Tentative Translation

# JST-Mirai Program

## (Small start Type / Large-scale Type)

FY2018

Application Guideline

Solicitation Period

Tue., June 12, 2018– Tue., July 31, 2018 at 12:00 noon

Japan Science and Technology Agency（JST）

## <Solicitation and Selection Schedule>

| | |
|---|---|
| R&D proposal acceptance begins | Tue., June 12, 2018 |
| Briefings of Solicitation | Check the website below for updated information.<br>(NOTE: only in Japanese.)<br>http://www.jst.go.jp/mirai |
| Application deadline (Deadline for submitting applications through the e-Rad system) | Tue., July 31, 2018 at 12:00 noon (Japan time) *No delays accepted |

Application of proposal is implemented via e-Rad system (http://www.e-rad.go.jp/). Researchers who do not have an e-Rad login ID and password should immediately complete the researcher registration procedure. As the application deadline approaches, heavy demands on the e-Rad system could slow the application process and even cause the application deadline to be missed. Please give yourself enough time to complete submission of proposal.

**No proposal for which the application procedure has not been completed via e-Rad by the deadline is subject to examination for any reason.**

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|---|---|
| Document screening period | Late August to Mid-September |
| Interview screening period | Mid-September to Early October |
| Notification/announcement of selected Proposals | Mid-November |
| R&D project begins | After Mid-November |

* The dates are expected dates. They are subject to change.
* As soon as it is determined, the document screening and the interview selection schedule will be announced on the website shown below:
  http://www.jst.go.jp/mirai/jp/application/research/
* The result of selection will be notified by document after all selection process is over. During the selection period, we will not notify about non-adopted proposals.

# ＜R&D Areas for which Proposals will be Solicited＞

Under the Application Guideline, JST-Mirai program will invite R&D proposals as follows.

**Period for submitting proposals :**

**Tue., June 12, 2018 – Tue., July 31, 2018 at 12:00 noon (No delays accepted)**

**No proposal for which the application procedure has not been completed via e-Rad by the deadline is subject to examination for any reason.**

**Only one application may be submitted across all prioritized themes and technology themes of the small start type and the large-scale type in R&D Proposal Applications.**

| R&D Type | R&D Areas for which Proposals will be Solicited |
|---|---|
| **Small start Type (Feasibility Study)** | **“Realization of a Super Smart Society (Society 5.0)” area**<br>(R&D Supervisor (Program Officer; PO): Akira MAEDA)<br>1. Building a service platform for creation of new services by collaboration and cooperation of various components<br>2. Modelling and AI for Integration of Cyber and Physical World |
| | **“Realization of a Sustainable Society” area**<br>(R&D Supervisor (PO): Hideyo KUNIEDA)<br>1. Innovation in manufacturing for new process of sustainable resource recycle<br>2. Improving intellectual capability to enhance “a Socially Active Life” for overcoming the reducing labor force<br>3. Creation of innovative food production technologies in response to environmental changes in the future |
| | **“Realization of the most Safe and Secure Society in the world” area**<br>(R&D Supervisor (PO): Ken-ichi TANAKA)<br>1. Development of the crisis navigator for individuals<br>2. Creation of "humane service" industries<br>3. Realization of a safe, secured, and comfortable town by removing a slight amount of hazardous substances hiding in living environments |
| | **“Realization of a Low Carbon Society, a global issue” area**<br>(R&D Supervisor (PO): Kazuhito HASHIMOTO)<br><br>Realization of a low carbon society through game changing technologies |

| | |
|---|---|
| | **“Common Platform Technology, Facilities, and Equipment” area**<br>(R&D Supervisor (PO): Nobuyuki Osakabe)<br><br>Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products |
| **Large-scale Type** | (R&D Supervisor (PO): Yoshio HAYASHI)<br>1. Ultrahigh precision time measurement technologies leading to a new time-business<br>2. Development of innovative adhesion technologies for realizing Society5.0<br>3. Innovative Hydrogen liquefaction technologies desired in future society |

## <Public Briefing Session>

Public briefing sessions will be held. Please refer to following website.
http://www.jst.go.jp/mirai/jp/

Contents

# Chapter 1

# Introduction:

# Invitation to Submit R&D Proposals

## 1.1 Overview of JST-Mirai Program

Today, new knowledge and ideas can have a great influence on the international competitiveness of organizations and nations. It is important to boldly attempt new experimentation and promote high-risk and high-impact research and development (R&D) that will yield important innovations. The Fifth Science and Technology Basic Plan states that “Japan will popularize and disseminate suitable methods for promoting challenging” in the R&D projects conducted by government ministries. Japan demands the large-scale promotion of new, profitable creations that can assist in the building of future industries and in reforming society; specifically, it is seeking the “realizing a world-leading super-smart society (Society 5.0).”

In response to the goals mentioned above, JST will commence the JST-Mirai program during the 2018 fiscal year.

By considering social and industrial needs (including potential needs), this program will set technologically challenging goals with clear targets (exits) designed to produce beneficial economic and social impacts. In an attempt to reach a stage (proof of concept: POC) where application feasibility may be judged, the R&D for prospective projects will take advantage of promising results produced by prior programs such as “Strategic Basic Research Program” and “Grants-in-Aid for Scientific Research”. This R&D will adopt operation practices that allow innovative ideas to be readily incorporated and rapidly, flexibly, and swiftly brought to commercialization.

The JST-Mirai program facilitates projects of two different approaches: “Small start Type” and “Large-scale Type”.

In small-start projects, R&D, in principle, proceeds stepwise from a feasibility study to full-scale research. To evaluate the feasibility of the ideas proposed, feasibility studies will adopt the small-start method[1] and incorporate many innovative ideas through calls. R&D themes will be called for in the areas[2] stipulated by the Ministry of Education, Culture, Sports, Science and Technology and along with the “prioritized themes” JST has chosen.

The large-scale type involves collecting and analyzing information on science and technology innovations and changes in existing technology systems. Investment will be concentrated towards R&D projects that relate to “technology themes” that have been judged by Ministry of Education, Culture, Sports, Science and Technology as important for forming bases for future technologies.

The JST-Mirai program applies a stage-gate method[3]. When considering small-start projects, R&D projects that can transition from feasibility study to full-scale research will be prioritized and invested in. Similarly, through narrowing down the research projects currently underway, the most suitable R&D projects will be chosen for concentrated investment. It should also be noted that large-scale type projects require the sourcing of private funds and investment during the R&D phase to facilitate investment of private funds.

Note 1: The small-start method: A system for adopting a large number of R&D projects despite relatively little funding being available at the time of adoption.
Note 2: Area: “Area selected when setting prioritized themes(divisions).”
Note 3: Stage-gate method: A system in which R&D is divided into a number of stages, with an evaluation conducted at each stage to decide whether to continue with the project or cancel it.

## 1.2 Purpose and characteristics of JST-Mirai program

The rapid development of digital technologies combined with progress in open innovation has forced the global structure of the creation of innovation to undergo great changes. Society and industries are at a great turning point in Japan. In the era of the great reformation that is now in progress, the JST-Mirai program sets a goal for “what research Japan should conduct and what strategic research Japan should strengthen in a style of challenging innovation creation to keep yielding new values.”

JST takes into account such social and industrial issues and the creation of new industries to connect the government, universities, and industries in a wide range of fields from basic research to application, challenge technologically extremely difficult research for a presently unclear market, and manage JST-Mirai program while being intensely conscious of permitting failures and teaming up with you to succeed in the realization of an “innovative eco-system” that keeps creating innovation.

## 1.3 Important matters of the JST-Mirai program and characteristics of its management

### (1) Focus on “new value” creation by R&D that meets the purpose of prioritized themes and technology themes

- Concrete forms of values that the society seeks

  The JST-Mirai program depicts a future society to practice back cast type R&D to realize science and technology for society.

  This project takes two approaches to define an image to be sought as a new value for society.

  One is an approach (the Small start type) for JST to define new values (prioritized themes) the society and industries seek through “calling for theme proposals”* by taking into account areas set by the Ministry of Education, Culture, Sports, Science, and Technology.

  The other one is an approach (the Large-scale type) through which the Ministry can collect and analyze information about science and technology innovations, alter the existing technology system, and specify technologies (technology themes) to be future base technologies.

  R&D in this program is performed to realize the prioritized/technology themes.

  *Calling for theme proposals:
  This project took the approach of calling for a wide range of proposals about the future image to be realized by science and technology (continuing throughout the year). Prioritized themes to calls for proposals were examined through calling for proposals until April,4,2018.

- Themes for attempting various mergers

  Prioritized themes and technology themes are yielded through the examination of various values that society and industries seek. Therefore, the themes are set to encourage collaboration and cooperation among various organizations and researchers

to merge science and humanity fields. The themes are also set to keep in mind the social implementation of realized values and to solve complex issues.

R&D proposals for this project that take into account these points are called for.

- R&D promotion by R&D supervisor

"Chapter V, Prioritized themes and technology themes to call for proposals" explains an outline of prioritized themes and technology themes and the R&D supervisor's policies for calling for proposals and selecting and managing them. Take into account the outlines and messages to prepare a proposal for this project. Base technologies common to measurements and determinations may be proposed for any prioritized theme.

The R&D supervisor aims for early completion of an R&D portfolio for each area and prioritized theme and makes announcements as necessary for public calls.

## (2) Duties and expectations for the Principal Investigator and R&D institution

- Expectation for setting the POC toward the realization of excellent ideas and values

The JST-Mirai program conducts R&D for reaching "a stage where application feasibility (proof of concept: POC) may be judged" that is necessary to realize prioritized themes and technology themes. The POC is set as a point for solutions based on core social and industrial problems for realizing prioritized themes and technology themes. The POC is set on the basis of the activities of society and private firms to whom the POC is passed after it is attained, and on ideas for overlooking its ramifications.

The Small start type selects Principal Investigators (project leader: PL) across prioritized themes in each area under an R&D supervisor through public calling, and the PL promotes research. A PL promotes R&D based on original and challenging ideas under flexible management by the R&D supervisor. An active approach is expected that accurately grasps social and industrial needs to improve feasibility.

The large-scale type selects Principal Investigators (program manager: PM) through public calling who have excellent ideas and are boldly given authority. A PL, as an R&D producer, chooses researchers. She/he is expected to recruit top-level knowledge in Japan.

The Principal Investigator takes into account prior evaluation and coordination with an R&D supervisor to set the POC (and milestones) and conduct R&D to aim to achieve it. During R&D, the Principal Investigator may flexibly review an R&D plan and form a team (including public calling for proposals) upon approval of the R&D plan by the R&D supervisor.

- Improving support systems

The R&D organization is requested to provide proper support for the promotion of R&D, for example, dispatching aides to assist R&D management by an Principal Investigator; setting up an intellectual property management committee associated with the creation, protection, and utilization of intellectual properties (see "(4) promotion and maintenance of collaboration between industries and academia" here); and supporting collaboration among R&D organizations. JST also cooperates in building

a support system.

- Positive participation and achievement of young researchers

We recommend a study with creativity rich in a challenge and expect a match with the learning field and the diversity various for literature and science, the age and a gender in particular. Therefore, in view of much of the researcher who gave excellent study results worldwide doing the study which becomes a basis of the outcome young time. Positive participation and achievement of the excellent researcher of the young people who will carry the future of science and technology of our country are recommended. It's recommended that researchers of the young people of industry-university-government work on management of research and development as a representative of research and development personally. It's assumed that JST also does the support which is management training of research and development as the need arises. We're waiting for many R&D proposals from young generation more than ever. Who have innovative and excellent ideas and techniques. We hope that R&D principal investigator will actively participate young researchers who have innovative and excellent ideas and techniques.

- Changing Principal Investigators

Challenging and highly creative research is encouraged. Approaches are expected that possess diversity in the fields of science and humanities, generation, and gender. It is also considered necessary to allow dynamic changes in the priority of R&D contents in the integrated management of basic and applied research during a set period for realizing values that the society and industries seek, or achieving their social implementation.

To put those into effective practice, the Small start type allows changes of Principal Investigators (Project Leader; PL). Sharing roles with aides is also presumed to be a form of practice. Continuous management by an Principal Investigator (Program Manager; PM) is a principle for the large-scale type. However, changing PMs is also allowed at a proper time during an R&D period, if there is a reason that R&D is to continue, under the condition that inducing private fund investment and a plan to lead to development after the POC, and a viewpoint of human resource development are taken into account for securing the continuation and development of the initial ideas. An R&D management committee decides PM changes upon receiving advice from an R&D supervisor.

## (3) Flexible and “thorough” R&D

- Spiral and flexible research promotion

The JST-Mirai program allows a “spiral model” of R&D in addition to that of a “linear model” that presumes reaching the POC from the seeds of basic research to applied research. For example, it allows timely responses, such as basic research conducted for solving issues appearing during R&D and a team for it to be formed (including public calling), new technologies and findings to be introduced, society and industries to respond to constantly changing needs, the results of some R&D to spin out, and collaboration with other organizations and ELSI to be responded to.

To improve the likelihood of reaching the POC and maximize results for any approach, R&D supervisors and JST staff examine progress in detail in addition to staging gate

evaluations to perform intense management.

● Stage gate implementation

The JST-Mirai program performs a “stage gate evaluation” during the R&D period, which is a strict evaluation for judging whether to continue or revoke R&D from the viewpoint of the likelihood of reaching the POC. Papers and patents are utilized as evidence for judging the feasibility of reaching the POC.

The Small start type has decided to adopt many small start R&D projects that have relatively small R&D budgets and aim to verify research plans, necessary technology, and research elements toward meeting the requirements for carrying out full-scale research (small starts), and prioritizing projects that have passed the stage gate evaluation as large-scale research (stage up).

Concerning projects that do not reach the stage up but can contribute to other projects for reaching the POC and the component research and technologies, the Small start type may take into account the encouragement of challenging and highly original research to attempt to merge with other projects or utilize them as component research.

The Small start type may also continuously survey and examine the potential of component research and technologies that are likely to make important contributions to the realization of prioritized themes in the future.

The large-scale type performs a first stage gate evaluation of approximately three years of R&D initiation, when the introduction of private funds is requested for subsequent R&D activities from the viewpoint of inducing private fund investment. Be sure to see “3.1.2(9), Stage gate evaluation” for the stage gate evaluation of the large-scale type.

The likelihood of reaching the POC is improved by research and its results through these approaches and an attempt is made to accelerate R&D toward social implementation.

## (4) Promoting Industry-Academia Collaboration

● Basic policies set out for managing intellectual properties

The JST-Mirai program has decided to connect R&D results to values for economic and social impacts in order to obtain secure and effective rights for the results in order to maintain reliability and superiority.

For this purpose, JST sets out basic policies common to this project, “Basic policies for the management of intellectual properties,” to attempt to integrate activities for R&D and intellectual properties and encourage the preparation of integrated policies for obtaining rights, announcement, non-disclosure, and utilization of results.

Principal Investigators need to establish the mutual agreement “Treaty of mutually owned intellectual properties,” which complies with the basic policies agreed with participating organizations and researchers. The treaty of mutually owned intellectual properties needs to be submitted to JST and the R&D supervisor within a certain period of time of research initiation and its review results will be used to judge whether R&D should be conducted.

Promotion of R&D based on basic policies is expected to strengthen collaboration and bridging with society and industries.

The basic policies are provided separately. See below for contents and details.

http://www.jst.go.jp/mirai/jp/uploads/chizaihoshin29.pdf

## 1.4 Management system for the JST-Mirai program

The PD (program director) supervises the whole JST-Mirai program for overall, and POs (program officer, R&D supervisor) are in charge of R&D area management (illustration below).

The “Program supervisors committee for the JST-Mirai program” has been set up as a supreme organization for managing the JST-Mirai program. The PD chairs the program supervisors committee, in which outside experts and JST executive director in charge participate as committee members.

The program supervisors committee reviews important management matters for the JST-Mirai program: it decides on the important policies of the program, sets prioritized themes, coordinates cross-disciplinary matters including budgets, selects project candidates for adoption as prioritized themes and technology themes, and decides whether to continue or to revoke projects on the basis of stage gate evaluations.

Each R&D supervisor(PO), who chairs the committee, her/his aides, outside gurus, and JST staff participate in an R&D management committee as committee members. This committee sets prioritized theme candidates (only the Small start type), selects candidate projects for adoption, instructs and manages R&D projects, through site-visit, and performs stage gate evaluations. An R&D supervisor(PO) also increases or decreases the amount of R&D budgets, merges projects, and revokes projects through evaluation.


Fig. Organization of JST-Mirai program

## 1.5 New matter from this fiscal year

New matters from this fiscal year is as follows. For details, refer to each items in each chapter.

- Small start Type（5.1”Small start Type” and 5.1.5“Common Platform Technology, Facilities, and Equipment” area）
- Feasibility Study (component technology type) is introduced some Small start Type Feasibility studies.（2.1.2 (1)”Mechanism of Small start type”）
- Positive participation and achievement of young researchers
  （1.3 (2) “Duties and expectations for the Principal Investigator and R&D institution”）

## 1.6 For Researchers Considering Applying for /Participating in the Program (reference)

### 1.6.1 Contribution to achieving Sustainable Development Goals (SDGs)

**JST contributes to achieving sustainable development goals (SDGs)**

The "Sustainable Development Summit of the United Nations," held in September 2015, unanimously adopted a resulting document, the "**Transforming our world: the 2030 Agenda for Sustainable Development**" centered Sustainable Development Goals (SDGs) as a more comprehensive and new goal for globally common actions for humans, the earth, and prosperity. JST takes into account science and technology innovations that are indispensable for achieving SDGs to actively make contributions through the management of the projects.

Michinari HAMAGUCHI
President, Japan Science and Technology Agency (JST)

*See the website below for Sustainable Development Goals and JST's approaches:
http://www.jst.go.jp/pr/intro/sdgs/index.html

## 1.6.2 Promotion of Diversity

### JST Promotes Diversity!

The diversity is essential requisite for promotion of scientific and technological innovations. It is possible to open a new perspective of science and technology by the collaboration and discussion with various stakeholders having different specialties and values, irrespective of gender and nationality.

JST is, by promoting advances in diversity in its all activities in science and technology, undertaking possible problems of our future society, contributing to the strengthening of industrial competing power of Japan as well as to the enrichment of spiritual happiness of people. Our activities in this field accord with the “Sustainable Development Goals (SDGs)” agenda of the United Nations, in which goals relevant to diversity advancement are shown, including gender equality, contributing to efforts on our domestic problems but also to those on problems common to various countries.

Currently, the activity of woman is being positioned at the core of the Growth Strategy of the Japanese Government, being started as “the largest potential of Japan” in the strategy paper. Expending the participation of woman researchers in research projects is substantially important for advancing research and development, as they are a party of various researchers supporting science and technology innovations. JST is expecting that woman researchers would take this opportunity, positively and will apply to our Strategic Basic Research Programs, actively. JST is undertaking the improvement of our “Childbirth, Child-raising, Nursing Care Support System”, to constantly, based on the voice of the system users, creating environments enabling a researcher on leave to return his/her research, for example.

The call for and review of research proposals will be conducted also from a viewpoint of advancing diversity. Our dear researchers, we cordially invite you to the call for research proposals of the Strategic Basic Research Programs.

Michinari HAMAGUCHI
President, Japan Science & Technology Agency (JST)

### We Are Waiting for Your Application!

JST is promoting diversity in research, based on our perspective that the diversity is for understanding of other researchers having ideas different from yours, and for creation of new values by combining your and their ideas. The diversity thus has potentials to give solutions not only to the domestic problems but also to problems common in all nations across the world. Therefore, JST is undertaking the societal problem of the globe such as the Sustainable Development Goals (SDGs), through the promotion of diversity in research, collaborating with foreign institutions.

JST is promoting the diversity by ensuring the activities of women researchers, of course young researchers, and foreign researchers having foreign citizenship. To ensure that each researcher is fully able to exercise his/her skills, JST is providing continual supports for childbirth, childcare, and homecare of elderly relatives, and also endeavoring to maintaining a balanced membership composition in committees and alike. JST especially welcomes the application of women researches to our program, from whom we cannot have so many research proposals in previous years, to realize environments where various kinds of researcher can work, cooperating and competing with each other. Through these activities, JST is pursuing the creation of new values.

We are sincerely waiting for your active applications, especially those form woman researchers.

Miyoko WATANABE
Deputy Executive Director and Director of Office for Diversity and Inclusion
Department of Personnel, Japan Science and Technology Agency (JST)

## 1.6.3 About responses to life events

JST is implementing supportive measures for assisting researchers to achieve balance between their research work and life events (gender equality expenses assistance that can be used to advance the R&D being carried out by the researcher in question or to reduce their financial burden) with the aim of enabling researchers to continue their R&D work without interrupting their careers due to a life event (childbirth, child-raising, nursing of elderly relatives, etc.) or in the case that the researcher must put their career on hold temporarily, enabling them to resume their R&D activities as soon as it becomes possible for them to do so and continue their career from that point onwards. JST also presents role models for female scientists. For details, please refer to the websites below.

JST's Diversity Activities http://www.jst.go.jp/diversity/research/index.html

### 1.6.4 Promotion of dialogue and collaboration with the public

Concerning the bilateral communication activities with the public, based on the decision (titled “Concerning the Promotion of Dialogue on Science and Technology With the Public, a Basic Approach Policy”) of the Minister in charge of science and technology policies and diet members with expert knowledge on June 19, 1010, it is considered essential for a research and development project, which has been provided with a minimum of JPY 30 million per year of public research fund (competitive or project research fund), to fulfill the following objectives: 1) achieve continued excellent results in the field of science and technology “scientific and technological dialogue with the public;” 2) obtain the public’s understanding and support; 3) maintain a standpoint on promoting science and technology jointly with the public; and 4) return the achievements in the development of science and technology to the public for the further development of the field in Japan. In addition, the Fifth-term Basic Plan for Science and Technology, as decided by the cabinet on January 22, 1016, requests the deepening of relationship for dialogue and collaboration among various stakeholders, such as researchers, the public, media, industries, and policy makers. Such relationship is considered as a “joint creation,” and is contrary to the conventional relationship in which science and technology and society stand opposite each other. From these viewpoints, an approach is requested to explain the contents and achievements of research activities to society and the public in the most widely understandable manner possible. To this end, researchers are requested to actively undertake the continual releases of research achievements, through lectures, symposia, and the internet, and full activities involving the participation of diverse stakeholders in a roundtable process.

(Reference) Concerning the “Promotion of Dialogue on Science and Technology With the Public, a Basic Approach Policy”:
http://www8.cao.go.jp/cstp/output/20100619taiwa.pdf

(Reference) Concerning the “Fifth-term Basic Plan for Science and Technology”:
http://www8.cao.go.jp/cstp/kihonkeikaku/5honbun.pdf

### 1.6.5 Open Access and Data Management Plan

JST announced the basic policies for handling research achievements toward the promotion of open science in April 2017. The policies stipulate the basic concepts for allowing one's access to papers on research achievements and archiving, as well as on managing and disclosing research data.

In principle, researchers participating in this program are mandated to produce documents on research achievements available to the public via the repository organizations or publications for open access. Researchers, whose proposals have been adopted in the newly set research areas after the 2016 fiscal year, are also requested to prepare a data management plan. This plan will contain details on policies and plans for archiving, managing, and publishing, or the non-disclosure of research data, which are developing as achievements. Researchers must also submit the plan, along with the research plan document to JST. It is also mandatory for them to undertake archiving, managing, and publication of research data based on this plan.

Please see the following for details:

- JST's basic policies for handling research achievements toward an open science promotion
  http://www.jst.go.jp/pr/intro/openscience/policy_openscience.pdf
- Guideline of the JST's basic policies for handling research achievements toward an open science promotion
  http://www.jst.go.jp/pr/intro/openscience/guideline_openscience.pdf

### 1.6.6 Registration at researchmap

JST-Mirai program plans to utilize a database operated by JST for researcher information (researchmap*). This database is a master database on achievement information in various scenes, including achievement reports in the future. In addition, a community function of researchmap will be used in project operation to distribute various files and event guides. For that, it is essential for the Principal Investigator and Lead Joint Researcher of an adopted R&D project at researchmap. Those who have not yet registered are recommended to register as soon as possible.

The information registered in researchmap is utilized effectively for surveying national plans on academic, science and technology or statistical use purposes. Registration at researchmap and updating of achievement information are requested.

Please confirm the specific registration method, "6.15 Regarding Registration with researchmap."

*Researchmap (the obsolete designation was Read&Research http://researchmap.jp/) is the largest Japanese database of researcher information to partially look at Japanese researchers nationwide. As of Feburary 2018, approximately 264,000 researchers are registered.

## 1.6.7 Towards the Promotion of Fair Research

### Towards the Promotion of Fair Research

Recent incidents involving misconduct and dishonesty in research activities have resulted in an alarming situation that threatens the relationship of trust between science and society, and hinders the healthy development of scientific technologies. To prevent misconduct in research activities, there must be a function of autonomous self-purification in the scientific community. Each researcher must strictly adhere to strict discipline and work to create new knowledge and inventions that are useful for society, based on high moral standards that meet the expectations of society.

As a funding agency for research, the Japan Science and Technology Agency (JST) considers research misconduct to be a grave issue and makes every effort to prevent it in cooperation with relevant organizations, with the goal of regaining public trust.

1. JST believes that honesty in research activities is extremely important for Japan, which seeks to develop itself through science and technology.
2. JST supports honest and responsible research activities.
3. JST strictly condemns any misconduct in research activities.
4. JST will promote education in research ethics and reform its research funding programs in cooperation with relevant organizations, in order to prevent misconduct.

We must develop a healthy scientific culture based on social trust, so as to build a society filled with hopes and dreams for a bright future. We therefore request the continued understanding and cooperation of the research community and related institutions.

Michinari HAMAGUCHI
President, Japan Science & Technology Agency (JST)

JST takes the following measures in response to misconduct in research activities and inappropriate usage etc. of research funds. Researchers participating in the Strategic Basic Research Programs and their affiliated research institutions are asked to comply with these measures.

(Note) "Misconduct in research" means fabrication, falsification and plagiarism of data or results of survey published in research papers etc. caused by intent or a gross negligence of basic duty of care as a researcher in the course of research and development activities.
"Inappropriate usage" means usage of competitive research funds etc. according to a false invoice in research and development activities, for other purposes or in violation of laws and JST's proposal submission requirement, contract etc.
"Fraudulent receipt" means cases in which research is adopted as a subject for a research program through dishonesty or any other fraudulent means.
"Misconduct etc." means misconduct in research, inappropriate usage of fund and fraudulent receipt.

(1) Enrolling in Educational Programs on Research Integrity

JST requires as a condition of application for the program that the research project applicant has completed an educational program on research integrity (beginning with the Invitation for Research Proposals for FY2015).

In addition, in the case that the R&D proposal is accepted, the Research Director, Individual Researcher and participants in the research project are required to take a JST-designated e-learning program on research integrity.

For details regarding the above, please refer to “8.1 Enrolling in and Completing the Educational Programs on Research Integrity” and comply with the measures promptly.

(2) Measures Regarding the Inappropriate Usage of Research Funds

In the case of inappropriate usage of research funding provided under this program, the research project in question will be cancelled and all or part of the project’s research funding, etc. must be returned.

Furthermore, depending on the details of the misconduct, limitations may be placed on the eligibility of those involved to apply for or participate in these programs or other Ministry of Education, Culture, Sports, Science and Technology (MEXT) competitive funding systems, competitive funding systems allocated by independent administrative agencies under the auspices of MEXT (hereinafter referred to as “MEXT-related competitive funding systems”), or competitive funding allocated by independent administrative agencies under other ministries and agencies..

(3) Measures Regarding the Implementation of Research Funding Management/Auditing Systems and Responses to Misconduct at Research Institutions

Research institutions need to take responsibility, implementing a system for managing and auditing research funds, ensuring that research funding is spent appropriately, and taking measures against misconduct etc. including compliance education. Furthermore, in the case that an accusation of misconduct is leveled at a research institution, a prescribed investigation must be conducted and the findings reported to JST. In the case that the actions taken by the institution are found to be inadequate, funding for indirect costs may be reduced.

For details, please refer to “6.7 Regarding implementation of systems based on the “Guidelines of Management and Audit of Public Research Funds in Research Institutes (Implementation standards)””.

(4) Measures Regarding Misconduct in Research Activities

In the case that misconduct in research activities (fabrication, falsification, plagiarism, etc.) is discovered, the research project in question may be cancelled; all or part of the project’s research fund etc. returned, and measures taken to publicize the facts of the matter. Furthermore, depending on the details of the misconduct, limitations may be placed on the eligibility of those involved to apply for or participate in these programs or other MEXT-related or national government ministry competitive funding systems.

For details, please refer to “6.6 Regarding implementation of systems based on the “Guidelines for Responding to Misconduct in Research Activities””.

(References)

The above measures shall be implemented in accordance with these application guidelines and the contract research agreement concluded between the research institution in question and JST based on related national government guidelines. The main related national government guidelines are as follows.

- “Guidelines for the Appropriate Implementation of Competitive Research Funding” (decided by the Liaison Conference among Relevant Ministries on Competitive Funds on September 9, 2005; revised October 17, 2012)
- “Guidelines on Management and Audit of the Public Research Expenses in Research Institutions (Implementation standards)” (decided by the Minister of Education, Culture, Sports, Science and Technology on February 15, 2007; revised February 18, 2014)
- “Guidelines for Responding to Misconduct in Research Activities” (decided by the Minister of Education, Culture, Sports, Science and Technology on August 26, 2014)

# Chapter 2
# Small start Type

## 2.1 Concerning the small-start type

### 2.1.1 Outline of the Small start type

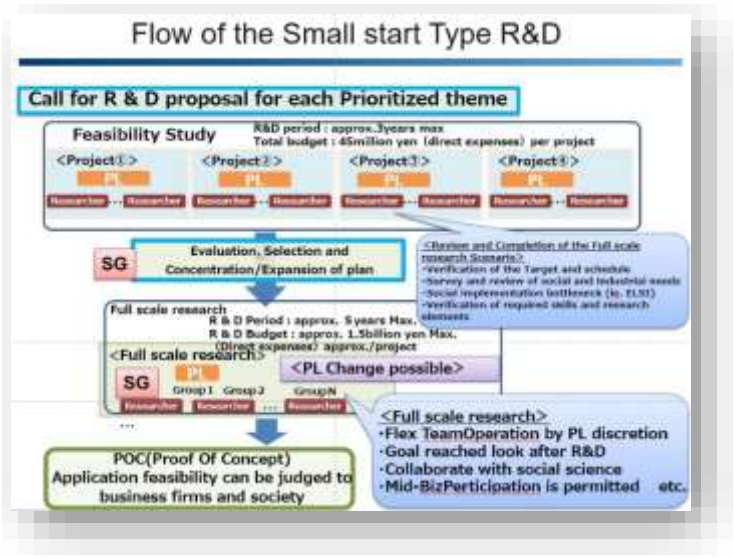
The JST-Mirai program has set images of the future society that can be achieved through developments in science and technology, or through creating new values sought by society and industries, as prioritized themes, and is requesting research ideas from researchers affiliated with universities, business firms, public research organizations, and select Principal Investigators (Project Leader: PL) (see Chapter V, “FY2018 Open Call Themes”).

**[Characteristics of Small start Type R&D]**

- The PL is affiliated with a university, business firm, or public research organization.
- R&D is pursued up to a stage (POC) where application feasibility can be judged, and then research results are actively submitted to business firms and society.
- The R&D proceeds stepwise, or from feasibility study to full-scale research (small-start method[1]). During the small-start stage, an R&D plan for full-scale research is examined in order to adequately judge the feasibility of the research idea before allowing the project to proceed towards full-scale research.
- A stage-gate method[2] is applied in order to narrow down R&D projects eligible for proceeding from the small-start stage to full-scale research and then becoming full-scale R&D projects. Then, optimum R&D projects are provided with concentrated investment.
- Small-start type R&D is conducted with a total R&D budget of approximately 45 million yen per project for a maximum period of three years, and full-scale research is conducted with a total R&D budget of two billion yen for a maximum period of five years.

(note 1) Small-start method: A mechanism for selecting a large number of projects despite a relatively small budget being available at the time of adoption
(the research scale is expanded when the research passes stage-gate evaluations).

(note 2) Stage-gate method: A system in which R&D is divided into a number of stages, with an evaluation conducted at each stage to decide whether to continue with the project or cancel it.



### 2.1.2 Mechanism of Small start type

### (1) Research for small-start projects (Feasibility study and Full scale research)

The small-start type adopts a small-start method. The PL conducts feasibility study and then advances to full scale research after passing a stage-gate evaluation.

We are requesting proposals for small-start-type R&D projects.

**Feasibility Study:**

During the research stage of a feasibility study(FS), the PL should examine a full-scale research plan (including topics such as: verifying component technologies necessary for conducting full scale research, verifying the social and economic impacts of POC, identifying the challenges for implementation into society, and creating a plan of necessary activities to be conducted after reaching POC) in order to judge the feasibility of conducting prospective full scale research.

Upon completion of feasibility study, JST performs stage-gate evaluations (specified by an R&D supervisor) to decide whether the research should be allowed to proceed to full-scale research or be cancelled. Depending on the judgement of the R&D supervisor, a number of R&D projects may be merged to form full-scale research projects.

**Feasibility Study (Component technology type):**

In addition to the proposals of research ideas for the transfer to full-scale research as described above, some of the prioritized themes invite the proposals of component technologies that contribute to achieving prioritized themes as the “Feasibility Study (Component technology type)”. We would like to ask the PL who performs the R&D of the “Feasibility Study (Component technology type)” to embark on the development of component technologies for introducing the results into a full-scale research to be conducted under this prioritized theme. Although a PL cannot receive a stage-gate evaluation for the transfer to full-scale research in principle, the PL may continue the R&D as the primary joint researcher under another PL conducting the full-scale research, when deemed necessary by the program officer. For such a purpose of the Component technology type, proposals of novel ideas by young researchers are expected.

The following is a prioritized theme requesting for the proposals of the “Feasibility Study (Component technology type)”:

Please ensure to check according to chapter V.

■”Realization of the safest and most secure society in the world” area
prioritized theme: “Development of the crisis navigator for individuals”

Please ensure to check according to chapter V.

■“Common Platform Technology, Facilities, and Equipment” area
All sub prioritized theme：Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products

（Target sub Theme ST01～09, except ST10）

For matters not specifically described in the application guidelines, Feasibility Study (Component technology type) will call for proposal, selected, and conducted research and development with the same treatment as in ordinary “Feasibility Study”.

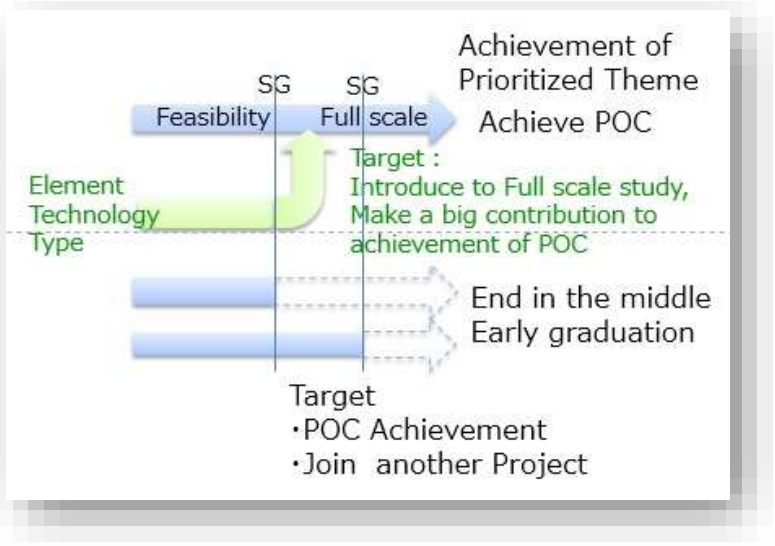



Fig.2 Image of the Small start Type research (Component Technology Type)

**Full scale research:**

The PL shall promote R&D activities toward achieving POC goals in consideration of the implementation of the results into society and its further development after completing R&D. Please see “4.1.3 Viewpoints for selection” for criteria for proposal selection (criteria for preliminary evaluation) and supplementary criteria for the selection of R&D proposals for the Feasibility Study.

## (2) R&D costs and periods

In principle, the total budget per project for small-start research is approximately 60 million yen (including indirect costs) and its maximum research period is approximately three years. Occasionally, customized R&D budgets and time periods are set for each prioritized theme. Be sure to see Chapter V before deciding on an R&D plan. JST pays R&D costs (direct costs) and indirect costs (a maximum of 30% of the direct costs) to the research organization on the basis of the R&D agreement made.

## (3) R&D system

We ask that the PL form an optimum R&D team composed of a number of researchers (a proposal may be submitted before the team is formed). In the case of “Feasibility Study (Component technology type)” proposal, individual research suggestions are also accepted.

a. The PL may establish a group (“joint research group”) consisting of researchers affiliated with other laboratories or research organizations, if necessary for realizing R&D ideas, in addition to a “PL group” composed of members of her/his own laboratory.
b. Representatives of the members of a “Joint Research group” are referred to as “Lead Joint

Researchers."

c. Depending on research progress, the PL is allowed to employ as many researchers and assistant researchers the budgeted R&D costs will allow (this budget is stipulated within the R&D agreement with the research organization) for participation in R&D.

See "2.2.5, Requirements for application" for requirements concerning research teams.

### 2.1.3 Flow of R&D promotion in small-start projects

(1) Seeking and selecting proposals for small-start projects

JST is recruiting R&D proposals for each prioritized theme in the area stipulated by the government. An R&D proposal of the small-start type, including a clear statement of the POC to be reached and the contents of full-scale research, should be submitted. The entire program shares information and collaborates to select projects for each prioritized theme.

However, in the case of a proposal for "Small start type research (Component technology type)", we will propose a research and development plan after clarifying the reason for contributing to the prioritized theme.

Members of the R&D management committee cooperate with the PL during the selection process (see "4.1.2, Selection procedure" and "4.1.3, Selection viewpoints" for details).

(2) Preparation of an R&D plan for an accepted proposal

The PL should prepare a full research plan representing the entire period of the accepted small-start research. The PL should also prepare an annual research plan for each year. The plans should contain research costs and detail the composition of the research team.

(3) Agreement

After adopting a proposal, JST, in principle, concludes an R&D agreement with the research organization that the PL and the main joint researchers are affiliated with.

(4) Executing research

In principle, research must be performed over two and a half years, from November 2018 to March 2021.

*A research budget and period are set for each prioritized theme. See "Chapter V, Prioritized themes and technology themes for which proposals are sought" before preparing an R&D plan.

(5) Evaluation

The R&D supervisor should determine the progress and results of research, receive cooperation from members of the R&D management committee, and make evaluations at stage gates and upon the completion of the R&D project.

<Evaluation of R&D projects>

a. The R&D supervisor should be able to gain an understanding of the progress and results of the R&D and should receive cooperation from members of the R&D management committee in order to be able to make evaluations concerning the transferring of small-start research to full-scale research (stage-gate evaluation). These evaluations will be conducted at stage gates of full-scale research, and upon its completion. Stage-gate evaluations are conducted in the third year of full-scale research and evaluations at completion are made as soon as the R&D is completed, or at a proper time before the completion, depending on the nature and progress of the R&D. R&D Projects of the "Small start Type research (Component technology type)" will carry out ex-post evaluation instead of evaluation for transition from feasibility study to full scale research (stage-gate evaluation).
b. In addition to the above, the R&D supervisor may evaluate R&D projects whenever she/he

judges it to be necessary.

c. Changes in coordination or resource distribution (increases or decreases in R&D costs and reviews of R&D group compositions) are reflected in the results of project evaluations. Depending on the evaluation results, R&D projects may be finished sooner (i.e., cancelled) or merged or integrated with other projects.

d. A certain period after the completion of R&D, a follow-up survey is conducted concerning the development and utilization of the R&D results and the activities of participating researchers. On the basis of these survey results, experts selected by JST perform a follow-up evaluation.

Besides evaluating of R&D projects, prioritized themes and R&D supervisors may also be evaluated. This evaluation is performed from the viewpoint of determining progress made towards achieving each theme and administrative performance. Selected Principal Investigators are requested to cooperate in the evaluation as appropriate.

## 2.2 Requesting and selecting small-start type research

### 2.2.1 R&D proposals sought

(1) R&D proposals concerning the six prioritized themes described in "Chapter V, Prioritized themes and technology themes for which proposals are sought" are requested

(2) Carefully read the policies of the R&D supervisor in charge of requesting and selecting proposals for each prioritized theme described in "Chapter V, Prioritized themes and technology themes for which proposals are sought," as this will allow you to make a R&D proposal that is suitable for the prioritized theme.

(3) Be sure to see the description of important common provisions contained in "Chapter IV, Common provisions for small-start research and large-scale projects."

### 2.2.2 Period for submitting proposals

**Tue., June 12, 2018 – Tue., July 31, 2018 at 12:00 noon (No delays accepted)**

Please see "main schedule" on the opening page for details of the schedules for briefings and selection.

Proposals for which, for any reason, the registration procedure is not completed on e-Rad by the deadline will not be accepted for examination.

### 2.2.3 Number of project proposals for adoption

The number of proposals to be adopted for each prioritized theme is 2–15.
(This can vary depending on the objective of each prioritized theme, status of proposal applications, and budget.)

### 2.2.4 Special treatment upon adoption

(1) Concerning possible coordination of areas and prioritized themes

For each prioritized theme included in the selection process, a project supervisor or an R&D supervisor may conduct interdisciplinary coordination of the related R&D proposals.

Consequently, a proposal made under a particular prioritized theme may be transferred to another prioritized theme. In such a case, a notice is sent to the proposer once this decision has been made.

(2) Concerning surveys on specific projects

A "specific project survey" may only be conducted on themes in order to attract proposals during this and the next submission window. Concerning the R&D proposals, for which small budgets are required, research data can be supplemented over short periods, and accurate evaluations may be expected when applied on and after the next recruitment, the R&D supervisor may request the R&D proposer to perform a specific project survey separately from the adopted project.

A prerequisite for a specific project survey is, in principle, a re-application made under the pertinent prioritized theme and by the deadline specified by the R&D supervisor. In such a case, the application is handled in the same way as other R&D projects; no priority is given. Further, no direct application is allowed for the specific project survey.

### 2.2.5 Requirements for application

Requirements for application are the following (1) – (3):

Be aware of the following, which relates to application requirements.

- R&D proposals that do not meet application requirements are, in principle, neither accepted nor adopted.
- Application requirements must be maintained throughout the entirety of the research project's duration, if adopted.

In principle, if the requirements cease to be maintained during the research period, the entire, or part of the, research project is cancelled (finished early).

In addition to (1) – (3) below, an application should only be made once you have gained an appropriate understanding of the contents of "4.1.1, Concerning restrictions on duplicate applications for the JST-Mirai program."

(1) Requirements for proposers

a. A research proposer, upon becoming a Principal Investigator, forms a research team from members of a domestic research organization (such as a private firm, an incorporated association, or an incorporated foundation) she/he is affiliated with in Japan (the proposer may be of any nationality).

   *The following individuals may also apply to be research proposers:

   - A researcher who is a foreigner and affiliated with a Japanese research organization.
   - A researcher who is not affiliated with any specific research organization or with an overseas research organization but who can work with a Japanese research organization to form a R&D team if adopted as a Principal Investigator (any nationality is acceptable).

b. A researcher who can undertake duties for an entire R&D project, functioning as a representative of a R&D team throughout a R&D period.
   (see "4.2.4 Responsibilities of Principal Investigator, Lead Joint Researchers after approval" for details).

c. A researcher who has completed a research ethics education program at the research organization she/he is affiliated with. (see "6.1 Enrolling in and Completing the Educational

Program for Research Integrity" for details).

d. A researcher who can pledge to observe the following four points:
   - That they understand and comply with "Guidelines for responding to inappropriate behavior during research activity" (a decision made by Minister of Education, Culture, Sports, Science and Technology, August 26, 2016)
   - That they understand and comply with "Guidelines for managing and auditing public research funds in research organizations (practice criteria) (revised on February 18, 2016)"
   - That they, as Principal Investigator and R&D participants, will refrain from participating in inappropriate conduct (fabrication, fraudulent alteration, fraudulent use) in regard to research activities, or inappropriate use of research funding, if their R&D proposal is adopted.
   - That they have no record of previous inappropriate research activity; this should be included in the proposal for full-scale research.
     (confirmation of this is required on the information input screen on e-Rad.)

(2) Requirements for research teams

The following requirements must be met.

a. A research team is an optimum system for realizing the idea of the R&D proposer, who will gain the position of Principal Investigator once the proposal is accepted.
b. A joint research group within a research team is necessary and essential for the realization of research ideas and can substantially contribute to achieving research goals.
c. If an overseas research organization participates as a joint research group (such as in a case where a researcher affiliated with an overseas research organization participates as a main joint researcher), it can be difficult to conduct research on realizing the research idea without input from the overseas organization (receiving such input requires approval from the R&D supervisor). In such a case, it should be possible to obtain results, such as intellectual property rights.

*When including an overseas research organization in a research team, describe in the R&D plan (form 3) for the R&D proposal the reason a researcher affiliated with an overseas research organization is required. Further, the overseas research organization must sign a contract agreeing to the proposed content stipulated by JST (maximum indirect costs is 30% of direct costs). Before the interview for proposal selection, submit the specified form (to be outlined later) that shows prior approval from a person in charge of contracts for the overseas research organization.

(3) Requirements for research organizations

Research organizations must fully recognize that the original funding for R&D agreements is sourced from public funds, and they should make efforts to conduct their research efficiently, as well as to comply with associated laws. Any research organization that cannot perform the duties described in "4.2.5 Responsibilities of R&D Institutions " will not be approved to conduct research. Therefore, be sure to obtain prior approval from the R&D organization at which you plan to conduct your R&D before submitting an application.

## 2.3 R&D proposal (Form) & Completion Requirements

The format of R&D proposal differs in Feasibility Study (2.3.1) and Feasibility Study (Component technology type) (2.3.2). Download and use the proposal forms for “small-start type” provided on e-Rad or JST Website (http://www.jst.go.jp/mirai/jp/open-call/research/h30). Be sure to comply with “Chapter 5, FY2018 Open Call Themes” when preparing proposal forms.

Conditions for applications may vary by prioritized theme.

The following is a prioritized theme requesting for the proposals of the “Feasibility Study Small start Type research (Component technology type)”:

■”Realization of the safest and most secure society in the world” area
prioritized theme: “Development of the crisis navigator for individuals”

Please ensure to check according to chapter V.

■“Common Platform Technology, Facilities, and Equipment” area
All sub prioritized theme：Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products
（Target sub Theme ST01～09, except ST10）

About these prioritized theme refer to「2.3.2 “Feasibility Study (Component technology type)” R&D proposal(Form) Completion Requirements.

Other prioritized themes refer to、「2.3.1 “Feasibility Study” R&D proposal (Form) Completion Requirements

In cooperation with the coordinator, when considering the problem, please state the opinion of the coordinator as far as possible. Submitting a proposal separate sheet(from download website http://www.jst.go.jp/mirai/jp/open-call/research/h30/) is optional and not mandatory. (except Feasibility Study (Component technology type))

### 2.3.1 “Feasibility Study” R&D proposal (Form) Completion Requirements

A list of the forms to be submitted is shown below. To appropriately prepare an R&D proposal, follow the guidelines provided on the next page onward concerning completing such forms. Be sure to use the forms stipulated for this fiscal year.

| Form No. | Document |
|---|---|
| Form 1 | R&D proposal, cover |
| Form 2 | R&D Project Description |
| Form 3 | R&D plan of Feasibility Study |
| Form 4 | R&D Budget |
| Form 5 | R&D Project Applicant (Project Leader) |
| Form 6 | Other Support |
| Form 7 | Measures for Protecting Civil Rights and Complying with Laws and Regulations |
| Form 8 | References |
| Extra form (optional) | View of the person promotes cooperation of academia and industry like coordinator or the person in charge of the company |

*Ensure the file does not exceed 3MB.

*Be sure to familiarize yourself with the definition of a stakeholder provided in “Chapter 4, 4.1.2, Selection method” (2) when preparing proposal forms.

*See “Chapter 7, Submission via the Cross-ministerial R&D Management System (e-Rad)” for application methods for R&D proposals.

*Be sure you have an appropriate understanding of “Chapter 6, Key Points in Submitting Proposals” and “Chapter4, 4.1.1, Concerning restrictions on duplicate applications for the JST-Mirai program” before making an application.

# (Form 1)
# R&D proposal "Small start Type" called for in FY2018, Cover

| | |
|---|---|
| Prioritized theme | *※In the "Realization of a low carbon society, a global issue" area, please describe the prioritized theme, subtheme number, classification of proposals, and bottleneck issue.*<br>*※In the "Common Platform Technology, Facilities, and Equipment" area, please describe the prioritized theme, classification of proposals, and subtheme.* |
| Title of R&D project | |
| R&D period<br>*※(1) = (2) + (3)* | (1) Total period: Month, 2018 – Month, Year ( years) |
| | (2) Feasibility study: Month, 2018- Month, Year ( years) |
| | (3) R&D project: Month, Year – Month, Year ( years) |
| R&D Budget<br>*※(1) = (2) + (3)*<br>*Omit decimal point* | (1) Total R&D budget for whole period ( million yen) |
| | (2) Total R&D budget for feasibility study ( million yen) |
| | (3) Total R&D budget for R&D project ( million yen) |

| | | |
|---|---|---|
| Name of R&D Project Leader | Initial | |
| | Last | *※same as above if same Principal Investigator* |
| Affiliated Institution, Department, Title | | |
| Effort for this FY | This fiscal year: ____% | |
| Conflicts of interest with PO<br>*※check* | Conflict of interest with R&D supervisor (PO): ☐ Yes ☐ No<br>*※If "Yes", describe contents in Form 3 "6. other"* | |
| Researcher number | *※Enter the 8-digit "e-Rad" login ID number which is provided by registering researcher information on the Cross-ministerial Research and Development Management System (e-Rad)* | |
| Information on Project Leader | URL:<br>author ID:<br>*※URL if website (lab website, researchmap page) available for information on Project Leader, or ID if ORCHID ID, Researcher ID, or SCOPUS author ID is known* | |

# (Form 2)
# R&D Project Description

*※Delete guidelines in blue letters when completing this form.*
*※Be sure to check the policies of the R&D supervisors for each area, which are described in the application information. See "4.1.3, Viewpoints for selection" and "Chapter V, Prioritized themes and technology themes for which proposals are sought."*

## 1. POC to be achieved by this R&D project

*※Provide simple and clear descriptions of the POC to be reached by these R&D projects during the small-start-type research phase and the full-scale research phase. POC is neither an outline nor purpose of the research.*

## 2. Reasons for setting the particular POC

*※Take into account the following when describing why you set a particular POC as a goal:*
- *What are the social and industrial problems relating to the prioritized theme for which immediate actions should be made to determine a solution? Also provide how and why these problems were chosen.*
- *Values, i.e. social and economic impacts, that are believed to create both in Japan and overseas when these problems were solved (social implementation of technologies that allow the POC to be reached)*

*※Prepare a separate compact summary of the contents of "1. POC to be reached by these R&D projects" and this description, not exceeding 300 words, and include this summary in the "research objective" section of "common provisions" on e-Rad.*

## 3. Measures necessary for reaching POC

*※Clearly describe the background and any problems that may hinder you in reaching the stipulated POC. Describe necessary measures that will be taken toward realizing the POC during both the small-start-type research phase and the full-scale research phase. Also, describe the originality, inherent challenges, and effectiveness of your proposal.*
*※If possible, describe ideas for developing the research results beyond the POC (business model, distribution to private firms) and their social implementation (optional). (These can be subjects approached during research into the small-start-type, even if they are not yet concrete ideas. In such a case, describe the preparatory situation using form 3.1).*
*※In the case of a proposal relating to the "realization of a low carbon society, a global issue" area, quantitatively show the degree to which the technology projects to be approached will contribute to the realization of a low carbon society by approximately 2050.*

*- Do not exceed two A4-size sheets (no exceptions) -*

# (Form 3)
# R&D plan of Feasibility Study

*※Delete guidelines in blue letters when completing this form.*

## 1. Preparatory situation at the beginning of full-scale research

*※Provide a concrete description of the following, including the preparatory situation for full-scale research and R&D trends in Japan and overseas.*

*- Evidence-based verification of social and industrial impacts, as well as social and industrial needs*

*- Technology issues and understanding of their difficulties and feasibility*

*- Your understanding of the problems relating to the social implementation of the proposal*

*- Details of the full-scale research plan (team to conduct research, budget, milestones)*

*- Details of activities to be taken, keeping in mind the development of research results (business model, passing research results to private firms, etc.)*

## 2. Matters to be achieved in small-start-type research

*※On the basis of 1., clearly describe, within 300 words, matters to be achieved during the small-start-type research phase.*

*※copy this description and paste it into the "research outline" section of e-Rad's "common provisions."*

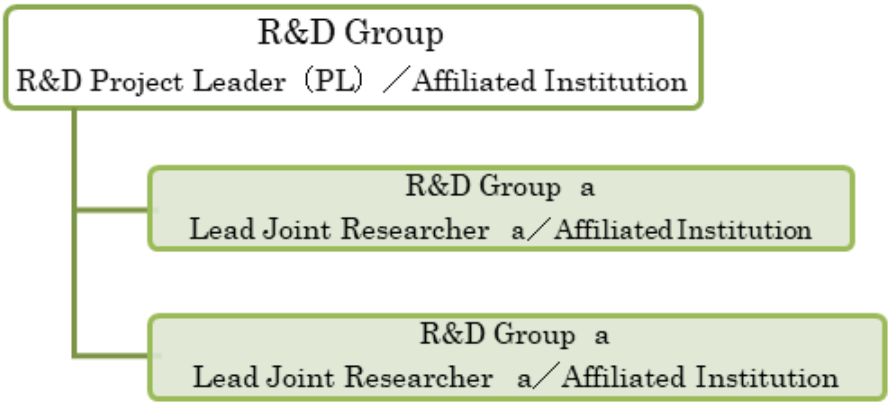
## 3. Contents of the execution of small-start-type research

*- Do not exceed 10 A4-size sheets (no exceptions) –*

## 4. Team to conduct small-start-type research

### (1) Schematic illustration of an R&D team

*※Illustrate an R&D team (Correct the illustration according to the proposed ideas and plans for R&D as appropriate. The illustration below is provided for reference.)*




*(to be continued on the next page)*

**(2) Project Leader's Group**

*(example)*

| Name of Project Leader | name of organization[1)] | title | effort[2)] |
|---|---|---|---|
| *OO OO* | *OOuniversity graduate school OOdepartment OOmajor* | *professor* | *40%* |
| Name of R&D Participant [3),4)] | affiliation (omit if same as above[5)] | title | |
| *OO OO* | | *professor* | |
| *OO OO* | | *associate professor* | |
| *OO OO* | | lecturer | |
| *XX XX* | *XX Co., Ltd., XX Institute* | *chief researcher* | |

*1) If the organization you are currently affiliated with differs from the organization at which you propose to conduct the adopted research, describe the latter in the column relating to special matters and inform us of the reason you have chosen this institution.*

*2) In the "effort" column, enter the distribution percentages (%) for the time required for the research relative to 100%, which represents the total work hours (including not only research activities but also education and therapeutic activities) of researchers in a year.*

*3) Fully describe the roles to be played by the members of the research group.*

*4) Add necessary information concerning the researchers participating in R&D. A description such as "X researcher" is acceptable in cases where the names of researchers are not known at the time the proposal is submitted.*

*5) When multiple organizations are required to research a particular item, the addition of members from different organizations as participants in the R&D process is acceptable.*

**(2-1) Role of the group in relation to generating R&D ideas**

**(2-2) Special matters**

*※Give details of situations (background, reasons, etc.) when work hours (effort) is necessary for completing special tasks (such as managers including the head of research departments or chairmen of academic associations in the process).*

*(to be continued on the next page)*

**(3) Joint R&D Group a**

*※When joint research groups (joint research organizations) outside of the organization the Project Leader is affiliated with are required, describe each group separately.*
*※It is possible to include members of various research organizations affiliated with industries, universities, and the government in joint research groups.*
*※There is no limit to the number of joint research groups; however, forming an optimal team for pursuing the Principal Investigator's research idea should be the priority.*
*※Add or delete tables depending on the number of research groups involved.*
*※It is not mandatory to add members of joint research groups to research teams.*

**Joint R&D group *a*** *(for example)*

| name of Lead joint researcher | name of joint research organization[1)] | title | effort[2)] |
|---|---|---|---|
| *OO OO* | *OOInstitute OODepartment OOteam* | *team leader* | *10%* |
| *Researcher number[6)]: 12345678*<br>*Research organization code[7)]: 1234567890* | | | |
| Name of R&D Participant[3,4)] | affiliation (omit if same as above) | title | |
| *OO OO* | | *chief researcher* | |
| *OO OO* | | *researcher* | |
| *Plan to employ two* | | *special researcher* | |
| *XX XX* | *XX Co., Ltd. X Institute* | *chief researcher* | |

*1)-5) See previous pages.*
*6) Provide the eight-digit number of the main joint researcher, which was given upon registering researcher information on the R&D management system common to ministries (e-Rad).*
*7) Provide the codes for each affiliated research organization given by the R&D management system common to ministries (e-Rad).*

**(3-1) Role of groups in generating R&D ideas**

*(to be continued on the next page)*

**(3-2) Special matters**

※*Enter situations when and reasons measuring of work hours (effort) is necessary during special tasks (such as when managers, such as heads of research departments or chairmen of academic associations, are involved).*

※*When adding an overseas research organization to a research team, see "(2) Requirements for a research team," of application information, "2.2.5, Requirements for applications," and then describe in this column the reason the inclusion of joint researchers affiliated with overseas research organizations is necessary.*

**(4) Other participating R&D organizations**

| Name of R&D participant[3, 4)] | affiliation | title |
|---|---|---|
| *OO OO* | *OOInstitute OODepartment OOteam* | *chief researcher* |
| *OO OO* | | *researcher* |
| *XX XX* | *XXCo.,Ltd. XXInstiture* | *chief researcher* |

※*Private firms and universities that have not signed an R&D agreement with JST in regard to participation but that are collaborating and cooperating with research groups that have signed an R&D agreement with JST relating to participation*

**(4-1) Role of organizations participating in R&D ideas**

**(4-2) Special matters**

※*When adding an overseas research organization to a research team, see "(2) Requirements for research teams" of application information "2.2.5, Requirements for application," beforehand and describe the reason joint researchers affiliated with overseas research organizations are required.*

*(to be continued on the next page)*

## 5. The Principal Investigator's management policies

### (1) Policies for research promotion

※*Improvement, correction of proceedings, introduction of new findings and technologies, policies for developing results*

### (2) Policies for managing intellectual property

※*Policies for managing intellectual property should include the following:*

- *A basic idea of the Principal Investigator concerning how to build a management system and manage the intellectual property of the project.*
- *A basic description of how research results created by this research project will be grouped so that they are not considered to constitute intellectual property; in addition, a basic plan for deciding whether the results should be disclosed to the public.*
- *A basic plan concerning acquiring and maintaining or abandoning or transferring (including how to obtain funding) intellectual property rights during and after researching this project*

## 6. Other

***(Common)***

※*Describe the current status of preparations and examinations as to the support measures and systems at major research organizations.*

※*Describe the contents of conflicts of interests with R&D supervisors, if any. Check (2) of "4.1.2 Selection methods" for a definition of conflicts of interests.*

***(by Prioritized Themes)***

※*If there are any other special matters specified by a prioritized theme, describe them here.*

# (Form 4) R&D Budget

*※Delete guidelines in blue letters when completing this form.*

*-During the small-start-type phase, different prioritized themes may have different research periods. Be sure to check the R&D supervisor's policies relating to the area in question by consulting the application information contained within "Chapter V, Prioritized themes and technology themes for which proposals are sought" when completing this form.*
*-Enter an annual research-expense plan for each expense item and for each research group.*
*-More detailed research expense plans are requested for selection interviews.*
*-Research expenses may be reviewed upon adoption or during the research period, depending on the budgeting situation of the entire program, the management of the research area by the R&D supervisor, or the project-evaluation situation.*
*-Propose a necessary, adequate, and optimum team composition for realizing the Principal Investigator's research idea. A joint research group is essential for realizing a research idea and would greatly contribute to achieving a research objective.*

○ **Research expense plan by expense account (for an entire team)**

| | Small start type | | | | | |
|---|---|---|---|---|---|---|
| | 1st year (2018 Nov. -2019 Mar.) | 2nd year (2019 Apr. -2020 Mar.) | 3rd year (2020 Apr.- 2021 Mar.) | 4th year (2021 Apr. -2022 Mar.) | 5th year (2022 Apr. -2023 Mar.) | total (million yen) |
| equipment expense | | | | | | |
| supplies expense | | | | | | |
| travel expense | | | | | | |
| personnel expense, gratitude (number of researchers) | ( ) | ( ) | ( ) | ( ) | ( ) | ( ) |
| other | | | | | | |
| direct cost | | | | | | |
| indirect cost | | | | | | |
| total(million yen) | | | | | | |

*(to be continued on the next page)*

*※Research expense accounts and their uses are as follows:*

*- Facility and equipment: purchases of facilities and equipment*

*- Supply: purchases of supplies*

*- Travel: travel expenses for the Principal Investigator and researchers*

*- Personnel and gratitude: personnel costs of researchers, engineers, research aids, and RA(※), as well as for providing tokens of gratitude*

*※See application information "4.2.6(1), Concerning improving the treatment of students in doctoral courses (the latter stage)" for RA (research assistant).*

○ **Special matters**

*※Stipulate optimum budget and ratio for each account.*

*※If applicable, describe the reasons personnel expenses exceed 50% of the total research expenses or supply expenses and travel expenses exceed 30% of the total research expenses.*

○ **R&D Budget plan by group**

*※Propose a necessary, adequate, and optimum team composition for realizing the Principal Investigator's research ideas. A joint research group is essential for realizing a research idea and can greatly contribute to achieving a research objective.*

| | 1st year (2018 Nov -2019 Mar.) | 2nd year (2019 Apr. -2020 Mar.) | 3rd year (2020 Apr. -2021 Mar.) | 4th year (2021 Apr. -2022 Mar.) | 5th year (2022 Apr. -2023 Mar.) | total (million yen) |
|---|---|---|---|---|---|---|
| Project Leader Group OO university | | | | | | |
| Joint research G-a XX university | | | | | | |
| Joint research G-b XX university | | | | | | |
| direct costs | | | | | | |
| indirect costs | | | | | | |
| Total (million yen) | | | | | | |

*(to be continued on the next page)*

○ **Major facilities to be utilized (name of instrument, installation site)**

○ **Major facilities planned for purchase (more than JPY5,000,000 for every order, name of instrument, approximate cost)**

*(example)*
*Group A:*

*XXXXXXXXX 15,000 K yen (1,000 yen) (Purchase fiscal year )*
*XXXXXXXXX 5,000 K yen (1,000 yen) (Purchase fiscal year )*
*XXXXXXXXX 10,000 K yen (1,000 yen) (Purchase fiscal year )*

*Group B:*

*XXXXXXXXX 7,000 K yen (1,000 yen) (Purchase fiscal year )*
*XXXXXXXXX 10,000 K yen (1,000 yen) (Purchase fiscal year )*

# (Form 5)
# R&D Project Applicant (Project Leader)

*※Delete guidelines in blue letters when completing this form.*

## ○ Basic information on the Project Leader (PL)

| | | | |
|---|---|---|---|
| (phonetic) Name | | | |
| Nationality/ gender | | birth date (A.D.) | |
| Affiliation, title | | | |
| Academic history (after graduation from college) | academic history：<br>*(Filling-in example)*<br>*OOyear OOuniversity OOdepartment graduation*<br>*OOyear HOOyear OOgraduate school OOdepartment master's course OOmajor*<br>*OOyear OOgraduate school OOdepartment doctoral course OOmajor*<br>*OOyear Ph.D. (OOmajor) (OOuniversity)* | | |
| Research history (main history and research contents) | job history：<br>*(Filling-in example)*<br>*OOyear-OOyear OOCo.,Ltd OOR&Ddepartment (development of OOOO)*<br>*OOyear-OOyear OOuniversity special associate professor (research on OOOO)*<br>*OOyear-OOyeat OOCo., Ltd OOdepartment (in charge of OO)* | | |
| Other special matters | (voluntary description on social contributions, international activities) | | |

## ○ List of achievements by the Project Leader(PL)

*※Describe up to 20 previous achievements, such as published papers and books, related to this R&D project in chronological order, starting with the most recent.*
*※Follow the instructions below concerning items on papers to be described (the same applies to authored books):*
*※You may choose the order of the items freely.*
*※Place a "●" mark before the title of a paper if the paper is cited in form 3.*

*(to be continued on the next page)*

**<Project Leader>**

*(example)*

- *Author(s)(all authors), Title, Journal/Book, Volume, Page numbers and Published year*

**<Lead Joint Researcher a>**

*(example)*

- *Author(s)(all authors), Title, Journal/Book, Volume, Page numbers and Published year*

**< Lead Joint Researcher b>**

*(example)*

- *Author(s)(all authors), Title, Journal/Book, Volume, Page numbers and Published year*

# (Form 6) Information on Other Supports

*※Delete guidelines in blue letters when completing this form.*

*※If the Principal Investigator and Lead Joint Researchers are receiving, applying for, or planning to apply for alternative funding systems or other research subsidies (including from private foundations or overseas organizations), describe the research title, research period, role, amount of research expenses received, and efforts made thus far for each of system or subsidy. Also, see application information "6.3, Measures to address unreasonable duplication and excessive concentration."*

*※If a description is found to be false, an adopted proposal may be cancelled later.*

*※If, during the selection process for this R&D proposal, a description in this form requires alteration because the research subsidies applied or planned to be applied for, as mentioned above, have been altered, correct this form and send a notification e-mail to the contact details provided at the end of these application requirements.*

*※Copies of the application documents and plans submitted to other systems may be requested during the selection interview.*

*(example)*

**Project Leader:** ***XX XX (name)***

| Name of System | receiving situation | name of research projects (name of representative) | research period | role (representative/ shared role) | (1) received research expense (whole period)<br>(2) (2018 fiscal planned)<br>(3) (H29 fiscal planned)<br>(4) (H28 fiscal actual) | effort (%) |
|---|---|---|---|---|---|---|
| *JST-Mirai Program (this Proposal)* | *applied* | | | representative | | |
| *Science research subsidy, base research (S)* | *received* | *◊◊ creation by xx (OOOO)* | *2015. Apr. -2019 Mar.* | *representative* | (1) 100 M yen<br>(2) 50 M yen<br>(3) 25 M yen<br>(4) 5 M yen | *20* |
| *JST strategic Research promotion CREST* | *applied* | *◊◊ upgraded function by xx (OOOO)* | *2017 Oct.- 2023 Mar.* | *shared role* | *(1) 140 M yen*<br>*(2) 35 M yen*<br>*(3) 8 M yen*<br>*(4)-* | |
| | | | | | | |

*-List, in descending order of the amounts received (over the entire period), subsidies received or expected to be received. Then, describe subsidies applied for and those that you plan to apply for, if applicable.*

*-If a subsidy is being received or you expect to receive it, enter "received." Enter "applied" if you have applied for but not yet received a subsidy or if you plan to apply for a subsidy.*

*(to be continued on the next page)*

*-Describe representative or shared duties under "role."*
*-Describe the amount (direct costs) to be received by the research representative her/himself under "research expenses received by the research representative."*
*-Describe the distribution ratio of the time required to perform the research relative to 100%, which represents total annual work hours (including not only time for research activities but also educational and therapeutic activities) under "effort" [as defined at the Comprehensive Science, Technology, and Innovation Convention]. Only account for efforts expended or planned to be expended on the presumption that a proposal is adopted by JST-Mirai program, not efforts made in regard to proposals submitted to other research organizations, such as those applied to or those planned to be applied to. The total efforts made during the small-start-type phase and efforts made toward subsidies being received should not exceed 100%.*
*-Add or delete lines as necessary.*

*(example)*

**Lead Joint Researcher *a: XX XX (name)***

| Name of System | receiving situation | R&D project name (name of representative) | research period | role (repre-sentative / sharing) | (1) received expenses (whole period)<br>(2) (H30 fiscal planned)<br>(3) (H29 fiscal planned)<br>(4) (H28 fiscal actual) | effort (%) |
|---|---|---|---|---|---|---|
| JST-Mirai (this Proposal) | applied | | | shared | | |
| | | | | | *(1) 000 yen*<br>*(2) 000 yen*<br>*(3) —*<br>*(4) —* | |
| | | | | | | |

*(to be continued on the next page)*

*(example)*

**Lead Joint Researcher *b: XX XX (name)***

| Name of System | receiving situation | R&D project name (name of representative) | research period | role (repre-sentative/ sharing) | (1)received expenses (whole period)<br>(2) (H30 fiscal planned)<br>(3) (H29 fiscal planned)<br>(4) (H28 fiscal actual) | effort (%) |
|---|---|---|---|---|---|---|
| JST-Mirai (this Proposal) | applied | | | shared | | |
| | | | | | *(1) 000 yen*<br>*(2) 000 yen*<br>*(3) —*<br>*(4) —* | |
| | | | | | | |

# (Form 7)
# Protection of Human Rights and Compliance with Laws and Regulations

*※Delete guidelines in blue letters when completing this form*

*※Describe the measures and actions that you will take if your research involves compliance with the related laws and regulations (e.g. research requiring the consent and the cooperation of the other party when implementing the research plan, research requiring consideration for the handling of personal information and research requiring efforts regarding bioethics and safety measures).*

*※This applies to surveys, research, experiments which require an approval procedure in an ethics committee inside and outside the research institution, such as for example questionnaire surveys in which personal information is involved, interview surveys, the use of provided samples, analysis study of the human genome, recombinant DNA experiments, experiments on animals, etc.*

*※Please indicate where this is not applicable.*

# (Form 8)
# References

※*Delete guidelines in blue letters when completing this form.*

References

※*Provide the names of two (2) individuals who have good knowledge of your Research Project (non-Japanese person(s) are acceptable). Provide names of the reference person, institution and contact information (phone numbers and e-mail address). The evaluators (JST and R&D Supervisor) may contact them regarding the R&D proposal during the screening process.*

※*Providing this reference information is not mandatory.*

# (Extra form)

# View of the person promotes cooperation of academia and industry like coordinator or the person in charge of the company

Author Name:
Affiliation:
Title:
Contact Address (voluntary):

** Submission of documents is optional.*
*If you submit an exhibit proposal form, please add it to the end of the proposal form (main form) and upload it as one file.*
** Please prepare within 1 page. (It is allowed to prepare by more than one person.)*
** Please prepare by not Project Leader and research participants but the parson promotes cooperation of academia and industry or the person in charge of the company who is supposed to receive the technology that achieve POC in the future. The person not written in form 3 "4. Team to conduct small-start-type research" is also Included.*
** The person promotes cooperation of academia and industry also include the person who support to achieve to POC.*
** Please mention that supplemental information that is not described in form 1-5.For example, Social or private firms' needs, a trend of domestic and overseas around this research proposal, expectation of the achievement of POC and possibility of the expand after POC, role of the person promotes cooperation of academia and industry, relationship with programs of government departments or local governments*
** It is not necessary to write the evaluation of PL and the reason of recommendation*

### 2.3.2 “Feasibility Study (Component technology type)” R&D proposal(Form) Completion Requirements

A list of the forms to be submitted is shown below. To appropriately prepare an R&D proposal, follow the guidelines provided on the next page onward concerning completing such forms. Be sure to use the forms stipulated for this fiscal year.

| Form No. | Document |
|---|---|
| Form 1 | R&D proposal, cover |
| Form 2 | R&D Project Description |
| Form 3 | R&D Project Applicant (Project Leader) |
| Form 4 | Other Support |
| Form 5 | Measures for Protecting Civil Rights and Complying with Laws and Regulations |
| Following documents only for interview applicants | |
| Form 6 | Team to conduct on R&D |
| Form 7 | R&D Budget |
| Form 8 | References |

*Ensure the file does not exceed 3MB.

*Be sure to familiarize yourself with the definition of a stakeholder provided in “Chapter 4, 4.1.2, Selection method” (2) when preparing proposal forms.

*See “Chapter 7, Submission via the Cross-ministerial R&D Management System (e-Rad)” for application methods for R&D proposals.

*Be sure you have an appropriate understanding of “Chapter 6, Key Points in Submitting Proposals” and “Chapter4, 4.1.1, Concerning restrictions on duplicate applications for the JST-Mirai program” before making an application.

# (Form 1)

# R&D proposal "Small start Type research (Component technology type)" called for in FY2018, Cover

| | | |
|---|---|---|
| *Prioritized theme*<br>*※Mark "O" for one applied theme. In case of "Common Platform------"area , put Subtheme No & Subtheme title.* | | "Realization of the most Safe and Secure Society in the world" area Development of the crisis navigator for individuals |
| | | "Common Platform Technology, Facilities, and Equipment" area Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products |
| | | (Subtheme)ST*XX*:*XXXXXXXXXXXXXXXXXXXX* |
| *Title of R&D project* | | |
| R&D period | Month, 2018 – Month, Year ( years) | |
| R&D Budget | R&D budget for R&D project( million yen) | |

| | |
|---|---|
| Name of R&D Project Leader | |
| Affiliated Institution, Department, Title | |
| Effort for this FY | This fiscal year: ____% |
| Conflicts of interest with PO<br>*※check* | Conflict of interest with R&D supervisor (PO): ☐ Yes ☐ No<br>*※If "Yes", describe contents in Form 3 "6. other"* |
| Researcher number | *※Enter the 8-digit "e-Rad" login ID number which is provided by registering researcher information on the Cross-ministerial Research and Development Management System (e-Rad)* |
| Information on Project Leader | URL:<br>author ID:<br>*※ URL if website (lab website, researchmap page) available for information on Project Leader, or ID if ORCHID ID, Researcher ID, or SCOPUS author ID is known* |

# (Form 2)
# R&D Project Description

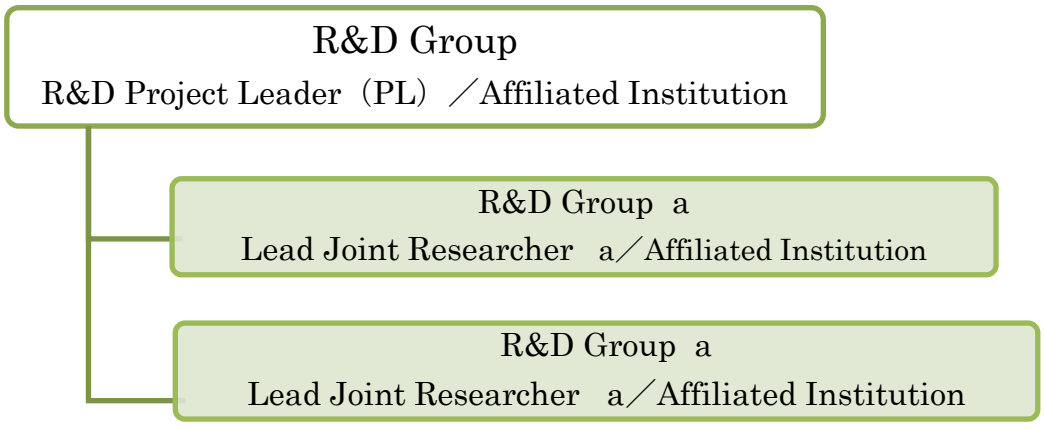
*※Delete guidelines in blue letters when completing this form.*
*※Be sure to check the policies of the R&D supervisors for each area, which are described in the application information. See "4.1.3, Viewpoints for selection" and "Chapter V, Prioritized themes and technology themes for which proposals are sought."*

## 1. Summary of this R&D proposal

*※Provide simple and clear descriptions of the Gist of this R&D, proposal within 300 letters(Japanese).*
*※Describe the goal as quantitatively as possible.*
*※Copy this summary to "Research summaries" of e-Rad "common item"*

## 2. Details of this R&D proposal

*(1) The goal of this R&D proposal*
*※ Describe component technologies that contribute to the realization of the Prioritized theme. Provide specifically description in which the success or failure can be judged.*
*(2) Background of the goal setting*
*※Assumptions that can contribute to achievement of the Prioritized theme. And Assumptions of technical impacts.*
*(3) Achievement Methodologies and contents*
*※Originality, Challenge ability, and Achievability*
(4) Schematic illustration of an R&D team
*※Illustrate an R&D team (Correct the illustration according to the proposed ideas and plans for R&D as appropriate. The illustration below is provided for reference.)*




- Do not exceed three A4-size sheets (no exceptions) -

# (Form 3) R&D Project Applicant (Project Leader)

*※Delete guidelines in blue letters when completing this form.*

## ○ Basic information on the Principal Investigator (PL)

| | | | |
|---|---|---|---|
| (phonetic) Name | | | |
| Nationality/ gender | | birth date (A.D.) | |
| Affiliation, title | | | |
| Academic history (after graduation from college) | academic history：<br>*(Filling-in example)*<br>*OOyear OOuniversity OOdepartment graduation*<br>*OOyear HOOyear OOgraduate school OOdepartment master's course OOmajor*<br>*OOyear OOgraduate school OOdepartment doctoral course OOmajor*<br>*OOyear Ph.D. (OOmajor) (OOuniversity)* | | |
| Research history (main history and research contents) | job history：<br>*(Filling-in example)*<br>*OOyear-OOyear OOCo.,Ltd OOR&Ddepartment (development of OOOO)*<br>*OOyear-OOyear OOuniversity special associate professor (research on OOOO)*<br>*OOyear-OOyeat OOCo., Ltd OOdepartment (in charge of OO)* | | |
| Other special matters | *(voluntary description on social contributions, international activities)* | | |

*(to be continued on the next page)*

# (Form 4)
# Information on Other Supports

*※Delete guidelines in blue letters when completing this form.*

*※If the Principal Investigator and Lead Joint Researchers are receiving, applying for, or planning to apply for alternative funding systems or other research subsidies (including from private foundations or overseas organizations), describe the research title, research period, role, amount of research expenses received, and efforts made thus far for each of system or subsidy. Also, see application information "6.3, Measures to address unreasonable duplication and excessive concentration."*

*※If a description is found to be false, an adopted proposal may be cancelled later.*

*※If, during the selection process for this R&D proposal, a description in this form requires alteration because the research subsidies applied or planned to be applied for, as mentioned above, have been altered, correct this form and send a notification e-mail to the contact details provided at the end of these application requirements.*

*※Copies of the application documents and plans submitted to other systems may be requested during the selection interview.*

*(example)*

**Project leader:** ***XX XX (name)***

| Name of System | receiving situation | name of research projects (name of representative) | research period | role (representative/ shared role) | (1) received research expense (whole period)<br>(2) (2018 fiscal planned)<br>(3) (H29 fiscal planned)<br>(4) (H28 fiscal actual) | effort (%) |
|---|---|---|---|---|---|---|
| *JST-Mirai Program (this Proposal)* | *applied* | | | *representative* | | |
| *Science research subsidy, base research (S)* | *received* | *◊◊ creation by xx (OOOO)* | *2015.Apr. -2019 Mar.* | *representative* | *(1) 100 M yen*<br>*(2) 50 M yen*<br>*(3) 25 M yen*<br>*(4) 5 M yen* | *20* |
| *JST strategic Research promotion CREST* | *applied* | *◊◊ upgraded function by xx (OOOO)* | *2017.Oct.-2023.Mar.* | *shared role* | *(1) 140 M yen*<br>*(2) 35 M yen*<br>*(3) 8 M yen*<br>*(4) -* | |
| | | | | | | |

# (Form 5)
# Protection of Human Rights and Compliance with Laws and Regulations

*※Delete guidelines in blue letters when completing this form*

*※Describe the measures and actions that you will take if your research involves compliance with the related laws and regulations (e.g. research requiring the consent and the cooperation of the other party when implementing the research plan, research requiring consideration for the handling of personal information and research requiring efforts regarding bioethics and safety measures).*

*※This applies to surveys, research, experiments which require an approval procedure in an ethics committee inside and outside the research institution, such as for example questionnaire surveys in which personal information is involved, interview surveys, the use of provided samples, analysis study of the human genome, recombinant DNA experiments, experiments on animals, etc.*

*※Please indicate where this is not applicable.*

*Following documents only for interview applicants*

# (Form 6)
# Protection of Human Rights and Compliance with Laws and Regulations

## 1. Project Leader's Group *(example)*

| Name of Project Leader | name of organization[1)] | title | effort[2)] |
|---|---|---|---|
| *OO OO* | *OOuniversity graduate school OOdepartment OOmajor* | *professor* | *40%* |
| Name of R&D Participant[3,4)] | affiliation (omit if same as above[5] | title | |
| *OO OO* | | *professor* | |
| *OO OO* | | *associate professor* | |
| *OO OO* | | *lecturer* | |
| *XX XX* | *XX Co., Ltd., XX Institute* | *chief researcher* | |

*1) If the organization you are currently affiliated with differs from the organization at which you propose to conduct the adopted research, describe the latter in the column relating to special matters and inform us of the reason you have chosen this institution.*

*2) In the "effort" column, enter the distribution percentages (%) for the time required for the research relative to 100%, which represents the total work hours (including not only research activities but also education and therapeutic activities) of researchers in a year.*

*3) Fully describe the roles to be played by the members of the research group.*

*4) Add necessary information concerning the researchers participating in R&D. A description such as "X researcher" is acceptable in cases where the names of researchers are not known at the time the proposal is submitted.*

*5) When multiple organizations are required to research a particular item, the addition of members from different organizations as participants in the R&D process is acceptable.*

**(1-1) Role of the group in relation to generating R&D ideas**

**(1-2) Special matters**

*※Give details of situations (background, reasons, etc.) when work hours (effort) is necessary for completing special tasks (such as managers including the head of research departments or chairmen of academic associations in the process).*

*(to be continued on the next page)*

## 2. Joint R&D Group a

- *When joint research groups (joint research organizations) outside of the organization the Principal Investigator is affiliated with are required, describe each group separately.*
- *It is possible to include members of various research organizations affiliated with industries, universities, and the government in joint research groups.*
- *There is no limit to the number of joint research groups; however, forming an optimal team for pursuing the Principal Investigator's research idea should be the priority.*
- *Add or delete tables depending on the number of research groups involved.*
- *It is not mandatory to add members of joint research groups to research teams.*

**Joint R&D group a** *(for example)*

<table>
<tr><td>name of Lead joint researcher</td><td>name of joint research organization[1)]</td><td>title</td><td>effort[2)]</td></tr>
<tr><td>OO OO</td><td>OOInstitute OODepartment OOteam</td><td rowspan="2">team leader</td><td rowspan="2">10%</td></tr>
<tr><td colspan="2">Researcher number[6)]: 12345678<br>Research organization code[7)]: 1234567890</td></tr>
<tr><td>Name of R&D Participant[3,4)]</td><td>affiliation (omit if same as above)</td><td colspan="2">title</td></tr>
<tr><td>OO OO</td><td></td><td colspan="2">chief researcher</td></tr>
<tr><td>OO OO</td><td></td><td colspan="2">researcher</td></tr>
<tr><td>Plan to employ two</td><td></td><td colspan="2">special researcher</td></tr>
<tr><td>XX XX</td><td>XX Co., Ltd. X Institute</td><td colspan="2">chief researcher</td></tr>
</table>

*1)-5) See previous pages.*

*6) Provide the eight-digit number of the main joint researcher, which was given upon registering researcher information on the R&D management system common to ministries (e-Rad).*

*7) Provide the codes for each affiliated research organization given by the R&D management system common to ministries (e-Rad).*

**(2-1) Role of groups in generating R&D ideas**

*(to be continued on the next page)*

**(2-2) Special matters**

※*Enter situations when and reasons measuring of work hours (effort) is necessary during special tasks (such as when managers, such as heads of research departments or chairmen of academic associations, are involved).*

※*When adding an overseas research organization to a research team, see "(2) Requirements for a research team," of application information, "2.2.5, Requirements for applications," and then describe in this column the reason the inclusion of joint researchers affiliated with overseas research organizations is necessary.*

## 3. Other participating R&D organizations

| Name of R&D participant[3, 4)] | affiliation | title |
|---|---|---|
| OO OO | OOInstitute OODepartment OOteam | chief researcher |
| OO OO | | researcher |
| XX XX | XXCo.,Ltd. XXInstiture | chief researcher |

※*Private firms and universities that have not signed an R&D agreement with JST in regard to participation but that are collaborating and cooperating with research groups that have signed an R&D agreement with JST relating to participation*

**(3-1) Role of organizations participating in R&D ideas**

**(3-2) Special matters**

※*When adding an overseas research organization to a research team, see "(2) Requirements for research teams" of application information "2.2.5, Requirements for application," beforehand and describe the reason joint researchers affiliated with overseas research organizations are required.*

## 4. Other

***(Common)***

※*Describe the current status of preparations and examinations as to the support measures and systems at major research organizations.*

※*Describe the contents of conflicts of interests with R&D supervisors, if any. Check (2) of "4.1.2 Selection methods" for a definition of conflicts of interests.*

***(by Prioritized Themes)***

※*If there are any other special matters specified by a prioritized theme, describe them here.*

# (Form 7)
# R&D Budget

*※Delete guidelines in blue letters when completing this form.*

*※During the small-start-type phase, different prioritized themes may have different research periods. Be sure to check the R&D supervisor's policies relating to the area in question by consulting the application information contained within "Chapter V, Prioritized themes and technology themes for which proposals are sought" when completing this form.*
*※Enter an annual research-expense plan for each expense item and for each research group.*
*※More detailed research expense plans are requested for selection interviews.*
*※Research expenses may be reviewed upon adoption or during the research period, depending on the budgeting situation of the entire program, the management of the research area by the R&D supervisor, or the project-evaluation situation.*
*※Propose a necessary, adequate, and optimum team composition for realizing the Principal Investigator's research idea. A joint research group is essential for realizing a research idea and would greatly contribute to achieving a research objective.*

○ **Research expense plan by expense account (for an entire team)**

| | 1st year (2018 Nov. -2019 Mar.) | 2nd year (2019 Apr. -2020 Mar.) | total (million yen) |
|---|---|---|---|
| equipment expense | | | |
| supplies expense | | | |
| travel expense | | | |
| personnel expense, gratitude (number of researchers) | ( ) | ( ) | ( ) |
| other | | | |
| direct cost | | | |
| indirect cost | | | |
| total(million yen) | | | |

*(to be continued on the next page)*

○ **Major facilities to be utilized (name of instrument, installation site)**

○ **Major facilities planned for purchase (more than JPY5,000,000 for every order, name of instrument, approximate cost)**

*(example)*

*Group A:*

*XXXXXXXXX 15,000 K yen (1,000 yen) (Purchase fiscal year )*
*XXXXXXXXX 5,000 K yen (1,000 yen) (Purchase fiscal year )*
*XXXXXXXXX 10,000 K yen (1,000 yen) (Purchase fiscal year )*

*Group B:*

*XXXXXXXXX 7,000 K yen (1,000 yen) (Purchase fiscal year )*
*XXXXXXXXX 10,000 K yen (1,000 yen) (Purchase fiscal year )*

# (Form 8)
# References

*※Delete guidelines in blue letters when completing this form.*

*※Provide the names of two (2) individuals who have good knowledge of your Research Project (non-Japanese person(s) are acceptable). Provide names of the reference person, institution and contact information (phone numbers and e-mail address). The evaluators (JST and R&D Supervisor) may contact them regarding the R&D proposal during the screening process.*
*※Providing this reference information is not mandatory.*

# Chapter 3
# Large-scale Type

## 3.1 Concerning the large-scale type

### 3.1.1 Outline of the large-scale type

An outline of JST-Mirai program (large-scale type) is included below.
For additional information, see “Chapter IV, Common matters arising in relation to small-scale and large-scale types and initiatives.”

(1) JST-Mirai program collects and analyzes information concerning science and technology innovations, introduces changes to current technology systems, and makes concentrated investments in technology R&D, in order to develop future base technologies specified by the Ministry of Education, Culture, Sports, Science, and Technology. These are used to carry out research for technological demonstrations.

(2) An R&D supervisor oversees several areas of technology and manages entire large-scale research initiatives. To accomplish this, s/he collaborates with experts in particular technological fields, using the following means to fully explore each technological theme, and to monitor the progress of the PM (Project Manager) and R&D projects:
•Select R&D projects;
•Advice, coordination, and approval of research plans (including R&D budget plans and teams);
•Evaluations of the work of PMs or research representatives, including how well they challenge, motivate, and give guidance to staff;
•Surveys carried out during site visits;
•Evaluations of the PM’s activities, achieved goals, and advice;
•Recommendations to the R&D supervisors conference that a PM be terminated or an R&D project revoked;
•various other means.

(3) The Project Manager (PM) develops the Proof of Concept (POC) based on excellent, original R&D ideas that s/he has established. S/he then prepares milestones and an R&D plan (including R&D costs and team plans). The PM is responsible for entire R&D projects and for the whole R&D team which s/he directs, manages, and guides in its progress, ensuring that the R&D reaches its goal.
The PM can flexibly form an optimum R&D teams composed of a number of researchers and organizations (for example, by issuing a public call for researchers) once the R&D plan has been approved by an R&D supervisor. The PM will promote the R&D project while receiving stage gate evaluation (to determine whether the R&D project should be continued or revoked) based on milestones set at the launch of the R&D project.

(4) To ensure swift social implementation of a newly created fundamental technology, while encouraging investment from the private sector, large-scale type encourage early participation by private firms and require a commitment to contribute funds from an “organization asked to provide funds” (a “sponsoring organization”). See “3.1.2, Mechanism large-scale type”.

If sufficient funding is not provided by a sponsoring organization, action may be taken to terminate the R&D project early (revocation). For additional information about stage gate evaluation, see “3.1.2, Mechanism large-scale type (9)

### 3.1.2 Mechanism large-scale type

**(1) The execution of R&D projects managed by the PM**

○ A PM employed by JST is selected by the R&D management convention on PM and R&D projects and by the R&D supervisors’ convention.

*There may be cases in which a quasi-mandate contract is offered in lieu of an employment contract, as described below.

○ JST signs a contract with an R&D organization on the basis of the PM’s R&D plan, which has been approved by an R&D supervisor. The R&D organization carries out R&D in accordance with the R&D agreement. The PM is responsible for the execution and management of the R&D.

**(2) PM progress reports**

○ The PM shall give an R&D progress report to the R&D supervisor approximately once every six months. To assist the PM in effectively assessing progress, The R&D supervisor and R&D management committee members will ask PM to make progress reports and site visits as necessary.

○ The R&D supervisor and R&D management committee members will take into account the content of the progress reports when asking the PM for necessary improvements. When requested to make improvements, the PM is encouraged to adopt high-risk high-impact approaches, as the system is set up to provide him/her with the necessary freedom and authority.

○ The R&D management convention shall be allowed to ask JST to terminate a PM on the following grounds: on the basis of an evaluation or examination by the R&D supervisor; if improvements requested by the R&D supervisor and R&D management committee members are not made; and when it seems unlikely that the project will achieve its stated goal.

○ The PM is allowed to ask for advice from the R&D supervisor and from R&D management committee members. When asked for advice by the PM, the R&D supervisor must provide proper advice, as required.

**(3) R&D budgets**

The budget of a project is 900-1400 million yen for the period of one to four fiscal years (a total of 2.7-4 billion yen for 10 years; approximately 200-350 million yen annually, for direct costs only; indirect costs are treated differently.)

The budget is set in accordance with the technological area involved. For more information, see “Chapter V, Calling for proposals in high priority or specified technological areas.”

Based on the R&D agreement, the JST makes a payment to cover R&D budgets and indirect

costs (up to a maximum of 30% of direct costs) to an R&D organization; these are contract R&D budgets.

**(4) R&D budgets: assessment and variability**

The proposed budget and R&D budgets are subject to assessment during the selection period; they can be changed to reflect constraints on the total budget. Actual R&D budgets are determined through the strict examination and approval of an R&D plan, stage gate reviews, and a clear understanding of progress.

The R&D budget is set each year, taking into account R&D progress and the total budget for all projects underway that year.

**(5) The R&D term**

An R&D period is about nine-and-a-half years maximum, from November 2018 to March 2028 (or until the end of the fiscal year following the 10th fiscal year), as long as the R&D initiative in question continues after the stage gate reviews. If the stage gate reviews and progress indicators result in an R&D termination, the PM is expected to consult with the R&D supervisor to summarize R&D achievements for the year.

The actual R&D period is determined through strict examination and approval of an R&D plan, stage gate reviews, and an assessment of progress.

**(6) The R&D team**

The PM is asked to form an optimum R&D team, composed of a number of organizations and researchers and drawn together by her/his own excellent, original R&D ideas. The team must be assembled using appropriate methods, including nominating and calling for experts. Japanese research organizations and researchers must be selected for their ability to contribute high-level knowledge and R&D capabilities.

a. The PM may set up a research group (“joint research group”) composed of researchers affiliated with laboratories or research organizations in order to follow through on R&D ideas.

b. Of the members of an R&D team, the representative of a “joint research group” is referred to as the “main joint researcher.”

c. Researchers and research assistants for an R&D project may be employed using R&D budgets (within the research organization’s R&D agreement) if needed to advance the research.

*See “3.2.4, Requirements for application” for a list of research team requirements.

d. If necessary, the PM can set up a research-focused “R&D representatives group” composed of researchers that s/he directs.

**(7) R&D support system**

As part of the R&D system, the PM is asked to establish a support system and measures to ensure that R&D will be carried out effectively and efficiently by researchers so that they can concentrate on R&D tasks.

To achieve this goal, the PM is asked to identify a system and relevant measures to support and

promote R&D, in cooperation with the main joint researchers and R&D organizations. The R&D organizations, in particular, are expected to fully exploit their various functions and mechanisms to support the R&D project, as well as providing any assistance needed by the PM. The PM is asked to summarize the supporting measures that research organizations have committed themselves to providing, and to include this summary in an R&D proposal.

**(8) Stage gate evaluation**

Stage gate evaluation may lead to (i) changes in team composition, (ii) increases or decreases in R&D budgets, and (iii) termination of an R&D project.

For projects accepted during the 2018 fiscal year, a first stage gate evaluation will be made by the end of the 2021 fiscal year, at the latest. The R&D supervisor will determine the timing of the stage gate evaluation, on the basis of an R&D plan.

To ensure that newly created fundamental technologies are brought swiftly to the stage of social implementation, and also to attract private investment, a certain amount of funding for planned R&D from a "sponsoring organization" (as defined below) is required at the first stage gate evaluation after the launch of an R&D project. If no sponsorship funding is secured, a comprehensive evaluation may lead to the early termination or adjustment of the R&D project.

- The types of organization that can be asked to provide funding (sponsoring organizations) include the following: private firms, such as corporations, holding companies, limited corporations, general incorporated associations, general incorporated foundations, public interest incorporated associations, or public interest incorporated foundations.

- Corporate sponsorship can be used to cover the following expenses:

(a) A corporate sponsor can support an R&D organization that has signed an R&D agreement with JST by funding or offsetting joint R&D budgets (including indirect costs) within a selected project. Appropriate forms of support include donations, gifts-in-kind (including the use of facilities, equipment, and supplies), personnel costs, gratuities, and travel expenses.

(b) R&D budgets can be directly funded by a sponsoring organization to promote R&D in selected projects. These expenses include the cost of supplies and equipment, personnel costs, gratuities, and travel expenses. They also include the salaries of researchers seconded by the corporate sponsor to an R&D organization that has signed an R&D agreement with JST.

(c) Expenses paid directly by the sponsoring organization to secure the right to make use of R&D results produced by the selected projects

- Definition of a "certain amount of funding"

20% or more of total R&D budgets (as set out in JST R&D agreement) per year must be funded by a sponsoring organization.

(Funding received from a sponsoring organization)/(Expenses associated with the R&D agreement are covered by JST and by funding provided by the sponsoring organization) = 20% or more

### 3.1.3 The promotion of large-scale type

**(1) Calling for and selecting R&D proposals**

JST calls for R&D proposals in every area of technology specified by the Ministry of Education, Culture, Sports, Science and Technology. The R&D supervisor collaborates with members of the R&D management committee to select proposals in each technological theme.

**(2) The preparation of an R&D plan**

When a proposal has been selected, the PM prepares a comprehensive R&D plan to cover the whole R&D period. In addition, the PM prepares an annual R&D plan for each fiscal year. An R&D plan includes project goals, such as POC and milestones, R&D budgets, intellectual property creation plans, and the composition of an R&D team.

**(3) Contract**

When an R&D plan has been chosen, JST signs an R&D agreement in principle with a research organization that the PM and main joint researcher are affiliated with.

The PM selects R&D organizations by using appropriate methods, including nomination and publicly calling for participants. In principle, chosen organizations may take part in R&D projects once they have signed an R&D agreement with the JST.

**(4) Conducting R&D**

An R&D period can last a maximum of about nine and a half years—
from November 2018 to March 2028 (it is possible to extend this period to the end of the 10th fiscal year). This timeframe includes stage gate reviews and R&D continuation (stage up). If stage gate review and progress management results lead to the R&D project being terminated, the PM is expected to consult with the R&D supervisor and to summarize the R&D results for that year.

**(5) Evaluation**

The R&D supervisor monitors the progress and results of the R&D and collaborates with members of the R&D management committee to evaluate the project at each stage gate review, and to ensure the completion of the project.

<Evaluating R&D projects and PMs>

a. An R&D supervisor monitors the progress and results of the R&D and collaborates with members of the R&D management committee to submit evaluations at stage gate reviews and to ensure the completion of R&D projects. A stage gate review is carried out approximately three years after the launch of the research project, to determine whether

or not it should continue. An interim evaluation is carried out approximately every three years after the stage gate review. A final assessment is made during the last year of an R&D period.

b. In addition to the above, an R&D project evaluation may be carried out whenever the R&D supervisor judges that it is necessary.

c. The results of project evaluations, including the interim review, are taken into consideration during subsequent adjustments to an R&D plan. They also contribute to resource distribution (an increase or decrease in R&D budgets, or a change in the composition of the research group). Some evaluation results may lead to early completion (termination) of an R&D project or to the adjustment of an R&D period.

d. Both the activities of the PM her/himself and the R&D project are evaluated. JST also evaluates project personnel each year.

e. At a set time after an R&D project has been completed, a follow-up survey is carried out to analyze the development and use of R&D results and the activities of research participants. Outside experts appointed by JST will provide a follow-up evaluation, based on the results of the follow-up survey.

In addition to the R&D project evaluation, the R&D supervisor's effectiveness in achieving a goal may be assessed, from a management viewpoint. The appointed PMs are asked to cooperate with these evaluations, as necessary.

**(6) Situations where it is difficult to continue an R&D project**

When one of the situations described below arises, JST determines whether an R&D project should be continued on the basis of analyses carried out by the R&D supervisor and management committee.

a. If a PM should pass away, or PM should receive an order of commencement of guardianship

b. If the PM misused R&D funds or other forms of inappropriate conduct related to the R&D activity

c. When other reasons to make it difficult to continue the R&D

## 3.2 Requesting and selecting large-scale research

### 3.2.1 R&D proposals sought

(1) R&D proposals are called for in three technological themes, as described in “Chapter V, Calling for proposals in high priority or specified technological areas.”

(2) Further information about the three key technological areas are described in ”Chapter V, Calling for proposals in high priority or specified technological areas.” This chapter also explains the policies by means of which the R&D supervisor calls for, selects, and manages proposals, ensuring that they fit within the three specified technological areas.

(3) Be sure to check important common matters described in “Chapter IV, Common matters arising in relation to small-scale and large-scale research projects and initiatives.”

### 3.2.2 Period for submitting proposals

**Tue., June 12, 2018 – Tue., July 31, 2018 at 12:00 noon (No delays accepted)**

See the “main schedule” for briefing and selection on the opening page.

Only if an application procedure has been completed through e-Rad by the deadline will a proposal be subject to examination.

### 3.2.3 Number of project proposals for adoption

We plan to accept one project in each technological theme.

### 3.2.4 Requirements for application

Application guidelines are described below in points (1)-(3).

Please be aware of the following requirements:

*An R&D proposal that does not meet all requirements by the selection deadline will, on principle, be neither selected nor accepted.

*Application guidelines and requirements must be adhered to throughout the entire R&D research period, once a proposal has been accepted. If any requirements are neglected during this period, the whole or part of the R&D project will be terminated. Before applying, ensure that you have read and understood “Chapter 6, Application Precautions” in addition to the following points, (1)-(3).

**(1) Requirements for submitting a proposal**

The applicants shall meet all of the following requirements.

- An application shall be made by one person; it may not be a joint proposal.

- PM shall be engaged as full-time JST staff or engage in PM work at JST and at the highest possible effort.

- An applicant who becomes the PM is affiliated with a research organization in Japan to form a research team there (there are no restrictions on the applicant's nationality).

*The persons mentioned below may also propose research projects:

Researchers of foreign nationality who are affiliated with research organizations in Japan;

Researchers who are not affiliated with any Japanese organization or affiliated with overseas research organization, but who can be affiliated with a research organization in Japan to form a research team if accepted as an R&D representative (there are no restrictions on the applicant's nationality).

*People affiliated with private firms, including research organizations other than universities, are also acceptable.

- The applicant can manage all aspects of the R&D project in question, as the person in charge of an R&D team.

*See "4.2.4, The duties of accepted R&D representatives and main joint researchers" for additional details.

-The applicant has completed a research ethics education program at the R&D organization that s/he is affiliated with. Alternatively, the applicant may have completed an education program provided by JST.

*See "6.1, Regarding attendance at and completion of a program of research ethics education" for details.

- The applicant pledges to observe the following four points and understands and agrees to comply with the "Guidelines for responding to fraudulent behavior at research organizations (Ruling by the Minister of Education, Culture, Sports, Science and Technology, August 26, 206)."

The applicant understands and agrees to comply with the "Guidelines for the management and audit of public research expenses at research organizations (practical criteria), revised on February 18, 2014."

The PM and R&D participants are forbidden to engage in fraudulent behavior (fabrication, fraudulent modification and use) or to declare fraudulent research expenses.

- The applicant has not been involved in fraudulent research activities involving research achievements described in the R&D proposal.

*The applicant is requested to confirm his/her acceptance of these terms by using the e-Rad screen for inputting application information.

**(2) Requirements for research teams**

A research team needs to meet the following requirements. Also see "4.1.3 Perspectives on selection."

a. A research team is an optimum system for realizing the R&D ideas of the author of an R&D proposal, acting as the research representative.

b. A joint research group, placed in an R&D team, is indispensable for realizing R&D ideas and can greatly contribute to achieving research objectives.

Research that an overseas research organization is collaborating as part of a joint research group (researchers affiliated with the overseas research organization are participating in the research as lead researcher), must be the one that it is difficult to achieve goal of R&D ideas without participation of the said foreign organization (the approval of the R&D supervisor is necessary). When working with an overseas body, it should be possible to fully grasp intellectual property rights arising from the research. *Those who wish to form an R&D team that includes an overseas research organization must describe the composition of the overseas team in the joint research group column of a large-scale R&D proposal (R&D system-form 5). They must also explain, under “special matters” why the joint researchers affiliated with the overseas research organization are needed.

The overseas research organization must, on principle, accept JST’s R&D funding guidelines (maximum indirect costs of 30%) when signing an agreement with JST. Please submit a form (to be finalized later) to show prior approval by a responsible person in the contract department of the overseas research organization before the selection interview. An overseas research organization is not allowed to participate in an R&D team unless an R&D agreement can be signed.

**(3) Requirements for R&D organizations**

An R&D organization must fully recognize that R&D funding is public money; it must therefore comply with the laws that require R&D to be carried out efficiently.

A project at an R&D organization that cannot fulfil the requirements and duties described in “4.2.5, Responsibilities of R&D Institutions Duties of an R&D organization” will not be approved. Be sure to obtain prior approval from the organization at which the R&D will be carried out before making an application.

## 3.3 R&D proposal (Form) Completion Requirements

A list of the forms to be submitted is shown below. To appropriately prepare an R&D proposal, follow the guidelines provided on the next page onward concerning completing such forms. Be sure to use the forms stipulated for this fiscal year.

Conditions for applications may vary by prioritized theme. Download and use the proposal forms for “large-scale type” provided on e-Rad. Be sure to comply with “Chapter 5, FY2018 Open Call Themes” when preparing “large-scale type” proposal forms.

| Form No. | Document |
|---|---|
| Form 1 | R&D proposal, cover |
| Form 2 | R&D proposal, Project Applicant (Project Leader) |
| Form 3 | R&D proposal, Project Description |
| Form 4 | R&D proposal, plan of Feasibility Study |
| Form 5 | Team to conduct on R&D |
| Form 6 | R&D Budget |
| Form 7 | List of achievements, results of evaluation at completion, list of patents |
| Form 8 | Information on Other Supports |
| Form 9 | Measures for Protecting Civil Rights and Complying with Laws and Regulations |
| Form 10 | References |

*Ensure the file does not exceed 3MB.

*Be sure to familiarize yourself with the definition of a stakeholder provided in “Chapter 4, 4.1.2, Selection method” (2) when preparing proposal forms.

*See “Chapter 7, Submission via the Cross-ministerial R&D Management System (e-Rad)” for application methods for R&D proposals.

*Be sure you have an appropriate understanding of “Chapter 6, Key Points in Submitting Proposals” and “Chapter4, 4.1.1, Concerning restrictions on duplicate applications for the JST-Mirai program” before making an application.

# (Form 1)
# R&D proposal "Large-scale Type" called for in FY2018

| | | |
|---|---|---|
| Technological theme applied<br>※ *Mark "O" for one applied theme* | | Ultrahigh precision time measurement technologies leading to a new time-business |
| | | Development of innovative adhesion technologies for realizing Society5.0 |
| | | Innovative Hydrogen liquefaction technologies desired in future society |
| Name of R&D<br>※*about 20 words* | | |
| R&D period | whole period: month, 2018-month, year ( years) | |
| R&D Budget<br>※*(1)=(2)+(3)*<br>*Omit decimal point* | (1) total R&D costs desired for the whole period ( million yen) | |
| | (2)total R&D costs desired for 1st to 4th year ( million yen) | |
| | (3)total R&D costs desired for 5th year and after ( million yen) | |
| Estimated fund from a sponsoring organization※ | total amount for year fiscal - year fiscal ( million yen) | |

※*Be sure to see "3.1.2 (8), Stage gate evaluation".*

| | |
|---|---|
| Name of R&D Representative (PM) | |
| Affiliation,Depart-ment and Title | |
| Conflicts of Interests with R&D supervisor<br>※*Check* | conflicts of interests with R&D supervisor yes □ no □<br>※*If "Yes", describe contents in Form 5 "4. other"* |
| Researcher number | ※*Enter the 8-digit "e-Rad" login ID number which is provided by registering researcher information on the Cross-ministerial Research and Development Management System (e-Rad)* |
| Information on R&D representative (PM) | URL: author ID: ※*URL if website (lab website, researchmap page) available for information on Project Leader, or ID if ORCHID ID, Researcher ID, or SCOPUS author ID is known* |

# (Form2)
# R&D proposal document, author of R&D proposal

Basic information on the R&D representative

| | | | |
|---|---|---|---|
| Name | | | |
| Nationality/ gender | | birth date (A.D.) | |
| Affiliation, title | | | |
| Addresses | | | |
| Academic history (after graduation from college) | academic history:<br>*(Filling-in example)*<br>*OOyear OOuniversity OOdepartment graduation*<br>*OOyear HOOyear OOgraduate school OOdepartment master's course OOmajor*<br>*OOyear OOgraduate school OOdepartment doctoral course OOmajor*<br>*OOyear Ph.D. (OOmajor) (OOuniversity)* | | |
| Research history (main history and research contents) | job history:<br>*(Filling-in example)*<br>*OOyear-OOyear OOCo.,Ltd OOR&Ddepartment (development of OOOO)*<br>*OOyear-OOyear OOuniversity special associate professor (research on OOOO)*<br>*OOyear-OOyeat OOCo., Ltd OOdepartment (in charge of OO)* | | |
| Other special matters | *(voluntary description on social contributions, international activities)* | | |
| information ① on quality and knowledge | *(major experience, achievement related to management of R&D aiming for commercialization or converting advanced technologies to business)* | | |

| | |
|---|---|
| information ② on quality and education | (reason why the applicant qualifies as PM this project seeks)<br><br>*※See "5. Validity of quality and knowledge of PM" of application information "4.1.3 Selection viewpoints" when filling in here.* |
| Concurrent | ☐Wish to be a PM exclusively affiliated with JST (direct employment by JST)<br><br>☐Wish to be a PM of JST while being affiliated with the present organization<br><br>*※The type of PM contract is determined after the adoption through coordination with JST.* |
| Effort after adopted as PM | % (planned) |

# (Form3)
# R&D proposal document, comprehensive ideas

*※Delete guidelines in blue letters for filling in when filling in this form.Be sure to check application information "4.1.3, Selection viewpoints" and "5.2.1, Management policies for large-scale research projects."*

## 1. The POC to be achieved by this R&D project

*※Provide a simple and clear description of the POC to be reached during the entire R&D period. The description must include enough detail to allow for an objective assessment of success or failure.*

## 2.Reasons for establishing the POC for this R&D project

*※Quantitatively and specifically, describe your reasons for setting this POC as a goal to be reached within a R&D period , in accordance with the questions below:*

*What problem needs to be worked on right now to demonstrate and achieve technological or social or industrial insights? Describe the historical context and reasons for setting this problem.*

*What values, or social and economic impacts, will be created in Japan and overseas, when this problem is solved (social implementation of the POC)*

*Is this a high-risk high impact project with a challenging technological theme that could not be approached by any other program? Does it aim for stand-alone innovation, rather than slow progress?*

*※Summarize "1., The POC that will be achieved through this R&D project" and the items of this article and describe it in "research objective" section of the e-Rad "common matters" page (in about 300 letters).*

## 3. Measures necessary for reaching POC

*※ Provide a quantitative and specific description, taking the following into consideration:*

*Clarify the context, background, and problems that could prevent the POC from being reached, after analyze the situation in Japan and overseas such as the market trends, social demands, and R&D and technology trends.*

*Take into account the above, describe the measures needed to overcome the problems that could prevent the POC from being reached. In addition, demonstrate the originality, challenge, and effectiveness of the measures used to describe recognized risks.*

*- Do not exceed two A4-size sheets (no exceptions) -*

# (Form 4)
# R&D proposal document, R&D plan

*※Delete guidelines in blue letters when filling in this form.*

## 1. Preparatory situation at the initiation of R&D projects

*※Provide specific descriptions of the preparatory situation concerning the following points, including R&D trends in Japan and overseas.*

*Understanding problems in social implementation*

*Understanding R&D projects and their difficulty and feasibility*

*Checking conventional technologies and existing intellectual property rights to understand differences and the superiority of the proposed creative technology*

*Plan to collaborate with and participate in industries toward understanding and solving problems and reaching the POC*

## 2. Detailed R&D plan and how to proceed accordingly

*※Set proper milestones (timing, contents) including how and when R&D will be carried out and describe a quantitative and specific progress schedule including the following points:*

*Approaches to problems in social implementation*

*Approaches to technological problems*

*Timing and contents of fund introduction from funding organizations*

*Understanding pertinent research and technology trends and evaluation followed by application to a necessary extent*

*※Summarize contents here concisely to describe the summary in the "research outline" of e-Rad "common matters." (in about 300 letters)*

## 3. Ideas for the creation, protection, and utilization of intellectual properties

*※ Concisely describe basic ideas of PM regarding intellectual properties for the items below:*

*(1) Basic ideas of PM about which team of which members are to be built for managing intellectual properties*

*(2) Basic ideas for classifying research results created by this project as intellectual properties, and basic ideas about announcement or non-disclosure of the subjects*

*(3) Basic ideas about obtaining rights, maintenance (including required funds), abandonment, and transfer of intellectual properties during and after the execution of this project*

## 4. Management policies for R&D carried out by PM

*※Concisely describe how to manage R&D to maximize results for each of the following:*

(1) Method for managing progress, policies for information management

(2) Policies for forming a joint research group

*※Method of group formation, how to manage competition and cooperation among groups*

(3) Policies for social implementation including industries

(4) Policies for improving or altering the track for R&D, introducing new findings and technologies, and developing achievements

*Form 4 should not exceed 10 pages including figures and tables.*

# (Form 5)
# Team to conduct R&D

*※Delete guidelines in blue letters when filling in this form.*

## 1. Idea for R&D team

*※Describe major R&D organizations highly expected to participate and the timing of their participation, their roles, needs, and the main joint researchers expected to participate. Describe research organizations expected to participate in the future and the timing of their participation to the extent possible. Also describe R&D groups to be given roles through public calls for participation after R&D initiation.*

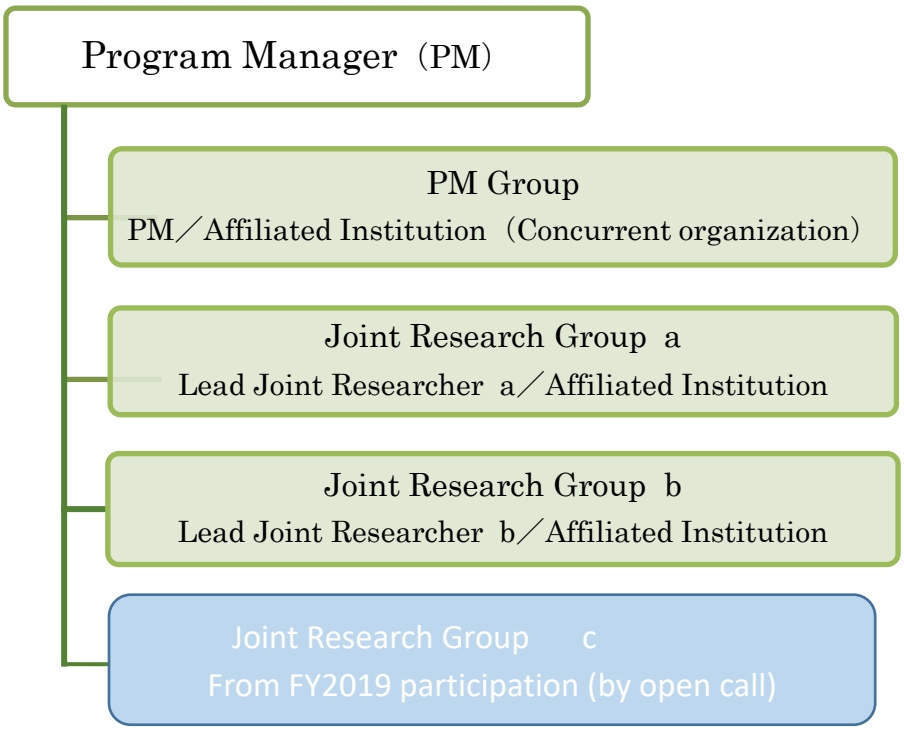
*In addition, provide special descriptions concerning important points about major joint researchers and R&D organizations planning to participate, such as top-level R&D capabilities and findings in Japan.*

## 2. Ideas for support system of R&D organizations

*※Describe support policies and systems of the leading research organizations expected to surely participate that will allow R&D to proceed effectively and efficiently and allow researchers to concentrate on R&D tasks. In addition, describe the leaders and the departments in the organizations that approve the support.*

## 3. Schematic illustration of an R&D team

*※Illustrate an R&D team (Clearly show the initial and future teams. Correct the illustration according to the proposed ideas and plans for R&D as appropriate. The illustration below is provided for reference.)*




*(to be continued on the next page)*

## 4. R&D team

(1) Team of R&D representative (PM) group

*※This is not necessary if PM is employed only by JST. Describe if PM has concurrent jobs.*

| Name of R&D Representative | Name of Research Organization[1)] | Title | Effort[2)] |
|---|---|---|---|
| *OO OO* | *OOuniversity graduate school OOdepartment OOmajor* | *Professor* | *10%* |
| Name of R&D Participant[3,4)] | Affiliation (omit if same as above[5] | Title | |
| *OO OO* | | *Professor* | |
| *OO OO* | | *Associate professor* | |
| *OO OO* | | *Lecturer* | |
| *XX XX* | *XX Co., Ltd., XX Institute* | *Chief Researcher* | |

*1) If adopted research is to be carried out at an organization different from the present affiliation, describe the former and inform us as a special matter.*

*2) Describe effort in percentage for ratio (%) of time distributed to the research relative to 100% for the whole annual work hours of the researcher (not only including research activities, but education and therapeutic activities).*

*3) Adequately examine the roles of research group members.*

*4) Add lines for research participants. A description like "00 researchers" is acceptable if their names are not definitely known.*

*5) In case a number of organizations need to approach the same research project, the addition of members of other organizations as research participants is acceptable.*

(1-1) Role of the relevant group in R&D ideas

(1-2) R&D outline

(1-3) Special matters

*-If special duties (managing position such as head of department or chairman of an academic association) demand work hours (effort), describe the situation and reasons.*

*(to be continued on the next page)*

**(2) Team of joint researcher "a"**

*-Describe in this form 5 each joint research group (joint research organization) besides the organization that the research representative is affiliated with.*
*-A joint research group may include various research organizations from industries, universities, and the government.*
*-No upper limit is set on the number of R&D groups. However, compose a team that is optimal, necessary, and adequate for carrying out the research ideas of the research representative. In forming a team, select R&D organizations and researchers through proper methods such as nomination and public calling for recruiting top-level R&D capabilities and knowledge in Japan.*
*-A team in which the main joint researcher does not play a central role or roles and the position of the joint research group is not clear is not an adequate R&D team.*
*-Add or delete tables depending on the number of groups.*
*-There is no need to describe names, affiliations, or titles of participants. However, provide clearly understandable descriptions of the number of participants. In addition, describe in special matters the timing of the call for proposals and what kinds of organizations and researchers are expected.*

Joint research group "a" (example responses)

| Name of main Joint Researcher | Name of joint R&D Organization [1)] | Title | Effort[2)] |
|---|---|---|---|
| *OO OO* | *OOInstitute OODepartment OOteam* | Team Leader | *10%* |
| *Researcher number[6)]: 12345678*<br>*Research organization code[7)]: 1234567890* | | | |

| Name of R&D Participant[3,4)] | Affiliation (omit if same as above) | Title |
|---|---|---|
| *OO OO* | | *Chief Researcher* |
| *OO OO* | | *Researcher* |
| *Plan to employ two* | | *Special Researcher* |
| *XX XX* | *XX Co., Ltd. X Institute* | *Chief Researcher* |

*See the prior page for 1)– 5).*

*6) Include the eight-digit researcher number for the main joint researcher that was granted when the researcher's information was registered in the R&D management system common to ministries (e-Rad [http://www.e-rad.go.jp/]).*

*7) Describe the code for affiliated research organizations of the R&D management system common to ministries (e-Rad [http://www.e-rad.go.jp/]).*

*(to be continued on the next page)*

(2-1) Role of the group in R&D ideas

(2-2) R&D outline

(2-3) Special matters

*-When forming the group through public call outs, input the timing and characteristics of expected organizations and researchers.*

*-If special duties (managing positions such as the head of department, chairman of an academic association) demand work hours (effort), describe the situation and reasons.*

(3) Other participating R&D organizations (*)

| Name of R&D participant[3, 4)] | Affiliation | Title |
|---|---|---|
| *OO OO* | *OOInstitute OODepartment OOteam* | *Chief Researcher* |
| OO OO | | *Researcher* |
| *XX XX* | *XXCo.,Ltd. XXInstiture* | *Chief Researcher* |

※*Business firms and universities that have not signed an R&D agreement with JST but collaborate and cooperate with research groups that have concluded an R&D agreement with JST.*

(3-1) Roles of participating organizations in R&D ideas

## 5. Other

※*If there are conflicts of interest with the R&D supervisor, describe the specific contents. Check (2) in the application information "4.1.2, Selection methods" for the definition of conflicts of interest.*

# (Form 6)
# R&D budget

*※Delete guidelines in blue letters when filling in this form.*

*-Fill in this form for a research expense plan by account for each R&D group separately for every fiscal year.*

*-A more detailed research expense plan needs to be submitted at the time of the selection interview.*

*-Research expenses may be reviewed at the time of adoption or during the research period, depending on the total budget situation, management by the R&D supervisor, and project evaluations.*

*-Form an optimum R&D team that is necessary and adequate for realizing the research ideas of the R&D representative (PM). The R&D group needs to be indispensable to the realization of research ideas and must be able to make great contributions to the goal.*

○ R&D plan by account (for a whole team) (example responses)

| *(Fill-in example)* | | 1st year (2018.Nov.-2019.Mar.) | 2nd year (2019.Apr.-2020.Mar.) | 3rd year (2020.Apr-2021.Mar.) | 4th year (2021.Apr.-2022.Mar.) | Total (million yen) |
|---|---|---|---|---|---|---|
| Direct Expenses | Equipment | *196* | *196* | *196* | *196* | *784* |
| | Supply | *60* | *60* | *60* | *60* | *240* |
| | Travel | *4* | *4* | *4* | *4* | *16* |
| | Personnel & Gratitude (number of researchers) | *22 (4)* | *22 (4)* | *22 (4)* | *22 (4)* | *88* |
| | Other | *26* | *26* | *26* | *26* | *104* |
| Direct cost total | | *308* | *308* | *308* | *308* | *1,232* |
| Indirect costs | | *92* | *92* | *92* | *92* | *368* |
| Subtotal | | *400* | *400* | *400* | *400* | *1,600* |
| Estimated fund introduction by fund introducing organizations | | *0* | *0* | *0* | *0* | *0* |
| Total (million yen) | | *400* | *400* | *400* | *400* | *1200* |

*(to be continued on the next page)*

| (Fill-in example) | | 5th yr (2022.Apr.-2023.Mar.) | 6th yr (2023.Mar.-2024.Mar.) | 7th yr (2024.Apr.-2025.Mar ) | 8th yr (2025.Apr.-2026.Mar.) | 9th yr (2026.Apr.-2027.Mar.) | Last yr (2027.Apr-2028.Mar.) | Total (million yen) |
|---|---|---|---|---|---|---|---|---|
| Direct expense | Equipment | *294* | *294* | *294* | *294* | *294* | *294* | *1,764* |
| | Supply | *60* | *60* | *60* | *60* | *60* | *60* | *360* |
| | Travel | *4* | *4* | *4* | *4* | *4* | *4* | *24* |
| | Personnel, gratitude (number of researchers) | *24 (4)* | *24 (4)* | *24 (4)* | *24 (4)* | *24 (4)* | *24 (4)* | *144* |
| | Other | *26* | *26* | *26* | *26* | *26* | *26* | *156* |
| Direct cost total | | *408* | *408* | *408* | *408* | *408* | *408* | *2,448* |
| Indirect cost | | *122* | *122* | *122* | *122* | *122* | *122* | *732* |
| Subtotal | | *530* | *530* | *530* | *530* | *530* | *530* | *3,180* |
| Estimated fund introduction by fund introducing organizations | | *133* | *133* | *133* | *133* | *133* | *133* | *798* |
| Total (million yen) | | *663* | *663* | *663* | *663* | *663* | *663* | *3,978* |

*※Accounts for R&D budgets are given below.*
*Equipment: expenses for purchasing equipment*
*Supply: expenses for purchasing supplies*
*Travel: travelling expenses for the R&D representatives and participants*
*Personnel, gratitude: personnel costs for researchers, engineers, research aides, RA (*), gratitude*
*※See application information (4.2.6(1), About improving treatment of students in doctoral courses (latter stage)) for RA (research assistant).*

(to be continued on the next page)

○ **Research expense plan by research group**

*Form an optimum R&D team that is necessary and adequate for realizing the research ideas of the R&D representative. The joint R&D group needs to be indispensable to the realization of research ideas and must be able to make great contributions to the goal.*

| *(Fill-in example)* | 1st year (2018.Nov.-2019.Mar.) | 2nd year (2019.Apr-2020.Mar.) | 3rd year (2020.Apr.-2021.Mar.) | Total (million yen) |
|---|---|---|---|---|
| R&D representative G Oo university | *20* | *40* | *25* | *145* |
| Joint research G-a Xx university | *0* | *30* | *10* | *80* |
| Joint research G-b Xx institute | *17* | *24* | *9* | *75* |
| Total direct costs | | | | |
| Indirect costs | | | | |
| Total (million yen) | *57* | *94* | *44* | *300* |

○ Major facilities for planned utilization (name of instrument, installation site)

○ Major facilities to be purchased (each facility > 5 million yen, name of instrument, approximate price)

*(example responses)*

*Oo group*

*ΔΔΔΔΔΔΔΔΔΔ 15 million yen (Purchase fiscal year )*

*ΔΔΔΔΔΔΔΔΔΔ 5 million yen (Purchase fiscal year )*

*ΔΔΔΔΔΔΔΔΔΔ 10 million yen (Purchase fiscal year )*

*Oo group*

*ΔΔΔΔΔΔΔΔΔΔ 7 million yen (Purchase fiscal year )*

*ΔΔΔΔΔΔΔΔΔΔ 10 million yen (Purchase fiscal year )*

# (Form 7)
# List of achievements, results of evaluation at completion, list of patents

*※Delete guidelines in blue letters when filling in this form.*

**1. Main papers and books related to this R&D proposal (15 or fewer reports)**

*※Describe items below for papers (the same applies to books).*

*※Place a "●" mark in front of a paper cited in Form 4.*

(1) Main papers and books by R&D representative (PM)

*※Authors (all authors), name of the paper, journal, volume, page, year*

(2) Main papers and books by the joint researcher(s)

*※Authors (all authors), name of the paper, journal, volume, page, year*

**2. Papers and books besides those stated above (30 reports or less)**

(1) Main papers and books by the R&D representative (PM)

(2) Main papers and books by a joint researcher

**3. Evaluation at the completion of the research project of another competitive funding system for which the R&D representative served as a representative**

(only those disclosed after fiscal year 2014)

**4. List of intellectual property rights related to this proposal**

*※Place a "●" mark in front of each of the important intellectual property rights*

*※See "Basic policies for managing intellectual properties" (http://www.jst.go.jp/contract/download/h30/h30mirais305manua180401.pdf) for specific subjects and definitions.*

# (Form 8)
# Information on Other Supports

*※Delete guidelines in blue letters when completing this form.*

*※If the Principal Investigator and Lead Joint Researchers are receiving, applying for, or planning to apply for alternative funding systems or other research subsidies (including from private foundations or overseas organizations), describe the research title, research period, role, amount of research expenses received, and efforts made thus far for each of system or subsidy. Also, see application information "6.3, Measures to address unreasonable duplication and excessive concentration."*
*※If a description is found to be false, an adopted proposal may be cancelled later.*
*※If, during the selection process for this R&D proposal, a description in this form requires alteration because the research subsidies applied or planned to be applied for, as mentioned above, have been altered, correct this form and send a notification e-mail to the contact details provided at the end of these application requirements.*
*※Copies of the application documents and plans submitted to other systems may be requested during the selection interview.*

*(example)*
**Project leader:** ***XX XX (name)***

| Name of program | Situation | name of research projects (name of representative) | research period | role (representative/ shared role) | received R&D budget (1) (whole period) (2) (FY2019) (3) (FY2018) (4) (FY2017) | effort (%) |
|---|---|---|---|---|---|---|
| JST-Mirai Program (this Proposal) | applied | | | representative | | |
| *Science research subsidy, base research (S)* | *received* | *◊◊ creation by xx (OOOO)* | *2015. Apr. -2019 Mar.* | *representative* | *(1) 100 M yen (2) 50 M yen (3) 25 M yen (4) 5 M yen* | *20* |
| *JST strategic Research promotion CREST* | *applied* | *◊◊ upgraded function by xx (OOOO)* | *2017 Oct.- 2023 Mar.* | *shared role* | *(1) 140 M yen (2) 35 M yen (3) 8 M yen (4) -* | |
| | | | | | | |

*※List, in descending order of the amounts received (over the entire period), subsidies received or expected to be received. Then, describe subsidies applied for and those that you plan to apply for, if applicable.*
*※If a subsidy is being received or you expect to receive it, enter "received." Enter "applied" if you have applied for but not yet received a subsidy or if you plan to apply for a subsidy.*
*※Describe representative or shared duties under "role."*

*※Describe the amount (direct costs) to be received by the research representative her/himself under "research expenses received by the research representative."*
*※Describe the distribution ratio of the time required to perform the research relative to 100%, which represents total annual work hours (including not only time for research activities but also educational and therapeutic activities) under "effort" [as defined at the Comprehensive Science, Technology, and Innovation Convention]. Only account for efforts expended or planned to be expended on the presumption that a proposal is adopted by JST-Mirai program, not efforts made in regard to proposals submitted to other research organizations, such as those applied to or those planned to be applied to. The total efforts made during the small-start-type phase and efforts made toward subsidies being received should not exceed 100%.*
*※Add or delete lines as necessary.*

*(example)*
**Lead Joint Researcher *a*: *XX XX (name)***

| Name of program | Situation | name of research projects (name of representative) | research period | role (representative/ shared role) | received R&D budget (1) (whole period) (2) (FY2019) (3) (FY2018) (4) (FY2017) | effort (%) |
|---|---|---|---|---|---|---|
| JST-Mirai Program (this Proposal) | applied | | | shared | | |
| Science research subsidy, base research (S) | received | ◊◊ creation by xx (OOOO) | 2015. Apr. -2019 Mar. | representative | (1) 100 M yen (2) 50 M yen (3) 25 M yen (4) 5 M yen | 20 |
| JST strategic Research promotion CREST | applied | ◊◊ upgraded function by xx (OOOO) | 2017 Oct.-2023 Mar. | shared role | (1) 140 M yen (2) 35 M yen (3) 8 M yen (4) - | |
| | | | | | | |

*(example)*

**Lead Joint Researcher *b*: *XX XX (name)***

| Name of program | Situation | name of research projects (name of representative) | research period | role (representative/ shared role) | received R&D budget (1) (whole period) (2) (FY2019) (3) (FY2018) (4) (FY2017) | effort (%) |
|---|---|---|---|---|---|---|
| JST-Mirai Program (this Proposal) | applied | | | shared | | |
| *Science research subsidy, base research (S)* | *received* | *◊◊ creation by xx (OOOO)* | *2015. Apr. -2019 Mar.* | *representative* | *(1) 100 M yen (2) 50 M yen (3) 25 M yen (4) 5 M yen* | *20* |
| *JST strategic Research promotion CREST* | *applied* | *◊◊ upgraded function by xx (OOOO)* | *2017 Oct.- 2023 Mar.* | *shared role* | *(1) 140 M yen (2) 35 M yen (3) 8 M yen (4) -* | |
| | | | | | | |

# (Form 9)
# Protection of Human Rights and Compliance with Laws and Regulations

*※Delete guidelines in blue letters when completing this form*

*※Describe the measures and actions that you will take if your research involves compliance with the related laws and regulations (e.g. research requiring the consent and the cooperation of the other party when implementing the research plan, research requiring consideration for the handling of personal information and research requiring efforts regarding bioethics and safety measures).*

*※This applies to surveys, research, experiments which require an approval procedure in an ethics committee inside and outside the research institution, such as for example questionnaire surveys in which personal information is involved, interview surveys, the use of provided samples, analysis study of the human genome, recombinant DNA experiments, experiments on animals, etc.*

*※Please indicate where this is not applicable.*

# (Form 10)
# References

*※Delete guidelines in blue letters when completing this form.*

*※Provide the names of two (2) individuals who have good knowledge of your Research Project (non-Japanese person(s) are acceptable). Provide names of the reference person, institution and contact information (phone numbers and e-mail address). The evaluators (JST and R&D Supervisor) may contact them regarding the R&D proposal during the screening process.*
*※Providing this reference information is not mandatory.*

# Chapter 4
# Common subject matters of
# Small start type and Large-scale type

## 4.1 Common matters concerning calling for and selection of project proposals

### 1.1. About restriction on duplicate applications to the JST-Mirai program

The following restrictions are imposed on duplicate applications concerning R&D proposals called for the JST-Mirai program in fiscal year 2018.

Certain measures may also be taken for unreasonable duplication or concentration for other projects inside and outside JST that are not described here. See “6.3, Measures for unreasonable duplications and concentration” for details.

<Common to small start type and large-scale type themes>

(1) A Principal Investigator (PL/PM) is only allowed to apply one proposal for every prioritized/technology theme of the small start type and the large-scale type.

(2) Applicants who are at the research representative(PM) of this project at the time of proposal cannot apply.
However, if the R&D period of that research subject is scheduled to be completed within the FY2018, it is possible to apply.

(3) The following restrictions are imposed on R&D proposals if the main joint researcher participates in research:

a .Multiple applications are not allowed in which the Principal Investigator and the main joint researcher exchange positions.

b. If a person participates in two or more R&D proposals as a Principal Investigator or a Lead Joint Researcher and multiple R&D projects are adopted, the R&D supervisor takes into account the contents and scales of the research to make adjustments, such as decreasing research expenses or disapproving some of the R&D projects in which the researcher participates.

<only applies to “Realization of a Low Carbon Society, a global issue” area (small start type)>

A “present Principal Investigator” of advanced low carbon technology development, a strategic creative research promotion project, is not allowed to apply for the JST-Mirai program (small start type) in the “Realization of a low carbon society” area (except for the case that the research period for the R&D project ends within fiscal year 2018).

### 4.1.2 Selection method

See “Solicitation and Selection Schedule” on the cover for the schedule related to selection.

### (1) Selection process

The R&D supervisor cooperates with the R&D management committee to review documents, and conducts interviews in order to make a selection. She/he may also seek cooperation from outside evaluators.

Document-based selection for small start type proposals may perform a first-stage selection mainly based on the proposal document “whole ideas of R&D projects – form 2” of the small start type R&D by prioritized theme, depending on the number of applications.

This first stage selection is mainly based on whether a proposal meets the purpose of the

prioritized theme (whether it is promising for achieving the objective of the prioritized theme) and on the viewpoint of whether it meets the objective of the small start type. Only proposals that meet the criteria proceed to full document-based selection by the "R&D plan for the small start type – Form 3."

The first stage selection is only for the small start type. When the first stage selection is conducted, it is not announced to the public.

In addition, surveys besides the above may be conducted if necessary for selection. Furthermore, if the Principal Investigator or a main joint researcher is affiliated with a commercial organization, submission of a financial statement may be requested.

JST selects Principal Investigators and R&D projects on the basis of the above selection.

Names of R&D management committee members are announced on the website of this project as soon as it is decided. However, this is not to guarantee that all of the names will be announced by the end of the selection.

Prioritized themes and technology themes: http://www.jst.go.jp/mirai/jp/theme/

## (2) Persons engaged in selection

Based on JST's rules and from the viewpoint of fair and transparent evaluation, the stakeholders described below do not participate in the selection of R&D proposers and the like.

a. Those who are in kinship with an R&D proposer
b. Those who are affiliated with the same department or laboratory of an R&D organization of a university or a national R&D agency or the same department of the same private firm
c. Those who conduct joint R&D closely related to an R&D proposer.
   (For example, conducting a joint project, writing a joint research paper, research members for the same objective, or those considered affiliated with a research group that is substantially similar to that of a Principle Investigator.)
d. Those who are in a close teacher-student relationship or in a direct employment relationship with an R&D proposer
e. Those who are in a directly competitive relationship with the R&D projects of an R&D proposer.
f. Others who are judged to be stakeholders by JST

## (3) Interviews for selection and notice of selection results

a. A proposer who is selected for interview as a result of document-based selection receives such a notice and is informed on guidelines for interview, schedule, and additionally requested information materials. Submission of applications and plans for other research funds may also be requested at the time of the interview. JST and the R&D supervisor may contact proposers subject to interviews concerning matters for which explanations are requested at the interview, depending on results of document-based selection and surveys. If an Principal Investigator or a Lead Joint Researcher is affiliated with a commercial organization, submission of a financial statement may be requested.

The interview schedule will be announced on the website that publicizes the calls for R&D proposals as soon as it is decided.

http://www.jst.go.jp/mirai/jp/application/research/

b. The R&D proposer her/himself is requested to explain the contents of the proposal at the time of the interview. Interviews are in principle conducted in the Japanese language. However, if a proposer finds it difficult to explain a proposal in Japanese, she/he may explain it in English.

c. An R&D proposer whose proposal is adopted as a result of selection receives a notice as well as a procedure for R&D initiation.

d. An R&D proposer whose proposal is not adopted receives a notice of the selection result after all selection process is over. The reasons why the proposal was not adopted are mailed separately. During the selection period, we will not notify about non-adopted proposals.

### 4.1.3 Selection Perspective

## (1) Selection Standards (Preliminary Evaluation Standards)

Common selection standards for the small start type and large-scale type are described below. All standards described in 1.-5. must be met for selection of the small start type (full-scale research) and the large-scale type.

| **Common to the small start type (full-scale research) and the large-scale type** |
|---|
| 1. Does the objective aim for the proof of concept (POC)?<br>・ Is the objective (and milestone) set to allow the POC to be clearly defined in a form that makes objective judgment possible? Also, does the objective meet the purposes of a prioritized theme and a technology theme? |
| 2. Whether highly impactful<br>・ Are the needs to achieve the proof of concept (POC), or so far non-existing social and economic impacts, and social and industrial needs for it verified on the basis of evidence? |
| 3. Are challenges and risks understood?<br>・ Is a bottleneck (technological issues and difficulty, issues and difficulties for social implementation) in achieving the proof of concept (POC) clearly recognized? And are risks in achieving it understood accurately? |
| 4. Are the R&D plan and R&D ideas appropriate?<br>・ Is a method for the bottleneck described in 3., or an R&D plan* appropriate? In addition, is a vision (business model and the like) for activities after research completion included in the plan?<br>*A specific plan of participation of industries for “large-scale type”<br>*The quality of the Principal Investigator (PL/PM) is judged as part of R&D ideas and to supplement selection criteria for the small start type and the large-scale type. |
| 5. Are the quality and achievements of the Principal Investigator appropriate?<br>Check “(2) Supplement for selection standard” on the next page for this item. |

## (2) Supplement for selection standards

In addition to the above “(1) Selection standards”, selection standards (standards for prior evaluation) for each of the small start type (Feasibility study) and the large-scale type are given below.

## <Supplement to selection standards for the small start type>

Feasibility studies of the small start type are selected using the following items based on selection standards.
Full-scale research projects are selected on the basis of evaluation after a feasibility study.

1. Is the goal clear and aiming for a proof of concept (POC)?
   - The proof of concept (POC) is defined as clearly as possible and is focused on the core of a prioritized theme.
   - Socially, industrially, and technologically challenging goals are explained as specifically as possible in a form that allows the proof of concept (POC)to be judged for validity and focused on the core of a prioritized theme.

2. Whether or not impactful?
   - Achievement of the proposed proof of concept (POC) exerts great social and economic impacts (if realized, it reforms the future of society and industries in Japan) and social and industrial needs for it are verified with concrete evidence, or the verification process is examined.

3. Are challenges and risks understood?
   - Is a bottleneck (technological difficulties, issues in social implementation) in achieving a proposed proof of concept (POC) explained clearly or is the verification process examined?
   - A set goal is adequate for clearing the bottleneck (technological issues and difficulties) and highly challenging considering research trends in Japan and overseas (“results of R&D are expected to be considered “marvelous” by society, business firms, and investors).
   - Risks in achieving the proposed proof of concept (POC) are accurately recognized, the likelihood of the achievement is indicated reasonably well, or the verification process is examined.

4. Are the R&D plan and ideas appropriate?
   - An R&D plan (execution system, budget, setting stage gates) for achieving a proposed proof of concept (POC) has been considered.
     *The goal for the feasibility study and a plan for achieving it are at least concrete and appropriate in the above plan.
   - Plans, techniques, and milestones have original contents.
   - An action plan that takes into account development (a business model including costs accruing after the POC and time, passing results over to business firms) of research results is examined.

Component technologies of the small start type are selected using the following items based on selection standards.

| |
|---|
| 1. Is the goal clear and aiming for a proof of concept (POC)?<br>• The proposed R & D goals are in sharp focus on core of the prioritized theme and contributing to realization.<br>• R&D goals are explained as specifically as possible in a form that allows the judged for validity. |
| 2. Whether or not impactful?<br>• It is clearly stated that the impact on the prioritized theme is extremely large by achieving of this proposed R&D goals. |
| 3. Are challenges and risks understood?<br>• Is a bottleneck (technological difficulties, issues in social implementation) in achieving a proposed proof of concept (POC) explained clearly?<br>• Creative and Challenging |
| 4. Are the R&D plan and ideas appropriate?<br>• R & D plan to achieve goal is conceived<br>• Plans, techniques, and milestones have original contents. |

The Principal Investigator for the small start type research plays a role in promoting R&D under the R&D supervisor. The Principal Investigator is expected to integrate collaboration with her/his aides and pass the position and support from an affiliated organization to another person in order to manage whole R&D project.

Considering the role and responsibilities of the Principal Investigator in small start type research, it has been decided that the quality and achievements of the Principal Investigator are evaluated using “5. Are the quality and achievements of a PM appropriate?” in “4.1.3, Selection viewpoints” <Supplement to selection standards for the large-scale type> defined for the large-scale type as a reference.

Measures and system preparation are required for supporting R&D at R&D institutions for the examination of transfer to full-scale research. The preparation and examination are used as references for selecting feasibility studies.

## <Supplement to selection criteria for the large-scale type>

Large-scale type studies are selected using the following items based on the selection criteria.

| |
|---|
| 1. Is the goal clear and aiming for a proof of concept (POC)?<br>• The goal (and milestones) aiming for the proof of concept are clearly set.<br>• The R&D plan concretely proves and shows a proof of concept (POC) to others, including private firms, so that feasibility may be judged when the goal is reached. |
| 2. Whether or not impactful?<br>• A reasonable vision for development after a proof of concept (POC) and a reasonable |

| |
|---|
| outcome that reforms the future of society and industries in Japan are depicted.<br>• A goal and a depicted outcome, if realized, bring great innovations (of high impact) to the society and industries in Japan in the future.<br>*It is desirable to indicate evidence-based and concrete impacts if possible. |
| 3. Are challenges and risks understood?<br>• The set goal is highly challenging enough to clear a bottleneck (technological issues and difficulty) (are R&D results expected to be considered “marvelous” by business firms and investors?).<br>• Risks in reaching the goal are accurately recognized.<br>• The likelihood of reaching the goal is indicated in a reasonable manner, taking risks into account. |
| 4. Are the R&D plan and ideas appropriate?<br>• The R&D plan aims to reach a goal and is appropriate (including an R&D team and setting stage gates).<br>• It can recruit top-level R&D capabilities and knowledge. In addition, it can be expected to yield excellent achievements to be publicized (papers and the like).<br>• On the basis of a reasonable vision for development after the proof of concept (POC), approaches are planned that lead to exits such as collaboration with private firms, venture businesses, passing R&D to other projects, and yielding human resources that can pass R&D over.<br>• Participation by industries is planned in a concrete manner. |
| 5. Are the quality and achievements of the Principal Investigator appropriate?<br>• Outstanding ideas, knowledge, planning ability, and management ability<br>• Expert knowledge and understanding of technology themes, ability to grasp news and R&D trends in Japan and overseas<br>• Ability to overlook a wide range of technologies and market trends, ability to commercialize and develop ideas from various viewpoints<br>• Ability to communicate not only with researchers but with all associated people, leadership for reaching a goal<br>• Network with experts in industries, academia, and the government and ability to collect technological information<br>• Willingness to achieve highly impactful innovations<br>• Ability to present comprehensible explanations about her/his own R&D ideas to outsiders |

**<supplement>**

1. See “Chapter V, Prioritized themes and technology themes to call for proposals” for item 1. “Purposes of prioritized themes and technology themes” of “4.1.3(1), Selection criteria (prior evaluation criteria”. Unique selection viewpoints and policies as well as management policies are also described by prioritized theme and by technology theme.
2. “Unreasonable duplications” or “excessive concentration” of R&D budgets is also a selection criterion. See “6.3, Measures for unreasonable duplications and excessive concentration” for details.

3. JST may ask for the submission of information materials besides proposal documents to manage conflicts of interests among researchers. (An example is a case in which a PM allows an organization in conflict of interest with the PM to participate in a joint research group.)

## 4.2 Common matters related to research promotion after adoption

### 4.2.1 Preparing a R&D Plan

a. Once selected, project leader and program manager (PL/PM) will be requested to an overall R&D plan covering the entire R&D project period. PL/PM will be also requested to prepare overall and annual R&D plans. R&D plans include information on the R&D budget and team structure. Actual R&D budgets are determined after confirmation and approval by R&D Supervisor (PO) when an annual R&D plan is prepared.

b. R&D plans (overall and annual plans) become official once they are checked and approved by the PO. The PO will offer advice and coordination assistance on the R&D plan, and provide instructions when necessary, based on information the PO gains through, for example, the project selection process, discussions with PL/PMs, regular progress updates, and the results of R&D evaluations.

c. The PO, in approving R&D project plans to achieve objectives including the accomplishment of the overall objectives of prioritized themes and technical themes, may merge or link R&D projects, or take other coordinative actions.

*R&D organizations and budgets set forth in R&D plans may be revised during the R&D project period in response to overall JST-Mirai program budget conditions, Area management actions taken by the PO, or factors like results of R&D evaluations.

### 4.2.2 R&D agreement

a. Once a R&D project is selected, JST, in principle, will enter into a contract R&D agreement with the R&D institutions with which the PL/PM, Lead Joint Researcher are affiliated.

b. If it is not possible to conclude contract research agreements with these research institutions, or not possible to put in place the management and audit systems required in connection with the use of public funds, or it the subject R&D institutions are conspicuously financially unstable, it may be impossible to pursue R&D at the subject R&D institutions. For more details, please refer to "4.2.5 Responsibilities of R&D Institutions".

c. In principal, patents and other intellectual property rights resulting from R&D shall, in accordance with contract R&D agreement terms, reside with R&D institutions under the condition that the R&D institutions abide by the items provided in Article 19 (Japanese version of the Bayh-Dole Act) of the Industrial Technology Enhancement Act. However, this rule does not apply to foreign R&D institutes.

[Important]
When a PL/PM is employed by JST (including cross appointments), depending on the R&D institution where the PL/PM will perform R&D work, there will be cases where joint R&D contracts need to be concluded in a different way from the usual contract R&D agreements and intellectual property rights dealt with separately.

### 4.2.3 R&D costs

JST will pay research institutions a contract research cost, which is defined as the sum of the research costs (direct costs) and overhead (indirect) costs, which is up to 30% of the direct costs.

(1) R&D Costs (Direct Costs)

R&D costs (direct costs) means costs that are directly related to and required for the pursuit of the subject research. R&D costs can include:

a. Commodities: Costs for the purchase of new facilities[1)], equipment, consumable supplies, etc.
b. Travel Expenses: Expenses for travel by the Principal Investigator, Lead Joint Researcher, research participants listed on the research plan and Individual Researcher.
c. Personnel costs: Salaries for research participants and honorariums.
However, duplications are avoided in personnel cost for a researcher (Principal Investigator, Lead Joint Researchers), a national university, an independent administrative corporation, or an incorporated educational institution that the government provides with a management subsidy or a private school subsidy.
d. Other Expenses: Costs related to the presentation of research results (research paper submission fees, etc.), costs for leasing and transferring of equipment, etc.

Note 1) The purchase of new research equipment and apparatuses will proceed according to the "Research Equipment and Apparatus Sharing Systems for Research Organization Units" (hereinafter referred to as "apparatus sharing systems"), which shall operate on the premises of "Introduction of New Research Equipment and Apparatuses Operating Integrally with Research Organization Management" (Advance Research Fundamentals Working Group, Scholarship Commission, November 2015). Please refer to "5.2.10 Other Considerations" for details.

*The following costs are examples of those not treated as research costs (direct cost).
・Costs for items not consistent with the research objectives.
・Costs that are considered to be more appropriately handled as overhead cost（indirect cost).

*For certain items, JST has created specific rules and guidelines from sources like the contract research agreement, administration manuals, and a common governmental expense categorization table. Universities, etc. (Universities, public research institutions and public-service corporations recognized by JST) and companies (mainly research institutions operated by private companies) may differ in their handling of administrative matters. For more details, please refer to the following URLs (only in Japanese).

<JST-Mirai program: > (TBA)
http://www.jst.go.jp/contract/index.html
<MEXT: Table of expense classification common to prefectures>
http://www.mext.go.jp/a_menu/shinkou/hojyo/1311601.htm

*In hiring research staffs, please give consideration to supporting the career paths of people who have recently completed their doctoral programs and improvement of working condition of doctoral course students. For more details, please refer to "4.2.4 Responsibilities of Research Directors, Lead Joint Researchers" and "4.2.6 Other

Considerations".

(2) Overhead (Indirect) Costs

Overhead (indirect) costs are costs required for the management, etc. of research institutes pursuing research; they are in principle capped at 30% of direct costs. According to "Common Guidance for the Execution of Indirect costs of the Competitive Fund" (agreed upon by the coordination committees of relevant ministries and agencies on April, 2001 and revised on May 29, 2014), regarding indirect costs, a policy on use, etc. shall be created and shall be systematically and properly executed to ensure that use is transparent.

(3) Multiple-year contract and Carryover

From the perspective of the effective and efficient use of research expenses to maximize research results and prevent unauthorized use, in order to be capable of carrying over research expenses and procurement contacts over financial years, JST has made research contracts into multiple-year contracts. With regard to carrying over, universities are treated differently from business firms. In addition, multiple-year contract or carrying over may not be acceptable to the office management system of some research organizations.

(4) Diversion of direct cost among items

Under certain requirements, flexibility can be diverted between expense items.

・Requirement of confirmation of JST is not required, requirements that can be diverted.

When the diversion amount by each expense does not exceed 50%（when this amount is less than 5 million yen it is 5 million yen） of the direct costs in the relevant fiscal year. JST confirmation is required beforehand if accompanied by a significant change in research plan.

・Requirements for confirmation of JST.

JST pre-approval is required when the amount of diversion in each expense exceeds 50% of the total direct costs and 5million yen in that year. Please note that diversion between direct and indirect costs is not permitted.

### 4.2.4 Responsibilities of Principal Investigator, Lead Joint Researchers after approval

(1) Research Directors, Lead Joint Researcher, and Individual Researchers are responsible for fully recognizing that JST research budgets are funded by precious tax revenues collected from citizens, and for fairly and efficiently executing budgeted expenditures.

(2) Once a proposed research project is selected, the Research Director and Lead Joint Researcher shall affirm that they will fulfill the following requirements, presented to them via JST briefings and other means, and submit to JST a written document evidencing this affirmation.

a. Comply with application guidelines and other requirements.

b. Pledge not to become involved in research misconduct (fabrication, falsification, plagiarism) or in the improper use of these funds.

c. To prevent any research misconduct (fabrication, falsification, plagiarism), enroll in and complete the JST-specified research integrity educational program (CITI Japan e-learning program) and promise to educate the research participants of the obligation

to enroll in and complete the program and make them understand. For details refer to “8.1 Enrolling in and Completing the Educational Program for Research Integrity.”

Note that failure to complete the research integrity educational program in c. above can result in the suspension of the research budget until confirmation has been made that the program has been completed.

(3) The Research Director and research participants are required to complete the research integrity educational program (CITI Japan e-learning program) specified by JST to prevent research misconduct (fabrication, falsification and plagiarism). For details, refer to “8.1 Enrolling in and Completing the Educational Program for Research Integrity.”

(4) Promotion and management of R&D

a. The Principal Investigator is held responsible for the whole R&D team, with responsibilities including preparation and implementation of a R&D plan. The Principal Investigator needs to comply with “Basic policies for the management of Intellectual Properties,” conclude “joint intellectual property treaties,” and cooperate with R&D institutions in order to promote proper activities for intellectual properties.
   The Principal Investigator is responsible for cooperation with R&D organizations to provide an R&D site and research environment necessary for R&D promotion. When serious obstruction of R&D implementation location and environments to promote research is found, R&D project may be cancelled.
   “Basic policies for the management of Intellectual Properties”
   http://www.jst.go.jp/contract/download/h30/h30mirais305manua180401.pdf

b. R&D teams shall also be responsible for submitting R&D reports and other required documentation to JST and Research Supervisors and taking steps required for &D evaluations. R&D teams shall also be responsible for providing the progress and other reports the Research Supervisor may request from time to time.

(5) Principle Investigators together with R&D institutions shall appropriately manage (expenditure planning, monitoring, etc.) overall R&D budgets for R&D teams. Lead Joint Researcher together with R&D institutions shall appropriately manage (expenditure planning, monitoring, etc.) R&D budgets for his/her own R&D team.
When students join to R&D team, their academic supervisors are also held responsible as “research monitors” for the terms and conditions of the contract research agreement with JST. If, for example, a student researcher has committed misconduct or other improprieties as defined by Article 13 of the contract research agreement, both the student and the academic supervisor will be held accountable.

(6) Principle Investigators and Lead Joint Researcher are asked to be mindful of research and working environments and conditions for their own group's research participants, and especially research staff and others whose employment is being funded by JST-Mirai program funds.

(7) It is recommended that Research Director Principle Investigators and Lead Joint Researcher actively support the development of varied domestic and international career paths for research staff who have recently completed doctoral programs and are being

employed with research budget funds. In the research project selection interview, research project applicants will be asked about plans for supporting the development of varied domestic and international career paths for research staff who have recently completed doctoral programs and will be employed with research budget funds. In addition, in interim and post-completion evaluations, questions will be asked regarding the status of career path assistance efforts and the post-completion career paths of the research staff who were the subject of career path assistance efforts.

* Please refer to the details in “4.2.6, Other Considerations”

(8) Handling of Research Results

a. Given that R&D results were obtained with national government funding, it is asked that R&D results are actively reported on both domestically and internationally, with due consideration for the acquisition of intellectual property rights. It is also asked that active efforts be made to secure intellectual property rights under the “Basic policies for the management of Intellectual Properties”. In principle, intellectual property rights are to be applied, in accordance with contract research agreement terms, by the research institutions with which researchers are affiliated.

b. When reporting on R&D results through research papers or other media, please indicate that the results were obtained via the JST-Mirai program (Small start type, Large-scale type).

c. The Principle Investigator is asked to submit to JST a data management plan that sets forth policy on storage, management, publicity and non-publicity in regard to research data obtained from research team activities and research data to be made public for each of the items below, together with a research plan document. Further, data storage, management, and publishing based on the above policy are requested.
For details regarding the following entries, please refer to the “Guideline of the JST’s basic policies for handling research achievements toward an open science promotion” below.

http://www.jst.go.jp/pr/intro/openscience/guideline_openscience.pdf

[Entries in the data-managing plan]

- Policy on the storage and management of research data to be managed
- Policy related to publicity and non-publicity in regard to research data
- Providing methods and systems for data to be made public
- Assumed use applications for public research data
- Initiative for the promotion of the use of public research data
- Other items of note

d. The adopted researcher is requested to participate in the workshops and symposia that JST holds in Japan and overseas, interdisciplinary activities and outreach activities aiming for the promotion of R&D collaboration and synergy in prioritized themes, technology themes and areas of this project with researchers of the R&D group. In addition, she/he is expected to actively promote global activities and issue information while promoting R&D activities.

e. It is asked that active efforts be made to secure intellectual property rights. In principle, intellectual property rights are to be applied, in accordance with contract research agreement terms, by the research institutions with which researchers are affiliated.

(9) Researchers are asked to actively engage citizens in discussions of science and technology to promote citizen's understanding and support of science and technology. Efforts to engage citizens in discussions of science and technology will be evaluated both interim and post-completion evaluations.

*Please refer to the guideline details in "1.5.4, Promotion of dialogue and collaboration with the public"

(10) Researchers shall abide by research agreements entered into by JST and research institutions, and shall abide by JST's various rules.

(11) It should be noted that JST will provide research project names, names of researchers, research budget information, and other required information to the Cross-ministerial R&D Management System (e-Rad) and the Government Research and Development Database ("6.2, Handling of Information Provided in R&D Proposals, Etc."). Principle Investigators and others, therefore, may be asked to provide various types of information in that connection.

(12) Researchers will cooperate with accounting examinations by JST, accounting audits by the national government, and similar activities.

(13) Researchers will cooperate with JST-Mirai Program evaluations. Researchers will cooperate by providing various types of information, responding to interviews, etc. in connection with follow-up evaluations performed sometime after project completion.

### 4.2.5. Responsibilities of Research Institutions

Research Institutions must fully recognize that the research funds are public funding, ensure compliance with related law, and make efforts to implement the research effectively upon implementation. Research institutes that cannot accomplish the tasks described below will not be enjoined to implement research; thus, when applying, the prior consent of the research institute at which the implementation of research is planned shall definitively be obtained.

(1) For Domestic Institutions

a. Research organizations shall conclude the research contract with the content proposed by JST. Further, research institutes are responsible for properly implementing research in accordance with the research contract document, administrative process document, and research plan. When the contract cannot be concluded, or when it is judged that research at the research institute is not being implemented properly, the implementation of research at the research institute shall not be admitted

*For the latest sample of the research contract document, please refer to the URL below.
http://www.jst.go.jp/contract/index.html

b. Research institutions, with an autonomously instituted management and audit system for public research budgets, are obligated to properly execute the contract research

funds in accordance with the “Guidelines for Management and Audit of Public Research Funds at Research Institutions (implementation standards)” (decided by the Minister of Education, Culture, Sports, Science and Technology on February 15, 2007; revised on Feb. 18, 2014). Research institutions, in addition to reporting the status of their management and audit system for public research budgets to the Ministry of Education, Culture, Sports, Science and Technology, are also obligated to support various investigations into their system implementation and other related matters

*”Regarding implementation of systems based on the Guidelines of Management and Audit of Public Research Funds in Research Institutes (Implementation standards)”
http://www.mext.go.jp/a_menu/kansa/houkoku/1343904.htm

c. In accordance with the “Guidelines for Responding to Misconduct in Research Activities” (August 26, 2014, adopted by the Minister of Education, Culture, Sports, Sciences and Technology), research institutes are asked to construct necessary regulations and systems that they are responsible for in order to prevent misconduct. Research institutes are responsible for responding to various investigations relating to systems construction based on the guideline

*“Regarding implementation of systems based on the “Guidelines for Responding to Misconduct in Research Activities”
http://www.mext.go.jp/b_menu/houdou/26/08/1351568.htm

d. Research institutes are responsible for ensuring that associated researchers fully recognize the contents of the above guideline described in a and b and have been trained with teaching materials related to research ethics provided by JST.

e. Research institutes shall expend and manage research expenses properly in accordance with the regulations of the research organization while considering flexibility; when items are regulated by administrative process documents, etc., provided by JST, which state rules specific to the project, the rules shall be obeyed. (For research institutes receiving Grants-in-Aid for scientific research expenses, it is possible that items not described in administrative process documents for use in research expenses may be handled in conformity with the Grants-in-Aid for scientific research expenses.)

f. Research institutes shall either enter into contracts with associated researchers that ensure that intellectual property rights resulting from the implementation of research will be accorded to the research institutes or construct work regulations in this vein. In case a student who is not employed by a research organization participates in research, a necessary measure, such as concluding a contract with the student in advance, needs to be taken in order for pertinent intellectual property right associated with the invention (including ideas) that the student made during the research to belong to the research organization unless it is clear that the student cannot be an inventor. Take into consideration eliminating conditions unfavorable to the student, the inventor, concerning the price of transferring the intellectual property right.
In addition, when intellectual property rights are transferred, exclusive licenses are granted, etc., in principle, the prior approval of JST is needed, and when application, registration, implementation, and renunciation are conducted, a prior report to JST is needed.

g. Research institutes are responsible for responding to accounting investigations by JST and account audits by the Government.

h. Research institutes shall obey measures pertaining to changing terms of payment and will accept decreased payments decided upon by JST based on JST investigations related to administrative managing systems, financial conditions, etc.

i. When research institutes are national or municipal organizations, such institutes concluding research contracts shall definitively implement necessary budgetary measures before starting research contracts for which they are responsible. (In case it becomes apparent that the non-fulfillment of necessary procedures after contracting will occur, measures to release the research contract and rescind research funds will be taken.)

j. As part of the effort to prevent misconduct in research and development activities, JST has required researchers, who are part of newly selected research projects and who also are affiliated with a research institution, to enroll in and complete the educational program on research integrity (The procedures required for enrollment will be handled by JST). Research institutions are to supervise, without fail, the enrollment in and completion of the program by the relevant persons.

In the event that the relevant researchers fail to complete the educational program as stipulated despite repeated reminders by JST, the research institution will be instructed to halt, partially or entirely, the execution of contract research fund payments. In line with this instruction, the research institution is to halt all use of the research funds and not restart their use until further notice from JST.

k. Take necessary measures, such as concluding a joint research contract with participating organizations within a range of contract research agreements with JST concerning handling of intellectual property rights or confidentiality in order to avoid problems in properly undertaking research or utilizing research achievement.

(2) For Overseas Institutions

a. In principal, R&D institutes shall conclude research contracts with content proposed by JST. (Indirect costs are capped at 30% of direct costs.) Further, research institutes are responsible for proper implementation of the research in accordance with the research contract document and research plan. When contracts cannot be concluded, or when it is judged that research at the research organization will not be properly implemented, the implementation of research at the research organization shall not be admitted.

*A sample of a research contract document for overseas institutes is in preparation. If necessary, please contact us by e-mail to the inquiries found at the end this application guide.

b. R&D institutes are responsible for properly disbursing and managing R&D budgets for which they are responsible based on the research contract, guiding principles, etc. When JST designates guiding principles, etc. separately; they are responsible for creating and reporting expense details (for domestic organizations, this corresponds to accounting books) in English. Research institutes shall respond to various investigations related to implementation status per JST request in the period of the contract.

c. Research institutes shall transfer intellectual property rights resulting from research without compensation (Article 19 of the Industrial Technology Enhancement Act, the Japanese version of the Bayh-Dole Act, will not apply to overseas organizations).

*From the view of the point of Security Export Control, JST may not conclude joint

research agreements with such institutions as Japanese Ministry of Economy, Trade and Industry (METI) announces in the “Foreign User List” (or “End User List”).

(3) R&D institutions that receive funds to cover overhead cost (indirect cost)

R&D institutions that receive funds to cover overhead cost (indirect cost) must appropriately manage their overhead cost (indirect cost) and properly retain, for a period of five years following the conclusion of the contract research agreement, receipts and other documentation* evidencing the proper use of funds for covering overhead cost (indirect cost). Furthermore, the head of a research institution that has received funds to cover overhead cost (indirect cost) must report, on the designated form, each fiscal year's overhead cost (indirect cost) expenditures by June 30 of the following fiscal year through Research and Technology Management System common to ministries (e-Rad).

*As documentary evidence, documentation that incorporates overhead cost (indirect cost) covered by other competitive funds may also be used (It is not necessary to employ segment accounting to reflect multiple research agreements.)

### 4.2.6 Other Considerations

(1) RA (Research Assistants)

The 3rd, 4th and 5th Science and Technology Basic Plan set a numerical target that “enabling 20 percent of doctorate course students to receive an amount equivalent to their living expenses” in order to attract quality students and business persons from Japan and overseas by increasing economic supports.

In “Reformation of Education in Graduated School Leading Future (Deliberation Summary)” (Work Group on Universities, Central Council for Education, September 15, 2015), it was requested that research assistant (RA) employment for (latter-stage) doctoral students be enhanced by various financial resources and that payment for employed (latter-stage) doctoral student RAs and TAs be standardized at a level approximating living expenses.

Given these intentions, it is requested that (latter-stage) doctoral students be employed as RAs and that payment at an appropriate level for living expenses and at an appropriate level for hours worked be established.

Excerpt from “Fifth term Basic Plan of Science and Technology, Chapter IV Strengthening basic force for science and technology, (1) human resource development”,①Development, securement, and activity promotion of human resources as intellectual professionals, (iii) Promotion of reforming graduate school education.

To attract excellent students and working people in Japan and from overseas, financial supports to graduate students, those in a Ph.D. course (the latter half) in particular, need to be improved. Universities and public research organizations are requested to increase employment and improve treatment of students in the Ph.D. course (the latter half) as teaching assistants (TA), research assistants (RA) or the like. The central government attempts to enlarge the fellowship program as well as promote approaches by relevant agencies. This aims to quickly achieve the goal for “about 20% of students in the PH.D. course (the latter half) to receive a fellowship roughly corresponding to living expenses”

set out in the basic plans of the 3rd and 4th terms. <omitted hereafter>

"Fifth term basic plan of science and technology"
(outline)
http://www8.cao.go.jp/cstp/kihonkeikaku/5gaiyo.pdf
(text)
http://www8.cao.go.jp/cstp/kihonkeikaku/5honbun.pdf

"Reforming graduate school education, which leads the future (summary by council)" (September 15, 2015, University subcommittee, Central council for education,)
(outline)
http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2016/02/09/1366899_02.pdf
(text)
http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2016/02/09/1366899_01.pdf

Note: Considerations in hiring doctoral course students as Research Assistants (RAs)

- It is recommended that annual compensation approximate 2 million yen per year, or 170,000 yen per month, so please estimate research budgets based on these figures.
- Judgments regarding the specifics of payment amounts, payment timing, etc. will be left to research institutions. There are no requirements concerning the payment of amounts either above or below the levels mentioned above.
- The prerequisite for one receiving scholarship or other program payments as an RA are that multiple funding sources are not a hindrance to the respective scholarship, program, and affiliated research institution and that expenses can be prorated to the time engaged on the other programs.

(2) Career Paths for Young Research Staff with Doctoral Qualifications

The Ministry of Education, Culture, Sports, Science and Technology's basic policy for supporting diverse career paths for young research staff who have doctoral qualifications and are being employed with public research funds (December 20, 2011 Council for Science and Technology, Committee on Human Resources) states that it is necessary to actively support public research institutions and research directors who are using public research funds to employ young research staff with doctoral qualifications in their efforts to secure diverse domestic and overseas career paths for these young research staff members. Given these intentions, when public research funds (i.e., competitive funds, other project research funds, and project-type education research funds) are used to employ junior doctoral researchers, when projects are adopted, active assistance to ensure that students can pursue various research career paths will be appreciated.

Further, considering the utilization of indirect costs for relevant initiatives will be appreciated. For more details, please refer to "4.2.4 Responsibilities of Principal Investigator, Lead Joint Researchers after approval" and the following URL.

http://www.mext.go.jp/b_menu/shingi/gijyutu/gijyutu10/toushin/1317945.htm

(3) Promotion of the sharing of research equipment and apparatuses

"About reforming competitive research fund toward sustainable creation of research

achievement (mid-term summary)" (June 24, 2015, Committee for reforming competitive research fund) is said to consider it proper to share relatively large facilities and instruments for universal use while aiming to fully achieve research objectives.

In addition, "About introduction of a joint use system for new research facilities and instruments integrated with research organization management" (November 2015, Advanced Research Base Subcommittee, Science, Technology and Academy Council) requests that universities and national research and development corporations operate "Joint use system for research facilities and instruments for each research organization unit" (instrument joint use system, hereafter).

Based on the above described background, follow a joint-use system for instruments of affiliated organizations within a range of management conditions for other research expenses to actively undertake joint-use of large and universal-use research facilities and instruments to be purchased for this project in particular to the extent giving rise to no problem in promoting relevant research issue, utilization of research facilities and instruments purchased with other research funds, purchase with combined research expenses, and their utilization. Note that balance needs to be maintained between management of instruments and facilities for joint use and use of instruments for achieving research objectives of relevant research issues.

Furthermore, attempt to actively collaborate with "Research facility network project for collaboration of universities" implemented for nationwide mutual facility utilization in Institute of Molecular Science, National Institutes of Natural Sciences, University Joint Utilization Corporation, and the all-university joint use system established by "facility support and preparation project" at universities to promote joint use of research facilities and instruments not bound to research organizations in addition to the above described joint-use system for instruments.

○"About introduction of a new joint-use system for research facilities and instruments integrated with research organization management" (November 25, 2015, Advanced Research Base Subcommittee, Science and Technology and Academy Council)
http://www.mext.go.jp/component/b_menu/shingi/toushin/__icsFiles/afieldfile/2016/01/21/1366216_01_1.pdf

○"About reforming competitive research expenses toward sustainable creation of research achievements" (mid-term summary)
(June 24, 2015, Committee for reforming competitive research expenses)
http://www.mext.go.jp/b_menu/shingi/chousa/shinkou/039/gaiyou/1359306.htm

○"About unifying rules for the use of competitive fund"
(March 31, 2015, Agreement at liaison conference of relevant governmental ministries related to competitive fund)
http://www8.cao.go.jp/cstp/compefund/siyouruuru.pdf

○"Research facility network project for collaboration of universities"
http://chem-eqnet.ims.ac.jp/

(4) About securing a research period up to the end of the fiscal year (undertaking R&D)

We have taken the following measures to enable you to conduct your research until the end of the fiscal year.

- Research organizations and researchers shall submit a project completion notice as an achievement immediately after project completion. JST inspects the completion and research achievement of the project.
- The deadline for submitting the “Actual Performance Report,” the report on research results for this fiscal year, will be May 31 of the next fiscal year.
- The deadline for submitting the “Actual Performance Report (and Settlement of Balance) for Contract Research” will be May 31 of the next fiscal year.

*R&D institutions should keep in mind that the measures above have been made to enable research to be conducted until the very last day of the fiscal year; thus, they should make efforts to prepare whatever necessary by that time.

# Chapter 5
# Emphasized Theme and Technology Theme for Research Proposals

## 5.1 Small start Type

For small start type, JST sets prioritized themes for proposals based on research areas (sections) selected by the Ministry of Education, Culture, Sports, Science and Technology. For more information, please refer to the following description or JST-Mirai Program web site(http://www.jst.go.jp/mirai/)

### About research areas for setting a prioritized theme by JST, National R&D Agency, in JST-Mirai program

JST, the National R&D agency, sets research themes (prioritized themes, hereafter) for the JST-Mirai program (small start type). There are tentatively four areas (sections) for the themes set in fiscal year 2017, the first year of the program, that reflect the Fifth Basic Plan of Science and Technology.

A review of prioritized themes must reflect the purpose of this project to rigorously examine a technologically challenging target that is both economically and socially impactful. The review must also be strategic while paying attention to a wide collection of novel and diverse ideas, be consistent with various policies of the government, and avoid the duplication of prioritized and challenging R&D performed by other National R&D Agencies.

① “Realization of a super smart society”

This research area is set as a transdisciplinary (lateral skewered) area from the viewpoint of creating new values toward the creation of industries and reformation of future society. Specifically, it includes spreading the utilization of networks and IoT not only to manufacturing industries but also to R&D in various other fields and strengthening base technologies (base technologies necessary for building a common platform through the effective utilization of IoT and base technologies that are a core of Japan’s strength in creating new values, including advanced measurement technologies) for maintaining and strengthening the competitiveness of Japan as a super smart society. It also includes technologies related to space, such as satellite position measurement, satellite remote sensing, satellite communications, and satellite broadcasting.

② “Realization of a sustainable society”

This is an area that includes stably securing resources and food (stable securing of resources and their utilization through recycling, stably securing food), realization of a sustainable society that responds to super aging and population decrease (formation of a healthy aged society using the most advanced medical technologies in the world, realization of a societal base for sustainable cities and regions, and measures for longer life with efficient and effective infrastructure), improving competitiveness in manufacturing and holding events, and response to biodiversity. It also includes marine technologies that contribute to the sustainable development and utilization of the ocean.

③ “Realization of the most safe and secure society in the world”

This is an area for responding to natural disasters; securing food safety, the living environment, industrial safety and health, and cyber security; and responding to national security problems.

④ “Realization of a low carbon society, a global issue”

This is an area that includes stably securing energy and the efficient utilization of energy (energy-saving technologies, improving the efficiency of reusable energy, and technologies for stabilizing energy utilization with hydrogen and stored energy).

⑤ “ Common Platform Technology, Facilities, and Equipment ”

This is an area set to target common platform technology and cutting-edge research equipment, that support a wide variety of research activities. This area makes it possible to open up a new interdisciplinary field, support capabilities of basic science in Japan as a basis for bringing world-leading research results, and contribute to create sustainable science and technology innovation.

## 5.1.1 “Realization of a super smart society (Society 5.0)” area

Research and Development Supervisor (Program Officer: PO):

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### I. Goal of the “realization of a super smart society (Society 5.0)” area

As set out in the Fifth Basic Plan of Science and Technology and the Comprehensive Strategy for Science and Technology Innovation 2017, Society 5.0 is defined as “a society centered on people that, through the merging of cyber space and physical space, provides goods and services that precisely respond to various needs and potential needs to support both economic development and solutions for social issues and allows people to live comfortable and active lives.”

This area assumes that a “super smart society” (synonymous to Society 5.0) is considered a “society in which things of the real society are incorporated with intelligent software for sophisticated functions (making it smart), and things cooperate to automate societal systems for high efficiency as well as facilitate new functions and services.” The question “how is it different from ”a smart society” or “an information society” referred to as in Society 4.0” may be answered as following: “assuming information technologies is for sophisticated information and data processing in cyber space, a super smart society incorporates intelligence of information technologies into a physical entity, such as electrical power systems, transportation systems, service robots, and similar entities, for them to interact for the expansion of the range of automation and autonomy as the whole system, and possesses a mechanism for sustainable creation of new services and businesses.

In other words, it is believed that in a “super smart society” or “Society 5.0”, cyber space cannot be separated from the real world; software is incorporated into things in the real world and the existing societal systems collaborate by IoT, integrated with real world (hardware) and software to constitute a system or “system of systems,”.

Based on this assumption, “system coordination,” “system of systems,” and “distributed coordination” that emphasize collaboration of the whole system were extracted from an analysis of about 400 offered opinion, which were proposed in the 2017 call for opinions for setting prioritized themes, and interviews with 39 experts. From the above, a base, in which functions implemented in various forms collaborate and cooperate flexibly and dynamically, was defined as a “service platform.” After a workshop with experts, “diverse and various components that collaborate and cooperate to build a service platform that allows the creation of new services” was set as the prioritized theme for fiscal year 2017.

This theme will continue to be used for calls for proposals in fiscal year 2018. Among those shown as necessary technologies for the realization of the service platform in the invitation last year, proposals are invited that mainly include technological themes that were not

adequately covered in the proposals adopted in fiscal year 2017, such as technologies for API and componentization and those for securing stability and reliability, including physical security.

In addition, “modelling and AI that tie up the cyber world and the physical world” is set as a new prioritized theme for fiscal year 2018. Calls for proposals and the adoption process in fiscal year 2017, the call for an “image of a future society produced by science and technology,” and interviews with experts again led to the recognition that are importance of the technologies for securing real-time properties and reliability for the service platform. These technologies capture characteristics of Society 5.0 as CPS (cyber-physical system) and SoS (system of systems). Among the technologies shown in the call for proposals in the last fiscal year, a “technology that uses modelling and simulation to secure real-time properties and reliability for the realization of functions to control goods and systems in the real world through APIs” was cut out as an independent problem and set as the prioritized theme as a new important technology utilizing AI and big data analysis techniques for a Society 5.0 platform.

We expect many R&D proposals based on the purpose of each theme. We also expect challenging proposals from young researchers.

## II. Prioritized theme

Continuation

### 1. Building a service platform for creation of new services by collaboration and cooperation of various components

#### (1) About the theme

To accelerate the realization of a ”super smart society”, this prioritized theme aims to build a “service platform”; a mechanism that allows the creation of new services by extract “functions” possessed by various instruments connected to networks by IoT, and the “functions” of existing and new systems are turned as components and combined for collaboration and cooperation. Specifically, functions* at various layers, including controls of things in the real world, are turned as components to provide an open API to build a mechanism for the collaboration and cooperation of various components. This allows for API to be accessed, utilize, and combine functions of components to realize new functions and services. Moreover, techniques, including artificial intelligence, automate collaboration of functions to develop technologies that allow flexible and dynamic collaboration and cooperation, including negotiation and mediation functions, among systems and instruments.

In addition, this prioritized theme for recruitment of research proposal keeps in mind new values and services to be realized through building the platform in carrying out research while depicting a scenario toward the goal.

At present, the 5th Science and Technology Basic Plan of the Cabinet Office sets out 11 systems to realize a “super smart society” (Society 5.0); these systems are, among others, smart manufacturing system, energy value chain system, and high degree transportation system. The Plan also implements policies to promote individual systems. In addition, to support the 11 systems, approaches have already begun for base technologies, including AI, big data processing technologies, and database construction. However, adequate approaches

have not yet been taken for a service platform mechanism by functional cooperation; these approaches include continued supplies of optimal services in flexible combinations of existing/new systems or instruments. The mechanism has not yet been realized.

To promote the prioritized theme for recruitment of research proposal and to realize a service platform for collaboration and cooperation of various functions allow the planning of automation, autonomy, and efficiency among a wide range of existing/new systems, and create a new system, a new service, a new business, a new innovation other than the 11 systems. A super smart society will be realized through research and development of API and component preparation techniques, collaboration and cooperation techniques for component combination, techniques to secure real time actions by modelling simulation, security techniques, and architectural design techniques.

In fiscal year 2018, calls are made mainly for proposals of technologies that is turning to API and components and securing stability and reliability, including physical security. These technologies were not adequately covered by projects adopted in fiscal year 2017.

* functions at various layers:

For example, technologies from transportation system to automated driving layer down to individual IoT sensors. Functions include not only information exchange in cyber space but also systems and controlling things in the real world.

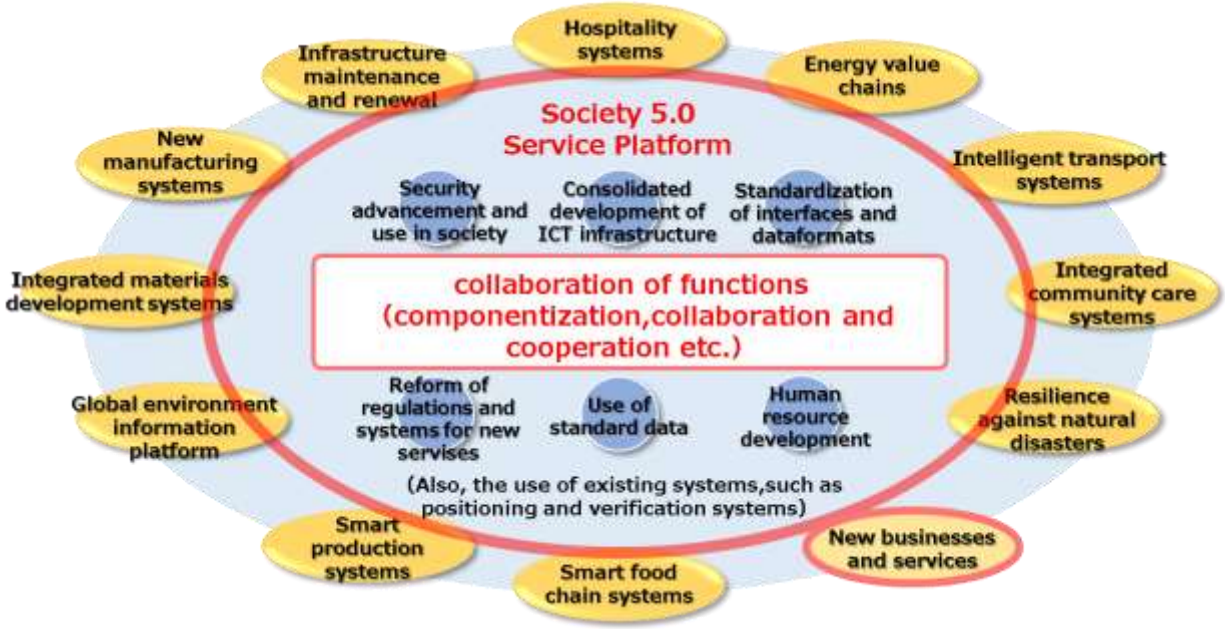



Fig. Primary target of this prioritized theme (red frame, red word)

## (2) Program officer's policies for call, selection, and R&D promotion

### ① Background

Recent rapid progress in information and communication technologies has connected humans to things, or things to things, in many fields, including manufacturing, transportation, finance, and medicine, to improve efficiency of existing services and create new businesses and services. The conventional society for "sophisticated information processing in cyber space" has been made super smart to be a society in which "information technologies

incorporate intelligence into things, and the intelligence interacts to create new values," This movement has been accepted by society and people to stimulate an emergence of new services, such as Uber and Airbnb, which are changing values and lifestyle, including sharing of economy that promotes changes from possession to utilization.

The Cabinet Office is promoting research and development for sophisticated individual systems by national policies and base technologies, including AI and big data and database, toward the realization of a super smart society. However, platform technologies, which connect between cyber space and things in the real world and go beyond data collaboration to allow collaboration and cooperation among systems and instruments, have not been developed adequately. Moreover, private companies have promoted research and development in IoT and AI, and begun approaches to cross-sectional data collaboration. However, technologies have not been developed adequately for API and component preparation for inter-systems and collaboration and cooperation among instruments.

This prioritized theme for recruitment of research proposal aims to build a service platform that serves as a basis for new service creation to contribute to the realization of a super smart society and accelerated creation of new values.

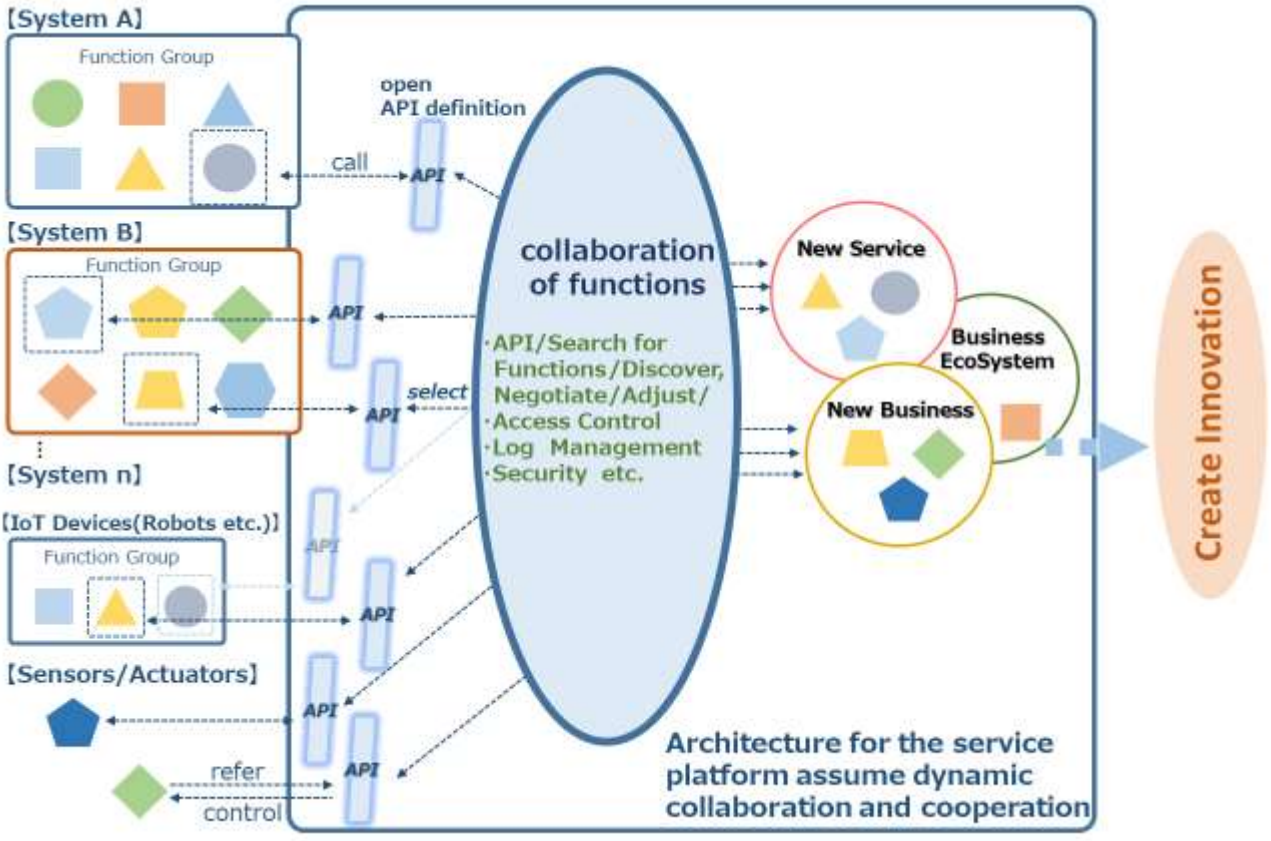



Figure: Collaboration of function by a service platform

**② Policies of proposals selection**

As a service platform, proposals are recruited for a system technology that allows flexible and dynamic collaboration of functions among systems and instruments.

Every proposal must include a specific scenario for how functional collaboration among systems and instruments creates values (societal and economic). Please depict a scenario for realization future value as much as possible, in addition to a research and development plan for achieving POC. In the case of a proposal for the development of a common base technology for various services, for example, please depict a specific partner of collaboration, such as an electrical power and a transportation system, and show how societal and economic impacts may be created. If the impacts are not clear, research contents may include a FS to clarify the impacts.

Moreover, a proposal of a component technology for systems is acceptable if its value is clearly shown in the service platform. In such case, please show clearly implemented contents of the FS for ideas of the scenario.

(Regarding technologies)

We welcome proposals for the development of the following new technologies necessary for building a service platform based on specific use cases or scenarios:

・ Technologies for turning sub-functions to API or components while utilizing existing systems as they are

・ Technologies that secure stability and reliability, in addition to realizing functions as a system through the collaboration and cooperation of many various components that are different in size and operational policies

・ Technologies that secure traceability, including information on records of API call outs

・ Security technologies common to the above technologies, and service platform technologies for security

・ Architectural design for the whole platform on the assumption of collaboration and cooperation

(Regarding team composition)

It is not necessary to form a team that covers all ideas at the beginning. It is acceptable to propose building a team during FS.

**③ Policies to promote research and development**

FS is performed during preparation of a full-scale research. In principle, FS period is one and a half years (until the end of FY 2018).

Specifically, an approach is supposed to be conducted to the following studies in FS:

- Verify social and economic impacts of research results and the scenario for realization of the impacts
- Verify technological feasibility, and specify technological development targets and a R&D plan
- Proceed to form an effective research team including business firms, as required.

Moreover, in transition from FS to a full-scale research, it is assumed that not only selection and concentration but also bold system changes, including sub-team reorganization within a project team, may take place. Emphasis is also placed on collaboration with a preceding project that was adopted as a theme in 2017. An earlier transition to a full-scale research (research and development proposal) is also possible depending on research progress.

Upon selection of the individual proposal in the prioritized theme for recruitment of research proposal, a whole platform architecture, incorporating tracking, value redistribution, and a societal system, will be considered. The architecture of a whole platform may be applied as a project. If not adopted, however, the research and development supervisor will manage the study of a platform architecture. Promotion of participation, coordination, and collaboration activities in an international collaboration frame will also be reviewed in this theme.

### ④ R&D Period and Budgets

The R&D budgets amounts to JPY 8 to 23 million (direct costs only) throughout the FS period (one and a half years in principle). Budget will be allocated flexibly depending upon research contents. When it moves up to a full-scale research, the budget is increased to a maximum of JPY 300 million (direct costs only) for carrying out research toward proof of concept (POC).

## 2. Modelling and AI for Integration of Cyber and Physical World

New

### (1) About the prioritized theme

Ⅰ. As stated in R&D policies for the “realization of a super smart society” area, Society 5.0 is defined as a society in which cyber space and physical space merge at a high level to allow people to live better lives. This research area takes this definition as a society in which cyber space and physical space merge, or software is incorporated into real-world goods, for their collaboration and cooperation to realize a mechanism that facilitates the realization of new functions and services. For “the high-level merger of cyber space and physical space,” a cycle needs to be repeated in which such feedback is performed as responses to complex and constantly changing situations in the real world (physical space), judgement and optimization based on data collected by sensing, and control, manipulation, and working on the real world. Subjects in the real world include energy and transportation, the whole cycle of manufacturing, various social systems including prevention and reduction of damage from disasters (the leading 11 systems of Society 5.0), and people engaged in them. In addition, the subjects also include constituents of systems, for examples taken from manufacturing, designs of plants and goods dealt with in the concept of digital twins promoted in so-called Industry 4.0, and control and maintenance mechanisms using IoT. This also applies to other social systems.

Modelling/simulation technologies and AI-machine learning technologies may be cited as representative examples of technologies to handle such complex and changing systems.

Modelling/simulation technologies are utilized in various fields. To handle complex social systems in Society 5.0, not only a mathematically strict model but also qualitative and partial models conceivably need to be utilized. Technologies to handle models in a stratified and integrated manner at different levels of abstraction including meta models are also conceivably necessary.

Moreover, AI/machine learning technologies have made remarkable progress in recent years to rapidly expand their scope of applications. So-called big-data approaches are powerful. On the other hand, it has been pointed out that the results of deep learning can be black boxes that are difficult for people to understand, and responses to irregular case are inadequate and result in failure.

In order to realize Society 5.0, it is important to take advantage of the merits of these technologies and deepen them to create technologies that can respond to important aspects of Society 5.0, such as CPS (cyber-physical system) and SoS (system of systems). For this reason, “modelling and AI to connect the cyber world to the physical world” has been chosen as the prioritized theme for fiscal year 2018.

The word “connect” was adopted to express an image of collaboration rather than a merge between the inherently different cyber and physical worlds, or an image to “closely tie” them through interactive communication rather than to simply link them.

This theme not only emphasizes technologies for systems and applications presumed for Society 5.0, but also their positions as a mechanism applicable to a number of fields and for yielding new innovations through combinations of different fields.

Furthermore, this prioritized theme keeps in mind specific cases of use concerning new values

to be realized to promote research while depicting a scenario for reaching them.
As for technological components, proposals are expected for not only upgraded and practicable technologies in respective fields for modelling/simulation and AI/machine learning but also for pioneering new application fields through merging the merits of both to realize new value. For example, the following technologies are included: technology that takes advantage of previously acquired knowledge concerning a subject to upgrade machine learning, technology for extracting utilizable knowledge of modelling/simulation from a machine-learned deep neural network, and technology for applying machine learning technologies to learn not only model parameters but also a model structure. Toward the realization of Society 5.0, the development of such technologies is expected as, for example, to feed back to the physical world in real time, to advance precision and information processing speed through merging conventional modelling/AI technologies, and to solve problems in the complex real world. When proceeding to full-scale research, it is important not only to make simple technological proposals but also to show a specific case of use, or how social and economic values can be realized by the proposed technology, and a hypothetical scenario for its realization.* This is a common requirement for all themes.
*Implementation in society is not essential at completion of full-scale research. A goal is set at a stage when a business firm can judge its practicability (POC).

### (2) Program officer's policies for call, selection, and R&D promotion

#### ① Policies for call and selection

Proposals are called for technologies that can safely and securely operate in the constantly changing social system of Society 5.0, in which people and modelling/simulation technologies and AI/machine learning technologies are included.
Every proposal is required to describe to what specific system and application and service a technology will be applied, how to create value (social and economic impacts) through its application, and a future image should be conceived. Describe not only an R&D plan for achieving POC but also a scenario to realize the image as much as possible.
When the social/economic impacts or the scenario are not clear, they may be clarified using the contents of a feasibility study.

(About technologies)
Proposals of the following new technology developments are welcome that are based on specific use cases or scenarios and are necessary for connecting the cyber world and the physical world:
・ Technology to utilize modelling and simulation to secure real-time properties and reliability for controlling goods and systems in real space
・ Technology to utilize previously acquired knowledge concerning a subject for a social system dealt with in Society 5.0 in order to upgrading machine learning
・ Technology to extract utilizable knowledge for modelling/simulation from a machine-learned deep neural network

・ Technology to apply machine learning techniques to learn not only model parameters but also model structure

We expect proposals that not only show examples of these technologies but also merge merits of AI/modelling to pioneer new application areas leading to the realization of new value.

(About team composition)

It is not necessary to initially form a team that covers the whole plan. Proposals that include building a team system during a feasibility study are acceptable. For example, proposals in which a team only has a simulation researcher at application and AI researchers are added during a feasibility study or vice versa are welcome. In such a case, clearly describe the following in the proposal documents:

・ What researcher(s) do you want to collaborate with to perform research?

・ What activities do you plan to carry out in collaboration?

There may be cases in which JST advises collaboration between proposing researchers based on the collaboration plan in a proposal document after selection or adoption.

### ② Policies for promoting R&D

A feasibility study is positioned as preparation for full-scale research. A feasibility study has a period of one and a half years, in principle (up to end of fiscal year 2019).

A feasibility study is presumed to take on the following specific research:

・ Verify the social/economic impacts that the research will bring about in the future and its scenario.

・ Specify technological development targets and a research plan by verifying technological feasibility

・ Proceed to form an effective team including AI/model researchers and business firms, as required

Furthermore, the premise for a shift from a feasibility study to full-scale research is not only selection and concentration but also a bold re-composition of the research team, including reorganizations of sub-teams within a project team. A project (R&D project) may proceed to full-scale research sooner, depending on research progress.

### ③ R&D period and budget

The budget for an R&D project is 8-23 million yen (direct costs only) for a feasibility study period (one and a half years, in principle). The budget is flexibly distributed depending on research contents. When transferred to full-scale research, the budget increases to a maximum of 300 million yen (direct costs only) for performing research toward POC.

## 5.1.2 “Realization of a Sustainable Society” area

R&D Supervisor (Program officer: PO)
Hideyo Kunieda
(Principal Fellow, JST / Councilor, Nagoya University)

### I Goals of “Realization of a Sustainable Society” area

“The Quest of a Sustainable Society” is an ultimate goal not only for Japan, but also for the whole of mankind. The world has turned its direction of development towards a sustainable society regarding economic development only. It is also expressed in the Sustainable Development Goals (SDGs) of the United Nations. We now face the necessity to increase the quality of life and at the same time realize sustainable development of society.

A review of the current situation of Japan finds a slow economy over the last 20 years or longer. The economy has remained slow in a changing global environment undergoing climate change and globalization for more than 20 years. Many industries, including the manufacturing industry, in which Japan has enjoyed advantages, are found to show signs of declining international competitiveness. In addition, a population decrease faster than that of other countries has begun to decrease the population of productive laborers in Japan and to increase the number of seniors who need social support. It is a fact that the sustainability of people’s lives is at risk. This research area takes maximum advantage of science and technology to flexibly adjust changes in “environment,” “society,” and “economy” and aim for realization of a higher-quality and more mature society.

The prioritized theme of this research area takes into account ideas from applied proposals and discussions with experts in various fields to aim for the goal of improving the natural environment (ecosystem services) and the human well-being / maximizing benefits for future generations.

In FY 2017, the following prioritized themes have been chosen: “Innovation in manufacturing for new process of sustainable resource circulation” and “Improving intellectual capability to enhance 'a Socially Active Life' for overcoming the reducing labor force.” In FY 2018, a new theme, the “Development of groundbreaking technologies in food production in response to the future changes in society and environment” has been added to the above two themes to call for R&D proposals on the three prioritized themes.

To realize a sustainable society, the expansion of layers for future-oriented researchers and practitioners is believed to be necessary. Various research fields and stakeholders need to tackle the future as a single, united team. For that reason, this area actively takes on the appointment of young researchers and the construction of multidisciplinary research systems.

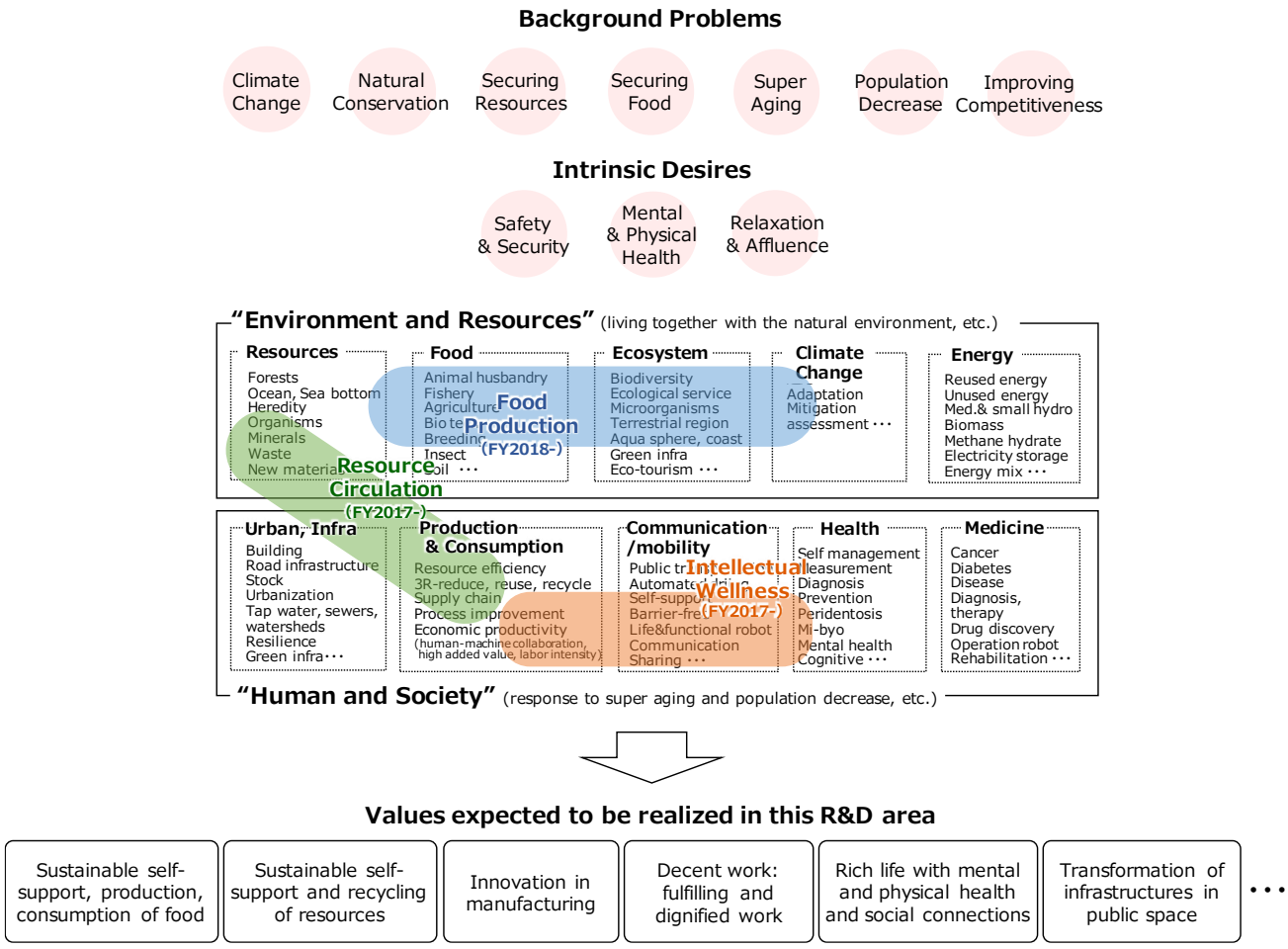



Fig.1: Designing process of the prioritized theme for the "Realization of a Sustainable Society" area

# II Prioritized Themes

Continuation

## 1. Innovation in manufacturing for new process of sustainable resource recycle

### (1) About the theme

This prioritized theme aims to promote improvements in industrial competitiveness to respond to changes in society and industries by sustainably utilizing globally tightening mineral resources (metal and non-metal resources) and fossil resources as materials for conserving the environment. For these purposes, it optimizes the whole cycle from material selection to design, production, use, separation, and re-use, performs R&D on material design, production, and separation for marked improvement in resource efficiency, and aims to create new processes for manufacturing.

The past mass-producing and mass-consuming society emphasized the performances and prices of many products that were to be disposed. However, to respond to the global tightening and exhaustion of resources, which will surely happen in the future, a shift to "resource recycling manufacturing" for highly efficient resource utilization is heavily demanded.

The UN adopted "Goal 12. Ensure sustainable consumption and production patterns" as an objective of its SDGs (sustainable development goals). Responses by societies and industries are imminent. In fact, under the concept of "CE: circular economy," the idea that business firms assume the burden of recovery and reuse costs, or manufacturers' responsibility, is becoming popular. That cost will be put on product prices. Therefore, the highly efficient recycling of resources is beginning to be directly linked to industrial competitiveness.

Approaches to the effective utilization of resources in Japan are limited to individual approaches, such as decreasing the use volume of resources (especially rare metals) or recovering resources related to used products. Re-utilization and long-term utilization (especially utilization after upgrading [1]), which is more resource-efficient than renewal utilization, have not been introduced in workplaces for actual reuse and renewal. Besides, many cases of "down cycling," or renewal for use in products with a lower added value, are observed in renewal utilization. Such an approach does not lead to a highly efficient resource recycling method. Therefore, it is necessary to conduct R&D to markedly improve resource efficiency through a new recycling method through fundamental reviews of design, production, use, separation and re(newal) utilization processes; conversion from down-cycling to recycling (renewal utilization for an equivalent value) and up-cycling (renewal utilization in a product of a higher added value); and conversion from renewal utilization to reutilization and long-term utilization.

The effective utilization of resources responds to progress in science and technology and changes in society, expands in scope from iron to rare elements and plastics, and is slowly changing from renewal utilization to more efficient renewal and long-term utilization. This theme promotes R&D for advanced element technologies, including "production, separation, evaluation," in various scenes ranging from product utilization to re(newal) and long-term

[1] upgrading: performance that is achievable by changing some parts or systems, not reintroducing the whole product, when improving a function and performance.

utilizations, and designs systems based on the element technologies and for systems incorporating them.

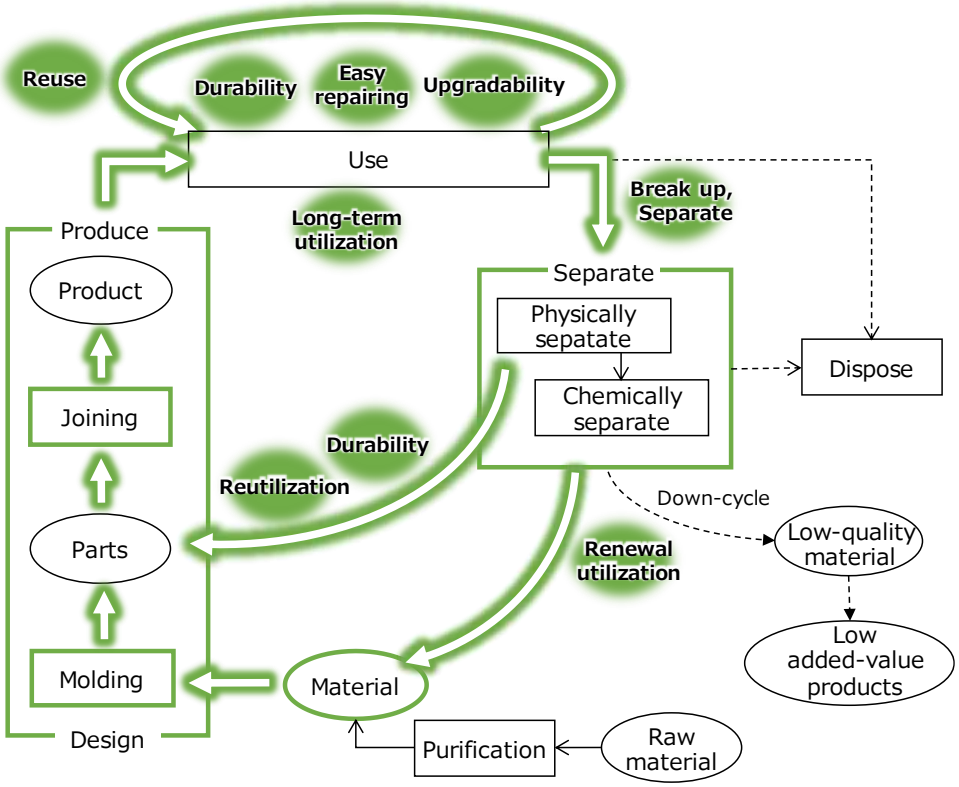



Fig. 2: New recycling loops presumed in this theme

## (2) Policies of the R&D Supervisor for proposal selection and R&D management

### ① Policies for proposal selection

This prioritized theme promotes a series of R&D for the efficient recycling of resources throughout the whole cycle including evaluation at each of the following processes: design, production, separation, and re(newal) utilization in manufacturing.

The basic policies for this call follow those in FY 2017. Taking into account the results of the call in FY 2017, however, the call in FY 2018 emphasizes upstream viewpoints in manufacturing, or innovative technologies and new concepts for the epochal promotion of resource circulation in design and production processes (including design for re(newal) utilization).

Furthermore, we welcome proposals that can contribute to recycling plans aiming for the reutilization of used parts and modules and to technology development for breaking up, repair, and credibility evaluation based on them.

A quantitative description of social and economic impacts is essential for every proposal.

The scope of “goods” for recycling includes, for example, social infrastructures such as buildings, civil engineering structures, and energy systems, which are mentioned in approaches and action plans of the industrial and business community toward the vision shown in Society 5.0 and products (group) including hardware presumed to rapidly increase in importance in the future society, such as novel transportation equipment and robots.

The following descriptions are the main requirements of full-scale research. They do not necessarily need to be planned in detail at application. However, it is essential to include “a new recycling method for resources and products” and “original and challenging solutions for bottlenecks.”

(Contents of R&D)

It is essential that R&D contents show a resource recycle plan, including feedback to upper stream and integration of the design, production, separation, evaluation, and reutilization in manufacturing, which improves resource utilization efficiency through a new circulation cycle for resources and products resulting from conversions from down-cycling to recycling/up-cycling, and from material recycle to reutilization and long-term utilization. R&D elements for realizing the whole plan must clearly show scientific and technological bottlenecks that would exert a high impact if solved, and propose highly original and challenging scientific and technological approaches for solving the bottlenecks.

Part of a resource recycle may presumably be the utilization and optimization of an existing technology. However, a plan to perform whole R&D on an extension of existing technologies will not be adopted. Proposals are expected to include R&D aiming for the development of discrete and innovative element technologies and to be based on scientific theories.

The following are examples of R&D elements conceivably constituting a whole plan:

i. Product design and R&D on the premise that parts and modules are changed or reused
Product design and R&D based on a specific plan are presumed to aim for substantially extending a product’s life and upgrading through exchanging parts of a product with a new, reutilized, or repaired part.

ii. Advanced material design and R&D that allow easy renewal utilization
Recycle recovery may be raised to a maximum. Material design and R&D is presumed to facilitate quality conversion from the initial level to an equal or higher quality.

iii. R&D for production process and facing that markedly extends a product’s life
R&D is presumed to be innovative for production processes and coating that substantially extend a product’s life.

iv. R&D for separation technology contributing to easily separable cementing and adhesive technologies and renewal utilization, as required
R&D is presumed for innovative cementing and adhesion technologies that facilitate separation for renewal utilization or for innovative separation technologies that do not damage parts or materials, while satisfying such performances as cementing and adhesion strength, airtightness, and tolerance to the environment.

v. R&D for credibility evaluation technologies
R&D is presumed to elucidate degeneration mechanisms, which are a key for determining the remaining life of a separated part, a module, or a huge structure to create credibility evaluation technologies for estimating a remaining value or function.

Use elements technologies as shown above to propose a whole plan. Specifically, the following proposal images may be presumed:

· A proposal that aims to develop advanced element technology for development and

production of an easily renewable material (R&D on adhesion technology for easy separation) for a manufacturing process that was used in down-cycling as renewal-utilized after crushing, establish a resource recycling method for highly efficient renewal utilization of each material for separation of materials with quality equivalent or superior to the initial material, and drastically reduce resource waste.

- A proposal that advances element technology development for production (development of production process and coating technologies for substantially extending a hitherto short product life and part lives and of cementing technologies for easy separation), realizes an extended product life, and provides easy repair and exchange for upgrading.
- Waste is created when safety coefficients are used for parts within a product or when parts are changed regularly using a use hour indicator based on experience, because the degeneration mechanisms are unknown. A proposal for avoiding such situations by making clear producer's specifications requested for parts including renewed parts, performing evaluations for use limit or credibility of parts through the evaluation of remaining life based on scientifically understood degeneration mechanisms, taking reasonable conformity between the two for preparing a plot acceptable to the upstream party, and completing a recycle plot.

A high evaluation score will be given to approaches that keep in mind the maximization of resource recycle efficiency, including the standardization of parts (making them common) and those that set specifications and standardizations for improving interchangeability through cooperation with a wide range of industries.

R&D on manufacturing equipment at actual manufacturing sites is excluded.

(Presuming where results are applied)

Society and industries are obliged to set clear targets for their needs and quantitatively measure social and economic impacts to approach R&D for recycling resources and products. Therefore, they need to examine specific products (group) as an example of applications of R&D results. To aim for a wider range of applications, however, it is extremely important to aim to develop technologies applicable to a wider range of products (group).

(R&D organization)

It is necessary to create results acceptable to industries to develop practicable element technologies and actually recycle resources and products. Therefore, participation by business firms is desirable before proceeding to full-scale research.

(Contents demanded at proposal)

Specific plans for the following contents are necessary for a proposal:

Clearly describe in proposal documents the vision and bottlenecks of a new recycling method for resources and products and original and challenging solutions for the bottlenecks. In the proposal documents, clearly describe proposals (including expectations for what cannot be set out specifically) for selection criteria for full-scale research and the R&D contents and research organization above. In addition, clearly describe the contents of R&D performed during a feasibility study and targets to be achieved by the end of the feasibility study.

In the foregoing description, present a plan based on the following backcasting theory. That is, be conscious of and organize a vision of recycling and manufacturing in a future society; define the POC to be achieved at completion of full-scale research to realize the vision; clarify the themes and objectives for the feasibility study that need to be checked, verified, and set as a step before moving to full-scale research; and break down the contents of the feasibility study for achieving the targets above.

A proposal having, for example, the following contents may be conceived during a feasibility study:

- Concerning an innovative technology or a basic process at a hypothesis stage, a feasibility study verifies a principle and clearly shows scientific and technological risks toward the POC of full-scale research.
- A feasibility study proposes a plan for the overall optimization of recycling resources and products, shows a specific recycle plan that maximizes social and industrial impacts during the study, and plans a team composition for full-scale research by business firms and academia.
- A feasibility study proposes a plan for applications to products (group), prepares a collaboration team with an industry during the study period, and sets up specific products (group) that will be impacted as an example for the development of research results.

**② Policies for R&D management**

This prioritized theme predicts rapid progress in the application of bottleneck solutions to society and industries at a stage to forecast large-scale impacts. For that reason, a feasibility study is subject to an active review for shift to full-scale research even during the feasibility study period. In addition, re-composition of a research team through merger of R&D themes is presumed whether at adoption or during research, when a program officer judges it necessary for maximum social and economic impact. In such a case, the R&D period or budget mentioned in ③ below may be altered.

**③ R&D Period and Budgets**

Concerning R&D themes to be initiated in 2018, a standard period for a feasibility study is a maximum of two years (however, FY 2018 is considered one year regardless of when R&D started) and the upper limit for the research budget is a total of JPY 25 million (direct costs only) for the whole feasibility study period, in principle.

Full-scale research has a research period of five years or less and a total research budget in a range of JPY 500-1,500 million (direct costs only) for the whole period of full-scale research.

Continuation

## 2. Improving intellectual capability to enhance a "Societally Active life[2]" for overcoming the reducing laborer force

### (1) About the theme

Japan is in an era of super aging and population decrease and faces various related problems, such as a shrinking labor force, due to a decreasing productive-aged population and increasing costs of social security. These problems require approaches to identifying untapped labor forces, such as extending "socially active life," in which various people play a role in society, and improving industrial competitiveness.

As for seniors, although more than 70% of retired workers want a job, their degenerating physical and intellectual functions may prohibit their willingness and opportunities. Progress has been made mainly in R&D and industrialization related to physical assistance. In addition, responses to intellectual functions are required. On one hand, demands exist for the acquisition of new abilities including handling IoT and big data, data literacy entailed in rapid progress in information technologies such as AI, and diversification of expert human resources. On the other hand, nurturing human resources and their increased mobility are imminent issues for which knowledge and techniques must be acquired. Furthermore, there is increasing concern that knowledge acquired from experience and implicit knowledge, such as specialized and proficient intellect and skills, may not be passed down and will be lost in the future.

Many countries are in a similar situation; the UN adopted "Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all." It is a globally common target to remove obstacles that inhibit social participation, including participation in labor, and improve QoL (Quality of Life) and QoW (Quality of Work).

As described above, creating a laborer population and maintaining and augmenting intellectual productivity are imminent issues to be addressed as responses to super aging and population decrease. Then, this prioritized theme aims to utilize various untapped labor forces and to strengthen industrial competitiveness for an objective to employ science and technology to create a system that effectively utilizes human "intellect." An approach to supporting "intellect" provided by a system this prioritized theme aims to create is expected to promote participation in society and employment as well as contribute to improvement in quality of life and work. This includes not only the quantity of intellectual manufacturing but also improvement in quality, such as the creativity of individuals who promote innovation. The quantity and quality will presumably lead to an environment in which people continue to express their personalities as human beings in a future society where popularization of AI and robots results in increased collaboration and symbiosis between people and machinery. This prioritized theme aims to realize a society in which everyone has a purpose for living, expresses her/his abilities as much as possible, and actively plays a role.

[2] socially active life: life in which there is time for social activities and in which individuals are self-reliant, active, and employed. This differs from "biological life" or "healthy life," which refer to the ability to live without health problems that restrict one's daily life.

**(2) Policies of the R&D Supervisor for proposal selection and R&D management**

**① Policies for proposal selection**

This prioritized theme calls for the R&D of a system to support peoples' intellectual activities to create a new labor force and intellectual productivity. The proposal must show the mechanisms of human intellectual activity to be examined, what is the bottle neck there, and the scientific and technological approaches which could solve them. Since the human intellectual activity has to be extended through the proposal, the function and performance of the proposed system have to be explained. Proposal also should show the vision how the decent work and the quality of life will be improved by the implementation of the proposed system and service in the society.

Examples of presumed intellectual augmentation are given below. However, proposals are not limited to these examples; we welcome proposals based on liberal ideas.

i. Maintaining, improving, and upgrading intellectual activities of individuals

There are cases in which a smooth intellectual activity is inhibited through a change in an intellectual function, for example, temporary loss of a memory or an ability to do something in a series of intellectual activities including in labor tasks. Such an incidence, if taking place often, would not only present a problem in actual work but is feared to reduce her/his willingness to participate in society as a result of alienation.

Support for recalling memory[3] based on information technologies has mainly utilized databases based on stored general information, such as dictionaries and internet searches. On the other hand, R&D has made no progress in timely provision of memories stored as information or concerning support and improvement of thinking and ideas. Providing a system for maintaining, improving, and upgrading intellectual activities for memories, thinking, and the creative power of individuals may be expected to realize a society in which everyone exhibits long-lived active performance.

ii. Support to responses to a new job or skill

Demands exist for new abilities to flexibly respond to changes in a society, such as handling IoT and big data and improving data literacy in rapid progress of AI and robots, nurturing human resources, their diversification, and their mobility. On the other hand, it is not necessarily easy for youths or experienced working adults to respond to changes in demanded occupational skills and by acquiring new knowledge and skills. Many jobs require acquiring knowledge and techniques through OJT, skill learning, and training.

Then, if a system is realized, based on understandings of intellectual mechanisms, that allows people to learn skills more effectively and efficiently, it would presumably lead to digging out new working human resources who have not been seen in laboring scenes, promoting mobility and optimization of jobs in response to changes of the labor market in a future society, life-long new challenges, and pioneering new fields.

iii. Elucidation of mechanisms for high-level intellect and skills and their transmission

Some so-called "professionals" and "master craftsman" possess very high-level intellect, such as intuition, knack, technique, action, and viewpoint, which cannot be imitated easily.

[3]memory recall: to recall a memory of an event experienced in the past or related images

These presumably cannot be transformed into formal knowledge because understanding of the key point in charge of the intellect and that in the mechanism for the high level intellectual activity have not advanced. If technologies for understanding high level intellectual activity and systems for transmitting and sharing it are realized, knowledge and skills dependent on specific individuals would be shared by society. The sharing would likely build a basis for creating social values, such as skills and culture, which would be passed down by people in a future society. Maintaining and passing down intellect and skills, which are inherent for professionals, would certainly mean that the intellect and skills are made available to the public and spread. It would fundamentally improve competitive power, such as designing abilities and productivity.

The description above is only an example of a topic. However, elucidation of mechanisms for human intellectual activities, evaluation of motivation, and technologies and techniques for feedback, shift, and transfer to people may be said to be important common viewpoints.

This theme excludes R&D aiming to support physical activities alone. It also excludes themes simply aiming to replace human labor/activity with a robot or AI. However, it would not exclude proposals taking on R&D for the utilization of robots or agent technologies during the augmentation of high-level human intellectual activities, augmented reality, or augmented humans.

Be aware that this theme excludes any proposal with an ultimate purpose of invasion into the brain or the nerve and direct action on the mind (emotions) alone.

This theme includes technological fields from basic/base research centered around information science and technology to high-level application technologies and presumes collaborations among various science fields including cognitive science, psychology, and neuroscience. Because this prioritized theme is presumed to contain immature R&D, it welcomes challenging research proposals and new participation from other research fields that have not yet being involved. Even a research plan at the idea stage or a lower TRL study could be proposed, if the proposal objectively and specifically shows a plan concerning how to approach what is lacking in the proposal during the feasibility study. However, proposals must explicitly show a future vision after achieving the POC and the size of presumed social and economic impacts. In addition, some feasibility studies may be actively merged/integrated for full-scale research. This may entail shrinking the research period/budget, depending on proposal contents, for adoption.

Respecting the wills of individuals (freedom to choose, agreements, or free will), consideration of privacy, physical and psychological influence and ethical issues, and an examination of system issues are indispensable. Therefore, a prepared R&D plan must explicitly show a scenario concerning how to solve various problems of ELSI[4] at a stage of component technology development and thereafter. Furthermore, it is important to examine how various gaps including the digital divide may be eliminated at the initial stage and thereafter as well as building durability and credibility of systems in aiming for the social development of results. Therefore, an approach of an inclusive design (include anyone,

[4] ELSI: Ethical, legal, and social issues manifesting at a point of contact with the society in advancing research

codesign) would conceivably be useful.

Because related science and technology and social situation change rapidly, this prioritized theme expects a team composition and an R&D plan for adequate understanding of local and overseas trends, active dialogues with users, and flexible examination.

### ② Policies for R&D management

This prioritized theme presumes that local and overseas social trends and progress in R&D and science and technology cause dramatic changes in the surrounding environment and requirements. Therefore, collaboration with related local programs and among researchers in this area will be promoted. In addition, open and continuous sharing of local and overseas information and discussions will be deepened, involving a wide range of participants.

Research and development supervisors conference prepares a management system for proper advice and guidance through meetings, site visits, and research associations and forms a team made up of the conference including program officers and researchers to promote R&D aiming to realize the goal of the theme. For this purpose, the conference may instruct mergers and integrations of R&D themes in progress or improvements in R&D plans (including reviews and cancellations of team compositions or budgets). In addition, the conference plays an active role in accelerating shifts to full-scale research. The program officer may judge that a feasibility study should be reviewed for shift to full-scale research, even during the study period.

### ③ R&D Period and Budgets

Plan a feasibility study for a period of 2-3 years (however, FY 2018 is taken as one year for calculation regardless of when the R&D starts) and research budget of JPY 10-40 million (direct costs only) for the whole feasibility study period, in principle.

Plan five years or less for a period of full-scale research and JPY 500-1,500 million (direct costs only) for a total budget for the whole period.

New

## 3. Development of groundbreaking technologies in food production in response to the future changes in society and environment

### (1) About the theme

This prioritized theme aims to establish technologies for stable and sustainable food supply in response to environmental changes in nature and society, including climate change, resource exhaustion, and variations in land use and population distribution. Especially, the call in FY 2018 sets a focus on food for animal protein supply to aim for the creation of innovative food production technologies, beyond simply making existing agriculture, animal husbandry, and fishery more efficient.

Stable and sustainable supplies of highly nutritious food are necessary and indispensable for building and maintaining a mature society with healthy longevity.

Population explosion and improved living standards in developing countries are predicted to increase food demands of the world 1.55 times[5] in 2050 from that of 2000. However, the global area of cultivated land cannot be expanded so much any more and increments in yield per area in recent years are decreasing. This sense of crisis is globally emphasized as the UN sets “Goal 2. NO HUNGER” as a goal in its SDGs.

Demands for products of animal husbandry and fisheries as the source of animal protein are predicted to increase more than agricultural produce (double in 2050) as economic affluence raises the level of protein consumption. On the other hand, in the current production systems, such as farming, raising animals, and aquaculture, the production efficiency is quite low, because 10 kg or more feed is necessary to get 1 kg beef meat, for example. In addition, questioned sustainability for reasons of occasional big environmental burdens including fertilizer resides and waste renders long-term sustainable production systems necessary.

In FY 2018, this prioritized theme produces food by entirely new methods without feeding animals (example: application of regeneration therapy technologies to food culture), markedly improves the sustainability of food production without natural origin feed (example: aquaculture of seawater fish without dependence on fish oil), and develop technologies necessary for creation of high-impact food industries (example: shortening a reproducing cycle for high-speed breeding) for food as a source supplying animal protein, to create rich life through eating, create new food industries, and contribute to the elimination of hunger from the world. It will provide us with highly sustainable food supply free from the environmental and societal changes.

[5] Based on an estimation by the Ministry of Agriculture, Forestry and Fisheries. Another source (report by FAO, Food and Agriculture Organization of the UN) predicts a 1.7-time increase.

**(2) Program officer's policies for call, selection, and R&D promotion**

**① Policies for call and selection**

The call in FY 2018 focuses on food as a source of animal protein to invite R&D proposals of innovative production technologies responding to changes in society and the natural environment.

Propose solutions centered on innovative science and technology upon presuming realistic future environmental changes in nature and society and specifying bottlenecks (science and technology themes and social implementation themes) in food production technologies as prerequisites.

The following are examples of innovative R&D to be placed at the center in proposals. However, proposals are not restricted to these examples; we welcome proposals based on a wide range of ideas for subjects of high impact.

(Example 1)

Present problems are the necessity to input feed several (chicken, salmon) to more than 10 times (beef, tuna) as much in weight as yielded meat or fish as well as feed residue and waste. Meat production technology by application of regeneration therapy technologies instead of improvement in the conventional production technologies including fattening and aquaculture would be expected to solve issues of food demand and reduced environmental burdens all at once. As described above, the development of an entirely new food production method, which does not rely on such existing food production technologies as fattening or aquaculture with large amount of feed for animal or fish, is expected to be a great measure.

(Example 2)

The present aquaculture of seawater fish requires polyvalent unsaturated fatty acids from natural small fish as a source material to be contained in feed. It is a situation of "raising fish with fish." On the other hand, catching natural fish may not be expected to increase sustainability, considering the amount of the resource, and is very variable. In addition, natural fish several times greater in weight than cultured fish needs to be given as feed. These are factors that greatly lower sustainability of aquaculture. To counter these problems, effective solutions may be development of feed that relies on absolutely no natural fish or creation of seawater fish capable of self-synthesis of polyvalent unsaturated fatty acids. As described above, the resolution of inhibitory factors against sustainability of present food production and solutions by totally new ideas for improving sustainability are expected.

(Example 3)

Intervals between successive crossings are considered a rate-limiting factor in breeding and species protection for improving competitiveness, especially when maturation takes a long time. A solution for this may be innovative technology for shortening the reproduction cycle. R&D is expected to serve as a basis for strategically creating food industries of high impact when food supply and demand is exposed to rapid globalization and severe global R&D competition.

Be sure to describe the following in proposal documents. The description is keenly expected to be as specific and quantitative as possible.

・Specific image of socially implemented proposal contents presumed for 2030-2050 and how great realistically presumed social and industrial impacts would be
  - no need to be restricted to Japan
・Bottlenecks that would be a barrier when realizing the aforementioned “image of social implementation” and that are difficult to solve at present
  - multifaceted examination, not only in scientific and technological aspects, is necessary for social implementation.
  - restriction to one bottleneck is not necessary. In case of multiple bottlenecks, describe prioritized key bottlenecks.
・POC aimed to be achieved at completion of full-scale research (a stage for the society and industries to be able to judge practicability)
  - it is necessary to clearly show innovative science and technology to solve the aforementioned “bottlenecks”
・Goal for the feasibility study that should keep achieving the POC in mind and perform confirmation, verification, and construction as a stage before full-scale research
  To check the feasibility of the POC, the feasibility study presumes the following contents to be included as required and requires a goal that meets the contents.
  - checking feasibility in the aspect of science and technology, including theoretical verification of technologies at the stage of idea and detailed examination of necessary component technologies.
  - checking feasibility at social implementation including research on bottleneck dissolution toward social implementation (for example, social permissibility)
  - checking social and industrial impacts including detailed surveys of social and industrial needs and maximization of the impacts
  - checking a research team composition for full-scale research including R&D team formation by business firms or academia for maximizing impacts

(R&D projects to be excluded)
・Projects aiming to handle gene-manipulated cells as food are excluded, in principle. However, projects for which realistic and specific measures are set and described for securing social acceptability are not excluded. On the other hand, projects to utilize metabolites from gene-manipulated cells are included but require description of specific implementation contents for securing social acceptability.
・Projects mainly for eliminating bottlenecks after food production, such as food processing and storage, are excluded.
・Mere upgrading food/increasing added value of food for current market development or simply improving efficiency/scaling up/saving labor mainly to respond to current social situations are not included, because the purpose is the creation of food production technologies that will be fully developed for a society around 2030-2050.
・Because the purpose is to solve key bottlenecks with innovative science and technology, simple expansion of subjects, improving the efficiency, automation, or scaling up for existing technologies or projects mainly for education, popularization, or multipoint development are excluded.

(Items for special consideration)
Because this prioritized theme is presumed to contain immature R&D, it welcomes

challenging research proposals and new participation from other research fields that have not yet being involved. Even a research plan at the idea stage or a lower TRL study could be proposed, if the proposal objectively and specifically shows a plan concerning how to approach what is lacking in the proposal during the feasibility study.

**② Policies for promoting R&D**

This prioritized theme considers active mergers of different fields beyond conventional scientific fields effective, because it aims for marked sustainability and stabilization of food production on the premise of creating innovative science and technology. Moreover, collaboration among business firms, society, and academia is keenly expected as it needs to be connected to strong demands from the society in the future. Such situations are taken into account to attempt collaboration with related domestic programs and promote R&D for maximizing results.

In addition, this prioritized theme is predicted to be quickly applied to society and industries through bottleneck solutions. Therefore, shift to full-scale research is positively reviewed even during a feasibility study period. Furthermore, when the program officer judges it necessary for maximizing social and economic impacts, re-composition of a team through merging R&D themes even at adoption or during research is presumed. In such a case, the research period and budget shown in ○3 may be altered.

**③ R&D Period and Budget**

Plan a period of two-three years for a feasibility study (however, FY 2018 is calculated as one year regardless of when R&D starts) for an R&D project initiated in FY 2018 and a total budget of JPY 10-40 million (direct costs only) for the whole feasibility study period.

Plan a research period of five years or less for full-scale research and a total research budget of JPY 500-1,500 million (direct costs only) for the whole full-scale research period.

## 5.1.3 “Realization of the most Safe and Secure Society in the world” area

Research and Development Supervisor (Program Officer: PO):
Ken-ichi Tanaka
(Senior Engineer, Mitsubishi Electric Corporation)

### I Goal of the “Realization of the most safe and secure society in the world” area

Our society is changing every day. We always need to explore how to improve “Safety and Security” with the social changes.

This research area is expected to deliver POC which provides “safety and security” to the society by various kinds of services and researches necessary for services. Above all, the most important thing is the continuity of the activities utilizing research results. To provide continuous services, it is necessary to design a clear business model and realize a good economic cycle. For this purpose, we would like to positively seek proposals concerning services to search for comfort and pleasure in addition to positive factors without adhering to the image of reducing/eliminating factors that have been found negative in association with such a keyword as “safety and security.”

In FY 2017, two subjects were chosen as prioritized themes. (1) Development of the crisis navigator for individuals-- for safety and security in emergency, and (2) The creation of humane service industries-- for people’s safety and security in their daily life.

Now in FY 2018, the 3rd theme was added such as “(3) Realization of a safe, secured, and comfortable town by removing a slight amount of hazardous substances hiding in living environments”. We are calling for proposals on these three themes in total.

As for themes (1) and (2), we have partly changed scope of the theme based on the selection results of FY 2017. In the theme of “(1) Development of the crisis navigator for individuals”, we call for proposals not only of new navigators but of component technology of innovative user interface. By delivering appropriate information to individuals, the performance of the navigator will be improved. The intensive call for proposals of “(2) Creation of humane service industries” is foods and spaces.

The explanation of each theme and the outline figure for details of and relations among the three themes are below.

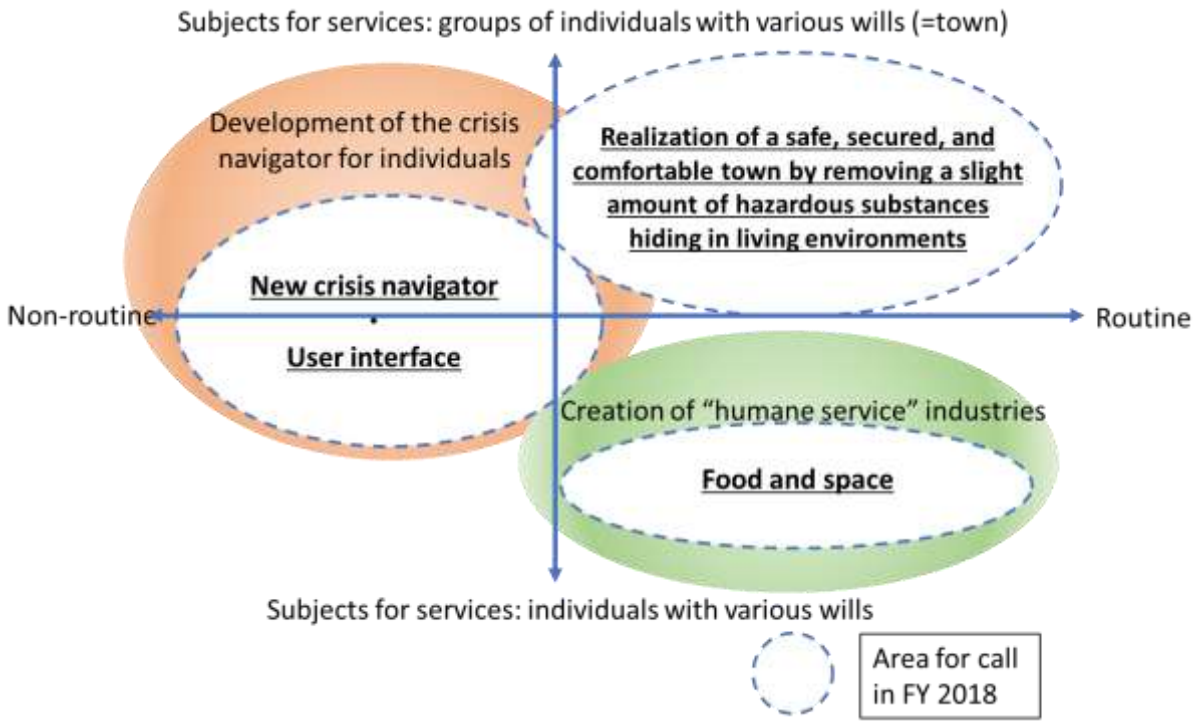



Fig. 1: Positioning three prioritized themes for "safety and security" area (outline figure)

# II Prioritized themes

## 1. Development of the crisis navigator for individuals

Continuation

### (1) About the Theme

**There are three types of hazard approaches such are prediction, prevention, and response phases. We focus on "response phase". Our goals are to improve the accuracy of decisions by organizations using technologies and to develop "navigator" which delivers options of actions to individuals.**

The word "Hazard" indicates not only natural disasters but also every dangerous factor that cause unexpected emergency such as accidents, incidents, and cyber-attacks. Our society is increasingly becoming more diversified and complex, for example, accelerating the globalization and expanding of the internet makes us easy to access to cyber-space. Under such circumstances, hazard and risk would not be eliminated naturally. To consider scientific approaches to eliminate the hazard or minimize damage, we must recognize that we are surrounded with various risks.

The approaches can be grouped into three phases: prediction of hazard (sensing hazard), prevention (preparing for damage), and response (responding to crisis to overcome it quickly). In the phase of those, prediction and prevention of hazard, have recently been upgraded by technologies. On the other hand, the response phase still tends to depend heavily upon "human decision." We consider a basic process of the response phase as follows; 1) people take action relying on decision of organizations[6] and 2) people take action to secure her or his own safety (escaping and hiding) or to secure safety of society(helping others, protecting something). Our goal is to establish high-level technology which supports these processes.

Also, we aim at developing a "navigator" to support decision of organizations and action of individuals.

[6] An organization means an entity that is responsible for securing safety of relevant individuals (members, users at the time). For example, the government, a municipality, a large-scale facility, an event manager, a building manager, a private company, and similar entities.

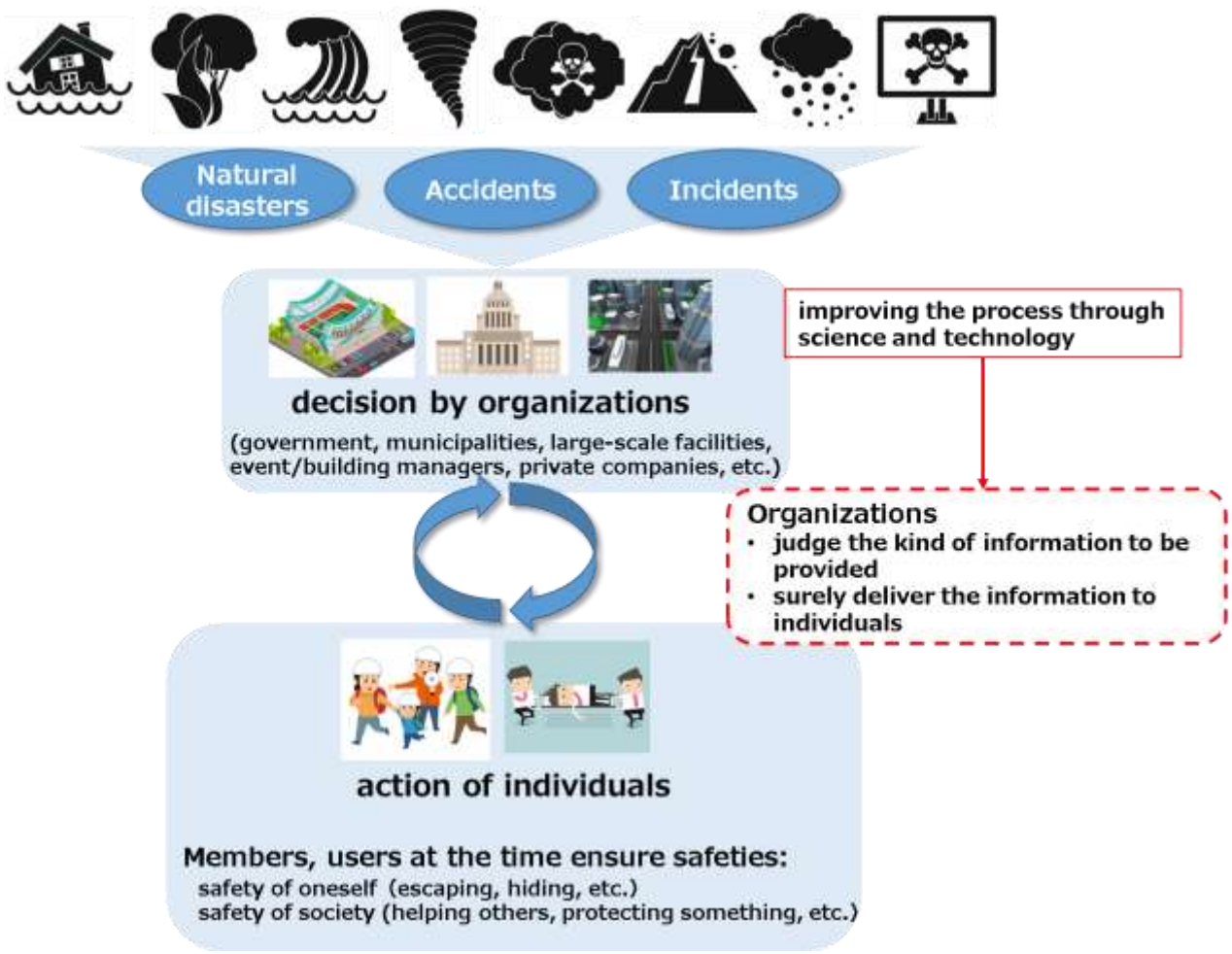



Fig.2: The aim of the crisis navigator for individuals

This navigator system would be able to provide not only the options for individuals with guide evacuation, but also each member of organizations, such as employee, with proper options for urgent responses, such as evacuation guidance. Therefore, it would give significant impacts to both individuals who want to secure safety in their daily lives and organizations which want to be recovered from damages caused by hazard. Also, it is presumed that navigator would contribute to develop new markets in recipients of its research outcomes; service industries (specifically, security companies), information and communications industries, and construction industries.

To add the useful functions for daily life other than emergency, the crisis navigator would be able to appeal additional values to the companies and administrative organizations which are introducing the navigator.

### (2) Policies of the R&D Supervisor for proposal selection and R&D management

**Key points in FY 2018**

**・ We are calling for proposals of the feasibility studies for component technologies which contribute to innovations in user interface besides new navigator.**

**・ The time of evaluation to the full-scale research is the same as that of the proposals adopted in FY 2017. Substantial research period would be one year.**
**・ We are planning to adopt about two proposals.**

## ① Policies for proposal selection

We aim at developing a navigator to greatly support response to hazard, mainly on initial response stage, by science and technology. Its realization needs the following technologies:

1) Observe, measure, determine and collect various information in a timely manner (prediction, prevention)

2) Integrate different kinds of information (information processing)

3) Derive options from the integrated information (information analysis)

4) Assured delivery of the options to individuals in a timely manner (information infrastructure, communications device)

5) Integrate the above technologies (systemization)

Improving accuracy of decision by organizations requires collecting quickly as much information as possible, visualizing situations and making a situation understandable (analyzing) and usable. It takes upgrading and optimizing of technology 1)-4). For developing a system as a "navigator," 5) is essential. Therefore, 5) is the must for the research proposals. It is not necessary to renew all of the 1)-4) technologies. It is welcomed to take advantage of existing research achievement.

Furthermore, in FY 2018, we are waiting for proposals to improve the completeness of navigators with basic component technologies which could deliver safety and security to individuals. For example, the innovative user interfaces which deliver appropriate action-options to every person from systems, or the communication method that can prevent confusion by providing information properly and timely. The R&D outlines of proposals of navigators adopted in FY 2017 are available on the website of the JST-Mirai program. A proposal should be described that what kind of hazards the navigator would deal with. It is not necessary to narrow down a single hazard. We would like the navigators which could be implemented all or multiple hazards. When you submit the proposal of feasibility studies for component technologies, please be sure to use a proposal form which is different from the one for proposing new navigator.

An important issue in the implementation of a navigator system in a society is how to guarantee reliability against such risks (for provider and user), including malfunction or false information. Concerning this, we encourage to consider where legal liability lies and to assess the users' acceptance with technology development.

## ② Policies for R&D management

Conducting challenging R&D activities, we encourage the diversity of a research team for incorporating innovative ideas, including the interdisciplinary approach, global activities and collaboration between industry and academia. R&D Supervisor and the committee members

will review your research activities and visit the research site and give you support and advices. We aim at realizing “safe and secure society in which everyone can feel protected.”

When transitioning from FS phase to full scale R&D, optimization of R&D plan will be considered again through restructuring research teams and so on.

## ③ R&D Period and Budgets

For the research proposal of navigator submitted in FY 2018, please plan within a maximum period of two years. However, time spent in FY 2018 is calculated to be one year regardless of when the research and development starts. Along with the navigators adopted in FY 2017, we evaluate your R&D activities for a full-scale research or a continuation of the FS at a time specified by the R&D Supervisor in charge until the end of FY 2019. As the R&D is supposed to start around autumn 2018, the substantial period up to evaluation is about one year. Please make a plan with a maximum total budget of 30 million JPY (direct costs only) in principle.

Please plan a maximum period of five years and a maximum total budget of 1.5 billion JPY (direct costs only) for a full-scale research.

For the research proposal of feasibility studies for component technologies submitted in FY 2018, please plan within a maximum period of two years which is the same as proposals of the navigator. Along with the other navigators, we evaluate your R&D activities for a full-scale research or a continuation of the FS at a time specified by the R&D Supervisor in charge until the end of FY 2019. We evaluate the proposals taking the possibilities of integration with other projects adopted as navigator into account. Please make a plan with a maximum total budget of 12 million JPY (direct costs only) in principle.

We are planning to adopt about two proposals in this theme.

## 2. Creation of “humane service” industries

Continuation

### (1) About the Theme

**We aim at realizing “humane services” that allow everyone feel safe, comfortable, and being secured by promoting human relations and controlling the environment around people.**

Science and technology have made our lives safe, secure, and rich. As the Fifth Basic Plan for Science and Technology (2016-2020) proposes a new society following the hunting society, the agricultural society, the industrial society, and the information society, science and technology are presumed to play increasingly larger roles in our lives in the future.

The proposal related to “safety and security” in the proposed theme of the JST-Mirai program has attracted anxiety and dissatisfaction associated not only with abrupt changes caused by environmental disasters but also with progress in science and technology. There are voices that fear the possibility of adverse mental and physical influence as frequent use of IoT and AI technologies dilute connections among people through the five senses.

Taking into account such opinions, we would like to utilize science and technology for creating new services. To achieve that, it is necessary to verify what services a future society requires and what science and technology can contribute to their realization. For example, current communications mainly use voice and characters as means. In the future, however, tactile sense, taste, or olfactory sense may allow sharing content that could not be shared through languages. Many people have probably experienced a flash of a good idea in a bath or a train. A future may arrive when the space to facilitate such flashes of ideas may be produced. Recent progress in science and technology in combination with our imagination should be able to create many better services and produce a safe, secure, and comfortable society.

### (2) Policies of the R&D Supervisor for proposal selection and R&D management

**Key points in FY 2018**

**・ We are intensively waiting for proposals concerning “food safety and pleasure of eating” and “high added-value space”.**

**・ The services providing certain products of which proposals focusing on R&D for new values of products are also acceptable.**

**・ In this prioritized theme, we are planning to adopt about four proposals.**

#### ① Policies for proposal selection

R&D under this theme aims at the services that recipients can accept without prejudice. The R&D is expected to contribute the society in which services based on advanced science and technology are naturally available in our life. A human interface is presumed that service recipients would accept it without any changes of their lifestyle nor acquire new skills.

In FY 2017, this prioritized theme has expected four categories as prospects based on

conducted analysis under proposed themes, however, the second call in FY 2018, we intensively would like proposals related to “food safety and pleasure of eating” and “high added-value space”. We have got meaning of “services” more widely, so that the services providing certain products of which proposals focusing on R&D for new values of products are also acceptable.

(1) Food safety and pleasure of eating: the value-added services to improve food safety and everyone can feel safe by providing proper information, the services which improve pleasure of eating, etc.

“Low-potassium melon” may be cited as such an example. Potassium is an essential nutrient for human bodies. However, it could cause numbness or irregular pulse and cardiopulmonary in case of a person whose renal function is low took an excess amount of potassium. Therefore, the development of low-potassium melon provides artificial dialysis patients with a new value through melons they are able to eat.

(2) High added-value space: instruments and services for building an environment that allows people to maximize the expression of their abilities as well as to reduce unconscious stress through designing space and controlling the environment.

Recently, the construction industry hopes to take into account designing spaces for wellness, or considering how people feel in certain spaces, as a new value following net-zero energy buildings and houses.

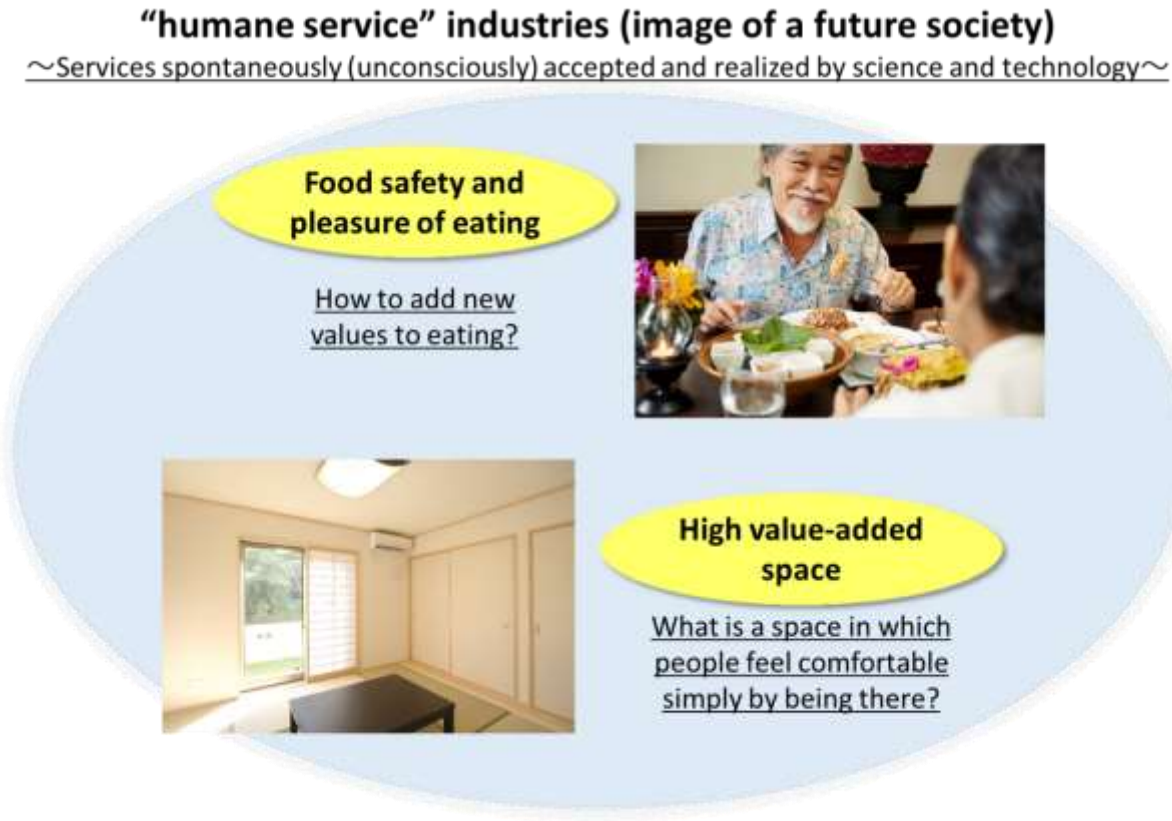



Fig. 3: Goal of humane service industries called for in FY 2018

For planning and developing new service, we need to have comprehensive views of these ideas and expect business development such as delivering POC. Our goal is to implement services in society, therefore it is considered desirable to start with services which have evidence proving of safety, security, and comfort by basic researches and verification tests.

Along with research and development, we would like you to consider that specific activities are necessary for standardization to implement of the society.

## ② Policies for R&D management

Conducting challenging R&D activities, we encourage the diversity of a research team for incorporating innovative ideas, including the interdisciplinary approach, global activities and collaboration between industry and academia. R&D Supervisor and the committee members will review research activities and visit the research site and give you support and advices. We aim at realizing “safe and secure society in which everyone can feel secured.”

To increase chances for success in new service creation, we would like to repeat short-term challenges even at the FS stage to search for better possibility under this theme.

When transitioning from FS phase to full scale R&D, optimization of R&D plan will be considered again through restructuring research teams and so on.

## ③ R&D Period and Budgets

For the research proposal of a feasibility study submitted in FY 2018, please plan within a maximum period of two years. However, time spent in FY 2018 is calculated to be one year regardless of when the research and development starts. We evaluate your R&D activities for a full-scale research or a continuation of the FS at a time specified by the R&D Supervisor in charge until the end of FY 2019. Please make a plan with a maximum total budget of 15 million JPY (direct costs only) in principle.

Please plan a maximum period of five years and a maximum total budget of 1.5 billion JPY (direct costs only) for a full-scale research.

New

## 3. Realization of a safe, secured, and comfortable town by removing a slight amount of hazardous substances hiding in living environments.

### (1) About the Theme

**This prioritized theme prospects R&D such as detecting, eliminating, and avoiding a slight amount of hazardous substances hiding in the living environment for wide area, so that all the people living there can feel safe, secured, and comfort.**

We always unconsciously enjoy the benefit of air and water of which are shared by many people across wide area in a town. On the other hand, it is known that a slight amount of hazardous substances[7] are hiding there, such as viruses, pollens, and chemical substances that can damage peoples' health. Once the town has intensely contaminated, the contamination exerts adverse effects on the health of many people. To deal with issues, it may be effective in some cases that wearing masks or installing water cleaners for household use. However, when considering about an ideal society in the future, our nation should engage in R&D to reduce the burdens of individuals and to remove anxious factors.

This prioritized theme aims to perform R&D to bring new values to everyone in the town where pollens do not fly around, masks are not needed, water cleaners are not needed, and the sea is always clean.

[7] A hazardous substance referred to in this prioritized theme presumes a causal substance to directly exert adverse effects on humans more broadly than hazardous substances prescribed in various laws and regulations do.


Fig. 4: Our goals in this theme of “realization of a safe, secured, and comfortable town by removing a slight amount of hazardous substances hiding in living environment”

### (2) Policies of the R&D Supervisor for proposal selection and R&D management

## ① Policies for proposal selection

This prioritized theme presumes hazardous substances for R&D, which are causal substances directly exerting adverse effects on people more broadly than those prescribed in various laws and regulations. This mainly refers to substances existing in the current living environment in Japan, whether apparent or latent. Subjects should have a large social and economic impact, so it must be excluded that the subjects which the level of influence is unexpectable. For example, the influenza virus, norovirus, pollen, and substances causing air and water pollutions such as PM 2.5 or PM 1.0 are considered as main subjects, however, the followings are subjects presumed to be excluded:

・ Substances which basically considered to have no infection sources in Japan, such as the ebolavirus

-> Because of low cost effectiveness of infrastructure investment in individual detection and response

・ Substances imported clearly with an ill intention, such as triacetone triperoxide (an explosive)

-> Because of low cost effectiveness of infrastructure investment in individual detection and

response

・ Substances causes problems by ingesting in agricultural products, such as cadmium in soil

->Because unlike ingestion through water or air, it could be deal with problems by testing products.

・ Water itself causing liquefaction in soil

->Because water itself is not a hazardous substance and its detection method is distinctly different from those for other called projects.

・ Floating substances in the seawater, such as microplastics

->Because researches of their effects to ecosystem are ongoing which makes difficult to judge the relevance of responses.

When you propose an idea, please firstly specify hazardous substances as references above; then describe clearly about the way how to deal with it by mentioning methods of detection, removal, and avoidance, concurrently with describing what kind of impact the idea would effect to society and economy in the process.

For example, it has not clearly understood how seasonal influenza spreads in a town. A reason for this may be the difficulties of detecting influenza virus in non-infected people or animals. Contact with the virus is known as trigger for influenza. If it became clear where and what quantities of the influenza virus exists in the living environment and the virus can be eliminated or avoided, it could be a great value to our society. When the POC could be indicated clearly of which specific measurement method or infrastructure for measurement, business firms would possibly accept it. On the other hand, because the dispersion of pollen has already been widely understood, R&D in this program must create measures to prevent exposure rather than methods to detect dispersed pollen.

A proposal to detect a chemical substance and evaluate its environmental effects which rely on regulation policies for response would be considered not to fit the purpose of this theme by reason of that no one might accept the POC although it depends on the scope and impact of influence of the chemical substance.

Concerning water, there are some aquatic facilities detect cryptosporidium and sterilize it with UV or ozone with high-cost; such a high-level treatment is feared to increase the cost burden of the government in infrastructure equipment. We need to find a new breakthrough which will take account of national finance and improves efficiency for the whole system in the future. Please apply your proposals based on new materials and methods that could be introduced into the existing systems for the elimination of environmentally hazardous substances in wastewater disposal facilities.

## ② Policies for R&D management

Conducting challenging R&D activities, we encourage the diversity of a research team for incorporating innovative ideas, including the interdisciplinary approach, global activities and collaboration between industry and academia. R&D Supervisor and the committee members will review research activities and visit the research site and give you support and advices. We aim at realizing “safe and secure society in which everyone can feel secured.”

To increase chances for success in new service creation, we would like to repeat short-term challenges even at the FS stage to search for better possibility under this theme.

When transitioning from FS phase to full scale R&D, optimization of R&D plan will be

considered again through restructuring research teams and so on.

## ③ R&D Period and Budgets

For the research proposal of a feasibility study submitted in FY 2018, please plan within a maximum period of three years. However, time spent in FY 2018 is calculated to be one year regardless of when the research and development starts. We evaluate your R&D activities for a full-scale research or a continuation of the FS at a time specified by the R&D Supervisor in charge until the end of FY 2020. Please make a plan with a maximum total budget of 45 million JPY (direct costs only) in principle.

Please plan a maximum period of five years and a maximum total budget of 1.5 billion JPY (direct costs only) for a full-scale research.

## 5.1.4 “Realization of a low carbon society, a global issue” area

Research and Development Supervisor (Program Officer: PO):
Kazuhito HASHIMOTO
(President, National Institute for Materials Science)

### I Goal of “Realization of a low carbon society, which is a global issue” area

It is a global issue to build a “low-carbon society,” in which the emission of greenhouse gases, especially carbon dioxide ($CO_2$), which is a cause of the global warming problem, should be suppressed. The “Paris Agreement,” adopted in the 21st session of the Conference of the Parties of the United Nations Framework Convention on Climate Change (COP21) held in December 2015, called for the parties to limit the temperature increase to less than 2 °C compared to pre-industrial levels and to pursue efforts to limit it to 1.5 °C. In correspondence with this agreement, the government of Japan set forth a target, “to reduce greenhouse gas emission in fiscal year 2030 by 26 % compared to fiscal year 2013,” in December 2015; to attain this target, the Global Warming Prevention Headquarters has determined to make steady efforts.

In addition, the “National Energy and Environment Strategy for Technological Innovation towards 2050” (NESTI 2050) compiled by the Council for Science, Technology and Innovation in April 2016 presented, keeping the year 2050 in view, some prospective technologies with the potential to reduce emissions that should have a large impact, as well as the organization to advance long-term research and development; furthermore, the “Plan for Global Warming Countermeasures,” a cabinet decision in May 2016, stated strategic endeavors with a long-term target in view; that is, “to pursue efforts to reduce the emission of greenhouse gas by 80 % by the year 2050.”

To attain this target, we need an innovative technology based on a completely new concept and science, in other words, the creation of “game-changing technology.”

For the creation of a game-changing technology, completely new proposals made by researchers in different fields are also important, in addition to the challenging proposals that may result from the integration, utilization, and/or development of the forefront research methods by researchers in this field.

To promote the creation of a game-changing technology based on the proposals for prioritized themes we called for from the general public as well as on the interviews with experts in relevant specific fields and other fields, we, in our R&D Steering Meeting, examined the prioritized theme for fiscal year 2018.

As a result, we came to a decision that it was extremely important to make continuous efforts to develop innovative technology; thus, the prioritized theme was set as a continuation from fiscal year 2017, “realization of a low-carbon society through ‘game-changing technologies.’” Furthermore, we classified the fields of the technologies in relation

to low-carbon emission into seven subthemes; then, based on the analysis of the contents in the prioritized themes called for from the general public as well as on the “bottleneck issues” (the issues facing the technologies in implementing achievements in the society) presented last fiscal year, we reset our bottleneck issues to call for more research-and-development proposals for solving those issues.

## II Prioritized theme

### Realization of a Low-Carbon Society through 'Game-Changing Technologies'

| Subtheme* | Classification of Proposals | Bottleneck Issue |
|---|---|---|
| ① $CO_2$-free hydrogen production technologies to build a hydrogen-energy-based society | B1 | $CO_2$-free hydrogen production technologies to build a hydrogen-energy-based society |
| ② Super-efficient implementation of systems and devices applied with innovative materials | B2 | Low loss and improved maintenance of cooling systems for superconducting instruments |
| | B3 | High performance and protection technologies of high temperature superconducting coil |
| | B4 | Energy saving and high efficient technologies of electric power / power conversion system |
| | B5 | Fundamental technologies of green electronics for data communications |
| ③ Innovative energy-saving technologies based on the high-efficiency application of physical/chemical processes | B6 | Development of low-cost recovery technologies for waste heat energy to be implemented in society |
| | B7 | Technologies for large-scale and efficient conversion of $CO_2$ into methanol, olefins, and other chemicals |
| | B8 | Development of highly efficient separation membrane and sorbent for greenhouse gas capture |
| | B9 | Process improving technologies using efficient and high-performance separation techniques |
| | B10 | Innovation of bulk chemicals production technologies based on new reaction fields to save energy required for causing chemically difficult reactions |
| | B11 | Development of highly efficient biomass gasification processes for chemicals production |

| | | |
|---|---|---|
| ④ Energy-saving technologies based on the high-efficiency application of metal material processes | B12 | Development of alloy and alloy powdering technologies suitable for lamination of structural materials |
| | B13 | Innovative bonding and separation technologies that possess both bonding strength and separation or decomposition functions |
| | B14 | Innovative reliable lifetime prediction technologies for durable structural materials contributing to $CO_2$ reduction |
| ⑤ Innovative energy storage technologies for next generation batteries, capacitors, or fuel cells | B15 | Development of solid electrolyte with high ionic conductivity based on ceramic technologies |
| | B16 | Formation technologies for the optimal interface between solid particles based on powder technologies or ceramic science |
| | B17 | Technologies for removing water vapor and carbon dioxide in the air |
| | B18 | Low-temperature operability of solid oxide fuel cell (SOFC) |
| | B19 | Stable electrolytes, electrode materials, or systems for electrochemical capacitors under high voltage and high capacity |
| | B20 | Development for the high-performance battery materials by clarification of the factors on the interface between different phases in the complex system |
| | B21 | Development for new materials by quantitative analysis methods of the degree of crystallinity of amorphous materials such as carbon or solid electrolyte |
| | B22 | Methodology to suppress large expansion and contraction for electrodes such as negative metal electrodes, negative silicon electrodes, etc. |
| | B23 | Development of composite electrolytes with high ionic conductivity, molding, interface formability based on the composite of inorganic solid electrolytes and polymer electrolytes |

| | | |
|---|---|---|
| ⑥ Innovative technologies for using sunlight by using optical science, quantum effects, etc. | B24 | Pb-free and high durable perovskite solar cell |
| | B25 | New concept solar cells to realize conversion efficiency twice or more as high as conventional solar cells |
| | B26 | Manufacturing technologies for super thin film crystal Si solar cells under 40 μm |
| | B27 | Innovative top-cell technologies for high-efficient tandem-type solar cells |
| | B28 | Organic-dye solar cells suppressing voltage loss |
| | B29 | Photochemical synthesis of useful materials with water as an electron source |
| ⑦ Energy/material technologies for using biomass design to replace petroleum-derived resources | B30 | Development of photosynthetic microorganisms robust against changes in environmental conditions for large-scale production |
| | B31 | Technologies for improving biomass productivity with minimum resource input |
| | B32 | Synthetic biology technologies for designing cells with high productivity for useful substances |
| | B33 | New synthetic technologies for high-efficient production of high-performance/high-functionality materials from biomass raw materials |
| | B34 | Technologies for controlling layer structures to create next generation nanocellulose materials |
| | B35 | Technologies for chemical modification/composition to create next generation lignin materials |
| ⑧ Other | B36 | New approaches for a low carbon society |

*”Subtheme” here refers to those in subclassification of the bottleneck issues. Proposals should be made in any one of the bottleneck issues.

### (1) About the theme

We aim to create a game-changing, innovative technology based on a completely new concept and science, and cooperate with other JST projects, endeavors by governmental bodies and others to implement our achievements in the society, satisfying the demands for

services that are expected to be present in 2050 and contributing to the realization of a low-carbon society where $CO_2$ emissions are drastically reduced.
FIG. 1 shows an overview of this area.

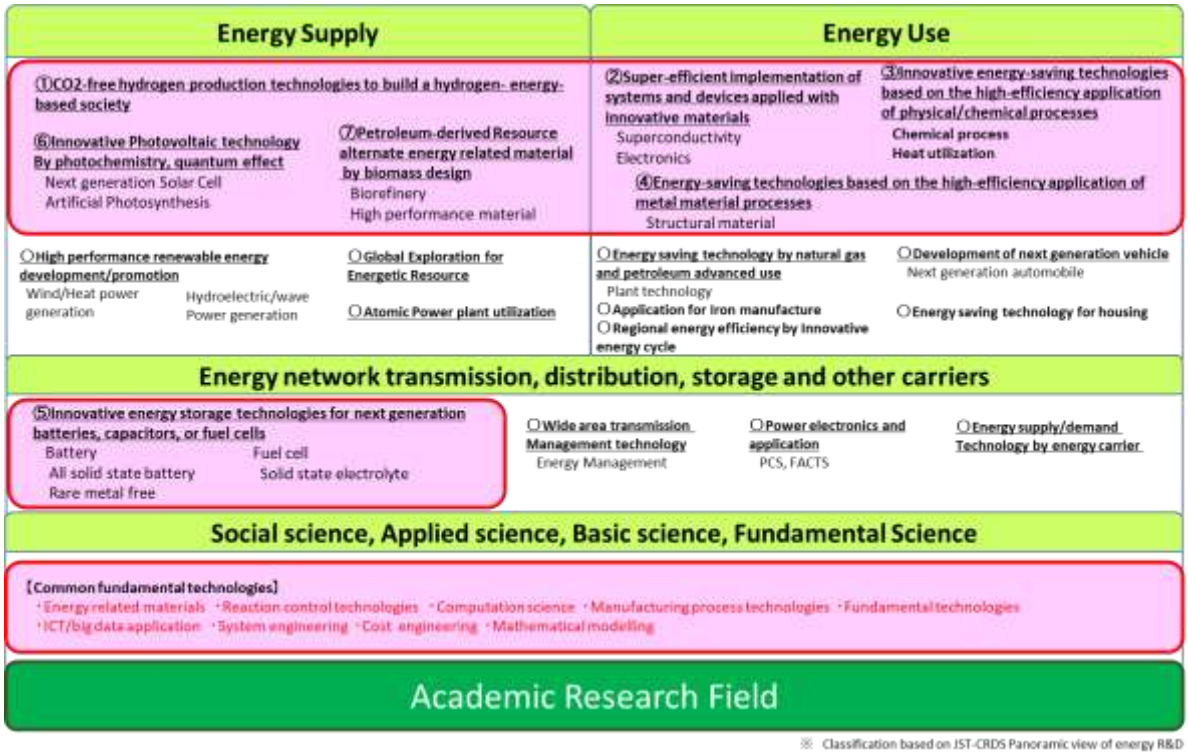



FIG. 1. An overview of the “Realization of a Low Carbon Society, a Global Issue” area

As mentioned above, the “Plan for Global Warming Countermeasures,” a cabinet decision in the year 2016, set up a target as the strategic objective with a long-term target in view; that is, “to pursue efforts to reduce the emission of greenhouse gas by 80 % by the year 2050.” To attain this target, it is “essential to create the innovation that realizes a drastic reduction in the amount of emissions in the whole world, including those technologies that are not a continuation of any conventional reduction technology;” therefore, it is one of the roles our country should play that “the mid- and long-term research and developments in the fields of energy and environment for realizing innovation in the reduction of $CO_2$ emission should be strongly advanced by wisdom gathered from the industries, academes, and governmental bodies, applying the achievements in the world.” This is one of the concepts involved in NESTI2050. This R&D strategy agrees with the concept of the creation of a game-changing technology that is addressed in this area, promoting the research and developments that are closely connected to the public interest.
Furthermore, we, considering the research and development funds from the government and also the impact on the society, expect that the point of view of “the cost engineering of a low-carbon technology” should be included in the proposals in this area. This is for the rational forecast of the technology development at the time of a low-carbon technology and system being introduced in the society in the future and also for the assessment of the effect on reducing the amount of $CO_2$ emission; this is also an important viewpoint for attainment

of the target by the year 2050, namely, the 80-% reduction of greenhouse gas emissions. We hope that, with respect to the low-carbon technology and system within the scope of the issues in the proposals, examinations should be made from the perspective of the cost, on the timing of the establishment of a technology as well as the timing of its industrialization, on the outlook for the market size, and on other aspects; in addition, we also hope that certain measures (scenarios) for the solution of these issues should be presented.

As for the point of view of the contribution to the international society, we can also assume, for instance, that we should use excellent technology to advance the endeavors or any other effort in cooperation with willing developing countries or any other country, such that our country may use its technological ability to play a core role in reducing the amount of $CO_2$ emissions around the globe. In the world of industries, the Japan Business Federation (Keidanren) has compiled “Keidanren's Action Plan for the Low-Carbon Society in 2030” (formulated in April 2015, revised in April 2017) and established “The Development of Innovative Technology” as one of the mainstays in their plans, stating that “we also make use of the cooperation among industries, academes, and governmental bodies to proactively cope with the development and practical implementation of the innovative technology in a mid- to long-term period even covering the years after 2030.” We can expect that we, apart from contributing to corporations in reducing their $CO_2$ emissions to attain the target of reduction, may be on the direct path to the enhancement of the industrial competitiveness of Japan only if an innovative technology is created to contribute to the solution of any bottleneck issues that hinder the low-carbon application aimed at in this area, and the technology is transferred to corporations.

### (2) Principle of the Research and Development Supervision in Proposal Selection and R&D Management

**●Principle of the Proposal Selection**

We select proposals by following the requirements listed below to adopt the issues that meet the concept of this program (the verification of the concepts based on innovative research and development).

・To be able to make a great contribution to the reduction of $CO_2$ emission (beyond the point of view of science)

・To propose a technology required by corporations that will undertake the burden of its implementation in the society

・To propose innovative research that ought to be managed by universities, colleges, and/or other academic institutes

Moreover, for the sake of the implementation in the society, we, if necessary, will cooperate with other governmental bodies in other programs to transfer our achievements.

Through our endeavors stated above, we aim to create a game-changing technology that will, while satisfying the expected demands for services in the year 2050, drastically reduce $CO_2$

emissions and, thus, we lead it to implementation in the society, contributing to the realization of the low-carbon society.

**●Evaluated Items and Norms**

Our selection will be based on the following evaluated items for the comprehensive examinations of proposals.

[Adequacy of Targets]

・The proposal uses quantitative expressions to present that the technological issue, which the proponent wants to cope with, will contribute to the realization of a low-carbon society by around the year 2050.

[Adequacy of Means]

・The measures for the solution of an issue, which the proponent wants to cope with to achieve a goal, exhibit superiority and uniqueness.

・The plan for the research and development is adequate (including the organization for the research and development and the scale of its implementation).

[Feasibility]

・The measures for the solution of an issue, which the proponent wants to cope with to achieve a goal, will be feasible at the time of the completion of the full-scale research.

・The scenario covering the events from after the completion of the full-scale research to the practical application is adequate.

**●Description on Research and Development**

There are, roughly classified, two types of approaches to solve the global warming problem; that is, “measures for applicability” and “measures for mitigation.” The former indicates the adjustment of the state of nature and/or the society to reduce the influence of the warming, whereas the latter indicates the suppression of the emission of greenhouse gas per se. For the measures for mitigation, the expectation is high with respect to the contribution by scientific technology; we, in this area, aim to create a game-changing technology that contributes to the realization of a low-carbon society based on measures for mitigation.

To this day, various trials have been performed in the course of the development of technologies that contribute to the reduction of $CO_2$, a large number of which have not been applied in the real world. The causes of this, i.e., “bottleneck issues,” will be compiled and presented by the parties relevant to this area.

In this area, we think that completely new proposals made by researchers in different fields are also important in addition to the challenging proposals that may result from the integration, utilization, and/or development of the forefront research methods made by the researchers in this field. Therefore, based on the analysis of the contents in the prioritized themes called for from the general public, as well as on the bottleneck issues presented in the last fiscal year, we reset our bottleneck issues to specifically describe the contents. The seven subthemes (① to ⑦) that classify this field are shown below.

## ① $CO_2$-free hydrogen production technologies to build a hydrogen- energy-based society

### B1. $CO_2$-free hydrogen production technologies to build a hydrogen-energy-based society

For the realization of a low carbon society, our country needs to drastically reduce its $CO_2$ emissions (to reduce the emission of greenhouse gases by 80% by 2050). The government, in the "Plan for Global Warming Countermeasures" (cabinet decision, May 13, 2016) and on other occasions, has expressed its determination to try and change the existing energy supply structure and migrate to a new energy system.

In recent years, our attention is focused on hydrogen as a type of energy carrier that neither involves carbon nor emits $CO_2$ while we use it. In its production phase, we can use the carbon dioxide capture and storage (CCS) technology and recyclable energy so as to complete use of an energy carrier that is $CO_2$-free.

As of date, they are using hydrogen generated as a by-product at factories or other places for the purpose of industrial use; however, owing to the practical application of hydrogen power generation (turbine) and the spread of fuel cells, the demand for hydrogen will increase by a thousand times by 2030 compared to the current level, in which the hydrogen power generation alone is estimated to consume 300,000 tons a year, demanding some technology to produce a considerable amount of hydrogen ("Basic Hydrogen Strategy," December 26, 2017).

A large quantity of hydrogen by-product is produced from methane steam reforming, wherein 11.5 tons of $CO_2$ are emitted for 1 ton of hydrogen. For $CO_2$-free hydrogen-producing technologies, we can think of a technology that uses water electrolysis and/or some other application of electricity, a technology that uses water photolysis or some other application of a light-related process, a technology that uses thermochemistry, a technology in relation to the bio-hydrogen production sourced from organic resources, among others; however, each involves some technological issues that are described below.

(i) Technological Issues in Water Electrolysis

Hydrogen production from water electrolysis has been highly expected in $CO_2$ free process, for utilysing renewable energy like solar energy, solar thermal energy and wind power. But it contains various problem like efficiency, load fluctuation, costs, lifespan and so on. Moreover, these problems contains conflicting elements, strategic research and development has needed.

For example, large-scale water electrolysis make full use of renewable energy is suitable for low cost alkali water electrolysis so development of separator with no cross over and low electro resistance separator, current collector, electrode materials are strongly needed. On the other hand, to use excess energy from renewable energy with no demands are suitable for polymer membrane type water electrolysis which highly adapted to frequently start-stop, but for its utilization, development of substitutional low cost materials are highly expected

for expensive electrode catalyst like plutinum, expensive polymer electlyte membrane consist of sulfonic fluorine resin, strong acid resisted electrolytic cell of Ti material.
It has been promoted to develop demand response function of power, coordination, emergency response adding to produce hydrogen. For these functions work for high temperature (800℃), cost down of device materials and thermal insulation technology are needed. For solid electrolyte are ceramics, improvement for large area, enforcement of mechanical strength and expansion and contraction by fluctuation of temperature are necessary.

(ii) Technological Issues in Water Photocatalytic Degradation

・The development of a high-efficiency photocatalyst that enables the production of hydrogen from water photolysis is one of the most important bottleneck issues. For this, we want the energy-conversion efficiency from sunlight to hydrogen to be at a level comparable to the energy-conversion efficiency in the case in which a solar cell is used for water photolysis. For this purpose, it is essential that the developed photocatalyst should function efficiently even under visible light. In addition, the stability that bears long-time use and, furthermore, separating generated hydrogen and oxygen are also among important issues.

・Almost all current researches are being performed in laboratories equipped with a model system where some electrolyte is added into pure water; however, in reality, it is difficult to have water in an area with strong sunlight. It is understood that the use of water involving saltwater, seawater, or some other type of water that involves chloride ions is essential; however, we need to selectively consider how we should deal with the oxidation catalyst that generates oxygen or the chlorine generated there. Moreover, it is necessary to examine the water-pretreatment technology in terms of cost.

(iii) Technological Issues in Thermochemistry Processes

・For producing hydrogen from the thermochemical decomposition of water, a variety of endeavors have been made till date, including copper-chlorine cycles, IS processes, UT-3 processes, among others. However, some problems do exist; that is, we have only some limited types of thermal sources if the reaction temperature is as high as 1,000°C or higher, whereas if the reaction temperature is low, we have complex reactions that generate hazardous by-products and the like. This is why we want the development of an innovative technology in thermochemistry processes that suppresses reaction temperatures, simplifies reactions, and suppresses the generation of harmful by-products and the like.

(iv) Technological Issues in Bio-hydrogen Production

・For the production of bio-hydrogen, they have been using dark fermentation, bio-photo reactions, and others. It is said that it is difficult to generate hydrogen from a variety of organic resources; the issues are not only the slow speed of hydrogen generation and the low efficiency of hydrogen conversion, but also the instability. Therefore, for the quick and stable generation of bio-hydrogen from organic resources, it is wanted that methods such as

synthetic biology, metabolic engineering, and process engineering should be used to design and control microorganisms and oxygen, thereby developing a technology that may drastically enhance the efficiency of hydrogen conversion. In addition, reductions in the generation of extra gases, including $CO_2$, in the course of the generation of hydrogen are also desired; what is wanted here is the development of a technology that converts $CO_2$ into some useful chemical compound and, at the same time, enables the production of hydrogen.

We are calling for methods of solving these issues and of producing hydrogen in $CO_2$-free processes.

## ② Super-efficient implementation of systems and devices applied with innovative materials

### B2. Low loss and improved maintenance of cooling systems for superconducting instruments

Superconductivity systems are about to enter the phase of social implementation; to excel in the competition against existing non-superconductivity systems and to be prosperous in social implementation, the whole system, including not only the superconductivity equipment per se but also the cooling system, should progress toward performance enhancement. More specifically, what is wanted here is the development of certain technologies for freezers, as the components of the cooling system, as well as for various other types of equipment in consideration of achieving lower losses, reduced operation costs, less frequent maintenance work, and so forth. In the development of a superconductivity system, the research and development of cooling systems is important, as described above; at the same time this needs to satisfy the preconditions of the system, including its practicability. We may need to select some cooling methods depending on the conditions of the system. However, it is also highly expected that an innovative technology will lead to a breakthrough on the issues with cooling systems based on a cooling technology that can be recognized as a common platform without strongly depending on any applicable equipment. For this purpose, to advance the research and development of cooling systems for superconductivity equipment with the use of MgB2 wire materials, REBCO wire materials, or Bi-related wire materials, we also call for proposals that aim to enhance the performance of freezers, compressors, refiners, flow meters, liquid level meters, and other low-temperature equipment; the heat-transfer flow of He, H2, N2, and other coolants; thermal-insulation pipe systems; and other components with sufficient consideration to the costs, system sizes, and maintenance performance.

### B3. High performance and protection technologies of high temperature superconducting coil

In the case of superconductivity equipment and systems with the application of magnetic fields, superconductivity coils are among the important components; increasing the performance of high-temperature superconductivity coils is one of the important issues in

enhancing the superiority of the superconductivity equipment to compete with other technologies. More specifically, it is wanted that the mechanism of high-temperature superconductivity coils, which ought to have high thermal stability by nature, should be revealed so that they do not cause any coil burnout or similar issue that could result from partial performance deterioration or uneven cooling. On this basis, the designing highly practicable coil systems, development of production technology, and development of technology for protecting coils should be effected. In addition, it is also necessary that the AC loss or similar that is generated with a coil should be sufficiently low, even if the coil is used under conditions where the magnetic field and/or the amperage may vary, such that there is sufficient competitiveness with respect to the loss and efficiency of equipment and/or systems. It is highly expected that an innovative technology will be developed for the enhancement in the performance and protection of such high-temperature superconductivity coils.

Under these circumstances, for the sake of the enhancement in the performance of high-temperature superconductivity coils using REBCO wire materials or similar, of the technology to protect such coils, and of the research and development of low-loss applications, we are calling for proposals for the development of new ideas, experimental verification, numerical analysis technology, and more. However, as for such high-temperature superconductivity coils and the conditions of their usage, it is required that they should be used for superconductivity equipment and/or systems that will be capable of making great contributions to low-carbon applications and that their future economic performance should be also considered in the proposals.

**B4. Energy saving and high efficient technologies of electric power / power conversion system**

Today, the gross power consumption of our country is 900 TWh, of which almost 60 % is used for the driving power of motors; we can drastically suppress the amount of greenhouse gas emission by some technology to reduce the power consumption in relation to such motors. The driver-power conversion efficiency of motors in present-day use exceeds 90 %; however, there is much more room for improvement in this efficiency regarding the power loss due to inverters and the technologies around them. Potential areas of improvement include, for ① the element structures and materials of integrated intelligent power modules, low-iron-loss magnetic materials and high-saturation-magnetic-flux-density magnetic materials; for ② the circuit operation of high-voltage resistant power switching elements (SiC, GaN, etc.), new gate driving methods and high-speed soft switching technology; and for ③ the control methods, a drastic reduction in transport energy is possible by miniaturizing and lightening the whole inverter system including motors and cooling devices. Additionally, of course, reductions in power losses from inverters can be achieved by introducing an automatic tracking technology to maximize the energy efficiency of motors or by some other means. The issues we need to tackle in this technology area include ① a power module that can operate around 200 ° C, ② a low-iron-loss magnetic material that generates only a low

amount of heat emission during electric-power conversion, ③ a high-speed switching element that is durable against voltages exceeding 1 kV, ④ an arbitrary waveform gate drive integrated circuit, and a variety of hardware in addition to some essential ingenuity for new software programs with a method to drive and control motors. We are calling for proposals that address these issues. When we assume a future large-scale implementation in the society, it is also important that the proposals include measures to reduce the development cost of the motors, magnetic materials, and so on that do not require rare magnetic elements and a high level of convenience based on invertor-integrated motors and so forth.

**B5. Fundamental technologies of green electronics for data communications**

In the coming years, there will be a rapid expansion of the usage of the Internet, in which sensors are attached to things and humans, such as for daily health management; to home appliances, buildings, and transportation equipment; and for certain agricultural uses or similar for communications in Internet of things (IoT) applications or machine-to-machine (M2M) communications, through which a vast number of data are uploaded to the cloud. In addition, in terms of mobile communication equipment, the needs for 4K/8K and other video content, as well as for high-resolution static images for security, educational content, medical content, and others have been rapidly increasing. The amount of data communication keeps on rapidly increasing. For instance, for the next-generation 5G communication systems, a capacity increase of one-thousand times or more and speeds exceeding 10 Gbps are expected; to satisfy the expanding demand for telecommunications in the long run, it is required to reduce the communication power consumption per bit to a tenth or lower.
The issues we should solve in this area of technology (communication bottlenecks) are everywhere in the communication paths from the edge side to the cloud side; we have to solve the bottlenecks in ① the high-efficiency power devices for telecommunications, ② ultralow-power-consumption edge information processing chips, ③ low-power-consumption high-speed router devices, ④ environmental power-generation devices, and a variety of hardware aspects. For implementation in the society twenty to thirty years from now, we call for new technologies for telecommunication-related hardware that are expected to embody an epoch-making reduction in the communication power consumption per bit.

## ③ Innovative energy-saving technologies based on the high-efficiency application of physical/chemical processes

**B6. Development of low-cost recovery technologies for waste heat energy to be implemented in society**

The energy included in the mid- to low-temperature (300 °C or lower) waste heat accounts for two thirds of the energy consumed in our country; collecting such waste energy is one of the keys to reducing the emission of global warming gases. In terms of technologies to collect mid- to low-temperature waste energy, binary power generation, magnetic heat pumps, thermoelectric conversion, acoustic engines, and others have been invented. At present, none of these presents an energy conversion efficiency that measures up to the production

of a system and its maintenance cost. The issues we should overcome for the future implementation of waste-energy collecting systems in the society include ① high-efficiency heat exchangers, ② heat-transfer media that have high heat-transfer efficiency, ③ high-temperature insulation/high-performance heat reservation materials, ④ high-efficiency thermoelectric conversion systems, and ⑤ the reduction in the costs of the production, operation, and maintenance of such systems. We call for proposals for the elemental technology and innovative waste thermal energy collecting systems that satisfy the abovementioned requirements. As there are various types of waste-heat sources, it is required to make clear the size and form of the waste-heat energy suitable to the characteristics of the proposed technology. Furthermore, when we assume a large-scale implementation in the society in the future, the system materials and maintenance costs are important points. For instance, in the case of a thermoelectric material or a magnetic heat pump, for which the physical characteristics of the material have a great influence on the efficiency of conversion, we expect proposals for the development of materials that are anticipated to collect an amount of electricity that exceeds the costs of the elements thereof and, also, the cost of production.

**B7. Technologies for large-scale and efficient conversion of $CO_2$ into methanol, olefins, and other chemicals**

Currently, chemicals are produced from fossil resources used as the source of carbon and also of energy, being, finally, discharged into the air as $CO_2$. The ultimate ideal in the production of chemicals in our low-carbon society is to embody the carbon circle, in which chemical products are synthesized from the chemical raw materials resulting from the reduction, with $CO_2$-free hydrogen, of the $CO_2$ emitted from energy sectors or others. As one of the courses in the development of the CCS technology, technologies to separate and collect $CO_2$ have been strenuously studied around the world; some of them are in the phase of verification tests. However, except for the case of the production of polycarbonate or similar materials, the development of technology to recycle collected $CO_2$ rarely advances. To acquire resources at a large-scale from $CO_2$, it is necessary to develop some technology for the mass production of hydrogen as a reducer by using recyclable energy without emitting $CO_2$. However, as the development of such technology is one of the long-term issues, we are allowing proponents in this area to assume a combination with some existing technology such as the use of methane, which emits relatively a low amount of $CO_2$, and are thus calling for proposals for the establishment of a technology for efficiently acquiring resources from $CO_2$ at a large-scale, which is one of the important elemental technologies.

Specifically, our issues include the synthesis of methanol from $CO_2$, reaction to synthesize FT from $CO_2$, property improvement of $CO_2$, general-purpose polymer materials acquired directly from $CO_2$, efficient application of the partial oxidation reaction of methane, and more.

**B8. Development of highly efficient separation membrane and sorbent for greenhouse gas capture**

The amount of $CO_2$ emissions that are caused by the use of greenhouse gas, especially fossil resources, is enormous; to reduce such emissions, the development of a technology for saving energy and the migration to $CO_2$-free, recyclable energy have been in progress. However, we, under current circumstances, cannot help depending on fossil energy for some time; according to a test calculation, approximately 14 % of the reduction in $CO_2$ in the future will be managed by CCS. According to a test calculation, the current cost of CCS is six thousand yen per t-$CO_2$ or higher; we require significant cost cutting for its practical application.

Of the costs for CCS as a whole, the cost for separating and collecting $CO_2$ covers 50 to 60 % of the total; the development of an innovative technology for such separation and collection is one of the bottlenecks that are preventing CCS from being accepted in general. Today, we have a variety of methods including chemical absorption, physical absorption, membrane separation, cryogenic separation, and absorption separation; in any of these methods, the development of innovative technology is wanted.

As for the technology to separate or collect $CO_2$, we can think of various approaches, because the operating conditions and requirements vary depending on the type of fuel used for this purpose. We expect that as proponents submit their proposals, they should clarify the conditions of operation and the size, consider how close their separated energy would come to the theoretical amount of energy, and also keep a low-cost application of the operation and facility in view to develop an innovative absorbent liquid, absorbent material, and/or separating membrane. At the same time, we also include in our scope the proposals for the development of new modules that can make efficient use of these materials. Apart from $CO_2$, our scope also includes the technology to separate and collect other gases that have a large global warming potential.

**B9. Process improving technologies using efficient and high-performance separation techniques**

The productivity of production processes in the chemical industry and their energy-saving performance are restricted by the energy and cost that are required to separate, collect, and recycle non-reactional raw materials, products, and solvents; because of the issue of the cost required for these, non-reactional raw materials and solvents are not recycled, and, therefore, are a large source of $CO_2$ emission. To develop an energy-saving process and/or to reduce the cost, we need to develop a high-efficiency, high-performance, and innovative separation process to strengthen such processes. The development of an innovative separation and refinement process that makes some hybrid use of separation technology together with various types of separation methods is a bottleneck to strengthen such processes. As for the technologies within this scope, apart from the development of high-performance separating membrane and the separation processes that make hybrid use of separating membranes, phase separation, absorption, extraction, crystallization, and various

other types of separation methods, our scope includes membrane reactors, reactive absorption, reactive crystallization, reactive distillation, and other technologies to separate reactions.
In particular, membrane separation processes are gathering attention as one of the prospective technologies for high-efficiency and energy-saving separation. As for the separating membranes, we have a variety of options to select, including organic polymer materials, inorganic materials, organic–inorganic compound materials, and others; however, any of these materials requires the development of some innovative technology with respect to permeability, selectivity, and/or durability for the sake of practical application, and thus our scope also includes research on the development of such new separating membranes, as well as the development of new membrane module structures and module materials that will embody the supporting body to configure the support layers of such separating membranes together with their energy-saving and low-cost application. To make a proposal, the proponent is required to include, in his or her view, the superiority (perspective) with respect to conventional processes regarding the energy-saving rate at the time when the separating technology and the reaction-separating technology are developed and embodied.

**B10. Innovation of bulk chemicals production technologies based on new reaction fields to save energy required for causing chemically difficult reactions**

C1 chemistry is a system of reactions in the production of the chemical products from the conversion of each type of carbon source into CO or $H_2$ or come directly from methane material, which involves several problems. For instance, the current process for synthesizing methanol is an irrational process that involves the steam reforming of methane in an endothermic reaction at temperatures of 750 °C or higher and, after this, an exothermic reaction to synthesize methanol. This process consumes a large quantity of energy and emits a large amount of carbon dioxide. Indeed, there is some research to synthesize methanol directly from the oxidation of methane; however, it is not so easy to oxidize methane, which has low reactivity, and to stop the process with methanol, which has high reactivity. Therefore, this is recognized as one of the difficult reactions to perform.
Low-energy applications are wanted for energy-consuming processes and, also, improvement is wanted in the selectivity concerning such reactions that are difficult to perform. Therefore, the development of catalysts for this type of chemical reaction is enthusiastically pursued, and thus breakthroughs are strongly desired for the rapid enhancement in catalyst performance.
Generally speaking, it is assumed that a catalyst should be used in a thermal equilibrium reaction field; however, in this area, we focus on the development of a catalyst that is highly active in a thermal nonequilibrium reaction field or in its reaction field, which means we are calling for proposals for new reactions and reaction processes that are not observed in conventional reaction fields. As the means for supplying energy to a new reaction field, we may think of electromagnetic waves, supersonic waves, magnetic fields, electric fields, and some complex thereof. As for the reactions, our scope includes the currently ongoing

reactions in which a large amount of energy is consumed for the production of general-purpose chemical products that are profusely produced, and the compatibility of a high-yield and low-energy application to the reaction that is difficult to make. The proponents are required to compare the energy provided to the production system (estimate) with the technology for the production in their proposal.

**B11. Development of highly efficient biomass gasification processes for chemicals production**

In order to alleviate global warming, we want, and are required, increasingly from the present time on, to make use of some source of carbon in place of fossil resources and to recycle it. Biomass resources or collected $CO_2$ are especially important as sources of carbon; however, establishing a process to convert either of them into chemical products and/or usable fuel is one of our important issues.

According to a test calculation, converting biomass into gas is more prospective than using collected $CO_2$ from a cost point of view. However, as of now, even the market price of methanol, which is one of the core chemical products, is estimated to be approximately three times higher than that of those acquired in the process of biomass conversion; cost cutting is the major key to the wide and general acceptance of this process.

To realize this, we need to attain an energy-utilization efficiency of 70 % or higher (cold gas efficiency) in the process of gas conversion with the well-known biomass types, and, in addition to this, we need to be able to provide a stable supply of some high-purity synthetic gas that does not have a negative influence on the downstream production processes of chemical products and fuel. By achieving these two types of technology, one can obtain a process that provides stable production of chemical products at a low cost.

We, on this occasion, also call for proposals for the issues of research in relation to the enhancement of downstream processes, including the applications to low-cost synthetics and high value-added chemical products, such as chemical products and fuel that use synthetic gas acquired from biomass conversion.

When you apply such technology to practical use, you can aim to make use of the potential of the abundant biomass resources in our country and, thus, to use domestically produced low-carbon energy; you can contribute to the realization of a low-carbon society and, by promoting the use of biomass, contribute to the activation of forestry as well.

## ④ Energy-saving technologies based on the high-efficiency application of metal material processes

**B12. Development of alloy and alloy powdering technologies suitable for lamination of structural materials**

High-temperature, high-strength materials that are used for high-efficiency energy equipment such as those for power generation, which have great influence on the reduction in $CO_2$, are under stringent design restrictions because they are difficult to process; this is a large obstacle to the application to high-efficiency energy equipment, which is linked to the

effective reduction in $CO_2$. It is understood that the laminated modeling, which has made rapid progress in recent years, is one of the prospective technologies that will be expanding in the field of the production of heat-resistant materials, as it enables the formation of even complex shapes. However, we have not yet established the technology for the systematic organization to supply high-quality, clean powder or for the laminated modeling that is free from contamination.

For instance, if you apply some existing technology for producing powder to a nickel-based alloy that involves Al or Ti, oxidation or nitridation occurs, causing such problems as a considerable decrease in the creep strength and/or toughness. Unlike the case of plastic or biomaterial-based porous ceramics or similar, to use a 3D-printing technology for avoiding the difficulty with the processability of structural materials and heat-resistant materials, we need to completely reconsider the composition of an alloy and, also need some technology to build up a composite integrated with a thermal history simulation, which could be a bottleneck. With these facts considered, we are calling for challenging proposals that develop the technology to produce clean powder, contribute to the development of robust alloys that are not easily contaminated in the process of powder production or laminated modeling, and also are effective for the oxides and nitrides generated from powder surfaces.

**B13. Innovative bonding and separation technologies that possess both bonding strength and separation or decomposition functions**

When you classify the amount of $CO_2$ emission by the source sector, the industrial (factories etc.) and transportation (vehicles, watercraft, etc.) sectors account for half of the total $CO_2$ emission in this country; more specifically, $CO_2$ is conspicuously emitted during the production of structures and products. Therefore, what is wanted here is some means (process) for comprehensively reducing $CO_2$, involving the production, conjunction, use, and disposal of materials. In terms of the production phase, this will require the production of such products that are excellent in $CO_2$ efficiency based on a multimaterial application effectively combining different types of materials; in addition to this, long-term use and reuse, which may require repairs, etc., are wanted as well as the application of low-$CO_2$ systems in recycling processes.

The technology for conduction and separation is one of the severe obstacles. If innovative connecting/separating technologies for compatible joining strength and separating/dismantling performance are established, we can reduce the energy necessary for the dismantling; therefore, we can embody a recycling society and low-carbon society involving a large number of products. In particular, we call for technology that enables the effective use of existing resources as the materials for social infrastructure, as well as rapid demolition and building, and the longevity of infrastructure systems. Additionally, we call for proposals that contribute to an innovative application for the joining and separation of multimaterials with consideration to the recycling performance of light-weight materials, which consume a large amount of energy during production.

**B14. Innovative reliable lifetime prediction technologies for durable structural materials contributing to $CO_2$ reduction**

A variety of structural materials that have high durability are used for equipment in relation to the conversion and/or use of energy; for instance, there are many cases in which the limitation on the operable temperature of a power generation facility or any other property of a material interferes with the life-cycle low-carbon designs of equipment. Currently, apart from the ALCA, developments of excellent materials for equipment that contributes to the reduction in $CO_2$ are ongoing all around the world; in order for them to connect to the designing of a low-$CO_2$ application to equipment and/or facilities, the forecasts of the performance and longevity are essential to guarantee the whole of their use periods. However, the use periods of such equipment and facilities are as long as tens of years; therefore, longevity assessments depending on tests that cover the whole of such periods impede the implementation in the society corresponding to the tempo of $CO_2$ reduction, which requires urgent handling.

This is why we are calling for the technology for innovative longevity assessment with high reliability that can predict the long-term deterioration behavior of durable materials contributing to the reduction in $CO_2$ generated from long-term use. What we want here includes knowledge and understanding based on the foundation of material science as well as the cooperative relationship with end users concerning the designing of $CO_2$-reducing equipment and facilities and the orientation to international standardization.

## ⑤ Innovative energy storage technologies for next generation batteries, capacitors, or fuel cells

**B15. Development of solid electrolyte with high ionic conductivity based on ceramic technologies**

As a key device for the construction of a low carbon society, the advent of a next-generation storage battery outperfroming lithium-ion batteries is expected. As for all-solid-state batteries, recently, a report has been made on the solid electrolyte of a sulfide type (10-2Scm-1 or higher) that exceeds the ionic conductivity of conventional electrolytic solutions; however, there is a downside that the solid electrolytes of sulfide types react with a small amount of moisture in the atmosphere. On the contrary, the solid electrolytes of oxide types are preferred because they no such downside.

The ionic conductivity of solid electrolytes required for next-generation storage batteries is 10-3Scm-1 or higher; one of the greater bottleneck issues here is that a solid electrolyte that can satisfy various preconditions necessary for real-use batteries, which include a low ionic conductivity in particles (bulk), has not been found. In contrast, the solid electrolytes of oxide types have less plasticity than solid electrolytes of sulfide types, indicating that a problem exists; that is, it is difficult to form a good interface between a solid and a solid particle. It is necessary to attain high ionic conductivity including a solid and a solid particle.

This is why the quest for a new solid electrolyte as a material for batteries is on the rise; the electrolyte should have all of the following characteristics: ① high ionic conductivity, ②

resistance to oxidation and reduction, ③ high plasticity, and ④ stability in the atmosphere. For instance, we are assuming that the development of a new oxide solid electrolyte should be performed based on the principle for material development considering the space charge layer in the bulk.
As for the production of real-use batteries, we assume cooperation with Specially Promoted Research for Innovative Next Generation Batteries, Advanced Low Carbon Technology Research and Development Program (ALCA-SPRING), in the JST Basic Research Program; we are currently calling for only proposals for the underlying technology.

**B16. Development of solid electrolyte with high ionic conductivity based on ceramic technologies**

As a key device for the construction of a low carbon society, the advent of a next-generation storage battery that outperforms lithium-ion batteries is expected. Among others, as for the all-solid-state batteries that use solid electrolytes in place of electrolytic solution, solid electrolyte of a sulfide type that exceeds the ionic conductivity of conventional electrolytic solutions has been recently discovered; there are high expectations with regard to its practical application as a battery having high energy density, high output, and high safety.
As for all-solid-state batteries, it is necessary to move ions through powder active materials and solid electrolytes; however, there is no established means for lowering the resistance between the particles that compose the powder, which is recognized as one of the issues. Furthermore, there is another issue that we need to overcome; that is, the destruction of the interfaces due to the expansion and contraction of the active materials that occurs with side reactions and/or electric charges/discharges on particle surfaces. With these considered, we are calling for proposals for the research and development of the technology to process the synthesis and the formation of interfaces and/or composite membranes that have optimum characteristics based on powder technology/ceramics material technology.
For instance, in the case of using some solid electrolyte to coat an active material, to suppress the side reactions from the active material and the electrolyte, we want your proposal to solve the issues in basic science, including the development of the technology to process formation of interfaces and/or composite membranes at a temperature close to room temperature and the relation between the ionic conductivity of acquired interfaces and composite membranes and the conditions for the forming processes.
As for the production of real-use batteries, we assume cooperation with Specially Promoted Research for Innovative Next Generation Batteries, Advanced Low Carbon Technology Research and Development Program (ALCA-SPRING), in the JST Basic Research Program; we are currently calling for only proposals for the underlying technology.

**B17. Technologies for removing water vapor and carbon dioxide in the air**

Metal–air batteries are expected to have the largest capacity among next-generation storage batteries, and they work using oxygen in the air as their active material at the anode; however, vapor, carbon dioxide, among others, cause deterioration of metal–air batteries,

and this is a bottleneck that needs to be removed. To solve this issue, what is important here is the research and development of the technology for membrane separation and the like.
A large-scale processing device (dew point: –50°C, $CO_2$: 20 ppm or lower) that uses an absorption/desorption rotor of a honeycomb structure is on market; however, we are assuming the installation of a metal–air battery on a vehicle and the use as a storage battery of a table installation type; so, we are calling for the proposals for the separation and removal of a device that is light and compact and can efficiently remove the gas described above.
As for the production of real-use batteries, we assume cooperation with Specially Promoted Research for Innovative Next Generation Batteries, Advanced Low Carbon Technology Research and Development Program (ALCA-SPRING), in the JST Basic Research Program; we are currently calling for only proposals for the underlying technology.

**B18. Low-temperature operability of solid oxide fuel cell (SOFC)**

SOFC's are highly efficient and do not require platinum, which is favorable from the viewpoint of resource; on the contrary, their operational temperature is as high as 700°C to 900°C, which is one of the essential issues in terms of technology. Consequently, the operational temperature should be lowered to around 500°C to 600°C and their service lives should be longer while their strengths such as their efficiency and no need of platinum catalysts are retained. For their low-temperature operation, it is important to develop the process of dispersing the carrier ions in the mid- to low-temperature range of electrolytes and to research the optimum structure and the material design method to make it easier.
In addition, the research and development is important to the materials and structures that may ease the activation and termination of systems. We are also calling for proposals for the development of some technology having its platform in basic science including, for example, clarifying the interrelation between optimum-structure designing and fuel-cell performance.

**B19. Stable electrolytes, electrode materials, or systems for electrochemical capacitors under high voltage and high capacity**

Electrochemical capacitors have excellent fast-charge/discharge characteristics; so, they are expected to be useful for a variety of purposes, including leveling the electric power acquired from recyclable energy. However, as they are inferior to storage batteries in terms of energy density, the development of large-capacity electrochemical capacitors is necessary for operation under high temperature for the sake of enhancing the energy density. More specifically, we are expecting proposals for the following themes.
・Electrolytes and electrode materials that are stable at high voltages (4 V or higher, for example)
・Development of electrode–electrolyte systems that exceed the capacity of existing capacitors (two times larger or more, for example) using carbon materials
・Research and development of a new pre-dope technology for Li-ion capacitors to enhance their performance

**B20. Development for the high-performance battery materials by clarification of the factors on the interface between different phases in the complex system**

To embody a low-carbon society, the next-generation platform industries, including those that apply EVs as mobile objects and apply stable recyclable energy, require the development of storage devices. There are many issues for the practical application of the development of high-conductivity solid electrolytes, among which the biggest fundamental issues are the designing and control of hetero-phase interphases for battery materials, and the solution of the mechanism of the reactions and ion conductance at interfaces for the optimum interface design. The designing of hetero-phase interphases is widely studied as basic science in the field of catalytic reactions, and thus some useful knowledge has been obtained from an unconventional point of view, even in the area of composite materials. The fact that multiscopic ideas from such different fields are accumulated for the designing and control of the hetero-phase interphases of storage batteries is expected to lead to an epoch-making achievement for the wide introduction of energy-conversion devices in our society.

In any real-application batteries, in order to extract the maximum performance in an environment in which a large number of different factors intertwine, including the destruction of interfaces generated by deformation resulting from a reaction, the influence from the reactional products generated on a surface between a solid and a solid interface, and the distribution of electric potential resulting from such events, our issues are to define the factors that are effective for the improvement of performance and to solve and understand the mechanism of the reactions caused on each interface to enable the designing of optimum interfaces. Furthermore, we also welcome an application of computational scientific analysis based on a new concept to this area.

**B21. Development for new materials by quantitative analysis methods of the degree of crystallinity of amorphous materials such as carbon or solid electrolyte**

It is necessary to use something defined based on a scientific, quantitative evaluation to compose the materials that constitute a storage battery. As for the materials that are not perfectly crystalline, especially carbon, they are difficult to evaluate; there are many cases in which a definition is made based on a manufacturer and a product name or made without the index of a scientific evaluation. For the index of the evaluation of a material that is not a perfect crystal, the degree of crystallinity may be more appropriate than anything else. We are expecting the means for quantification based on high-level analyses and new ideas.

**B22. Methodology to suppress large expansion and contraction for electrodes such as negative metal electrodes, negative silicon electrodes, etc.**

Selecting the materials for the anode and cathode active materials with high capacity is necessary to increase the capacity of storage batteries; among others, lithium metal and silicon, with a large logical capacity, are expected to be active cathode materials. However, these substances change their volumes on a considerable scale as electric charging/discharging progresses; therefore, it has been difficult to make good use of them.

We are expecting methods of designing batteries for suppressing the large-scale expansion and contraction of electrodes that result from electric charging/discharging.

**B23. Development of composite electrolytes with high ionic conductivity, molding, interface formability based on the composite of inorganic solid electrolytes and polymer electrolytes**

Recently, an inorganic solid electrolyte has been developed and it has an ionic conductivity exceeding that of electrolytic solutions; there are high expectations for its practical application to all-solid-state batteries. However, inorganic solid electrolytes are, in general, hard; therefore, it is difficult to form a good interface between a solid and a solid particle, which may lead to the case where the ion conductance resistance is high on the whole. On the contrary, polymer electrolytes are, in general, soft; therefore, we can expect the use of composite applications for a good formation of such interfaces and, thus, to compose a composite electrolyte with excellent high ionic conductivity, formation performance, and interface-formation performance. We are expecting the use of their strengths to develop excellent composite electrolytes.

## ⑥ Innovative technologies for using sunlight by using optical science, quantum effects, etc. *(See item “(3) Others”.)

**B24. Pb-free and high durable perovskite solar cell**

Lead-containing solar cells require specific management for their production and disposal, which increases their costs. Apart from mega-solar systems, the application for home-appliance use is also increasing; to prevent the environmental load from growing, lead-free applications are essential. Some institutes have already begun to cope with some lead-free application to perovskite solar cells; however, currently, they have not yet achieved sufficient characteristics.

In addition, it is necessary to replace solar cells in a short period if they do not have sufficient durability; therefore, what we want here is solar cells that have high durability for long-term use. It is guaranteed that the solar cells currently in use can be used for 20 to 25 years. Perovskite solar cells have improved durability, owing to the optimization of materials and processes; however, this is not yet sufficient.

With these circumstances considered, we call for challenging proposals to realize a perovskite solar cell that is lead-free, has high durability, and embodies the efficiency as high as 20 % or more.

**B25. New concept solar cells to realize conversion efficiency twice or more as high as conventional solar cells**

The conversion efficiency of the cells used in Si solar cells has reached approximately 25 %; the logical maximum efficiency of the single-junction-type solar cells is said to be around 29 %. Ordinary solar cells cannot absorb light that has energy lower than the band gap;

therefore, in the case of light with high energy, the residual energy is converted to heat and is then lost. However, in the case of quantum dot solar cells, it is possible to form an intermediary band in the band gap; thus, it has been pointed out that it becomes possible to convert a large portion of the energy from light into electricity. In the case of an intermediary-band solar cell, it is said that an efficiency of 60 % or more, logically, can be attained with a concentrator type. Having said that, the conversion efficiencies that have actually been attained are still low; apart from the fundamental and principle-based examinations, including the adequacy and the feasibility of the theoretical model, we need quantum dots or other intermediary-band materials, the method of formation, the structural optimization of solar cells, and more. With these conditions considered, in this area of our call for proposals, we call for challenging proposals for the designing principle of the use of new concepts such as quantum effects to embody conversion efficiencies twice or more as high as that of single-junction-type solar cells, for the structure of solar cells and the construction of the formation method based on such principle, and for the embodiment of these. Our scope includes a variety of solar cells types that use quantum dots (the method of realizing a high density and a long carrier lifetime), nanowire (wall), near-field light (dressed photon), photon up-conversion, multi-exciton formation, hot carriers, and so forth. There is no restriction on materials or mechanisms; we are expecting proposals that probe the superiority to conventional solar cells as well as specific methods of production.

**B26. Manufacturing technologies for super thin film crystal Si solar cells under 40 μm**

The thickness of Si wafers is, at present, as low as approximately 180 μm; if you can have it as low as 40 μm or thinner, you will be able to significantly reduce the cost of polycrystalline Si materials. Furthermore, in the case of thin-type solar cells, they are as flexible as existing thin-type solar cells; therefore, you can install them even in places where you cannot install conventional Si-crystal solar cells. By doing so, you can drastically expand the scope of places where you can install highly durable Si solar cells that have high conversion efficiency, which increases the amount of Si solar cells to be introduced there. As a method of making the Si wafers as thin as 40 μm or even thinner, we can think of several types of technology, such as crystal growth, slicing, exfoliation, and smart cuts; it is necessary to reduce the amount of Si wasted at the time of processing by as much as possible, and to sufficiently maintain the quality of the thinner Si wafers as to let the solar cells function. Moreover, one of the issues regarded as a bottleneck in implementing super-thin crystalline solar cells in the society is the process to form strings that implement and connect the crystalline-type Si solar cells. In addition, the technology to form modules in accordance with the production processes and the technology to enhance the durability, including the durability against repeated weighing coming from modules, are also among the important issues.

With these circumstances considered, in order to reduce the cost of Si solar cells and to expand the places of installation, we call for proposals for maintaining the workability of solar cells, for making Si wafers as thin as 40 μm or even thinner, and for forming cells and modules that can be made highly efficient.

**B27. Innovative top-cell technologies for high-efficient tandem-type solar cells**

In order to realize drastic enhancement in the conversion efficiency of 30 %, which is the theoretical limit on single-junction-type solar cells, it is expected to laminate semiconductor materials of different band gaps to expand the absorbing wavelength band for tandem-type solar cells; however, this has not brought any sufficient enhancement in terms of efficiency. As the solar cells in the bottom layer, Si and CIGS solar cells (band gap 1.1 eV), are optimum as they have high conversion efficiency and are exhibit excellent durability. As the solar cells on in the top layer, solar cells with semiconductor layers of approximately 1.5–1.7 eV have been studied; however, any low-cost solar cells that have both high efficiency and high durability are yet to be embodied. For instance, perovskite solar cells (band gap 1.5 eV), chemical compound semiconductors (CuGaS), and others have been studied as a top layer; however, they have not brought any sufficient enhancement in terms of efficiency.

The materials for the top layer and the development of devices are essential to realize high-efficiency tandem-type solar cells. Furthermore, in order to develop tandem-type solar cells, we need to understand the optimum joining interface and output amperage/voltage characteristics of the multi-junction and, also, need to design and/or optimize the structure, including photon management. Therefore, apart from the solution of the electric and optical characteristics for a drastic enhancement in the efficiency of the top layer, we are expecting challenging proposals that aim for a conspicuous enhancement in the performance of solar cells by applying a tandem-type structure in consideration of the electric and optical characteristics of the system as a whole for its practical application.

**B28. Organic-dye solar cells suppressing voltage loss**

Organic-dye solar cells are light and flexible, have excellent characteristics, and their costs are low; therefore, they are among the prospective candidates for solar cells in the future. As solar cells that have similar characteristics, the development of perovskite solar cells is advancing; however, the organic lead, which is included in them, requires specific management for its production and disposal. This is one of the significant obstacles to the application for the home-appliance use, beyond the application to mega-solar systems. Perovskite solar cells can have both high short-circuit current density (Jsc) and open-circuit voltage (Voc); therefore, conversion efficiencies exceeding 20 % have been attained. On the contrary, the conversion efficiency of organic solar cells is as low as approximately 13 %, particularly because of the process of losing Voc. We need to solve the mechanism such voltage loss and to construct a scenario to connect to the enhancement in efficiency; moreover, we need the development of materials that suppress the route of voltage loss based on such construction.

With these circumstances considered, we call for challenging proposals to embody organic-dye solar cells that can have both good Jsc and good Voc. Specifically, we can think of using a metal complex redox couple or solid electrolyte for dye-sensitized solar cells (DSSC) and, for bulk heterojunction solar cells, of using a non-fullerene acceptor as a candidate.

In the case of a current non-fullerene acceptor, a bulky substituent is used empirically, but it is not known whether such application has any advantage for electron transport. We call for challenging proposals that aim to solve the molecular mechanism of such electron and hole transport and, based on that, to develop a material and/or cell structure for an epoch-making enhancement in efficiency.

**B29. Photochemical synthesis of useful materials with water as an electron source**

Artificial photosynthesis is, to embody a low-carbon society, the ultimate goal. We call for "proposals in relation to the photochemical synthesis of useful substances with water as an electron source" as an artificial photosynthesis project that is surely useful to the society but is not a mere model research. It is a key to use water as an electron source, but not to use a sacrificial electron donor. The development of catalysts that enable the production of hydrogen from water photolysis is one of the very important bottleneck issues. In this issue, it is important to be efficiently functional even with visible light, which gives advantage to the use of solar light, and to be durable for long-term use. The composite catalysts of the Z-scheme type, in which the generation of hydrogen and oxygen take place in different portions, as shown in the research currently in progress, are prospective candidates. Furthermore, separating the generated hydrogen and oxygen is also one of the important issues. In the case of a composite catalyst of the Z-scheme type, hydrogen and oxygen are generated at different sites; therefore, there may be some advantage in their separation. For the synthesis of organic chemical compounds, apart from the fact that the product is useful for the sake of the society, it is also important that the electrons extracted from water are accumulated in a material to be reduction products. We are expecting comprehensive proposals involving the separation processes of products.

## ⑦ Energy/material technologies for using biomass design to replace petroleum-derived resources

**B30. Development of photosynthetic microorganisms robust against changes in environmental conditions for large-scale production**

There has been considerable interest in the production of chemical products and fuel from microalgae, cyanobacteria, or other photosynthetic microorganisms because we can produce substances from $CO_2$ during photosynthesis. Till date, there have been researches for the efficient production of a target substance based on the examination on cultivation conditions and the technology to control genes. Some of these achievements involve the production of value-added chemical products or the like, which seem to be prospective for their practical application; various types of large-scale verification tests have been attempted for the practical applications. What has been revealed there are that there are several high hurdles in large-scale cultures we should overcome and that they are different from those in laboratories. The topmost issue is that the productivity, in the cases of large-scale cultures, is extremely low compared to the analyses at laboratories. For instance, the appropriate light intensities are different depending on the types of microalgae; in a laboratory, you can use an

ideal light and temperature environment for the microalgae of your subject. However, the light and temperature environments outdoors vary considerably depending on the weather, which is difficult to artificially control. This variance of the intensity makes it impossible to maintain a high-density culture outdoors, leading to the degradation of the productivity of a subject, contamination, and the issue of a cost recovery. In addition, not only in the case of a large-scale closed-system cultures outdoors but also in the case of such cultures indoors, there are issues completely different from those in analysis systems in a laboratory; these include the difference in the cell environments in the surface layer and the deep layer of a culture tank, stirring issues, and the issues of the necessity of illumination to light up deep area.

We are calling for proposals for the development of photosynthetic microorganisms robust against environmental changes to overcome the bottleneck of large-scale productions. For instance, as described above, if you can develop microalgae that can keep productivity constant regardless of the light intensity or the depth of a culture tank and/or the microalgae that can realize a high density of cell concentration in a room with soft illumination, then you are causing a large ripple effect. Moreover, if an effective fracturing technology is linked to the extraction of chemical compounds from collected fungus bodies, the feasibility of a practical application becomes even higher.

**B31. Technologies for improving biomass productivity with minimum resource input**

The methods for increasing the amount of biomass production of plants contributing to $CO_2$ reduction include the expansion of the habitat and productivity increment and enhancement. In either case, it is understood that the effective measures here include the feasibility of the culture with a small amount of water and nutrients and the development of plants that can sustain their yields and growth in various unsuitable environments or variant environments by being extremely durable against environmental changes, and resistance against disease and vermin; however, there is no technology for any drastic solution yet. Furthermore, investing in water, nutrients, and other resources means, in other words, investing in energy; moreover, suppressing such energy investment is important from the viewpoint of energy efficiency per yield.

With these considerations, we are calling for proposals for the development of revolutionary plant thremmatology for growing plants even with extremely little amount of resource investments to obtain plants robust against the environment. For instance, you can think of a variety of measures including promoting the intake of substances into plants and/or the transfer in plants and enabling the use of a nitrogen source that cannot be used up until now, by adding a new metabolic pathway. Moreover, we are also expecting the development of technology to realize optimum design and/or breeding so that we can maintain the balance of a plant at a high level as a whole by way of some link to photosynthesis, metabolism, hormone, or the like.

Furthermore, we also calling for proposals for the development of technology to use microorganism agents by isolating and identifying those symbiotic microorganisms that

contribute to the acceleration of growth and improve resistance against diseases and vermins, based on the understanding of the interactions with the microorganisms cohabiting with plants and the chemical compounds that can control environmental microorganism groups. The states of the growing of plants are largely different depending on the difference in the soil; the difference in microbial florae may be regarded as one of the important factors to make such difference, but its clarification and its efficient control are among the issues in the future. What we are expecting here include the following: (1) research on identifying the optimal composition of microbial florae for excellent culturing fields; (2) the development of technology to cultivate plants that maximizes the functionality of microbial floras to establish the use of microorganism in technology to increase the production of plant biomass resources for practical use; and (3) research on using genome information to modify plants. Furthermore, we also welcome proposals on innovative methods of producing low-energy biomass resources from the viewpoints of information analysis and/or engineering with respect to the plants and soil in culturing fields.

**B32. Synthetic biology technologies for designing cells with high productivity for useful substances**

When you introduce a bio-process to the production of a substance and, thus, reduce the energy required for the production, you can expect a reduction in $CO_2$ emission. When you aim for the generalization of bio-processes and scaling them up, and when you advance omics analysis, system biology, flux analysis, genome editing, and genome synthesis technology, then you can introduce an artificial metabolic pathway in microorganisms and impart a new ability to produce the substance. These kinds of researches have been tried to synthesize chemical products from a variety of sugar sources and low molecular weight gas such as $CO_2$ and methane.

However, even if a pathway is introduced, it has been frequently observed that we cannot attain any sufficient productivity because of factors such as the short duration, the absorption into redundancy, the failure to attain the expected degree of effectiveness, the deterioration of the growth speed caused by some disorder in the balance of metabolism in cells or of energy, oxidation, and reduction resulting from the alteration and/or introduction of the pathway. In addition, it is necessary to reduce the amount of energy input for the production of the substance; for this purpose, it is necessary to develop a new method after determining the functions of autotrophic microorganisms. Furthermore, there is another issue: target products present toxic characteristics and, thus, their productions are not feasible. In order to solve these issues, we are calling for proposals on developments contributing to the synthetic biological technology for the designing of cells to realize the overall optimum production of substances by, for example, combining an artificial metabolism pathway with energy and reducing-power supply systems. We are expecting the proposals such as the following.

・The development of high-efficiency ATP and/or reducing power regeneration systems that can be introduced commonly to a variety of microorganisms

・The technology to use the functions of autotrophic microorganisms, including the ability to supply electrons, the ability to supply chemical energy, and the ability of carbon fixation.
・The establishment of a method that can realize an efficient creation of artificial enzymes necessary for artificial metabolism pathways.
・The establishment of a rational method of designing genetic circuits that can produce even highly toxic substances with enhanced yields and energy efficiency.
・The development of the designing tools for synthetic-biological designing by using the above-mentioned
・The development of the platform host cells suitable for synthetic-biological developments.

**B33. New synthetic technologies for high-efficient production of high-performance/high-functionality materials from biomass raw materials**

An important issue is the development of a new technology for the high-efficiency production, in an energy-saving process, of chemical products and/or polymeric materials that are useful for our daily lives and/or for industrial use from saccharide and/or lignin collected via component separation of biomass resources (woody plant- or herbaceous plant-related materials). In recent several years, a variety of processes have been proposed to pertinently separate mainly the three constituents—cellulose, hemicellulose, and lignin—from woody or herbaceous plant materials; the development of the separation technologies, each with special characteristics, has been progressing rapidly. Consequently, now it is possible to produce cellulose, saccharide, lignin, etc., of a relatively high purity.

To develop a bio-refinery system for this country, it is necessary to contribute to the low carbon society and to simultaneously make it profitable. Therefore, the first bottleneck is to develop a new chemical/biological synthesis method of converting cellulose, saccharide, and lignin, which are produced from bio-mass resources, efficiently into the high-performance and/or highly functional chemical products and/or polymeric materials that are wanted by the society. In addition, it is also necessary to develop the technology to convert terpene, polyphenol, etc., which are not attracting attention because they include only small amounts of biomass resources, into some functional products with high added value. The second bottleneck is the development of the technology that can produce general-purpose chemical products, such as organic acids and alcohol, from biomass resources at a low cost. When these bottlenecks are solved, petroleum-based platforms can be converted into biomass-based platforms for the first time ever, and thus, after a low carbon society, a genuine carbon-circulating society will be realized.

On this occasion, we are calling for challenging proposals on the development of a new synthesis technology to realize the efficient production of high-performance or high-function chemical products or polymeric materials by using energy-saving processes and materials including those in the first bottleneck issues, that is, cellulose, saccharide, lignin, terpene, and polyphenol.

We are expecting the proposals such as the following.

Cellulose, saccharide, lignin, terpene, polyphenol, or the like is not converted into inexpensive general-purpose chemical products or energy sources such as organic acid or alcohol but, instead, into, for instance, the following:

・Some high-performance or high-function chemical products or polymeric materials by making use of the skeletal structure such as the biologically originated six-membered ring contained in, e.g., cellulose, sugar chain, lignin, terpene, and polyphenol converted by a chemical or biological synthesis technology

・The chemical products that are expected to be in short supply in the future because of the difficulty in the production based on natural gas or shale gas, which is expected to be produced more profusely in the future; an example is C4 chemical compounds and aromatic compounds produced at a low cost efficiently by using cellulose, saccharide, lignin, terpene, polyphenol, or the like based on the developed synthesis technology

**B34. Technologies for controlling layer structures to create next generation nanocellulose materials**

The development of technology to efficiently separate, from biomass resources, nanocellulose of approximate thickness 20 nm (cellulose nanofiber (CNF), cellulose nanocrystal (CNC), etc.) has advanced; domestically and abroad, some test productions for the industrial use of nanocellulose have begun. The tensile strength (3 GPa) and the modulus of elasticity (140 GPa) of nanocellulose are generally the same as those of aramid fiber and other ultrahigh-strength fibers, and its thermal deformation is small, too; therefore, nanocellulose has much potential as a high-performance material. In addition, nanocellulose has a large surface area, and its surface has such a large number of hydroxyl groups that you can introduce various types of functional groups after chemical modification, or make metal ions and metal nanoparticles adhere on the surface of nanocellulose at high density; nanocellulose has a great potential as a highly functional material, too.

However, to use hydrophilic nanocellulose solely or in a composite with some other material to produce a high-performance or high-function material, you need to develop technology for the accurate structure control of each layer of the primary, secondary, and tertiary-layered structures of the materials on the platform of nanocellulose. We are calling for challenging proposals in relation to the technology development to use CNF for the design and creation of next-generation materials.

We are expecting the proposals such as the following.

・The technology to control crystalline regions and non-crystalline regions

・The technology to remove moisture with the evenly dispersed super-structure in water maintained

・The technology to control hydrophilic/hydrophobic characteristics for the complete dispersion over hydrophobic polymers or rubber

・The technology in consideration of a new function resulting from layered structures and/or of a drastic improvement in the performance (hygroscopicity, heat resistance, etc.)

・The technology to add some robust and flexible characteristics and/or shock-resistance performance for applications in fabricating automobile bodies and/or some other components.

**B35. Technologies for chemical modification/composition to create next generation lignin materials**

Conventionally, the metamorphosis of lignin advances with the preprocess of paper making, which is collected in the form of a blackish liquid (black liquor) mixed with a chemical used for the preprocess, and thus used as fuel for some industrial use. However, to reuse lignin as a material for chemical products or polymers, research and development has been enthusiastically pursued to decompose lignin into low-molecular-weight substances and to convert the acquired low-molecular-weight chemical compounds into chemical products or to polymerize them into polymers. However, there are several serious issues including the slow reactions, low yields, multiplicity of phases in the processing, and high energy consumption; at present, there is no perspective on practical application. Nevertheless, as the research and development to separate lignin has been advancing in recent years; it is gradually becoming possible to acquire pure lignin, generally free of metamorphosis from biomass resources. Lignin has many hydroxyl groups; therefore, it is an attractive material that has the possibility of recycling as a high-performance and high-function material that has never been before when it is chemically modified it and various functional groups are introduced, or it is composited with some other material. We are calling the challenging proposals in relation to the technology development to convert lignin as a polymer into a next-generation material without decomposing it as in conventional approaches.
We are expecting proposals such as the following.
・The technology to control its quality by understanding the structure of lignin and by solving the relation between its structure and characteristics, because lignin is a chemical compound that has different basic structures and characteristics depending on the type of its raw material
・The technology to recycle lignin as a high-performance and high-function material by chemically modifying it and by introducing various functional groups to make it complex with a polymeric material or an inorganic material, because it has many hydroxyl groups

## ⑧ Other

**B36. New approaches for a low carbon society**

Apart from the abovementioned subthemes, we are also calling for proposals in which the researchers specify the issues on their own for “the realization of a low-carbon society.” However, as this area aims at the low-carbon society based on the development of a technology as the measures for mitigation, our scope does not include the proposals for the measures for applicability, such as the observation of climate changes and/or the influence over the ecosystem.

In this new idea type (B36), the examination board in charge of the technology area that seems to be the closest to the contents of the proposal will make the assessment.

**●Assumption on Where Achievements Are Applied**

In this area, the challenging research and development are advanced for the solution of the bottleneck issues stated above; therefore, some of the technologies included here may take years to be applied to a practical use. This is why we start cooperation at early stages with other programs at JST and programs provided by other governmental bodies; besides the transfer of the achievements to the industrial sector, we will examine transferring the issues requiring further endeavors to other research and development programs that are closer to a practical application.

**●Cooperation with Relevant Programs**

We will promote the cooperation with, among the pilot research programs of NEDO, “Untrodden Challenge 2050” started in 2017. To create innovative research and development for the realization of the low-carbon society in the year 2050, JST promotes solutions of the bottleneck issues by mainly focusing on the fields of academia, whereas NEDO aims to solve the issues, viewing the needs of the industrial world, mainly based on cooperation between the industries and academic institutions.

**●Organization for the Projects**

In the case of feasibility studies, we have a strong awareness of the exits while adopting challenging research themes. In the case of the assessment at the stage gate, we assess whether research is heading for the realization of a low-carbon society in the future or, namely, if a proposal contributes to the targets in this area. The assessments at the stage gate are not merely the means for “sifting out proposals” but rather “for the correct awareness of the direction of excellent research and, at the same time, for its effective enhancement and growth.” Therefore, this is a method of fostering the technologies that may have a great contribution to the reduction in $CO_2$ emission in the future.

In the phase of full-scale research, we, being well aware of “the possibility of the contribution to a low-carbon society,” take management to accelerate the research and development for the implementation in the society.

**●Principles in Promoting Research and Development**

JST, since year 2010, has been continuing "Advanced Low Carbon Technology Research and Development Program" (ALCA). In the ALCA, we have adopted "the Small Start & Stage Gate method" as a program that is specialized for the research and development to realize a low carbon society. This method is an endeavor for adopting a large number of relatively less budget-consuming issues when we adopt them (small start), and, once they have successfully passed our stage-gate assessment, we expand the scale of the research by placing focus on them.

Besides this, we have more endeavors such as cooperating with the Ministry of Economy, Trade and Industry and other governmental bodies in relevant programs and projects etc., providing the measures for accelerating research and developments aiming at the implementation of the achievements and transferring it for practical applications in the society in around year 2030.

In this area, we follow the principles of the ALCA management and advance the research and development with more challenging targets, aiming to contribute to the significant reduction in greenhouse-gas emission by around the year 2050. In addition, we, as part of the ALCA, will advance research and development programs with the same goal, i.e., the realization of a low carbon society, aiming at synergy effect (FIG. 2).

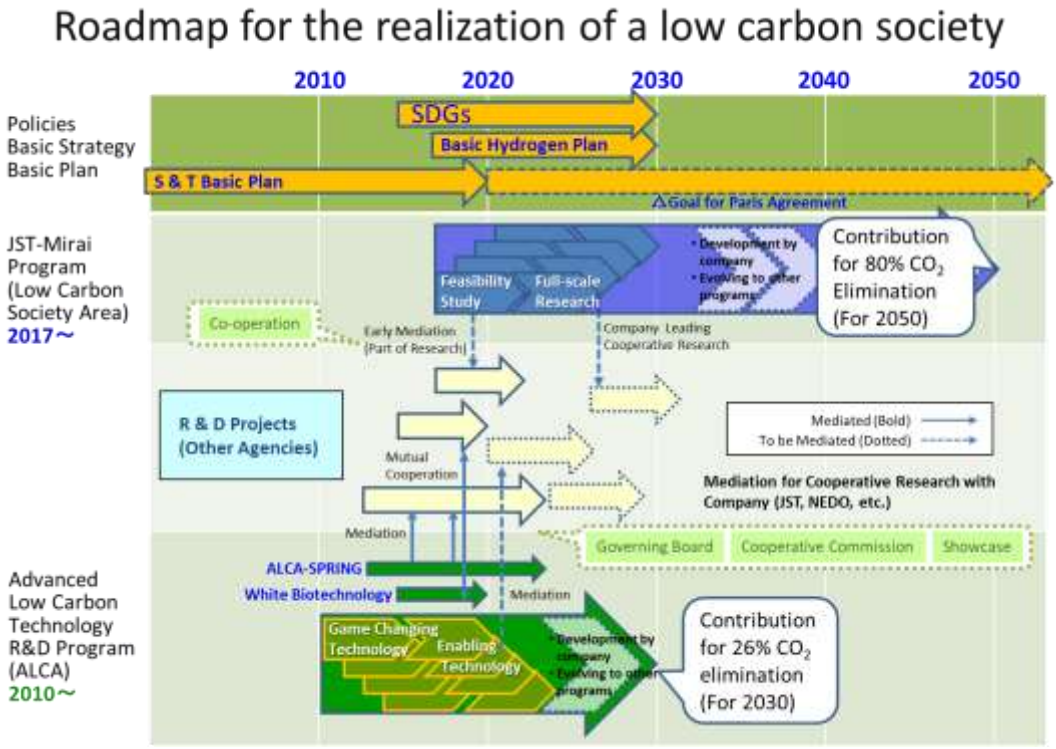



FIG. 2. A roadmap for the realization of a low carbon society

Furthermore, in this area, when a large impact is estimated on the society and/or the industrial world based on the solution of a bottleneck, we can expect a rapid implementation and/or application in the society and/or the industrial world; therefore, even if the period of a feasibility study is incomplete, we will proactively examine the transfer to full-scale research. Moreover, if the Research and Development Supervisor determines the necessity for the maximization of the social and/or economic impact, we may integrate two or more research and development issues and reorganizing research teams, etc.

**●R&D Periods and Budgets**

① Feasibility Study

In this area, the standard feasibility study period starting in fiscal year 2018 is five years until the end of fiscal year 2023 (however, the part of the period in fiscal year 2018 is regarded as

one year regardless of the actual day of the start of each research and development project); the upper limit of the research cost in your plan must be 130 million yen (direct cost) in total, covering the whole period of the feasibility study.

② Full-scale Research

In this area, the period and the budget for a full-scale research project are determined based on the assessment at the stage gate of the feasibility study; the period of the full-scale research at the phase of proposal is five years at the maximum; the upper limit of the research and development cost in your plan must be 500 million yen (direct cost) in total, covering the whole period of the full-scale research.

### (3) Others

See the following instructions if you are going to make a proposal for a bottleneck issue in subtheme ⑥, “Innovative technologies for using sunlight by using optical science, quantum effects, etc.”

For the research and development on the bottleneck issues included in this subtheme, you can use, if necessary, the research environment organized at The Fukushima Renewable Energy Institute, National Institute of Advanced Industrial Science and Technology (Koriyama City, Fukushima), in “FUTURE-PV Innovation” *1, the Ministry of Education, Culture, Sports, Science and Technology (referred to “Platform” for short). *2 You need arrangements with the Platform administrator, and so on, to use it.

*1. FUTURE-PV Innovation is a project that was implemented by JST from fiscal year 2012 to fiscal year 2016 consigned by MEXT. JST has organized a research environment in relation to superhigh-efficiency solar cells, mainly silicon-based cells, at The Fukushima Renewable Energy Institute, National Institute of Advanced Industrial Science and Technology.

*2. The elements organized on this Platform include a plasma CVD device and MOCVD device for Si heterojunction solar cells, processing-related devices including an imprinting device, basic facilities including a clean room and draft chamber, assessment devices such as SEM, and other device groups.

## 5.1.5 “Common Platform Technology, Facilities, and Equipment” Area

Research and Development Supervisor (Program Officer: PO):

Nobuyuki Osakabe

(Corporate Officer/CSO&CTO of Healthcare Business Unit, Hitachi, Ltd.)

### I Goal of the “Common Platform Technology, Facilities, and Equipment” Area

This area was established to cover common platform technologies underlying a wide range of research and development (R&D) activities and advanced research instruments in the fiscal year (FY) 2018.

Research and development has served as the fountainhead of innovative knowledge and products that impact future society. However, the number of published papers, an indicator for R&D vigor, has not increased much in recent years. It is feared that the R&D capability of Japan may be declining with the rise of other countries and changes in Japan’s demographic structure. Therefore, strengthening basic science is essential for improving R&D capabilities in present-day Japan. To encourage more activities in R&D, it is necessary to steadily promote research to meet needs of R&D activity as well as research toward an exit to social needs. Considering this background, this area emphasizes the following three points: (1) development of high-risk and high-impact advanced measurement and analysis technologies/instruments; (2) development and systemization of applications, such as data analysis and processing technologies; and (3) technology development that contributes to improving productivity of research fields. “Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products” has been adopted as a prioritized theme.

For building a common platform, this area emphasizes improvements in analysis based on mathematical science and mathematical engineering, which have made recent rapid advances in application development, including research aiming for systems and instruments. The two groups adopt a management style (see Fig. 1) of optimal mutual collaboration aim for creating new values that have not yet been realized.

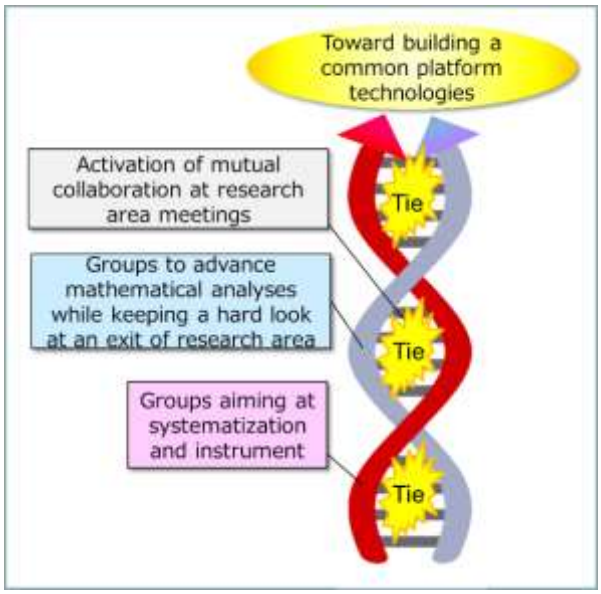



Fig.1: Mechanism of Area Management

## II Prioritized Theme

### Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products

#### (1) About the Theme

<Background>

A disruptive technology is one which displaces an established technology and shakes up the industry or a ground-breaking product that creates a completely new industry. R&D is no exception. Existing R&D techniques are being replaced by new technologies, such as atomic level structure analysis for membrane proteins and single molecules by cryo-electron microscope, which earned Jacques Dubochet, Joachim Frank and Richard Henderson the 2017 Nobel Prize for Chemistry, massive parallel genome sequencing using next generation sequencers, and the gene editing technology: CRISPR-Cas9.

For example, the human genome project cost USD 3 Billion from 1990 through 2003, whereas next generation sequencers can analyze genomes of five persons per day with the cost of $1000 apiece. The marked decrease in analytical costs expanded its applications from a technique in R&D laboratories to a medical testing technology indispensable for realization of tailor-made medicines. This technology spawned Illumina, which owns the technology and grew to a market capitalization at $42B as of May 2018.

Innovations have proceeded also in materials development. An example is the “material genome initiative,” which has been promoted in the U.S. since 2011. It aims to take advantage of data-driven science to halve the 20-year period from material development to practical application fielding. It is a grand plan, to which more than $500M is said to have been invested thus far. China has followed suit by producing many results. The National Institute of Materials Science, a National R&D Agency, has played a central role in R&D in Japan.

Japan, which has fewer researchers and a smaller research budget than the U.S. or China, should perform efficient and effective R&D based on its basic science capabilities to improve research. This requires an innovative common platform.

<Goal>

This program aims for Proof of Concept (POC) within a period of full-scale research. A POC for this area means that a state in which a prototype should be used to reach a level for verifying usefulness in R&D laboratories.

Common platform technologies created in this program is expected to contribute to one of the following goals:

| |
|---|
| Goal1：To Take Advantage of Common Platform Technologies to Improve the Research Capability of Japan |
| Goal2：To Convert Common Platform Technologies to Commercialization that Strengthen the Industrial Competitiveness of Japan |

Goal 1 demands that research using a developed system/instrument should exert a big industrial or academic impact on society. Even if a system/instrument itself is not the core of the program, research using the system/instrument is expected to create big results.

Goal 2 aims for the system/instrument itself to become the core of a big program. A system/instrument initially used for solving problems in research fields is expected to improve in performance, including cost and throughput, and will lead to the creation of a program exerting a big impact on the society, which may directly contribute to industries and services beyond the framework of research fields.

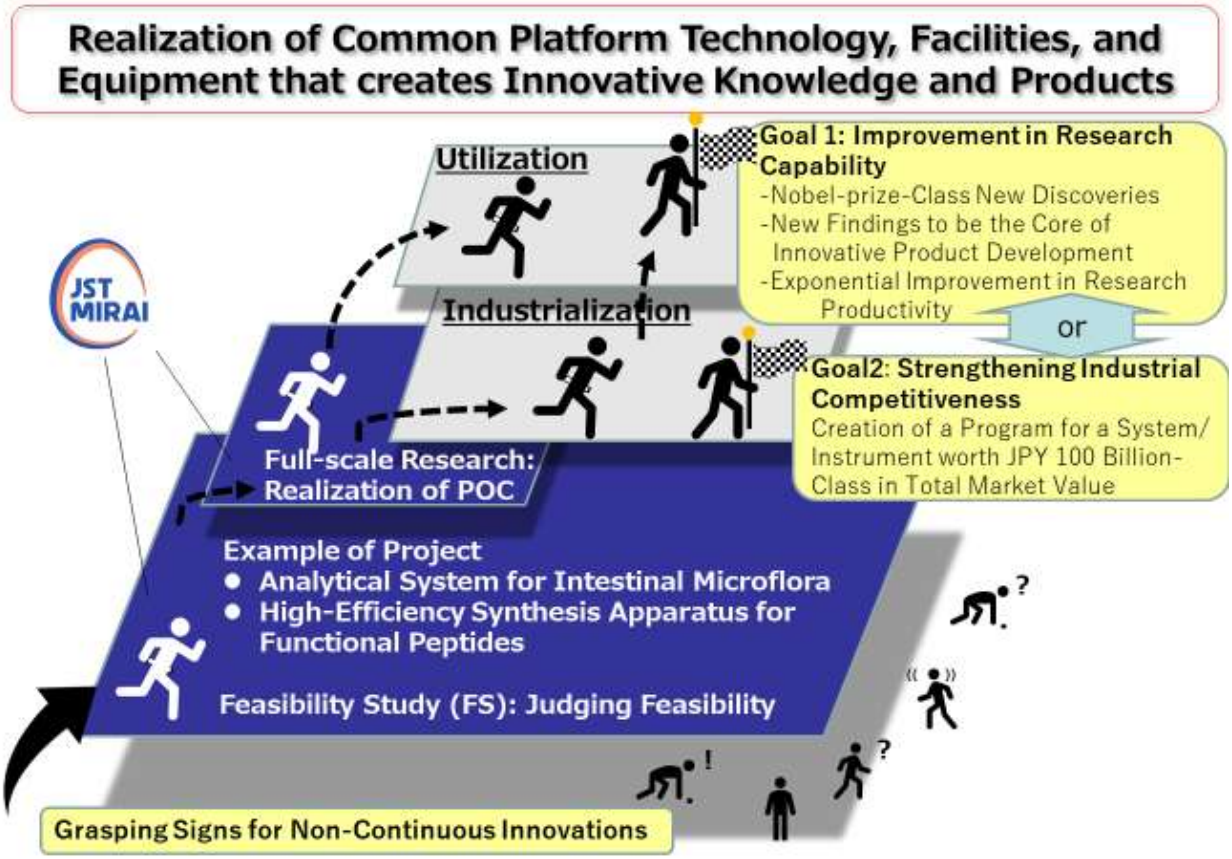



Fig.2: Conceptual illustration of the goal of the Prioritized Theme and R&D phase

### (2) Program Officer's Policies for Call, Selection, and R&D Promotion

- **Policies for Proposal Selection**

To achieve these difficult objectives, it is important to concentrate a limited budget within a certain range. With the condition of narrowing the range of investment in Subsequent FYs however, we call for a wide range of proposals in FY 2018, the initial year. In calling for proposals in this FY, we adopt as Sub-Themes technological areas judged closely related to various needs based on opinions and ideas, which are found on this program website, and results of independent surveys by JST.

This area calls for proposals for each Sub-Themes. A representative of an adopted project is asked to perform R&D under the supervision of the theme manager.

In this FY, proposals of a "small start" Component Technology Type, which contributes to the realization of the prioritized theme, are called for in addition to research proposals aiming for transfer to full-scale research.

The R&D representative who performs R&D of a Component Technology Type is asked to take on the R&D and introduce the results into full-scale research under the prioritized theme and to establish a component technology for achieving the POC {see 2.1.2. (2)). In this FY, however, priority is given to ordinary feasibility studies, and proposals are called for mainly by section ST09, which is expected to be a common platform covering several Sub-Themes. Section ST10 is excluded.

Considering the contents, some proposals applied as ordinary feasibility studies may be adopted, provided they satisfy the condition to participate as a Component Technology Type.

Theme Manager (Tentative; Serve Concurrently as a Program Director)
Nobuyuki Osakabe
(Corporate Officer/CSO&CTO of Healthcare Business Unit, Hitachi, Ltd.)

Theme Manager
Hiroshi Okajima
(Project General Manager, R&D and Engineering Management Division, Toyota Motor Corporation)

Theme Manager
Kazuyuki Aihara
(Professor, Institute of Industrial Science, The University of Tokyo)

● **List of Sub-Themes**

| Classification | Sub-Theme |
|---|---|
| ST01 | Structure Analysis |
| ST02 | Atomic/Molecular-Scale Measurement |
| ST03 | Multi-Scale Analysis of Interface and Surface |
| ST04 | Deep-Site/Internal Measurement |
| ST05 | Ultrafast Dynamics Observation |
| ST06 | Temporal Observation |
| ST07 | Automation and Efficiency Improvement of Routine Work |
| ST08 | Sophistication of Processing, Synthesis, Separation and Purification |
| ST09*1 | Mathematical Models or Analytical Methods to Investigate Truth from Diverse Real Data |
| ST10*2 | Other Common Platform Technology, Facilities, and Equipment that Satisfy Purposes of Prioritized Theme |

*1 The upper limit of the R&D budget for ST09 is different from those of other Sub-Themes (see “Period/R&D budget,” described later.)

*2 This Sub-Theme does not ask for a proposal of the Component Technology Type.

* Describe the name of Prioritized Theme, Classification and the Sub-Theme in the “prioritized theme” column on the cover of the R&D proposal documents (Form 1).

【Example of Description】

| | |
|---|---|
| Prioritized Theme | Realization of Common Platform Technology, Facilities, and Equipment that creates Innovative Knowledge and Products<br>ST01: Structure Analysis |

*For those applying for Feasibility Study (Component Technology Type), add a description similar to the above to the cover of the proposal documents in the appropriate form.

*Individual Sub-Themes are not necessarily independent but may be related. Therefore, a proposal is presumed related to several Sub-Themes. Thus, choose a Sub-Theme closely related to the technology or “ST10” for application.

*Selection is not performed independently by each Sub-Theme but proceeds by comparing all proposals regardless of Sub-Themes, simultaneously. Some Sub-Themes may have several adopted projects and some may have none of consequence.

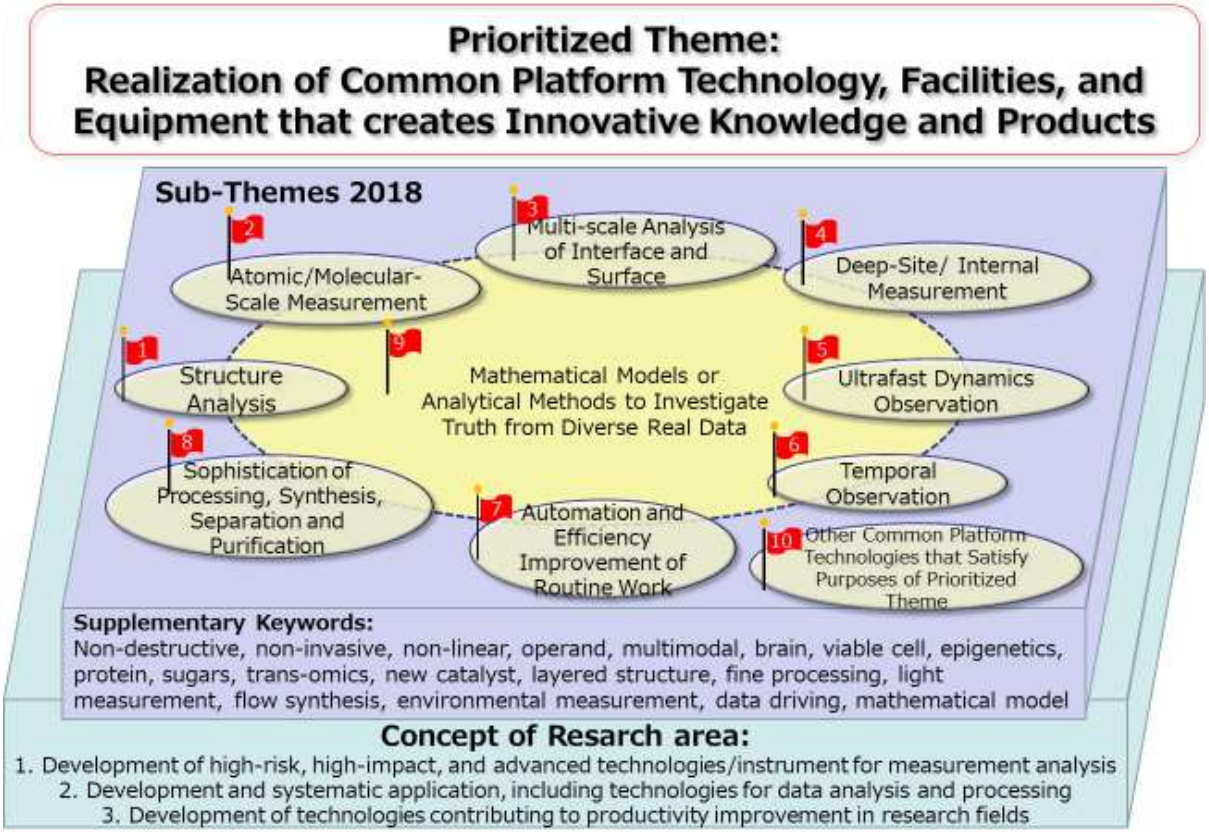



Fig.3: Image of Sub-Themes within Prioritized Theme

## ●Contents of R&D

(1) Structure Analysis (ST01)

This Sub-Theme performs common platform technology development of structure analysis for substances of complex structures.

The field of material science has many needs for grasping a detailed structure of a newly prepared material to elucidate a relationship between the structure and properties for designing a new material. Structure analyses of multidimensional materials, non-homogeneous materials, and complex polymer materials are an issue, along with how to grasp structural defects and the positional information of dopants. Difficulty of analyzing light atoms has long been a problem. Techniques are still sought for solving the problem and developing simpler and more accurate analyses.

In the field of life science, structure analysis of various molecules in a living body is an important element of development, especially in the field of health care, therapy, and drug discovery. For example, attention is paid to such drug discovery targets as higher structures of chromatin, complex proteins, membrane proteins, 3D structures of peptides, and sugar chains.

A broader conceptual view of structure analysis would find intense needs for sequencing DNA. We request technology development to make marked improvement in existing techniques for subsequent generation technologies beyond the so-called “next generation sequencers,” which are the mainstream at present.

(2) Atomic/Molecular-Scale Measurement (ST02)

This Sub-Theme develops techniques for measuring various subjects in an Atomic/Molecular-Scale that exert various effects on whole systems.

To understand properties and specific characteristics of a material, the material science field

demands measurement of electric/magnetic fields, photons, phonons, spins, electronic states, oscillations, and fluctuations.
The field of life science demands observation of a single molecule, not average values of a group of molecules. Needs are for single molecular analyses of membrane protein structures, especially G-protein-coupled receptors and Channel; their relations with a ligand; single molecule separation by microfluid dynamics; evaluation of its functions; and, analytical technology for analysis of single molecules in a viable cell.

(3) Multi-scale Analysis of Interface and Surface (ST03)
This Sub-Theme attends to interfaces and surfaces for performing R&D for measuring localized sites and for micro-, meso- and macro-scale analyses.
The material science field requires evaluations from micro- to macro-viewpoints in research of material design and tribology. Development of technologies is desired for detailed and wide-ranged analyses as part of R&D for substance evaluation and improved performance. The research is expected to realize development of reliable and durable products and to contribute to resource and energy savings.
The life science field seeks to analyze not only part of the cell membrane but also the molecules that are distributed throughout the whole membrane. Membrane proteins on cell surfaces are an important subject of analysis for communications between a cell and extracellular space. For example, an R&D field that tries to implement substance production using cells in a society seeks detailed analyses for elucidating phenomena.
*Check the contents of proposal of a large-scale type project, “Development of innovative adhesion technologies for realizing Society 5.0,” for measurement techniques of material adhesion interface to proceed to selection of a prioritized theme/technological theme (see 4.1.1(1)).

(4) Deep-Site/Internal Measurement (ST04)
This Sub-Theme performs R&D for measuring structure of deep/internal sites of a substance and internal phenomena.
The field of material science seeks measurement of internal degeneration for checking and evaluating the quality of structural materials and batteries, detecting internal impurities, and observing internal chemical changes to analyze situations of function expression.
The field of life science seeks deep-site measurements for cell dynamics in the blood vessel, analysis of a single cell in organs, and brain analysis (nerve plasticity).
Low/non-invasive or non-destructive manipulation to avoid situation changes during observation is important for all fields. Development of measurement technologies should take these into consideration.
*Check contents of a large-scale project, “Development of Innovative Adhesion Technologies for realizing Society 5.0,” for measurement techniques of material adhesion interface, and proceed to selection of proposed prioritized/technological themes (see 4.1.1(1)).

(5) Ultrafast Dynamics Observation (ST05)
This Sub-Theme performs R&D that aims to make marked improvements in time-resolution of existing measurement methods as technology for observing ultrafast dynamics, including transitional situations of chemical reactions.
Electrons, for example, move too fast to be directly observed by ordinary measurement techniques. However, research fields of various areas may need to build a hypothesis to explain

ultrafast dynamics for the elucidation of physical properties in product development. The ultrafast dynamics requires observation for its verification. New techniques should be established by controlling femtosecond and attosecond lasers or by raising the level of pump–probe methods through improving detection performance.

(6) Temporal Observation (ST06)

This Sub-Theme develops technologies required for research subjects in individual fields and for high-impact temporal observations.

The material science fields desperately need technologies to observe internal heat conduction in an all solid battery and to observe and understand what triggers material degeneration in addition to needs for observation and measurement of chemical reaction progress on a catalyst. New findings are sought for time-consuming elucidation of creep phenomena and new measurement methods of efficiently testing accelerated degeneration. Development of the above technologies are expected to improve durability and reliability of products.

The life science field demands new technologies for quantitative analysis of gene expression, chronological modifications, such as DNA methylation, various omics analyses of protein and metabolites, and temporal observations of drug dynamics.

(7) Automation and Efficiency Improvement of Routine Work (ST07)

This Sub-Theme automates and makes efficient work already sorted by type in research fields to realize exponential improvement and acceleration of research productivity and to aim to reach results in a shorter time. Various needs and subjects are presumed. In the field of material science, for example, technology exists for preparing a novel material possessing a desired atom sequence by stacking individual layers one-by-one. This is a task requiring specialized skills. Therefore, demand exists for automation, robotic efficiency, and passing technology down through generations. Automated preparation of a chemical compound library in combinatorial chemistry is also needed.

The field of life science requires automation, improved efficiency, and high speeds of various biochemistry and molecular biology experiments. A specific example is the standardization of the pretreatment for omics analyses and automated measurement. Not only automation, but also higher levels and simplification of various treatment prior to measurement are sought.

(8) Sophistication of Processing, Synthesis, Separation and Purification (ST08)

This Sub-Theme conducts R&D for raising levels of universal technologies in research fields, including processing, synthesis, separation, and purification technologies.

For example, processing/synthesis technologies in the field of material science seeks to raise levels of crystal growth technologies, fine processing technologies, and layered structure technologies. For example, one problem that has been pointed out is that fine parameters of a prepared sample are altered by the equipment used for crystal growth for novel drug discoveries. A fundamental solution is in demand. There are discussions about utilization of artificial intelligence for chemical synthesis processes and of building modular flow synthesis systems for efficient substance production. By realizing such apparatus, functional peptides, which are needed for various industries, including drugs, food, and cosmetics, are predicted to decrease in manufacturing cost.

An example of separation and purification technology in the field of life science is protein

purification from a living body sample. There are strong needs for complex proteins and proteins in an elementary process among them, not only as research elements but also as drug discovery targets. Separation and purification of intracellular particles and exosomes released from cells have many problems of yield and purity, for which universal technologies are sought.
ST08 partly overlaps ST07, automating technologies for processing, synthesizing, separating, and purifying existing materials already sorted by type. ST08 contains basic element technologies that have not yet been realized for processing, synthesizing, separating, and purifying. That is how we distinguish ST08 from ST07.

(9) Mathematical Models or Analytical Methods to Investigate Truth from Diverse Real Data (ST09)

From viewpoints of the abstract and universality of mathematics, this Sub-Theme aims at creating mathematical models and solutions for describing/extracting "intrinsic information" about findings in the measurement/analysis fields related to a common platform technology area. It also develops new mathematical techniques that lead fundamental reorganization of measurement technologies. Research is promoted for building the common platform technologies this area aims for. For example, multidimensional and noisy time series data obtained from research fields via non-invasive measurements are used to estimate nonlinear dynamics of a system producing the data to develop a mathematical model. If the research realizes technology for building a mathematical model of a data-driving type, which extracts hidden law, the technology is expected to provide breakthroughs in various research fields.
Basic mathematical technologies are also important for building new techniques for analysis and processing of measured big data. For instance, measurement information of life dynamics observed in ST06 should be further subjected to integrated mathematical analysis for understanding life phenomena. Mathematical scientific and engineering analysis of multilayered-omics data that integrate groups of molecules (omics layers) of different properties (e.g., DNAs, RNAs, proteins, and metabolites) elucidate not only each layer but also an integrated multi layered network structure, including mutual interactions between the layers. More profound understanding is sought for life phenomena.
The field of material science recognizes how important the utilization of big data is in property assessment and materials informatics. Furthermore, new mathematical models born in such approaches are expected to play intrinsically important roles for understanding real phenomena.
*Propose a proper budget according to the proposal contents. No lower limit is set.
*This area will be managed to allow mathematical models and analytical techniques yielded from research on this Sub-Theme to contribute to solutions of important programs of other Sub-Themes. One group aiming to develop a system/instrument and another aiming to raise levels of mathematical models and analyses are expected to effectively collaborate on an increasing basis and in an optimal form to solve problems.

(10) Other Common Platform Technology, Facilities, and Equipment that Satisfy Purposes of Prioritized Theme (ST10)

Proposals are requested for cases that relate to more than one of the nine Sub-Themes described above and for R&D projects that do not completely meet the purpose of this prioritized theme, but instead create common platform technologies that do. For example, a research field that analyzes symbiosis between the human body and intestinal bacterial flora requires detailed analysis of the flora via integration of various techniques. Such a proposal should select this

Sub-Theme. This Sub-Theme does not ask for proposals of a Component Technology Type.

## ● Presumed Applications of Results

This area collaborates with other JST programs and programs of other ministries at an early stage. This is to allow other R&D programs closer to actual application, to build on results of projects needing a longer-term approach and for passing results to start-up firms and industries.

## ● Collaboration with Related Programs

To aim for the procurement of innovative knowledge and products and promoting challenging R&D that impacts research activities, this area closely collaborates with other JST programs and those of other ministries to positively promote utilization of results of programs at a research stage. Collaboration with facilities and equipment for joint use is encouraged from the viewpoint of promoting R&D by considering users' needs (see 6.15).

## ● Policies for Promoting R&D

In approaching challenging R&D projects, this area positively promotes multidisciplinary collaboration without constraints of conventional academic boundaries, participation of young researchers, and collaboration with business firms and academia to emphasize diversity of research teams and incorporation of novel ideas. A management system that provides advice and guidance through checking research plans and site visits by members of the R&D management conference, including theme managers, is prepared and aims to reorganize research techniques and realize a common platform system/instrument that procures innovative knowledge and products. For the transition from feasibility study to full-scale research project, the recombination of individual groups is envisioned each participating in the research project and themes, as well as their termination or reorganization.

## ● Research Period and Budget

Plan a period within 3 years for a feasibility study to be adopted for FY 2018. However, calculate FY 2018 as one year regardless of when the R&D is initiated. The feasibility study is subject to review for transfer to full-scale research at a time instructed by the program officer up to the end of FY 2020. Plan a maximum total R&D cost of 45 Million yen (direct expenses only) for a feasibility study.

Plan a total R&D cost of 1,500 Million yen and a period of five years maximum for full-scale research. However, a total is set at a maximum of 500 Million yen for a proposal of ST09 "Building Mathematical Models or Analytical Methods to Investigate Truth from Diverse Real Data".

As mentioned earlier, proposals of a Component Technology Type are called for, mainly in ST09, this FY.

Plan a proposal of a Component Technology Type within a research period of 3 years. However, FY 2018 is calculated as 1 year, regardless of when the R&D is initiated. Transition to full-scale research is subject to review at a time instructed by the program officer effectively in charge up to the end of FY 2020. Plan a research budget within a total of 30 Million (direct expenses only) yen in principle.

## 5.2 Large-scale Type

The technology themes of large-scale type that are believed to be important for forming the bases of future technologies, has been determined by The Ministry of Education, Culture, Sports, Science and Technology based on the information analysis on science and technology innovations. For the 2018 fiscal year, proposals are sought for large-scale R&D projects relating to the technology themes described herein.

Research and Development Supervisor (Program Officer: PO):
Yoshio Hayashi
(Program Director, JST)

### 5.2.1 Management policies for projects in large-scale type

#### (1) Policies for requesting and selecting proposals and R&D (common to all themes)

To achieve the realization of the three technology themes presented, projects should include an adequate R&D process to reach a stage (proof of concept, POC) where application feasibility can be judged by society and/or industry. Continued development of research achievements after the POC stage is expected to result in the enhancing of relevant base technologies that will exert impacts on a wide range of sectors.

Therefore, technology themes for technology fields are stipulated and relatively clearly defined. The R&D representatives (program manager, PM) themselves are expected to define the POC that will lead to the implementation of these technologies in society. The PM is requested to choose a high-level, challenging goal; create, protect, and utilize intellectual property strategically; and depict the overall vision as noble so that its achievement would be considered “marvelous” by business firms and investors. The PM is also expected to describe their vision for the project’s development after POC, an outcome in which the technology creates innovations in society and industries in the future, and to plan an exit strategy, such as collaboration with business firms or participating in a related business venture.

It is crucial for projects to boast the highest level of R&D capability and knowledge. See “4.1.3, Selection viewpoints” for a description of the evaluation criteria for the adoption of proposals. During the R&D process, projects are expected to be managed to use those opportunities to merge with various technology fields or collaborated with researchers or research organizations, including opportunities to recruit new members or obtain new findings or technologies.

Projects are also expected to attract investment from private sectors during the R&D process preceding the POC. Projects should encourage cooperation and active participation from business firms, as well as the introduction of funding at the beginning of or during R&D.

At the first stage gate, an evaluation will be conducted that will include an assessment of the project's ability to attract private investment (see "3.1.3 (9) Stage-gate evaluation"). The PM is requested to set a mid-way goal (a goal and a milestone for the first stage gate) that can attract cooperation from such firms and to engage in active and flexible dialogue with such enterprises in order to ensure the achievement of the POC.
It is also advised to collaborate and cooperate with such firms at the stages of defining the POC, studying visions for the future development of the POC, planning R&D, and promoting R&D.
In promoting research and development (R&D), we consider local and overseas R&D trends and changes in the social environment to boldly review our R&D plan for flexible management.

## (2) Policies for seeking proposals, selecting projects, and R&D (by technology theme)

### Theme1. Super-precise time measurement that leads to the acquisition of a market for communications and time business

Technologies for controlling the oscillation frequency at a level of precision higher than that of the present standard instrument of time as well as those technologies entailed in their realization, including, for example, a highly precise synchronization between multiple points or over a long distance, are keenly expected to contribute to the improved efficiency of communications and become new sources of growth for a wide range of industries. Among such sources of growth, Japan has many technology seeds which Japan has a lot of advantages. R&D representatives (PM) are asked to set a highly effective and reliable POC by back-casting from industries, collect a wide range of findings from high-precision time measurement technologies to sharing technologies, and possess the R&D management capability and vision for powerfully promoting the social implementation through the creation of new industries. Various technology seeds are presumed to mature and create tougher global competition in this area in the future. Therefore, PMs are expected to flexibly adjust to the global R&D situations and social environment in promoting R&D.

As for the commissioned R&D cost from 1$^{st}$ to 4$^{th}$ year, the amount of fund is set at 350 million yen/year (total of 1.4 billion yen) for direct costs only. Indirect costs are treated differently for each fiscal year. Plan R&D period of 10 years with the total funds of 4.0 billion yen.

### Theme2. Development of innovative adhesion technologies for realizing Society 5.0

To establish the next-generation adhesion technologies based on scientific findings, it will be the key to gather findings in polymer chemistry and surface chemistry, which Japan holds strength, for basic research advancement. It is expected to utilize techniques and knowledge of the large group of Japanese researchers capable of leading the world in polymer surface chemistry research, who have been nurtured by national projects such as that of JST's and the ImPACT. Therefore, technologies and the findings of local groups are likely to be utilized. R&D representatives (PMs) are expected to provide management for efficiently collecting ideas and findings from a number of groups in addition to their own creative ideas. Further, the established evaluation and analysis technologies serving as a common base for adhesion technologies and the creation of innovative novel adhesion technologies would exert

significant impacts on a wide range of industries for sensor devices and structural materials. Therefore, PMs are expected to build a collaboration through system with industries at the early stages, that allows academia and the government to swiftly of industries in research projects.

As for the commissioned R&D cost from 1st to 4th year, the amount of fund is set at 230 million yen/year (total of 0.9 billion yen) for direct costs only. Indirect costs are treated differently for each fiscal year. Plan R&D period of 10 years with the total funds of 2.7 billion yen.

### Theme3. Innovative hydrogen liquefaction technologies for the future society

Costs of production, transportation, and storage are to be reduced for the popularization of hydrogen energy in a society. The utilization of liquid hydrogen is important for the realization of mass transportation and mass storage. In addition, because the liquid temperature is low at -253 °C, the liquefaction process can remove impurities. The liquid is considered a suitable supply source for sites requiring high-purity hydrogen.

The most important technological issue for hydrogen liquefaction is the high-efficiency cooling technologies. The “basic hydrogen strategies” (determined on December 26, 2017) adopted by the country describes the “realization of high-efficiency hydrogen liquefying equipment” as a necessary innovative technology to be developed in the future. A “hydrogen society” with mass consumption of hydrogen would expect simpler, innovative, and low-cost liquefaction technologies. R&D representatives (PMs) are expected to provide management for the development of innovative liquefaction technologies and early social implementation. The Agency for Natural Resources and Energy and NEDO also promote R&D policies related to hydrogen. The flexible promotion of R&D projects is expected, including the utilization of results from past projects and collaboration with ongoing projects.

As for the commissioned R&D cost from 1st to 4th year, the amount of fund is set at 260 million yen/year (total of 1 billion yen) for direct costs only. Indirect costs are treated differently for each fiscal year. Plan R&D period of 10 years with the total funds of 3.3 billion yen.

### 5.2.2 Technology Themes

## 1. Super-precise time measurement that leads to the acquisition of a market for communications and time business

### (1) Theme name

Super precise time measurement that leads to the acquisition of a market for communications and time business

### (2) Outline

Technologies for the accurate measurement of time have been sought after and evolved in the long history of mankind. The unit, “time,” is a basis for all physical phenomena. It has been used in every academic and industrial sector and incorporated into technologies supporting the base of present civilized society, such as providing global positioning information and large-scale communications.

In recent years, research has advanced to improve time measurement by two to three digits in precision to super-precise time measurement. The synchronization of super-precise time measurement and a communications system or information instrument is expected to improve the advanced technologies for utilizing time, including communications and information technologies.

### (3) Goal

The purpose is to introduce time measured at a super-high precision in every academic and industrial field as well as to aim for the early establishment of super-precise time measurement technologies while considering the international discussions of redefining the units of “seconds.” R&D will be conducted on super-precise time measurement instruments that are compact, light, and stable as well as on the peripheral instruments of systems and repeaters for networking until a stage (POC) is reached where a practical application is judged feasible. The R&D will be conducted in collaboration with researchers in related fields, such as laser technologies and atom cooling technologies, and for the development of universal technologies used in a wide range of fields. Hence, the R&D will be promoted in collaboration with the industries related to communications and information technologies and flexibly incorporate such ideas as supplies of new systems and applications, thus leading to the formation of a high-level societal infrastructure for clear targets. Further, it is desirable to promote R&D while preserving the internationalization of peripheral technologies to maintain an exit image, and collaborating with ministries associated with communications and information technologies.

### (4) Future society image to be kept in mind while conducting research

The promotion of the R&D project is believed to lead to the realization of a future society, as described below:

- A comfortable information society, in which time measured at a super precision is synchronized with various instruments to render faster, larger in volume, and stable communications.
- A safe and secure society, in which a timing-synchronized network is established to compensate for GNSS to minimize the effects of damage and system disturbance (jamming, spoofing) caused by natural phenomena in communications and

positioning formation services utilizing GNSS.

- A safe and secure society, in which the super-precise time measurement has realized spacetime sensors to measure gravity variations and monitoring has been popularized for earthquake prediction and tectonic fluctuations due to minute changes in gravity potential.

- A society, in which the popularization of compact, light, and super-precise time measurement instrument accelerates scientific and technological innovations through the improvements in scientific and industrial technologies including the search for natural resources and measurements of land survey, surveying measurement, and scientific research.

## (5) Specific research examples

Specific research examples may include the following:

- R&D of technologies that allow short-time measurement with high reliability for super-precise time measurements improved by two to three digits compared to past time measurement techniques. In addition, the R&D of compact and durable time measurement instrument that steadily realizes equivalent super-precise time measurement in real environments for a long time (improved reliability and stabilization of laser, and stabilization of a narrow frequency band).
- Establishment of a timing synchronization network to compensate for the GNSS and R&D of technologies for synchronizing a super-precise time with a number of time measurement instruments
- R&D of repeaters for transmitting high-precision clock signals over a long distance toward their utilization in the communications and network field, and R&D associated with the implementation technologies for communications instruments
- R&D for high-precision and quick measurements of extremely minute changes in gravity potential corresponding to a vertical difference of approximately one centimeter

## (6) R&D trends

Concerning the International System Units (seven basic units including length, mass, and time), the process redefinition is ongoing following the redefinition of mass (kilogram) in 2018. Regarding the super-precise time measurement technologies using light, a technology to trap a single ion was established in the 1980s, followed by the R&D on an “ion trap atomic clock.” In the early 2000s, a technology was demonstrated for the first time in the world for trapping atoms for an “optical lattice clock” technology that allows time measurements to be conducted in a short time. All of the clocks are considered a promising candidate technology for redefining the units “seconds” as a standard instrument. The R&D is ongoing in more than 20 countries worldwide, including a comparative experiment with an optical lattice clock using long distance fibering between Germany and France.

The U.S. is advancing R&D, primarily on the compact standard instrument. In Europe, R&D is ongoing for the loading on a satellite to replace the cesium atomic clock. Germany set up an

optical clock project in 2017. Countries worldwide are investing rapidly in R&D to acquire the next-generation time infrastructures.

In recent years, Japan has been conducting R&D for the most advanced time measurement technologies in the world, including time measurement technologies with 10-19 precision. A number of research organizations and private business firms are cooperating to begin a verification experiment using a compact and light apparatus outside laboratories. The applications of super-precise time measurement technologies are expected to be realized sooner in foreign countries.

## 2. Development of innovative adhesion technologies for the realization of Society 5.0

### (1) Theme name

Development of innovative adhesion technologies for the realization of Society 5.0

### (2) Outline

The realization of Society 5.0 requires transforming everything to become compact and multifunctional. The establishment of adhesion technologies is essential as a key technology for the realization of innovative devices. In the field of mobility, for example, using nonmetals or polymers for a lighter body, electric driving with batteries, and compact electronic devices for auto cars are intelligent ideas, for which the established reliance on adhesion technologies and improved performances are indispensable. However, adhesion technologies are currently developed with the experience and intuition of skilled people. The lack of established methods for the evaluation and analysis of adhesion interfaces (*) between solids is a bottleneck for the creation of the next-generation adhesion technologies. This technology theme aims to establish the evaluation and analysis methods for the adhesion interface and create the next-generation adhesion technologies based on scientific findings for the realization of Society 5.0.

*Adhesion interface includes the surrounding adhesion layers hereafter.

### (3) Goal

Adhesion technologies are a key for creating lighter mobility, electrically driven, and intelligent systems. They are researched and developed up to a stage (POC), where practical applications can be judged feasible, for the creation of the currently difficult evaluation and analysis methods for the adhesion interface between two solids and for the creation of the high-functioning next-generation adhesion technologies that are based on scientific findings and construction of guidelines. Thus, it is aimed at developing adhesion technologies for universal base technologies in a wide range of fields. In particular, in creating the next-generation adhesion technologies, R&D will be promoted for clear targets under the close collaboration with industries by exploiting the results of various basic studies for the efficiency, aiming for the POC establishment as early as possible and properly timed spinouts. For reaching the goal, it is desirable to build sustainable collaboration teams with the participations of various entities including industries, universities, and government.

### (4) Future society image to be kept in mind while conducting research

The promotion of R&D projects is believed to lead to the realization of the following society in the future:

- An energy-saving and low-carbon society, in which adhesion technology innovations replaced metal as a structural material with polymer to create lighter mobility
- A super-smart society, in which designing adhesive agents based on scientific findings allowed various sensors to be compact and highly functional, and batteries functioned without degeneration for a long time, and can be loaded on most objects

### (5) Specific research examples

Specific research examples include the following:

• Evaluation and analysis technologies for adhesion interface

The observation of thick layers {interpenetration layer (IPL)} near the adhesion interface with a 3D electron microscope, the types of interfacial molecular structures by sum-frequency generation spectroscopy, the orientation of radicals, the detection of new bonds at adhesion interfaces, the detection of new bonds at adhesion interfaces by radiation, simulation technologies using a supercomputer or AI, and materials informatics are integrated for a comprehensive utilization to establish the scientific understanding of the whole phenomena occurring at the adhesion interface. The designing guidelines are constructed for the adhesion technologies that secure high reliability based on such understanding.

•Next-generation adhesion technology

The findings obtained as described above are used to create highly reliable adhesion technologies (for example, adhesion technology for different kinds of materials for cars that meets the following criteria: strength of 30 MPa, heat resistance of 120 °C, resistance to climate, and humidity resistance of 30 years or longer) that secure safety, heat resistance, and durability without using a bolt or a rivet for the adhesion between various materials; super-precision adhesion technologies for super-compact sensors that control Nano level gaps; adhesion technologies for complete sealing that extend battery longevity by controlling moisture contamination to nearly zero. This theme is not confined to the research examples above but sets clear targets of significant impacts in close collaboration with industries.

## (6) R&D trends

The global observation of adhesion technologies relates to a large research center that is the Fraunhofer Institute, and powerful adhesive manufacturers in Germany. China has also set up a prioritized national laboratory related to adhesion at Tsinghua University. Although R&D is globally conducted for adhesion technologies, the R&D primarily concerns the application research in machinery fields and no large-scale R&D has been performed to elucidate the principles of the adhesion mechanism.

Japan is strong in chemistry and possesses large-scale research facilities, which are globally precious, such as the SPring-8 and J-PARC. In addition, projects such as the Strategic Creative Research Promotion and Innovative R&D Promotion (ImPACT), advance the understanding of the importance of interface structure, interface properties, and adhesion technologies in the expression of material functions and nurture researchers who are capable of leading the world in polymer interface research. Furthermore, Japan has a world-class share in electronic components including image sensors. Teams in industries and universities are likely to elucidate the adhesion mechanisms and develop adhesion technologies that suit the exit, and are based on scientific findings for creating a new tide in the world.

## 3. Innovative hydrogen liquefaction technologies necessary for the future society

### (1) Theme name

Innovative hydrogen liquefaction technologies necessary for the future society

### (2) Outline

For the realization of the future society advanced in energy saving and carbon lowering, the utilization of liquid hydrogen is essential, which has characteristics such as a volume 1/800 that of hydrogen gas, mass transportation, mass supply, mass storage, space saving, and super-high purity. The present hydrogen liquefaction with a compressor is disadvantageous, including low liquefaction efficiency at manufacturing and loss resulting from evaporation. The development of high-efficiency, low-cost, compact, durable, and innovative technologies for hydrogen liquefaction is expected to enable the mass utilization of hydrogen and contribute to an increased volume of hydrogen use for hydrogen power generation, storage of surplus power, and means of transportation.

### (3) Goal

R&D will be conducted for innovative hydrogen liquefaction technologies, which are high in liquefaction efficiency essential for the increased utilization of liquid hydrogen and in liquefied volume, up to a stage (POC) where practical applications can be judged feasible, aiming at the development to universal base technologies in a wide range of fields. It is desirable for the base technologies for hydrogen liquefaction to be not only for hydrogen but also for universal applications, including helium. Furthermore, the R&D team formation in collaboration between industries and universities should be preserved by considering applications after the completion of the program and internationalization.

### (4) Future society image to be kept in mind while conducting research

The promotion of R&D projects is believed to lead to the realization of the following future society:

- A society, in which substantial decreases in the loss of liquid hydrogen resulting from high-efficiency production, mass storage, mass transportation, and reduced evaporation during storage and transportation of liquid hydrogen have accelerated hydrogen utilization in a wide range of fields, including power generation and transportation (airplane, railroad, hydrogen/fuel battery cars, rocket, etc.).

### (5) Specific research examples

The following are believed to be specific examples:

- R&D for innovative hydrogen liquefaction technologies to efficiently produce large amounts of liquid hydrogen through the optimization of a freezing cycle for increased cooling effects
- R&D to elucidate a mechanism for embrittlement in extremely low to low temperature zones, and R&D on embrittlement-resistant materials

## (6) R&D trends

Countries are competing fiercely in the development of innovative hydrogen liquefaction technologies of high efficiency, low-cost, and long durability.

For example, Germany and France, which have been applying plant technologies, are developing increasingly more efficient hydrogen liquefaction by a gas-freezing method. A joint team of the U.S. and Canada is promoting a DOE project for a magnetic freezing method. Korea is conducting advanced research in which high-temperature super conducting magnet is used. Europe is performing research that may be applicable to the next-generation energy-saving air conditioning and refrigerators (free of chlorofluorocarbons) because it is applicable to “room temperature freezing.” Governments of France and the U.K. are supporting venture firms that manufacture household electrical appliances (refrigerators). Research is also ongoing in Germany and Denmark. Japan is conducting R&D on hydrogen liquefaction technologies of internationally outstanding efficiency.

- Positive participation and activities of young researchers

Challenging and creative research is encouraged and diverse approaches are expected in the academic field, humanities and arts, as well as different age groups and gender. Many researchers who yielded globally outstanding results had performed underlying basic research when they were young. Hence, we encourage excellent young researchers, who will shoulder Japan based on science and technology in the future, to participate in positive roles.

We encourage young researchers in industries, universities, and the government to assume R&D management as an R&D representative. We will provide supports, such as training for R&D management, as required. We anticipate for more R&D proposals from the younger generations and expect the R&D representatives to positively invite young researchers possessing novel and excellent ideas to participate in R&D as joint researchers.

# Chapter 6
# Key Points in Submitting Proposals

○ Violation of the guidelines provided in this chapter or any other inappropriate behavior may result in withdrawal of approval for the research project or cancellation of the research; return of all or part of the project's research funding, and measures taken to publicize the facts of the matter.

○ Violation of related laws or guidelines, etc., in conducting research may result in cancellation of your research funding allocation or withdrawal of the research funding allocation decision.

## 6.1 Enrolling in and Completing the Educational Program for Research Integrity

The research project applicant must complete the educational program for research integrity as a prerequisite for application. Note that if completion of the program cannot be confirmed, the application will be disqualified for failing to meet the requirements. Enrollment in and completion of the research integrity educational program by the time of application is not a prerequisite for Lead Joint Researcher applicants.

To enroll in the educational program for research integrity and to submit a declaration of completion, follow either procedure (1) or (2) below.

(1) For applicants who have completed an equivalent program at their institution
Applicants who have already completed an e-learning program or educational seminar on various aspects of research integrity (including the CITI Japan e-learning program) by the time of their application are requested to make the declaration on the e-Rad application information entry screen.

(2) For applicants who have not completed an equivalent program at their institution (including for applicants at institutions that do not have such a program)

a. Applicants who have in the past completed a CITI Japan e-learning program in a JST program.
Applicants who have in the past completed a CITI Japan e-learning program in a JST program by the time of their application are requested to make the declaration on the e-Rad application information entry screen.

b. For other applicants for whom a. above does not apply.
Applicants who find it difficult to enroll in an educational program for research integrity because their institution does not offer such a program at their institution or for other reasons may enroll in and take the condensed version of the CITI Japan e-learning program offered through JST. Instructions for enrolling in this program may be found on the Invitation of R&D Proposal website:
http://www.jst.go.jp/mirai/jp/open-call/research/h30/

There is no cost for enrolling in and completing the program, which will take between one to two hours to complete. Once enrolled, applicants are expected to complete the program without delay and then to declare the completion of the program and to also enter the certificate completion number from the completion certificate (the Ref # to the right of

the completion date) in the e-Rad application information entry screen.

* Educational programs for research integrity are the responsibility of each research institution. JST does not specify the specific teaching material to be used in those programs.

(Reference)

According to the “Guidelines for Responding to Misconduct in Research Activities” (August 26, 2014, adopted by the Minister of Education, Culture, Sports, Sciences and Technology), which will be implemented from April 2015, research institutions are required to implement a structure for preventing misconduct, such as the installation of a Research Integrity Education Manager, and to conduct education at the institutional level. Further, the allocating institution is also required to confirm researcher enrollment in the institution’s research integrity education program.

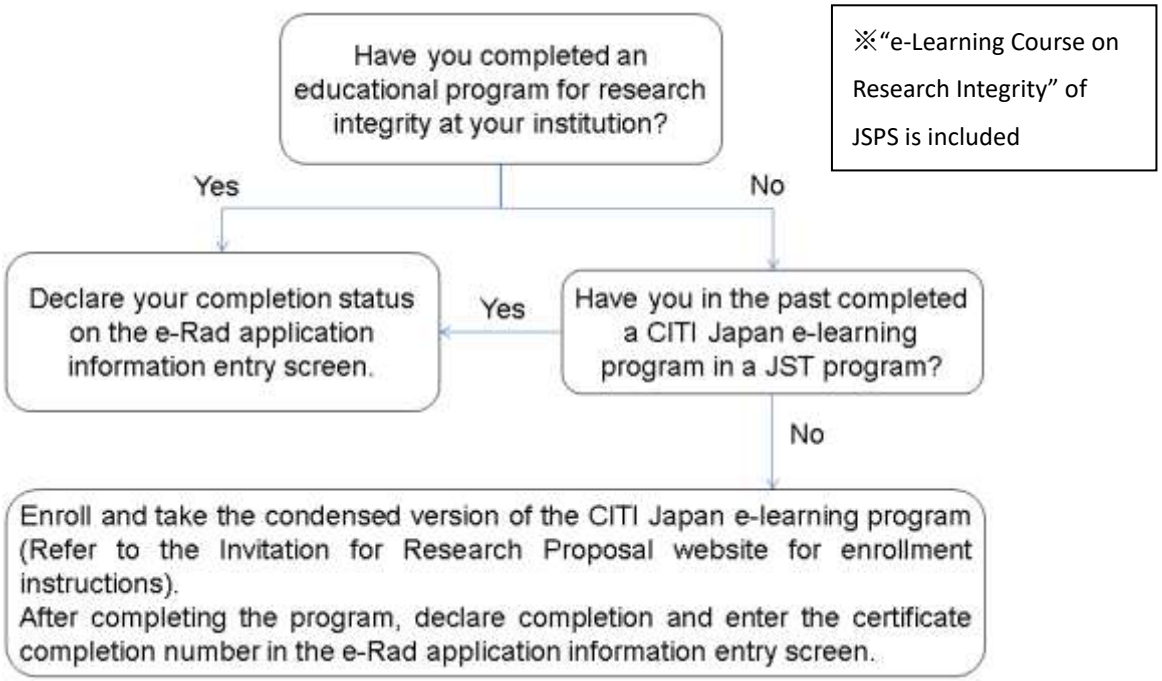
Note however that the details in the above guidelines focus on misconduct in academic papers and does not cover bioethics and conflicts of interest, which are different topics.

■ Contact for consultation on the educational program for research integrity
Japan Science and Technology Agency
Department of Audit and Legal Affairs, Research Integrity Division
E-mail： rcr-kousyu@jst.go.jp

■ Contact for consultation on the public invitation for application
Japan Science and Technology Agency
Department of Research and Development for Future Creation
E-mail： kaikaku_mirai@jst.go.jp

* Include the program name, e-Rad project ID, research applicant name and the project name in the body of the email.

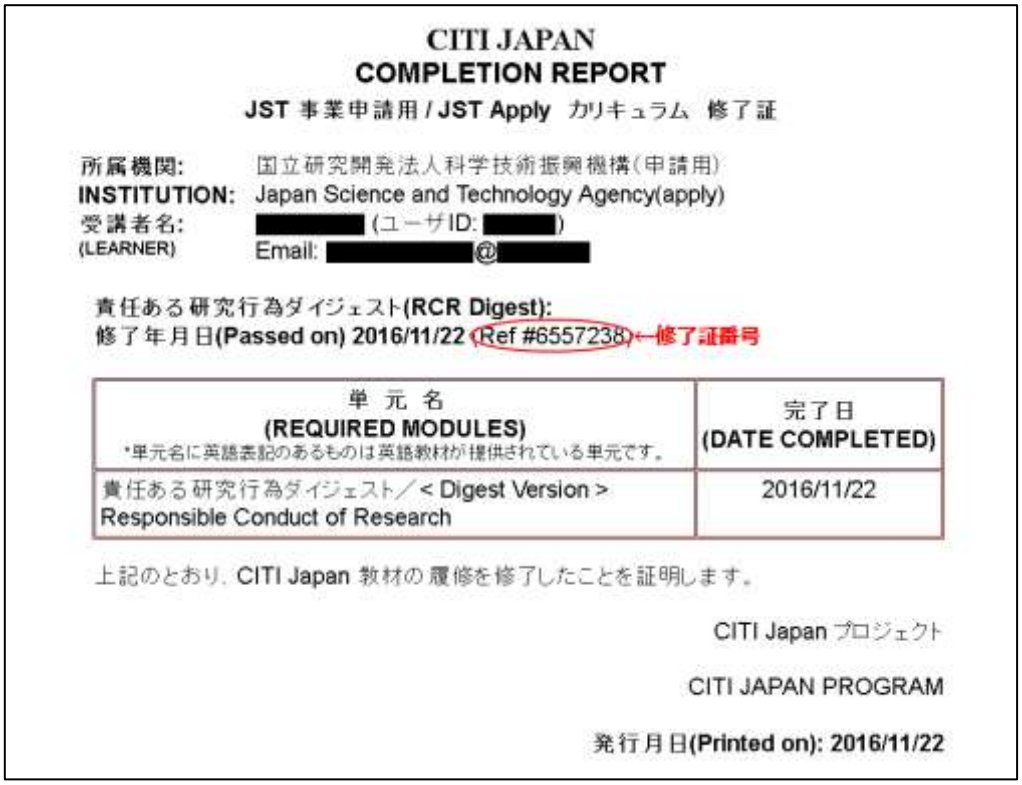
［Flow chart for declaring enrollment and completion of the educational program for research integrity］




*Declaring completion with the certificate completion number

To view the completion certificate, click the link for the completion certificate in the Completion Report column on the Main Menu. The Ref # printed to the right of the completion date is the certificate completion number.


↑ Main Menu for the condensed CITI Japan e-learning program digest



CITI JAPAN
COMPLETION REPORT
JST 事業申請用 / JST Apply カリキュラム 修了証

所属機関: 国立研究開発法人科学技術振興機構(申請用)
INSTITUTION: Japan Science and Technology Agency(apply)
受講者名: [redacted] (ユーザID: [redacted])
(LEARNER) Email: [redacted]@[redacted]

責任ある研究行為ダイジェスト(RCR Digest):
修了年月日(Passed on) 2016/11/22 (Ref #6557238)←修了証番号

| 単元名 (REQUIRED MODULES) *単元名に英語表記のあるものは英語教材が提供されている単元です。 | 完了日 (DATE COMPLETED) |
|---|---|
| 責任ある研究行為ダイジェスト／< Digest Version > Responsible Conduct of Research | 2016/11/22 |

上記のとおり、CITI Japan 教材の履修を修了したことを証明します。

CITI Japan プロジェクト

CITI JAPAN PROGRAM

発行月日(Printed on): 2016/11/22

↑ Sample of certificate of completion

JST has required researchers participating in JST-Mirai program to enroll in and complete seven designated modules of the CITI Japan e-learning program. Since the requirement will remain unchanged for FY2017, in principle all research participants will be required to enroll in and complete the seven designated modules from the CITI Japan e-learning program (excluding applicants who have already completed the seven designated modules from the CITI Japan e-learning program at their institution or in a JST program).

## 6.2 Handling of Information Provided in R&D Proposals, Etc.

○ From the standpoint of maintaining the interests of the applicant, the "Act on the Protection of Personal Information Held by Independent Administrative Agencies, etc.", and other standpoints, R&D proposals shall not be used for any purpose other than the selection process. Confidential information regarding R&D proposal details shall be strictly maintained. For details, please refer to the following website.
http://law.e-gov.go.jp/htmldata/H15/H15HO059.html

○ Handling of Information Regarding Selected Projects
Information regarding individual projects that have been selected (name of system, name of research project, name of affiliated research institution, name of Research Director, budget amount, implementation period, etc.) shall be deemed to be "information that is scheduled to be made public" as prescribed under Article 5, Paragraph 1, Item (a) of the "Act on Access to Information Held by Independent Administrative Agencies" (Act No. 140 of 2001).

The name of the researcher, name of the affiliated research institution, name of the research project, and the research project overview summary are scheduled to be made public. In addition, the R&D proposals of selected applicants may be used by the JST to promote the research after the proposal's approval.

○ Provision of Information from the Cross-ministerial R&D Management System (e-Rad) to the Government Research and Development Database

The Fifth Term Basic Plan of Science and Technology is said to attempt to complete the registration of funds for public solicitation for the promotion of science and technology innovation policies based on objective evidence in a research and development management system common to ministries in order to perform evaluation and analysis. Information registered in e-Rad is utilized for properly evaluating research and development with the country's fund and for planning effective and efficient comprehensive strategies. For the purpose, CSTI and relevant ministries have decided to complete registration of achievement information and accounting achievements, such as papers and patents, in e-Rad in order to connect output and outcome information related to inputs to the publicly solicited research fund system.

Information on research achievement and accounting and on use of indirect costs related to competitive fund for adopted issues shall be input in e-Rad every year. The information necessary for macroscopic analysis, including information on research achievement and accounting performance, will be provided to the cabinet office.

## 6.3 Measures against Unreasonable Duplication and Excessive Concentration

○ Measures against "Unreasonable Duplication"

In the case that a researcher is unnecessarily receiving competitive funding from multiple sources for the same research project (name or content of research receiving competitive funding; hereinafter the same shall apply) being undertaken by the same researcher and any of the following applies, the researcher shall be made ineligible to apply for this program, selection of their research project withdrawn, or their research funding reduced (hereinafter referred to as "withdrawal of research project selection").

① In the case that simultaneous proposals have been submitted for multiple competitive research funds and duplicate approval granted for essentially the same research project (including cases in which there is a considerable degree of research content duplication; hereinafter the same shall apply).

② In the case that a duplicate application is made for funding of a research project that is essentially the same as another research project that has already been selected and has already received competitive research funding.

③ In the case that there is overlap in the intended application of research funding between multiple research projects.

④ Other cases equivalent to the above

Although at the application stage for this program there are no limitations regarding the submission of proposals to other competitive funding programs, etc., in the case that a

research project is selected by another competitive funding program, please report this promptly to the JST at the contact address given at the end of this document. If reporting is omitted, the approval decision for the research project may be revoked.

○ Measures against "Excessive Concentration"

Even if the content of the research proposed for this program differs from the content of research being carried out under another competitive funding program, in the case that the overall research funding allocated to the same researcher or research group (hereinafter referred to as "researchers") in the relevant fiscal year exceeds an amount that can be utilized effectively and efficiently and cannot be used within the research period, and any of the following applies, selection of the research project under this program may be withdrawn.

- In the case that an excessive amount of research funding is being received in light of the capabilities of the researchers and the research methods being used, etc.
- In the case that an excessive amount of research funding is being received in comparison with the amount of effort (percentage of the researchers' overall working time[8] that is required for carrying out the said research project) being allocated to the research project.
- In the case that highly expensive research equipment is purchased unnecessarily.
- Other cases equivalent to the above

For this reason, in the case that you submit proposals to other competitive funding programs, after submitting your application for this program, and the research project is selected by another competitive funding program, or if any information provided on your application changes, please report this promptly to the JST at the contact address given at the end of this document. If reporting is omitted, the approval decision for the research project may be revoked.

○ Information on proposal contents provided to eliminate unreasonable duplications and excessive concentration

In order to eliminate unreasonable duplication and excessive concentration, to the extent necessary information regarding some proposals (or selected projects/programs) may in some cases be provided through the Cross-ministerial R&D Management System (e-Rad) to other departments in charge of competitive funds, including other government ministries. Furthermore, when it is required that checks be made for duplicate project applications under other funding programs, information may be provided in a like manner.

○ In the case that the researcher is receiving Grants-in-Aid for Scientific Research or other competitive research funding operated by the national government or independent administrative agencies (including national research and development agencies), or other research grants (including funding for which applications have been submitted), please provide information about this funding on the R&D proposal in accordance with the

[8] This is based on the Council for Science, Technology and Innovation's definition of 'effort', which is "the percentage of working hours required for conducting the relevant research when the researcher's total annual working hours are 100%". Note that "total working hours" does not refer only to the number of hours spent in research activities but to the substantive total working hours, including educational and medical activities.

prescribed format (Small start Type: Form 6; Large-scale Type: Form 8).

Based on information regarding the content of the R&D proposal and effort (research time allocation rate), in the case that either unreasonable duplication or excessive concentration of competitive funding has occurred, the R&D proposal may not be selected or selection may be withdrawn, or research funding may be reduced. Furthermore, the R&D proposal may also not be selected or selection may be withdrawn, or research funding may also be reduced in the case that the information provided on the R&D proposal is found to be false.

○ In order to eliminate the unreasonable duplication or excessive concentration of competitive funding mentioned above, in the case that a researcher is receiving other competitive funding operated by the national government or independent administrative agencies (including national research and development agencies), or other research grants, or in the case that a researcher has been selected for such funding, the researcher may not submit proposals for this program for research with the same project name or content.

○ In the case that the applicant is scheduled to receive 100 million yen or more in research funding under other systems or research grants, etc. in FY2017 or 2018, in view of the purpose of eliminating unreasonable duplication and excessive concentration, as a general rule final selection of the research project and budget amounts are decided in an integrated manner. In the case that the applicant is scheduled to receive a total of 100 million yen or more from multiple funding systems/grants, he/she is given individual consideration accordingly within the selection process.

Although not relevant for research projects at the application stage, the R&D proposal may be removed from the selection process for this program or the selection decision withdrawn depending on the outcome of selection for other competitive funding or research grants. Furthermore, when it is discovered, during the selection process for this program, that the research project has been approved/rejected for another competitive funding system, please report this promptly to the JST at the contact address given at the end of this document (kaikaku_mirai@jst.go.jp).

## 6.4 Measures against Inappropriate Usage of Research Funds

Inappropriate use and reception (referred to as “inappropriate use and the like” hereafter) of research expenses related to implemented issues are strictly treated as described below.

○ Measures to be taken in case inappropriate use and the like of research expenses are found

(i) Measures to cancel contracts

Contract research agreement is cancelled or altered concerning issues in which inappropriate use and the like are found and a request is made for refunding all or part of trusted expenses. Contract for the following year and thereafter may not be concluded.

(ii) Measures to restrict application and participation[9]

Restriction measures set out in the table below depending on the levels of inappropriate use and the like are taken against application and participation by researchers[10] (including researchers who conspired, referred to as ("researchers who conspired inappropriate use and the like")) who exercised inappropriate use and the like of research expenses of this project or those whose involvement in inappropriate use and the like is not proven but who violated the duty of good care.

Furthermore, the outlines of pertinent inappropriate use and the like (names of researchers who exercised inappropriate use and the like, project names, affiliations, research issues, amounts of budget, fiscal year of research, contents of inappropriate use and the like, contents of measures taken) are provided to persons of other prefectures and their independent corporations in charge of competitive funds, who may restrict application and participation in other systems for competitive fund of the prefectures. "Application and participation" means proposal, subscription, and application of a new issue; participation in research as a new joint researcher; and participation in an ongoing research issue as a joint researcher.

| Details of Research Funding Usage | : Period of Limitation on Application (starting from the next fiscal year in which the misconduct in research activities is deemed to have occurred[11]) |
|---|---|
| 1. Cases in which the extent of the inappropriate use of research funds, etc. is deemed to have had minimal effect on society and the maliciousness of the action is deemed to be low. | : 1 year |
| 2. Cases in which the extent of the inappropriate use of research funds, etc. is deemed to have had a large effect on society and the maliciousness of the action is deemed to be high. | : 5 years |
| 3. Cases apart from 1 and 2 in which the impact of the action on society and its maliciousness are taken into consideration. | : 2-4 years |
| 4. Cases in which the research funds were used to attain personal economic gain, regardless of 1 to 3. | : 10 years |
| 5. Cases in which dishonest means, such as deceit, were used to have the research project in question selected for the program. | : 5 years |
| 6. Although not directly involved in the inappropriate use of research funds, cases in which the use of research funds is deemed to have violated the due care of a prudent manager. | : 1-2 years |

(iii) About public announcement of a case of inappropriate use and the like

Regarding those researchers whose application to or participation in this program, among those who make inappropriate usage of the program's research funds or those who are in breach of their duty for diligence, information regarding the outline of the

[9] "Application and participation" means proposal, subscription, and application of a new issue; participation in research as a new joint researcher; and participation in an ongoing research issue as a joint researcher.

[10] "researchers who violate the duty of good care" means those whose involvement in inappropriate use and the like is not proven but who violated the duty of good care a good manager should exercise.

[11] Limitations shall also be placed on participation for the fiscal year in which the misconduct in research activities is deemed to have occurred

misconduct etc. (name of researcher, name of program, name of affiliated institution, fiscal year of research, details of the misconduct and details of measures taken) will be disclosed in principle by JST. Moreover, details of the misconduct (the title of the case, type of misconduct, the research area of the misconduct case, the name of the funding in regard to which misconduct occurred, the outline of the misconduct case, the measures taken by the research institution, the measures taken by the funding organization, etc.) will be disclosed in principle by MEXT.

Furthermore, according to the "Guidelines of Management and Audit of Public Research Funds in Research Institutes (Implementation standards)", once misconduct is determined as the outcome of an investigation, it will be the responsibility of the research institution to announce the results of the investigation; hence, we ask each institution to deal with the matter appropriately.

http://www.mext.go.jp/a_menu/kansa/houkoku/1364929.htm

## 6.5 Measures taken for researchers whose application and participation are restricted in another competitive fund system

Researchers on whom restriction is imposed for the reason of inappropriate use and the like of research expenses in another competitive fund system [12] under the central government or independent corporations are subject to restricted application to and participation in this project while their qualifications are restricted for application in the competitive fund system.

It includes systems that finished in 2017 fiscal and those that publicly invite proposals in 2018 fiscal. "Other competitive fund systems" include those systems that publicly begin inviting proposals newly in 2018 fiscal and those that finished before 2017 fiscal.

## 6.6 Regarding implementation of systems based on the "Guidelines of Management and Audit of Public Research Funds in Research Institutes (Implementation standards)"

○ Regarding implementation of systems for managing and auditing public research funds

In implementing the program research institutions must stringently observe the "Guidelines on Management and Audit of the Public Research Expenses in Research Institutions (Implementation standards)" (decided by the Minister of Education, Culture, Sports, Science and Technology on February 15, 2007; revised February 18, 2014)[13].

There is a need for the research institutions to take responsibility, having implemented a system for managing and auditing public research funds, to make every effort to properly spend the contract research fund in line with the aforementioned guidelines. If the Ministry

[12] See the table of competitive fund systems in the URL below for other specific systems.
http://www8.cao.go.jp/cstp/compefund/
Note that some the systems described above may be altered.

[13] Please refer to the following URL for the details of the "Guidelines on Management and Audit of the Public Research Expenses in Research Institutions (Implementation standards)".
http://www.mext.go.jp/a_menu/kansa/houkoku/1343904.htm

of Education, Culture, Sports, Science and Technology recognize the system of a research institution for managing and auditing as insufficient based on the investigation according to the guideline, there is a possibility that measures such as reduction of overhead costs of competitive funding could be taken on the said institution.

○ Regarding the "Self-evaluation Checklist for Implementation of Proper Systems"

In concluding the contract for this project, research organizations[14] need to prepare a management and auditing system for research expenses based on the captioned guidelines and to submit “Self-evaluation check list for system preparation” (“check list”, hereafter), which is a report on situation and so on (research undertaking is not approved unless the check list is submitted).

It is necessary for a research organization to use the research and development management system (e-Rad) common to ministries in order to submit the check list in the form given on the website below to the Competitive Fund Coordination Office, Promotion Planning Section, Promotion Bureau, Ministry of Education, Culture, Sport, Science and Technology by the date of concluding the contract research agreement. However, submission of a new checklist is not necessary if it has been submitted on another occasion after April 2018.

See the website of Ministry of Education, Culture, Sports, Science and Technology below for details of a method for checklist submission.

http://www.mext.go.jp/a_menu/kansa/houkoku/1301688.htm

*Note: a perfect environment for using e-Rad is necessary for check list submission. Organizations that have not been registered in e-Rad should make the registration soon. (Note it usually takes about two weeks. See the website below in addition to the website given above for detailed procedure for using e-Rad).

http://www.e-rad.go.jp/shozoku/system/index.html

Because the captioned guidelines contain viewpoints of “promotion of issuing and sharing information,” describe the checklist on the websites of research organizations to actively issue information.

○ About duty to complete education for research ethics and compliance

Researchers who participate in research issues of this project shall receive lectures on research ethics education for the prevention of misconduct in research activities required in “Guidelines for responding to misconducts in research activities” and on compliance education required in “Guidelines for management and audit of public research expenses in research organizations”.

During the process of concluding a contract research agreement after the adoption of proposed research issues, it is necessary for all researchers participating in research issues of this project including Principal Investigator to receive lectures on research ethics education and compliance education and submit a document to confirm that they understood the contents of the lectures.

[14] Research organizations include not only those whose Principal Investigator is affiliated with but also those of major joint researchers to whom research expenses are distributed.

## 6.7 Regarding implementation of systems based on the "Guidelines for Responding to Misconduct in Research Activities"

In applying to this funding program and conducting research activities, research institutions are required to adherence to the ""Guidelines for Responding to Misconduct in Research Activities"(decided by the Minister of Education, Culture, Sports, Science and Technology on August 26, 2014, hereinafter referred to as the "guideline").

In case the Ministry of Education, Culture, Sports, Science and Technology finds defects in the situation of system preparation by organizations as a result of survey on the situations based on the guidelines, the Ministry may take measures including reduction of indirect costs of the whole competitive fund for the pertinent organization.

## 6.8 About submission of a checklist related to the situation of approaches based on "Guidelines related to responding to misconducts in research activities"

When concluding the contract for this project, research organizations[15] need to submit "a check list related to the situation of approaches based on "Guidelines for responding to misconduct in research activities"" (referred to as a "check list of inappropriate research conduct, hereafter"). (Research undertaking is not approved unless a checklist of inappropriate research conduct is submitted).

Therefore, it is necessary for a research organization to use the research and development management system (e-Rad) common to ministries in order to submit the check list in the form given on the website given below to the Office of Equitable Research Promotion, Human Resources Section, Academic Policy Bureau, Ministry of Education, Culture, Sport, Science and Technology by the date of concluding the contract research agreement. However, there is no need to submit a check list of inappropriate research conduct, if it is already submitted on a different occasion after April 2017.

See the website of Ministry of Education, Culture, Sport, Science and Technology (MEXT) for details of the method for submitting a checklist of inappropriate research conduct.

http://www.mext.go.jp/a_menu/jinzai/fusei/1374697.htm

*note: A perfect environment for using e-Rad is necessary for the submission of a checklist for inappropriate research conduct. See the website given below for details of the procedure related the use of e-Rad:

http://www.e-rad.go.jp/shozoku/system/index.html

[15] Research organizations include not only that the Principal Investigator is affiliated with but also those of major joint researchers to whom research expenses are distributed.

## 6.9 Measures taken for misconducts in research activities based on "Guidelines for responding to misconducts in research activities"

Misconducts in research activities in this project are treated strictly as described below.

(i) Measures to cancel contract

In case this project finds specific misconducts (fabrication, fraudulent alteration, theft,) in research issues, it cancels or alters the contract research agreement and requests refunding all or part of trusted expenses. Furthermore, there may be no contract in the following years.

(ii) measures to restrict qualification for application and participation

Measures given in the table below depending on the level of inappropriateness and responsibility of specific misconduct to restrict application to and participation in this project are imposed upon researchers involved in certain misconduct in research papers or reports of this project and those whose involvement has not been established but who are found responsible to an extent for the violation of the duty of good care as a manager of pertinent papers and reports. Furthermore, in case such restriction measures are taken on qualification for application and participation, information is provided to pertinent sections of competitive fund systems (referred to as "competitive fund system related to Ministry of Education, Culture, Sport, Science and Technology" hereafter) distributed by Ministry of Education, Culture, Sport, Science and Technology and independent corporations of the ministry and to pertinent sections of competitive fund systems (referred to as "competitive fund systems related to other ministries" hereafter) distributed by other ministries and their independent corporations, which may similarly restrict qualification for application and participation in competitive fund systems related to Ministry of Education, Culture, Sport, Science and Technology (MEXT) and to other ministries.

<table>
<tr><th colspan="3">Persons incurring limitations on applications due to Specific misconduct</th><th>Extent of Specific misconduct</th><th>Period of limitation on applications[16]</th></tr>
<tr><td rowspan="3">Person Involved in the Specific misconduct</td><td colspan="2">1. Especially malicious individual who intentionally engages in Specific misconduct from the outset of the research</td><td></td><td>10 years</td></tr>
<tr><td rowspan="2">2. Author of academic paper, etc. related to research in which there has been Specific misconduct</td><td rowspan="2">The author responsible for the academic paper in question (supervisor, first author, or other position of responsibility deemed equivalent)</td><td>The impact on the advancement of research in the relevant field or society is large, and the maliciousness of the misconduct is deemed to be high.</td><td>5-7 years</td></tr>
<tr><td>The impact on the advancement of research in the relevant field or society is small, and the maliciousness of the misconduct is deemed to be low.</td><td>3-5 years</td></tr>
</table>

[16] Imposed from the fiscal year following the year in which misconduct is officially recognized. Limitations on participation will also be imposed in the fiscal year that the Specific misconduct is officially recognized.

| | | | | |
|---|---|---|---|---|
| | | Author other than that listed above | | 2-3 years |
| | 3. An individual involved in misconduct other than that stipulated in 1 or 2 | | | 2-3 years |
| An author responsible for academic papers, etc. related to research in which there has been Specific misconduct but who was not involved in the Specific misconduct (supervisor, first author, or other position of responsibility deemed equivalent) | | | The impact on the advancement of research in the relevant field or society is large, and the maliciousness of the misconduct is deemed to be high. | 2-3 years |
| | | | The impact on the advancement of research in the relevant field or society is small, and the maliciousness of the misconduct is deemed to be low. | 1-2 years |

(iii) measures taken to researchers whose qualification is restricted for application to and participation in competitive fund system and base expenses

Qualification is restricted for application to and participation in this project by researchers whose qualifications are restricted for application to and participation in competitive fund systems related to Ministry of Education, Culture, Sorts, Science and Technology; management grant to national university corporations, university joint use organization corporations and independent corporations under the ministry; base expenses including private school subsidies; or competitive fund systems related to other ministries during the period while the restriction is in effect.

(iv) Public announcement of misconducts

In principle, JST makes a public announcement with regard to the outline of a pertinent misconduct in research activities of this project (name of researcher, project name, affiliation, research year, contents of misconduct, and measures taken). Ministry of Education, Culture, Sorts, Science and Technology also makes a public announcement concerning the contents of the pertinent misconduct (name of misconduct, kind of misconduct, research field of misconduct, name of expense account of misconduct, outline of misconduct, measures taken by research organization, measures taken by fund distributor, and so on).

The captioned guidelines state that a research organization announces the survey result immediately. Each organization is requested to handle the case accordingly.

http://www.mext.go.jp/a_menu/jinzai/fusei/1360483.htm

## 6.10 Measures for Protecting Civil Rights and Complying with Laws and Regulations

In the case that, in implementing a research initiative, the initiative involves research requiring the consent/cooperation of other parties, research requiring particular care in handling personal information, research requiring bioethical or safety measures to be taken, and other research requiring procedures required by laws and regulations, be sure to carry

out the necessary procedures, such as obtaining the approval of an external and internal ethics committee of a research institution. If research activities are conducted overseas or collaborative research activities with institutions overseas are conducted, please confirm the regulations and laws in advance adhere to them.

With regard to life science-related research in particular, the main laws and regulations prescribed by each government ministry are as follows. Please note that, depending on the research content, there are also cases in which laws and regulations other than these have been established.

- Act on Regulation of Human Cloning Techniques (Act No. 146 of 2000)
- Guidelines for Handling of a Specified Embryo (Public Notice of Ministry of Education, Culture, Sports, Science and Technology No. 173 of 2001)
- Guidelines on the Derivation and Distribution of Human Embryonic Stem Cells (Public Notice of Ministry of Education, Culture, Sports, Science and Technology No. 156 of 2009)
- Guidelines on the Utilization of Human Embryonic Stem Cells (Public Notice of Ministry of Education, Culture, Sports, Science and Technology No. 157 of 2009)
- Ethical Guidelines for Human Genome/Gene Analysis Research (Public Notice of Ministry of Education, Culture, Sports, Science and Technology/ Ministry of Health, Labour and Welfare/ Ministry of Economy, Trade and Industry No. 1 of 2001)
- Ministerial Ordinance on Good Clinical Practice for Drugs (Ordinance of Ministry of Health, Labour and Welfare No. 28 of 2009)
- R&D Using Human Tissue Extracted during Operations, Etc. (Report of the Health Science Council 1998)
- Ethical Guidelines for Epidemiological Research (Public Notice of Ministry of Education, Culture, Sports, Science and Technology/ Ministry of Health, Labour and Welfare No. 2 of 2002)
- Guidelines for Gene Therapy Clinical Research (Public Notice of Ministry of Education, Culture, Sports, Science and Technology/ Ministry of Health, Labour and Welfare No. 1 of 2002)
- Ethical Guidelines for Clinical Studies (Public Notice of Ministry of Health, Labour and Welfare No. 225 of 2003)
- Act on the Conservation and Sustainable Use of Biological Diversity through Regulations on the Use of Living Modified Organisms (Act No. 97 of 2003)
- Ethical Guidelines for Medical and Health Research Involving Human Subjects (Public Notice of the Ministry of Education, Culture, Sports, Science and Technology and the Ministry of Health, Labor and Welfare No. 3 of 2014)
-Laws and regulations on access or distribution of hereditary resources in each country

For information regarding Ministry of Education, Culture, Sports, Science and Technology measures on bioethics and safety assurance, please refer to the following website.

- Life Sciences no Hiroba “Measures on Bioethics and Safety Assurance” (only in Japanese)
  http://www.lifescience.mext.go.jp/bioethics/index.html

In the case that the research plan includes research or surveys that require consent/cooperation of other parties and/or social consensus, be sure to take appropriate measures for protecting civil rights and interests prior to applying to this program.

## 6.11 Security Export Control (Measures against the Leakage of Technology Internationally)

○ Many cutting-edge technologies are studied at research institutions. Universities in particular have seen an increase in the number of international students and foreign researchers due to internationalization, and there is an increasing risk of cutting-edge technologies and/or research materials/equipment being leaked or used for bad purposes such as the development and production of weapons of mass destruction. For this reason, in carrying out their various research activities, including the relevant contract research, research institutions are required to take organizational measures to ensure that research results that could be used for military purposes do not fall into the hands of people who could carry out fearful activities such as developers of weapons of mass destruction or terrorist groups.

○ In Japan there are export controls* based on the Foreign Exchange and Foreign Trade Act (Act No. 228 of 1949) (hereinafter referred to as the "Foreign Exchange Act"). Accordingly, when attempting to export (provide) goods or technologies controlled by the Foreign Exchange Act, as a general rule it is necessary to obtain the license of the Minister of Economy, Trade and Industry. Be sure to comply with the Foreign Exchange Act and other laws, ministerial ordinances, and notices issued by government ministries and agencies.

*Currently, Japan's security export control system mainly comprises two systems based on international consensus: (1) systems under which the license of the Minister of Economy, Trade and Industry is required as a general rule when attempting to export (provide) goods (technologies) with specifications/functions that are above certain criteria, such as carbon fibers or numerically-controlled machine tools (list control); and (2) systems under which the license of the Minister of Economy, Trade and Industry is required when attempting to export (provide) goods (technologies) to which list controls do not apply and certain requirements (use application requirements, end-user requirements, and notification (inform) requirements) have been met (catch-all control).

○ Not only the export of goods but also the provision of technology is subject to Foreign Exchange Act controls. When providing list control technologies to foreigners (non-residents), license to provide the information must be obtained in advance. "Technology provision" includes the provision of technology information such as blueprints, specifications, manuals, specimens, and prototypes by means of storage media such as paper, e-mail, CD, and USB memory, and also includes the provision of operational knowledge through technical guidance and skills training as well as technological support through seminars. There are also cases in which technology provision includes a large amount of technology exchange that could be subject to Foreign Exchange Act controls in the acceptance of international students and joint research activities.

○ Detailed information about security export control is provided on the website of the Japanese Ministry of Economy, Trade and Industry (METI) and other organizations. Please see the list below for details.

- Ministry of Economy, Trade and Industry (METI)：Security export control (general)
  http://www.meti.go.jp/policy/anpo/englishpage.html

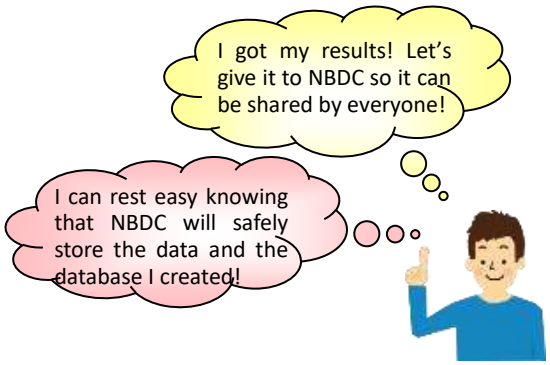
- Ministry of Economy, Trade and Industry (METI)：Security Export Handbook
  http://www.meti.go.jp/policy/anpo/seminer/shiryo/handbook.pdf
- Center for Information on Security Trade Control
  http://www.cistec.or.jp/english/index.html
- Guidance on machine technology control in relation to security export control (for universities/research institutions)
  http://www.meti.go.jp/policy/anpo/law_document/tutatu/t07sonota/t07sonota_jishukanri03.pdf

## 6.12 Cooperation with the National Bioscience Database Center

The National Bioscience Database Center (NBDC)[17] hosts the Life Science Database Archive (http://dbarchive.biosciencedbc.jp), an archive that provides access to wholly downloadable datasets generated by researchers in Japan in the life sciences. Another hosted database is the NBDC Human Database (http://humandbs.biosciencedbc.jp), a platform for sharing various human data produced from human-derived specimens such as human genome data. We ask all researchers to provide NBDC with their data for publishing on the Life Science Database Archive and the NBDC Human Database so that data results from your life sciences research may be used extensively for a long time.

Contact information:

Japan Science and Technology Agency
The National Bioscience Database Center (NBDC)
Life Science Database Archive contact:
dbarchive@biosciencedbc.jp
Human Database contact:
humandbs@biosciencedbc.jp




Feel free to contact us with any questions you may have on using/publishing life sciences databases.

[17] The National Bioscience Database Center (http://biosciencedbc.jp/en/) researches, develops, and provides services for integrating and easily accessing life sciences databases generated in Japan. The objective is to stimulate research and development through extensive sharing and broad use of research data.

## 6.13 Regarding Registration with researchmap

JST-Mirai program plans to use the researcher information database (researchmap*) managed by JST as a master database in order to utilize it in various scenes including achievement reports and the like. In addition, the community function of researchmap is used for utilization in project management, including distribution of various files and event notices. Because registration in researchmap of researchers whose proposals are adopted is necessary for the purposes, those who have not are requested to make the registration soon.

Information registered in researchmap is effectively utilized for surveying national plans of academic, scientific, and technological policies and statistical purposes. Register and update achievement information and the like in researchmap.

* researchmap (previously referred to as Read&Researchmap http://researchmap.jp/) is a largest database covering all Japanese researchers. As of Feburary 2018, about 264 thousand researchers are registered in it. Registered profile information and achievement information are continually and stably managed as a service by a public organization in order to make them available to the public via Internet. Furthermore, researchmap collaborates with e-Rad and many databases of university instructors to render registered information available through other systems. Therefore, researchers do not need to register the same achievement repeatedly in various application forms and databases. That allows tasks associated with research activities to be performed efficiently.

See (1) below to confirm the state of registration in researchmap and the log-in procedure; see (2) below for the procedure of new registration of non-registered researchers; see (3) below for re-issuing procedure for passwords to register researchers; and see (4) below for the procedure of achievement data output in case a researcher prepares a list of achievements at proposal application using achievement information registered in researchmap.

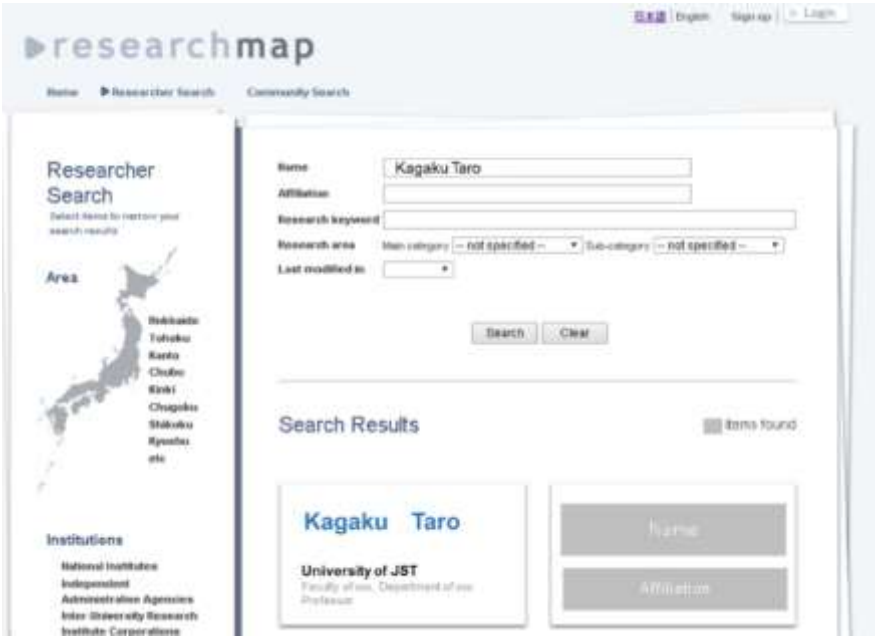
## (1) Methods for confirming state of registration in researchmap and for log in

(1)-1. Check whether registration already exists.

Even if a researcher him/herself has not registered, a research organization may have registered the affiliated researcher in researchmap. Names and so on may be searched for by researcher search.

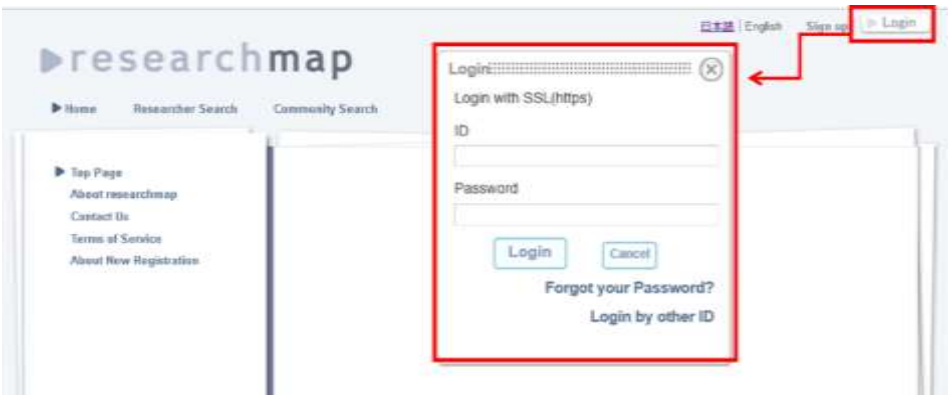
Top page: http://researchmap.jp/search/

Use the search results to check whether information on a researcher him/herself exists. See (2) below to make new registration in case of no registration.




(1)-2. In case registration exists and log-in ID and password are known

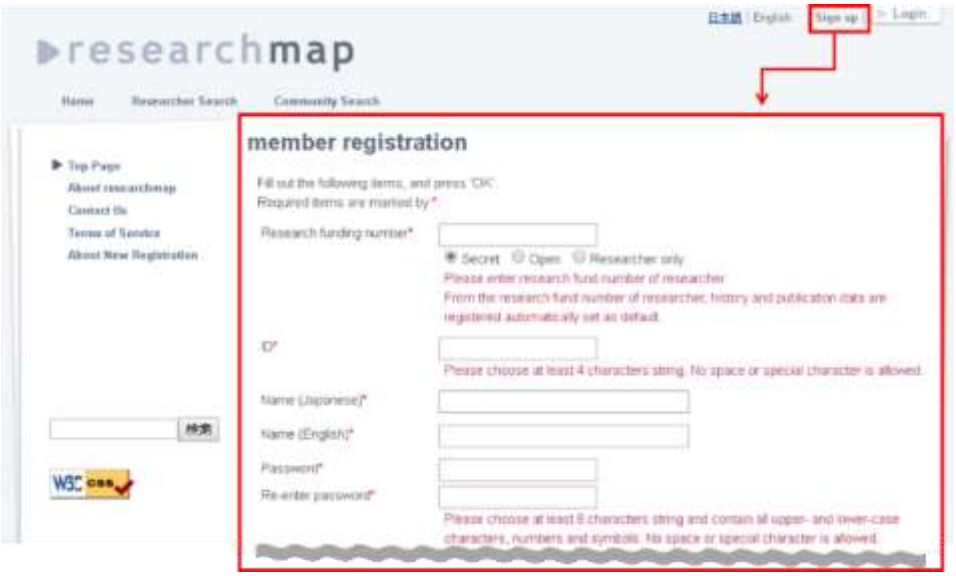
Log-in ID and password are used to log in for researcher information in researchmap.




## (2) Method for new registration

(2)-1. In case a researcher has a researcher number

Click “new registration” upper right on the researchmap top page, input the researcher number and other relevant matters to complete new registration.

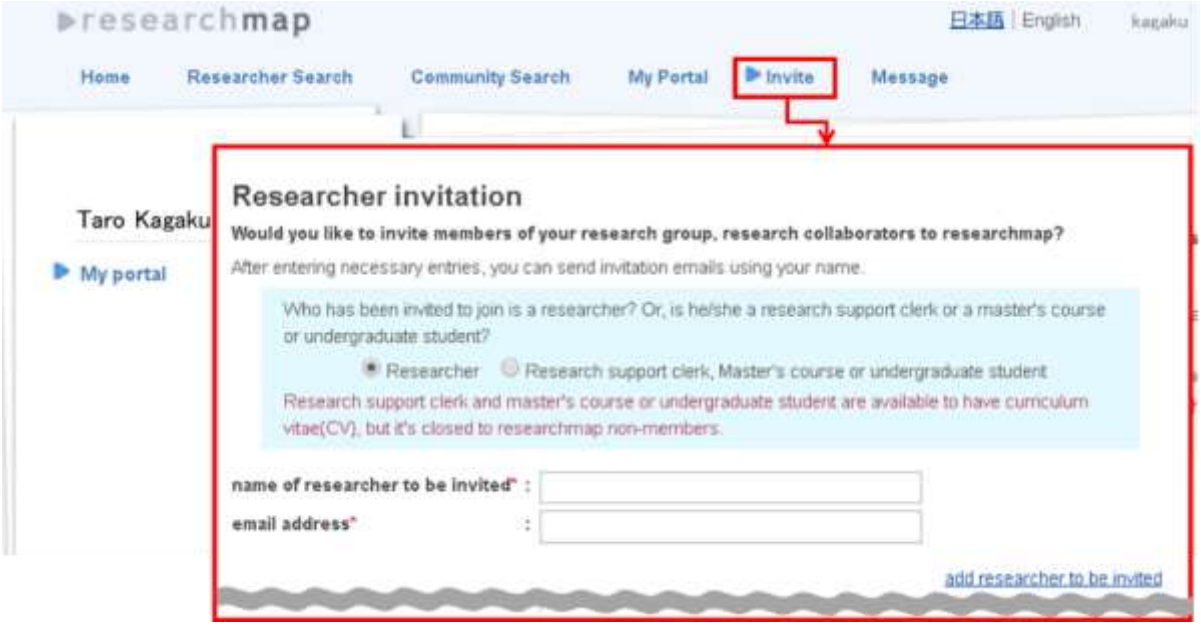



(2)-2. In case a researcher has no researcher number

Click “about new registration” link top left on the researchmap top pate to use “New registration form for a researcher who has not researcher number for scientific research expense.” Add titles of main papers (or books) and proceedings (or publishers’ names) for checking that the applicant is indeed a researcher. An invitation mail is sent upon confirmation by JST service center.


(2)-3. Invitation by researchers who have registered

An invitation by a researcher who has registered in researchmap allows new registration regardless of whether a researcher number exists. A researcher who has registered may use an “invite” link after logging in researchmap to send an invitation mail to a researcher who has not registered.




**(3) Procedure for re-issuing a password**

(3)-1. In case a registered log-in ID or password is forgotten

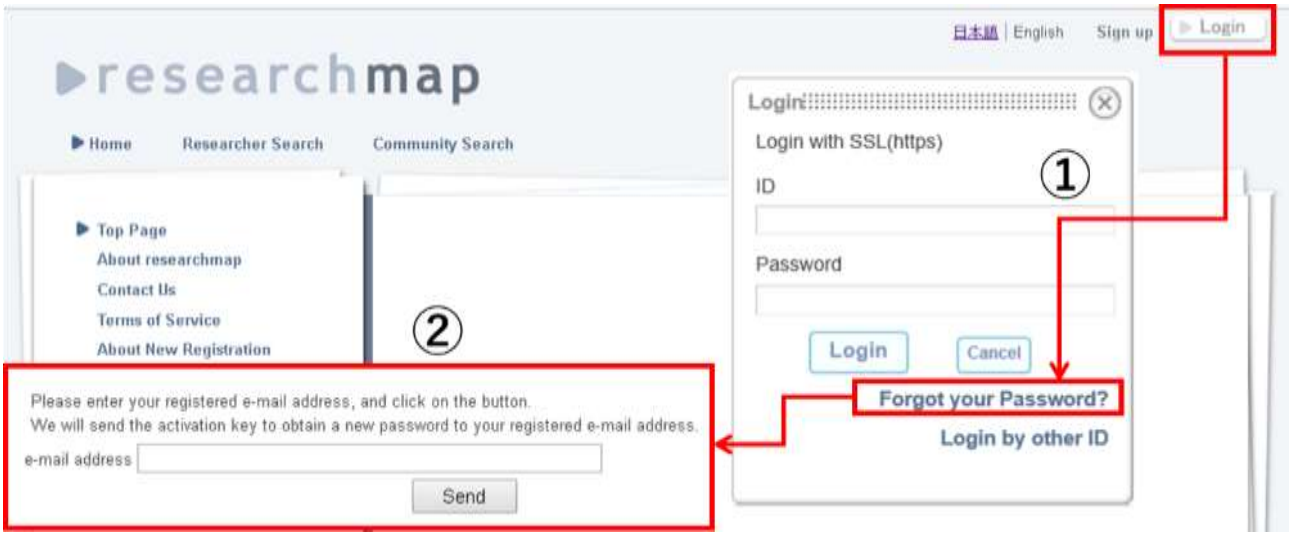
The procedure below allows a log-in ID or password to be re-issued.

① Click “log in” upper right on the researchmap top page and click “password re-issue.”

② A screen for inputting a registered mail address appears. Input your mail address and send the mail. A log-in ID and a password are sent to you in due course of time.

③ When an error occurs in the procedure of password re-issue for researchmap, use the question form to contact the researchmap top page.

http://researchmap.jp/public/inquiry/

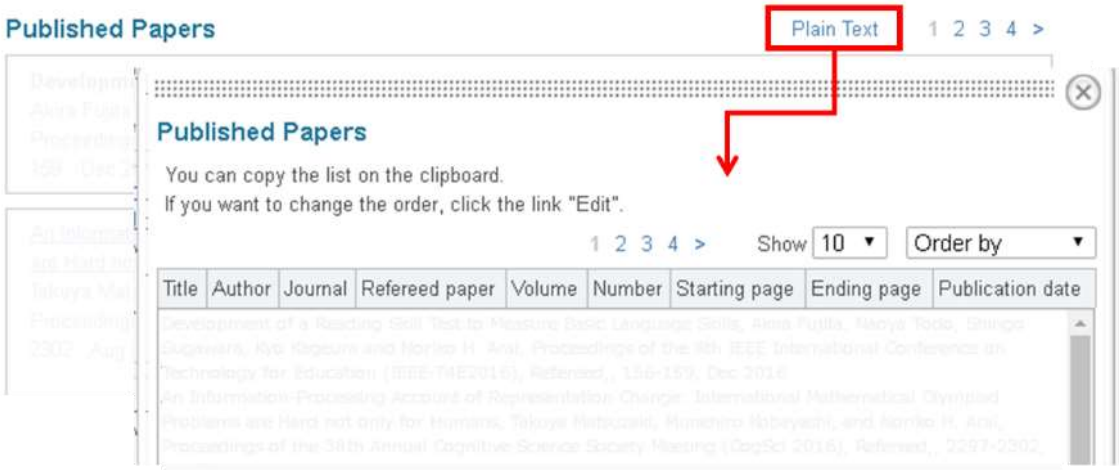



**(4) Output procedure for achievement information registered in researchmap**

Information registered in researchmap may be downloaded in (4-1) text style, (4-2) csv or an XML file.

(4)-1. Presentation in a text file

Achievement information may be presented in a text file from your own page. When you save data in your own PC, copy and paste the text data on the screen to use the data.




(4)-2. Downloading in csv or XML file

Logging in researchmap allows file output by the kind of achievement to be saved in your own PC.

① choose “SML” or “csv”

② Input a check mark for achievement wanted to be output and click “decision.”


## 6.14 About the use of JREC-IN Portal

The database of research human resources (JREC-IN http://urecinjst.go.jp/) is a largest website to support research human resources in Japan. It is a free service to carry information on human resources including researchers, their supporter, engineers involved in research for glancing.

At present, it annually carries more 16,000 pieces of information on wanted human resources by universities, public research organizations, and private business firms in addition to more than 100 thousand registered users. Utilize JREC-IN Portal by all means when looking for research human resources (post doctors, researchers, and so on) with high levels of knowledge to promote research projects.

Furthermore, JREC-IN Portal collaborates with researchmap. It may be logged in by ID or password of researchmap. Its functions for the preparation of résumés and achievement lists may use information registered in researchmap to prepare these documents.

## 6.15 Efficient promotion of research and development through effective use of currently available research facilities and equipment

The Ministry of Education, Culture, Sports, Science and Technology is promoting the development of the grounds for sharing research institutes and facilities and integrating different research fields in accordance with the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities (Act No. 78, 1994); the Act on Enhancement of Research and Development Capacity and Efficient Promotion, etc., of Research and Development, etc., by Advancement of Research and Development System Reform (Act No. 63, 2008); and other laws. If the uses and purchases of research facilities and equipment are being considered upon the application, please consider actively using facilities and equipment

owned by universities and national research and development agencies and made available to others and opportunities for cooperation among industries, academia, and the government from the perspective of effective promotion of consigned research in this program; effective use of already available facilities and equipment; and removing overlaps in purchasing facilities and equipment.

In addition, universities etc. are requested to actively promote sharing research facilities in research projects funded by competitive research funds. Please refer to 4.2.6-(3) in the application guidelines for details.

<Reference: Examples of shared facilities and equipment>

| |
|---|
| Facilities covered in the Act on the Promotion of Public Utilization of the Specific Advanced Large Research Facilities<br>(Please refer to the instructions from each facility for schedule of project proposal and other information related to utilization)<br>SPring-8, the large synchrotron radiation facility<br>(Applications are accepted around May and November every year.)<br>http://user.spring8.or.jp/?lang=en<br>SACLA, an X-ray free-electron laser facility<br>(Applications are accepted around May and November every year.)<br>http://sacla.xfel.jp/?lang=en<br>J-PARC, a large intensity proton accelerator<br>(Applications are accepted around May and October every year.)<br>http://is.j-parc.jp/uo/index_e.html<br>High Performance Computing Infrastructure (HPCI) including the K computer<br>http://www.hpci-office.jp/folders/english |
| Projects for promoting the sharing of advanced research facilities<br>*See URL below for information on this project, which started in 2016 fiscal. Also see URL below for information concerning “Platform formation project for joint use of advanced research base,” which finished in 2015 fiscal.<br>http://www.mext.go.jp/a_menu/kagaku/shisetsu/index.htm |
| Nano technology platform<br>http://nanonet.mext.go.jp/english/ |
| Development of research base network toward the construction of a low-carbon society<br>http://www.nims.go.jp/lcnet/ |
| Tsukuba Innovation Arena for Nanotechnology (TIA-nano)<br>http://www.tia-nano.jp/en/index.html |
| Project for Platform for Drug Discovery, Informatics, and Structural Life Science (four bases)<br>http://pford.jp/ |
| National BioResource Project<br>http://www.nbrp.jp/ |
| Japanese Experiment Module (KIBO) / International Space Station (ISS)<br>http://iss.jaxa.jp/kiboexp/participation/ |

## 6.16 Regarding the Results of JST's Development of Systems and Technology for Advanced Measurement and Analysis Program

- ○ JST implements a wide variety of research and development programs ranging from basic research to industry-academia collaborations and so on, and a great deal of these research results have been put into practical use already.
- ○ Among these, the development of systems and technology for advanced measurement and analysis program, which seeks to build and develop a basic research and development platform, has resulted in the practical use of many research and development tools.
- ○ It would be a pleasure if a researcher sees a research and development tool to be newly examined for the promotion of research and development.

Visit the Advanced Measurement website:
http://www.jst.go.jp/sentan/en/index.html) for details.

# Chapter 7
# Submission via the Cross-ministerial R&D Management System (e-Rad)

○ About the cross-ministerial system (e-Rad)

The e-Rad system is a cross-ministerial system that enables online completion of all processes (Application receipt → Evaluation → Selection → Management of selected research topics → Reporting of results, etc.) related to the management – referring primarily the competitive funding systems overseen by individual ministries - of research and development.

※The e-Rad system has been sifted to the new system from Feb. 28. 2018.

・From the point of Usability, screen design, menu composition, etc. were completely revamped.

・The manual of the new system is posted on the e-Rad portal site. Since we have described even the difference, please be sure to check.

## 7.1 Points to Note with Regard to Submission via the Cross-ministerial R&D Management System (e-Rad)

Calls for R&D proposal applications are made via the e-Rad (http://www.e-rad.go.jp/en/index.html)[18] system. The process for submitting R&D proposal applications via e-Rad is described below.

Please pay attention to the following points in particular.

○ **Please submit your applications via e-Rad.**

**No proposal for which the application procedure has not been completed via e-Rad by the deadline is subject to examination for any reason.**

Operation Manuals (for researchers) :
https://www.e-rad.go.jp/en/manual/for_researcher.html

○ **Researcher registration is required in advance.**

https://www.e-rad.go.jp/organ/index.html

○ **Please allow several days or more after the application deadline for inputting information into e-Rad.**

Input of information into e-Rad takes a minimum of around 60 minutes. Furthermore, on the day of the application deadline, there is a risk that the e-Rad system may be crowded and inputting may take a long time. Please allow ample time before the application deadline to commence inputting information into e-Rad.

Inquiries https://www.e-rad.go.jp/en/contact.html

○ **It is possible to "temporarily save" input information.**

It is possible to discontinue input of and temporarily save application information part

[18] "e-Rad" is an abbreviated name of the Ministry of Common Research and Development Management System 、derived from the words "electronic" and "research and development" (for science and technology).

way through. For details, please refer to the “Saving and Reassessing your Application Information” section under “7.4.4 Entering the Required Information into the e-Rad System” and/or “Usage Manual for Researchers” or “Frequently Asked Questions” sections on the e-Rad portal site.

○ **“Retraction” is possible, even after the R&D proposal has been submitted.**

**Up to and including the day prior to the application deadline,** it is possible for researchers to retract and re-edit their R&D proposals. For details, please refer to the “Amending Submitted Application Information: ‘Retraction’ ” section under “7.4.4 Entering the Required Information into the e-Rad System” and/or “Usage Manual for Researchers” section on the e-Rad portal site.

**Do not “retract” R&D proposals on the day of the application deadline**. On the day of the application deadline, there is a risk that the e-Rad system may be crowded and re-editing the proposal after retraction may take a very long time.

## 7.2 Flow of Application Process Using e-Rad

(1) Enter information on the research institution and researcher

Applicants who do not have a login ID or password must request the administrative section of their research institution to register the institution in the e-Rad system. It should be noted that the registration process can take more than two weeks.

(2) Obtain application requirements and R&D proposal forms

Check the list of current calls for R&D proposal applications on the e-Rad portal site, and download the application requirements and R&D proposal forms.

(3) Prepare a R&D proposal (maximum file size of 3 MB）

(4) Enter the application information into the e-Rad system

Enter the required information into the e-Rad system. Input takes around 60 minutes.

(5) Submit the R&D proposal

Submit your R&D proposal by uploading it.

## 7.3 System Availability and Where to Direct Questions

### 7.3.1 How to use the e-Rad system

The manual for e-Rad operation may be seen in or downloaded from portal site (http://www.e-rad.go.jp/). Apply upon agreeing to the rules of use.

Please check (http://www.e-rad.go.jp/terms/requirement/index.html) before using the e-Rad system.

### 7.3.2 Where to direct questions on how to use the e-Rad system

Questions regarding JST's systems and programs should be directed to JST. Questions on how to use the system should be directed to the e-Rad helpdesk.

Please read carefully the explanation of the application process contained in this chapter, and the contents of the e-Rad portal site, before submitting a question.

No answer is given to questions concerning the review or adoption of a proposal.

| | | |
|---|---|---|
| Questions regarding matters like systems and programs, preparation of documentation for submission, and submission procedures | Department of Research and Development for Future Creation | Please submit inquiries by email (except for urgent inquiries).<br><br>E-mail：**kaikaku_mirai@jst.go.jp**<br>Tel： +81-3-6272-4004 (Mon.-Fri. 10:00-17:00*)<br>* Except Saturdays, Sundays, and National Holidays<br>[Communication by e-mail may be requested even when a question is asked by telephone.] |
| Got questions regarding use of the e-Rad system | e-Rad helpdesk | Tel: 0120-066-877 (navi dial)<br>Hours: 9:00-18:00<br>●Except on Saturdays, Sundays, holidays, and the year-end and new year period<br>[In the case that the navi dial is unavailable]<br>03-6631-0622 (direct line) |

- Website for this program:
  (http://www.jst.go.jp/mirai/jp/open-call/research/h30/index.html)
- e-Rad portal website (http://www.e-rad.go.jp/)
- e-Rad Inquiries website (https://www.e-rad.go.jp/en/contact.html)

### 7.3.3 e-Rad system availability

Monday to Sunday 0:00-24:00　Available 24 hours a day, 365 days a year.

※ Maintenance and inspection schedules are announced ahead of time on the portal site.

## 7.4 Detailed Submission Instructions and Precautions

### 7.4.1 Entering information on research institutions and researchers

Research organizations need to be registered in e-Rad before application. They are requested to select an office representative concerning e-Rad, who downloads a registration form for research organization from the e-Rad portal site (referred to as “portal site” hereafter) to apply for registration.

Applicants must first register their researcher information and obtain an e-Rad login ID and password. For applications, registrants include the PL, PM and all Joint Researchers. (If registration via a system or program of another ministry or other government organization has already been completed, doing so once again is not required.)

The following registration procedures are required. **Please allow two weeks or more for completing procedures**. For details, please refer to the “Preparations for Using the System” or “Frequently Asked Questions” sections on the e-Rad portal site.

1) For researchers affiliated with a domestic research institution

, Operator: administrator at the research institution

Registration details: research institution and information on the researcher

2) For researchers affiliated with a foreign research institution, and researchers affiliated with no research institution

Operator: applicant

Registration detail: information on the researcher

### 7.4.2 Obtain application requirements and research proposal forms

Please download from the following project Website.

http://www.jst.go.jp/mirai/jp/open-call/research/h30/index.html

※Please use the form of each theme to apply.

Prioritized theme: Small start Type or Small start Type research (Component technology type) Technological theme: Large-scale Type

### 7.4.3 Preparing a Research Proposal

- Make sure that application requirements are understood before preparing a research proposal.
- Research proposals (doc format) must be converted to the PDF format before uploading to the e-Rad system. PDF conversion can be performed using the menu that appears after login. It is also possible to download the conversion software from the same menu and install it on the researcher's computer.

### 7.4.4 Entering the Required Information into the e-Rad System

Please refer to the following Website.
http://www.e-rad.go.jp/en/manual/for_researcher.html

※ When applying, be sure upload on the written proposal made in 7.4.3.
※ After preparing a research proposal, log in once again, search for calls for proposals.

Please make sure to visit our Invitation for R&D Proposals page for the latest updates:

http://www.jst.go.jp/mirai/jp/open-call/research/h30/

**【Contact for Inquiries】**

Please submit inquiries by email (except for urgent inquiries).

Japan Science and Technology Agency (JST)
Department of Research and Development for Future Creation
K's Gobancho, 7 Gobancho, Chiyoda-ku, Tokyo 102-0076 Japan

E-mail： **kaikaku_mirai@jst.go.jp**

Tel： +81-3-6272-4004 (Mon.-Fri. 10:00-17:00*)

* Except Saturdays, Sundays, and National Holidays

[Communication by e-mail may be requested even when a question is asked by telephone.]