PD’s supplement

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1. Project Manager (PM) Recruitment and Selection Policy, etc.

(1) Basic Requirements for Proposals

To achieve Moonshot Goal 10 (MS10): " Realization of a dynamic society in harmony with the global environment and free from resource constraints, through diverse applications of fusion energy, by 2050," your proposal must consider what should be done now to accelerate the practical application of fusion energy. It should start with a vision of the future in 2050 and work backward, proposing research and development scenarios up to 2050, along with goals to be achieved 3, 5, and 10 years from the time of plan adoption.

The proposed plan must be clearly distinct from that of conventional development routes which lead from the International Thermonuclear Experimental Reactor (ITER) to DEMO and be challenging and innovative. Plans that are predictable, conventional, or merely extend existing research do not align with the purpose of this project. The MS project's slogan, "Challenge without fear of failure," is a cheer for those seeking to pioneer uncharted territory. That implies that if your meticulous research program is assembled on robust research techniques, even if it fails to yield the anticipated results, it should still pave the pathway for new discoveries that diverge from initial expectations. In selecting PMs, proposals will be evaluated primarily based on the challenge and originality of the plan and the reliability of the research methodology. You are to provide a persuasive explanation based on best analysis and rationale on how you will set challenges and what you will achieve by 2035 to lead to societal implementation. Please also consider ethical, legal, and social issues (ELSI) related to societal implementation.

(2) The Aims of Moonshot Goal 10

The standard scenario for the practical application of fusion energy is the development of a baseload power source, but current scientific knowledge is not sufficient to foresee the practicality of this aim. With approximately 70 years of research history, the focal point of research and development has now evolved from the initial trial-and-error phase. It has shifted from an objective of achieving nuclear fusion to the advanced and sophisticated fusion systems. To gain economic competitiveness, it's essential to work towards making fusion reactors smaller and more efficient. Achieving these aims involves more than just a deeper understanding of core plasma; it necessitates groundbreaking advancements in key technologies, including the enhancement of superconducting magnets and reactor materials, as well as improvements in system stability. MS10 adopts a backcasting approach, starting from a future society that assumes the multifaceted use of fusion energy, in contrast to the forecasted approach of progressing research and development from ITER to prototype and then commercial reactors. This backcasting approach aims to produce broader perspectives and aim for game-changing innovations through entirely new challenges. The research and development are expected to produce synergistic effects that not only increase the options for solving challenges in the development of baseload power sources aimed for through forecast-based approaches but also expedite their achievement.

(3) Approach to Goal Setting in Research and Development Projects

Broadly, there are two types of directions for the project proposals, both of which aim to accelerate the practical application of fusion energy: "innovative societal implementation type" and "innovative underlying technology type."

For proposals of the innovative societal implementation type, assume diverse applications of nuclear fusion reactions as layer (1), backcast from there to propose a specific image of the required fusion system as layer (2), and then propose the foundational technologies that make it possible as layer (3). These three layers must be consistent with each other and be constructed with scientific and technological rationale. Examples of layer (1) related to societal implementation include proposals for using energy generated from nuclear fusion reactions as off-grid or space development energy sources or for utilizing high-energy particles generated from fusion reactions in advanced medical technologies or high-level waste transmutation. However, original applications are also welcomed. For layer (2), not only high-temperature plasma systems but also various fusion system, can be considered. For the foundational technologies in layer (3), proposals should go beyond merely employing existing or conventional technologies designed for standard prototype reactor development. Instead, research and development efforts aimed at achieving disruptive innovations are encouraged.

When proposing an innovative underlying technology type, the technology should not only substantially propel the practical application of fusion energy forward but also have broad applicability. It should be a seed for producing innovative ripple effects with existing industrial technologies or synergizing with other emerging technologies to spawn disruptive innovations. Ripple effects may include accelerating the realization of a hydrogen society through innovations in high-temperature superconducting technology or cryogenic technology, applying high-speed big data processing technology to the fields of medicine and welfare, traversing unexplored territories in extreme environment materials, and realizing a safer future society through ultra-small analysis and detection technology, among others. However, concepts are not limited to these examples. Your proposal should transcend producing elemental technological innovation as an output and provide a persuasive explanation of the expected impact of social implementation as an outcome.

In the application form, evidence-based explanations are required for the originality, international competitiveness, and feasibility of the plan. For proposals of the innovative underlying technology type in particular, specifically explain why the goals set cannot be reached by extending existing research and development and how they will be achieved in the MS10 project.

(4) Approach to Strategies for Realizing the Research and Development Concepts of MS10

To realize the 2050 vision within the 10 years of the MS project, it is necessary to integrate various challenges and acquire powerful tools to win the competition in fusion energy development. For instance, developing a digital fusion energy system that combines diverse elements, including theoretical models, simulation technologies, information science, mathematical science, material science, control engineering, and experimental benchmarks for the development of innovative fusion systems. These design tools could enable MS10 to act as a driving force for industry and contribute to the realization of future visions. The fundamental scientific knowledge of these various underlying technologies will serve as guiding principles for innovation, becoming tools for leading global technology development.

The tools should not be limited to empirical rules applicable to specific systems but should have high generality capable of accurate prediction and verification even for research and development concepts that challenge unknown territories. In addition, to continuously connect the results of MS10 to societal implementation, an active relationship of cooperation must be built with industries during the project implementation period.

In the first 5 years of the MS project, the production of innovative scientific knowledge and underlying technologies is required. To embark on bold challenges from innovative perspectives, collaboration across different fields is essential. This approach opens up wide prospects without being constrained by established working hypotheses. Interdisciplinary approaches are essential for this aim. Particularly in the context of proposing projects focused on innovative underlying technologies, there is an expectation that you will create highly versatile technology seeds. These seeds should have the potential to integrate with other future technologies—such as space, quantum, medical, environmental technologies and so on—to drive disruptive innovation.

To promote this type of research and development, it is necessary to encourage participation from excellent researchers and engineers with diverse backgrounds in the field of fusion, forming interdisciplinary research teams. To enable this, challenges should be formulated as interdisciplinary themes (here, formulated implies not necessarily a mathematical expression of the challenges, but logically sharing their essence and how you will approach them) and propose research and development projects that involve diverse talents by sharing problem awareness with researchers and engineers from other fields.

PMs are required to actively manage the research and development project to lead it to success, including revising the research plan and reorganizing performers according to the progress of the project, etc.

(5) Expected Ripple Effects

The MS project is expected to contribute to invigorating the field of fusion energy. PMs are required to actively engage in outreach to increase public interest in fusion research, diversify career paths by involving industry, strengthen talent development, and build a solid international collaboration through circulating personnel and intellectual expertise facilitated by international cooperation.

2. Notes on Promoting Research and Development

(1) Portfolio Management

From the standpoint of managing the portfolio within MS10's goals, PDs are required to produce collaboration and competition among PMs, taking into account the relationships between multiple research and development projects. PMs, during the refinement period after being adopted, are required to consult with PDs, sub-PDs, and advisors and make changes to the initial proposal, reorganize performers, and review budget plans from the perspective of rationality and effectiveness of the research.

(2) Industry-Academia-Government Collaboration

To advance research and development towards achieving the 2050 goals, outcomes must be generated that support the development of various industries through the MS project, with practical applications deployed. Therefore, active efforts are needed to ensure participation from private companies in each research and development project. It is strongly desired that research cooperation and joint development with industries be commenced within 5 years after the project starts.

(3) International Collaboration and Competitiveness

In conducting research and development projects, opportunities for information gathering must be produced, such as through international symposiums, to constantly assess both domestic and international research and development trends and aim for world-leading results. If necessary, actively collaborate with overseas institutions to conduct research and development. In addition, anticipate future supply chain management by striving for active international collaboration to build an international network.