

Development of Minimally Invasive High-throughput Optical Condensation System

Protect human health, food, and the environment by our “optical condensation technology”!

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Director, Research Institute for LAC-SYS (RILACS), OPU



※ Institute for the development of “Light-induced Acceleration System (LAC-SYS)” for biochemical reactions.
Category 2: Institutes founded by the President for strategic studies and researches since May, 2017)

Our vision and realization for future society

Detect previously undetectable molecules by optical condensation for saving lives of many people!

We will realize "ultra-early examination, diagnosis and treatment of people at the pre-disease stage.

We believe our technology will provide a society with a long and healthy life span for everyone from the elderly to infants, without fear of cancer, infectious diseases, dementia, or food shortages.



Bright, fun and energetic!

Providing infrastructure for medical, food, and environmental measurements in Smart city (independent and decentralized)

Portable, easy, fast testing & diagnosis anywhere



"On-site" diagnosis at clinics and pharmacies

Examination at home as remote medical care

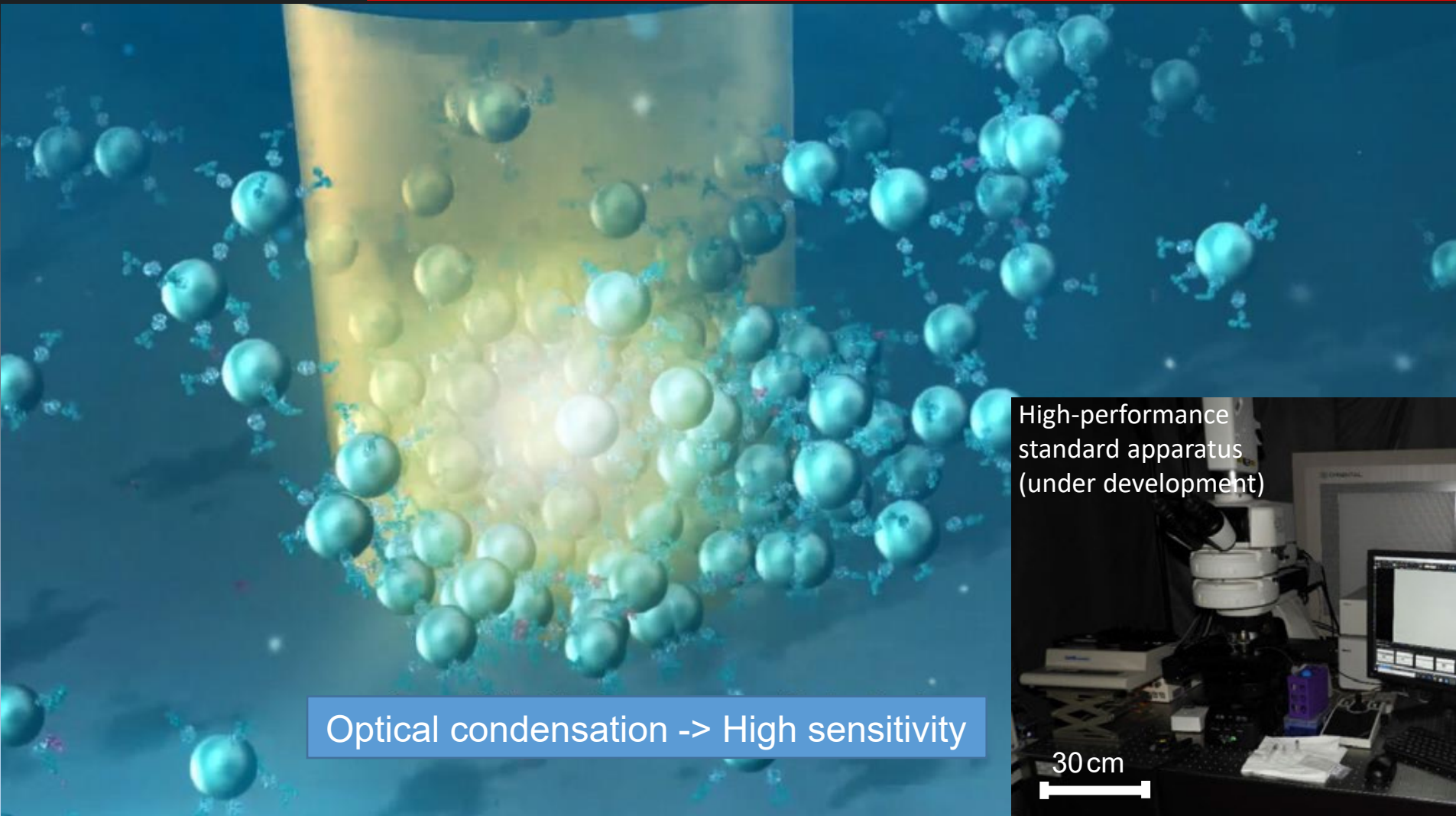
Pre-shipment & onsite quality inspection of food & beverage products



Pre-shipment inspections for restaurants and supermarkets, and speed up "on-site" inspections and origin inspections

Optical condensation

Highly efficient collection and condensation of biomolecules by "Light" leading to acceleration of reactions into a few minutes (conventional method: a few hours)

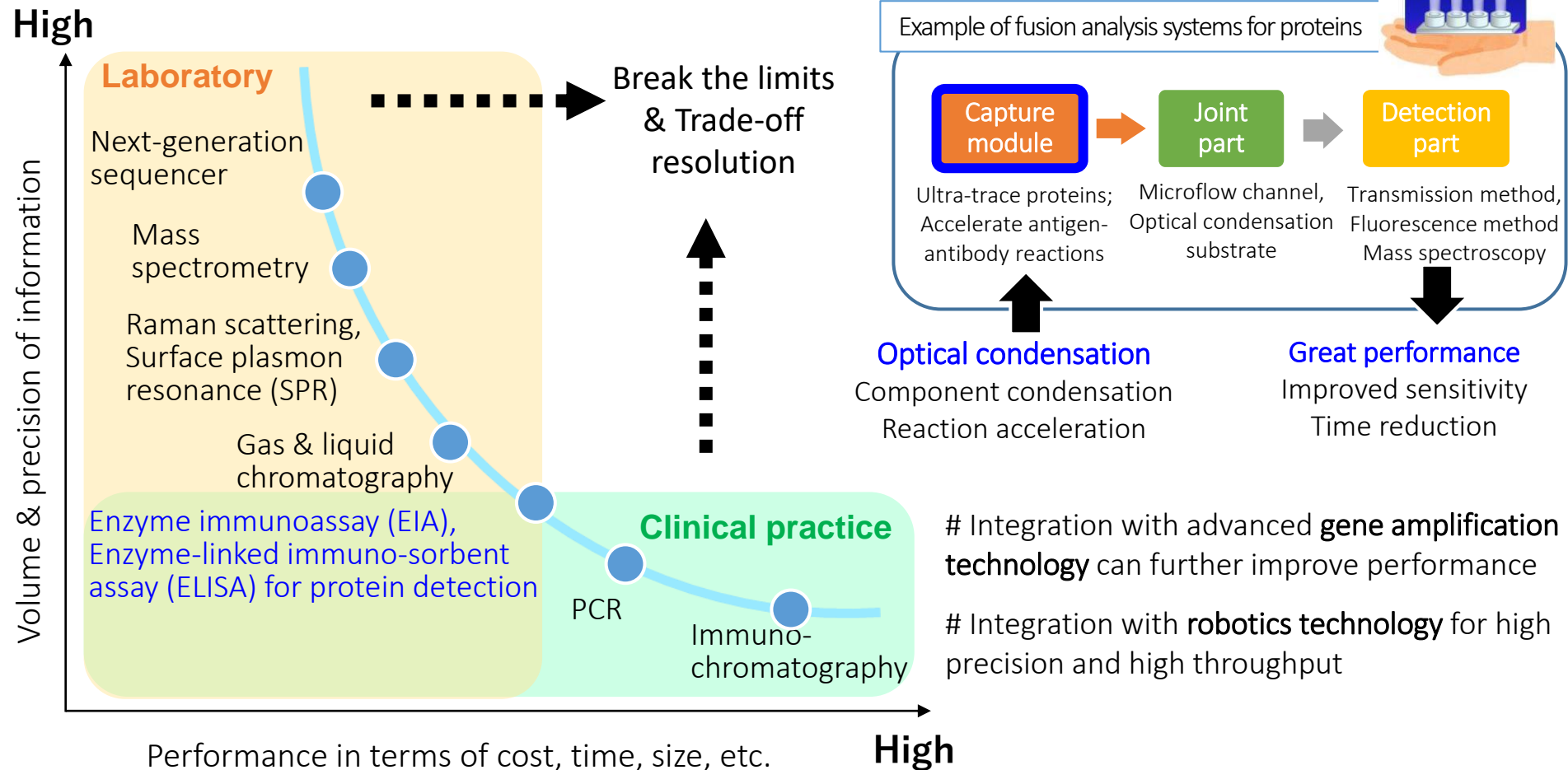


Optical condensation -> High sensitivity

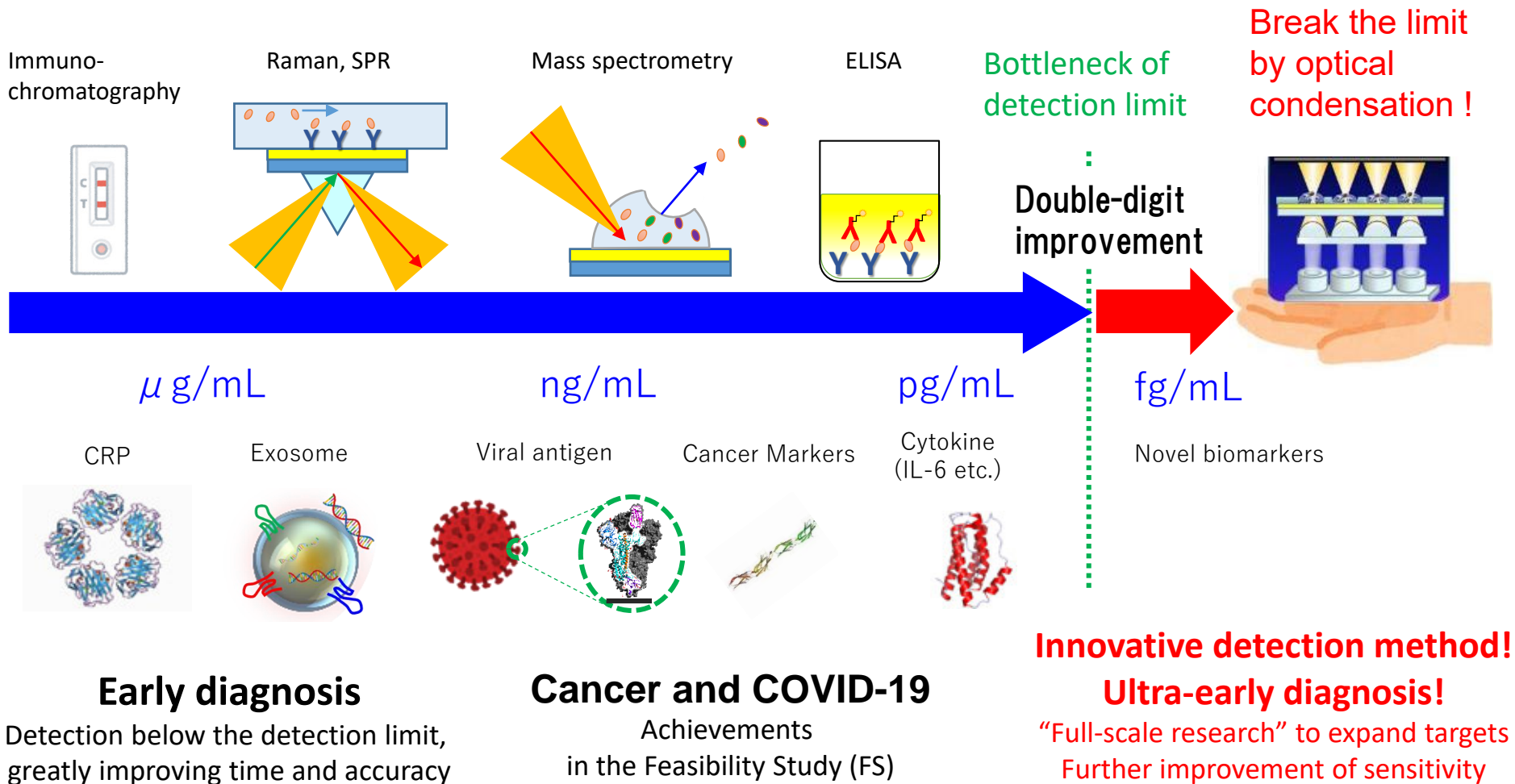
The 2018 Nobel Prize in Physics for its ability to capture and transcend optical tweezers
Innovation revolutionizing the pretreatment of various bioanalytical instruments

Breakthrough in reaction acceleration by optical condensation

“**Optical condensation**” provides us **remote, low damage, label-free, precise, compact, and fast pretreatment** in comparison with other condensation methods (physical principles such as centrifugal force, electric field, magnetic field, etc.).
 → Contribute to “*Common Platform Technology, Facilities, and Equipment*” mission area (for increasing productivity and accelerating research)



Realize the detection of proteins that were previously undetectable

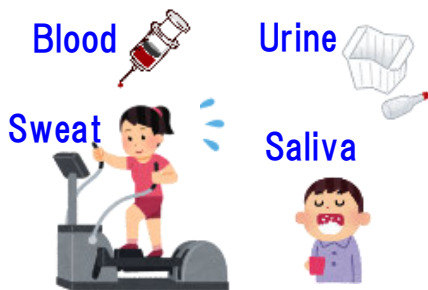


“Optical condensation” is the accelerator for deepening blood proteomics!

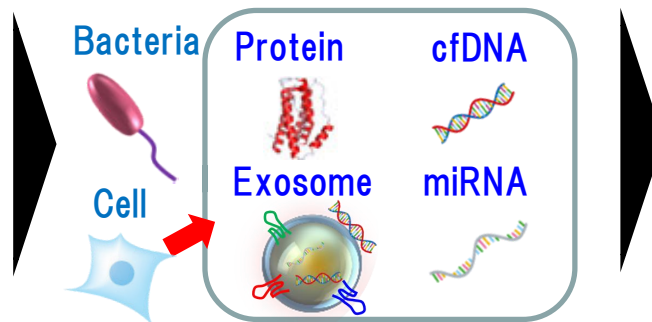
Proof of concept (POC) in our “Full-scale research” stage

- (1) Elucidation of **mechanism of intermolecular interactions by “optical condensation”** and establishment of a high-throughput measurement method
- (2) Implementation of **high-performance standard apparatus**, and achievement of ultra-early diagnosis (colorectal cancer) in collaboration with medical institutions
- (3) Detection of microbes (SARS-CoV-2, bacteria etc.) by **portable general-purpose equipment**, and horizontal development toward food inspection, pharmaceuticals, and environment measurements.

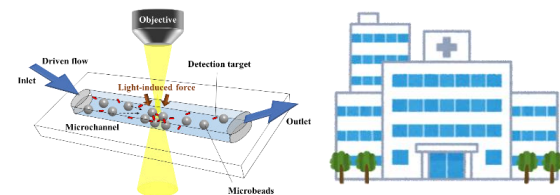
Examples of non-invasive body fluid samples



Examples of multi-biomarkers



Example of social implementation



Expanding from implementation in large hospitals to general use

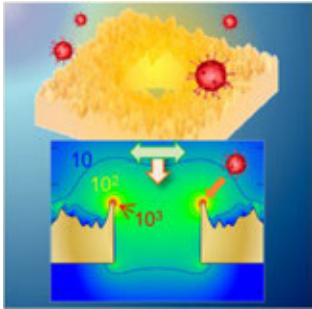
Successful validation of initial concept using clinical samples in FS stage

Biomarkers in trace amounts of body fluids (blood etc.), and microbes in food and beverage supernatants

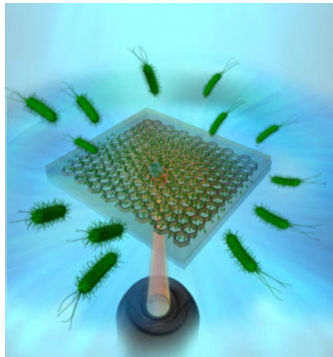
100 times higher sensitivity, 60 times faster speed, and double-digit trace amounts

(Achievements) Damage-free assembly of microbes using our original "optical condensation substrates"

Theatrical prediction by Iida group
J. Phys. Chem. Lett 2017



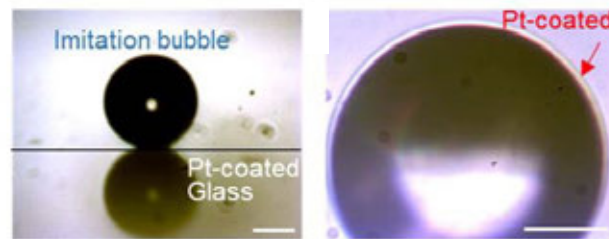
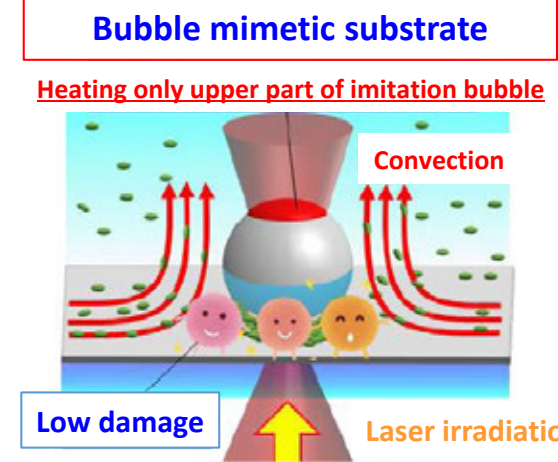
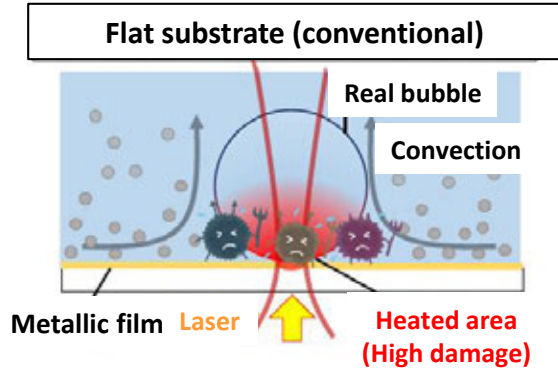
Honeycomb substrate by Tokonami group, Science Advances 2020



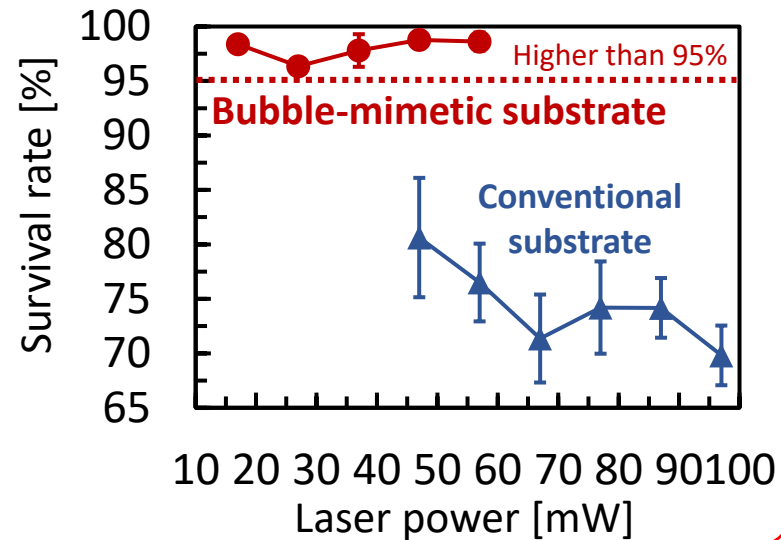
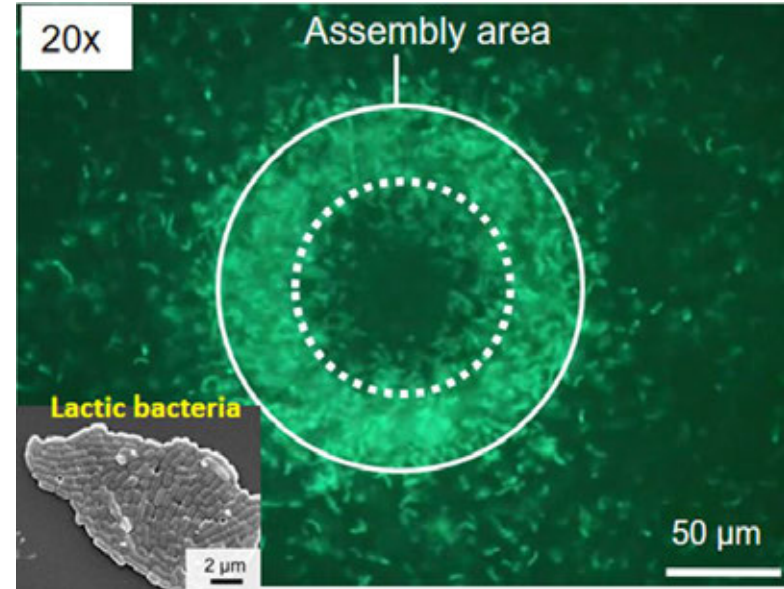
Portable optical condensation system, CEATEC 2019



K. Hayashi, S. Tokonami*, T. Iida*, et al., Communications Biology 2021, [Nature Research]



40000 cells can be assembled within 300 s

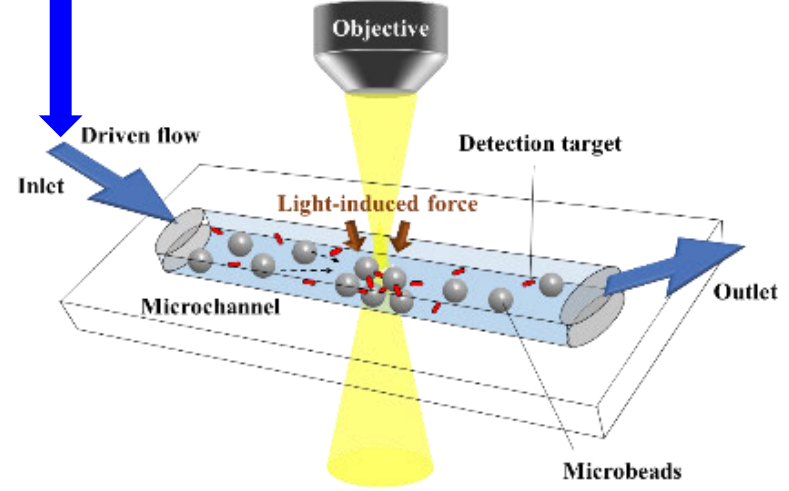
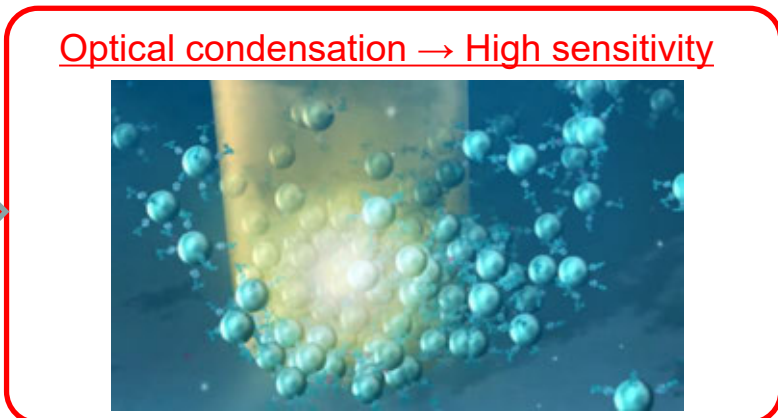
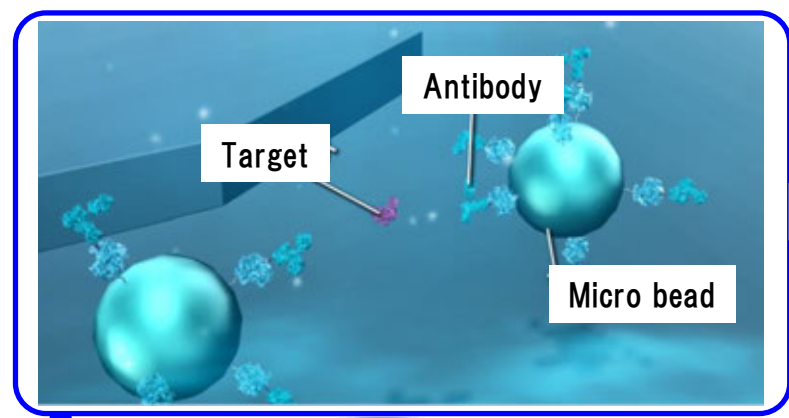
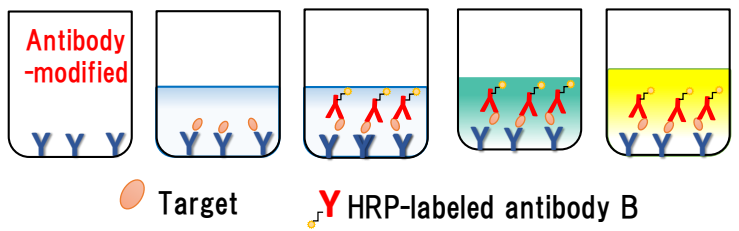


<https://www.youtube.com/watch?v=CGNjohGkFxl>

(Achievement) Sensitive & rapid specific detection of **proteins** by light-induced antigen-antibody reaction

T. Iida, S. Tokonami, et al.,
 Patent applied (2020);
 APL Photonics (2019);
 New paper submitted (2021)

5-6 hours are required in conventional ELISA

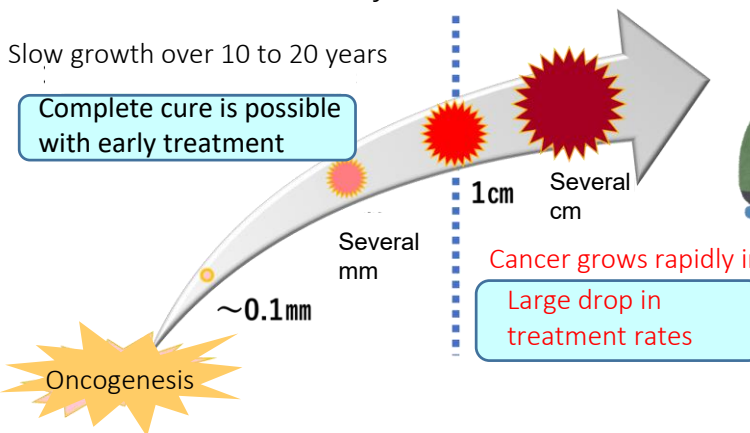
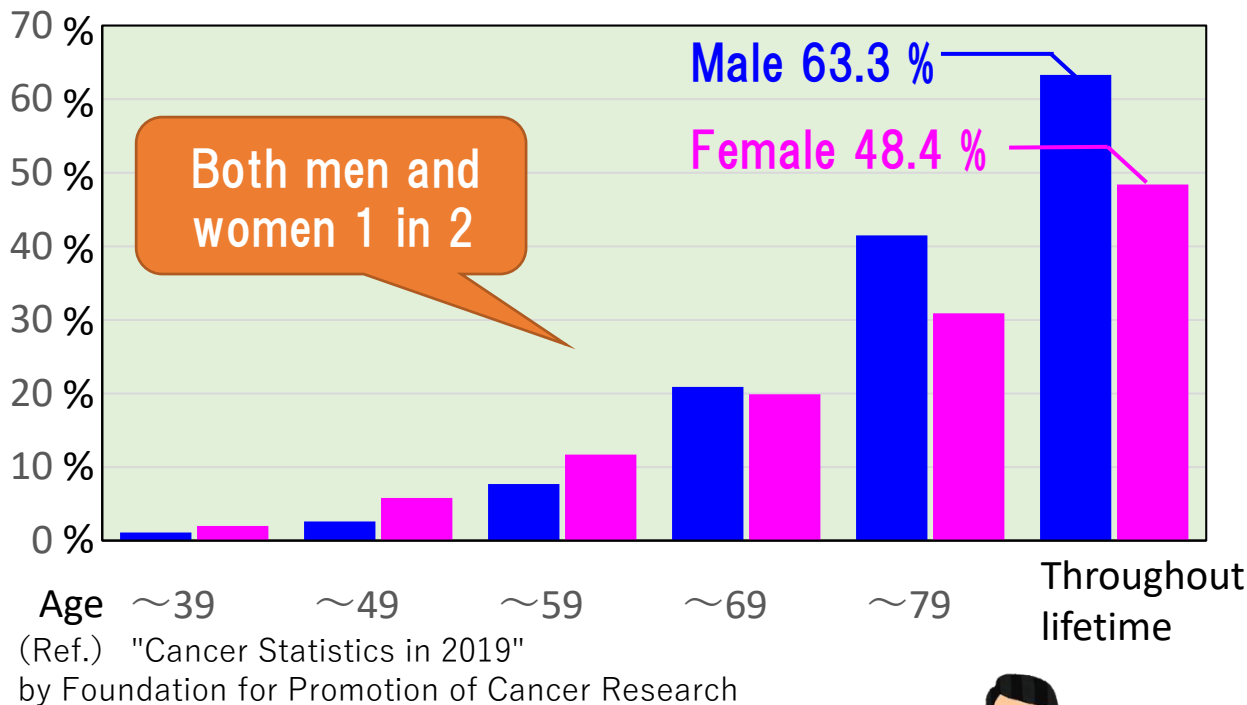


- Omits complicated processes such as incubation and washing
- Sample volume: 10^2 nl to 1μ l, measurement time 3 to 5 min
- Detection sensitivity: 1-2 order higher sensitivity than ELISA



Social issues (A): Early detection of cancer

One in two Japanese will develop cancer in their lifetime.



#Busy
#Scared
#Pain

Approximately 50,000 people die every year from colorectal cancer
Annual medical expenses: approximately 600 billion yen

(Ref.) Ministry of Health, Labour and Welfare (2017)

Solution: Development of an ultra-early diagnosis by “Optical condensation”



Prof. Takuya Iida,
Director of RILACS



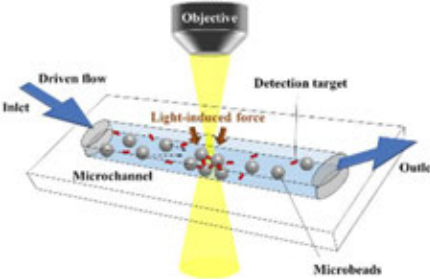
Prof. Shiho Tokonami,
Deputy Director of RILACS



Prof. Ayumu Taguchi, Chief of
Division of Molecular Diagnostics, ACC



Prof. Ikuhiko Nakase,
Assistant Director of RILACS



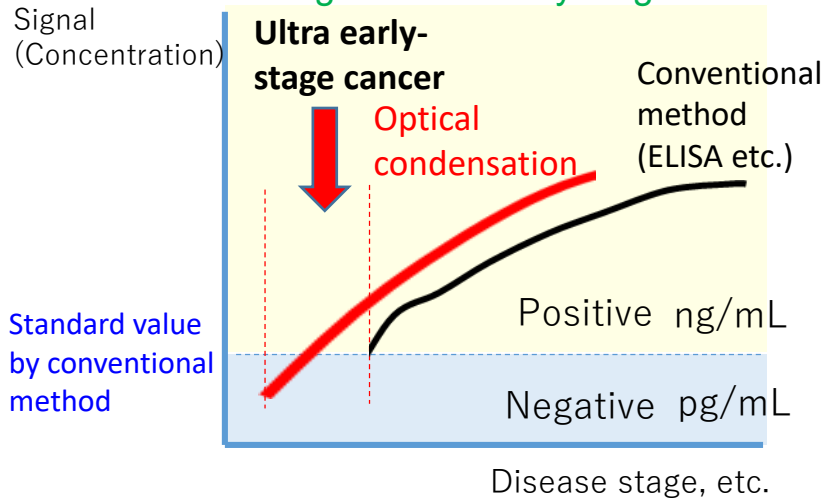
- #Development of apparatus
- #Measurement method
- #Elucidation of mechanism



- #Proof of concept in clinical practice
- #Novel marker discovery and expansion to low frequency refractory cancer markers
- #Multi-itemization

also, collaboration with “Advanced Optics Team”
(Osaka University, Waseda University, Okayama University)

< Image of ultra-early diagnosis >

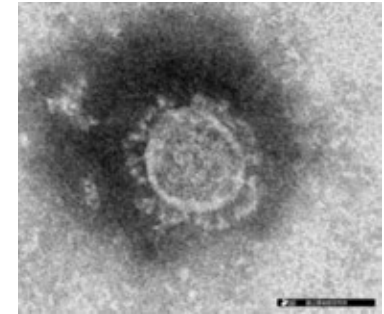


Ultra-early-stage cancer, which is difficult to detect with conventional methods, can be detected by “optical condensation”, leading to ultra-early diagnosis and treatment.

Mont Saint-Michel
(Ref.) Wikipedia

Social issue (B): COVID-19 pandemic and our solution

Solution: Easy “on-site” and high-sensitivity testing by compact optical condensation devices

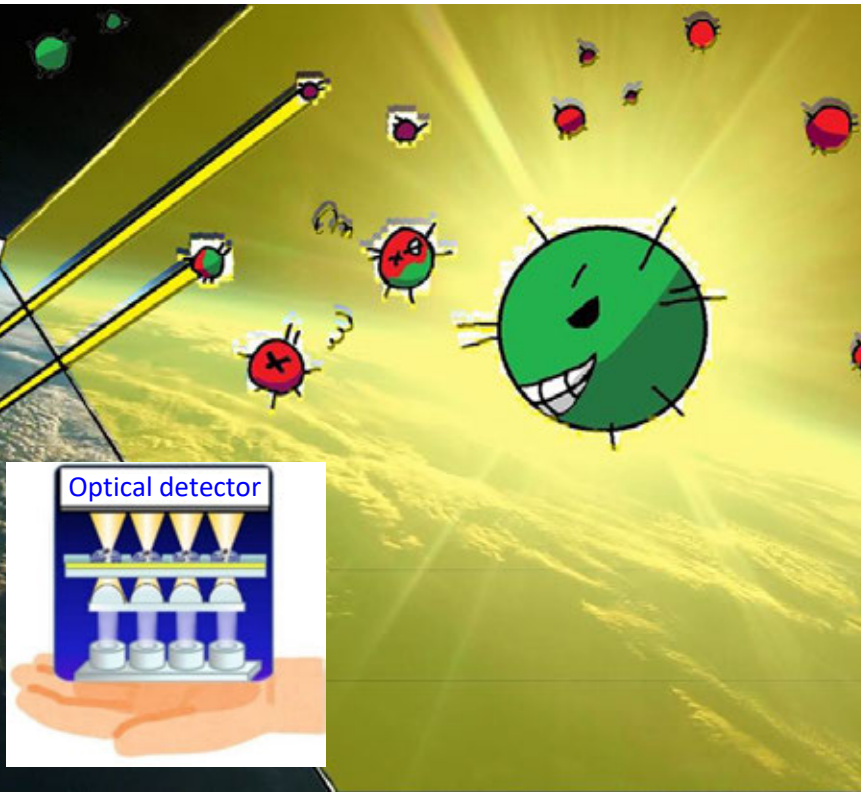
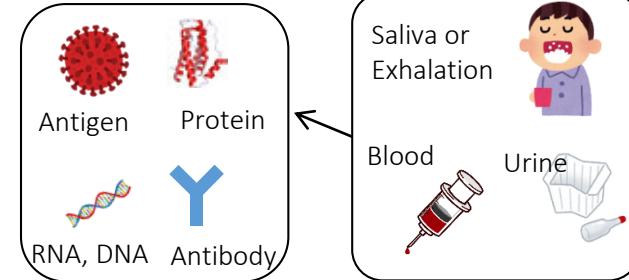


Electron micrograph of a SARS-CoV-2 virus (diameter ~100 nm)
(Ref.) National Institute of Infectious Diseases

Home, health centers, clinics, airports, and drive-through "on-site" inspections



Virus related-samples



By Mayu I.

Aiming at the same or better performance as high-performance standard machines (Large travel bag size)

Research and development roadmap for “Well-being of people in the world”



~5 years

Completion of the liquid biopsy testing system by optical condensation

Development of optical condensation testing method (FS stage)

- ✓ Presentation of innovative measurement principles
- ✓ Proof of clinical value

Utilizing the advantages of optical condensation, early implementation in purpose-built devices

Realization of health monitoring at clinics, pharmacies, and home

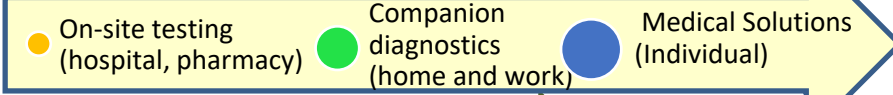
~10 years

Social implementation and horizontal development

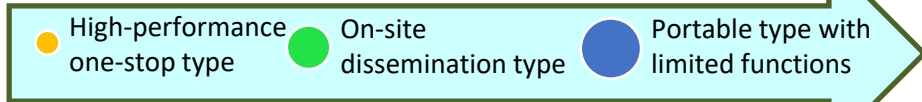
- ✓ Implemented in health checkups (focusing on cancer testing)
- ✓ Horizontal deployment (infectious diseases, dementia, food testing, pharmaceutical, environmental measurement)



Service



Device



~15 years

Standardization as a test method



- ✓ High precision and high throughput for early diagnosis, prediction of treatment effect, and prediction of recurrence /prognosis
- ✓ Growing into a global business as a core testing method, driving the spread of Precision Medicine



Bright, fun and energetic!

- #Ultra-early detection of pre-disease stage
- #Improvement of QOL and healthy longevity

Thank you very much for your kind attention !

Protect human health, food, and the environment by our "Optical condensation technology"!

Optical condensation Accelerate reactions in a trace amount of biomaterials

High-performance optical condensation system to detect a small amounts of biomaterials in a few minutes

Innovate pretreatment of various bioanalytical instruments

Applicable to various biological substances

Photo-responsive particle **Bio-materials**

High sensitivity, Rapid, Trace amount, Convenience, Low cost, High scalability

Body fluid sample Minimally invasive

Target biomaterials



Examples of social problems and implementation of this technology (medical, pharmaceutical, food, environment)

Easy and quick inspection / diagnosis anywhere

Detector

"On-site" diagnosis at clinics / pharmacies

Inspection at home, online medical care

Inspection and drug evaluation pharmaceutical process

High-throughput microbial testing at pharmaceutical factories, acceleration of drug efficacy evaluation at the cellular level

Pre-shipment and on-site inspection of food & drink

Super Market

Pre-shipment inspections at restaurants and supermarkets, speed up in "on-site" and production area inspections

Environmental measurement and monitoring

Air **Water**

Detection of harmful microorganisms, harmful substances, environmentally hazardous substances, new measurement method using useful microorganisms



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