HAMAMATSU
PHOTON IS OUR BUSINESS

Current Status of Target Fabrication for Inertial Fusion Research at HAMAMATSU

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Power Laser Development Section, R&D group
HAMAMATSU PHOTONICS K.K.

20th Target Fabrication Meeting
Eldorado Hotel and Spa, Santa Fe, NM

HAMAMATSU PHOTONICS K.K.

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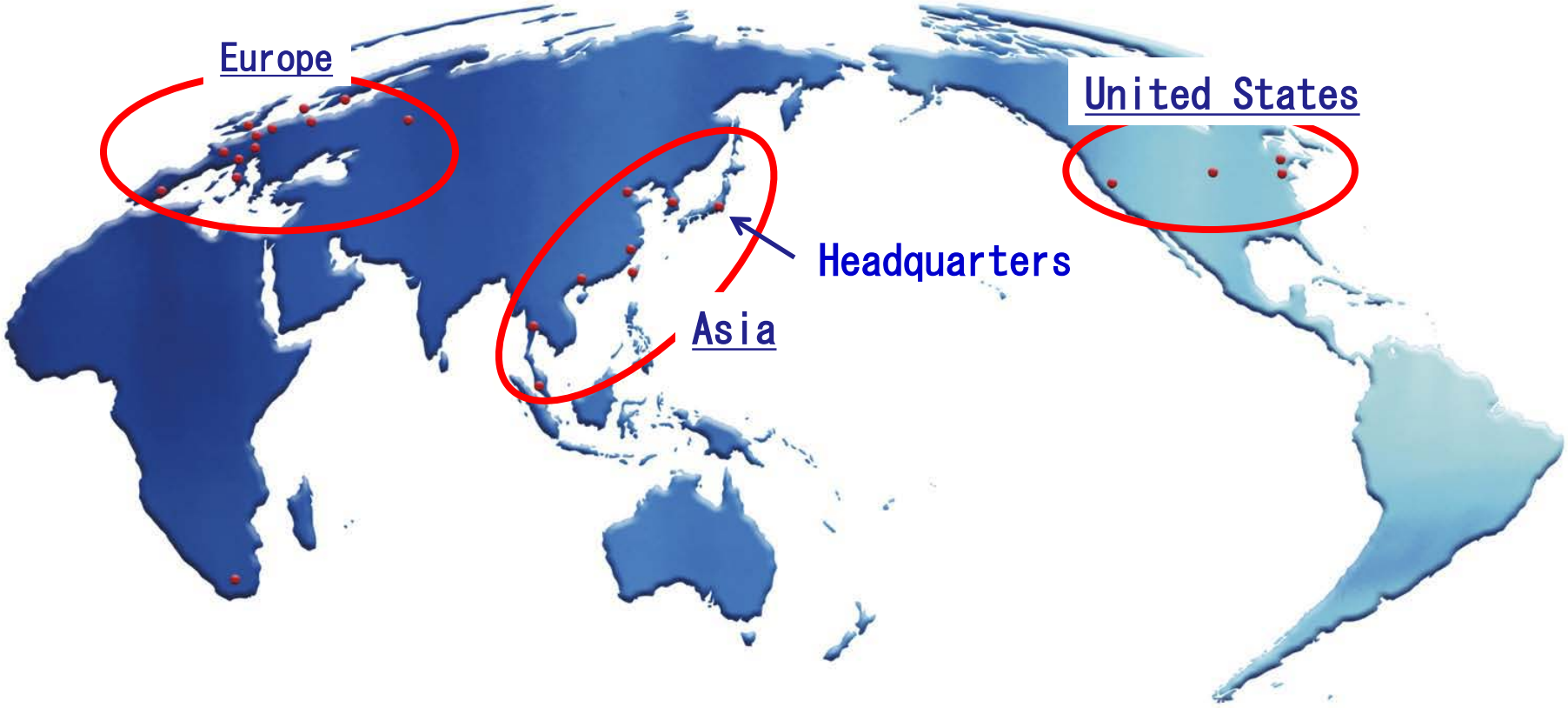
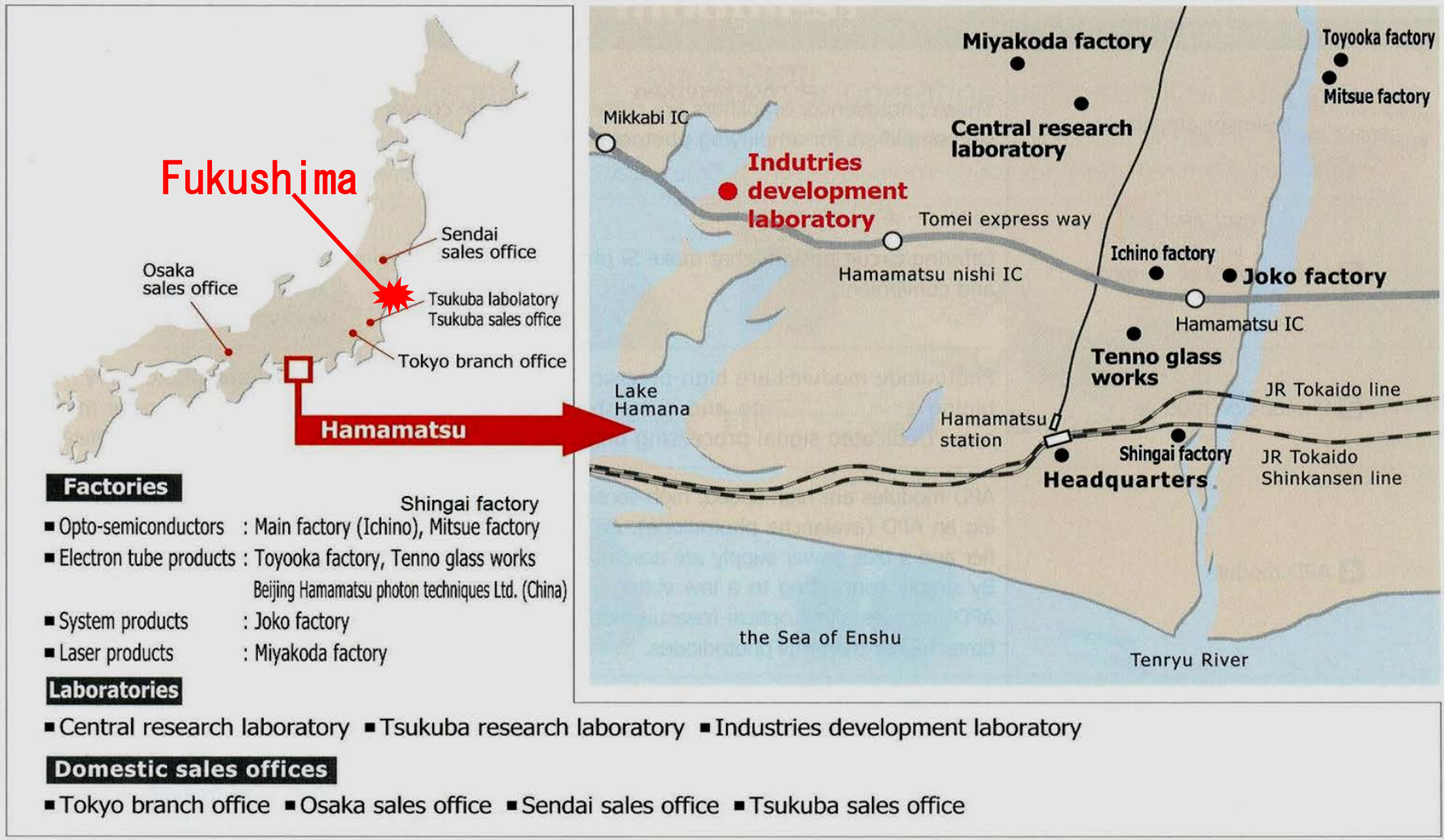
HAMAMATSU group network in the world



Established Sept. 23, 1953
Number of Employees 4,188

Net Sales 102 billion yen ($ 1323 million)
Capital stock 35 billion yen ($ 453 million)
[September 30, 2011]

Hamamatsu Photonics K.K. in Japan



Factories

Shingai factory

- Opto-semiconductors : Main factory (Ichino), Mitsue factory
- Electron tube products : Toyooka factory, Tenno glass works
  Beijing Hamamatsu photon techniques Ltd. (China)
- System products : Joko factory
- Laser products : Miyakoda factory

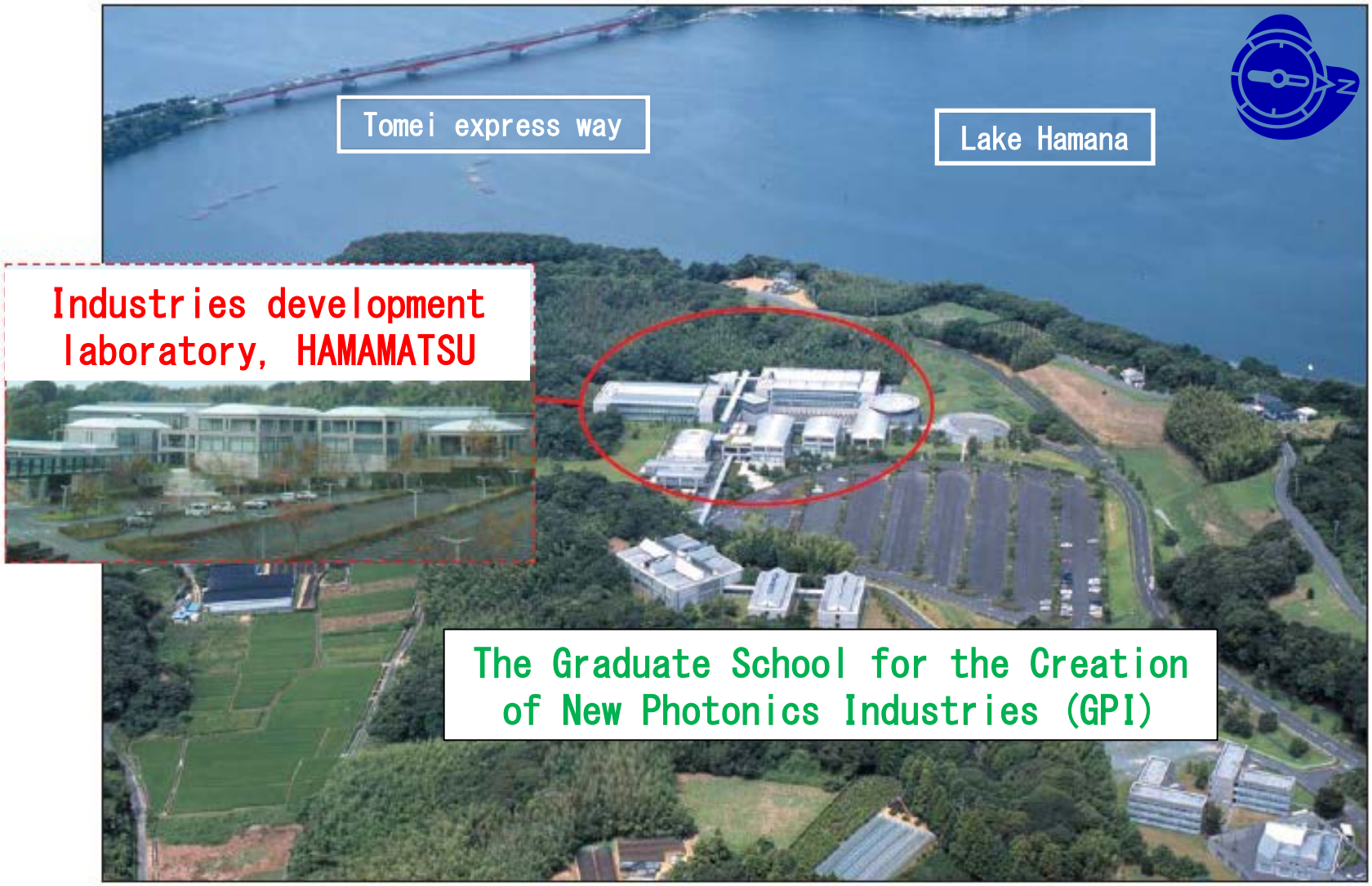
Laboratories

- Central research laboratory
- Tsukuba research laboratory
- Industries development laboratory

Domestic sales offices

- Tokyo branch office
- Osaka sales office
- Sendai sales office
- Tsukuba sales office

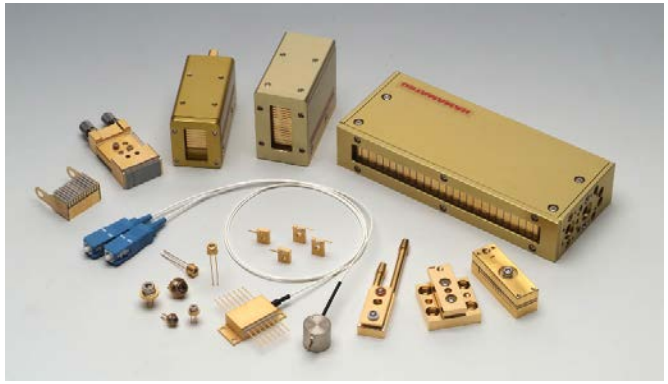
Industries development laboratory and GPI



HAMAMATSU Products by our factories

Laser group, Development bureau

Semiconductor lasers



System division

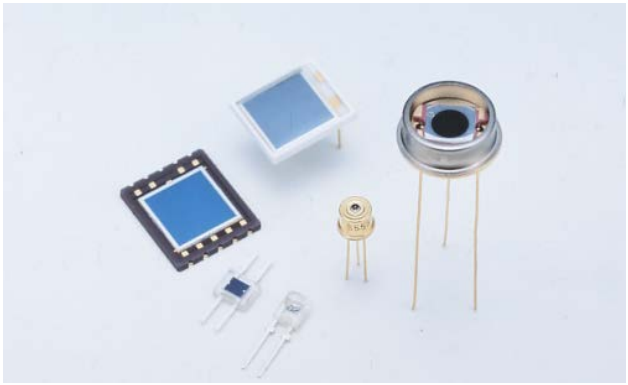
Imaging systems

Electron tube division

Photo-multipliers

Solid state division

Photo-sensors



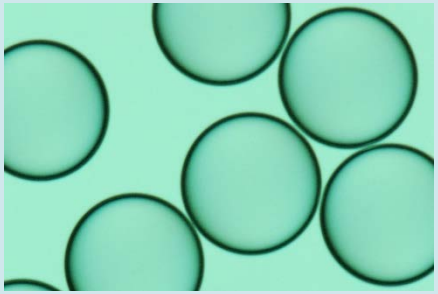
Why does HAMAMATSU PHOTONICS K.K. has working on inertial fusion research ?

Chairman of HAMAMATSU PHOTONICS K.K.

Low cost Energy
¥3.5/kWh

Target

- Materials
- Fabrication
- Injection
- Tracking
- ...



Laser

- Laser diode
- Amplifier
- Optics
- Laser system
- ...

Plasma Diagnosis

- Ion, Electron
- Neutron
- X-ray camera
- X-ray source
- ...

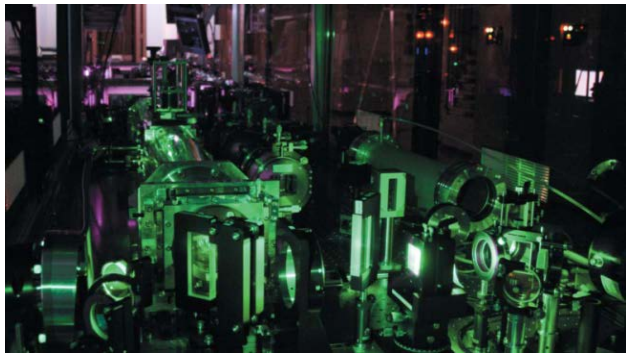
HAMAMATSU PHOTONICS will play an important role in the IFE community with the technologies on targets, lasers and plasma diagnosis.

High power laser systems of our section

MATSU-1

Diode-Pumped High Intensity Laser

Wavelength	800 nm
Output energy	2 J
Palse-width	50 fs
Peak power	40 TW
Shot cycle	10 Hz



KURE-1

Diode-Pumped High Energy Laser

Wavelength	527 nm
Output energy	12 J
Palse-width	10 ns
Shot cycle	10 Hz

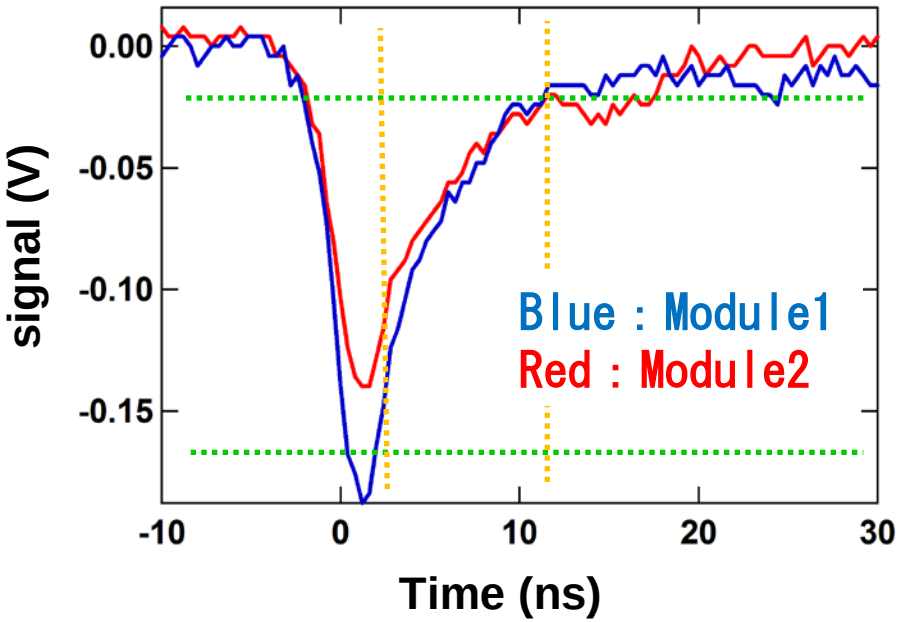
Because high energy, high efficiency and high repetition are required to laser driver, the semiconductor laser module is a key device to achieve.

High response neutron detector using ^{6}Li scintillator

Detector module view
72mm(Dia.)　200mm(L)

Li-6 density : 8 wt%

Detector response



Collaborators

ILE, Osaka Univ.

Kumamoto University

Chemistry with a heart
TOKUYAMA

Contents

Target technologies for laser fusion demonstration

Target Factory

- *Microencapsulation*
- *Laser machining*
- Coating

- *Metrology*
  - *Interferometry*
  - X-ray imaging
- *Assembly*

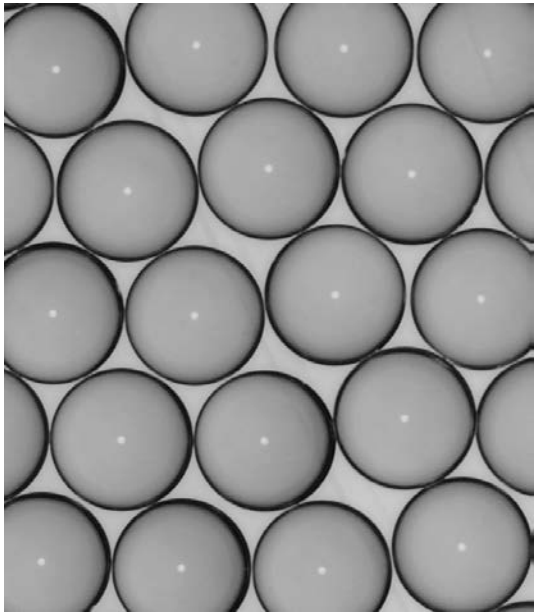
Ignition Facility

Laser driver

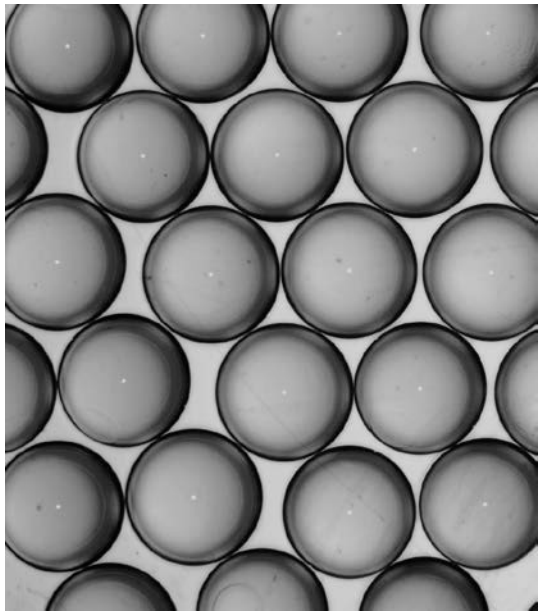
Target chamber

- Target Injection
- Cryogenic cooling
- Tritium handling

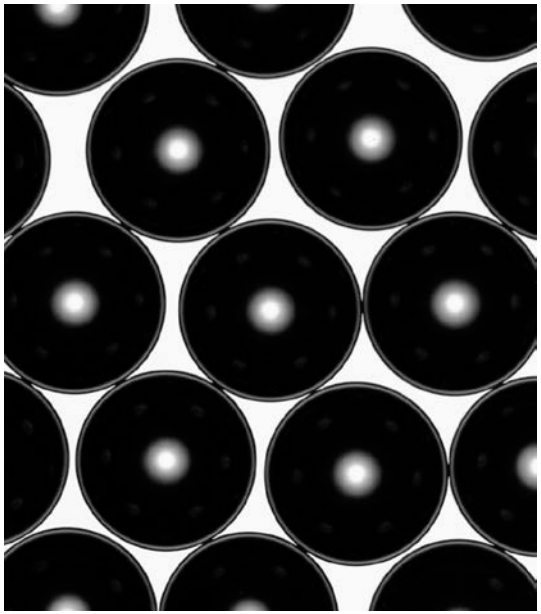
Our fabricated shells and beads



CD shells
500 microns



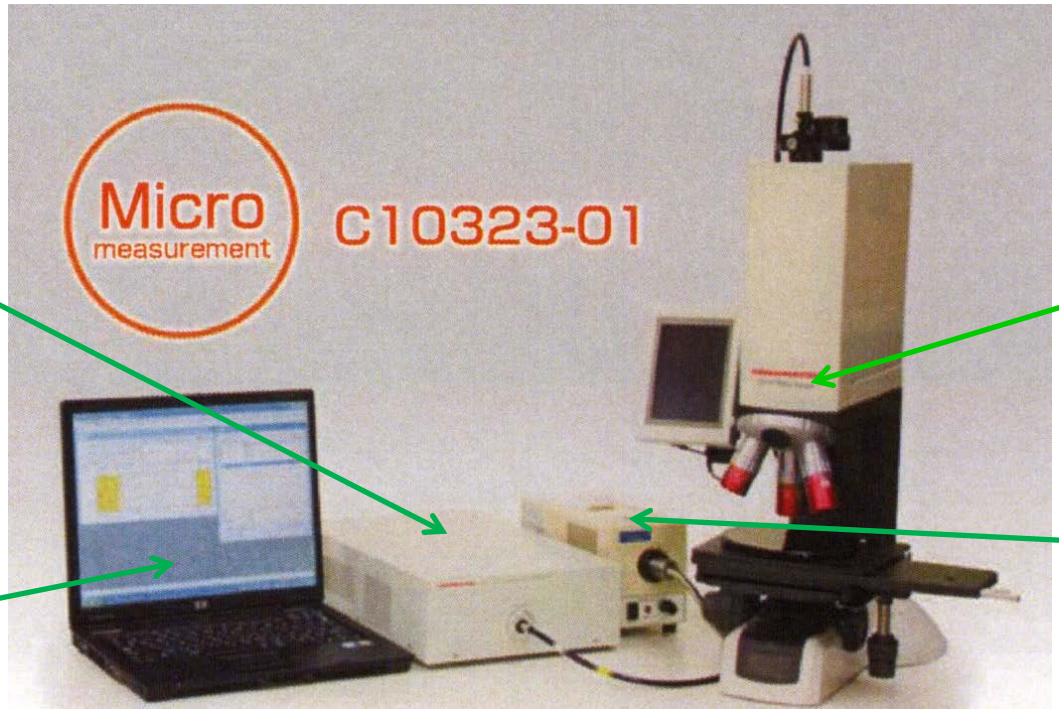
PAMS shells
1870 microns



CH beads
900 microns

Our plastic shells are made by microencapsulation. W/O emulsions are made using droplet generator. These are cured and organic solvent is lost, then core water in the shells dries out.

Optical non-contact measurement without damage



Photonic Multichannel analyzer

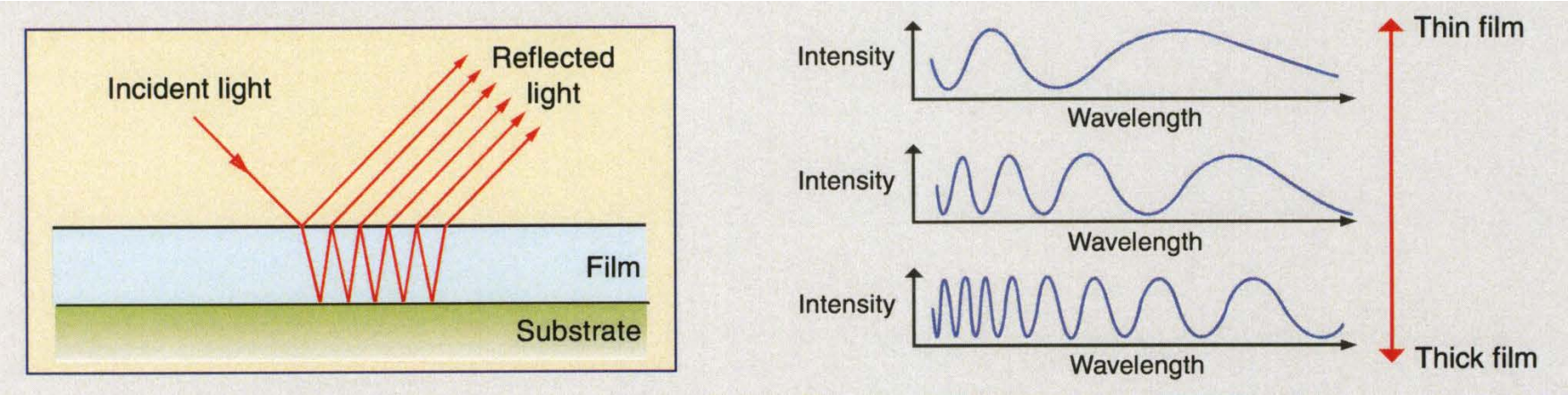
Data analyzer

Microscope

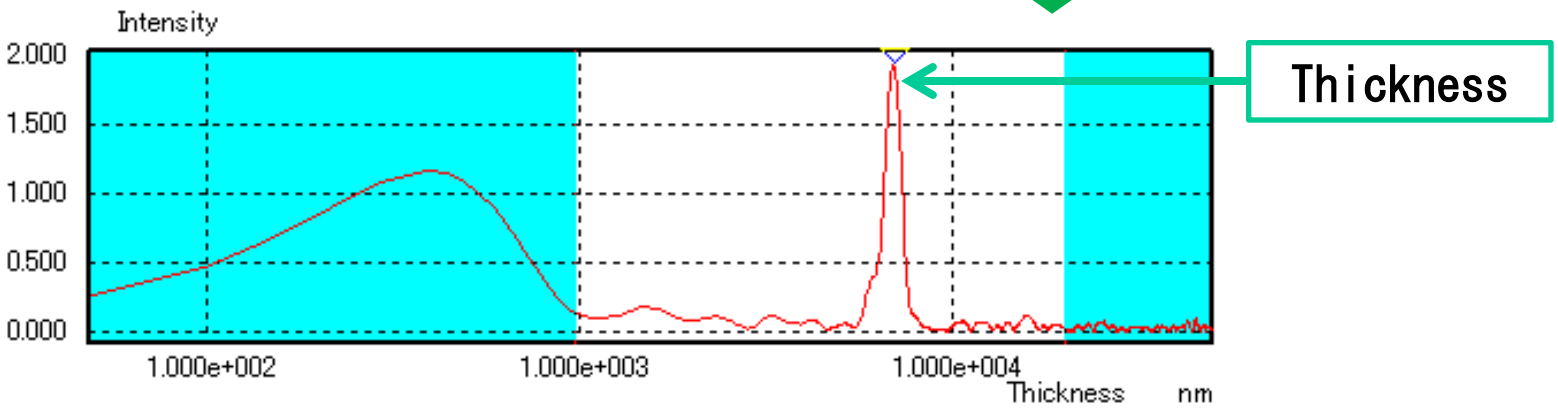
Light source

Measurement thickness:	0.020-50μm
Repeatability:	0.02nm
Measurement spot size:	Φ8-80μm
Number of measurement layers:	10
Analysis:	FFT or Curve fitting

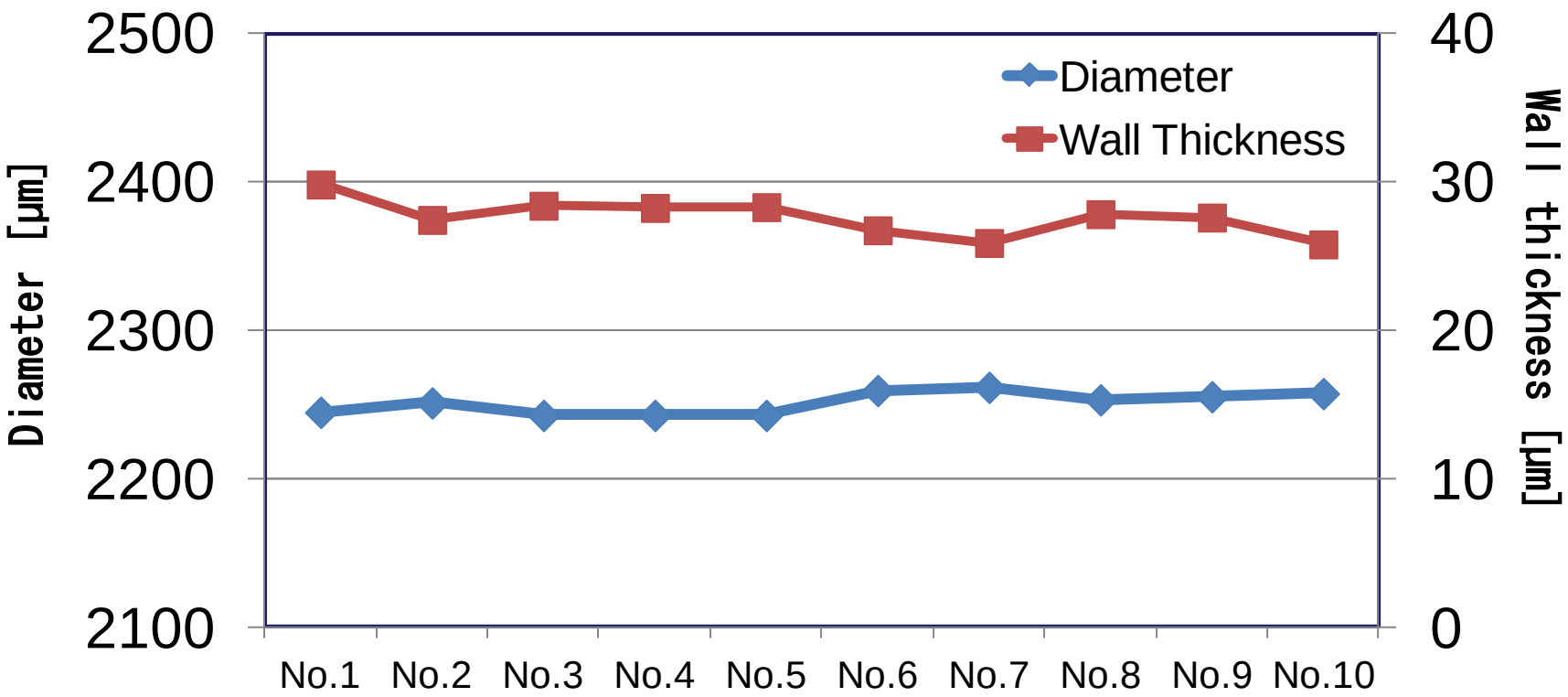
Principle of acquiring a wall thickness



Fast Fourier Transform



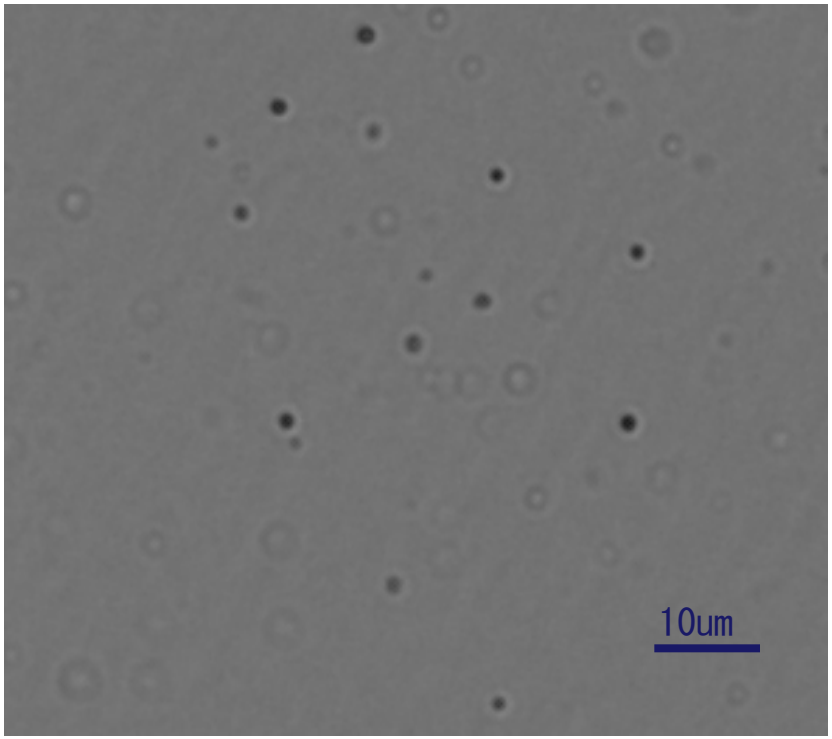
Diameter and wall thickness of PAMS shell were measured after we picked up 10 shells randomly.



Average±SD (um)	Value
Diameter	2251.3±7.4
Wall thickness	27.63±1.23

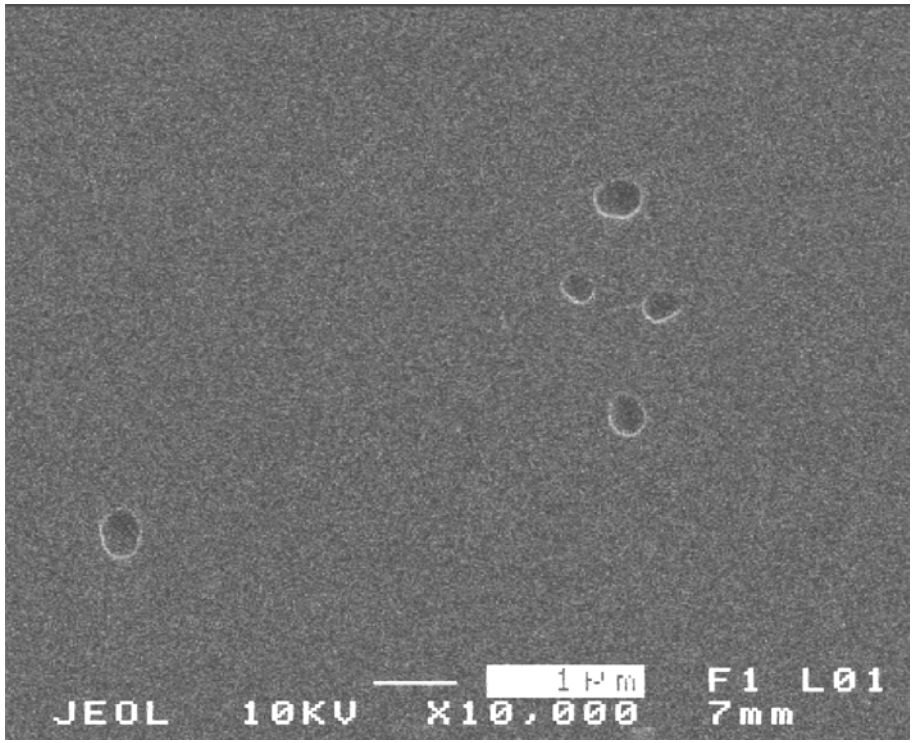
Many sub micron sized dents and vacuoles are found in a shell wall using usual method.

Microscope image



Dent : Clear circle
Vacuole : Fuzzy circle

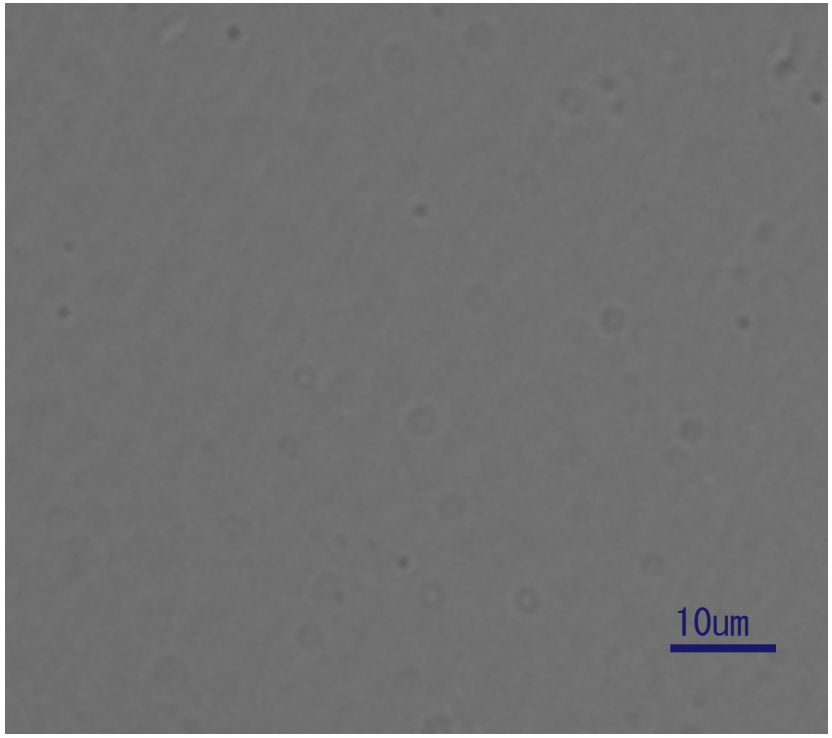
SEM image



Dent only

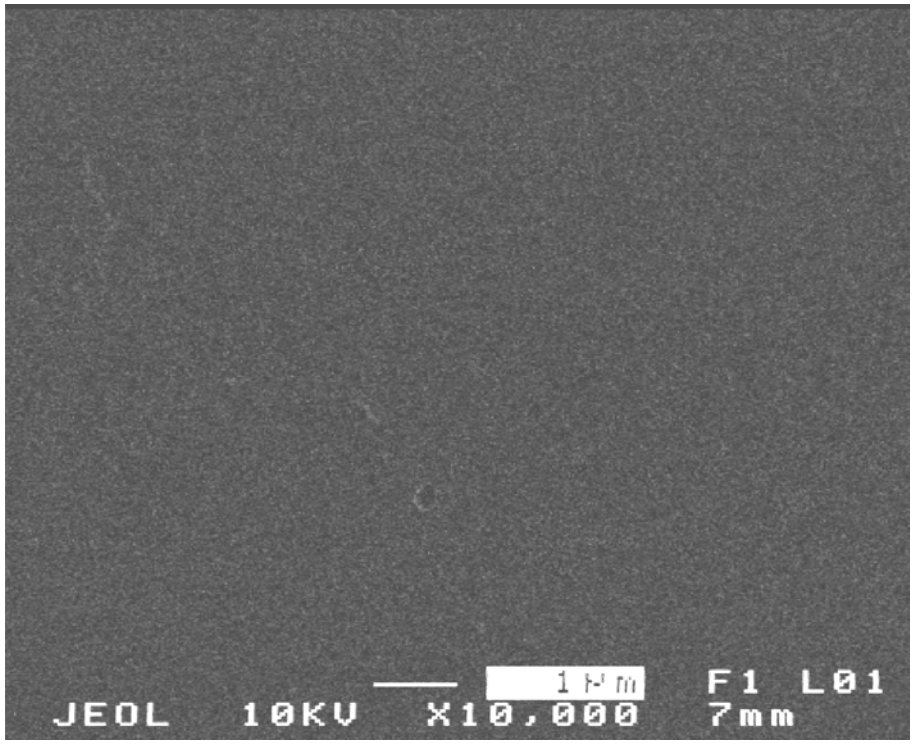
Dents and vacuoles are fairly decreased using improved method.

Microscope image



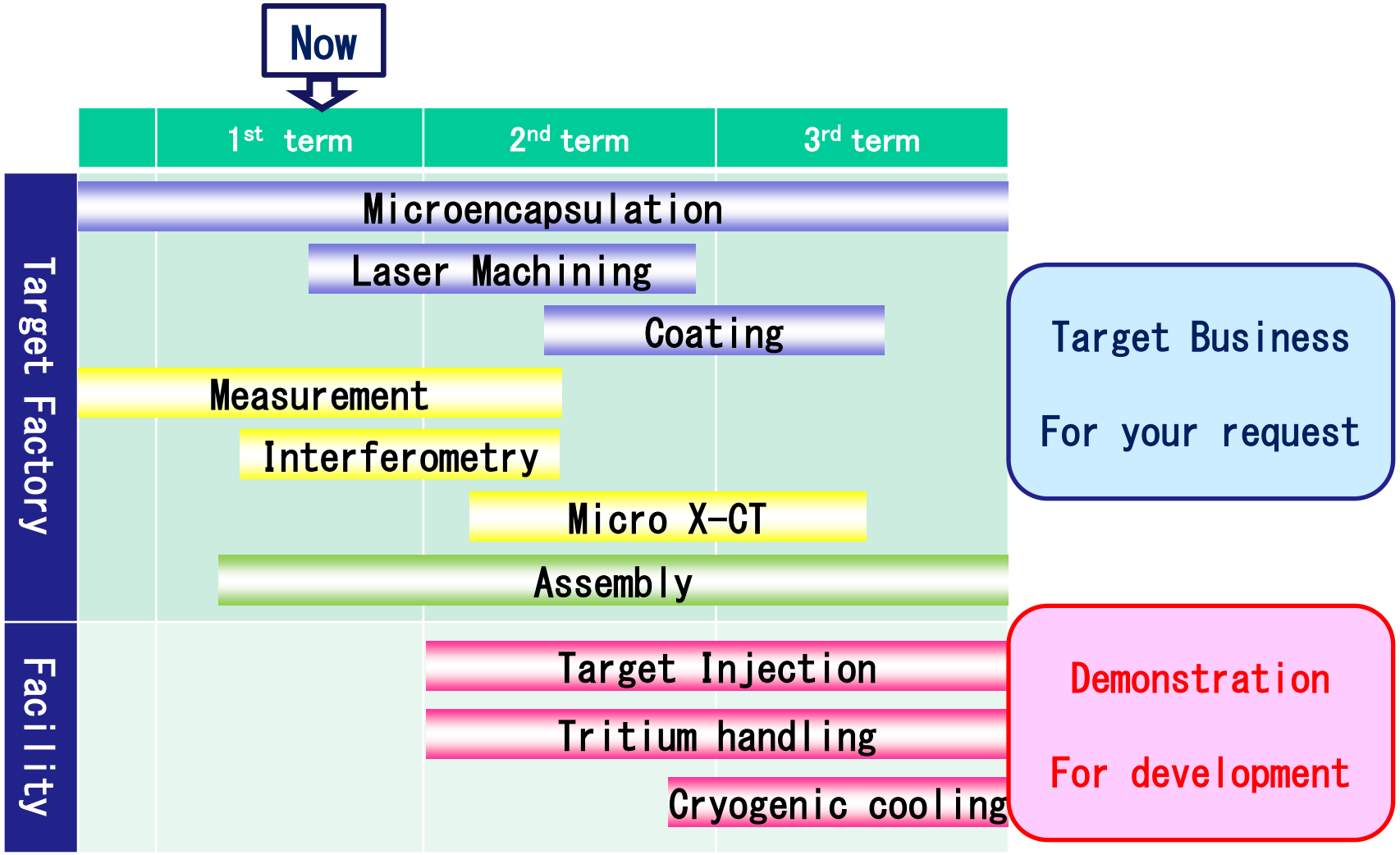
Dent : Clear circle
Vacuole : Fuzzy circle

SEM image



Dent only

Our roadmap of target development



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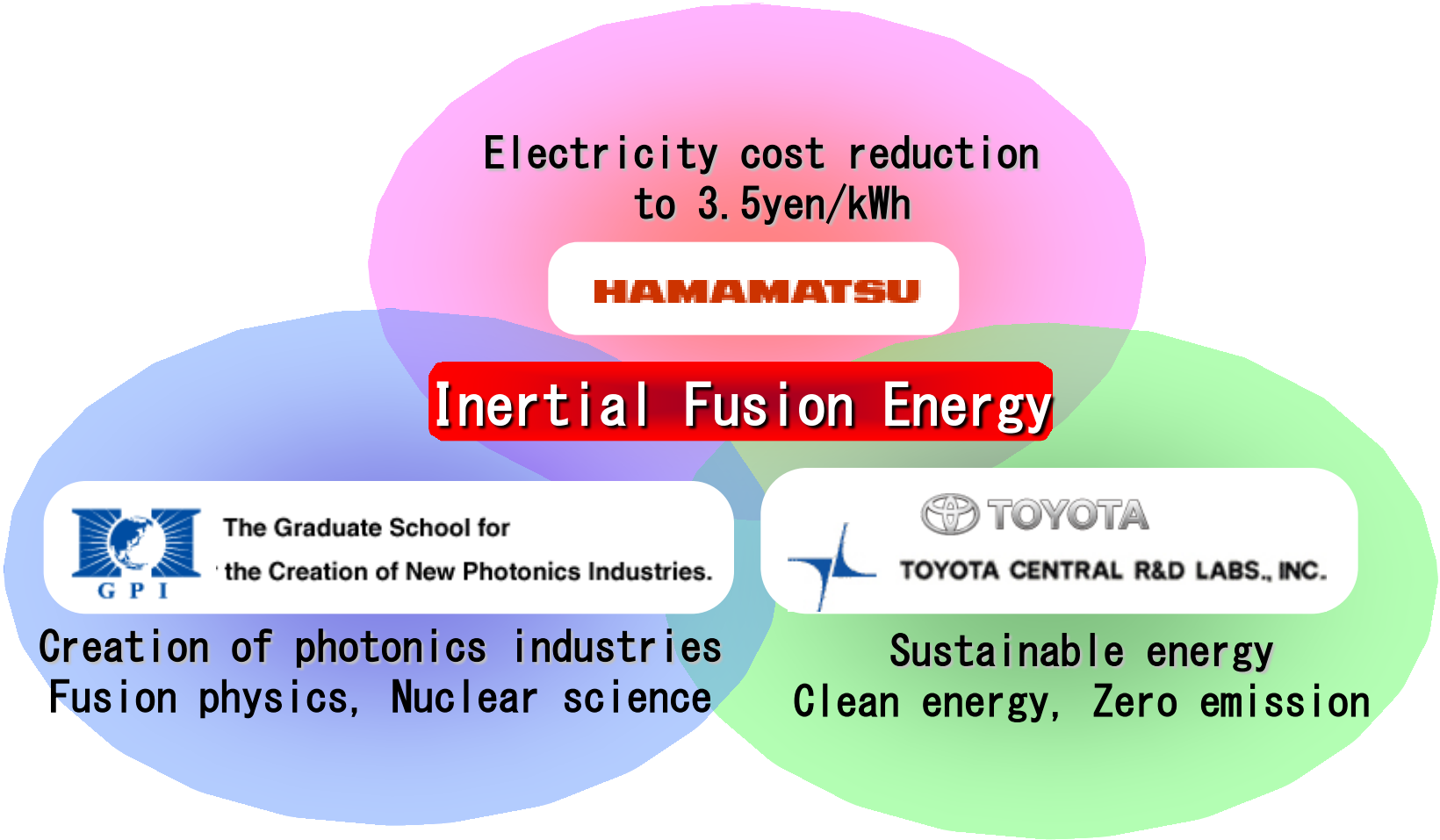
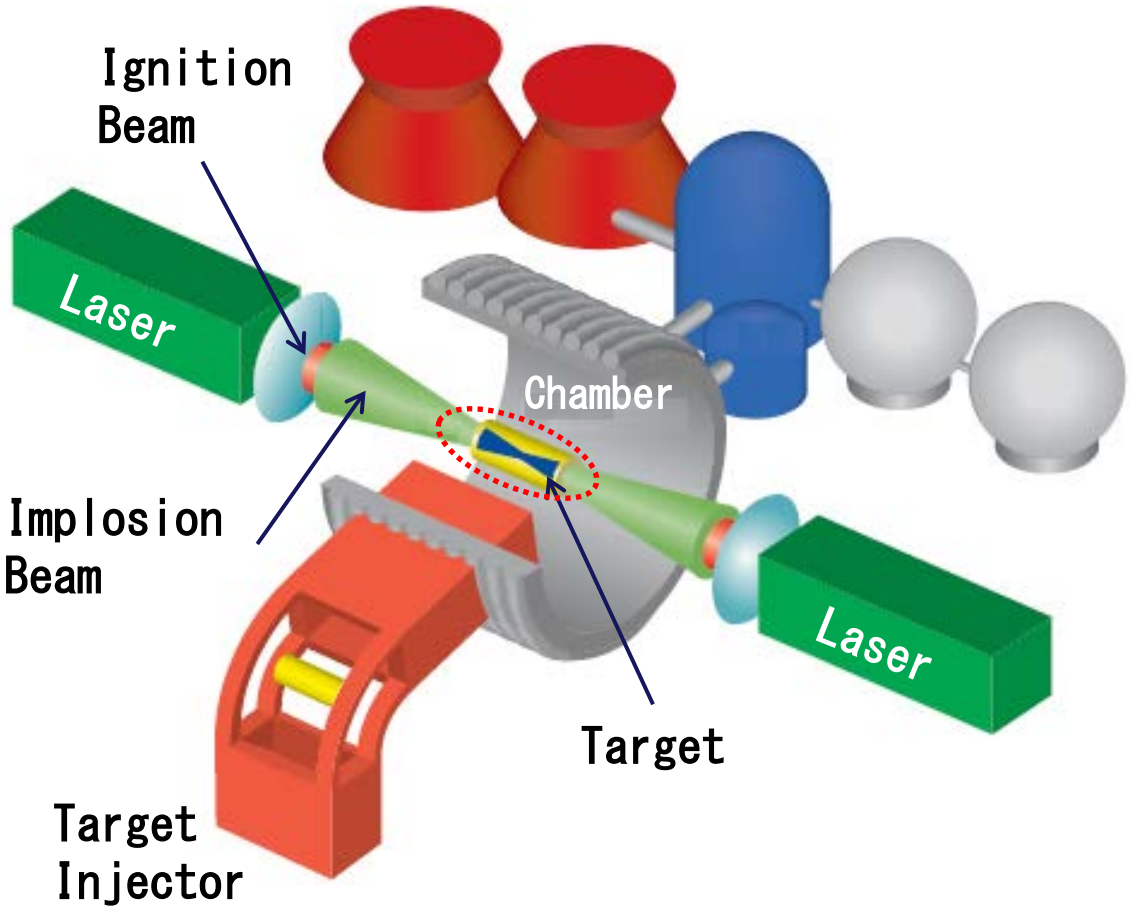
Civilian project for inertial fusion energy

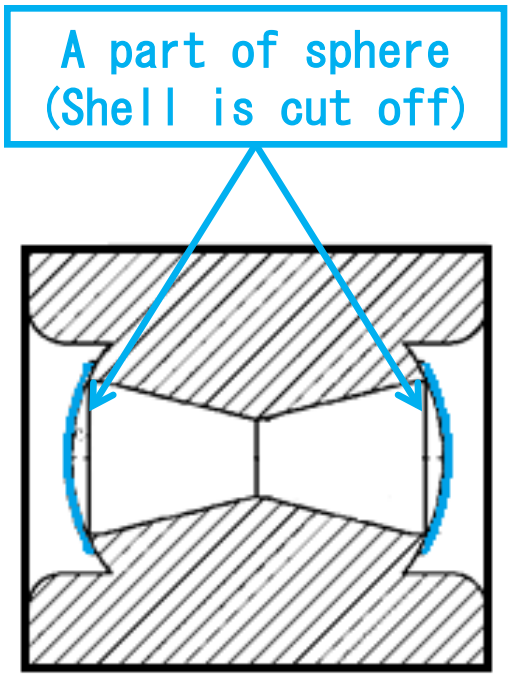


Mr.Komeda presents P-04 poster at tomorrow afternoon.

New fusion ignition concept of this collaboration

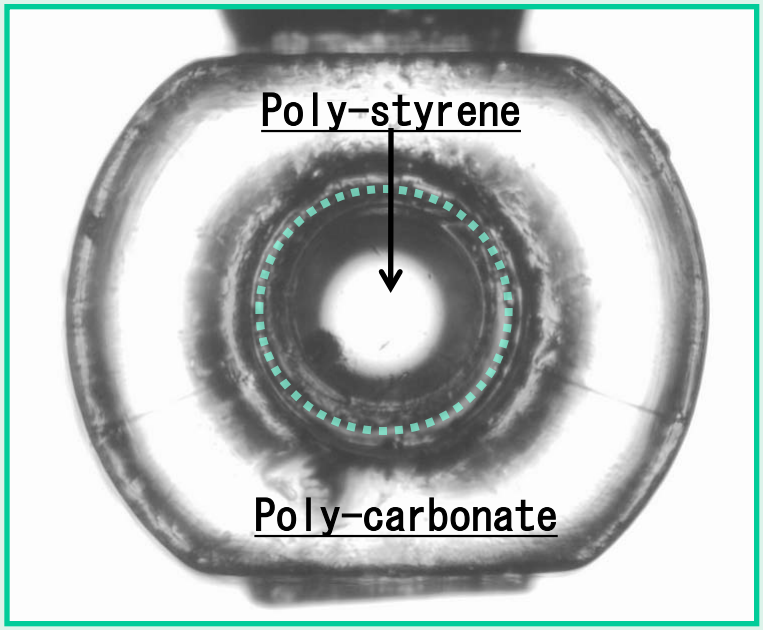


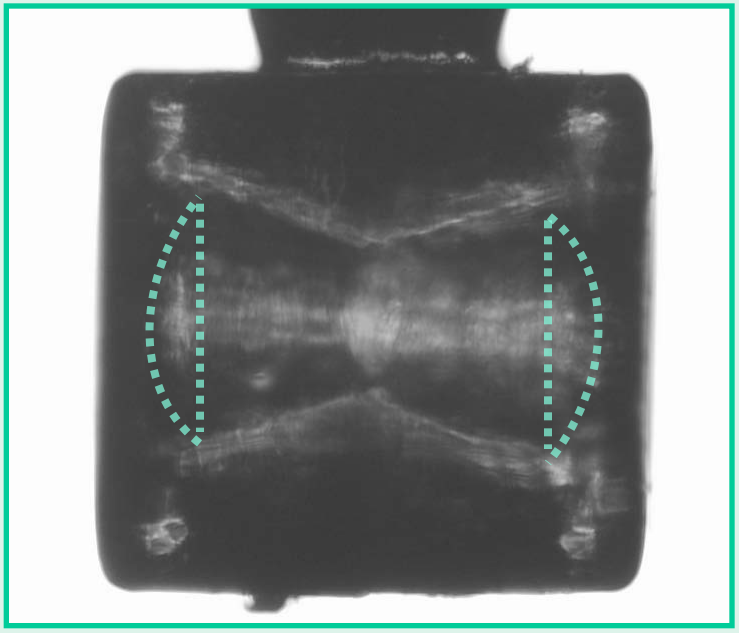
Power Plant image



Target Cross-section

Target view by microscope



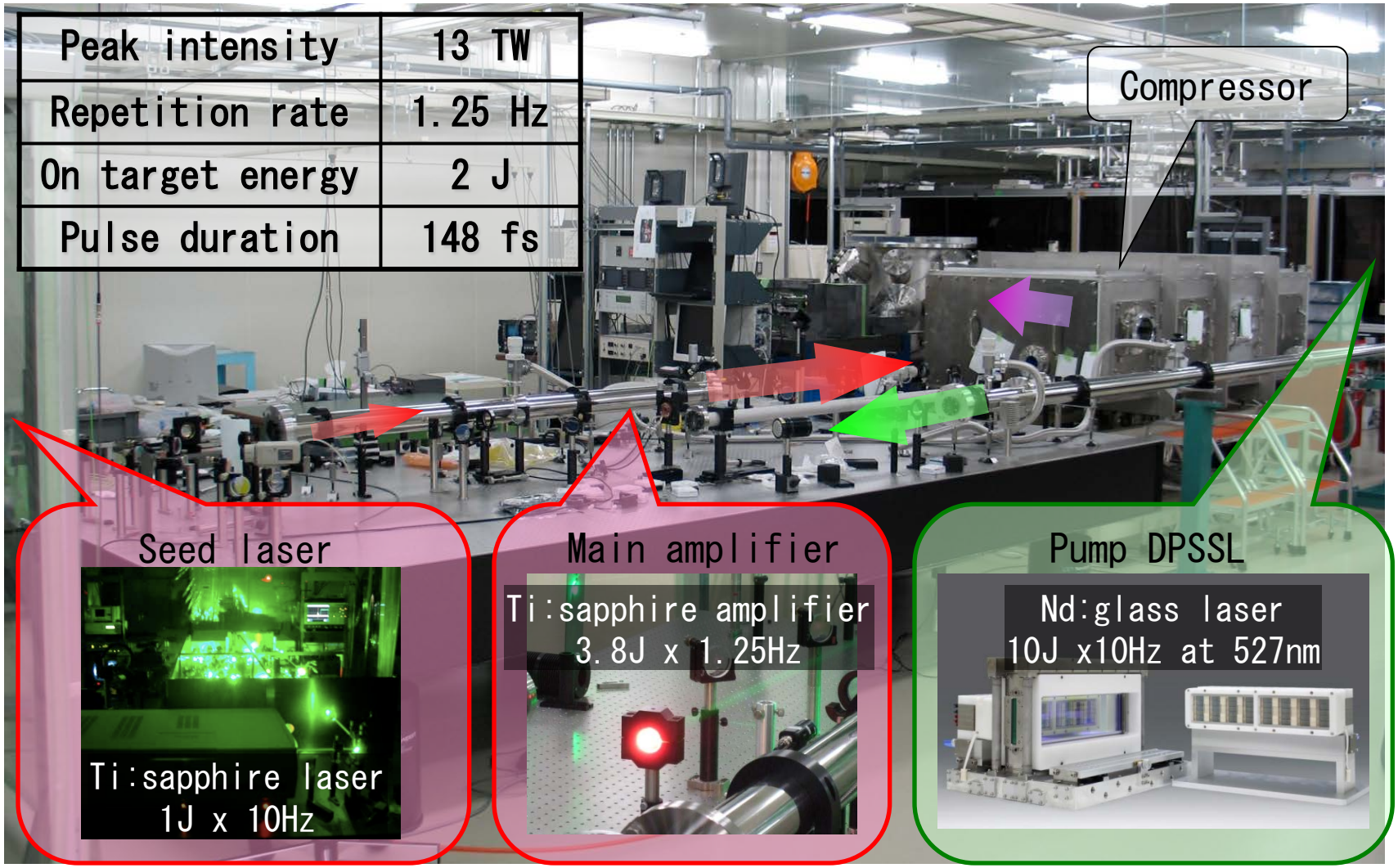


700μm Diameter, 600μm Height

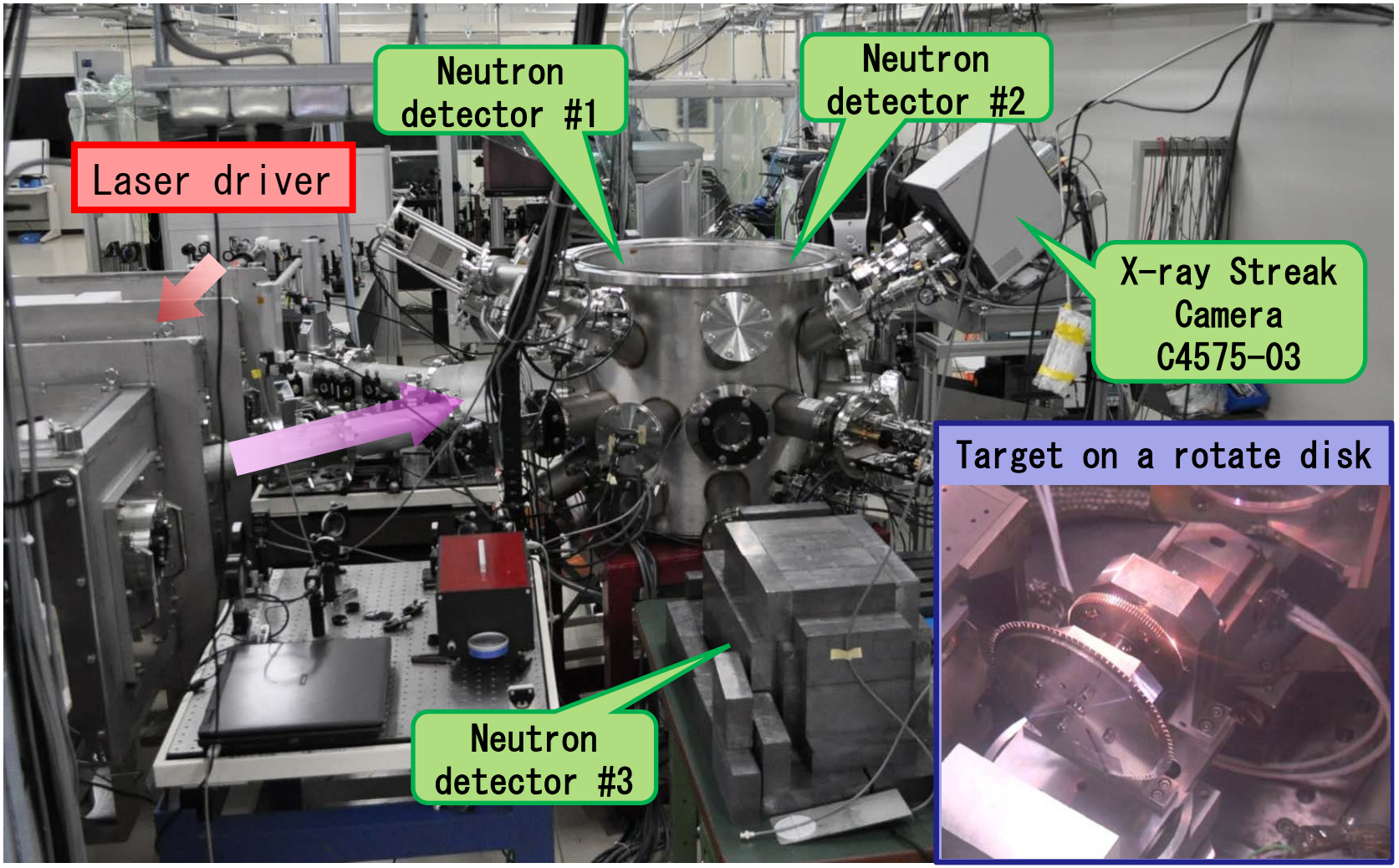
We fabricated and assembled the above target. These targets will be irradiated using our laser driver or that of ILE, Osaka university.

13TW Laser driver for Inertial Fusion Research

Peak intensity	13 TW
Repetition rate	1.25 Hz
On target energy	2 J
Pulse duration	148 fs



Disk Target in chamber and some measurement systems



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Summary and conclusion

1. We have been developing the key technologies, such as target and laser driver, for commercial power generation using inertial fusion reactor in future. In target technology, we are advancing for business and IFE research according to our roadmap.

2. We have started to fabricate more kind of plastic shells. The merits of our shells are high sphericity and uniformity of wall thickness, and there are not almost dents and vacuoles. Our high quality shells will be great importance in the implosion experiment for high gain.

3. We have promoted a small civilian project toward the IFE development with TOYOTA group and GPI, since 2008. We hope to progress larger project of IFE research.

Acknowledgements

Target Fabrication and evaluation
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T. Norimatsu (ILE, Osaka Uviv.)

Target material supply
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Neutron Detector Development
Y. Arikawa, N. Sarukura, H. Azechi (ILE, Osaka Univ.)
T. Murata (Kumamoto Uviv.) et al.

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Thank you for your attention.