

June 30, 2026

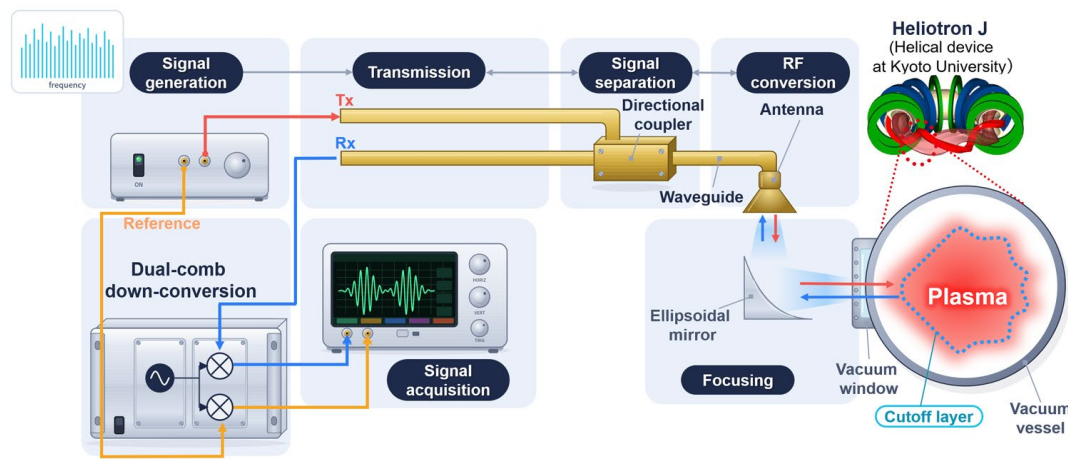
Mitsubishi Electric Corporation

Kyoto University

National Institute for Fusion Science

Advanced System for Simultaneous, Long-duration, Multi-point Plasma Measurement Developed in Japan

Plasma control diagnostics expected to advance the implementation of fusion energy



New plasma diagnostics system

Mitsubishi Electric Corporation, Kyoto University's Institute of Advanced Energy, and the National Institute for Fusion Science (NIFS) announced today that they have developed an advanced, world-class¹ microwave plasma measurement system for fusion energy.² The system is capable of simultaneously measuring plasma conditions at multiple points over extended periods. The joint team successfully demonstrated the system using the [Heliotron J](#) fusion experimental device at Kyoto University. The three collaborators aim to promote the development of plasma diagnostics technologies necessary for the practical implementation of fusion energy.

Fusion energy is highly anticipated as a next-generation, carbon-free energy source. Under its Fusion Energy Innovation Strategy³ and related initiatives, the Japanese government is supporting R&D and industry-academia-government collaboration targeting power generation demonstrations by the 2030s. To realize fusion energy, it is essential to establish reliable diagnostic technologies for the real-time monitoring of fusion plasma, which reaches temperatures exceeding 100 million degrees Celsius. Microwave measurement technology is a promising approach because it allows key components to be installed separately from the plasma, even inside a fusion reactor, where equipment is susceptible to damage from neutron irradiation. Since 2025, Mitsubishi Electric, Kyoto University and NIFS have been collaborating to advance microwave measurement technologies and their implementation in experimental systems.

¹ According to research by Mitsubishi Electric, Kyoto University, and NIFS as of June 29, 2026.

² Energy released when light atomic nuclei fuse to form a different nucleus—the same form of energy that powers the sun.

³ <https://www8.cao.go.jp/cstp/fusion/index.html> (Japanese website).

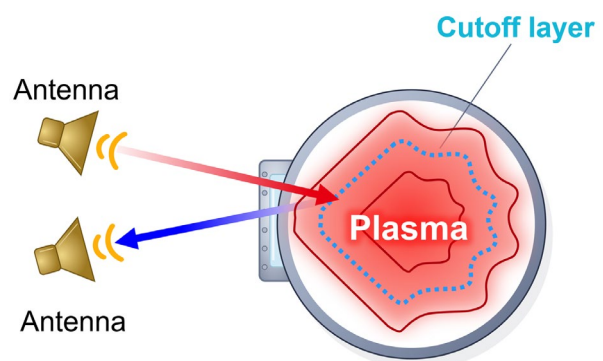
The new system utilizes frequency comb⁴ microwaves, which use multiple frequency components at the same time to simultaneously acquire reflection signals from multiple measurement points within the plasma. Furthermore, by adopting a dual-comb down-conversion⁵ method in the receiver system to reduce the load on high-frequency signal processing, the team achieved continuous measurement throughout the entire discharge duration. As a result, the system achieved world-class performance capable of simultaneous measurements at up to 34 points⁶ over long durations, which were successfully demonstrated with the Heliotron J.

These research results were presented at [the EPS Plasma Physics Conference 2026](#), Europe’s largest international conference on plasma physics, held in the United Kingdom from June 29 to July 3.

Features

1) *World-class simultaneous measurements at up to 34 points over long durations*

- When microwaves are injected into plasma, they are scattered and reflected at specific electron densities (cutoff density⁷) corresponding to their frequency. The reflected waves undergo frequency shifts due to the Doppler effect,⁸ which are determined by the rotational speed of the reflecting layer. Using frequency comb microwaves enables simultaneous multiple-point measurement of these frequency shifts.
- The system utilizes a frequency comb with 34 teeth (frequencies), enabling simultaneous measurement at up to 34 points.
- Integration of the dual-comb down-conversion method in the receiver system enables stable, long-duration measurements.



Measurement principle of the microwave reflectometer

2) *Integrated plasma diagnostic system successfully demonstrated with the Heliotron J*

- A system integrating everything from the frequency comb microwave transmitter to transmit-receive optics was installed in the Heliotron J fusion plasma experimental device.
- Experimental results confirmed the successful long-duration measurement of frequency shifts at up to 34 points in response to changes in the plasma state.

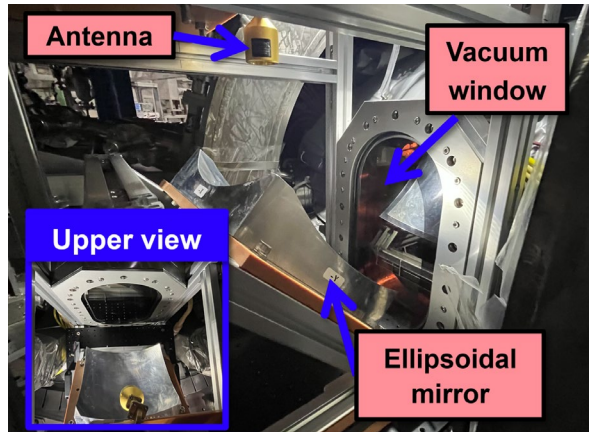
⁴ Microwaves consisting of numerous frequency components arranged at equal intervals, resembling the teeth of a comb, incorporating multiple frequency components simultaneously.

⁵ A method that combines two frequency comb signals with slightly different intervals to convert high-frequency signals into easier-to-measure low-frequency signals, enabling the simultaneous acquisition of numerous frequency components.

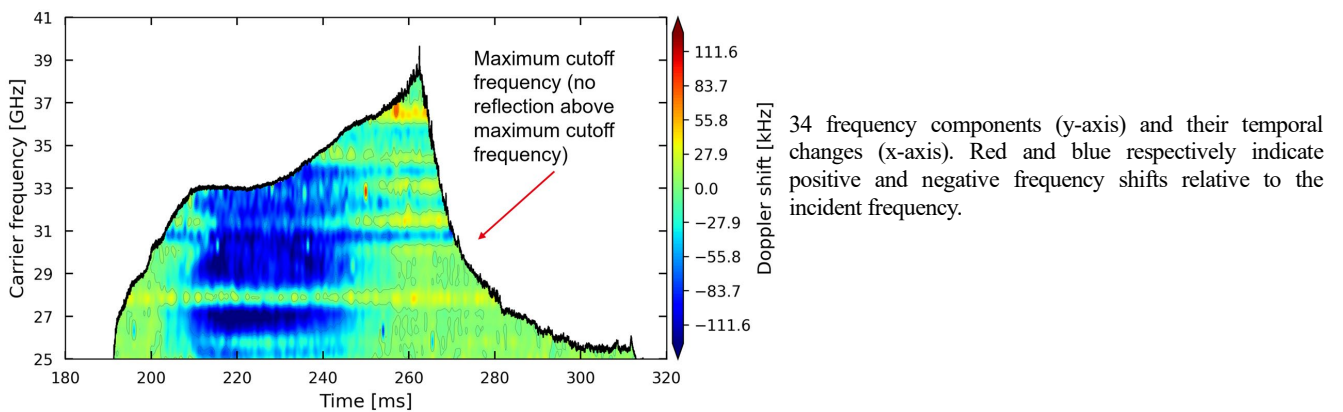
⁶ The number of measurement points depends on the state of the plasma’s electron density and varies according to discharge conditions.

⁷ The electron density at the boundary where microwaves can no longer propagate deeper into the plasma and are reflected. Since this density varies with the microwave frequency, the internal structure of the plasma can be analyzed by varying the frequency.

⁸ A phenomenon in which the frequency (such as the pitch of a sound) of waves is observed to change when the source of the sound or radio waves is in motion.



Diagnostic system developed for the Heliotron J



Multi-point measurement results of frequency changes in plasma over time

Roles in System Development

Entity	Responsibilities
Mitsubishi Electric	Development of microwave transmit-receive systems and construction of measurement system for Heliotron J
Kyoto University	Generation of high-density plasma and analysis of plasma physical phenomena
NIFS	Development of dual-comb down-conversion method and analysis of plasma physical phenomena

Future Development

Mitsubishi Electric, Kyoto University and NIFS will continue to advance plasma control technologies using frequency comb microwaves, aiming to construct even more detailed plasma measurement systems. They will also study the construction of systems with superior environmental resistance for use in commercial reactors, targeting power generation demonstrations in the 2030s.

About Mitsubishi Electric Corporation

Guided by its [corporate philosophy](#), Mitsubishi Electric Corporation (TOKYO: 6503) places sustainability at the core of its operations and values stakeholder trust—encompassing society, customers, shareholders and employees. In pursuing profitability, capital efficiency and growth, Mitsubishi Electric works closely alongside customers to develop value-added solutions that address today’s complex challenges while enhancing the company’s sustainable corporate value.

Founded in 1921, Mitsubishi Electric has over a century of experience in delivering reliable, high-quality products and solutions. With over 200 group companies and approximately 150,000 employees worldwide, the company is a recognized global leader in manufacturing, marketing and selling electrical and electronic equipment and systems across a broad range of sectors, including public utility systems, energy systems, defense and space systems, factory automation systems, automotive equipment, building systems, air conditioning systems & home products, digital innovations, and semiconductor & devices.

Mitsubishi Electric recorded consolidated revenue of 5,894.7 billion yen (U.S.\$ 36.8 billion*) in the fiscal year that ended on March 31, 2026. For more information, please visit www.MitsubishiElectric.com

*JPY 160=USD 1, the approximate rate on the Tokyo Foreign Exchange Market on March 31, 2026

About Kyoto University

Kyoto University is one of Japan and Asia’s premier research institutions, founded in 1897 and responsible for producing numerous Nobel laureates and winners of other prestigious international prizes. A broad curriculum across the arts and sciences at both undergraduate and graduate levels is complemented by numerous research centers, as well as facilities and offices around Japan and the world. For more information please see:

<http://www.kyoto-u.ac.jp/en>

About National Institute for Fusion Science (NIFS)

The National Institute for Fusion Science conducts research in various fields essential for realizing practical fusion energy, including plasma physics, micro-quantum processes, materials science, and engineering technologies for fusion-related equipment. As a university cooperative institution, we provide a wide range of research facilities, including the magnetic confinement plasma device, supercomputers, and other large-scale research facilities, for joint use, and promote joint research with universities and research institutions both domestically and overseas, thereby promoting the development of fusion science and the formation of a foundation for science and technology.

Media Inquiries

Mitsubishi Electric Corporation

Public Relations Division

E-mail : prd.gnews@nk.MitsubishiElectric.co.jp

Kyoto University

Public Relations Division

E-mail : iae-koho@mail2.adm.kyoto-u.ac.jp

National Institute for Fusion Science (NIFS)

E-mail : taigai-kakari@nifs.ac.jp

Customer Inquiries

Mitsubishi Electric Corporation Advanced Technology R&D Center

<https://www.MitsubishiElectric.com/ssl/contact/company/rd/form.html>

<https://www.MitsubishiElectric.com/rd/>

Kyoto University

E-mail : comms@mail2.adm.kyoto-u.ac.jp

National Institute for Fusion Science (NIFS)

E-mail : taigai-kakari@nifs.ac.jp