Investigation on the edge structure of tokamak plasmas by edge current profile measurement with ultra-high spatial resolution

Takaaki Fujita
(Japan Atomic Energy Research Institute, Department of Fusion Plasma Research, Principal Scientist)

【Outline of survey】

In an H-mode plasma, a standard operation scenario in ITER, an edge transport barrier (ETB) with a steep pressure gradient is developed at the edge region, and the pressure at the top of ETB, determined by the ETB width and by the ETB pressure gradient, mainly determines the global plasma confinement. In this study, we develop a Zeeman polarimetry system using a Lithium beam probe for the precise current density profile measurement in the ETB region on the JT-60U tokamak, and make the ETB structure clear employing other diagnostics data including the temperature and pressure profiles in the ETB. The ETB is formed through the reduction of radial transport, and hence its width is possibly related to the current profile or the magnetic shear. On the other hand, the pressure gradient in the ETB is mainly determined by repetitive instabilities called Edge Localized Modes (ELMs). The edge current density profile, together with the pressure profile, enables us to perform Magnetohydrodynamics (MHD) stability analysis and to reveal the conditions for appearance of giant ELMs and small ELMs. Based on the obtained knowledge of the ETB width and the appearance conditions of ELMs, we will aim at developing control techniques for maintaining a large pressure at the top of ETB without giant ELMs. Part of existing Motional Stark Effect polarimetry system is used for the development of Zeeman polarimetry system.

【Expected results】

Detailed profiles of current density in the ETB region allow us to validate the models for ETB formation and those for ELMs. It is our concern that the repetitive pulsed heat load onto the divertor targets due to large ELMs would cause rapid erosion of target materials. Establishment of control techniques for maintaining a large ETB pressure without giant ELMs would provide a more efficient and higher performance operation scenario of ITER and a reduced cost of electricity of a fusion reactor through longer lifetime of divertor targets and higher fusion power. The Lithium beam will also be employed for precise measurement of edge electron density profiles through the Beam Emission Spectroscopy (BES) technique, and hence is expected to play a significant role in the research on the ETB.

【References by the principal researcher】

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[2] T. Fujita, "Spatial structure of internal and edge transport barriers", Plasma Phys. Control. Fusion **44**, A19-A35 (2002).

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【Homepage address】 http://www-jt60.naka.jaeri.go.jp/