§56. Heat and Particle Deposition Profiles on the Helical Divertor during Magnetic Axis Swing Operation

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In the helical divertor, heat and particle deposition profiles are not uniform in both toroidal and poloidal directions, and the profile changes with changing magnetic configuration, e.g., major radius of magnetic axis (R_{ax}) [1]. Fig.1 shows temperature rise of torus inboard (Div#1) and bottom (Div#6) divertor plates in 80 seconds ICH discharges with different R_{ax}. In the case of inward shifted R_{ax}, heat deposition is intensive at torus inboard side, and torus top and bottom become the intensive heat deposition area in outward shifted R_{ax} discharges.

In LHD, long pulse discharge experiments have been conducted mainly using ICH. One of the limits of discharge duration is believed to be overheating of divertor plates at intensive heat deposition area [2]. The foregoing characteristic of heat deposition profile in the helical divertor was utilized to avoid the overheating of divertor plates by dispersion of time averaged heat deposition profile with R_{ax} swing operation during discharges, and heat and particle deposition profiles during the operation were investigated.

Fig. 2(a) and (b) show the time evolutions of temperature rise of the divertor plates and rate of temperature rise at torus inboard side and bottom, respectively, and Fig.2(c) shows R_{ax} during a R_{ax} swing ICH discharge. It is very clearly shown that heat deposition to both divertor plates is modulated with R_{ax} swing. As shown in Fig.1, heat load to the torus inboard side divertor plate (Div#1) and bottom plate (Div#6) is almost same at R_{ax}=3.67-3.69m. This R_{ax} swing operation was conducted in the range of R_{ax}~3.65-3.69m. It is important that R_{ax} swing range is centered near R_{ax}=3.67-3.69m for effective dispersion of the divertor heat load. For example, in the discharge with R_{ax} swing in the range of R_{ax}=3.62-3.65, heat deposition profile is not modulated. Fig.2(d) and (e) shows the ion saturation current, that is, particle flux profiles on the divertor plates at torus inboard side and bottom, respectively, and these profiles were also modified by R_{ax} swing. It means that R_{ax} swing operation can modify heat and particle deposition profiles on the helical divertor, and also on each divertor plate. Therefore, this operation is effective tool to avoid overheating of divertor plates, and to extend the discharge duration. The discharge with duration of over 30 minutes and total input energy of 1.3GJ was achieved with this operation [3].

Reference
[1] Masuzaki, S. et al., Nucl. Fusion **42** (2002) 750.
[2] Mutoh, T. et al., Nucl. Fusion **43** (2003) 738.
[3] Mutoh, T. et al., J. Plasma and Fusion Res. **81** (2005) 229.

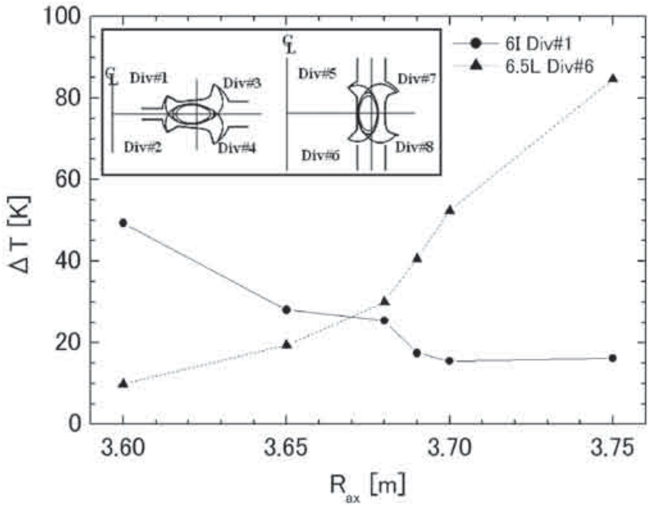

Fig.1. Temperature rises of torus inboard (Div#1) and bottom (Div#6) divertor plates during discharges with different R_{ax}. Insertion shows positions of the divertor plates in which thermocouples are embedded in a toroidal section.

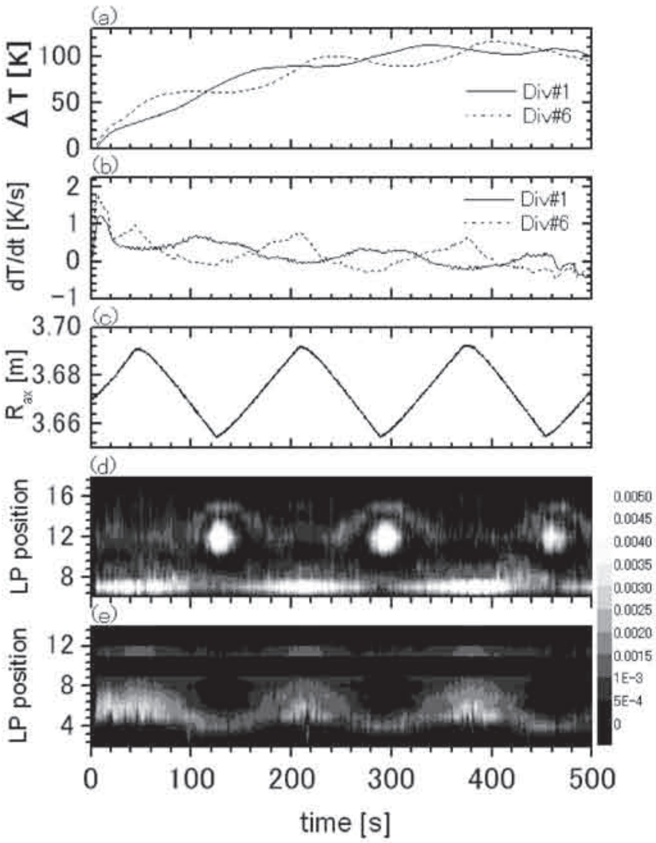

Fig.2. time evolutions of (a) temperature rise of the divertor plates, (b) rate of the temperature rise, (c) R_{ax} position, ion saturation current on the divertor plates at torus inboard-side (d) and bottom (e), respectively.