§64. Experimental Studies of Energetic Electron Behavior Outside of Plasma Region and Blob Trigger Mechanism Using a Hybrid Directional Probe in Quest

Nagaoka, K., Osakabe, M., Takeiri, Y., Mahira, Y. (Kyushu Univ.), Zushi, H. (Kyushu Univ.)

Energetic particle confinement is one of the key issues for steady state operation scenario in the thermonuclear fusion research, because the loss of energetic particle could give serious damage to the first wall in the vacuum vessel. In particular, the energetic electrons accelerated by RF heating in ST (spherical torus device) tends to distribute outside of the bulk plasma. Recently, the localized loss of such energetic electrons was observed on the first wall.

In order to estimate energetic electron energy flux, a hybrid directional probe was installed in QUEST. Figure 1 shows the electrode arrangement on the probe. The electrodes of Channel 1-4 are sheath thermocouple and can measure directional heat flux at the probe position. Figure 2 shows the time evolution of heat flux evaluated by a model in which radiation loss is taken into account,

$$q_{\mathrm{ext}} = \int \rho C \frac{\partial T}{\partial t} dV/S - \sigma(T^4 - T^4_{\mathrm{baking}}) \qquad [\mathrm{W/m^2}], \ (1)$$

where ρ, C, T, V, S, σ, T_{baking} are mass density, specific heat coefficient, measured temperature, volume of electrode, surface of probe, Stefan-Boltzmann constant and baking temperature of chamber wall, respectively. Figure 3 shows the heat flux structure in radial position and time. These observations indicate that energetic electrons outside of the plasma increases twice in a discharge, in which the plasma current increases significantly. The energetic electrons outside of plasma is considered to carry plasma current at the first current ramp up phase, then the plasma current penetrate in the plasma region. The comparison with numerical calculation is planned to discuss more detail behavior of energetic electrons.

Investigation of trigger mechanism of blob is another target of this collaboration program. Fast camera and electrostatic probes identified the blob activities in QUEST plasmas, so far. In order to investigate the trigger mechanism of blob, a new probe head was designed and constructed with a magnetic probe. Using this new probe system, the magnetohydrodynamic (MHD) activities is planned to be observed at the same position of electrostatic probe position (blob observation location). In fiscal year of 2013, we will try to observe blob behavior with measurement of MHD activities simultaneously to discuss the trigger mechanism of blob generation.

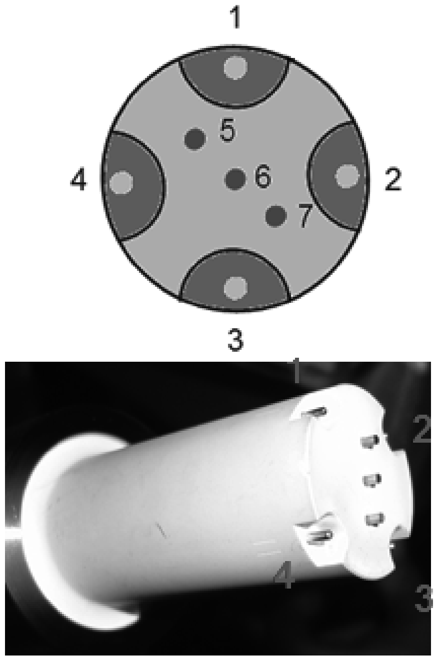

Fig. 1: (Upper) Schematic of electrode arrangement on the hybrid directional probe head. (bottom) A picture of probe head.

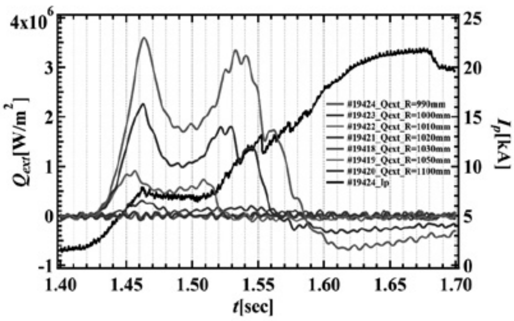

Fig. 2: Time evolution of heat flux due to energetic electrons.

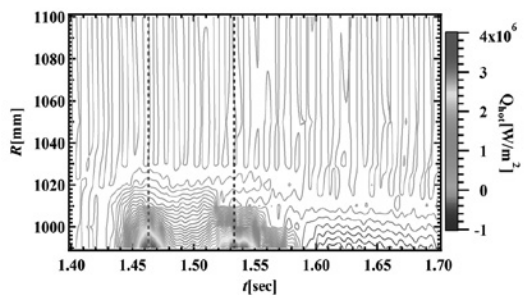

Fig. 3: 2-dimensional contour of energetic electron heat flux as functions of radial position and time.