§23. Study of Magnetic Structure and Transport Using Heat Pulse Propagation Method

Tsuchiya, H., Ohdachi, S., Suzuki, Y., Narushima, Y.

In helical magnetic field, the magnetic structure in the edge region is stochastic in vacuum condition. The stochastic state is also assumed to change the structure by existence of toroidal current or increasing β in the numerical study. The boundary between stochastic region and closed surface region (i.e. last closed surface) is important to define the global plasma parameter such as plasma volume or averaged beta. However, in experiment study, the definition of the last closed surface is not easy. In this study, the heat pulse propagation method is used for the study of characteristic of boundary region. The heat pulse propagation method has been used for the discriminate among the closed surface, magnetic field and stochastic field in the half radius of LHD [1].

The heat pulse is generated by power modulation ECH. To check the characteristic of heat pulse propagation, it is necessary to set the start point at outer half radius (i.e. off-axis heating) shown as fig.1. Because the density and temperature is generally low in the edge region, the ECH enhanced the high energy particle, which make the ECE measurement accuracy worse. To avoid the generation of high energy particle, the experiment has done in condition of high density sustained by balanced NB injection. Because the steep density gradient in the edge region refract the beam of ECH, we can set the ECH deposition at half radius at R_{ax} = 3.9m configuration. The radial profile analysis and analysis of heat pulse propagation are shown in fig.2. The heat pulses propagate outward from R~4.42m. We can see the folding point at R~4.5m at H.P. delay time even though there are no significant change in T_e,T_i abd V_c profile. This would indicate the change of transport coefficient derived from difference of magnetic structure.

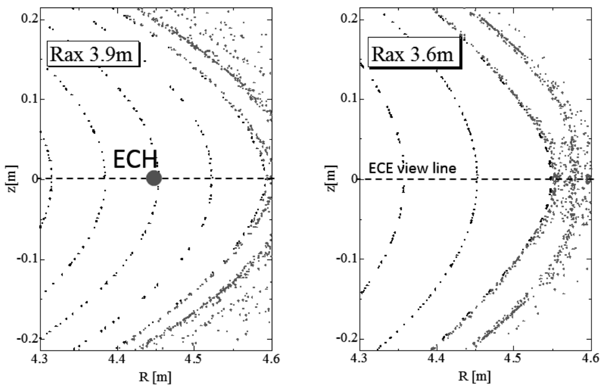

Fig. 1 Poincare plot of Magnetic field line at horizontally elongated cross-section where ECE measurement is located in case of magnetic axis (R_{ax}) is 3.9m (left) and 3.6m (right).

Fig.3 shows the radial heat pulse velocity dependence on β. The folding point of heat pulse velocity located at R~4.5m in this beta range. It is necessary to investigate the location of the boundary in high beta range to identify the folding point as the boundary. Summary, it is found that the transport coefficient just inside the predicted stochastic region is larger than one in closed surface region, but it is smaller than one in the stochastic region (see ref.2).

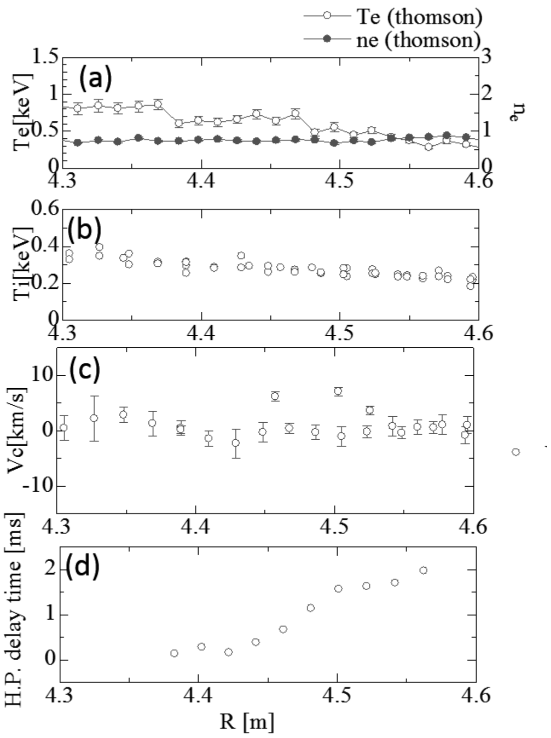

Fig.2 Radial profile of (a) electron temperature (left axis), electron density (right axis) (b) ion temperature, (c) plasma rotation velocity (d) heat pulse(H.P.) delay time at R_{ax}=3.9m.

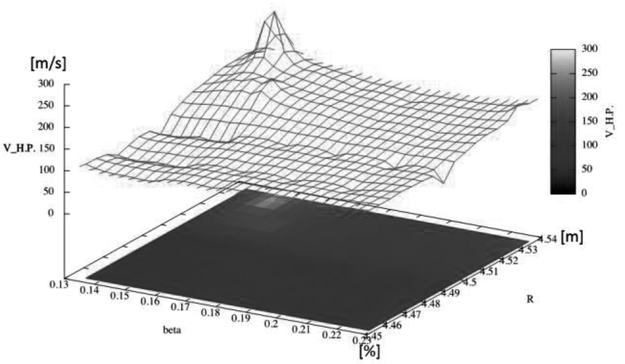

Fig.3 radial heat pulse velocity dependence on β.

1) K. Ida et.al. Nature communications, **6**, 5816 (2015).
2) Tsuchiya, H. et al. : Ann. Rep. NIFS (2013-2014) 52.