

§8. Finite Beta Effect on Plasma Parameters of LHD Divertor Legs

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In the helical plasma experiments such as LHD, interaction between plasma and neutral particle is an important factor for the control of heat and particle of the whole device. However, since their profile is intrinsically three-dimensional, experimental information is still insufficient. Especially, little information on ion temperature and plasma potential makes it impossible to deduce plasma heat flux. We have proposed a new analysis method¹⁾ to deduce time-dependent plasma heat flux from thermocouple data of hybrid directional langmuir probe (HDLP)²⁾. Conventional method can provide only total heat load per a discharge pulse, and can not be used to study the heat flux change due to plasma confinement transition.

Figure 1 shows one example of NBI plasma (SN.110821). Discharge starts at $t = 3[s]$ and sustained till $t = 6.5[s]$. As shown by ion saturation current signal, a transition to detach plasma state occurs at $t = 4.5[s]$ ³⁾. After that, numerous burst signal (so-called blob ?) is observed. Heat flux deduced from thermocouple (TC) data with present analysis method shows the rapid increase around $t = 4.5[s]$ and begin to decrease at $t = 5[s]$. The latter corresponds well to the second transition of saturation current. After that, detach plasma is established and particle/heat transport is reduced. This observation is the first success to show the evidence that the heat transport by blob really exists.

Although time response of HDLP sensor is not so fast, it can be used to measure the divertor leg profile of the plasma heat flux by scanning HDLP spatially. Figure 2 shows four time trace of thermocouple (TC) signals. HDLP was drawn back by 6[cm] during 30[s]. Plasma was sustained only by ECH and its duration was 10[s] without confinement transition. Four TCs cross the divertor leg one by one and shows each peak after a few seconds delay. These temperature data was analysed and time trace of the obtained heat flux was converted to spatial profile. The result is shown in Fig. 3. Horizontal axis is the artificial marking of the whole HDLP position. Complete profile was obtained only for ch2 and ch3. The difference of peak position can be explained with the shift of TC channel on the HDLP body.

- 1) H.Matsuura *et al.*, Ann. Rep. NIFS, Apr.2011-Mar. 2012(2012)47.
- 2) K.Nagaoka *et al.*, Rev. Sci. Instr., 79, 10E523 (2008).
- 3) H.Tanaka *et al.*, Ann. Rep. NIFS, Apr.2011-Mar. 2012(2012)45.

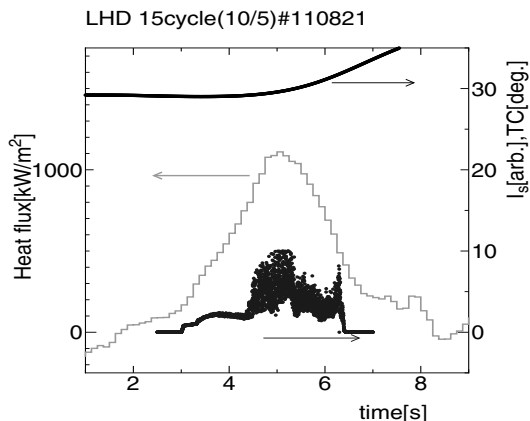


Fig. 1: Heat flux evolution of NBI plasma discharge with confinement transition. Time traces of ion saturation current and thermocouple signal are also plotted.

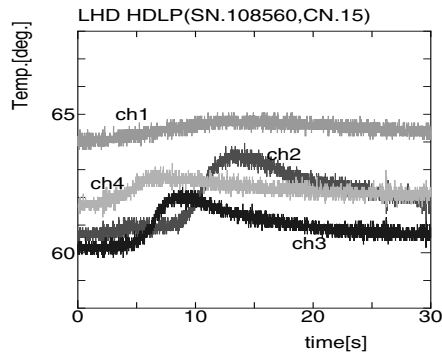


Fig. 2: Temperature data of 4 channel HDLP thermocouple. HDLP was scanning across the divertor leg.

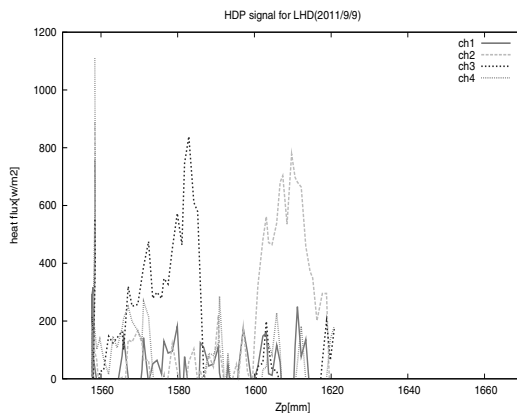


Fig. 3: Estimated heat flux profile across the divertor leg.