§5. Plasma Heat Transport through LHD Divertor Leg

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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 fluxes to the divertor. Their experimental observation of divertor leg plasma is limited, since the 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. A new analyzing model was proposed to deduce time-dependent plasma heat flux from thermocouple (TC) data of the hybrid directional Langmuir probe (HDLP).[1)] It has successfully demonstrated to measure heat flux change due to detach plasma formation so far, although characteristic time of the evolution shorter than 1[s] is still difficult to detect.

In this study, we applied this model to evaluate the time evolution of heat flux on NB2 armor plates.[2)] The armer plate is placed on the counter wall of the NB-injection ports and 30 channel calorimeter tips are equipped.[2, 3)] Although the response time of most calorimeter tips is longer than that of HDLP (over 1 sec), Five tips are designed and constructed to reduce the response time by mounting two TCs. (One is set 1mm from the irradiation surface and another is 3mm.) Figure 1 shows an example of time evolution of temperature measured by two TCs mounted on tip No.17. The near TC signal measured near the surface has faster response than that obtained with TC far from the surface Both signals show the rapid change due to a pellet injection.

Figure 2 show the comparison of heat flux estimation with two TCs. The heat flux estimated with faster temperature measurement (TC near the surface) has faster time resolution up to 50 m sec. The discontinuity in heat flux at $t = 4.52$ sec was caused by sudden jump up in plasma density due to an impurity pellet injection. It is noted that the proposed model give the similar heat flux evolution (Fig. 2) from the different temperature evolution shown in Fig. 1.

Figure 3 shows comparison of shine-trough power density estimated by present estimation with deposition power estimated by plasma density evolution data. Time evolution of both power signale shows reasonable agreement. After the pellet injection, deposition power becomes twice and shine-through power becomes about half. If port-through power can be kept constant, present heat power estimation may become an important diagnostic tool in the future.

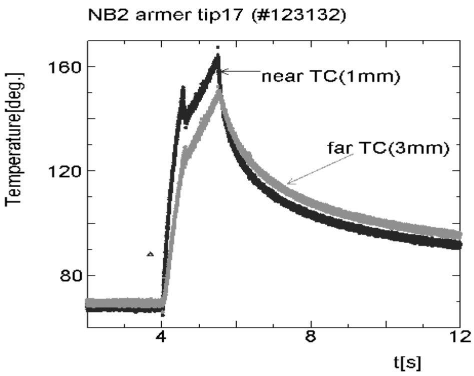

Fig. 1: Fast TC signal obtained with NB2 armer calorimeter tip No.17. They show the rapid change due to a pellet injection.

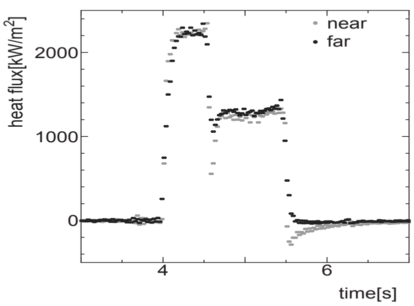

Fig. 2: Heat flux on NB2 armer tiles analyzed with Fig.1 data. (#123132, near:TC at 1mm, far:TC at 3mm)

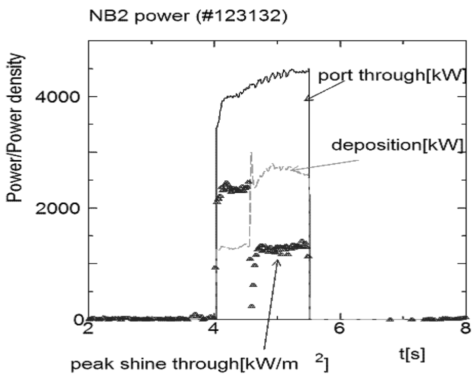

Fig. 3: Comparison with conventional beam power estimation. The shine-through power obtained with the present model is indicated by triangles.

1) H.Matsuura *et al.*, Contrib. Plasma Phys. 54, 285 (2014).

2) M.Osakabe et al, Rev. Sci. Instrum. 72, 590 (2001).

3) M.Osakabe et al, Rev. Sci. Instrum. 72, 586 (2001).