# §40. Development of the Monitoring System for Divertor Heat Flux Distribution

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Helical axis heliotron such as Heliotron J has intrinsic divertor field lines and flexibility to make both helical divertor configuration and magnetic island divertor configuration. So at the first experimental campaign of Heliotron J, two set of divertor probe arrays were installed and particle flux asymmetry or divertor foot point movement due to plasma current have been investigated[1]. Unfortunately, one probe array at port 3.3 was removed recently, since new thomson scattering system was installed there. Figure 1 shows the used probe array and probe pin setting. Near the top of the probe array, last closed flux surface is expect to have direct contact with it, and sub channels along toroidal direction are prepared there.

In this work, new divertor probe array with calorimeters to estimate plasma heat flux is designed. Type of calorimeters is selected to be the insulated thin film ones, since its size could be reduced, signal-noise ratio would be large, and mathematical model to determine heat flux would be simple. Calorimeter body volume is minimised and heat conduction loss to the support body is also reduced. So even small heat flux would induce large temperature increment and it would be easy to detect it. For large heat flux, temperature must be kept under the material limitation. The maximum heat flux density expected is similar as those measured with HDP around last closed flux surface[2]. For one plasma shot, it was reported to be about $2 \times 10^6 \mathrm{J/m^2}$. Figure 2 shows the plasma irradiated Mo film temperature increment shot by shot of Heliotorn J. Even conduction heat loss is designed to be minimized, radiation loss keeps file temperature below 1300 K. This is still pessimistic expectation, since divertor plasma leg size is assumed to be larger than film size and no conduction along film occurs.

In FY2015 experiment, old 3.5 port probe array is re-installed to 5.5 port. Unfortunately, plasma interaction point on the probe array material might move slightly. Metal impurity contents in this campaign is reported to increase. Figure 3 shows the photo image around this probe array measured during plasma discharge shot with fast camera (Photron, FASTCAM MC2.1). It clearly shows bright peak along expected divertor leg position on the array main surface and strong interaction occurs there. It should be noted that these is also another bright peak at the light side of probe array body. In the design of new probe array, carbon protecter is prepared to prevent from this side surface plasma interaction.

Fig. 1: Photo of old divertor probe array used at port 5.5. Probe pin setting was a little modified from the original[1].

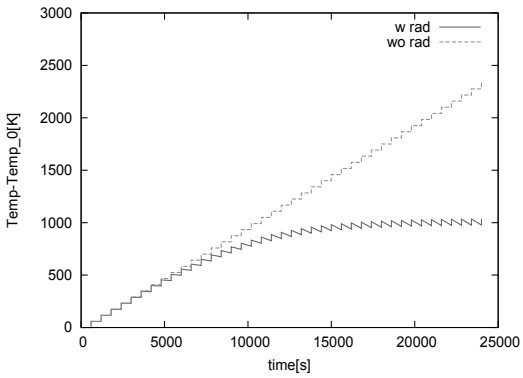


Fig. 2: Estimation of Mo thin film temperature. Green line is for perfectly insulated film case and Red line is for the case with radiation heat loss.

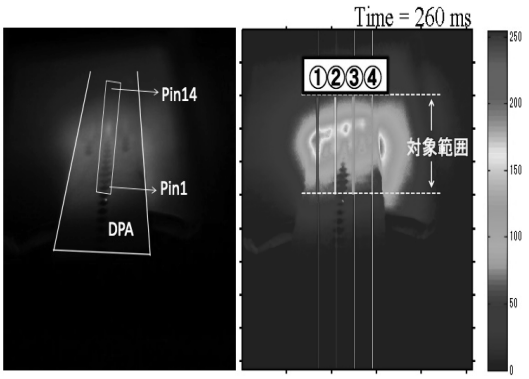


Fig. 3: Fast camera image near 5.5 port divertor probe array.

1) W.Ang *et al.*, J. Plasma Fusion Res. SERIES **5**, 292 (2002).

2) H.Matsuura *et al.*, Plasma Fusion Res. **5**, S1045 (2010).