Development of divertor heat flux monitoring system based on the exact heat balance model calculation

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For the design of fusion reactors, it is necessary to control heat flux onto plasma facing materials, especially in transit state such as ELM or detachment formation. In order to get such heat flux information, precious heat conduction model and temperature evolution data with minimum noise is necessary. Such a model assumes control volume containing temperature measurement point, and must satisfy heat conservation law. Heat flux crossing the boundary, heat generation in control volume, and internal energy evolution must be balanced. So in order to validate the obtained heat flux, not only measured temperature but also its time evolution must be reproduced with the conduction model and obtained flux. In other word, without the proper boundary condition at the backside, temperature response is completely different [1].

This means that sensors structure or cooling ability must be considered exactly in deducing plasma irradiating heat flux. Osakabe made the sensor with two thermocouples for neutral beam protection armer tiles and proposed 1D-conduction model to deduce though beam power [2]. In [3], another model was proposed to reproduce observed whole temperature evolution. These two model was compared and good agreement was confirmed for GAMMA 10/DPX end plug plasma heat flux.

Since there is time delay from plasma irradiation start in temperature signal of these sensors, time resolution of deduced heat flux has the limitation. So the sensor improvement has been conducted for GAMMA 10/PDX and Heliotron J. Moreover, there is many kinds of electromagnetic wave fluctuation around such fusion experiments, which easily contaminates thermocouple signal and also set limitation on heat flux estimation. We have developed noise protection method and extracted temperature data from raw signals.

In the conference, current heat flux measurement results and further improvement idea will be presented.

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