1P099

Heat Flux Estimation with Divertor Probes Array in Heliotron J

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1. Introduction

In Heliotron J experiment (Kyoto University), thin plate type calorimeters are installed to the Divertor Probes Array (DPA) to measure the divertor heat flux. This calorimeter consists of a thin target plate and a thermocouple (TC) attached to the backside. The raw signal from such a thermocouple is contaminated by two different noises: high-frequency noise induced by the coil current system and low-frequency large spikes owing to the magnetic field generation in the Heliotron J operation. In this study, signal processing was applied to the thermocouple signal to reduce the noises and to obtain an exact heat flux estimation.

2. Thermocouple signal processing

The subtraction between TC signals of different discharge shots can remove the low-frequency spikes noise caused by magnetic field generation. In Fig.1 orange line data is obtained by subtraction between shot no. 74586 (80ms ECH) and shot no. 74585 (40ms ECH) [1], which corresponds to temperature response for 40ms of ECH plasma shot. High-frequency fluctuations are removed by a 100Hz low pass filter.

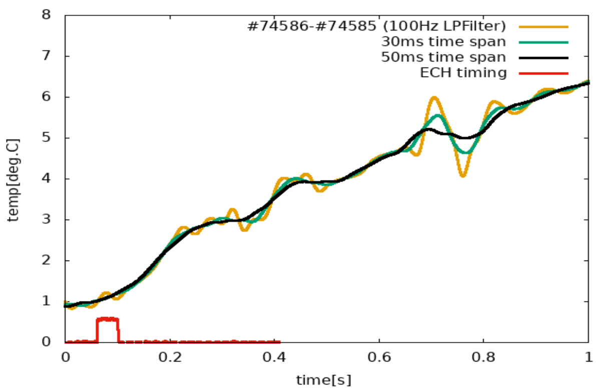

Figure 1. Subtraction of TC data for #74586-#74585 with 100Hz Low pass filter and moving least square fitting results with different time span Δt of 30ms and 50ms.

3. Heat flux estimation

Heat flux irradiates to the thin plate type calorimeter is estimated by this equation

$$Q = c\rho L \frac{dT}{dt}$$

Where *c, ρ, L,* are heat capacity, mass density, and target thickness, respectively. Even after low pass filtering, however, the temperature time derivative is still sensitive to fluctuation noise. So a small time window $[t - \Delta t,\ t + \Delta t]$ is set and, temperature signal $T(t)$ is fitted to the linear function $T(t) = at + b$. As shown in Fig.1, the wider time span Δt can lead to smoother temperature evolution (green line and back line).

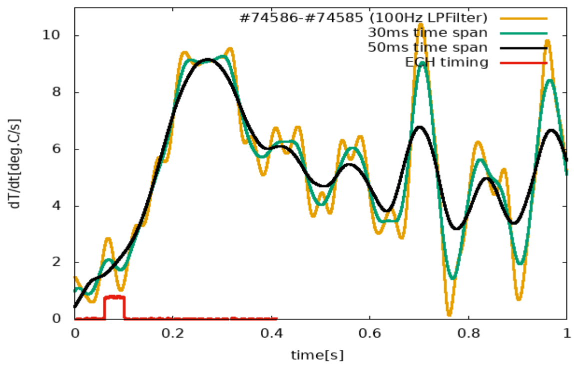

Figure 2. Time derivative (*a*) of TC signal estimated with different time span *Δt* from Fig.1 original data.

Figure 2 indicates temperature time derivative (coefficient *a*) is less sensitive to fluctuation. The peak value in $t=0.3$s corresponds to the heat flux value of ~40 kW/m^2.However, the interpolation time span *Δt* needs to be optimized for not only lowering the fluctuations but also not changing the real increment from signals.

4. Primary delay model for TC signal

In comparison to the previous Hybrid Directional Probe [2], the target thickness of present calorimeter is smaller (0.5mm) to reduce temperature response delay to the heat flux. However, heat flux data estimated shows a large delay against the ECH injection and the plasma discharge. This means that there exists time delay in TC signal to target "real" temperature. To analyze this, a primary delay model has been applied. Preliminary results will be shown in the meeting.

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