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二次元温度応答関数を用いたLHDダイバータターゲット熱流束分布解析

Analysis of heat flux profile on LHD divertor targets using 2-D temperature response function

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1 Introduction

To increase the Tritium breeding rate in DEMO reactors, number of port plugs and windows must be limited. Therefore, developing alternative methods rather than using infra-red (IR) thermography to monitor heat flux onto divertor targets is necessary. The divertor tile equipped with thermocouples (TCs) can be one of the candidates although its spatial resolution is lower in comparison to that of the IR cameras.

Temperature response functions for step-like heat flux have been applied to analyze sensor data in LHD [1] and GAMMA 10/PDX [2] experiments. In this work, we propose expanding the response functions to 2D with consideration of the boundary condition in parallel and perpendicular directions of the divertor target. The 2D model is applied to LHD divertor tile surface temperature data [3] to study the effect of monitored temperature profile spatial resolution to the reconstructed heat flux profile. This might be helpful to determine TCs embedding methods in DEMO's divertor targets.

2 2D temperature response function

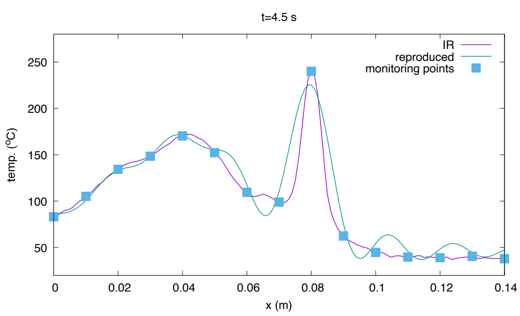

Fig. 1: Comparison of function S(x,z,t) and monitored temperature profile.

The 2D response function $S(x,z,t)$ can be generalized as:

$$\frac{S(x,z,t)}{\Delta T} = \frac{\alpha_0}{2} g_0(\frac{z}{L_z},t) + \sum_{n=0}^{n_{max}} \alpha_n g_n(\frac{z}{L_z}) \cos(n\pi \frac{x}{L_x}) \qquad (1)$$

where $\Delta T = \frac{q_0 L_z}{\kappa}$. g_0 and g_n are defined depending on back-boundary conditions. α_0 and α_n are deduced by interactive fitting to temperature data.

The spatial resolution of the IR temperature profile is reduced to check the applicability of the response function. Figure 1 indicates a comparison between IR temperature data (magenta line) and a temperature profile reproduced by the temperature response function (green line). The reproduced profile is deduced from 15 monitoring points (blue scatters). In general, it is consistent to IR temperature data. We found that the accuracy of the reproduced profile is contributed by monitoring spatial resolution, monitoring position, and series number n_{max} in the fitting process.

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References

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