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Evaluation of impurity source distribution by combination of reconstruction technique and impurity transport code

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Photon emission from carbon ions is one of major paths of power loss from magnetically confined plasma in carbon wall devices, such as JT-60U [1]. Carbon generated from the divertor target is transported and distributed, leading to complicated two-dimensional photon emission profile. The carbon source distribution along the divertor plates is one of key factors that determines spatial profiles of carbon ion emissions. In cold dense plasma, such as detached plasma, chemical sputtering on the divertor plate is dominant in carbon generation process.

In Most cases, edge transport codes assume that chemically sputtered carbon flux is proportional to incident deuterium flux onto the carbon divertor plates. However, the chemical sputtering yield depends on the incident deuterium flux and the temperature of the carbon divertor plates. It is expected that dependences affect the spatial profile of photon emission from carbon ions in the divertor plasma even with carbon ion transport. Hence distribution of the chemical sputtering yield along the carbon divertor plates should be determined experimentally and then used for an input for an edge transport code.

An experimental evaluation technique of carbon source distribution by combination of reconstruction technique and edge transport code has been developed. The integrated divertor code SONIC [2][3] with a new feature of multi-program multi-data can allow us to simulate the transport of additional small amount of carbon ion on a background plasma with carbon ion distribution previously calculated to reproduce experimental carbon emission profile. From a point source on a certain location of the divertor plate, carbon impurity is launched, transported on the background plasma and distributed spatially. Then, C II 3s-3p (658 nm) emissions from the carbon ions are synthesized along the line-of-sight of the visible spectroscopy as shown in Figure 1. This simulation provides the correspondence between the point carbon source and a spatial profile of the photon emission. This correspondence enables reconstruction of the carbon source distribution along the divertor plates from experimentally measured profile of carbon photon emission by an inverse calculation technique.

The new evaluation technique was tested in JT-60U cold dense plasma to investigate carbon source distribution on the divertor plate and the dome. It is found that distribution of the carbon source rate is not simply proportional to that of the incident deuterium flux, suggesting the temperature and/or the flux dependence affects the carbon sputtering yield. Furthermore, the reconstructed carbon source distribution is input to the background plasma simulation to revise carbon generation. The revision of carbon generation improves the reproducibility of experimental emission peak location. Iterative calculation result of the revision will also be presented in meeting.

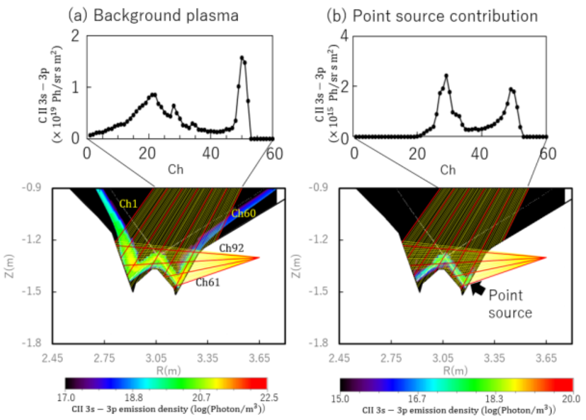

Figure 1 (lower) Two-dimensional C II 3s-3p emission profile and (upper) synthesized emission along line-of-sight of visible spectroscopy calculated (a) from background plasma and (b) from contribution of a certain carbon point source with SONIC.

References

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