Generation of Synthetic Radiation Patterns for Tomographic Studies in DTT Plasmas

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The Divertor Tokamak Test (DTT), currently under construction at ENEA Frascati, is designed to investigate power exhaust solutions and plasma-facing component protection under reactor-relevant conditions [1]. Among its diagnostic systems, bolometry will play a key role in characterizing plasma radiation, impurity studies, radiative cooling including detached divertor scenarios [2]. Since experimental measurements are not yet available, synthetic emissivity distributions are required for the development of synthetic diagnostics, including the optimization of tomographic reconstruction algorithms and to support the design of the diagnostic system. In this work, synthetic emissivity maps are generated for a set of DTT plasma scenarios obtained from ASTRA simulations, enabling a systematic investigation of the radiation patterns expected under different operating conditions. The approach combines magnetic equilibrium information with radiated power density profiles obtained from ASTRA simulations of full-power single-null plasma discharges [3]. Starting from one-dimensional radiated power density profiles, a numerical procedure has been developed to reconstruct emissivity distributions within the Last Closed Magnetic Surface. The methodology has been developed to preserve the original radial power profiles while exhibiting different poloidal radiation distributions. In particular, the study has focused on both axisymmetric configurations characterized by isoradiative flux surfaces and non-axisymmetric emissivity, which mimics fluctuations in emissivity.

The resulting synthetic phantoms have been then provided as inputs for a Maximum-Likelihood-based tomographic reconstruction code applied for DTT [4]. Preliminary analyses demonstrate that the actual diagnostic layout can reproduce both the global radiated power density profiles and the main features of the investigated emissivity distributions. In particular, good agreements have been observed between the original modelled profiles and the reconstructed ones for both axisymmetric and non-axisymmetric cases. These results demonstrate the flexibility of the proposed framework in generating physically consistent synthetic radiation scenarios during the DTT phases. They also provide a basis for future studies involving more complex radiation patterns, including those related to X-points.

References

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