Heat loads from ICRF and LH wave absorption in the SOL: characterization on JET and implications for the ITER-Like Wall

L. Colas[1], Ph. Jacquet[2], M.-L. Mayoral[2] and JET-EFDA Contributors*
JET-EFDA, Culham Science Centre, OX14 3DB, Abingdon, UK
[1] CEA, IRFM, F-13108 Saint-Paul-Lez-Durance, France.
[2] Euratom/CCFE Association, Culham Science Centre, Abingdon, OX14 3DB, UK.
** See the Appendix of F. Romanelli et al., Proceedings of the 23rd IAEA Fusion Energy Conference2010, Daejeon, Korea.*

Ion Cyclotron Resonance Frequency (ICRF) and Lower Hybrid (LH) waves can interact with the local plasma in the vicinity of the wave launchers. While the spurious localized edge power losses could be tolerated by the carbon JET Plasma Facing Components (PFCs), their impact needed assessment in preparation for the new ITER-like wall (ILW), featuring Be tiles with a power handling capability of 6MW/m^2-10s. To this end ICRF and LH-induced heat loads have been localized spatially and estimated quantitatively.

The experimental analysis relied on the deconvolution of surface temperature time traces from infrared thermography measurements on three of the five ICRF antennas, the surrounding limiters and upper dump plates. Signal processing required thermal modelling of the monitored PFCs (including possible surface layer effects) that was assessed from the measurements. Quantitative uncertainties remained due to a limited spatial resolution of IR cameras, evolving surface state of PFCs, and non-stationary heat fluxes.

When using ICRF, heat loads were observed on the antenna structures and on limiters close to the powered antennae and explained by ion acceleration in RF–rectified sheath potentials. In worst conditions the heat flux from ICRF/plasma interaction was estimated to be ~2MW/m^2 on the A2 antenna septa (i.e. ~5MW/m^2 along field lines). The absorption of high-$N_{//}$ LH wave spectral components through electron Landau damping generated fast electron beams on field lines passing in front of LH waveguides, carrying localized heat fluxes with peak intensity up to 7MW/m^2 projected on tile surface in worst cases. The estimated beam radial extension was more than 3.5cm. Various cross-couplings were evidenced between adjacent launchers: heat fluxes from an ICRF antenna onto its neighbours and modification of LH electron beams by a magnetically connected ICRF antenna. Parametric dependences were also evaluated to better understand the physics driving these wave absorption phenomena and to reduce them in operation with the ILW. In particular both IC and LH heat loads increase with the local density in front of the launchers, so that a trade-off needs to be found with efficient wave coupling. The new hardware and operational strategy associated with the ILW safety are also briefly presented.

This work, part-funded by the European Communities under the contracts of Association between EURATOM, CEA and CCFE and was carried out within the framework of the European Fusion Development Agreement. The views and opinions expressed herein do not necessarily reflect those of the European Commission. This work was also part-funded by the RCUK Energy Programme under grant EP/I501045.