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Experiments and Modelling towards Long Pulse High Confinement Operation with Radiofrequency Heating and Current Drive in EAST

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The radiofrequency (RF) heating and current drive systems play a crucial role in the mission of the Experimental Advanced Superconducting Tokamak (EAST) [1]. RF experiments and modelling were carried out on EAST in 2014-2015, within the framework of the Associated Laboratory ASIPP-IRFM, with the aim to optimise EAST long pulse high performance scenarios. H-mode plasmas have been sustained by LHCD + ICRH, in which most of the plasma current (Ip = 0.4 MA) is non-inductively driven (loop voltage < 140 mV). In the density range considered, i.e. line averaged density $\langle n_e \rangle_{lin} = 2.4 - 3.2 \times 10^{19} m^{-3}$, it is found that ˜ 50% of the power launched from the 2.45 GHz LHCD antenna may damped at the plasma edge and not entering the plasma core. This interpretation is partially consistent with RF spectrum measurements in the scrape-off layer, which indicate broader pump width for the 2.45 GHz antenna [2].
First principle quantitative modelling has been carried out for various plasma conditions with the C3PO/LUKE codes [3]. The standard ray tracing and Fokker-Planck calculations yield off-axis LH current density profile and hollow calculated hard X-ray profile, in disagreement with experimental observations. By introducing a fast-fluctuating power spectrum at the plasma edge [3], leading to a tail in the launched power spectrum at the separatrix, the calculated LH current density profile becomes more central and broad, more consistent with the toroidal MHD equilibrium one.
In addition to the experiment and modelling results obtained, EAST experiments in 2015 have revealed some operational issues important for long pulse operation. Arcing at the 4.6 GHz LHCD antenna, accompanied by emission of flakes near the antenna and divertor regions, was observed via visible cameras. Several corrective actions were therefore taken before the 2016 campaign, such as cleaning all plasma facing components from deposits and installing new LHCD guard limiters. The commissioning phase of EAST in early 2016 seemed to indicate improved power handling of the 4.6 GHz antenna, as well as improved plasma performance in general, such as facilitated access to H-mode.
[1] B. Wan et al., Nucl. Fusion 55 (2015) 104015
[2] M.H. Li et al., this conference
[3] Y. Peysson et al., Plasma Phys. Control. Fusion 58 (2016) 044008

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