Modelling of the effects of divertor recycling conditions and toroidal field direction on divertor power and particle flux asymmetries between and during ELMs with PARASOL for COMPASS-like plasmas

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Particle and energy fluxes to the plasma facing components (PFCs) during edge localized modes (ELMs) are expected to unacceptably shorten the lifetime of PFCs in ITER [1]. Non-linear MHD simulations of ELMs for ITER have shown that some aspects of empirical extrapolations, such as the broadening of the ELM power footprint at the divertor plate, may not apply at the ITER scale [2]. However, these findings are questionable because the particle and energy transport along the field lines in these MHD simulations are modelled in a fluid approximation. The ELM transport in the ITER SOL-divertor plasma is essentially collisionless given the high pedestal plasma temperature. In order to understand the consequences of kinetic effects on the power and particle fluxes to PFCs by ELMs, particle simulations with PARASOL [3] have been carried out. Initial 1-D simulations for ITER showed that the in/out asymmetry of the ELM divertor power/particle fluxes is strongly affected by the magnitude of the ELM energy loss and by the thermoelectric current flow [4]. In order to understand the 2-D aspects of the ELM energy flow to the divertor, initial PARASOL-2D simulations for COMPASS-like tokamak plasmas were carried out in stationary conditions and during ELMs including both the effects of drifts and divertor recycling [5]. It was found that: (i) the directions of the ion ∇B drift "normal" and "reversed" had a strong effect on the steady-state in/out heat/particle flux divertor asymmetries $E_{in}/E_{out} \sim 0.3$ and 1.0 respectively, (ii) the energy load was generally larger during an ELM at the inner divertor for "normal" ∇B and at the outer divertor for "reversed" ∇B. This finding is robust to modelling assumptions (recycling ratio, ELM energy loss magnitude) and in good qualitative agreement with experiment. The paper will report on improved simulations of COMPASS-like plasmas and the comparison of the results with previous COMPASS experimental results [6] and those of more recent experiments. Consequences regarding the comparison between kinetic and fluid modelling for ELMs will be described in the paper.

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