Time-dependent modelling of ELMing H-mode at TCV with SOLPS5

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This contribution describes work which builds on the recent first successful attempts at modelling the inter-ELM phase of TCV Type III ELMing ohmic H-modes using the coupled fluid-Monte Carlo SOLPS5 code [1]. These simulations have been extended to include both a time dependent model, allowing ELMs to be described, and poloidal drifts, permitting a study of their effect on divertor asymmetries and parallel flows in the ELM-free phase. The simulations are constrained by experimental upstream Thomson Scattering (TS) and Langmuir probe (LP) T_e and n_e profiles. Modelled divertor profiles are compared with LP and fast IR camera measurements at the targets.

The typical single null lower (SNL) ohmic H-mode discharge at TCV has I_p = 400 kA, n/n_{GW}~0.3 (n_{GW} is the Greenwald density) and ~1s steady-state ELMing phases with f_{ELM}~200 Hz, where each ELM exhausts only a few 100 J of plasma stored energy (~1-2% of W_{dia}). Edge TS measurements show that these ELMs provoke very little decrease in the pedestal T_e, but a larger decrease in n_e and are thus more convective in nature (so that $T_e\Delta n_e$ is responsible for most of the energy outflux). Their benign nature and the relatively collisional TCV scrape-off layer (SOL) makes the application of the fluid plasma simulation more appropriate since the ELMs are insufficiently large for kinetic effects (such as parallel heat flux limits or varying sheath heat transmission coefficients) to be significant. The ELM is simulated as an instantaneous increase in the anomalous radial transport coefficients with a Gaussian poloidal distribution centred on the outside midplane region and over duration of 100 μs such that the total energy expelled is consistent with the experimentally estimated typical ELM energy loss. Although the steady state ELM-free solution can be used as the pre-ELM condition, these time dependent ELM simulations are challenging, requiring that the Monte-Carlo neutral code (Eirene) be run with time steps equivalent to those of the fluid code (B2.5) and sufficiently small to achieve adequate resolution of the ELM.

First attempts have also been made to include poloidal drifts in the inter-ELM simulations with encouraging trends regarding the response of divertor target asymmetries seen in experiment but only thus far observed in the drift free simulations as a consequence of magnetic geometry in the unconventional SNL TCV configurations. Results will be presented in comparison with target plate profiles and with measurements of parallel SOL flows.

[1] B. Gulejova et al., to be published in J. Nucl. Mater. (2007)