SOLPS5 modelling of ELMing H-mode on TCV

B. Gulejová, R. A. Pitts, M. Wischmeier[b], D. Coster[b], R. Behn, J. Horacek, J. Marki

CRPP-EPFL, Association EURATOM-Confederation Suisse, Ch-1015 Lausanne. Switzerland

[b]*Max-Planck Institut für Plasmaphysik, EURATOM-Association, Boltzmann Str.2, D-85748, Garching, Germany*

Although ohmic H-modes have long been produced on the TCV tokamak and the effects of ELMs at the divertor targets studied in some detail [1], no attempt has yet been made to model the scrape-off layer (SOL) in these plasmas. This contribution describes details of the first such efforts to do so. Simulations with the coupled fluid-Monte Carlo SOLPS5 code are constrained by careful upstream Thomson scattering and fast reciprocating Langmuir probe profiles and the results compared with measurements at the divertor targets.

Recent experiments with high power ECRH at the third harmonic have produced large, possibly Type I ELMs on TCV for the first time, but in standard ohmic H-modes operating close to the L-H transition threshold power, only Type III ELMs are obtained. Typical single null lower H-mode discharges have I_p = 400 kA, n/n_{GW} ~ 0.3 and steady ELMing phases with f_{ELM} ~ 100 Hz, where each ELM exhausts only a few 100 J of plasma stored energy. As such, these ELMs cannot be compared with larger events typical elsewhere regarding the magnitude of target power fluxes etc., but their behaviour with respect to transport in the SOL and interaction with the targets is no different. In fact, their benign nature makes the fluid plasma simulation in some ways more appropriate since the ELMs are insufficiently large to require a true kinetic simulation and are likely to be less perturbing in the sense of parallel heat flux limits and variations in sheath heat transmission coefficients.

The modelling attempts described here broadly follow the approach in [2], seeking first the closest match to upstream experimental profiles during inter-ELM phases using a step-like ansatz for the perpendicular particle and heat diffusivities (D and $\chi_{i,e}$) in the edge and SOL regions, but also introducing a poloidal variation of the transport coefficients both in the main chamber and divertor. This is extremely important in TCV, where the unconventional divertor geometry means that care must be taken in the presence of steep H-mode edge barriers to tailor differently the transport in this region compared with the core. Similar reasoning applies even more to the ELM itself, which is known to burst into the SOL in the outboard, unfavourable curvature region and is thus extremely poloidally localised. This has also been accounted for in the simulations which, as in the earlier SOLPS5 attempts to simulate Type ELMs in JET [3], model the ELM as an instantaneous local increase in the transport coefficients and simulate the subsequent SOL transport in a time dependent way.

Good agreement is found between code and experiment in the inter-ELM phase. Experimentally, these Type III ELMs are too rapid for comparison on an individual ELM basis. Instead, many similar events are coherently averaged and simulation compared with power and particle flux measurements at the divertor targets and line integrated observations of recycling in the divertor volume obtained using a new fast AXUV diode camera system filtered for Lyman-alpha emission.

[1] R. A. Pitts et al., Nucl. Fusion 43 (2003) 1145

[2] A. Kallenbach et al., Plasma Phys. Control Fusion **46** (2004) 431

[3] F. Subba et al., 30th EPS, St. Petersburg, 2003 ECA Vol. **27A**, P-2.85