Contribution ID: **148** Type: **Poster**

The physics of the heat flux narrow decay length in the TCV scrape-off layer: experiments and simulations

Friday 21 October 2016 14:00 (4h 45m)

Dedicated experiments have been performed in TCV to investigate the heat flux onto the first wall of inboard limited L-mode plasmas. An enhancement of the heat deposition, measured with an infrared (IR) camera, is observed in the vicinity of the contact point. Indeed, for all the discharges, the parallel heat flux profile exhibits a double decay length in the scrape-off layer (SOL), with a short decay length of about 3 mm and a longer one of about 18 mm. The enhanced heat load in the vicinity of the contact point could be a problem for ITER if it is too large therefore its first wall design has been recently revised. It is shown that the power deposited onto the inner wall due to the narrow feature increases mainly with the electron temperature, and decreases with plasma density, current and elongation. Dedicated numerical nonlinear simulations using the code GBS with realistic TCV parameters have been performed. The simulated parallel heat flux profiles on the limiter are in qualitative agreement with the experimental ones obtained by means of infrared thermography, showing a double scale length. Complementary experiments are currently being performed to better understand the physics of the narrow heat flux decay length. For Deuterium and Helium plasmas, inboard limited plasmas are investigated as a function of the plasma current, the plasma density and the plasma shape. In particular, TCV is well suited to investigate the effect of the elongation and the triangularity. The ion saturation current and the floating potential are measured with wall-imbedded Langmuir probes and will complement the heat load measurements onto the inner wall with an upgraded IR thermography system. In addition, measurements of the ion saturation current, floating potential, Mach number and electron temperature and their fluctuations are done with a recently installed 10 tip reciprocating probe. While the narrow SOL width is clearly seen by the IR thermography on the inner wall, if it is present in the outboard midplane SOL, its measurement with the reciprocating probe strongly depends on the accuracy of the LCFS location. Different analysis methods, from the reciprocating probe data, are under evaluation to reduce the uncertainty of the LCFS position.

Paper Number

EX/P8-25

Country or International Organization

Switzerland

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Session Classification: Poster 8

Track Classification: EXC - Magnetic Confinement Experiments: Confinement