SOL profile and transport and relation to divertor conditions in H-Mode plasmas: a cross-machine comparison

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Plasma Exhaust and Plasma Wall Interaction (PWI) are subjects of intense studies in the context of fusion energy research for the understanding of the amount of heat loads, tritium retention, and the lifetime of different Plasma Facing Components. On this context in order to ensure reliability of predictive edge modeling for future devices, it is mandatory to determine the transport properties of the Scrape Off Layer (SOL) in condition close to the operational point foreseen for ITER and future devices. From the ITER divertor perspective, to keep the power fluxes densities acceptable for target material, high neutral pressure and partial detachment are needed to ensure maximum tolerable loads based on avoidance of W recrystallization [1]. Thus experimental investigation of SOL transport needs to be extended also to these operational regimes.

The SOL properties results from a competition between sources and losses parallel and perpendicular to the magnetic field: it is strongly dominated by the presence of turbulent filaments, which strongly contribute to particle and energy losses both in L- and H-mode regimes.

In present experiments the regimes matching ITER divertor operational point are obtained with high gas throughput leading to high density regimes. In L-Mode these operational conditions are associated to the appearance of a *density shoulder* i.e. progressive flattening of the density scrape off layer profile at high density [2–5]. It has been proved that density shoulder appear starting from high-recycling regimes and become broader after target density rollover [10], even though differences have been observed depending on divertor geometry [0], or if high recycling condition are achieved through impurity seeding rather than high fuelling [0, 7]. The density shoulder is actually accompained by an increase of the filamentary activity [5, 7, 6], together with an increase of their associated convective transport [8], Preliminary investigations suggested that similar inter-ELM SOL density profile broadening is observed in H-mode as well [10, 8, 9], with a stronger dependence on the neutral pressure [10]. Furthermore in case of highly dissipative divertor with high gas throughput the pedestal profile modification move the plasma towards a small-ELM regime [0] wheare a clear increase of the SOL density decay length is observed.

Despite the large experimental effort, a comprehensive understanding of the mechanism leading to an H-mode shoulder formation is presently lacking and this motivated a joint experimental within the european tokamaks. The present contribution will indeed report results obtained in a coordinated effort within 3 different devices, JET, ASDEX-Upgrade (AUG) and TCV focusing on the SOL profile evolution in different divertor recycling states, correlating the observed profile modification with different turbulent SOL plasma transport. 1 shows the typical plasma shapes used in the present investigations. In JET, 2MA/2.3T low-δ plasma with 16 MW of applied NBI power were analyzed, where plasma divertor shapes were investigated in horizontal or vertical targets in order to take advantages of the different neutral compression achieved [0]. Plasma fuelling in the different divertor configurationx has been varied to explore different recycling states determined by spectroscopic measurement combined with langmuir probes embedded on the tiles. On AUG 0.8MA/2.1T scenarios were investigated where different power levels (from 3 to 17 MW) and different fuelling schemes were used in order to explore a wide range of divertor parameters and recycling state. Finally on TCV high-δ low current (0.18 MA) discharges were investigated with an additional 1 MW of NBI heating where different fueling levels and fueling scheme (main chamber or divertor fuelling) were used.

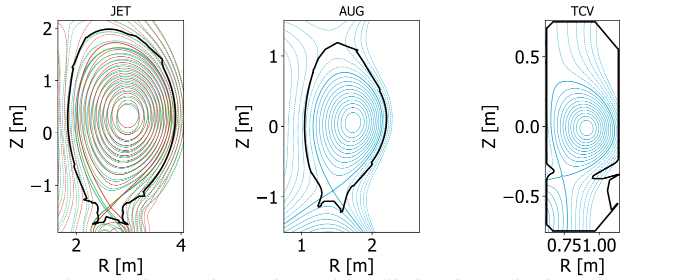

Figure 1: Plasma shapes investigated in all the three devices. For JET the 3 different configuration are shown as well

Acknowledgment

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

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