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Near LH Grill Density Variations as a Function of Gas Puff and LH power

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** See annex of Watkins M. et al, Proc. 21th IAEA Conf. 2006, China, paper OV/1-3.*

We present numerical modeling of near Lower Hybrid (LH) grill Scrape-off-Layer (SOL) plasma density variations $n_{e,SOL}$ as a function of gas puff and LH power with the fluid code EDGE-2D. The computational grid was created for the JET #66972 shot [1]. The gas ionization is difficult to model because it is a 3D problem, the antenna, first wall components and gas pipe have finite dimensions in the toroidal direction, but a 2D poloidal – radial model can provide useful insights. The code includes direct SOL ionization by the LH wave [2]. It is assumed that the ionization by the LH wave is produced due to the local SOL electron heating by the wave. A fraction of power lost in SOL increases the SOL Te, which in turn increases ionisation in the SOL. Locally generated fast particles can also participate in the heating process. EDGE-2D [2] is modified so that it can model a SOL up to 10 cm or more. Modelling of the private space in front of the grill needs to introduce limiter-like features into EDGE-2D. This is attempted in the present contribution. The poloidal limiters are modeled as spatially localized sinks, where the recombination is artificially strongly enhanced. The 2D modeling with poloidal limiters acting as sinks allows to distinguish the private space of the grill between the poloidal limiters in the modeling. In this way, it is possible to investigate the impact of parameters such as gas puffing rate, gas puffing poloidal location, LH power dissipated in the SOL and radial location of the LH dissipated power (e.g., radially near the grill mouth, or further away from the grill mouth), separately on the $n_{e,SOL}$ in the private launcher SOL and in the private RCP (Reciprocating Probe) SOL space. However, the gas puff location in the 2D modeling is always magnetically connected to the LH grill private space, Fig. 1. It is therefore impossible to distinguish between magnetically connected and not-connected gas puffing. Similarly, the RCP location is always connected to the LH grill private space. Obviously, there is a need for a 3D modeling code, to obtain a more quantitative description of the trends obtained by the 2D model.

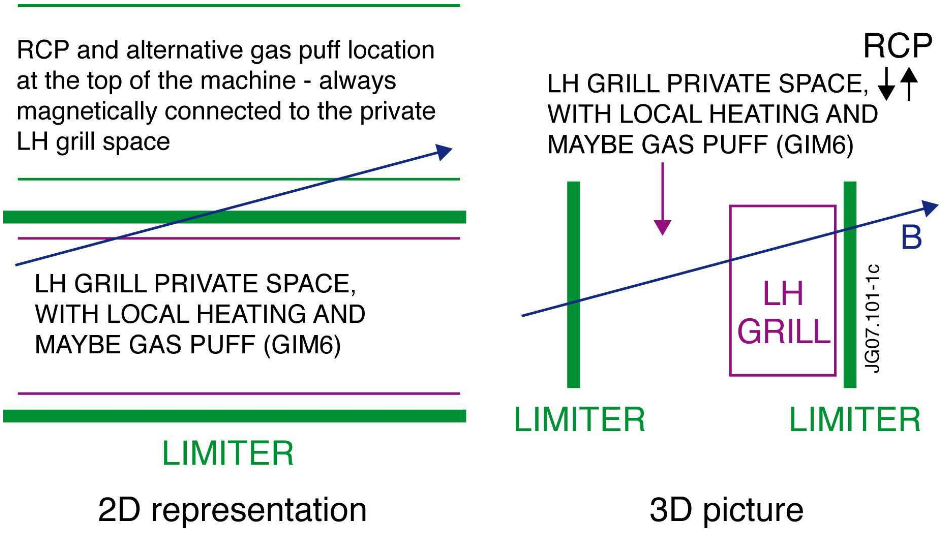

Fig. 1. Schematic representation of the 2D and 3D configuration of the LH grill and RCP.

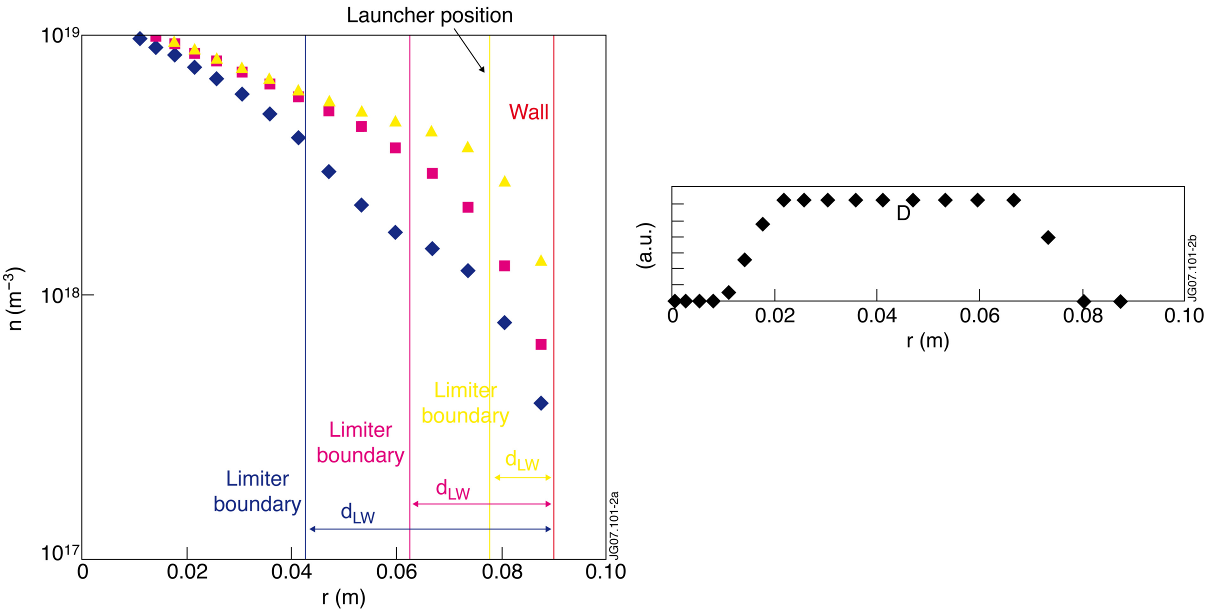

*Fig. 2. Left figure: Effects of the limiter boundary location. x- axis: distance from separatrix in m. Right figure: Profile "***D***" of the LH field dissipation [a.u.]. Series 1 (blue diamonds): d_{LW} =4.75 cm (grill ~ 3 cm behind the limiter), series 2 (magenta rectangles): d_{LW}= 2.75 cm (grill ~ 1 cm behind the limiter), and series 3 (yellow triangles): d_{LW}= 1.25 cm (grill is ~ flush with the limiter).*

Figure 2 then shows $n_{e,SOL}$ in LH private SOL as a function of the limiter boundary location (changing the distance limiter – wall d_{LW} is similar to changing the distance launcher-limiter) Gas puff is 1e22 el/s near the outer mid-plane (OMP), i.e., by "GIM6". Heating in front of the grill is 150 kW. The assumed profile of the LH SOL dissipation used in this contribution is shown as profile "**D**" on the bottom figure. The upper figure shows the $n_{e,SOL}$ in the OMP (between limiters acting as a sink) in the launcher private SOL. The next Figure 3 shows $n_{e,SOL}$ in the limiter sink (top figure) and at the RCP location (bottom figure) as a function of the limiter boundary location. Gas puffing and heating is the same as in Fig.2.

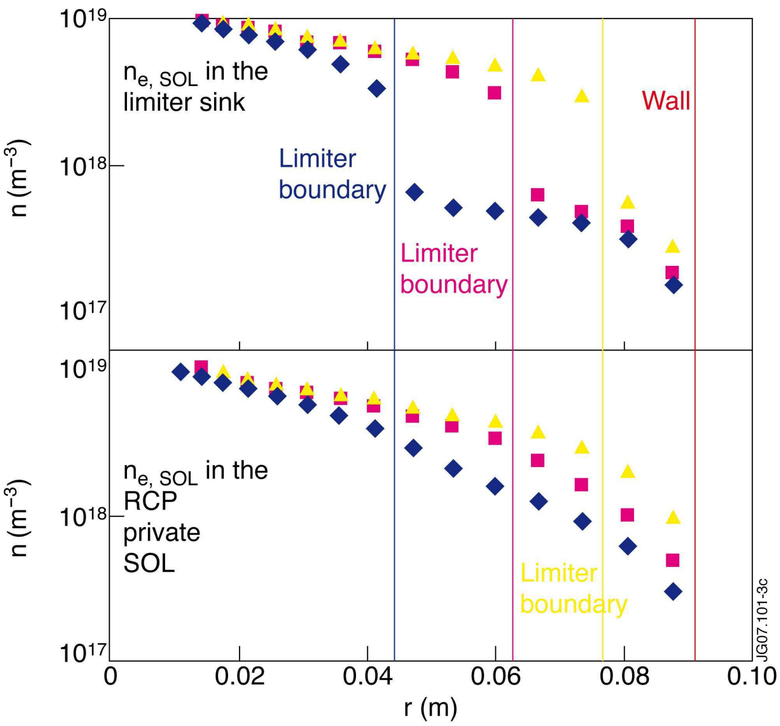

Fig. 3. Profiles of $n_{e,SOL}$ near limiters and in the RCP private SOL.

Figure 4 shows $n_{e,SOL}$ in the OMP (upper figure) as a function of the heating and puff rates, with d_{LW} = 4.75 cm; on the bottom figure there are neutrals profiles in the OMP. Let us note that joined heating and gas puffing tend to flatten the $n_{e,SOL}$ profile, cf. the cyan curve. It can be demonstrated that the flatness of the $n_{e,SOL}$ profile depends also on the assumed profile of the LH wave dissipation. The nearer to the grill the LH power is dissipated, the flatter the $n_{e,SOL}$ profile is. Figure 5 shows $n_{e,SOL}$ in the OMP in grill private SOL, as a function of the gas puffing location, d_{LW} = 1.25 cm, with heating in front of the grill = 150 kW.

Main results: Both gas puffing and heating/ionization are important in raising the density in the far SOL. Although OMP seems to be the best location for gas puffing, the other two gas puffing locations (near RCP, at the top) also give an increase in $ne_{,SOL}$ with heating. This is important for ITER, where top gas puffing is currently planned. The modeling shows the flattening of the far $ne_{,SOL}$ profile, which is observed in experiments [1].

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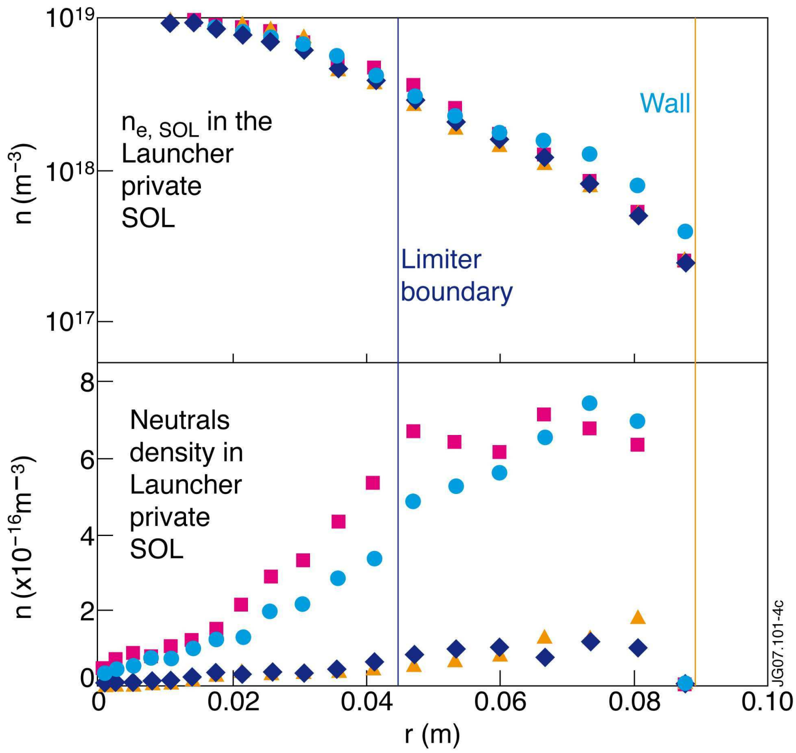

Fig. 4. Upper figure: $ne_{,SOL}$ as a function of the heating and puff rates, at the bottom figure there are corresponding neutrals profiles in the OMP. Blue diamonds: 0 heating, 0 puff, magenta rectangulars: 0 heating, puff = 1e22 el/s, yellow triangles: heating = 150 kW, 0 puff, Cyan circles: heating = 150 kW, puff = 1e22 el/s.

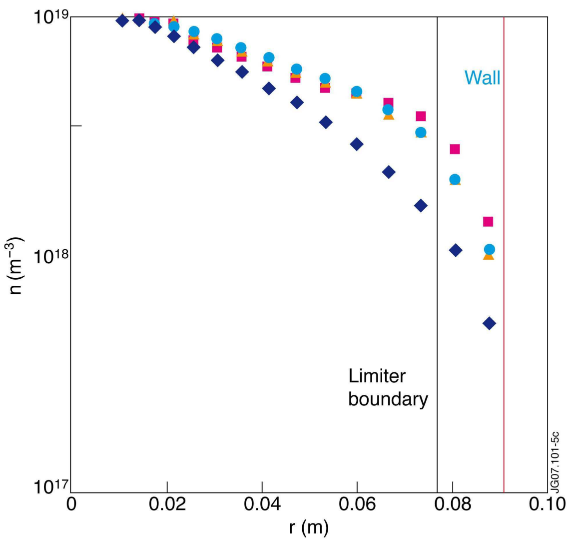

Fig. 5. Profile of $n_{e,SOL}$ in the OMP in grill private SOL, as a function of the gas puff location. Blue diamonds: 0 heating, 0 puff, magenta rectangulars: gas puff 1e22 el/s near OMP, yellow triangles: gas puff near RCP, cyan circles: gas puff at the top.

[1] M. Goniche *et al*., this Conference; K. Rantamäki *et al*., 17th USA RF Conference 2007.

[2] V. Petrzilka *et al*., submitted into Nuclear Fusion.