35th EPS Conference on Plasma Phys. Hersonissos, 9 - 13 June 2008 ECA Vol.**32D**, P-1.106 (2008)

On SOL Variations as a Function of LH Power

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Numerical modeling is presented of the JET Scrape-off-Layer (SOL) time evolution with the fluid code EDGE2D. The code includes direct SOL ionization by the LH wave [1] and effects of near LH grill limiters [2]. In [1] and [2], a stationary state was modeled. In contrast, the original contribution here is that we also explore for the first time the SOL time evolution when switching on/off the LH and near grill gas puff. Our interest in this problem was originally motivated by recent Tore Supra measurements. Shorter (less than

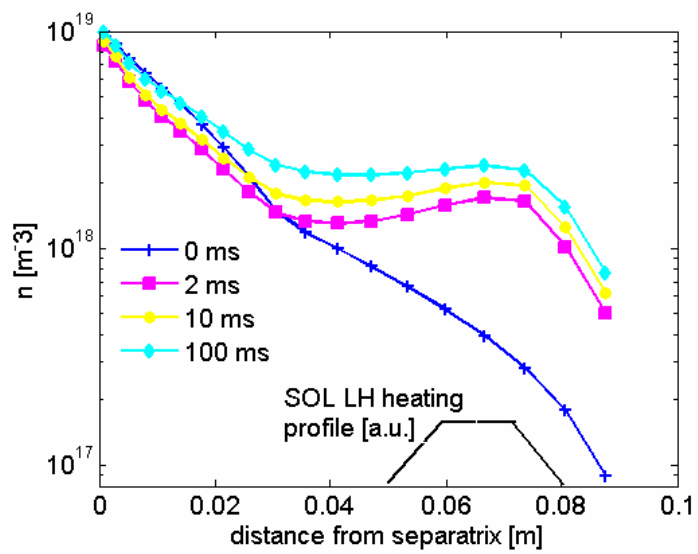

Fig. 1. OMP plasma density at switching on the LH field – 50 kW dissipated in front of the grill, gas puff 1e22 el/m^3.

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* See annex of Watkins M. et al, 2006 Proc. 21th Int. Conf. on Fusion Energy 2006 (Cheng Du, China, 2006) (Vienna: IAEA) paper OV/1-3.

about 10 ms) and longer (about 50 ms) characteristic times for the SOL plasma density evolution in locations magnetically connected and not-connected to the LH launcher are measured by frequency swept reflectometry on Tore Supra during LH power modulation. We realized that similar effects can be present also on JET. On Fig. 1 and 2, we can see the plasma density changes at the JET OMP (Outer mid-plane) and at the RCP (Reciprocating probe) locations at switching on the LH field. The grill mouth is assumed to be at 8 centimeters from the separatrix, 1 cm retracted behind the limiters.

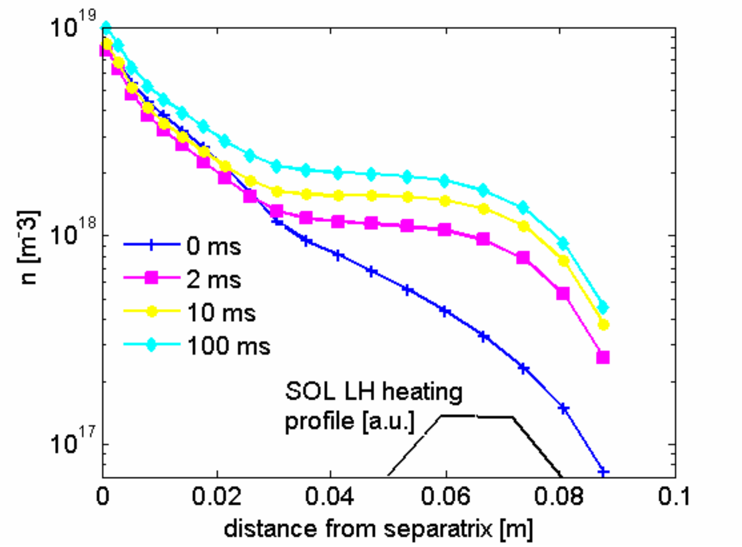

Fig. 2. RCP location plasma density at switching on the LH field – 50 kW dissipated in front of the grill, gas puff 1e22 el/m^3.

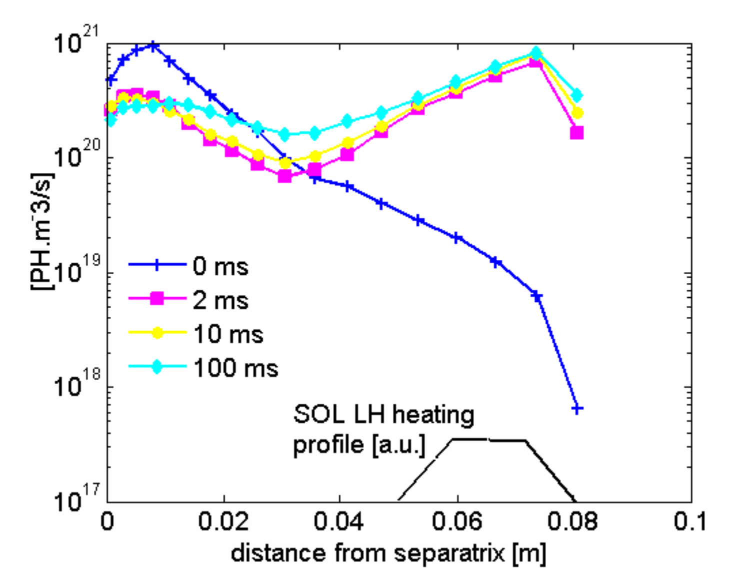

Fig. 3. OMP H_alpha radiation density at switching on the LH field – 50 kW dissipated in front of the grill, gas puff 1e22 el/m^3.

The SOL parasitic absorption takes place near the grill mouth [1,2], between 5 and 8 centimeters from the separatrix. At switching on/off the LH field or the gas puff, the plasma density reaches equilibrium after 50 -100 ms. More far from the separatrix, the equilibrium is reached more quickly (in about 10 ms) than more near to the separatrix.

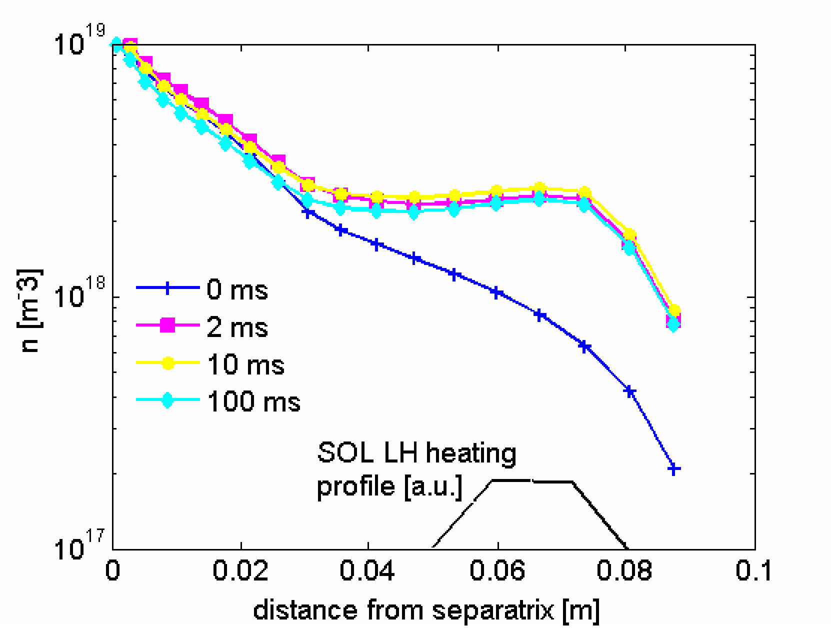

Fig. 4. OMP plasma density at switching on the gas puff 1e22 el/m^3; LH field – 50 kW dissipated in front of the grill

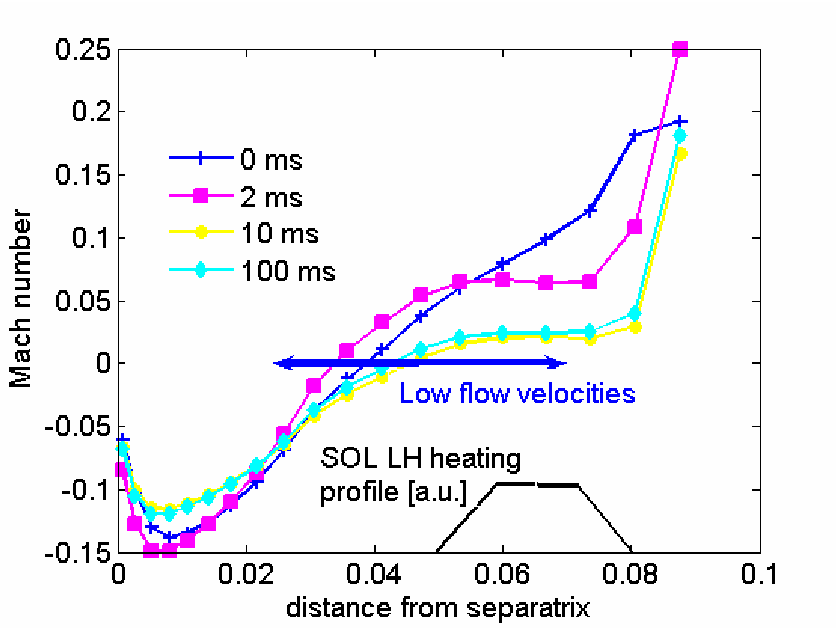

Fig. 5. Flow Mach number variations at switching on the gas puff 1e22 el/m^3; LH field – 50 kW dissipated in front of the grill.

Similar temporal behavior is exhibited also by the H_alpha radiation intensity, Fig. 3. The density rises at LH switching on at a constant gas puff because of the direct LH ionization in the SOL. On Fig. 4, there is illustrated the temporal behavior of the plasma density at switching on the gas puff, when the LH is on. Then, at switching off the LH/or gas puff at constant gas puff/or LH power, the plasma density is decreasing to its previous values, again more quickly far from the separatrix, where the parasitic LH absorption and corresponding direct LH SOL ionization are taking place. The plasma flows and their temporal behavior can be seen on Fig. 5. The flow velocity is rather low in the region denoted by the blue arrow in Fig. 5, what can perhaps explain the relative slower relaxation times in some parts of the SOL.

Conclusions: More far from the separatrix, where the LH parasitic dissipation and corresponding local SOL heating takes place, the computed plasma density increases with time at the onset of the local LH wave ionization with a short characteristic time of less than about 10 ms. Closer to the separatrix, the plasma density approaches the new equilibrium with a several times longer characteristic times. Naturally, the SOL plasma variations at LH switching on/off are larger with a larger near grill gas puff and also with larger variations of the LH power (not shown on the figures). Evolution of the SOL neutral particles density and of other SOL parameters was also explored. The results are relevant to JET LH coupling and modulated LH power experiments, and corresponding measurements of SOL temporal variations are being prepared. It may be important to take into account the computed JET SOL relaxation times in evaluation of LH coupling, LH driven currents and other parameters.

This work, supported by the European Communities under the contract of Association between EURATOM/IPP.CR Prague, was carried out within the framework of the European Fusion Development Agreement. The views and opinions expressed herein do not necessarily reflect those of the European Commission. V. Petrzilka acknowledges partial support by the Czech Grant GACR 202/07/0044 and by MSMT CR Grant# LA08048. Advice of J. Spence concerning EDGE2D is also gratefully acknowledged.

[1] V. Petrzilka et al., 33rd EPS Rome 2006 Conference, paper P-1.067.

[2] V. Petrzilka et al., 34th EPS Warsaw 2007 Conference, paper P-4.100.