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Simulations of filamentary transport in the SOL and estimations of the power deposition profile

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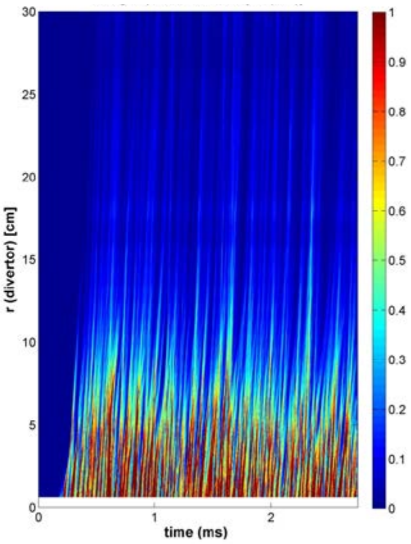
The transport in the edge region and through the scrape-off-layer (SOL) at the outboard mid-plane of magnetically confined toroidal plasmas is known to be strongly intermittent and dominated by filamentary structures of enhanced plasma pressure – plasma blobs. These structures are generated in the edge region and propagate through the SOL with velocities up to a few percent of the ion acoustic speed. They play a significant role in setting up the plasma profiles in the SOL and for the power deposition profiles. We have investigated the transport dynamics, the ensuing density and pressure profiles in the SOL, and estimated power depositions on plasma facing components by applying the HESEL code. HESEL is an energy conserving four-field Braginskii model governing the dynamical evolution of generalized vorticity, density, electron, and ion pressures [1]. The parallel dynamics in the SOL is parametrized and different divertor conditions - attached or detached - are mimicked by applying sheath boundary conditions to either the full potential field or only its profile, respectively. This significantly affects the evolution of the plasma blobs and thus the transport of energy and particles through the SOL. We further observe an asymmetry between the ion and electron temperature both in the blob structures and in the background SOL plasma. Ion temperatures are typical 2-4 times higher than the electron temperature, which is a result of different parallel and perpendicular dissipation rates. The power deposition profile at the divertor is obtained by mapping the mid-plane pressure profiles to the divertor region along the magnetic field lines [2], see figure (for the "attached" case) where the traces of the individual blob structures are clearly identified. We have investigated different L-mode scenarios including cases with high upstream SOL density – the so-called "shoulder" formation - recently characterized in JET and ASDEX Upgrade [3]. Within the present model we observe - for the same divertor condition – the formation of a 'shoulder' in the density profile by increasing the connection length, thus decreasing the efficiency of the SOL ability to remove plasma from the outboard midplane.

Power deposition at divertor (MJ/sm^2)



HESEL is embedded into a Kepler workflow developed within the EUROfusion Integrated Modelling framework [2]. This consists of a workflow allowing access to experimental Langmuir probe data as well as discharge parameters.

[1] J. Madsen et al. Phys. Plasmas **23**, 032306 (2016).
[2] A.H. Nielsen et al. 42nd EPS Conference on Plasma Physics, Lisbon, Portugal 2015, P1.105, ECA Vol. **39E.**
[3] D. Carralero et al. J. Nucl. Mat. **463,** 123, (2015); Phys. Rev. Lett. **115**, 215002 (2015).

Preference: ☐X Oral in session: *Understanding power decay length in the SOL*