Impact of self-consistent neutrals dynamics and particle sources on edge plasma transport and turbulence in 3D first principle simulations

P. Tamain[a], C. Baudoin[ab], H. Bufferand[a], G. Ciraolo[a], D.-M. Fan[c], N. Fedorczak[a], D. Galassi[b], Ph. Ghendrih[a], B. Luce[ab], Y. Marandet[c], N. Nace[ab], E. Serre[b] and F. Schwander[b]

[a] *CEA, IRFM, 13108 Saint-Paul-lez-Durance, France.*
[b] *Aix-Marseille Univ, CNRS, Centrale Marseille, M2P2, Marseille, France.*
[c] *Aix-Marseille Univ, CNRS, Centrale Marseille, PIIM, Marseille, France.*

Email of corresponding author: patrick.tamain@cea.fr

In tokamaks, heat and particle exhaust as well as confinement depend on the interplay of multi-physics phenomena occurring in the boundary of the plasma. A comprehensive modelling of the physics at play should involve a consistent description of plasma transport - including turbulence -, plasma-wall interaction, atomic and molecular physics, all treated in realistic magnetic and wall geometries. Due to the complexity of such modelling, the state of the art has for long been compartmentalized between mean-field codes, lacking a self-consistent description of transverse transport, and turbulence codes, ignoring neutrals physics and most often in simplified geometries. In the latter case, turbulence simulations have to be driven by an incoming flux of heat and particles arbitrarily imposed by the user, usually located at the inner boundary of the simulation domain.

In this contribution, we report the results of first principle simulations including self-consistently turbulence and neutrals physics. The TOKAM3X-EIRENE code package is used for that purpose, combining a fluid-drift description of the plasma and a kinetic description of neutrals. We analyse simulations run in an idealized circular limited geometry before turning to realistic diverted cases. In both cases, a comparison is made to simulations flux-driven from the inner boundary of the simulation domain. We show that the change of the location of the particle source from the core to the separatrix in the limiter case and to the target plates in the divertor case impacts both the equilibrium profiles and turbulence. In the closed field lines region, the need to evacuate power without an associated particle flux leads a flattening of density gradient and a change of turbulence nature from RBM-like to ITG-like. The ionization source due to recycling neutrals is found to fluctuate due to the interaction of the neutrals cloud with hot and dense turbulence filaments. The impact of these fluctuations on the non-linearities of atomic and molecular terms is evaluated. A density scan is also performed to show the dependence of these effects with scrape-off layer density regimes.