SOLPS modeling of impurity seeded plasmas in ASDEX Upgrade

F. Hitzler[1,2], M. Wischmeier[1], F. Reimold[3], M. Bernert[1], X. Bonnin[4], A. Kallenbach[1], the ASDEX Upgrade Team[5] and the EUROfusion MST1 Team[6]

[1] *Max-Planck-Institut für Plasmaphysik, 85748 Garching, Germany*

[2] *Physik-Department E28, Technische Universität München, 85747 Garching, Germany*

[3] *Forschungszentrum Jülich, 52425 Jülich, Germany*

[4] *ITER Organization, 13067 St. Paul-lez-Durance, France*

[5] *See author list "A. Kallenbach et al., 2017 Nucl. Fusion 57 102015"*

[6] *See author list "H. Meyer et al., 2017 Nucl. Fusion 57 102014"*

Power exhaust is a critical issue for future fusion devices. The unmitigated power loads at the divertor targets can easily exceed the foreseen material limit of $10\,\mathrm{MWm^{-2}}$. A reduction of these power loads can be achieved by controlled impurity seeding. The resulting high densities and low temperatures in the divertor lead to the so-called detachment state, which is characterized by strongly mitigated target particle and power fluxes. In order to optimize the impurity seeding recipe and to identify the potential of mixing impurities to maximize the impurity radiation while minimizing the impact on the pedestal validated numerical simulations are crucial.

In this contribution impurity seeding of nitrogen and argon is investigated using the SOLPS code package for interpretative simulations, comparing the modeling results to experimental data from ASDEX Upgrade. Impurity seeding scans were performed with constant perpendicular diffusive transport coefficients, neglecting drifts and neo-classical transport effects. The modeling results show a change of the impurity distribution with increasing seeding rate. With the onset of detachment in the inner divertor the impurity radiation and density on the low field side suddenly drop, while they increase on the high field side and in the confined plasma region. This leads to a temperature drop in the confined region in the order of 12 % for argon, and 2 % for the nitrogen seeding cases at comparable divertor conditions. The mechanisms causing this redistribution are examined in this work. The stronger effect of argon can partly be explained by its radiation efficiency. Expectations from atomic databases yield argon radiation efficiencies in coronal equilibrium which are much higher than those for nitrogen. Comparing the calculated radiation efficiencies to the modeling results, it can also be observed that impurity transport in the simulation leads to a deviation from the coronal equilibrium which results in so-called non-coronal enhancement, i.e. enhanced radiation efficiencies.

Focusing on the comparison of radiation patterns using synthetic diagnostics and spectroscopic data, the code results will be validated with selected ASDEX Upgrade H-mode discharges.