Numerical modelling of detached plasma experiments with differential pumping in Magnum-PSI

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Sufficient decrease of plasma pressure, ion and heat flux along the scrape-off layer of a tokamak fusion reactor are imperative to ensure the survival of the divertor tiles. This specific condition, defined as detachment, occurs within low temperature, high density, highly recycling plasma that can also be realized in linear plasma devices such as Magnum-PSI [1]. In Magnum-PSI, high recycling is achieved by utilizing differential pumping across three vacuum chambers. Experiments have been conducted to mimic detachment in the Magnum-PSI linear device by varying the neutral background pressure at the chamber of the recycling target via H_2 gas puffing [2], while the hydrogen plasma source parameters are kept constant across the experiments. Numerical modelling is carried out to help gain further insights regarding the physics behind detachment.

The experiments are benchmarked with a coupled fluid-kinetic approach using the B2.5- EUNOMIA code package [3]. EUNOMIA is a Monte Carlo neutral simulation optimized for linear geometry. Thomson scattering measurements without gas puffing are used as a plasma boundary condition at the source in the simulation, and the gas pressure in the target chamber will be varied. The resulting electron density and temperature simulated profiles near the target are compared with profiles measured in experiments. This paper presents the result of the benchmark tests, and identifies the collisional processes and other physical effects relevant to the detached plasma state.

References

[1] H. J. N. van Eck et al., Plasma Sources Science and Technology **20**, 4 (2011)

[2] I. Classen et al., Abstract, 59th Annual Meeting of the APS Division of Plasma Physics, http://meetings.aps.org/link/BAPS.2017.DPP.PP11.77 (2017)

[3] R. C. Wieggers et al., Contributions to Plasma Physics, **52**(5-6):440-444 (2012)