SolEdge2D-Eirene simulations of Pilot-PSI plasmas

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The exhaust of power is a crucial issue for ITER and next step fusion devices [1]. Predictions for divertor operation are heavily dependent on edge plasma simulations typically utilizing a fluid plasma code in combination with a Monte Carlo code for neutral species. Therefore it is important to validate the codes using well-diagnosed experimental setups. The Pilot-PSI device offers a high density ($n_e \sim 10^{19} - 10^{21}$ m$^{-3}$), low temperature ($T_e < 5.0$ eV) plasma comparable to that expected in the ITER divertor region. In this work, hydrogen plasma discharges in Pilot-PSI have been modelled using the Soledge2D fluid plasma code [2] coupled to the Eirene neutral Monte Carlo code. In the model, the plasma is generated using external volumetric sources of plasma density and power in the region of the cascaded arc plasma source and a constant H$_2$ gas inflow rate. It is found that only a small amount of plasma has to be injected externally in order to sustain the plasma beam, typically less than 1\% of the total plasma output of the source, the balance being maintained by partial ionization of the neutral inflow to the source region. The external power source is found to be the main control parameter of the simulations and is set in order to match experimental $n_e$, $T_e$ profiles from Thomson scattering (TS) 4 cm downstream of the cascaded arc nozzle. The total injected power is typically 2 – 3 kW, consistent with experimental observation. The simulation results are compared to TS measurements 56 cm downstream from the source nozzle (2 cm in front of the Pilot-PSI target) and a Langmuir probe embedded in the target. The choice of radial transport coefficients appears to be important in order to match experimental data at this location. Additionally, this work shows the flexibility of SolEdge2D-Eirene, a code primarily intended to simulate tokamak edge plasma, which could readily be applied also to the geometry of a linear plasma device.

References


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