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Drift and non-uniformity mitigation in H- source with Plasma Ion Funnels

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The H- multiaperture ion sources requested by NBI for fusion researches need fair plasma uniformity on those apertures placed on in the so called Plasma Grid, both to facilitate perveance matching of all beamlet and to balance erosion of caesium layer in long pulses. The flow of particle drifts due to both the magnetic filter (Bf), needed in the extraction region to reduce electron density temperature, and to the extraction electric field, forms a pileup with resulting top/bottom plasma asymmetry. The plasma density, however, can be controlled by funnel electrodes and bias plate (BP) with proper polarization. Assuming that filter current flows vertically, as in SIPDER, and in designs for MITICA and DTT (Divertor Test Tokamak), we have Bf horizontally directed and vd vertically directed, say in toward bottom to fix ideas. In smaller sources, pile up is less important, but non-uniformity of plasma near walls is proportionally more important. The variety of experimental results and conditions suggest a long and careful discussion. Several remedies were proposed, based on modification of the E x B pattern, to reduce plasma flow accumulation at specific points (source bottom). In the funnel concept, the BP is supplemented by many electrodes inside the extraction region. Voltages among PG, BP, funnel and wider plasma chamber walls, as well Bf, are key parameters. Due to the large computation size of the full problem, several approximate simulation methods were used. 3D simulations with no space charge have shown good ion extraction condition for preventing direct electron co-extraction [V. Variale, M. Cavenago, on Proceedings IPAC 2022, Bangkok (Thailand)]. In this contribution an empirical model for plasma sheath and space charge is also solved in 2D (using nonlinear multiphysics solvers) and a discussion on drift trajectories that mostly confirm similar 3D results is introduced. Comparisons with other fluid models in the literature are considered. Effects of wall condition are also critically discussed.

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