Experimental and numerical investigation on the asymmetry of the current density extracted through a plasma meniscus in negative ion accelerator

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Abstract:In multi-beamlet negative ion accelerators for neutral beam injectors, the transverse magnetic field necessary for suppressing the co-extracted electrons induces a deflection of the negative ion beamlets that must be corrected. For the design, particle-tracing simulation codes are used to compute ion trajectories and optical properties of the beamlets in the acceleration stage. In these codes, uniform boundary conditions are normally assumed for the ion current density distribution at the surface (called meniscus), where negative ions are extracted from the plasma and form beamlets, which are accelerated across the apertures of the accelerator grids. Recently, experimental campaigns dedicated to the accurate measurement of the beamlet deflection in the acceleration phase revealed higher deflection than foreseen by simulations. In this work, we demonstrate that an agreement with the experimental data can be obtained by incorporating in the numerical simulations a non-radially symmetric distribution of the ion current density extracted across the meniscus surface. In the first part, the asymmetry of the ion current density at the meniscus is studied in an empirical way, by analysing and fitting the experimental results obtained with different operating parameters. In the second part, we show that the ion current asymmetry estimated by this procedure is well consistent with the flow pattern of H– ions calculated in the meniscus zone using a detailed particle in cell (PIC) model of the ion source in the presence of transverse magnetic field.