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Investigation of spatially resolved plasma parameter and potential distributions at the BATMAN Upgrade ion source

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In H^- ion sources for neutral beam heating applications, the creation of negative ions relies on the surface conversion of H atoms and positive ions at the plasma grid surface. The yield of this process is strongly influenced by the energy of the impacting particles. In general, a higher energy or velocity of H or H_x^+ results in a higher conversion rate. However, the velocity of the created H^- ions does also increase which can lead to a higher beam divergence. In a simple picture, the velocity of the positive ions is largely determined by the spatial distribution of the plasma potential between the driver region, where the ions are created, and the plasma grid. Spatially resolved experimental investigations of the plasma potential are scarce. Therefore, a detailed investigation is carried out exemplarily at the geometry of the BATMAN Upgrade ion source setup using a 2D fluid code with a self-consistent consideration of the RF power coupling [1, 2]. The code does not only yield the spatial distribution of plasma parameters and potentials, but also of the particle fluxes (which are compared to results of Mach probe measurements in another contribution to this conference [3]). Therefore, the fluid code allows for a detailed investigation of the particle fluxes and of the positive ion velocity impinging on the plasma grid. Calculations are performed for a variation of pressure, RF power and for different strengths and topologies of the magnetostatic filter field. Where available, the results are compared to experimental measurements. Furthermore, a variation of the both the driver and expansion region geometry is investigated in order to study the impact of source design changes especially on the plasma potential in axial direction.

[1] D. Zielke, S. Briefi, S. Lishev, U. Fantz; Modeling inductive radio frequency coupling in powerful negative hydrogen ion sources: validating a self-consistent fluid model; Plasma Sources Sci. Technol. 31 (2022) 035019
[2] D. Zielke, S. Briefi, U. Fantz; Numerical study of RF power coupling in fusion-relevant single- and multi-driver H^- ion sources; contribution to this conference
[3] V. Wolf, D. Zielke, D. Rauner, S. Briefi, U. Fantz; Mach probe diagnostic for determining positive ion fluxes in H^- ion sources; contribution to this conference

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