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Particle Transport and Heat Loads in NIO1

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NIO1 is a compact radio frequency (RF) ion source based on inductively coupled plasma (ICP), jointly developed by Consorzio RFX and INFN-LNL [1], installed at RFX and currently in its initial operation phase. It is designed to generate a 60 kV-135 mA hydrogen negative ion beam, composed of 3 x 3 beamlets over an area of about 40 x 40 mm2. There are three acceleration grids named plasma grid (PG) at -60 kV, extraction grid (EG) at -52 kV and post acceleration grid (PA) at the ground voltage, followed by a repeller electrode (REP) for a better control of the space charge compensation of the extracted beam [1].

A major difference with other H- ICP sources is that NIO1 aims at continuous operation (in conditions similar to those foreseen for the larger ion sources of the Neutral Beam Injectors for ITER, exploiting its flexibility to address the several still open important issues related to beam extraction, optics, and performance optimization) which implies a detailed thermo-mechanical analysis of the beam-facing components, in particular the accelerator grids.

Together with the first operation of NIO1, the construction of a new ion extraction system was started for optimizing the beam optics and exploring alternative electrostatic and magnetic configurations [2]. In particular, the accelerator will be modified by completely replacing the extraction grid: the new electrode will feature larger apertures with an increased chamfer at the hole exit and the realization of other slots in between apertures, to place additional magnets, useful to optimize the electron filtering and residual ion deflection [3].

A fully 3D analysis of the entire NIO1 beam considering the new extraction grid has been performed for the first time by a fully 3D version of EAMCC [4,5], a relativistic particle tracking code based on the Monte-Carlo method for describing the transport of particles under prescribed electric and magnetic fields and the main secondary particle formation processes responsible of non-negligible heat loads on the accelerator grids. The H- beam, the beam halo fraction and the co-extracted electrons have been simulated for determining the heat loads on grids and the power transmitted out of the accelerator. The main results are presented in this paper, after a brief description of the device, the proposed upgrade and the reference conditions for the simulations.

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References

[1] M. Cavenago et al., *Design of a versatile multiaperture negative ion source*, Rev. Sci. Instrum. 81, 02A713 (2010).

[2] P. Veltri et al., *Design of the new extraction grid for the NIO1 negative ion source*, AIP Conf. Proc. 1655, 050009 (2015).

[3] M Cavenago et al., *Deflection compensation for multiaperture negative ion beam extraction: analytical and numerical investigations*, Plasma Sources Sci. Technol. 23, 065024 (2014).

[4] G. Fubiani at al., *Modeling of secondary emission processes in the negative ion based electrostatic accelerator of the International Thermonuclear Experimental Reactor*, Phys. Rev. ST Accel. Beams 11, 014202 (2008).

[5] N. Fonnesu et al., *A multi-beamlet analysis of the MITICA accelerator*, AIP Conf. Proc. 1655, 050008 (2015).