Simulations for the generation and extraction of negative hydrogen ions in RF-driven ion sources

R. Gutser, D. Wünderlich, U. Fantz, P. Franzen, B. Heinemann, R. Nocentini and NNBI Team

Max-Planck-Institut für Plasmaphysik, EURATOM Association, Boltzmannstr. 2, D-85748 Garching, Germany

The RF-driven ion source being developed at IPP Garching [1] was chosen by the ITER board as the new reference source for the ITER neutral beam injection.
In order to support the NBTF program the large-scale RF testbed ELISE (Extraction from a Large Ion Source Experiment) is now under construction at IPP. [2]
The ion source development is accompanied by a modeling program to understand the physical processes involved in the production and extraction of negative ions in the RF source. Several numerical codes are developed for different scaling lengths to simulate as closely as possible the experimental conditions and the results from them are then compared to experimental observations.
Negative ions are produced on a converter surface (plasma grid) with a low work function which is achieved by covering the surface with cesium. It is difficult to keep Cesium conditions stable during operation of the ion source. Under development is a Monte Carlo simulation to investigate ways to obtain a stable cesium distribution.
Because of the low binding energy of the additional electron negative hydrogen ions can easily be destroyed on the way from the plasma grid surface to the extraction region where the beam formation takes place. It is therefore very important to increase the extracted current by optimization of the negative ion transport. The effect of the converter geometry, especially the aperture diameter of the extraction system is a question of particular importance. A code based on the test particle principle in combination with a Monte Carlo collision module is used to investigate the effects of aperture diameter parameter variations within the electric and magnetic field topology of the IPP ion source.
The physics of ion beam formation and electron deflection is investigated by Ray Tracing simulations. Results of 3D ion optics calculations are presented focusing primarily on the influence of effects related to the large-scale extraction, such as the magnetic filter field and heat load induced grid deformations.

References

[1] E. Speth et al., Nuclear Fusion 46(6) (2006)
[2] P. Franzen et al., this conference

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Corresponding Author: Raphael Gutser
raphael.gutser@ipp.mpg.de
Max-Planck-Institut für Plasmaphysik, EURATOM Association
Phone: +49 89 3299 1491, FAX: +49 89 3299 2558