Overview of the RF source development programme at IPP Garching

E. Speth, H. Falter, P. Franzen, U. Fantz, M. Bandyopadhyay [a], S. Christ, A. Encheva, M. Fröschle, D. Holtum, B. Heinemann, W. Kraus, Ch. Martens, P. McNeely, S. Obermayer, R. Riedl , R. Süss , A. Tanga, D. Wünderlich

Max-Planck-Institut für Plasmaphysik, EURATOM Association, Postfach 1533, D-85740 Garching, Germany; e-mail: speth@ipp.mpg.de
[a]IPR Gandhinagar, Bhat, India

The development of a large-area RF source for negative hydrogen ions, an official EFDA task agreement, is aiming at demonstrating ITER-relevant ion source parameters. This implies a current density of 20 mA/cm^2 accelerated D^- ions at a source filling pressure of < 0.3 Pa and an electron to ion ratio of < 1 from a PINI-size extraction area for pulse lengths of up to 1 hour. The work is progressing along several lines in parallel utilising three different test stands. "**BATMAN"** is devoted to small extraction areas (<100 cm^2) and short pulses (<10 s). "**MANITU"** allows to investigate extended extraction areas (<300 cm^2) and pulse lengths of up to 3600 s. "**RADI"** houses a size-scaling demonstration of a half-size ITER plasma source.
The major achievements on the "**BATMAN** " test bed are the following. With Cs seeding the source can now be operated reliably and reproducibly. Calorimetric current densities of up to 33 mA/cm^2 accelerated H^- and 23 mA/cm^2 accelerated D^- ions from an extraction area of about 70 cm^2 have been reached in the right pressure range with electron to ion ratio of < 1.
On "**MANITU**" the experiments are focussed on large area extraction up to the size, which is likely to be supplied by one RF driver in an ITER size source. The extraction area has been enlarged by changing the grid masking from the initially 74 cm^2 in two steps to 152 cm^2 and 306 cm^2. All three cases show a linear increase of the electrically measured ion current density with extraction voltage. This suggests that the driver is capable of illuminating extraction areas up to 300 cm^2 with sufficient plasma uniformity. With 10 kV extraction voltage and a RF power of 100 kW a total H^- ion current of 9.7 A has been measured at 0.45 Pa. However, with 306 cm^2 the calorimetric current density saturates, indicating interference with the stronger magnetic field in the outer parts of the extraction area, which are closer to the filter magnets.
In preparing the long pulse experiments, a high voltage power supply and a 180 kW, 1 MHz RF power supply for c.w. operation have been procured and are being commissioned. Also a cryo pumping system, developed in collaboration with FZ Karlsruhe, has been partly delivered and is nearing completion.
A third test facility ("**RADI"**) dedicated to demonstrate size scaling is under construction. The new test facility is devoted to testing the geometry and the number of drivers as well as the uniformity of large plasmas. This source will have roughly the width of the ITER source and half the height; its modular concept will allow an extrapolation to the full size ITER source. Full size extraction will not be possible due to the lack of a large size extraction system and beam dump. The source will be equipped with a dummy grid matching the specific conductance of the ITER source grid. The RF power supply consists of two RF generators of 180 kW maximum power each with pulse lengths of up to 10 s. The generators are currently being commissioned at IPP. The entire experiment is scheduled to be ready for commissioning in summer 2005.