Results of the SINGAP Neutral Beam Accelerator Experiment at JAEA

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Two accelerator concepts are being considered for neutral beam injection (NBI) on ITER. These are the Multi Aperture, Multi Grid (MAMuG) and the Single Gap, Single Aperture (SINGAP) concepts. In MAMuG, 1280 D^- beamlets are accelerated in 5 intermediate steps to 1 MeV, whereas in SINGAP 1280 pre-accelerated beamlets are accelerated in one single step to 1 MeV. Total accelerated current is 40 A. The advantage of SINGAP over MAMuG is technical simplicity, which comes at the cost of more complicated physics.

CEA Cadarache and JAEA Naka have entered into a collaboration in order to test a SINGAP accelerator at the JAEA Megavolt Test Facility (MTF) at Naka, Japan. Whereas at the CEA testbed the acceleration current was limited to 0.1 A, at JAEA 0.5 A is available. This allows the acceleration of 15 H^- beamlets in SINGAP to be tested, an increase by an order of magnitude.

Two experimental campaigns have been conducted: the first in August-October 2007, the second in February – March 2008. Contrary to MAMuG, in SINGAP electrons are accelerated to high energy and for the second campaign special electron dumps and magnets to deflect electrons on these have been installed.

High-voltage conditioning in the SINGAP configuration has been quite slow, with 600 kV in vacuum achieved after 120 hours of conditioning. With 0.1 Pa of H_2 gas present in the accelerator 800 kV could be achieved.

Beam optics results in the first test appear in reasonable agreement with calculation results. However, because the beamlets are merged on the target, the comparison could not be too detailed. For the second test the geometry has been changed and the beamlet directions have been designed to be slightly divergent. At perveance match the individual beamlets can be resolved and their divergence appears to be better than 5 mrad.

Both MAMuG and SINGAP produce electrons and here SINGAP is at a disadvantage because the electrons can be accelerated to full energy, whereas in MAMuG they can be intercepted on the individual grids. Whereas the measured drain current suggests equal amounts of electrons and negative ions, thermal data from one of the electron dumps suggest that around 27% of the power is in electrons. 2/3 of this power can be explained by stripping losses and ionisation of residual gas in the accelerator (at 0.087 Pa pressure).

Detailed results of the two experimental campaigns will be presented.