Design of the 1 MeV D^- SINGAP accelerator for ITER neutral beam injection.

H P L de Esch, R S Hemsworth and P. Massmann,
Association EURATOM-CEA, CEA/DSM/DRFC, CEA-Cadarache,
13108 ST PAUL-LEZ-DURANCE (France)
hubert.de-esch@cea.fr

The physics design of a 1 MeV D^- accelerator for ITER based on the SINGAP (SINgle aperture, single GAP) principle has been completed. The ITER SINGAP accelerator accelerates 1280 pre-accelerated beamlets (~40 keV) in one single step to 1 MeV. The post-acceleration grid contains not 1280 small circular apertures, but 16 large rectangular ones, through each of which pass 80 post-accelerated beamlets.

To obtain acceptable beam optics, it was found necessary to have pre-accelerated beamlets with a large diameter (~12 mm) that are convergent in order to minimise the effect of space charge on the beamlet divergence during the post acceleration phase. Moreover, the shape of the pre- and post-acceleration grids had to be chosen in such a way that beamlets of each group of 80 beamlets (5 horizontal x 16 vertical) are pushed inwards towards the centre of the group to offset beamlet-beamlet repulsion. Finally, the space-charge interaction between groups of beamlets also had to be taken into account.

Each grid of the accelerator is made up of 4 horizontal “sub-grids”, as per the ITER multi-aperture, multi-grid (MAMuG) reference accelerator design. In the proposed SINGAP accelerator the plasma- and extraction grids are completely flat. The pre-acceleration grid is flat, but with structures added on the downstream side. The post-acceleration grid is flat in the horizontal plane, but V-shaped in the vertical one in order to provide the required vertical steering. The solution arrived at makes almost no use of aperture-offset steering. However it is possible to steer the ITER neutral beams between 'on-axis' and 'off-axis' heating by simply moving the grounded post-acceleration grid vertically in stead of the whole source and accelerator, which is at -1 MV potential.

The paper will describe the present SINGAP solution for a 1 MeV D^- accelerator for ITER and the beam-optics simulations in some detail. The transmission to ITER will be estimated and some other issues, like electron production by stripping reactions, will be discussed.