Electron leakage in the ITER MAMuG accelerator

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The Multi Aperture, Multi Grid (MAMuG) accelerator for the neutral beam system of the International Tokamak Experimental Reactor (ITER) accelerates the extracted D^- beams in 5 stages of 200 keV each to 1 MeV. Electrons are co-extracted from the negative-ion source. In order to prevent their acceleration to high energy, permanent magnets are incorporated in the extraction grid. These magnets deflect the electrons out of the beam. However, electron backscattering and emission of secondary electrons cause some electrons to leak into the first acceleration stage of the MAMuG.

The leakage fraction (defined as the ratio of the number of electrons getting into the first acceleration stage and the number of co-extracted electrons from the ion source) has been calculated numerically. In approximation the transmission t is equal to: $t \propto e^{-\frac{L}{r_L}}$, where L is the thickness of the extraction grid and r_L is the Larmor Radius of the electrons in the magnetic field by the permanent electron suppression magnets. Lower transmission can be achieved by ensuring that the electrons have to make more bounces inside the extraction grid. For the presently adopted 6 mm long permanent magnets, a leakage fraction of 1 - 2 % of the co-extracted electrons is calculated. Electron leakage has also been investigated experimentally at CEA-Cadarache. The results of these experiments are within a factor of 2 from the results of the numerical calculations.

Stripping reactions of the D^- beam and the ionisation of D_2 background gas that is present due to the gas flow from ion source and neutraliser cause additional electrons. The code EAMCC [1] has been used to calculate the electron power deposited onto the acceleration grids, the electron power escaping from the accelerator and the positive ion power streaming back into the ion source.

In the MAMuG design, the Japanese Domestic Agency (JADA) proposes to expand the acceleration gap length from 50 mm in the original design to around 100 mm in order to improve voltage holding capability [2]. The issues in expansion of accelerator gap length are spread of the beamlets causing direct interception of beam halo and production of more stripped electrons and secondary electrons by beam hitting at grid.

Mitigation measures such as decreasing aperture diameter in the upstream grids (reduces leakage of electrons from upstream to downstream) while increasing aperture diameter in the downstream stages (reduces direct interception) will be reported in the conference.

[1] G. Fubiani, H. P. L. de Esch, A. Simonin, R.S. Hemsworth, Physical Review Special Topics - Accelerators and Beams **11** (2008) 014202

[2] M. Taniguchi et al., to be reported in this conference.