Compensation of beamlet repulsion in a large negative ion source with a multi aperture accelerator

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In long pulse beam acceleration of large negative ion sources for JT-60U and ITER neutral beam (NB) system, one of issues is to suppress excess heat loads on the accelerator grids and down stream components. The heat loads are generated by deflected beamlet, which are caused by repulsion among beamlets due to their own space charge. In JT-60U, metal bars were attached around the beam extraction area at the exit of the electron suppression grid (ESG)[1]. Forming electric field distortion, beamlets from outermost apertures were steered inward to compensate the space charge repulsion. So as to compensate all beamlets properly and to verify compensation by ESG aperture offset, multi beamlets are analyzed to utilizing a three dimensional beam calculation code, OPERA-3d. The grid structure of a three stage accelerator in JT-60U was modeled with the apertures arranged in a lattice pattern of 5 x 10.
Figure 1 shows a beam footprint at 3.5 m downstream from the accelerator at operation condition of 340 keV, 110 A/m^2 D$^-$ beam. The beamlets (each beam axis indicated in red point) are deflected outward from aperture position (white circles). The center beamlets from outermost apertures are most deflected, 6 mrad. Then aperture offset was applied properly to each aperture at ESG. The displacement was estimated from the thin lens theory. The maximum displacement of 0.7 mm was applied to compensate the deflection of 6 mrad. Deflection angle in X direction before/after aperture offset are shown in Fig.2. The deflected beams are properly compensated by the ESG aperture offset. The details including the deflection under the magnetic field in extraction area are reported in this paper.

References
[1] *M. Kamada et al., Rev. Sci. Instrum.*, ***79***, *02C114(2008).*

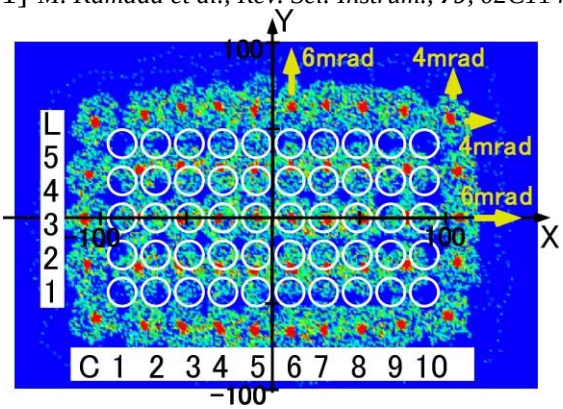

Fig. 1. Beam footprint at 3.5 m downstream from grounded grid before setting aperture offset

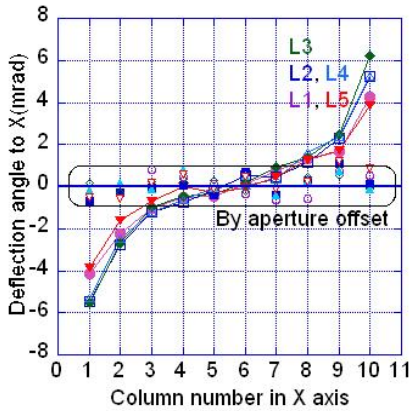

Fig. 2. Deflection angle to X direction before and after setting aperture offset.

Topic: 2. H- and D- Sources for Fusion, accelerators and other applications

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