Improvement of voltage holding and high current beam acceleration by MeV accelerator for ITER NB

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1 MeV H^- ion accelerator R&D for ITER Neutral Beam Injector is on going at Japan Atomic Energy Agency (JAEA). Target performance of the proof-of-principle accelerator (MeV accelerator) is 1 MeV, 200 A/m^2 (total current: 462 mA) H^- ion beam acceleration for several tens seconds. A key to achieve such a high power beam acceleration is voltage holding. The maximum voltage holding of the MeV accelerator was -835 kV. Improvement of the voltage holding was observed by feeding H_2 gas to the ion source, and -1 MV has been sustained in a pressure range (0.05 ~ 0.12 Pa) of a typical MeV accelerator operation. However, the voltage holding during beam acceleration was lower than that without beam acceleration. This fact indicates that some margin of voltage holding is required for stable beam acceleration. For this purpose, -1 MV holding without gas feeding was strongly desired to achieve higher voltage holding than -1 MV in the pressure range of the operation.

Review of voltage holding results ever obtained with various geometries of the accelerator at JAEA revealed that the voltage holding of the accelerators were much lower than that obtained from an ideal small Rogowski electrode, which was used for designing the accelerator. This is considered due to local electric field concentration in the accelerators such as edge and steps between multi-aperture grids and its support structures. To lower these electric field concentrations, the accelerator was modified by expanding the gap length between the grid supports from 72 mm to 100 mm. By this modification, local electric field concentration at a cathode side was lowered from 4.9 to 2.9 kV/mm. From a result of beam trajectory calculation, it was confirmed that increase of beam divergence was only from 3.1 mrad to 3.7 mrad with the new gaps, which fulfils the requirement for the ITER accelerator (7.0 mrad). This modification was effective to improve the voltage holding, and the accelerator succeeded in sustaining -1 MV without gas feeding.

Figure 1 shows a result of beam acceleration test with the new accelerator. Improvement of the voltage holding enhanced the accelerated H^- ion current and energy. At the perveance match condition, a 879 keV, 360 mA (157A/m^2) beam was successfully accelerated. Slightly below the perveance, a 937keV, 330 mA (144 A/m^2) beam was obtained with the comparable power of the above beam. Such progress of the beam acceleration performance has been obtained by improvement of voltage holding of the accelerator. Further, to increase the beam pulse length, compensation of beamlet deflection is under study [1].

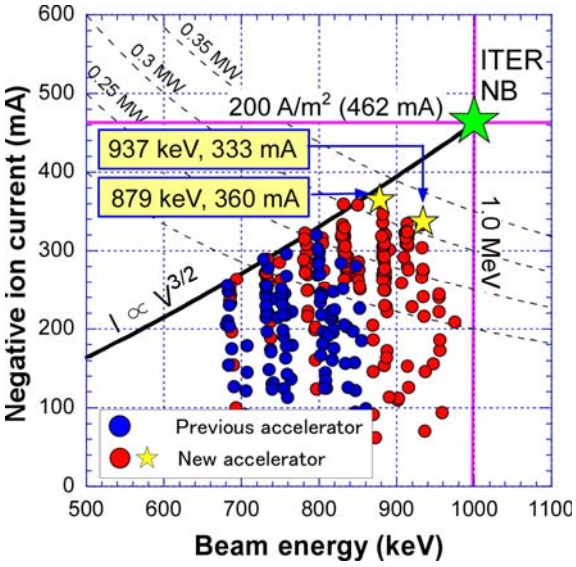

Fig.1 Current and energy achieved in MeV accelerator

[1] M.Kashiwagi et.al., in this conference