Development of 1 MeV H^- accelerator at JAEA for ITER NB

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The neutral beam (NB) injection system for ITER is required to produce 16.5 MW of D^0 beams per one injector at the energy of 1 MeV. To realize the ITER NB system, high power H^- accelerator R&D is on going at JAEA MeV test facility (MTF) whose power supply capability is 1 MV, 0.5 A for 60 s. For the accelerator of ITER NB, two concepts are proposed, one is the MAMuG (Multi-Aperture Multi-Grid) accelerator and the other is the SINGAP (Single-aperture Single-Gap) accelerator. This paper reports the recent results of both accelerator tested at the MTF.

For the MAMuG accelerator, the H^- ion beam of 836 keV, 206 mA (146 A/m^2) was successfully accelerated in 2005. However, after such a high power beam acceleration, the H^- ion beam current was lowered due to air leak in the KAMABOKO ion source. This trouble was caused by unexpected high heat load due to backstream positive ions impinged on the un-cooled port plug located at the top of the ion source. To solve this problem, water cooled backstream ion dump was installed. As the result, operation of the MAMuG accelerator was improved even under high power operation and H^- ion beam of 320 mA (140 A/m^2) was accelerated up to 796 keV. The accelerated drain current including co-accelerated electron (421 mA) reached close to the power supply limit of the MTF.

In 2007, a collaborative R&D program to develop the SINGAP accelerator was started between JAEA and CEA Cadarache. The SINGAP accelerator was installed in the MTF and two experimental campaigns were performed for the comparison of both concepts. Table.1 summarizes the high performance data of both accelerators obtained. As for the SINGAP accelerator, H^- ion beam of 225 mA (97 A/m^2) at 626 kV and 140 mA (61 A/m^2) at 680 keV was accelerated so far. The electron current of the above beam reached 105 % of negative ion current (32 % in MAMuG). Not only the stripped electrons but the secondary electron from the pre-accleration grid due to the incidence of backstreaming is considered to be the source of large co-accelerated electron. Countermeasures against the co-accelerated electron are considered to be inevitable for the SINGAP accelerator.

Table.1 High performance data of MAMuG and SINGAP accelerator tested at MTF.

	MAMuG	SINGAP (at MTF)
Voltage holding (kV)	756 kV without H_2 gas (base pressure; 7.2x10^{-4} Pa) 1 MV with H_2 gas of 0.21 Pa	573 kV without H_2 gas (base pressure; 7.2x10^{-4} Pa) 787 kV with H_2 gas of 0.25 Pa
Beam current (mA)	320 mA (140A/m^2) at 796 keV	140 mA (61 A/m^2) at 680 keV 225 mA (97 A/m^2) at 626 keV
Beamlet divergence (mrad)	5.5 mrad at 750 keV, 140A/m^2	4.9 mrad at 450 keV, 54 A/m^2

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