## Present status of negative ion based NBI system for long pulse operation on JT-60U

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The 500-keV negative-ion based neutral beam injector for JT-60U started operation in 1996. The availability of the N-NBI system has been improved gradually through modifying ion source and optimizing its operation parameters. Recently, the extension of the pulse duration up to 30 s has been intended to study quasi-steady state plasma on JT-60U. The most serious issue is to reduce the heat load on the grids for long pulse operation. Two modifications have been proposed to reduce the heat load. One is to reduce the stripping loss, where the electron of the negative ion beam is stripped and accelerated in the ion source and then collides to the grids. The ion source was modified to reduce the pressure in the accelerator column to suppress the beam-ion stripping loss. The other is to suppress the beam spread which may caused by beamlet-beamlet interaction in the multi-aperture grid due to the space charge force.

Indeed, the investigation of the beam deflection, which was measured by the infrared camera on the target plate set 3.5 m away from the grid, indicates the beam spread is in proportion to the current density. The thin plates were attached on the extraction grid to modify the local electric field. The plate thickness was optimized to steer the beam trajectory. Up to now, a long pulse injection of 17 s for 1.6 MW and 25 s for ~1 MW has been obtained by one ion source with these modifications.



Fig. 1 Progress of JT-60U N-NBI operation Long pulse injections more than 10 sec were done by one ion source, which was modified with a large vacuum conductance and thin plates on the extraction grid field.