

PERFORMANCE OF UPGRADED JET NEUTRAL BEAM INJECTORS

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JET Neutral Beam Injection (NBI) system upgrade project was launched in spring 2005 as part of the JET Enhanced Performance 2 (EP2) programme with the following aims: a) to increase the total injected power in deuterium from present 24MW to at least 34 MW; b) to increase the NBI pulse duration from present 10s to 20s and c) to improve availability and reliability of the system [1]. The increase in power is achieved by modifying the magnetic configuration of all present JET ion sources from supercusp to pure chequerboard configuration and by optimising the injector accelerator for 125kV/65A operation in deuterium. The modification of the magnetic configuration results in increased yield of molecular ion species (D_2^+ and D_3^+), which have higher neutralization probability, which, together with the increase of extracted current from 55A to 65A, contributes to the considerable rise of injected neutral beam power from present 1.4MW to >2MW per injector. A number of JET EP2 Positive Ion Neutral Injectors (PINIs) were assembled and successfully commissioned at JET Neutral Beam Test Bed. These tests confirmed predictions of increased neutral beam power and higher transmission. Two EP2 chequerboard PINIs were installed on JET Octant 8 Neutral Injector Box in late spring 2009 and commissioned for operation at beam voltages above 120kV within two weeks (~900 pulses or ~300s beam-on time). A detailed measurement of the neutralisation efficiency was carried out over a wide range of beam energies (Fig. 1). Despite predicted depletion of the neutralisation target due to gas heating effect [2] at extracted beam power above $V_b I_b \sim 3.5$ MW ($V_b > 95$ kV), the design goal of injecting >2.13 MW per PINI was achieved by operating the injectors a few percent above optimum current (shaded area in Fig. 1). Measurements also confirmed that the power loading of all beamline components is within engineering limits of the JET beamlines. Two EP2 PINIs were successfully operated during JET experimental campaign in autumn 2009 and were delivering routinely ~2MW in deuterium and ~1.4MW in helium – new record values for JET injectors. These results allow us to predict with confidence the performance of JET NBI system after the completion of the upgrade in early 2011: maximum total injected power above 34MW in deuterium or tritium and above 24 MW in helium.

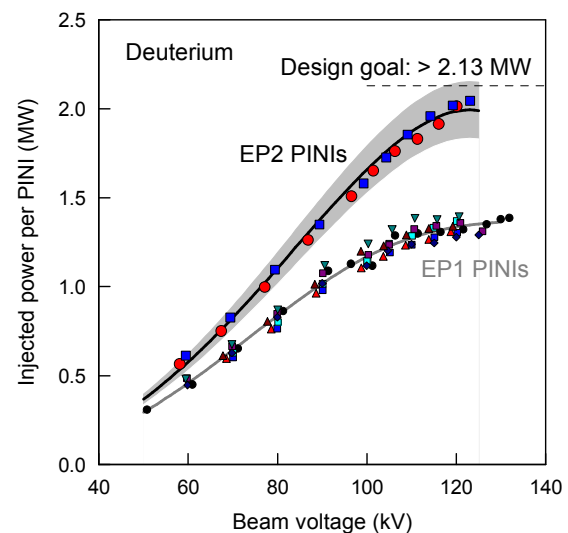


Figure 1: Injected deuterium beam power for upgraded (EP2) and present (EP1) JET PINIs.

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- [1] D. Ćirić et al., Fusion Eng. Des. 82, 2007, pp. 610-618.
- [2] E. Surrey et al., Fusion Eng. Des. 73, 2005, pp. 141-153.