

HV Holding in Vacuum, a Key Issue for the ITER Neutral Beam Injector

The contribution of Consorzio RFX

A. De Lorenzi

Consorzio RFX – Corso Stati Uniti 4, 35127 Padova, Italy

email: antonio.delorenzi@igi.cnr.it

Abstract

The achievement of burning plasma in ITER will require at least 33 MW of additional heating transferred to the plasma core by means of two 16.5 MW – 1 MeV injectors (N-NBI – Negative ion based - Neutral Beam Injector) of H or D atoms, with an extracted negative ion current of 40 A (i.e. 40 MW of extracted beam). A third Injector is foreseen as a future upgrade, to increase the power delivery to the ITER plasma up to 50 MW. These extremely demanding parameters required the construction of the Neutral Beam Test Facility – NBTF, located at the Consorzio RFX – Padova (I) premises, aimed at realizing the full scale prototype of the ITER N-NBI.

Among other fundamental achievements (e.g. extracted current uniformity, efficient ion neutralization, long pulse duration), the success of the experimentation of the NBTF requires the achievement of a stable and easily obtained 1 MV voltage holding during the negative ions extraction and acceleration.

The electrostatic configuration of the ITER and NBTF N-NBIs is extremely complex. It includes 5 main electrodes at high potential: five accelerating grids and a negative ion source, operating respectively at -0.2, -0.4, -0.6, -0.8, -1 MV with respect to the containing vessel. All electrodes have large surface (up to 10 m² for the ion source, which constitutes the cathode); gap lengths are in the order of 100 mm between accelerating grids and a minimum of 980 mm for the -1 MV-to-ground gap. In such a peculiar situation, the full voltage attainment and holding is a key issue, being affected by Total Voltage Effect (TVE), Area Effect, residual gas pressure and electrode surface conditioning.

This contribution, after a brief discussion of the present state-of-the-art about the voltage holding in the NBI accelerators, gives an overview of the R&D so far carried out at the Consorzio RFX lab in Padova and of the near future plan to achieve reliable voltage holding in the NBTF-MITICA accelerator. An example of spin-off of these researches is also given.