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Design and setup of the High Voltage Radio Frequency Test Facility for the characterization of the dielectric strength in vacuum of RF drivers for Neutral Beam Injectors Ion Sources

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PRIMA (Padova Research on ITER Megavolt Accelerator) is a large experimental facility under construction in Padova, Italy, aimed at the development and test of the full scale prototype of Neutral Beam Injectors (NBI), called MITICA, for ITER.
MITICA is designed to accelerate a beam of 40 A of negative deuterium ions up to 1 MV, in order to deliver a power of about 17 MW to the plasma with a pulse length of one hour; requirements that have never been reached before all together.
The negative ions are produced by means of an ion source composed of 8 radio frequency (RF) drivers working at 1 MHz, each generating a cold plasma at a pressure of 0.3 Pa with a power of 100 kW. A set of grids at different electrical potentials, extracts and accelerates the negative ions producing a negative ion beam which is then neutralized in order to enter and heat the plasma. To prove the possibility to achieve these requirements a second experiment will be hosted in PRIMA, called SPIDER: the full scale prototype of the ITER NBI negative ion source.
To gain experience on the RF voltage holding in vacuum, a dedicated experimental investigation is needed. Thus, the High Voltage Radio Frequency Test Facility (HVRFTF) is being built in Padova, at Consorzio RFX. The HVRFTF scope is to reproduce operating conditions of RF components in the ITER NBI ion source, in particular the voltage up to 15 kV at 1 MHz and the operating pressure in the range of 0.001 –0.3 Pa.
In HVRFTF a vacuum vessel is used to contain a low pressure atmosphere of the desired gas species produced by a gas injection and pumping system. The devices to be tested are placed inside and insulated from the vacuum vessel, and are supplied with RF voltage by means of a couple of feedthroughs. At first, circular planar stainless steel electrodes are used to derive Paschen curves with RF and dc voltage. The distance between the electrodes is adjustable, since one feedthrough is mounted on a bellow which is axially moved by a linear translator. Both the pressure and distance can independently adjusted, to derive the breakdown voltage threshold for the specific gas and for a specific configuration of electrodes. The RF high voltage is generated exploiting an LC resonance of a circuit supplied by a low voltage broadband amplifier. The operating frequency is adapted to look for the resonance frequency of the circuit, which is influenced by the parasitic capacitance of the device to be tested.
The paper will present the specific features and issues related to the design and setup of the HVRFTF and how they have been faced and solved.

Eligible for student paper award?

No

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