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First operation and experimental results of the High Voltage RadioFrequency Test Facility

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PRIMA (Padova Research on ITER Megavolt Accelerator) is the ITER Neutral Beam Test Facility in Padova, Italy, for the development of the ITER Neutral Beam Injectors (NBI). It comprises two experiments: MITICA, the full-scale prototype of the NBI, designed to produce and neutralize a 40 A negative ions beam, accelerated up to the energy of 1 MeV, and SPIDER, the full-size negative ions source of the NBI.
ITER NBI includes a Radio Frequency (RF) plasma source where plasma is produced by the inductive coupling with coils wound around complex vacuum chambers called drivers. Each coil is fed at 1 MHz up to a power of 100 kW, which corresponds to a voltage of about 12 kV rms, with nominal plasma parameters.
The voltage hold off in vacuum of the beam source components is one of the most critical issues connected to the fulfillment of the requirements for ITER, not only for the particles acceleration system subjected to very high dc voltage (up to 1 MV) but also for the RF circuits of the plasma source and in particular the RF drivers.
The development of a simple, accessible and flexible device called "High Voltage Radio Frequency Test Facility"(HVRFTF) was launched to effectively characterize the voltage hold off of the RF drivers of SPIDER and MITICA, subjected to radiofrequency E-fields at low pressure.
The experimental arrangement worked out to reproduce the driver operating conditions includes a vacuum vessel capable to host different types of Devices Under Test (DUT), a gas injection and pumping system to supply the desired gas species up to the test pressure and a RF circuit designed to produce the high voltage.
The first DUT tested with the HVRFTF is composed of planar circular electrodes, a configuration not directly relevant for the driver but widely treated in literature and significant for the validation of the basic test assessment.
This paper presents the results obtained during the first operations of the HVRFTF with the DUT in an Argon atmosphere in the pressure range 10⁻³ –10² Pa. A voltage up to 10 kV rms, at the frequency of 1 MHz was applied to the electrodes, with gaps of 0.1 mm –40 mm.
Breakdowns were observed for pressures higher than 0.2 Pa, associated with the appearance of a glow discharge between the high voltage electrode and the grounded vacuum vessel, as expected according to the Paschen's law. For lower pressures the measuring equipment did not detect any breakdown, although sparks were noticed between the electrodes.

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