ANALYSIS OF BREAKDOWN ON THERMAL AND ELECTRICAL MEASUREMENTS FOR SPIDER ACCELERATING GRIDS

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The PRIMA test facility, under realization in Padova, includes a full size plasma source prototype for ITER, called SPIDER (Source for the Production of Ions of Deuterium Extracted from RadioFrequency plasma).

In this paper the effects of breakdown in the electrical insulation inside the Ion Source are analyzed with particular care to the embedded diagnostic system, i.e. the thermal and electrical measurements installed on the grids and ion source case and transferred by multipolar cables to the acquisition system, located inside the 100 kV insulated deck and hosting the Ion Source power supply, the signal conditioning and the acquisition cubicles. The breakdown events affect strongly the measurements in terms of differential and common mode overvoltages and common mode currents. They have to be mitigated in order to guarantee adequate reliability and availability of the whole measurement set.

A parametrical study has been carried out on a detailed circuital model for fast transients, implemented using SimPowerSystems™ tool of Matlab Simulink® code. The model includes all the relevant conductors of the subsystems downstream the insulating transformer of the Accelerating Grids Power Supply (AGPS), i.e. the AGPS rectifier, the multipolar Transmission Line, the 100 kV High Voltage Deck, the Ion Source Power Supply and the Ion Source itself. In particular all the magnetic and capacitive couplings have been computed by a proper 2D fem model. Waiting for a suitable model for large gap (some tens cm) breakdown was modeled as a pure short-circuit.

Through the accurate modeling of the circuit the optimization of the cabling layout, of the wire screening and of the protection devices, like surge arresters and resistors, has been carried out. The energy dissipated on each ion source surge arrester is estimated and adequate TSD (Transient Suppression Devices) are selected. A peculiar and difficult to satisfy requirement is the high number of surges that the TSD has to withstand.

Breakdowns between components polarized at different voltages have been considered, in order to inspect the worst condition during a breakdown. The full voltage breakdown between the source body and the vacuum vessel, even if unusual, appears to be the most stressing condition both for the insulation strength and for the EMI.

The work is done in order to define the requirements of the technical specification for the procurement and the installation of the SPIDER diagnostic system.