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Study of X-ray spectra emitted during High Voltage DC conditioning in high vacuum

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High voltage insulation across a single gap in vacuum and low-pressure gas is a critical issue in relation to the development and realization of the electrostatic accelerator for the ITER Neutral Beam Injector (NBI).
The present paper describes and analyzes the recent experimental results obtained at the High Voltage Padova Test Facility (HVPTF), the laboratory aimed at supporting the development of the Beam Source of MITICA, the prototype of the ITER NBI now at the beginning of the commissioning phase, in Padova

The high voltage conditioning procedure is an in situ treatment based on progressively increase of the voltage with frequent breakdown aimed at reaching the ultimate voltage holding, by eliminating the sources of breakdown located on the surface of the electrodes (microtips, particles, adsorbed gas) insulated by high vacuum (<10-3 Pa).
High voltage conditioning procedure, though the high-voltage insulation in vacuum technology dates back to the beginning of the last century, has still remained more an empirical knowledge than a consolidate technology. As a matter of fact a large amount of literature has been dedicated to this topic, but so far a consolidated explanation of the physical phenomena appearing during the voltage conditioning doesn't exist yet.
HV conditioning is featured by electron emissions and gas desorption processes. This paper focuses on the rich phenomenology associated to the X-ray emission during HV conditioning due to the bremsstrahlung radiation of energetic electrons impinging the electrode surfaces. An interesting results is the possibility to measure the electron component of the current. The method allows to measure the fast transient (electron) current bursts (always associated to the voltage conditioning) which cannot be measured with nA ammeter.
The technique adopted to observe the time evolutions of X ray emissions up to fractions of ms is the Time-Correlated Single Photon Counting (TCSPC). The analysis of the TCSPC appears a promising, not invasive method, to identify, in a multi electrode system, the stage where pre-breakdown currents and microdischarges are present.
The X-ray spectra measured at the HVPTF are interpreted by a simple analytical model based on the Kramer equation, extended to any multi-electrode system insulated by high vacuum gaps like the MITICA electrostatic accelerator.

Primary author: PILAN, Nicola (Consorzio RFX)

Co-authors: Dr DE LORENZI , Antonio (Consorzio RFX, Associazione EURATOM-ENEA sulla Fusione, Padova, Italy); Dr FONTANA, Cristiano (Università degli studi di Padova, Italy); Dr SPADA , Emanuele (Consorzio RFX, Associazione EURATOM-ENEA sulla Fusione, Padova, Italy); Prof. PESAVENTO, Giancarlo; Mr LOTTO, Luca (Università degli studi di Padova, Italy); Mr FINCATO, Michele (1Consorzio RFX, Associazione EURATOM-ENEA sulla Fusione, Padova, Italy); Dr MC CORMAN , Oisin (Università Milano-Bicocca, Italy); Dr FELIX, Pino (Università degli studi di Padova, Italy); Dr GOBBO , Renato (Università degli studi di Padova, Italy); Dr SPAGNOLO, Silvia (1Consorzio RFX, Associazione EURATOM-ENEA sulla Fusione, Padova, Italy)

Presenter: PILAN, Nicola (Consorzio RFX)

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