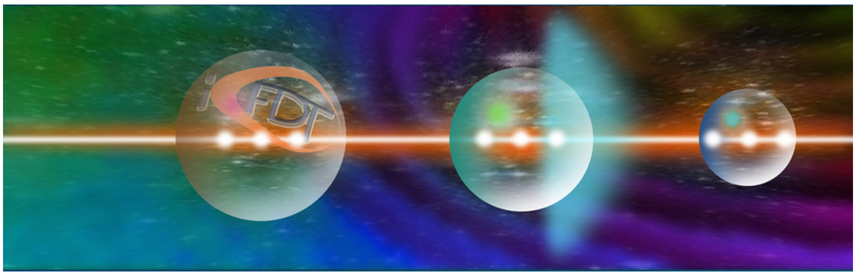
ICFDT5 - 5th International Conference on Frontier in Diagnostic Technologies



Contribution ID: **63** Type: **Poster**

# Calibration of a Cherenkov diagnostic to study runaway electrons dynamics

*Thursday, October 4, 2018 2:30 PM (1h 30m)*

Studies of runaway electrons in tokamaks are essential to improve prediction and control of plasma disruptions, for a reliable application on nuclear fusion [1]. The potential damage of such a localised beam of highly-energetic particles striking the vessel wall is substantial, particularly in view of future large tokamaks, such as ITER, since the runaway generation rate increases exponentially with the plasma current. This damage must be avoided or reduced using mitigation techniques [2] to make stable and reliable ITER operation. In addition, measurements of runaway electrons produced in the plasma core and escaping from it are of interest to study processes occurring inside the plasma itself. A Cherenkov diagnostic detector was installed on FTU and its performances have been investigated [3]. In this work a laboratory characterization of the Cherenkov probe is presented. The contribution of visible light and X-rays up to 85 keV was explored confirming that soft and hard X-rays do not affect the measurement of the probe (by 1%). A first calibration of the Cherenkov probe with an intense electron beam of 2.3 MeV and at high fluxes (1012 e−, much higher than the 104 e− of the radioactive sources) was done at ENEA's Microtron source facility [4]. The characterization was performed together with a spectrometric analysis, which gave a deeper insight of the phenomena occurring inside the detectors. The results show an ionization spectrum, confirming the suspects that the signals observed during plasma discharges are due mainly to luminescence. Nevertheless the validity of the Cherenkov probes as diagnostic tool is not compromised, considering the good correlation with plasma instabilities and runaway electrons production measured by different diagnostics. Moreover, the direct detection of runaway electrons with high time resolution showed interesting features not present in other diagnostics. This configures the Cherenkov as a very promising diagnostic for real time control and monitoring of runaway electron beams for future machines. Thanks to this calibration, bunches of runaway electrons have been estimated in 8x107 e- of about 2.3 MeV, corresponding to a signal of 2 V in FTU.

[1] B. Esposito, et al., Plasma Physics and Controlled Fusion 59 (2017) 014044.

[2] D. Carnevale, et al., Runaway Electron Beam Control, submitted on Plasma Physics and Controlled Fusion (2018).

[3] F. Causa, et al., Nuclear Fusion 55 (2015) 123021.

[4] M. Perenzoni, et al., Physics and Appl. of Terahertz Radiation, 23 Springer Series in Opt. Sci. 173, Chap. 5.

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**Session Classification:** POSTER SESSION