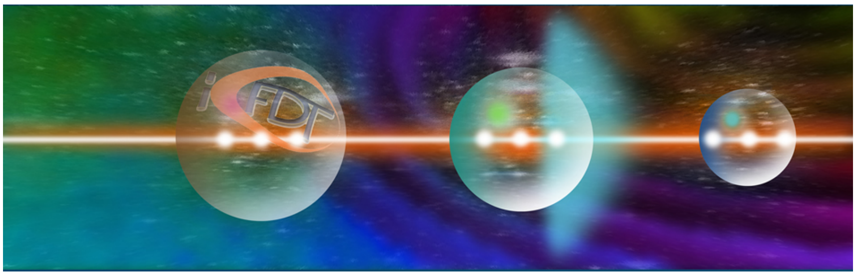

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Gamma-ray Imaging of Fusion Plasmas

Thursday, 4 October 2018 14:30 (1h 30m)

Gamma-ray diagnostics are some of the most important tools for the fast-ion studies in fusion devices. Intense gamma-ray emission is produced when fast ions (fusion products, ICRF driven ions and NBI-injected ions) react either with plasma fuel ions or with the plasma impurities such as beryllium and carbon [1]. On JET, the gamma-ray emission measurements are routinely used to interpret different fast ion physics effects arising during ICRF and NBI heating. Spatial profiles of the gamma-ray emission in the energy range $E\gamma > 1$ MeV are tomographically reconstructed on JET by using the gamma-cameras [2], which comprise two fan shaped multi-collimator cameras, with 10 channels in the horizontal camera and 9 channels in the vertical camera. The 2-D slice determined by the 19 lines of sights (LOS) is in the poloidal plane and has a thickness of approximately 75 mm. Integrated gamma-ray measurements along the 19 LOSs are used as input signals to determine the two-dimensional (2-D) spatial distribution of the gamma emission intensity.

Due to the availability of only a limited number views and to the coarse sampling of the LOS, the measurements themselves do not identify a unique solution and therefore the tomographic inversion is a limited data set problem. Therefore, appropriate algorithms, able to work with the specific constrains and allowing effective tomography from the available limited data, have been developed. The method developed by Ingesson et al. [3] is based on a series expansion of the reconstructed image, with a grid of pyramid local basis functions. The solution is found by a constrained optimization, which uses anisotropic smoothness on flux surfaces as objective function (a priori physical information about the expected emission profile) and measurements as constraints. The approach base on the Maximum Likelihood (ML) mehtod [4] finds the estimate of the emissivity distribution that is most consistent with the measured tomographic projections in the sense of maximizing the likelihood (conditional probability of the data given the parameters). The regularization procedure assumes smoothness along magnetic profiles. Recently an algorithm based on a generalization of the known Abel inversion and taking into account the non-circular shape of the plasma flux surfaces has been proposed [5]. Methods, based on the Fisher information and already successfully applied for JET neutron tomography [5], may represent also a valuable solution.

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Summary

Primary author: Dr KIPTILY, Vasily (UKAEA Fusion)

Co-authors: Dr FERNANDES, Ana (dInstituto de Plasmas e Fusão Nuclear, Instituto Superior Técnico, Universidade de Lisboa, Portugal); Dr MURARI, Andrea (Consorzio RFX); Dr BIELECKI, Jakub (Institute of Nuclear Physics, Polish Academy of Sciences, Krakow, Poland); Dr CRACIUNESCU, Teddy (National Institute for Lasers, Plasma and Raadiation Physics, Bucharest, Romania)

Presenter: Dr CRACIUNESCU, Teddy (National Institute for Lasers, Plasma and Raadiation Physics, Bucharest, Romania)

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