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PhD PROPOSAL 2014

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Titre du sujet de thèse : Real-time Bayesian reconstruction of soft X-ray emissivity profiles

Résumé du sujet : **Remark :** this topic is proposed in the frame of the FUSION-DC Erasmus Mundus Doctoral College (coordinated at Ghent University) and by such involves Ghent University, IPP Garching and CEA Cadarache.

Soft X-ray (SXR) emission depends on various plasma parameters such as the electron density, electron temperature and impurity concentration. Hence in tokamak plasmas, the SXR diagnostic can be useful for deriving the magnetic equilibrium and the spatial distribution of impurities. In addition, it can be applied for studying MHD activity (mode analysis), which generally requires a high accuracy and resolution of the diagnostic. SXR spectroscopy has thus the potential to contribute greatly to plasma control, e.g. for real-time control of the local impurity concentration. As with many spectroscopic diagnostics for fusion plasmas, SXR requires a tomographic reconstruction algorithm, for deriving local emissivity profiles within a poloidal cross-section from the line-integrated measurements (generally from SXR diodes). However, typically there are various uncertainty sources entering the data descriptive model, the calibration and the measurements. These may be of a statistical or systematic nature, which may render an accurate and fast inversion process a very challenging task.

The objective of this doctoral work is to provide a new approach to the problem of (real-time) SXR imaging and inversion, based on the techniques of Bayesian probability theory (BPT). Using the Bayesian approach, the physical measurement principle is encoded in a forward model, which, together with the modeling of the statistical uncertainties, provides the likelihood distribution. Another important feature of the Bayesian methodology is the dependence on 'prior information', which, according to the situation, can either be chosen to be rather uninformative or may actually include valuable knowledge from previous experiments or other diagnostics. This way the prior information can contribute to the inversion process by narrowing down the possible solution space. Then, through a careful modeling of the uncertainty sources that are believed to be influential, Bayes' theorem yields the so-called 'posterior distribution' of the physical quantities of interest (e.g. a parameterized impurity concentration profile).

The first aim of this work is to design and implement a tomographic reconstruction method for the soft X-ray diagnostic at the WEST tokamak (IRFM, CEA Cadarache, France) and at ASDEX Upgrade tokamak (IPP Garching, Germany) using Bayesian modeling tools. The second aim of the work is to validate the obtained profiles by comparing with results from other diagnostics when available like for example the classical SXR diodes tomography reconstruction. The method will first be tested on existing database signals of ASDEX and Tore Supra and will be then applied in measurement campaigns at ASDEX Upgrade and WEST. This activity will be in line with the ITER concern about W control.

Compétences souhaitées : Formation de base en physique des plasmas et rayonnements, temps réel

Intitulé du master préconisé : Sciences de la Fusion, Traitement du Signal