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PROPOSITION DE STAGE 2012-2013

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Niveau du stage : INGENIEUR
Durée du stage : 6 mois

sujet du stage :

Titre : Polycapillary lenses for Soft X ray measurement in magnetic fusion plasma devices

Contexte et objectifs : Plasmas produced in magnetic fusion devices (called tokamaks) are extended volumetric sources of Soft X-rays (SXR) and these emissions could reveal a lot of information about the processes occurring into the plasmas. Soft X-ray diagnostics are meant both as tomography (using classical SiLi diodes) and imaging. Unfortunately, the constraints posed by these devices (high neutron flux, gamma and Hard-X background, and so on) are very severe and limit strongly the possibility to install X-ray detectors directly into or close to the tokamaks. The development of optics is thus needed in order to move back the SXR detectors and polycapillary lenses are potential good candidates.

Nature du travail à réaliser par l'étudiant :

The proposed internship is first dedicated to the characterisation in laboratory of polycapillary lenses for SXR measurement and second to the development of a subsequent model for characterising the photonic transmission. This optics has been used so far for punctual SXR sources at distances close to the focal point of the lens [1, 2]. Unlikely for the internship, the studies will be focussed on the possibility of using the polycapillary optics for X-ray imaging or tomography in tokamaks. In these case the plasma (X-ray source) is extended (from a few to hundreds cubic meters) and optics have to be located far from the plasma. Detectors also should be moved as far as possible from the plasma, because of the strong background radiation (neutrons, hard-X, gammas) in the vicinity of the plasma. First tests will be performed to characterize the polycapillary lenses (convergence, divergence, efficiency, spectral dispersion and so on) in the SXR range 5-25 keV and for distances much larger than the optical focal length of the lenses, both for the detector and the source. A CCD camera will be used as detector and a micro focus X-ray tubes as “point-like” sources (tens of microns). Imaging capabilities of polycapillary optical elements, even at very poor spatial resolution, will be also investigated, using a Gas electron multiplier detector.
Then, based on theoretical work [3], a transmission model will be elaborated for a single capillary and extrapolated to the full lens. Comparisons with experimental data will be done. Conclusion will be then drawn on the viability of the use in tokamaks of such lenses for SXR measurement.
It is worth noting that this work is part of a broader collaboration between LNF-INFN, ENEA-Frascati and CEA-Cadarache in the field of SXR techniques for Nuclear Fusion experiments. The student will be thus in contact with this Italian team and it is likely that some experiments could be performed also in the laboratory of Frascati (Italy, near Roma), like the characterisation of lenses in presence of Hard X ray source. That is why good practice of English is required.

[1] SCHIELDS P.J. *et al.*, *Powder Diffr.* **17** (2), 70-80 (2002).
[2] HAMPAI D. *et al.*, *Optics Letters*, **33** (23), 2743 – 2745 (2008).
[3] DAGABOV S *et al.*, *Physics-Uspekhi*, **46** (10), 1053-1075 (2003)

Domaine de spécialité, compétences : Physique générale notamment optique ondulatoire, électromagnétisme.
Prolongement possible thèse : OUI