CEA/CADARACHE
DIRECTION DES SCIENCES DE LA MATIÈRE (DSM)
INSTITUT DE RECHERCHE SUR LA FUSION PAR CONFINEMENT MAGNETIQUE (IRFM)
CEA/Cadarache - 13108 St Paul-lez-Durance Cedex - France

PhD PROPOSAL 2012

Supervisor :	**e-mail :**	Sebastien.hacquin@cea.fr
Sébastien HACQUIN / Roland SABOT	**phone :**	+33 442 25 61 25
	secretary :	+33 442 25 62 33
Research Team : SCCP/GTTM		

Title : Study of the radial asymmetry of turbulence characteristics of fusion plasmas

Summary :

One of the most critical issues in magnetic fusion research is the control and better understanding of turbulent transport that is responsible for degradation of the plasma confinement, thus limiting the performances of so-called tokamak devices. Both comprehensive modelling activities and good plasma measurements are essential for better understanding of the plasma turbulence mechanisms. Reflectometry, which is based on the radar principle and consists in probing the plasma with electromagnetic waves, is a versatile diagnostic particularly useful to infer the density fluctuation characteristics [1]. It is proposed in this thesis to study in detail fluctuation spectra obtained from reflectometry data. Analysis of their shape and identification of the various components will help at the validation of the theoretical models describing the turbulence mechanisms. In particular, special emphasis will be put on the study of the asymmetry of the turbulence characteristics between the inner (high magnetic field side) plasma region and the outer (low magnetic field side) plasma region, which is predicted by neoclassical theory [2], shown by gyrokinetic simulations [3] and has already been observed in various machines, such as T-10 and TEXTOR [4]. The reflectometer diagnostics installed on the TORE SUPRA tokamak are clearly suitable for such investigations since their large probing frequency ranges (50 - 160 GHz) allow for turbulence measurements almost all along the plasma radius (in typical plasma scenarios developed in Tore Supra). This is expected to provide a clearer explanation for various kinds of turbulent fluctuations observed in tokamak plasmas (ballooning modes, ITG driven turbulence, ETM, …). Through a close collaboration with the IPP Juelich (Germany) the candidate will confront the results in TORE SUPRA with those obtained in the TEXTOR tokamak. Further collaborations with other European and/or Russian tokamaks (T-10, JET, …) will also be encouraged. Moreover in order to help at the interpretation of the experimental reflectometry data, some simulation works shall be carried out using reflectometry codes (developed in collaboration with the university of Nancy and the European Reflectometry Code Consortium within the EFDA ITM Task Force). To use relevant turbulence parameters as input, it is foreseen to make use of turbulence codes, such as GYSELA developed in our institute and GENE developed by German colleagues in IPP Garching.

[1] G.D. Conway, *Plasma Phys. Control. Fusion* **50** 124026 (2008)
[2] F.L. Hinton, R.D. Hazeltine, *Rev. Mod. Rhys.* **48** (2) 239 (1976)
[3] Z. Lin *et al*, *Science* **281** 1835 (1998)
[4] D.A. Shelukhin *et al*, *Proceedings of 8th International Workshop on Reflectometry* (2007)

Skills : good knowledge of plasma physics highly desirable; interest for signal processing and ability for numerical simulation required (familiarity with Matlab, Fortran and/or C will be a strong asset)