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Measurements of density fluctuations in magnetic confined plasmas

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Magnetic confinement fusion, which is one of two major branches of fusion energy research, has experienced major progress during the last decades. However, performances of actual magnetic confinement machines, such as tokamaks, are limited by the development of micro-turbulence that generates most of the radial transport of heat and particles. The prediction and the control of energy confinement, and therefore of performance of such machines are then important issues. A key element in the effort for understanding of turbulent transport is the confrontation between precise measurements and theoretical predictions.

Different types of diagnostic systems are generally used in order to measure and characterize various fluctuations in the core of hot magnetized plasmas, where probes and cameras are not usable. Among those are two major diagnostic families which rely on scattering of electromagnetic waves on plasma fluctuations. On one hand, there is reflectometry that uses microwave frequency range to obtain a cut-off layer inside the plasma. On the other hand, there are wave-scattering systems based on the detection of probing waves scattered by the fluctuations of the plasma.

The Doppler backscattering technique combines advantages of both reflectometry and scattering techniques. It is based on the detection of the field backscattered on density fluctuations in the vicinity of the cut-off layer. This technique gives access to both spatial scales and dynamic of density fluctuations and with a good spatial localization due to the presence of a cut-off layer. Doppler backscattering systems installed on the French tokamak Tore Supra, provides the repartition of energy fluctuation over the different spatial scales, which corresponds to the wavenumber spectrum, and radial profiles of density fluctuation velocity.

Description of these techniques and their applications on fusion plasmas micro-turbulence studies will be presented.

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