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Pedestal and core turbulence dynamics using $1\mu\text{s}$ sweeping profile reflectometry

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Plasma turbulence is a key parameter governing the confinement quality of magnetically confined plasmas. It is responsible of a substantial particle and heat transport that affects the performance of a nuclear fusion device. More detailed knowledge and understanding are constantly needed and requires more and more precise measurements with, in turn, improved diagnostic performance. Swept frequency reflectometry, traditionally devoted to electron density profile measurements, have been constantly progressing in terms of sensitivity (S/N ratio) and sweeping rate. In this paper the symbolic limit of $1\mu\text{s}$ sweep time with a dead time in between sweeps of $0.25\mu\text{s}$ has been recently reached by the Tore Supra (TS) reflectometers, which are today successfully experienced on the ASDEX Upgrade (AUG) tokamak. Such a high sampling rate of 800 kHz improves the observation of the plasma temporal dynamic and high radial resolution from the edge to the plasma center. They provide plasma measurements for a broad and continuous radial range, from the edge to the center, at an acquisition rate which competes now with fixed frequency systems. In addition to fluctuation profiles or k_r spectra during L-I-H transition with high temporal resolution, it extends the observation to high frequency coherent modes and microinstabilities such as TEM and ITG over the entire plasma with a high radial resolution. We can follow the temporal evolution of an edge coherent oscillation around 100 kHz and see how at the ELM crash, this mode temporarily disappears and then rapidly recovers. The radial dependency of the spectra also provides an observation of the interplay between localized MHD neoclassical tearing modes and Trapped Electron Modes (TEM). Comparisons with synthetic diagnostic simulations coupling a 2D reflectometry full-wave code with gyro-kinetic (GENE) turbulence simulations have been performed. It has contributed to the assessment of the measurements as well as the numerical codes. It has pointed out the role of the plasma rotation and provided insights in the turbulence structure.

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