Application of the microwave beam steering from poloidal correlation reflectometry for investigation of the L- and I-mode turbulence

D.Prisiazhniuk[1], G.D.Conway[1], T.Happel[1], S.Freethy[1],
P.Manz[1], A.Krämer-Flecken[3], U.Stroth[1,2] and the ASDEX Upgrade Team
[1] *Max Planck Institute for Plasma Physics, 85748 Garching, Germany*
[2] *Physik-Department E28, Technische Universität München, 85748 Garching, Germany*
[3] *Institut für Energieforschung - Plasmaphysik, Forschungszentrum Jülich, 52425, Germany*

Poloidal correlation reflectometry (PCR) is a powerful tool to study correlation properties of turbulent density fluctuations [1, 2]. In the typical application of PCR several poloidally and toroidally separated receiving antennas simultaneously measure the reflected beam from the cut-off layer in the plasma. The correlation of the receiving antenna signals allows to determine the velocity, the correlation length and life time of turbulent density fluctuations [3]. In this contribution an alternative application of the PCR diagnostic is proposed. All receiving antenna signals are combined in post-processing software with different phases to create a total receiving beam in a specific direction using the phased antenna array concept. The principle of this method is similar to the synthetic aperture microwave imaging (SAMI) system [4, 5], but with only 4 receiving horn antennas. The method is robust and can be applied to every discharge. Using the PCR antenna cluster at ASDEX Upgrade the total receiving beam can be steered in the poloidal direction ($\theta \simeq \pm 10^\circ$) and in the toroidal direction ($\phi \simeq \pm 4^\circ$) with characteristic 3 dB half-width beams of order $\Delta\theta \approx 1.5^\circ$ and $\Delta\phi \approx 2.7^\circ$ - thus operating as a steerable Doppler reflectometer with corresponding backscaterring wavenumbers $k_\perp \simeq \pm 3\,\mathrm{cm}^{-1}$ and $\Delta k_\perp \simeq 0.6\,\mathrm{cm}^{-1}$

The application of the method to L- and I-mode plasmas is presented. The measured velocity from the Doppler shift is compared with classical PCR time delay analyses [2] and with other diagnostics. Influence of the magnetic field line pitch angle is also shown. Quasi coherent modes with $k_\perp \approx 1\ \mathrm{cm}^{-1}$ can be decoupled from background turbulence and enhanced. Observations of the intermittent events reported in [6] are discussed.

References

[1] A.Krämer-Flecken et al., *Nucl. Fusion* **57**, 066023 (2017)
[2] D.Prisiazhniuk et al., *Plasma Phys. Control. Fusion* **59**, 025013 (2017)
[3] D.Prisiazhniuk et al., "Density fluctuation correlation measurements in ASDEX Upgrade using poloidal correlation reflectometry", sumbitted to PPCF (2018)
[4] D.A. Thomas et al., *Nucl. Fusion* **56**, 066023 (2016)
[5] S.J. Freethy et al., *Nucl. Fusion* **55**, 124010 (2013)
[6] T.Happel et al., *Nucl. Fusion* **56**, 064004 (2016)