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Correlation reflectometry on Wendelstien 7-X: correlation properties, sensitivity, and prospects for nT-crossphase measurements

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The poloidal correlation reflectometer (PCR) diagnostic on Wendelstein 7-X (W7-X)[1,2] is two-frequency system covering the Ka- and U-bands comprised of four receiving antennas and a single transmitting antenna. This diagnostic measures plasma density fluctuations in close proximity to two correlation radiometry antennas (CECE)[3] and two Doppler reflectometer systems (DBS)[4]. The PCR on W7-X is typically used to determine the poloidal flow velocity and correlation length from the signal correlation between adjacent receivers. During operational phase 1 of W7-X (OP1), the PCR antennas were uncooled and the system operated in the Ka-band. During OP2.1, the antennas were integrated into a monolithic water-cooled antenna head and the U-band reflectometer was added. Frequency hopping steps were separated into (1) a fullband scan in 0.5 GHz increments, and (2) a localized scan at 40 GHz with the two reflectometers separated in 0.2 GHz increments. In this work, the correlation properties measured by the two systems will be presented. Additionally, the signals from the receivers are combined to form a coarse phased array antenna system as in [5], with a poloidal steering range limited to approximately ±10 deg. and the wavenumber sensitivity of the diagnostic is investigated. For OP2.2, a water-cooled PCR antenna head has been installed that is optimized to match wave polarization to the magnetic field-line pitch at the last-closed flux surface. When combined with improvements to the CECE, the correlation between plasma density and electron temperature fluctuations may be measured to aid in the characterization of turbulence and transport.

[1] A. Krämer-Flecken *et al.*, *Nucl. Fusion* **57** 066023 (2017)
[2] T. Windisch *et al.*, *Plasma Phys. Control. Fusion* **59** 105002 (2017)
[3] G.M. Weir *et al.*, *Rev. Sci. Instrum.* In-proc. HTPD 2024 (in-prep.)
[4] T. Estrada *et al.*, *Nucl. Fusion* **61** 046008 (2021)
[5] D. Prisiazhniuk et al., In-proc. 45th EPS (P1.1008)

Primary author: Dr WEIR, Gavin (Max Planck Institute for Plasma Physics)

Co-authors: KRÄMER-FLECKEN, Andreas (Forschungszentrum Jülich); WINDISCH, Thomas (IPP); HIRSCH, Matthias (IPP Bereich Greifswald); ALEYNIKOV, Pavel (IPP Bereich Greifswald); MARUSHCHENKO, Nikolai (IPP Bereich Greifswald); GRULKE, Olaf (IPP Greifswald); SCHROEDER, Timo (IPP Bereich Greifswald); KLINGER, Thomas (IPP Bereich E5 Greifswald)

Presenter: Dr WEIR, Gavin (Max Planck Institute for Plasma Physics)

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