Core electron heat transport measurements on Wendelstein 7-X and correlation microwave diagnostics for Operational Phase 2

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The advanced stellarator Wendelstein 7-X (W7-X) [1] is optimized to have an approximately quasi-isodynamic magnetic field with reduced neoclassical transport [2], and turbulent heat transport is expected to be dominant across the majority of the minor radius. The ion temperature gradient (ITG) and trapped electron ode (TEM) are expected to dominate the ion-scale turbulence in W7-X plasmas with volume averaged pressure below 1% [3]; however, the experimental electron heat transport measured in the core of W7-X is comparable to that predicted from electron temperature gradient (ETG) mode driven turbulence. The experimental electron heat transport measured during transient transport experiments is presented in three magnetic configurations of W7-X, where the stiffness in the electron heat flux is measured to be less than 2 and trend downwards with increasing collisionality at low plasma-$\langle\beta\rangle$ [4].

For the next operational phase of W7-X we are extending the capabilities of the correlation reflectometry [5] and correlation radiometry diagnostics to aid in the characterization of turbulence and transport. Two new correlation electron cyclotron emission (CECE) antennas are being installed that overlap with the measurement region of the poloidal correlation reflectometer, and the measurement range of the correlation reflectometer will be increased to allow access to plasma densities up to $4x10^{19}$ m^{-3}.

[1] T. Klinger *et al., Plasma Phys. Control. Fusion* **59** 014018 (2017).

[2] J. Nührenberg and R. Zille, *Phys. Lett.* **A 129** 113 (1988).

[3] G.G. Plunk *et al., Phys. Rev. Lett.* **122** 035002 (2019).

[4] G.M. Weir *et al., Nucl. Fusion* **61** 056001 (2021).

[5] A. Krämer-Flecken, S. Soldatov, B. Vowinkel, and P. Müller*, Rev. Sci. Instrum.* **81** 113502 (2010).