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CECE and nT-phase measurements in ASDEX Upgrade tokamak

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Turbulent heat and particle transport are related to the amplitude of density, temperature, potential fluctuations, and the cross-phase angles between these fluctuating quantities. While cross-phase between the density and temperature might not be directly linked to the transport, it can provide information on the relative changes of turbulent properties with changing plasma parameters and provide insight into the type of turbulence.
The density temperature cross phase (nT-phase) can be measured experimentally by cross-correlating co-located density fluctuation signals from a reflectometer and temperature fluctuation signals from a Correlation Electron Cyclotron Emission (CECE) radiometer [1,2]. A dedicated nT-phase system has been constructed for the first time at ASDEX Upgrade, using a W band X-mode reflectometer and a 24-channel CECE system. Initial measurements with this new system capture the nT-phase of broadband fluctuations in the outer core and pedestal region. Previous nT-phase measurements in AUG were performed using the standard CECE system coupled with Doppler reflectometers operating in normal incidence mode [3]. These measurements include those of the Weakly Coherent Mode (WCM), which is found to have out-of-phase nT-phase in both L-mode and I-mode [4].
In addition, CECE radiometer, toroidally separated from the nT-phase system, is operated routinely for the outer core and edge measurements at standard 2.5 T field configuration. Further upgrades that involve the extension of that system to cover a major portion of the plasma radius and the operation at a low magnetic field are discussed.

[1] Häse et al, Rev. Sci. Instrum. 70, 1014 (1999)
[2] White et al, Phys. Plasmas 17, 056103 (2010)
[3] Freethy et al, Phys. Plasmas 25, 055903 (2018)
[4] Bielajew et al, Phys. Plasmas 29, 052504 (2022)

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