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Experimental investigations of turbulent temperature fluctuations and phase angles in ASDEX Upgrade.[1]

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A complete experimental understanding of the turbulent fluctuations in tokamak plasmas is essential for providing confidence in the extrapolation of heat transport models to future experimental devices and reactors. Guided by "predict first" nonlinear gyrokinetic simulations with the GENE code, two new turbulence diagnostics were designed and have been installed on ASDEX Upgrade (AUG) to probe the fundamentals of ion-scale turbulent electron heat transport. The first, a 30-channel correlation ECE (CECE) radiometer, measures radial profiles (0.5 <r/a <0.8) of low-k (ktheta rhos <0.3) temperature fluctuations as well as frequency spectra and radial correlation lengths in unprecedented detail in both L- and H-mode. Typical L-mode levels are in the range 0.3 – 0.8%. The second is formed by the addition of a reflectometer on the same line of sight to enable measurements of the phase angle between turbulent density and temperature fluctuations. Design predictions are followed by a more traditional "post-diction" validation study with GENE. Using a cutting edge synthetic diagnostic GENE shows a factor 1.6 - 2 over-prediction of the fluctuation amplitude, while matching both ion and electron heat fluxes within experimental error. Detailed sensitivity scans are underway to understand the robustness of this disagreement and a detailed assessment of the experimental errors has been carried out. The discrepancy opens questions about the role of multi-scale turbulence physics, but also indicates the need for the comparison of more experimental turbulence properties to have a more complete validation hierarchy. In an effort to understand the discrepancy, *predictions* of the nT-phase and the radial correlation length have been made along with an assessment of their sensitivity to experimental errors. Comparison to experimental measurements will be discussed.

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