Gyrokinetic modelling and experimental comparisons of radial correlation and time delay Doppler backscattering measurements in JET

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Radial Correlation Doppler Reflectometry (RCDR) [1] is routinely used to extract the radial correlation length of the underlying turbulence by cross-correlation of neighbouring Doppler backscattering signals (DBS). An evolution to RCDR using cross-correlation-time-delay estimations has recently been used to characterise the tilt-angle of turbulent eddies in the perpendicular direction to the background magnetic field [2]. We present a conceptual study of radial correlation and time delay measurements using nonlinear gyrokinetic simulations from GYRO [3] and GS2 [4] based on experimental NSTX H-mode and JET L-mode discharges. A linear response, local synthetic model for the DBS signal applied to gyrokinetic simulation output shows that DBS measurements are not sensitive to the real turbulence radial correlation length, but to the scale-dependent correlation length corresponding to the selected binormal wavenumber $k_\perp$. Nonlinear gyrokinetic simulations show that the turbulence naturally exhibits a power-law dependence of the radial correlation length with binormal wavenumber $l_r(k_\perp) \sim C\, k_\perp^{-\alpha}$ $(\alpha \approx 1)$, which may partly explain recent radial correlation length measurements [5]. The radial correlation length is only measurable when the radial beam dimension at the cutoff location W_n satisfies $W_n \ll l_r$, likely only satisfied for ion-scale measurements ($k_\perp \rho_i \lesssim 1$). Initial measurements of the radial correlation length, eddy aspect ratio and eddy tilt angle are presented for the sweeping frequency Doppler backscattering system at JET, as well as comparisons to the model predictions.

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