High-k Turbulent Fluctuations in NSTX

presented by

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NSTX Results Review
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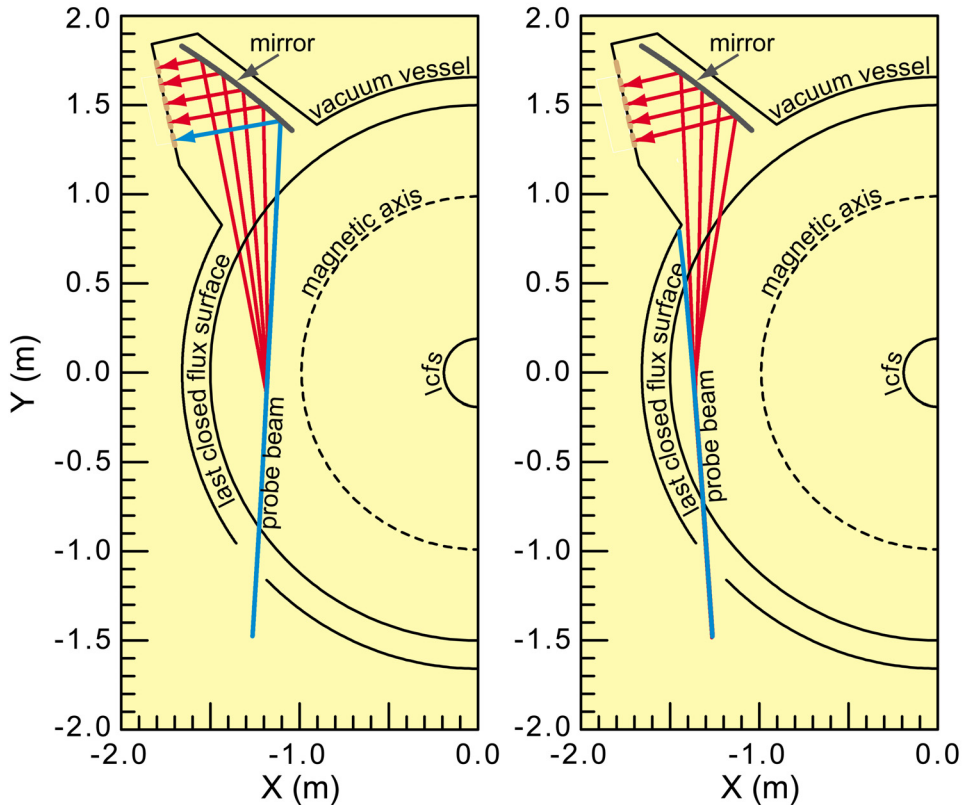
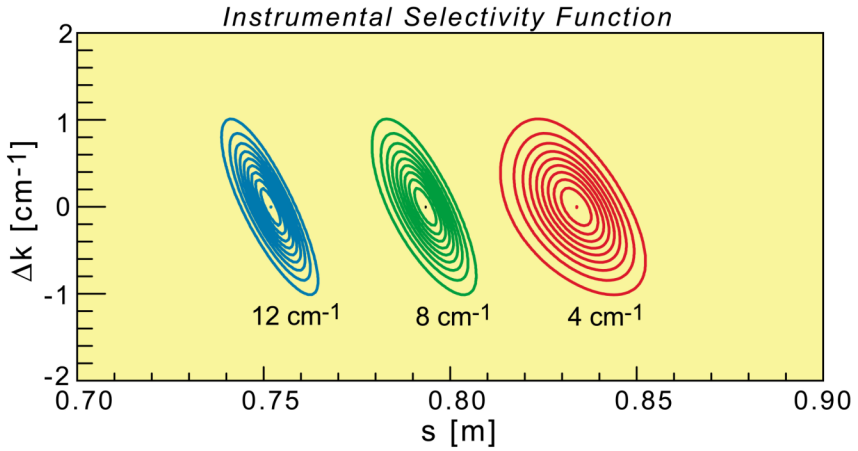
Motivation

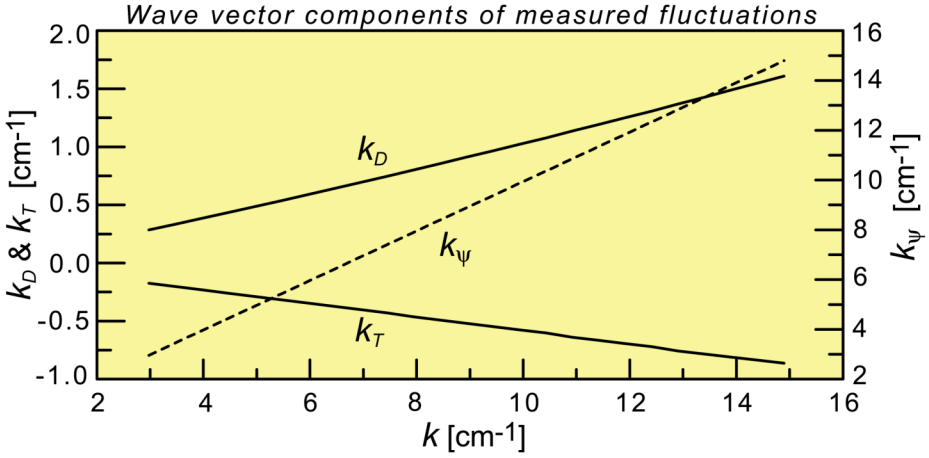
- *The primary goal of XP-821/735 was:*
  - *a) to check whether turbulent fluctuations with an electron gyro-scale exist in NSTX plasmas*
  - *b) identify their nature*
- *Turbulent fluctuations were measured with coherent scattering of 280 GHz waves using a novel scattering geometry with good spatial resolution*



Good radial and wave number resolution

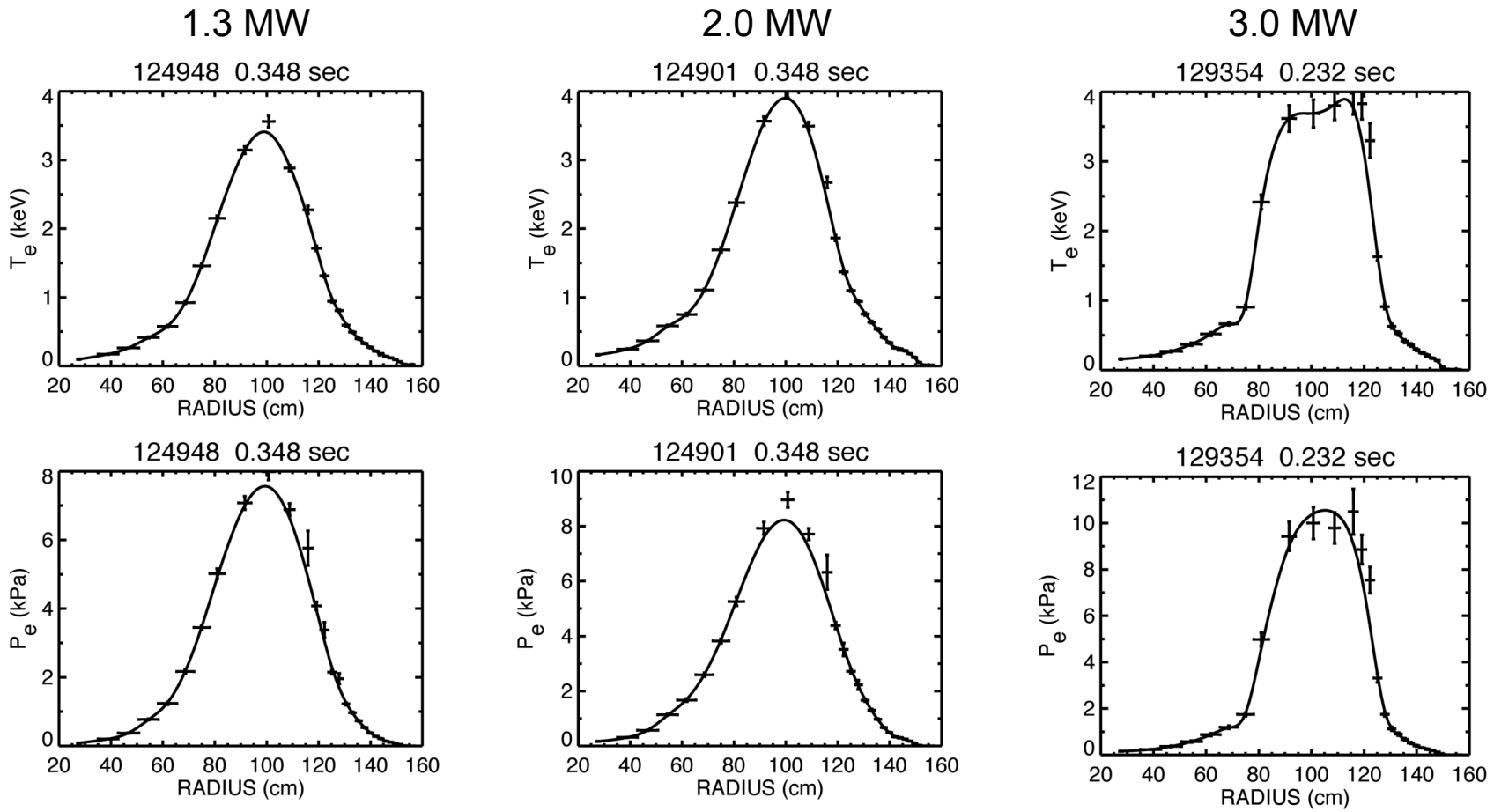
- *Spatial resolution takes advantage of the anisotropy of plasma fluctuations ($k >> k_{||} \sim 1/qR$) and the curvature of magnetic lines – i.e., the change in direction of the magnetic field within the scattering region modifies the instrumental selectivity function by detuning the receiver*
- *Both radial (± 3 cm) and wave number (± 1 cm^{-1}) resolution is set by the size of the probing beam*
- *Wave vectors of fluctuations are mainly perpendicular the magnetic surfaces, but have small components in the electron diamagnetic and toroidal directions as well*





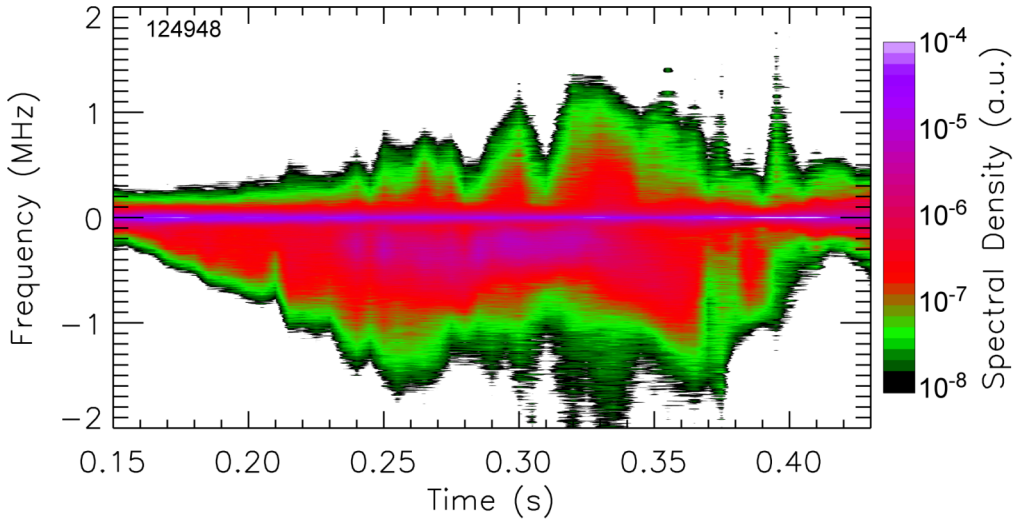
HHFW

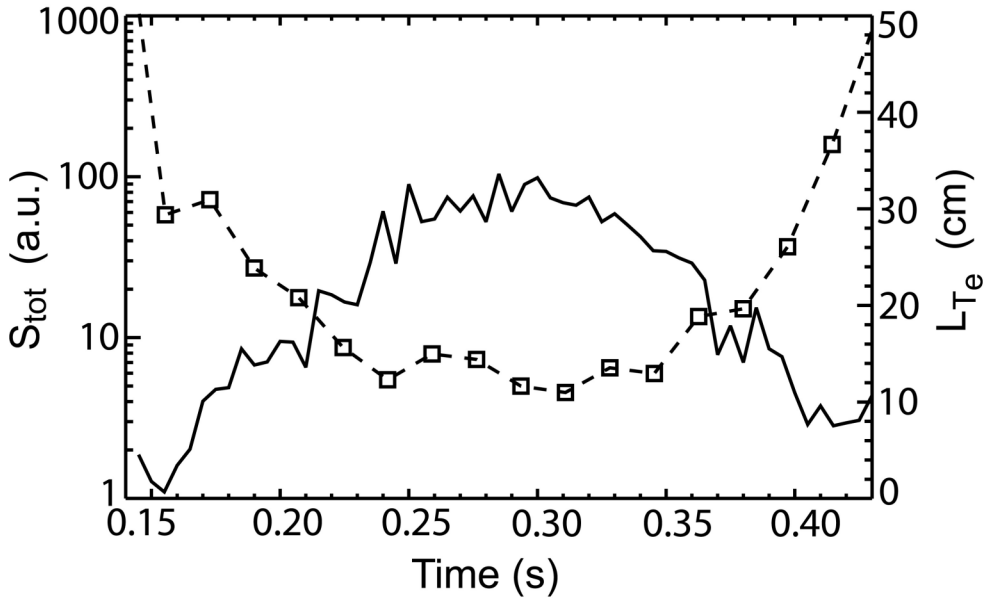
- *Use of HHFW – best available tool for obtaining T_e profile with large central values and steep gradients. However, RF-results were not very reproducible.*



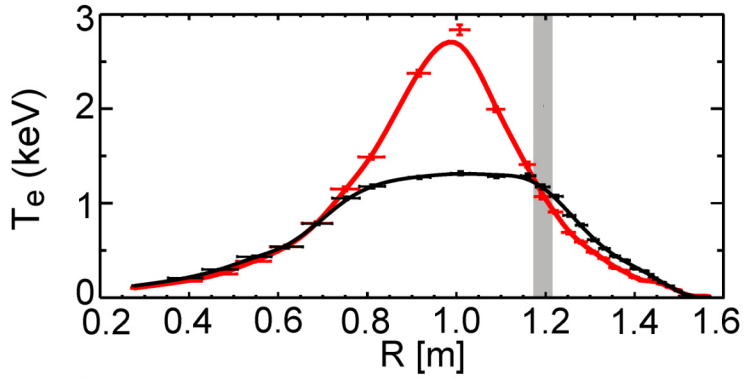
High-k Turbulent Fluctuations

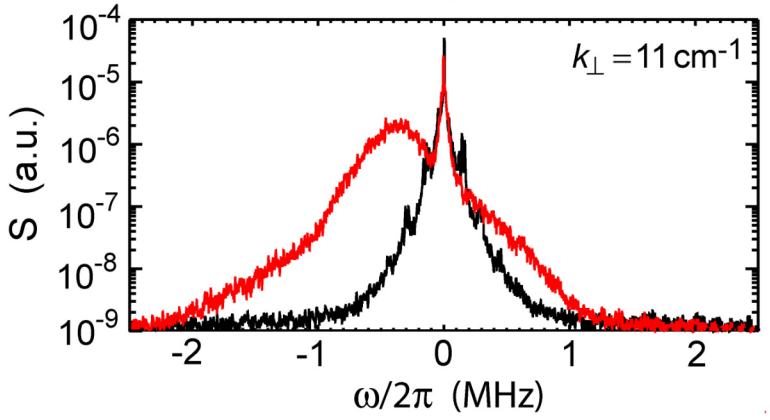
- *HHFW heating in He plasmas drives core turbulent fluctuations with wave numbers in the range $k_\perp\rho_e$=0.1-0.4 and $k_\perp\rho_s$=8-16.*





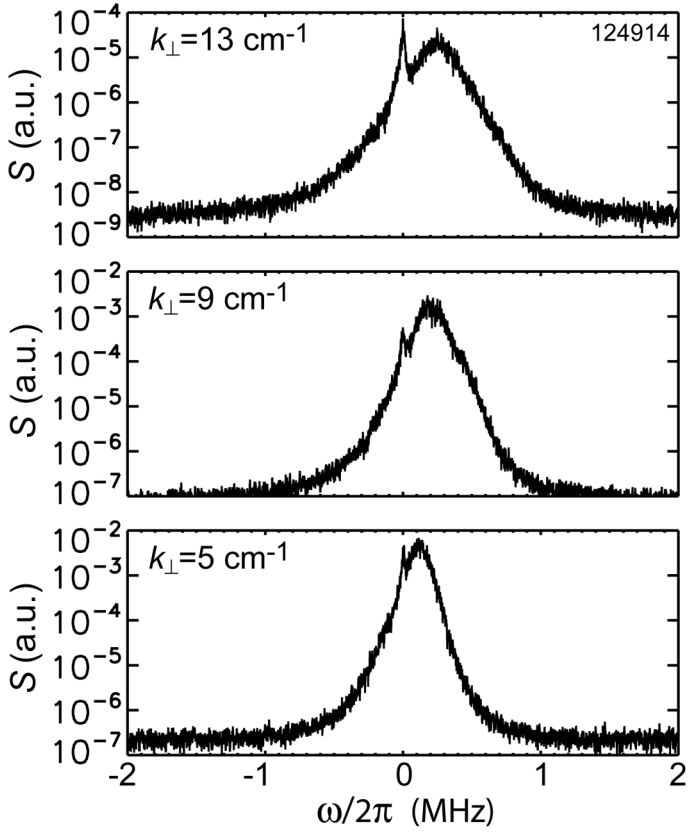
- *Results show a clear dependence on the gradient of T_e*

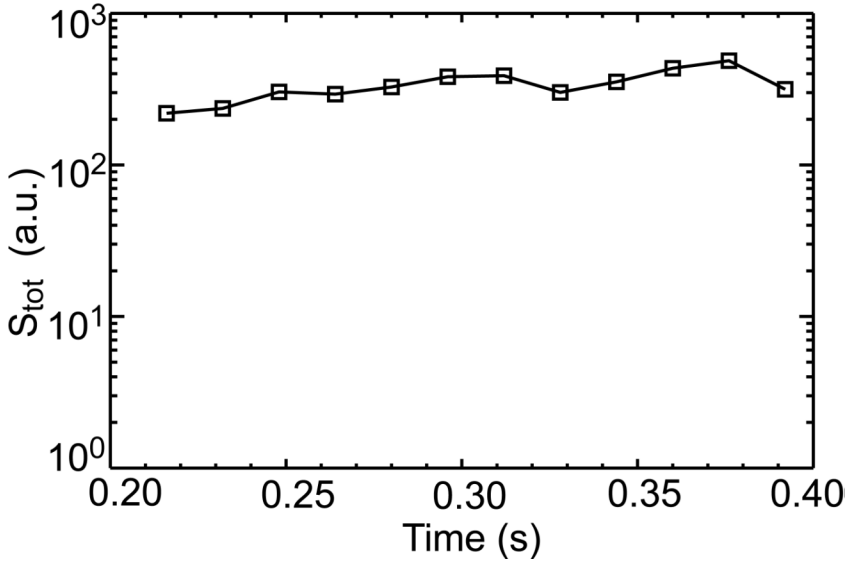




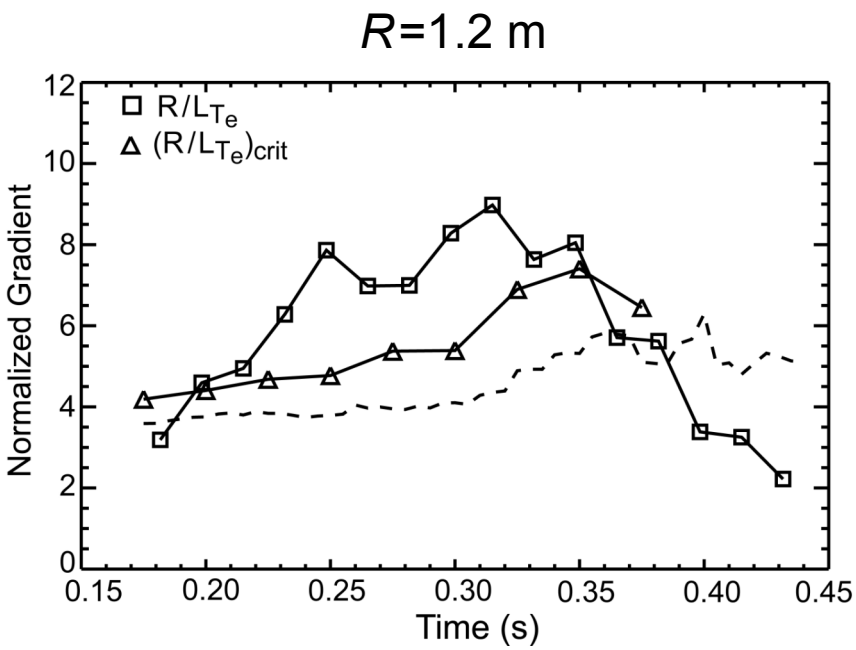
High-k Turbulent Fluctuations

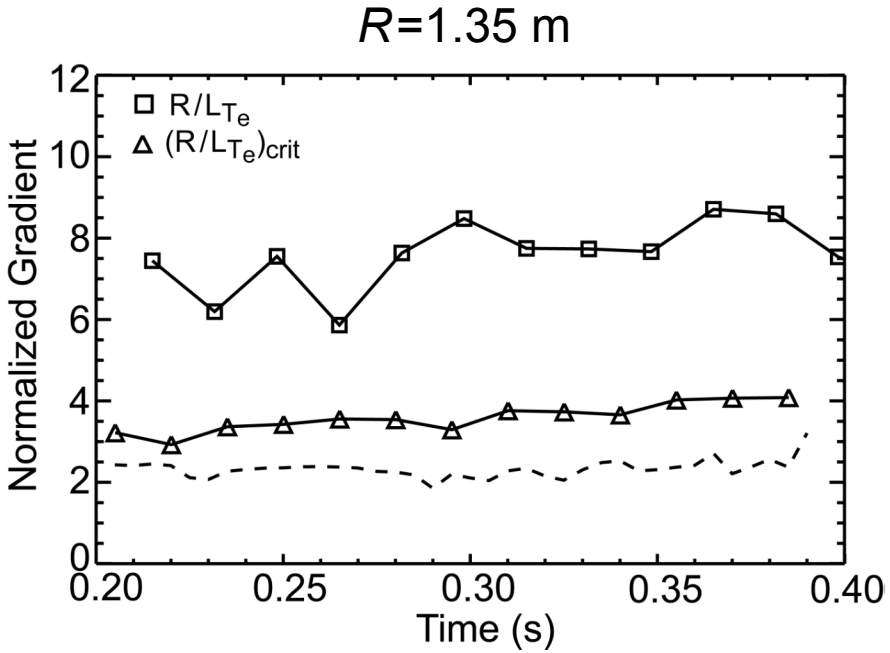
- *High-k fluctuations were observed on the plasma outer region as well (R~1.35 m) with wave numbers in the range $k_\perp \rho_e$=0.1-0.2 and $k_\perp \rho_s$=4-8.*



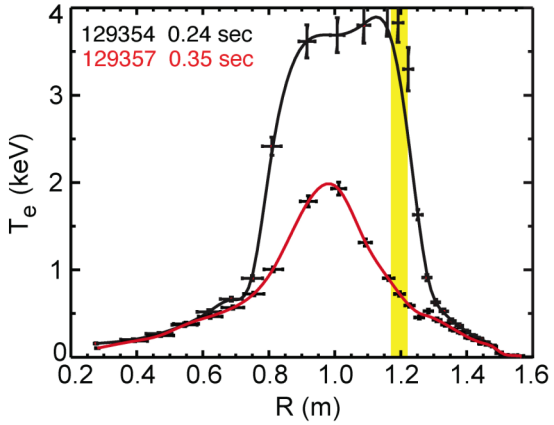


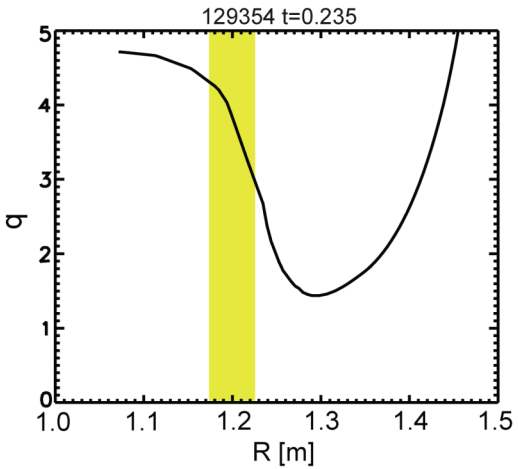
Observed fluctuations agree with predictions of linear GS2 code

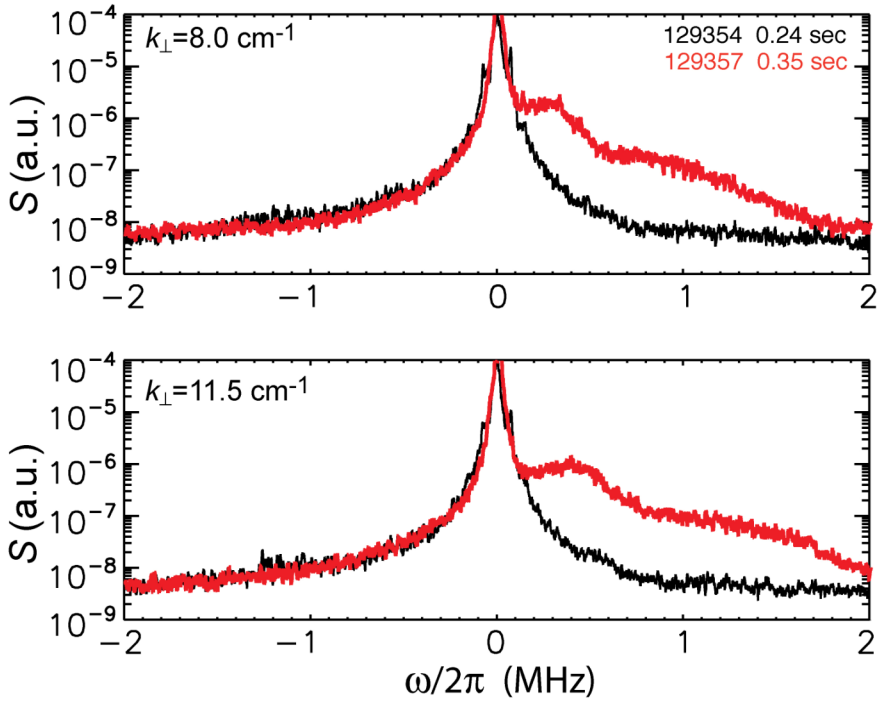




Suppression of fluctuations by reversed shear

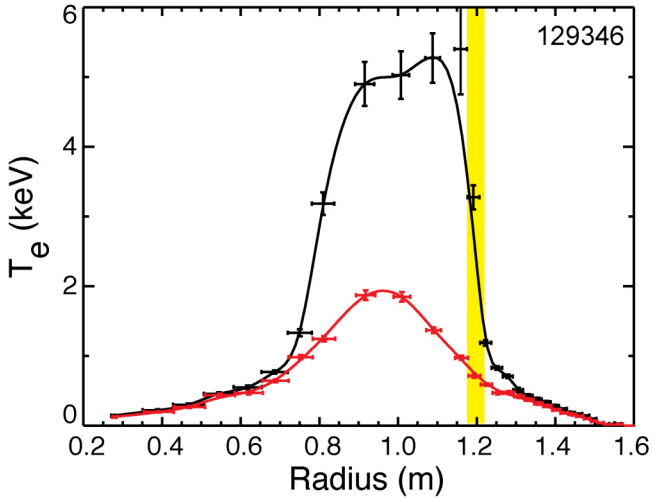


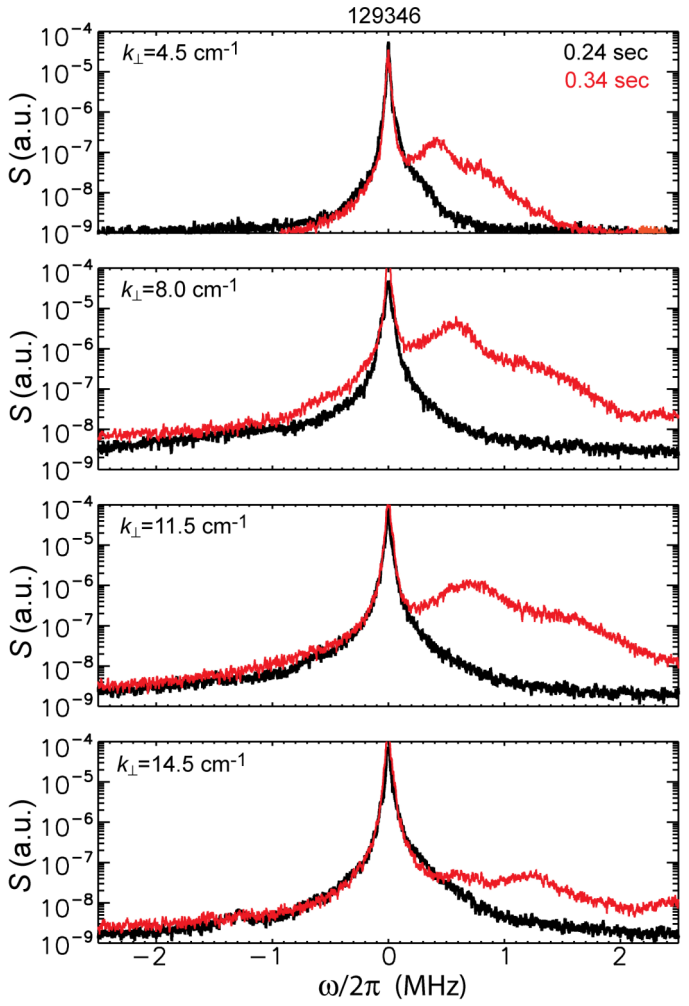




- *Fluctuations are suppressed by a strong reversed shear (Jenko and Dorland PRL 89, 2002, Yu et al., APS 2007)*

Suppression of fluctuations by reversed shear





- *Is the strong gradient of T_e where fluctuations are suppressed evidence of the role played by ETG on plasma transport?*

Conclusions

- *Our results indicate the existence of turbulent fluctuations with the electron gyro-scale in NSTX*
- *Large values of $k\rho_i$, propagation along the electron diamagnetic direction and a strong correlation with the gradient of T_e rule out the ITG mode as the source of turbulence*
- *A qualitative agreement with the predictions of the linear gyrokinetic GS2 code supports the conjecture that the observed turbulence is caused by the ETG instability*
- *Need for further measurements and non-linear numerical simulations for assessing the importance of these fluctuations on plasma transport*

Recommendation

- *The existing scattering system should be upgraded to cover the full range of possible wave numbers – from ITG to ETG*
- *Another microwave scattering system should be installed for the measurement of the poloidal spectrum of fluctuations*