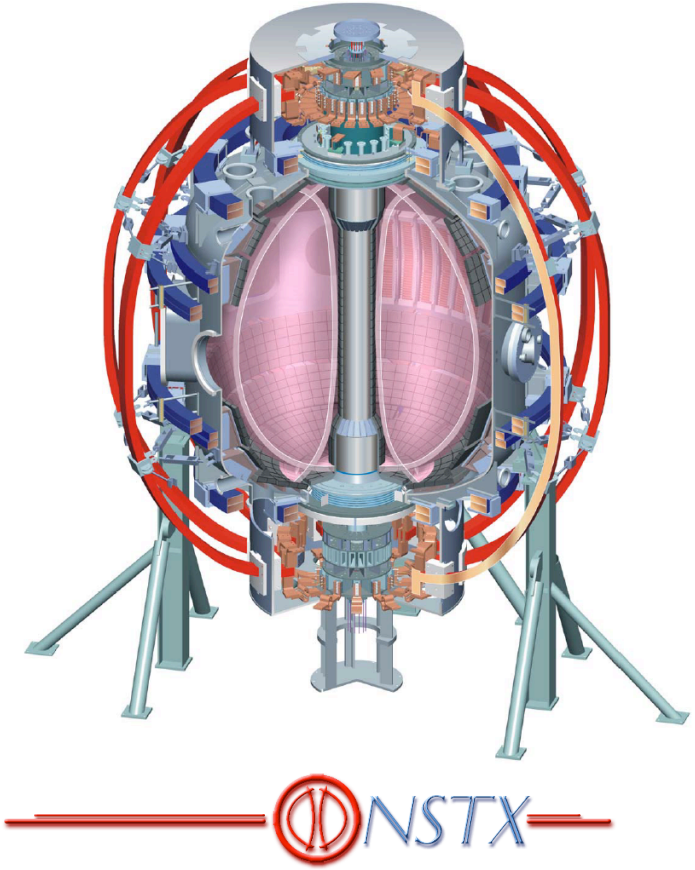
Investigation of the nature of long-wavelength turbulence in the core of NSTX plasmas



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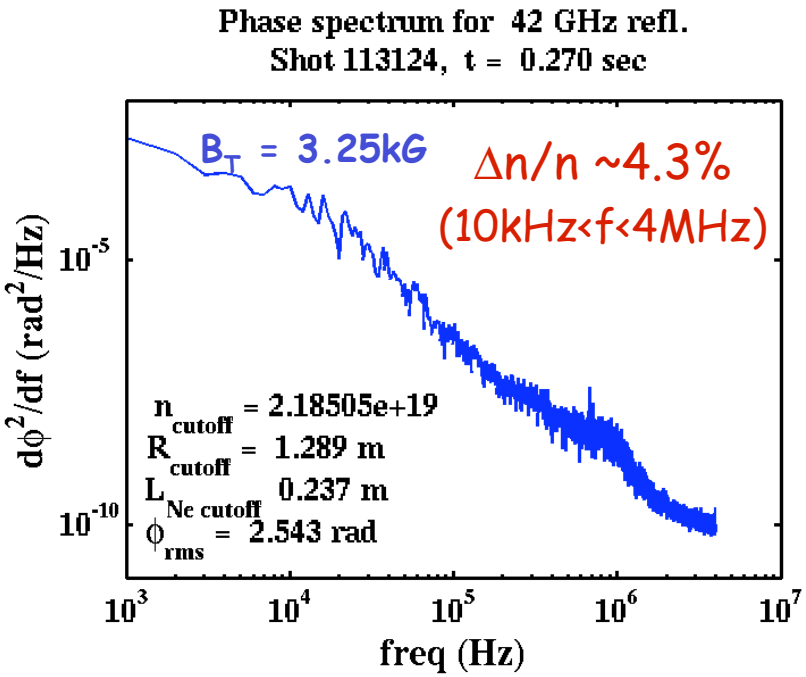
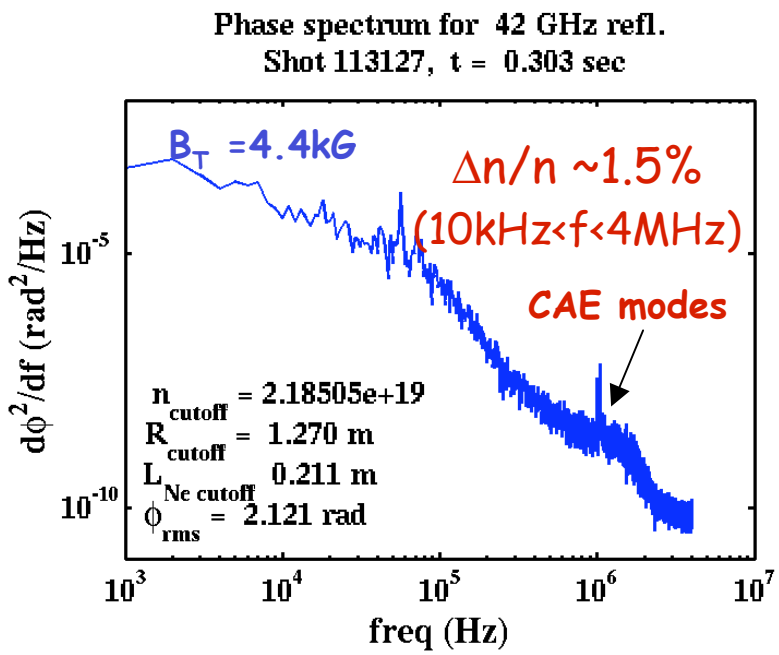
Variation of turbulence characteristics with ρ*

B_T = 4.4kG, 3.25kG Ip = 800 kA,600kA ~1MW 60kV beam

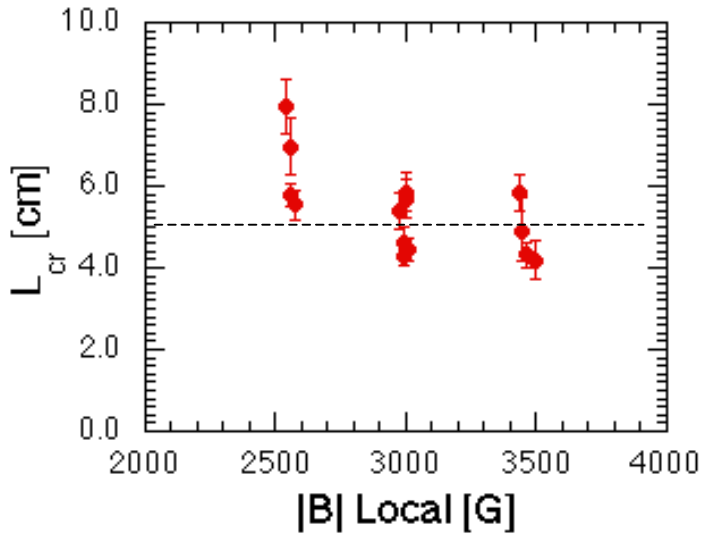




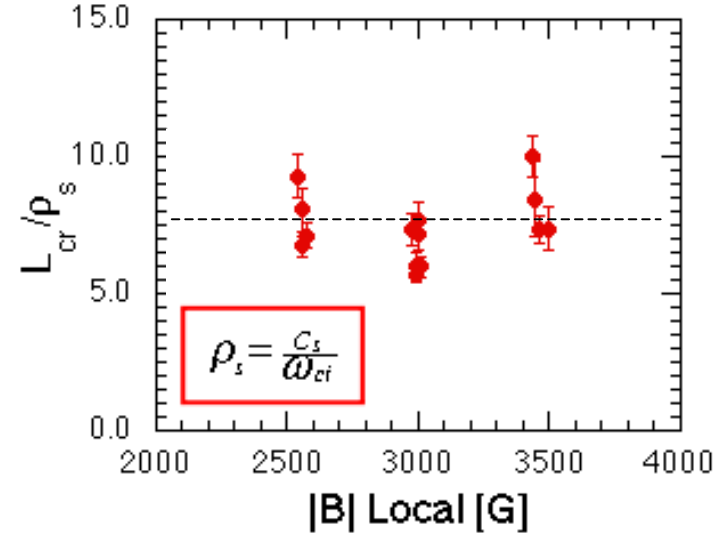
- Phase spectra allow estimate of density fluctuation levels to be made.
- **Fluctuation levels ~ 3 times larger in lower field, lower current plasmas.**
- **Correlation lengths also significantly larger in lower field plasmas.**
- Transport observed to degrade at lower field

Correlation length measurements

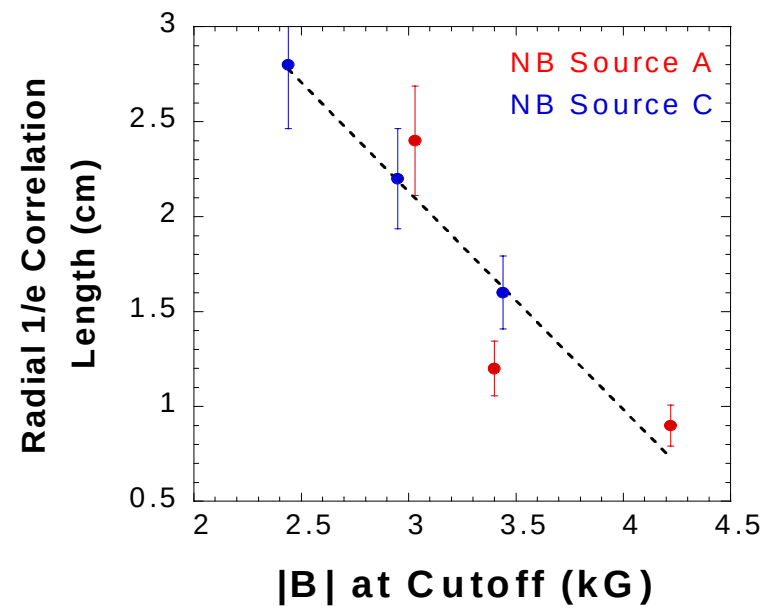
ρ* Scan: B_T=3.25, 3.85 & 4.4 kG, rho~.7



rho ~0.7



- Lcr ranges from 4-8 cm at radius of rho ~0.7.
- **Lcr increases inversely with B.**
- Lcr normalized by ρ_s is ~ constant
- Consistent with previous data from rho~0.95 where correlation lengths increased with decreasing local field. Normalization to ρ_s gave a constant ratio of ~6 .



Observe very long correlation lengths deep in the core

- Correlation lengths up to~ 20cm have been observed e.g shot 112996
- ITG turbulence – generally expect stabilization in core plasma. However, needs nonlinear calculations (GYRO : D. Mikkelsen).
- We are investigating correlation analysis. Does not appear responsible.
- Possible alternative picture: beam heated plasmas have a "sea of fast particle driven modes" covering a broad spectral bandwidth.

  We may be dealing with "turbulent" spectra in the core with significant magnetic fluctuations which also appear as density fluctuations (this is seen, for different reasons, in the RFP). These modes can be global and also more local. The strong drive from the fast particles can potentially overcome any stabilizing effects from ExB shear.
- We are investigating this through cross correlation analysis with the fast Mirnov coil signals. Some supporting evidence.
- **Important to look in plasmas where fast-particle modes are absent: Basis of XP proposal.**

Proposed turbulence measurements in Ohmic plasmas

- Originally XP 439 proposed to look at Ohmic plasmas. Need to return to original goal and compare with XP 439.
  - Eliminates/reduces fast driven instabilities present in beam heated plasmas.
    - Measure fluctuation levels and correlation lengths. Still long correlation lengths?
  - **Reduces** ExB shearing rate.
    - Provides contrast with XP 439 performed with 60kV single-beam L mode plasmas
    - Potentially increases likelihood of observing ITG turbulence in core.
- Employ **beam blips** (~20-40ms) in low target density Ohmic plasma to **preferentially heat electrons.**
  - Increases Te/Ti ratio which is a sensitive parameter determining growth rates for both ITG and ETG modes. **Destabilizes long wavelength ITG**.
- Measure density fluctuations levels and correlation lengths. **If full field operation available investigate B field dependence of turbulence & transport.** Possible ρ^* scan if stable, reproducible discharges can be achieved.
- **Probably needs some discharge development.**
- **Total Requested Shots: 20-30 (1 day).**

Ohmic H-mode, RF only & beam-heated plasmas

- Ohmic H –mode allows access to the core of H-mode plasmas.
  - Not possible with normal H-mode.
  - Allows turbulence comparison in the core of L and H –mode plasmas
  - Can also cross correlate with GPI and probe near the edge. **Coordinate XP with Charles Bush.**
- RF only plasmas also allow access to the core (peaked profiles).
  - Te > Ti provides contrast to beam heated plasmas where Ti>Te
  - This ratio is a sensitive parameter in calculating growth rates for ITG and ETG modes. **Piggy back XP.**
- Beam heated plasmas.
  - He can produce peaked profiles with high input beam power (e.g. 113549).
  - GYRO can model.
  - Comparison with turbulence measurements on DIII-D (aspect ratio, etc.).
  - Will require dedicated time on both machines.