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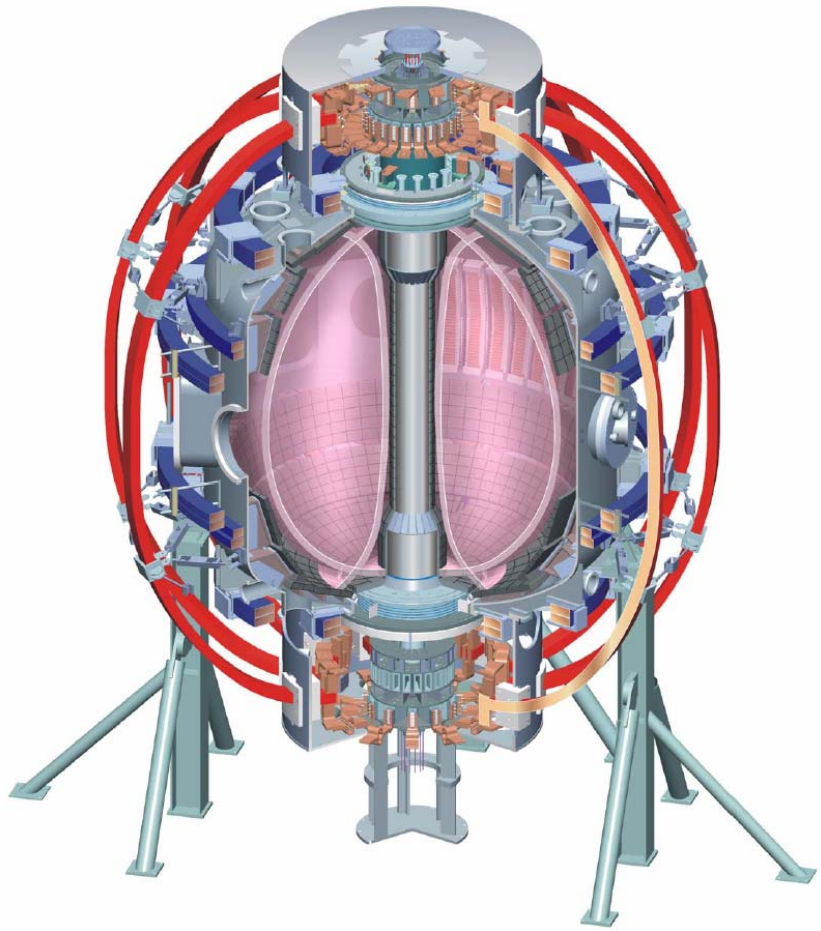
NSTX

Observation of the Enhanced Scattered High-k Spectra during H-mode Phase on NSTX



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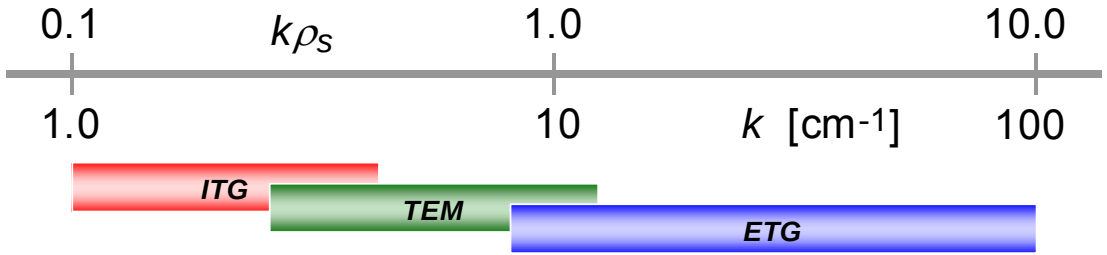
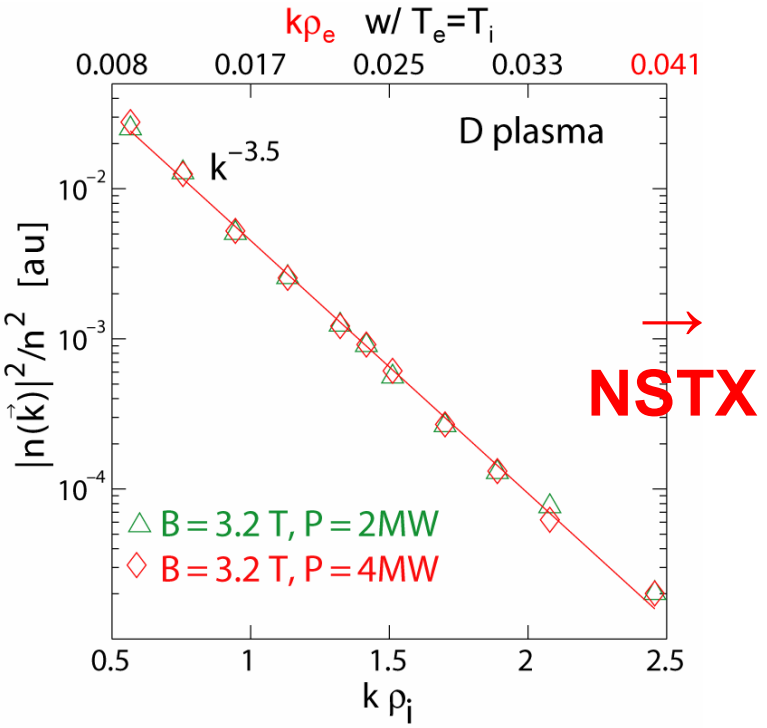
[4] *LLNL, CA*
[5] *The Johns Hopkins University, MD*

NSTX plays a key role in extending fluctuation measurement beyond the present data base

Turbulence type and transport physics



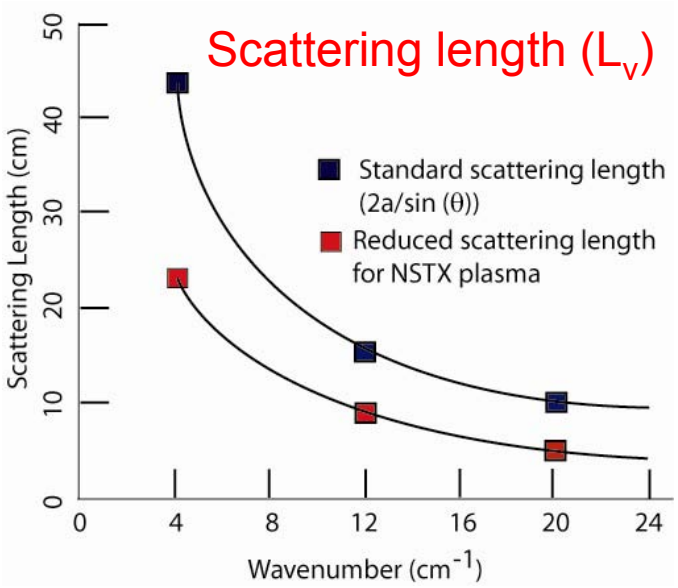
- Multi-channel system → k-space turbulence continuum
- Capable to investigate turbulence physics up to $k_\perp\rho_e$~0.7 on NSTX
  - Present experiment is ~ up to $k_\perp\rho_e$~0.04
  - Ion loss is close to neo-classical
  - Electron loss is anomalous
  - Full exploitation of the turbulence based transport physics is the goal

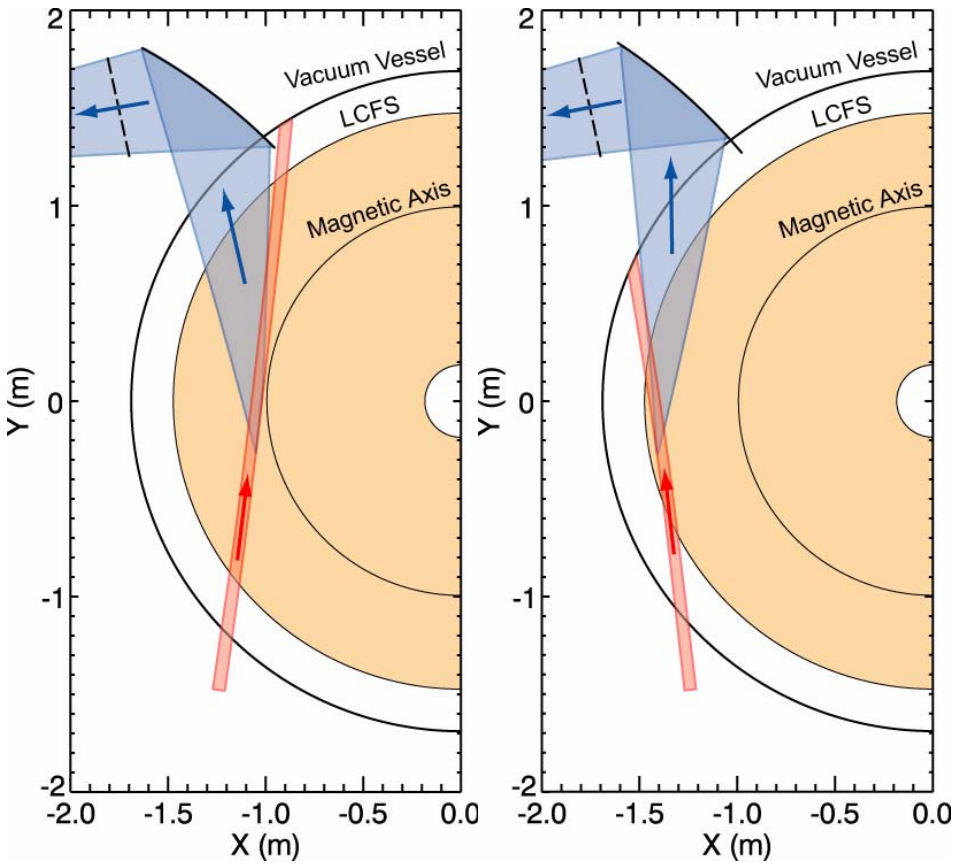


Hennequin et al. PPCF 46, 2004

Characteristics of the scattering system on NSTX

- Tangential multi-channel (5) scattering system:
  - P_o ~100 mW
  - λ_o ~1 mm (280 GHz)
- System resolution
  - Wave-number resolution ~$\Delta k = a/2$ ~1.0
  - Spatial resolution

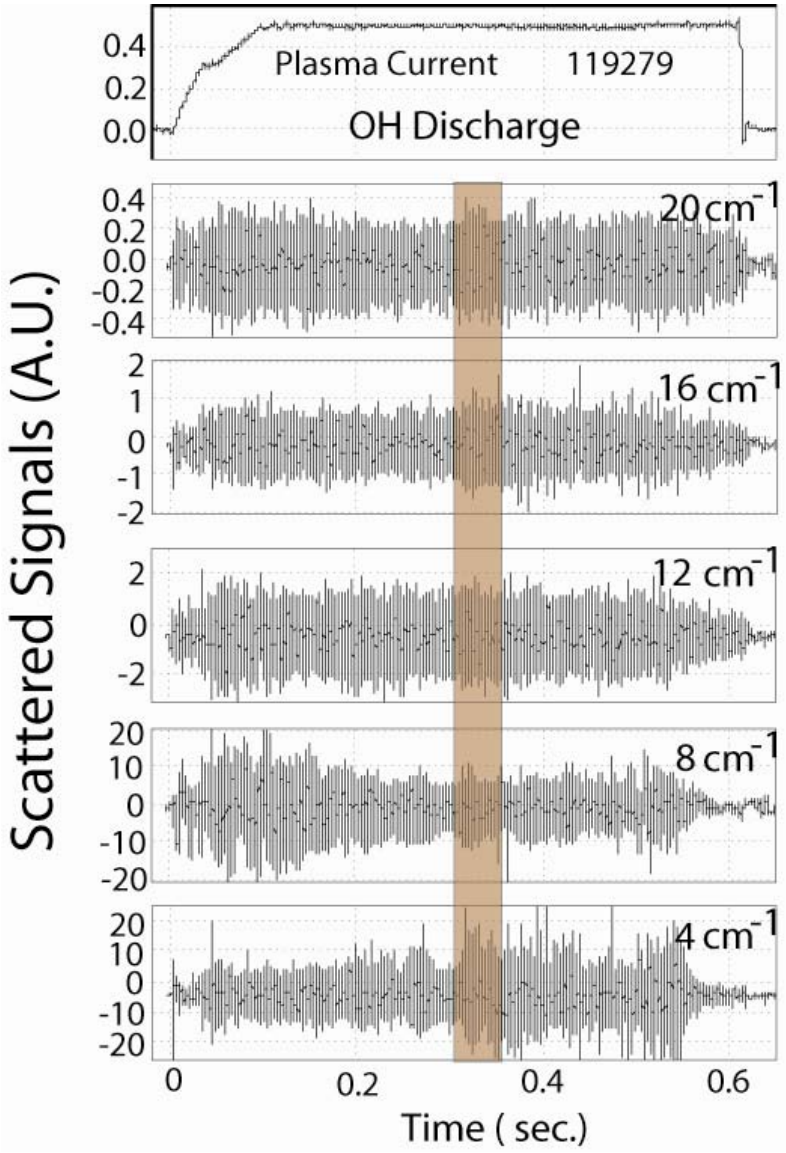


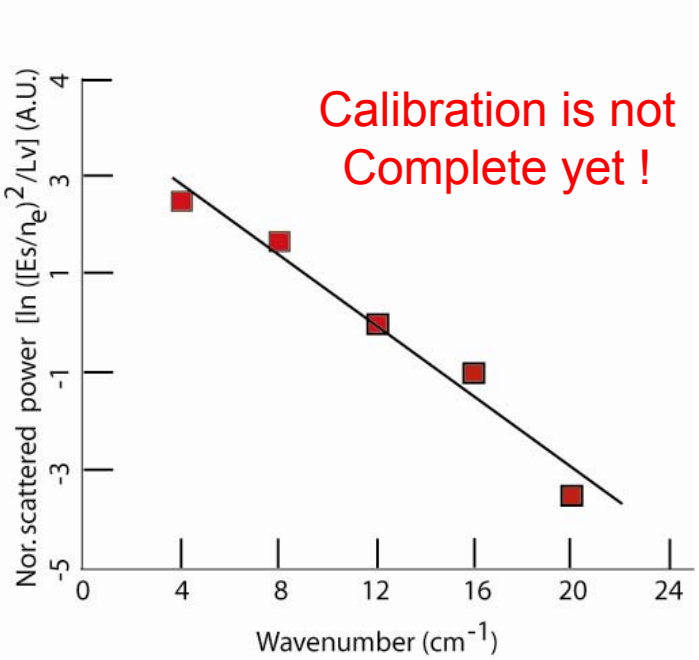


Inboard ρ = 0.05
$k_\perp \rho_e$ up to 0.7

Outboard ρ = 0.75
$k_\perp \rho_e$ up to 0.4

Initial test results from Ohmic discharge (He)

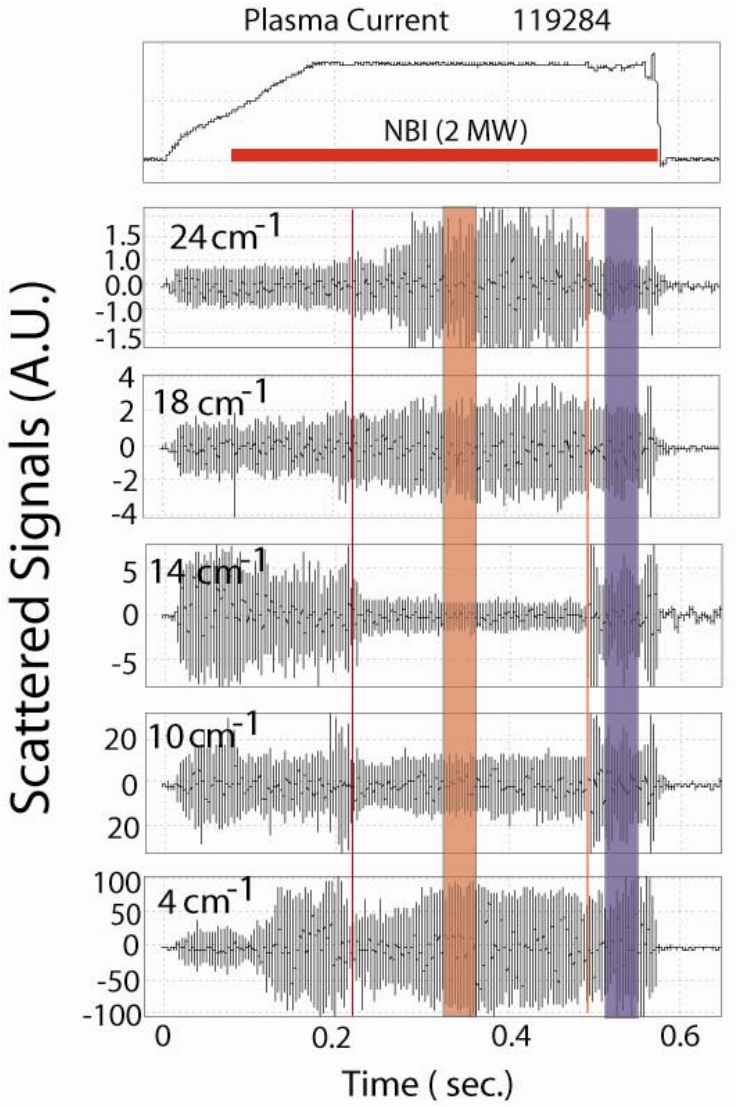




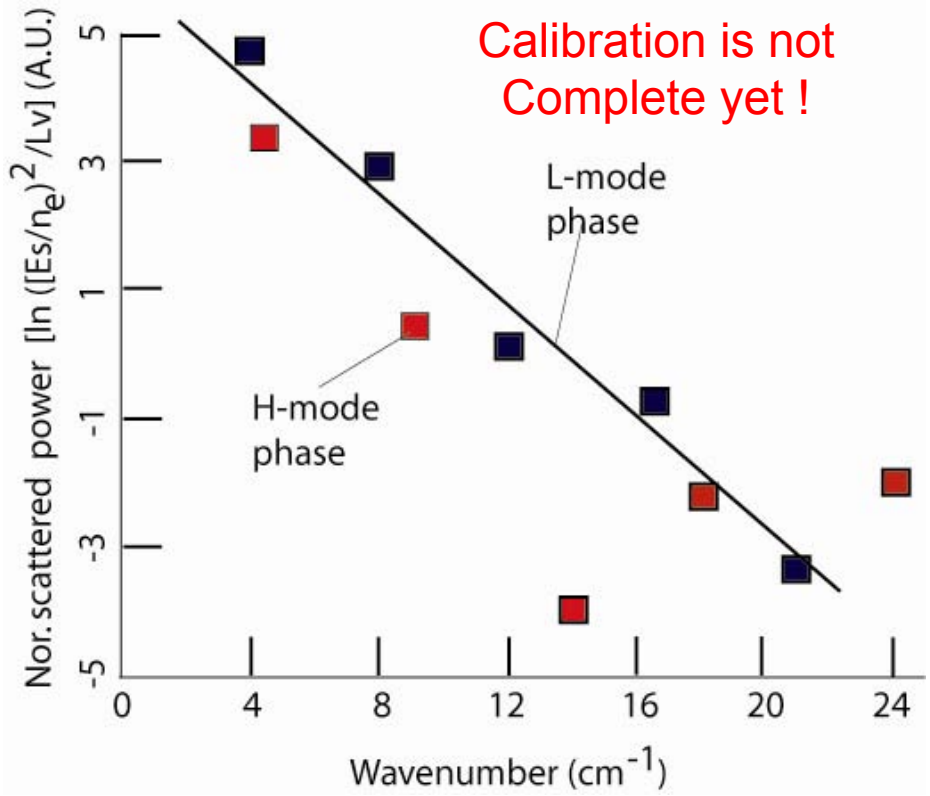
Calibration is not Complete yet !

- Monotonically decreasing power spectra as a function of wave-numbers in OH plasma
- Plasma parameters
  - n_e (0) ~ $2.5 \times 10^{13} cm^{-3}$
  - T_e (0) ~ 200eV
  - r/a ~0.85

Initial test results from NBI heated plasmas

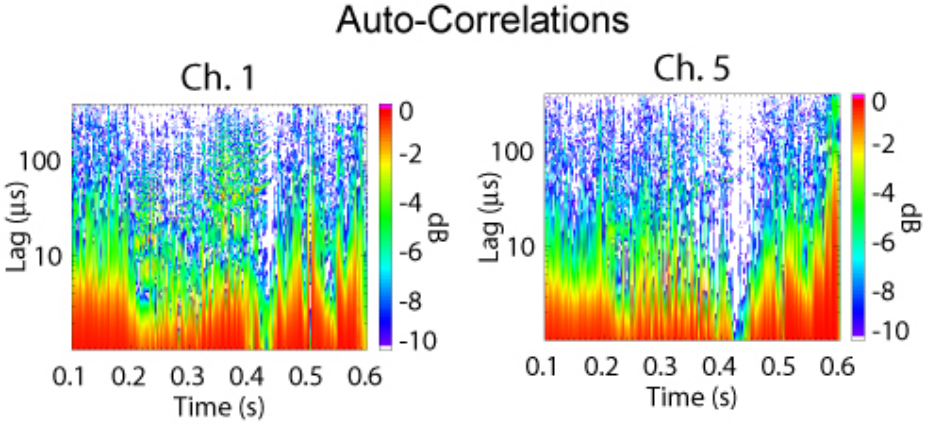


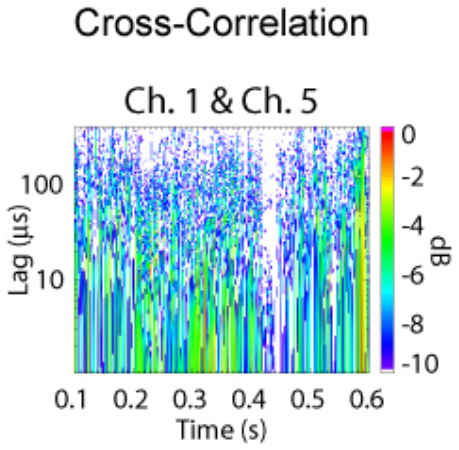
- Monotonically decreasing power spectra during L-mode phase
- Non-monotonic power spectra during H-mode phase



Verification of the system performance

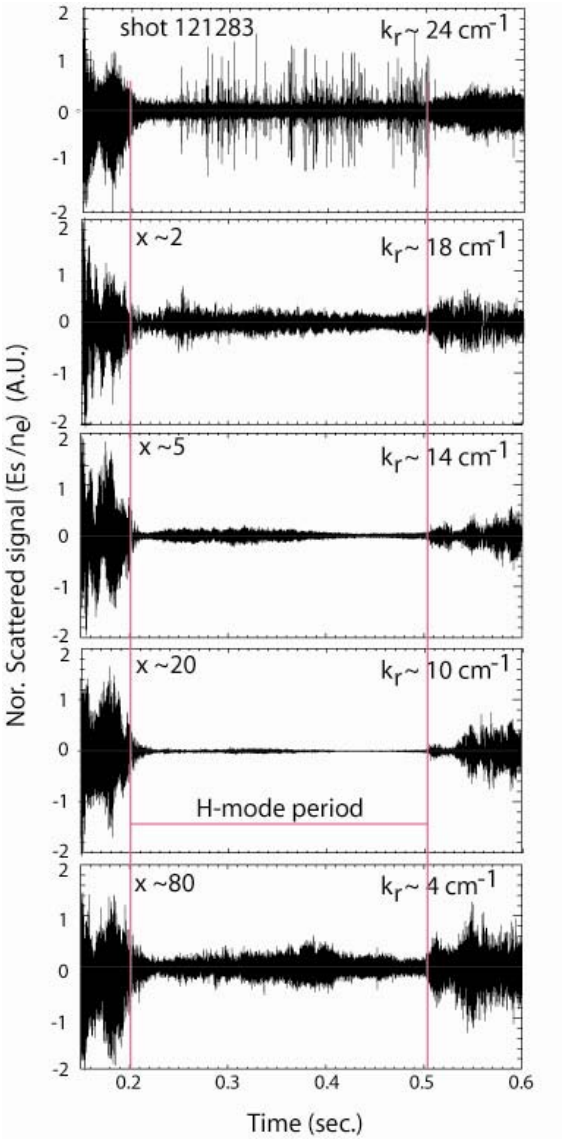
- Relative calibration is not completed
  - Scattering volume, relative efficiency between channels and k-matching conditions
- Source of errors
  - Emissions from plasma at this wavelength is negligible
  - Cross talk between channels is minimized by optically attenuating the signals of the low k channels.



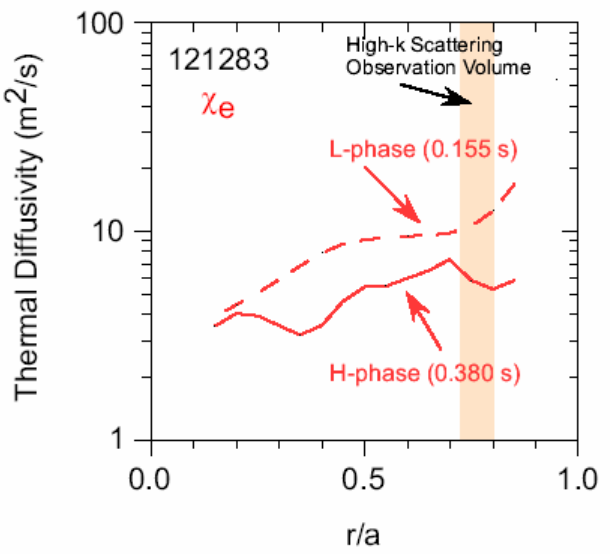


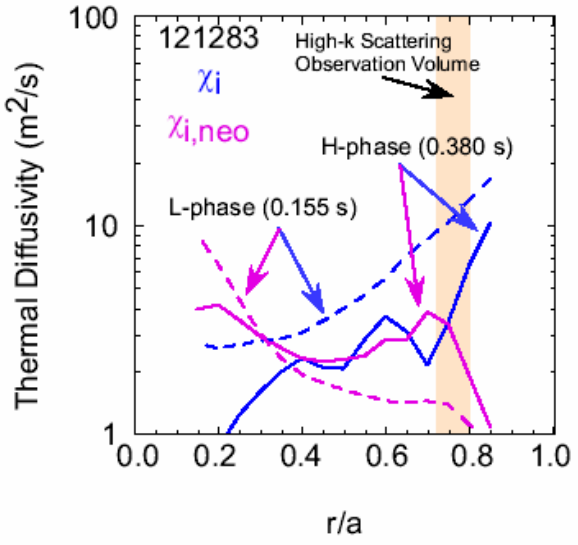
Test of cross coupling

Reduction of fluctuation is well correlated with improved confinement



- Scattering system measures reduced fluctuations ($\frac{\tilde{n}_e}{n_e}$) both upper ITG/TEM and ETG ranges during H-mode
- Ion and electron transport change going from L- to H-modes
- Bursts of scattered signal at the highest k is noted.

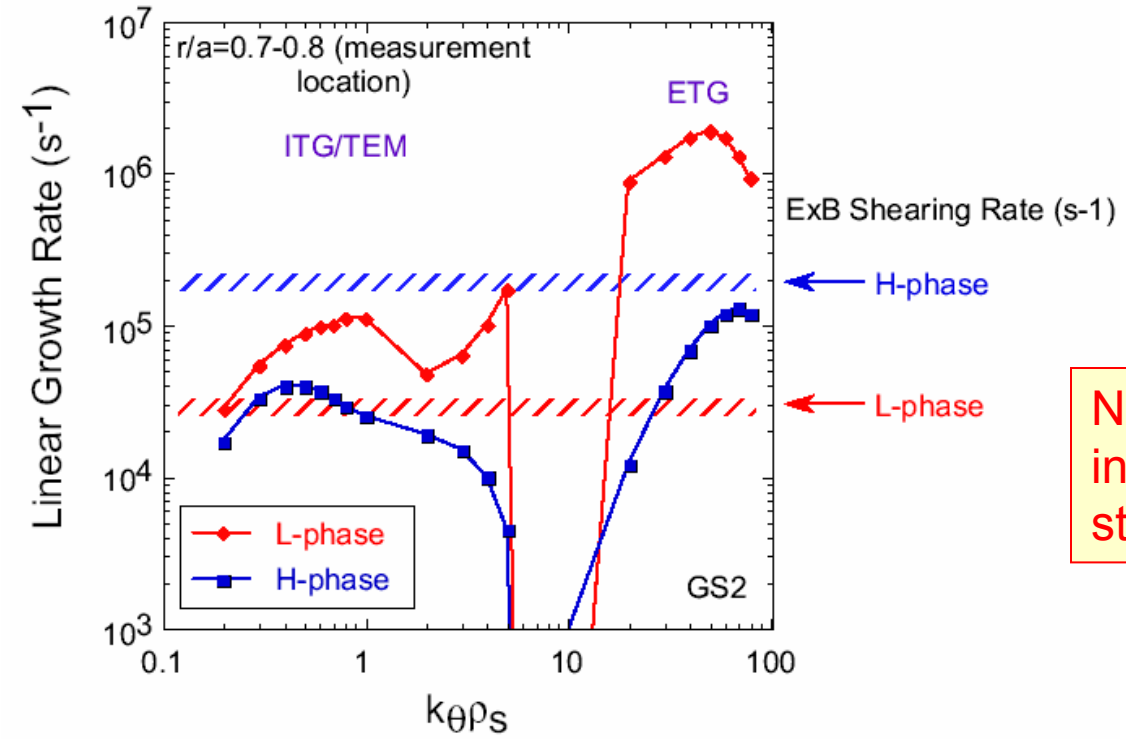




Theoretical calculations Indicate both ITG,TEM and ETG are possible candidates for electron transport

- GS2 calculations indicate lower growth rates at all wavenumbers during H-mode phase
- ETG unstable

$\gamma_{lin} >> \gamma_{ExB}$ during L-phase for all $k_\theta \rho_s$
$\gamma_{lin} << \gamma_{ExB}$ during H-phase for ITG/TEM
$\gamma_{lin} \sim \gamma_{ExB}$ during H-phase for ETG

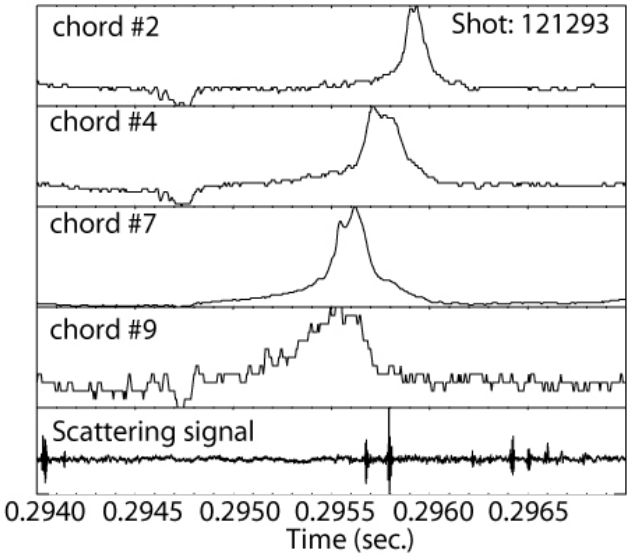


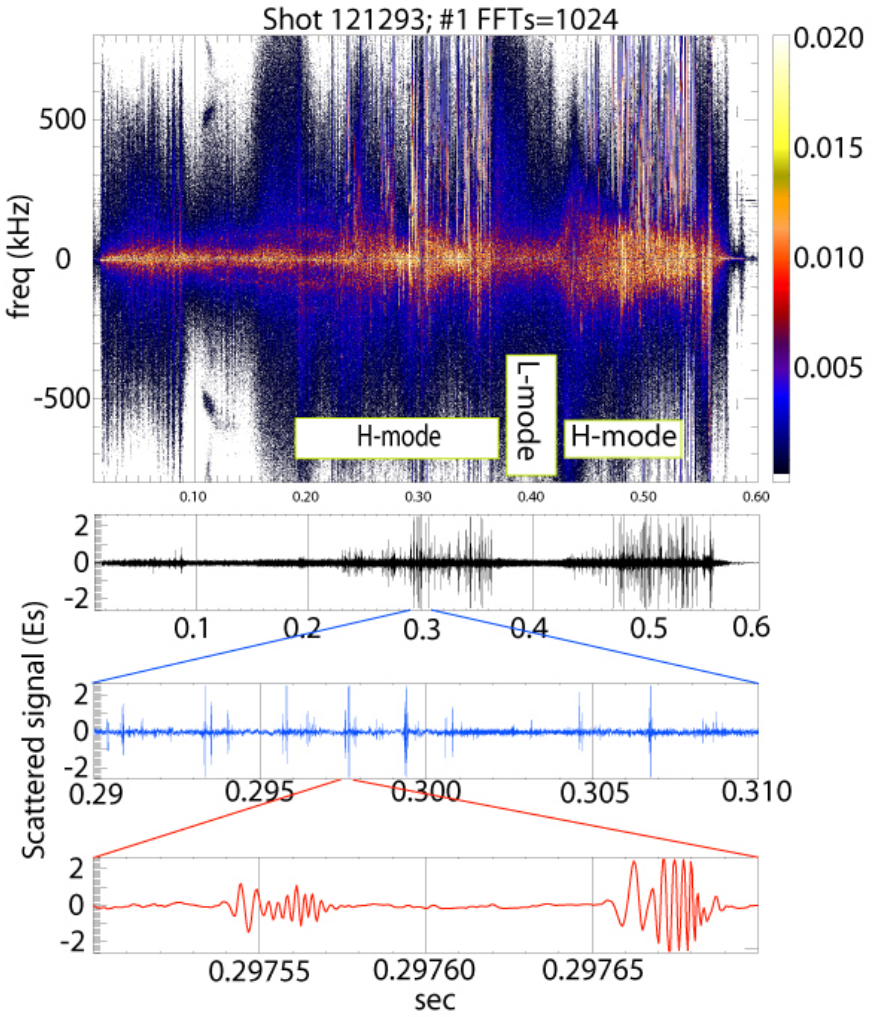
Non-linear GTC results indicate ITG modes stable during H-phase

Spectral characteristic of bursts at the highest k

- Bursts were measured mainly at the highest wavenumber during H-mode phase
  - The burst consists of a highly coherent ES mode (400 kHz ~ 600 kHz) with a life time of 20 μs ~ 50 μs
  - The direction of this ES wave packet is toward the core of the plasma (edge probe did not measure)

Bolometry signal #4 is crossing the Scattering volume





Burst is highly correlated with ELM D_α lights (Slusher et al., PRL 53, 667, 1984)

Summary

- Multi-channel scattering system on NSTX to investigate TEM/ETG modes has been successfully commissioned in FY 06
- Reduction of fluctuations at the edge of H-mode plasma is consistent with the improved edge confinement
  - Monotonically decreasing (k-a) fluctuation level in L and OH plasma is consistent with other devices
  - Enhanced fluctuation is noted at higher k ($k_\perp \rho_e \sim 0.4$) is observed.
  - Reduction of fluctuation level in intermediate k ($k_\perp \rho_e \sim 0.1 – 0.2$) is pronounced (TEM mode suppression?)
- ES wave packets at Highest k during H-mode phase
  - The burst consists of a highly coherent ES mode (400 ~ 600 kHz) with a life time of 20 μs ~ 50 μs
  - The direction of this ES wave packet is toward the core of the plasma (edge probe could not measure)
  - Bursts of coherent mode which are highly correlated with the type V ELM close to the scattering volume