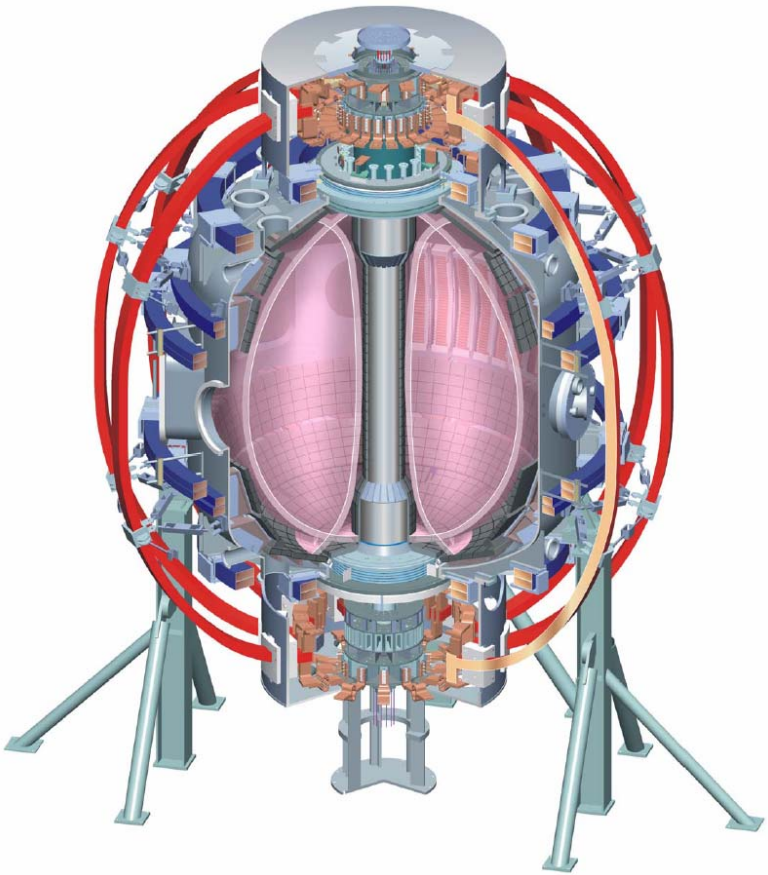
Observation of the Enhanced Scattered High-k Spectra during H-mode Phase on NSTX



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NSTX Review

on July 26-27, 2006

Collaborators;

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Examples of Previous and Existing Scattering Systems

Microwave scattering
- Mazzucato, Phys. Fluids **21**,1063 (1978)

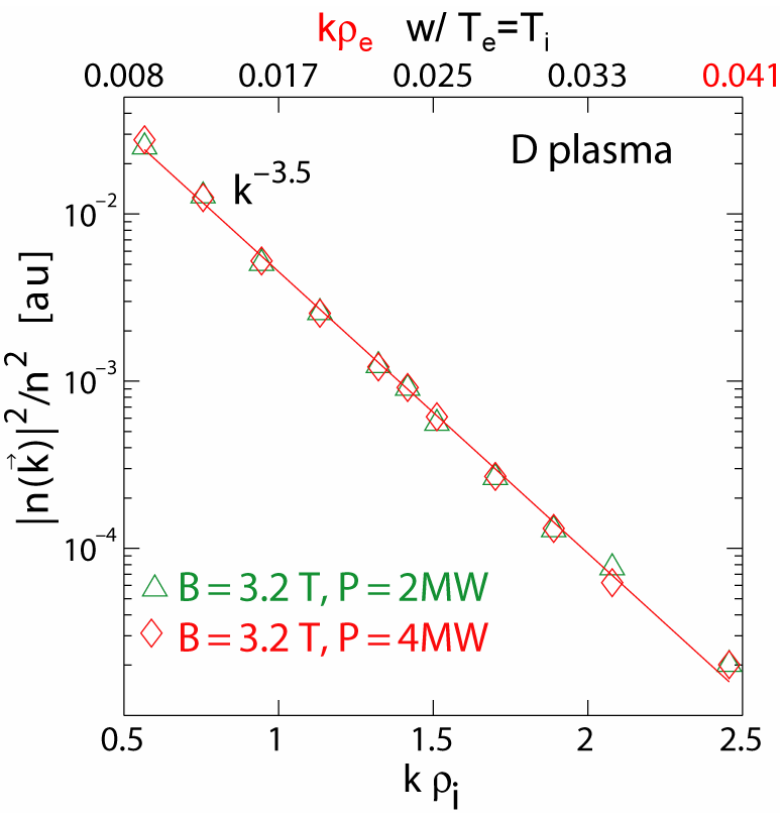
Laser scattering
- Slusher & Surko, Phys. Fluids **23**, 472 (1980)

FIR scattering
- Park et al., RSI **53**, 1535 (1982)

High-k scattering systems
- Hennequin et al., PPCF **46**, B121 (2004)
- Rhodes et al., IAEA (2004)

NSTX is a low-field machine
→ up to $k_\perp \rho_e \sim 0.7$

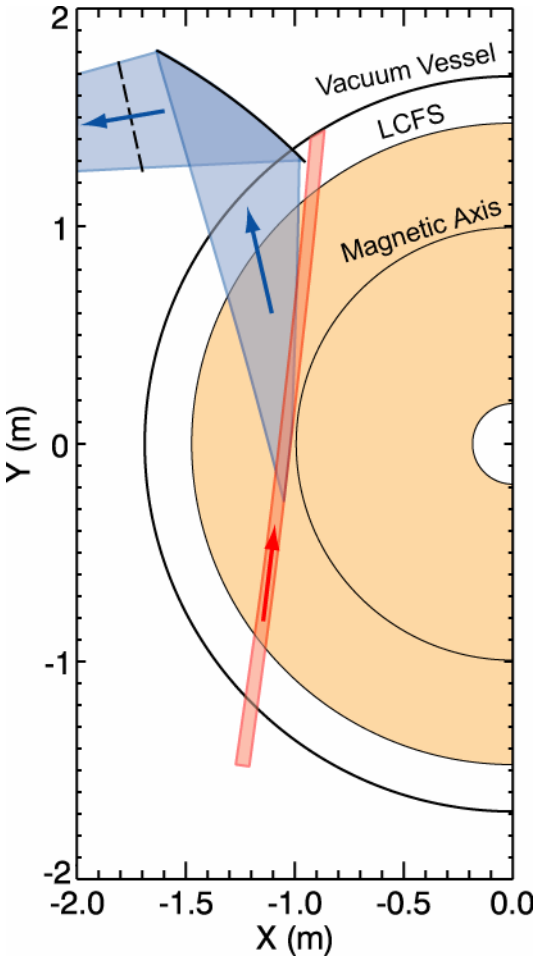
Simultaneous, multi-channel measurements
→ k-space turbulence continuum



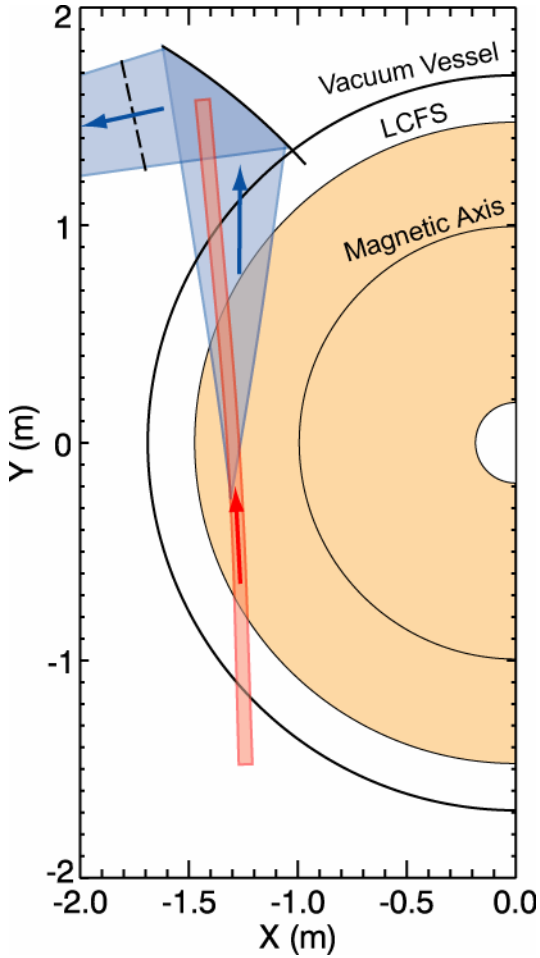
Hennequin, 2004

Steerable Optics Enable Good Radial Coverage

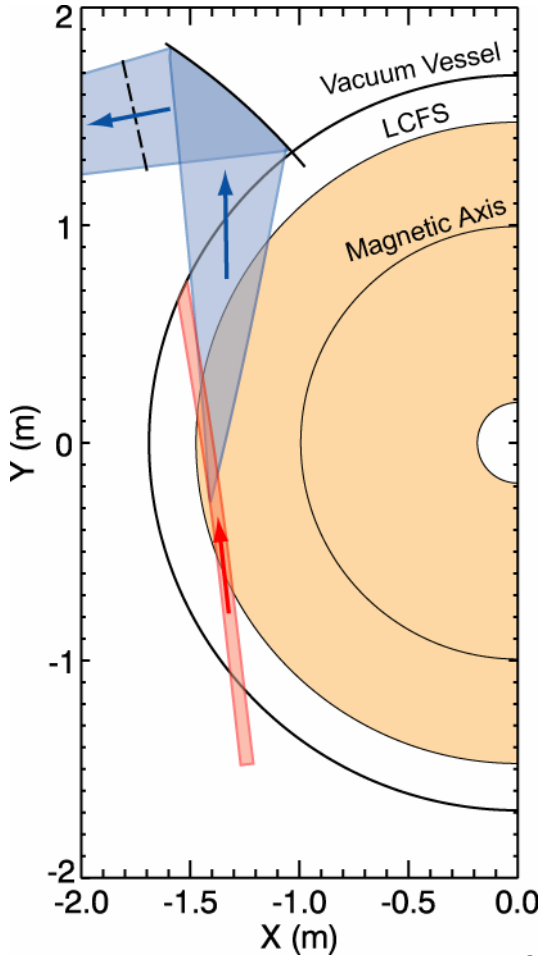
Inboard ρ = 0.05
$k_\perp \rho_e$ up to 0.7



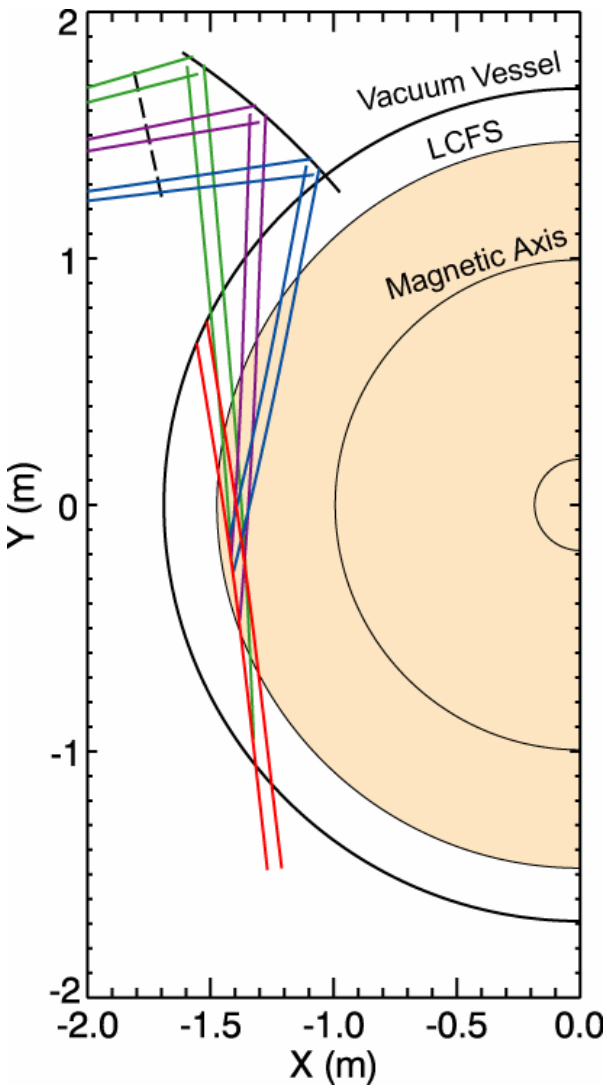
Intermediate ρ = 0.4
$k_\perp \rho_e$ up to 0.3

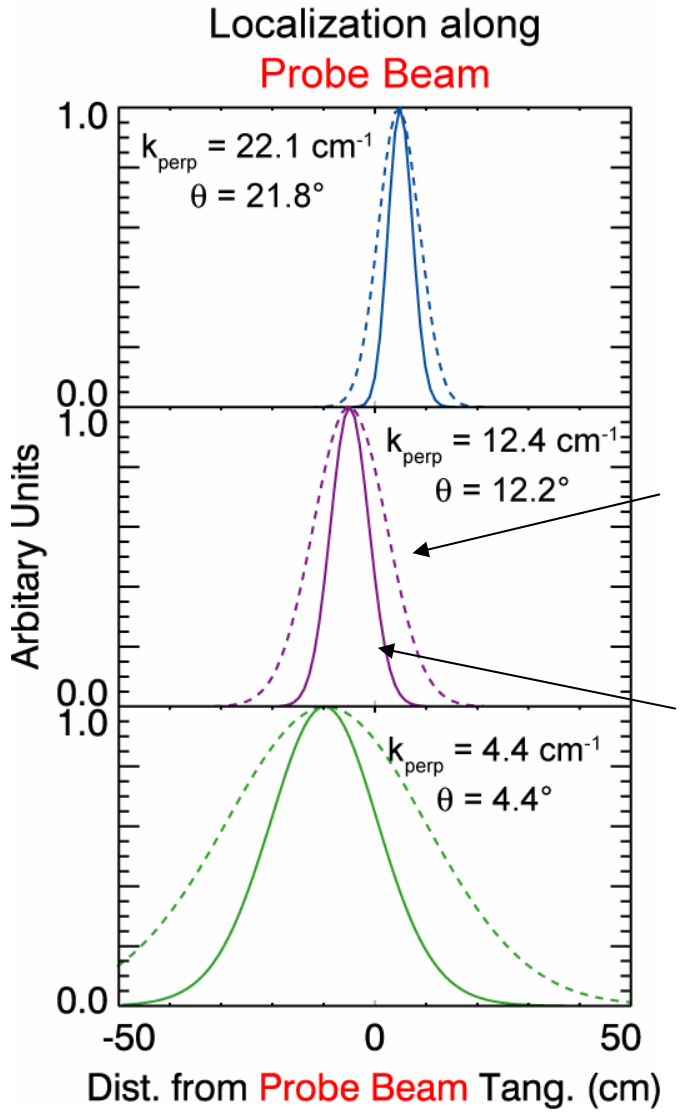


Outboard ρ = 0.75
$k_\perp \rho_e$ up to 0.2



Enhanced Localization in NSTX





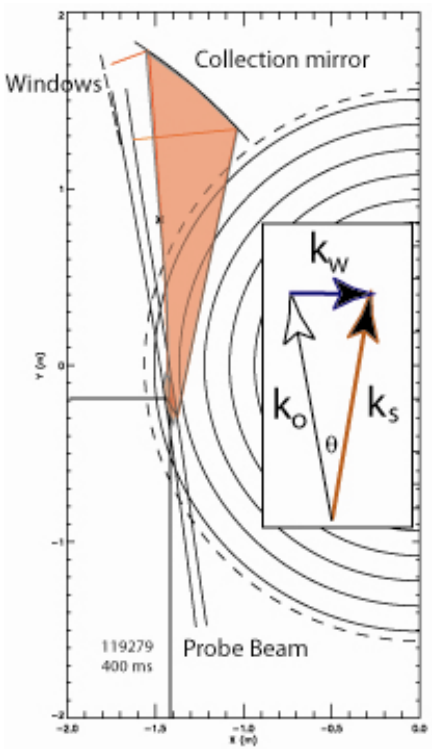
beam overlap

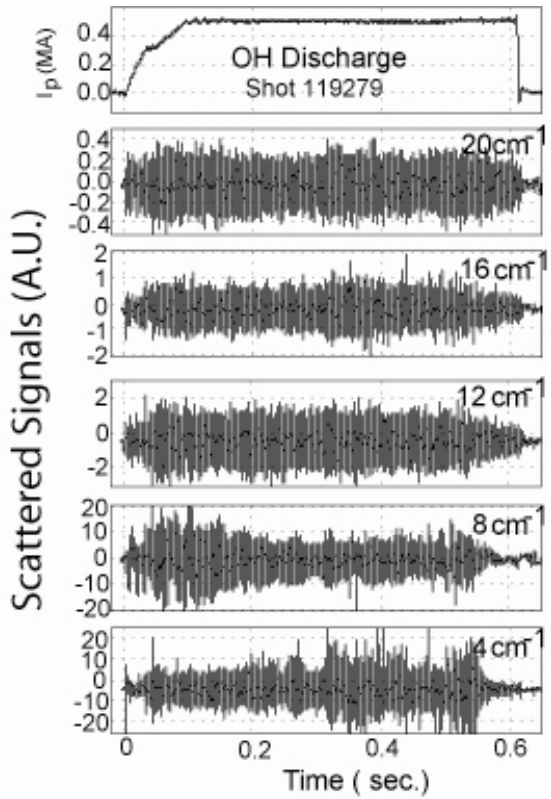
$$L_z = 2a / \sin(\theta)$$

instrument selectivity

Ohmic Discharge (He)

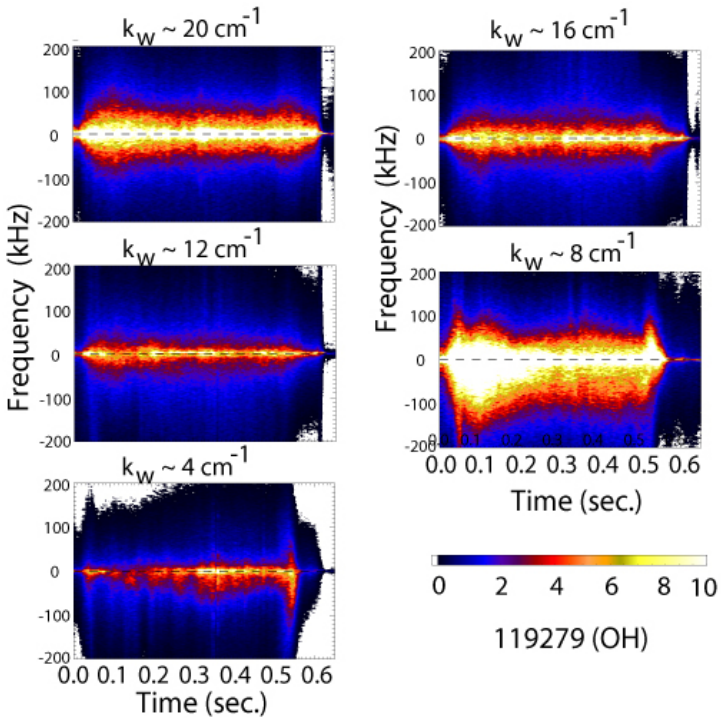
- **Plasma parameters**
  - n_e (0) ~ $2.5 \times 10^{13} cm^{-3}$
  - T_e (0) ~ 200eV
- **Spatial coverage**
  - r/a ~0.7
  - Wavenumber ~ 4 cm^{-1} – 20 cm^{-1}
- **Monotonically decreasing power spectra as a function of wavenumbers**
  - **Resembles previous measurements in many devices**

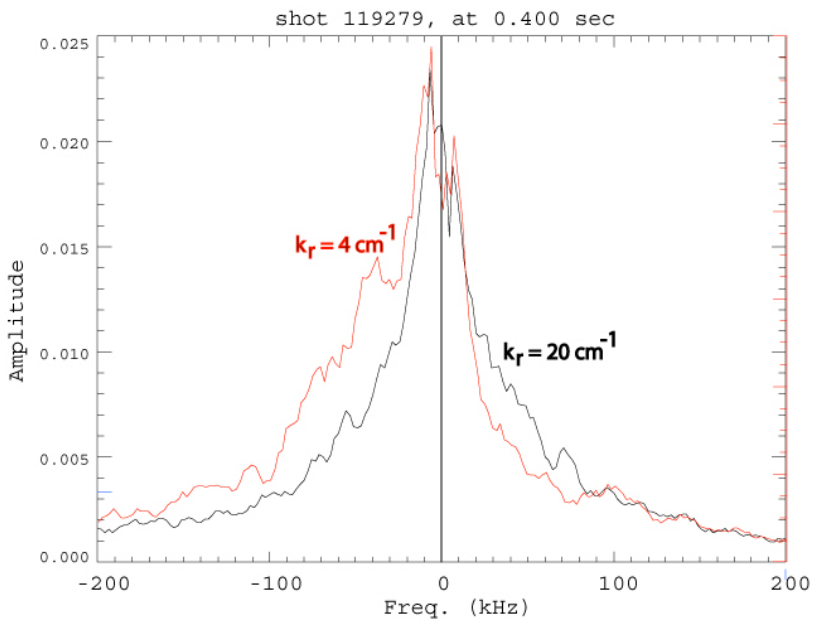




Spectral Analysis of OH Discharge

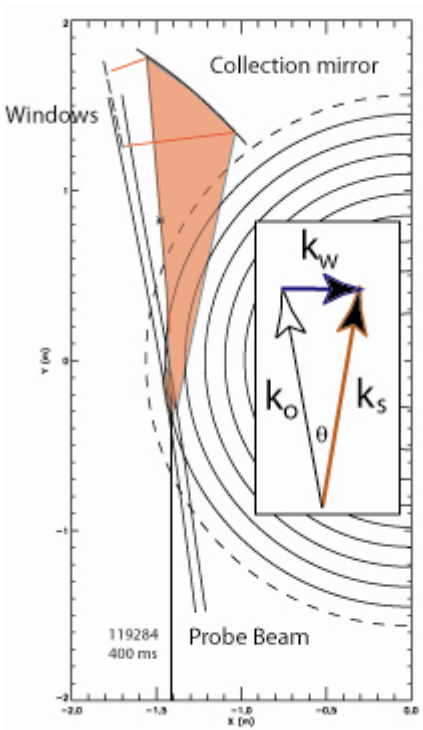
- **Plasma parameters**
  - n_e (0) ~ 2.5x10^{13}cm^{-3} and T_e (0) ~ 200eV
- **Spatial coverage**
  - r/a ~0.85 and wavenumber range of ~ 4 cm^{-1} – 20 cm^{-1}
- **Symmetric frequency spectra at high k and asymmetric frequency spectra at low k**
  - Outward flow at the low k is dominant.
  - Energy transport at the low k (ITG)?

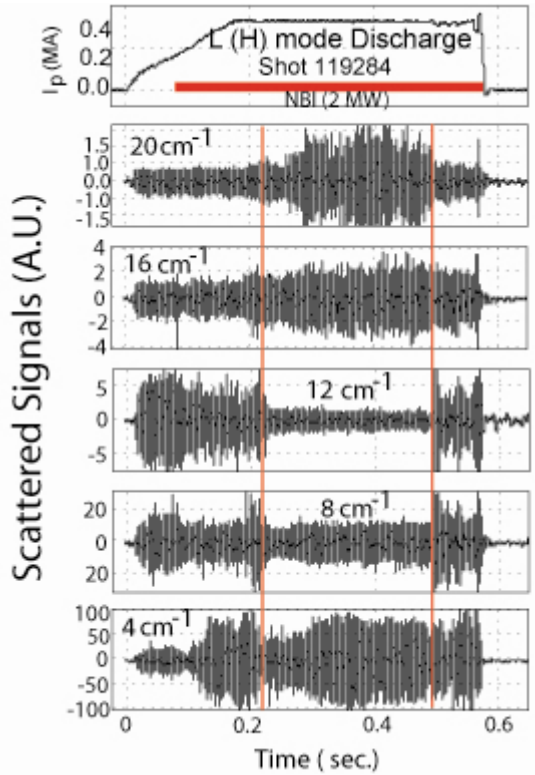




L/H-Mode Discharge

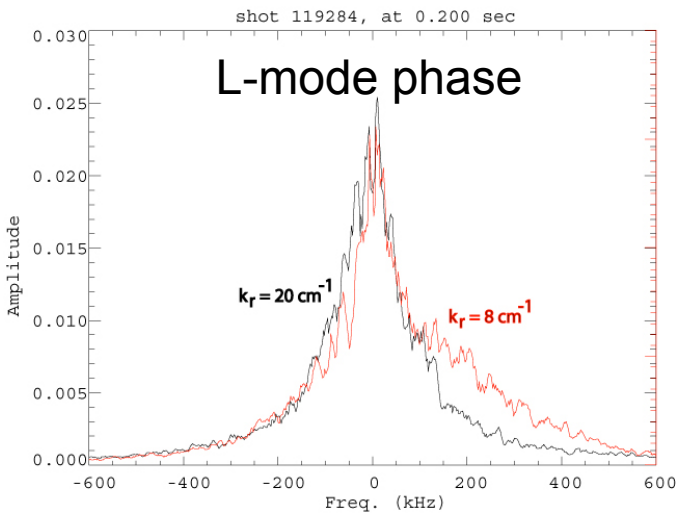
- **Plasma parameters**
  - n_e (0) ~ 6 x 10^{13} cm^{-3}
  - T_e (0) ~ 1000eV
- **Spatial coverage**
  - r/a ~0.95
  - Wavenumber ~ 6 cm^{-1} – 27 cm^{-1}
- **Monotonically decreasing power spectra during L-mode phase**
- **Reduction in amplitude at the medium wave-numbers during H-mode phase: mainly due to refraction effect**

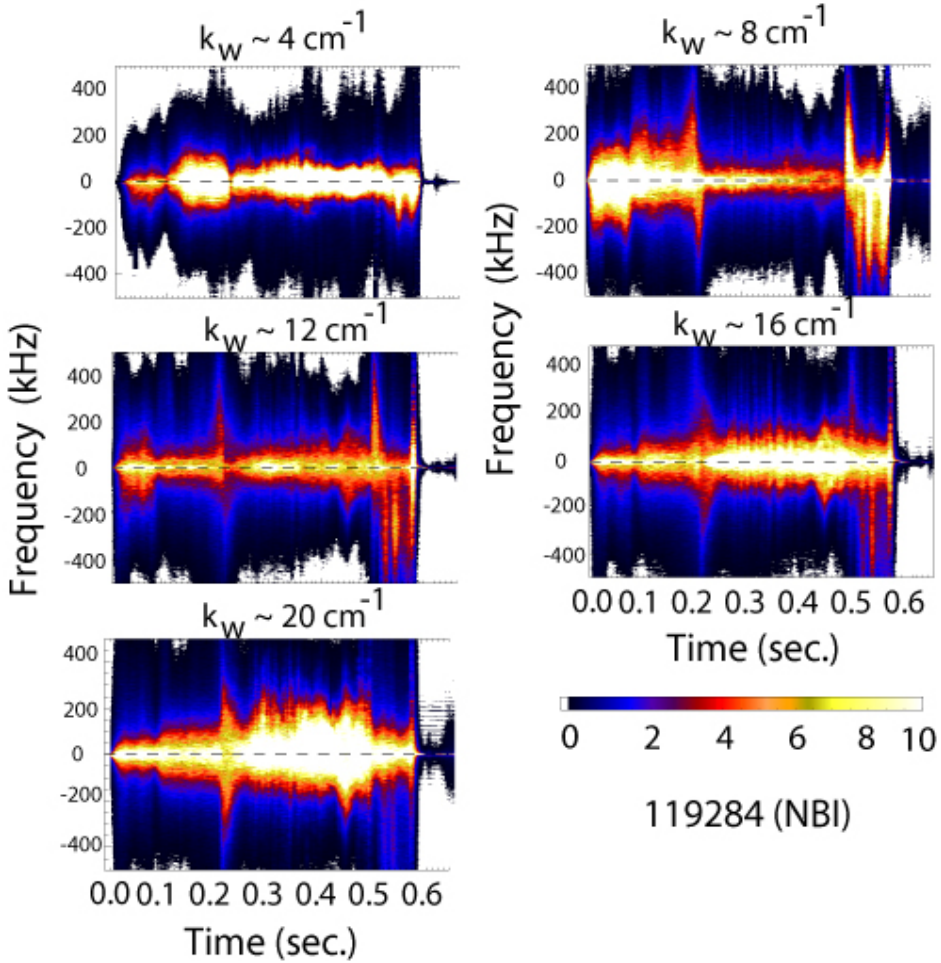




H-Mode Transition

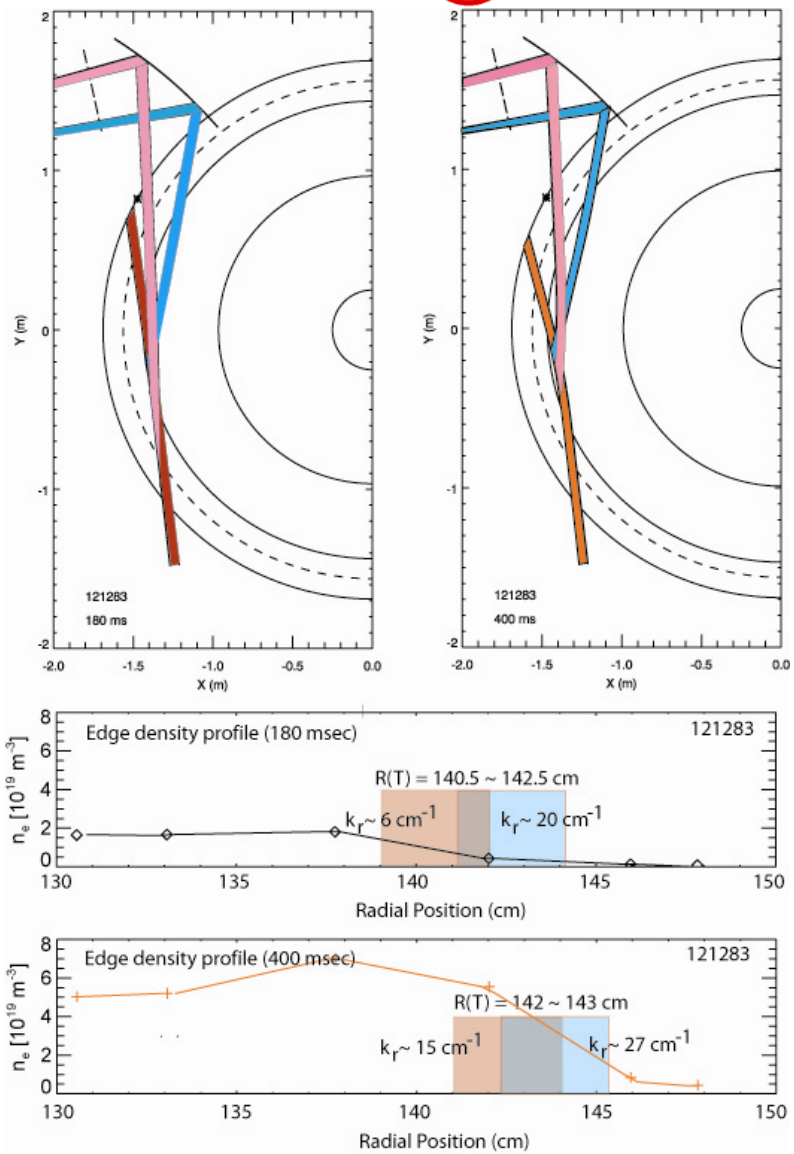
- **Plasma parameters**
  - n_e (0) ~ 6 x 10^{13} cm^{-3}
  - T_e (0) ~ 1000eV
- **Spatial coverage**
  - r/a ~0.95 and wave-number range of ~ 6 cm^{-1} – 29 cm^{-1}
- **Symmetric frequency spectra during L-mode phase**





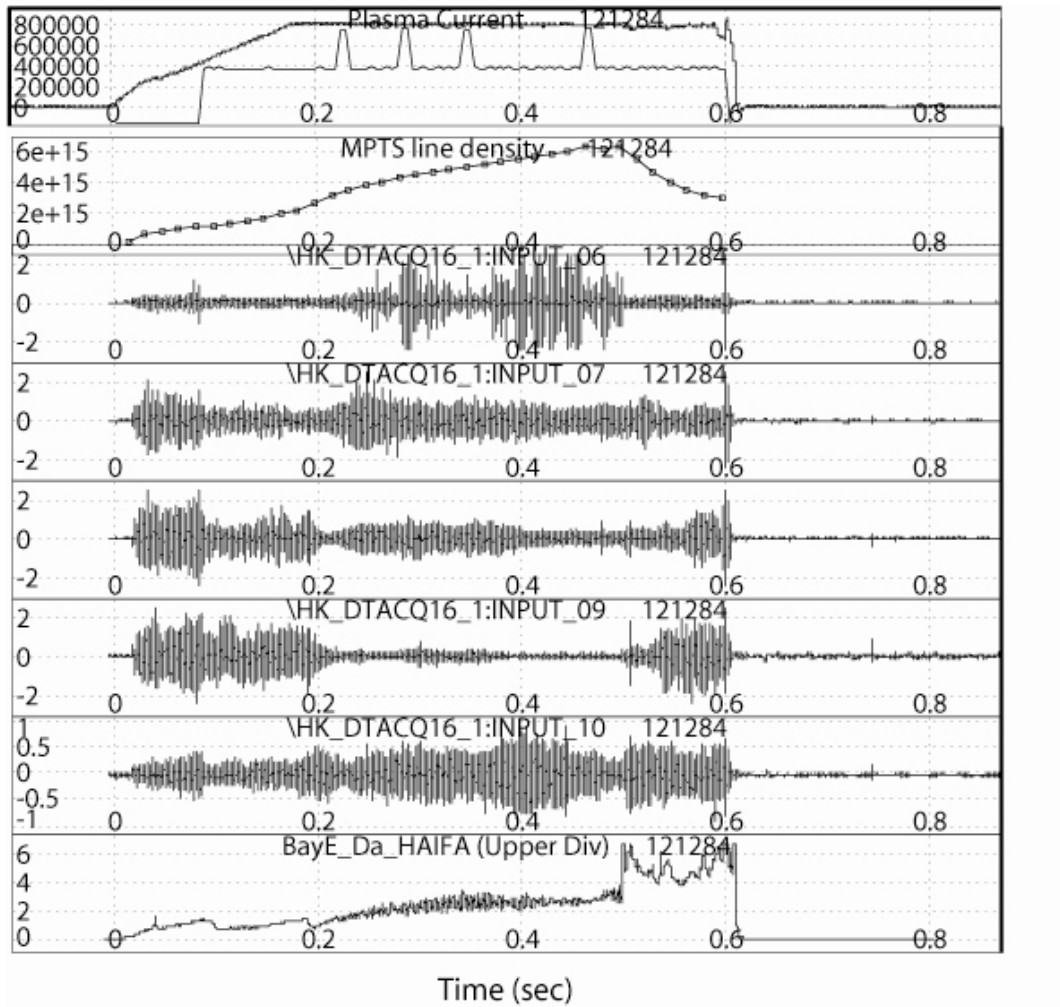
Ray tracing of L/H-Mode Discharge

- **Plasma parameters**
  - n_e (0) ~ 6 x 10^{13} cm^{-3}
  - T_e (0) ~ 1000eV
- **Spatial coverage**
  - r/a ~ 0.8 - 0.95
  - Wavenumber ~ 6 cm^{-1} – 29 cm^{-1}
- **In H-mode with steep density gradient, probe beam refract outwards and scattered beam refracts inward – increasing scattering angle**
- **Reduction in amplitude at the medium wave-number is largely due to refraction and increase of high-k spectra is pronounced**



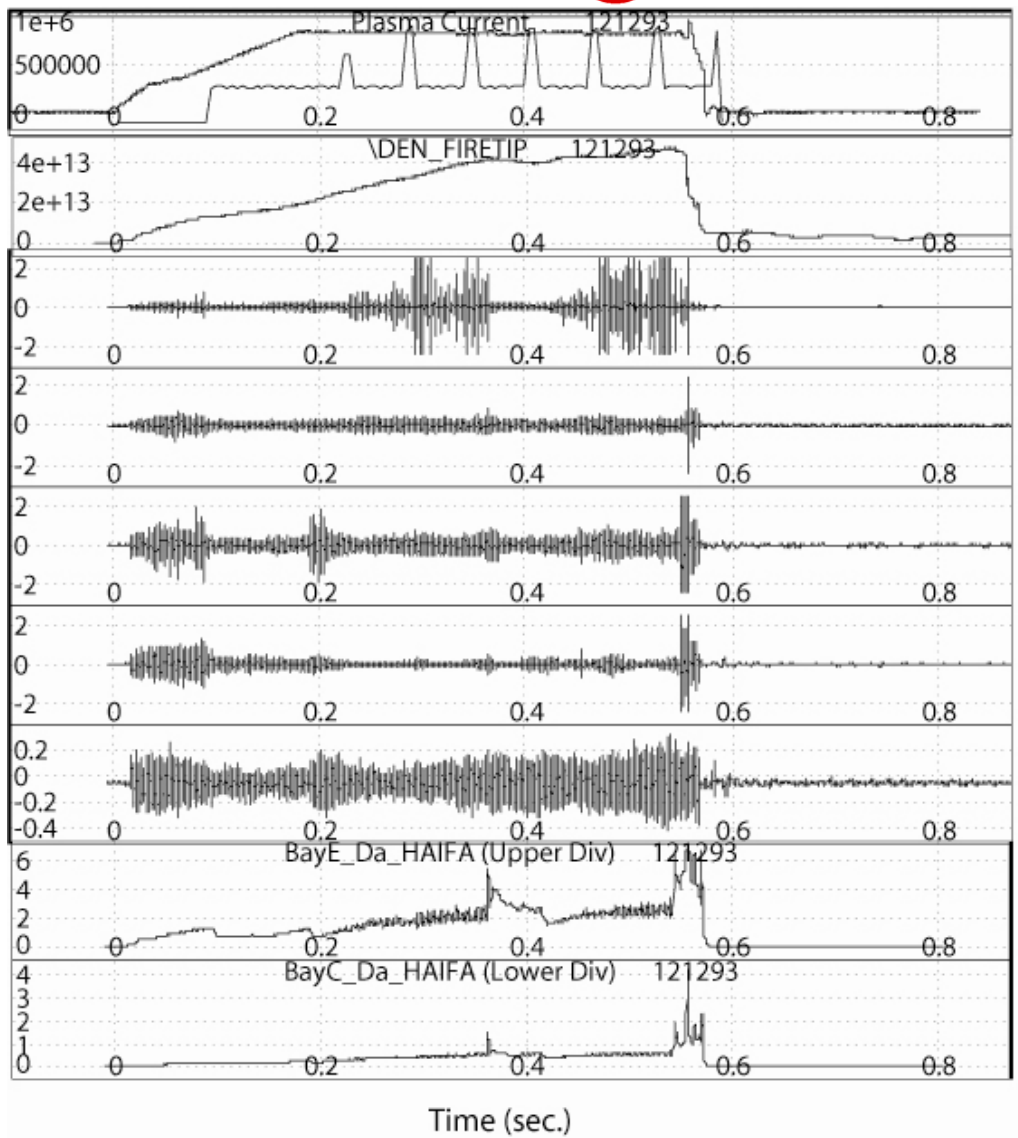
Preliminary results of XP 629

- **Plasma parameters**
  - n_e (0) ~ 2.5x10^{13}cm^{-3}
  - T_e (0) ~ 200eV
- **Spatial coverage R=142 cm)**
  - r/a ~0.9 – 0.95
  - Wave-number coverage ~ 4 cm^{-1} – 29 cm^{-1}
- **Reproduced the initial experimental results**
  - **More burst type of increased signal at high wave-numbers.**
  - **Only present during Hmode phase.**

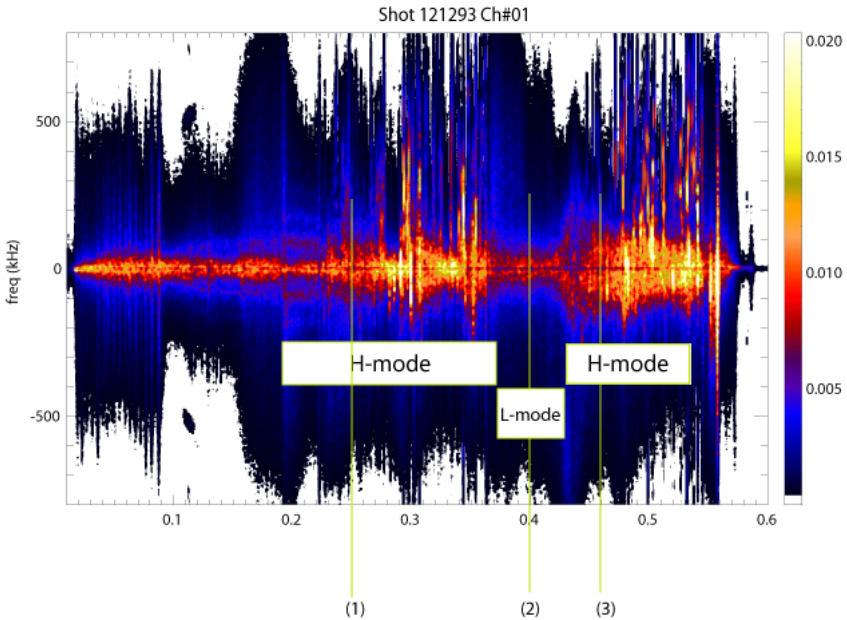


Preliminary results of XP 629

- **Plasma parameters**
  - n_e (0) ~ 6 x10^{13}cm^{-3}
  - T_e (0) ~ 1.0 keV
- **Spatial coverage (R=137 cm)**
  - r/a ~0.8 – 0.85
  - Wave-number coverage ~ 4 cm^{-1} – 25 cm^{-1}
- **Double H-mode phase**
  - **Clear correlation between the increased power spectra at high k and H-mode phase.**



Characteristics of the Power Spectra



Time history of frequency spectra of the highest k_r channel (k_r =27 cm^{-1} for H-mode phase and k_r =20 cm^{-1} for L-mode phase)