

# CONSIDERATIONS FOR A BEAM EMISSION SPECTROSCOPY DENSITY FLUCTUATION DIAGNOSTIC FOR NSTX

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## Outline

- **Motivation for a BES System on NSTX**
- **BES Measurement Capabilities**
- **Some Issues to Consider**

**NSTX 5-YEAR PLANNING FORUM: TRANSPORT & TURBULENCE  
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# MOTIVATION TO IMPLEMENT A BES SYSTEM ON NSTX

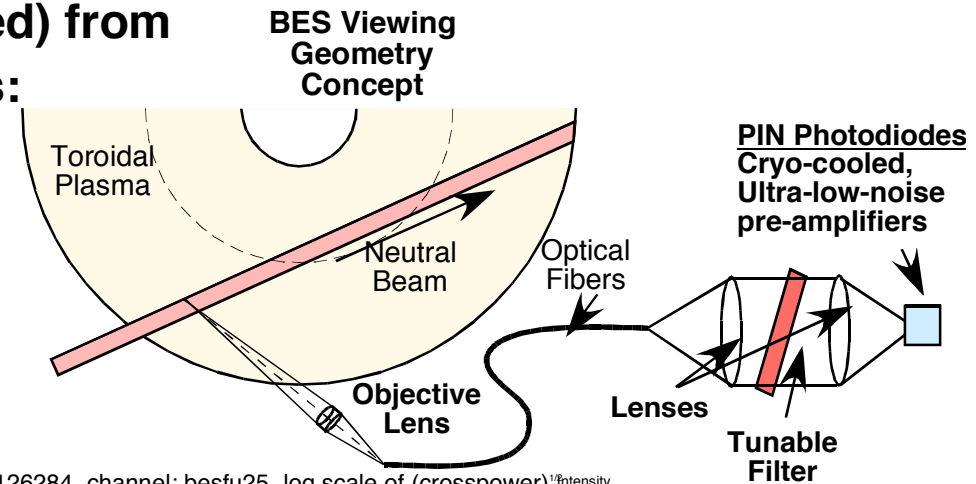
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- **NSTX provides unique opportunity for advanced studies of Turbulence & Transport in the ST regime:**
  - Numerous modes of operation: L, H, EP-H, RS modes
  - Array of profile diagnostics
  - Maturing suite of fluctuation diagnostics (Scattering, GPI, Reflectometry, SXR, polarimetry, probes)
- **Intriguing observations:**
  - Near neoclassical ion confinement in some regimes
- **Unique opportunity to study underlying turbulent transport processes in ST**
  - Predicted inherent stability against longer-wavelength modes (C. Bourdelle)
- **BES system would complement existing fluctuation diagnostics and provide added capabilities**
  - *Wide fluctuation phase space to be investigated:*  
low-k, high-k, core, edge, n, T, B, f fluctuations
  - *Assessment of BES on NSTX performed (D. Johnson, January, 2001)*
- **Opportunity to compare and contrast turbulence behavior in ST and Tokamak**
  - Extend dimensionless scaling studies (Aspect ratio,  $\beta$ )
- **Longer-Term: Contribute to the validation of turbulence simulations**

# BES MEASURES SPATIO-TEMPORAL CHARACTERISTICS OF “LONG-WAVELENGTH” ( $k_{\perp} \rho_i < 1$ ) DENSITY FLUCTUATIONS

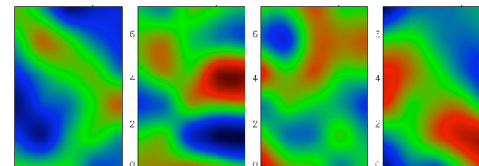
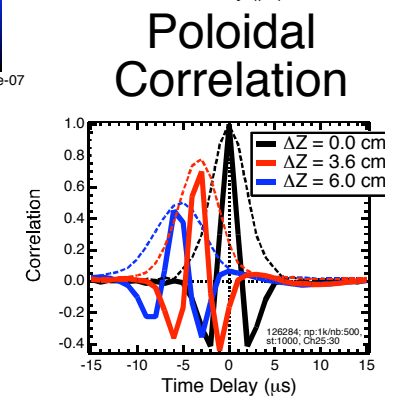
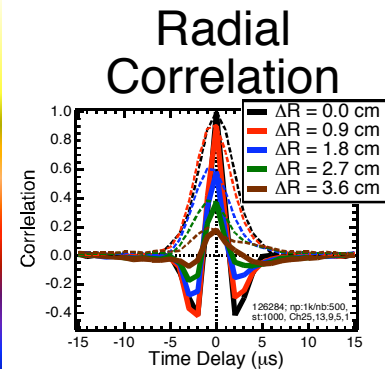
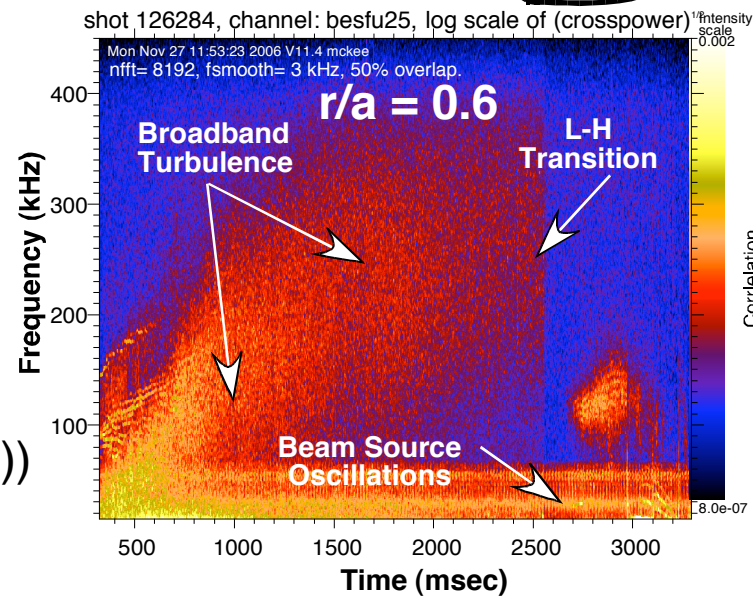
- Measures intensity of  $D_{\alpha}$  (Doppler-shifted) from collisionally-excited neutral beam atoms:

- Relate  $I$  to  $n$  (via atomic physics)
- Core, edge & SOL
- $\Delta R, \Delta Z \sim 1$  cm,
- Multi-channel (R,Z)  $\implies$  2D imaging



## Turbulence Properties Measured:

- Local Turbulence Spectra
- Fluctuation amplitude ( $\tilde{n}/n$ )
- Correlation Lengths:  $L_{C,r}, L_{C,\theta}$
- Decorrelation Time,  $\tau_c$
- Poloidal advection,  $v_{\theta}$
- Eddy structure via imaging
- Time varying poloidal flows ( $\tilde{v}_{\theta}(t)$ ) (Zonal Flows, GAMs)
- Bispectra, phase coherence (nonlinear: energy transfer)
- Velocity Field ( $\mathbf{v}(r,\theta,t)$ ) via velocimetry



# OPPORTUNITIES AND ISSUES FOR CONSIDERATION

- High  $T_I$ , low  $B_T \implies$  Large  $\rho_I$ ,  $L_{c,r}$   
High spatial resolution and wavenumber sensitivity,  $L_{c,r}$ : 2-20 cm  
(S. Kubota, APS-06, S. Zweben, GPI)
- Spatial resolution and radial coverage will depend sensitively on local magnetic field pitch angle:
  - 3 NB sources
  - Viewing geometry considerations
  - Core vs. Edge
  - Focus on core turbulence?
    - Flat  $q$ -profile to large radius
  - Diagnostic Discussion next week...
- Carbon edge lines near 660 nm?
- BES can study:
  - Alfvén eigenmode structure
  - Pedestal/ELMs
  - MHD structure
- An auspicious time: Chinese New Year welcomes the year of the Golden Pig a time of especially good luck, but also, much *turbulence* [BBC, 2/17/07]

