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# Initial density fluctuation measurements from the NSTX Beam Emission Spectroscopy diagnostic system


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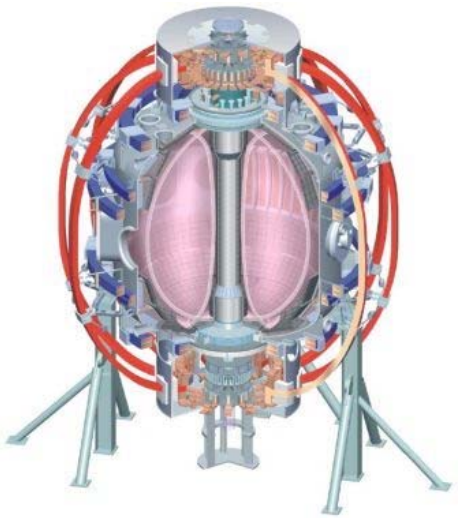

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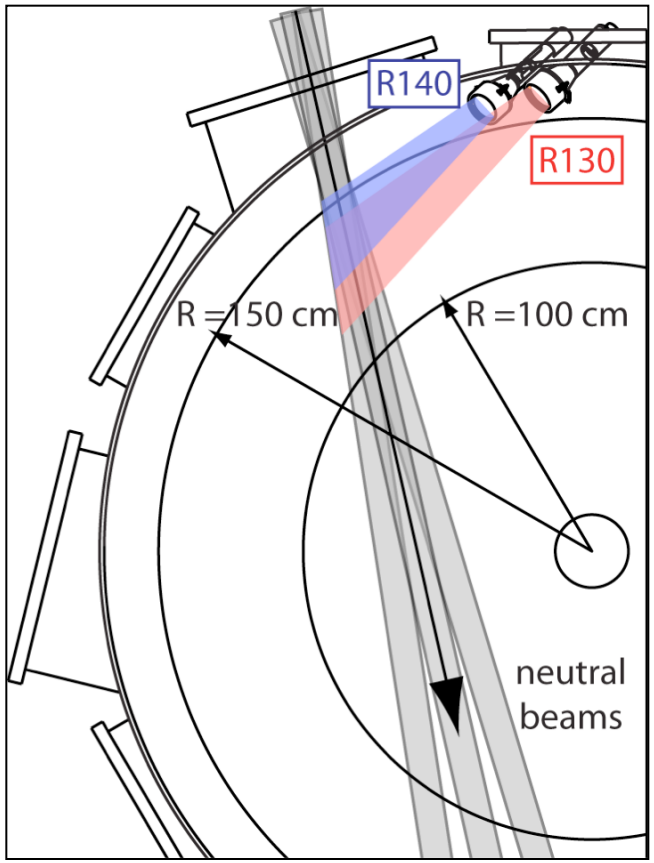
# Overview

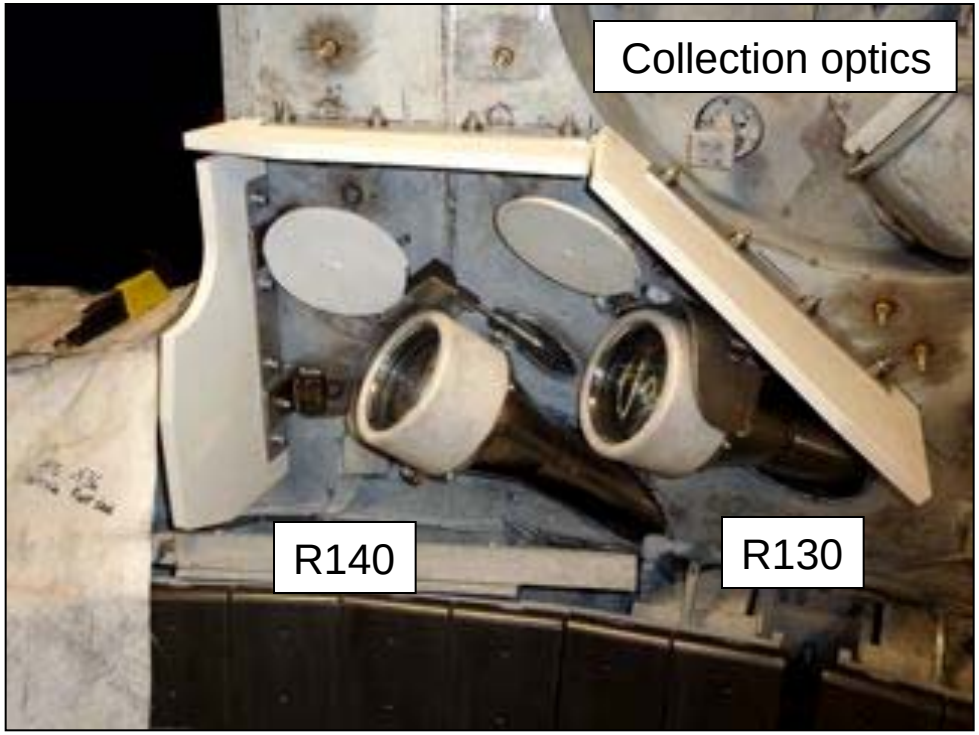
- A beam emission spectroscopy (BES) system has been commissioned on NSTX to study long wavelength ($k\rho_i < 1$) fluctuations
  - Measures Doppler-shifted $D_\alpha$ emission from deuterium neutral beams
  - Up to 24 detection channels were employed in FY10
    - 32 channels planned for FY11
- Initial measurements show…
  - Edge fluctuations decrease at LH transition
  - Broadband fluctuations exist in many discharges
  - Fluctuations increase during large ELMs
  - Inter-ELM harmonic features around 100 kHz
  - Radial structure of TAE and GAE modes

# A BES system commissioned on NSTX in 2010 will study long wavelength ($k\rho_i < 1$) fluctuations

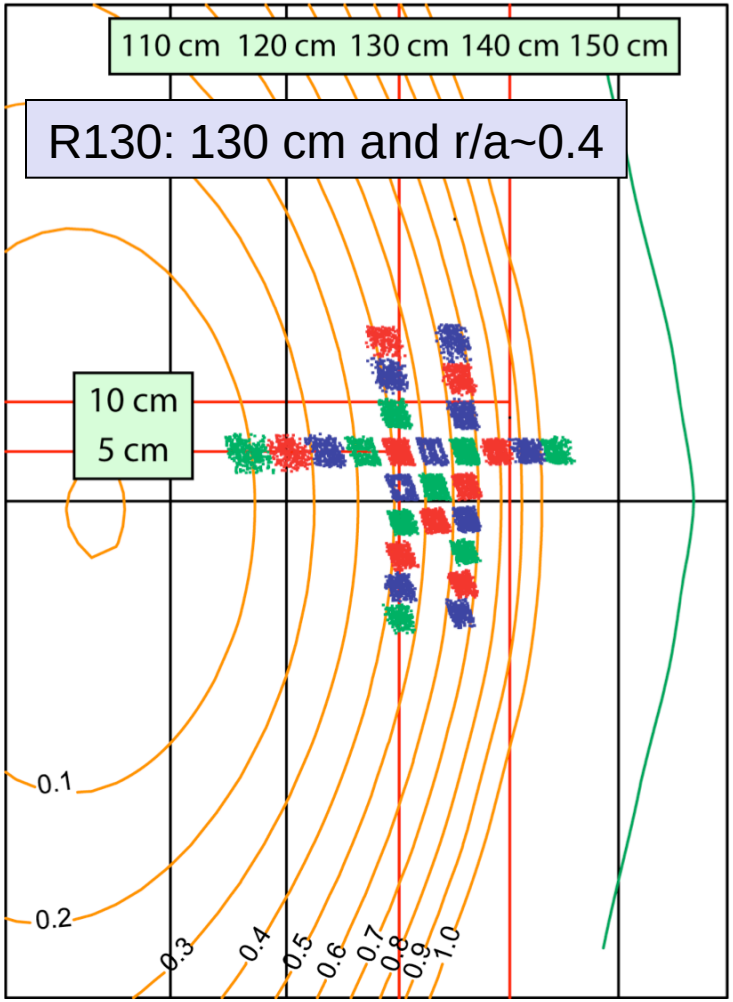
- Doppler shift and filter isolate NB $D_\alpha$ emission from thermal $D_\alpha$
- Two optical views (R130 and R140) are aligned to steep NSTX pitch angles

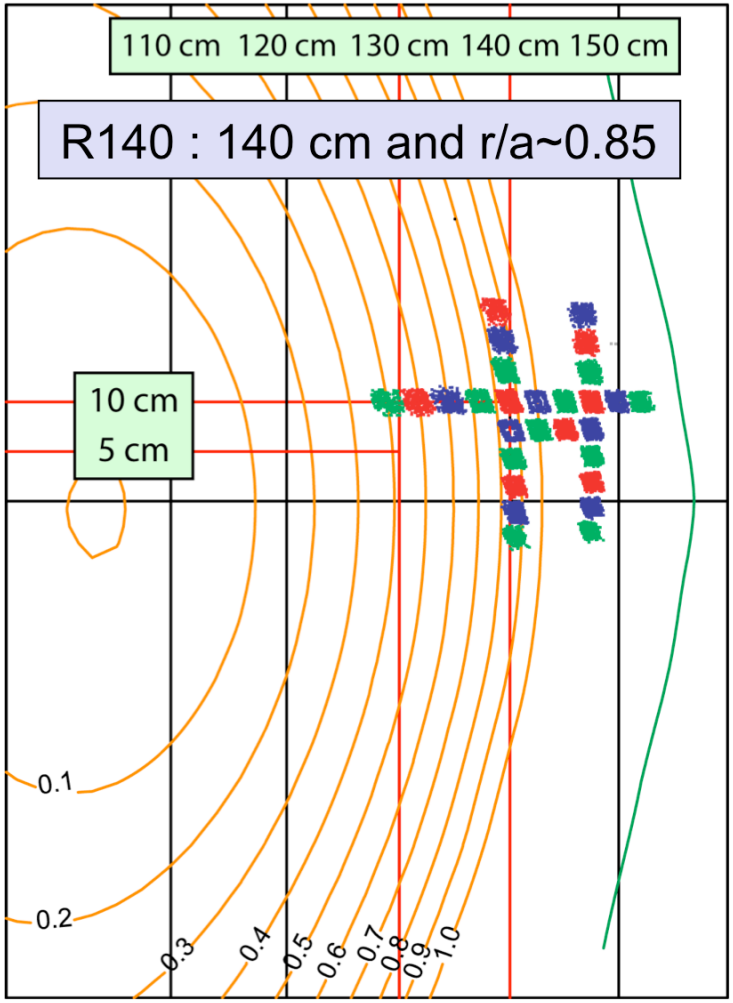



- 32 channels planned for FY11
- DAQ sampling with 1 MHz Nyquist
- Digital filter eliminates e-noise > 1 MHz
- Refrigerant cooling at -20 °C
- D. R. Smith et al, RSI 2010;
  N. L. Schoenbeck et al, RSI 2010
- N. L. Schoenbeck, BP9



# Two optical views with 56 fiber bundles provide radial coverage from r/a≈0.1 to SOL with 2-3 cm spot sizes

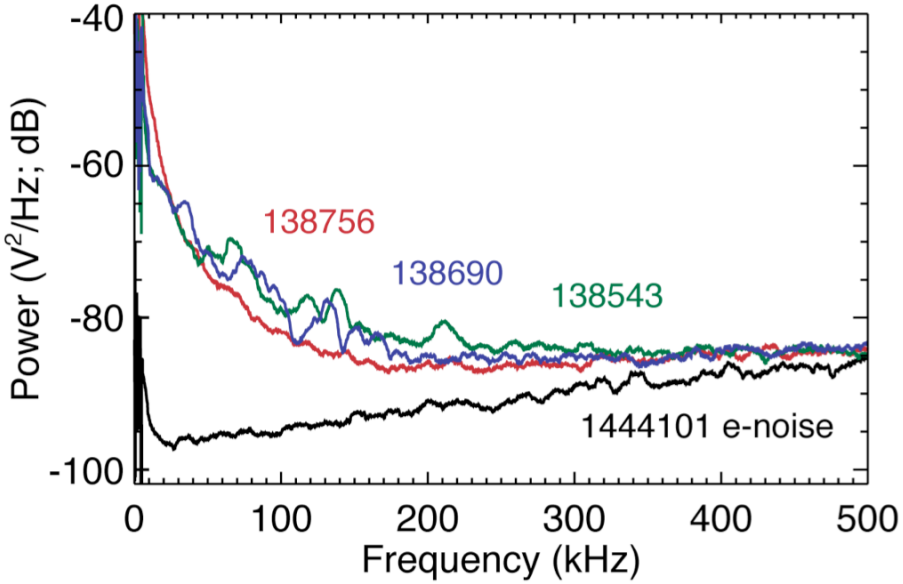


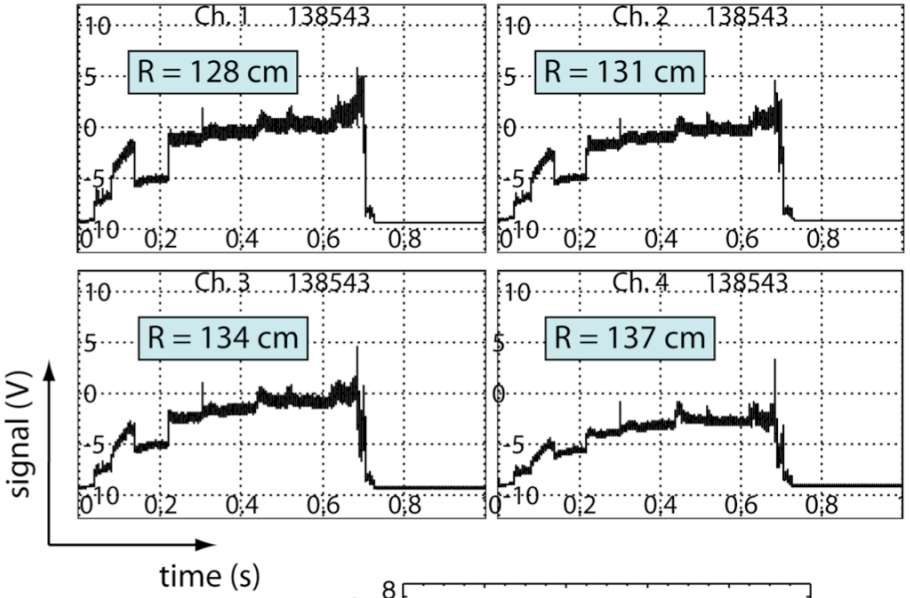

Channel layout provides radial and poloidal correlation lengths and k-spectra

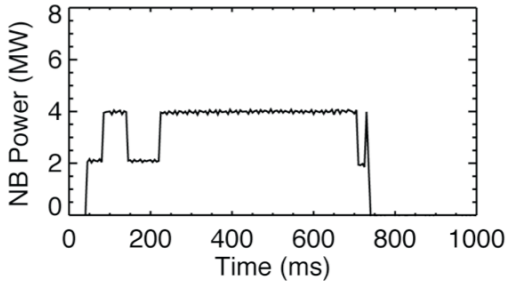
# Measured spectra exceed e-noise and signal amplitudes correspond to NB power

## Measured spectra exceed e-noise



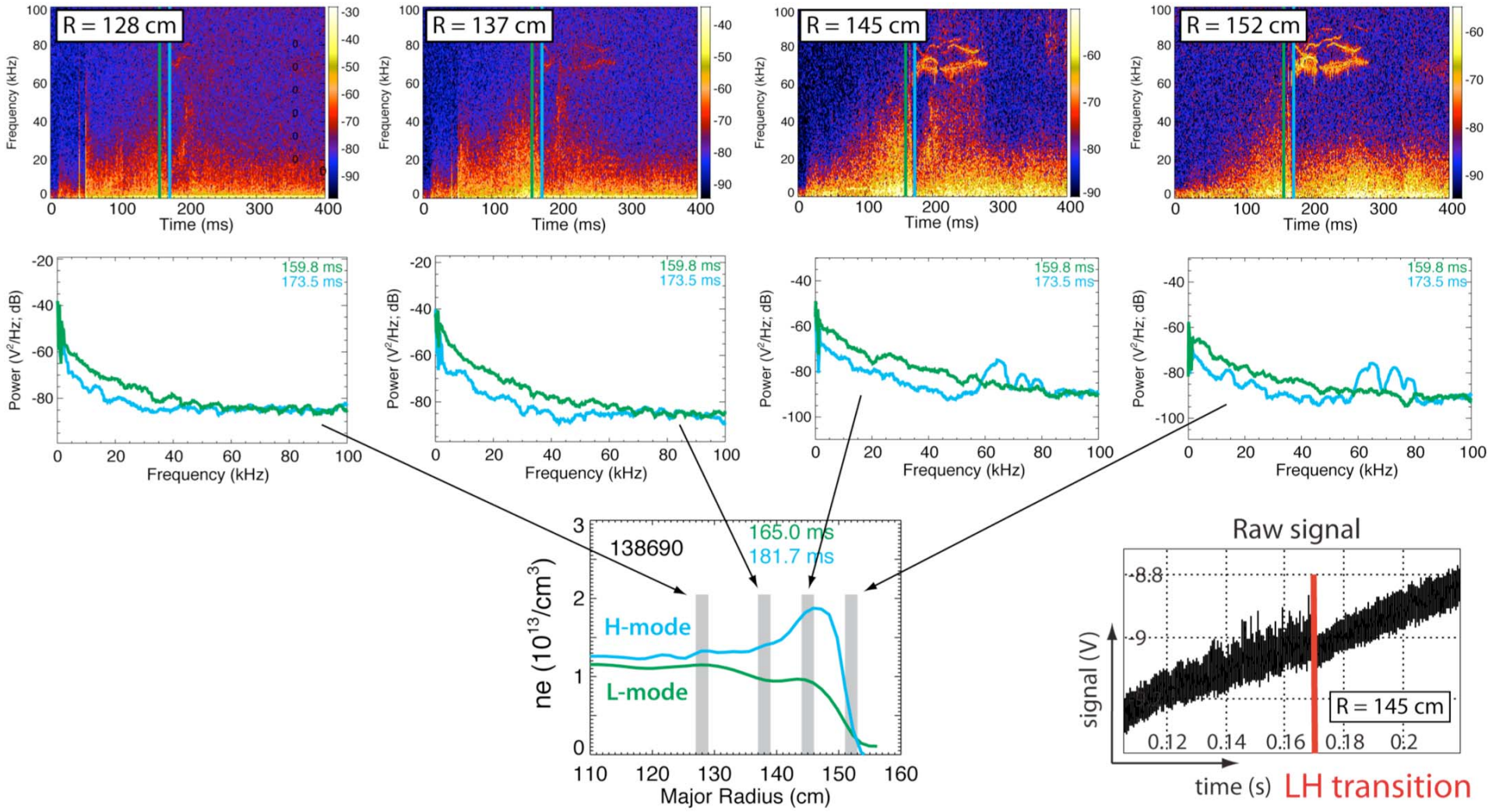

## DC signals correspond to NB power



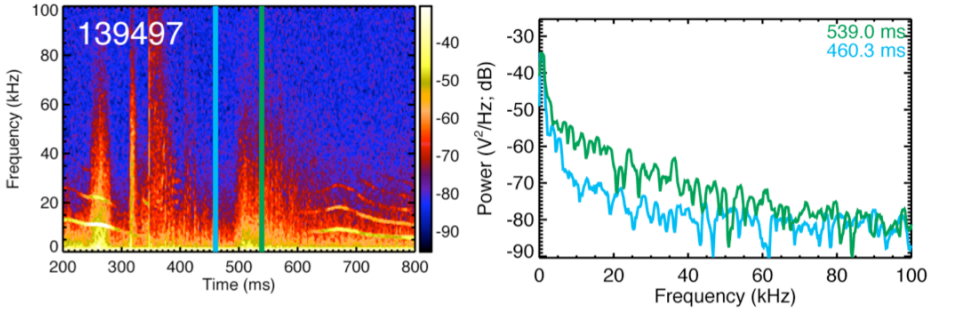

E-noise and photon noise must be removed from measured spectra to isolate plasma fluctuation spectra

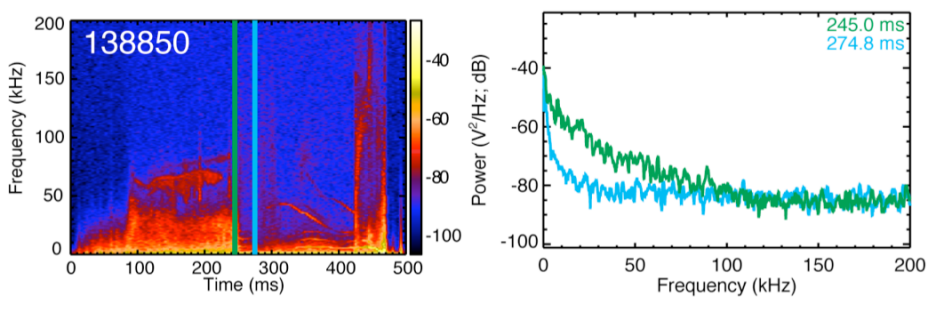
# Decrease in fluctuations at LH transition observed from edge to core regions

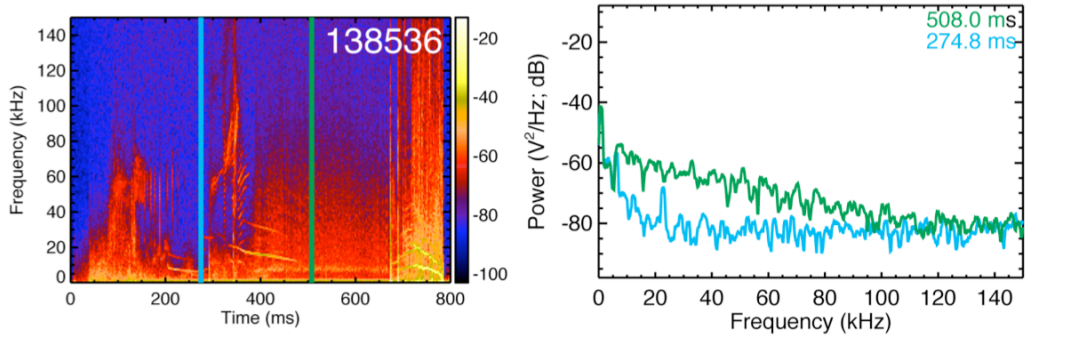


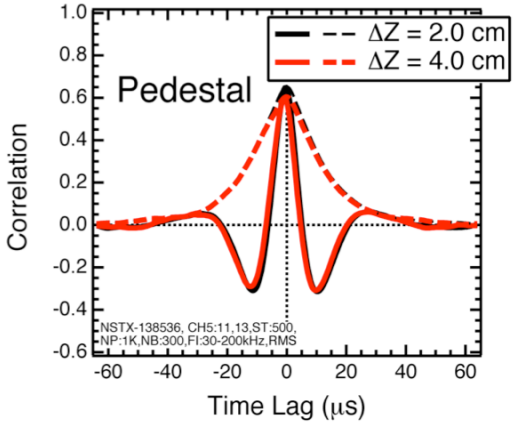

Similar increase in fluctuations observed at HL back-transitions

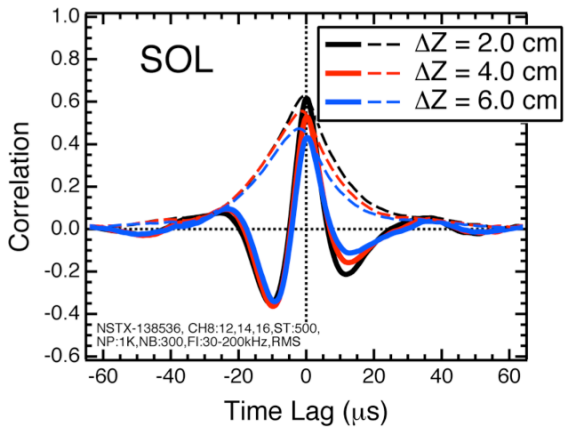
# Broadband fluctuations have been observed in many discharges



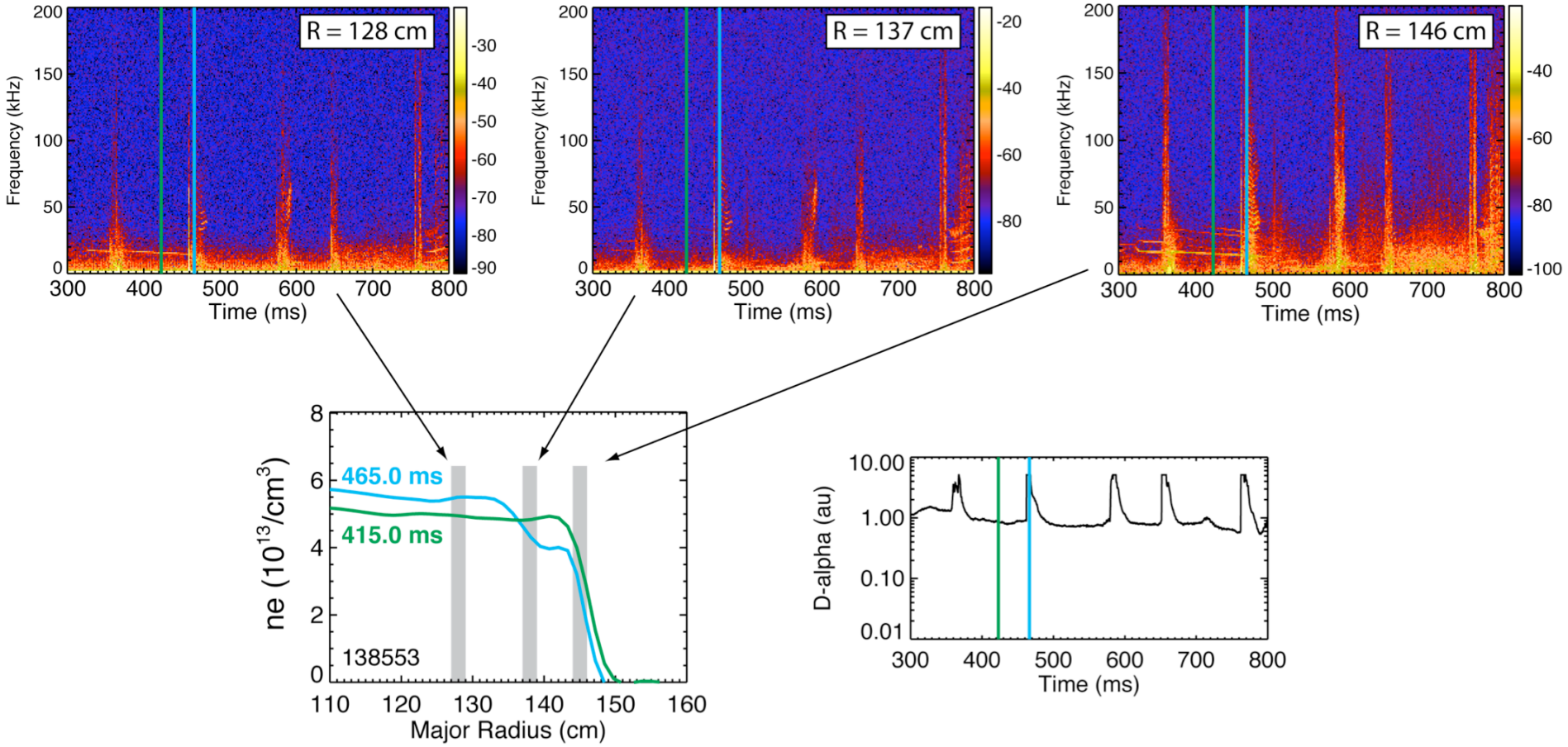



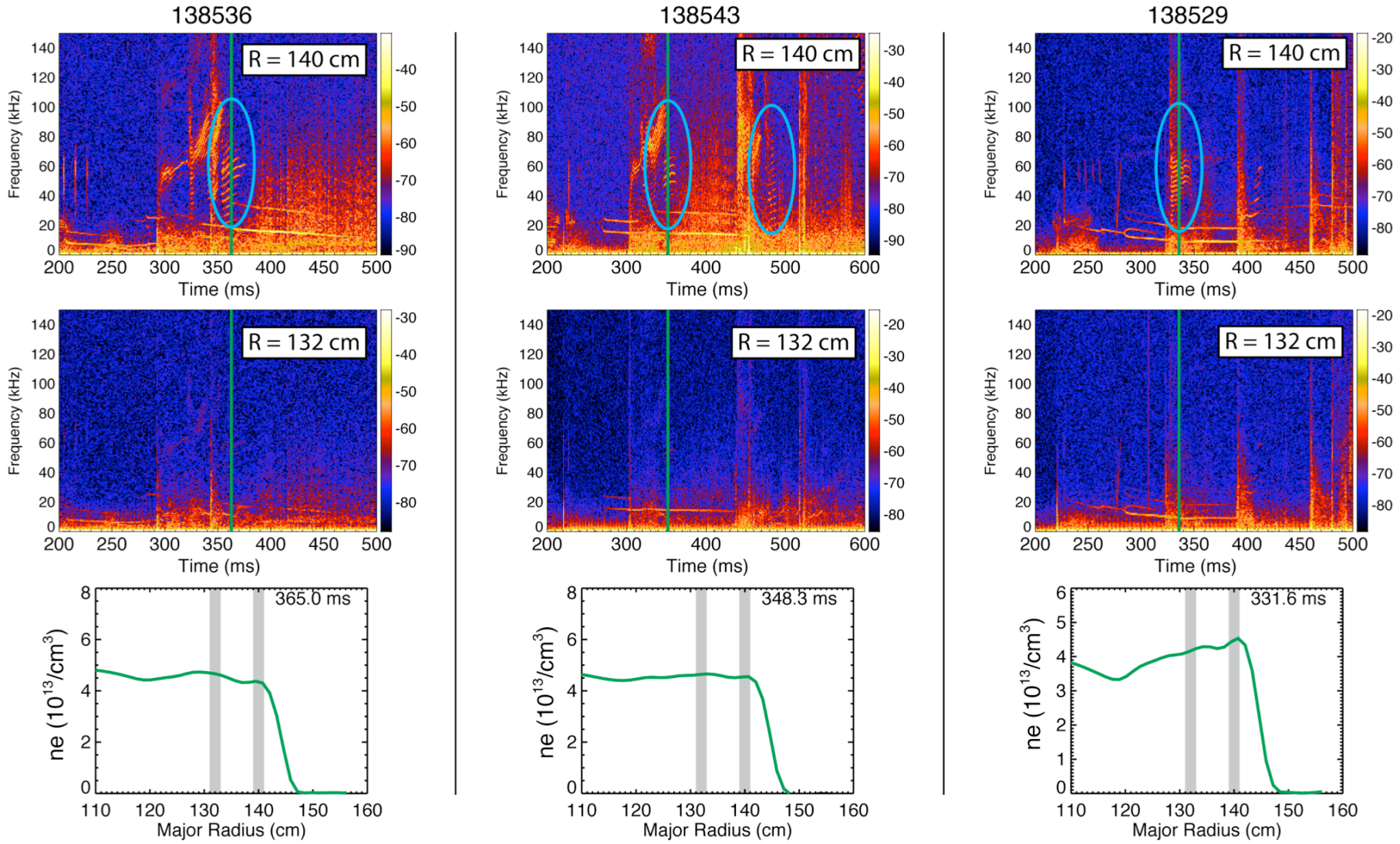




- Preliminary poloidal correlation measurements
  - Not corrected for photon and e-noise, but SNR is large
- Rapid poloidal advection
  - ~10-20 km/s in SOL
  - Greater in pedestal
- SOL correlation shows dispersion
- Decay indicates correlation lengths ~10 cm

# Fluctuations increase during large ELMs



# Inter-ELM harmonic features around 100 kHz are localized near the edge

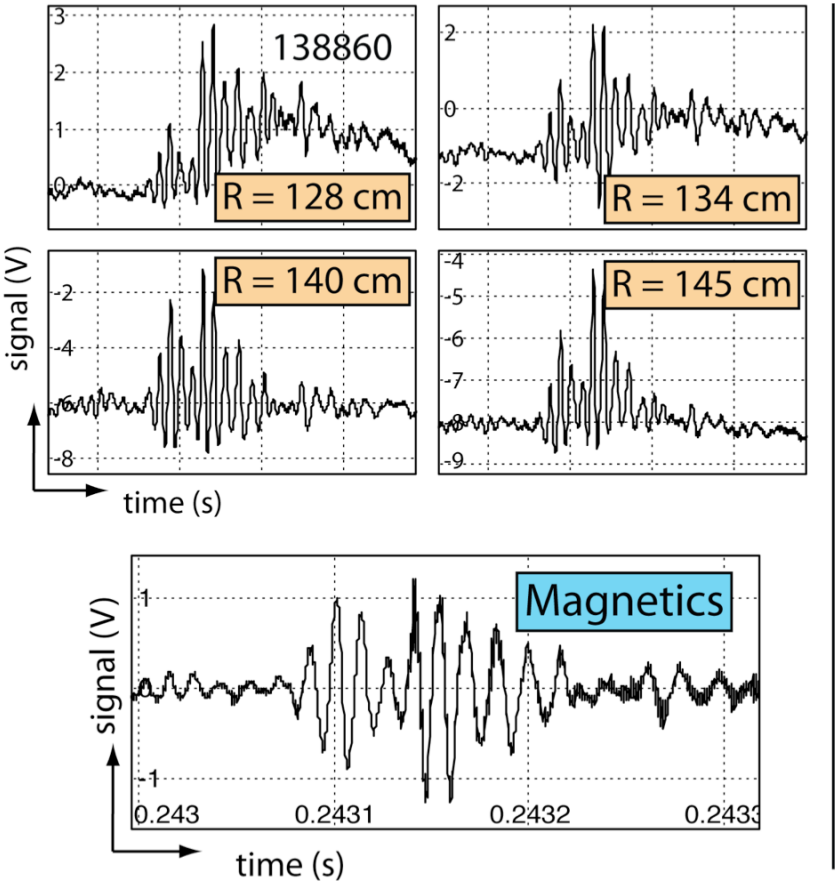



Z. Yan, GI2

Harmonic features are either absent from or weakly present in magnetic spectra

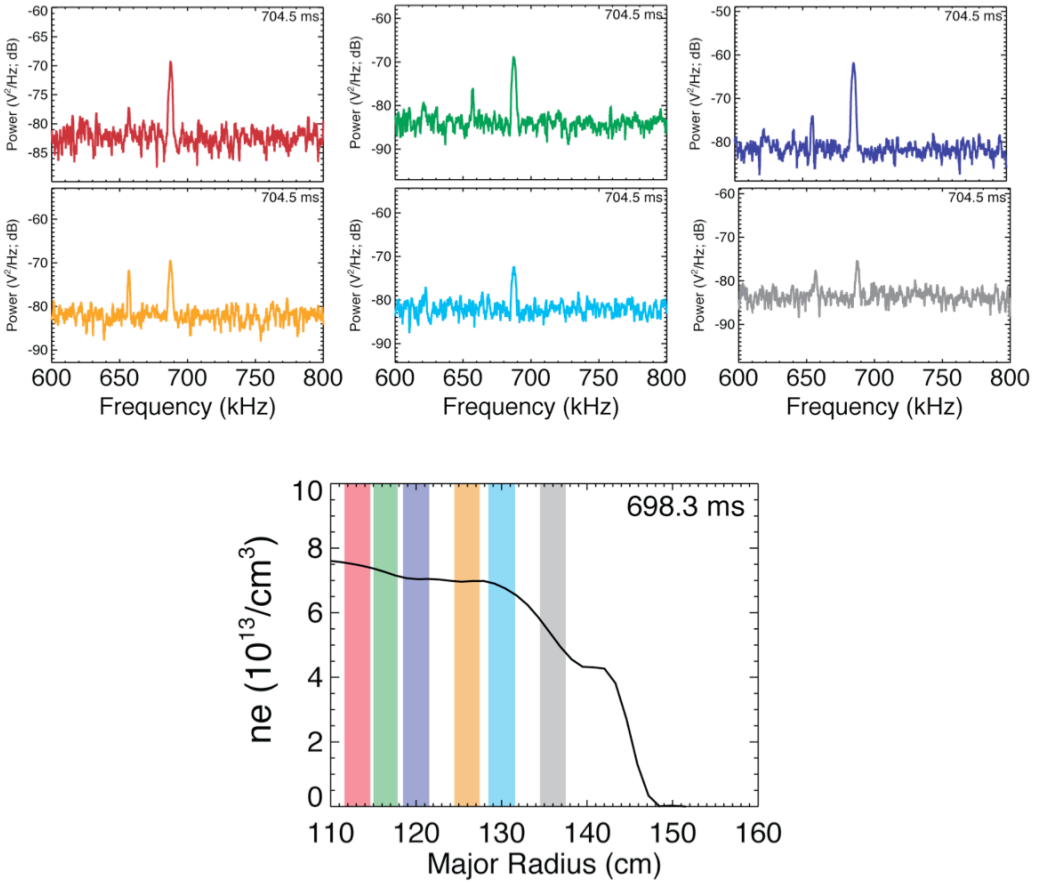
# TAEs and GAEs have been observed in extended radial regions

## TAE burst




Heidbrink, CO4

## GAE mode




Tritz, PI2

# Summary

- A BES system has been commissioned on NSTX
  - Radial coverage from r/a~0.1 to SOL with 2-3 cm spot sizes
  - Measured spectra exceed e-noise spectra
  - Up to 24 detection channels were employed in FY10
  - 32 detection channels expected in FY11
- Initial measurements show…
  - Change in fluctuations at LH and HL transitions
  - Broadband fluctuations
  - Inter-ELM harmonic features localized near pedestal
  - TAE and GAE radial structures
- Future work
  - Assess radial and poloidal correlation lengths
  - Calculate spatial transfer function to assess spatial and k-space measurement characteristics