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

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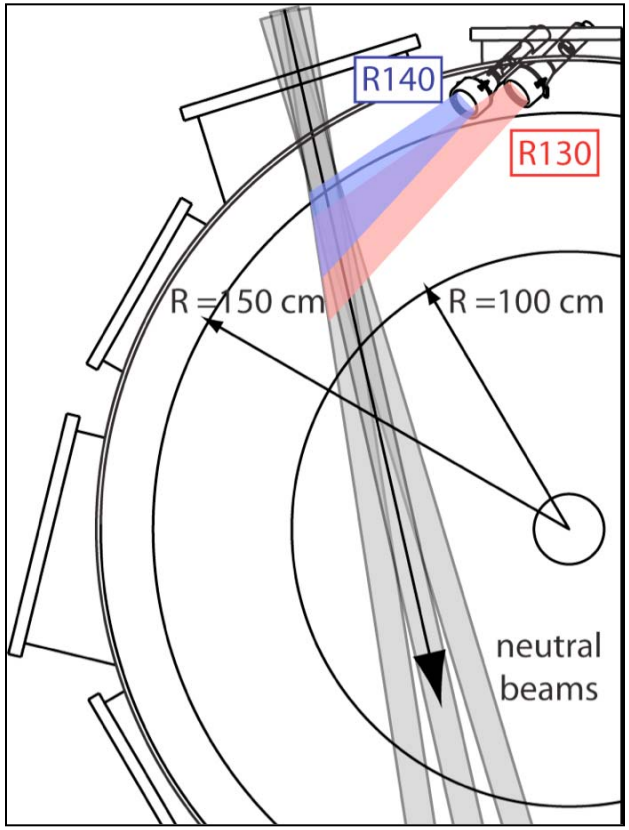
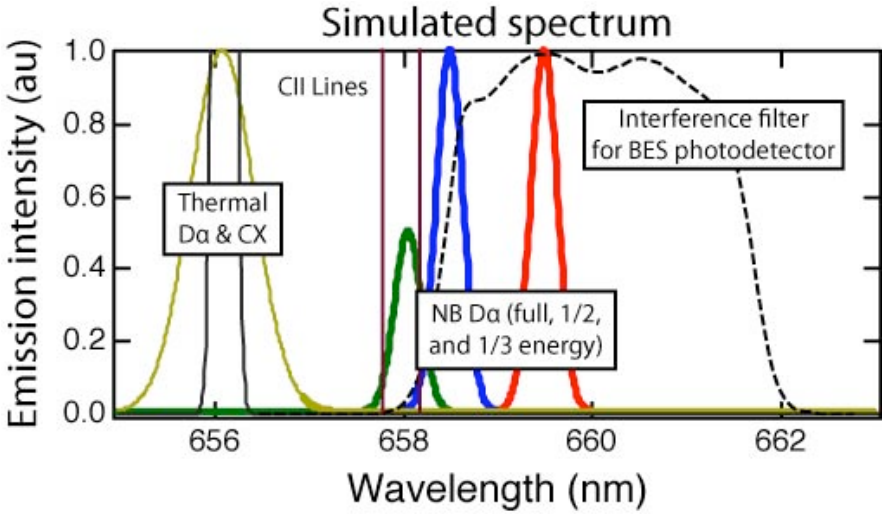
Outline

- BES overview and status
  - Example measurements and e-noise
- Initial measurements
  - H-mode transitions and back-transitions
  - Broadband fluctuations
  - ELMs and post-ELM harmonic features
  - Toroidal Alfven eigenmodes
- Summary

BES measures neutral beam D_α emission to study long wavelength ($k\rho_i<1$) density fluctuations

- Doppler shift isolates NB D_α emission from thermal D_α
- Red-shift optical views are field-aligned with spatial resolution $\Delta x \approx$ 2-3 cm
- D. R. Smith et al, RSI 2010

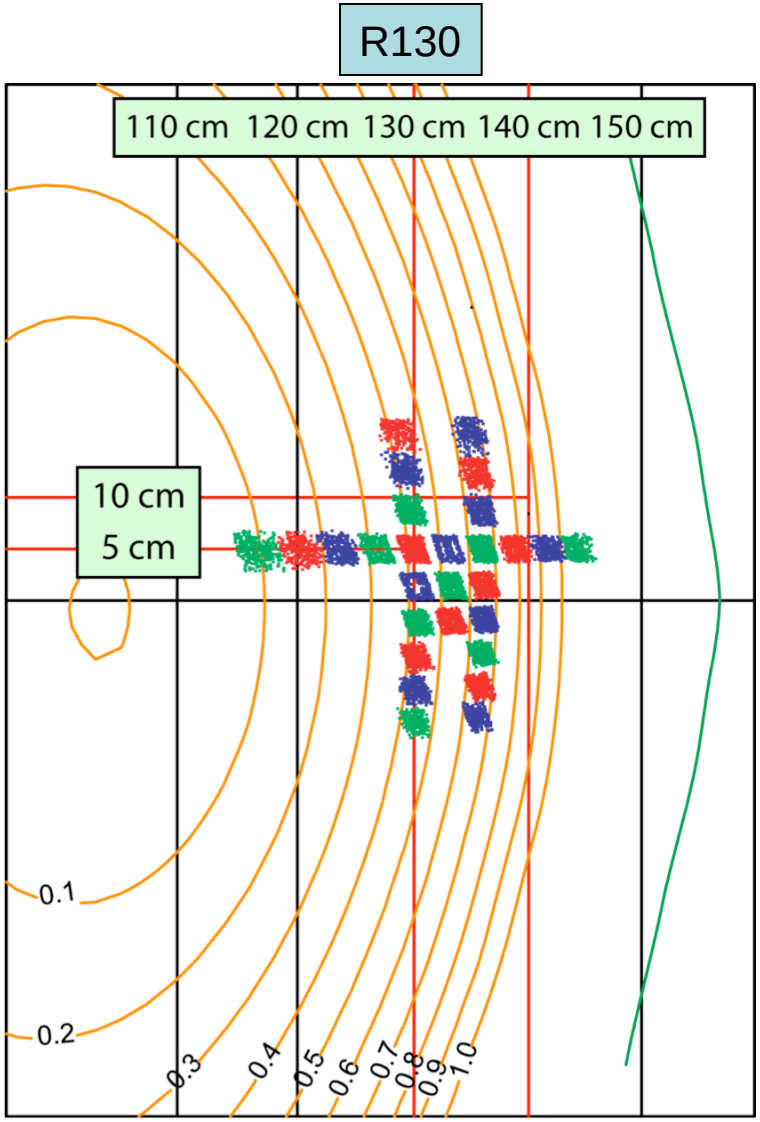


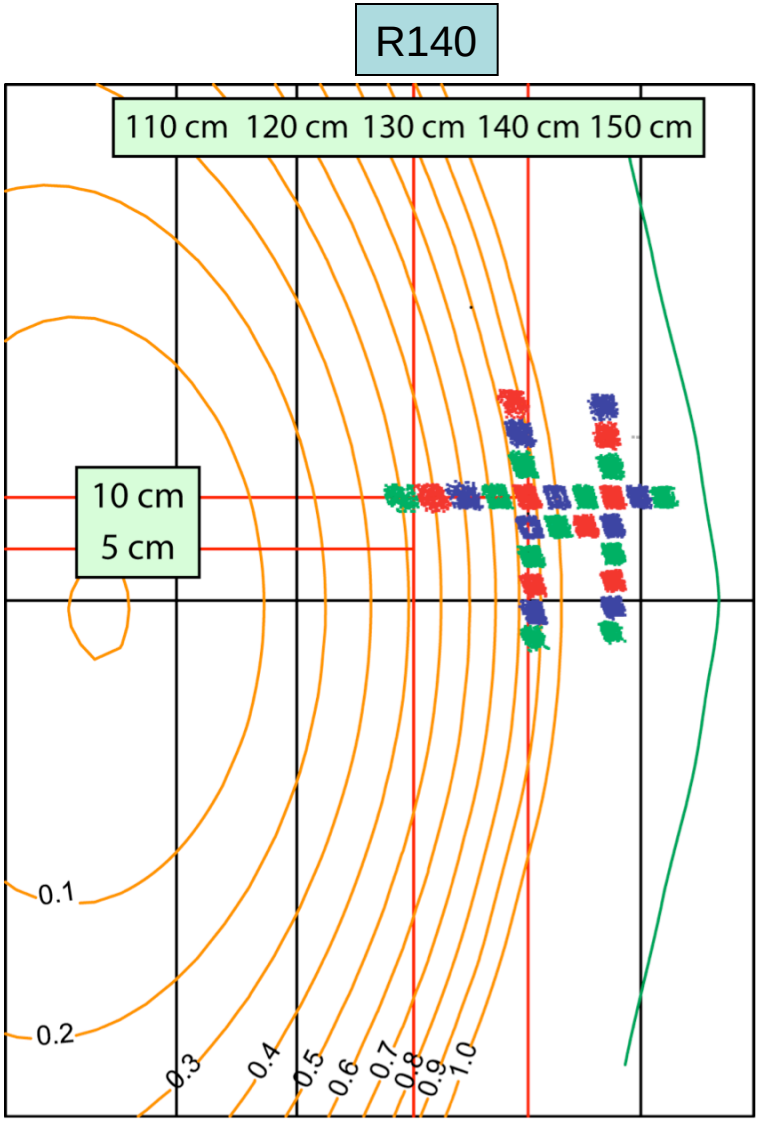


First measurements in June 2010; presently operating with 24 detection channels

- 16 channels in two detector boxes produce strong 3-10 V signals well above e-noise
  - 8 channels in third detector box exhibit lower response (~1/2), but SNR comparable; under investigation
  - 8 additional channels (32 total) will be available in FY11
  - 3-10 V signals achieved with x15 gain; remarkably close to x20 gain estimated in design phase
- 56 fiber bundles with 9 1-mm fibers provide high throughput with 2-3 cm spot sizes at NB
  - 2.3 mm^2-ster étendue at f/1.5
  - About 45% relative transmission
- Data obtained for 35+ run days in FY10; most data from R140 view
  - R130 shutter did not operate reliably ; manual operation was possible
  - Shutter mechanisms will be reconfigured for FY11
- Digital FIR filter in DAQ eliminates e-noise > 1 MHz
  - 2 MHz output sampling rate
  - DAQ internal clock generates time dilation at about 4 ms per second; under investigation
- Control, cooling, and vacuum systems are functional
  - Refrigerant cooling at -20° C
  - Control via programmable automated controller and LabView

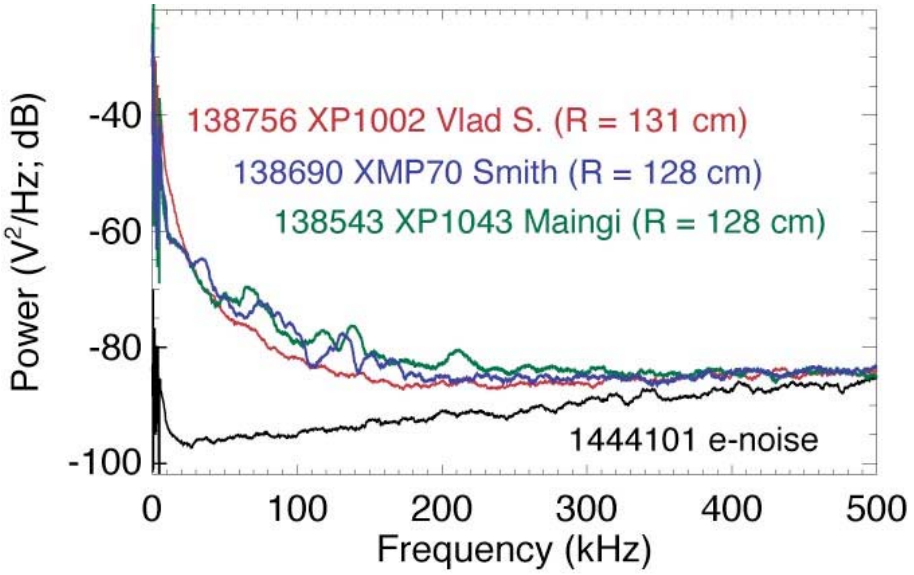
Two optical views with 56 fiber bundles provide coverage from r/a≈0.1 to the SOL



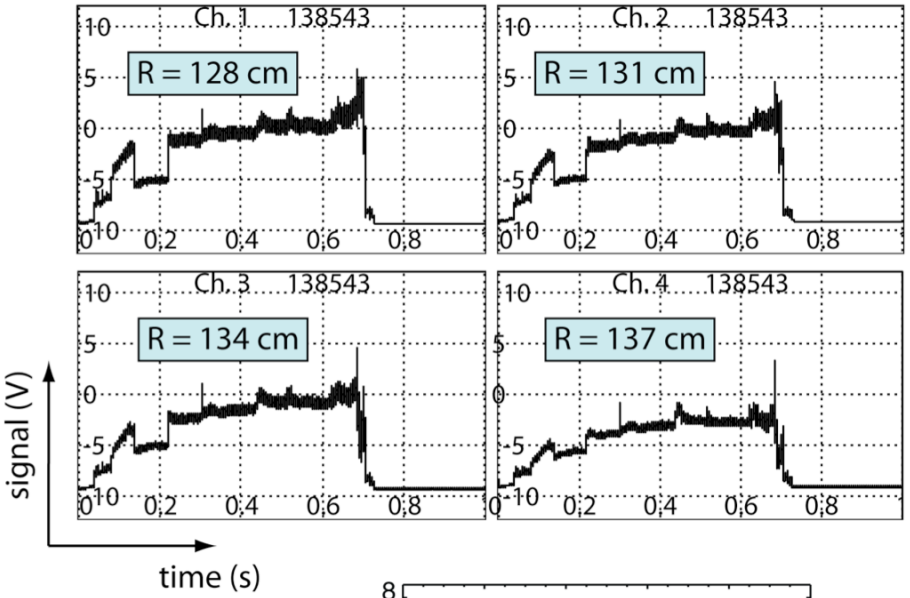


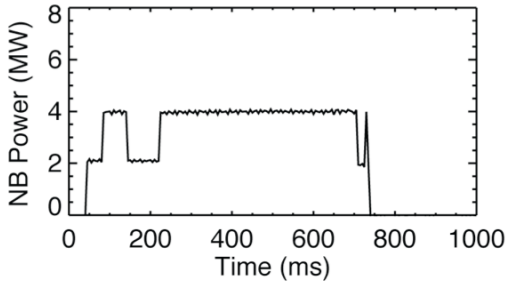
Measured fluctuation spectra exceed e-noise spectra; signal amplitudes correspond to NB power

Signals exceed e-noise



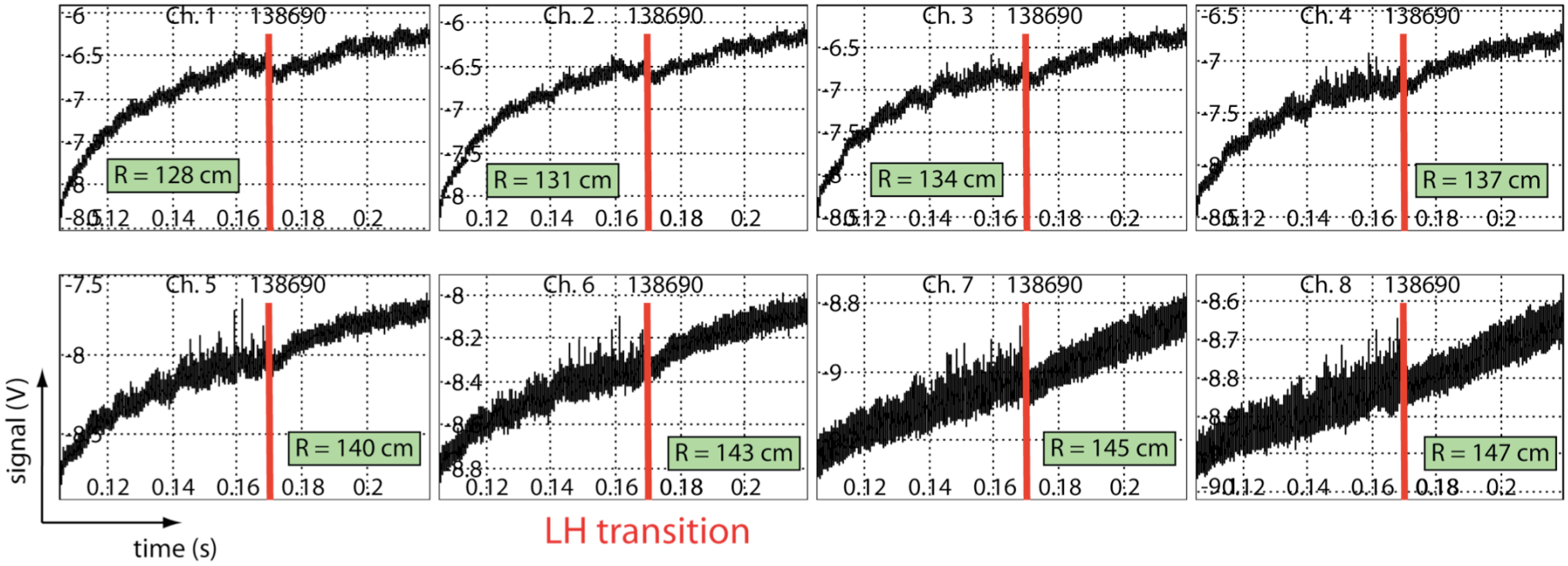
Signals correspond to NB power



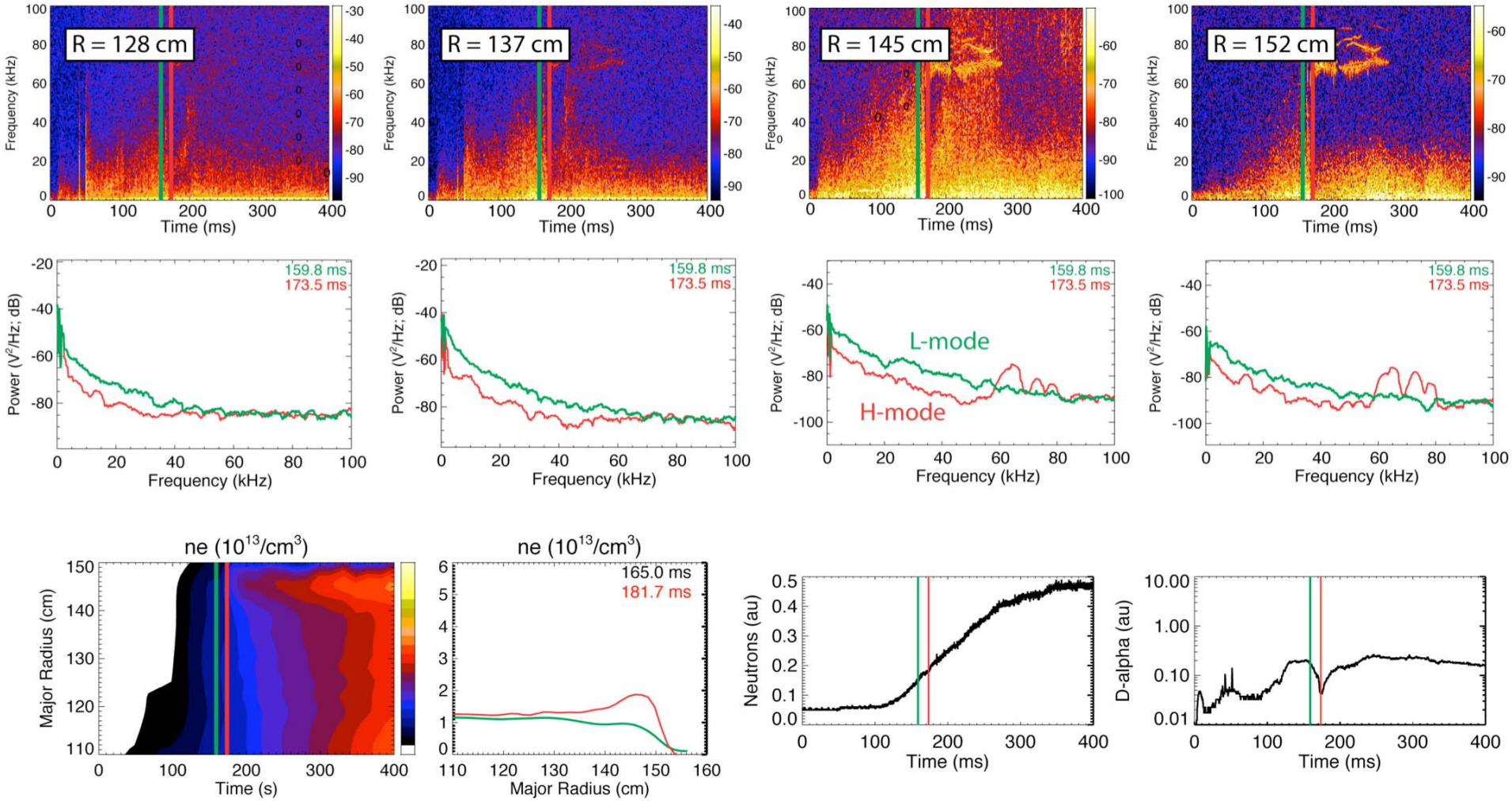


- E-noise and photon noise spectra must be removed from measured spectra to isolate plasma fluctuation spectra.

Signal RMS amplitudes decrease at LH transition in outer channels (R>137 cm)



Fluctuation amplitudes decrease at LH transition across radial observation region (R=128 cm to 152 cm)



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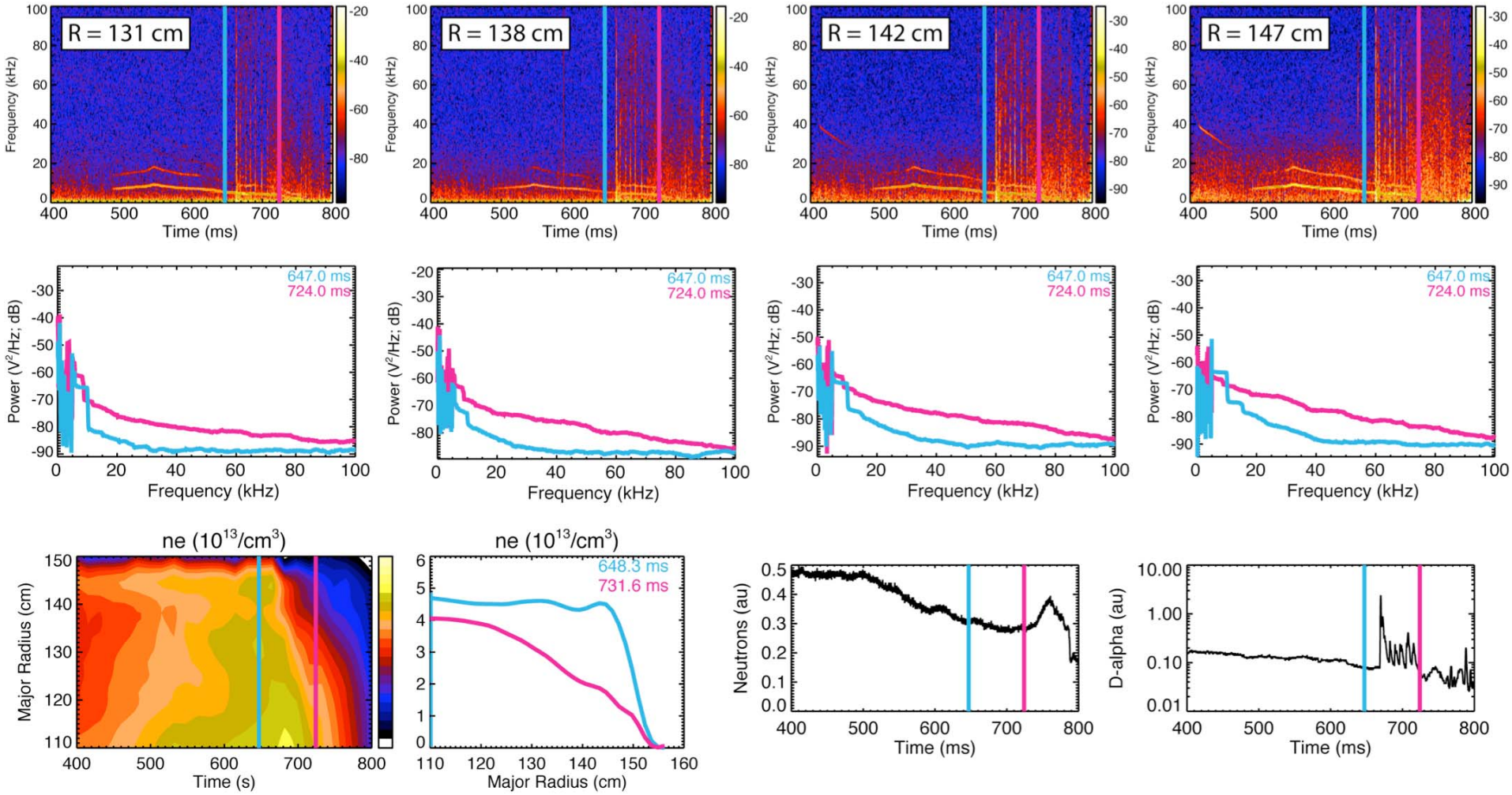
Fluctuation amplitudes increase at HL back-transition



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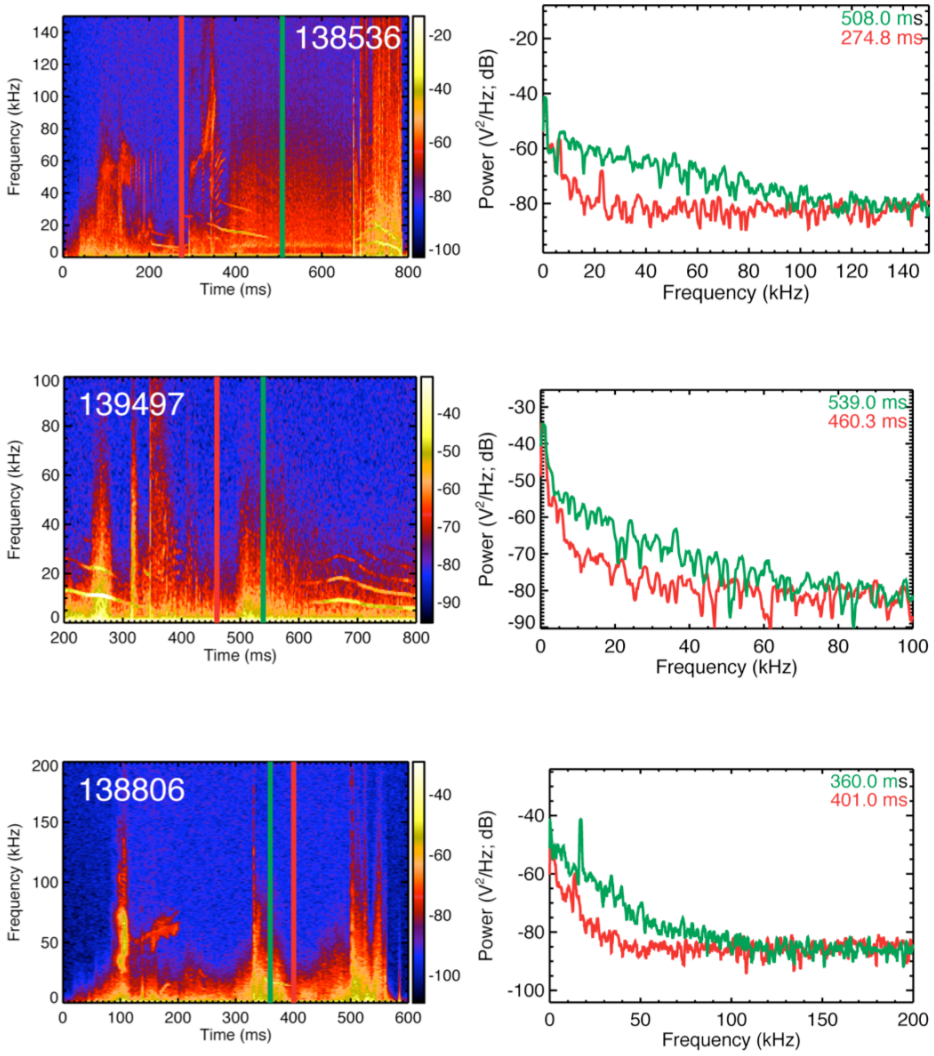
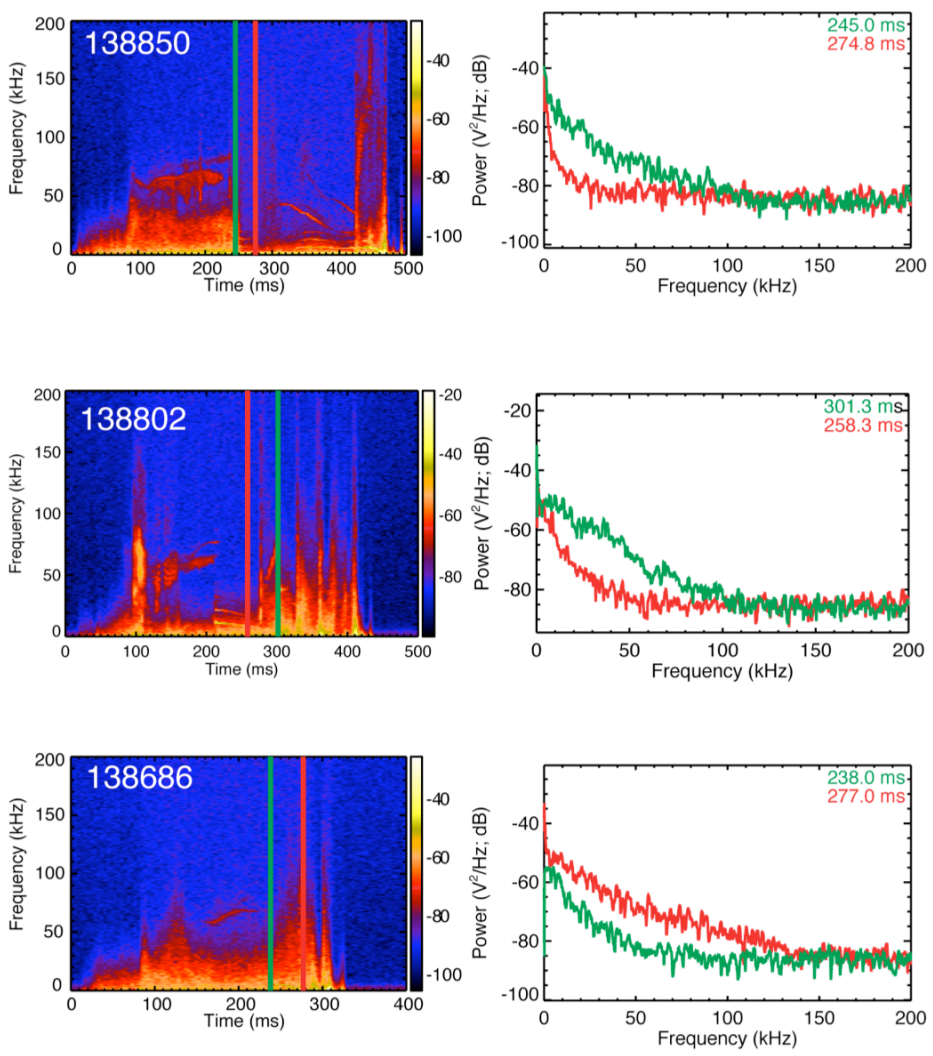
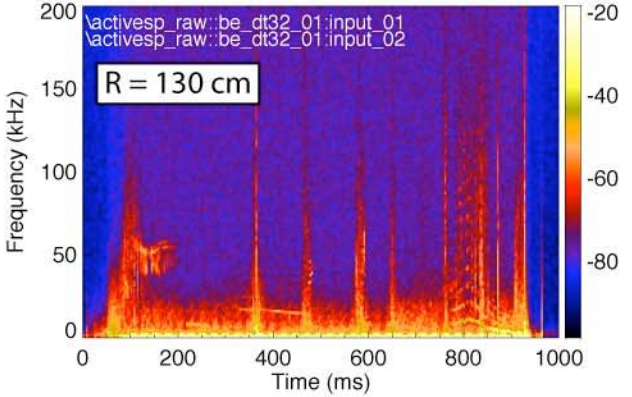
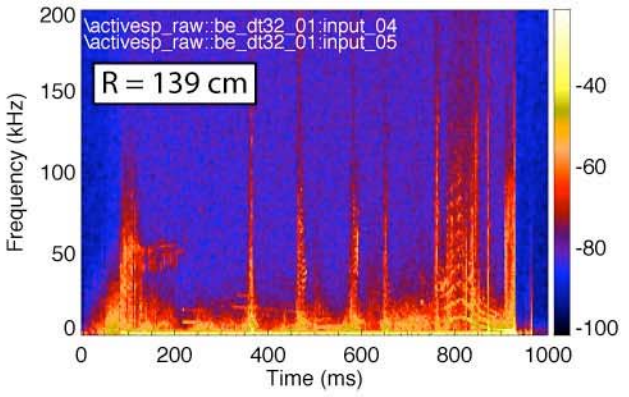
Persistent broadband fluctuations have been observed

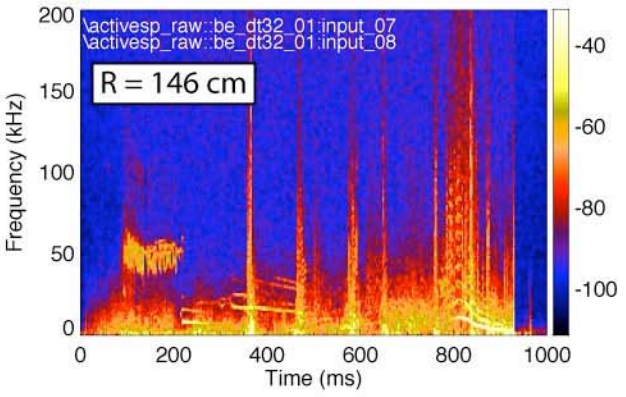


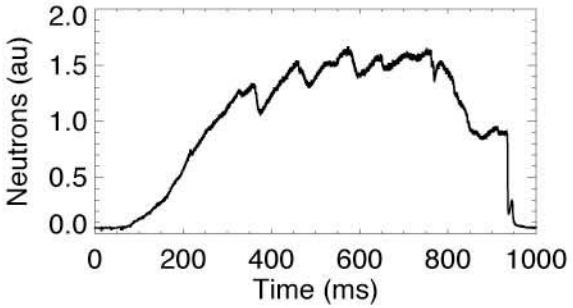


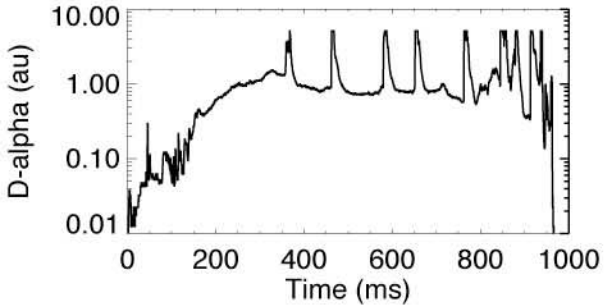
Fluctuations increase during ELMs

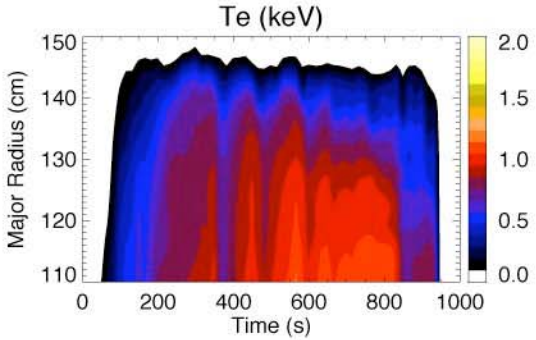


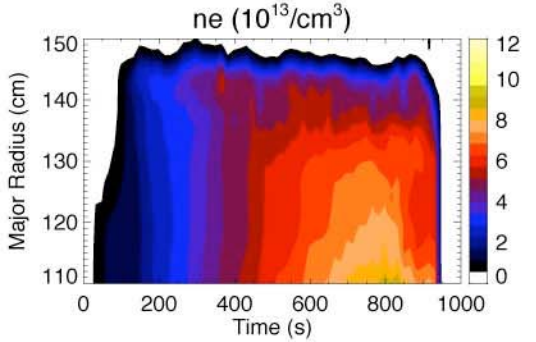


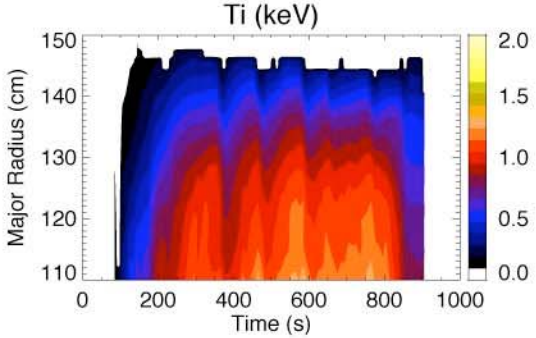


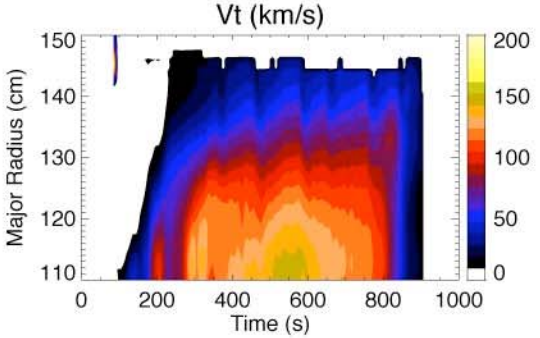












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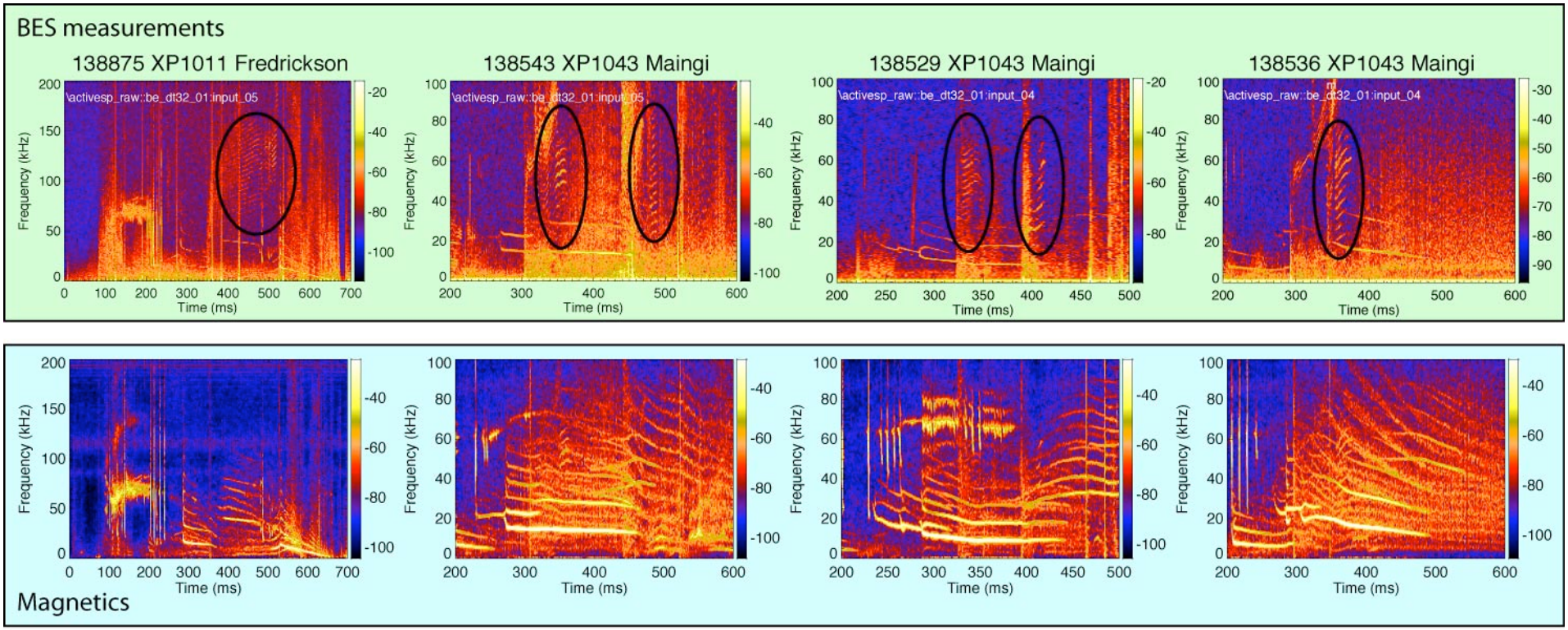
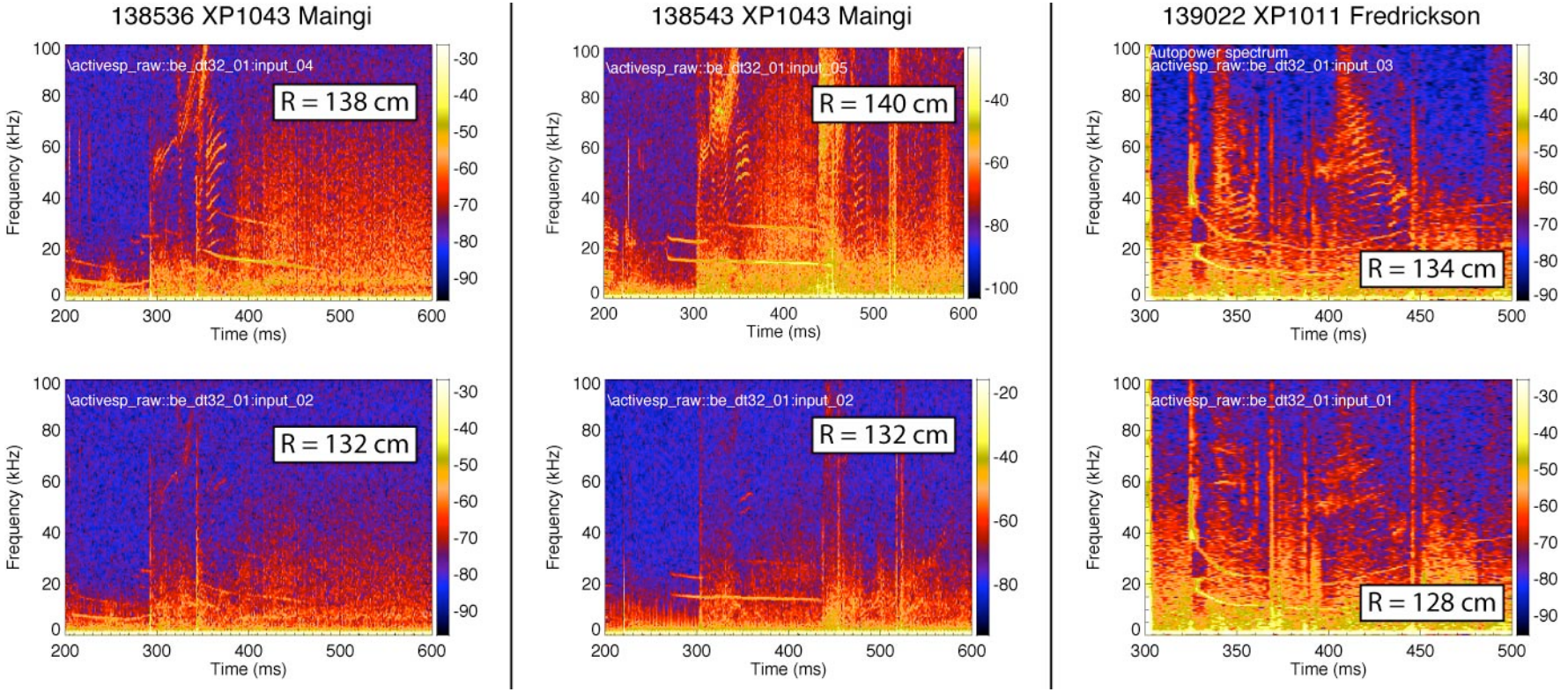
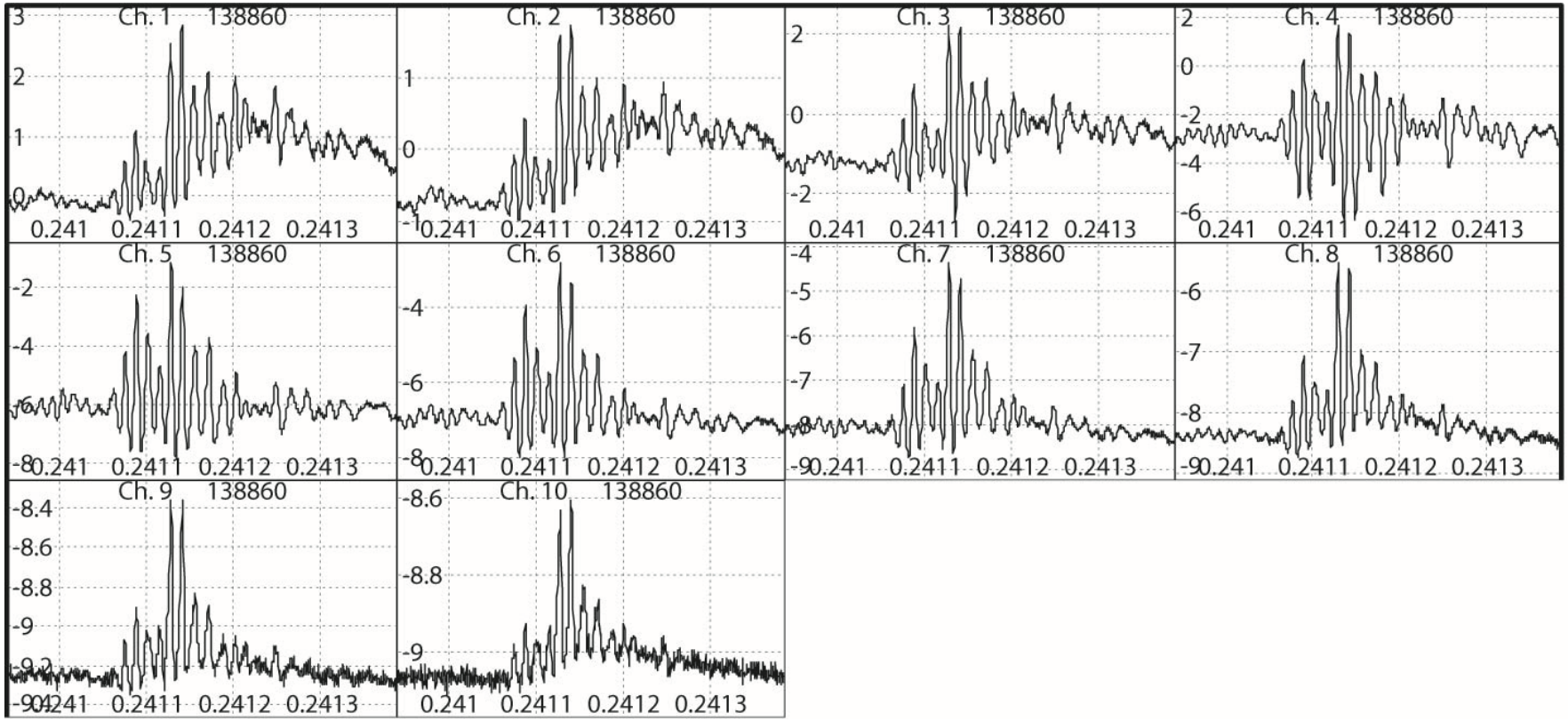
Harmonic features up to 150 kHz observed after ELMs; features difficult to discern in magnetics



Post-ELM harmonic features are radially localized to pedestal region



TAEs can be observed from R = 128-152 cm



Summary

- BES system has been commissioned on NSTX
  - 32 channel expected in FY11
- Measured spectra exceed e-noise spectra
  - DC signals correspond to NB power
  - 3-10 V signals are consistent with design expectations
- Initial measurements show…
  - H-mode transitions and back-transitions
  - Broadband fluctuations
  - ELMs and post-ELM harmonic features
  - TAEs
- Future work
  - Point spread function and spatial transfer function calculations are needed to assess spatial and k-space measurement characteristics