

Initial measurements and status of the BES system

D. Smith, R. Fonck, G. McKee, N. Schoenbeck, D. Thompson,
I. Uzun-Kaymak, and G. Winz

University of Wisconsin-Madison

H. Feder, R. Feder, G. Labik, and B. Stratton

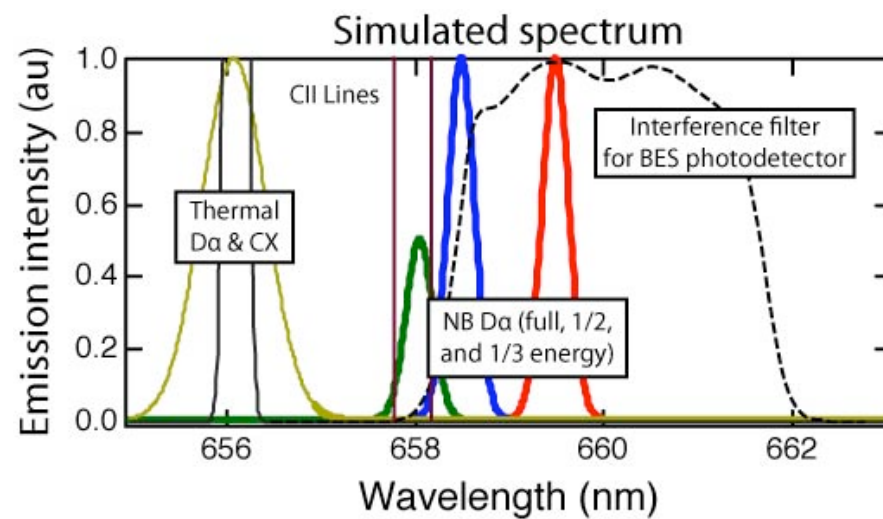
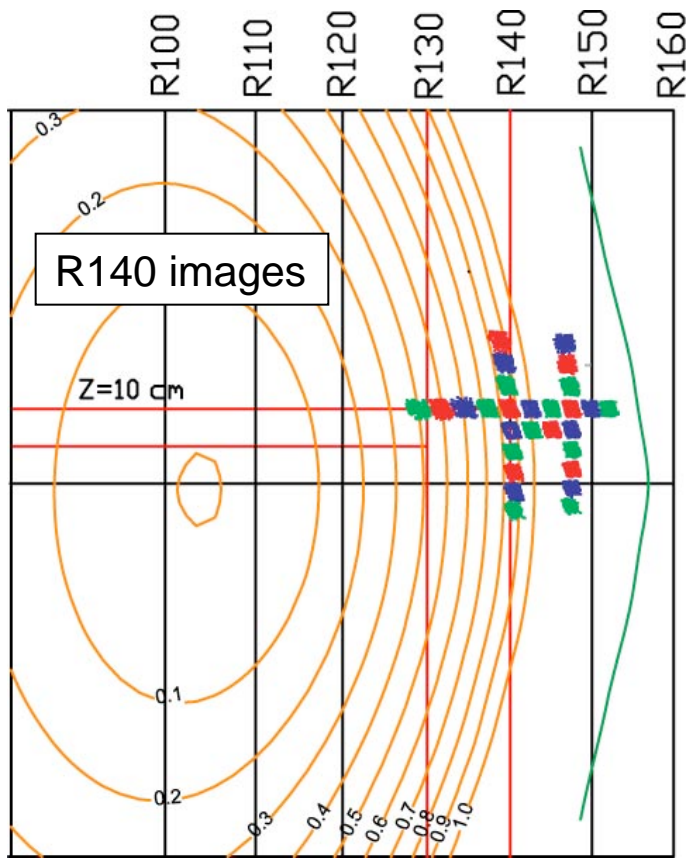
PPPL

Outline

- BES overview and status
- Example measurements and e-noise
- H-mode transitions and back-transitions
- Impact of rotation of fluctuations
- ELMs and post-ELM harmonic features
- TAEs
- Planned XPs
- Summary

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

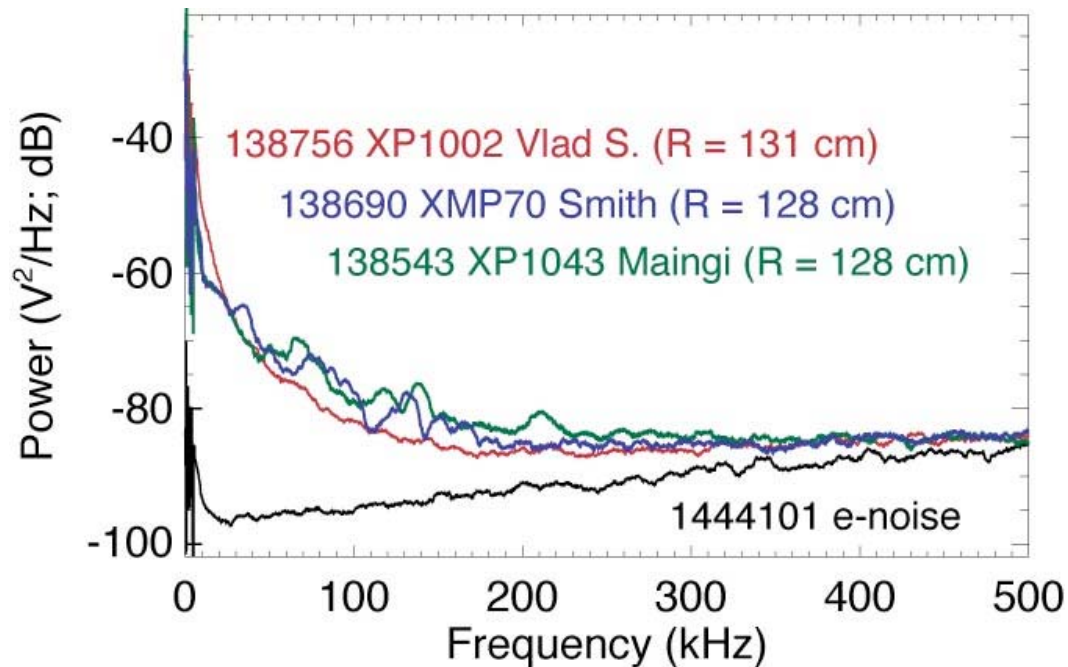
- Doppler shift isolates NB D_α emission from thermal D_α
- Optical views are field-aligned with spatial resolution $\Delta x \approx 2-3$ cm
- RSI paper in press (Oct 2010)



First measurements with 16 channels on June 15, 2010

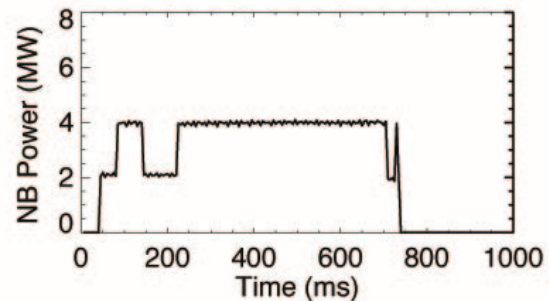
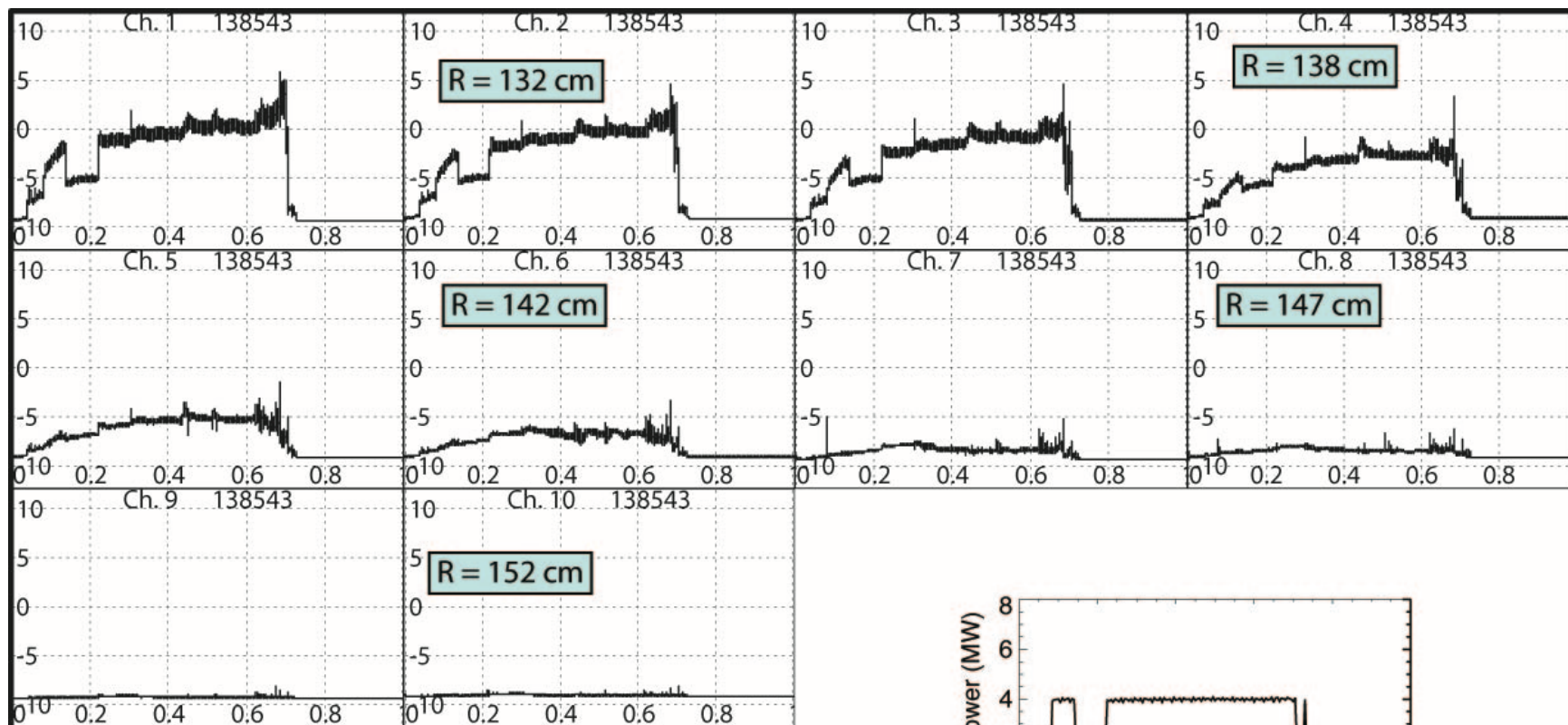
- Presently have data for 13 days covering 13 XPs
- R140 shutter is operational with radial coverage $R \approx 128-152$ cm
- R130 shutter does not operate reliably
 - Measurements possible with manual intervention
- Channels 1-8 (detector box #1) show higher response than Channels 9-16 (detector box #2), but SNR appears the same
 - Under investigation
- Channels 1-8 produce $\sim 3-10$ V signals with $\times 15$ gain
 - Remarkably close to $\times 20$ gain estimated in design phase
- Potential line-of-sight from parked Bay F Litter presently limits BES measurements
 - Engineering analysis may indicate no line-of-sight access
- Anti-alias FIR filter attenuates e-noise above 1 MHz
 - DAQ presently constrained to internal clock which exhibits ~ 3 ms drift
- Control, cooling, and vacuum systems are functional
 - LabView control intelligence needs improvement to protect equipment
- 16 additional channels (32 total) are onsite at PPPL and will be available for measurements soon

Measured fluctuation spectra exceed e-noise spectra

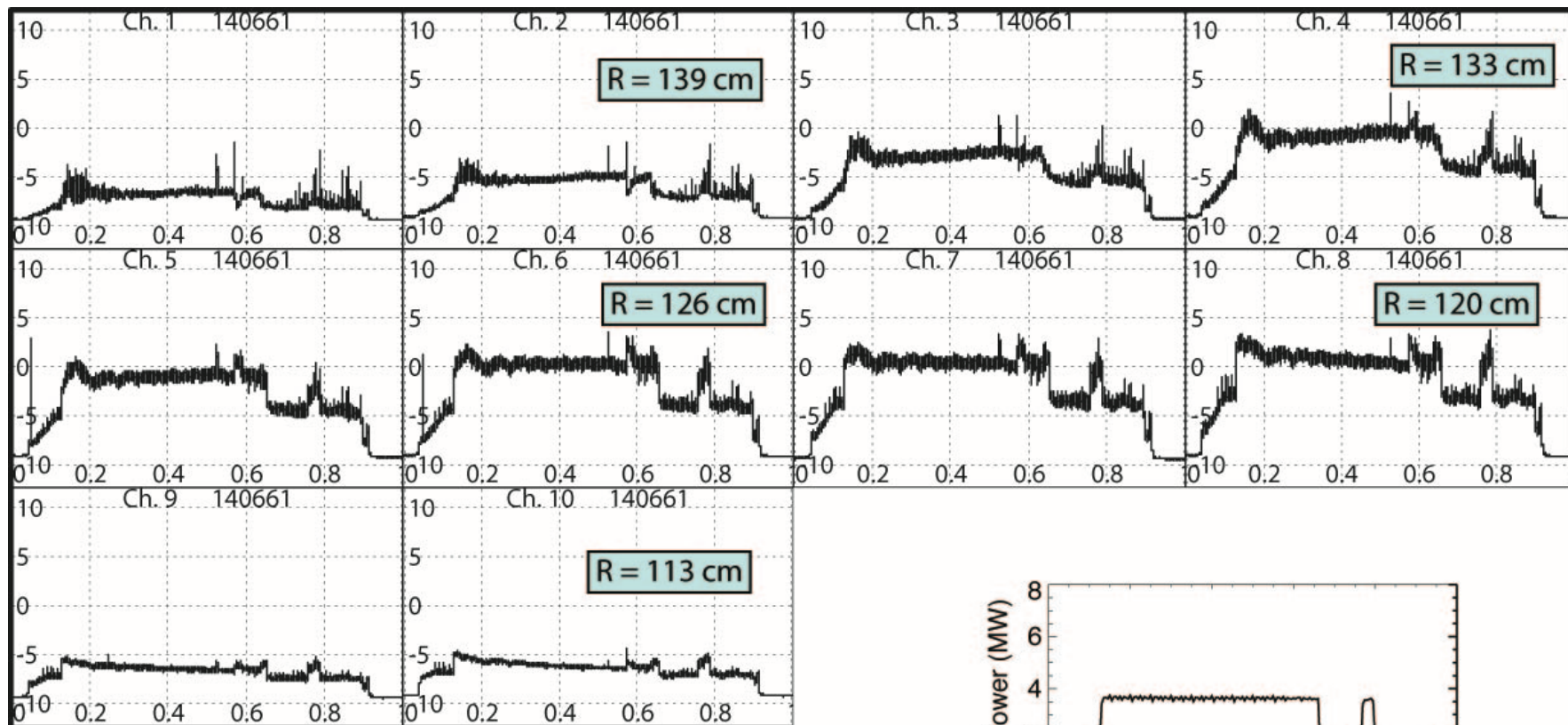


- To isolate plasma fluctuation spectra, **e-noise** and **photon noise** must be removed from measured spectra.

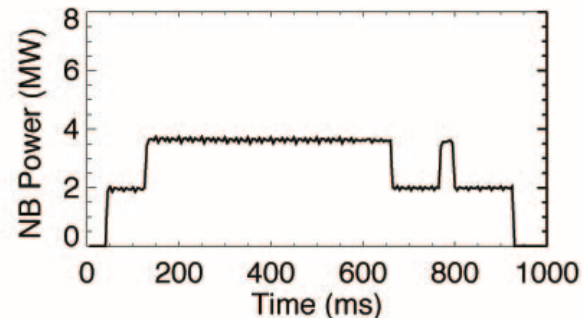
Signal amplitudes correspond to NB power (R140 view)



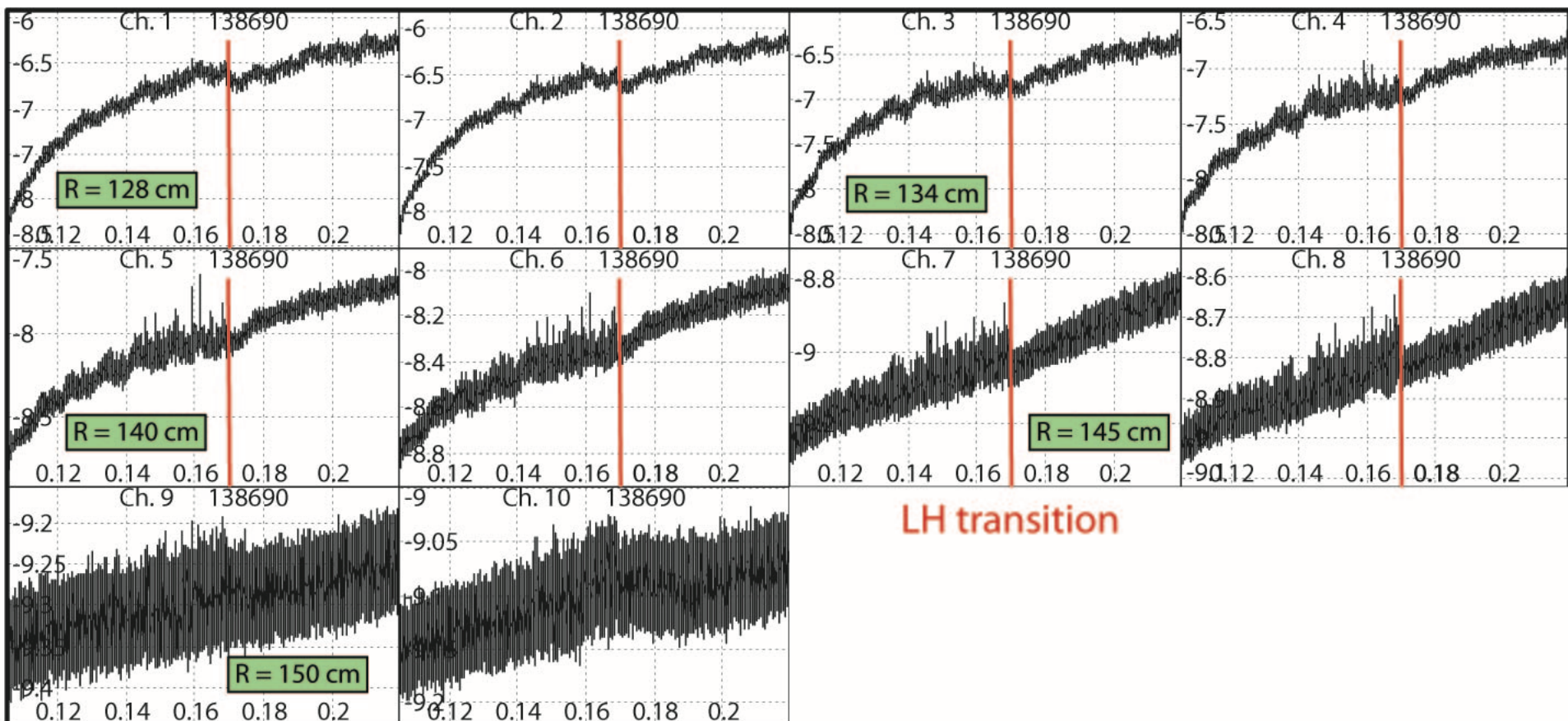
Signal amplitudes correspond to NB power (R130 view)



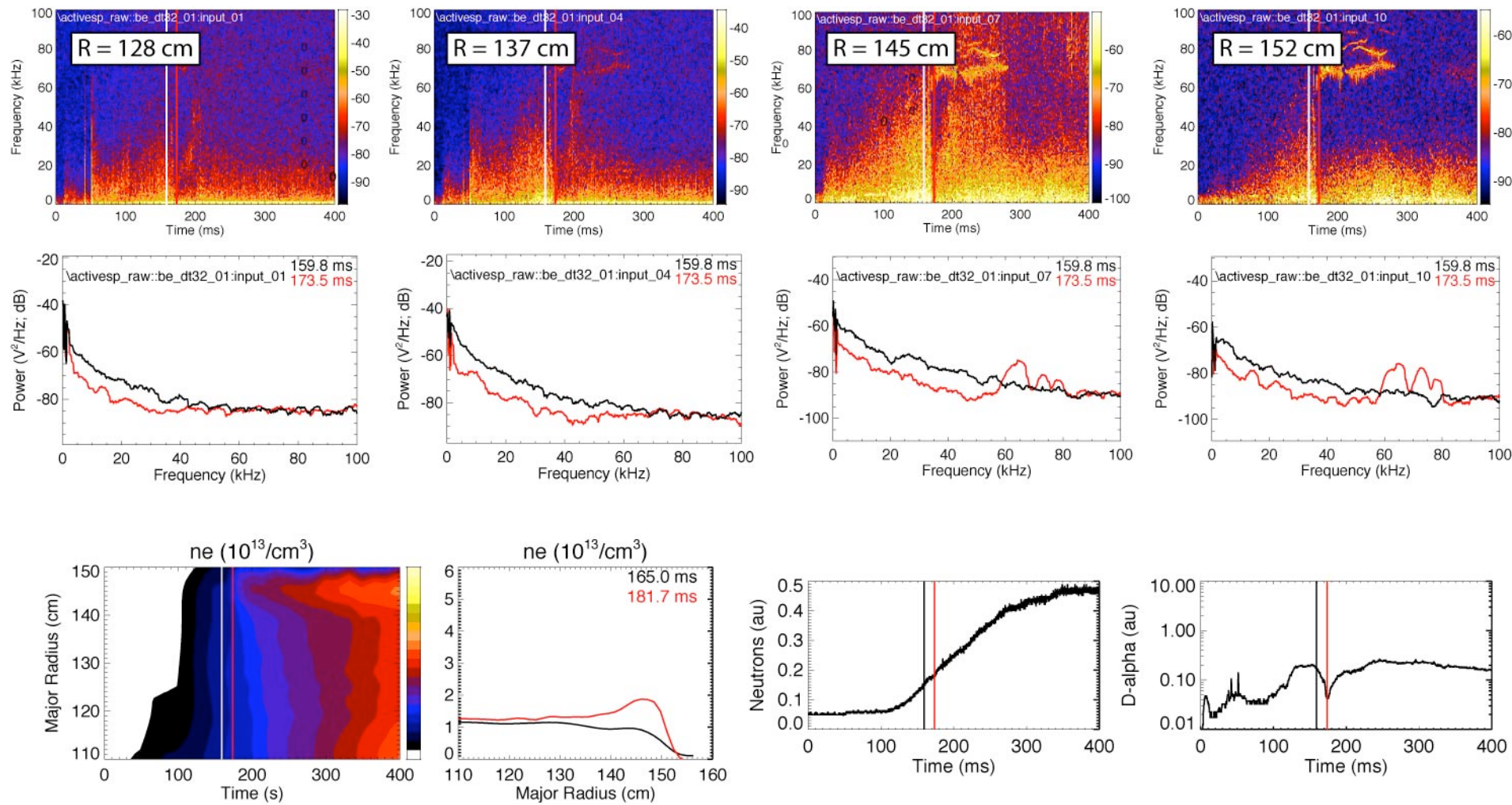
(First data from R130 taken this morning!)



Signal RMS amplitudes at $R > 140$ cm decrease at LH transition

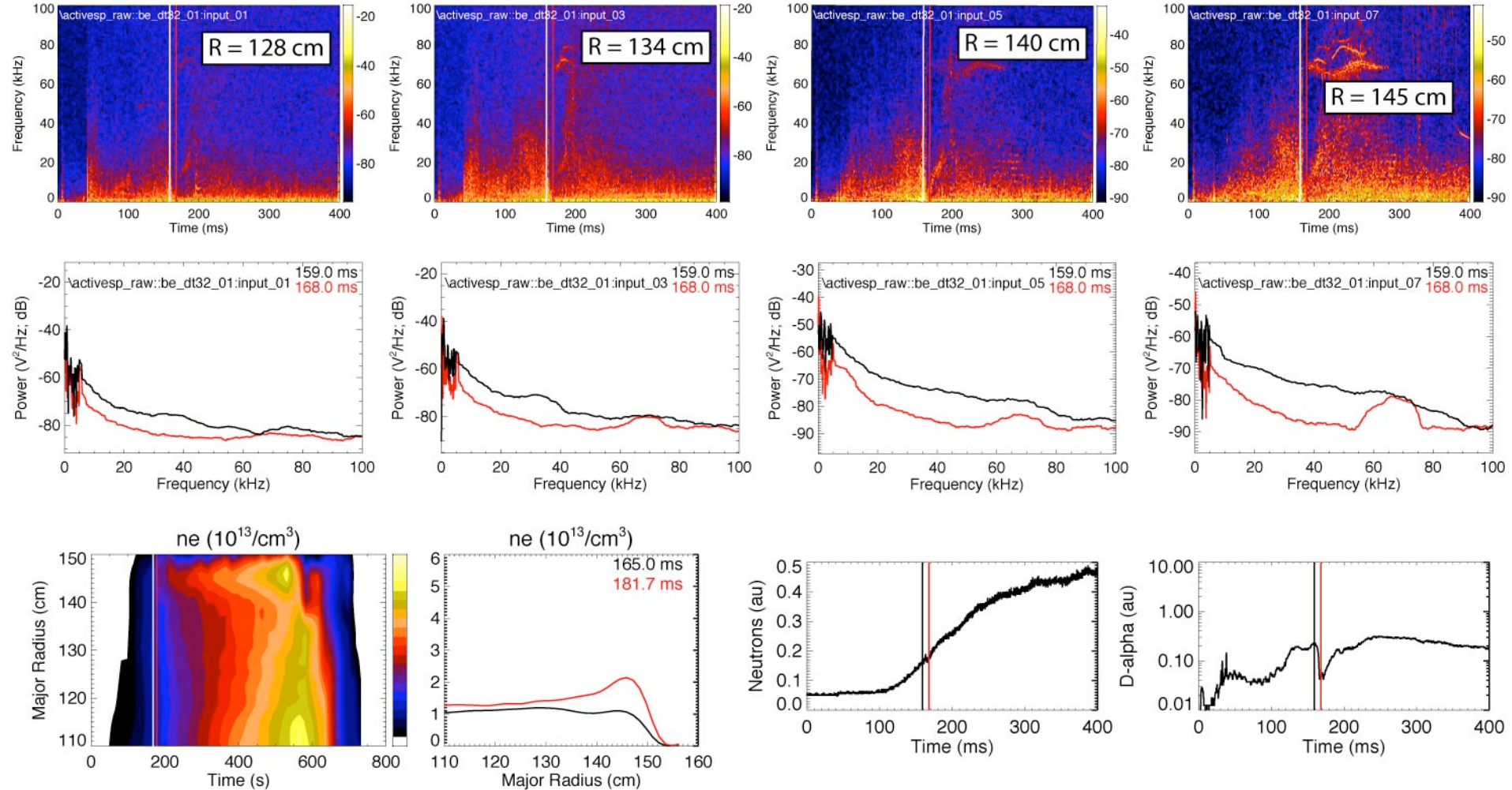


Fluctuation amplitudes decrease at LH transition across entire observation region (R=128 cm to 152 cm) (1)



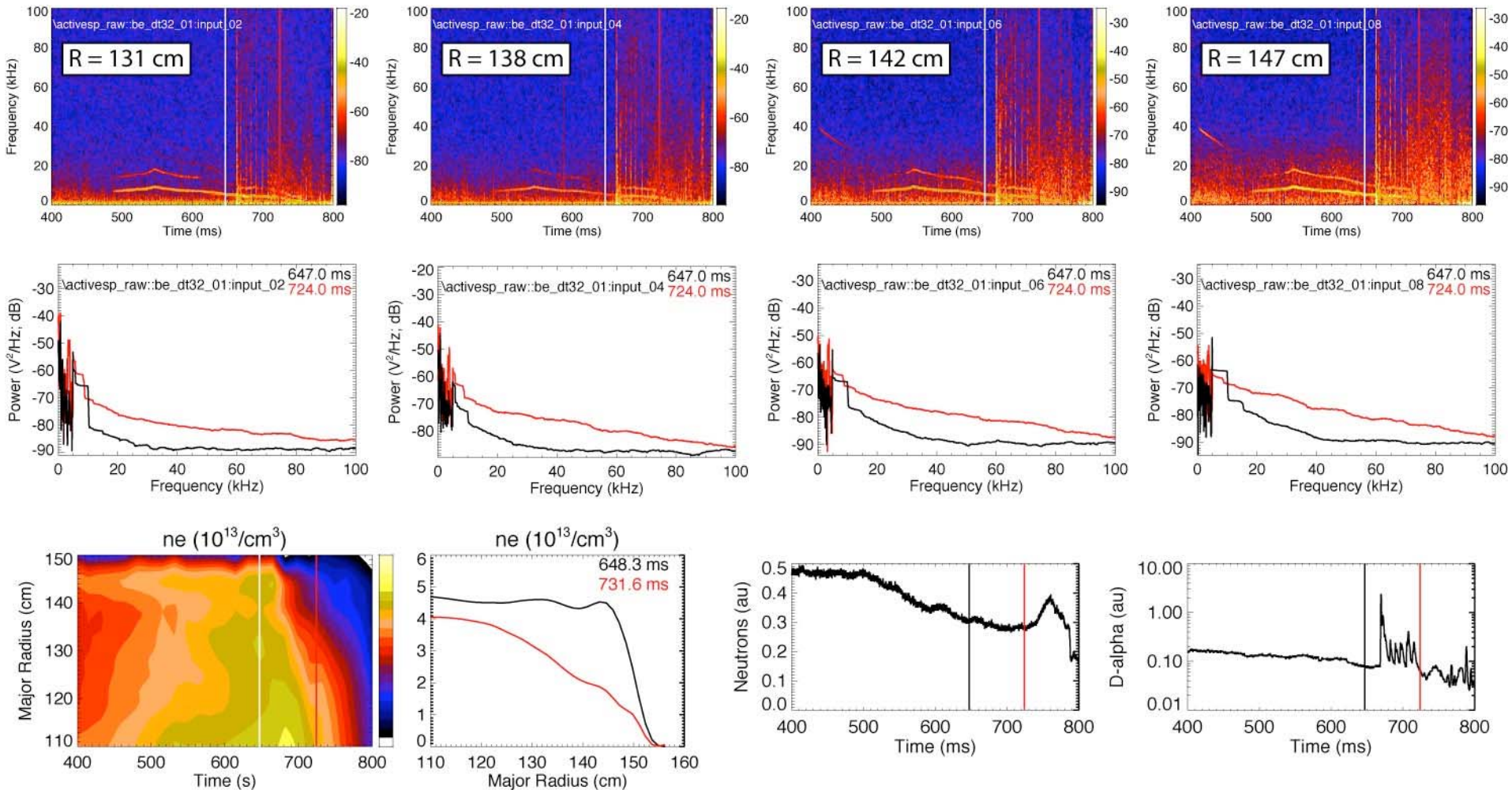
138690 XMP70 Smith

Fluctuation amplitudes decrease at LH transition across entire observation region (R=128 cm to 152 cm) (2)



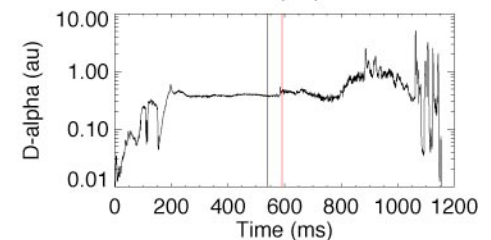
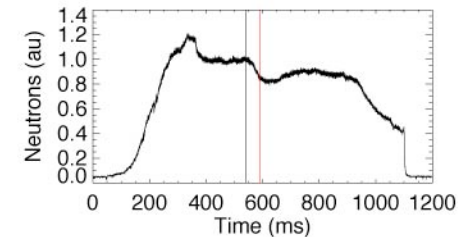
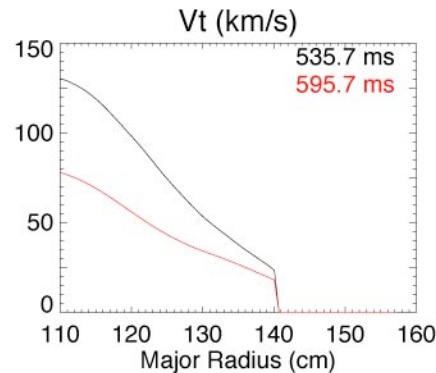
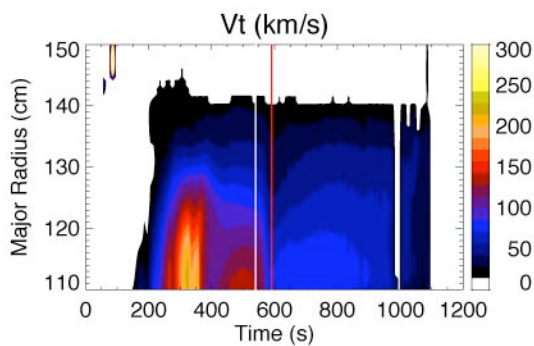
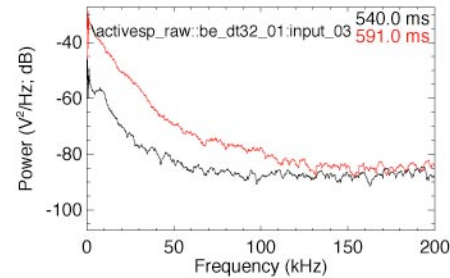
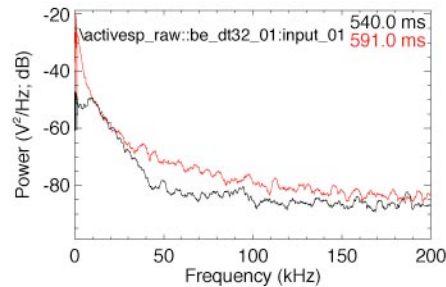
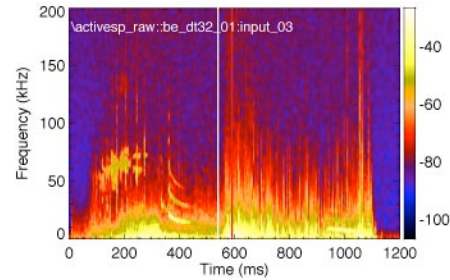
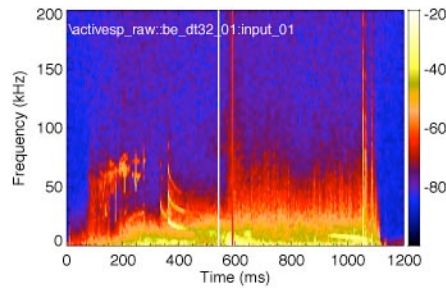
138693 XMP70 Smith

Fluctuation amplitudes increase at HL back-transition



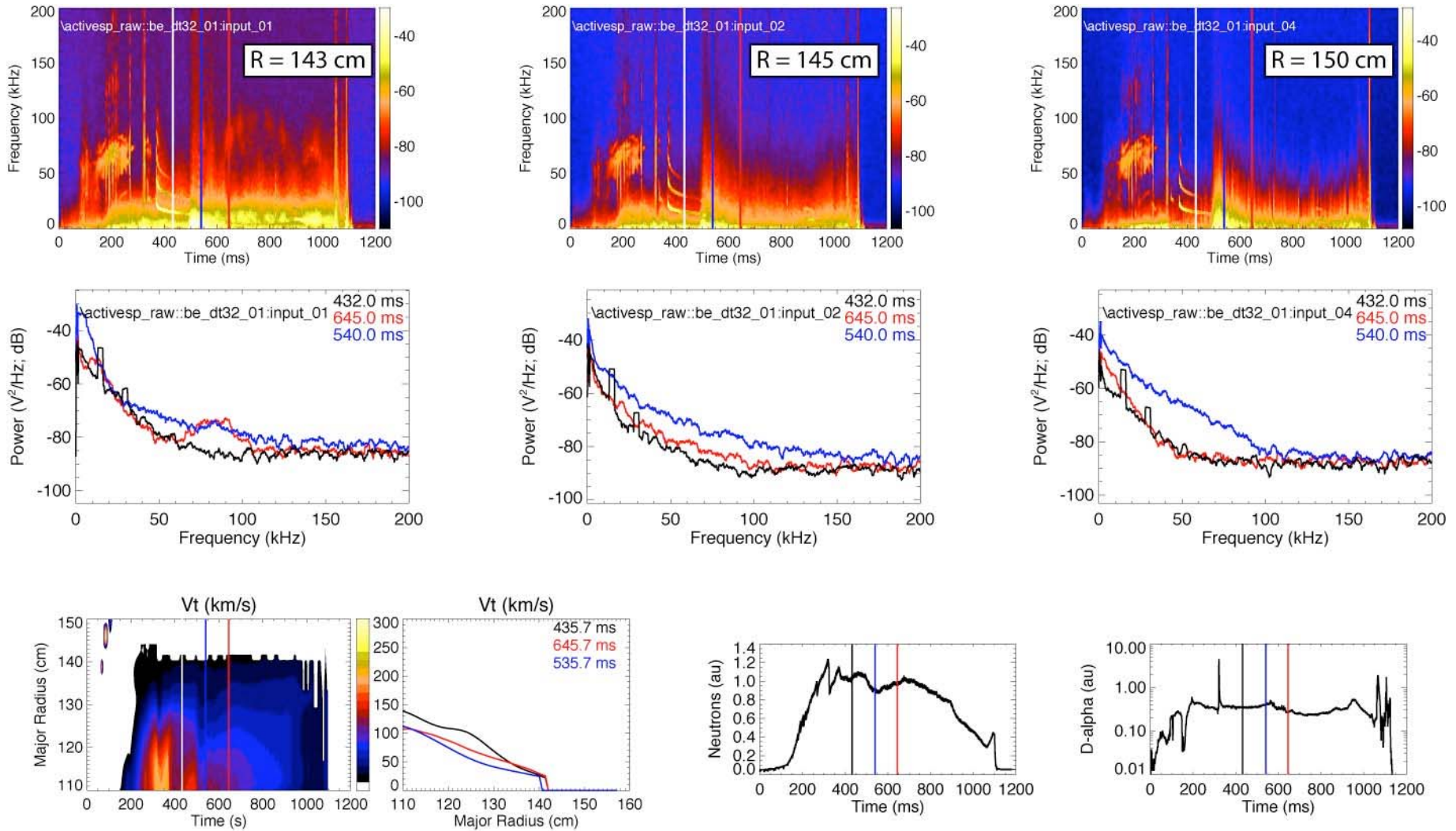
138690 XMP70 Smith

Fluctuation amplitudes increase when rotation slows (1)



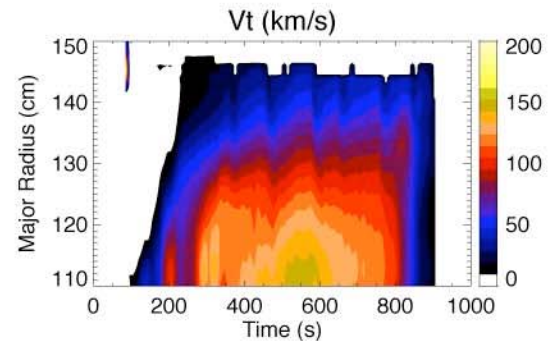
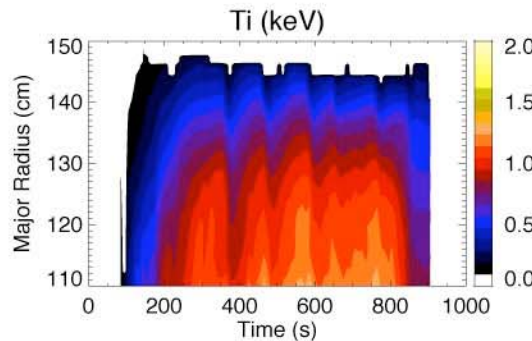
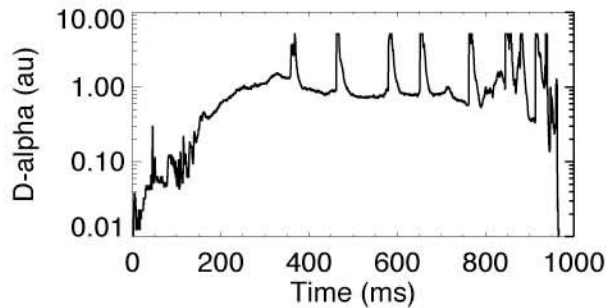
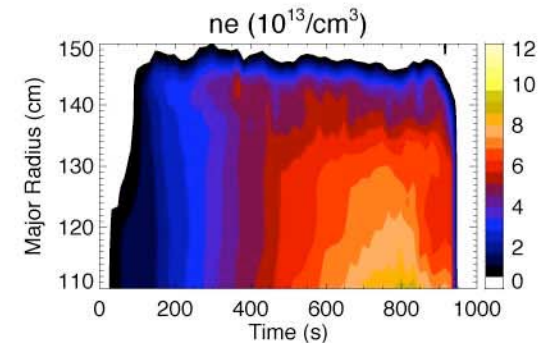
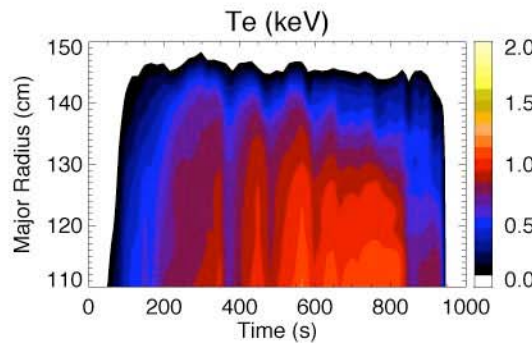
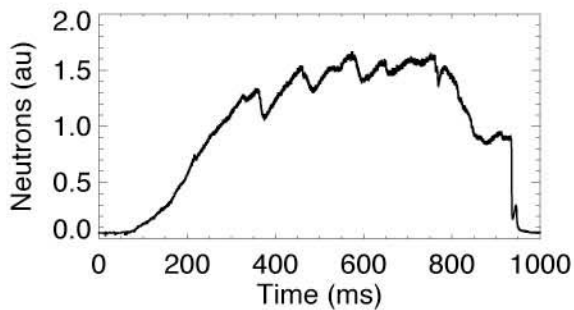
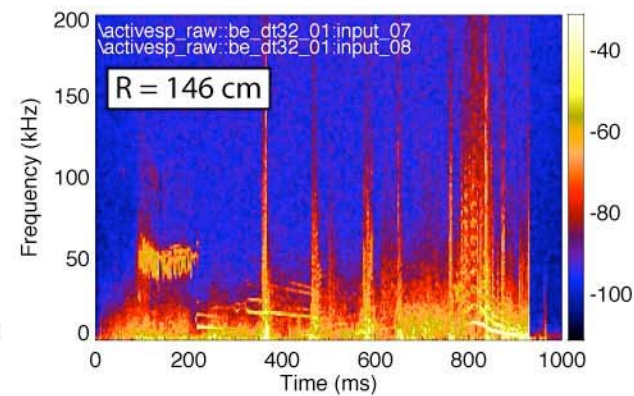
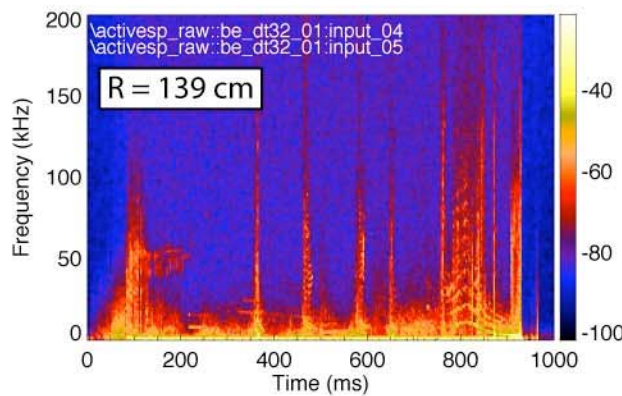
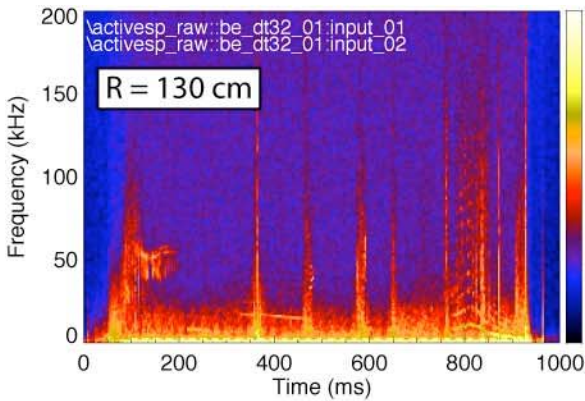
138756 XP1002 Vlad S.

Fluctuation amplitudes increase when rotation slows (2)



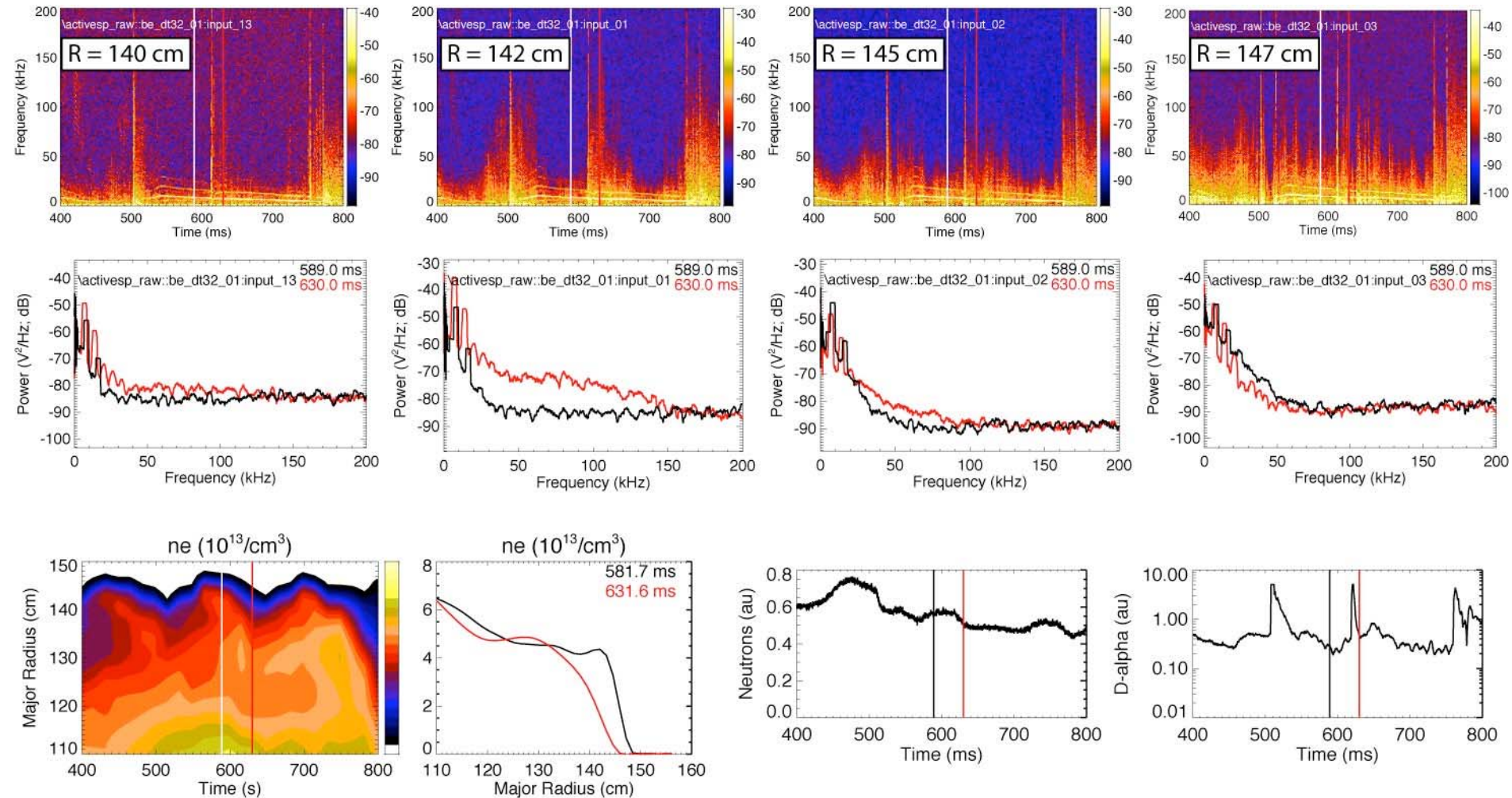
138754 XP1002 Vlad S.

Fluctuations increase during ELMs (1)



138553 XP1043 Maingi

Fluctuations increase after ELMs (2)

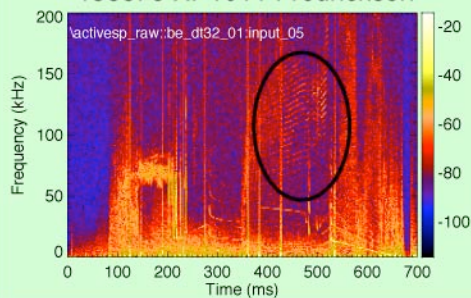


138805 XP1031 Sabbagh

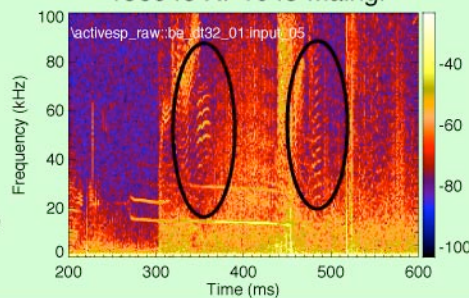
Harmonic features up to 150 kHz observed after ELMs; features not apparent (or barely apparent) in magnetics

BES measurements

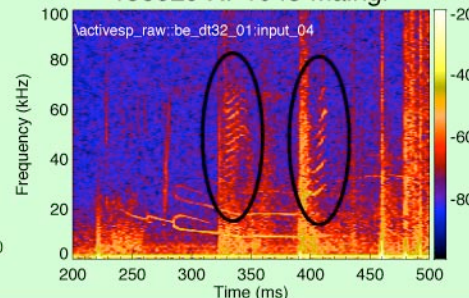
138875 XP1011 Fredrickson



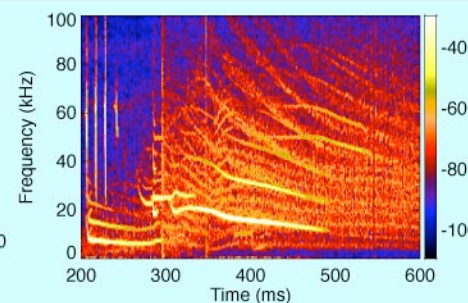
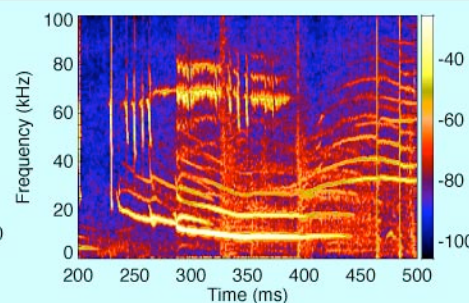
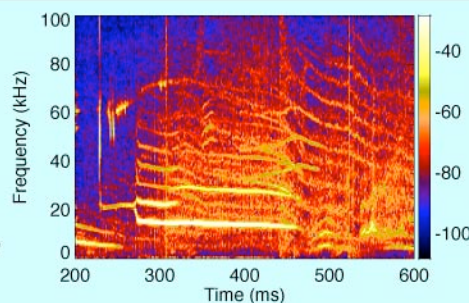
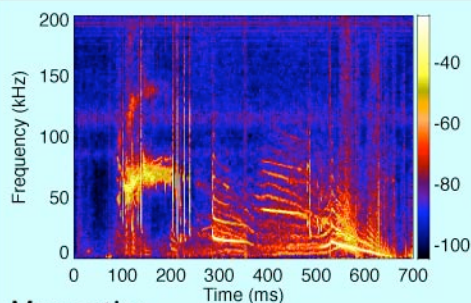
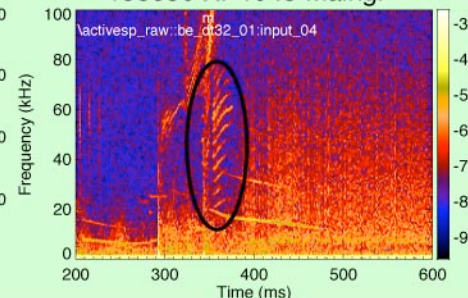
138543 XP1043 Maingi



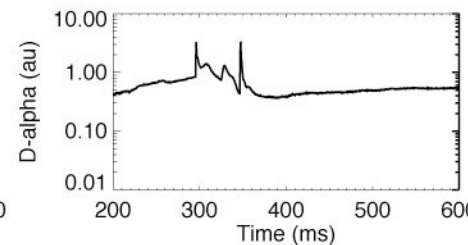
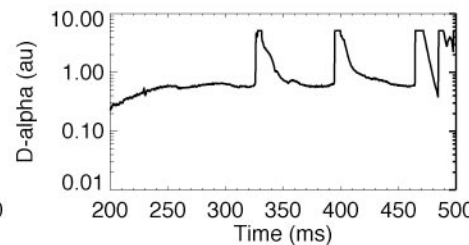
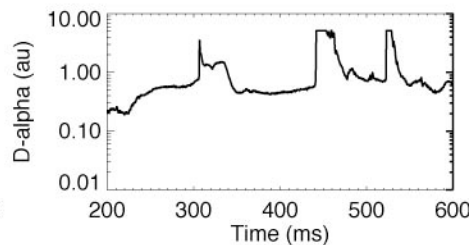
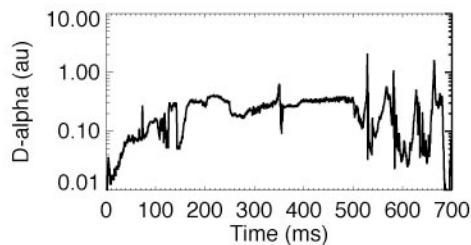
138529 XP1043 Maingi



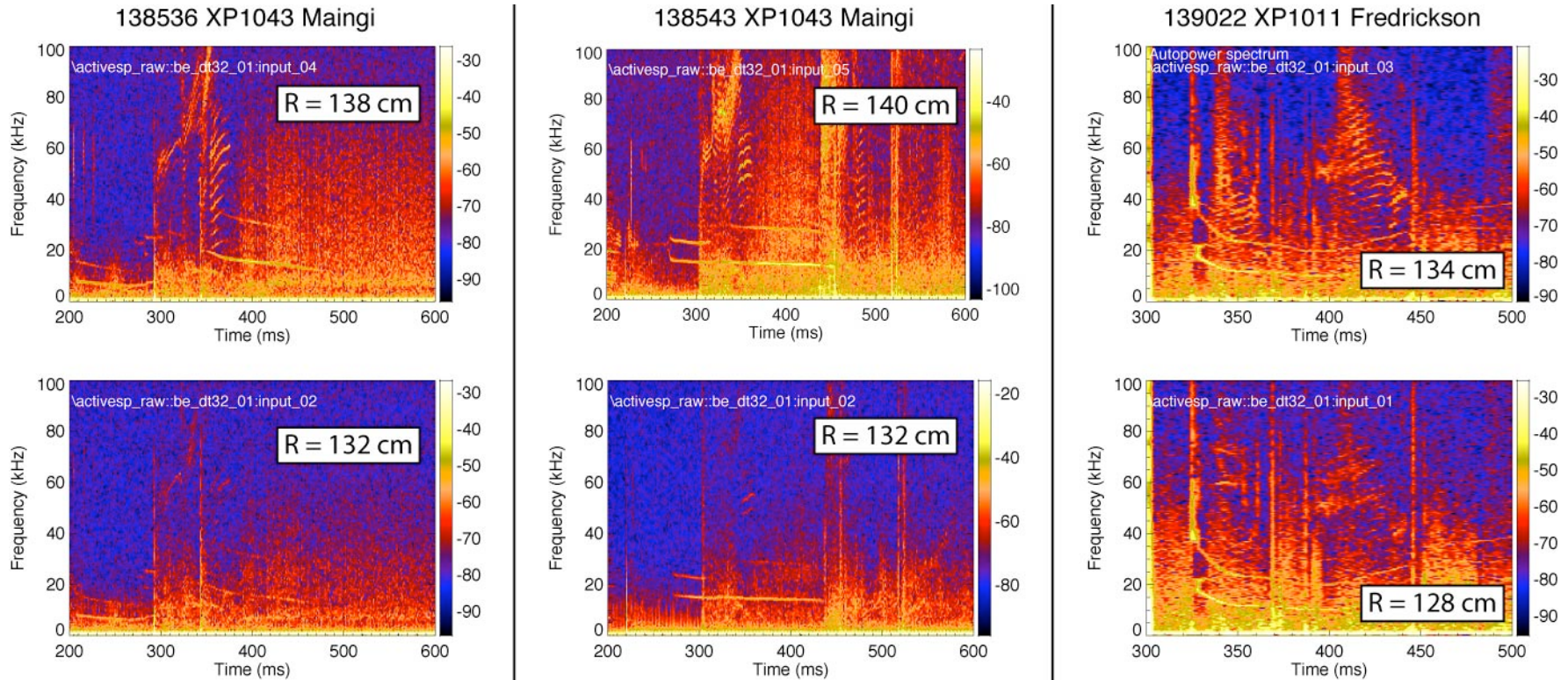
138536 XP1043 Maingi



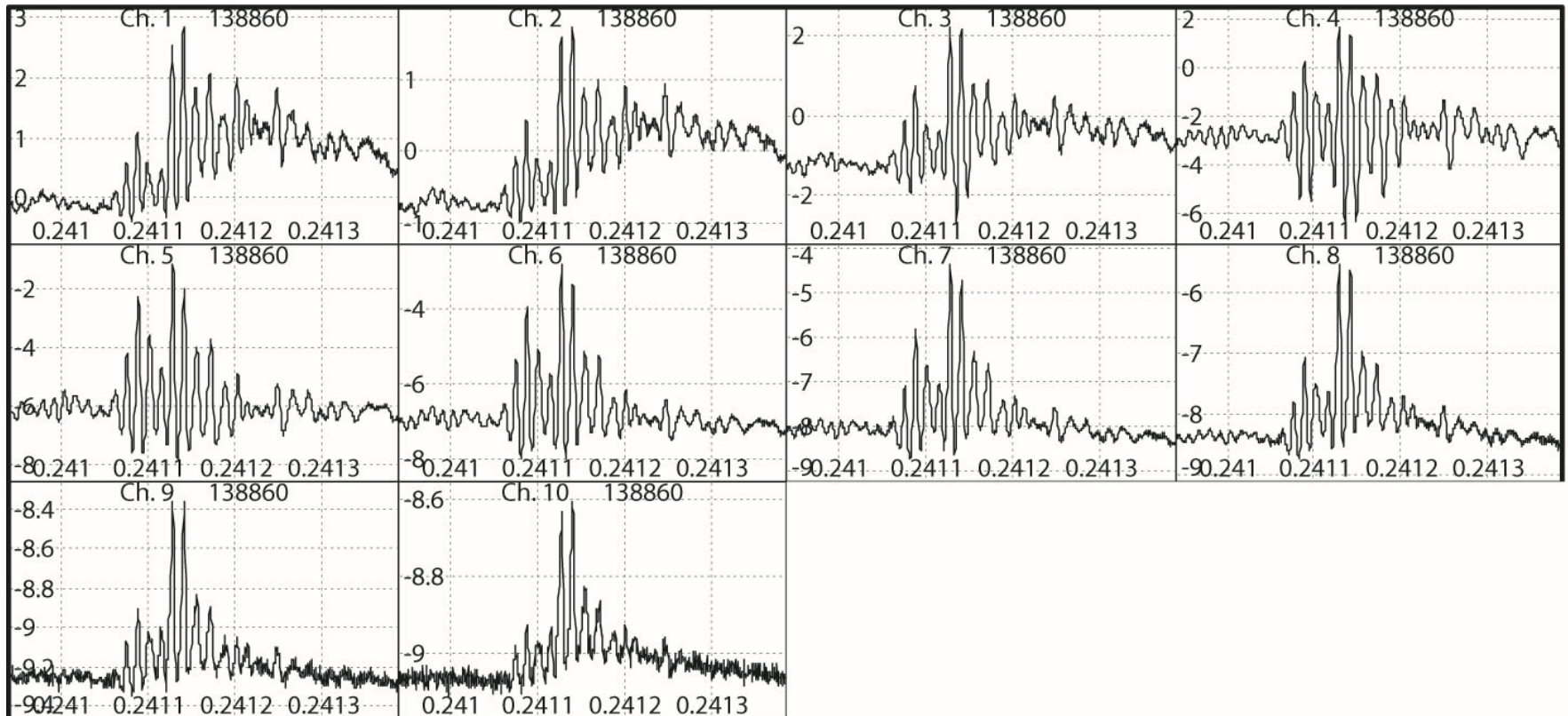
Magnetics



Post-ELM harmonic features are radially localized



TAEs can be observed from R = 128-152 cm



Several upcoming XPs require or desire BES measurements

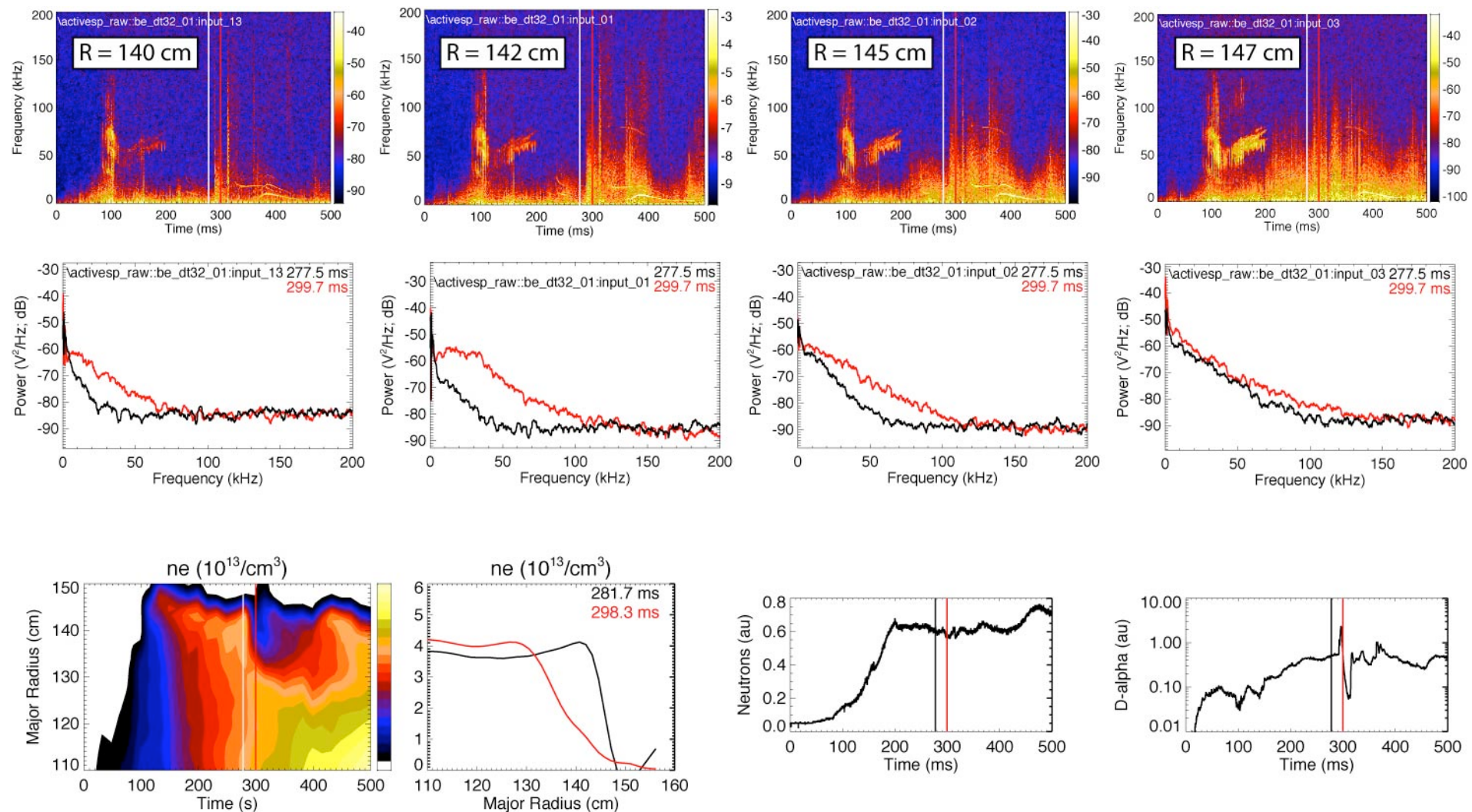
- Require BES measurements
 - XP1038 Smith, multi-scale turbulence
 - XP936 Kaye, rotation impact on energy and momentum
 - XP1013 Tritz, *AE induced electron transport
 - XP1011 Fredrickson, TAE avalanche
 - Fu, M3D-K validation for TAEs
- Desire BES measurements
 - XP1037 Ren, high-k parametric dependence
 - XP1039 Kubota, ohmic H-mode
 - XP1040 Yuh, RS ITBs
 - XP1036 Battaglia, P_{LH} in D and He using RF
 - XP1041 R. Bell, poloidal rotation in NSTX/DIII-D
 - XP1014 Heidbrink, anglefish
 - Canik, disappearing ELMs

Summary

- BES system has been commissioned with 16 channels
 - R130 shutter does not operate reliably
 - Bay F Litter presently limits BES operation
- 3-10 V signals are consistent with design expectations
 - Signals well above e-noise
- 16 additional channels (32 total) will be online soon
 - I. Uzun-Kaymak from UW-Madison will visit PPPL beginning next week to help incorporate additional channels
- DAQ exhibits ~3 ms drift due to internal clock
- Initial measurements show...
 - H-mode transitions and back-transitions
 - Broadband fluctuations
 - ELMs and post-ELM harmonic features
 - Rotation impact on turbulence
 - TAEs

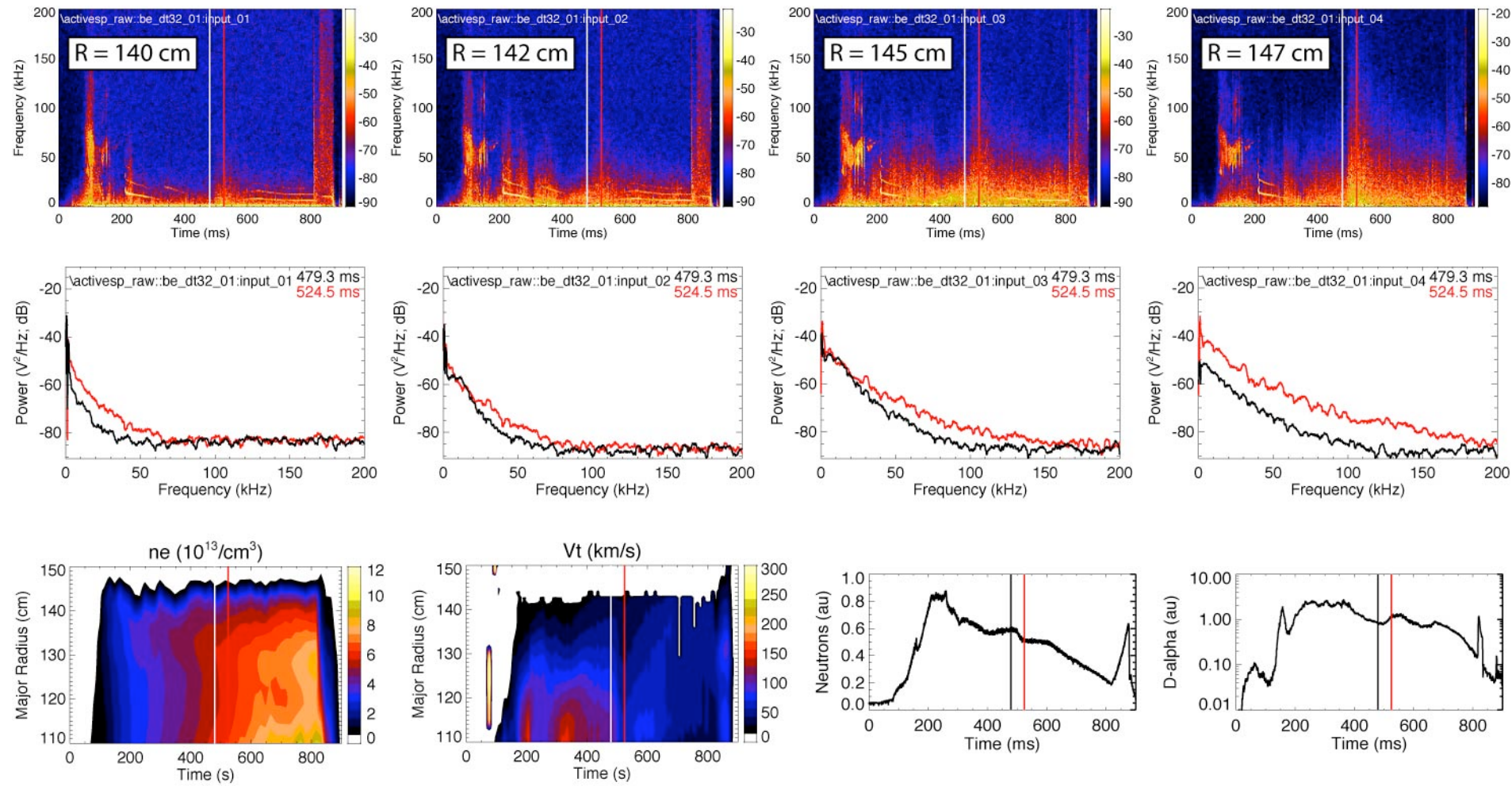
Backup slides

Fluctuation amplitudes increase at HL back-transition (2)



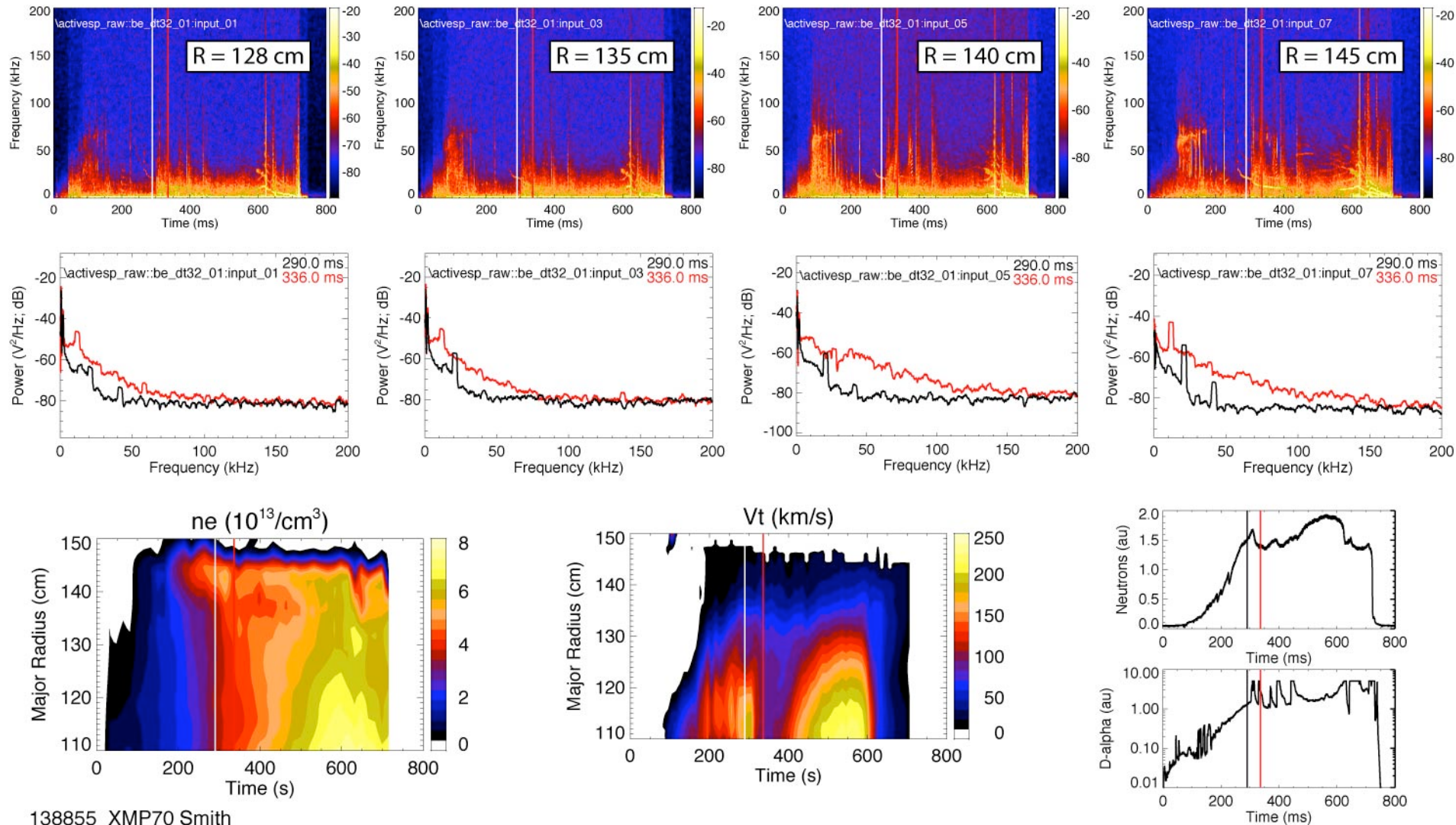
138805 XP1031 Sabbagh

Fluctuation amplitudes increase when rotation slows (3)



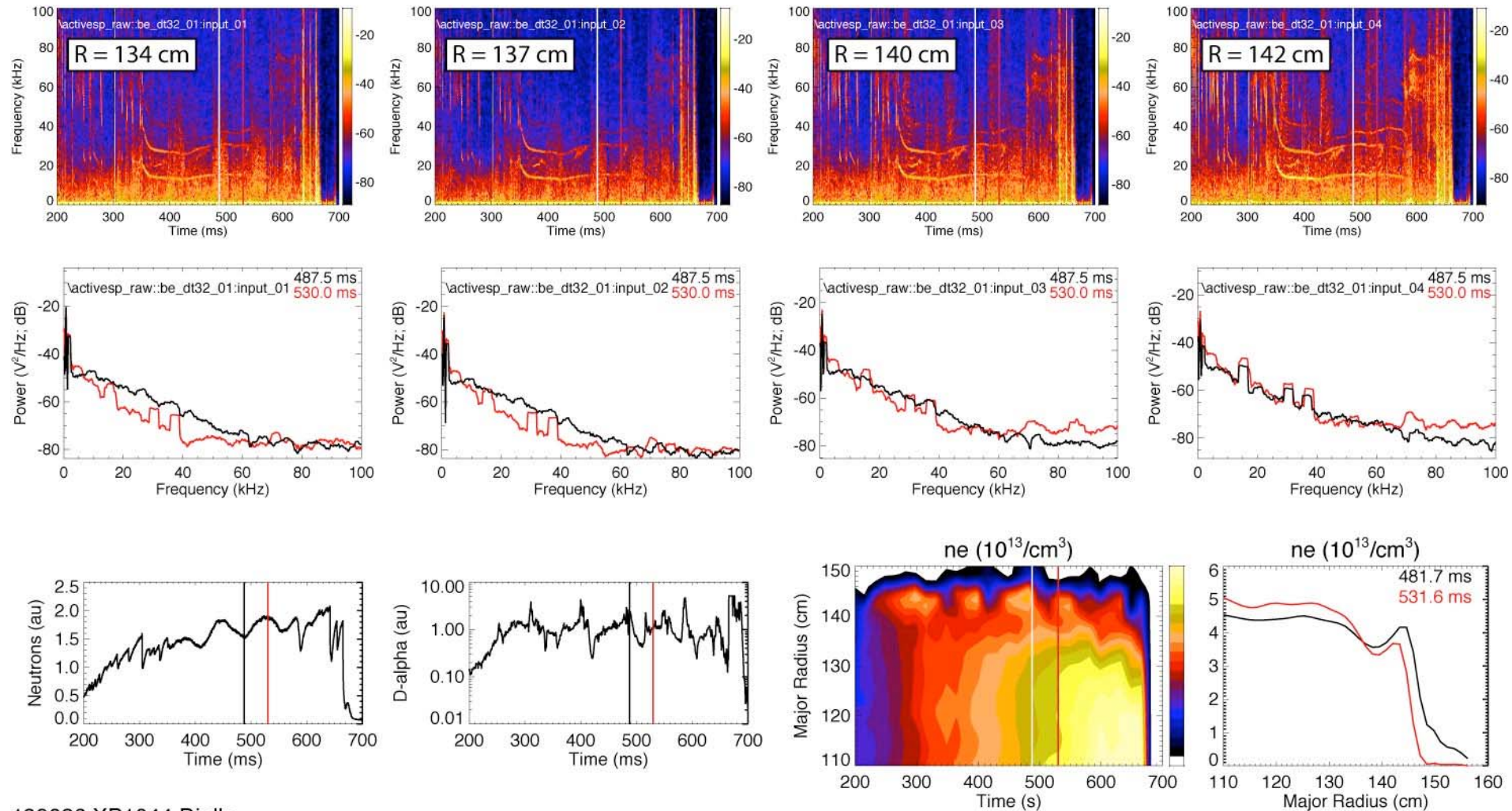
139494 XP1045 Vald S.

Fluctuation amplitudes increase when rotation slows (4)



138855 XMP70 Smith

Fluctuations increase after ELMs (3)



139026 XP1044 Diallo