



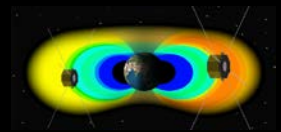
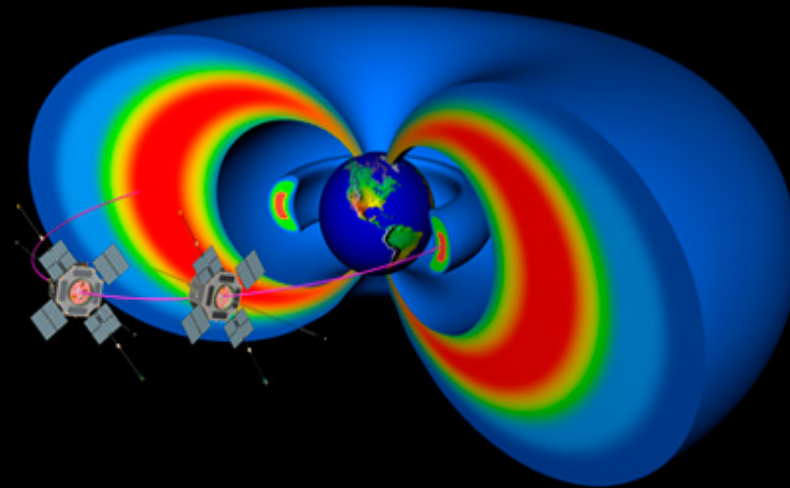
# Chorus Element Properties: Statistics of From Automated Chorus Detection

C. A. Kletzing

A. Sen Gupta

I. Christopher

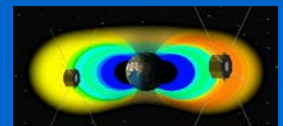
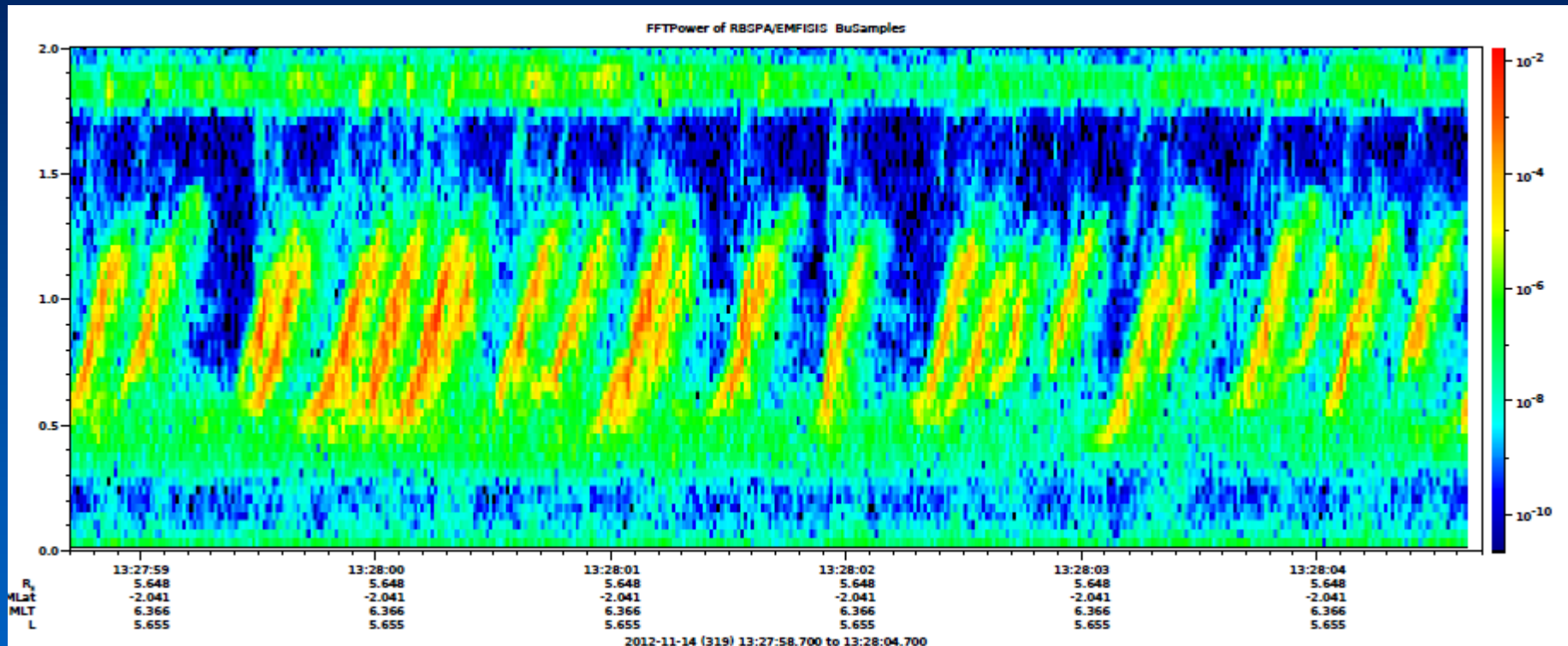
*The University of Iowa*





# The Problem: Element Properties

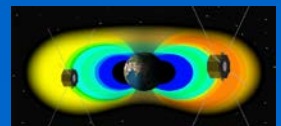
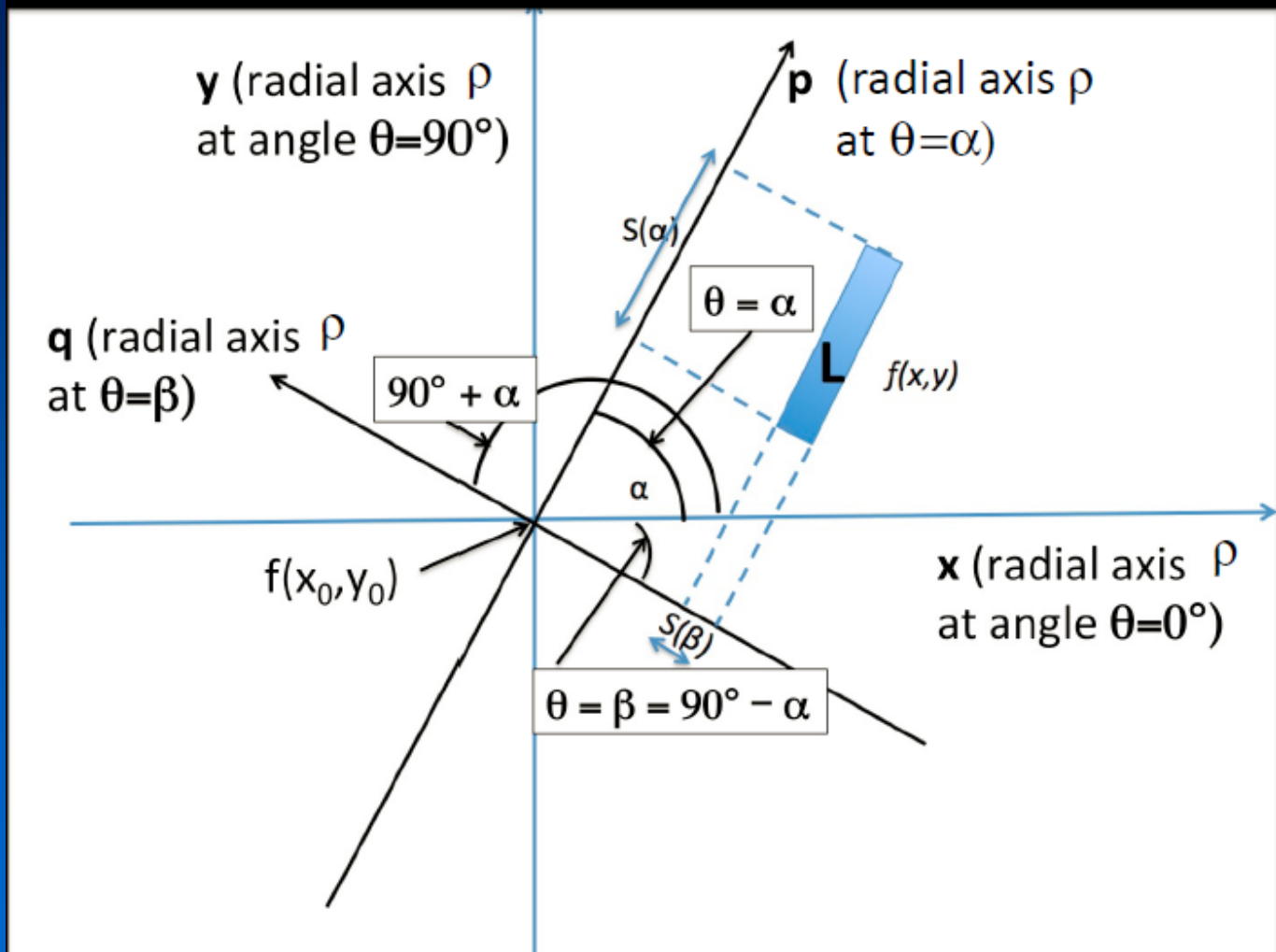
Humans can pick out chorus elements, but not so easy for a computer





# Radon Transform

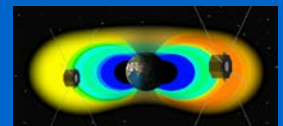
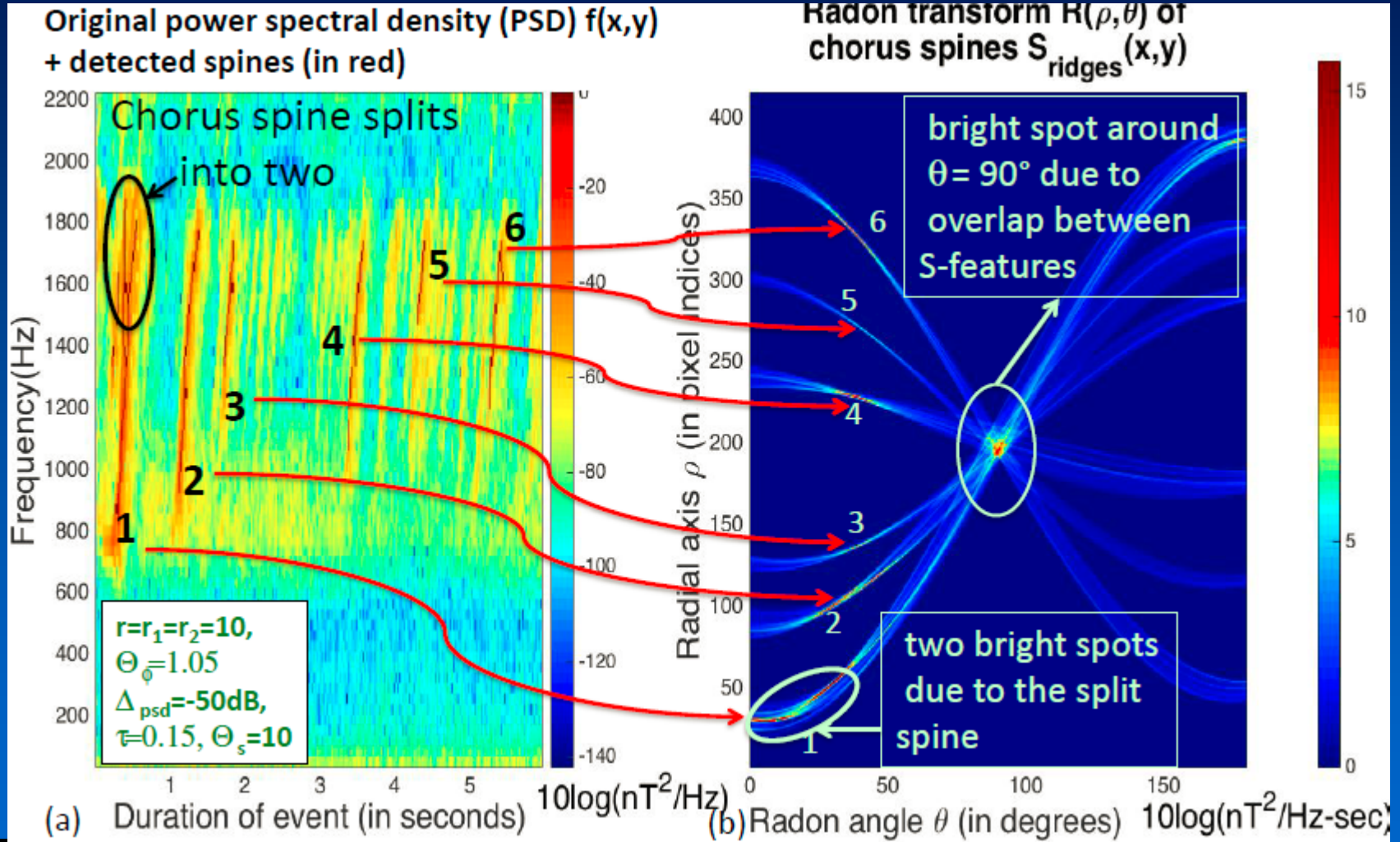
Signal processing technique enables new science





# Elements in Radon Space

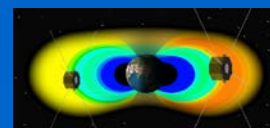
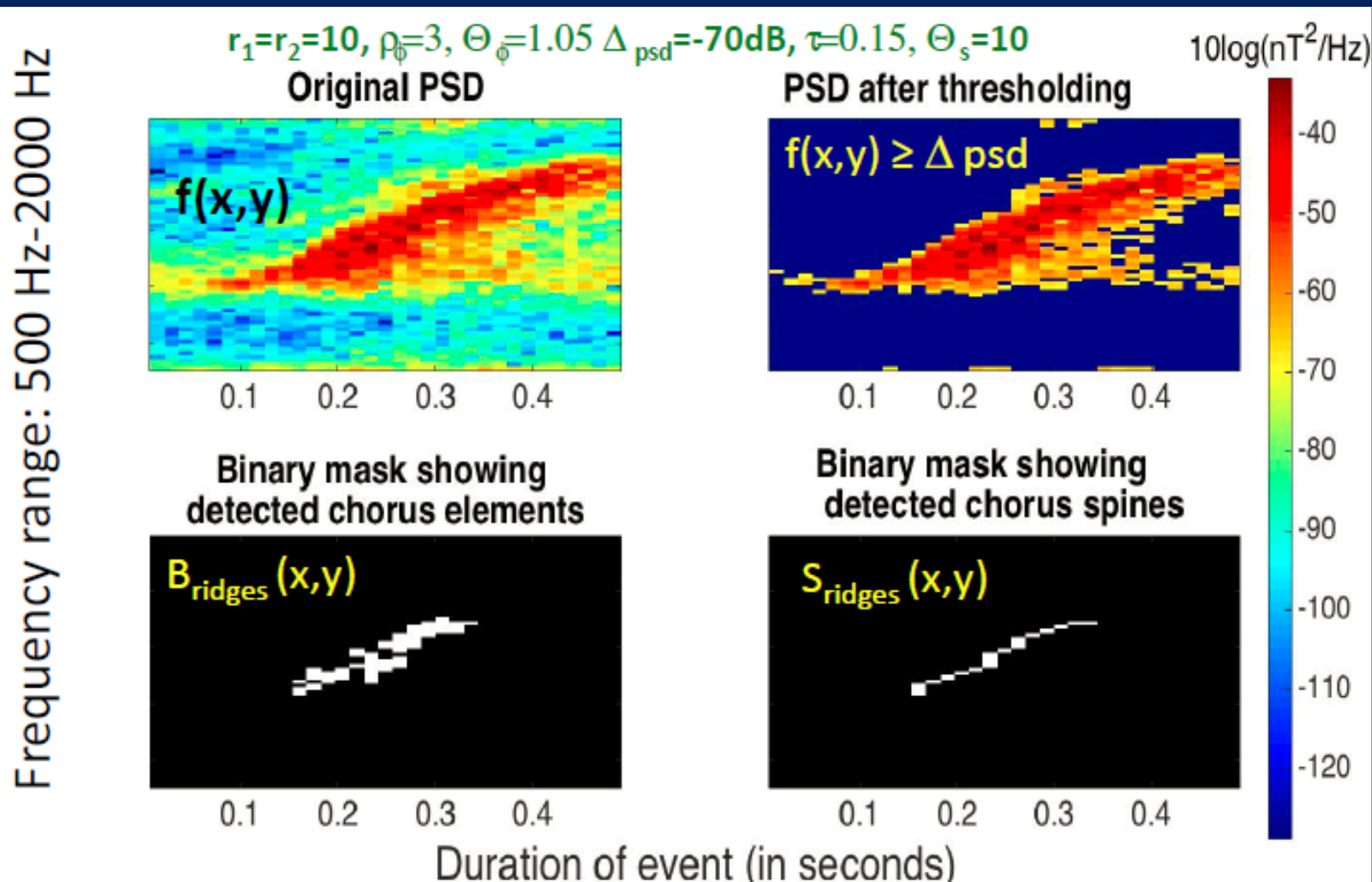
Automated techniques allow statistical properties to be analyzed





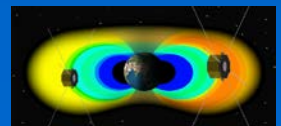
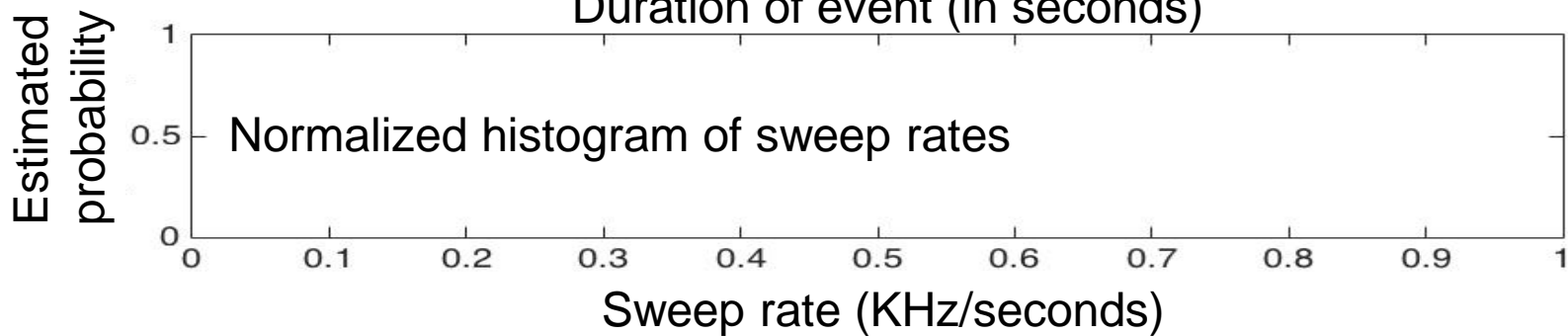
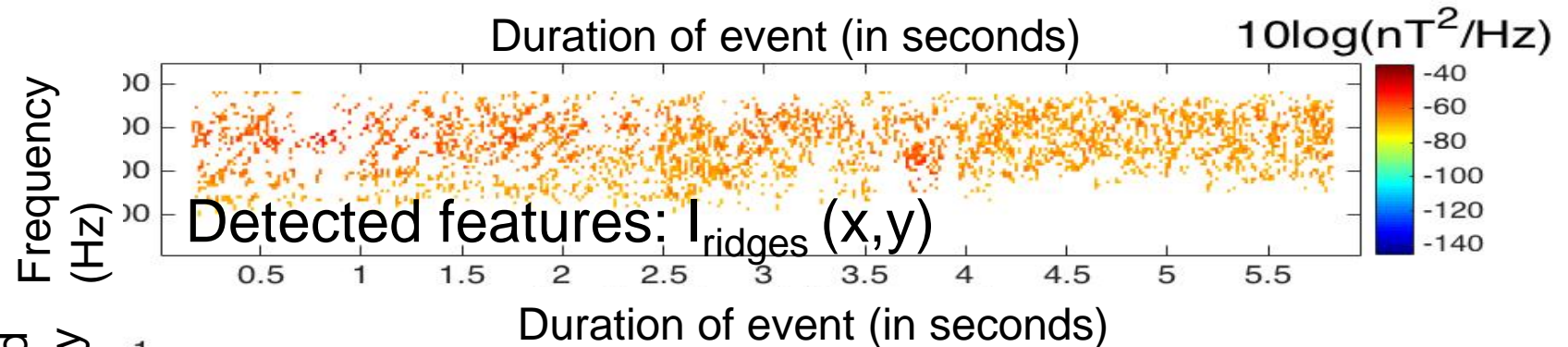
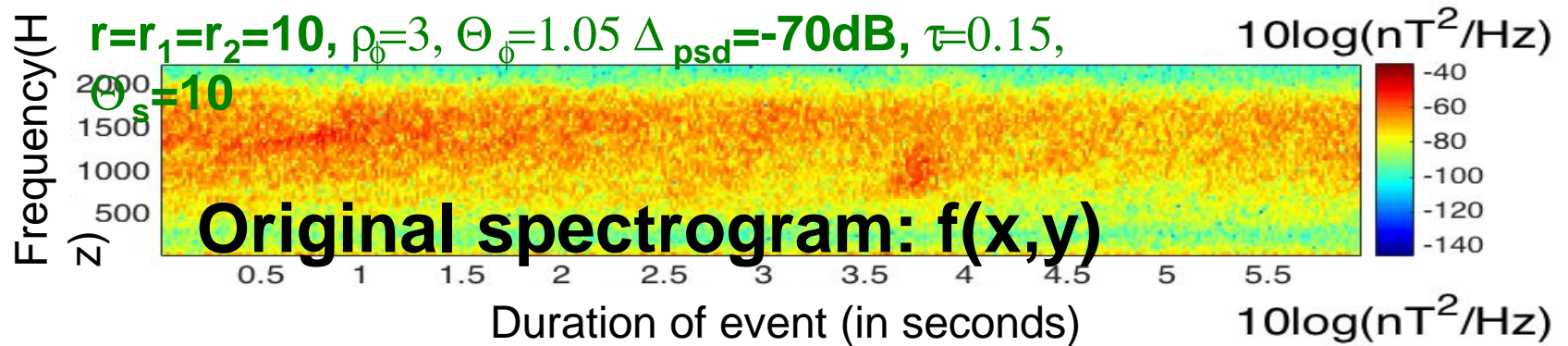
# Chorus Element Identification

Automated techniques allow statistical properties to be analyzed



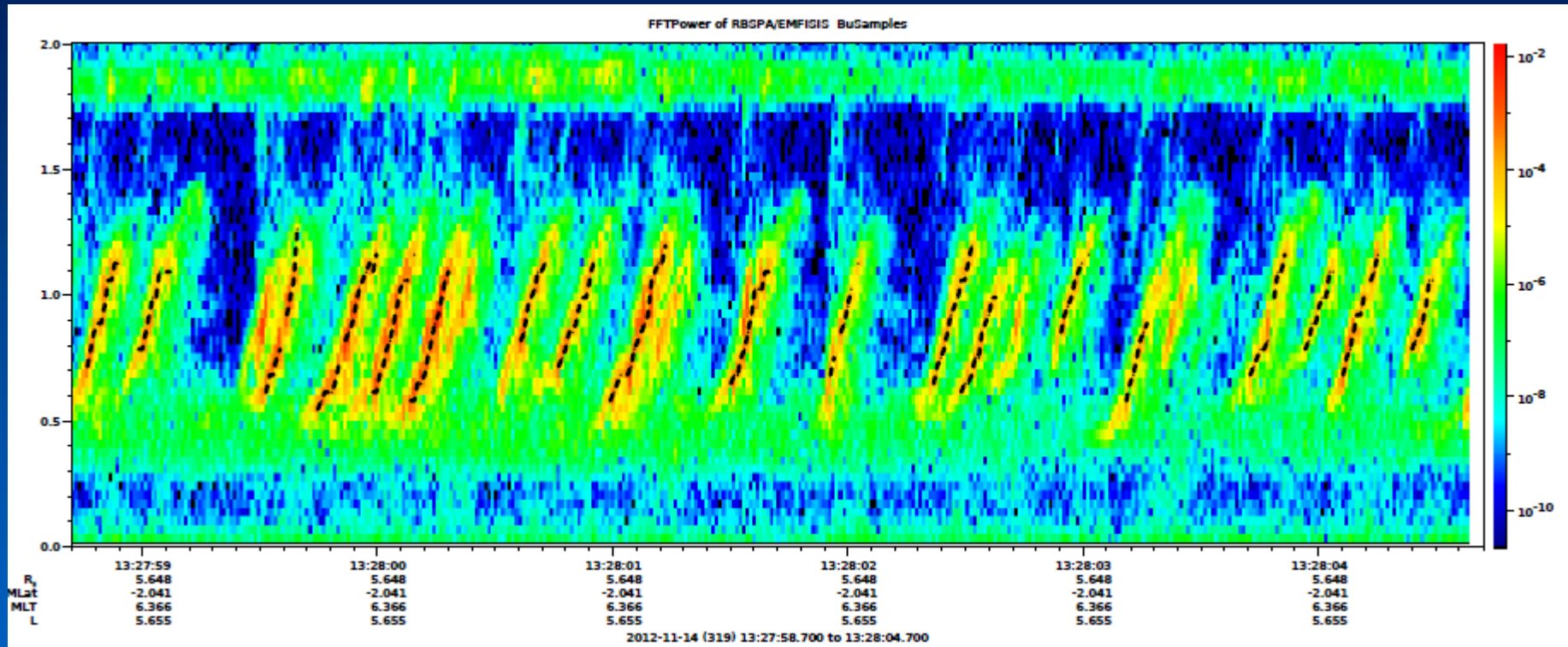


# Null Case – No Detection

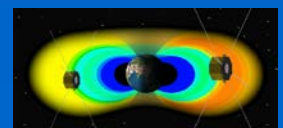




# Chorus Traces

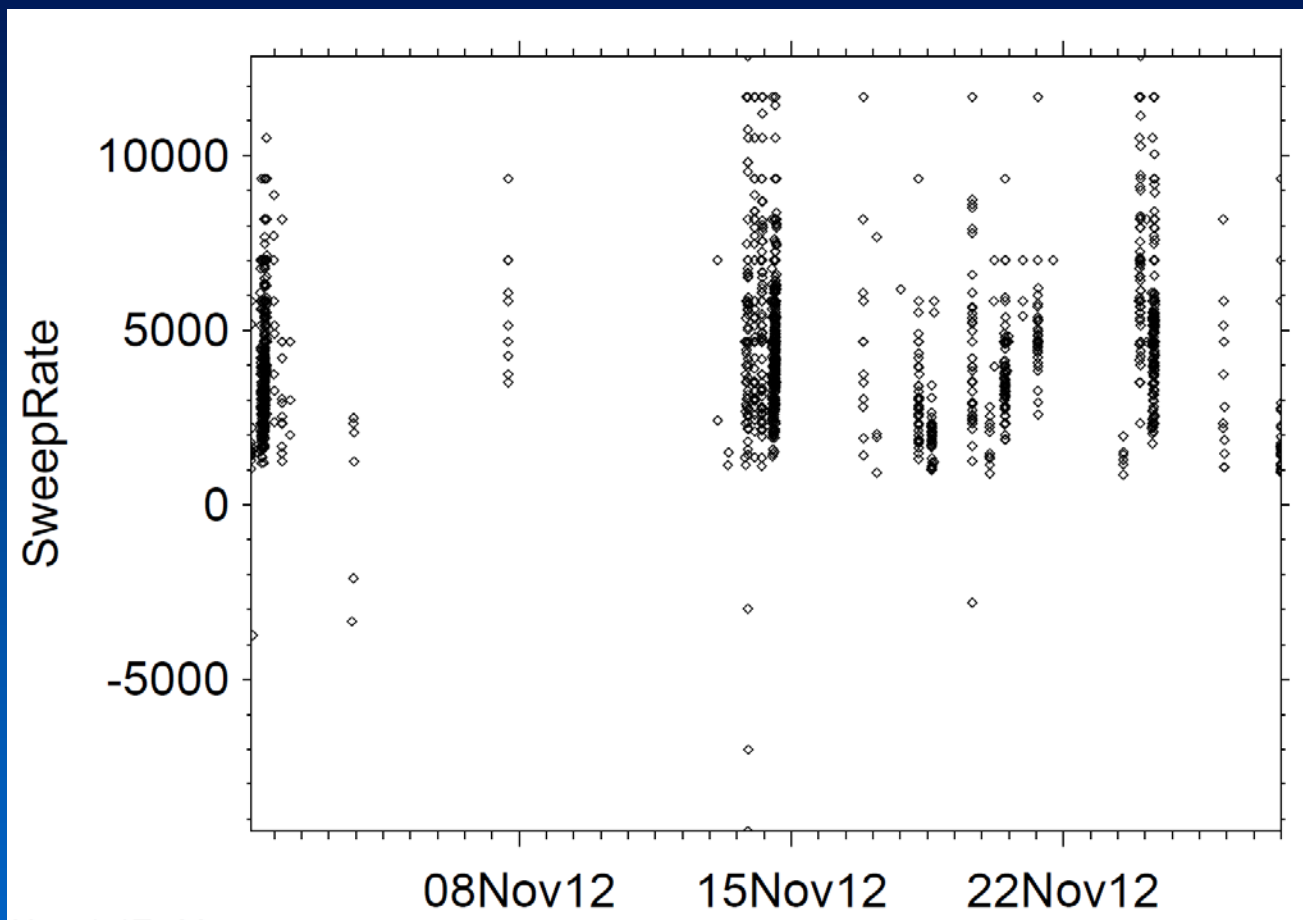


- The algorithm successfully identifies chorus.
- Error rate is less than 2.5%

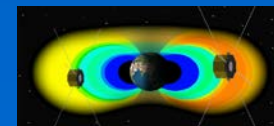




# Sweep Rates During November 2012



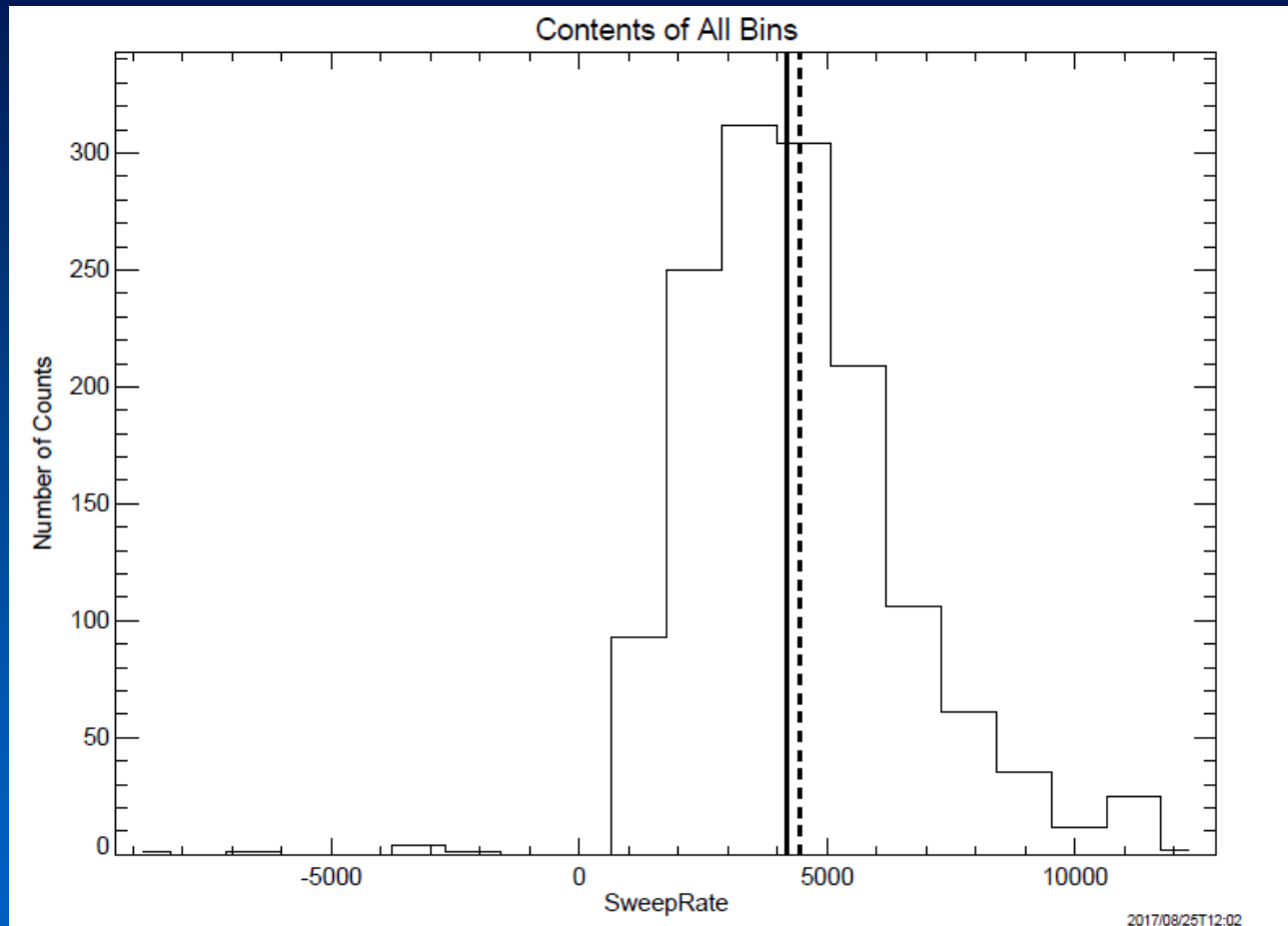
- Sweep rate can vary widely for a given orbit



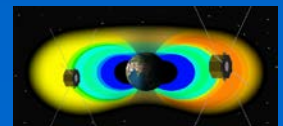




# Sweep Rate Histogram

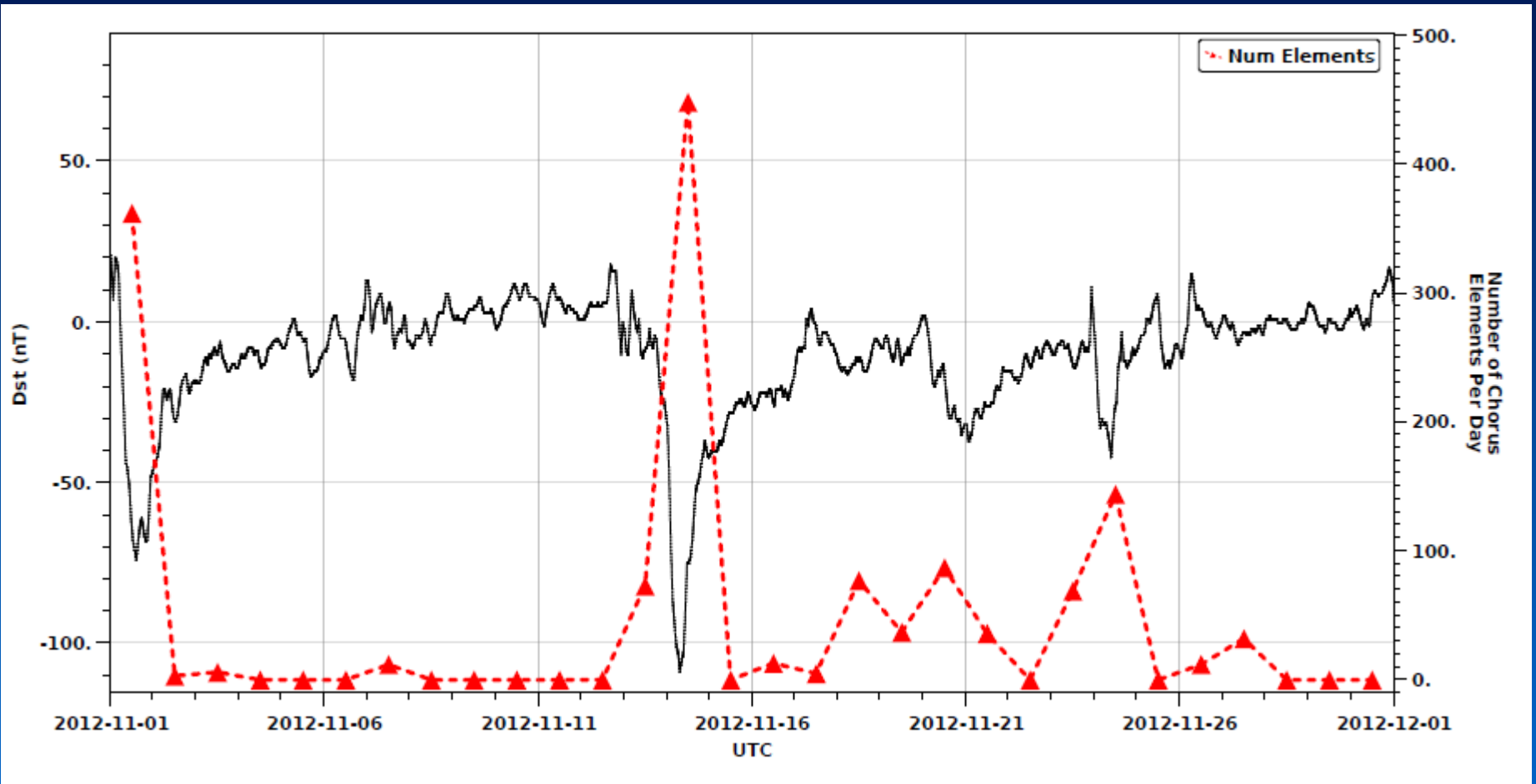


- Sweep rate distribution peaks around 4 Khz/s..
- Consistent with past results

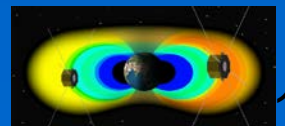




# November 2012: Chorus vs. Dst



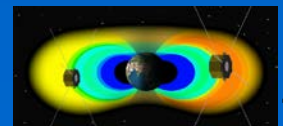
- The comparison with Dst is quite good.





# Larger Sruvey

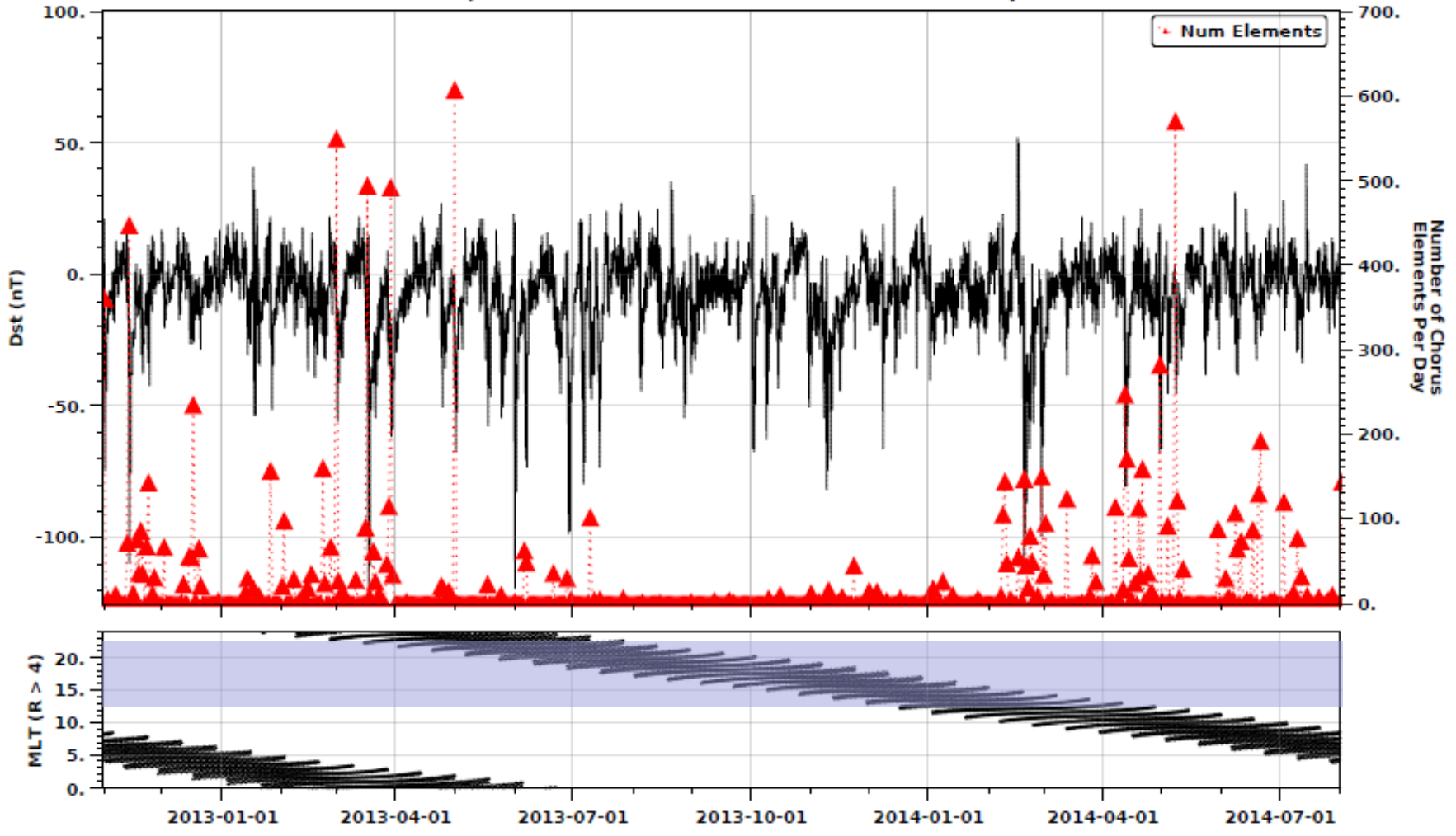
- Analyzed November 2102 to August 2014 on RBSPA.
- Provides on full sweep of MLT.
- Traces of each chorus element are saved to file
- Determine sweep rate and spectral density along the chorus trace.
- Caveats:
  - Thresholding gives priority to larger amplitude chorus, typically spectral densities greater than  $1e-5$  nT<sup>2</sup>/Hz.
  - While null results are small, many elements are missed.



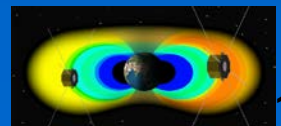


# Nov 2012- Aug 2014: Chorus vs. Dst

Comparison of Dst with Number of Chorus Elements Per Day

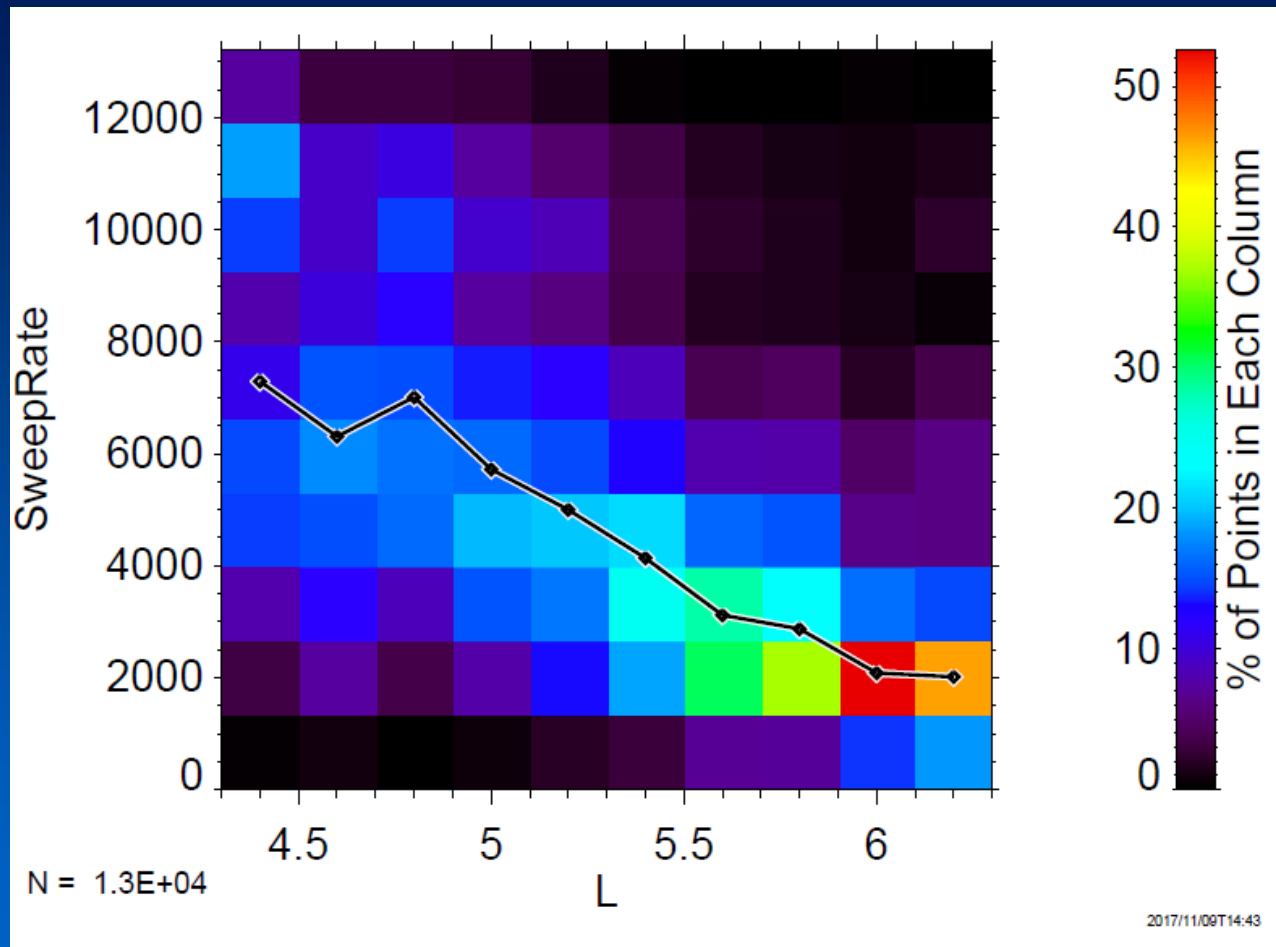


Comparison with Dst depends on MLT.

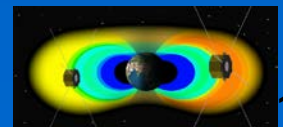




# Chorus Sweep Rate vs. L



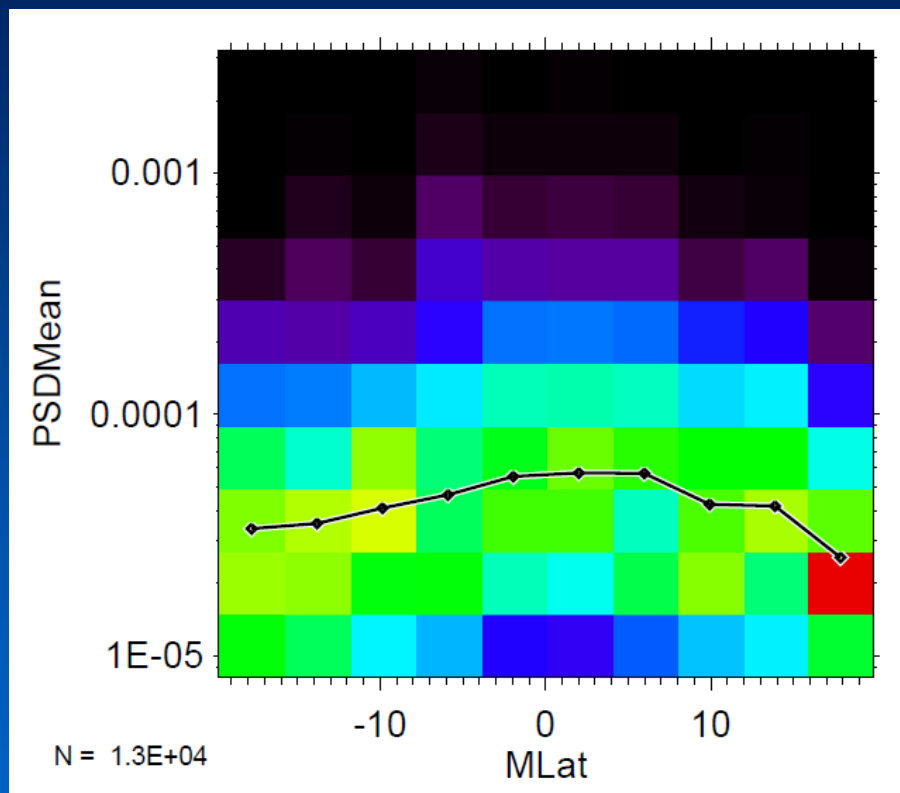
- Sweep rate decreases with increasing L.



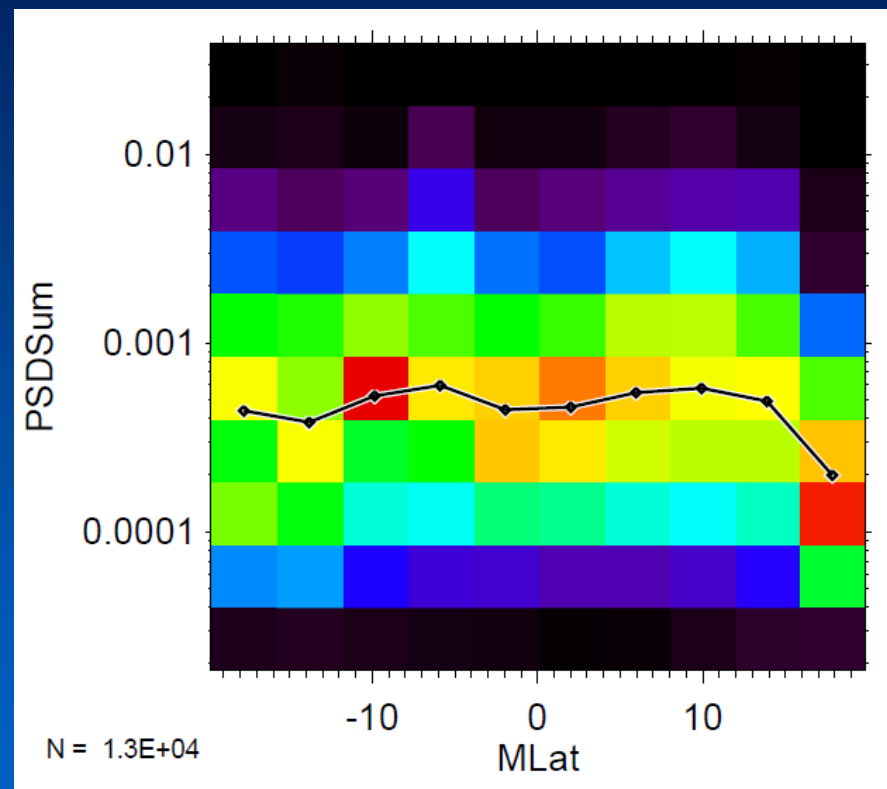


# Chorus Spectral Density vs. MLat

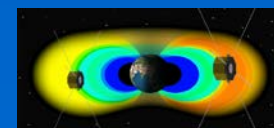
## Mean



## Sum



- Weak trend shows *decrease* in power moving away from the equator.

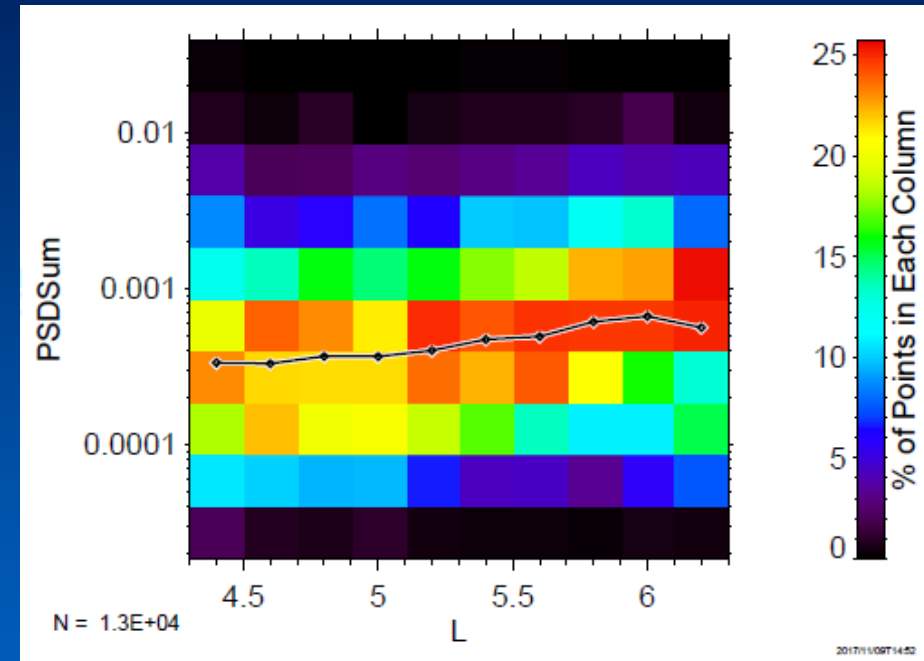
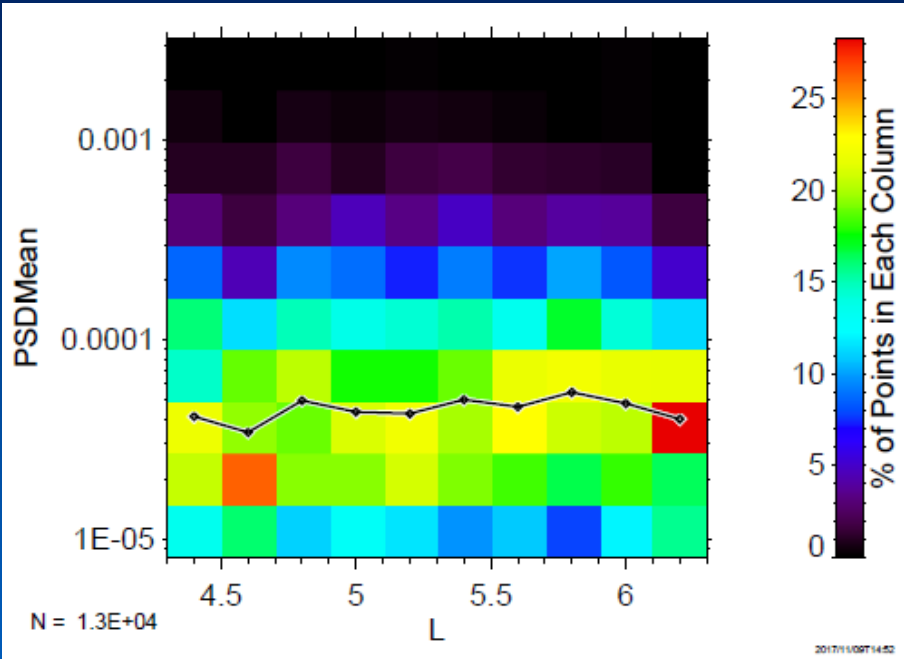




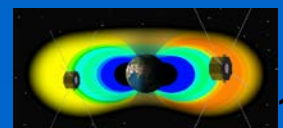
# Spectral Density vs. L

## Mean

## Sum

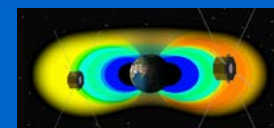
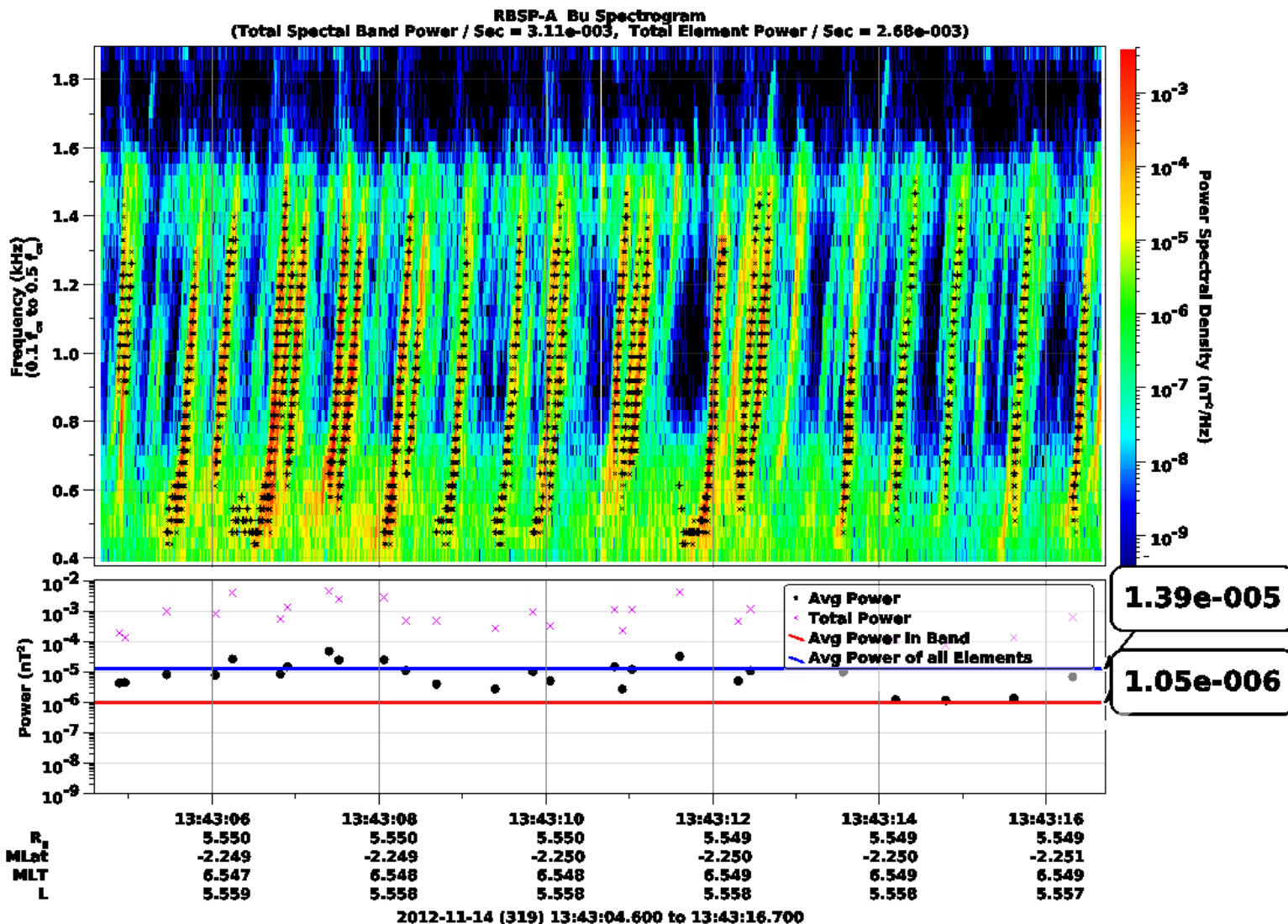


- Somewhat larger spectral density for total power of a chorus element, but mean power show no trend.





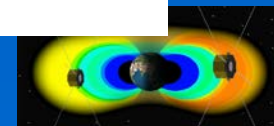
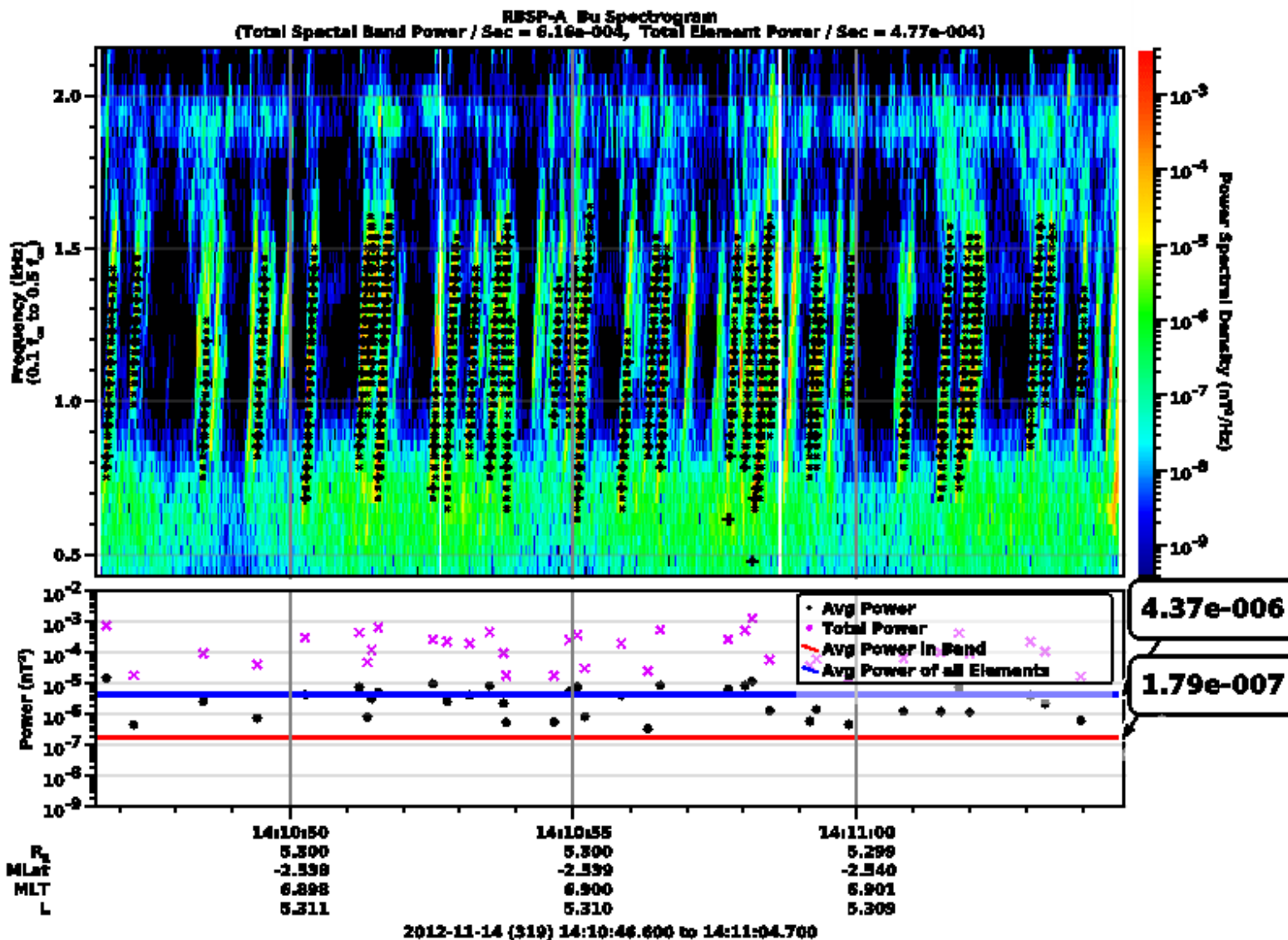
# Chorus Power: Elements vs. Band





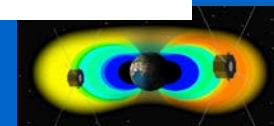
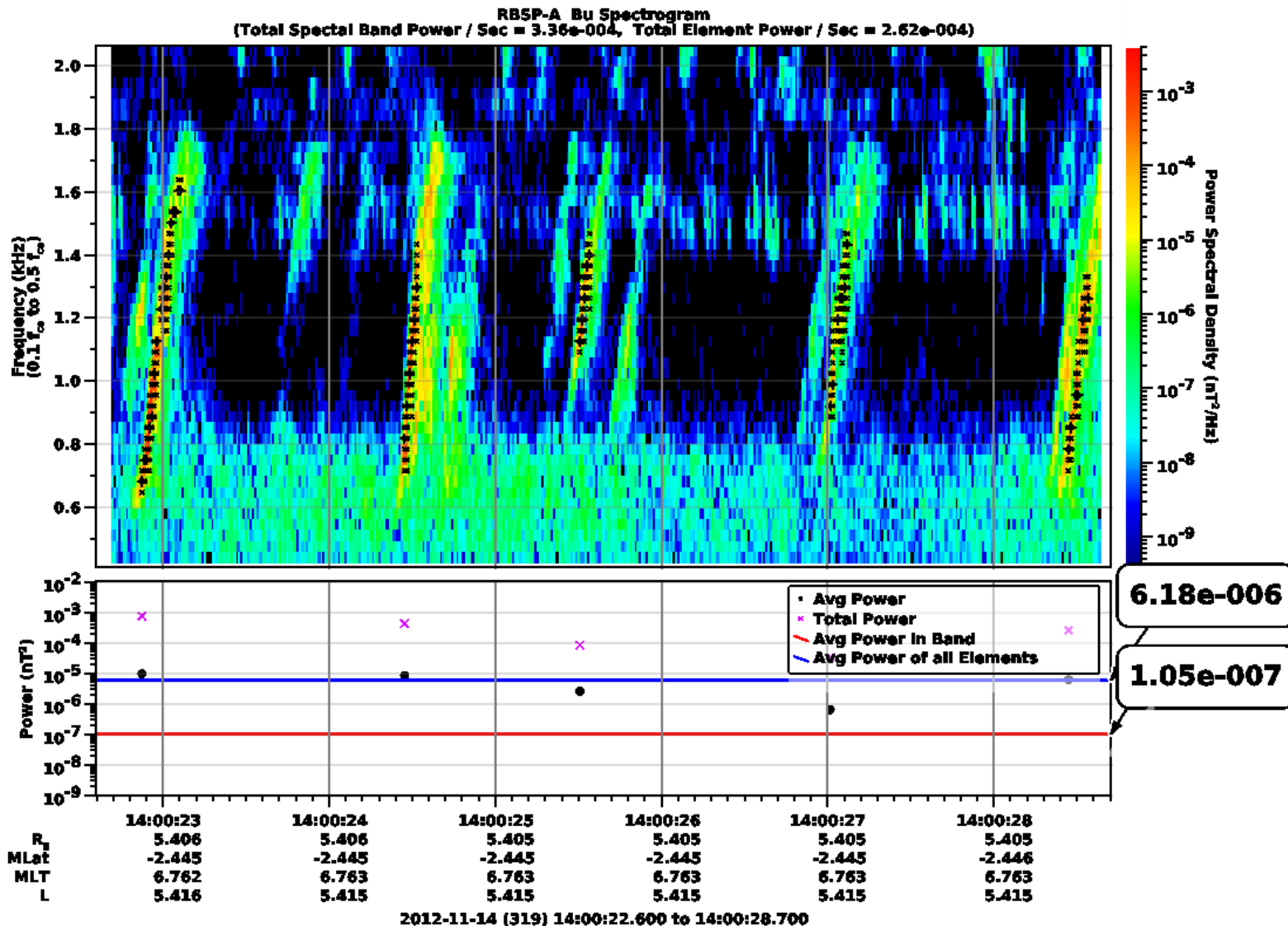


# Chorus Power: Elements vs. Band



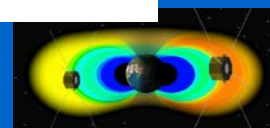
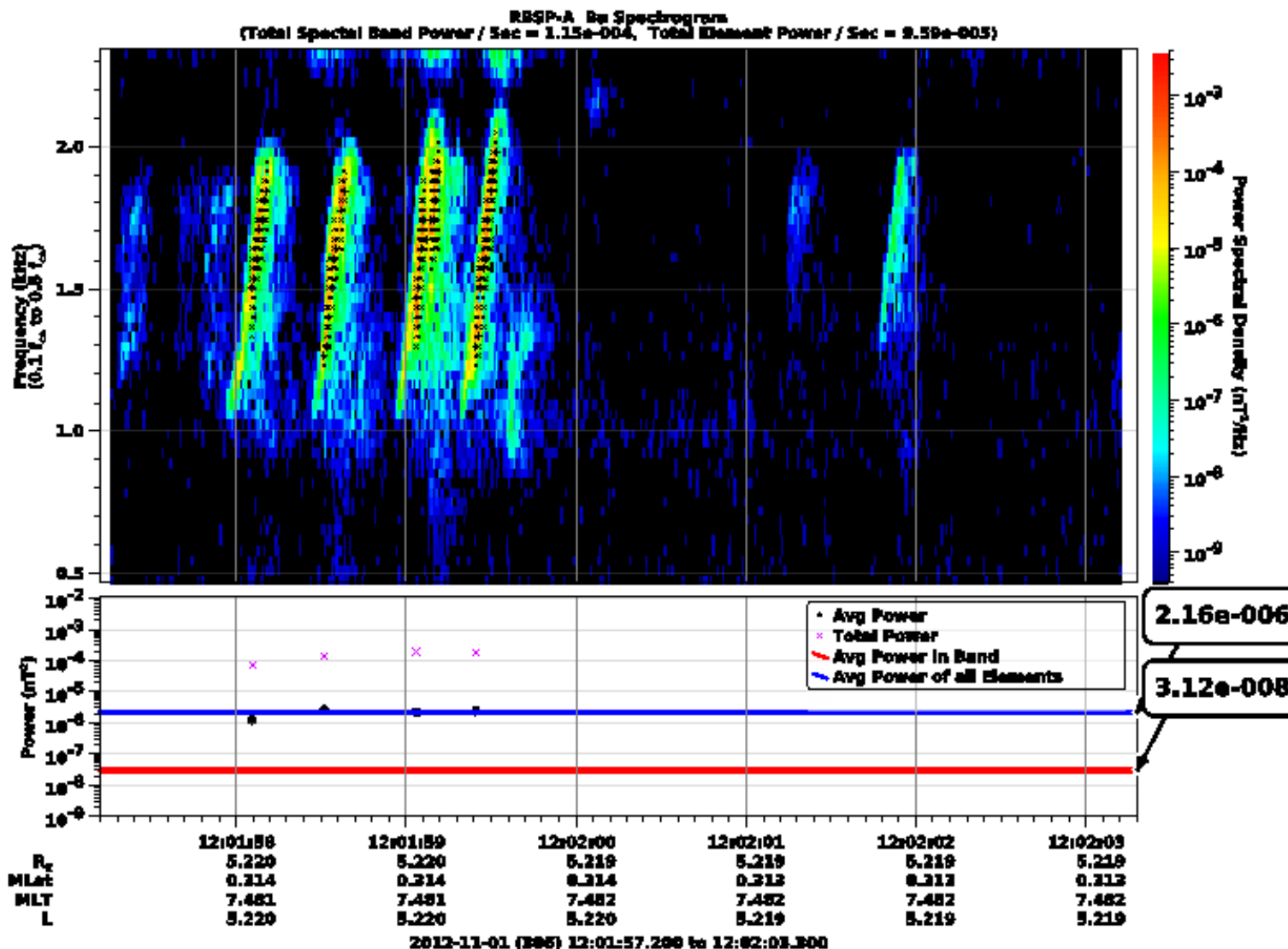


# Chorus Power: Elements vs. Band





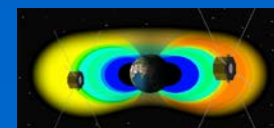
# Chorus Power: Elements vs. Band





# Chorus Power: Elements vs. Mean

Chorus	Band	Ratio
$1.4 \times 10^{-5}$	$1.0 \times 10^{-6}$	14
$4.4 \times 10^{-6}$	$1.8 \times 10^{-7}$	25
$6.2 \times 10^{-6}$	$1.1 \times 10^{-7}$	57
$2.2 \times 10^{-6}$	$3.2 \times 10^{-8}$	67





# Conclusions

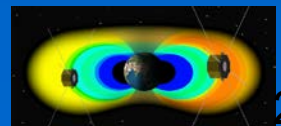
- Automated chorus element algorithm is working with a good error rate, allowing new types of studies of chorus
- Sweep rate of elements can be quite variable for a given orbit, but the peak of the distribution is 4-5 kHz/s.
- Sweep rate decreases with increasing L.
- Chorus elements correlate fairly well with Dst, but this also depends on MLT.
- No correlation of chorus spectral density and MLat.
- Element power can be 10-70x more than band average, but power in elements alone varies far less.



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**That's all folks!**



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