Multi-Spacecraft Observations of Whistler-Mode Wave-Particle Interactions: Temporal or Spatial Structures?

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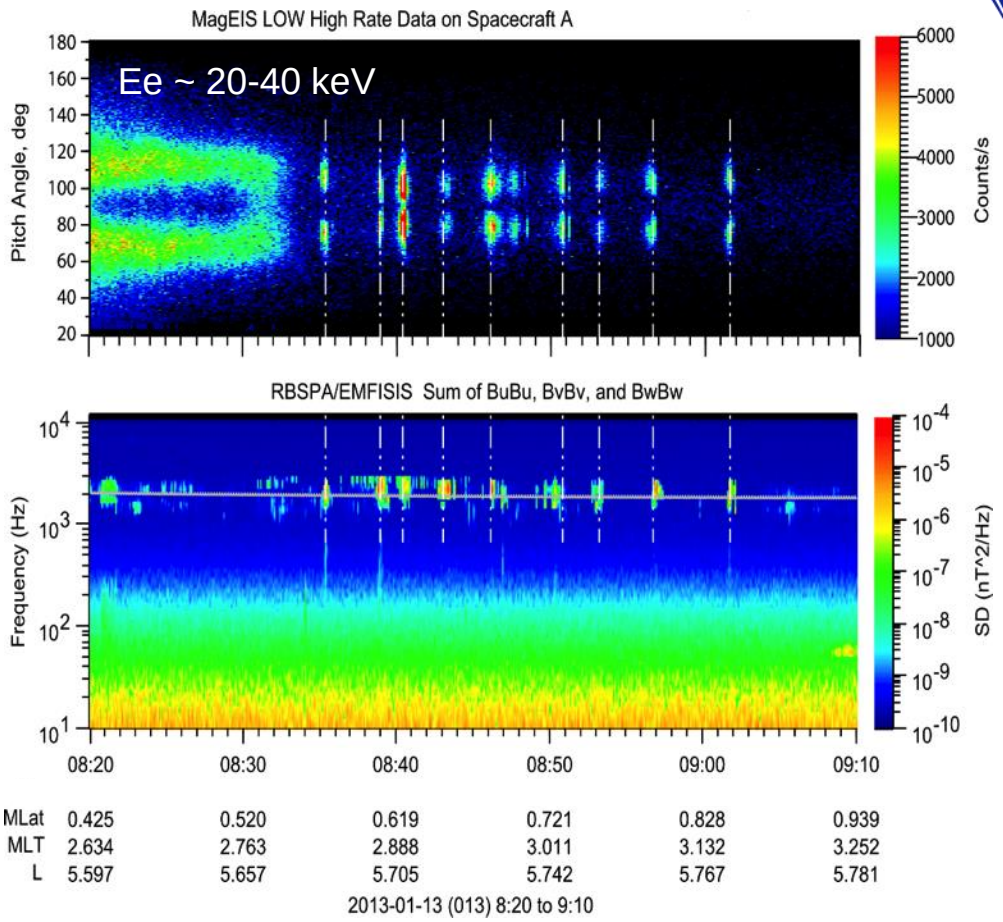
Wave-Particle Interaction Events

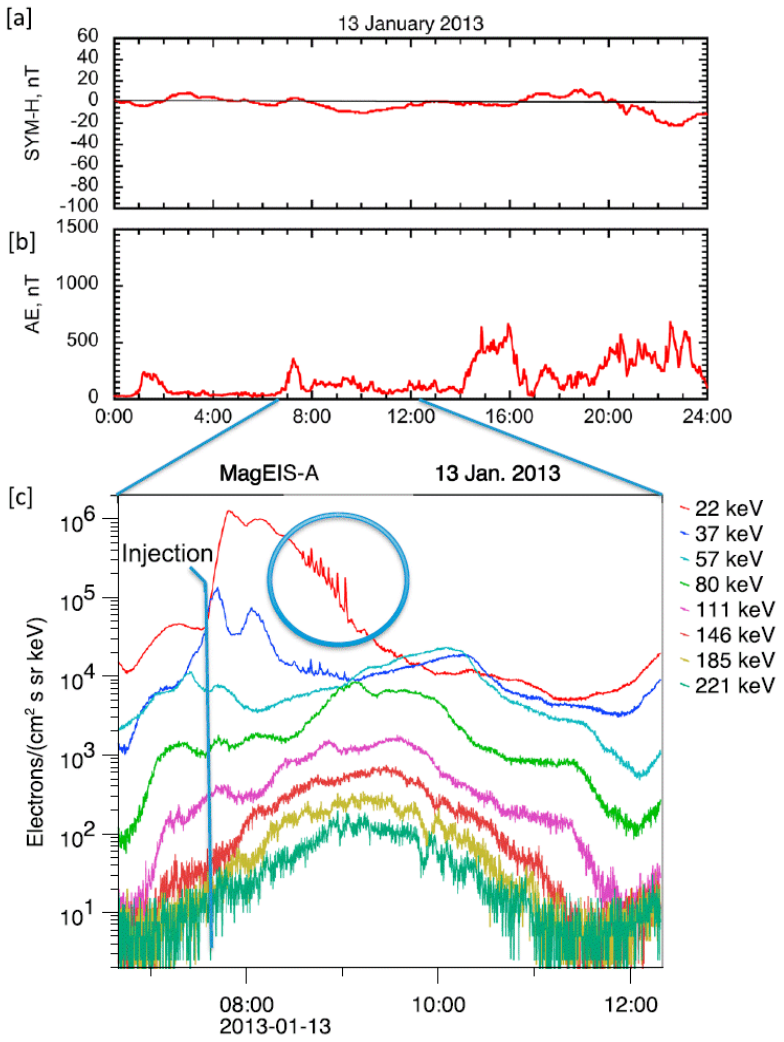
- MagEIS High-Res mode on Van Allen Probes provides electron angular distributions of 1000 samples every 12-s spin
- 20-40 keV fluxes show quasiperiodic bursts at 77º and 105º pitch angle
- Flux increases superposed on a trapped electron background population with a broad peak at 90º
- Flux bursts correlate with simultaneous bursts of whistler-mode upper-band chorus waves



Taken from Fennell et al. [2014]

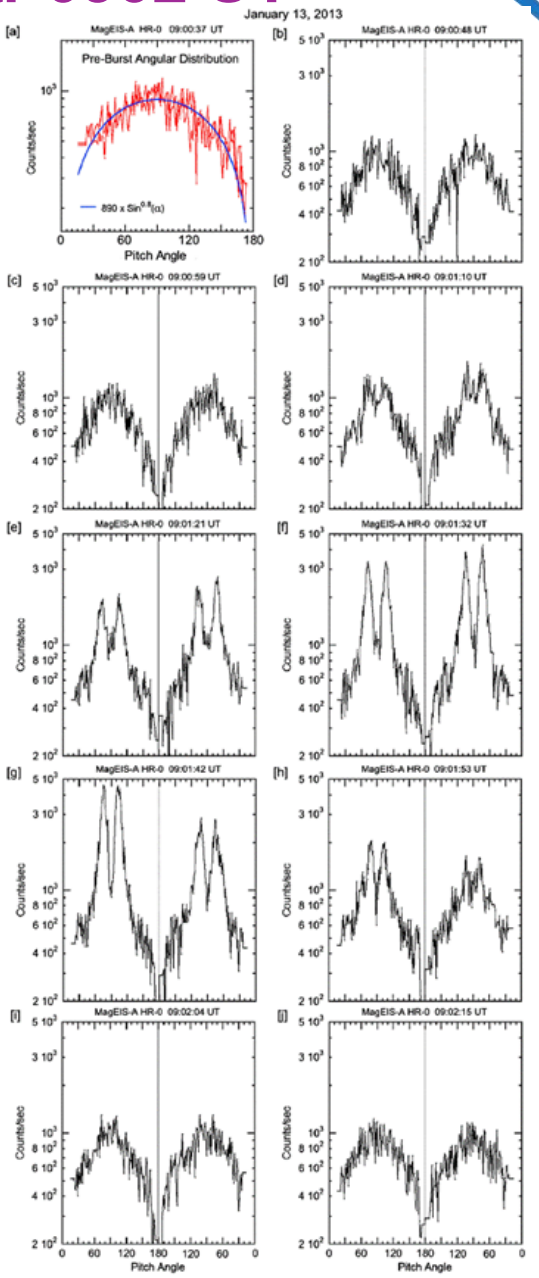
Variations of Plasma Injection Signature

- Bottom panel is a plot of MagEIS-A electron fluxes from selected channels for one orbit on the 13 January 2013
  - The period of interest is highlighted by the blue circle around the 22 keV electron flux
- A dispersive electron injection onset occurred at ~0730 UT
  - Top panel is SYM-H for January 2013
  - SYM-H ≥ -20 on day of interest
- A small AE increase started near 0730 UT in association with the electron injection
- AE had returned to <200 nT during event



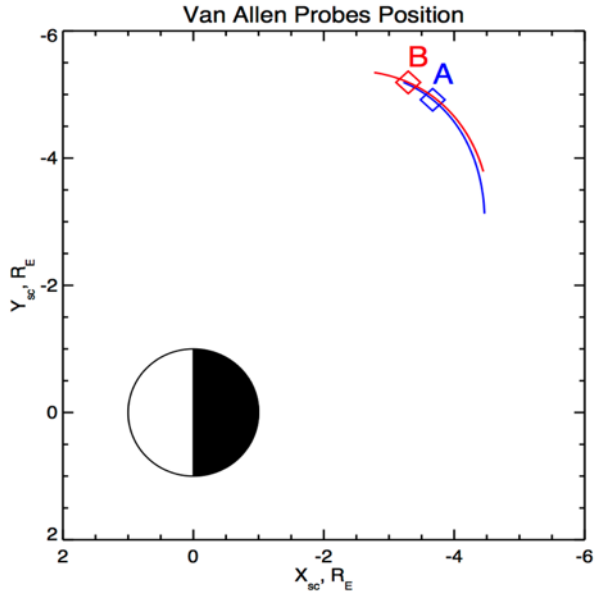
Evolution of Electron Flux Burst Near 0902 UT

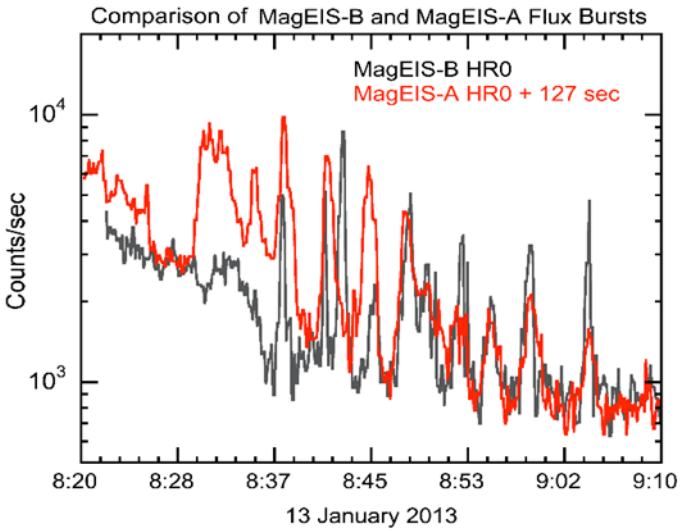
- Pre-burst angular distribution (*on 0-180° scale*) that was fit with A $\sin^N(\alpha)$
- Evolution of distributions as the flux burst waxes and wanes
  - Each panel represents one satellite spin
  - At the beginning and end of the flux burst the pitch angle distributions were of form A $\sin^N(\alpha)$
  - The peak flux occurs at ~75° and 105°
  - The fluxes at angles outside the bursts remained essentially unchanged
  - The evolution relatively fast with significant changes occurring over a spin period



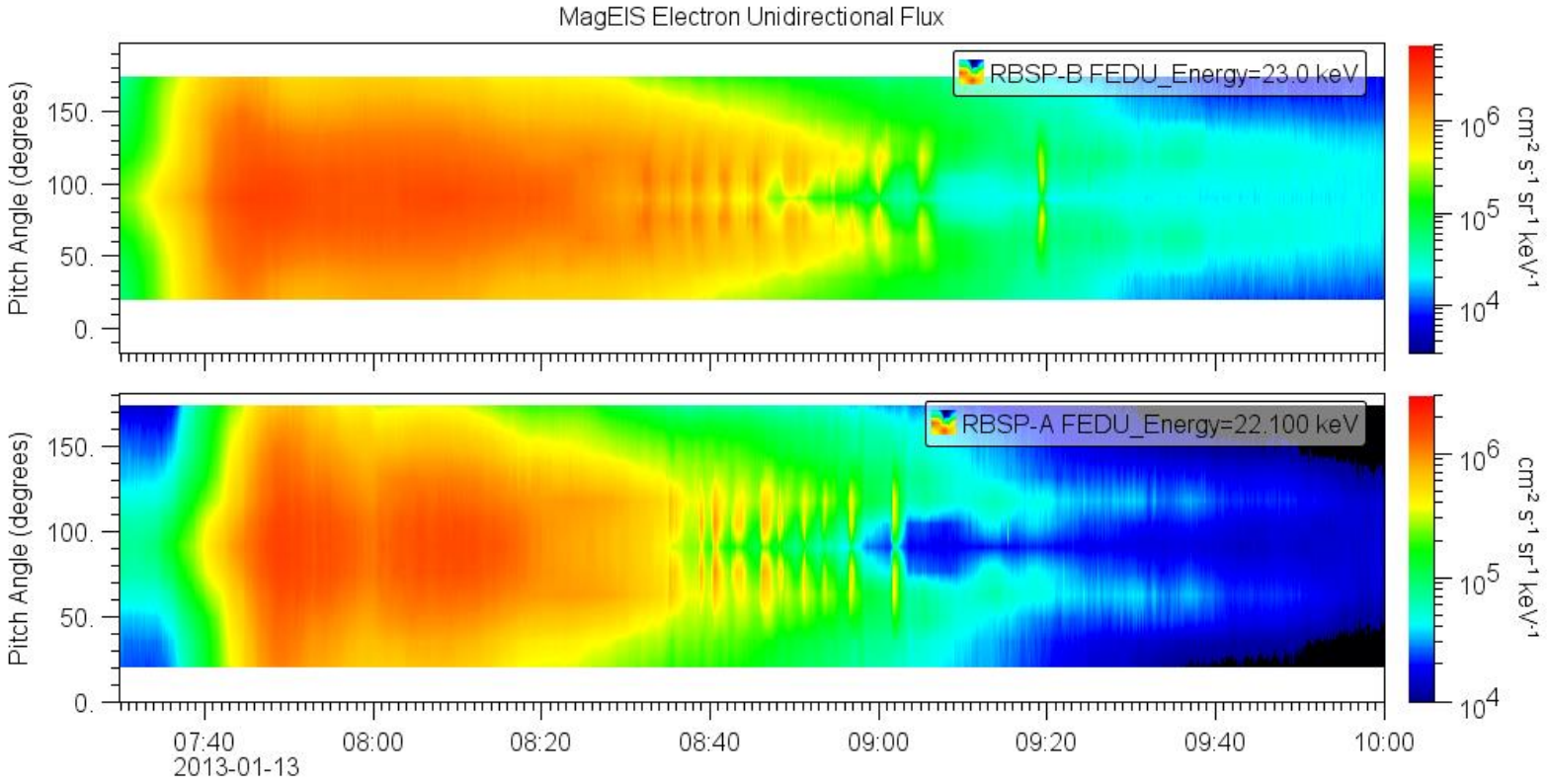
Comparison of Electron Bursts from Probes-A and -B

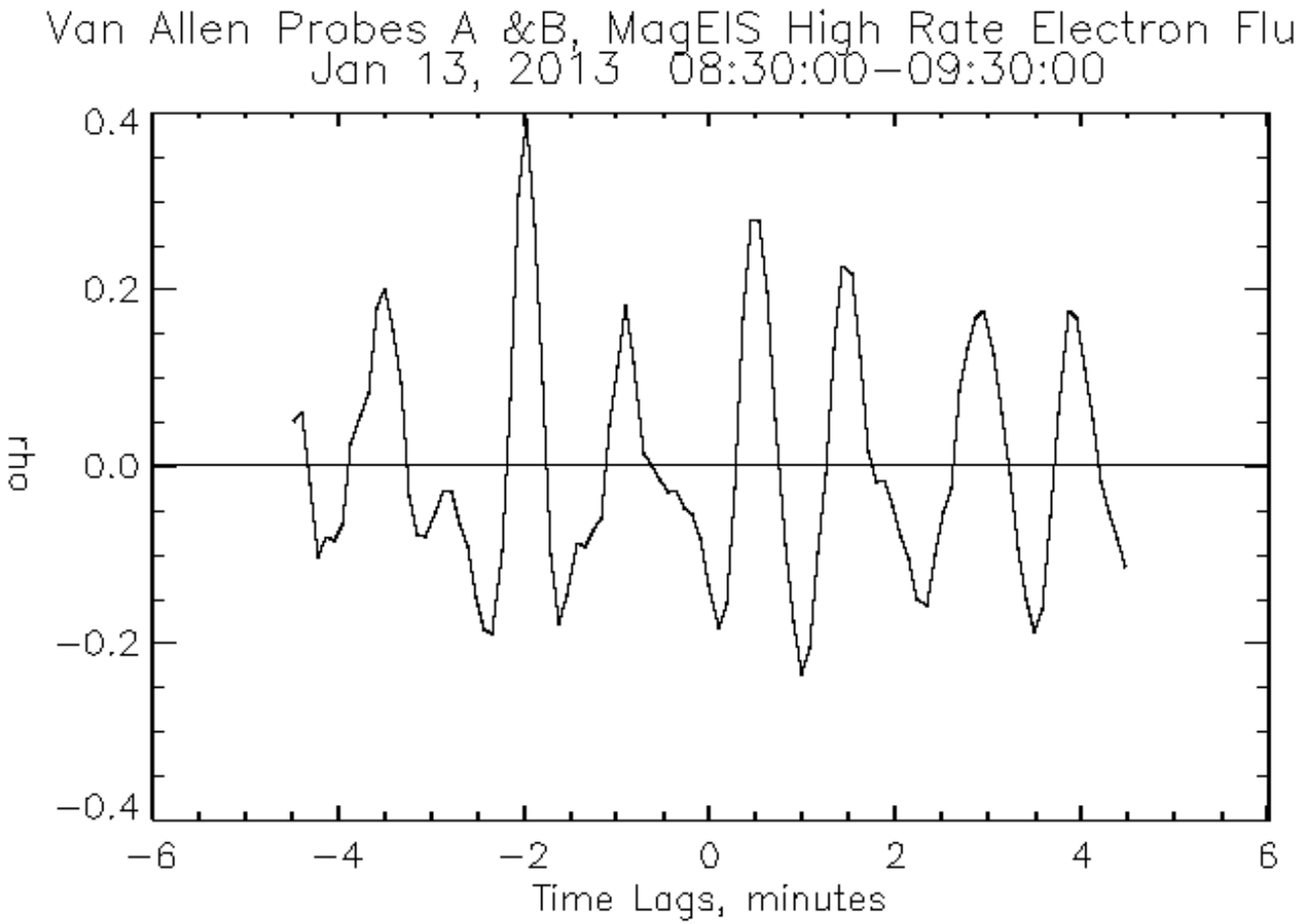
- Bursts observed by Probe-A correlate well with Probe-B fluxes when delayed by 127 s
- RBSP-A is trailing –B at lower altitude during the event
- Correlation implies that bursts are spatial structures drifting slowly outward
- Direction of burst drift is opposite to normal convective flow.
- What is drifting toward the nightside—a plasma population or waves?



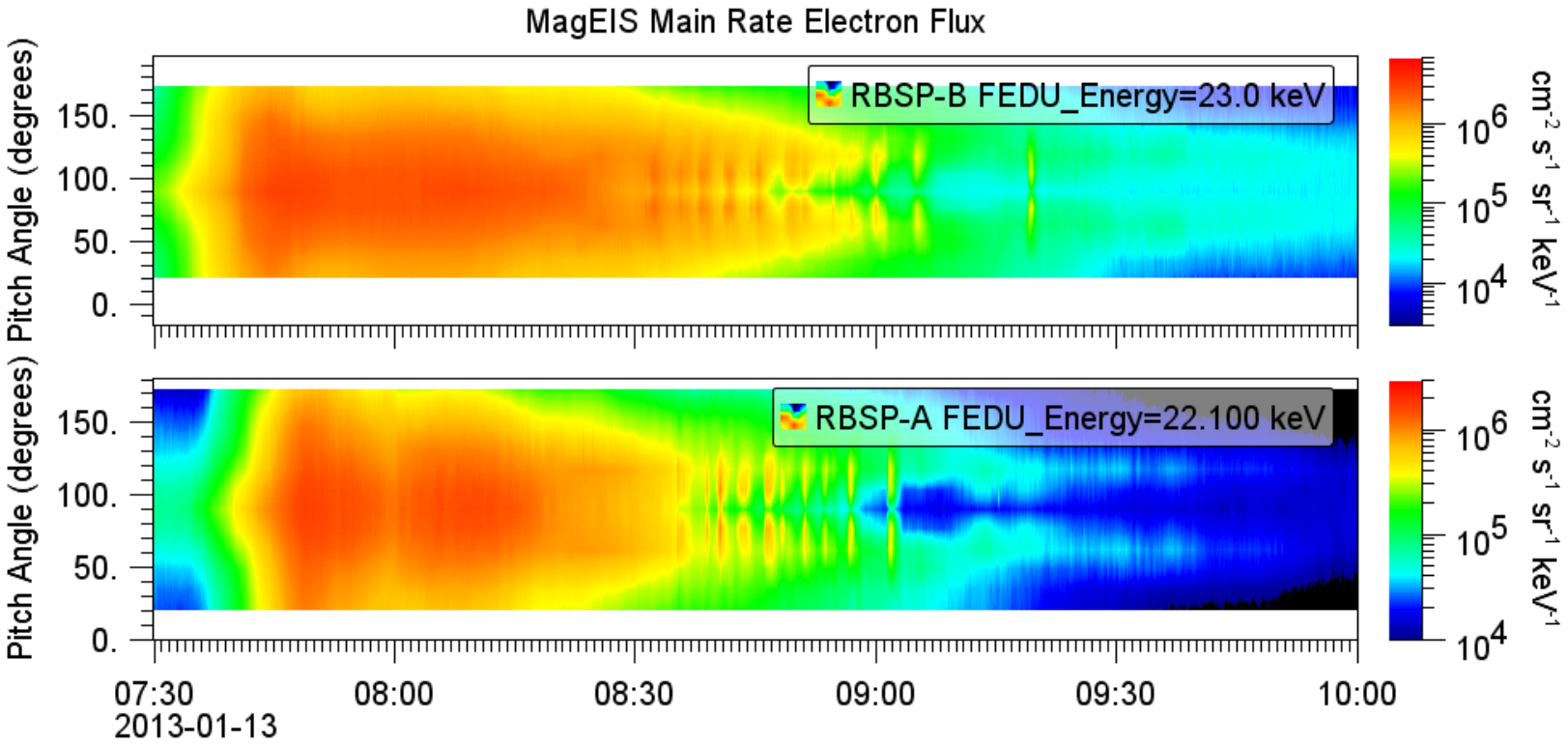


High Rate MagEIS Electrons




Van Allen Probes A &B, MagEIS High Rate Electron Flux
Jan 13, 2013 08:30:00–09:30:00
0.4
0.2
0.0
−0.2
−0.4
rho
−6
−4
−2
0
2
4
6
Time Lags, minutes

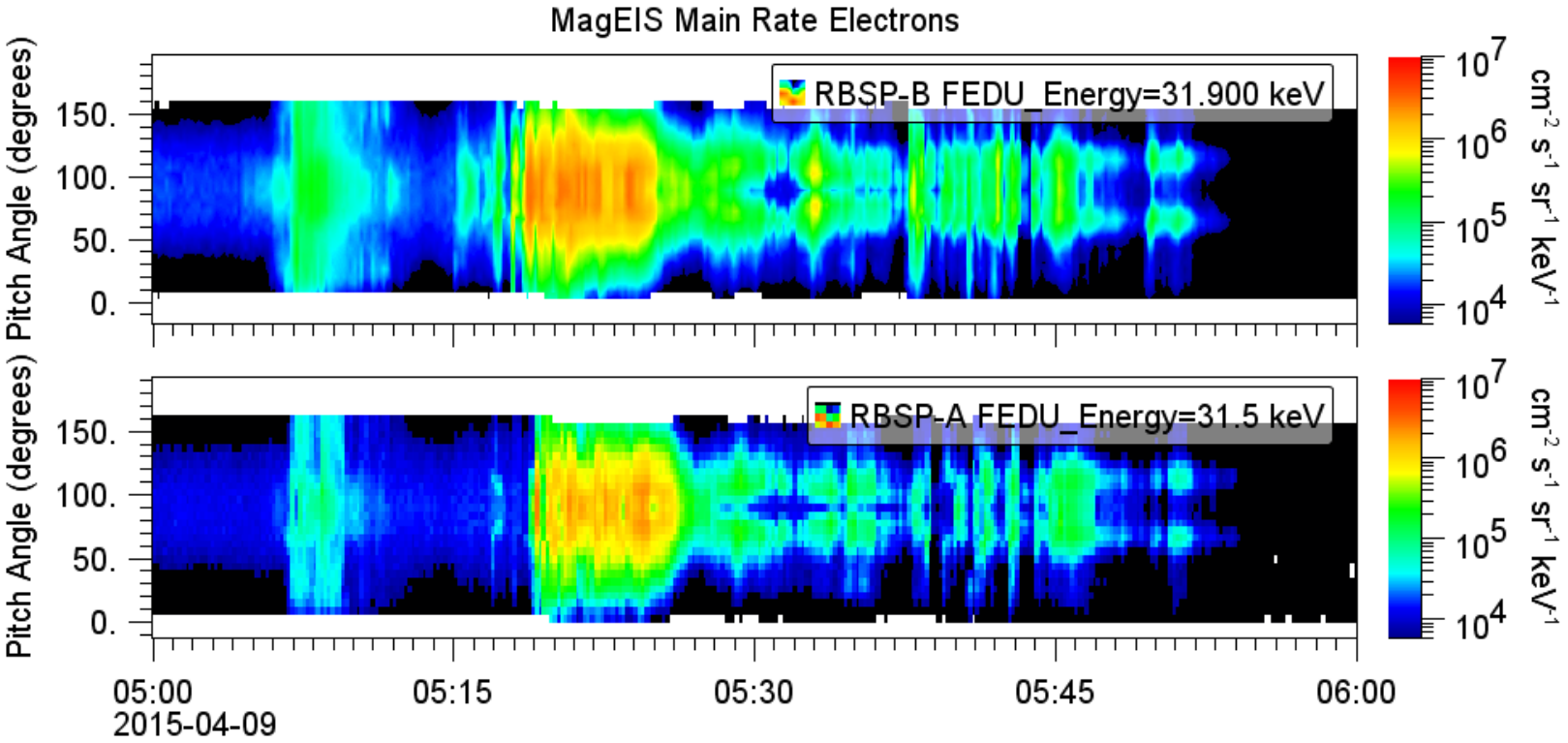
Main Rate MagEIS Electrons



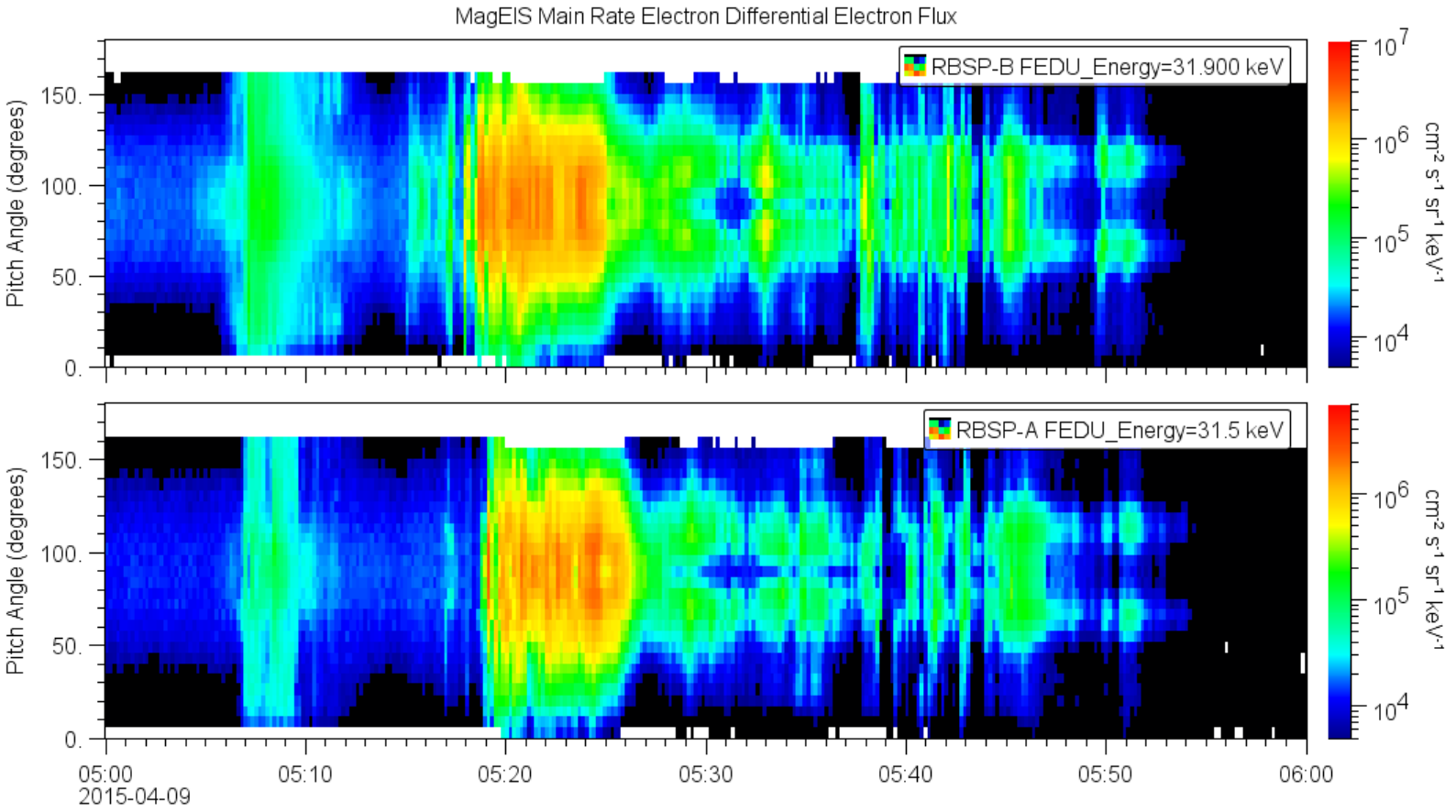
Cross Correlation Results

- Five flux burst events during RBSP close approach intervals in 2013-2015
- Relatively low values of correlation (0.3-0.4) between electron flux bursts
  - Good time coincidence of bursts
  - Poor correlation of burst intensity
- Time lags of peak correlation
  - Not simply related to inter-spacecraft distance
  - General tendency to smaller time lags at small separation
- Complex dependence of time lag
  - Pitch angle dispersion
  - Energy channel

High Rate MagEIS Electrons



Main Rate MagEIS Electrons



Summary

- Comparison and correlation of energetic electron flux bursts observed by RBSP-A and –B close approaches
- Low correlation values and wide variation of time lags for five events
- Complex dependence on pitch angle and energy
- Perceived correlations may be random coincidences of two sporadic quasiperiodic pulse trains
- Provides evidence that interactions are small scale, independent phenomena: “raindrops”
- Contradicts picture of slow drift of flux burst features