Long-term Analysis of Cosmic Ray Background

Seen by the RAPID Electron Detector on Cluster

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Contents

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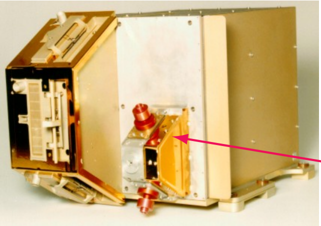
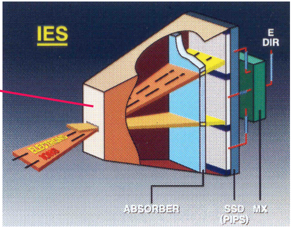
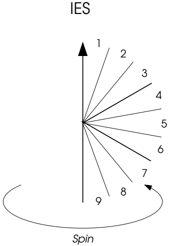
The **I**maging **E**lectron **S**pectrometer (IES) is the electron part, consisting of 3 units, each with 3 detectors, covering the angular range from 0° to 180° in 9 segments.







IES Characteristics

Field-of-view	$\pm 17.5^\circ \times 180^\circ$
Angular coverage	
Polar	$180^\circ/9$
Azimuthal	$360^\circ/16$
Geom. Fact.	$2.2 \times 10^{-3}\ \mathrm{cm}^2 \cdot \mathrm{sr}$
(per detector)	

Chan	Low limit, keV	
	BM	NM
1	39.2	39.2
2	50.5	50.5
3	68.1	68.1
4	94.5	94.5
5	127.5	127.5
6	175.9	244.1
7	244.1	—
8	336.5	—
Upper	406.5	406.5

The IES Background Counts

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Electron Background Rates

Previous work

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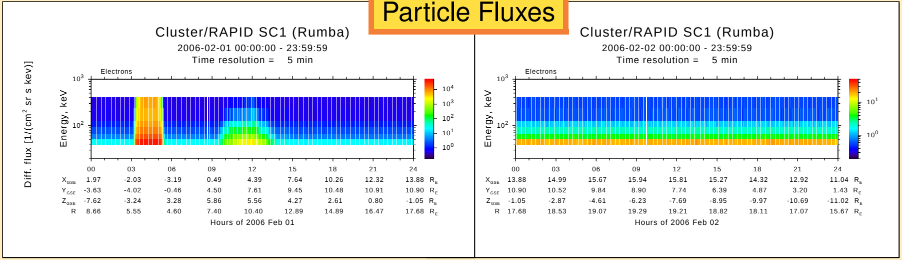
Particle Fluxes



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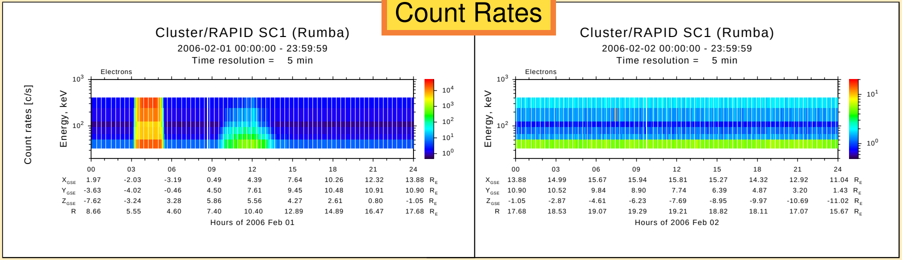

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- In 2006, we examined some examples to determine that it was random noise (Poisson statistics) and not at a regular frequency.
- We considered it to be some kind of internal instrumental noise, although no one could really explain what it might be.

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Current work

Properties of the BG

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- One needs to accumulate over long times to get reliable statistics.

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But for this work we need something more mathematically precise!

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- On the other hand, we must ensure that only BG is within that interval, excluding any true events.

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It is the Poisson test that is the trickiest part of this procedure.

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- For a normal distribution, the 95% level is at 1.64 s.d.; Monte Carlo find this for Poisson distribution, which $\rightarrow$ 1.64 as $\lambda \rightarrow > 5$.

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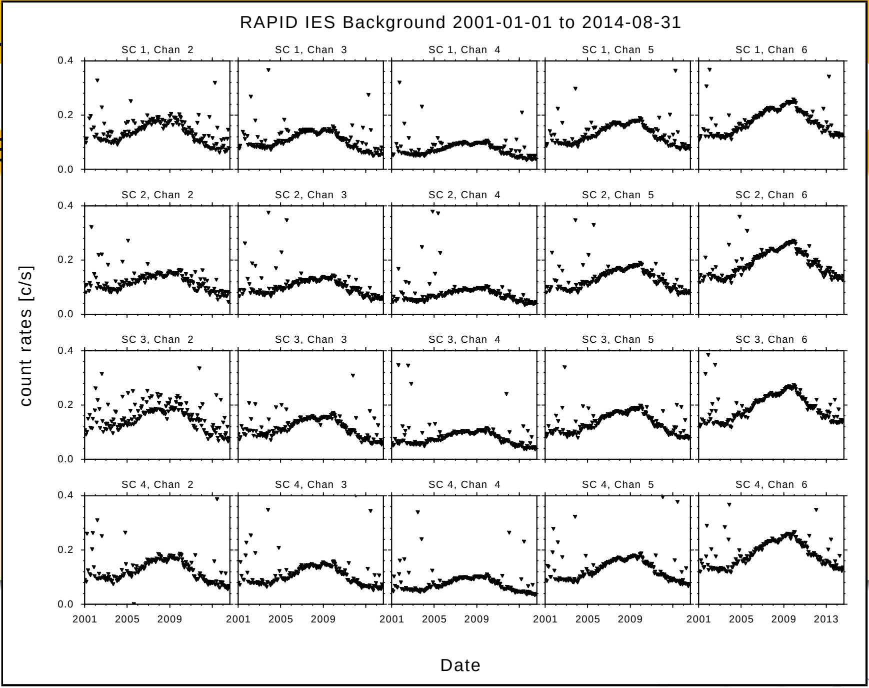
- Once λ varies from $1 \rightarrow 2$, do we get significant rejection rates.

Long Term Results

Electron Background from 2001 to mid-2014

- We plot the orbit minima for the 4 SC and energy channels 2–6.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SC 1, Chan 2
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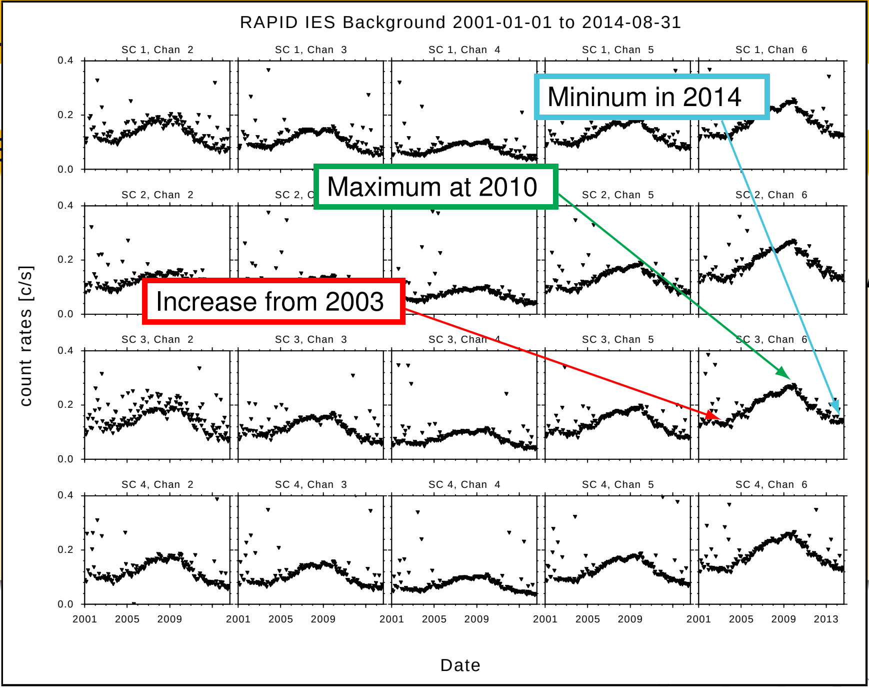
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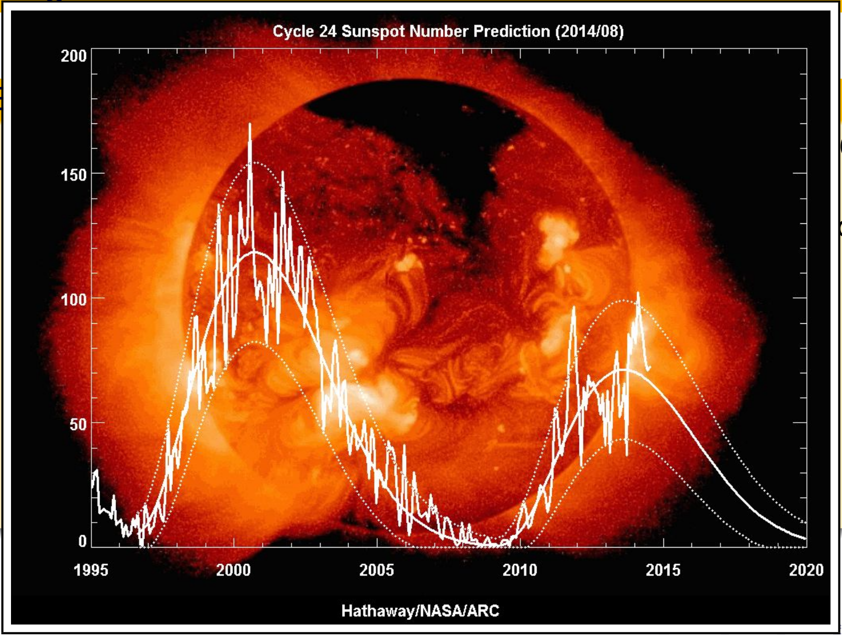

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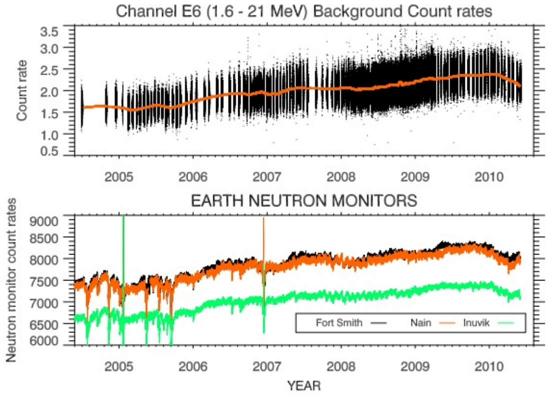

Figure 2. (top) Temporal variation of the E6 electron channel background. The background is sampled for a region of a few Saturn radii outside 20 R_s, where foreground fluxes of MeV electrons are typically below the instrumental background. A smoothed profile is also overplotted. Several small intensifications (e.g., during 2005) are attributed to solar wind energetic events [*Roussos et al.*, 2008], but the overall profile is affected by changes in the heliospheric fluxes of penetrating GCRs which dominate the E6 background. (bottom) Count rates from three neutron monitors at the Earth. The long-term profile is a proxy for the solar cycle modulation of the cosmic ray flux input to the Earth's atmosphere. Dropouts correspond to Forbush decreases (see also section 4.3), while spikes are from ground level enhancements. Data are available through the Bartol Research Institute Web site at http://neutronm.bartol.udel.edu/.

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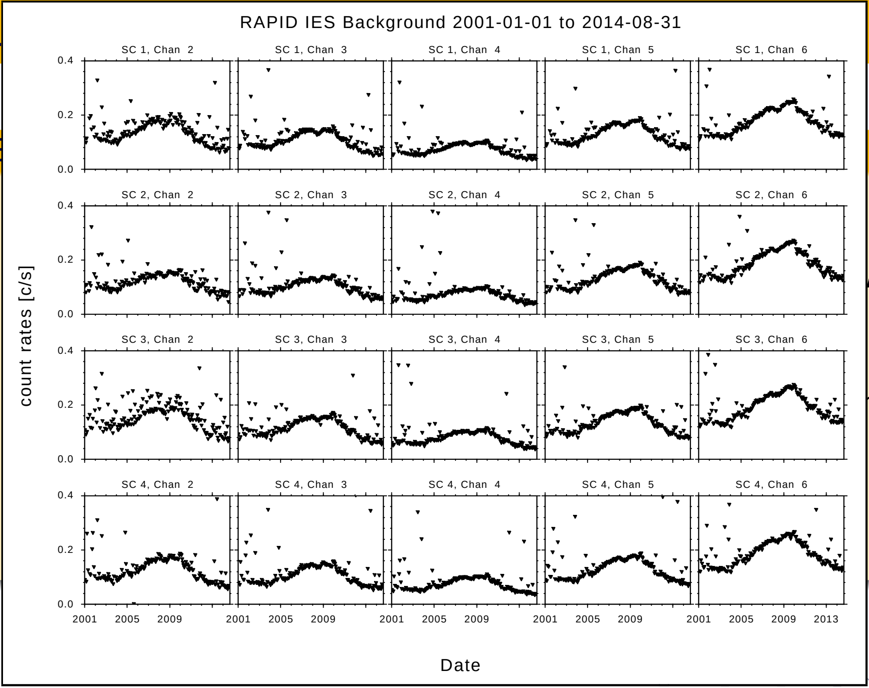
- A similar pattern for background particle radiation has been seen on Cassini at Saturn.
- We therefore conclude that this RAPID electron background is also a product of penetrating cosmic ray radiation, modified by solar cycle activity.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