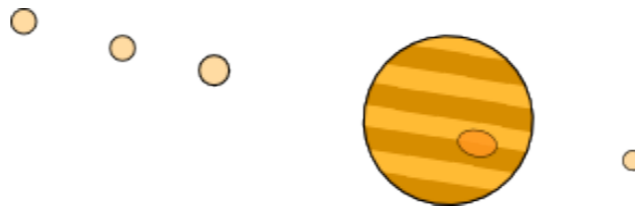


The Pitch-Angle Dependent Propagation of Jovian Electrons

Ulysses KET/HET Observation of Anisotropies and Temporal
Variations during the Jupiter approach in 2004

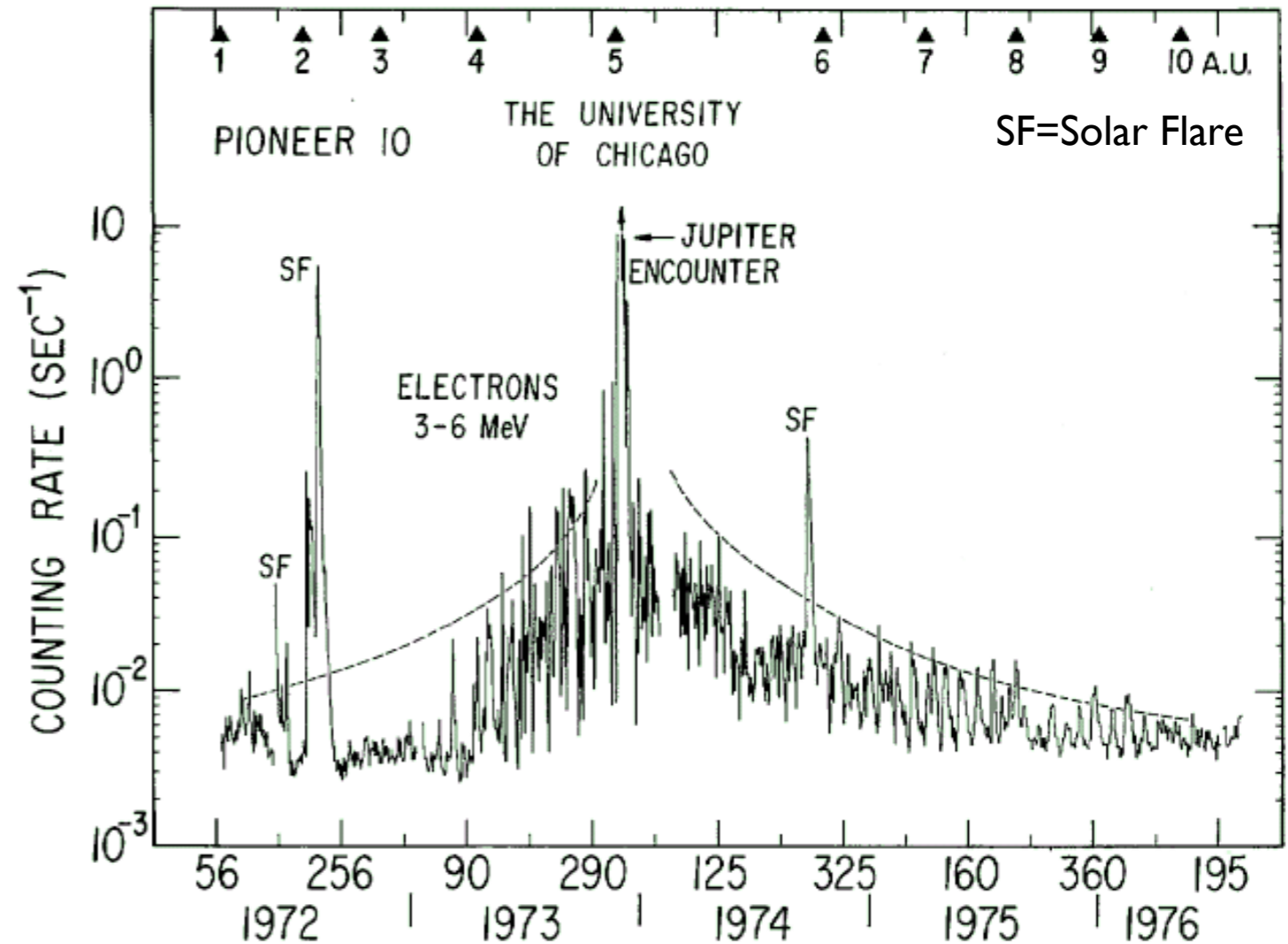


Phillip Dunzlaff
Christian-Albrechts-Universität zu Kiel

13.09.2011

Introduction

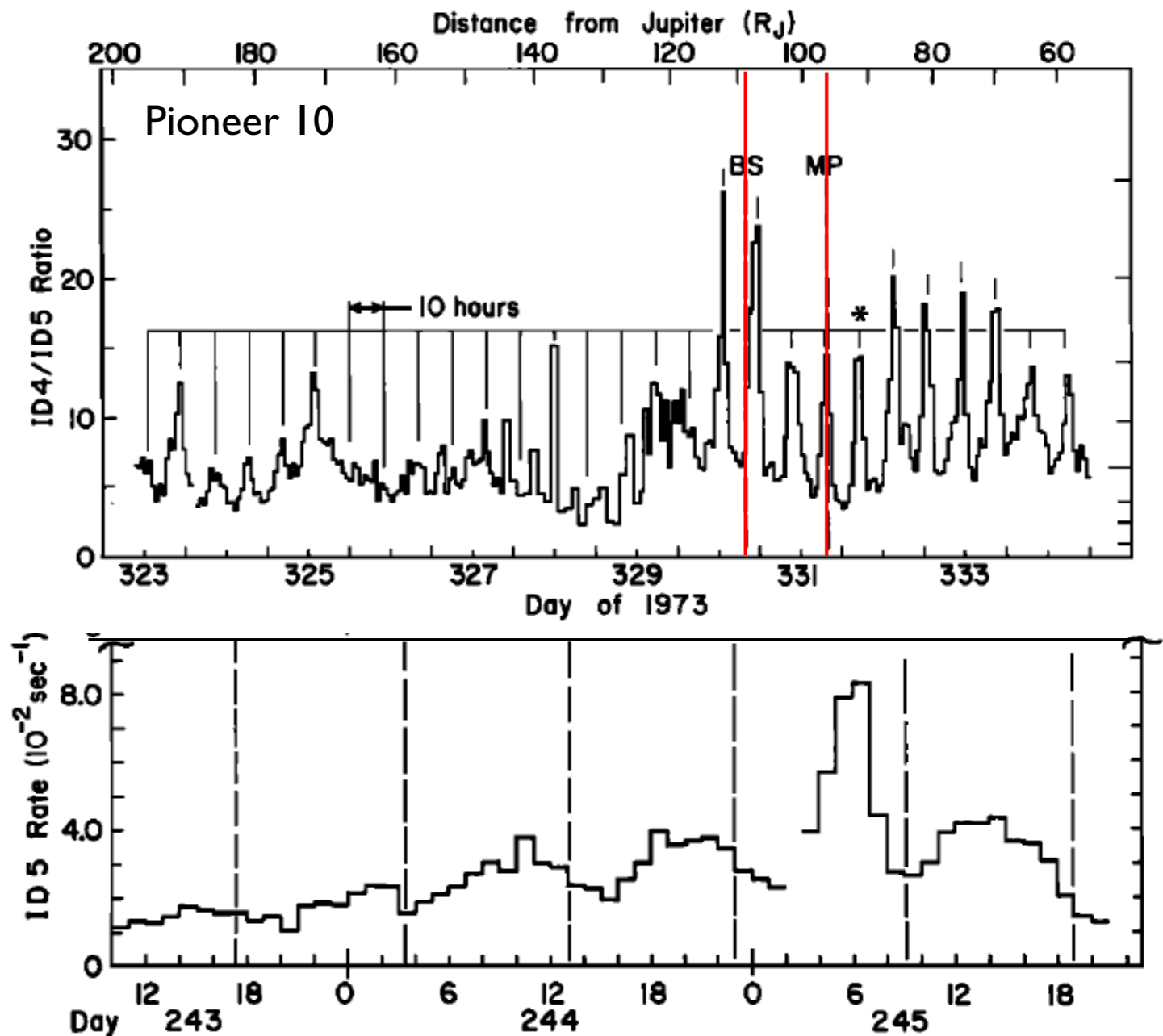
- Pioneer 10/11 → Jupiter is a source of MeV electrons (Chenette et al. 1974)
- Periodic increases of electrons at Earth's orbit were attributed to Jovian influence (Teegarden et al. 1974)
- Detection of Jovian electrons up to ~25 AU (Lopate, 1991)
- ➔ Jovian electrons are virtually observed in the whole heliosphere



From: Pyle & Simpson (1977)

Introduction

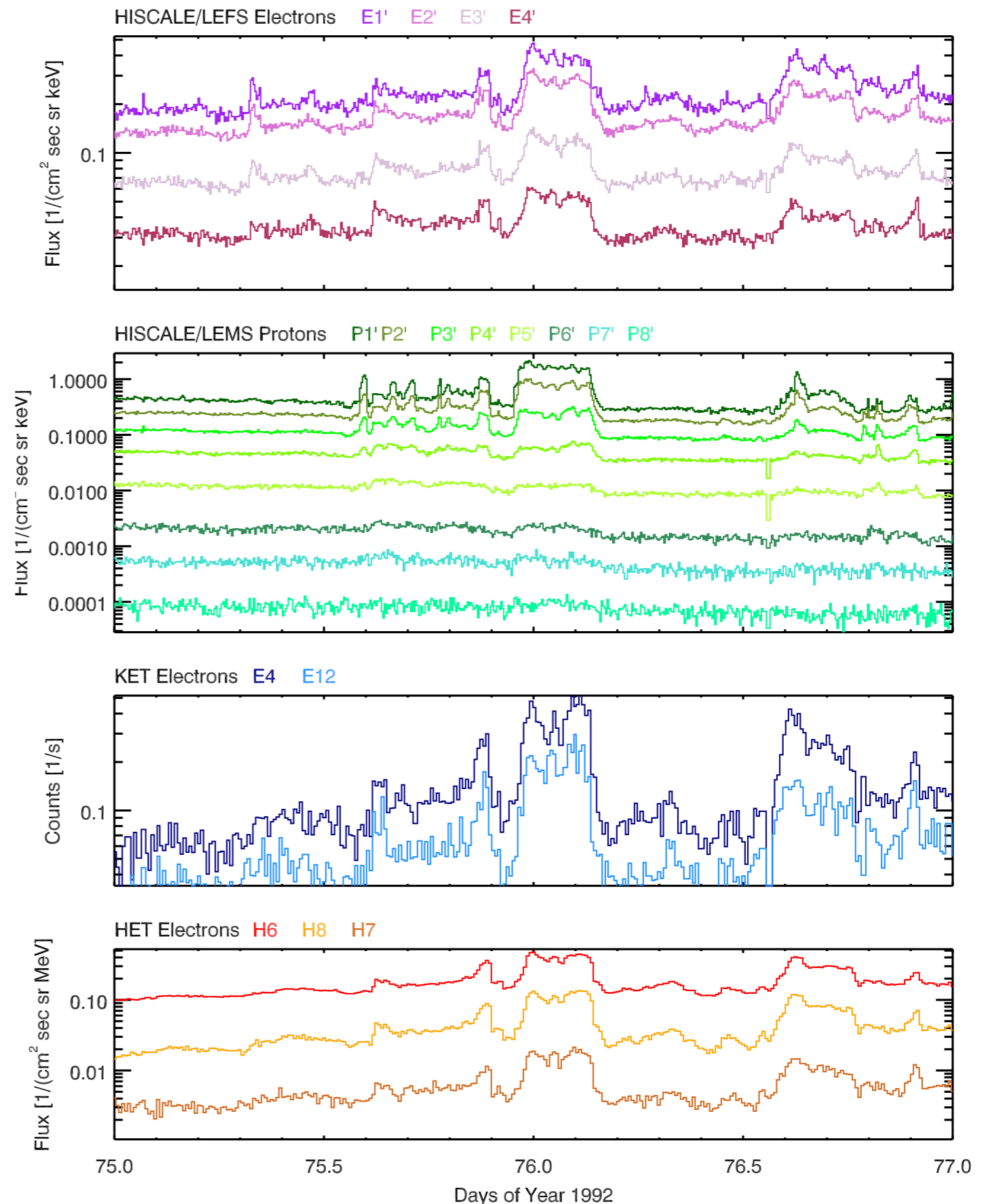
- “Bursts” of electrons with notable anisotropies already noted by Chenette et al. (1974), related to IMF direction (Smith et al., 1976); frequently showing the 10 h periodicity of Jupiter (see also Schardt et al., 1983)
- Ferrando et al. (1993) → Short-time “jets” of Jovian electrons with strong anisotropies and significant flux increases observed during first flyby in 1992 up to ~1 AU
- Similar events observed during second encounter between ~0.8 and 2.2 AU (McKibben et al., 2007)
- Reinvestigation of Pioneer data (provided by R.B. McKibben) reveals that several events can be attributed as jets



From: Chenette et al. (1974), modified

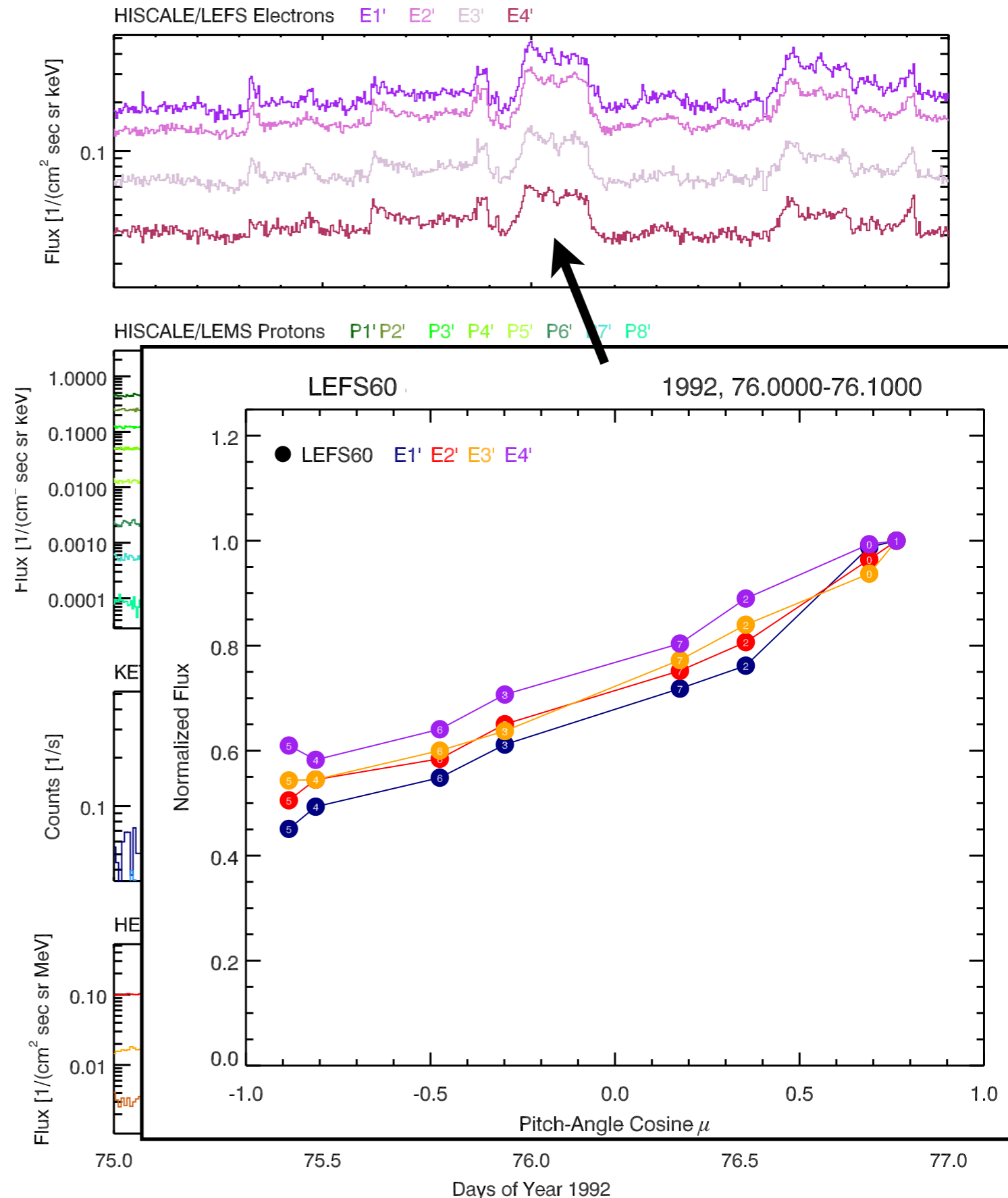
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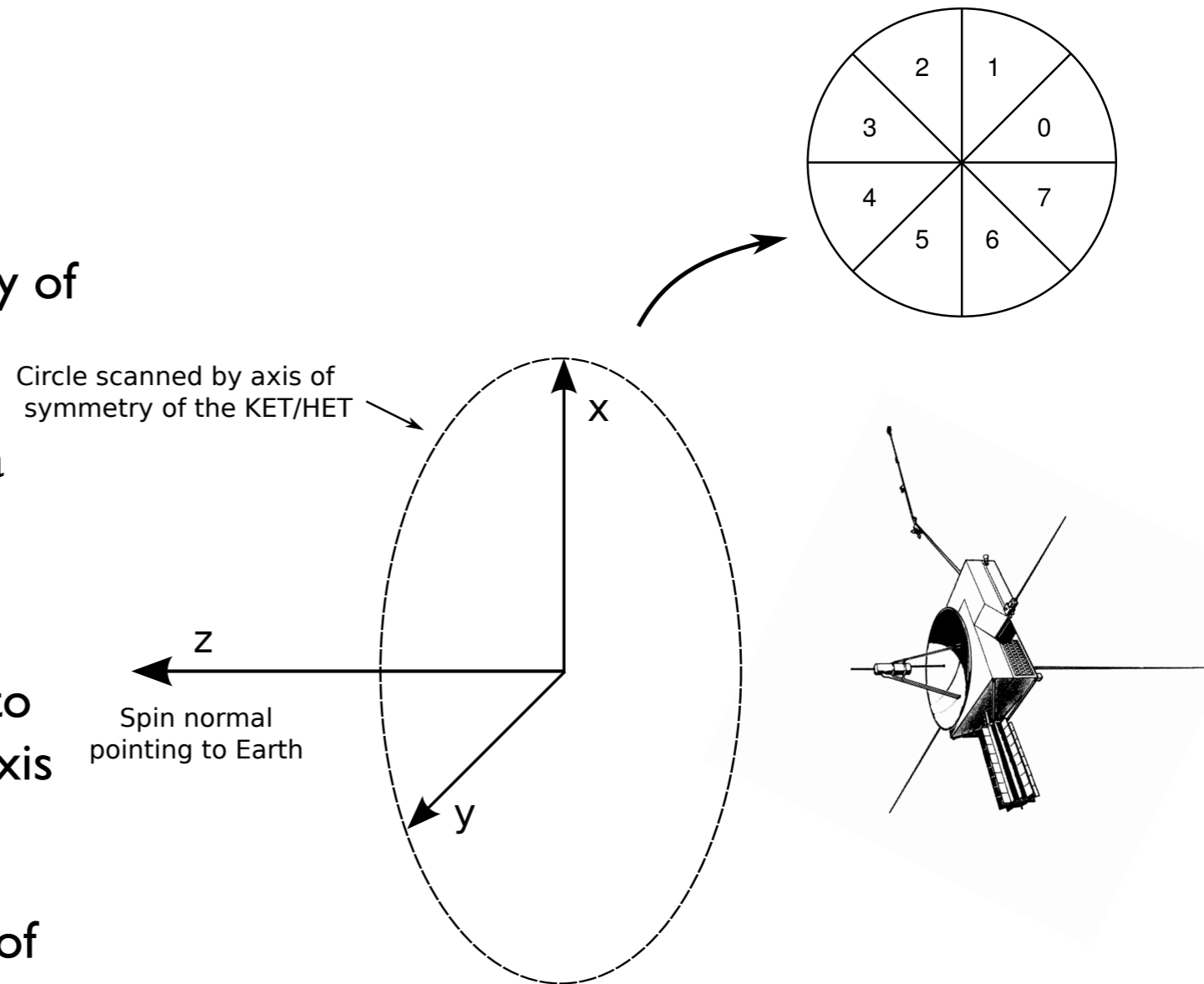
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Long-Term JoEI Fluxes in 2004

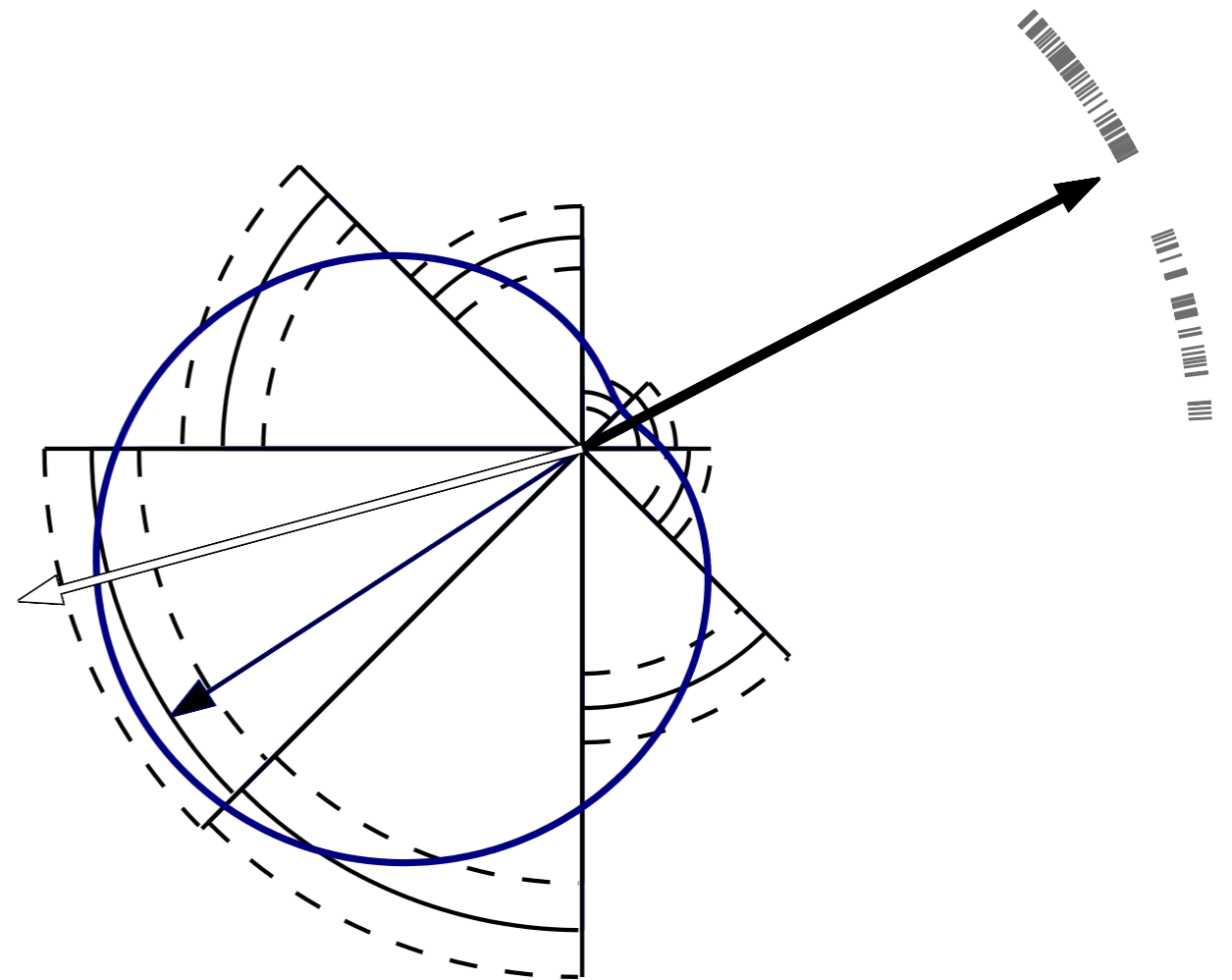
- 12 jet events observed in 2004, but also several time intervals with weaker (but significant) anisotropies
- ➔ Algorithm to search for events most likely of Jovian origin
 - Sector counts are accumulated over a reasonable accumulation interval (e.g 120 mins), calculate stddev
 - Fit sector counts by a Fourier series to derive the degree of anisotropy and axis of symmetry
 - An event is counting if the fitted axis of symmetry is in agreement with the B-vector and the direction to Jupiter and the anisotropy is statistically relevant



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Ulysses/KET 2004/101.669, Accu. Time: 120 min



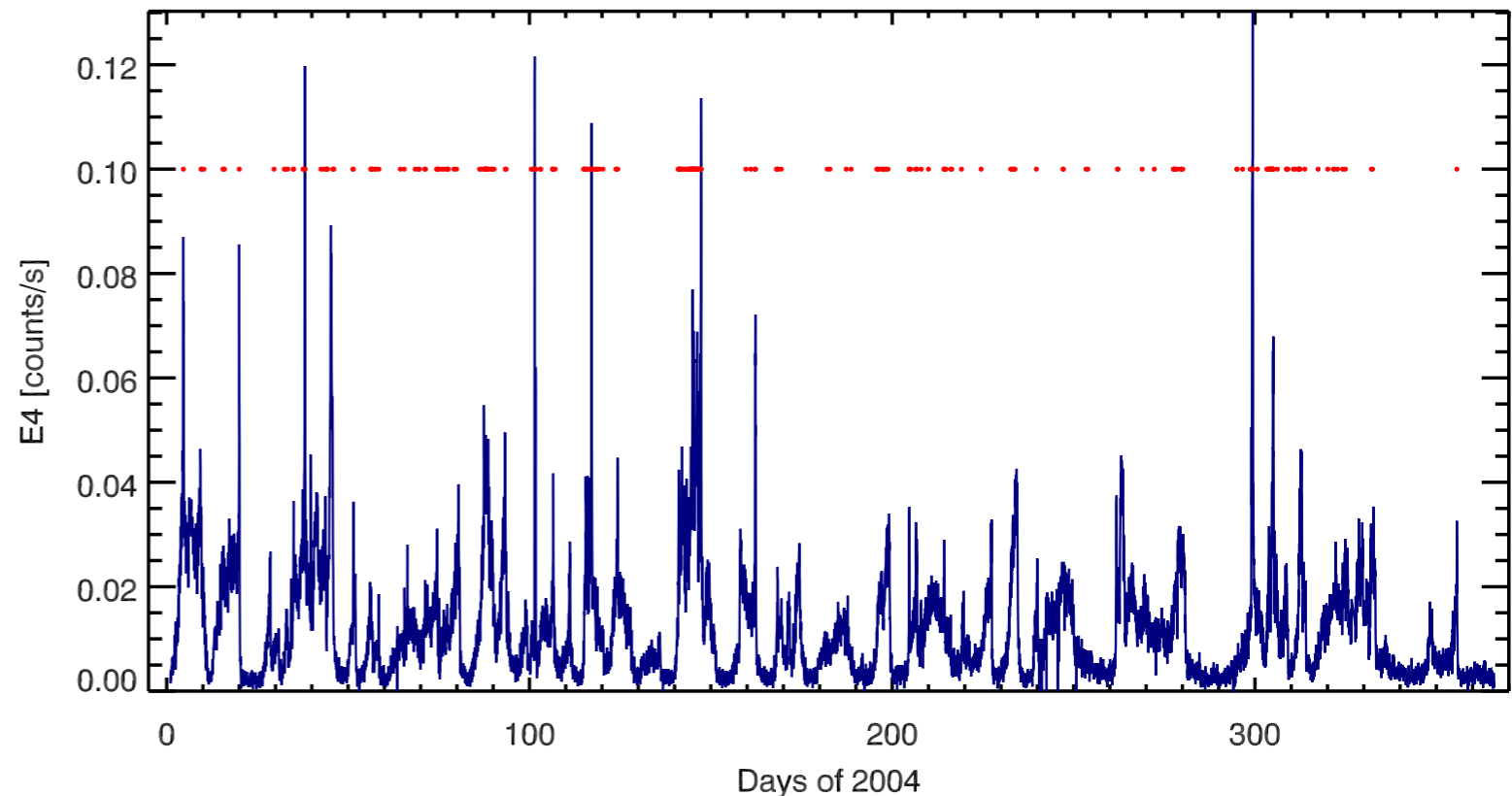
$$A_1 = 90.8 \pm 5.4 \%$$
$$A_2 = 13.4 \pm 6.1 \%$$

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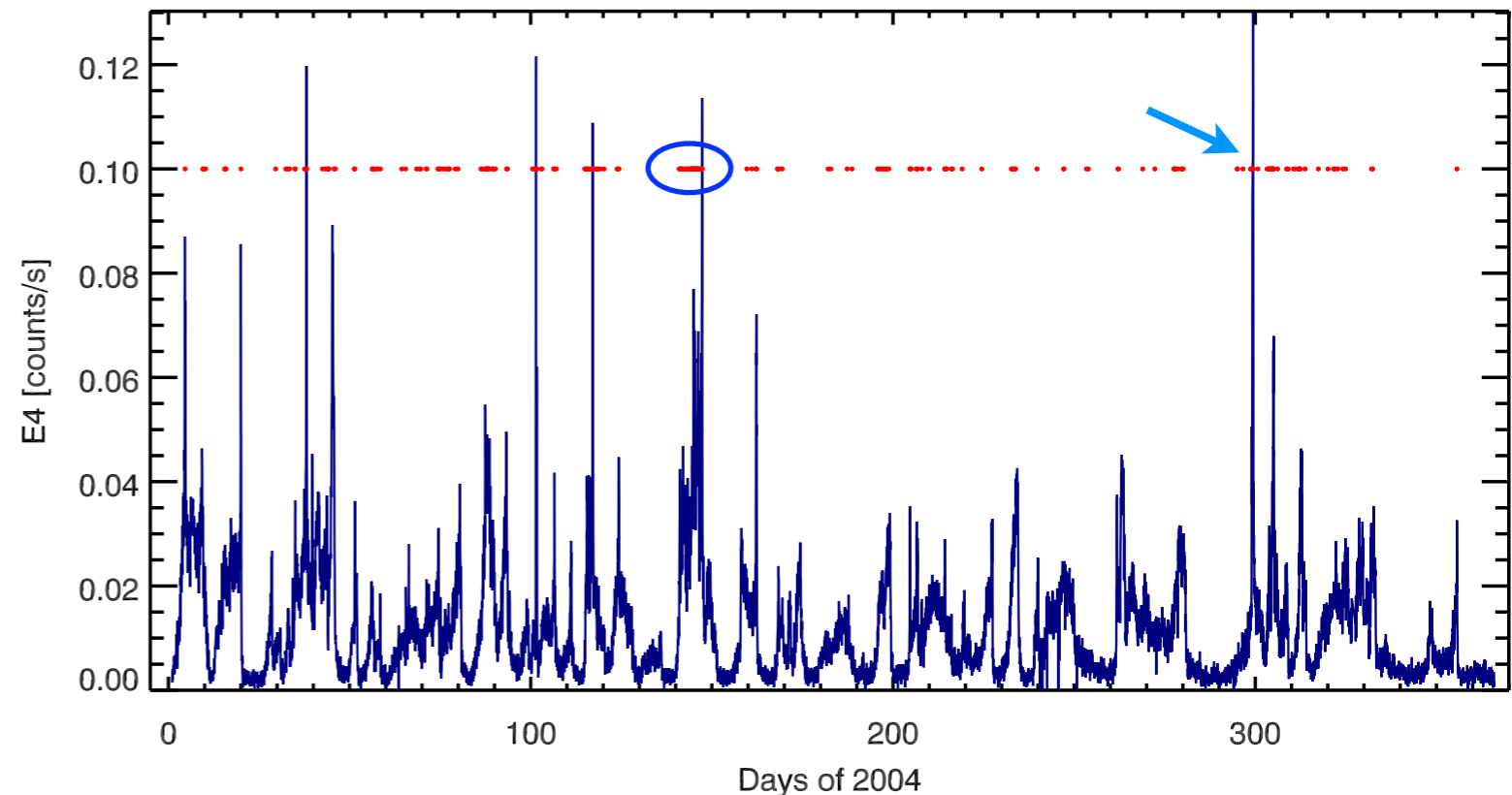
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Counted events: 6% of total data

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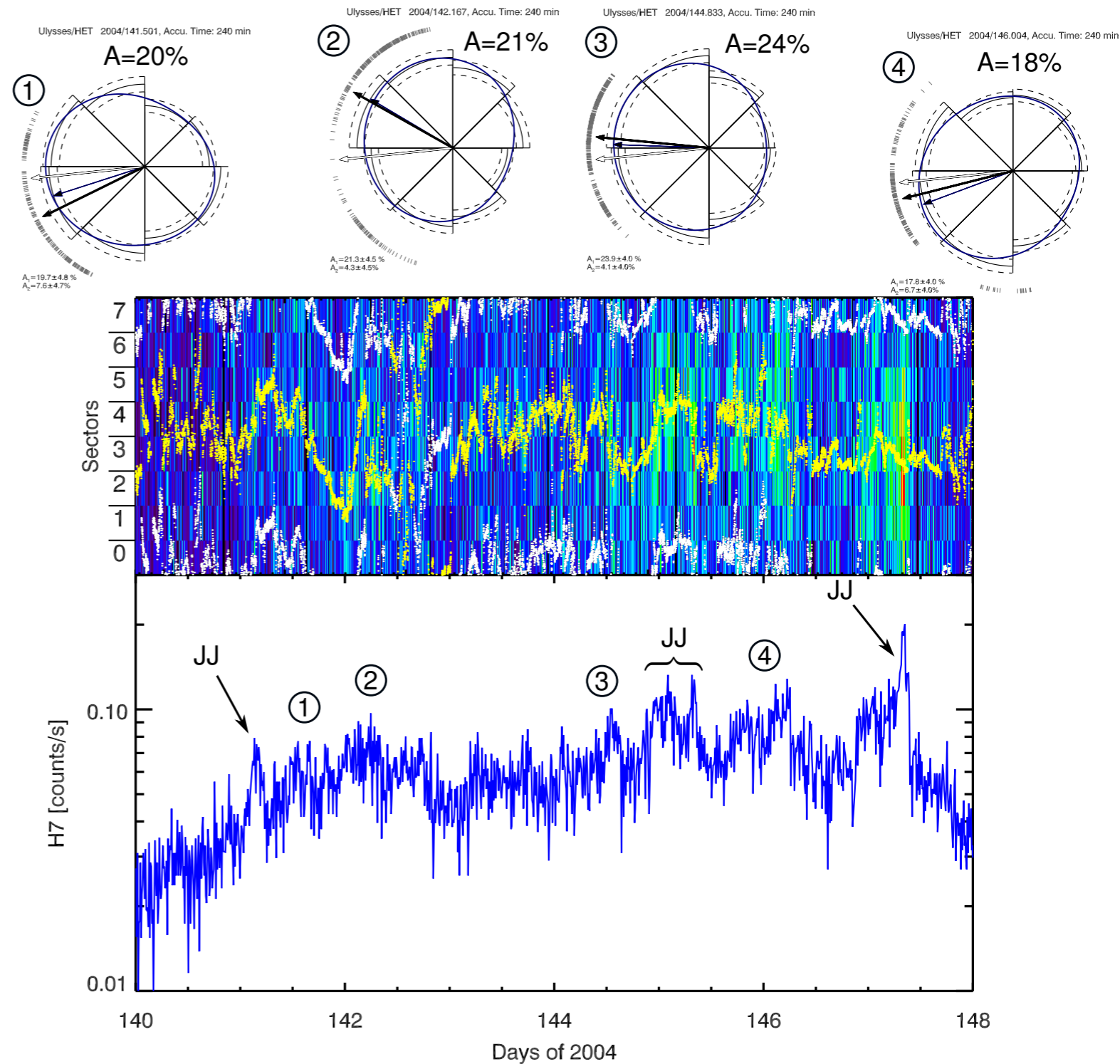
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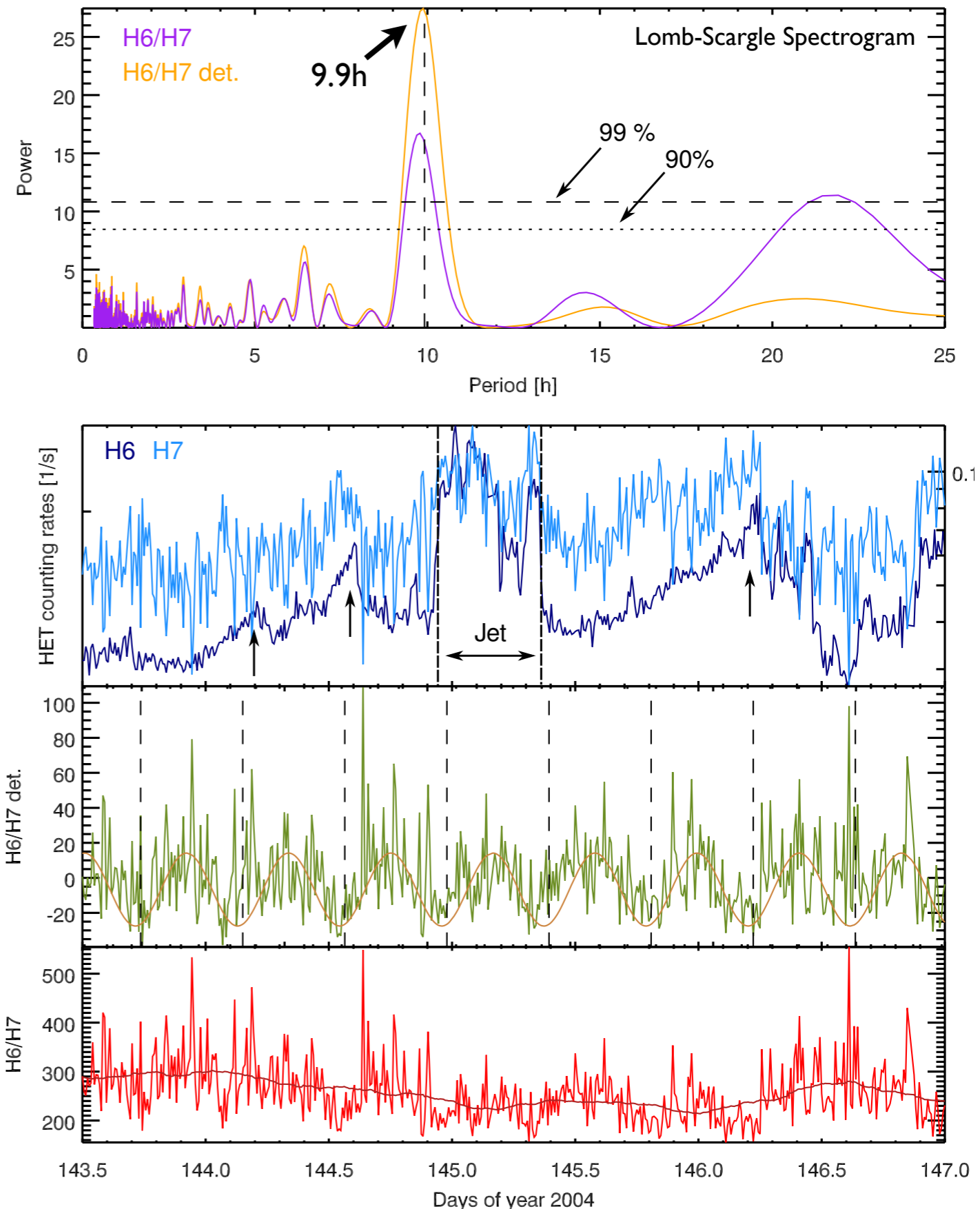
Periodic Variations of Fluxes & Spectrum

- ~1.2 AU away from Jupiter
- Enduring directional anisotropy of electrons coming from Jupiter
- Clear 10h periodicity observed in the H6/H7 ratio...
- ...and also in the counting rates
- ➔ Clear indication that the particles are of Jovian origin
- Phase *difference* between the measured and *expected* spectral rocking
- ➔ Presumably a propagation effect, similar observation in 1992 (Simpson et al, 1993)



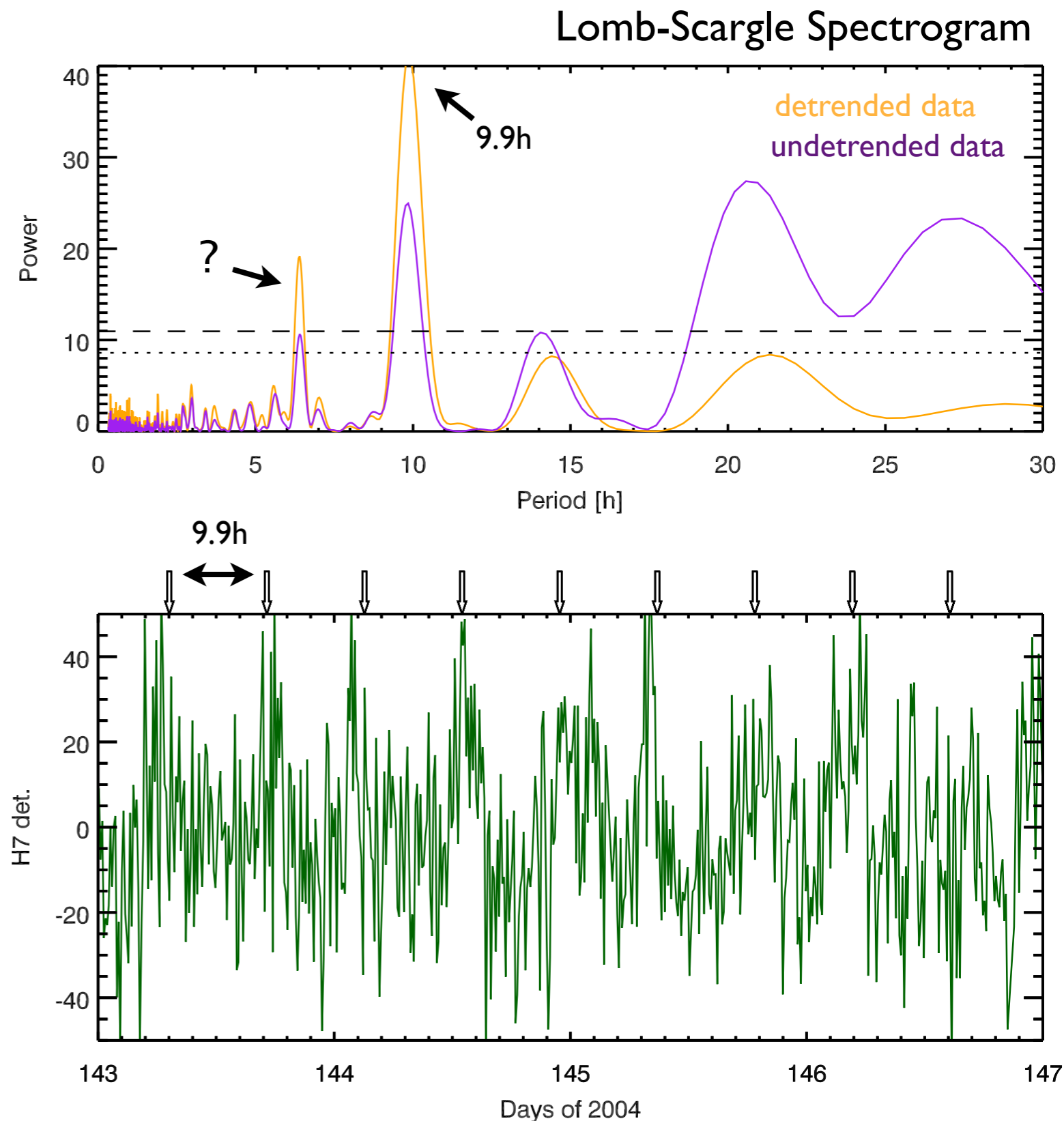
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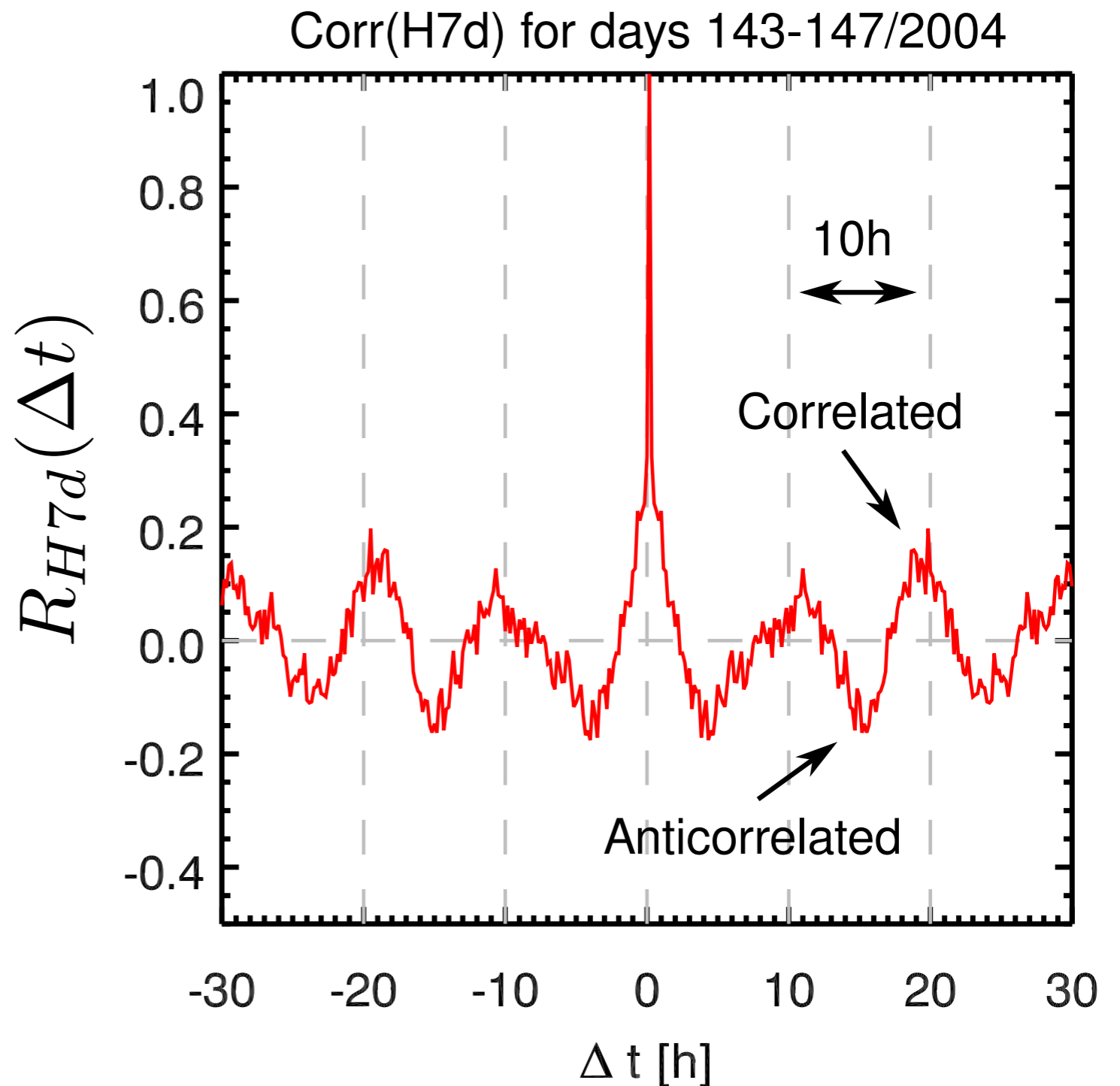
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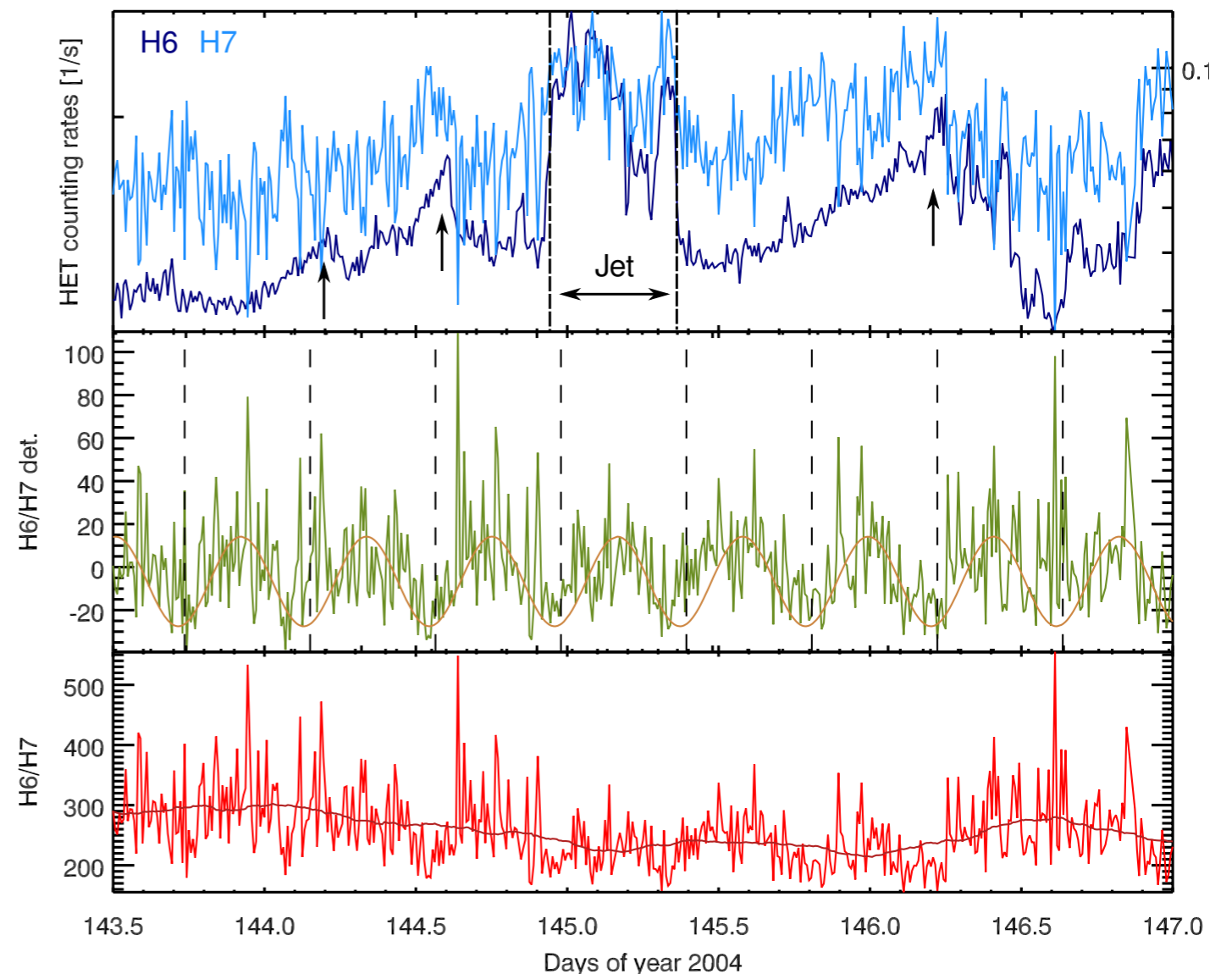
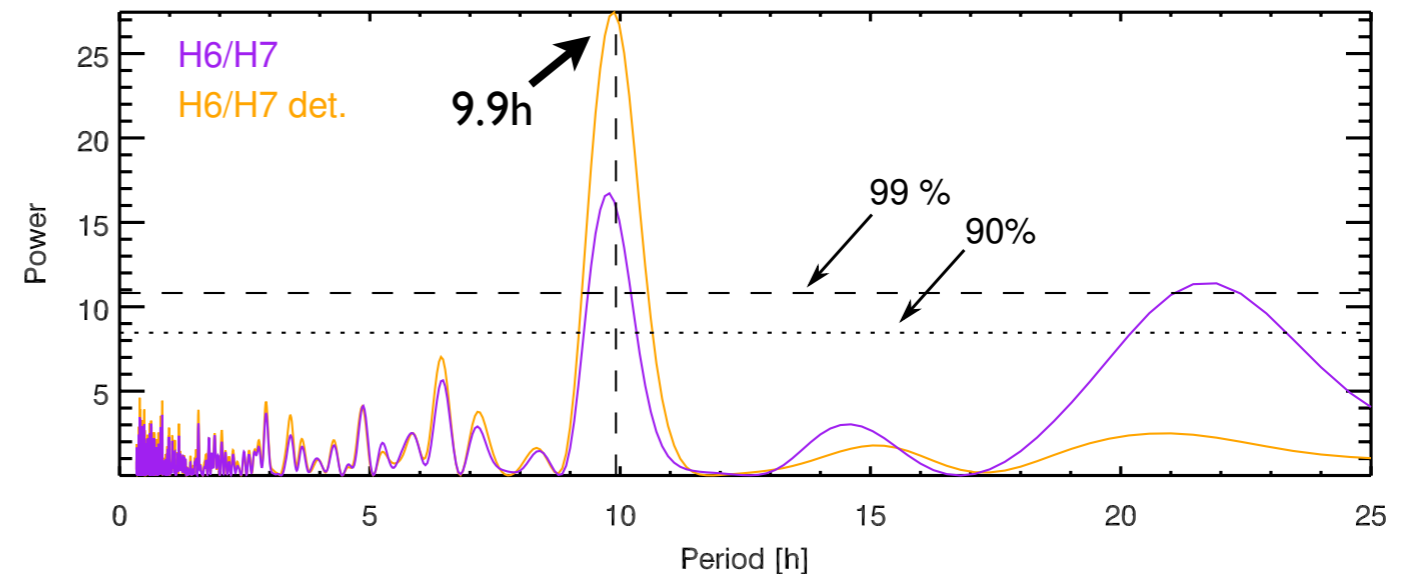
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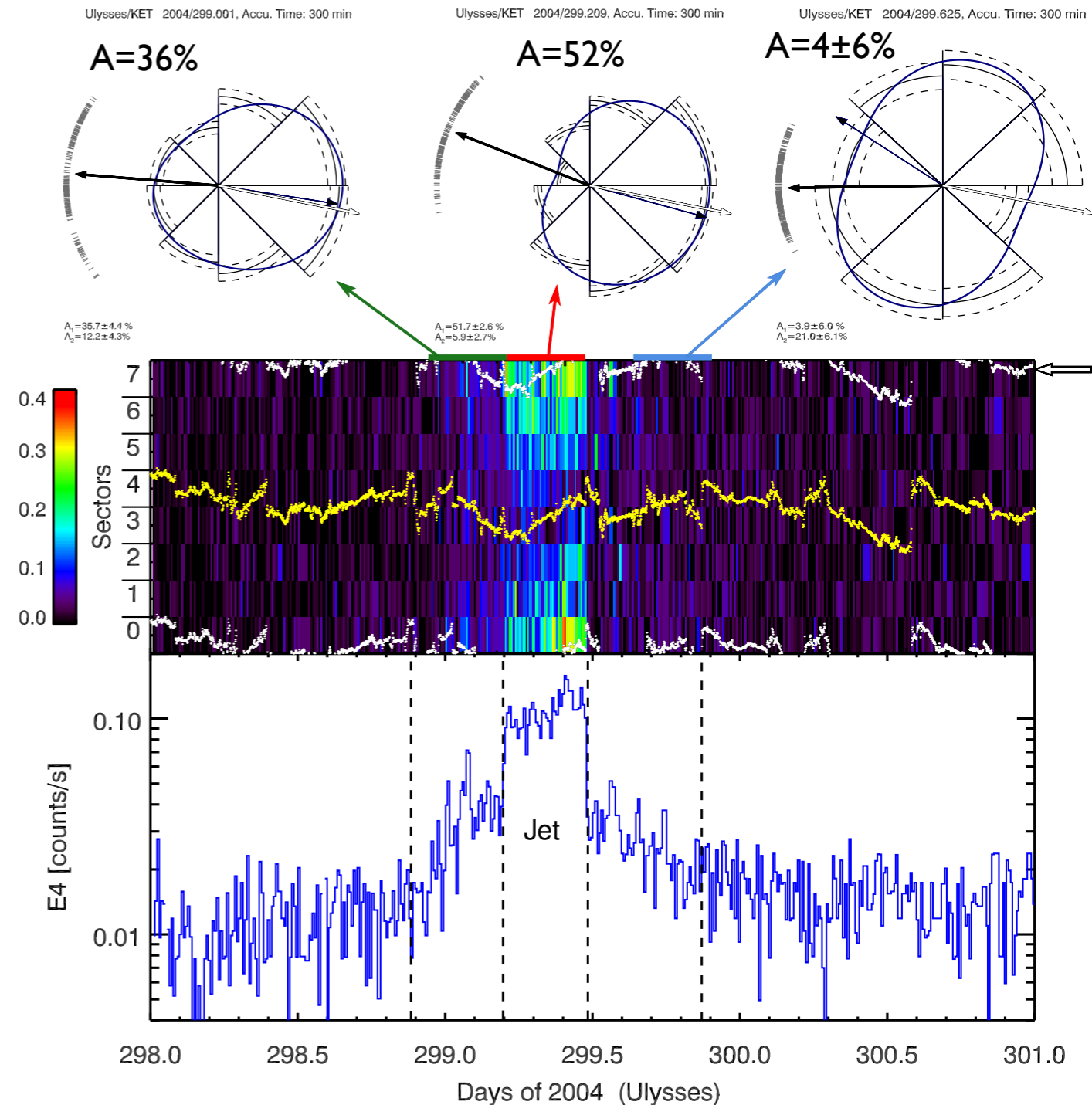
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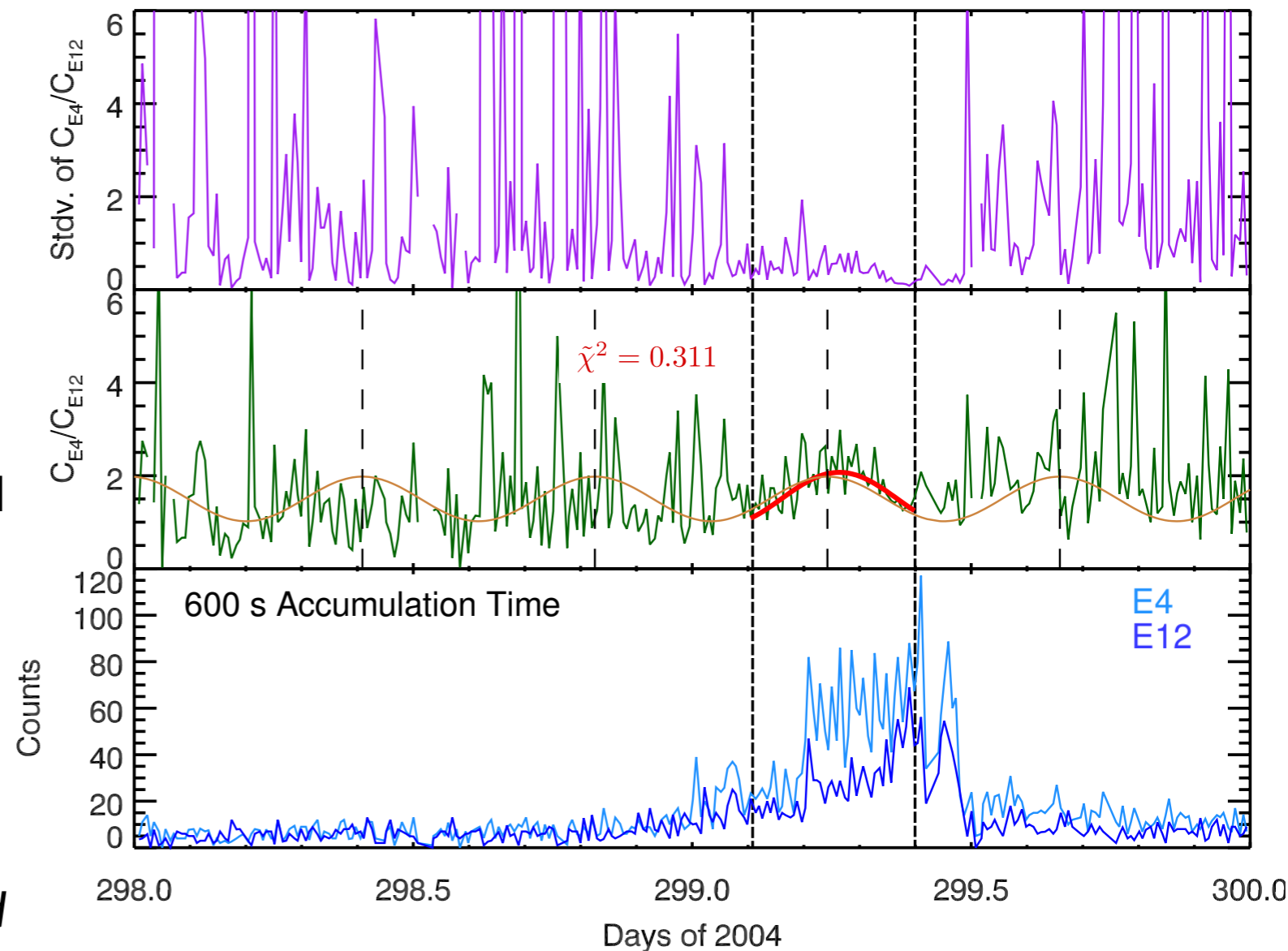
Spectral Modulation Beyond 2 AU from Jupiter?

- Day 299/2004, 2.2 AU away from Jupiter
- Observation of a well defined jet
- Visual impression of a sine-like variation in E4/E12 ratio?
- Fitting this time interval with a sine (P=10h, but free phase and amplitude) supports this impression. Unfortunately, the important time interval is rather short
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- ➔ Weak scattering (i.e. large mean free path) expected



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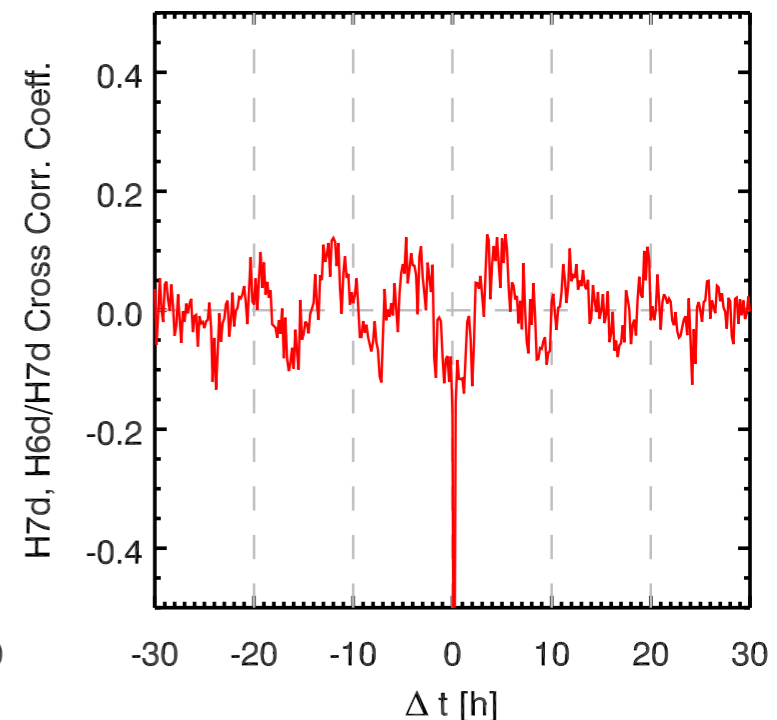
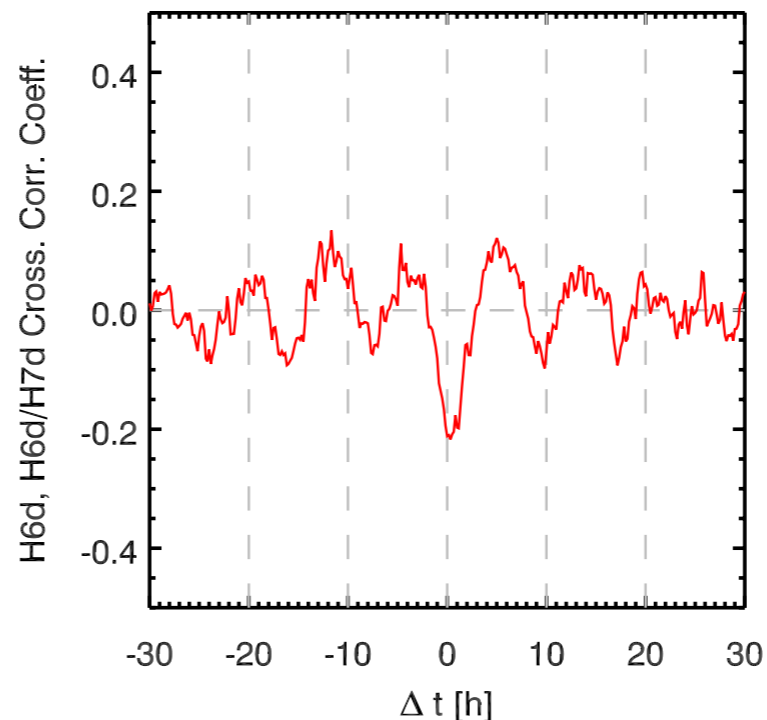
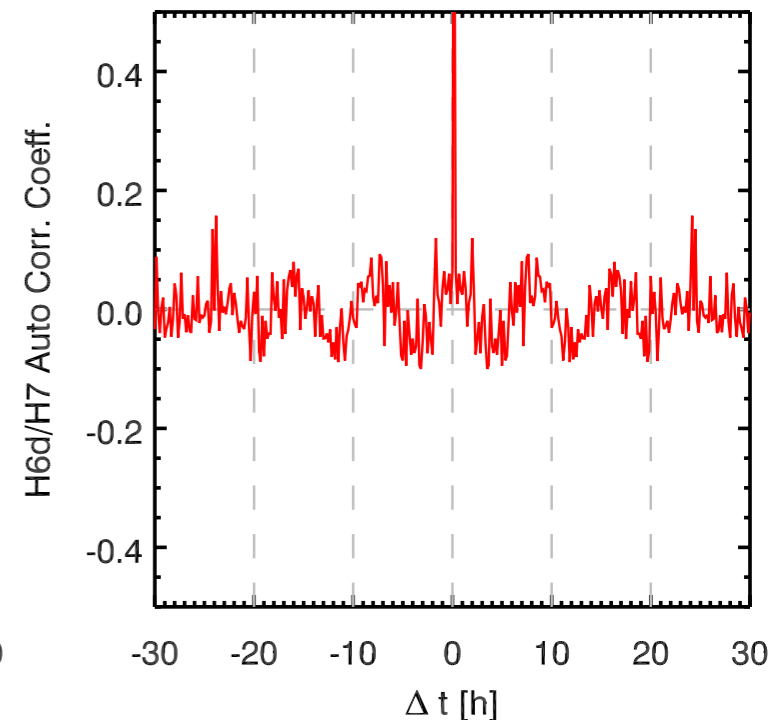
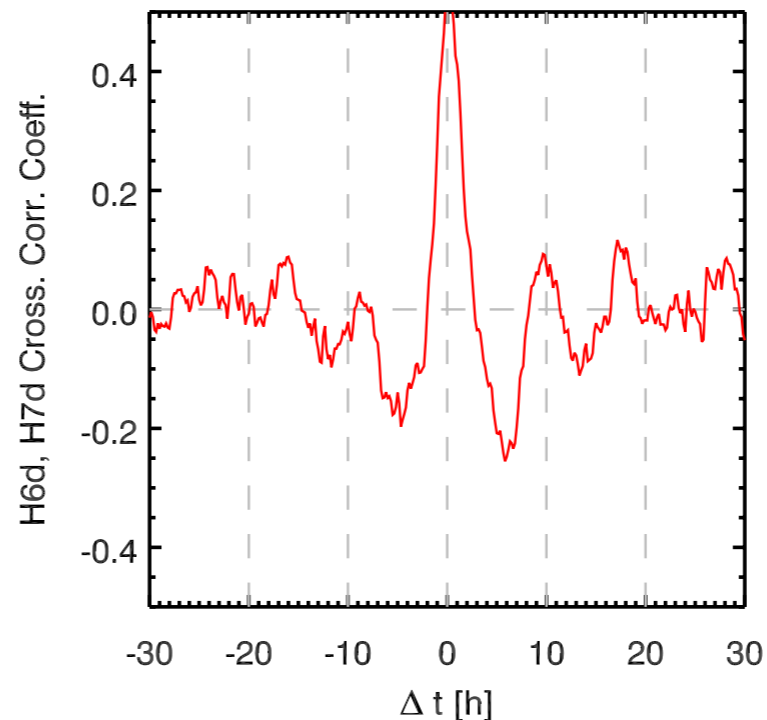
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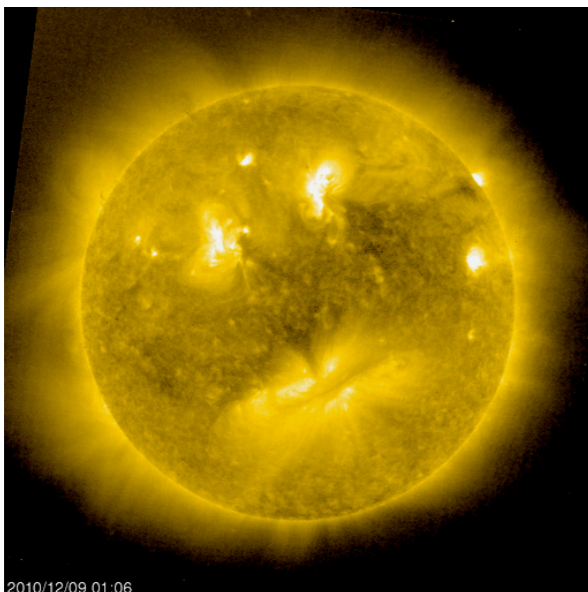
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Summary

- Beside the known jet events, long lasting net fluxes of JE were observed by Ulysses
- Jupiter's "fingerprint" detectable 1.2 AU away or even beyond 2 AU in the energy spectrum and counting rates
- Connection between observation of anisotropies and Jovian periodicity
- Pitch-angle dependent transport models may help in understanding the first hours of a Jovian electron burst (ongoing work...)



2010/12/09 01:06

SOHO, 2010/12/09