Another Look at the December 2006 SEP Events

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STEREO SWT Meeting

Meudon, France

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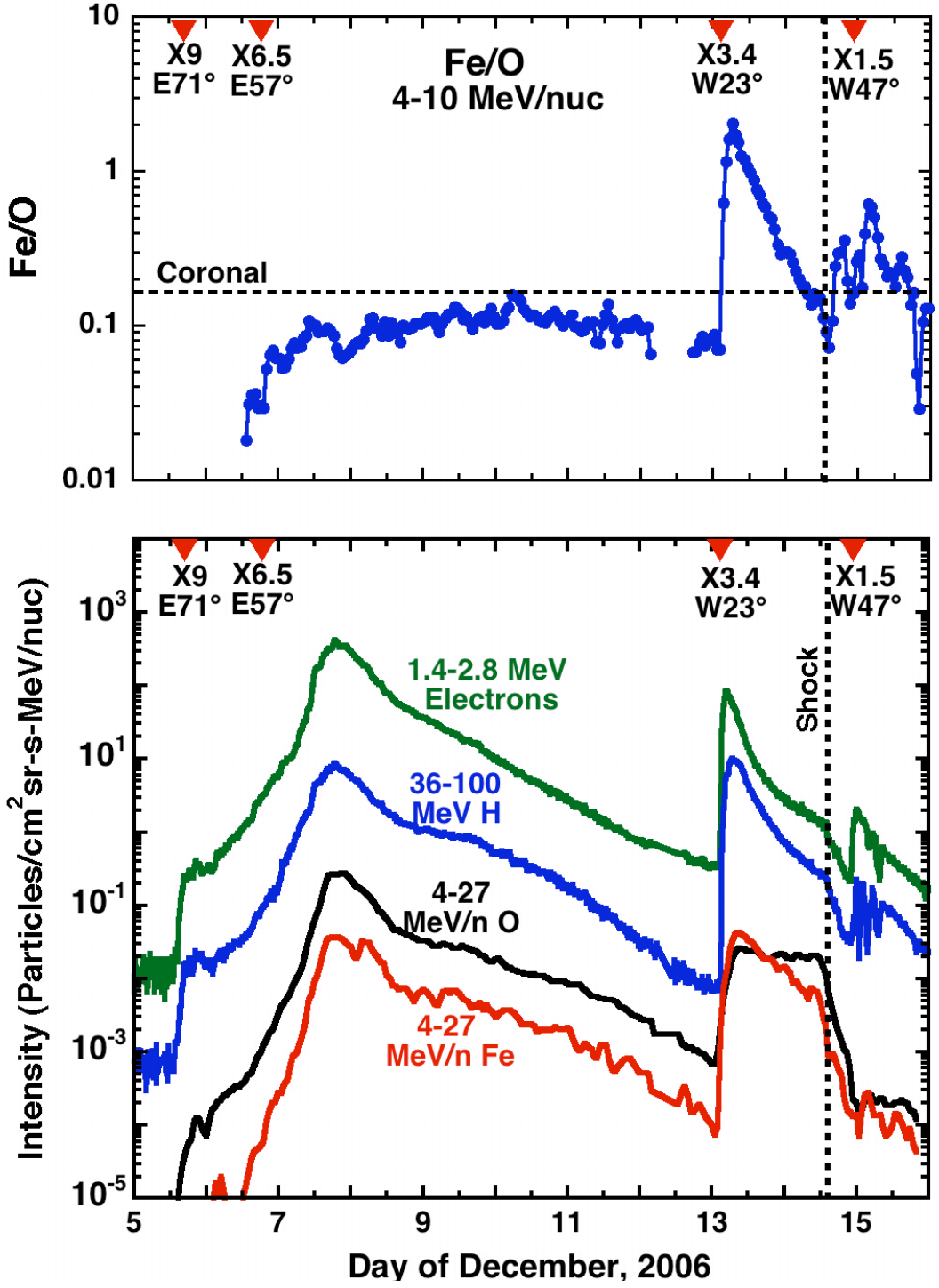
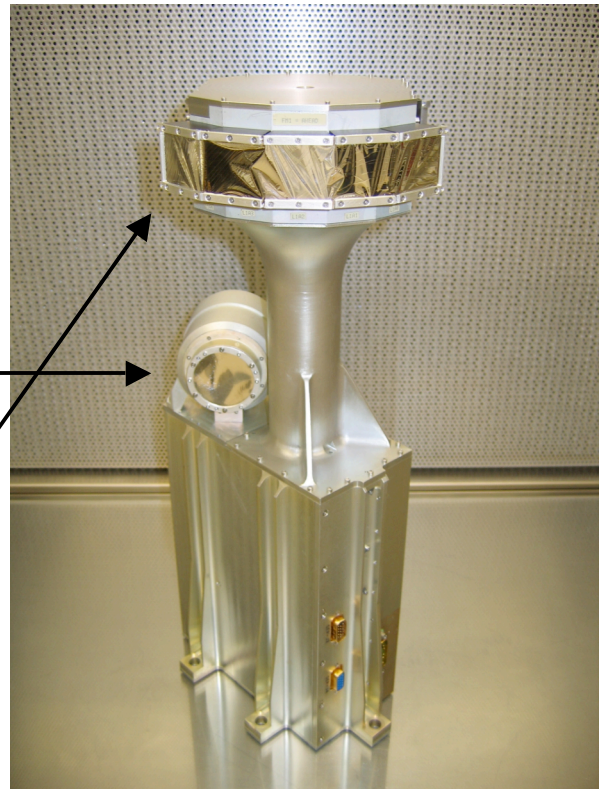
The SEP Events of December 2006



HET

LET



On-going Studies involving the December 2006 Events

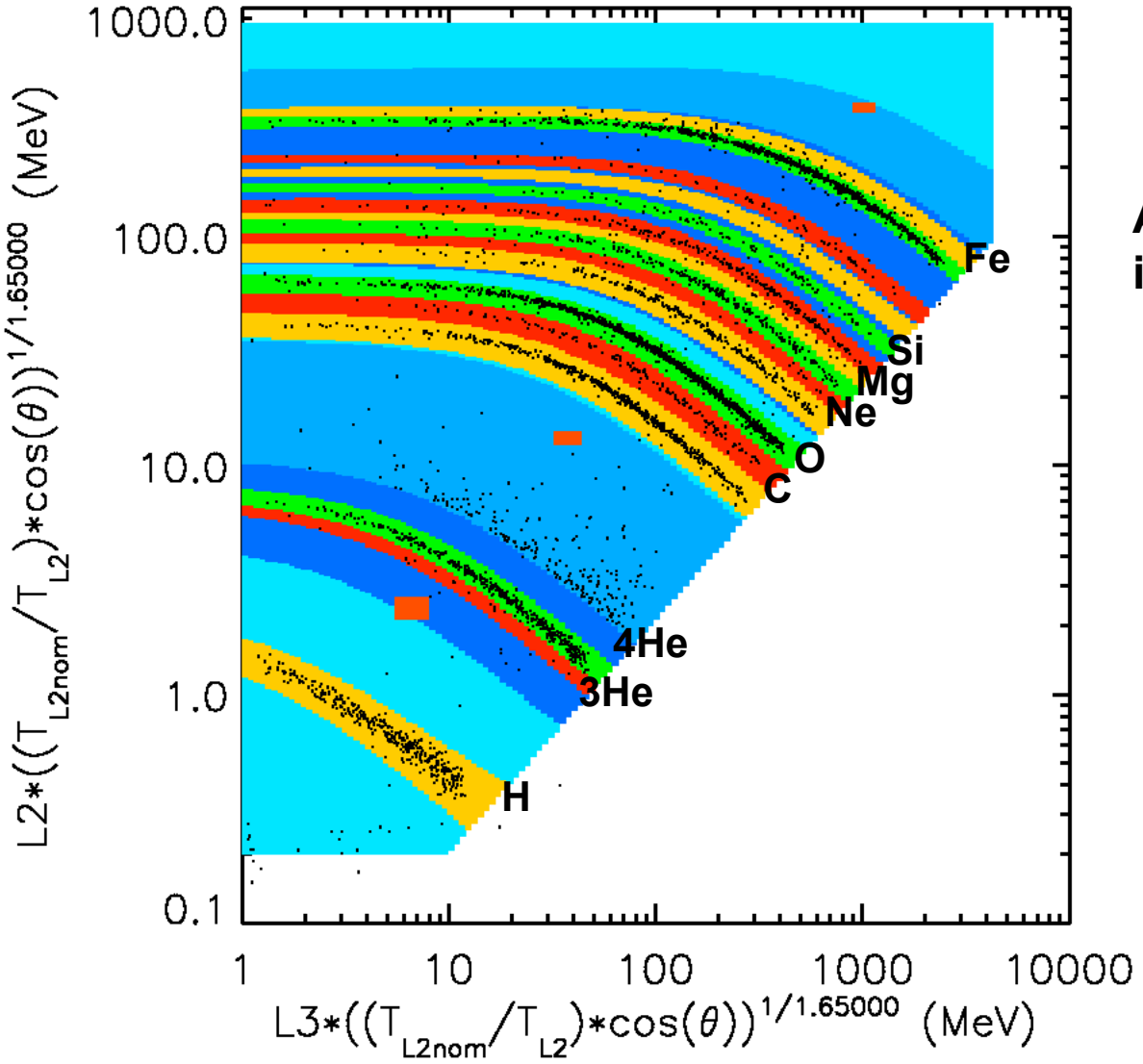
- Test models for “hybrid events” (mixed impulsive and gradual composition)
- Determine Q/M-dependence of spectral breaks - relate to acceleration & transport models
- Survey 50 largest SEP events of solar cycle 23
- Multi-spacecraft study of SEP study of transport
- Comparison of SEP and CME kinetic energies

Today:

Compare SEP arrival times with flare and CME timing

First preliminary results using STEREO instruments

Onboard analysis sorts hundreds of events per second by species and energy

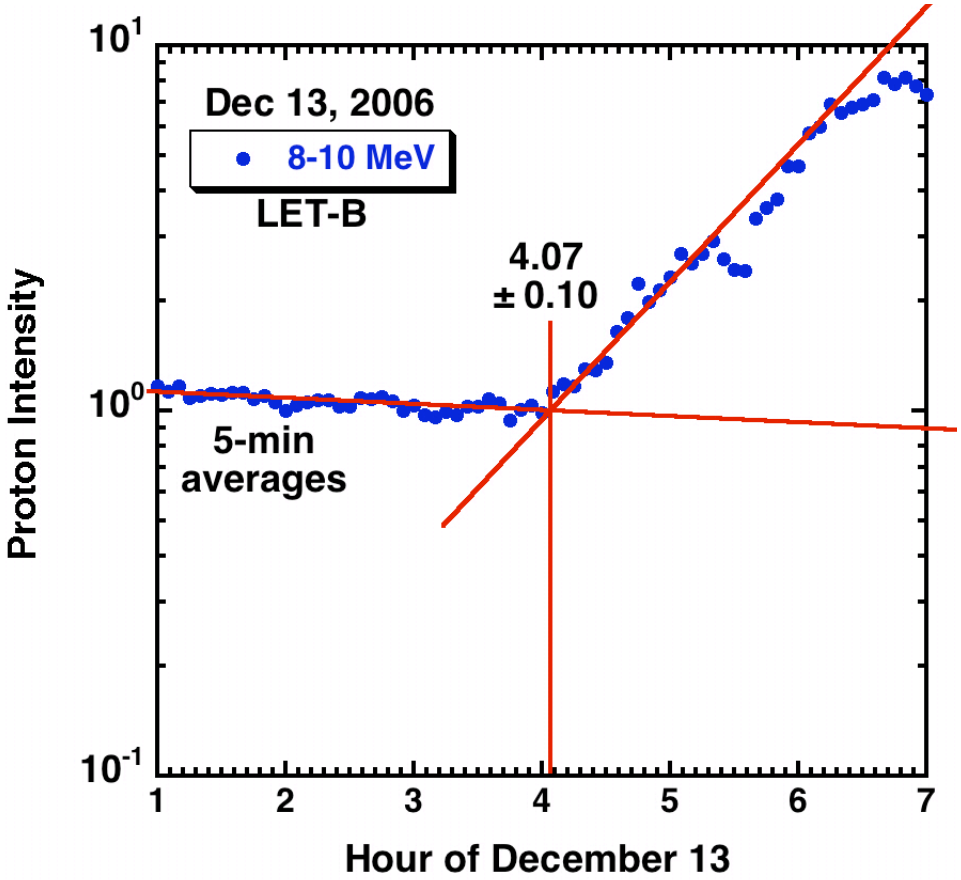


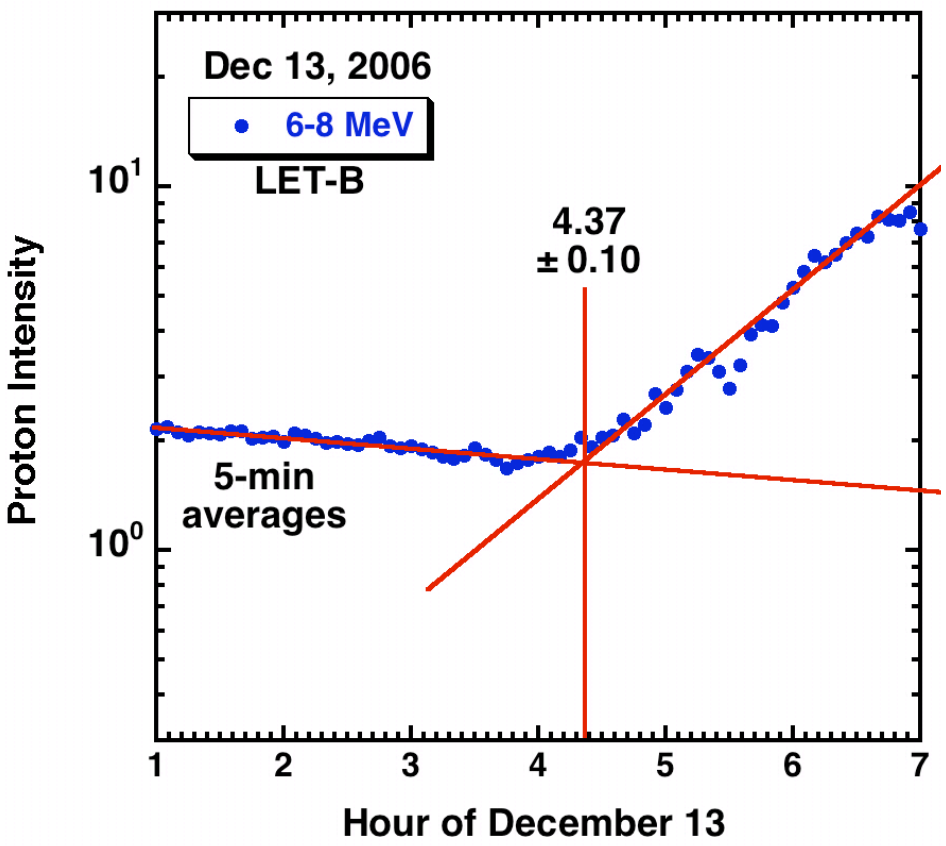
LET L2 vs L3 Response Matrix

A total of 16 species are identified in ~12 energy bins

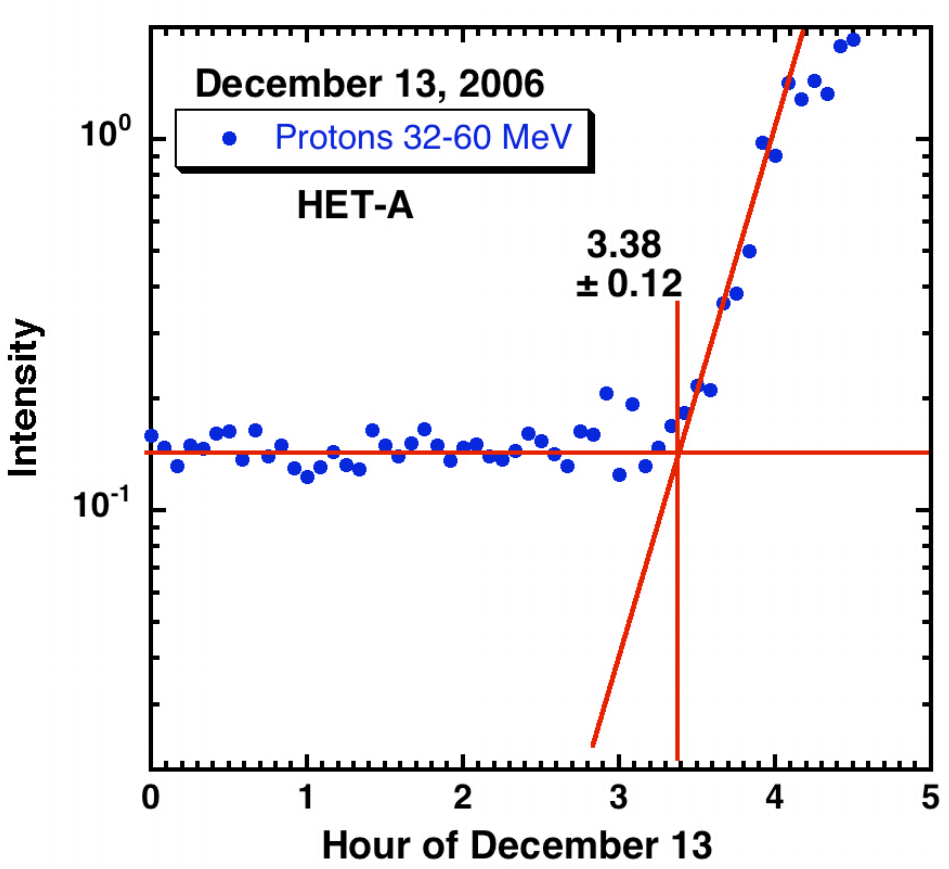
How do we measure SEP arrival times?

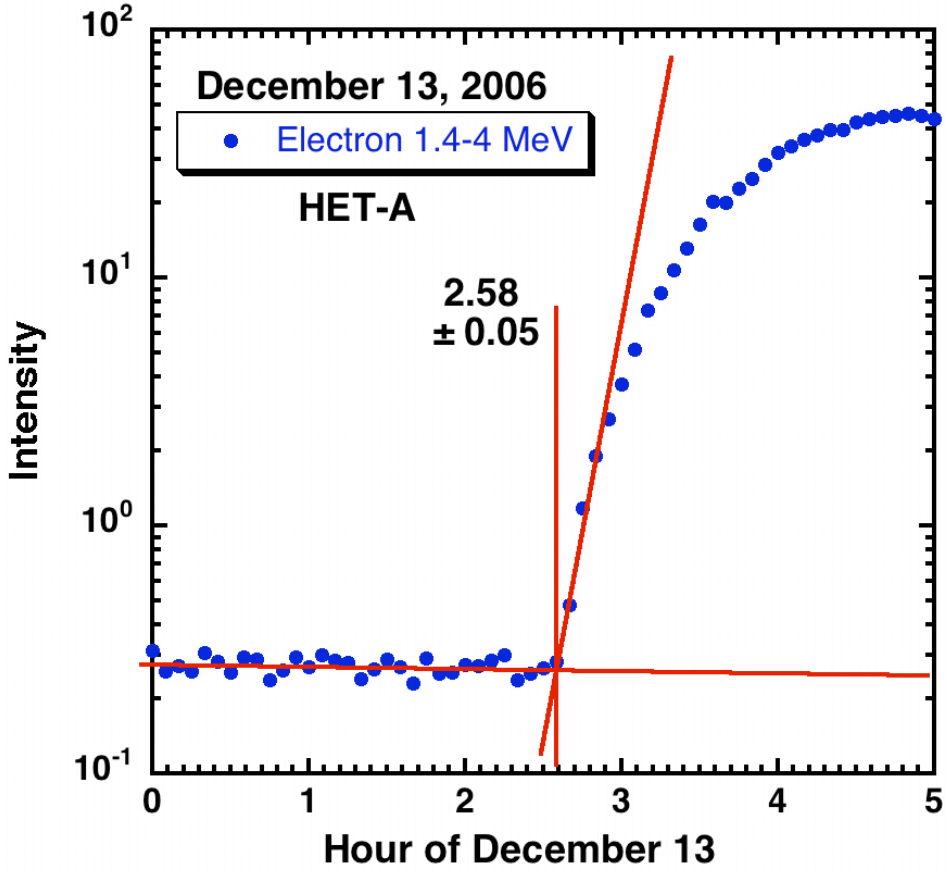
Examples from LET: Onboard processing allows up to ~1000 events

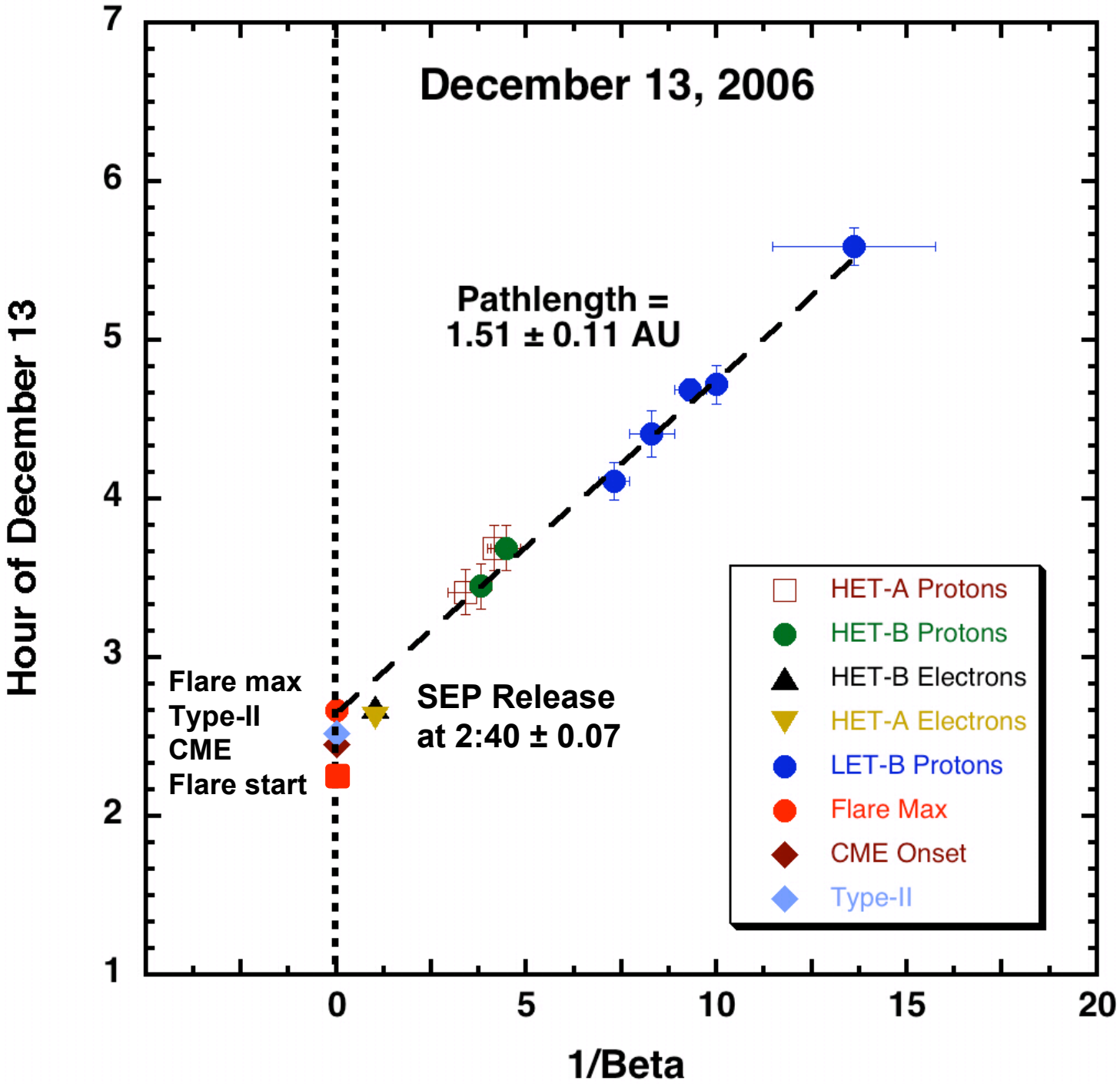




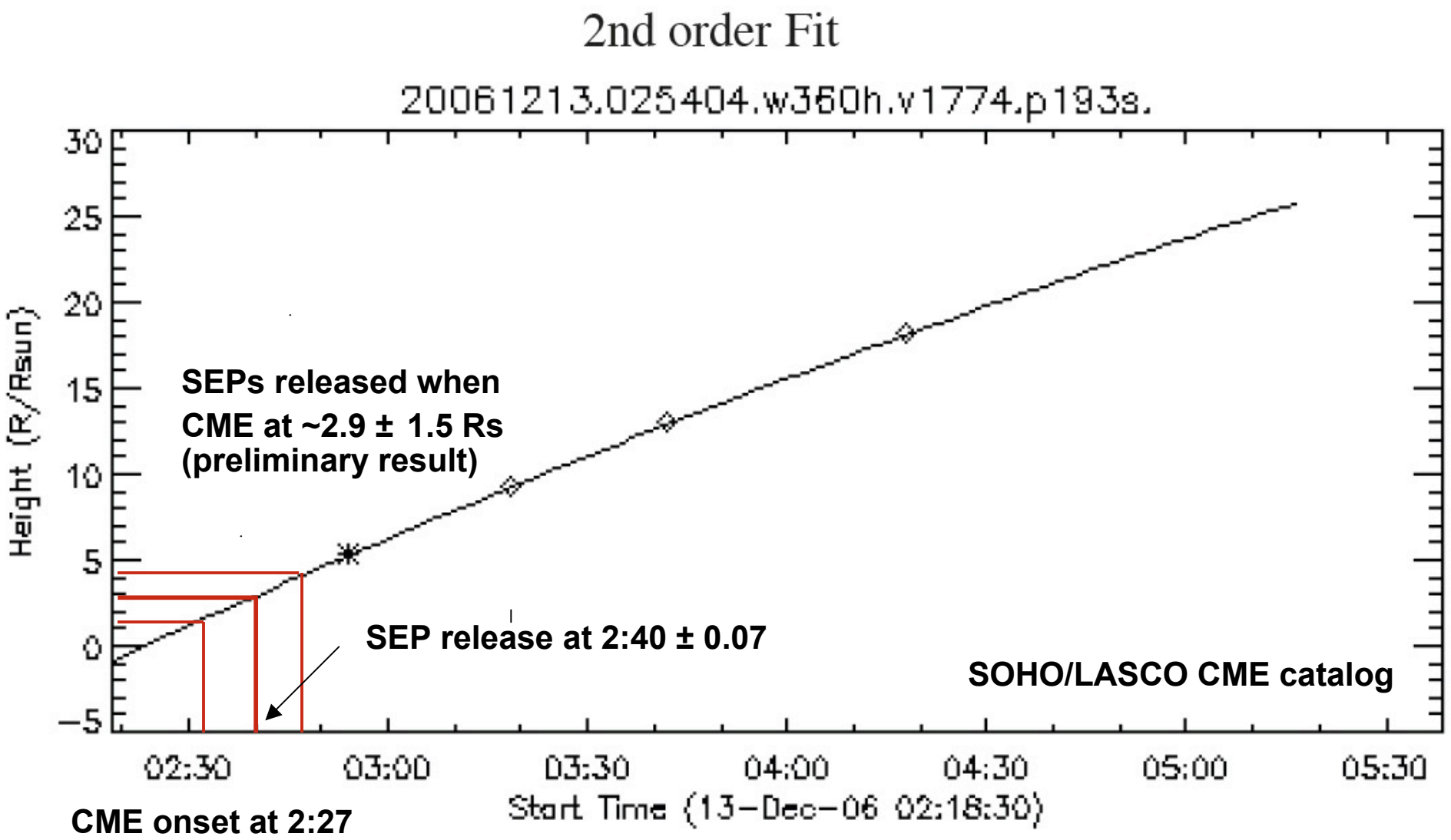
Examples from HET



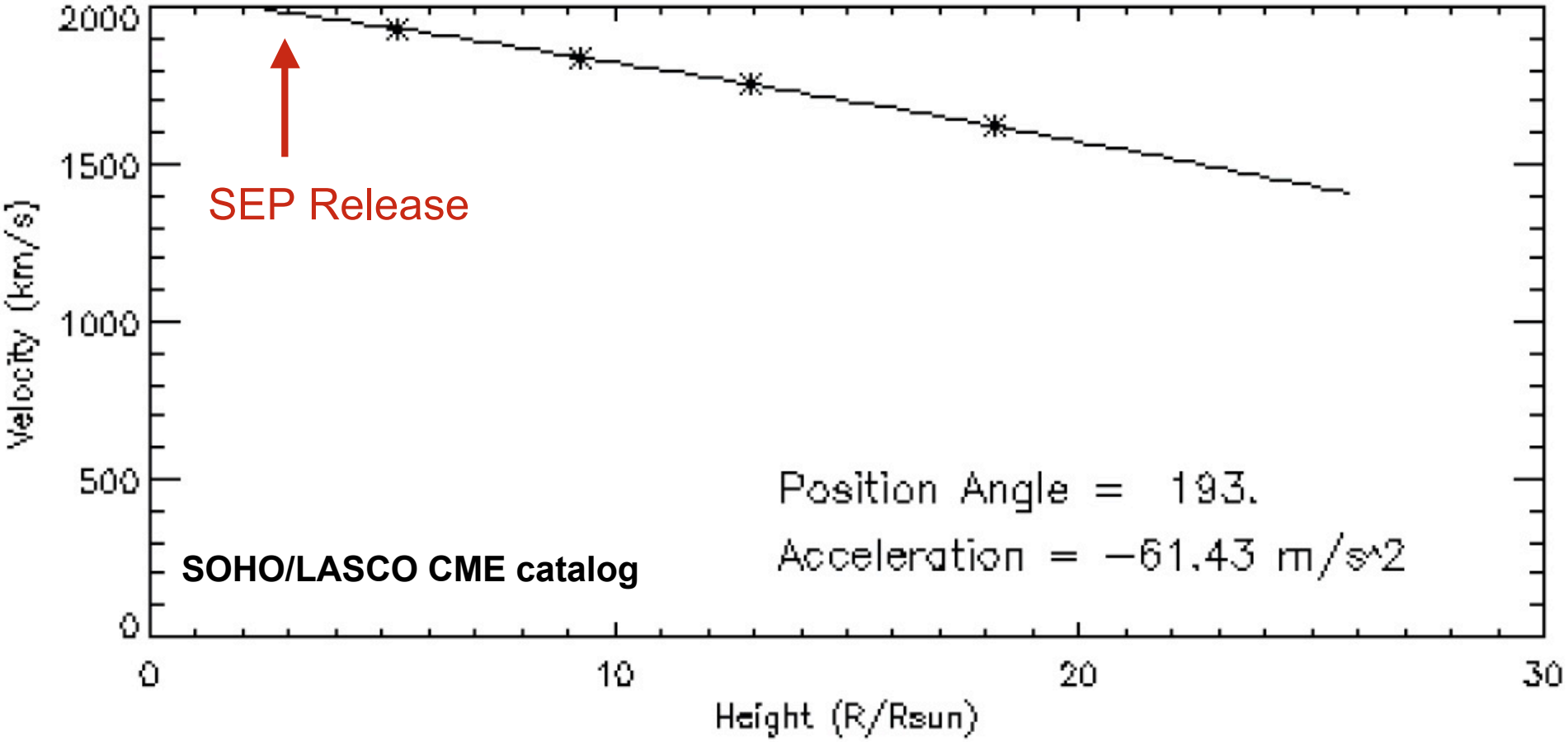



December 13, 2006
Pathlength =
1.51 ± 0.11 AU
SEP Release
at 2:40 ± 0.07
Flare max
Type-II
CME
Flare start
HET-A Protons
HET-B Protons
HET-B Electrons
HET-A Electrons
LET-B Protons
Flare Max
CME Onset
Type-II
Hour of December 13
1/Beta
1
2
3
4
5
6
7
0
5
10
15
20

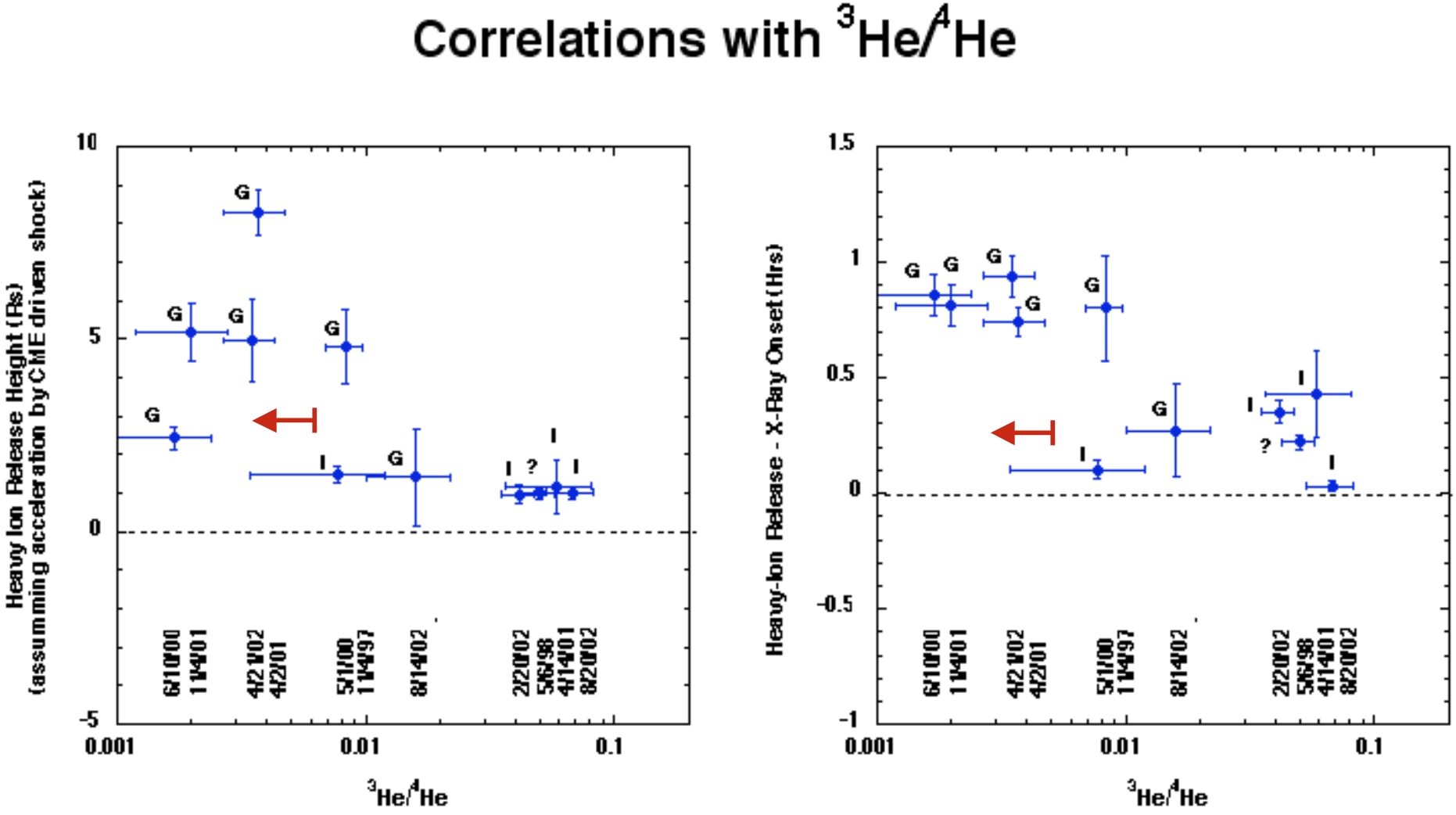
Where was the CME when SEPs were released?



At the time when SEPs were apparently released, the CME velocity was ~2000 km/s

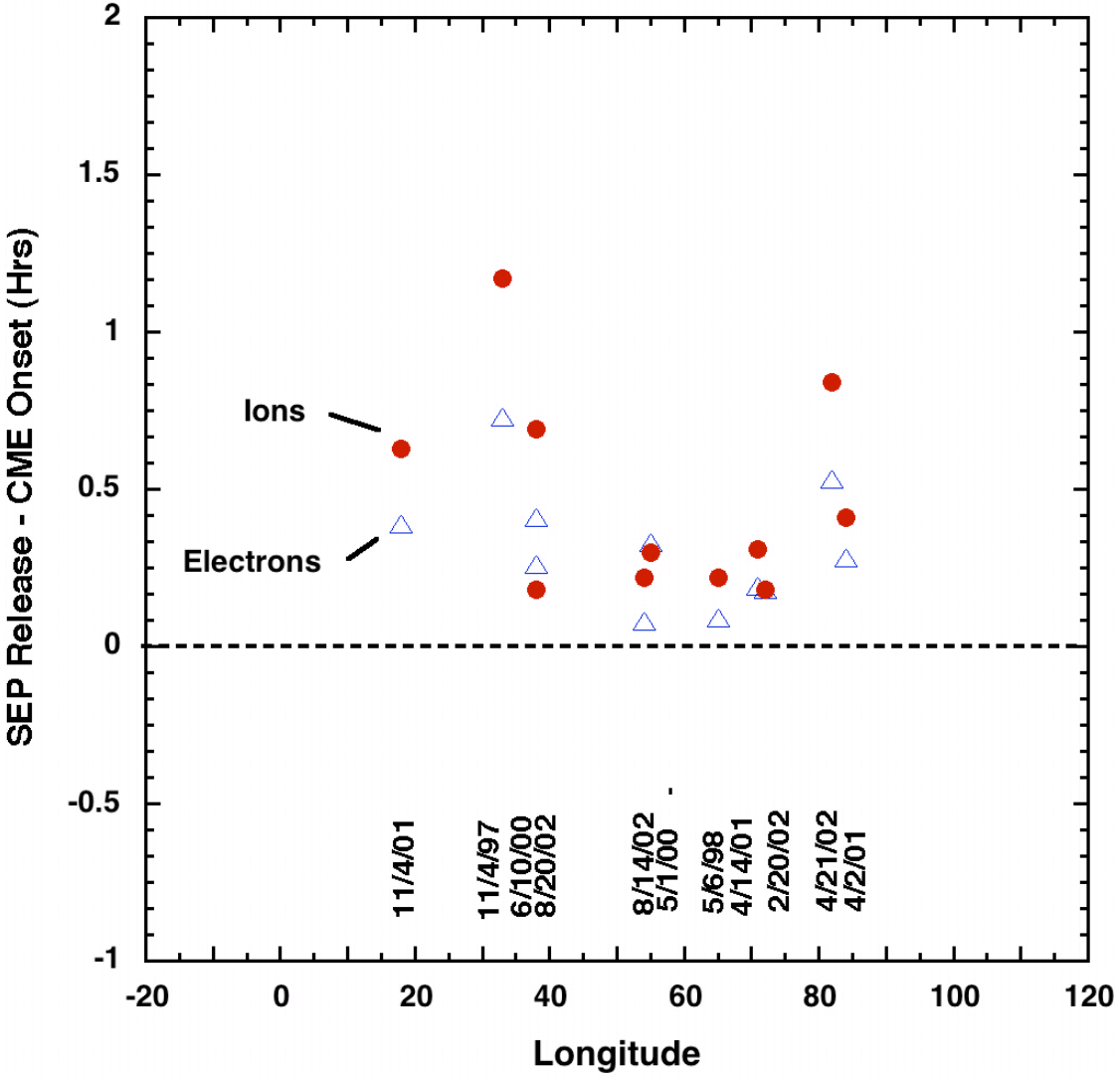


Comparison with earlier work:



Based on ACE, SOHO, and GOES data from solar cycle 23 - Mewaldt et al. 2003

Earlier study found SEP delays depend on longitude



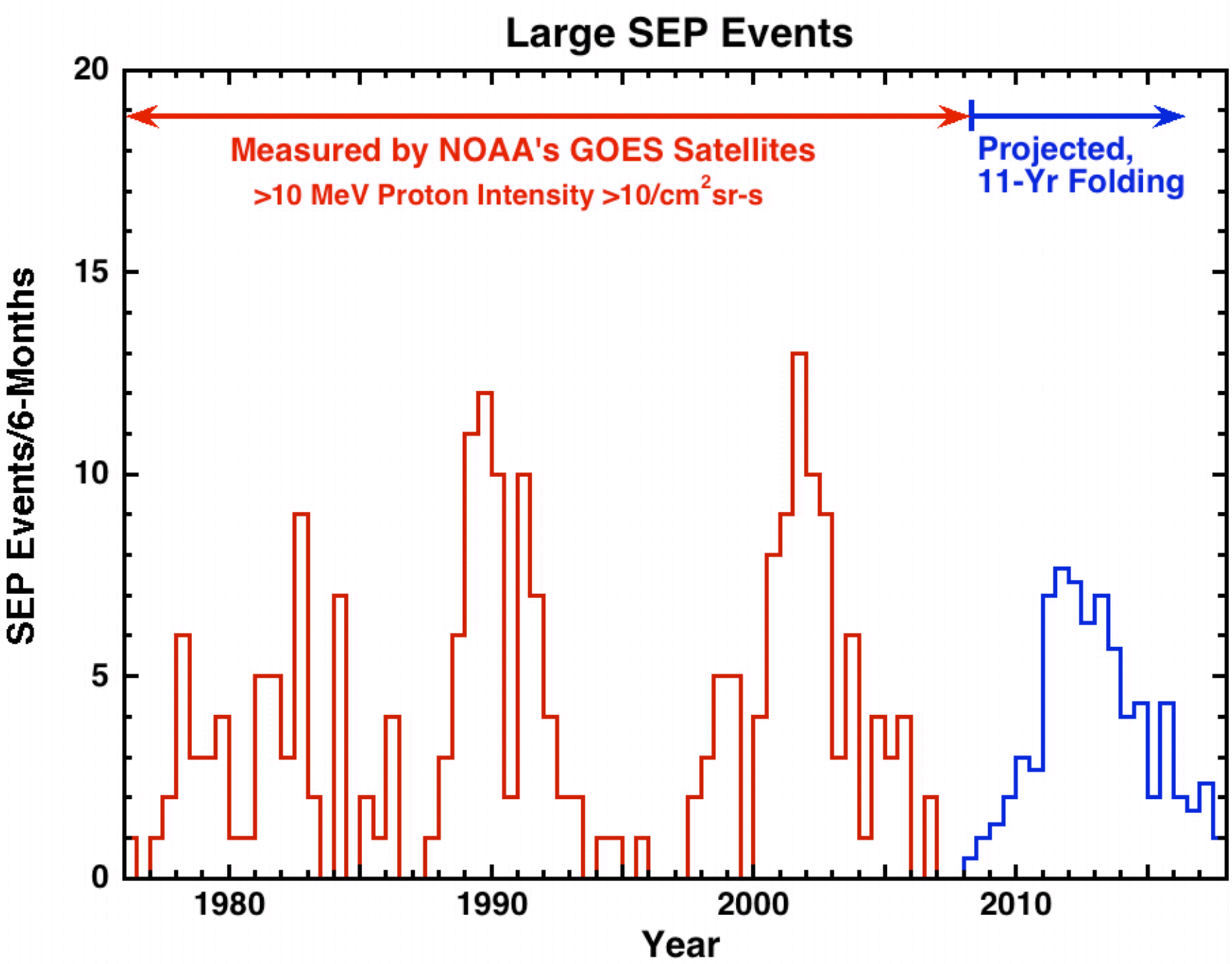
- Scattering?
- Time for shock to reach field line?
- Flare contribution?

STEREO can investigate these possiblities

Mewaldt et al. 2003

Summary

- The on-board analysis capabilities provide high count rate data that facilitate accurate timing of large SEP events
- Possible issues: some HET proton bins have some electron contamination and two LET proton bins may have higher energy proton contributions (hopefully fixed when we uploaded final matrices in April, 2007).
- SEPs in the December 13, 2006 event apparently were released very low in the corona (<5 Rs) and may include either flare or shock accelerated particles, or both.
- Multi-spacecraft studies of SEP timing may resolve key issues of SEP origin and transport


Large SEP Events
Measured by NOAA's GOES Satellites
>10 MeV Proton Intensity >10/cm2sr-s
Projected,
11-Yr Folding
SEP Events/6-Months
Year
0
5
10
15
20
1980
1990
2000
2010