MEPS Justification for 2 Units

In our last ppt, we showed that events can be missed or other wrong information may be gleaned from incomplete pitch-angle coverage.

In this presentation, we show results of a more quantitative study which we performed using STEREO MAG data and a representative configuration of MEPS on a possible L5 S/C.

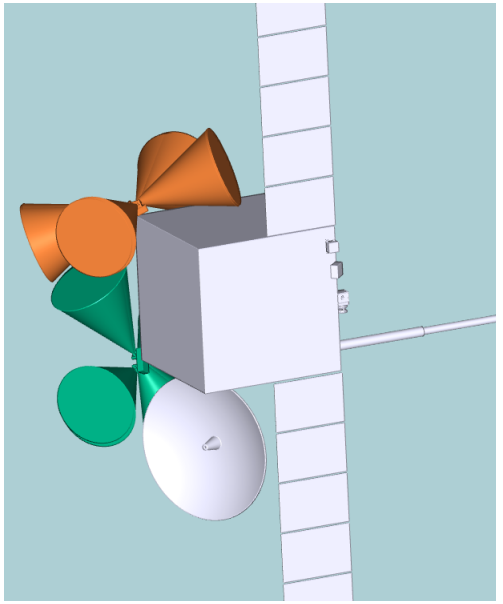
Input

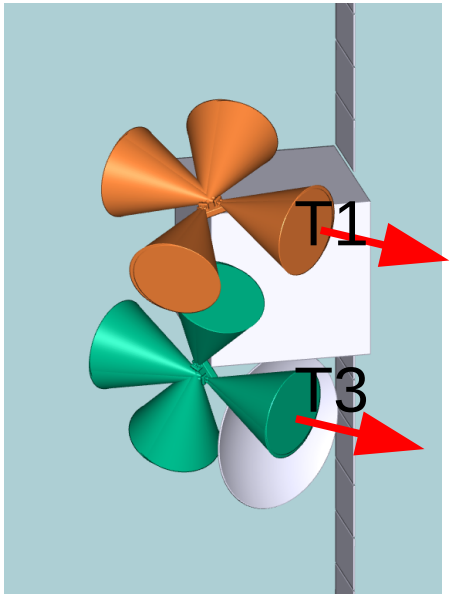
- STEREO A MAG data at 1 minute, 10 minute and 1 hour time resolution for 2007 – 2017 (omitting 2015)
- Data taken from http://aten.igpp.ucla.edu/forms/stereo/level2_plasma_and_magnetic_field.html
- Lines of sight for MEPS telescope FOVs as per César Martin‘s accomodation study.
- 45-degree full opening angle of a single MEPS telescope
- 40 degree angular width for the onset times of a particle event (Krucker & Lin, ApJ, **542**:L61–L64, (2000))
- Thus consider acceptance angle

$$\alpha = \sqrt{22.5^2 + 40^2} \sim 46^\circ$$

Accommodation and FoVs

The bidirectional MEPS telescopes point in four different directions. Accommodation on S/C is not easy, but preliminary studies showed that the following configuration is feasible:



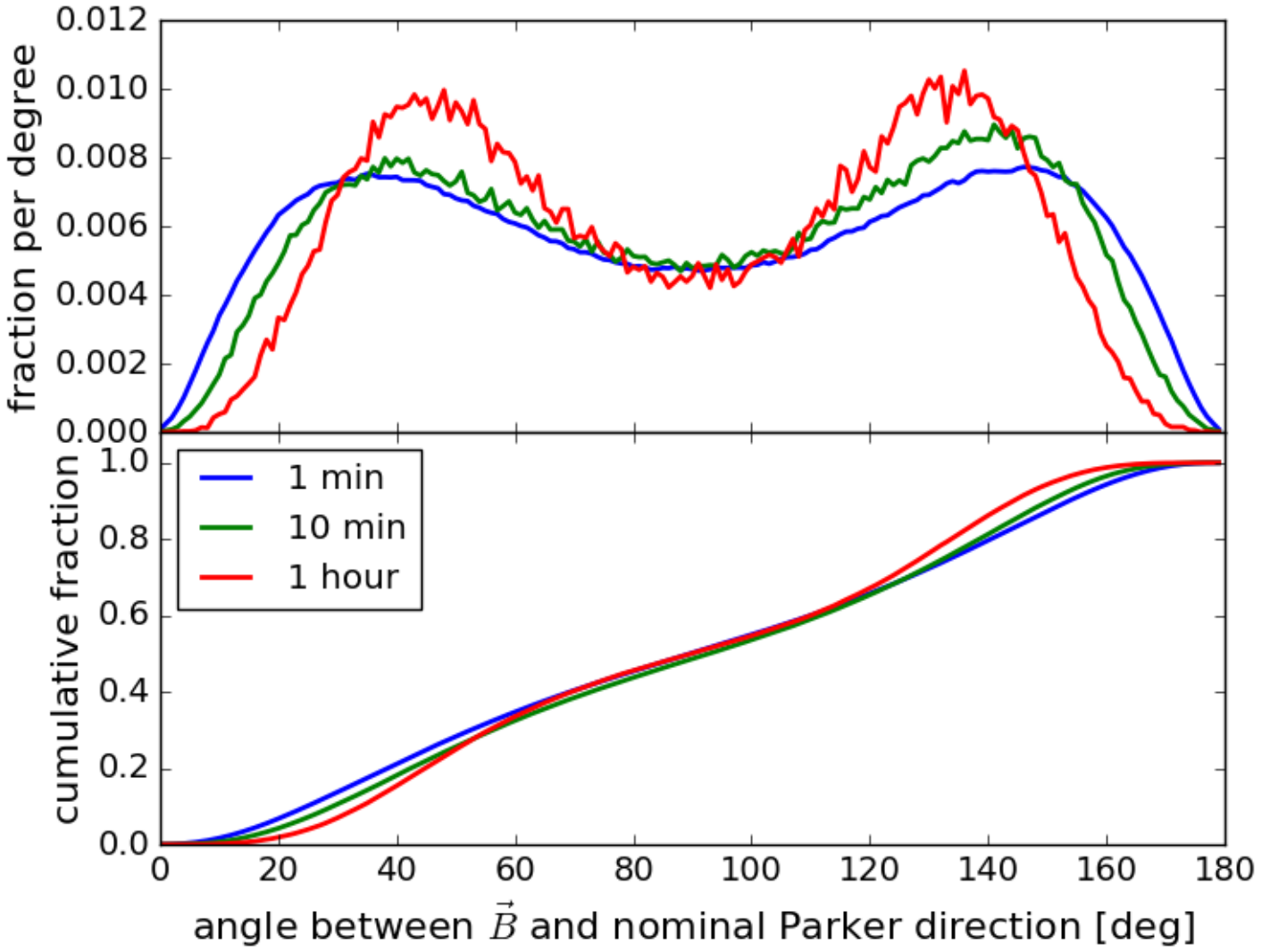


T1 and T3 point approximately in the direction of the nominal Parker spiral (45°).
T2 and T4 point in the only directions which could be accommodated.

The lines of sight of the four telescopes point in the following directions in RTN coordinates which were also used for B_{IMF}:
T1: (-0.652, 0.755,-0.059); T2: (0.452, 0.815, -0.363)
T3: (-0.752, 0.648, -0.113); T4: (-0.084, 0.510, 0.856)

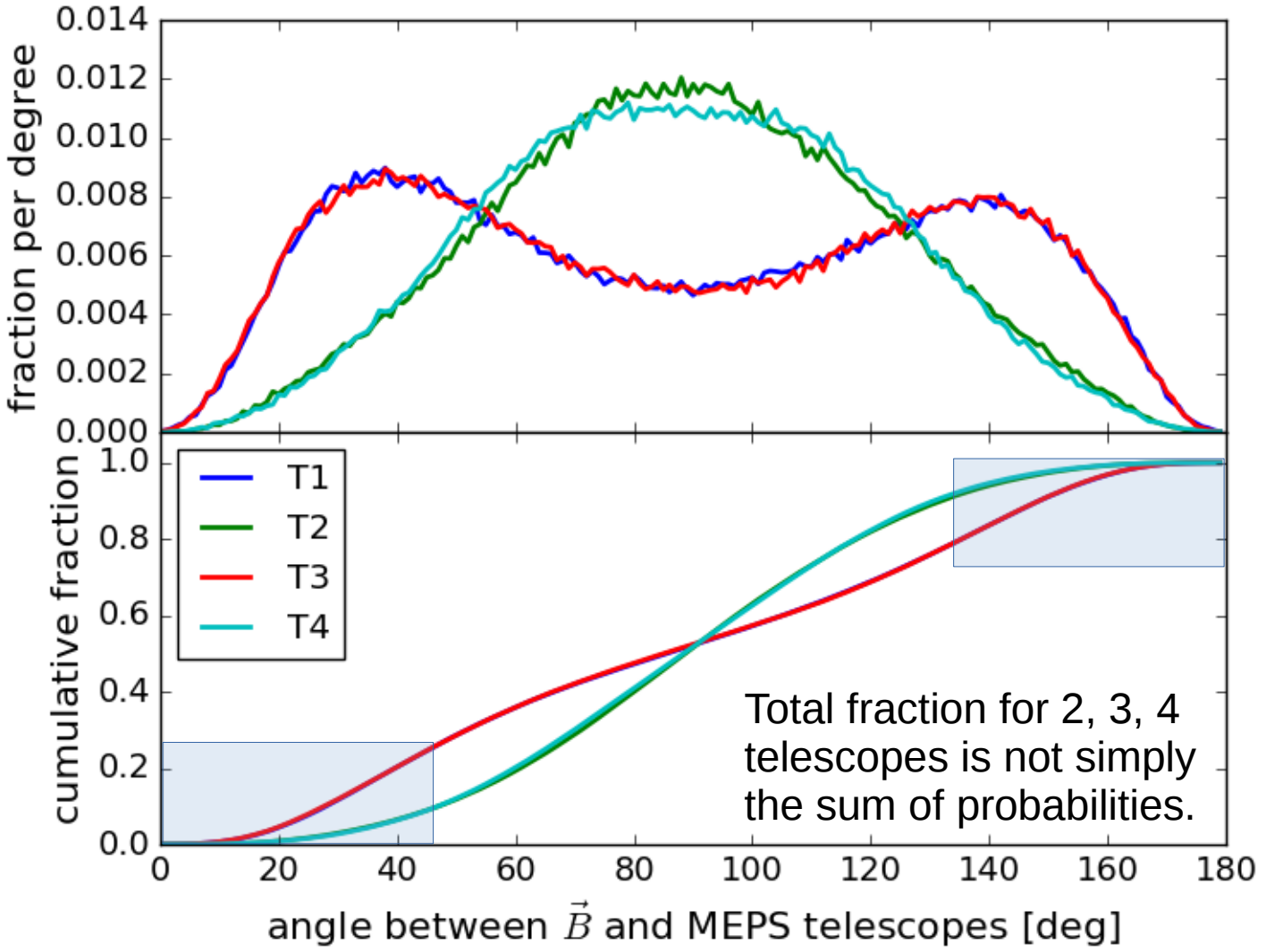
Direction of B_{IMF}

Distribution of B_{IMF} angles with respect to nominal Parker angle



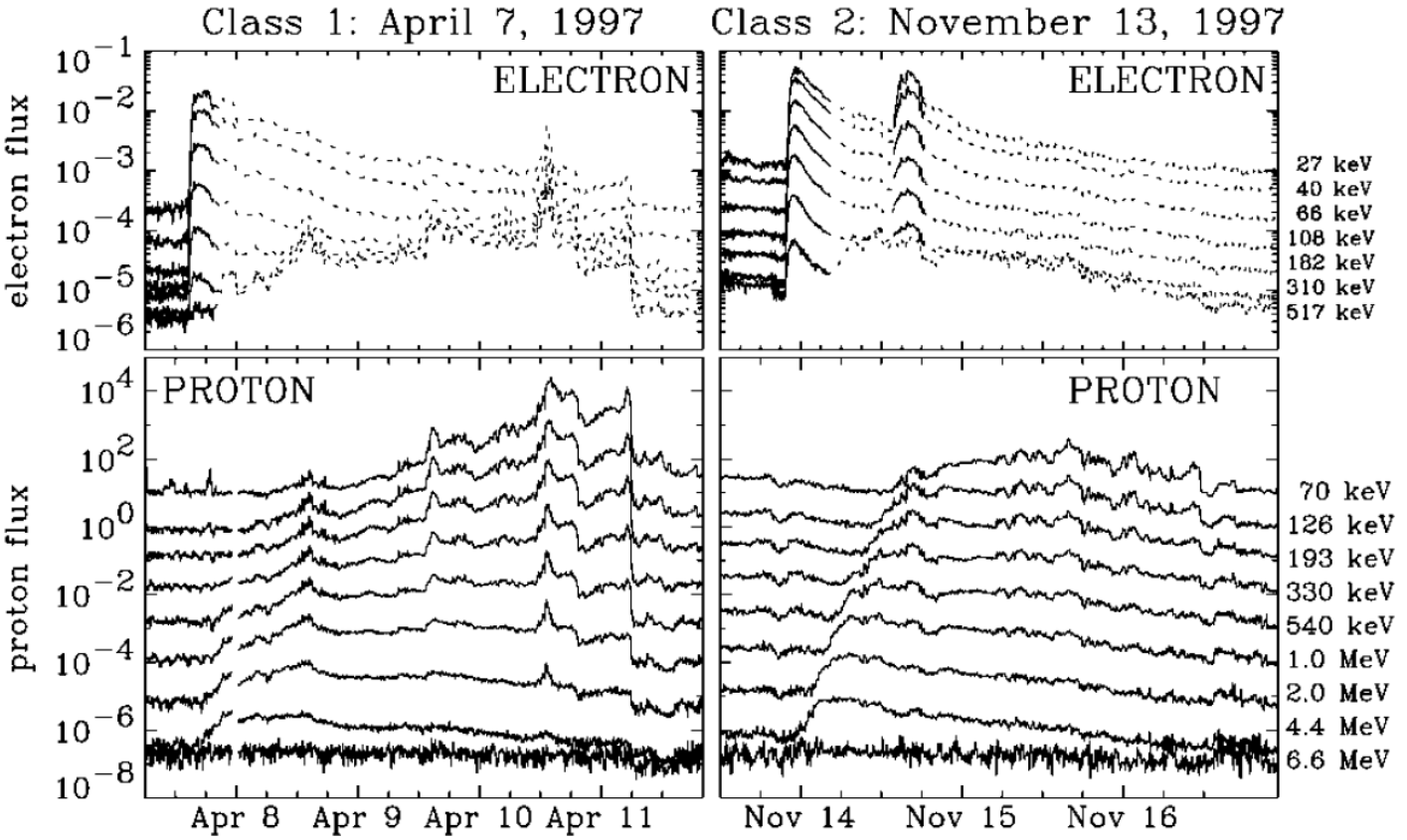
Direction of B_{IMF}

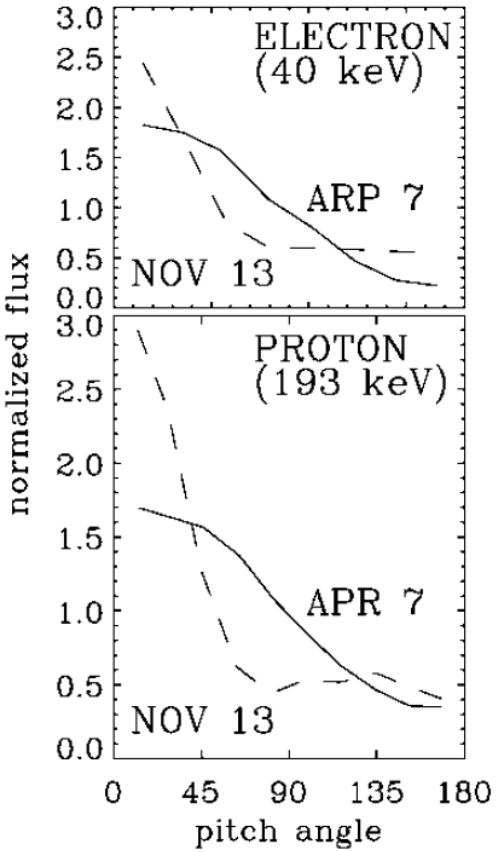
Distribution of B_{IMF} angles with respect to MEPS telescopes



How often do we see Onsets?

Calculate probability that B_{IMF} falls within one of the MEPS telescopes, accounting for the pitch-angle widths of particles during the onset phase. $\alpha = \sqrt{22.5^2 + 40^2} \sim 46^\circ$





How often do we see Onsets? II

Results (using 1 min, 10 min, 1 hour B_{IMF} data):

T1 sees onset (50%, 46%, 40%) of the time
T2 sees onset (23%, 18%, 11%) of the time
T3 sees onset (50%, 46%, 40%) of the time
T4 sees onset (22%, 17%, 10%) of the time

Probability to see onset of event in T1 or T2 is (67%, 61%, 49%)
Probability to see onset of event in T3 or T4 is (67%, 60%, 48%)

Probability with all four telescopes is (86%, 77%, 60%)

In other words, with only T1 (ESA baseline), we miss every second event onset. Is this good enough for an operational mission?

Discussion & Conclusions

- The numbers presented in the previous slide are sobering.
- Two assumptions drive the results:
  - Pitch-angle width during the onset times:
    - This can be wider or narrower, seemed like a good value
    - If we choose too wide a value, we‘ll see events which are smaller that they actually are
  - Opening angle of telescopes:
    - We could increase the opening angle to, say, 55 degrees
    - This has implications for resolvig isotopes
    - This has implications for accommodation. It gets more difficult!
- In the end it is up to ESA to decide whether a <50% probability of seeing the onset is „good enough“.