

Data based correction of Helios E6 measurements - Proton contamination of relativistic electron measurements

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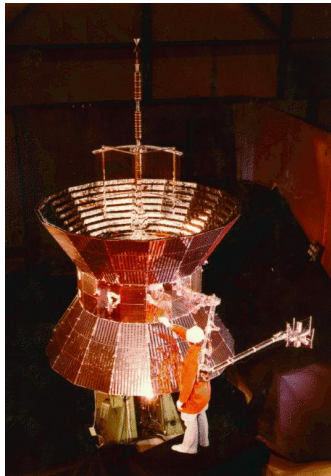
26. September 2018

Motivation

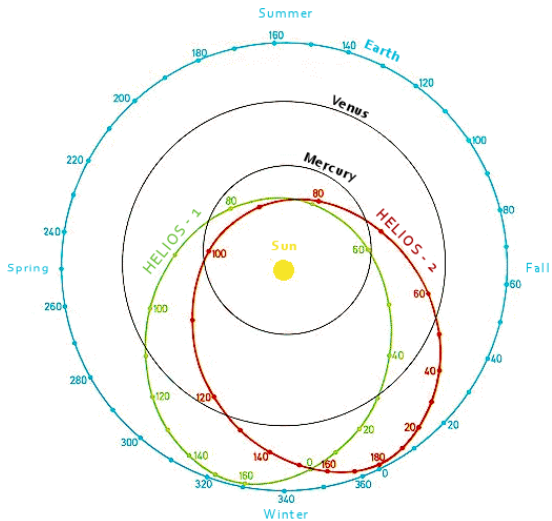
- 42 years after the launch of the twin spacecraft HELIOS in SC 21, Parker Solar Probe and Solar Orbiter will explore the inner heliosphere during SC 24/25.
- Although Helios was only equipped with in-situ instruments many problems concerning SEPs can be addressed
- Especially SC dependence of particle propagation parameters investigations in the inner heliosphere
- Multi-spacecraft events ...
- But studies relies on data quality!



Orbit

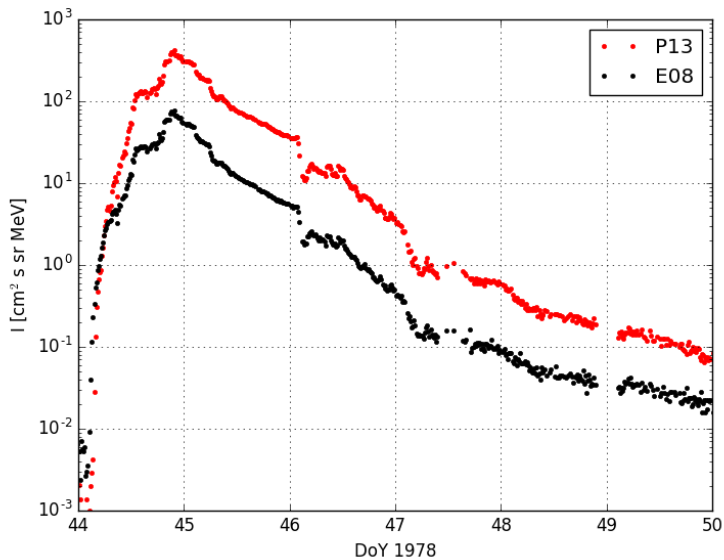


NASA

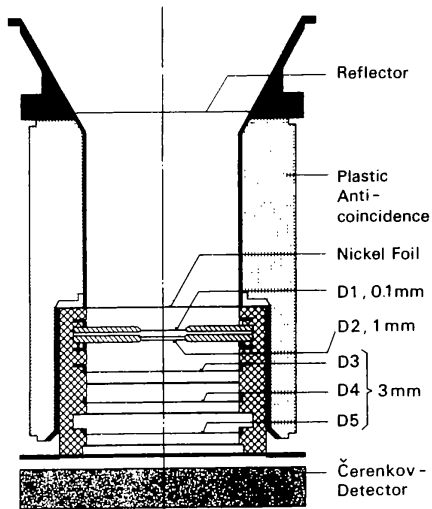


NASA

Motivation



Scheme of the particle telescope Experiment 6



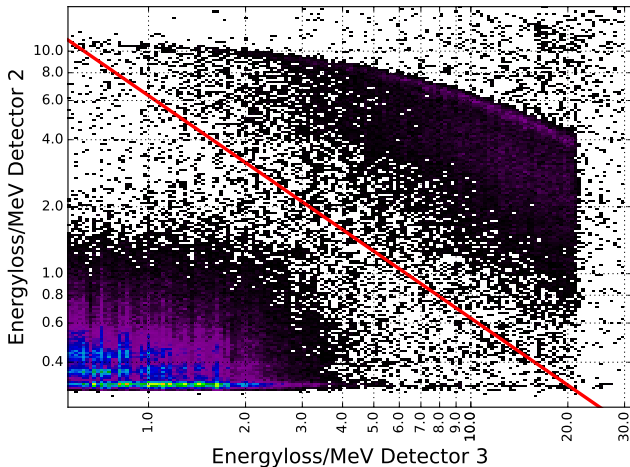
Heber, 1989

Relevant channels

Name	Energy/MeV	Coincidence
P13	12.8 – 26.8	1, 2, 3, $\bar{4}$
P27	26.8 – 36.6	1, 2, 3, 4, $\bar{5}$
E08	0.8 – 2.0	$\bar{1}$, 2, 3, $\bar{4}$
E2	2.0 – 3.0	$\bar{1}$, 2, 3, 4, $\bar{5}$

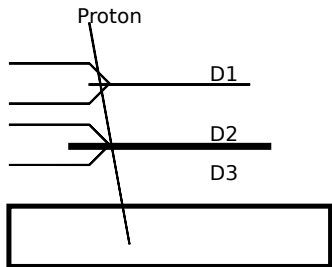
$\bar{1}$: Energyloss in detector 1 below 185 keV

Particle Identification

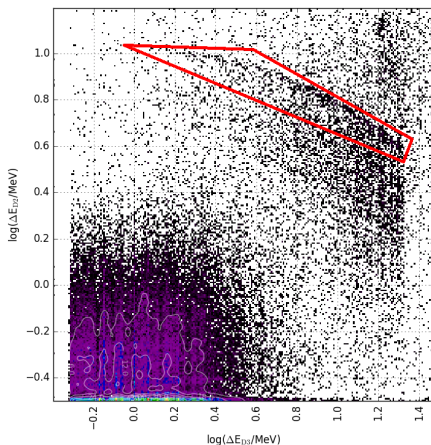


Energy loss in detector 2 versus detector 3 measured for the whole year 1978. Entries below and above the line are identified as electrons and protons, respectively.

Misinterpretation of protons in electron channels

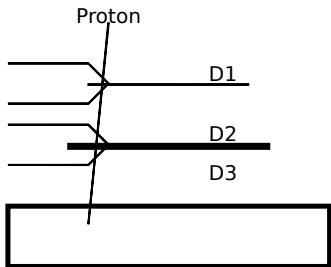


Coincidence: $\bar{1}, 2, 3$ (E08)

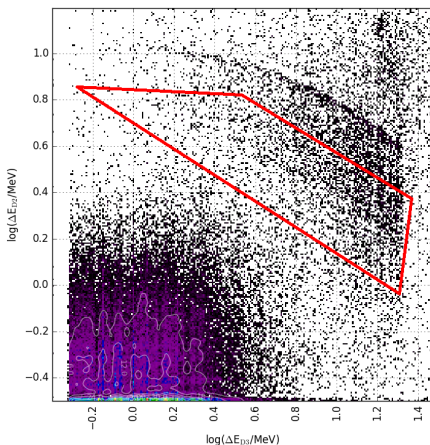


Data accumulated for one year

Misinterpretation of protons in electron channels

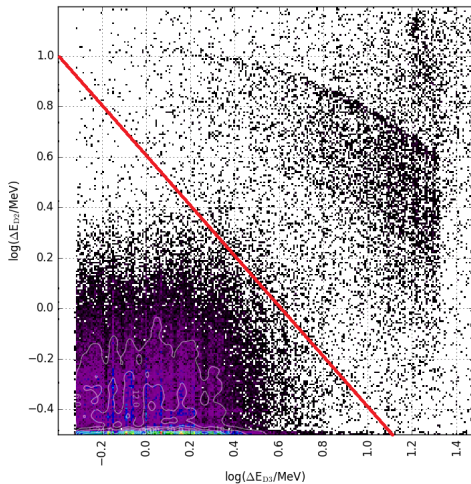


Coincidence: $\bar{1}, 2, 3$ (E08)



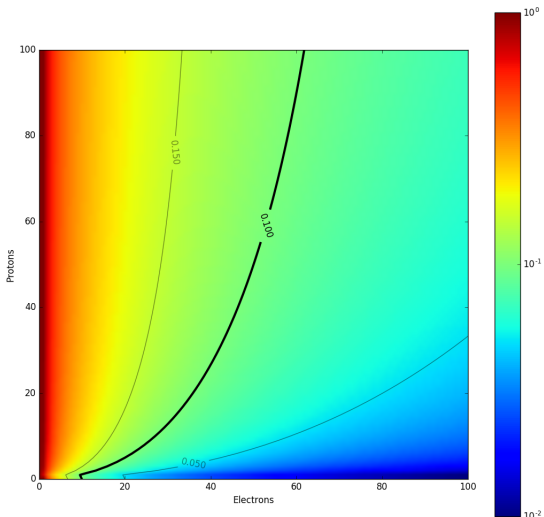
Data accumulated for one year

Application of the PHA correction



- Assuming e/p ratio r equal in PHA and countrates, thus:
- $C_{\text{corr}} = C_{\text{meas}} \cdot r$
- $r = \frac{N_{\text{below}}}{N_{\text{total}}}$
- Problem: PHA coverage

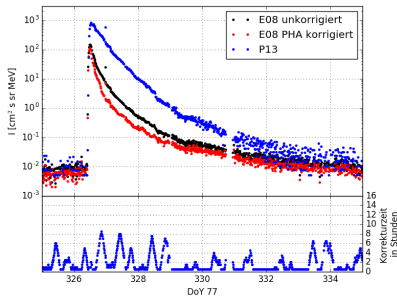
Estimation of statistical errors



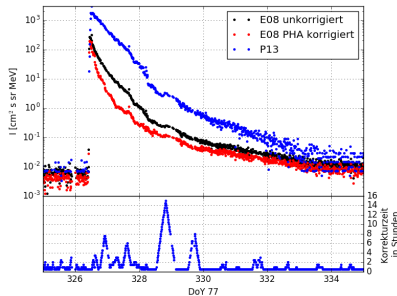
- Plotted statistical error as function of electron and proton counts in the electron channel
- We aim for a statistical error of less than 10% (indicated by lines)
- PHA accumulation times equal or larger than count rate sampling time
- Problem: In most cases accumulation time above a few hours

PHA correction (multi-spacecraft SEP event November 22, 1977)

Helios A



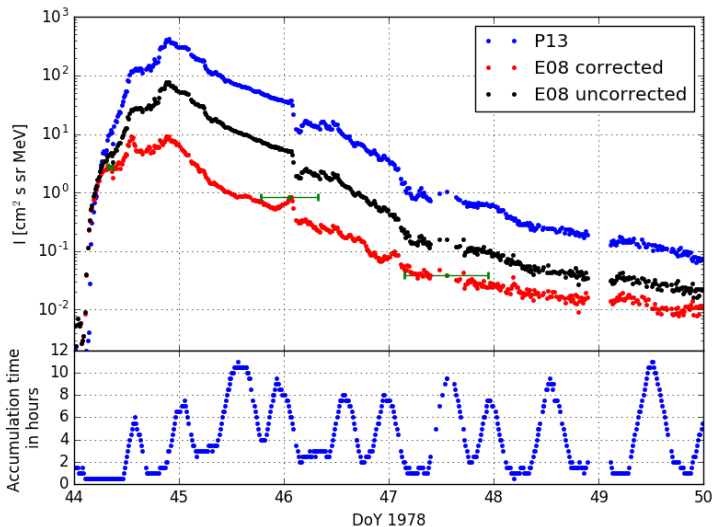
Helios B



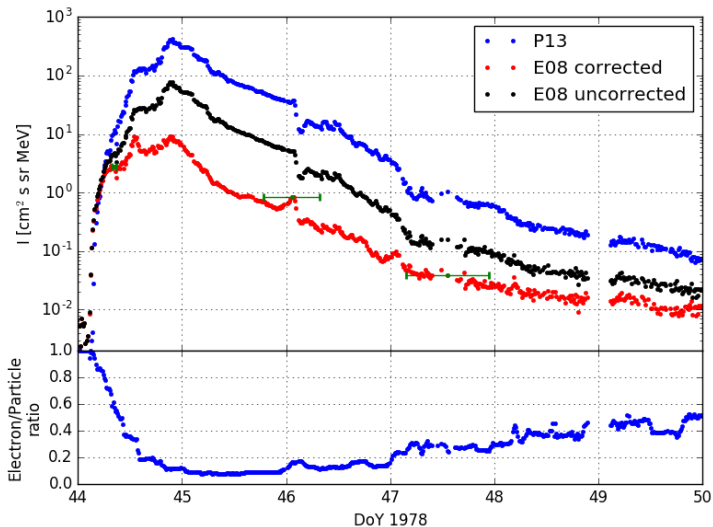
Upper panel: Uncorrected count rates of protons (blue dots), uncorrected count rates of electrons (black dots), PHA corrected count rates of electrons (red dots)

Lower panel: Needed accumulation time for statistical error below 10%

Corrected intensities (SEP event February 13, 1978, major problems)



Corrected intensities (SEP event February 13, 1978, major problems)



Summary

- Helios E6 electron measurements suffer from proton contamination due to instrumental reasons
- PHA based method developed and applied showing major cross talks. Less than 10% of the particles are electrons during the February 13, 1978 SEP event
- Correction are based on averaging periods longer than 2 hours in order to be statistically significant.
- The method leads to expected time profiles during the November 22, 1977 event
- But for the February 13, 1978 artefacts are observed.