Solar energetic particle measurements with EPD/LET

E. Valtonen[1)]
for the Solar Orbiter EPD/LET Team
[1)] Space Research Laboratory, Department of Physics and Astronomy, University of Turku, FI-20014 Finland

Science goals, instrument capabilities and measurements

Sources, acceleration mechanisms, and transport processes of SEPs

When does ion acceleration start and when is a shock most effective in accelerating particles?
- Where and when CME energy is converted to SEP energy
- How is acceleration related to changing magnetic geometry
- Sources of ion spectral breaks

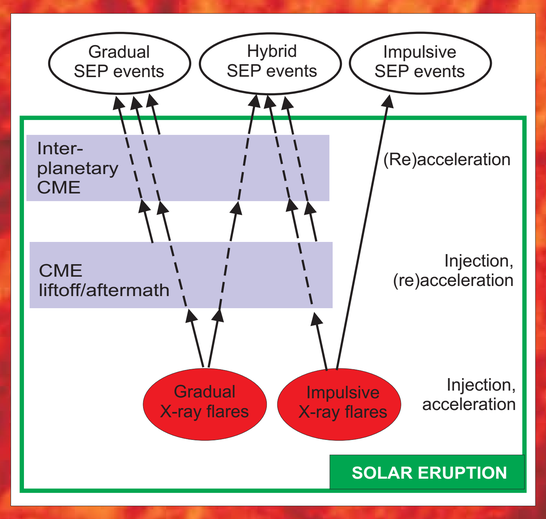
Why is the CME acceleration efficiency so variable?
- Why are gradual SEP event intensities and composition so variable
- Effects of the conditions in the inner heliosphere and IP space
- Proton amplified Alfven waves in shocks

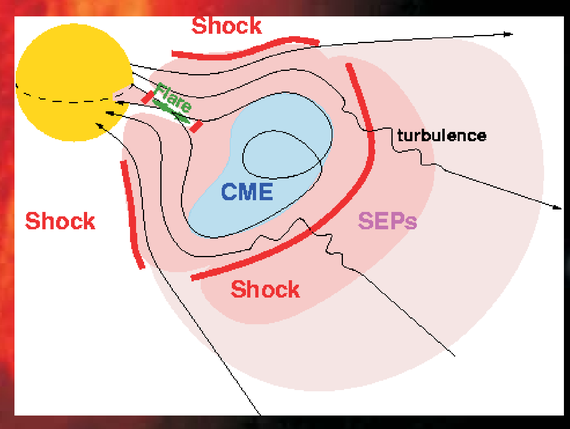
Impulsive SEP events
- Why is ^{3}He enrichment so variable
- Causes of enrichments of trans-Fe elements
- Variations of successive SEP event composition from the same active region

Role of hybrid SEP events
- Significance of flares in gradual SEP events
- Association of impulsive SEP events with large flares
- Association of ions with jets of narrow fast CMEs

Escape of particles to the heliosphere and scattering and transport along IP magnetic field
- Role of various escape mechanisms
- Solar wind turbulence
- Lateral transport

Collaborative observations with other EPD sensors and other Solar Obiter instruments

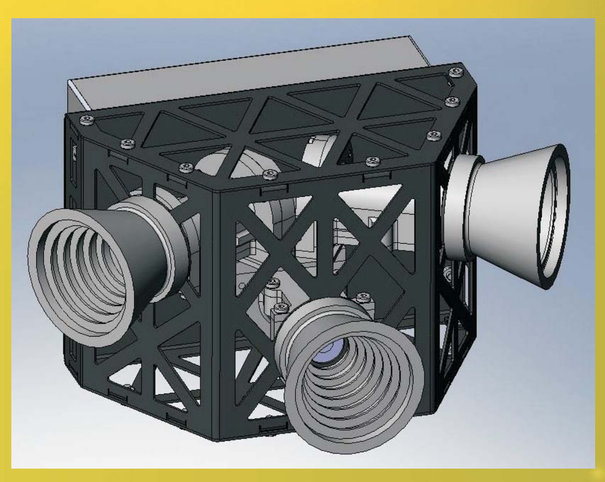


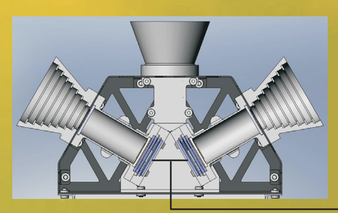


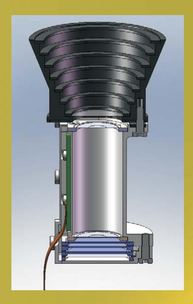
Measured species	p, ^{3}He, ^{4}He, C, N, O, ..., Fe, trans-Fe
Energy ranges	
Protons	1.5 - 20 MeV
^{4}He	1.5 – 20 MeV/n
Oxygen	2.6 – 40 MeV/n
Iron	3.3 – 60 MeV/n
All particles (mainly p, 4He)	0.5 – 1.5 MeV/n (single detector counts)
Isotopes	^{3}He/^{4}He, ^{22}Ne/^{20}Ne, ^{26}Mg/^{24}Mg
Time resolution	
Nominal	10 s
Burst mode	1 s
View cones	
Number of apertures	6
Separation of view cone directions	60°, in and out of ecliptic plane
Full view cone size	40°
Angular resolution	14°/40°
Geometric factors/view direction	
Protons and helium	6x0.0024 cm^{2}sr (hi-flux conditions)
Heavy ions (and p, He)	6x0.21 cm^{2}sr (nominal)

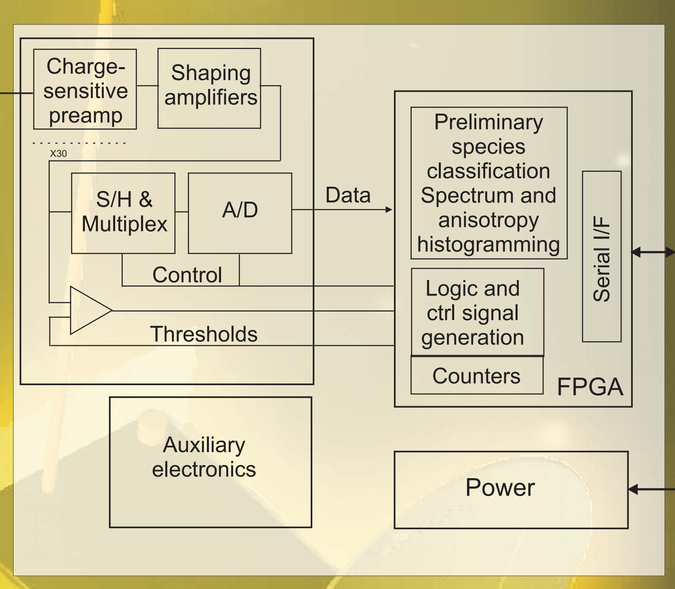
Instrument design

- Sensor system
  - Three silicon detector telescopes in different directions
  - Two identical units
- Electronics
  - Charge amplification and pulse shaping
  - AD-conversion
  - Digital control
- Software
  - Particle identification
  - Energy spectra
  - Anisotropy tables





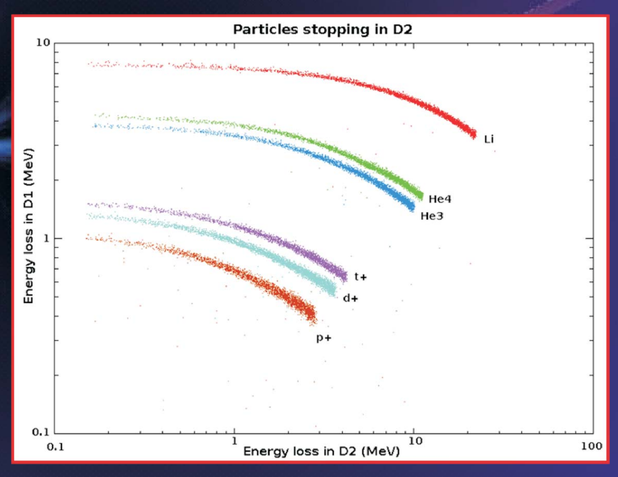




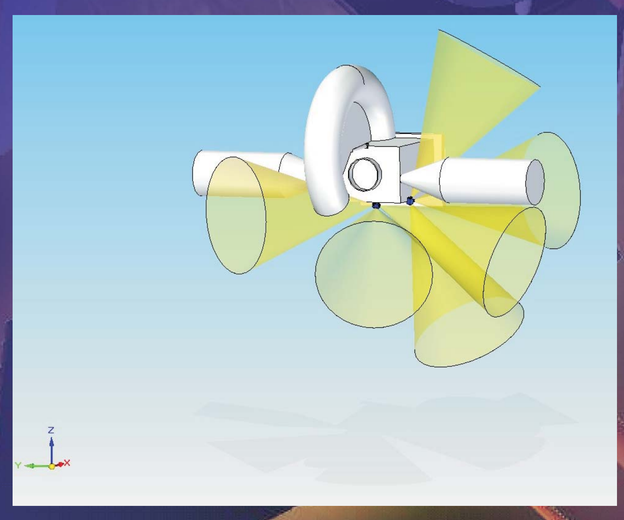
Well-proven dE-E-technique of particle identification

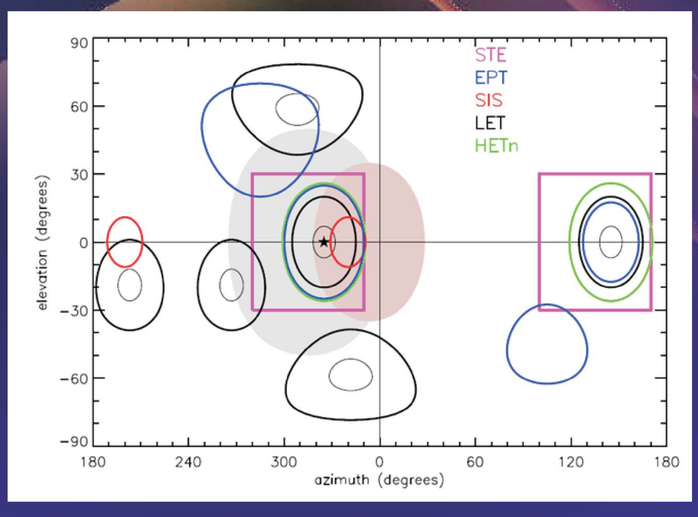
- Energy loss patterns in successive detector layers
- Charge and mass identification
  - Limited by angle of incidence variation and detector thickness nonuniformity

Particle identification



Accommodation and field of view





Resources requirements

Quantity	Total for two units
Mass (kg)	2.2
Power (W)	4.9
Envelope dimensions (cm^3)	2x(22x15x11)
Telemetry (bits/s)	1000

Preliminary data collection scheme

- 10-second buffers from each LET unit
- 13 energy channels for p, ^{3}He, ^{4}He
- p and ^{4}He anisotropy spectra
  - 6 directions
  - 4 channels in each direction
- Fast counters for p, He, CNO, and Fe group
  - 4 energy channels
- Fast counters for
  - Single detector hits
  - Acceptable events
  - False event recognition
  - For normalization purposes
- Samples of pulse height data