Observations and results from the High-Energy Particle Detector (HEPD) on-board CSES-01 satellite

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Summary

The China Seismo-Electromagnetic Satellite (CSES-01) is a mission developed by the Chinese National Space Administration (CNSA) together with the Italian Space Agency (ASI), to investigate the near-Earth electromagnetic, plasma and particle environment. In addition, it has been designed to detect a wide number of disturbances of the ionosphere/magnetosphere transition region. One of the main instruments on-board CSES-01 is the High Energy Particle Detector (HEPD); it is an advanced detector, completely designed and built in Italy, based on a tower of 16 scintillators and a silicon tracker that provides good energy resolution and a wide angular acceptance for electrons/positrons (3–100 MeV), protons (30–200 MeV) and light nuclei up to Oxygen.

CSES-01 satellite

Platform	Mass	$\simeq$ 700 kg
Orbit	Type	Sun-Synchronous
	Altitude	507 km
	Inclination	97°
	Period	94 min
	Local time descending node	14:00
	Revisit period	5 days
Mission	**Life Span**	**$\geq$ 5 years**

CSES-01 Launched by CZ-2D Vehicle on Feb 2. (15:51)
@Jiuquan Sat. Launching Center

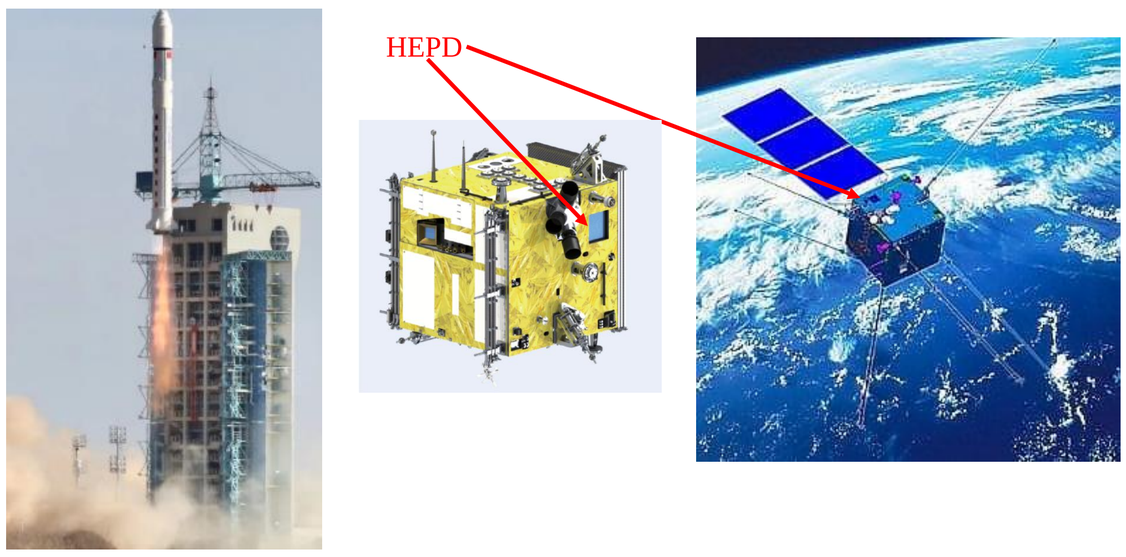


Figure 1: The CSES-01 satellite.

High Energy Particle Detector

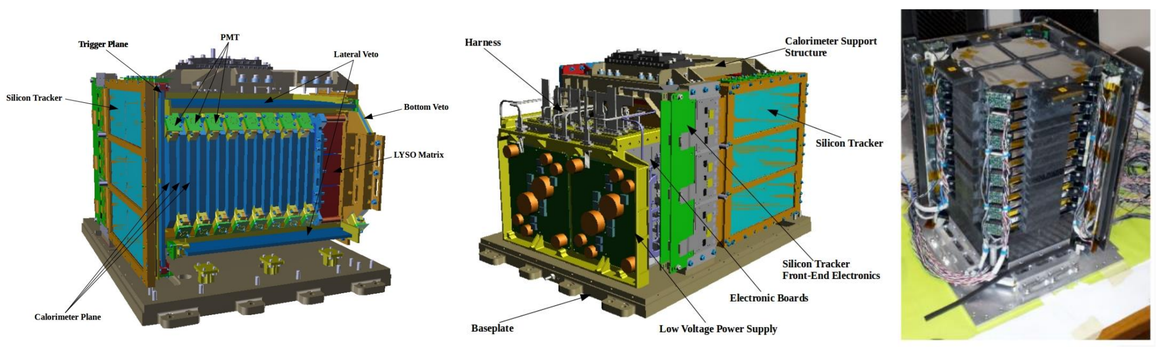


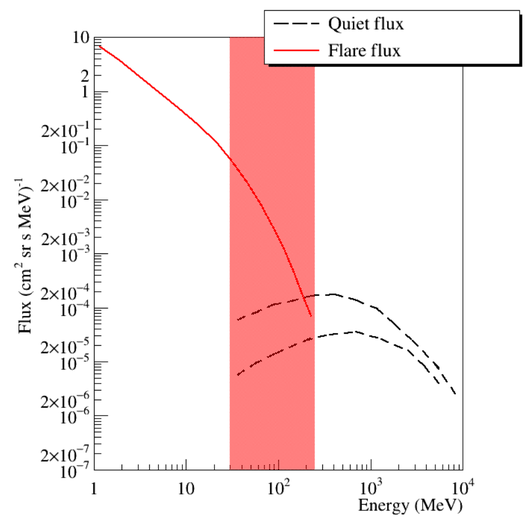
Figure 2: The HEPD instrument.

- 2 planes of double-sided Si microstrip sensors (tracker) $\longrightarrow$ track-related information
- 1 layer of plastic scintillator $\longrightarrow$ trigger
- range calorimeter comprising:
  - 16 layers of plastic scintillator planes ($15\times15\times1$ cm^3) read out by PMTs $\longrightarrow$ energy deposit
  - 3×3 matrix of inorganic scintillator LYSO crystals read out by PMTs $\longrightarrow$ increase energy range
- 5 (5 mm-thick) plastic scintillator planes $\longrightarrow$ veto

More details on HEPD detector can be found in (Picozza et al., 2019)

Solar Particle Events with HEPD

- Solar Particle Events accelerate particles (p, He ...) close to the Sun (*flare*) or in interplanetary space (*CME shocks*)
- Spectral shape/time-evolution could shed more light on acceleration site/mechanism
- Un-disturbed heliosphere could help disentangle transport effects
- Last SEP on 2017 Sep. 10 (X8)
- HEPD could fill the gap between *in situ* observations and Neutron Monitors data on ground



Observations from HEPD

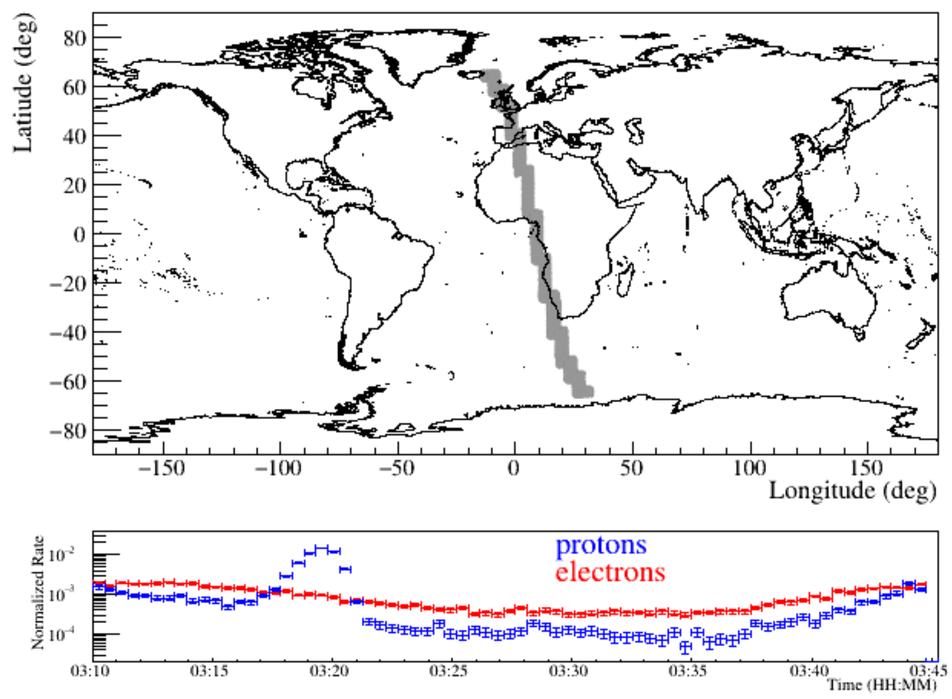


Figure 3: Electron (red) and protons (blue) profiles along CSES-01 orbit.

Along CSES-01 orbit, the HEPD FoV allows to collect wide number of protons and electrons from various populations. High statistics and stability in time allow the instrument to be extremely well-suited to measure variations inside such populations to investigate ionospheric/magnetospheric disturbances caused by geomagnetic or seismic activity.

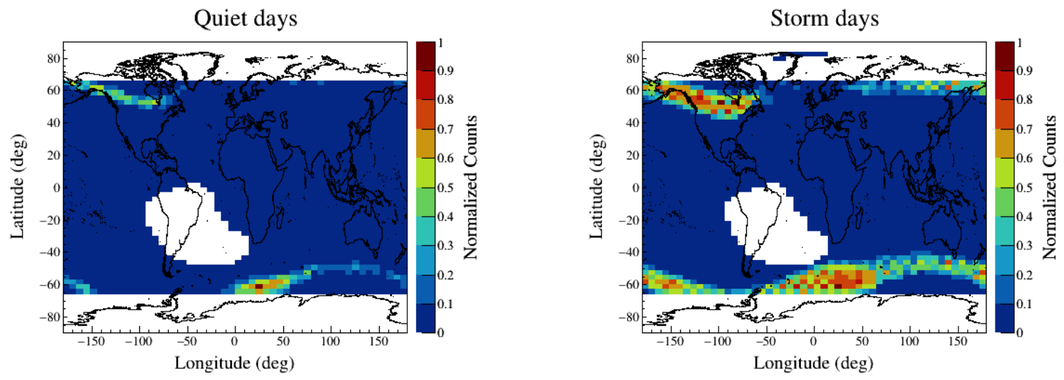


Figure 4: Effects on trapped electrons of a geomagnetic storm (right), with respect to a quiet period (left).

For example, HEPD can detect trapped electrons (energies $<$ 10 MeV) in the outer belts (L $\sim$3/4) which happen to be very sensitive to geomagnetic storm and to other phenomena. Left panel shows the configuration of trapped electrons in the outer belt during a quiet day, while right panel shows the effect of a G3 storm on such population.

Referències

Picozza, P., Battiston, R., Ambrosi, G., Bartocci, S., Basara, L., Burger, W. J., ... Zoffoli, S. (2019, jul). Scientific goals and in-orbit performance of the high-energy particle detector on board the CSES. *The Astrophysical Journal Supplement Series*, *243*(1), 16. doi: 10.3847/1538-4365/ab276c