# The High-Energy Particle Detector (HEPD-01) as a space weather monitoring instrument on board the CSES-01 satellite

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## Introduction

Magnetic storms represent major signatures of variability in the Sun-Earth interaction and can severely impact infrastructures at the ground level and in space, also posing a hazard to human health. On $20^{th}$ August 2018, a large-scale filament gradually erupted from a quiet region of the Sun into an interplanetary coronal mass ejection that affected the Earth's environment a few days later, starting **on late $25^{th}$ August 2018** and giving rise to the **third largest geomagnetic storm of Solar Cycle 24** [1]. The magnetospheric disturbance was strong enough to trigger a response in the High-Energy Particle Detector (HEPD-01) on board the China Seismo-Electromagnetic Satellite (CSES-01) [2].

## The HEPD-01 detector

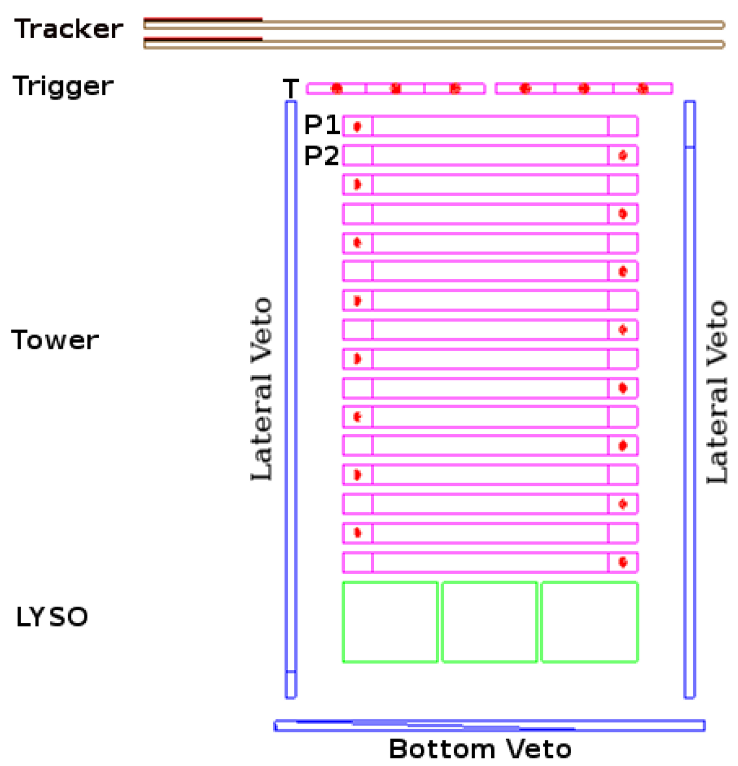


**Fig.1:** Schematic of the HEPD-01 detector.

The HEPD-01 (Fig.1) is made up of a silicon **tracking system**; a **trigger system** that includes one plastic scintillator layer segmented into six paddles; a **range calorimeter** comprising a tower of 16 plastic scintillator planes, a matrix of $3 \times 3$ LYSO (lutetium–yttrium oxyorthosilicate) scintillator crystals, and an **anti-coincidence (VETO) system** equipped with 5 plastic scintillator planes, out of which 4 are placed at the lateral sides of the apparatus and 1 at the bottom (for further details, see [3]).

## HEPD-01 response to the August 2018 storm

Fig.2 illustrates a comparison between the HEPD-01 count rate maps before ($20^{th}$-$23^{rd}$ August; upper panel) and after the impact of the storm ($25^{th}$-$27^{th}$ August; lower panel).

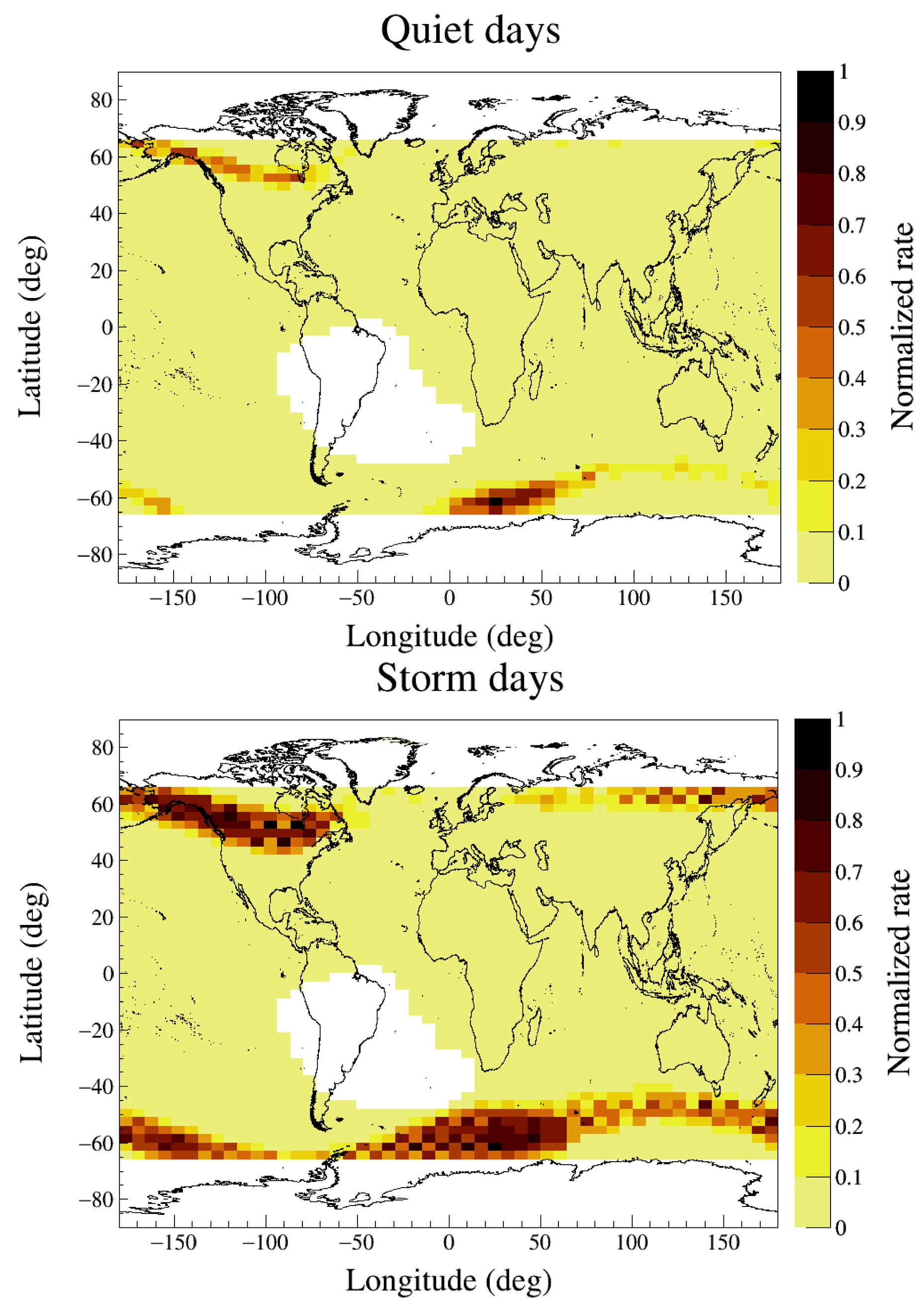


**Fig.2:** HEPD-01 trigger rate map before (upper panel) and after (lower panel) the impact of the storm.

In the bottom panel, an **increase in the count rate is evident at both northern and southern latitudes**—especially in the southern region—as a consequence of the storm's arrival. The increased particle rate, during the storm time, is also visible as a function of the L-shell and time in Fig.3.

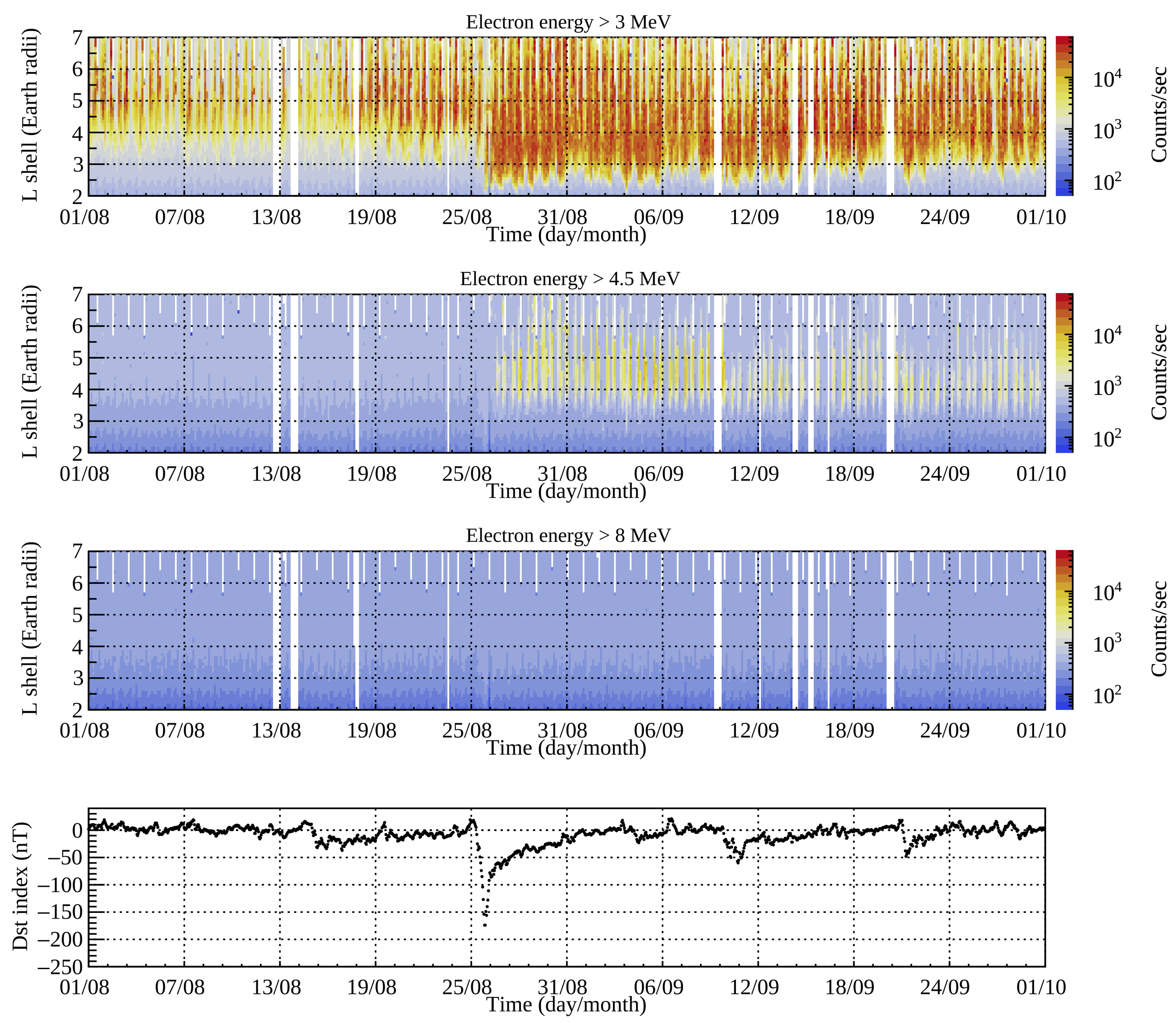


**Fig.3:** Top three panels: Trigger rates for three different HEPD-01 configurations over the period August-September 2018. Bottom panel: Time evolution of the Disturbance storm-time index.

The **enhancement of HEPD-01 trigger rates at L-shells > 3** during the storm's recovery phase suggested a phenomenon of **acceleration of energetic electrons**, which lasted several days.

## Conclusions

Considering the sky-rocketing focus on space weather studies in this last decade, HEPD-01's results prove promising, especially in view of the already-planned constellation of CSES satellites in the next few years (CSES-02 is currently under construction).

## References

[1] F. Palma and et al., *Appl. Sci.*, vol. 11, p. 5680, 2021.
[2] X. Shen and et al., *Sci China Tech Sci*, vol. 61, no. 5, p. 634, 2018.
[3] P. Picozza and et al., *Astrophy. J. Suppl.*, vol. 243, no. 1, 16, p. 16, Jul. 2019.