Measurement of the re-entrant lepton spectrum with the High-Energy Particle Detector on board CSES-01

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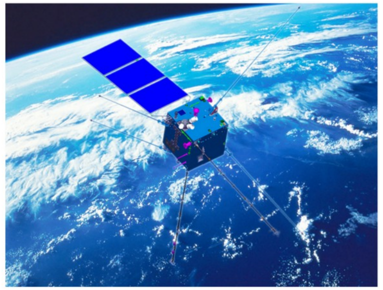

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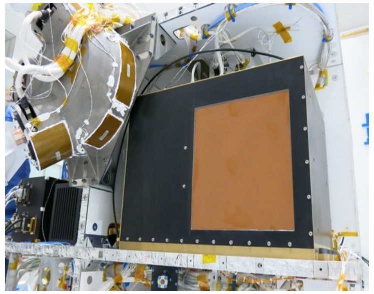
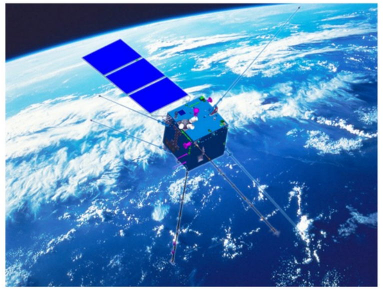


LOC Institutes and Organisations

CSES-01 Mission and HEPD-01 Detector

CSES-01 (China Seismo-Electromagnetic Satellite) is the first of a series of scientific space missions dedicated to monitoring electromagnetic fields, plasma, and particle perturbations in LEO regions (**~500 km altitude**).

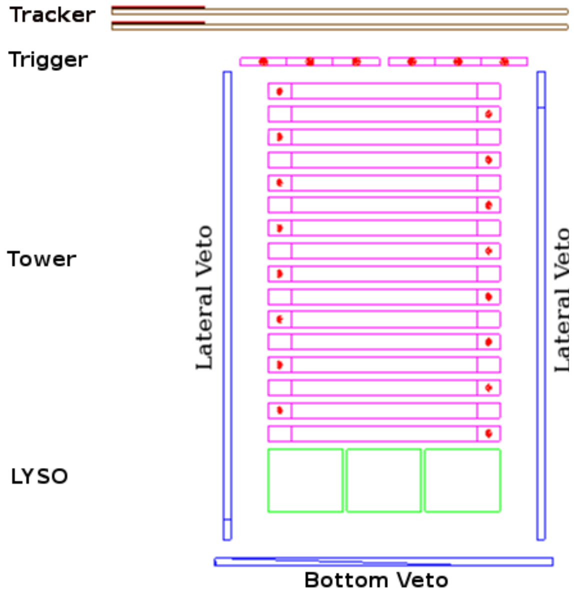
CSES-01 is in orbit since February 2nd, 2018 equipped with several instruments, among them the **Italian High-Energy Particle Detector (HEPD-01)**.



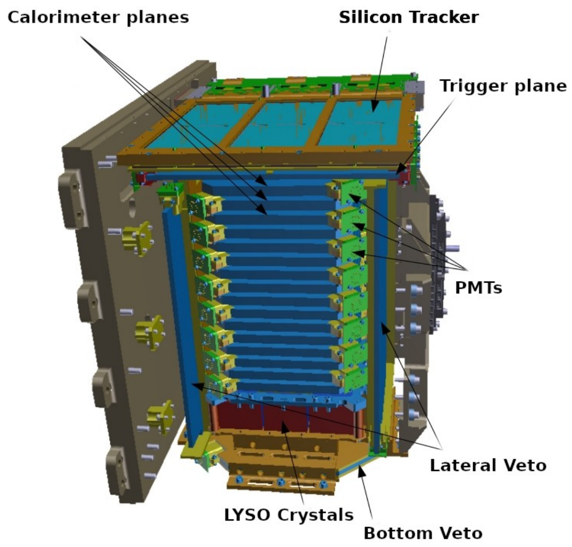
For most of its acquisition time along CSES-01 orbits, HEPD-01 collects particles with energy below the local geomagnetic cutoff, thus being perfectly suited for the study of **re-entrant albedo particles → secondary particles whose trajectories are bent by the geomagnetic field back to the Earth**

HEPD-01 is devoted to the measurements of electrons (3-100 MeV) and protons (30-200 MeV) fluxes and their variations. The detector is composed of :

- **the tracker system** - made of two layers of double-sided silicon strip sensors - for the reconstruction of the incoming particle direction
- **the trigger plane** - made of a segmented layer of 6 plastic scintillator bars - for the generation of the trigger pulse
- **the calorimeter** - made of a plastic scintillator tower (16 planes) plus a final layer of LYSO inorganic crystals - for the measurement of the energy deposition
- **the veto system** - made of 5 plastic scintillator planes - for the rejection of particles not fully contained inside the calorimeter



Geant4 Simulation



CAD Model

Data Sample and Analysis

A trigger is generated when a particle hits **T & P1 & P2** (the trigger plane and the first two planes of the plastic scintillator tower).

Further selections are then applied offline to clean the lepton sample and to select the re-entrant albedo component:

- **the containment** → needed for the reconstruction of the deposited energy. The bottom anti-coincidence is also used to remove splash albedo particles with an upward direction.

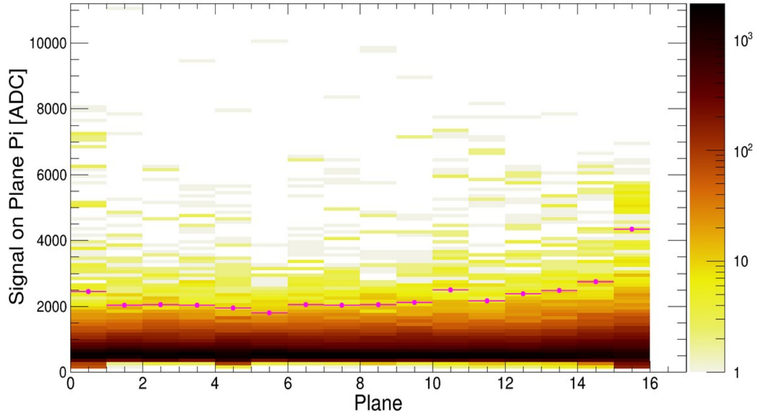
- **a trigger multiplicity equals 1** → rejection of multi-particle events;

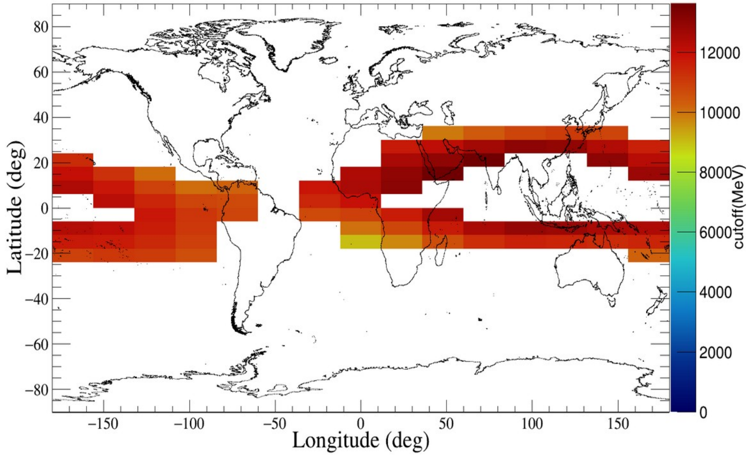
- **plane continuity** → a continuous release of signal inside the scintillator tower is requested;

- **lepton selection** → to separate electrons and positrons from protons, ionization energy losses inside each calorimeter plane are required to be compatible with the expectation for a singly charged minimum ionizing particle (MIP);

- **1.1 R_E < L-shell < 1.2 R_E and B > 23000 nT** → selection of sub-cutoff particles outside of the SAA → live time accumulated considering the time spent in this region with the detector capable to acquire new events.

Lepton Selection





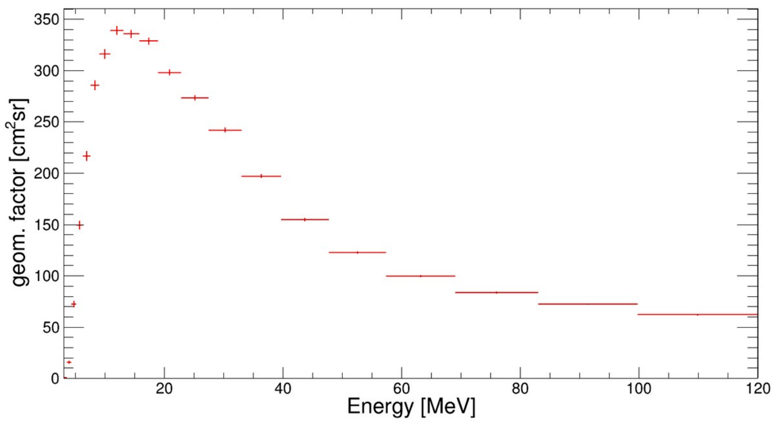
Re-entrant Selection

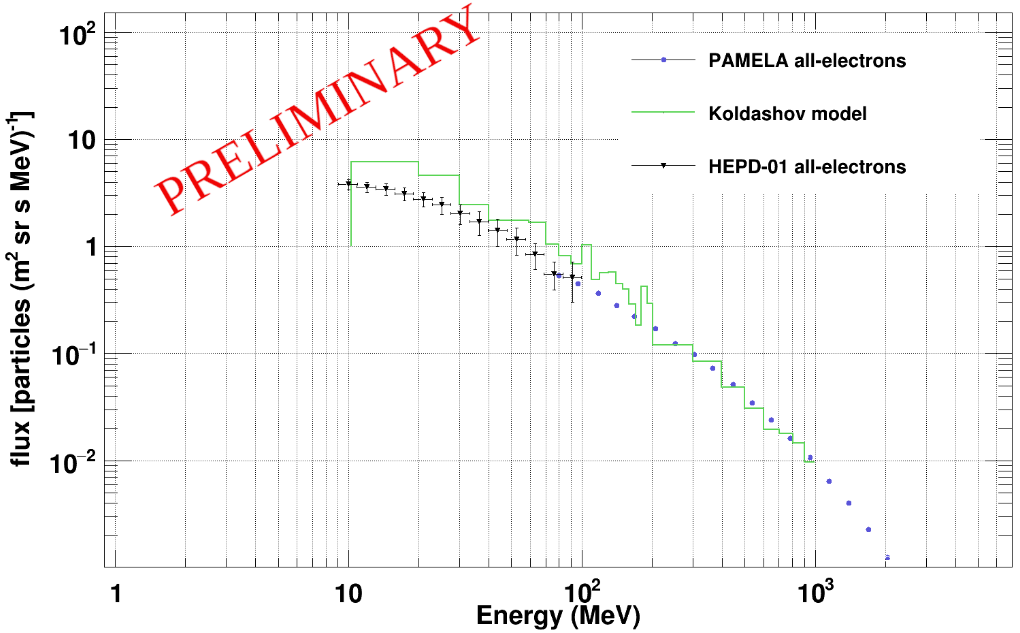
Results

The Geometrical Factor of HEPD-01 **(~ 350 $cm^2 sr$ @ peak)** and all the selection cut efficiencies have been evaluated with Monte Carlo (MC) simulations tuned with test beam data.

The **contamination** due to high-energy protons (E > ~500 MeV), contained inside the calorimeter because of inelastic interactions, has been estimated with MC simulations (**< 5% in the whole energy range**)

GF for fully-contained e^-





HEPD-01 data shown together with PAMELA measurements*[1]* (same L-shell cut) and with a theoretical model*[2]* used for the calculation of secondary electron and positron fluxes at the top of atmosphere.

[1] O. Adriani et al., Measurements of quasi-trapped electron and positron fluxes with PAMELA

[2] S. V. Koldashov et al., Electron and Positron Albedo Spectra with Energy more than 20 MeV.