











## 37th International Cosmic Ray Conference (ICRC 2021) July 12th – 23rd, 2021 Online – Berlin, Germany

## The High Energy Particle Detector operational status during 3 years of flight on board the China Seismo-Electromagnetic Satellite

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## The HEPD Control & Housekeeping system

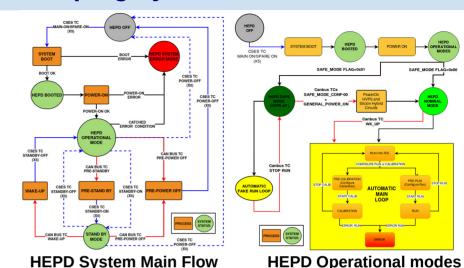
The High Energy Particle Detector (HEPD) on-board *the China* Seismo-Electromagnetic Satellite is devoted to the observation of electrons in the energy range 3-100 MeV and protons in the energy range 30-200 MeV.

To ensure correct operations and optimal performances, the Central Processing Unit (CPU board) hosts the Control & Housekeeping (C&H) system is responsible for:

- management of HEPD operations and diagnostic routines by means of the internal Slow Control link (SpaceWire link) that allows communications between CPU and the other electronics boards;
- Management of the bi-directional CAN-bus interface allowing to receive both satellite broadcasts and TeleCommands (CAN-bus TCs) and to send back instrumental command replies and instrumental TeleMetry (CAN-bus TM) containing information about the detector status;
- management of timing information and storage of non volatile information as HEPD configuration (FRAM).

After CPU boot the C&H system manages the power-on sequence of the electronics, setting HEPD in one of the OPERATIONAL modes (SAFE or NOMINAL mode) and starting the main acquisition loop during which runs and calibrations are configured and executed automatically depending on the orbital zone configurations.

During operations, the C&H system periodically monitors the whole apparatus collecting diagnostic information which is sent as TM data to the satellite, while other housekeeping and auxiliary information are included in the scientific data.



HV Control board

Board Status, Voltages

Run & Configuration data, Voltages

Run & Configuration data, Voltages

Board Status, Voltages

Run & Configuration data

Board Status, Lemperature PMT Rate Meters

Board Status

DAQ board

Trigger board

Trigger board

Trigger board

Trigger board

Trigger board

Trigger board

DAQ board

Tracking detector data

Tracking detector data

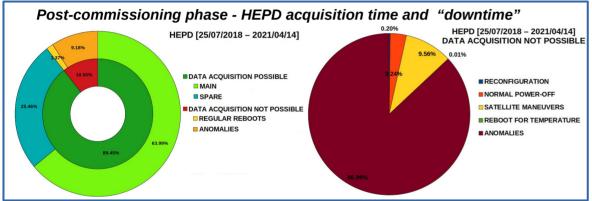
Data packaging

Tracking detector Data

## **In-flight Operation and Status**

The HEPD was launched on-board CSES on February 2, 2018 from the Jiuquan Satellite Launch Center (Inner Mongolia, China) and since July 28th 2018 HEPD has been set for regular data-taking mode, collecting about 14000 hours of acquisition.

Since first HEPD power-on, The Control & Housekeeping system demonstrated to handle correctly detector activities and operations, allowing several changes of configuration and to perform recovery actions in case of anomalous behavior.

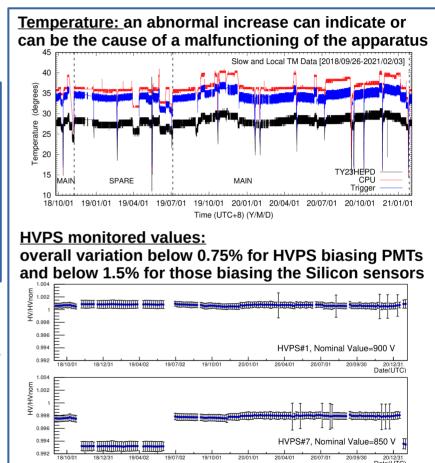


**Post-commissioning operations:** 

- power-off procedure for satellite maneuvers or temperature issues (standard procedure)
- Detector reconfiguration (specific procedure)
- recover HEPD functionality from anomalous behaviors (standard reboot or specific procedures)

The Telemetry data:

- identify anomalous behaviors and to investigate the possible source of malfunctions:
  - Partial/Total power-off of HEPD electronics due to LVPS issue
  - Anomalies related to Radiation issue
  - check the stability of the electronics



Thanks for your attention