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CSES-Limadou data processing at ASI-SSDC

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The CSES space mission, an international collaboration between China and Italy, aims at monitoring the perturbations originated by electromagnetic emissions in the ionosphere, magnetosphere and in the Van Allen radiation belts, and at investigating possible correlations with seismic events. The Italian collaboration, named LIMADOU, contributed to the mission with the realization of the High Energy Particle Detector (HEPD), an instrument developed on the basis of a long experience in developing advanced space detectors for charged and neutral particles and gamma rays – on a wide range of energies – for applications in solar physics as well as in extra-galactic astrophysics and cosmology. The CSES Satellite was launched from the Jiuquan Satellite Launch Center on February 2, 2018 and the expected mission lifetime is of 5 years. Satellite data are transferred to the Institute of Crustal Dynamics (ICD) of the China Earthquake Administration (CEA) in Beijing, China. After the donwlink HEPD raw data are transferred to the Italian Ground Segment. In the IGS, HEPD raw data are processed from level0 to level2 after calibration and equalization and are then stored in a high-availability processing server and stored in a high-resilience storage. In this poster we present a schematic of the HEPD detector data structure and the processing pipeline that has been built at the Italian Space Agency – Space Science Data Center

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1. Introduction

In the framework of the "Limadou fase D2" project, the design activity of the Italian Limadou Ground Segment at the Space Science Data Center (SSDC) located in the ASI HQ has been carried out.
This facility performs: storage of all CSES scientific payloads data (level2), storage and processing of HEPD raw data, storage of the HEPD Level2 data, bookkeeping of all the transferred files, server to transfer the HEPD level2 to ICD-CEA, access to the CSES data to the Italian Scientific Community (INFN, INAF, INGV etc. . .) via the web page of ASI-SSDC.

2. HEPD Detector

The High-Energy Particle Detector (HEPD2), developed by the Italian Collaboration, detects electrons, protons and light nuclei. The main objective is to measure the increase of the electron and proton fluxes due to short-time perturbations of the radiation belts caused by solar, terrestrial and anthropic phenomena. The energy range explored is 3 - 100 MeV for electrons and 30 - 200 MeV for protons.
The instrument consists of several detectors. Two planes of double-side silicon microstrip sensors placed on the top of the instrument provide the direction of the incident particle. Just below, two layers of plastic scintillators, one thin segmented, give the trigger; they are followed by a calorimeter, constituted by other 16 scintillators and a layer of LYSO sensors. A scintillator veto system completes the instrument. The power supply and electronics are inserted in a box placed at one side of the detector. The HEPD is contained in an aluminum-honeycomb box. Four different models have been realized and fully tested: Electrical Model (EM), Structural and Thermal Model (STM), Qualification Model (QM) and Flight Model (FM).

3. HEPD Data Scheme

The reconstruction occurs in three phases, which determine three different data formats, namely 0, 1 and 2, with increasing degree of abstraction.

Raw data as down-linked from CSES are converted to ROOT format (Level0) to be integrated with the processing software. Level 1 data contain all detector responses after calibration and equalization. Level 2 data contain higher level information, such as: estimated energy loss in the tracker, estimated energy loss in the trigger planes, estimated energy loss in the scintillator tower, estimated arrival direction, particle identification estimators.

4. Downlink and Pre-processing

The CSES-Limadou mission's ground segment consists of two elements: the Chinese Ground Segment at ICD-CEA and the Italian Ground Segment at SSDC (ASI, Italy). Major elements of the China Ground Segment are: the Data Receiving System, the Data Processing System and the Data Application System. Quasi real-time data are transferred to the Italian processing ASI-SSDC.

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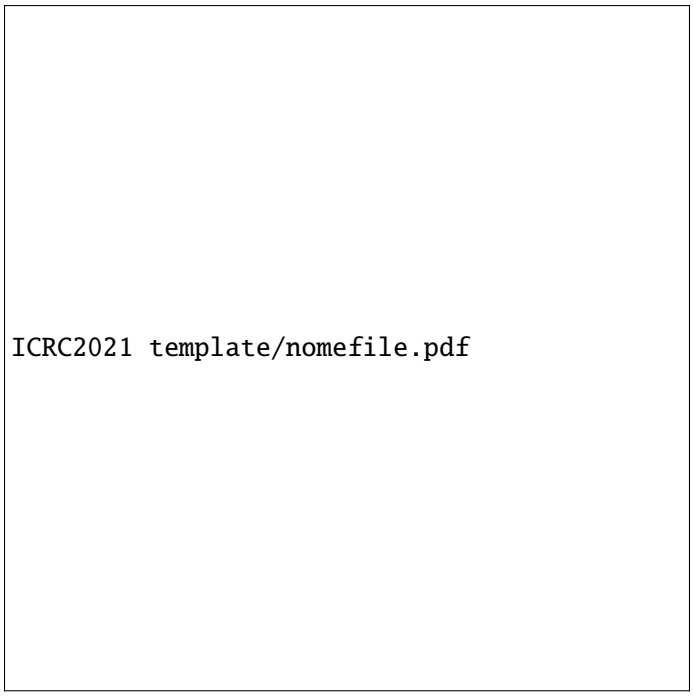

Figure 1: placeholder[1]

5. Processing pipeline

The processing pipeline has been developed as several layers of software with an interface to a processing database and to the storage of the infrastructure. A MySQL Database, with JSON capability, is used to keep track of the different stages of processing and for data bookkeeping.
The pipeline before the start of the commissioning phase has been extensively tested with HEPD flight model ground data (cosmic muons). After flight when real data became available the software and database where adjusted to fit with data size and peculiarity of the flight data. The first part up to level0 hasn't changed much while the level0-to-level1 and level1-to-level2 are constantly adapted to the development of the processing software and adjusted to the payload data acquisition configurations. The high modularity of the pipeline allow to achieve asynchronously single steps of the processing.

References

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