Enabling low-power MAPS-based space trackers: a sparsified readout based on smart clock gating for the High Energy Particle Detector HEPD-02

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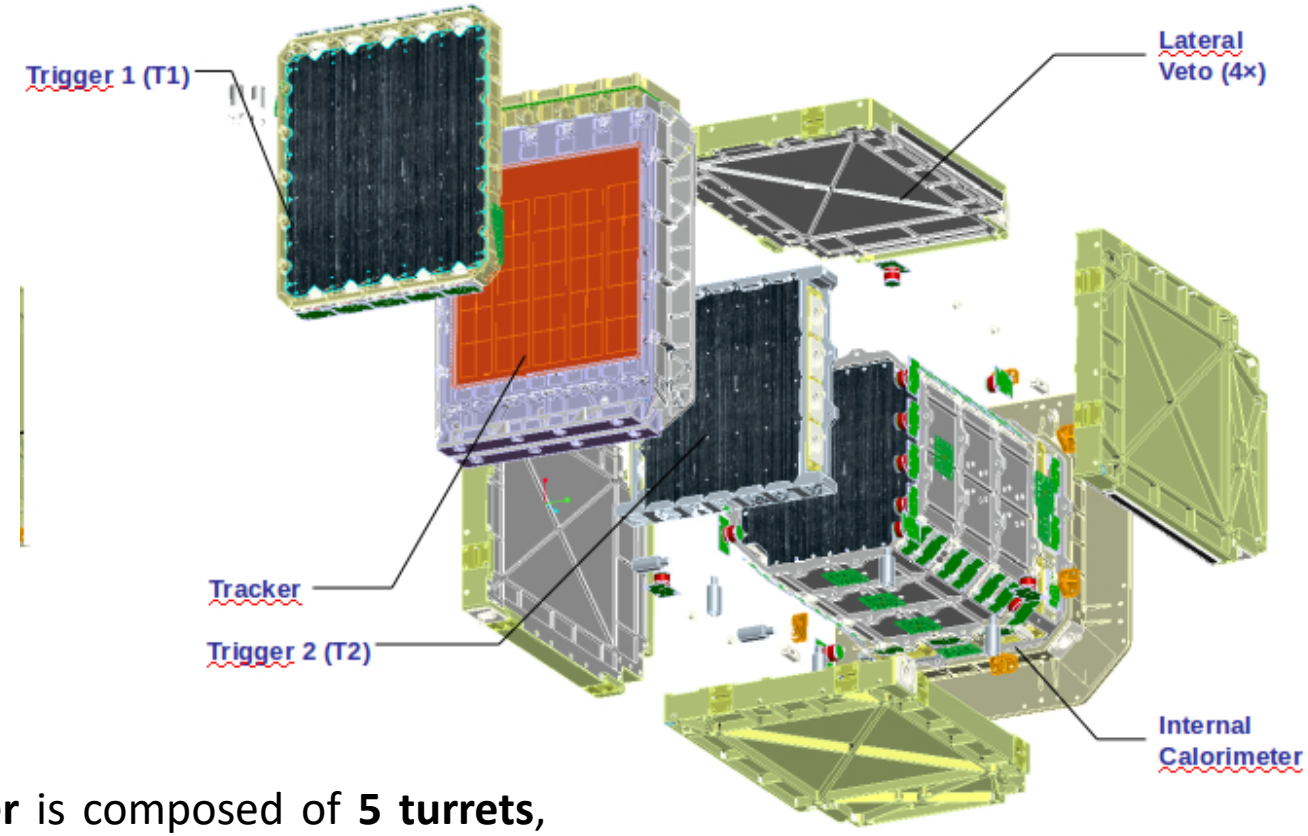
The HEPD-02 tracker

- **HEPD-02** is one of the payloads of the **China Seismo Electromagnetic Satellite** (**CSES-02**) to be launched by end 2022, aimed at measuring the flux of particles trapped in the terrestrial magnetosphere through calorimetry (scintillators) and tracking measurements of **electrons** between **3 and 100 MeV** and **protons** between **30 and 200 MeV**.



- The **HEPD-02 tracker** is composed of **5 turrets**, each made of 3 planes or "staves". Each **stave** houses 10 **ALPIDE monolithic active pixel sensors (MAPS)** for a total of 150 ALPIDE sensors (**80 Mpixels**).

The ALPIDE low-power readout architecture

- The use of ALPIDE in HEPD-02 constitutes **the first space application of MAPS**. Compared to the traditional hybrid microstrip sensors employed in previous space experiments, MAPS enable **higher granularity, low noise, compact assembly** (with sensor and front-end circuit on the same Si substrate) with **much fewer bonding interconnections.**

- On the other hand, the satellite application imposes a **strong design optimization effort in terms of power**, to match the **budget constraints** and to allow for an adequate **cooling in vacuum** by pure conduction through the stave CFRP toward the external Al-alloy frame.

- An application-specific **low-power parallel readout architecture** has been therefore implemented, with several changes with respect to the one designed for the original ALPIDE application in the ALICE detector at CERN.