

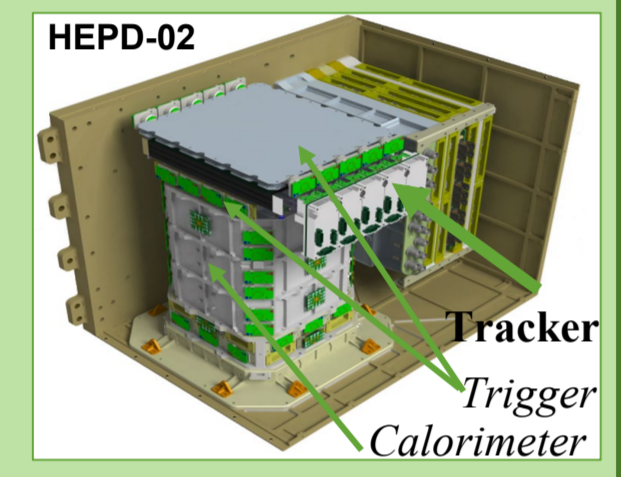
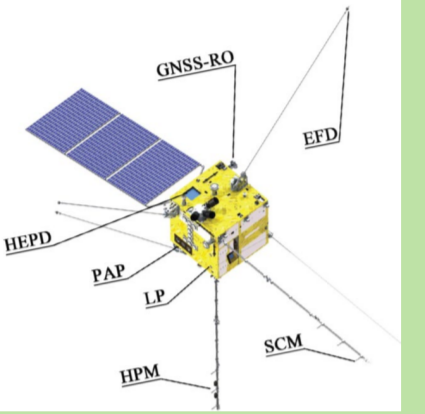
# Development of a Carbon-fiber reinforced polymer-based mechanics for embedding ALPIDE pixel sensors in the High-Energy Particle Detector space module onboard the CSES-02 satellite

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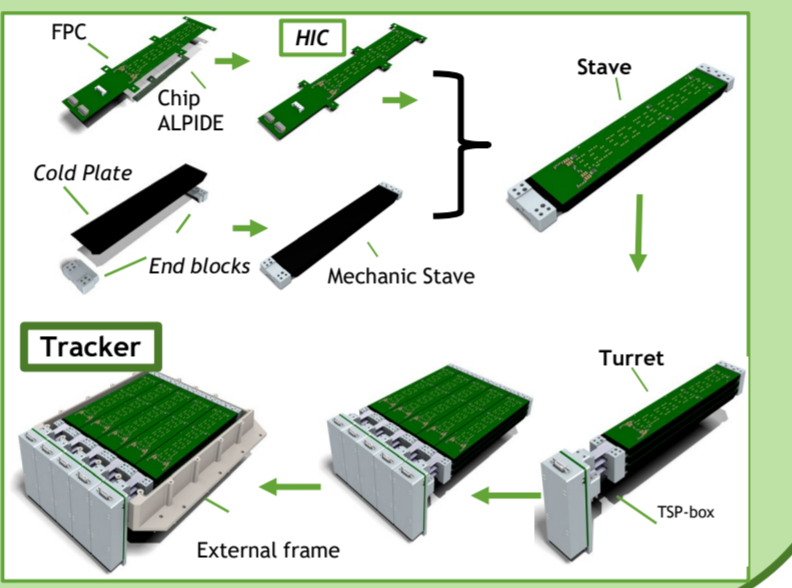
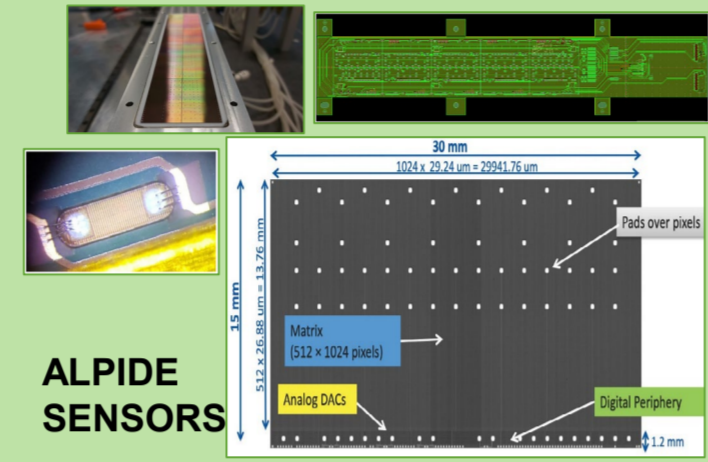
Scan here for references



CSES-02 (China Seismo-Electromagnetic Satellite): a constellation of satellites equipped with the most advanced technologies for correlating ionosphere perturbations with the occurrence of seismic events. HEPD-02 (High-Energy Particle Detector) aimed at detecting electrons and protons trapped in Earth's Magnetosphere. The HEPD-02 tracker is based on monolithic active pixel sensors ALPIDE, supported by light CFRPs structures to carry the heat to the radiative plate.

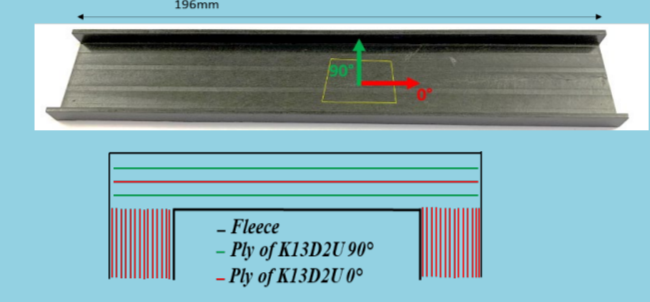


**HEPD-02:**  
 Kin. energy range (electron): 3 MeV to 100 MeV  
 Kin. energy range (proton): 30 MeV to 200 MeV  
 Operating temperature: -10 °C to +35 °C  
 Operating pressure  $\leq 6.65 \cdot 10^{-3}$  Pa  
 Mass budget: 50 kg  
 Power Budget: 45 W  
 Data budget  $\leq 100$  Gb/day  
**HEPD-02 Tracker:**  
 Alpid sensors: 150  
 Power dissipation: 12W

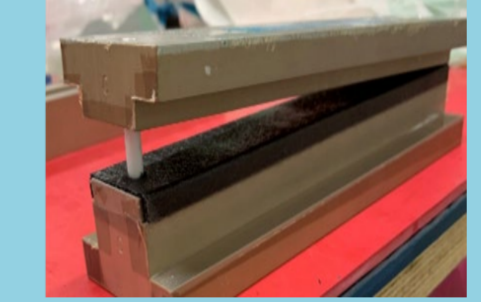


## CFRP Cold Plate (CP) Design Layout and manufacturing process

Lightweight structure (K13D2U + EX1515) with plies properly oriented aims at minimizing the temperature gradients and the material budget.



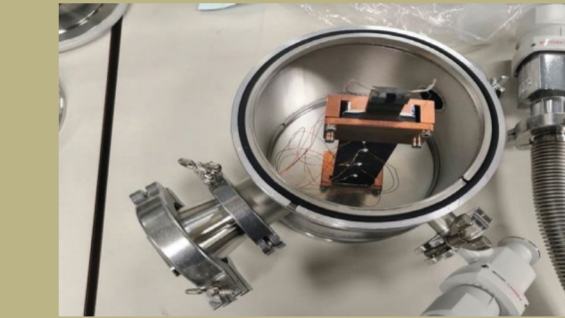
**0.4mm: material thickness in sensitive area**



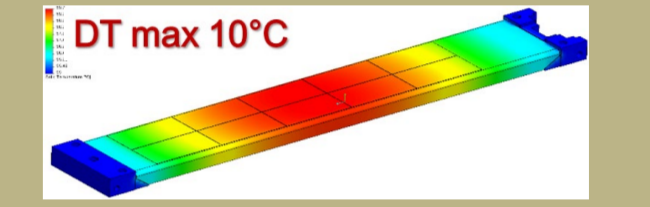
Mold for CP production.

## CFRP Cold Plate (CP) thermal conductivity

CP thermal conductivity evaluation with custom-made setup and CP heated in a vacuum chamber.



**Th. conductivity**  
 $K_{//} = 343-367$  W/m·K  
 $K_{\perp} = 173-180$  W/m·K



**HEPD-02 TRACKER DESIGN drivers and test:**  
**MATERIAL BUDGET** (for multiple scattering); **THERMAL EFFICIENCY** (P= 12W); **STIFFNESS** (launched by rocket); **OPERATIVE TEMP.** (-10°C; +35°C).

## Assembly steps:

- CHIP assembly (with CMM)
- FPC alignment and gluing
- Alignment quality Metrology
- Wire bonding operation
- Qualification test
- FPC and wings cut
- Titan pins in the end blocks
- Additional glue layer on CP
- CP-end blocks gluing
- HIC- CP gluing
- Metrology and qualification test
- TPS box assembly
- TSP-3 staves assembly
- Turret assembly in the frame

## Assembly Procedures and Jigs

**Alignment accuracy**

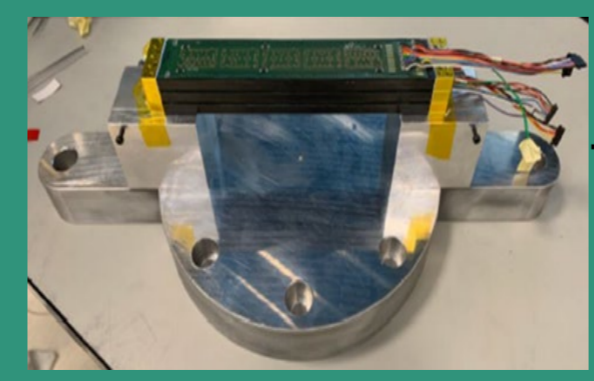
## Engineering Model (EM) vibration test

Turret submitted to a vibration test, according to qualification requirements:

- Resonance search [20 -2k Hz]
- Sine wave test
- Random test
- Resonance search [20 -2k Hz]

Axis	$f_n$ [Hz] single STAVE	$f_n^*$ [Hz] single TURRET
Z	832.8	842.5
Y	1092.0	1150.0
Z	1741.6	1634.6
X	1792.5	1625.2

Test repeated for the 3 axes:



**TEST RESULTS: MODEL VALIDATED**

- first resonance mode >800 Hz ;
- no mechanical anomalies;
- detector performances not affected.

## Thermal cycle test:

Thermal cycle test on stave with the "cursor system" to compensate different structure material CTE due to thermal gradients.

