The Gamma-ray Transients Monitor (GTM) on board Formosat-8B

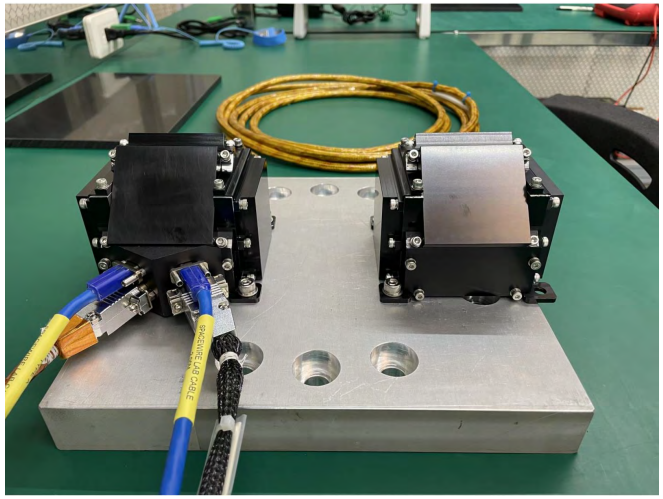
Hsiang-Kuang Chang
National Tsing Hua University (NTHU), Hsinchu, Taiwan
On behalf of the GTM team

@ EAMA-11, Niigata, Japan, December 9-12, 2025

Gamma-ray Transients Monitor (GTM)

1. Science goal:

To monitor Gamma Ray Bursts (GRBs), and bright gamma-ray transients from other sources in 30 keV – 2 MeV.



2. Instrument design

3. Current status

*** A quick summary:**

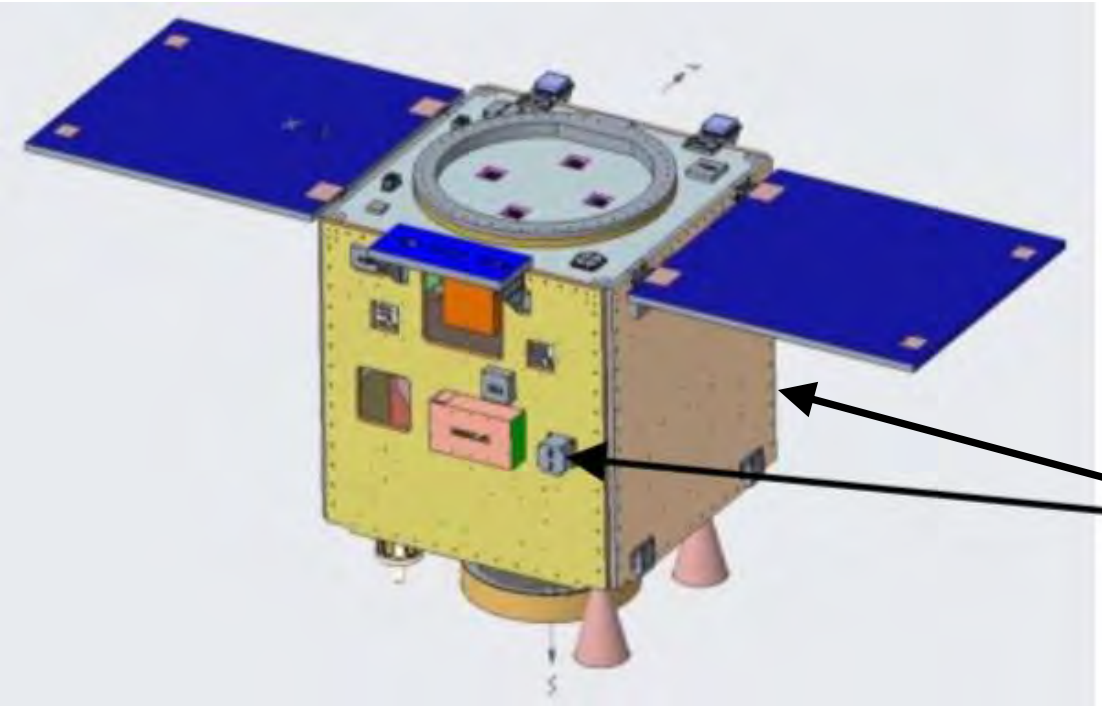
FS-8B will be launched into a sun-synchronous LEO in 2026.
GTM is expected to detect about 50 GRBs per year.
GTM can detect and localize GRBs, can perform spectral analysis, and, for very bright GRBs, can measure polarization states.

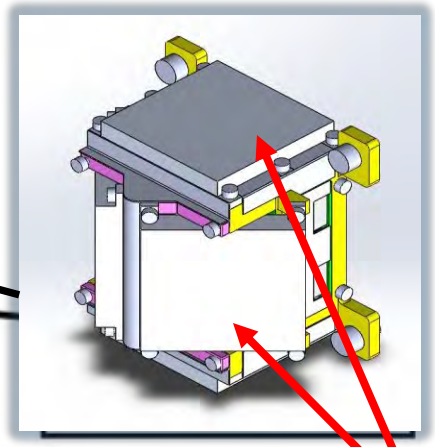
TSING HUA UNIVERSITY

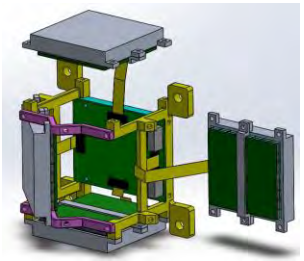
ACADEMIA SINICA 1928

TASA

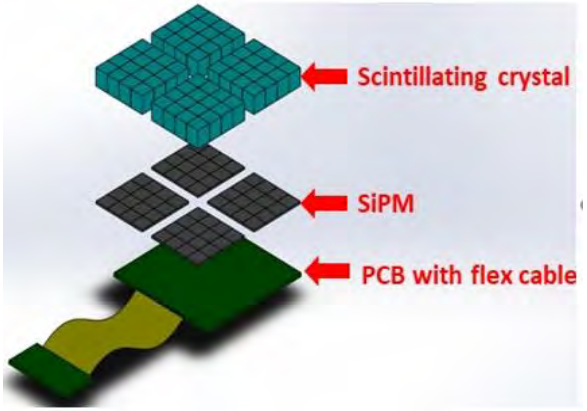
GTM on board Formosat-8B



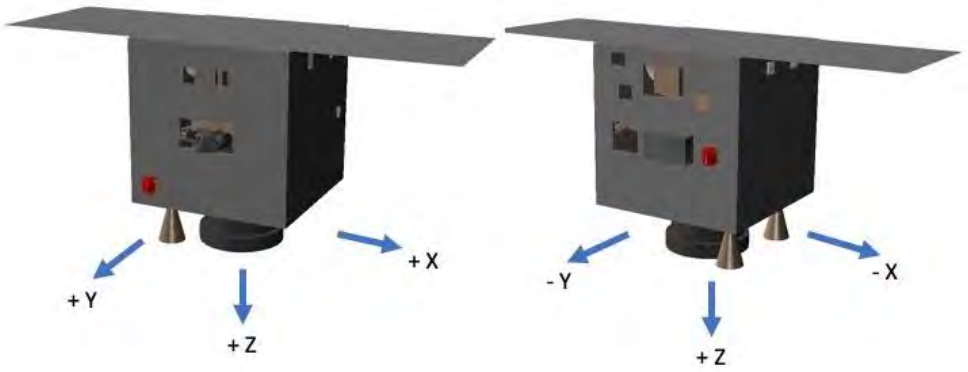




The Gamma-ray Transients Monitor (GTM) consists of two identical modules located on two opposite sides of FS-8B. Each module has four sensor units facing different directions to cover the whole sky. Each sensor unit is composed of a GAGG scintillator array (51 mm x 51 mm x 8 mm) and SiPM of corresponding pixel size for readout. (Chang et al. 2022, ASR, 69, 1249)



FS-8B/GTM, Source and Background Models



MEGAlib (Zoglauer et al. 2008)

Background:

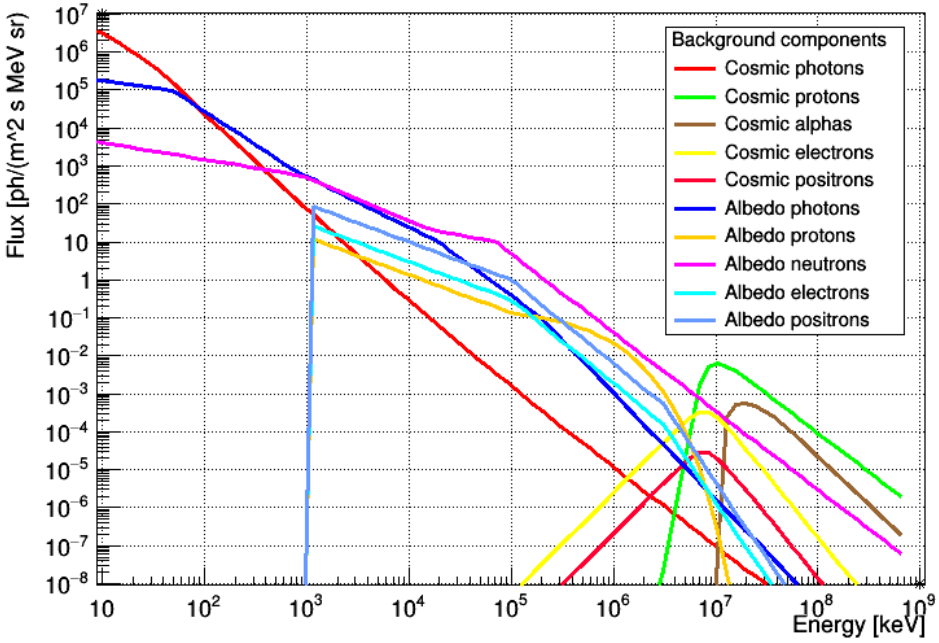
A polar (97°), low-altitude (560 km) Earth orbit; embedded in MEGAlib.

Source spectral model:

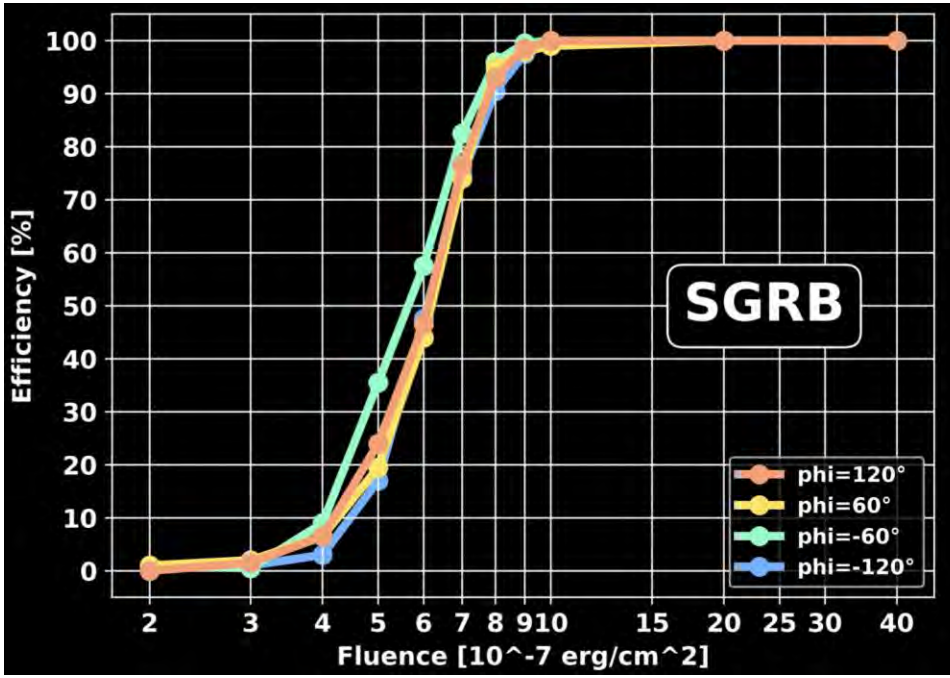
$$N_E \propto E^{\alpha}\, e^{(-E(2+\alpha)/Ep)}$$

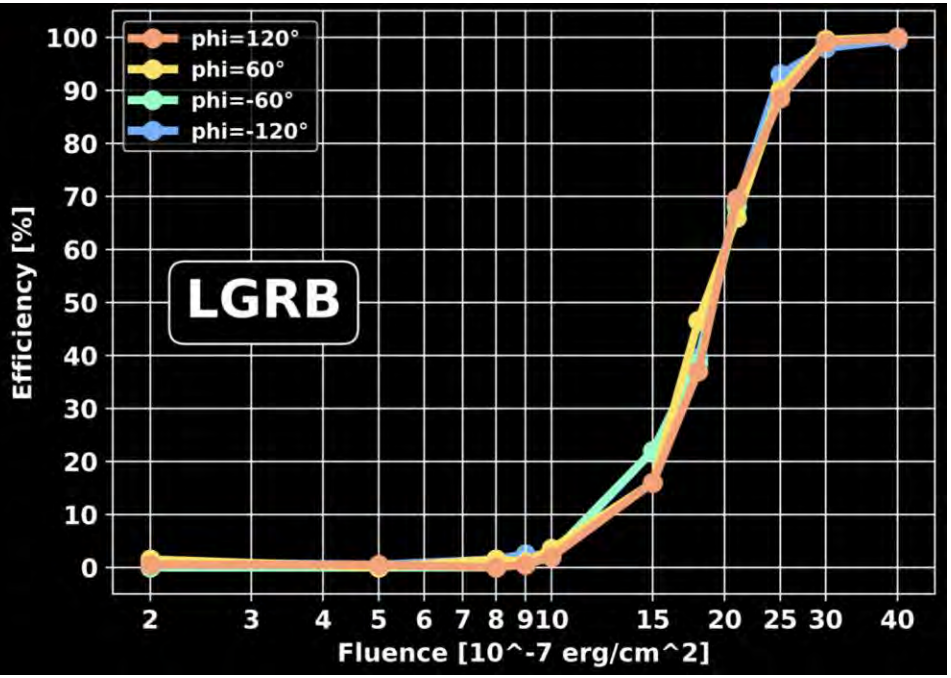
Long GRBs:
$\alpha = -1$, E_p = 300keV, duration 10 sec
Short GRBs:
$\alpha = -0.5$, E_p = 500keV, duration 0.5 sec

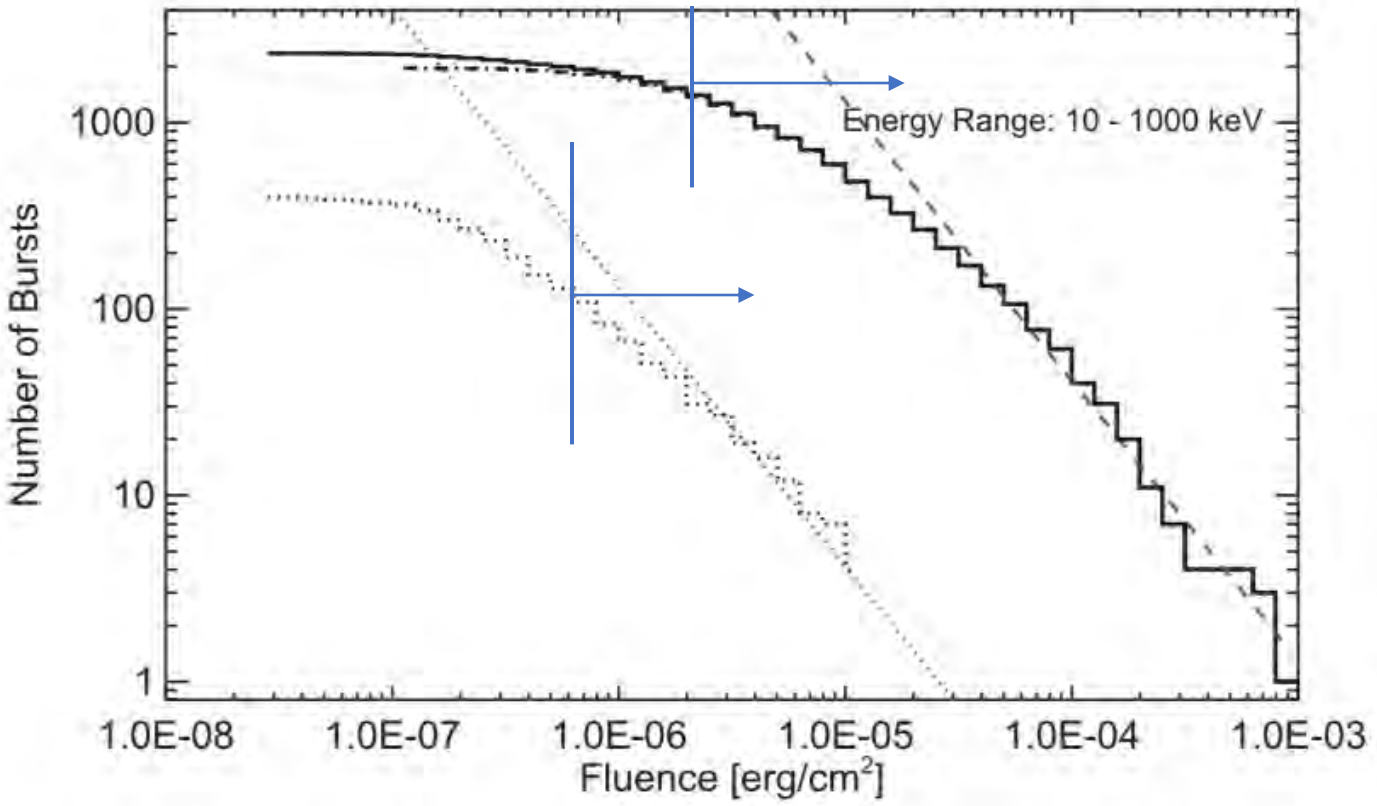
These numbers are the median of t_{50} and corresponding spectral parameters of Konus-WIND-detected GRBs (Svinkin et al., 2016; Tsvetkova et al., 2017).



GTM's GRB detection efficiency





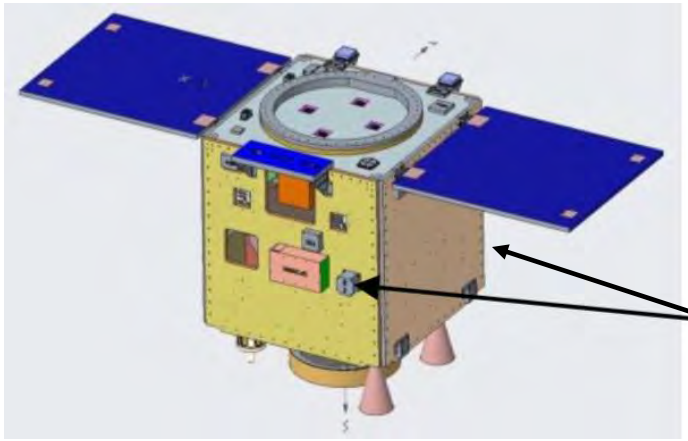


Fermi/GBM 10-year GRB fluence distribution (von Kienlin et al. 2020)

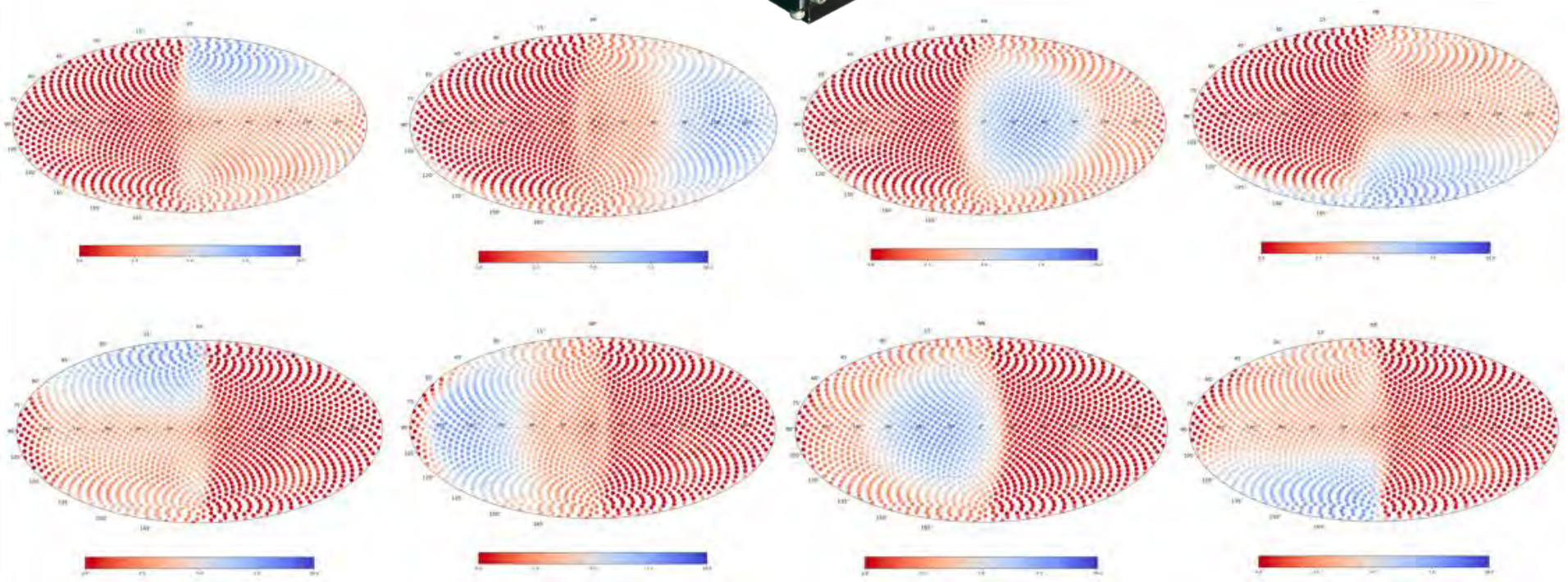
Assuming a 36% duty cycle,
FS8B/GTM will detect about 50 GRBs per year.

Detector response (50-300 keV) of the 8 sensors in different directions in the sky

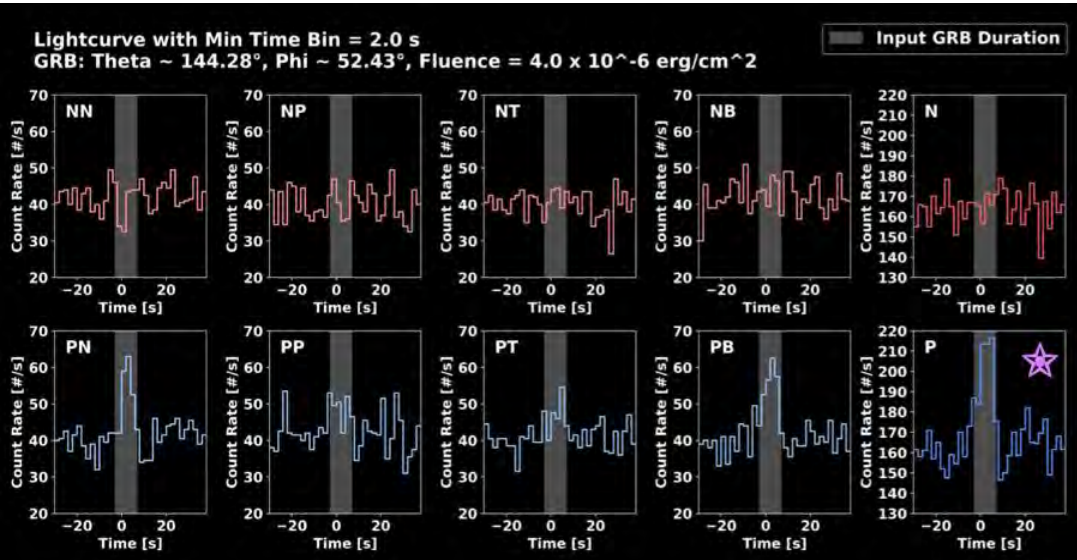
($\alpha = -1$, $E_p = 300$keV)

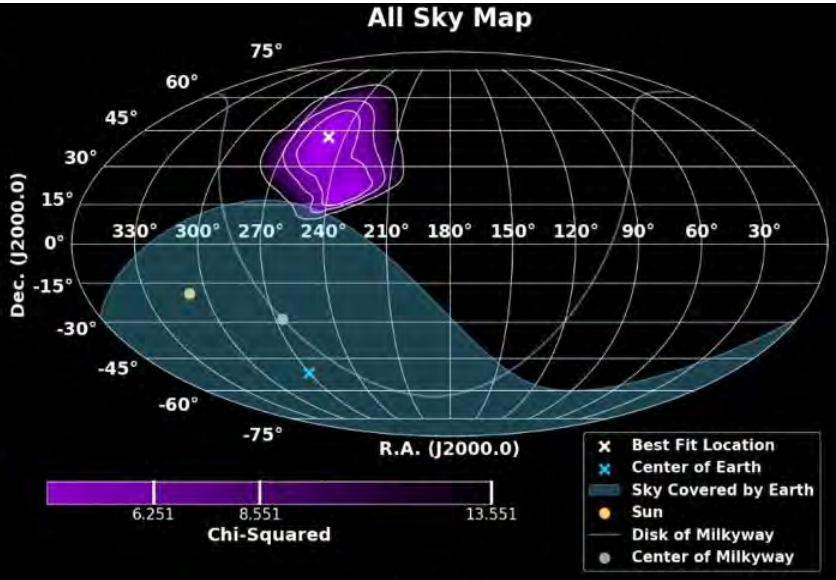


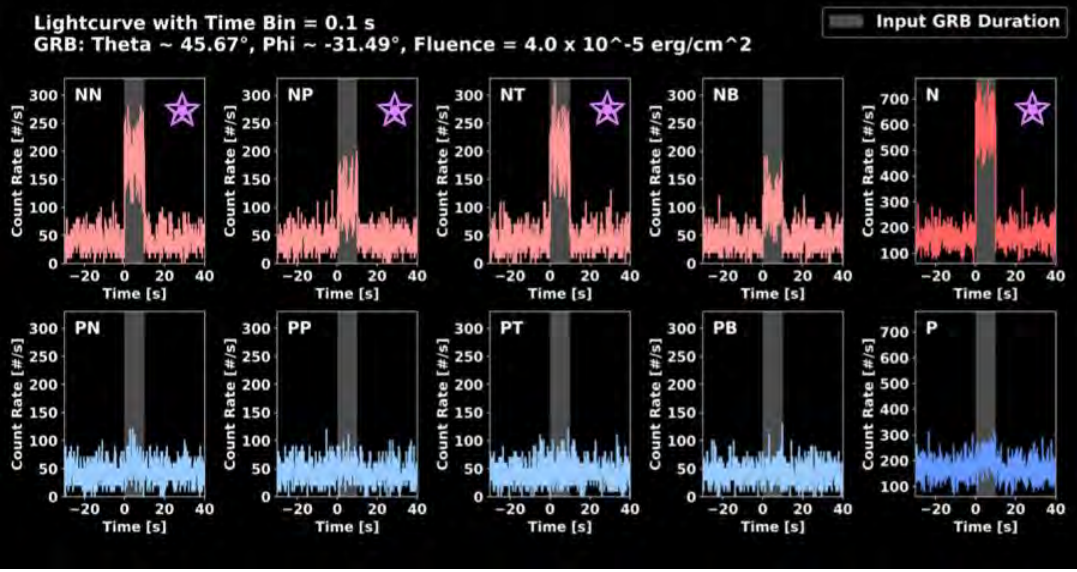


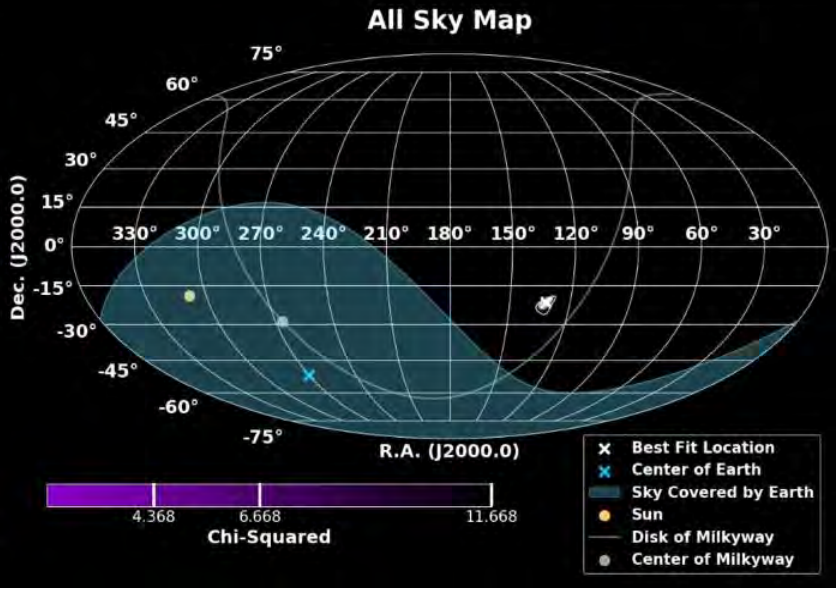


Examples of GRB detection and localization from GTM simulation







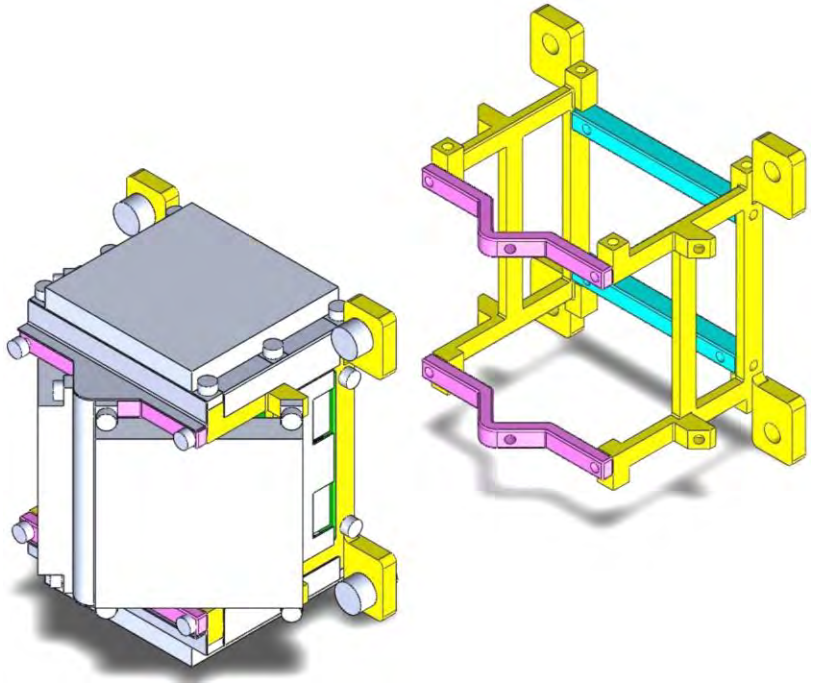


Mechanical design

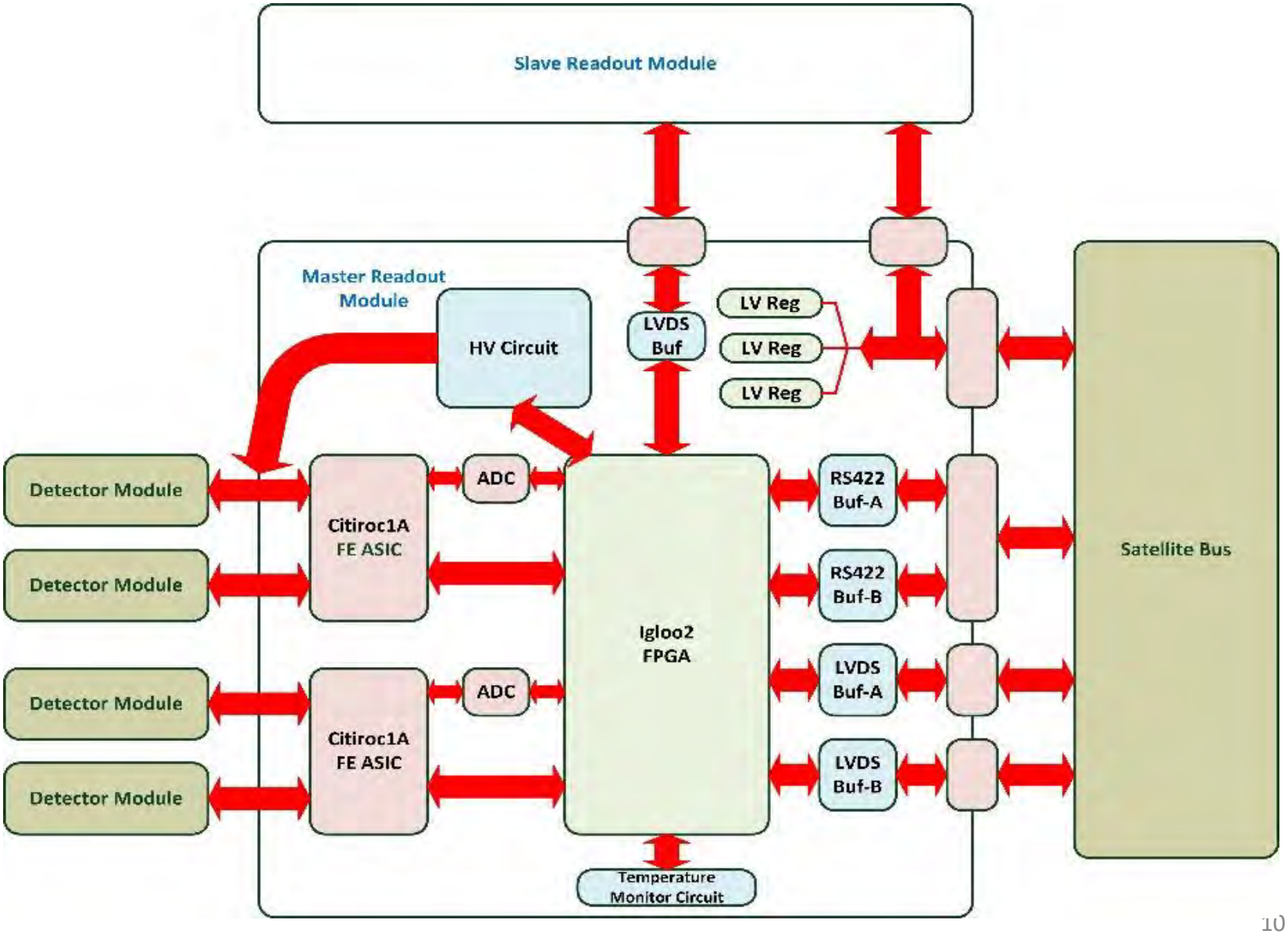
- **Weight budget: 1 kg/unit**
  - **Four sensor modules ~ 600 g**

- **Frame structure with multiple parts**
  - Light weight and easy manufacturing
  - Easy to revise and replace
  - Truss structure with high rigidity in limited mass.

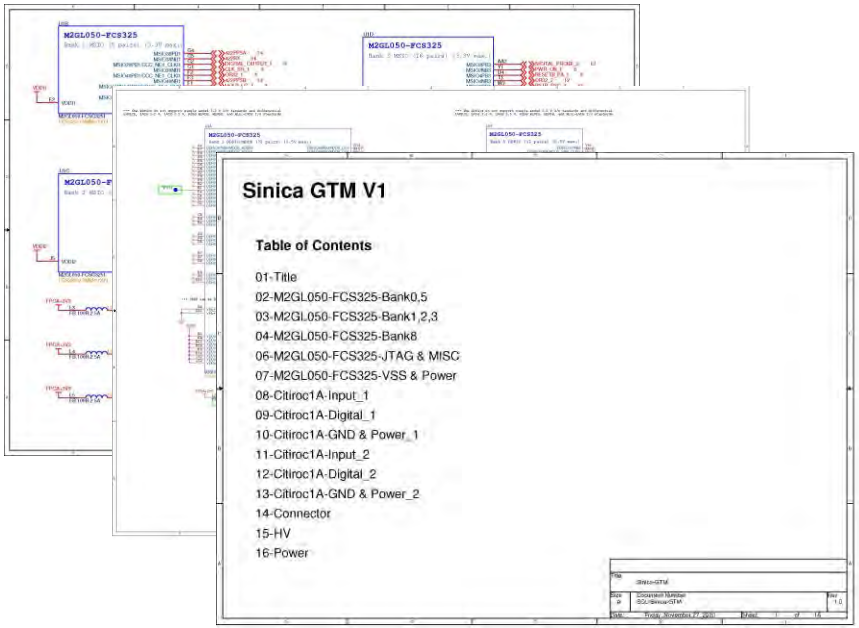
- **Sufficient heat conduction verified by analysis and tests.**

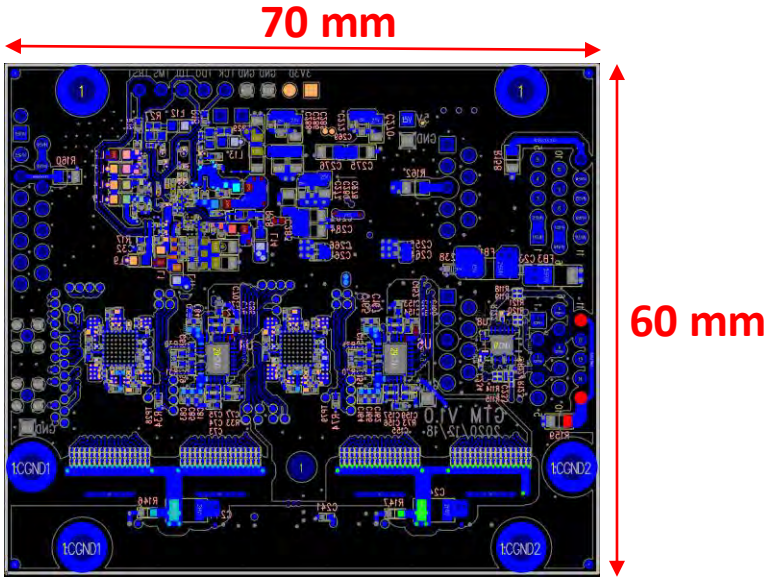


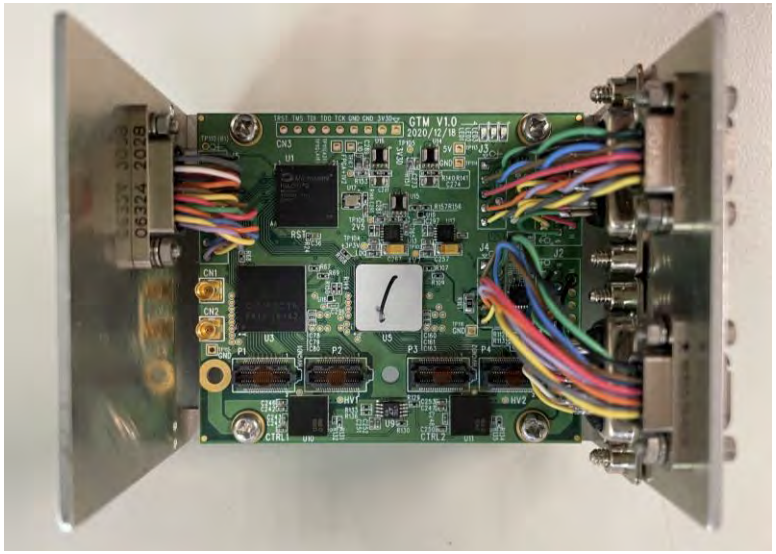
Readout system

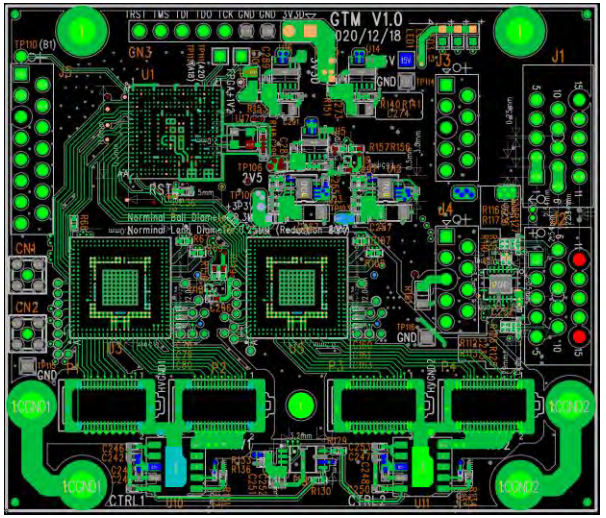


Readout system

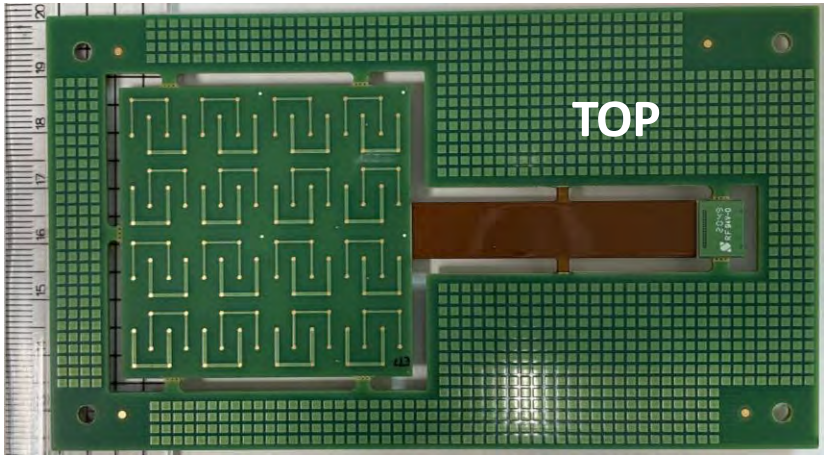


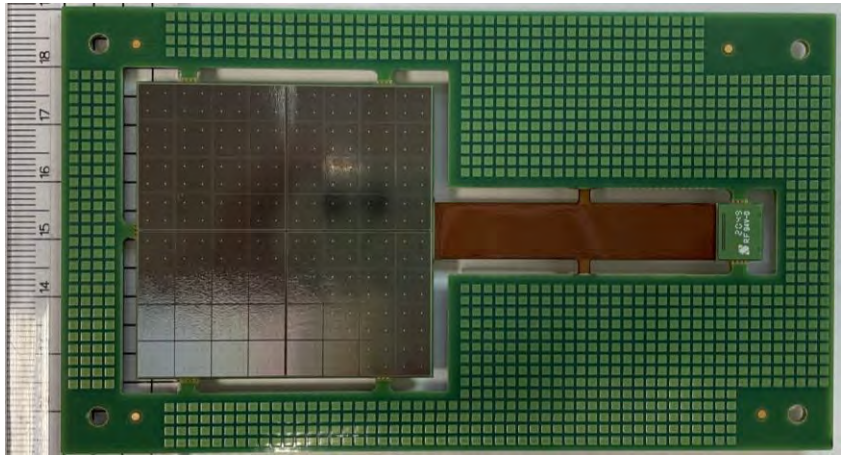


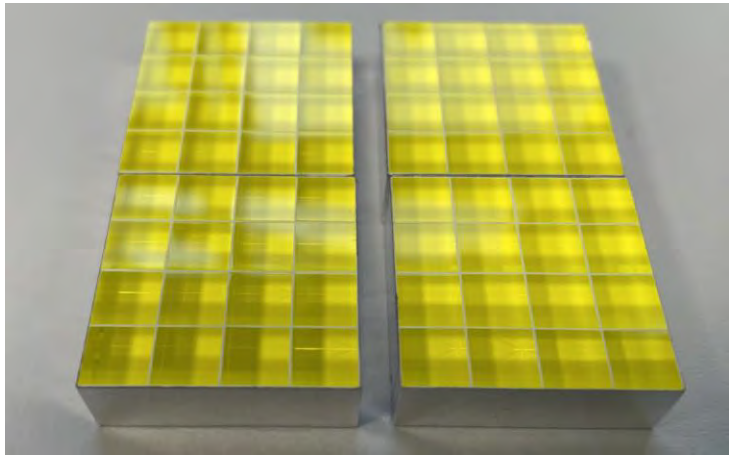


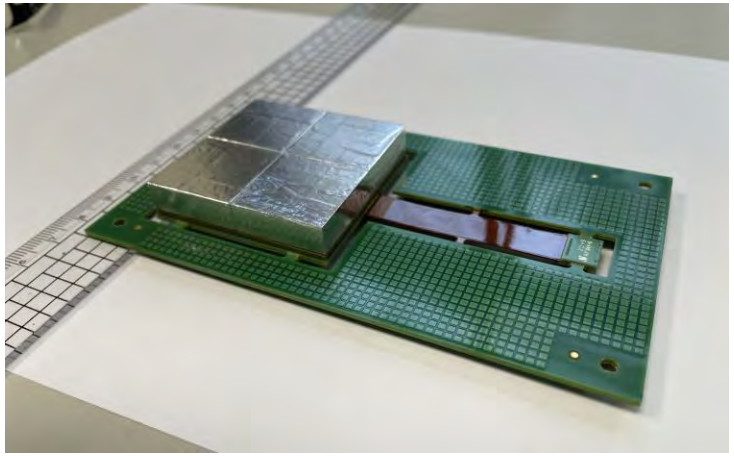


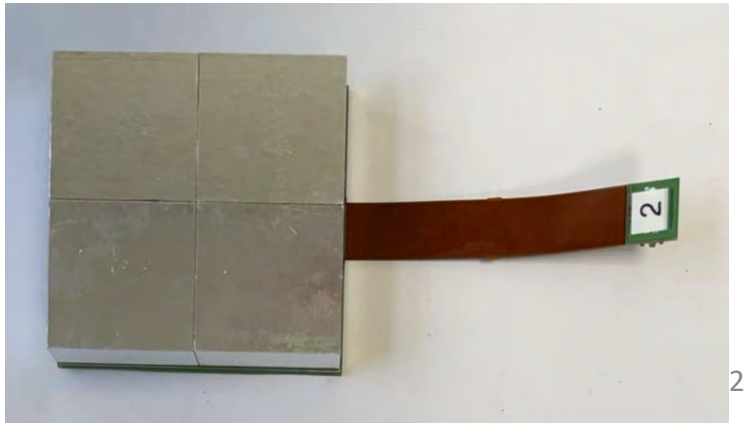
Sensor module



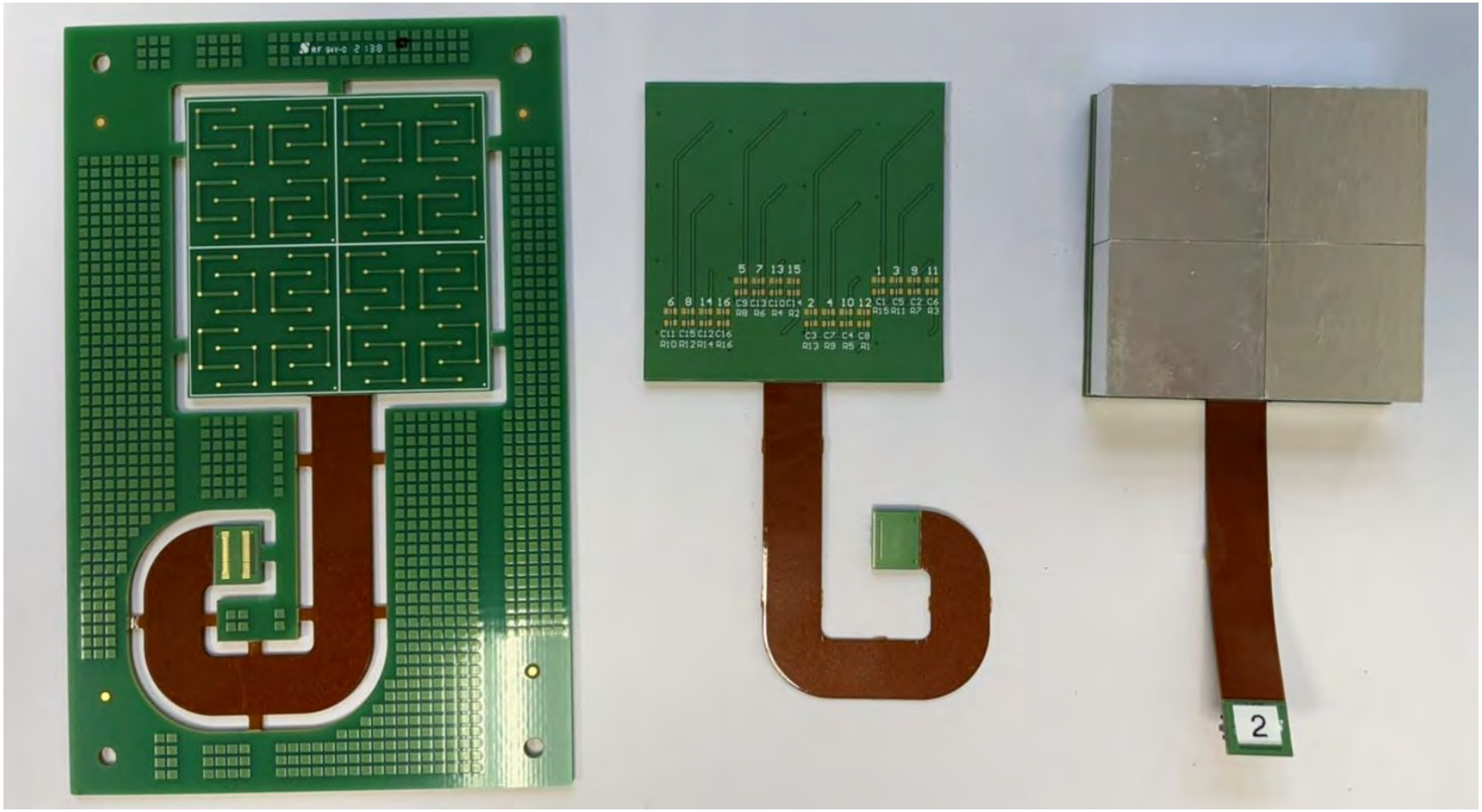




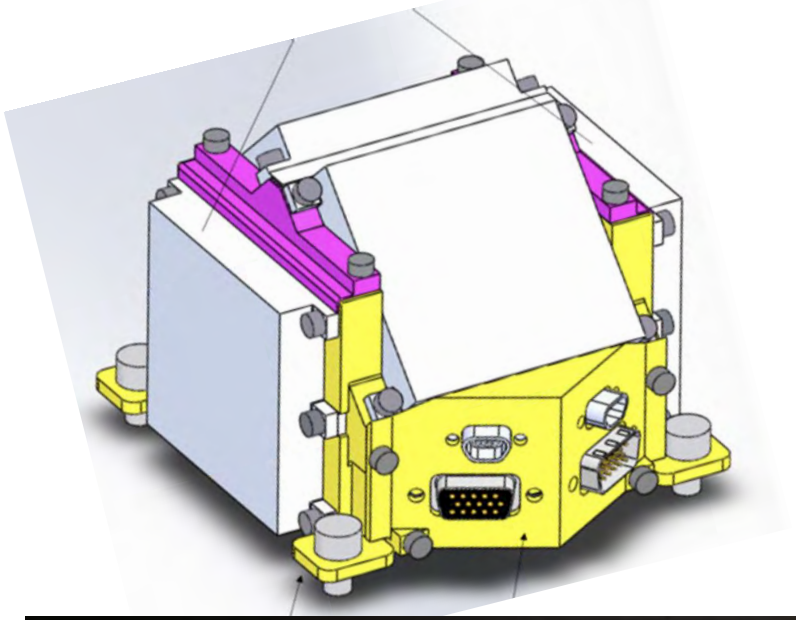


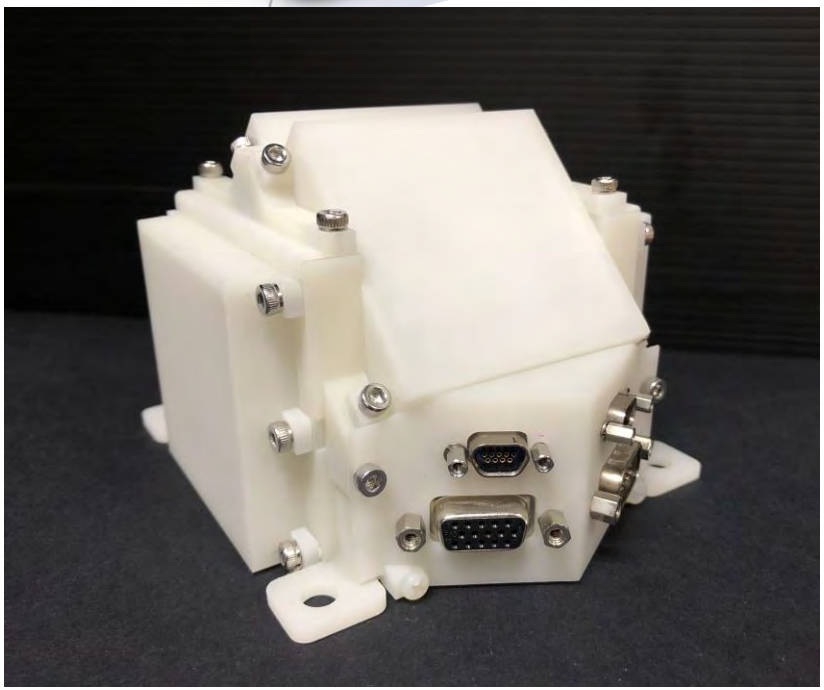


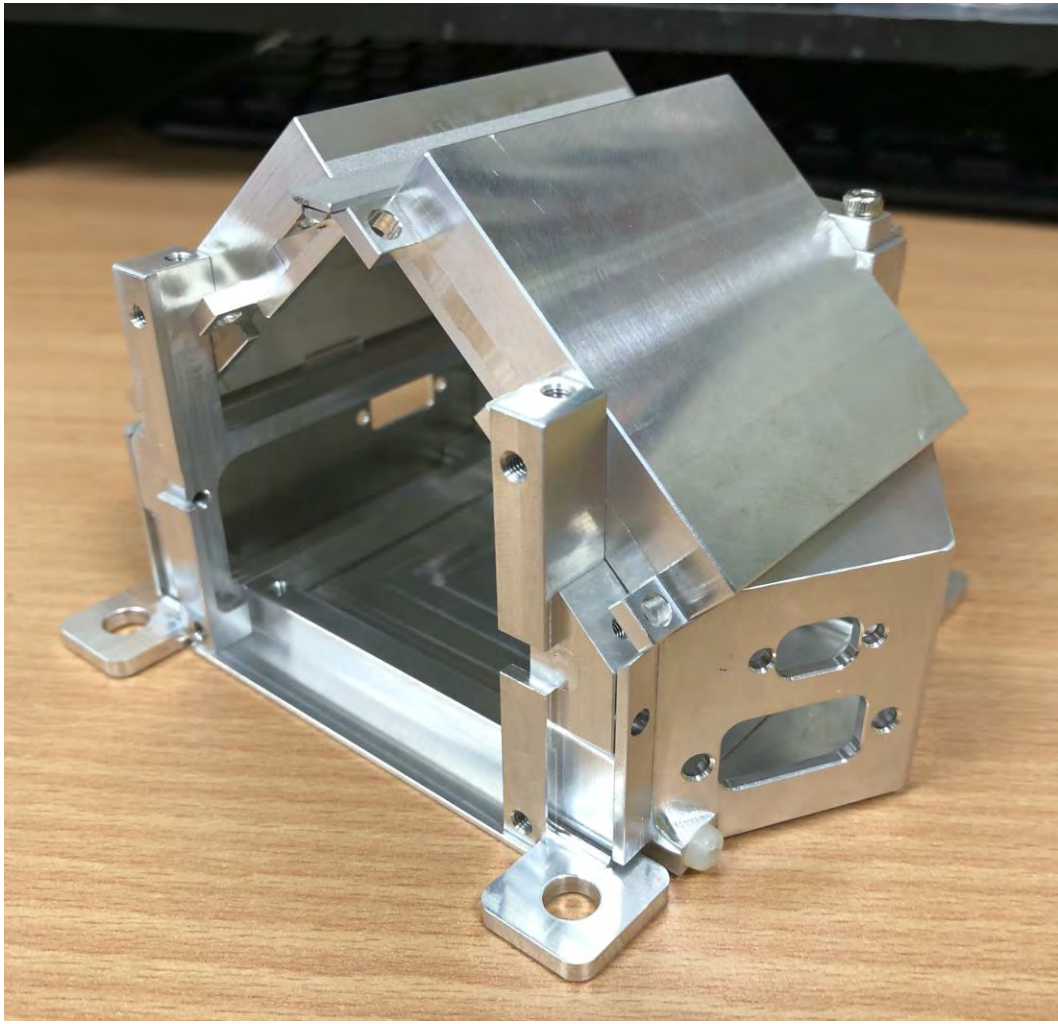
Sensor module



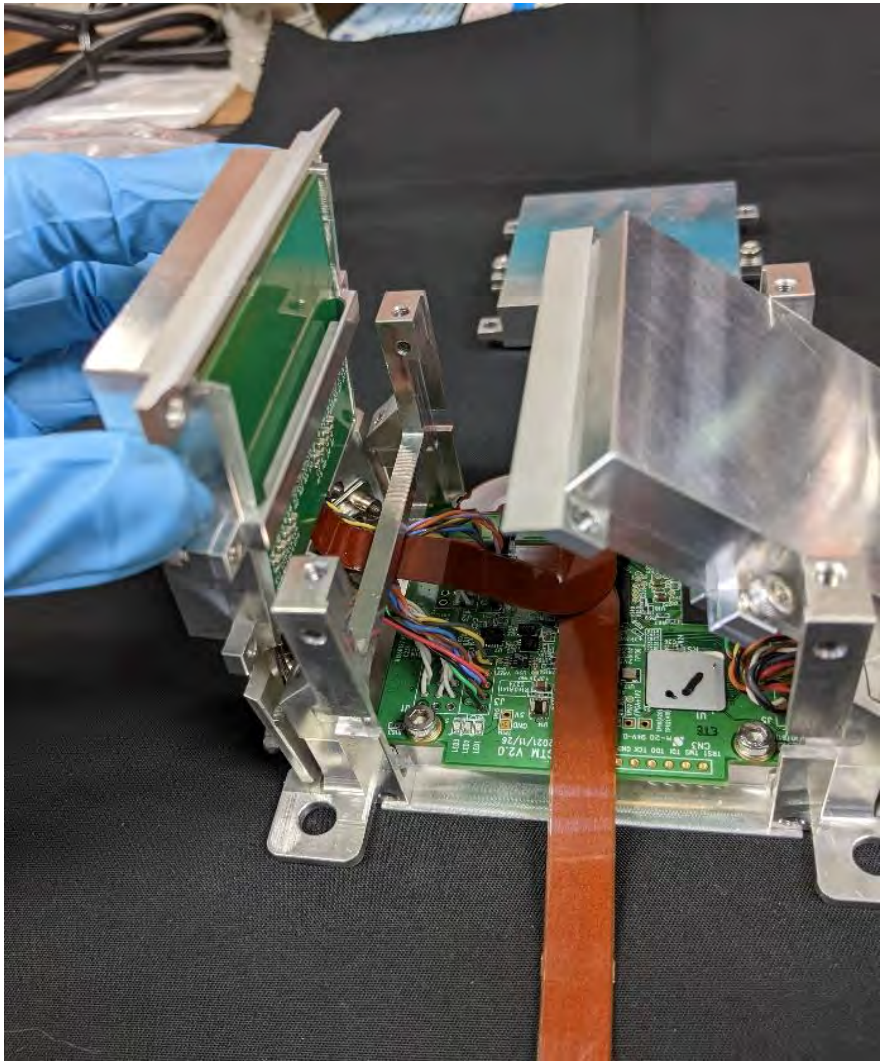
Mechanical structure

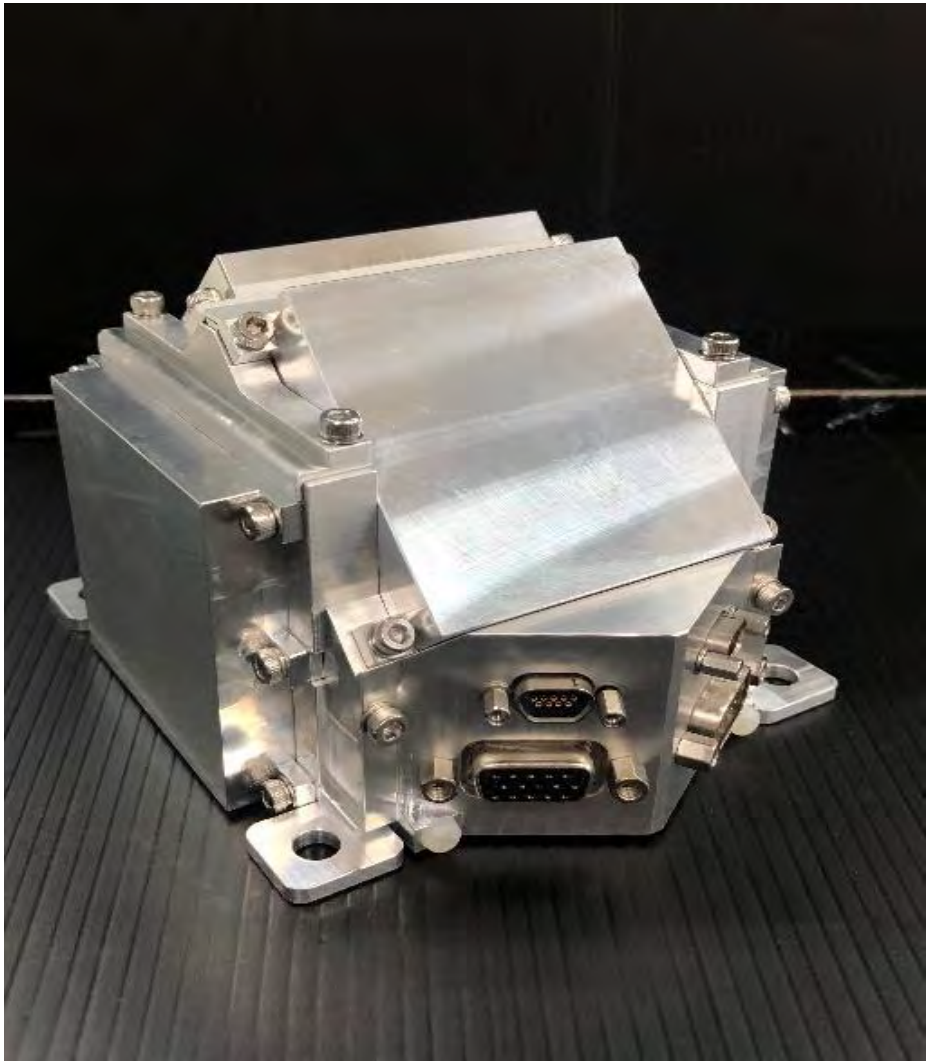




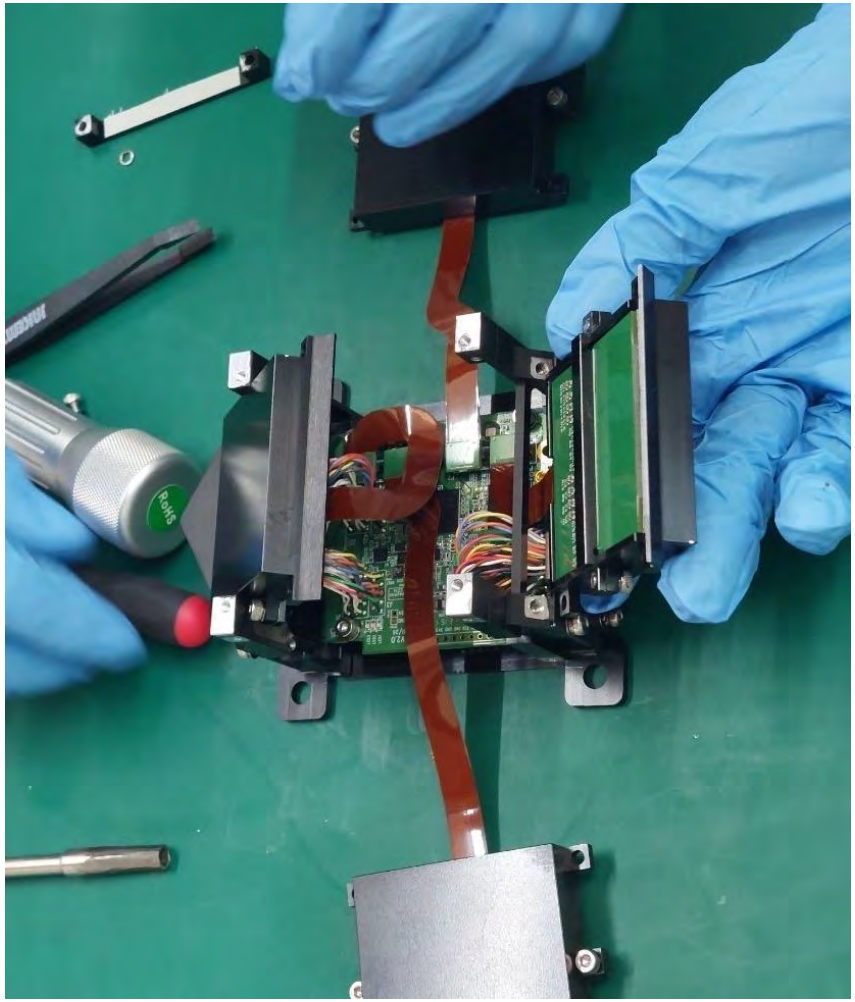


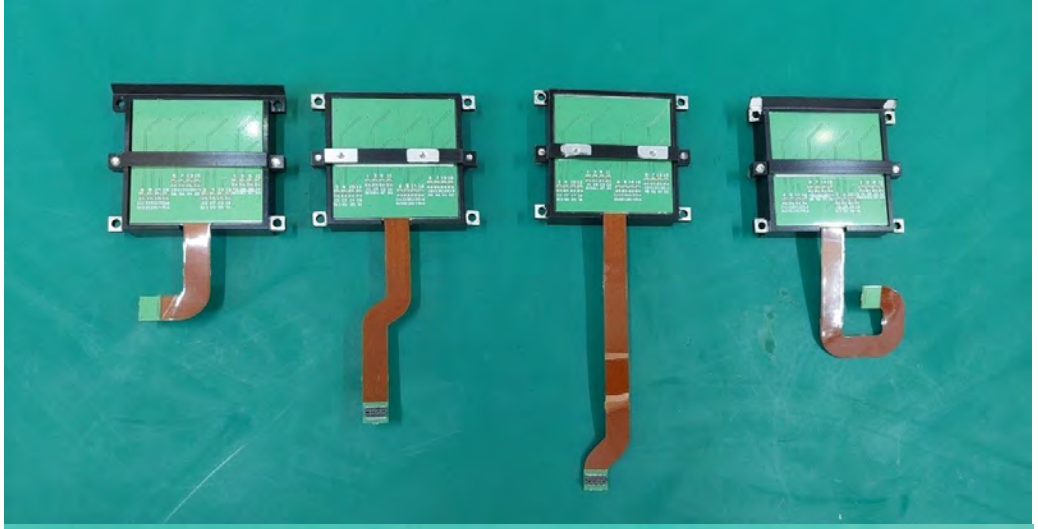
EM assembly

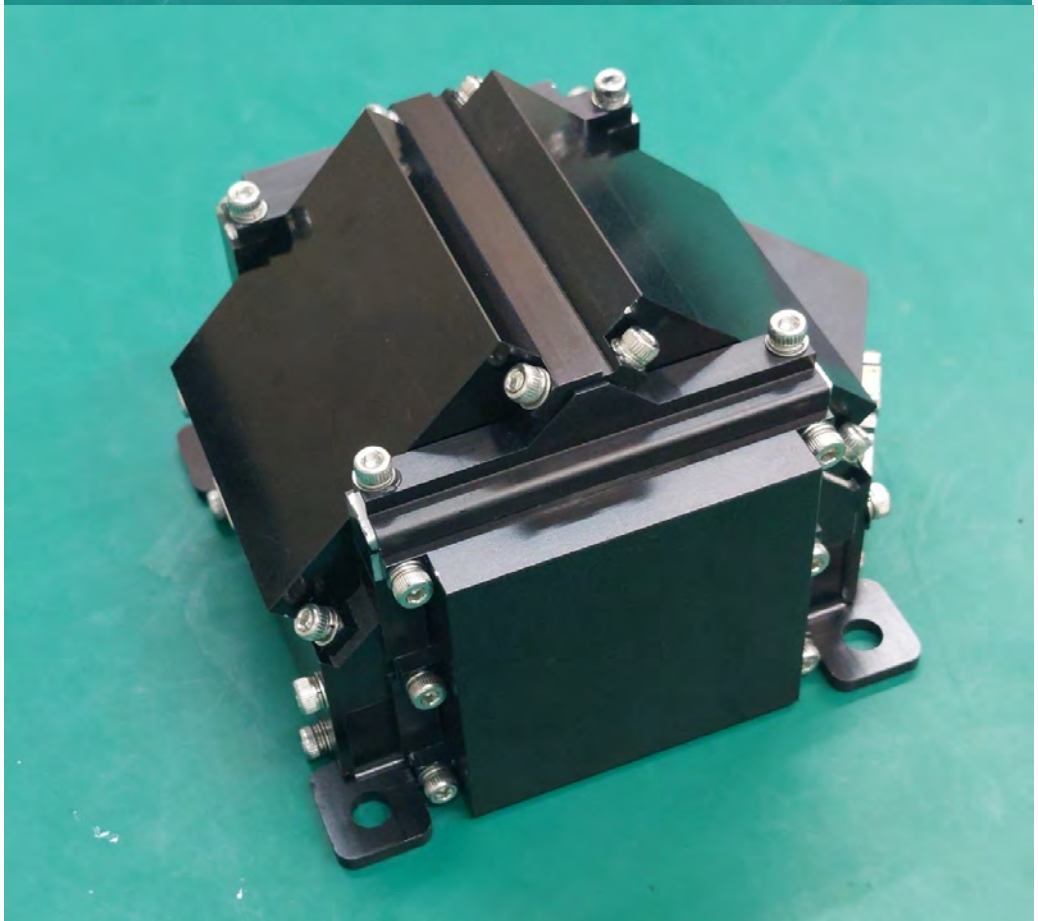




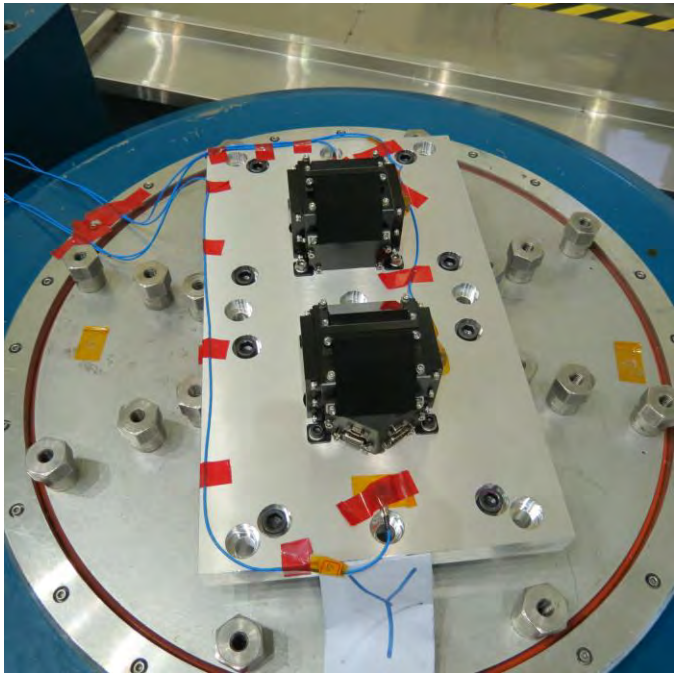
EQM assembly



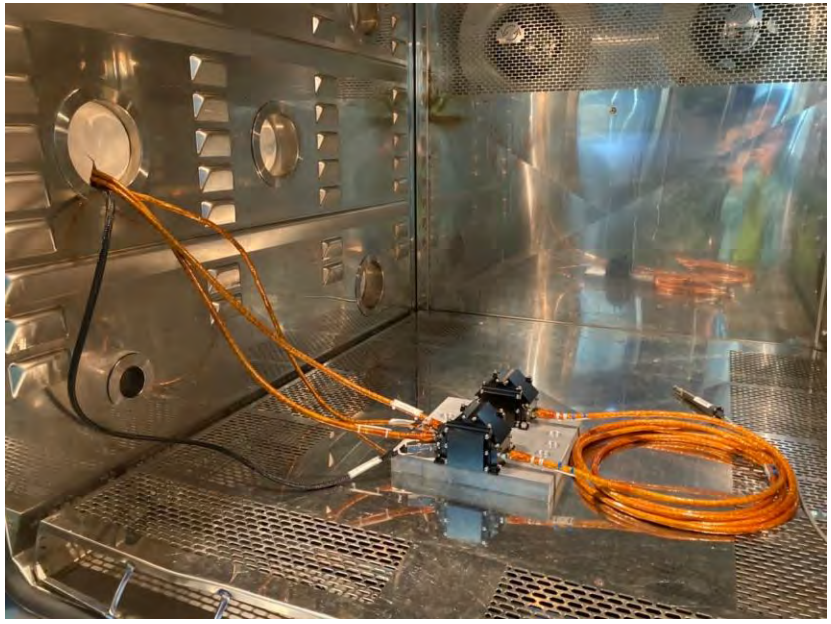


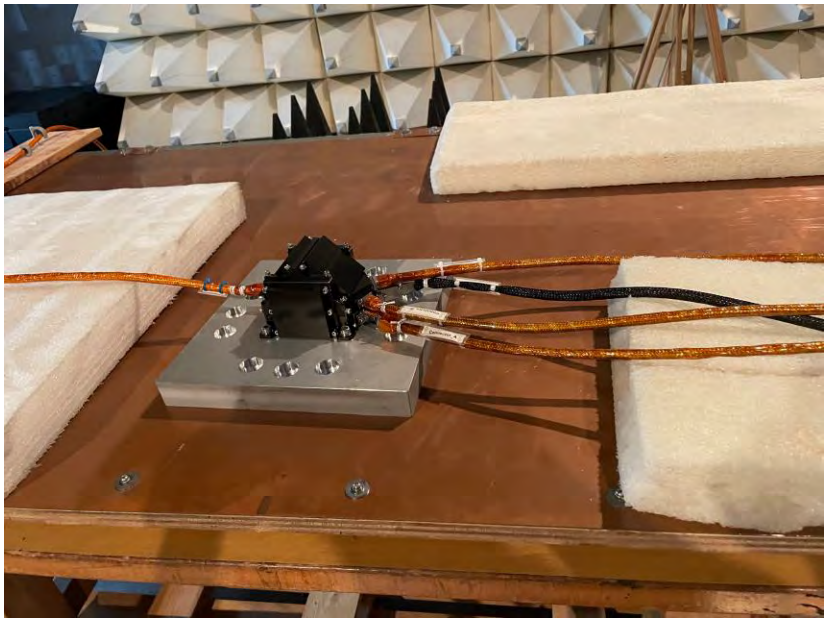


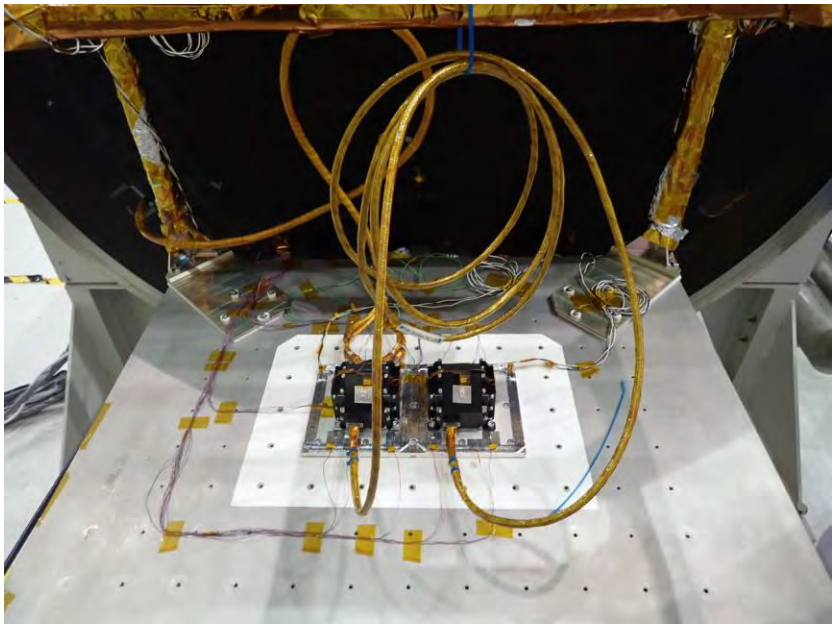


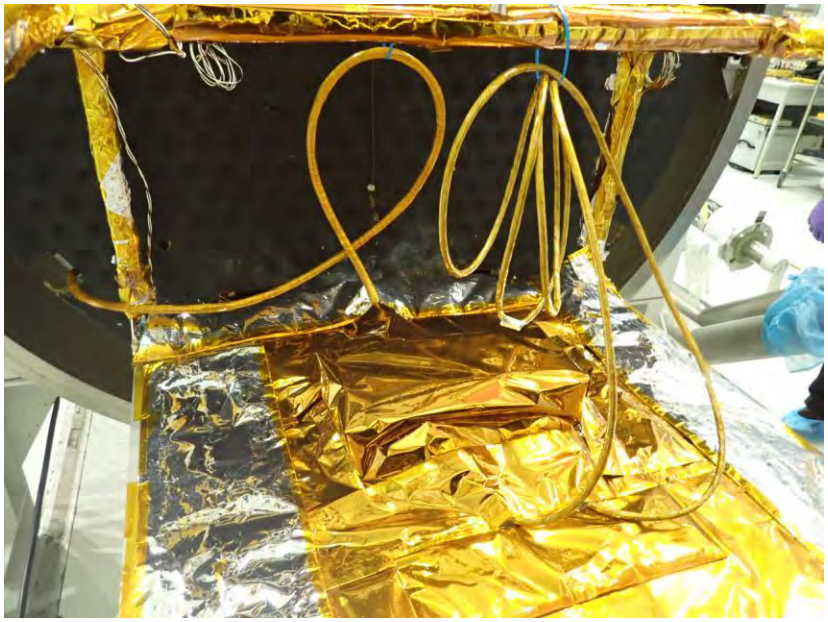


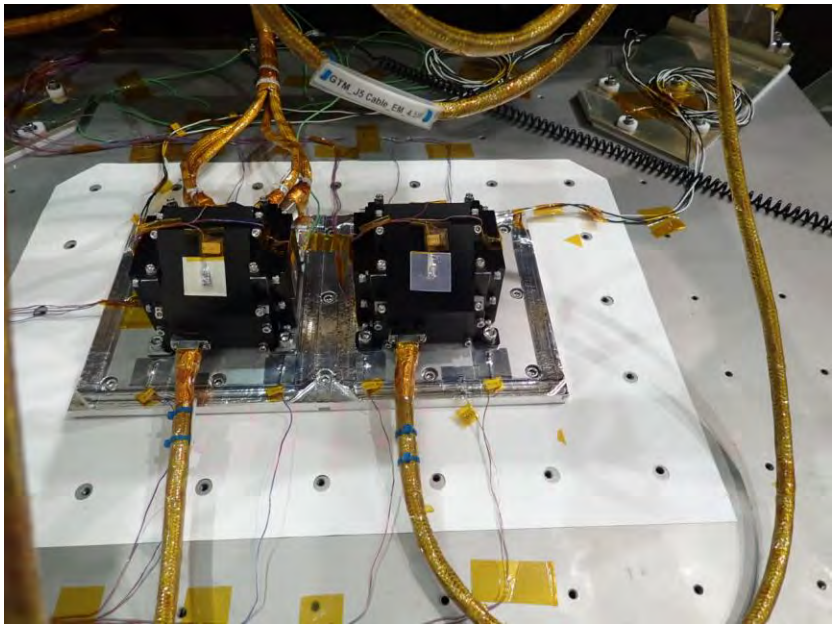
GTM EQM functional, vibration, shock, thermal cycle and EMC/EMI tests (Sep-Oct, 2022).













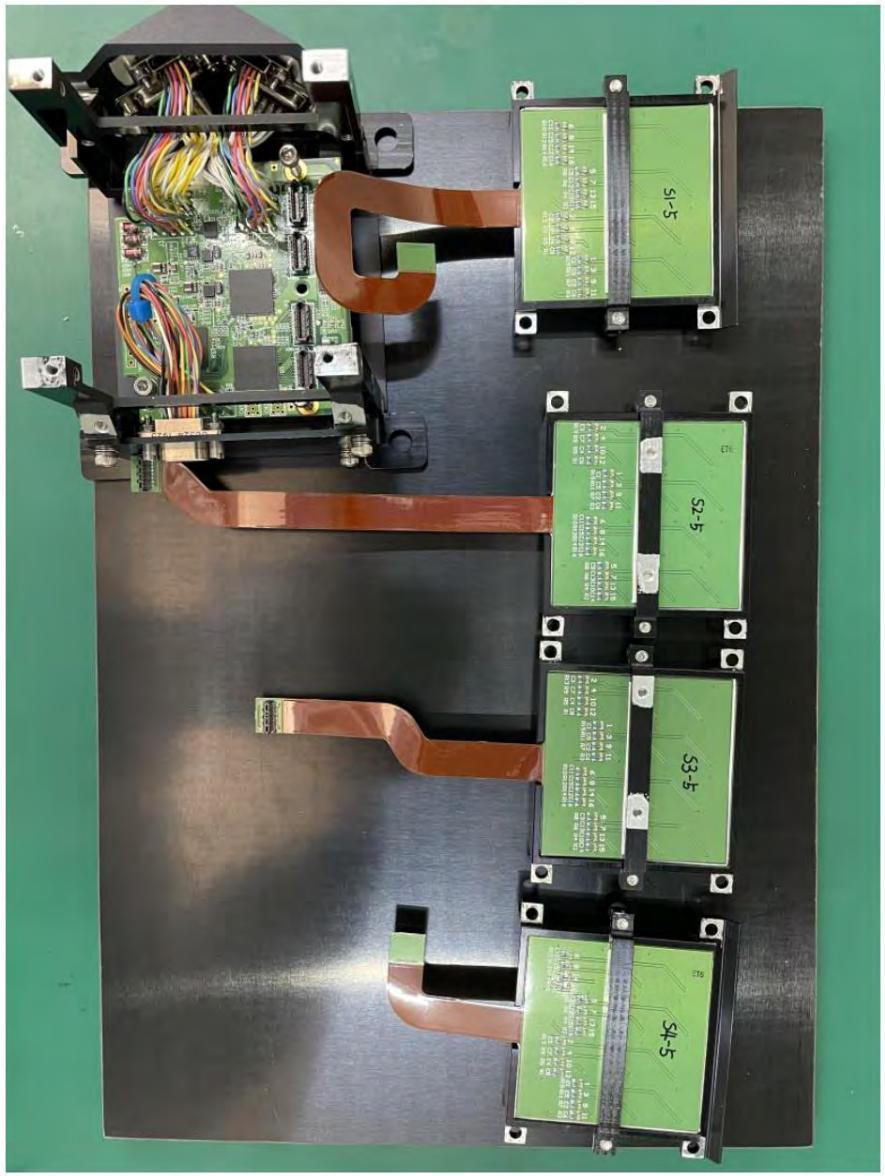
GTM EQM thermal vacuum test at TASA in January 9-13, 2023

GTM Flight Model (FM) assembly (March 6-7, 2023)

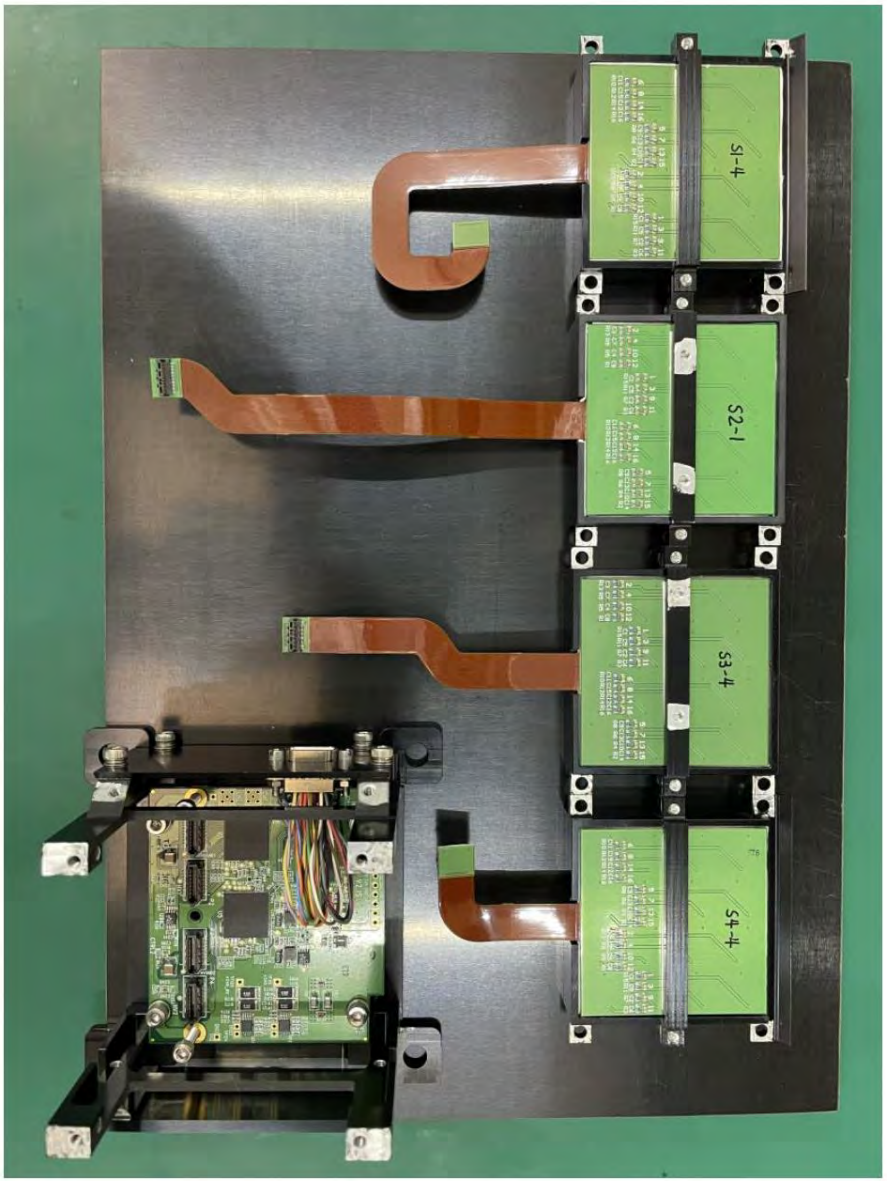


GTM Flight Model (FM) assembly

Master

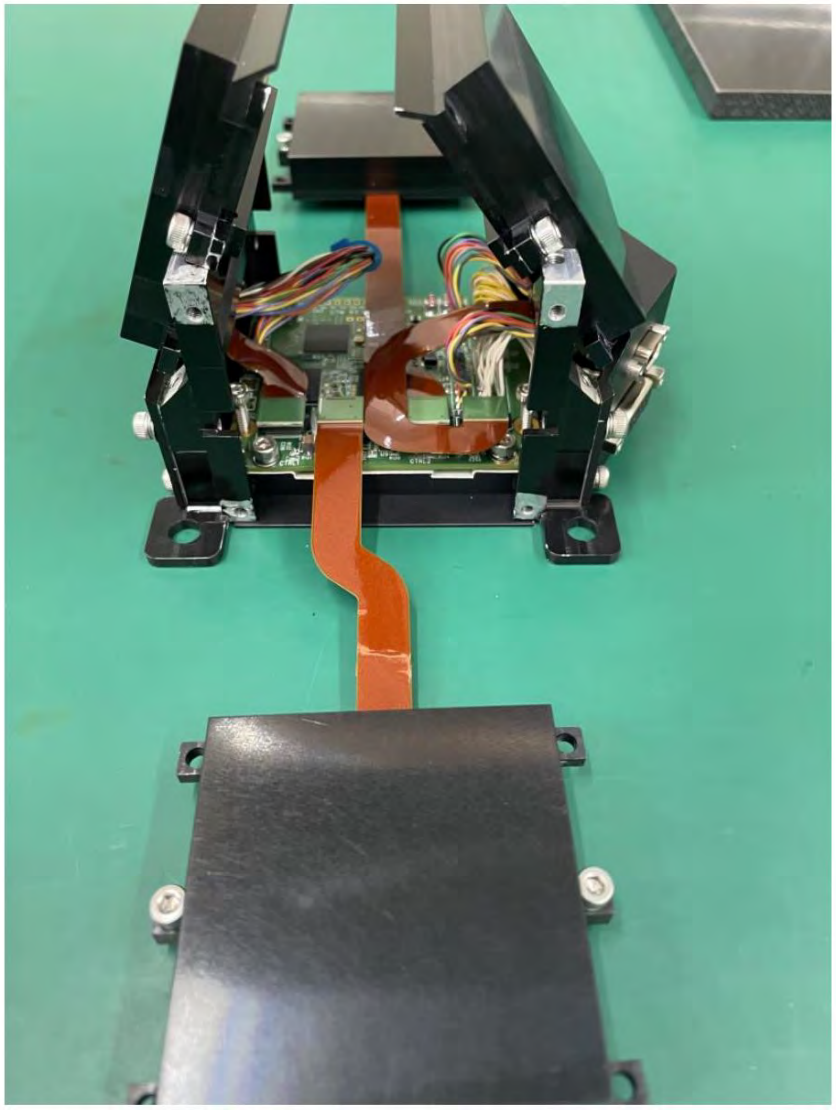


Slave

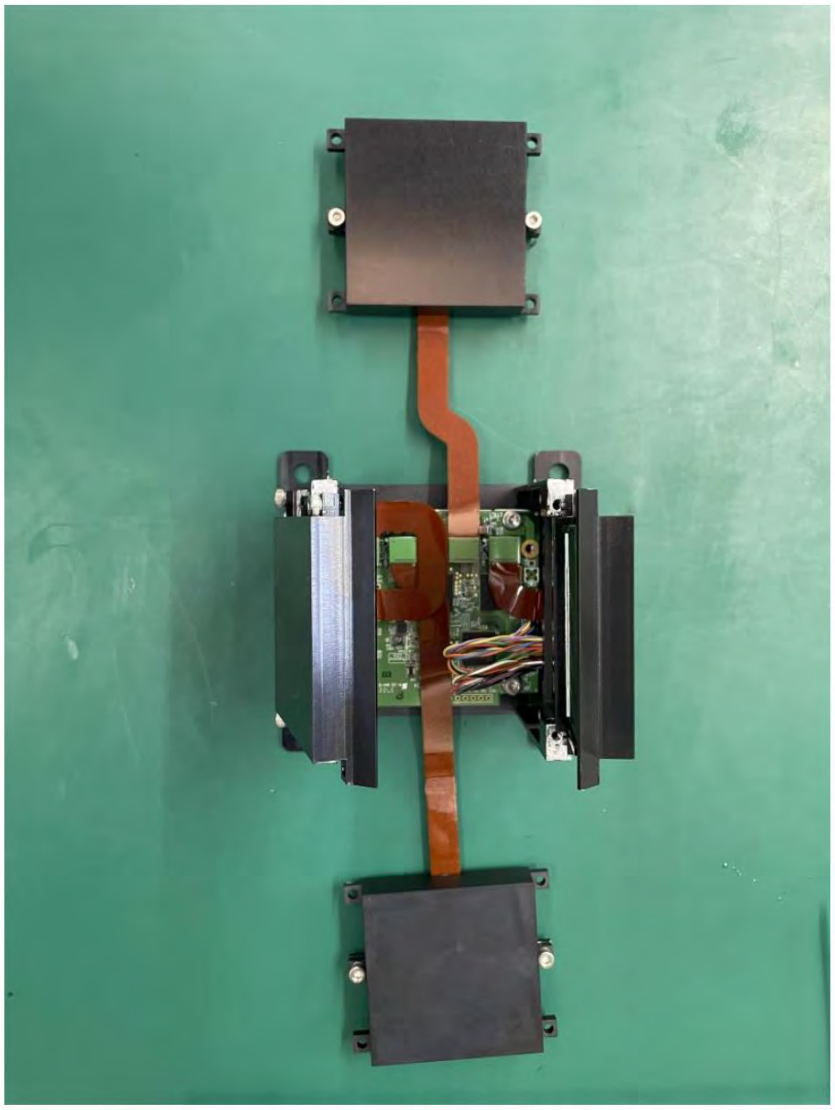


GTM Flight Model (FM) assembly

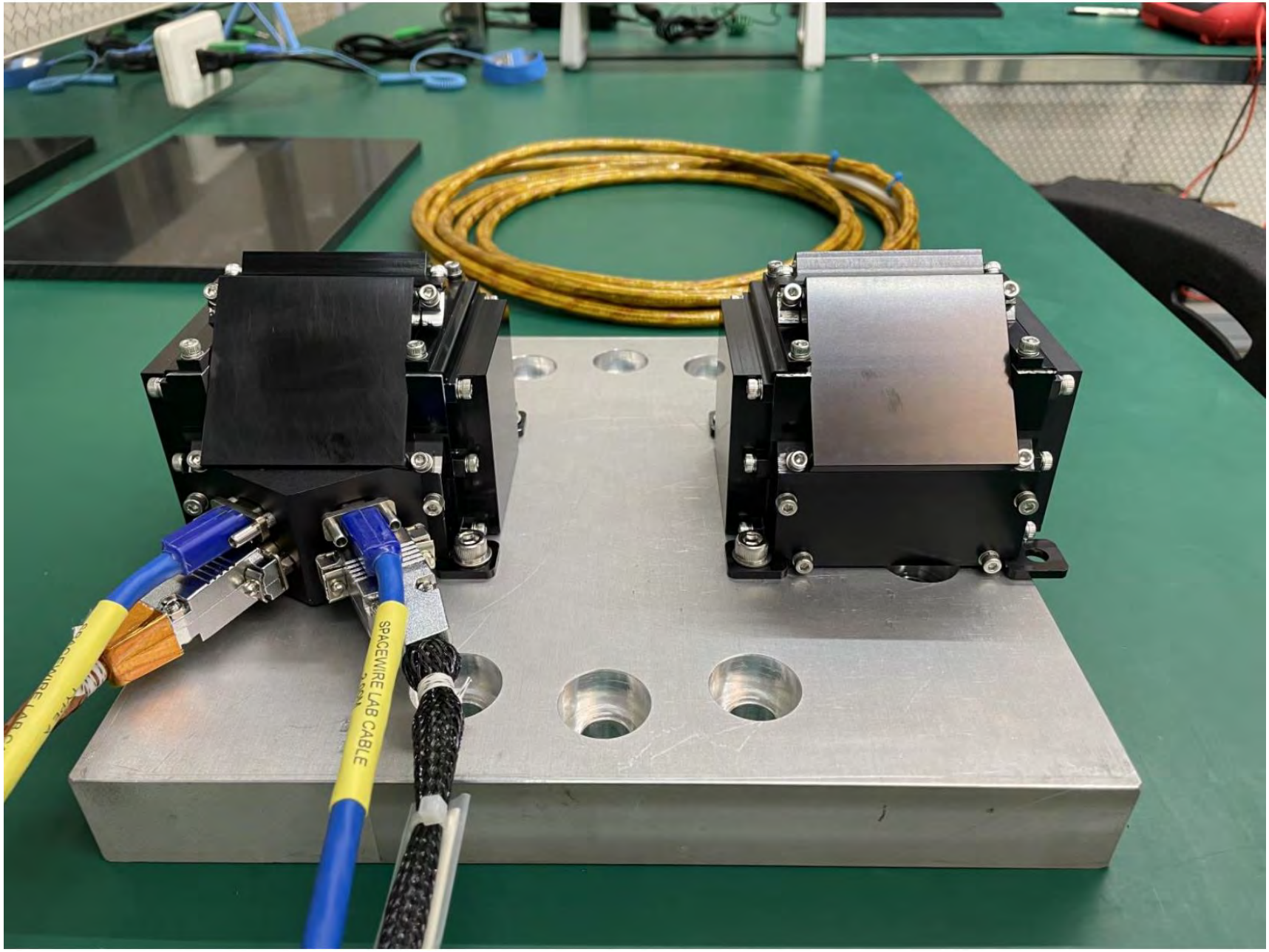
Master



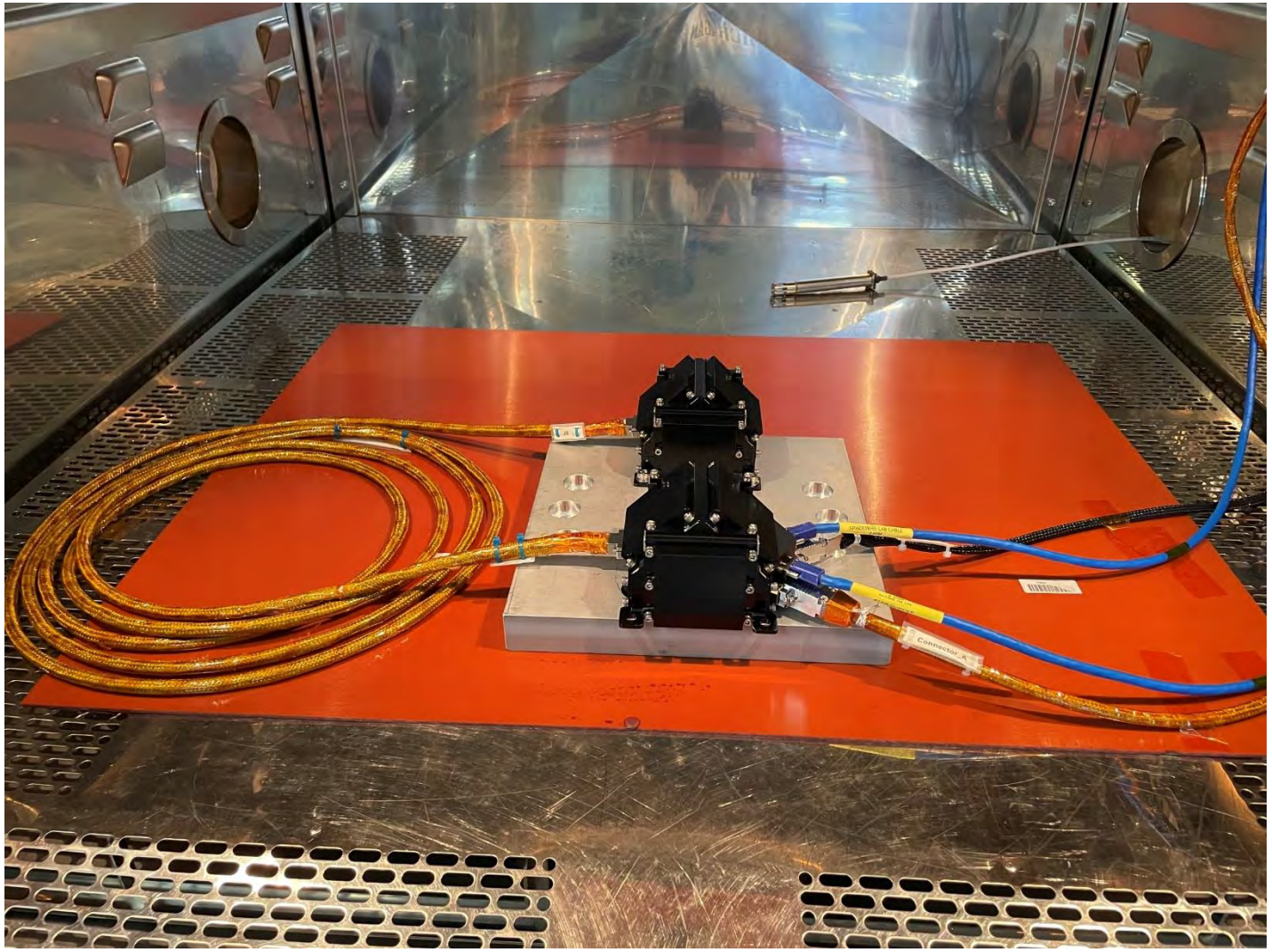
Slave



GTM Flight Model (FM) assembly



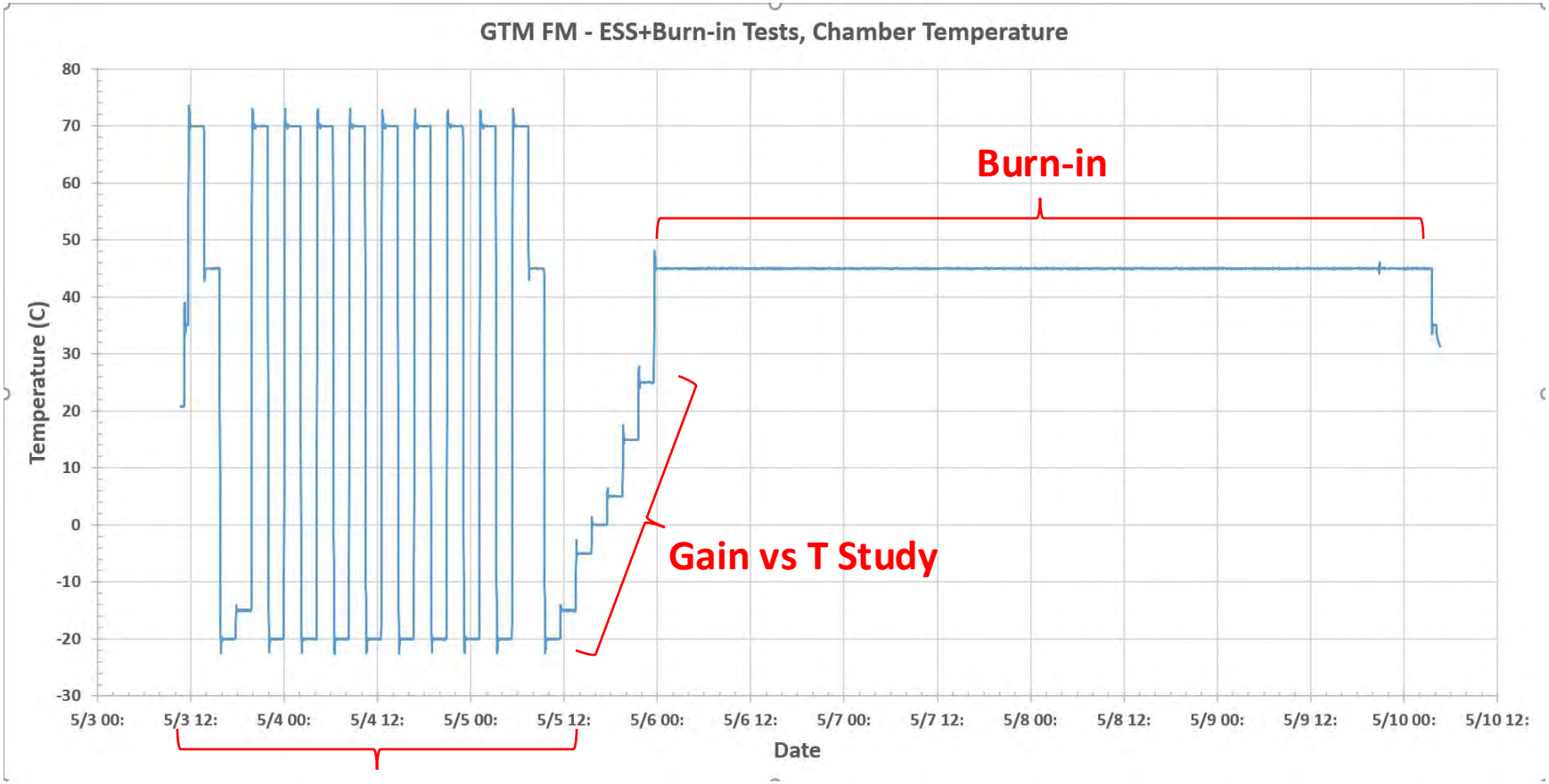
GTM FM ESS+Burn-in Tests - Setup



(@ iST, Hsinchu; chamber filled with N_2; May 3-10, 2003)

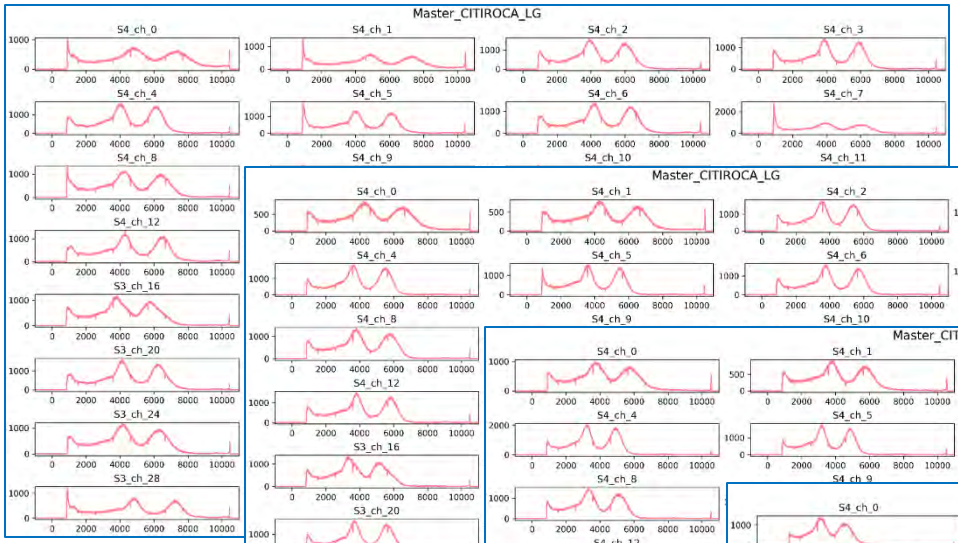
GTM FM ESS+Burn-in Tests – Chamber Temperature Log

- **Non-operation: -20°C to 70°C**
- **Operation: -15°C to 45°C**



GTM FM ESS+Burn-in Tests – Gain vs Temperature

-5ºC

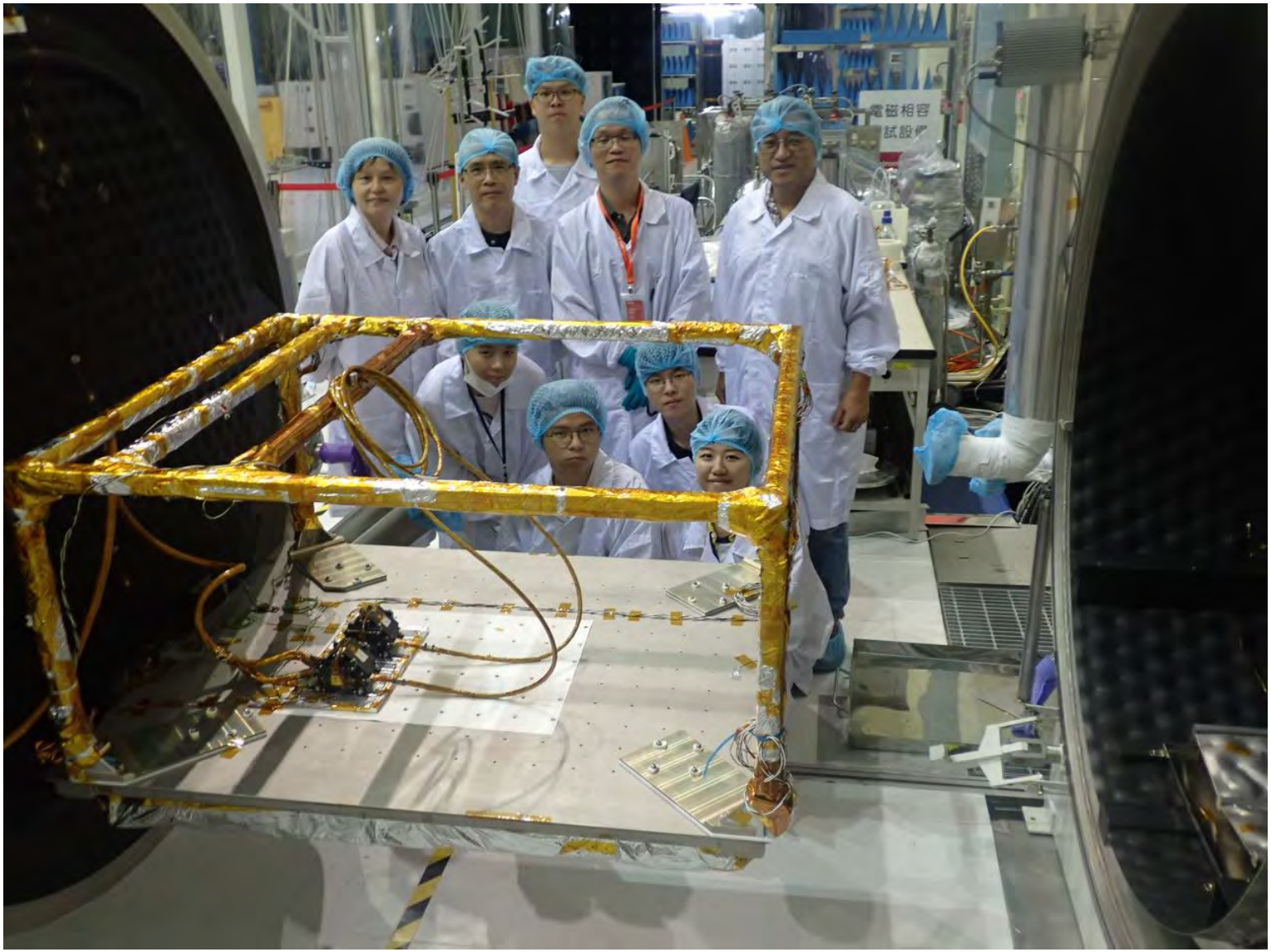


0ºC

+5ºC

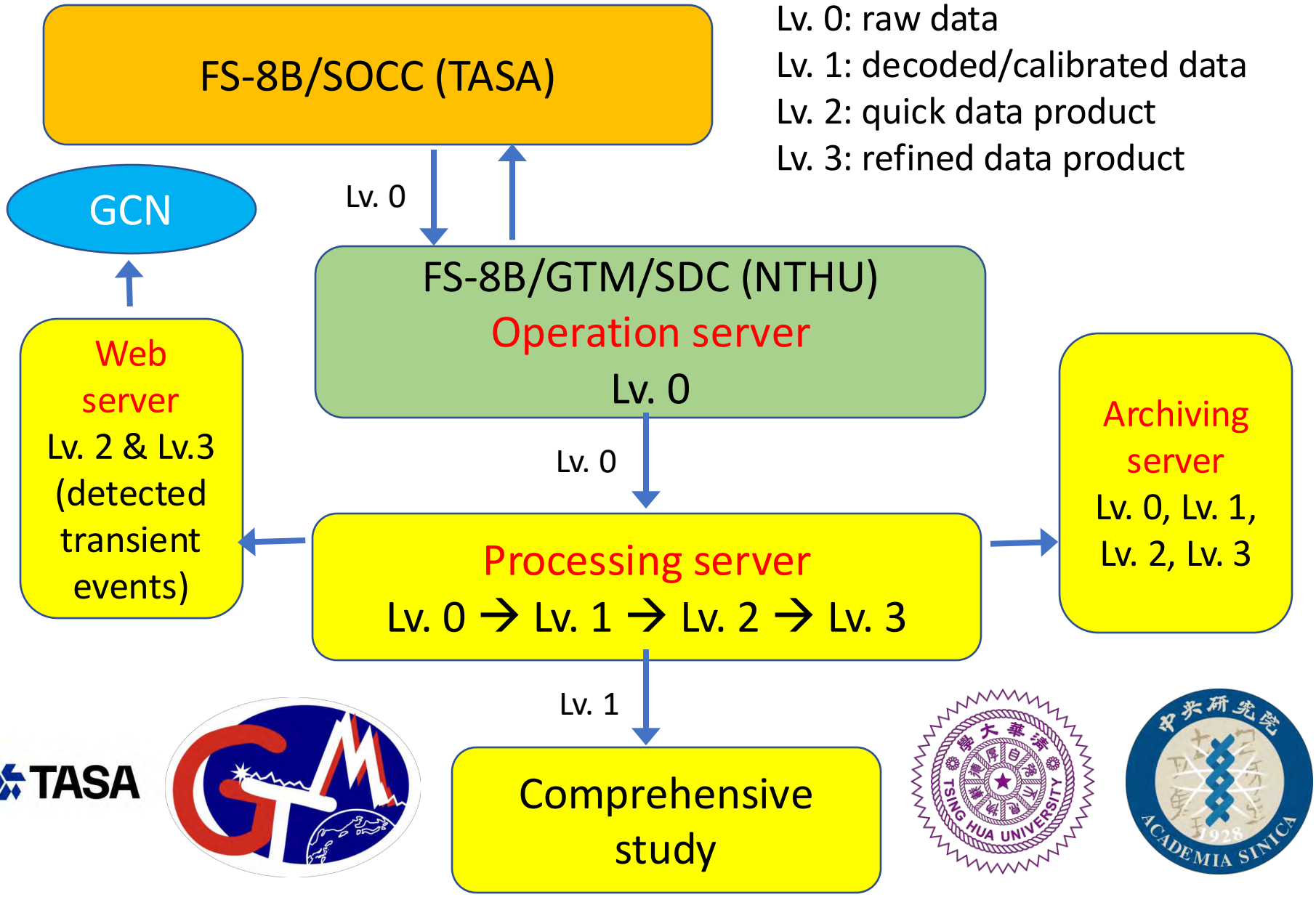
+15ºC

GTM FM TVT successfully completed

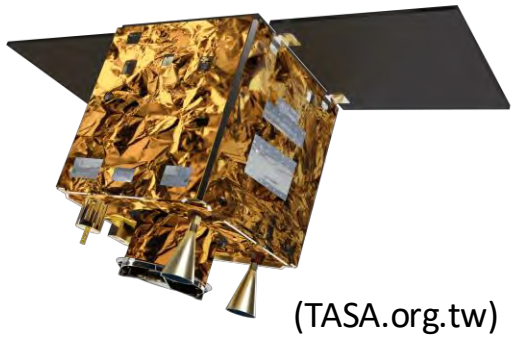


(@TASA, Aug. 28, 2023)

FS-8B/GTM data flow



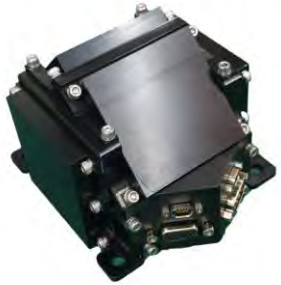
Current status (December 2025)

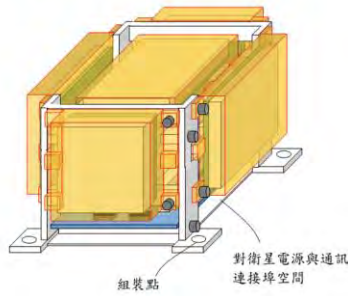

(TASA.org.tw)

- Calibrations on ground have been conducted.

  (See Huang et al. 2025, NIMA 1075, 170312)
- Integration and tests with FS-8B bus has started since June 2025; scheduled to launch by SpaceX with Falcon-9 in Q4 2026.
- A GTM successor, called Gamma-ray Polarimeter and Monitor (GPM), has been selected to fly on Formosat-8D, aiming at launch in 2028.

FS8B/GTM → FS8D/GPM





The GTM Team

