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

Hsiang-Kuang Chang
(Institute of Astronomy, National Tsing Hua University, Taiwan)

Chih-Hsun Lin
(Institute of Physics, Academia Sinica, Taiwan)

Che-Chih Tsao
(Department of Power Engineering, National Tsing Hua University, Taiwan)

Gamma-ray Transients Monitor (GTM)

Science goal

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

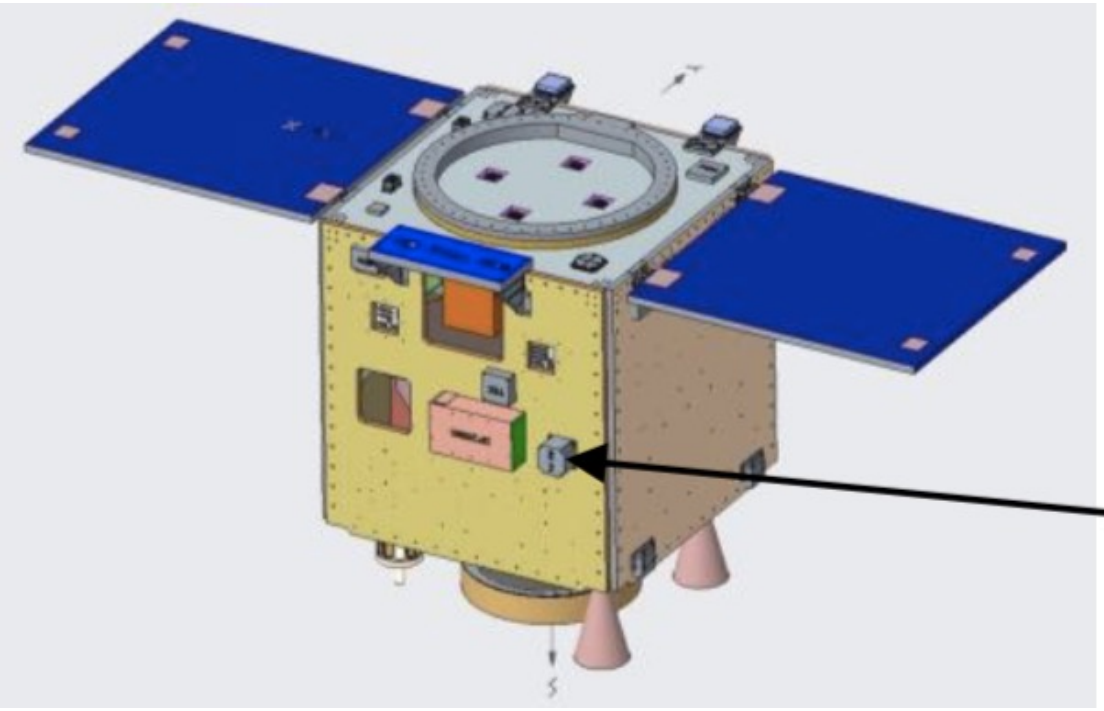
Instrument design

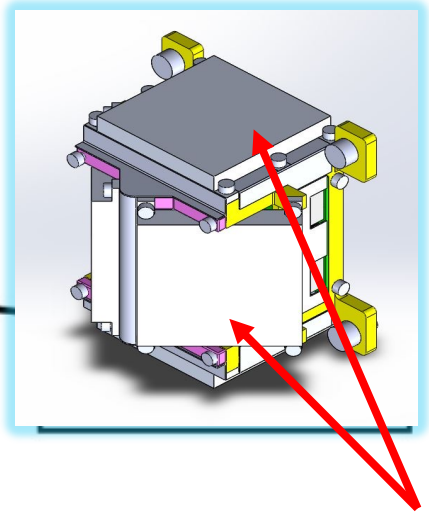
Current status

A quick summary:

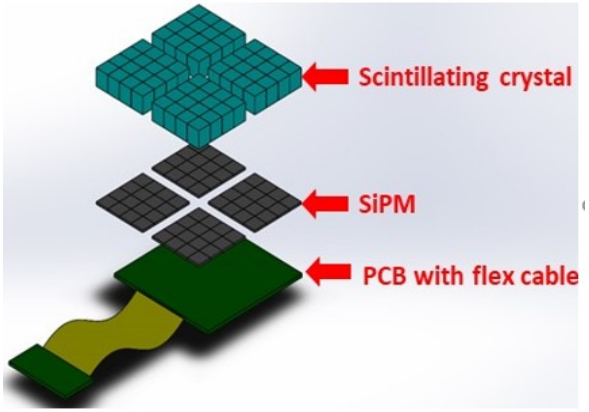
FS-8B will be launched into a sun-synchronous LEO in 2025.
GTM is expected to detect about 40 GRBs per year.

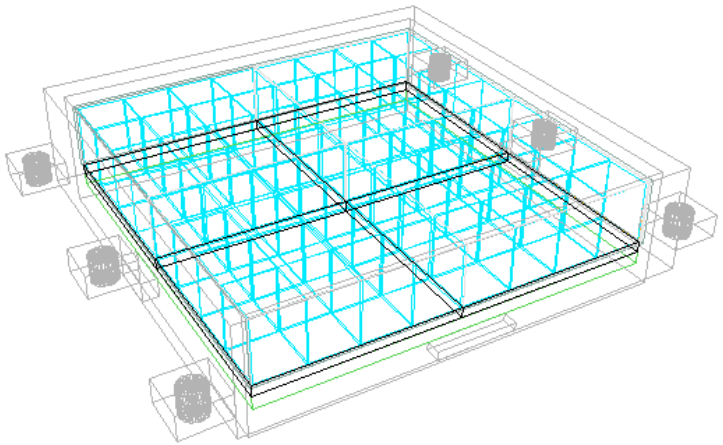
Concept of GTM on board Formosat-8B

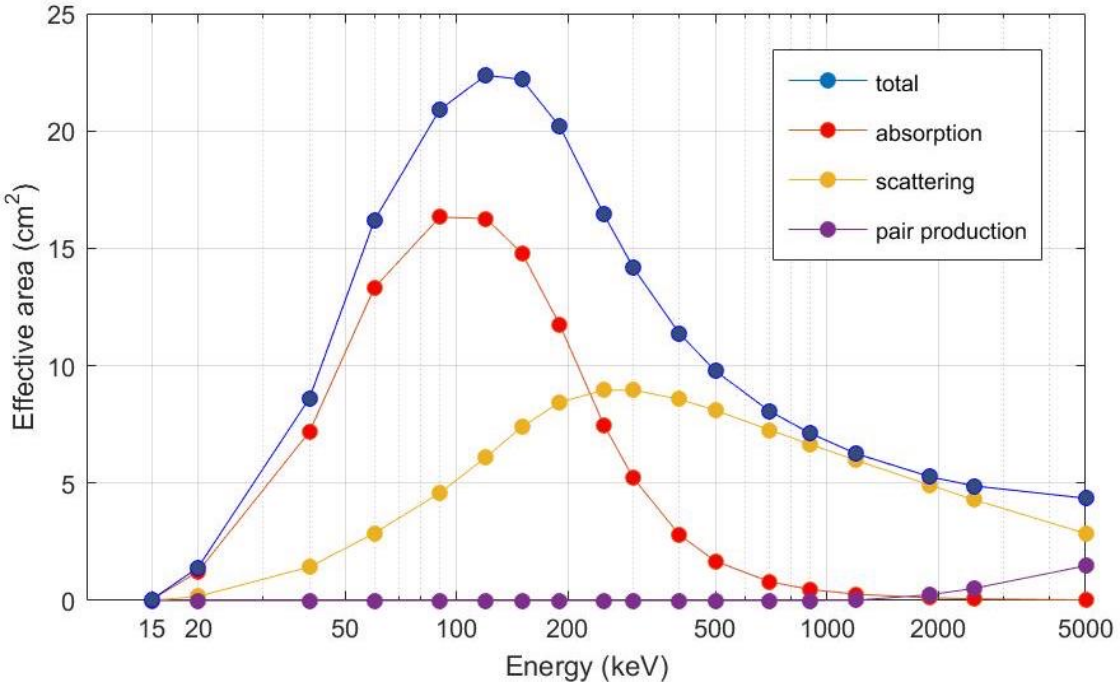




The Gamma-ray Transients Monitor (GTM) consists of two identical modules located on two opposite sides of FS-8B. Each module has four sensor units facing different directions to cover the whole sky. Each sensor unit is composed of a GAGG scintillator array (51 mm x 51 mm x 8 mm) and SiPM of corresponding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

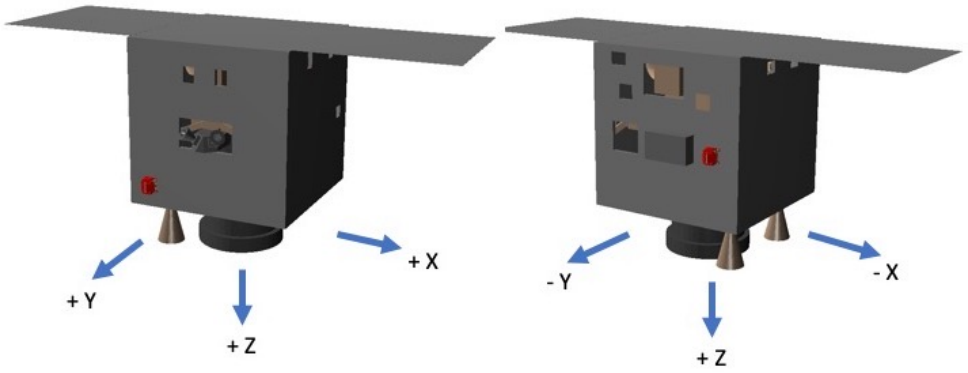






The effective area of one GTM GAGG (Gadolinium Aluminum Gallium Garnet)
sensor unit.

Detection performance simulation for FS-8B/GTM, Source and Background Models



MEGAlib (Zoglauer et al. 2008)

Background:

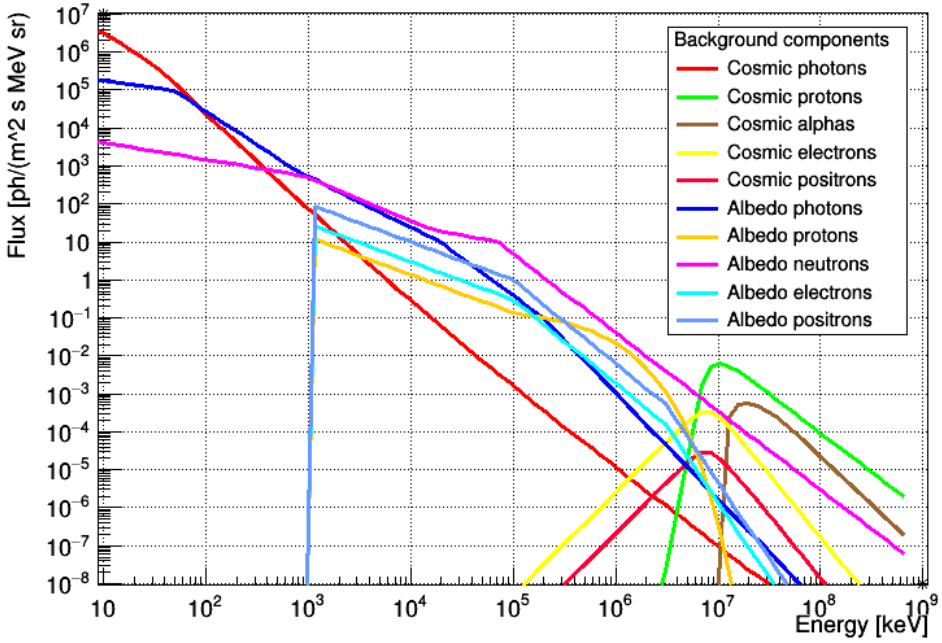
A polar (97°), low-altitude (560 km) Earth orbit; embedded in MEGAlib.

Source spectral model:

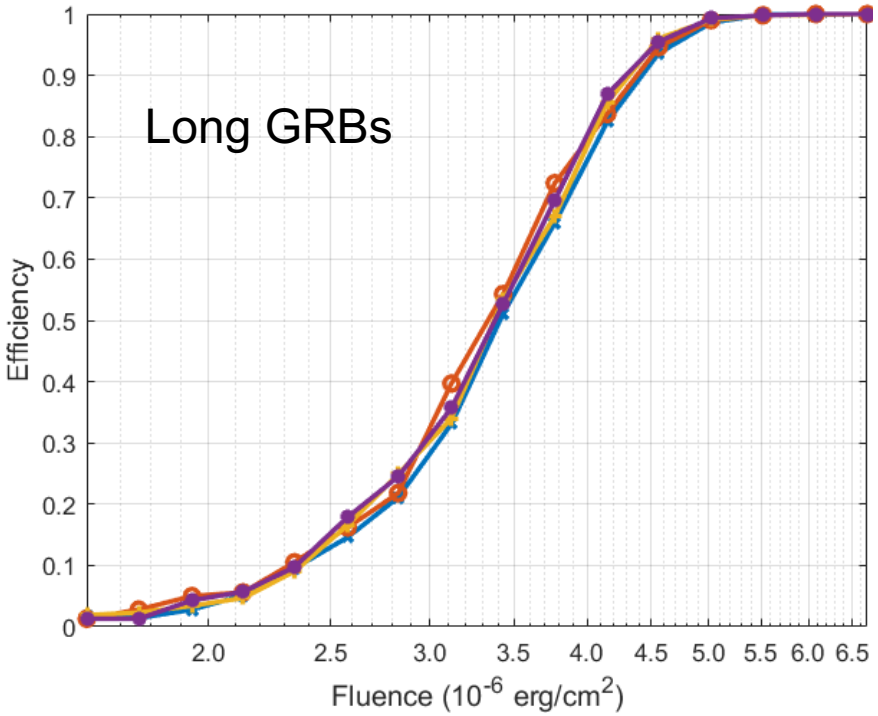
$$N_E \propto E^{\alpha}\, e^{(-E(2+\alpha)/Ep)}$$

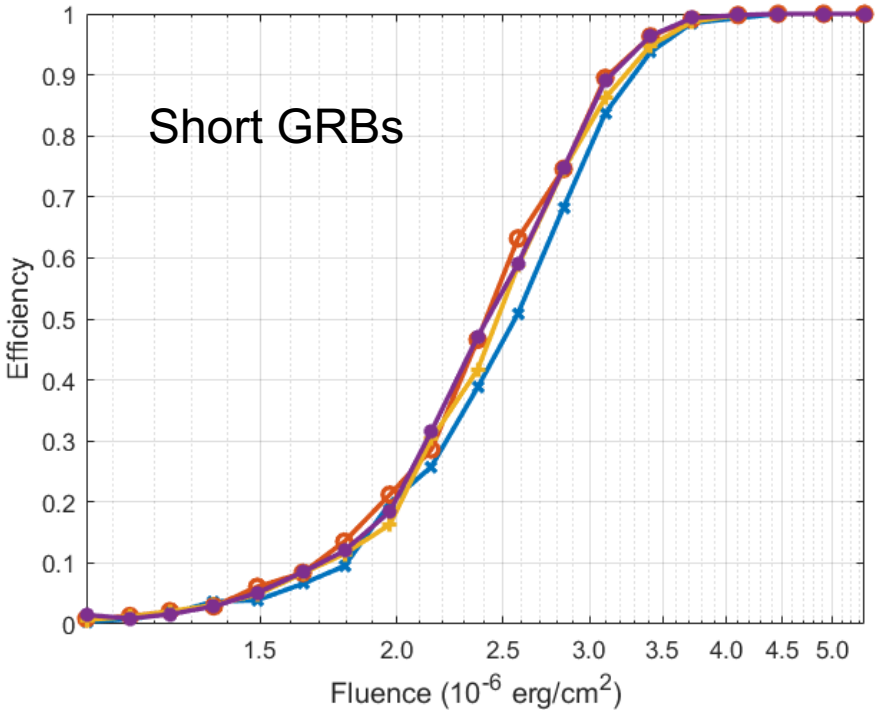
Long GRBs:
α = −1, E_p = 300keV, duration 10 sec
Short GRBs:
α = −0.5, E_p = 500keV, duration 0.5 sec

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).

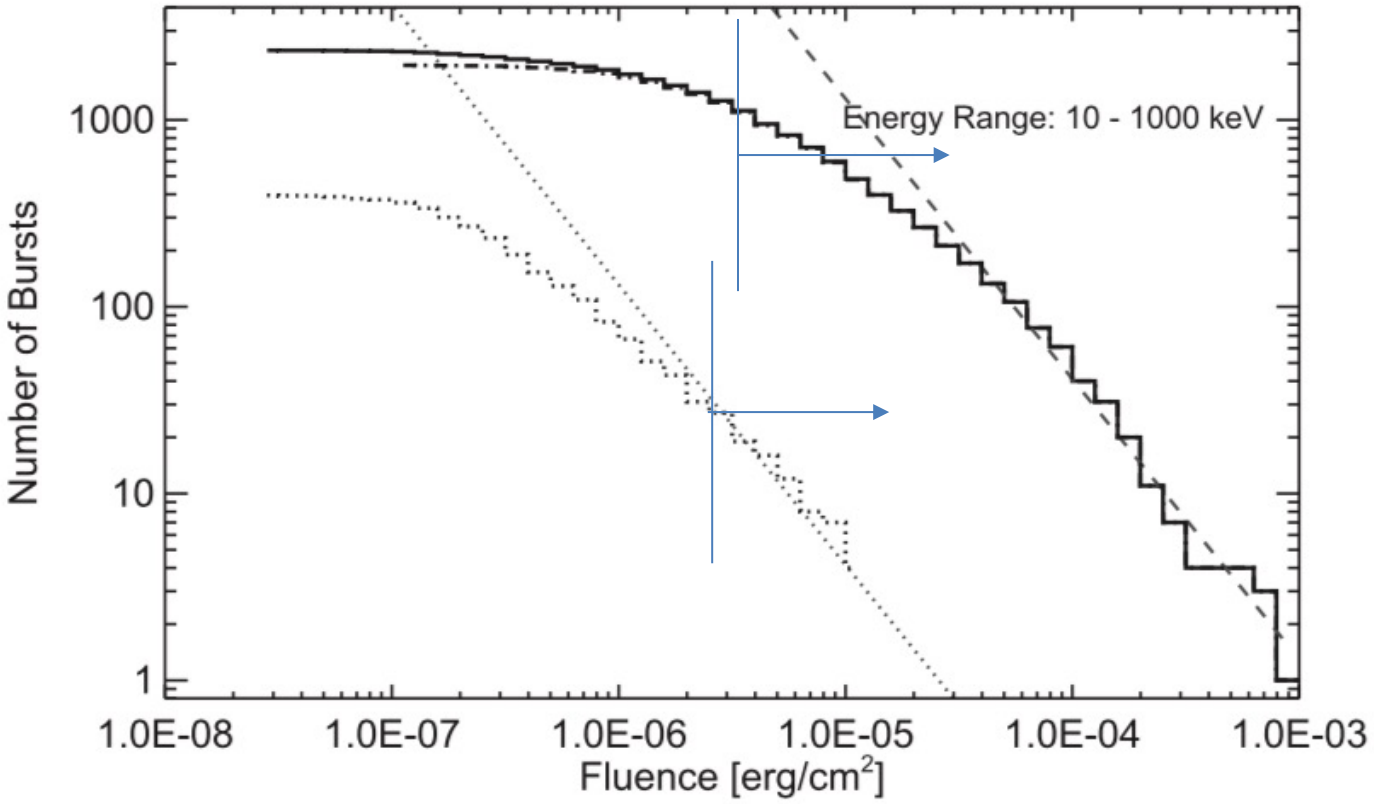


GTM's GRB detection efficiency





(Chang et al. 2022, AdSpR 69, 1249)

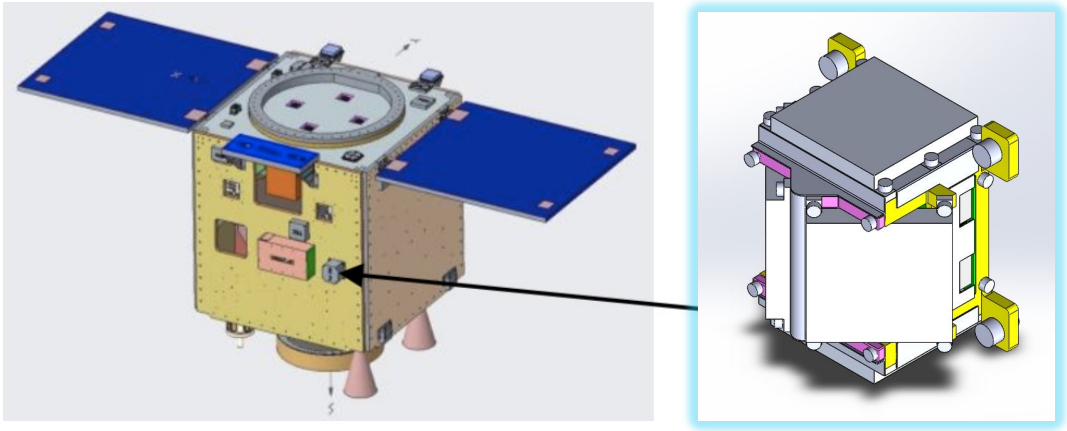


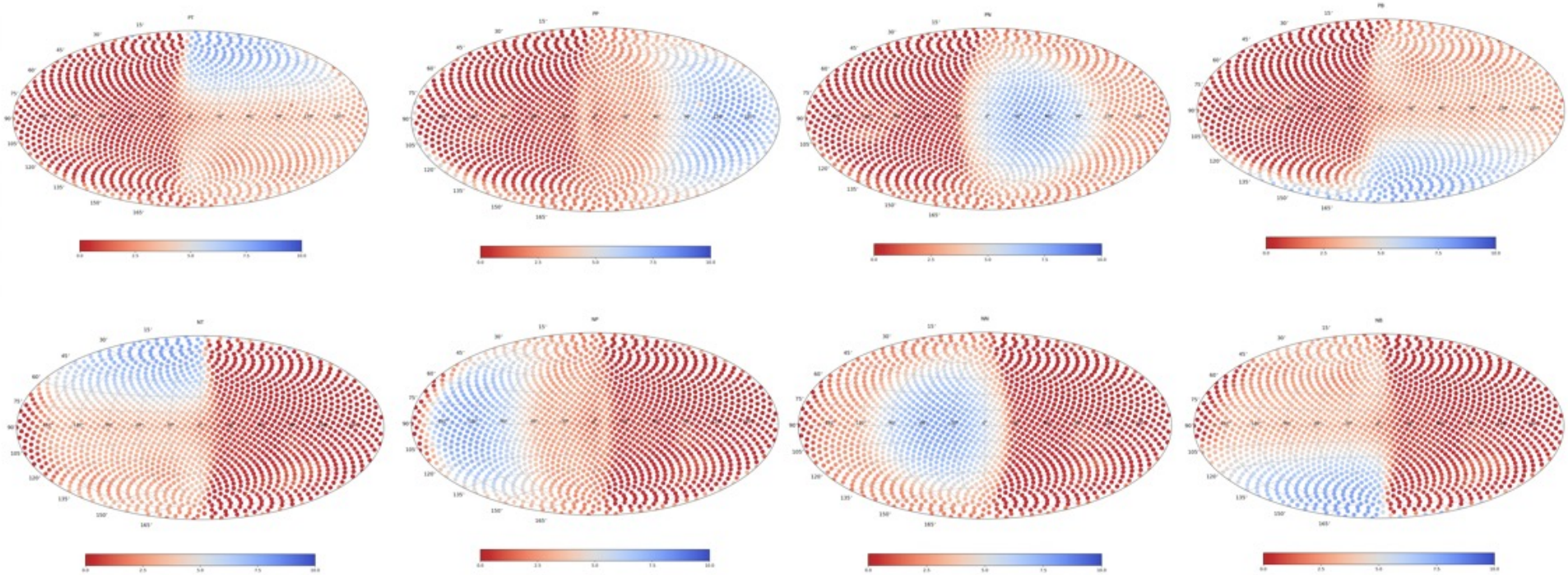
Fermi/GBM 10-year GRB fluence distribution (von Kienlin et al. 2020)

Assuming a 36% duty cycle,
FS8B/GTM will detect about 40 GRBs per year.

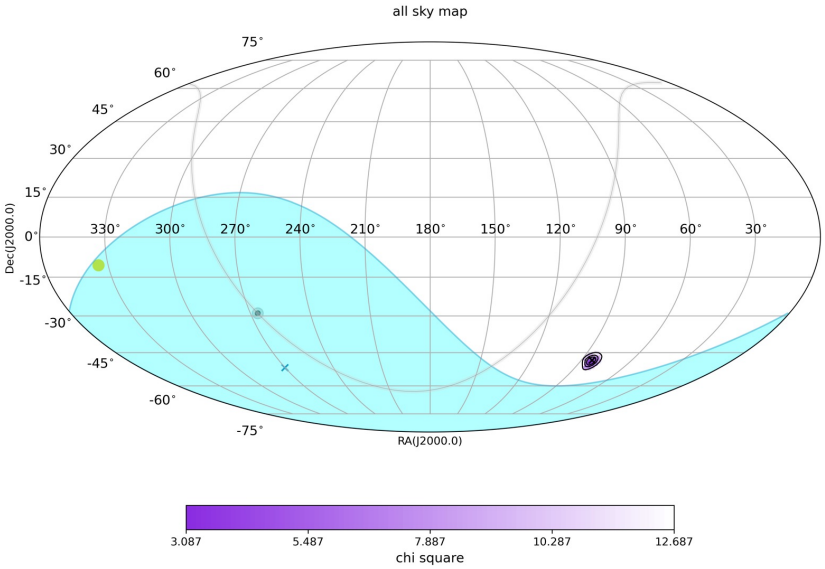
Detector response (50-300 keV) of the 8 sensors in different directions in the sky

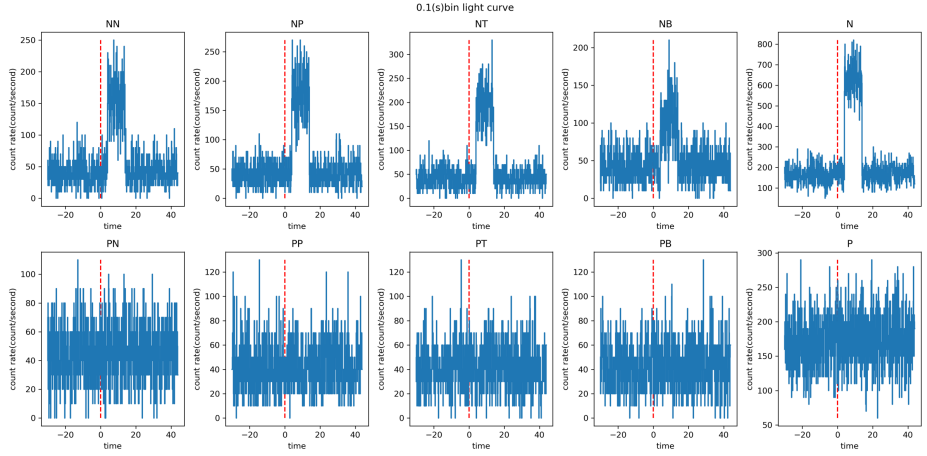
($\alpha = -1$, $E_p = 300$keV)



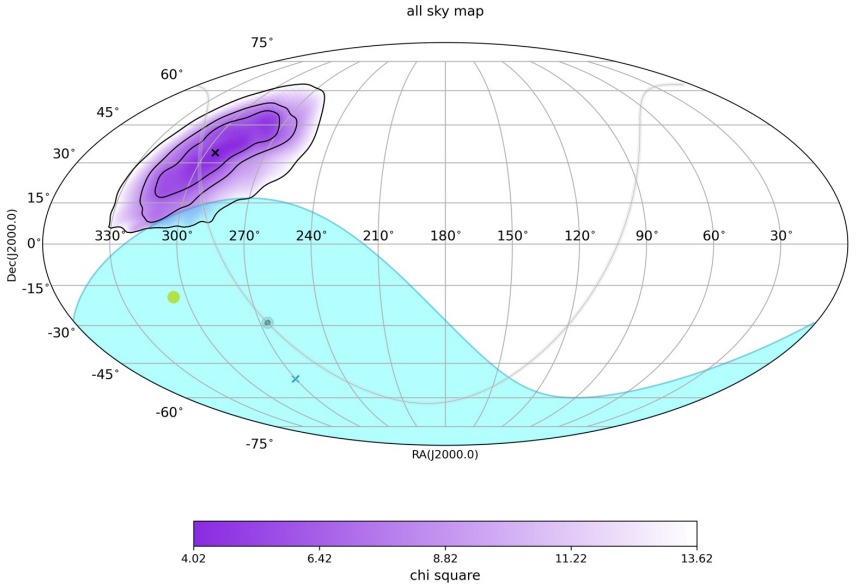


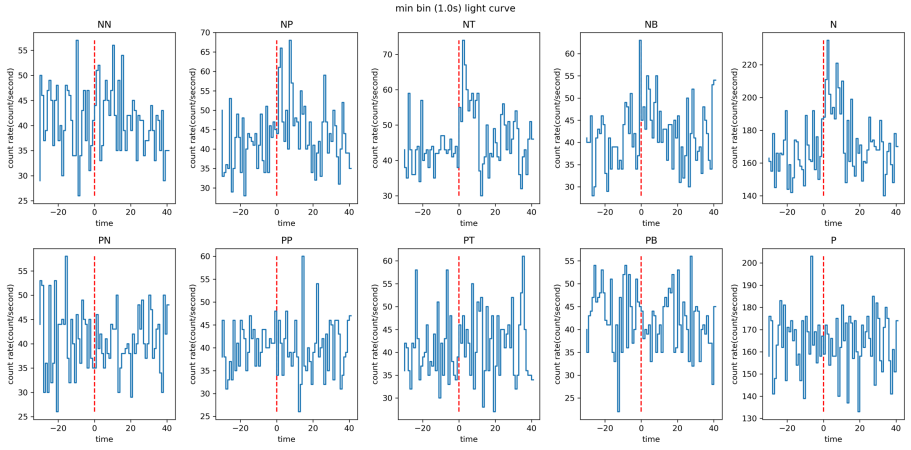
Examples of GRB detection and localization from GTM simulation





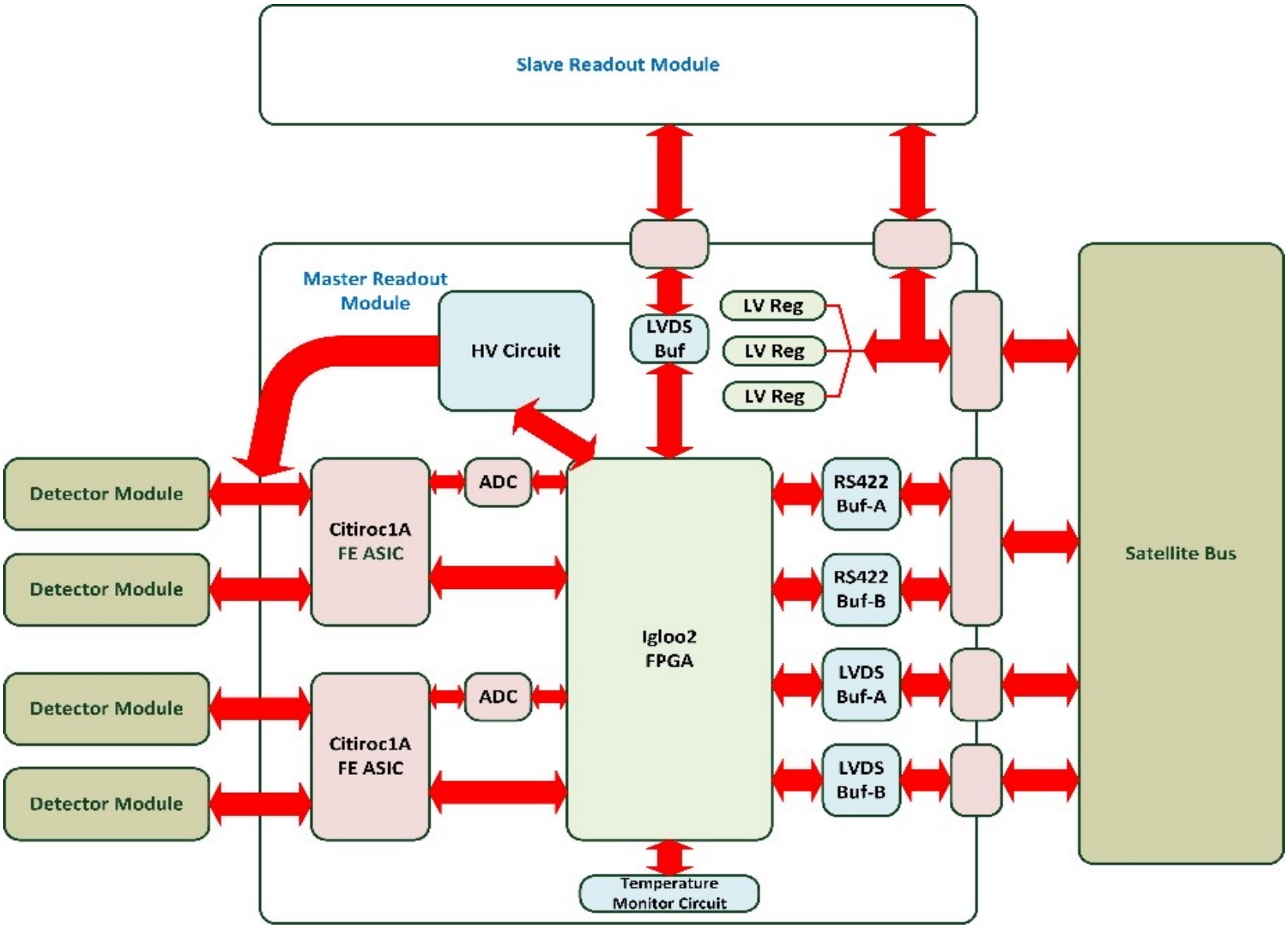
(Fluence = 4x10^{-5} erg/cm^2 in 10-1000 keV)



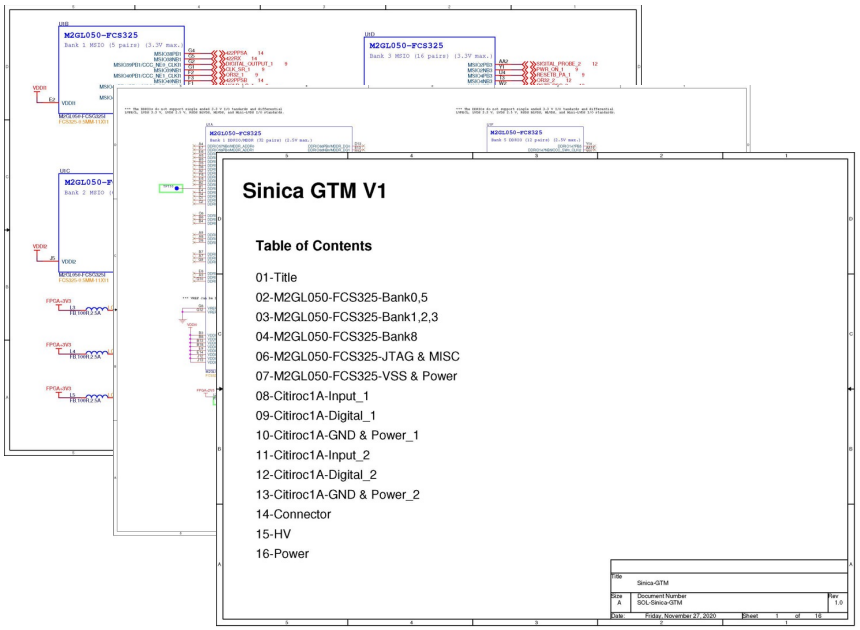


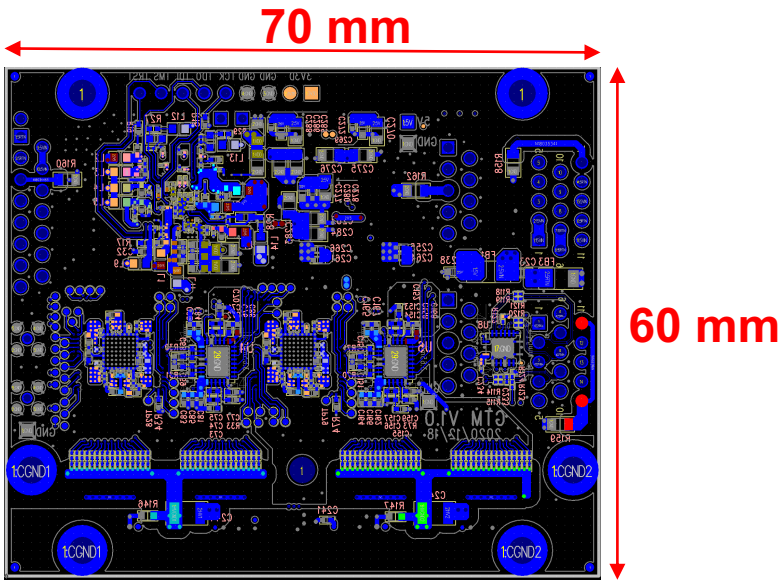
(Fluence = 4x10^{-6} erg/cm^2 in 10-1000 keV)

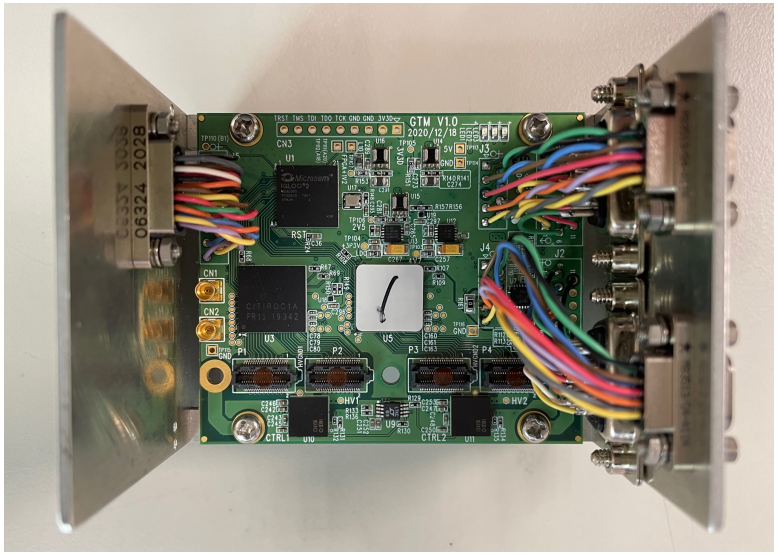
Readout system

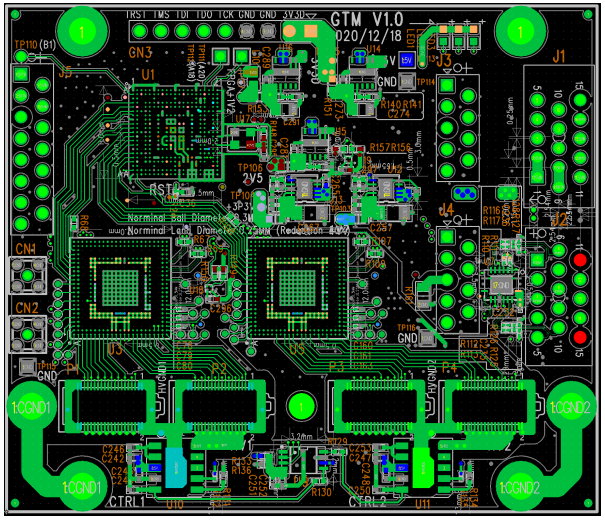


Readout system

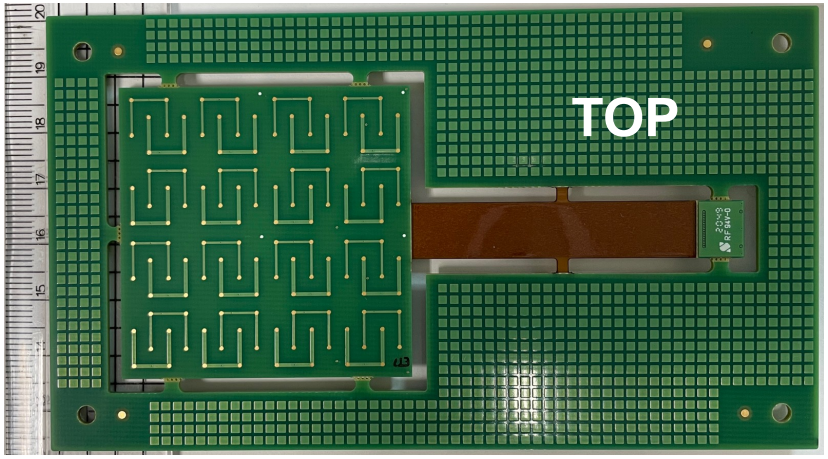


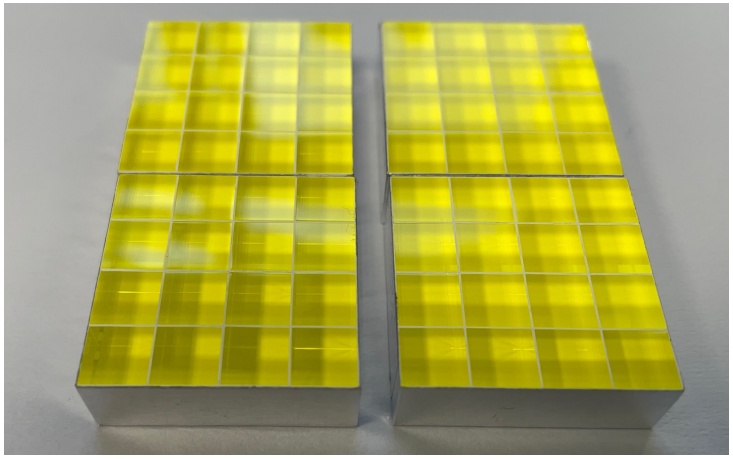


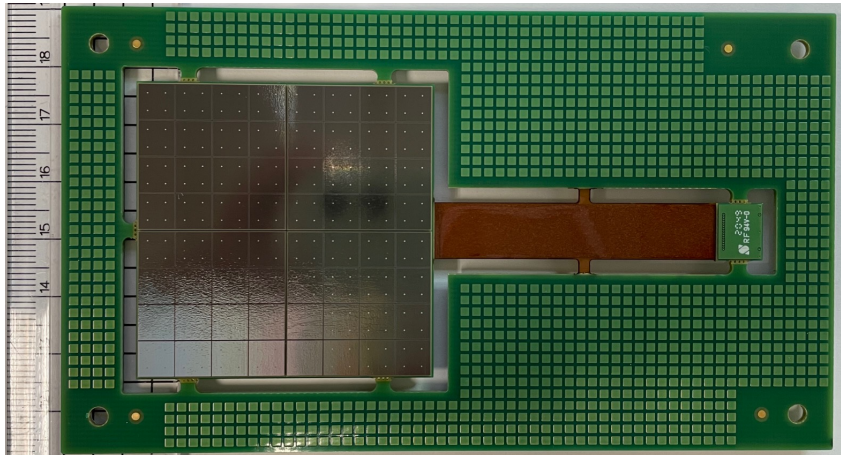


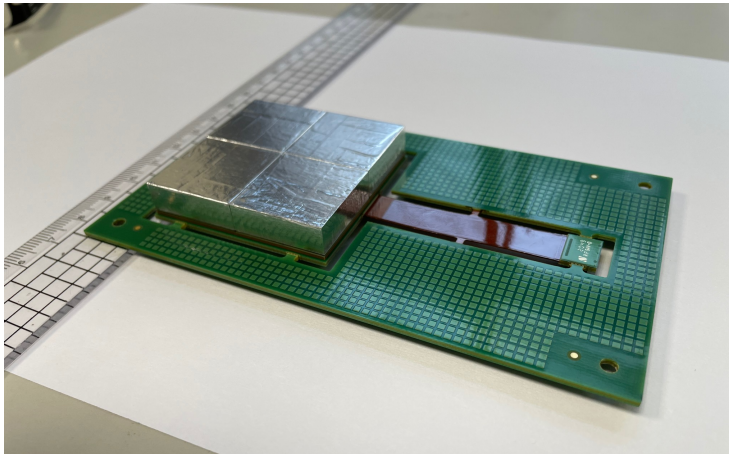


Sensor module

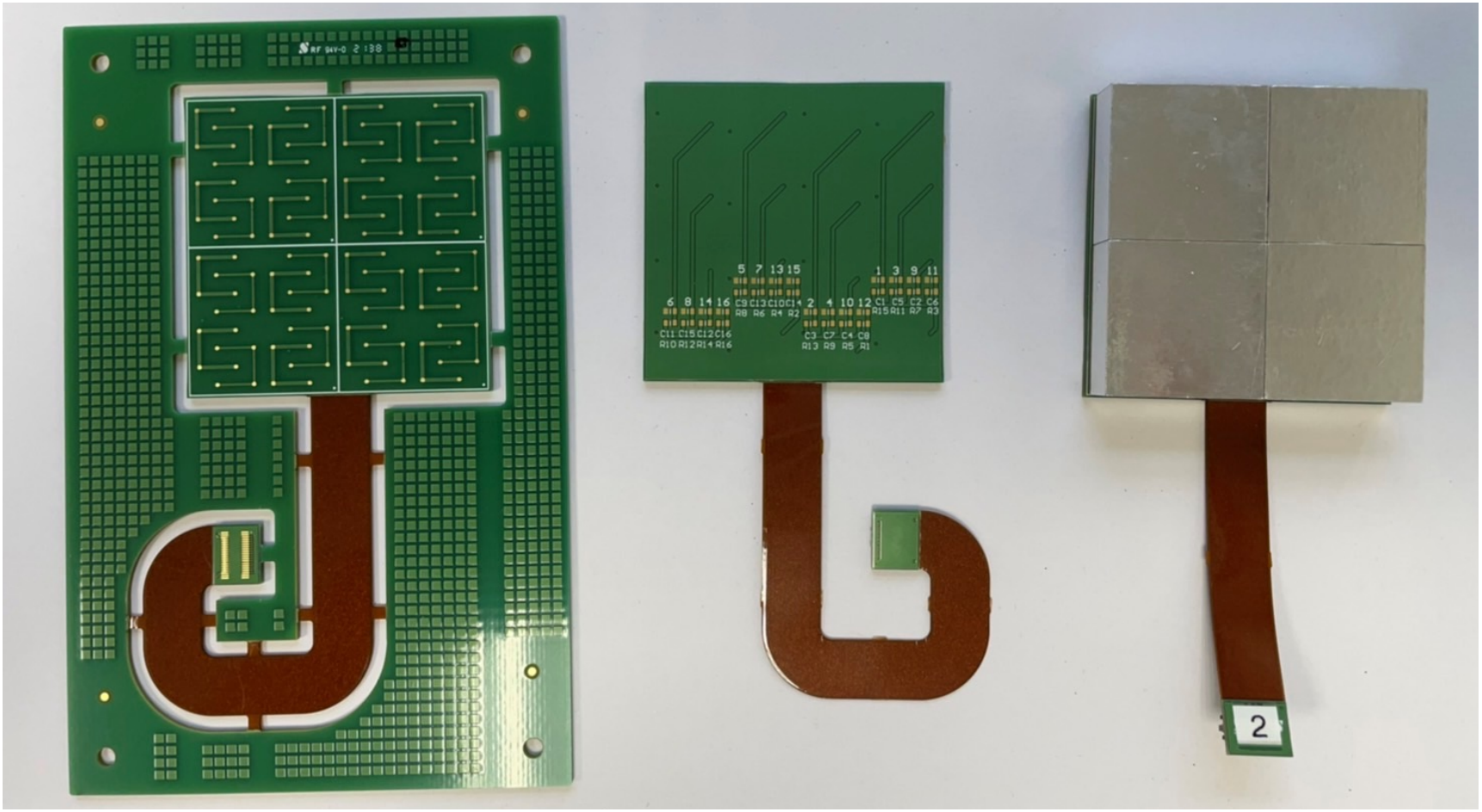




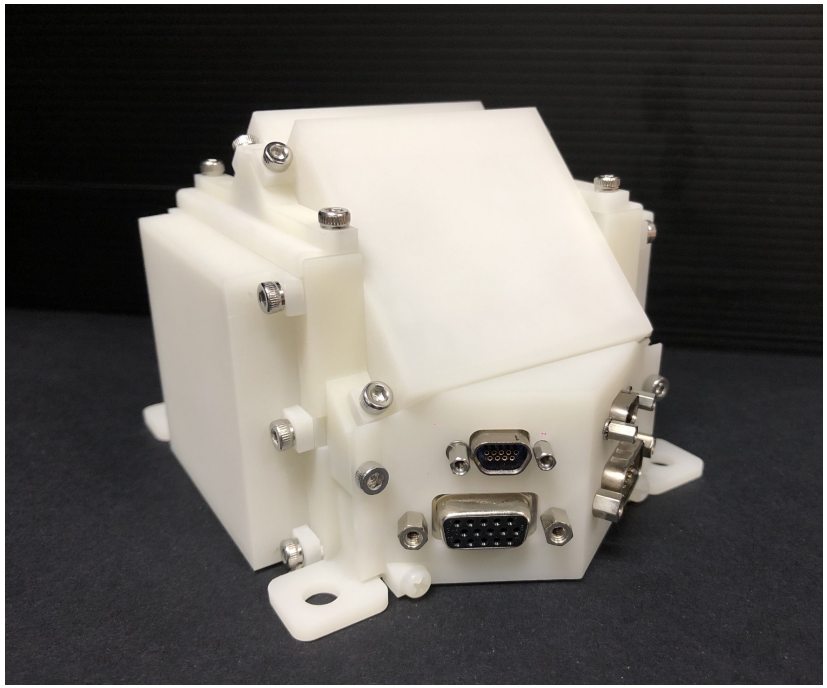


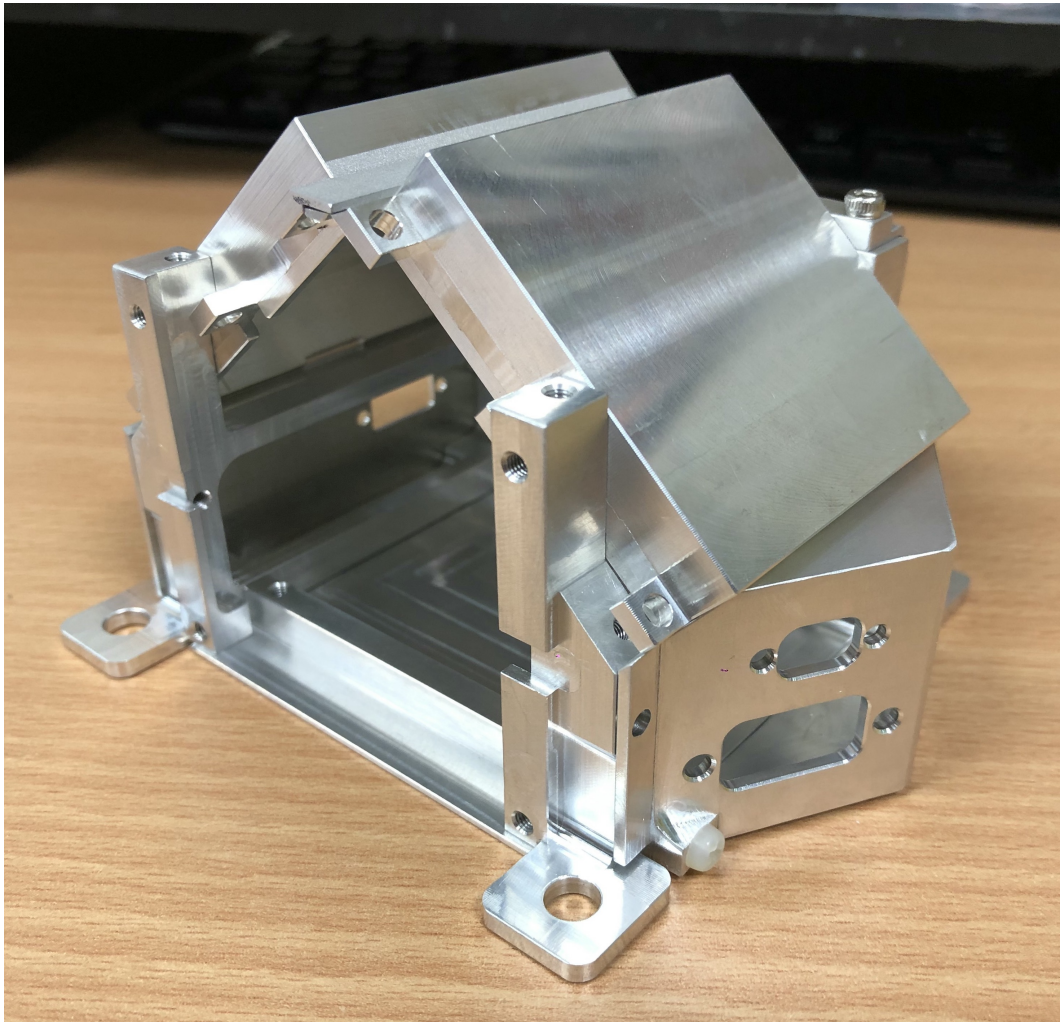


Sensor Module

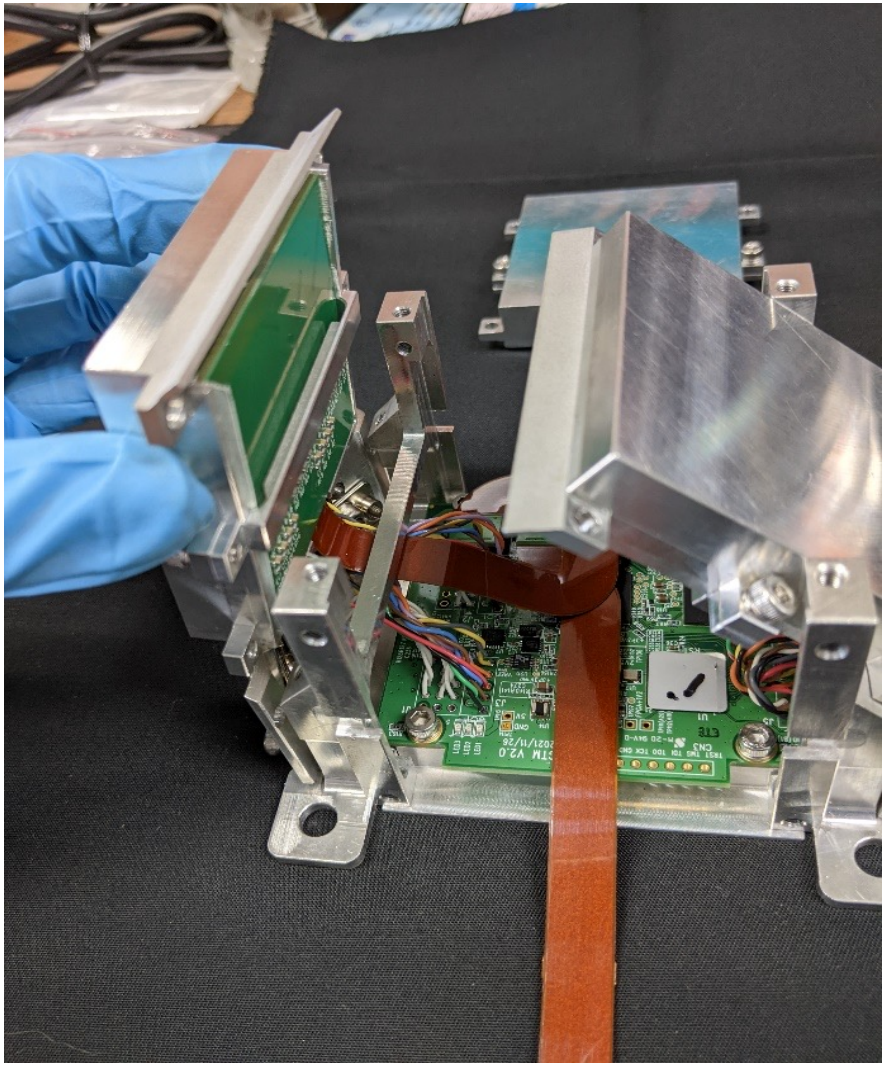


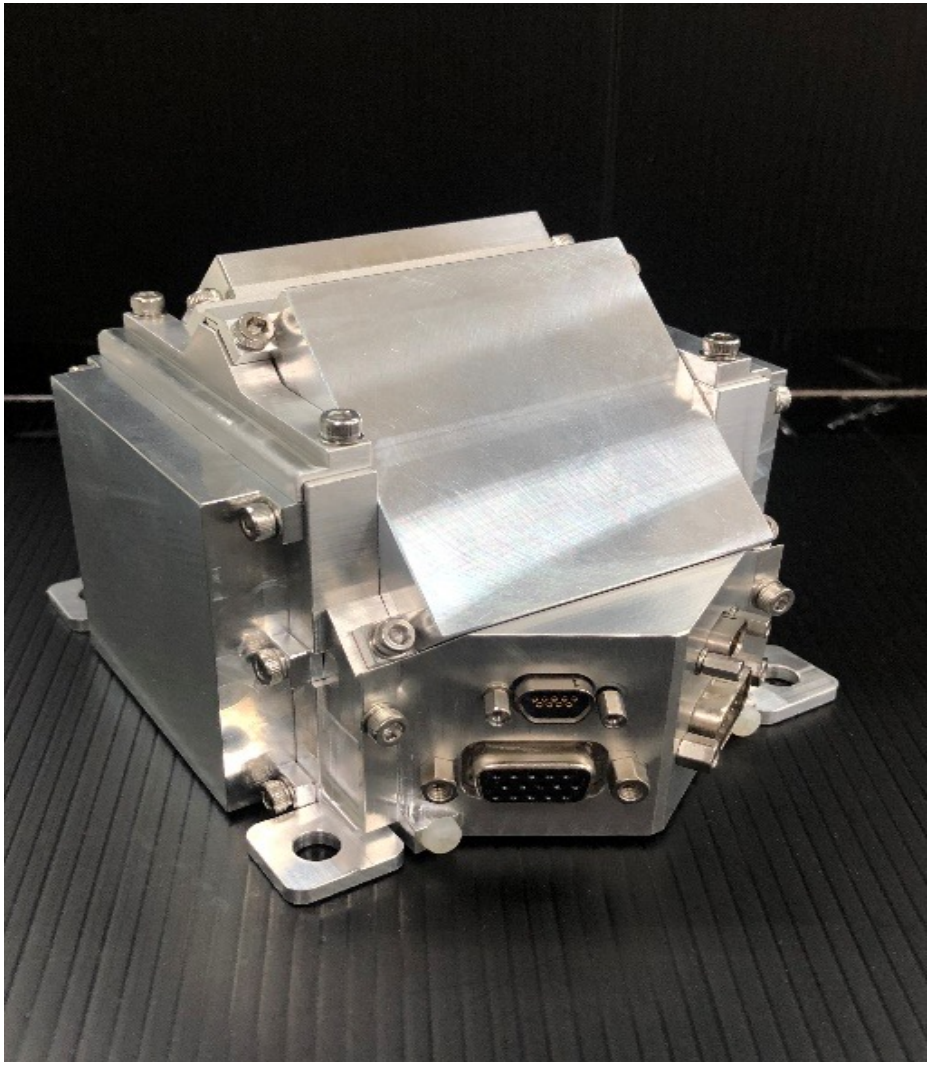
Mechanical Structure



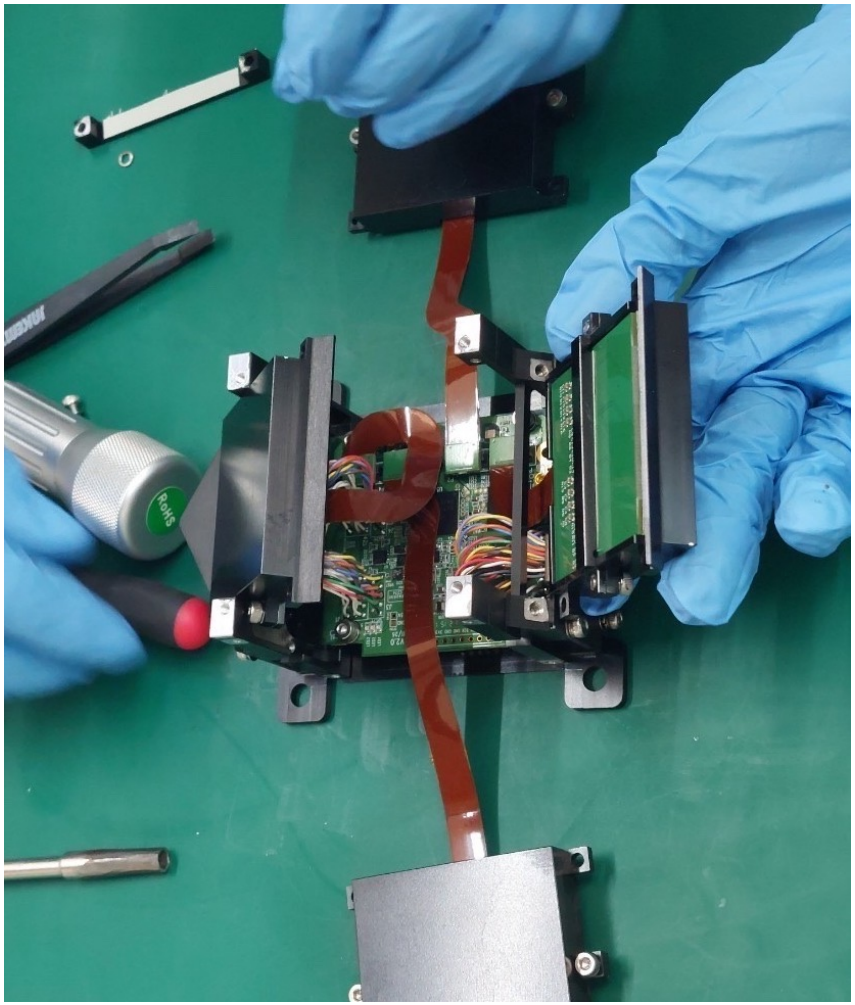


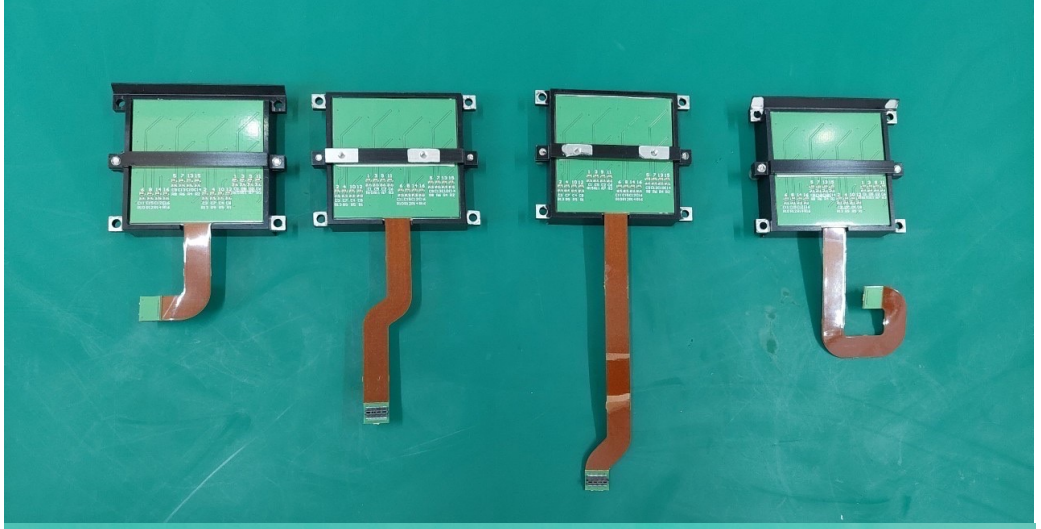
EM assembly

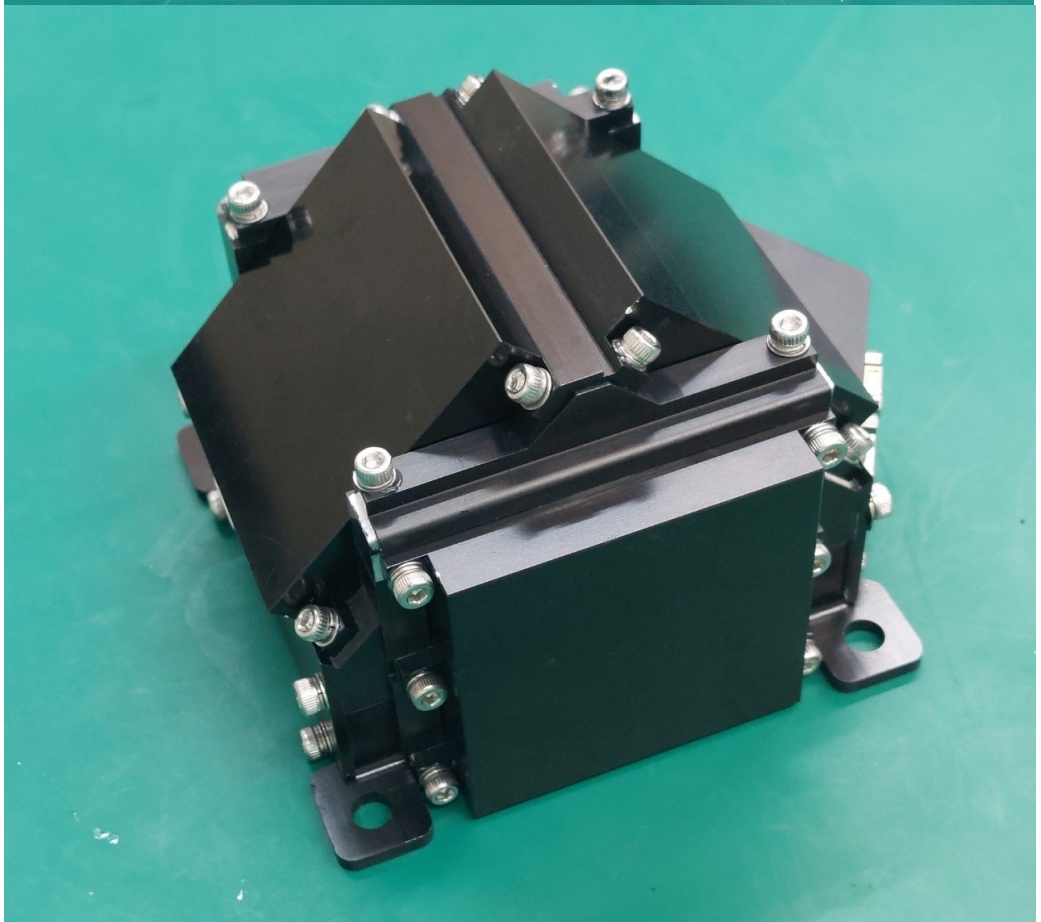




EQM assembly







Gamma-ray Transients Monitor (GTM)

Current status

- EM vibration and functional tests were successful.
- EQM has been built and its environmental tests are being scheduled.
- FM will then be built and go through again all the environmental tests.
- Calibration measurements will be conducted in 2023.
- Integration with FS-8B bus will be in 2024.

A quick summary:
FS-8B will be launched into a sun-synchronous LEO in 2025.
GTM is expected to detect about 40 GRBs per year.

Thanks for your attention!

FS-8B/GTM data flow