GRID – a Student Project

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On behalf of the GRID collaboration

The GRID Concept
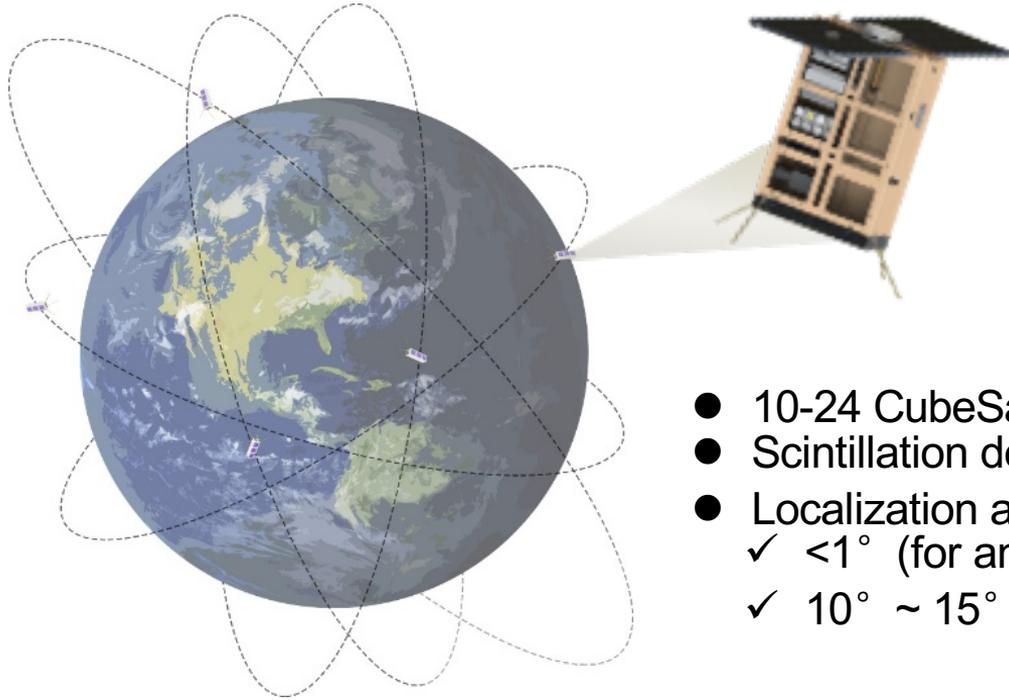
- 10-24 CubeSats in LEO
- Scintillation detector, ~60 cm^2 each
- Localization accuracy for GRBs within 200 Mpc
  - ✓ <1° (for an on-axis event, ~0.14 yr^{-1})
  - ✓ 10° ~ 15° (for a GRB 170817A like event, ~5 yr^{-1})

GRID (Gamma Ray Integrated Detectors)

Crystal - GAGG:Ce
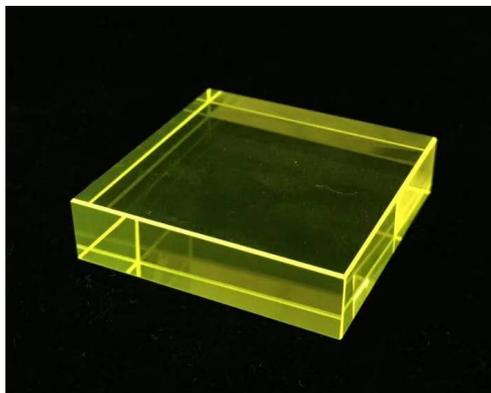
Crystal size	$38 \times 38 \times 10$ mm^3
Light yield	46000 ph/MeV
Density	6.63 g/cm^3
Effective Z	54
Energy resolution	6% @ 662 keV
Hygroscopic	No

top

bottom
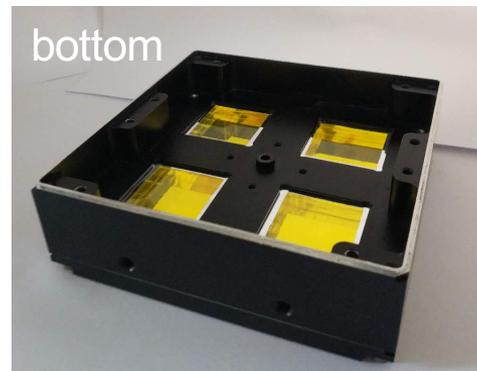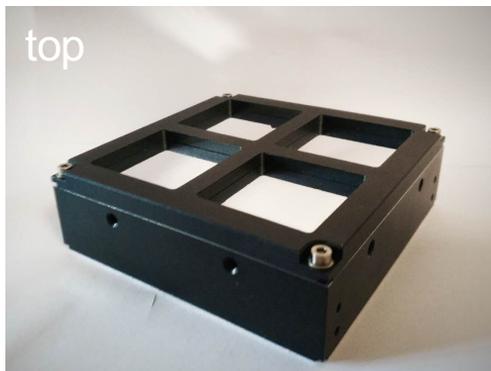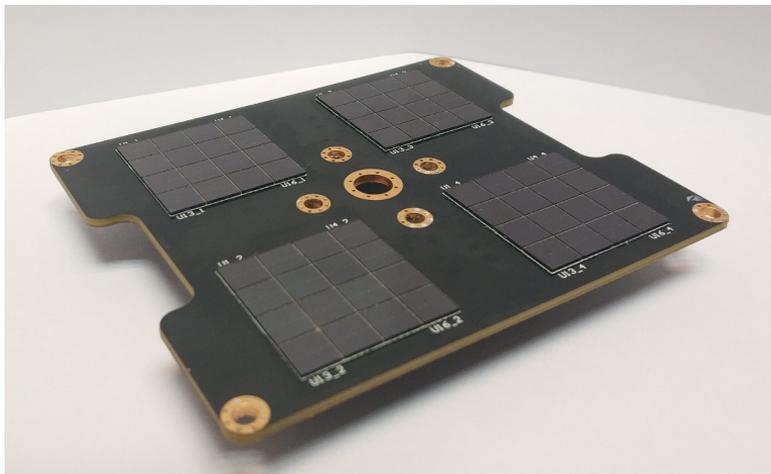
SiPM

4 Arrays of SiPM
1 Array = 4 $\times$ 4 chips (SenSL J-60035)

Bias voltage	~ 30 V
Photon detection efficiency	> 25%
Dark count rate	~ 150 kHz/mm^2
Temperature dependence of V$_{br}$	21.5 mV/℃

Detector

Specifications	
Size	0.5 U (10×10×5 cm³)
Weight	780 g
Power	3 W
Detection area	~ 58 cm²
Energy range	10 keV ~ 2 MeV
Dead time	~ 10 µs
Background count rate	~ 500 Counts/s
Telemetry	~ 1 GB / day

GAGG

SiPM Array

FEE

BEE & CE
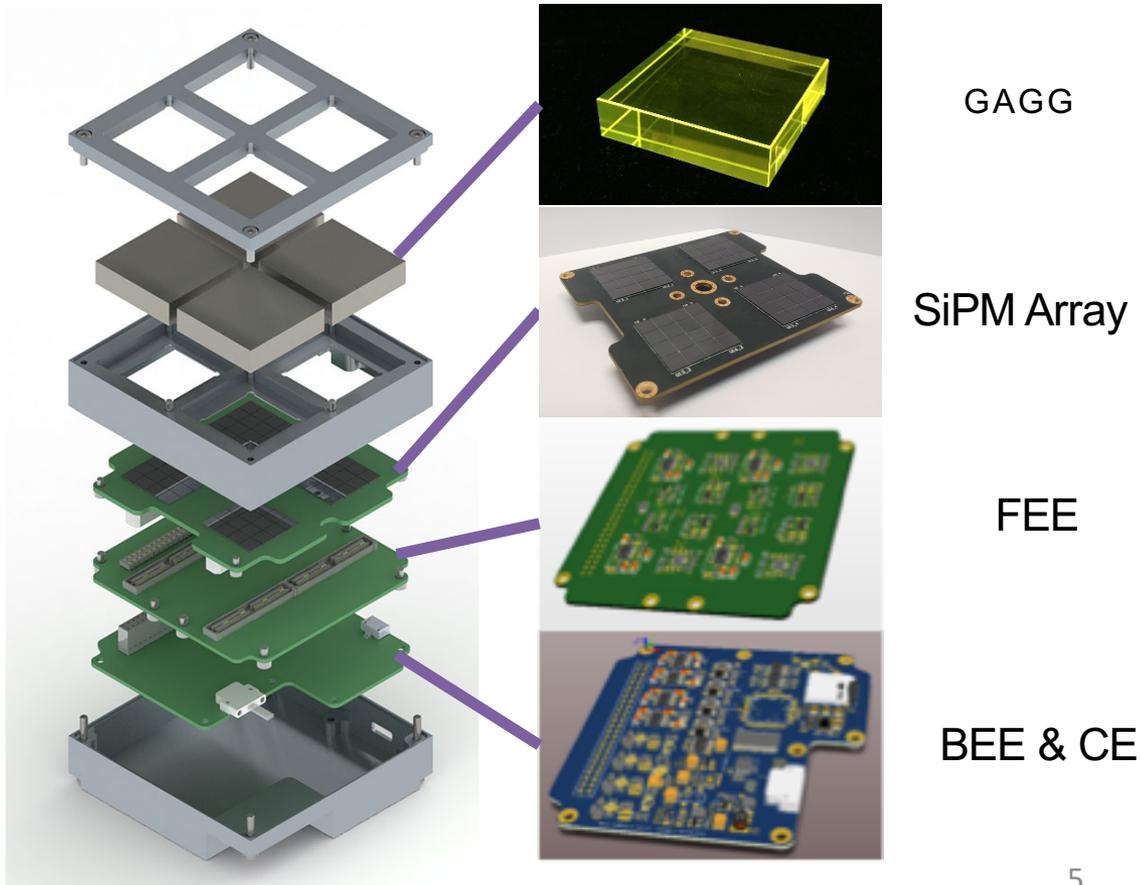
Flight model & satellite

Energy Spectra

Am241
60 keV

Cs137
662 keV

43 keV
87/105 keV
Eu155
Na22
511 keV

80 keV
Th228
239 keV
583 keV
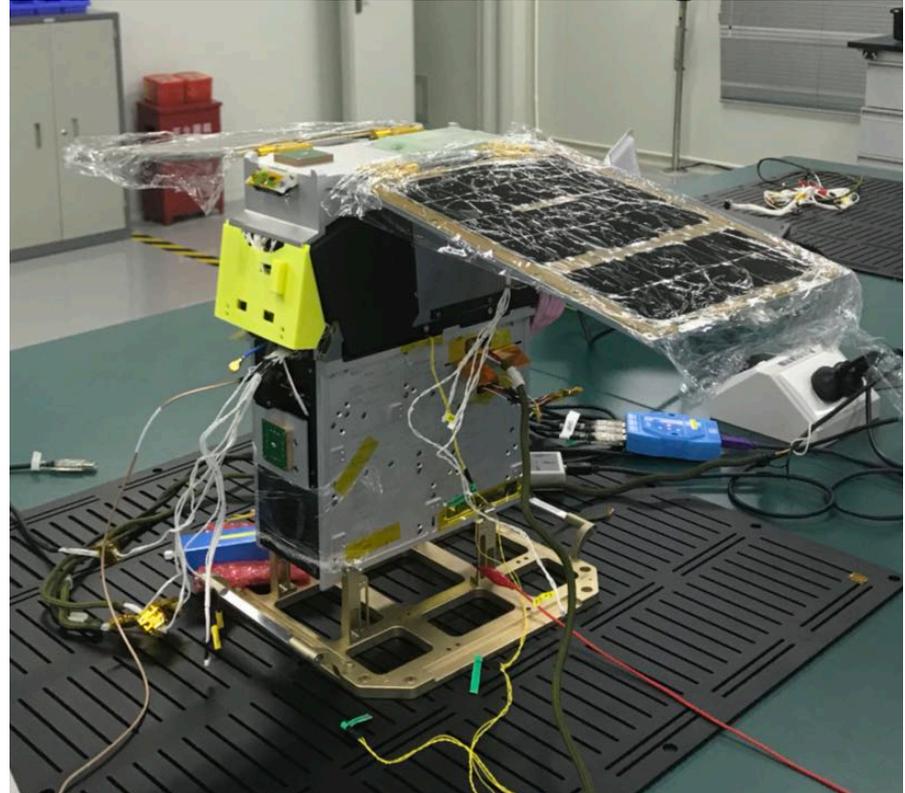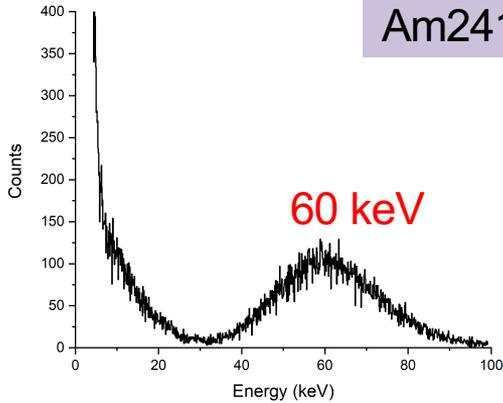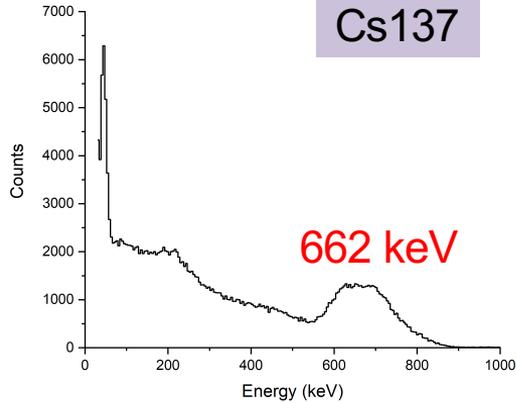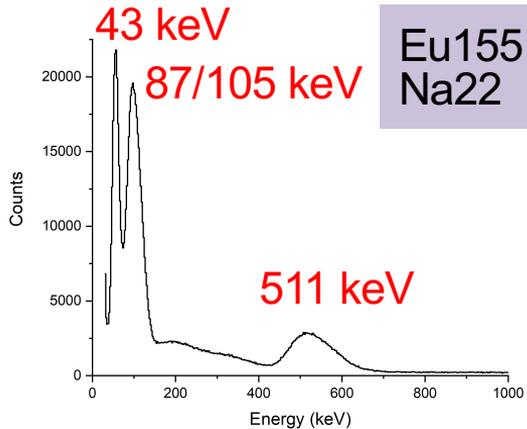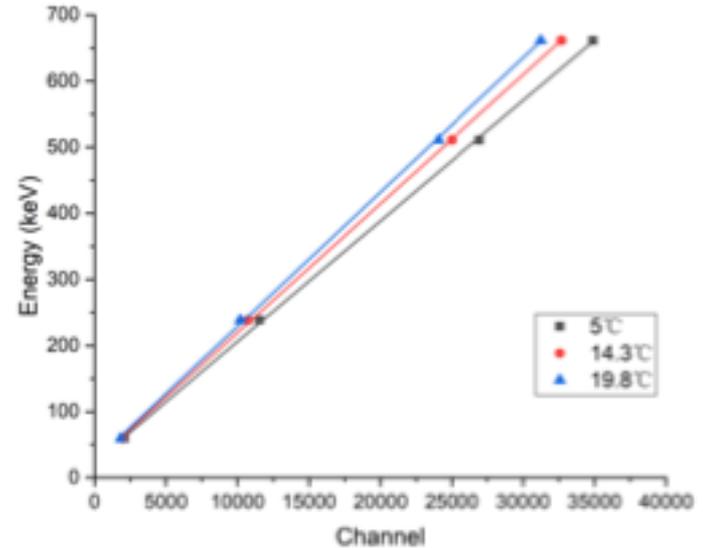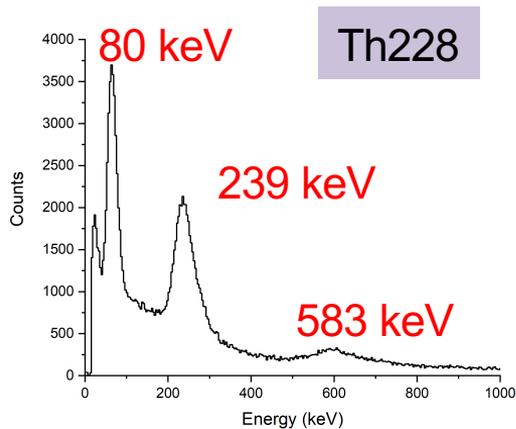
Temperature ↘   Gain ↗

Space environment test

Test		Time	Conditions
Mechanical	Random	2018.8	Frequency：5~2000 Hz Acceleration < 100 g
	Sinusoidal	2018.8	Frequency：5~2000 Hz Acceleration < 100 g
	shock	2018.8	Acceleration: 1000 g
	Resonance Search	2018.8	Three Times Frequency：5~2000 Hz
Thermal		2018.8	6.5 cycles, −10 ~ 35 ℃
Thermal Vacuum		2018.9	1 cycle, −10 ~ 30 ℃ Th228 Acquisition at −5, 0, 5, 10, 15, 20 ℃

Space environment simulations

Mechanical

Thermal vacuum

Thermal test
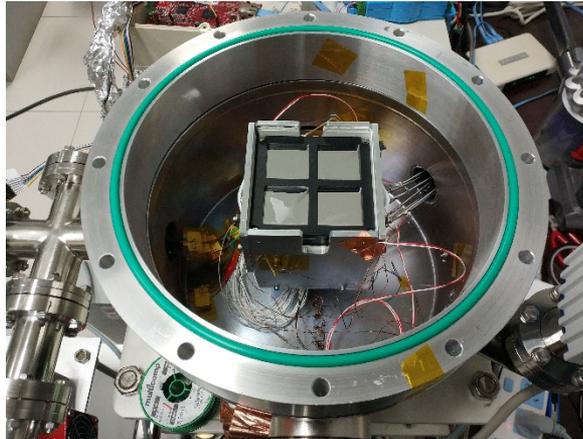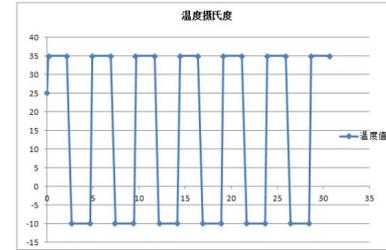
Data Transfer and rapid communication?

How to build a world-wide UHF receiving network?

UHF broadcasting

- **UHF**
  - **small data package (6.3 kB)**
  - **Triggered data**
  - **Lightcurves with 4 different time steps in 8 different energy bands (programable)**

- **S band**
  - **full data package**
  - **events file**

A student project

The first group

Testing the detector

Talking at COSPAR 2018

- Started since 2016 October at Tsinghua
- More than 50 Students from 16 universities have joined the GRID collaboration by now
- Most of the hardware work was done by students

The GRID Collaboration

The 1st GRID collaboration meeting

Open source framework

- ✓ Fix the design with 1-2 launches

- ✓ 100% open to member institutes

- ✓ Member institutes can build their own detector/ground station/satellite

Future Plan

- Stage Ⅰ
  - Technical demonstration (2018)
  - First launch
  - Ground segment, database and reduction software

- Stage Ⅱ
  - Preliminary operation (2019)
  - A network of 3 or more CubeSats
  - To detect ~100 GRBs

- Stage Ⅲ
  - Normal operation (2020~2025)
  - At least 10 CubeSats in the orbits

Conclusion

- GRID
  - Compact: 0.5 U
  - Low cost
  - Student training
  - Open and sharing

Expecting a larger GRID