GECAM: An all-time all-sky X/γ monitor in multi-messenger/wavelength era

Shaolin XIONG

xiongsl@ihep.a.cn

Institute of High Energy Physics (IHEP),
Chinese Academy of Sciences (CAS)

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Two satellites, launching in 2020, will watch for gamma rays from the violent birth of gravitational waves.
INSTITUTE OF HIGH ENERGY PHYSICS, CAS

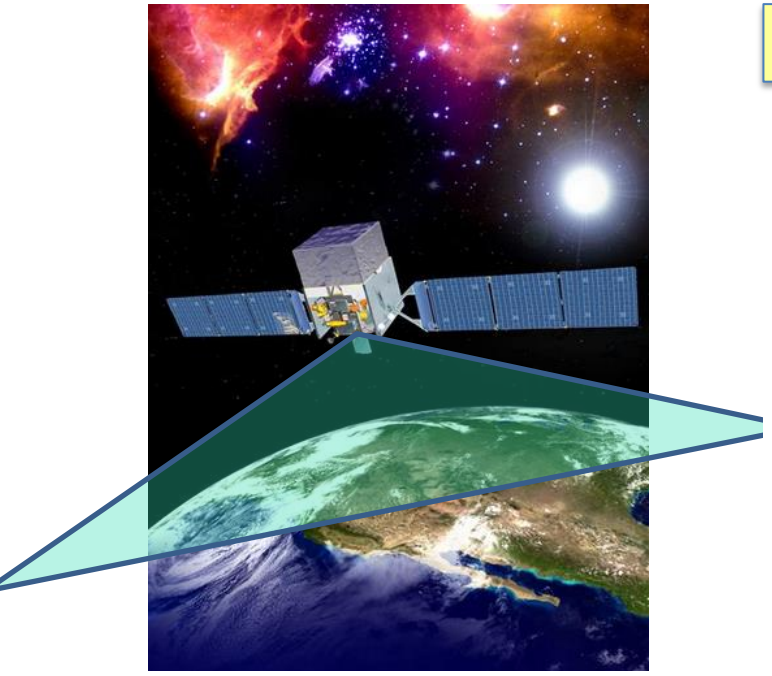
New China space missions will watch for colliding black holes, solar blasts

By Dennis Normile | Jul. 11, 2018 , 12:45 PM

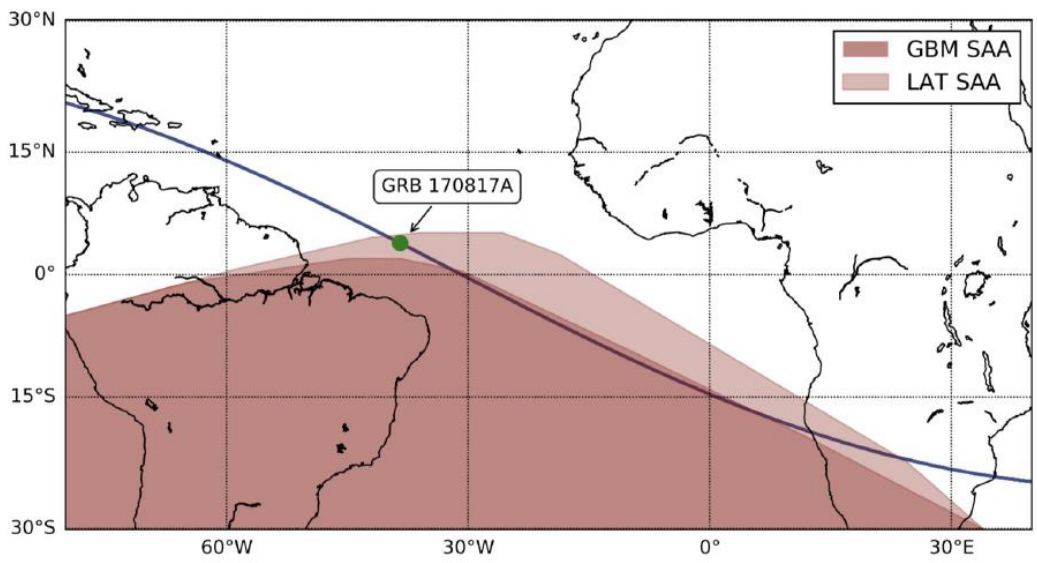
What do we learn from GRB170817A?

Lessons learned from GRB170817A

- **FOV** (GBM vs. Swift/BAT)
- **Localization** (GBM vs. SPI-ACS)
- **Energy coverage** (GBM vs. *Insight*-HXMT)
- **Sensitivity** (GBM vs. Konus-Wind)

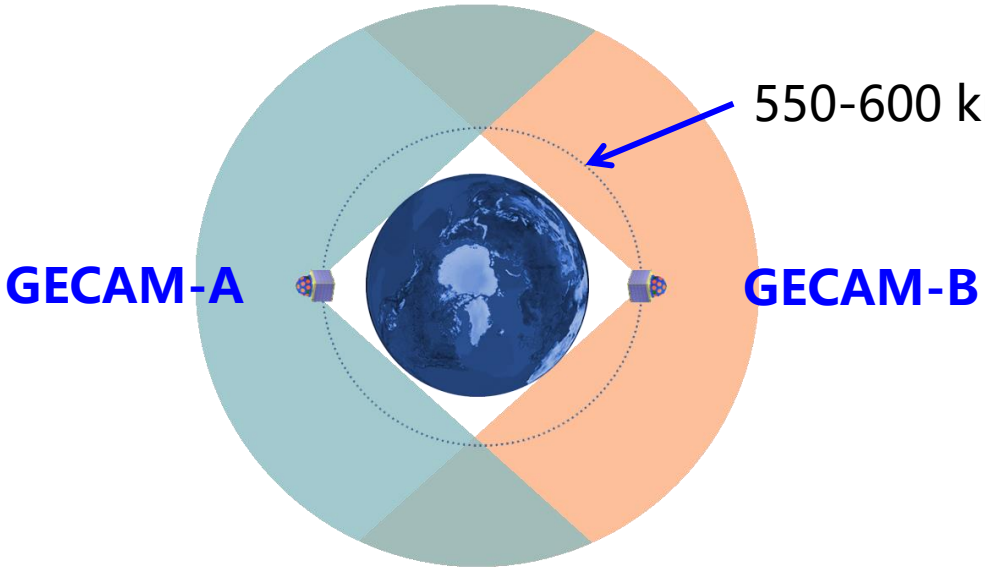


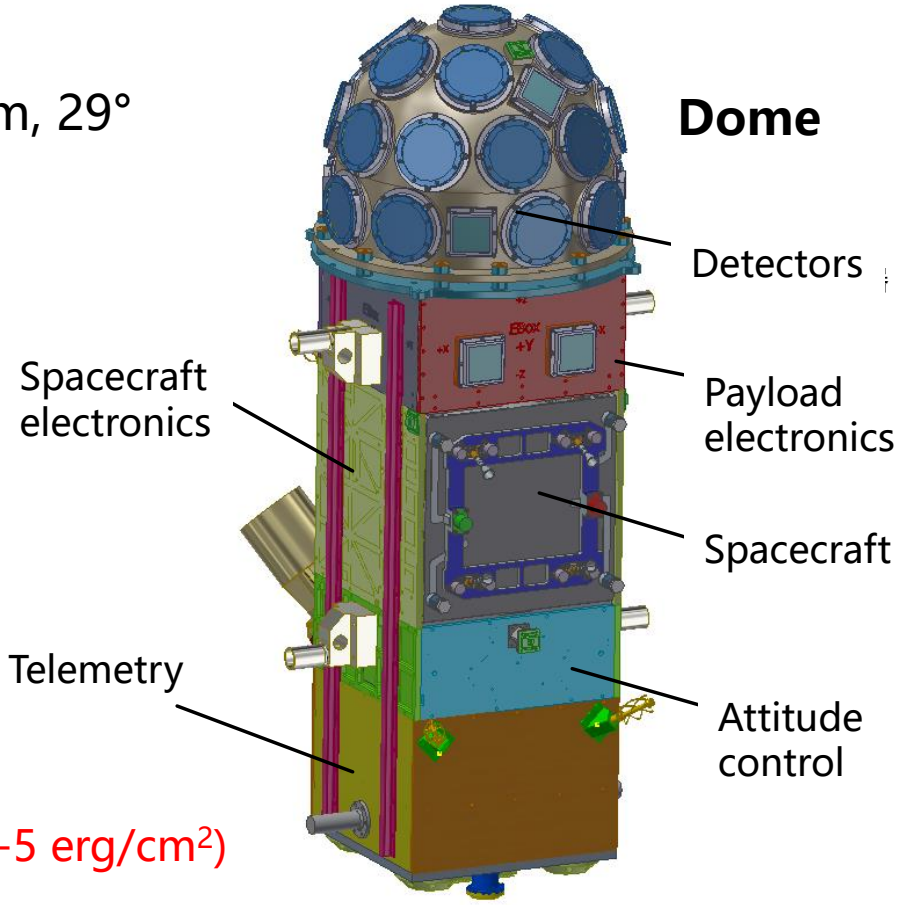
However, GBM suffers Earth shielding and SAA turn-off



GECAM

Gravitational wave high-energy Electromagnetic Counterpart All-sky Monitor

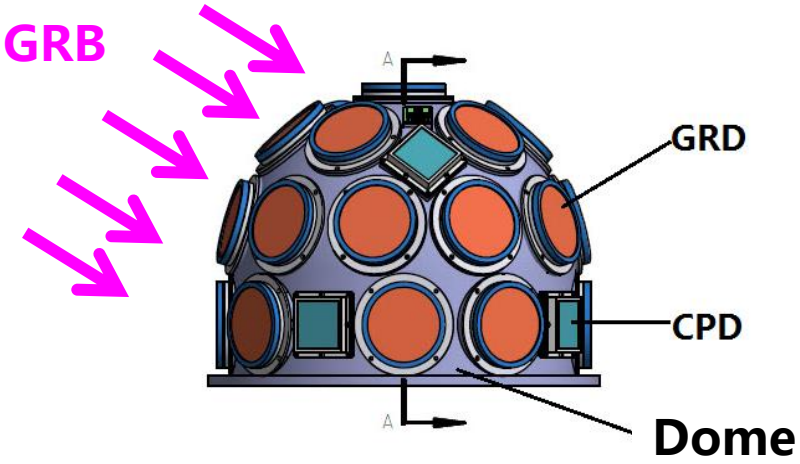




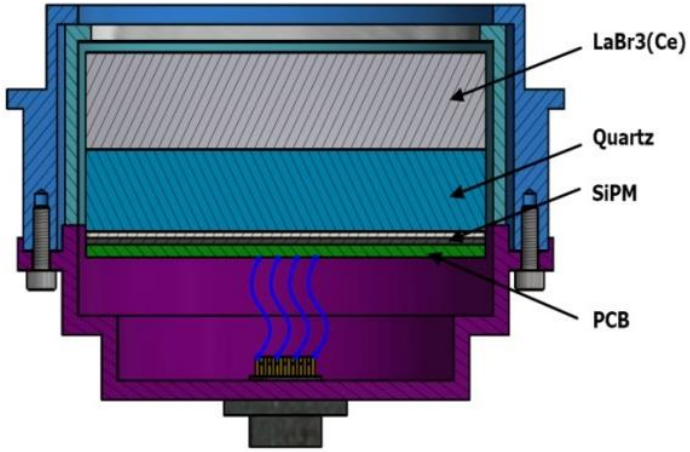
GECAM satellite (~140 kg for each)

- **Characteristics**
  - **FOV:** 100% all-sky
  - **Sensitivity:** ~2E-8 erg/cm^2/s
  - **Localization:** ~1 deg (1-σ stat., 1E-5 erg/cm^2)
  - **Energy band:** 6 keV – 5 MeV
- **Planned to launch by the end of 2020**
  - since LIGO will reach the design sensitivity around 2020 to 2021

Compact low-energy $LaBr_3$+SiPM detectors



- **Configuration for each satellite**
  - **25 Gamma-ray detectors (GRD)**
  - **8 Charged particle detectors (CPD)**
- **Novel technology**
  - **$LaBr_3$+SiPM, very compact, HV-free**
  - **Stay on during SAA passage**



SiPM-based detector

Journal of Instrumentation

A low-energy sensitive compact gamma-ray detector based on $LaBr_3$ and SiPM for GECAM

P. Lv[a,b,c], S.L. Xiong[a], X.L. Sun[a,b], J.G. Lv[a,b] and Y.G. Li[a]

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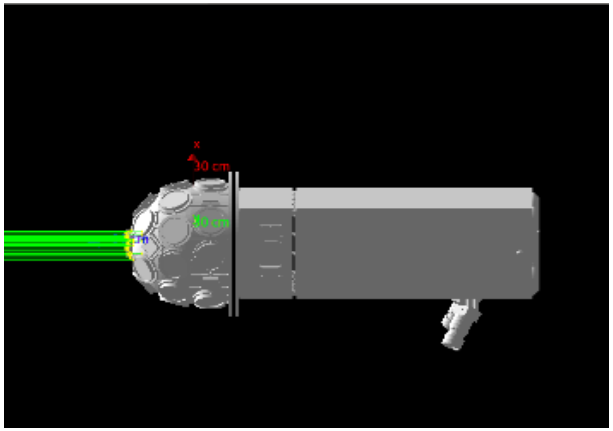
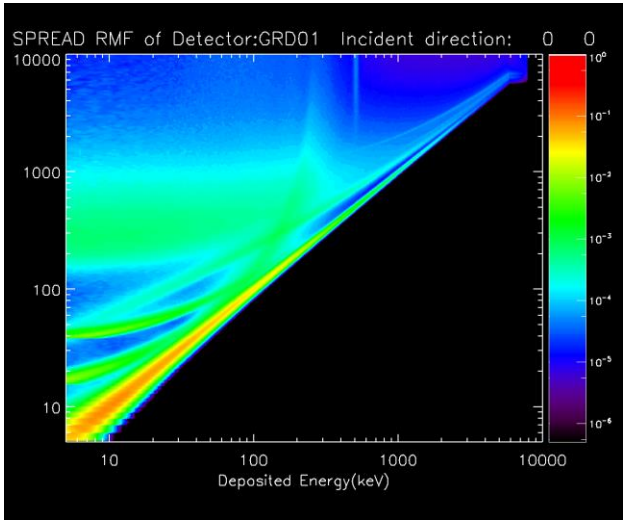
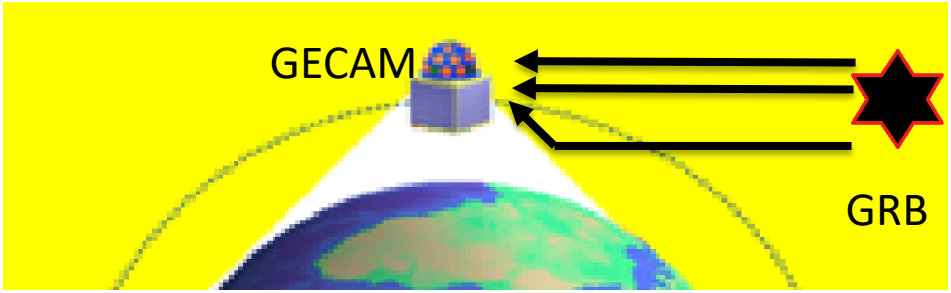
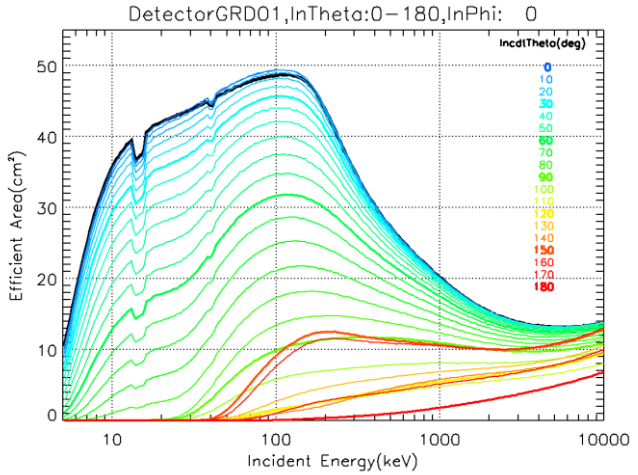
Journal of Instrumentation, Volume 13, August 2018

Monte Carlo simulations

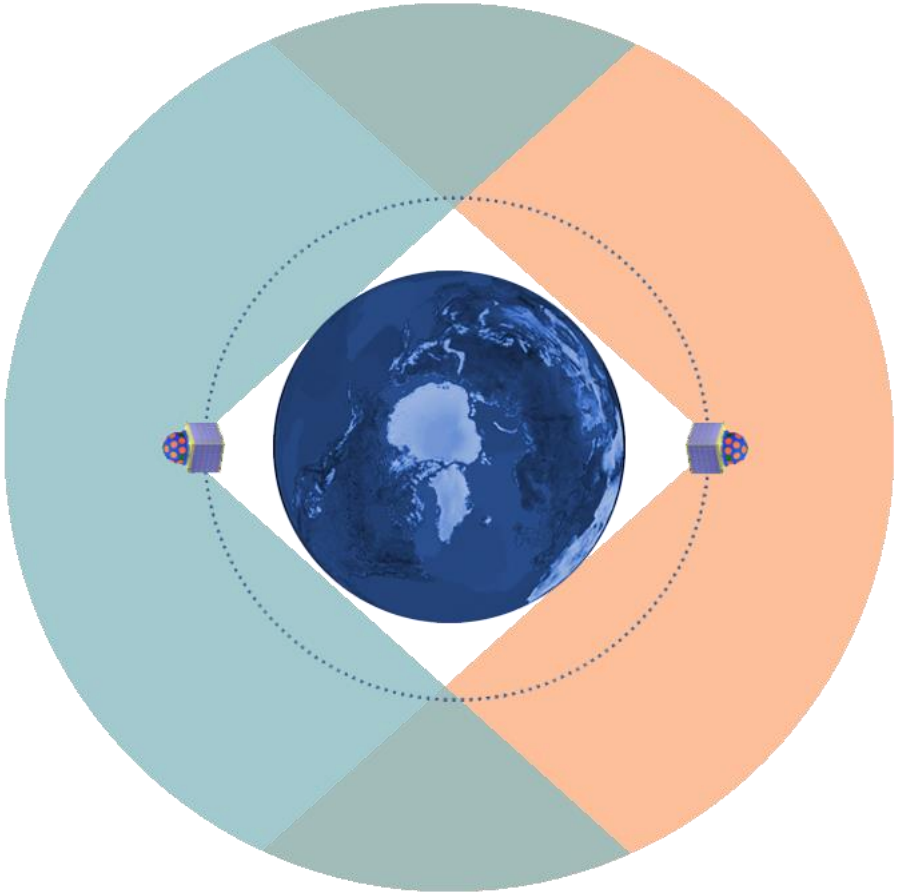


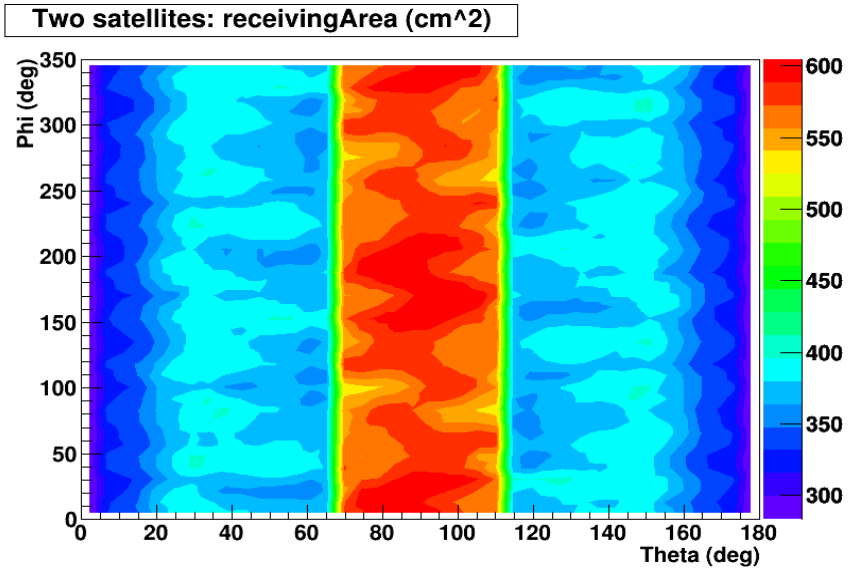


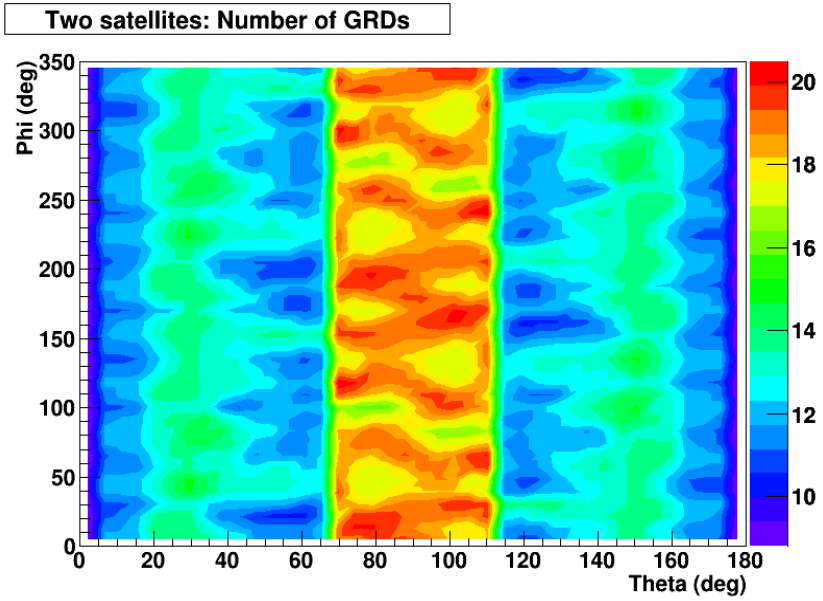




Illuminated detectors vs. incident direction



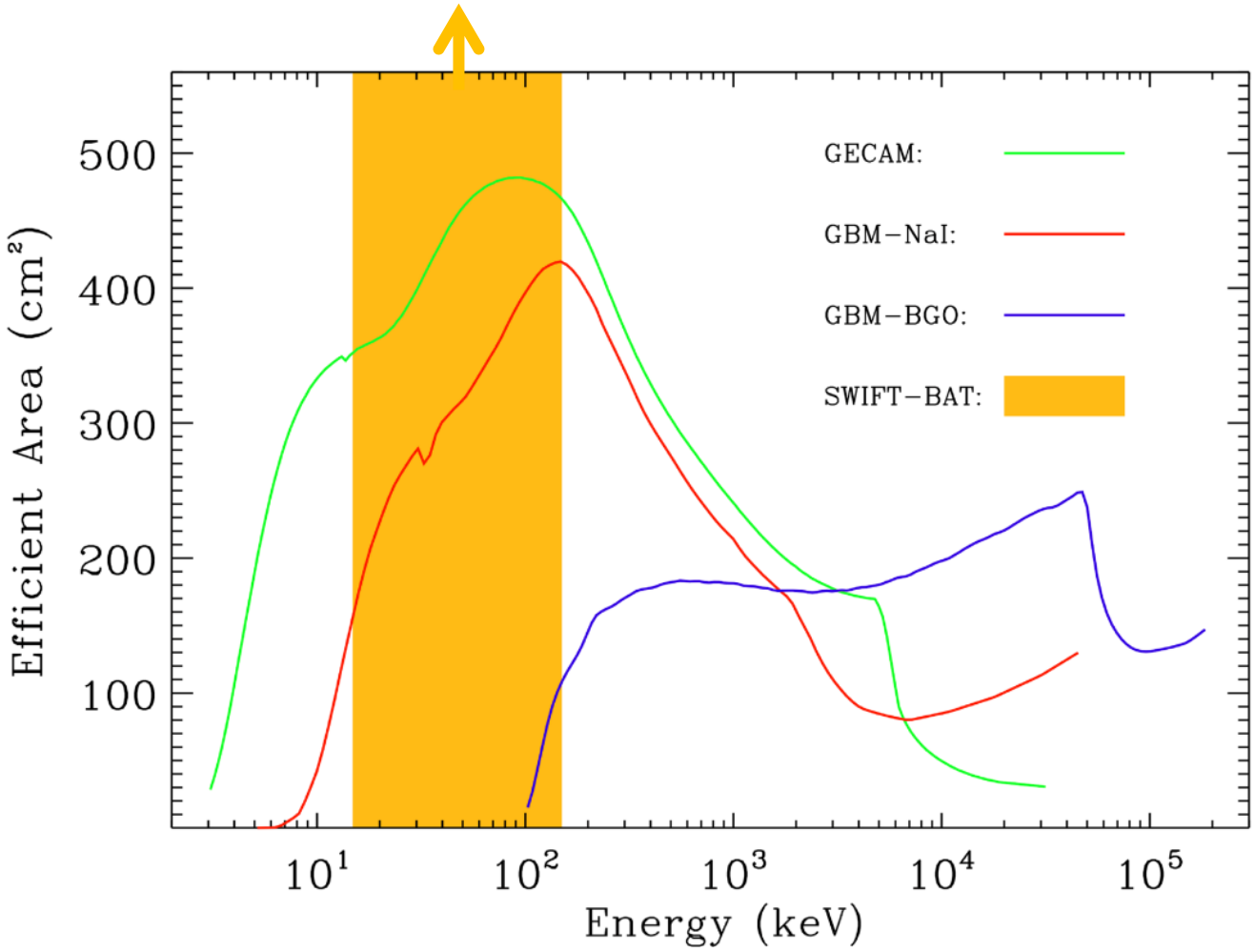




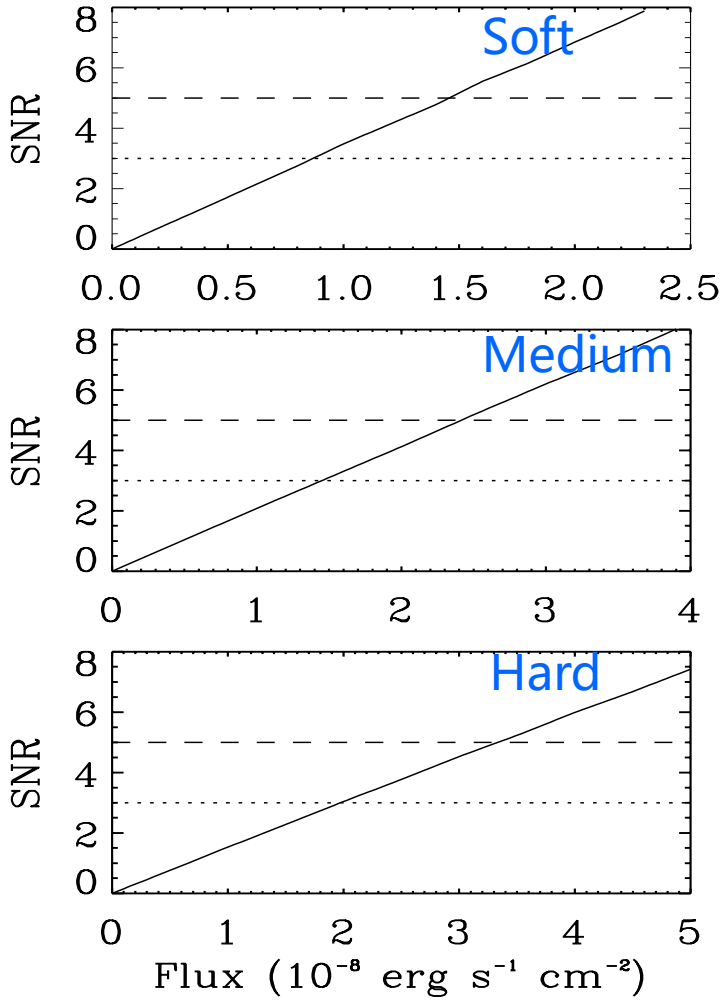
Energy range and Effective Area

- **Lower energy coverage**

  → Very helpful for detecting GRB170817A-like GWGRB



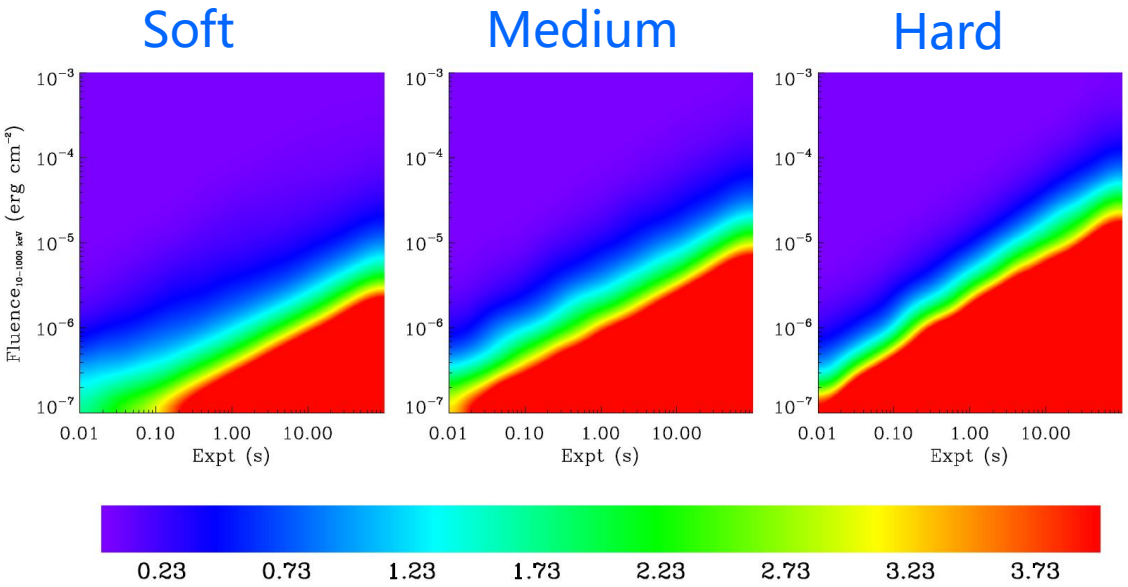
Sensitivity

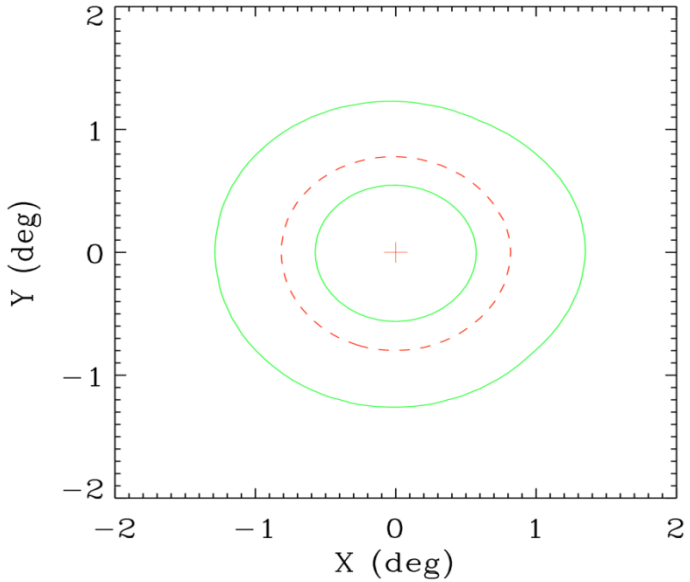


Band	α	β	Epeak (keV)
Soft	-1.9	-3.7	70
Medium	-1.0	-2.3	230
Hard	0.0	-1.5	1000

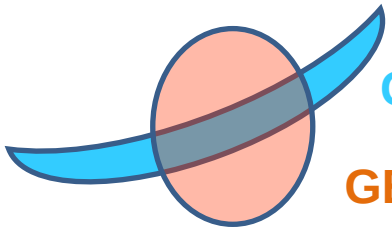
Sensitivity for three types of Band spectrum: ~10^{-8} erg/cm^2/s

Localization





Simulation of GRB 160724444
Lines correspond to 1σ, 90%, 3σ error regions. Red + is the input location.

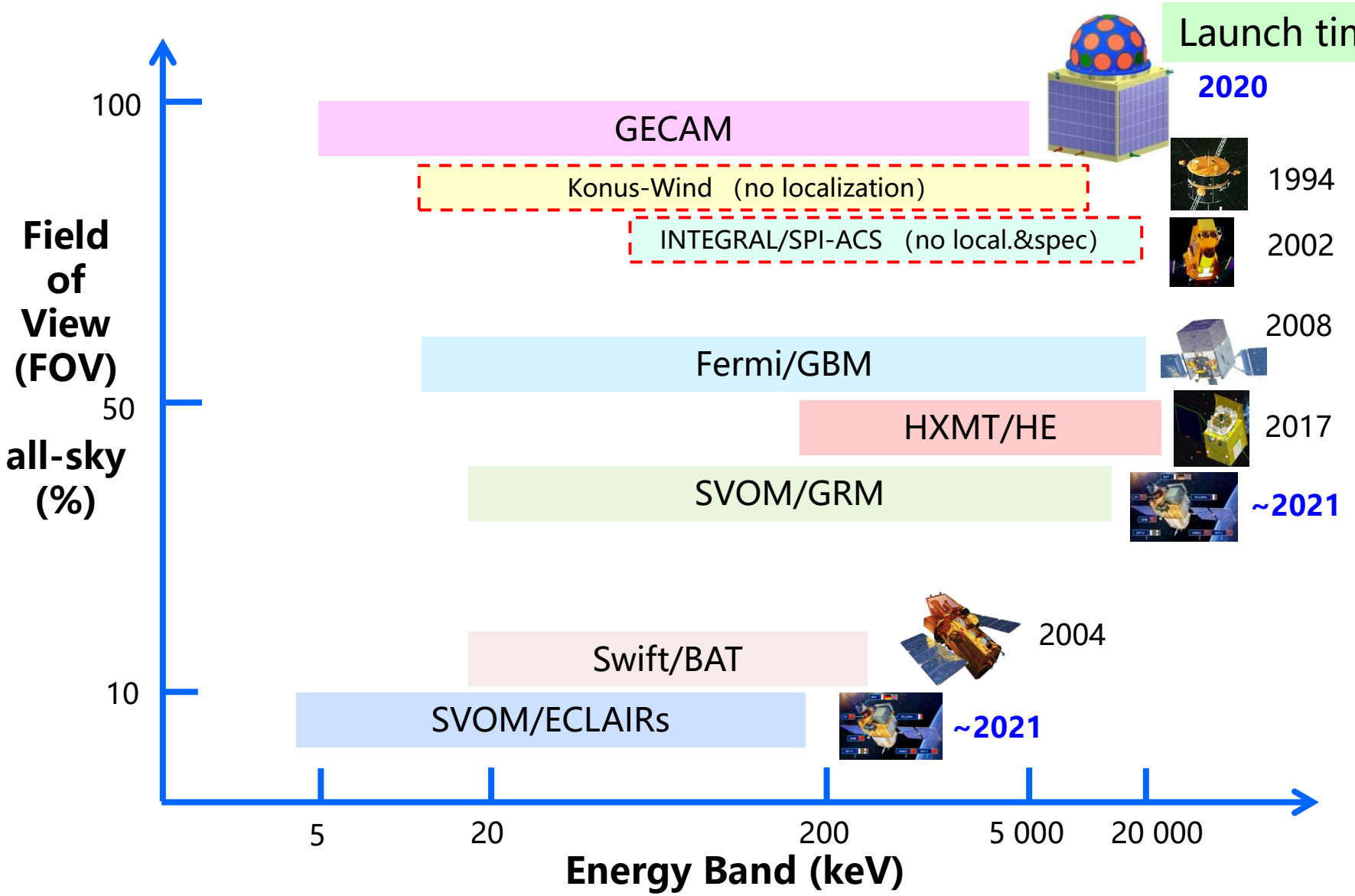


GW localization

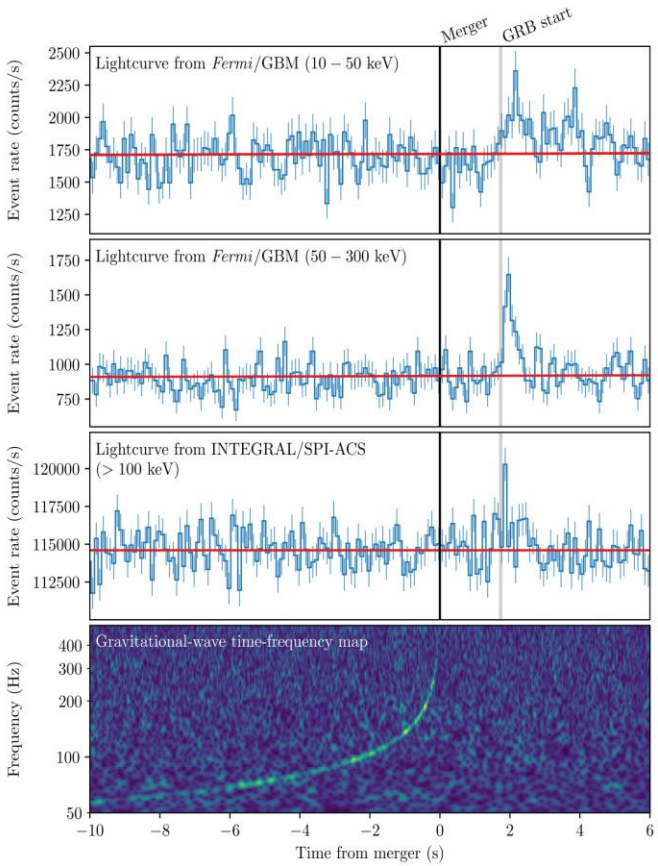
GECAM localization

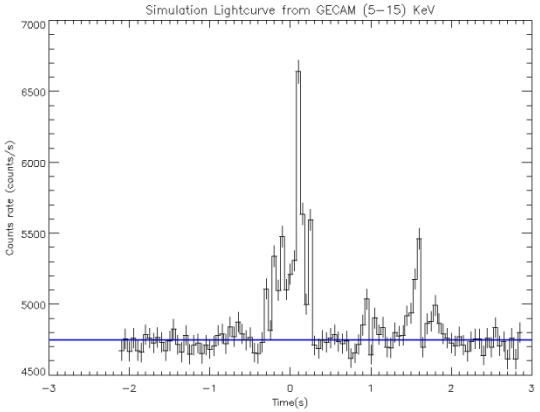
GECAM will have smaller systematic error in localization

X/gamma-ray telescopes

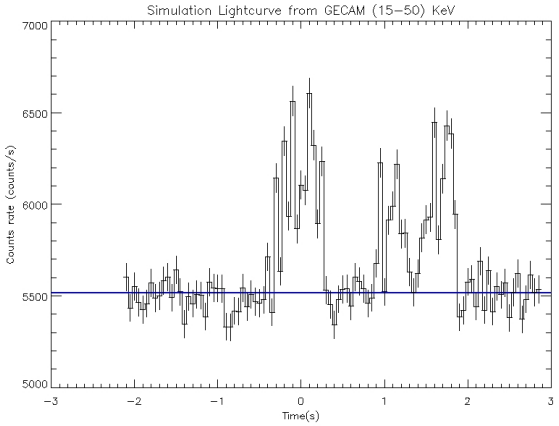


Simulation of GRB170817A

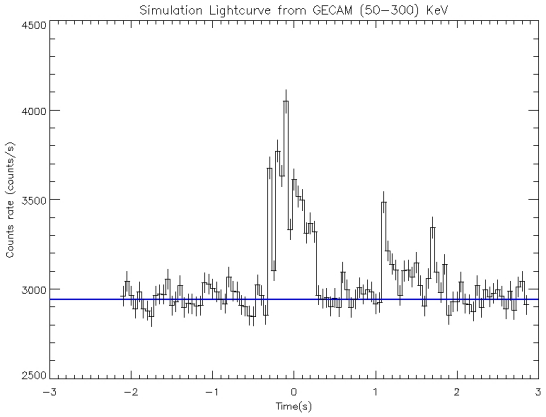




5-15 keV



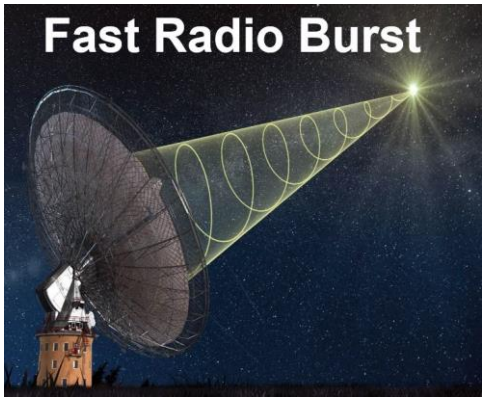
15-50 keV

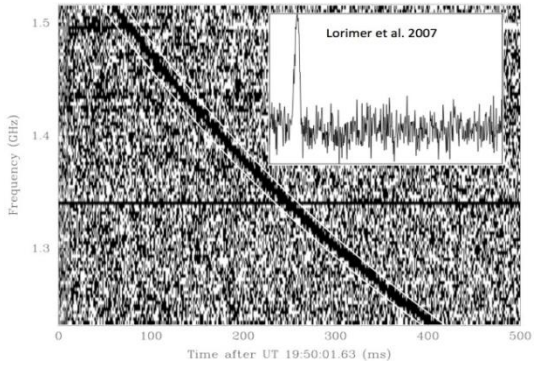


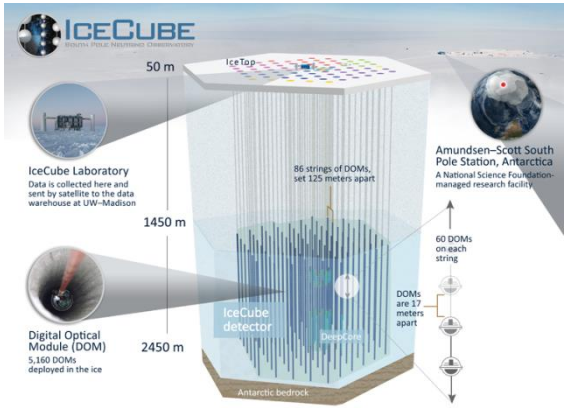
50-300 keV

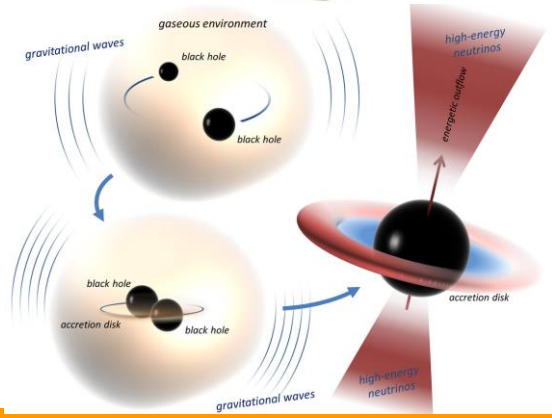
Science cases beyond GW (1)

- Multi-messenger and Multi-wavelength
  - High Energy Neutrinos (HEN)
  - Fast Radio Bursts, etc.
- GECAM is the ALL-TIME ALL-SKY Monitor



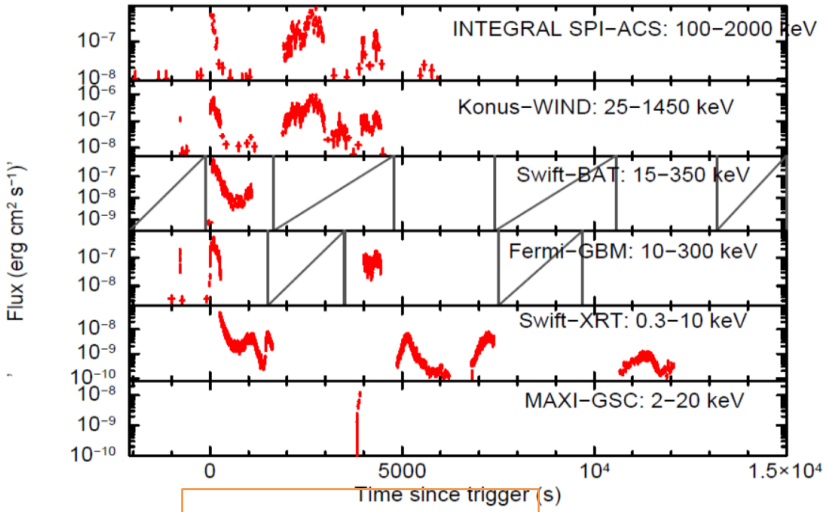




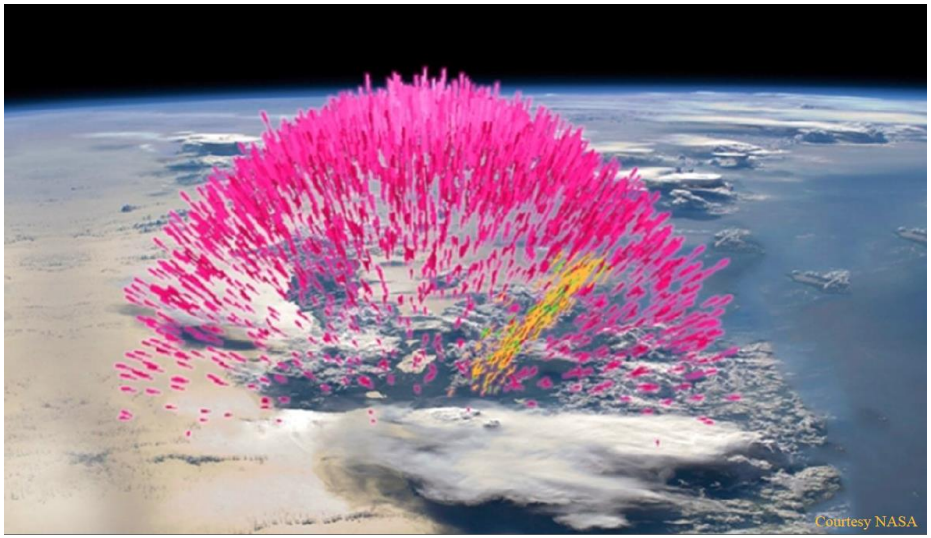


Science cases beyond GW (2)

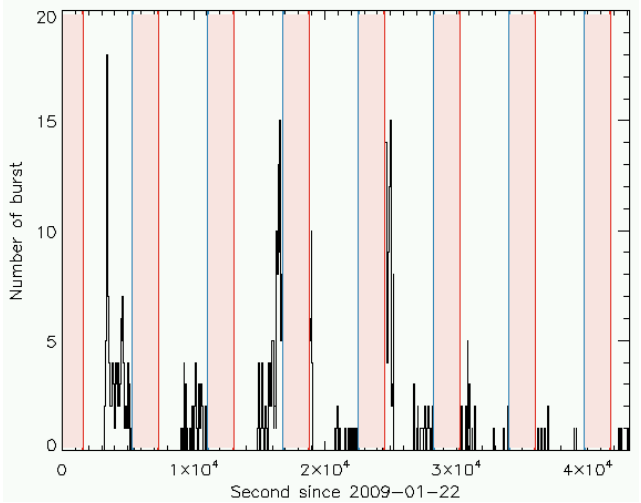
- Ultra-long GRBs
- X-ray Flashes
- X-ray-rich GRBs
- Magnetars
- Terrestrial Gamma-ray Flashes



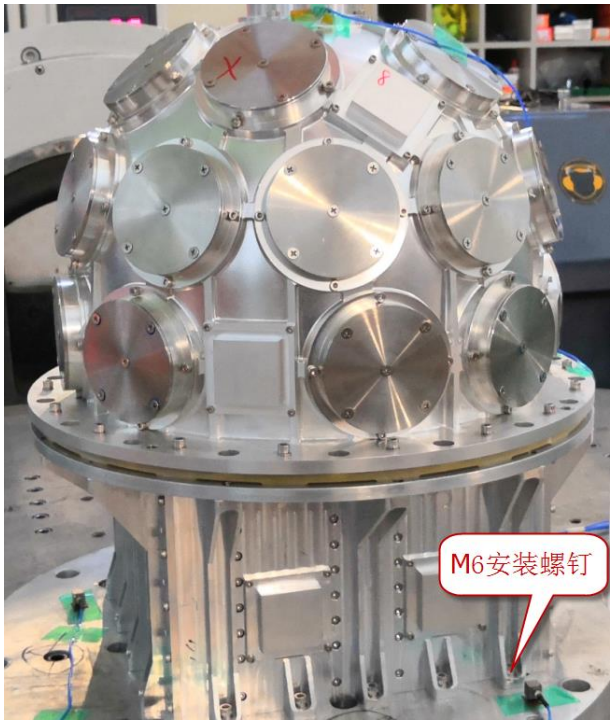
GRB 130925A

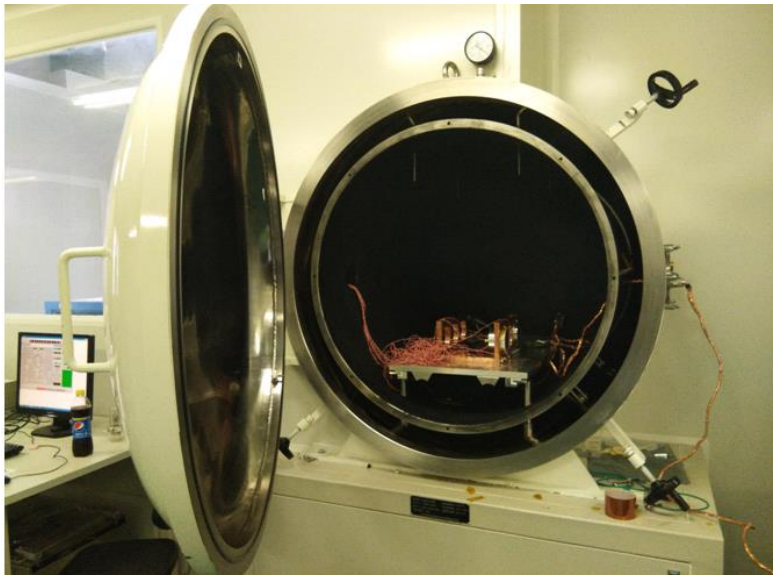


TGF



Hardware development

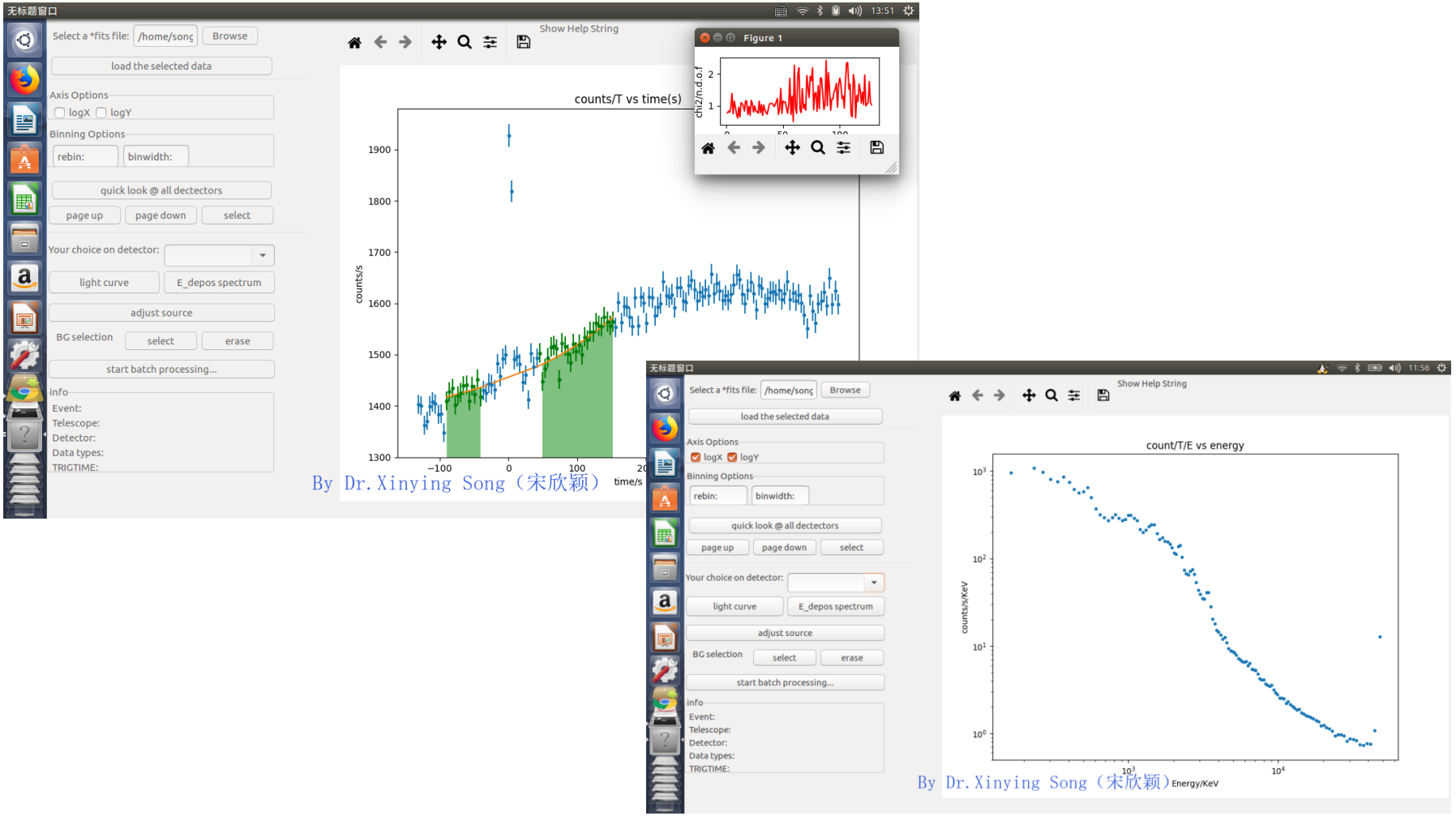




Vibration Test
Vacuum thermal Test

Data Analysis Software

- Python-based



Summary

- GECAM consists of two small satellites (~140 kg)
  - **100% FOV, 6 keV to 5 MeV, moderate localization (~1 deg)**
  - **Real-time (minutes) alerts for each satellite**
- Selected as the first *Mission of Opportunity* in China, officially announced in July 4, 2018
- Progress well, aiming for launch by the end of **2020**

Collaborations are very welcome!

Thank you!