GECAM, a new GW Counterpart All-sky Monitor in 2020's

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（On behalf of GECAM Team）

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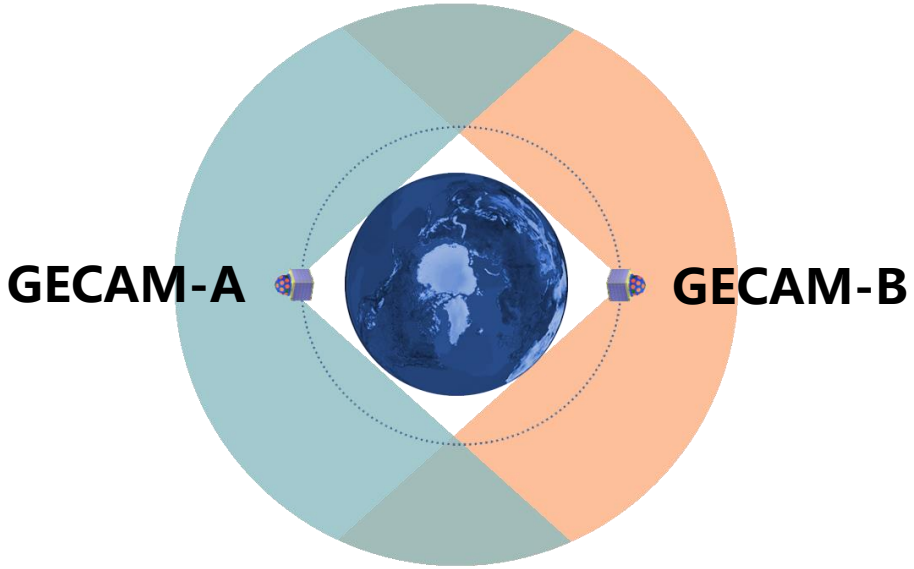
2021-04-17, The Ninth International Fermi Symposium

Outline

- Overview
- Preliminary results
- Summary & Outlook

GECAM: Gravitational wave high-energy Electromagnetic Counterpart All-sky Monitor

Photo by REN Hui
(http://www.yidianzixun.com/article/0SKwP948?appid=s3rd_op398&s=op398)



- Two small satellites: ~160kg for each

- Altitude: ~600 km
- Inclination: 29 degree
- Rocket: CZ-11
- life time: > 3 years

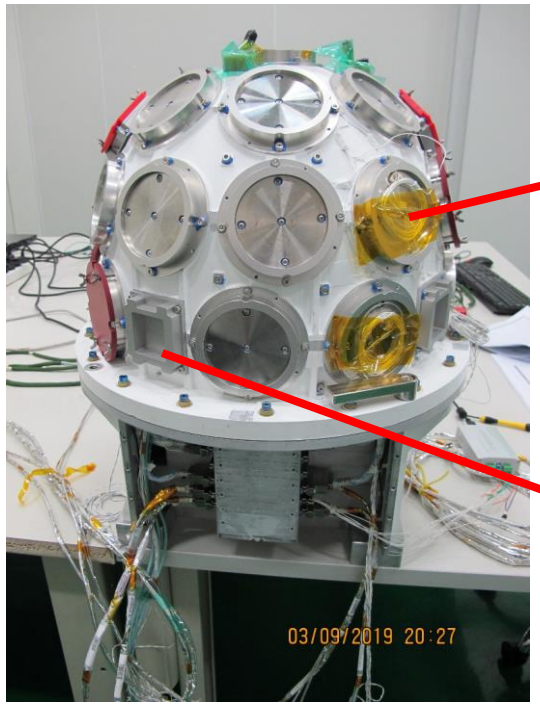
Launched successfully on Dec. 10, 2020

PI: Shaolin Xiong from IHEP, CAS

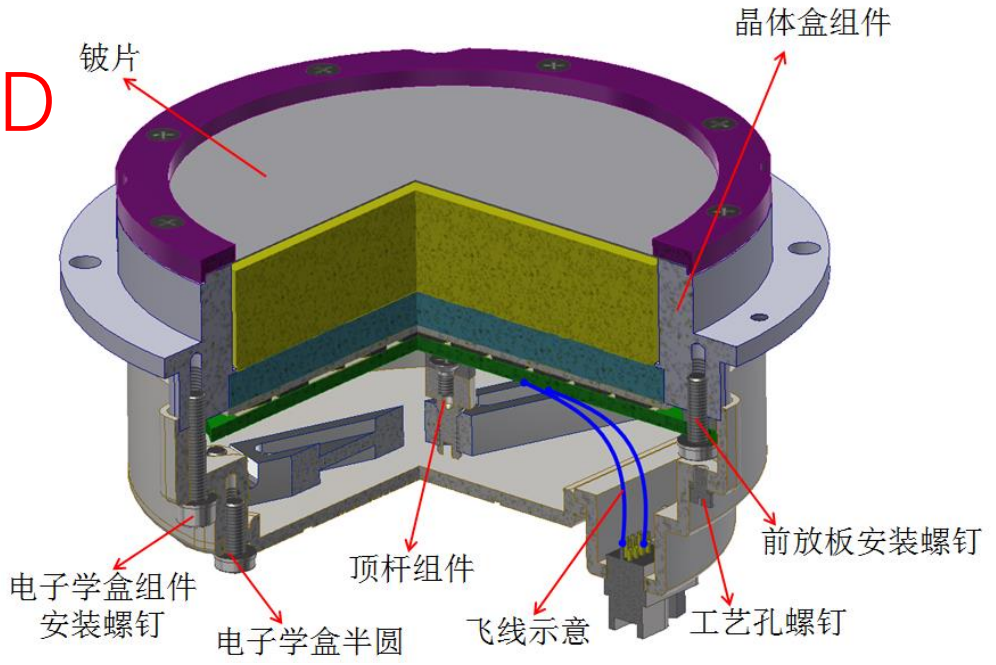
Scientific objectives

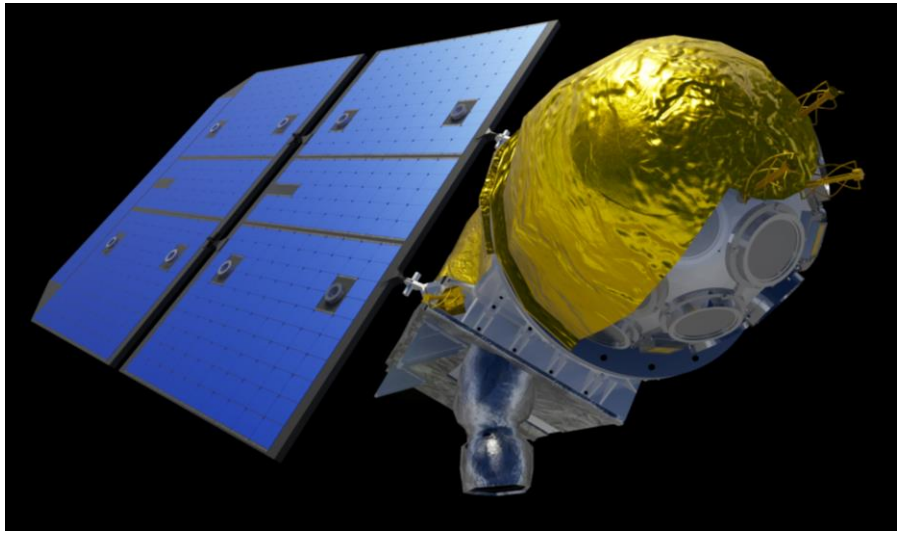
- Monitor the high-energy electromagnetic counterparts of GW events with all the sky, find a large amount of GW GRBs and the other new radiative phenomena to study the merging processes.
- Monitor the possible high-energy radiation of FRB with all the sky to study their physical origin and radiation mechanisms
- Monitor the special GRBs, magnetar outbursts all the time to study of their outburst mechanisms

And X/gamma-ray sources, Terrestrial Gamma-ray Flashes (TGF), Terrestrial electron beams (TEB), pulsars et al.

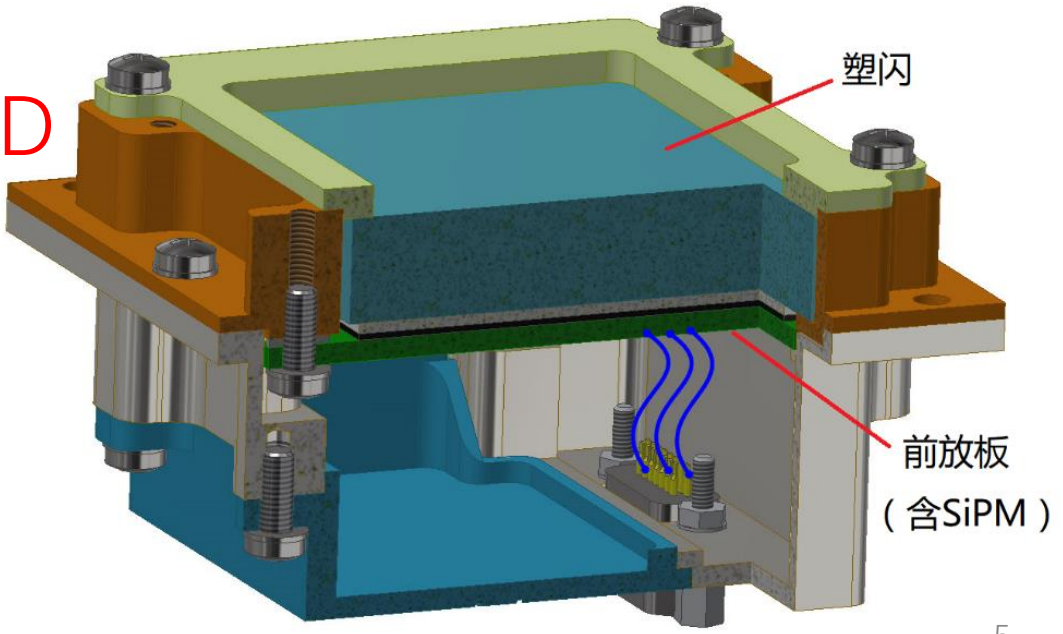

03/09/2019 20:27

GRD


晶体盒组件
铍片
前放板安装螺钉
顶杆组件
电子学盒组件
安装螺钉
电子学盒半圆
飞线示意
工艺孔螺钉



CPD

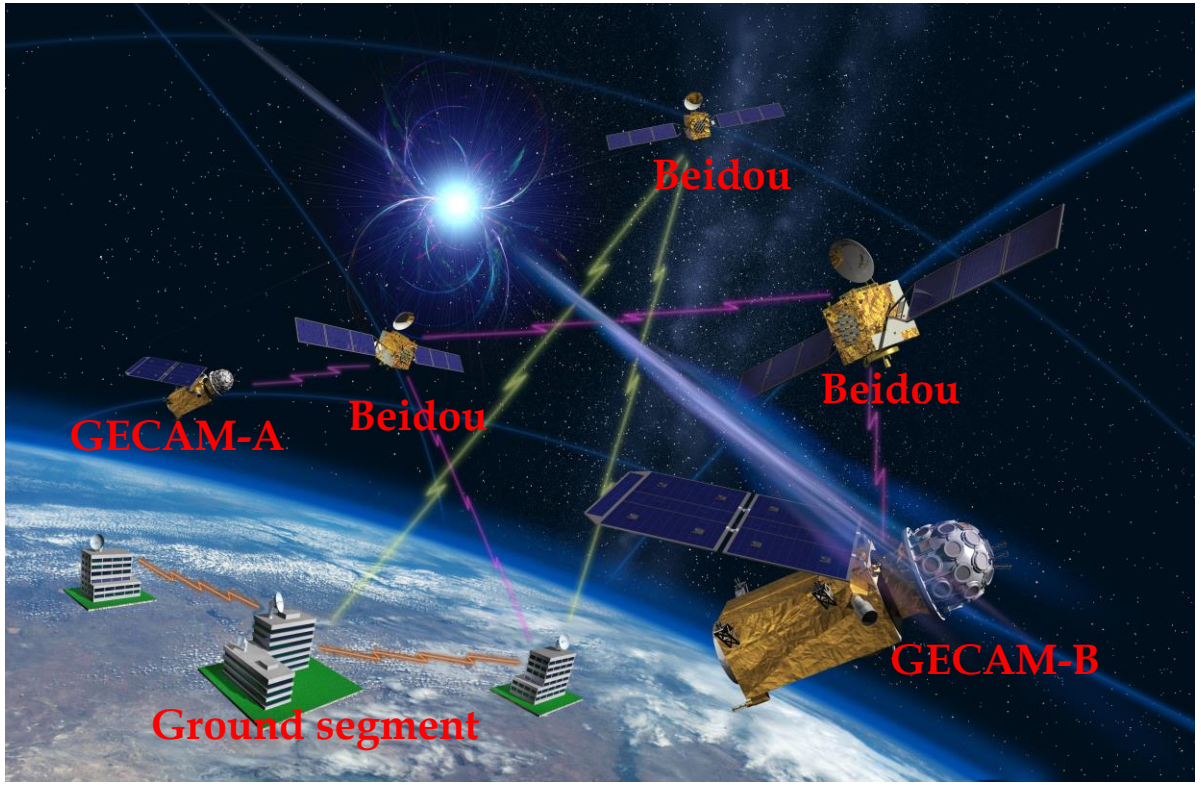

塑闪
前放板
（含SiPM）

Main Characteristics of GECAM

Items	Value	Comments
Orbit	600 km, 29 deg	550-600 km
Launch and lifetime	2020/12， 3yrs	5 yrs (goal)
Gamma-ray energy range	8 keV – 2 MeV	6 keV – 5 MeV (goal)
Gamma-ray detection eff.	≥50%@8 keV	GRD
Gamma-ray FOV	100% all-sky	Two GECAM satellites
Burst sensitivity	<2E-8 erg/cm^2/s (20 s, 10-1000 keV)	Band normal spectrum
Burst location error	< 1 deg (1-σ, stat. error)	1E-6 erg/cm2/s, 10s
Electron energy range	300 keV - 5 MeV	CPD
Dead time	≤5 μs (normal event)	GRD and CPD
Absolute time accuracy	< 10 μs	GPS
Relative time accuracy	~ 0.5 μs	GRD and CPD detectors
Data Volume	< 50 GB/day (two satellites)	Except large solar flare

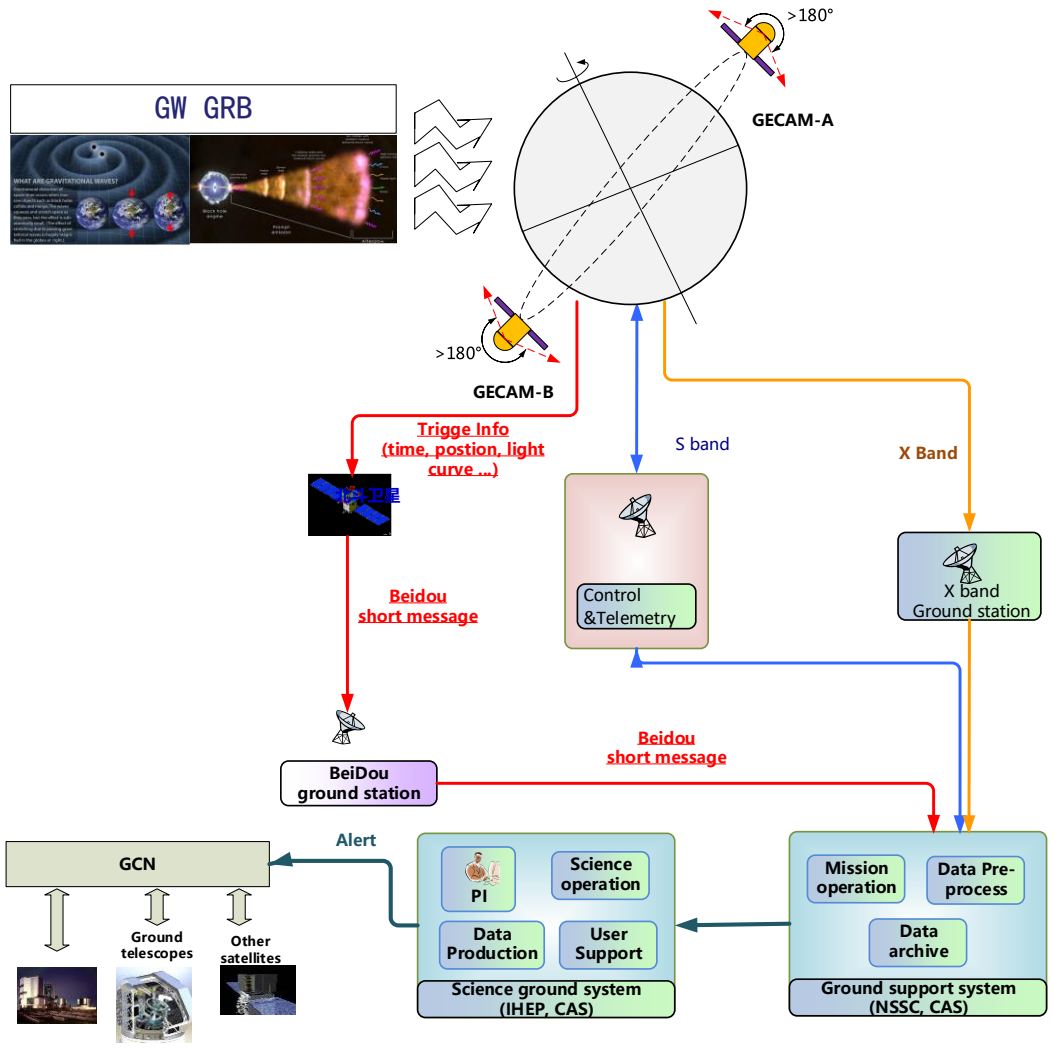
Real-time alert system

Beidou navigation system (China)



Beidou short messages used to send the onboard trigger info to the ground in ~minutes

Real-time alert system



GRB alert & quick look and submitted to GCN

- From Beidou short message:

  ~several minutes

- From event data (one satellite):

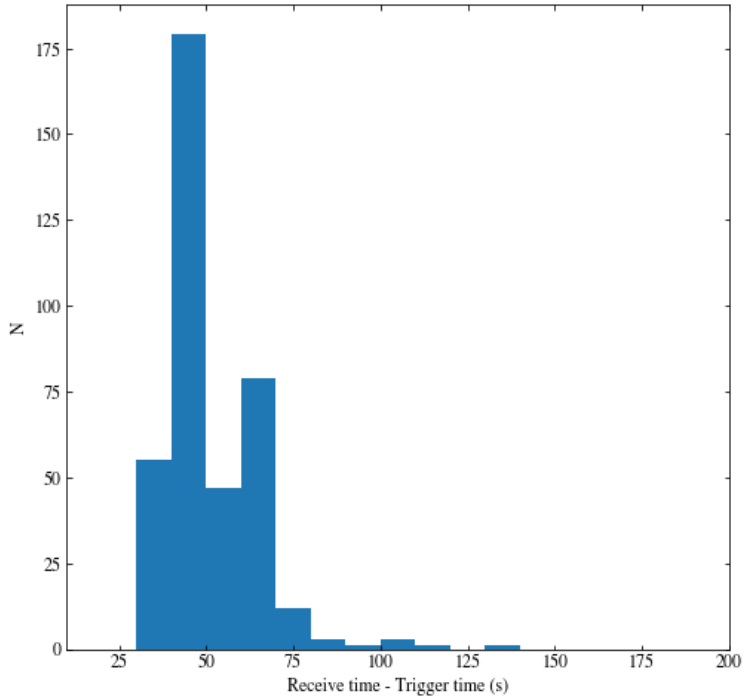
  ~several hours

- From event data (two satellites):

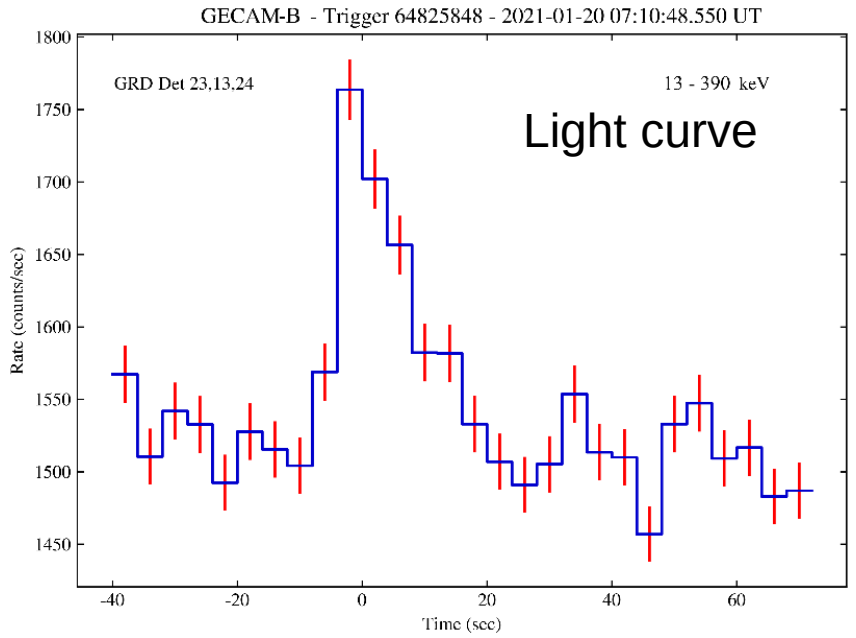
  > 10 hours

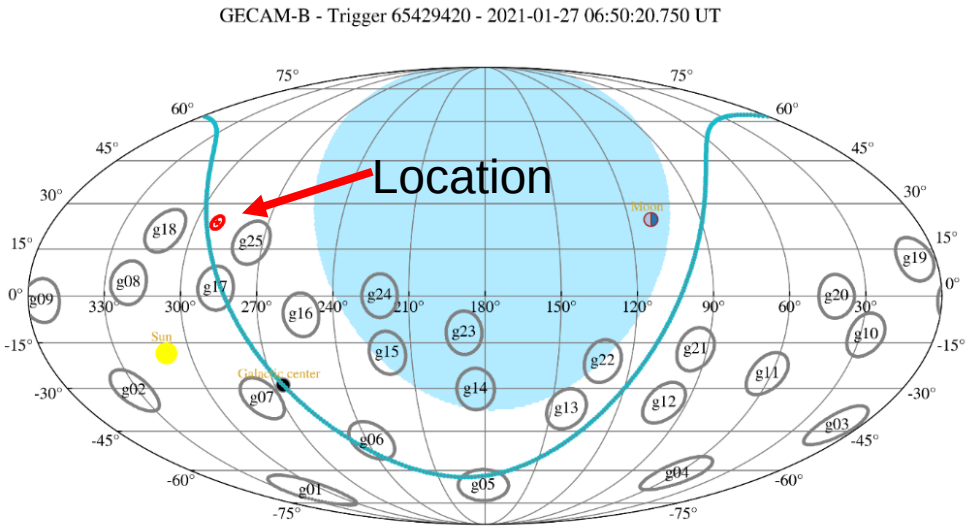
Up to now, more than 400 on-board triggers received, including:

GRBs, binaries, pulsars, solar flares, TGFs, particle events…



From trigger to receiving ~1 min

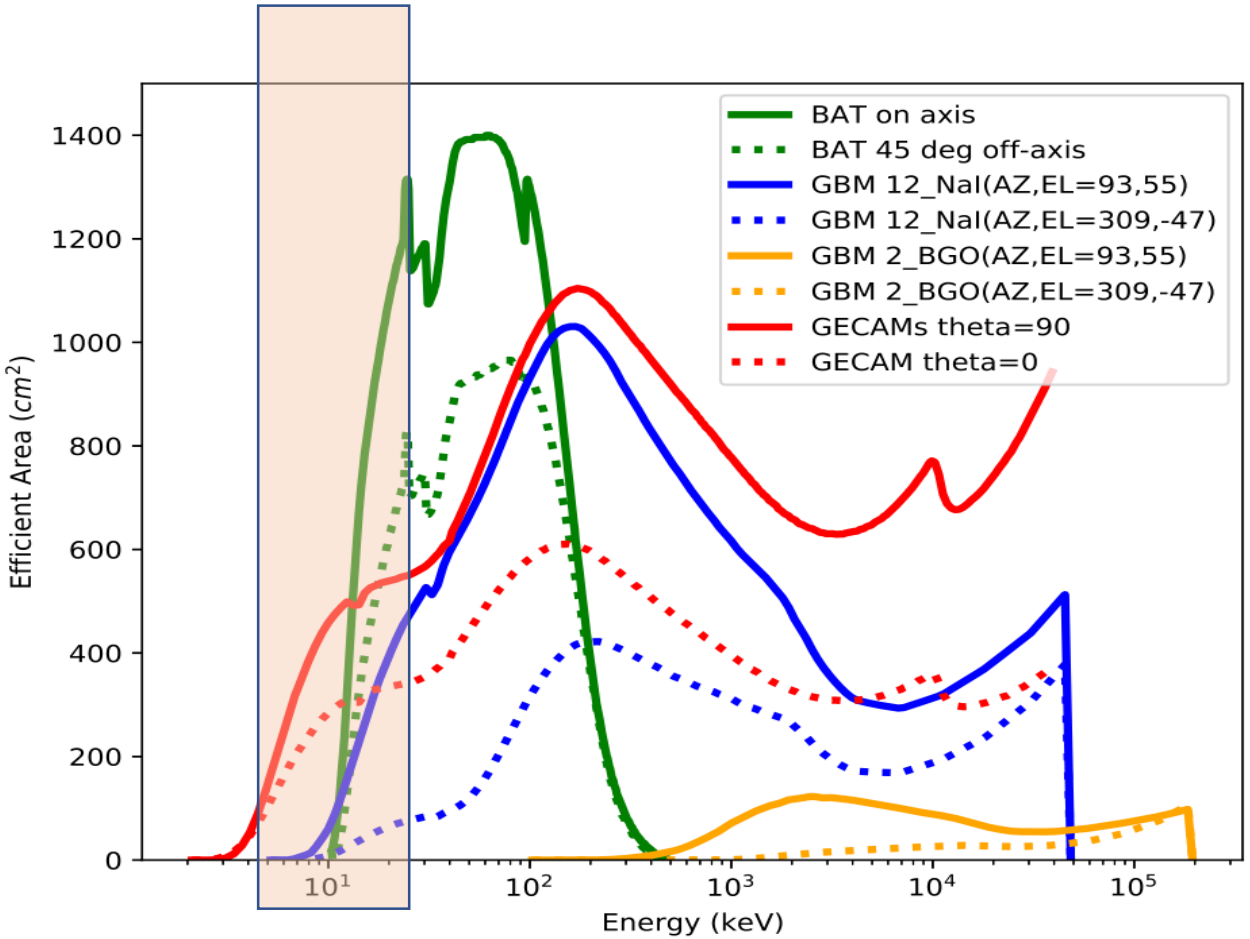




Preliminary results

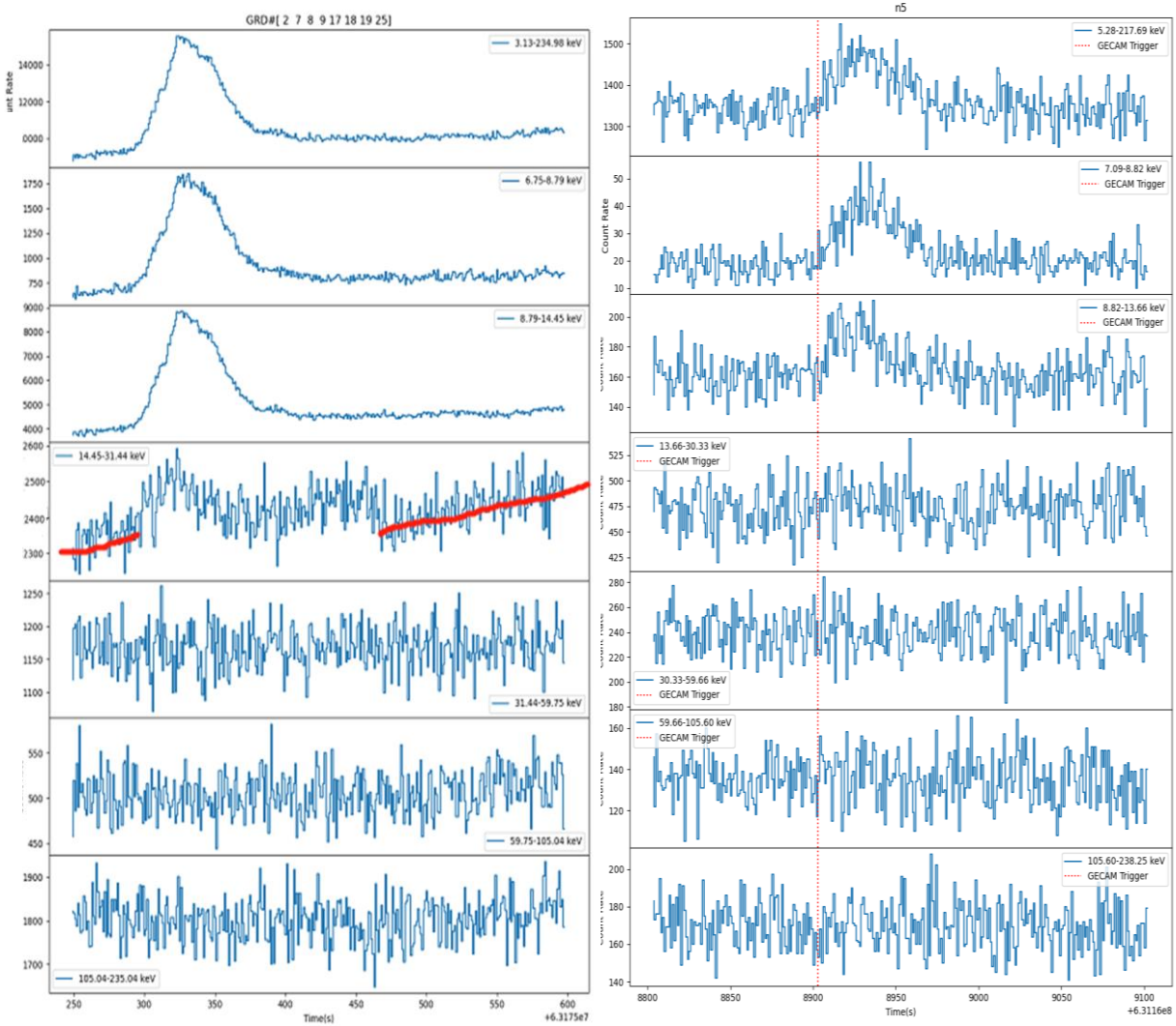
Performance

Advantages in Low energy band



GECAM vs. Fermi/GBM, Swift/BAT

Trigger (UTC：2021-01-01 04:41:38.65)



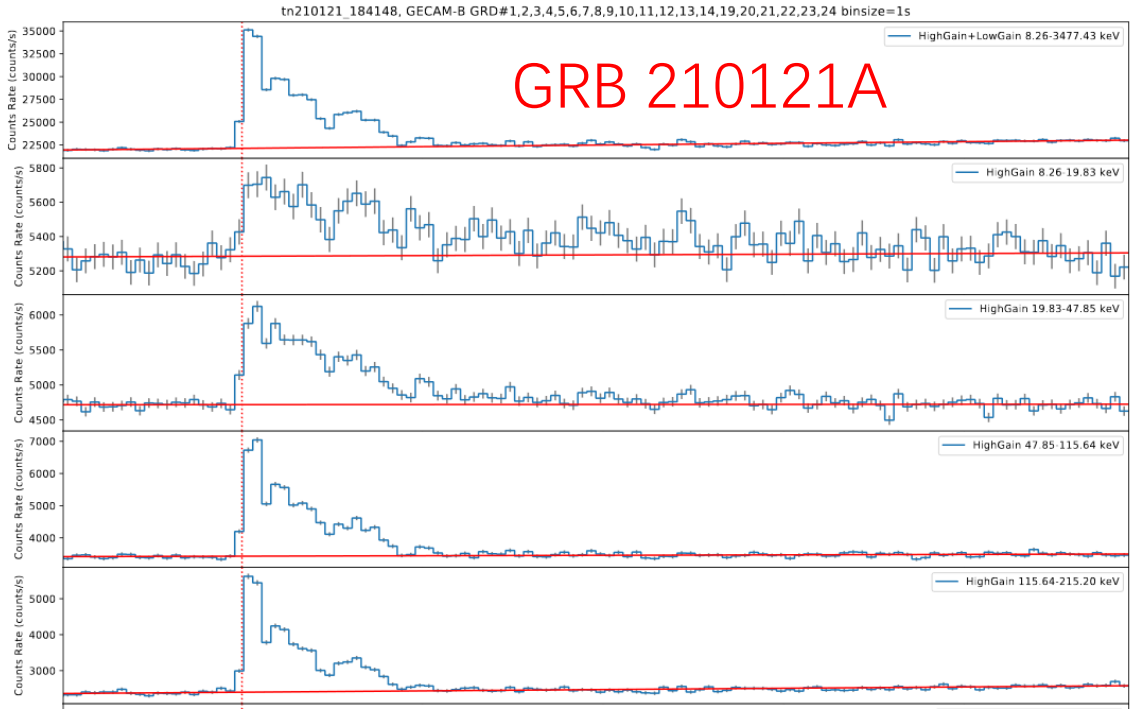
GECAM 02 **Fermi-GBM**

GRB detections

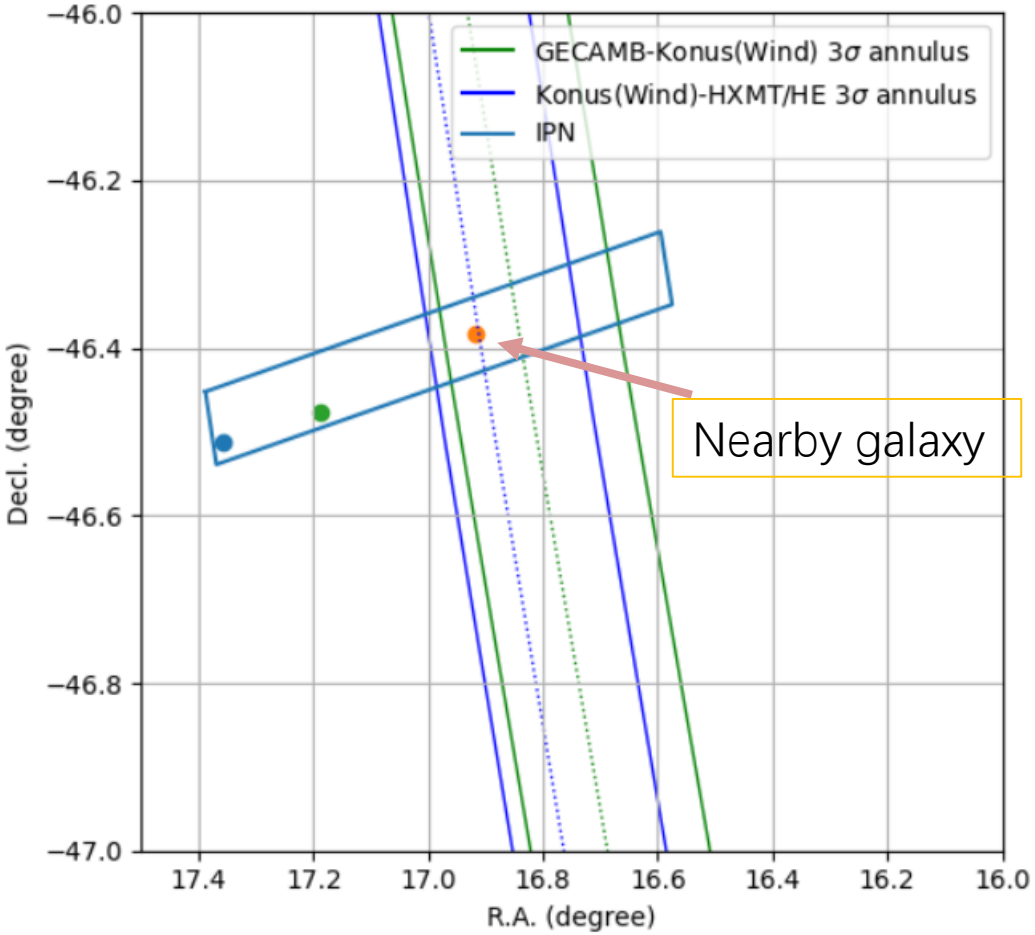
UTC time	GRB	#GCN编号 (GECAM)	Fermi/GBM detetion?
2021-01-19T02:54:09.850	GRB 210119A	29331	Yes
2021-01-20T07:10:48.550	GRB 210120A	29338	Yes
2021-01-21T18:41:48.800	GRB 210121A	29347	No
2021-01-26T10:00:10.600	GRB 210126A	29356	Yes
2021-01-31T12:29:12.000	GRB 210131A	29379	No
2021-02-04T06:30:00.600	GRB 210204A	29392	Yes
2021-02-07T21:52:14.050	GRB 210207B	29486	Yes
2021-02-28T06:38:32.600	GRB 210228A	29588	No
2021-03-07T08:42:38	GRB 210307A	--	No
2021-03-07T05:56:39.100	GRB 210307B	29614	No

15 GRB in total
(partially in work during in orbit test)

Joint localization together with other GRB missions

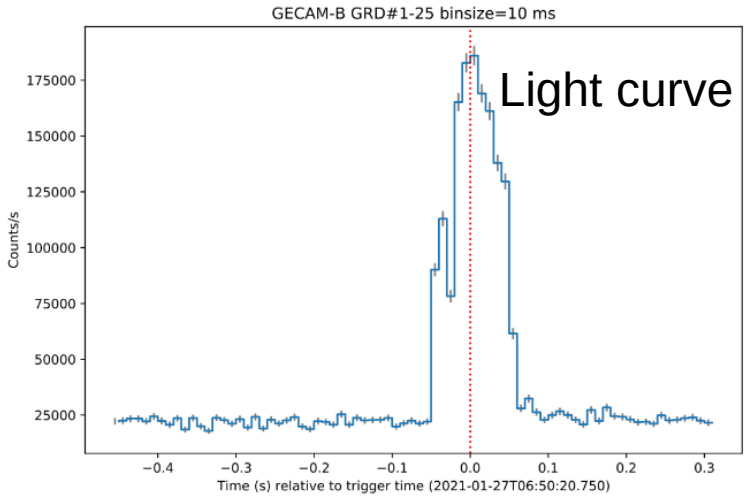


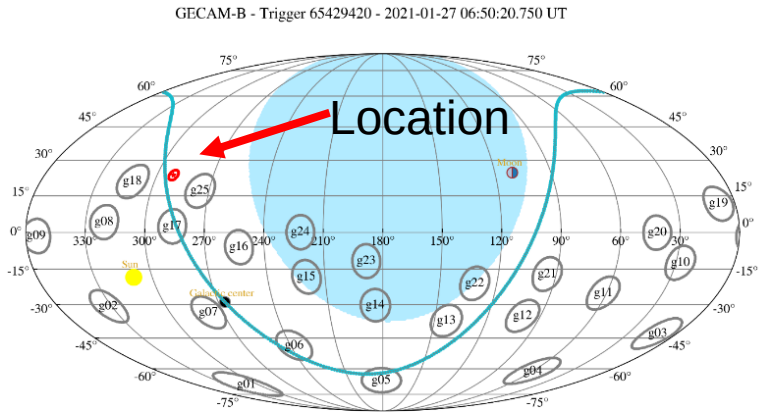
Clear spectral evolution



IPN location + GECAM
Possibly from a neighboring galaxy (80 Mpc) ? ?

New outburst of Magnetar (SGR J1935+2134)





Since Jan 27, a series of bursts have been detected and send to GCN at firstly!

GCN report first timely

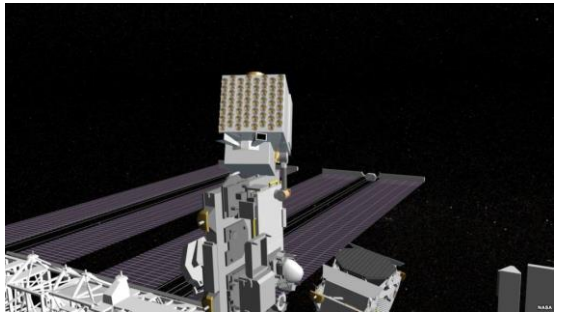
The bright, short-duration, soft burst
(GECAM detection: Huang et al., GCN Circ. 29363)
was detected by GECAM, Konus-Wind, and Swift (BAT)
at about 24617 s UT (06:50:17) on January 27.
The burst was outside the coded field of view of the BAT.

We have triangulated it to a Konus-BAT annulus centered at
RA(2000)=315.213 deg (21h 00m 51s) Dec(2000)=-14.116 deg (-14d 06' 56"),
whose radius is 41.658 +/- 0.174 deg (3 sigma).

The position of SGR 1935+2154 lies inside the annulus at 3.5 arcmin
from its center line.

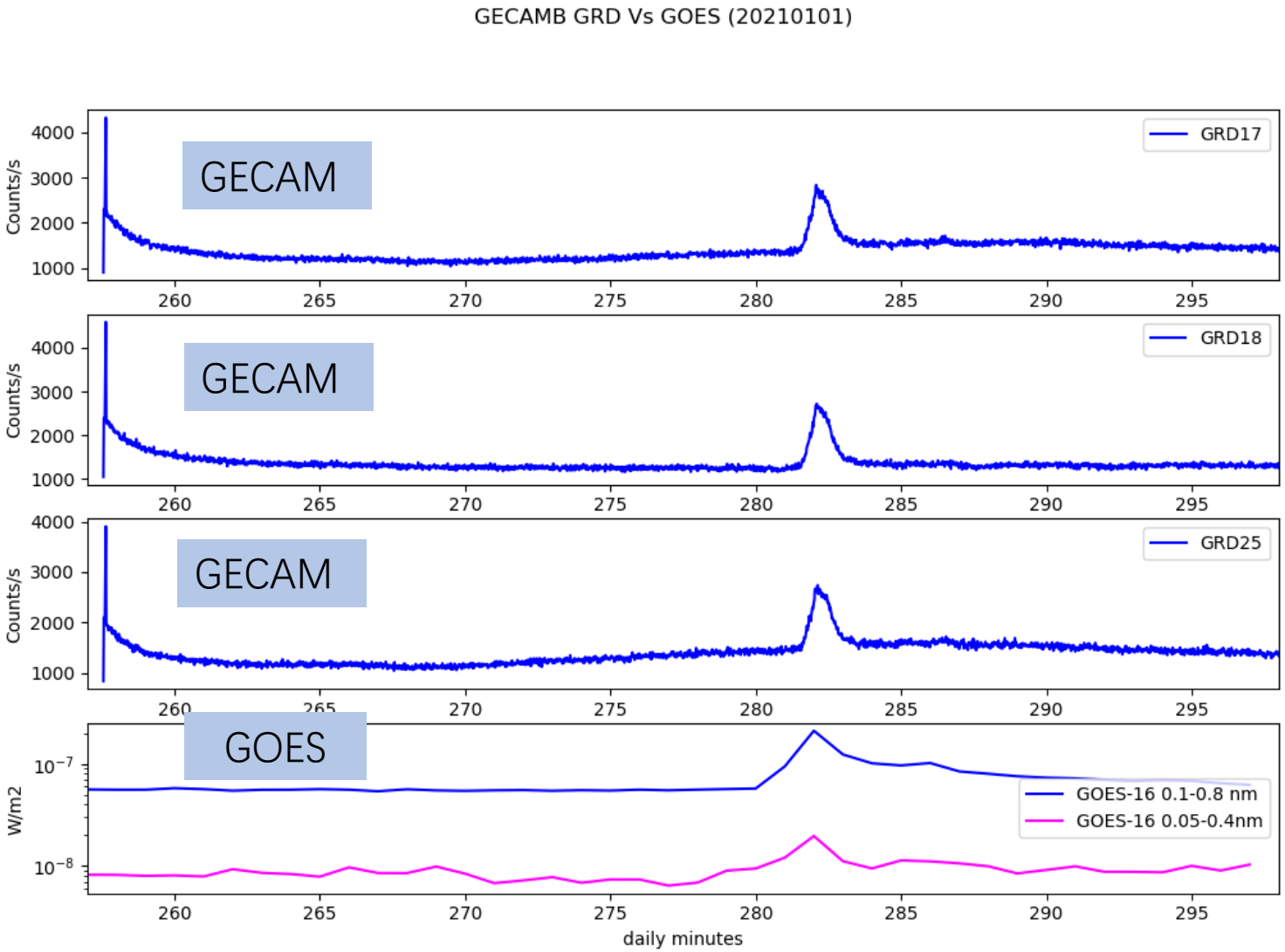
Given the positional coincidence (initially suggested in GCN 29363) of
this burst with SGR 1935+2154, its time history, and softness of its
spectrum (as observed by Konus-Wind), we conclude this burst is
likely originated from SGR 1935+2154.

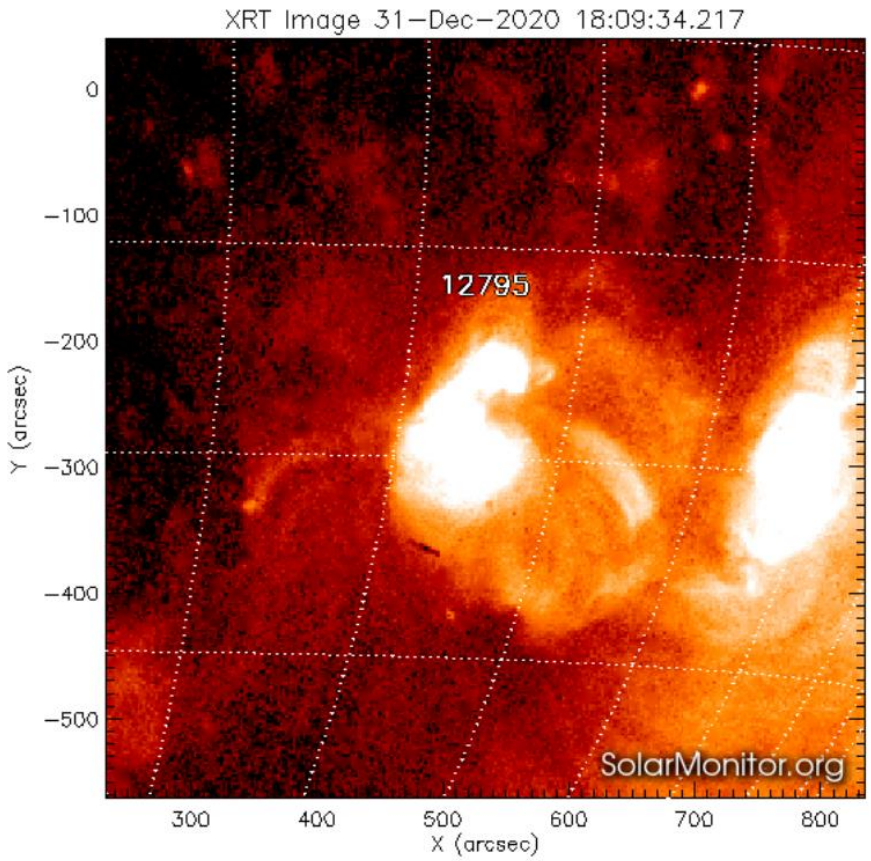
A triangulation map is posted at
http://www.ioffe.ru/LEA/SGRs/210127_T24616/IPN/



Co-ordinate observations with FAST, NICER

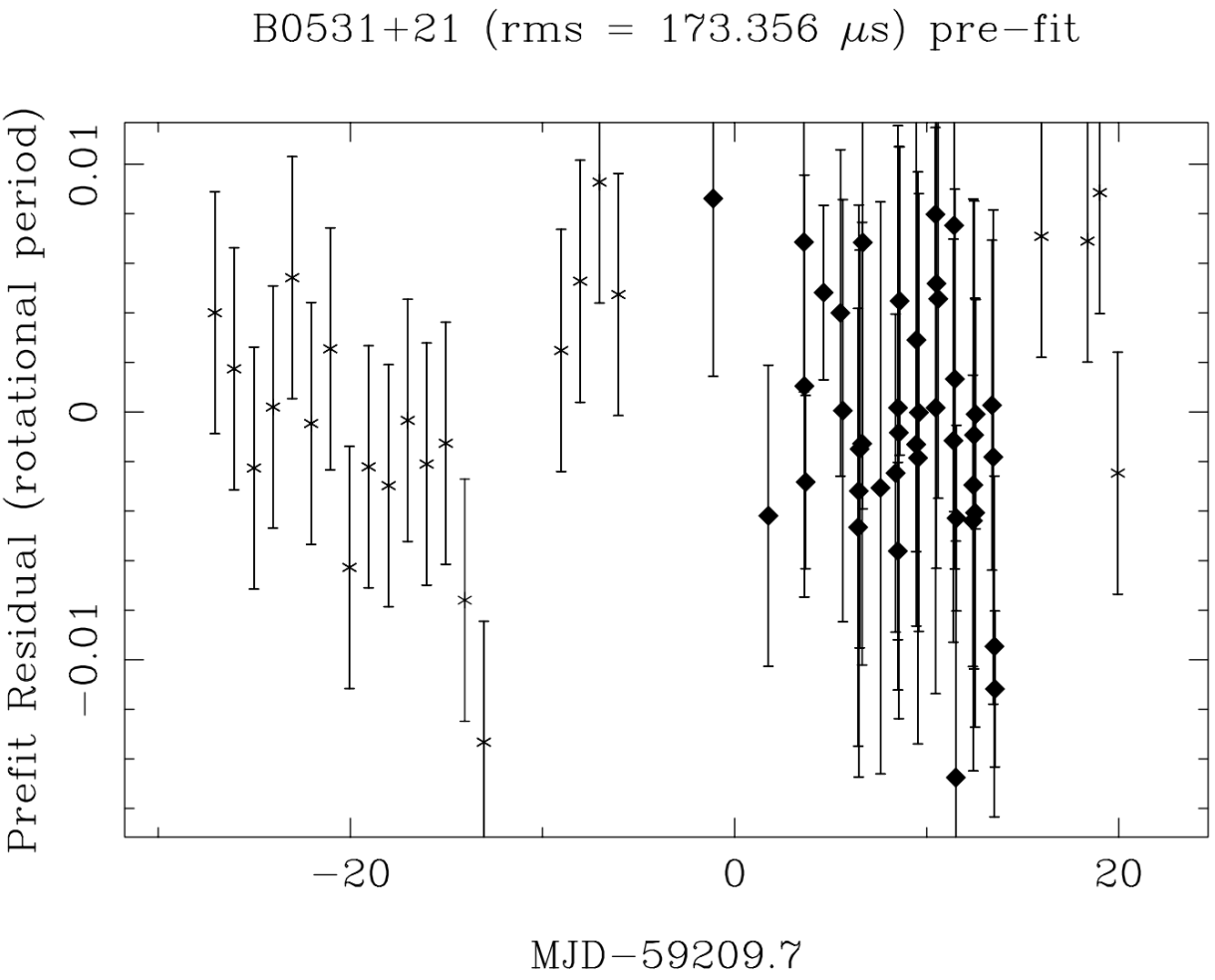
Solar Flares



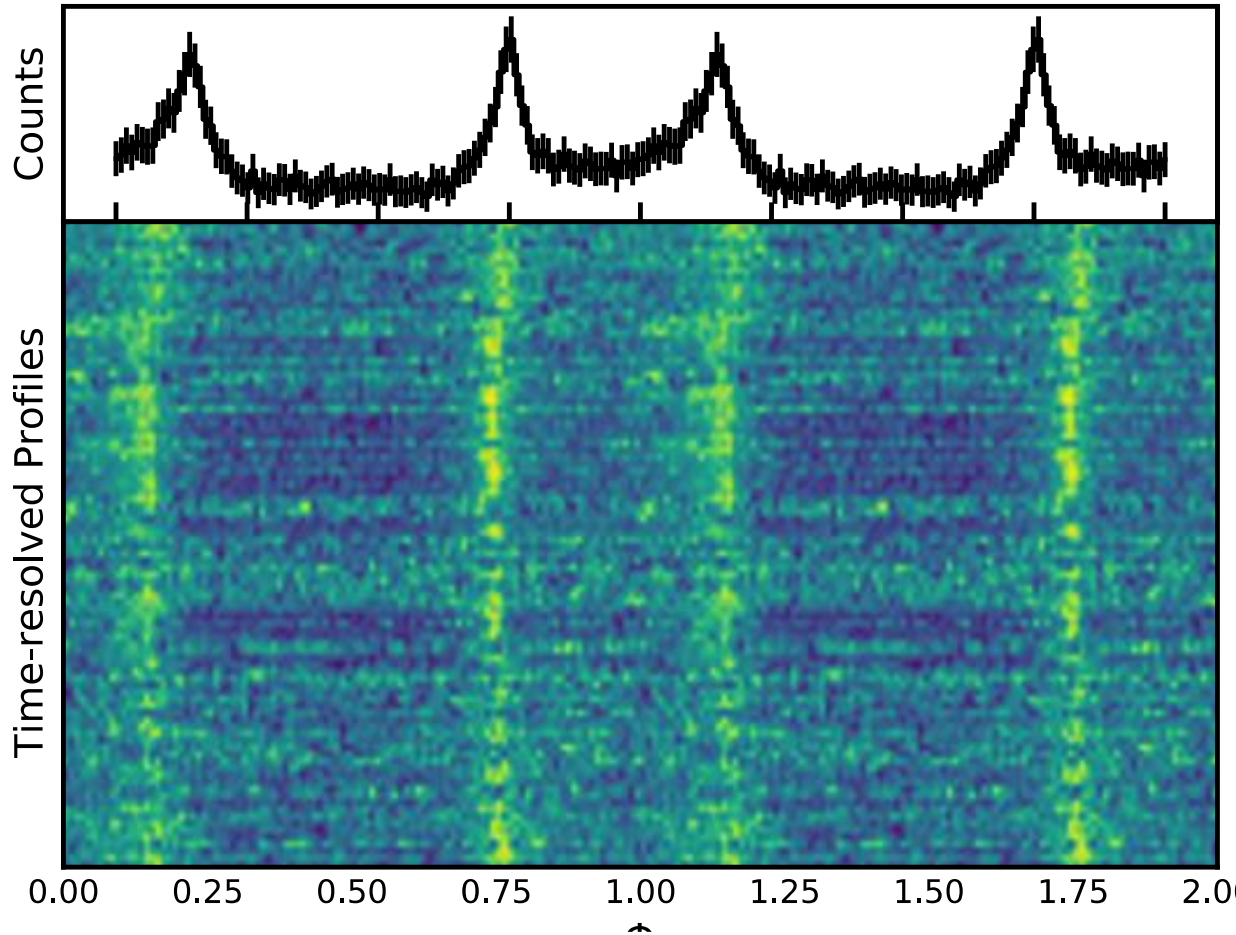


B2.1 class flare

Crab pulsar

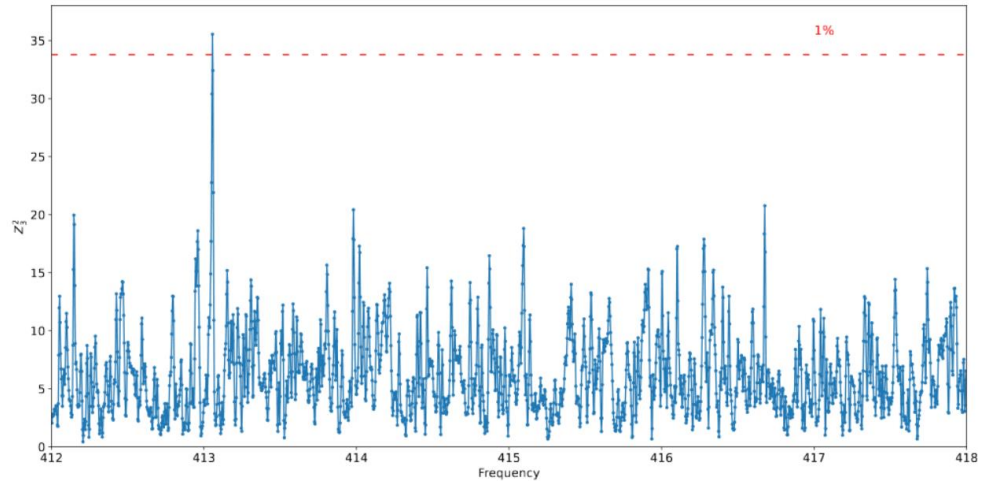


Timing noise < 0.01 phasebin



Profile of Crab pulsar

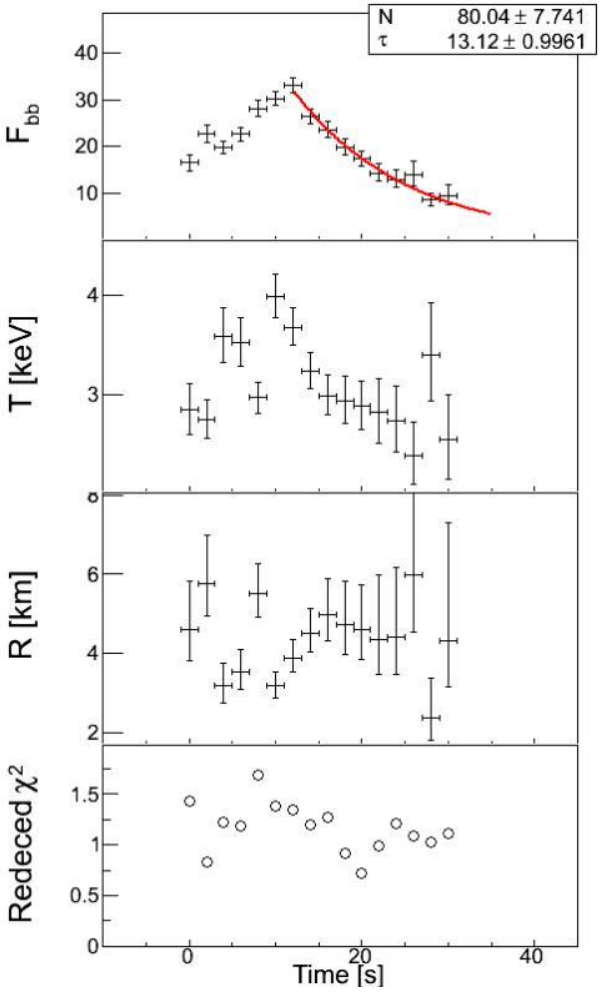
GECAM detection of Type I burst from NS X-ray Binaries



PSD confirmation of 4U 0614+09

- **Candidates**
  - 4U 1608-52
  - 4U 1636-536

Atel



GECAM detection of a bright thermonuclear burst from 4U 0614+091

ATel #14363; *Y. P. Chen (IHEP), J. Li (USTC), S. L. Xiong (IHEP), L. Ji (SYSU), S. Zhang (IHEP), W. X. Peng (IHEP), R. Qiao, X. Y. Zhao, Y. Huang, F. J. Lu, S. N. Zhang, L. M. Song, S. Xiao, C. Cai, B. X. Zhang, Z. H. An, C. Chen, G. Chen, W. Chen, M. Gao, K. Gong, D. Y. Guo, J. J. He, B. Li, C. Li, C. Y. Li, J. H. Li, Q. X. Li, X. B. Li, X. Q. Li, Y. G. Li, X. H. Liang, J. Y. Liao, J. C. Liu, X. J. Liu, Y. Q. Liu, Q. Luo, X. Ma, G. Ou, D. L. Shi, J. Y. Shi, X. Y. Song, G. X. Sun, X. L. Sun, Y. L. Tuo, C. W. Wang, J. Z. Wang, P. Wang, X. Y. Wen, Y. B. Xu, Y. P. Xu, W. C. Xue, S. Yang, M. Yao, Q. B. Yi, C. Y. Zhang, D. L. Zhang, Fan Zhang, Fei Zhang, H. M. Zhang, K. Zhang, P. Zhang, Y. Q. Zhang, Z. Zhang, S. Y. Zhao, Y. Zhao, C. Zheng, S. J. Zheng, X. Zhou (IHEP), report on behalf of GECAM team:*

on 1 Feb 2021; 05:06 UT

Credential Certification: Yu-Peng Chen (chenyp@ihep.ac.cn)

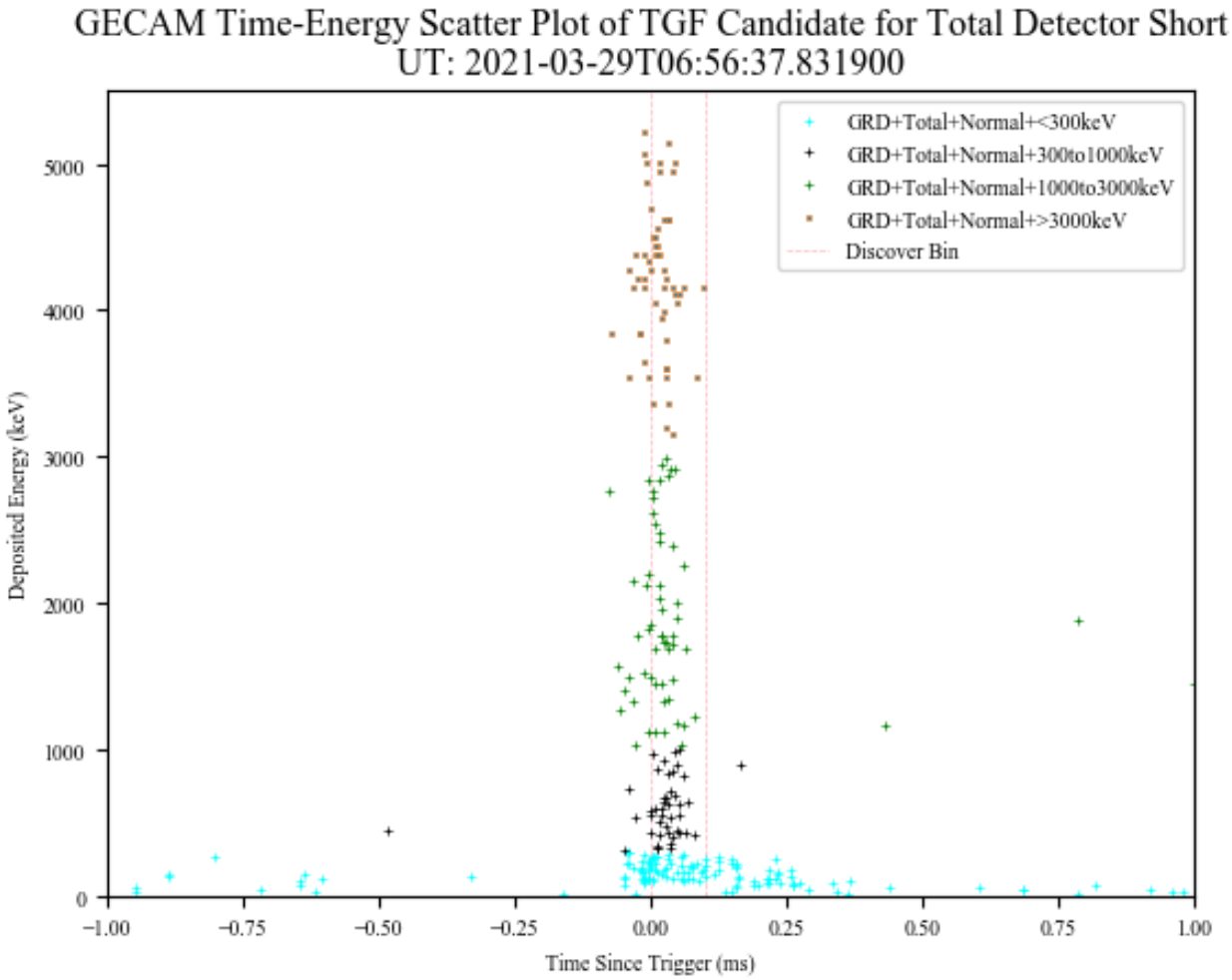
Subjects: X-ray, Binary, Neutron Star

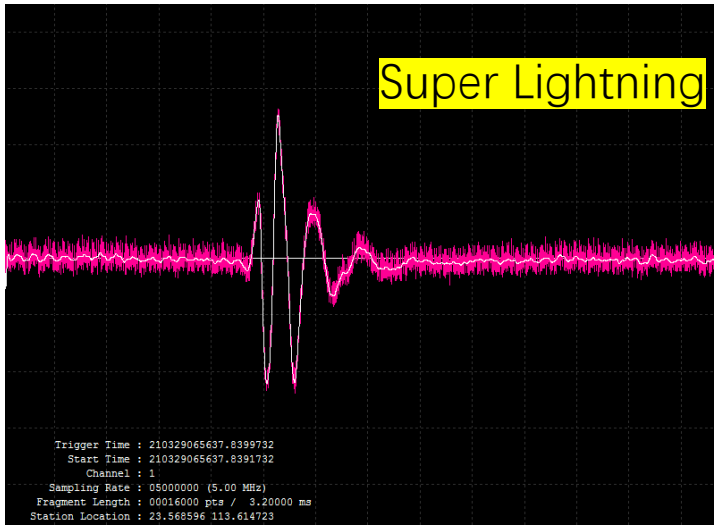
Tweet

During the commissioning phase, GECAM-B detected a very bright X-ray burst at 2021-01-24T11:50:03.600 UTC (denoted as T0, GCN 29350) from a direction centered on Ra: 94.9 degree, Dec: 6.6 degree with an error circle 2.7 degree (1-sigma, statistical only). The burst has a fast rise of 10 s, an exponential fashion decay and a duration of ~60 s. With 4 detectors out of 25, the peaks flux is ~700 cts/s above the pre-burst emission.
A pulsation at 413 Hz is detected with ~4 sigma. The 2-second time bin burst spectra are well represented by a blackbody, with a temperature peaking at 4.0+/-0.2 keV and a peak flux (3.3+/-0.2) x 10^-7 erg/cm2/s. The spectrum softens with the temperatures from ~4 keV to ~2 keV during the decay. Assuming the source at a distance 3 kpc, the unabsorbed bolometric peak luminosity is (3.6+/-0.2) x 10^38 erg/s, which is well consistent with the Eddington limit with a stellar mass of 1.4 solar mass for hydrogen-poor matter.
This analysis shows convincingly the burst is a genuine thermonuclear X-ray burst from 4U 0614+09, a faint and persistently accreting neutron star X-ray binary lying within the location error, from which the 415 Hz burst oscillation was first reported with data from Swift/BAT (Strohmayer et al. 2008). Since 4U 0614+091 has a burst recurrence time ~12 day (Linares et al. 2012), thanks to the very wide field of view (more than a half sky) of GECAM-B, more bursts should be detected during future observations of GECAM-B.

Gravitational wave high-energy Electromagnetic Counterpart All-sky Monitor (GECAM) mission consists of two small satellites (GECAM-A and GECAM-B) in Low Earth Orbit (600 km, 29 deg), launched on Dec 10, 2020 (Beijing Time), which was funded by the Chinese Academy of Sciences (CAS).

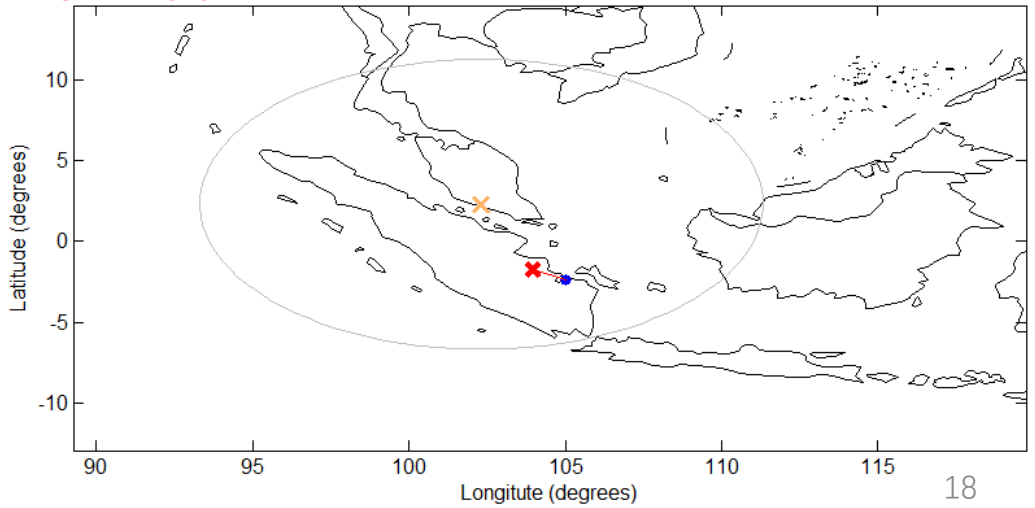
Terrestrial Gamm-ray Flashes (TGF)





Red: lighting position

Blue: Point Under the GECAM-B



Summary & Outlook

- **GECAM: a new high-energy monitor in the multi-messenger and multi-wavelength era in the early 2020s**
- **Launched in Dec 10, 2020. Currently in the commissioning phase**
- **Near Real-time alerts with typical latency of ~1 mins**
- **Detections of GRBs, SGRs, Type I bursts, Solar flares, TGFs, etc.**
- **Welcome to the joint observations and joint analysis!**

Thank you for the attention!

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