# On-orbit operation and gamma-ray burst observations with the CALET Gamma-ray Burst Monitor



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# Outlines

- Instrument and operation
- GRB observation with CGBM
- Search for EM counterparts of gravitational wave
- CGBM data archive
- Summary

### CALorimetric Electron Telescope (CALET)



CALET has been observing since October 2015.

#### CALorimeter (CAL)

Electron	1 GeV – 20 TeV
Gamma-ray	1 GeV – 10 TeV
Proton & Nucleus	10 GeV – 1000 TeV

#### **Gamma-ray Burst Monitor (CGBM)**

- Hard X-ray Monitor (HXM) x 2
- Soft Gamma-ray Monitor (SGM)

### CALET Gamma-ray Burst Monitor (CGBM)

#### Hard X-ray Monitor (HXM)

Soft Gamma-ray Monitor (SGM)



	НХМ	SGM
Crystal	LaBr <sub>3</sub> (Ce)	BGO
Number of detectors	2	1
Diameter[mm]	61	102
Thickness [mm]	12.7	76
Energy range [keV]	7-1000	40-20000
Field of view	~3sr	~8 sr

CGBM covers the energy range from 7keV to 20 MeV.

### Effective area of CGBM



- Broader energy coverage than Swift/BAT
- Sensitivity for lower energy X-ray than Fermi-GBM and BATSE

# Data collection and GRB trigger mode



Data	Channel	Time resolution
Time History (monitor)	4 ch x 2 gain (high/low)	1/8 s
Pulse Height (monitor)	102 + 410 ch (high/low)	4 s
Event data	4096 ch x 2 gain (high/low)	62.5 us

CGBM is collecting monitor data with 58 % duty cycle.

#### If CGBM detects GRBs:

Event data capture





- Reduce CAL threshold
  - 10 GeV -> 1 GeV (γ-ray)
- Optical image capture
  - Advanced stellar compass
  - 2 images

### Light curve and spectrum observed by CGBM





CGBM can measure the duration and spectral parameters of GRB.

### CGBM-GRB summary



long mean = 17.14 s short mean = 0.41s

long mean = 27.6 sshort mean = 0.46 s

long mean = 25.18 sshort mean = 0.49 s

long mean = 40.06 s short mean = 0.34 s

- Simultaneous detection
- Swift-BAT: 25
- Fermi-GBM: 87
- Fermi-LAT: 19
- KONUS-Wind: 119

### Fluence ratio vs $T_{90}$



The distribution observed by CGBM is consistent with that of BATSE.

# Distribution of spectral parameters



- CGBM distribution is consistent with others.
- CGBM observe only hard bursts ( $E_{peak} > 100$  keV). Hard bursts tend to be brighter than soft bursts.

# Search for EM counterparts of GW

# CGBM was observing when 6 / 11 gravitational wave triggers occurred.

Event	UTC TIME	CGBM observation
GW150914	09:50:45.4	Before observation
GW151012	09:54:43.4	HV off
GW151226	03:38:53.6	No signal (upper limit) O.Adriani et al. 2016
GW170104	10:11:58.6	HV off
GW170608	02:01:16.5	HV off
GW170729	18:56:29.3	HV off
GW170809	08:28:21.8	No signal
GW170814	10:30:43.5	No signal
GW170817	12:41:04.4	No signal (upper limit) Abbott et al. 2017
GW170818	02:25:09.1	HV off
GW170823	13:13:58.5	No signal

Abbott et al. submitted



CGBM counts rate

Time [s] since 08/17/17 12:41:04.4

#### We will continue to search for EM counterparts during O3.

# CGBM data archive and web-tool

• CGBM monitor data has been publicly available from DARTS/ISAS since May 2018.

### http://darts.isas.jaxa.jp/astro/calet/

Bin Size Bin Size 1 sec	\$
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beletion and thereby range for tightcurve z	
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0-1000 keV    Energy Range  7-100 keV	0
Display Light Curve Get Permalink	
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0 2'5 50 75 100 13'5 150 13'5 200 22'5 2'0 25'5 time since 2016/06/25122:40.15.49 (s)	
o 25 50 75 100 125 150 175 200 225 250 275 time since 2016/06/23122-40-15.49 (s)	
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CGBM light curves are available via the CGBM web tool.

http://darts.isas.jaxa.jp/astro/ca let/cgbmweb/LCViewer.html

We are planning to release full CGBM data from HEASARC.

- Event data
- Monitor data
- Response files

# Summary

- CALET has been observing since October 2015.
- CGBM is collecting monitor data with 58% duty cycle.
- If GRBs are detected, event data are captured.
- CGBM has detected 147 GRBs (long:131 short:16)
  - Detection rate: 42.4 GRBs / year
- GRB observations with CGBM are consistent with other observations.
- CGBM were observing when 6 gravitational triggers occurred.
  - There was no significant signal around the gravitational wave triggers.
- CGBM archive data are publicly available via DARTS.
  - We are planning to release the full data via HEASARC.

# Backup

### Discussion: the trend of short duration



Discussion: no soft GRBs

