



Fermi

Gamma-ray Space Telescope

Fermi GBM Status, Results, & Plans

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Fermi Users Group Meeting

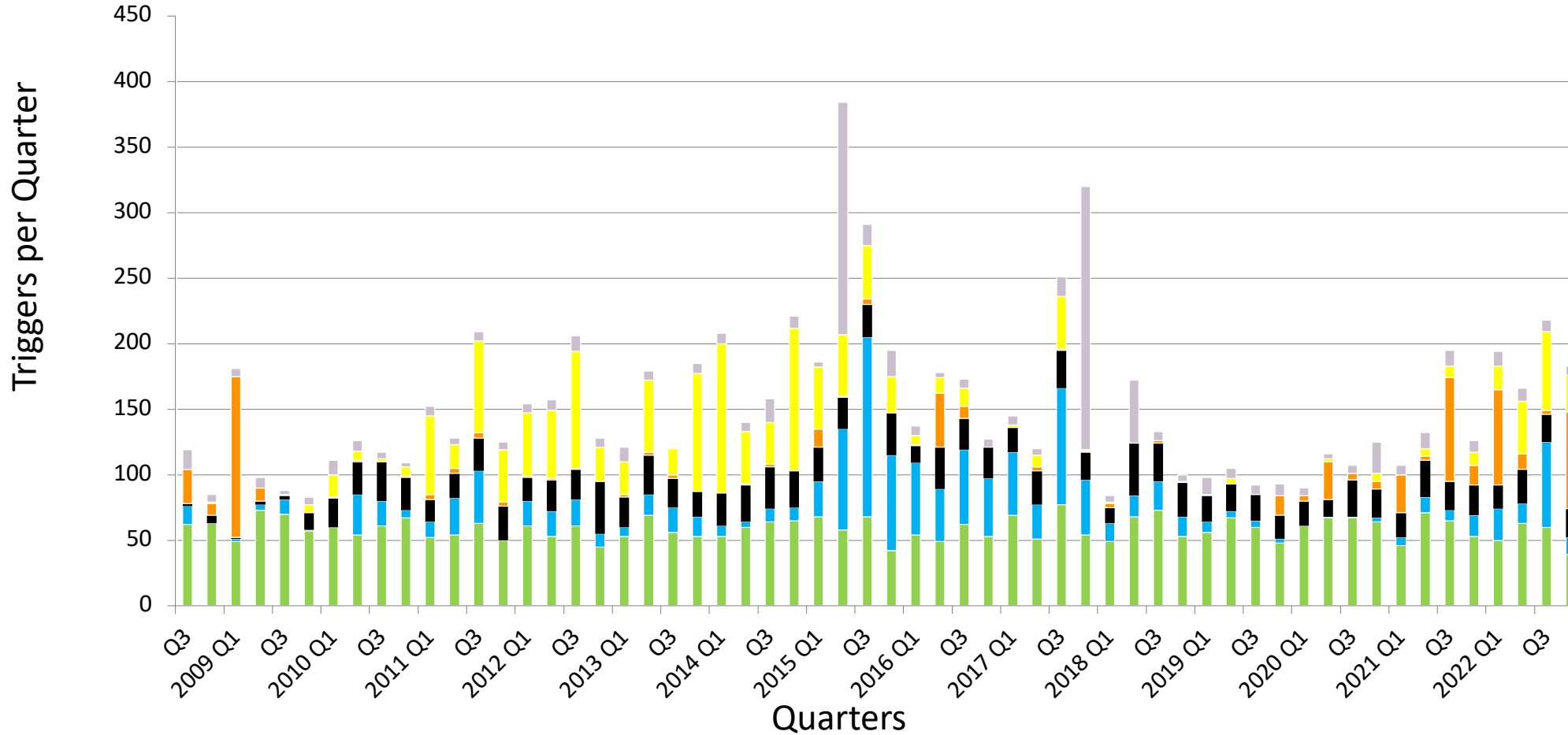
December 14, 2022

Outline

- Trigger History
- Operational Updates
- Progress on Senior Review Objectives
- Science Highlights

GBM Trigger History

GRBs Particles TGFs SGRs Solar Flares Other

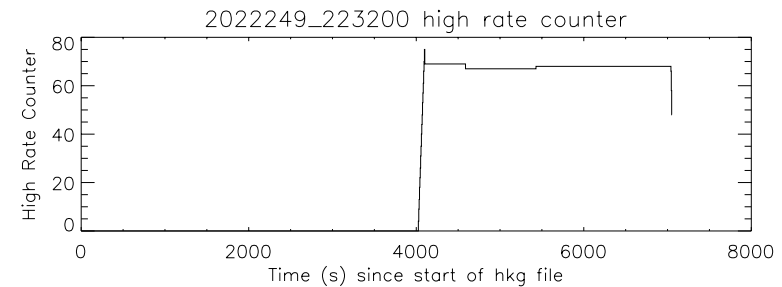
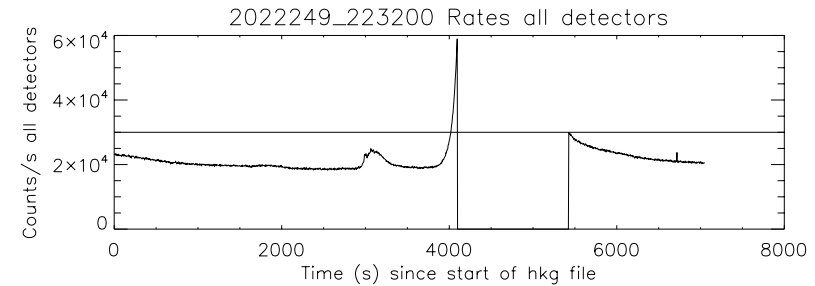
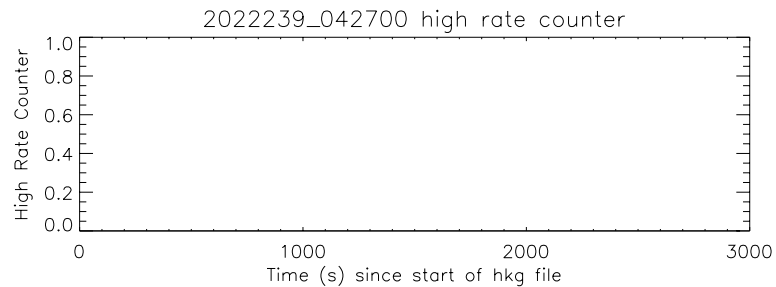
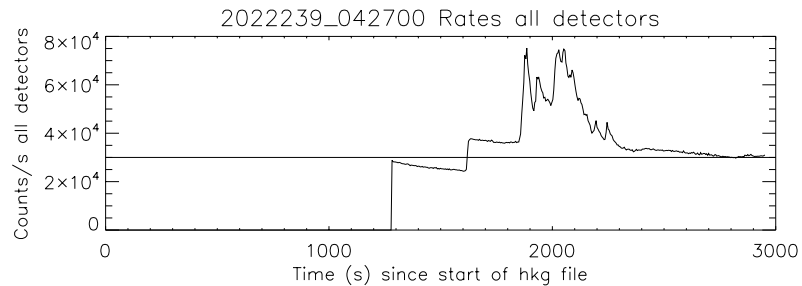


As of Dec 6, 2022:
8845 Triggers
3412 GRBs
1291 Particles/SAA
1268 TGFs
620 SGRs
1361 Solar Flares
886 Other

GBM CTTE Throttling Issue

Throttling counter not advancing Aug 27, 2022.
CTTE data was turned off from Aug 30-Sep 6, 2022.

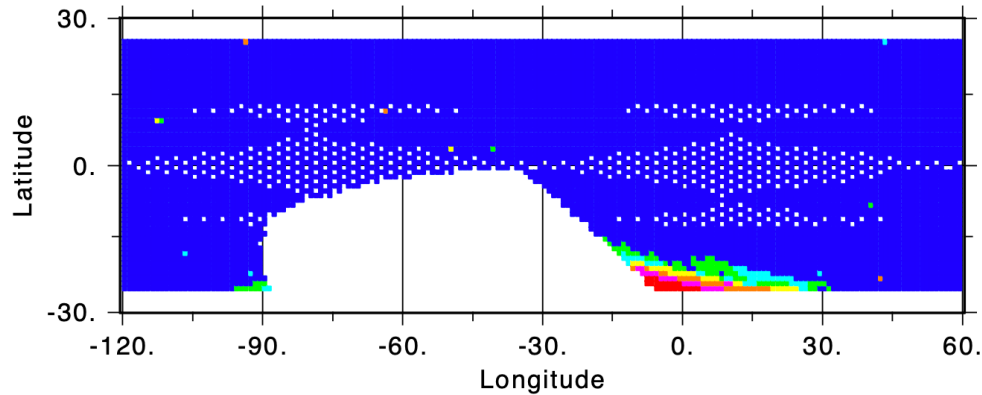
After TTE was turned back on, counter began advancing as expected.



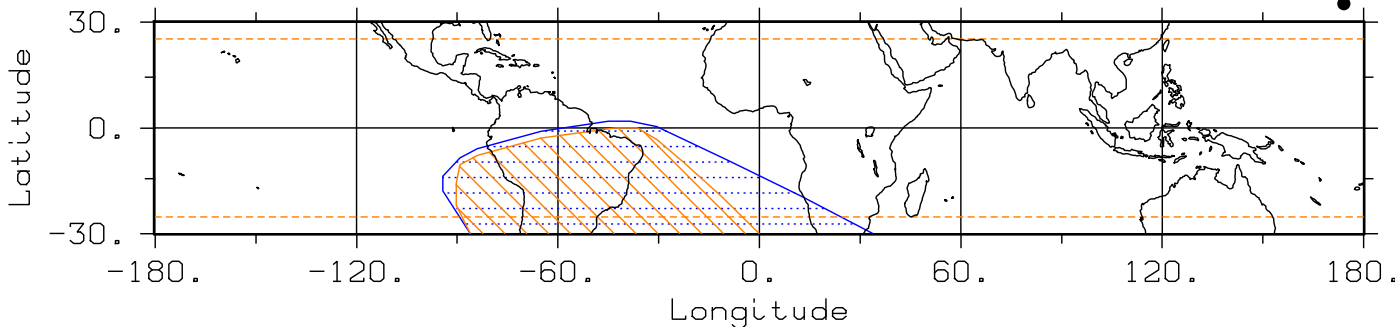
The counter advances as expected after TTE was turned back on. The GBM team will continue to monitor this and has given the FOT the instructions to reset TTE if the recorder starts rapidly filling again. The reason the counter stopped counting is still under investigation.

GBM SAA Study

Maximum Rate



Comparison between current (blue) and test (red) SAA regions



- SAA experiment data from Aug 3-Aug 11, 2022
 - Rates in 4 NaI detectors
 - Peak rates (red) reach >100,00 cps
- GBM FSW update
 - Add ground commands to enable SAA-like mode for the brightly colored regions
 - Ground SAA commands will set a flag that will OR with current SAA flag.
 - Times for ground SAA commands will be calculated using orbit predicts and put into ATS loads
- New SAA with concave region results in an increase in livetime from ~87% to ~90%.
- Note that GRB 170817A was 2 minutes before SAA entry

GBM Progress on Senior Review Initiatives

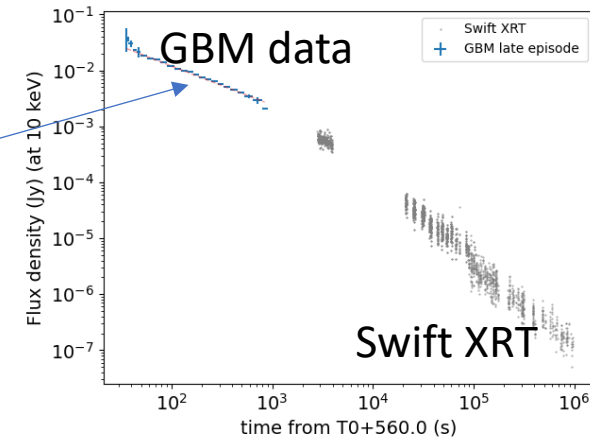
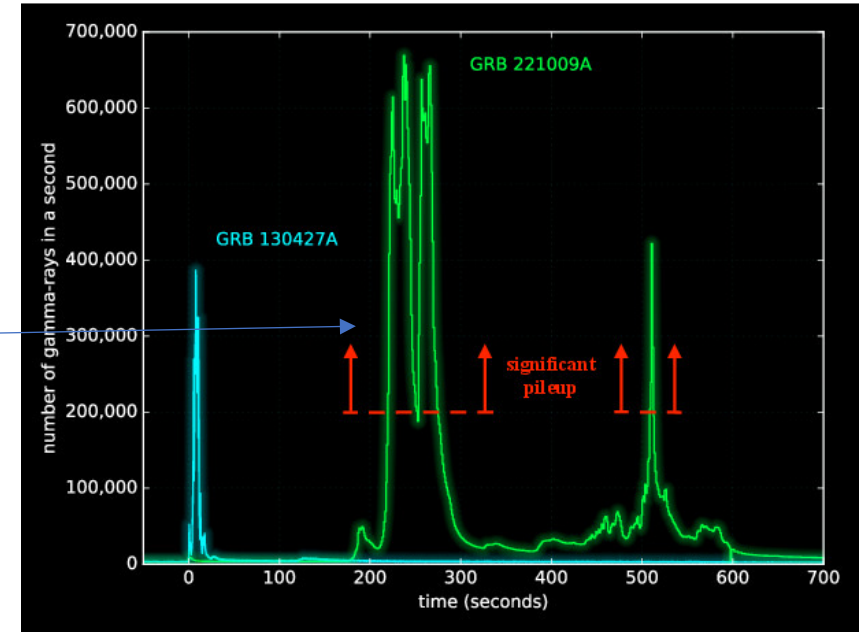
- Update alert technology & automate targeted search
 - Receiving kafka alerts through new GCN since Oct 2022.
 - Currently measuring alert latency/stability ahead of O4
 - Implementing kafka producer to automatically send GBM Targeted search candidates to LVK using new GCN system
 - Working to get private alert stream from LVK via new kafka system
- Extend the targeted search to search for FRB counterparts in the alerts stream from CHIME
 - Atel #15794 Younes et al. 2022, GBM detection of a faint magnetar-like burst temporally coincident with a CHIME/FRB radio burst
- GRB neutrinos
 - Continue to monitor neutrino events with GBM targeted search
 - Recent joint paper with Ice Cube (Abbasi et al. 2022, ApJ, 939, 116)
<https://iopscience.iop.org/article/10.3847/1538-4357/ac9785>
 - Includes updated GBM localizations back to 2008 <https://zenodo.org/record/6727152#.Y5idwC-B1pQ>
- GBM Data Tools
 - Finalizing transition to Gamma-ray Data Tools, generalized toolkit
 - Exploring options to host publicly to allow community contributions

O4 Updates

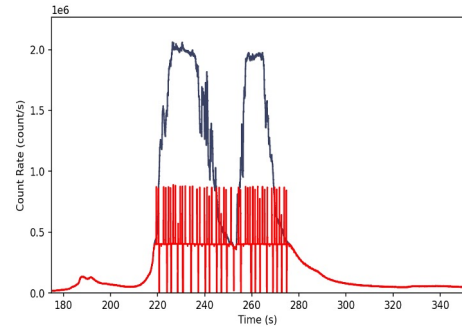
- Improved handling of edge cases near SAA
- Updated localization systematic as part of O3 follow-up paper
- Atmospheric scattering templates for angles outside Fermi's typical rocking profile (130 +/- 5 deg wrt geocenter)
 - Reduces large systematic for 30% of events that currently lack atmospheric scattering templates

GRB 221009A: Brightest of All Time

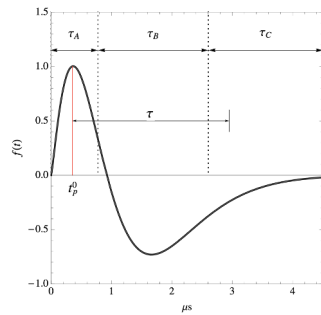
- Brighter than the previous record holder
- Pileup problem
- GBM can constrain
 - Peak energy -> where the bulk of the energy was emitted
 - Timescale of variations (0.1 s)
 - Total energy (if isotropic $\sim M_{\text{SUN}} c^2$)
 - Lorentz factor – outflow speed
 - Detailed spectra – emission mechanism
 - Afterglow – typically detected by pointed X-ray instruments. GBM observes it for ~ 1000 s



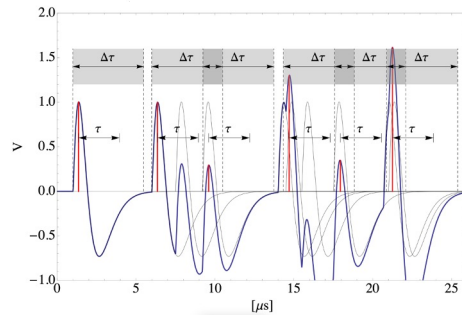
GRB 221009A – Pulse Pileup Correction



TTE and CSPEC data are saturated (severe pulse pile-up)



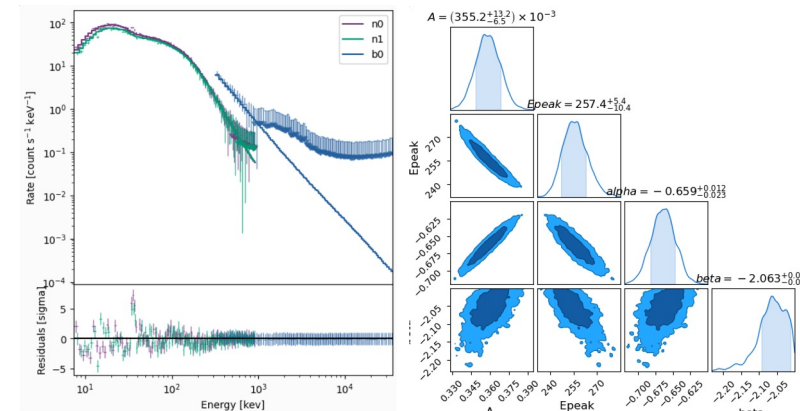
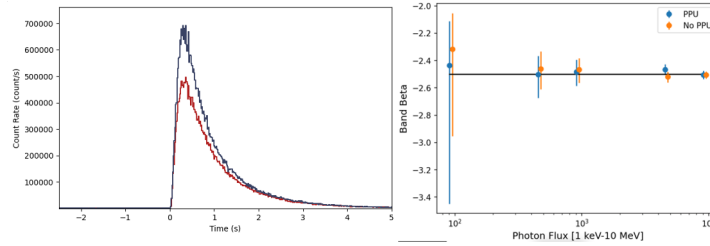
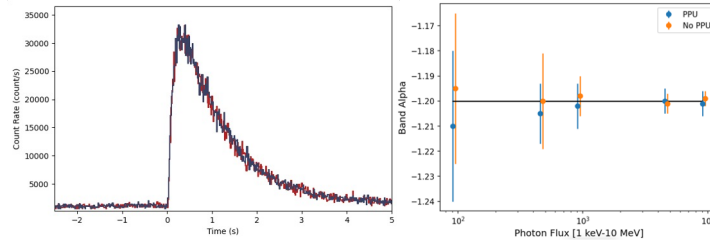
A single data pulse



A realistic picture of PPU

Pulse Pile-up (PPU) means:

- A decrease in count rate
- An increase in energy



PPU corrected lightcurves and spectra for simulated data (PPU not needed = top) (PPU needed = bottom)

PPU fits match original input (90% confidence)

2 independent methods will be used for data recovery

(Non-linear least squares reduction = left) (Markov chain Monte Carlo - MCMC = right)

PPU corrections have been successful for TGF analysis

Summary

- GBM continues to operate nominally
- A GBM FSW update will allow a concave SAA region via pre-computed ground commands to increase GBM's livetime from ~87% to ~90%.
- The GBM team is making good progress on GBM-related technical initiatives
- GBM is implementing improvements in atmospheric scattering response to reduce systematic errors for LVK O4
- On October 9, 2022, GBM detected the brightest GRB of the mission
 - Pulse pile-up modeling is in work to enable analysis of saturated intervals