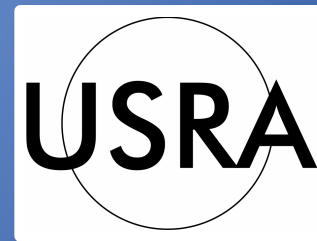
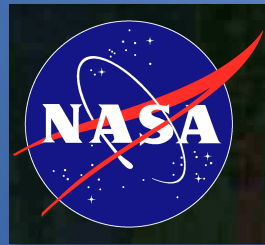


# Fermi/GBM Spectral & Temporal Analysis of SGR J1550-5418 Bursts During its Extreme Activation in January 2009

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Universities Space Research Association

NASA / Marshall Space Flight Center

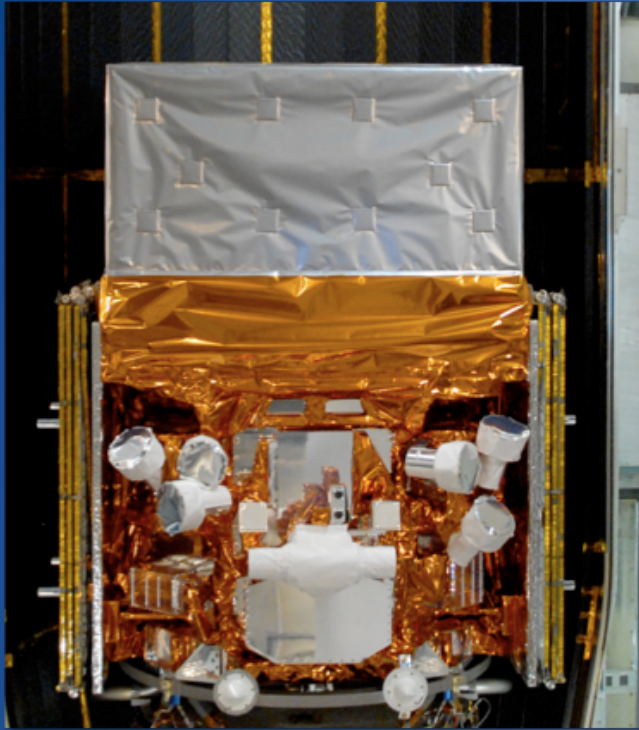


Thanks to:

Chryssa Kouveliotou, Yuki Kaneko,  
Ersin Gogus, Lin Lin, Nicholas Gorgone

On behalf of the GBM Magnetar Team

# Fermi GBM & Magnetar Bursts

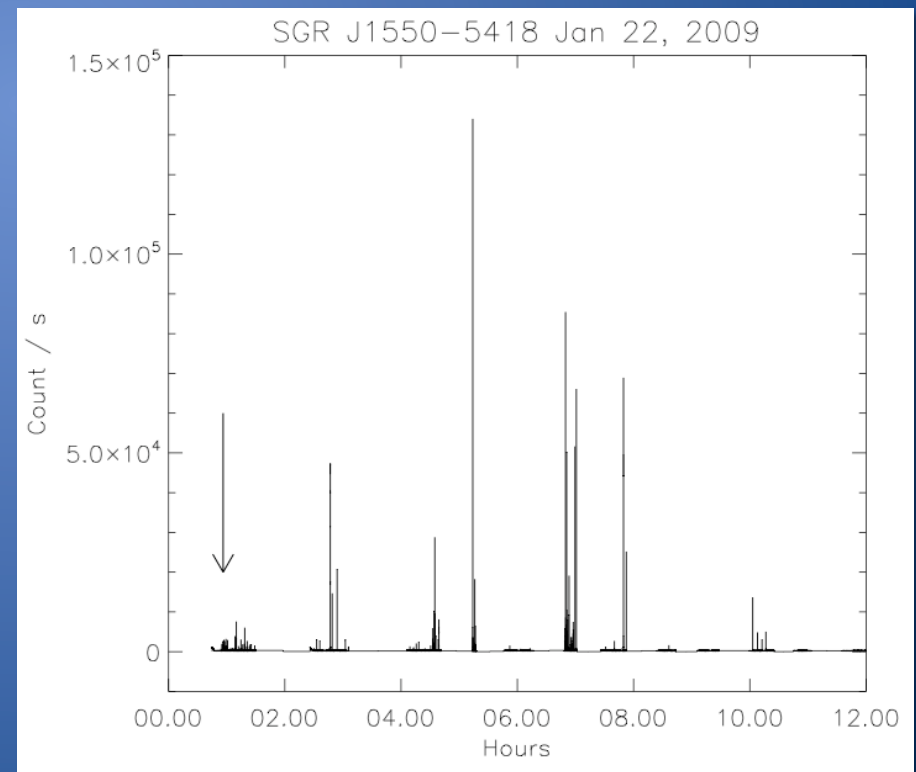
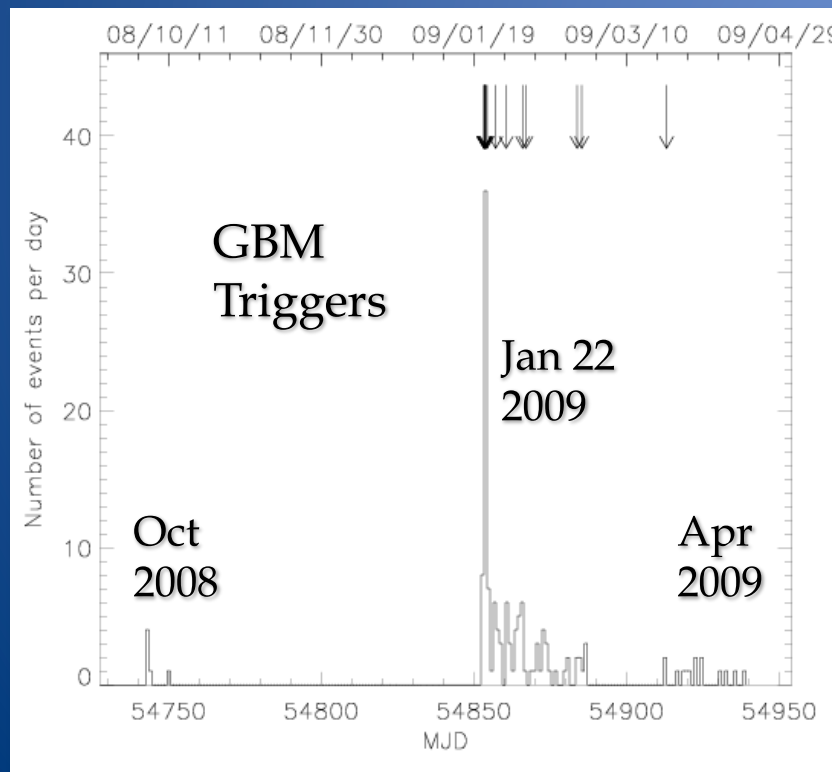


- Entire un-occulted sky
- 8 keV – 40 MeV
- Untriggered burst search in CTIME data
- Spectral & temporal analysis with Time Tagged Event data
- Spectral analysis in RMFIT

SGR Source	Active Period	Triggers	Comments
J0501+4516	Aug/Sep 2008	26	New source at Perseus arm
1806-20	Nov 2008	1	Old source - reactivation
J1550-5418	Oct 2008 Jan/Feb 2009 Mar/ Apr 2009	7 117 14	Known source – first burst active episodes
J0418+5729	June 2009	2	New source at Perseus arm

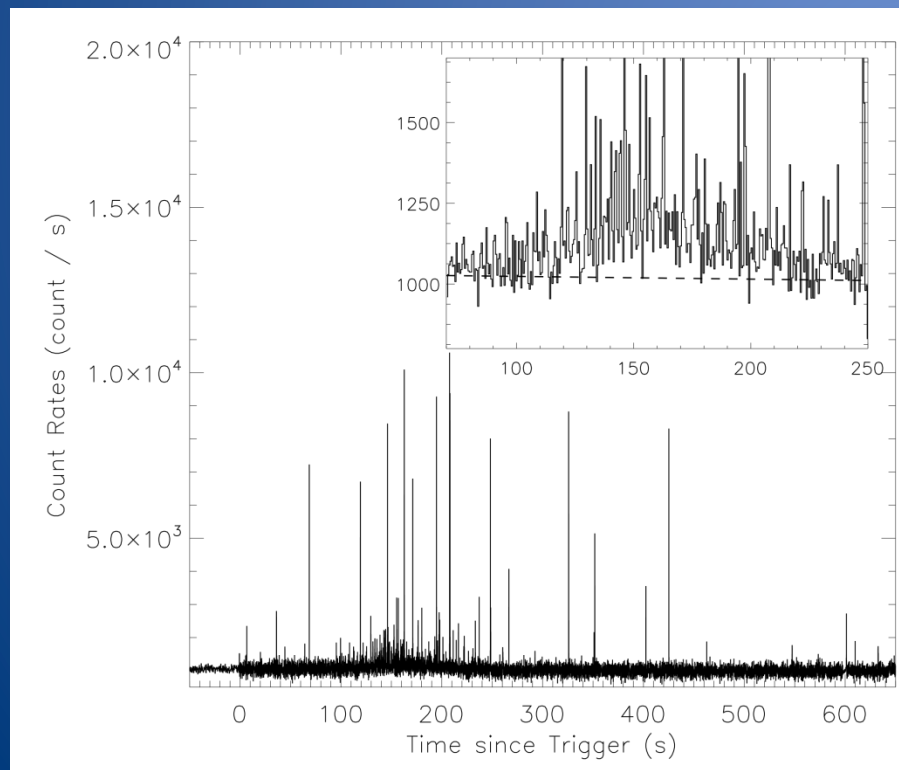
# SGR J1550-5418

- SGR J1550-5418 = AXP 1E1547.0-5408
- ASCA, XMM-Newton: magnetar candidate
- Radio:  $P = 2.07$  s,  $\dot{P} = 2.3 \times 10^{-11}$  s/s,  $B = 2.2 \times 10^{14}$  G
- Fastest rotating magnetar; only 3 radio magnetars



# Enhanced Persistent Emission

- First GBM trigger on January 22, 2009
- Energy dependent pulsations at spin period
- No pulsations after enhancement ( $\sim 150$  s)
- Spectrum: power law (-2.1) + black body (17 keV)

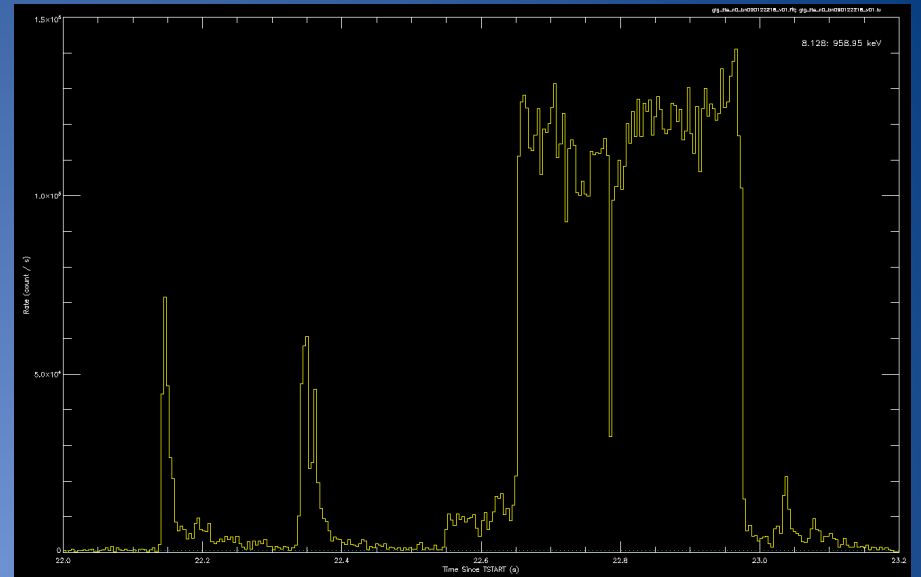
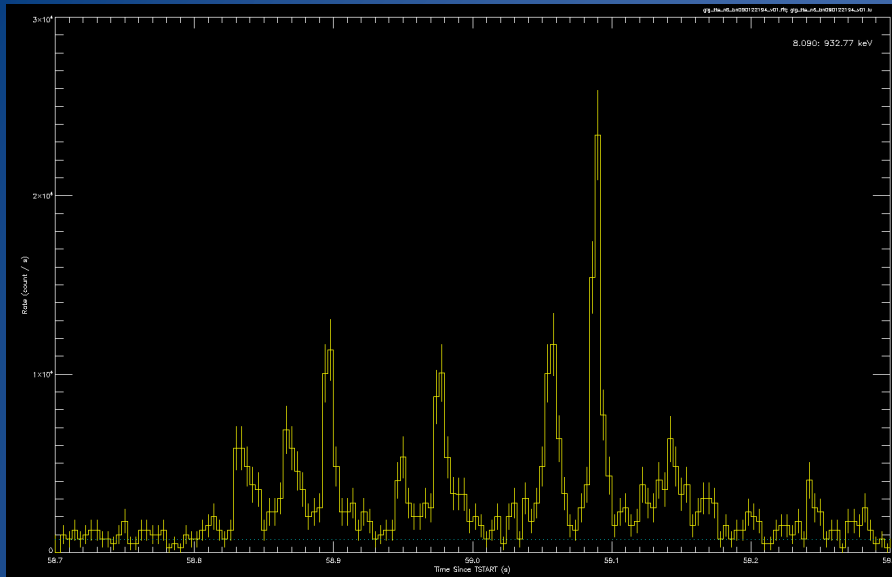


- Energy  $\sim 2.9 \times 10^{40}$  erg (assuming 5 kpc distance)
- Smallest ( $\sim 120$  m) hot spot for any magnetar
- Small trapped fireball in severely twisted B-field

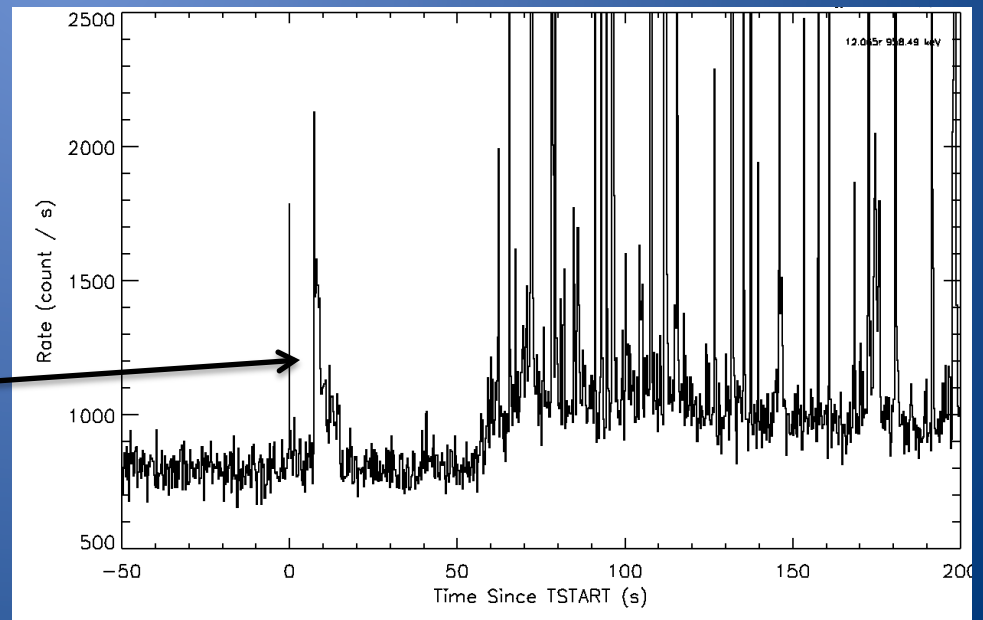
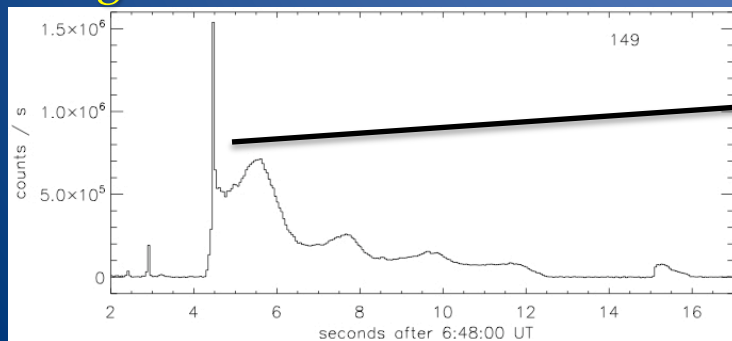
Kaneko et al. 2010



# Many Bright Bursts in GBM



## Integral SPI-ACS



# Spectral & Temporal Analysis

Large sample:

- 291 bursts in total
- 90 single, unsaturated bursts
- 179 multi-peaked, unsaturated bursts
- 22 saturated bursts

Photon models:

- Power law
- Black body
- Optically Thin Thermal Bremsstrahlung
- Power law with exponential cut-off (Comptonized)
- Power law + black body
- Black body + Black body

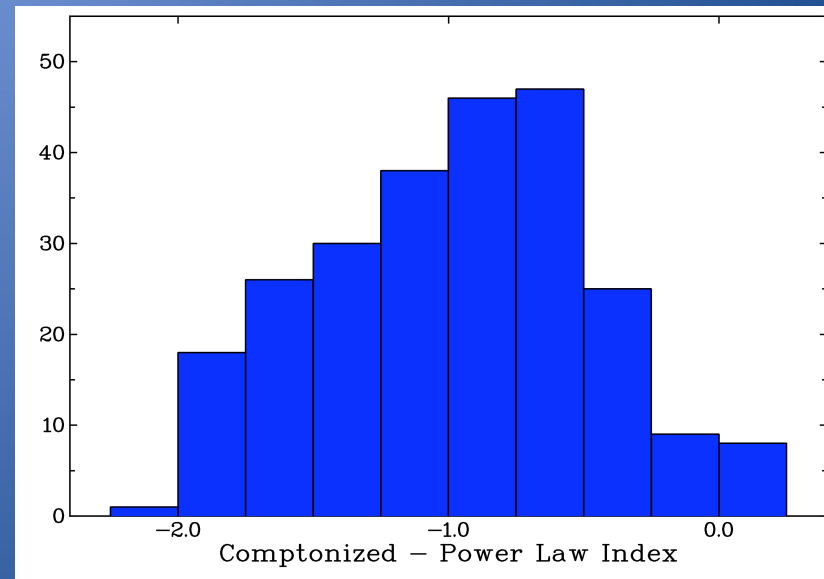
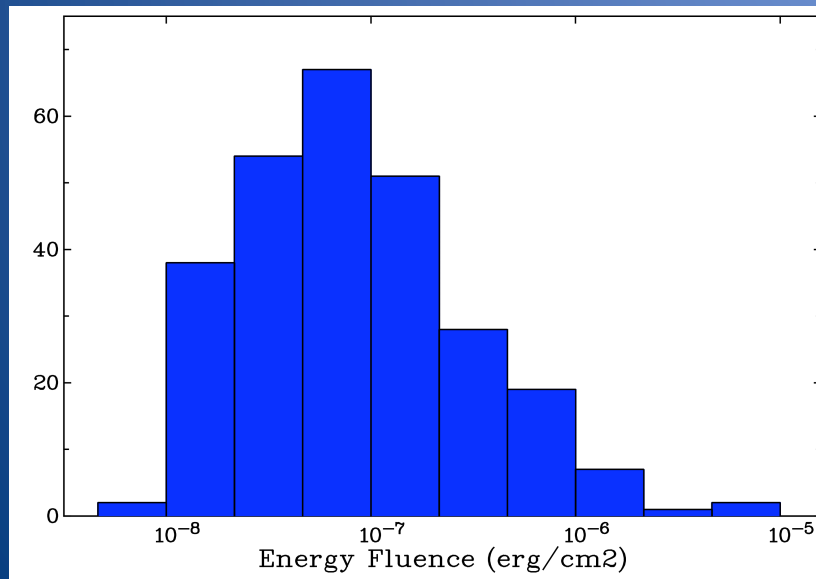
# Time-Integrated Spectra

Best spectral fits:

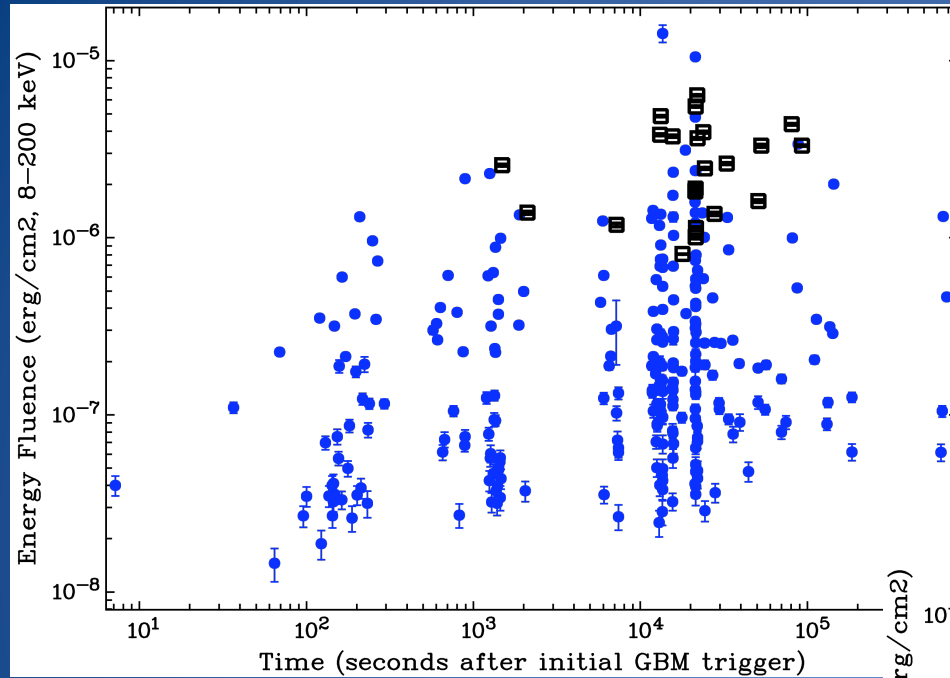
- Optically Thin Thermal Bremsstrahlung
- Comptonized with index  $\sim -1$

Brightest bursts:

- Two black body functions frequently preferred ( $\sim 5$  and  $\sim 20$  keV)

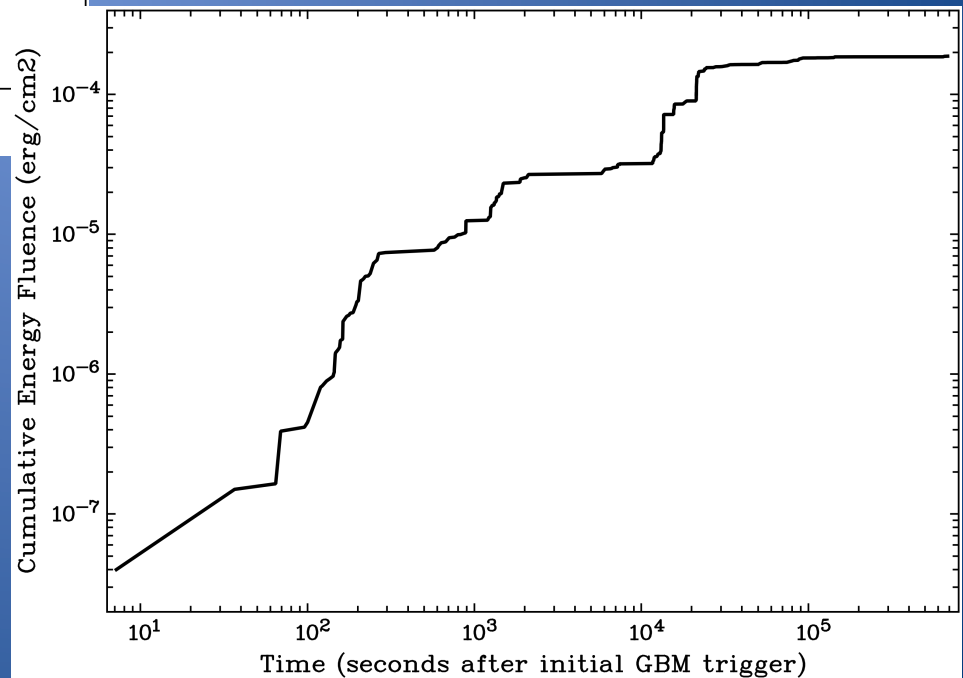


# Energetics



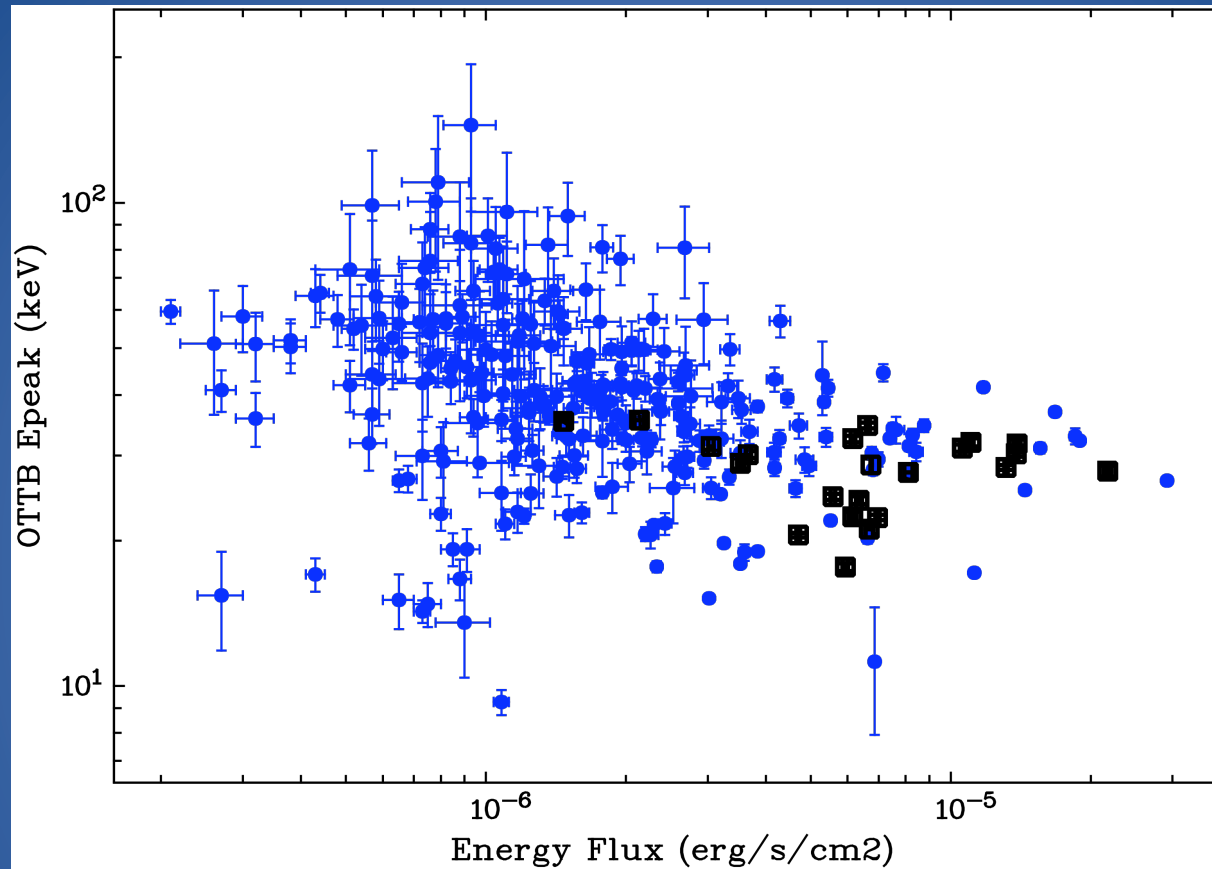
Burst luminosities  
<  $\sim 10^{41}$  erg

Total fluence  
>  $1.9 \times 10^{-4}$  erg/cm<sup>2</sup>  
Cumulative energy  
>  $5.7 \times 10^{41}$  erg



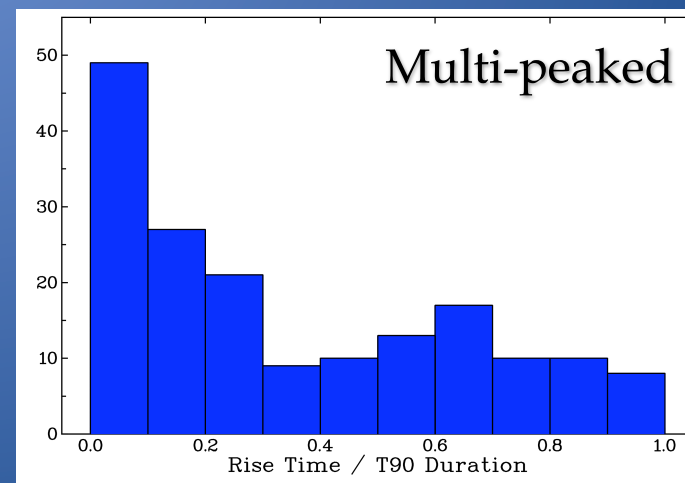
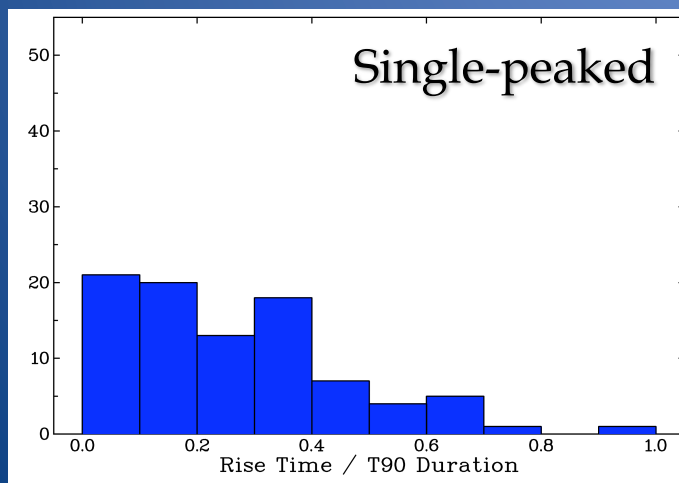
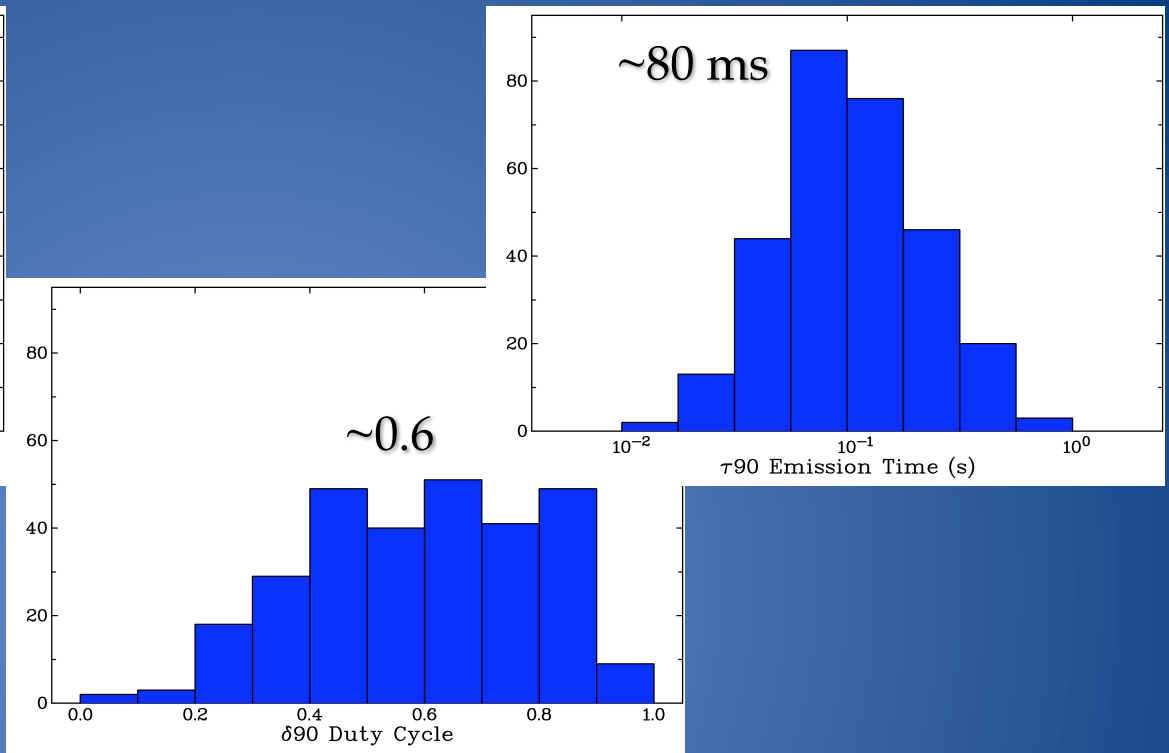
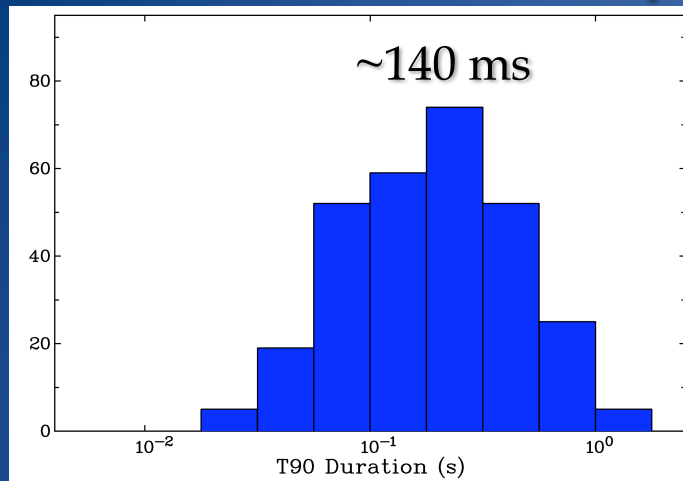


# Hardness vs Flux

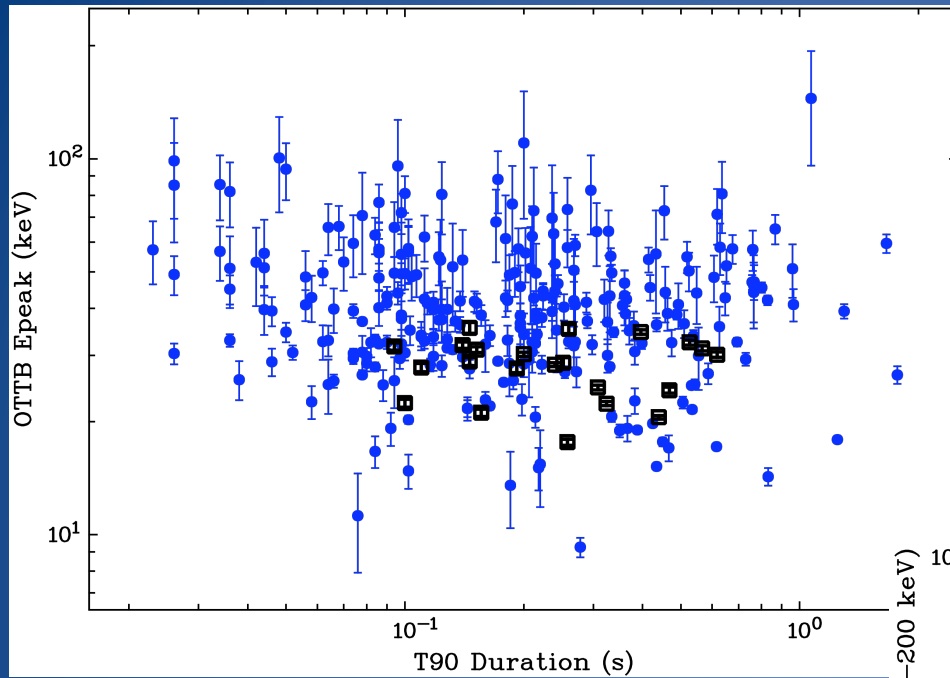


Anti-correlation of Hardness & Flux:  
Typical for SGRs, not for AXPs (?)  
(SGR 1806-20, SGR 1900+14, AXP 1E2259+586,  
Gogus et al. 2001, Gavriil et al. 2004, Gotz et al. 2006)

# Temporal Parameters

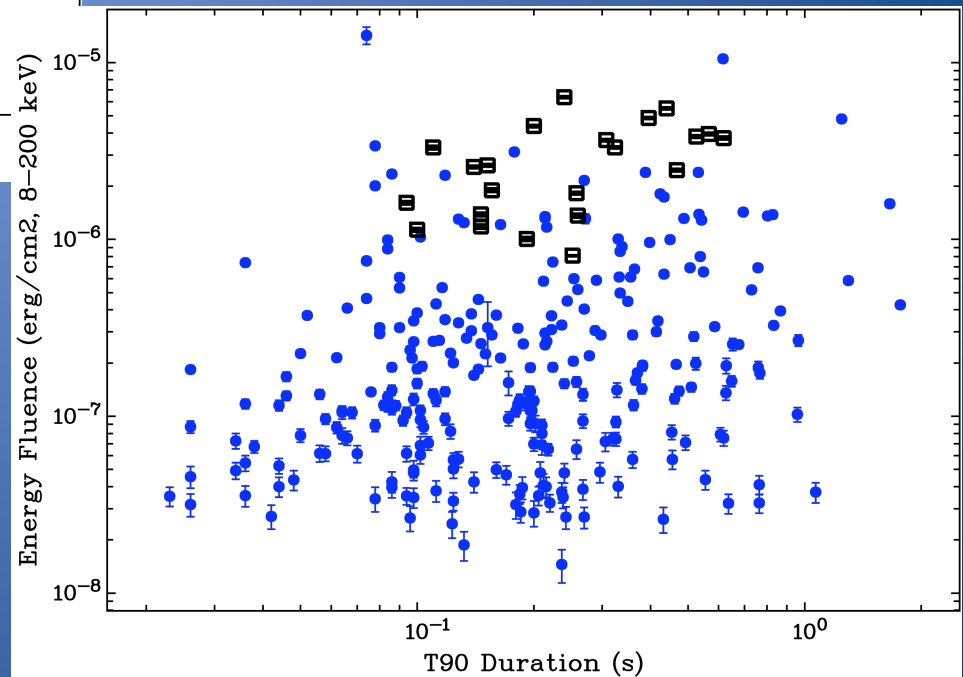


# Correlations?



No correlation of  
Hardness & T90:  
Typical for SGRs & AXPs  
(Gogus et al. 2001,  
Gavriil et al. 2004)

No correlation of  
Fluence & T90?



# Conclusions & Outlook

- Fermi GBM: very well suited for SGR burst studies
- Extreme bursting activity of SGR J1550-5418
- Detailed spectral & temporal analysis:
  - Cumulative energy in 1 day  $> 6 \times 10^{41}$  erg (at 5 kpc)
  - Tested several spectral models: OTTB or BB+BB preferred
  - Typical temporal parameters:  $T_{90} \sim 144$  ms
  - Anti-correlations: Hardness & Flux
  - No correlations: Hardness &  $T_{90}$ , Fluence &  $T_{90}$
- Ongoing efforts:
  - Time-resolved spectroscopy
  - Comparison with other activity periods and other SGRs
  - Broadband spectral analysis with other instruments