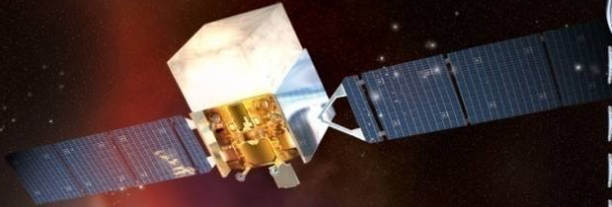




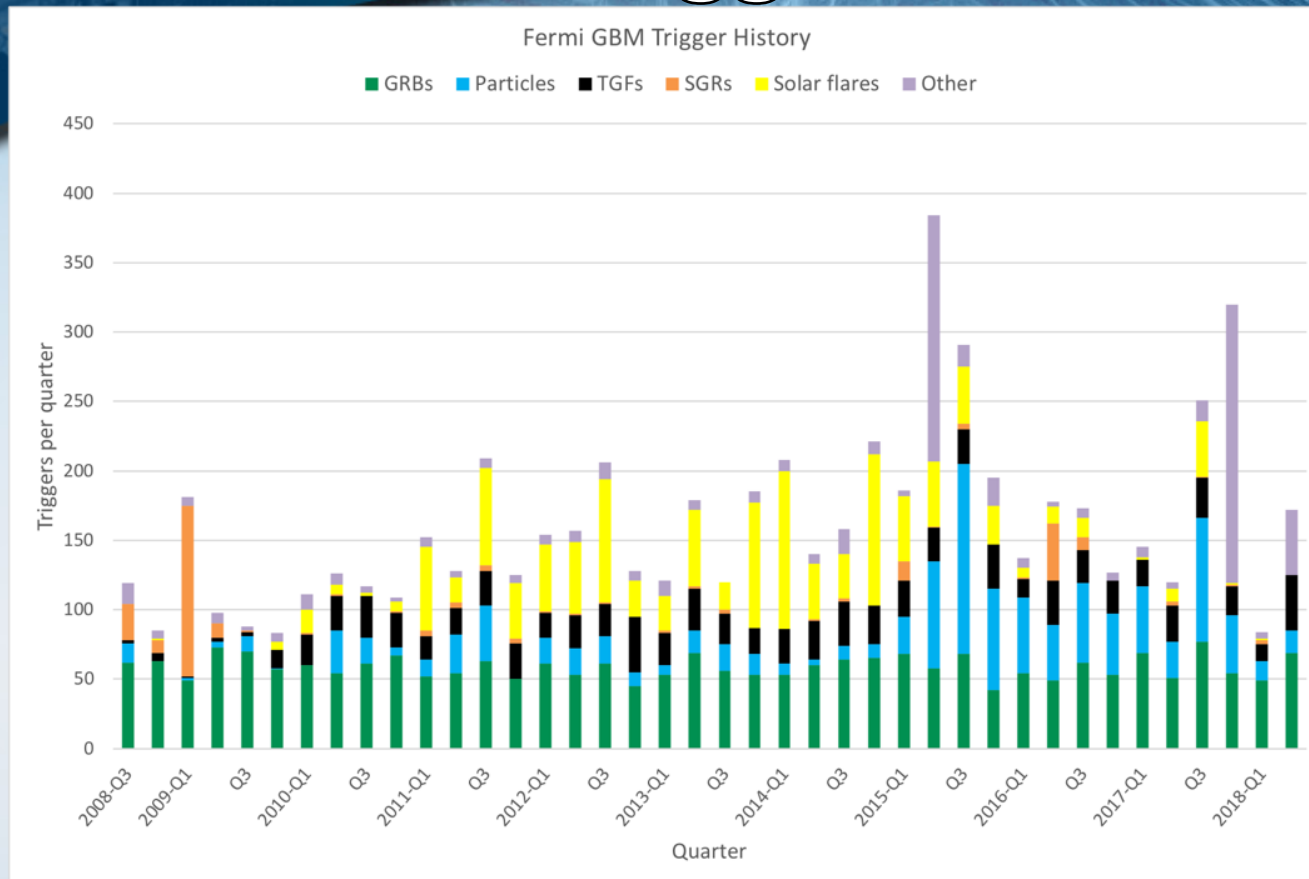
# Fermi Gamma-ray Space Telescope



## **Fermi GBM Status, Results, Plans** **Colleen Wilson-Hodge** **GBM PI, NASA/MSFC**

Fermi Users Group  
30 July 2018

# GBM Trigger Rate



- 6505 triggers as of July 22, 2018
- **Gamma-ray bursts (GRBs): 2377**
- **Soft gamma repeaters (SGRs) aka magnetars: 280 (from 6 sources)**
- **Terrestrial gamma flashes (TGFs): 879 triggered, ~5x more untriggered**
- **Solar Flares: 1177**
- **Particles: 1072**
- **Others (galactic XRBs, accidental, uncertain): 720 (189: Swift J0243.6+6124, 169: V404 Cygni)**
- 214 positive Autonomous Report Recommendations (Currently disabled)

2018

- GBM 10 yr GRB trigger + spectral catalogs (in prep)
- GBM 10 yr Accreting Pulsar compendium (in prep)
  
- GBM 8 yr TGF catalog (Roberts et al. 2018)
- GBM 6 yr trigger catalog (3FGBM) (Bhat et al. 2016)
- GBM 5 yr magnetar catalog (Collazi et al 2015)
  
- GBM 4 yr time-resolved spectral catalog (Yu et al. 2016)
- GBM 4 yr GRB spectral catalog (Gruber et al. 2014)
- GBM 4 yr trigger catalog (2FGBM) (von Kienlin et. al 2014)
  
- GBM 3 yr X-ray burst catalog (Jenke et al. 2016)
- GBM 3 yr Earth occultation catalog (Wilson-Hodge et al. 2012)
  
- GBM 2 yr GRB spectral catalog (Goldstein et al. 2012)
- GBM 2 yr GRB trigger catalog (Paciesas et al. 2012)

2008

- Hourly CTTE data
  - Now available from Nov 26, 2012-present at the FSSC
  - Removes timing glitches and improves latency for ground searches
  - Convenient: simpler to predict which file contains an event
- On-ground trigger classification
  - Testing a version of the FSW trigger classification using improved ground automated localizations, which we plan to implement prior to senior review
  - Preliminary results show that the improvement in localization (error) may be making the algorithm overconfident in classification
  - Investigating recalibrating the code and/or including a localization systematic prior
- GSPEC – modern replacement for Rmfit with backend to XSPEC
  - V0.9 release planned for Fall 2018
  - Part of a larger API that will allow users to write their own scripts to do automated batch processes

# GSPEC Demo

- Testing changes to the targeted search to make it both more sensitive and faster.
  - Preliminary results show the changes are improvements over O2 version
- Working with LVC to implement, in one of their pipelines, a way to read in and combine GBM sky localizations w/ LVC localizations and send out improved sky maps via GCN
- Testing the FSW source classifier on sub-threshold candidates that are confirmed SGRBs from other instruments – positive results
- Using simulated signals, we are assessing the sensitivity dependence of the untargeted search on fluence and spectral shape.

# Invited GBM/GRB talks (1)

- Invited talks on GBM/GRB/GW since Oct/Nov 2017

- Elisabetta Bissaldi (10)

- 3 Nov 2017: INFN Seminar, Univ of Bari, Italy
- 7 Dec 2017: INFN Seminar, Univ of Trieste, Italy
- 13 Dec 2017: 10 years of AGILE Workshop, Rome, Italy
- 29 Jan 2018: Clues on GRB Origin from Chemical Evolution Models, Sexten, Italy
- 15 Mar 2018: 10 years LAT Workshop, Pisa, Italy
- 23 Mar 2018: 23<sup>rd</sup> APP Symposium, Driebergen, Netherlands
- 24 May 2018 Vulcano Workshop 2018, Vulcano, Italy
- 11 Jun 2018 10 years Fermi Celebration, ASI, Rome, Italy
- Rencontres du Vietnam 2018, Qui Nhon, Vietnam
- 11 Sep 2018 Neutrino Oscillation Workshop 2018, Ostuni, Italy

- Michael Briggs (2 + 1 TGF)

- Oct 2017, INTEGRAL Symposium, Venice, Italy
- Feb 2018, Transient Universe, Singapore, 2018

- Eric Burns (5)

- Oct 2017, 7<sup>th</sup> Fermi Symposium, Garmish-Partenkirchen, Germany
- Apr 2018, April APS Meeting, Columbus, OH
- Aug 2018, Very High Phenomena in the Universe, Quy Nhon, Vietnam
- Aug 2018, TeVPA 2018, Berlin, Germany
- Nov 2018, 2018 Annual Meeting of the Mid-Atlantic Section of the APS, College Park, MD (passed)

- Tito Dal Canon (1)

- Sep 2018, PIC201 Symposium, Bogota, Columbia

- Adam Goldstein (3)

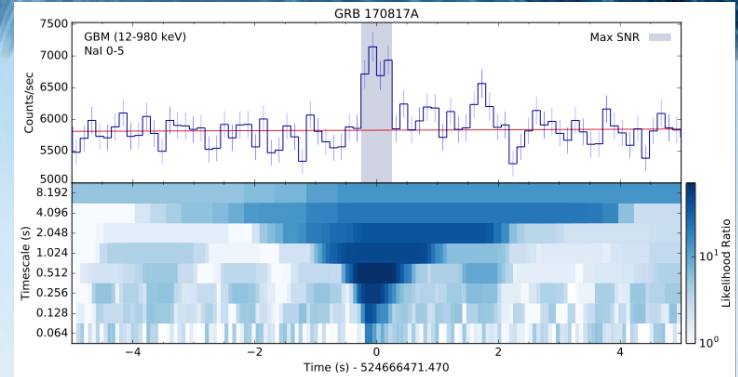
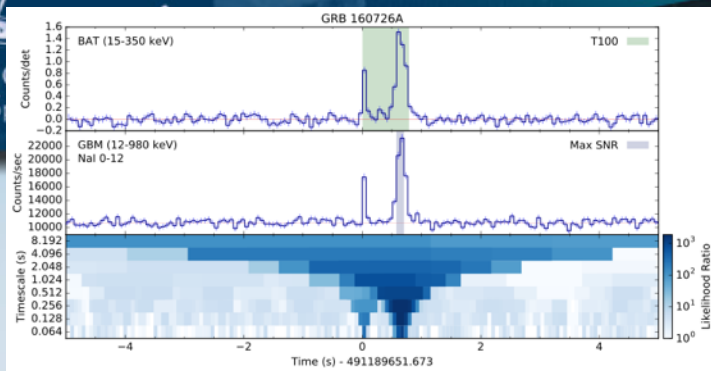
- Dec 2017, A Decade of AGILE, Rome, Italy
- Jan 2018, 231<sup>st</sup> AAS, National Harbor, MD
- Jul 2018, COSPAR, Pasadena, CA

# Invited GBM/GRB/GW talks (2)

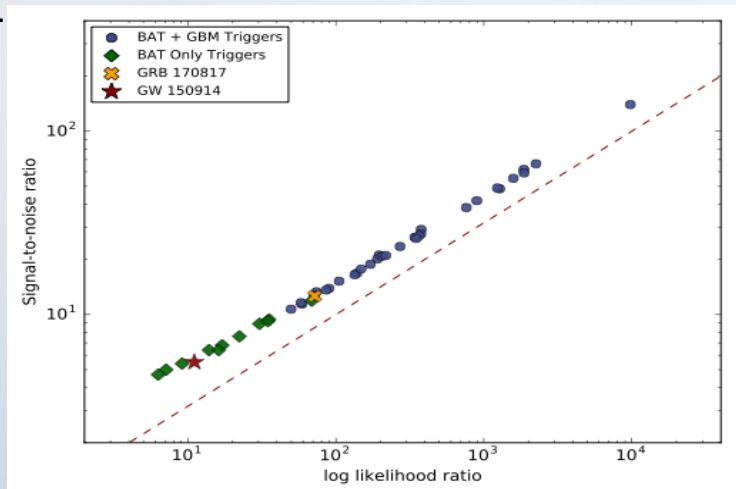
- Invited talks on GBM/GRB/GW since Oct 2017
- Dan Kocevski (1)
  - Nov 2017 Colby College, Waterville, ME
- Tyson Littenberg (1)
  - Jan 2018 231<sup>st</sup> AAS, National Harbor, MD
- Rob Preece (1)
  - Jul 2018, 15<sup>th</sup> Marcell Grossman Meeting, Rome, Italy
- Judy Racusin (2)
  - Apr 2018 EWASS, Liverpool, UK
  - Jul 2018 COSPAR, Pasedena, CA
- Peter Veres (5)
  - Oct 2017, Columbia Univ. Rapid Response Workshop
  - Oct 2017, IAU Symposium Gravitational Wave Astrophysics, Baton Rouge, LA
  - Dec 2017, GW170817: The First Double Neutron Star Merger, Santa Barbara, CA
  - Feb 2018, Physics and Astrophysics at the Extreme, State College, PA
  - Jun 2018, CIPANP18, Palm Springs, CA (couldn't attend)
- Andreas von Kienlin (1)
  - May 2018 Mondello 2018 Workshop, Palermo, Italy
- Colleen Wilson-Hodge (6)
  - May 2018, Pass the Torch, Huntsville, AL
  - April 2018, HEAD 2020 discussion panelist, Chicago, IL
  - June 2018, 3<sup>rd</sup> Panda Symposium, Chengdu, China (couldn't attend)
  - Aug 2018, IAU XXX, Vienna, Austria
  - Nov 2018, Seminar, Texas Tech, Lubbock, TX
  - Jan 2019, Rossi Prize talk, 233<sup>rd</sup> AAS, Seattle, WA



# An Analysis of Subthreshold SGRBs in GBM Data

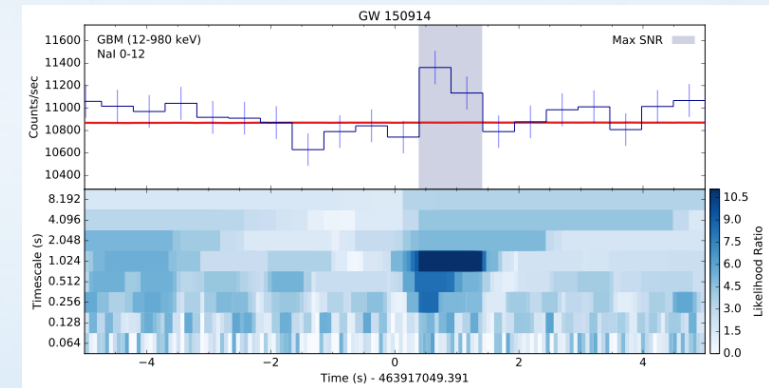


Kocevski et al. 2018 completed a study of the sensitivity of the offline targeted search of CTTE data using a control sample of sGRBs detected by Swift that were also in the GBM FOV. The sample included 33 SGRBs triggered both BAT & GBM and 11 SGRBs triggered only BAT.



The analysis shows that the volume of the Universe in which GRB 170817A could be detected by the targeted search can be increased by a factor of 5. SGRBs with SNR  $\sim 10$  are no longer detected onboard. The targeted search recovers them down to SNR  $\sim 4-5$ .

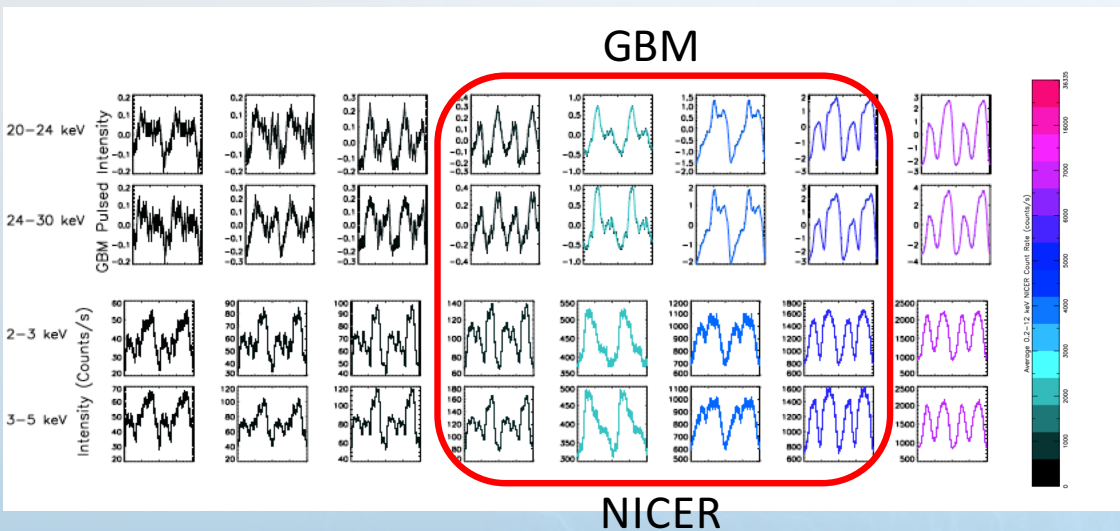
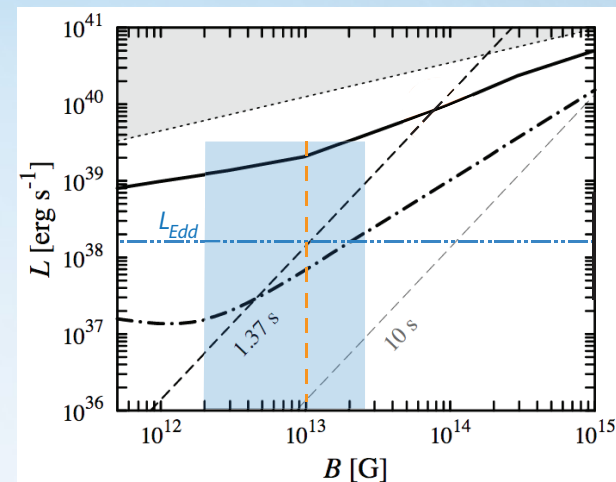
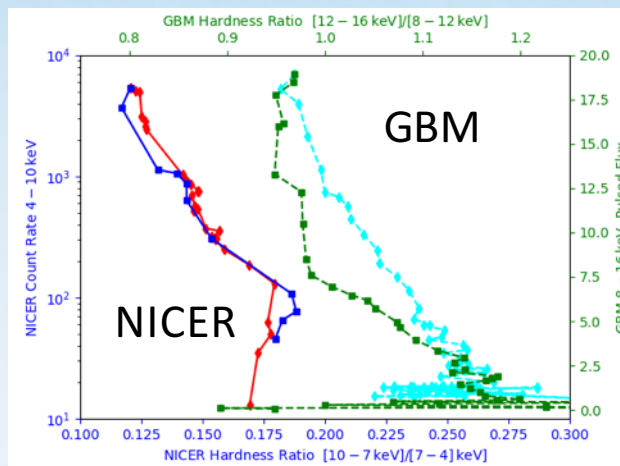
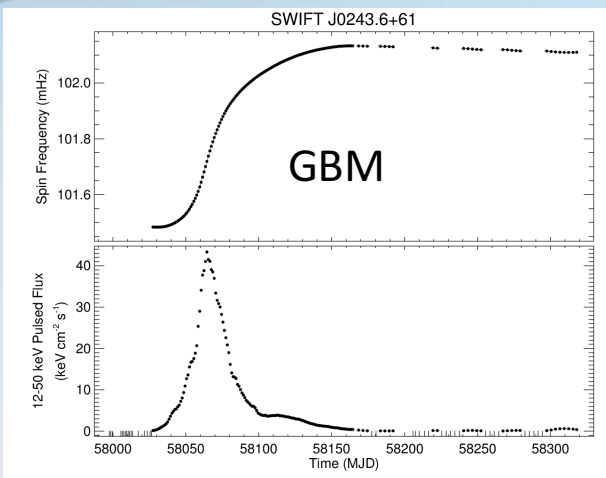
GRB 170817A was weakly detected by the onboard triggering algorithms, but easily recovered using the targeted search.



The analysis showed that the targeted search can recover astrophysics signals as weak as the signal associated with GW 150914 (the first BH-BH merger). This association is still controversial since no EM emission is expected from the merger of black holes. More detections will be needed to conclusively resolve the nature of this source.

# Science Highlight

## Swift J0243.6+6124

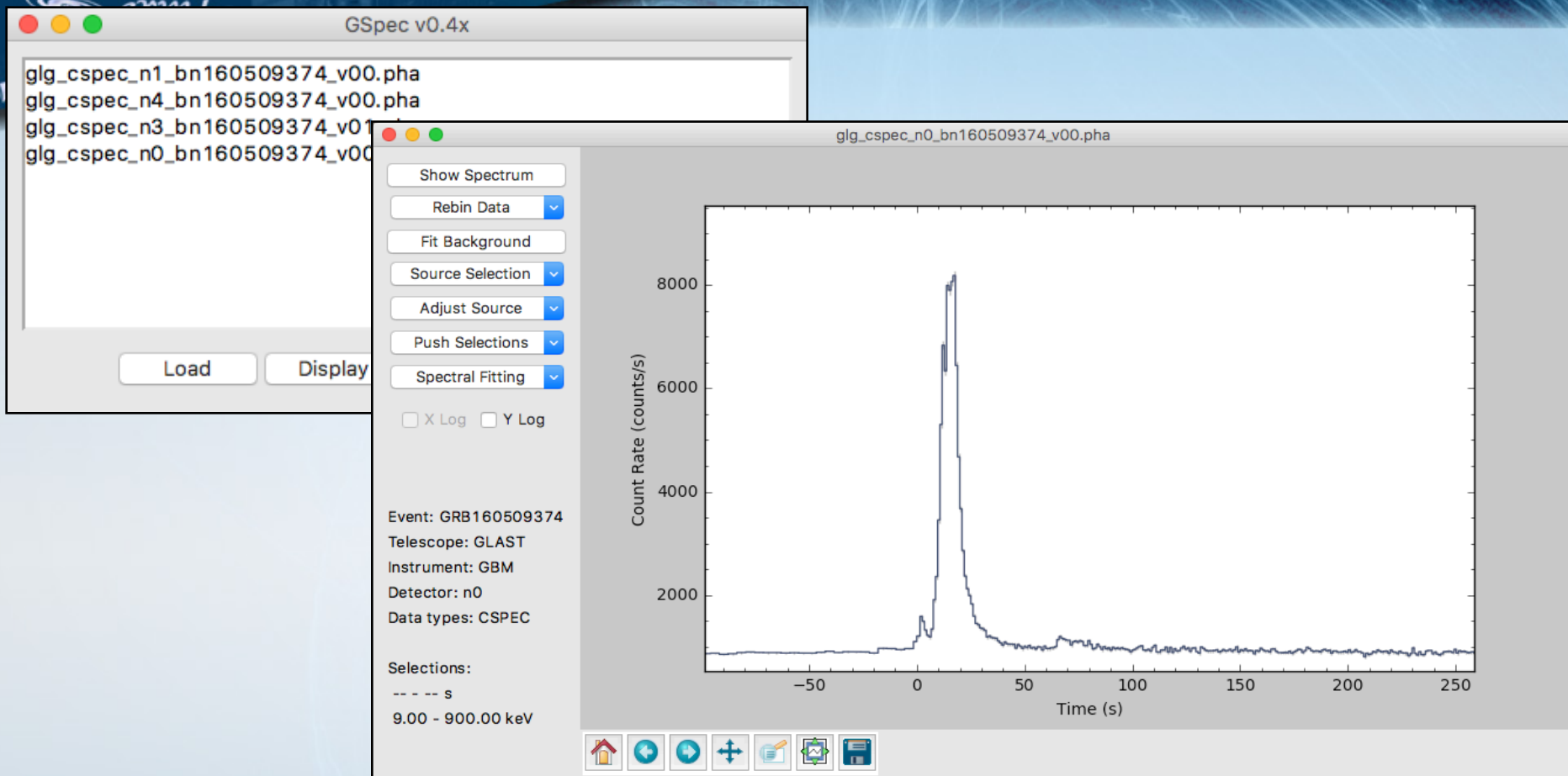


- First Galactic ULX Pulsar!
  - Peak  $L \sim 2 \times 10^{39}$  erg/s ( $d=7$  kpc)
- Transition from sub- to super-critical accretion at  $L \sim 10^{38}$  erg/s
  - Pulse profiles
  - Pulse fraction
  - Hardness Ratio
  - QPO
- Magnetic field  $\sim 10^{13}$  G
- GBM and NICER data combined.

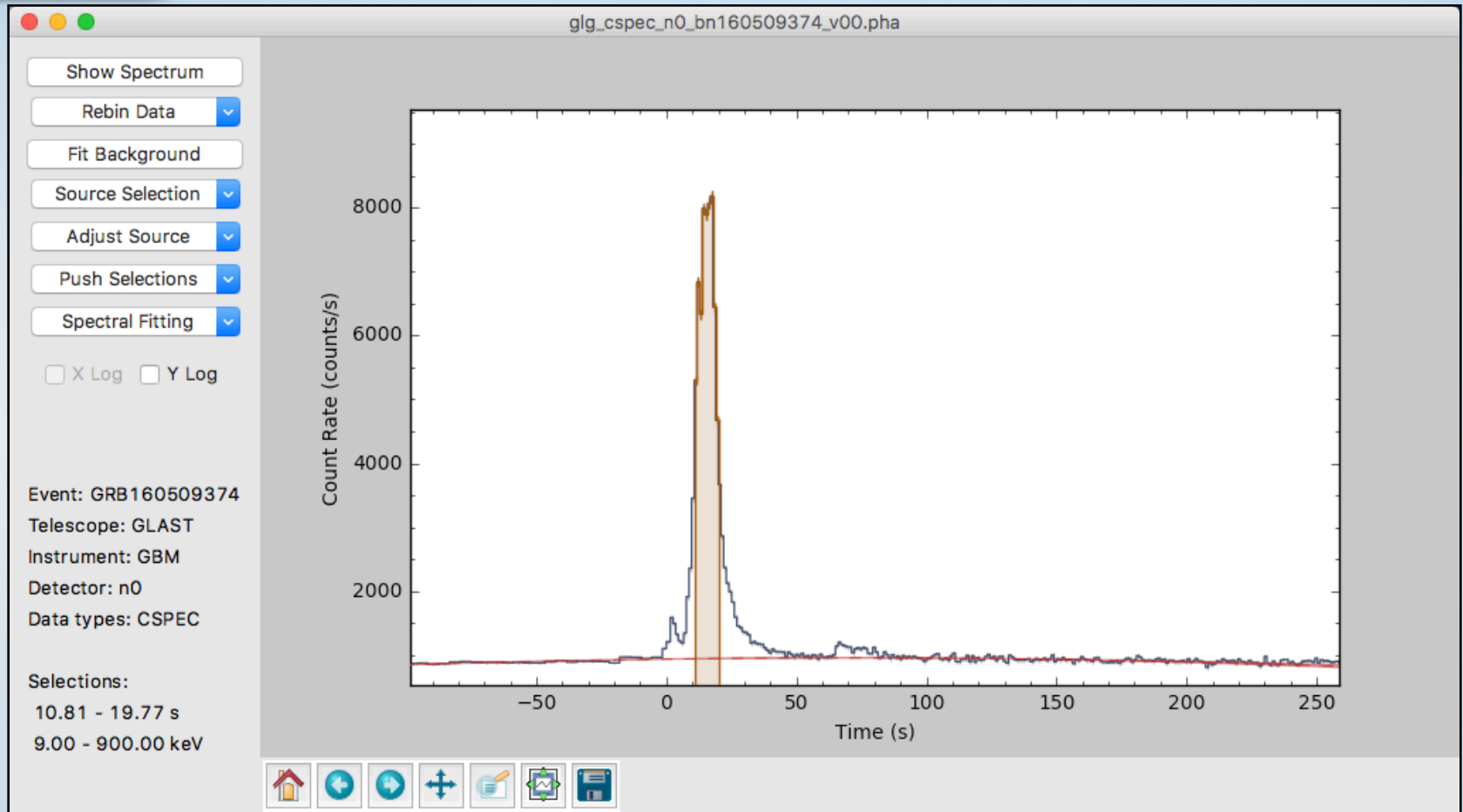
- GBM is operating well and continues to observe many exciting transient events
- The GBM team has given/been invited for 38 talks related to GBM/GRBs/GW since Oct 2017!
- GSPEC, a modernized replacement for RMFit – release Fall 2018
  - Key features
    - Python interface to XSPEC
    - Interactive background fitting
    - Push selections to other detectors
    - Full capability of XSPEC – accessible from the Fit Log Window
    - Creates XSPEC compatible files automatically
  - Part of a larger API that will allow users to script batch processes
- Continued improvements are underway for Targeted and Untargeted searches for LIGO/Virgo O3 and neutrino searches
- GBM is publishing results with newly launched instruments

# GSPEC Demo

# GSPEC v0.5

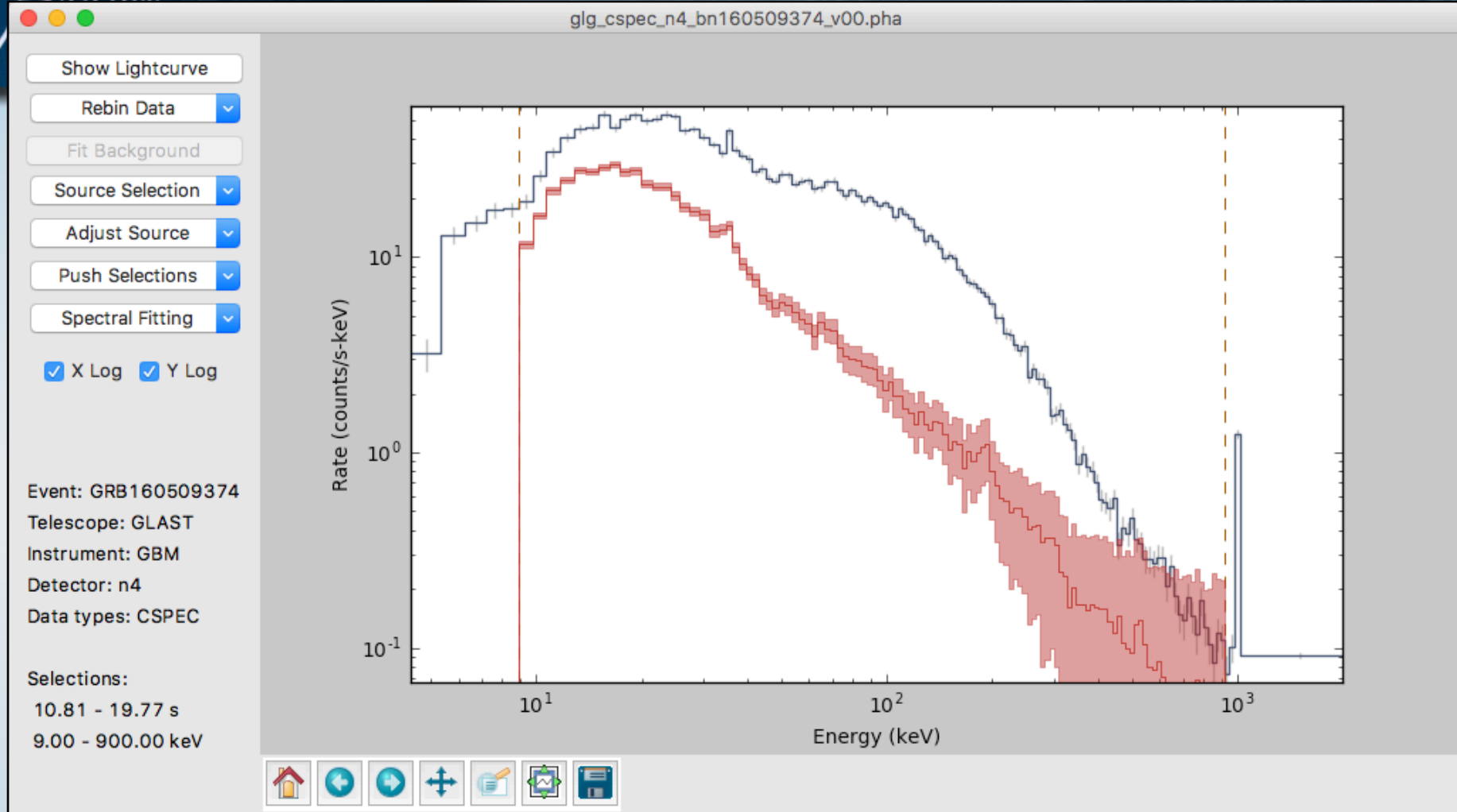


- Python based replacement for RMFIT using XSPEC under the hood
- Inherently cross-platform, working with Win 10, Mac, & Linux systems



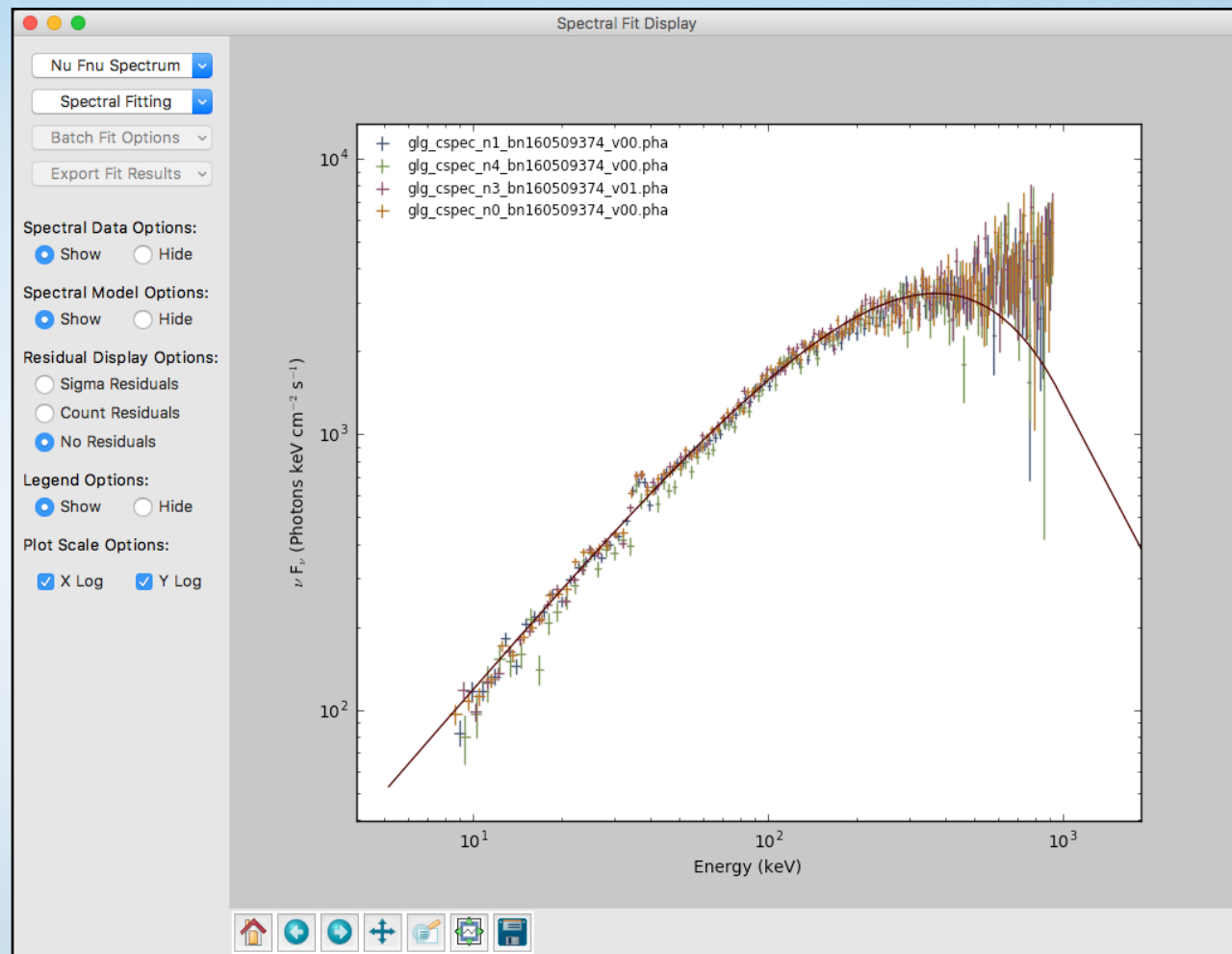
- GSPEC allows for fully interactive background and source selection
- This was one of the advantages of RMFIT compared to other fitting packages

# Interactive data selection (Spectral)



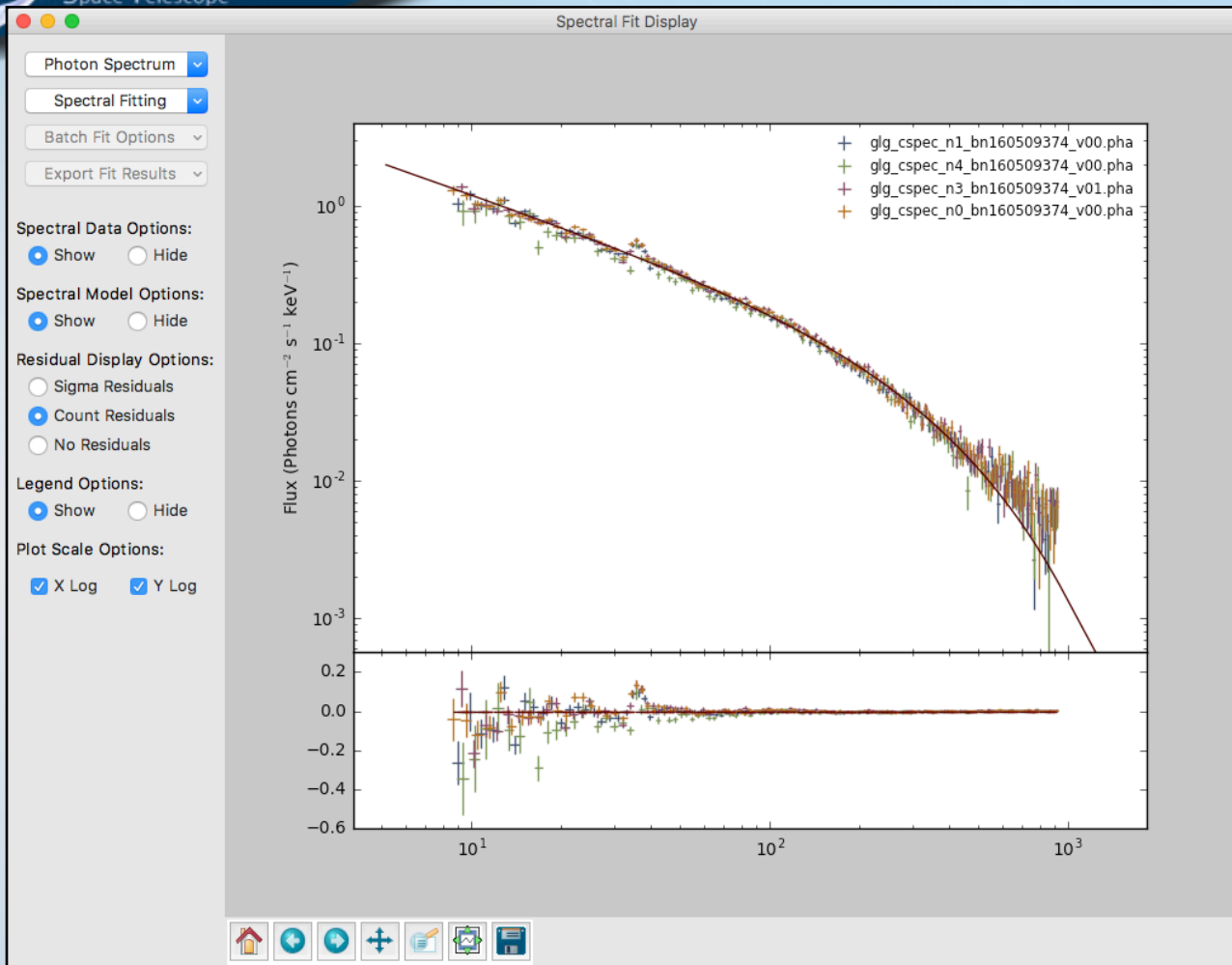
- GSPEC allows for fully interactive energy selection
- This was one of the advantages of RMFIT compared to other fitting packages

- All data selections are passed to XSPEC for spectral fitting
- Spectral results are displayed in modern and fully interactive plots using matplotlib
- User has access to all XSPEC models and fitting statistics
- User has access to any XSPEC command through the fit log window
- XSPEC input files are created automatically from the user source and background selections





# GSPEC release candidate – Fall 2018



- GSPEC development is proceeding quickly
- First “release candidate” is expected in fall of 2018
- Cross platform fully interactive access to GBM data with fitting performed by XSPEC
- Ultimate goal is to make the code modular and include capability to form joint GBM and LAT fits
- The addition of XRT data down the road would make GSPEC a general front end to XSPEC.