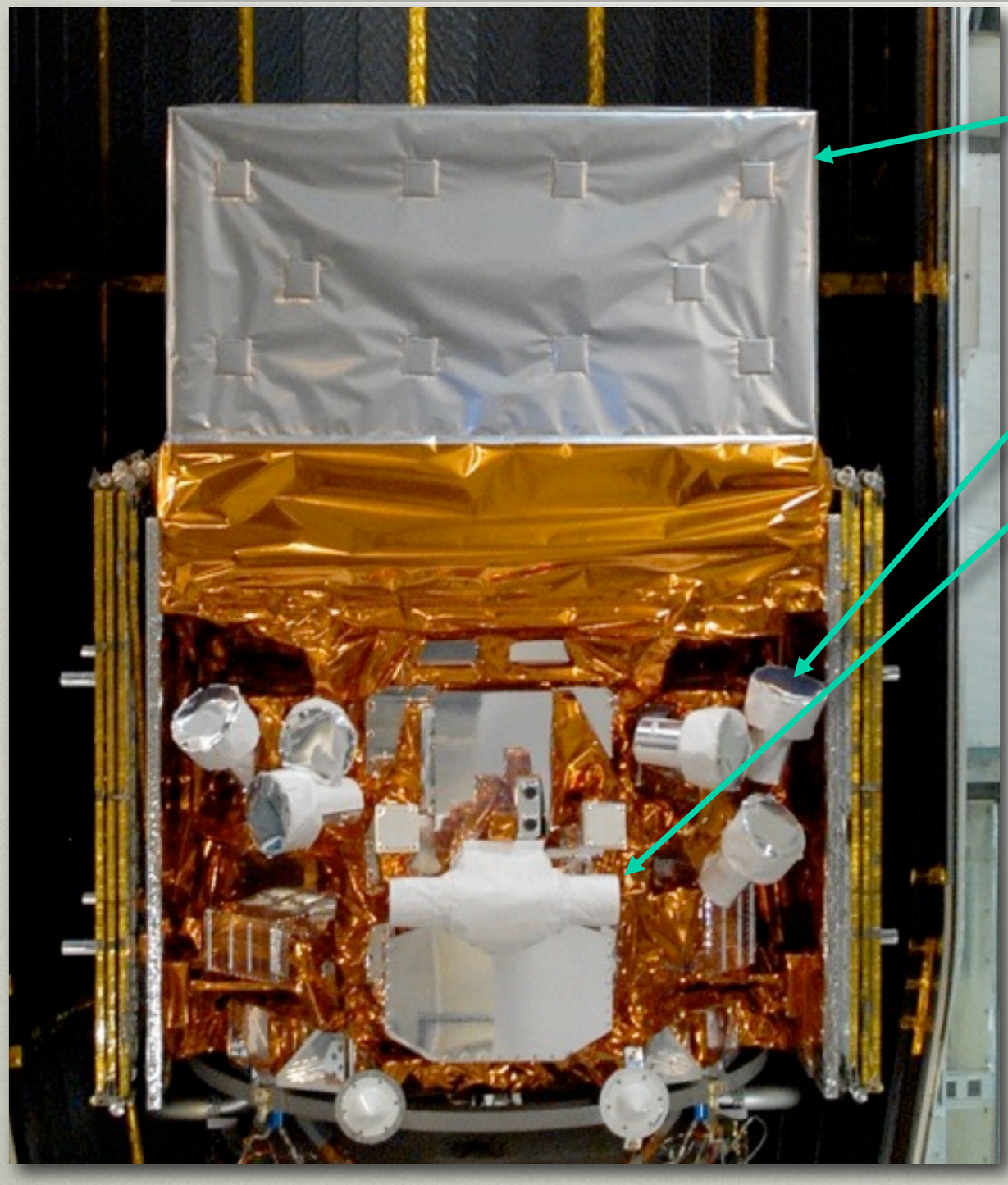
Current Status and Recent Improvements of Fermi/GBM

Adam Goldstein
on behalf of the GBM Science & Ops Team

The Fermi Spacecraft



Large AreaTelescope (LAT)
30 MeV - >300 GeV

Gamma-ray Burst Monitor (GBM)
Nal and BGO Detectors
8 keV - 40 MeV

KEY FEATURES

- **Huge field of view**
  - **–LAT: 20% of the sky at any instant; in sky survey mode, expose all parts of sky for ~30 minutes every 3 hours. GBM: whole unocculted sky at any time.**
  - **–Decreased detection dead time 2.6 μs**
- **Huge energy range, including largely unexplored band 10 GeV - 100 GeV. Total of >7 energy decades!**
- **Large leap in all key capabilities. Great discovery potential.**

Current GBM Public Data

- Trigger data
- Continuous/daily data
- GRB trigger and spectral catalogs
- GRB lightcurves
- Earth occultation lightcurves, pulsar spin histories, etc.
- Spectral analysis software - RMfit

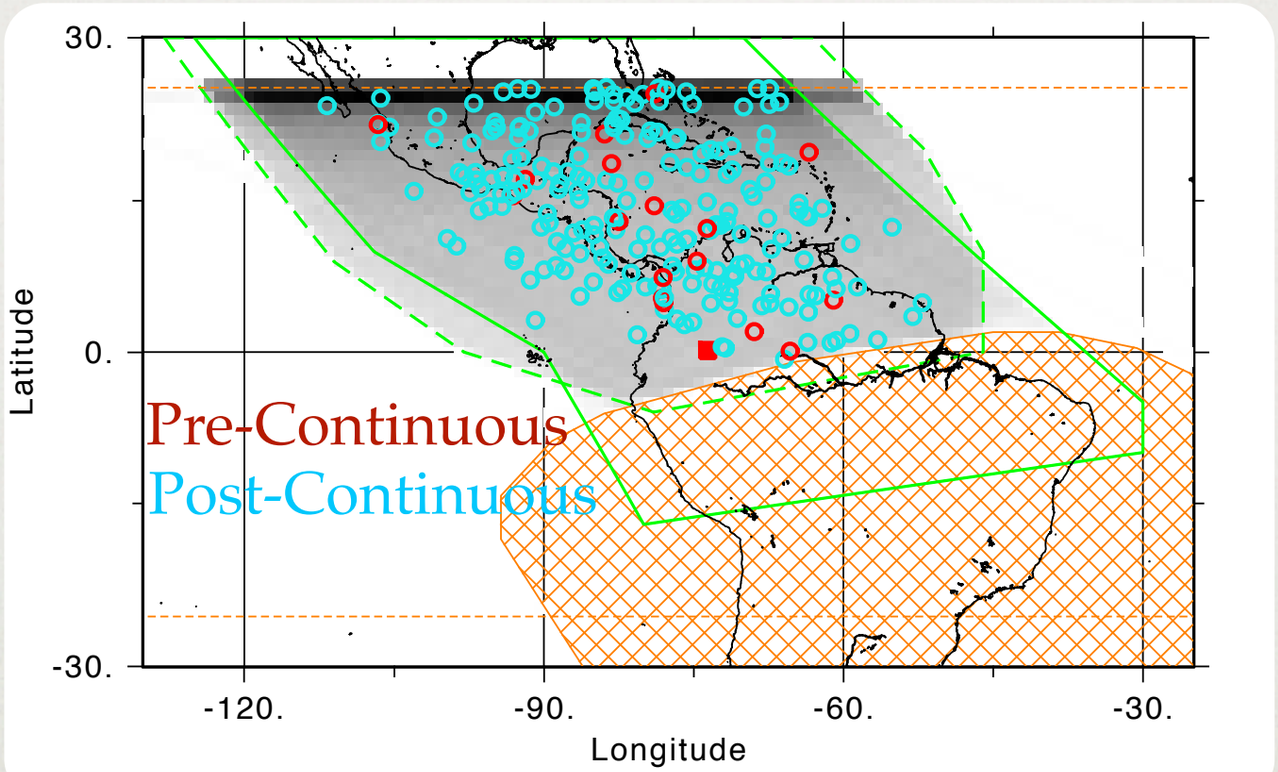
http://fermi.gsfc.nasa.gov/ssc/data/access/

Continuous TTE

Data Type	Time Resolution	Energy Resolution
TRIGDAT	1024/256/64 ms	8 channels
CTIME	256/64 ms	8 channels
CSPEC	4096/1024 ms	128 channels
TTE	2 μs	128 channels

- Initially TTE was available ~30 s pre-trigger - ~300 s post-trigger
- Implemented on November 26, 2012

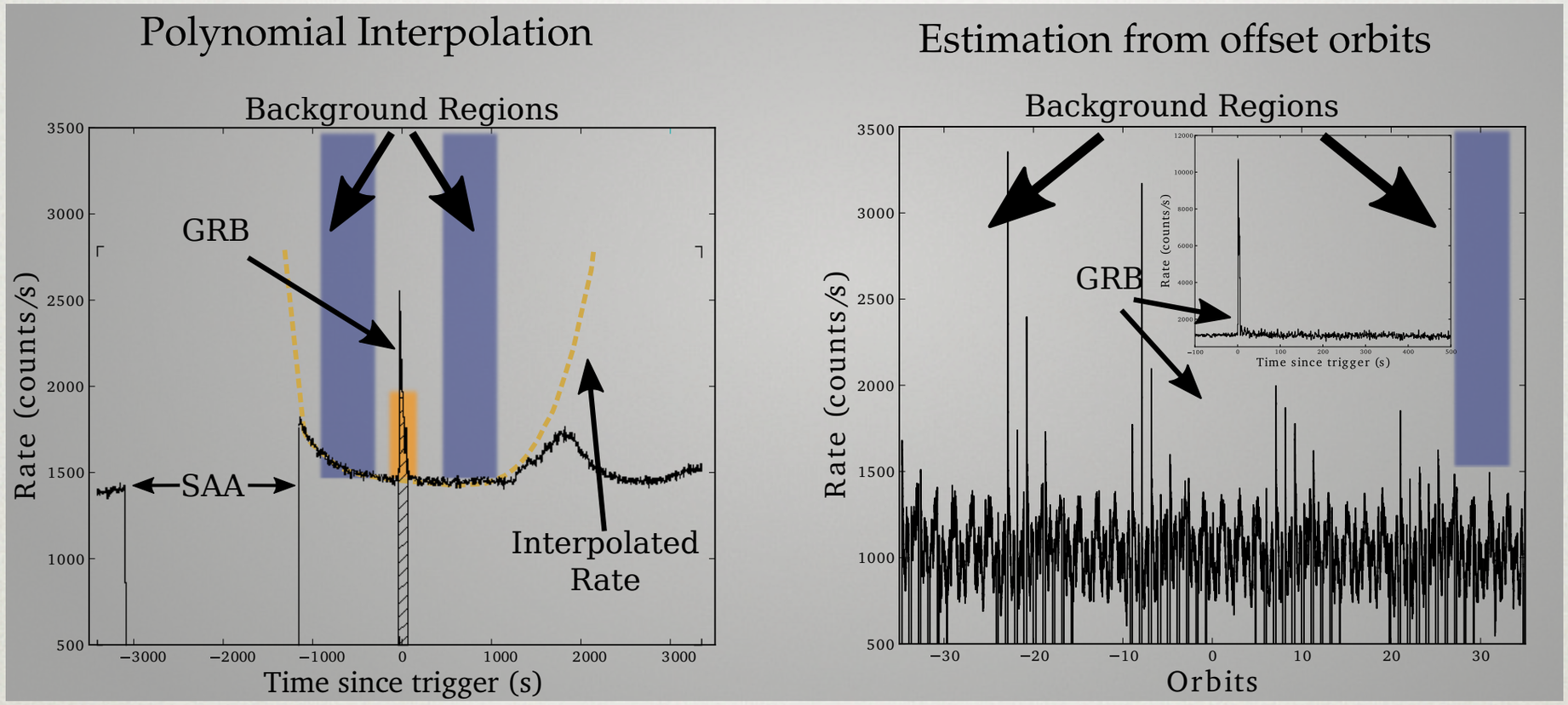
Continuous TTE

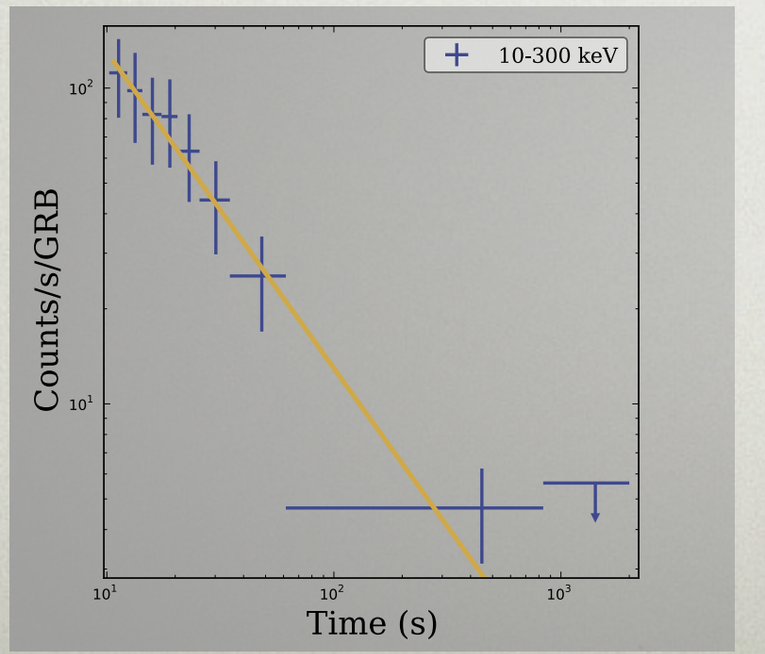


- 10x improvement in TGF detections
- Less improvement for GRB candidates, but useful for ground search, precursors, fine-temporal lightcurve analysis, etc.
- Currently working on ground search software for un-triggered short GRBs/ GW followups

Briggs et al. JGR: Space Physics 2013

Orbital Background Subtraction



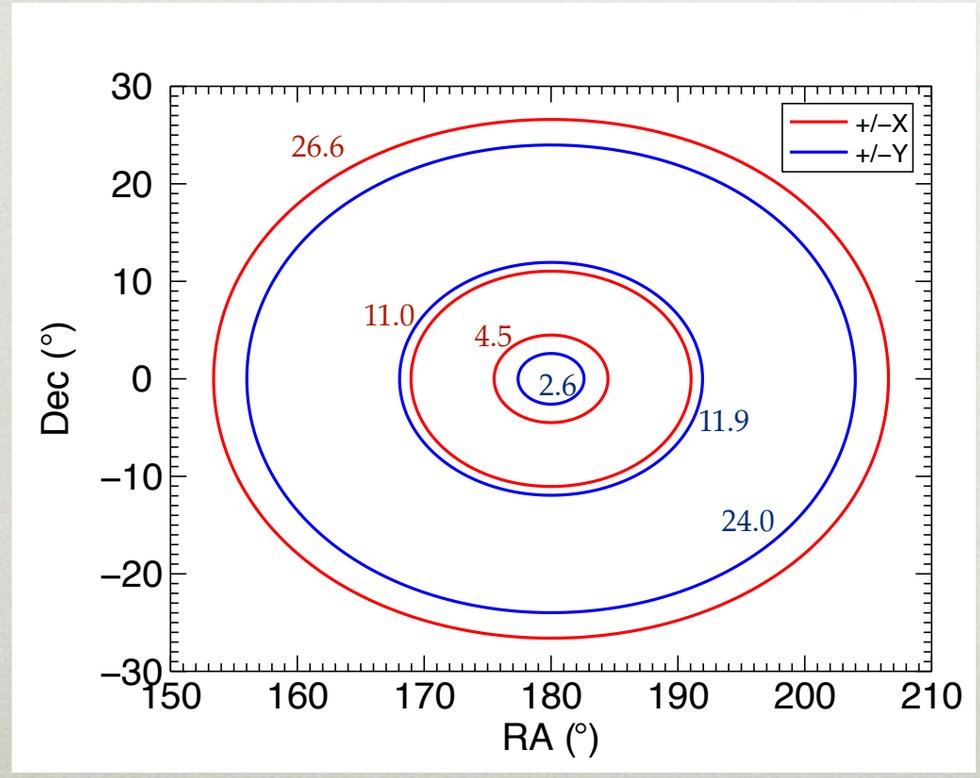


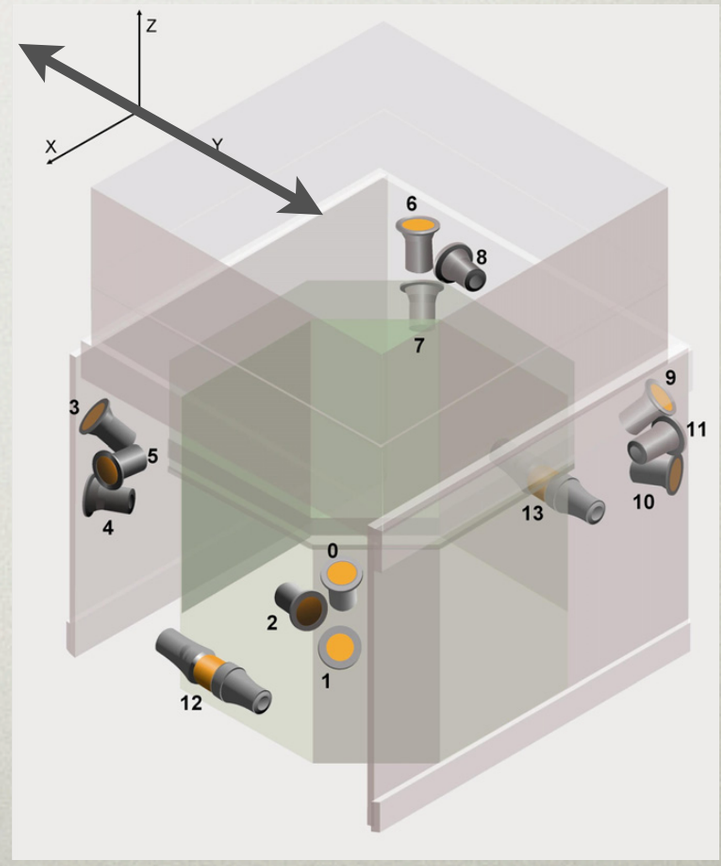
- Accurate alternative for polynomial-fitting, esp. in long-lasting emission scenarios
- Potentially used to study extended gamma-ray emission. Lightcurve stacking suggests a PL decay of the lightcurve.

Fitzpatrick et al. arXiv:1111.3779

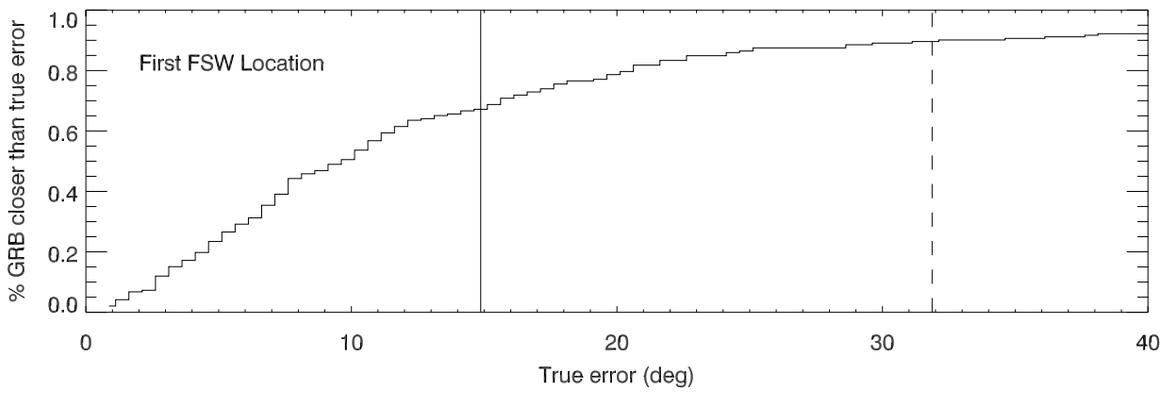
GBM Localization Systematics

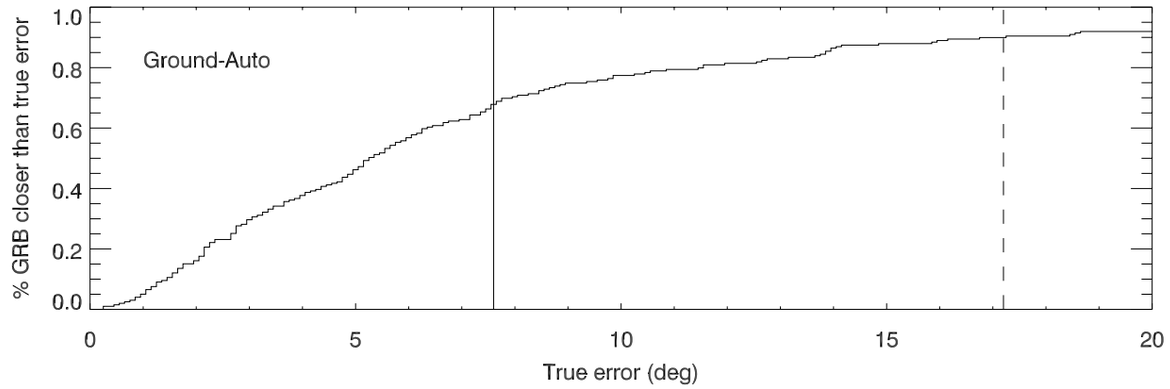
- 203 GBM GRBs also localized by Swift or IPN annulus
- Systematic model of core+tail Fisher distribution
- Model is azimuthally-dependent in spacecraft coordinates (by x-y quadrant)
- 1-sigma systematic has 2.6-4.5 deg. radius
- More details in Connaughton et al., submitted & poster

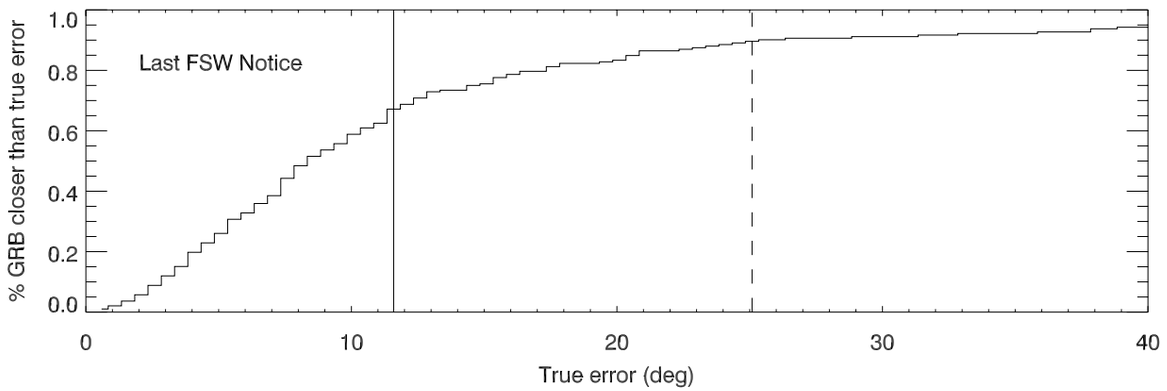


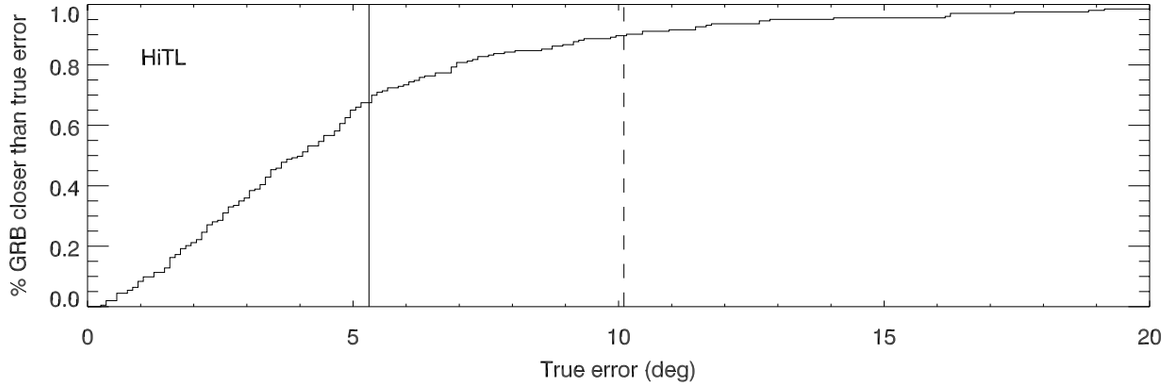


GBM Localization Systematics







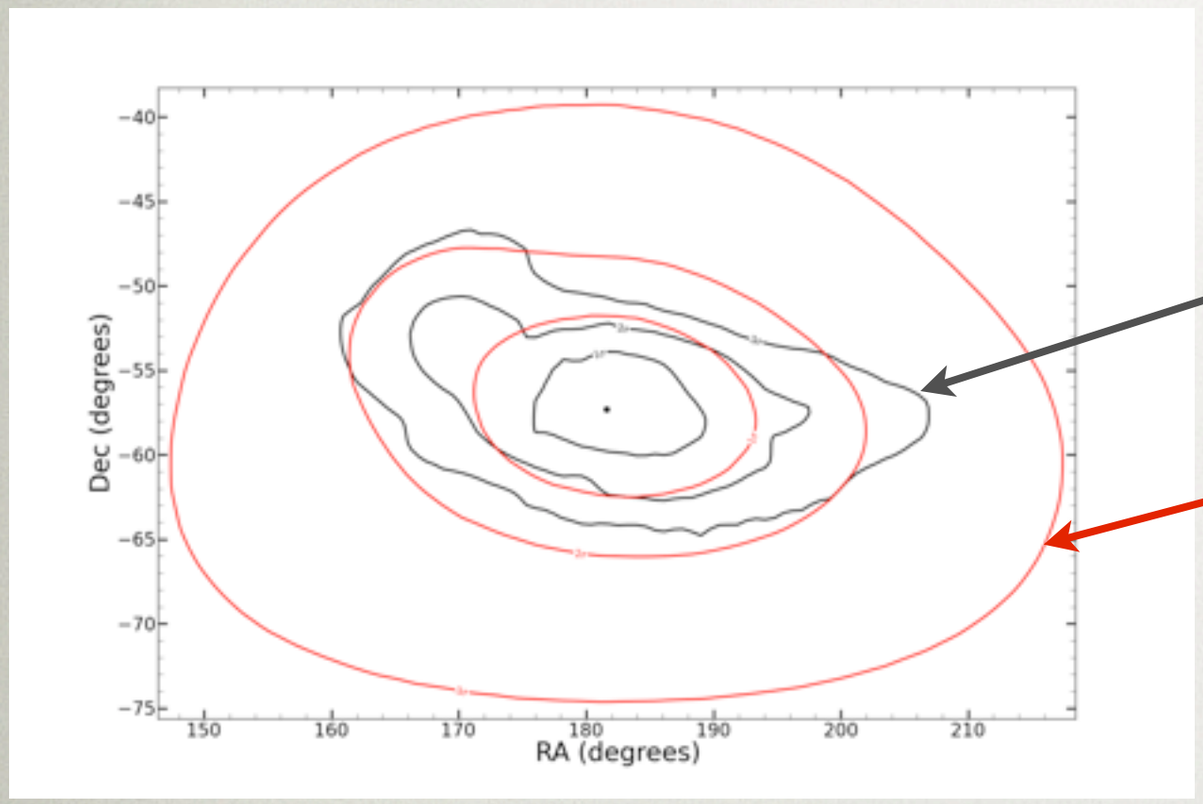


- 68% containment: 15^{o} (1st FSW), 11.5^{o} (last FSW), 7.5^{o} (GA), 5^{o} (HitL)
- 90% containment: 32^{o} (1st FSW), 25^{o} (last FSW), 17^{o} (GA) 10^{o} (HitL)
- Main factors in improvement: More accurate background modeling and longer, more accurate source selection.

Total Localization Uncertainty

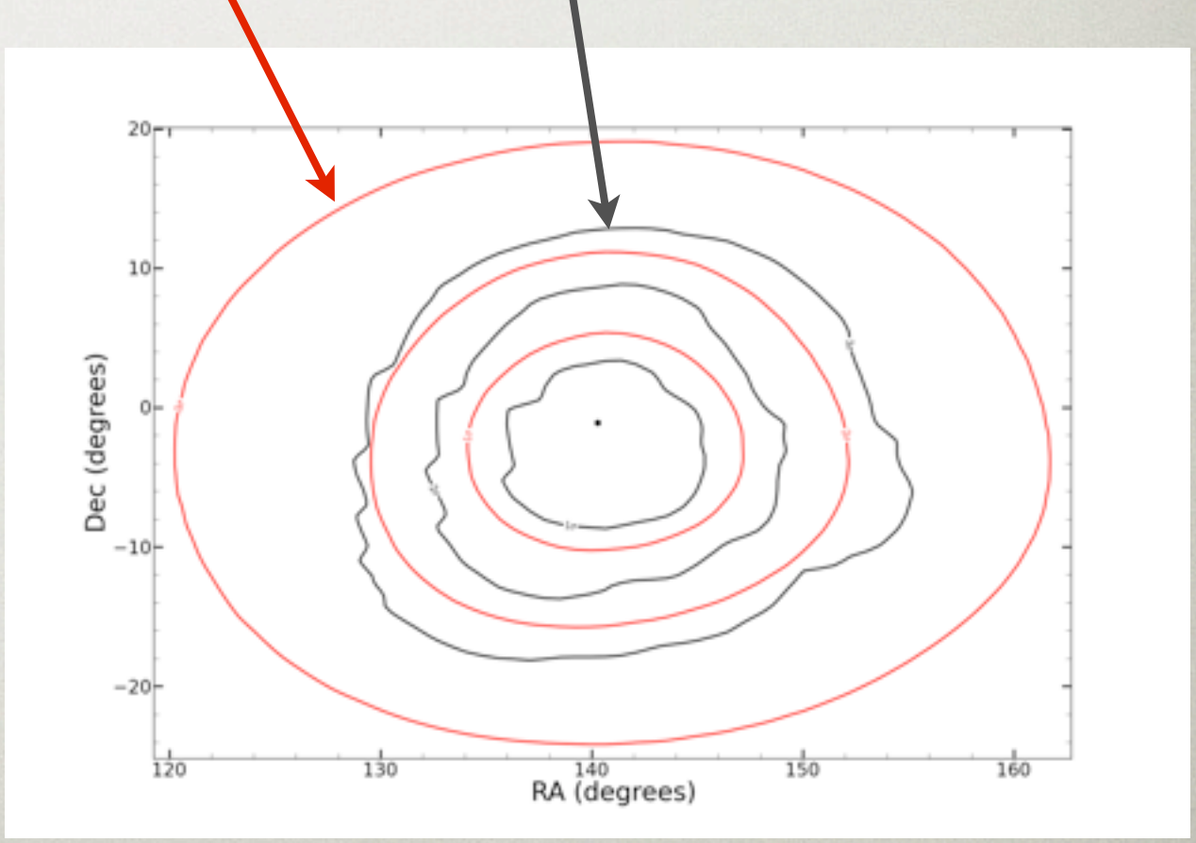
- Convolving the statistical probability map with the systematic model, a total uncertainty map can be produced
- Currently 1,2,3-sigma contours are calculated. A png and ascii file displaying coordinates of the contours are provided
- Special requests from observers will be considered.

Total Localization Uncertainty Contours



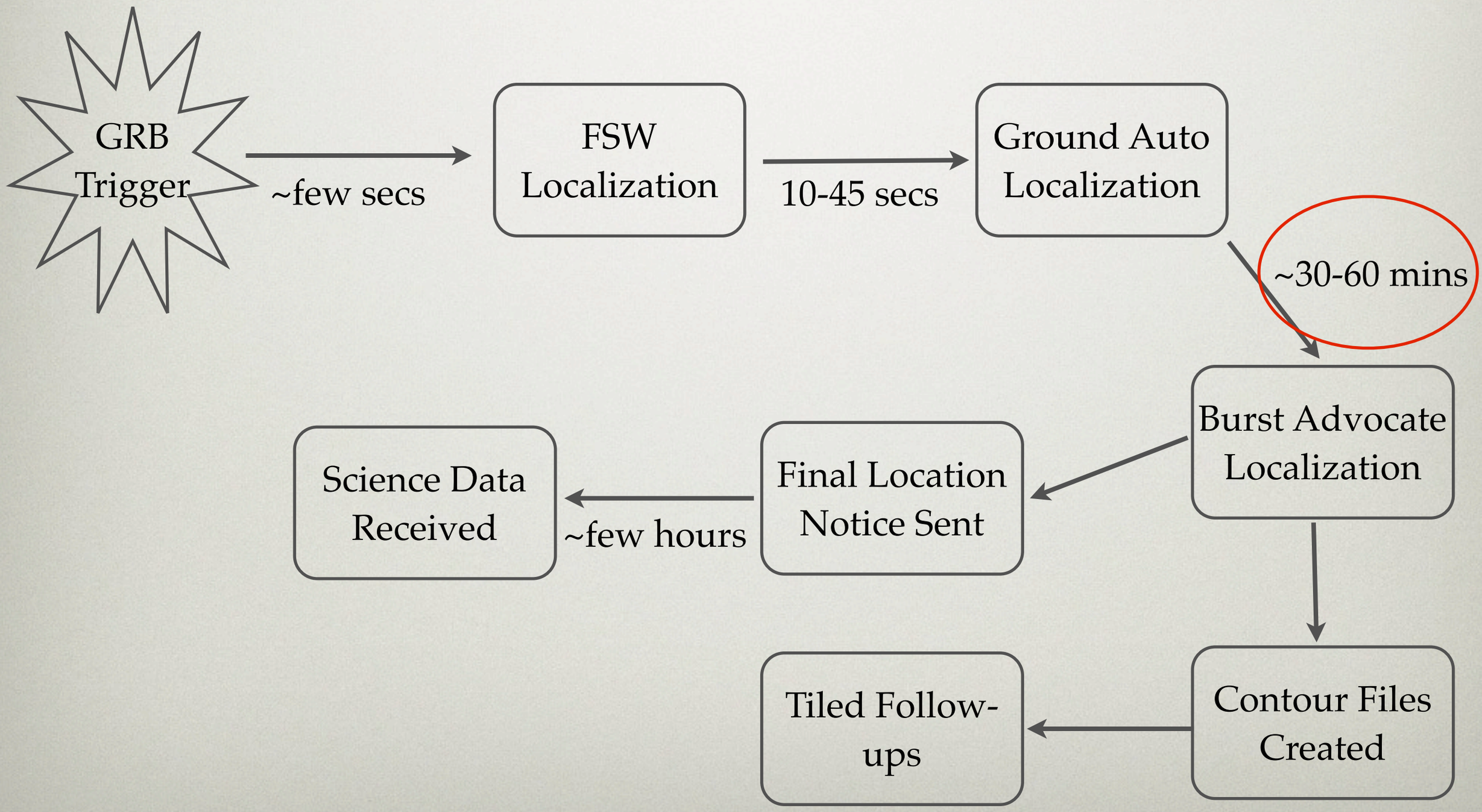
Statistical Uncertainty

Total Uncertainty

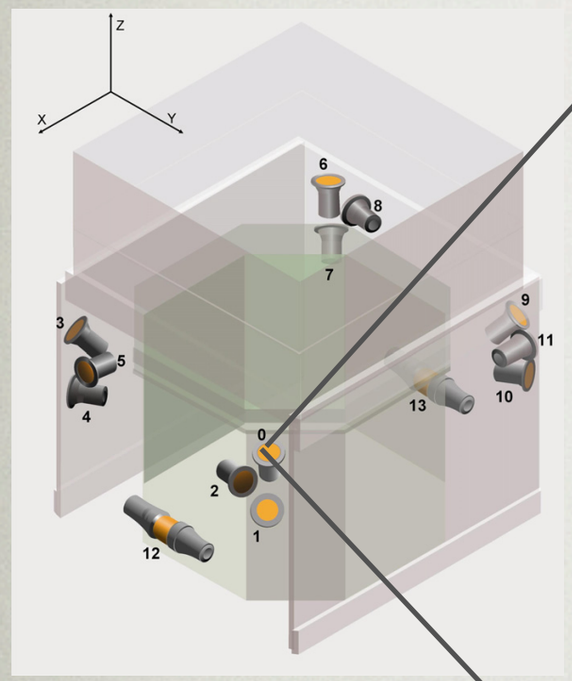


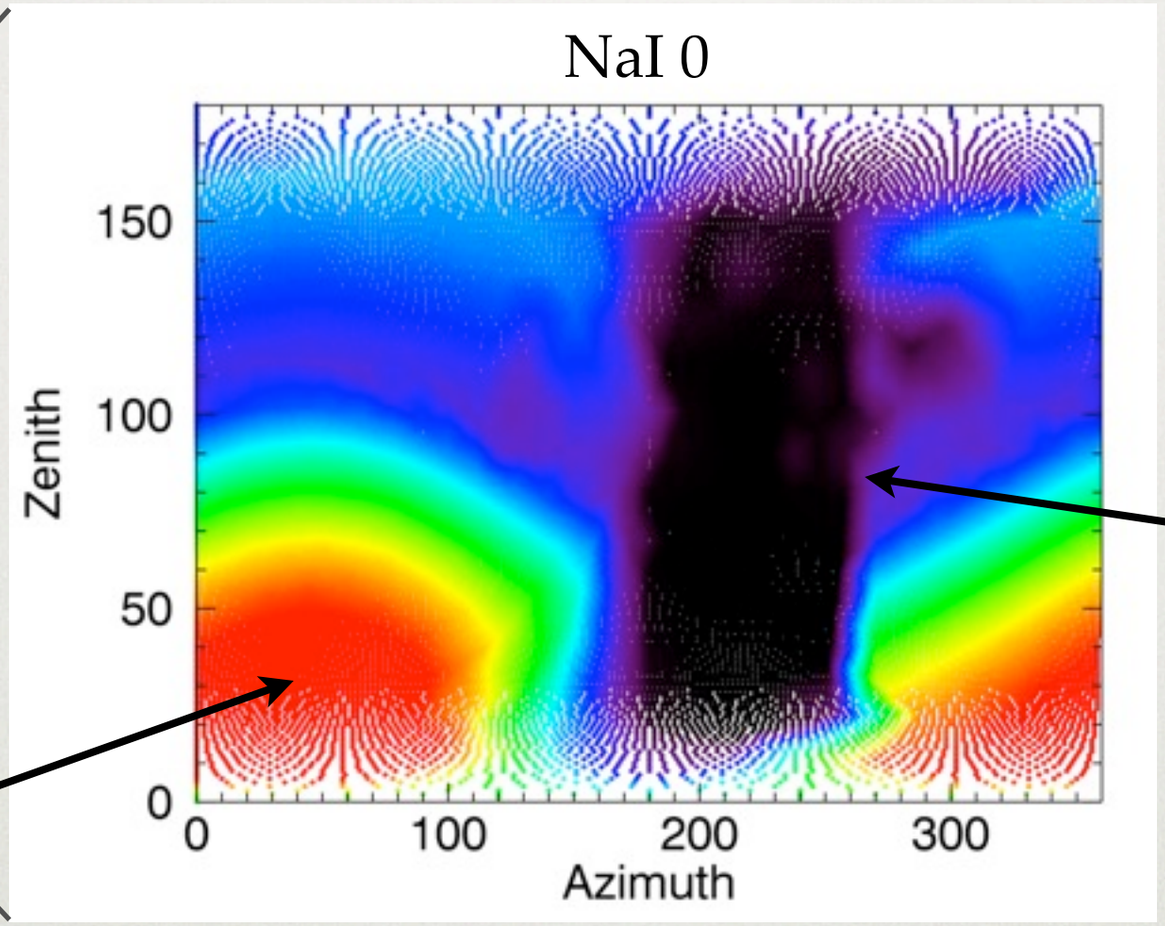
- Files to be created when a final position GCN notice is sent
- Contour files will be available at FSSC website as an official data product
- Already two successful follow-ups with iPTF using the contour files (130702A & 131011A)

Current GRB Trigger Timeline



Investigation to Improve Speed & Accuracy of Localizations





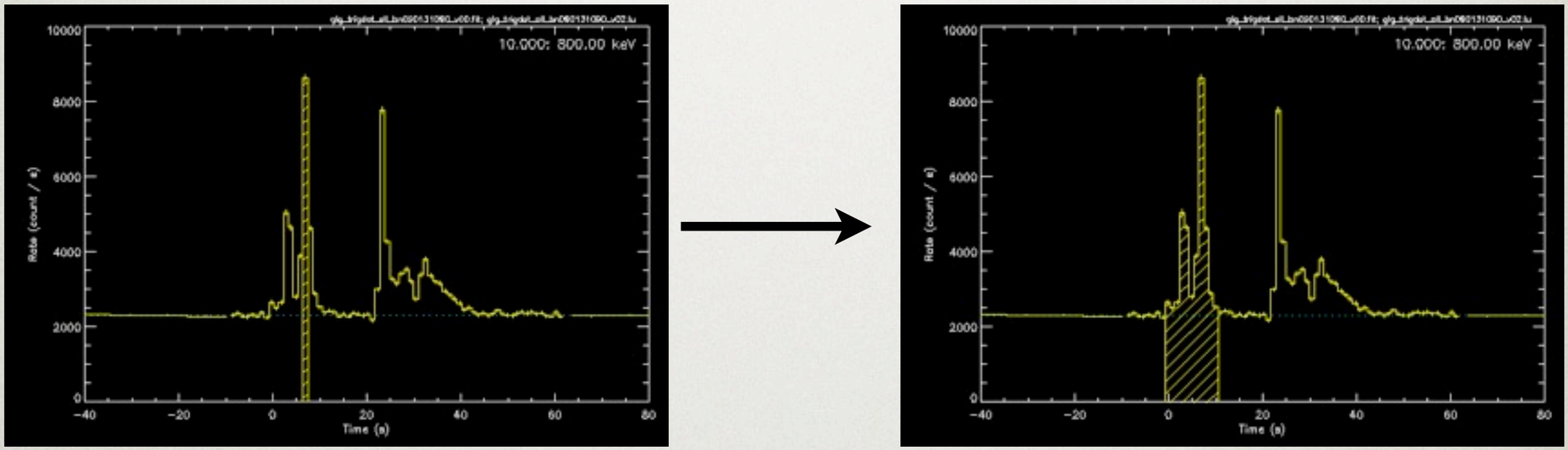
Low Rates - Spacecraft Blockage

High Rates

- Localization is performed by comparing the relative observed rates from the GRB in each detector compared to the expected rates given the GRB is emanating from any of equally spaced 41,168 points on the sky in spacecraft coordinates.
- This requires an assumption of the spectrum, and the sky grid limits to a statistical minimum uncertainty of 1 degree.

Investigation to Improve Speed & Accuracy of Localizations

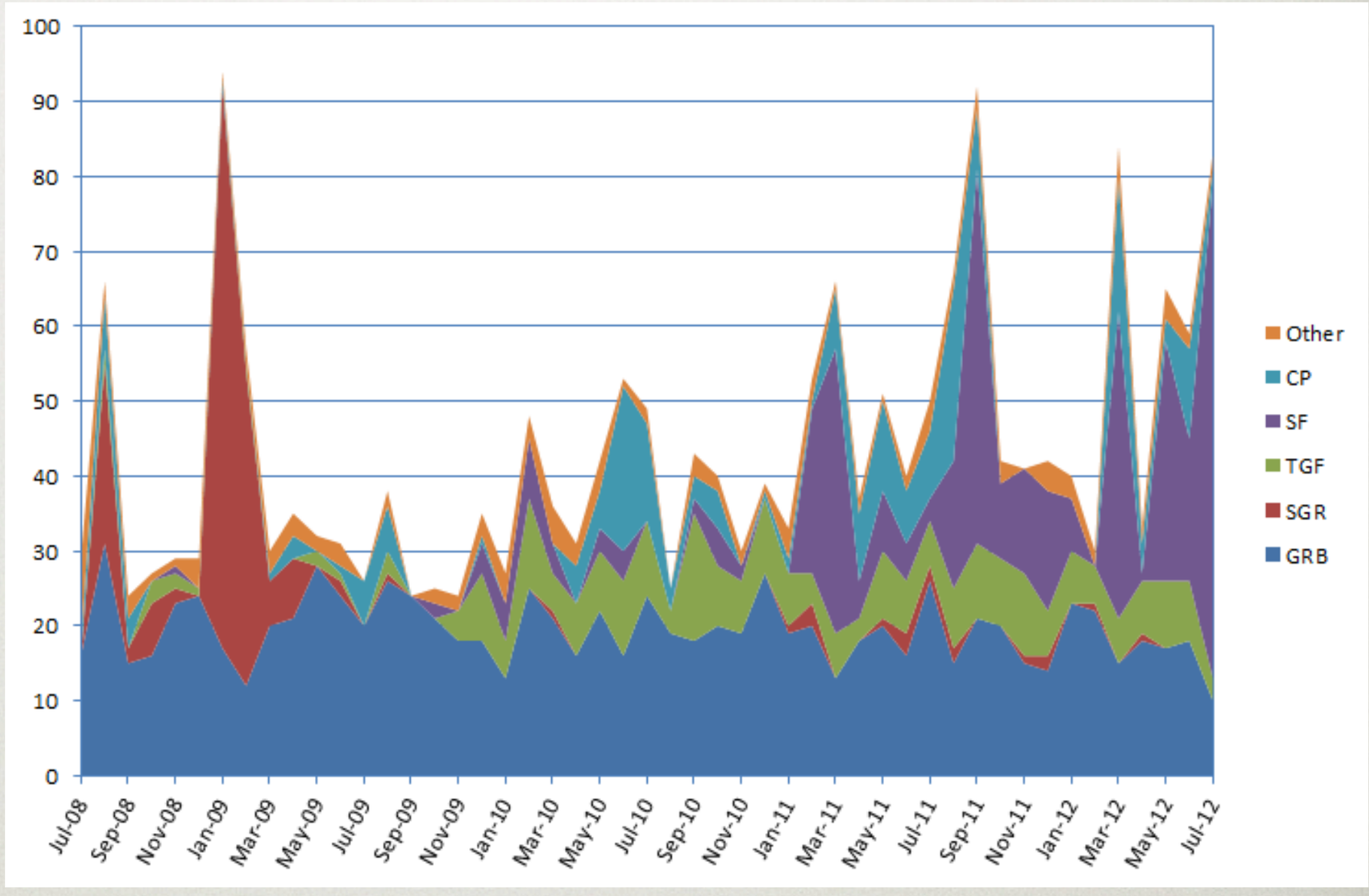
- Primary delay in final localization is the Human-in-the-Loop (HitL).
- Currently the Ground Auto (GA) localization is done using a single bin that contains the peak count rate flux at 1024, 256, or 64 ms timescale.



- To improve the statistics of the localization, use a fluence-based source selection that selects all of the signal over a certain time interval (e.g. 20 s).
- The background is given as the average of the background bins before the trigger. This can be improved by implementing an algorithm to identify the source and fit the background so that more accurate background-subtraction can be performed.

GBM Triggers - First 4 years

- 954 GRBs
- 410 Solar Flares
- 273 TGFs
- 201 Charged Particles
- 192 SGRs

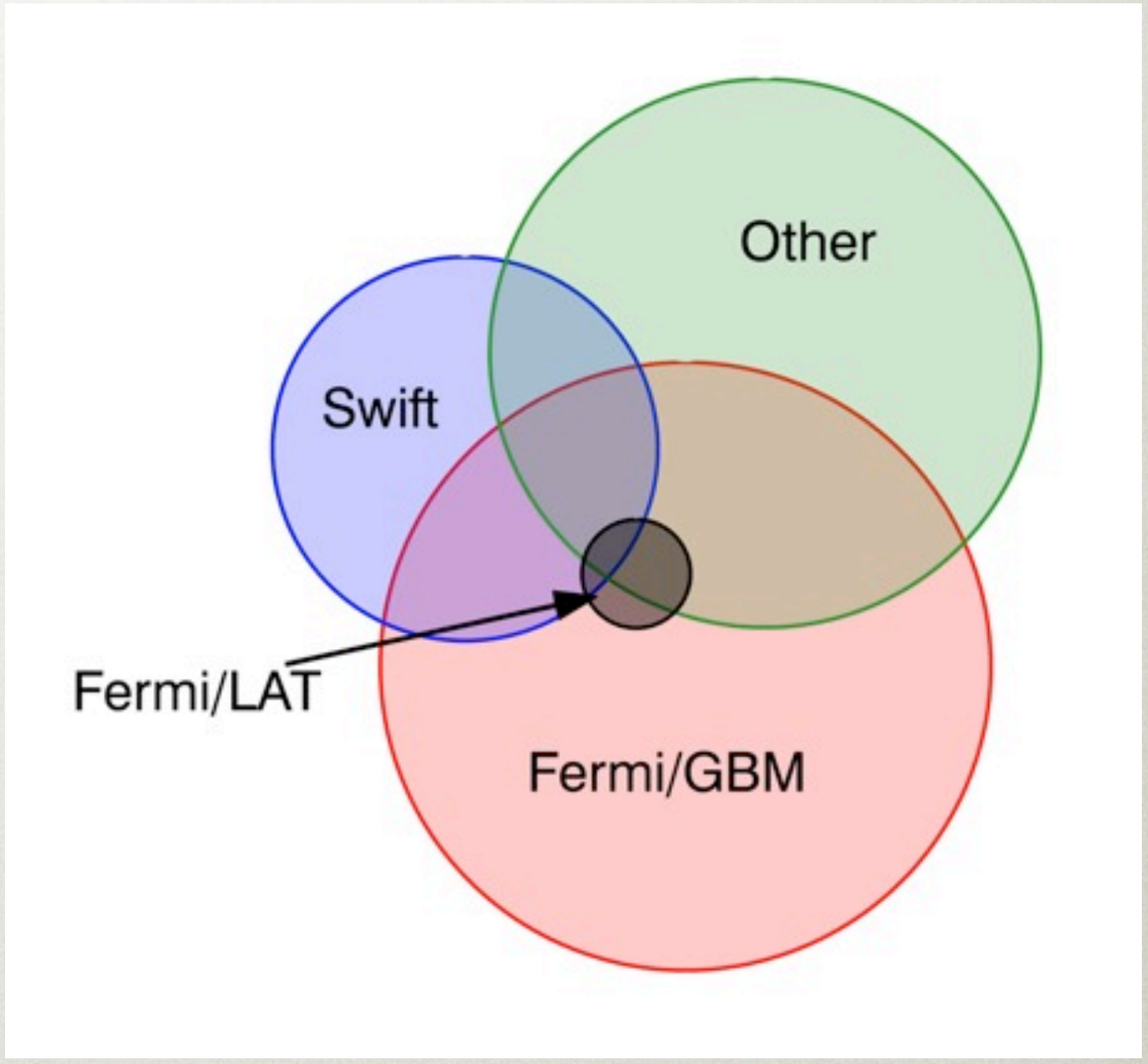


von Kienlin et al. submitted to ApJS

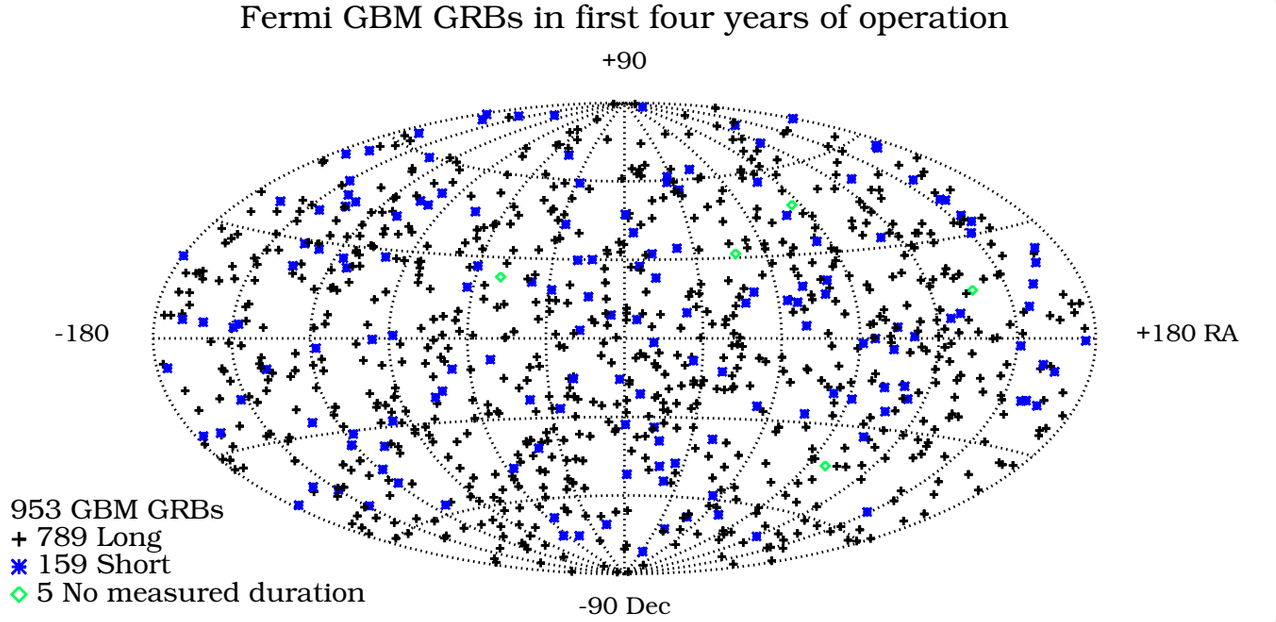
Prompt GRB Observations - Synergy

Through October 2013:

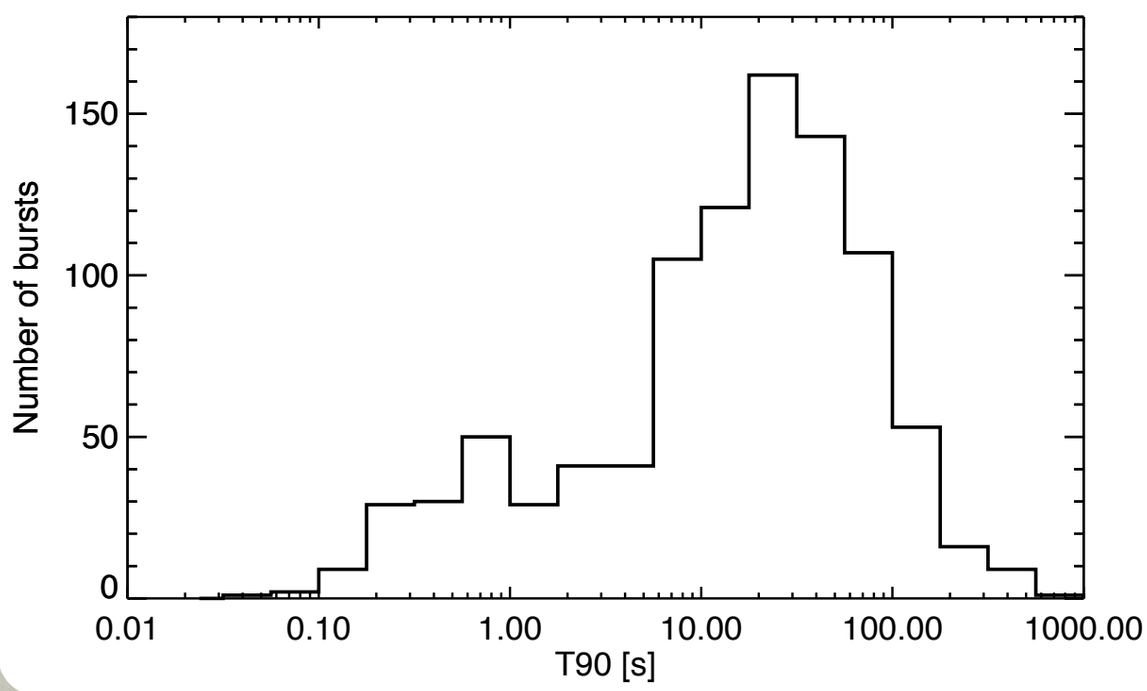
- 1254 GRBs
- ~200 Swift+GBM
- ~35 LAT+GBM
- >300 GBM+other
- 442 GRBs resulting in 3124 GCN Circulars

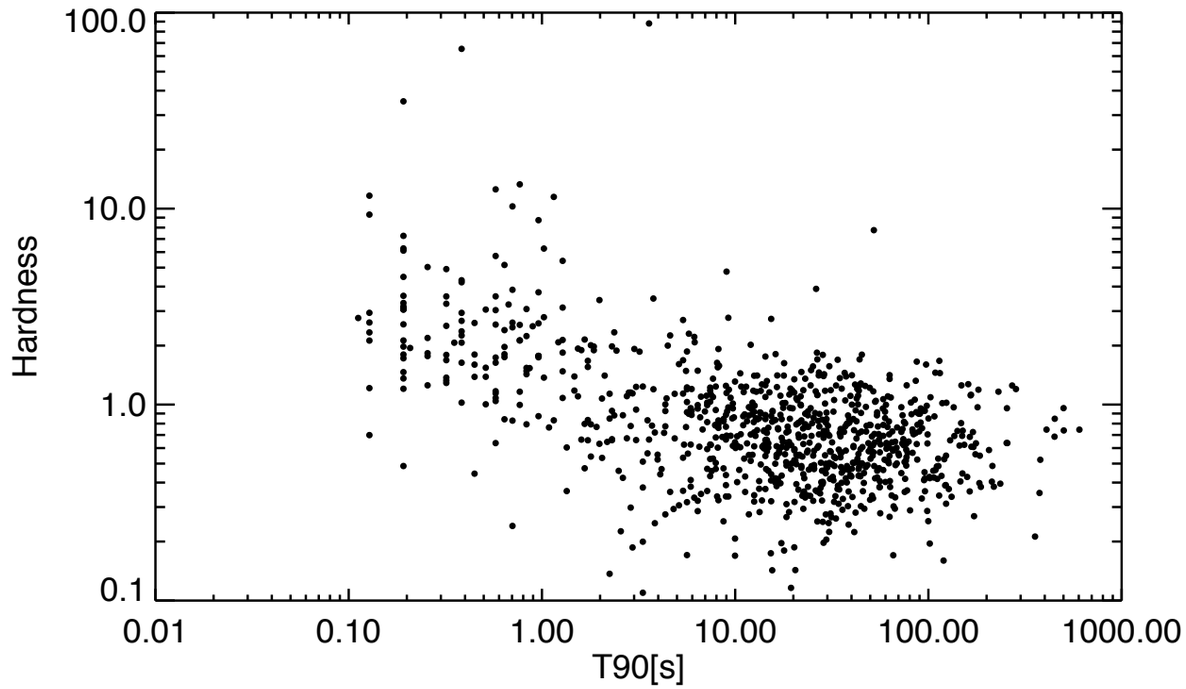


GBM 4-year GRB Catalog (07/2008 - 07/2012)



- 953 GRBs
- Locations/Localizing Instrument
- T50/T90 (50-300 keV)
- Peak flux (64/256/1024 ms; 50-300 & 10-1000 keV)
- Fluence (50-300 & 10-1000 keV)

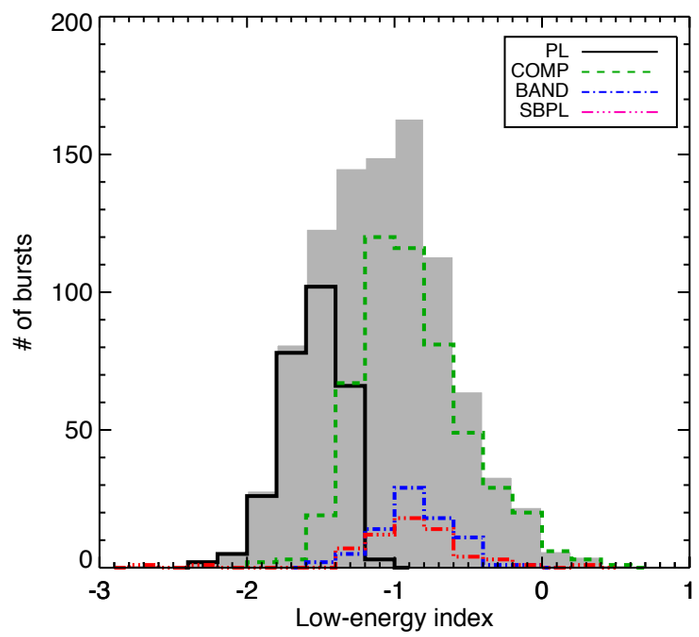


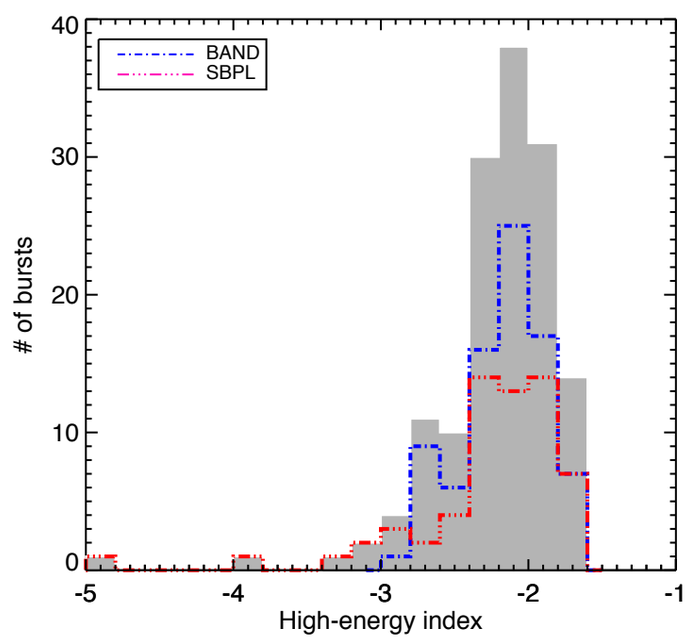


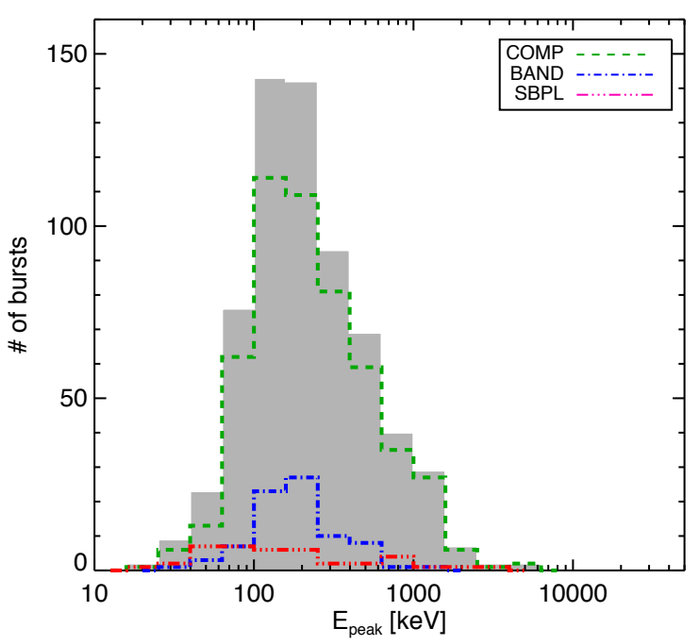
von Kienlin et al. submitted to ApJS

GBM 4-year GRB Spectral Catalog (07/2008 - 07/2012)

- 943 GRBs
- 2 types of spectra: 3.5 sigma S/N duration-integrated & (1024/64 ms) peak
- 4 spectral models
- >7500 spectral fits
- Well-constrained parameters and preferential models presented



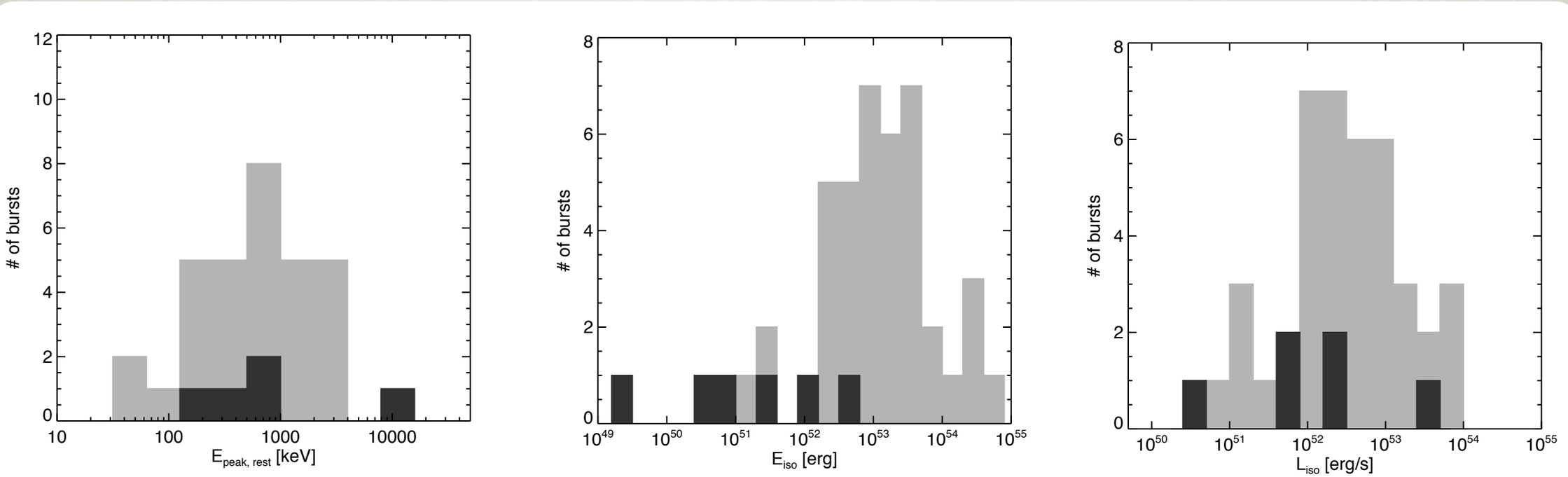




Gruber et al. submitted to ApJS

GBM GRB Spectral Catalog - Redshift Bursts

- 48 GRBs with redshift (42 long, 6 short)
- Rest-frame energetics calculated: E_{peak}, E_{iso}, L_{iso}
- Sufficient sample size to start studying correlations and consistency with samples from other instruments



Gruber et al. submitted to ApJS

Conclusions

- Continuous TTE - Fine time res/Fine spectral res - Always on
- New background estimation using orbital rate subtraction technique to study extended emission
- Understanding of Localization Systematics - New contour maps
- Continuing to improve localization speed and accuracy
- Great synergy with prompt and follow-up communities - afterglow, GW searches, cosmic-ray/neutrino searches
- New GRB trigger and spectral catalogs out soon

See Rob Preece's talk next week on GRB 130427A

BACKUP