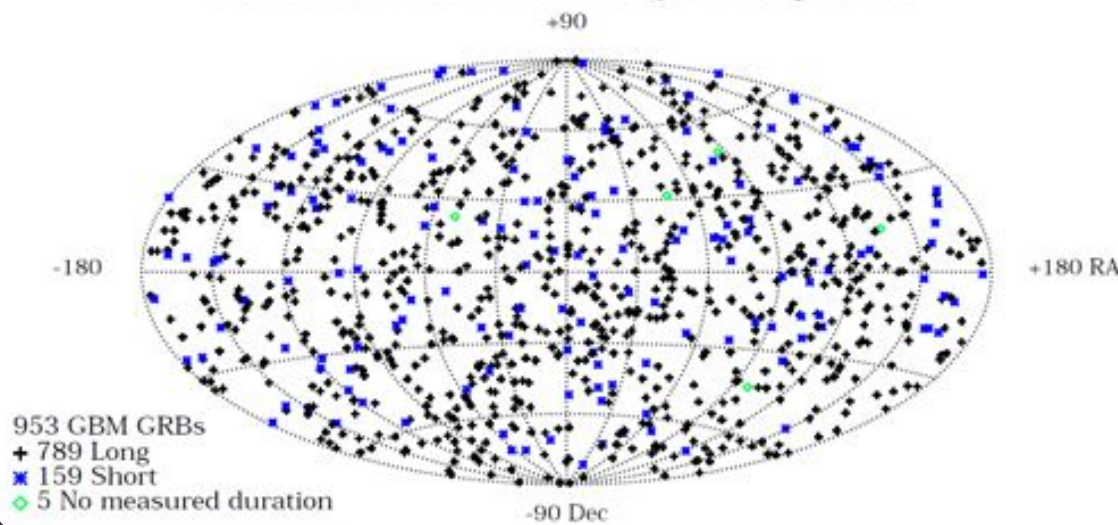


The Fermi GBM



Gamma-Ray Burst Catalog + Spectral Catalog ⇒ Years Three & Four

Fermi GBM GRBs in first four years of operation



Jochen Greiner
MPE Garching

for

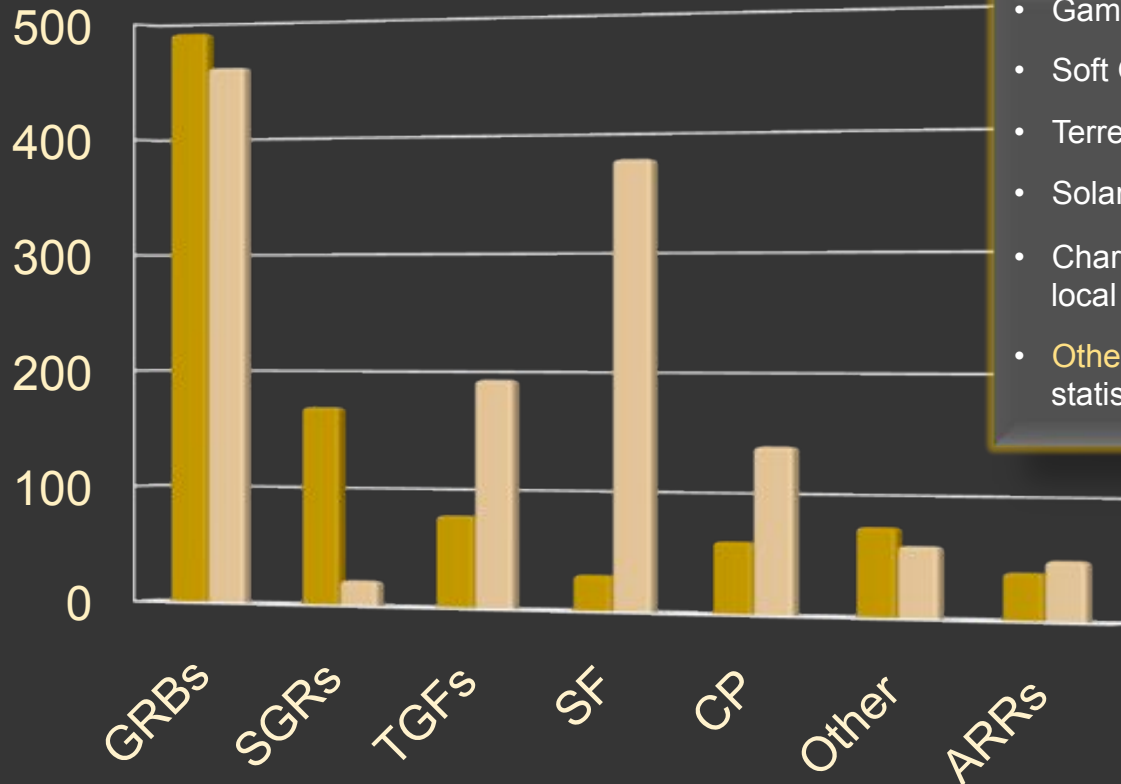
Andreas von Kienlin
on behalf of the GBM Team

GBM Triggered Sources

Fermi launch: 2008 June 11

GBM Trigger enabling: 2008 July 12

⇒ short transients detected by on-board trigger algorithm



- Gamma-Ray Bursts (GRBs)
- Soft Gamma Repeaters (SGRs)
- Terrestrial Gamma Flashes (TGFs)
- Solar Flares (SFs)
- Charged Particle (CP): Cosmic Rays, local particles, distant particles, SAA entry
- Other: galactic source, accidental statistical fluctuations, too weak to classify

	GRBs	SGRs	TGFs	SF	CP	Other	ARRAs
■ Year 1 & 2	492	170	79	31	61	75	40
■ Year 3 & 4	462	22	194	379	140	60	50

2008 July 12 - 2010 July 11

2010 July 12 - 2012 July 11

→ Triggers at high geo-magnetic latitude disabled

GRB Catalog

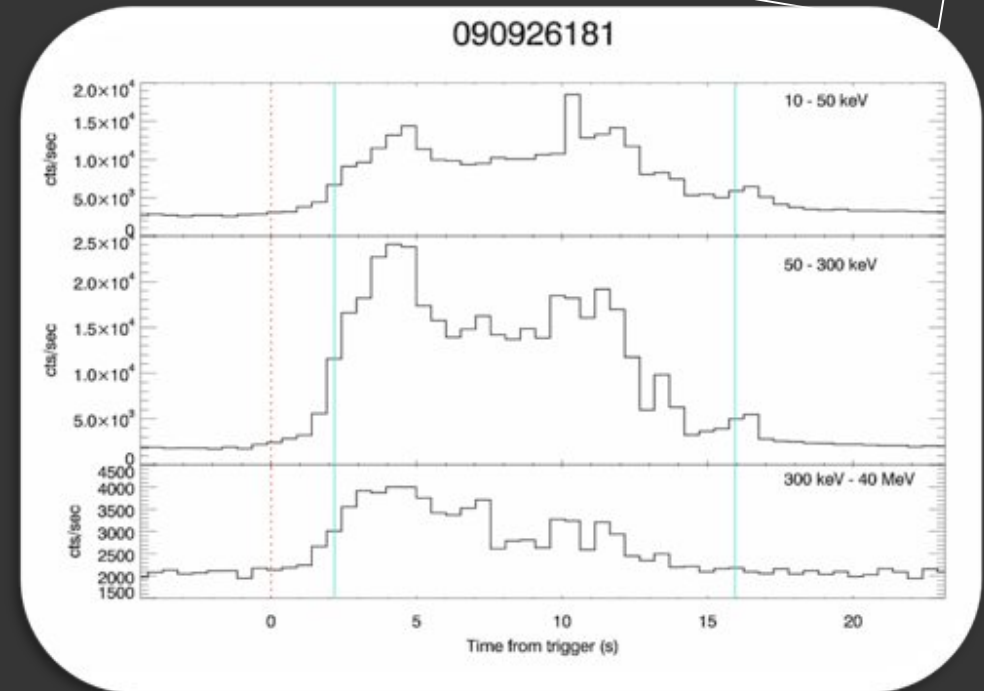
- ◆ Locations
 - RA, DEC
- ◆ Durations
 - (T_{50} , T_{90}) in 50–300 keV
- ◆ Peak flux (ph/cm²s)
 - 64 ms, 256 ms, 1024 ms
 - 50 – 300 keV, 10 – 1000 keV
- ◆ Fluence (erg/cm²)
 - 50 – 300 keV, 10 – 1000 keV
- ◆ Light curves ⇒

http://gammaray.nsstc.nasa.gov/gbm/science/grbs/month_listings/
(2008 07 – 2010 07)

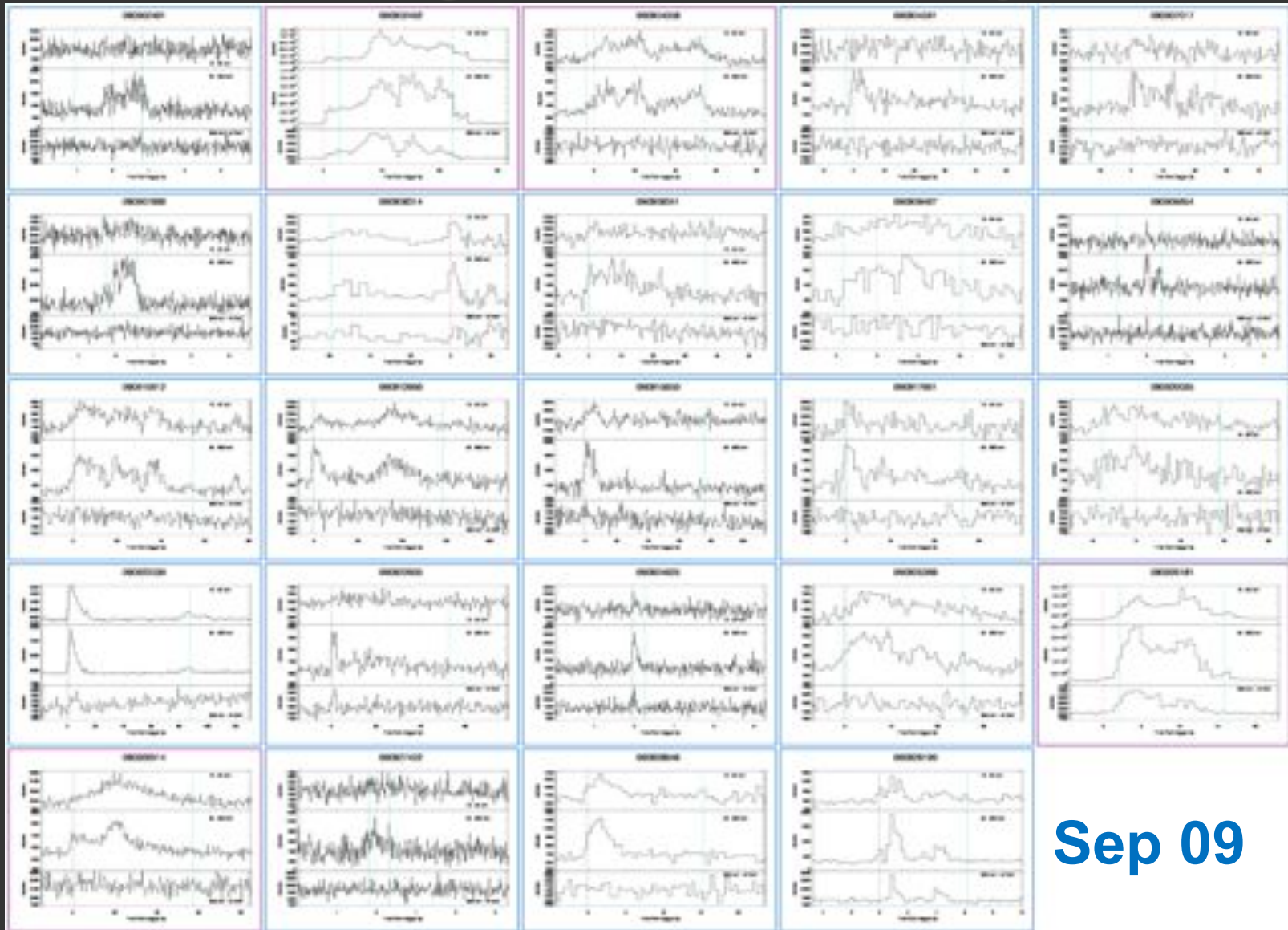
- ◆ Catalog results are accessible on-line through FSSC ⇒

<http://heasarc.gsfc.nasa.gov/W3Browse/fermi/fermigbrst.html>

Year 1 & 2 Catalog:
Paciesas, W.S. et al. 2012 ApJS 199, 18
Year 3 & 4 Catalog:
von Kienlin, A. et al. → in preparation



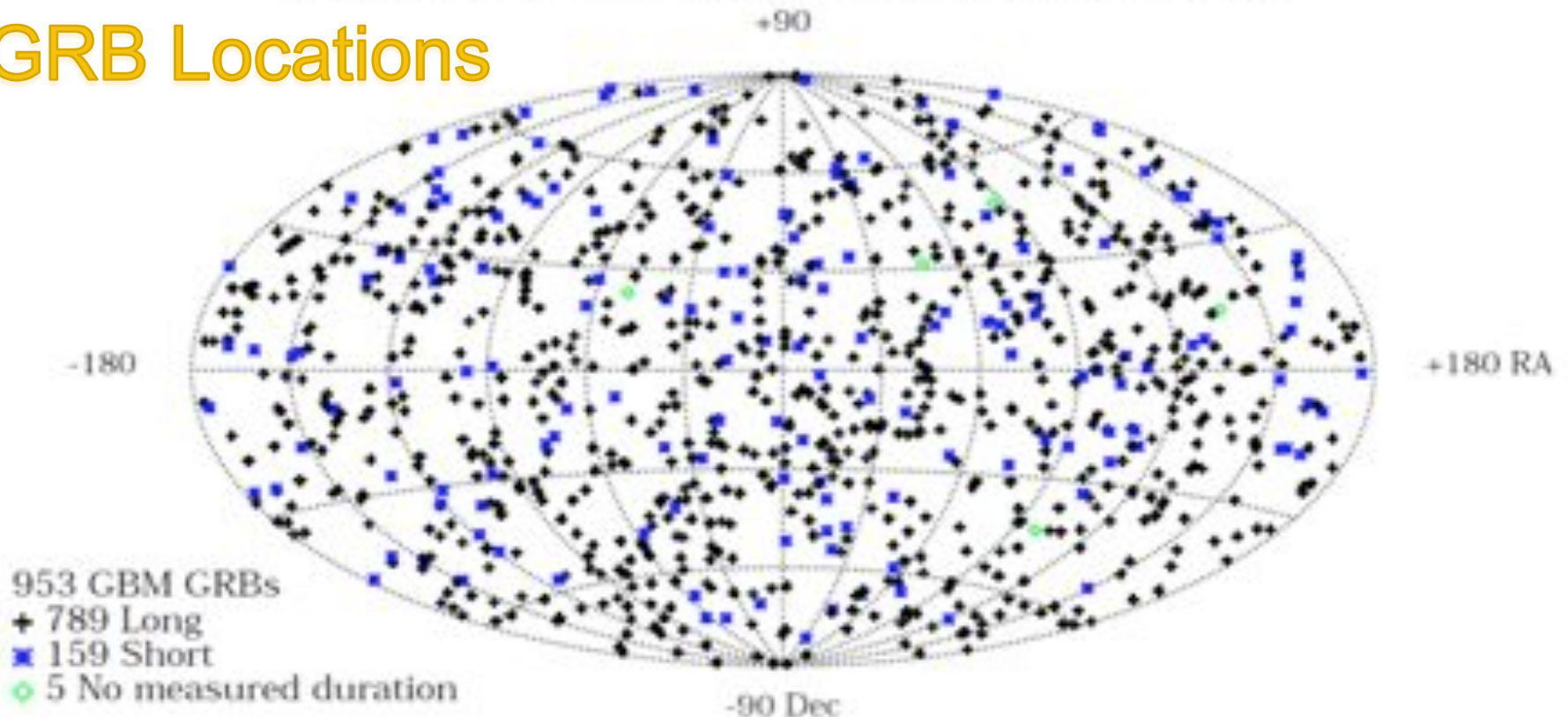
GBM GRB Lightcurves Month by Month



⇒ http://gammarray.nsstc.nasa.gov/gbm/science/grbs/month_listings/

GRB Locations

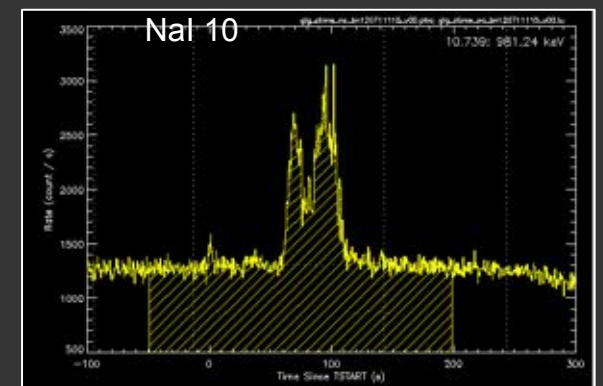
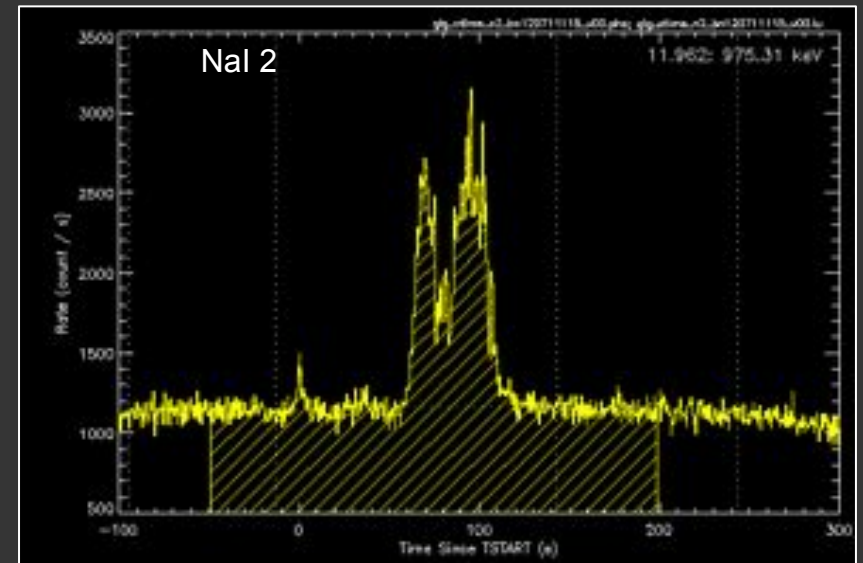
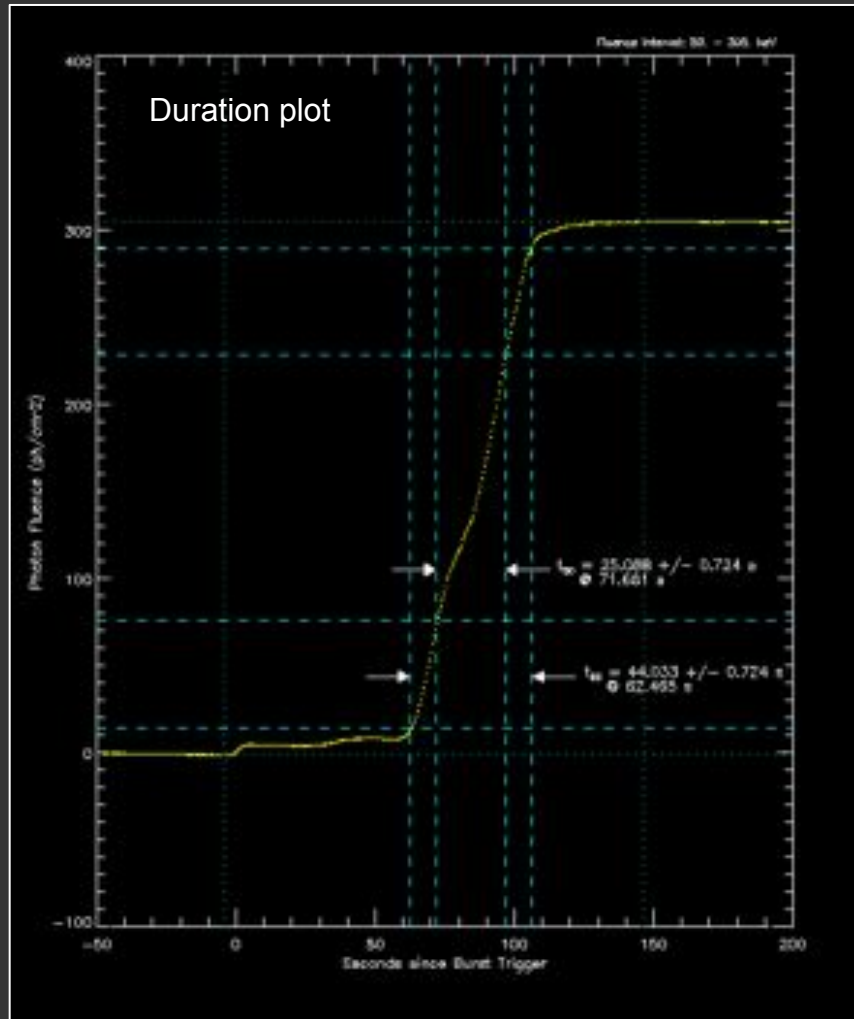
Fermi GBM GRBs in first four years of operation



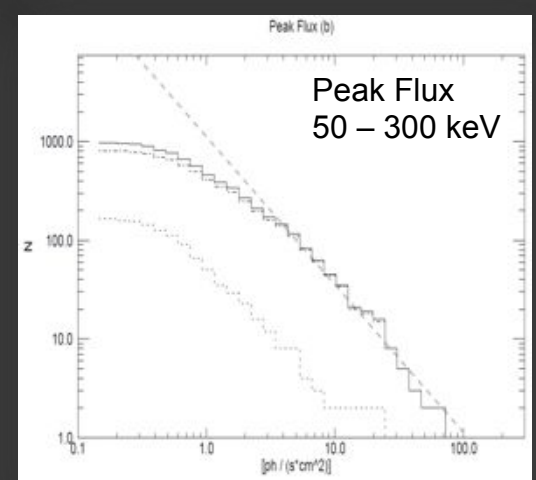
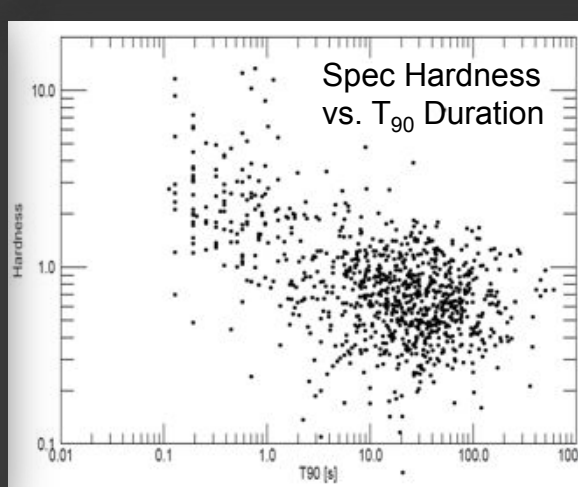
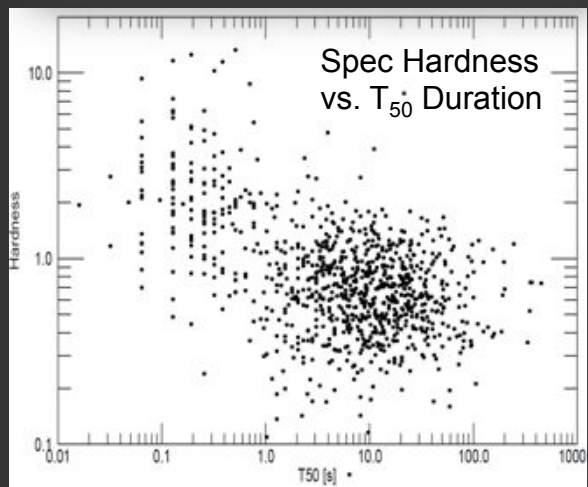
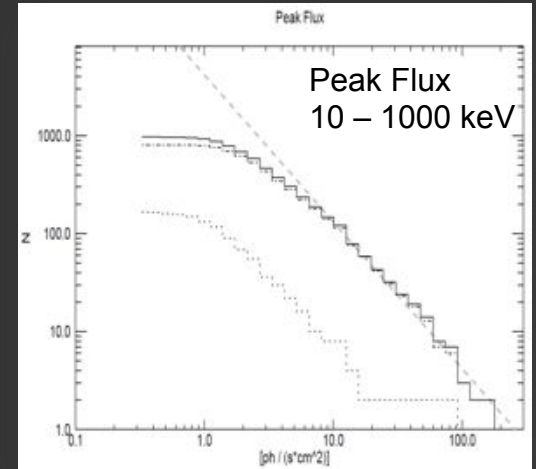
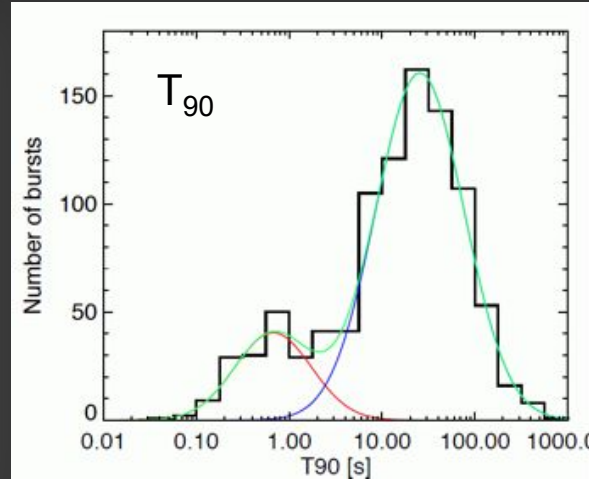
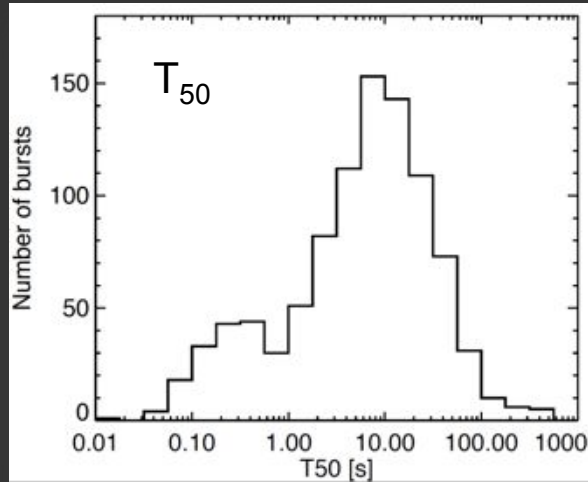
- ◆ Accuracy of the GBM burst localizations / GBM human-in-the-loop location errors:
 - derived by comparing with *Swift*, *INTEGRAL*, IPN, ... locations
 - best described by combining the statistical error in quadrature with a systematic error ⇨
 - **current best model for systematic errors**: a Gaussian with a long tail on one side
 - ▶ Gaussian of 3° models about 90% of the GRBs (at the 68% CL), and the long tail containing 10% goes out beyond 10° (Connaughton, V. et al. in preparation)
 - Hurley et al. (in prep) for the IPN-localized sample

Duration, peak flux & fluence estimate

- ◆ Using CTIME data: counts spectrum in each 64ms time bin is deconvolved and T, P, F are computed from the time history of fitted photon spectra (Compt model)
- ◆ example: GRB 120711A / Trigger bn12071115 (the INTEGRAL GRB)



GRB T_{90} -, T_{50} -Durations, Flux & Fluence



⇒ Data from Year 1 - 4

GBM GRB Spectral catalogs

- ◆ The “Peak Flux and Fluence” Spectral Catalog:

- Two Spectra from all but the weakest GRBs:
 - ▶ 1.024 s Peak Flux Spectrum \Rightarrow Long GRB
 - ▶ 64 ms Peak Flux Spectrum \Rightarrow Short GRB
 - ▶ > 3.5 sigma integrated Fluence Spectrum
 - ▶ Year 1 & 2: 487 GRBs, ~3800 spectra
 - ▶ Year 3 & 4: ~450 GRBs, ~3600 spectra
- BATSE Heritage: Mallozzi et al. 1995; Goldstein et al. 2012

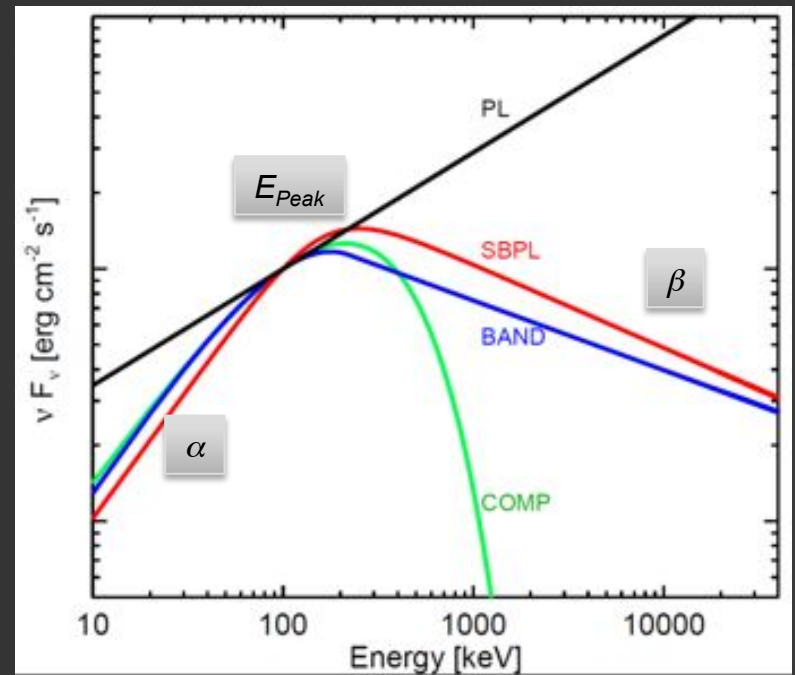
- ◆ Four Spectral Models Fit to each spectrum:

- Power Law: A & α
- Exponentially-attenuated Power Law (“Comptonized”): A , α & E_{peak}
- Band function: A , α , β & E_{peak}
- Smoothly-Broken Power Law: A , α , β , Δ & E_{break}
 - ▶ For current analysis Δ fixed to 0.3!

- ◆ Catalog results are accessible on-line through FSSC

Year 1 & 2 Spectral Catalog:
Goldstein, A. et al. 2012 ApJS 199, 19

Year 3 & 4 Spectral Catalog:
Gruber, D. et al. \rightarrow in preparation

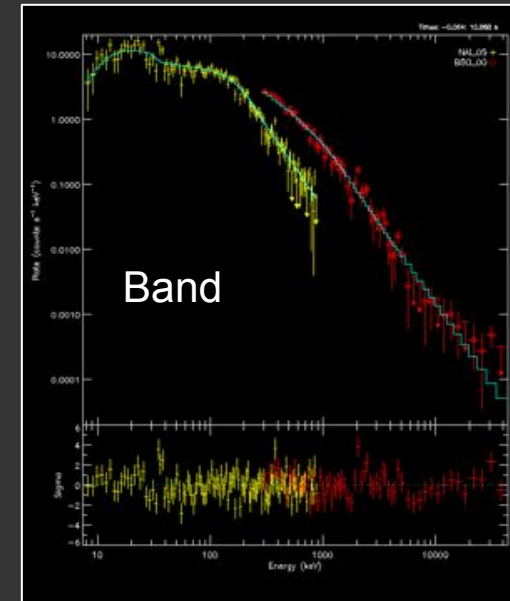
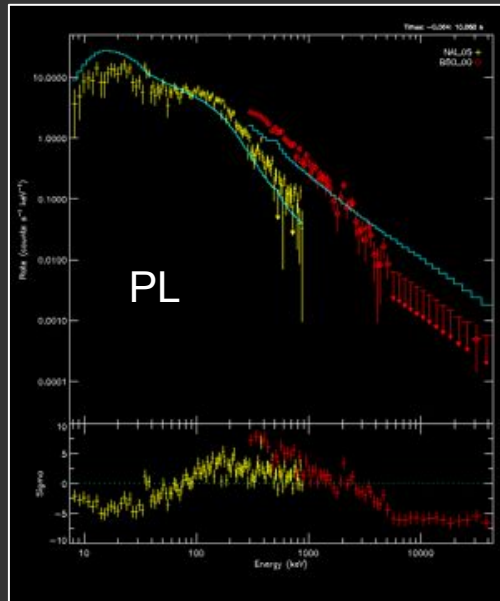
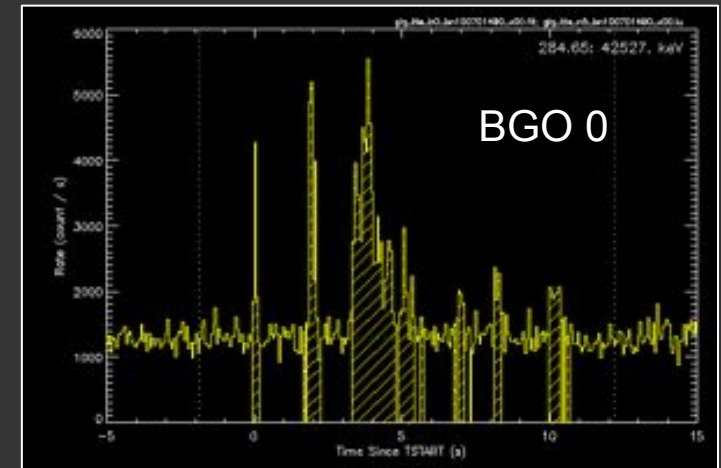
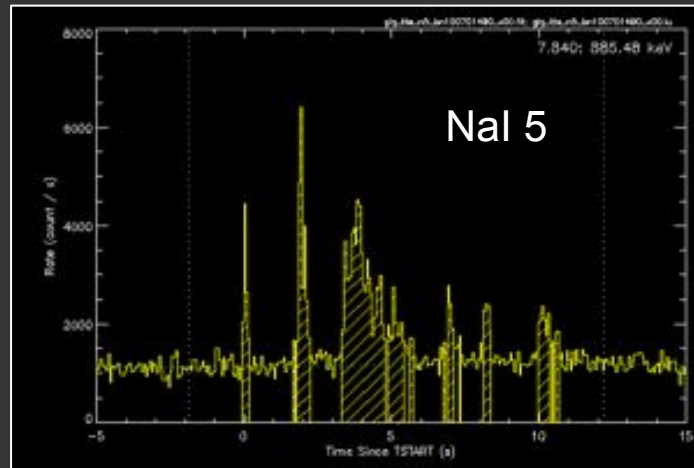


Method

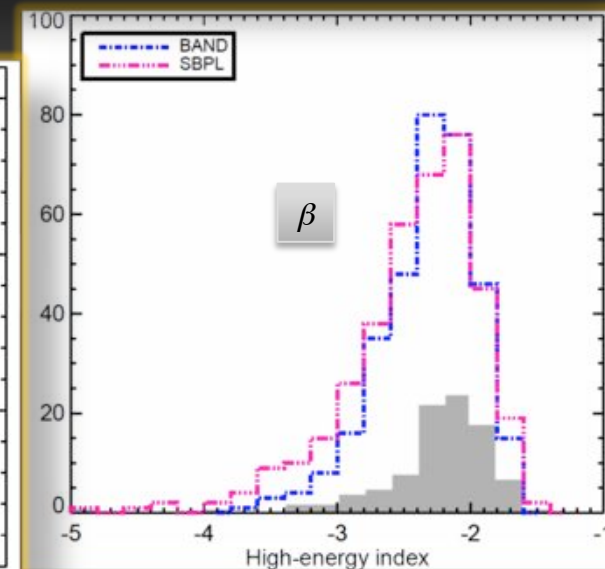
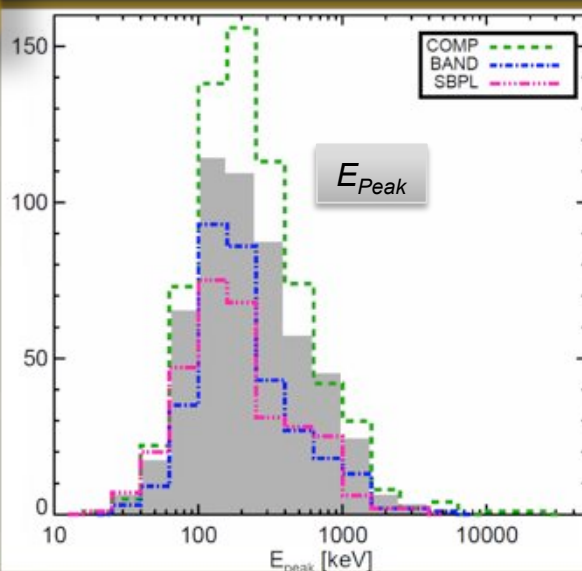
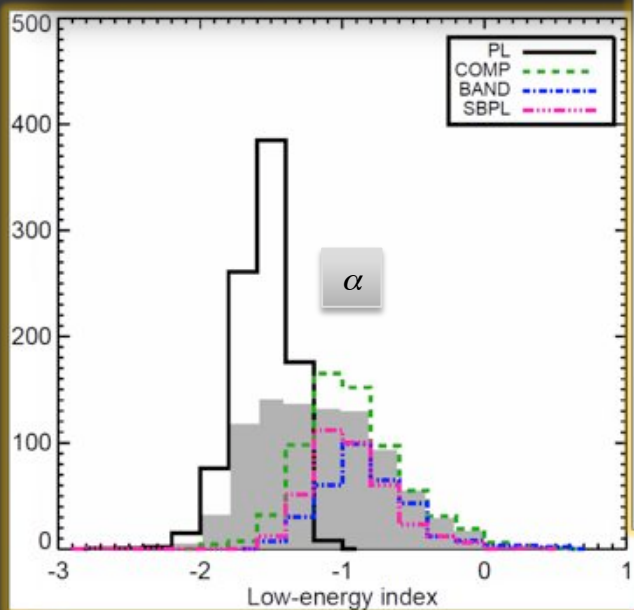
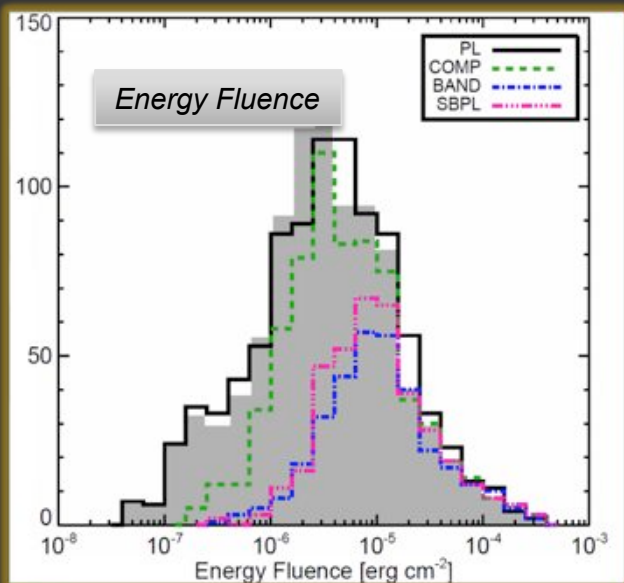
- Source selection for fluence spectra: only time bins with $S/N > 3.5\sigma$

GRB 100701.409

TTE data, 64 ms binning



Catalog Results



GOOD sample:

⇒ Data cuts for well constrained parameters

- ▶ Low-energy PL indices: errors less 0.4
- ▶ High-energy PL indices: errors less than 1.0
- ▶ Amplitude, E_{peak} : relative error < 0.4

Best Sample: (plots: grey shaded)

⇒ Selection of preferred model (one model for each burst)

- ▶ More complex model is preferred, only if all fit parameters are constrained (see above)
- ▶ Otherwise a statistically simpler model is used

Year 3 & 4 spectral catalog
Gruber, D. et al. → in preparation

GBM GRB Catalog Summary

- ◆ GRBs
 - Full year 1 to 4 sample: location, duration, peak flux, fluence
 - 953 GRBs ! Year 3 & 4: 462 GRBS
 - Analysis done, expect to submit paper soon
- ◆ GRB Spectra
 - Nearly full sample: peak flux & fluence spectra
 - Four spectral models
 - Year 1 to 4 analysis in progress, expect to submit paper early 2013
- ◆ All results are available at FSSC

Outlook:

- ◆ The “Time-Resolved” Spectral Catalog for Bright Bursts:
 - At least two spectra for each burst, fit as a time sequence:
 - ▶ $> 15\sigma$ integration for each spectrum
 - ▶ Approximately 50 bursts per year
 - BATSE Heritage: Preece et al. 2000; Kaneko et al. 2006