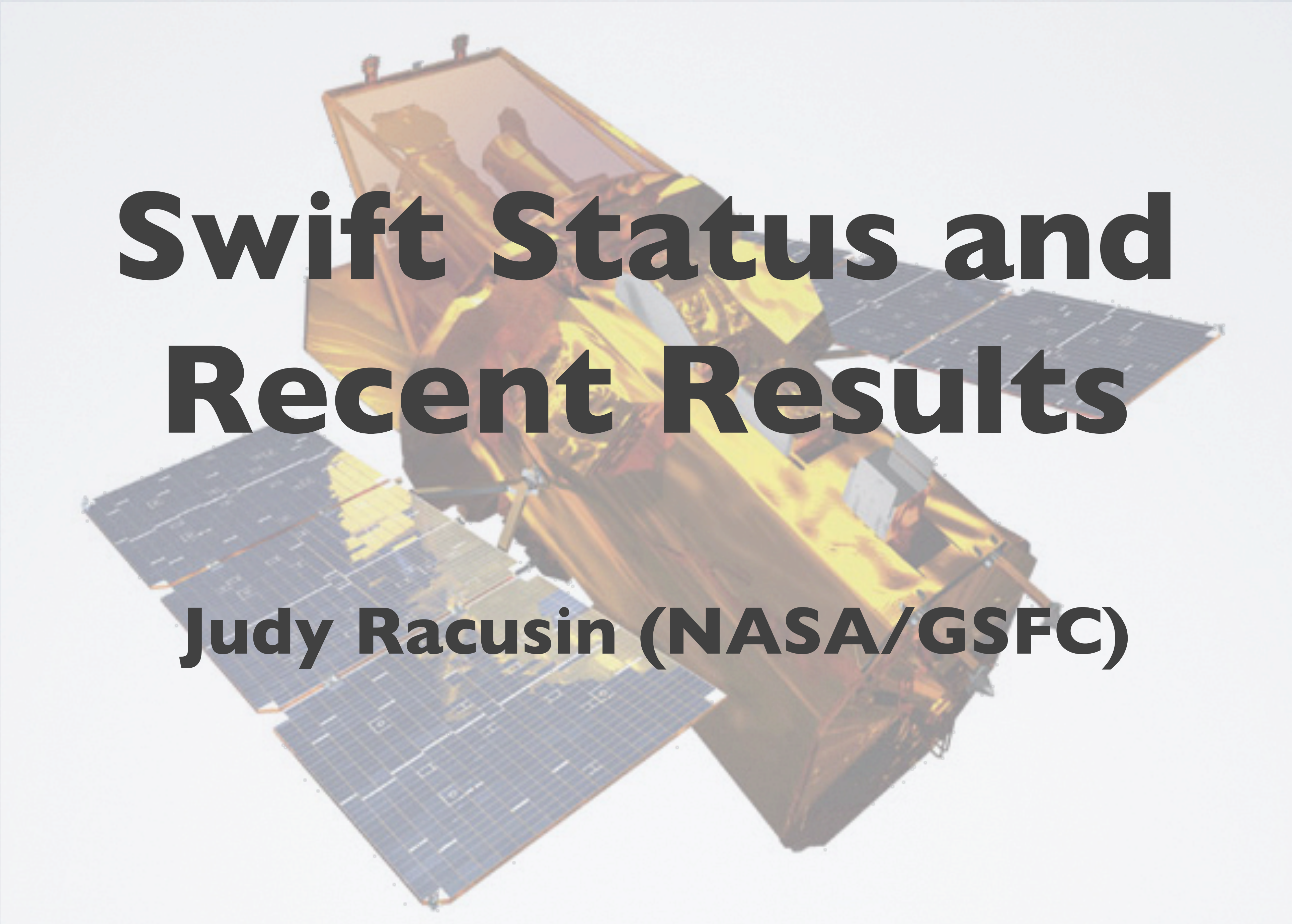


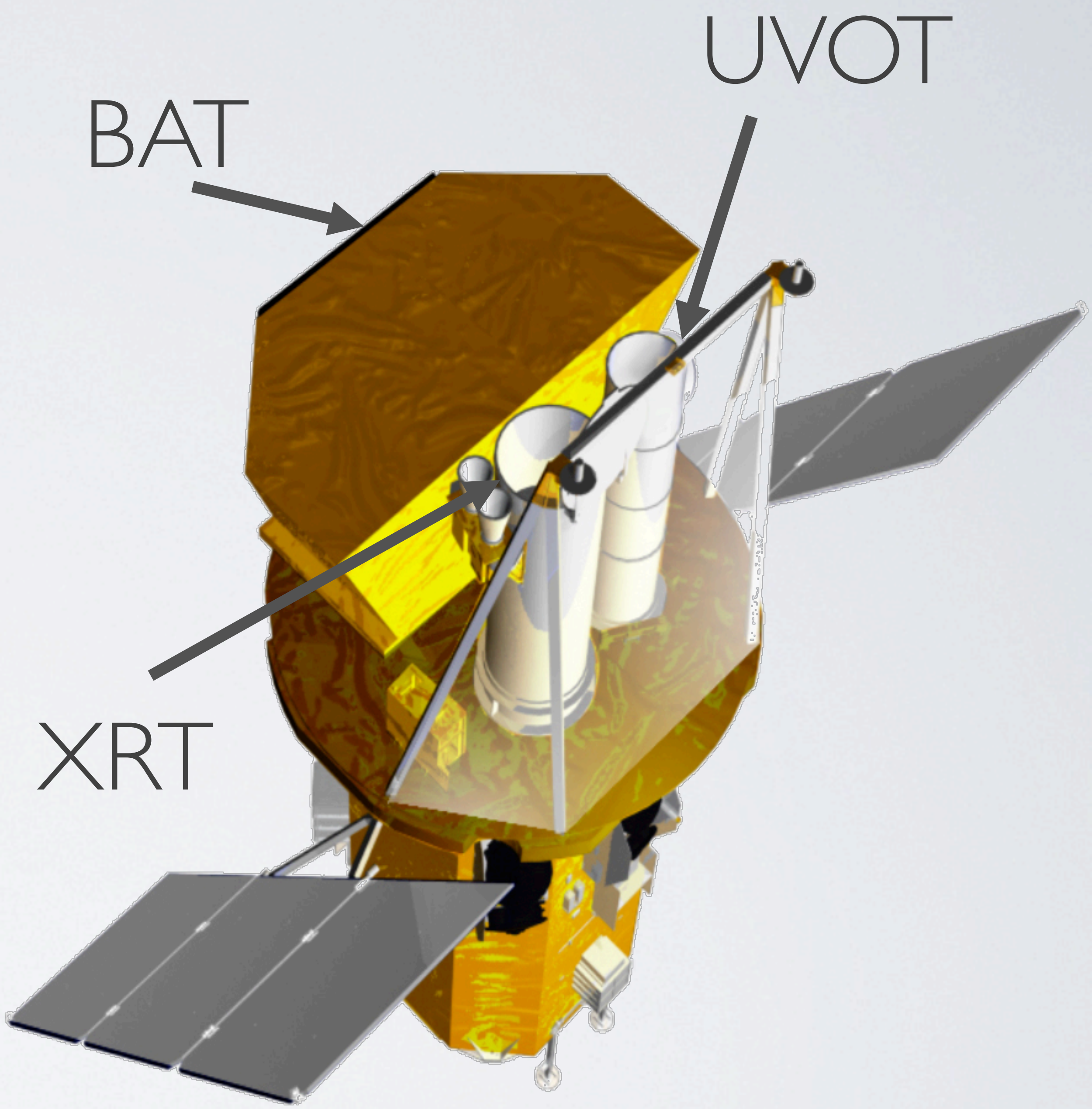
Swift Status and Recent Results

Judy Racusin (NASA/GSFC)

Fermi/Swift GRB Conference 2012, Munich Germany, May 7-11, 2012

Swift Status

- NASA's Astrophysics Senior Review recommends funding Swift through 2016
- BAT, XRT, and UVOT are all operating nominally
- Observatory still in excellent condition (orbit good >2025)
- Interesting and unusual GRBs and other transients continue to surprise us



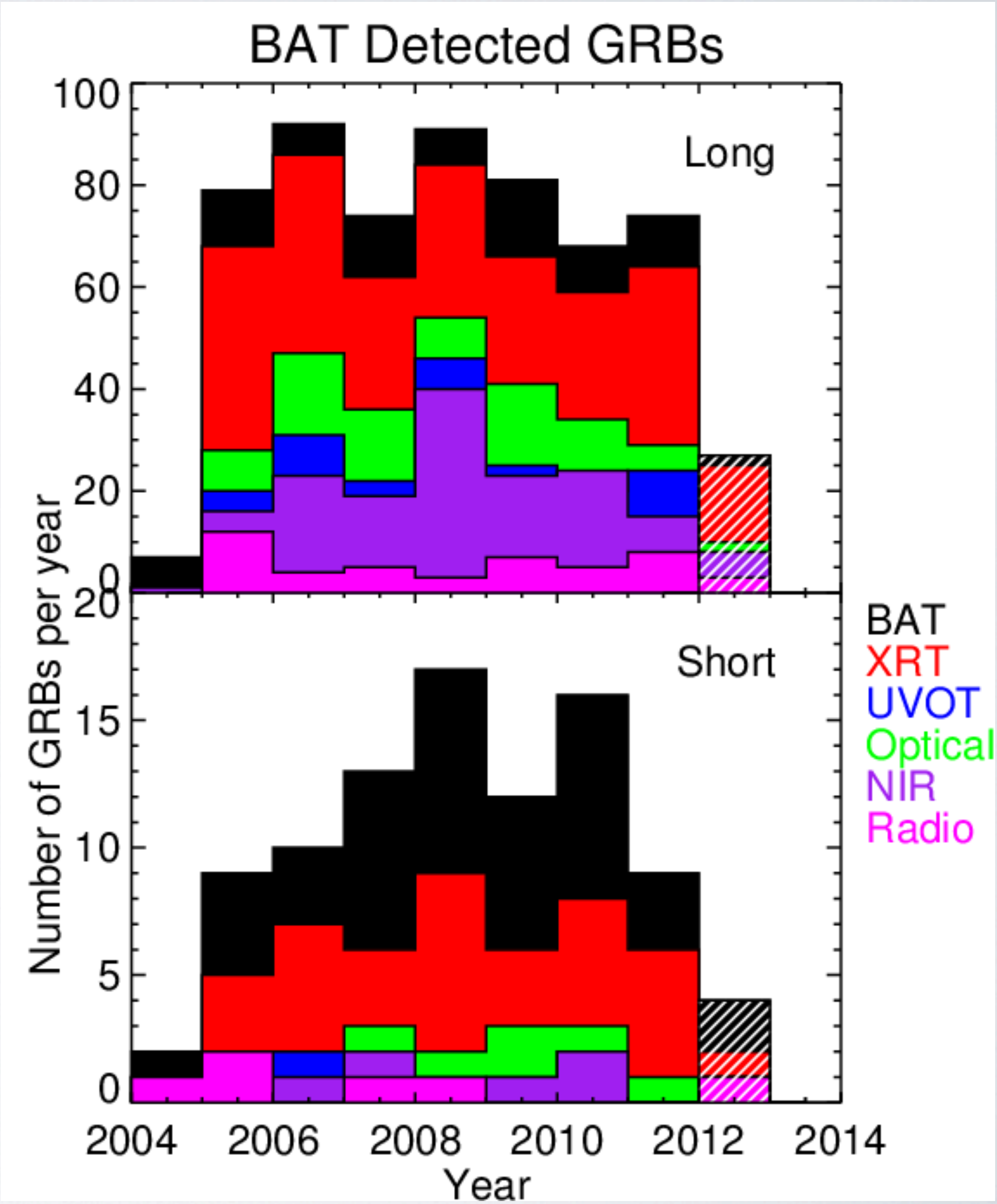
Swift GRB Statistics

	Total	Long	Short
BAT	686	593	92
XRT	564 (82%)	515 (87%)	49 (53%)
XRT (t_{obs}<200 s)	443 (97%)	407 (100%)*	36 (72%)*
UVOT	206 (30%)	196 (33%)	10 (11%)
UVOT (t_{obs}<200 s)	168 (38%)	161 (41%)*	7 (15%)*
Optical	298 (44%)	280 (47%)	18 (20%)
NIR	179 (26%)	169 (28%)	10 (11%)
Radio	53 (8%)	47 (8%)	6 (7%)
Swift Follow-up	113	--	--
Redshifts	199 (29%)	192 (32%)	7 (8%)

(xx%) - $N_{instrument}/N_{BAT}$ %

* fraction of bursts detected if observations started in 200 s

non-BAT bursts (Integral, HETE-2, IPN, AGILE, Fermi-LAT/GBM) followed up by XRT/UVOT



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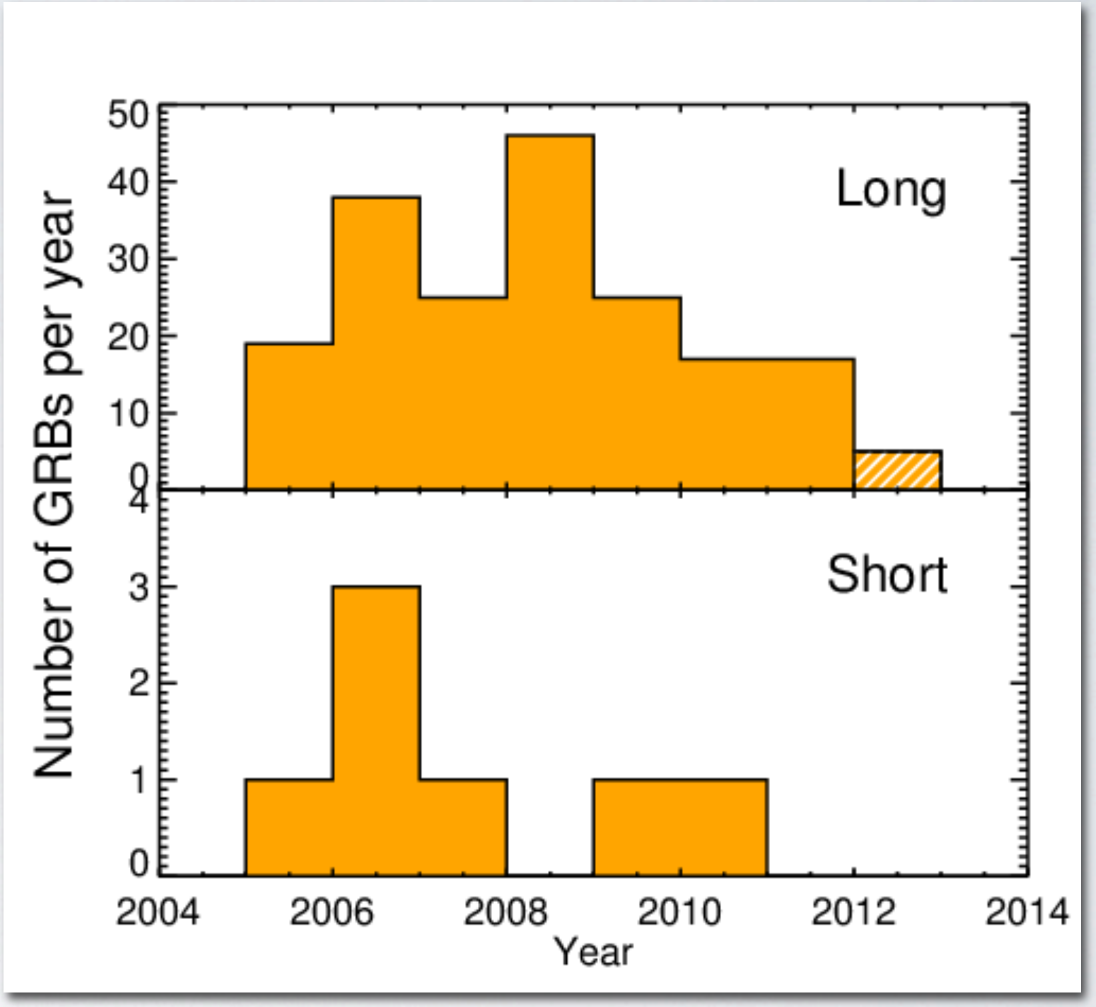
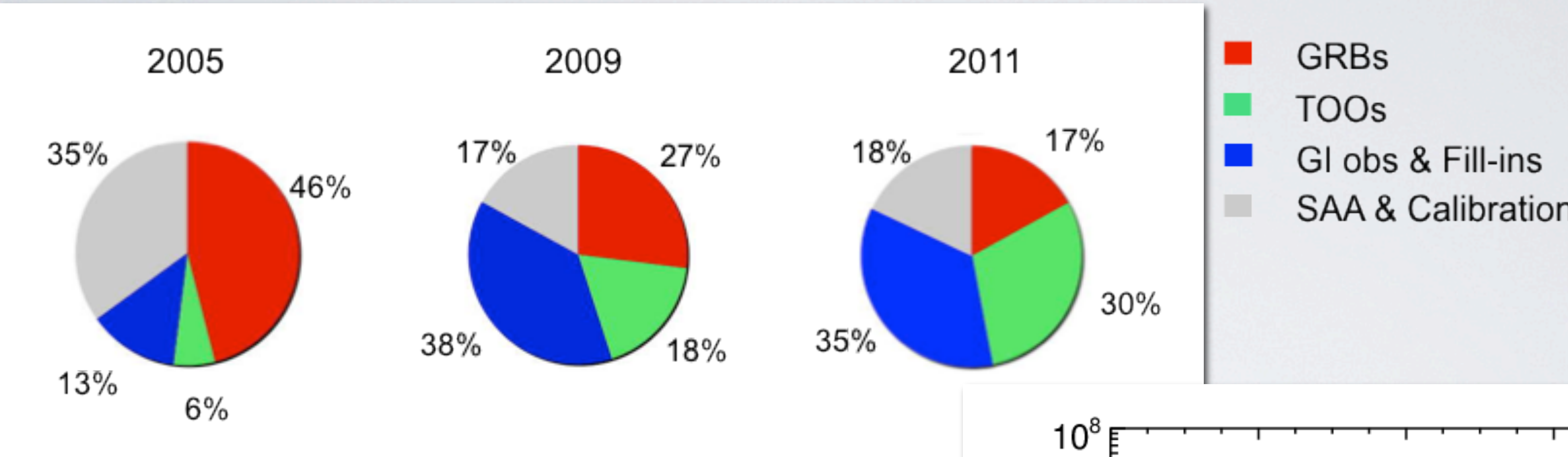
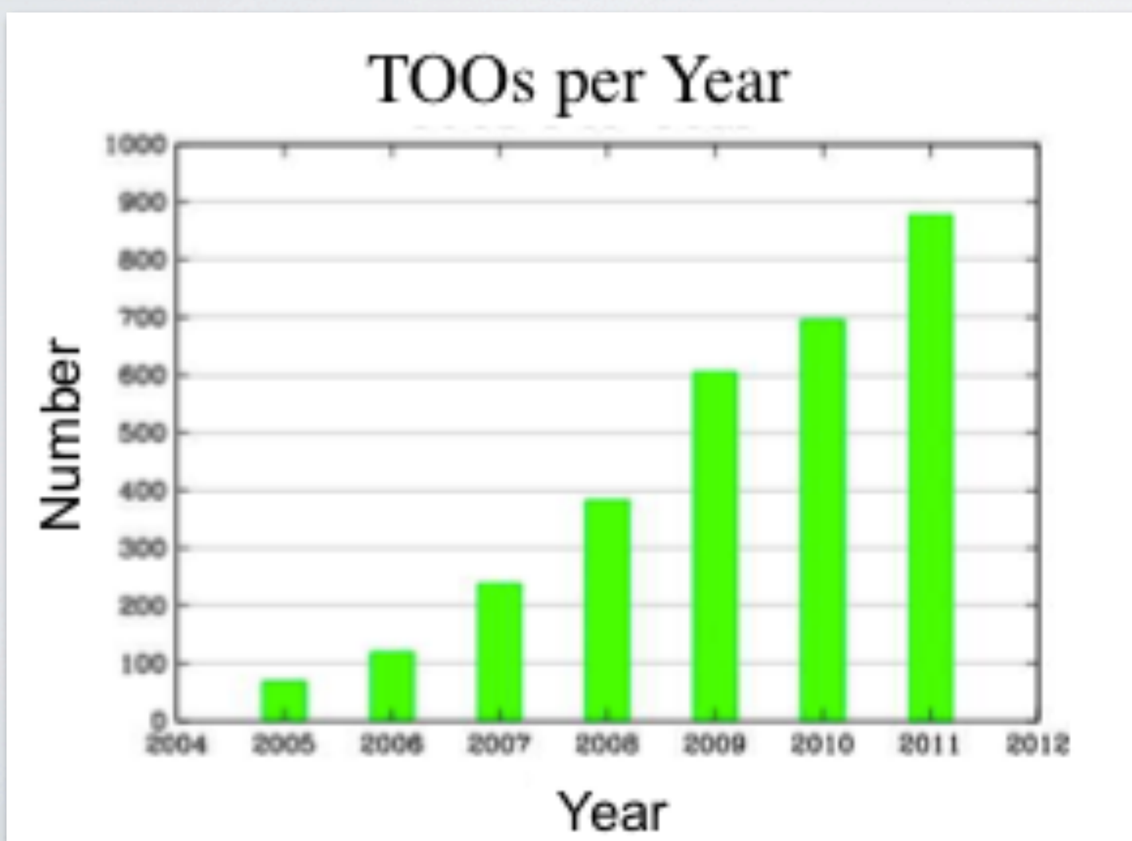
Redshift

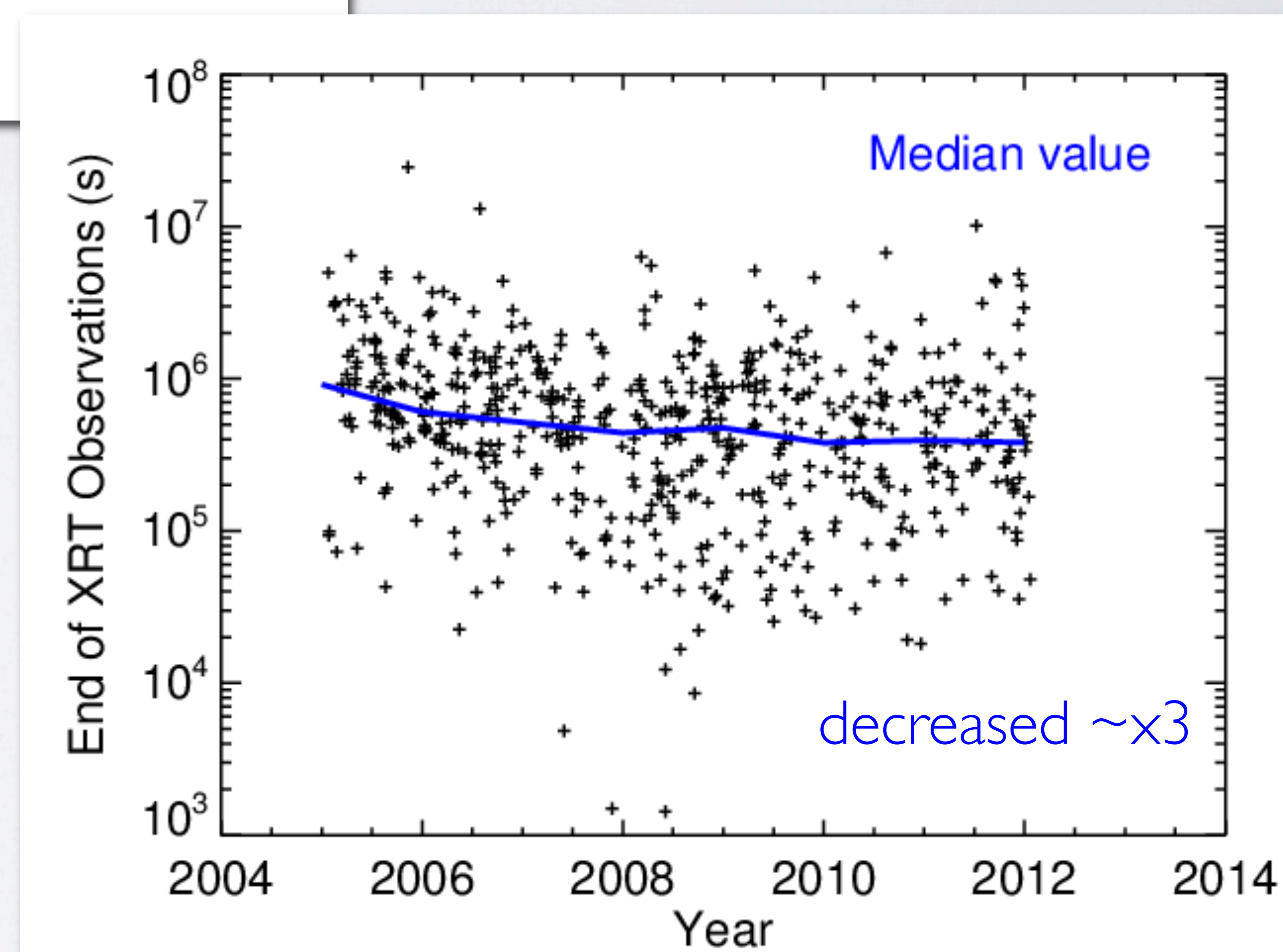


- Why the decrease?
  - Anti-Sun Swift pointing variations?
  - Difference in follow-up strategy?

Evolving Observing Time



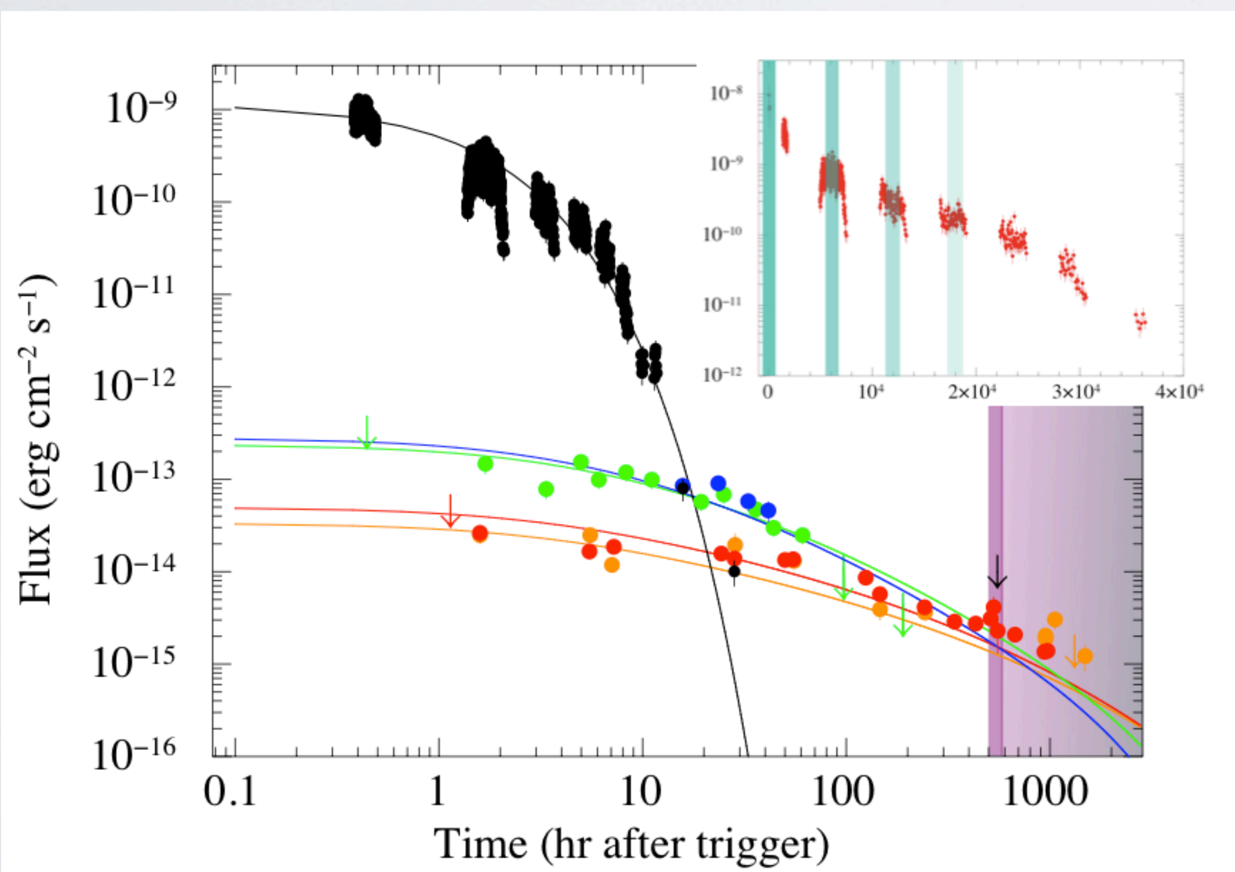




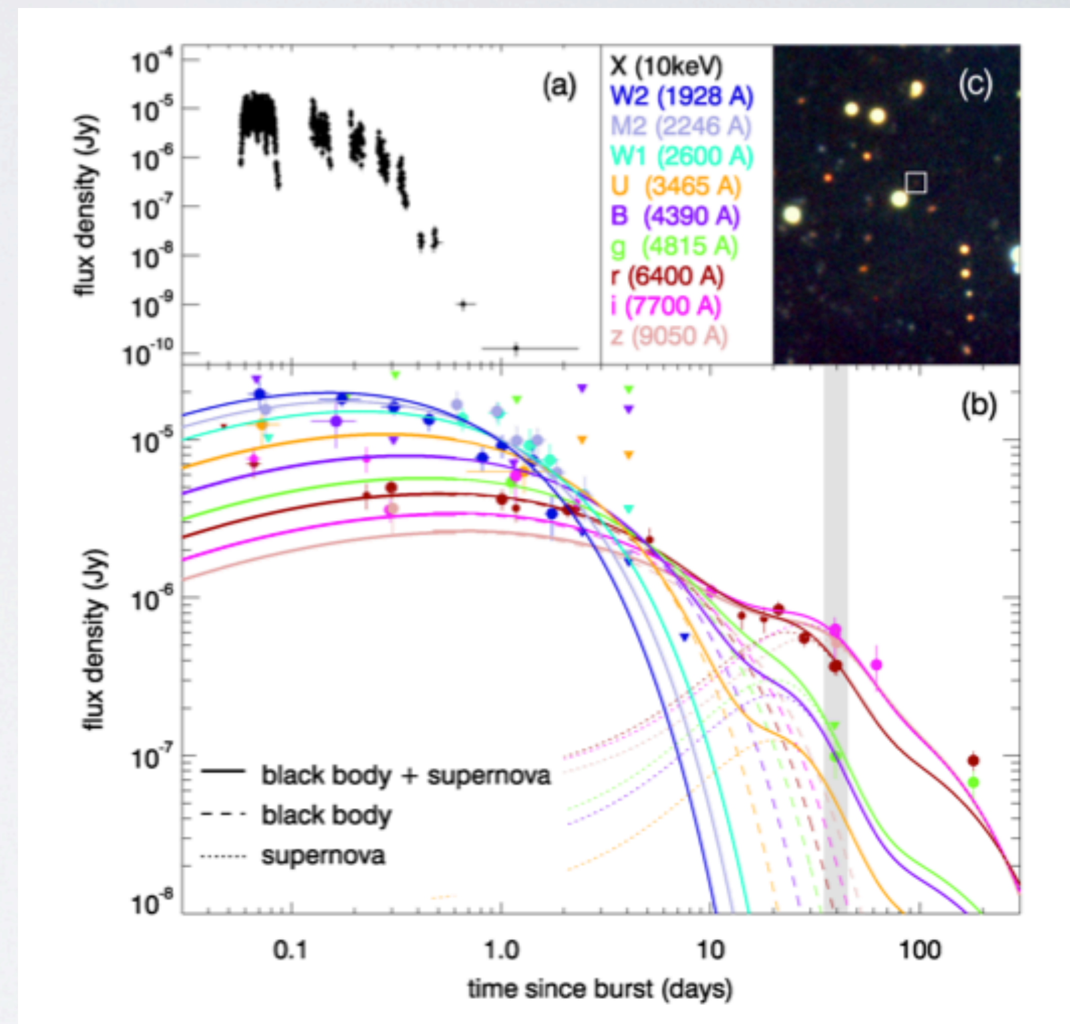
Exceptionally Long and Unusual GRB 101225A

$T_{90} > 2000$ s, blue continuum spectrum, soft thermal component, no obvious host

Tidal Disruption of a minor body falling into a neutron star in our Galaxy



Campana et al. 2011



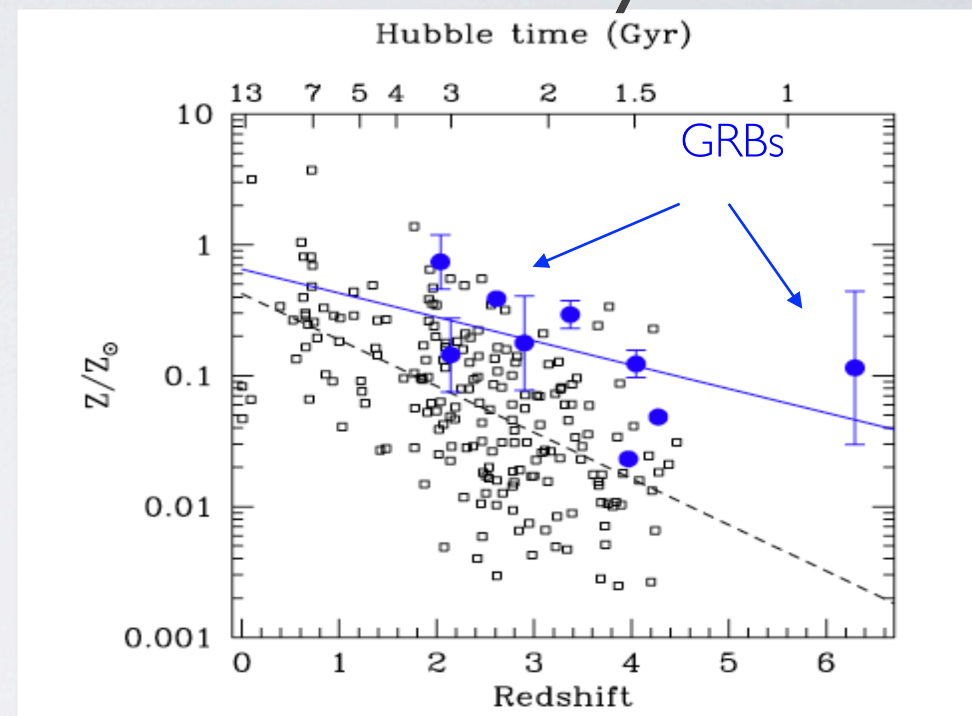
Thöne et al. 2011

Helium star – neutron star merger led to GRB-like jet and SN at z=0.3

High-Redshift GRBs

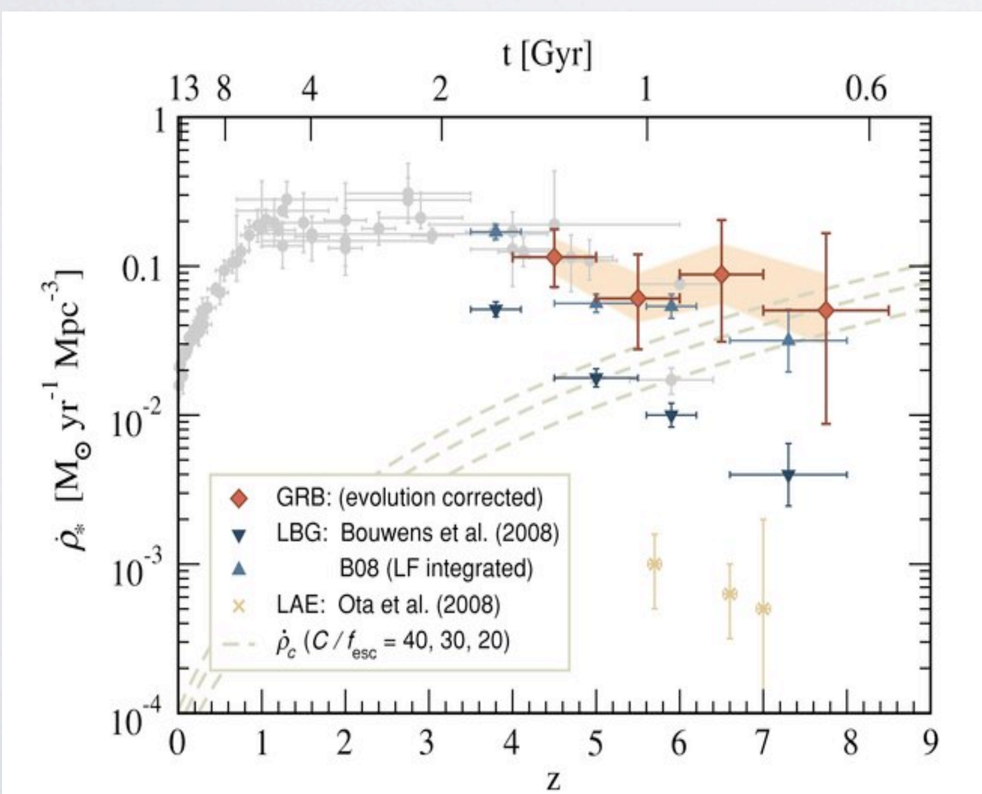
z	GRB	Optical Brightness
9.4	090429B	K = 19 @ 3 hrs
8.2	090423	K = 20 @ 20 min
6.7	080813	K = 19 @ 10 min
6.29	050904	J = 18 @ 3 hrs
5.6	060927	I = 16 @ 2 min
5.3	050814	K = 18 @ 23 hrs
5.11	060522	R = 21 @ 1.5 hrs

Metallicity



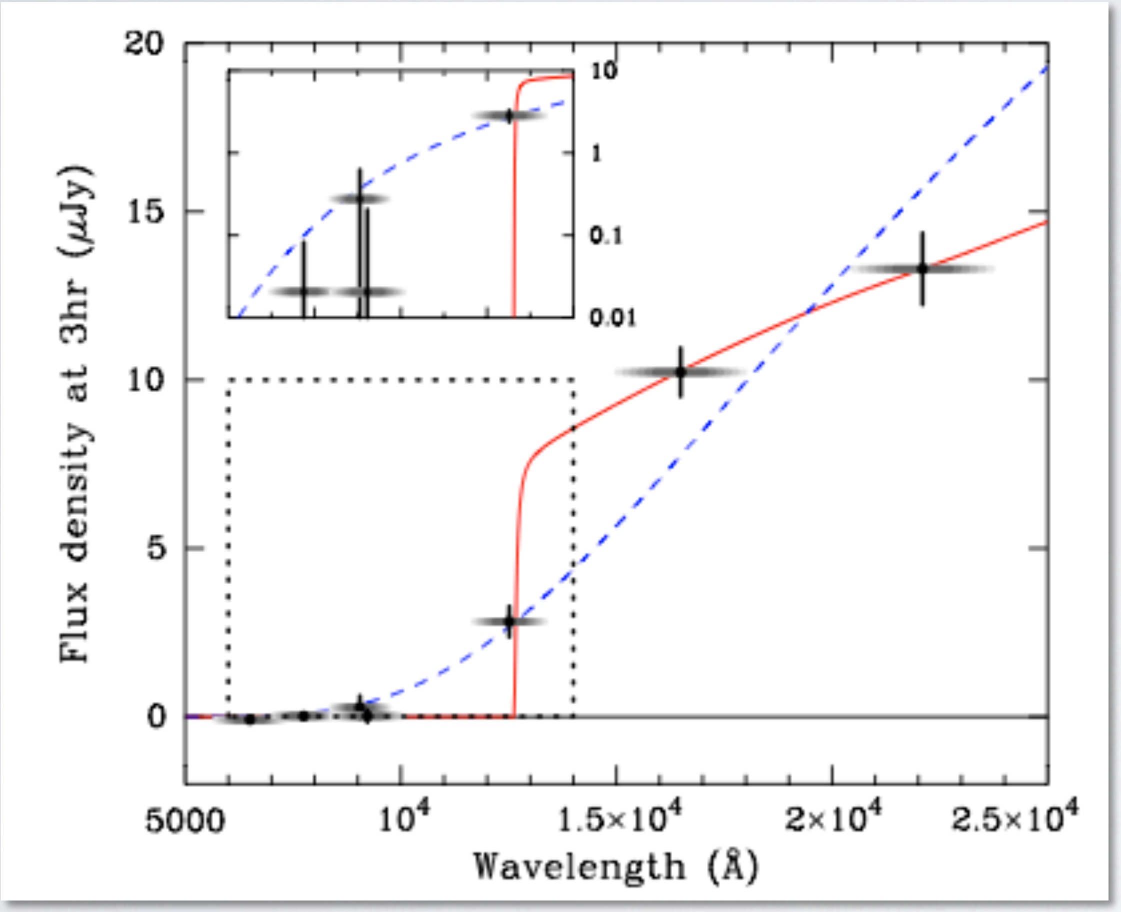
Savaglio 2006

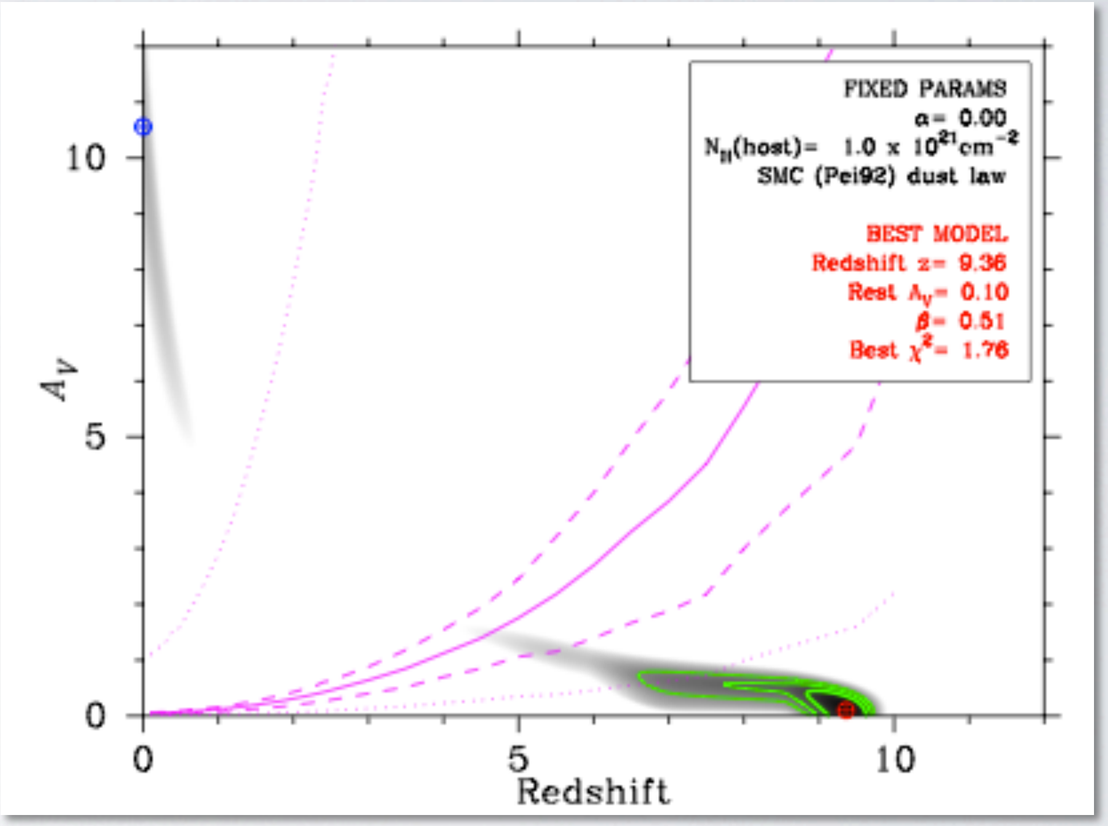
Star Formation Rate



Kistler et al. 2009;
Robertson & Ellis 2011

High-Redshift GRBs
GRB 090429B

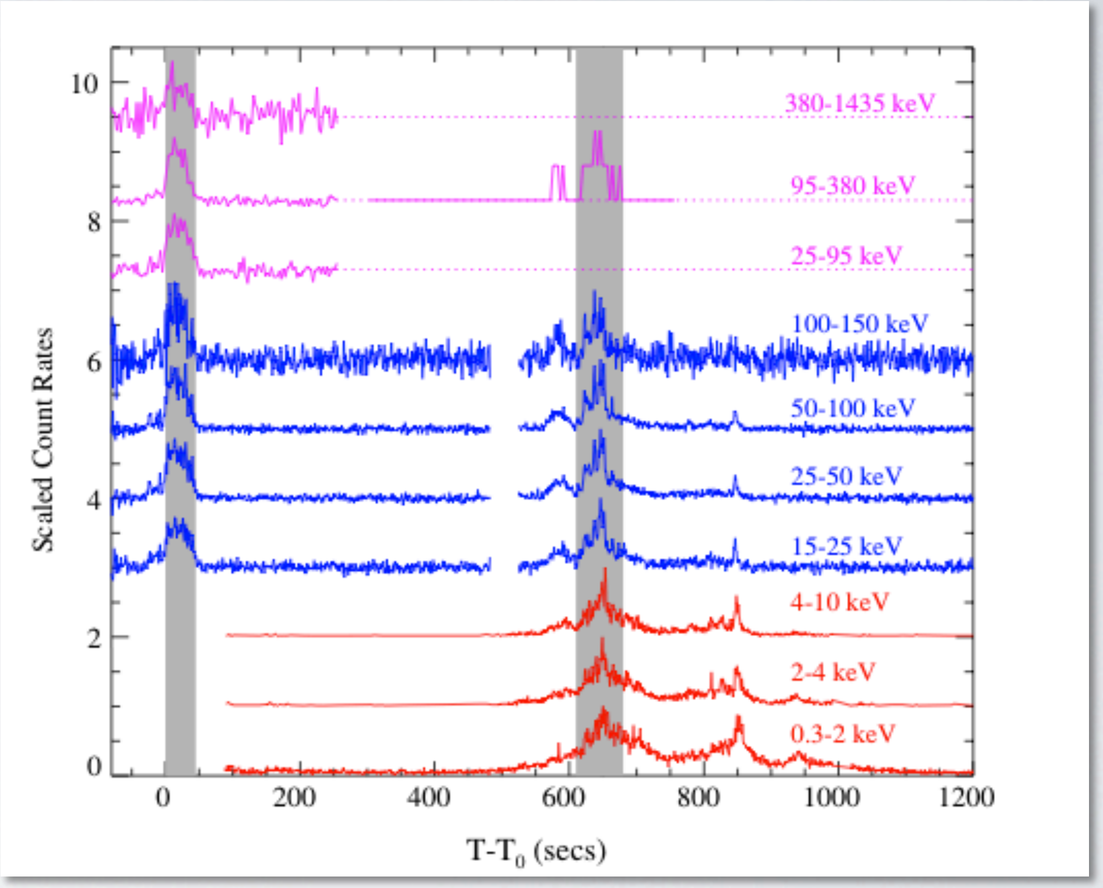


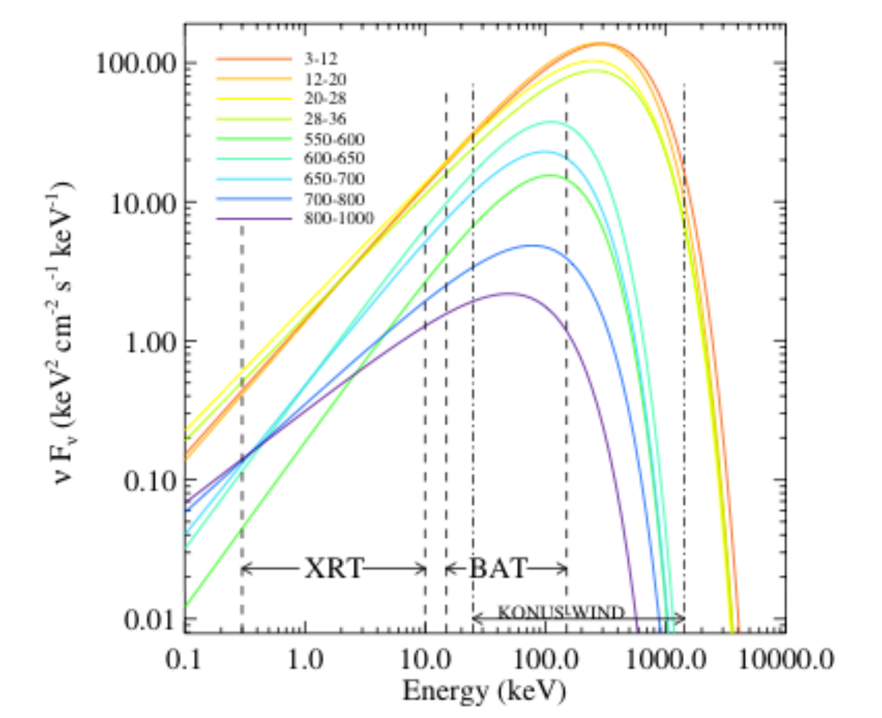


- Cucchiara et al. 2011
- photometric redshift with low and high-z solutions
- Lack of host galaxy and energetics support high-z hypothesis

Double Burst – GRB 110709B

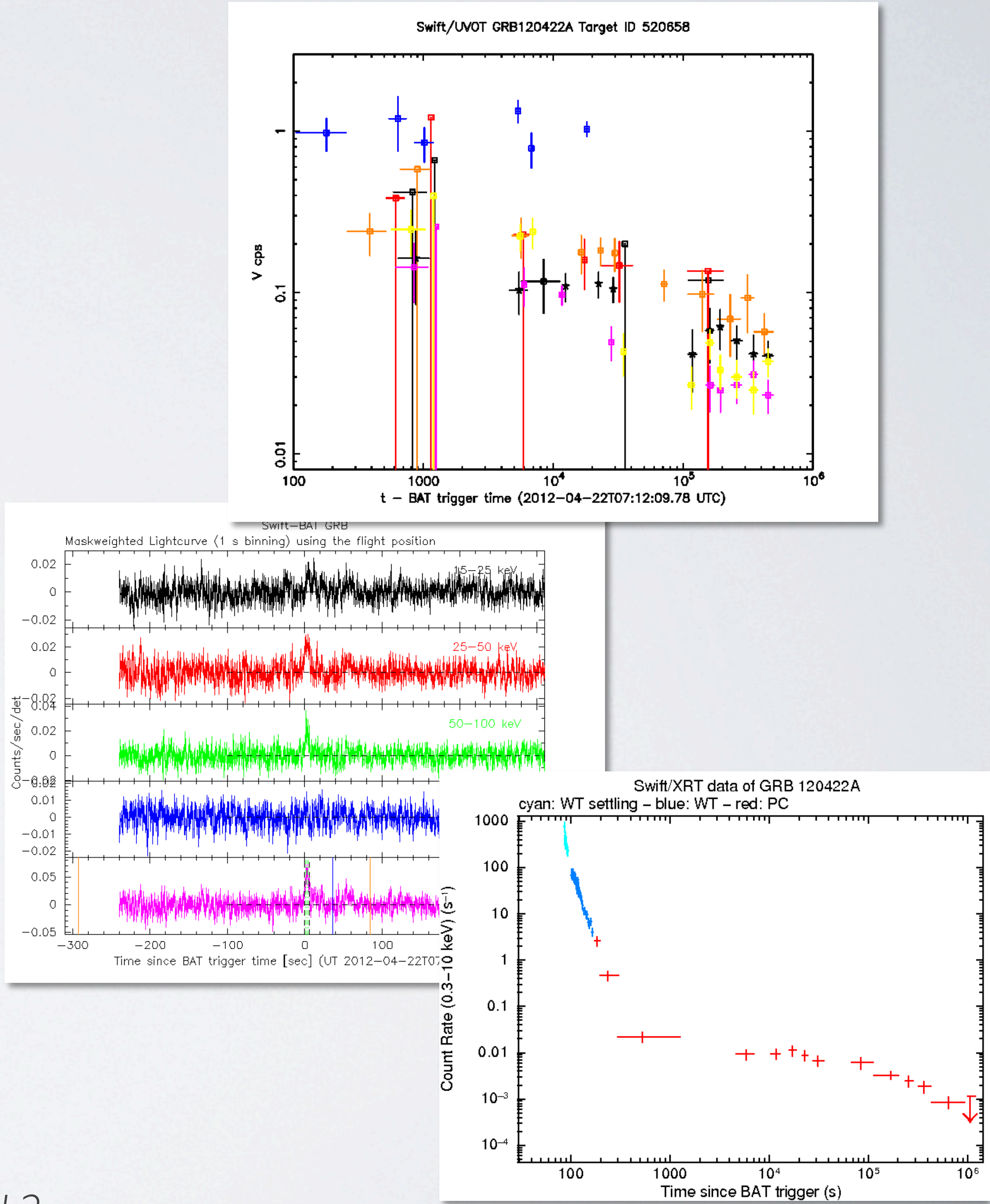
- Zhang et al. 2012
- Two BAT triggers similar intensity
- Spectral evolution suggests different episodes of the central engine
  - magnetar-to-BH accretion system





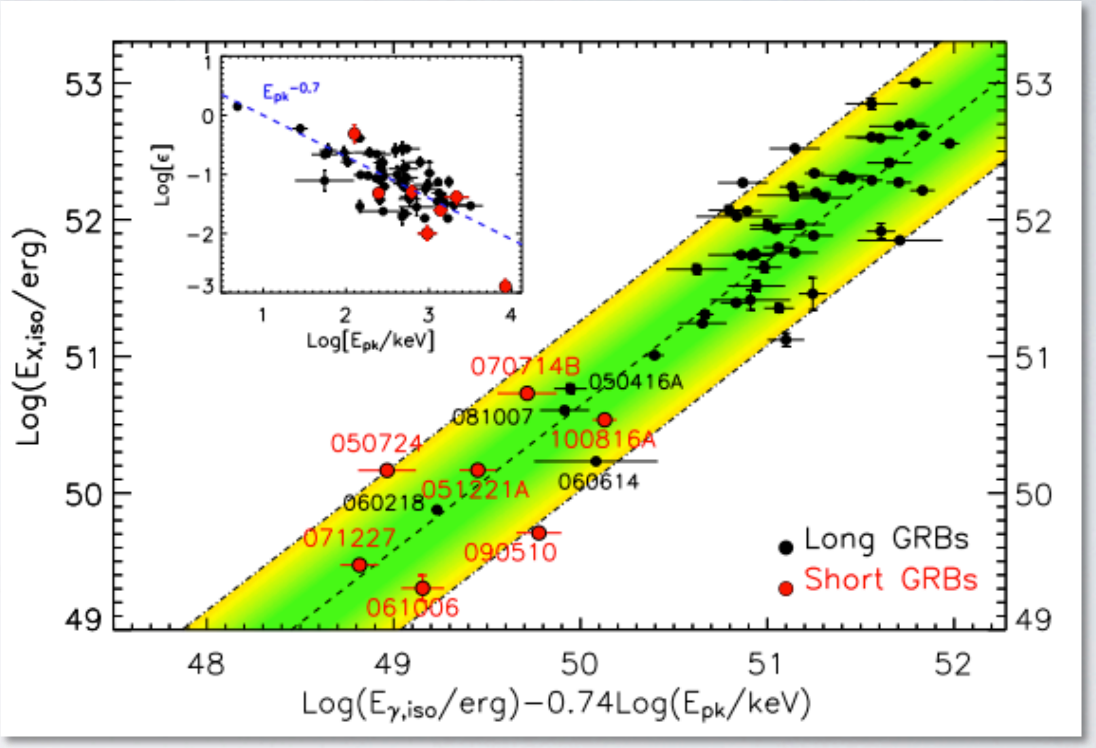
GRB 120422A - New SN GRB

- T90=5.4 s
- Nearby SDSS galaxy just outside XRT error circle (z=0.28)
- Many optical detections (photometry & spectroscopy), NIR, radio
- SN similar to 1998bw both photometric and spectroscopic (GCN 13276, 13277)
- Large 8 kpc offset and $>10^{21}$ cm^2 excess X-ray absorption

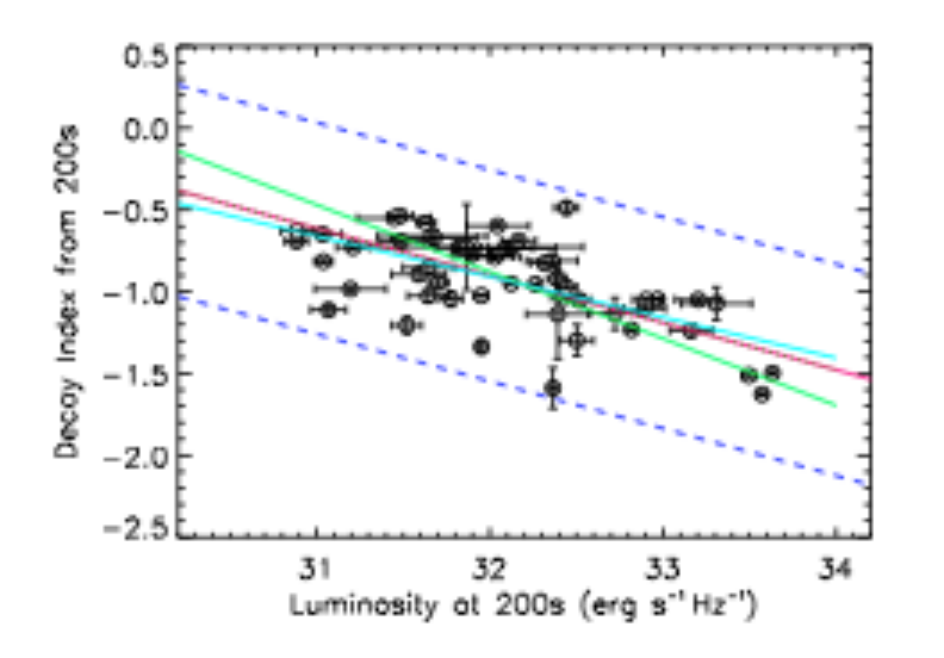


Rest Frame Afterglow Studies

- Margutti et al. 2012 (see talk Tuesday)
  - Analysis of ~650 X-ray afterglows
  - 85 with redshifts for rest-frame properties
  - Comparisons to prompt emission properties
- Oates et al. 2012, in-prep (see talk Tuesday)
  - 69 UVOT afterglows with redshifts
  - Correlations among rest-frame properties



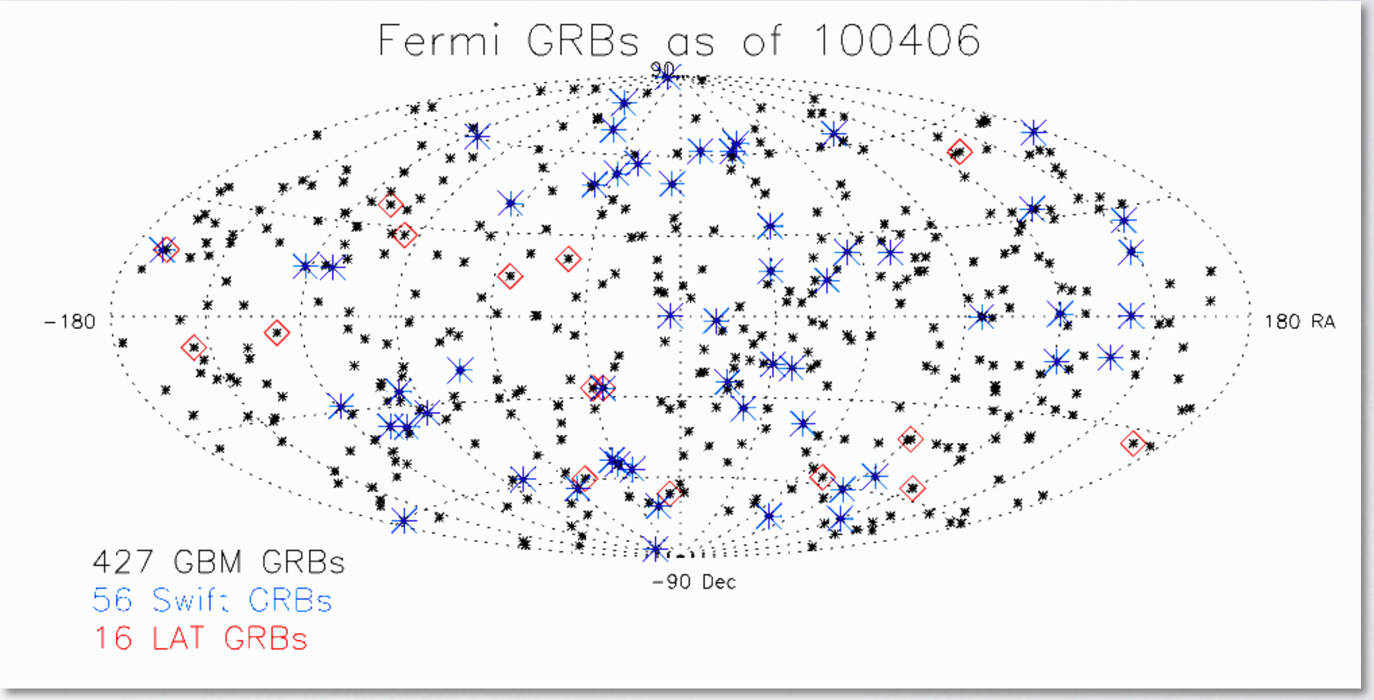
Margutti et al. 2012



Oates et al. 2012

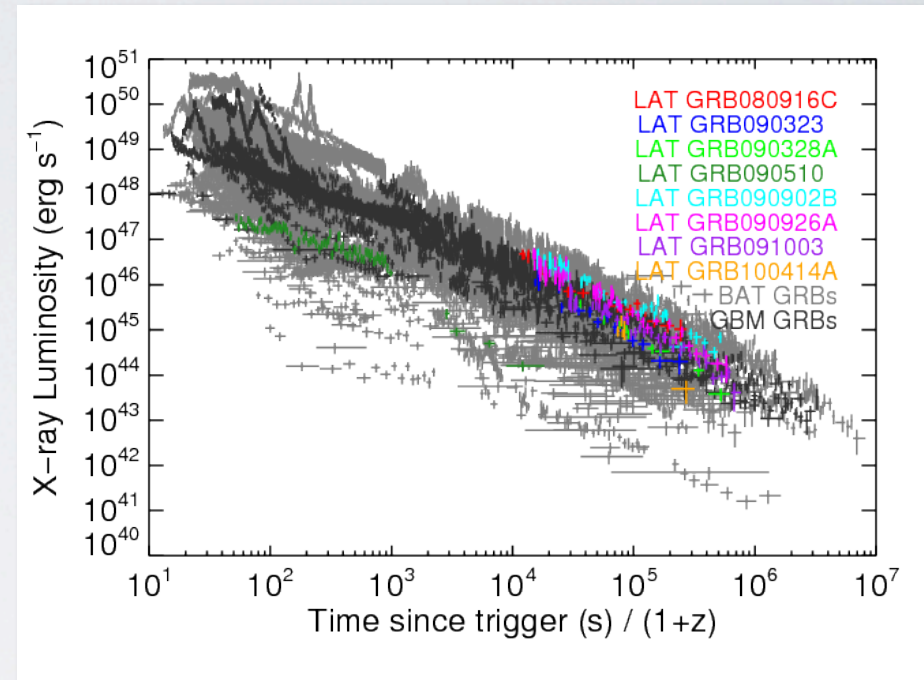
Swift-Fermi GRBs

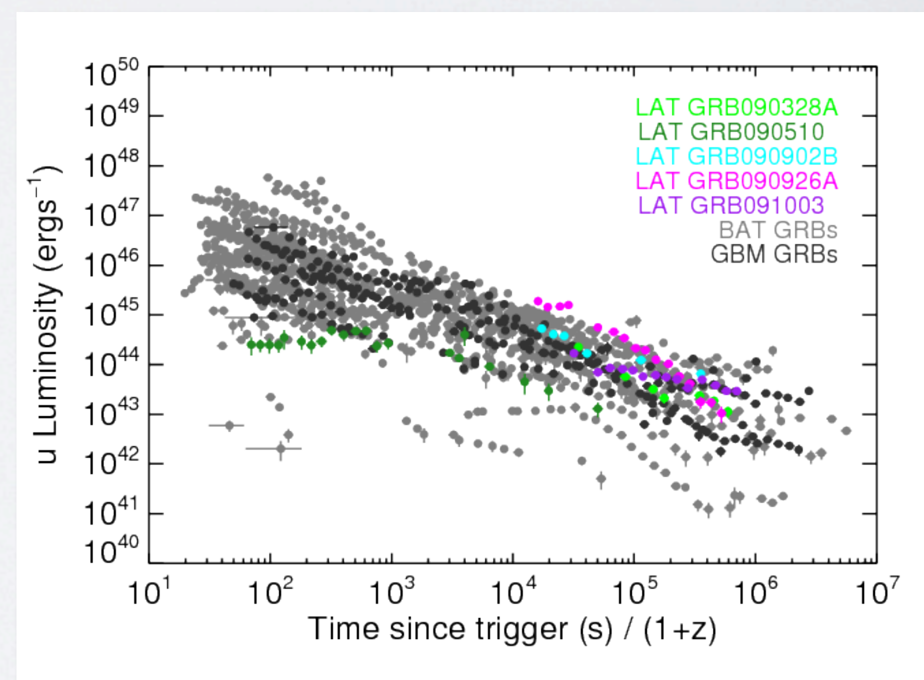
- ~1/3 of BAT GRBs are also GBM GRBs (>120 to date)
  - Prompt emission spectra 8 keV – 40 MeV (GBM)
  - Early afterglow observations and arcsec positions
- More may be in untriggered in GBM (Gruber Poster P-II-15)
- Rich data set yet to be fully explored



Swift-Fermi GRBs

- Bright LAT bursts with good localizations are all followed-up by *Swift*
  - 11 attempted
  - 8 detected by XRT
  - 7 detected by UVOT
- LAT bursts have brighter than average afterglows (see Cenko et al. 2010, McBreen et al. 2010, Racusin et al. 2011)



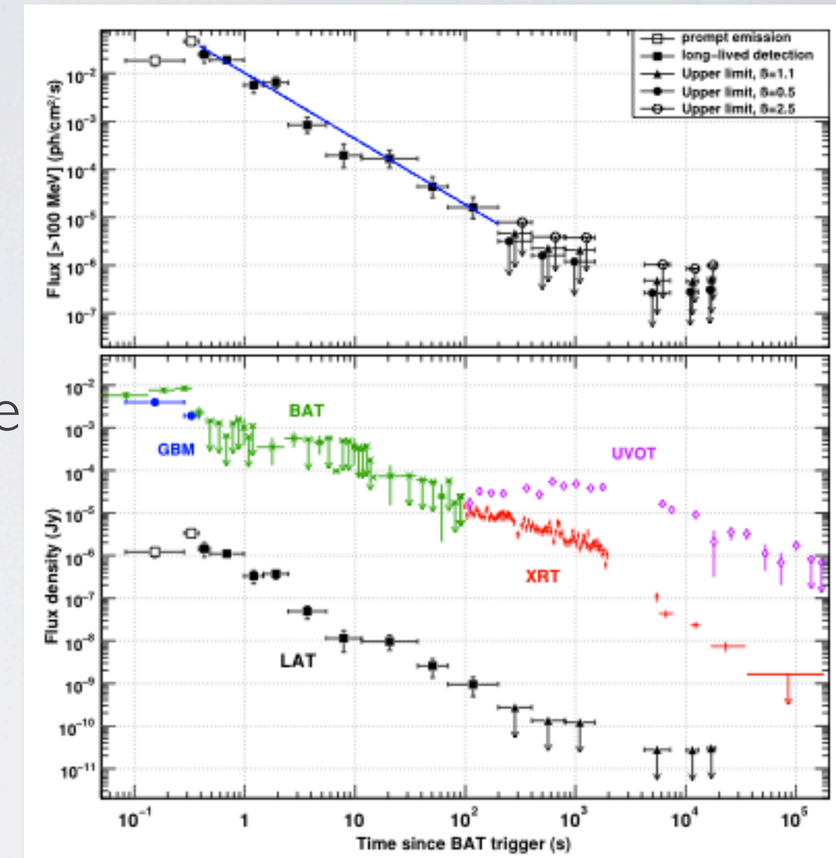


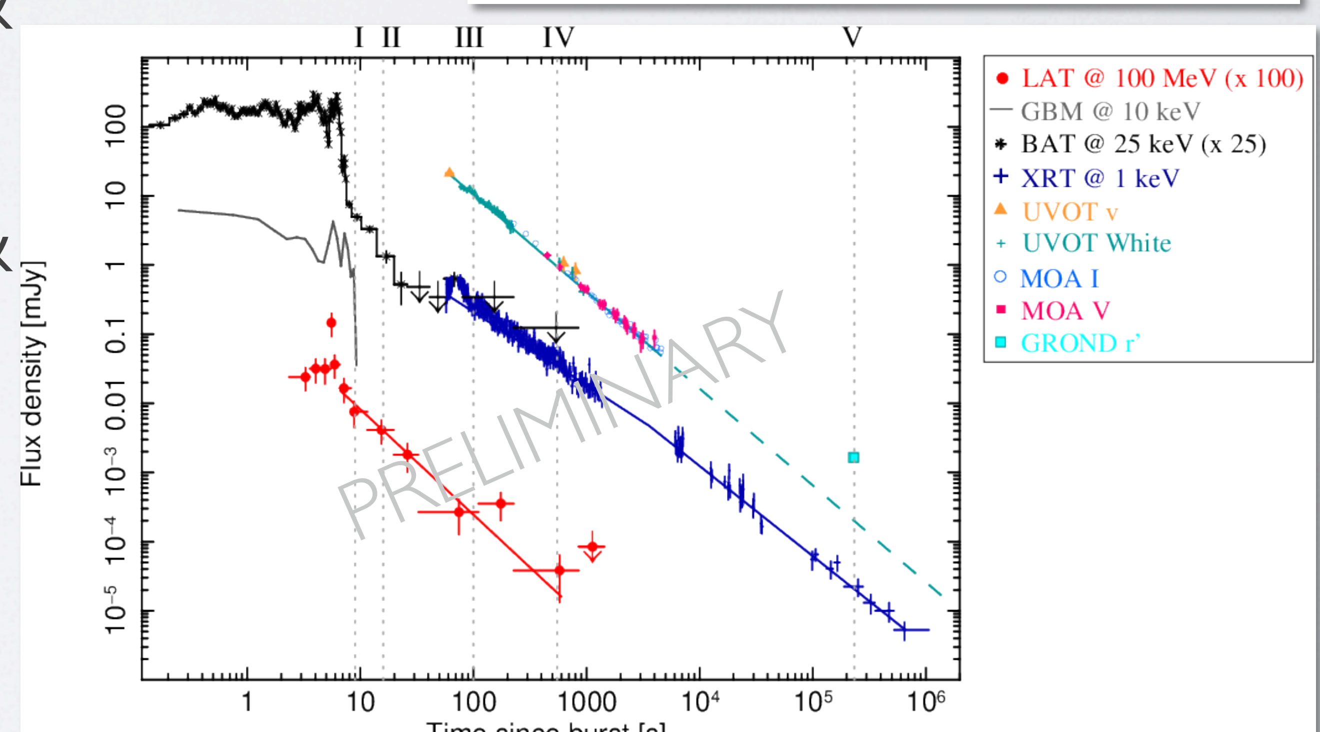
Racusin et al. 2011

Swift-Fermi GRBs

- 4 Joint BAT-GBM-LAT detected bursts
  - GRB 090510 (de Pasquale et al. 2009)
  - GRB 100728A (Abdo et al. 2011)
  - GRB 110625A (Fermi LAT & GBM Teams in-prep)
  - GRB 110731A (Fermi LAT & GBM Teams in-prep)
    - Talk by Johan Bregeon on Tuesday

de Pasquale et al. 2009

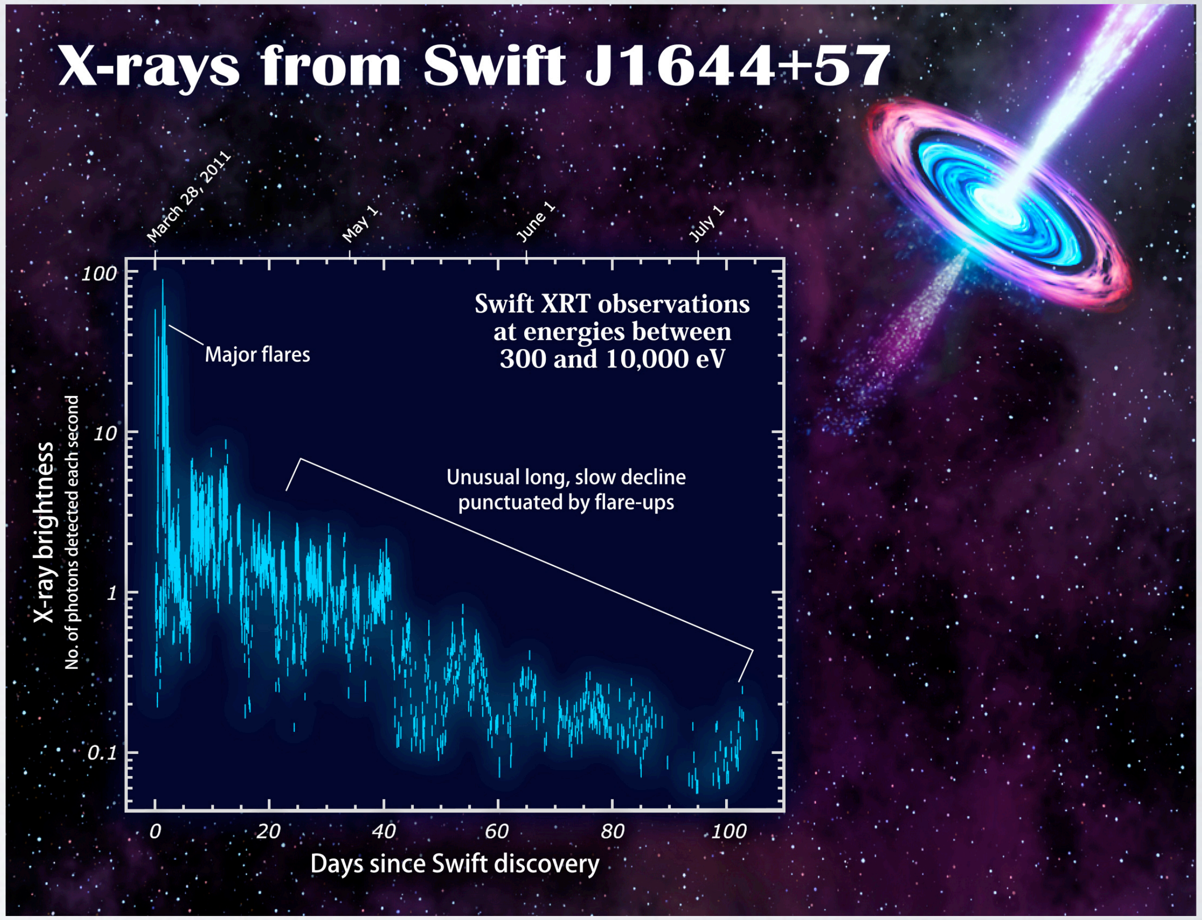




Fermi LAT & GBM et al. in-prep

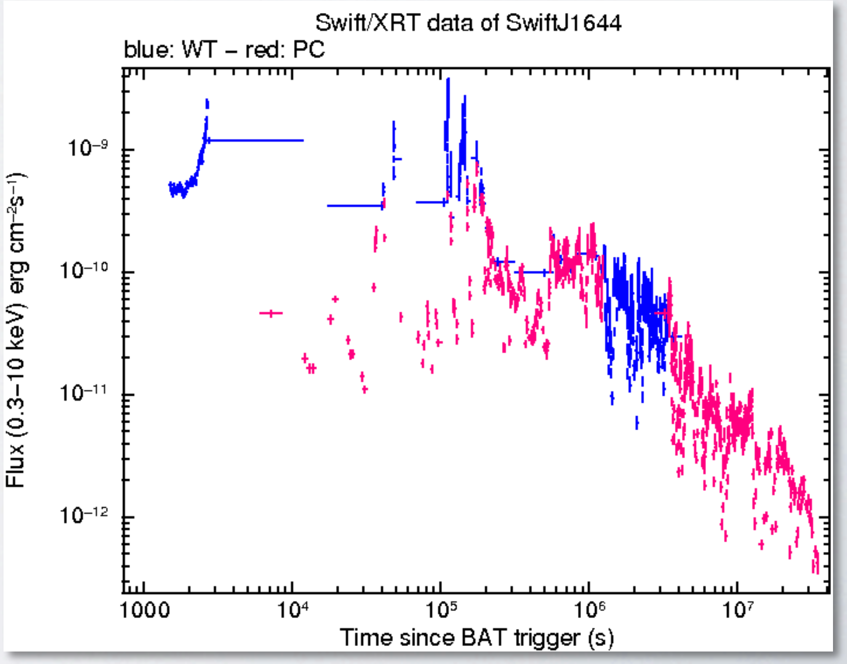
Tidal Disruption Events (initially mistaken for GRBs)

- Swift J1644 (aka GRB 110328A)
  - BAT triggered 4 times in 2 days
  - Located at center of non-AGN galaxy
  - Emission likely due to a relativistic jet from a star disrupted by ~10^6 M black hole
- Swift J2058
  - Found in ground BAT analysis
  - Cenko et al. 2012



Bloom et al.; Levan et al. *Science* 2011

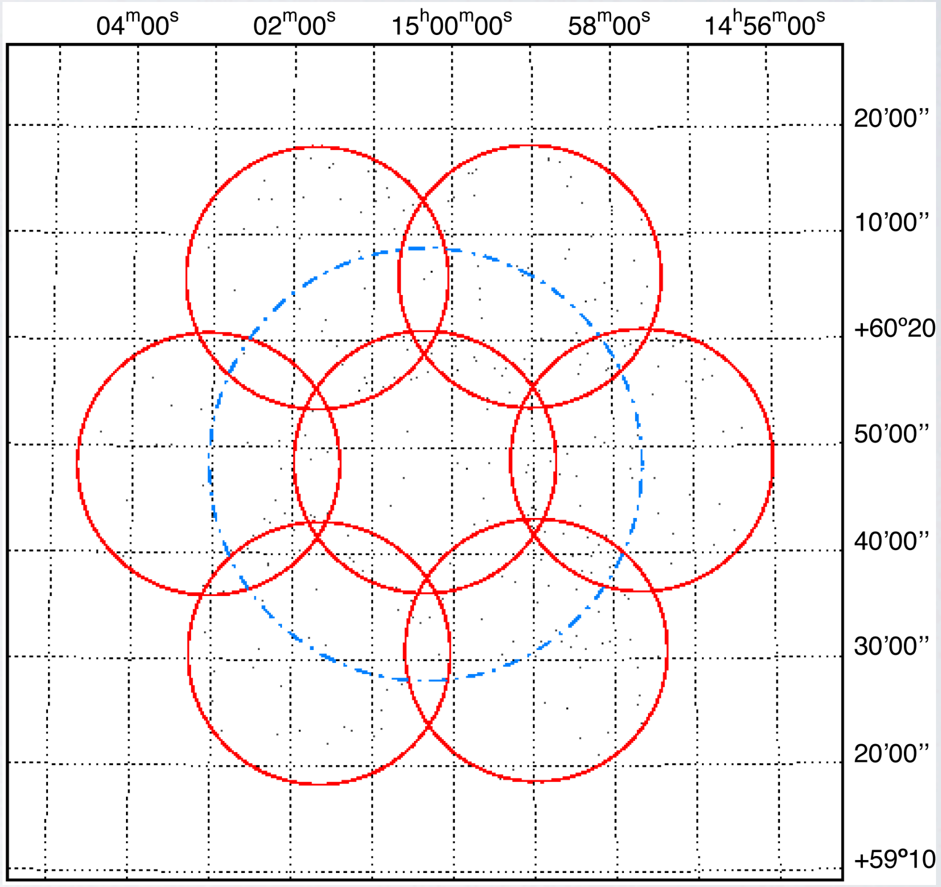
Burrows et al.; Zauderer et al. *Nature* 2011



New *Swift* Capability Tiling

- Cover larger error circles (from *Fermi*-LAT, LIGO, IPN, etc.)
- Observed all tiles within one orbit (rather than multiple TOOs)
- 4 configurations
  - 2x2 (~0.3 deg radius)
  - 7 (~0.5 deg radius)
  - 19 (~0.7 deg radius)
  - 37 (~1 deg radius)
- Significant observing campaign, but worthwhile for high priority targets
- Plan in place for LAT onboard trigger follow-up

Auto Sky Tiling



New BAT Trigger Features

- Fluence Triggers (as opposed to rate or image)
  - New trigger type for long-duration transients (galactic superbursts, high-z GRBs)
- Nearby galaxy sample onboard
  - Lower threshold for triggers in the vicinity of nearby galaxies
  - May pick up SGRs, short bursts, other low-luminosity transients

Summary

- *Swift* still discovering new and unusual transients and GRBs
- Many new and impressive follow-up instruments operating within the last few years – need to take full advantage of time while both *Swift* and *Fermi* are operating
- Ever versatile *Swift* spends an increasing fraction of observing time on non-GRB transients – how to optimize GRB observing (currently focused on those with ground follow-up or other unusual characteristics)
- What can Swift and the GRB community do differently over the coming years to detect more unusual, high-z, low-z, SN-GRB, etc. bursts?