The Future of Swift

Neil Gehrels
NASA-GSFC

Penn State
May 1-2, 2007

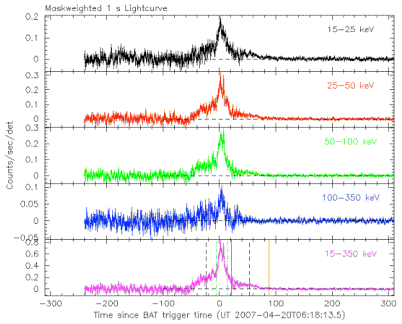
Swift Goals & Capabilities

- *Swift* goals for "prime mission":
  - determine the origin of GRBs of all types
  - determine how the blastwave evolves and interacts with surroundings
  - use GRBs to study the early universe
  - perform a sensitive hard X-ray survey of the sky

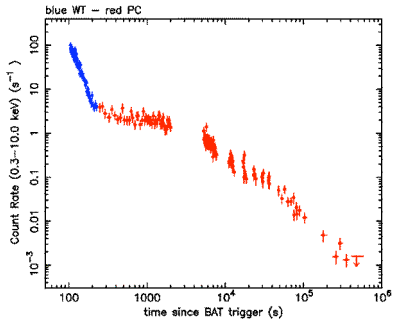
- Broad capabilities listed at 2006 Senior Review
  - GRB sensitive detection & rapid follow-up
  - rapid response astronomy
  - flexible multiwavelength campaigns
  - surveys

GRB 070420

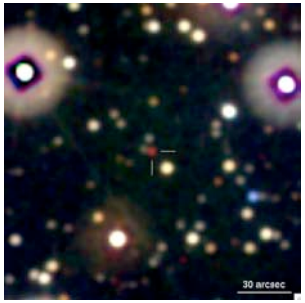
BAT



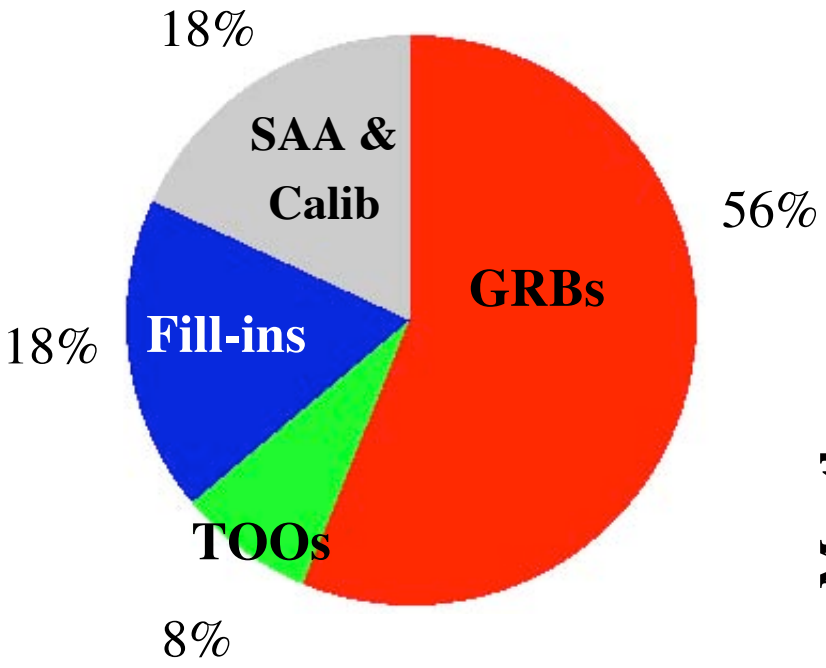
XRT

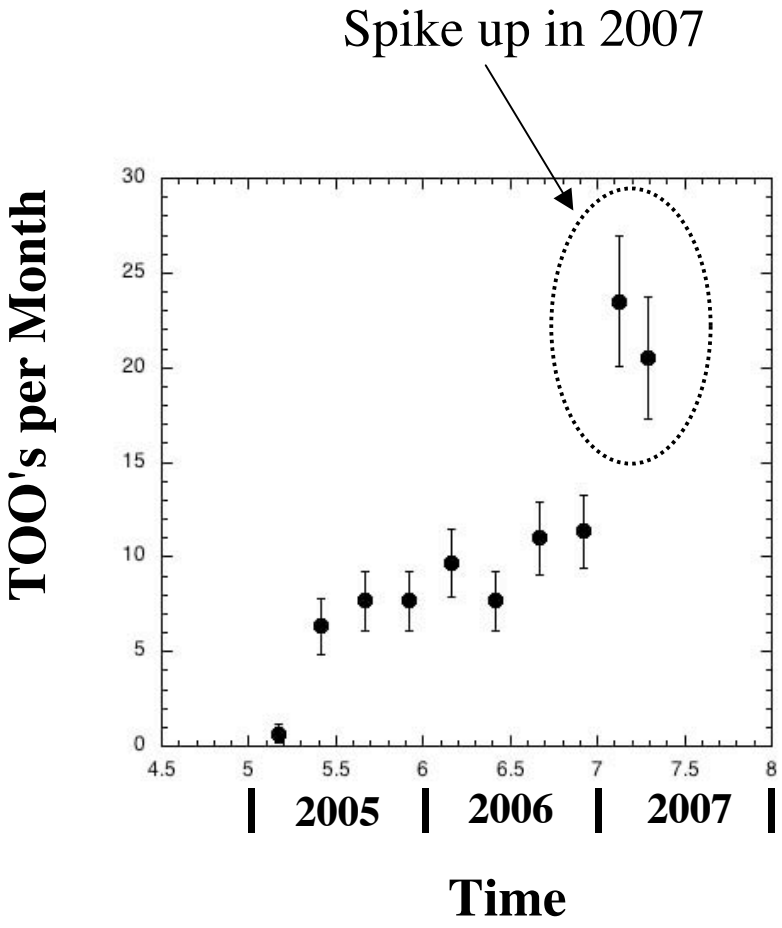


UVOT



Observing Time





Scientific Productivity

- E-mail survey performed of approved TOO observations
- Combined with lists of paper compiled for GRBs and fill-ins/surveys
- The Numbers:

	GCNs, ATELS, CBETs, IAUCs	Publications	Observing Time	**Publications per Msec**
GRBs	880 - 2000	**200+**	34 Msec	**5.8+**
TOOs	48	29	6 Msec	**4.8**
Fill-ins & Surveys	-	~30	10 Msec	**3.0**

- Conclusions:
  - GRB observations highly productive. Likely to decrease, but stay large
  - TOO observations are also productive and likely to remain steady/incease
  - Fill-ins and surveys have not produced many papers. Could be a concern, or could be that these projects have longer-term payoffs

TOO Categories

- ~120 responses to TOO e-mail survey out of 259 TOOs
- Comparison of different TOO categories:

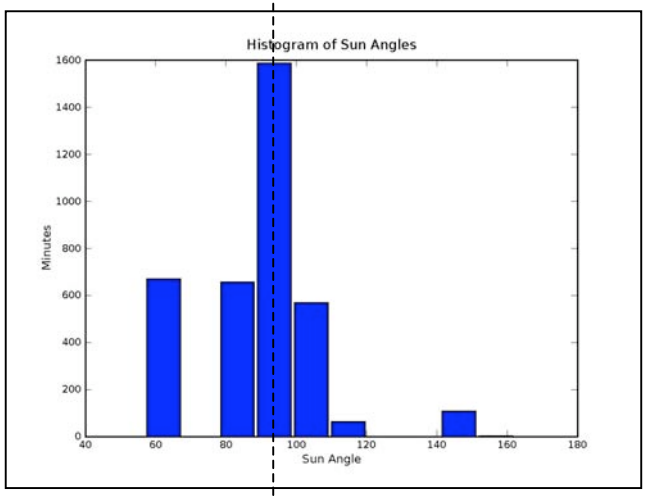
	ATELS, CBETs, IAUCs	Publications	Total	Fraction with Publications or ATELS
galactic accretion	29	11	~100	**0.40**
supernovae	13	5	~50	**0.26**
novae, CVs	3	2	~20	**0.25**
AGN	-	8	~40	**0.20**
other (ULX, UNID, SNR, pulsar)	-	3	~25	**0.12**

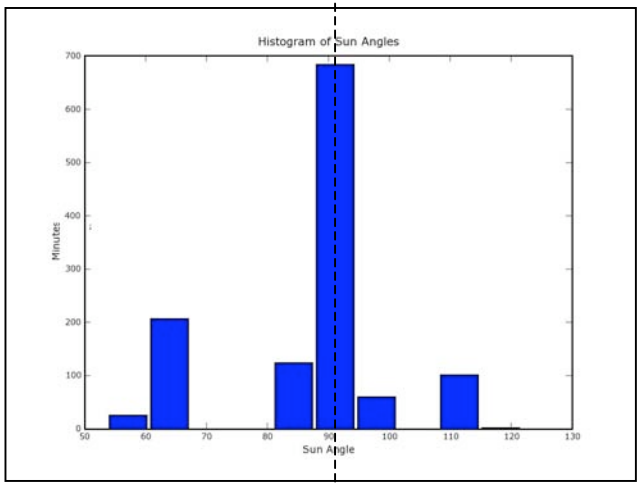
- Conclusions:
  - no weak areas found
  - ~25% of TOOs produce significant results

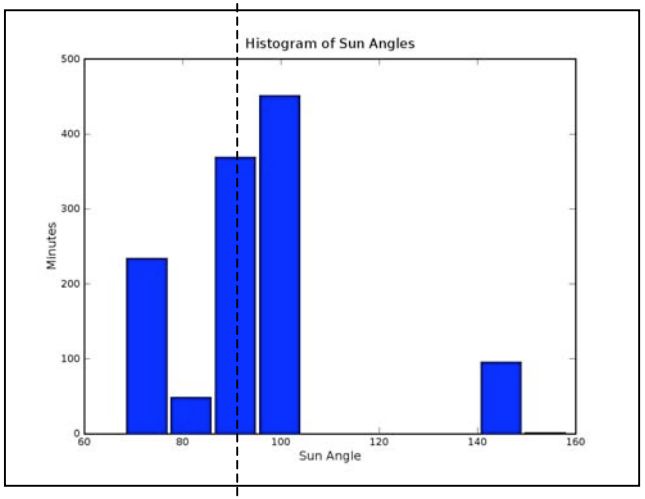
Sun Angle

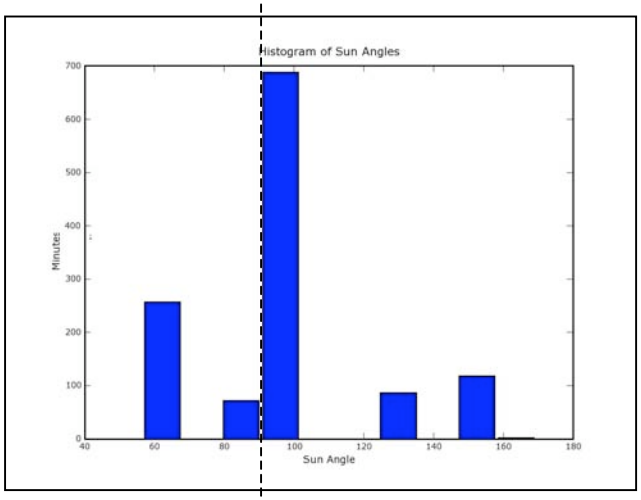
- Some observatories benefit from GRBs at ~90˚ to sun (XMM, Spitzer)
- Most follow-ups greatly benefit from large angle (anti-sun GRBs)
  - High-z and short bursts particularly require difficult observations
  - More likely to have multiple telescope follow-up and rapid large-telescope follow-up when GRB is far from dawn & dusk
- *Swift* must have some observing time in the sunward hemisphere due to orbit
- *Swift* ops team working toward giving more observing time in anti-sun region
- Costs of anti-sun biasing:
  - More restrictive TOO acceptance criteria
  - GRBs near sun have XRT/UVOT observations terminated early

Typical Sun Angle Pre-March '07





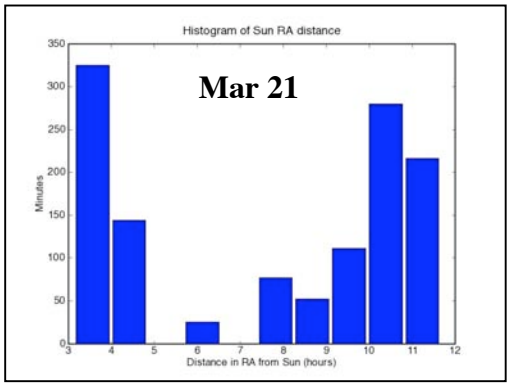


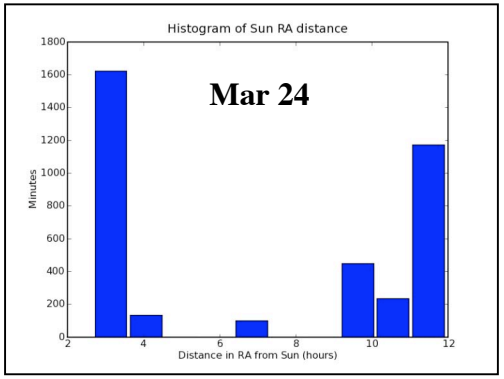


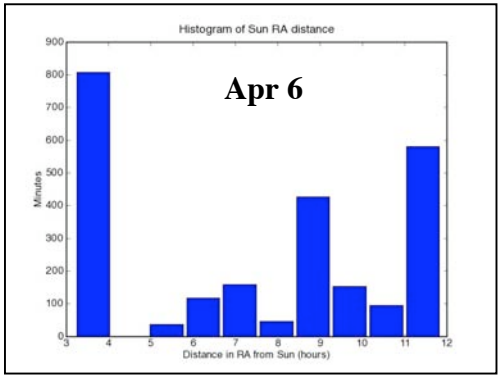
6 hr

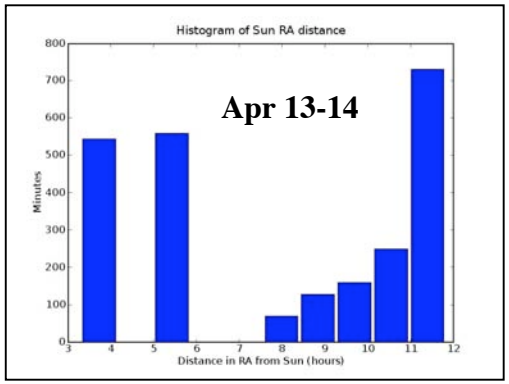
6 hr

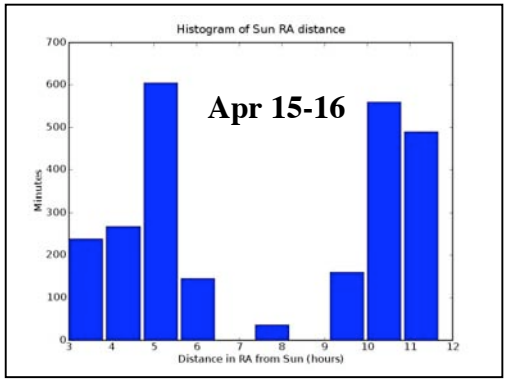
Sun Angle Experiment - Mar-Apr '07

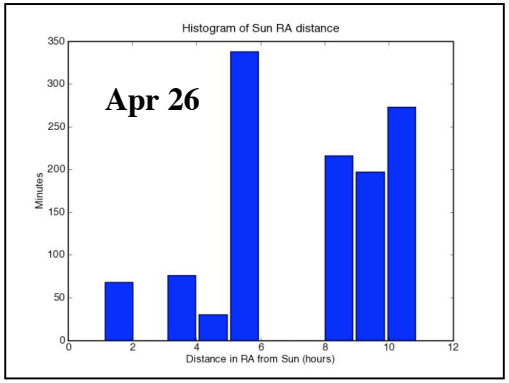


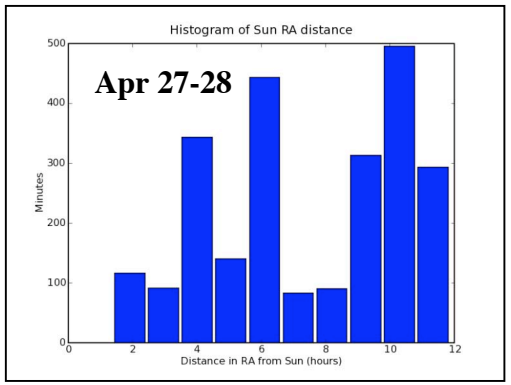


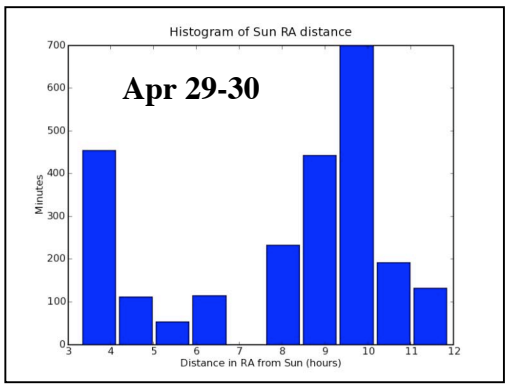










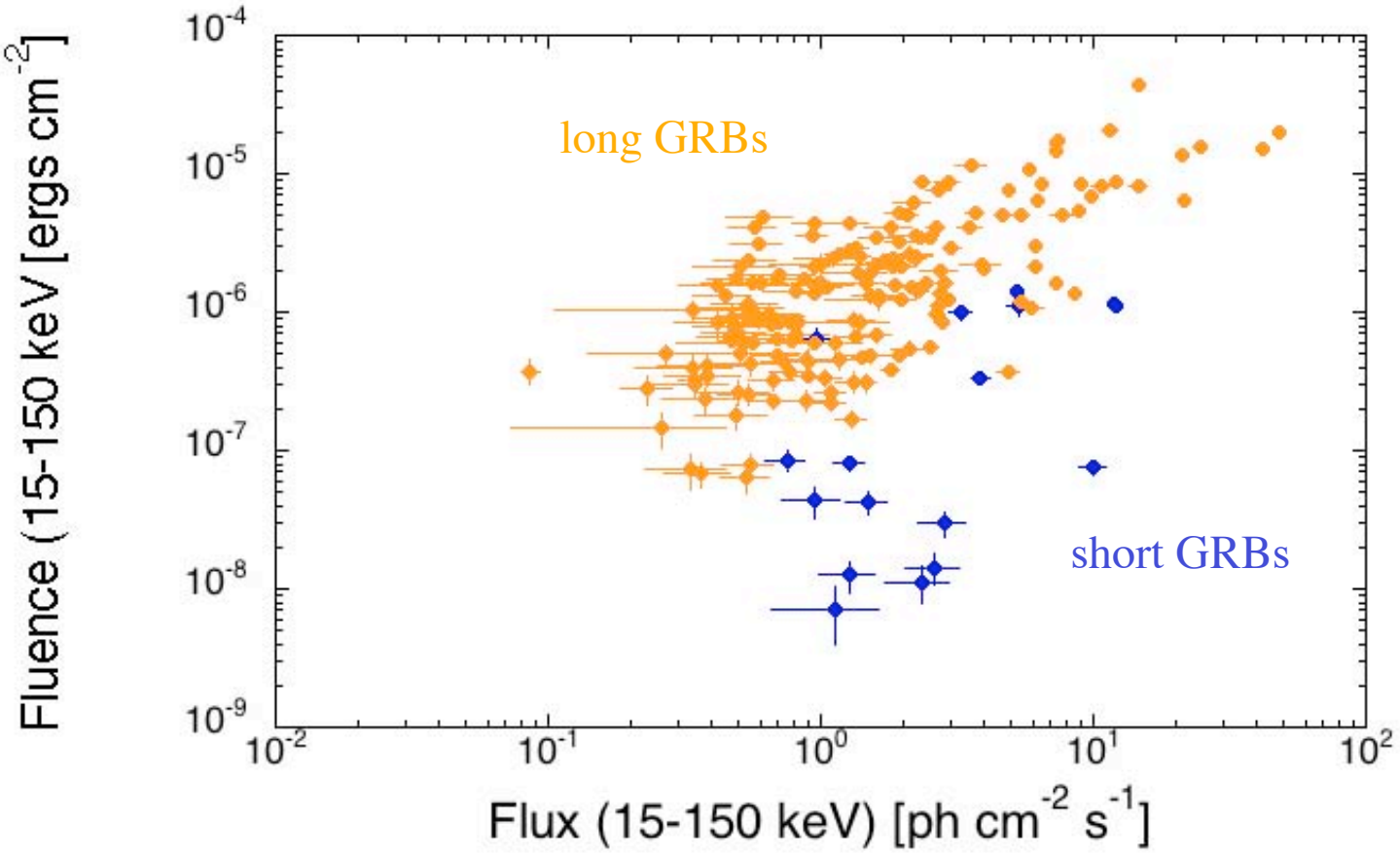


- Move 90° peak to higher angle
- Still have significant 90° time
- 31% GRBs at >8 hr Mar-Apr '07
- 14% GRBs at >8 hr Jan-Dec '06

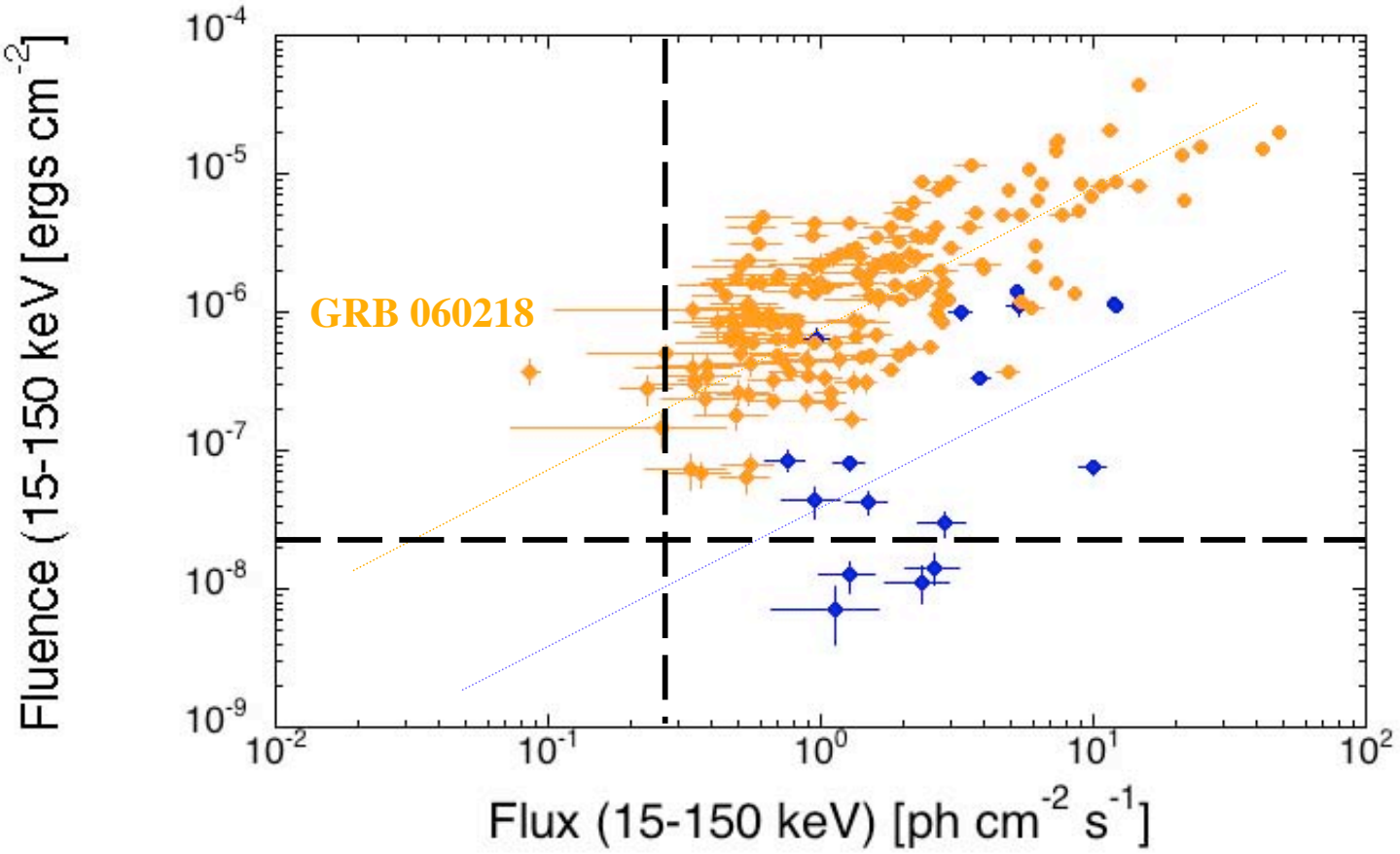
BAT Thresholds

- Can we learn more about GRBs by lowering the BAT thresholds?
- BAT trigger is complex with hundreds of rates and time domain trigger criteria plus image-only triggering
- Normal trigger requires ~7 sigma rate increase **and** 7.0 sigma image
- Proposal is to experiment with significantly lower image and/or rate threshold
  - High false trigger and slew rate
  - Real GRBs recognized by X-ray afterglows
  - Block GCN Notices for low significance events
  - AT time set at 2ks for low significance events
- What to gain?
  - Weak long bursts - underluminous class, high redshift
  - Weak short bursts - but may be hard to work with

Fluence vs Flux for All BAT GRBs



BAT Fluence and Flux Limits



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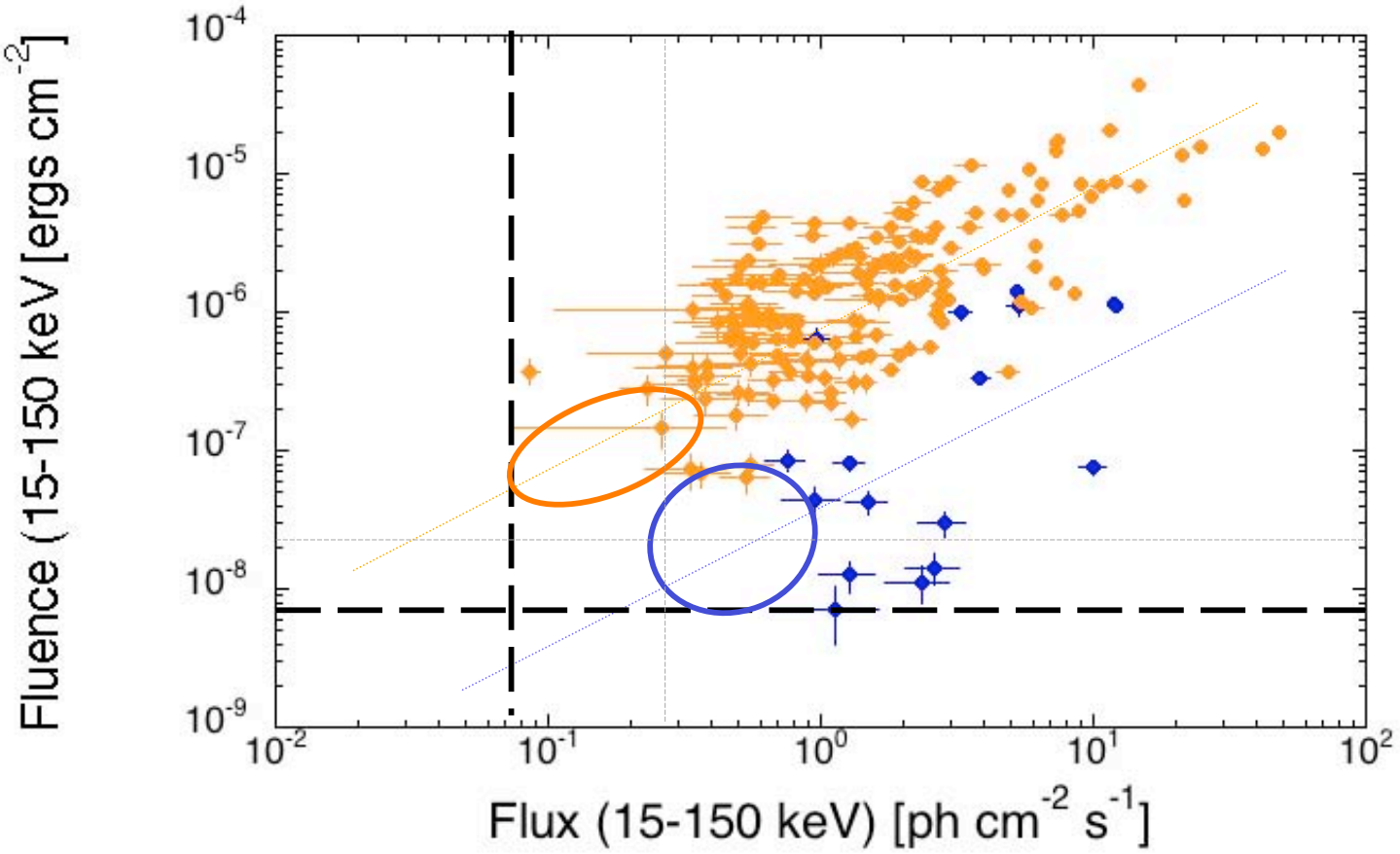

Conclusions

- *Swift* is highly productive across a broad reach of science disciplines

- Feedback desired during workshop on following questions:
  - Is a "bimodal" sun angle distribution preferable to peak at 6 hrs?
  - What can be gained from detecting weaker GRBs? Is it worth some disruption in normal ops and a potentially higher false trigger rates?
  - What is needed for further progress on short and high-z GRBs?
  - What is the best balance between GRBs and TOOs?
  - How much time should be devoted to GLAST follow-up and support?