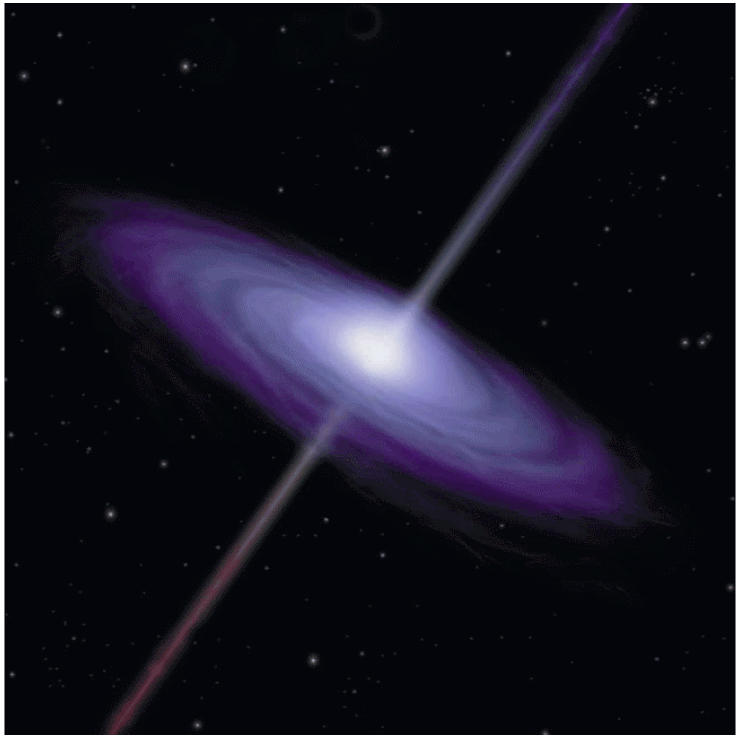
Enhancing GRB light curve studies

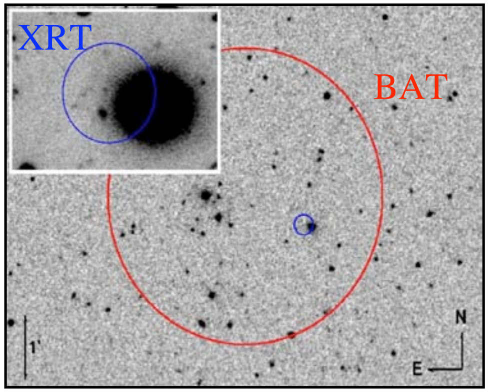


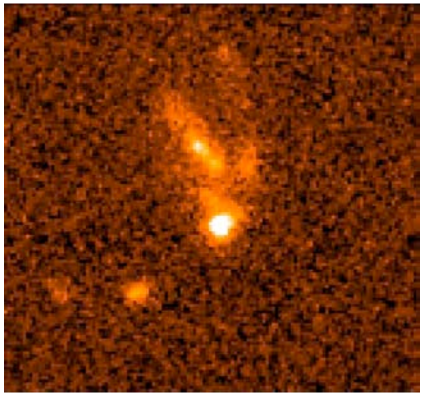
Paul O'Brien & Phil Evans
University of Leicester

PSU meeting, 1 May 2007

Short GRBs
in low-SF
Galaxies?

Binary mergers





Long GRBs
in high-SF
Galaxies

Collapsars

How are we doing?

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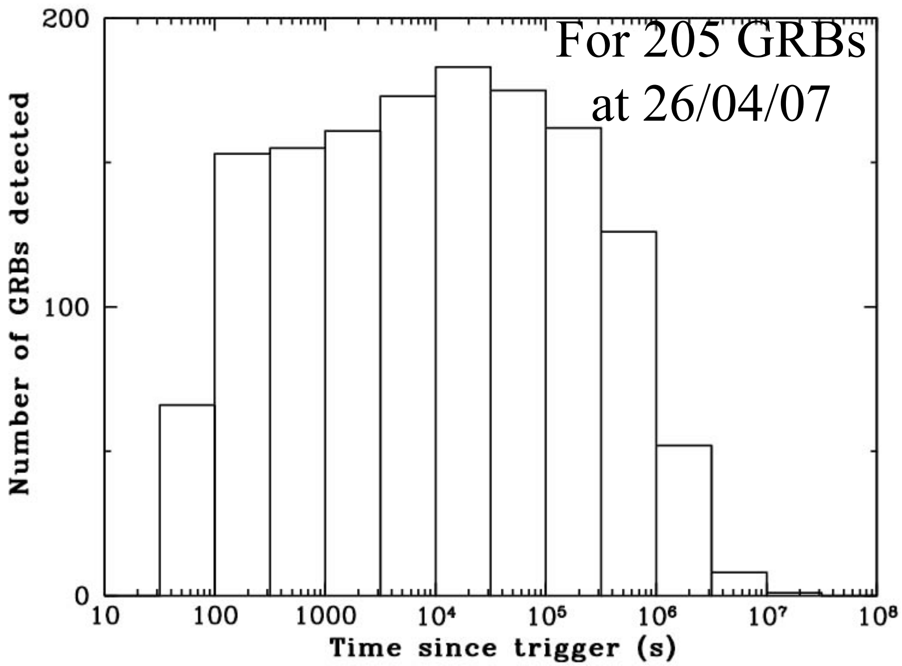

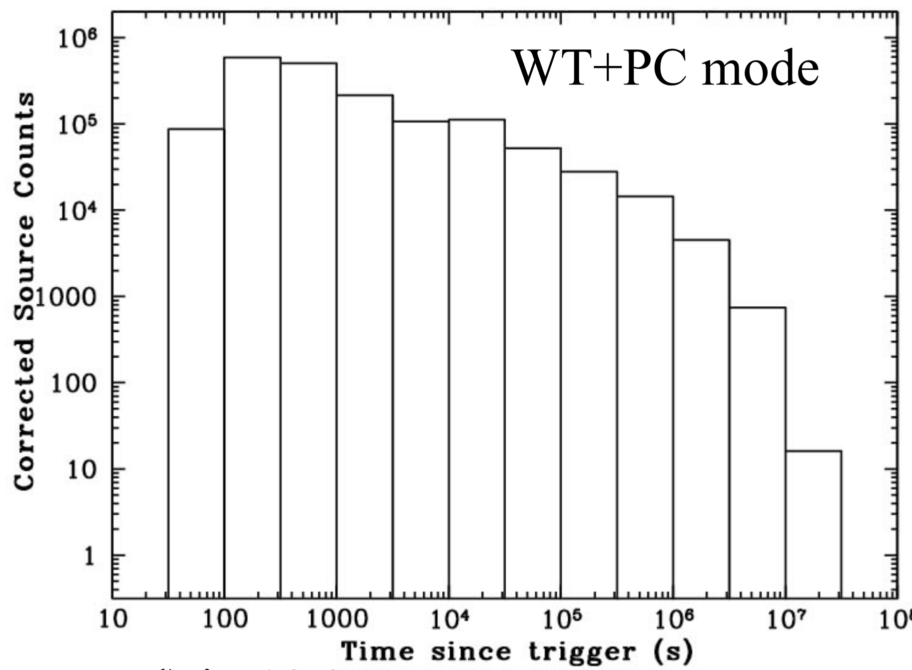

Total counts	:	1.69 Mcts (corrected) in 18.2 Ms.
Upper limits	:	1190 cts in 3.6 Ms.
Mean GRB	:	8200 cts in 89 ks. 23 >20kcts but 45% have <1kcts.

Redshifts : ~30% of Swift GRBs have a redshift (higher fraction if well-placed)
~70% of UVOT detected ones (in V) have a redshift
~60% of those with redshifts are detected by UVOT

XRT fraction early & late

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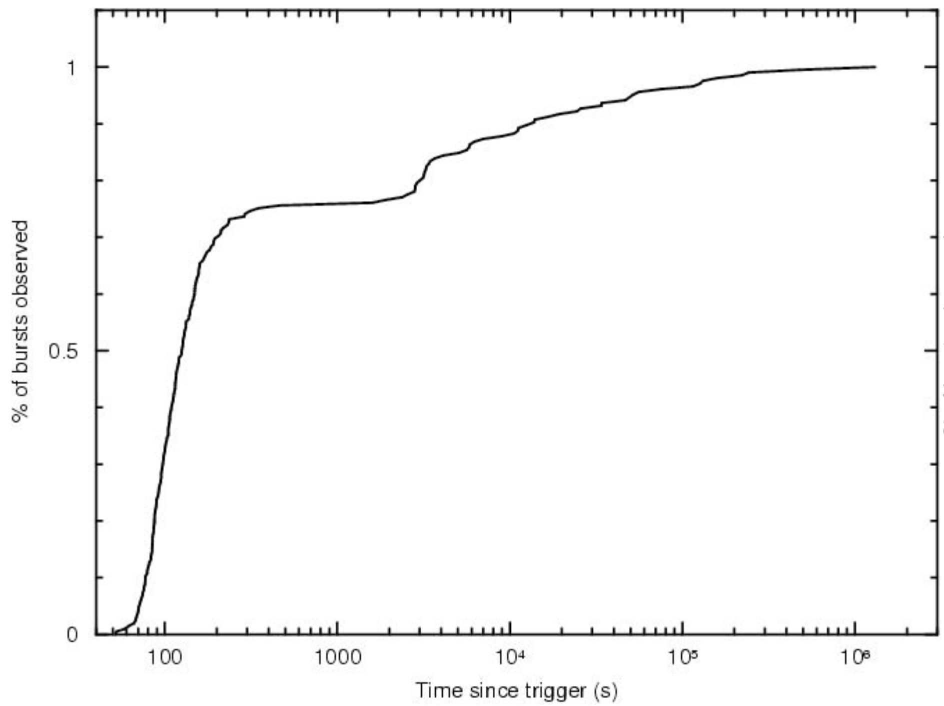
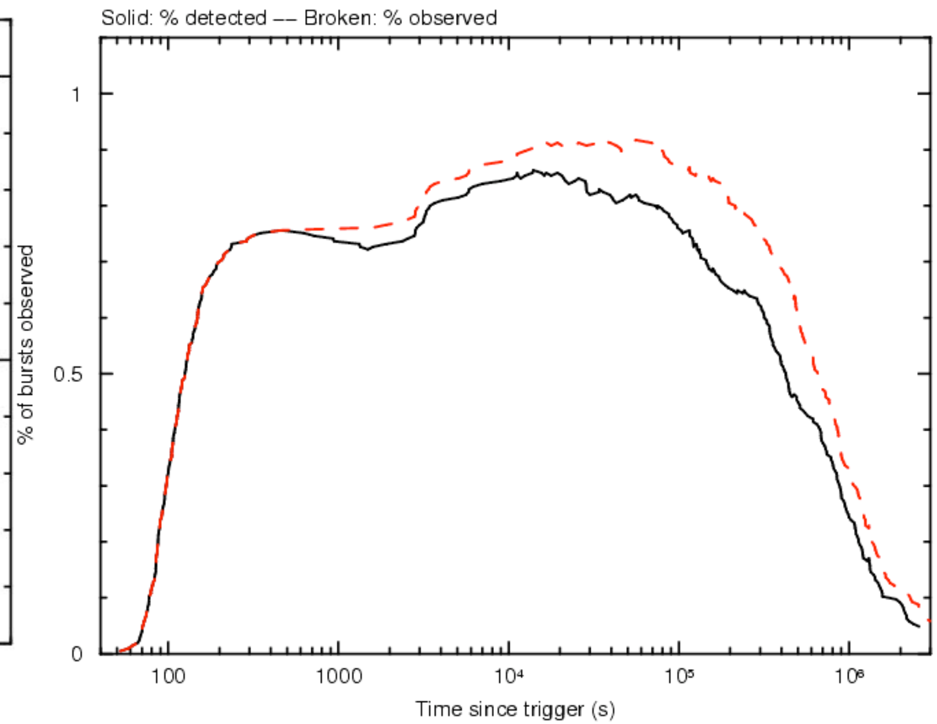
Cumulative start time



Fraction observed



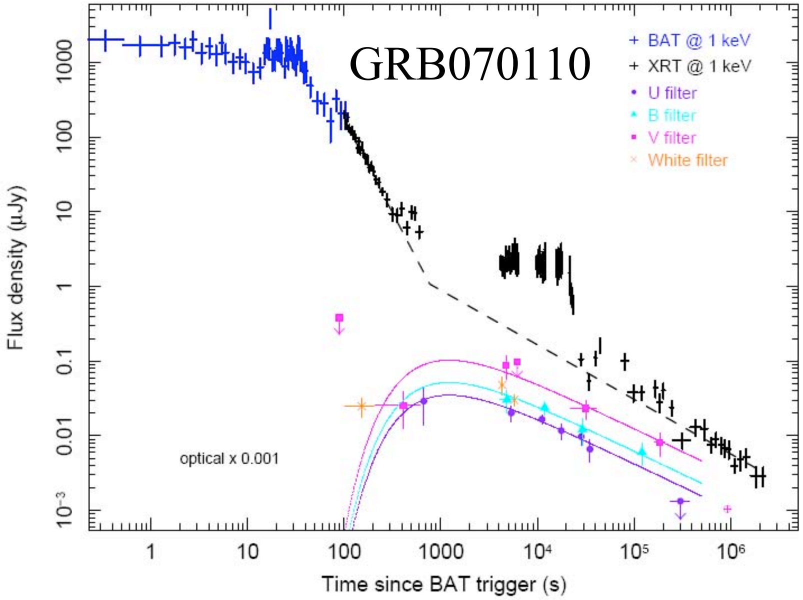
~75% are detected within a few hundred seconds (early slew)

~50% are not X-ray detected when >400ksec from trigger

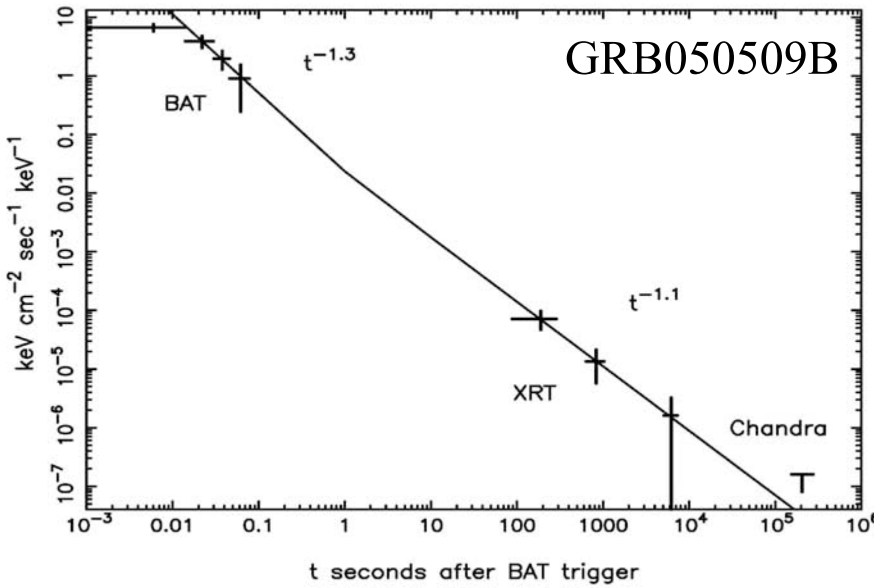
Some key GRB science issues

- What are the prompt and afterglow emission?
  - Need broad band-pass (Konus, Agile, GLAST useful) and follow-up.
  - Need to study spectral evolution and temporal breaks. Need redshift.
- What causes flaring, the plateau and temporal breaks?
  - Need to study spectral evolution and breaks – so need bright events.
  - To make progress we need more multi-wavelength data and redshifts.
- What are the long and short burst progenitors?
  - Long GRBs: single massive stars or binaries? (nearly 100 redshifts)
  - Short GRBs: several progenitors? Few Swift (~20) and fewer redshifts.
  - Need more redshifts, localisations, host galaxies, environmental data.
- GRBs as cosmic probes
  - Very few high-z GRBs identified. ~10 at $z>4$.
  - Little information on distant hosts (but legacy science using JWST etc.).

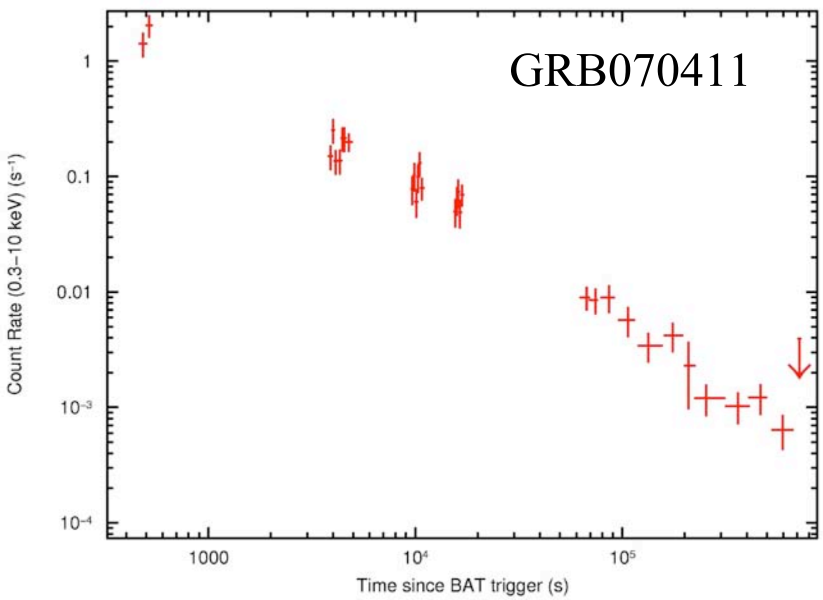
Bright with optical data



Short with redshift



Modest Counts



- Best science from bright GRBs with multi-wavelength data, short GRBs or high-redshift GRBs.
- Should we give less emphasis to "ordinary" long GRBs with no redshifts or multi-wavelength follow-up?
- Problem: we have few early indicators of how important a GRB will be.

Some options

1. Favour the early
   - Play to Swift's strengths. Study early emission. Possibly give priority to GRBs also seen by other satellites (e.g. GLAST) and with redshifts.
   - Could lower Swift thresholds to increase sample size? But, will we get more redshifts that way or more multi-wavelength data?
2. Favour the late (or bright)
   - Study (bright) GRBs for as long as possible (particularly those with redshifts). Probe environment/progenitor. Drop weak long bursts.
   - Better multi-wavelength data on plateau and jet breaks.
3. Pre-select using trigger system (image, short rate…)
   - Can we adjust the trigger system to better pre-select "interesting" GRBs, particularly short bursts and high-redshift ones?
   - But. first orbit data required to give location and brightness – new XRT/UVOT system can yield "early" accurate X-ray location (<2″)
   - Selection unlikely to be faster than a day (downlink, thinking…)

Conclusions

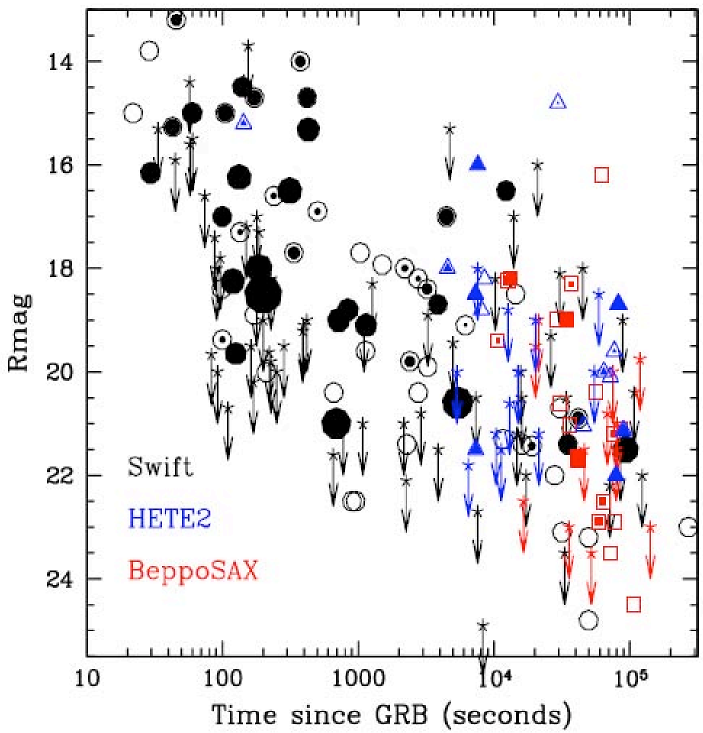
- If we wish to concentrate on the best GRB science and leave time for high-impact non-GRB science we need to focus.
- Best follow-up targets tend to be anti-Sun(!) and Moon, away from Galactic plane and away from Earth poles (i.e. visible).

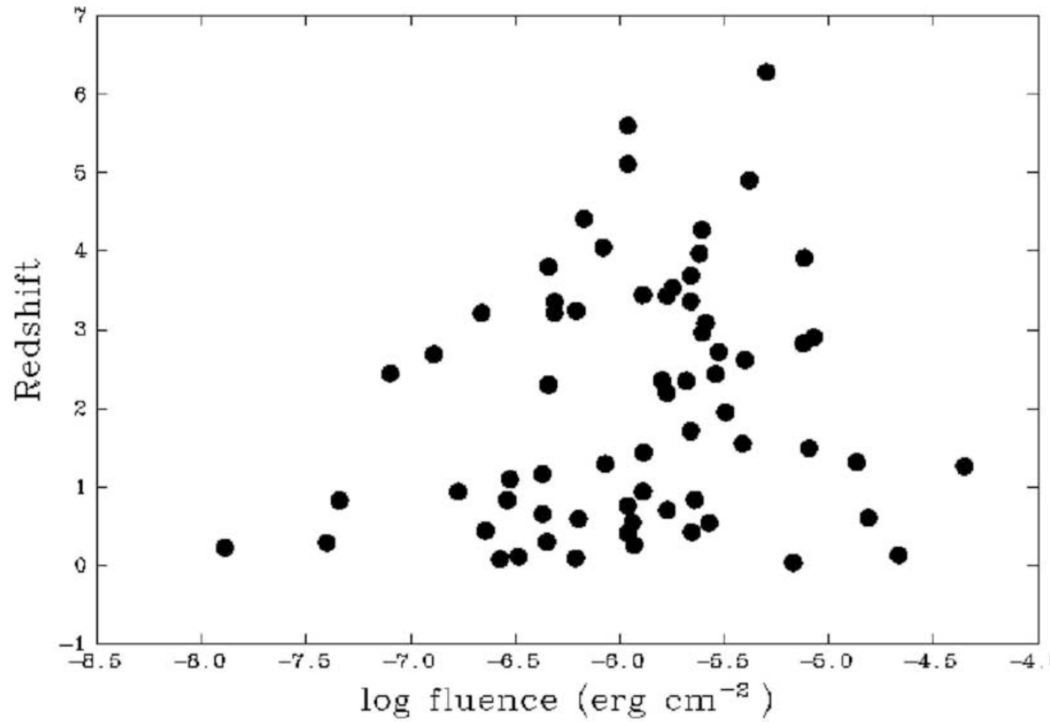
- We could change/alternate operational priorities. e.g.,
  - Could spend periods with higher or lower thresholds
  - Could have periods of no triggers, e.g. do monitoring “legacy projects”
  - Make intense monitoring of highly ranked ToOs more automatic
  - Could have public surveys, with high-quality data products

- Should the Swift project ask NASA for dedicated time on other space facilities (Chandra, HST etc.) to maximise GRB science? (with all such data public immediately)

Early selection is hard

Fiore et al. (2007)





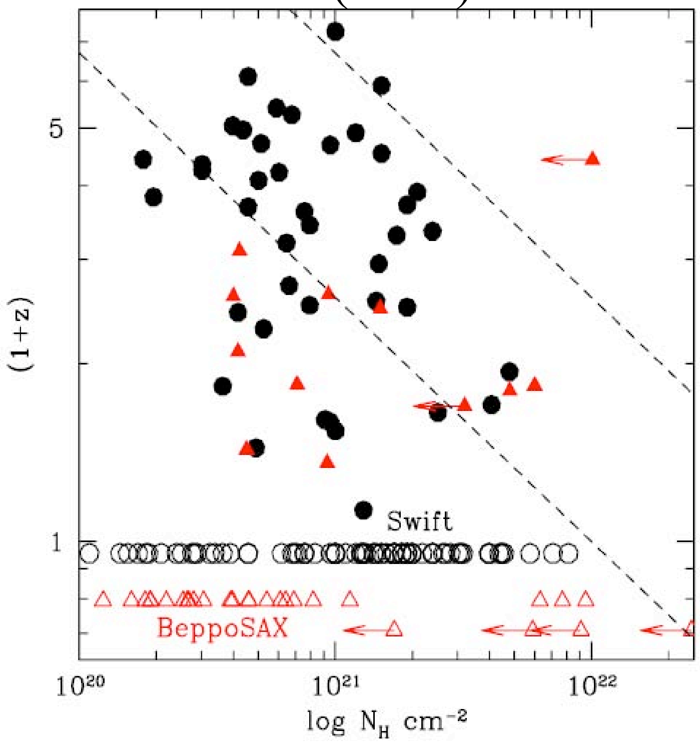
Need good early data from UV/optical/IR.

Fluence – z correlation weak.

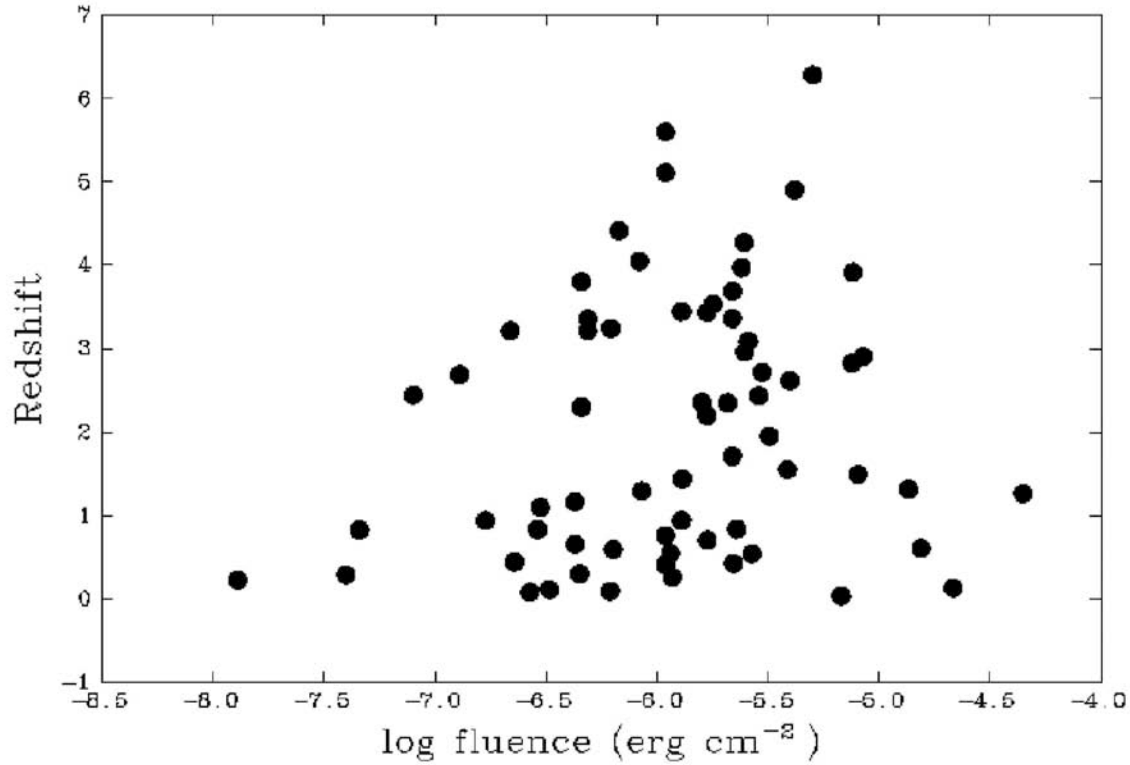
Early optical – X/γ-ray correlation weak.

GRB redshift vs. absorption and fluence

Fiore et al. (2007)



Nh – z correlation is weak.



Fluence– z correlation is weak.

Optical R-band vs. time and fluence

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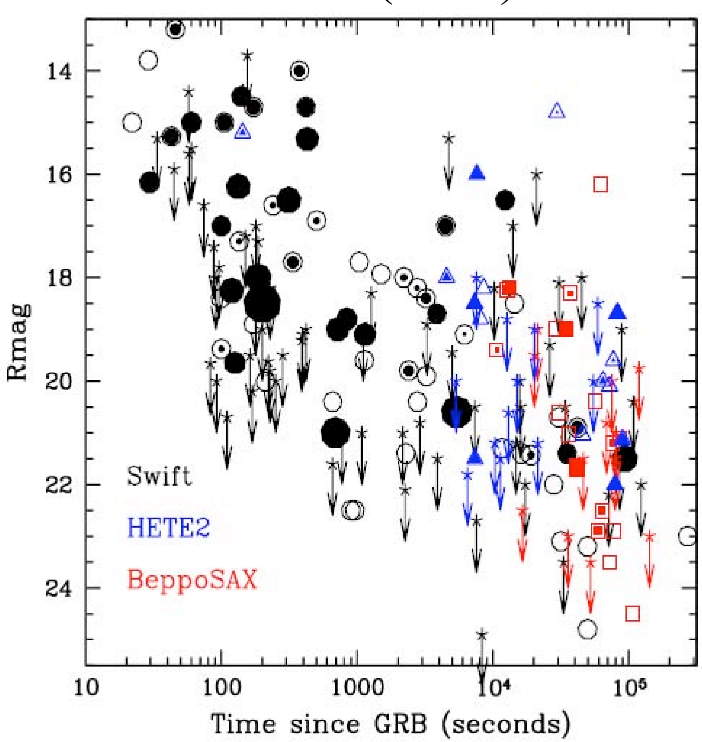
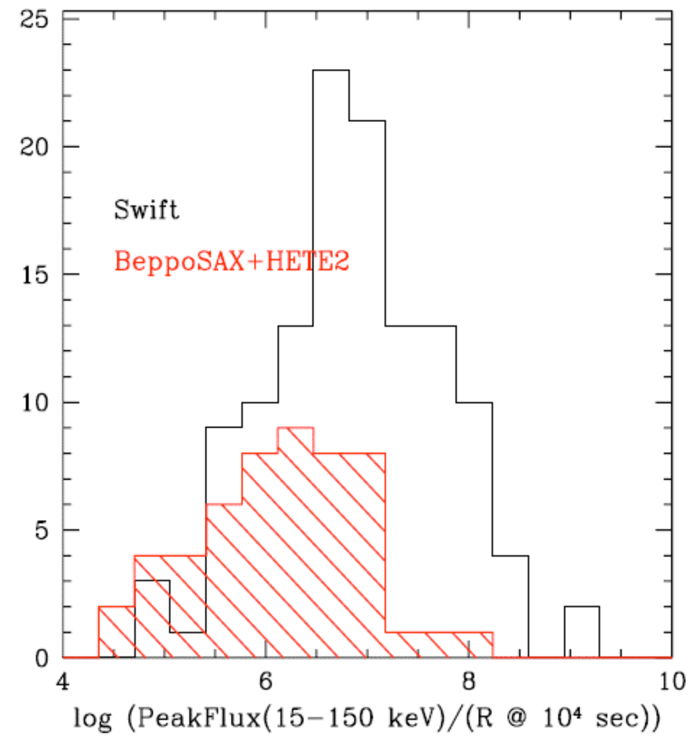
Fiore et al. (2007)





Long GRBs: correlations are weak. Need early UV/optical/IR data to make target selection (e.g. for spectroscopy, polarimetry).