Swift observation strategy: GRB Redshifts

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Contents

- Importance of **anti-Sun pointing**
- Screening “possible” high redshift GRBs from the BAT prompt emission properties

Importance of anti-Sun pointing

Importance of GRB redshifts

- High-z GRBs Huge potential for studying early universe (z>10)

1. IR detection and spectroscopy
2. Deep optical observations
3. Notify a "possible high-z" from the Swift data

- Luminosity indicators Measurement of Dark energy (Schaefer)

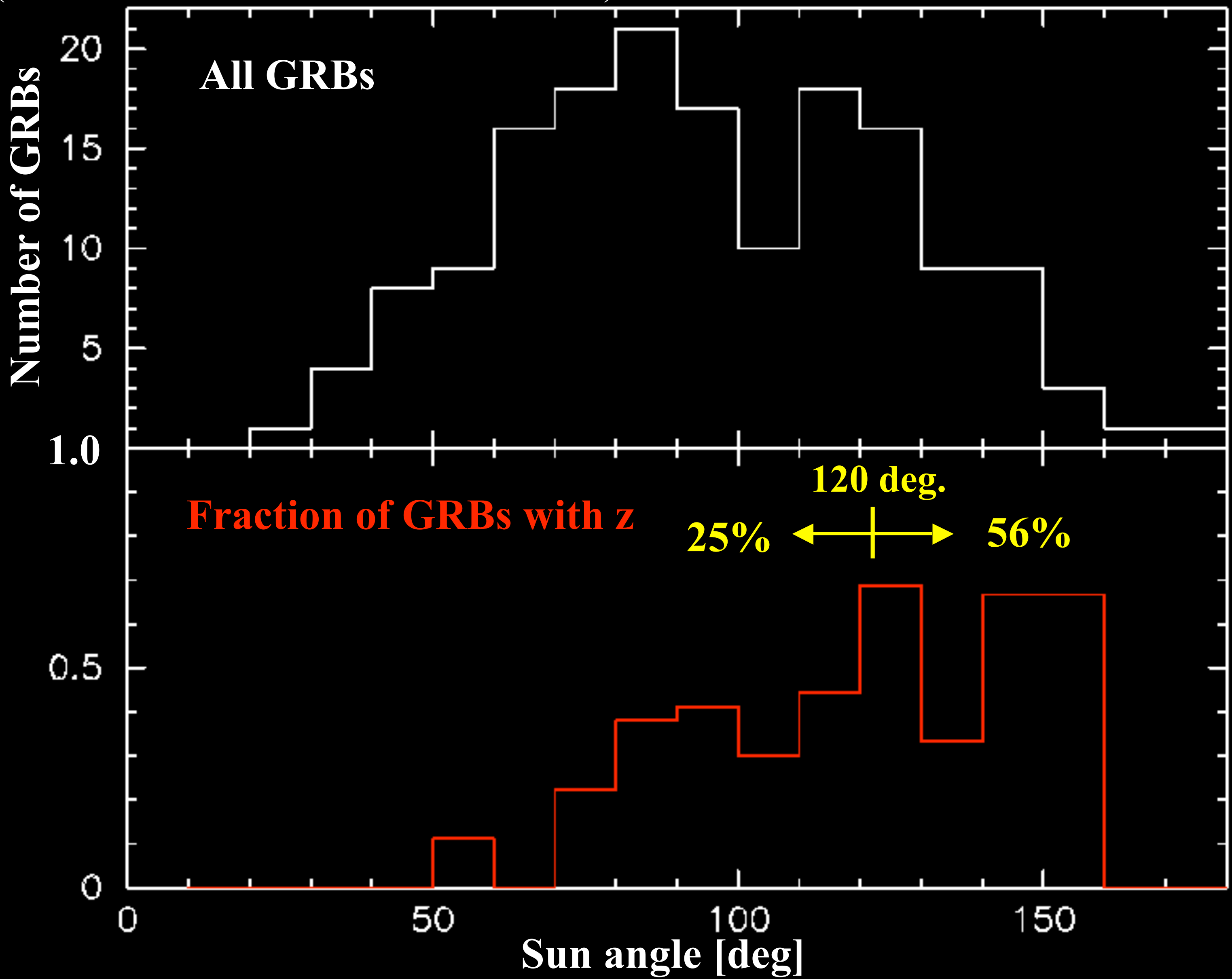
GRB properties (Ep, V, Lag, ..) + redshift

Variety of redshifts (from low to high z)

GRBs at the anti-Sun directions

Sun angle vs. Redshift

(from GRB 050502B to GRB 061222B)



Swift

Swift observation strategy

- XRT positions
- Bursts with anti-Sun directions

• **Point Swift to anti-Sun position as far as we can.**

• **XRT will focus on the prompt localization + early X-ray AG.**

• **No long follow-up by Swift (Sun angle < 120 deg. bursts)**

Screening "possible" high redshift GRBs from the BAT prompt emission properties

Screening "possible" high-z GRBs from the BAT data

Find common characteristics of high-z GRBs

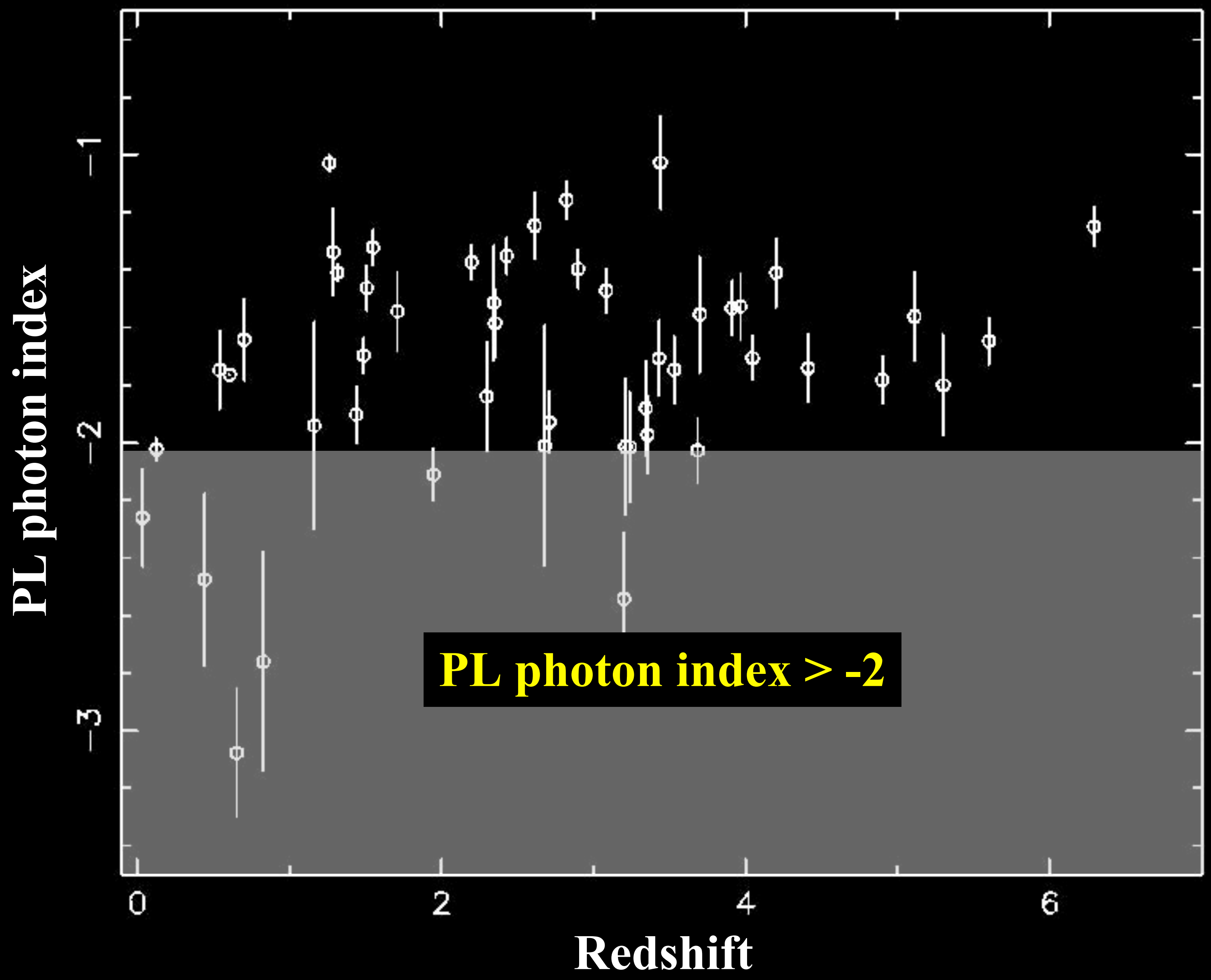
↓

Alert the ground observers as a "possible" high-z GRB

Sample of GRBs

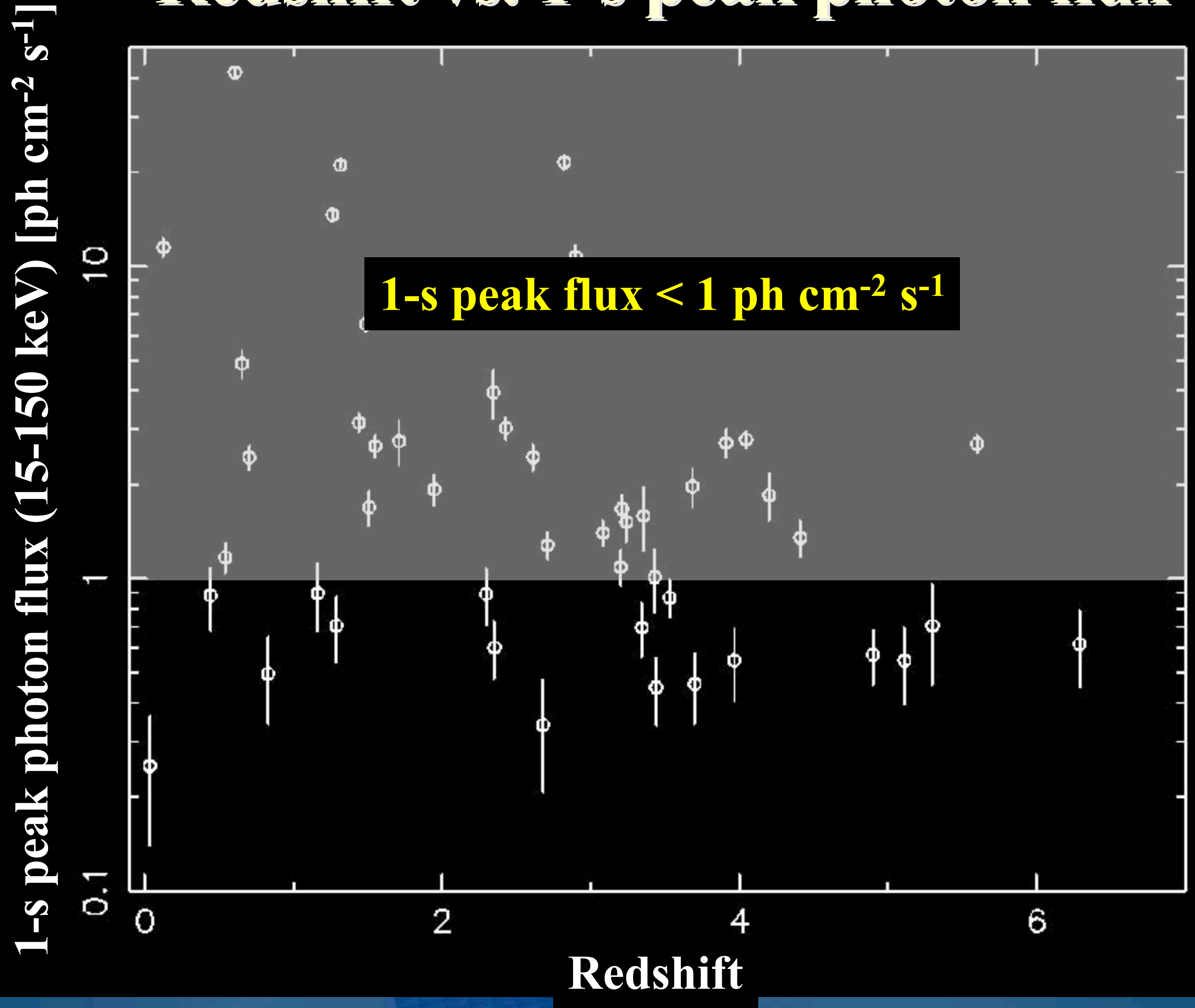
- 49 known-z long GRBs (T90 > 2 sec)
- 188 long GRBs (Dec 2004 – Feb 2007)
- BAT event data analysis (*batgrbproduct*)

Redshift vs. PL photon index



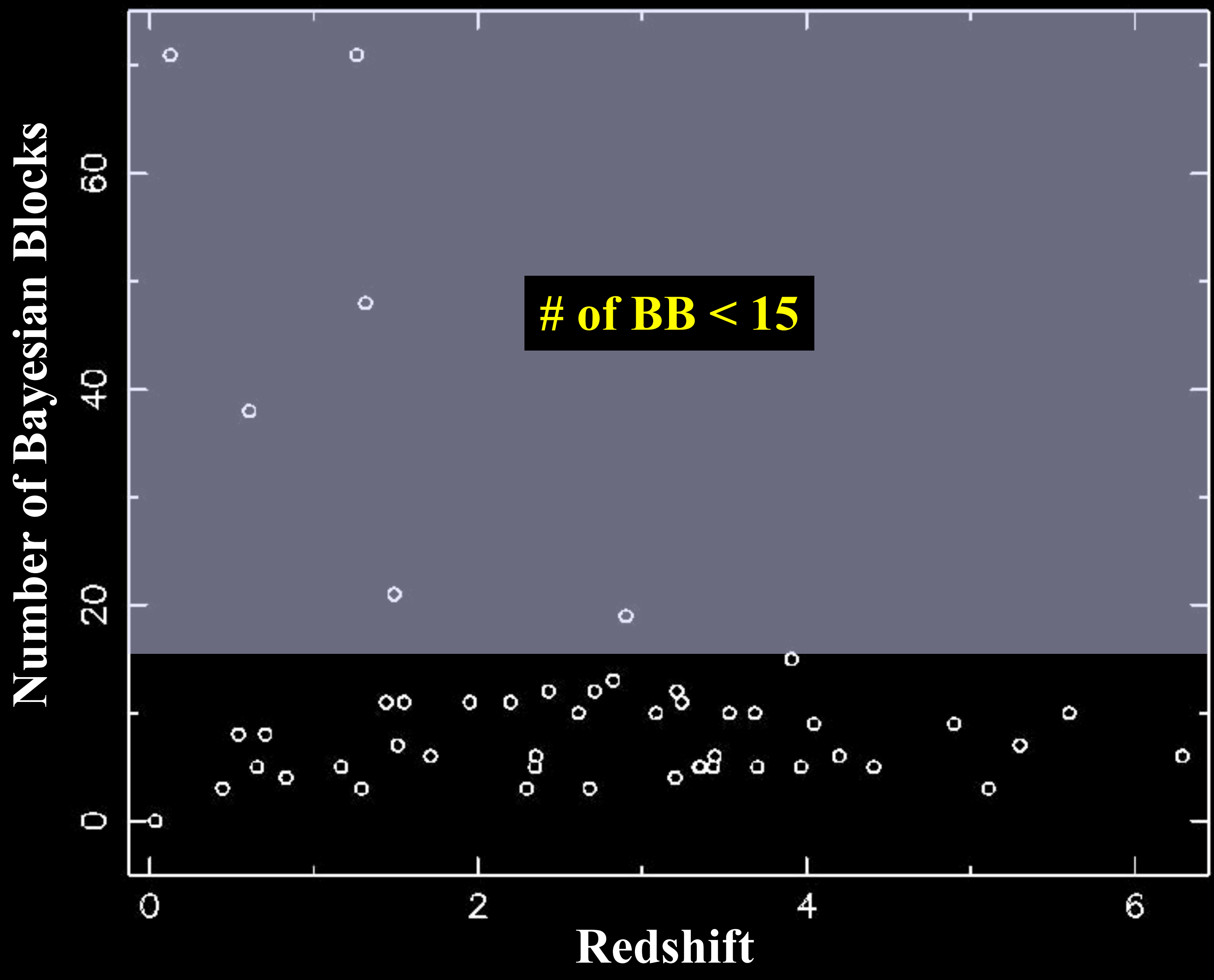
Swift

Redshift vs. 1-s peak photon flux



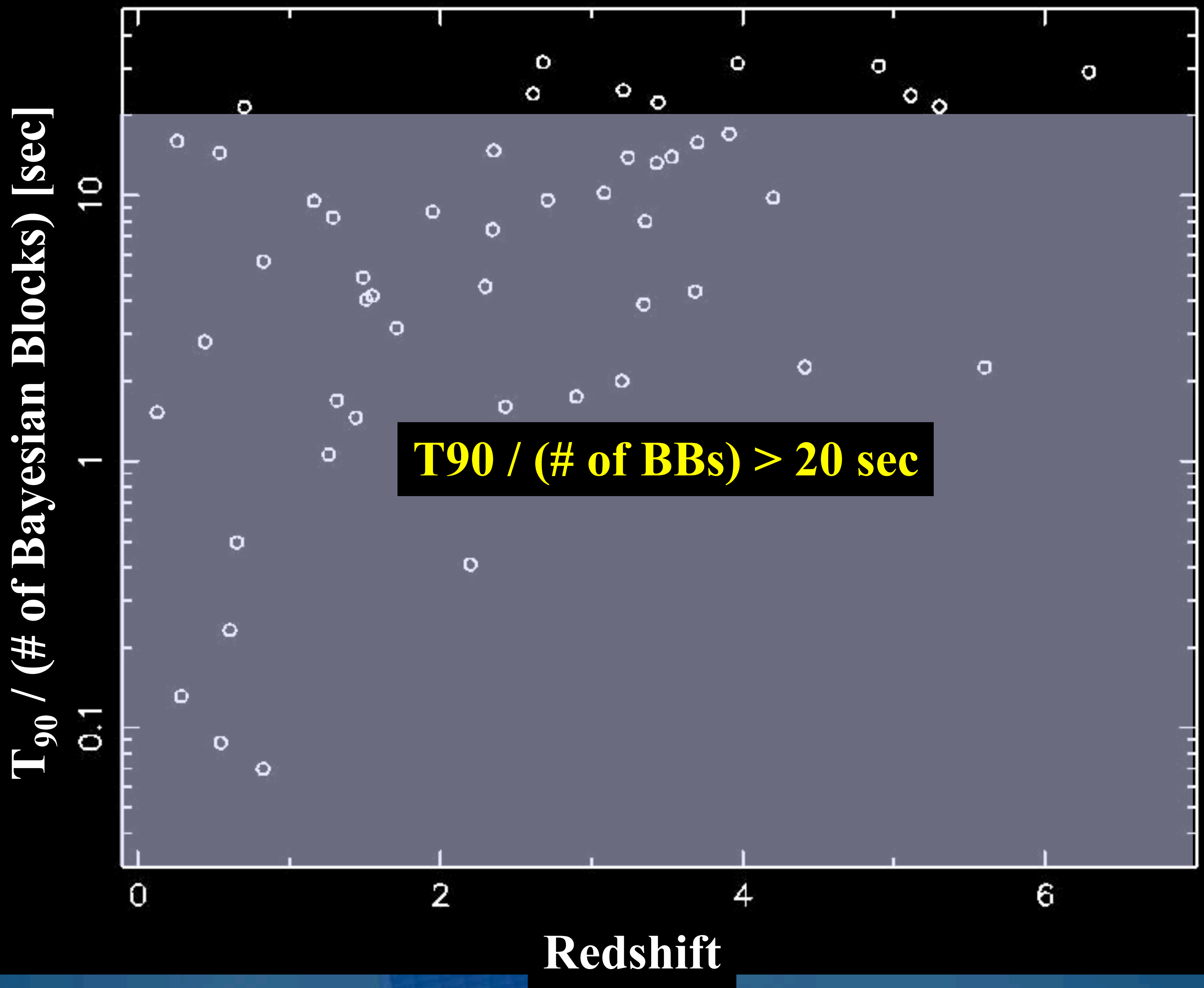
Swift

Redshift vs. # of Bayesian Blocks



Swift

Redshift vs. T90 / (# of BBs)



Swift

Screening high-z GRBs

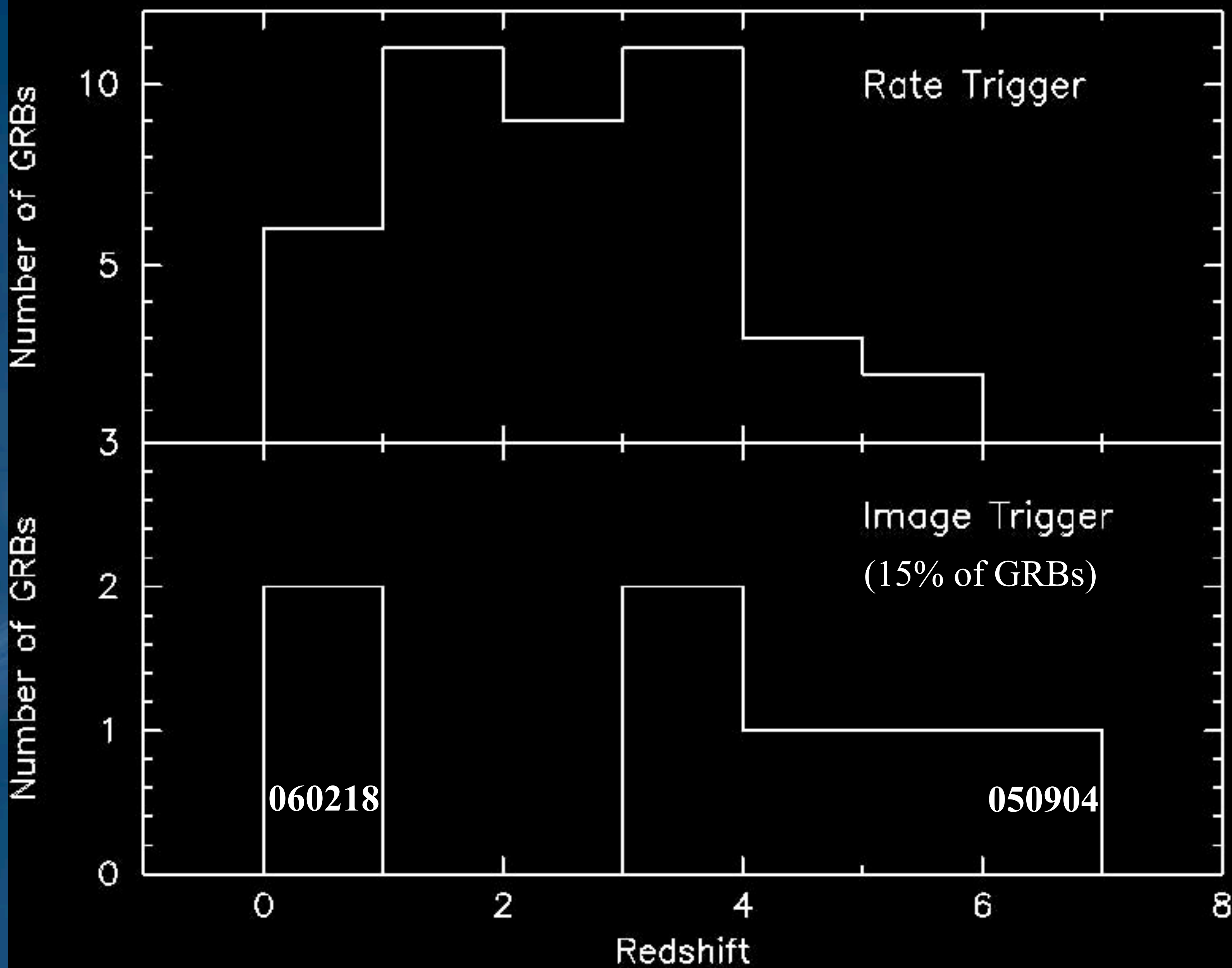
- PL photon index > -2
- 1-s peak flux < 1 ph cm^{-2} s^{-1}
- # of BBs < 15
- T90 / (# of BBs) > 20 sec

GRB	z	PhIndex	Peak flux	BB	T90/BB
050730	3.967	-1.53	0.5	5	31.3
050814	5.3	-1.80	0.7	7	21.6
050904	6.29	-1.25	0.6	6	29.0
060510B	4.9	-1.78	0.6	9	30.6
060522	5.11	-1.56	0.5	3	23.7
061110B	3.44	-1.03	0.4	6	22.3

[Excluded GRB with z > 4.5 is 060927 (z = 5.6)]

6 GRBs / 49 known-z long GRBs (11 GRBs / 188 long GRBs)

BAT image trigger

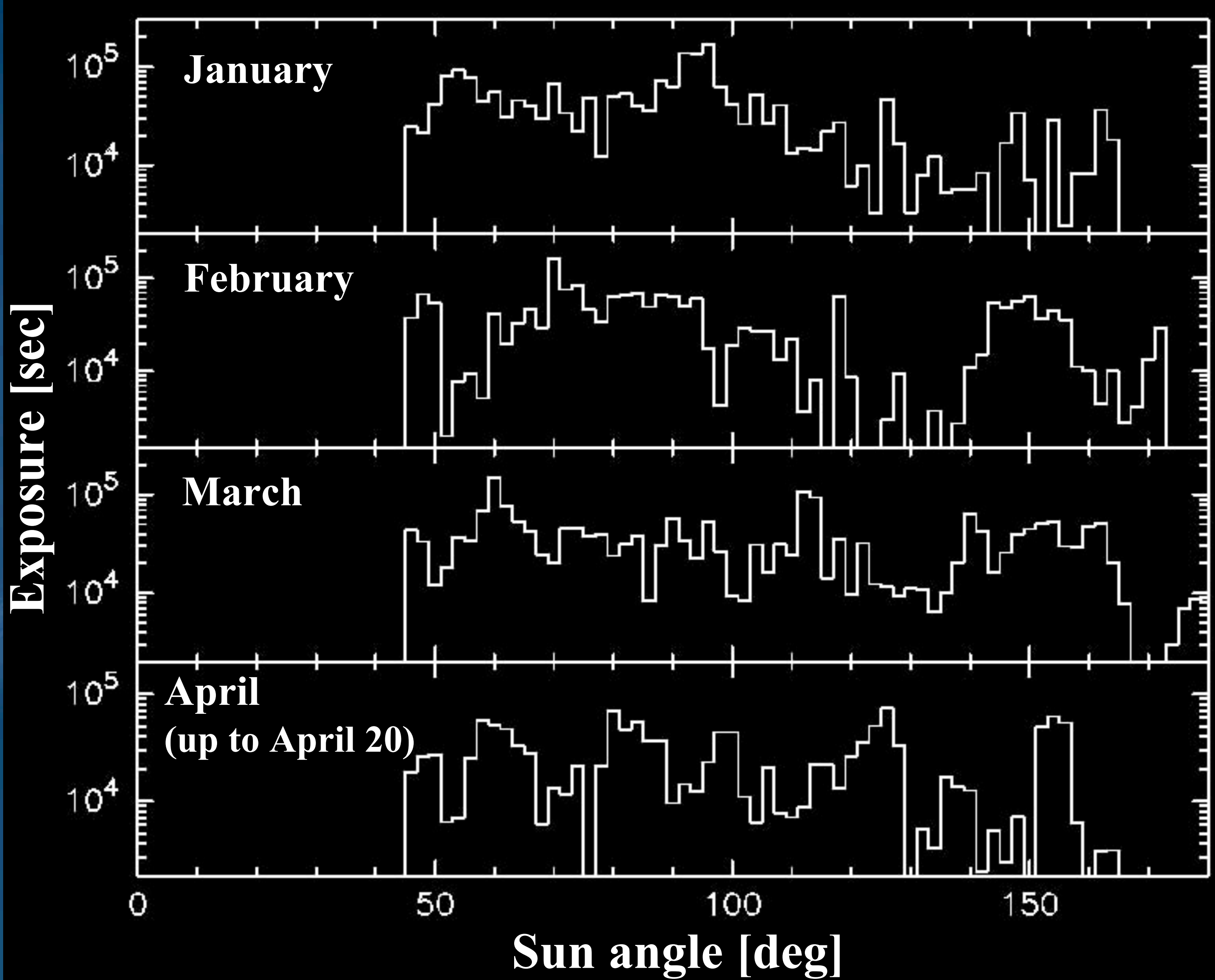


Summary

- Point Swift to the **anti-Sun direction**

  Double the number of redshifts
  - XRT: prompt position but no long follow-up
  - Q1. How long do we need to cool XRT to get the position?
    (Is cooling XRT during the SAA period enough?)
  - Q2. Is it possible to change the threshold of a mode switching?
- Screening "possible" high redshift GRBs from the BAT prompt emission properties
  - We can alert possible high-z ($z > 4$) GRBs (~5 GRBs year^{-1})
  - GRB detected by the BAT image trigger is very likely to be an "interesting" burst

Sun angle distribution 2007

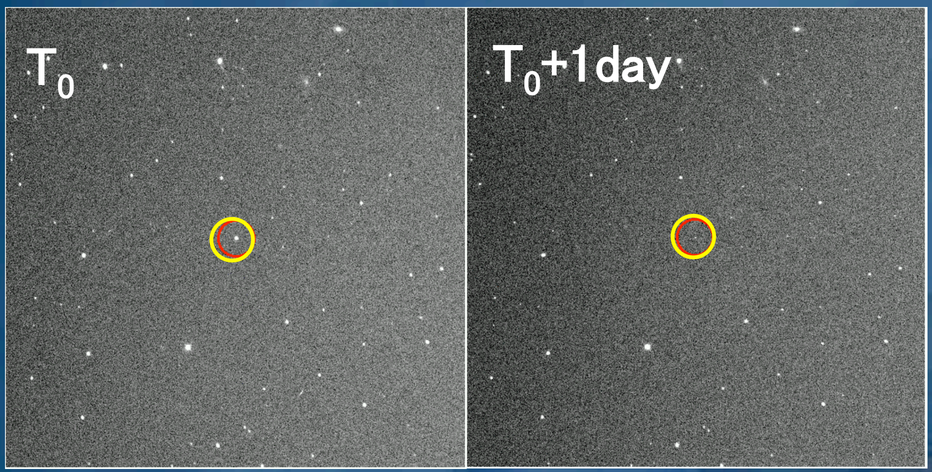


Swift

City lights are not an excuse

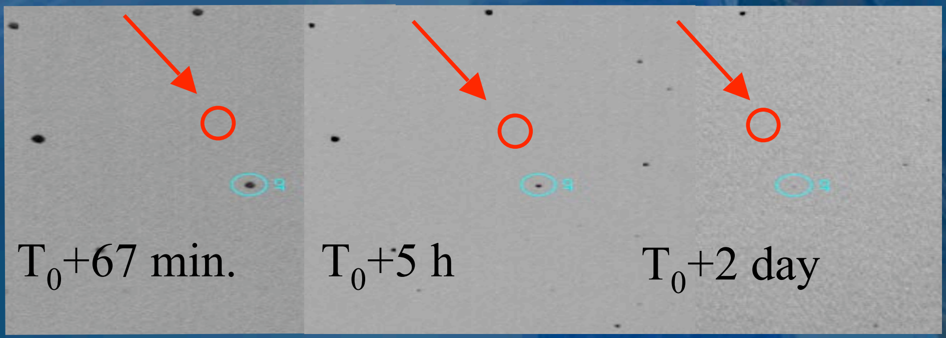
Optical observations of GRB 030329

Roof of RIKEN main building (Wako, Saitama)



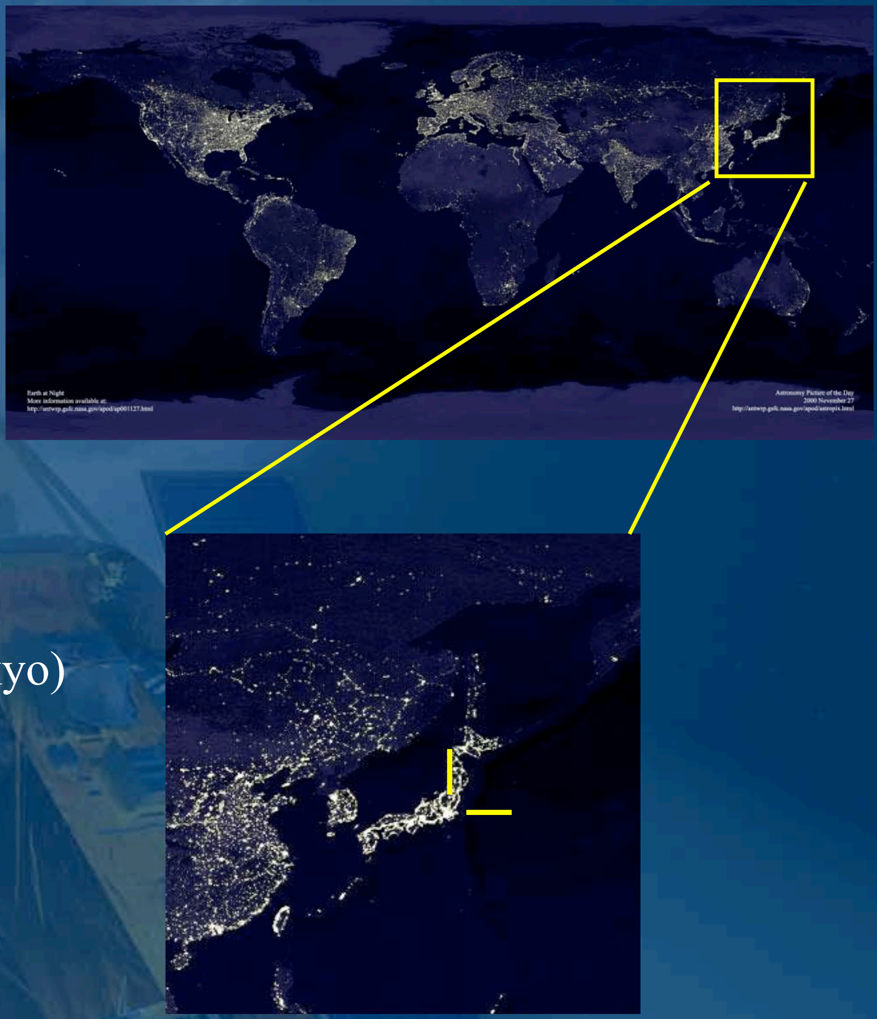
(Torii)

Roof of Tokyo Tech. main building (Meguro, Tokyo)

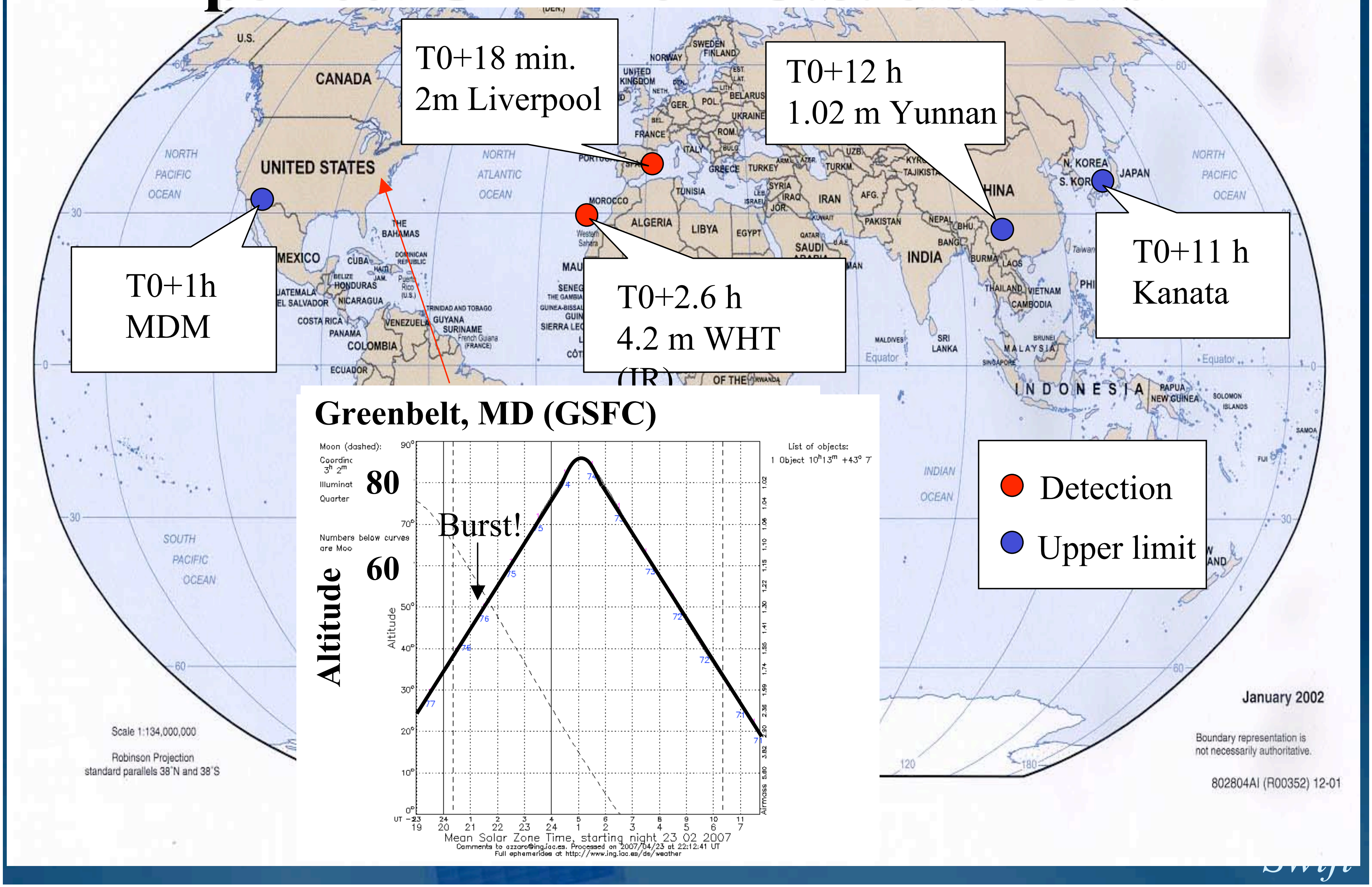


(Sato et al.)

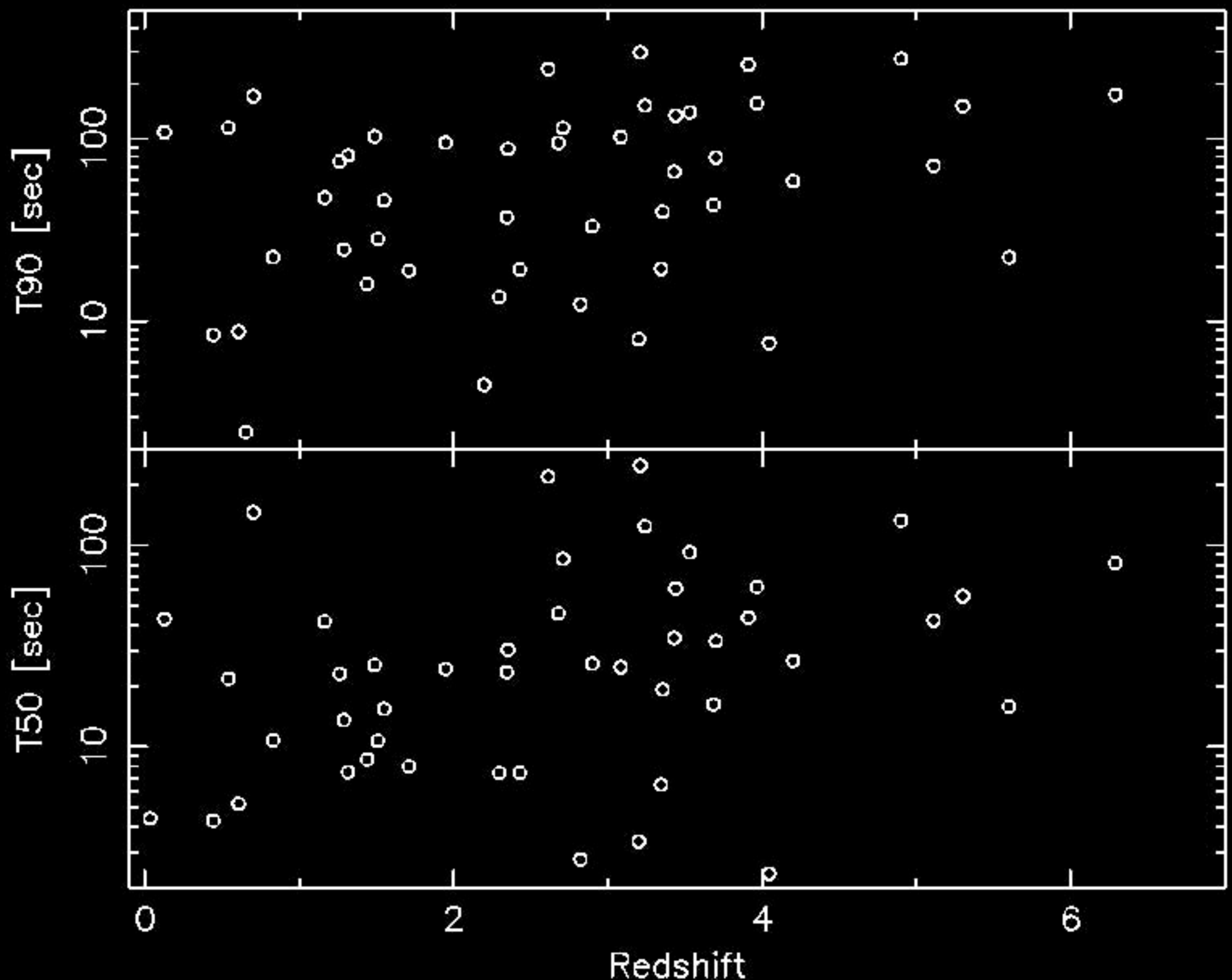
Astronomy Picture of the Day (11/27/00)



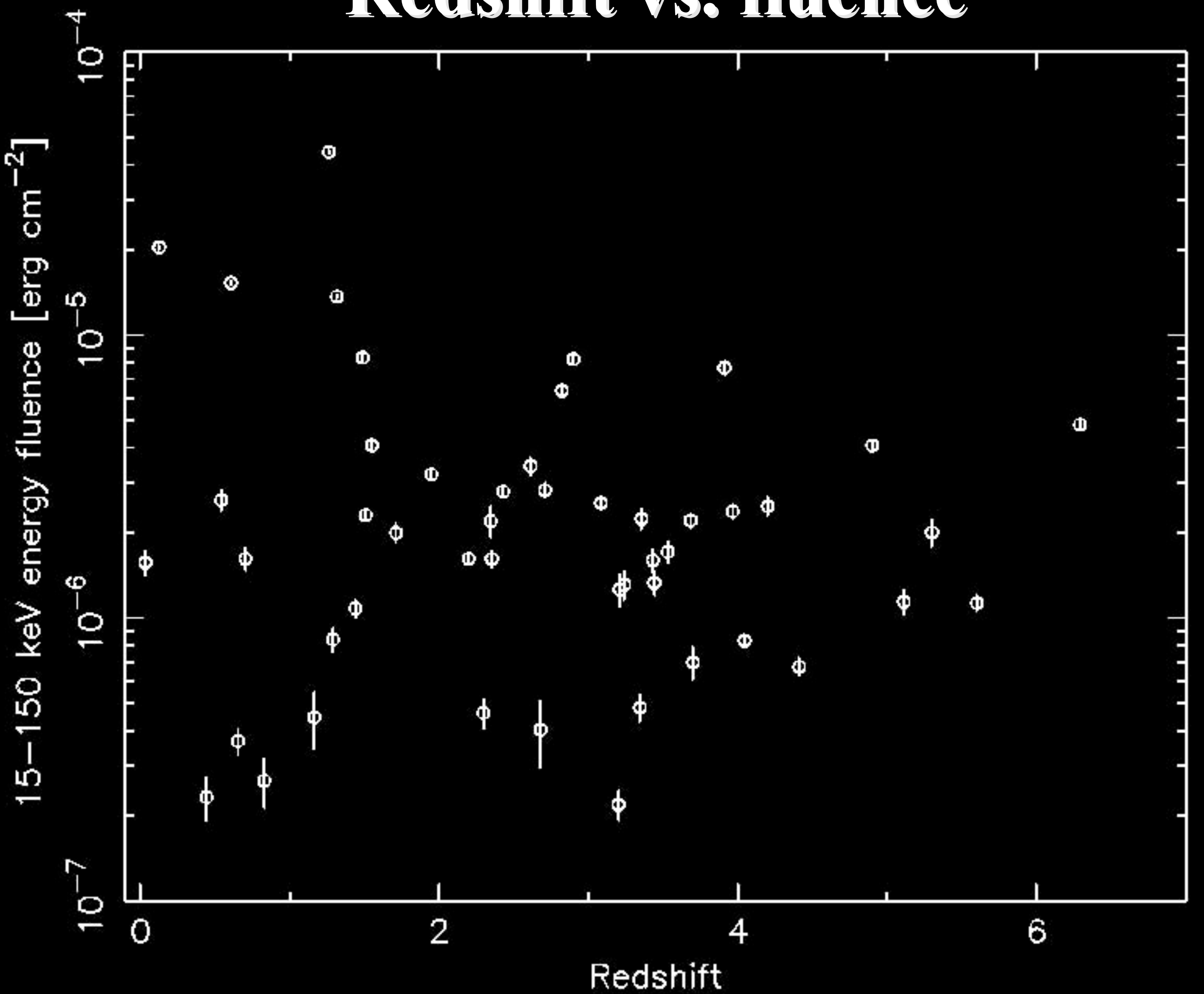
GRB 070223: perfect GRB from U.S. east coast



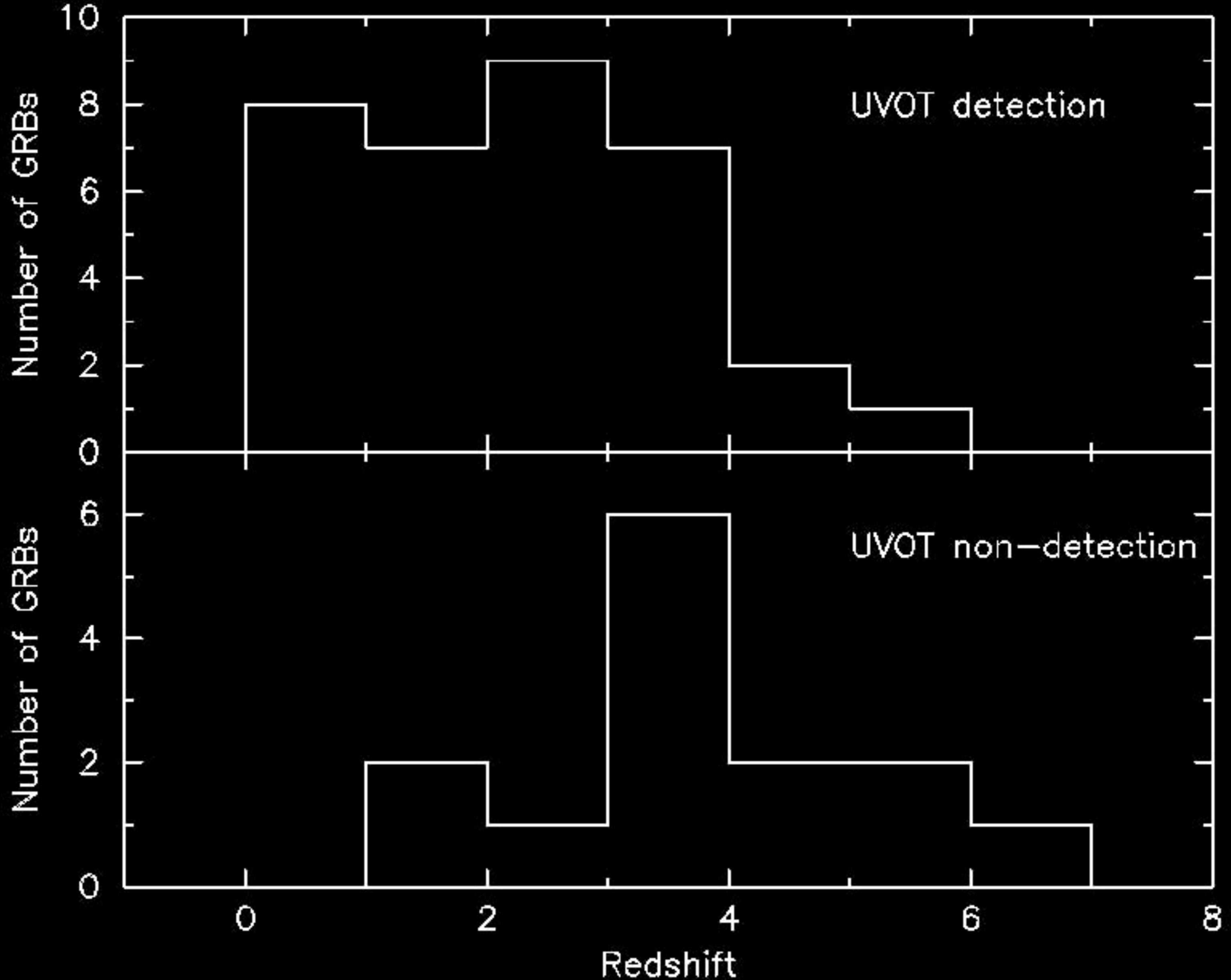
Redshift vs. T90/T50



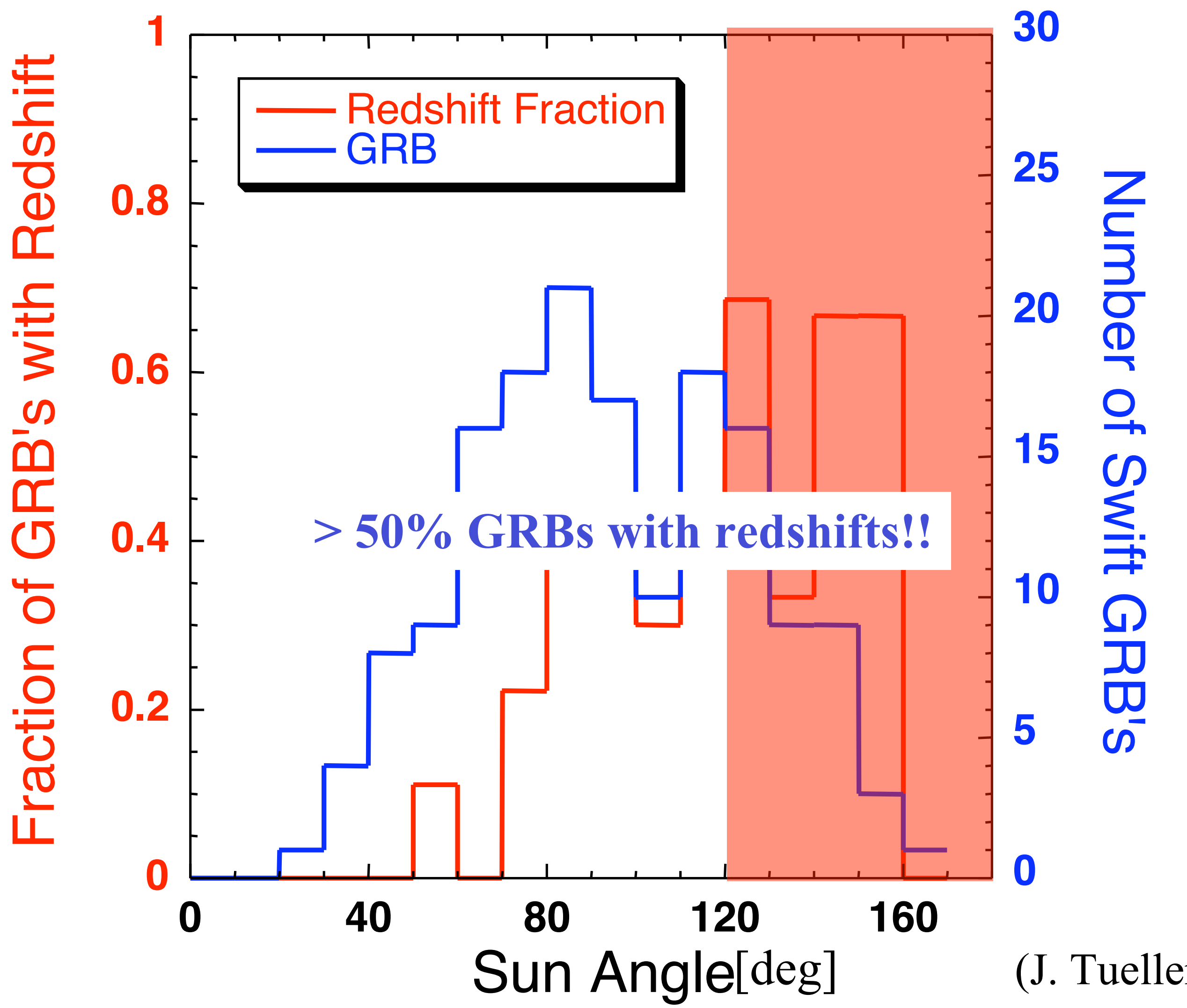
Redshift vs. fluence



Redshift vs. UVOT AG detection



Sun angle vs. redshifts



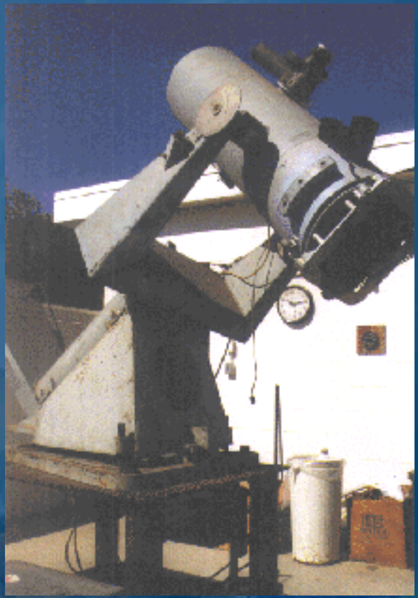
(J. Tueller)

Telescopes around GSFC

UMBC/Joint Center for Astrophysics

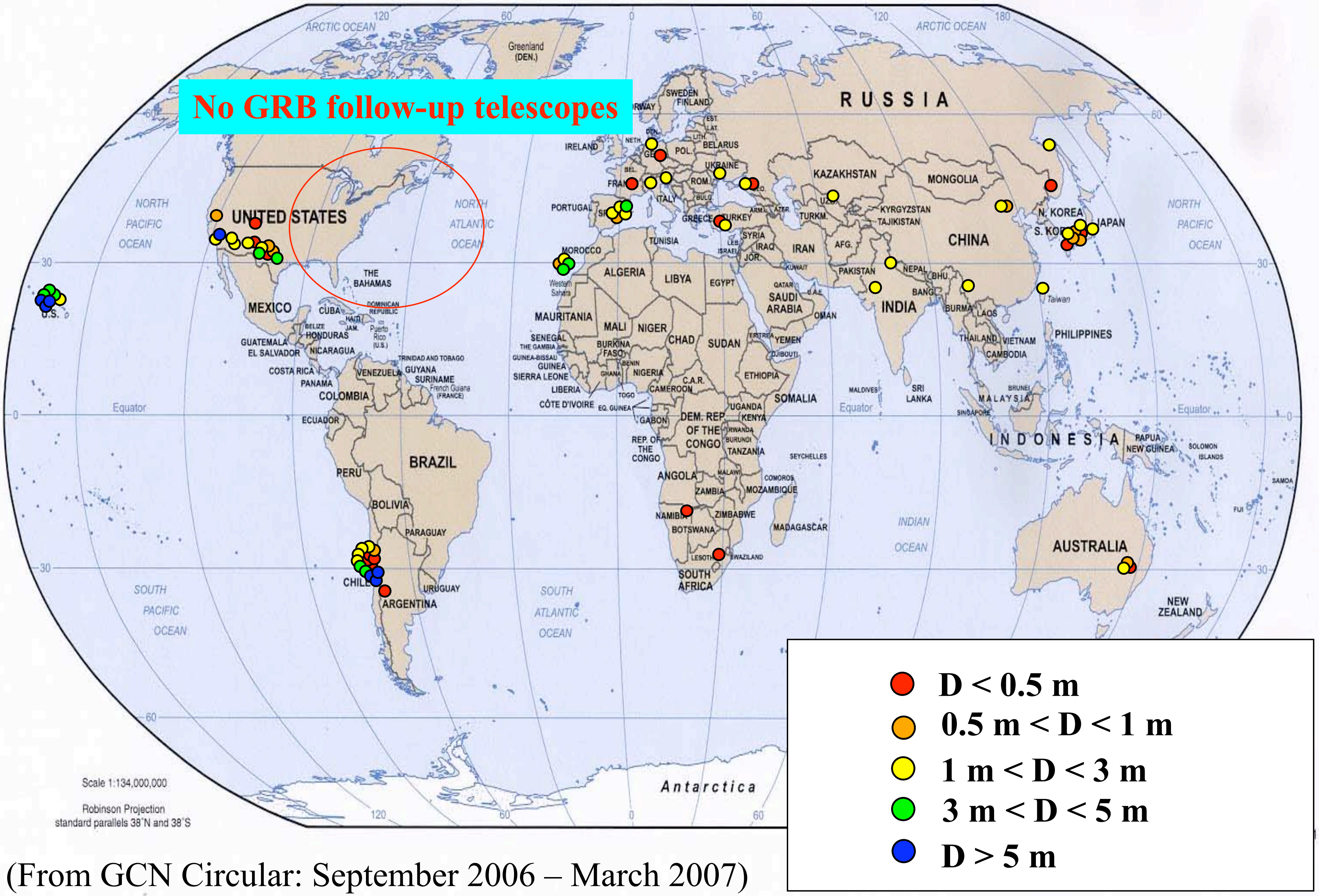
0.83 m (top of physics building)

University of Maryland Observatory



GRB follow-up telescopes at the east coast of U.S.

GRB follow-up telescopes

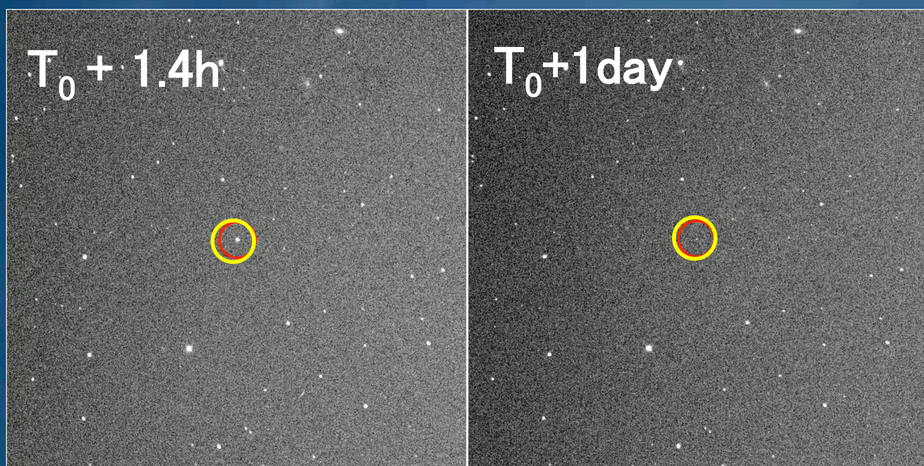


(From GCN Circular: September 2006 – March 2007)

City lights are not an excuse

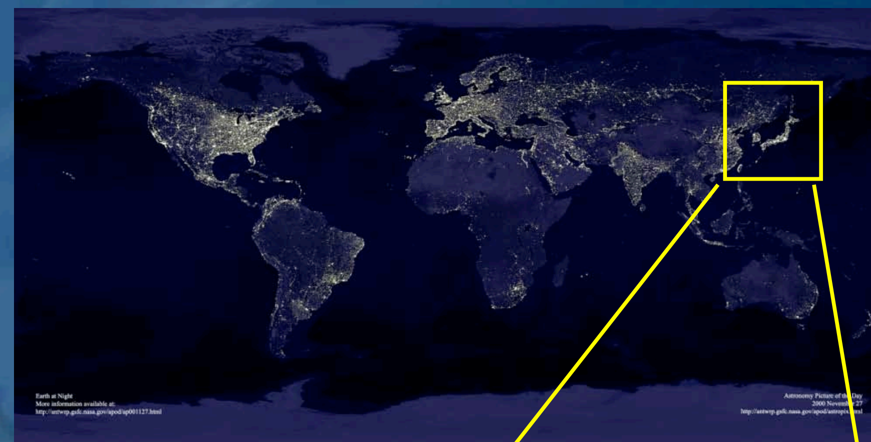
Optical observations of GRB 030329

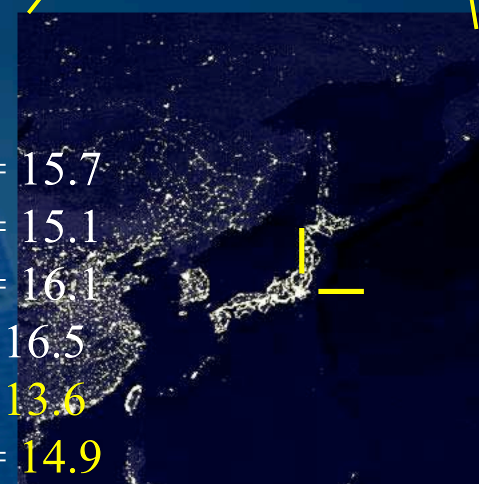
Roof of RIKEN main building (Wako, Saitama)



(0.25m Torii)

Astronomy Picture of the Day (11/27/00)



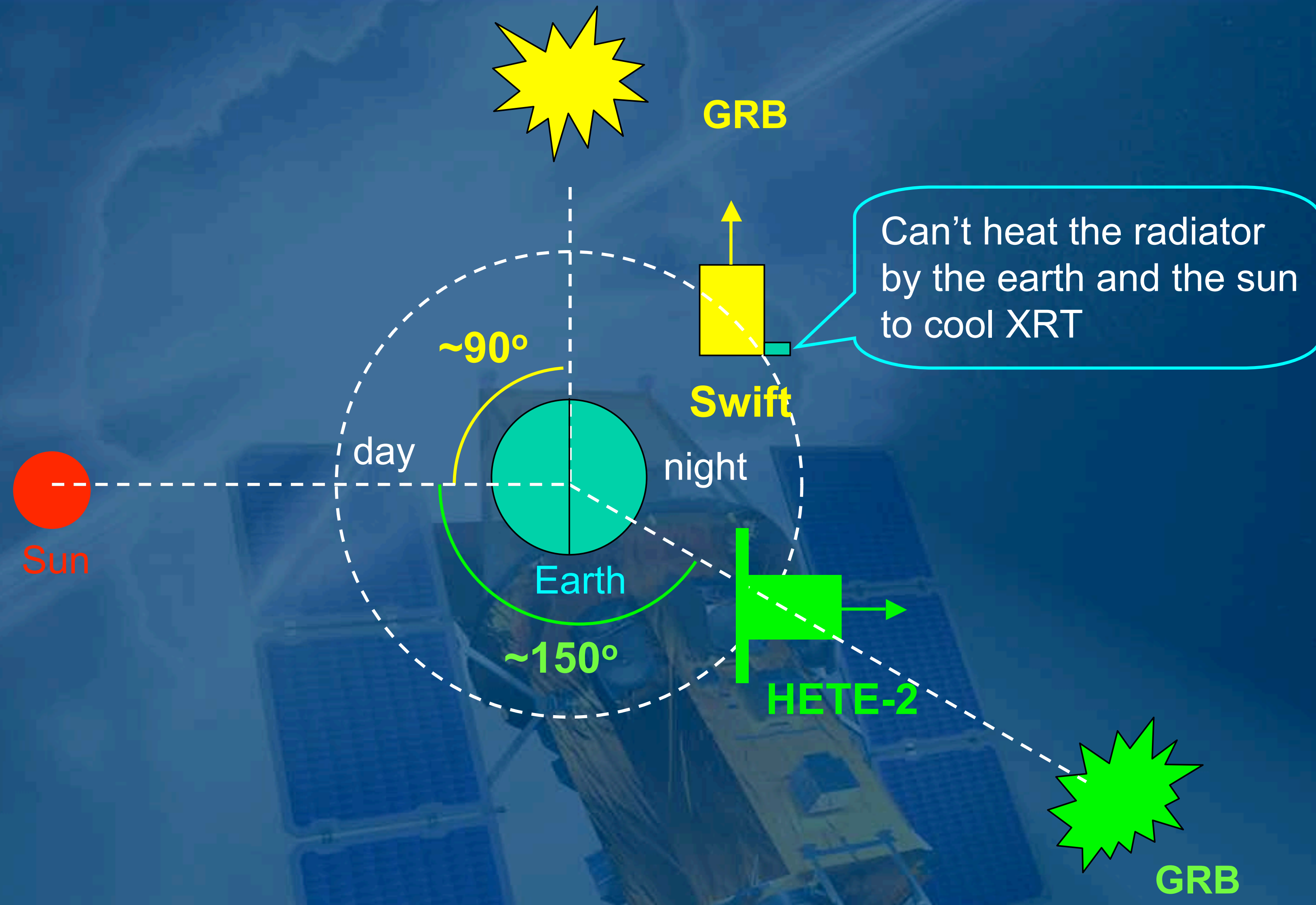


Swift GRBs (magnitude < 17 mag)

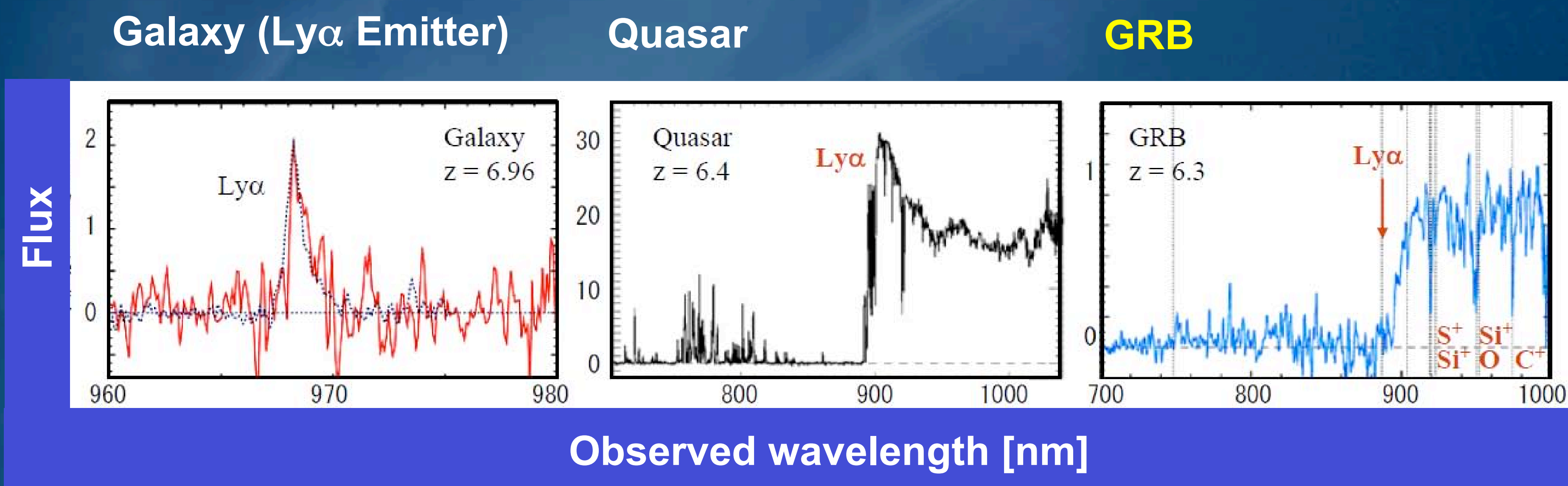
- 050319A : unflt = 16
- 050525A : unflt = 14.7
- 050603A : R = 16.5
- 050801A : unflt = 15
- 050820A : R = 14.7
- 050822C : V = 15.5
- 050922C : unflt = 14.7
- 051109A : unflt = 15.4
- 051111A : unflt = 13
- 051211B : unflt = 16.2
- 060117A : R = 11.5
- 060418A : V = 14.5
- 060512A : white = 16.2
- 060605A: unflt = 16.3
- 060607A : white = 15.7
- 060908A : white = 15.1
- 060912A : white = 16.1
- 060927A : unflt = 16.5
- 061007A : unflt = 13.6
- 061021A : white = 14.9
- 070318A : V = 15.4

10 GRB yr^{-1} (mag < 17 mag)

Why Swift is pointing closer to the Sun



High-z objects:
Galaxy, Quasar, … and GRB



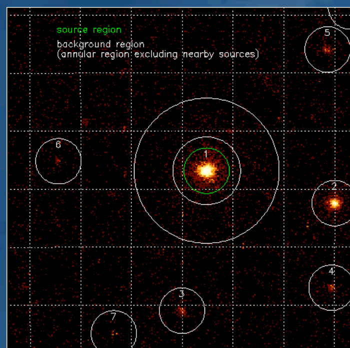
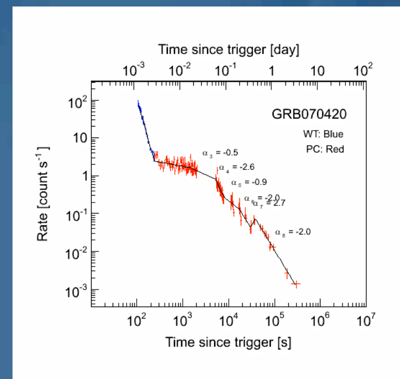
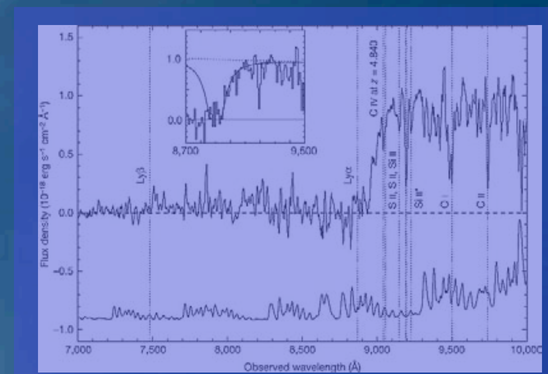
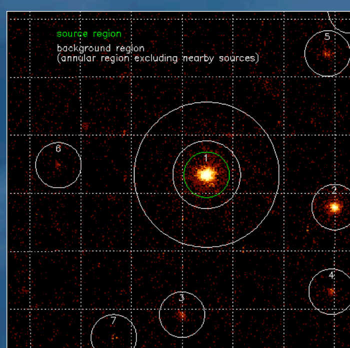
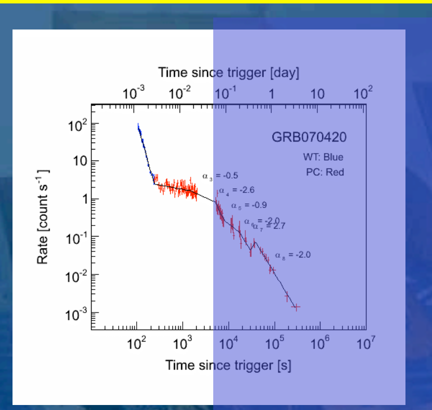
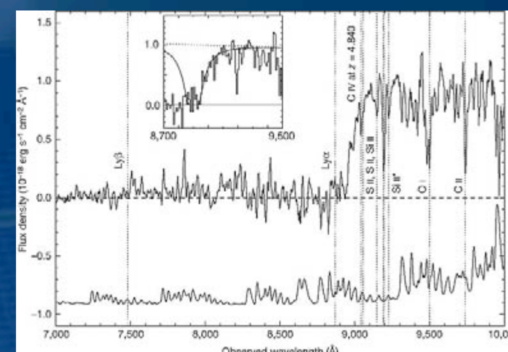
(Ohta Kyoto GRB workshop)

Galaxy:
- Very dim (low SN)
- Limited spectral information

Quasar:
- Not a 'normal' enviroment
- Ionized by own UV radiations
- Complicated spectrum

GRB:
- 'Normal' (star forming) environment
- Transient emission
- Simple power-law spectrum

Swift GRB observation strategy

	XRT position	XRT light curve	Spectroscopy
A			
B			

- Point Swift to anti-Sun position as far as we can.
- XRT will focus on the prompt localization + early X-ray AG.
- No long follow-up by XRT (Sun angle < 120 deg. bursts)

Advantage of GRBs for measuring dark energy

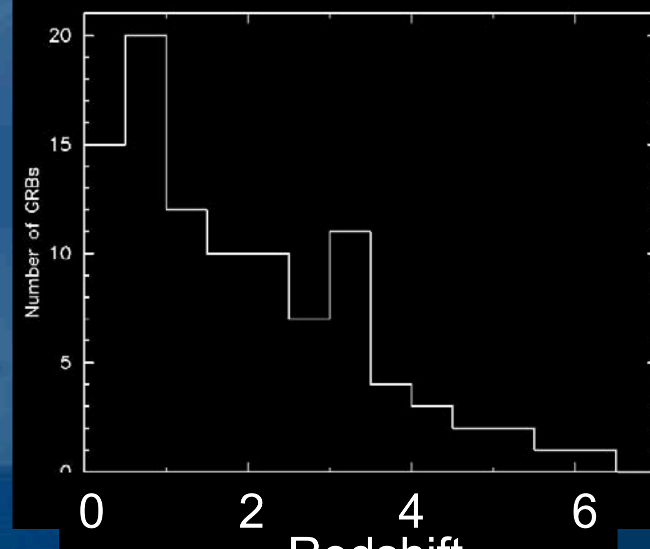
GRB

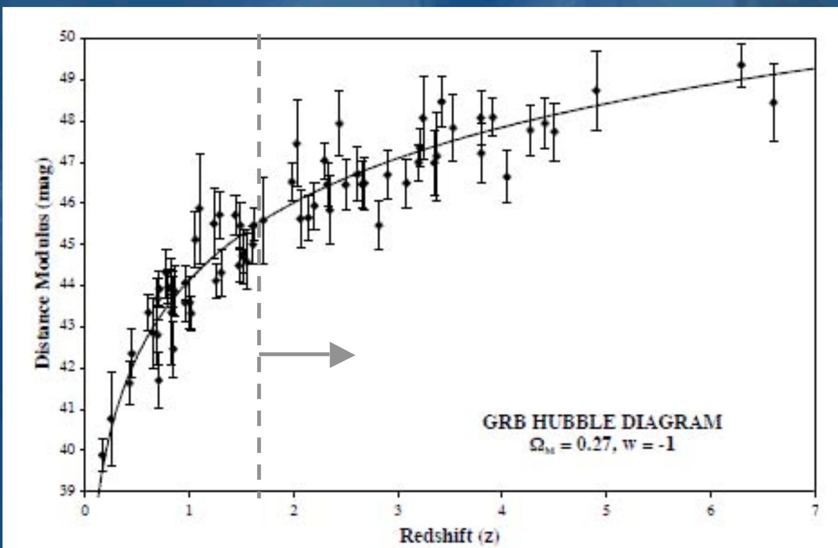
Luminosity indicators + Redshift

- $E_{peak} - E_{iso}$
- $E_{peak} - L_{iso}$
- $E_{peak} - E_{gamma}$
- $Lag - L_{iso}$
- $Variability - L_{iso}$
- etc…

Similar method to SN Ia with a great advantage

GRB redshift





GRB can be used to measure dark energy!

However…

GRB luminosity indicators are premature.

We need to..

- Confirm the GRB luminosity indicators
- Calibrate the indicators

Importance of GRB redshifts

- High-z GRBs Huge potential for studying early universe (z>10)

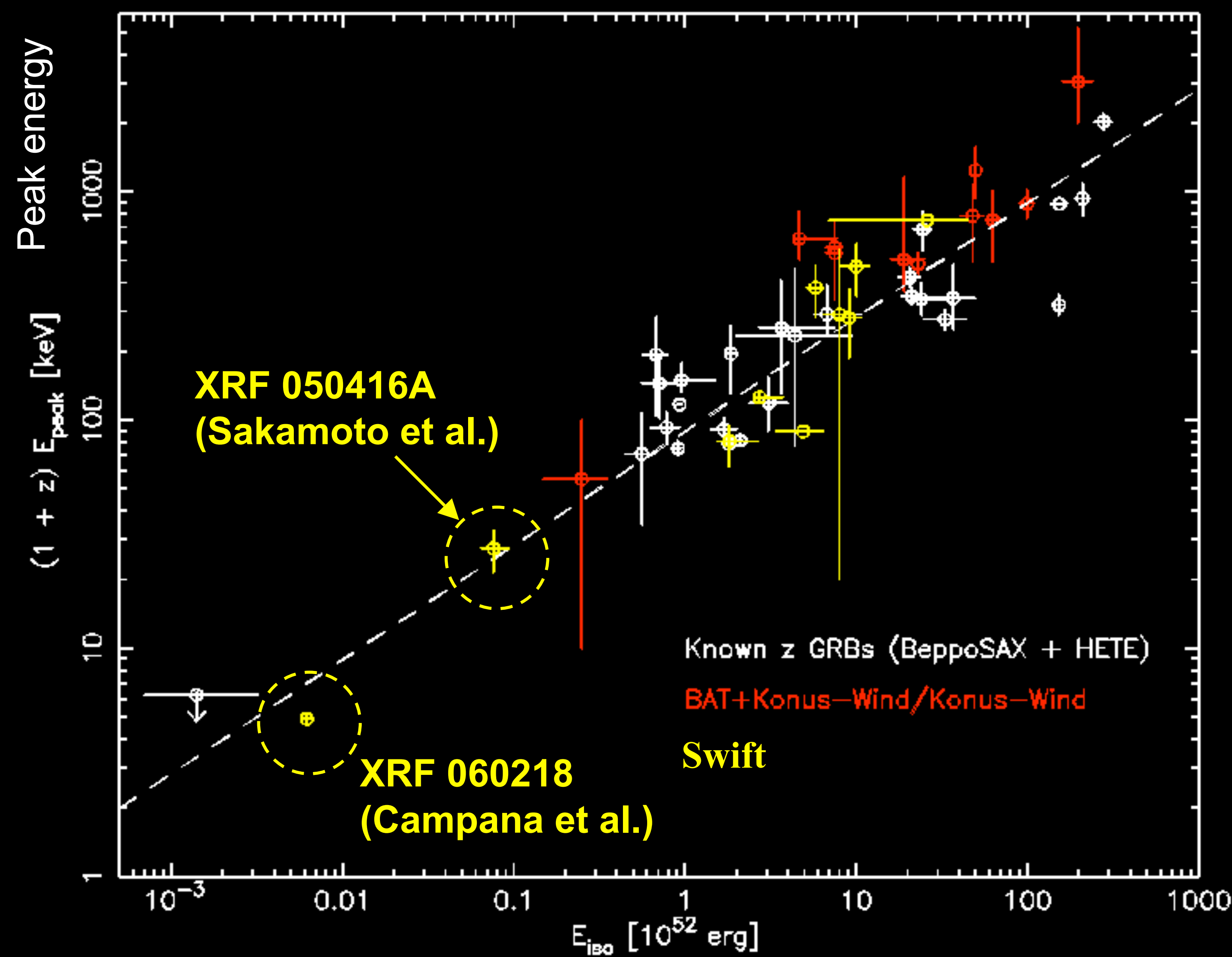
1. IR detection and spectroscopy
2. Deep optical observations
3. Indication of "possible high-z" from the Swift data

- Luminosity indicators Measurement of Dark energy (e.g. Schaefer)

GRB properties (Ep, V, Lag, ..) + redshift

1. Variety of redshifts (importance of low-z GRBs)
2. Optical/IR/radio detection of AG
3. Spectroscopy

$E_{peak} - E_{iso}$ relation (Swift)



Swift

Summary

- Point Swift to the **anti-Sun direction**

  Double the number of redshifts

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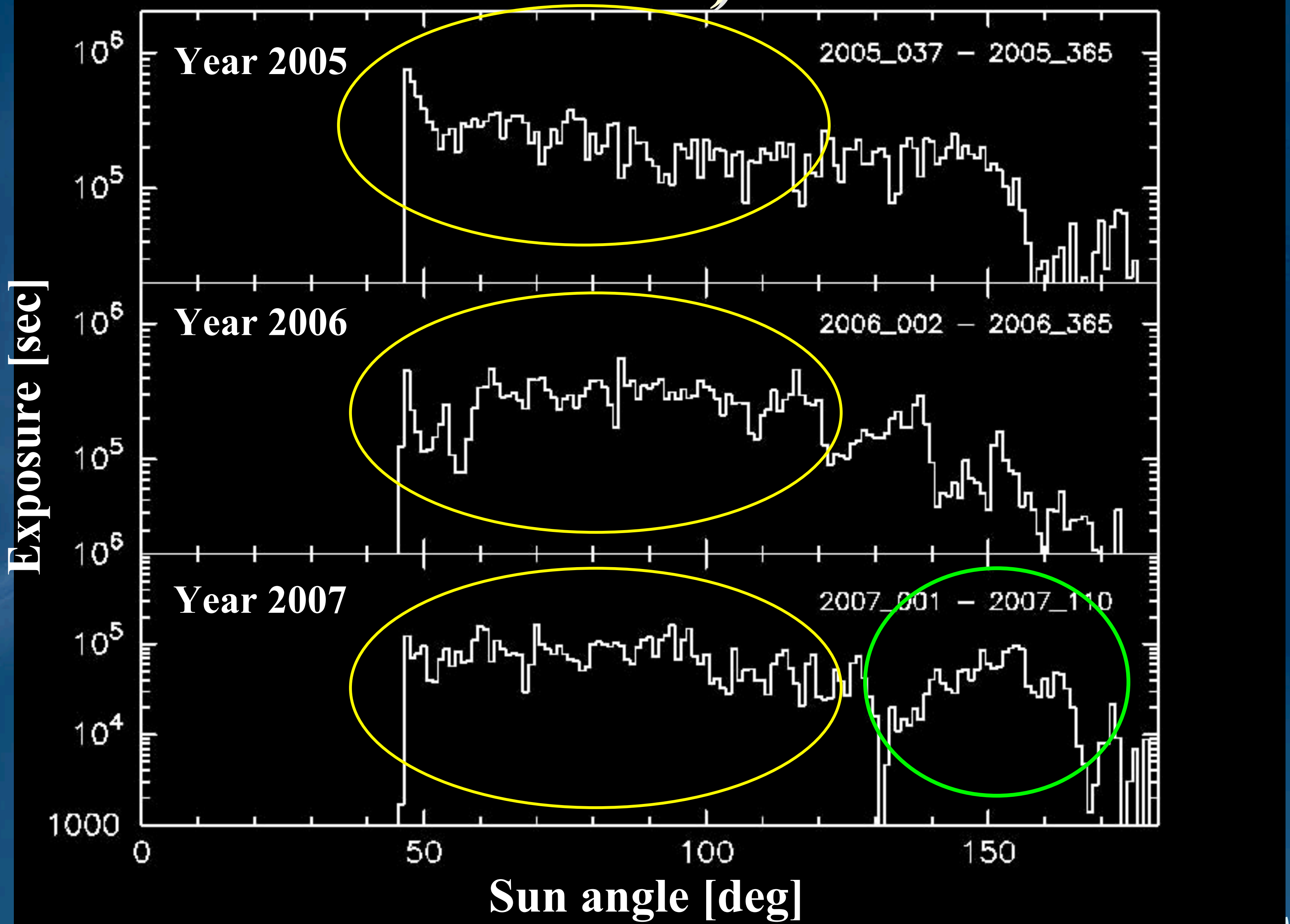
  - We can alert possible high-z ($z > 4$) GRBs (~5 GRBs $year^{-1}$)

Sun angle distribution (excluding SAA)



Swift