GRB ToO Observations in the frame work of the East Asia GRB Follow-up Observation Network

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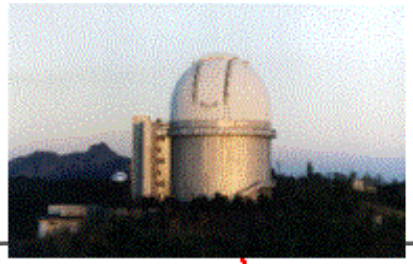
EAFoN

East-Asia GRB Follow-up Observation Network

- 6 (+1)telescopes in EA
- 1(+1) telescope in USA
- 1 unique instrument in Japan

Beijing 2, 1, 0.8 m

Beijing 2004～



WIDGET

WIDGET 2004～

Ultra Wide FOV.
40 x 40 degree
High Time resolution
Automatic Operations
(Tamagawa et al.)

Kiso(1m)

Kiso 2001～

Lulin (1m)

Lulin 2003～

LOAO(1m)

2006~

SNU

2006~

2005~

Maidanuk 1.5m

CFHT
PanSTARRs

GEODSS

SBAG

ROTSE-III
SSO

Breakthroughs in GRB research

(1) GRBs are cosmological

(2) Detection of afterglows in 1997 : GRB 970228

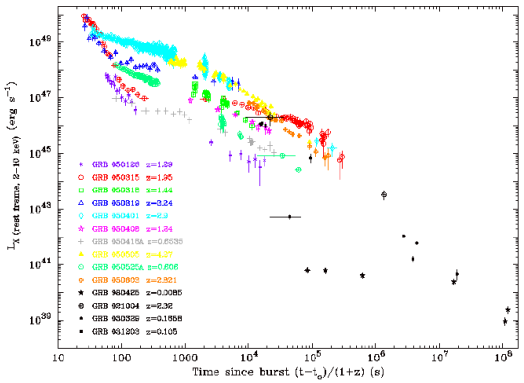
(3) Supernovae associated with long-duration GRBs

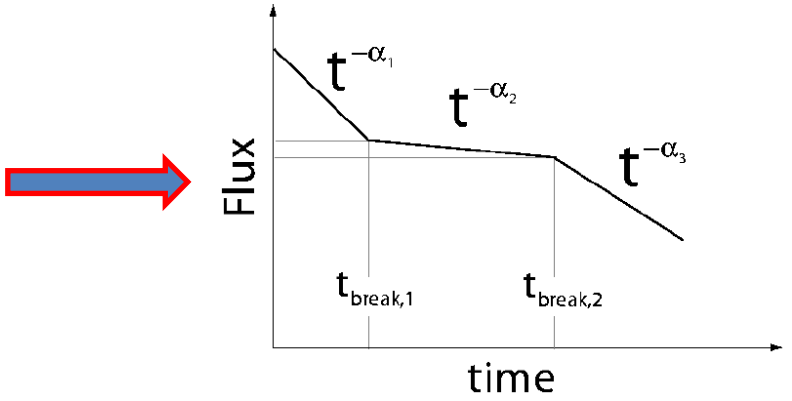
GRB	Related SN	Redshift (z)
GRB 980425	SN 1998bw	0.0085
GRB 030329	SN 2003dh	0.165
GRB 031203	SN 2003lw	0.105
GRB 060218	SN 2006aj	0.033

GRB	T_{90} (s)	redshift (z)	host galaxy
GRB 050709	0.5	0.16	Star-forming galaxy
GRB 050724	3	0.257	Elliptical galaxy
GRB 051221A	1.4	0.546	Star-forming galaxy

(4) Optical afterglows of short/hard GRBs

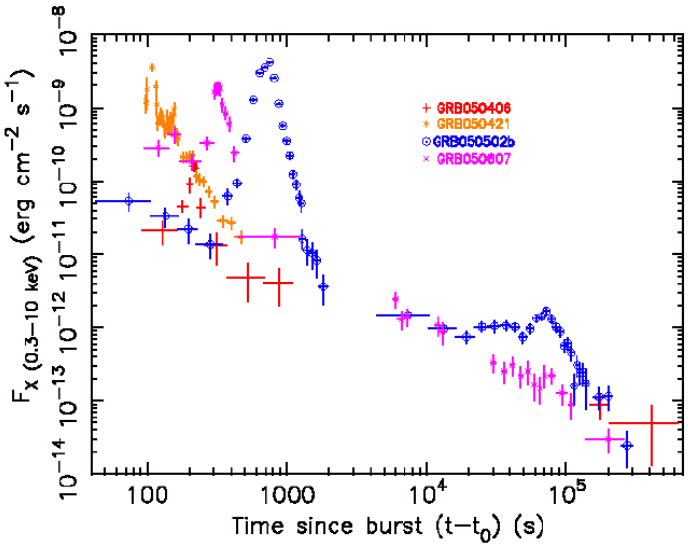
(5) Discovery of the canonical behavior of X-ray afterglows





GRB Afterglows

- First afterglow was discovered in 1997 → GRB 970228
- Power-law evolution
  → synchrotron emission
- Detection rate :
  X-ray afterglows > 90%
  Optical/IR afterglows ~ 50%
  Radio afterglows ~ 20%
- Breaks are frequently seem in temporal evolution.



- Before the Swift era, afterglow light curves are well described by several power-law components
- Recently, the swift events show complicated evolution (e.g. flares, shallow decay)

The mechanism of emission is still a puzzle!!

East-Asia GRB follow-up Observation Network (EAFON)

Advantages in East-Asia

A blank in the East Asia

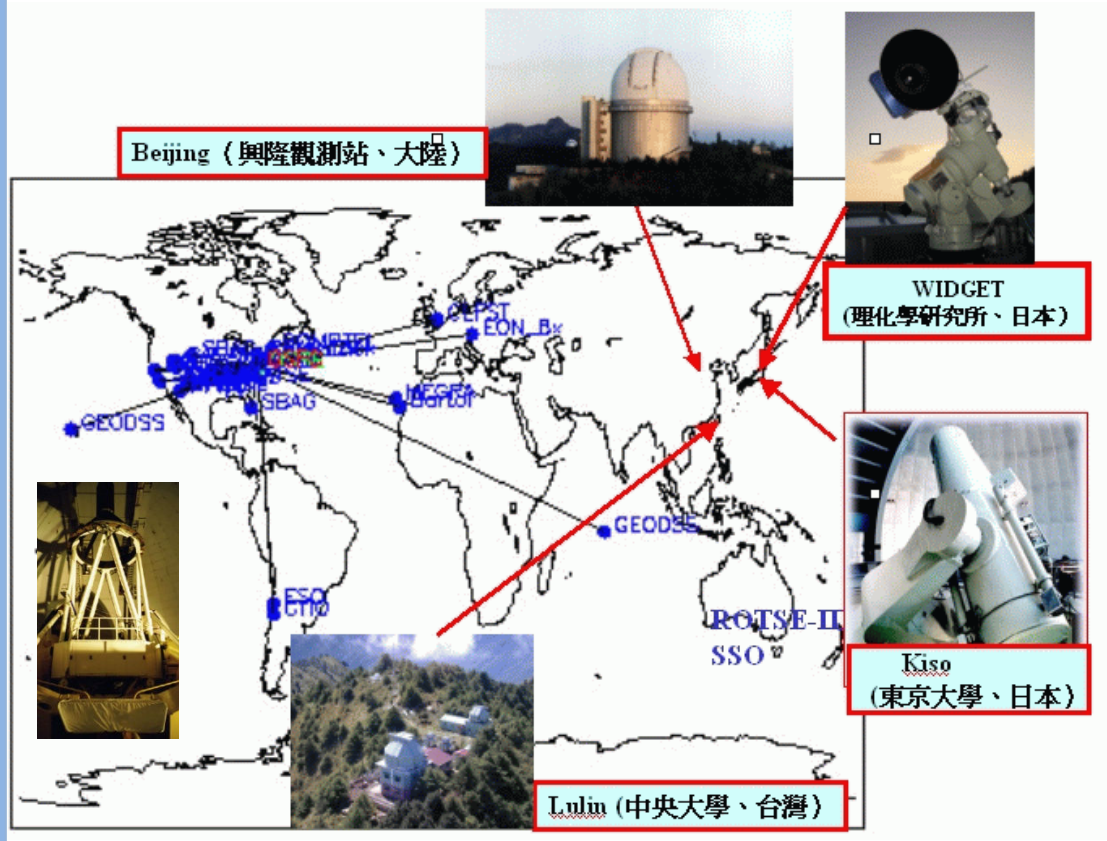
→ The follow-up are expected to provide valuable observations for GRB field.

Different positions of sites

→ To reduce the risk of weather.

→ Allow the cover range to up Dec~ -40 deg

→ Complete multi-band lightcurves.



EAFON Webpage :
http://cosmic.riken.jp/grb/eafon/

EAFON Publications in 2006-2007

Red : Kiso observational results

(1) Multicolor Shallow decay and Chromatic Breaks in the GRB 050319 Optical Afterglow
(Huang et al. 2007, ApJL)

(2) When do Internal Shocks End and External Shock Begin?
Early-Time Broadband Modeling of GRB 051111
(Bulter et al. 2006, ApJ)

(3) Very early multicolor observation of the GRB 041006 rebrighting afterglow
(Urata et al. 2007, ApJL)

(4) Extensive multiband study of the X-ray rich GRB 050408. A likely off-axis event with an intense energy injection
(A de Ugarte Postigo et al. 2007, A&AL)

(5) A multi band study of optically dark GRB 051028
(Urata et al. 2007, PASJ, accepted)

(6) Simulataneous Multi-color Observation of the Early Optical Bump of the GRB021004 afterglow
(Urata et al. 2007, ApJ submitted)

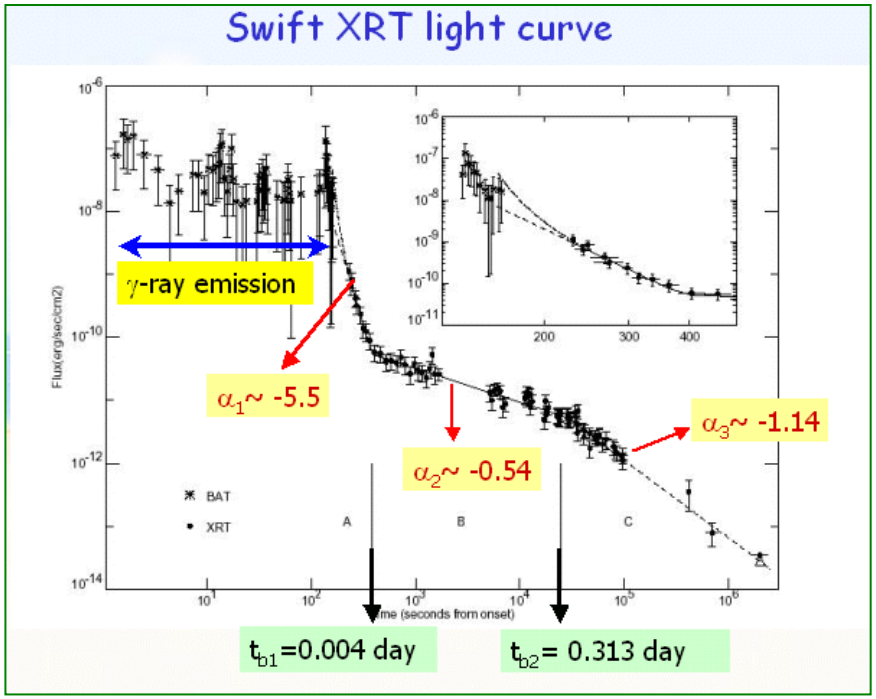
(7) Detection of GRB060927 at z=5.47: Implications for the Use of Gamma-Ray Bursts as Probes of the End of the Dark Ages
(Ruiz Velasco et al. 2007, ApJ submitted)

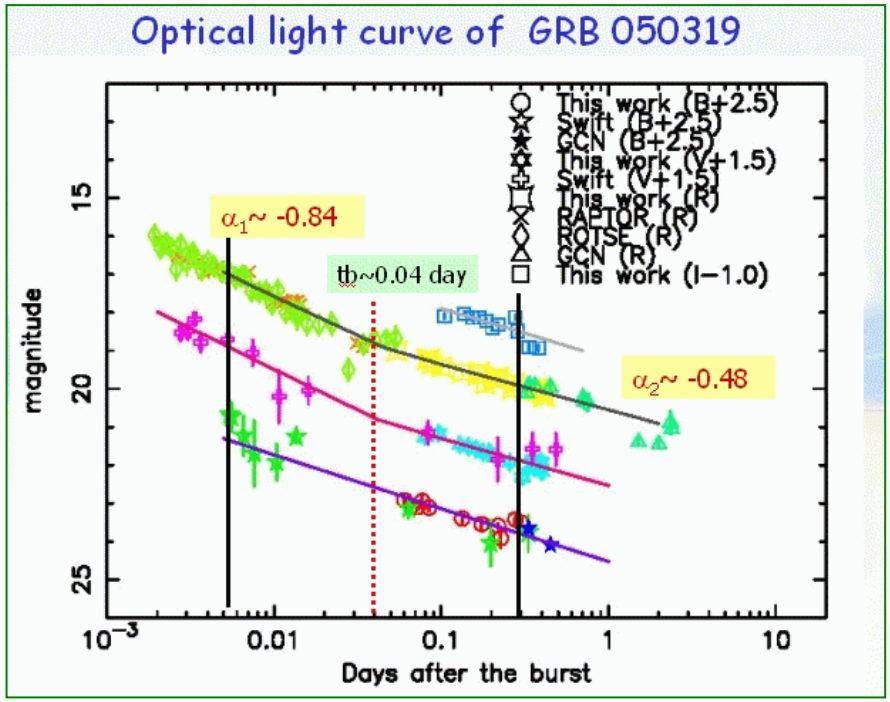
(8) Are Late time X-ray Afterglows of Gamma-ray Bursts Normal ?
(Urata et al. 2007, ApJL in prep.)

An important burst :

GRB 050319 (z=3.24) -- X-ray and optical results

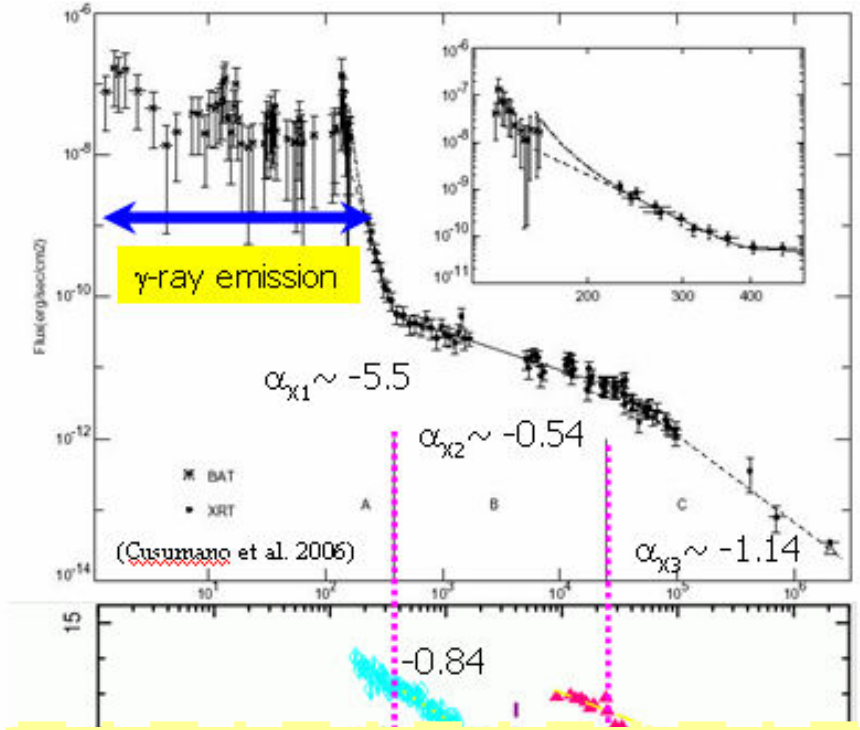
Huang et al. 2007 ApJ, 628, L93





- The break time is different from that of X-ray afterglow.
- The unusual shallow decay displayed during our observations.
- The shallow decay in both X-ray and optical may have similar origin relate to energy injection.

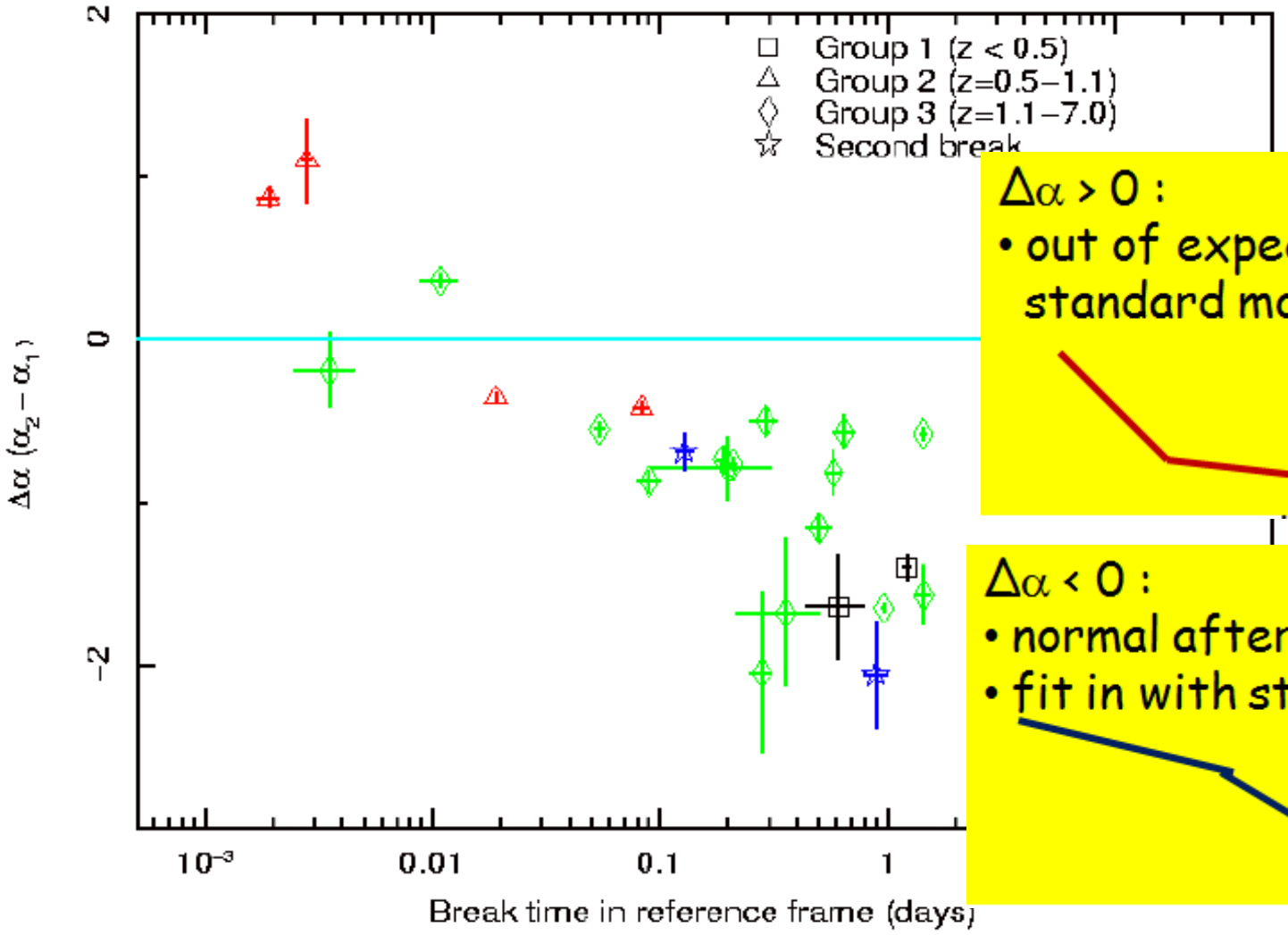
Serious problem in the standard model



- Shallow decay
  - → energy injection
  - → when energy stop to supply, break should appear at same time in afterglow evolution.
  - → chromatic breaks in afterglow observations.
- Jet break did not be found in X-ray (~ 28 days), but in optical

Mechanism of X-ray afterglows and optical afterglows should different
or
Optical emission region is different from that of X-ray.

Temporal Evolution in optical afterglows

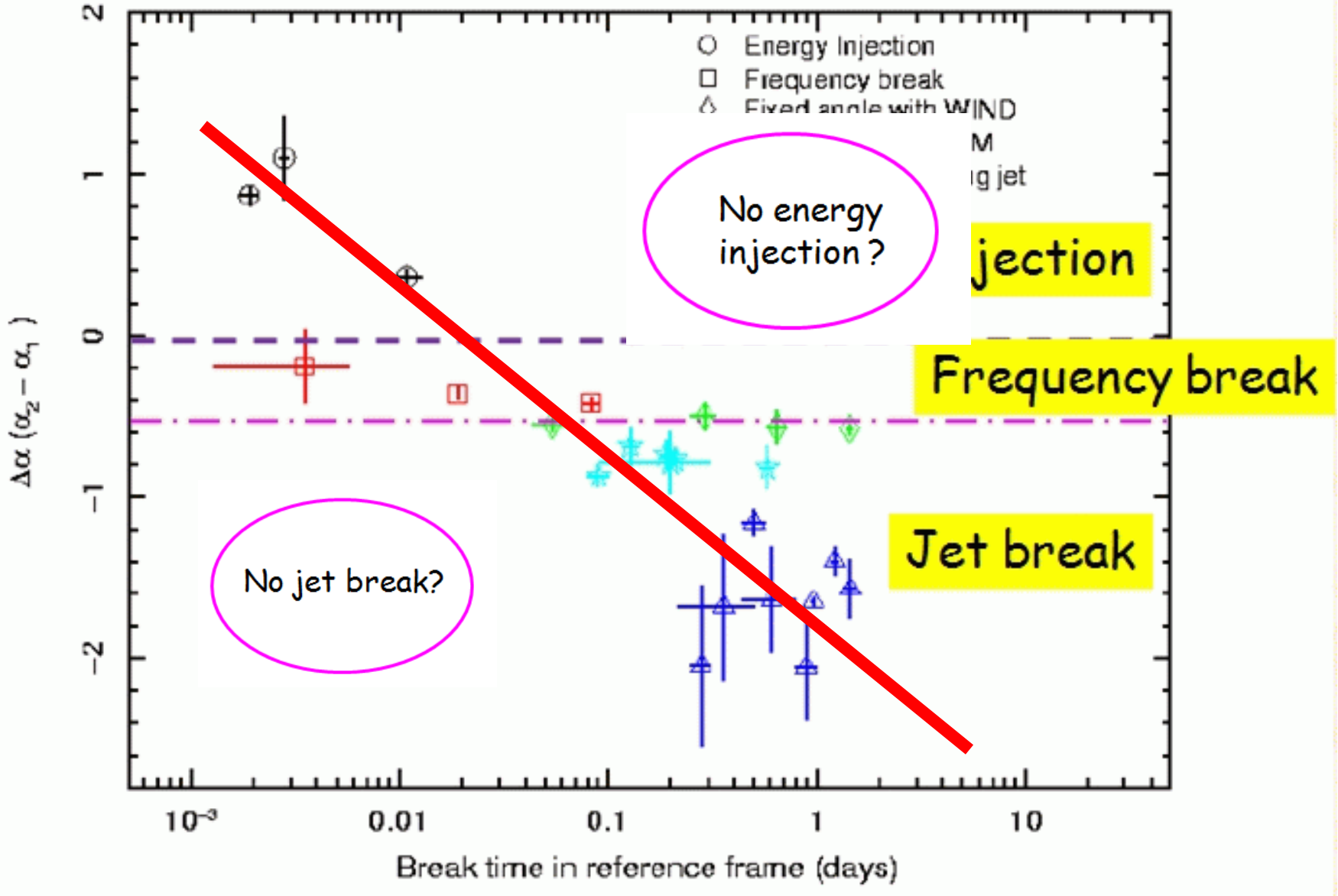


$\Delta\alpha > 0$:

- out of expectation of standard model

$\Delta\alpha < 0$:

- normal afterglow decay
- fit in with standard model


Energy Injection
Frequency break
Fixed angle with WIND
M
g jet
No energy injection ?
jection
Frequency break
Jet break
No jet break?
2
1
0
−1
−2
$\Delta\alpha\ (\alpha_2 - \alpha_1)$
10^{-3}
0.01
0.1
1
10
Break time in reference frame (days)

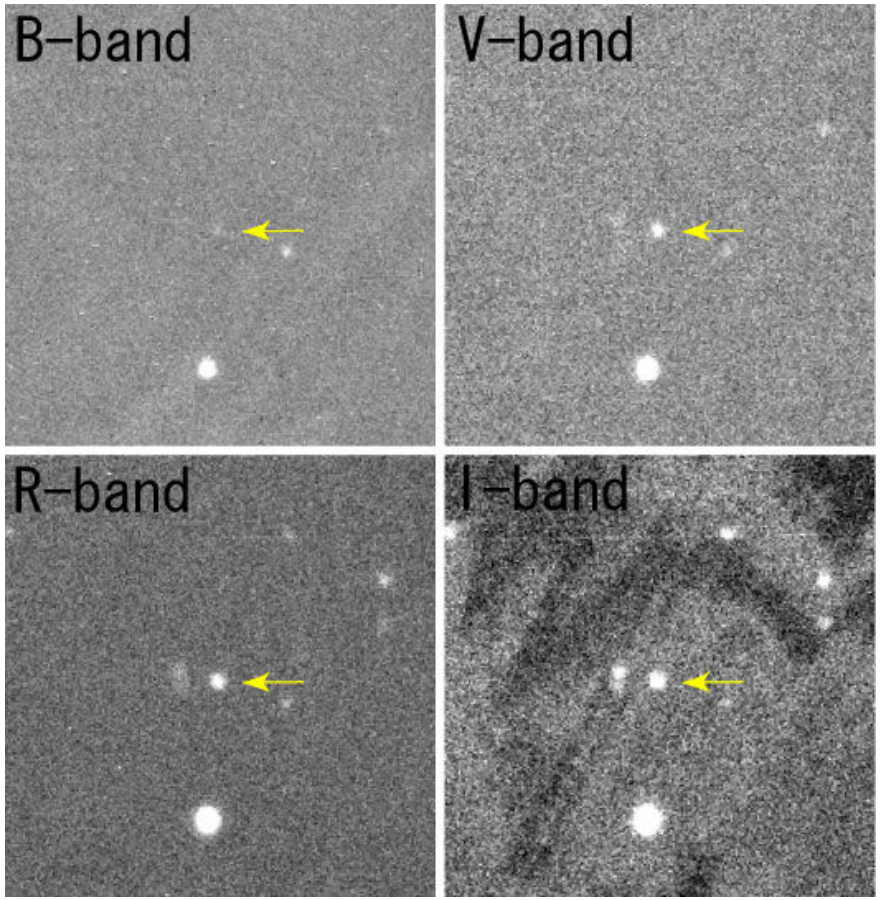
High-z (z>3) GRB

Totally, there are 25 events @2007.07.10.

We have detected 1/5 of high-z events including 2nd high-z event using ~1 m telescopes.

	z	GRB	Sites	Comments
•	**5.47**	060927	Kiso &Xinglong	2nd high-z event!
•	**4.048**	060206	Lulin	
•	3.78	060605	Xinglong	
•	3.240	050319	Kiso & Lulin	
•	3.221	060526	Lulin	

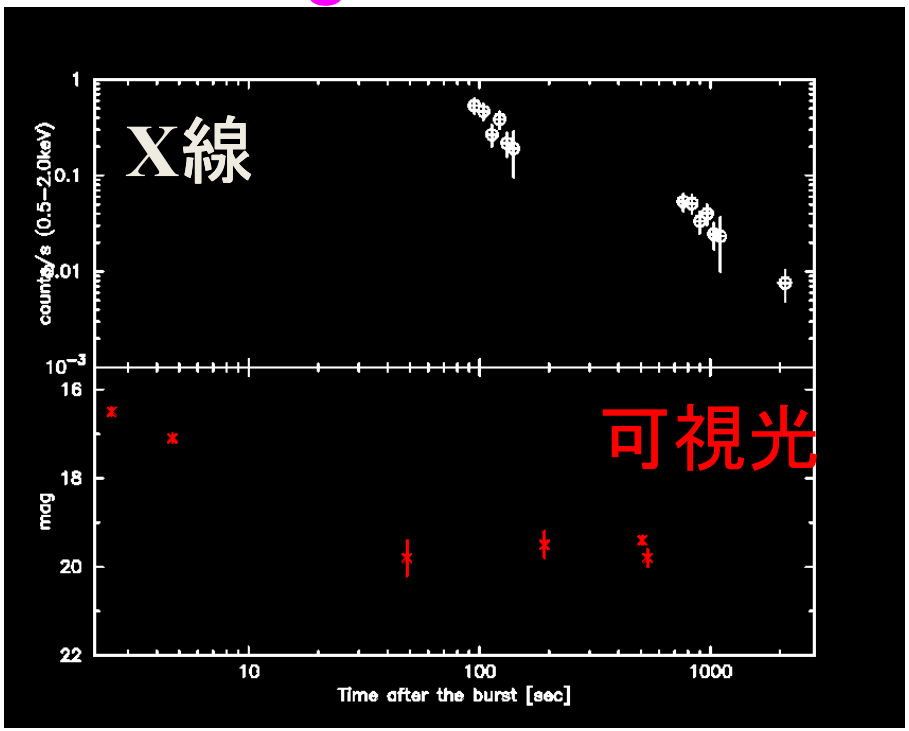
(1)GRB060206 (**z=4.408**)



R=18.8 mag@15.86h (Lulin)

(2)GRB060927 (**z=5.47!!**)

2nd highest GRB！



Different behaviors in both X-ray and optical

Summary

- The EAFON works well for GRB optical follow-up observations.

- Our observational results showed
  -- small telescopes have potential for studying cosmological objects.
  -- Detail optical afterglow light curves play an important role to understand mechanism of GRBs .

- Combine with other well-observations, we found that "energy injection" only occur in early temporal evolution and "jet break" occur in late time from our 22 samples.