



Observation of GRB Optical flash with Ashra prototype

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Ashra Project Plan



2002

2003

2004

2005

2006

2007

phase 0

R&D

Ashra Prototype
Optical Flash obs.

phase 1

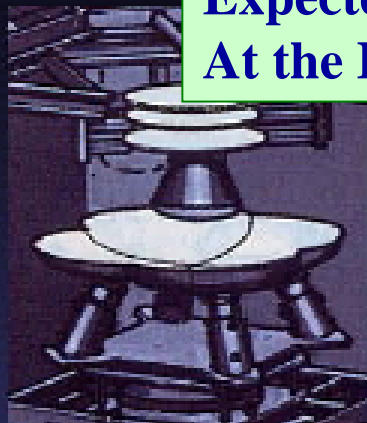
Pioneering

phase 2

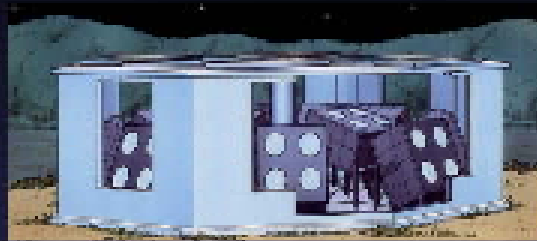
High Statistics

sub-telescope

Expected Time to Install All Electronics
At the End of the Construction Term



prototype in labo.



2 Mt.s on the Hawaii Is.

complete 3 stations



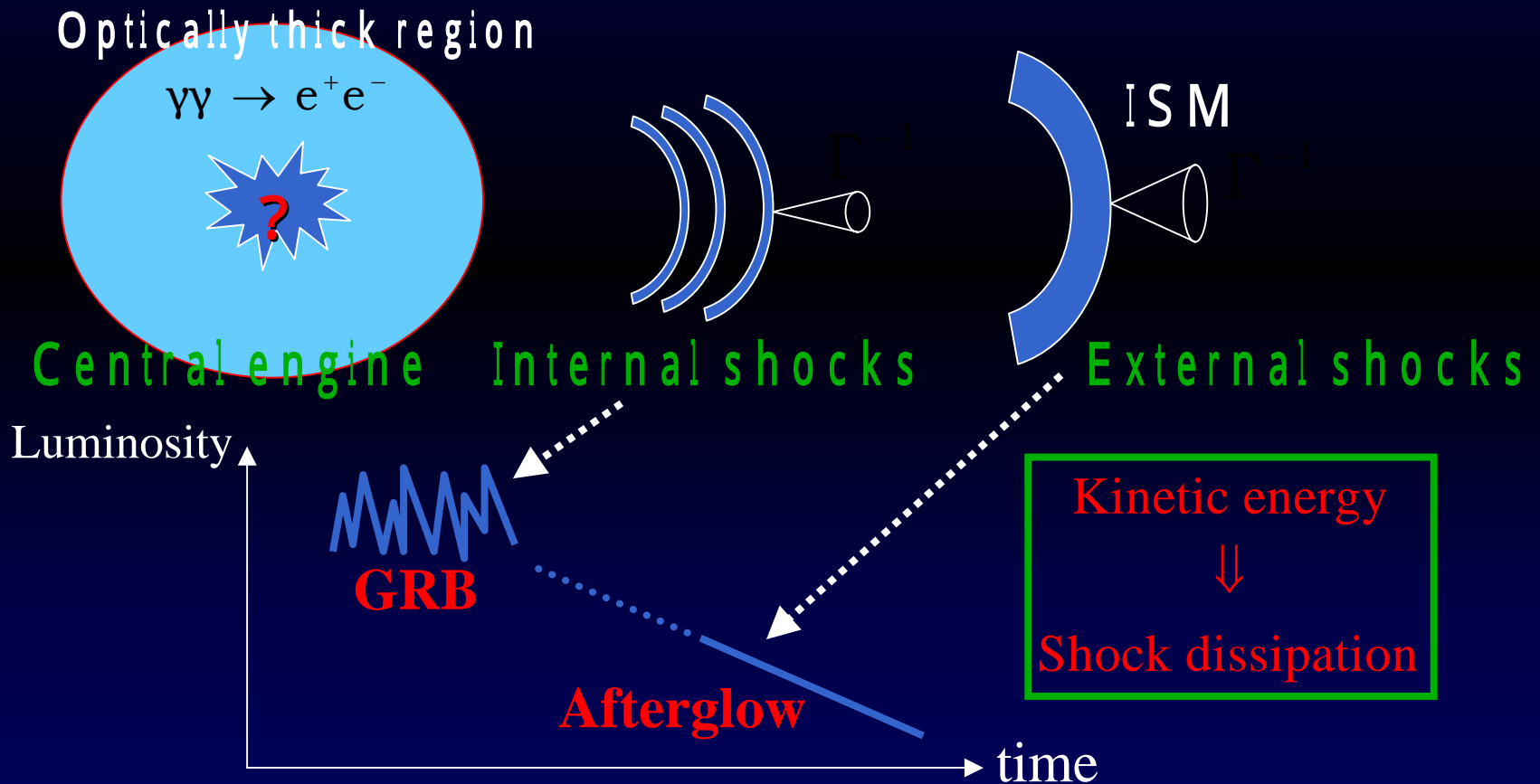
3 Mt.s on the Hawaii Is.

Gamma Ray Burst



Beppo-SAX identified with ~ 3 arcmin. resolution.

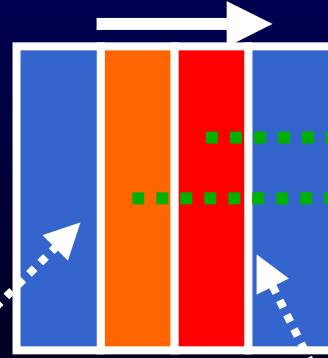
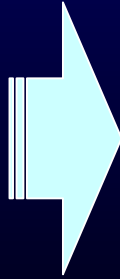
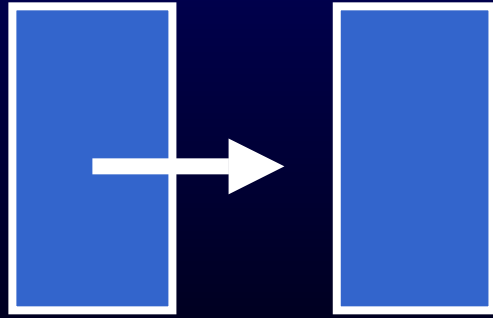
\Rightarrow Multi-wavelength Analysis (1997~)



ASHRA all-sky optical, , survey with ~ 1 arcmin reso.

Optical Flash

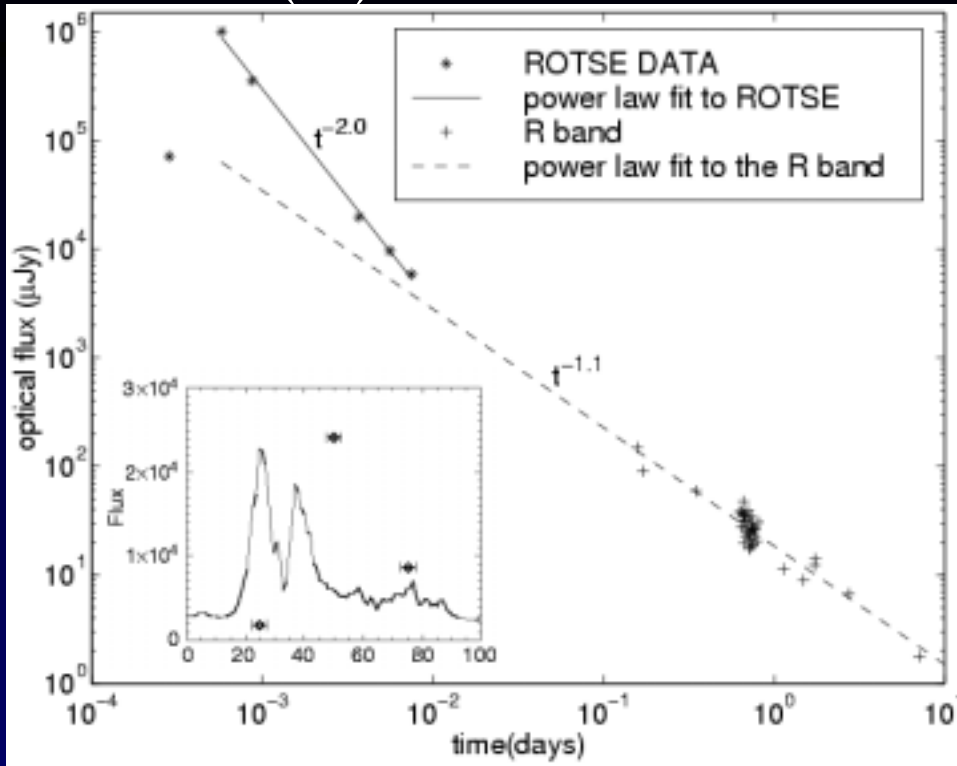
Ashra ?



Shock
emission

reverse shock forward shock

Sari&Piran(99)



No independent observation without satellite alert so far.

Great chance even in the test observation with Ashra optics+commercial CCD

- **GRB model test :**

$$\text{RS} < \text{FS} < \text{GRB}$$
$$\Rightarrow \text{OPT} > \text{X} >$$

- **-free Hypernova search**

GRB Optical Flash Experiments



- **ROTSE** - Triggered by alert from HETE-
 - Time delay before GRB alert
 - Biased for gamma ray emission
- **RAPTOR** - Self Trigger
 - **No** time delay before GRB alert
 - **Un**biased for gamma ray emission
- **Ashra**



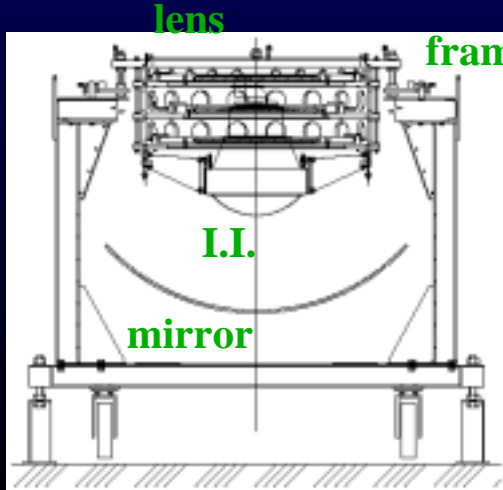
All-sky Survey High Resolution
Air-shower telescope

Ashra

**Superior feature of
Ashra**



Ashra Prototype Telescope

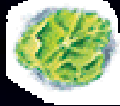


	Ashra-P1/3	Ashra-P2/3
F.O.V.	30 ° x 30 °	45 ° x 45 °
Aperture (mm)	340	600
Resolution	0.6	1

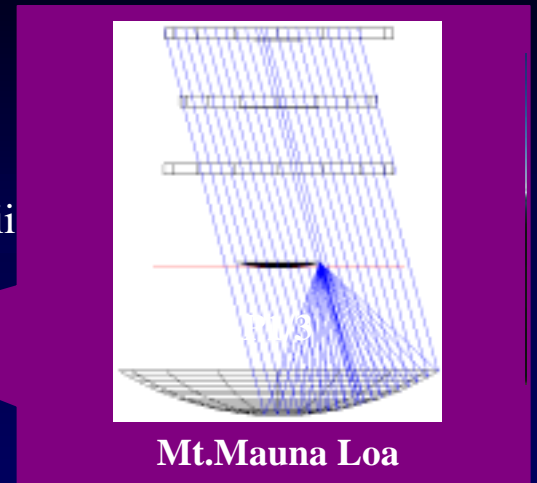
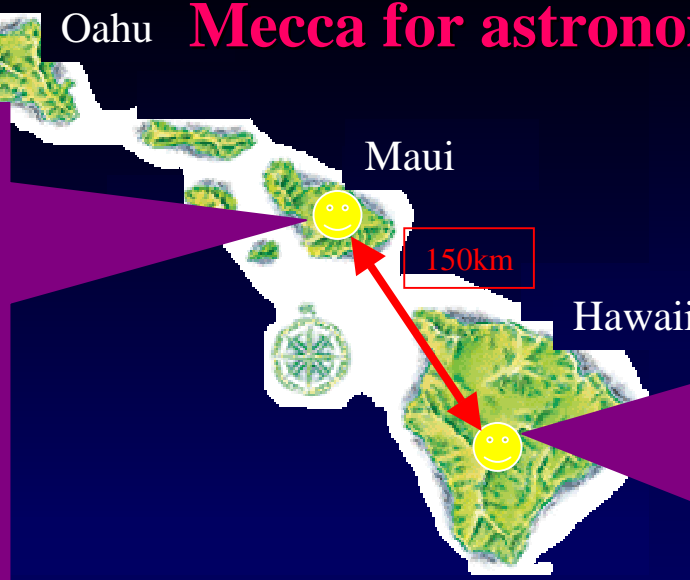


11M pixel CMOS
Canon EOS-1Ds

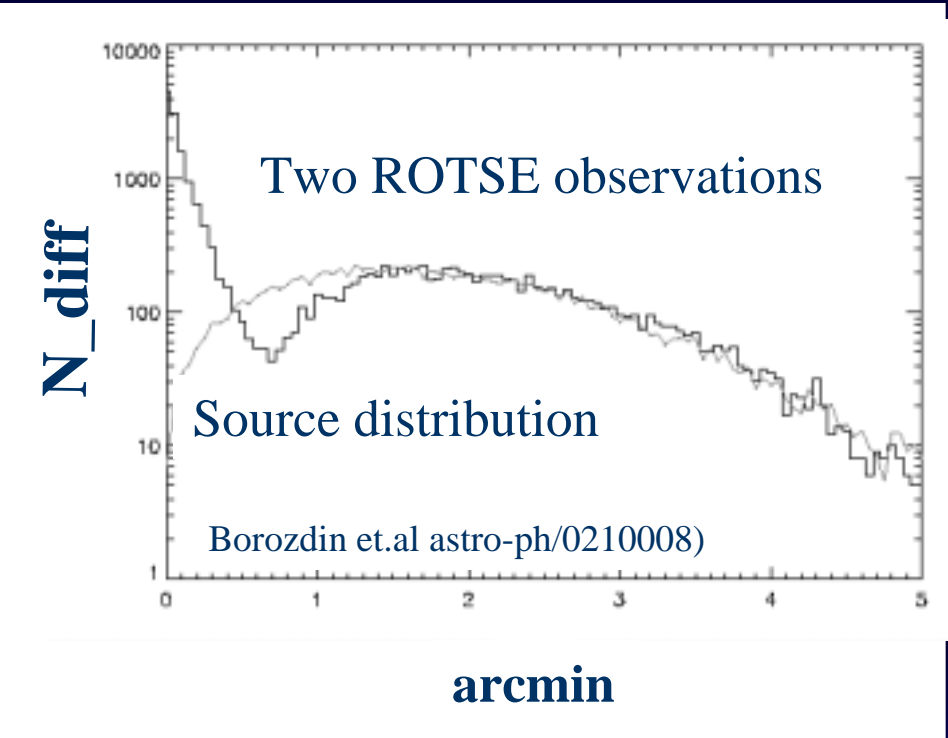
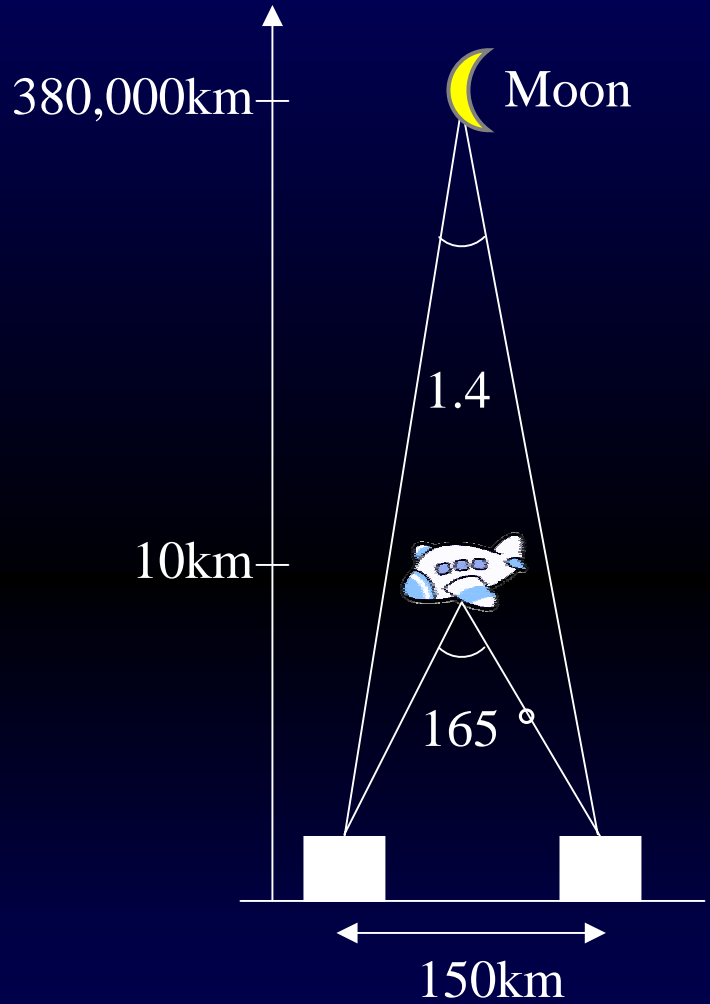
Two prototype telescopes



Oahu **Mecca for astronomers**



Reduction of Local Fake Objects



- Distance 150km, Parallax ~ 1 arcmin
Objects nearer than the moon can be rejected

Instantaneous Sensitivity

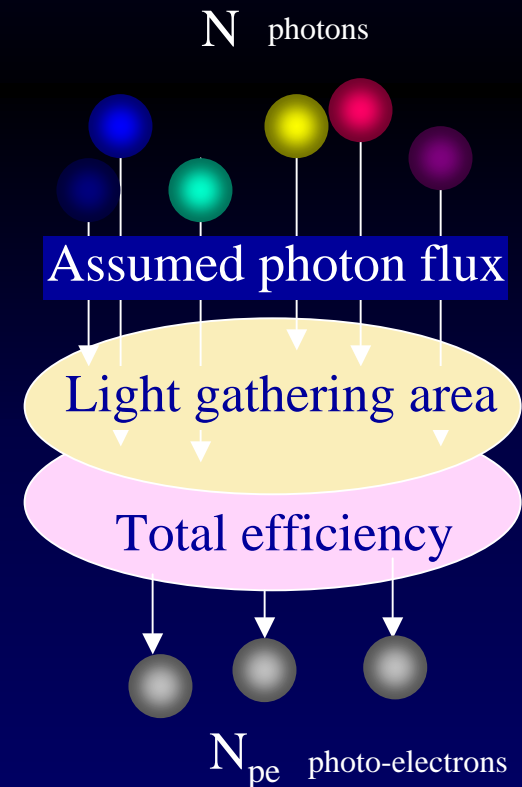
Instantaneous Sensitivity (observed photoelectron rate) $S \equiv \frac{dN_{pe}}{dt} = \int da \int \varepsilon(\lambda) \frac{d^3 N}{dt da d\lambda} d\lambda$

Light gathering area

Total efficiency

Assumed photon flux

- Light gathering area
 - Aperture, Obstruction
- Total efficiency
 - Quantum efficiency, Transmittance, etc.
- Assumed photon flux
 - Sari, Piran (1998)





Detector Sensitivity

	RAPTOR	Ashra-P1/3	Ashra-P2/3	Ashra-1
Light gathering area	1	6	17	48
Total efficiency & Assume d photon flux	<p>$N_{pe}=1$ (?) Dark current?</p>	<p>$N_{pe}=0.35$ Complementary (wavelength energy) range</p>		

- Ashra : Large Aperture, U-band, Low noise
- RAPTOR : Small Aperture, R-band, Dark Current?



Signal vs. Night-Sky BG Noise

➤ Signal

- Assumed Flux

$$\frac{d^3 E}{dt da d\nu} \equiv \alpha \nu^{-1/2} [\text{erg/s/cm}^2/\text{Hz}] \quad (\text{Sari, Piran})$$

- $M_v = 0$ (@ $5.5 \times 10^{14} \text{Hz}$)

$$3.65 \times 10^{-16} [\text{erg/s/cm}^2/\text{Hz}] \quad (\text{Oke, Schild : Ap.J., 161})$$

$$\alpha = 8.6 \times 10^{-13} [\text{erg/s/cm}^2/\text{Hz}^{1/2}]$$

$$\frac{d^3 N}{dt da d\lambda} = \left(\frac{\partial \nu}{\partial \lambda} \right) \left(\frac{\partial N}{\partial E} \right) \frac{d^3 E}{dt da d\nu} = 2.4 \times 10^5 \lambda^{-1/2} [\text{photons/s/cm}^2/\text{nm}]$$

$$\frac{dN_{pe}}{dt} = \int da d\lambda \left(\frac{d^3 N}{dt da d\lambda} \right) \epsilon_{tot}(\lambda) = 3.8 \times 10^8 [\text{p.e./s}]$$

➤ Night-Sky Background

$$\frac{dN_{pe}}{dt} = 2.6 \times 10^3 [\text{p.e./s}]$$

Component	$S_{10}(\text{vis})$	$10^{-9} \text{erg/cm}^2/\text{s/sr}$
Airglow	55	66
Zodiacal light	135	162
Star light	130	156

Trigger condition

$$S/N > \Sigma$$

(scientific chronological table)

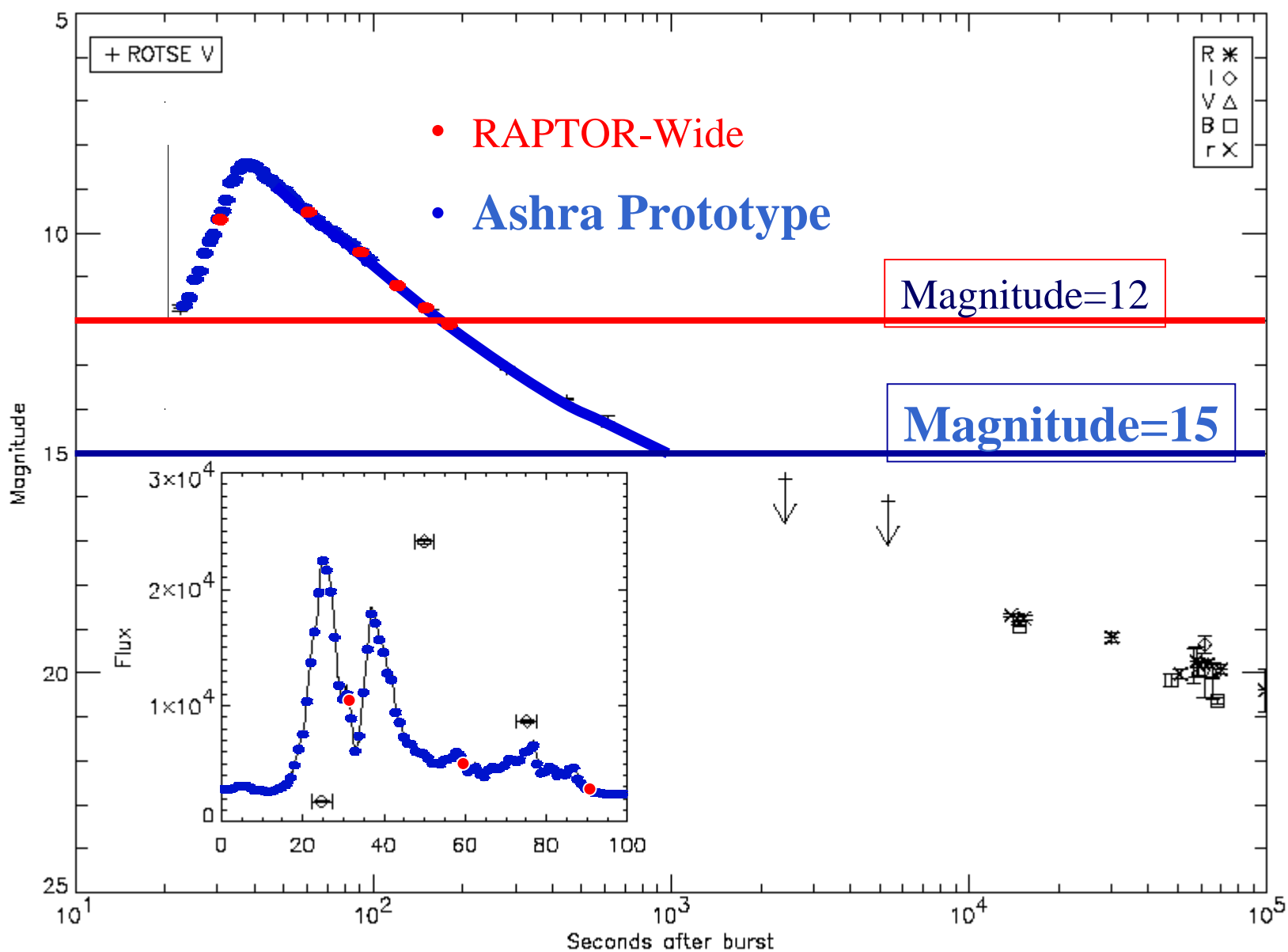
Limit magnitude

$$M < 17.3 - 2.5 \text{Log} \Sigma$$

$$\Sigma = 4 \Rightarrow M < 16$$

$$\Sigma = 10 \Rightarrow M < 15$$

Demonstration of GRB Optical Flash



Comparison of GRB Optical Observation



	RAPTOR -A,B (wide)	Ashra -P1/3	Ashra -P2/3
FOV (sr)	0.36	0.21	0.48
Light gathering area (cm²)	57	318	990
Resolution (arcmin)	0.57	0.6	1.0
Wavelength band	R	U	U
Limit magnitude / exposure	12 / 30sec	14.5 / 1sec	15 / 1sec
Start	2002.10	2004.5	2004.5

Even Ashra Prototype Observation

=> **Fairly Competitive**

Conclusion

Strongest GRB Optical Explorer Even with the Ashra Prototype

- Self-Trigger
- Wide F.O.V.
- High Sensitivity (U-band)
 - Independent discovery
 - No time delay before GRB alert
 - Unbiased for gamma ray emission
 - Precise time structure
 - Complementary wavelength region

