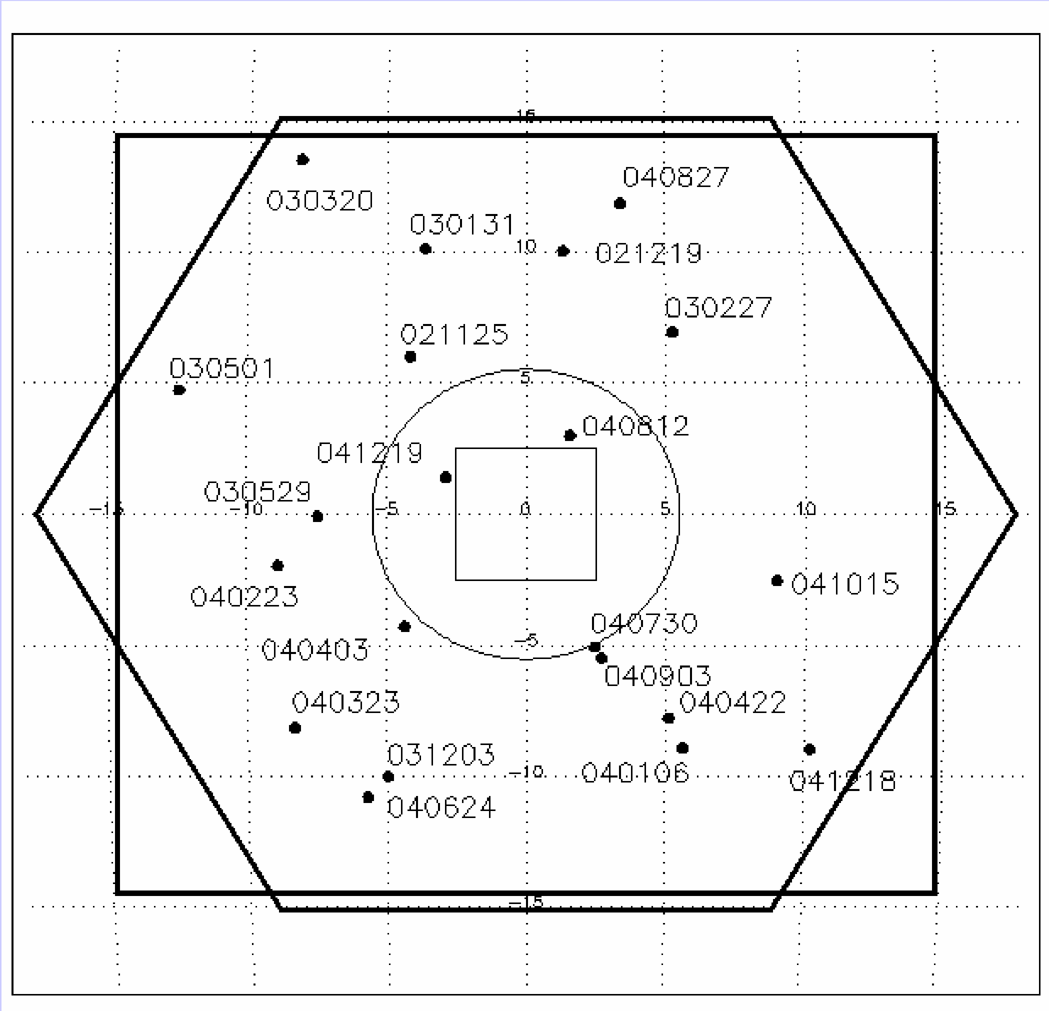
Two years of GRB localizations with IBAS

Sandro Mereghetti
IASF - Milano

http://ibas.mi.iasf.cnr.it

21 GRBs localized by IBAS in the INTEGRAL instruments FOV



GRB 021125		0.9 days	Malaguti et al. 2003, A&A 411, L307
GRB 021219		5 hr	Mereghetti et al. 2003, A&A 411, L311
GRB 030131	O	2 hr	Götz et al. 2003, A&A 409, 831
GRB 030227	X	48 min	Mereghetti et al. 2003, ApJ 590, L73
GRB 030320		6 hr	von Kienlin et al. 2003, A&A 411, L321
GRB 030501		**24 s**	Beckmann et al. 2003, A&A 411, L 327
GRB 030529	found in off-line search		---
GRB 031203	X, O, R, z= 0.1	**18 s**	Sazonov et al. 2004, Nature 430, 646
GRB 040106	X, O?	**19 s**	Moran et al. 2004, A&A in press
GRB 040223	X	**210 s**	GCN
GRB 040323	O ?	**30 s**	GCN
GRB 040403		**21 s**	Mereghetti et al. 2004, A&A in press
GRB 040422		**17 s**	GCN
GRB 040624		6 hr	GCN
GRB 040730		**35 s**	GCN
GRB 040812	X	**30 s**	GCN
GRB 040827	X , O	1.5 hr	GCN
XRF 040903		**32 s**	GCN
GRB 041015		2 hr	GCN
GRB 041218		**~20 s**	GCN
GRB 041219	IR, O	**~20 s**	GCN

Some statistics

- 21 GRBs / 25 months = (0.8 ± 0.2) GRB/month

- Time distribution:

  2 in Nov-Dec 2002
  6 in 2003
  13 in 2004

- Observ. type distribution:

PV / Calibr.	3
Core Program	5
AO 1	2
AO 2	11

some more statistics

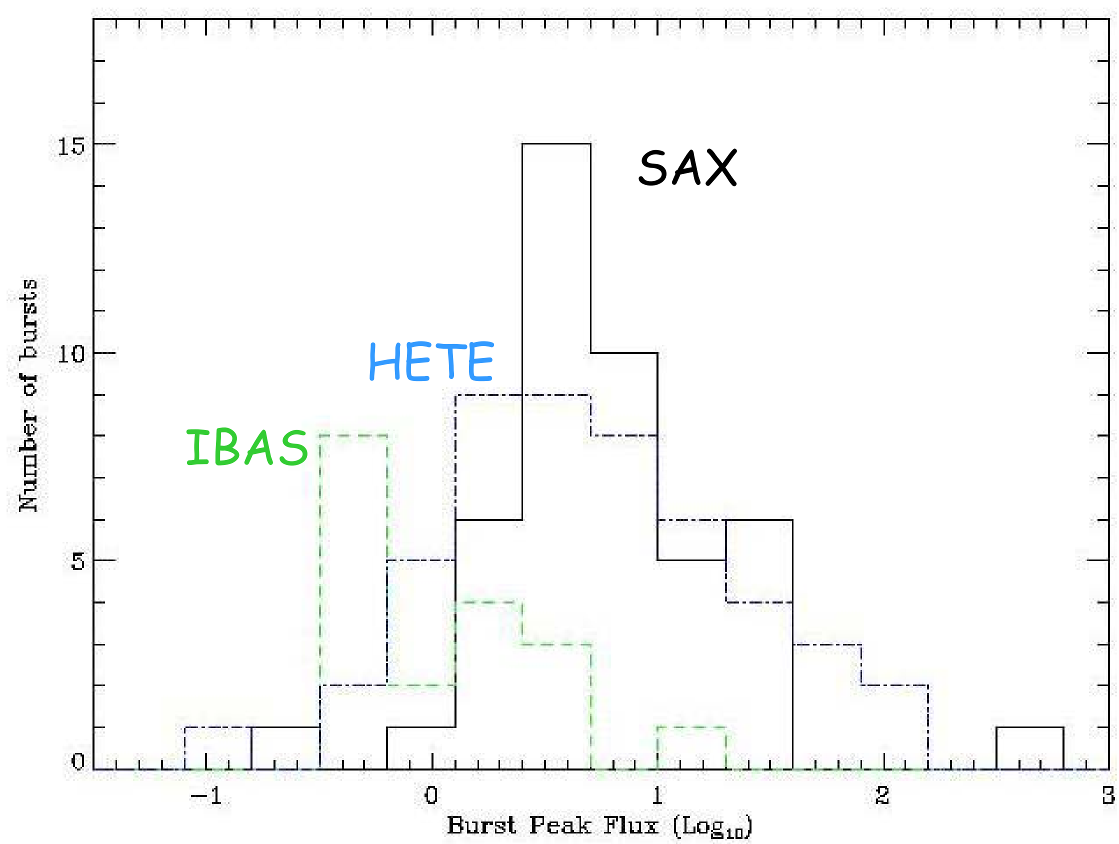
- Speed of alerts:

Rapid	12	(~ seconds)
Slow	9	(~ hours)

- Counterparts:

6 X-ray afterglows (100% of follow-ups)
~5-6 Optical/IR transients
plus a few interesting upp. Limits
1 redshift (z=0.1)
1 simultaneous IR flash

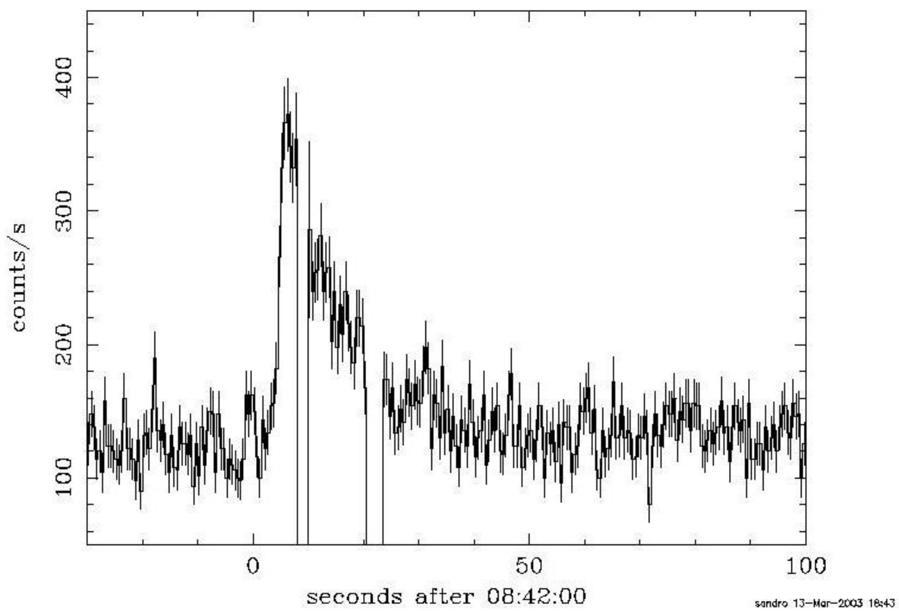
The INTEGRAL bursts are among the faintest with good localizations

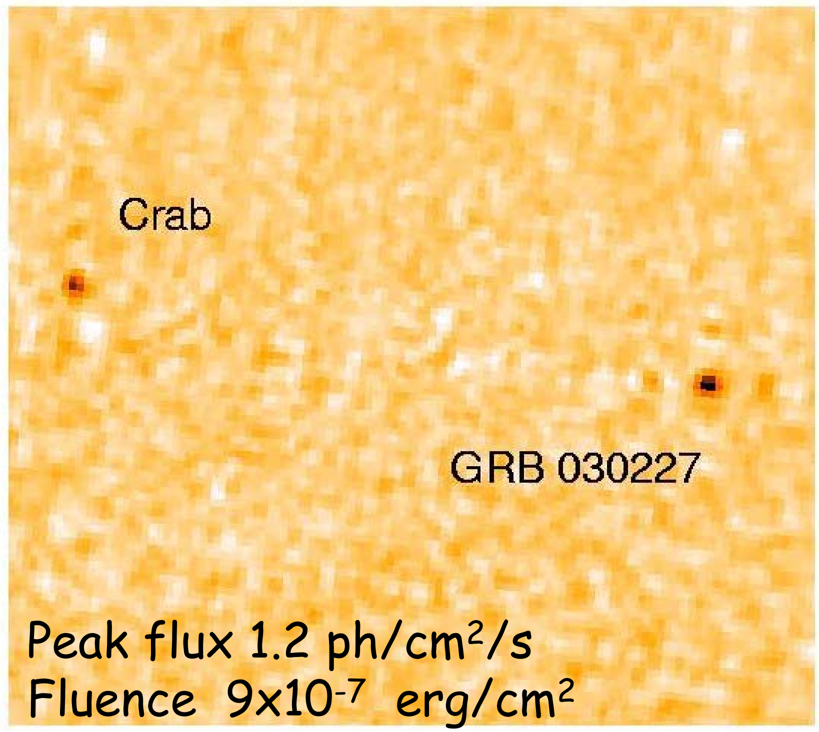


Some highlights:

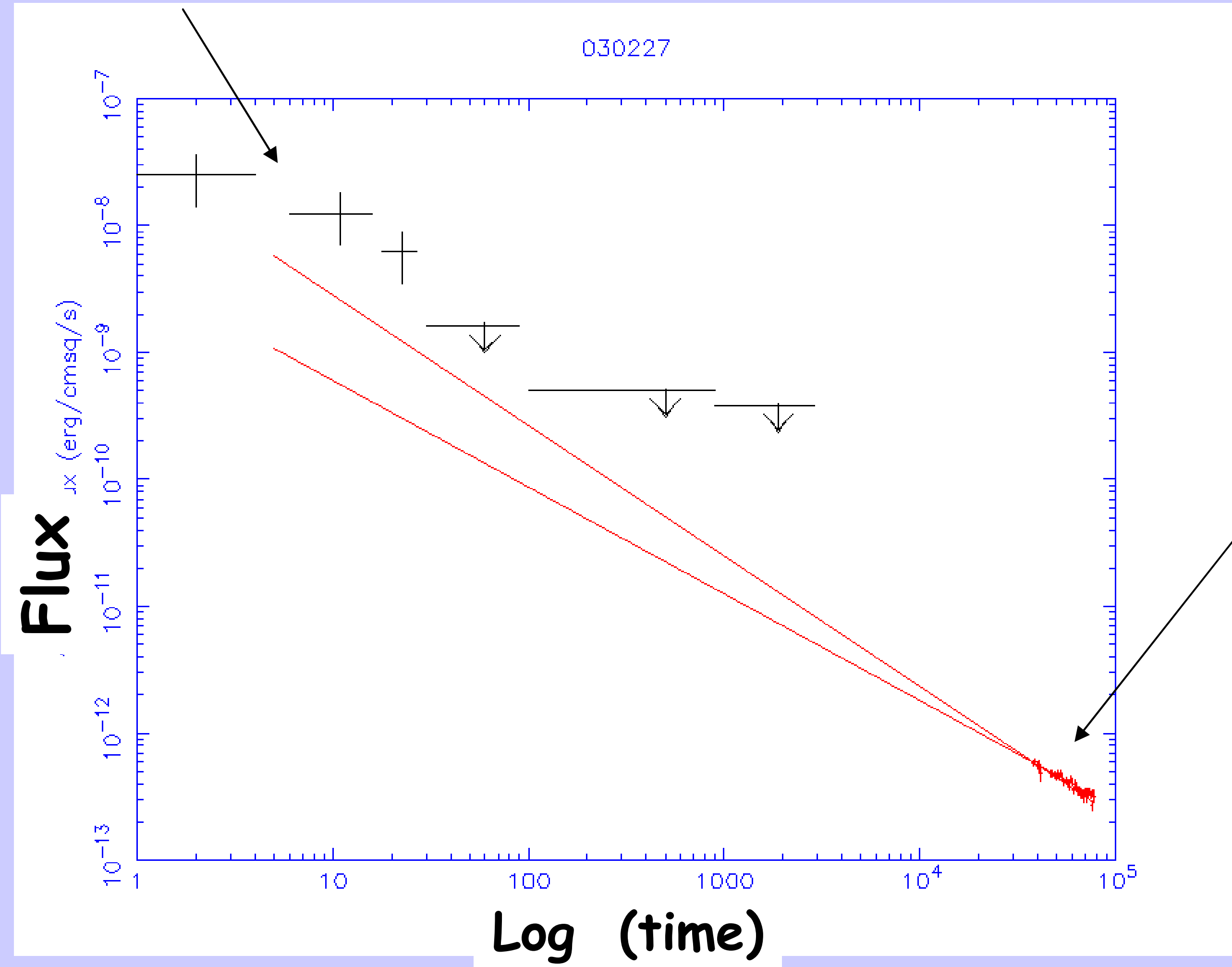
- GRB 030227 Mereghetti et al. 2003
  - X-ray afterglow with high intrinsic absorption
  - X-ray lines from light elements

(Mereghetti et al 2003)





GRB 030227
IBIS



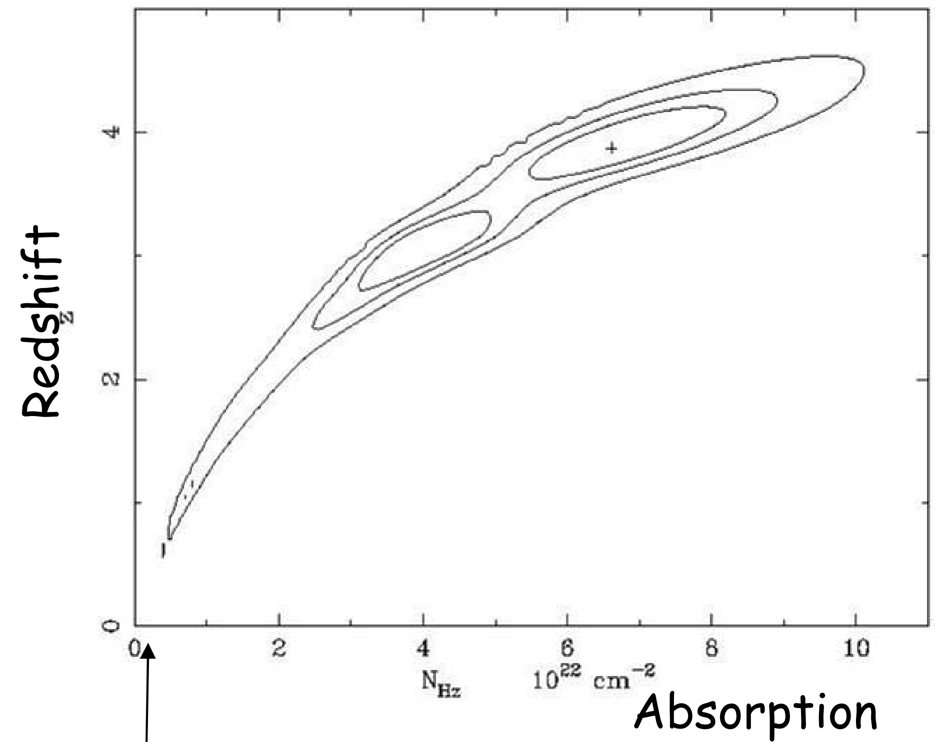
X-ray afterglow
XMM-Newton

GRB 030227

X-ray afterglow with XMM-Newton

Evidence for intrinsic absorption from EPIC spectrum

(Mereghetti et al 2003)



Galactic $N_H = 2 \times 10^{21}$ cm^{-2}

GRB 030227

X-ray afterglow with XMM-Newton

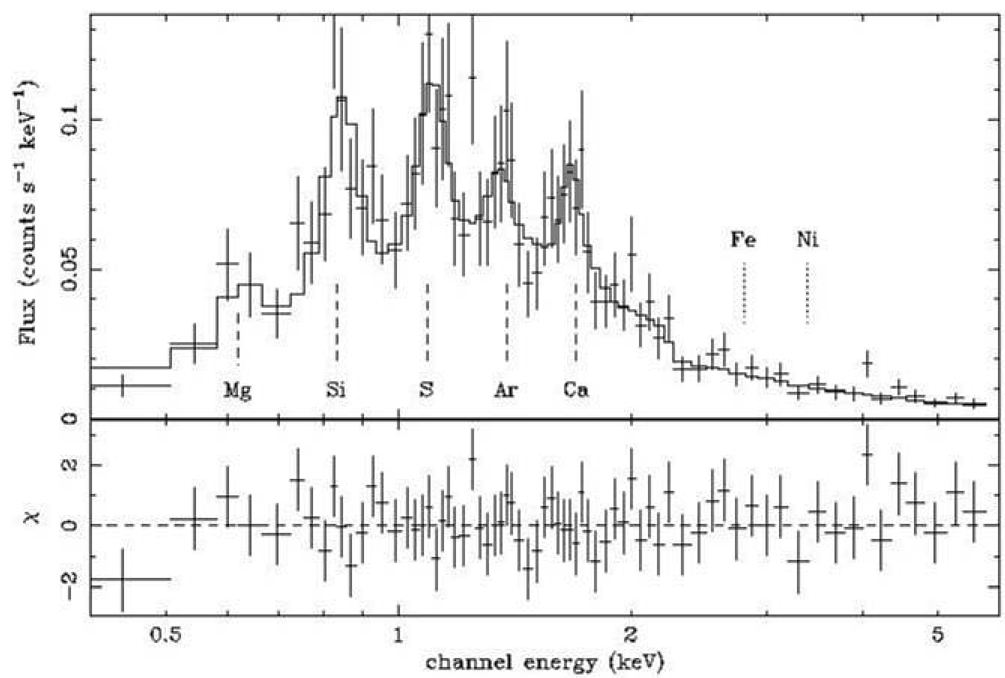
Evidence for lines in last 10 ks of observation

Mg, Si, Ar, Ca,

at z=1.4

but no Fe, Co, Ni

(Watson et al. 2003)

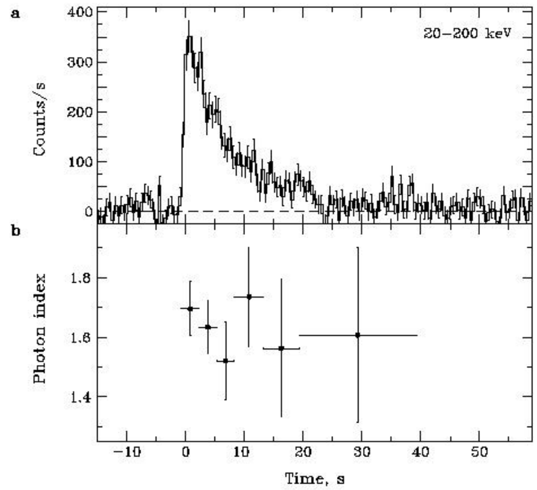


Some highlights

- GRB 030227 Mereghetti et al. 2003
  - X-ray afterglow with high intrinsic absorption
  - X-ray lines from light elements
- GRB 031203 Sazonov et al. 2004, Malesani et al. 2004, Vaughan et al. 2004
  - closest GRB z=0.1
  - spectroscopic SN identification
  - expanding dust scattering X-ray halo (X-ray flash ?)

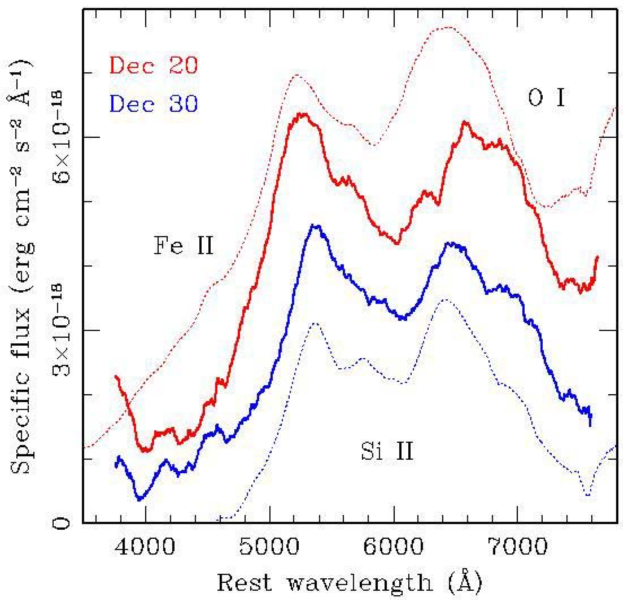
GRB 031203

z = 0.1
(Prochaska et al 2004)



- hard GRB spectrum
  (Sazonov et al 2004)

- $E_{iso} \sim 6\text{-}14 \times 10^{49}$ erg s^{-1}



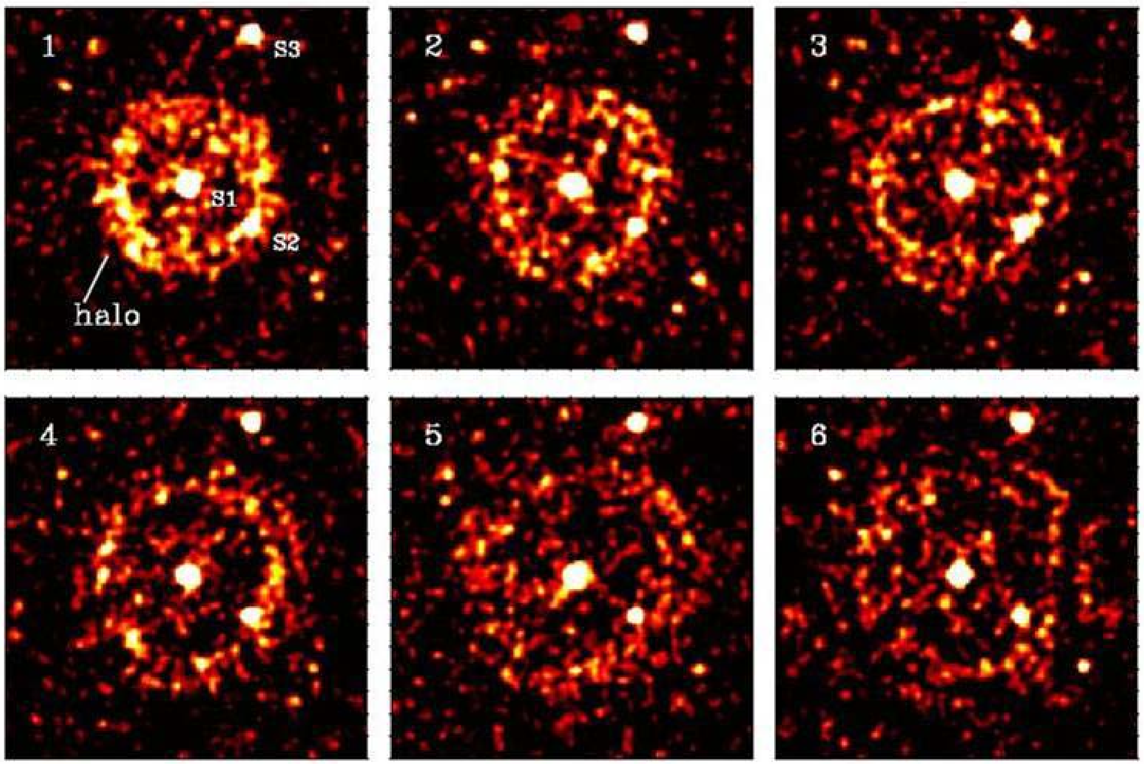
SN 2003lw
(Malesani et al 2004)

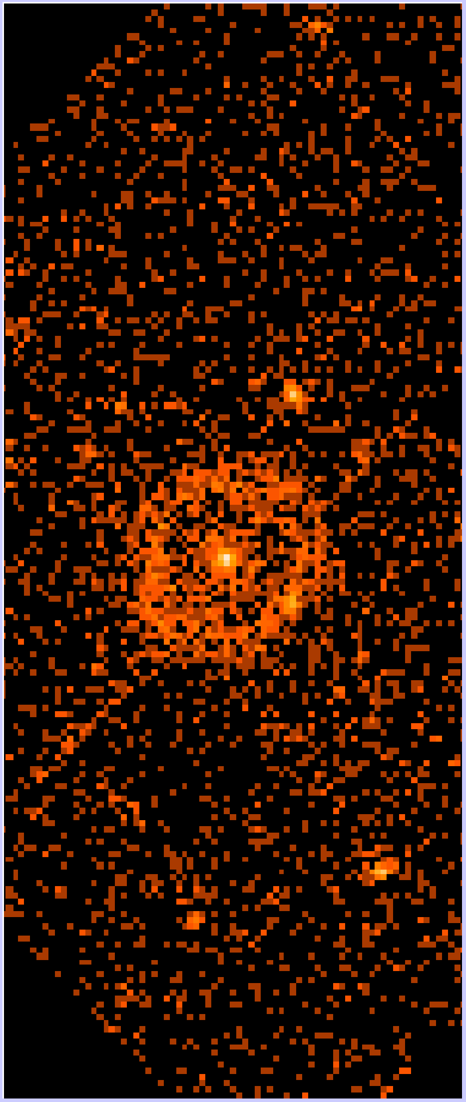
→ It does not fit the Amati relation !

GRB 031203

Expandig dust scattering halo seen in X-rays

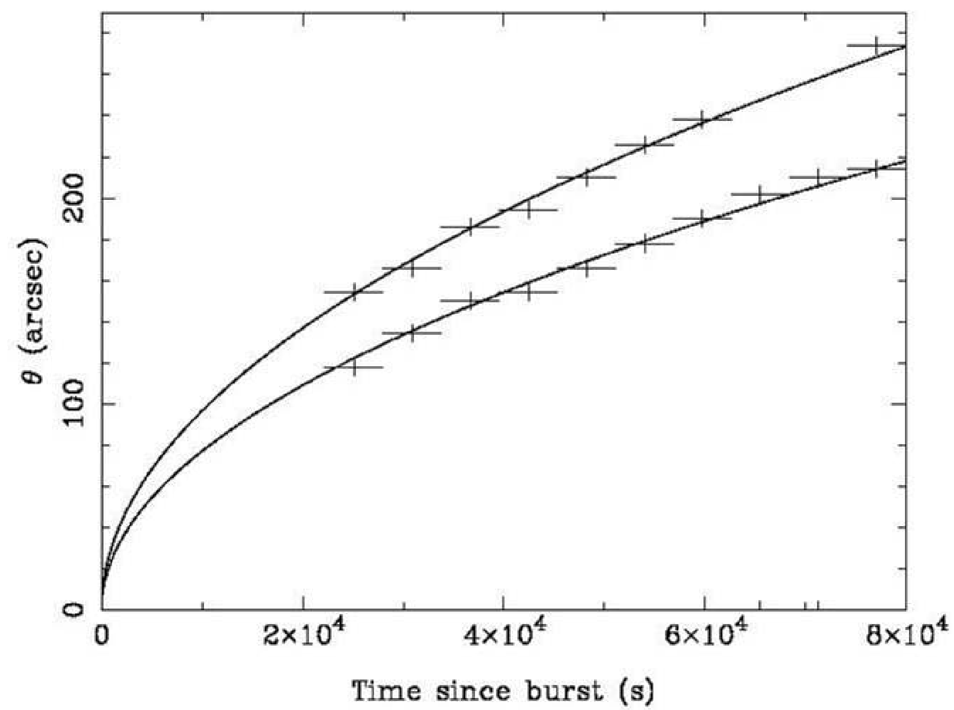
(Vaughan et al 2004)





GRB 031203

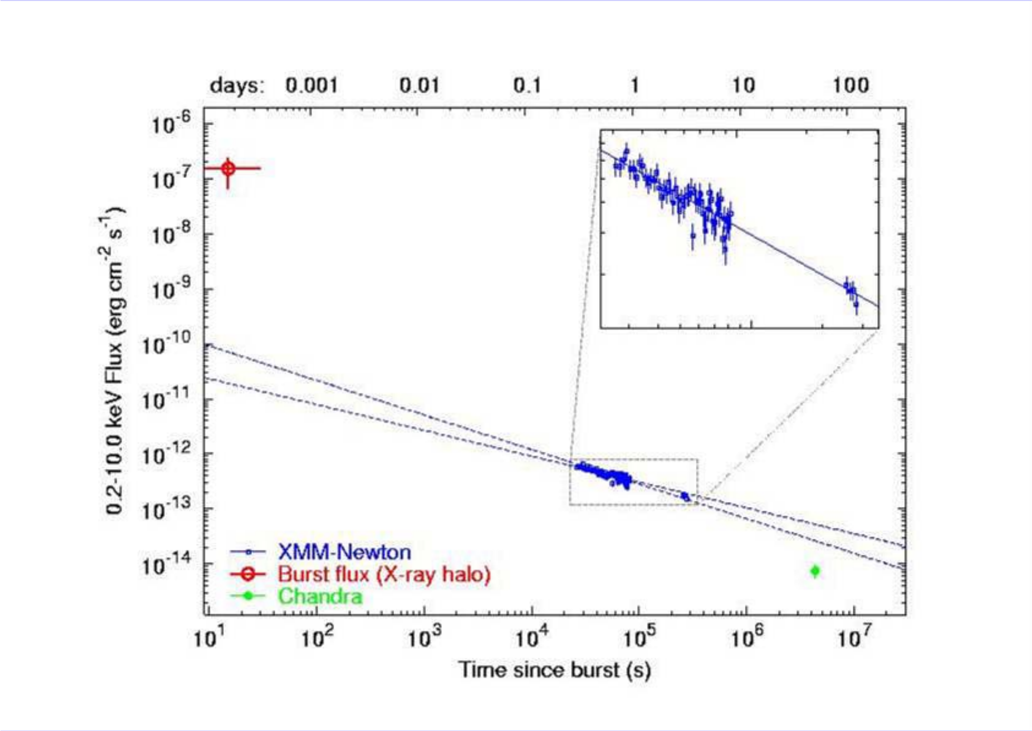
(Vaughan et al. 2004)

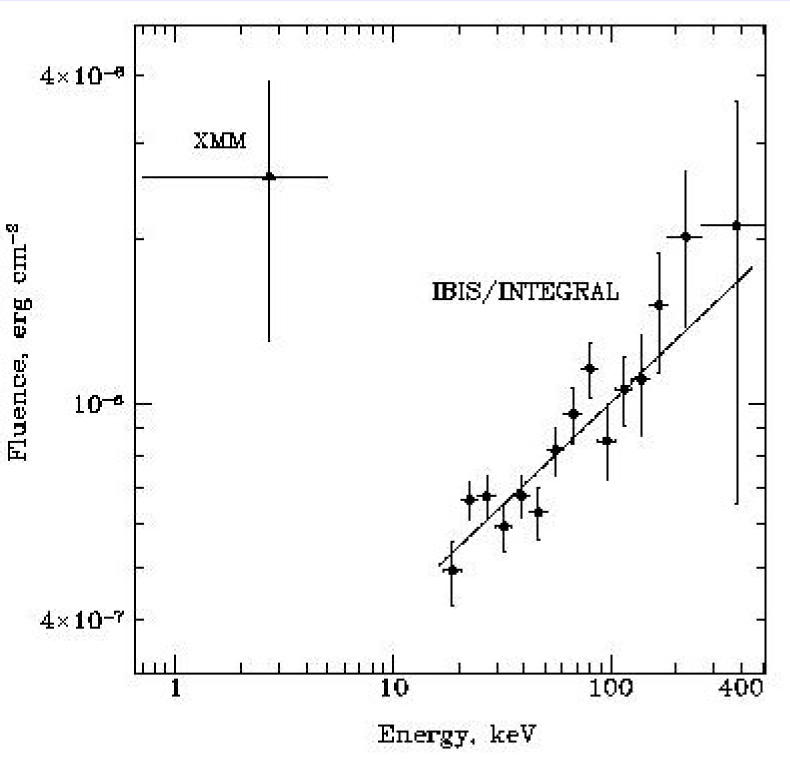


Time delay = $(D_{Earth\text{-}dust}) \times \Theta^2/2c$

→ $D_{Earth\text{-}dust}$ = 882 and 1388 pc

GRB 031203





From the dust halo Vaughan et al. (2004) derive
Fx ~ (1.5+/-0.8) x 10^{-7} erg cm^{-2} s^{-1} (0.2-10 keV)
for the prompt X-ray emission

Some highlights

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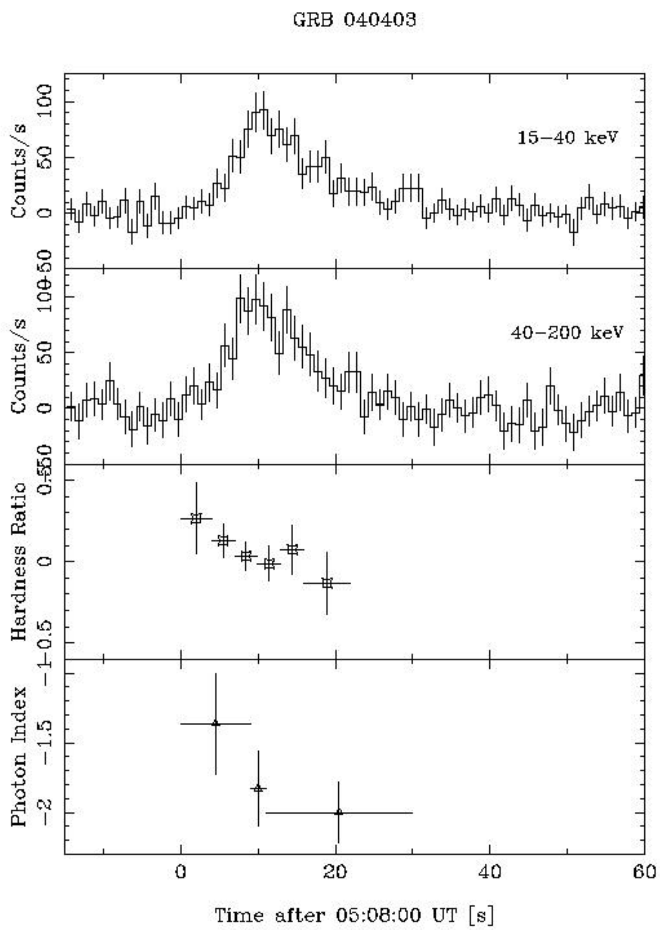
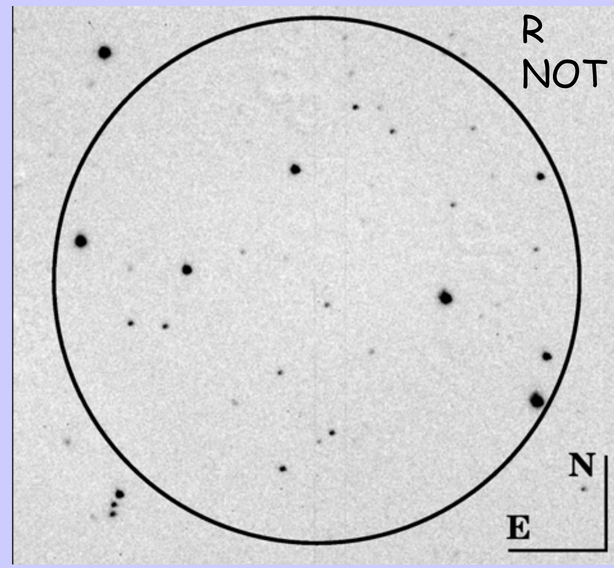
  - closest GRB z=0.1
  - spectroscopic SN identification
  - expanding dust scattering X-ray halo (X-ray flash ?)
- GRB 040403 Mereghetti et al. 2004
  - Faint, X-ray rich, OT>24.2 mag @ 16 hr

GRB 040403

(Mereghetti et al 2004)



Peak flux ~ 0.5 ph/cm^2/s
Fluence 5x10^{-7} erg/cm^2



X-ray rich
Optically faint R>24.2 @ 16 hr

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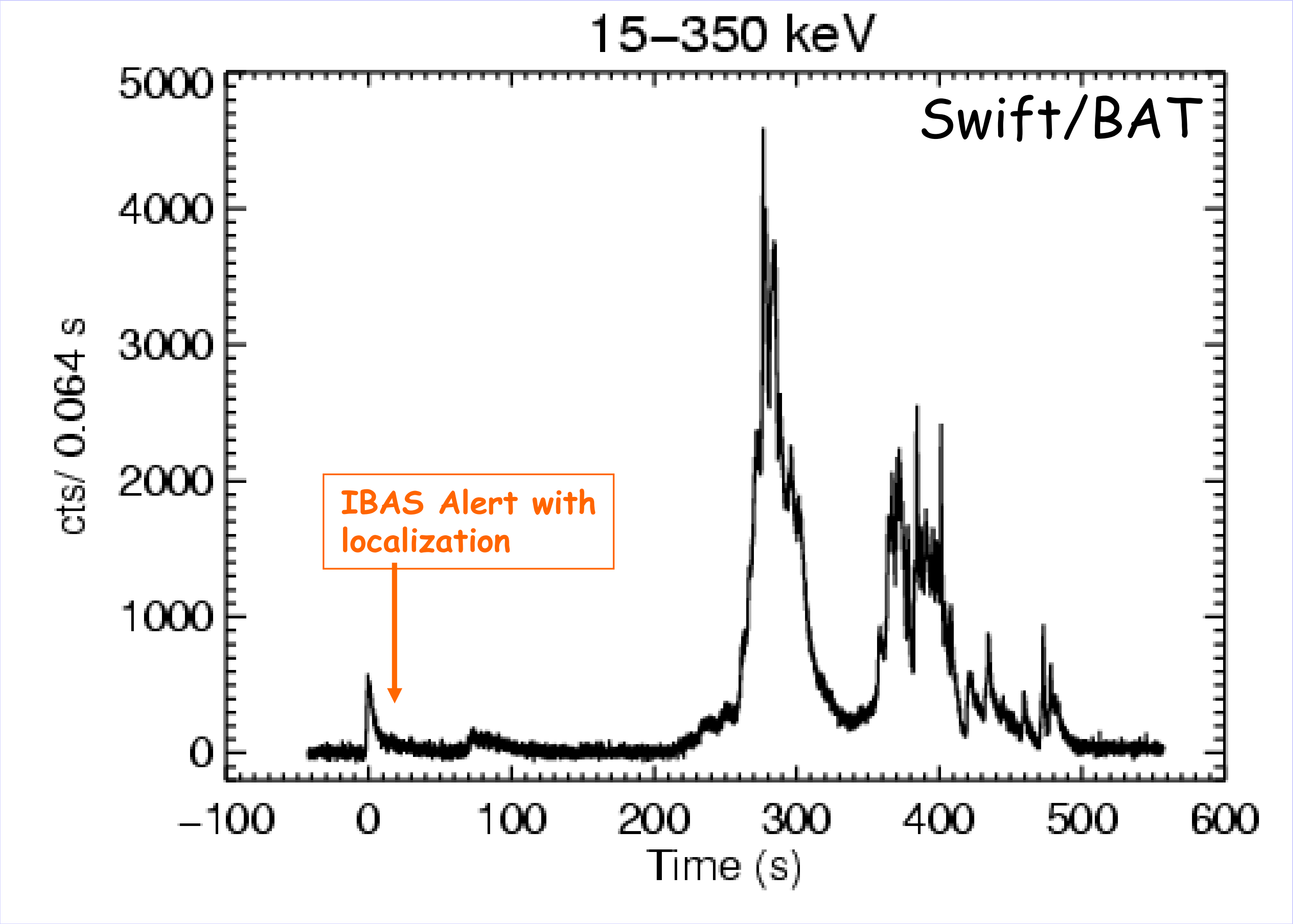
- GRB 040403 Mereghetti et al. 2004
  - Faint, X-ray rich, OT>24.2 mag @ 16 hr
- GRB 041219
  - Very high fluence, long duration
  - simultaneous IR flash

GRB 041219



15–350 keV
Swift/BAT
IBAS Alert with localization
cts/ 0.064 s
5000
4000
3000
2000
1000
0
–100
0
100
200
300
400
500
600
Time (s)

GRB 041219

- Thanks to the rapid IBAS localization (2.5 arcmin) robot telescopes could observe during the GRB emission

- An IR "flash" K~15.5 simultaneous with the GRB was discovered by Bloom, Blake et al.

INTEGRAL/ISGRI vs. SWIFT/BAT
ON-AXIS SENSITIVITY

$$S_{min} \propto (BKG / A_{eff})^{\frac{1}{2}}$$

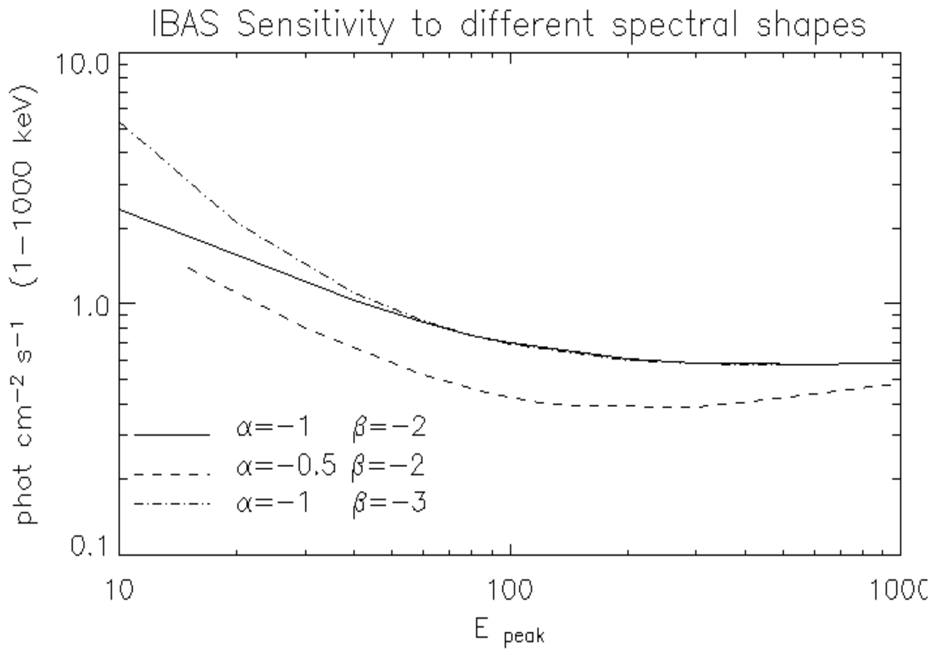
$A_{ISGRI} / A_{BAT} = 1/2$

$BKG_{ISGRI} \sim 0.6$ kHz

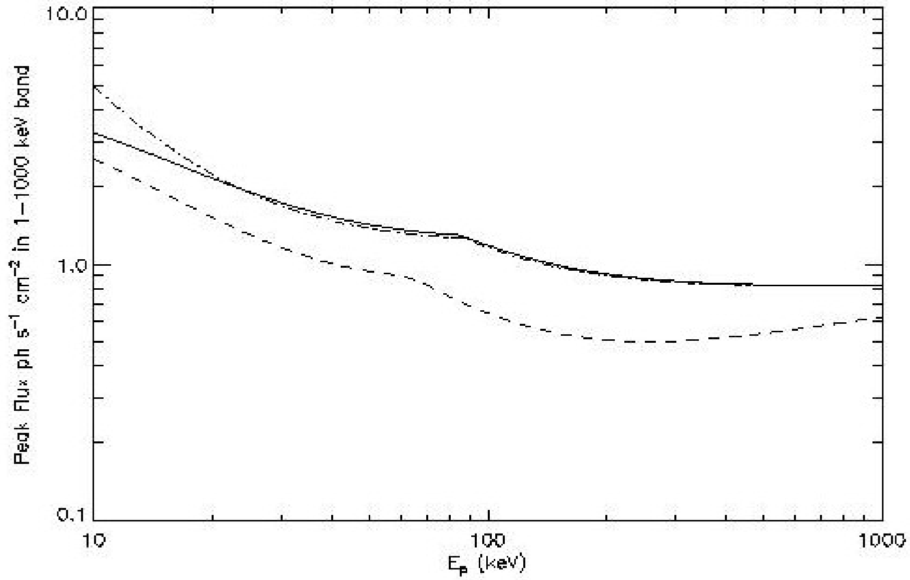
$BKG_{BAT} \sim 12$ kHz

→ **ISGRI is more sensitive by a factor ~ 3**

A proper computation taking detector area and mask transparency (both energy dependent) into account:

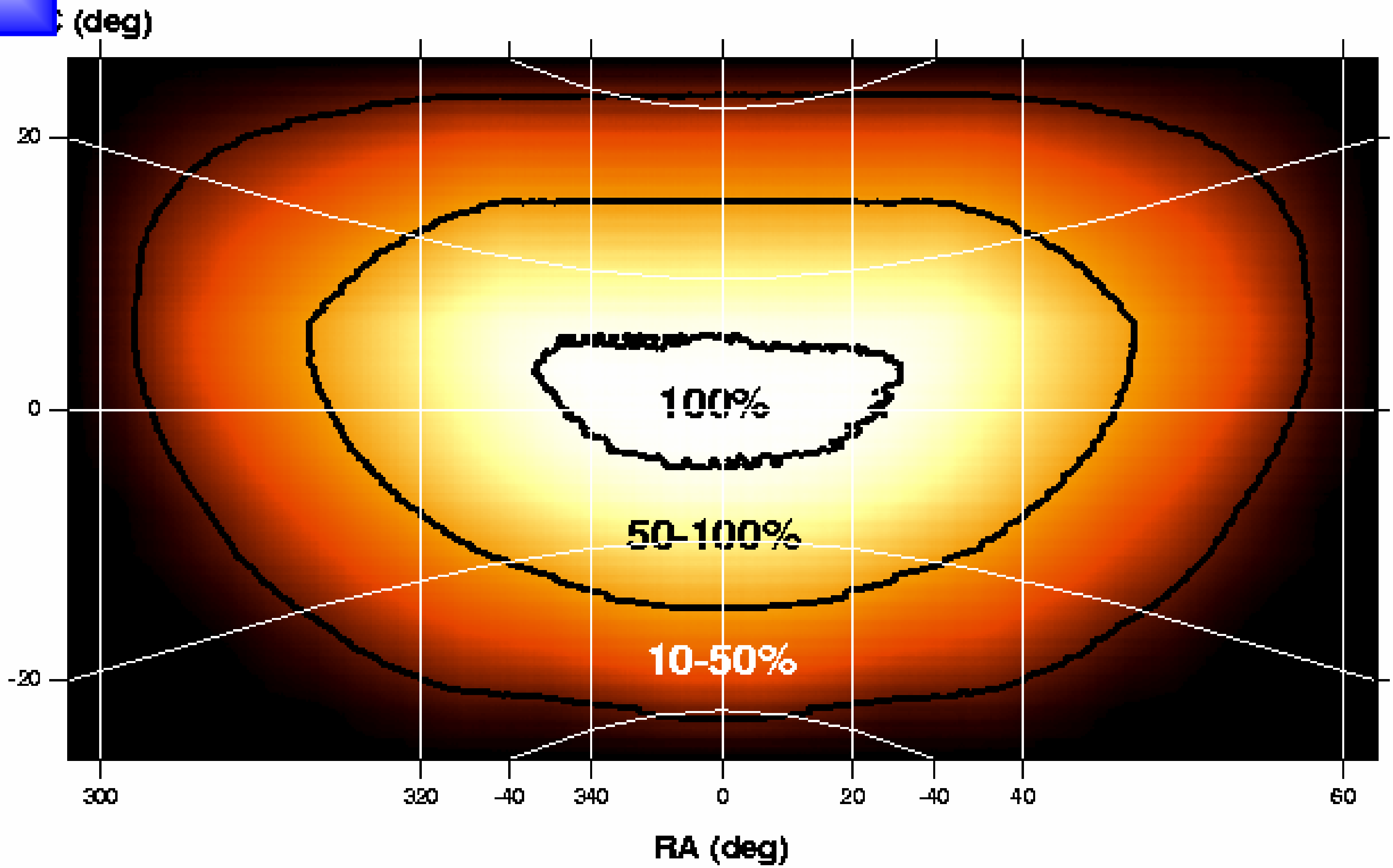


BAT (Band 2003)



IBIS on axis sensitivity is 20-40% better than the Swift one

BAT Partial Coding Map



What have we learned ?

Most IBAS GRBs are rather faint → not much can be extracted from the INTEGRAL data alone

Exciting results have been obtained whenever the rapid localizations provided by IBAS could be exploited for multi-wavelength observations

INTEGRAL has excellent capabilities for "real-time" science – Not only GRBs

… until the launch of Swift this was unique…

IBAS has evolved…

- Better localizations, increased sensitivity, less false alerts, etc.…
- Extended to include Soft Gamma-ray Repeater Alerts and, more recently, type I bursts from known LMXRB

•… and it must continue to evolve:

- add JEM-X - very useful for X-ray bursts
- add Compton mode – see next talk
- provide more real-time information/data on GRBS

more on IBAS and INTEGRAL GRBs at

http://ibas.mi.iasf.cnr.it

IBAS is successful thanks to the excellent work and continuous support of many people, in particular:

D.Götz, J.Borkowski, M.Beck, N.Mowlavi, S.Shaw, A. von Kienlin, A.Rau, N.Lund, R.Walter,

and many other at the ISDC, ESTEC/ESOC, and in the Instrument Teams…