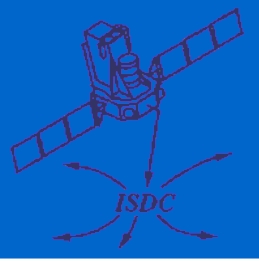
GRB analysis with INTEGRAL



- *INTEGRAL* field of view (e.g. IBIS) is about 0.1 sr (compare with ~ 3 sr FoV of *SWIFT*). This enables the detection of ~ 1 GRB / month (compare with [1 GRB / month * 3/0.1] ~ 1 GRB / day for *SWIFT*)

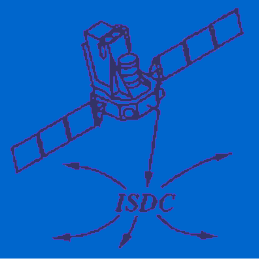
- After 4 yr in orbit *INTEGRAL* has detected about [4*12]~ 50 GRBs

- Both for *INTEGRAL* and for *SWIFT* the background is dominated by diffuse sky hard X-ray emission. Having smaller FoV *INTEGRAL* has lower than *SWIFT* background count rate which allows detection of weaker bursts.

- Both the imager ISGRI and spectrometer SPI on-board of *INTEGRAL* are sensitive in a wider energy range, than *SWIFT*'s high energy instrument BAT.

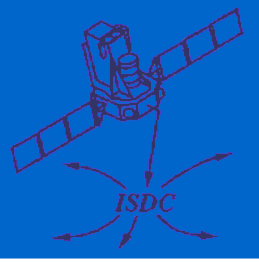
- SPI anti-coincidence shield (ACS) works as a non-imaging GRB detector.

ISGRI GRB analysis



- INTEGRAL science data are naturally divided on "Science Windows" (periods of continuous data taking) of duration of several kiloseconds
- GRBs are short events of duration of ~ 0.1-100 sec
- Normally, GRBs are not seen in the sky images produced by standard ScW-by-ScW analysis: the background counts accumulated over several ksec dominate over the GRB counts.
- However, the GRB normally dominates the detector count rate during a short period of time.
- The idea of the GRB analysis is to select and analyze the data only of the short time span around the GRB maximum.
- IBAS (INTEGRAL Burst Alert System) analyzes variaitons of detector count rates in real time to find GRBs and alert the community.

INTEGRAL GRBs on the net



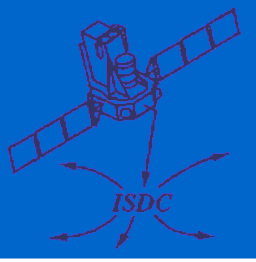
- The list of GRBs detected by IBAS is available on the net together with "standard" GRB analysis results
  http://ibas.iasf-milano.inaf.it/IBAS_Results.html

- Similarly to the *INTEGRAL* Source Results page, the results of GRB analysis give the "first look" at the GRB. If you are interested in e.g. the follow up afterglow observations and need only the GRB lightcurve and overall spectrum, you can directly use these results for publicaitons.

- To get a more detailed information on a particular GRB one needs to download and analyze the raw data.

- Note that there can be "undiscovered" GRBs in archival INTEGRAL data which escaped the detection by IBAS (e.g. Because they are weaker than a pre-defined threshold for an automatic alert). To find them one also needs to re-analyze the raw data.

IBAS Results



IBAS: Results

Table with all the GRBs localized with IBAS

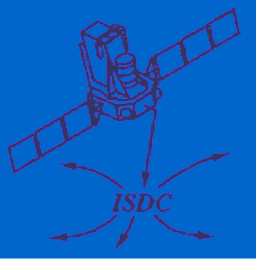
GRB	R.A.[1] (J2000) [hh:mm:ss]	Dec.[1] (J2000) [dd:mm:ss]	Unc.[2] [arcmin]	Peak Flux[3] (20-200 keV) [ph cm^{-2}s^{-1}]	T_{start} UTC [hh:mm:ss]	T_{90} [s]	Counterparts	References[4]	GCN Circulars Compilation	Notes	Products
060930	20:18:09	-23:37:31	2.5	0.3	09:04:09	20	O	-	here	-	Here
060912B	18:04:52	-19:52:50	2.5	0.08	17:32:30	200	-	-	here	-	Here
060901	19:08:38	-06:38:22	2.5	>6.5	18:43:51	20	X	-	here	-	Here
060204A	15:28:56	-39:26:38	2.5	0.1	13:19:50	78	-	-	here	-	Here
060130	15:16:54	-36:54:43	2.0	0.2	04:56:27	40	-	-	here	Below the threshold for automatic Alert delivery.	Here
060114	13:01:07	-04:44:53	2.0	0.3	12:39:44	100	-	-	here	-	Here
051211B	23:02:45	+55:04:44	2.0	0.8	22:05:44	80	X/O	-	here	-	Here
051105B	00:37:51	-40:28:52	2.0	0.35	11:05:43	20	-	-	here	-	Here

GRB ID

Basic information (time, coortinates)

Spectra, lightcurves

IBAS Results



IBAS: Results

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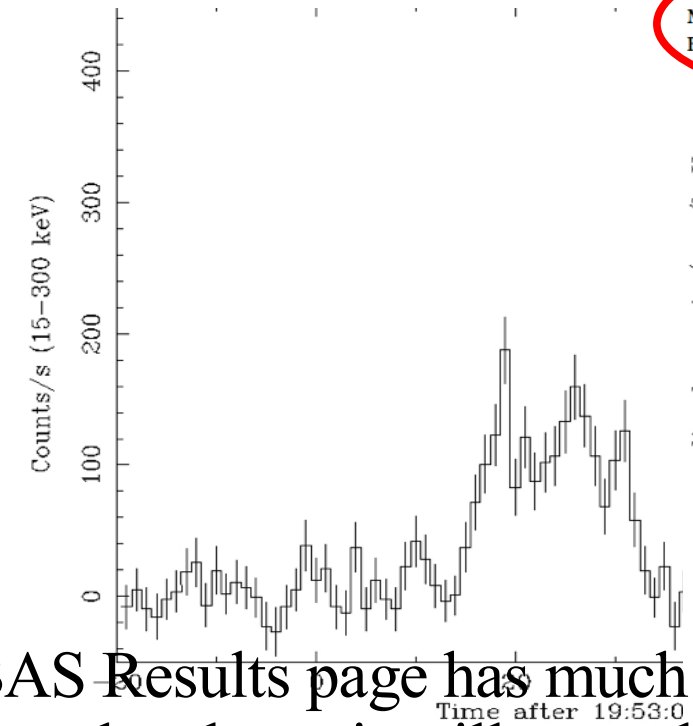
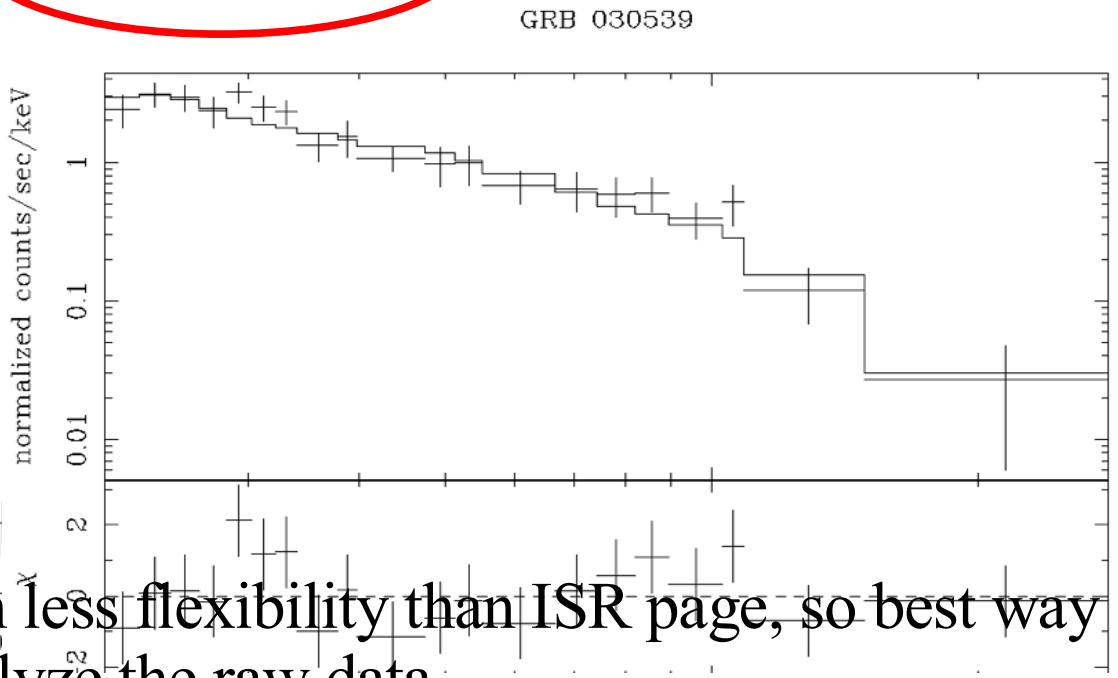
GRB	R.A.[1] (J2000) [hh:mm:ss]	Dec.[1] (J2000) [dd:mm:ss]	Unc.[2] [arcmin]	Peak Flux[3] (20-200 keV) [ph cm^{-2}s^{-1}]	T_{start} UTC [hh:mm:ss]	T_{90} [s]	Counterparts	References[4]	GCN Circulars Compilation	Notes	Products
060930	20:18:09	-23:37:31	2.5	0.3	09:04:09	20	O	-	here	-	Here
060912B	18:04:52	-19:52:50	2.5	0.08	17:32:30	200	-	-	here	-	Here
060901	19:08:38	-06:38:22	2.5	>6.5	18:43:51	20	X	-	here	-	Here
060204A	15:28:56	-39:26:38	2.5	0.1	13:19:50	78	-	-	here	-	Here
060130	15:16:54	-36:54:43	2.0	0.2	04:56:27	40	-	-	here	Below the threshold for automatic Alert delivery.	Here
060114	13:01:07	-04:44:53	2.0	0.3	12:39:44	100	-	-	here	-	Here
051211B	23:02:45	+55:04:44	2.0	0.8	22:05:44	80	X/O	-	here	-	Here
051105B	00:37:51	-40:28:52	2.0	0.35	11:05:43	20	-	-	here	-	Here

Basic spectral information, which can be useful for the followup studies

Spectral Parameters:

Model: Power Law; Photon Index = 1.71+/-0.20.
Fluence (20-200 keV) = 4.0×10^{-7} erg cm^{-2}.





IBAS Results page has much less flexibility than ISR page, so best way to study a burst is still to analyze the raw data.

ISGRI GRB analysis

As an example we take the GRB031203. Basic information on GRB can be extracted from the GCN report on this GRB:

IBAS: Results

Table with all the GRBs localized with IBAS

GRB	R.A.[1] (J2000) [hh:mm:ss]	Dec.[1] (J2000) [dd:mm:ss]	Unc.[2] [arcmin]	Peak Flux[3] (20-200 keV) [ph cm^{-2}s^{-1}]	T_{start} UTC [hh:mm:ss]	T_{90} [s]	Counterparts	References[4]	GCN Circulars Compilation	Notes	Products
060930	20:18:09	-23:37:31	2.5	0.3	09:04:09	20	O	-	here	-	Here
060912B	18:04:52	-19:52:50	2.5	0.08	17:32:30	200	-	-	here	-	Here
060901	19:08:38	-06:38:22	2.5	>6.5	18:43:51	20	X	-	here	-	Here
060204A	15:28:56	-39:26:38	2.5	0.1	13						
060130	15:16:54	-36:54:43	2.0	0.2	04						
060114	13:01:07	-04:44:53	2.0	0.3	12						
051211B	23:02:45	+55:04:44	2.0	0.8	22						
051105B	00:37:51	-40:28:52	2.0	0.35	11						

TITLE: GCN GRB OBSERVATION REPORT
NUMBER: 2459
SUBJECT: GRB 031203: A long GRB detected with INTEGRAL
DATE: 03/12/03 23:20:36 GMT
FROM: Diego Gotz at IASF-CNR <diego@mi.iasf.cnr.it>

D. Gotz, S Mereghetti, M. Beck and J. Borkowski on behalf of the IBAS Localization Team, N. Mowlavi on behalf of the INTEGRAL Science Data Centre and the INTEGRAL Science Working Team report:

A 20 s long GRB has been detected with IBAS at 22:01:28 UTC.
The GRB has been detected in IBIS/ISGRI data in the 15-200 keV energy band.

The coordinates (J2000) are R.A. 08h 02m 30s Dec. -39deg 50" 49" with an uncertainty of 2.5 arcmin.

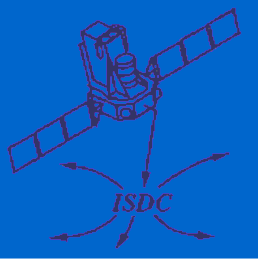
GRB ID

Arrival time

Duration

Sky coordinates

ISGRI GRB analysis



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First, we want to know which ScW should be taken for the analysis:

```
converttime UTC 2003-12-03T22:01:28 ""
Log_1 : Input Time(UTC): 2003-12-03T22:01:28 Output Time(REVNUM): 0139
Log_1 : Input Time(UTC): 2003-12-03T22:01:28 Output Time(UTC): 2003-12-03T22:01:28
Log_1 : Input Time(UTC): 2003-12-03T22:01:28 Output Time(YYYYDDDHH): 200333722
Log_1 : Input Time(UTC): 2003-12-03T22:01:28 Output Time(SCWID): 013900150010
```

We download the data and run **ibis_science_analysis** on this ScW to see what field was observed and to locate the GRB in the FoV

ISGRI GRB analysis

TITLE: GCN GRB OBSERVATION REPORT
NUMBER: 2459
SUBJECT: GRB 031203: A long GRB detected with INTEGRAL
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FROM: Diego Gotz at IASF-CNR <diego@mi.iasf.cnr.it>

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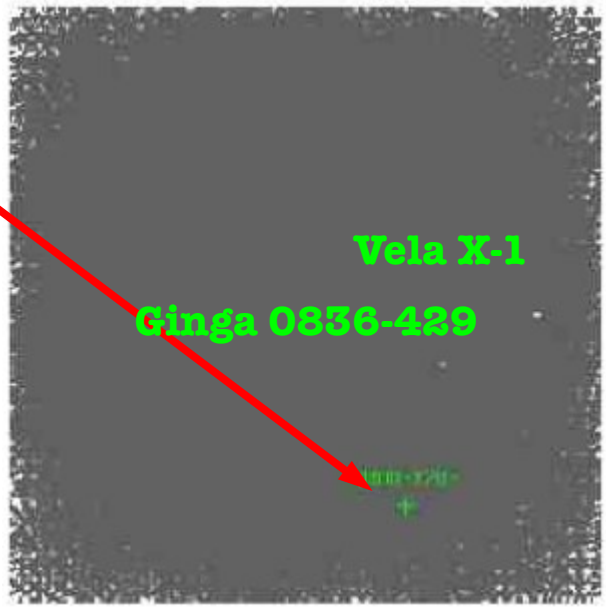


As expected, the GRB is not visible in ISGRI image of the whole ScW. Instead, two bright persistent sources are detected, Vela X-1 and Ginga 0836-429

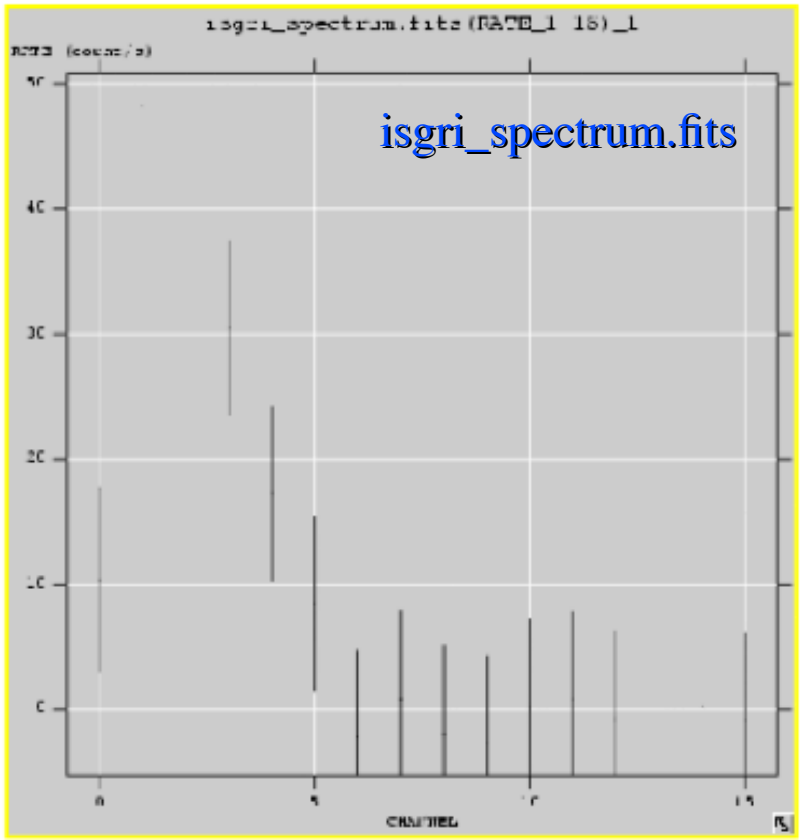
ISGRI GRB analysis

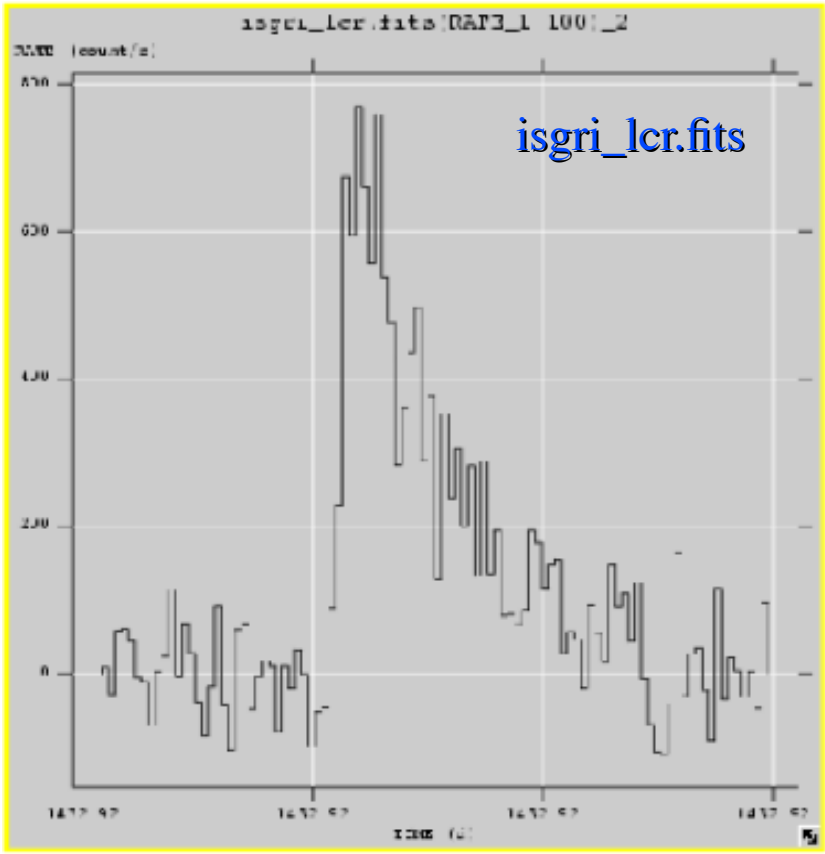
To select only a short time interval around the GRB arrival time we define "Good Time Inteval" (GTI) to be only a short interval starting at
[UTC 2003-12-03T22:01:28 – 10 sec] till
[UTC 2003-12-03T22:01:28 + 30 sec] with the help of **user_gti** command and rerun **ibis_science_analysis** till IMA step:

Now the two persistent sources are not detected (too short exposure time), but the GRB is clearly visible

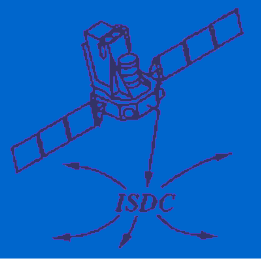
ISGRI GRB analysis

One can force **ibis_science_analysis** to extract the lightcurve and spectrum of the GRB by providing a user-defined input catalog, which includes the GRB (along with the two bright persistent sources in the FoV)



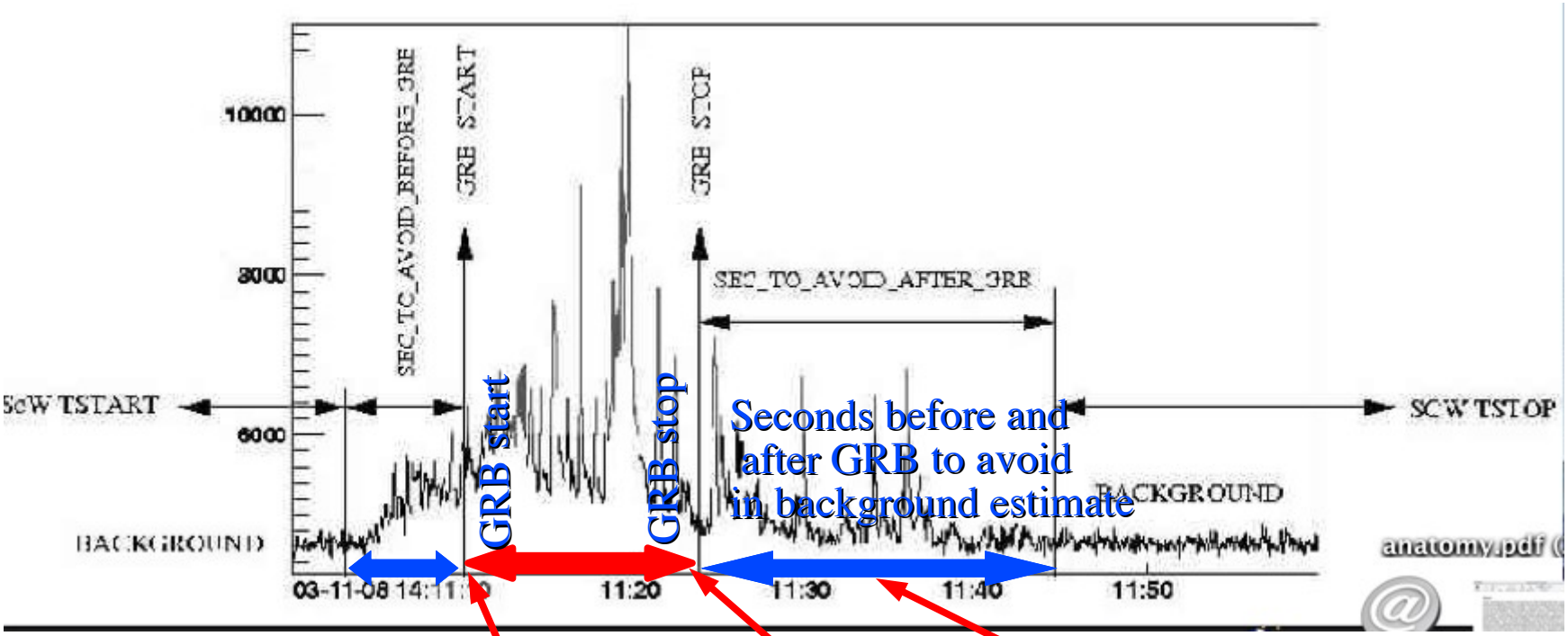


SPI GRB analysis



- The spectrometer SPI has wider field of view than the imaer ISGRI and, therefore, higher sky background count rate. This makes it less sensitive than ISGRI (for the purpouse of GRB detection).
- GRB spectra are thought to be (broken) powerlaw, without line features: one does not really need high spectral resolution to model GRB spectra
- However, SPI detector is sensitive to photons of higher energies. The break in the powerlaw spectra of GRBs are often at several hundreds keV energies.
- Contrary to *SWIFT* whose BAT detector is sensitive only up to 150 keV, *INTEGRAL* can see brighter GRBs at several hundreds keV (up to MeV) which is crucial for proper spectral modelling.

SPI GRB analysis



For SPI the GTI selection, background estimation and and **spi_science_analysis** for the corresponding GTI are incorporated in the script

spi_grb_analysis 2003-12-03T22:01:28 2003-12-03T22:01:48 UTC 10 30

Time format