



The Swift Gamma-Ray Burst Mission -- Science and Data Analysis

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CRESST / USRA /
NASA Goddard
Space Flight Center

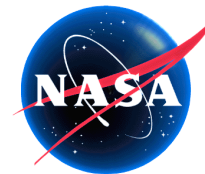
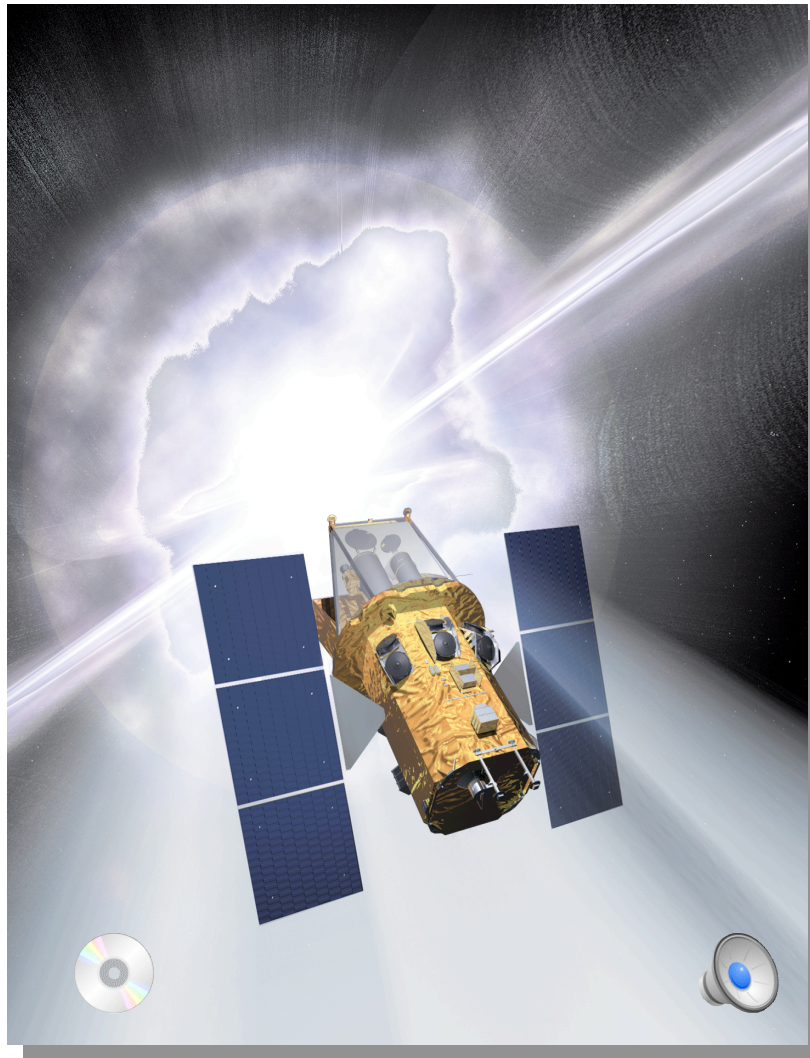
July 29, 2008

Urbino 2008: High Energy Astrophysics Summer School

Outline

- The *Swift* mission
 - Introduction/Instruments
 - Science highlights
- The *Swift* Burst Alert Telescope (BAT) and Coded mask imaging
- *Swift* BAT Analysis techniques
 - GRBs and event analysis
 - Survey data analysis

The Swift Mission



GSFC



Los Alamos
NATIONAL LABORATORY



SPECTRUMASTRO



Berkeley
University of California



SWALES
AEROSPACE

Sonoma State University

ONITRON
inc.



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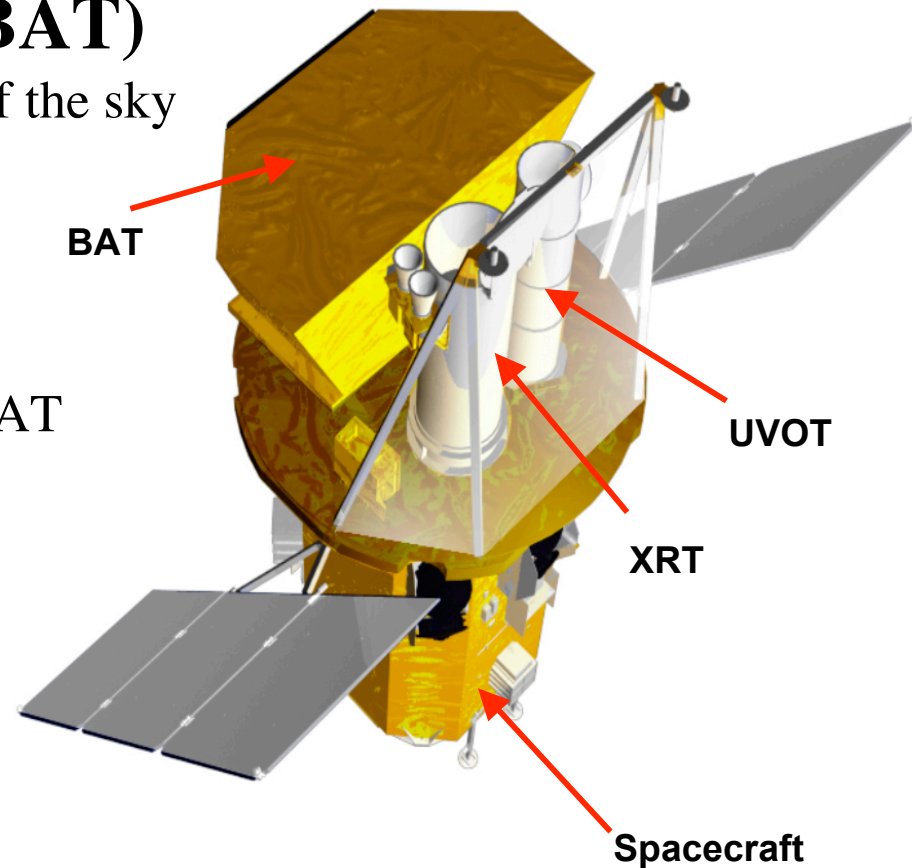
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Swift Instruments

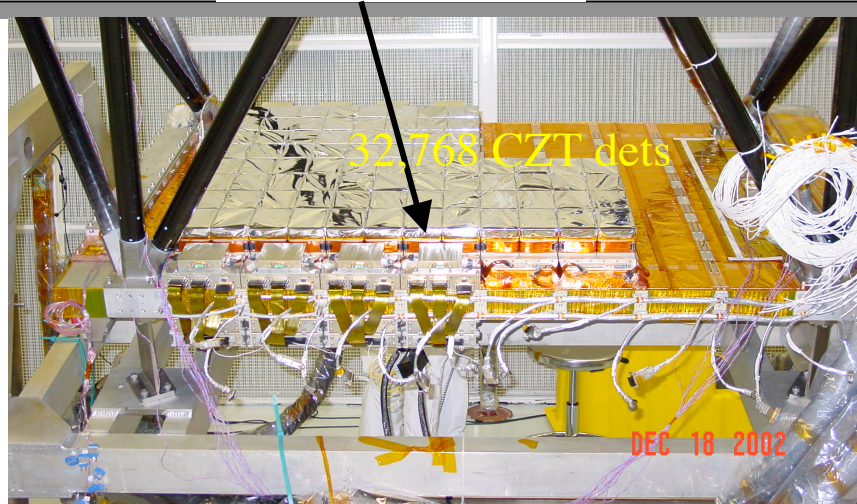
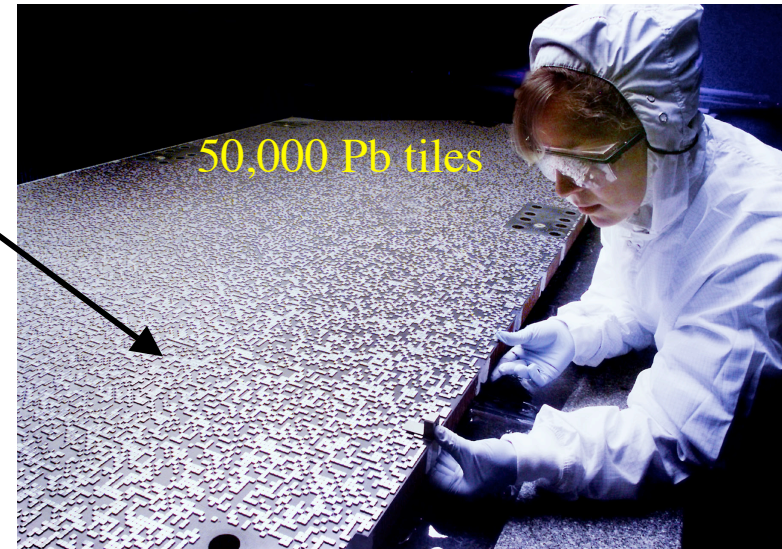
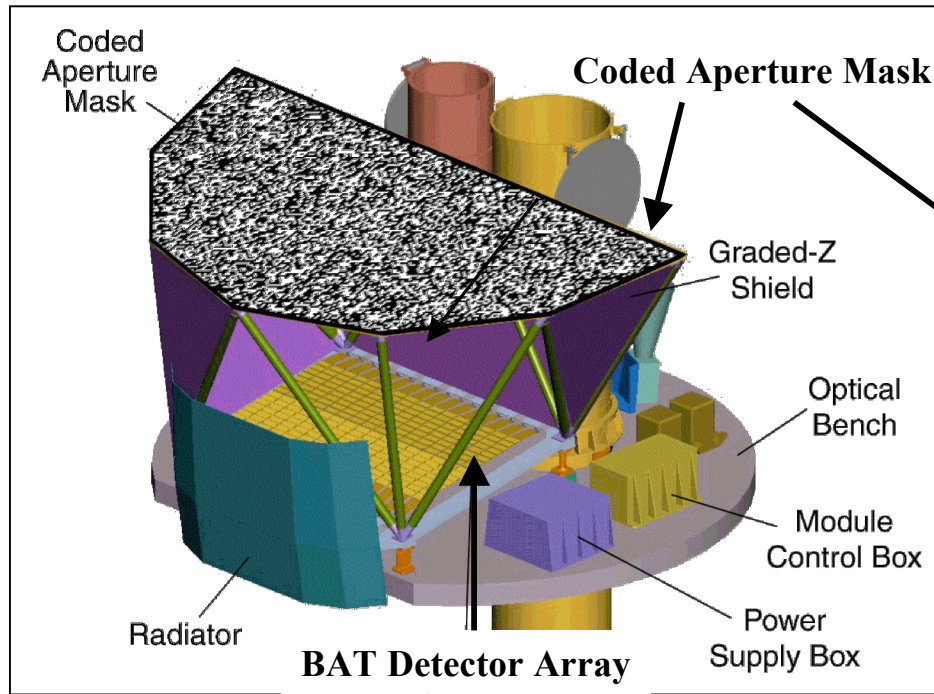
- **Burst Alert Telescope (BAT)**
 - Wide field monitor -- sees 1/6 of the sky
 - GRB trigger for Swift
- **X-Ray Telescope (XRT)**
 - Very precise GRB positions
 - Much more sensitive than the BAT
- **UV/Optical Telescope (UVOT)**
 - Very precise positions
 - Shows optical light from bursts

- **Spacecraft:**

- Rapidly re-pointing
(~ 1 minute response)



Burst Alert Telescope (BAT)



BAT Characteristics

- E Range: 15-350 keV
- E Resolution: 5 keV
- Location Resolution: 1-4 arcmin
- PSF: 21.8 arcmin
- 2 steradian field of view
- 32K CZT dets, 5200 cm²
- Autonomous operations



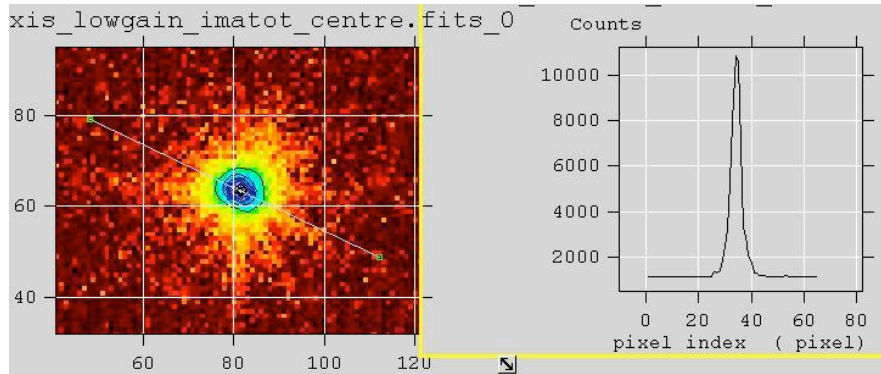
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BAT background: 12 Kcnts/s measured,
17 Kcnts/s predicted

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XRT Instrument

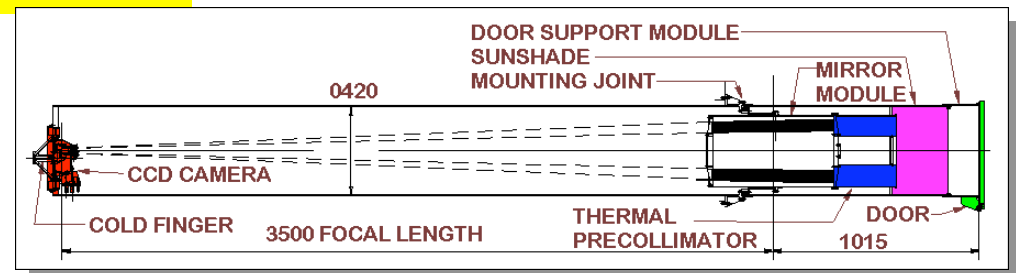


XRT Mirror Module



- Imaging mode: accurate centroids up to 26X Crab flux
- Photon counting mode for spectroscopy and time structure of afterglows.
- 15 arc-second half energy width
 - sharp core yields 2.5 arcsec locations
- CCD array covers 0.2-10 keV band
- 24 x 24 arcmin field of view
- Cooled to -100 degrees C

Grazing incidence optics



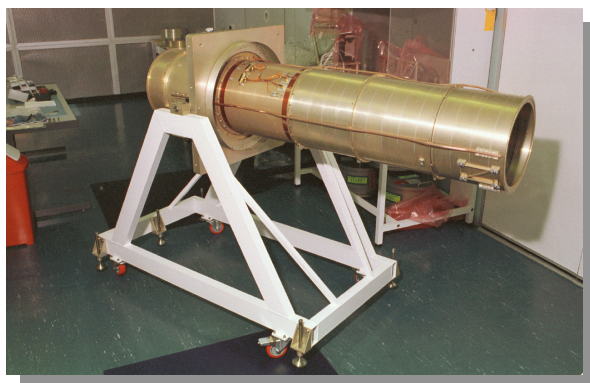
3.5 m focal length

UVOT Instrument

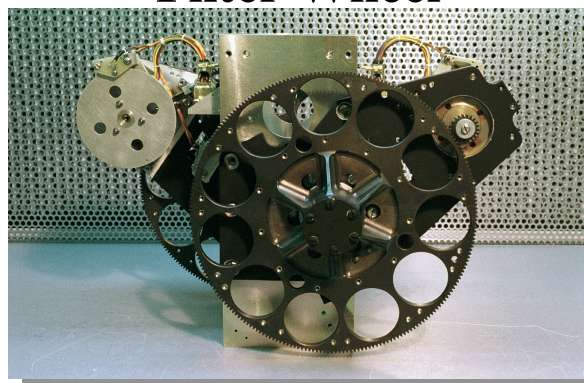
- Based on XMM OM design
 - Covers 170 nm to 650 nm
 - 30 cm Ritchey-Chrétien telescope
 - 21 mag in 1000 s with 17' x 17' FOV
 - Image intensified CCD array
 - Positions to 0.3 arc seconds



XMM OM



Filter Wheel



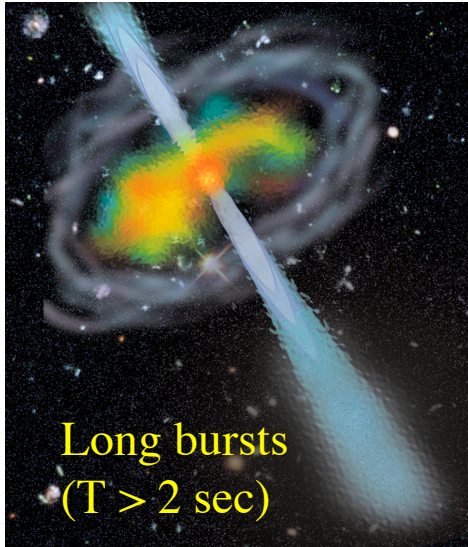
Swift Science Highlights

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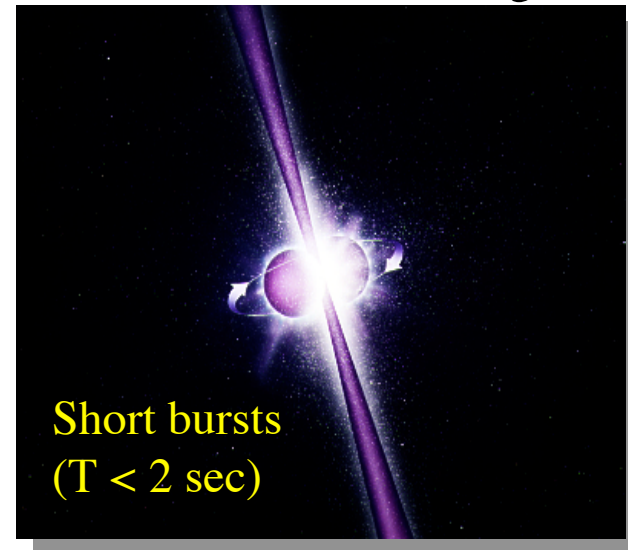
Theories of Gamma-Ray Bursts

Collapsar - Massive Star Explosion



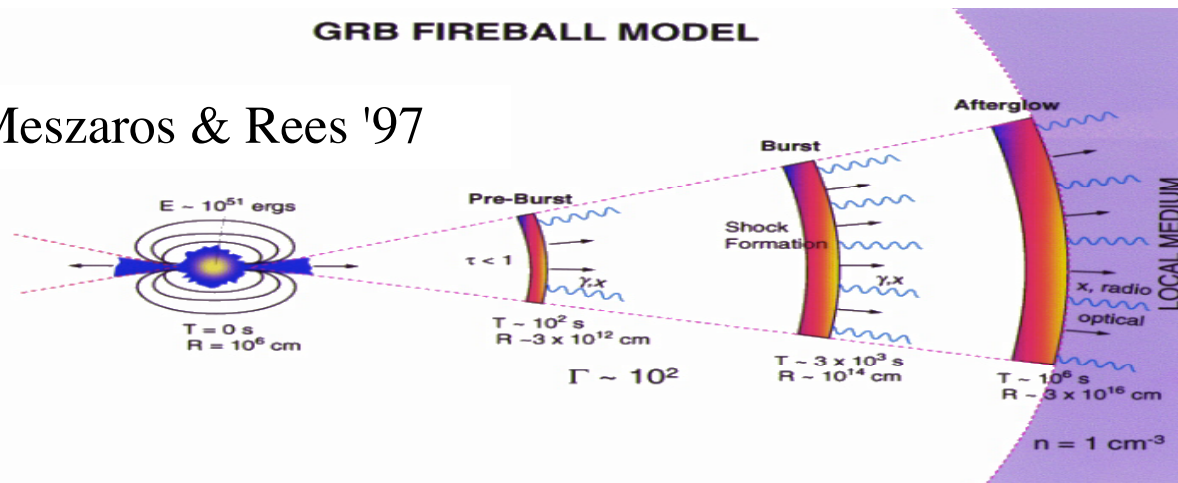
1/1000
supernovae
 $M > \sim 40 M_{\odot}$

Neutron Star Merger



GRB FIREBALL MODEL

Meszaros & Rees '97



Swift is detecting GRBs at higher z than previous missions

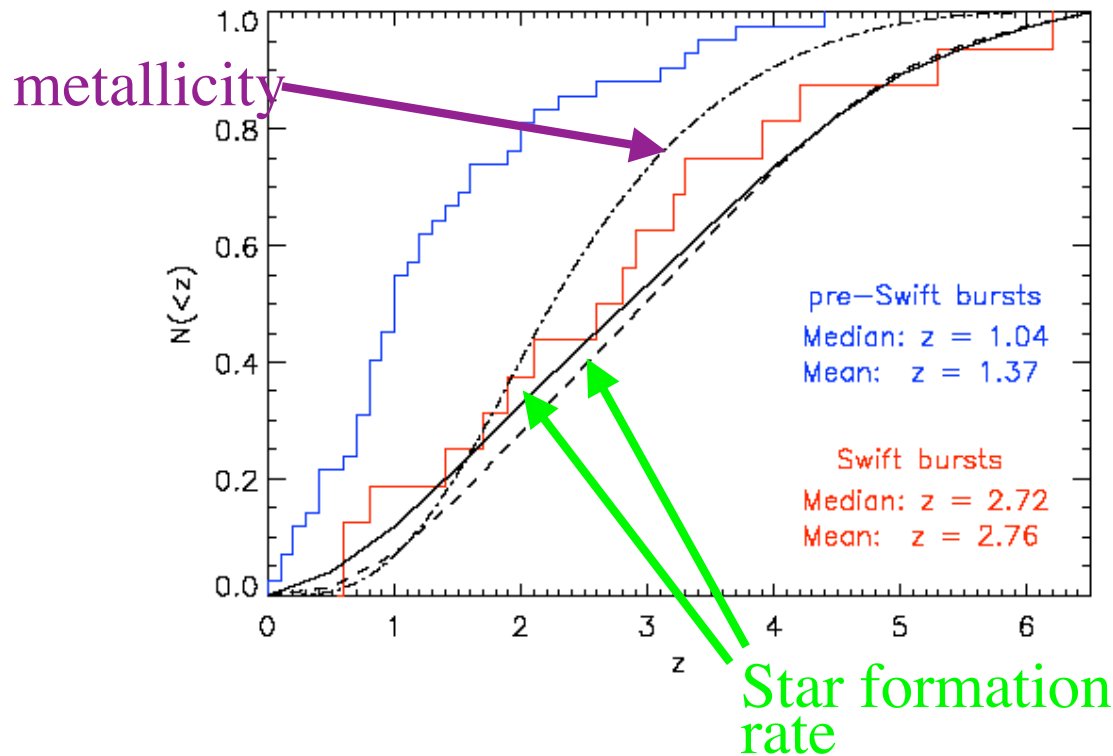
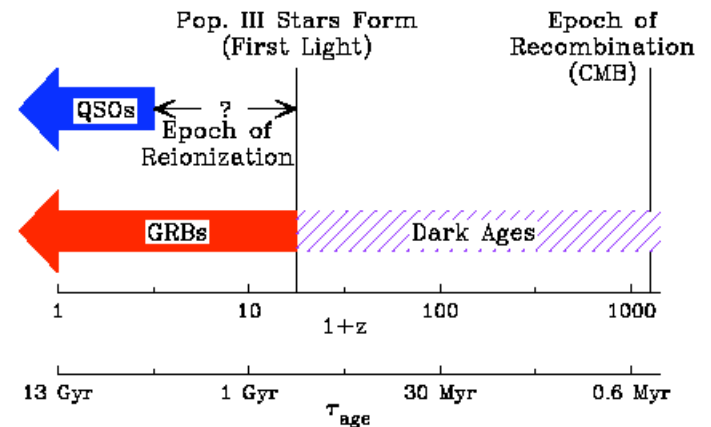


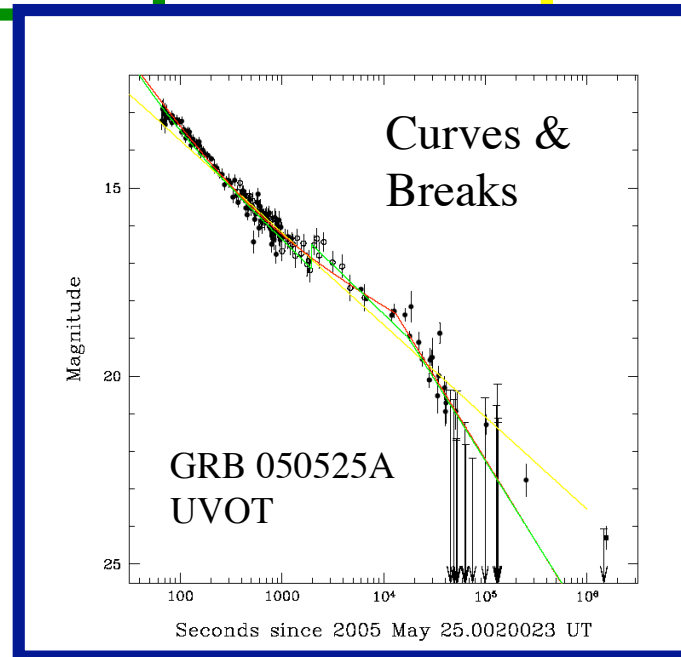
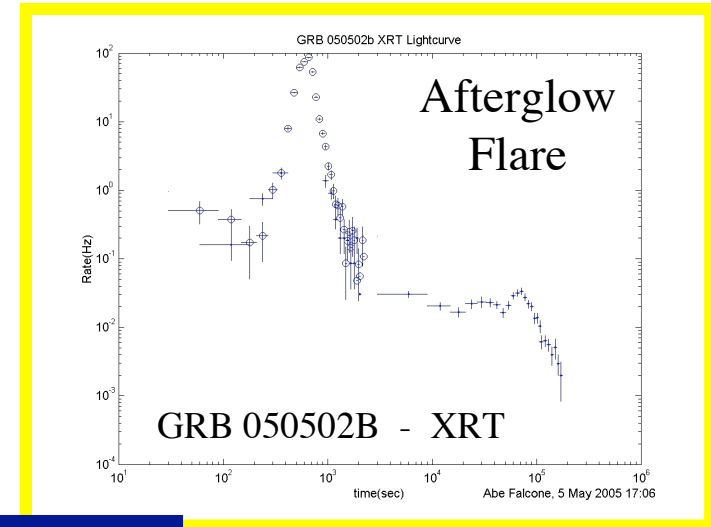
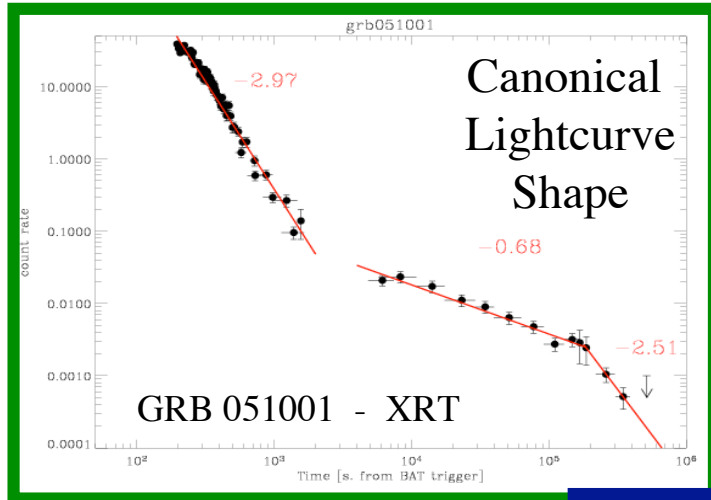
Figure from P. Jakobsson et al,
A&A 447, 897–903 (2006)

GRB 060116 may
be as far as $z=6.6$

Swift average (22 bursts): 2.76
[Now have redshifts for 115 bursts]
Pre-Swift average: 1.37



Afterglow discoveries

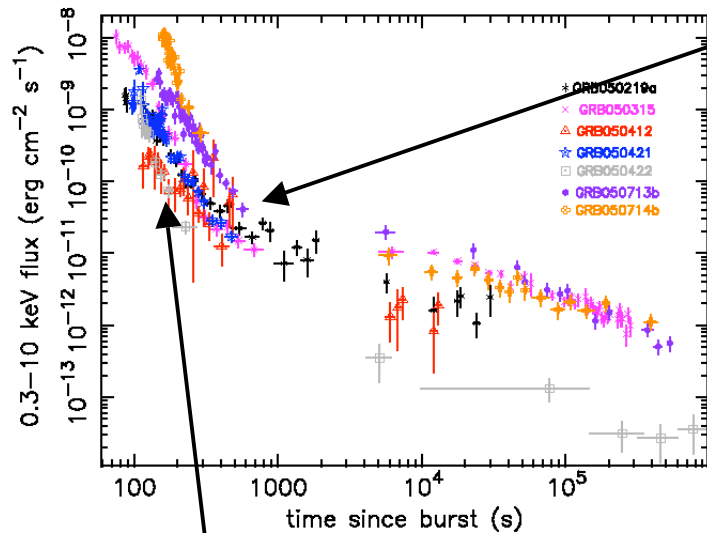


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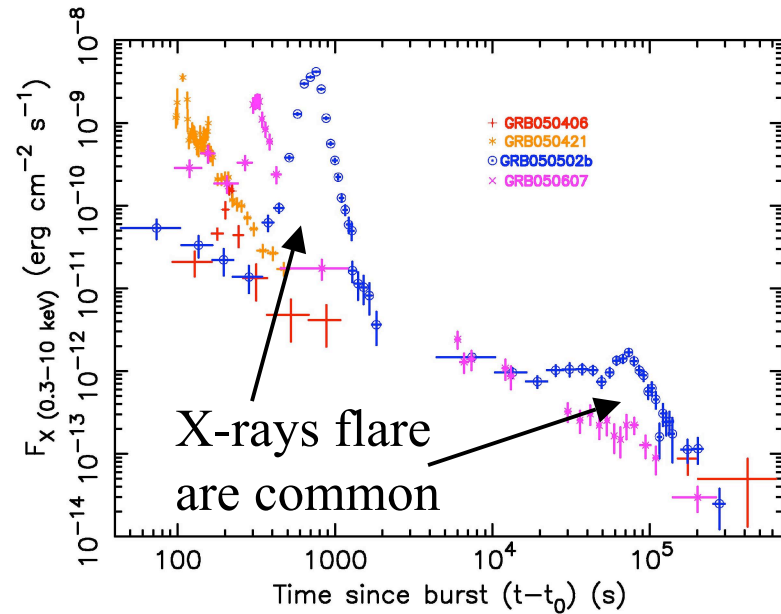
Typical XRT afterglows

(Nousek et al., *ApJ*, **642**:389, 2006)



Temporal break around 500-1000 s

Steep decline common

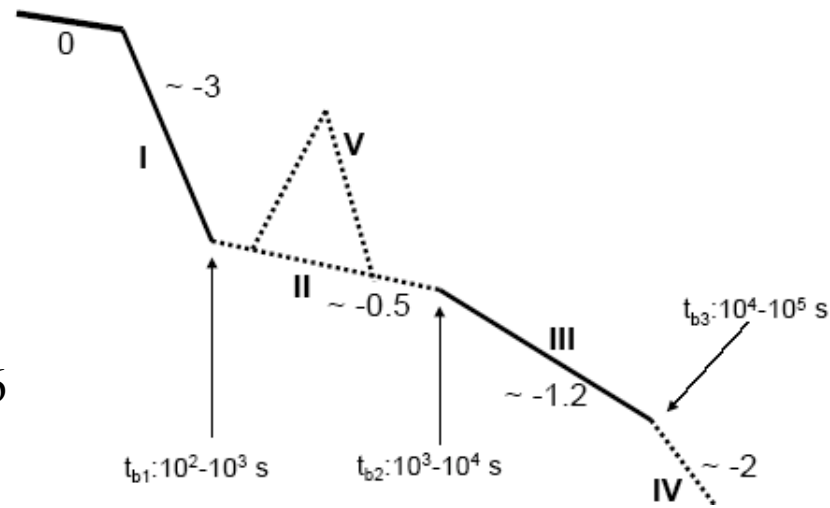


X-rays flare are common

Unified picture: e.g.

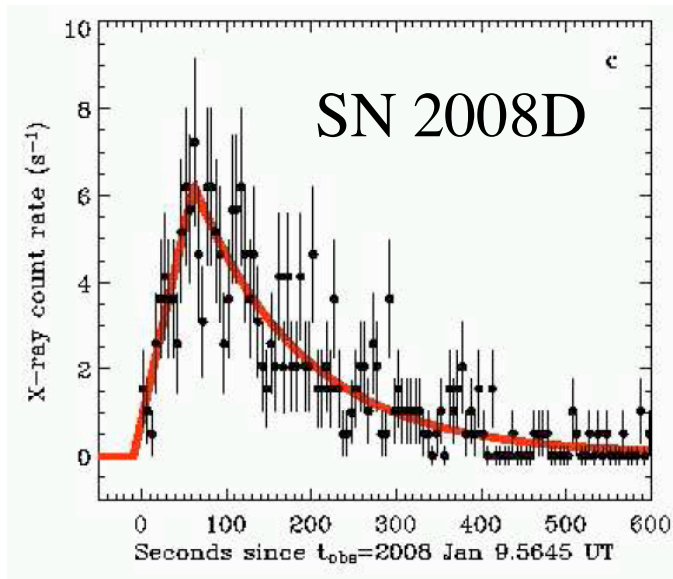
Zhang et al, *ApJ*, **642**:354–370, 2006;

O'Brien et al, *ApJ*, **647**:1213–1237, 2006

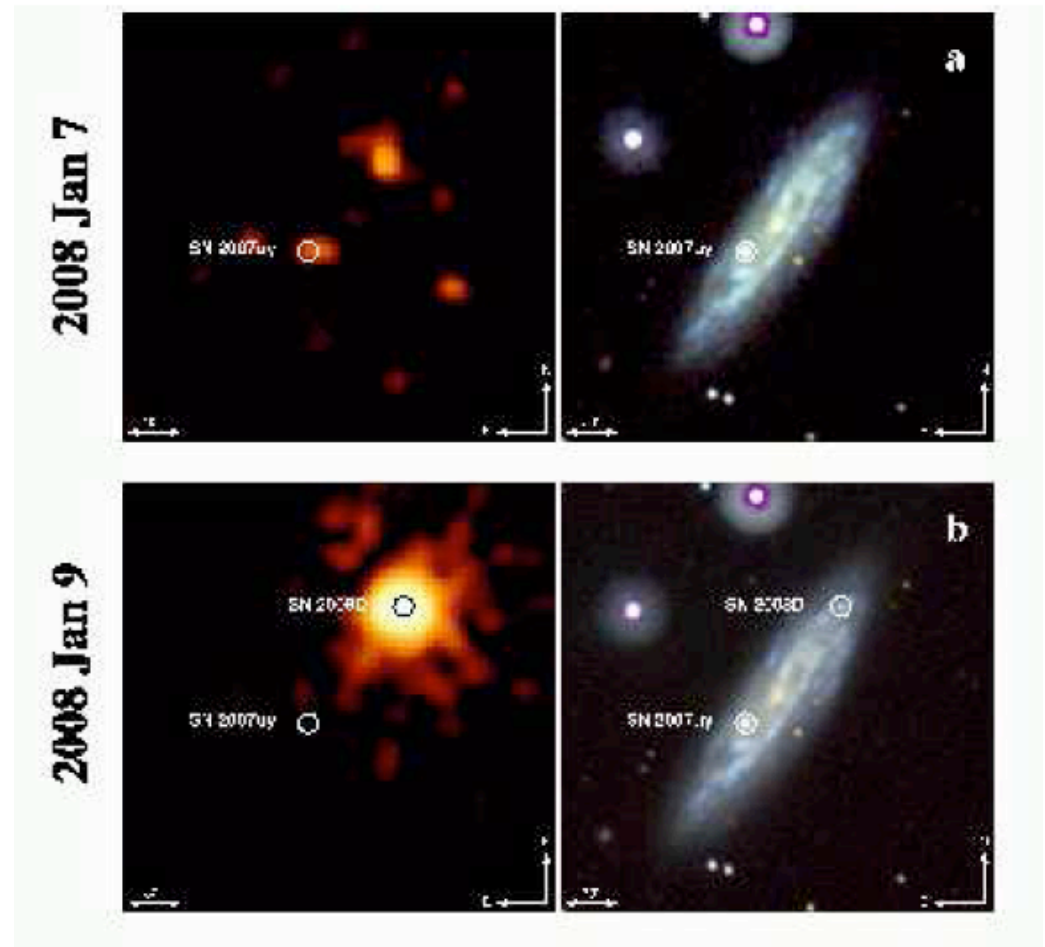


Two supernovae in one galaxy

NGC 2770



Most supernovae are detected many days after the explosion -- this is a unique opportunity to see the whole supernova

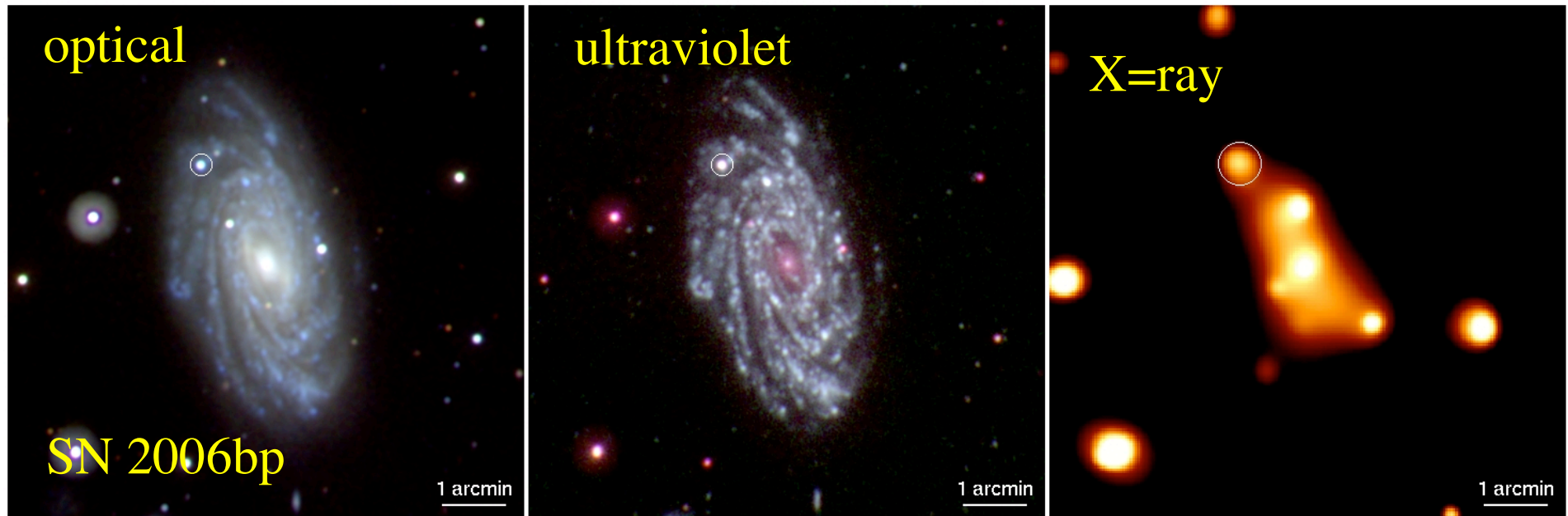


A. Soderberg et al, *Nature* **453**, 469-474 (2008)

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More Swift-observed supernovae

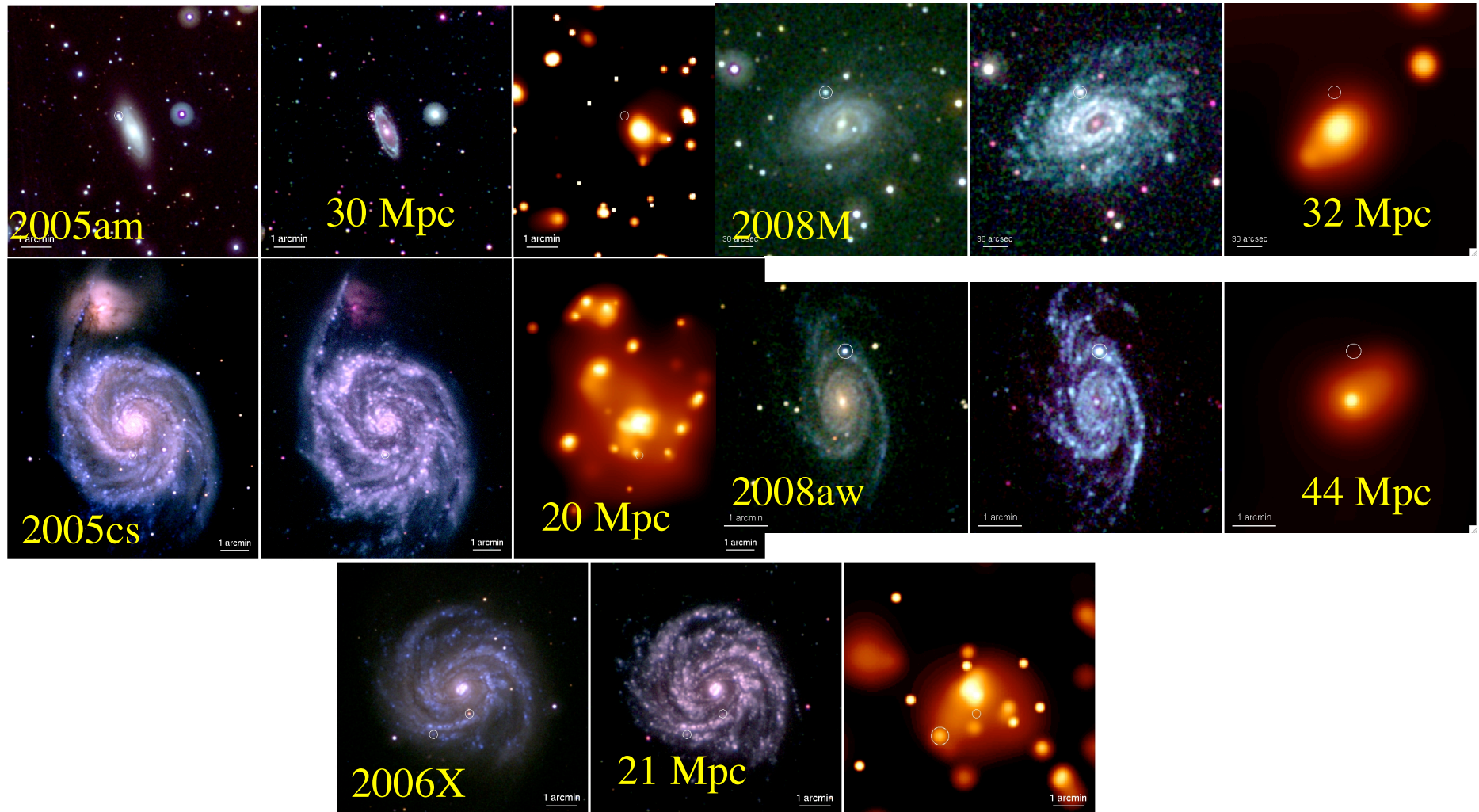


NGC 3953 (15 Mpc away)

70 supernovae observed by Swift

Even “late” X-ray and UV measurements are important for understanding how supernova ejecta interact with their environment

More Swift supernovae

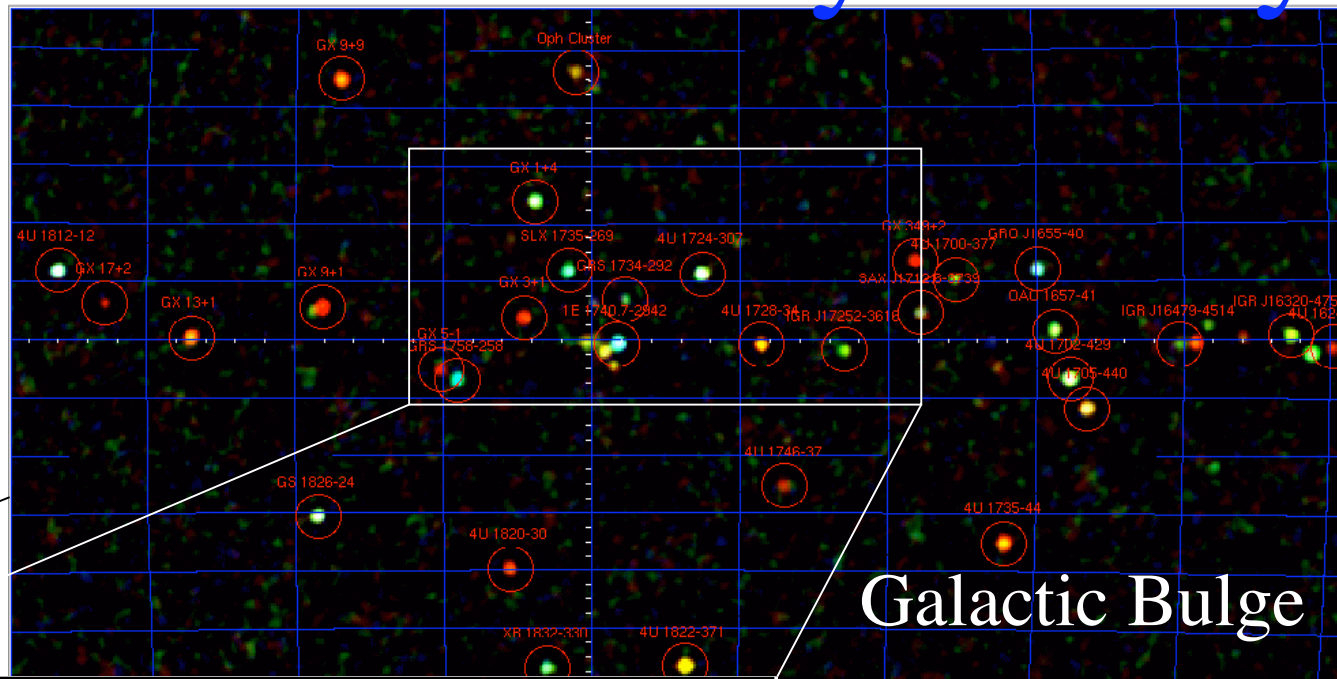


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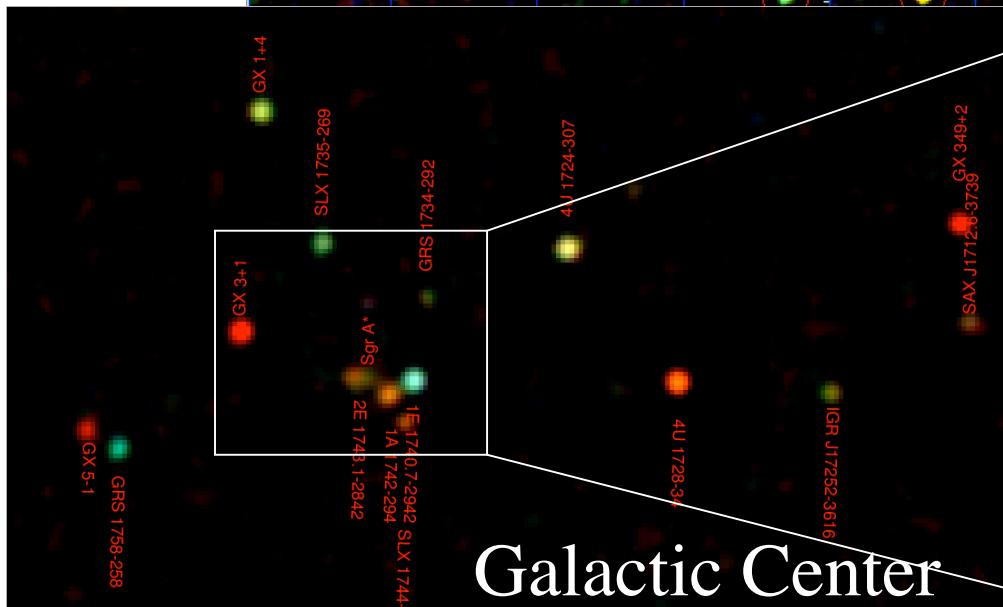
BAT All-Sky Survey

4 Energy Bands:
15-25-50-100-195 keV

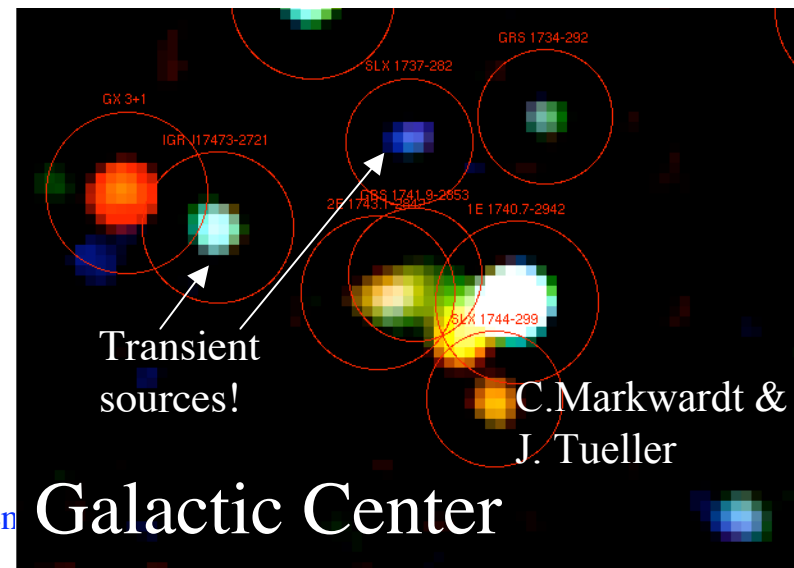


- 171 galactic sources
- 271 active galactic nuclei (AGN)

Galactic Bulge



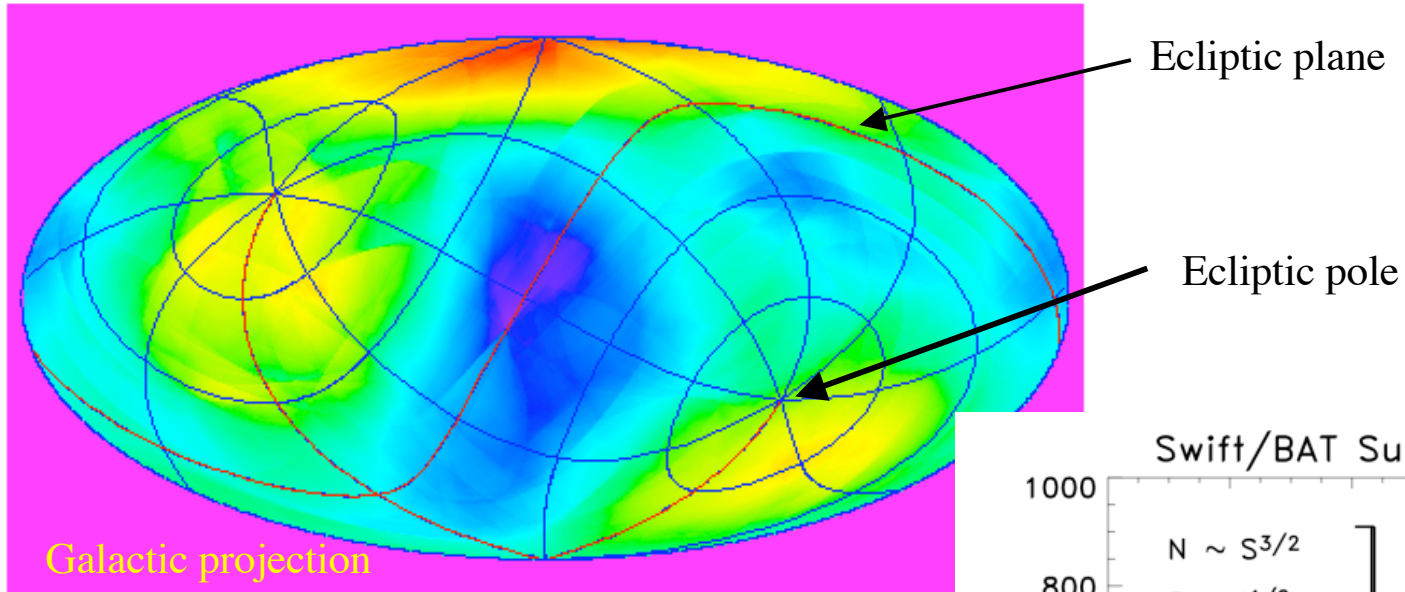
Galactic Center



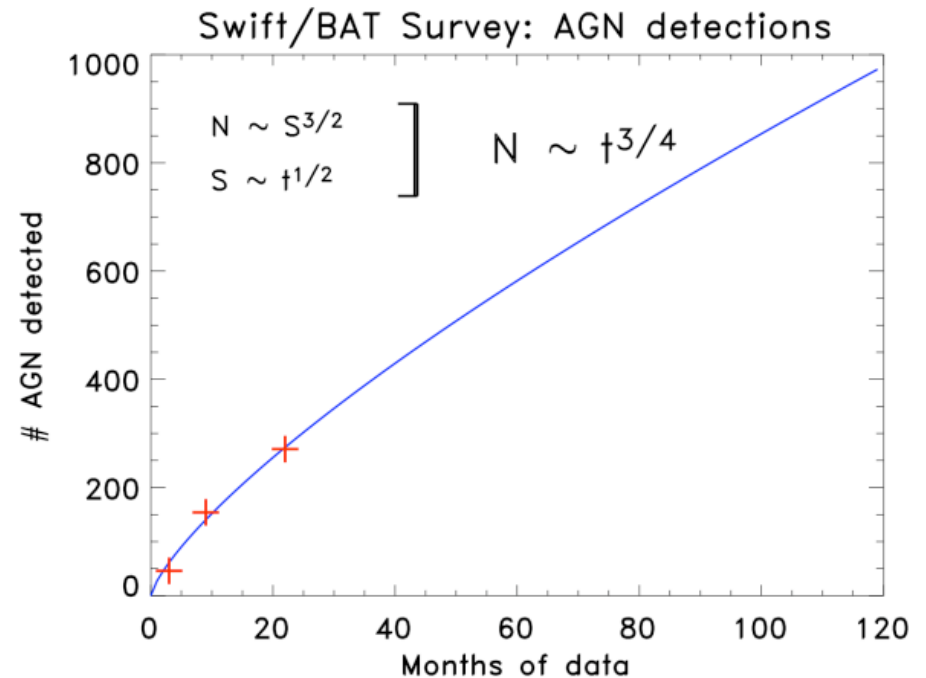
Galactic Center

En

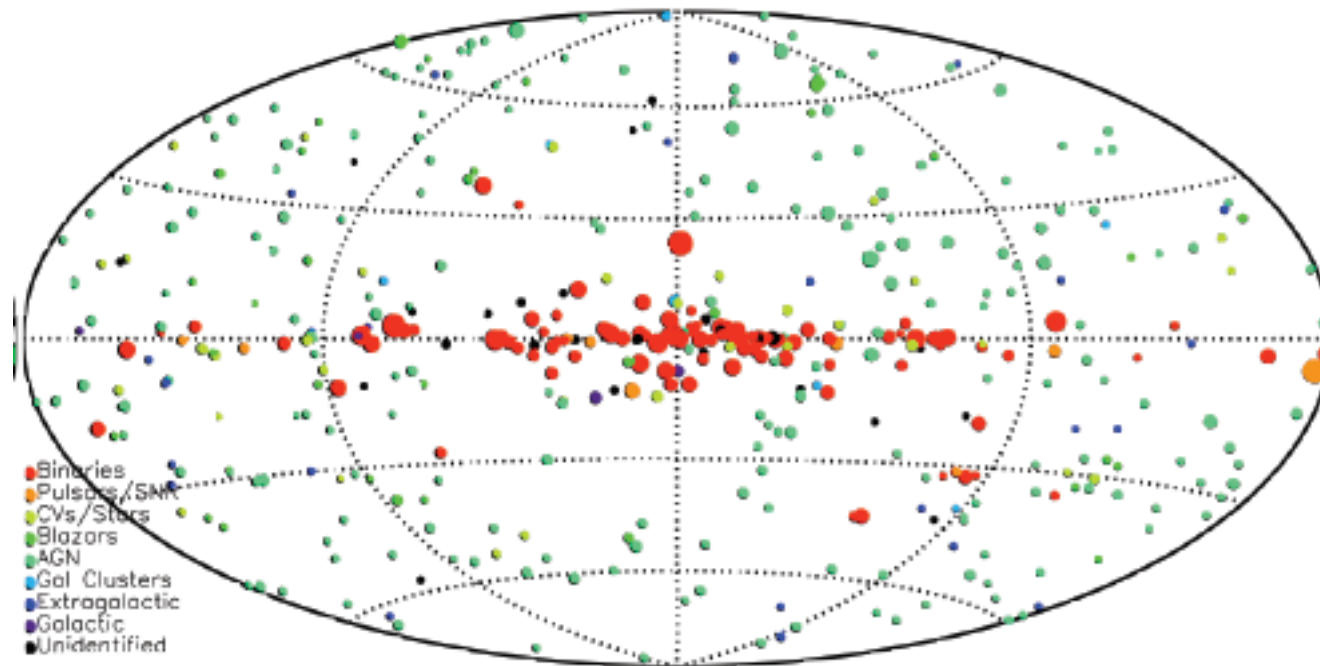
Exposure for All-Sky Survey



Red: highest exposure
Blue: lowest exposure



22 Month Survey Results



Source type map.

Some Results:

- First uniform, all sky flux-limited sample of AGN
- Detection of many “hidden” AGN without typical optical characteristics
- BAT galaxies are much more likely to be interacting and peculiar than non-BAT galaxies

Figure from Baumgartner et al.
Results from Tueller et al., *ApJ*,
681, 113-127 (2008)
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BAT and Coded Mask Imaging

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Shadow Imaging



Wayang

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Shadow Imaging



A sundial uses a gnomon and its shadow on a patterned plane to determine the elevation and azimuth of the sun.

Image Courtesy of Taganrog (Russia) Local Government

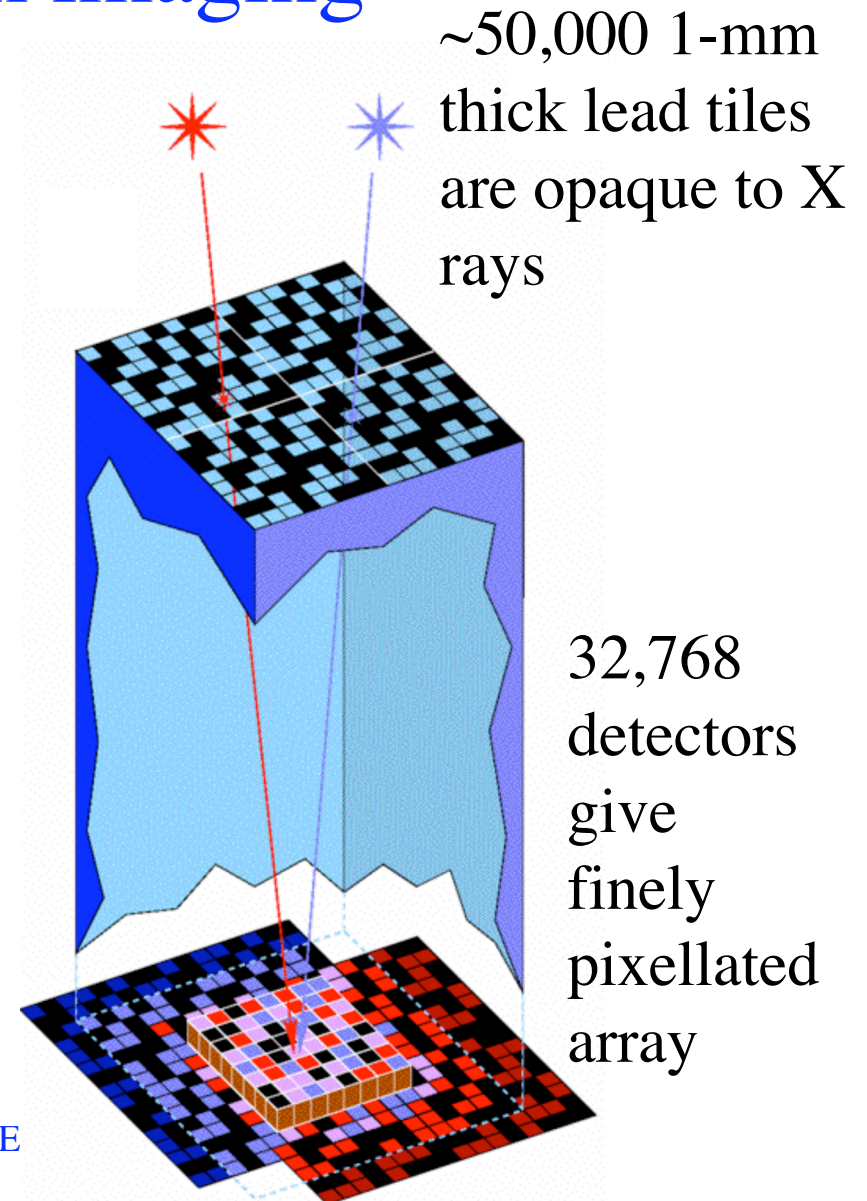
Swift/BAT uses a mask and detector array to do coded mask imaging



Good compromise --
large field of view
with reasonable
angular resolution!

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Coded Mask Imaging -- History

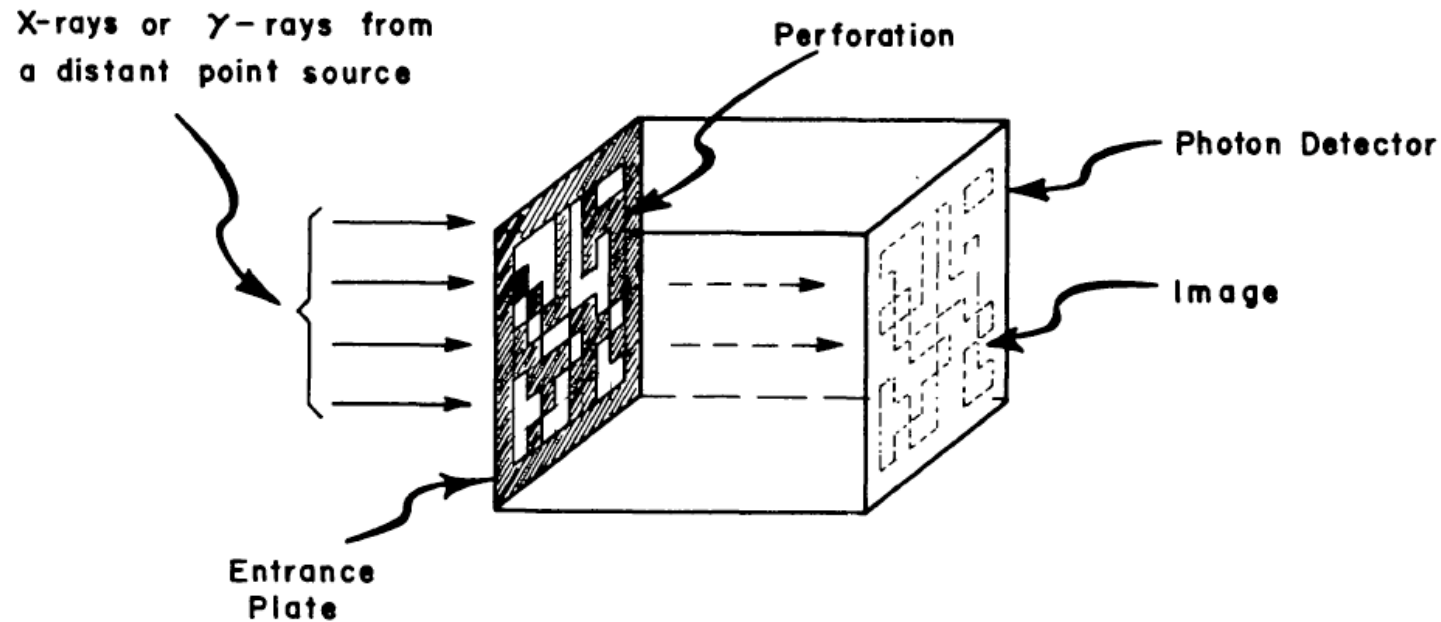


FIG. 1.—Scatter-hole camera. The entrance plate is randomly perforated to provide randomly positioned pinholes. The image is recorded photographically, photoelectrically, or with a photon counter, such as a wire spark chamber.

Figure from Dicke, R. H., ApJ 153 (1968) -- First reference to the technique

Coded Mask Imaging -- History

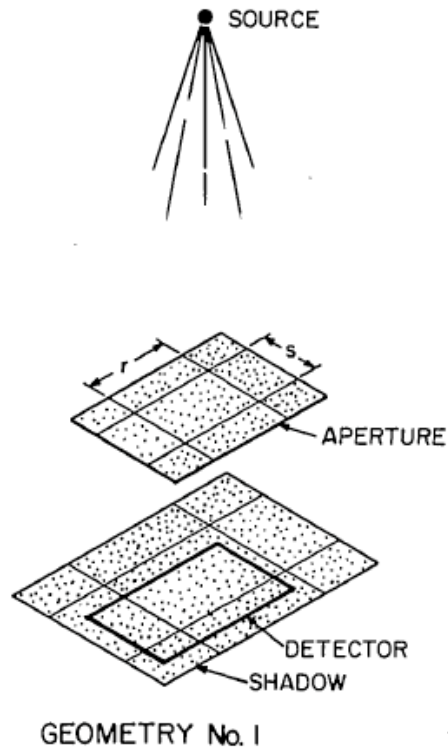


Fig. 3. This arrangement for a coded aperture imaging system employs a $2r$ by $2s$ aperture composed of a mosaic of basic r by s patterns. Emitting points in the source produce shadows of cyclic versions of the basic aperture pattern upon the detector, which need be only r by s in size.

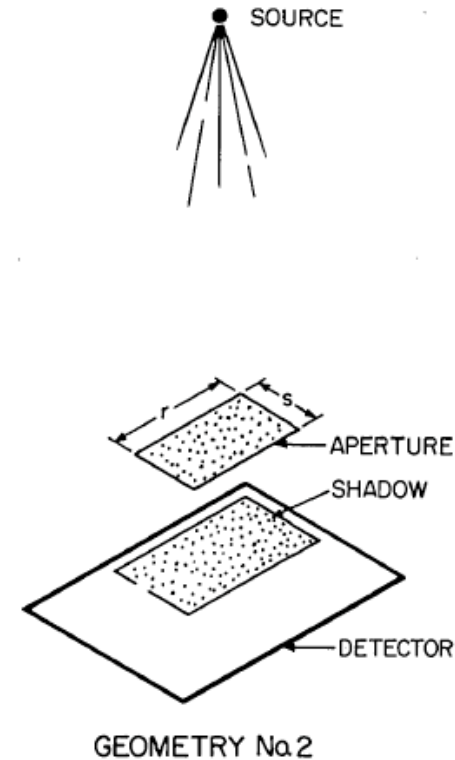


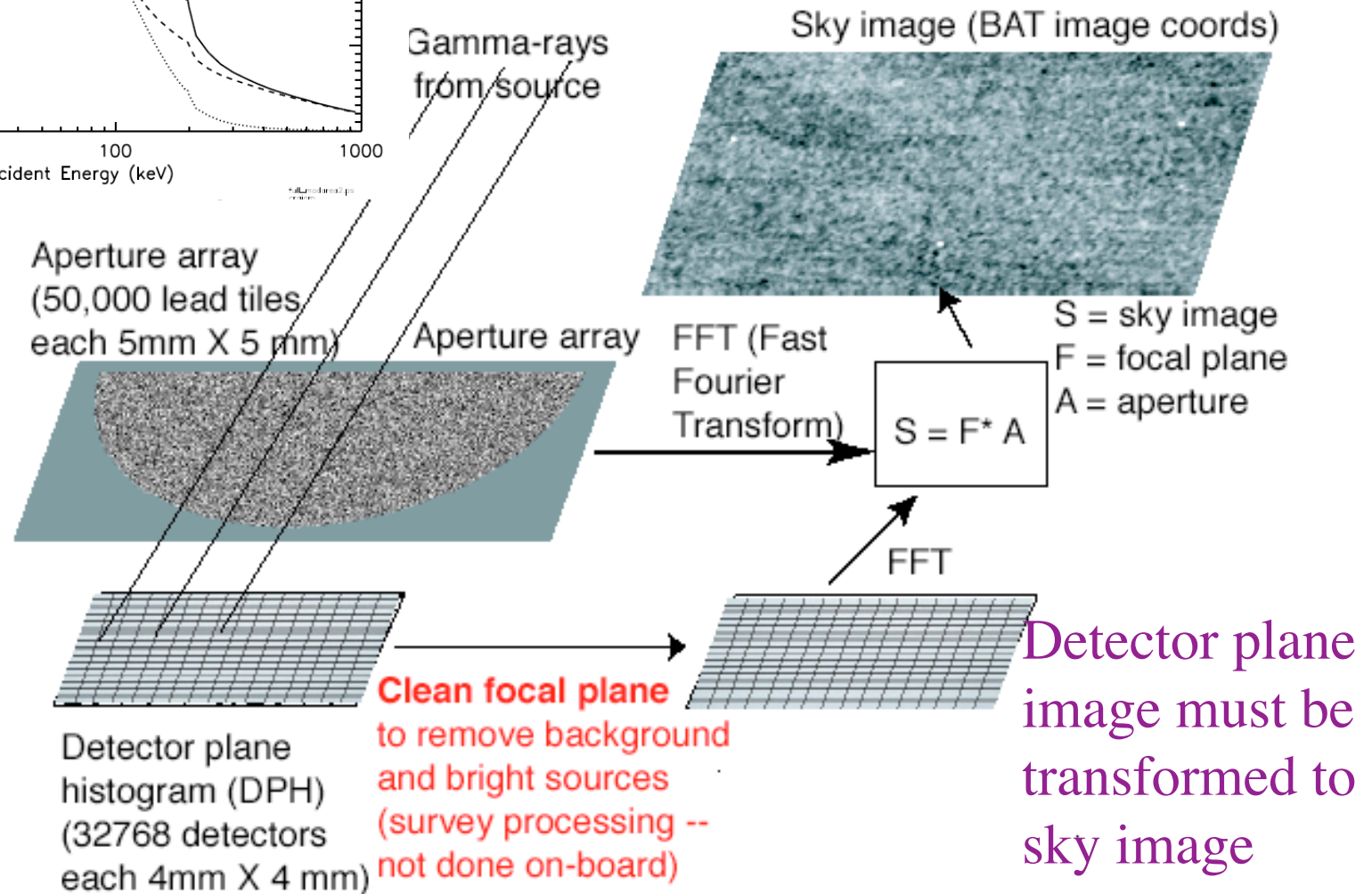
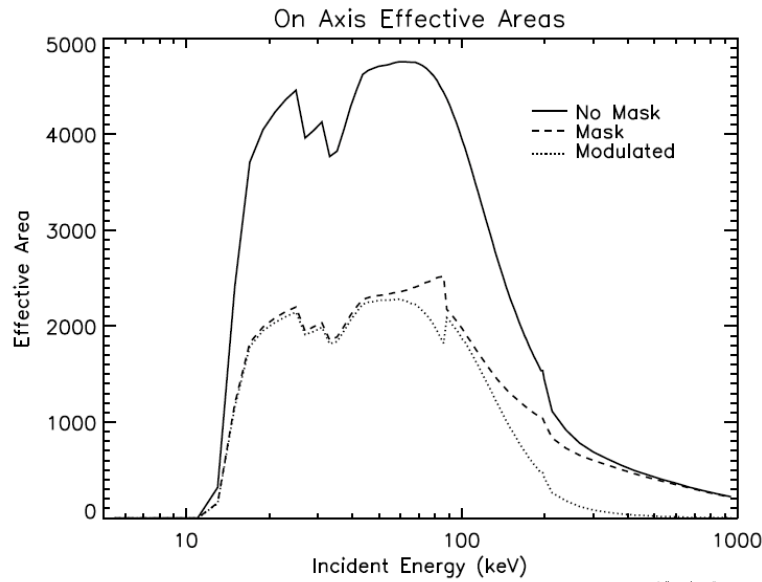
Fig. 4. This coded aperture arrangement employs only the basic r by s pattern for the aperture and has the disadvantage that the detector must be large enough to contain the image from the full field of view.

Coded Mask Telescopes in space

- Sounding rocket flight 1969 (A.P. Willmore et al)
- Balloon flight 1981 (D. Cardini et al)
- Satellite HXT on Tenma (Japan) 1983-84
- More recently:
 - SIGMA on Granat 1989-99
 - WFC on BeppoSAX 1996-2002
 - WXM on HETE-II 2000-05
- Currently:
 - ASM on RXTE
 - IBIS, SPI, JEM-X on INTEGRAL
 - BAT on Swift

Ref: Jean in 't Zand, <http://astrophysics.gsfc.nasa.gov/cai/coded.html>

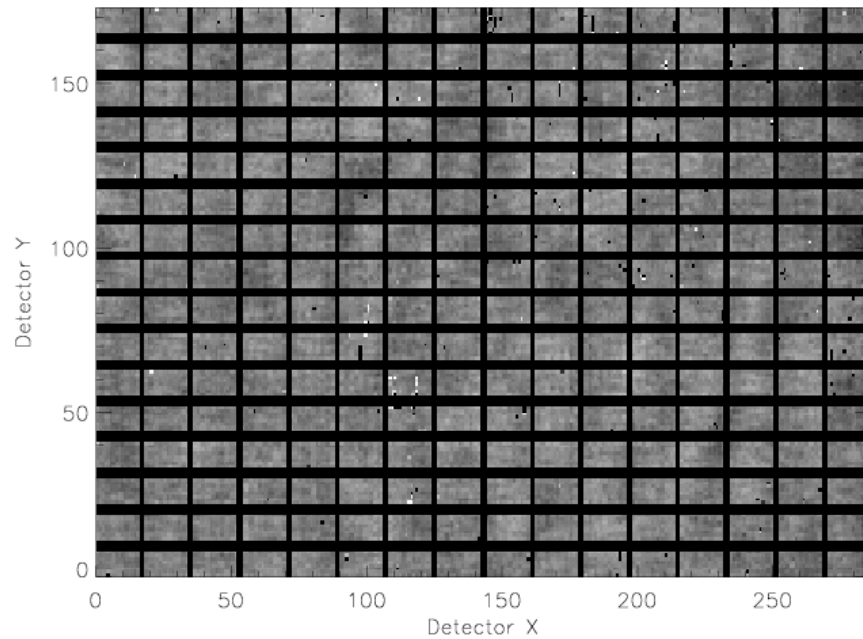
Basic image processing



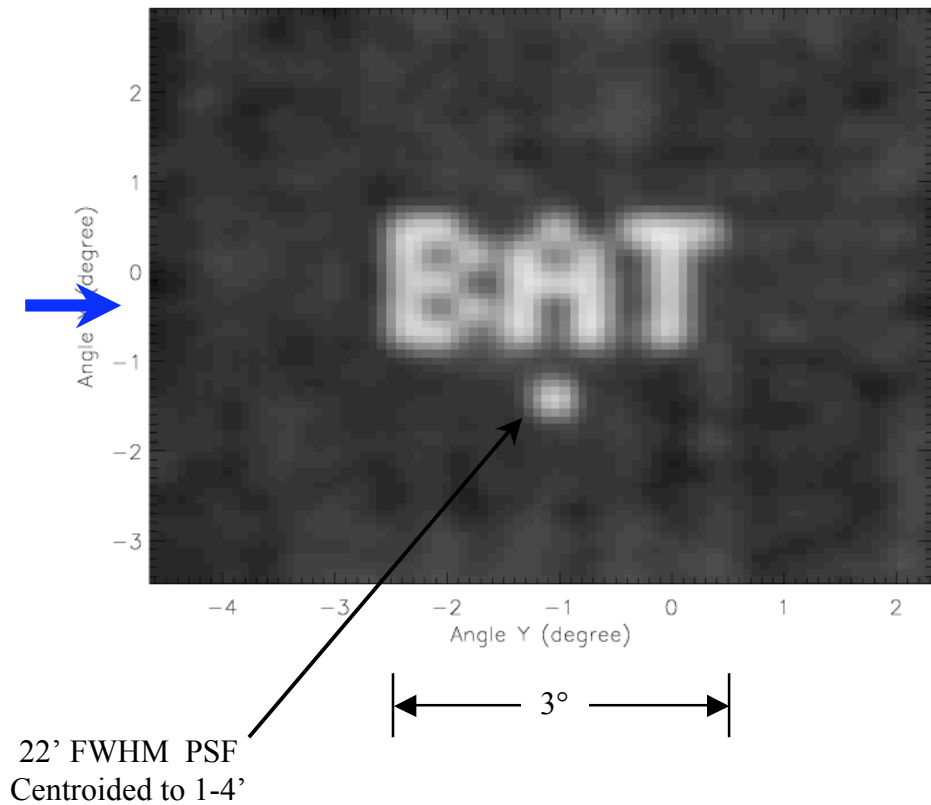
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Coded Aperture Before and After

Raw Detector Rate Map
True spatial layout shown (ie the gaps)

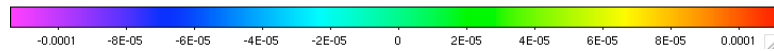
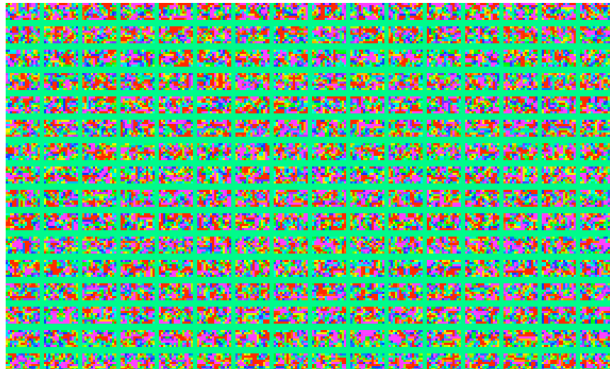


Sky Image, after FFT, Mask Convolution, InvFFT

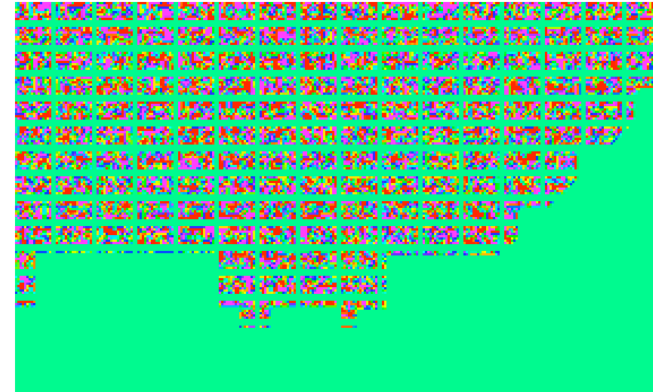


Different source locations

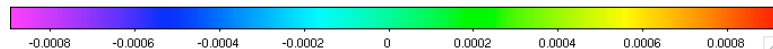
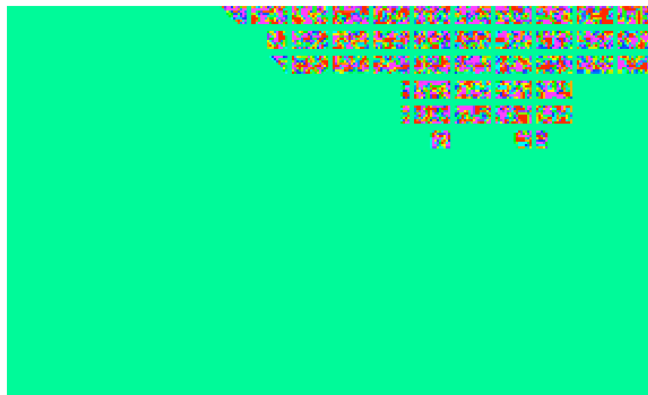
100% coded



60% coded

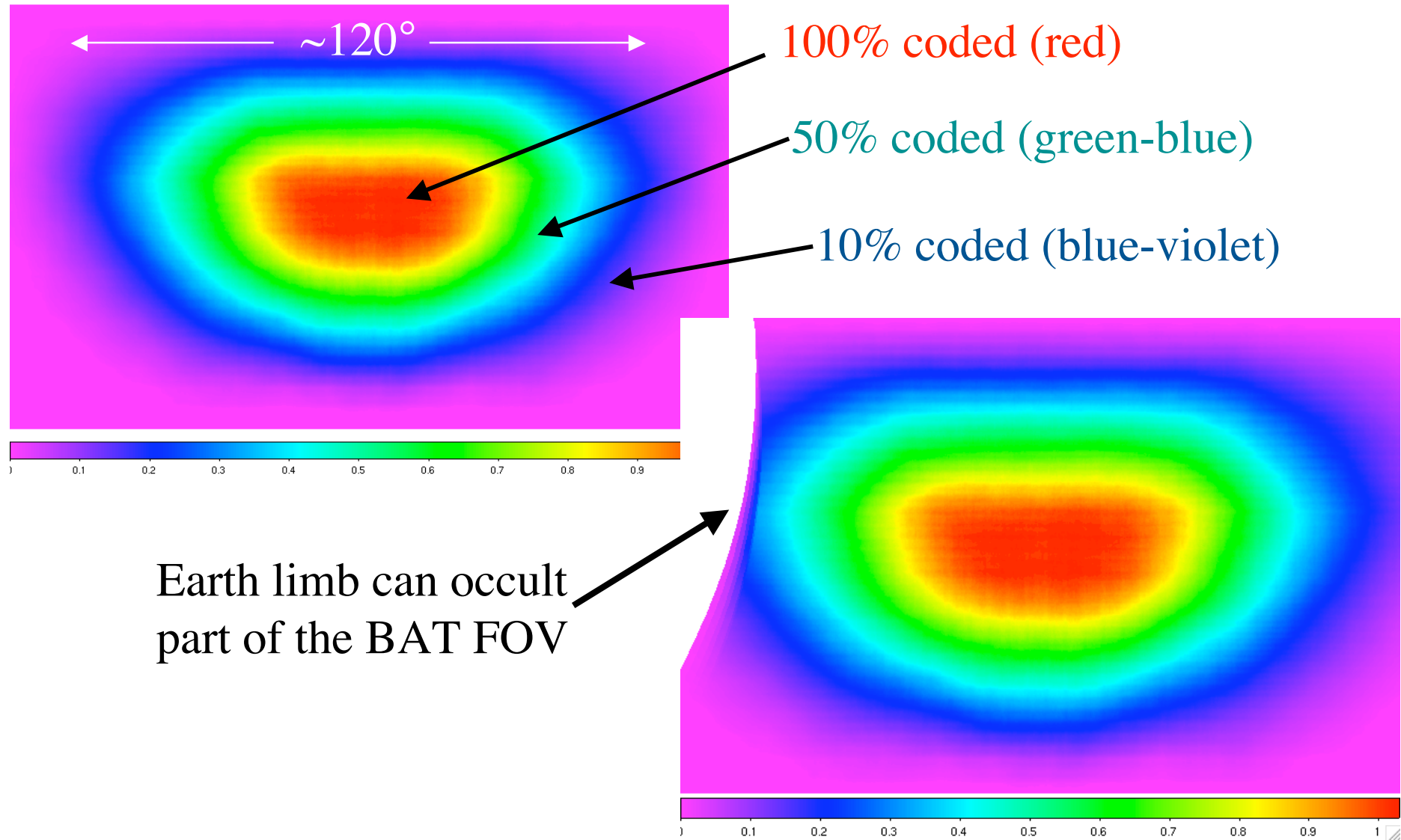


10% coded



All detector plane images are “balanced” so that background averages to zero.

Partially Coded Sky



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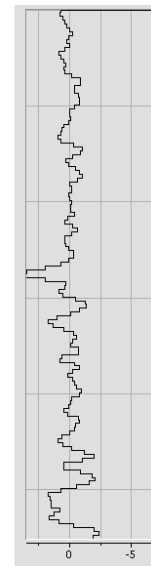
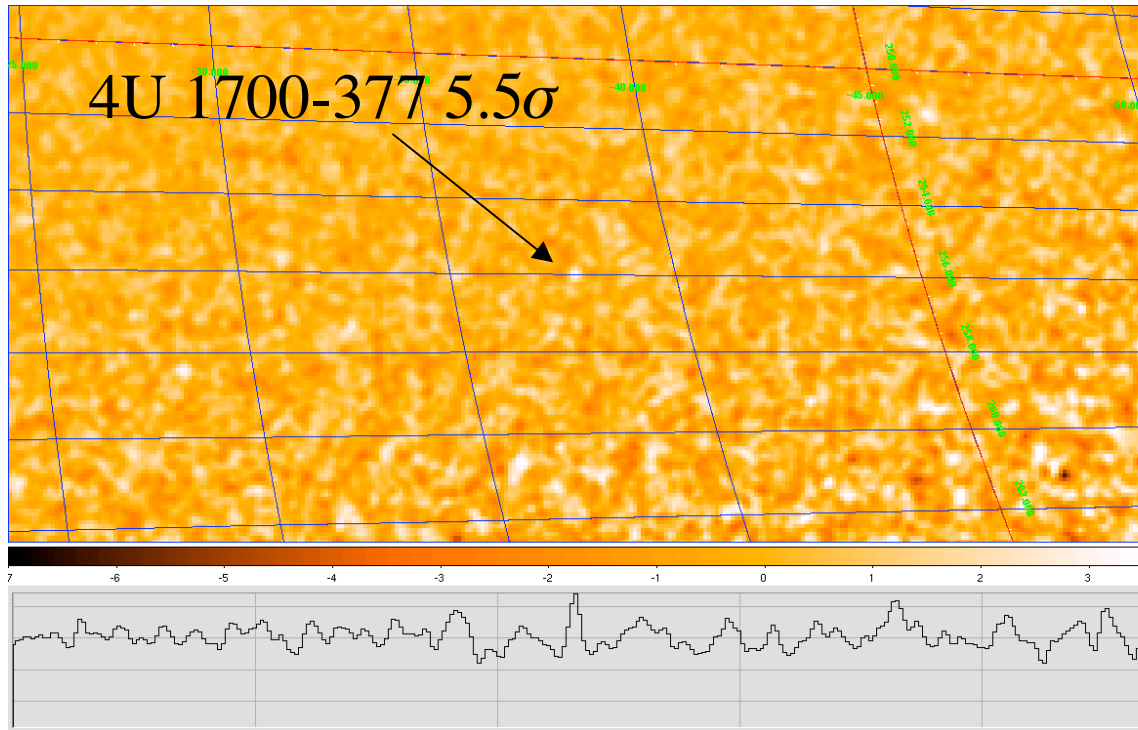
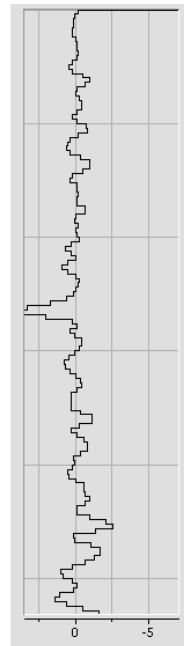
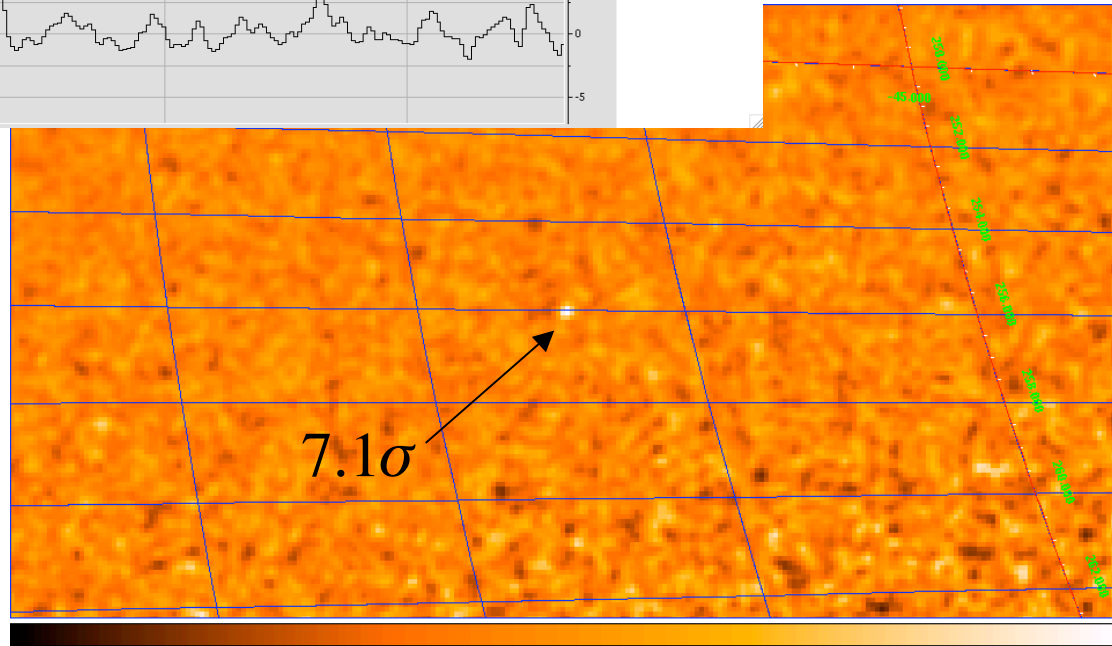


Image “cleaning”

Sco X-1 in this field
of view -- cleaned
from the lower right
image

BAT point spread
function 17 arcmin --
can centroid to ~ 1
arcmin

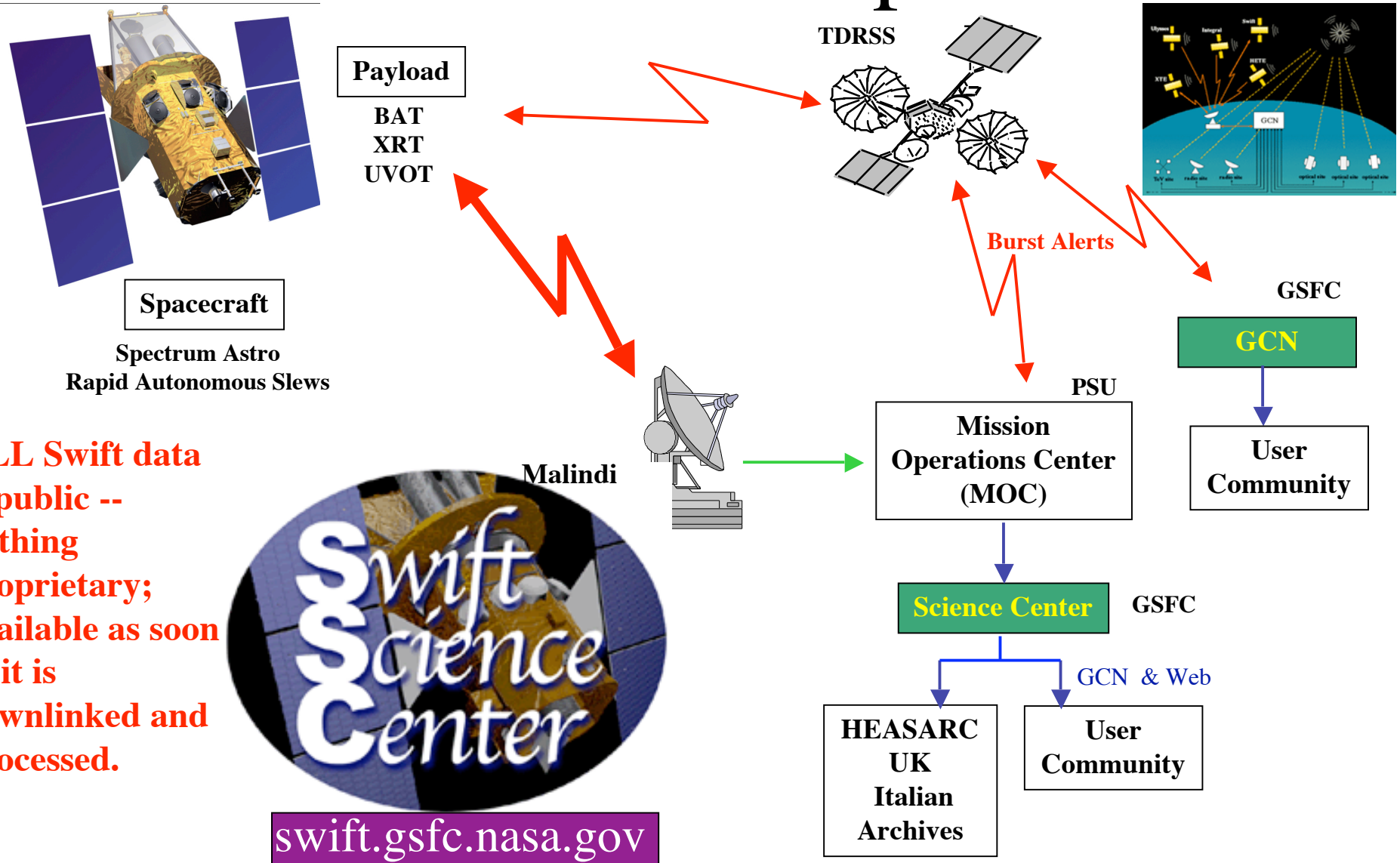
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BAT Data Analysis

I. How to get the data

Swift Mission Operations



ALL Swift data is public -- nothing proprietary; available as soon as it is downlinked and processed.



swift.gsfc.nasa.gov

BAT Data


BAT data is of two types:

- **Event data** (mostly just for GRBs and short outbursts)
 - This is a data point (time, energy, detector) for each photon -- 100 μ sec time resolution
 - Usually 1000 seconds around the trigger and during some spacecraft slews
- **Survey data** (for most other astrophysical sources) -- format is called Detector Plane Histogram (DPH) and must be cleaned and transformed before use.
 - This is an 80-channel spectrum for each detector with typically 5-minute time resolution
 - All times except during event data capture and spacecraft slews

Swift Quicklook Area

Data here for one week before it goes to the HEASARC/ISAC -- use for current bursts and other recent observations (like ToOs)

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**GODDARD
SPACE FLIGHT CENTER**

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Swift: Catching Gamma-Ray Bursts on the Fly


 U.S. site


 Italian site


 U.K. site

ABOUT SWIFT

QUICKLOOK DATA

GCN

SWIFT RESULTS

SCHEDULES & STATUS

RELATED SITES

Swift Quick-Look Data

Wed Jul 23 19:10:13 2008 GMT

Preliminary bat and uvot [high level data products](#) can be found [here](#).
 If you know the obsid of interest, faster access can be obtained by including this at the end of the URL, eg
http://swift.gsfc.nasa.gov/SDC/data/local/data1/data/old_products/00106415000.

Please [acknowledge Swift](#) in publications using Swift data.

Jump to:

- [Swift Data Center Homepage](#)
- [Swift Data Processing](#)
- [Swift Data Flow Diagram](#)
- [SDC Processing Progress](#)
- [Swift As-Flown Timeline](#)
- [Expected Malindi Contacts](#)

Instructions:

- Click on a sequence number to access data for that sequence.
- Click on a column header to sort the table by that column.
- Rows with a gray background have been replaced by a more recent reprocessing.
- After one week the data are archived at HEASARC, ISAC, and UKDC and removed from this list.
- The columns are described at the bottom of the table.

Please note that Quick Look data is by its very nature preliminary, and should be treated with caution.

Check out the [Quick Look status page](#) for a list of current known problems.

Sequence	Vers	Object	Observed	Processed	Comment
00020079001	001	GRB Discovered Elsewhere	2008-07-23T17:04:01	2008-07-23T18:51:59	new data moc2008-07-23T180802
00030296053	003	IGRJ16479	2008-07-17T13:25:01	2008-07-23T11:00:00	FINAL FOR ARCHIVE
00030296055	001	IGRJ16479	2008-07-21T02:10:01	2008-07-21T10:19:30	new data moc2008-07-21T091702
00030334031	012	WPVS007	2008-06-18T23:59:01	2008-06-25T04:47:50	FINAL FOR ARCHIVE
00030334032	004	WPVS007	2008-07-19T15:25:01	2008-07-20T01:17:58	new data moc2008-07-19T205602
00030707011	002	IGRJ08408-4503	2008-07-17T22:25:00	2008-07-23T10:45:26	FINAL FOR ARCHIVE

Swift Quicklook Area

Observation ID
(000 for GRB
prompt
emission)

Target ID
is matched
to the
source

00317508003	010	GRB080721	2008-07-23T00:37:00	2008-07-23T18:05:08	new data moc2008-07-23T164201
00317508003	011	GRB080721	2008-07-23T00:37:00	2008-07-23T18:40:59	new data moc2008-07-23T171808
00317508990	007	GRB080721 (TDRSS only)	2008-07-21T10:10:18	2008-07-21T16:33:59	1st day TDRSS ONLY moc2008-07-21T160102
00317508991	006	GRB080721 (XRT only)	2008-07-21T10:09:19	2008-07-21T16:36:11	1st day XRT ONLY moc2008-07-21T160102
00317508992	006	GRB080721 (UVOT only)	2008-07-21T10:09:19	2008-07-21T16:53:46	1st day UVOT ONLY moc2008-07-21T160102
00317662000	005	Burst (274.490, -6.899) ●	2008-07-23T04:03:27	2008-07-23T14:12:08	new data moc2008-07-23T125802
00317662001	002	Burst (274.490, -6.899)	2008-07-23T11:10:01	2008-07-23T15:12:51	new data moc2008-07-23T143901
00317662002	001	GRB080723	2008-07-23T14:04:00	2008-07-23T17:36:44	new data moc2008-07-23T164201
00317662002	002	GRB080723	2008-07-23T14:04:00	2008-07-23T19:01:15	new data moc2008-07-23T180802
00317662990	003	Burst (274.490, -6.899)	2008-07-23T04:04:26	2008-07-23T13:33:58	1st day TDRSS ONLY moc2008-07-23T125802
00317662991	005	Burst (274.490, -6.899)	2008-07-23T04:03:27	2008-07-23T13:38:12	1st day XRT ONLY moc2008-07-23T125802
00317662992	005	Burst (274.490, -6.899)	2008-07-23T04:03:27	2008-07-23T14:02:27	1st day UVOT ONLY moc2008-07-23T125802

Column Descriptions:

Sequence

A unique identifier for each data set. The first eight digits identify the target and the last three digits distinguish different observations of the same target.

Vers

The number of times a sequence has been processed. The SDC reprocesses a sequence when new data have arrived from the satellite and to correct bugs in the processing script.

Object

The intended target of the observation.

Observed

The date and time of the start of the observation. This corresponds to the time of the first piece of data currently available. The format is yyyy-mm-ddTHH:MM:SS.

Processed

The date when the sequence was processed (yyyy-mm-dd).

Comment

The reason the sequence was reprocessed. Usually this is because new data were received from the Mission Operations Center (MOC).

Avoid "TDRSS only"
for analysis

If you have a question about Swift, please contact us via the [Feedback form](#).

This page was last modified on Friday, 22-Dec-2006 07:21:58 EST.

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Swift PI: [Neil Gehrels](#),
Responsible NASA Official: [Phil Newman](#)
Web Curator: [J.D. Myers](#)
PAO Contact: [Susan Hendrix](#) (301-286-1707)

[Privacy Policy and Important Notices](#).

July 29, 2008

HEASARC/ ISAC/UKDC

Also download
Swift software

Check this out!

Permanent data
archive (Swift data
after 7 days)
-- Searchable
-- Use for older
bursts and other
astrophysics
targets

July 29, 2008

The screenshot shows the HEASARC website homepage. At the top, there are logos for NASA Goddard Space Flight Center and the Smithsonian Astrophysical Observatory. A search bar is located in the top right. Below the logos is a navigation menu with tabs for HEASARC HOME, OBSERVATORIES, ARCHIVE, CALIBRATION, SOFTWARE (highlighted with an orange circle), TOOLS, and STUDENTS / TEACHERS / PUBLIC. A table of data is visible in the background. Below the navigation menu is a banner for "NASA's High Energy Astrophysics Science Archive Research Center". Underneath the banner are tabs for ABOUT THE HEASARC, RESOURCES FOR SCIENTISTS, FAQ/HELP, SITE MAP, and OTHER ARCHIVES. On the left side, there are sections for "Guest Observer Facilities & Science Centers" and "NASA Archives", both with "Select One" dropdown menus. Below these is a "HEASARC Tip" section with a link to "Our Resources for Scientists". In the center, there is an "Archive Data Search Form" with a search criteria input field and a "More Search Options" link. Below the search form are two image thumbnails: "HEASARC Picture of the Week" and "APOD: Astronomy Picture of the Day". At the bottom right, there is a "Latest News" section with several news items, including "Changes to the organization of AO-7 and beyond", "Suzaku long term schedule 2008 Aug-Dec", "General CALDB updated", "Suzaku CALDB updated", and "Chandra Cycle 10 Peer Review Recommended Proposals/Targets". There is also an RSS feed icon and a link to "What is this?".

Very cool sites

Special Swift Browse interface (not available at the ASDC)

HEASARC HOME SWIFT HOME ARCHIVE DATA ANALYSIS PROPOSALS & TOOLS EDUCATION & PUBLIC INFO

Swift: Catching Gamma-Ray Bursts on the Fly

U.S. site
Italian site
U.K. site

ABOUT SWIFT QUICKLOOK DATA GCN SWIFT RESULTS SWIFT OPERATIONS RELATED SITES GALLERY

[Browse Home](#) Browse: Swift Mission [Swift Interface Help](#) [Tip Archive](#) [Hera](#) [HELP](#) **Latest News**

[HEASARC News](#)

Pull down menu to select a Swift GRB. Coordinates or Target id will appear in the form below. Not all data are available. The [Data Caveat](#) provides the latest availability information

Display Bursts By Year Display By Month Select Burst

HEASARC Archive Search [Data Caveat](#)

Target id: (e.g. 100001)
Observation id: (e.g. 00100001000)
Object Name Or Coordinates:
Observation Dates:

Search Type **Radius:**
 BAT FOV beta test, Master Log only

Master Log [parameter search form](#)
 BAT Log [parameter search form](#)
Observation Logs: **UVOT Log** [parameter search form](#)
 XRT Log [parameter search form](#)
 TDRSS Log [parameter search form](#)

Query the HEASARC SWIFT tables using parameters set above

Remote Site Searches

NVO Search will be by coordinates if available GCN Search will be by object name if available
Searches are based on values from Archive Search Form above

July 29, 2008

For searching BAT field of view

HEASARC HOME SWIFT HOME ARCHIVE DATA ANALYSIS PROPOSALS & TOOLS EDUCATION & PUBLIC INFO

Swift: Catching Gamma-Ray Bursts on the Fly

U.S. site
Italian site
U.K. site

ABOUT SWIFT QUICKLOOK DATA GCN SWIFT RESULTS SWIFT OPERATIONS RELATED SITES GALLERY

Browse Home Browse: Swift Mission Swift Interface Help Tip Archive Hera HELP

Latest News

HEASARC News

Pull down menu to select a Swift GRB. Coordinates or Target id will appear in the form below.
Not all data are available. The [Data Caveat](#) provides the latest availability information

Display Bursts By Year [v] Display By Month [v] Select Burst [v]

HEASARC Archive Search [Data Caveat](#)

Target id: [] (e.g. 100001)

Observation id: [] (e.g. 00100001000)

Object Name Or Coordinates: Swift J1753.5-0127 [2000 v]

Observation Dates: 2008-07-01..2008-07-10

Search Type

Radius: Default [] arcmin [v]

BAT FOV beta test, Master Log only

Master Log [parameter search form](#)

BAT Log [parameter search form](#)

Observation Logs: UVOT Log [parameter search form](#)

XRT Log [parameter search form](#)

TDRSS Log [parameter search form](#)

Start Search Query the HEASARC SWIFT tables using parameters set above Reset

Click this button

Remote Site Searches

NVO Search Query GCN

NVO Search will be by coordinates if available GCN Search will be by object name if available

Searches are based on values from Archive Search Form above

July 29, 2008

Results of BAT FOV search

Table Legend:

- 🔍 Display all parameters for a row
- ⬇️ Sort by a column in order: 1,2,3 ⬆️ Sort by column in reverse order: 3,2,1 ⬇️/⬆️ Current table sort
- Services links: O: Digitized Sky Survey image, R: ROSAT All-Sky Survey image, N: NED objects near coordinates, S: SIMBAD objects near coordinates, D: get list of data products, H: analyze data products
- G: GRB Coordinate Network (GCN) notices, F: FOV plot for observation
- Scroll down below tables to select Data Products and Further Actions.

Search distance tells only part of the story.

Multiple targets on a day

Swift Master Catalog (swiftmastr)

Search radius used: 10800.00'


Select	Related Links	Services	name	obsid	ra	dec	start time	processing date	xrt exposure	uvot exposure	bat exposure	archive date	Search Offset
<input type="checkbox"/> All			↕	↕	↕	↕	↕	↕	↕ [s]	↕ [s]	↕ [s]	↕	['] from (target)
<input type="checkbox"/>	UVOT XRT	O R N S D H	SWIFTJ1535.9+1431	00037387001	15 35 43.77	+14 32 46.4	2008-06-28 23:59:34	2008-07-05	9871.85000	10322.99600	10601.00000	2008-07-05	259.305 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ19405-3016	00036657009	19 40 33.48	-30 18 19.2	2008-06-29 02:05:01	2008-07-05	406.16500	403.59500	784.00000	2008-07-06	2305.906 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	SWIFTJ1711.7-0732	00037189003	17 11 42.92	-07 31 45.3	2008-06-29 02:14:00	2008-07-05	279.29500	237.67100	364.00000	2008-07-06	722.813 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	UVOT XRT	O R N S D H	SDSSJ154831.6+112149.0	00037933001	15 48 22.48	+11 23 43.2	2008-06-30 14:30:01	2008-07-06	2652.13900	2522.94100	2758.00000	2008-07-07	2018.204 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	XRT	O R N S D H	WR86offset3	00057013001	17 18 20.49	-34 21 24.9	2008-06-30 18:18:00	2008-07-06	123.21500	0.00000	300.00000	2008-07-07	2034.882 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	UVOT XRT	O R N S D H	WR86offset3	00057013002	17 18 24.46	-34 25 23.7	2008-06-30 18:23:00	2008-07-06	698.20600	691.14700	562.00000	2008-07-07	2038.287 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	XRT	O R N S D H	WR86offset4	00057014001	17 18 16.44	-34 18 59.1	2008-06-30 19:54:01	2008-07-06	123.21200	0.00000	300.00000	2008-07-07	2033.536 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	UVOT XRT	O R N S D H	WR86offset4	00057014002	17 18 21.40	-34 24 16.8	2008-06-30 19:59:00	2008-07-06	698.20400	690.37400	562.00000	2008-07-07	2037.386 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	UVOT XRT	O R N S D H	SWIFTJ1753.5-0127	00030090051	17 53 29.81	-01 25 26.8	2008-06-30 21:24:24	2008-07-06	1993.19000	1988.98200	2022.00000	2008-07-07	1.744 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ18410-0535	00030988047	18 40 57.11	-05 34 39.9	2008-06-30 21:48:04	2008-07-06	57.31100	58.39700	77.00000	2008-07-07	752.571 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	Gal.Center	00035650111	17 45 27.09	-29 02 29.4	2008-07-01 00:20:01	2008-07-07	1248.87000	1213.00300	1384.00000	2008-07-08	1659.307 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ19405-3016	00036657010	19 40 31.63	-30 18 31.4	2008-07-01 03:53:01	2008-07-07	210.60500	211.76600	228.00000	2008-07-08	2305.758 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	V2491Cyg	00031194050	19 43 01.84	+32 21 44.2	2008-07-01 07:09:01	2008-07-07	2798.40200	2801.80000	2234.00000	2008-07-08	2555.575 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	SDSSJ164238.7+272637.3	00037960002	16 42 32.12	+27 26 54.6	2008-07-01 13:03:01	2008-07-07	839.41200	814.51600	557.00000	2008-07-08	2013.648 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	AXJ1719.3-3703	01036146003	17 19 15.08	-36 59 21.3	2008-07-01 13:41:01	2008-07-07	1688.89300	1690.50900	1779.00000	2008-07-08	2184.205 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	SN2008cg	00131229001	15 54 07.28	+10 59 36.6	2008-07-02 00:24:01	2008-07-08	7058.87000	6906.26800	7159.00000	2008-07-09	1930.578 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	RXSJ171824.2-402934	00050056017	17 18 08.44	-40 29 33.4	2008-07-02 00:56:00	2008-07-08	2054.57000	2052.16800	2045.00000	2008-07-09	2391.190 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	Gal.CenOff2	00037156069	17 44 44.77	-29 14 15.9	2008-07-02 21:48:01	2008-07-08	623.75900	623.65800	642.00000	2008-07-09	1671.771 (Swift J1753.5-0127)
<input checked="" type="checkbox"/>	UVOT XRT	O R N S D H	SWIFTJ1753.5-0127	00030090052	17 53 34.16	-01 29 03.6	2008-07-03 08:33:01	2008-07-09	1909.23000	1903.75300	1940.00000	2008-07-10	2.407 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	V2491Cyg	00031194051	19 43 01.30	+32 21 56.8	2008-07-03 10:34:01	2008-07-09	2059.25200	2059.85800	2112.00000	2008-07-10	2555.651 (Swift J1753.5-0127)

Only a few are at the center of the BAT FOV

The BAT hard X- ray transient monitor

Results currently
available through
Swift web site --
will be placed in
the HEASARC

July 29, 2008




GODDARD
SPACE FLIGHT CENTER

[+ Swift Help/FAQ](#)
[+ Swift What's New](#)
[+ NASA Homepage](#)


Search the Swift site:


HEASARC Quick Links
--- Quick Links ---


HEASARC HOME
SWIFT HOME
ARCHIVE
DATA ANALYSIS
PROPOSALS & TOOLS
STUDENTS / TEACHERS / PUBLIC



Swift: Catching Gamma-Ray Bursts on the Fly


U.S. site


Italian site


U.K. site

ABOUT SWIFT
QUICKLOOK DATA
GCN
SWIFT RESULTS
SWIFT OPERATIONS
RELATED SITES
GALLERY

Swift/BAT Hard X-ray Transient Monitor

Please Read Before Using These Results: [README](#)

All light curves on one page (except flare stars): [Monitored Sources](#)
 Flare stars light curves: [Flare Stars](#)
 MOJAVE radio sources light curves: [MOJAVE](#)
 Calibration Pointings: [Blank sky locations](#)

Data current through 15:35 UT, July 23 (DOY 205), 2008

This page was last modified on Wed Jul 23 21:47:33 UTC 2008 (6.20194 hours later)

Swift/BAT Transient Sources

	Source Name	RA J2000 Degs	Dec J2000 Degs
1	QSO B0003-066	1.55789	-6.39315
2	QSO B0007+107	2.62919	10.9749
3	QSO B0016+73	4.94078	73.4583
4	V709 Cas	7.20362	59.2894
5	IGR J00291+5934	7.26300	59.5720
6	QSO B0033+595	8.96929	59.8346
7	IGR J00370+6122	9.25000	61.3670
8	Zeta And	11.8346	24.2672
9	NGC 262	12.1964	31.9570
10	QSO B0048-09	12.6722	-9.48478
11	SMC X-3	13.0250	-72.4330
12	CF Tuc	13.2825	-74.6517
13	XTE J0055-727	13.4708	-72.4450
14	Gam Cas	14.1772	60.7167
15	7C 0059+5808	15.6907	58.4031
16	4C 01.02	17.1615	1.58342
17	QSO B0109+224	18.0243	22.7441
18	AY Cet	19.1513	-2.50028

Currently 541
sources listed
-- BAT
detects or has
detected
around 125 of
these

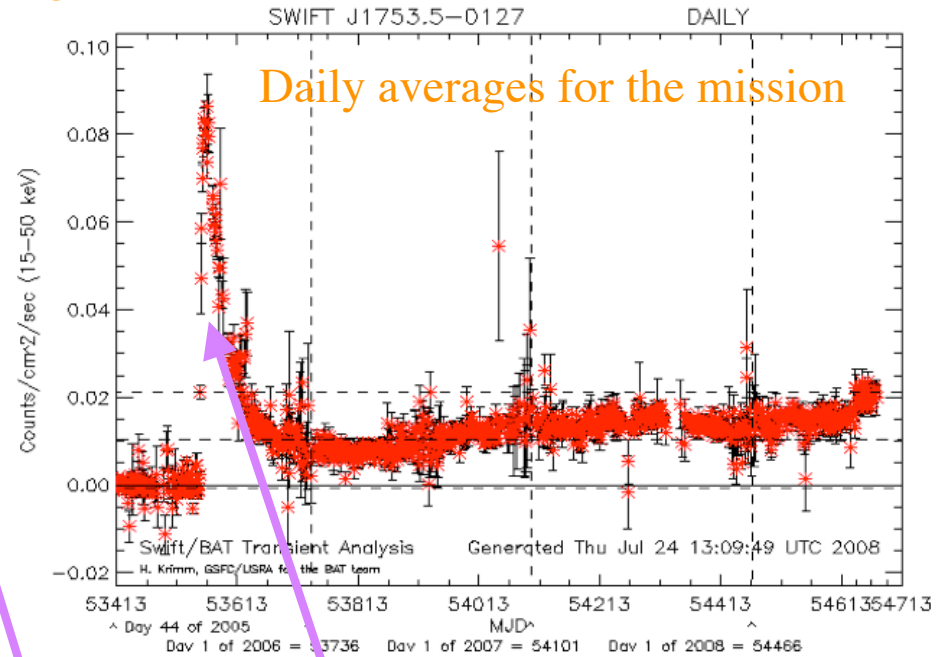
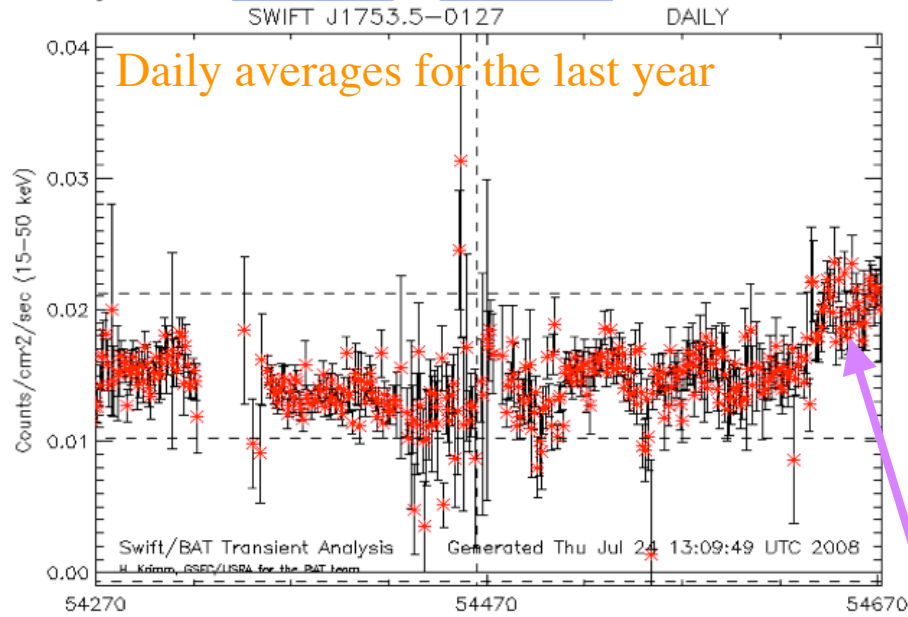
BAT transient monitor page for Swift J1753.5-0127

Back to [Main page](#)

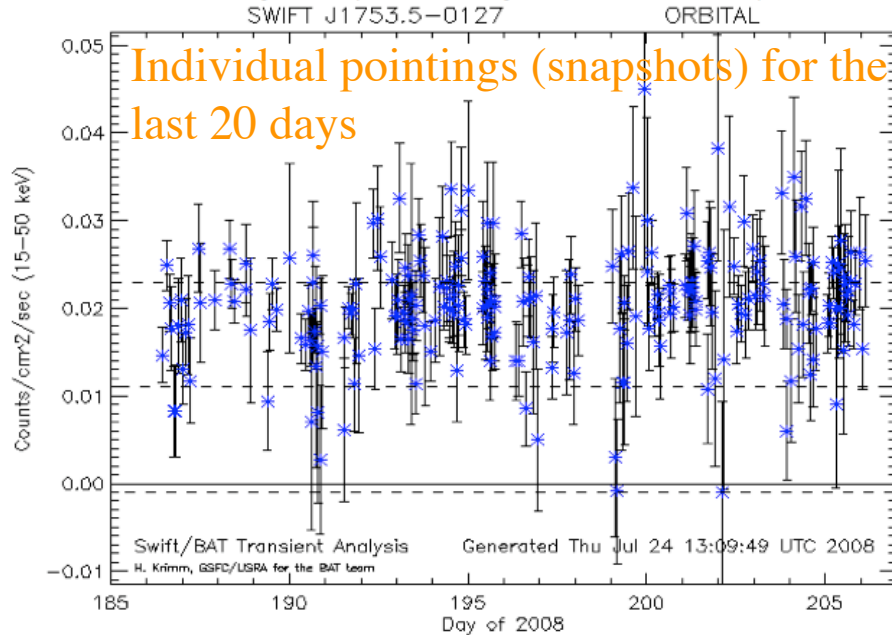
Daily light curves: [FITS version](#) or [ASCII version](#)

Orbital light curves: [FITS version](#) or [ASCII version](#)

← Links to the light curves



Dashed lines show average rate (and +/- 1 sigma standard deviation) for this source (derived from this plot)



Discovery (before the monitor) Atel #546

Recent enhanced activity Atel #1599

Black hole candidate

Text light curve for Swift J1753

Time in Swift MET
(use Xtime to convert)

Pointing duration

Dither flag

Rate and errors in
15-50 keV band

Partial coding
fraction

```
# Swift-BAT single pointing light curve for SWIFT J1753.5-0127
# Generated Thu Jul 24 13:09:49 UTC 2008
#
#
```

TIME	RATE	ERROR	YEAR	DAY	MJD	TIMDEL	STAT_ERR	SYS_ERR	PCODEFR	DATA_FLAG	DITHER_FLAG
s	count/cm ² /s	count/cm ² /s	yr	d	d	s	count/cm ² /s	count/cm ² /s			
129944584.00	0.01476569	0.00646714	2005	43	53413	1472.00	0.00584670	0.00067922	0.17578125	0	1
129946208.00	0.00174295	0.00323271	2005	44	53414	448.00	0.00293792	0.00008018	0.81250000	0	1
129949528.00	0.00987962	0.00538321	2005	44	53414	480.00	0.00487636	0.00045446	0.56250000	0	1
129950088.00	-0.00708218	0.00607224	2005	44	53414	1728.00	0.00551227	-0.00032578	0.17578125	0	1
129951968.00	-0.00102799	0.00381393	2005	44	53414	320.00	0.00346694	-0.00004729	0.81250000	0	1
129955688.00	-0.00444743	0.01493197	2005	44	53414	88.00	0.01357325	-0.00020458	0.56250000	0	1
129955848.00	0.00030805	0.00585557	2005	44	53414	1776.00	0.00532323	0.00001417	0.17578125	0	1
129957792.00	-0.00506692	0.00349946	2005	44	53414	384.00	0.00317426	-0.00023308	0.81250000	0	1
129961712.00	0.00007814	0.00576341	2005	44	53414	1688.00	0.00523946	0.00000359	0.17578125	0	1
129963552.00	0.00863119	0.00329471	2005	44	53414	448.00	0.00297337	0.00039703	0.81250000	0	1
129967808.00	-0.00298839	0.00706025	2005	44	53414	1368.00	0.00641719	-0.00013747	0.17578125	0	1
129969312.00	-0.00604033	0.00334281	2005	44	53414	448.00	0.00302840	-0.00027785	0.81250000	0	1
129973864.00	0.00492673	0.00899948	2005	44	53414	696.00	0.00817875	0.00022663	0.17578125	0	1
129980896.00	-0.00073199	0.00438535	2005	44	53414	256.00	0.00398657	-0.00003367	0.81250000	0	1
129991528.00	0.01114542	0.01726471	2005	44	53414	288.00	0.01568827	0.00051269	0.17578125	0	1
130002032.00	0.00351086	0.00601954	2005	44	53414	1840.00	0.00547034	0.00016150	0.17578125	0	0
130004048.00	-0.00417589	0.00319554	2005	44	53414	448.00	0.00289978	-0.00019209	0.81250000	0	1
130007800.00	0.00942940	0.00599360	2005	44	53414	1880.00	0.00543444	0.00043375	0.17578125	0	1
130009792.00	-0.00065238	0.00457871	2005	44	53414	192.00	0.00416237	-0.00003001	0.96093750	0	1
130013152.00	0.00508445	0.00559150	2005	44	53414	384.00	0.00507874	0.00023388	0.56250000	0	1
130013624.00	0.00523332	0.00580103	2005	44	53414	1760.00	0.00526912	0.00024073	0.16992188	0	1
130015616.00	0.00181747	0.00285294	2005	44	53414	448.00	0.00259247	0.00008360	0.95312500	0	1
130019424.00	0.00313550	0.00553095	2005	44	53414	1816.00	0.00502643	0.00014423	0.17578125	0	1
130021376.00	0.00355266	0.00288632	2005	44	53414	448.00	0.00261972	0.00016342	0.95312500	0	1
130025184.00	-0.00596877	0.01331533	2005	44	53414	320.00	0.01210227	-0.00027456	0.17578125	0	1

All rates are corrected to what they
would be if the source were on-axis

Matching up observations

Swift Master Catalog (swiftmastr)

Search radius used: 10800.00'

Select	Related Links	Services	name	obsid	ra	dec	start time	processing date	xrt exposure	uvot exposure	bat exposure	archive date	Search Offset
<input type="checkbox"/> All			↕↕	↕↕	↕↕	↕↕	↕↕	↕↕	↕↕ [s]	↕↕ [s]	↕↕ [s]	↕↕	['] from (target)
<input type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ18410-0535	00030988048	18 41 02.25	-05 34 16.2	2008-07-04 13:29:01	2008-07-10	1077.29400	1077.58600	1095.00000	2008-07-11	753.655 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ17391-3021	00030987055	17 39 14.83	-30 20 03.6	2008-07-04 15:27:01	2008-07-10	1046.06800	1047.06900	1066.00000	2008-07-11	1744.697 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	SN2008cg	00031229002	15 54 09.57	+10 59 41.1	2008-07-04 16:29:01	2008-07-10	3542.79000	3511.44800	3624.00000	2008-07-11	1930.082 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	XMMSL1J172700.3+181422	00037852001	17 26 53.54	+18 15 35.6	2008-07-05 00:38:01	2008-07-11	2278.79200	2261.81500	2348.00000	2008-07-12	1246.112 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	V2491Cyg	00031194052	19 43 01.13	+32 20 57.4	2008-07-05 03:58:00	2008-07-11	3805.90800	3730.89000	3879.00000	2008-07-12	2554.902 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H				29 18.9	2008-07-05 10:38:01	2008-07-11	2061.11000	2062.02100	2096.00000	2008-07-12	2390.492 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H				12 11.4	2008-07-05 13:51:01	2008-07-11	10			2008-07-12	1654.073 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H				35 11.8	2008-07-05 15:27:00	2008-07-11	56			2008-07-12	1654.073 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	Gal.Cen(off)	00037994002	17 45 31.05	-28 57 18.4	2008-07-05 21:59:01	2008-07-11	10			2008-07-12	1654.073 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	SWIFTJ1753.5-0127	00030988048	17 53 25.79	-01 26 05.4	2008-07-06 07:28:00	2008-07-12	3283.07000	3194.47400	3317.00000	2008-07-13	1.233 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	Gal.Cen(off)	00037994003	17 45 21.26	-29 00 19.2	2008-07-06 18:28:54	2008-07-12	992.88900	991.08800	1008.00000	2008-07-13	1657.241 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ17544-2619	00035056044	17 54 27.24	-26 18 58.6	2008-07-06 18:48:01	2008-07-12	1237.31100	0.00000	1264.00000	2008-07-13	1491.894 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	V2491Cyg	00031194053	19 42 58.78	+32 22 04.7	2008-07-06 20:15:01	2008-07-12	2783.76000	2743.39600	2819.00000	2008-07-13	2555.385 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	Gal.Cen(off)	00037994004	17 45 22.77	-28 59 40.0	2008-07-07 09:04:01	2008-07-14	1461.76000	1461.45400	1478.00000	2008-07-14	1656.564 (Swift J1753.5-0127)
<input type="checkbox"/>	UVOT XRT	O R N S D H	IGRJ17391-3021	00030987056	17 39 10.11	-30 20 12.4	2008-07-07 10:47:01	2008-07-14	1046.06800	1047.51000	1066.00000	2008-07-14	1744.974 (Swift J1753.5-0127)

Fully coded -- on axis

Half-coded

90% coded

236905064.00	0.02095263	0.00474133	2008	186	54651	1024.00	0.00422030	0.00096382	0.32421875	0	0
236911248.00	0.01311704	0.00404037	2008	187	54652	672.00	0.00363188	0.00060331	0.64843750	0	0
236917008.00	0.01727532	0.00379825	2008	187	54652	880.00	0.00337653	0.00079466	0.64062500	0	0
236922832.00	0.01811257	0.00563464	2008	187	54652	256.00	0.00506609	0.00083318	0.64843750	0	4
236928592.00	0.01170120	0.00489635	2008	187	54652	320.00	0.00442425	0.00053825	0.64062500	0	0
236947208.00	0.02686794	0.00498639	2008	187	54652	1216.00	0.00439164	0.00123593	0.32031250	0	0
236953024.00	0.02062102	0.00682222	2008	187	54652	768.00	0.00614178	0.00094857	0.20507812	0	0
236988080.00	0.02092033	0.00336594	2008	187	54652	1024.00	0.00293222	0.00096234	0.83593750	0	0
237022264.00	0.02671767	0.00326514	2008	188	54653	688.00	0.00275000	0.00122901	1.00000000	0	0
237028024.00	0.02277575	0.00281995	2008	188	54653	1096.00	0.00238010	0.00104768	1.00000000	0	0
237033784.00	0.02070246	0.00247366	2008	188	54653	1408.00	0.00207546	0.00095231	1.00000000	0	0
237061936.00	0.02515696	0.00447663	2008	188	54653	952.00	0.00393134	0.00115722	0.53125000	0	0
237063008.00	0.02223148	0.00315373	2008	188	54653	1216.00	0.00271211	0.00102265	0.89843750	0	0
237074472.00	0.01746104	0.00823628	2008	188	54653	1472.00	0.00745184	0.00080321	0.11523438	0	0
237114360.00	0.00941398	0.00560664	2008	189	54654	1464.00	0.00508172	0.00043304	0.58593750	0	4
237120552.00	0.01843468	0.00329076	2008	189	54654			4800	0.76562500	0	0
237125584.00	0.02274326	0.00290688	2008	189	54654			4619	1.01562500	0	0
237137128.00	0.01986019	0.00245811	2008	189	54654			1357	0.89843750	0	0
237168056.00	0.02577908	0.01079999	2008	190	54655	432.00	0.00975881	0.00118584	0.15429688	0	0
237195520.00	0.01654359	0.00280458	2008	190	54655	960.00	0.00245396	0.00076100	0.83593750	0	0

Can be > 100%

11% coded

Can also use “As-Flown Science Timeline” (AFST) to match up observations

AFST_2008188000_2008189000_00.txt

Begin Obs	End Obs	Target Name	RA	Dec	Roll	Target ID	Seg No	XRT mode	UVOT mode	FOM	Time Observed (s)
2008-188-00:06:02.327480	2008-188-00:06:56.727440	M31_N1	9.9450000	40.968000	59.867000	37710	1	AUTO	0x308F	50	54
2008-188-00:06:58.927900	2008-188-00:48:52.526760	AT	130.26600	-45.069000	335.92300	316063	0	AUTO	0x8000	100	2514
2008-188-00:48:55.927400	2008-188-00:56:00.126820	SWIFT J1626.6-5156	246.60600	-51.963000	226.67900	90043	27	AUTO	0x30ED	99	424
2008-188-00:56:03.143340	2008-188-01:26:00.726780	saa-cold-188-9	212.47800	-75.004000	258.73300	74200	16	AUTO	0x0009	100	1798
2008-188-01:26:02.327440	2008-188-01:42:57.728100	Mkn335	1.6140000	20.194000	56.934000	90006	6	PC	0x30ED	99	1015
2008-188-01:42:59.727400	2008-188-02:25:18.726920	AT	130.24000	-45.074000	335.93400	316063	0	AUTO	0x8000	100	2539
2008-188-02:25:21.927440	2008-188-02:36:01.126840	SWIFT J1626.6-5156	246.61100	-51.968000	228.07200	90043	27	AUTO	0x30ED	99	639
2008-188-02:36:02.127400	2008-188-03:04:00.326740	saa-cold-188-10	230.43600	-79.995000	238.03400	74195	20	AUTO	0x0009	100	1678
2008-188-03:04:02.127320	2008-188-03:15:58.126820	IRXSJ184050.3-834305	280.15300	-83.737000	196.69900	37682	2	AUTO	0x011E	50	716
2008-188-03:16:02.336020	2008-188-03:19:22.326800	M31_N2	10.171000	41.132000	60.099000	37711	1	AUTO	0x308F	50	200
2008-188-03:19:27.326900	2008-188-04:01:46.326800	AT	130.27900	-45.067000	335.91700	316063	0	AUTO	0x8000	100	2539
2008-188-04:01:50.327440	2008-188-04:17:59.526800	SWIFT J1626.6-5156	246.61900	-51.969000	227.70900	90043	27	AUTO	0x30ED	99	969
2008-188-04:18:02.327360	2008-188-04:47:00.526820	saa-cold-188-10	230.42300	-79.992000	238.05300	74195	20	AUTO	0x0009	100	1738
2008-188-04:47:02.128120	2008-188-04:55:51.667040	M31_N2	10.164000	41.129000	61.834000	37711	1	AUTO	0x308F	50	530
2008-188-04:55:55.727520	2008-188-05:38:14.526820	AT	130.26400	-45.069000	335.93500	316063	0	AUTO	0x8000	100	2539
2008-188-05:38:17.127440	2008-188-05:53:01.326820	SN2008bo	275.02000	74.616000	358.73700	31189	47	PC	0x011E	84	884
2008-188-05:53:02.127500	2008-188-05:58:57.333880	saa-cold-187-8	300.01200	60.019000	14.372000	75178	2	AUTO	0x0009	100	355
2008-188-05:59:02.327480	2008-188-06:28:00.126820	saa-cold-188-12	332.34300	45.001000	43.846000	74189	5	AUTO	0x0009	100	1738
2008-188-06:28:02.129140	2008-188-06:32:20.126920	M31_N2	10.164000	41.145000	59.666000	37711	1	AUTO	0x308F	50	258
2008-188-06:32:22.727360	2008-188-07:14:41.326760	AT	130.25900	-45.069000	335.93100	316063	0	AUTO	0x8000	100	2539
2008-188-07:14:44.127420	2008-188-07:28:58.726940	SN2008bo	275.01100	74.616000	357.94800	31189	47	PC	0x011E	84	855
2008-188-07:29:02.127500	2008-188-07:43:01.728460	Swift J1753.5-0127	268.35500	-1.4350000	328.61800	30090	53	WT	0x10EE	80	840
2008-188-07:43:02.327380	2008-188-08:08:46.526760	saa-cold-188-13	20.041000	4.9940000	67.592000	75039	3	AUTO	0x0009	100	1544
2008-188-08:08:49.527400	2008-188-08:51:09.326860	AT	130.24600	-45.067000	335.91600	316063	0	AUTO	0x8000	100	2540
2008-188-08:51:10.928420	2008-188-09:05:00.726840	SN2008bo	274.98700	74.616000	358.80700	31189	47	PC	0x011E	84	830
2008-188-09:05:02.127520	2008-188-09:26:01.726800	Swift J1753.5-0127	268.36200	-1.4340000	328.61400	30090	53	WT	0x10EE	80	1260
2008-188-09:26:02.327480	2008-188-09:45:14.927600	saa-cold-188-14	40.583000	10.002000	69.412000	74999	5	AUTO	0x0009	100	1153
2008-188-09:45:17.528120	2008-188-10:27:35.126820	AT	130.26100	-45.060000	335.91600	316063	0	AUTO	0x8000	100	2538
2008-188-10:27:38.727620	2008-188-10:40:58.927160	SN2008bo	274.97900	74.618000	357.24000	31189	48	PC	0x018C	84	800
2008-188-10:41:02.127360	2008-188-11:07:01.526740	Swift J1753.5-0127	268.35500	-1.4350000	328.61900	30090	53	WT	0x10EE	80	1559
2008-188-11:07:02.327440	2008-188-11:21:44.526800	saa-cold-188-15	60.197000	5.0000000	62.983000	74144	6	AUTO	0x0009	100	882
2008-188-11:21:46.527420	2008-188-12:04:03.527000	AT	130.26400	-45.056000	335.91100	316063	0	AUTO	0x8000	100	2537

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How to choose observations to process

- Use only on-axis for joint BAT/XRT/UVOT (fully coded is not necessarily on-axis!).
- Fine to use $< 100\%$ coded BAT data -- just lose statistics off-axis, but data is otherwise corrected.
- We recommend not using $< 10\%$ coded data unless really necessary.

- How many BAT observations you use depends on how finely you want to sample.

BAT Data Analysis

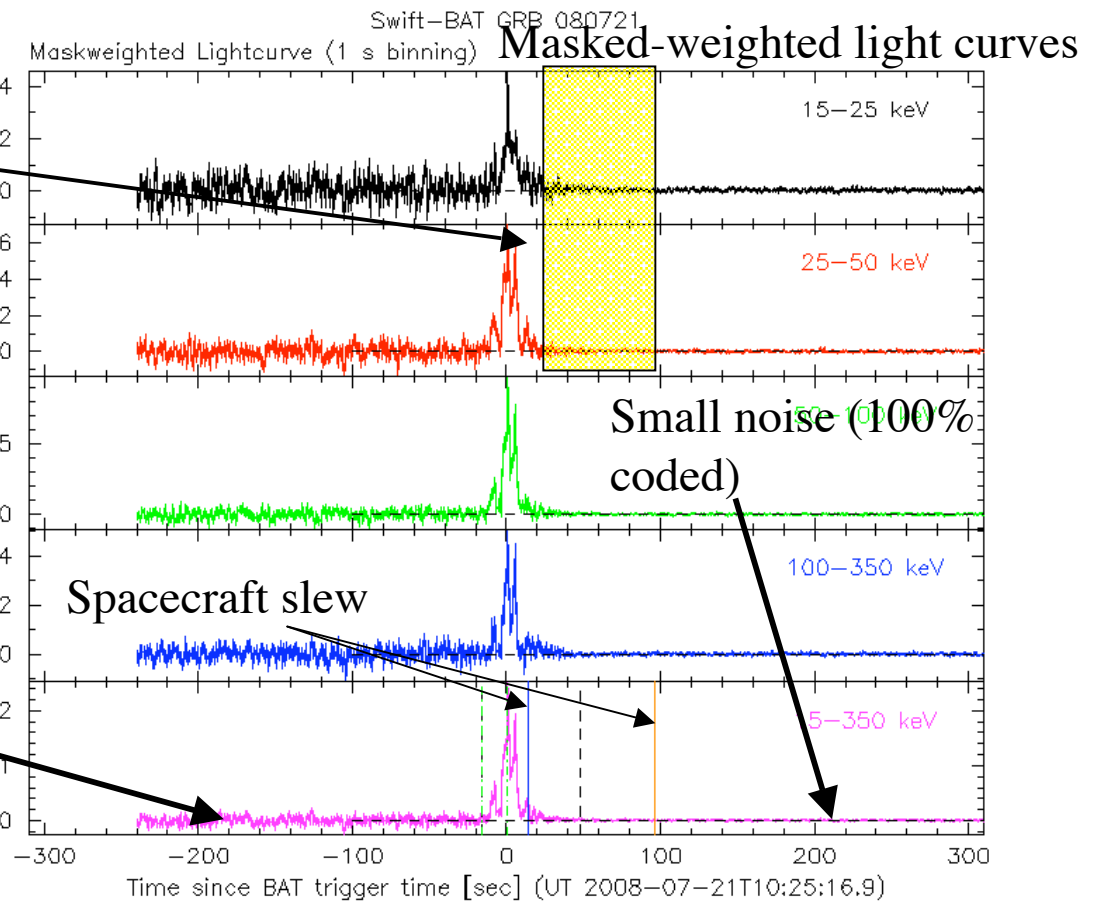
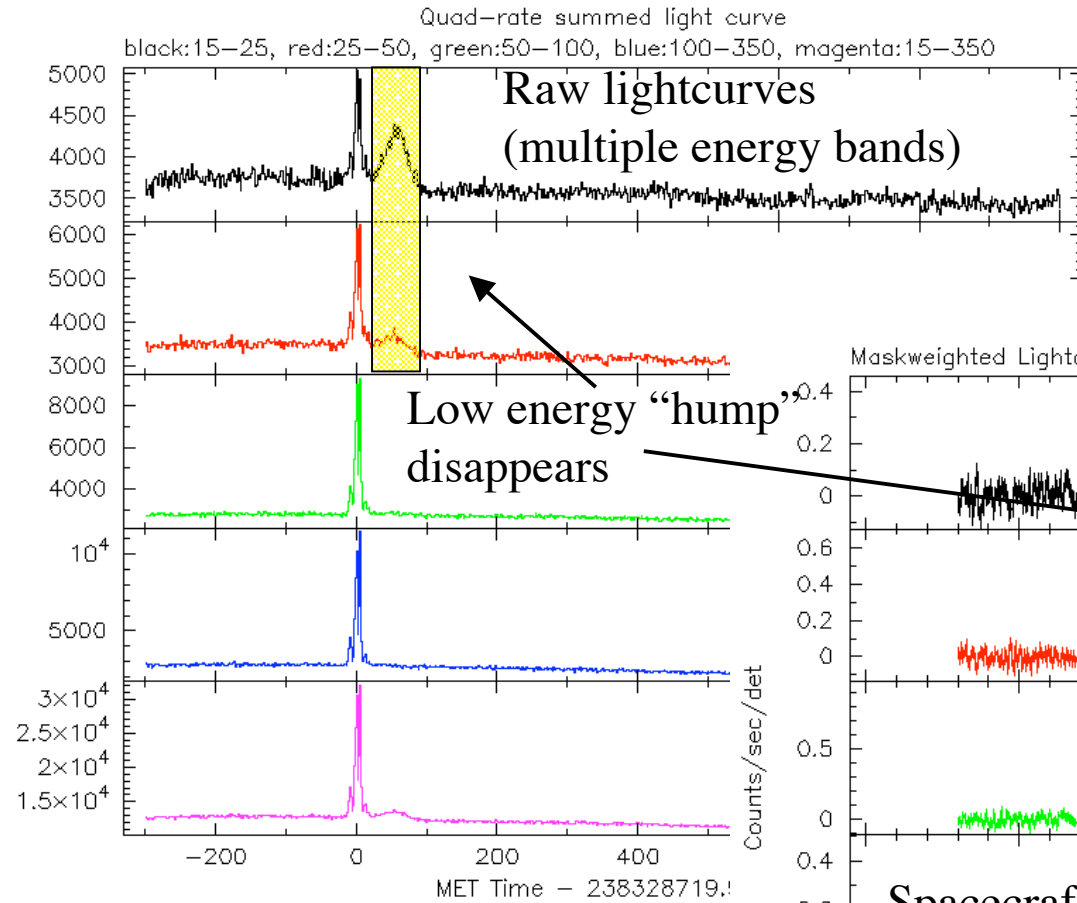
II. How to process the data

BAT Burst analysis

- Download data from archive using special GRB interface
- BAT burst processing is based on event data
- Initial processing using tool “batgrbproduct”
 - Runs a suite of standard Swift-BAT FTools
 - Usage: `batgrbproduct input_directory output_directory`
 - Output:
 - Standard light curves
 - Good-time intervals (total, T_{90} , slew, etc.)
 - Standard spectral files
 - Log file listing ALL of the individual commands run --
easy to use as a template for customized analysis

Advantages of mask-weighting

Mask weighting scales each photon by its "view" to the source -- light curve is tailor-made to the source

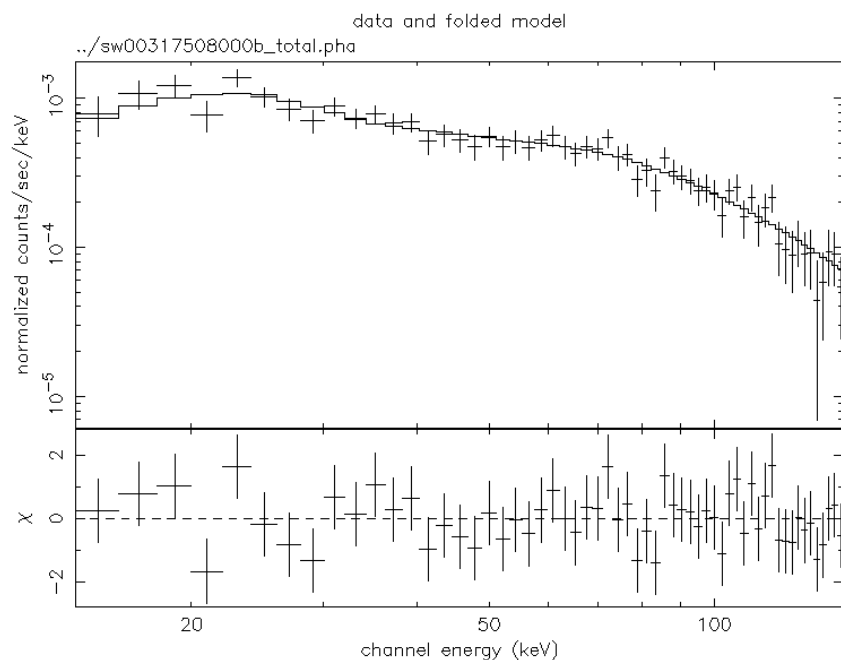


Large noise (4% coded)

GRB 080721

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BAT Spectra



- Recommend fit only 15-150 keV
- Use systematic error vector (batphasyserr)
- Very little absorption above 15 keV -- usually fit to power law, cutoff power law (cutoffpl) or Band (grbm)

No background spectral file needed -- mask weighting removes the background.

For bursts -- can use data during the slew -- but you must be careful since response is a strong function of angular position. Best to derive response for short time intervals and average.

Survey Analysis

- Download data using special Swift interface (as discussed earlier)
- Main tool is “batsurvey” ← Brand new tool in HEASOFT 6.5
 - Runs a suite of standard Swift/BAT Ftools
 - Use an input catalog file (can download from transient monitor page or create your own)
 - Does all of the data screening used in the BAT survey and monitor
 - Produces a separate set of results for each pointing
 - Main output is a catalog with multi-channel rates for each source in the input catalog

Turning Catalogs into Spectra

One more step is necessary before one can fit BAT survey spectra--

Run a script to pull out the multi-channel data from the output catalog and format it for input to xspec. Also derive a response matrix using batdrmgen.

Script is not public, but available for download from

http://swift.gsfc.nasa.gov/docs/swift/results/transients/make_survey_ph

A similar tool will be released as part of the next software release.

A few cautions

- Help file for `batsurvey` recommends against using the results for off-axis sources -- however, if you use `batdrngen` to make a response file for a specific source, off-axis effects are accounted for properly
- Make sure to check the `*_status.txt` file for each pointing to make sure the data was processed properly.
- The `batsurvey` tool takes a long time to run (~1 hour) if there are multiple pointings in an observation.

Conclusions

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Conclusions

- Swift continues to operate well -- ~3.5 year data archive and promise for > 4 more years!
- All data is public, archived and ready for your analysis
- Excellent Swift-only archive interfaces allow ease of retrieving data
- BAT survey data is very rich and largely unmined
- New tools allow for much easier processing of survey data