The Swift Gamma Ray Burst Mission

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NASA-GSFC

San Diego AAS Meeting

January 12, 2005

Swift Papers and Posters at AAS Meeting

Talks - Wednesday 10:00 am Town & Country

116.01	**Gehrels**	**Swift Science & Early Results**
116.02	**Nousek**	**Swift Instruments & Ops**

Talks - Thursday 10:00 am Pacific Salon 1

160.01	**Barthelmy**	**BAT Instrument**
160.02	**Burrows**	**XRT Instrument**
160.03	**Roming**	**UVOT Instrument**

Posters - Wednesday

115.01	**Gronwall**	**UVOT On-orbit Calibration**
115.02	**Hullinger**	**BAT Spectral Response**
115.03	**Ivanushkina**	**UVOT & Gemini Studies of Dark GRBs**

NASA MIDEX Mission selected in 1999

Primary science is to study gamma-ray bursts throughout the Universe

International hardware participation from UK and Italy

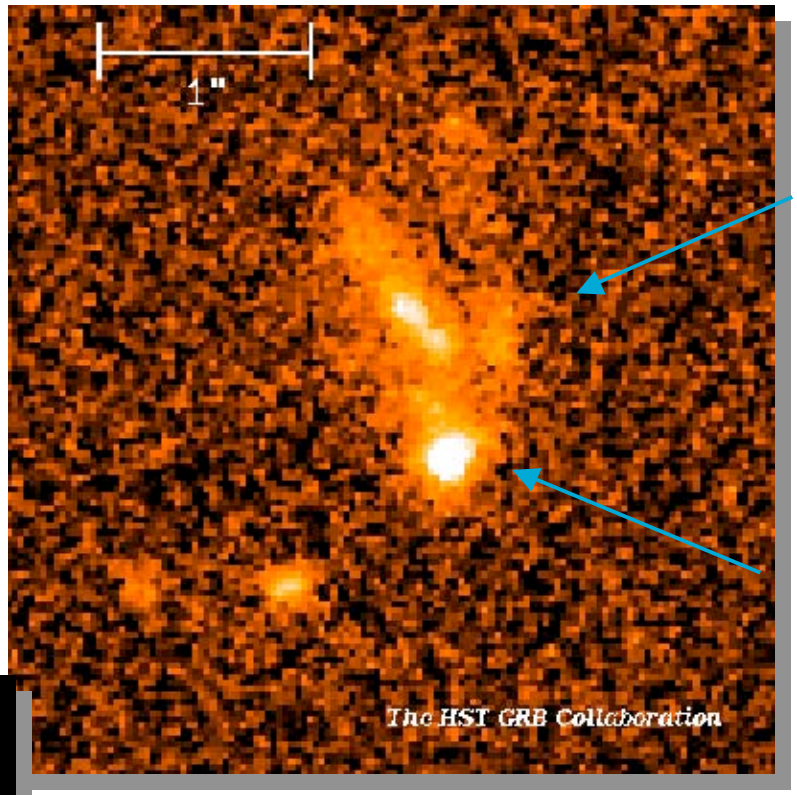
Launch on November 20, 2004

Motivations for Swift

Black Hole Birth

Ultrarelativistic Outflows

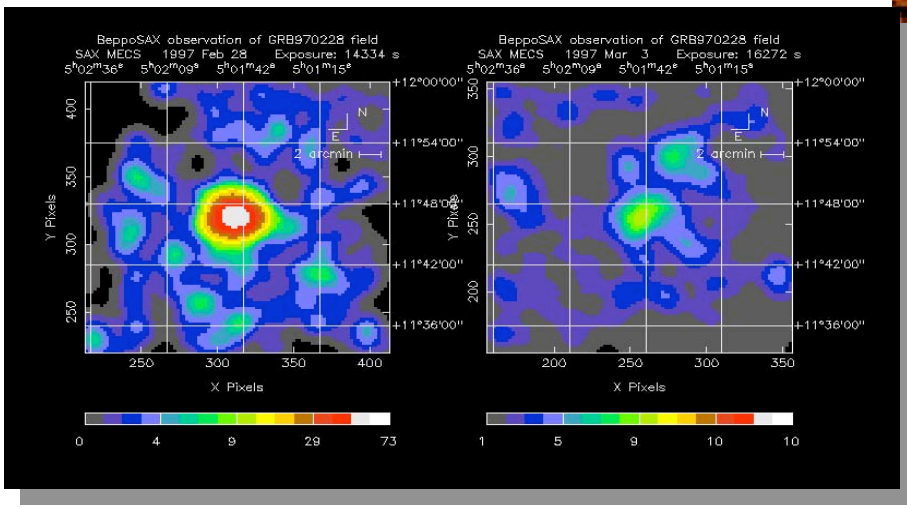
Early Universe Probes



host galaxy

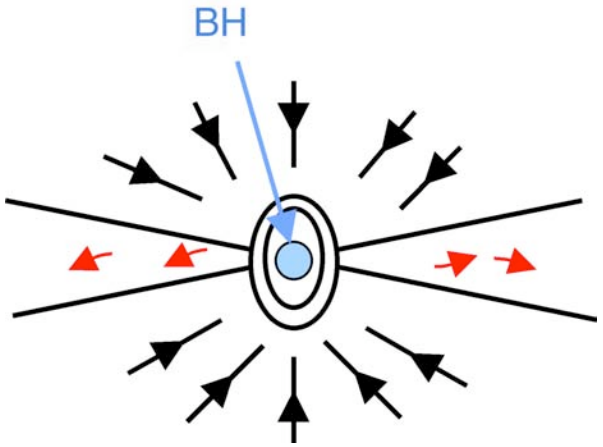
GRB

GRB 970228 - BeppoSAX

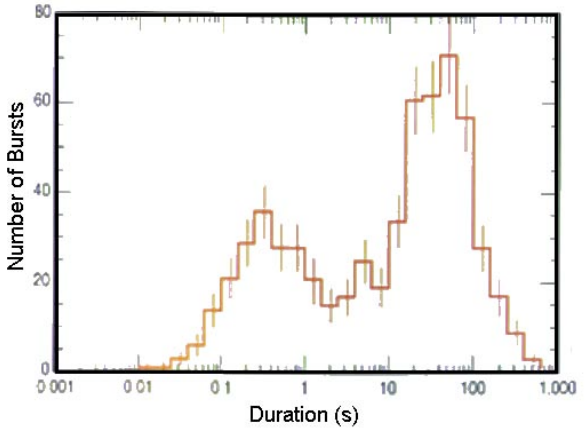


Swift Designed to Answer GRB Key Questions

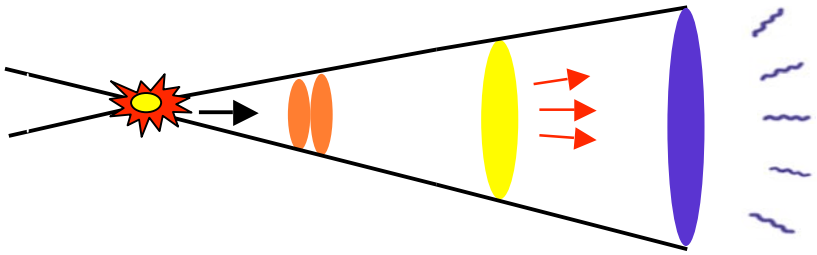
What causes GRBs?



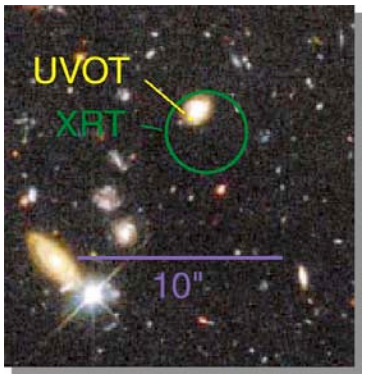
What is the nature of subclasses?



What physics can be learned about BH formation and ultra-relativistic outflows?



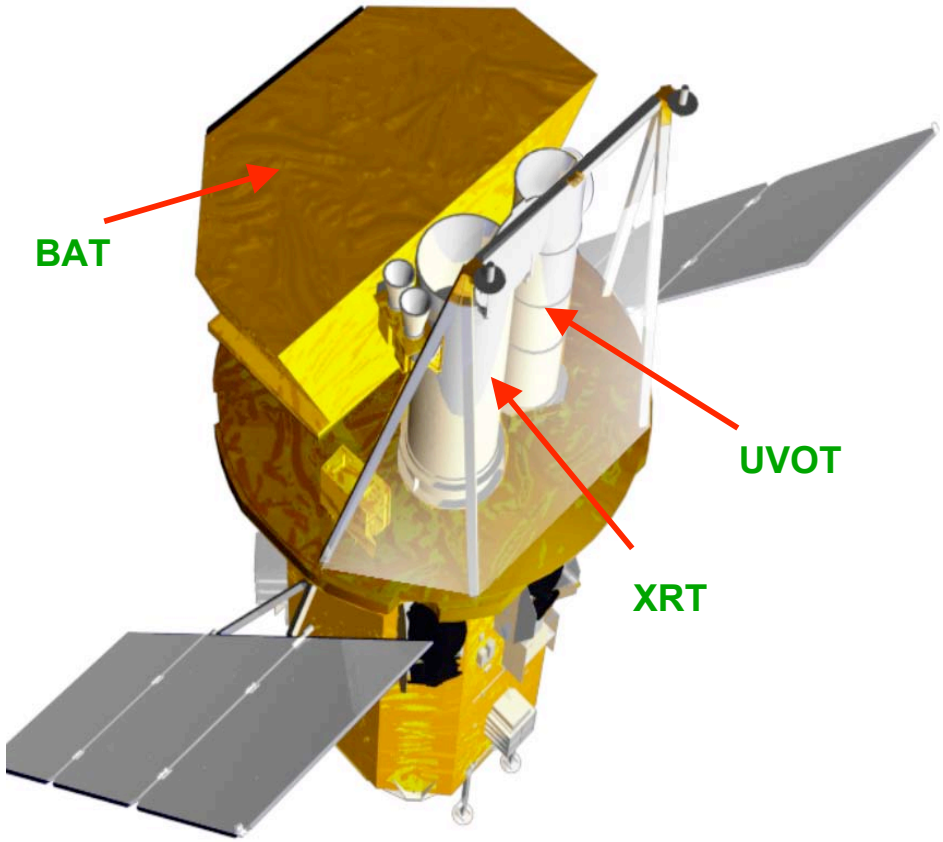
What can GRBs tell us about the early universe?



Swift Instruments

Instruments

- **Burst Alert Telescope (BAT)**
  - **New CdZnTe detectors**
  - **Most sensitive gamma-ray imager ever**
- **X-Ray Telescope (XRT)**
  - **Arcsecond GRB positions**
  - **CCD spectroscopy**
- **UV/Optical Telescope (UVOT)**
  - **Sub-arcsec positions**
  - **Grism spectroscopy**
  - **24th mag sensitivity (1000 sec)**
  - **Finding chart for other observers**



Spacecraft

- **Autonomous re-pointing, 20 - 75 s**
- **Onboard and ground triggers**

Mission Capabilities

Multiwavelength observations on all time scales

>100 GRBs per year of all types

BAT sensitivity 2 - 5 time better than BATSE

Arcsec positions & counterparts for 100's GRBs

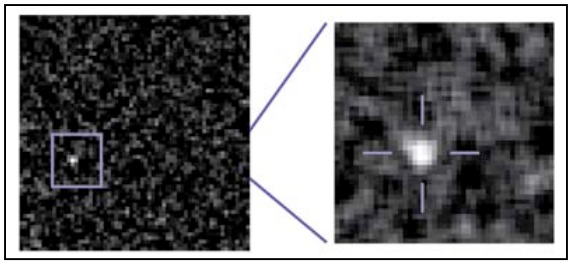
Rapid GRB notifications via GCN

Identification of host galaxies offsets

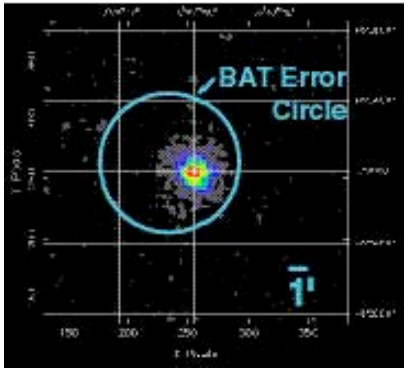
X-ray and UV/optical spectroscopy

Upload capability to slew to GRB and transients detected by other observatories

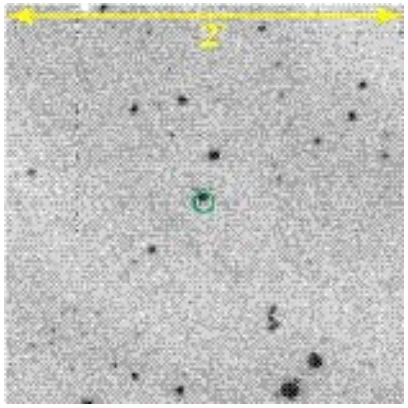
BAT



XRT



UVOT



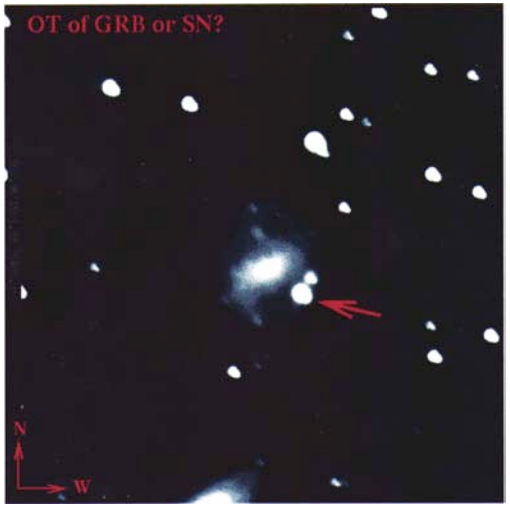
Swift Science - Supernova Connection

- **Supernova-GRB connection**
  - **Connections between SNe Ic and GRB are emerging.**
  - **Swift's rapid subarcsec positions and lightcurve monitoring will allow SN searches on 100's GRBs.**
  - **Questions addressed:**

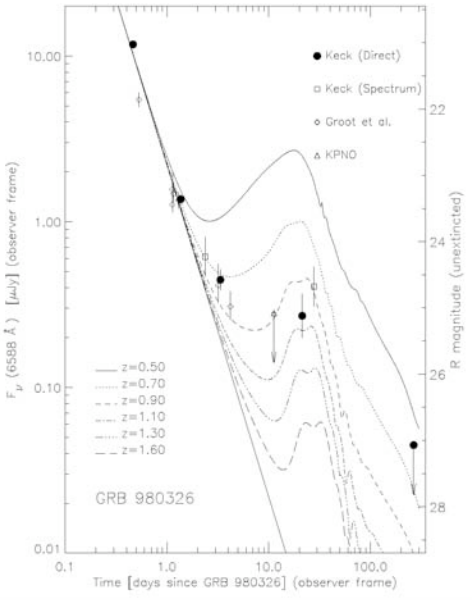
    What fraction and what kinds of GRBs have underlying SN?

    What fraction and what kinds of SN have accompanying GRBs?

SN1998bw - GRB 980425

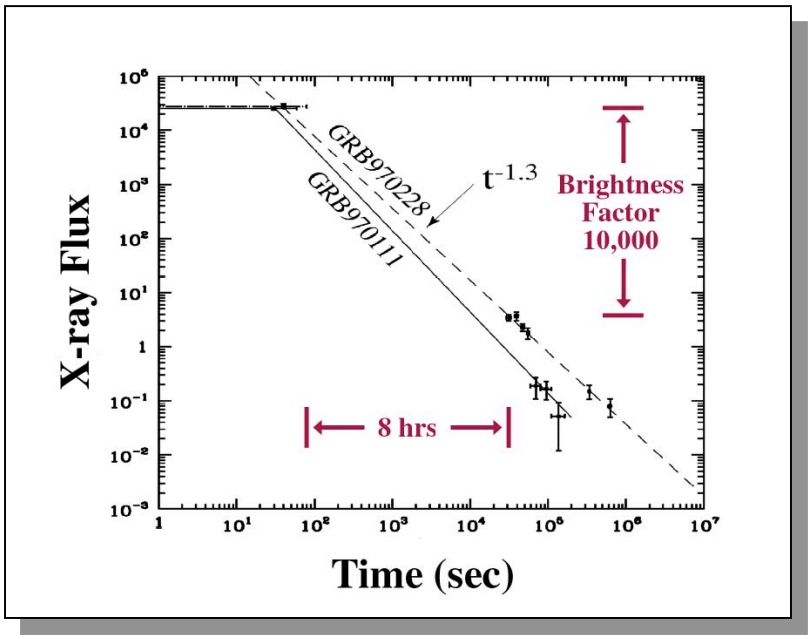


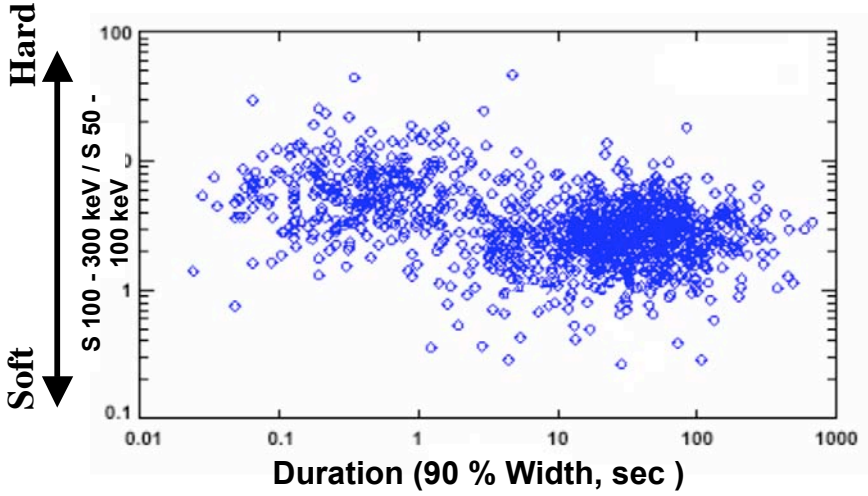
GRB 980326



Swift Science - Classes of GRBs

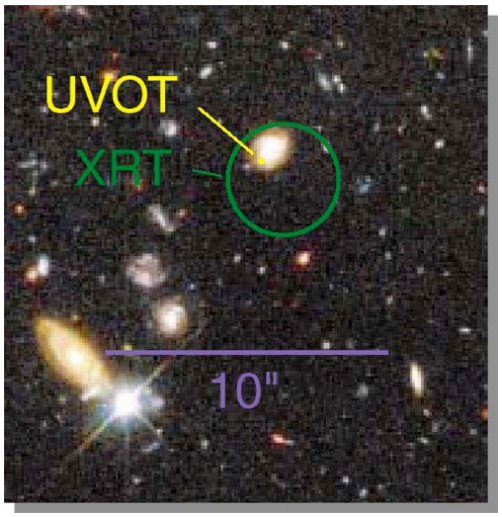
- **Swift sensitive to**
  - **Normal l o n g GRBs**
  - Short **GRBs**
  - **X-Ray Flashes ✲**
  - **Weak GRBs**
  - **U l t r a - l o o o o o n g GRBs**
- **GRBs subclasses - example: short GRBs**
  - **Not understood. No counterparts detected. Appears to be a separate class.**
  - **Non-detection of GRB 020531 indicates afterglow is weak or rapidly declining.**
  - **Swift will perform rapid follow-up observations of ~100 short GRBs**

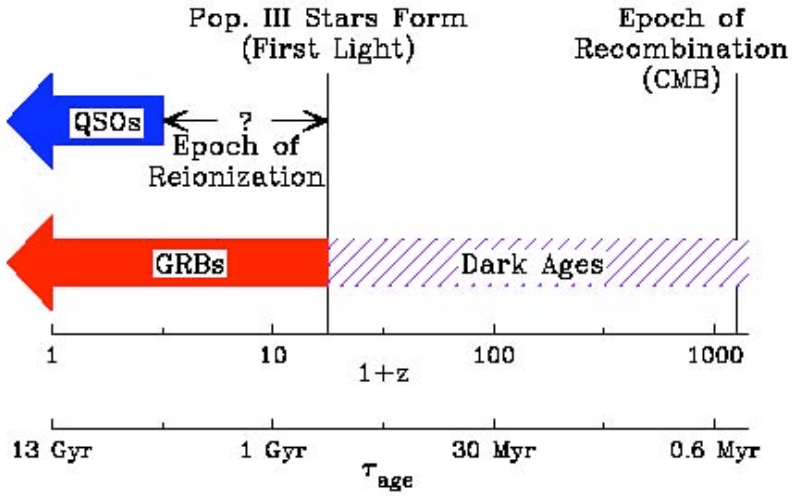




Swift Science - Early Universe

- **Early Universe**
  - **GRBs are the brightest events in universe.**
  - **Afterglow is detectable to z~15 by Swift (3 to15 per year at z>10)**
  - **Topics addressed:**
    - **Epoch of first stars (GRB may be unique probe of Pop III stars)**
    - **Star formation history**
    - **Re-ionization of IGM**
    - **Metallicity history**
    - **Dust and gas content of early galaxies**
    - **Large-scale structure of universe**





Lamb & Reichart (2000)

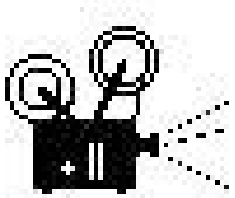
Swift Observatory in Goddard Clean Room

Arrival at KSC

Swift Observatory at KSC


USAF
BOEING
DELTA
NASA


USAF
BOEING
DELTA

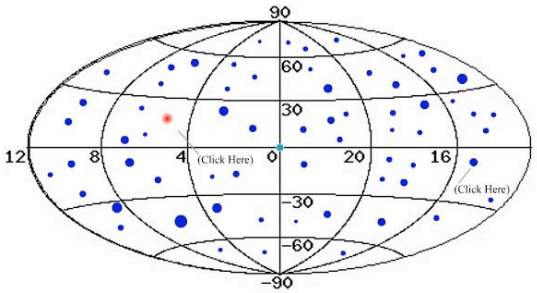


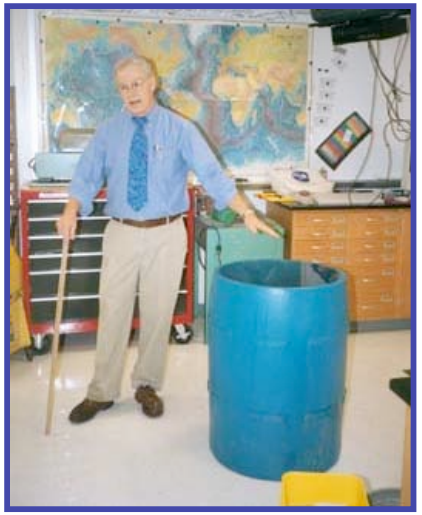
Swift Launch video

Swift Activation

- **Following launch, 1.5 months activation and 3 months verification. Observatory will be fully operational on April 5, 2005**
- **Public data and GI program start after verification phase.**
- **Any GRB reliably detected during verification will be distributed on GCN (non-realtime, after BAT-team checking)**
- **35 proposals selected for Cycle 1 of Guest Investigator program. Cycle 2 proposals due July 2005.**
- **Swift follow-up team coordinated by K. Hurley**
- **EPO team coordinated by L. Cominsky**

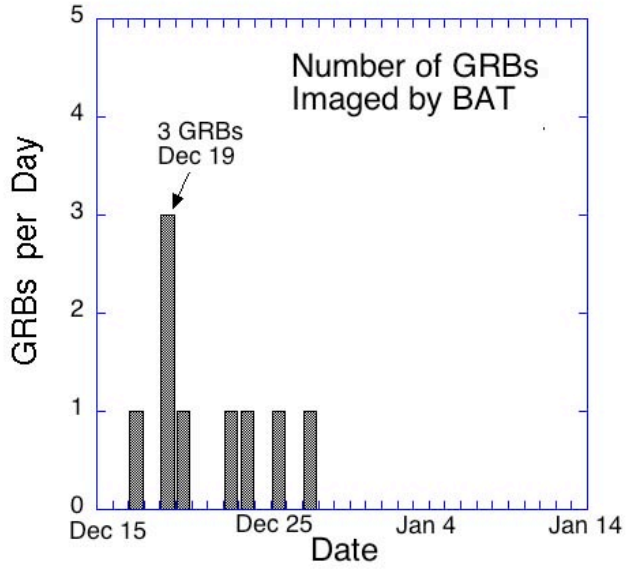
Gamma-ray Burst Alert Portal



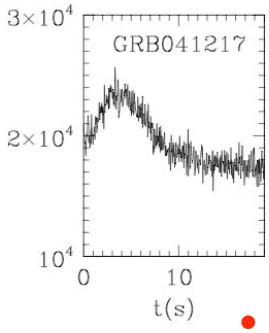


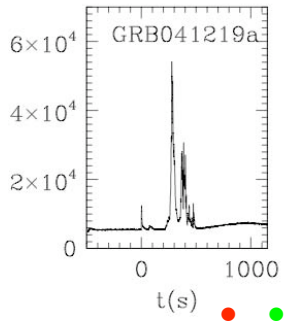
Scientific Findings To Date

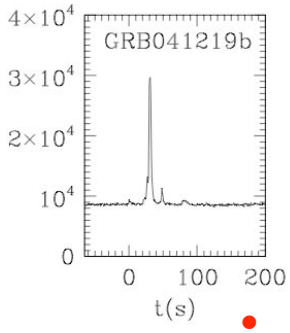
- **9 GRBs detected since Dec. 17**
- **Large GRB detected on Dec. 19 (GRB 041219)**
- **XRT pointed at GRB 041223 via ground command at ~4.5 hours. Afterglow detected.**
- **Giant flare detected from soft gamma repeater SGR 1806-20 on Dec. 27**
- **BAT is performing sensitive monitoring of hard x-ray sky**

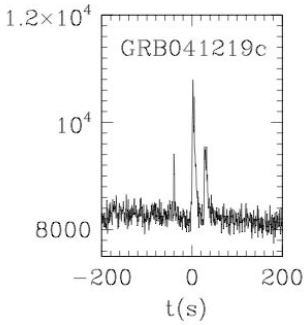


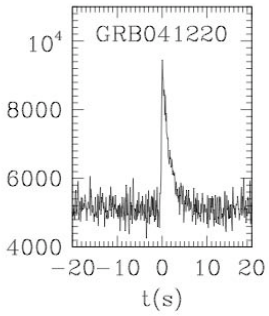
Light Curves of BAT GRBs

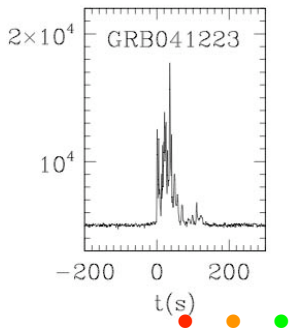


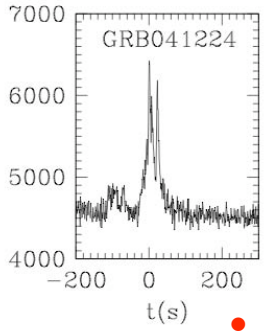


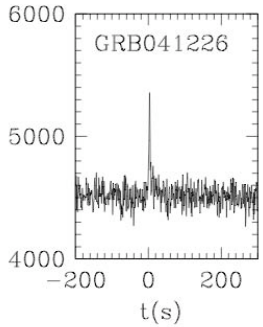


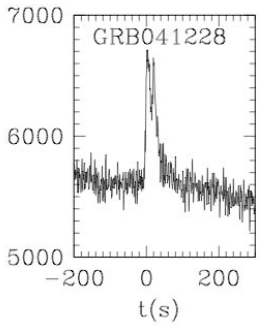






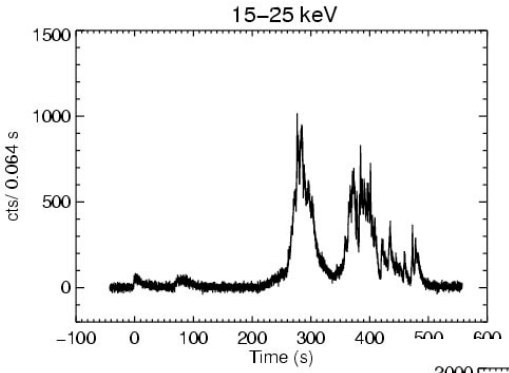


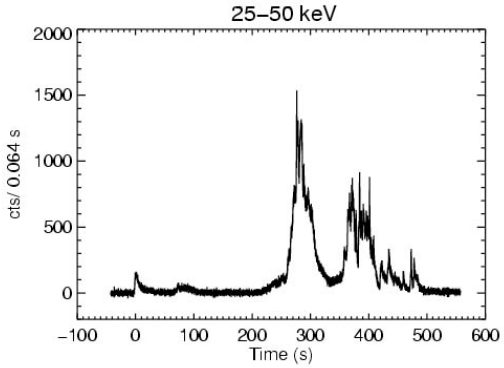




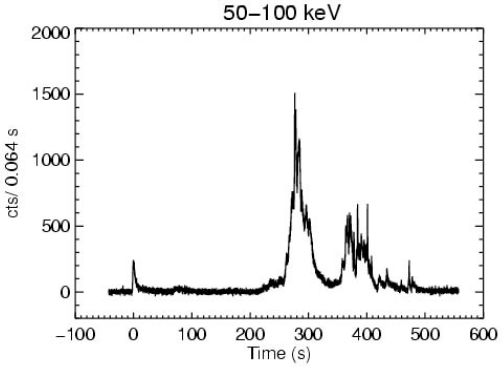
- = detected by other gamma-ray instrument
- = slewed to and imaged by XRT
- = detected by ground-based optical/IR

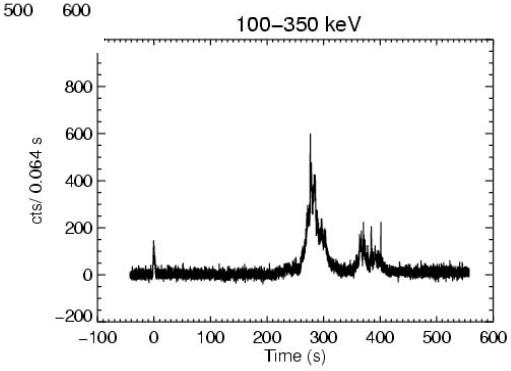
GRB 041219





- Long duration GRB lasting 500 s
- Fluence of ~10^{-4} erg cm^{-2}
- Fluence in top 1% of CGRO/BATSE bursts
- Duration in top 2% of CGRO BATSE bursts
- Imaged by INTEGRAL & Swift

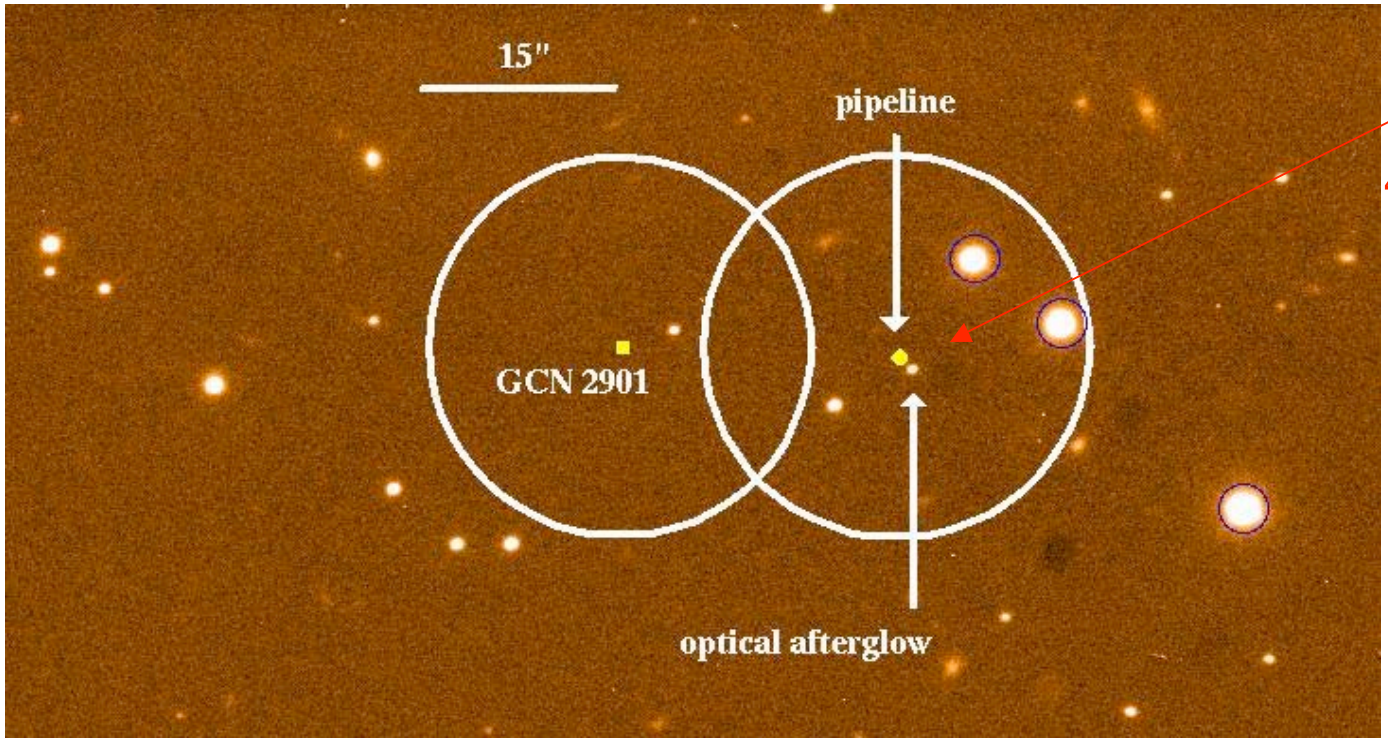




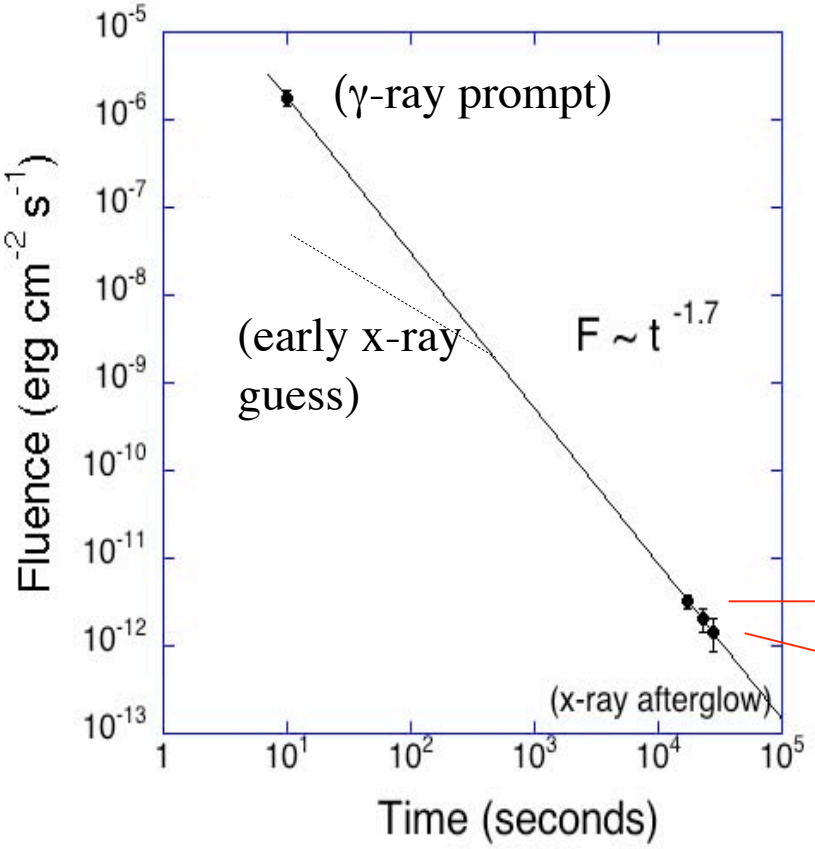
- IR fast-fading counterpart ("flash") discovered at early time
- Real-time (RAPTOR) optical detection
- Radio counterpart
- Campaign underway to determine host and redshift

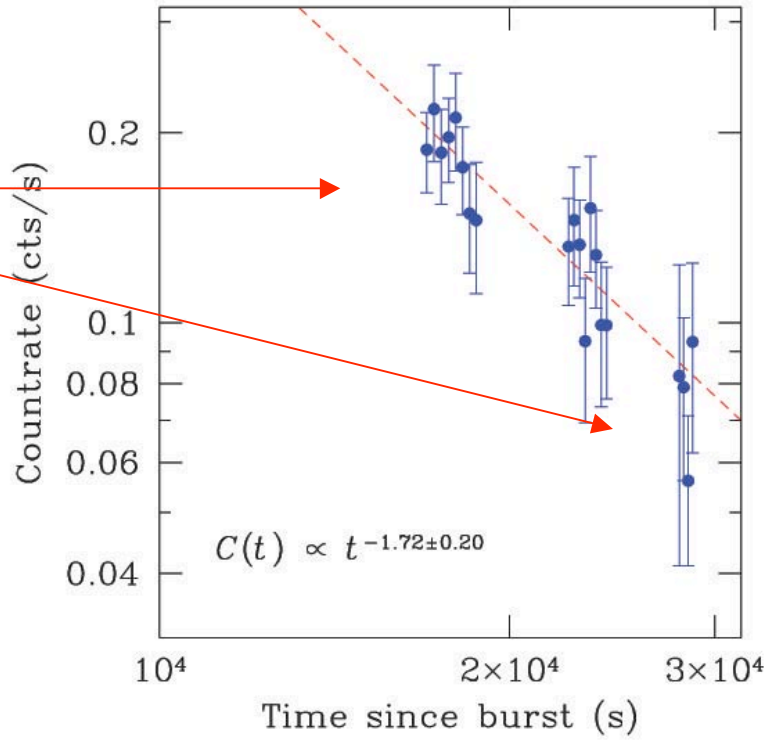
GRB 041223
First XRT GRB Afterglow

J-Band Image with XRT Position



GRB 041223 Decay Lightcurve





Giant Flare from SGR 1806-20

SGRs are galactic neutron stars with huge magnetic fields (~10^{15} G) that have occasional active periods and outbursts.

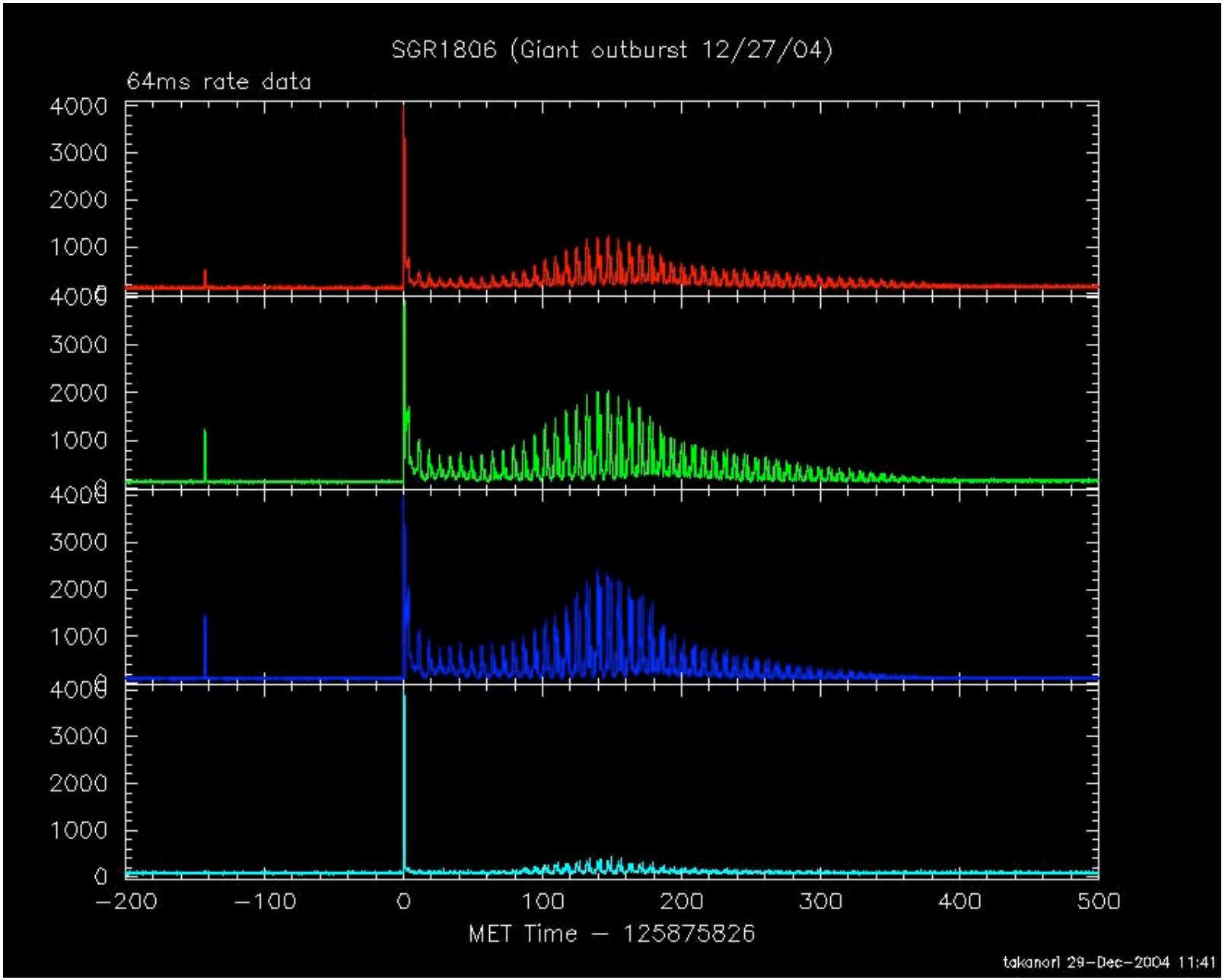
SGR 1806-20 discovered in 1986. Four known SGRs

Detected on Dec. 27, 2004 by all non-occulted gamma-ray detectors in space

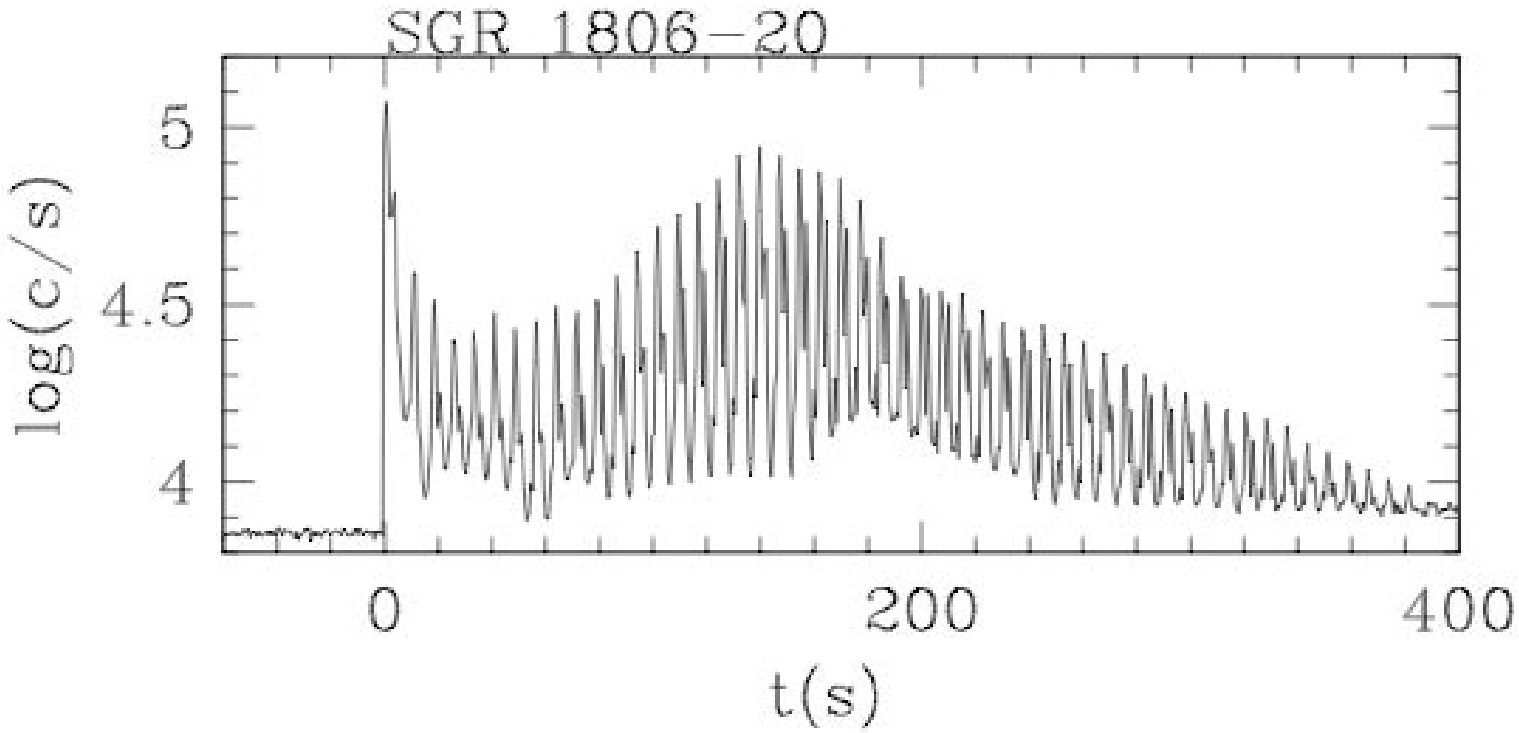
Huge main peak lasting 0.5 sec followed by 400 sec of pulsations

Estimate (Boggs et al. GCN 2936) puts fluence greater than ~0.1 erg cm^{-2}, 1-2 orders of magnitude greater than SGR 1900+14 1998 and SGR 0526-66 1979 flares.

Radio transient detected. Slightly extended source. Polarization detected.


SGR1806 (Giant outburst 12/27/04)
64ms rate data
4000
3000
2000
1000
0
−200
−100
0
100
200
300
400
500
MET Time − 125875826
takanori 29-Dec-2004 11:41

BAT Detection of 7.6 sec Pulsations

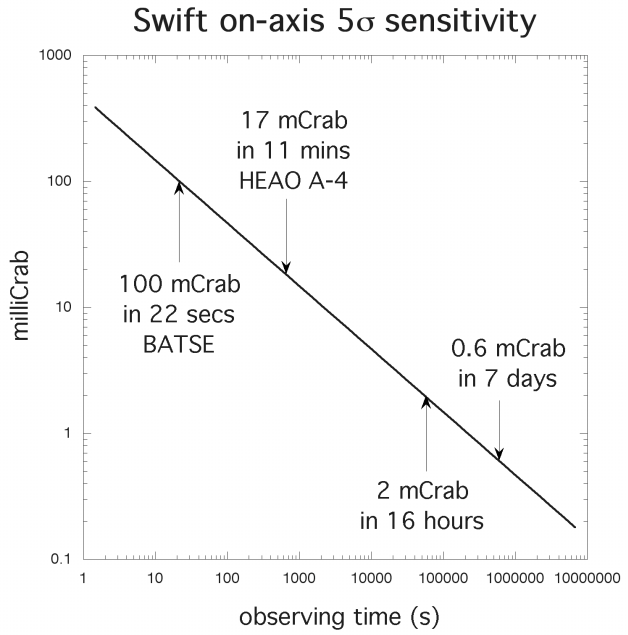


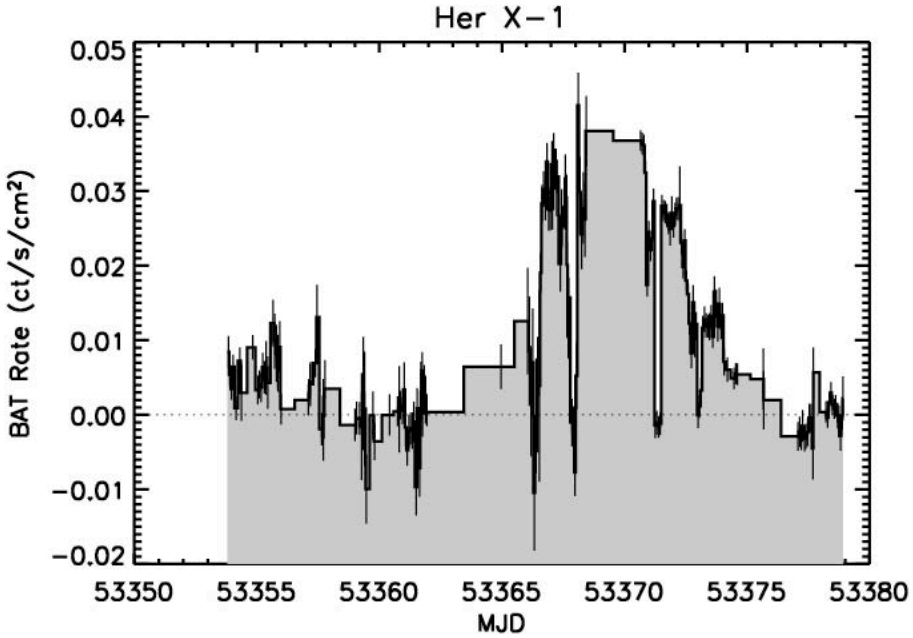
Swift Non-GRB Capabilities

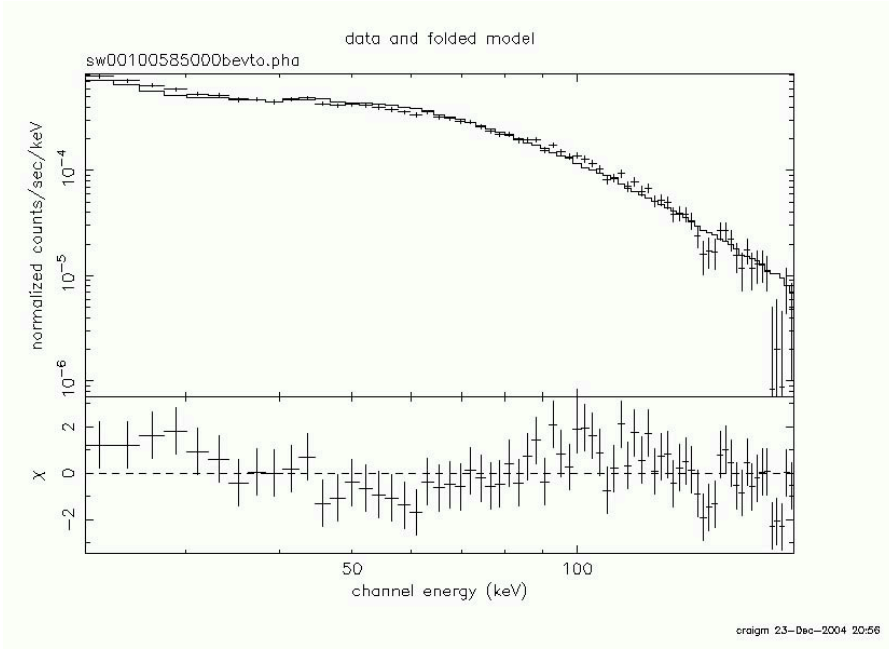
Hard x-ray survey of sky

Transient monitoring

Multiwavelength response to transients detected by others







Swift Team

University of Leicester

NASA

GSFC

PENNSTATE 1855

UCL MSSL

asi agenzia spaziale italiana

OSSERVATORIO ASTRONOMICO DI BRERA

SPECTRUMASTRO

SONOMA STATE UNIVERSITY LUX MENTIS • LUX ORBIS • 1960

THE UNIVERSITY OF CALIFORNIA 1868

SwRI

eV PRODUCTS

MPE

SWALES AEROSPACE

Los Alamos NATIONAL LABORATORY

OMITRON inc.