



# BAT <sup>to</sup> <sub>the</sub> FUTURE

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PSU

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- Brief Status (Noisy Dets; Lack of Bursts)
- GRBs vs Sun Angle
- What can we do with BAT in the Future



# Number of Disabled Detectors

- Number had grown large (7K 2-3 month ago).
- Number is composed of 4 major components:
  - Sporadically noisy (which I periodically reclaim),
  - Permanently noisy (which is hard to tell what the growth rate is; but it is small),
  - Latch-ups (which get periodically reclaimed),
  - SAA-clobbered dets (which get periodically reclaimed).
- Currently, Number is down in the 3K's (10-12%).
  - After total-array scanning/re-enable and after reboot.
- Long-term outlook is good: <25% in 5 more years.



# Recent Lack of Bursts



- Last 3-4 months a drop of  $\sim 32\%$  in burst rate.
  - Poisson statistics says 4% chance.
- Burst rate is complicated mix of many contributors.
  - Instrumental and astrophysical (variable sources in FOV).
- We have looked at the following:
  - Amount of time off-line: small and no different than other times.
  - Disabled detectors: up & down during this time (like before).
  - Trigger rate has been constant. (7-15 triggers per orbit)
  - Control params are all the same (eg THPOSS=6.5sigma).
  - Image-domain detections are the same as before (number and significance)!
- We are still (and always) looking & monitoring.

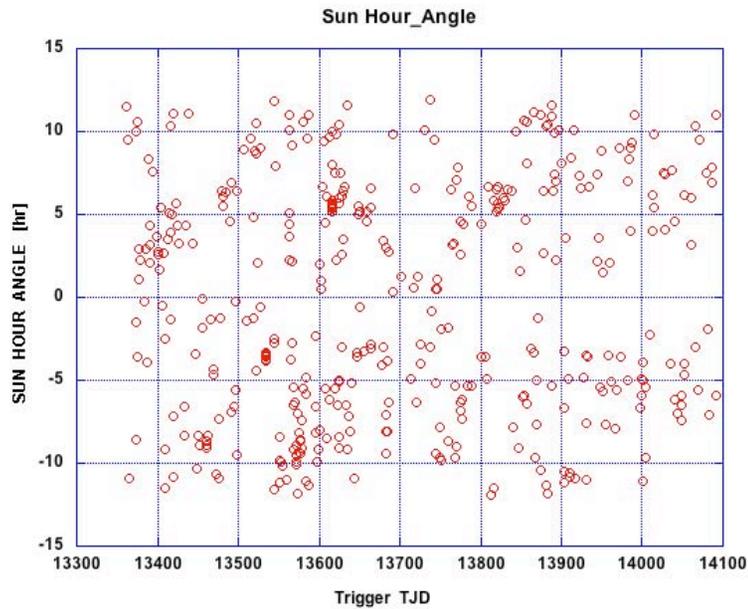


# Sun Hour\_Angle Distribution



## over the Mission

- First 2.0 years.
- Hour\_angle of each trigger.
- Hint of improvement in the last year.



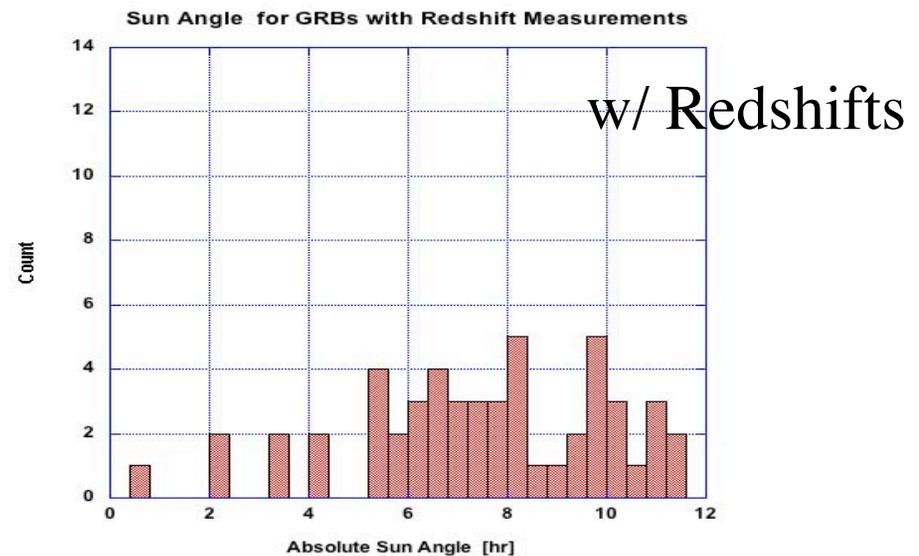
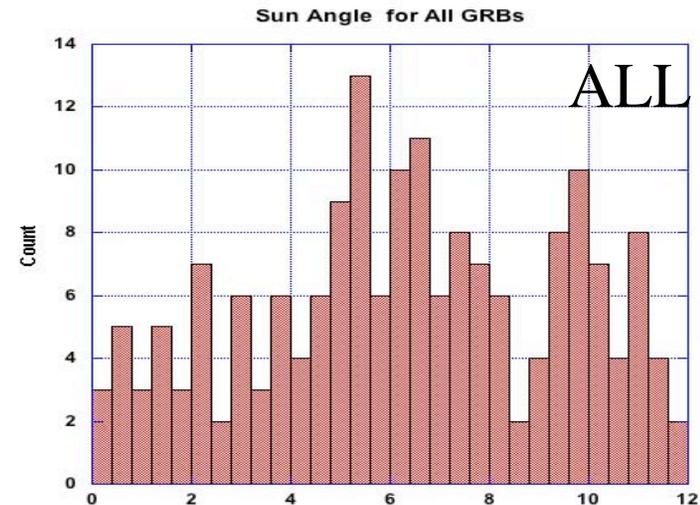
Dec 04

Dec 06



# Hour\_Angle Distributions *Swift*

Histos of all GRBs and those with redshifts vs Sun Hour\_Angle.  
Correlation: More redshifts for the higher Hour\_angles.

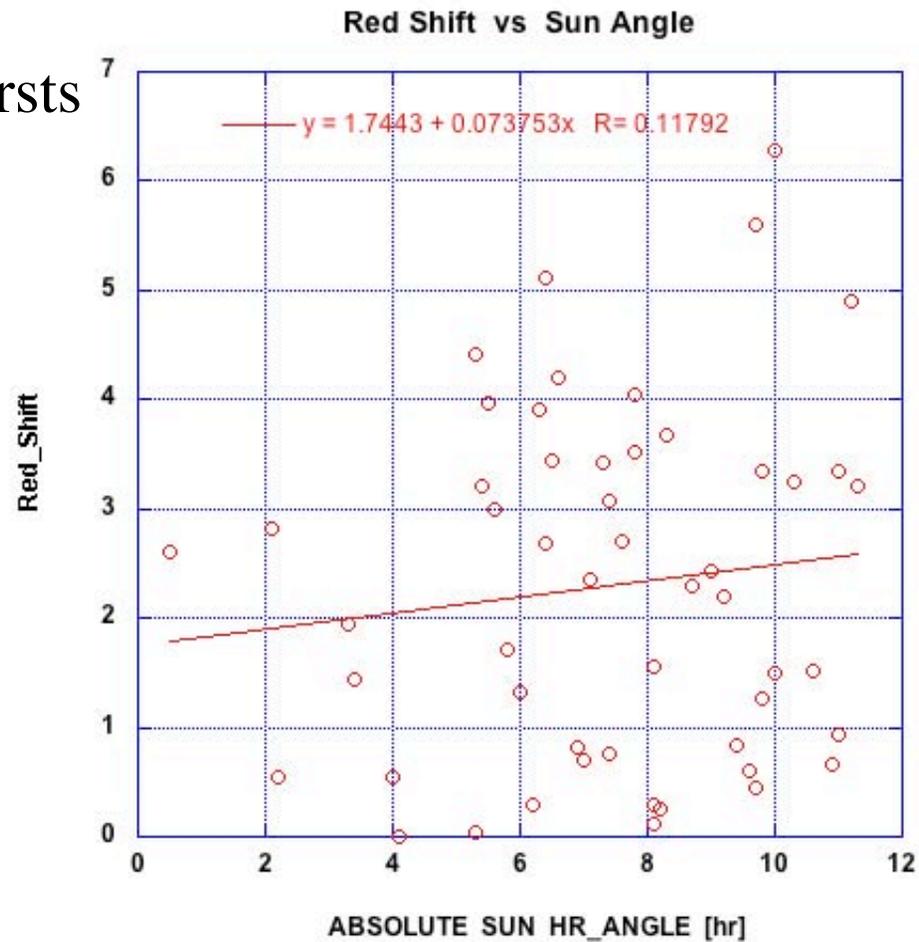




# Redshift Value vs Hour\_Angle



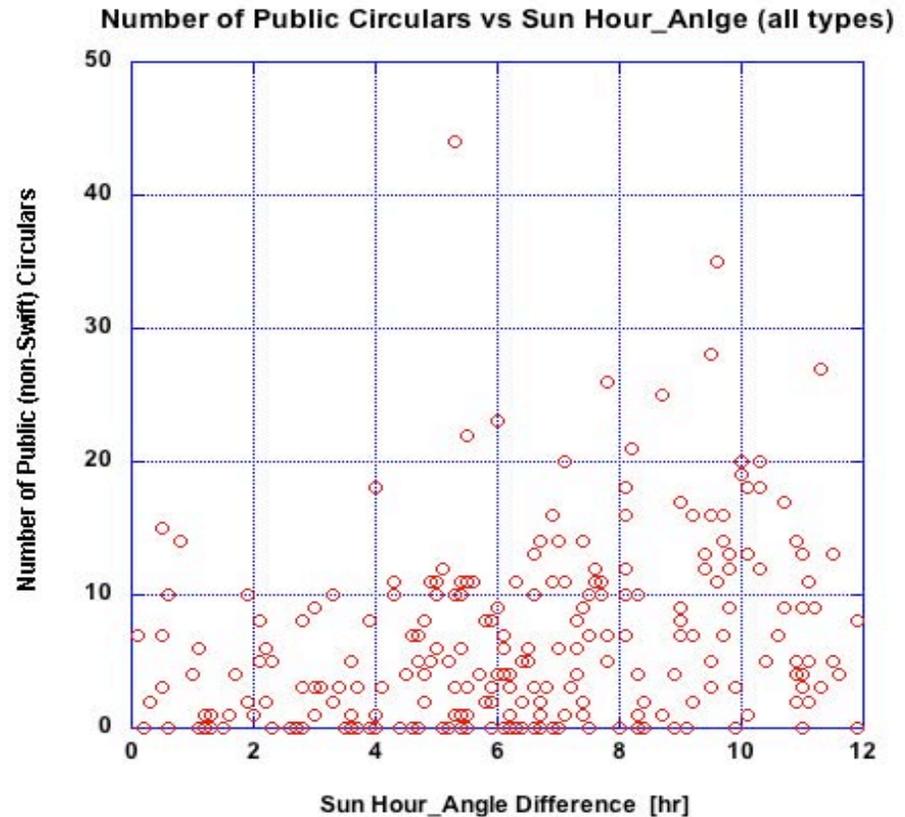
More time on target  
to dig out those fainter bursts  
with the higher redshifts.





# Number of Circulars vs Hour\_Angle

The larger the Sun angle the more observations; more specifically, the more successful observations.





# Sun-block for Swift?



- The number of bursts with redshifts increases, the distance ( $z$ ) increases, and the number of follow-up observations increases if we look farther away from the Sun.
- These are all good “Science” performance metrics.
- Clearly, it is desirable to figure out a way to increase the average Sun hour\_angle distance in our observing program.



# What do you want to see developed within BAT?



- Next slides will give some parameters and functionality that can be changed/expanded to accomplish your desiresments.
- A) Responses tailored to a specific source.
- B) Responses tailored to classes of sources.
- C) Responses to all catalog sources.
- D) Change the response to GRBs.



# Things that might be changed

- Catalog Sources and Responses:
  - Can add up to 400 more sources in the On-board catalog;
  - Can add up to ~30 more src-specific or class-specific responses;
    - Scripts contain the BAT and Swift response functions.
    - More than 30 will require FSW changes (harder but not impossible).
- What specific responses?
  - Slew or not\_slew by controlling the merit. (ie all 3 instruments or BAT-only response).
  - Amount of event-by-event data to capture.
  - Rate and duration of accelerated survey images (ie DPHs).
  - Modes for the NFIs.
  - Pulsar lightcurve folding.
  - Change the auto-escalation of the threshold (for the next successful trigger).
    - Currently it is 2x; but maybe (say) 1.5x. (Source-specific?)



# Misc (1of2)



- Any sources to be added/deleted from the On-board Catalog?
  - If you add a source, then it can have a specific response.
  - If you delete a source, then it will get the "burst" response.
- Add/delete to the Ground Catalogs?
  - Can be different from On-board catalog.
  - Typically has more sources than On-board (~25 more now).
  - There is a “block distribution” ground catalog -- nothing in it so far.
    - Notices from those sources are not distributed.
- GRB vs Transient Identification:
  - a) GRB (<300sec), b) Unknown Transients ( $\geq$ 300sec), and c) Known Transient sources (catalog items).
  - Move the 300-sec GRB-vs-Transient boundary?



## Misc (2of2)



- Any new BAT telemetry data products you'd like to see?
- Any new features you'd like to see in the GCN Notices? Services?
- Remind people that we pulsar lightcurve folding capability (nobody ever uses it).



# You Need To



- Please email me/Neil with what you want.  
(Try to be specific where it needs to be specific and to be general/loose where it does not need to be specific. We will merge any conflicting desirements/requirements.)
- When might these changes be implemented?
  - Some things we can/will implement quickly (2-3 weeks);
  - Other things will take FSW changes (3-4 months).



# Possible Future Experiments



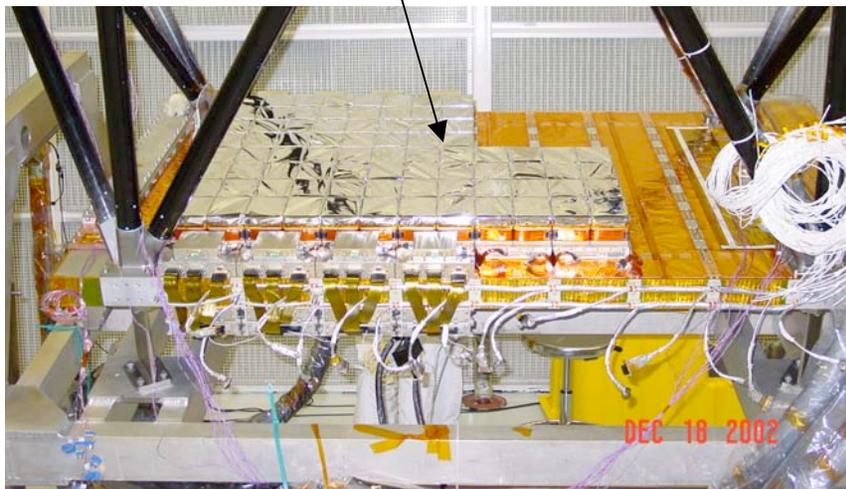
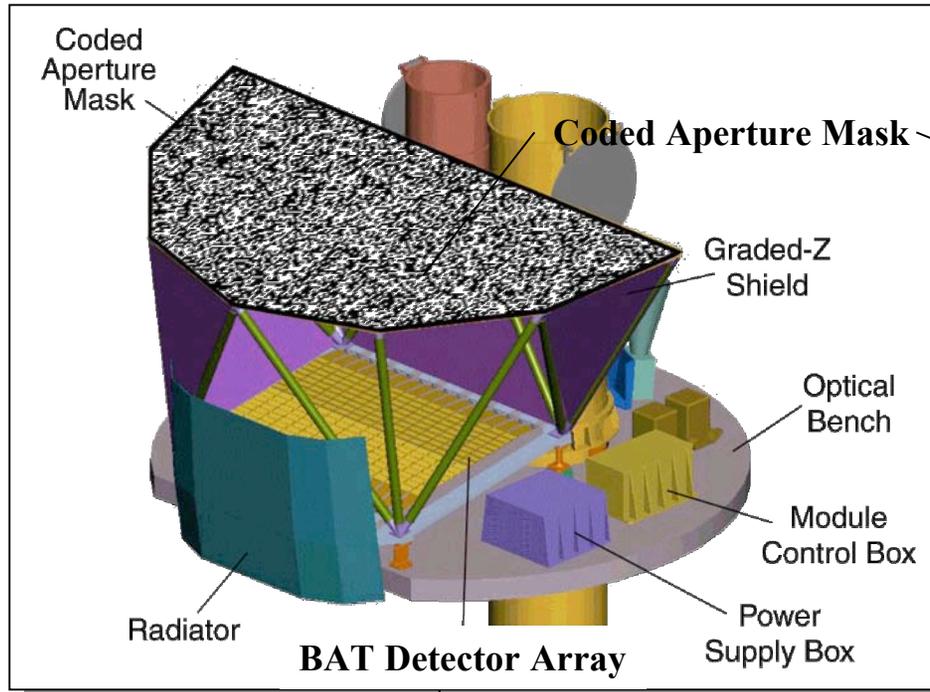
- Lower the Threshold to go after fainter/farther bursts.
  - Will also get increased False\_Positives
    - Handle them with new flag or different GCN Notice type.
    - Or block them in GCN distribution to the world.
  - Do only during day shift so FOT can kill the false positives.
- Eliminate the real-time human response to triggers.
  - No “1st Circulars” declaring GRB or Not during off-hours.
    - Wait until next day shift (includes weekend day shifts).
  - The false-positive rate is 2%.
    - “Questionable” triggers don’t count as false-positives.
  - The false-negative rate is 7%.
    - Real GRBs that went out with the “Questionable” flag set.
  - How many of you use this human-in-the-loop added value?
    - We really do want to hear from you.



## Backup/Optional Slides

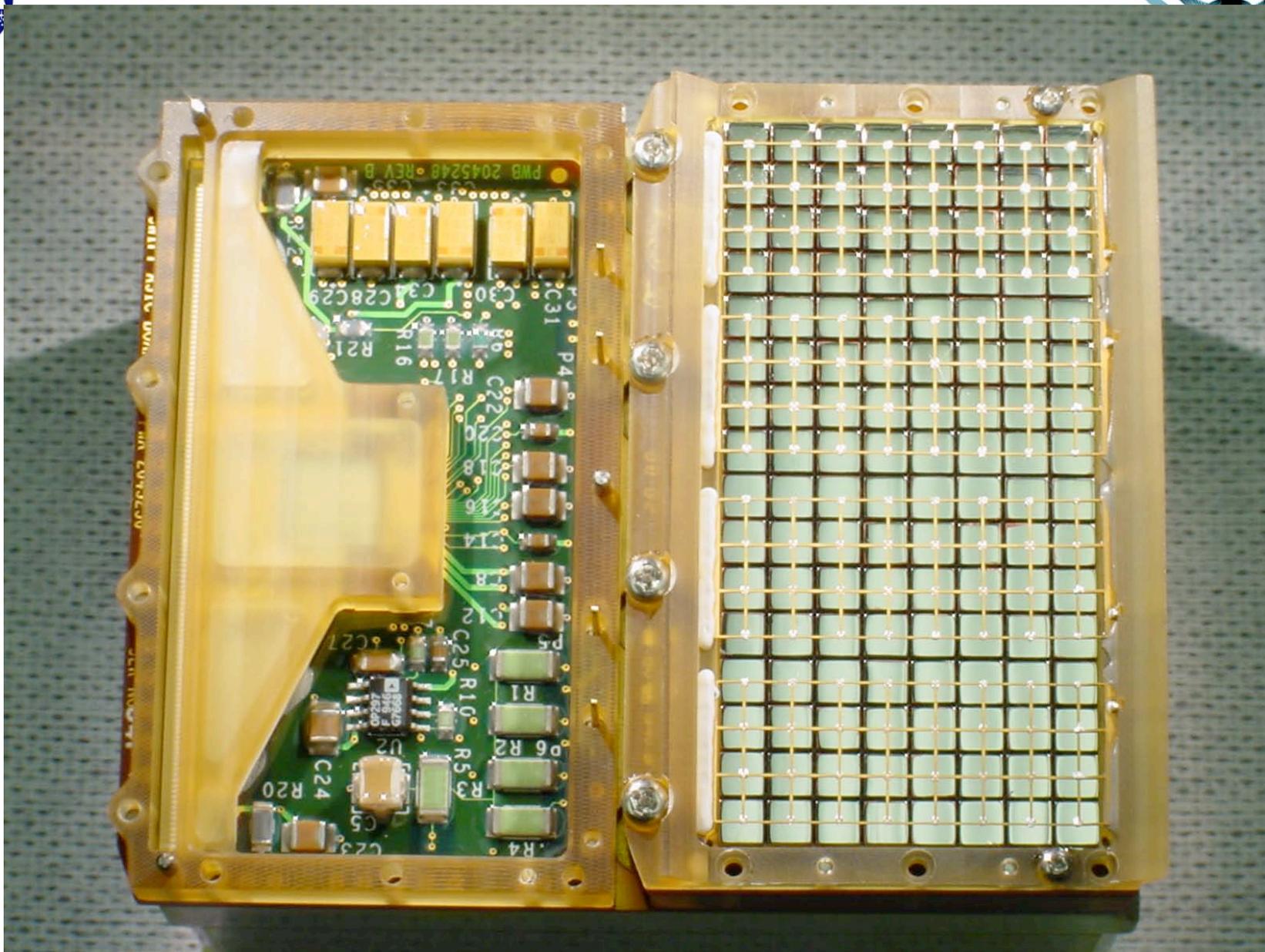


# Burst Alert Telescope (BAT) *Swift*



## BAT Characteristics

- E Range: 15 - 150 keV (12-300)
- E Resoln: 7 keV (5)
- Loc Resoln: 1-4 arcmin (1-4)
- PSF: 22 arcmin (21.8)
- 2 steradian field of view
- 32K CZT dets, 5200 cm<sup>2</sup>
- Autonomous operations



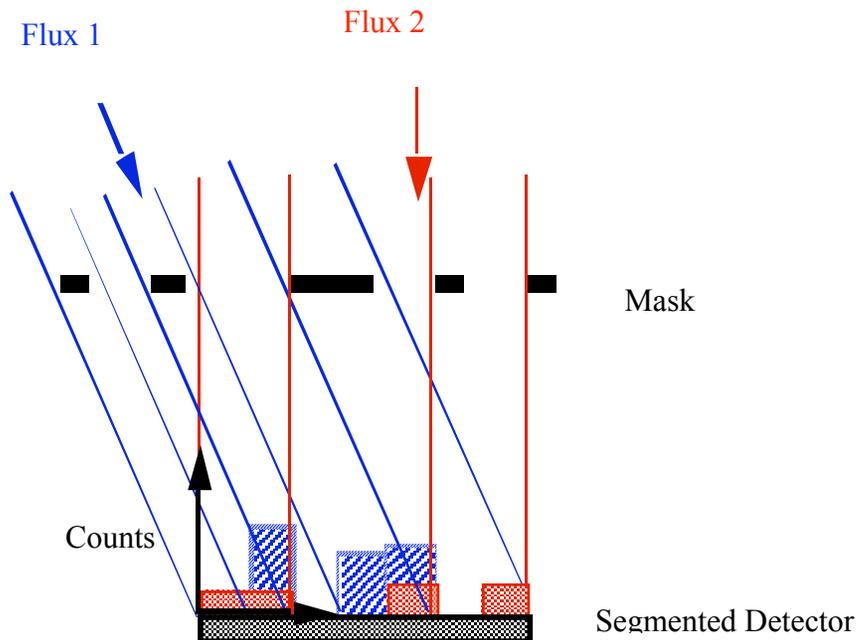
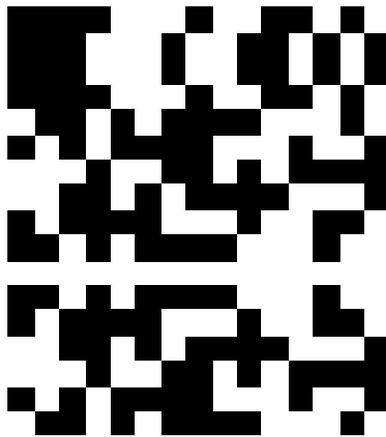
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# Coded Aperture Imaging



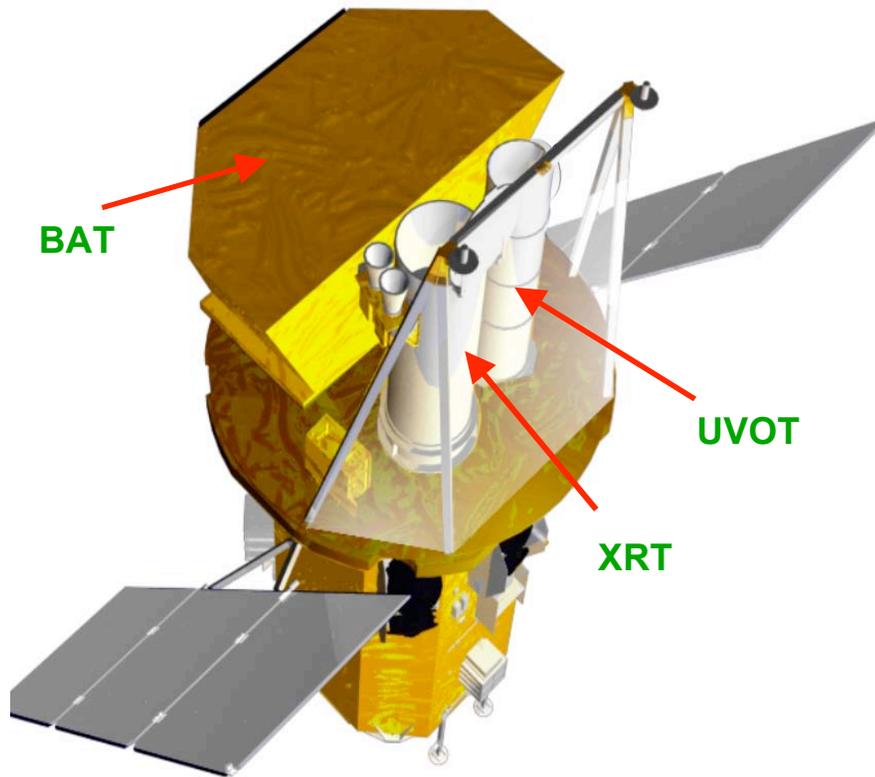
Coded Aperture  
Mask Pattern



- Source Photons “Encoded” by Partially Blocked Aperture
- Can be Decoded in Data Analysis to Determine Source Position



# Swift Instruments



## Instruments

- **Burst Alert Telescope (BAT)**
  - New CdZnTe detectors
  - Detect >100 GRBs per year depending on logN-logS
  - Most sensitive gamma-ray imager ever
- **X-Ray Telescope (XRT)**
  - Arcsecond GRB positions
  - CCD spectroscopy
- **(UVOT) UV/Optical Telescope**
  - Sub-arcsec imaging
  - Grism spectroscopy
  - 24<sup>th</sup> mag sensitivity (1000 sec)
  - Finding chart for other observers