



Lessons from HETE-2 Ops



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Pre-Trigger Ops



- ❑ Calibration on Orbit
 - ❑ Sources:
 - ❑ Crab
 - ❑ Sco X-1
 - ❑ SGRs
 - ❑ Known X-ray sources
 - ❑ Spectral effects can be important
 - ❑ Pointing plan – calibration may take several weeks
 - ❑ Very hard question: Do we need to correctly localize several GRBs before starting to slew?
 - ❑ Might take a week
 - ❑ But if we need good image S/N or we can't initially run triggers at Poisson threshold, mean time between GRBs will be several times longer



Pre-Trigger Ops



- ❑ Astrometry
 - ❑ Rotation matrix between BAT and spacecraft coordinate systems might be needed
 - ❑ Corrections for mechanical tolerances:
 - ❑ Height of mask
 - ❑ X- and Y-offsets
 - ❑ Possible thermal effects
- ❑ Multiple Algorithms Are Very Valuable
 - ❑ Chicago/RIKEN localization software
 - ❑ CESR/Chicago/Los Alamos/RIKEN spectral analysis software



Trigger Ops



❑ Trigger Criteria

- ❑ We will not run all of them, but we will want good coverage of timescales
- ❑ Bracket criteria are effective in defending against increases in background, although they will still occasionally fire in SAA (protons) or Ecuadorian anomaly (electrons)
- ❑ Bracket criteria are therefore good for detecting bursts
- ❑ One-sided criteria are better for optimizing image SNR (i.e., for selecting optimal background and foreground time intervals)
- ❑ Be prepared to change trigger criteria, particularly in the early going



Trigger Ops



- ❑ Trigger Thresholds
 - ❑ Poisson floors useful for bracket triggers (i.e., use Poisson thresholds, not “n-sigma” thresholds, esp. for triggers with short foregrounds):
 - ❑ Triggers w. short foregrounds will be limited by Poisson noise, not trends in the background
 - ❑ Essential to set thresholds at the Poisson floor; if we operate at, say, 3 x Poisson threshold, the rate of GRB detections and localizations will be reduced by this factor
 - ❑ Be prepared to change thresholds, particularly in the early going



Post-Trigger Ops



- ❑ **Burst Alerts**
 - ❑ Very valuable to have certain info in burst alerts
 - ❑ HETE-2 VHF messages contain:
 - ❑ Goodness (~ light curve S/N)
 - ❑ Virtue (~ image S/N)
 - ❑ Trigger criterion that fired
 - ❑ Trigger timescale that fired
 - ❑ Terrestrial longitude of spacecraft
 - ❑ Orbit phase relative to the sun
 - ❑ Localization update number
 - ❑ Burst alert info allows a quick assessment of flight localization
 - ❑ This is very valuable in the case of HETE-2
 - ❑ This would seem to be critical in the case of *Swift*, since TDRSS telemetry rate is limited and Malindi downlink might be delayed



Post-Trigger Ops



- ❑ Ground Processing
 - ❑ Essential that someone inspect flight and ground pipeline results in real time (even at 4 a.m.)
 - ❑ Essential that results can be inspected from home (*especially* at 4 a.m.) – potential firewall issues
 - ❑ Essential that refined analyses can be performed from home (*especially* at 4 a.m.) – again, potential firewall issues
 - ❑ Important to have Web interface to data
 - ❑ Essential to have version control of refinement analyses:
 - ❑ Several tries may be necessary to obtain the best results
 - ❑ Essential to keep track of the results of successive tries
 - ❑ Essential that “best result” be placed in results archive, even if it is not the result of the last try



Post-Trigger Ops



❑ Communication

❑ Essential to have a chat tool:

- ❑ e-mail does not work because of the latency involved
- ❑ Contributors may be in U.S., Europe, and elsewhere
- ❑ Many people will be exchanging real-time results
- ❑ Many people may be offering opinions about the burst and what should be done to refine localization, etc.
- ❑ All comments and results need to be logged for future reference (in 5 minutes, 5 hours, 5 days, 5 months)

❑ Who is in Charge (at 4 a.m.)?

- ❑ Flight localization retractions
- ❑ Ground analysis updates
- ❑ Spacecraft repointings
- ❑ Whoever is in charge must be able to respond/decide/command quickly, and “break” the nominal schedule, if necessary



Post-Trigger Ops



- ❑ GCN Policies:
 - ❑ GCN Position Notices – Who decides about retractions of flight localizations (incl. when and how)?
 - ❑ GCN Position Notices – Who decides about sending out refined ground analyses of flight localizations?
- ❑ GCN Circulars:
 - ❑ Authorship protocol needs to be settled in advance
 - ❑ Who is in charge of getting them out?
 - ❑ What kind of triggers merit a GCN Circular?
 - ❑ GRBs
 - ❑ SGRs
 - ❑ Other?
 - ❑ What numbers will be included in GCN Circulars?
 - ❑ When will these numbers get produced?



Conclusions



- ❑ “Lamb’s Law:” Dimension of Space of GRB, Instrument, and Spacecraft Operations Parameters is Very Large → Every GRB Occurs *Very* Near an Edge in This Space
- ❑ The More Pre-Launch Planning That Can Be Done for
 - ❑ Pre-Trigger Ops
 - ❑ Trigger Ops
 - ❑ Post-Trigger Opsthe Better (of Course)
- ❑ The Bottom Line:
 - ❑ The challenge of rapidly disseminating time-critical information on GRBs and GRB afterglows is large
 - ❑ It is like nothing else in astronomy
 - ❑ It is very exciting and very rewarding