



Opportunities for *Swift*

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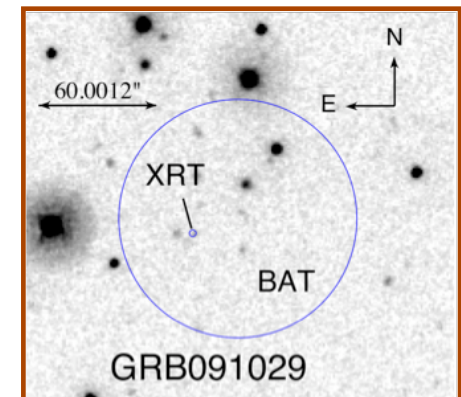
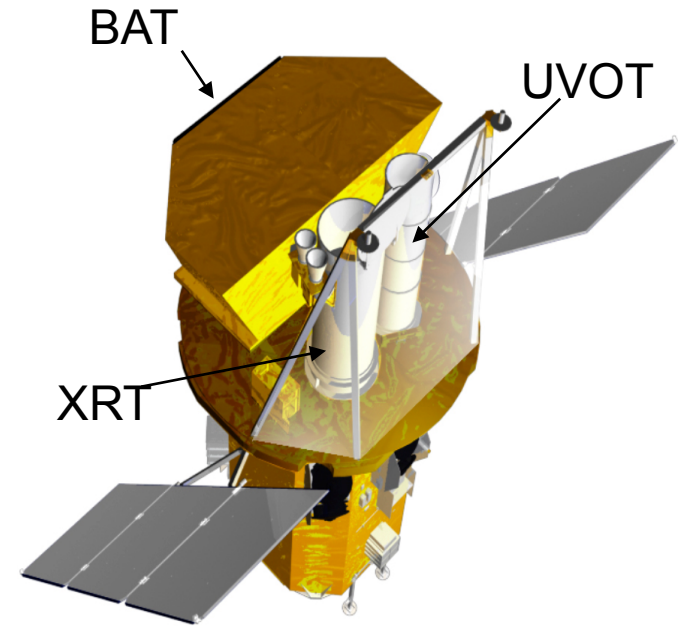
Santorini Workshop
September 20, 2013

Senior Review

- NASA's review of operating mission every 2 years
- Missions under review
 - Fermi
 - Kepler
 - NEOWISE
 - NuSTAR
 - Planck
 - Spitzer
 - Suzaku
 - Swift
 - XMM
- Proposals due January 15, 2014
- Presentations ~ March 2014

Swift – Time Domain Observatory

- **On orbit since 2004**
 - Hardware performing well
 - Stable funding
- **GRB Science**
 - >800 GRBs with arcsec positions
- **Non-GRB Science**
 - >700 TOOs per year
 - AGN, SNe, novae, CVs, LMXBs, stars, comets, ...
- **GI program & Budget**
 - > 4 oversubscription, \$1.2M, 5Ms awarded per year
 - Total Swift budget ~\$5M per year



Swift Game-Changing Discoveries

- 2005: Short burst mystery solution. Due to NS-NS mergers
- 2005: Flares & bright afterglows in GRBs
- 2008: First detection of a supernova shock break-out X-ray flash
- 2008: Naked-eye GRB from reverse shock jet physics
- 2009: Discovery of 2 GRBs with $z > 8$
- 2005-2011: Star formation rate and metallicity evolution to $z > 5$
- 2010: Large fraction of galaxy mergers in hosts of absorbed AGN
- 2011: Tidal disruption super-flare of star eaten by black hole
- 2012: Discovery of very young (2500 year old) SNR
- 2013: Detection of anti-glitch *spin down* in magnetar 11E 2259+586
- 2013: Evidence for kilonova emission in a short GRB

The New York Times

October 29, 2009

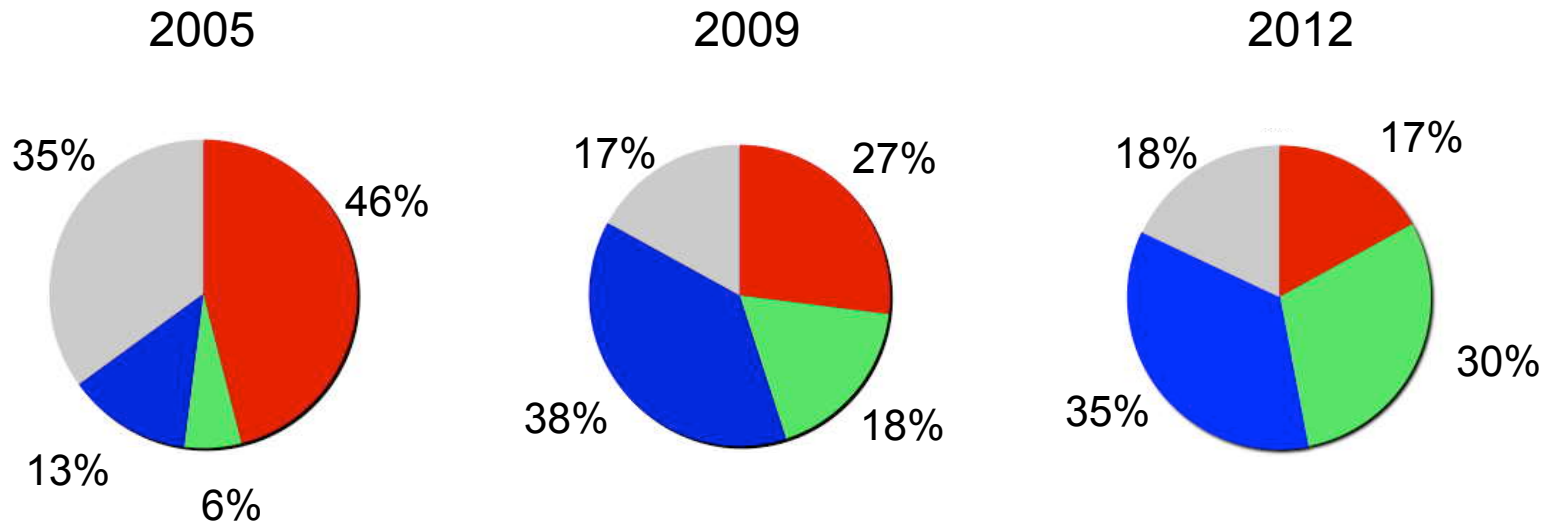
"Extraordinarily violent explosion that ended the life of a distant star."

April 16, 2011

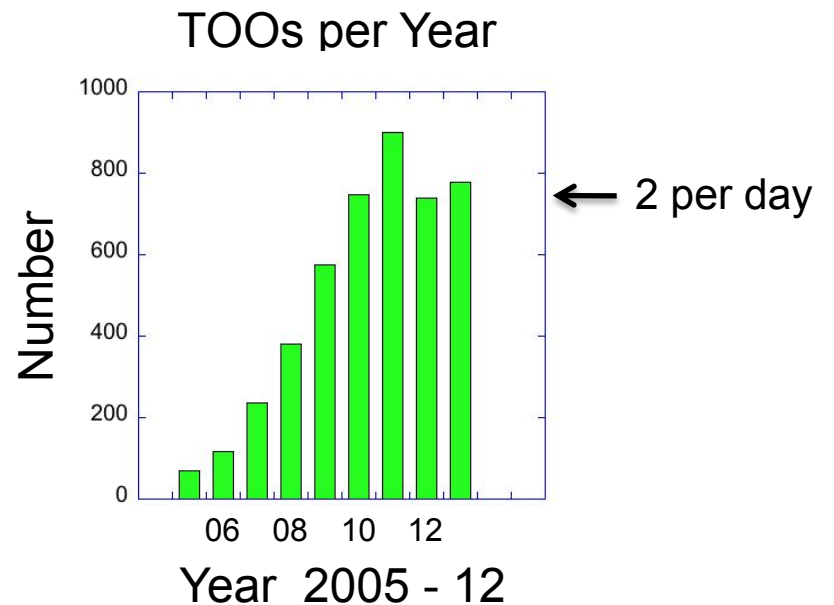
"Unusual celestial event was black hole swallowing a star."

Yearly breakthroughs with Swift

Evolving Observing Time



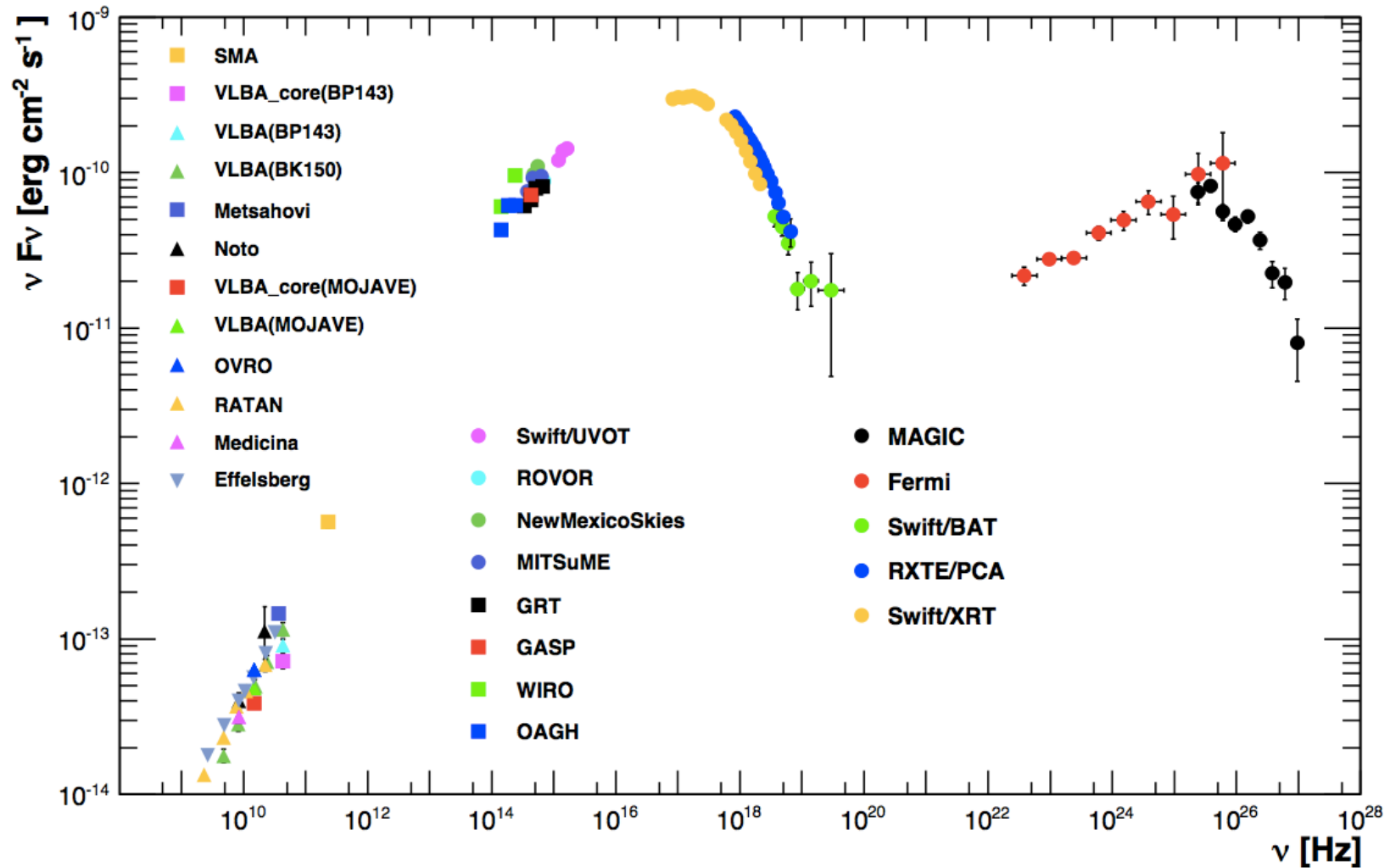
- GRBs
- TOOs
- GI obs & Fill-ins
- SAA & Calibration



Synergies with Other Missions

- Fermi & AGILE: Follow-up of GRBs, blazars, unidentified sources,
- NuSTAR: BAT source finder, XRT/UVOT simultaneous observations
- Planck: Joint observations of blazars
- INTEGRAL: Follow-up of transients GRBs,
- MAXI: Follow-up of transients
- XMM and Chandra: Synergy in TOO programs
- HST: Deep follow-up observations of GRBs
- TeV observatories: Joint observations of blazars, triggers for GRB searches
- LIGO/VIRGO: Follow up of transients, triggers for GRB searches
- Herschel: UV grism observation of young stellar systems
- IceCube: Follow up of transients, triggers for GRB searches
- EVLA, ALMA & LOFAR: Triggers for GRB searches

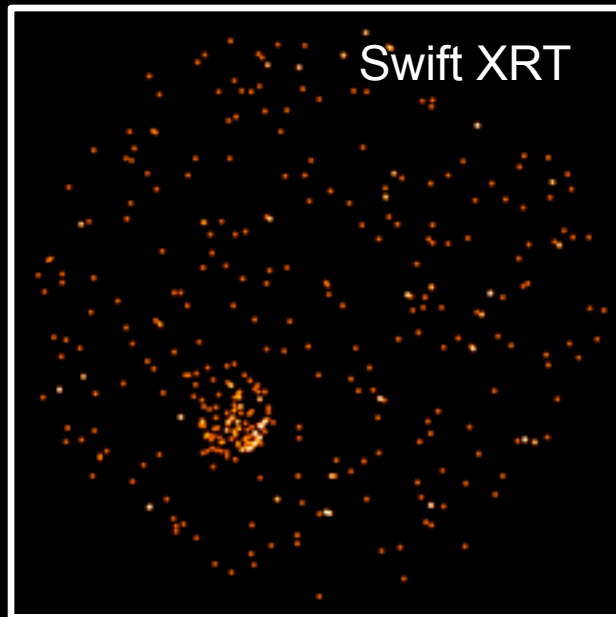
Mrk 421 Campaign



Abdo+ 11

corr. authors: Paneque, Finke,, Georganopoulos,, Reimer, Tescaros

G306.3-0.9 - Young SNR



Swift XRT

~ 2500 years old
weakest radio SNR
bright in X-rays



Chandra + Spitzer

UVOT LMC Mosaic

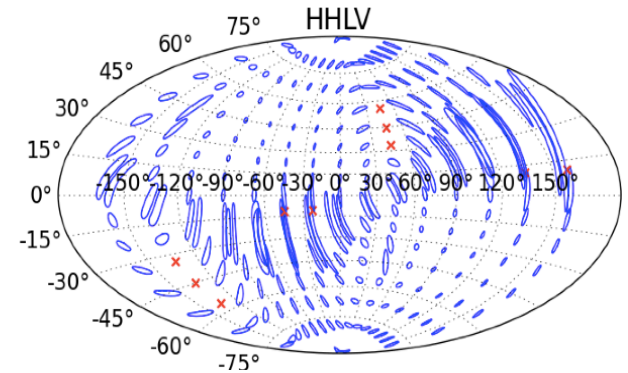


Siegel+ '13

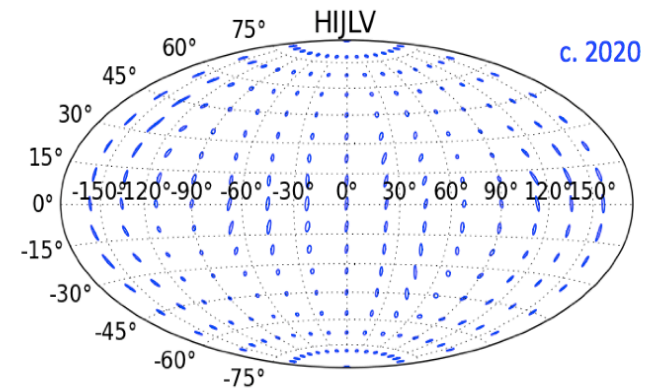
Covering Large Error Boxes

- GRB follow-up community has struggled with large error boxes from IPN and GBM
- Recent successes with PTF tiling of GRB 130702A and Swift tiling of 2 IPN bursts
- GW error boxes will be 10's to 1000 sq deg
- Galaxy strategy used in *Swift* observations of LIGO S6 triggers (Livingston + Hanford)

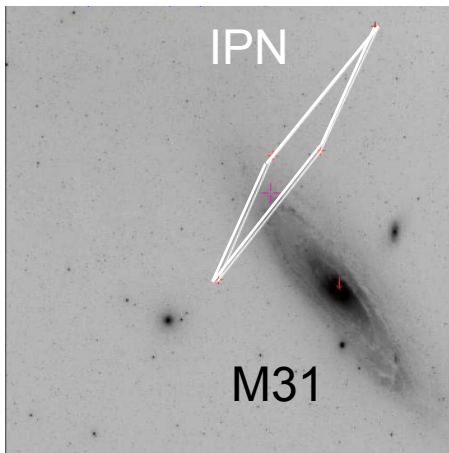
Sky localization with 3 sites ...



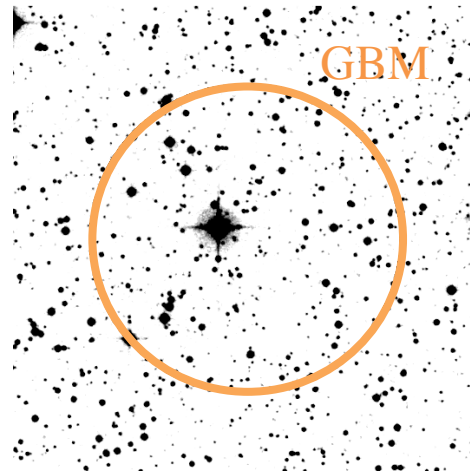
... and with 5 sites



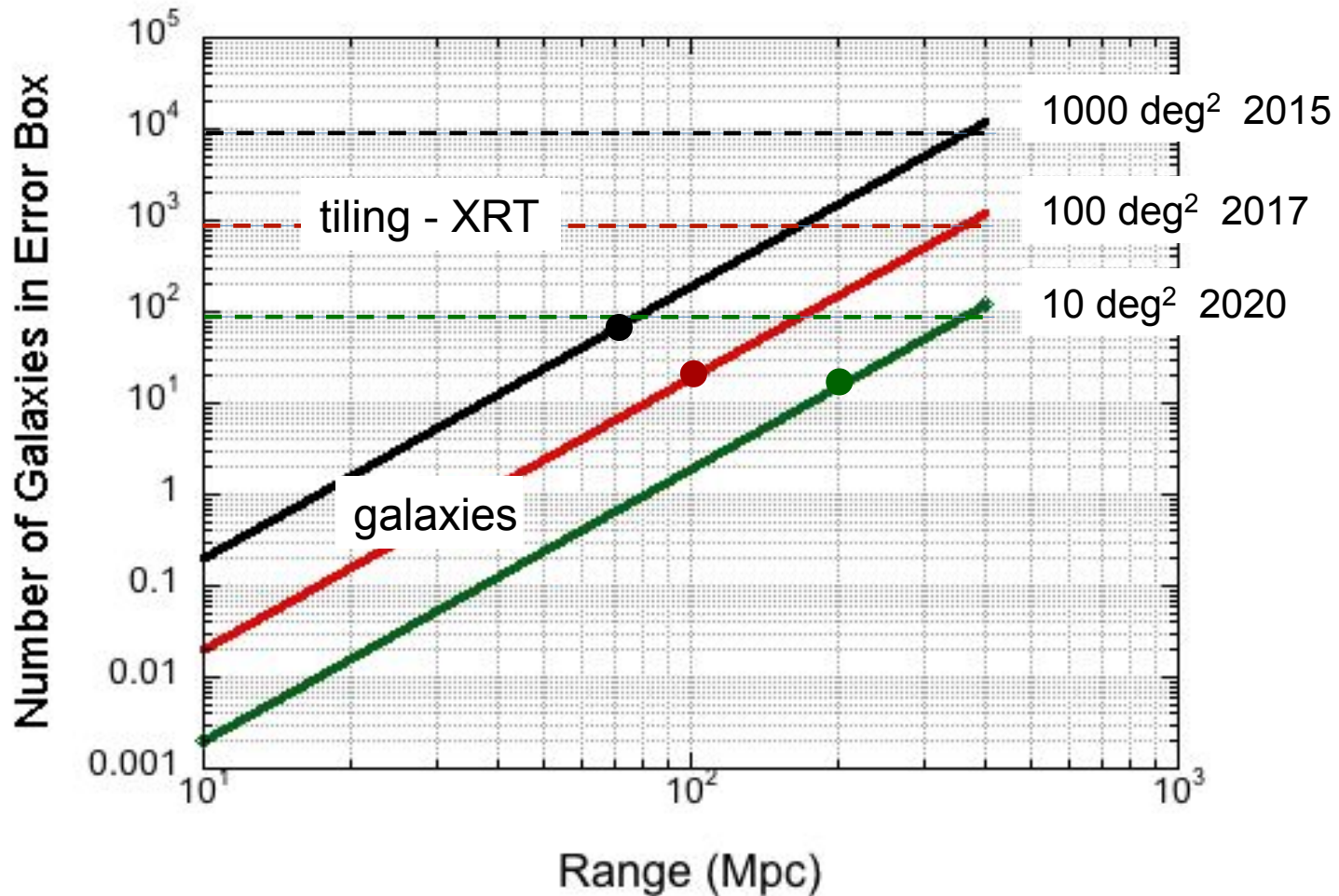
Fairhurst (2011)



GRB 081024



Large Error Boxes – Galaxy Strategy



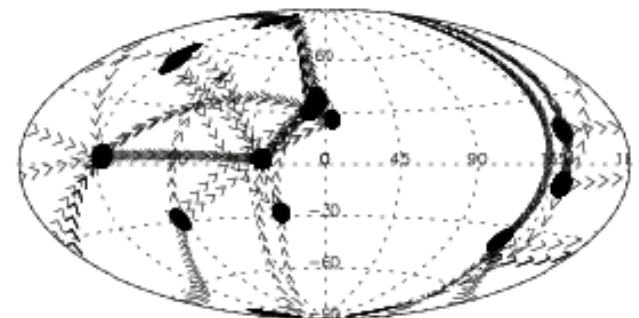
galaxies to cover 50% of light
XRT FoV = 0.11 deg^2

Kanner+ 2012

New Operations Initiatives

- Rapid uplink after hours through White Sands
- Large error box and long-narrow box tiling (100 tiles)
 - GBM or LIGO error boxes
- Automated XRT software to find new serendipitous sources
- More ground station coverage for BAT event data during slews
- Re-activate BATSS software to find GRBs during slews
- New BAT survey user-friendly survey tools for off-axis source analysis
- Transmit the Subthreshold BAT messages down real-time
- Tune hard triggers to detect more short bursts
- Subthreshold triggers from nearby galaxies in on-board catalog

BATSS Slew Paths



New Science Initiatives

- High redshift GRBs with new ground capabilities (RATIR, RIMAS, MOSFIRE, JVLA, ALMA,)
- Follow-up of the new radio bursts
- G2 cloud monitoring
- Complete the ROSAT source key project
- Complete GP survey away from bulge
- Swift Target of the Month