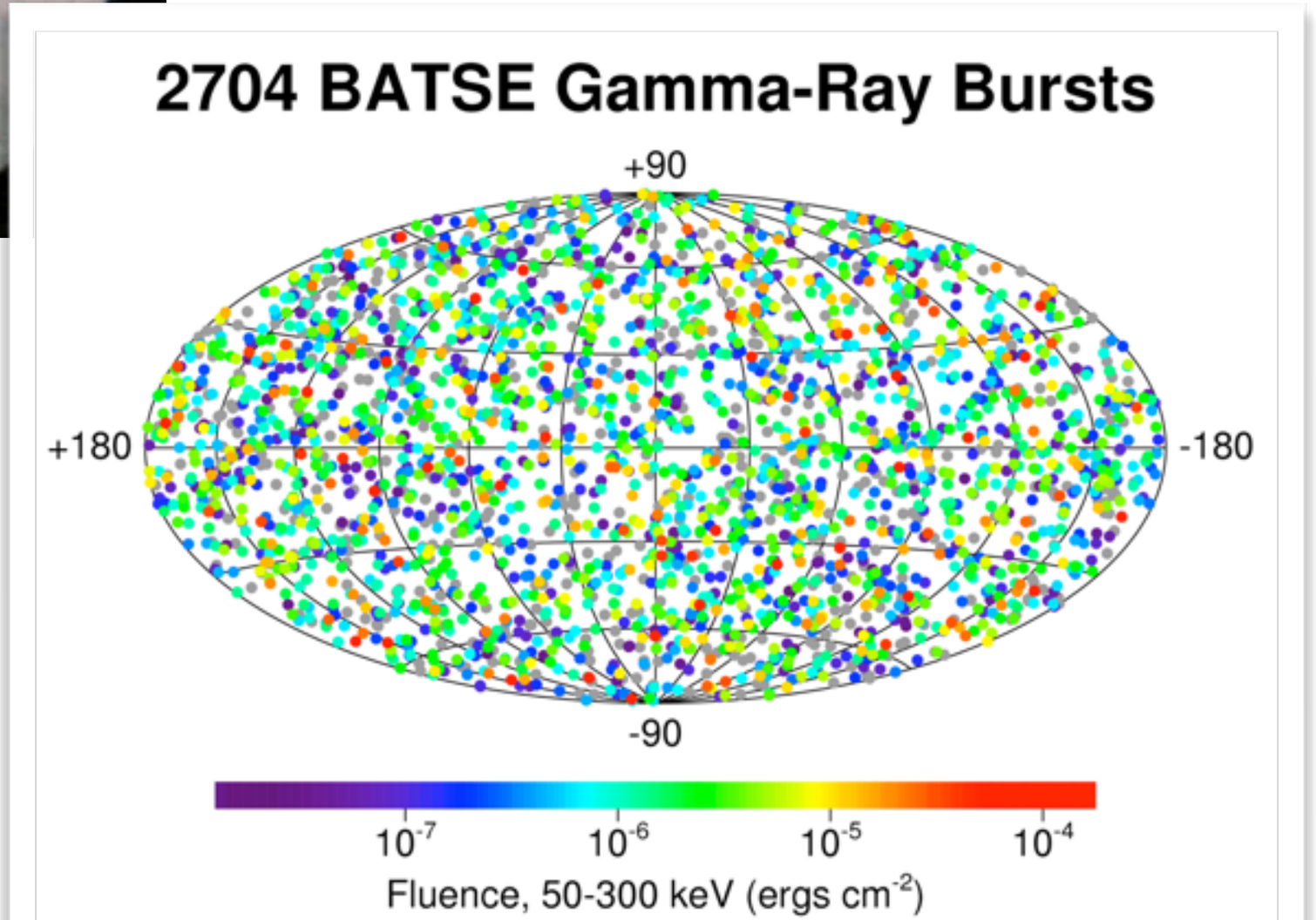
A golden era of Gamma-Ray Burst observations inspired by Neil Gehrels: looking forward to SVOM

Some thoughts from Valerie Connaughton (USRA) who can't be here owing to shoulder surgery…

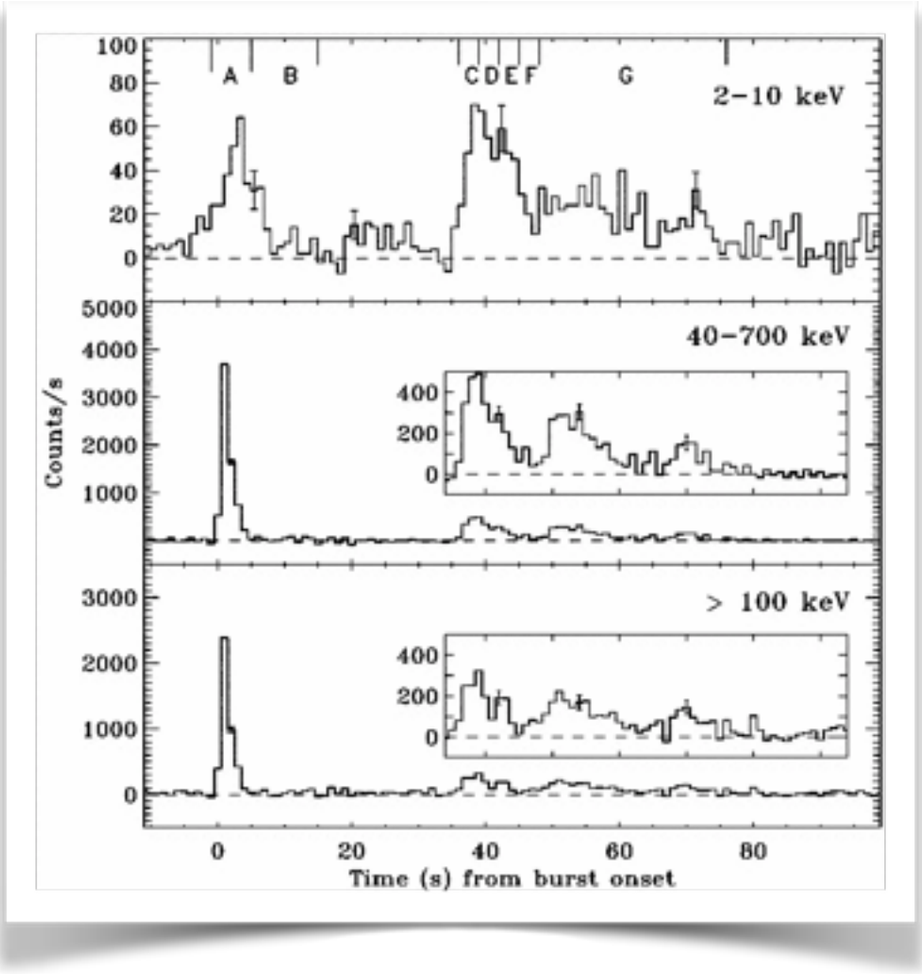
Neil's connection to the GRB field and to us in the gamma-ray astronomy group in Huntsville was vast and deep

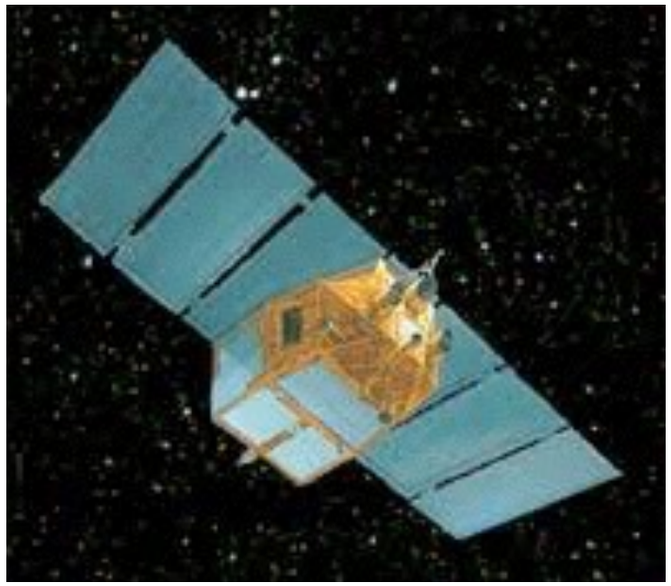
- Project scientist for Compton Gamma-Ray Observatory - major contributions to the Burst and Transient Source Experiment (BATSE) team
- PI of Swift
- Senior scientist for Fermi and close collaborator of both Fermi Large Area Telescope (LAT) and Gamma-ray Burst Monitor (GBM)

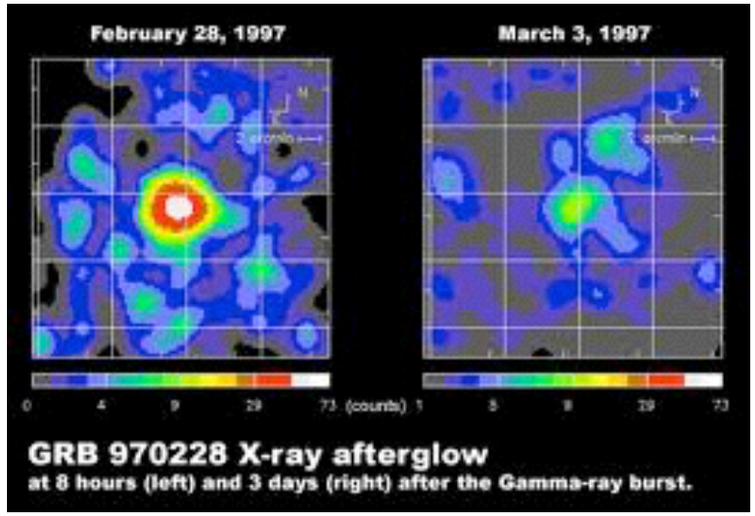
CGRO era - GRBs really are cosmological



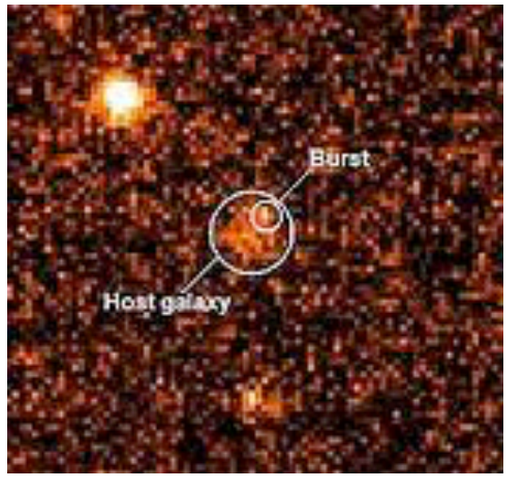
GRBs have afterglows!







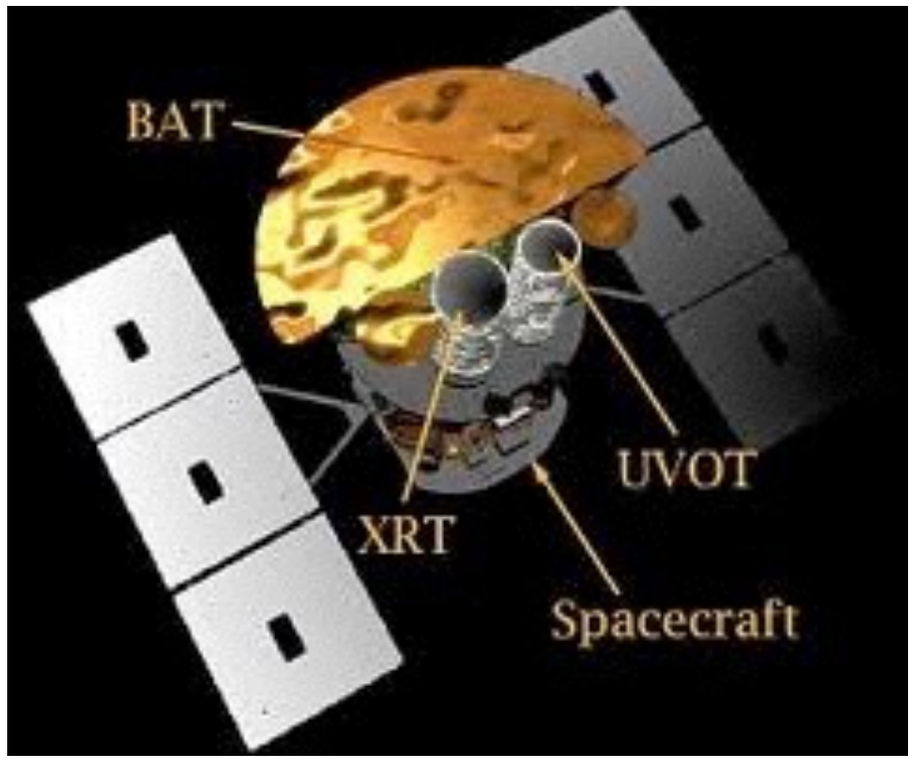
BeppoSAX + WHT + Hubble.



Costa et al. 1997

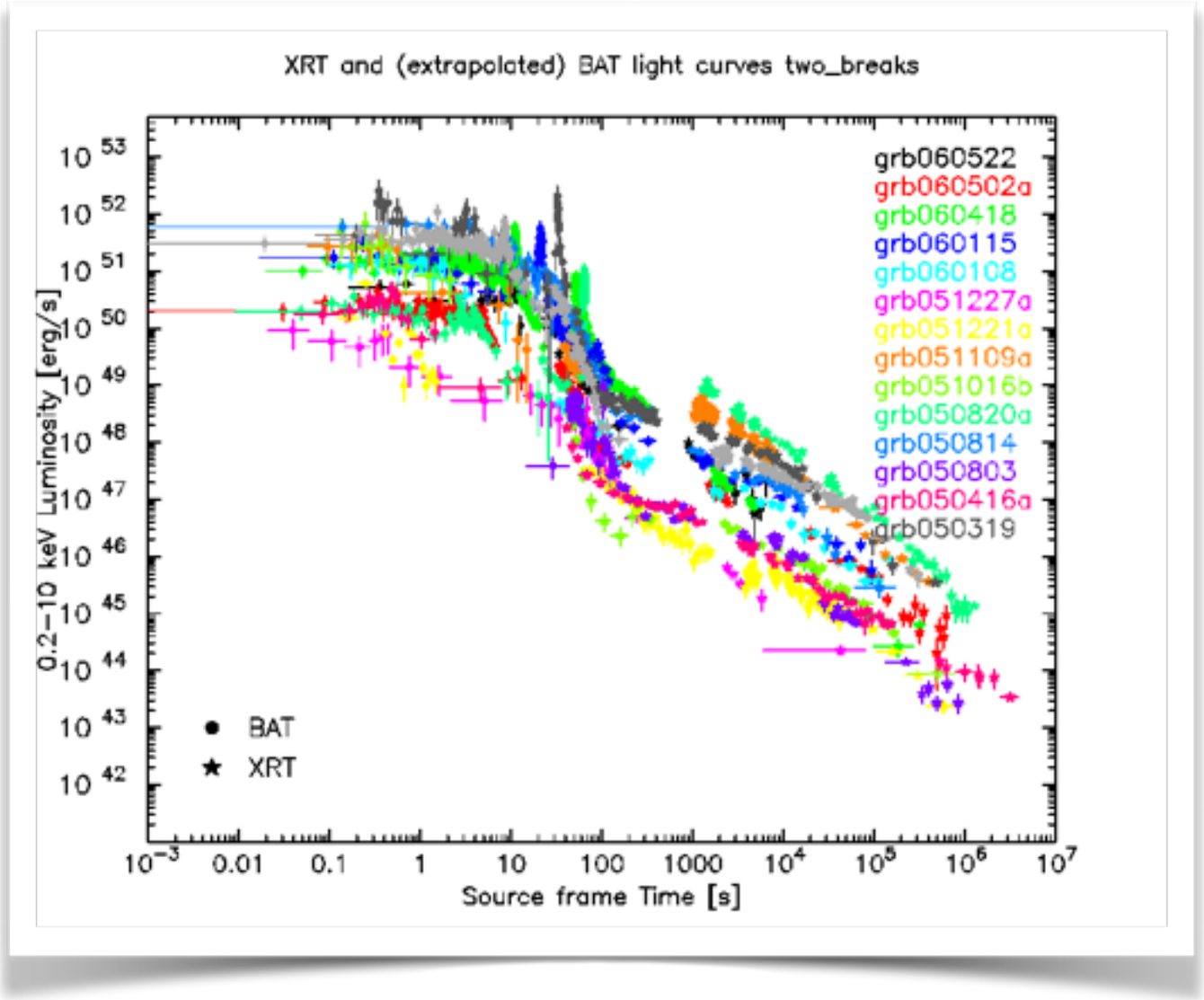
- Discovery involved commanded repointing of BeppoSAX Narrow-Field Instruments after discovery with Wide Field Camera - hours!

Swift was Neil's brainchild: automatic repointing following BAT trigger ensured more afterglows and many discoveries!



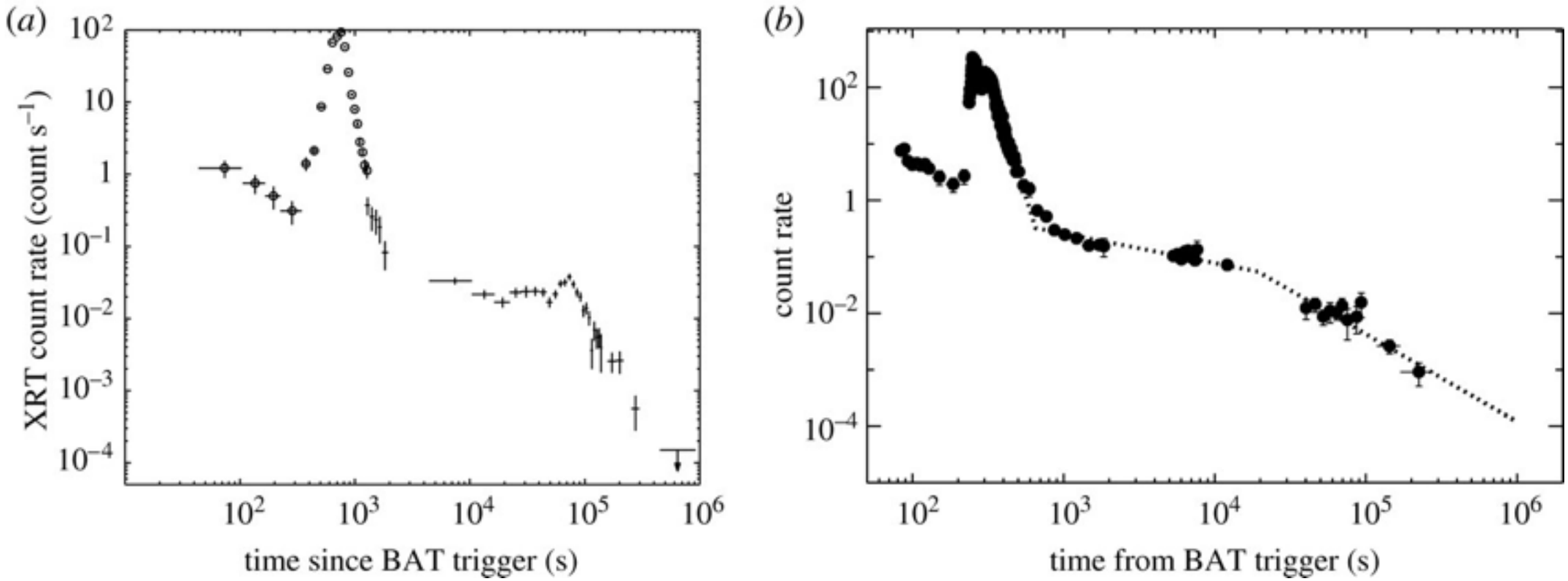
- Although Swift was Neil's baby, he was always thinking of the next instrument or encouraging and serving other instrument concept teams.

The breakthrough with Swift: rapid X-ray observations (i) plateau phase



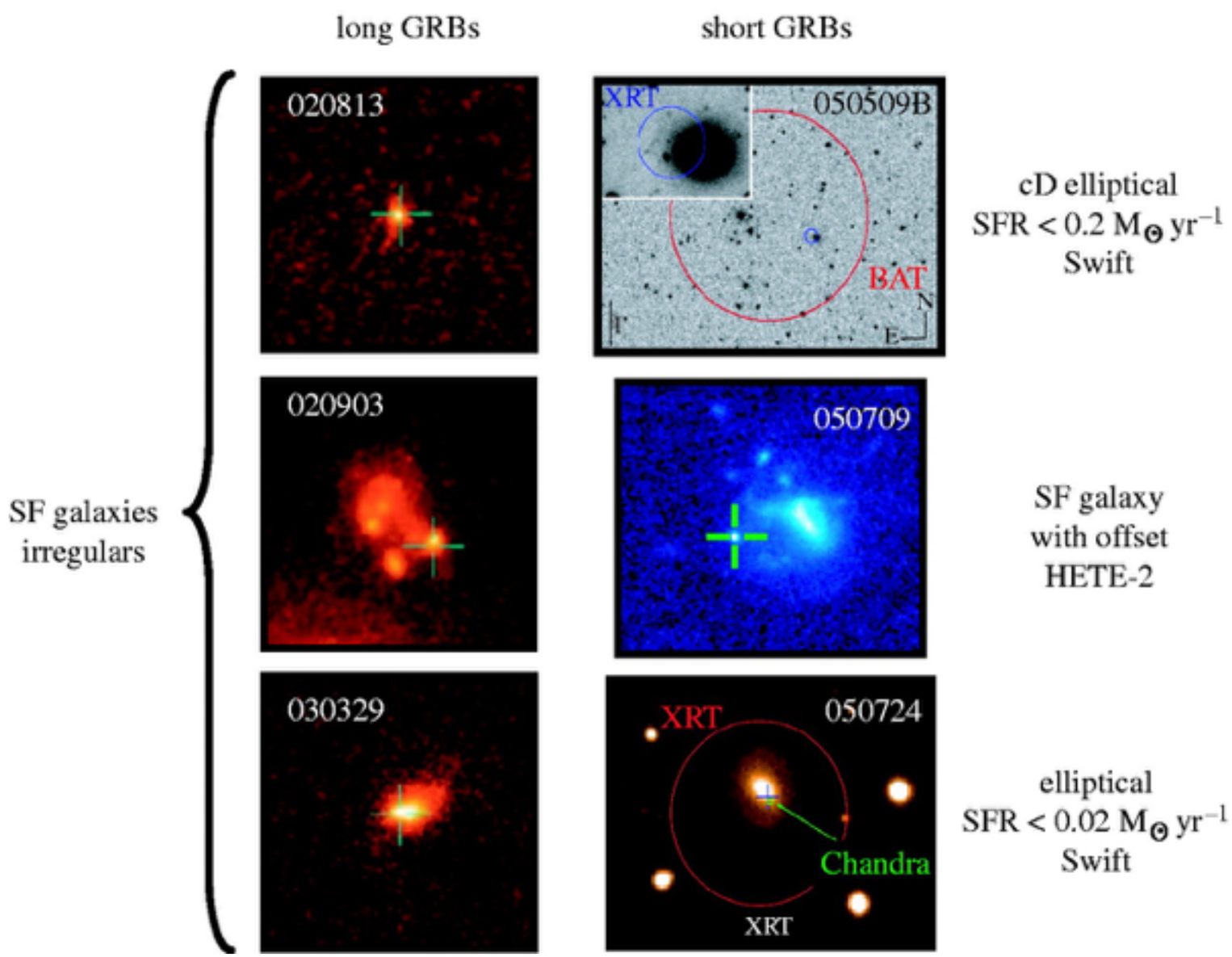
Mangano et al. 2006

The breakthrough with Swift: rapid X-ray observations (ii) X-ray flares



Burrows et al. 2007

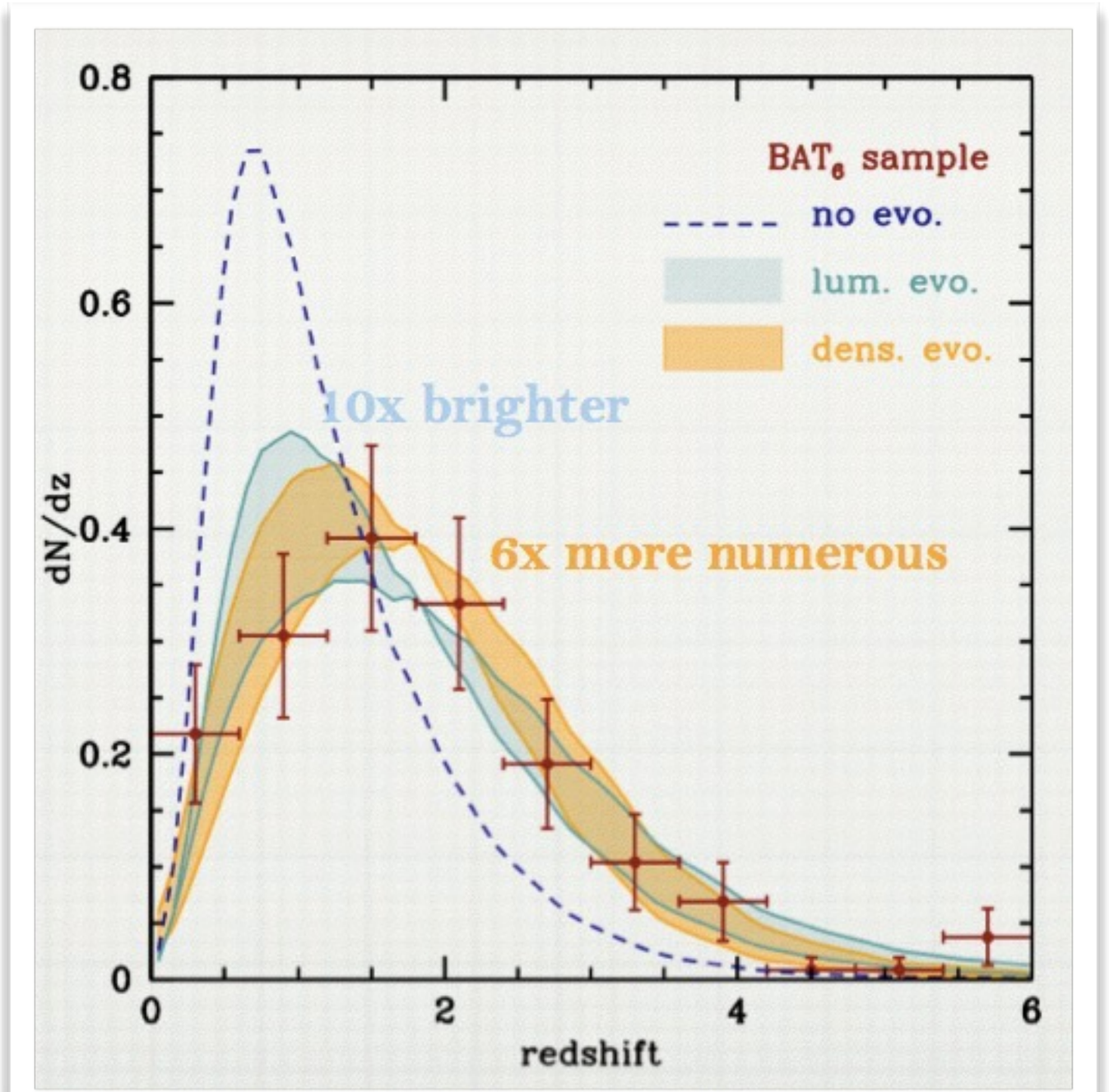
The breakthrough with Swift: rapid X-ray observations (iii) short GRB afterglows and hosts



Gehrels 2007

- Short and long GRBs have different host galaxies and different locations within their host galaxies: long GRBs in star-forming regions of star-forming galaxies, short GRBs from older stellar populations of elliptical galaxies, sometimes ejected outside their host.

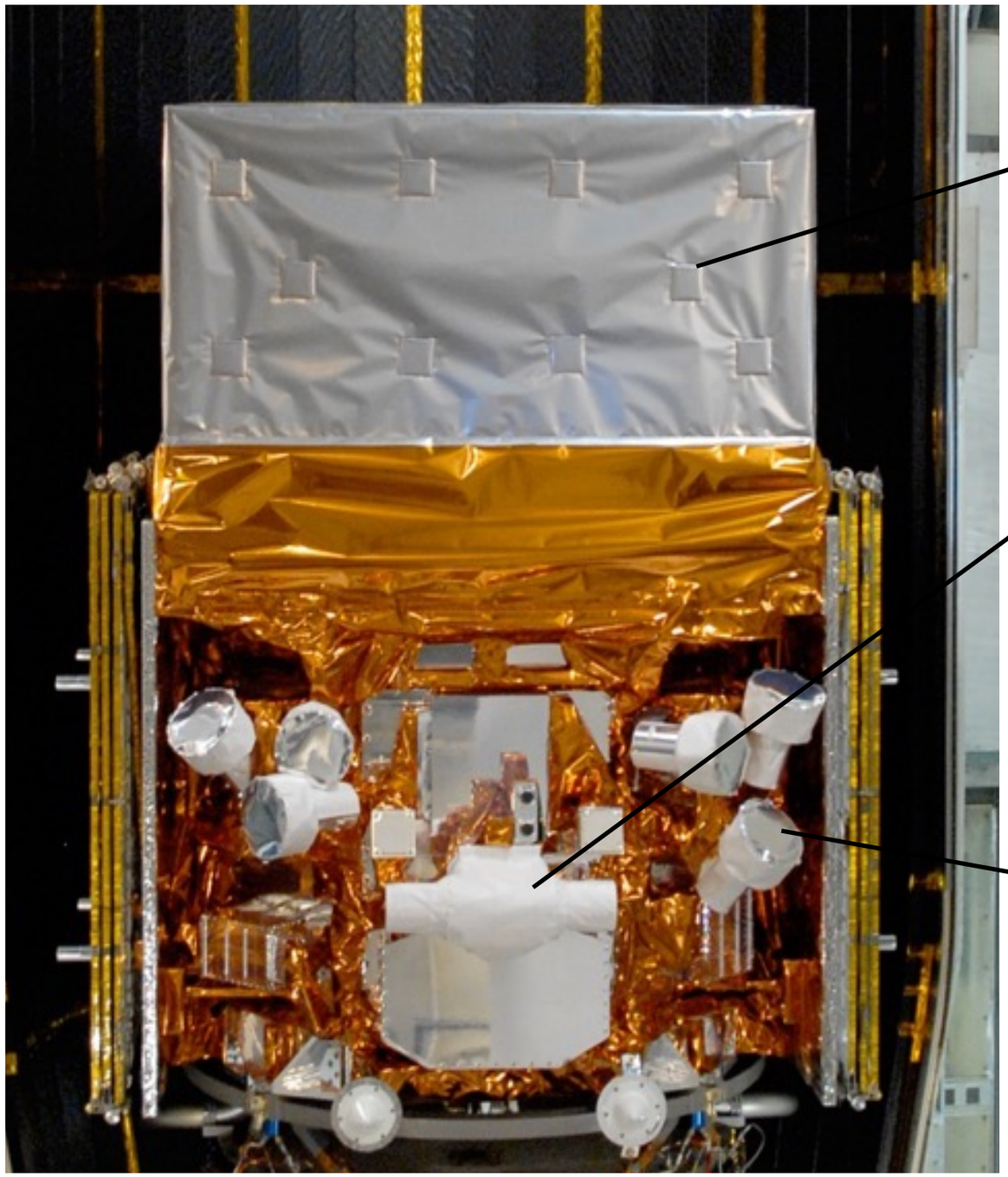
Breakthroughs with Swift: (iv) many more afterglows enable GRBs to be used as a probe of the high redshift universe



Most distant GRB: z=8.2 (090423) z=9.4? (090429)

Salvaterra et al. 2012

The Fermi Era: remembering the gamma rays in GRBs!

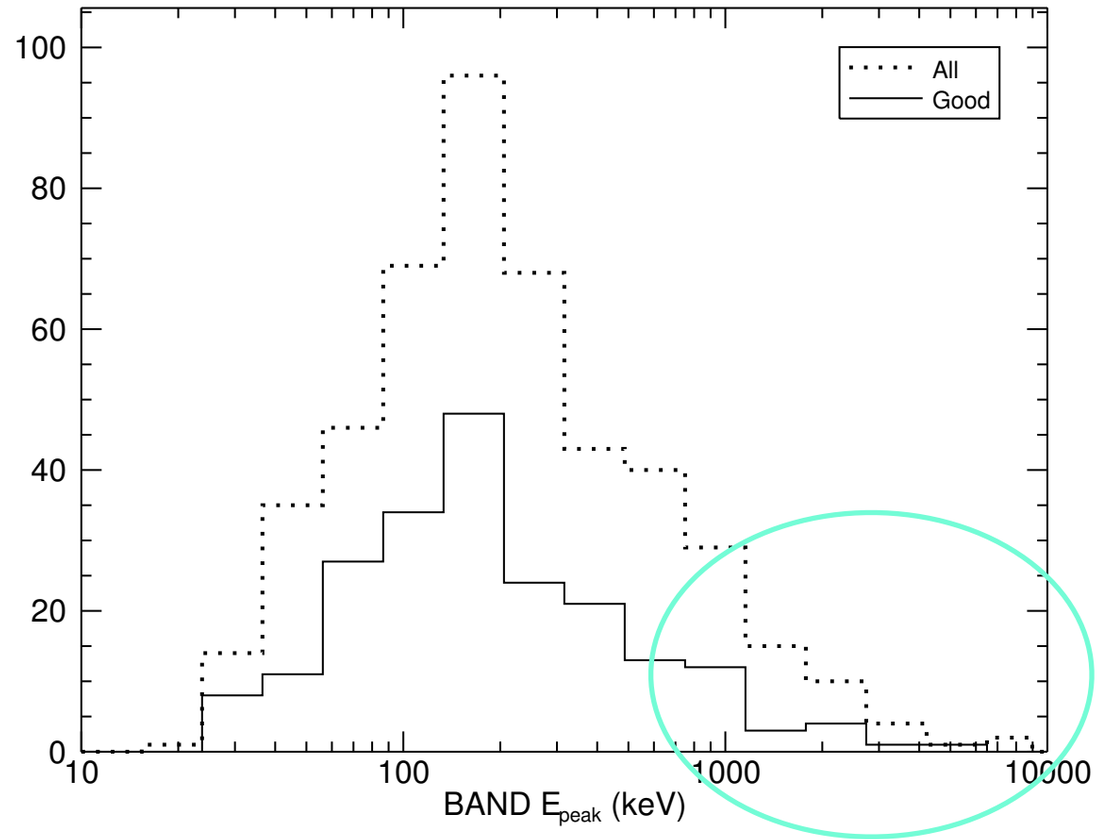


The Large Area Telescope (LAT)
20 MeV -- 300 GeV

GBM BGO detector.
200 keV -- 40 MeV
126 cm2, 12.7 cm
Spectroscopy
Bridges gap between NaI and LAT.

GBM NaI detector.
8 keV -- 1000 keV
126 cm2, 1.27 cm
Triggering, localization, spectroscopy.

GRB spectra: the Band function revisited by GBM using a broader energy band than with BATSE



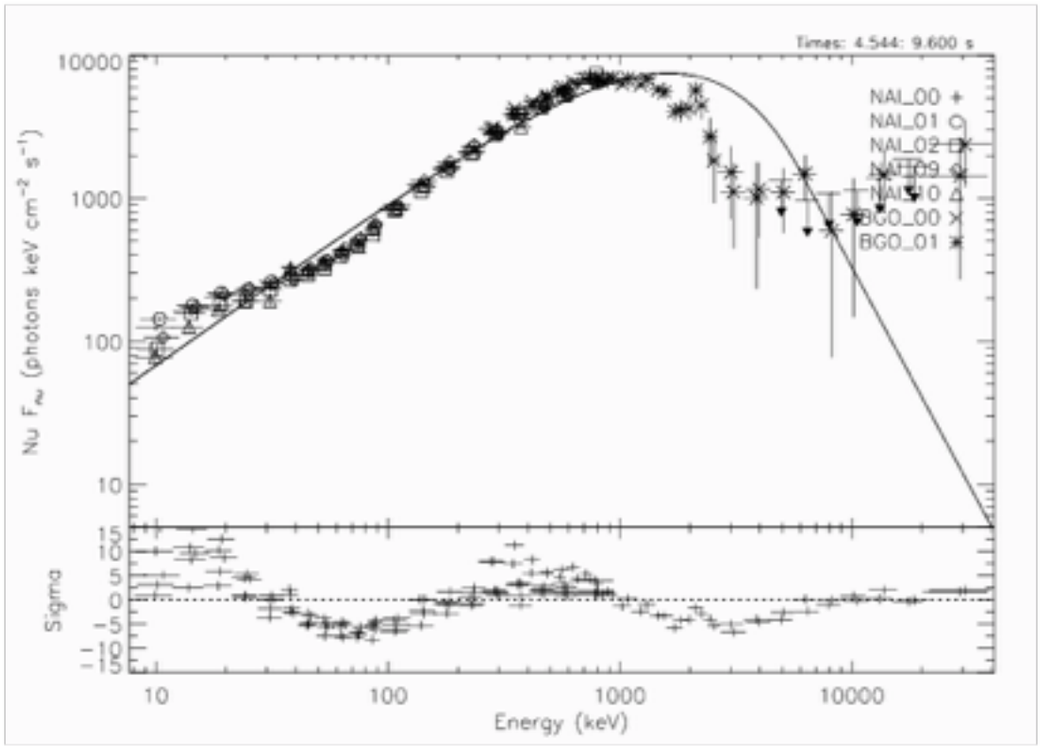
Extending the EPeak distribution:
Better study of short bursts.

Goldstein et al. 2012

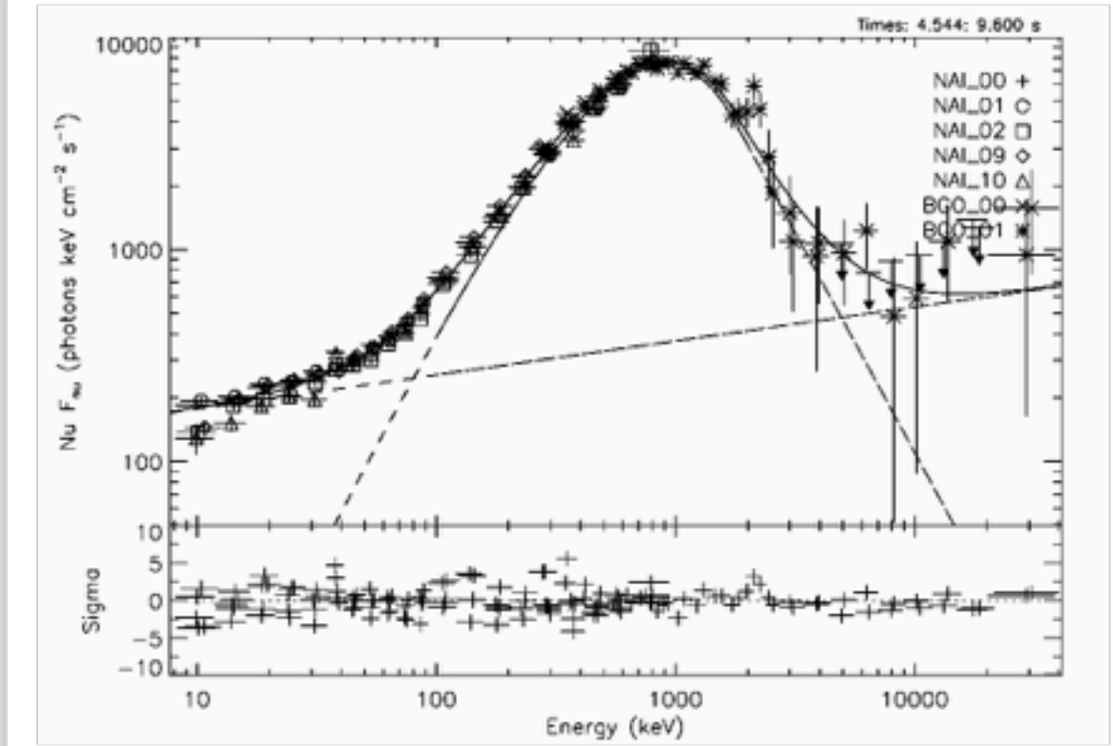
- Fermi GBM and LAT allow us to probe the gamma-ray spectra and thus physical mechanisms and energetics of the prompt GRB emission

GRB spectra: the Band function doesn't always work very well

GRB 090902B

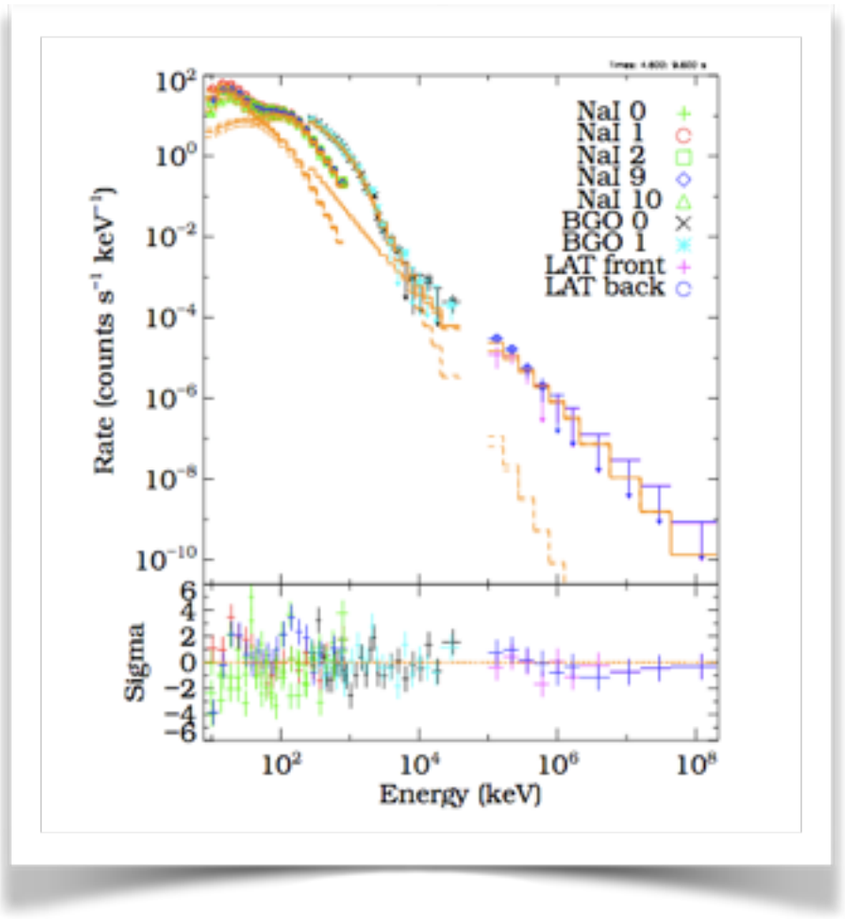


Deviations from Band function at LE

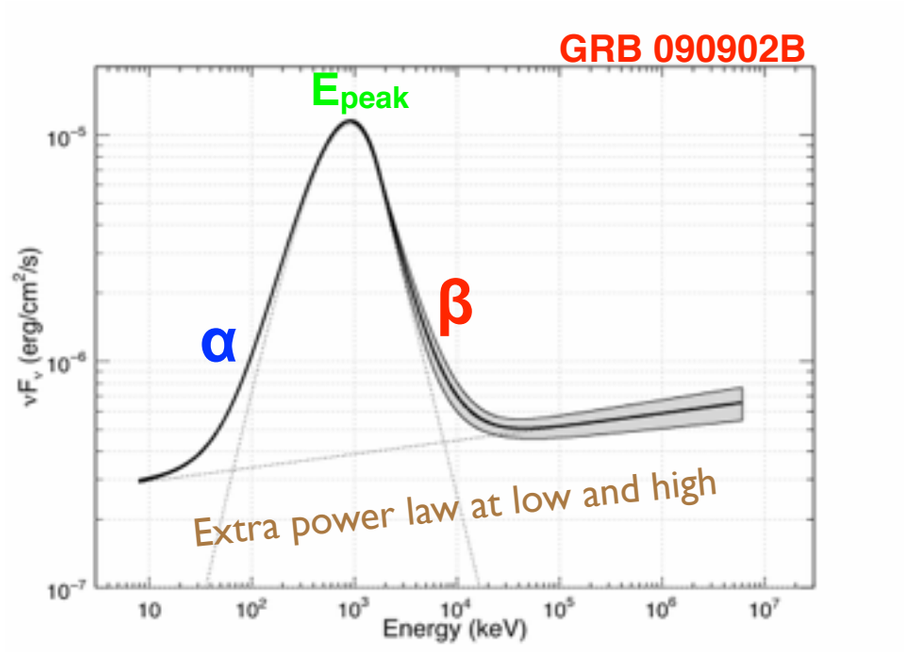


Addition of power-law improves fit

High-energy emission from GRBs: extra spectral components to the prompt emission and extended temporal emission appear common > 100 MeV!

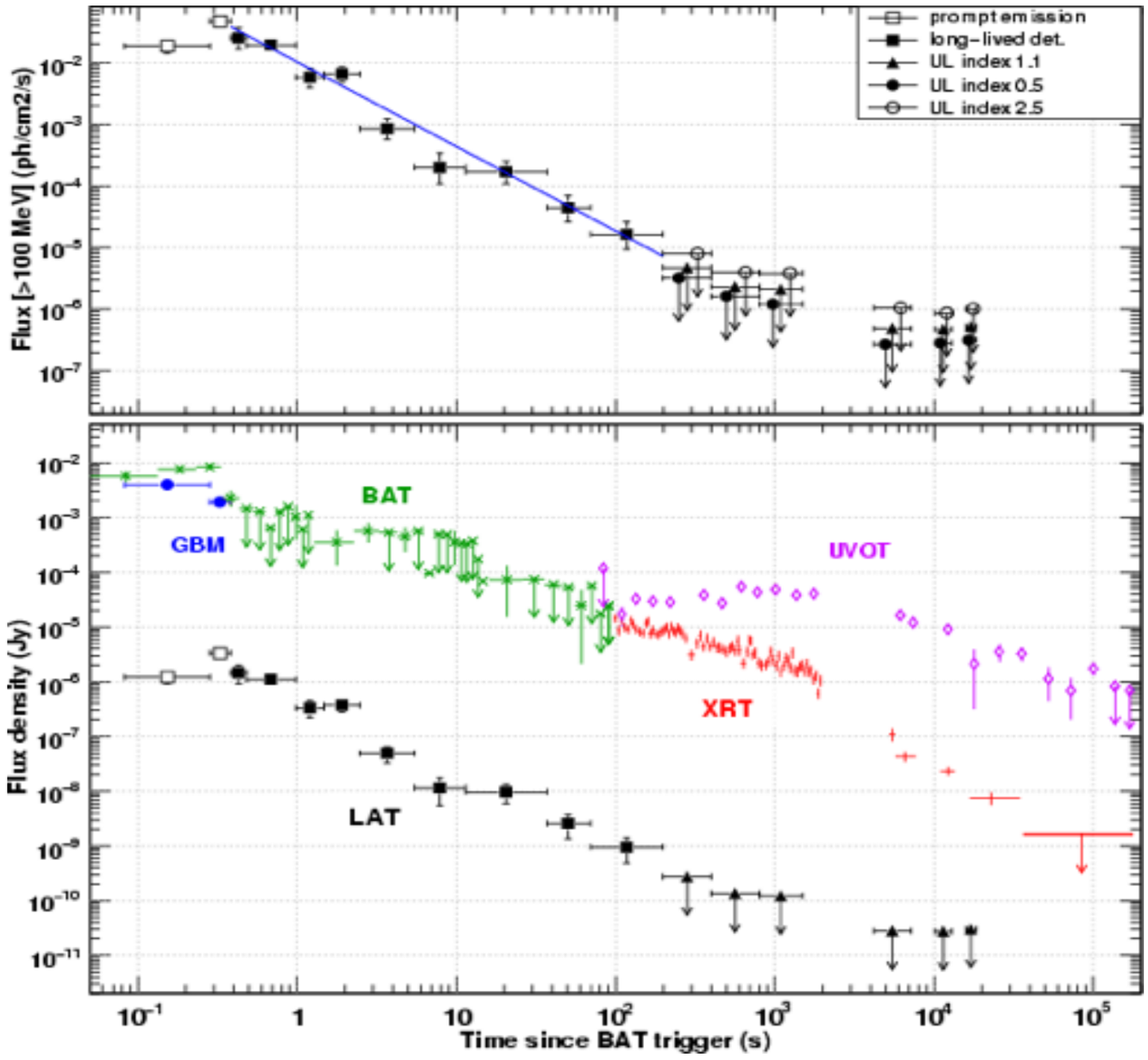


GRB090902b: LAT data consistent with additional power-law.



Abdo et al '09

High-energy temporally extended emission: prompt or afterglow? Swift and Fermi together observe GRB 090510

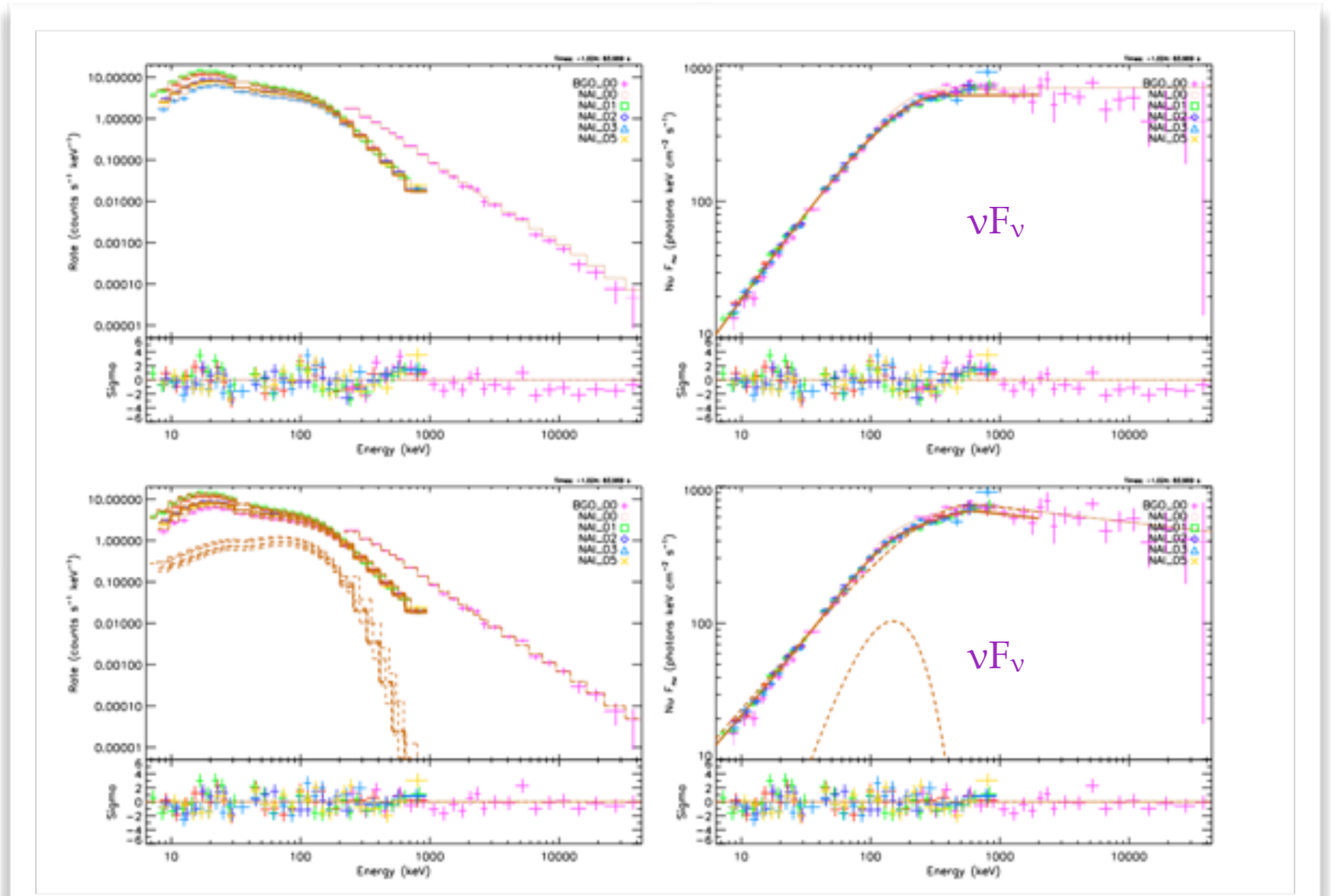


de Pasquale et al. 2010

Thermal emission from GRBs?

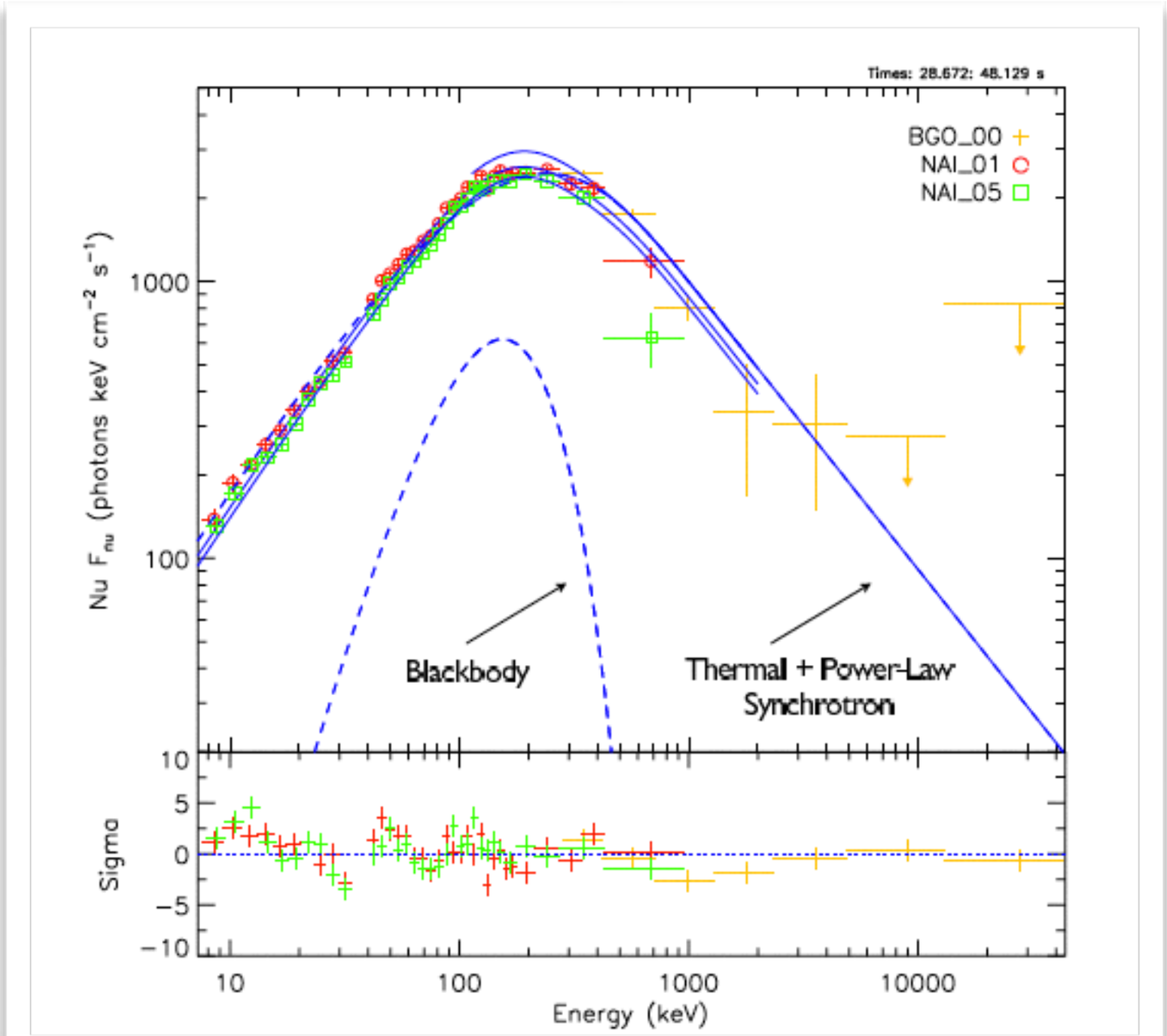
GRB100724B: Count spectra show systematic deviations in "heart" of GBM energy range.

Count spectra residuals improve with addition of blackbody.



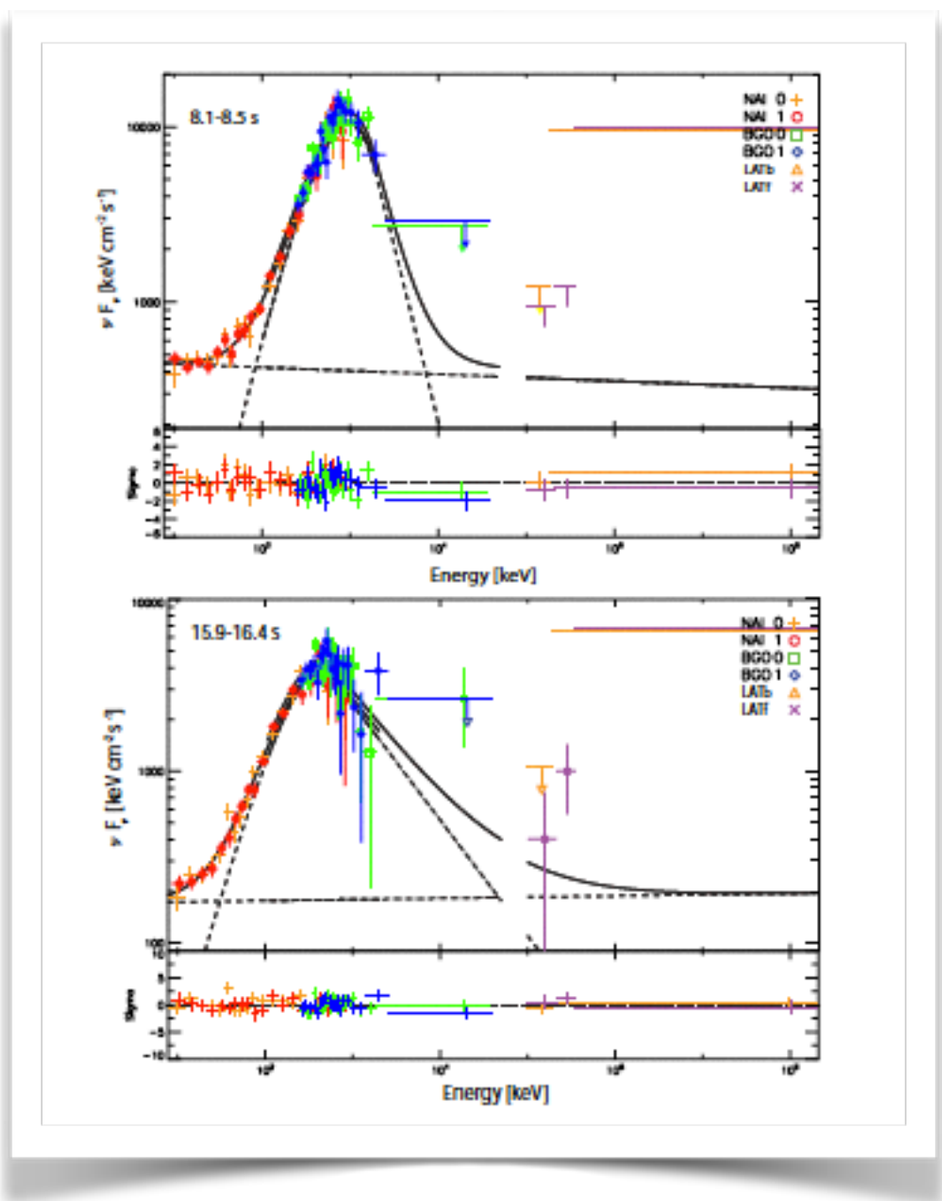
Guiriec et al., 2011

GRBs: Physical Modeling (i) Synchrotron



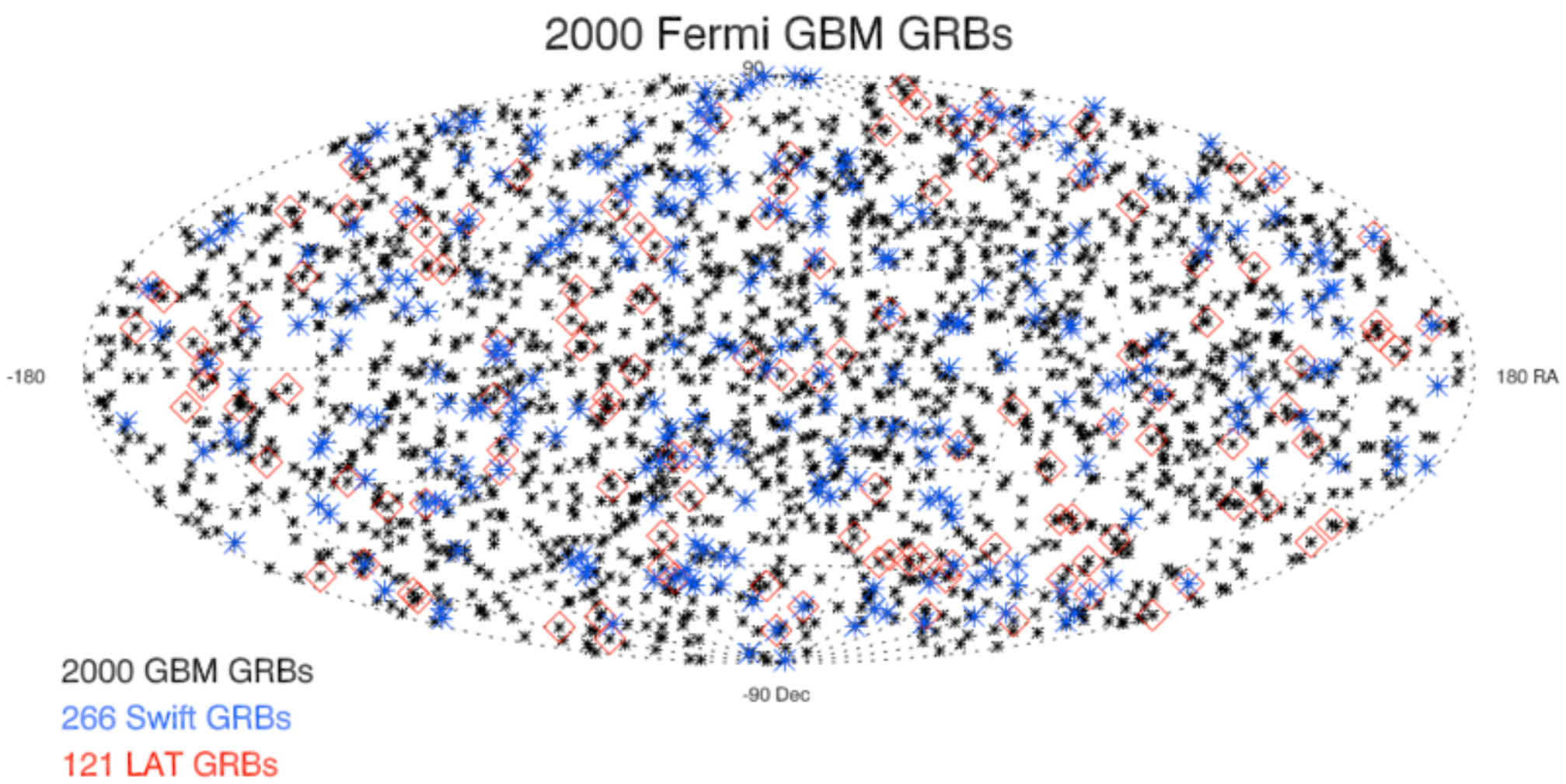
GRB 090820
Burgess et al. 2011

Physical Modeling: (ii) Photospheric models



GRB 090902B
Ryde et al. 2011

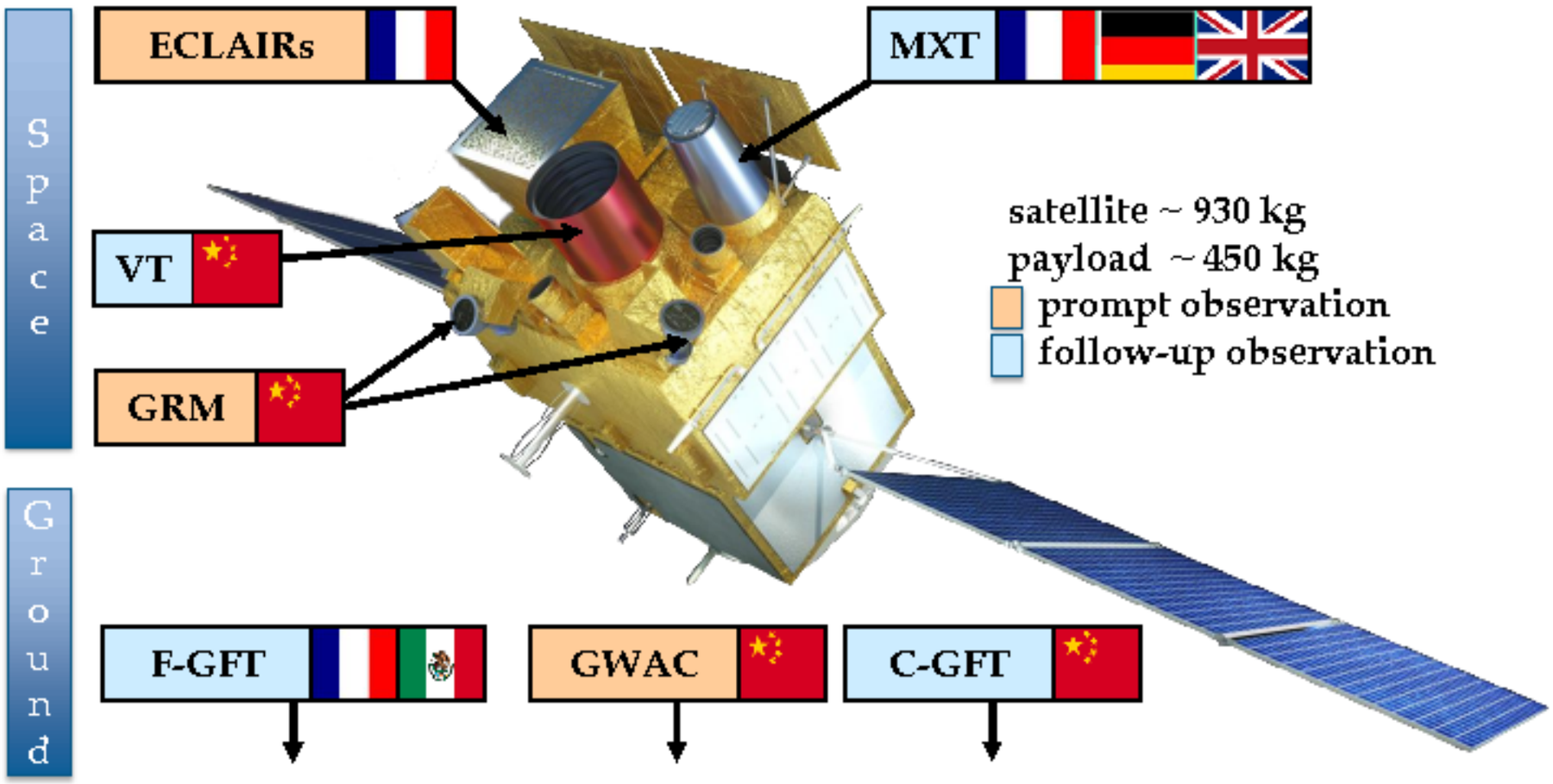
A golden era: Swift and Fermi together



- Swift BAT triggers on 1 in 7.5 GBM-triggered GRBs. Swift allows efficient afterglow and host observations - GBM excellent spectral data for the prompt emission. 6% of GBM-detected GRBs are detected by the LAT above 100 MeV. This joint Swift-GBM-LAT sample is a golden sample of GRBs in spectral, temporal, and afterglow observational coverage.

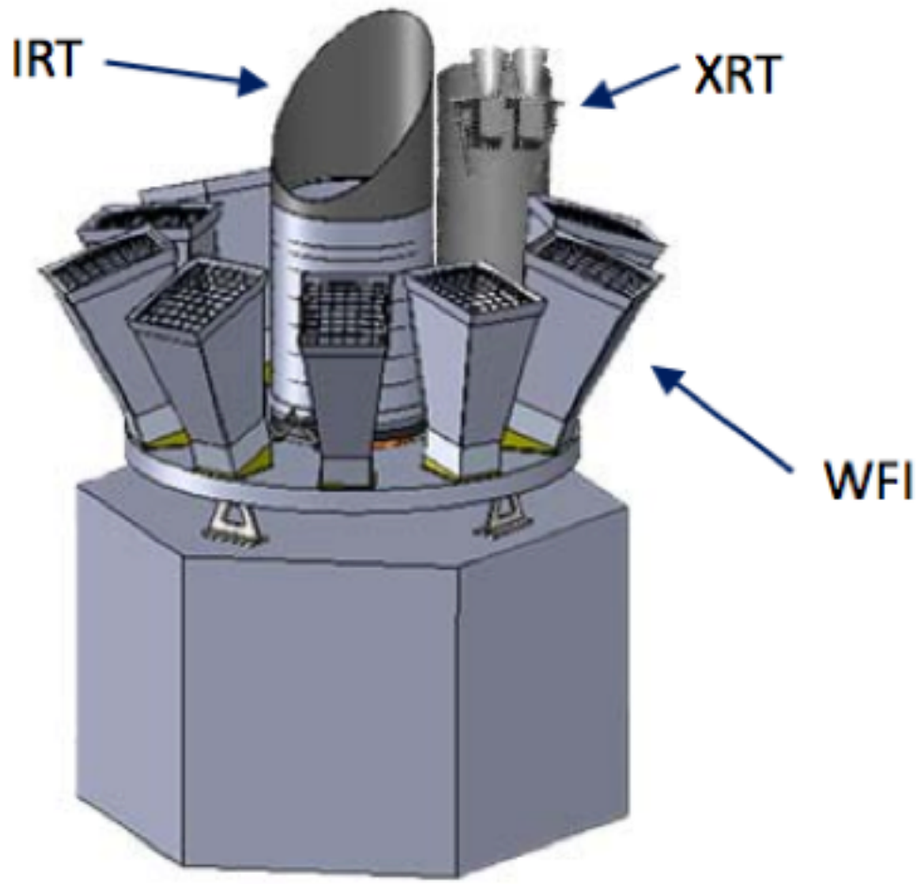
- For GRBs detected by LAT and not triggered by Swift BAT Neil was exuberantly in favor of repointing Swift XRT - and we asked him often! Fortunately XRT afterglows of LAT-detected GRBs are usually bright and long-lasting (except the short GRBs) so we are typically well rewarded!

SVOM: continuing Swift's legacy



- SVOM combines the rapid X-ray positions needed for afterglow observations with the gamma-ray coverage necessary for spectral analysis and a broad network of optical follow-up.

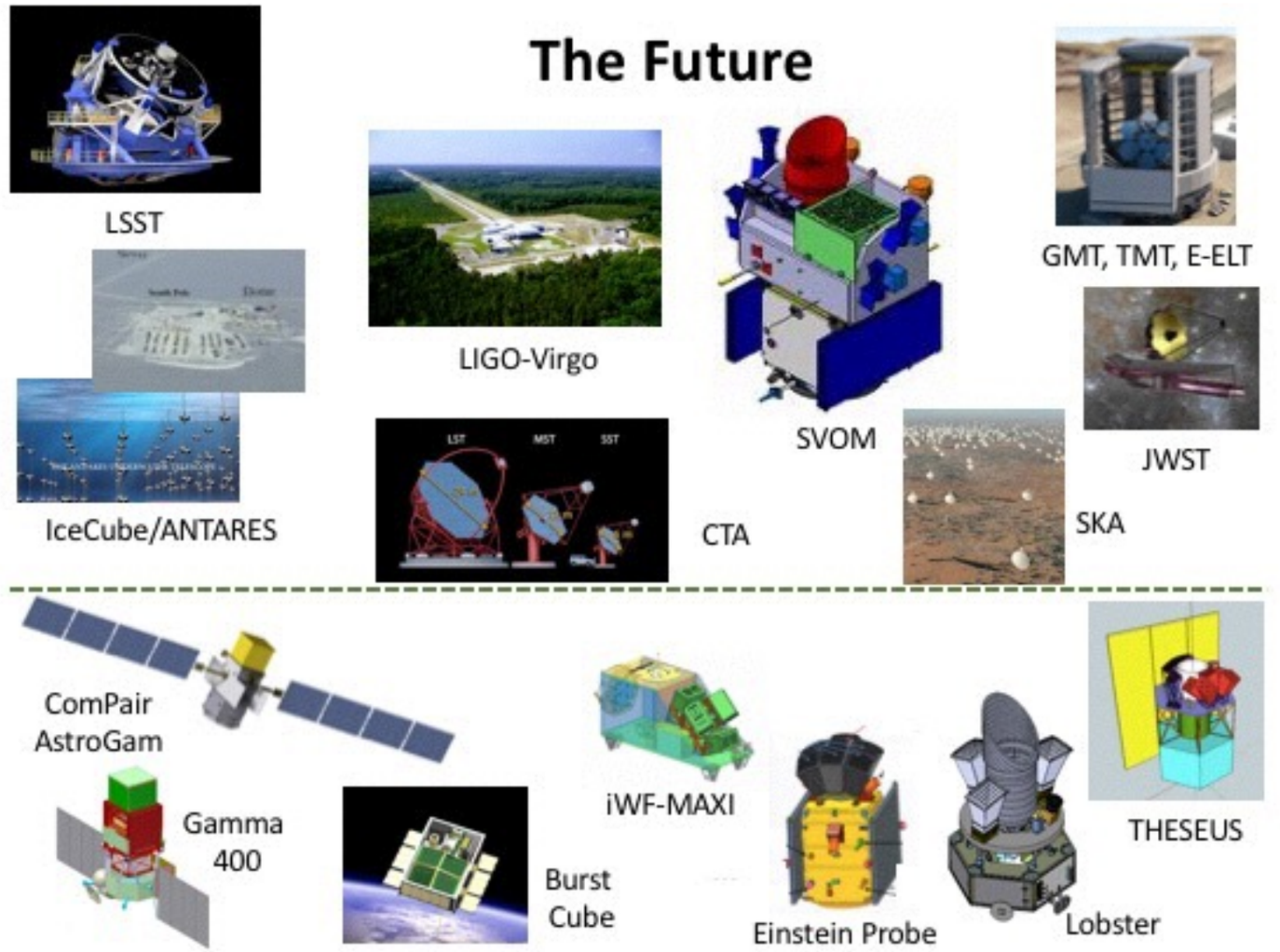
Neil's philosophy: the most important thing is rapid, accurate X-ray positions. His future experiment: (i) broad sky coverage with excellent X-ray positions and (ii) on-board redshift determination for high-z GRBs



Transient Astrophysical Probe (TAP) concept submitted as White Paper to call from NASA and funded for study. (Camp and Gehrels 2017)

- In the gravitational wave era, why bother with gamma-ray emission? Go straight to the X-ray measurement of short GRBs! (not sure I quite agree here… we had many discussions!)

Neil's vision of the future from the GRB meeting in Huntsville, October 2016



- Opening presentation from Neil. I co-organized two of the Huntsville series GRB meetings with Neil and remember most his enthusiasm for communication and sharing science in conferences and workshops. He would certainly be here with you in QianNan!