On The Lack of LAT Detected GRBs

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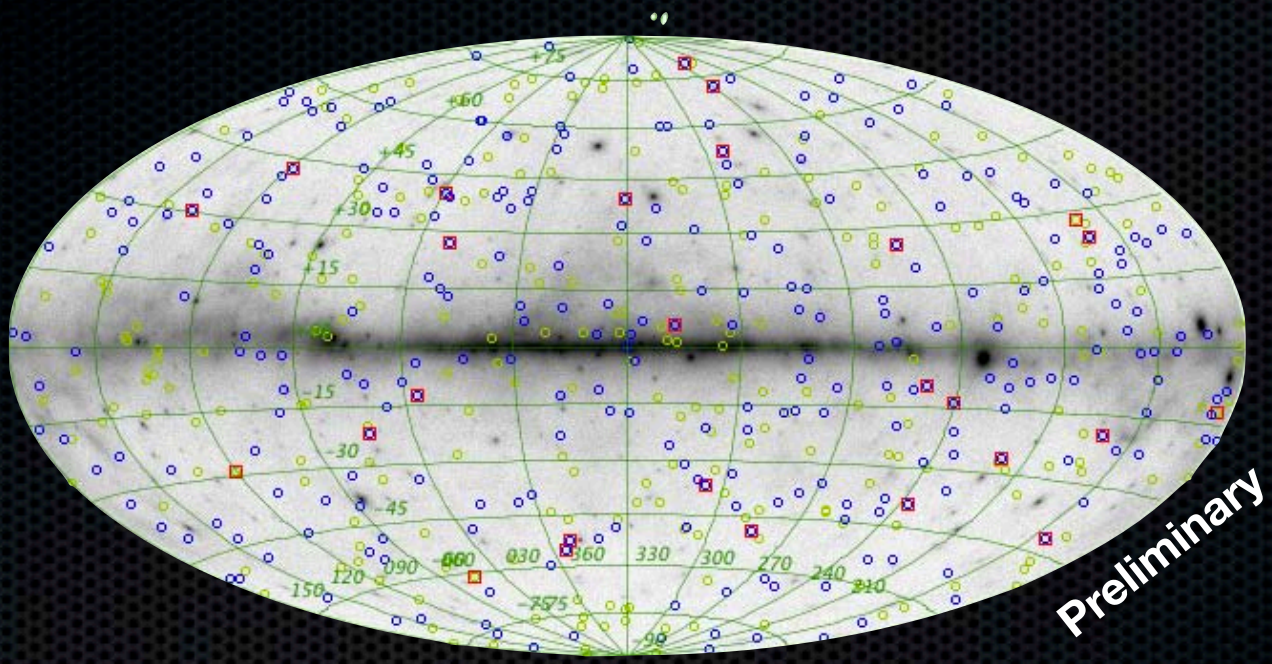
On behalf of the Fermi collaboration

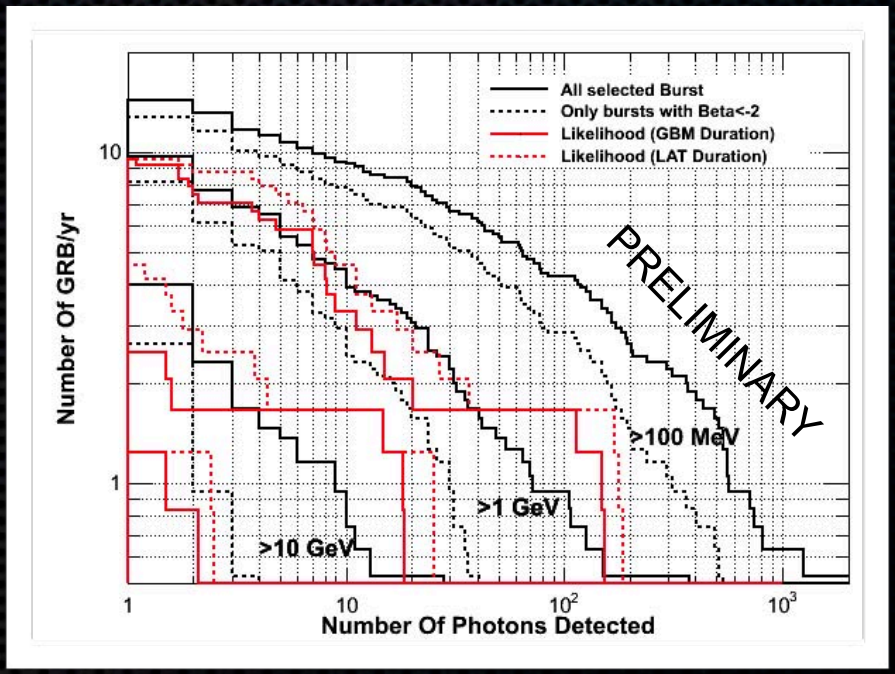
Fermi GRB Detections



- GBM Detected GRBs (until March 1st): 620 - Blue
- GRBs in LAT FOV: 288 (46%) - Green
- LAT Detected GRBs (>100 MeV): 23 (8%) - Red
- LAT LLE Only Detected GRBs: 5 (2%)

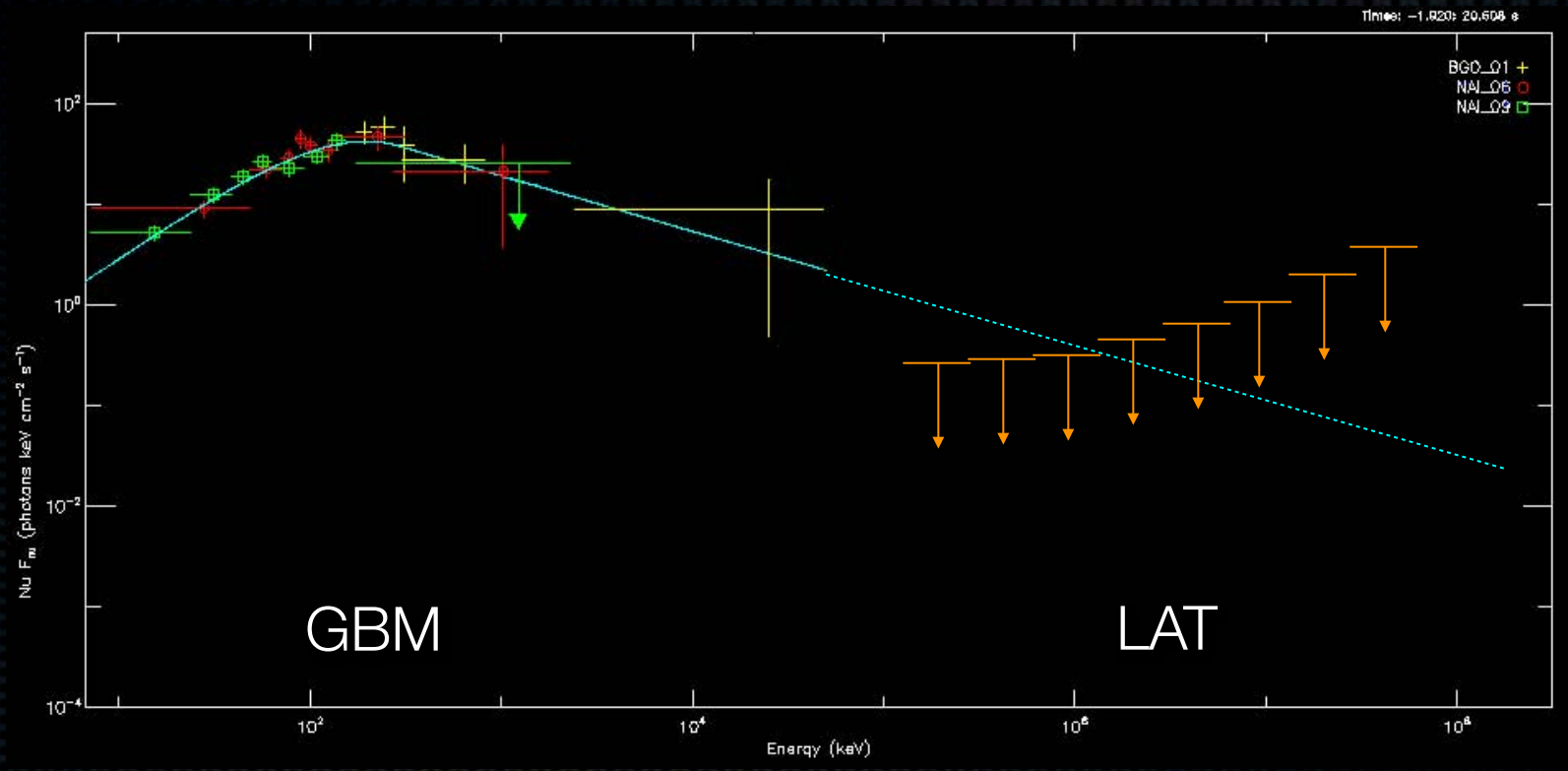
Expected Detection Rate

- Take BATSE spectra, extrapolate and compare to actual detection rate
  - Predicted: 9.3 GRBs/year > 100 MeV
  - Observed: 8.0 GRBs/year > 100 MeV
- This includes GRBs with extra components
- We are seeing fewer GRBs then predicted, especially at GeV energies
- Possible explanations
  - High energy emission is suppressed
  - Extrapolations are uncertain
- Extra components must be rare!



Omodei's Presentation

Spectral Fits

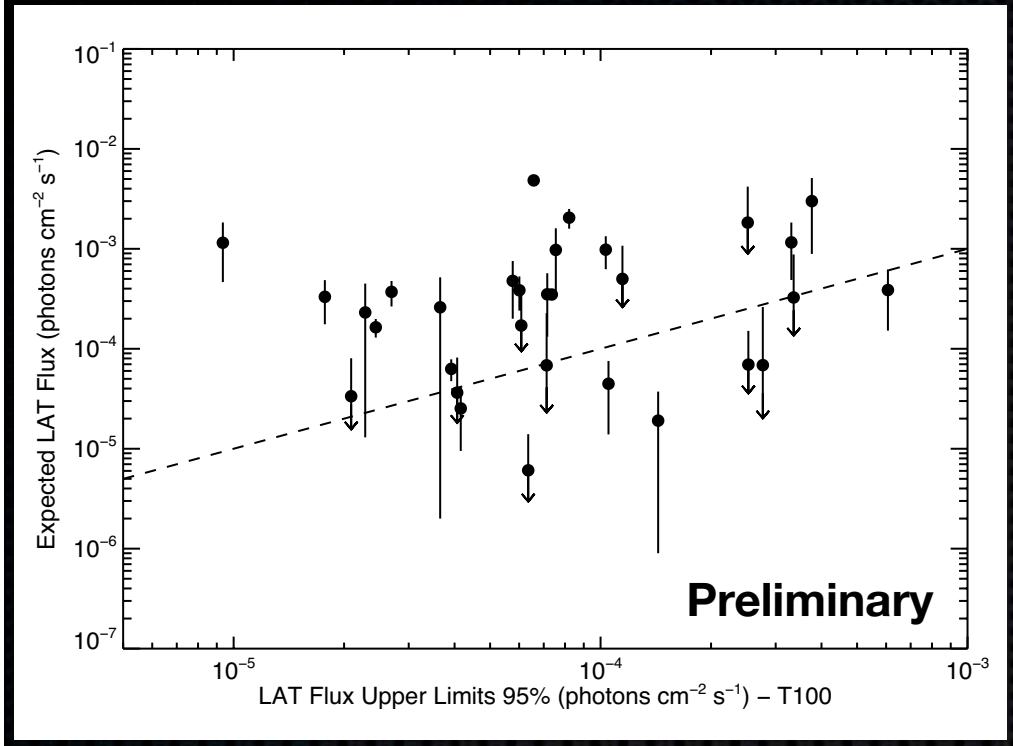


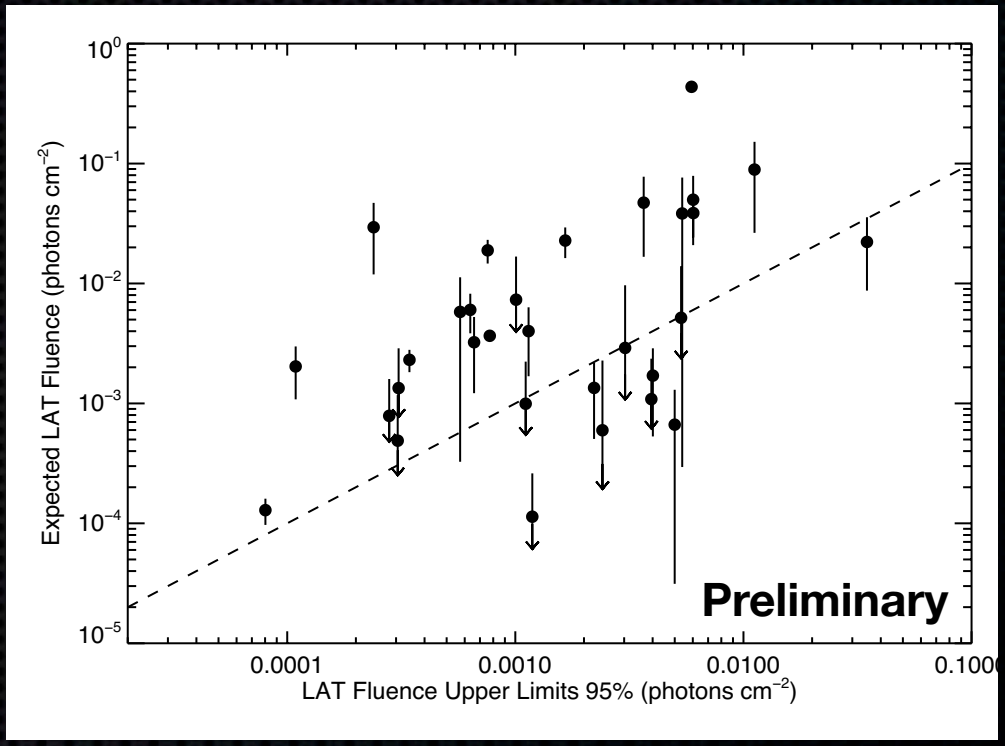
- Fit NaI+BGO spectrum from 8 keV to 40 MeV in RMFIT
- Estimate the expected flux in the 100 MeV to 10 GeV range
- Compare upper limits to the expected LAT flux

Spectroscopic Sample

- Bright BGO Sample:
  - GRBs with 70 cts/s in BGO in LAT FOV: 92
  - "LAT Dark GRBs" (i.e. no LAT detection)
- "Gold" Sample:
  - Number of bright BGO GRBs with ΔBeta < 0.5: 30
- Expected LAT Flux
  - Extrapolate β to find expected LAT flux
  - We use the full covariance matrix to estimate beta error

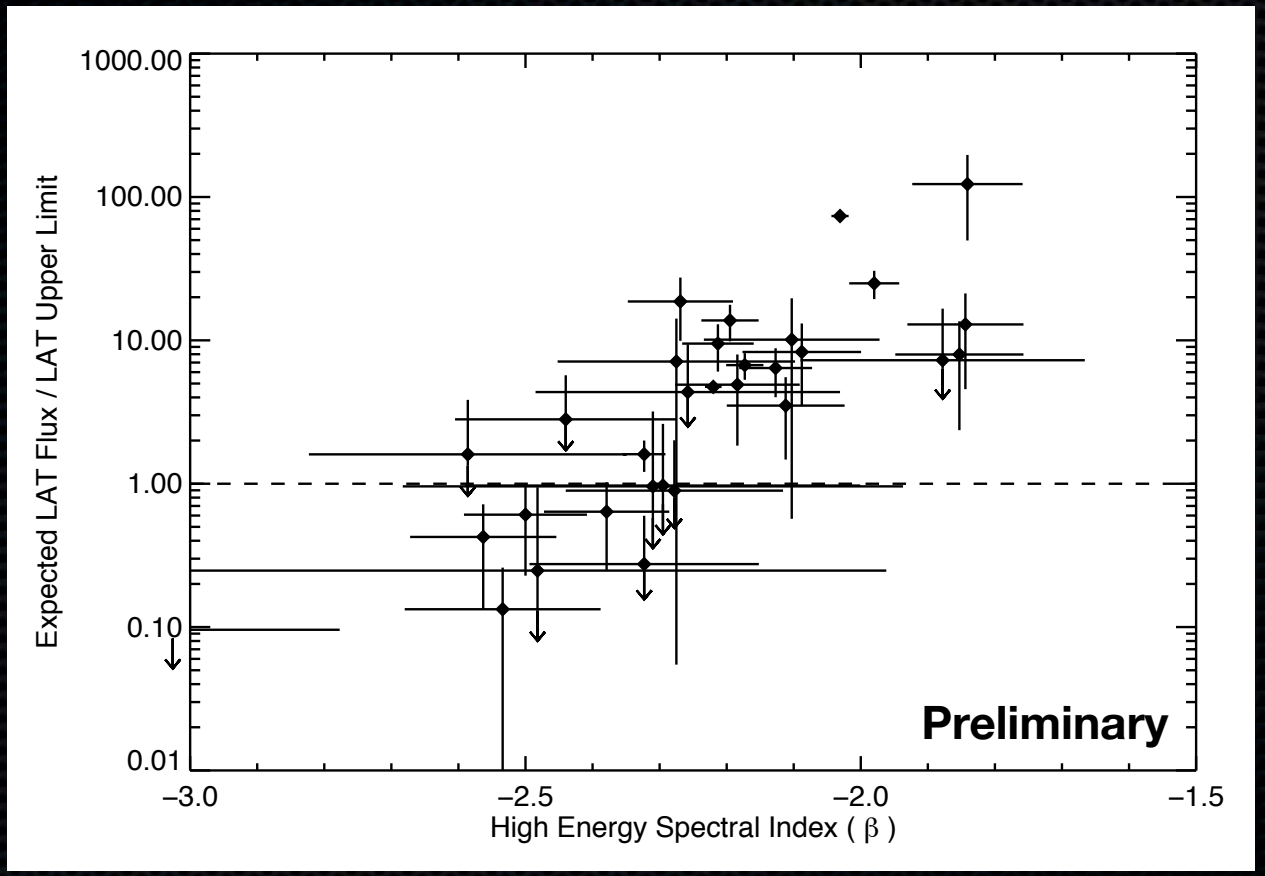
Expected Flux Comparisons





- 15 of the 30 GRBs have expected photon flux that exceed the T90 LAT photon flux upper limit
- Same for the expected photon fluence and LAT fluence upper limit

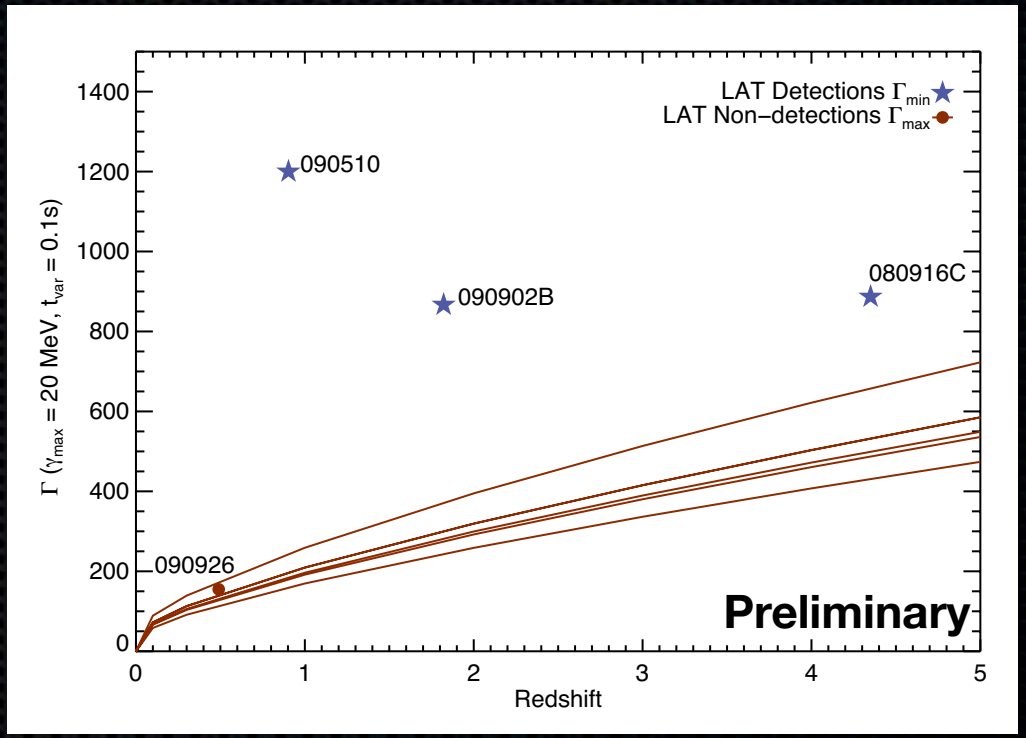
Beta vs Ratio



- GRBs with values of $\beta > -2.2$ typically exceed the LAT upper limits

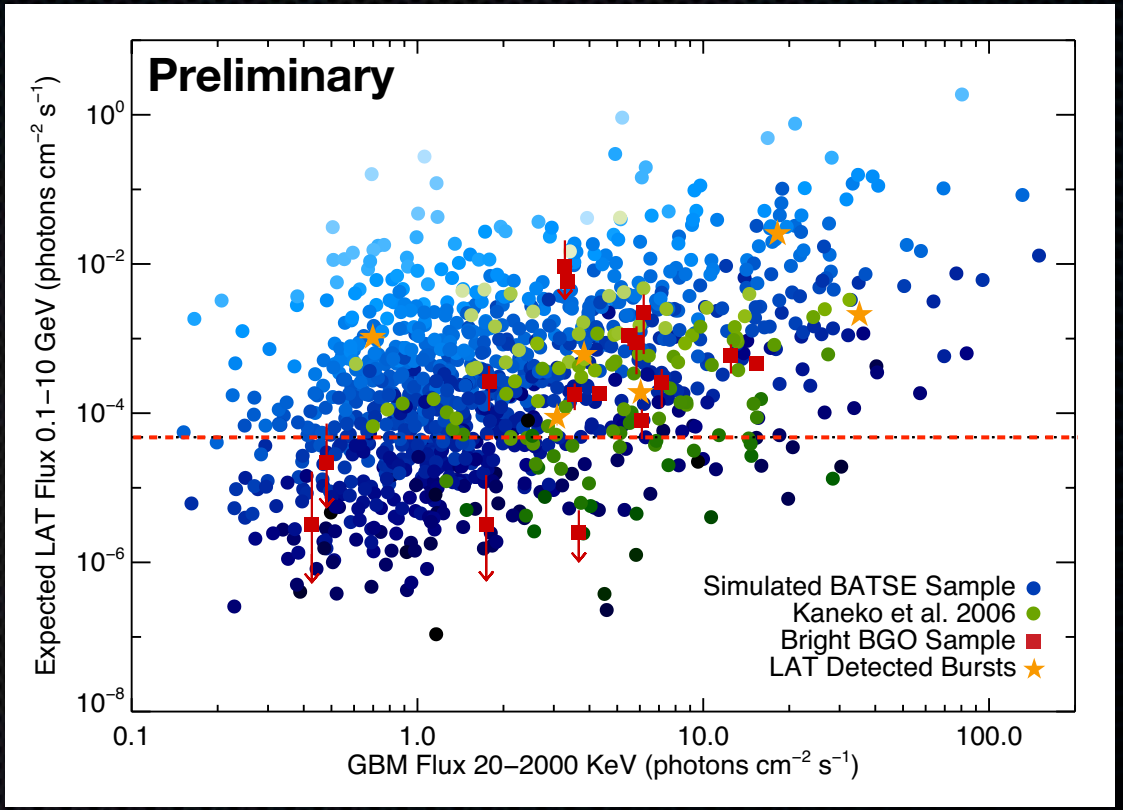
Lorentz Factor Distribution

- 3 LAT detected bursts have $\Gamma_{min} > 800$
- For 6 LAT dark GRBs:
  - $\Delta t \sim 0.01$s and $1 < z < 5$
  - If we assume $E_c \sim 100$ MeV
    - $\Gamma_{max} \sim 50$-600
- LAT bursts may represent the high end of the Γ distribution
- LAT dark bursts may represent the low end of the Γ distribution



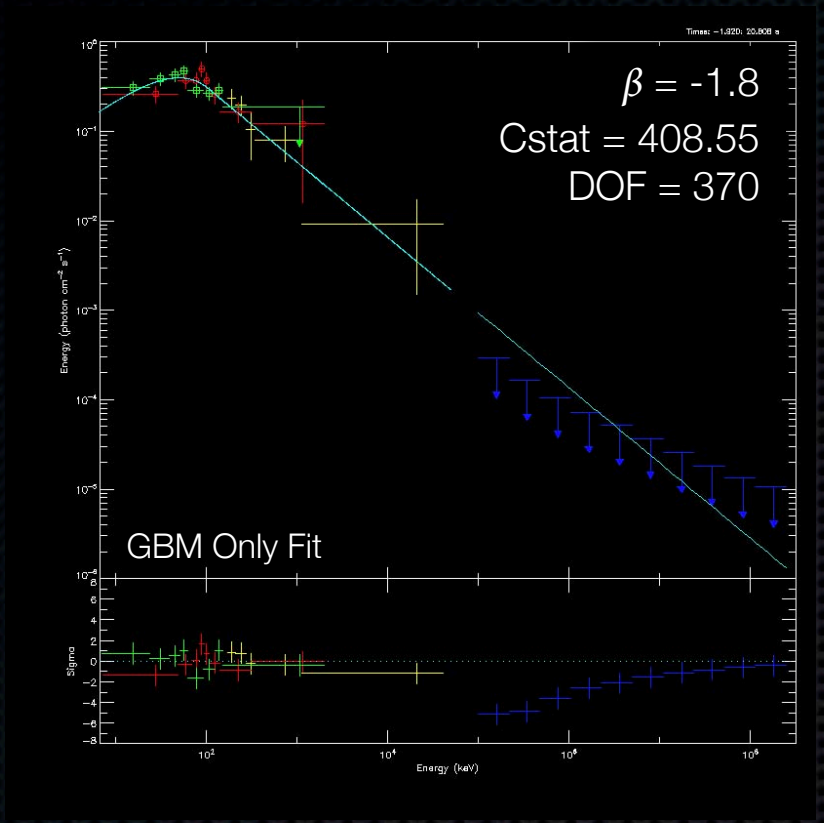
Expected LAT Flux

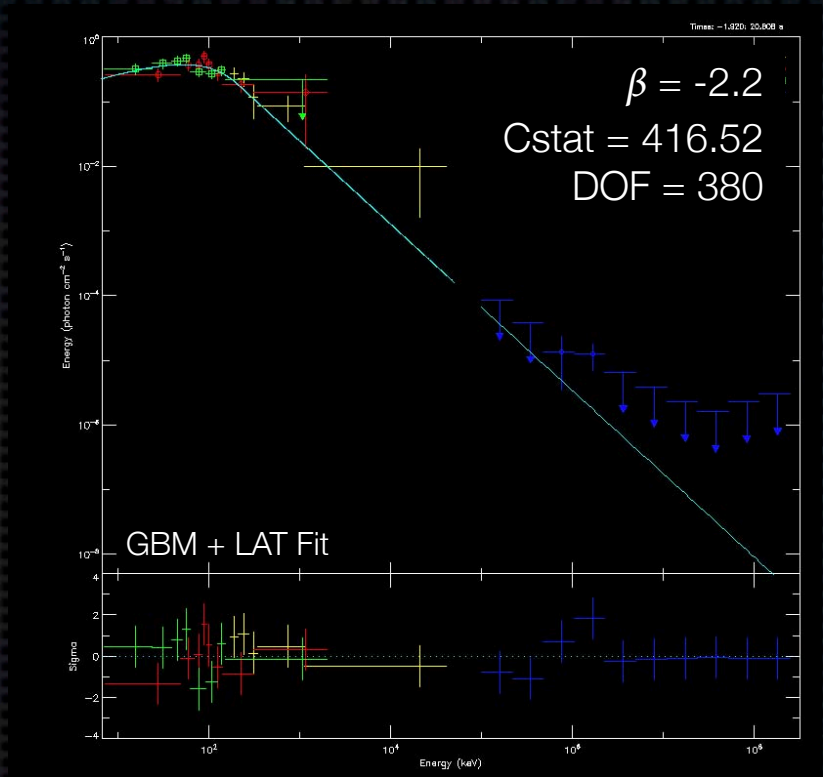
- Simulate a population of GRBs using BATSE E_{pk}, α, and β distributions
- Roughly 65-75% of a simulated BATSE sample have expected flux values that exceed the median 30s LAT sensitivity



- High energy extrapolations must be misleading in order to explain the number of LAT "dark" bursts

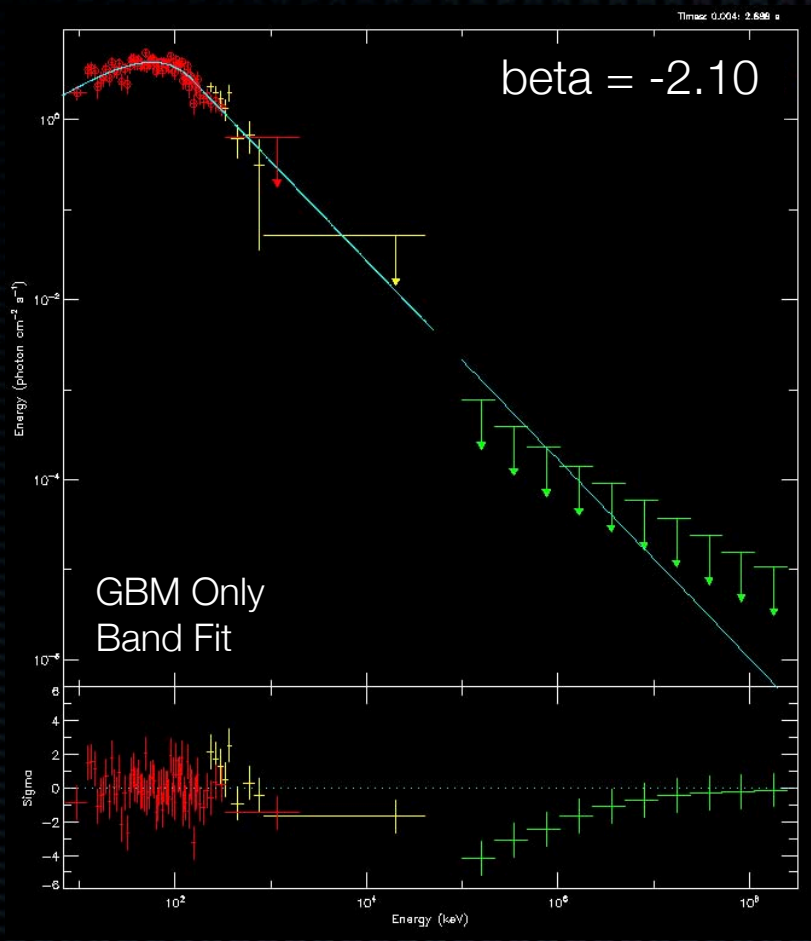
Joint GBM+LAT Spectral Fits

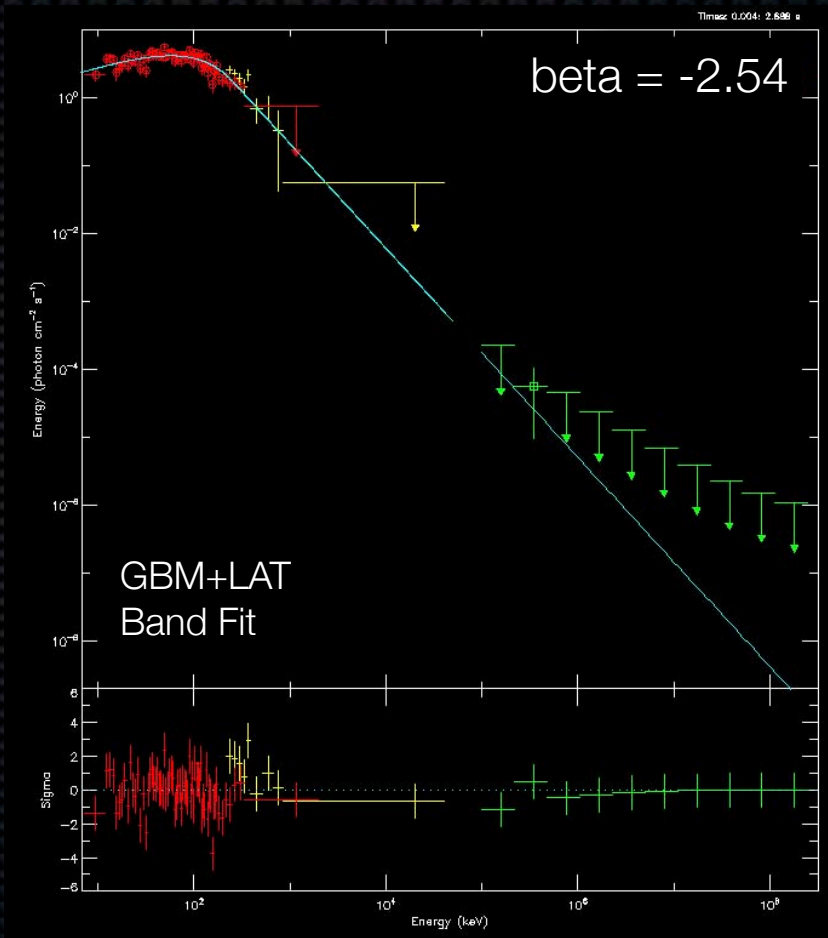




- Very different beta value if we include LAT limits in the spectral fits.
- For bright BGO sample, median β = -2.2 -> -2.5
- Which fit is statistically preferred?

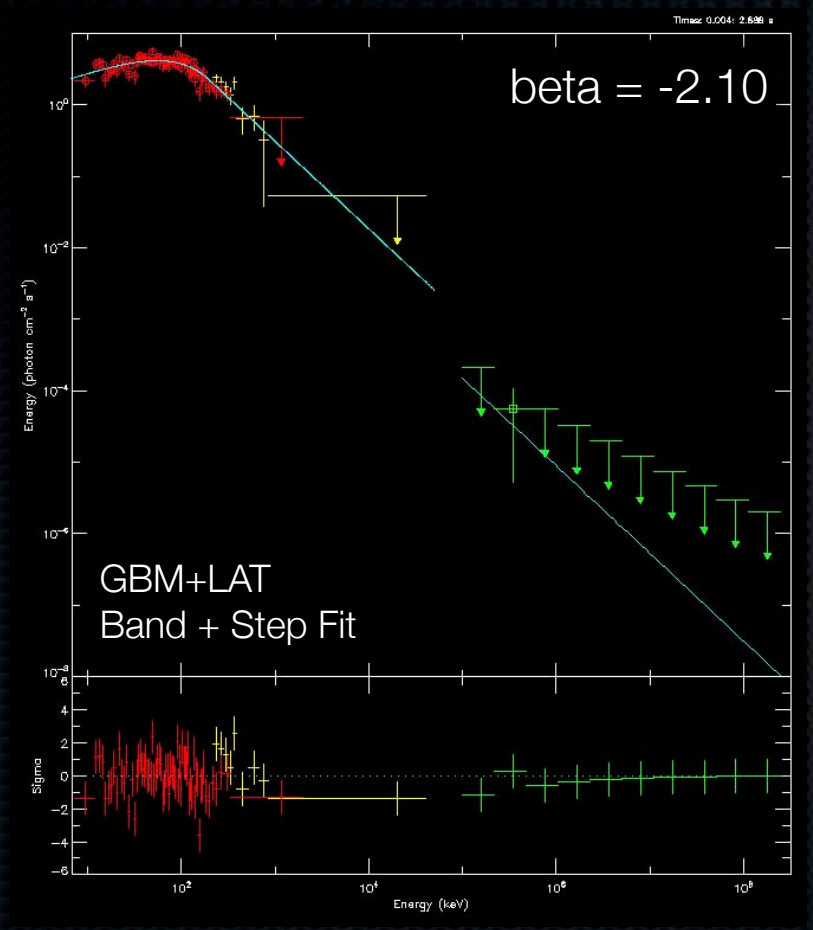
Model Comparisons?

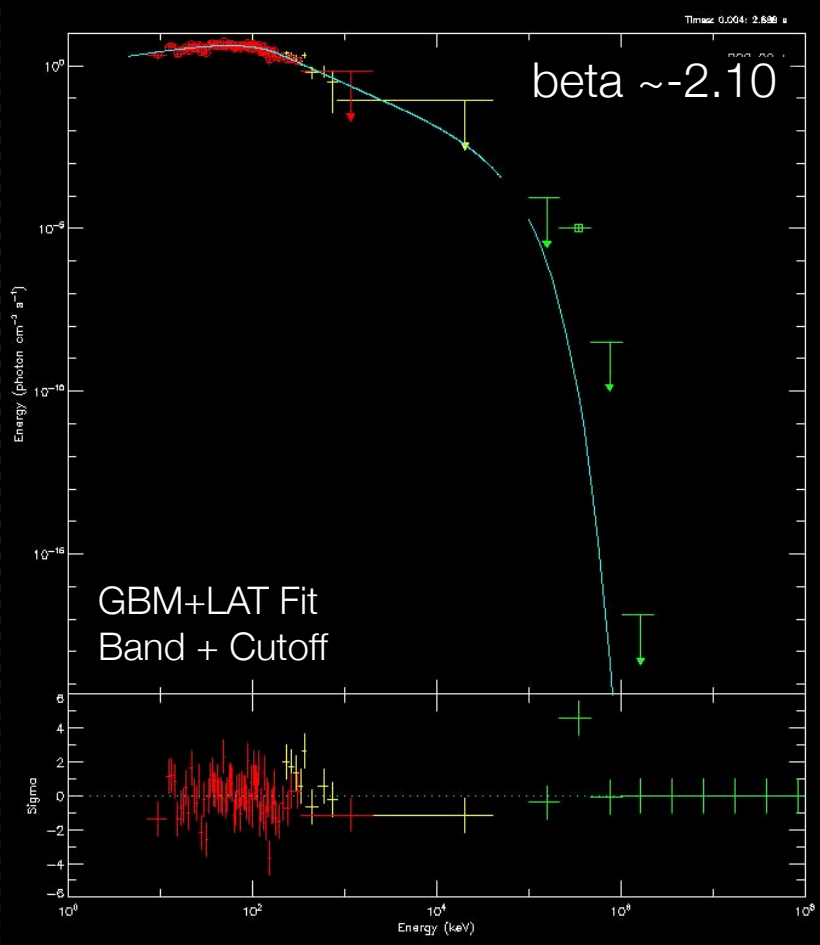




We cannot statistically compare these two scenarios using ΔC-Stat because we are using different data sets for the two fits

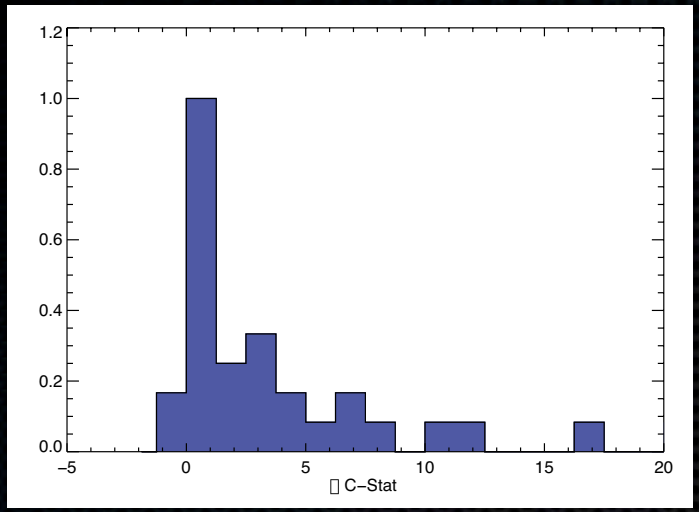
Nested Model Comparisons



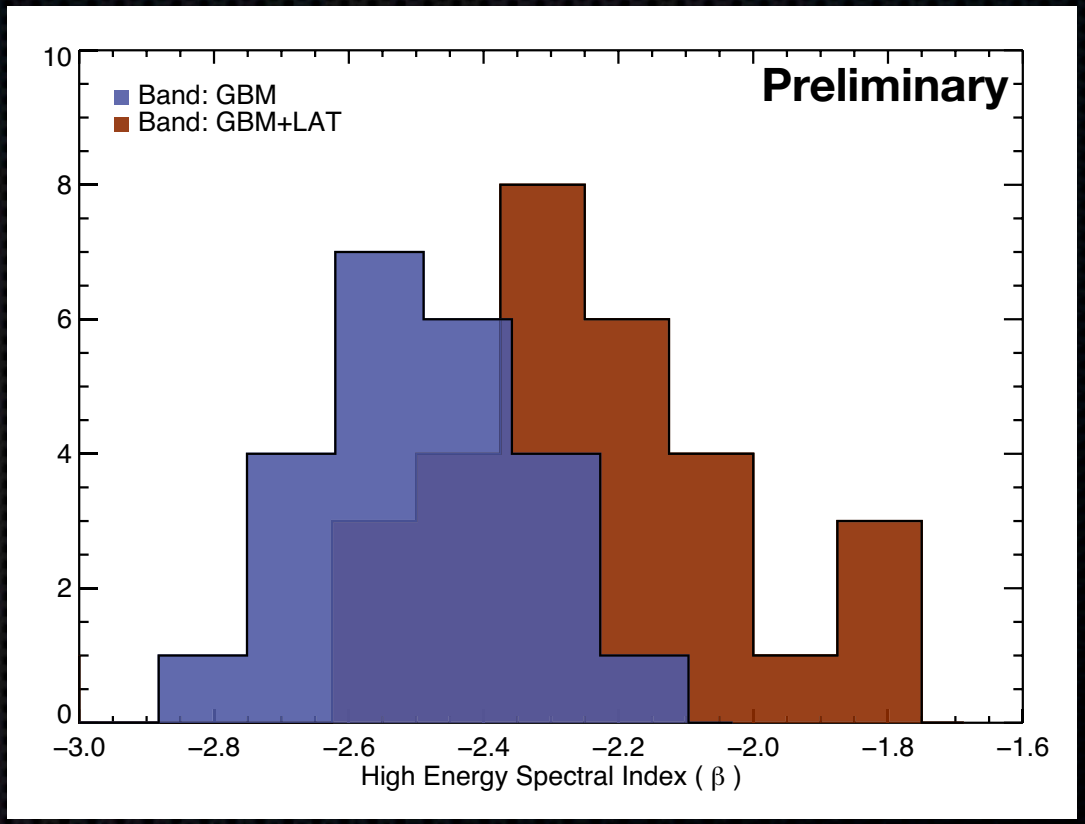


We have to compare the ΔC-stat values for the Band only, Band +Step Function, and Band+Cutoff fits to the same GBM+LAT data

ΔC-Stat

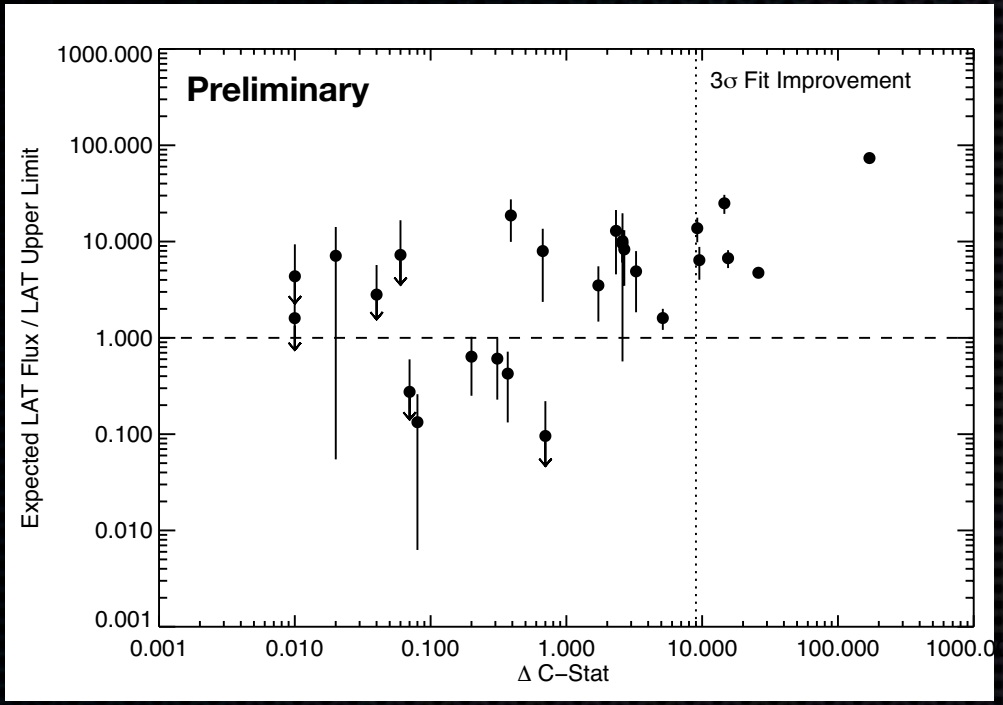


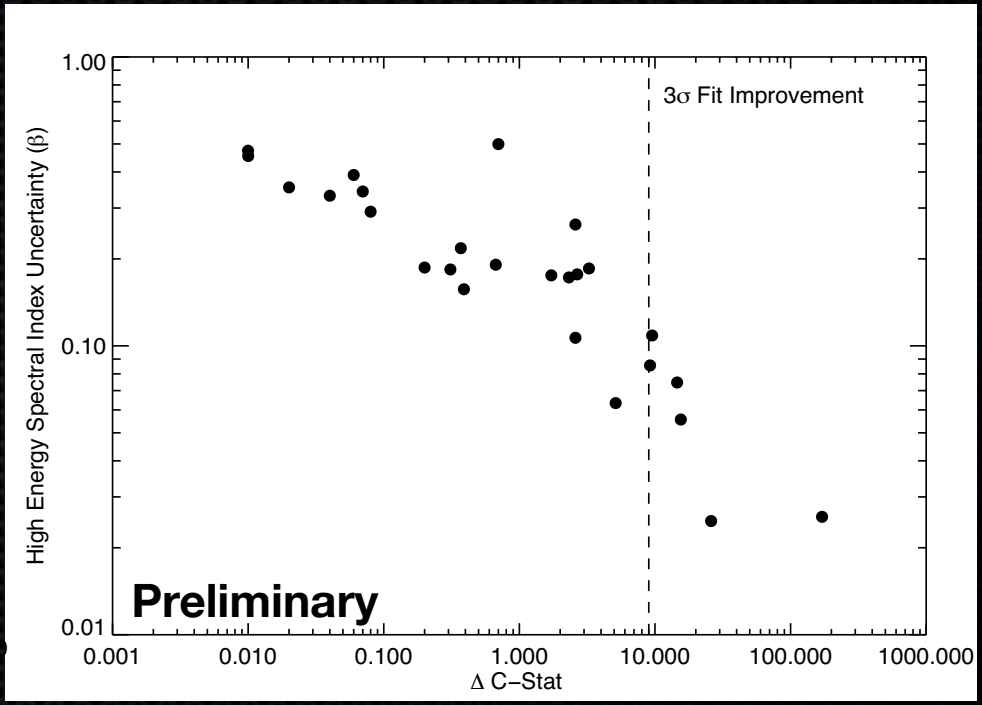
- Band vs. Band + Step Function, change of 1 degree of freedom
- Only 6 of 30 (20%) GRBs result in ΔC-Stat > 10
- We can reject the null hypothesis (the Band model) only for these bursts



- Band fit to GBM+LAT data results in softer beta values compared to fits to GBM data alone
- Possibly consistent with suggestions by Hascoet (this conference)

ΔC-Stat Correlations





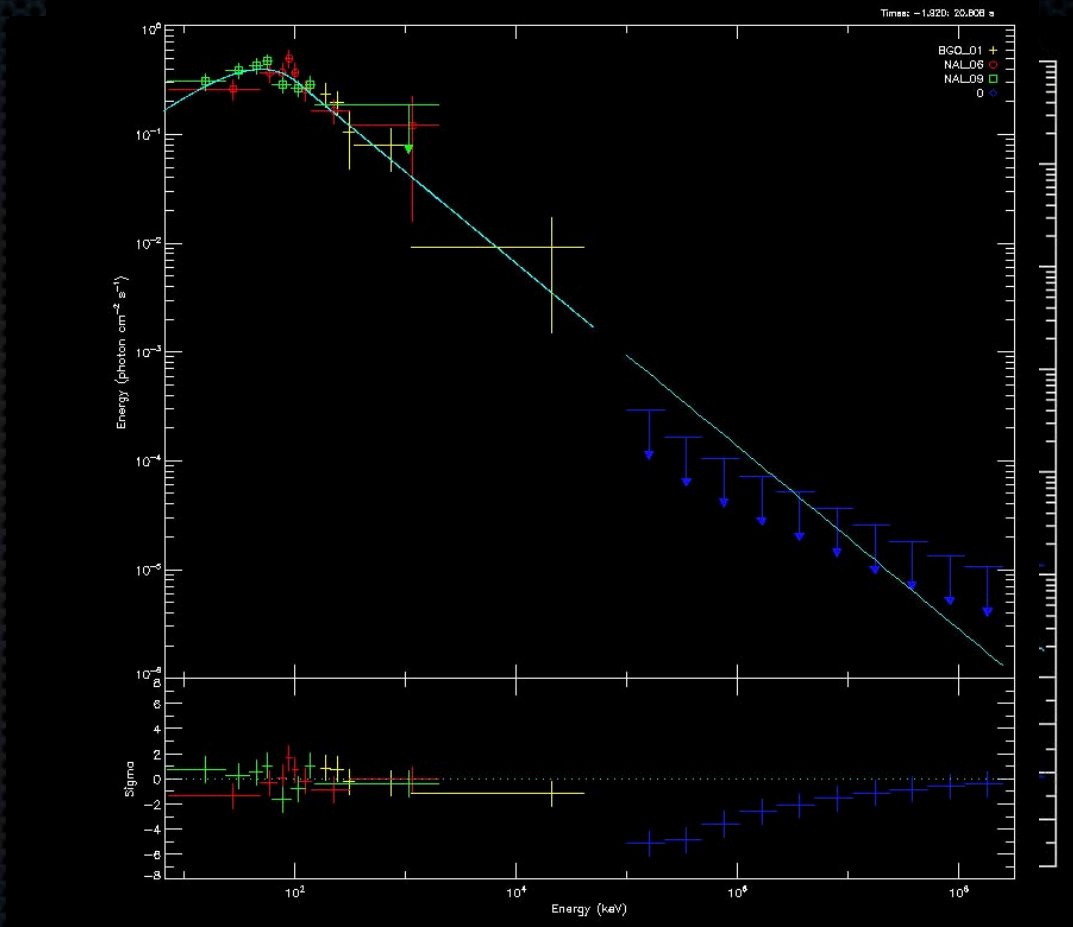
- Correlation between over-prediction of LAT flux and ΔC-Stat. Likewise, anti-correlation between σ_β and ΔC-Stat
- Statistical errors on β do not reflect the true, systematic, uncertainty in the parameter estimation

Conclusions

- GBM to LAT extrapolations can be misleading!
- Statistical uncertainties may not fully reflect the systematic uncertainties and cross-correlations among the spectral parameters
- ΔC-stat for a nested model comparison is the proper method of distinguishing between fits of increasingly complexity
- 24 (80%) GRBs in our spectroscopic sample are consistent with having a steeper beta value
- 6 of 30 (20%) prefer a spectral break
  - Two of these bursts show this break in the LLE selection
- Our previous estimates of the β distribution may be biased
- Use of future LLE data may help distinguish between cutoffs and softer β

Simulation Tests

- GRB 101113483
  - GBM Only: β = -1.8
  - GBM+LAT: β = -2.2
  - GBM+LAT+Step: β = -1.8
  - ΔC-stat ~ 5
- Simulated GRB: β = -1.8
  - GBM Only: β ~ -1.8
  - GBM+LAT: β ~ -2.2
  - GBM+LAT+Step: β = -1.8
  - ΔC-stat ~ 25



- Nested model comparison can distinguish the difference between the two scenarios, even though the different beta values are statistically excluded