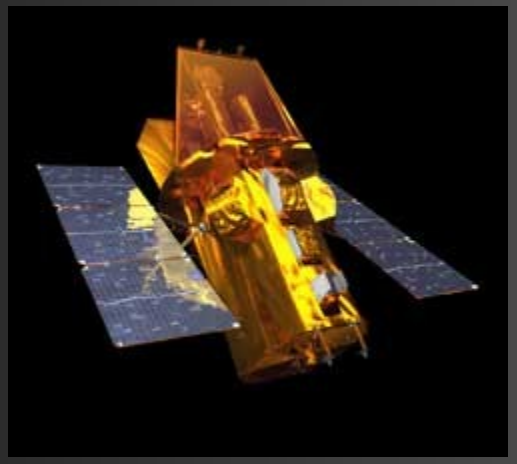
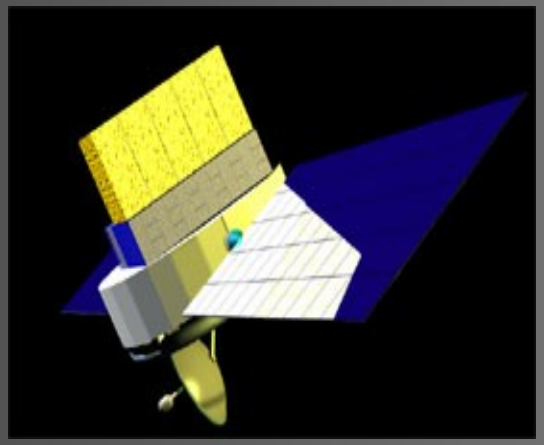
Swift Late GRB Emission and GLAST





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w/ Daniel Kocevski, Josh Bloom, Daniel Perley, Weidong Li, Alex Filippenko.

GRB Work at Berkeley

Ground-based Robotic Optical and IR Followup with PAIRITEL (J. Bloom) and KAIT (A. Filippenko)

Ground-based imaging and spectroscopy via approved Keck and Lick projects.

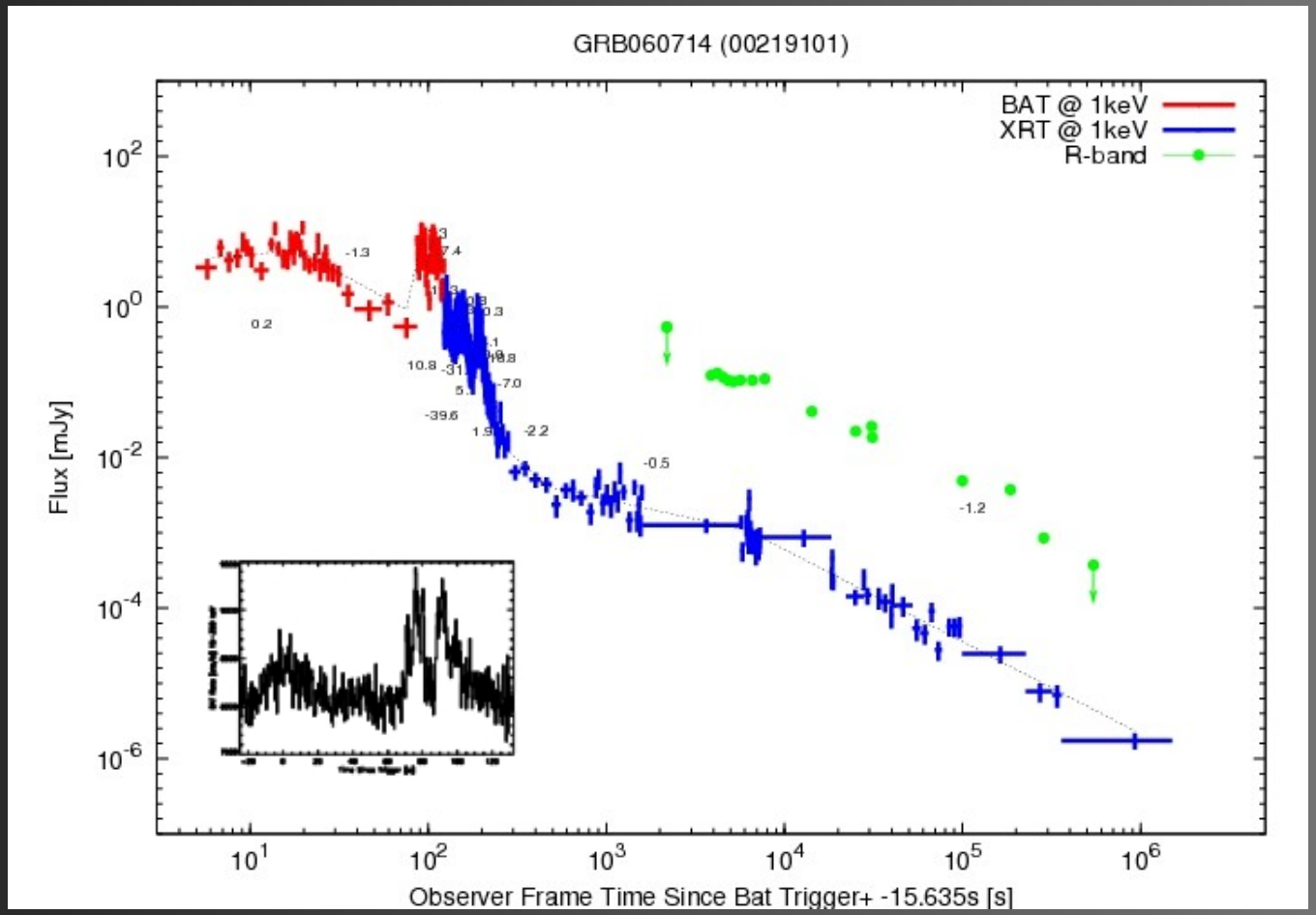
High energy data analysis collaborations using automated pipeline for Swift BAT and XRT data. Reductions produce refined X-ray positions and GRB/afterglow properties in near real time.

This Talk: Summarize New Phenomenology (T=100-1000s) in context of BATSE and other previous observations. What will GLAST see?

GRB060714
z=2.71

γ-ray and X-ray Flaring

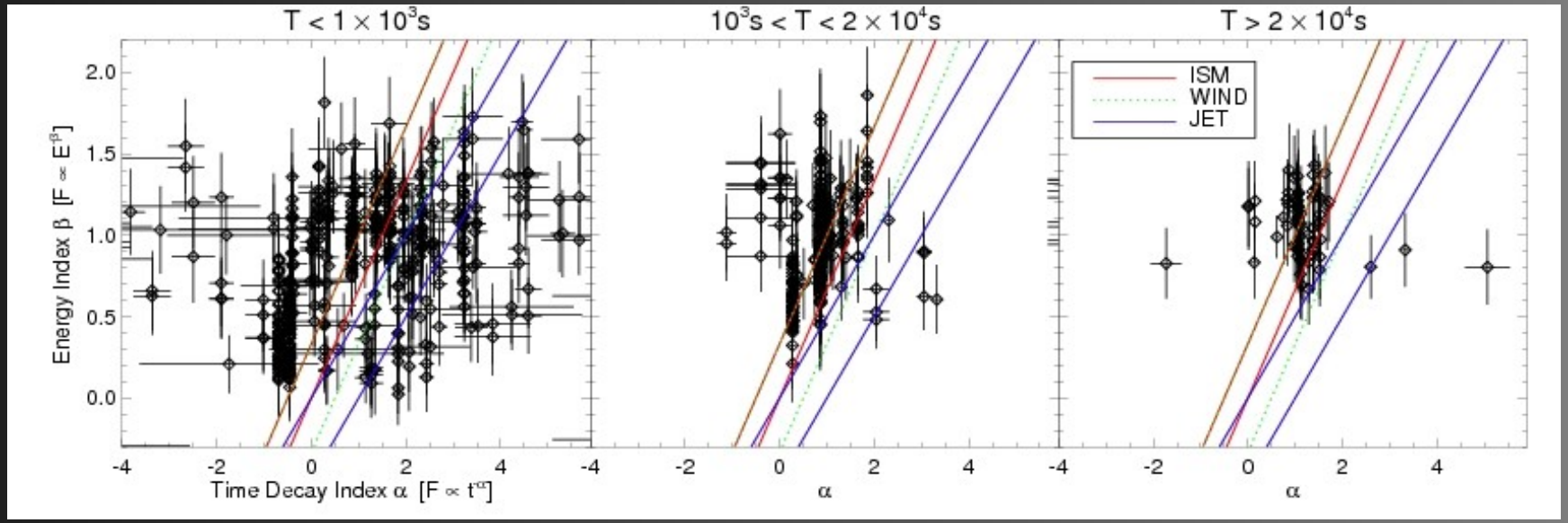
Example GRB+X-ray AG with fine time structure.



see, also, Nousek et al. (2006); O'Brien et al. (2006); Burrows et al. (2007)

3 Distinct Phases

Phase 1 | Phase 2 | Phase 3



Prompt | Plateau | Pre-Swift

see, also, Willingale et al. (2007)

Prior to Swift, X-ray afterglows (measured >2 x 10^4 s after the GRB) showed simple powerlaw time evolution, with simple powerlaw spectra.

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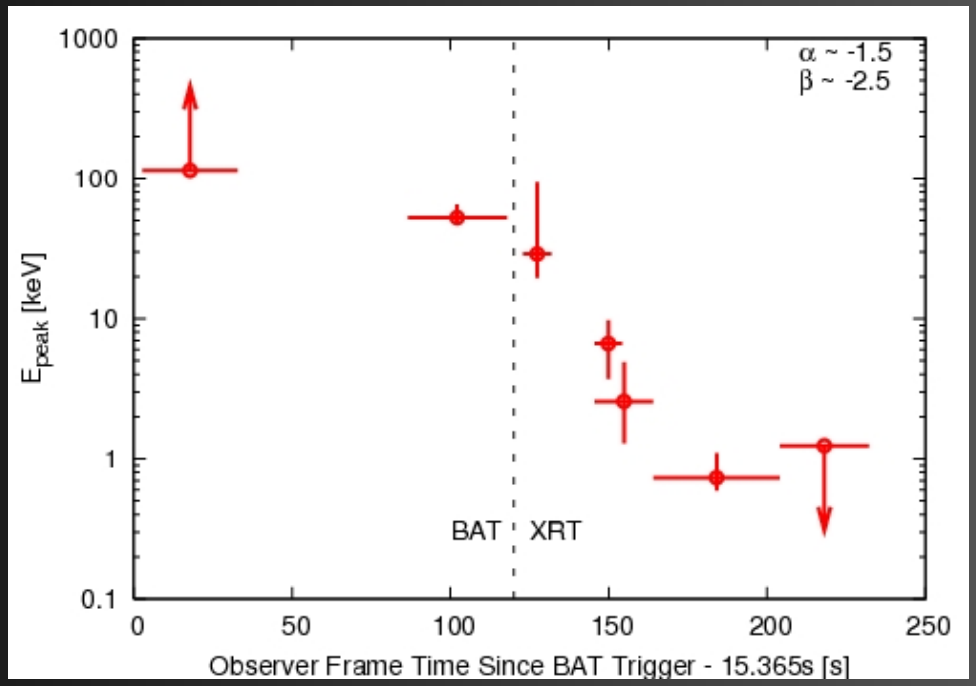
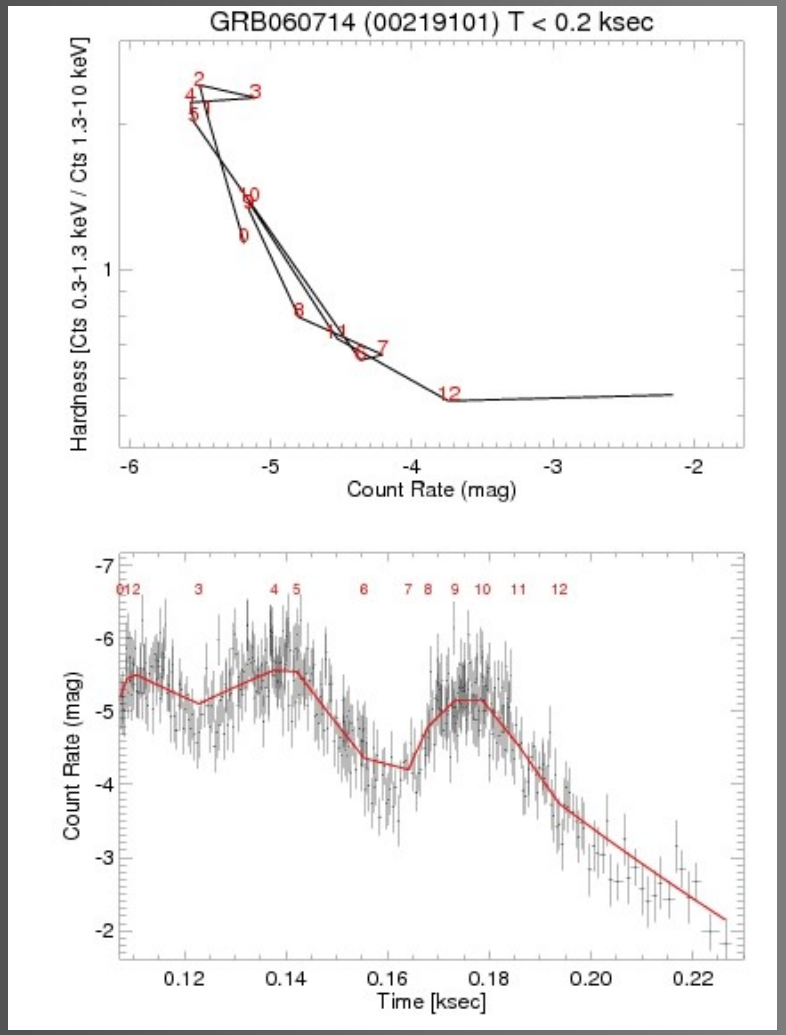
γ-ray and X-ray Flaring



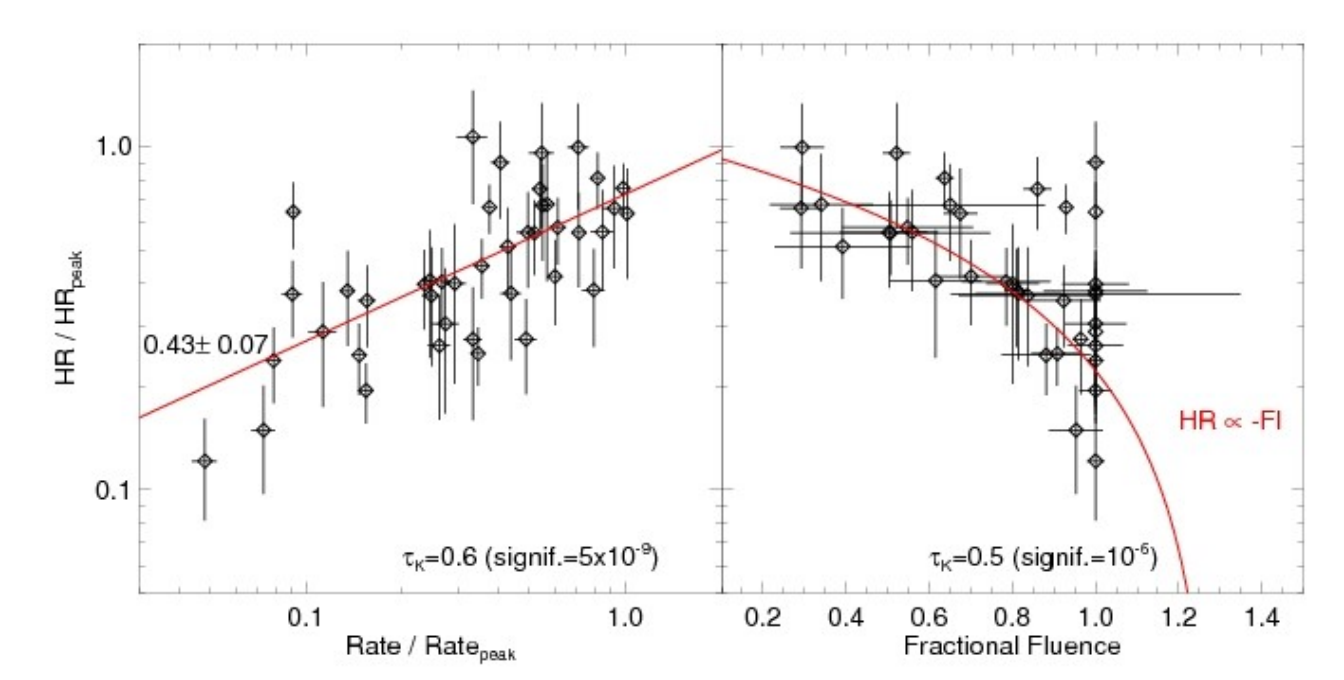


Continuous E_{peak} evolution from the γ-ray's to the X-rays (Butler & Kocevski 2007).

At finer resolution the flares show hardness evolution tracking the flux.

Spectral Properties

From a sample of 35 bright (>10 cts/s peak) X-ray flares:



Flare spectral evolution exhibits HI correlations and HF correlations as found for prompt γ-ray emission. (e.g., Kargatis 1995, Liang & Kargatis 1996, Borgonovo & Ryde 2001, Ryde & Petrosian 2002, Kocevski, Ryde, & Liang 2003)

GLAST & T>10^2s Emission

There is extremely bright, high-energy emission until 1000s!
What is it?

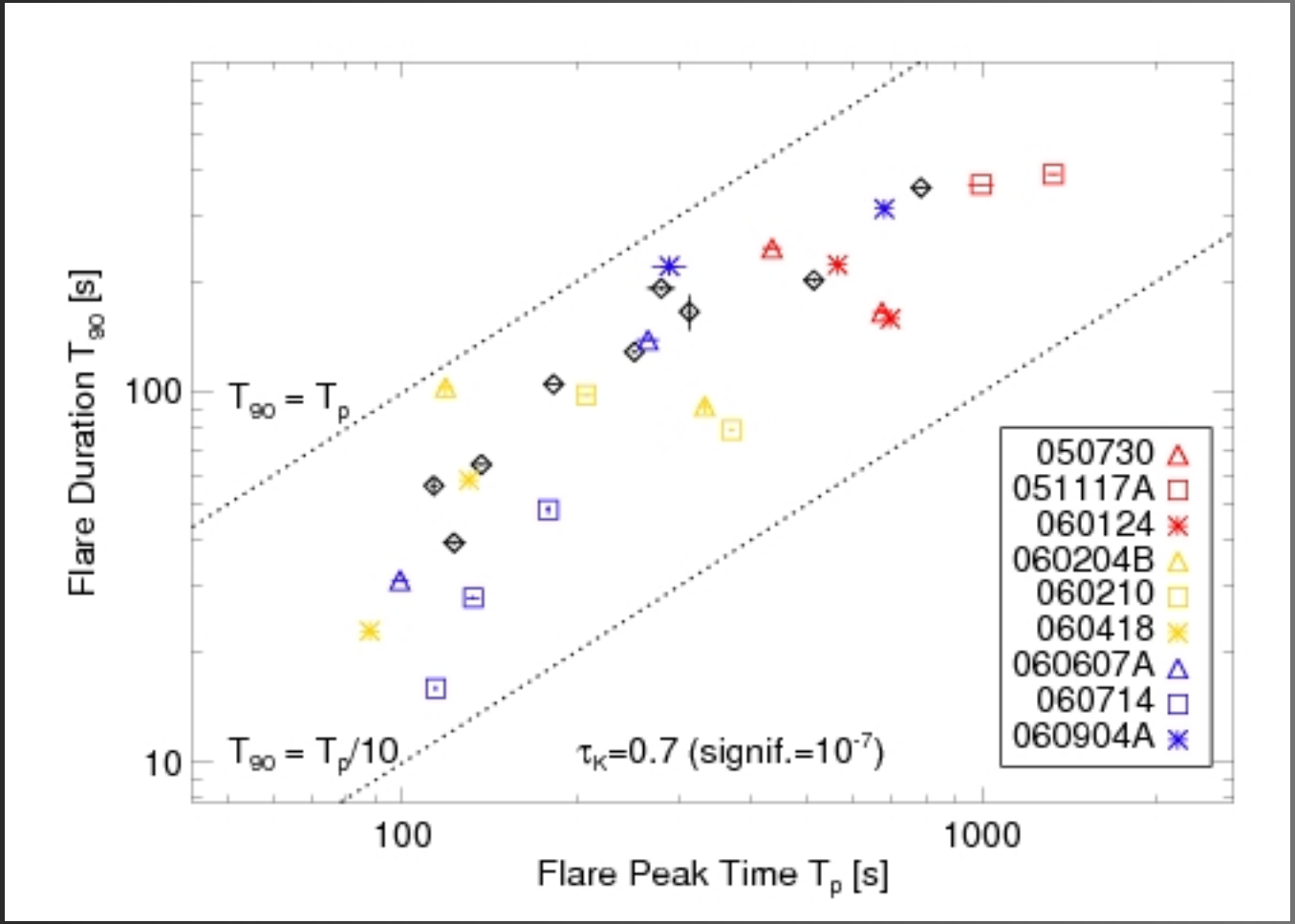
Fits to XRT+BAT data indicate late-time GRB activity, but with E_{peak} ~ 1 keV and $\beta \leq -6$! in some cases. (GLAST should not see this.)

If we are wrong,

- GLAST light curves could reveal *finer* time structure at high energies.
- High energy spectra (or detections alone) could reveal hard emission.
- In fact, some of the late-time flares may be quite hard.
- The shape of the spectra will help to firmly say whether emission is due to GRB or afterglow (see, also, Galli poster; Giblin et al. 2002).

Possible Inverse Compton Emission

Pulse Width Evolution?



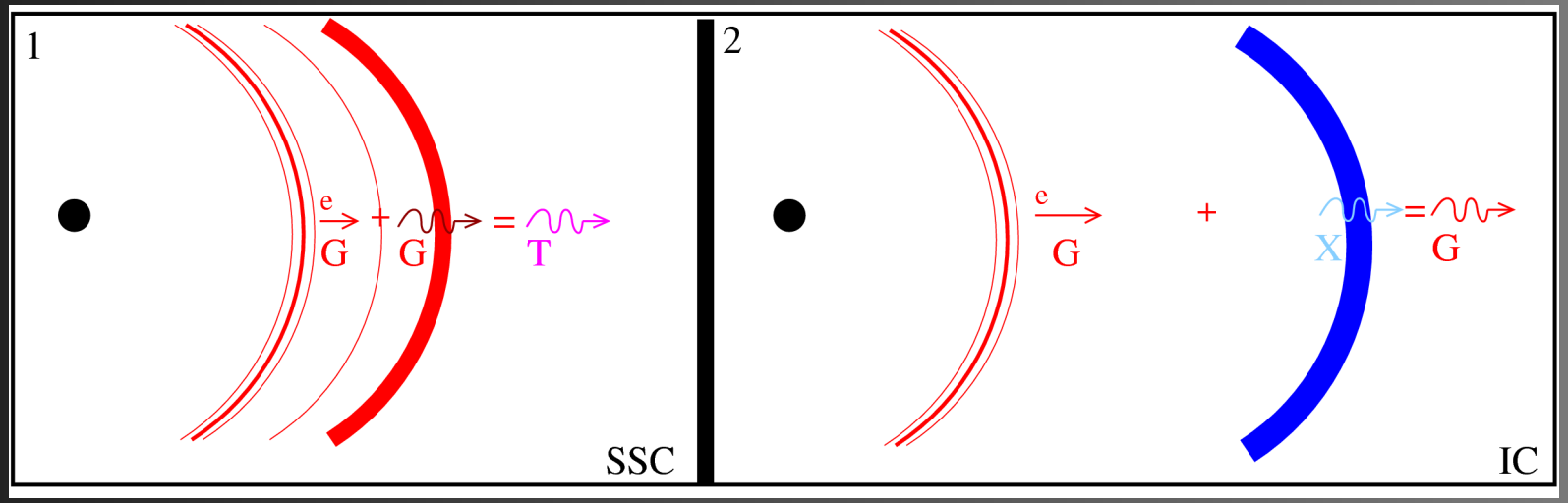
see, Kocevski poster

GLAST & T>10^2s Emission

Possibilities for Inverse Compton Emission...

Imagine models with deceleration by ISM or decrease in central engine duty cycle.

Can have interacting shells with a wide range of Lorentz factors, spanning a wide range of radii from the central engine.



see review in Zhang (2007; astro-ph/0701520)