

Crab Nebula Variations in Hard X-rays



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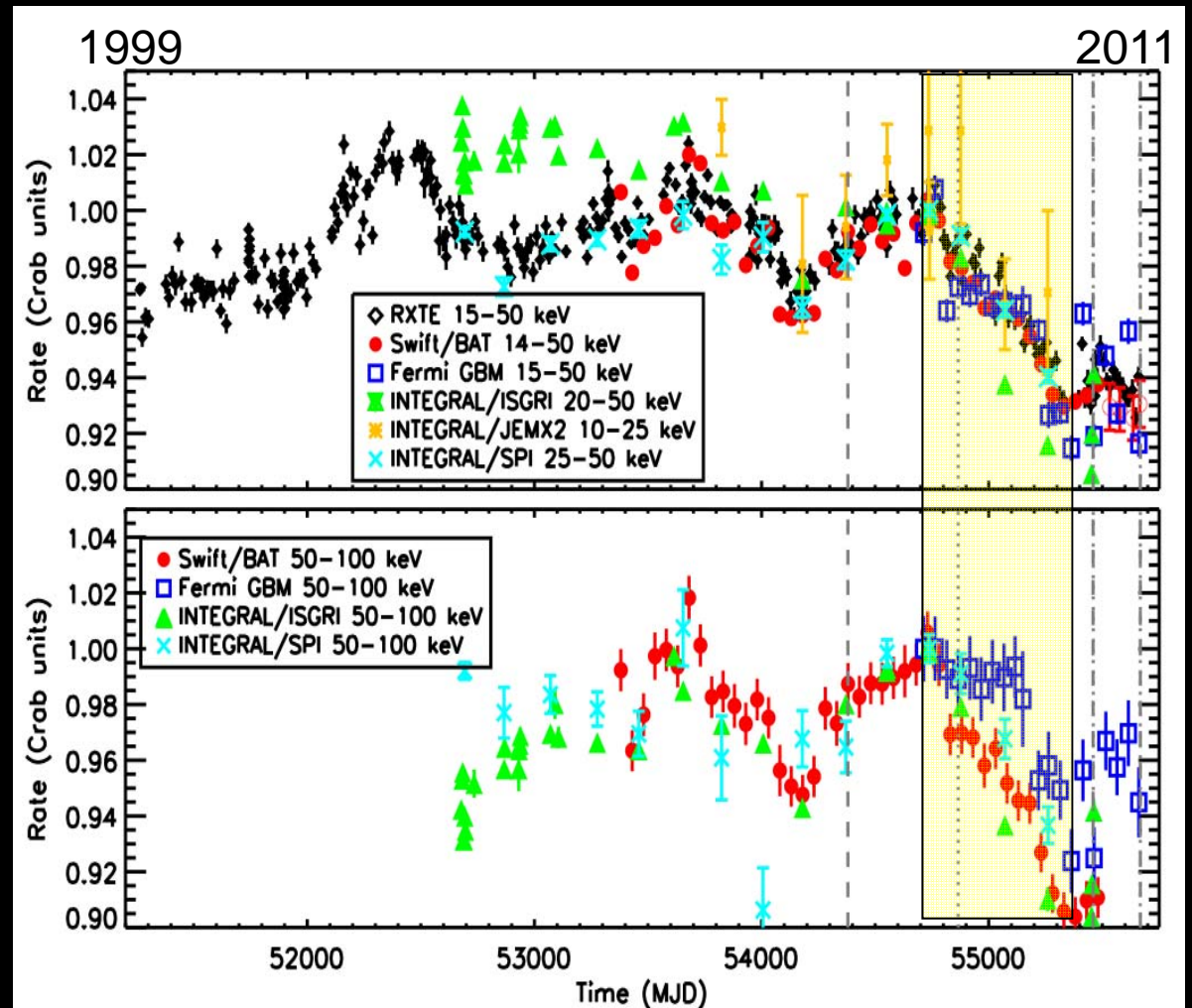
Collaborators

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MAXI data from <http://maxi.riken.jp>

The Crab Nebula 1999-2011

- Light curves for each instrument are normalized to its average rate from MJD 54690-54790.
- RXTE/PCU2 - Black
- BAT - Red
- IBIS/ISGRI - Green
- JEM X2 - orange
- SPI - Light blue
- GBM - Blue squares
- Instruments on four separate spacecraft show $\sim 7\%$ decline in Crab (nebula+pulsar) flux from summer 2008 to summer 2010.

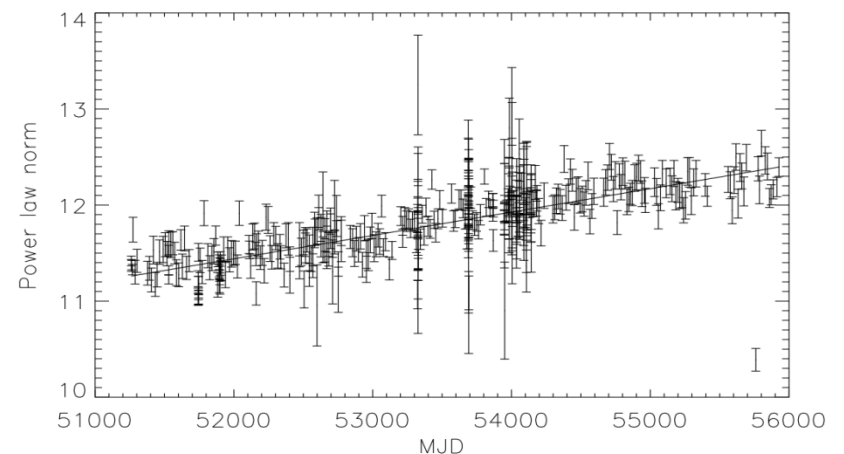
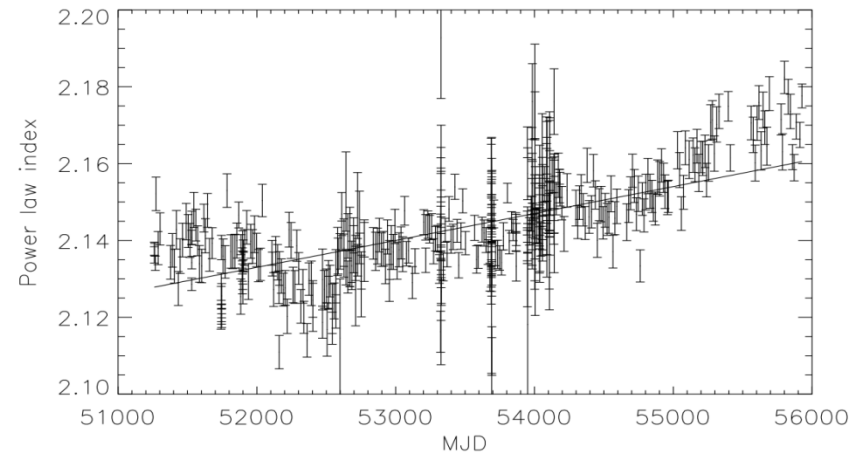


Wilson-Hodge et al. 2011, ApJ, 727, L40;

Wilson-Hodge et al. 2011, PoS(HTRS 2011), 043

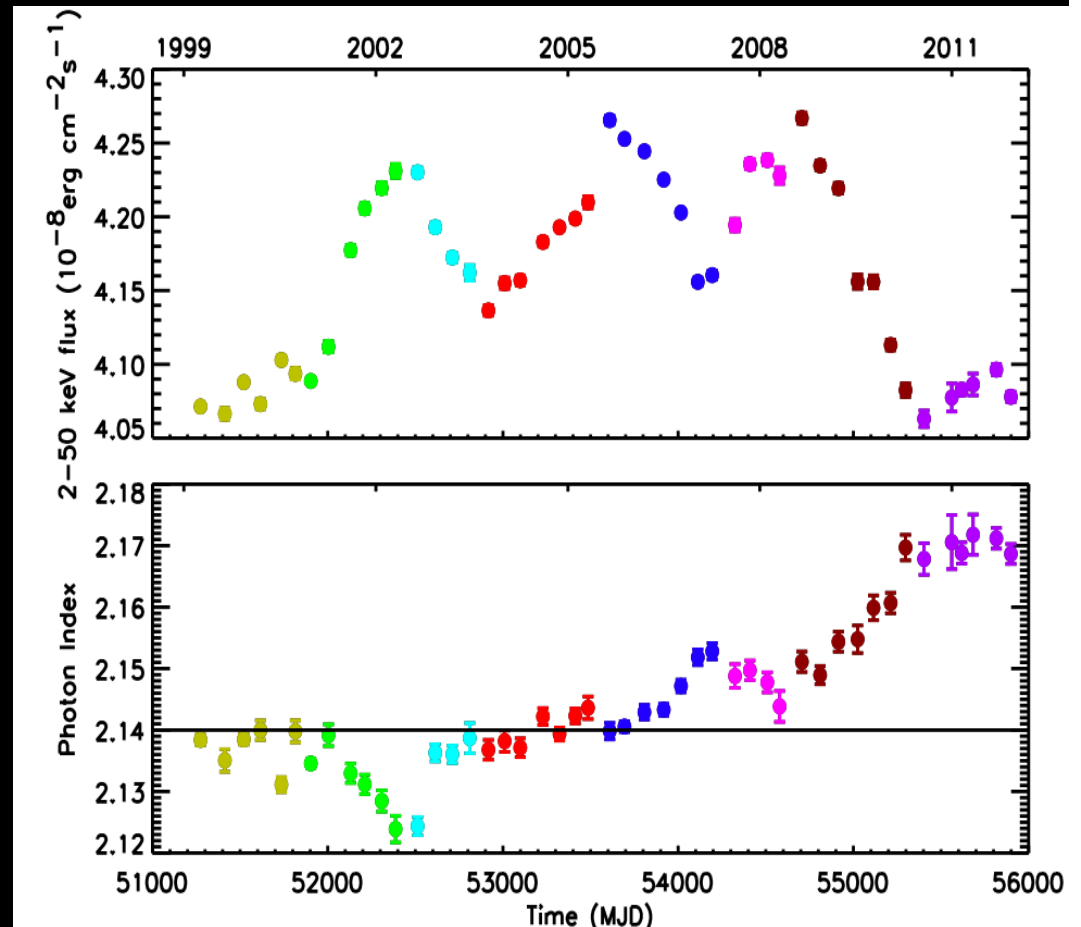
Crab PCU2 Spectra

- Each Individual observation fitted
- PCU2 layer 2&3 data
- Absorbed Power-law
- N_h fixed $0.97 \times 10^{22} \text{ cm}^{-2}$
- Increase in spectral index

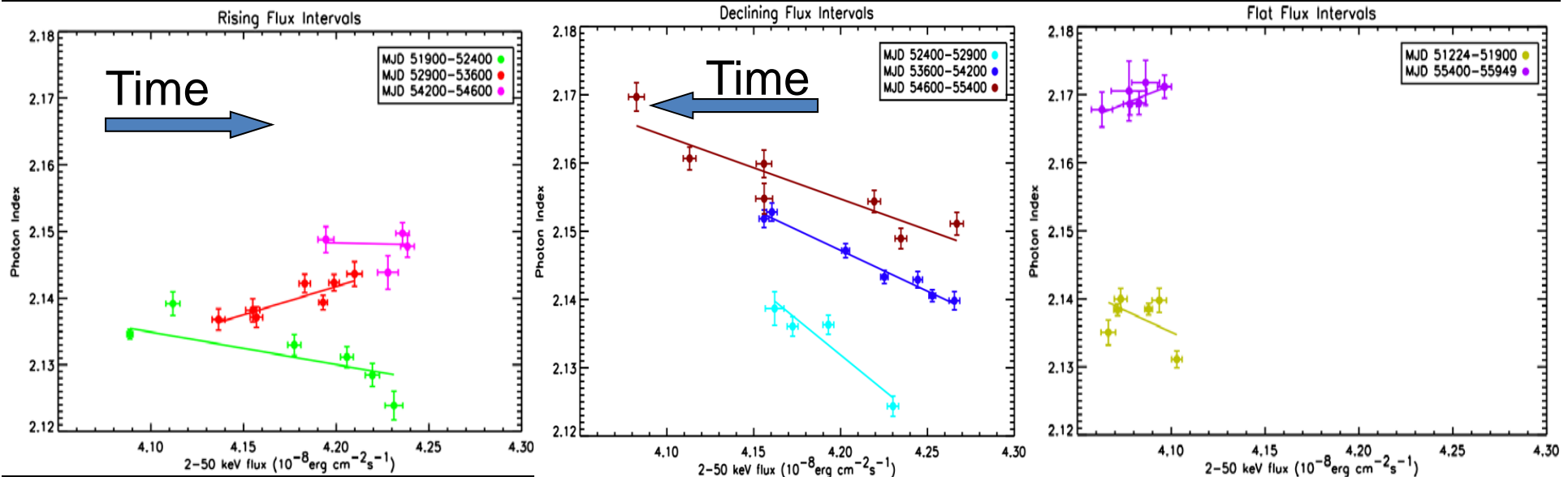


RXTE PCA Spectra

- Averaged fit results in 100-day bins
- Colors denote “rising”, “declining” and “flat” intervals.
- Photon index softens from 2.15 to 2.17 during 2008-2010 flux decline
- 8-sigma effect



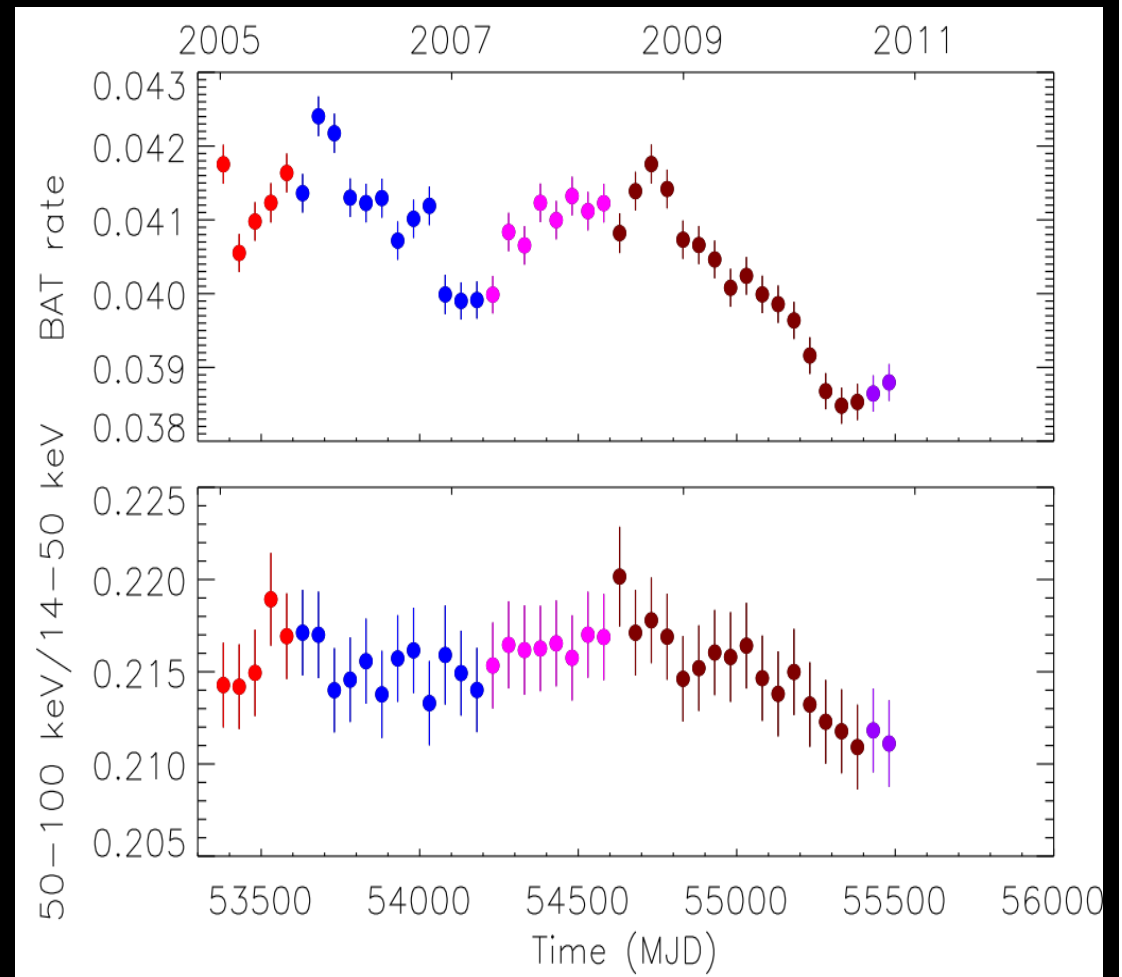
Comparing “rising”, “declining”, and “flat” flux intervals



- Photon index softened from 2.14 to 2.17
- Softening occurring in declining phases
- Hardening during initial rise
- Similar results in PCU 3 & 4

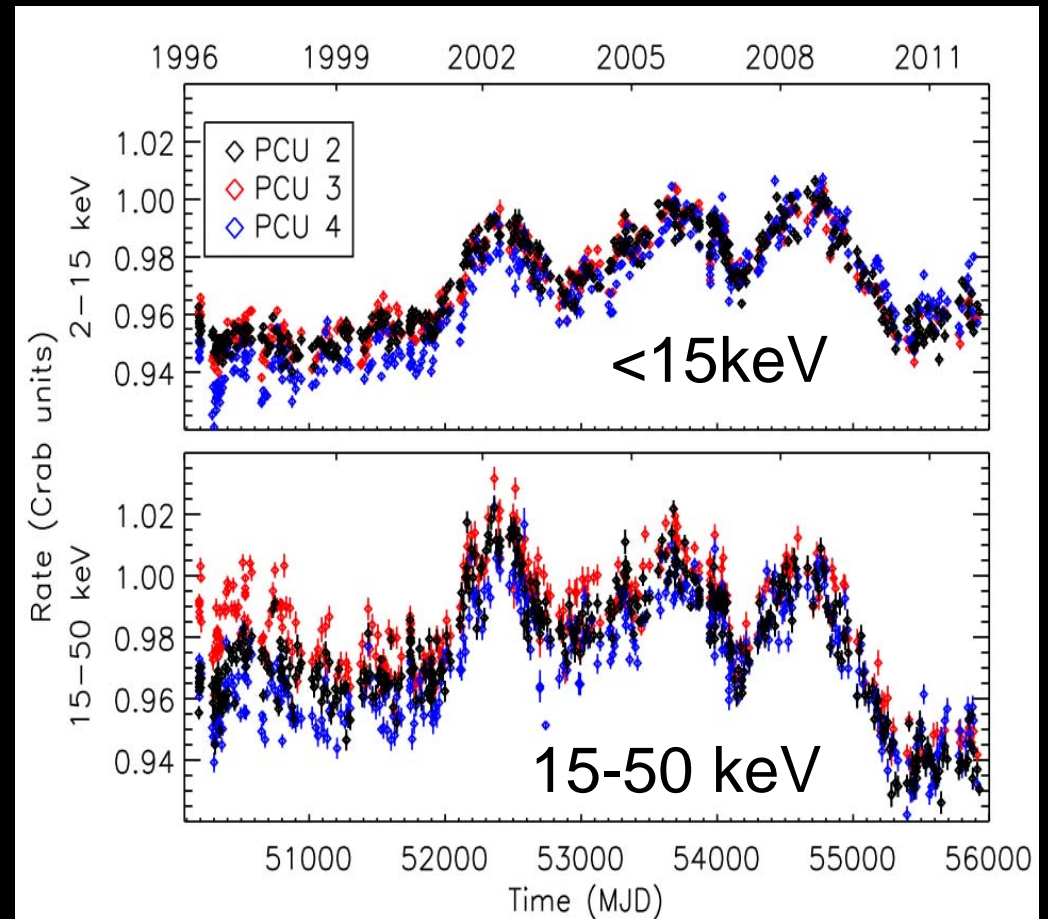
Evidence for Softening in Swift/BAT

- Color scheme matches RXTE Softening during 2008-2010 decline
- Earlier intervals consistent with constant hardness
- Hardness ratios 14-50 keV/50-100 keV BAT 58-month survey data
- 50-day averages

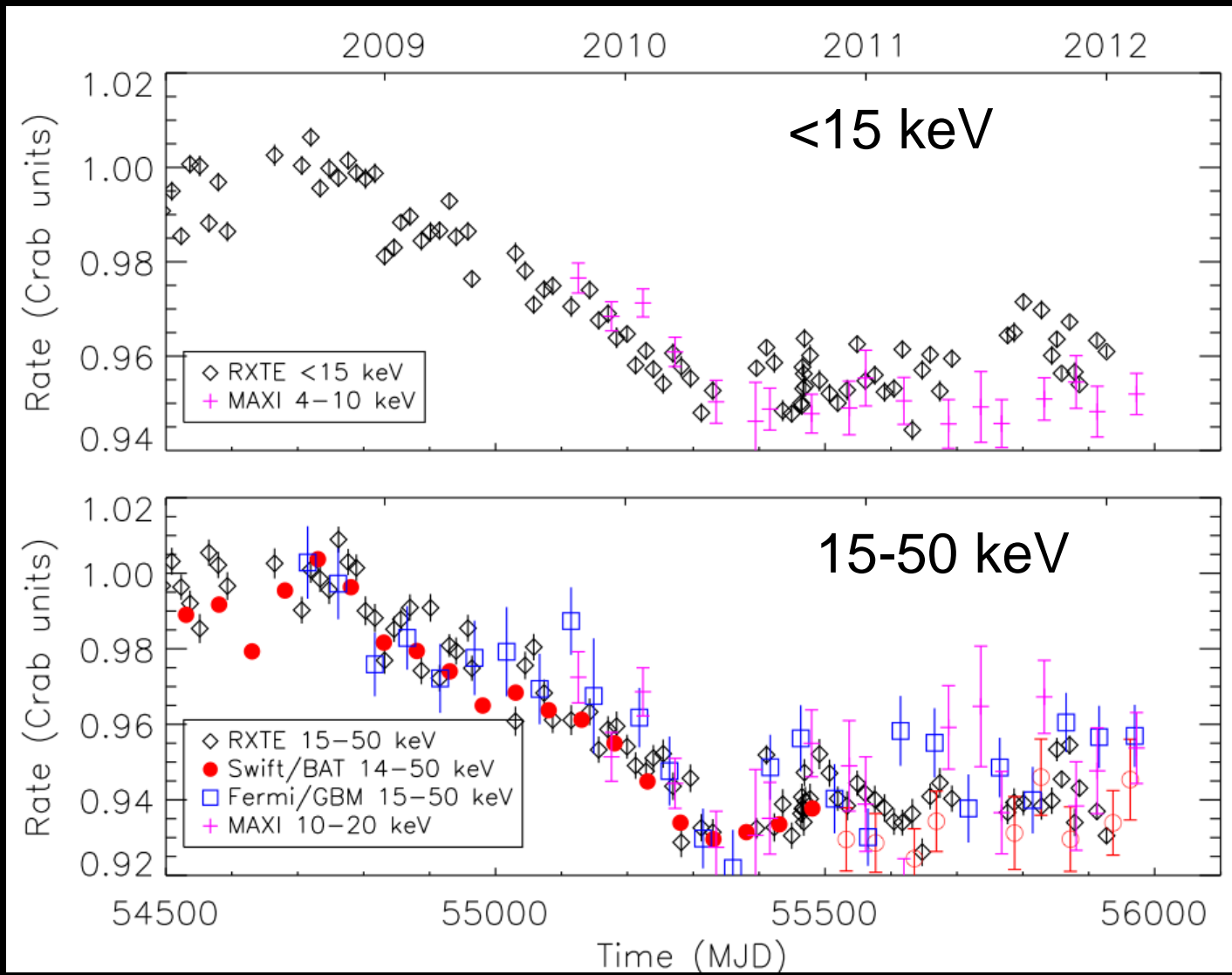


RXTE Mission-long Light Curves

- Very active period 2001-2010
- December 2011 flux is at or below level before 2001.
- Larger variations in 15-50 keV band
- 3 PCUs, layers 2&3
- Count rates corrected for dead time and response

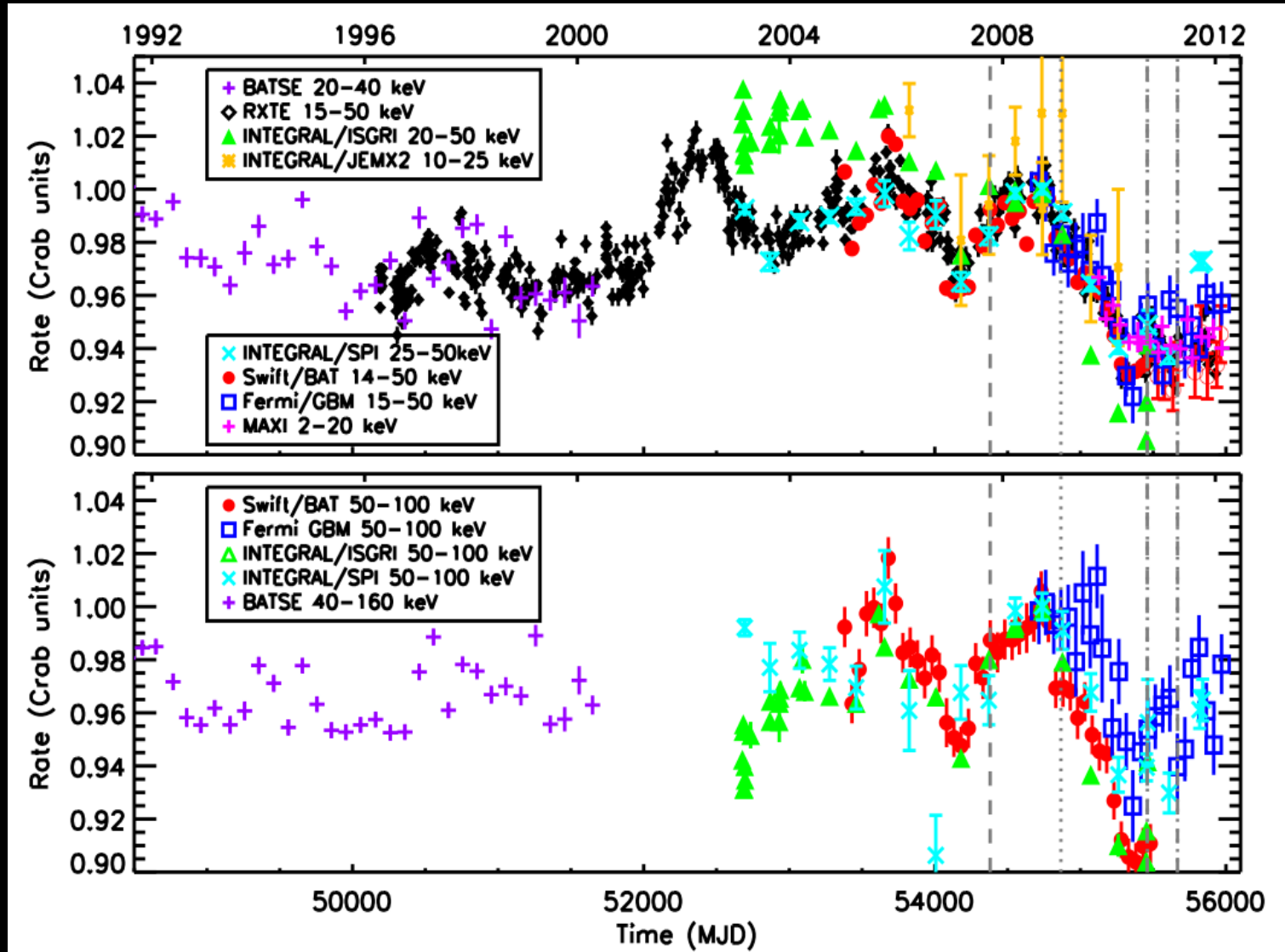


Recent Data 2008-2012



20-year Crab Nebula Light Curve

15-50 keV



50-100 keV

Summary & Conclusions

- The Crab Nebula was surprisingly variable from 2001-2010, with less variability before 2001 and since mid-2010.
- We presented evidence for spectral softening from RXTE, Swift/BAT, and Fermi GBM during the mid-2008-2010 flux decline.
- We see no clear connections between the hard X-ray variations and the GeV flares