

Non-thermal SNR WG Meeting 2016

Bashkara 3 Hall

Attendees:

D.Bhattacharya,C.Markwardt, J.Kennea, L.Natalucci,
V.Kashyap,J.Drake,B.Wu,P.Sreekumar,S.Athray, S.Panini,T.Chattoparday, A.Beli,
Mithun N P S, A.R. Rao, A.Rakeshkanna, S.Chakrabarti,D. Pawar, S.Wadawale,
M.Guainazzi, A.Nandi, Ravishankar B.J., M.C.Ramadewi, R. Kushwah,
A.Vibhute,G.Dewangan, H.Yue, S.Zhang, X.Li, S.Xiong, L.Song, L.Mallik,
M.Pahari,N. Iyer

Agenda

- Crab cross-calibration: summary and update, workplan
- Presentation by Gary Case (GBM team)
- ASTROSAT Crab observations
- Future goals and projects:
 - PSR1509-58
 - G21.5-0.9 (update after Masahiro's paper)

Update on Crab project

- Fermi/GBM results added
- Epochs slightly revised compared to the previous implementations
- The paper will be largely based on the results of these nearly simultaneous periods rather than using average spectra.
- The two most recent epochs (2012 and 2014) include Nustar and GBM
- Discussion on how to deal with epic-PN data

Energy bands and epochs

Instr.	Energy Bands (keV)
XIS	3-10
PIN	10-25, 25-80
GSO	25-80 [^] 100-300
PCA	3-10, 10-25, 25-80
IBIS	25-80, 100-300
SPI	25-80, 100-300
NuSTAR	3-10, 10-25, 25-80
EPIC	3-10
GBM	(25-80), 100-300

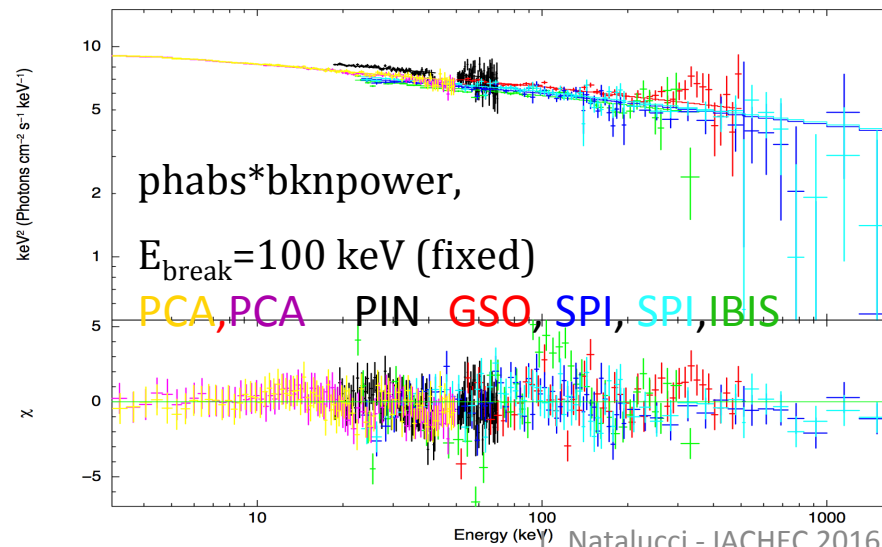
[^]for GSO, E >40 keV

Epochs	Instruments	Period	<1 week(*)
A	PCA, PIN, GSO, IBIS, SPI	2005-09-15 to 2005-10-11	
B	PCA, PIN, GSO, IBIS, SPI	2006-09-05 to 2006-09-29	
C	XIS, PCA, PIN, GSO, IBIS, SPI	2007-03-11 to 2007-03-22	
D	PCA, IBIS, SPI	2007-09-22 to 2007-09-27	Y
E	PCA, PIN, GSO, IBIS, SPI, GBM	2008-08-27 to 2008-09-26	
F	PCA, IBIS, SPI, GBM	2009-08-14 to 2009-08-26	
G	PCA, IBIS, SPI	2010-02-23 to 2010-03-04	
H	PCA, PIN, GSO, GBM	2010-04-03 to 2010-04-17	
I	PCA, SPI, GBM	2010-09-22 to 2010-09-25	Y
J	PCA, IBIS, SPI, GBM	2011-02-12 to 2011-02-19	Y
K	PCA, PIN, GSO, GBM	2011-03-17 to 2011-03-27	
L	NUSTAR, (PIN, GSO), IBIS, SPI, GBM	2012-09-21 to 2012-09-26	Y
M	EPIC, NUSTAR, IBIS, SPI, GBM	2014-10-01 to 2014-10-02	Y

(*) except for GBM (obs. elapsed time ~40days)

Fitting broad band data 2-2000 keV

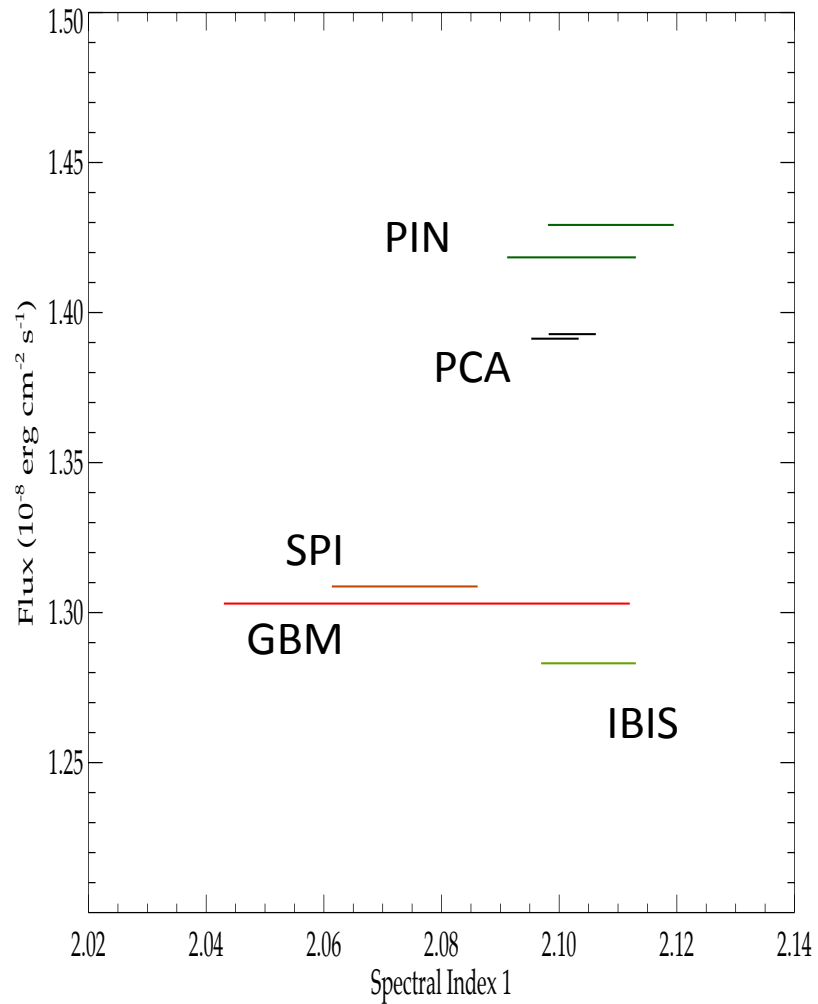
- Reference model: Broken power law model, with Break energy fixed at 100 keV
- Joint fits for each epoch with varying normalization and PL slopes
- 1% systematic error added to all spectra
- Fits are generally good with above prescriptions: red. $\chi^2_{\text{red}} \sim 1-1.2$ for most epochs



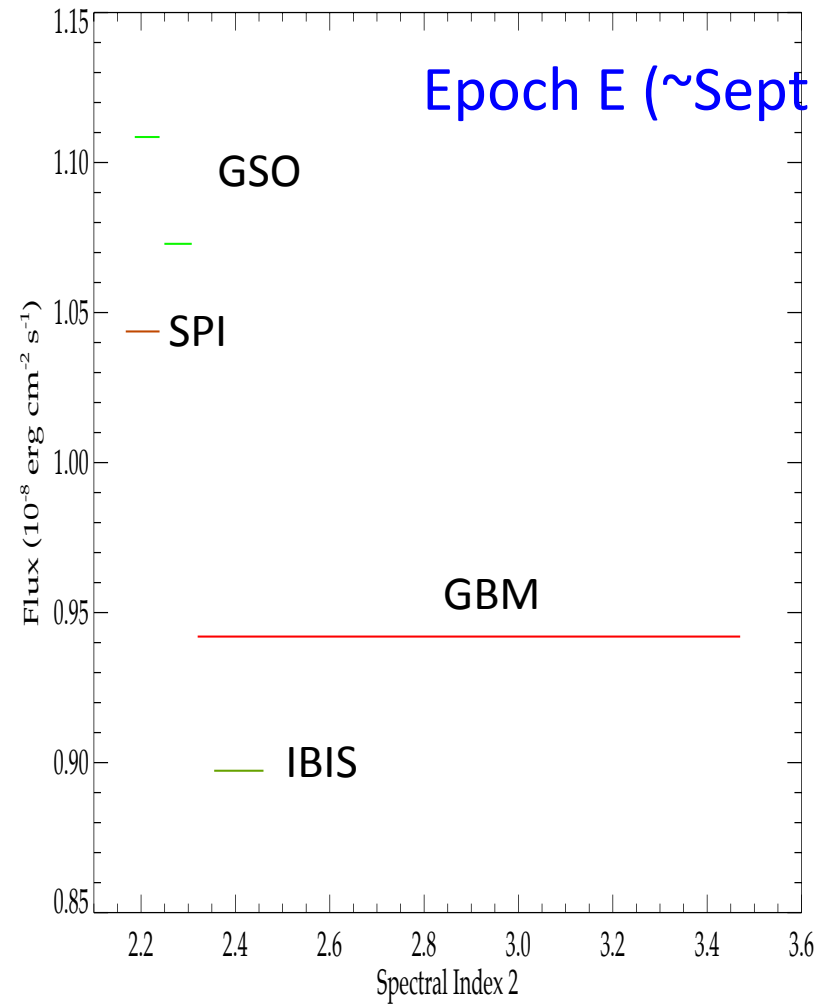
Feb-March 2011

Flux vs Spectral Index

Γ_1 vs 25-80 keV flux

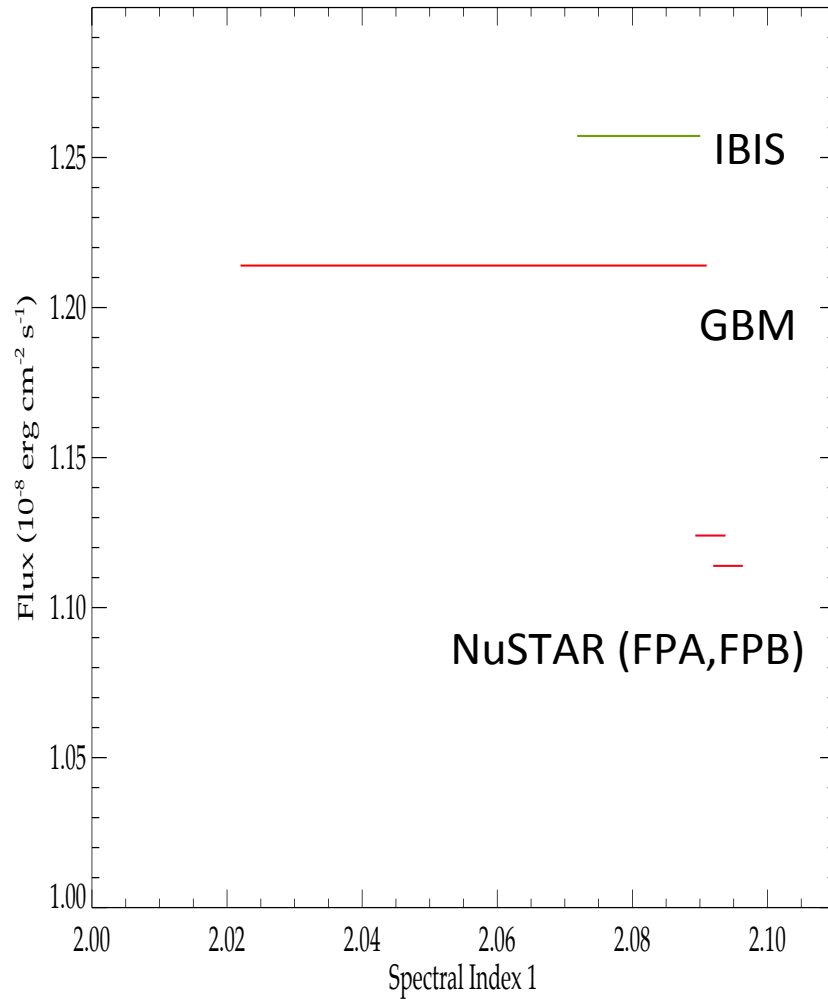


Γ_2 vs 100-300 keV flux



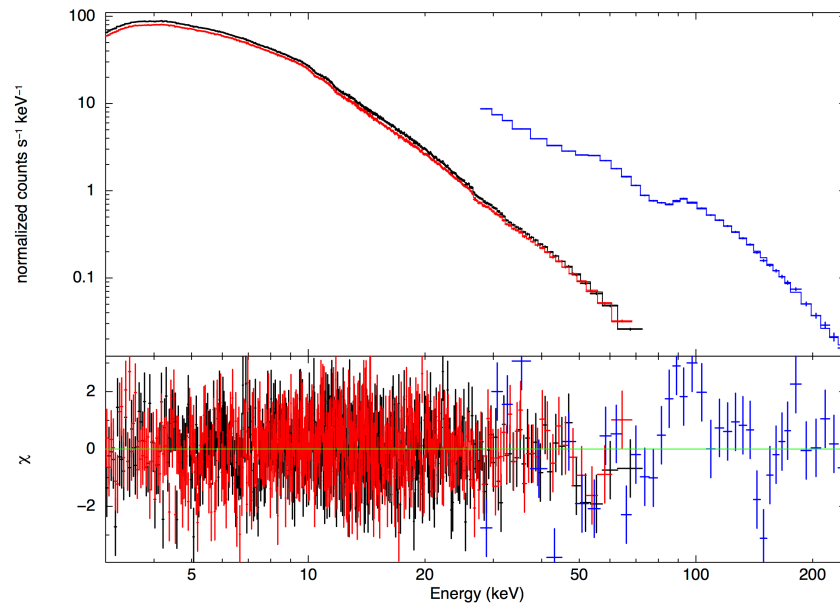
Flux vs Spectral Index

Γ 1 vs 25-80 keV flux



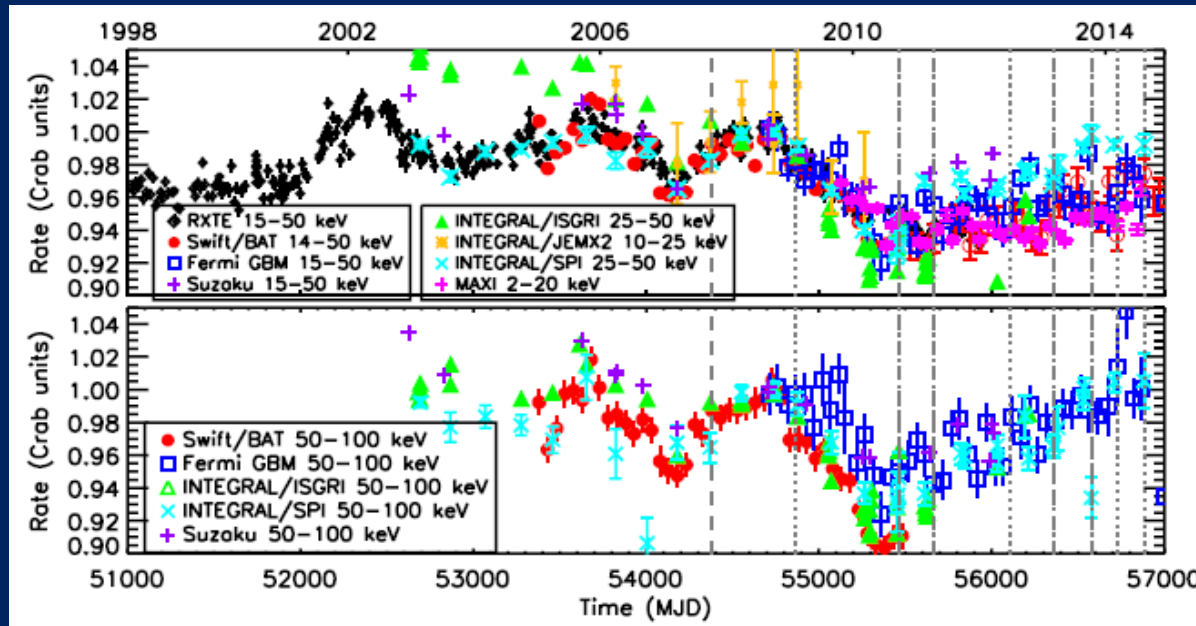
Epoch L (~Sept 2012)

- To be added:



What the Crab has Been Up to Lately...

- Light curves for each instrument are normalized to its average rate from MJD 54690-54790.



(Thanks to Colleen Wilson-Hodge)

Fermi/GBM

Credit: Gary Case

50-100 keV band has recovered to pre-decline level
15-50 keV band has only increased ~50% of the way
back to pre-decline level

Fermi/GBM: Crab Spectra

- Complicated by the fact the response is constantly changing
- Use CSPEC data binned into 16 logarithmically-spaced channels from 10-400 keV, though lowest 3 bins ignored for now (possible internal calibration issue)
- Spectra fit for Epochs E-K for energy range 20-400 keV
- Minimum 40 days integrated, centered on middle of epoch

Epoch	Begin date	Begin day (MJD)	End date	End day (MJD)
E	2008-08-22	54700	2008-10-01	54740
F	2009-08-02	55045	2009-09-11	55085
G	2010-03-03	55258	2010-04-17	55303
H	2010-09-05	55444	2010-10-15	55484
I	2011-02-12	55604	2011-03-27	55647
J	2012-09-03	56173	2012-10-13	56213
K	2014-09-12	56912	2014-10-22	56952

Fermi/GBM

Credit: Gary Case

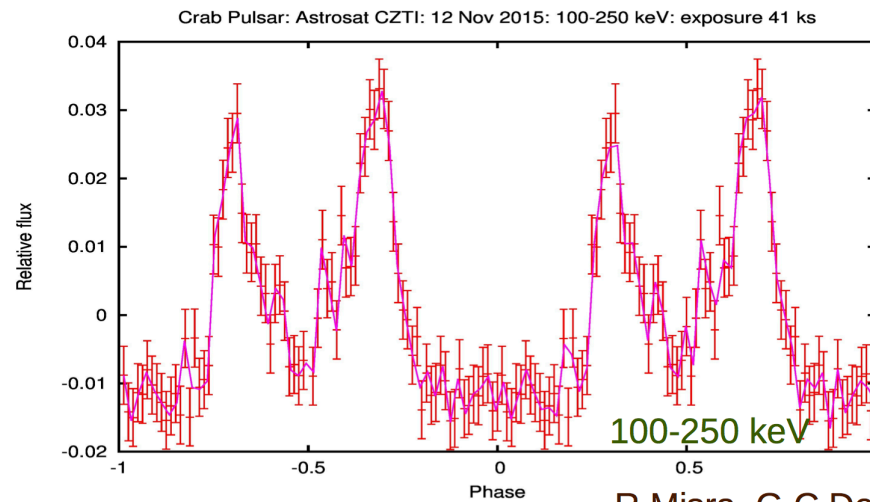
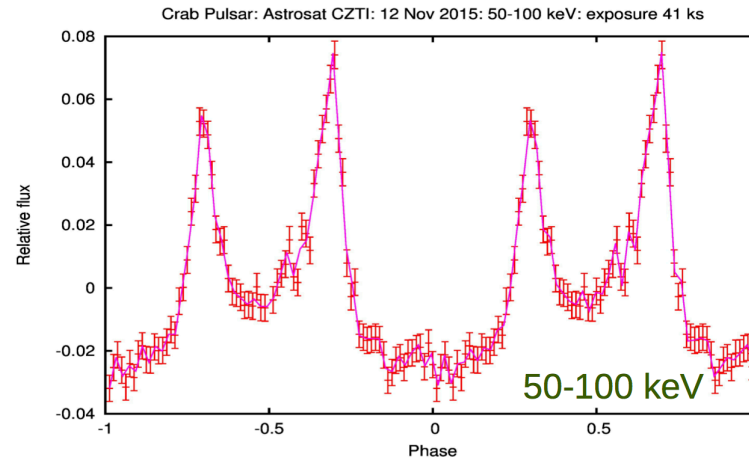
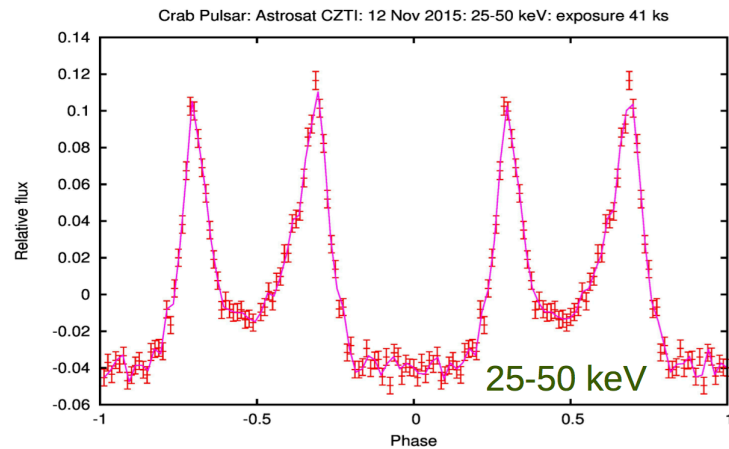
Conclusions

- Spectra generated for the Crab for 7 epochs from August 2008 to October 2014 using GBM.
- As more epochs are defined, GBM spectra can be generated relatively easily.
- The GBM spectral results generally agree with the other instruments, though the GBM spectra are a little harder below the break and a little softer above the break.
- GBM will continue to monitor the Crab.

Fermi/GBM

Credit: Gary Case

Crab pulsar



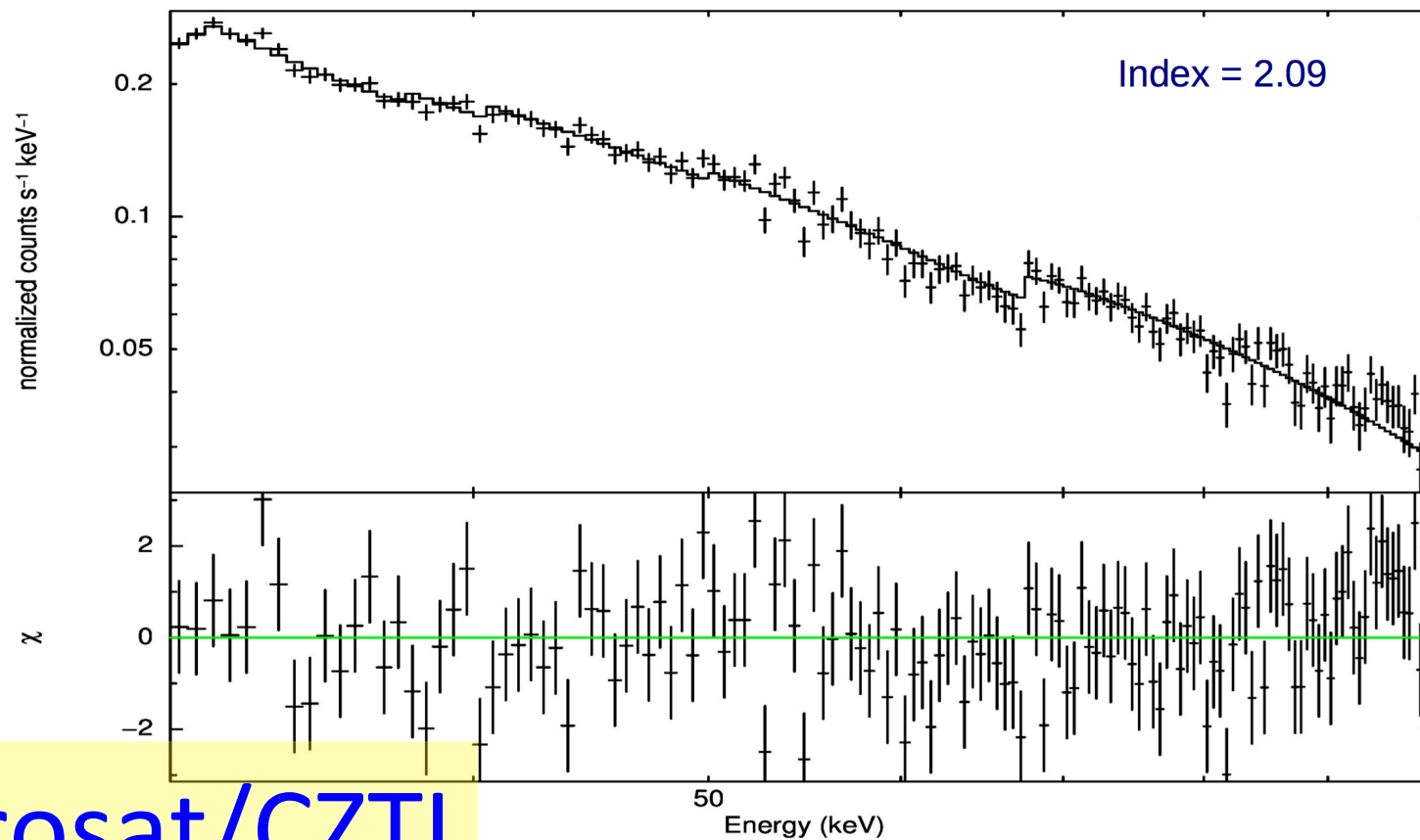
R Misra, G C Dewangan, D Bhattacharya

Astrosat/CZTI

Presentation by Mithun Neelakandan PS

Crab observations for calibration

- 11 pointed observations at crab with different exposures
- Quasi-simultaneous observations available with other missions

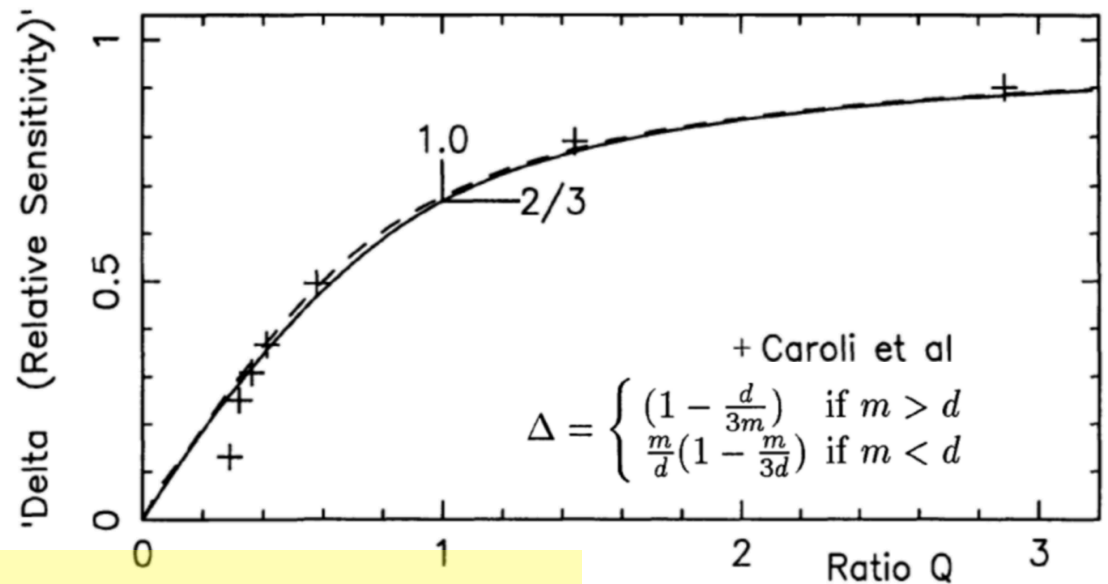
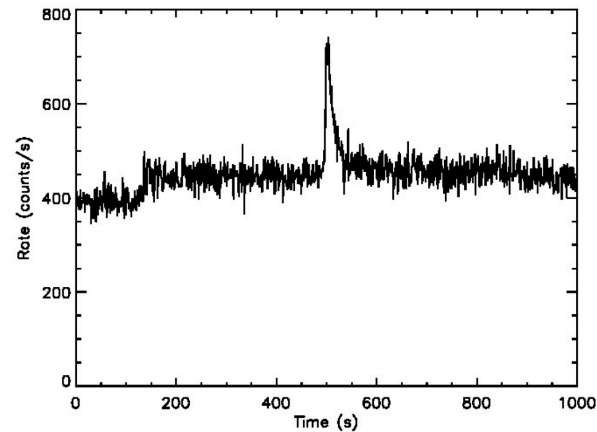


Astrosat/CZTI

Presentation by Mithun Neelakandan PS

Crab for calibration: Norm 5.58 instead of 10!

- Observed count rate: 16 counts/s/quadrant
- Rate in maskweighted spectrum: 8.32 cts/s/quadrant
- Approximately half the counts missing after mask weighting, hence normalization is different



Skinner 1994
(Proc.Capri Workshop)

Astrosat/CZTI

Summary and workplan

- LN to circulate updated draft of Crab paper with fitting results and plots (~1 month).
- Startup new projects based on pulsar timing:
PSR1509—58 (Astrosat, Integral, +...?), Crab?
...
- another Crab paper could be released in the future with the contribution of Hitomi and Astrosat.
- G21.5-0.9:
relevant cross-cal info could be released within the concordance projects. A new cross-cal paper could be planned e.g. after observation by Hitomi.