

Energy calibration refinement of the EPIC-pn Burst mode

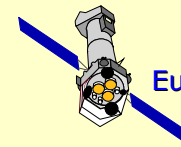
M.G.F. Kirsch¹, E. Kendziorra², G. Sala³, G. Winroth^{1,4}

¹ ESA XMM-SOC, ESAC Spain

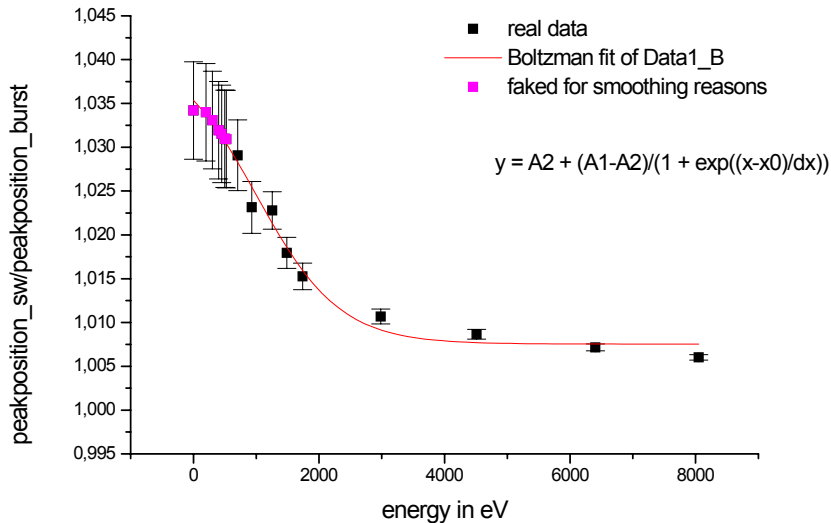
² IAAT, University of Tuebingen, Germany

³ MPE, Munich, Germany

⁴ University Linköpings, Sweden

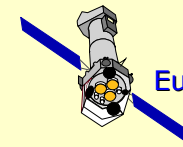


Burst mode ground cal

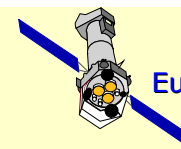
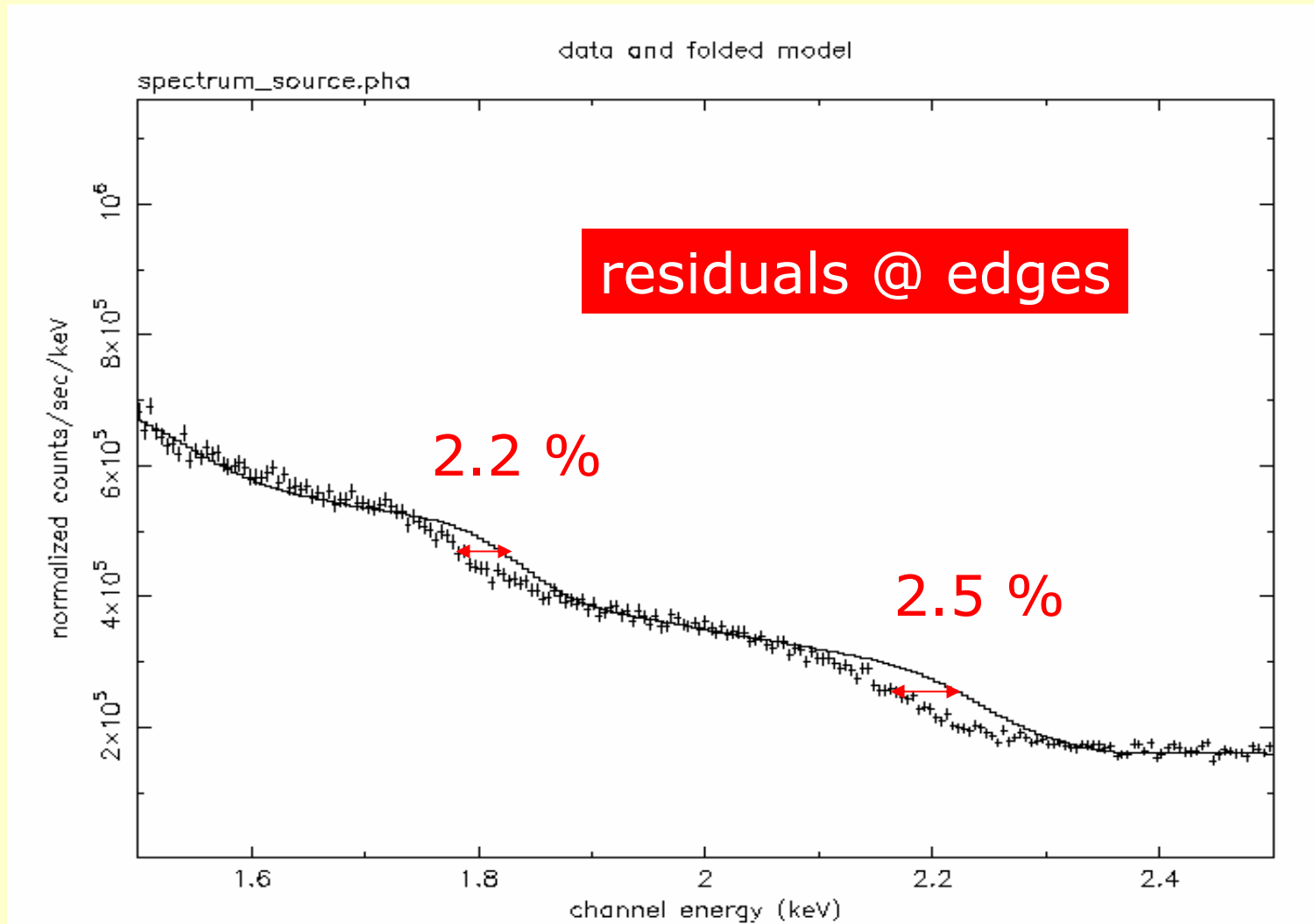


- 6 working days measurement
- CTI/Gain correction was derived by adjusting the burst mode data with a tuning function to SW mode data using ground calibration monochromatic line measurements
- But that camera was finally not launched

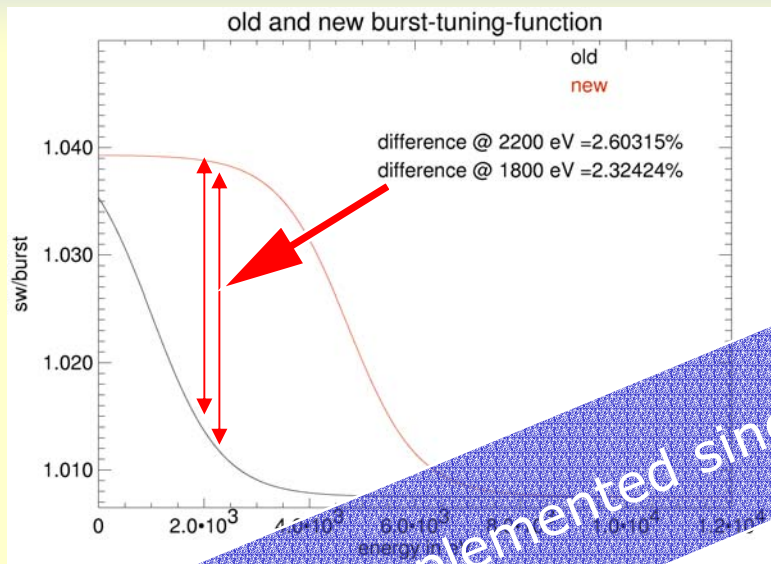
Target	Energy in eV	FFnc (10 singles/s) Messzeit in min	SW POS1 (10 singles/s) Messzeit in min	SW POS2 (10 singles/s) Messzeit in min	faktor	SW POS2 (10*f singles/s) Messzeit in min	Burst POS2 (10*f singles/s) Messzeit in min	Offset Zeit in min	Zeit in min
O	525	16,7	23,3	23,3	1,8	13,0	308,6	40,0	426,7
Fe-L	705	16,7	23,3	23,3	1,8	13,0	308,6	40,0	426,7
Cu-L	930	16,7	23,3	23,3	7,3	3,2	76,1	40,0	189,9
Mg-K	1254	16,7	23,3	23,3	6,0	3,9	92,6	40,0	205,8
Al-K	1487	16,7	23,3	23,3	17,0	1,4	32,7	40,0	154,4
Si-K	1740	16,7	23,3	23,3	17,0	1,4	32,7	40,0	154,4
Mo-L	2293	0,0	0,0	0,0	15,2	0,0	0,0	0,0	15,2
Ag-L	2984	0,0	0,0	0,0	15,4	0,0	0,0	0,0	15,4
Ti-K	4511	16,7	23,3	23,3	11,5	2,0	48,3	40,0	165,2
Fe-K	6404	16,7	23,3	23,3	2,9	8,0	191,6	40,0	305,9
Cu-K	8048	16,7	23,3	23,3	5,0	4,7	111,1	40,0	224,1
					100,9				
Schlitzmessungen in Camex-Nähe zur Untersuchung Amplification & CTE im Burst & SW Mode								Summe in min	2182,8
								Summe in h	36,4
								Summe in wdays	6,06



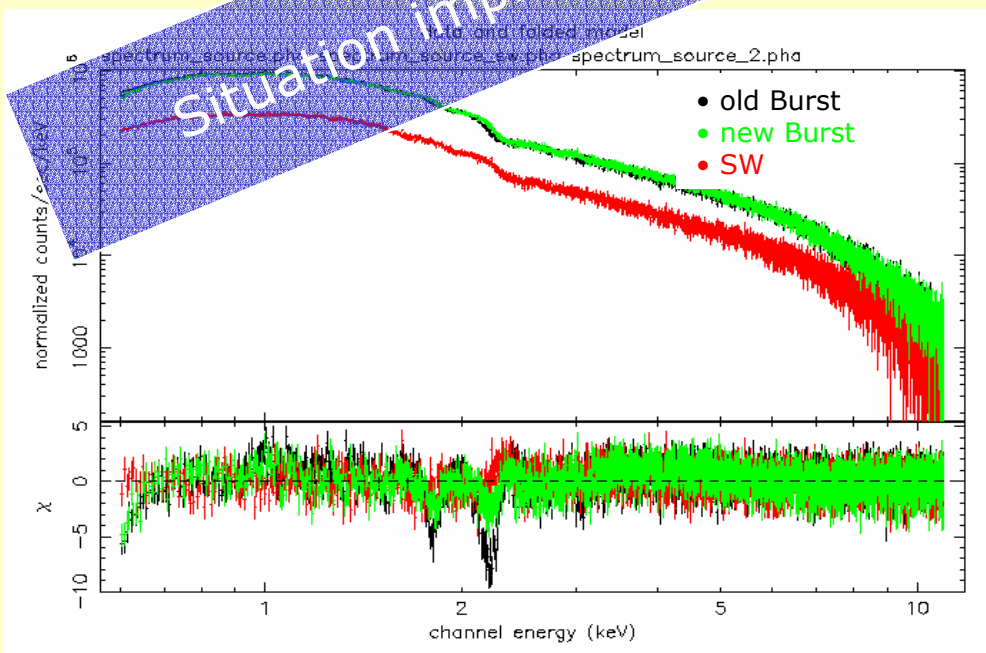
results with ground tuning function for real data from CRAB observation



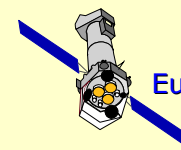
Burst mode CTI correction



- Orbit data of the Crab have then been used to redefine that tuning function trying to reduce the residuals around Si and Au edges

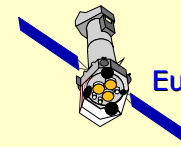


- Energy calibration is believed correct within 5 %

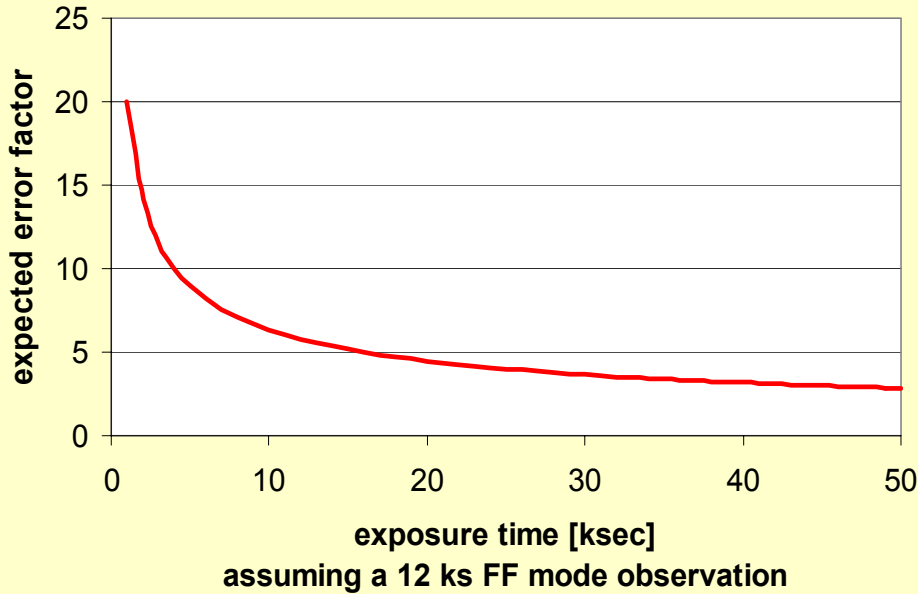


possible improvement

- Further improvement can only be achieved using line rich SNR observation
- Idea: observe Cas-A in FF/SW and Burst mode and adjust Burst mode according to the different line-positions found
- Problem: Lifetime in Burst mode is only 3 % → targeting the same number of events as for FF (12 ks) would blow up the exposure time for burst to 400 ks
- But we do not need the same number of events, we just need to determine the line positions with an acceptable error (that goes with $1/\sqrt{N}$)

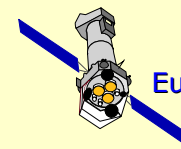


error estimate rel. to FF

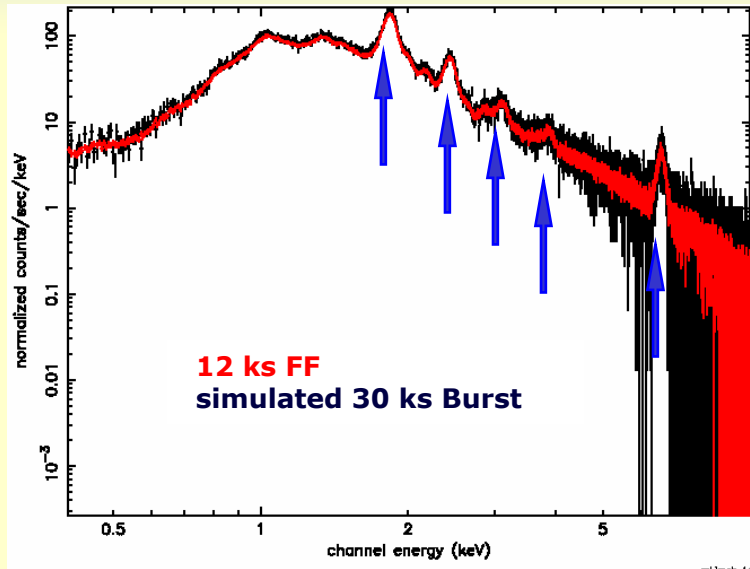


- Error of line determination scales with sqrt(N)

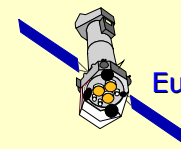
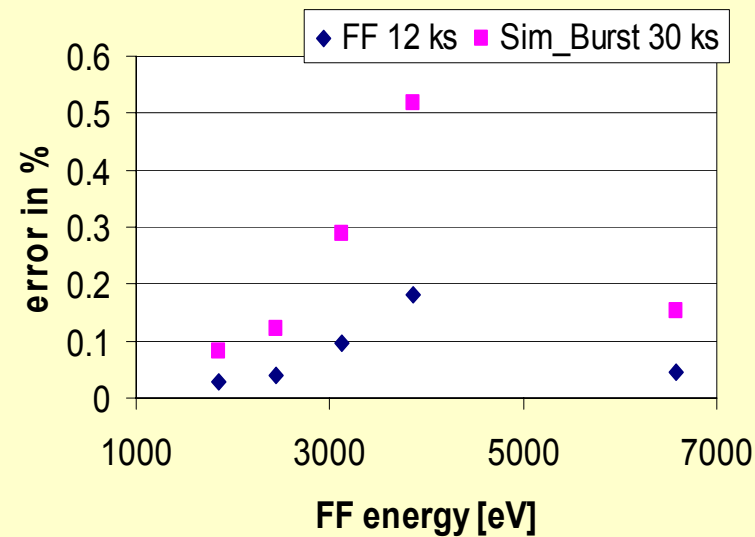
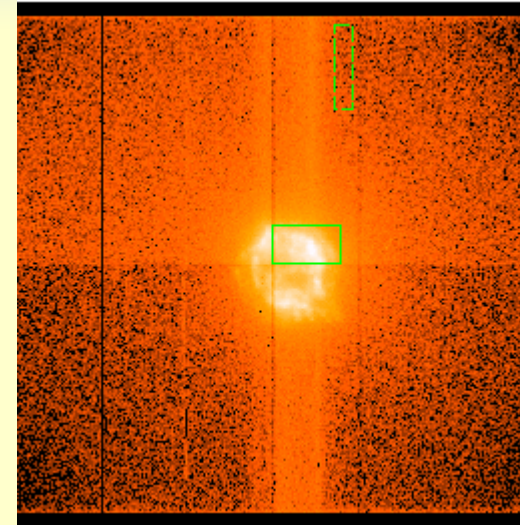
$$\begin{aligned}
 \frac{error_{Burst}}{error_{FF}} &\approx \frac{\sqrt{N_{FF}}}{\sqrt{N_{Burst}}} \\
 &= \sqrt{\frac{N_{FF}}{N_{Burst}}} \\
 &= \sqrt{\frac{c \cdot T_{FF}}{c \cdot T_{Burst} \cdot \frac{3}{100}}} \\
 &= 5.7 \cdot \sqrt{\frac{T_{FF}}{T_{Burst}}}
 \end{aligned}$$



error simulation

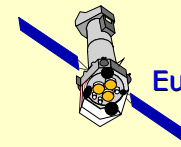


- only CCD4 events
- simulated errors for determination of line position for a 30 ks Burst observation
- Burst errors:
~ factor of 3 larger
- Agrees with estimate



strategy for cal improvement

- recalibrate gain-tuning for Burst
 - 15 ks: Cas-A FF or FF or SW as reference
 - 40 ks: Cas-A Burst
 - (Perhaps in addition a source with more low energy lines)
- in addition CTE rate calibration

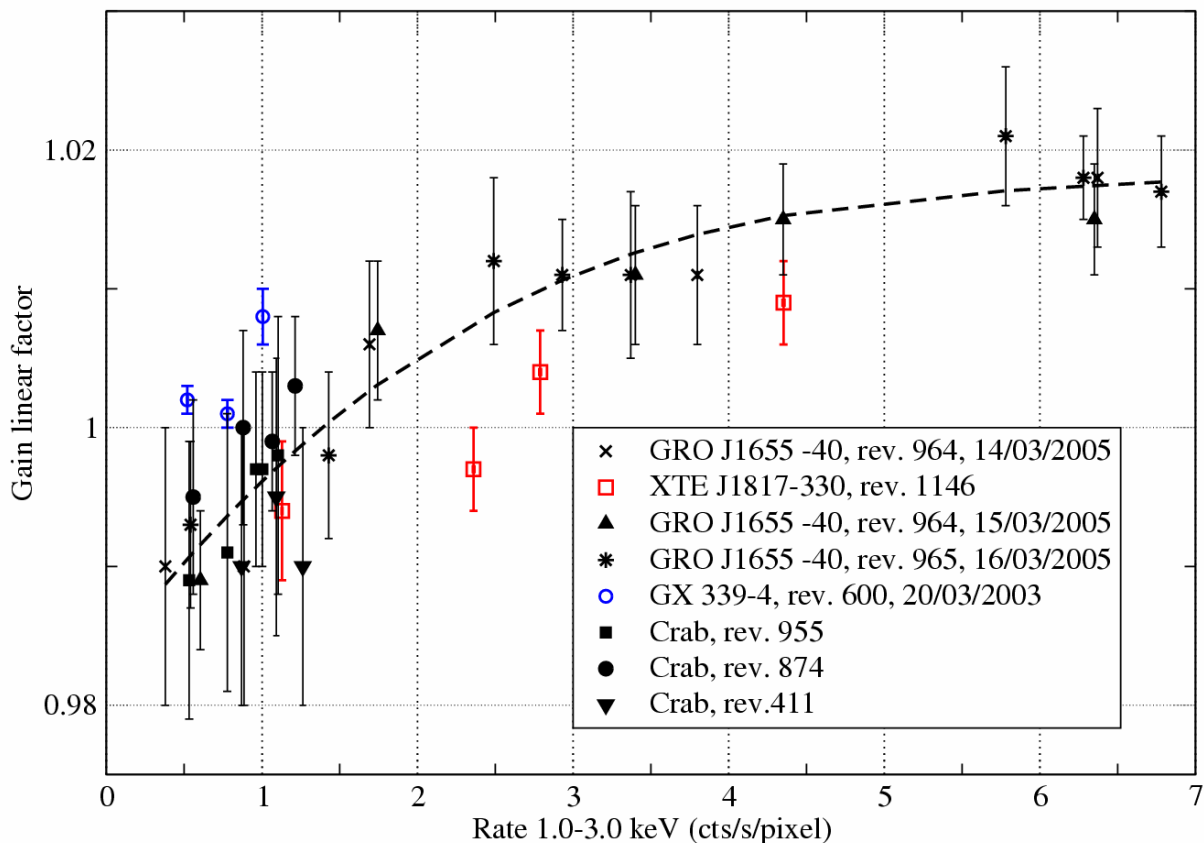


CTE rate dependence

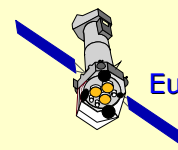
GRO J1655-40, XTE J1817-330, GX 339-4 and Crab

EPIC-pn "burst" gain factor on Au edge

May 2006



- Effect less than 2 %
- **Results not consistent**
- Need to improve statistics
 - GX339-4 observation in archive (ODF with problems, currently not available)
 - TOO NRCO on point source with flux > 1 Crab → 30 ks
 - In addition accepted AO5 G. Sala Proposal on GRO J1655-40 (will be observed if source is in bright state (> 1, > 2 Crab))



further proceeding

1. NRCO for the retuning of the CTI/Gain using Cas-A (if you agree?)
2. rate calibration refining the precursor calibration of the general EPIC-pn CTI correction after 1)

