

Calibration status of the *XMM-Newton* RGS

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<http://xmm2.esac.esa.int/docs/documents/CAL-TN-0030-5-1.pdf>

SRON Utrecht & XMM-SOC@ESAC

RGS calibration work 2008-2009

- ❑ Bad surface remains close to post-cooling levels of a few %
 - See the RGS monitor pages
- ❑ RGS SAS utilities for v9
 - `rgscombine`
 - λ -spectra allow combination of RGS1 and RGS2
 - extensive consistency checks
 - `rgslccorr`
 - source & background
- ❑ Audit of effective area EFFAREACORR CCFs
 - Time-variable model unchanged from last year
 - See also Stuhlinger's cross-calibration talk
- ❑ RGS contributions to cross-calibration and IACHEC
 - continuum sources ⊕ line-rich sources
 - SNR 1ES0102-7219, comets, ζ Pup et al. give complementary information
 - See also Guainazzi's EPIC talk
- ❑ Bright-source methods
 - RGS small-window mode planned for AO9 subject to success of commissioning campaign
 - reduce pile-up of point-sources
 - Crab extended-source test done
 - Cyg X-2 point-source test imminent
- ❑ RGS wavelength-scale systematic errors
 - suggestions of a thermal expansion origin

RGS plans from last year

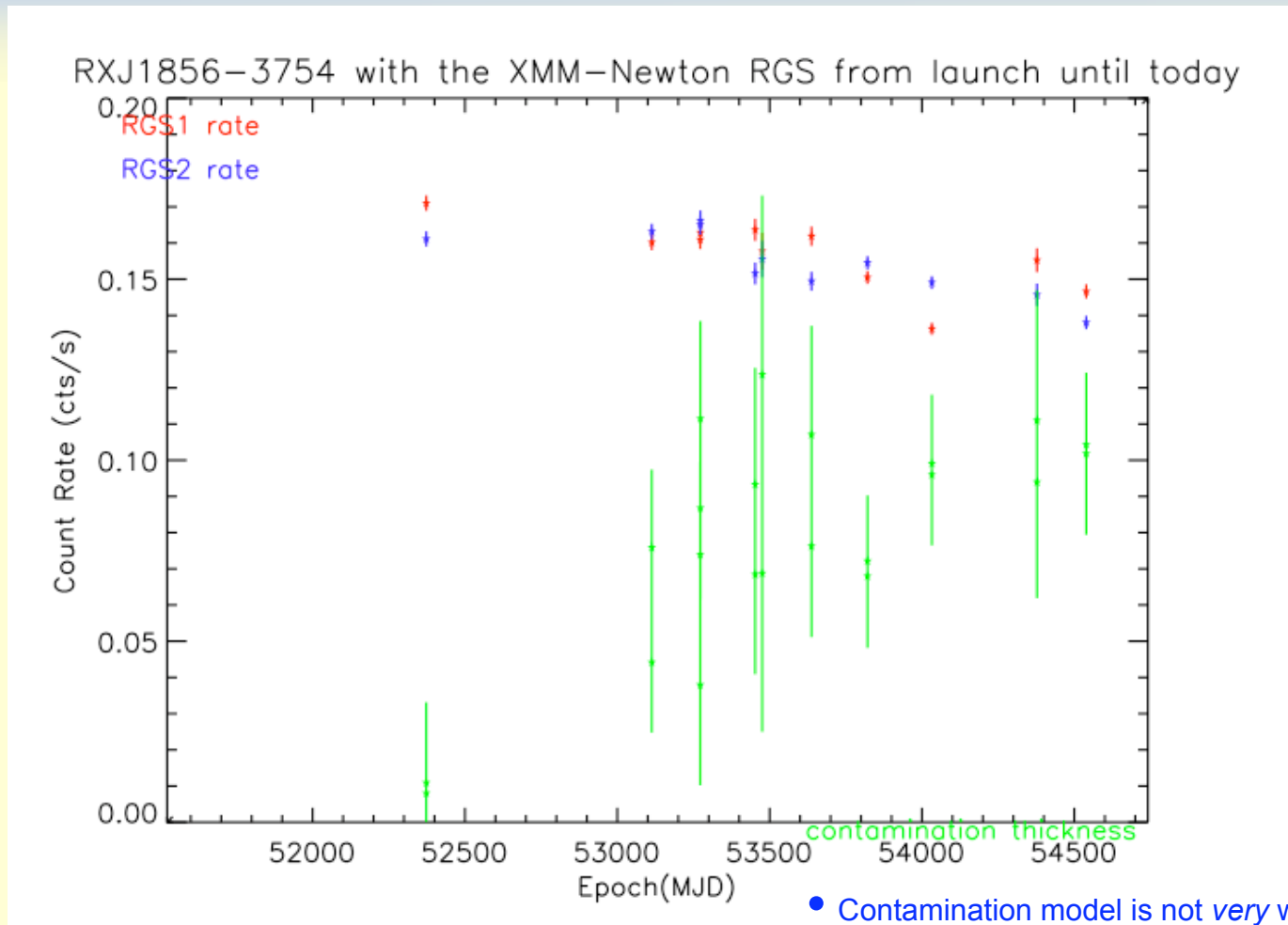
- ❑ Effective area EFFAREACORR CCFs
 - contamination monitoring ✓
 - 10% discrepancy with EPIC at long-wavelengths ✗
- ❑ RGS wavelength-scale
 - origin of the systematic errors ✓
- ❑ Bright-source methods
 - data handling on-board (DPP) ✓
 - new RGS SW mode ✓
 - data analysis methods (*cf* EPIC pile-up PSF core removal) ✗
 - quantitative pile-up model (*cf* Capella) ✗
- ❑ RGS background
 - RGS2 single-node background ✓

The RGS effective area model

$$\text{EFFAREACORR CCF} = \text{absorption}(C^*(t-t_0), \lambda) \times \text{areaCorrection}(\lambda)$$

- linearly increasing thickness of carbon contamination $C^*(t-t_0)$
 - RXJ1856-3754 constant
- $\text{areaCorrection}(\lambda)$
 - Mkn421 power-law spectrum
 - slope estimated from centre of the RGS waveband
 - Crab adjustment

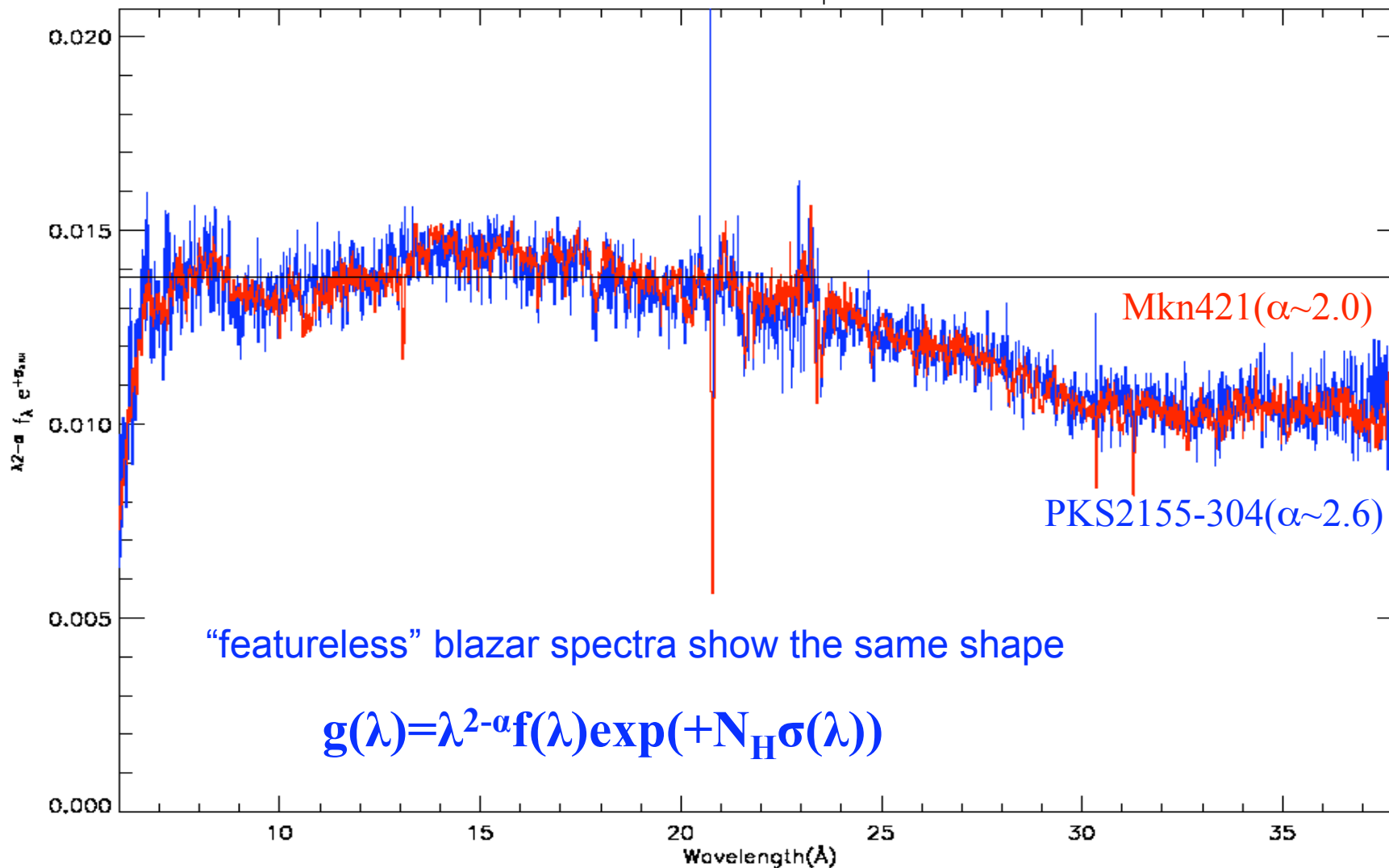
Individual RGS observations of RXJ1856-3754



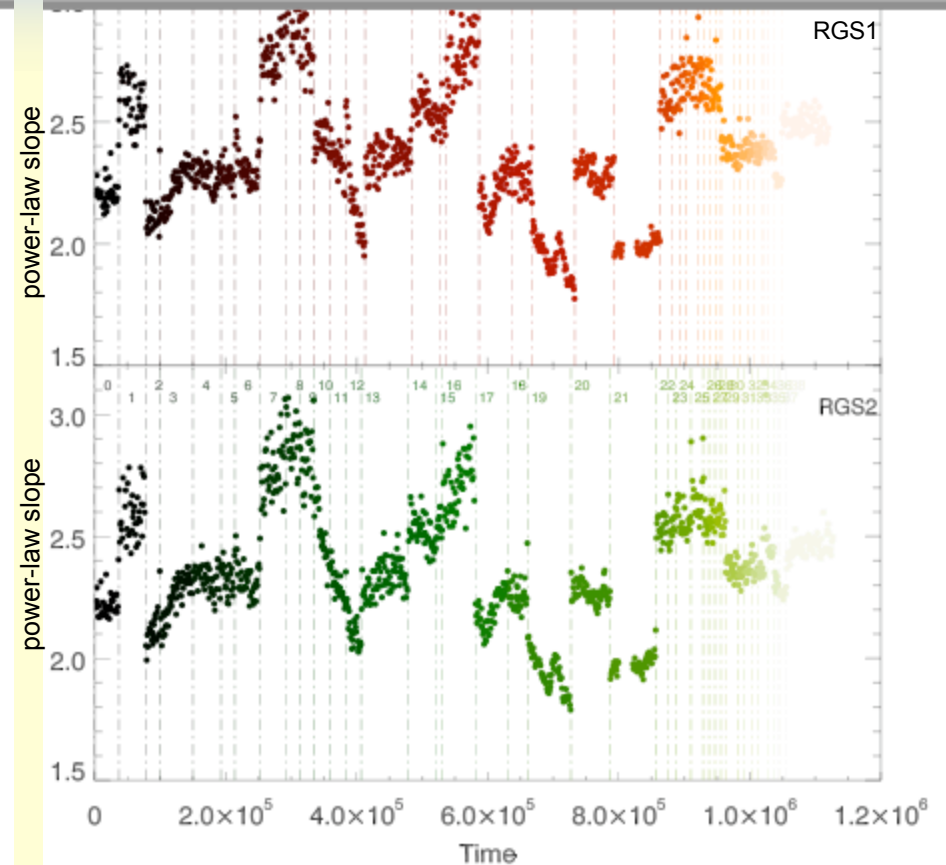
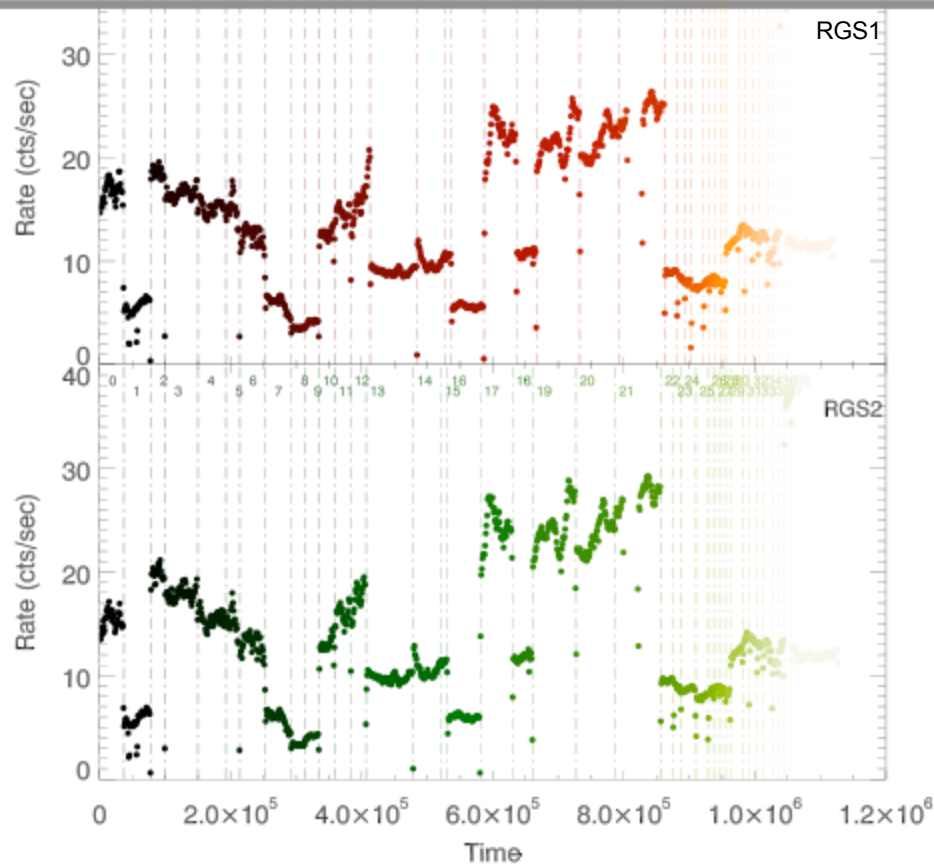
- Contamination model is not very well constrained
 - $3990 \leq N \leq 16113$ counts per spectrum
 - linear carbon increase C-statistic=81523.8
 - noisy individual carbon C-statistic=81510.4
- Vela PWN helps

Basis of RGS effective-area corrections

Power Law and ISM transformed RGS fluxed spectra of Mkn421 and PKS2155-304



Mkn421's RGS history in 1ks shots

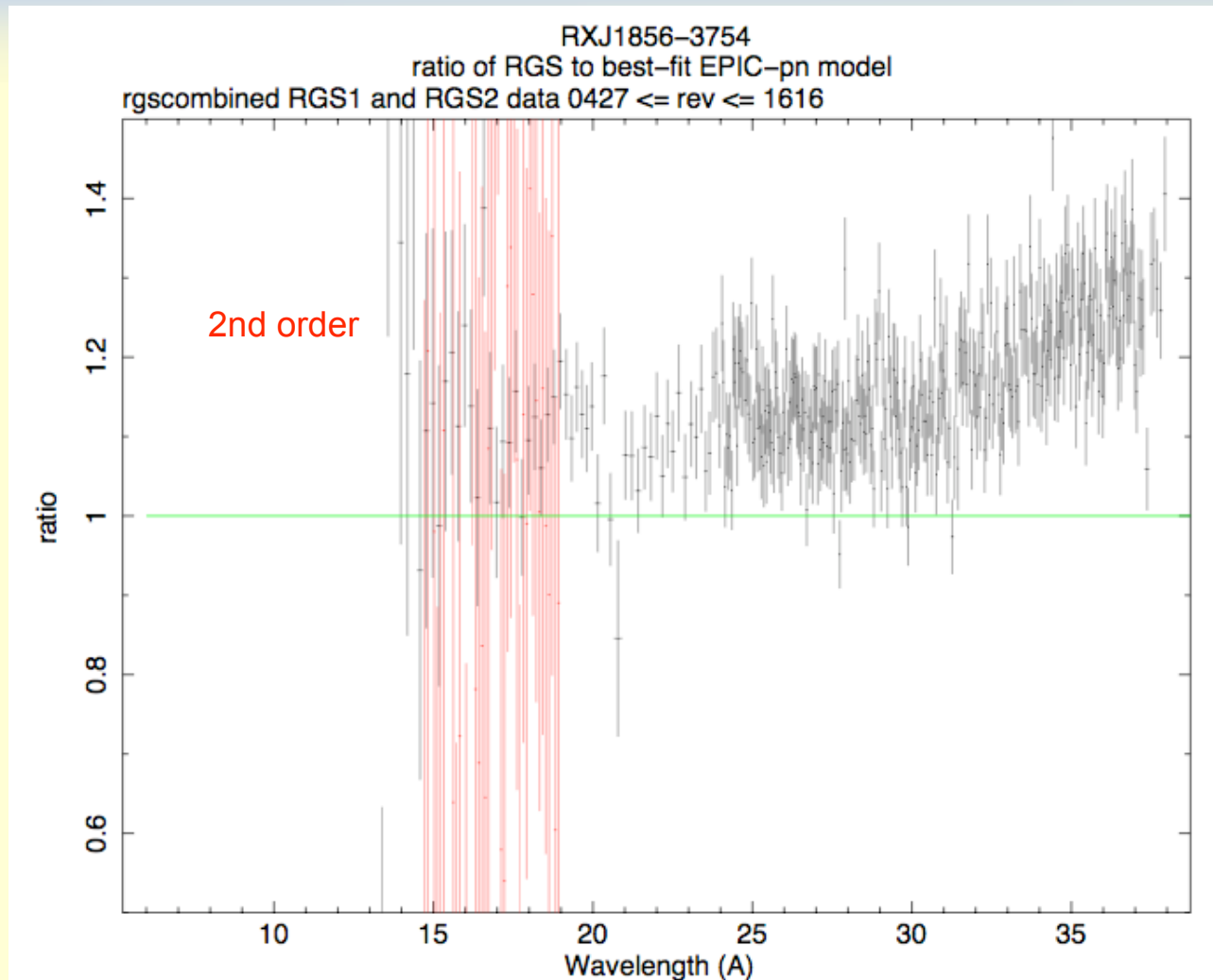


2008-2009 RGS calibration

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rgscombined RXJ1856-3754 T=1.396Ms



1st order

2nd order

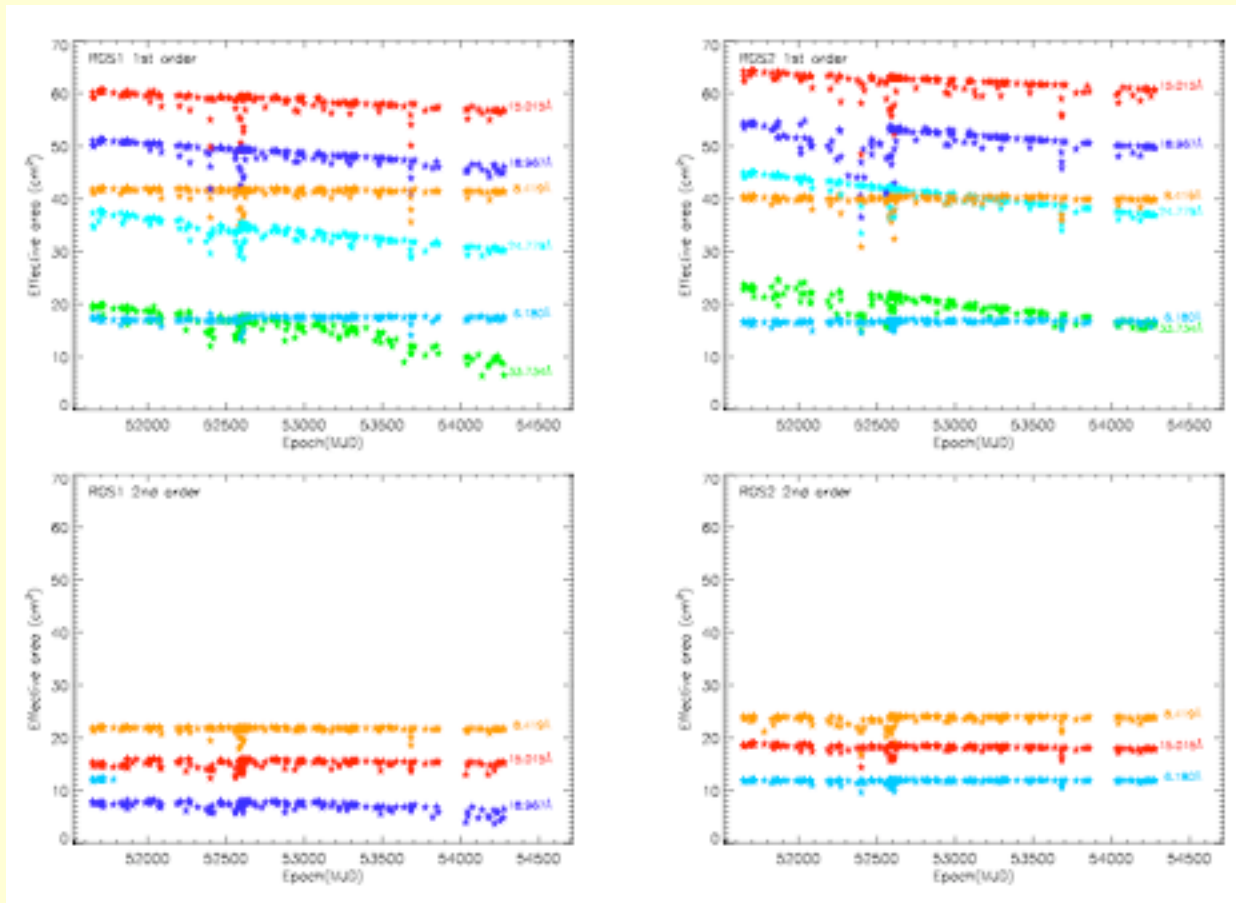
- current calibration
- similar to XCal discrepancies

RGS CCF area model(t, λ)

- 157 XCal observations

RGS1

RGS2



1st order

2nd order

RGS Calibration Status v5

Audit of the RGS effective-area model

Q: How is progress being made with the last 10% ?

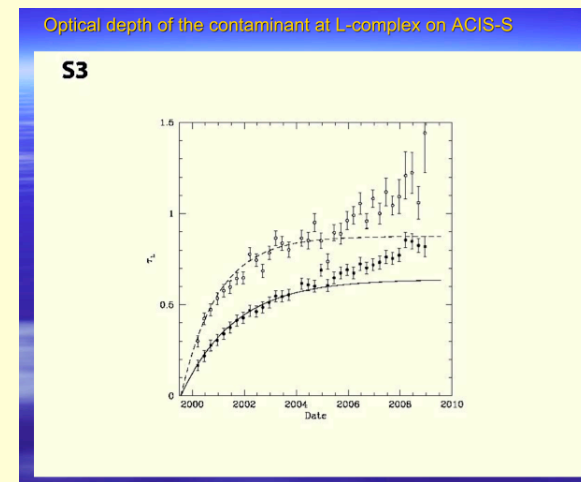
- RXJ1856+3754
 - constant
 - this constraint needs explicitly to be included
 - model is empirical
 - physical model some way off (*cf* White Dwarves)
 - not yet a(n IACHEC) calibration standard

- Mkn421
 - far from constant in flux or slope within exposures
 - spectral curvature argued in the literature
 - *cf* SRON Crab nebula analysis

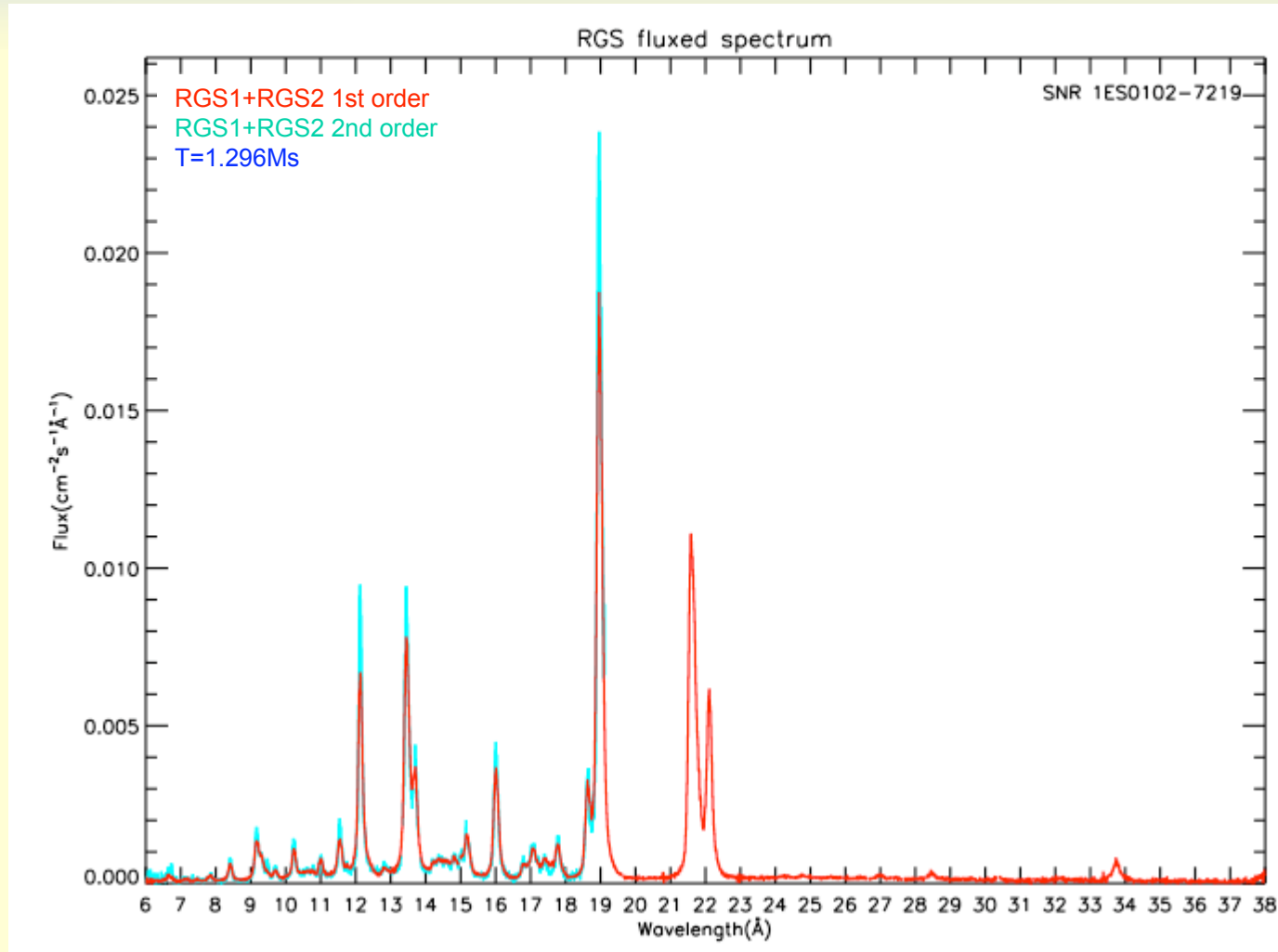
- Complementary contamination information required
 - *cf* IACHEC contamination discussions
 - Chandra mirrors and filters
 - new HRMA contamination model
 - new filter contamination model due
 - Suzaku filters
 - monthly observations of SNR 1ES0102-7219
 - ζ Pup's NVI and NVII lines
 - SNR 1ES0102-7219's OVII and OVIII lines
 - Mkn421's oxygen edge

- Background issues

A: Consider line-rich cross-calibration sources

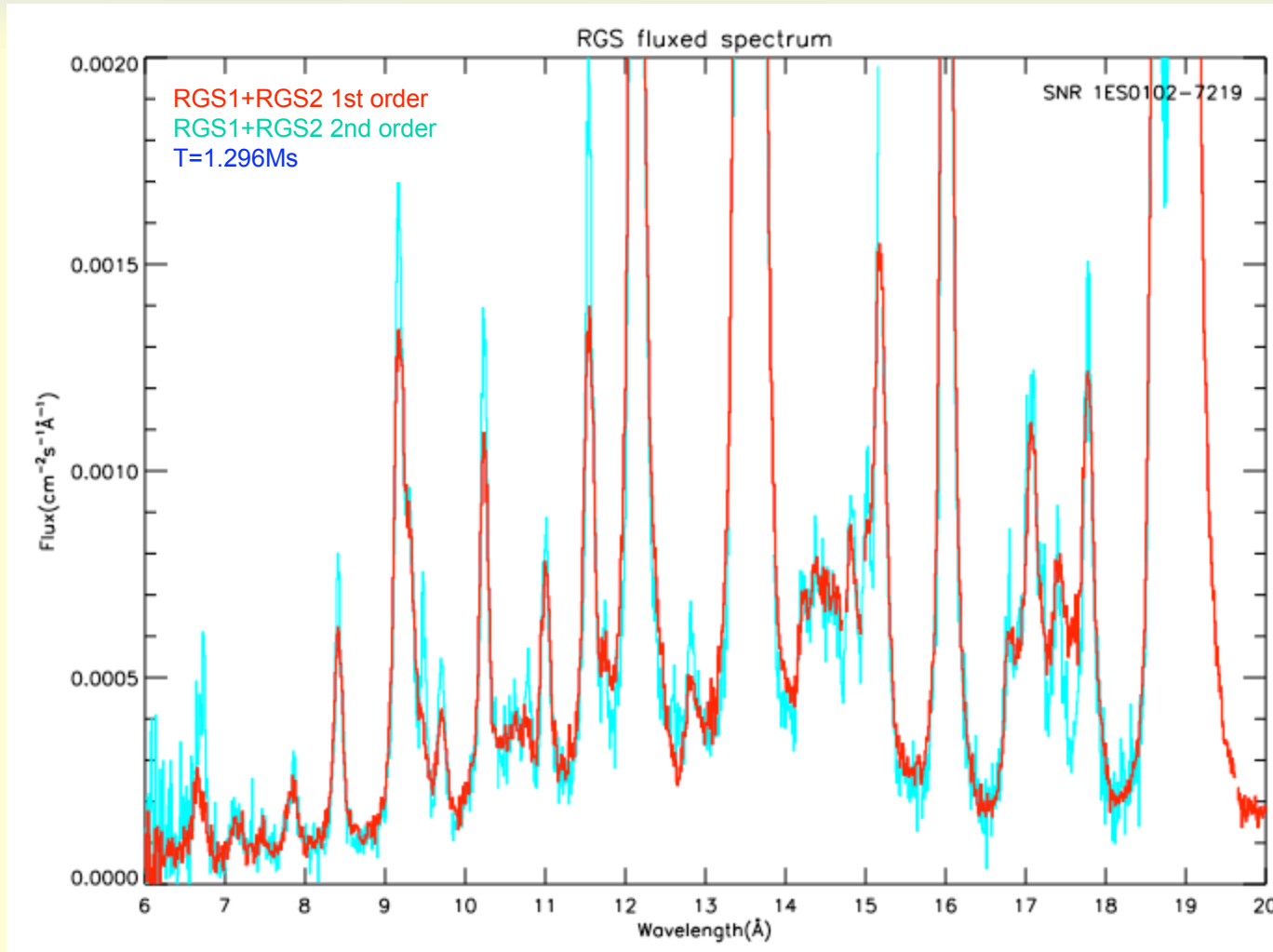


Line-rich IACHEC sources : SNR 1ES0102-7219



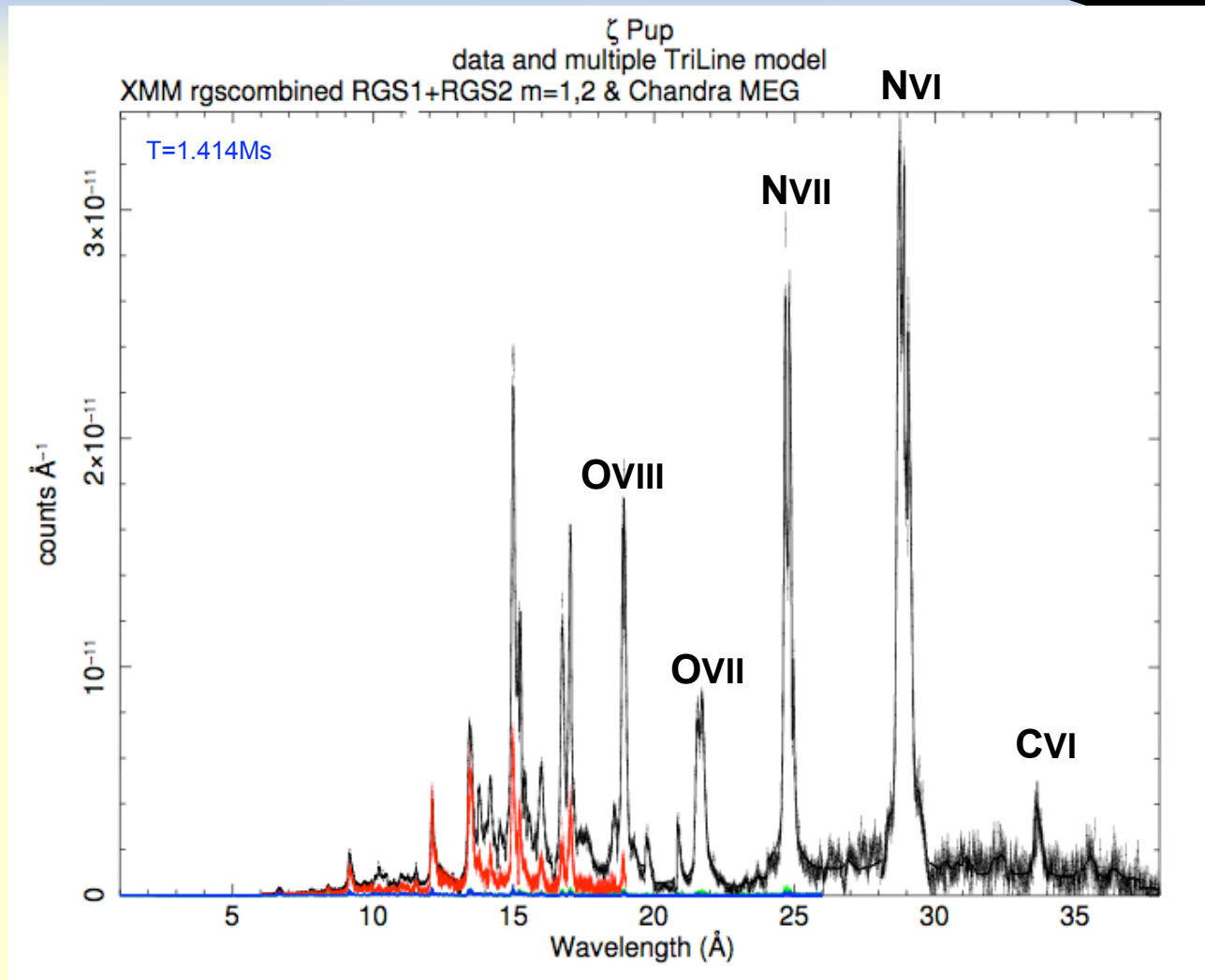
- Use `rgscombine` to synthesise multiple-line phenomenological RGS model

Line-rich IACHEC sources : SNR 1ES0102-7219



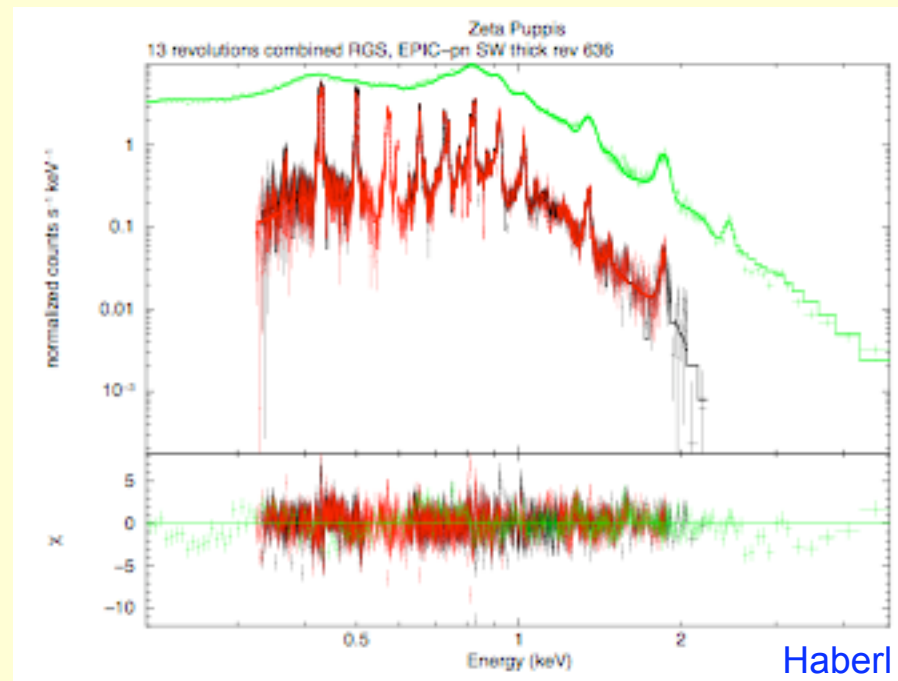
- Use synthetic RGS model for cross-calibration \Rightarrow Stuhlinger's talk and Plucinsky+ SPIE 2008

Line-rich XCal sources : ζ Pup



- Same 185-line model fits RGS-o1(1), RGS-o2($\times 1.01$), MEG($\times 0.97$), HEG($\times 0.93$)and EPIC-pn ($\times 0.97$)

Line-rich XCal sources : ζ Pup (cf Guainazzi)

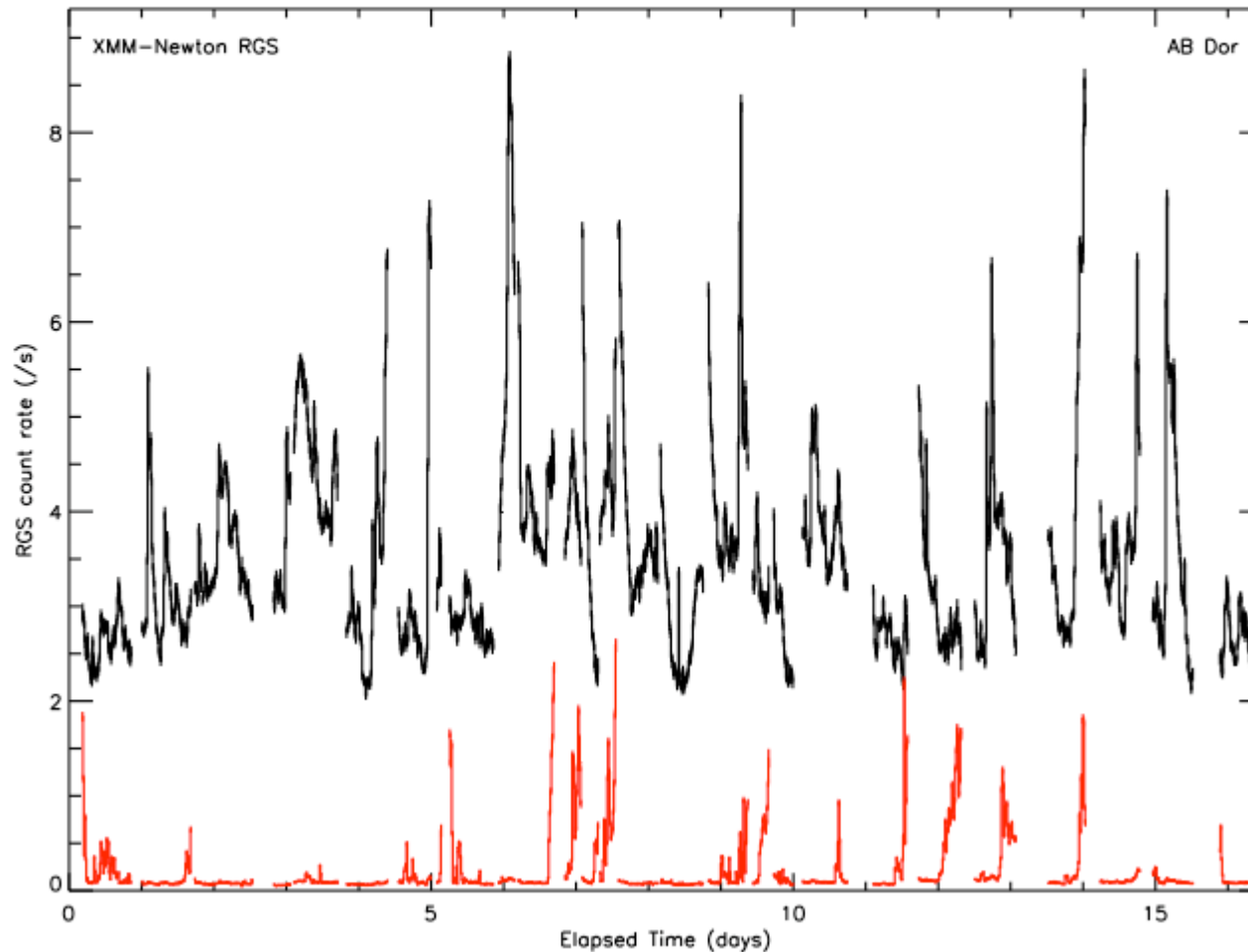


Haberl

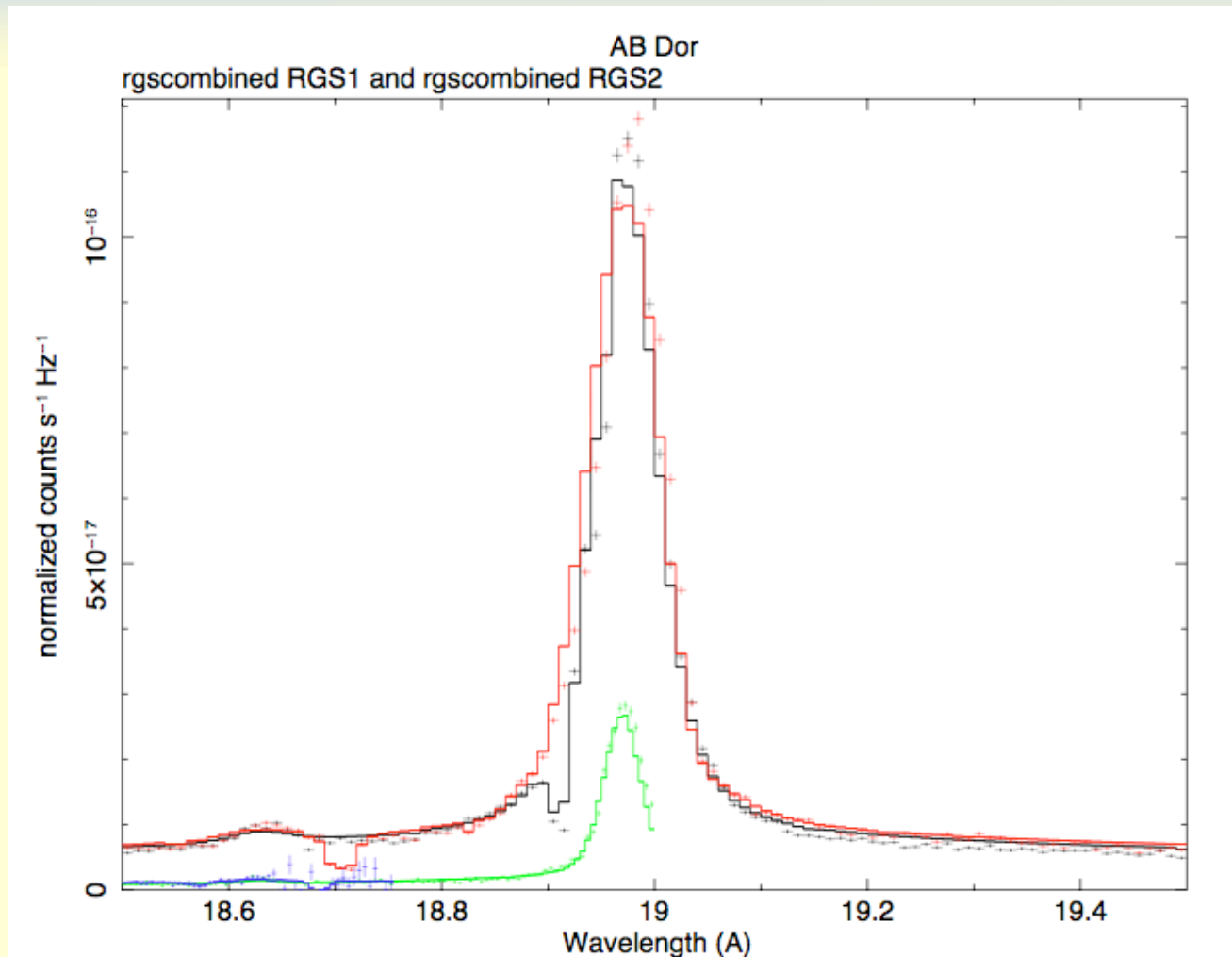
RGS effective area interim position

- ❑ Continuum spectra show agreement between RGS and EPIC+ within 10%
 - X-ray interstellar absorption law ?
- ❑ Emission-line spectra give complementary information
 - seem to show better agreement between RGS and EPIC
 - ζ Puppis
 - used for EPIC redistribution
 - pn by Haberl+
 - MOS by Sembay+
 - Comet C2000 WM1
 - Dennerl+ in prep.
 - 2001 December 13-14
 - Charge exchange lines from CVI to OVIII
 - Other examples in the literature
 - θ Car (Nazé & Rauw 2008)
 - Soft spectrum with narrow lines
 - Bright NVI & NVII
 - No C
- ❑ The last 10% is being tackled with the help of emission-lines
 - Goal of consistent description of both continuum and emission-line spectra

Line-rich XCal sources : AB Dor with rgs1ccorr

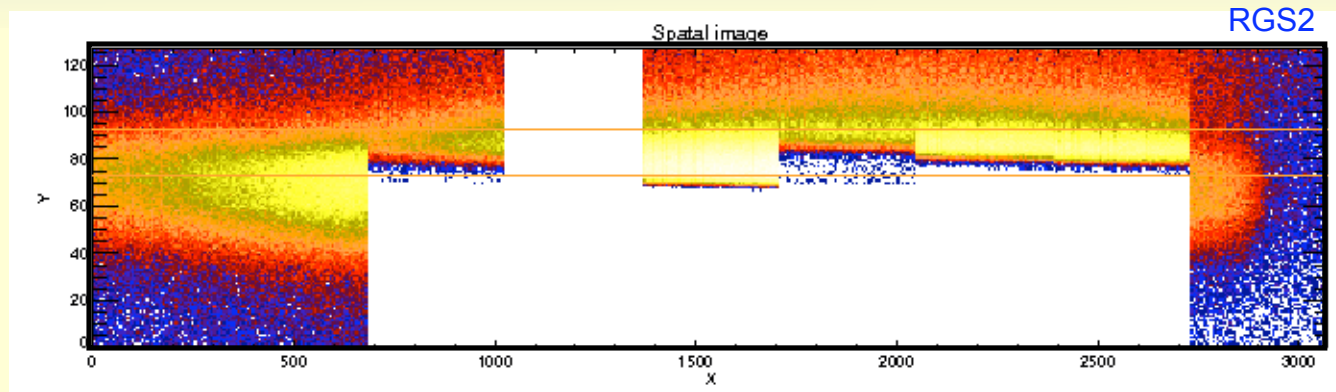


Line-rich XCal sources : AB Dor

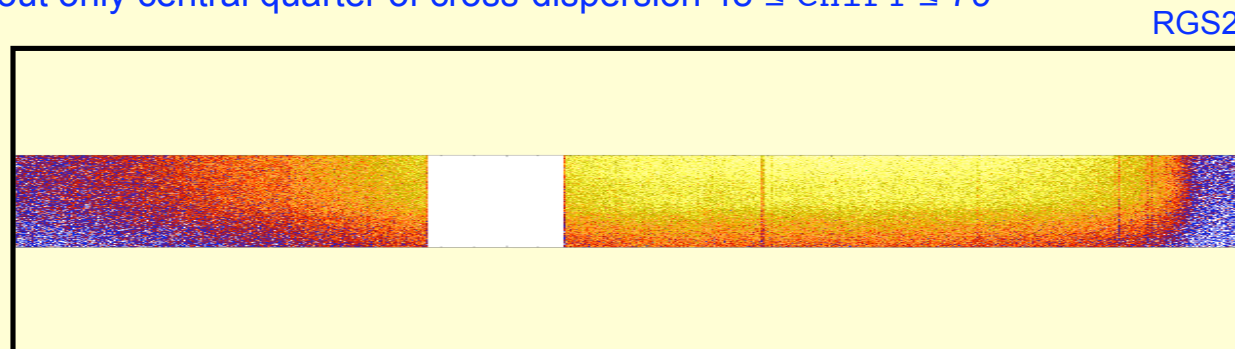


- RGS line-spread function
- $\lambda_{RGS}((X,Y)_{EPIC})$?
- $\lambda_{RGS}(T_{RGS})$?

RGS small-window mode : Crab test

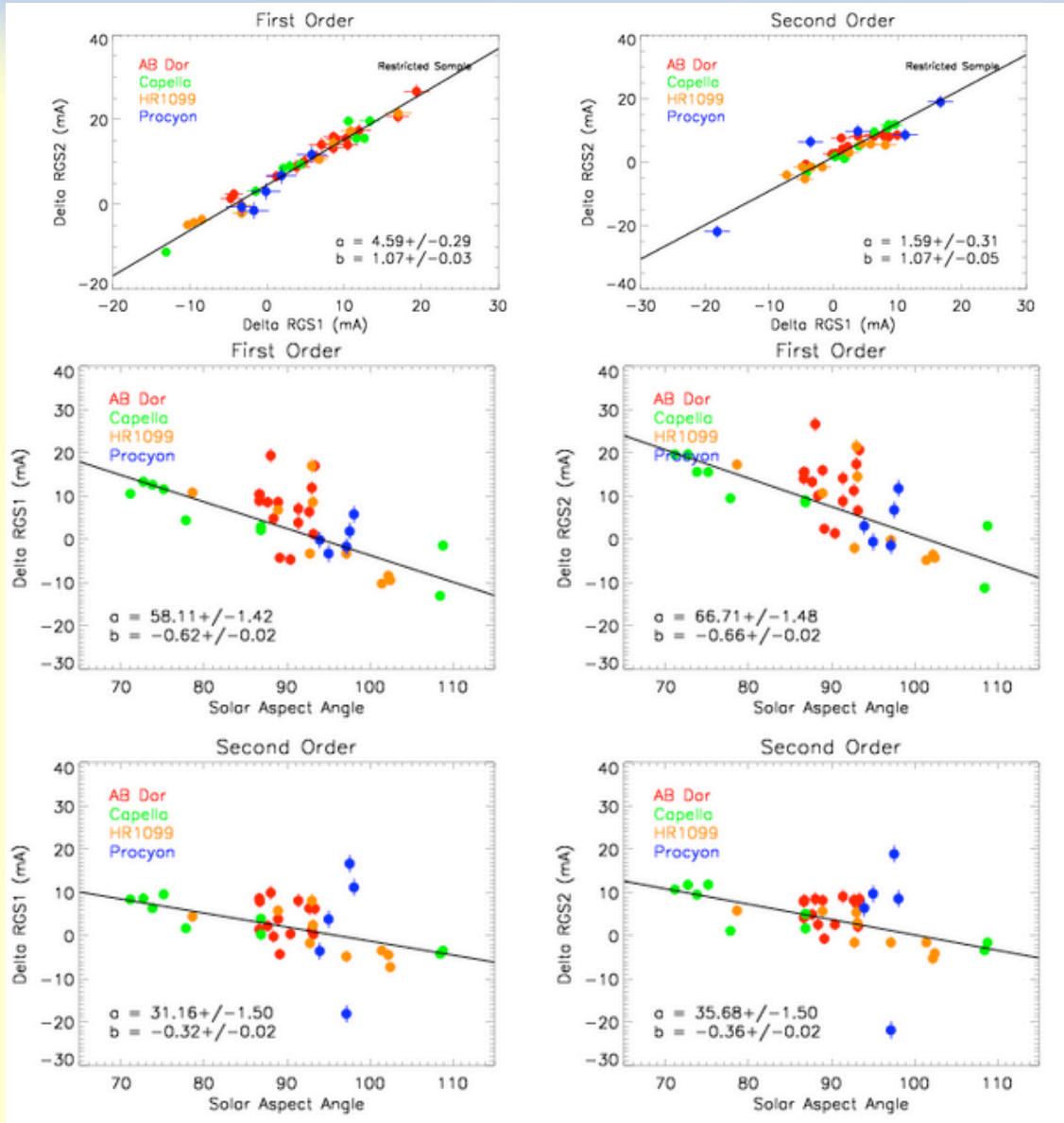


- read out only central quarter of cross-dispersion $48 \leq \text{CHIPY} \leq 79$



- Cyg X-2 point-source test scheduled next week

RGS wavelength-scale mA systematic errors



- RGS2 vs. RGS1

- 1st order vs. solar aspect angle

- 2nd order vs. solar aspect angle

RGS objectives for 2009-2010

- ❑ Effective area EFFAREACORR CCFs
 - improve contamination model
- ❑ Standard multiple emission-line models for RGS, XCal and IACHEC
 - SNR 1ES0102-7219
 - ζ Puppis
 - Capella
 - NGC1068
- ❑ Bright-source methods
 - commission RGS SW mode for AO9
 - historical data analysis methods (*cf* EPIC pile-up PSF core removal)
 - quantitative pile-up model (*cf* Capella)
- ❑ RGS background
 - Investigate variety of weak correlations between source and background