Calibration status of RXTE PCA

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Agenda

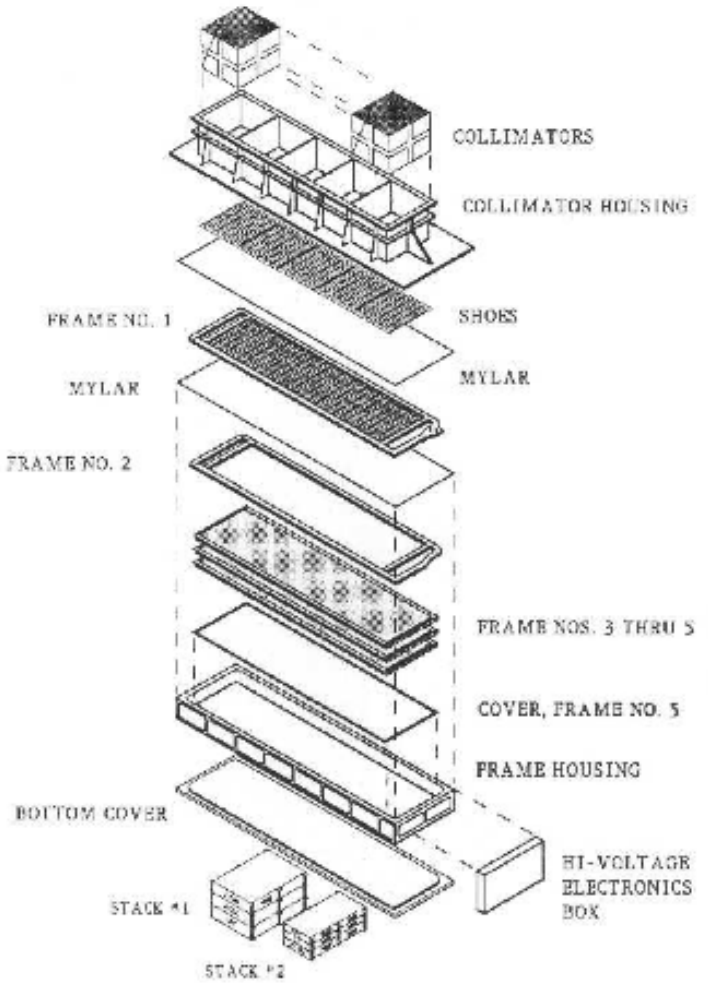
- RXTE PCA: remember that?
- Spectral response updates
- Prospects of using the Propane Layer for science
- Background model updates
- New software and tools

Rossi X-ray Timing Explorer

- Operated 1995-2012 (decomissioned)
- Three Instruments
  - Proportional Counter Array (2-60 keV)
  - HEXTE (15-250 keV)
  - All-Sky Monitor (2-12 keV; all-sky)
- Dedicated to fast x-ray timing, high flux targets, transient response, and monitoring

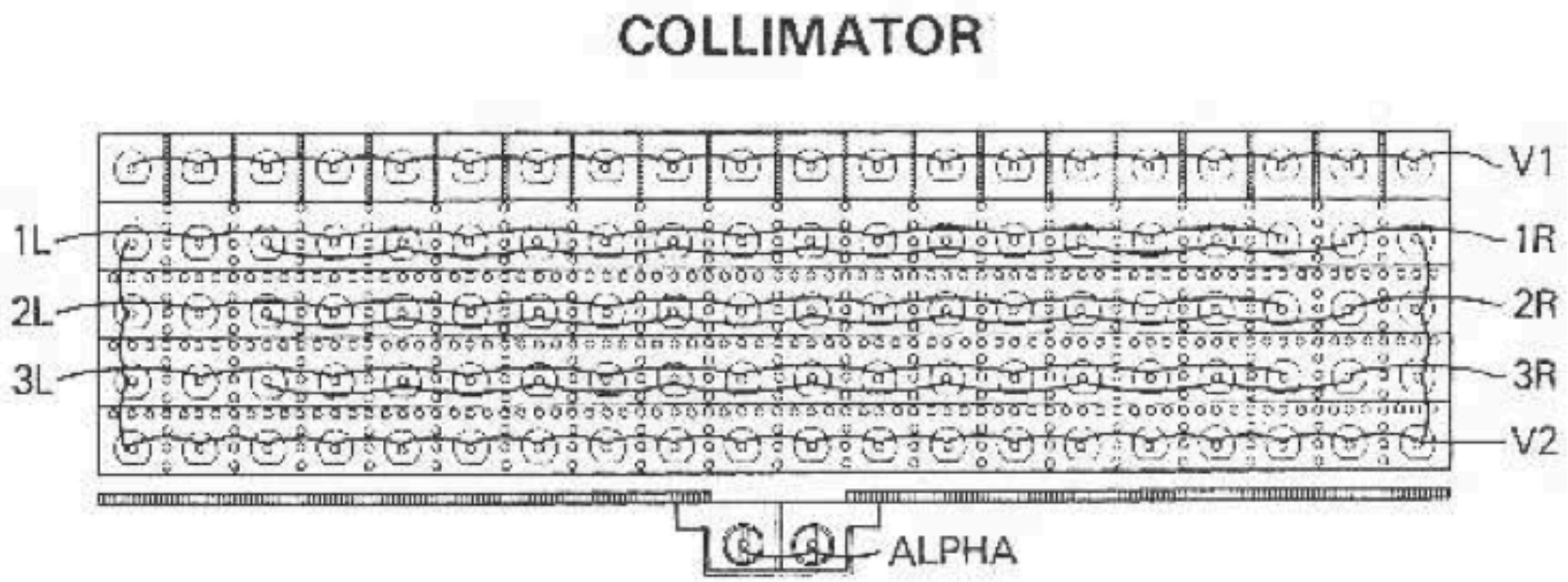
Proportional Counter Array

- 5 PCUs: ~1250 cm^2 each
- Energy range: 2-60 keV
- Energy resolution: < 18% at 6 keV
- Time resolution: 1 microsec
- Spatial resolution: collimator with 1 degree FWHM
- Collecting area: 6500 cm^2
- Layers: 1 Propane veto; 3 Xenon, each split into two; 1 Xenon veto layer
- Sensitivity: 0.1 mCrab
- Background: 2 mCrab

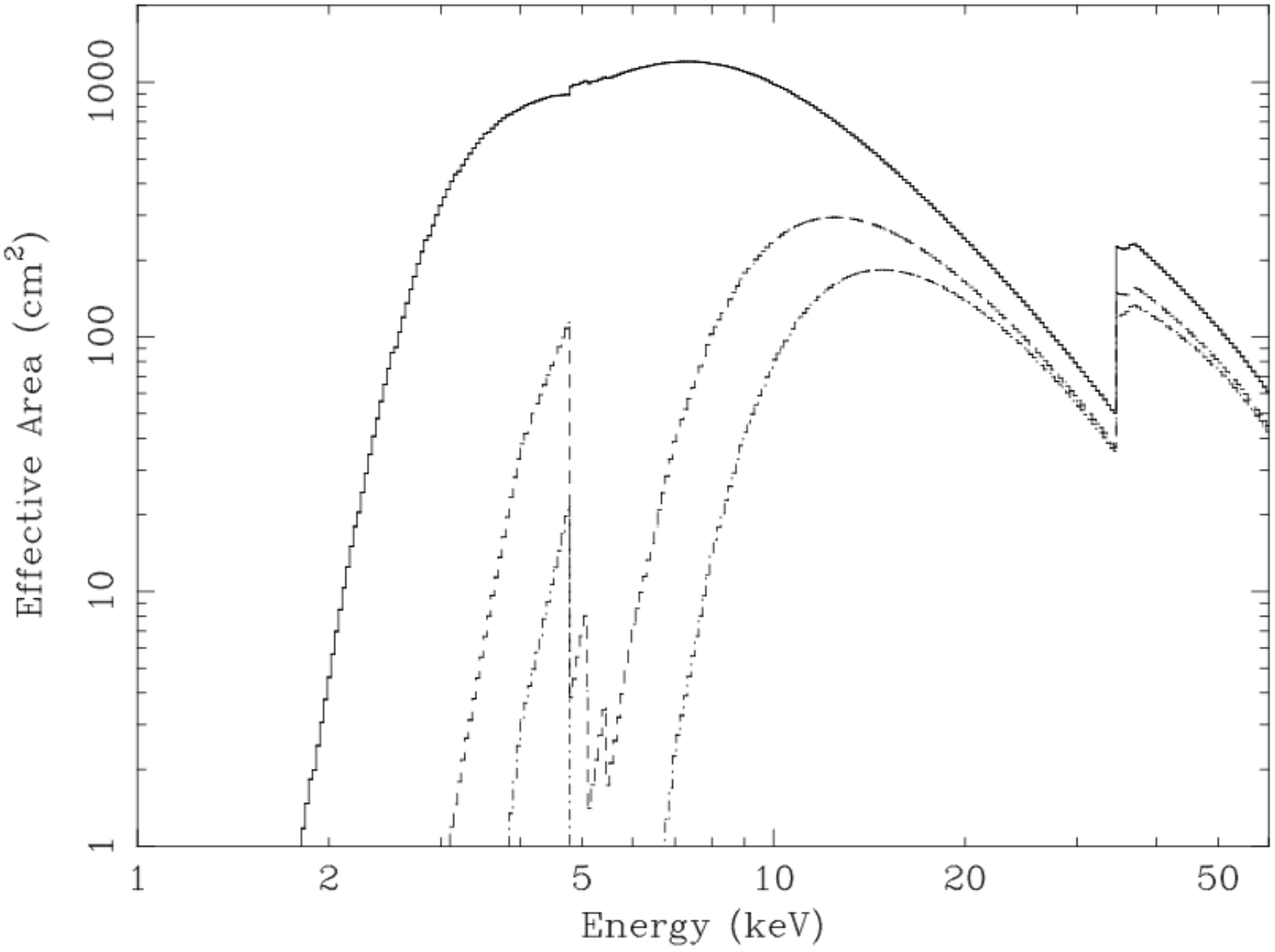


Proportional Counter Array

- Three layers plus propane “veto” layer



PCA Effective Area(s)



Response Calibration Approach

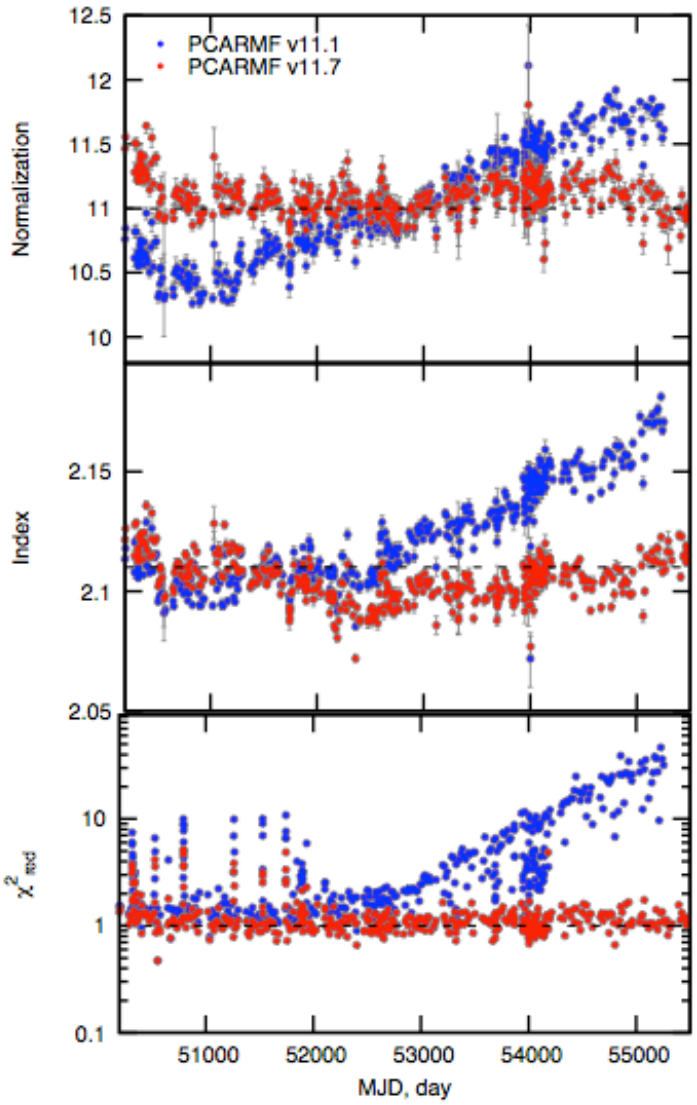
- Pre-2004
  - v03: “First principles” calibration based on ground calibration quantities
- Post-2004
  - 2004 (Shaposhnikov et al)
    - Fix the Crab Nebula+Pulsar (3-50 keV)…
      - NH = 0.34 x 10^{22} cm^{-2}
      - Γ = 2.11
      - N = 11.0 ph s^{-1} cm^{-2}
    - … and fit response parameters
  - 2009-2010: Revised energy to channel relation (Shaposhnikov et al)
  - 2011
    - Additional correction for collimator response

2009-2010

- More consistent Crab parameters
  - Fit quality much improved
  - Flux
  - Power law index
  - Individual PCU-PCU normalizations consistent
- Remaining variability intrinsic to Crab

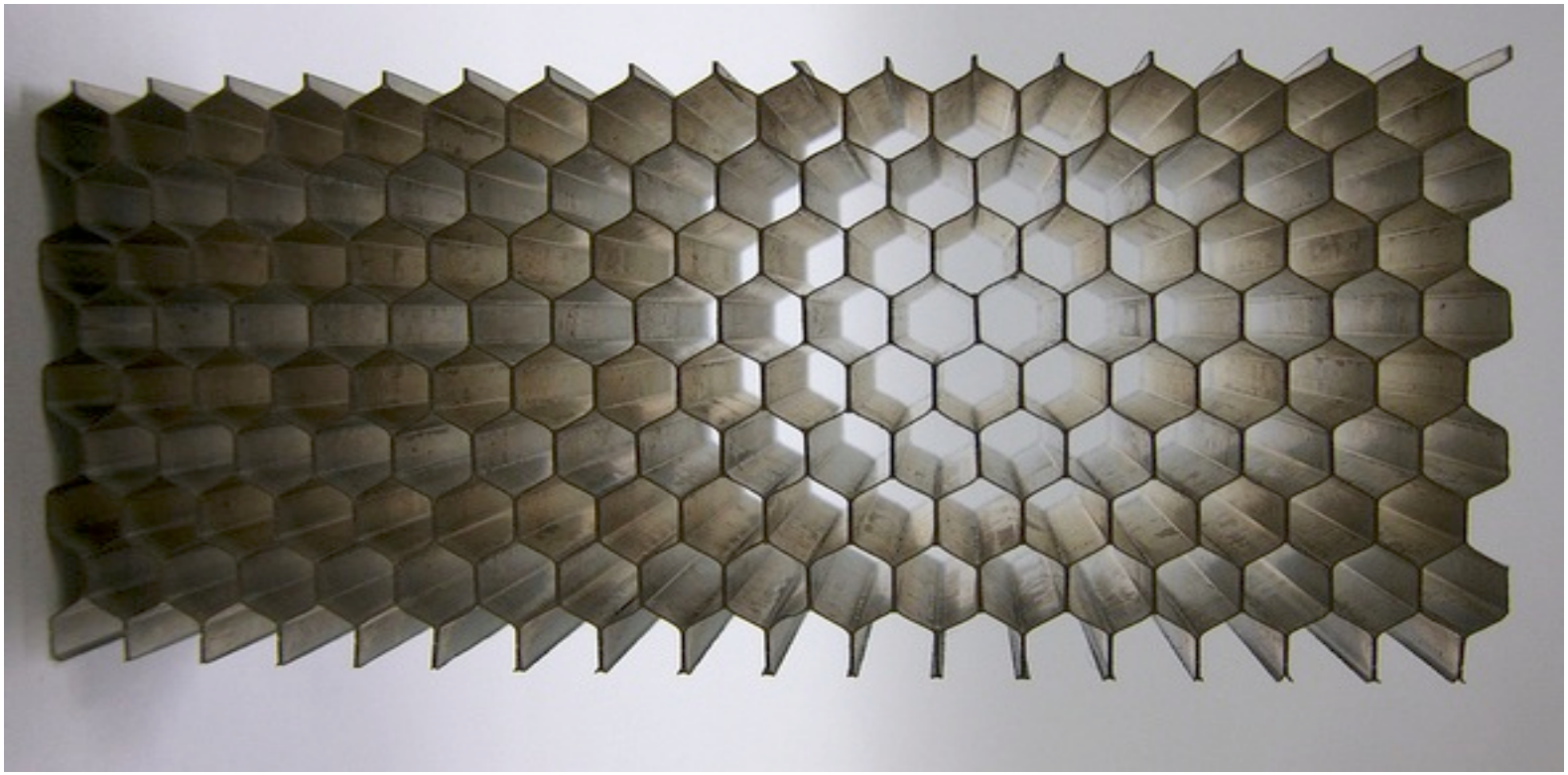
Blue = Old = BAD!

Red = New = GOOD!

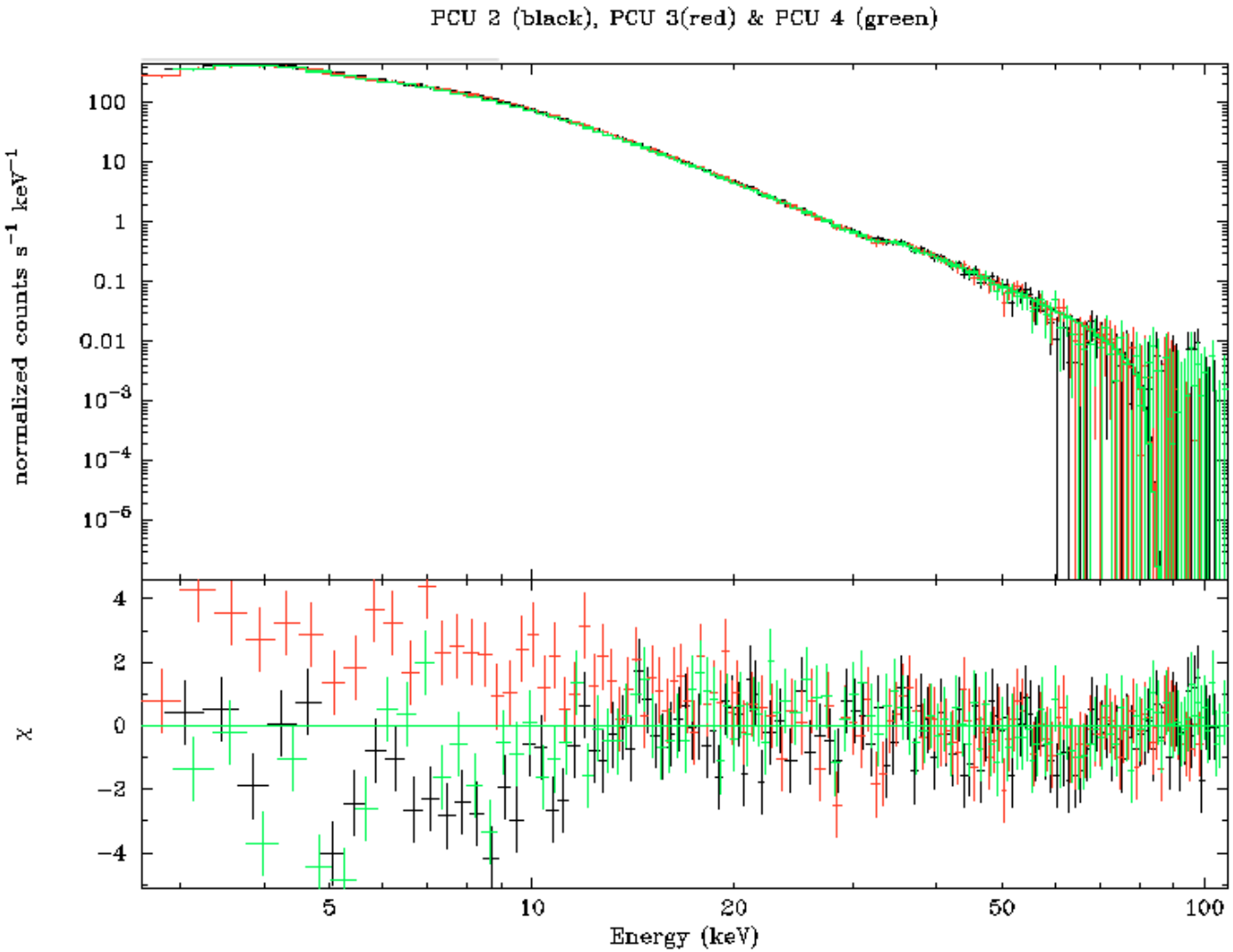


Collimator Correction

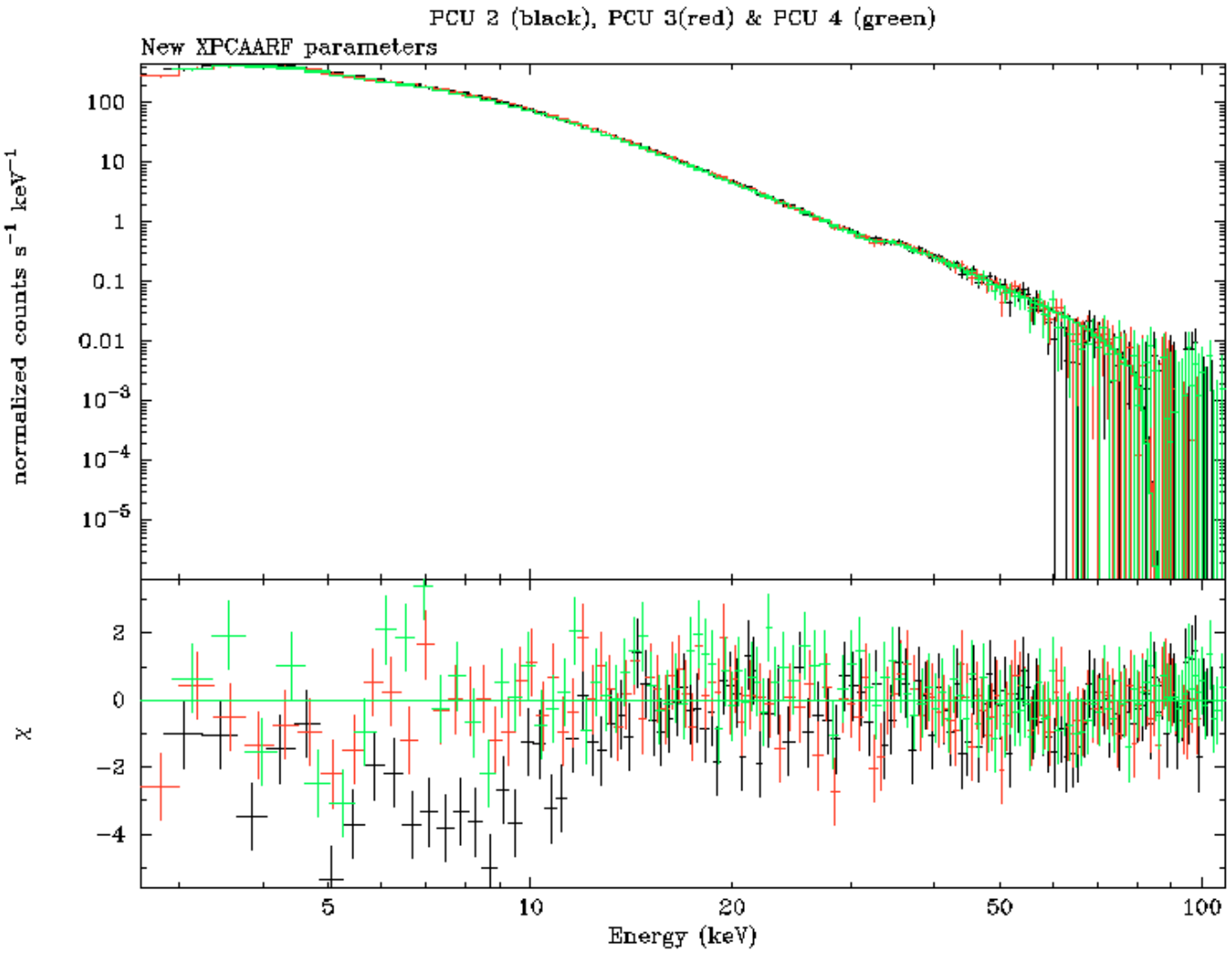
- 2011: Discovery that collimator response was not properly accounted for in calibration fits
- Typical error 0.5%, max 0.1%



Collimator Correction: Before

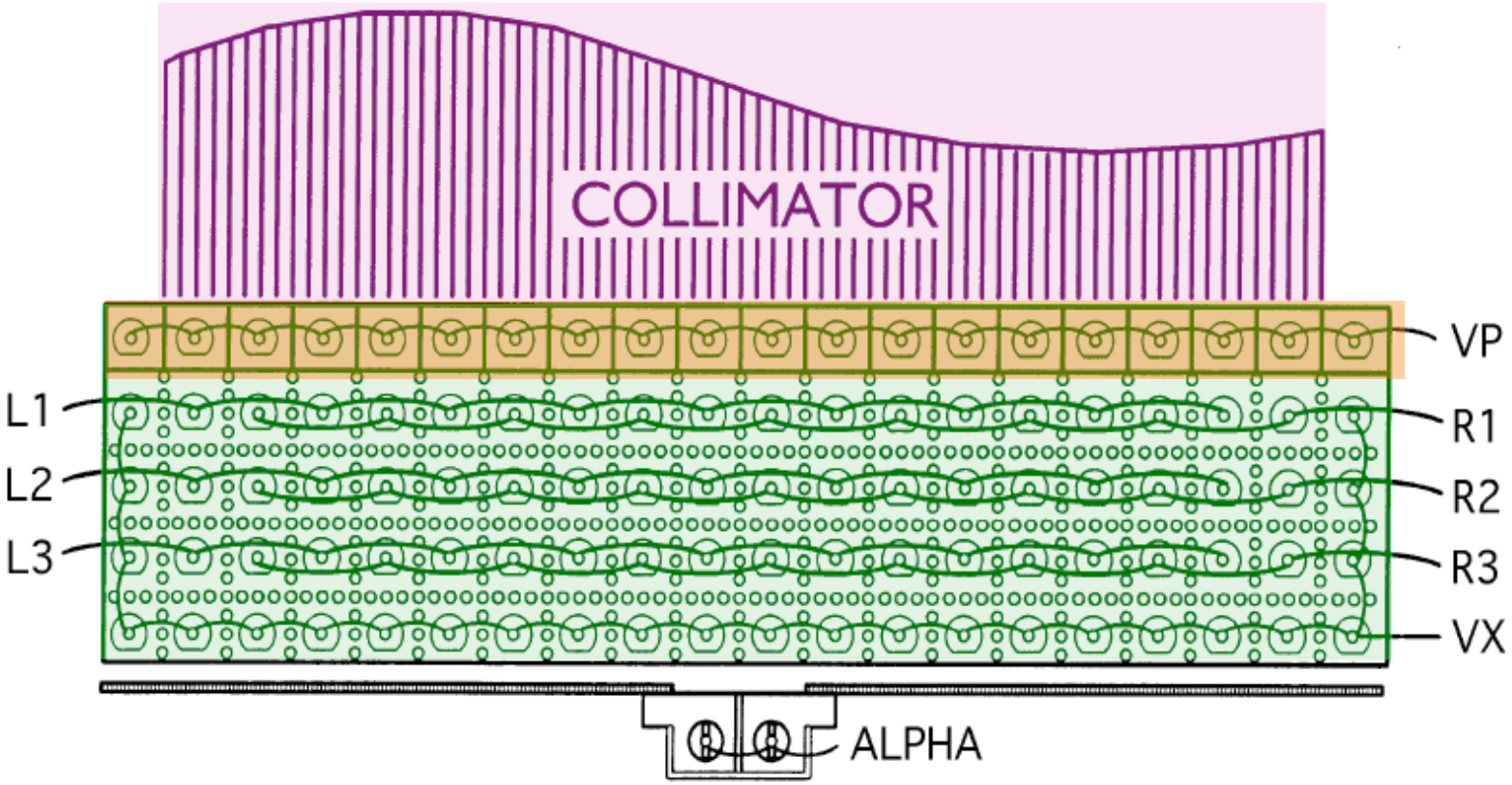


Collimator Correction: After

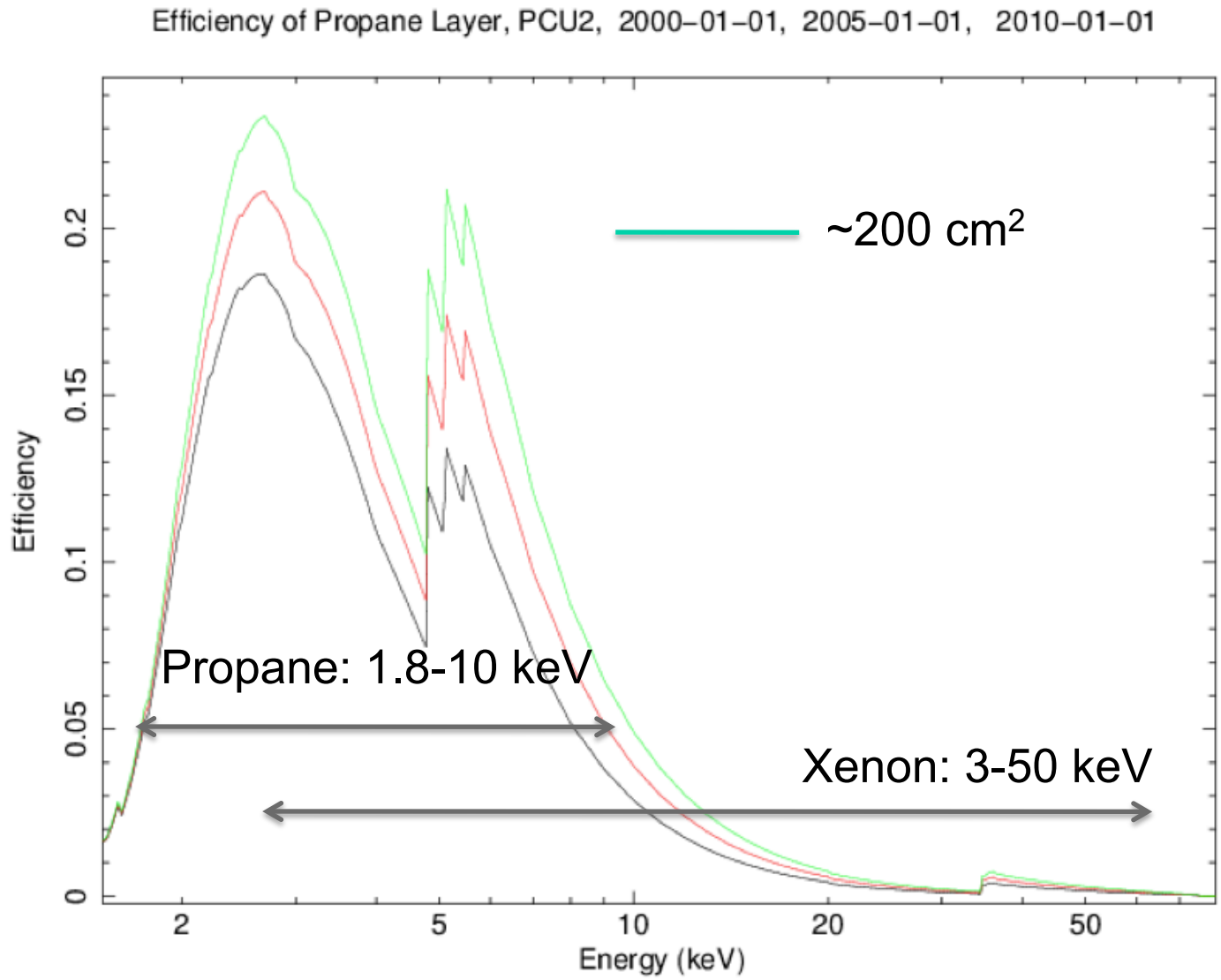


Prospects of Using Propane Layer for Science

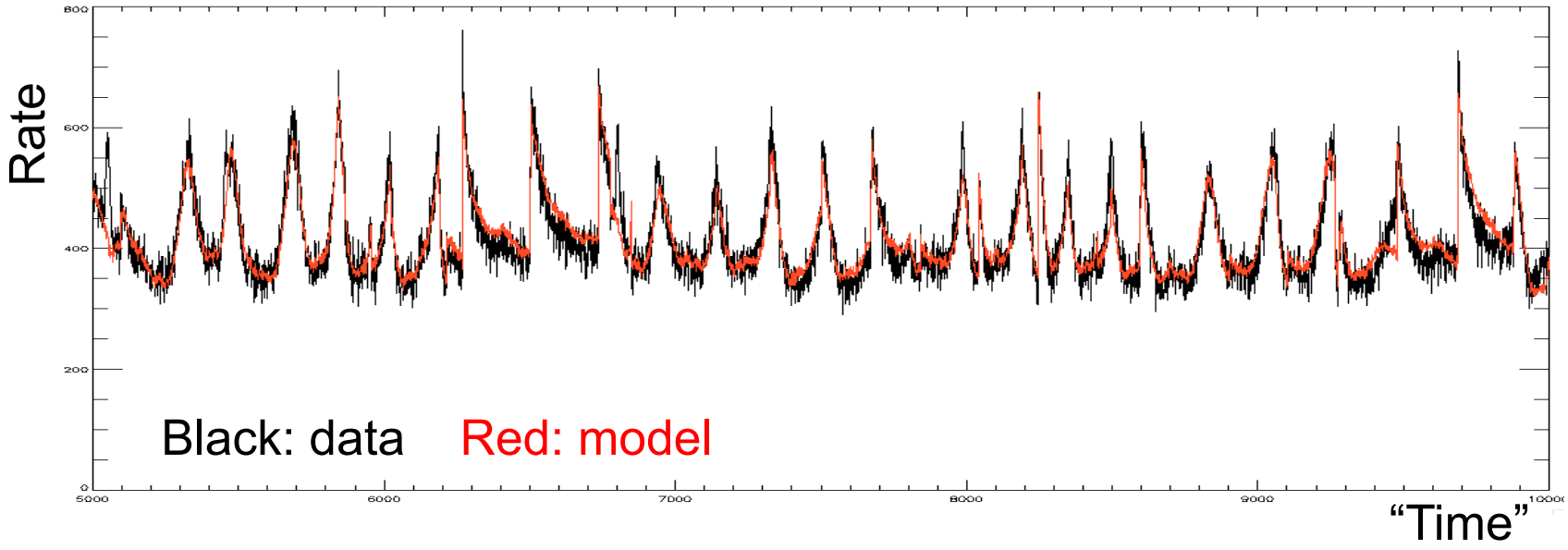
- Propane layer used as particle veto
- But: propane also sensitive to X-rays
  - At later times Xenon leaked into Propane layer



Propane Effective Area



Propane Background

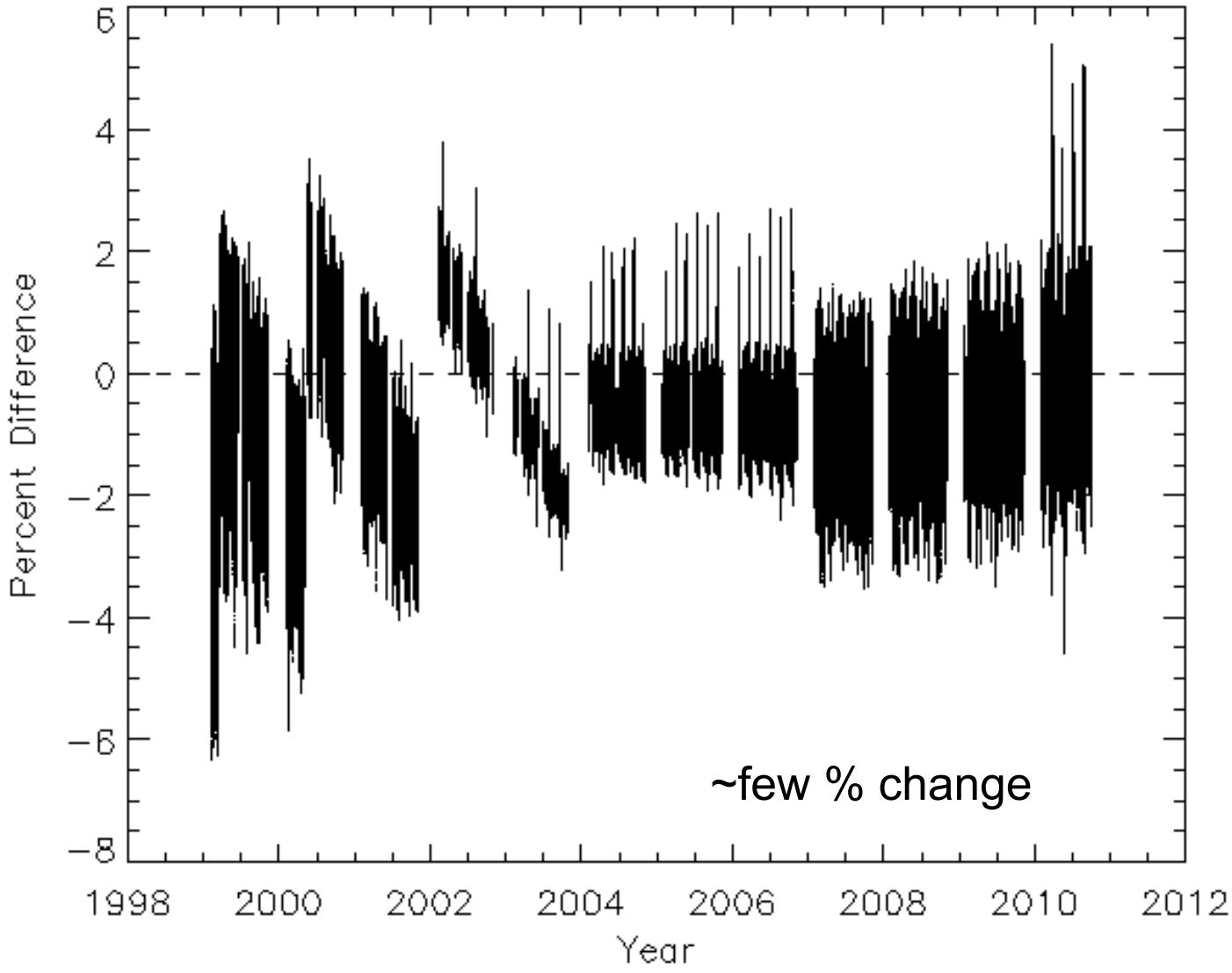


- Same modeling techniques as Xenon
- Generally good subtraction
  - RMS residuals ~3-4% (of background)
  - Some flares associated with geography (probably e^- precipitation events)
- Useful for moderately bright targets with careful background screening

Xenon Background Models

- Final post-decommissioning background model
- Previously the PCA team recommended two different models:
  - L7 for “faint” targets (better response for activation terms)
  - VLE for bright targets (better response for bright targets)
  - Confusion and inconvenience of choosing two models
  - Now 10-40% biases known for L7 model even for “faint” sources as defined by advice to observers
- New super-VLE model
  - Extended range to full mission
  - Applicable to all sources, bright and faint
  - Activation terms now handled properly
  - No biases for faint sources
  - Original L7 model also regenerated to cover end-of-mission
- Performance
  - ~1% r.m.s. unmodeled background errors
- Release: June 2014

VLE PCA Background Changes



New Data & Software

- GOAL: make RXTE legacy data more easy to use
- Existing RXTE PCA tools difficult to use, and use properly
  - No facility to perform deadtime correction
  - Difficult to filter & sum PCUs based on breakdowns or on-offs
- New tools for Standard data:
  - `pcaprepobsid` – Standard PCA setup
  - `pcaext{spect,lc}{1,2}` – Extract light curves and spectra from Standard{1,2} data with proper PCU filtering and Response matrix summing
  - Plans to extend to more data modes (GoodXenon at least)
- New archive standard products
  - New event files with all columns populated: PCU_ID, ANODE_ID, PHA
  - Possible to use `xselect` for basic analysis
  - Now users can perform filtering without crazy bitmasks