ACIS QE: Investigating the FI/BI Ratio

- Grating & Cluster data want FI/BI ratio lower than CALDB
- Size of effect: $\sim 10 - 15\%$
- wavelength dependent, especially notable for $E < 1.5$ keV.
- Absolute calibration from ground (XRCF) data may settle the issue

Two effects:

- Dead area due to cosmic ray blooms: larger effect on FI than BI
- Reassessment of QE at low energies.

This investigation is in response to two action items from the 2002 Nov Calibration Workshop.

ACIS Cosmic Ray Bloom Dead Area

12 June 2003

- Cosmic Ray blooms typically involve 500 pixels above split threshold on FI chips
- Grey effect
- Memo by Yousaf Butt and Brad Spitzbart based on raw frame data (including cuckoo-clocking data).
- Correction is $3.68 \pm 0.21\%$ for FI chips (grade 0)
- possibly as much as $\sim 5\%$ for all grades
- Estimate an order of magnitude lower ($\sim 0.29\%$) for BI chips.
- define $y \equiv 1 - .0368 = 0.9632$, for later use.

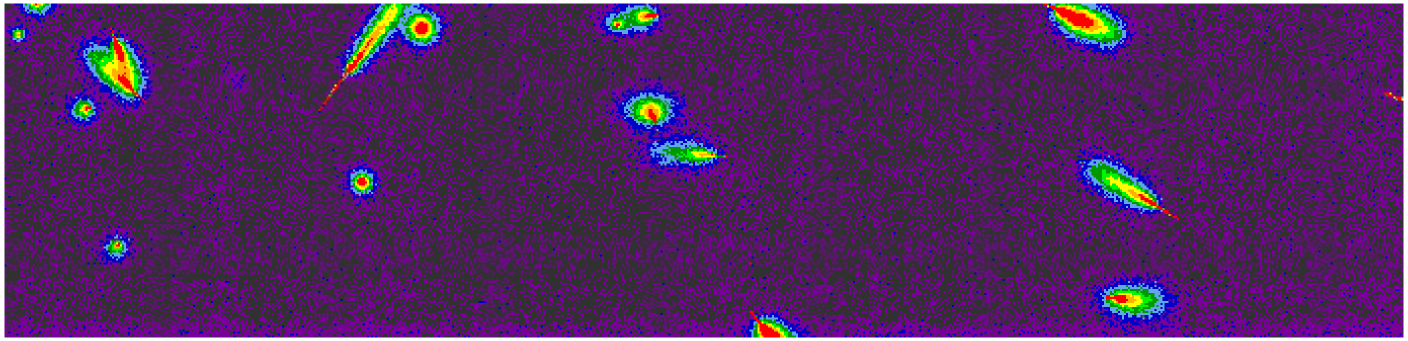

Figure 1: One node of raw-mode data from an FI device, showing cosmic ray blooms.

Re-analysis of XRCF Flat Field data at low energies

- **Better modelling of spectral features, teasing apart continua and lines.**
- **Accounts for non-Gaussian line shapes, especially important at low energies.**
- **Comparison to synchrotron-calibrated Flow Proportional Counter in same beam**

	Oxygen	**Copper**
energy	**0.5249 keV**	**0.9297 keV**
	measured	
QE(S2)	0.228 ± 0.005	0.558 ± 0.014
QE(S3)	0.615 ± 0.013	0.841 ± 0.024
S3/S2	2.697 ± 0.0772	1.508 ± 0.0577
	CALDB	
QE(S2)	**0.2120**	**0.5644**
QE(S2)	**0.5230**	**0.7861**
S3/S2	**2.467**	**1.3928**
XRCF/CALDB	$1.093 \pm .0313$	1.083 ± 0.041
CALDB/XRCF	0.915 ± 0.026	0.9234 ± 0.035
ground corrected r/y	0.900 ± 0.05	0.946 ± 0.05

- **Agreement between last 2 rows is good.**

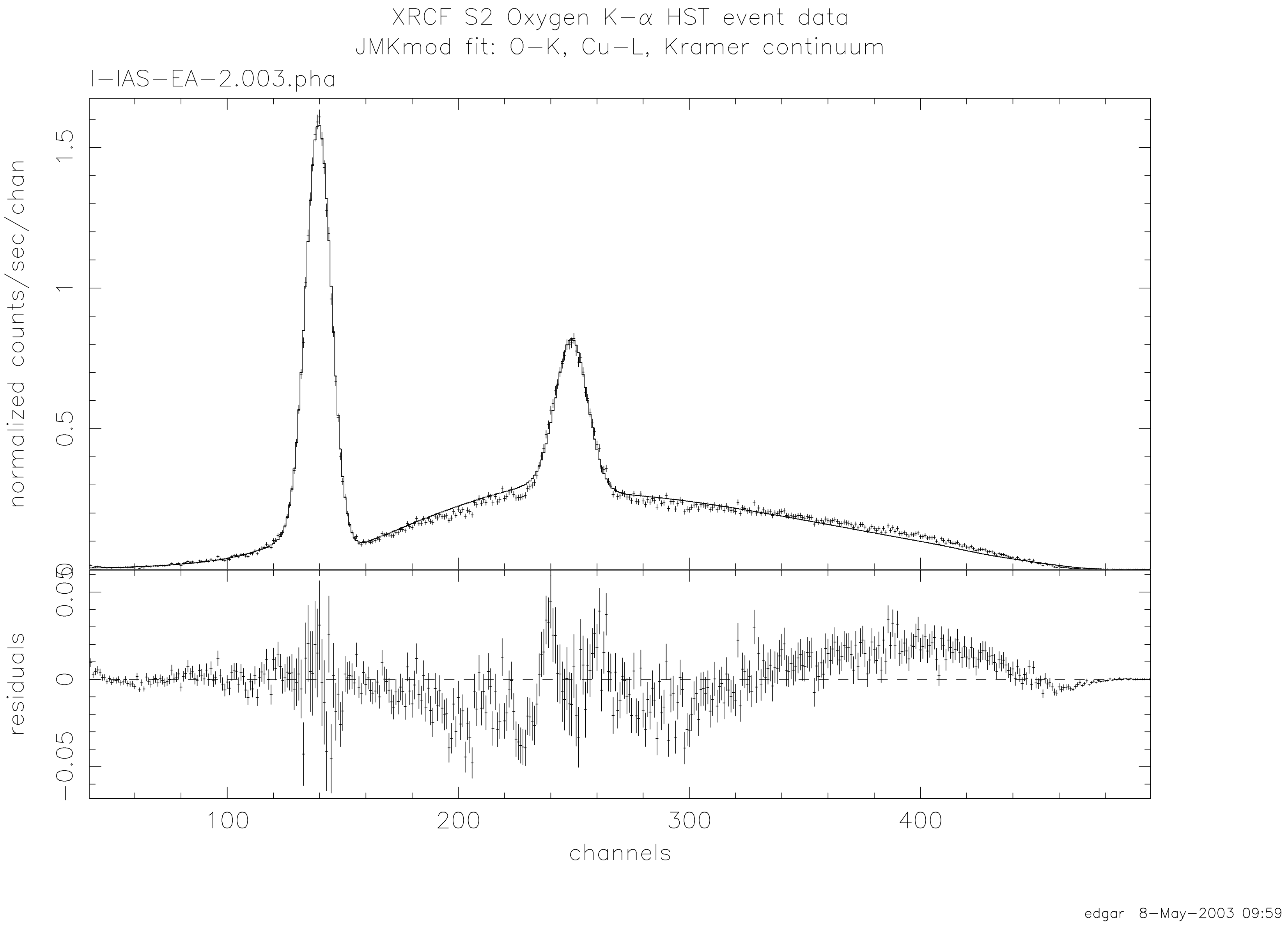

Figure 2: Fitted pulse-height spectrum for S2 (full chip).

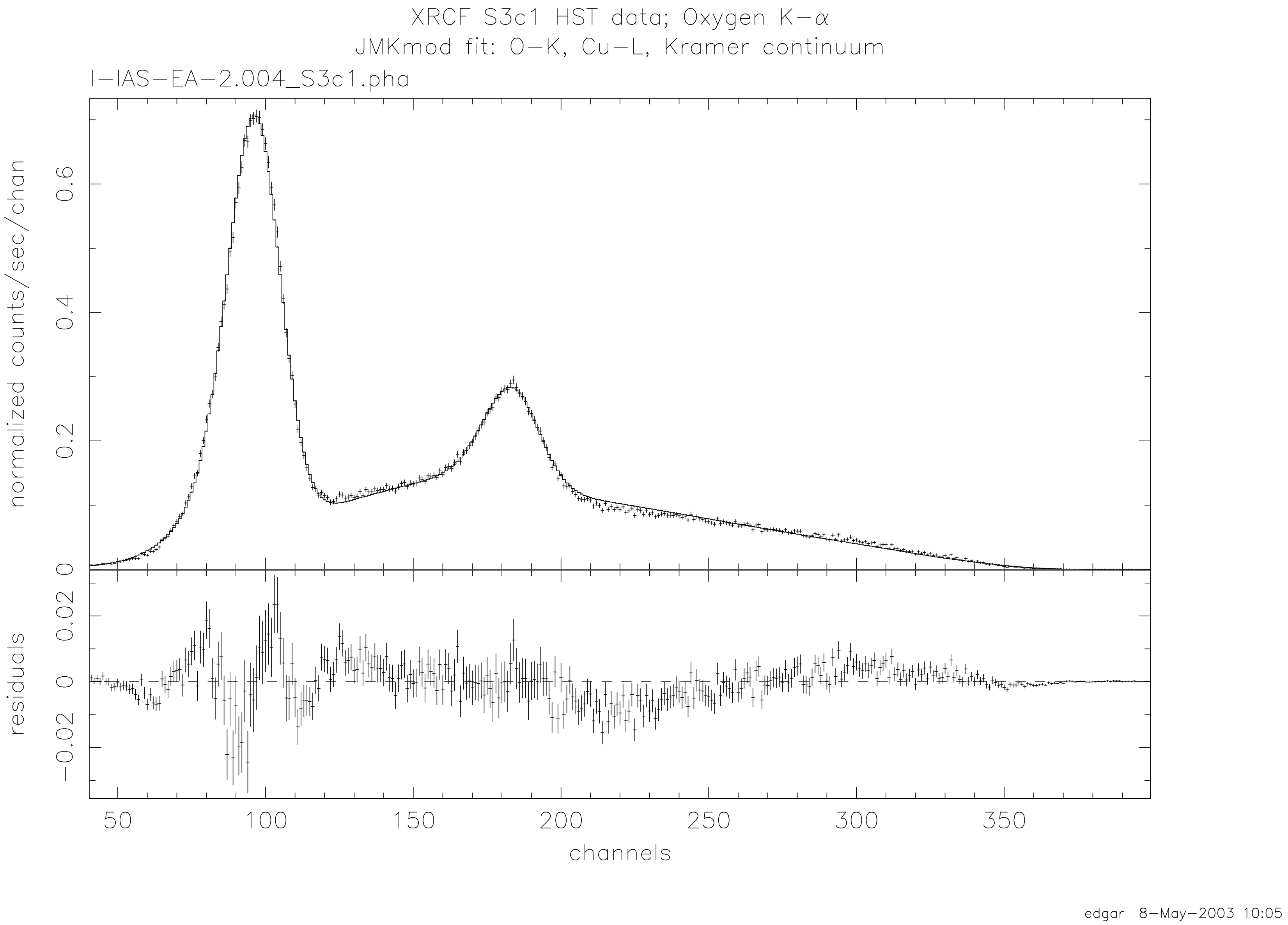

Figure 3: Fitted pulse-height spectrum for S3 (node 1).

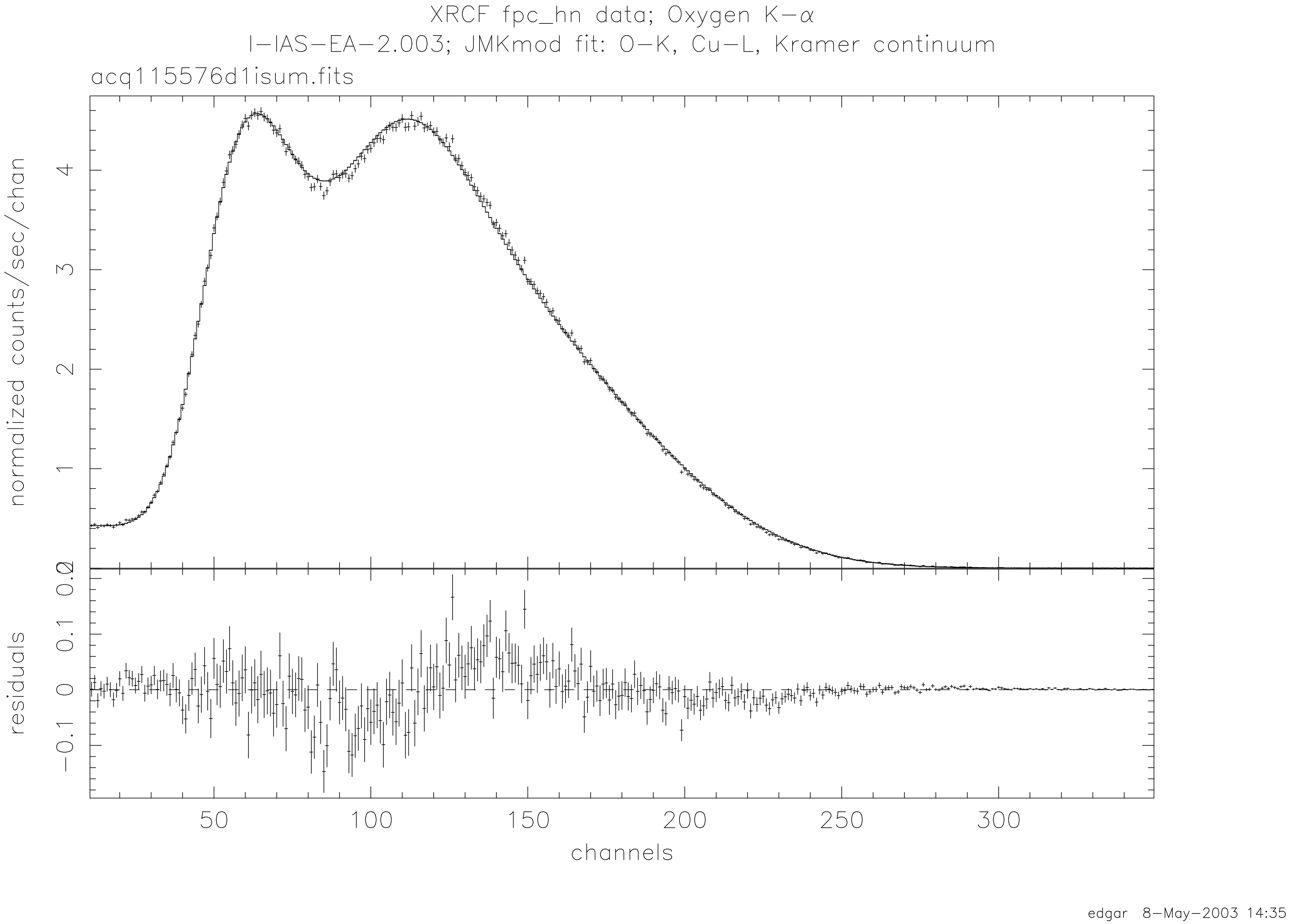

Figure 4: Fitted pulse-height spectrum for FPC_HN.

ACIS QE: FI/BI from XRCF data

30 October 2001

For each detector, the source luminosity is given by:

$$S = \frac{C_{det}}{A_{det} QE_{det}} \times d_{det}^2 BU_{det}$$

where:

- C = **countrate in the line** (cts s^{-1})
- A = **active detector area** (cm^2)
- QE = **quantum efficiency** (cts photon^{-1})
- d = **source distance** (cm)
- BU = **Beam Uniformity factor (dimensionless).**

Then:

$$QE_{ACIS} = QE_{hn} \times \frac{C_{ACIS}}{C_{hn}} \times \frac{A_{hn}}{A_{ACIS}} \times \frac{BU_{ACIS}}{BU_{hn}} \times \frac{d_{ACIS}^2}{d_{hn}^2}$$

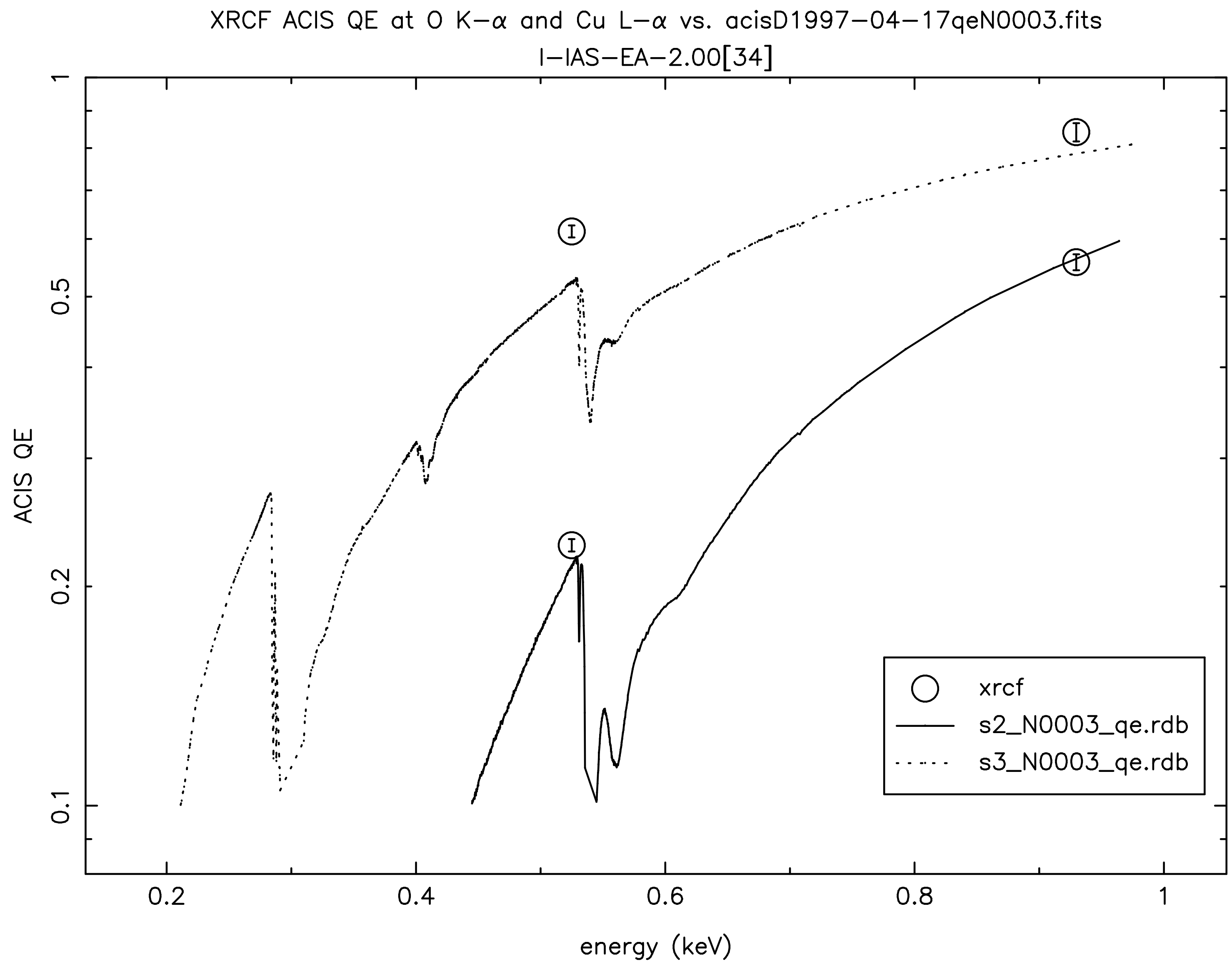

Figure 5: S2 and S3 quantum efficiency from CALDB N0003 (curves) and measured (data points).

Results in Context

12 June 2003

- **Marshall defines**

$$r(\lambda) \equiv \frac{(QE_{FI}/QE_{BI})_{true}}{(QE_{FI}/QE_{BI})_{caldb}}$$

- **This is his proposed correction to the FI QE curve (see fig 6).**
- **Since based on flight data, r includes a factor of the FI cosmic ray QE decrement $y = 0.9632$.**
- **FOR COMPARISON TO GROUND DATA ONLY, we will correct QE(S3) by factor y/r. (See fig 7)**

Recommendations for flight calibration products:

- **Decrement FI QE curves by factor y at all energies.**
- **Increase BI QE curves by factor consistent with y/r (but details of energy dependence TBD).**

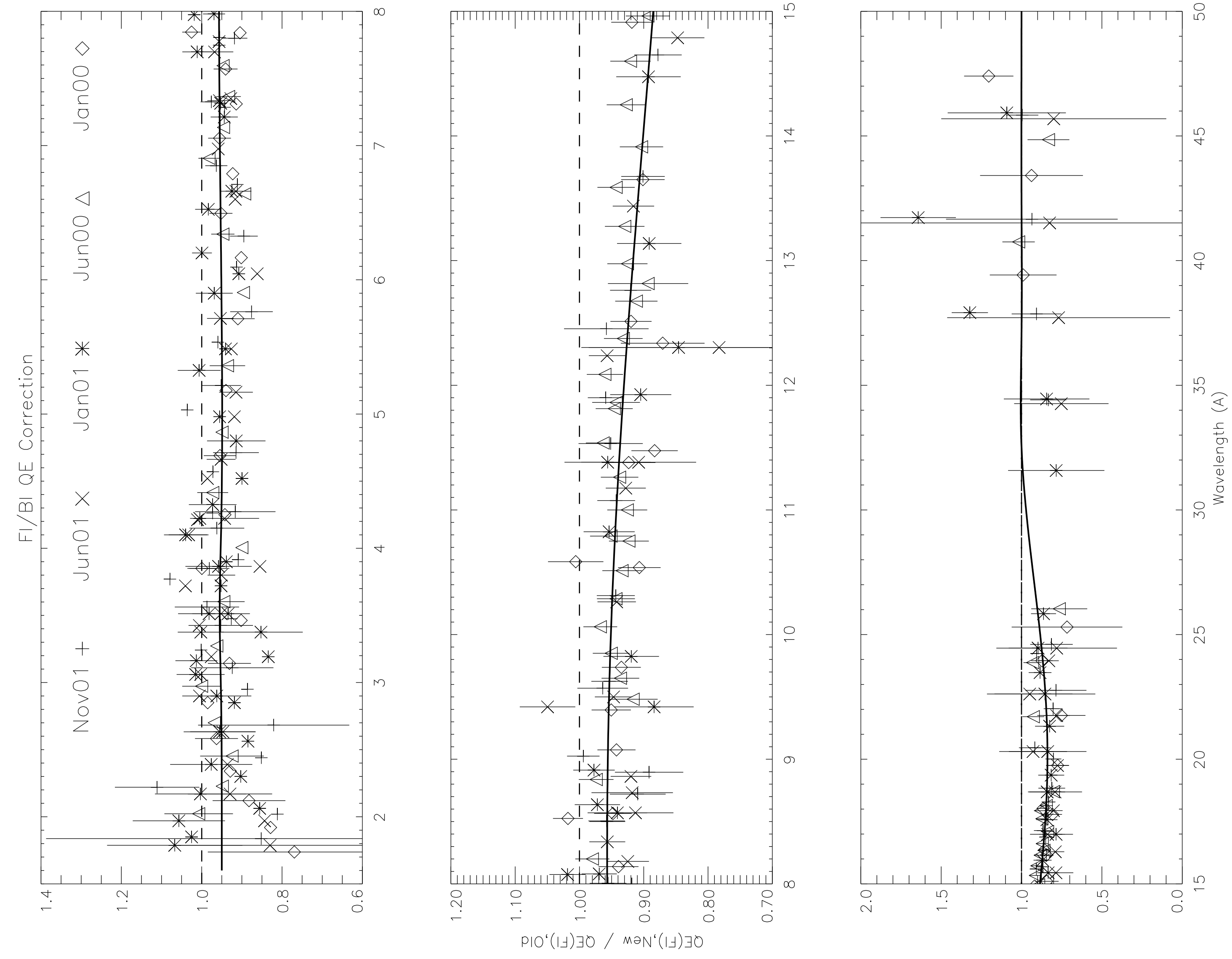

Figure 6: Marshall's plot of r vs. wavelength. This is his proposed correction to the FI QE curve.

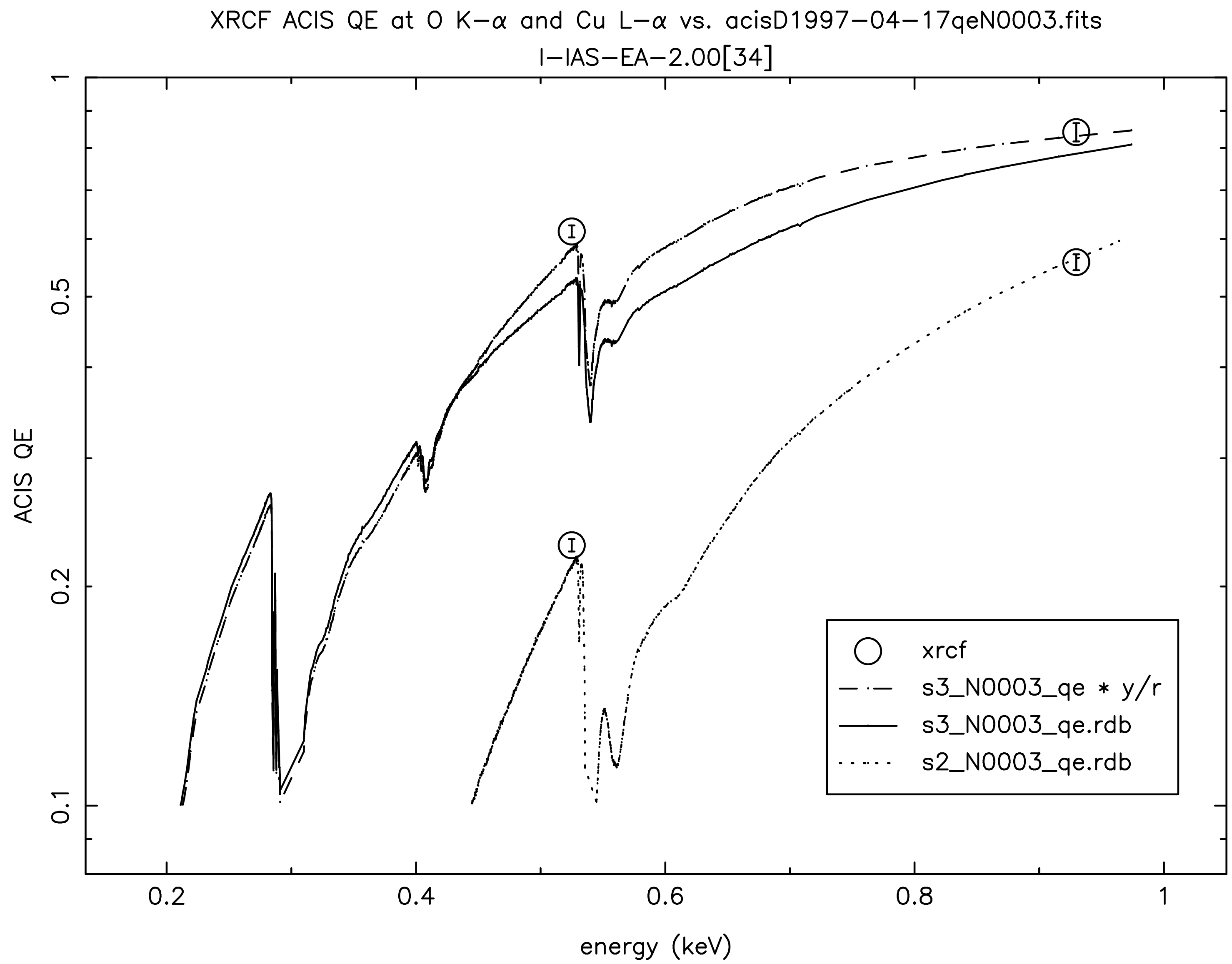

Figure 7: S2 and S3 quantum efficiency from CALDB N0003 (curves) and measured (data points). Now including corrected S3 QE curve for comparison.

ACIS QE FI/BI Ratio Future Work

30 October 2001

- **Correct FI QE curves by factor $y = 0.9632$ to account for cosmic ray blooms.**
- **Investigate CR bloom effect for BI chips, and correlations with other radiation measures.**
- **Analyze ground data at Fe L–α (0.705 keV), and at higher energies.**
- **Analyze ground data for BI chips at C K–α (to aid with extrapolation to low energy).**
- **Extend analysis to other chips (including the I array).**