Chandra Calibration Status Report

CUC Meeting (June 25, 2002)

1. Instrument Status (ACIS, HRC, LETG, and HETG)
   - 1.1 New and Improved Calibration Products Since Last CUC Meeting
   - 1.2 Caveats with New Products
   - 1.3 Present Plans

2. AO4 Calibration Plan

3. Chandra/XMM-Newton Cross Calibration Issues

Chandra Instruments and Calibration

The pages below are maintained by the Chandra X-ray Center Calibration group and contain information on the calibration of Chandra instruments. Any data products provided are to be used by observers at their own risk.

A summary of Chandra Instruments and Calibration Status can be found in the Proposers' Observatory Guide

For officially released data products for use in CIAO analysis software, refer to the Chandra Calibration Database (CALDB) Webpage.

COMMENTS:
CXC Cal

Last modified:06/05/02

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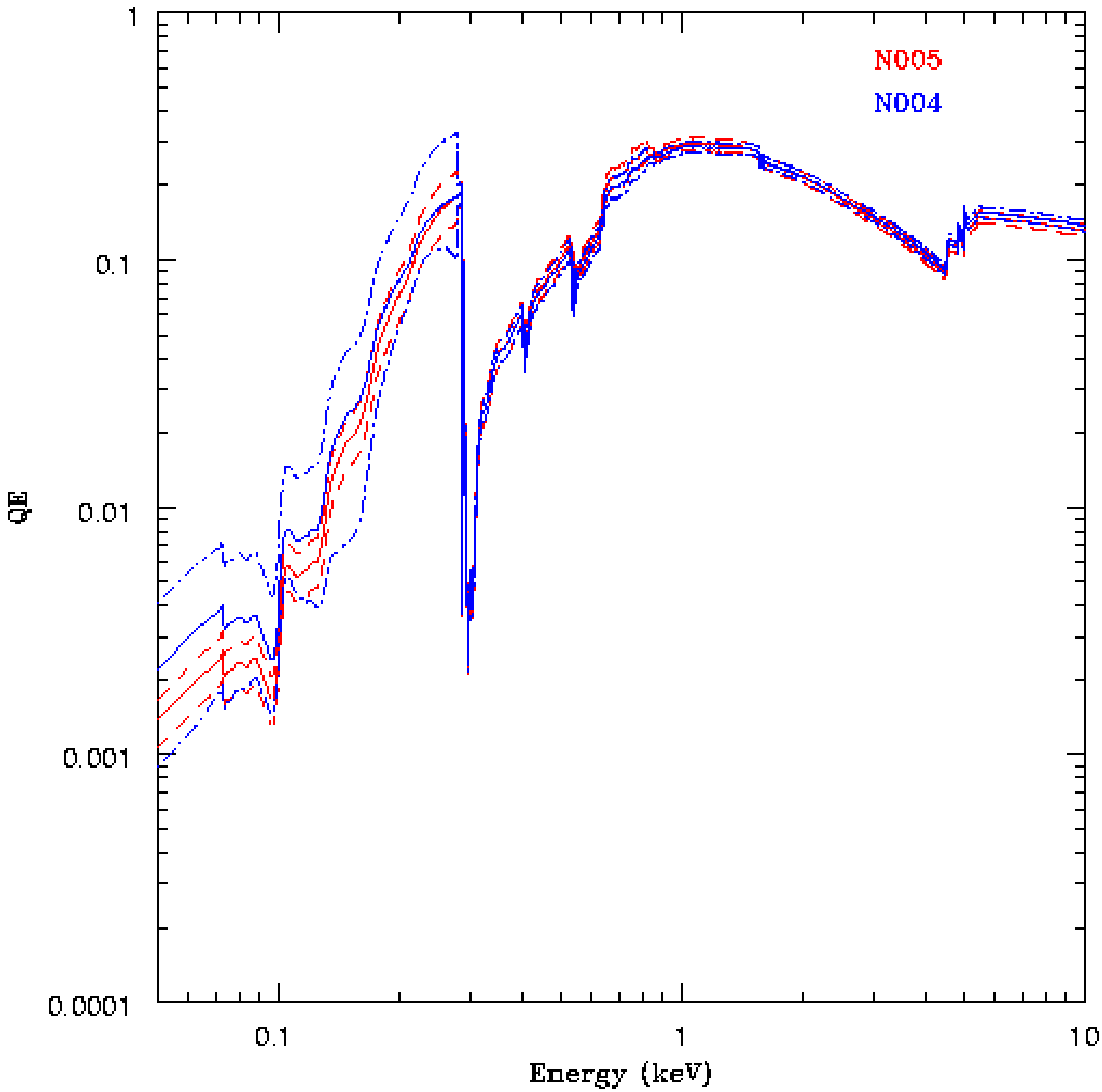


N005
N004
QE
1
0.1
0.01
0.001
0.0001
0.1
1
10
Energy (keV)

LETGS Calibration Issues

Effective Area

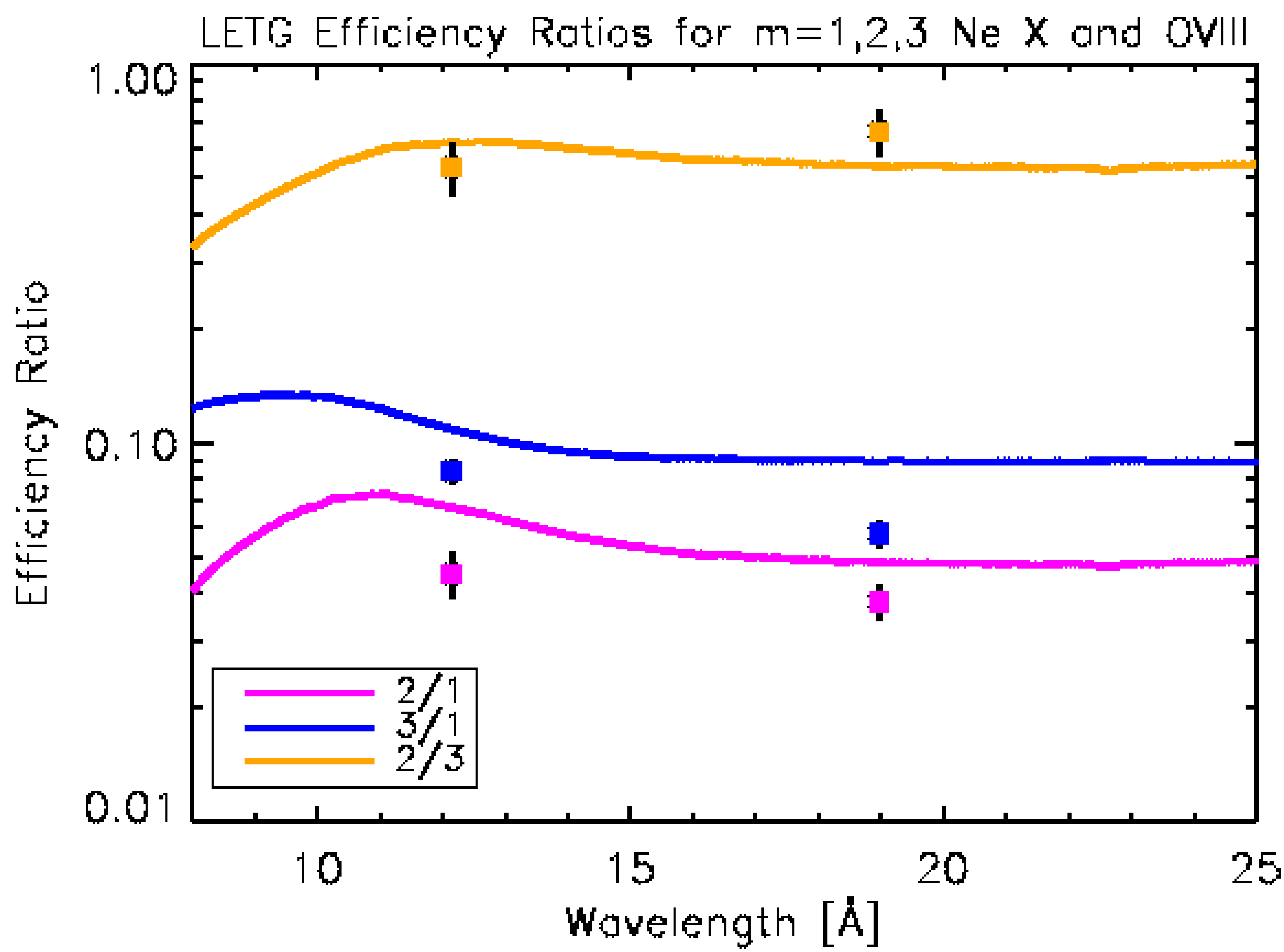
- C–Edge in HRC–S UVIS transmission model requires shift of ~0.25eV to match edge in observed continua likely due to error in synchrotron energy calibration]
  – Fix has been implemented in new release (July 2002)

- HRC–S QE model "discontinuity" near 80 AA. Arises from joining WD– and AGN–derived QE's.
  – Improvement has been implemented in new release; Further study ongoing.

- LETG diffraction efficiencies at > 10 AA appear to be overestimated in current diffraction model by ~30%
  – Problem is under study; efficiencies at shorter wavelengths (< 10 AA) agree better with calibration data, so analytical model for higher orders might need empirical adjustment.

- Cs features at 15–17 AA are poorly modelled in current HRC–S QE.
  – Fix has been implemented in new release.

LETG Diffraction Efficiency Ratios from In–flight Data



- 2nd, 3rd orders appear less efficient than model predictions at > 10 AA

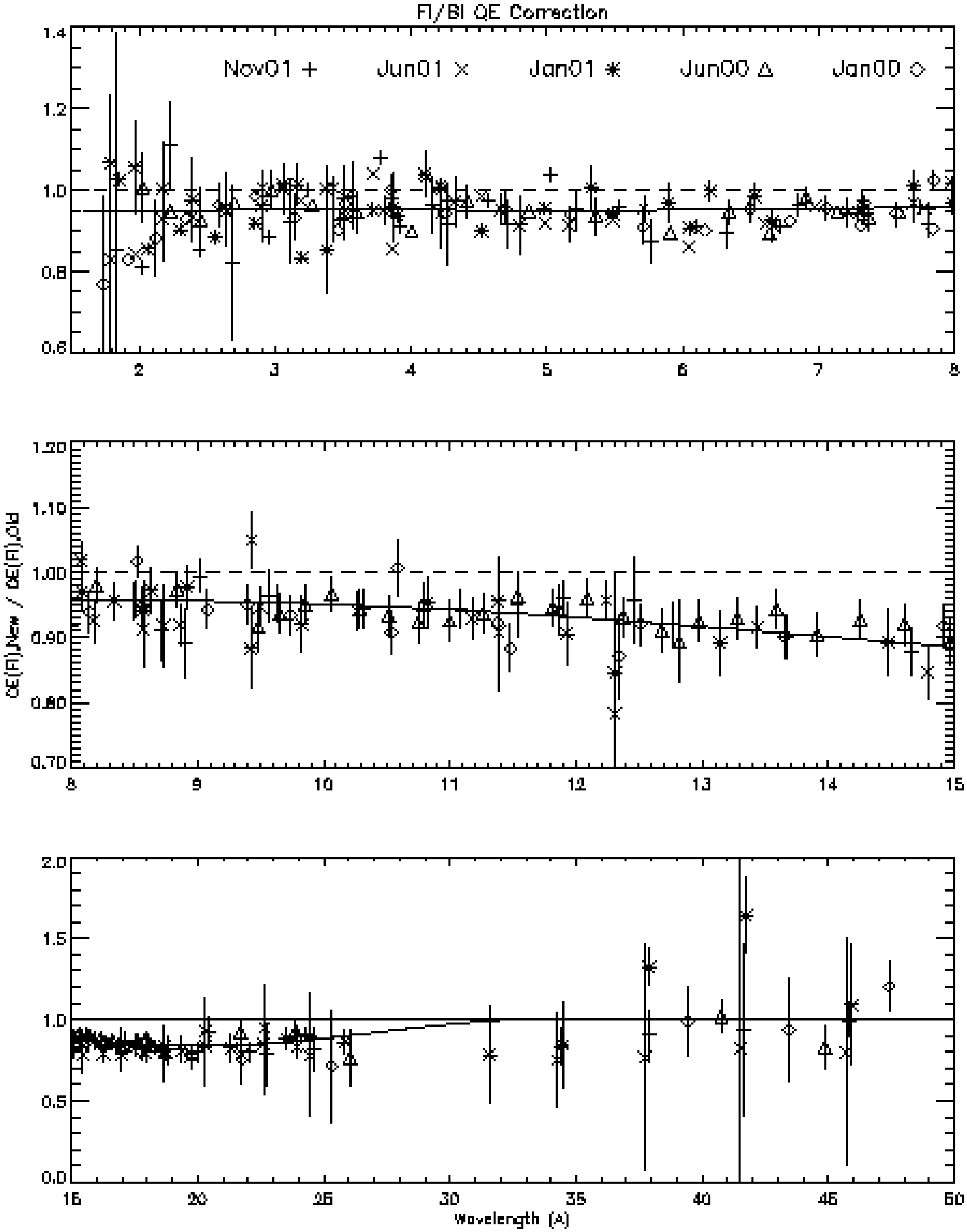


Figure 1: The ratio r as a function of wavelength for each observation set. The data are not segregated by grating type because the results are independent of the grating where comparisons are possible. All comparisons involving two FI chips gave R consistent with 1 and are not shown. The heavy line is a polynomial fit to the data with Gaussian roll-off to the ends to avoid poor behavior of the polynomial extrapolation where the data are not as good.

Current HETG Calibration Plans

1. Compare XMM observations of PKS2155-304 with simultaneous HETGS and LETGS data.
2. Visit XMM calibration scientists at SRON.
3. On-going verification of LSFs and dispersion relation.

PSF_wing_profile_XRCF.tex 1.0 June 23, 2002

June 23, 2002

Assessing the Chandra PSF Wings: An Estimate from Ground Calibration Data

T. J. Gaetz

Version 1.0

2002 June 19

Terry Gaetz
2002-06-23

```
theta:            angle (arcsec)
theta_arcmin:     angle (arcmin)
energy:           (keV)
SB_hrma           full HRMA surface brightness (cts s^-1 arcsec^-1)/source cts s^-1)
E_ex_hrma:        excluded energy; fraction of the PSF exterior to theta
SB_1              shell 1 surface brightness (cts s^-1 arcsec^-1)/(source cts s^-1)
SB_3              shell 3 surface brightness (cts s^-1 arcsec^-1)/(source cts s^-1)
SB_4              shell 4 surface brightness (cts s^-1 arcsec^-1)/(source cts s^-1)
SB_6              shell 6 surface brightness (cts s^-1 arcsec^-1)/(source cts s^-1)
f_1:              shell 1 spatial frequency (mm^-1)
f_3:              shell 3 spatial frequency (mm^-1)
f_4:              shell 4 spatial frequency (mm^-1)
f_6:              shell 6 spatial frequency (mm^-1)
twoW_1            shell 1 2W1(f)  (Angstrom^2 mm)
twoW_3            shell 3 2W1(f)  (Angstrom^2 mm)
twoW_4            shell 4 2W1(f)  (Angstrom^2 mm)
twoW_6            shell 6 2W1(f)  (Angstrom^2 mm)
twoW_hrma         HRMA    2W1(f)  (Angstrom^2 mm)
A_eff_1           shell 1 effective area (35 mm on-axis) (cm^2)
A_eff_3           shell 3 effective area (35 mm on-axis) (cm^2)
A_eff_4           shell 4 effective area (35 mm on-axis) (cm^2)
A_eff_6           shell 6 effective area (35 mm on-axis) (cm^2)
A_eff_hrma        hrma  effective area (35 mm on-axis) (cm^2)
: A_eff_1 = 3.3570
: A_eff_3 = 72.8670
: A_eff_4 = 96.7720
: A_eff_6 = 72.9560
: A_eff_hrma = 244.4730
: energy = 6.4
```

energy	theta	theta_arcmin	SB_hrma	E_ex_hrma	SB_1	SB_3	SB_4	SB_6	f_1
6.4	4.2	0.069	8.897e-04	0.149	9.057e-04	3.700e-04	8.815e-04	1.401e-03	1.55
6.4	4.4	0.073	7.676e-04	0.144	8.232e-04	3.316e-04	7.627e-04	1.192e-03	1.63
6.4	4.6	0.076	6.625e-04	0.139	7.483e-04	2.972e-04	6.598e-04	1.014e-03	1.71
6.4	4.8	0.080	5.719e-04	0.135	6.801e-04	2.663e-04	5.708e-04	8.621e-04	1.79
6.4	5.1	0.084	4.939e-04	0.131	6.182e-04	2.387e-04	4.938e-04	7.332e-04	1.88
6.4	5.3	0.088	4.267e-04	0.127	5.619e-04	2.139e-04	4.272e-04	6.236e-04	1.98
6.4	5.6	0.093	3.687e-04	0.123	5.107e-04	1.917e-04	3.696e-04	5.303e-04	2.08
6.4	5.9	0.098	3.187e-04	0.120	4.641e-04	1.718e-04	3.197e-04	4.510e-04	2.18
6.4	6.1	0.102	2.756e-04	0.117	4.218e-04	1.540e-04	2.766e-04	3.835e-04	2.29
6.4	6.5	0.108	2.384e-04	0.113	3.834e-04	1.380e-04	2.392e-04	3.261e-04	2.40
6.4	6.8	0.113	2.063e-04	0.110	3.484e-04	1.237e-04	2.069e-04	2.773e-04	2.52
6.4	7.1	0.119	1.786e-04	0.107	3.167e-04	1.108e-04	1.790e-04	2.358e-04	2.65
6.4	7.5	0.124	1.547e-04	0.105	2.878e-04	9.933e-05	1.548e-04	2.005e-04	2.78
6.4	7.8	0.131	1.340e-04	0.102	2.615e-04	8.902e-05	1.339e-04	1.705e-04	2.92
6.4	8.2	0.137	1.161e-04	0.099	2.377e-04	7.977e-05	1.158e-04	1.449e-04	3.07
6.4	8.6	0.144	1.007e-04	0.097	2.160e-04	7.149e-05	1.002e-04	1.232e-04	3.22
6.4	9.1	0.151	8.734e-05	0.095	1.963e-04	6.406e-05	8.664e-05	1.047e-04	3.38

0.3	5.0	0.129	0.135	0.136	0.133	0.151	0.288	0.171	0.133
5.0	10.0	0.142	0.146	0.141	0.147	0.151	0.432	0.154	0.144
10.0	12.0	0.079	0.082	0.075	0.083	0.089	0.529	0.090	0.080
2500	3000	0.083	0.084	0.083	0.086	0.094	0.653	0.096	0.084
WITH VF FILTERING:									
0.3	10.0	0.201	0.207	0.203	0.206	0.225	0.586	0.224	0.204
0.5	2.0	0.042	0.044	0.043	0.044	0.052	0.110	0.052	0.043
2.0	5.0	0.053	0.055	0.054	0.055	0.061	0.096	0.059	0.055
0.3	5.0	0.101	0.105	0.103	0.104	0.119	0.232	0.120	0.104
5.0	10.0	0.100	0.102	0.100	0.101	0.106	0.353	0.105	0.101
10.0	12.0	0.043	0.044	0.040	0.044	0.047	0.434	0.045	0.043
2500	3000	0.044	0.043	0.045	0.042	0.047	0.517	0.039	0.044

** For those who has picked up the unofficial version 080102 of the acisi_D files: it had the status bits garbled. This is fixed in ver. 080202 and up.

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Files aciss_D_* (ACIS-S in aimpoint, Dec 2000 - Dec 2001):

	Clean exposures, s						N_H,	R45
obsid	I2	I3	S1	S2	S3	S4	1e20	*
2241	89970	89970	0	89970	87895	0	1.46	150
1694	77771	77771	78030	77771	78030	77771	4.70	100
1899	45892	45892	44336	45892	44336	45892	3.63	160
2503	21520	21520	21001	21520	21001	21520	3.63	160
2127	43555	43555	42259	43555	42259	43555	2.81	120
2221	37854	37854	0	37854	37336	37854	2.26	125
2980	27483	27483	20742	27483	20742	27483	1.94	130
total	344045	344045	206368	344045	331599	254075	avg:	130

* R45 is the PSPC flux in the R4-R5 band in units used in the RASS images, see above. The average is weighted by the S3 exposures.

The files have PHA boundaries of 25-3000 ADU (3000 ADU corresp. to 11.5-13.5 kev depending on the detector position). The gain table acisD2000-01-29gainN0003.fits is used.

The S4 files were processed by 'destreak' with default settings. The cosmic ray afterglow events were flagged by the CIAO tool 'acis_detect_afterglow' with default settings and excluded.

For all chips, the holes left by the source exclusion are filled as described above. For users' information, the exposure maps used for this correction are included in the subdirectory ./expmaps .

Most observations are performed in Faint mode, so the status column is not included.

These files have the following count rates (cts/s/chip) in different energy bands (the last line is the PHA band):

E, keV		I2	I3	S1	S2	S3	S4	I23
0.3	10.0	0.277	0.283	1.401	0.303	0.759	0.325	0.280
0.5	2.0	0.063	0.061	0.139	0.072	0.130	0.089	0.062
2.0	5.0	0.060	0.062	0.111	0.068	0.108	0.064	0.061

AO4 CALIBRATION PLAN

1. ACIS
   - 1.1 Low Energy Gain (E0102-72)
   - 1.2 Standard Candles (Cas A and G21.5-09)
   - 1.3 Filter Transmission (Betelgeuse and Vega)
   - 1.4* Particle Background
   - 1.5* Low energy QE Degradation (under discussion)

2. HRC
   - 2.1 Low Energy Gain and QE (HZ43 and PKS2155-304 with LETG)
   - 2.2 Standard Candles (Cas A and G21.5-09)
   - 2.3 Filter Transmission (Betelgeuse and Vega)
   - 2.4 Small Scale Gain Variations (ArLac)
   - 2.5* Low Energy QE Map and Degap Map (Vela Remnant)

3. LETG/HRC-S
   - 3.1 Continuum Sources (HZ43 and PKS2155-304)
   - 3.2 Line Sources (Capella)

4. HETG/ACIS-S
   - 4.1 Continuum Sources (PKS2155-304 and 3C273)
   - 4.2 Line Sources (Capella)
   - 4.3* Continuum Source with SIM-Z off-set (PKS2155-304)

5. LETG/ACIS-S
   - 5.1 Continuum Sources (PKS2155-304 and 3C273)

6. HRMA
   - 6.1* Mirror Vignetting (G21.5-09)

1.1 Continue monitoring the low energy response of the CCDs using the oxygen rich supernovae remnant E0102-72. The table below gives the chip number, node, and position within the node for the monitoring observations of E0102-72. Each exposure is 8 ksec. These positions are identical with observations taken in AO-2 and AO-3.

Chip	node	position relative to read out		frequency
		BI chips		
S3	0	middle		6 mos
S3	1	middle	(sub-array)	6 mos
S1	2	middle		6 mos
		FI Chips		
I3	3	near read out	(sub-array)	6 mos
I3	3	middle		6 mos
I3	3	opposite read out		6 mos
I3	2	middle		6 mos
I3	1	middle		6 mos
I3	0	middle		6 mos
S0	2	middle		12 mos
S2	2	middle		6 mos
S4	2	middle		6 mos
S5	2	middle		12 mos
I0	2	middle		6 mos
I1	2	middle		6 mos
I2	2	middle		6 mos

1.2 Standard Candles

Continue observing our standard candles every 6 months with S3 and I3 which we have done since launch. These observations are useful for monitoring the response of the detectors and cross-calibrating between the detectors.

Observe Cas A on I3 and S3 for 2 ksec each
Observe G21.5-09 on I3 and S3 for 10 ksec each

1.3 Filter Transmission

Continue monitoring the red and UV transmission of the optical filters on ACIS once per year.

Observe Vega for 2 ksec with ACIS-I and ACIS-S
Observe Betelgeuse for 2 ksec with ACIS-I and ACIS-S

1.4 ACIS Particle Background

A 100ksec observation with the standard ACIS-I chip configuration in VF mode with the aim point between the HRC-I and ACIS-I.

Total integration time for ACIS calibration in AO4 = 396 ksec

2.0 HRC Calibration

PKS2155-304	30 ksec	+4mm	12 mos.
Capella	30 ksec	0	12 mos.
3C273	30 ksec	0	12 mos.

Total integration time for LETG/ACIS-S calibration in AO4 =120 ksec

6.0 LETG/ACIS-S Calibration

target	exposure	frequency
PKS2155-304	30 ksec	12 mos.
3C273	30 ksec	12 mos.

Total integration time for LETG/ACIS-S calibration in AO4 = 60 ksec

7.0 HRMA Vignetting

Observe G21.5-09 at off-axis angles of 5, 15, and 20 arcminutes for 10 ksec each.

Total integration time for HRMA calibration in AO4 = 30 ksec

Total integration time for all calibration observations during AO4 = 911 ksec.