Chandra ACIS BI Low-E Gain

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Overview

- ACIS low-E gain: BI chips
  - S1 treated here
  - S3 issues under investigation
- nominal model $\Rightarrow$ large gain errors at low E
- S1: large CTI $\Rightarrow$ shift to lower PHAs
  - lower event threshold can be an issue
- Use LETG+ACIS observations
  - narrow range in E_{grat} $\Rightarrow$ accurate $E \sim$ *independent of PHA*
  - aimpoint (offset y) shifted to put different energy ranges on S1 & S3

Observations

ObsID	Y offset (arcmin)	⟨CHIPY⟩ (pix)	Ontime (ks)	Date Obs	Target
01701	−0.33	179.8	24.9	2000-04-18	XTE_J1118
01703	−1.5	135.7	26.2	2000-05-31	PKS_2155
01795	6	183.7	20.0	2000-08-07	PKS_2155
01796	8	180.7	19.8	2000-08-08	PKS_2155
01797	10	184.9	19.8	2000-08-08	PKS_2155
01798	12	186.7	19.8	2000-08-08	PKS_2155
01799	14	185.3	20.1	2000-08-10	PKS_2155
01015	6	258.2	9.6	2000-12-06	PKS_2155
02323	6	508.4	9.1	2000-12-07	PKS_2155
02324	6	651.6	8.8	2000-12-07	PKS_2155

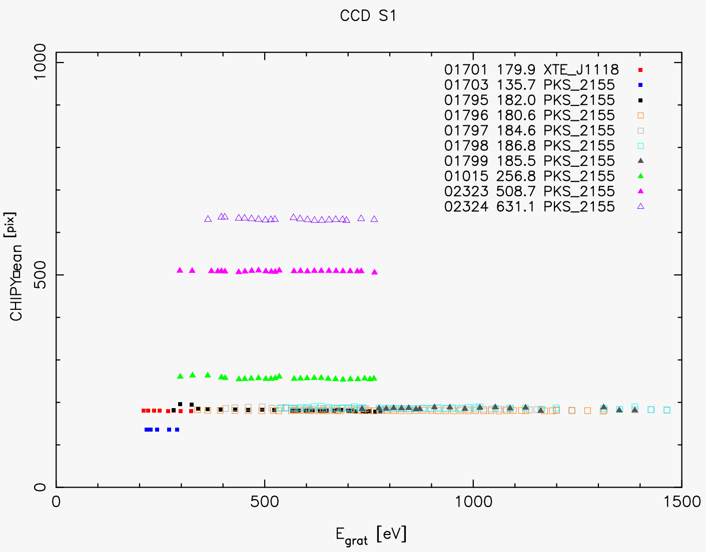
Analysis Approach

- gain: relation between pha (or pi) and E
  - pha (or pi) $\Longrightarrow E_{pha}$
- ratio E_{pha}/E gives estimate of gain error.
- LETG grating provides E based on dispersion relation
- estimate E with E_{grat} over narrow E_{grat} bands
  - split E_{grat} band at node boundary
- use $E_{pha}(\langle E_{grat} \rangle)$ to estimate shape of RMF
  - at low energies, PHA distribution deviates markedly from nominal; distortions due to low-E cutoffs
  - need at least several hundred events to get estimate of $E_{pha}(E_{grat})$ distribution

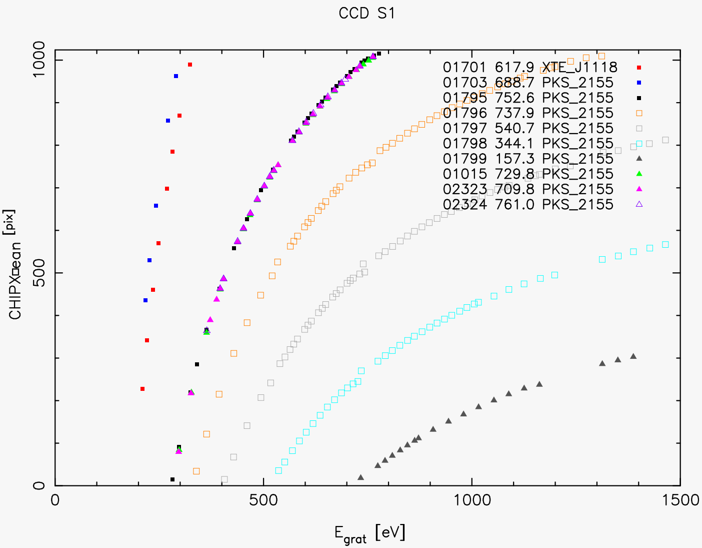
Analysis Approach

- observations cover a range of
  - energy (function of `chipx`, but see below)
  - `chipy` (but sparsely)
  - `chipx`, but the `chipx`-energy relation varies with obsid (different "Y-offsets)

S1: CHIPY vs. E_{grat}



S1: CHIPX vs. E_{grat}



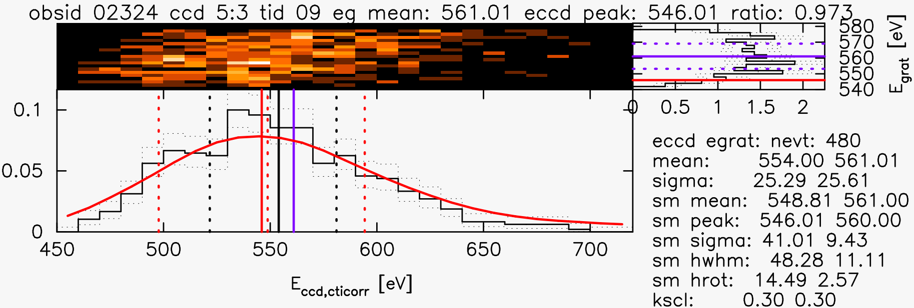
Analysis Approach: part 1

- reprocess data with gain file with existing low-E tweak removed.
- use narrow ranges ("tiles") in E_{grat}
  - if enough counts, split into smaller tiles
  - split if node boundary crossed; include if enough counts
- narrow range in `chipy` (cross dispersion plus OSIP clipping)
- estimate $E = \langle E_{grat} \rangle$ within tile
- estimate $E_{pha}(E)$ distribution (smoothed $E_{pha}(\langle E_{grat} \rangle)$ histogram)
  - iteratively determine effective peak as mean counts in E_{pha} bin weighted by E_{pha}
- examine $\langle E_{pha,peak} \rangle / \langle E_{grat} \rangle$ as a function of $\langle E_{grat} \rangle$, $\langle \texttt{chipx} \rangle$, $\langle \texttt{chipy} \rangle$ to derive a gain tweak function

Analysis Approach: part 2

- apply new gain tweak function $\Rightarrow$ new gain, response
- reprocess data with new gain, response files
- apply asymmetry correction to obtain new $\langle E_{PHA,corr} \rangle$.
- examine $\langle E_{PHA,corr} \rangle / \langle E_{grat} \rangle$ to see whether gain tweak worked as a function of E, X, Y

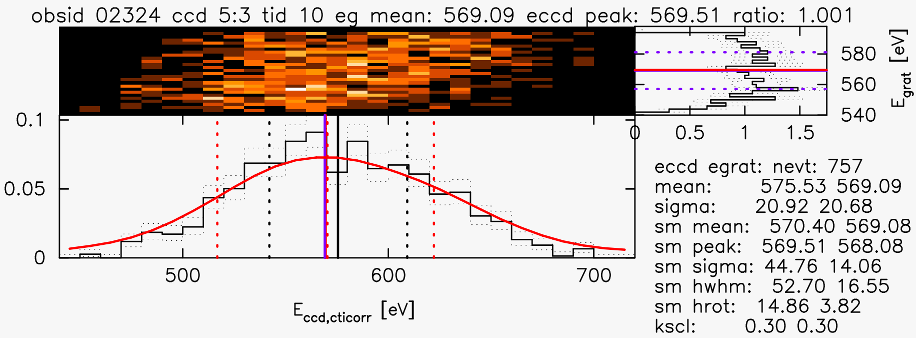
Current CALDB



eccd egrat: nevt: 480
mean: 554.00 561.01
sigma: 25.29 25.61
sm mean: 548.81 561.00
sm peak: 546.01 560.00
sm sigma: 41.01 9.43
sm hwhm: 48.28 11.11
sm hrot: 14.49 2.57
kscl: 0.30 0.30

Example $E_{grat} - E_{pha}$ Tiles

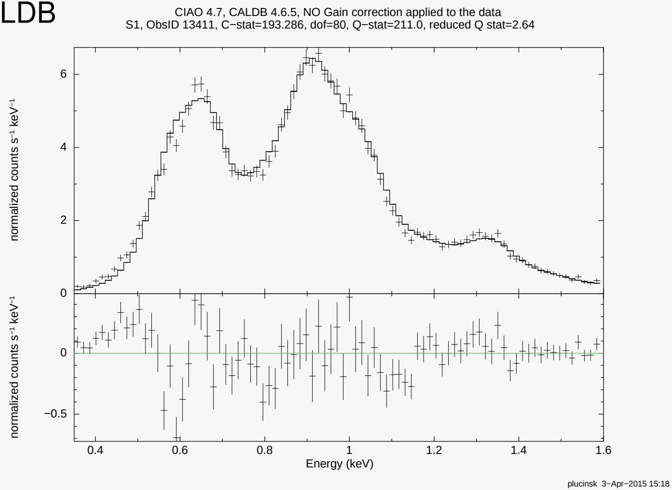
With Tweak



S1 - E0102-72.3 Tests

Tweaked is better (low-*E*), worse (O lines), OK higher *E*

Current CALDB



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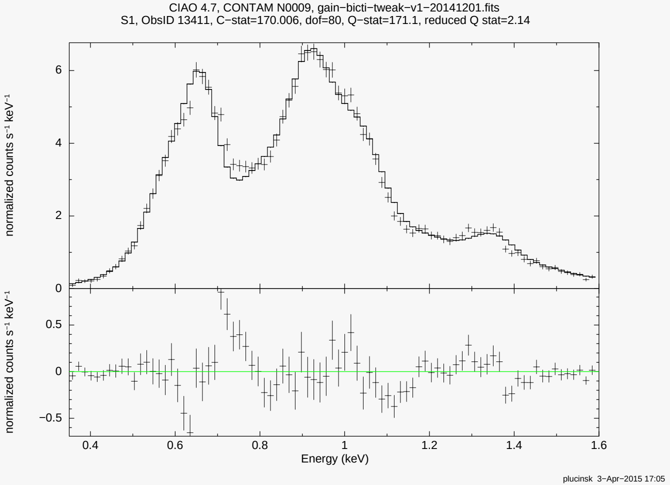

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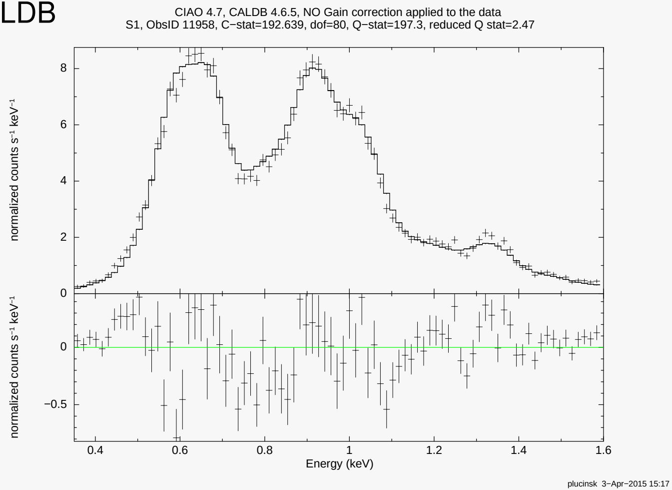

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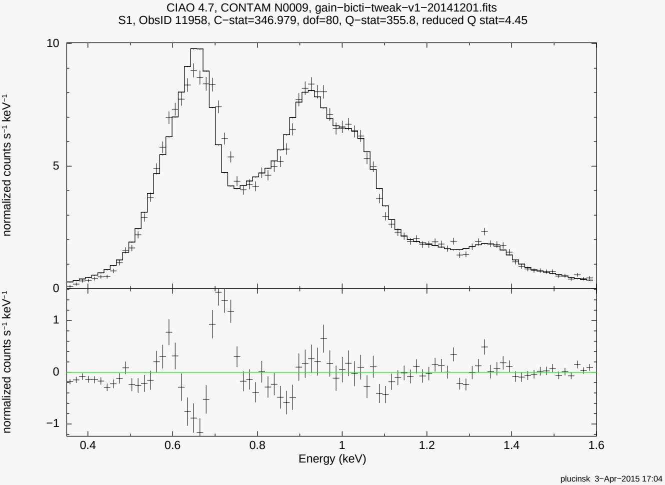

Summary

- event energy based on grating dispersion
- estimate gain error from ratio of weighted peak E_{pha} to mean E_{grat}
- test with E010272.3 data
- improvement with gain tweak not as good as hoped (so far)
  - better below $\sim 0.5 keV$
  - sometimes better, sometimes worse $\sim$ 0.5 – 1.0 keV
  - OK above $\sim$ 1.0 keV
- reasons under investigation
  - sparse `CHIPX`, `CHIPY`, *E* coverage
  - sparse set of E010272.3 observation `CHIPX`, `CHIPY` coverage
- need to constrain $E \sim 0.5 - 1$ keV for better agreement with E0102-72.3 CCD data
  - a possibility: blend ACIS-LETG estimate (below O-lines) with CALDB version (O-lines and above)