Great waves IACHEC
Buoys us through calibrating
To bring our fish home
### CHANDRA CALIBRATION STATUS

### REMINDER OF CHANDRA HARDWARE COMPONENTS

**ACIS**

<table>
<thead>
<tr>
<th>SD</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
</tr>
</thead>
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**HRC**

- 30 arc min
- 6 arc min
- 99 arc min
OUTLINE

- Point Spread Function
  - Secular trend or worsening PSF in HRC-S
- ACIS
  - mid-chip gain droop; contamination
- HRC-S,I
  - QE decline; gain decline
- HETG
  - 0th to 1st order relative calibration
POINT SPREAD
FUNCTION
The HRC-I PSF has remained stable over the mission.

HRC-S PSF is steadily increasing in width and appears about 10% larger now than at the start of the mission.

Degradation is possibly related to decline in gain.

- Intrinsic detector psf?
- Degap drift?
POINT SPREAD FUNCTION

PSF MONITORING

Chandra On-axis Point Source Encircled Energy
ARLAC  HRCI  31 Observations

Encircled Energy (arcsec)

Year

85% EE
70% EE
50% EE
30% EE
10% EE
ADVANCED CCD IMAGING SPECTROMETER (ACIS)
ADVANCED CCD IMAGING SPECTROMETER (ACIS)

MID-CHIP GAIN DROOP (T. GAETZ)

I0

I1

I2

I3
### MID-CHIP GAIN DROOP (T. GAETZ)

<table>
<thead>
<tr>
<th>I0</th>
<th>I1</th>
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</thead>
<tbody>
<tr>
<td>I2</td>
<td>I3</td>
</tr>
</tbody>
</table>
MID-CHIP GAIN DROOP FIX (T. GAETZ)

~30 eV gain drop

Before correction
MID-CHIP GAIN DROOP FIX (T. GAETZ)

After correction
MID–CHIP GAIN DROOP (T. GAETZ)

Mn K (lower S/N)
ADVANCED CCD IMAGING SPECTROMETER (ACIS)

PROGRESS WITH TIME-DEPENDENT GAIN (R. DURHAM, P. PLUCINSKY)

ACIS ECS Fits I3 e70-e75 Fitted FWHM + RMF (added in quadrature)
FILTER CONTAMINATION LAYER (A. BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

![Graph showing energy vs. counts per second for different years: 2000, 2005, 2010, 2013, 2016, 2019. The data is labeled A1795. The x-axis represents energy in keV, ranging from 0.5 to 3 keV, and the y-axis represents counts per second per keV, ranging from 0.1 to 10. The graph compares the energy spectra for different years on the ACIS-S detector.]
FILTER CONTAMINATION LAYER (A. BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)
HIGH RESOLUTION CAMERA
QUANTUM EFFICIENCY DECLINE (P. RATZLAFF, J. DRAKE, V. KASHYAP, B. WARGELIN)

HZ 43: HRC/LETG Count Rates

HRC-I: 0th
HRC-S: 0th
HRC-S: -1st: 57-157
HRC-S: +1st: 69-173

HRC-S High voltage increase
HIGH RESOLUTION CAMERA

QUANTUM EFFICIENCY DECLINE (P. RATZLAFF, J. DRAKE, V. KASHYAP, B. WARGELIN)

HRC-S Gain Decline
HIGH RESOLUTION CAMERA

QUANTUM EFFICIENCY DECLINE (P. RATZLAFF, J. DRAKE, V. KASHYAP, B. WARGELIN)

HZ43 LETG+HRC-S Empirical QEU Corrections

Corrections expressed relative to 2.35%/yr grey decline
Gain-related problems for PI-base background filtering

- +ve order long wavelength source signal now same PI as lowest PI background events
- PI-base bg filtering removes significant signal
Use multiple HETG+ACIS-S sources in M31 that are not piled up in 0th order to calibrate 0th relative to first order.

Simultaneous diskbb+powerlaw model fits.
Simultaneous model fits to both: zero-order and HETG first order

Source model: column density \( \times (\text{disk blackbody} + \text{powerlaw}) \)

HETG: apply average M31 diffuse background and allow for 20% variation

HETG norm: diskbb

Agreement to 8% from individual sources, 2-3% from stacked
CHANDRA CALIBRATION UPDATE

SUMMARY

- Chandra calibration challenges are as a result of aging and decline of instrument performance and accumulation of contamination on ACIS.
- HRC-S PSF is increasing and this behavior is not currently understood.
- ACIS mid-chip gain droop calibration coming shortly.
- ACIS contamination model is being regularly updated: slower rate of increase seen last year is not born out in newer data.
- Continuing HRC-S QE secular changes are being calibrated (HV increase on HRC-S is only a matter of time).
- HETG 0th vs 1st order calibration is looking good - few % - at energies above 1.5 keV; need more data for lower E.
SUPPLEMENTARY MATERIAL
PSF MONITORING: WARM HRMA
HIGH ENERGY TRANSMISSION GRATING (HETG)

0TH:1ST ORDER CALIBRATION (N. SCHULZ)

M31 stack[m31stack], 3441 ks, MEG + HEG

Counts/bin

Wavelength (Å)

Stacked source spectrum

Stacked M31 diffuse background spectrum