CHANDRA CALIBRATION

JEREMY J. DRAKE AND THE CXC CALIBRATION GROUP

CHANDRA CALIBRATION STATUS
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CHANDRA HARDWARE COMPONENTS

[Diagrams and images of ACIS and HRC components]
OUTLINE

- Point Spread Function
  - calibrating EDSER; empirical PSFs
- ACIS
  - mid-chip gain droop; QEU; contamination
- HRC-S,I
  - QE decline; gain decline
ACIS PSF WITH EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)

- Energy Dependent Subpixel Event Repositioning (EDSER) - ACIS images can be sharpened significantly at sub-pixel resolutions

- Applies corrections to event locations based on photon energy and grade (Li et al. 2004, ApJ 610, 1204)

- **BUT**: EDSER’d PSFs have not yet been calibrated
QUANTIFYING EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)

ID: 10528, OBSID:13644, 40_Eri_C, ACIS S, 5.0000ks, 0.159c/s
QUANTIFYING EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)
EMPIRICAL PSF WITH EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)

Preliminary ACIS-BI empirical stacked and derolled PSF in different bands
HRC-I EMPIRICAL PSF  
(V. KASHYAP)

- HRC-I is the best for high spatial resolution analysis
- **pros**: no pixels, no pileup, low(ish) background
- **cons**: colorblind, tailgated events broaden PSF

On-axis HRC-I AR Lac data, filtered on status-bits and tailgated events, derolled, and stacked (contours at 10% intervals from peak)
ADVANCED CCD IMAGING SPECTROMETER (ACIS)
MID-CHIP GAIN DROOP (T. GAETZ)
Epoch 1, -120.19 to -119.19 C
MID-CHIP GAIN DROOP (T. GAETZ)

Epoch 1, -120.19 to -119.19°C
QUANTUM EFFICIENCY UNIFORMITY  (R. DURHAM, P. PLUCINSKY)

ECS yr2000 QEU Correction chipY=33:64

1.5 keV

4.5 keV

5.9 keV
FILTER CONTAMINATION LAYER (A, BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

![Graph showing the increase of τ (E = 0.66 keV) over time from 2000 to 2015 for Abell 1795 with ACIS-S.]
FILTER CONTAMINATION LAYER

Edge - Center

Δτ

Date


ECS

Abell 1795
HIGH RESOLUTION CAMERA
HRC-S DEGAP UPDATE (V. KASHYAP)

- HRC-S aim point degap solution improved in 2012 ==> sharper images
- But...! Caused a shift in derived wavelengths relative to 0\textsuperscript{th} order location...

http://cxc.harvard.edu/cal/Hrc/Degap/hrcsdegap_centershift.html
QUANTUM EFFICIENCY DECLINE

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

HZ 43: HRC/LETG Count Rates

High voltage increase
QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)
HIGH RESOLUTION CAMERA

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

HZ43 Empirical QEU Corrections
QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)
No evidence of change in high-energy QE
New observation coming up in May 2018
SUMMARY

▸ EDSER PSF calibration well underway; empirical PSFs soon
▸ ACIS mid-chip gain droop calibration ongoing
▸ ACIS QEU improvements underway
▸ ACIS contamination model will be updated: slower rate of increase; uniform rate of increase across detector
▸ Continuing HRC-S QE secular changes calibrated; HRC-I QE re-calibration underway
▸ HV increase on HRC-S…. Only a matter of time
So, how is the concordance project coming along?
A simple fix: shift the degap for V taps near aim point by +2.5 pix

Top: old (blue, green, red are AMP_SF=1,2,3)
Bottom: new (dashed = old AMP_SF=1)
QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)

HRC-S/LETG Effective Area in 2018

- Red line: QEUV N0009, TG M = -1
- Dashed red line: QEUV N0008, TG M = -1
- Black line: QEUV N0009, TG M = +1
- Dotted black line: QEUV N0008, TG M = +1
ADVANCED CCD IMAGING SPECTROMETER (ACIS)

FILTER CONTAMINATION LAYER (A. BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

E0102 O VIII normalisation
HRC-S aim point degap solution improved in 2012 ==> sharper images

But introduced a 2-3 pixel offset in absolute astrometry!

Caused a shift in derived wavelengths relative to 0\textsuperscript{th} order location

Measured shifts between strong lines seen in coronal sources observed with LETGS+HRC-S

http://cxc.harvard.edu/cal/Hrc/Degap/hrcsdegap_centershift.html
HRC-S DEGAP UPDATE (V. KASHYAP)

Old line profile difference

New line profile difference
CHANDRA CALIBRATION STATUS

CHANDRA HARDWARE COMPONENTS

- ACIS (CCDs)
  - 8.3' x 8.3'
  - Grid:
    - SD
    - SL
    - S2
    - S3
    - S4
    - S5

- HRMA Mirrors
  - 8.3' x 8.3'

- HRC (Microchannel plates)
  - 30 arc min
  - 99 arc min

- LETG, HETG diffraction gratings