Resolving the Chandra / ACIS PSF using Actual Data

Deron Pease, Diab Jerius, and CXC Optics Group

Credit: NASA/CXC/Northwestern U./C.Heinke et al.
Previous Studies: HRC

- AR Lac on HRC-I
  ObsID 1385 (~19ks)

- Correct for systematic errors in event positions

- Model: HRMA + 20 \( \mu m \) HRC blur + 0.06 \( \text{arcsec} \) Aspect blur
Previous Studies: ACIS

- DJ’s SPIE paper from 2003
- 12 sources
- ACIS-I & -S
- Various coadditions
- Energy cuts
- Comparison with HRC-I AR Lac

Extended, “puffy”

Expectations?
Source Selection Criteria

- Point sources (stars, QSOs)
- Within 50″ of optical axis

- High galactic latitude \( \Rightarrow |b| > 10° \)
- Low counts per frame \( \Rightarrow < 0.1 \)
- High counts \( \Rightarrow \geq 100, \) prefer \( \geq 1000 \) *
- FAINT, VFAINT mode to further select low count rates
- No grating (excludes most high energy sources) *

- Preferably uncrowded fields
- Any other concerns — literature info
Sources Found & Analyzed

1. Start with ~100,000 sources
2. 1\textsuperscript{st} cut $\Rightarrow$ ~250 Stars ~290 AGN (all followed up)
3. 2\textsuperscript{nd} cut $\Rightarrow$ 28 Stars 12 AGN (these fully analyzed)
4. 3\textsuperscript{rd} cut $\Rightarrow$ 3 Stars 2 AGN (these best by far)

$\Rightarrow$ 47 Tuc & PG 1634+70

- Visual inspection
- De-Roll
- Clean & filter data properly (dmtools, funtools)
- Light-curve inspection
- Grade analysis — looking for pile-up effects
- Encircled energy & radial profile analysis
## Observations

<table>
<thead>
<tr>
<th>Source</th>
<th>ObsID</th>
<th>Detector</th>
<th>Exposure (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 1634+70 (QSO)</td>
<td>69</td>
<td>ACIS-S</td>
<td>5713.55</td>
</tr>
<tr>
<td></td>
<td>1269</td>
<td>ACIS-S</td>
<td>13309.95</td>
</tr>
<tr>
<td>47 Tuc (GC)</td>
<td>953</td>
<td>ACIS-I</td>
<td>33368.23</td>
</tr>
<tr>
<td></td>
<td>955</td>
<td>ACIS-I</td>
<td>33368.73</td>
</tr>
<tr>
<td>AR Lac</td>
<td>1385</td>
<td>HRC-I</td>
<td>18831.93</td>
</tr>
</tbody>
</table>
ACIS Results

PG1634+70 ACIS–S & 47 Tuc ACIS–I

Enclosed Fraction

Radius [arcsec]
Chandra ECF

AR Lac HRC–I vs. PG1634+70 ACIS–S vs. HRMA

Detector | FWHM (arcsec)
---|---
HRC | 0.70
HRC (pre-cor) | 0.80
ACIS | 0.72
ACIS (no pix rand) | 0.63
Conclusions

✓ We’ve shown that the ACIS PSF (with pixel randomization) is comparable to the HRC PSF

• But what’s going on with pixel randomization off?
  • One might say: pixel randomization is necessary because we don’t know where an event landed in a pixel. EOS
  • But clearly there is a significant difference: