Spatially Dependent Detector Properties

- Quantum efficiency variations
- Resolution variations (E/AE)
- Gain variations (photon energy → detector pulse height)
  - Calibration on 256x32 pixel scale on all FI chips
  - Calibration on 64x64 pixel scale on S1
  - Calibration on 32x32 pixel scale on S3
- Properties different for FI (ACIS-I) and BI (ACIS-S) chips
- Discussion limited to ACIS
Variations in Source Properties

- Data quality (S/N ratio)
- Hard versus Soft spectrum
- Multiple sources
  - Star clusters, deep fields
- Density structure
  - Shells, cavities, filaments
- Temperature structure
  - Gradients, shocks, knots, etc
CXC

- Surface brightness profiles
- Hardness ratios
- Narrow and broad band images
- Flat fielding (using exposure maps)

Imaging Analysis
- 2D maps of spectral fit parameters
- Measuring gradients using multiple extraction regions
- Single spectral fit for extended region (larger than 32x32 pixels)

Spectral Fitting

Typical Analysis Tasks
Gain calibrations less accurate at low energies
Linearization process less accurate at low energies
Intrinsic detector gain is non-linear below ~0.7 KeV
\[ P_I = \text{INT}(E/14.6) + 1 \] where \( E \) is in eV
\( P_I \) values are gain corrected to a uniform linear scale

Use of \( P_I \) channels recommended

Stronger on 13 (~15%, due to CFI effects)
Appreciable on 53 (~5%)
Recommended for extended source analysis.

Does not correct for spatial variations in resolution.

\[ \text{PI} = \text{INT} \left( \frac{E}{1.46 \text{ eV}} \right) + 1 \]

Linear energy scale.

Scaling of PHA data preserves resolution:

\[ \frac{\text{E}_{\text{AE}}}{\text{E}_{\text{PI}}} = \text{PHA} \]

Constructed from PHA PDF data files.

Gain corrected detector channel.
Figure 6: Histogram of ACIS S3 and I3 Gain Variations.
Figure 3: ACIS Gain variations. Notice the size of the squares.
Figure 4: ACIS Gain variations. Notice the size of the squares.
Figure 5: ACIS Gain variations. Notice the size of the squares.
Resolution Variations

- Single RMF, Weighted RMF
- Weak sources on 13
- Multiple RMFs, Weighted RMF
- Strong sources on 13
- Single position RMF typically adequate on S3
- Linear decrease in resolution with CHIP on 13
- Variations larger at lower energies
- Very strong on 13 (~2-4 over chip)
- Small on S3 (~20% over chip)
Figure 12: ACIS FWHM variations for S3 at 1.487 keV.
Figure 13: ACIS FWHM variations for S3 at 5.898 keV.
Figure 14: ACIS FWHM variations for I3 at 1.487 keV.
Figure 15: ACIS FWHM variations for I3 at 5.898 keV.
Quantum Efficiency Variations

- Non-uniform on S3
- Small ~10% on S3 at all energies
- Correlated with CHIPY on I3 due to CTI
- Effect less than 5% below 1.0 keV on I3
- Variation ~30% at 6.0 keV over I3 chip
- Recommend weighted ARFs for very large regions
CHIP: S3 - 120C, ENERGY: 1.487 keV
CHiP: S3 - 110C Energy: 5.898 keV

N = 13