High Resolution Mirror Assembly (HRMA) PSF
29 June 2001

On-axis PSF

- PSF core ($\approx$90% encircled energy)
  - low frequency mirror figure errors; misalignments
- PSF wings
  - scattering from mirror microroughness (high frequency errors)
  - low level (especially at low energies); requires bright source to see wings above background, leading to pileup for ACIS detectors.
  - expected to be steep at low energy, flatter at high energies.
- fraction of power $10''$–$200''$ radius:
  - $\approx$2% (0.2–2 keV),
  - $\approx$10% (5–8 keV),

Off-axis PSF

- dominated by geometry and alignment of the optics
- complex structure; substructure depends on azimuth as $\sim \phi/2$
Figure 1: Left: AR Lac (HRC). Right: LMC X-1 (ACIS)
HRMA PSF – Core
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Figure 2: Encircled energy for AR Lac; obsid 1385. [Jerius et al., Proc. SPIE, 4012, 17 (2000)]
HRMA PSF – Wings
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• long observation of 3C273 on ACIS-S3 (∼30 ks total, ∼22 ks good time)
  • energy slices
  • high background times excluded (→ 22 ks GTI).
  • applied detector QE.
• profile extracted with *funcnts*; θ ≤ 540″
• normalized by source rate [estimated from transfer smear; 10″ wide regions]
• fits to powerlaw plus background, θ ≥ 10″
Figure 3: 3C273 on S3
0.5–2.0 keV

Figure 4: Left: Data vs. fit.
Right: Data - background vs. powerlaw fit component. [Normalized by source rate].
Figure 5: Left: Data vs. fit.
   Right: Data - background vs. powerlaw fit component. [Normalized by source rate].
Energy Dependence

Figure 6: Left: Data - background. [Normalized by source rate].
Right: powerlaw fit component.
Powerlaw fit parameters vs. energy

Power law amplitude [3C273, obsid 1712]
Fit form: $A \theta^0 + B$

Power law slope [3C273, obsid 1712]
Fit form: $A \theta^\alpha + B$

**Figure 7:** Left: normalized powerlaw amplitude. Right: powerlaw slope.
Normalized background vs. energy

Power law amplitude [3C273, obsid 1712]
Fit form: $A \theta^B + B$

Figure 8: Normalized background.
HRMA PSF Wings
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Summary

- PSF has ∼powerlaw wings; relevant for bright sources, especially those with hard spectra.
- fraction of power 10″–200″ radius:
  - ≤2% (0.2-2 keV),
  - ≤10% (5-8 keV),

Web Pages

- HRMA Calibration
  - http://asc.harvard.edu/cal/Hrma
- HRMA PSF wings: Preliminary report (soon to be updated)