High Resolution Mirror Assembly (HRMA) PSF
29 June 2001

On-axis PSF

- PSF core ($\lesssim$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:
    - $\lesssim$2% (0.2-2 keV),
    - $\lesssim$10% (5-8 keV),

Off-axis PSF

- dominated by geometry and alignment of the optics
- complex structure; substructure depends on azimuth as $\sim\phi/2$

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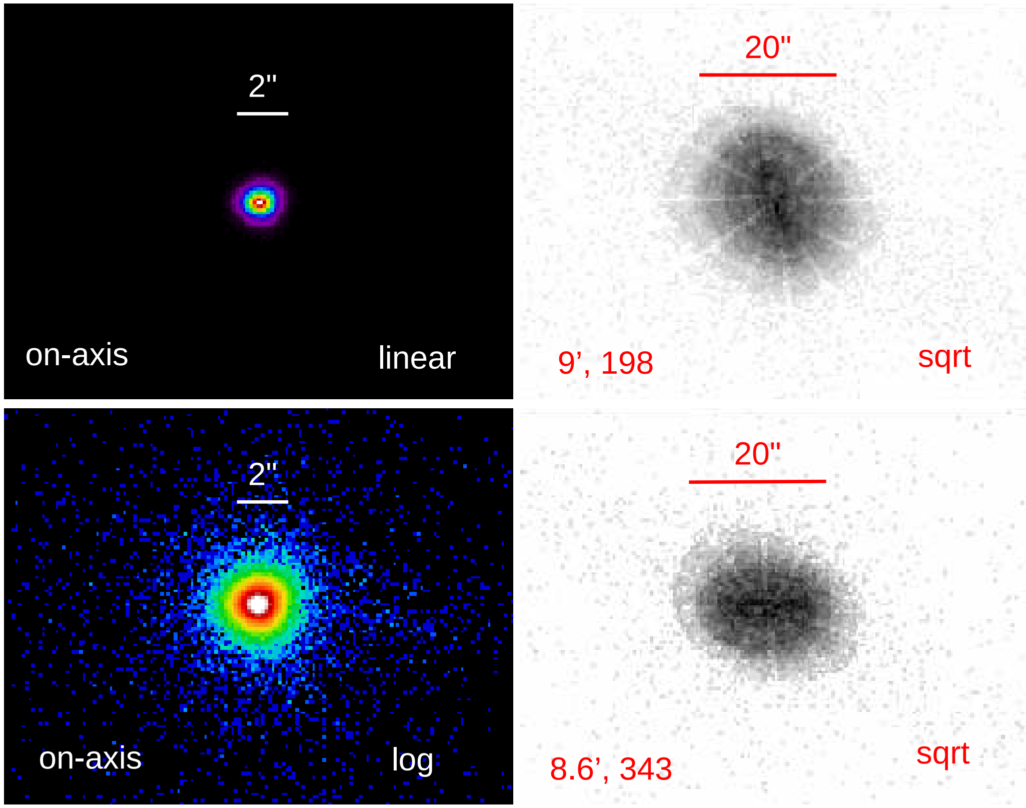

Figure 1: Left: AR Lac (HRC). Right: LMC X-1 (ACIS)

HRMA PSF – Core

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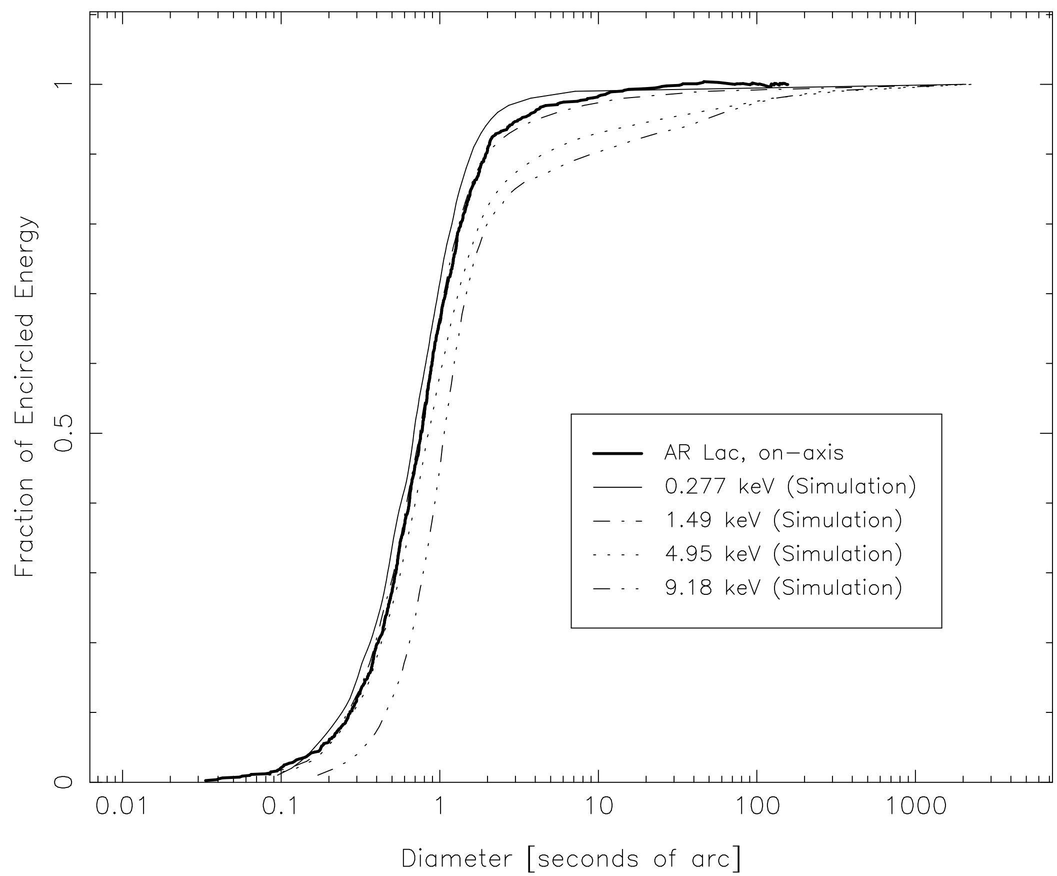

Figure 2: Encircled energy for AR Lac; obsid 1385. [Jerius *et al.*, Proc. SPIE, 4012, 17 (2000)]

HRMA PSF – Wings
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- long observation of 3C273 on ACIS-S3 ($\sim$30 ks total, $\sim$22 ks good time)
  - energy slices
  - high background times excluded ($\longrightarrow$ 22 ks GTI).
  - applied detector QE.
- profile extracted with `funcnts`; $\theta \leq 540''$
- normalized by source rate [estimated from transfer smear; $10''$ wide regions]
- fits to powerlaw plus background, $\theta \geq 10''$

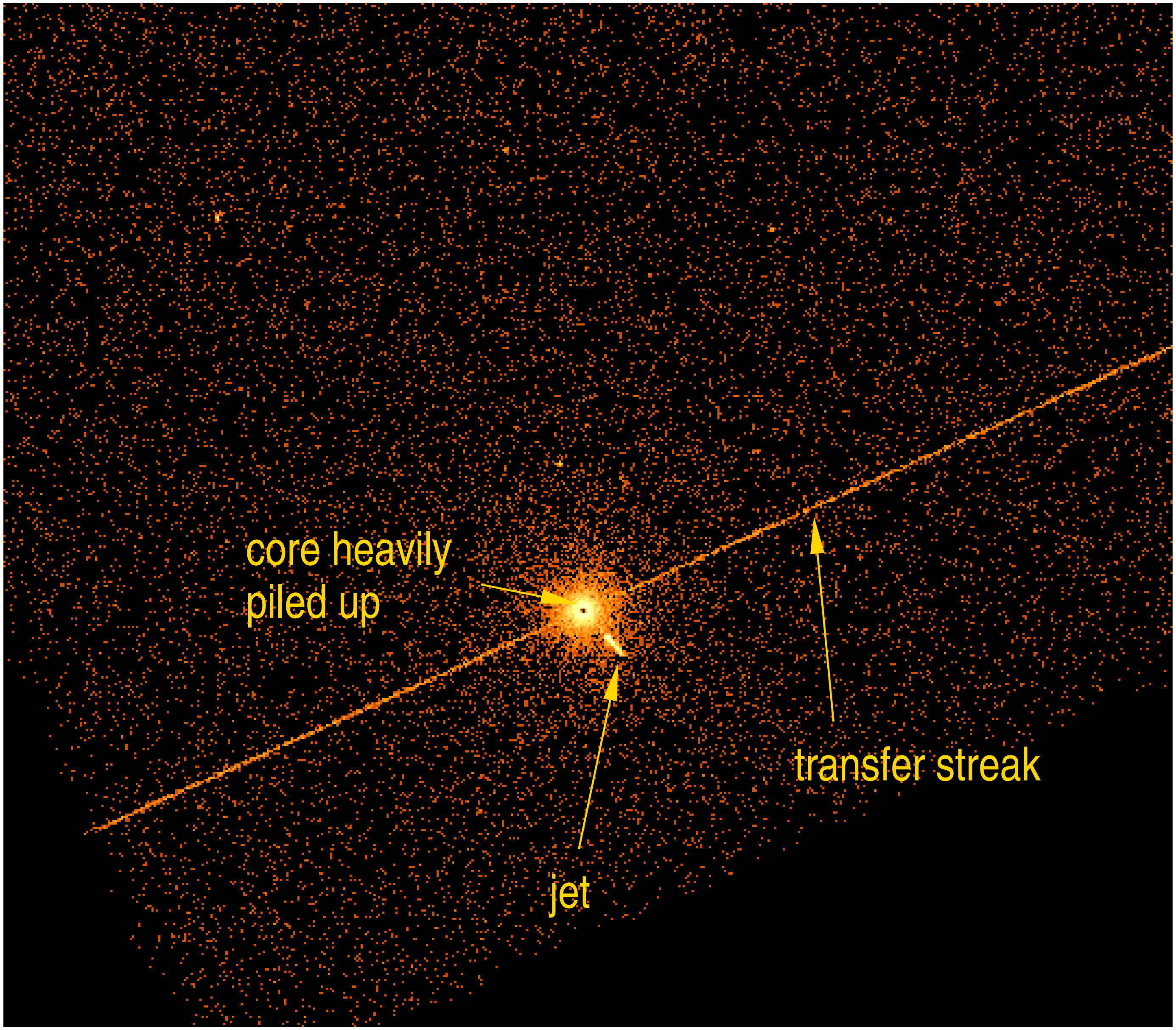

Figure 3: 3C273 on S3

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0.5–2.0 keV

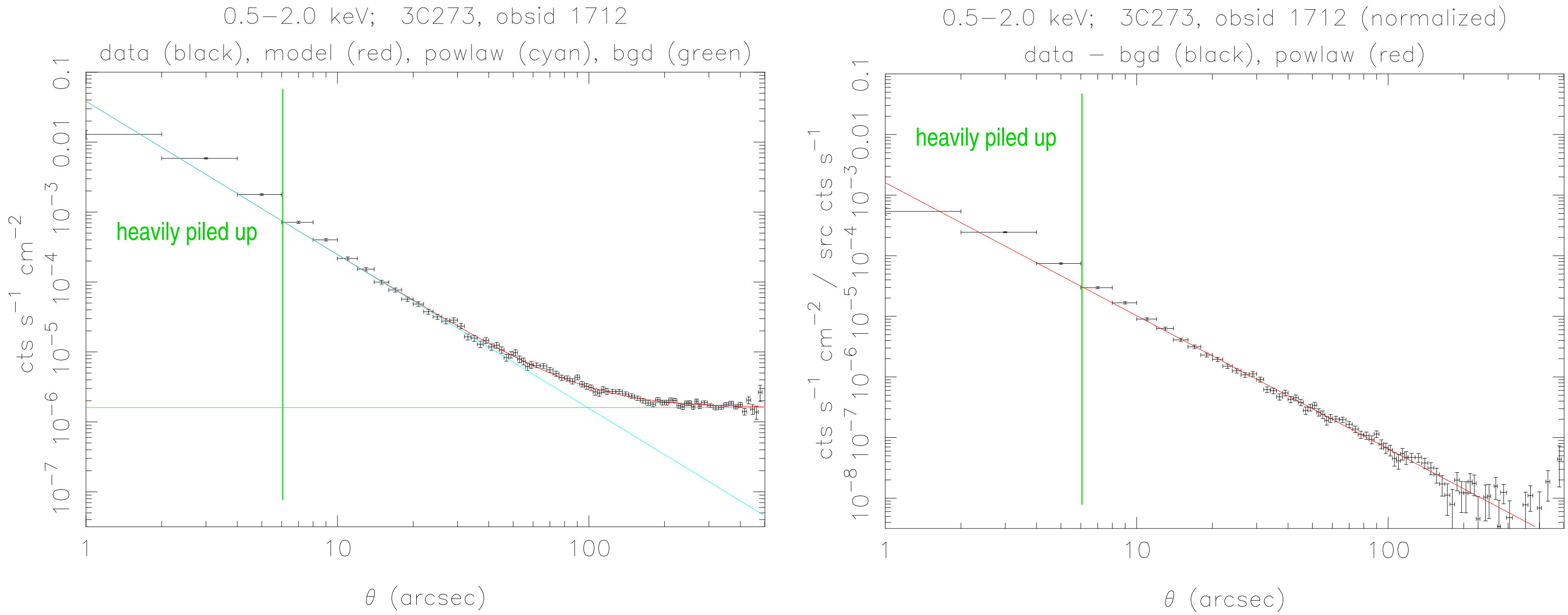

Figure 4: Left: Data vs. fit.
Right: Data - background vs. powerlaw fit component. [Normalized by source rate].

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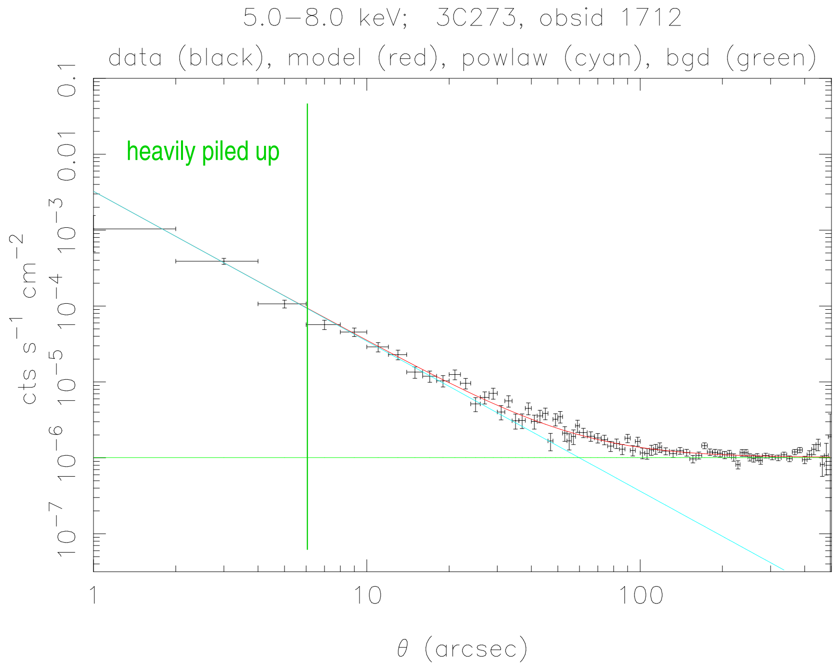
5.0–8.0 keV



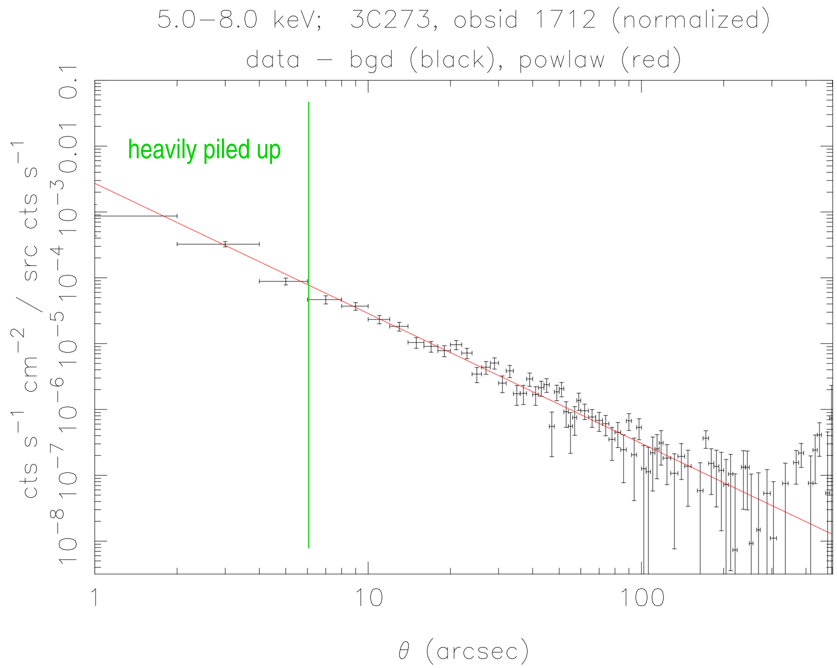


Figure 5: Left: Data *vs.* fit.
Right: Data - background *vs.* powerlaw fit component. [Normalized by source rate].

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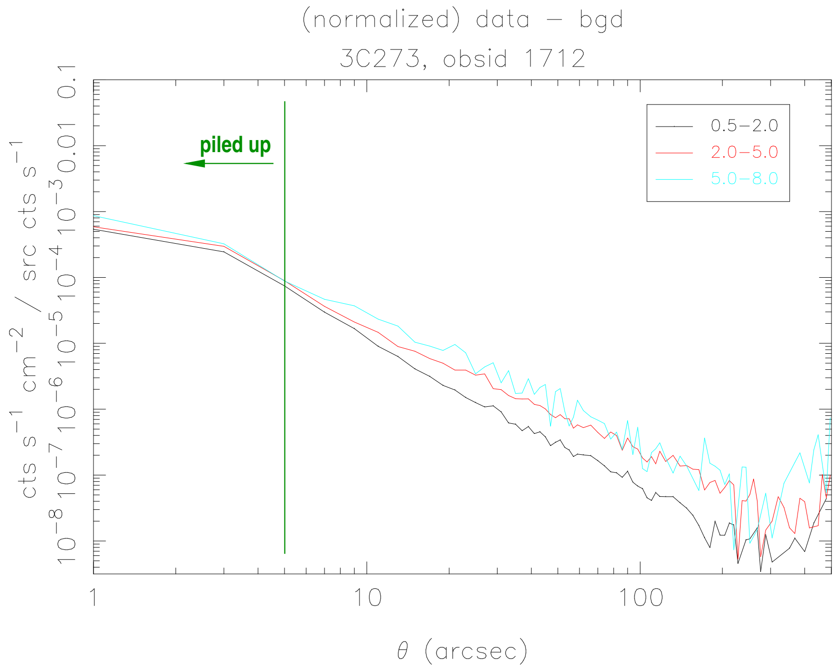
Energy Dependence



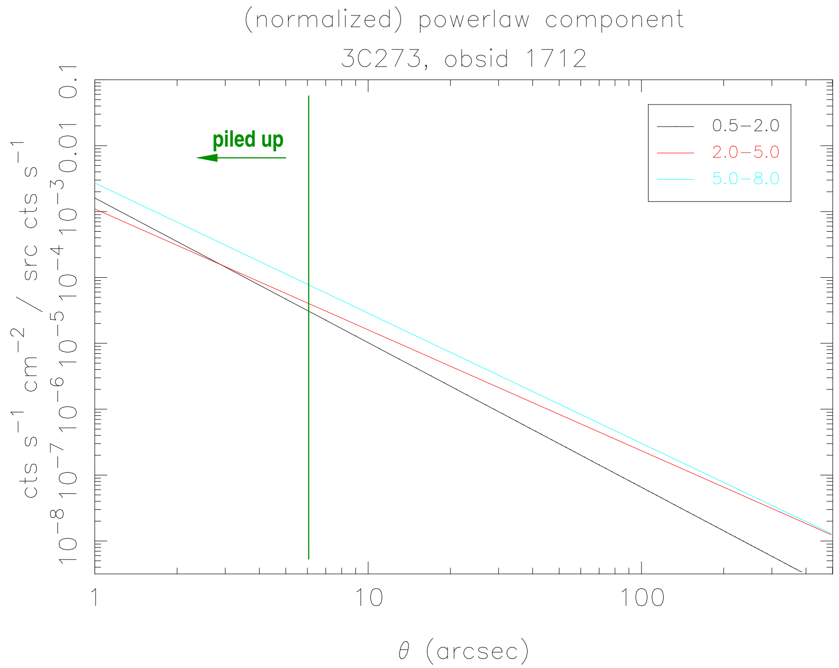


Figure 6: Left: Data - background. [Normalized by source rate].
Right: powerlaw fit component.

Powerlaw fit parameters vs. energy

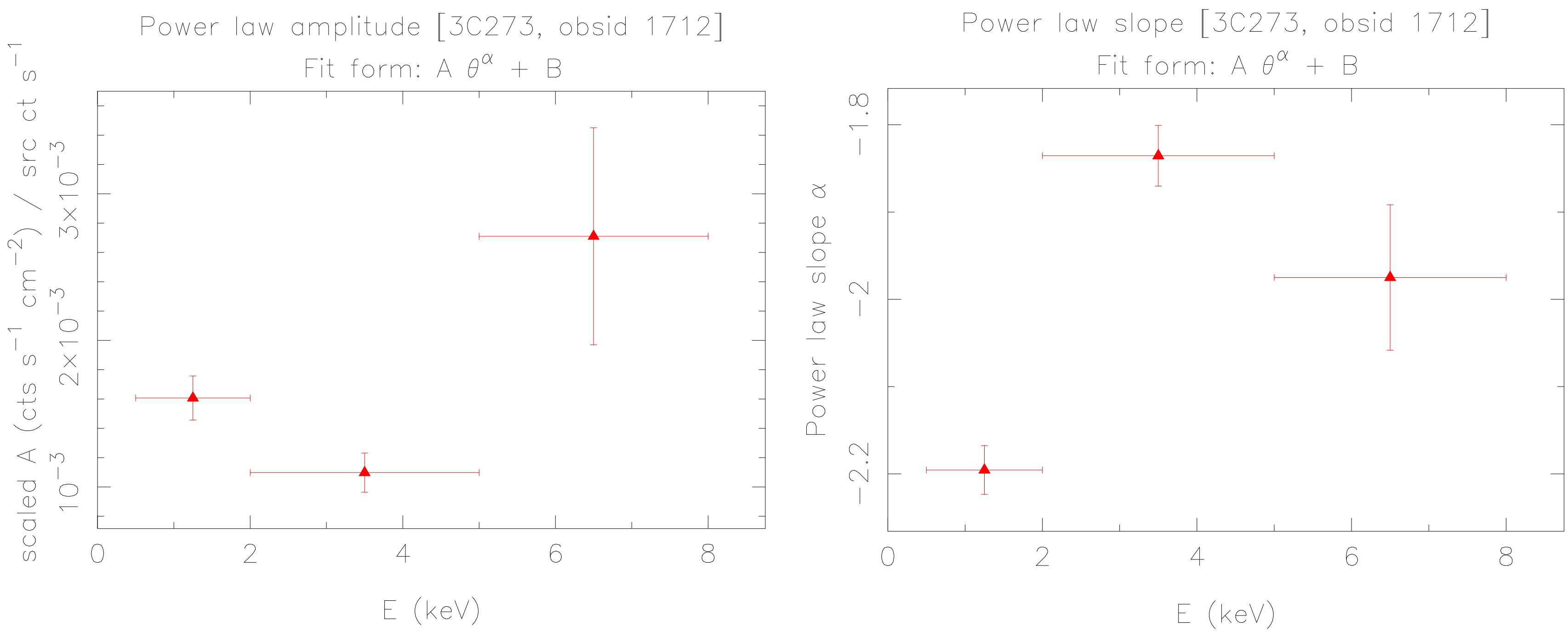


Figure 7: Left: normalized powerlaw amplitude. Right: powerlaw slope.

Normalized background vs. energy

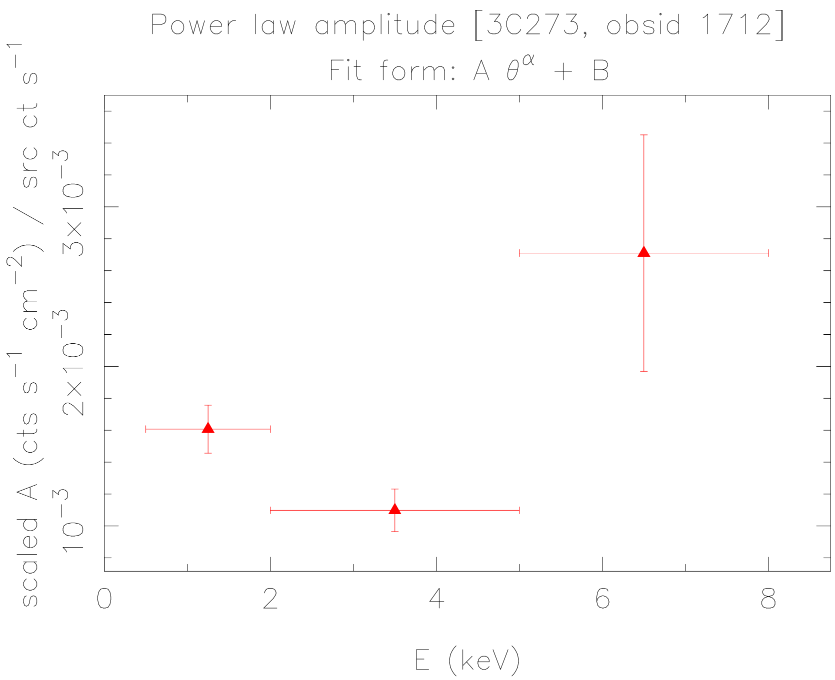


Figure 8: Normalized background.

HRMA PSF Wings
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Summary

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

Web Pages

- HRMA Calibration
  - http://asc.harvard.edu/cal/Hrma
- HRMA PSF wings: Preliminary report (soon to be updated)
  - http://asc.harvard.edu/cal/Hrma/hrma/psf/PSF_wings_3c273/psf_wings.html