

# High Resolution Mirror Assembly (HRMA) PSF

## 29 June 2001

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### 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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# HRMA PSF

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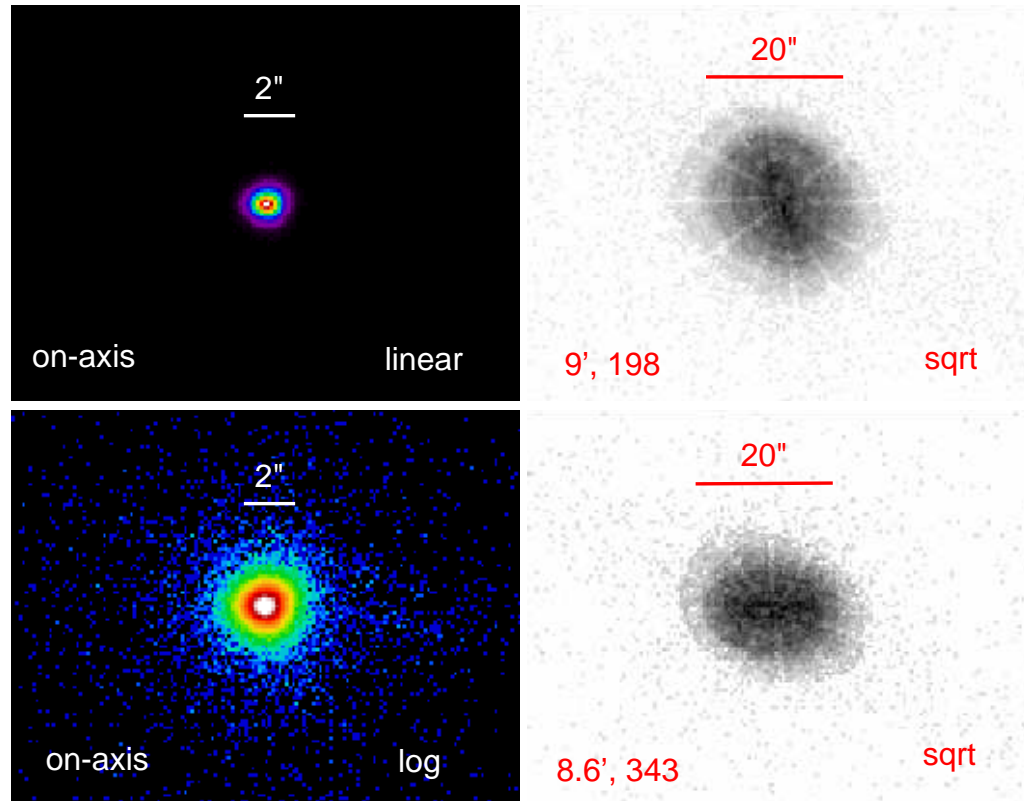
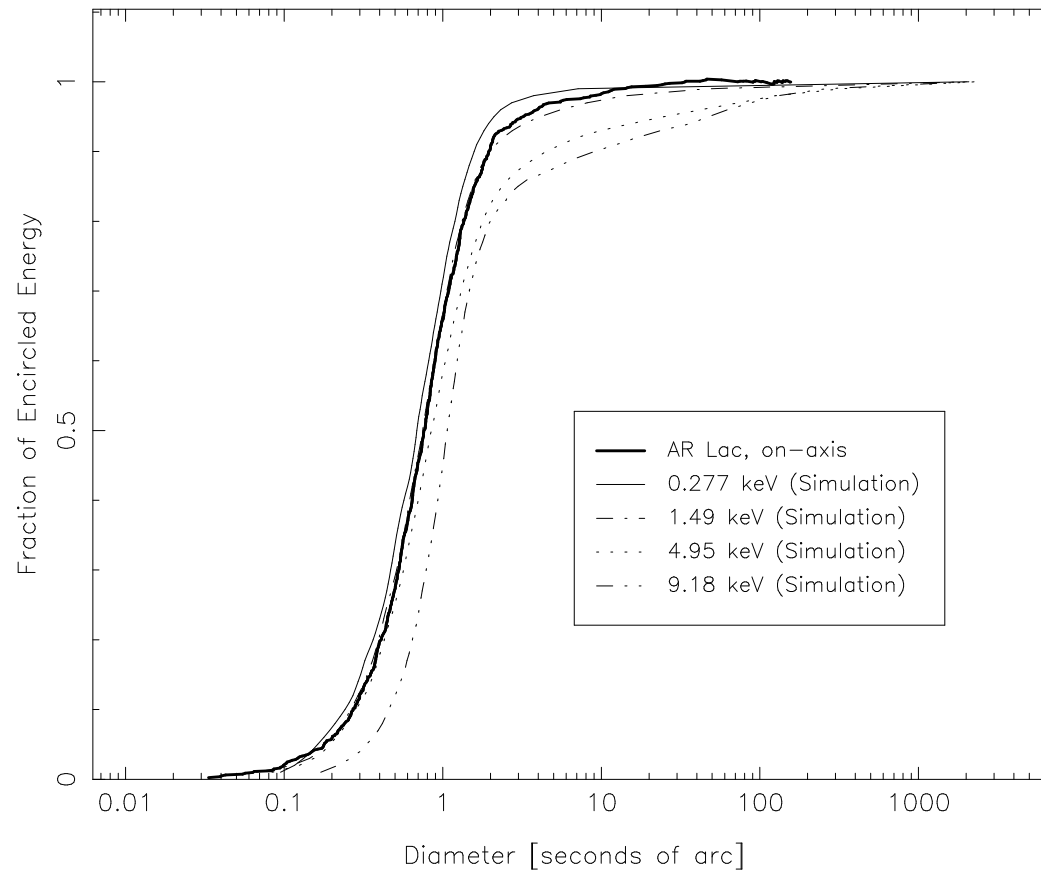


Figure 1: Left: AR Lac (HRC). Right: LMC X-1 (ACIS)

# HRMA PSF – Core

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

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# 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,  $\theta \geq 10''$

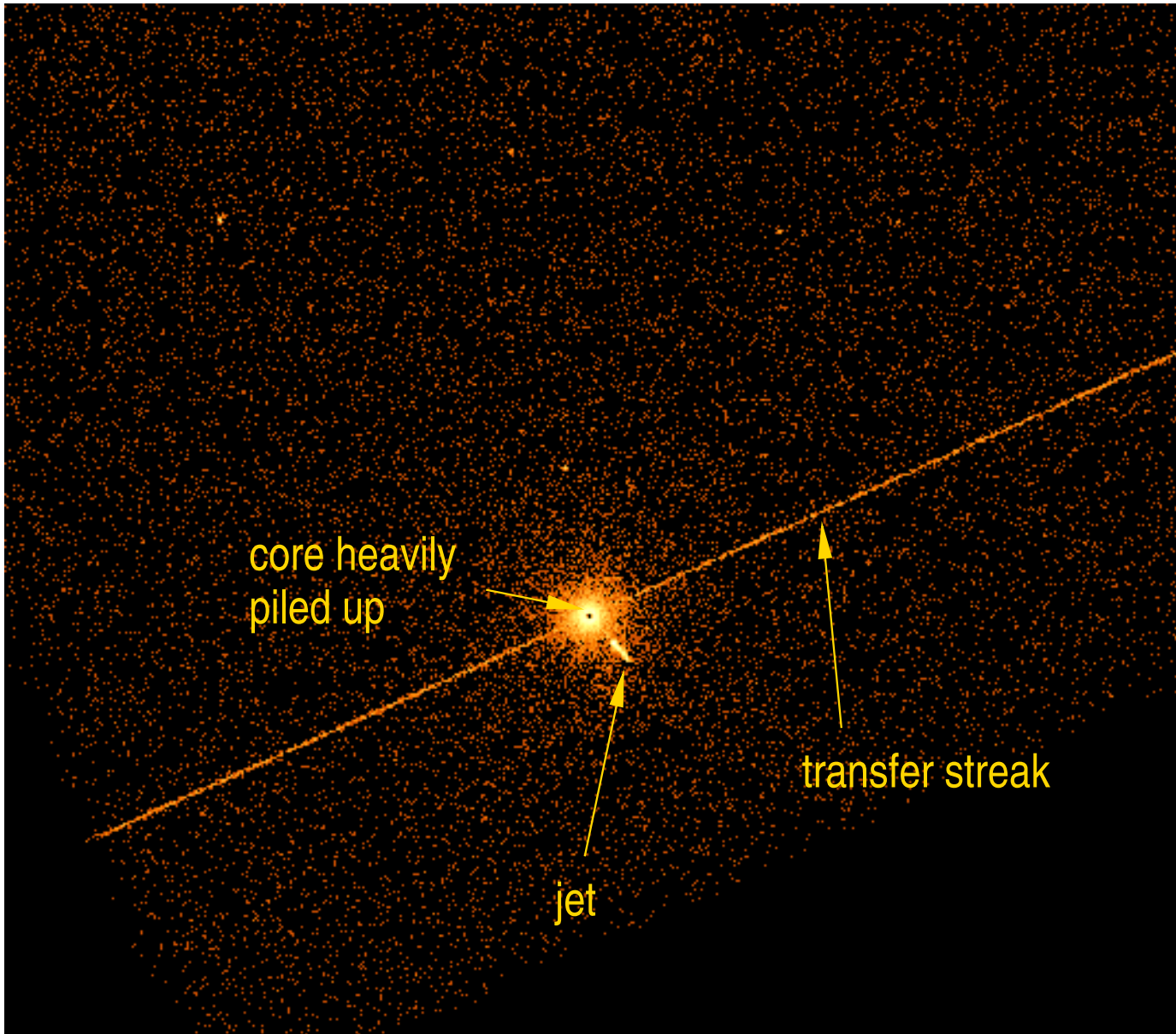
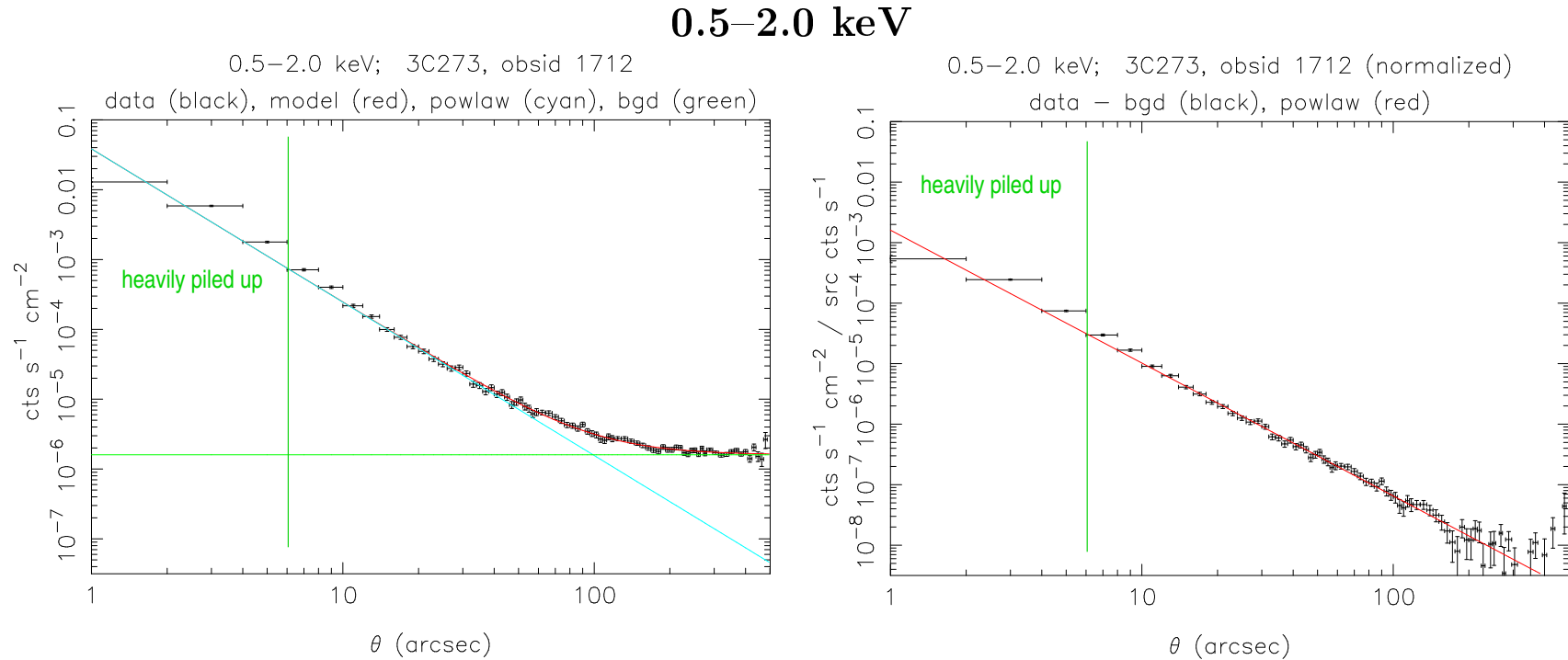


Figure 3: 3C273 on S3

# HRMA PSF – Wings

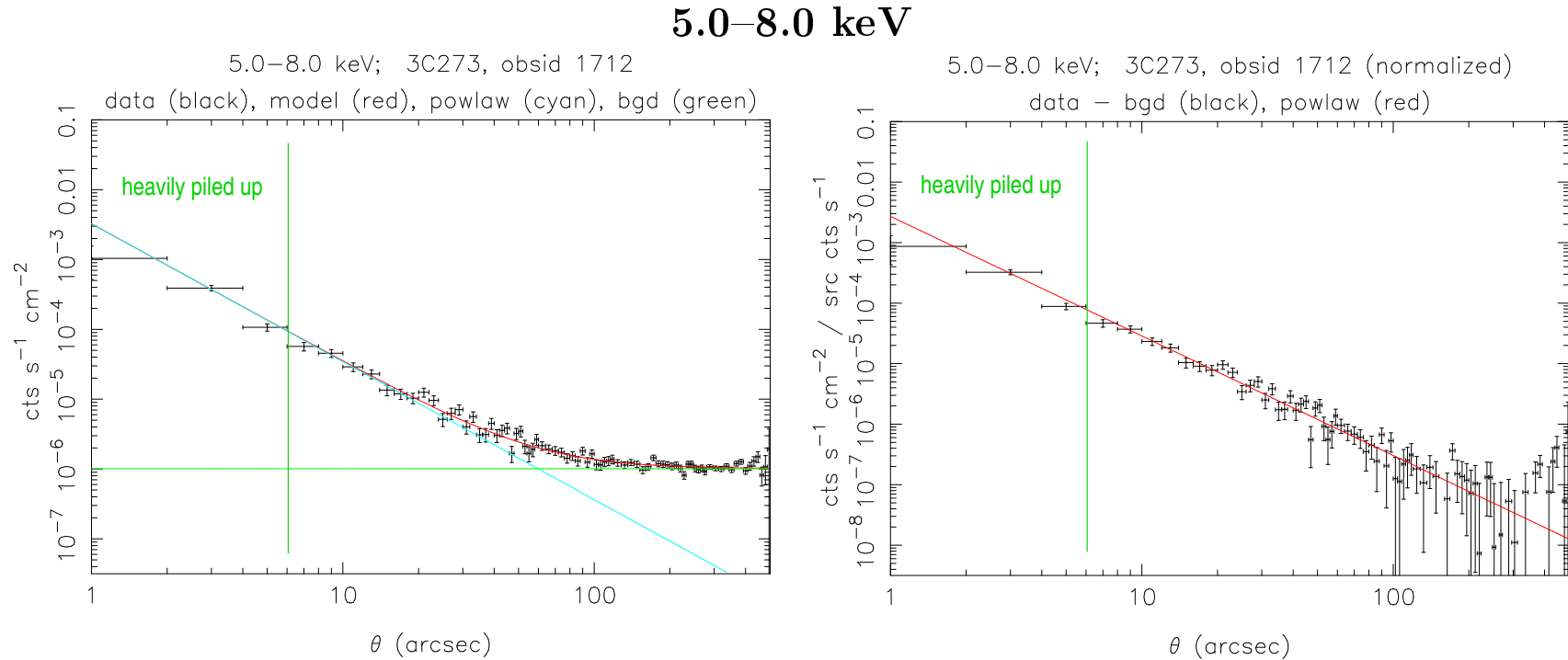
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**Figure 4:** Left: Data vs. fit.  
Right: Data - background vs. powerlaw fit component. [Normalized by source rate].

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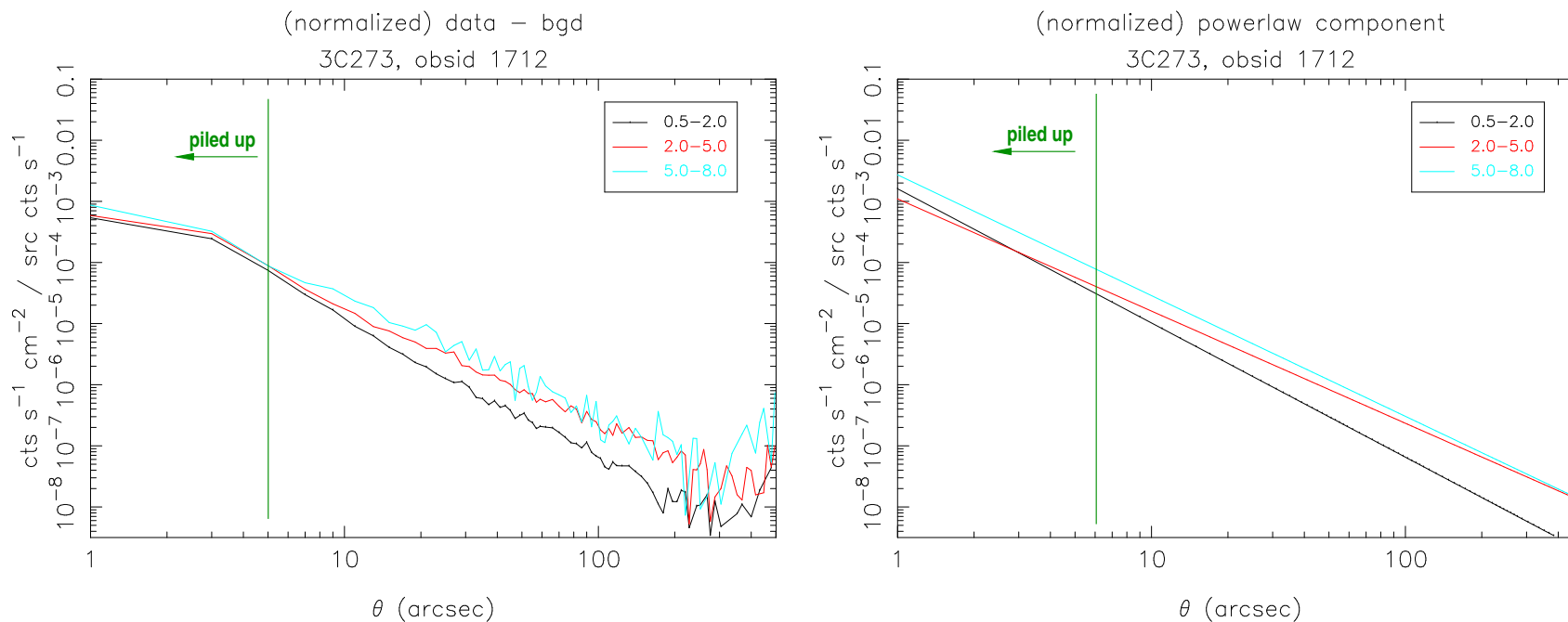


**Figure 5:** Left: Data *vs.* fit.  
Right: Data - background *vs.* powerlaw fit component. [Normalized by source rate].

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## Energy Dependence



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

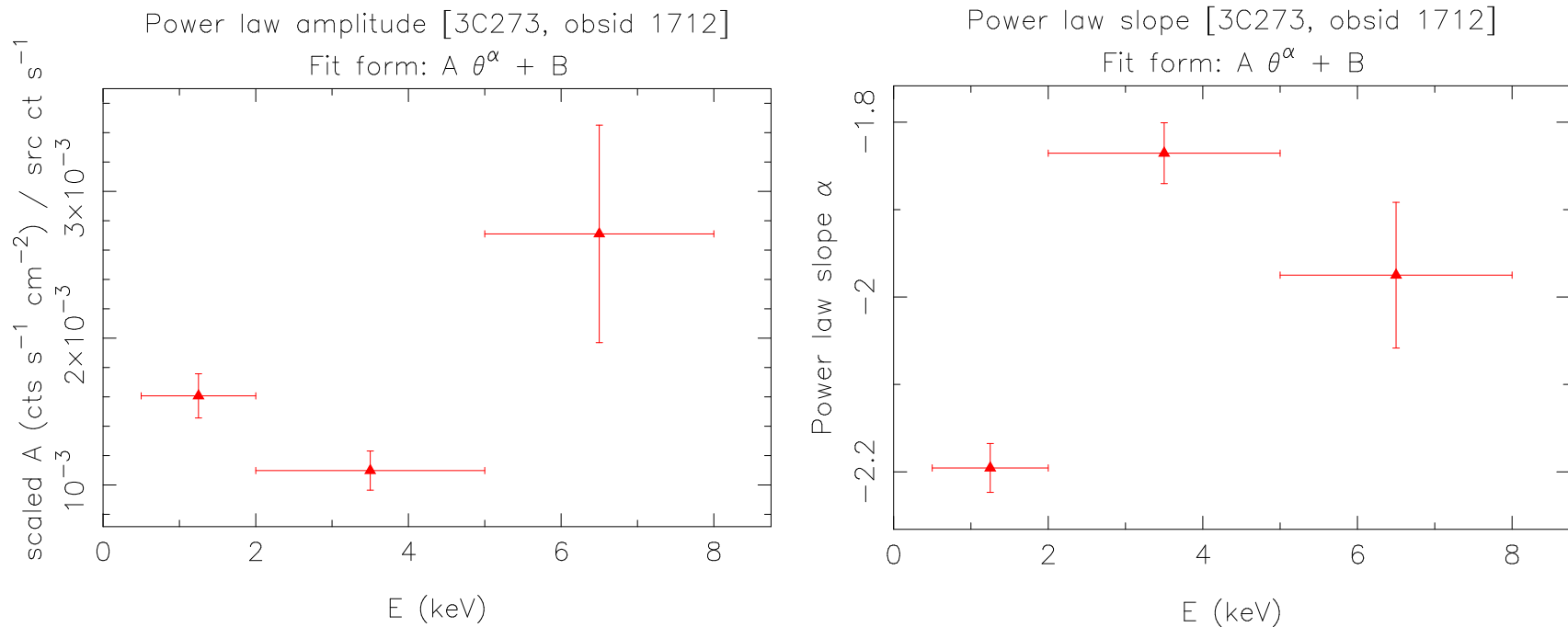


# HRMA PSF – Wings

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## Powerlaw fit parameters vs. energy



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

# HRMA PSF – Wings

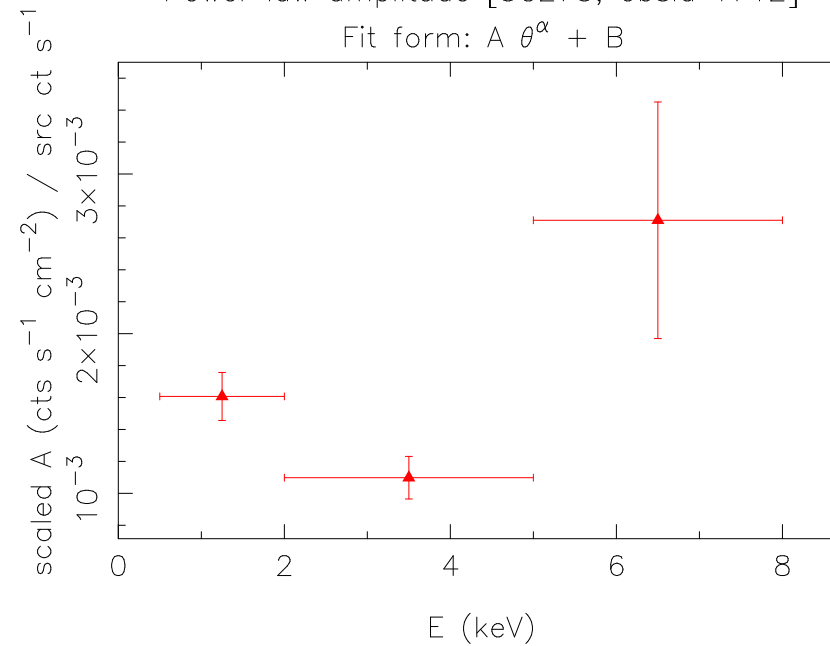
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## Normalized background vs. energy

Power law amplitude [3C273, obsid 1712]

Fit form:  $A \theta^\alpha + B$



**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](http://asc.harvard.edu/cal/Hrma/hrma/psf/PSF_wings_3c273/psf_wings.html)