Analysis of the X-ray PSF

PSFs in the CCF
MCG-6-30-15
3C273

Calibration of the PSF
PSFs in the CCF

‘Low’ : Analytic
‘Medium’ : Image library
‘Extended’ : Analytic
‘High’ : Analytic
PSFs in the CCF

**LOW**: Analytic

6 Parameters, varying with E and theta

- E: 0.1, 1.5, 3, 4.5, 6, 7.5, 9, 10.5, 12, 13.5, 15 keV

M1=M2=PN

0.1keV=1.5keV, thereafter variation with E

variation with theta

Parameters P1, P6 not used (?)
PSFs in the CCF

Medium : Image Library

- E : 0.1, 1.5, 3, 4.5, 6, 7.5, 9, 10.5, 12, 13.5, 15 keV (same as Low)
- Theta : 0’, 3’, 6’, 9’, 12’, 15’ (same as Low)

M1=M2=PN

0.1keV=1.5keV, thereafter variation with E

variation with theta
PSFs in the CCF

Medium

M1 (= M2 = PN)

E = 0.1, theta = 0, phi = 0
E = 1.5, theta = 0, phi = 0
E = 3.0, theta = 0, phi = 0

E = 6.0, theta = 0, phi = 0
E = 6.0, theta = 9', phi = 0
E = 6.0, theta = 9', phi = 90°
PSFs in the CCF

Extended: Analytic – ‘KING’ profile

E: 0, 0.1, 1.5, 3, 4.5, 6, 7.5, 10, 12, 13.5, keV
M1, M2, PN different variation with instrument
variation with E
variation with theta (?)

Also, BETA profile exists in CCF
3 Parameters
M1=M2 (no PN)
PSFs in the CCF

Extended King

M1 (not = M2, PN)

- E=0.1, theta=0, phi=0
- E=1.5, theta=0, phi=0
- E=3.0, theta=0, phi=0
- E=6.0, theta=0, phi=0
- E=6.0, theta=9', phi=0
- E=6.0, theta=9', phi=90
PSFs in the CCF

Extended King

Variation with Instrument
PSFs in the CCF

Extended Ring

Variation with Energy
PSFs in the CCF

Extended King

Radial profiles – rp_Npsf_m1_E_6000_0-540_0.ps

Counts/pixel

Variation with Theta

1 + radial distance (pixels)

1 10 100
PSFs in the CCF

**HIGH** : Analytic – ‘3 Gaussians’ profile

1 Set of 7 parameters (M1: P6=P7=0)

M1, M2, PN different variation with instrument

No variation with E

No variation with theta
PSFs in the CCF

Variation with Instrument
MCG-6-30-15

Rev 0301 – SW M-filter - 82.0 ksec – some low-level flaring

Rev 0302 – SW M-filter - 123.5 ksec – clean (a few small flares)

Rev 0303 – SW M-filter - 125.0 ksec – very clean

Bright point source – not too piled-up

Analysis of 2-10 keV flare-subtracted singles
MCG-6-30-15

Annuli: 0, 5, 10…40 pixels [1 pixel = 1.1”]
MCG-6-30-15

MOS1 0301
R > 5 pixels

MOS1 Model
RAWY = 280.7

PI Channel [eV]
MCG-6-30-15

MOS1 0301
R > 10 pixels
MCG-6-30-15

Power-law index vs Radius (0301)

![Graph showing power-law index vs radius for MCG-6-30-15 with different symbols for MOS1, MOS2, and PN.]
MCG-6-30-15

Normalization vs Radius (0301)

Rev 0301
- MOS1
- MOS2
- PN

Radius (1.1" pixels)
Alpha vs R

Rev 0301
- MOS1
- MOS2
- PN

R = 0 - 40
R = 5 - 40
R = 10 - 40

Norm vs R

Rev 0301
- MOS1
- MOS2
- PN

R = 0 - 40
R = 5 - 40
R = 10 - 40

Note MOS symbols reversed for 0303

Rev 0302

Rev 0302

Rev 0303

Note MOS symbols reversed for 0303
MCG-6-30-15

0301 M1 PSF study

Distance from source in pixels
MCG-6-30-15

0301 M2 PSF study
MCG-6-30-15

King profile, though good, may show underprediction in the core –
(status of EPIC calibration CAL-TN-0018)

Figure 1-6: The radial profile binned at 1 arcsecond shows an underprediction in the core. This gets smeared out in the 4 arcsec binned plots in figure 1-4
Only part of ARF that changes with R is the EE component

EE comp. of ARF for different annuli (0303 M2) … for R=0-5, 5-10 & 35-40 for M1, M2 & PN (0301)
Other components of ARF (effective area, quantum efficiency, filter transmission) do not change with R (for each instrument)
MCG-6-30-15

Power-law index vs. Radius

Normalization vs. Radius

Radius (pixels: 1.1")
Rev 0301 M1
Alter EE component Of ARF:
(S)lope *0.5, 0.0
(N)orm.*0.8,1.2
3C273

18 MOS SW observations
6 M1 (0094, 0095, 0096, 0277[x2], 0563
12 M2 (0094, 0095, 0096, 0277[x2], 0370, 0373, 0472[x2],
       0554, 0563[x2])

Source more piled-up than MCG-6-30-15
Analysis of 2-10 keV singles
3C273
3C273

Rev 0094 Power-law index vs radius

Rev 0094 Normalization vs radius

Radius (1.1” pixels)
3C273

Power-law index vs radius

Radius (1.1” pixels)
3C273

Normalization vs radius

Radius (1.1” pixels)

Andy Read (amr30@star.le.ac.uk)
EPIC Calibration Meeting
Saclay 24/09/03-25/09/03
Calibration of the PSF

Large number of bright source observations
Only specific range of radii allowed – pile-up at small R
- statistics/window size at large R
Stack the observations on to one-another (keeping good R range), to build a
good 2-D representation

Problems: normalising the maps w.r.t. each other
very different count rates per frame
different exposures, levels of OOT events
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