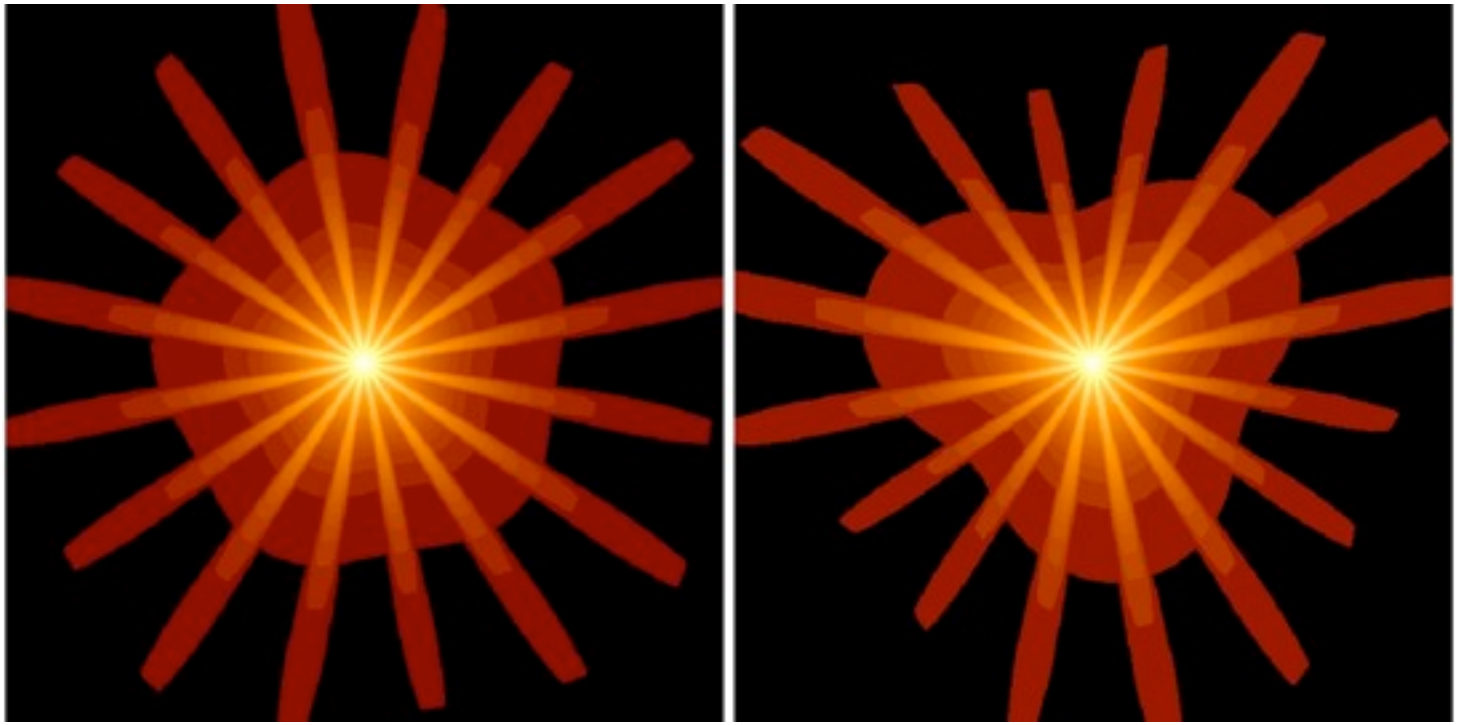
The 2-d PSF

encircled energy

Encircled energy calculation

- In ELLBETA mode this is performed by integrating PSF image rather than analytically
- This is slower but means that arbitrary shapes can be used for the extraction region. Very useful for avoiding chip gaps, bad columns and for optimising extraction regions for S/N.
- *arfgen* uses a user-selectable PSF model; default will be ELLBETA in SAS 12 for all extraction region shapes.
- Method published in *Read et al. 2011, A&A, 534, A34*



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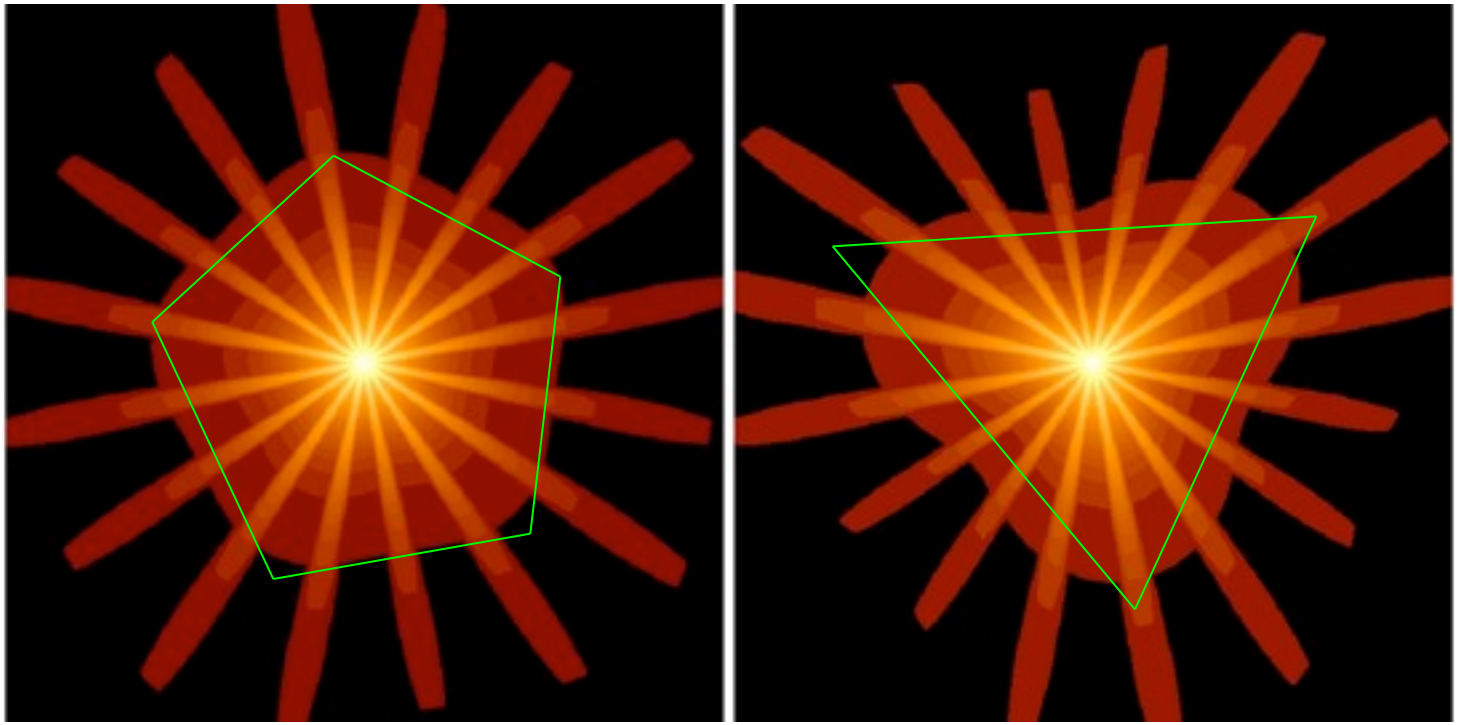
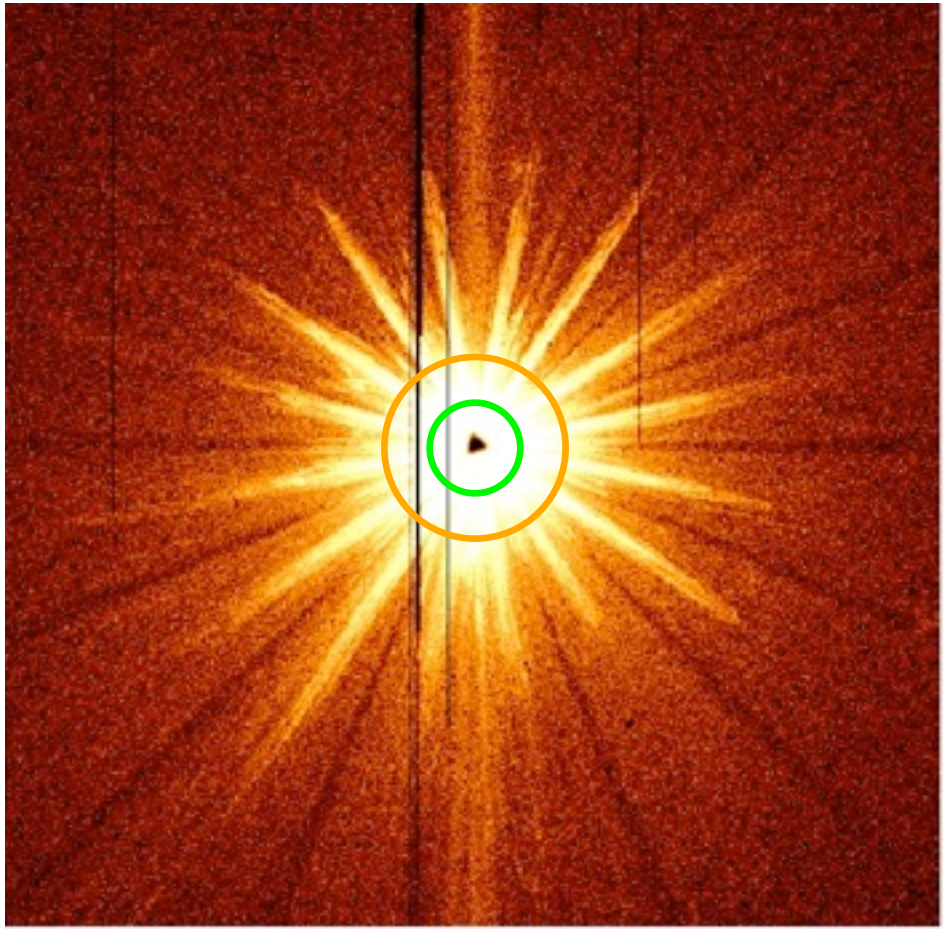


On-axis EE comparison

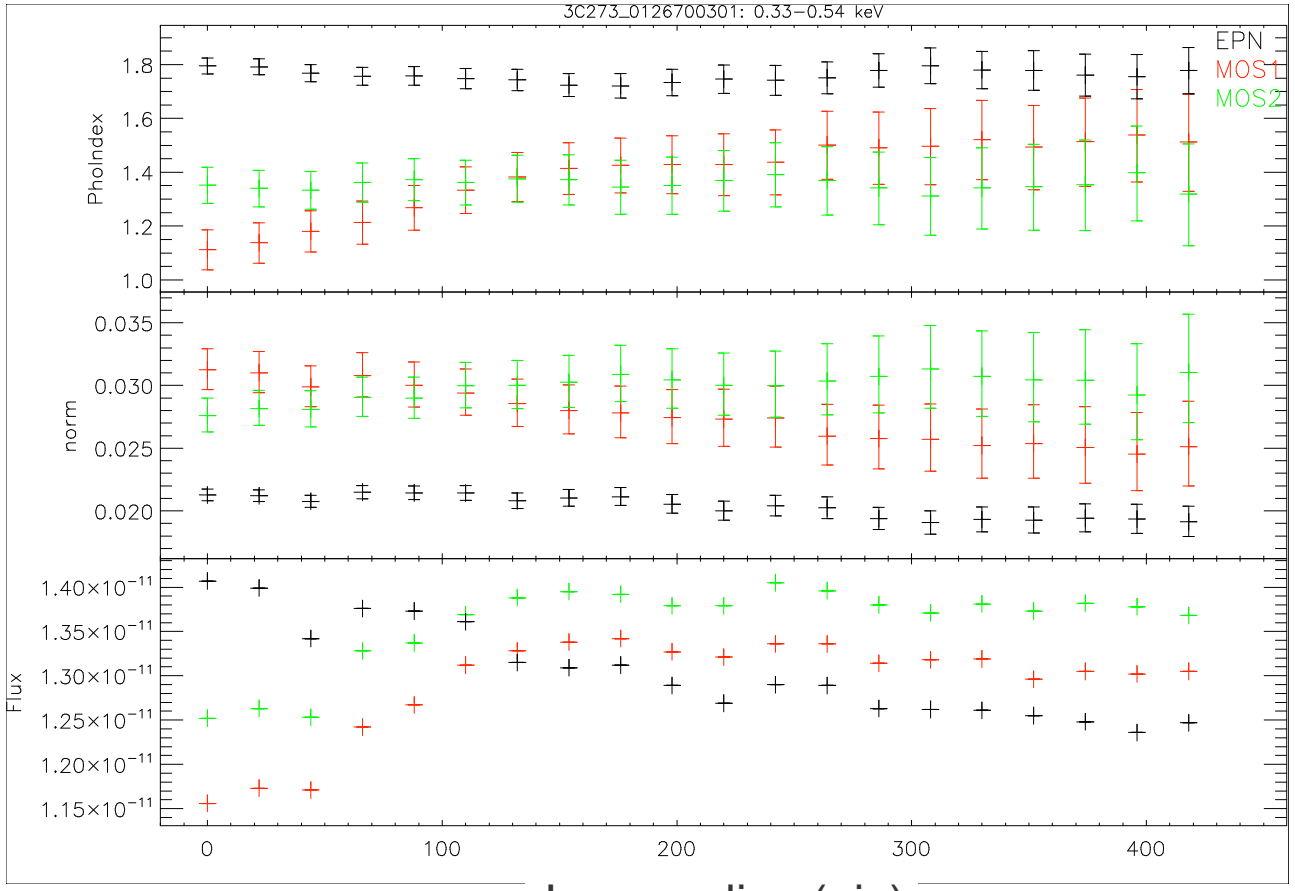
Compare flux returned by different extraction annuli for a set of ‘non-piled-up’ sources.



At various photon energies.

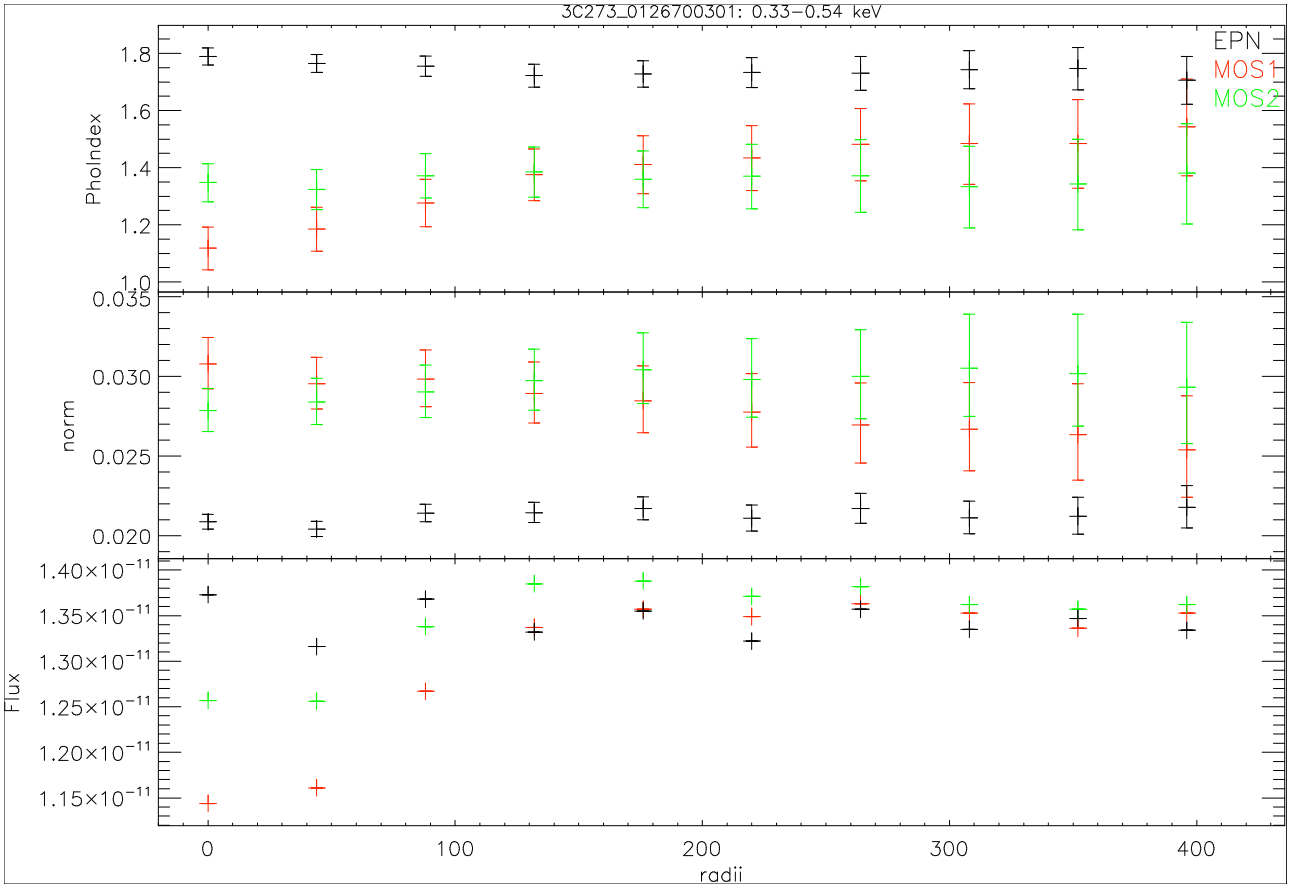
3C273 – flux from annulus of n-40”
350-540 eV

MOS-1
MOS-2
PN



Old CCF - 12

Adjust slope of King function for each camera to “flatten” the parameters

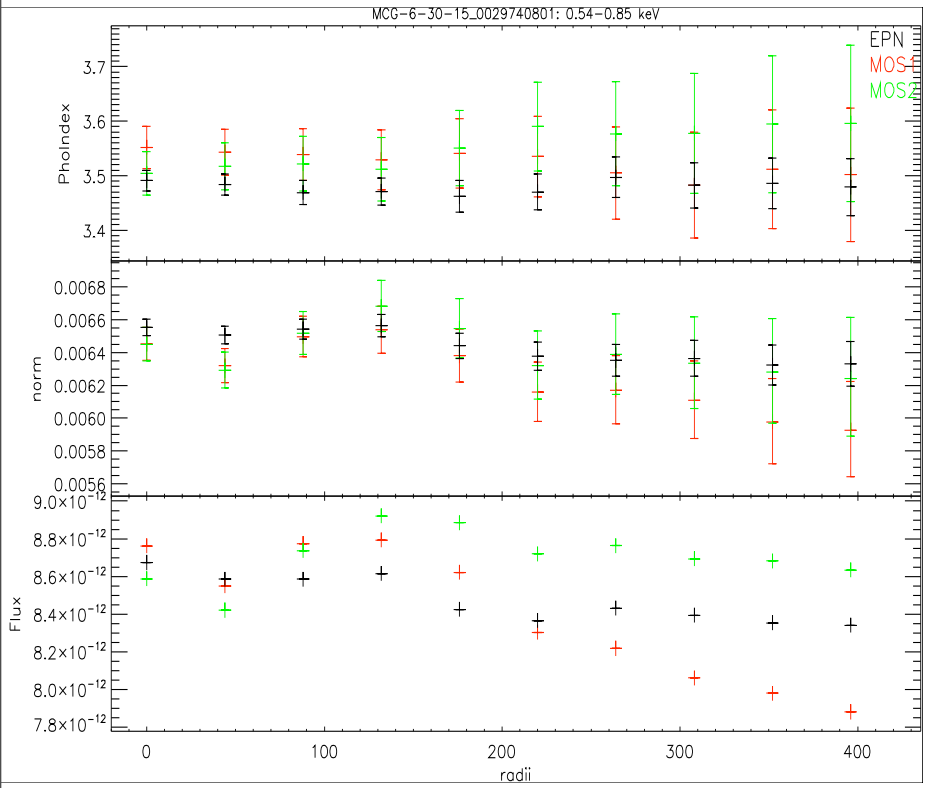


New CCF-14

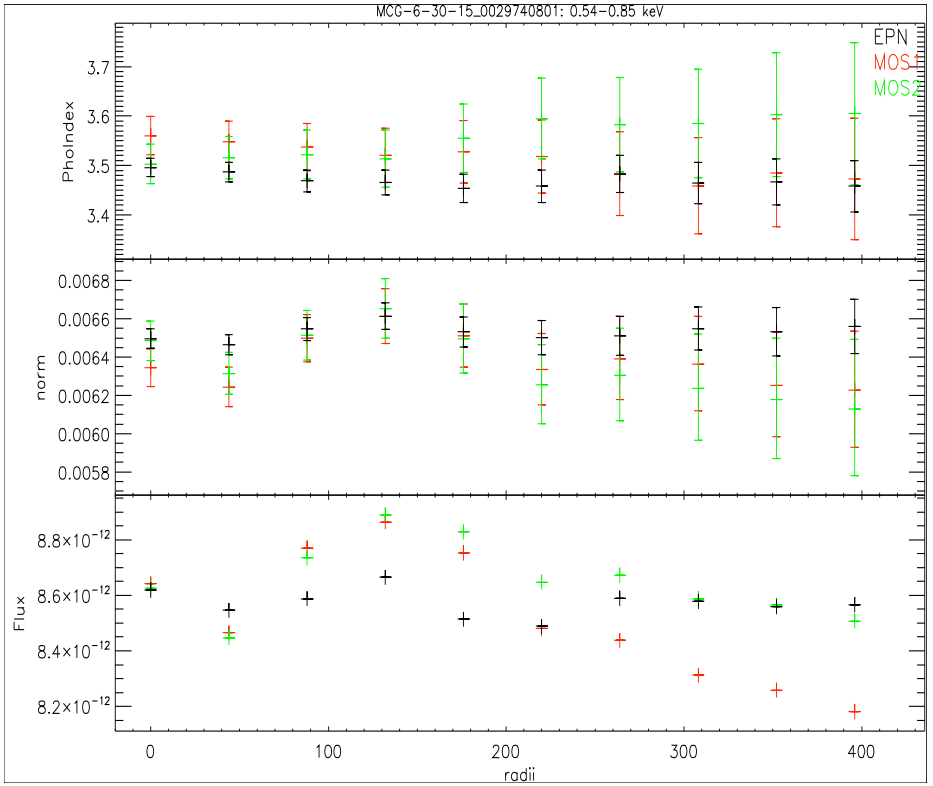
Repeat for many sources

Actually 8

MCG 6-30-15 : 0.54 - 0.85 keV

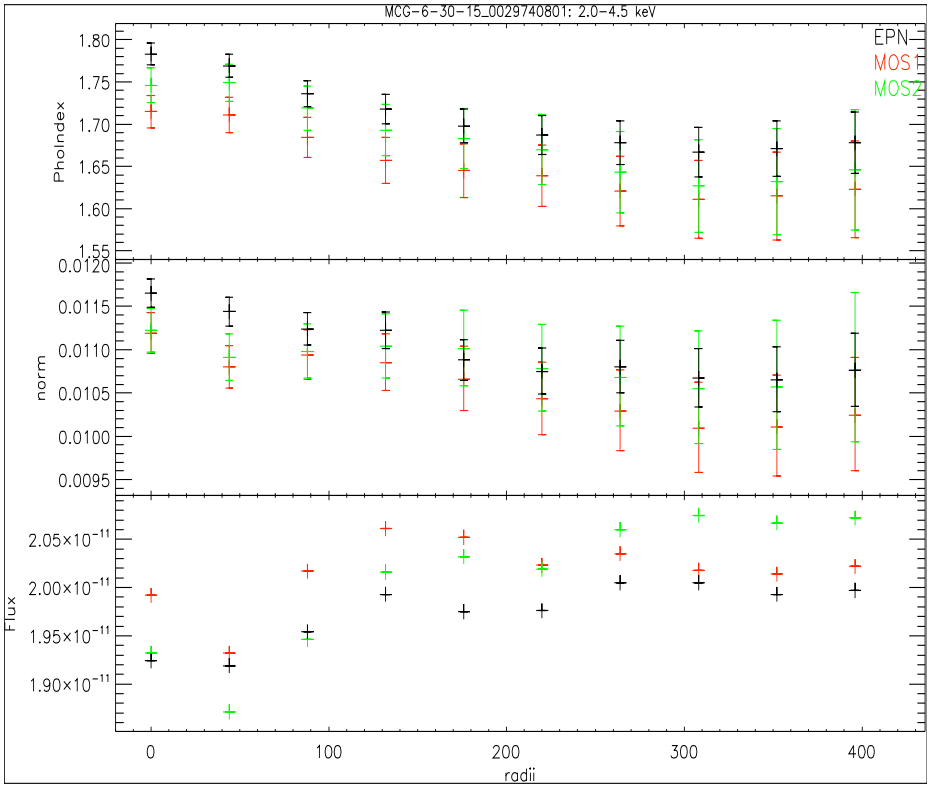


CCF 12

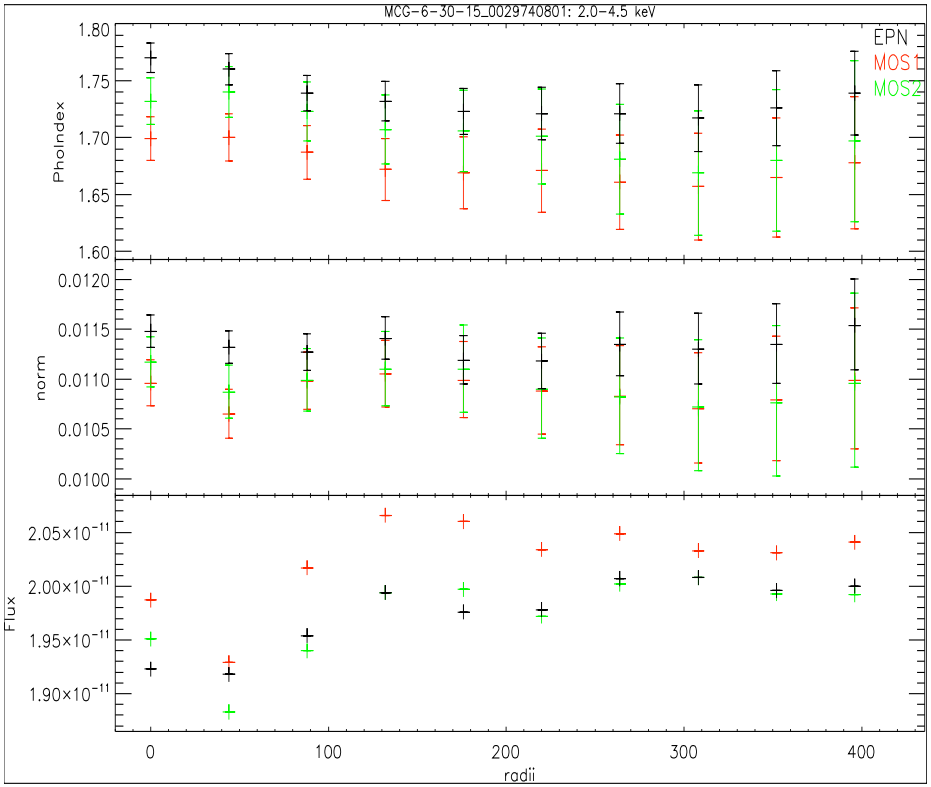


CCF 14

MCG 6-30-15 : 2 – 4.5 keV

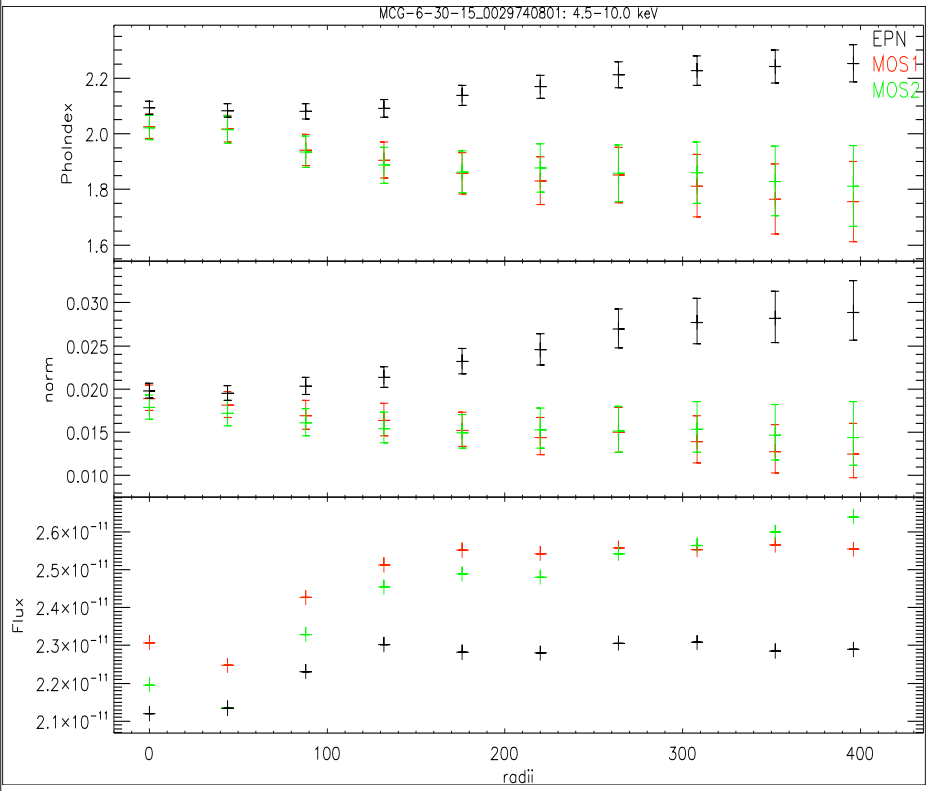


CCF 12

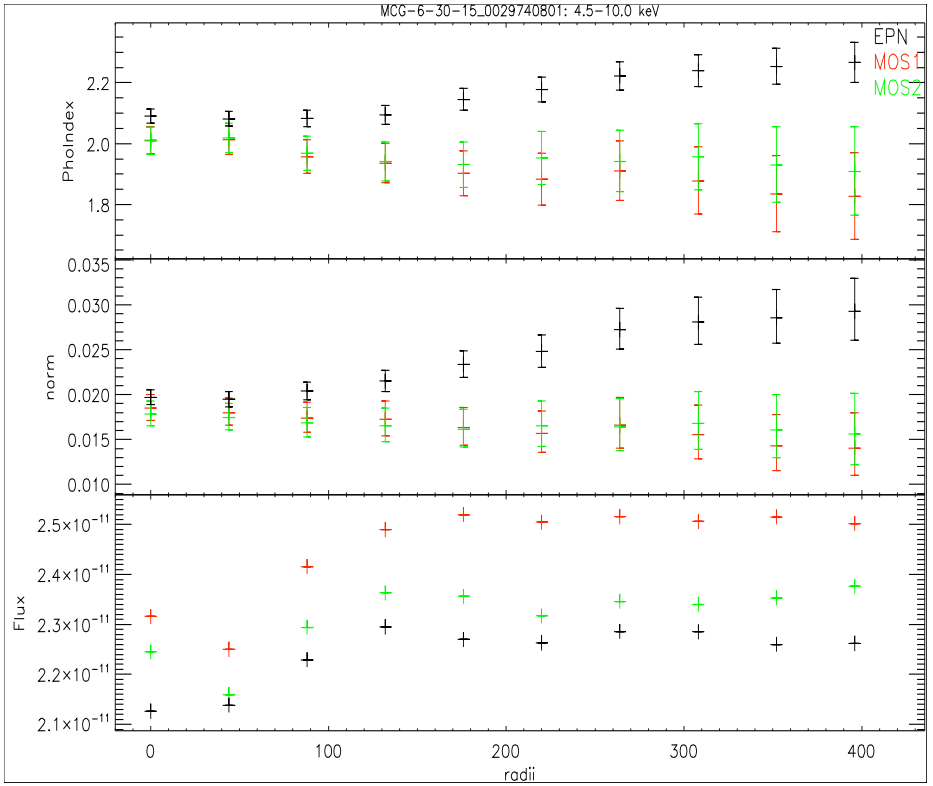


CCF 14

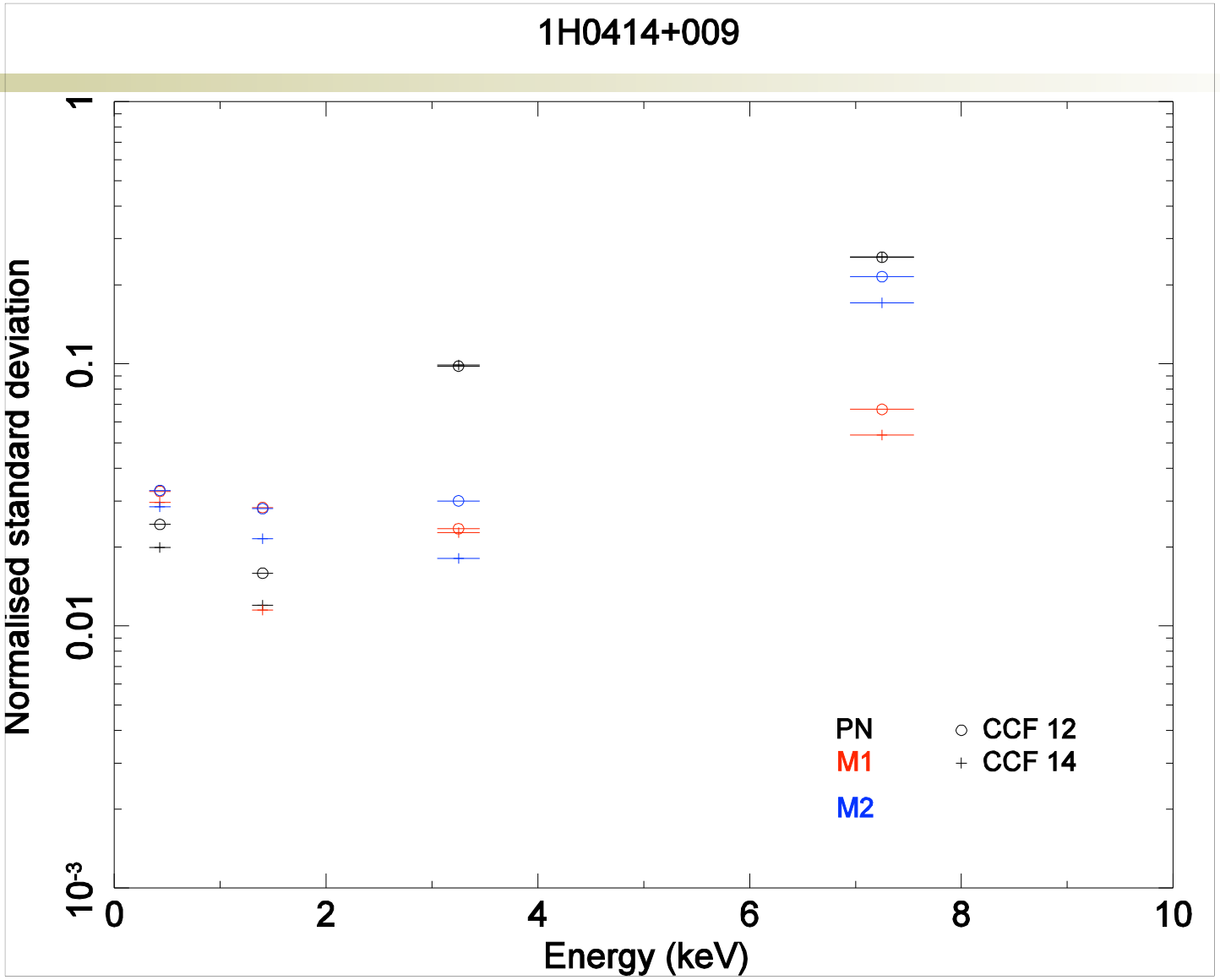
MCG 6-30-15 : 4.5 - 10 keV

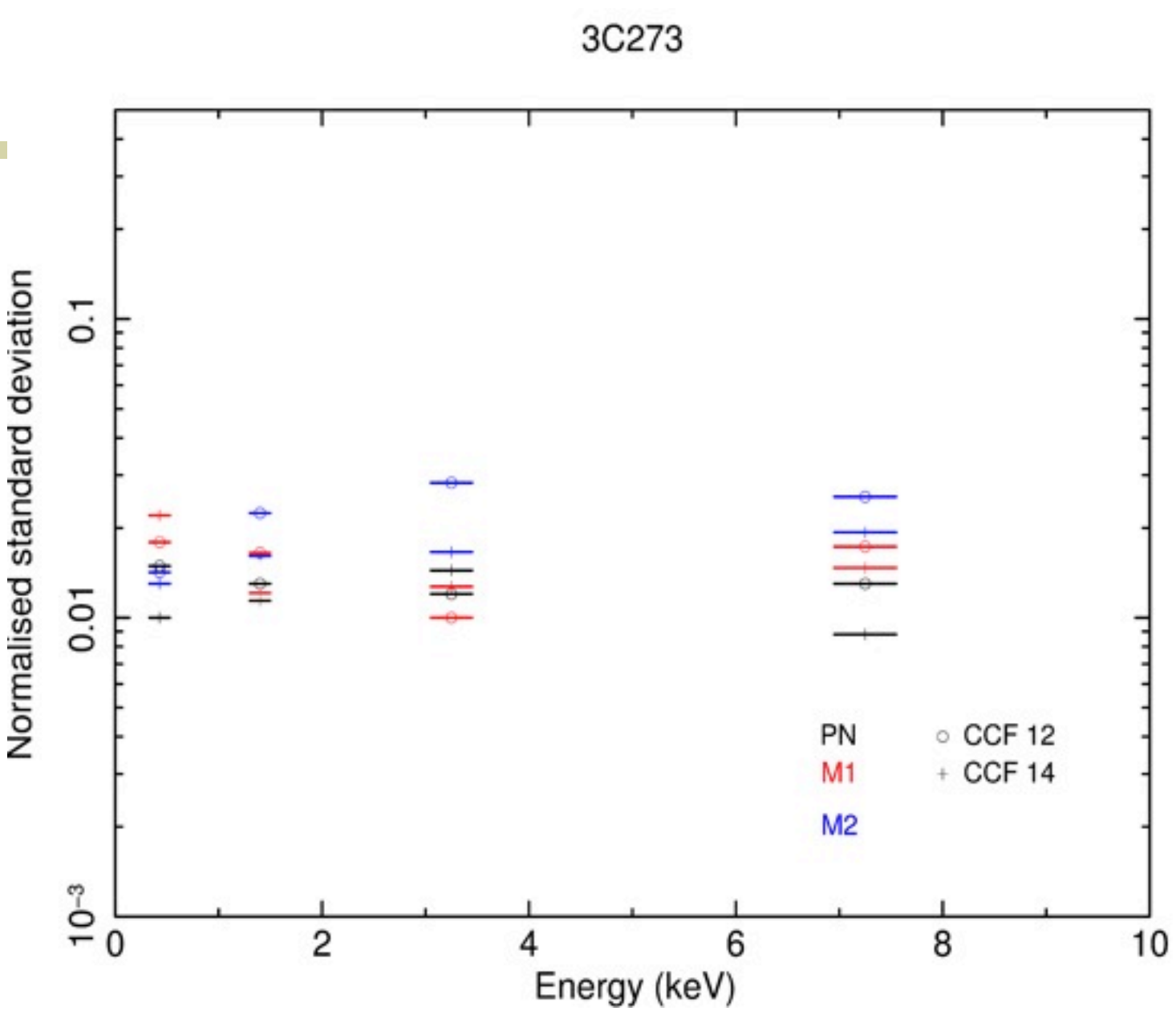


CCF 12



CCF 14


1H0414+009
Normalised standard deviation
1
0.1
0.01
10-3
0
2
4
6
8
10
Energy (keV)
PN
M1
M2
CCF 12
CCF 14


3C273
Normalised standard deviation
0.1
0.01
10^{-3}
0
2
4
6
8
10
Energy (keV)
PN
M1
M2
CCF 12
CCF 14

Sanity Checks

On-axis EE comparison - CCF12 (%)

	MOS-1		MOS-2		PN	
	1 keV	8 keV	1 keV	8 keV	1 keV	8 keV
0-15”	-2	+14	+3	+10	-7	+7
0-30”	-2	+8	+2	+6	-4	+4
5-60”	+2	-6	+2	-7	+6	0
15-60”	+3	-24	-4	-22	+14	-13

(EE_ELLBETA - EE_EXTENDED) / EE_EXTENDED

On-axis EE comparison - CCF14 (%)

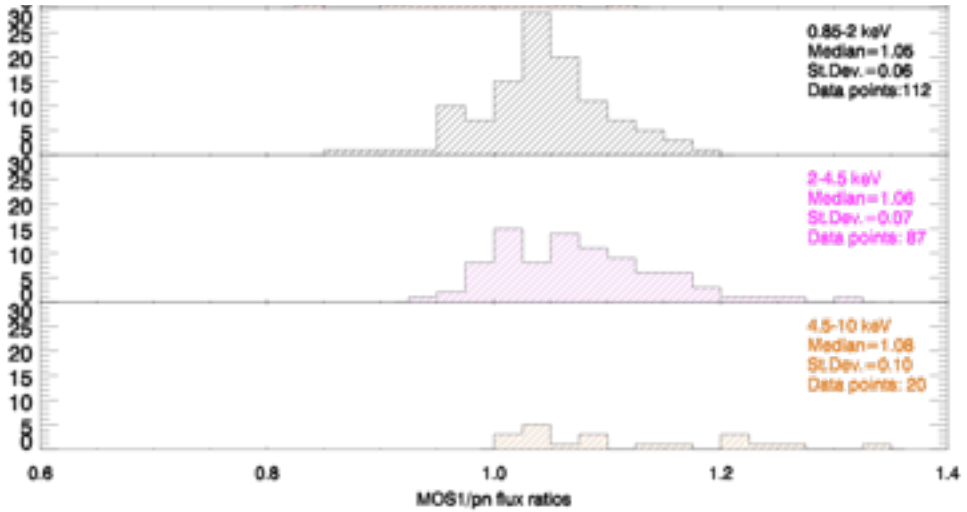
	MOS-1		MOS-2		PN	
	1 keV	8 keV	1 keV	8 keV	1 keV	8 keV
0-15”	-3	+11	-7	+4	+2	+8
0-30”	-3	+7	-5	+2	+1	+5
5-60”	-	-	-	-	-	-
15-60”	-3	-20	+1	-8	-6	-14

(EE_ELLBETA - EE_EXTENDED) / EE_EXTENDED

MOS / PN flux comparison

CCF 12

MOS-1

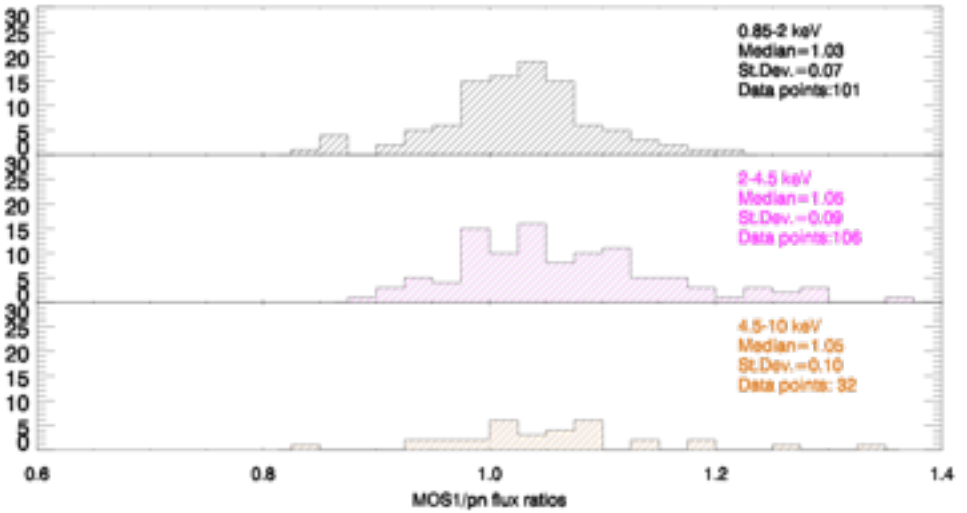


0.85-2 keV, 1.05

2-4.5 keV, 1.06

4.5-10 keV, 1.08

CCF 14



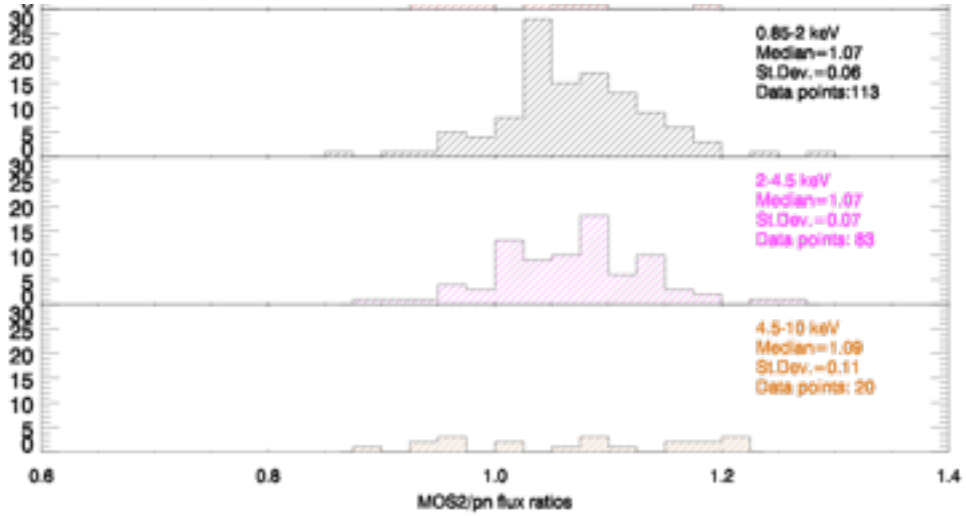
0.85-2 keV, 1.03

2-4.5 keV, 1.06

4.5-10 keV, 1.05

MOS / PN flux comparison

CCF 12



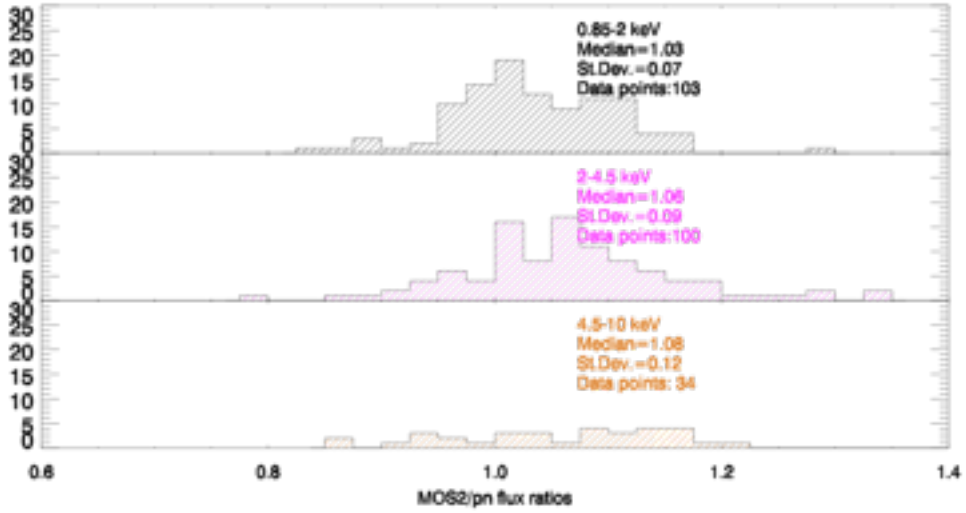
0.85-2 keV, 1.07

2-4.5 keV, 1.07

4.5-10 keV, 1.09

MOS-2

CCF 14

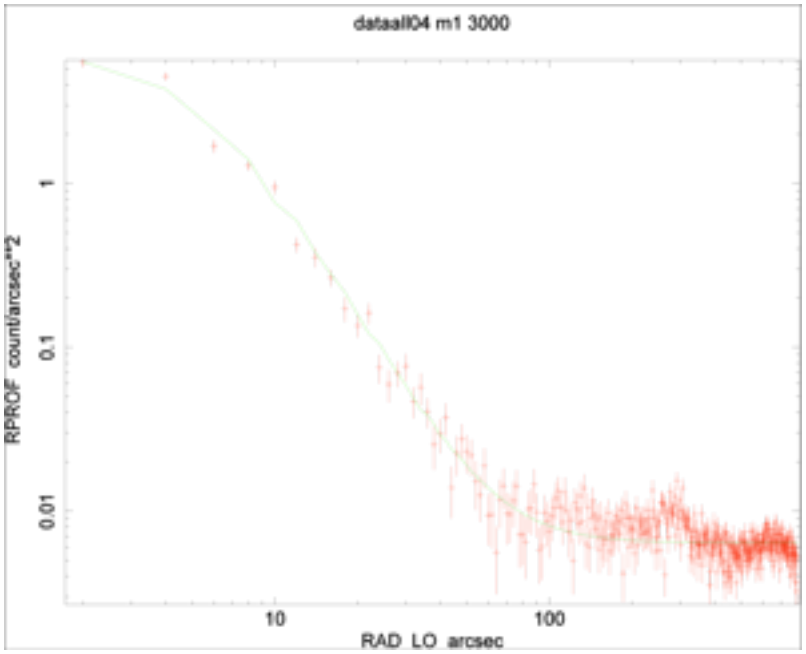


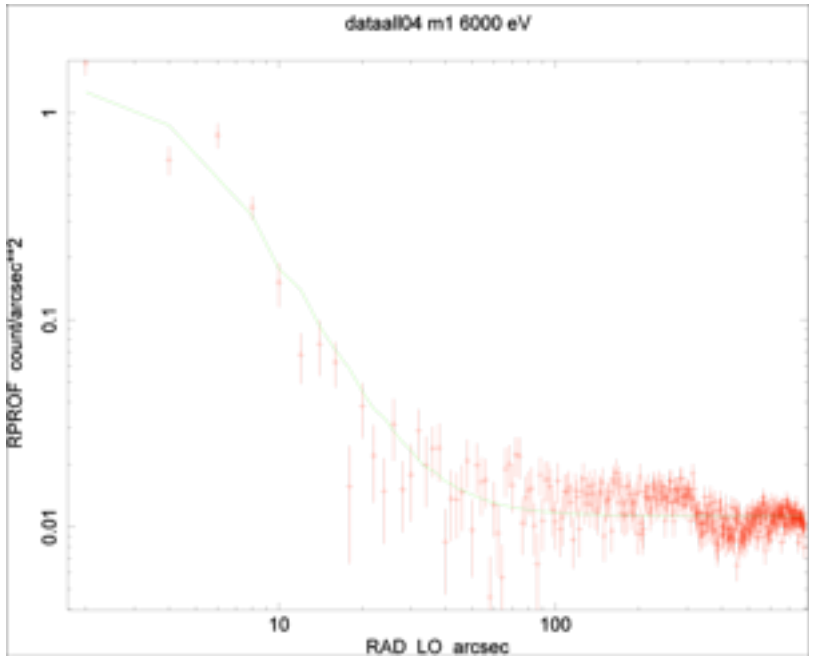
0.85-2 keV, 1.03

2-4.5 keV, 1.06

4.5-10 keV, 1.08

Radial Profiles - RXJ 0156



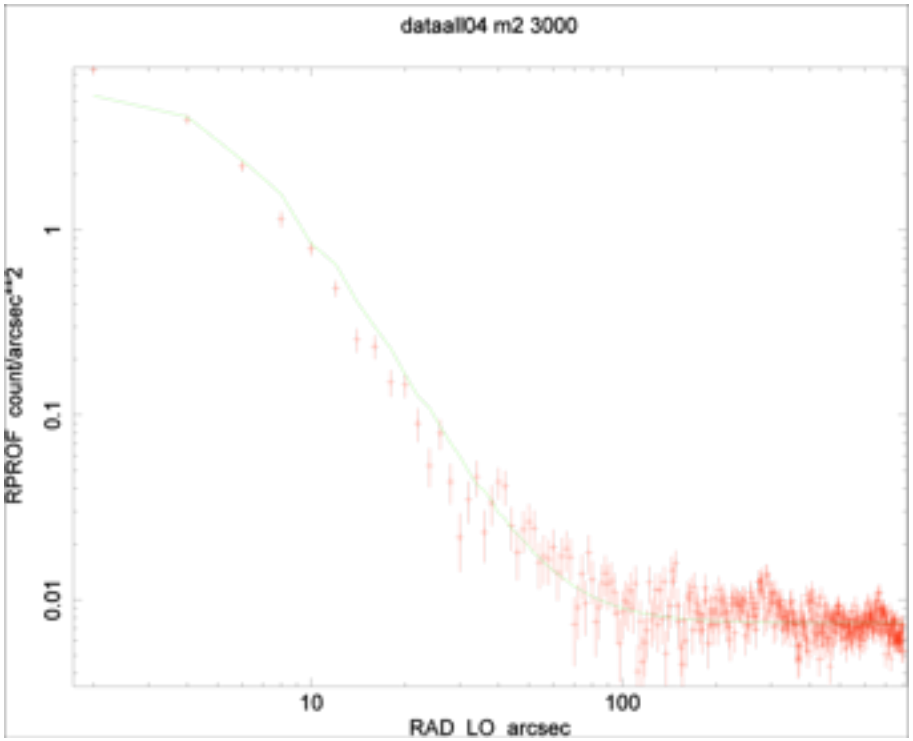


3 keV

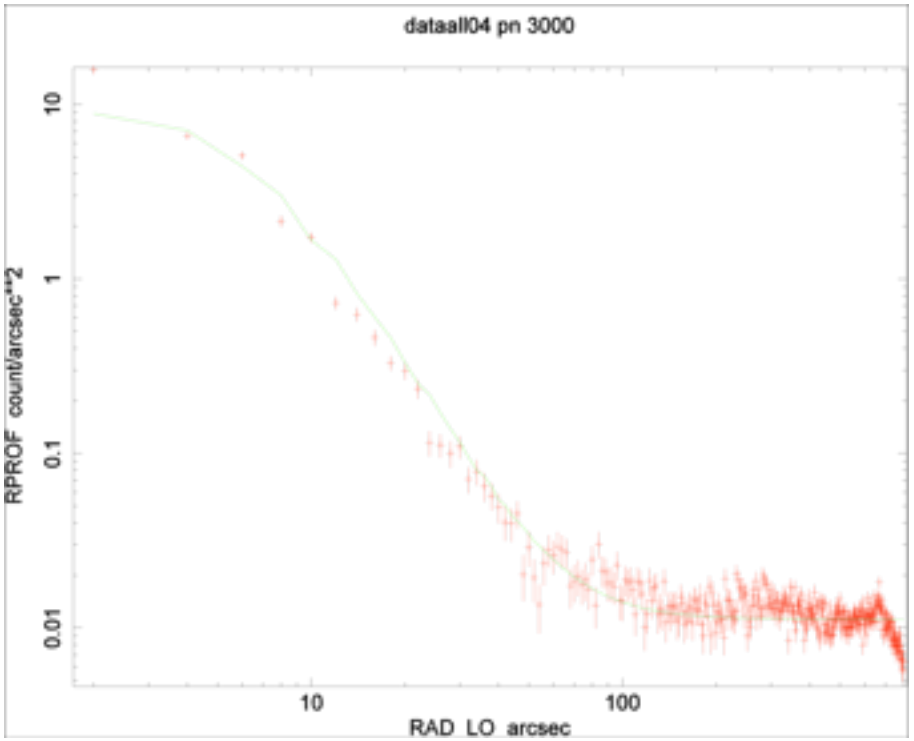
6 keV

MOS 1

Radial Profiles – RXJ 0156

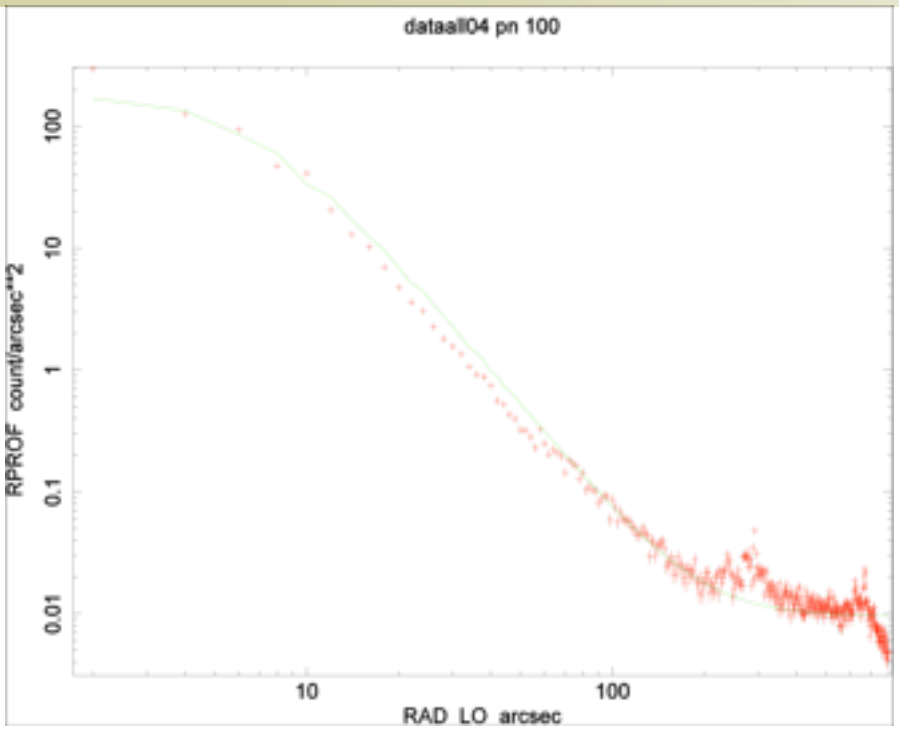


MOS-2 3 keV

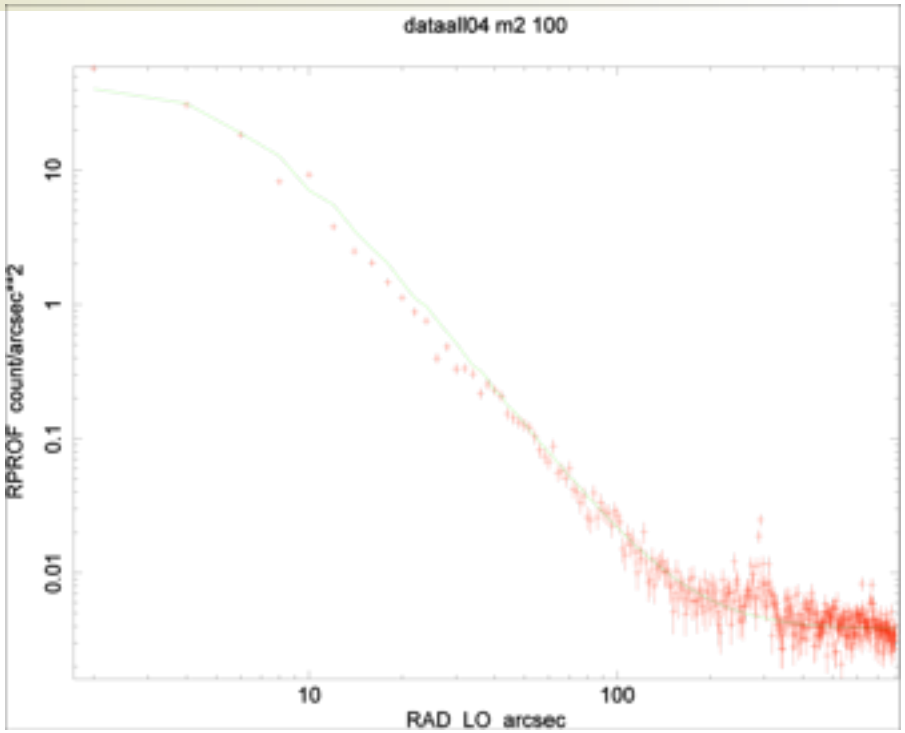


PN 3 keV

Radial Profiles – RXJ 0156

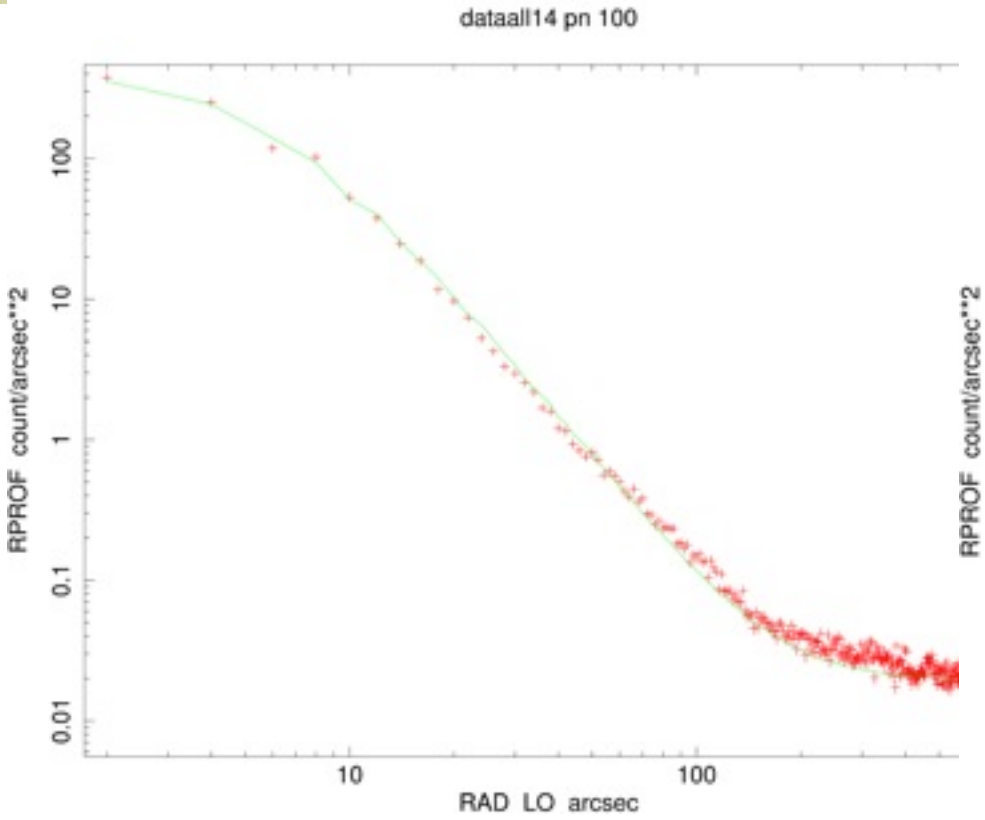


PN 100 eV

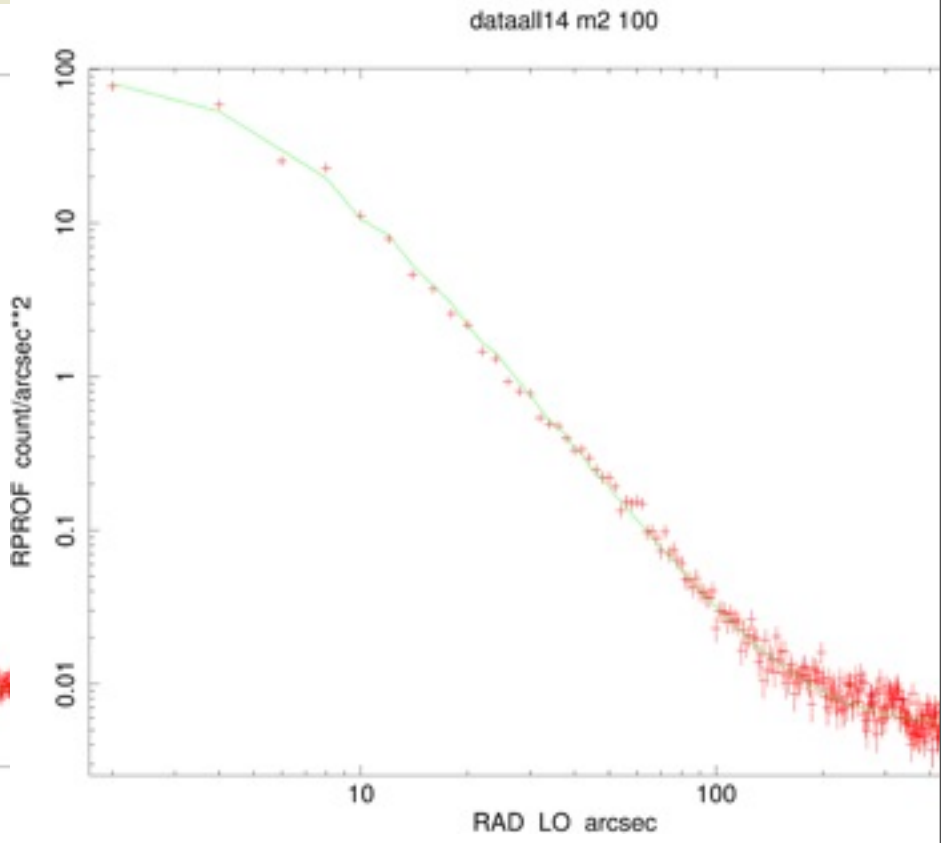


MOS-2 100 eV

Radial Profiles – 1H0707



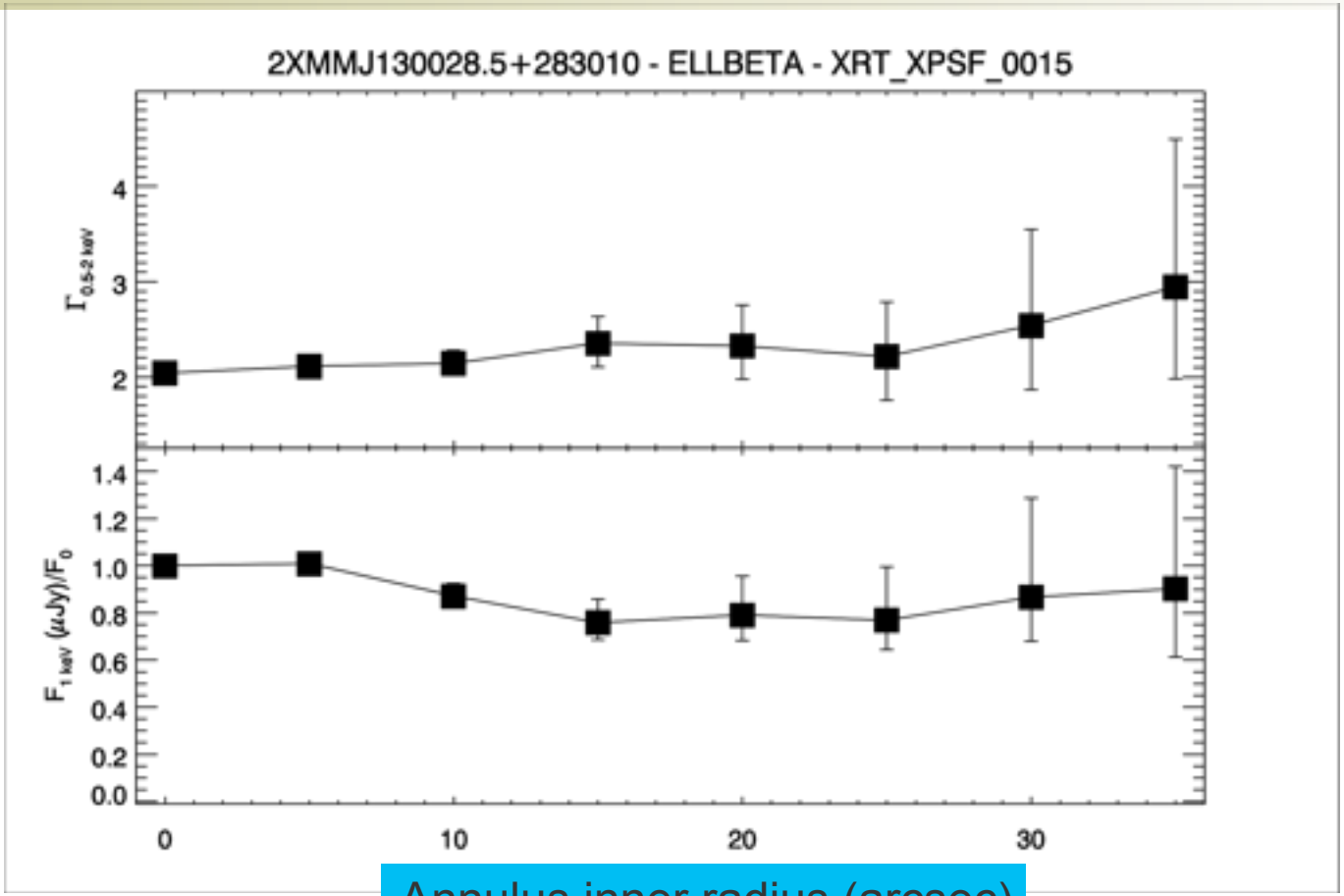
PN 100 eV



MOS-2 100 eV

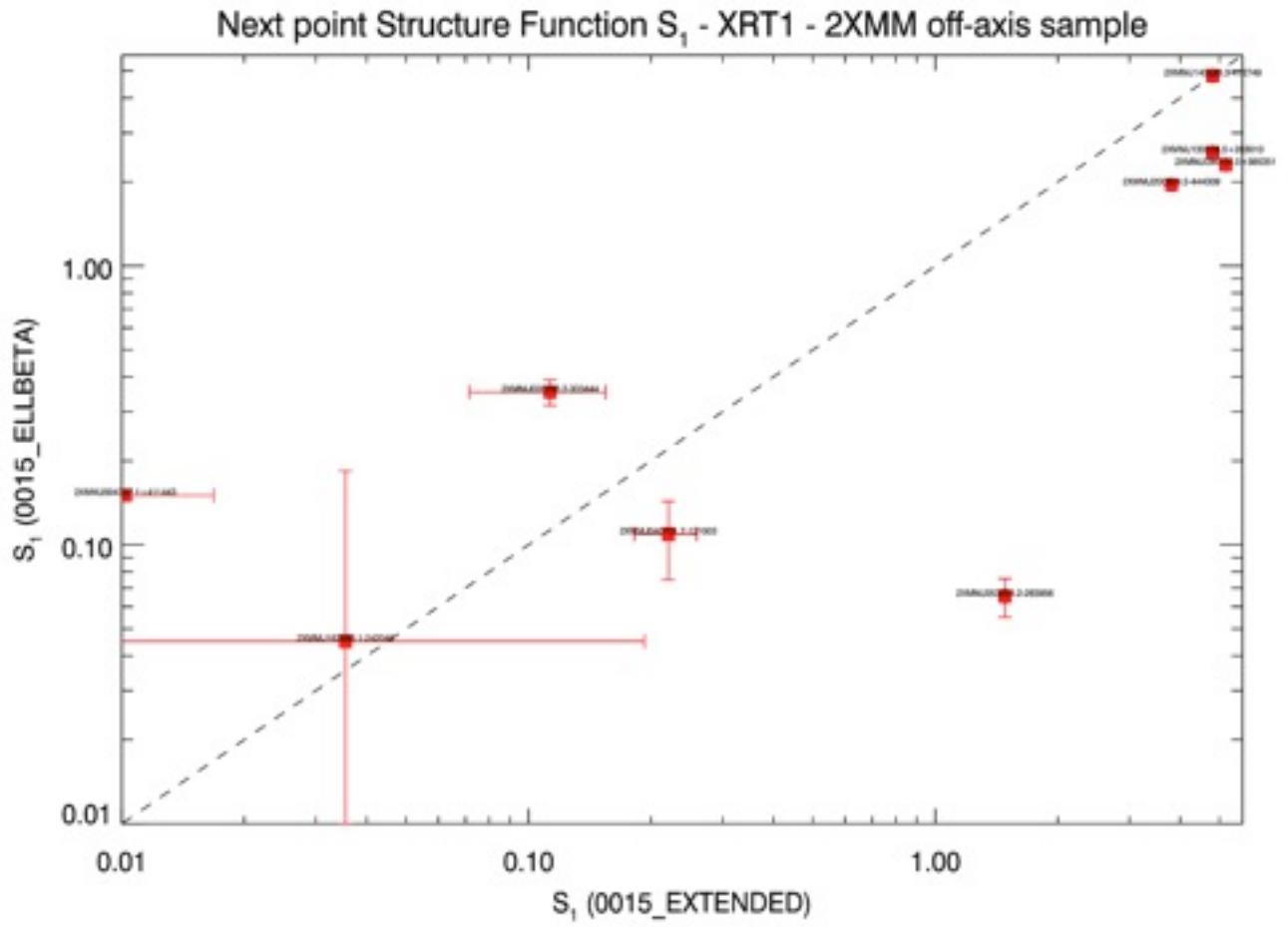
OFF-axis PSF encircled energy

Sources between 5 and 12’ off axis

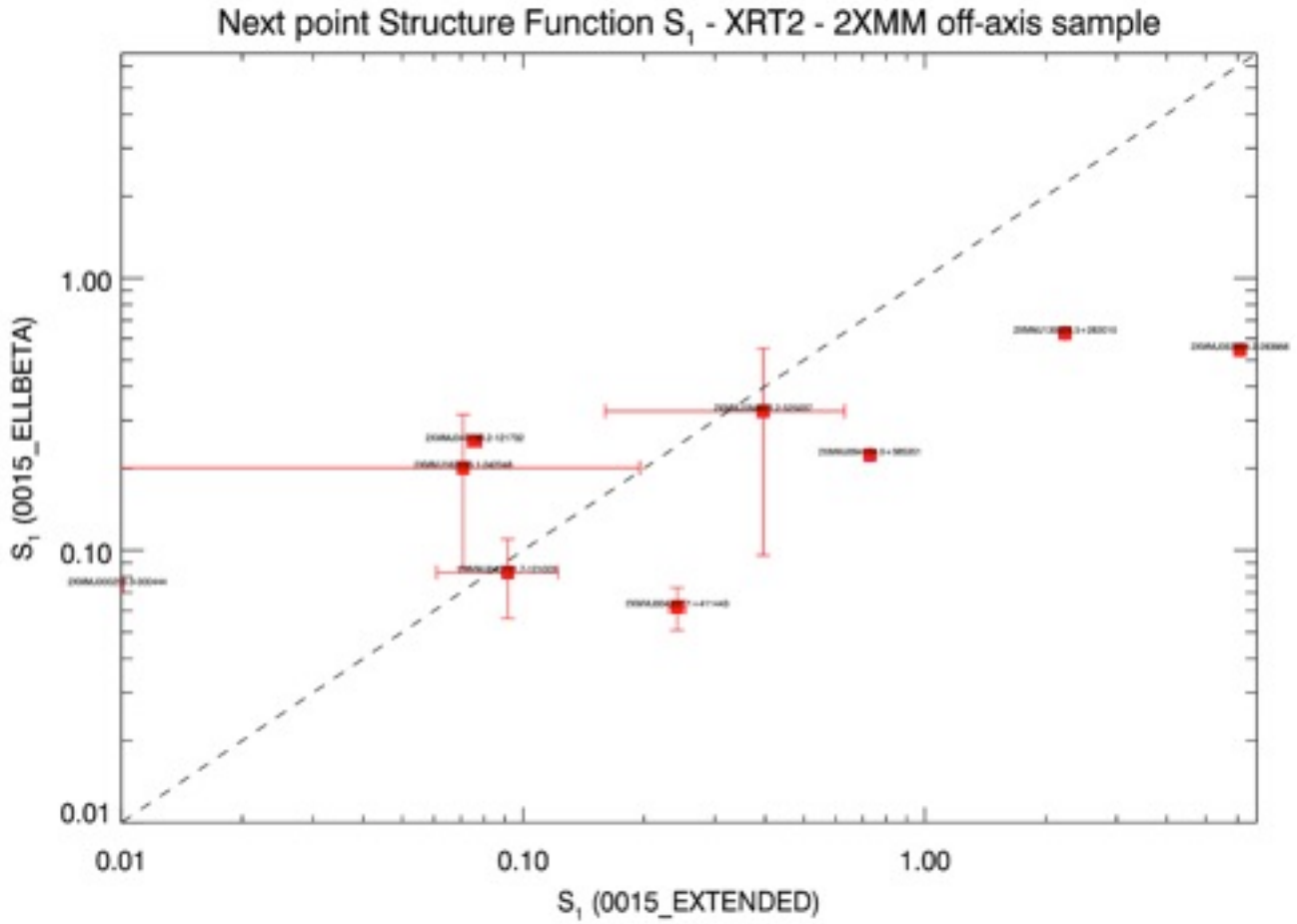


Slope and normalisation for annuli between n and 60””

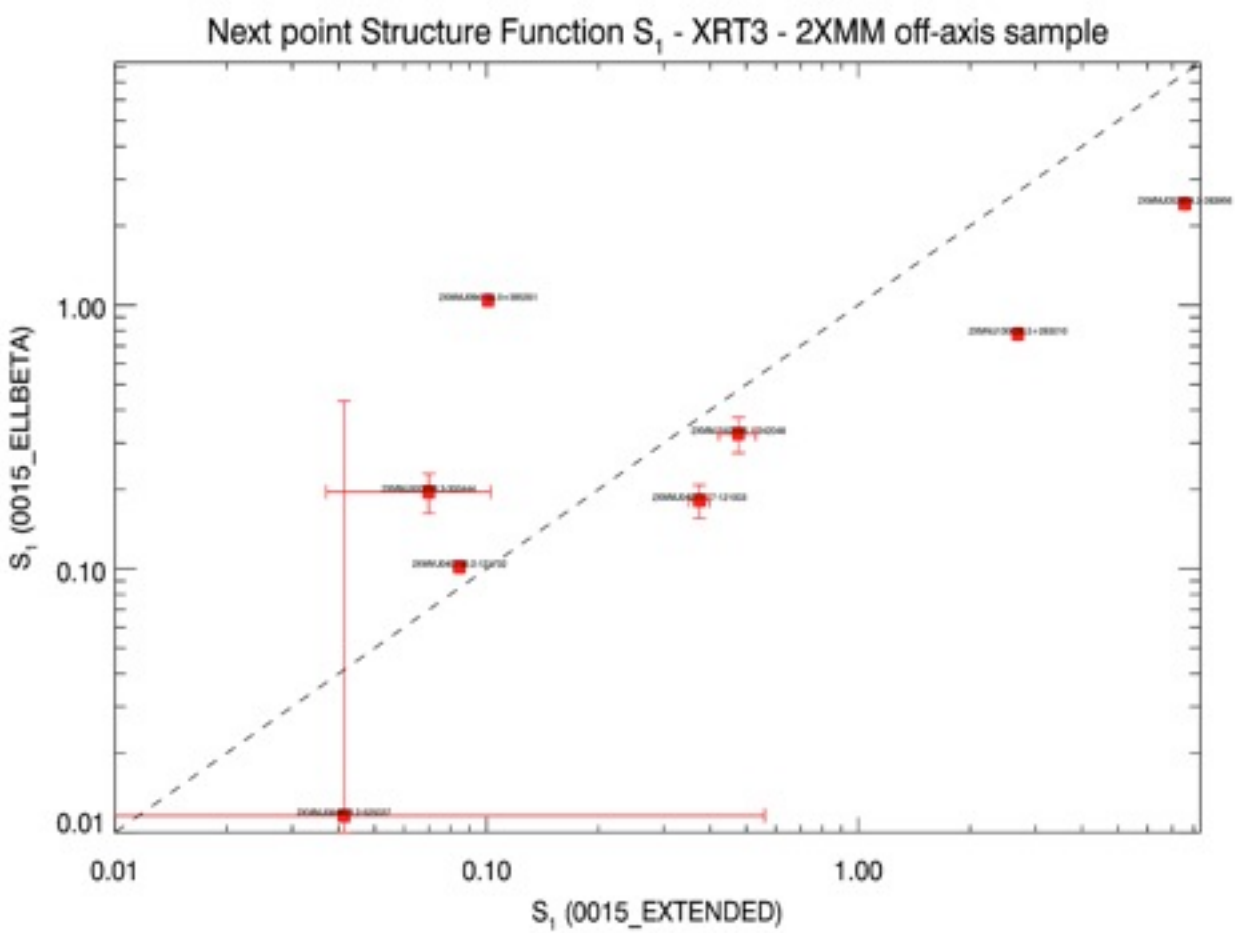
Off-axis structure function - MOS-1



Off-axis structure function - MOS-2



Off-axis structure function - PN

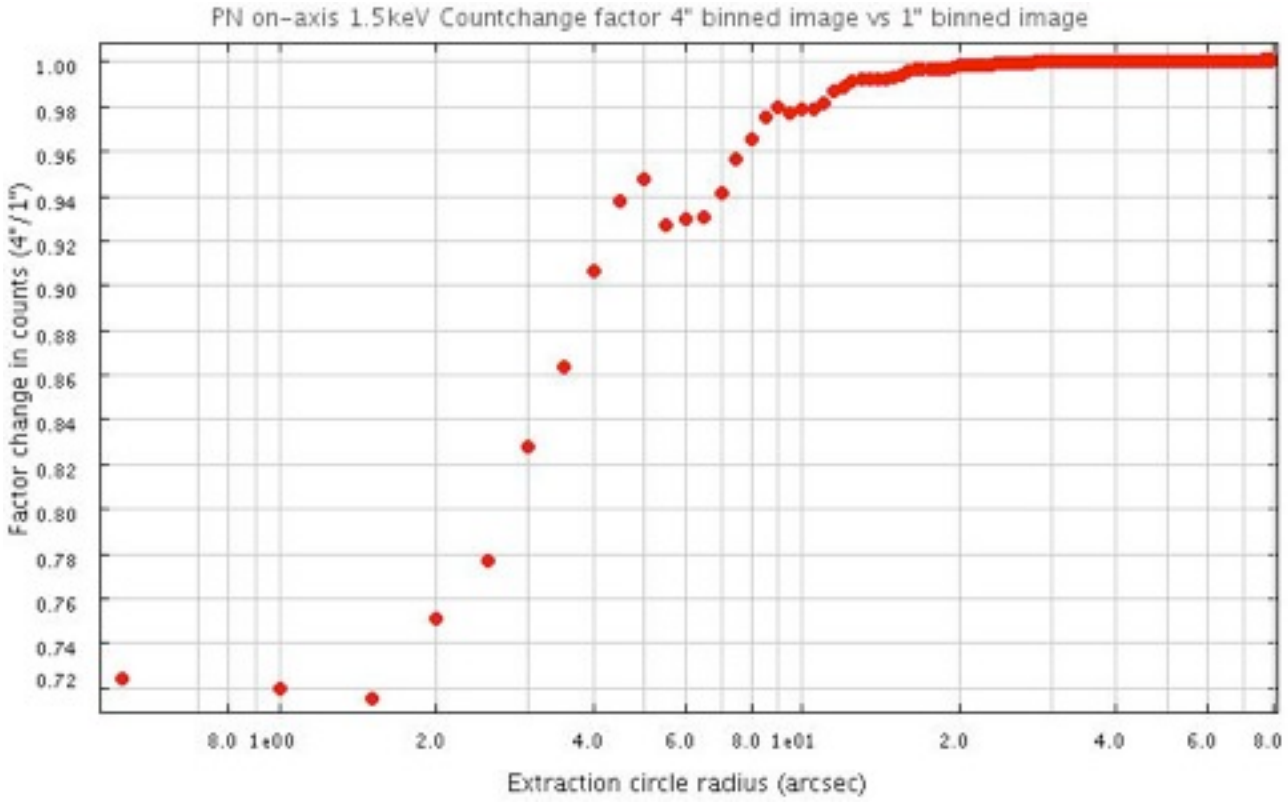


Pixellisation with ELLBETA

	Pixel	0-60”	5-60”	20-60”
	1” pix centres	93.4	67.3	16.6
MOS data extraction	1” pix with 0.05” subpix	93.2	64.5	16.5
	4” pix centres	92.4	66.1	18.2
PN data extraction	4”pix with 0.05” subpix	93.4	68.5	16.9

Arfgen uses the 1” pixel centres at the moment for PN and MOS

Pixellisation with ELLBETA



Effect of 1” v 4” PSF image binning

CCF status

Was XRT1_XPSF_0012, XRT2_XPSF_0012.CCF XRT3_XPSF_0012.CCF

Recently the spoke strength and radial profile have been reworked (see AMR talk)

and

The on-axis King function slopes have now been optimised

Now XRTn_XPSF_0014.CCF

Summary

- On-axis fluxes more or less independent of extraction region.
- Off-axis EE also looking reasonable but sparsity of data
- Fairly consistent with current circular King profile model - larger differences at high energies especially for annuli
- Will change the PN / MOS cross-calibration by up to 10% (depending on extraction region) at all energies.
- Spokes reasonable approximation of reality.