# MOS/pn cross-calibration in hard X-ray band

•Comparison between MOS and pn in 3-10 keV band
(no instrumental edges)
•Bright source with hard spectrum

| Source | Rev. | Obsid | Mode | Exp (ks) | Region (arcsec) |
|---|---|---|---|---|---|
| 3C273 (a) | 0277 | 0136550101 | SW | 43 | 5-40 |
| 3C273 (b) | 0277 | 0136550101 | SW | 45 | 5-40 |

•Aim is to compare MOS and pn spectra with all corrections taken into account (CTI, EEF and vignetting effects etc.)

All encircled energy corrections have been made using data in CCF

pn latest CTI correction → SAS 5.3
response matrices → version 6.2

MOS CTI correction → SAS 5.2 (latest is SAS 5.3, $\Delta\Gamma \sim -0.03$)
response matrices → q20 and q21

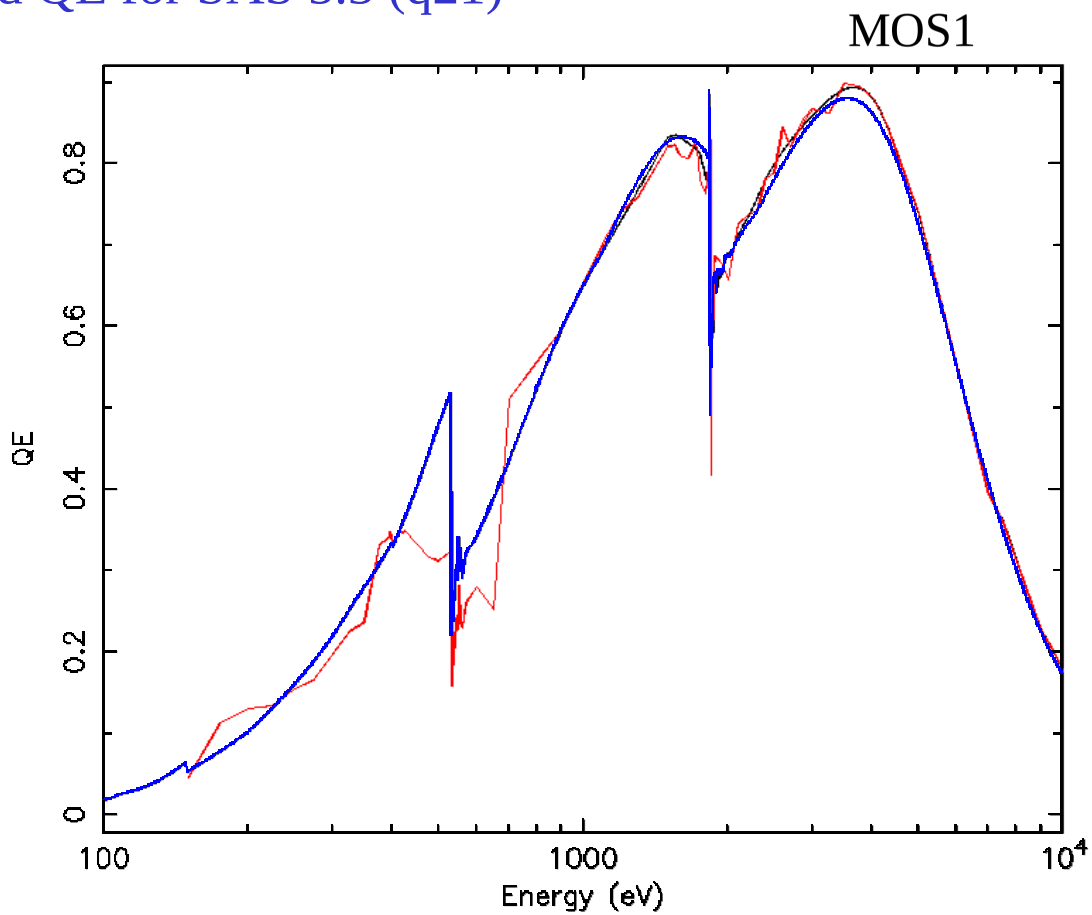
Simple power-law model used

# MOS effective area issues

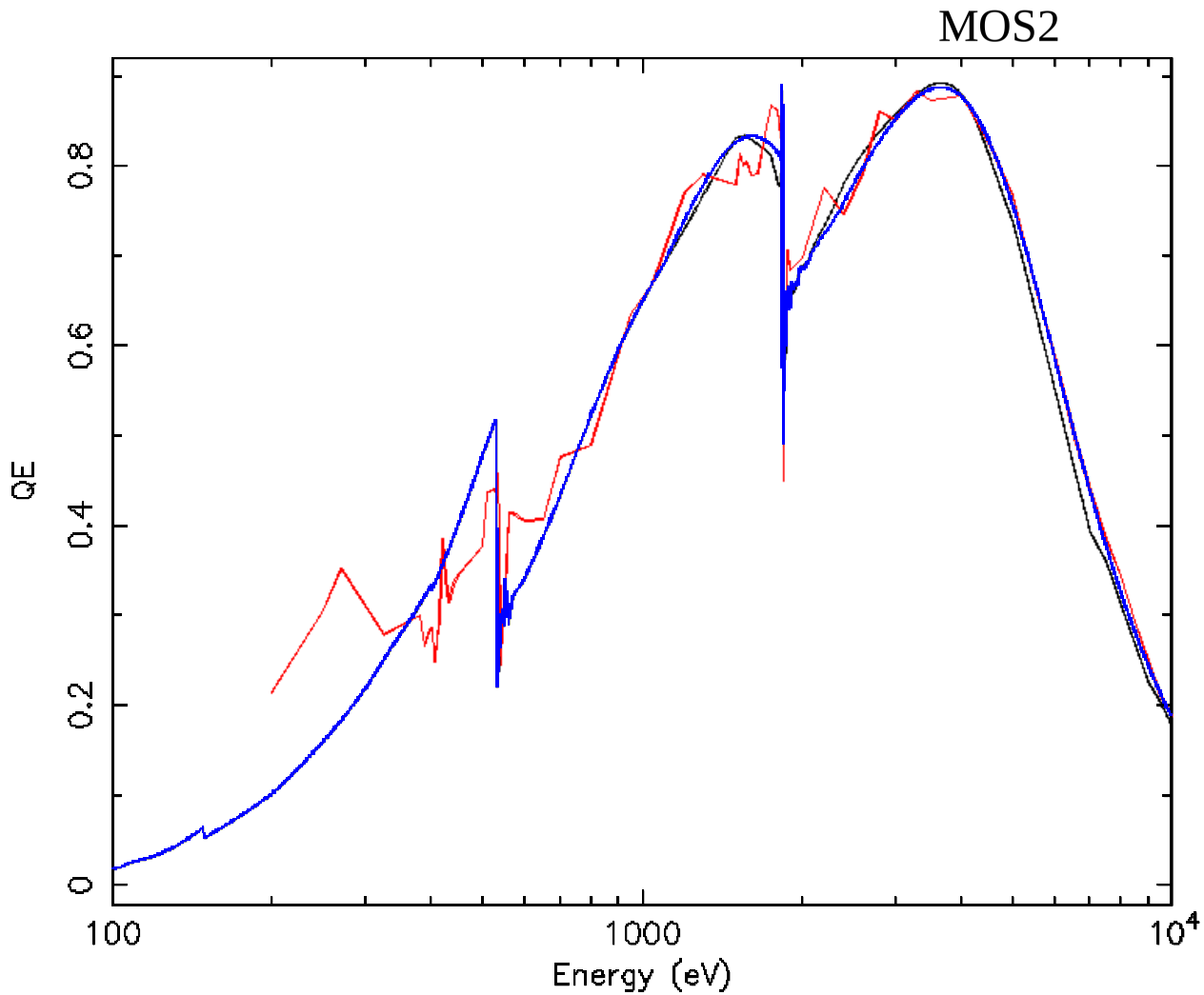
Current matrices: m<1/2>_<filter>v9q20t5r6_all_15.rsp

=> MOS1 and MOS2 QE identical

Proposed QE for SAS 5.3 (q21)



# Proposed QE for SAS 5.3 (q21)

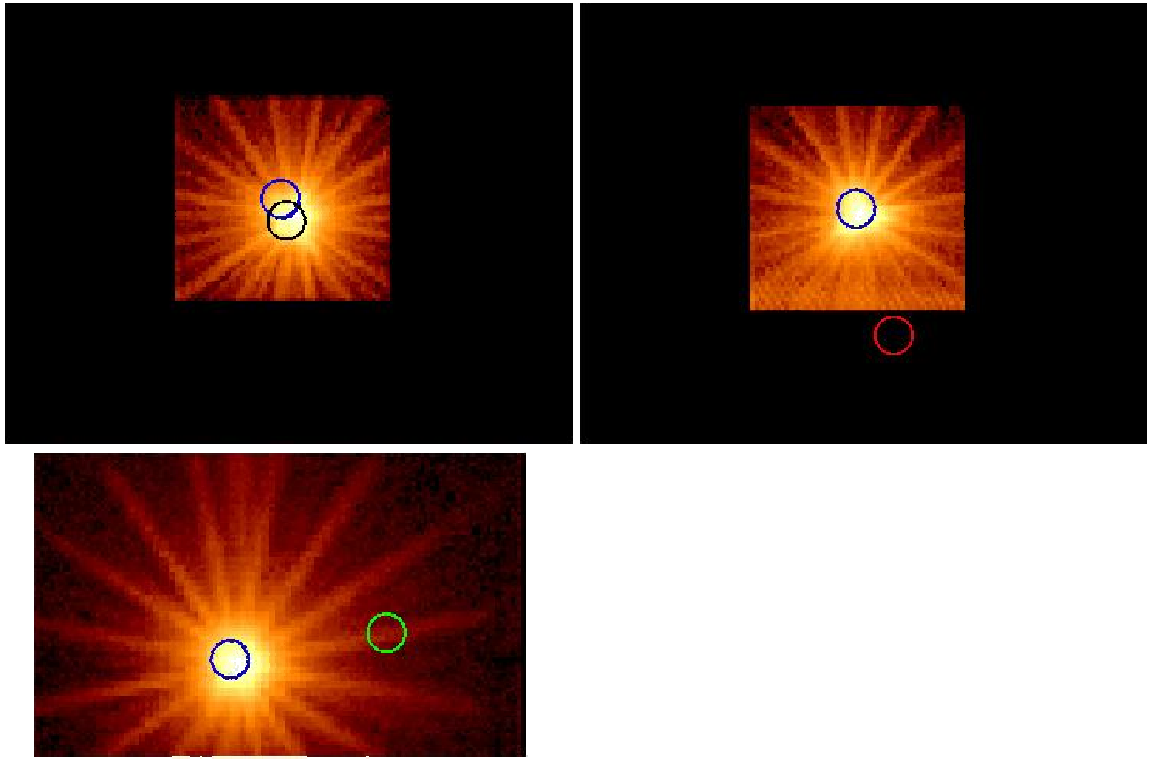


Recently Dave Lumb suggested vignetting corrections required for "on-axis" observations of MOS2 and pn

Blue – (DETX,DETY) = (0,0)

Black – MOS1 optical axis, Red – MOS2 optical axis,

Green – pn optical axis

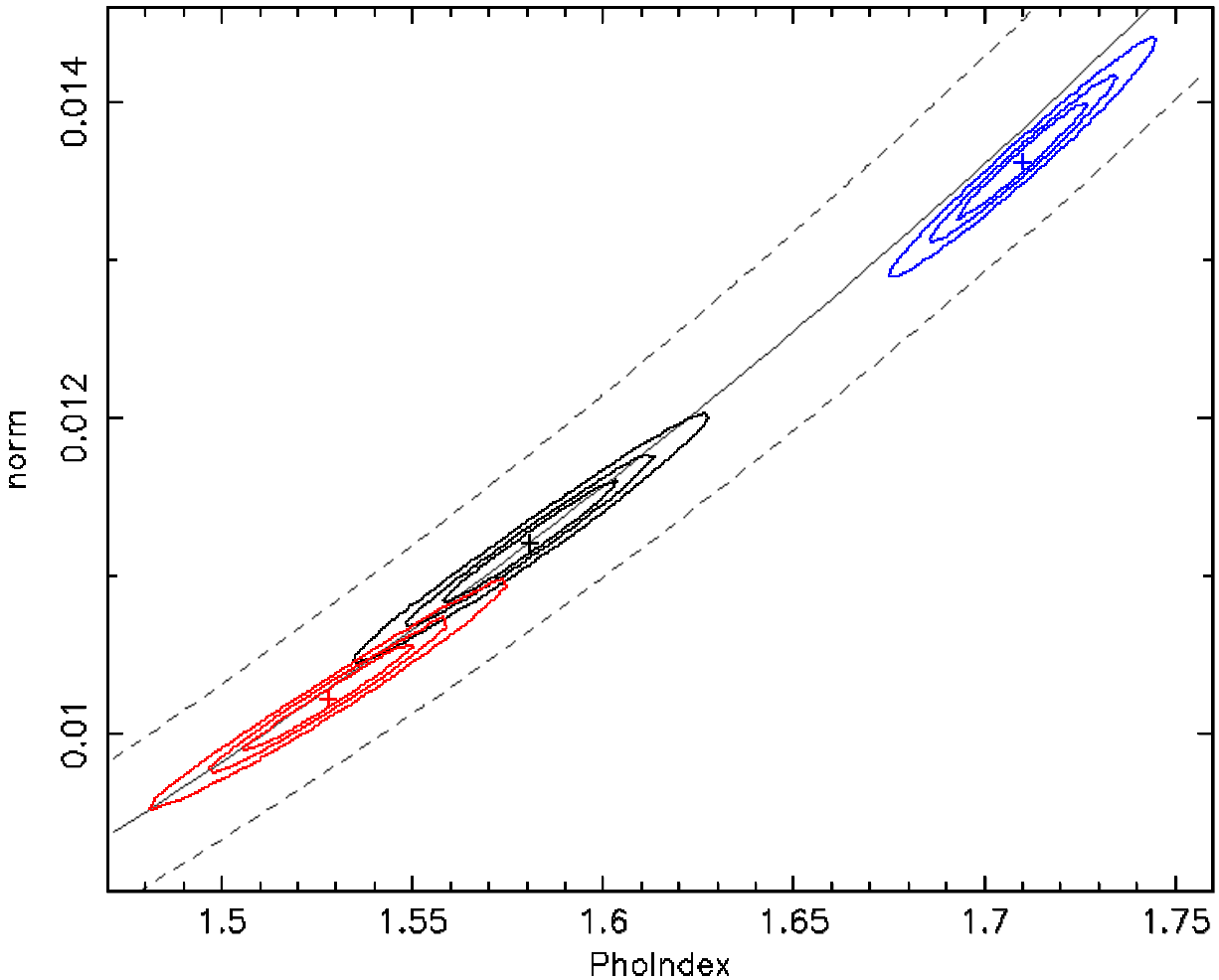


| | | | Best fit Γ (± 0.01) | | |
|---|---|---|---|---|---|
| Response MOS/pn | Correction | Source | MOS1 | MOS2 | pn |
| q20/6.2 | none | 3C273 (a) | 1.58 | 1.53 | 1.71 |
| | | 3C273 (b) | 1.59 | 1.57 | 1.74 |
| q20/6.2 | EEF only | 3C273 (a) | 1.45 | 1.41 | 1.71 |
| | | 3C273 (b) | 1.46 | 1.45 | 1.74 |
| q21/6.2 | none | 3C273 (a) | 1.60 | 1.63 | 1.71 |
| | | 3C273 (b) | 1.61 | 1.67 | 1.74 |
| q21/6.2 | EEF + vignetting | 3C273 (a) | 1.47 | 1.50 | 1.67 |
| | | 3C273 (b) | 1.48 | 1.54 | 1.70 |

**MOS1 ΔΓ ~ -0.13 MOS2 ΔΓ ~ -0.12 pn ΔΓ ~ 0.0**
**MOS1 ΔΓ ~ +0.02 MOS2 ΔΓ ~ +0.10 pn ΔΓ ~ 0.0**
**MOS1 ΔΓ ~ -0.11 MOS2 ΔΓ ~ -0.03 pn ΔΓ ~ -0.04**

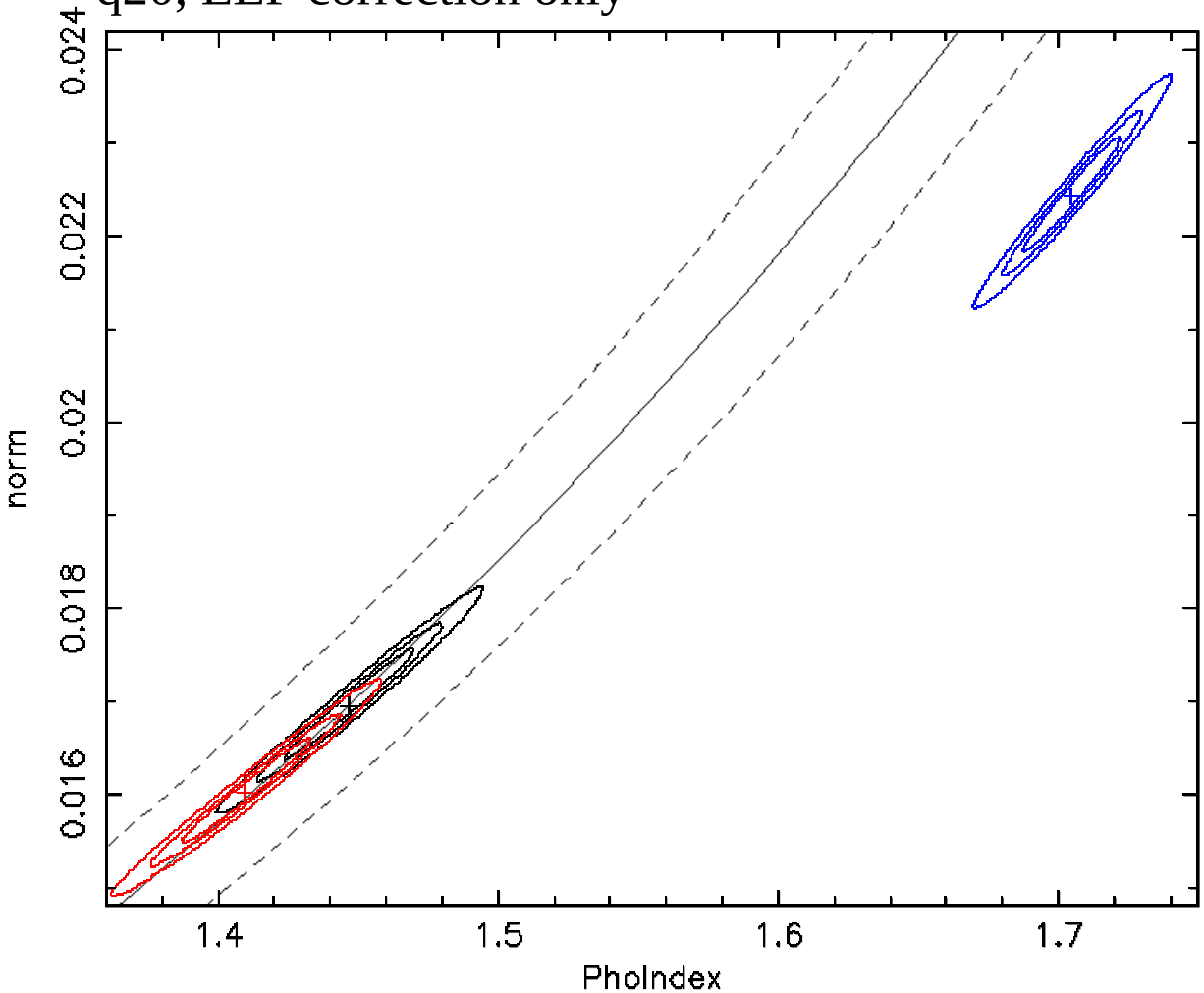
3C273 (a) MOS1 – black, MOS2 – red, pn - blue

q20, no correction



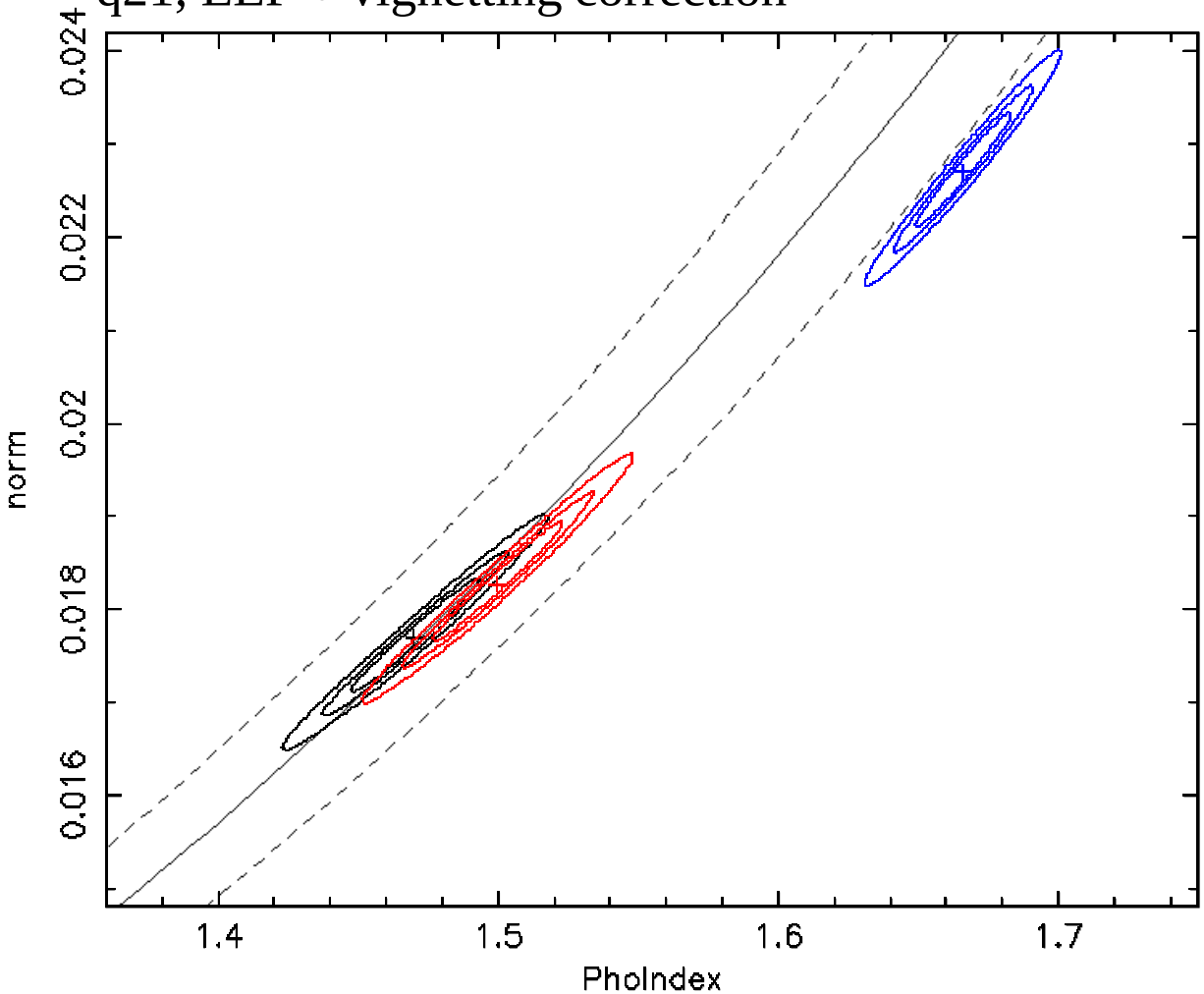
3C273 (a) MOS1 – black, MOS2 – red, pn - blue

q20, EEF correction only



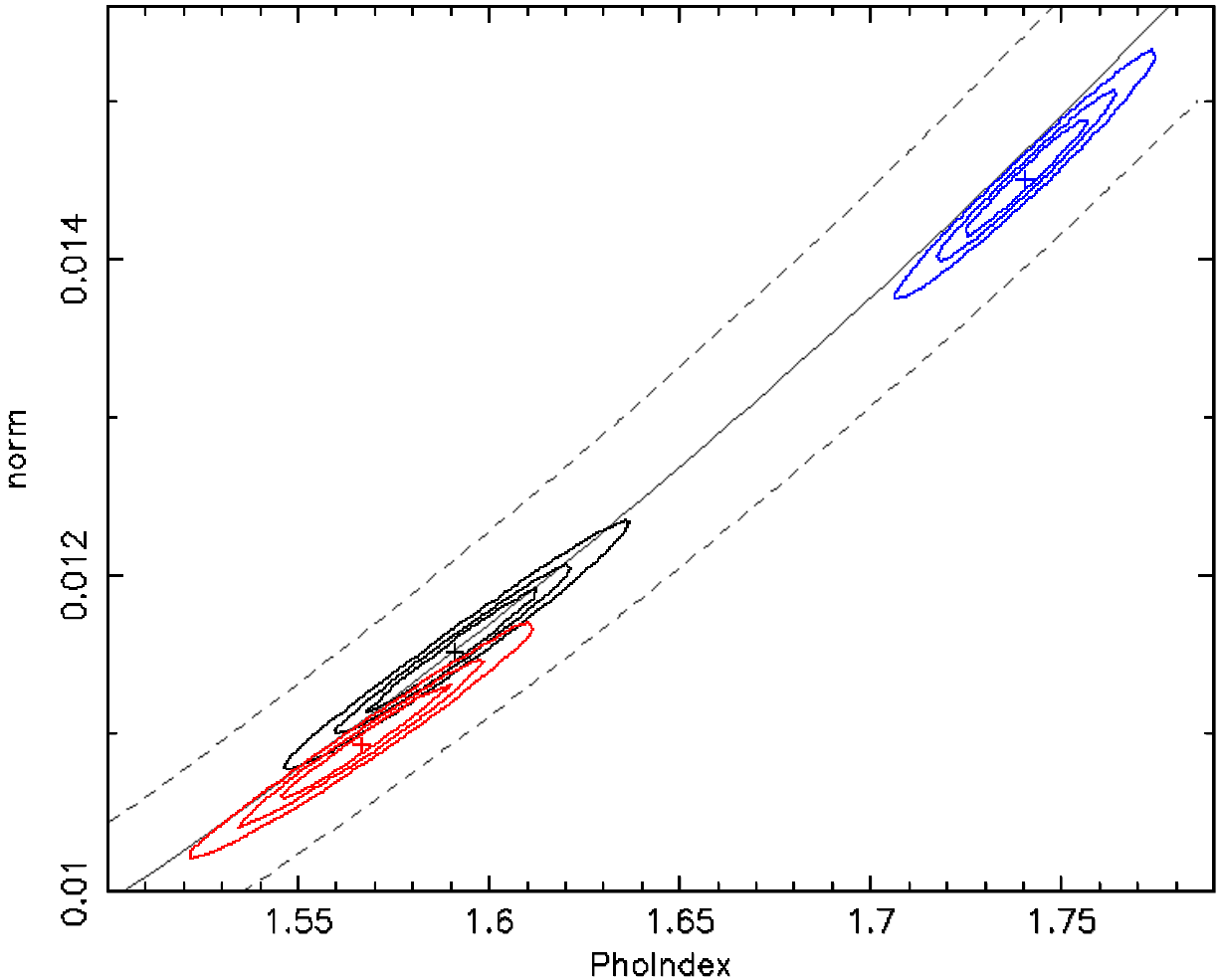
3C273 (a) MOS1 – black, MOS2 – red, pn - blue

q21, EEF + vignetting correction



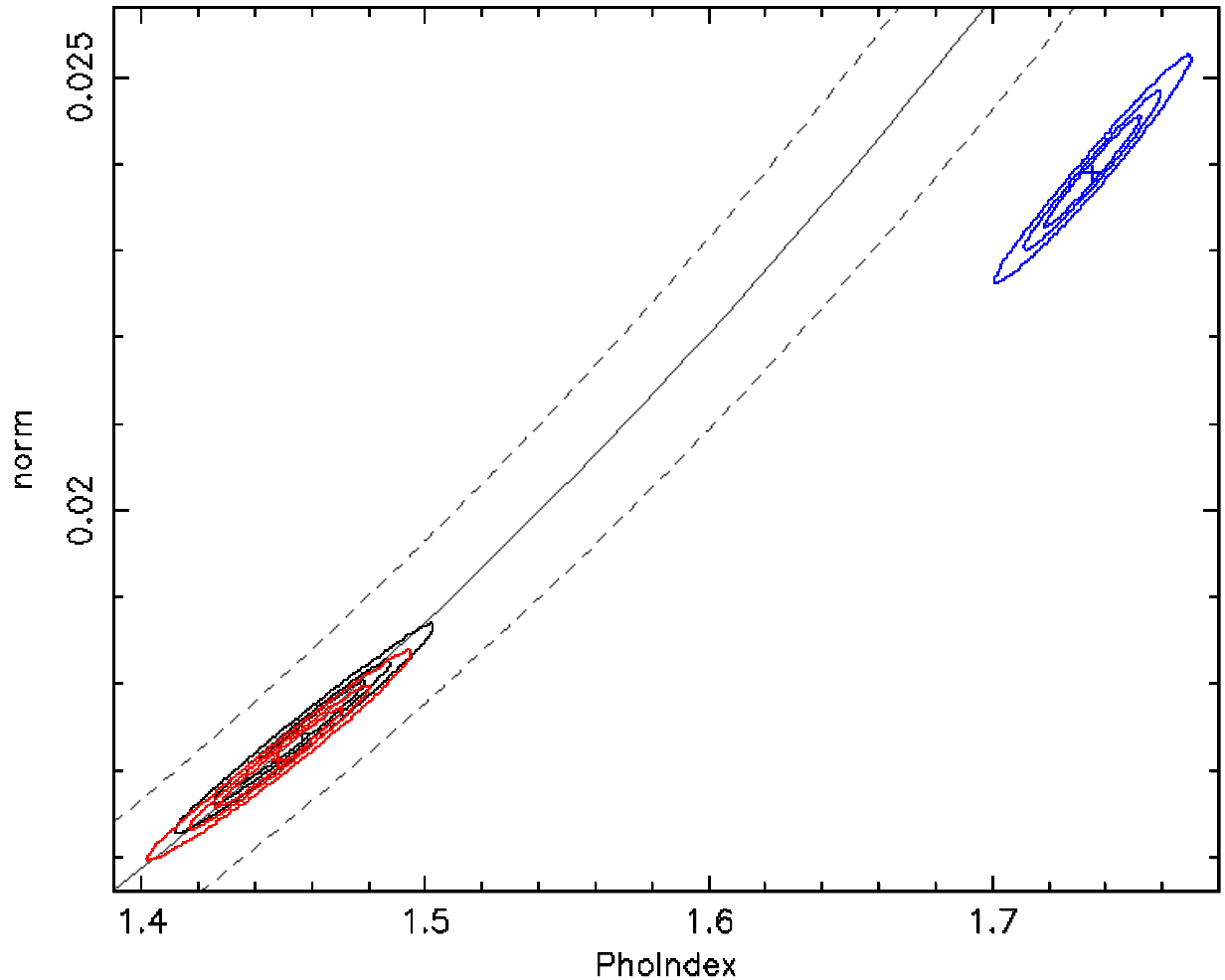
3C273 (b) MOS1 – black, MOS2 – red, pn - blue

q20, no correction



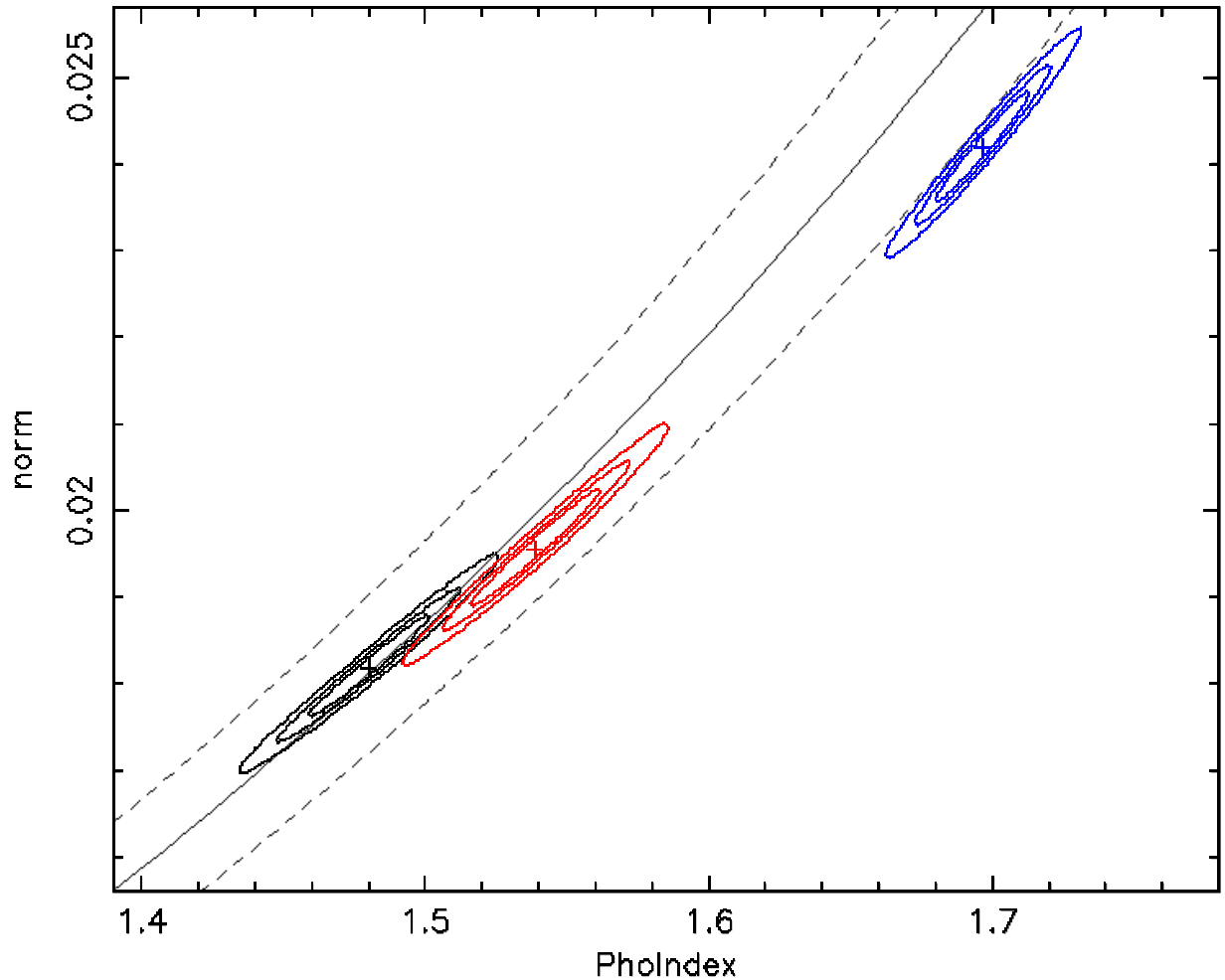
3C273 (b) MOS1 – black, MOS2 – red, pn - blue

q20, EEF correction only



3C273 (b) MOS1 – black, MOS2 – red, pn - blue

q21, EEF + vignetting correction



# Summary

•When all corrections made to best of current knowledge, there is still a large discrepancy between MOS and pn spectra in the 3-10 keV band

•Difference must be due to QE or mirror area

•Assumption is mirrors have been calibrated very well

$\Rightarrow$ Which QE should we trust, MOS or pn (or neither)?