Cross-calibration

Method of analysis

Assumption is that ratio of spectra taken simultaneously is independent of spectral shape source and equivalent to ratio of effective areas convolved with redistribution function.

e.g. $O_{m1} = S_{src} \cdot R_{m1}$

$O_{m2} = S_{src} \cdot R_{m2}$

$\Rightarrow O_{m1}/O_{m2} = R_{m1}/R_{m2}$

(O ≡ observed spectrum, S ≡ source spectrum, R ≡ response matrix)

Aim is to search for systematic differences between ratio of observed spectra and "expected" ratio.

Comparison of MOS Filters

Two calibration observations of PKS 2155-304 have been made where one MOS had medium filter for duration while other MOS cycled through all 3 filters.

Rev 0362 Obsid 0124930301

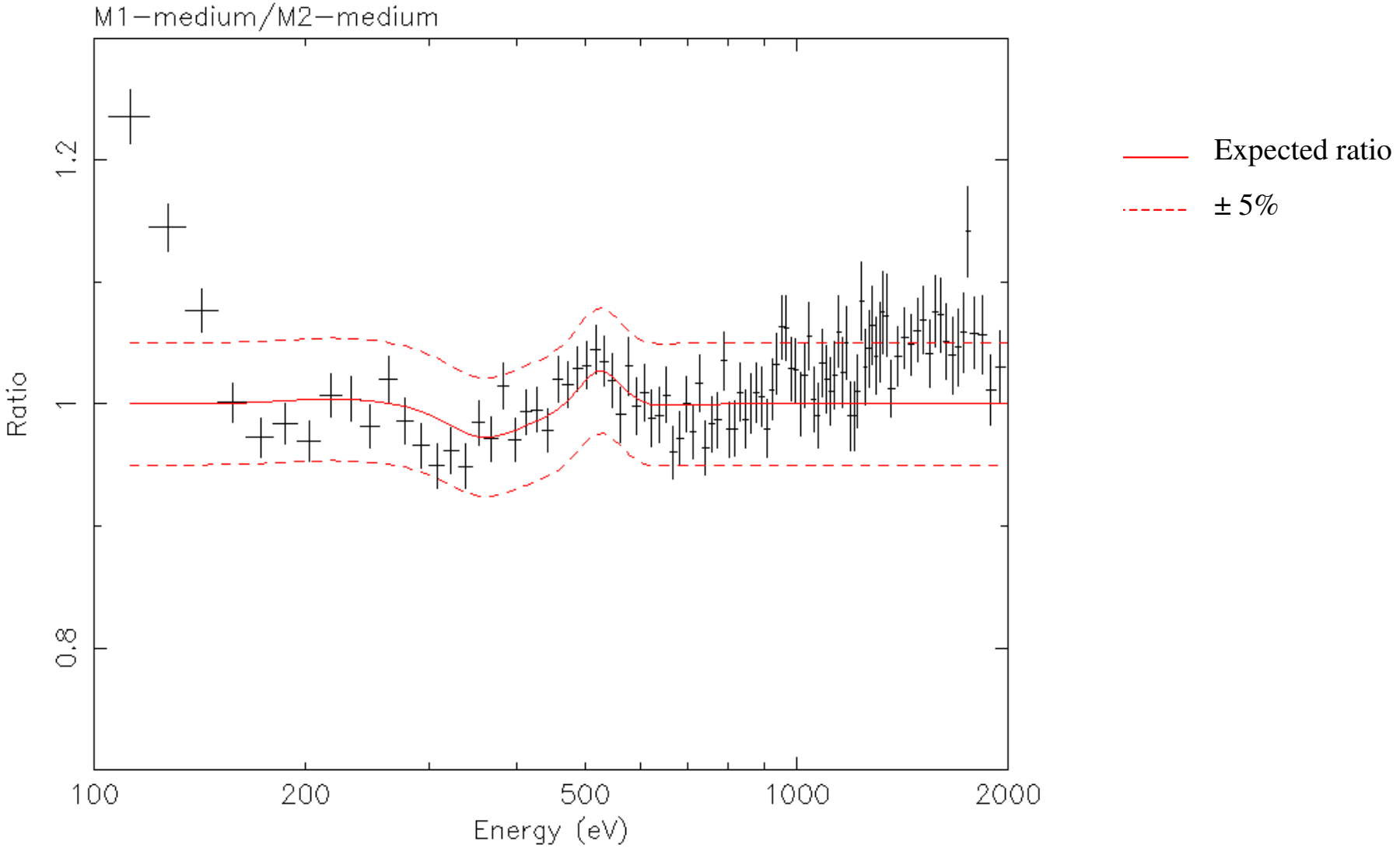
MOS1 -	Medium filter	38 ks	MOS2 -	Medium filter	92 ks
	Thick filter	25 ks			
	Thin filter	28 ks			

Rev 0450 Obsid 0124930501

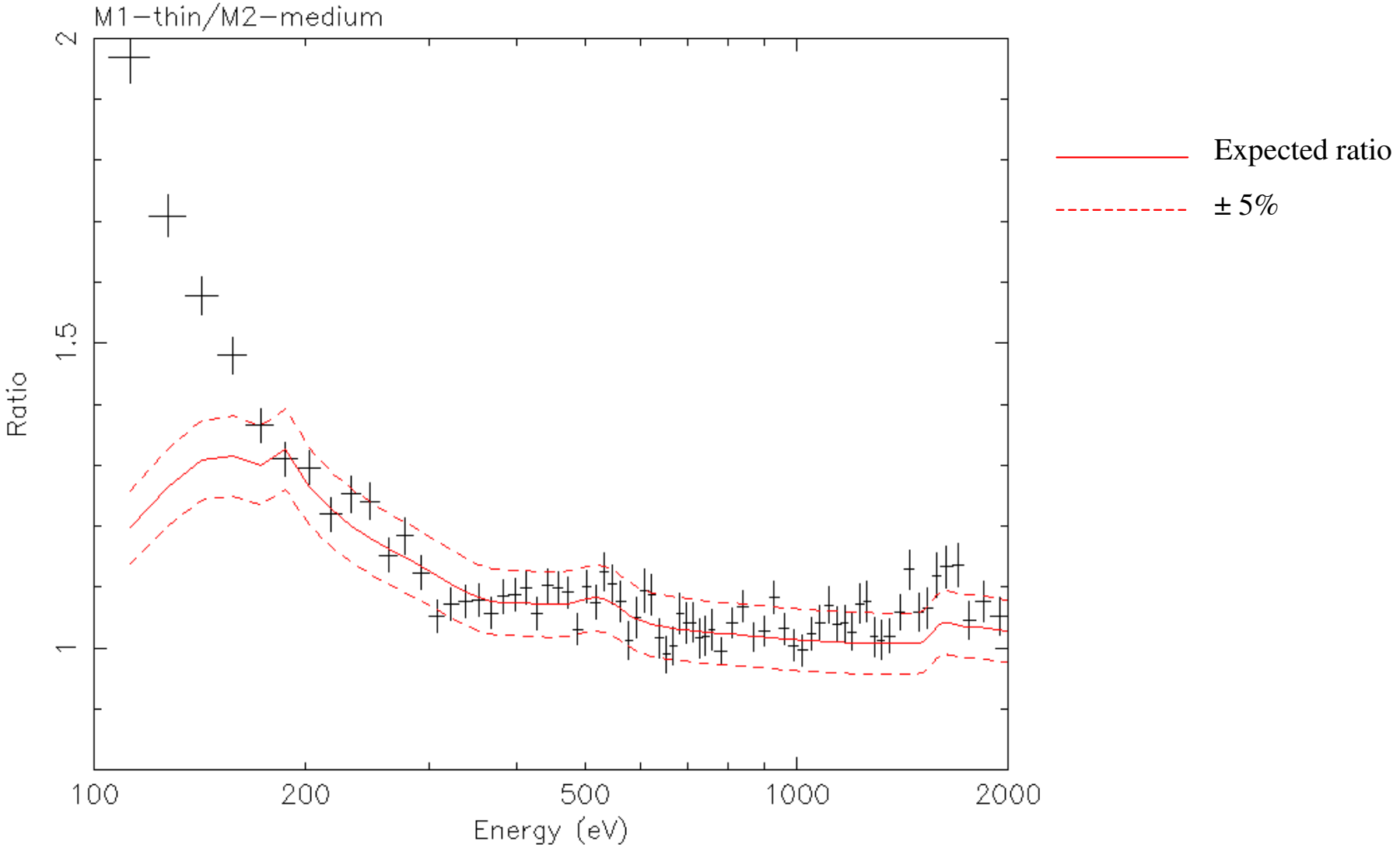
MOS1 -	Medium filter	99 ks	MOS2 -	Medium filter	33 ks
				Thin filter	33 ks
				Thick filter	31 ks

In each case taken filter transmission and folded through redistribution matrix to get "expected" ratio in 0.1-2.0 keV band

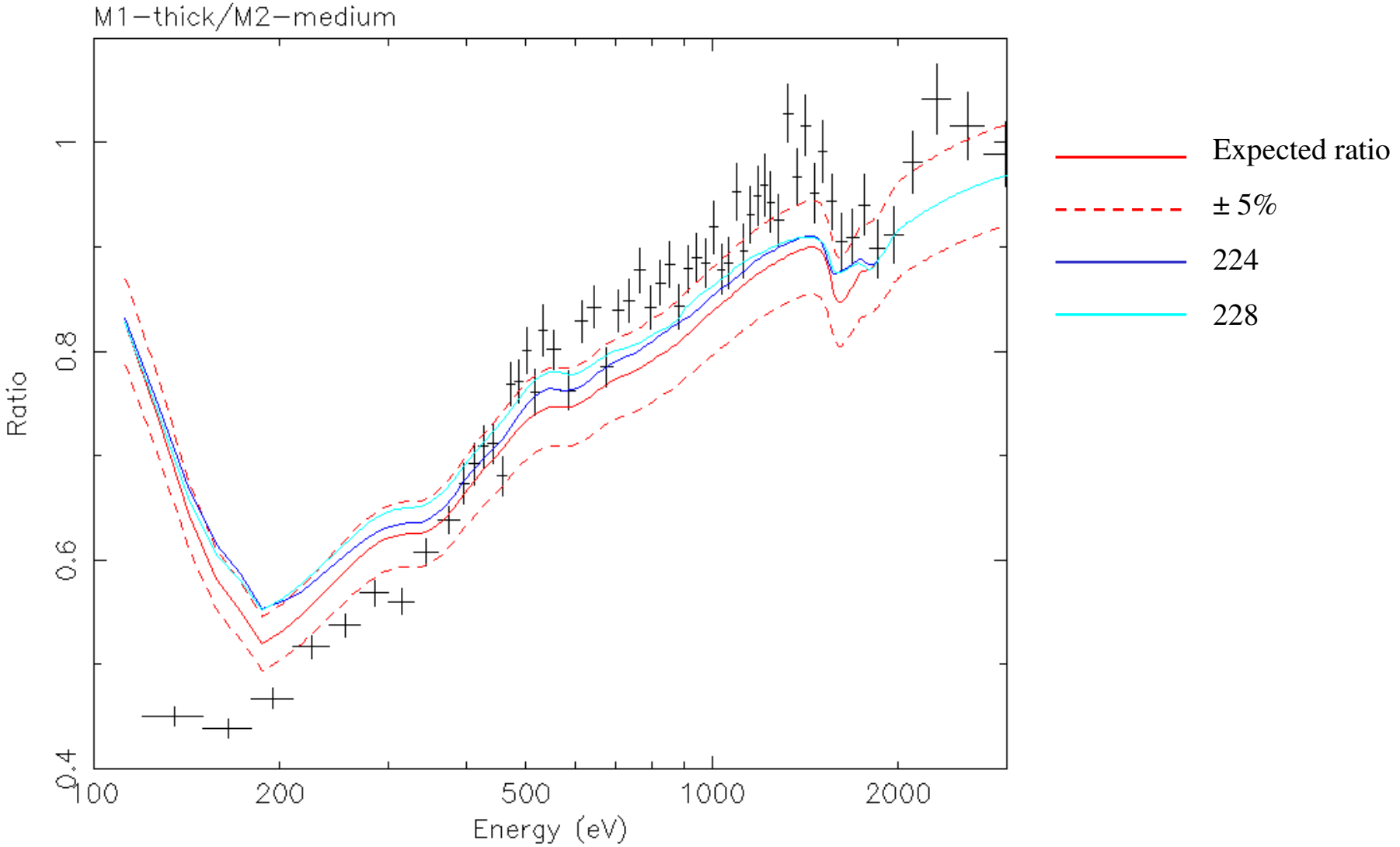
Note: mean count rate was factor 2 higher during rev 0362 than rev 0450



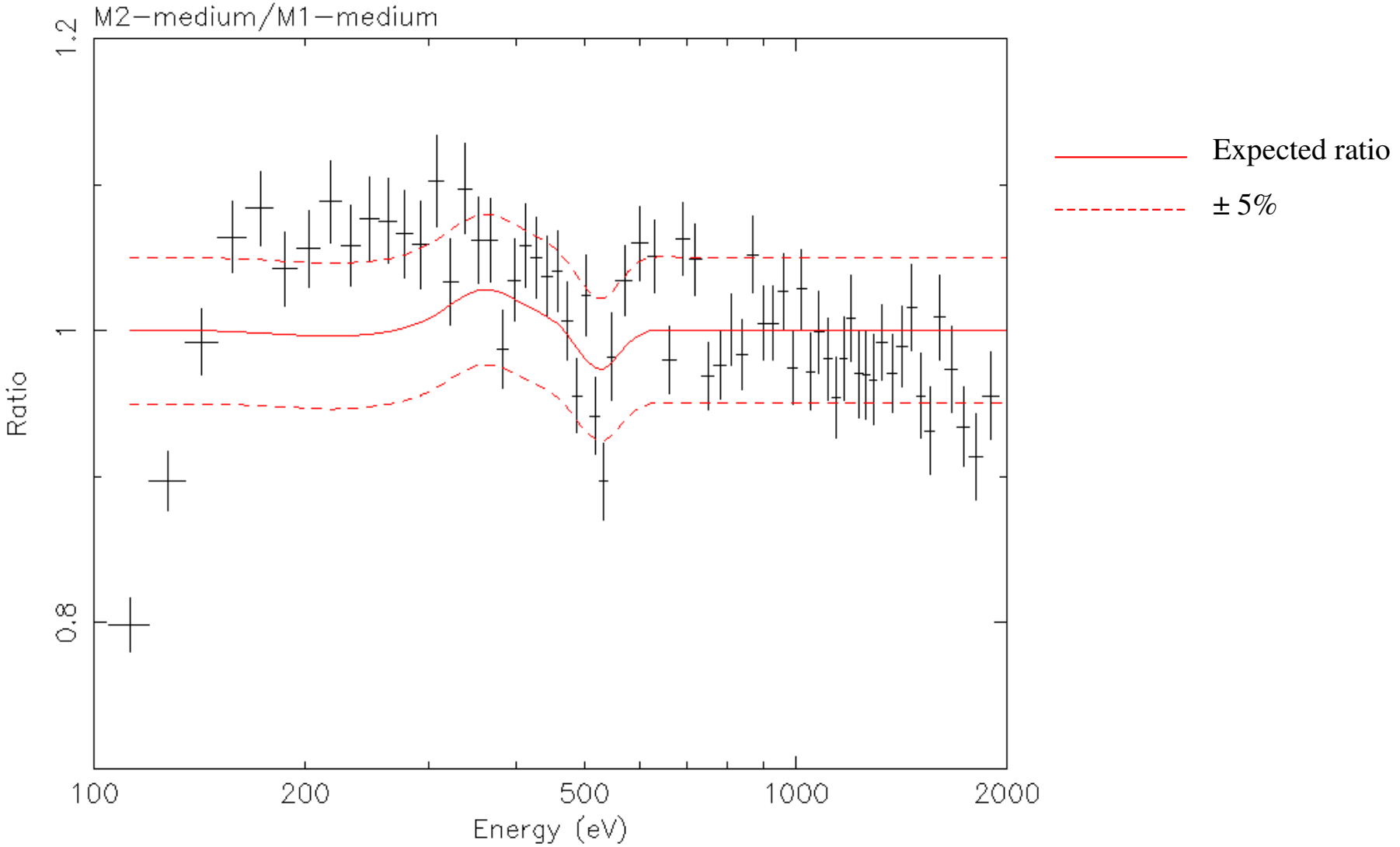
Good agreement (better than 5%) between medium filters above 200 eV



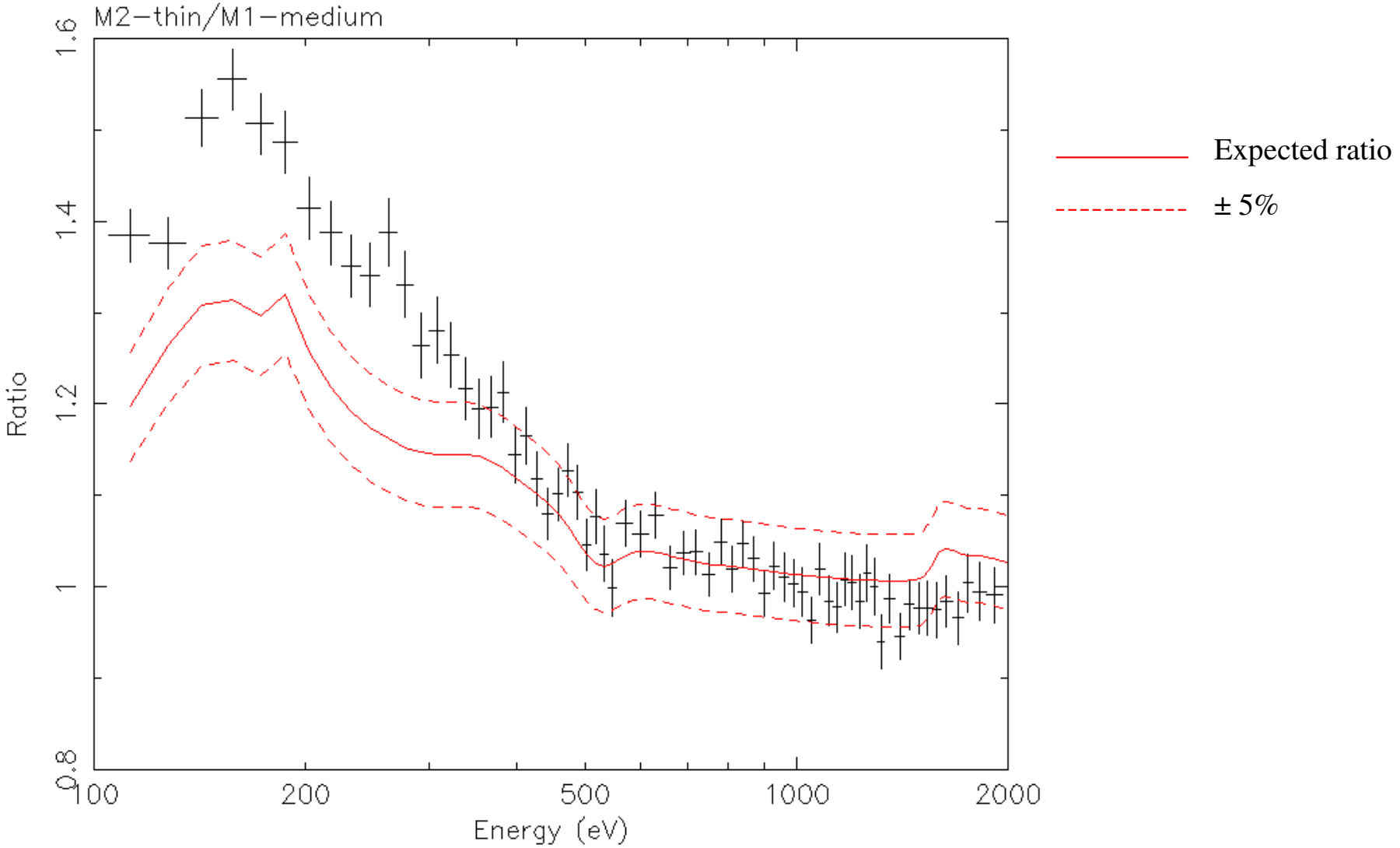
Good agreement (better than 5%) between M1 thin filter and M2 medium filter above 200 eV



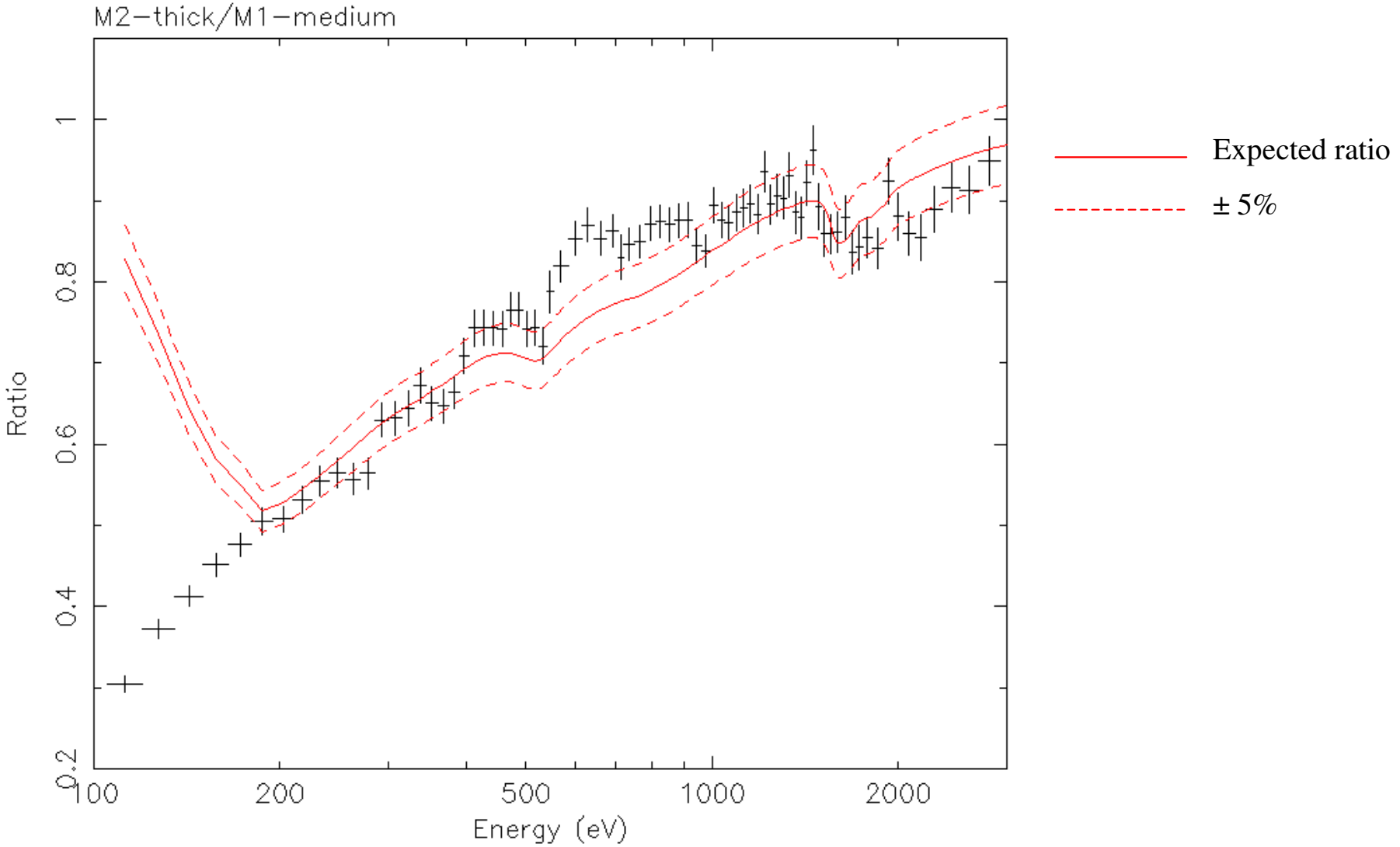
About 10% discrepancy between M1 thick filter and M2 medium filter.
No real improvement with other filter transmissions provided by pn team.



Agreement between medium filters not as good as in previous observation.



More than 10% discrepancy between M2 thin filter and M1 medium filter below 300 eV.



Better agreement between M2 thick filter and M1 medium filter than for M1 thick filter.

MOS1/MOS2 cross-calibration

Source used: 3C273
Rev 0277 Obsid 0136550101

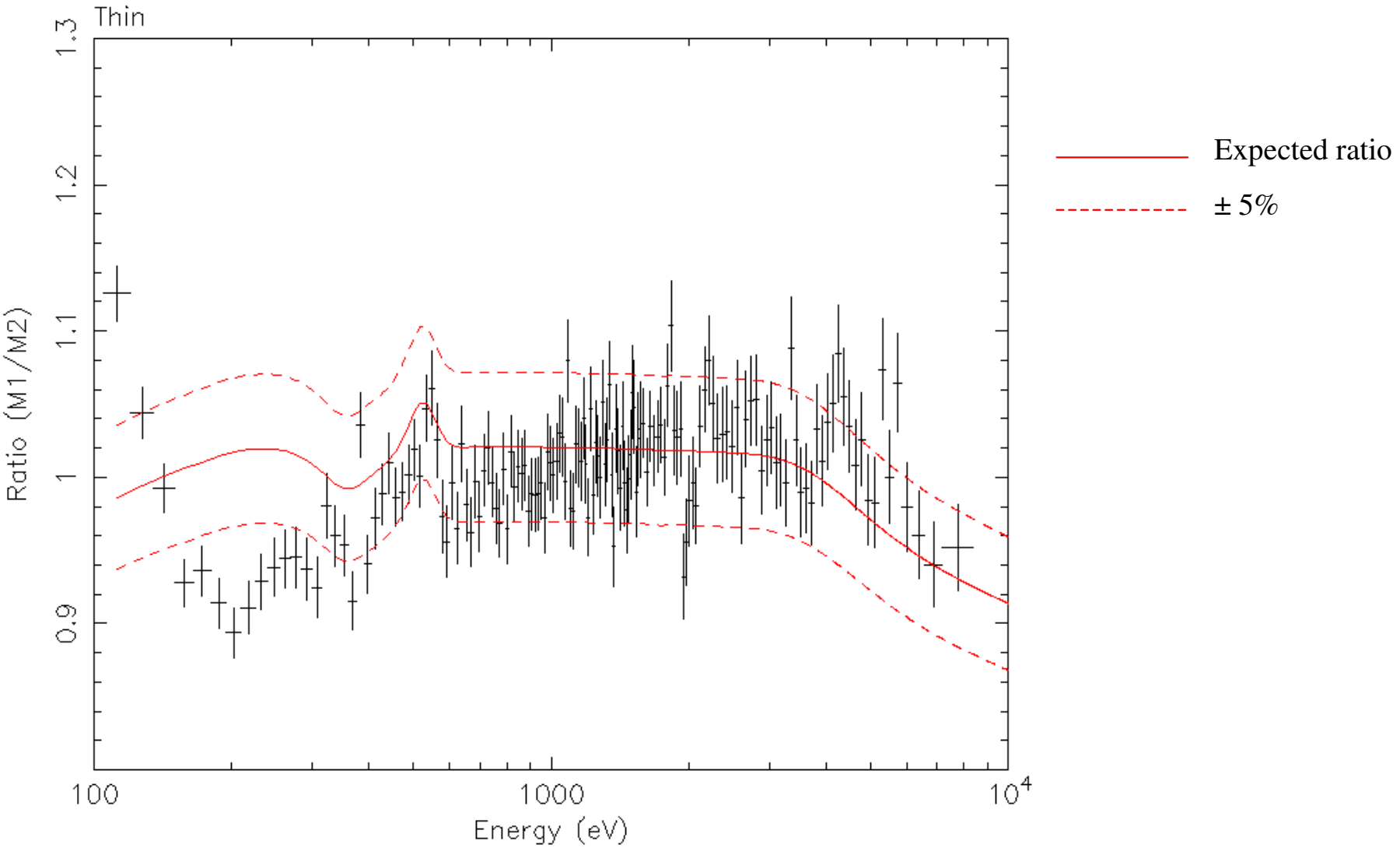
MOS1 -	Thin filter	43 ks	MOS2 -	Thin filter	43 ks

then

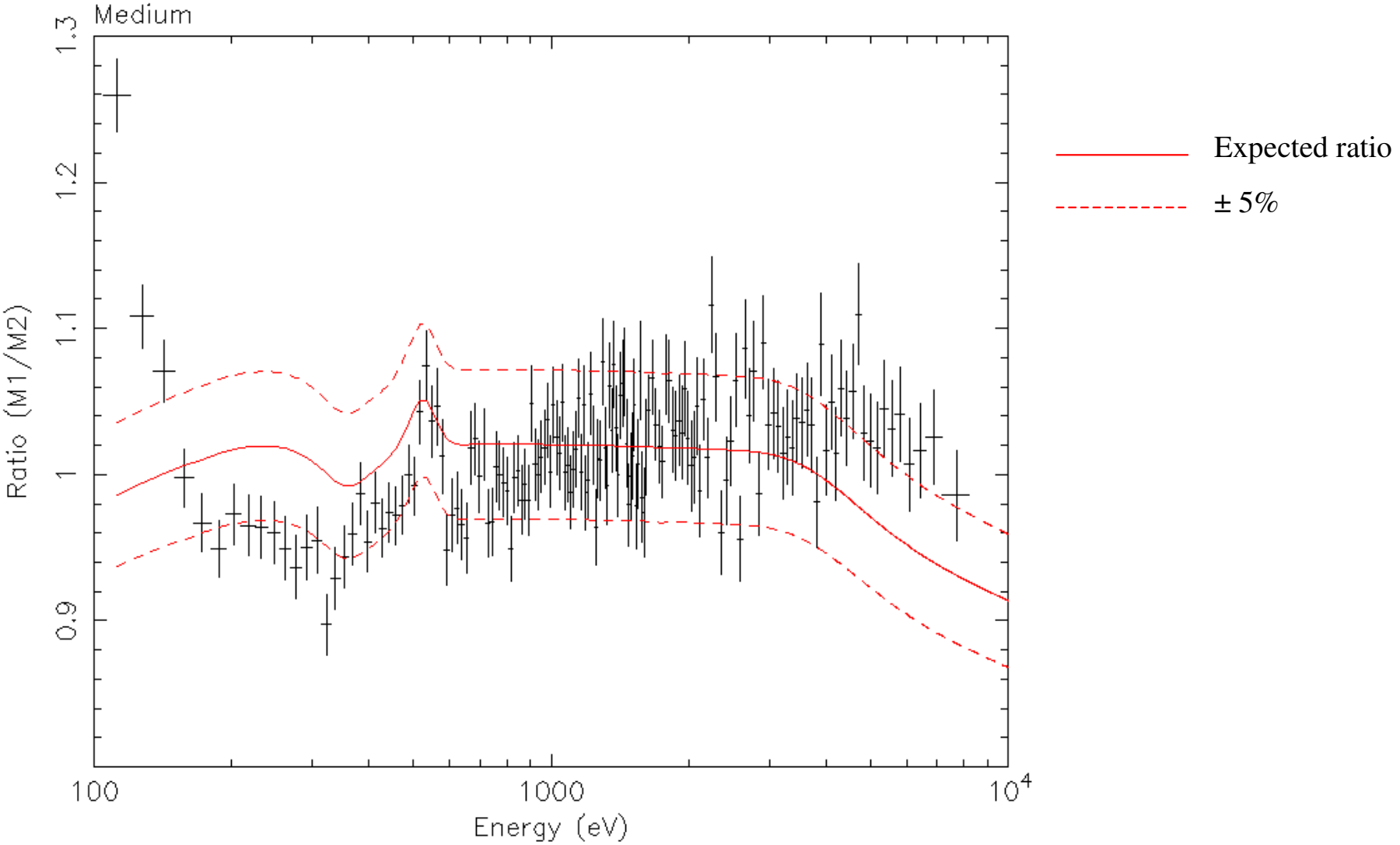
MOS1 -	Medium filter	45 ks	MOS2 -	Medium filter	45 ks

Source extraction region used = 5-42 arcsec annulus

For each observation taken filter transmission, QE and EEF correction and folded through redistribution matrix.



In 0.4 – 10.0 keV band ratios agree to within better than 5%



Similar to previous observation apart from above 5 keV where deviation from expected ratio is greater.

MOS/pn cross-calibration

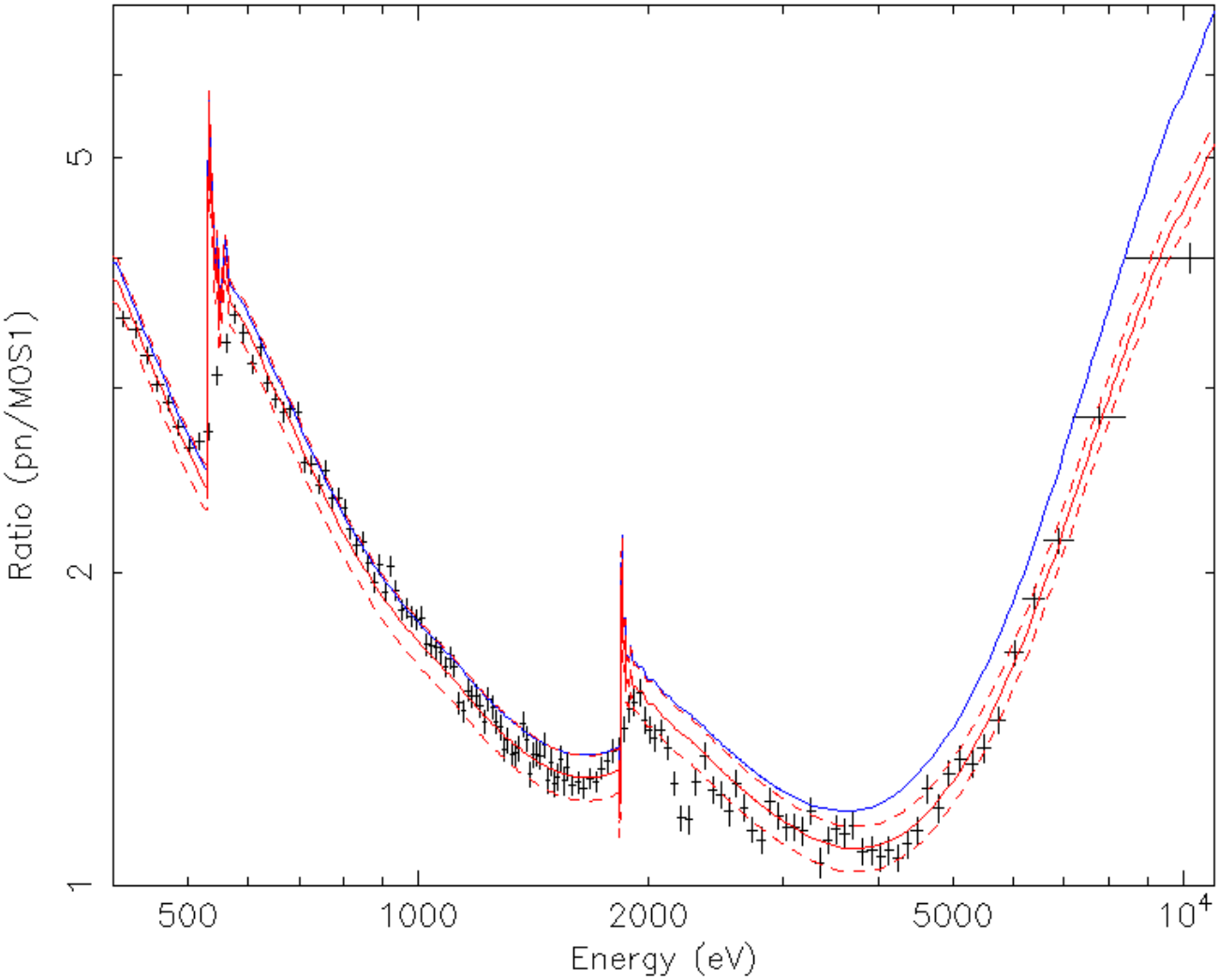
Source used: 3C273 Rev 0277 Obsid 0136550101 (again)

Currently unable to fold pn QE and filter transmission etc.. through pn redistribution matrix. Because of this the "expected" ratio is not correct at low energies but can still be useful at high energies.

The "expected" ratio is therefore the ratio of the QEs and RGS transmission (if applicable). Also shown is the expected ratio after EEF correction is applied.

Note that the pn EEF used here is not the one produced by Simona, our software needs to be updated to read the different CCF file format.

Will this method allow us to visualize where pn and MOS diverge from expectation?



Expected ratio

± 5%

Including EEF correction

MOS/pn cross-calibration

In Gareth's presentation "MOS/pn cross-calibration in hard X-ray band" at Ringberg meeting it was shown that MOS spectra are harder than pn spectra in 3-10 keV band. The EEF correction made MOS even harder w.r.t. pn and this can be seen in the "expected" ratio (blue curve).

However if EEF correction is not applied the data in the 3-10 keV band agrees with model to within 5% even though spectral fits show a difference in Γ of ~ 0.1? There is no obvious divergence between data and model apart from last bin.
Will taking rmf into account change ratio at high energies (this was not the case when considering MOS only)?

<u>Future work</u>

- Take rmf into account
- Apply method to several sources
- Might be able to sum spectra of different sources together to improve signal to noise?