IACHEC standards

Matteo Guainazzi (ESA)

Outline

- Standards that are likely to remain adequate in the future
- Standards that we may need to revise

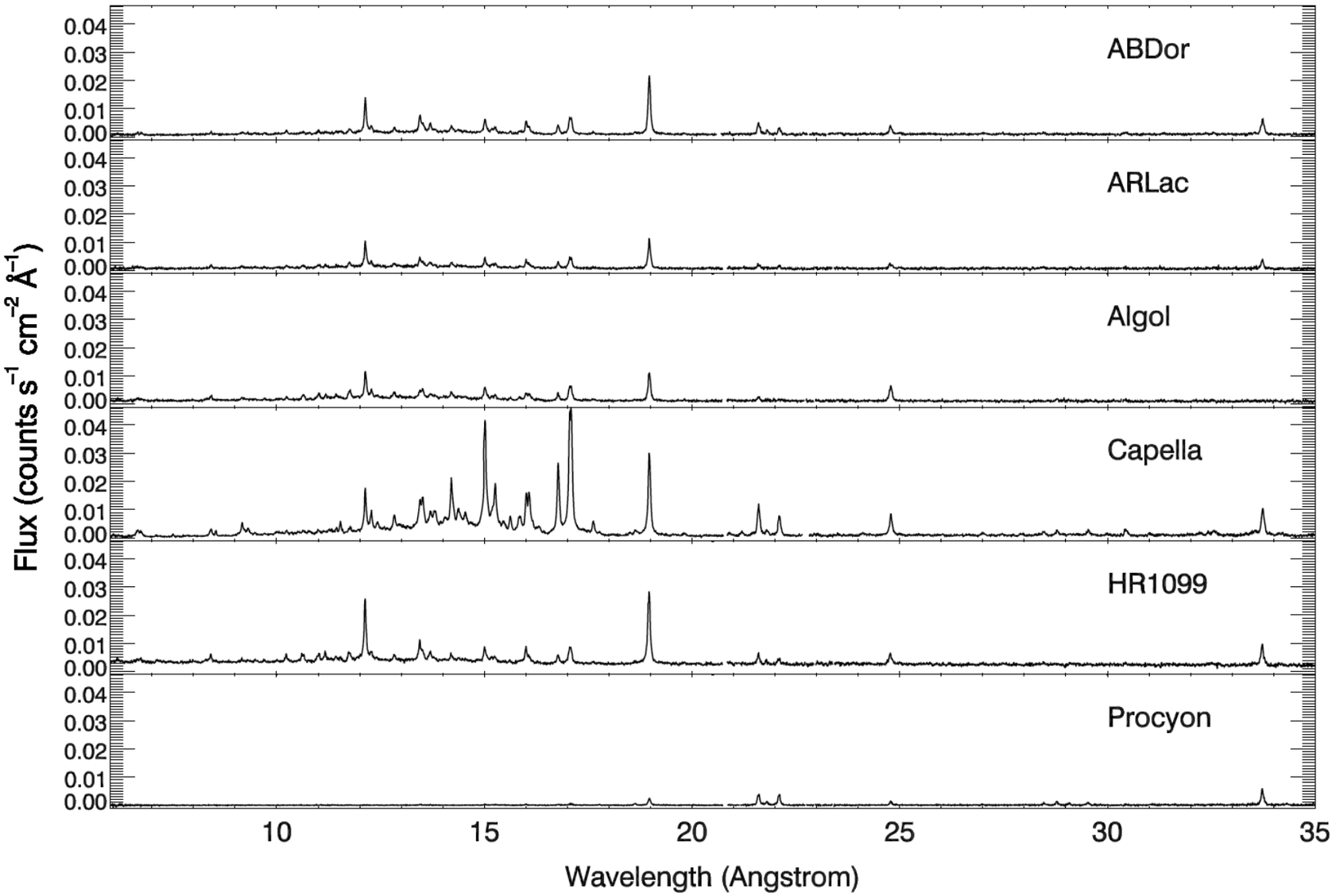
Standards likely to be adequate in the future

- Good standard candles to in-flight calibrate the LSF/ energy scale at μ-calorimeter resolution at E≤2 keV

High-resolution LSF and wavelength scale (soft)

Guainazzi et al., 2015, JATIS, 1(4), 047001

RGS spectra of calibration targets (same y-scale)



Caveats:

- rotational broadening
- orbital broad^{ng}
- thermal broad^{ng}

Safe for *Resolve* (requirement 1 eV)

Unclear for X-IFU (requirement 0.15 eV)

Alternative: ADLeo, $v\ sin(i) \leq 6$ km s^{-1}

Standards likely to be adequate in the future

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- Good standard candles to identify/monitor molecular contamination in-flight (1E0102-72, RXJ1856-3754, Abell1795 …)

- Good standard candles for timing

The “timing lot”

Guainazzi et al., 2016, JAXA-ASTH-SOT-001. Main inputs by Y.Terada (Saitama University) & T.Enoto (Kyoto University)

	Crab	PSR B1509-58	PSR B0540-69	Cen X-3	Vela X-1	PSR B1821-24	burst phenomen
Exposure	100 ks (PV) + **2 x 10 ks**	**40 ks (TBD)**	**50 ks**	xx ks (PV Target)	xx ks (PV Target)	(80 ks) optional, not recommended	short bursts from any possible ToOs
Exposure	**Absolute Time / Phase** Sharp pulse peak is compared with the radio ephemeris	**Relative Time** Pulse profile and period could be reproduced? (broad profile)	**Relative Time** Pulse profile and period could be reproduced? (broad profile)	**Relative Time** Pulse profile and period could be reproduced?	**Relative Time** Pulse profile and period could be reproduced?	**Timing Jitter Each Event** broadening of spiky peak is a good marker for the timing jitter	**Relative precise time** serendipitous bursts in ToO: relative timing phase among instruments
A/I	- SXS grade, dead-time	- Exposure is TBD		- Coordination of SXI modes		(optional)	(optional)
Intensity	1 Crab (~10%	~1 mCrab	~1 mCrab			~0.1 mCrab	N/A
Period	33 ms	151 ms	50.5 ms	3 s	283 s	3 ms	N/A
SXS	△	◎	◎	○	○	◎	◎
SXI				△ (1/8 mode)	◎ (any mode)		◎
HXI	◎	◎	◎	○	○		◎
SGD	◎ (100 ks)	△	△				◎

Proposed Targets

additionally proposed exposure for our timing calibration is shown in red

◎: mainly used, ○ : used, △ : used with an issue to be checked

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- Good standard candles for timing

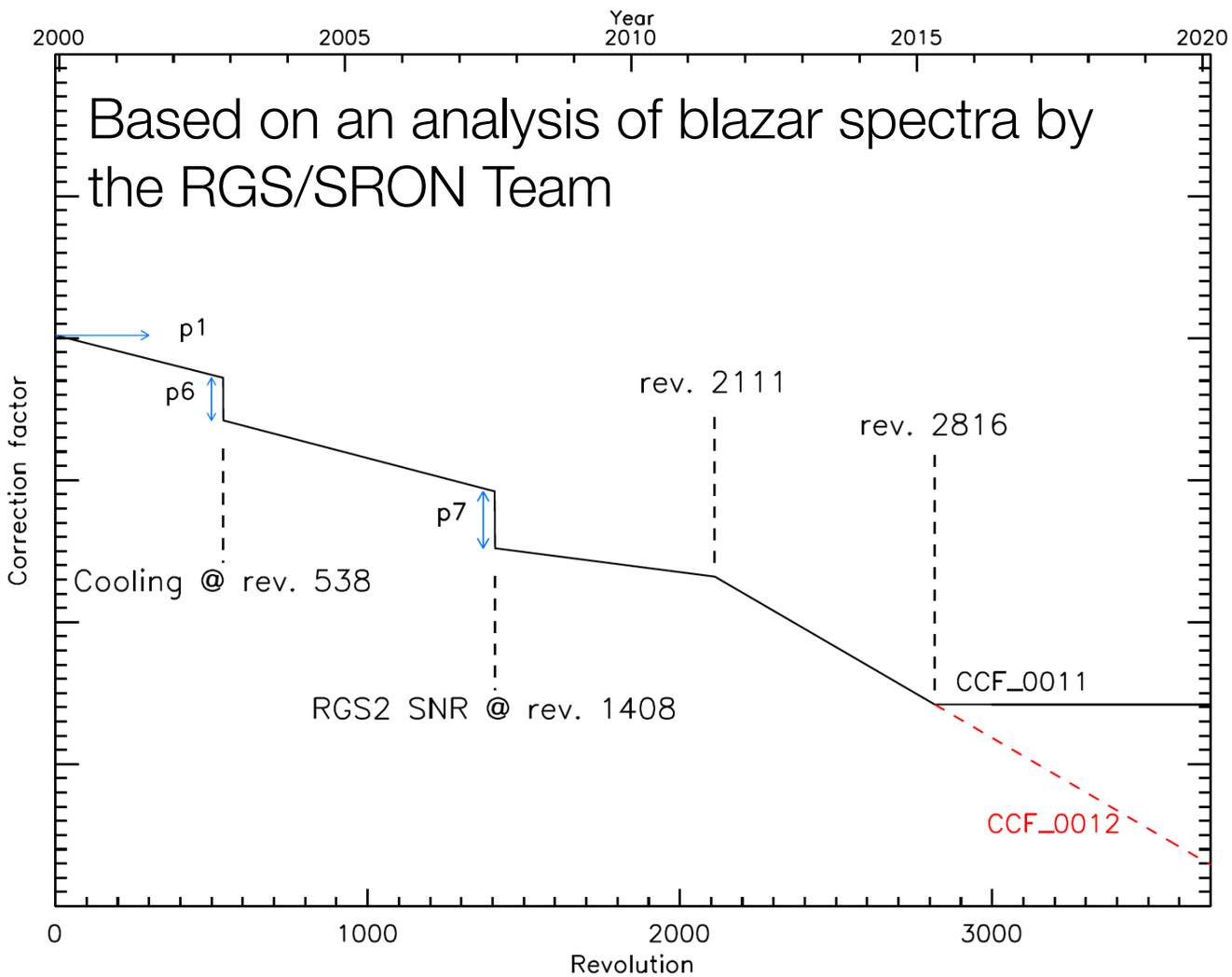
- “Fudges happen” (R.Petre) - we will continue making use of allegedly smooth continuum sources to correct areas

Latest examples of (area) “fudges happen”

Gonzalez-Riestra, 2017, XMM-CCF-REL-349

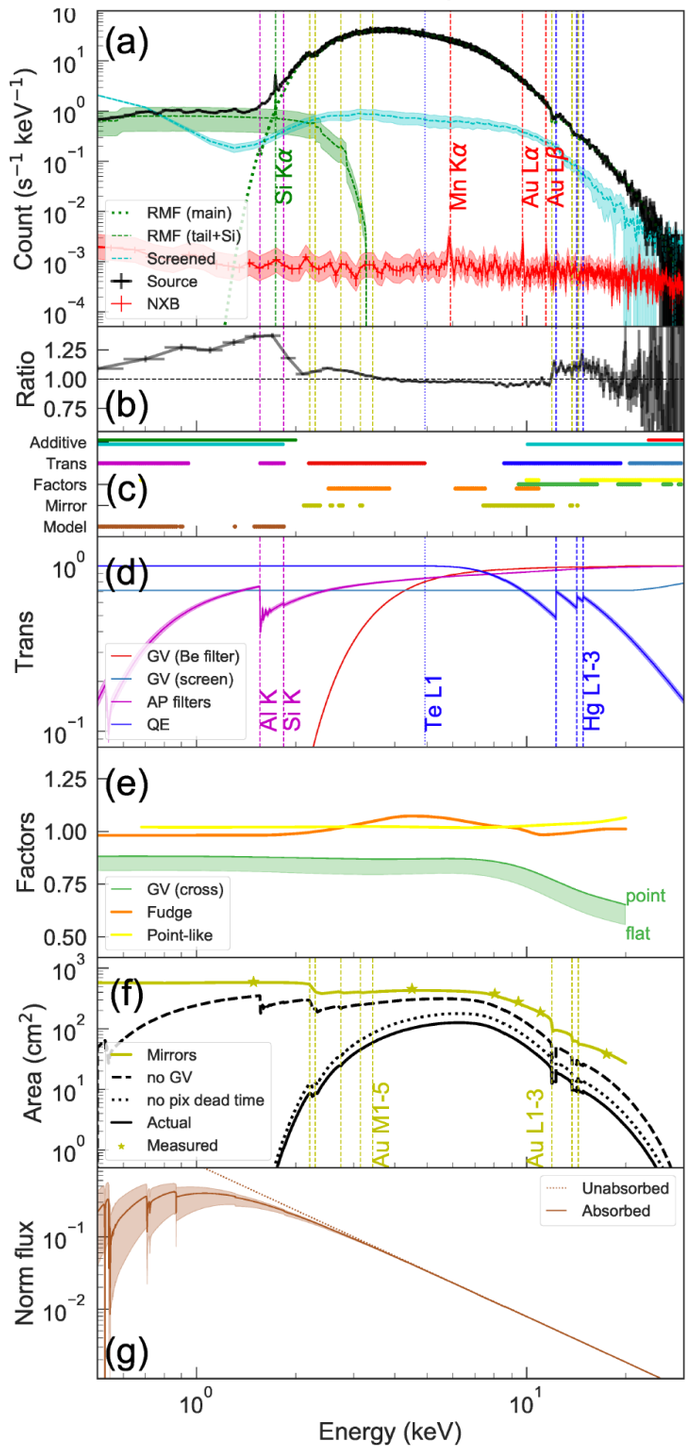
Tsujimoto et al., 2018, arXiv:180102104

XMM-Newton/RGS



Hitomi/SXS

SXS Crab spectrum



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- Good standard candles for timing

- “Fudges happen” (R.Petre) - we will continue making use of allegedly smooth continuum sources to correct area

- Ground-based calibration will continue to be a key factor

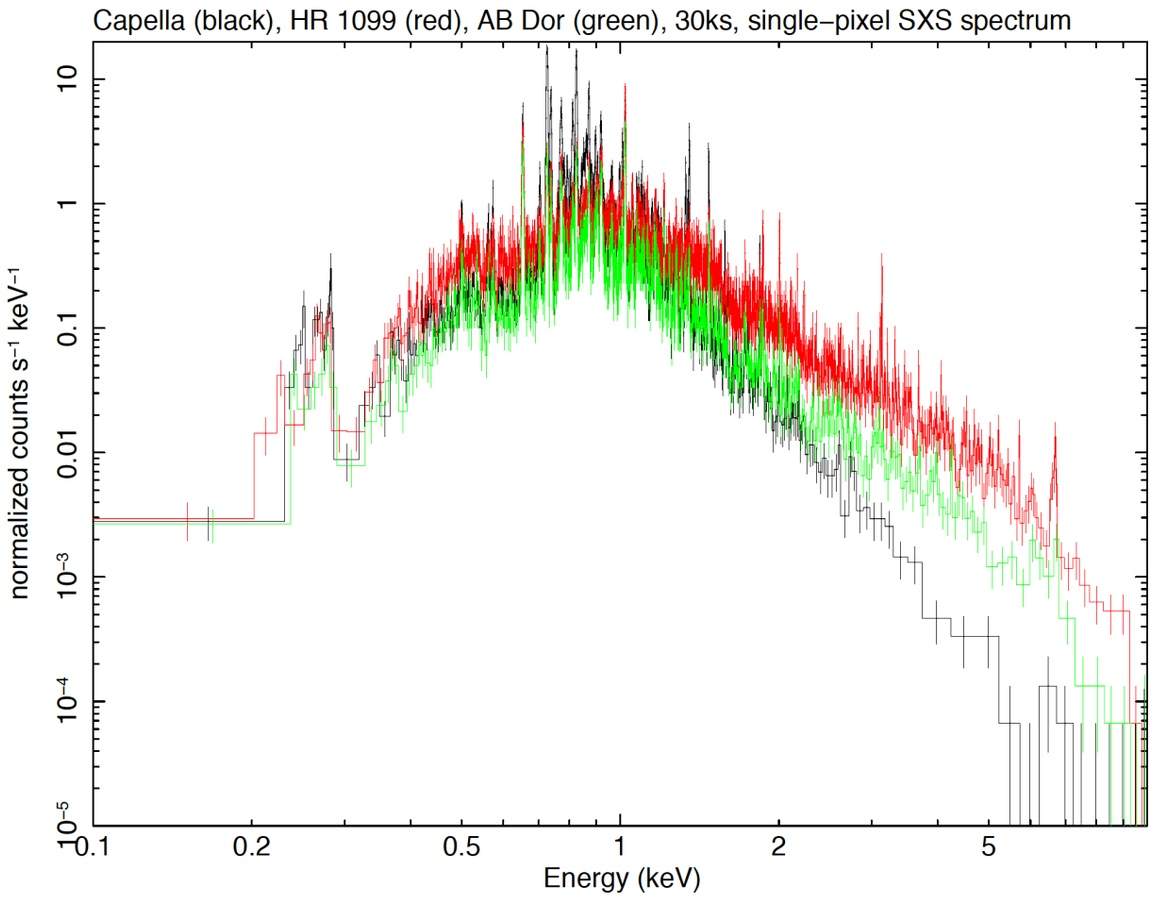
Standards that we may need to revise

- LSF/energy scale at μ-calorimeter resolution for E≥2 keV?

SXS LSF/energy scale

Guainazzi et al., 2016, JAXA-ASTH-SOT-001. Main inputs by M.Audard (Un. Geneva)

ABDor, HR1099



HR1099: rotational broadening 0.85 eV @FeXXV
ABDor: thermal broadening only (Drake et al. 2015)

Alternatives?

- XRB: Ionisation status and broadening of Fe line uncertain
- Highly-obscured Be binaries? Uncertainties on the origin of the lines, poor constraints on the broadening by Chandra/ HETG
- Galaxy clusters cores? Simple, but dynamical properties still poorly known

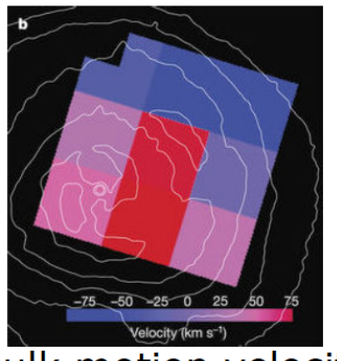
Standards that we may need to revise

Hitomi Collaboration, 2016, *Nature*, 535, 177

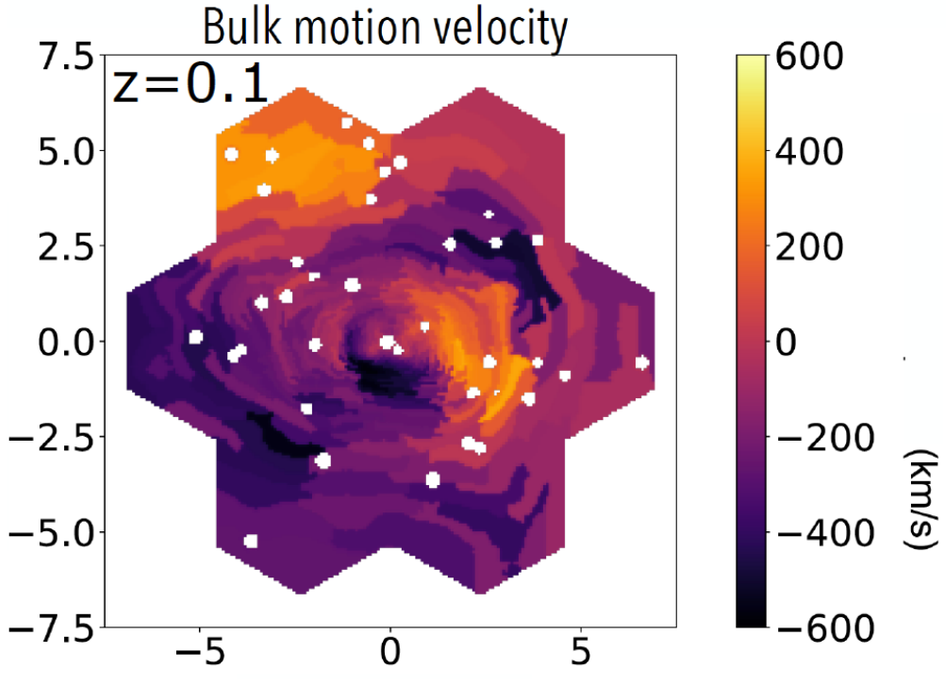
Courtesy E.Cucchetti (IRAP) and the X-IFU Team

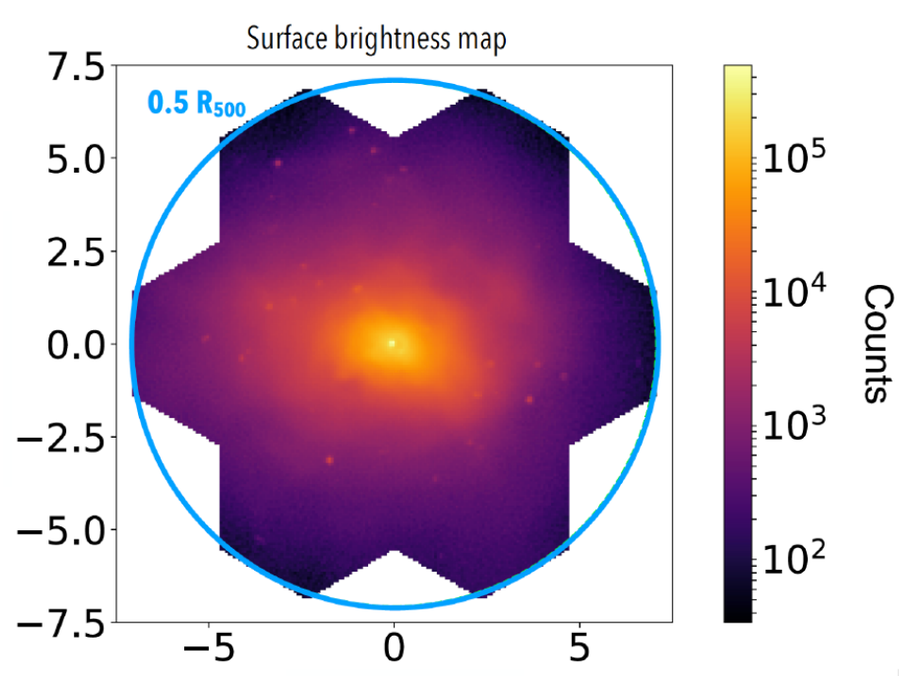
- LSF/energy scale at μ-calorimeter resolution for E≥2 keV?
- How to calibrate 3800 μ-calorimeter's pixels?

Hitomi/SXS
Perseus Cluster
(z=0.0179)



Bulk motion velocity

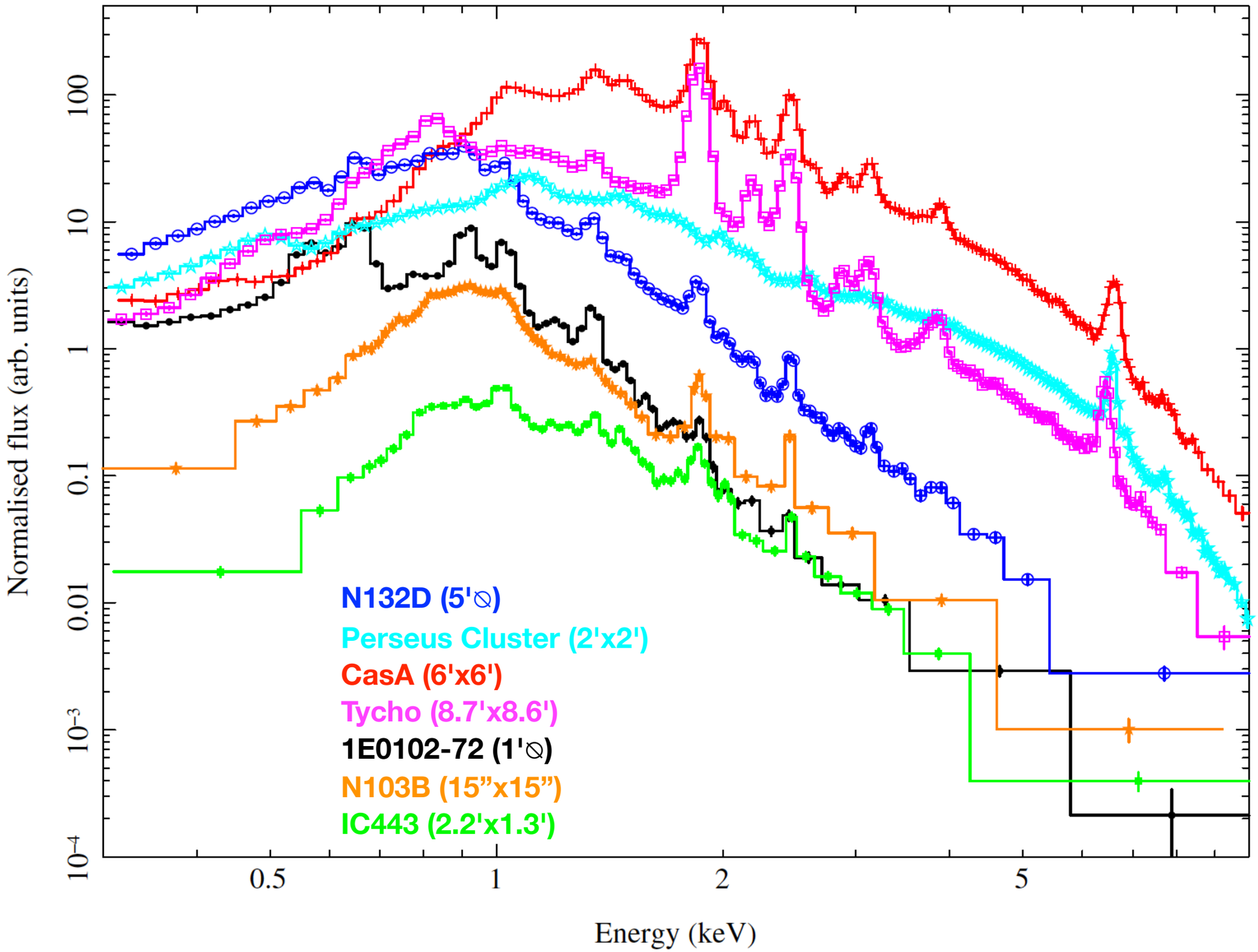




In the SXS we planned a **~260 ks** pixel-by-pixel scan of Capella

SNRs: energy scale and area

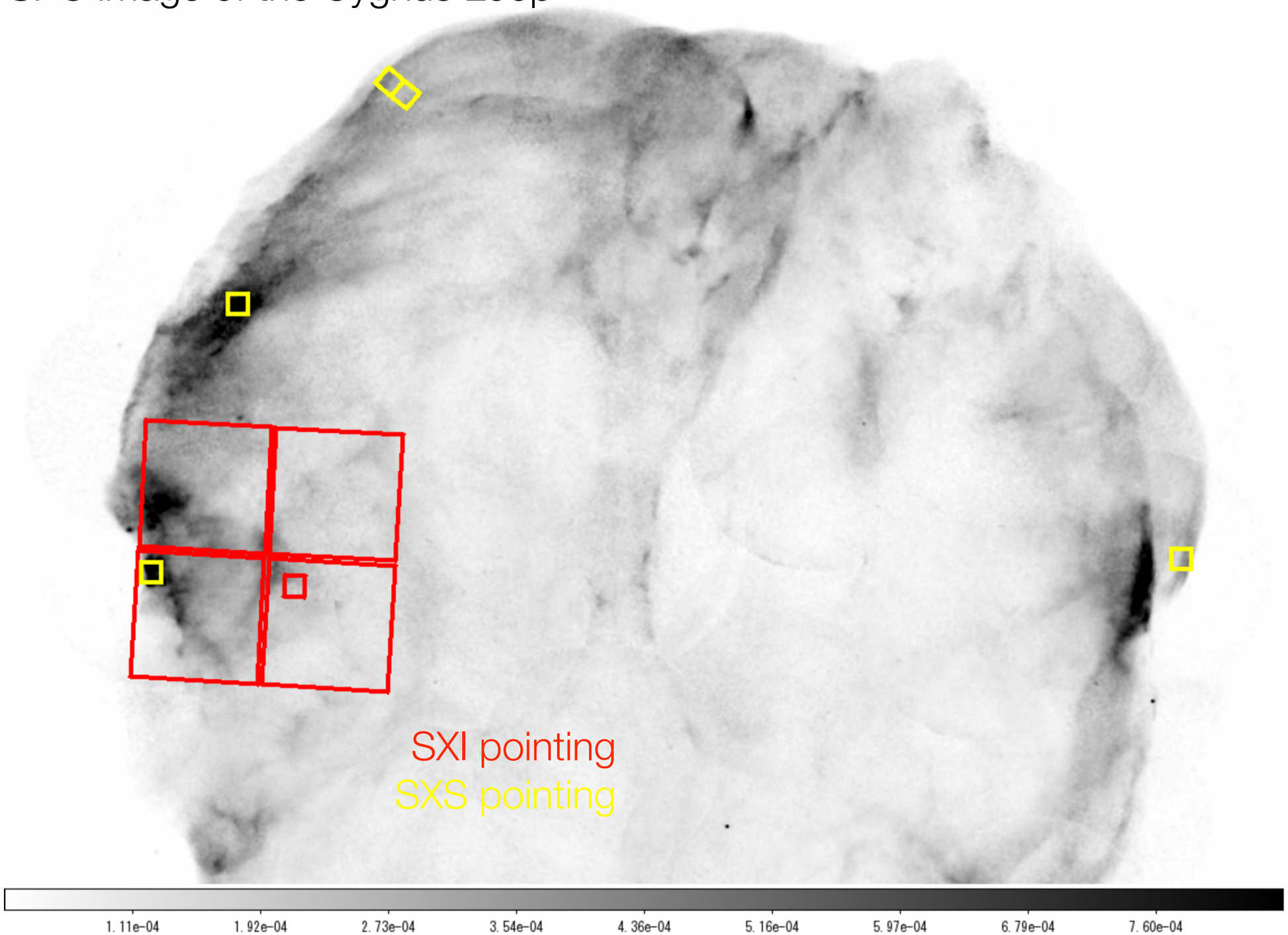
Guainazzi et al., 2015, JATIS, 1(4), 047001



Even larger structures considered for the SXS …

Guainazzi et al., 2016, JAXA-ASTH-SOT-001. Main inputs by K.Mori (Miyazaki University)

ROSAT/PSPC image of the Cygnus Loop

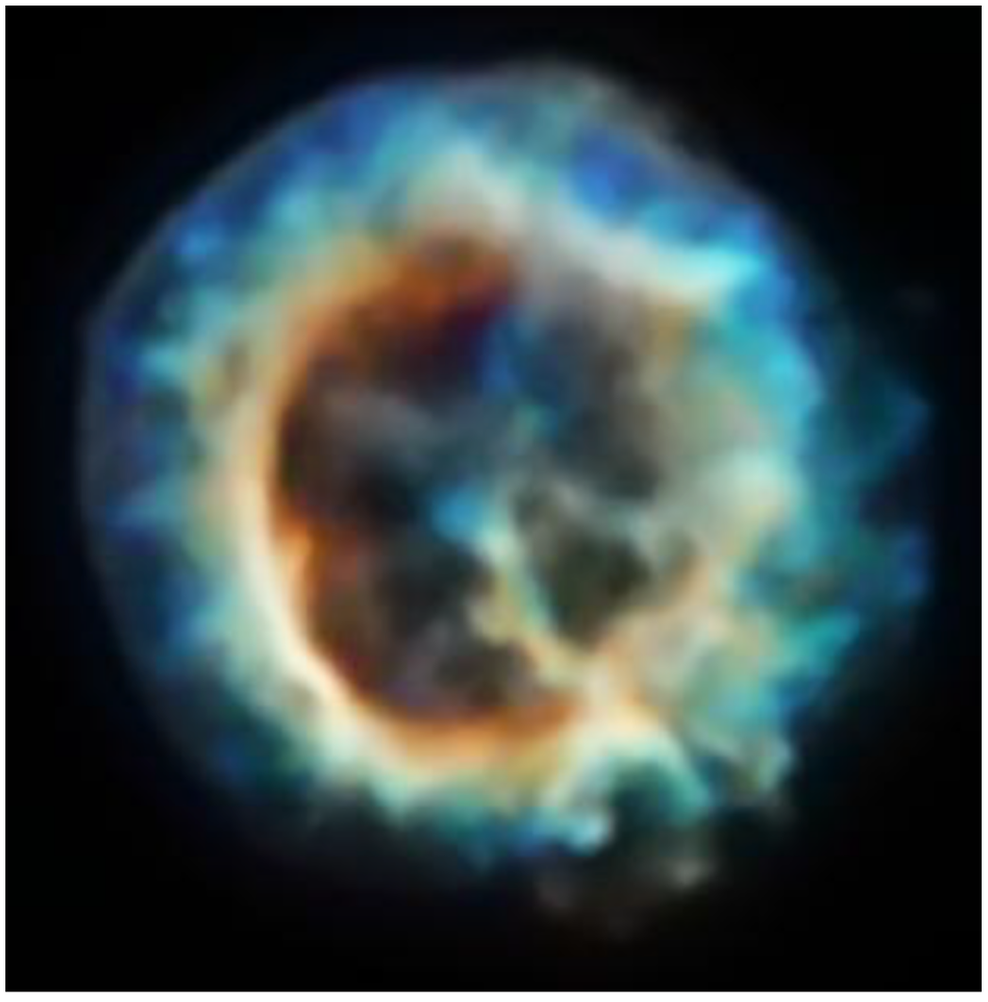


Ionisation and velocity structure

P.Plucinsky, 11th IACHEC

Hitomi Collaboration, arXiv:1712.02365

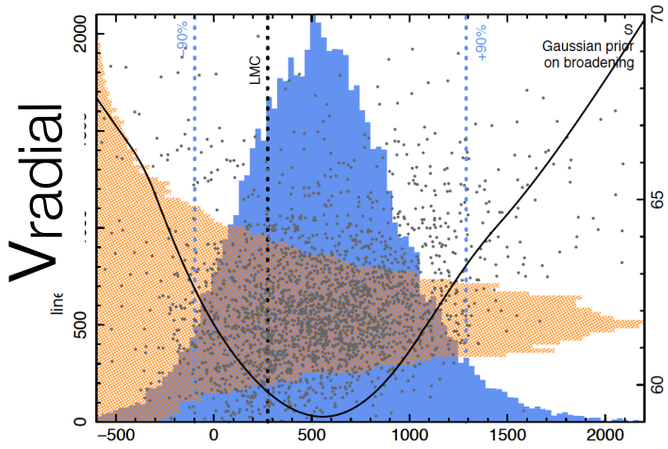
1E0201-72 - Chandra/ACIS



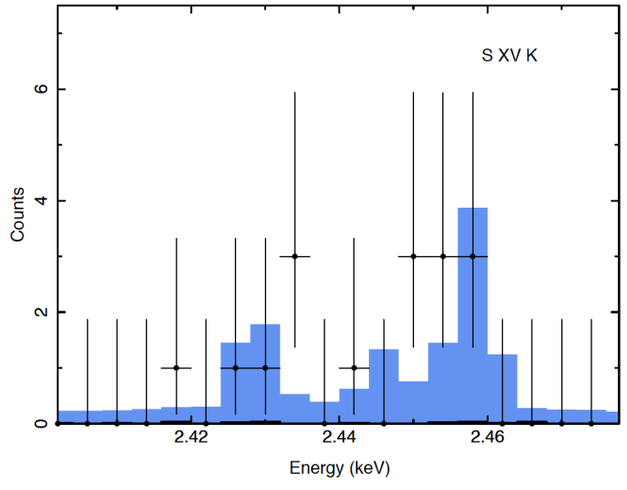
Red (0.3-0.5 keV), Green (0.5-0.75 keV)
Blue (0.75 – 7.0 keV)

N132D - *Hitomi*/SXS

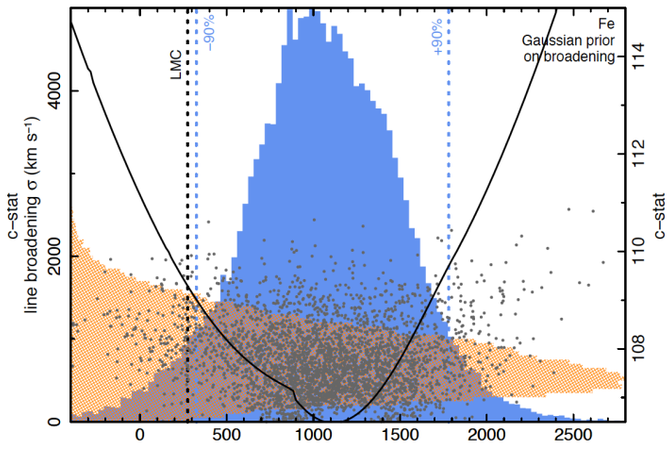
Si-K



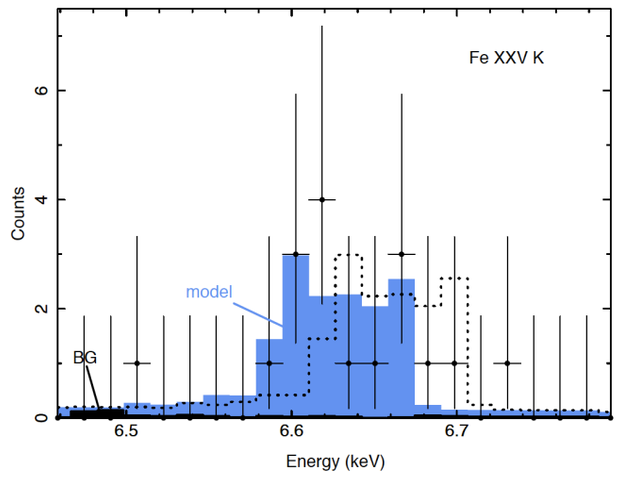
Vradial



Fe-K

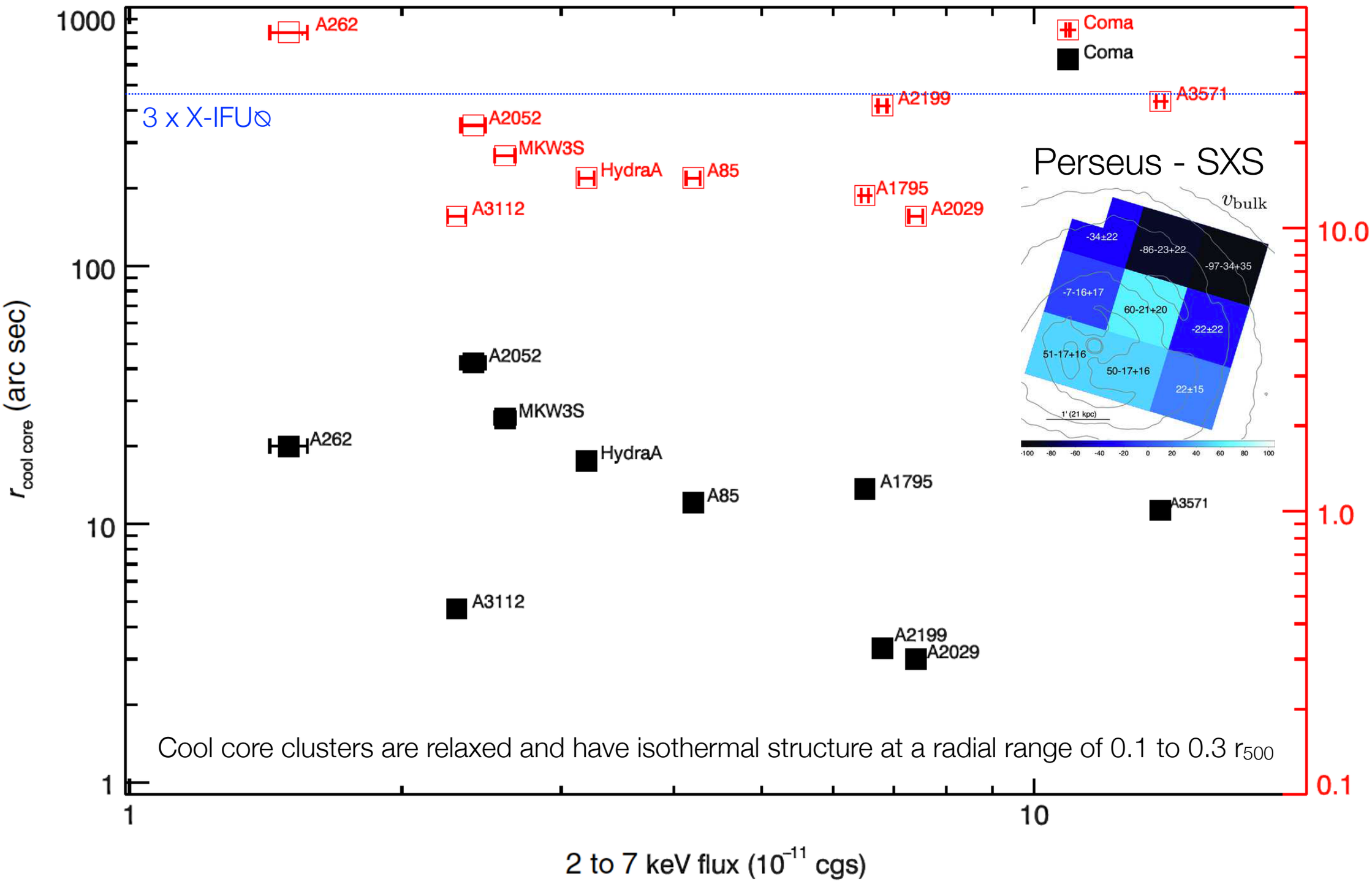


Vradial



Galaxy clusters: energy scale and area

Guainazzi et al., 2015, JATIS, 1(4), 047001. Main inputs by J.Nevalainen (Tartu University)

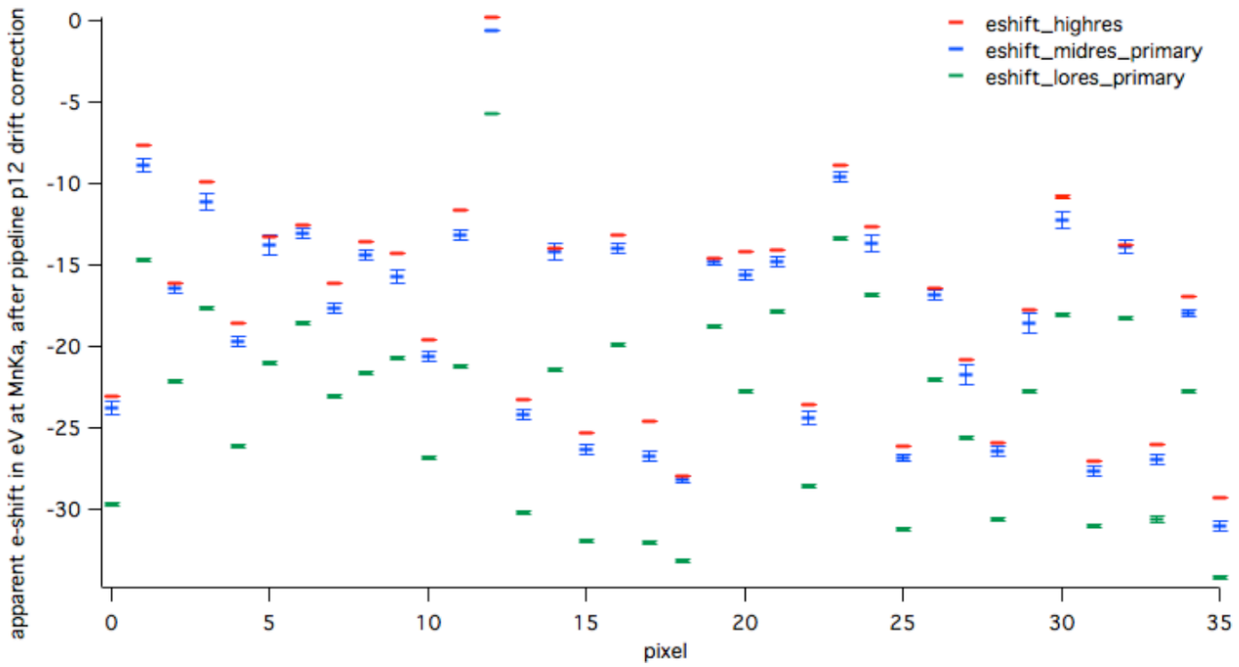


On-board calibration sources on the *Hitomi*/SXS

Eckart et al., 2017, ASTH-SXS-CALDB-GAINPIX

- Calibration pixel: ^{55}Fe
- Filter Wheel: ^{55}Fe
- Direct modulated X-ray source: Cr-K, Cu-K
- Indirect modulated X-ray source: MXS+AL/Mg targets (unclear if it would be used)

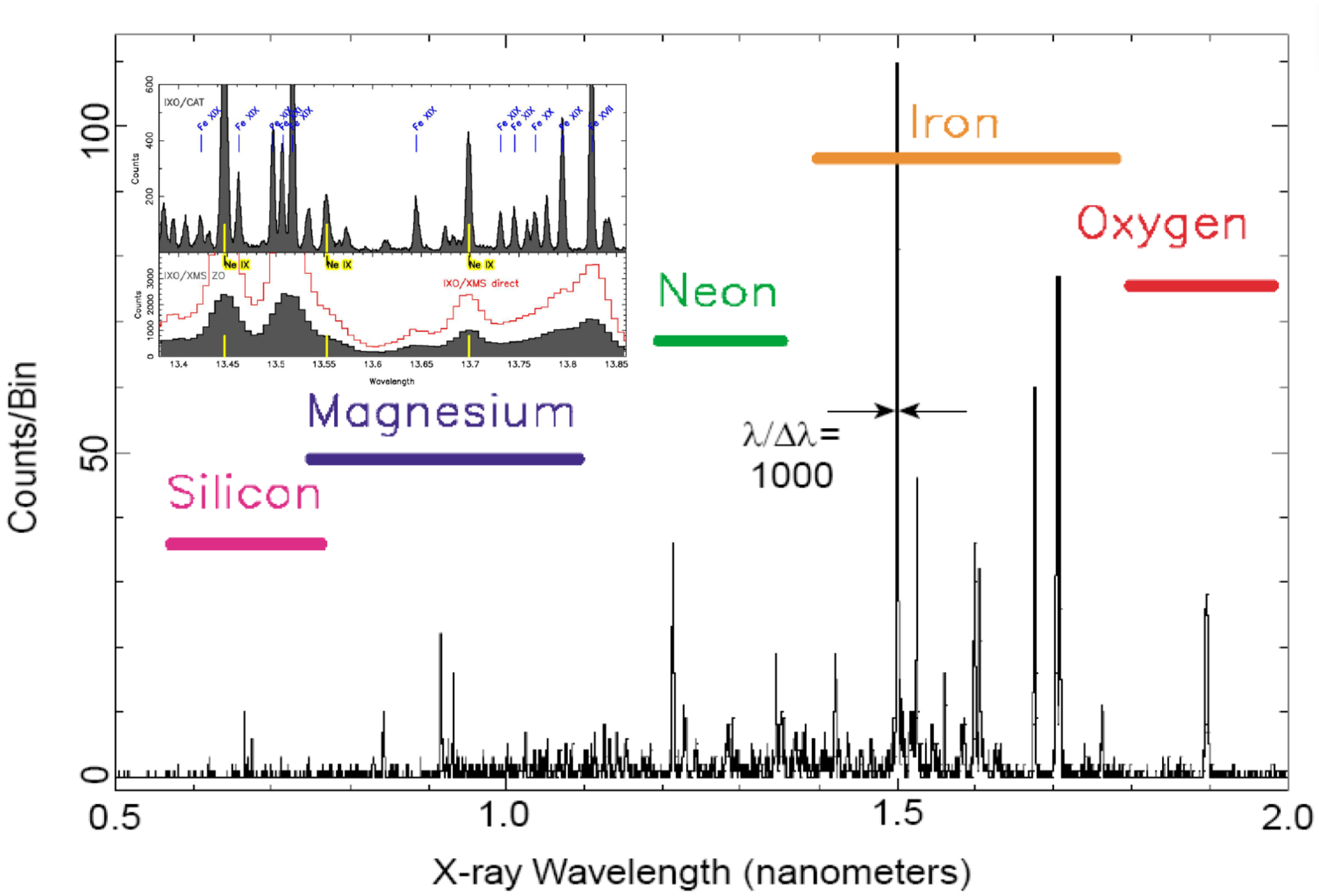
Energy shift per pixel from the FW ^{55}Fe (March 19)



Standards that we may need to revise

- LSF/energy scale at μ-calorimeter resolution for E≥2 keV?
- How to calibrate 3800 μ-calorimeter's pixels?
- How to calibrate R>1000 grating instruments?

Capella (lacking of better alternatives?)



Alternatives: σGem (longer orbital period), ISM?

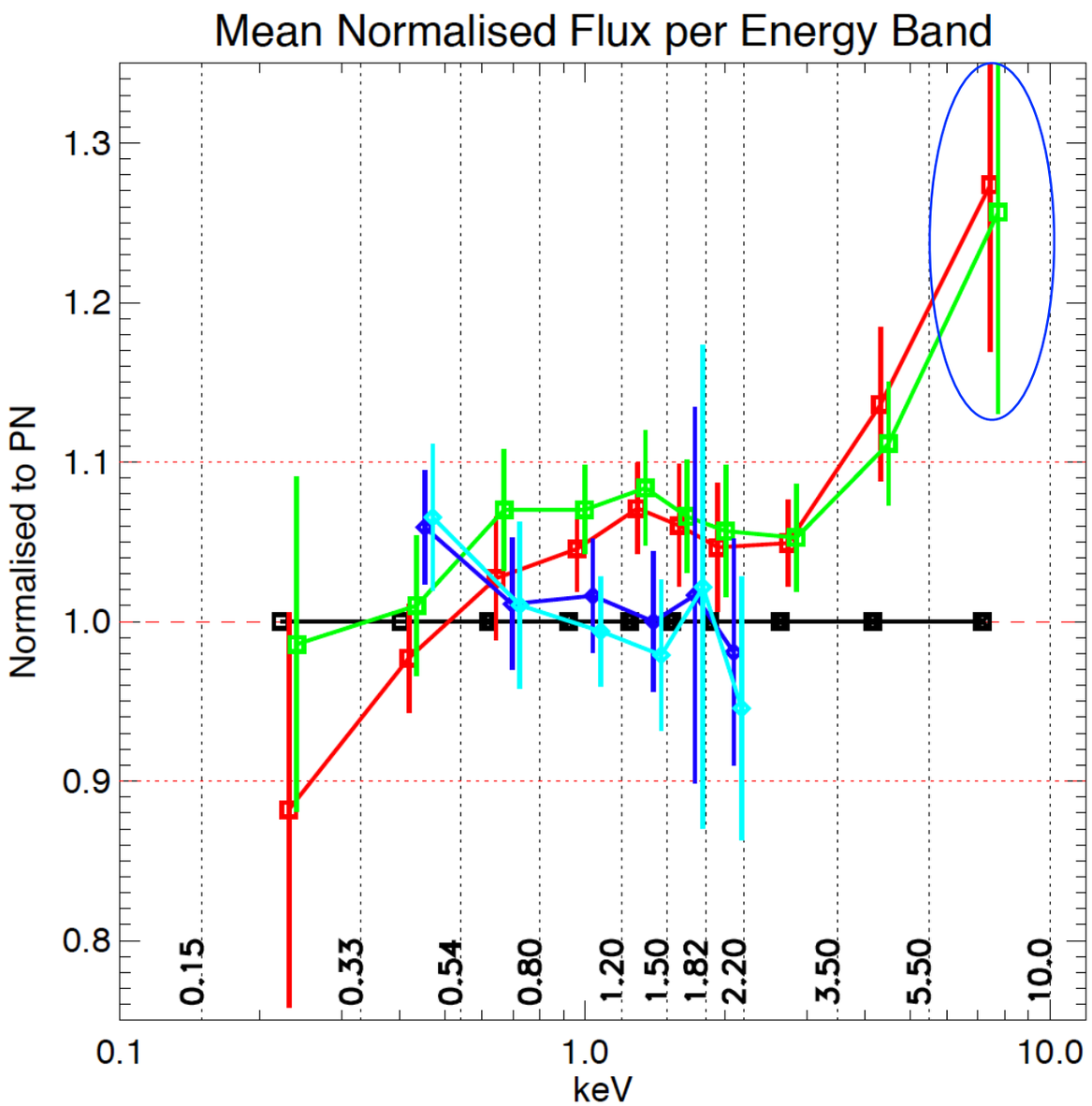
Standards that we may need to revise

- LSF/energy scale at μ-calorimeter resolution for E≥2 keV?
- How to calibrate 3800 μ-calorimeter's pixels?
- How to calibrate R>1000 grating instruments?
- Which featureless sources do we need for the future?

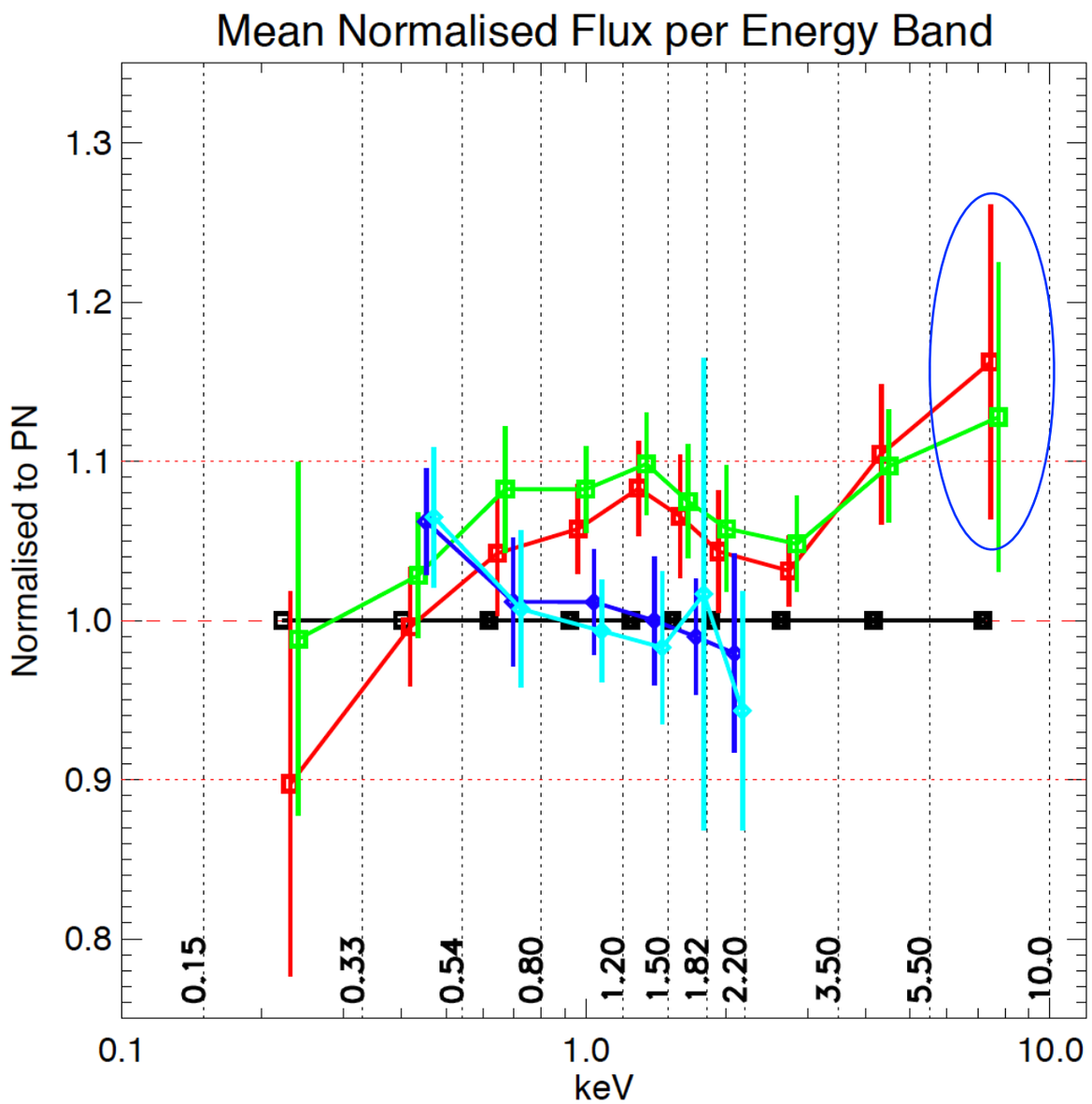
Cross-talk area vs. PSF

Smith et al., 2017, XMM-CCF-REL-348

2016 XMM-Newton PSF



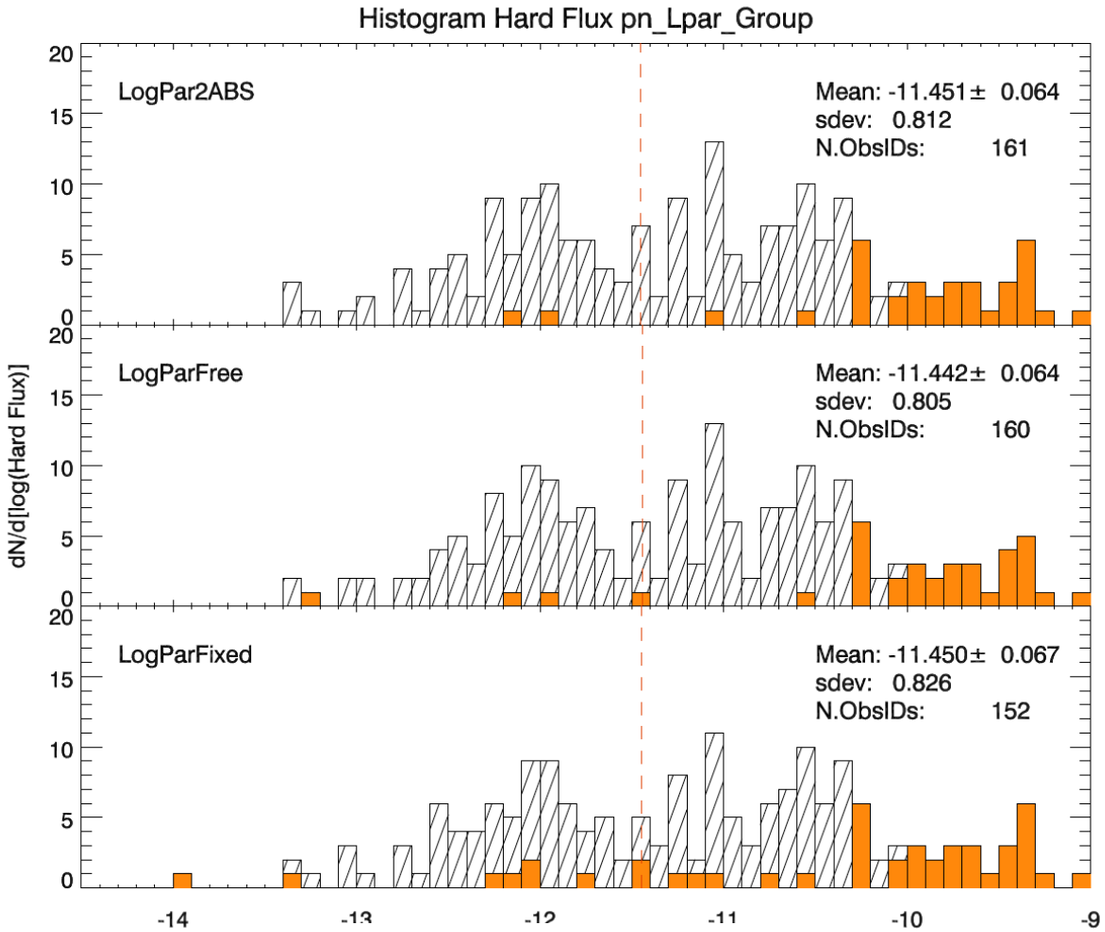
2017 XMM-Newton PSF



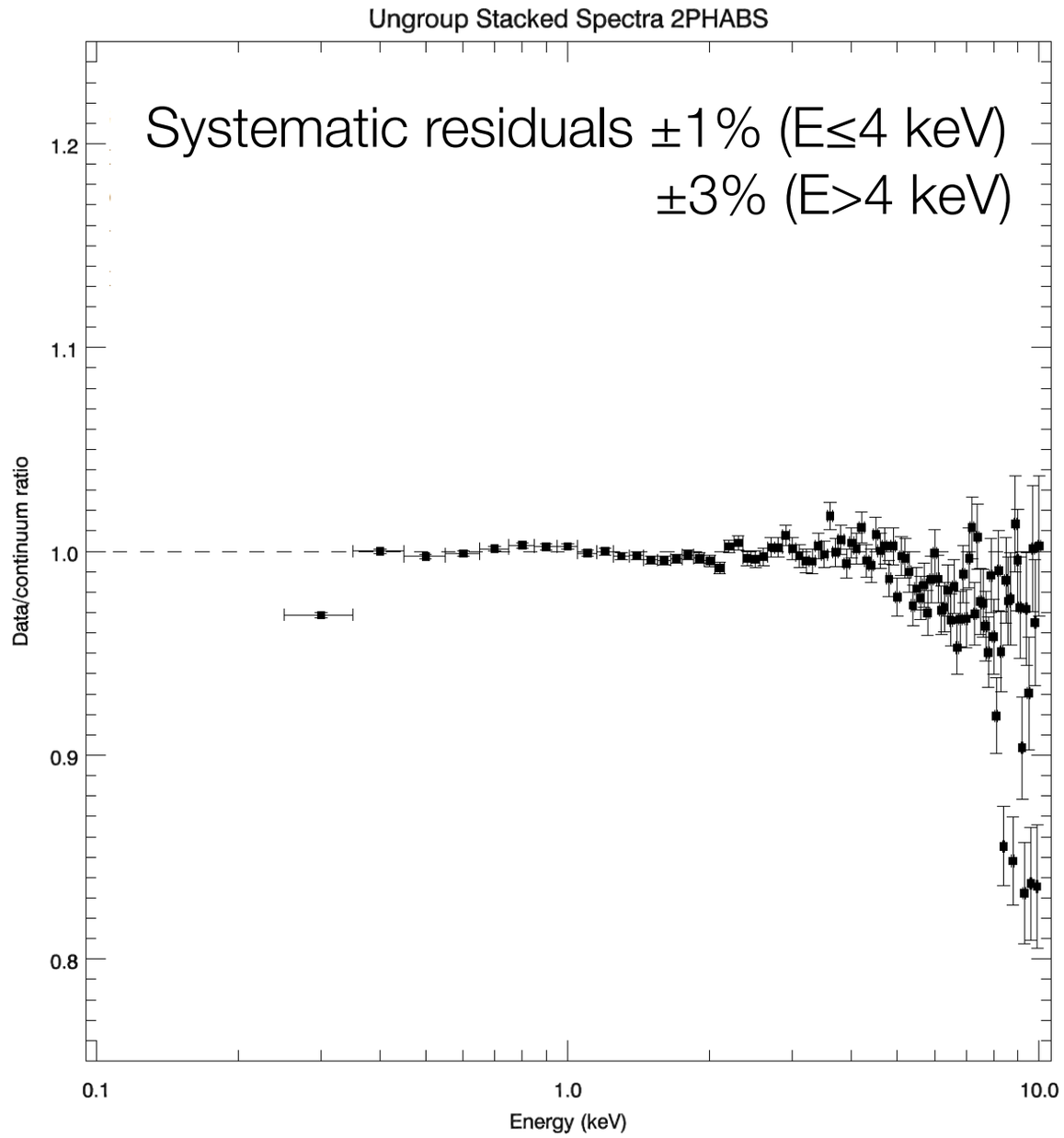
Secondary blazars

Rouco-Escudero et al., in preparation

Sample of 104 BLLac observed by XMM-Newton



2-10 keV flux



(in *Hitomi*: 1ES0033+595; see L.Brenneman's talk)