Thermal SNRs Working Group Report

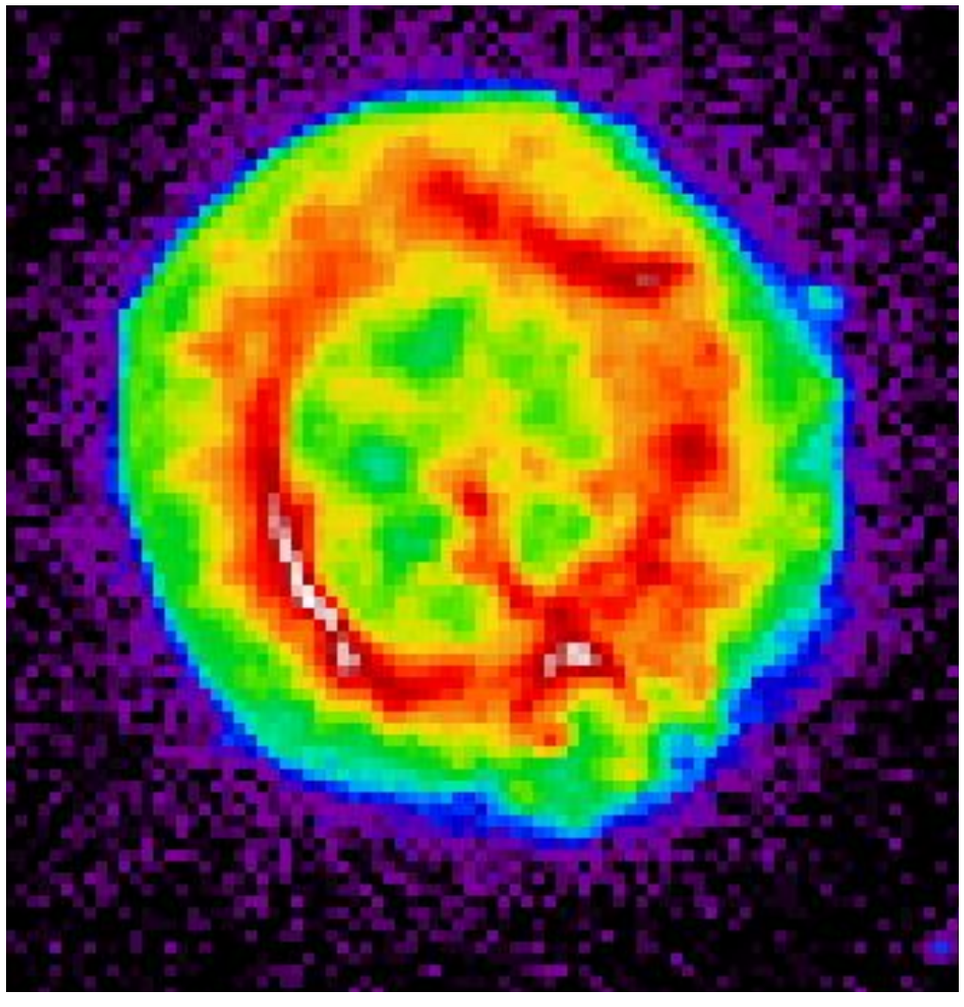
Paul Plucinsky on behalf of the IACHEC Thermal SNR Working Group

Thermal SNR Working Group

One of the "Standard candle" working groups.
This presentation is a summary report of this group's work:

XMM-Newton	Andy Pollock, Matteo Guainazzi, Martin Stuhlinger (ESAC)
Chandra HETG	Dan Dewey (MIT)
XMM-Newton MOS	Steve Sembay (Leicester)
XMM-Newton pn	Frank Haberl (MPE)
Chandra ACIS	Paul Plucinsky (SAO)
Suzaku XIS	Eric Miller (MIT)
Swift XRT	Andrew Beardmore (Leicester)
Models	Adam Foster (SAO)

E0102: X-ray brightest in the SMC
0.77X0.77 arcmin, 13X13 pc
t ~ 1,000 yr (Hughes et al. 2001)
L_X(0.3-10.0 kev) = 2.5x10^{37} ergs s^{-1}
no compact object
"O-rich" core-collapse SNR



ACIS 0.35-8.0 keV

N132D: X-ray brightest in the LMC
1.7X2.3 arcmin, 25x33.5 pc
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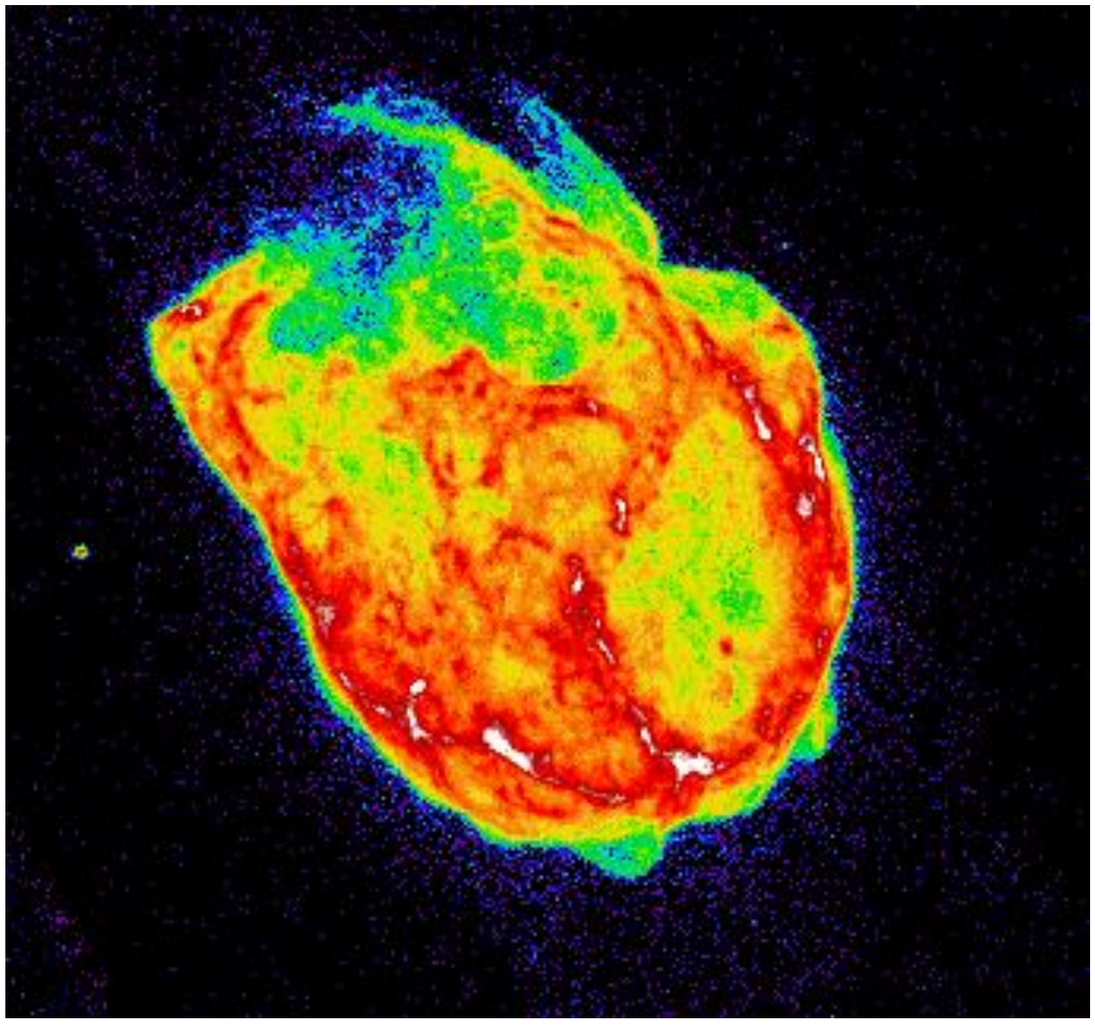

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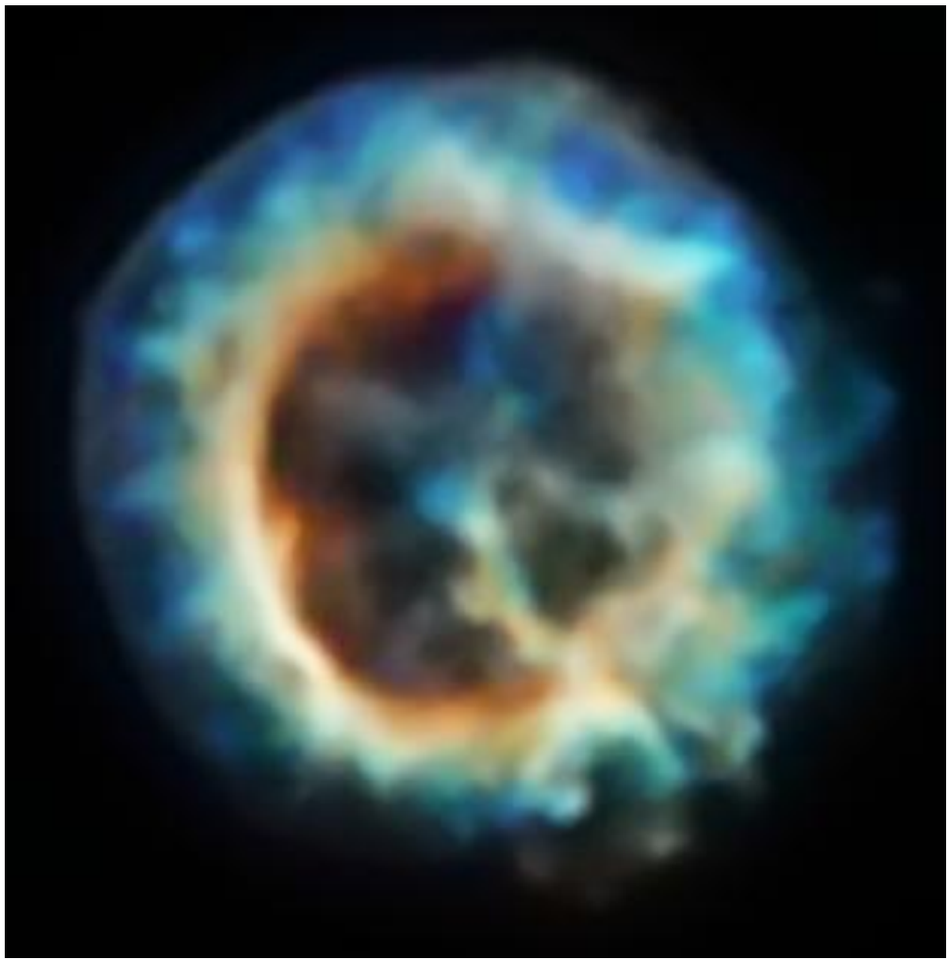

Red (0.3-0.5 keV), Green (0.5-0.75 keV)
Blue (0.75 – 7.0 keV)

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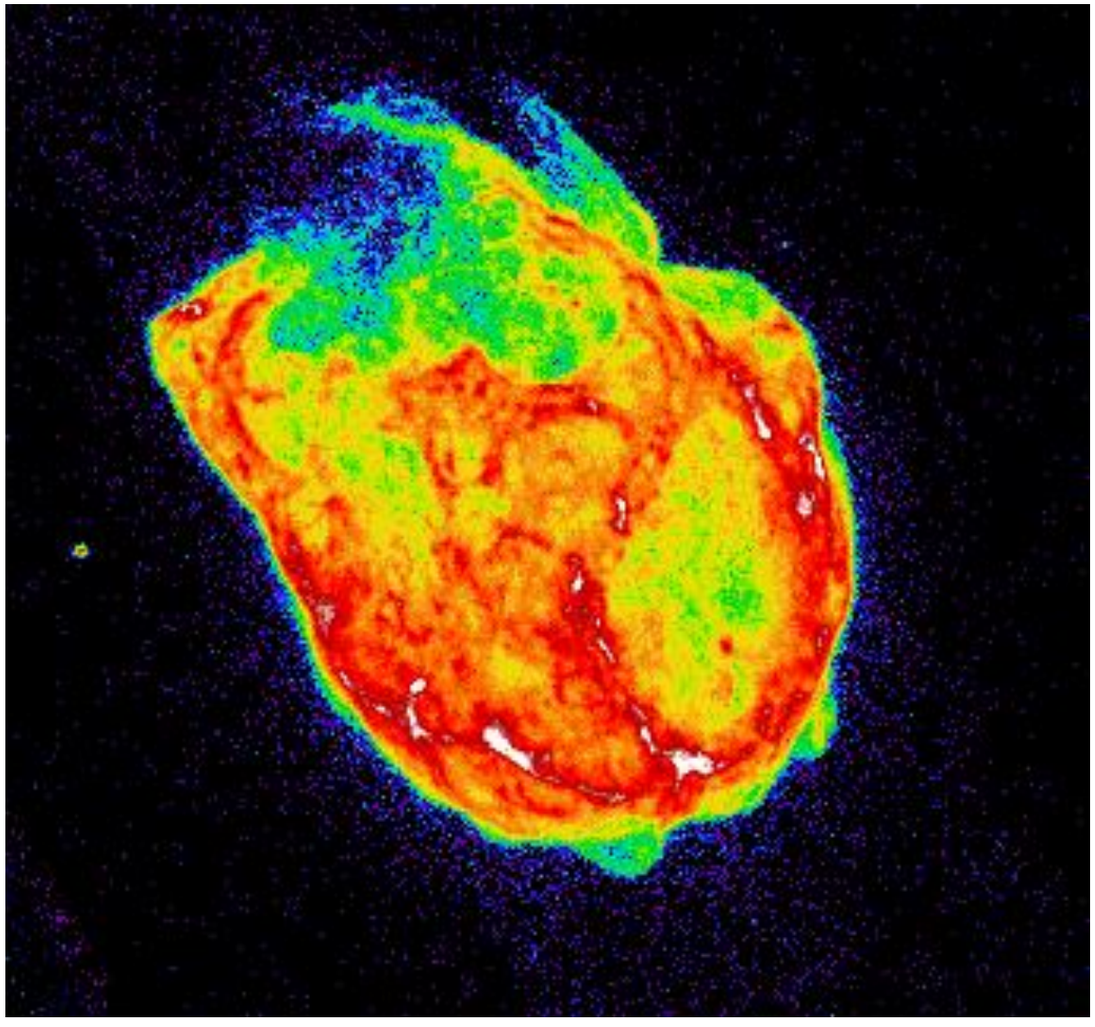

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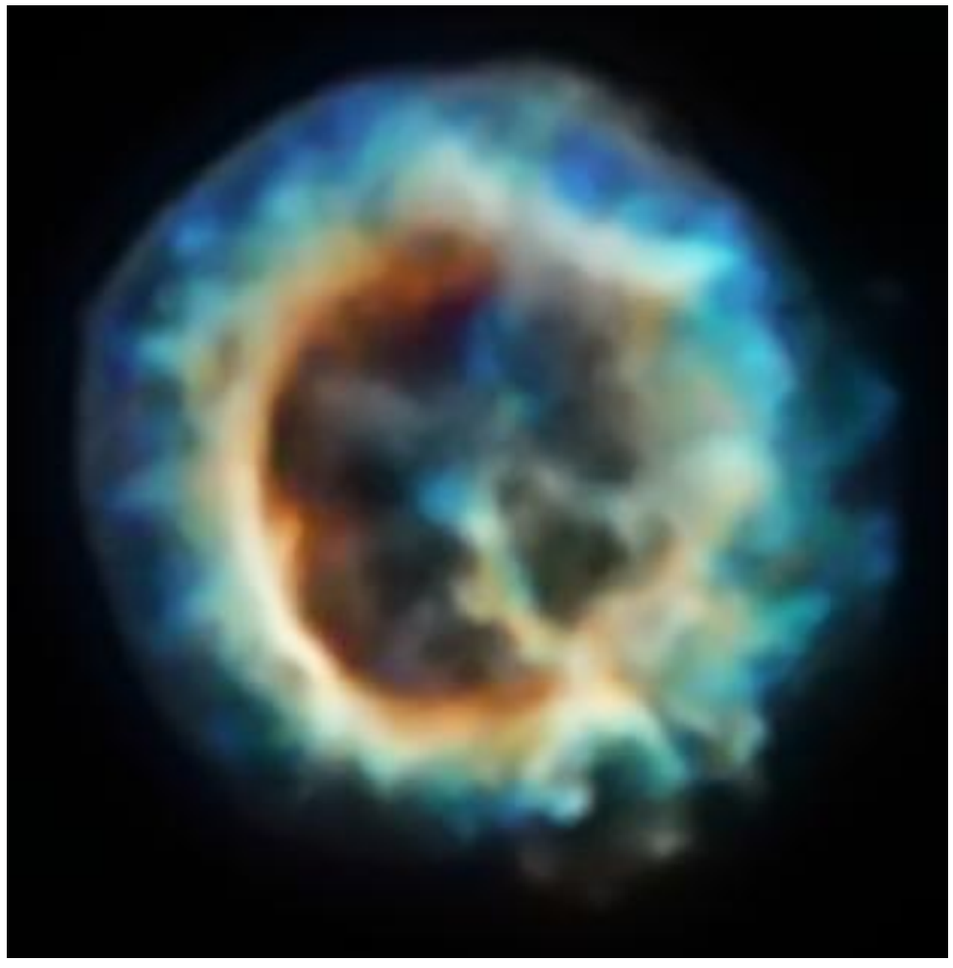

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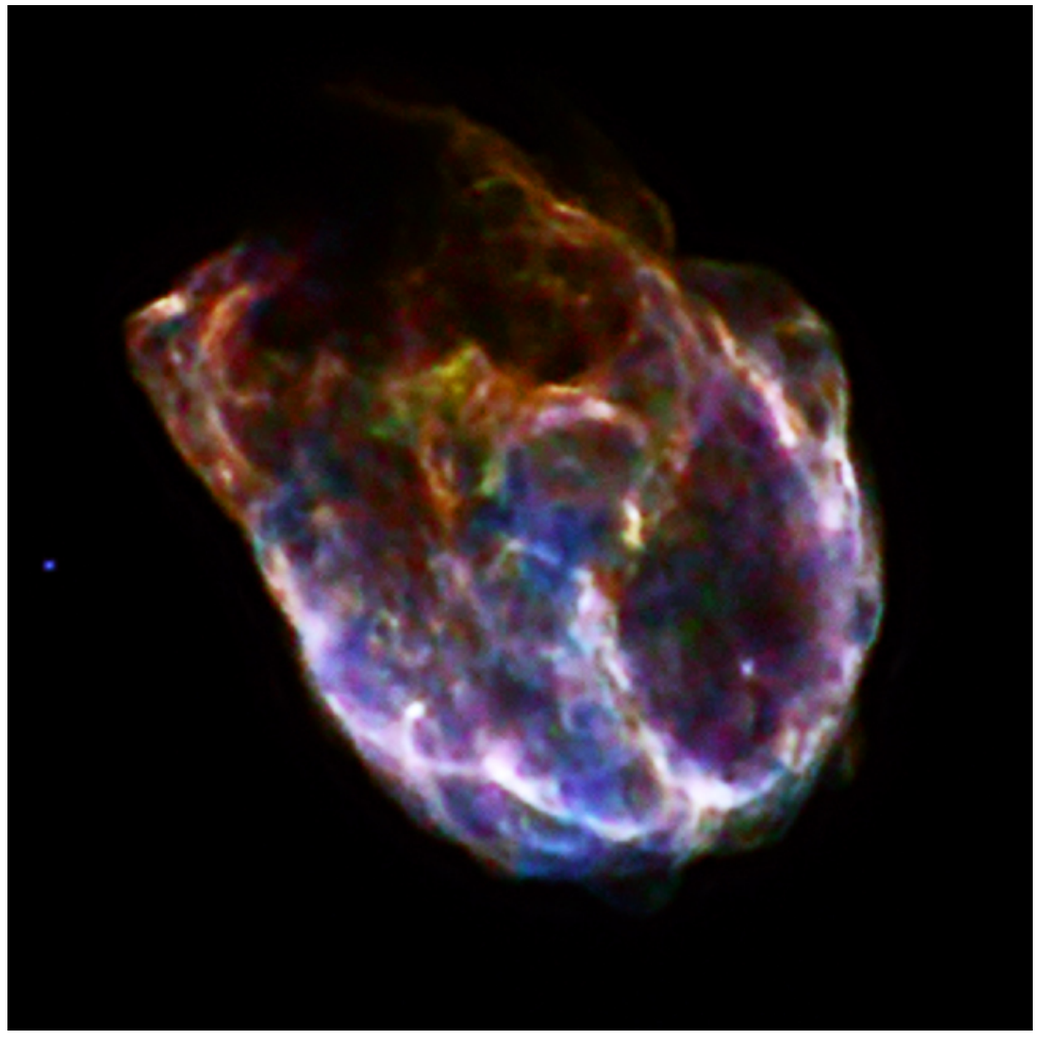
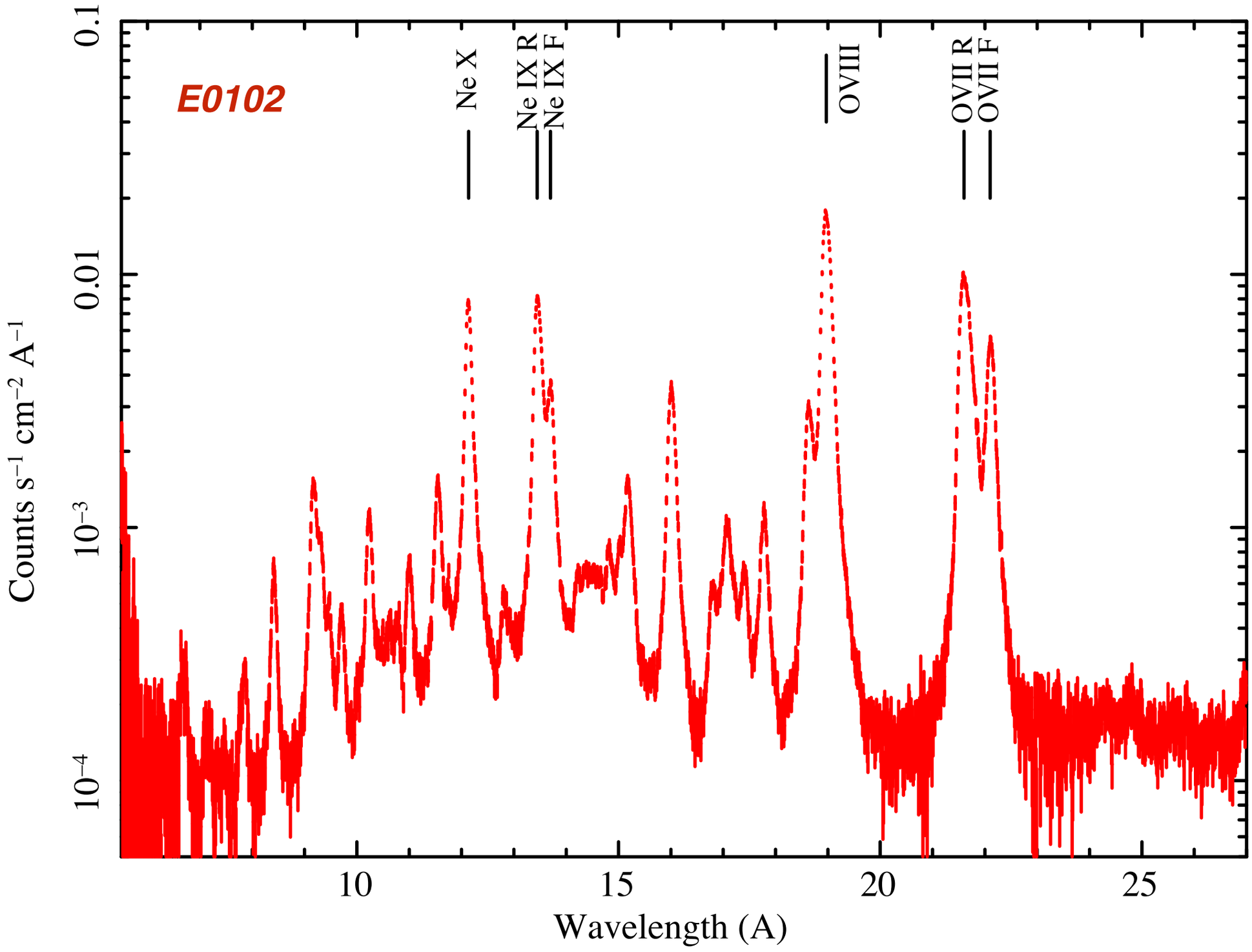


Red (0.3-0.75 keV), Green (0.8-1.1 keV),
Blue (1.1 – 2.0 keV)

RGS Spectra of E0102 & N132D

XMM RGS Courtesy A. Pollock (ESAC)



The Standard IACHEC Model

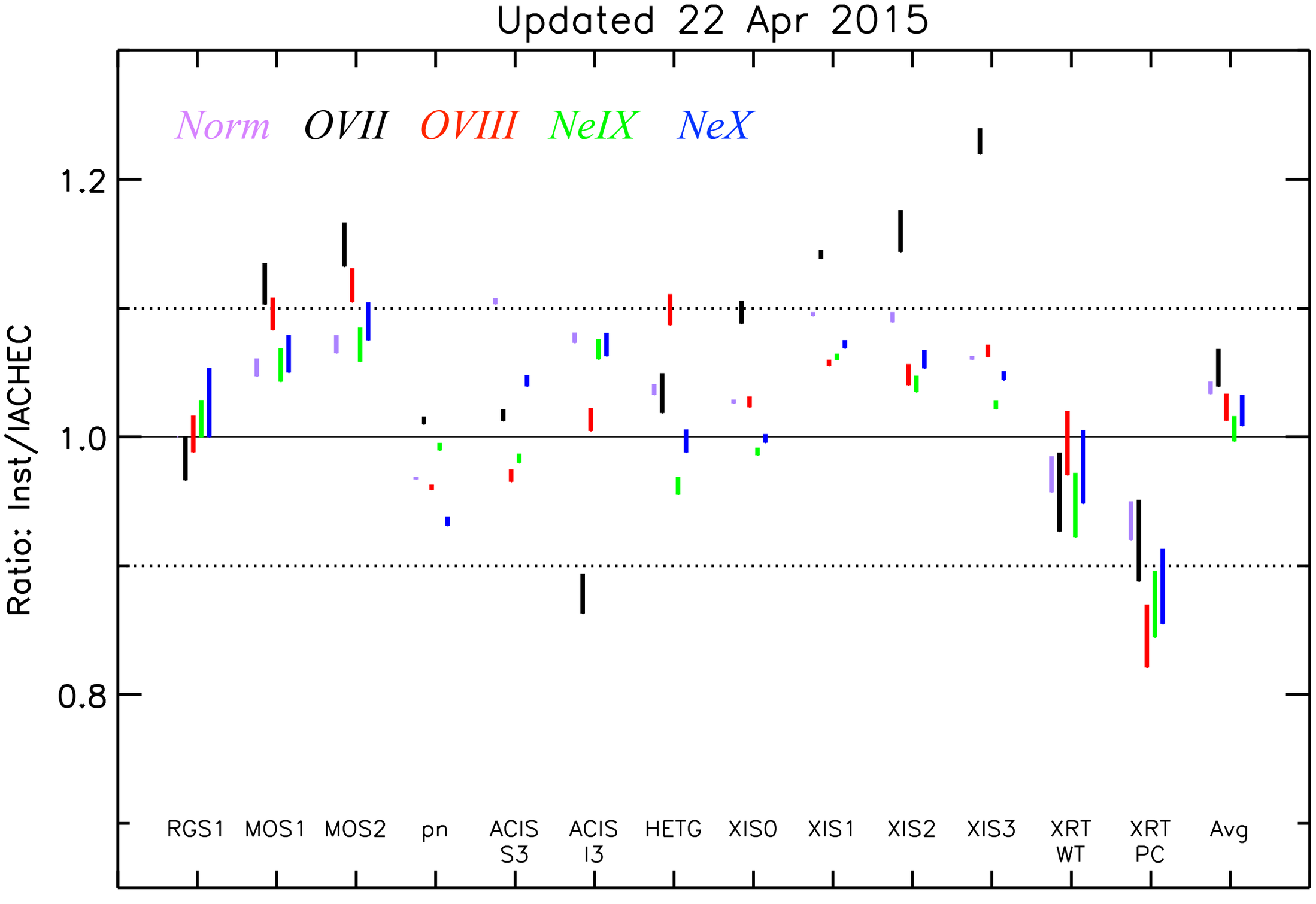
The IACHEC Standard model for E0102 has been unchanged for 5 years

The development of the model has been described in 2 SPIE papers and in previous IACHEC meetings:
Plucinsky et al. 2008 SPIE
Plucinsky et al. 2012 SPIE

Uses of the E0102 Standard IACHEC Model

- ACIS - verify contamination model, check low energy gain, & monitor temporal changes
- MOS - verify contamination model, constrain redistribution function and monitor temporal changes
- pn - examine redistribution function at low energies
- XIS - develop contamination model, low energy gain and monitor temporal changes
- XRT - examine redistribution function at low energies and check response in PC and WT modes

E0102: Comparison of Fitted Normalizations relative to the IACHEC Model



N132D Data

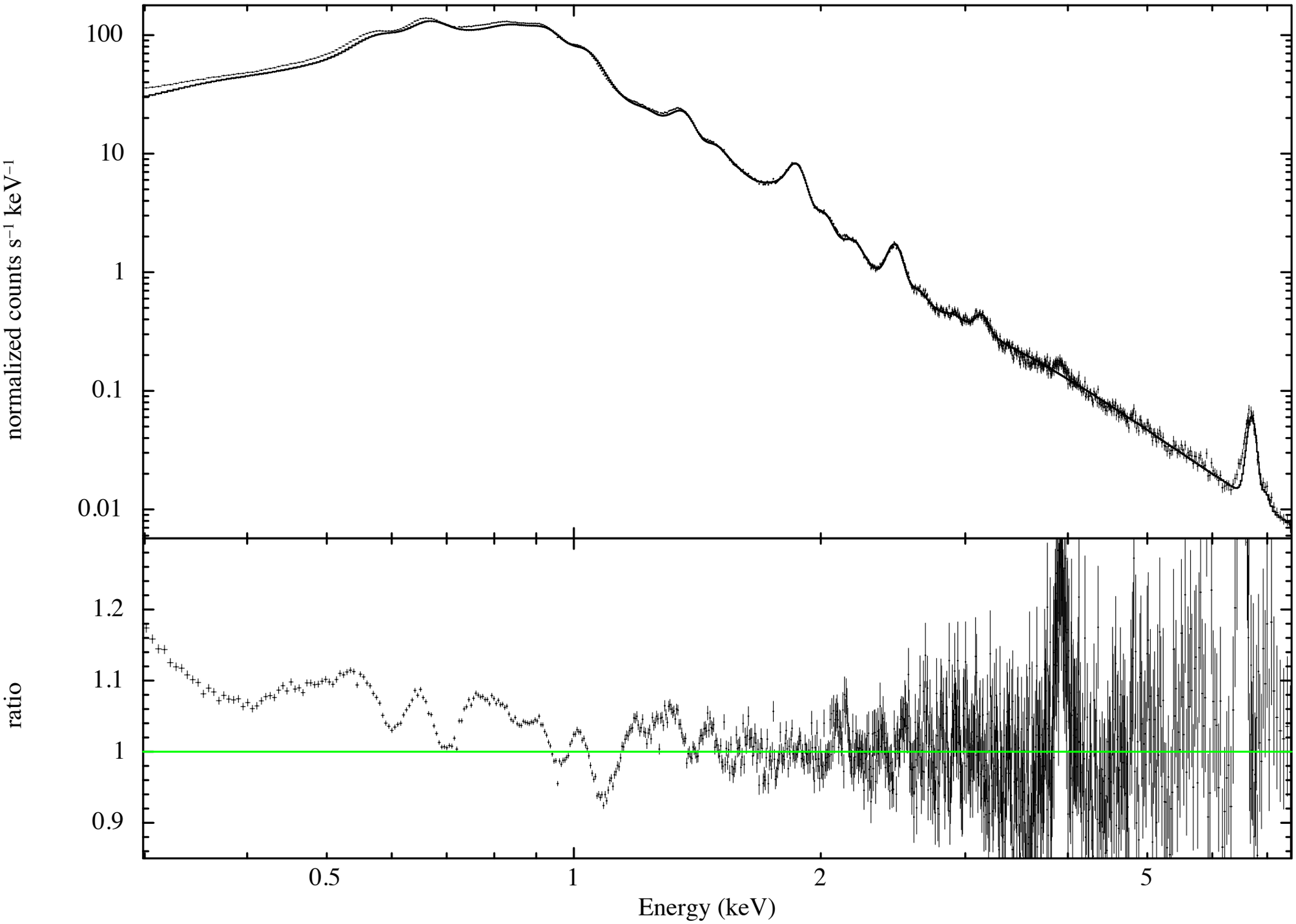
- 44 XMM pn observations, 39 MOS1/MOS2 observations
- Only pn data in Small Window mode (10/44) can be used since Large Window mode and Full frame have significant pileup
- Gain is allowed to adjust in pn fits, just an offset, slope is set 1.0 per Frank's suggestion. This only works in a narrow bandpass.
- Ideally we want a non-linear gain correction that works across the entire 0.3-10.0 keV bandpass
- Only MOS data in PrimePartialW3 mode are used
- Steve recommends that three observations had a less accurate CTI correction since they were acquired before the FP temperature was reduced (24/39 observations)
- Steve pointed out that we used a non-standard pattern selection for the MOS data
- Steve wants to investigate the bad columns that intersect the extraction region and check that they are accounted for properly
- Only two ACIS observations exist, one with the HETG and one without the HETG, the observation without the HETG is significantly piled-up
- 10 Suzaku XIS observations
- XIS0,3 (FI CCDs) have Si edge residuals which Eric will investigate, XIS1 is a BI CCD and does not have these residuals
- a handful of Swift XRT observations

N132D Model Development

- **Version 2.6 of the IACHEC model was developed by Martin, Andy, and Matteo based on RGS and pn data**
- **Paul hacked v2.6 of the IACHEC model to add lines in the 1.5-3.5 keV region**
- **Paul set the widths of many lines to zero**
- **Paul set the ratio of the Resonance to Forbidden line in a triplet to be the value expected in CIE for a temperature of ~1.2 keV. Typically 1.7 - 2.0. Some triplets in the v2.6 line had all of the flux in the Resonance line or all in the Forbidden line.**
- **Paul fit in the 1.5-3.5 keV and allowed the normalization of the 1.13 keV continuum and the power-law to vary. This improves the fit in the 1.5-3.5 keV range but makes the fit at low energy worse.**
- ***Background is currently modeled as a power-law, we should remove this and allow each instrument to add their own detector-specific background model.***
- **We want a model that works across the entire bandpass from 0.3 to 10.0 keV so we plan to go back to the version 2.6 model and attempt to merge the v2.9 model with the v2.6 model**

N132D 10 pn spectra with v2.9 model

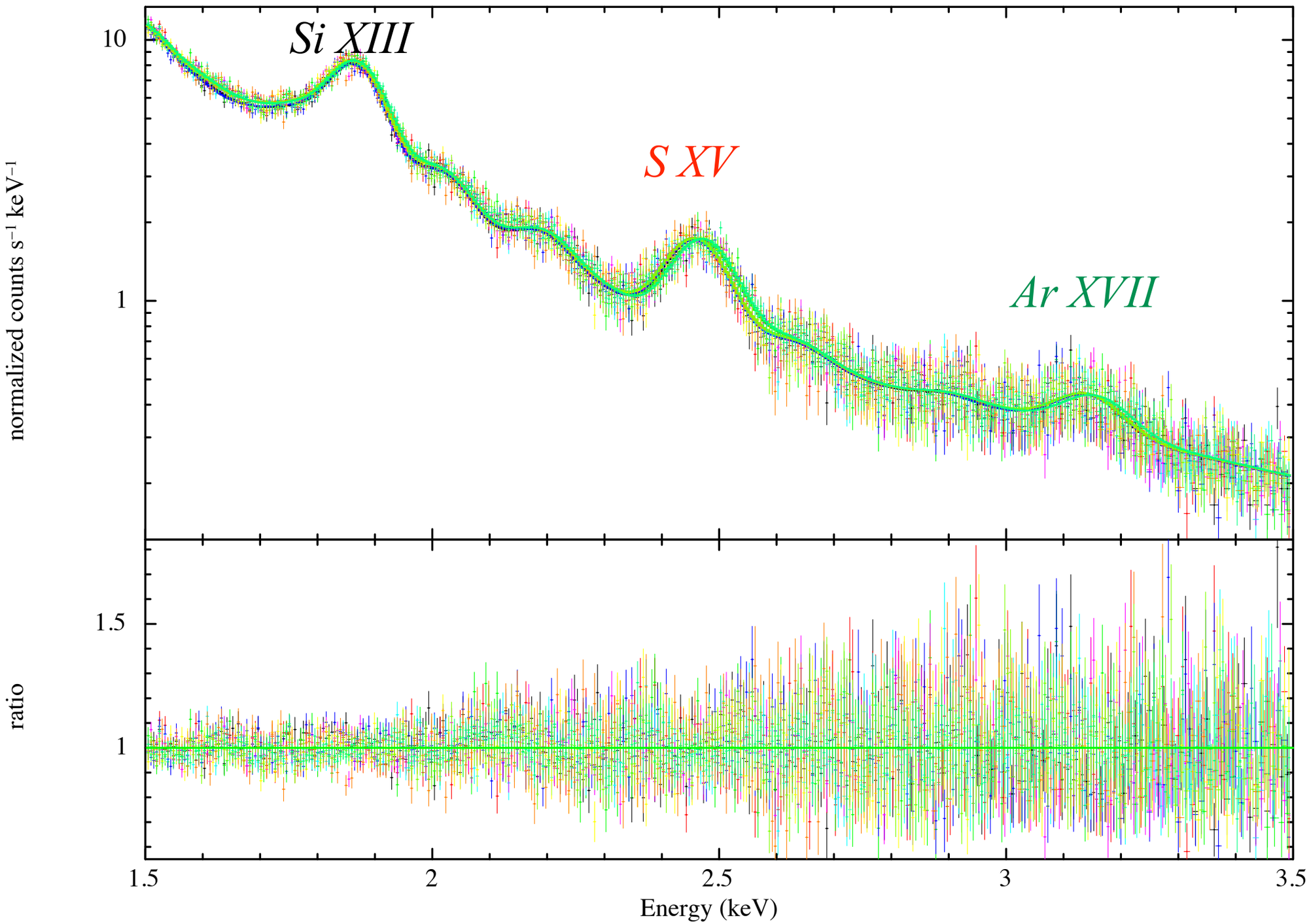
N132D: 10 pn spectra with v2.9 IACHEC mode overplotted
data and folded model



Model and gain shifts for the pn optimized for the 1.5-3.5 keV range. The v2.6 model fits better across the entire bandpass.

N132D pn Spectral Fits

N132D, pn, fit 10 SW mode spectra simultaneously, gain offset free for each,
CStat=4369,DOF=3996,PChi=1.09,Norm=0.917,Si XIII For=4.7e−4,S XVII For=1.28e−4



Gain allowed to vary for each of the 10 observations individually

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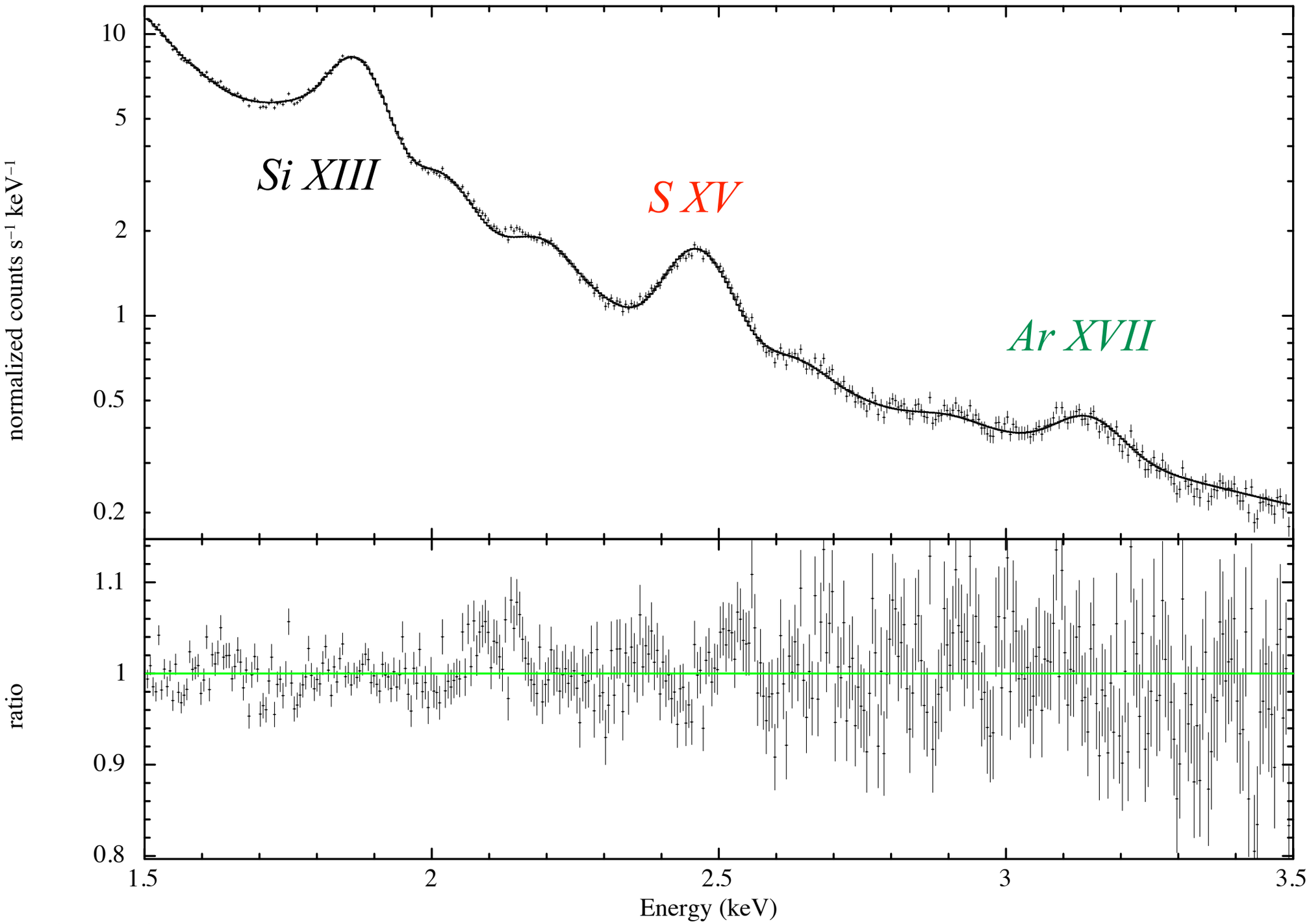

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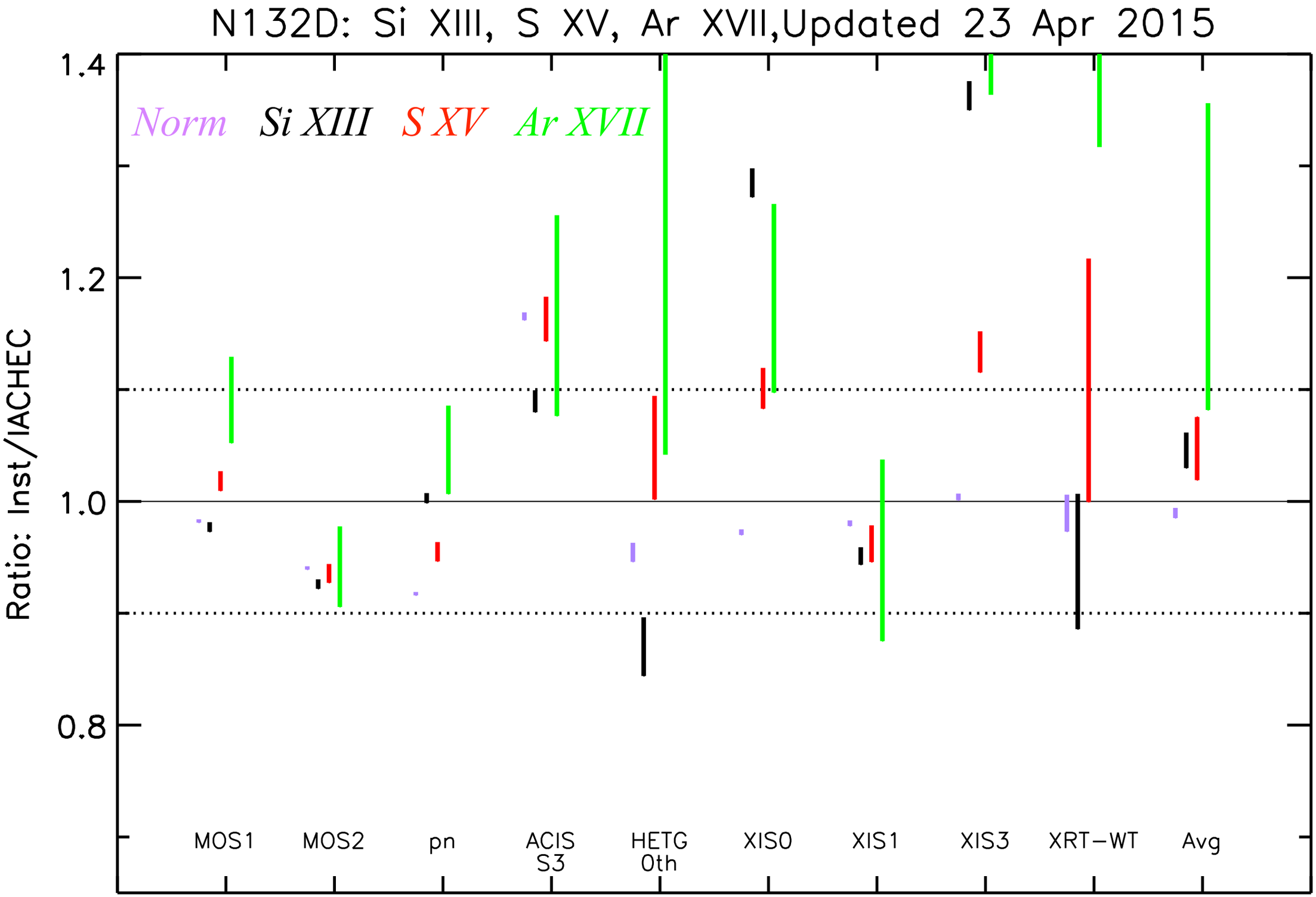
N132D: Comparison of Fitted Norms for S XIII, S XV, & Ar XVII



Plan for Post-IACHEC Activities

E0102

- *decide on presenting representative, early-mission data in the multi-instrument comparison plot and the time history of each instrument versus presenting simultaneous fits in the multi-instrument comparison plot*
- *submit A&A paper*

N132D

- *Matteo volunteered to lead the effort to merge the v2.6 and v2.9 models to provide a good fit across the entire 0.3-10.0 keV band*
- *remove the power-law to model the sky and instrument background and each instrument will add a sky and instrument background model appropriate for their instrument*
- *MOS data need to be reprocessed with standard grade set*
- *Steve needs to check bad column correction in MOS*
- *Develop a non-linear gain correction for the pn data and apply the correction to the events and do NOT use "gain fit" in XSPEC*
- *the WG will then fit N132D and compare the normalizations for Si XIII, S XV, and Ar XVII*