Thermal SNR Working Group: Activities over the Last Year

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 (ESAC)
Chandra HETG	Dan Dewey (MIT)
XMM-Newton MOS	Steve Sembay (Leicester)
XMM-Newton pn	Frank Haberl (MPE)
Chandra ACIS	Jenny Posson-Brown, Joe DePasquale, & Paul Plucinsky (SAO)
Suzaku XIS	Eric Miller (MIT)
Swift XRT	Andrew Beardmore (Leicester)
Models	Adam Foster & Randall Smith (SAO)

Activities Over the Last Year

① Use the standard IACHEC model for 1E 0102.2-7219 to test the calibration products for the various instruments

The major challenge over the last few years has been characterizing ***the time-dependent*** performance of the various instruments:

ACIS: ***contamination*** (CTI & gain)

MOS: ***patch & contamination(?)*** (CTI)

pn: most stable, (spectral redistribution function and gain)

RGS: ***contamination***

HETG: ***contamination*** on ACIS

XIS: ***contamination*** (CTI, charge injection)

XRT: CTI

② Development of IACHEC standard model for N132D

Led by Matteo & Andy based on RGS data

③ Transition our fitting methodology to using unbinned spectra, the C statistic & modeling background

Chandra X-Ray Observatory

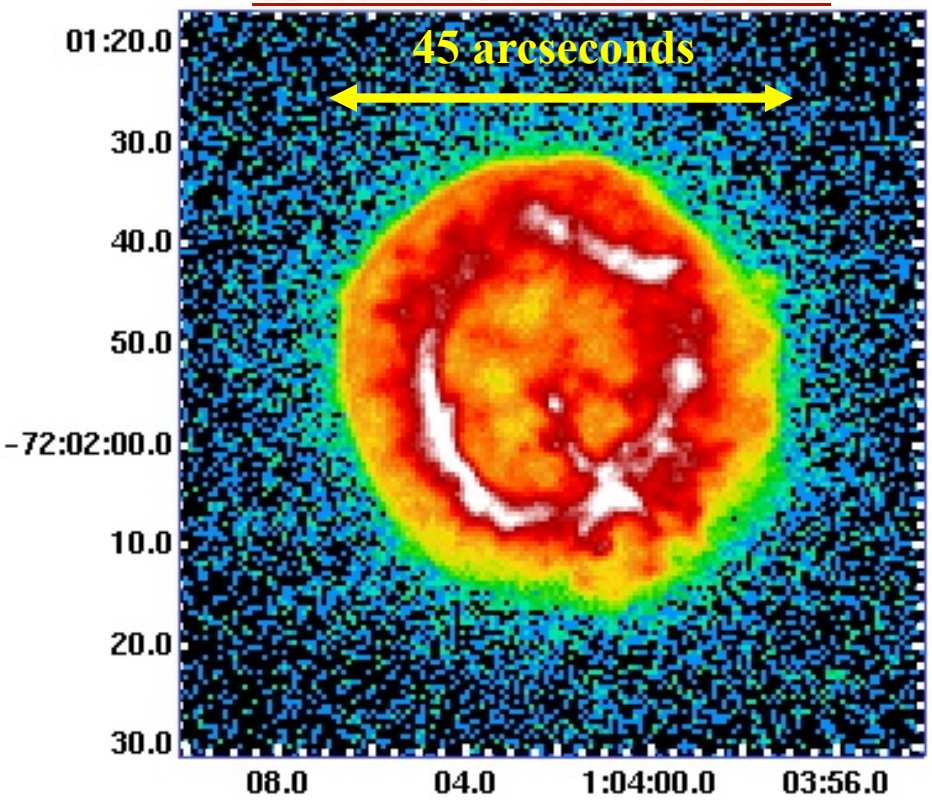
CXC

E0102 "The Nearly Perfect Calibration Source"

- Simple morphology - but significant spectral variations as a function of position
- Extended source - minimizes pileup, small size minimizes impact of PSF effects
- Simple spectrum – very little or perhaps no Fe !
- Constant – very little time variability

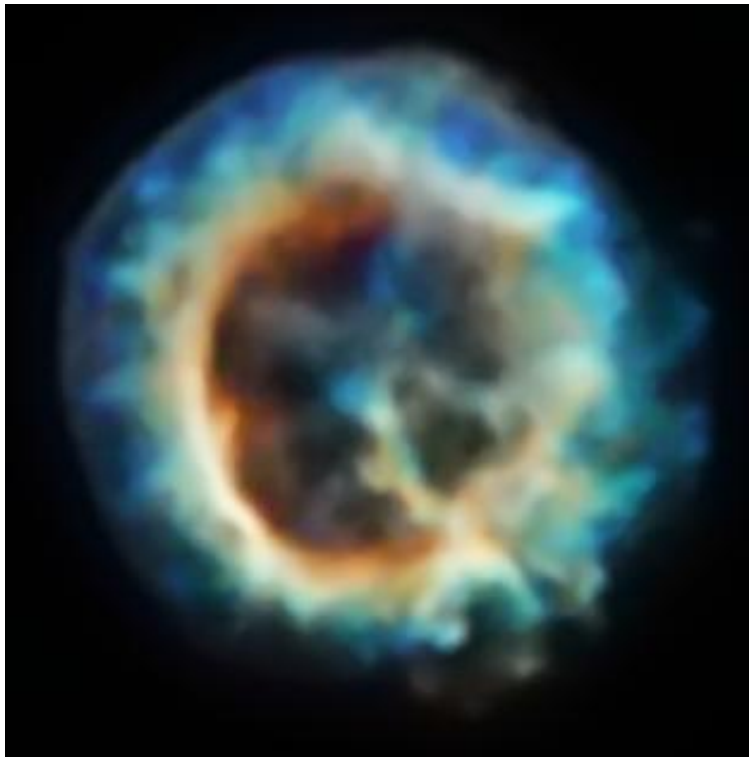
DePasquale (SAO)

S3 Summed Data ~248 ks

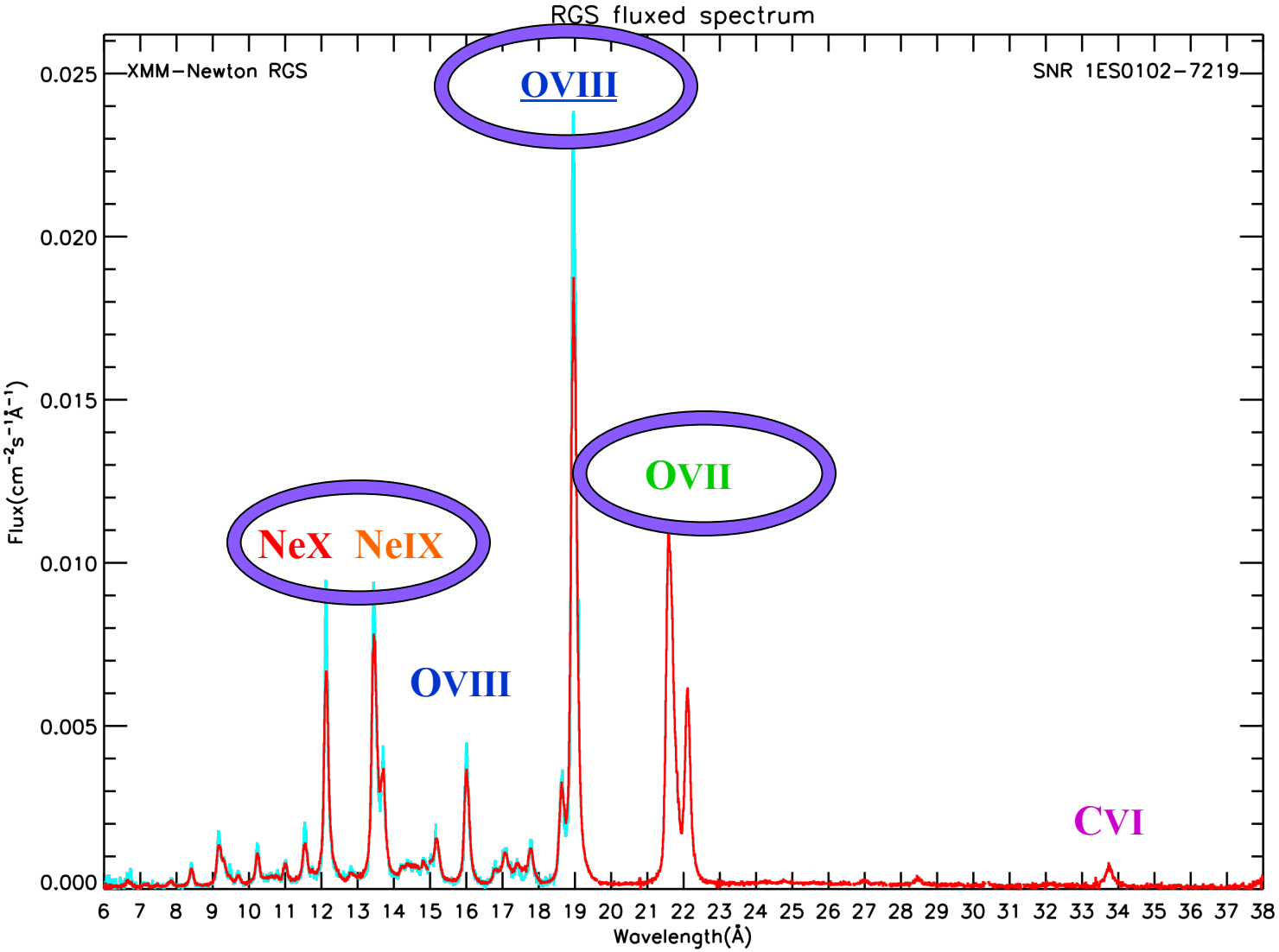


Three Color Image

Red: 0.2-0.75 keV, Green: 0.8-1.1 keV, Blue: 1.1-2.0 keV



XMM-Newton RGS Spectrum of E0102:



Pollock (ESAC)

Relatively simple spectrum dominated by O & Ne,

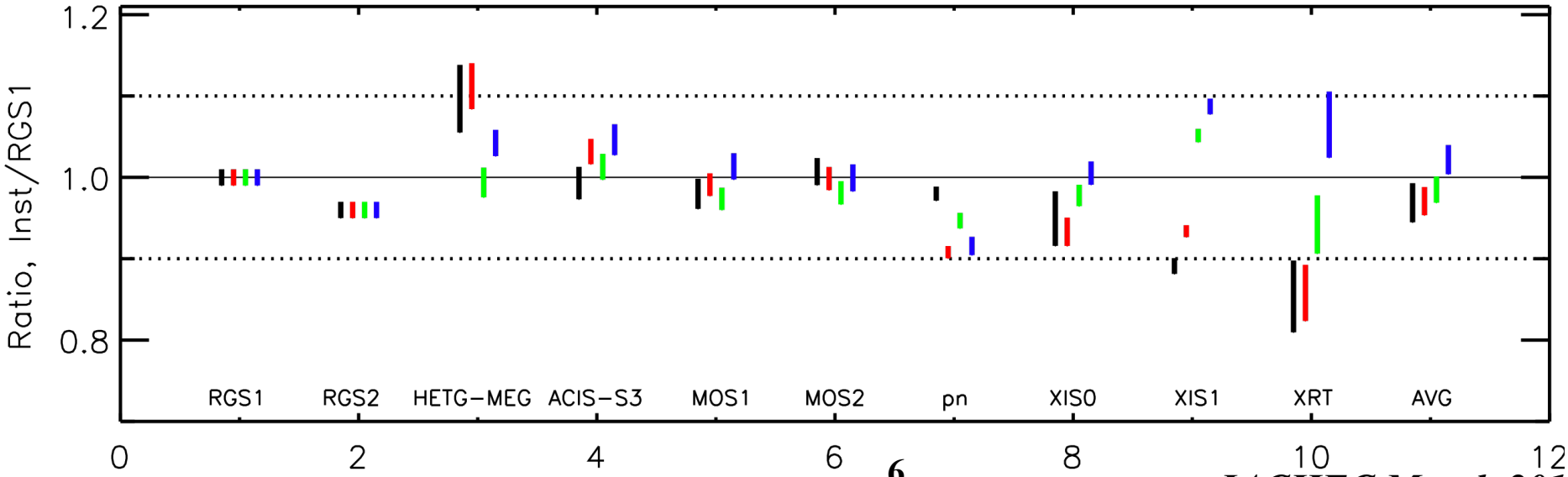
little or no Fe emission

In most applications, line energies & widths are frozen, only 4 normalizations are allowed to vary **OVII**, **OVIII**, **NeIX**, & **NeX**

Comparison of Fluxes for Bright Line Complexes:

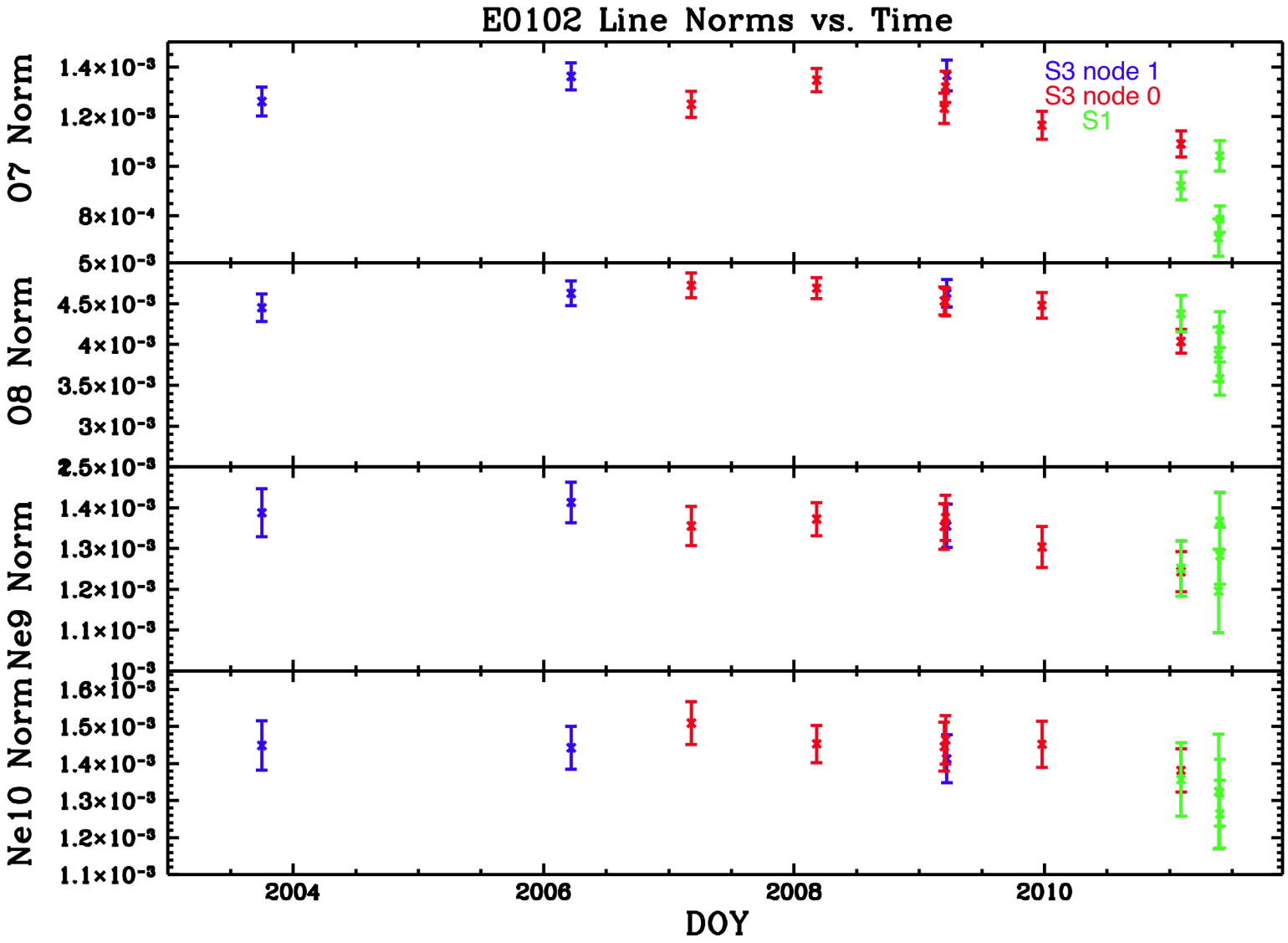
- Results published in 2008 SPIE (Plucinsky et al. 2008, SPIE, Vol. 7011, arXiv:0807:2176)
- Only 5 or 7 free parameters, normalizations for the OVII triplet (560-574 eV), the OVIII Ly-a (654 eV), the NeIX triplet (905-922 eV), and the NeX Ly-alpha line (1022 eV) and gain for some of the instruments
- Fitted normalizations for the OVII, OVIII, NeIX, and NeX line complexes agree to +/- 10%
- based on only a ***handful*** of the available E0102 observations
- we are struggling with how to make a meaningful comparison of the various instruments over their mission lifetimes that is useful for the observer communities of the various missions

OVII black **OVIII red** **NeIX green** **NeX blue** ***DePasquale(SAO)***



Monitoring the ACIS Contamination

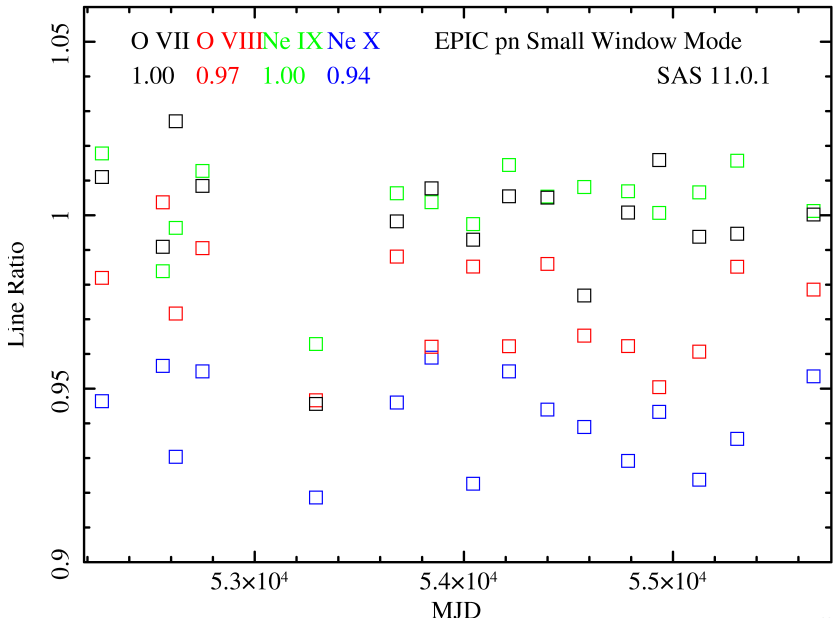
ACIS contamination model is generated based on cal source and HETG data and E0102 is used to verify the model



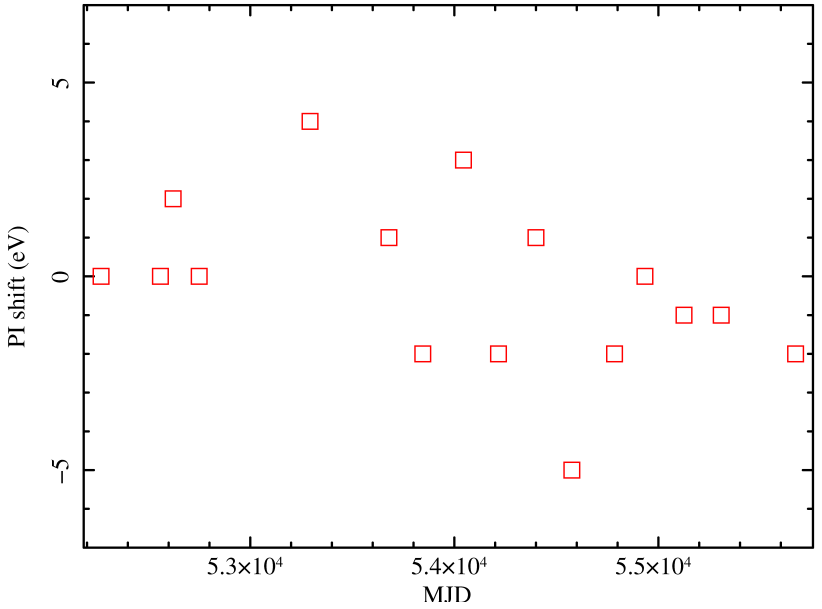
XMM pn Response Frank Haberl (MPE)

- pn team uses E0102 to check the response model
- line normalizations are stable to within a few percent over the mission
- the pn is the most stable instrument among the instruments in this analysis
- the Ne X line normalization is about 5% low compared to the IACHEC model
- the pn team is still exploring issues with the spectral redistribution function and the gain variation from one observation to another

Norms vs. time



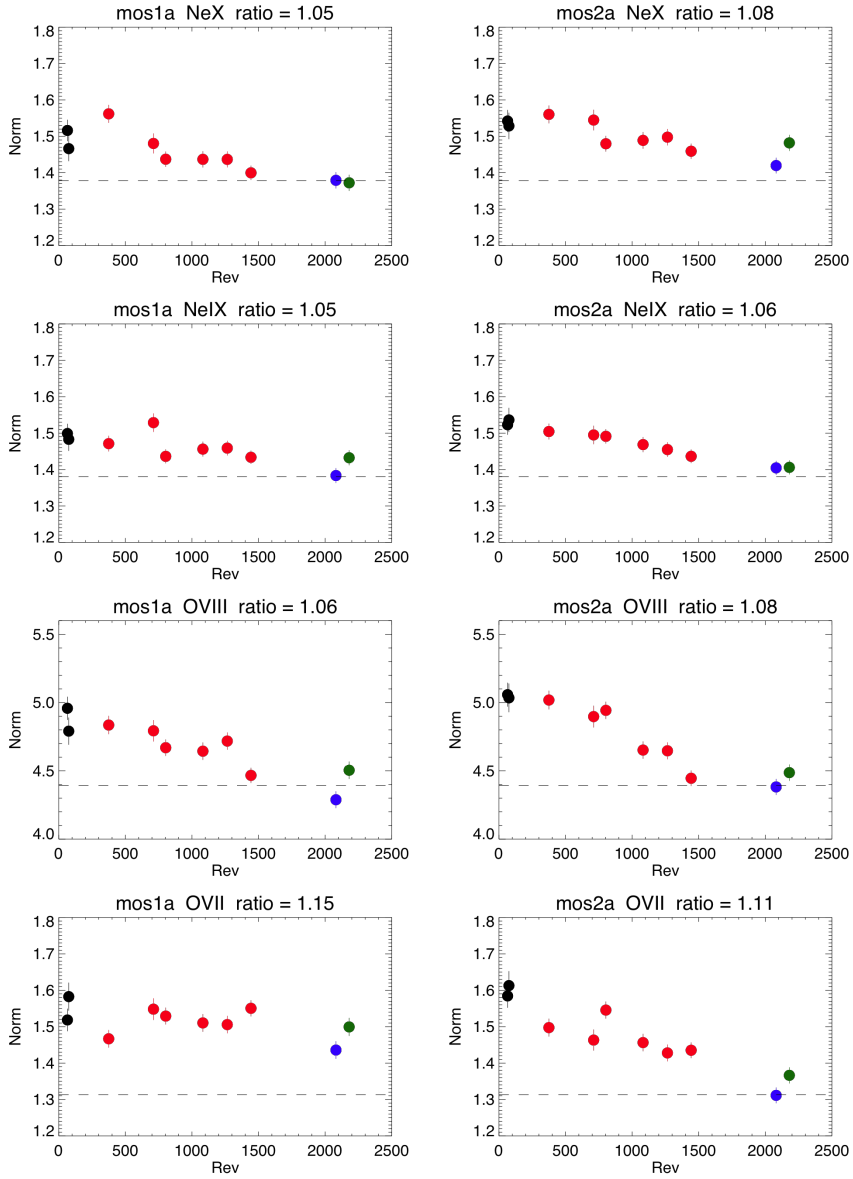
Gain vs. time



XMM MOS Response

Steve Sembay (Leicester)

- MOS1/MOS2 show a different evolution in time of the line normalizations
- is this contamination ?
- E0102 is also one of a standard set of sources that new response models for the MOS are verified against

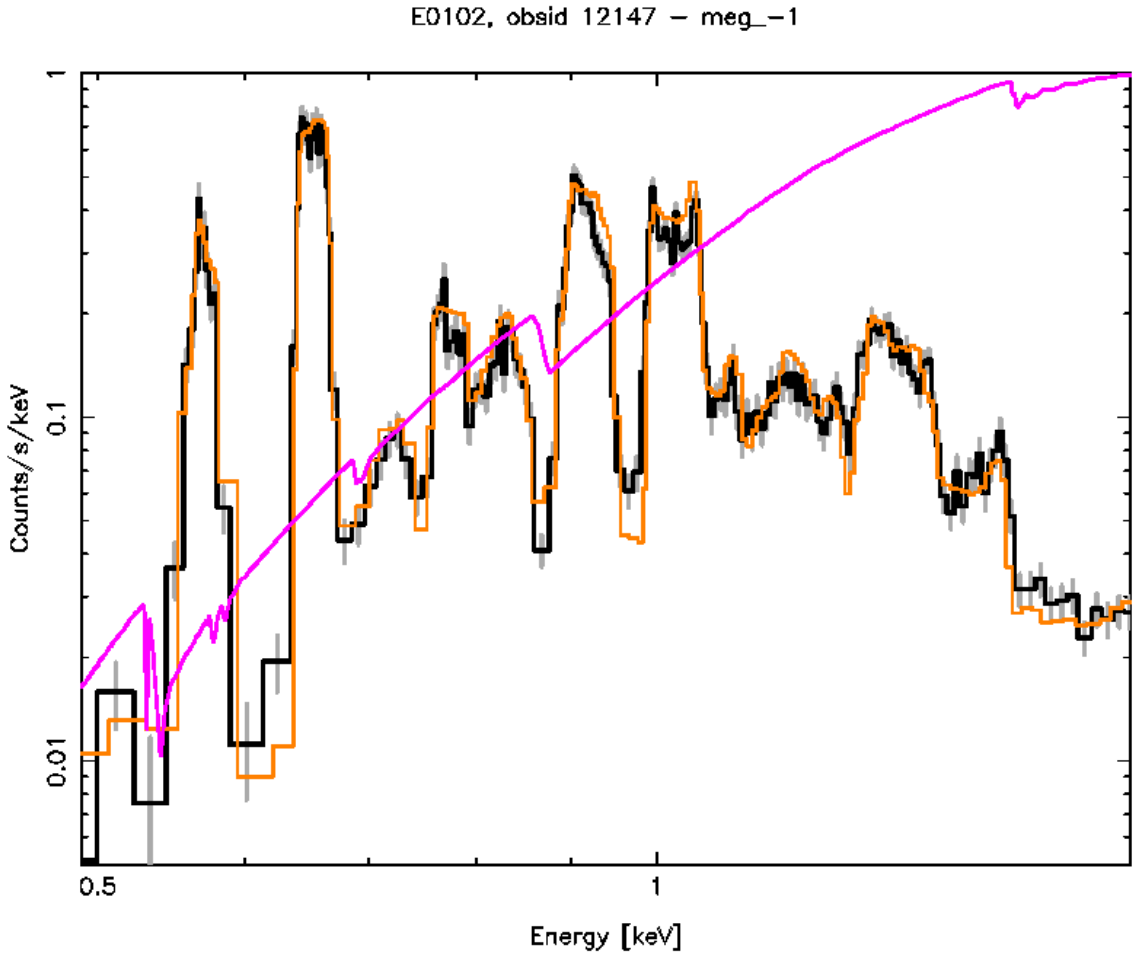


Chandra HETG Response

Dan Dewey (MIT)

- IACHEC model is compared to HETG data
- model includes broadening due to the extent of E0102
- provides a test of the ACIS contamination model at different locations on the ACIS-S array

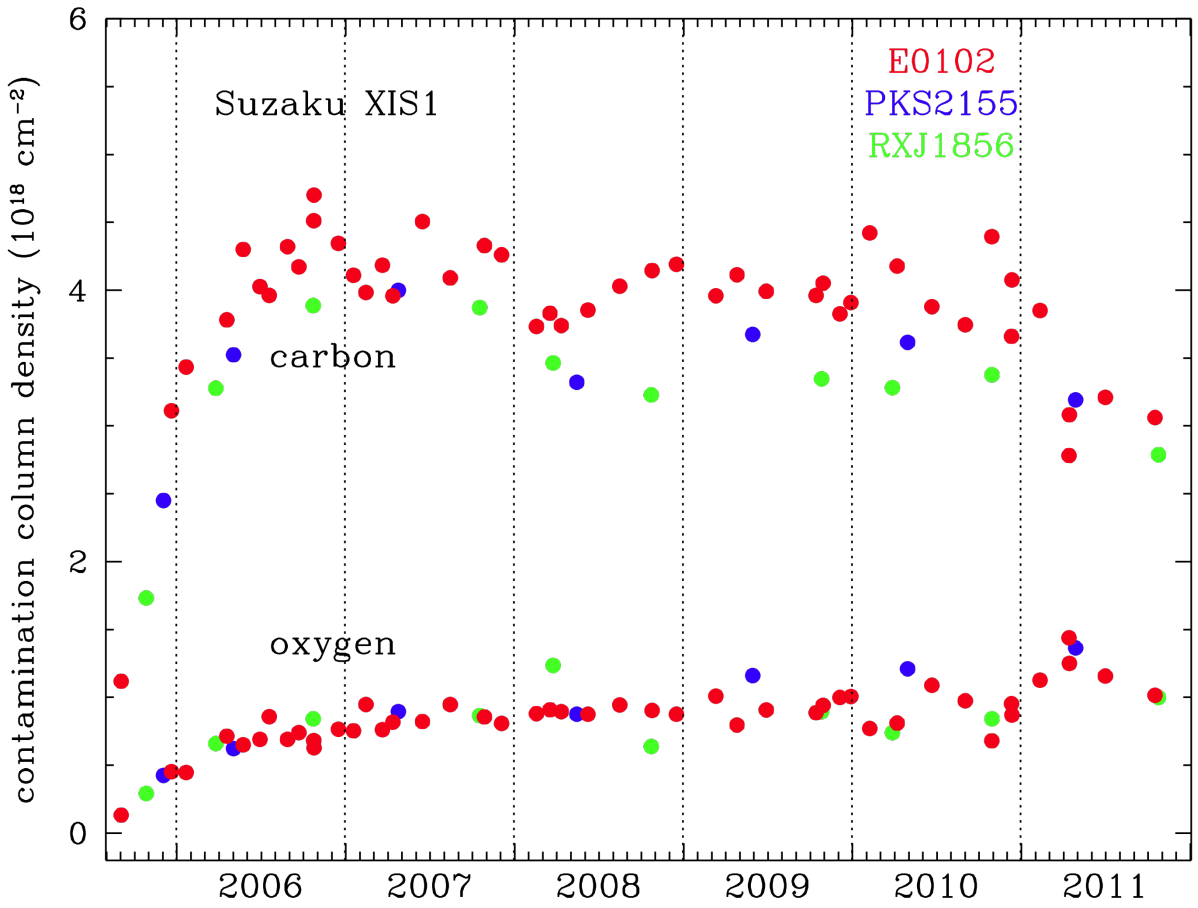
Data (black), model (orange), EA curve (magenta)



Suzaku XIS Response

Eric Miller (MIT)

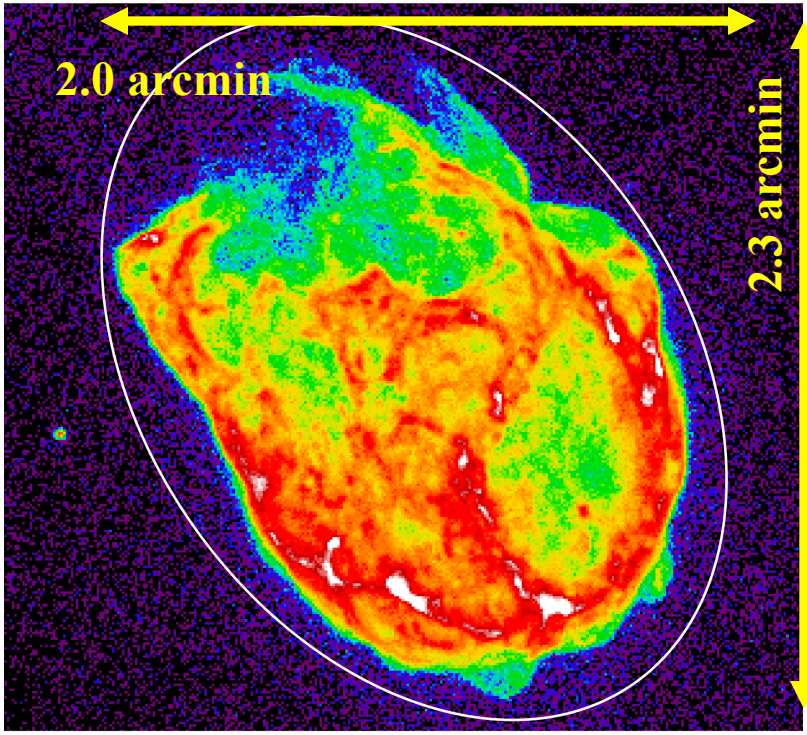
- IACHEC model is used to develop the contamination model for the XIS
- E0102 is the primary source to monitor the buildup of the contaminant
- different from ACIS where the contamination model is developed based on cal source and gratings data

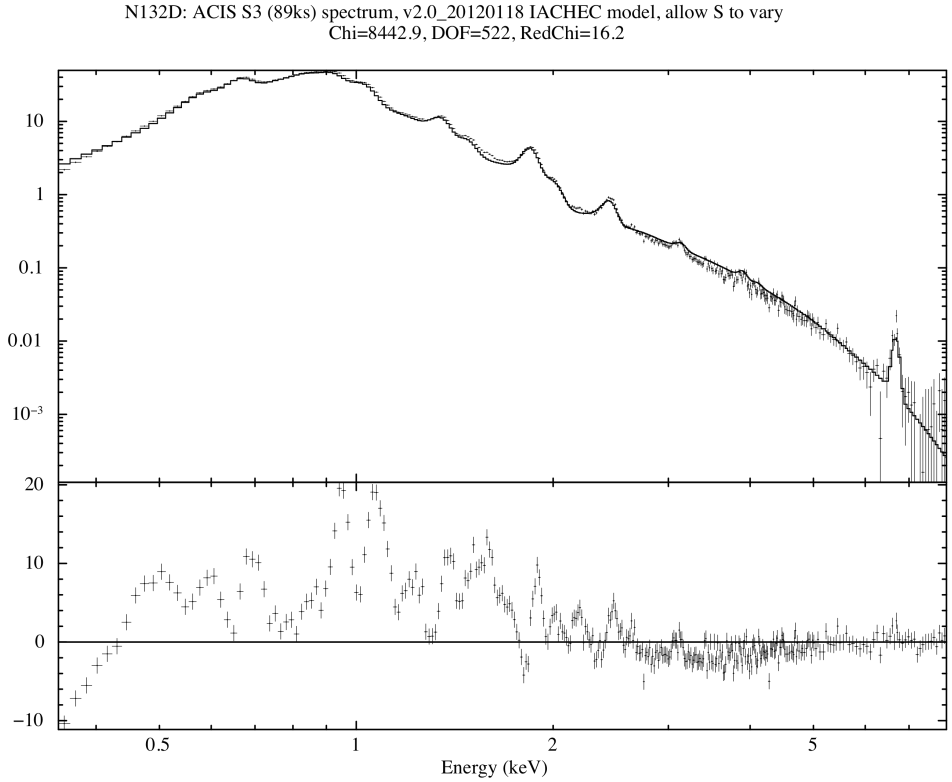


N132D: Brightest SNR in the LMC

- larger than E0102 and more complicated, absorption varies significantly across the remnant
- spectrum is significantly more complicated due to significant Fe emission, but RGS data constrain the lines in the 0.5-2.0 keV band

ACIS S3: 89 ks, fit with RGS model

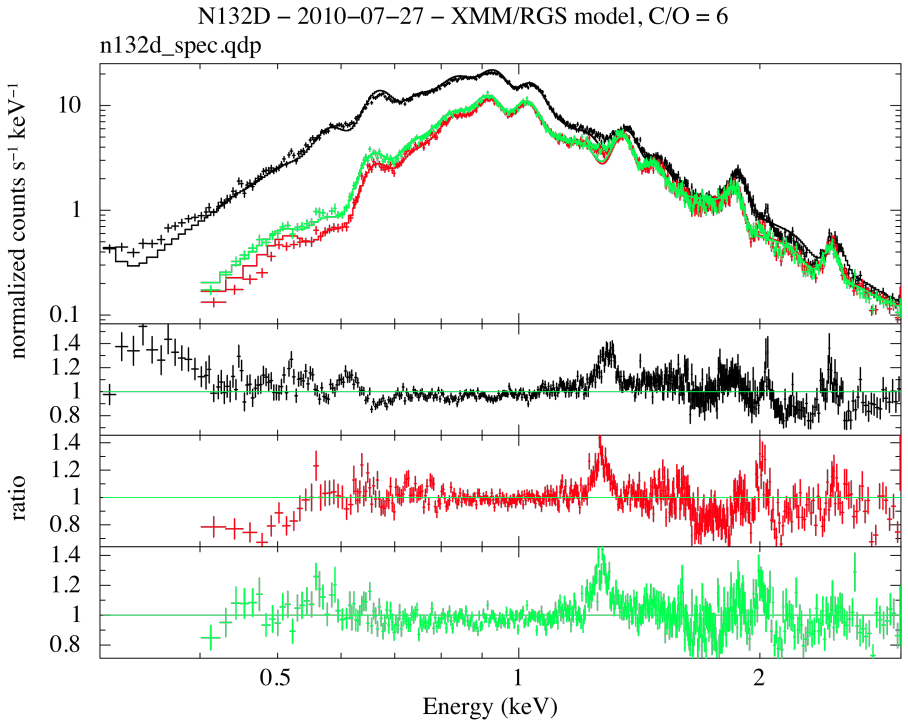


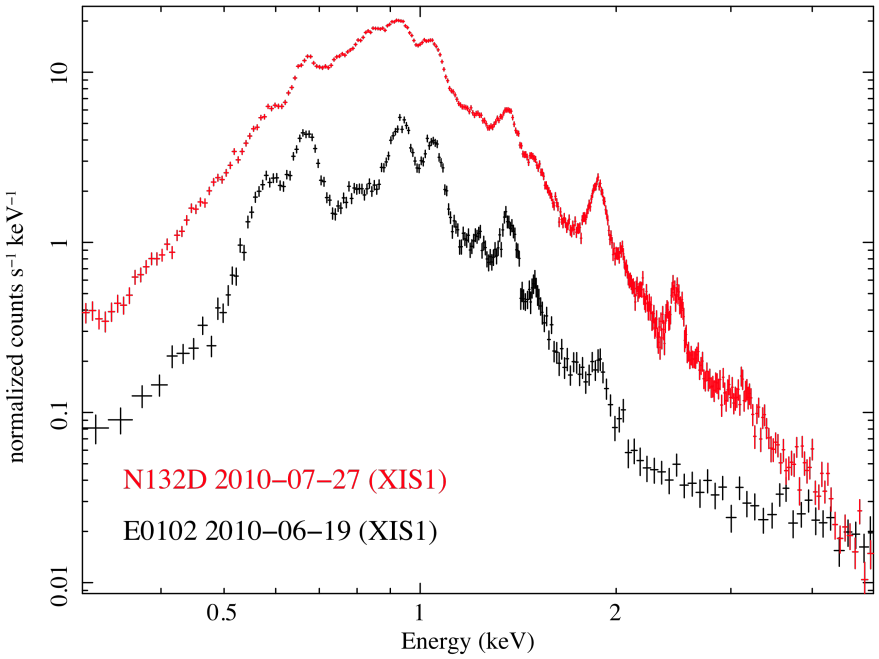


Suzaku Specturm of N132D

Miller(MIT)

- Suzaku specturm with RGS model folded through, E0102 spectrum shown for reference
- significant Fe emission makes this spectrum more complicated than E0102
- objective at this meeting is the development of an IACHEC standard model for N132D

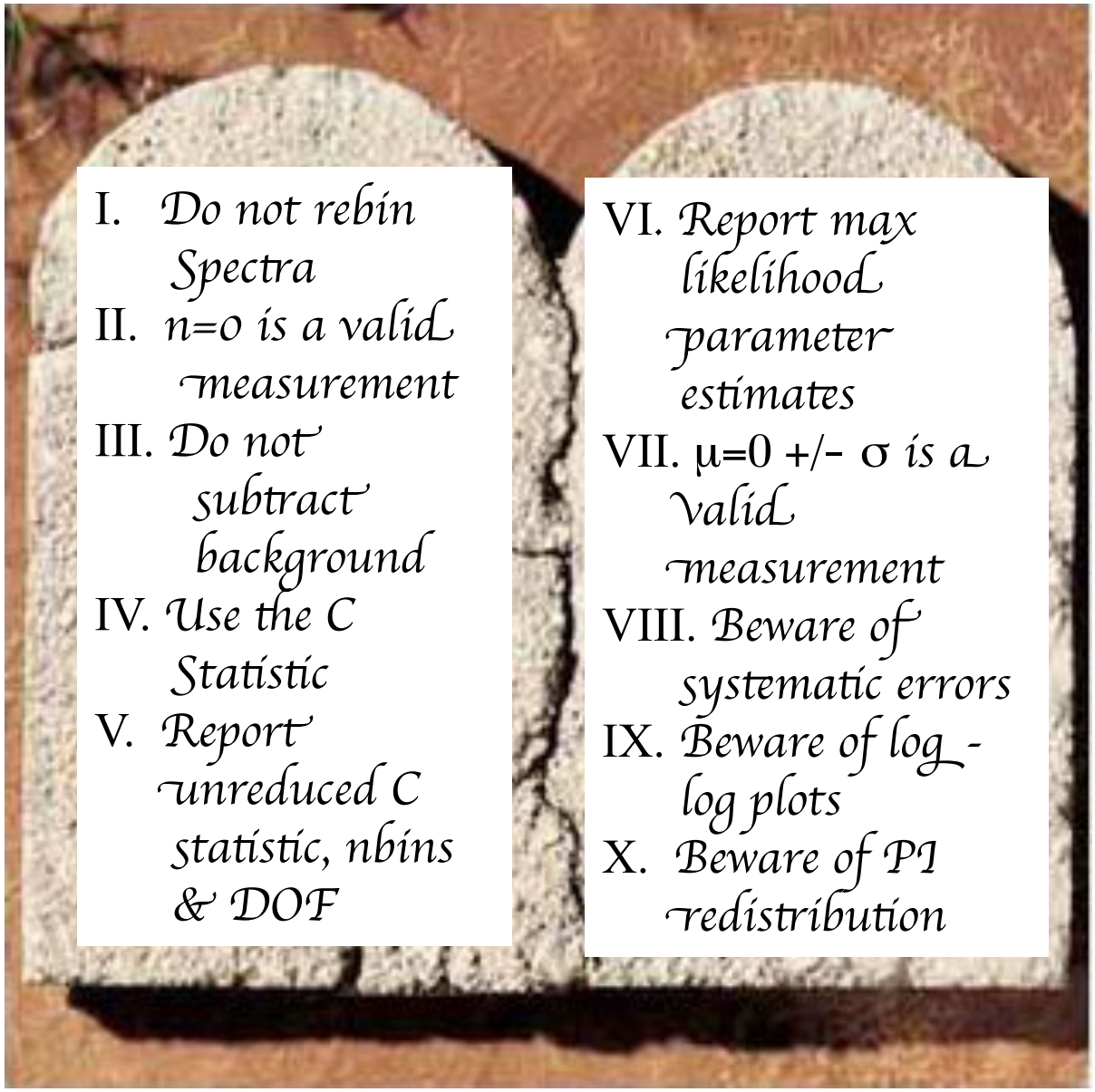




Fitting Methodology:

The Ten Commandments

Andy Pollock (ESAC)



Summary

1 E0102-7219:

• We need to decide what we want to publish (if anything) on the multiple measurements over the course of the mission

N132D:

• We want to develop a standard IACHEC model of N132D that we can use for calibration purposes

Fitting Methodology:

• We want adopt the approach of using unbinned spectra, modeling the background, & using the C statistic

• We believe the IACHEC should take the lead in encouraging the User community to adopt this approach