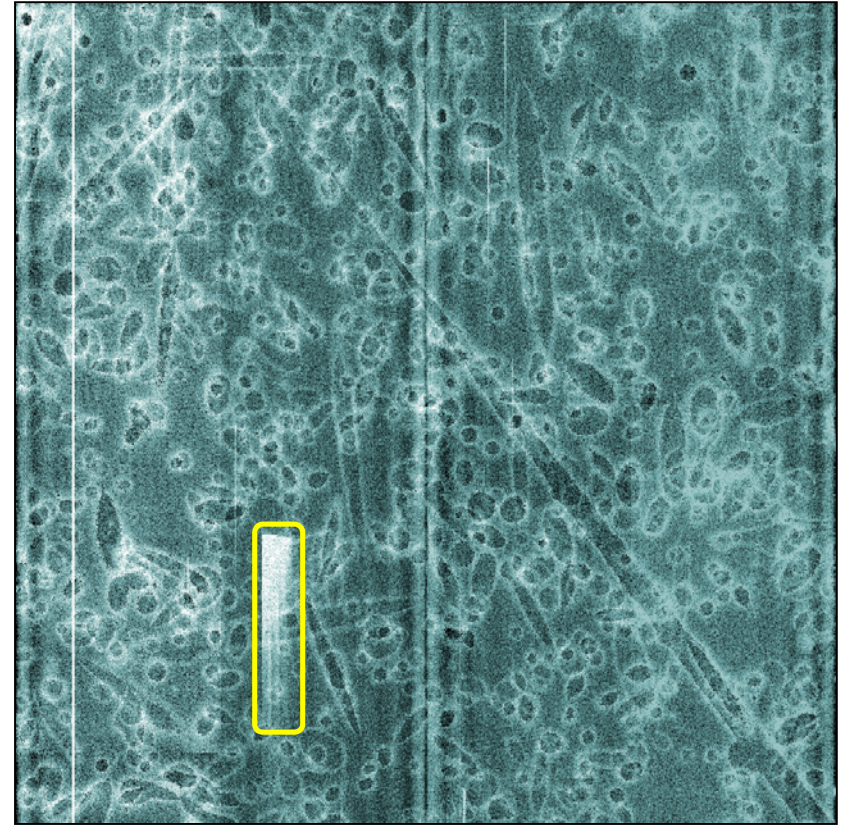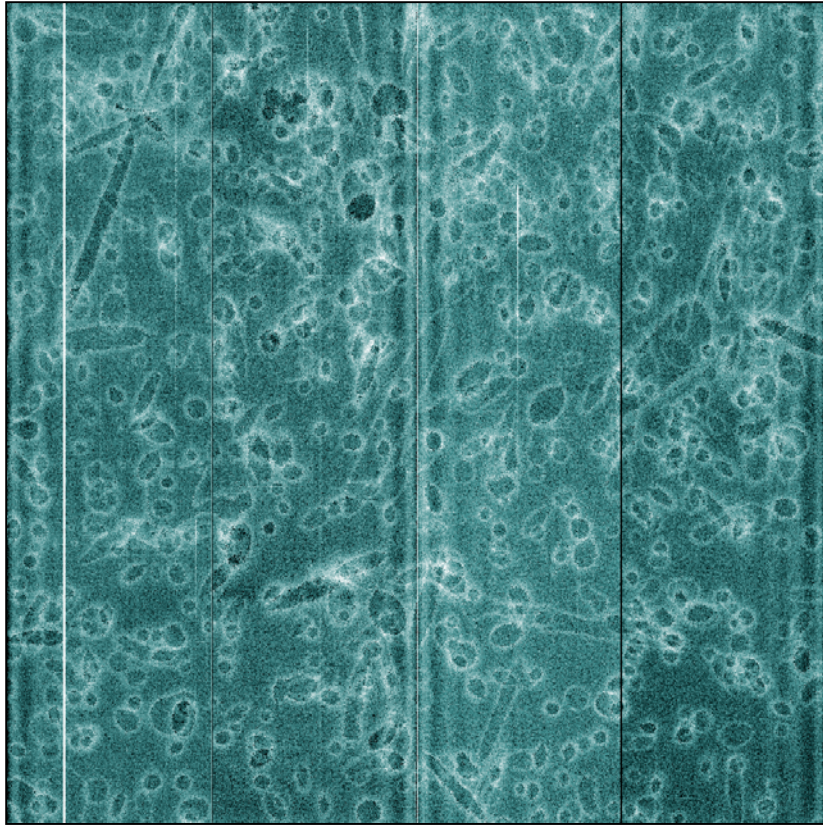# Evaluating the Effectiveness of the ACIS Superbias

Joseph M. DePasquale, Paul P. Plucinsky, Beverly LaMarr, Peter G. Ford
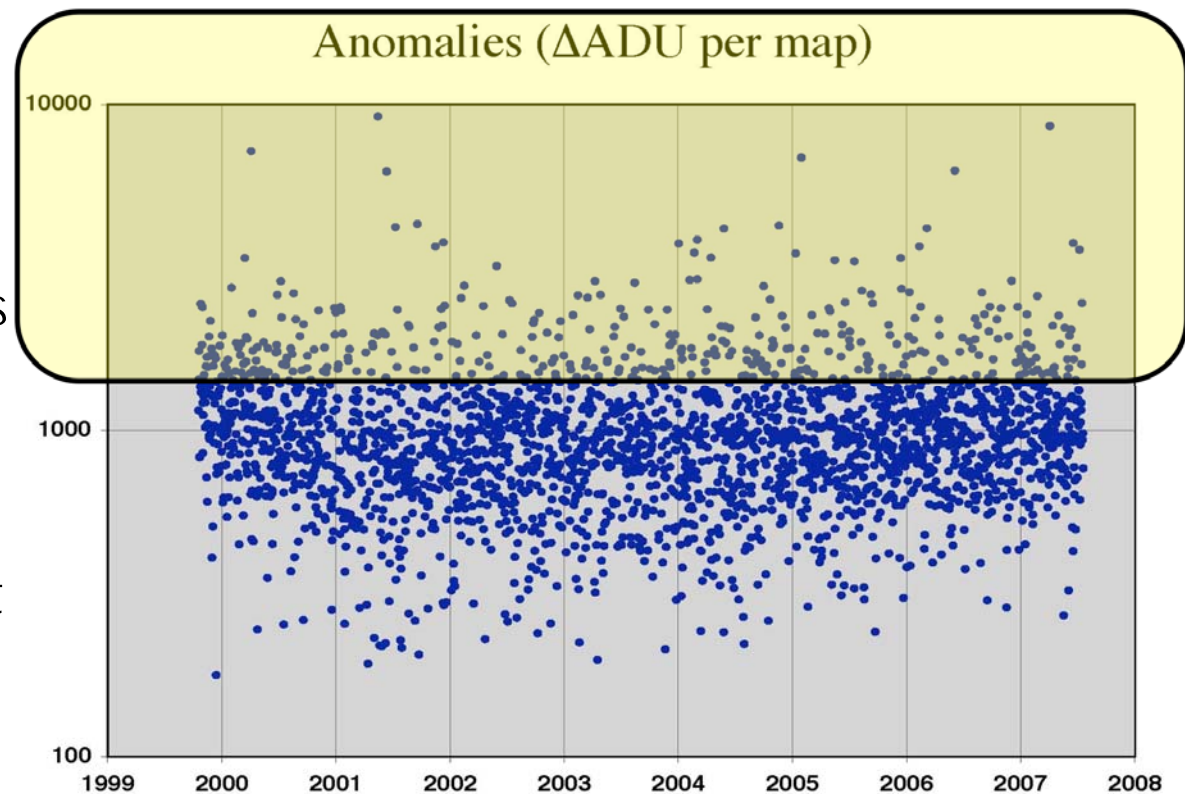
Frequency

- Artifacts are actually quite common among FI bias maps
  Peter Ford's analysis shows 72% observations affected
  using a very strict algorithm to flag artifacts

- concerned with

artifacts > 5 columns

~3.5 % of all bias maps

Figure demonstrates

that artifacts have not

increased over time

Anomalies (ΔADU per map)
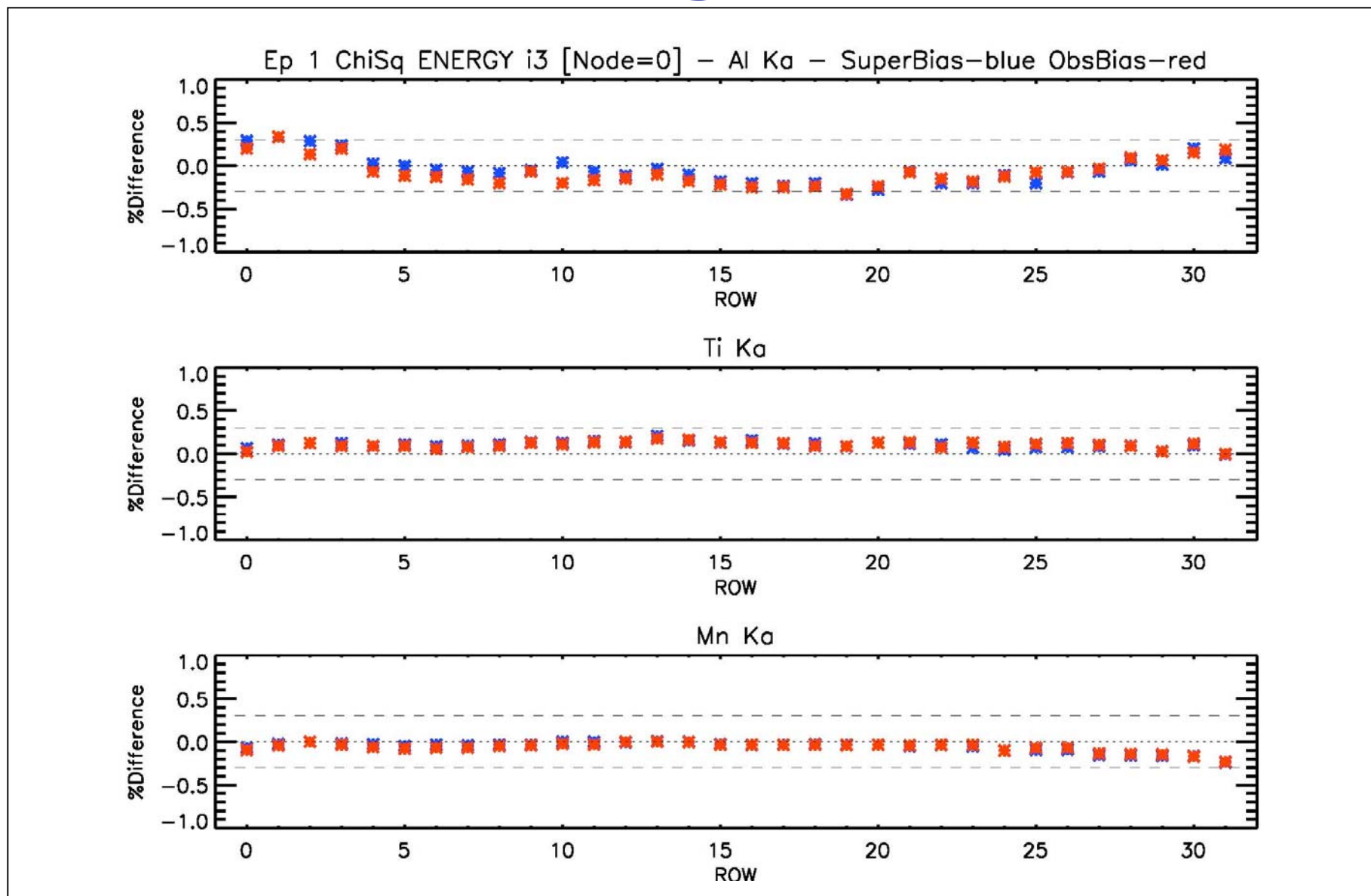
Utilizing the Superbias

- To investigate the superbias, we analyze two epochs of ECS data as well as observations of E0102 with a simulated artifact

- Underlying goal is to determine if the superbias can be used in processing without the need for new calibration products
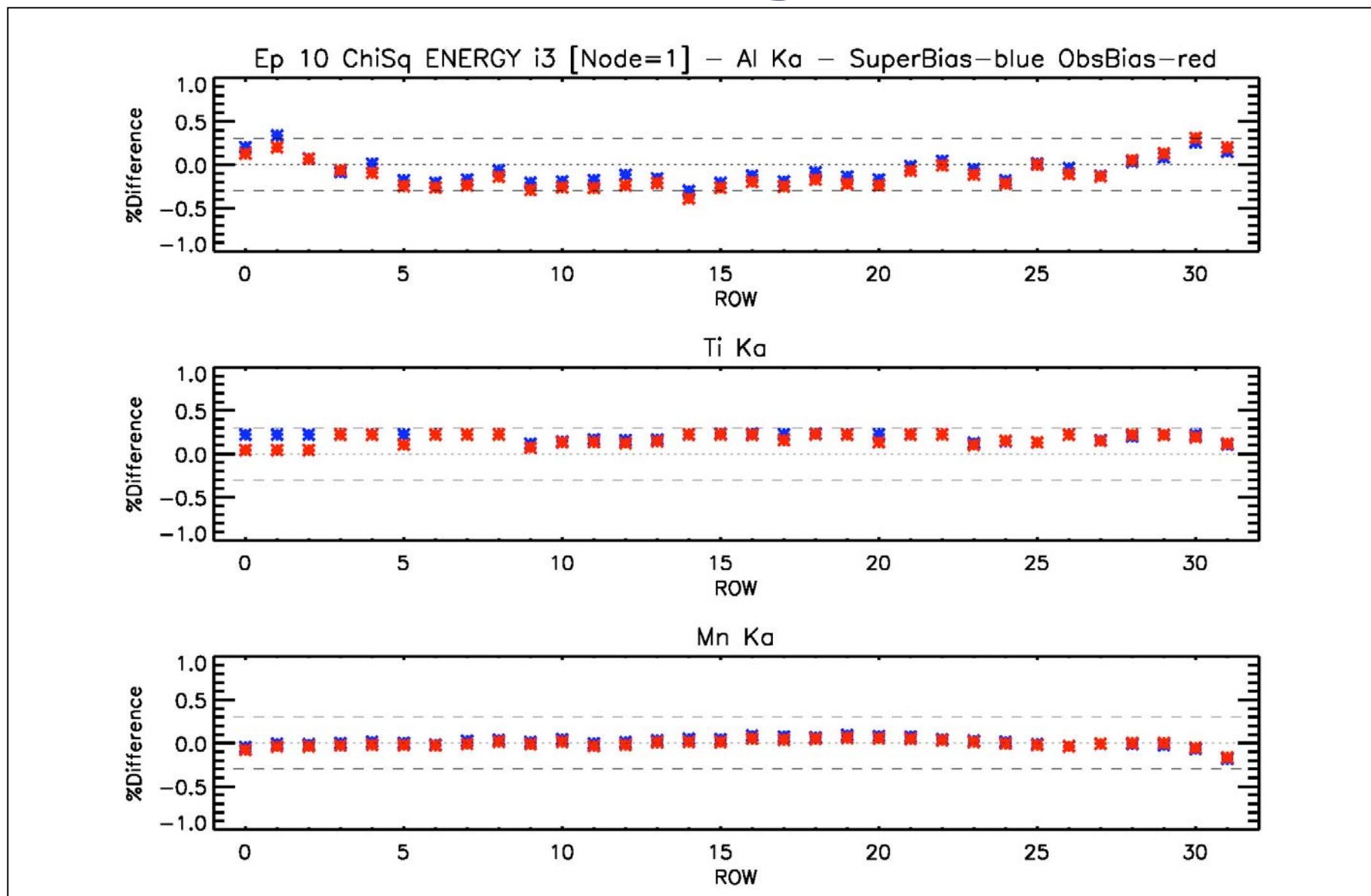
I. External Calibration Source - Epoch Summary

- individual ECS observations from epochs 1 and 10 processed with superbias maps and combined into a merged evt list for each epoch

- Spectra extracted from merged evt lists in 256x32 pixel regions for I3 and fit in XSPEC with gaussians for the 3 lines: Al kα, Ti kα, Mn kα

- We measure gain and width of the lines at all regions and compare to standard processing
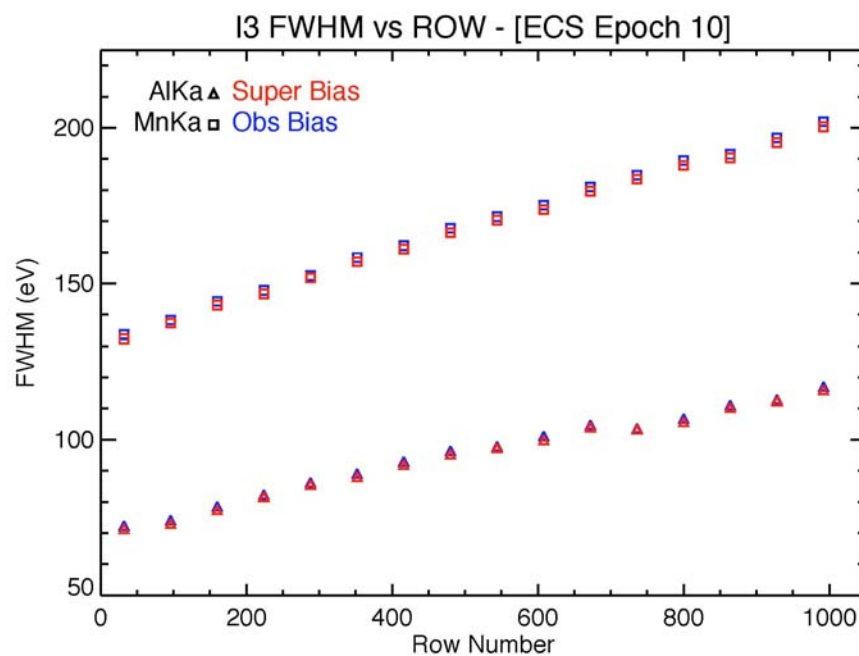
ECS - epoch 1gain

Ep 1 ChiSq ENERGY i3 [Node=0] — Al Ka — SuperBias—blue ObsBias—red

Ti Ka

Mn Ka

ECS - epoch 10 gain

Ep 10 ChiSq ENERGY i3 [Node=1] — Al Ka — SuperBias-blue ObsBias-red

Ti Ka

Mn Ka

ECS - Epochs 1 & 10

Gain Summary: percentage regions within 0.5% difference at Al kα

	Inst-Bias	Superbias
epoch 1	98%	97%
epoch 10	95%	97%

FWHM Summary:

I3 FWHM vs ROW - [ECS Epoch 1]


I3 FWHM vs ROW - [ECS Epoch 10]
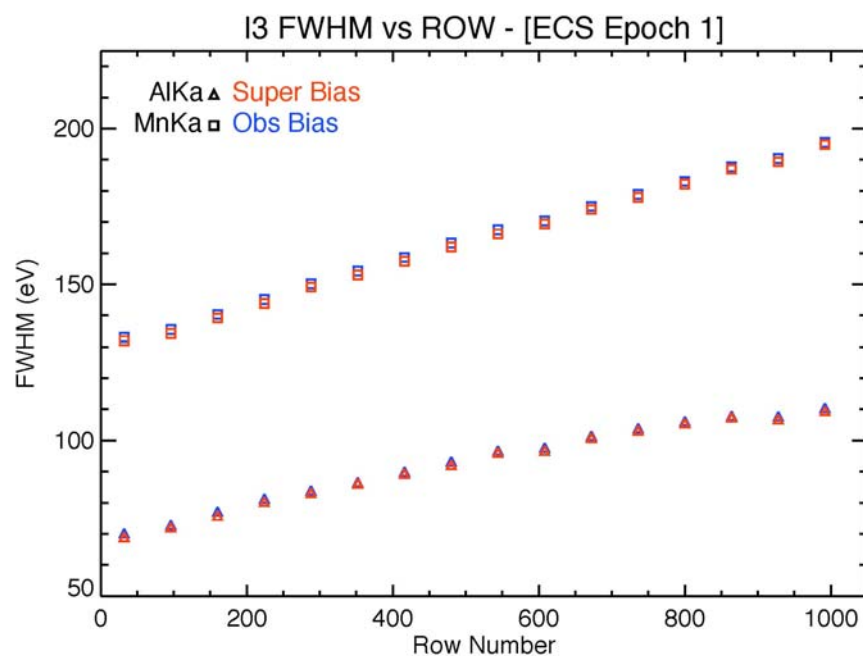
ECS - bias artifacts

II. Epochs 1 & 10 bias artifacts

• It is clear that for the three month epochs, the superbias has no net affect on the results of the ECS fits

• Now consider the worst-case-scenarios of specific bias artifacts in an ECS dataset

- 93 ECS observations in epoch 1; 6 bias artifacts
- 55 ECS observations in epoch 10; 1 bias artifact

• Analyze by extracting spectrum from the affected region (artifact), and spectrum from a control region of the same size with no artifact

-4   2   9
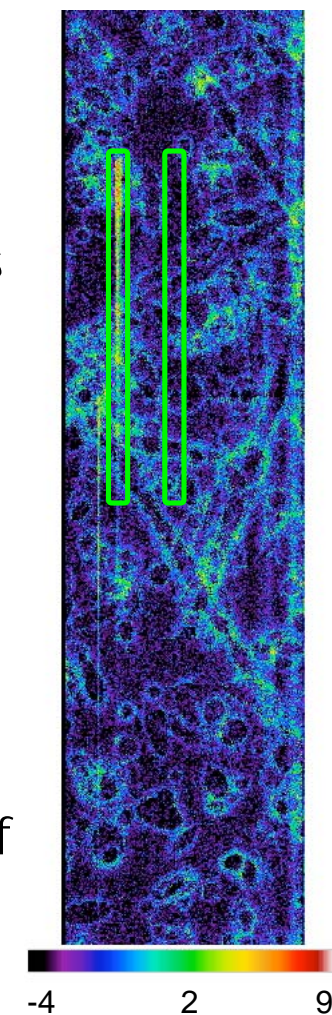
ECS - bias artifacts

Epochs 1 bias artifacts

ObsID	CCD	Node	Year	Day of Year	ArtX	ArtY
62191	i0	1	2000	33.054	307:345	200:358
62127	i0	3	2000	72.007	769:811	419:720
62095	i1	2	2000	95.865	540:555	000:805
62189	i3	1	2000	34.991	310:318	318:856
62139	s2	3	2000	64.159	940:954	149:903
62121	s2	0	2000	75.234	077:123	067:601

Fit results for OBSID 62139 (pha chan)

|	Al kα	Mn kα	Al kα FWHM	Mn kα FWHM
InstB-Art	383.62	1534.08	125.06	214.95
InstB-Cntrl	386.39	1539.15	112.42	205.06
Sup-Art	385.82	1538.04	120.5	207.46
Sup-Cntrl	387.31	1539.9	106.34	205.57

E0102 Simulated Artifact

- ECS analysis only tells part of the story

- Simulate a bias artifact which directly impacts a E0102 observation

  - Create regions with extra charge up to 5 ADU in bias maps

  - Consider two cases:
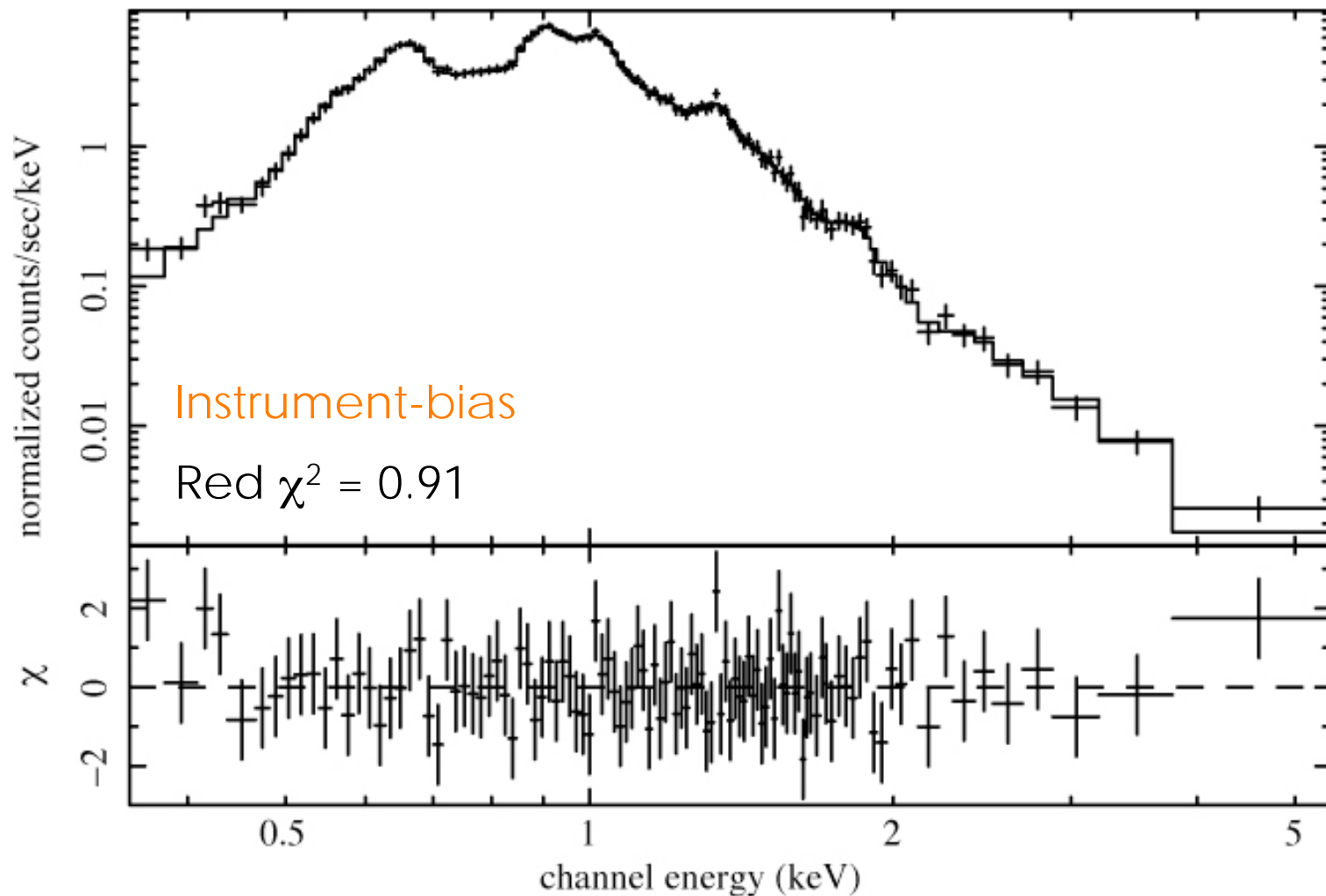
E0102 in chip coordinates   Case 1: fully covered   Case 2: half covered
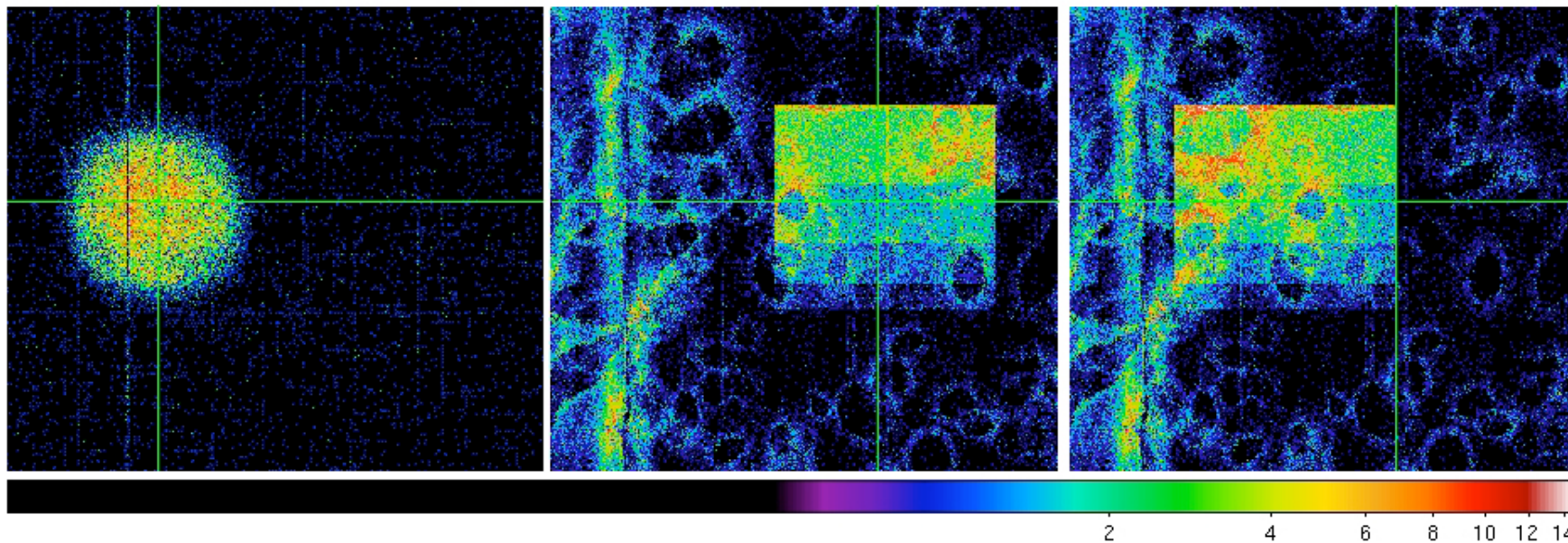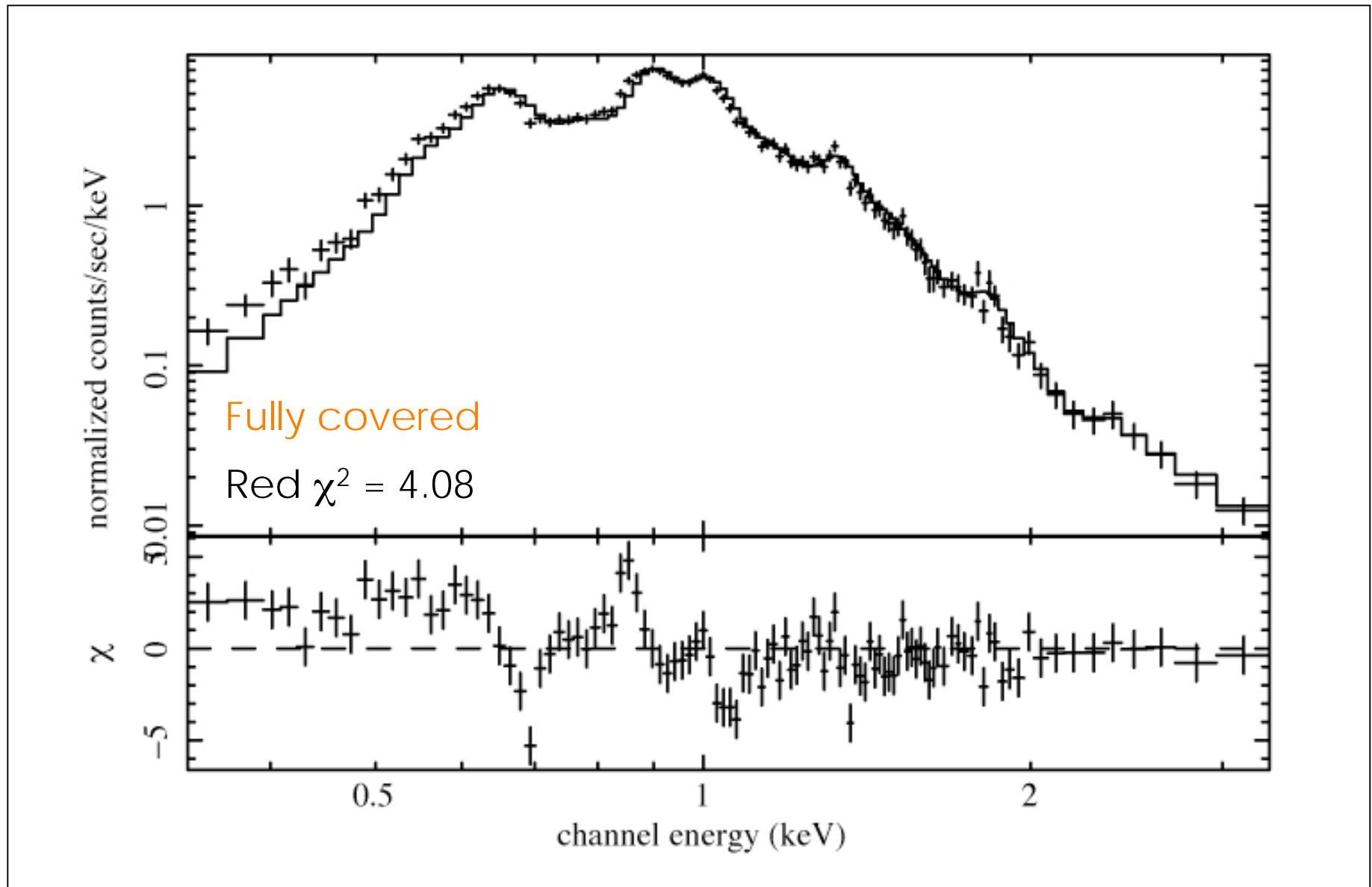
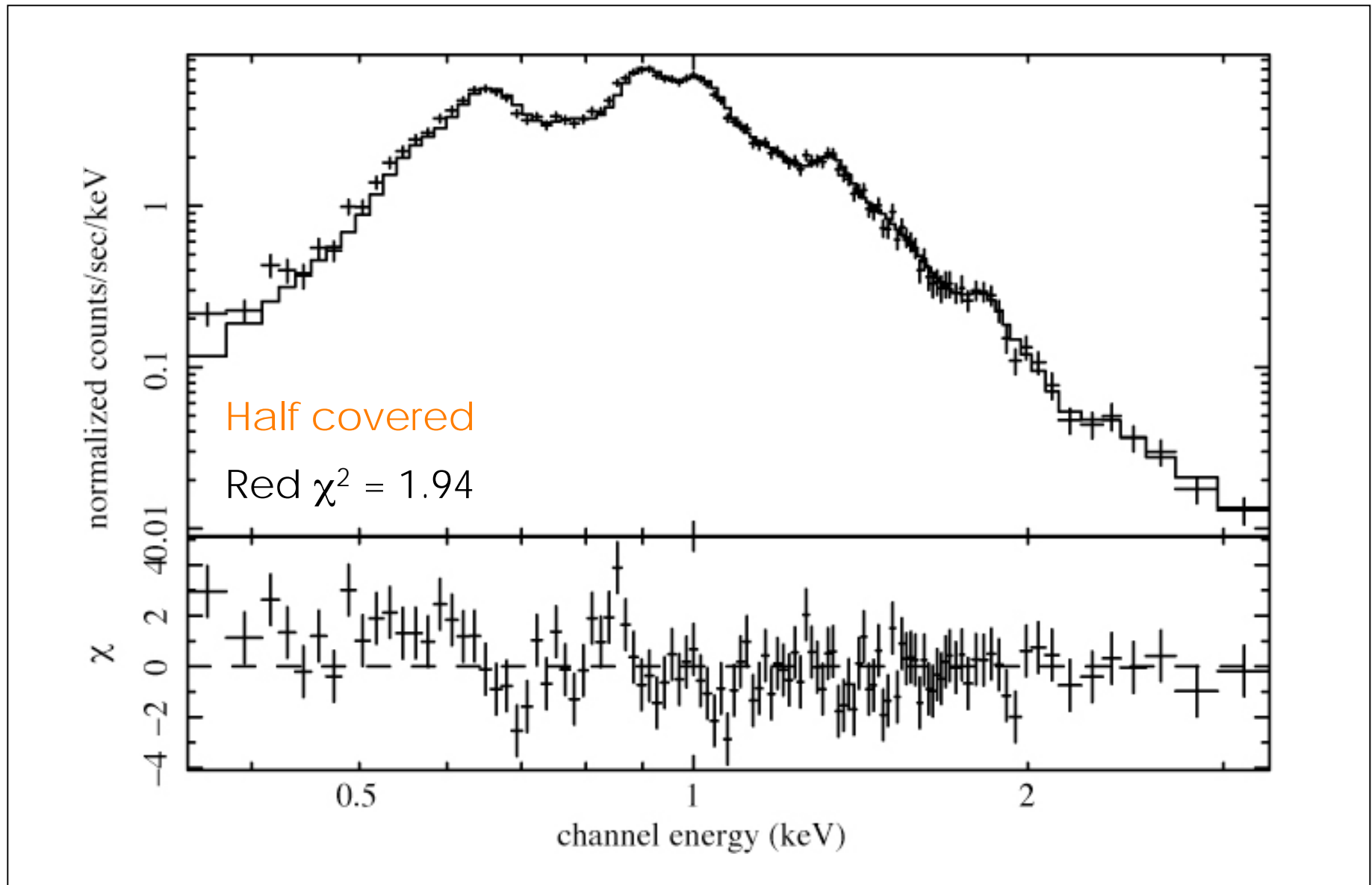# E0102 Simulated Artifact

• OBSID 440: near the I3 aim-point, from early 2000

Instrument-bias

Red χ^2 = 0.91

E0102 Simulated Artifact

Fully covered

Red χ^2 = 4.08

E0102 Simulated Artifact

Half covered

Red χ^2 = 1.94

E0102 Simulated Artifact

Superbias

Red χ^2 = 1.03
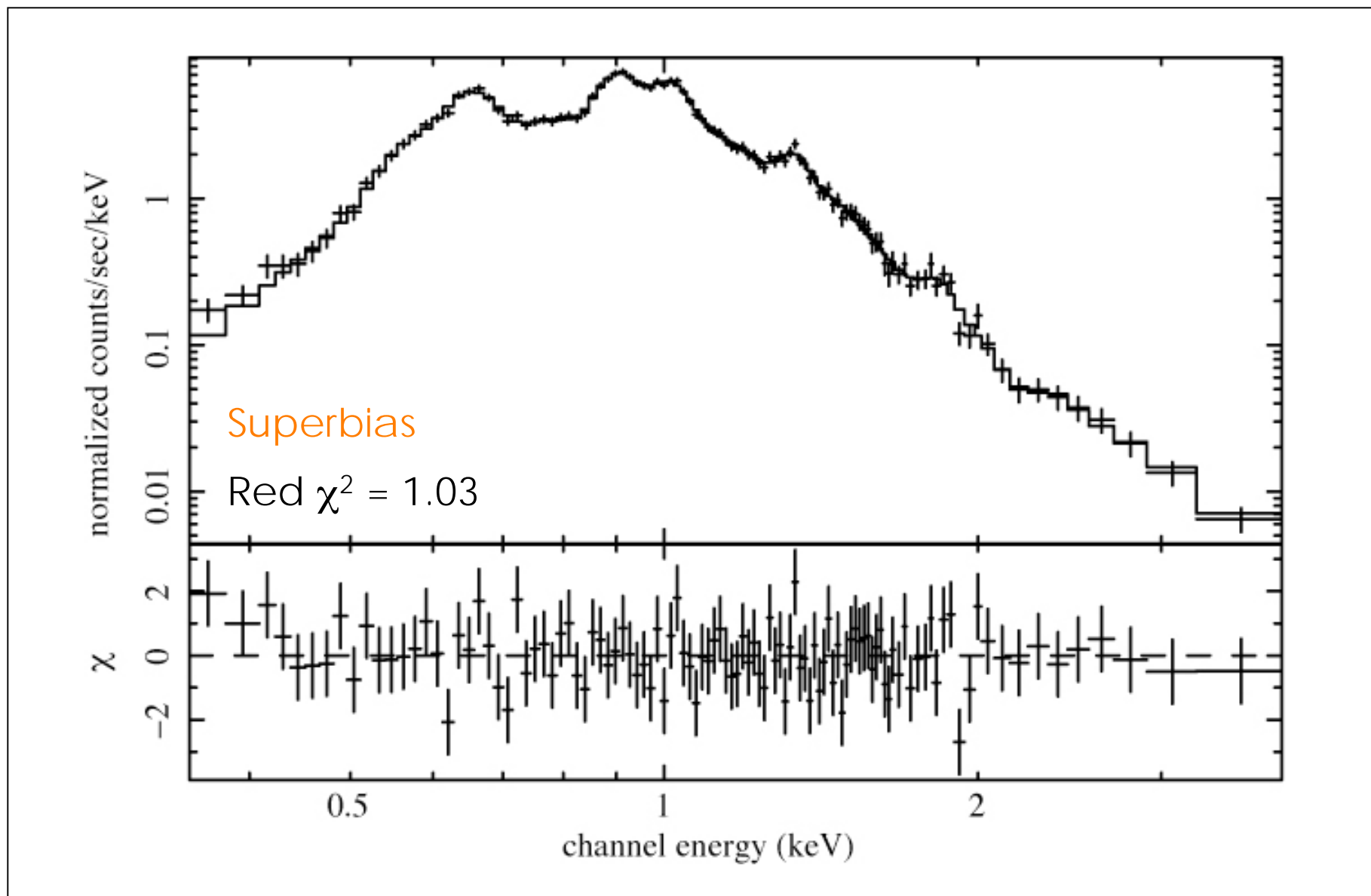
E0102 Simulated Artifact

- The actual fitted energies of a selection of the strong lines in the E0102 spectrum for each of the cases presented:

	OVII-For 561 eV	OVII-Res 574 eV	OVIII-Lyα 654 eV	NeX-Lyα 1024 eV
Full	545	568	643	1010
Half	553	569	649	1015
Superbias	560	573	654	1022
InstB	561	574	654	1022

- A clear gain shift is present in the results from the simulated artifacts
- Use of the superbias file helps to recover the results derived from the instrument bias map

Conclusions

- Bias artifacts spanning more than 5 columns in width have affected ~3.5% of all bias map created
- A superbias map composed of a modified median of bias files for 3 month intervals has been created and evaluated
- Analysis of two epochs of ECS data show that the superbias has no net positive or negative impact on fit results covering the whole epoch
    - However, the superbias can help in cases where an artifact exists
- Analysis of a simulated artifact in an E0102 dataset shows that processing with the superbias map mitigates a potential gain shift
- In Oct 2006, the Chandra Data Systems Operations group implemented a bias artifact detection and removal algorithm in standard processing
- If a user suspects that a bias artifact is present in their FI CCD data, they are encouraged to submit a custom processing request