ACIS QEU S-array Status & Future

Why we need a quantum efficiency uniformity (QEU) map

Producing QEU maps:
Source illumination, Line Flux, additional factors

Current QEU test: absolute flux

QEU improvements & future

Source Flux = counts/sec/ (effective area x response)
Effective Area = QE(E,ccd) x QEU(E,x,y,t)

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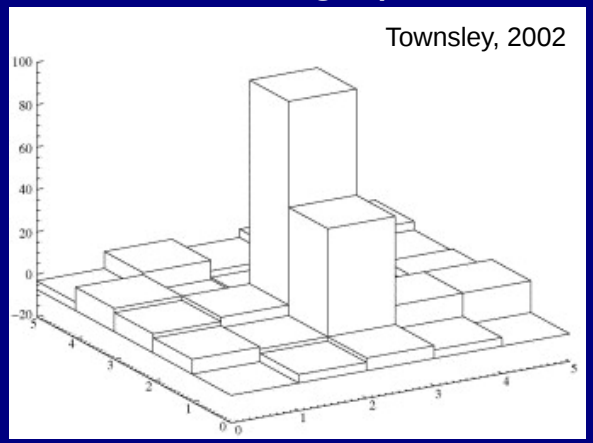
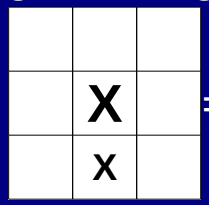
Source Flux = counts/sec/ (effective area x response)
Effective Area = QE(E,ccd) x QEU(E,x,y,t)

Why do we need QEU corrections?
- CTI -

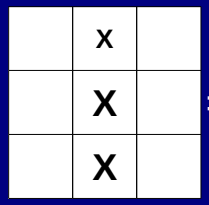
event charge packet



grade migration

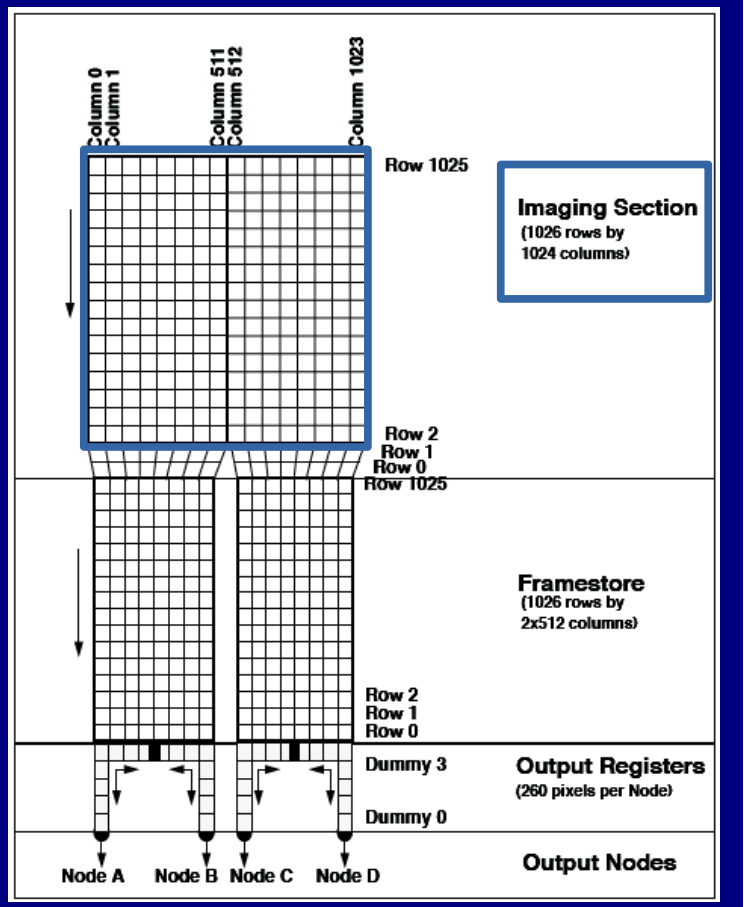


= Flight Grade 2
GOOD



= Flight Grade 66
REJECTED

ACIS CCD architecture



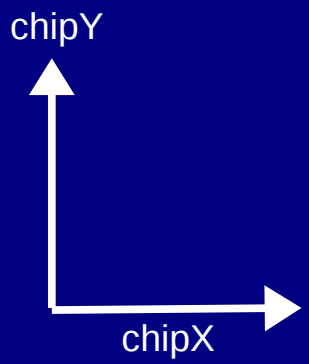
"Trapped" event charge is re-emitted into a trailing event island pixel during readout.

Parallel CTI (imaging area) affects all ACIS CCDs. QEU(E,row#)
Serial CTI (framestore area) affects BI only. QEU(E,col#)

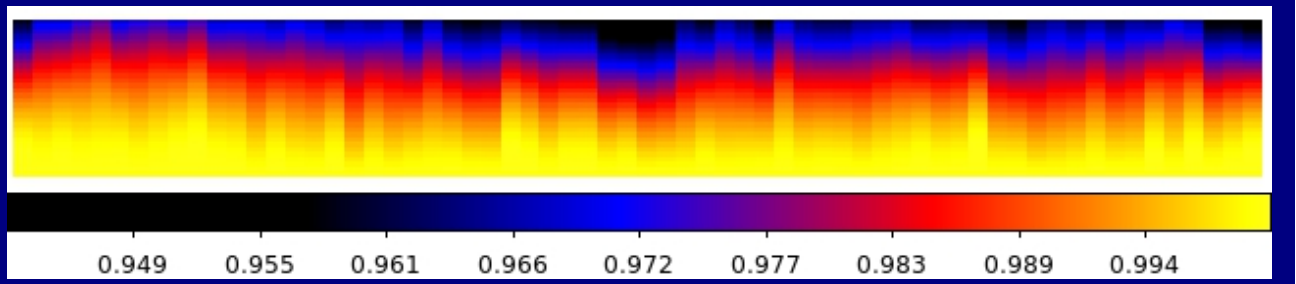
CTI variations across focal plane in 2000 at -120°C

FI parallel	$1\text{-}2\times10^{-4}$
FI serial	$< 10^{-6}$ (negligible)
BI parallel	1.5×10^{-5}
BI serial	8×10^{-5}

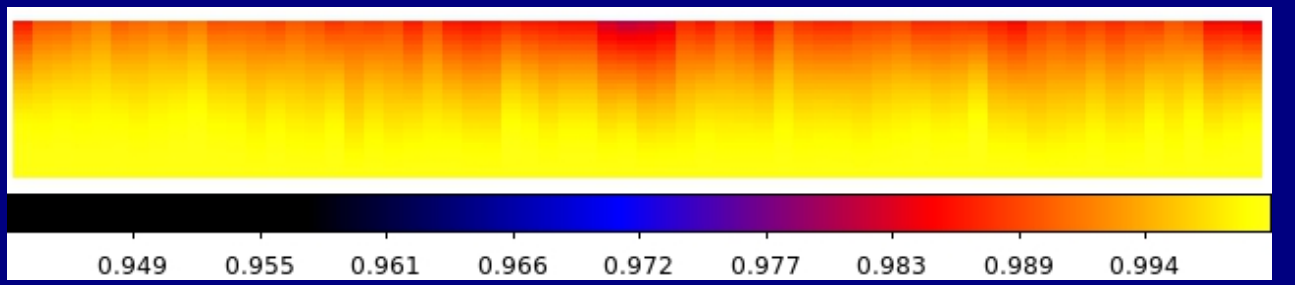
Enter the QEU maps
QE(E,x,y,t)



S2 5.62keV



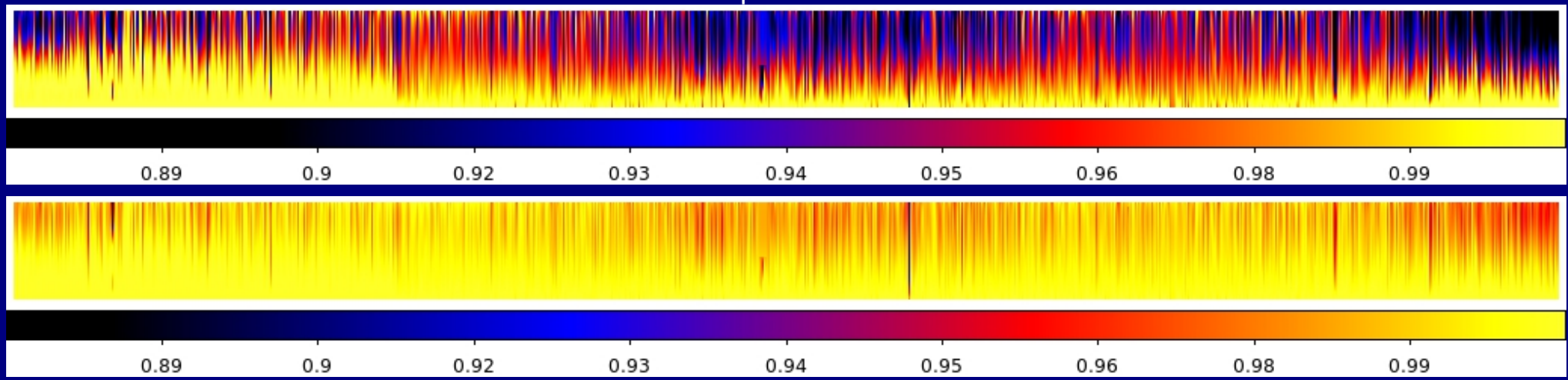
S2 1.47keV



FI 16x32 pixel resolution

S3 5.62keV and 1.47keV

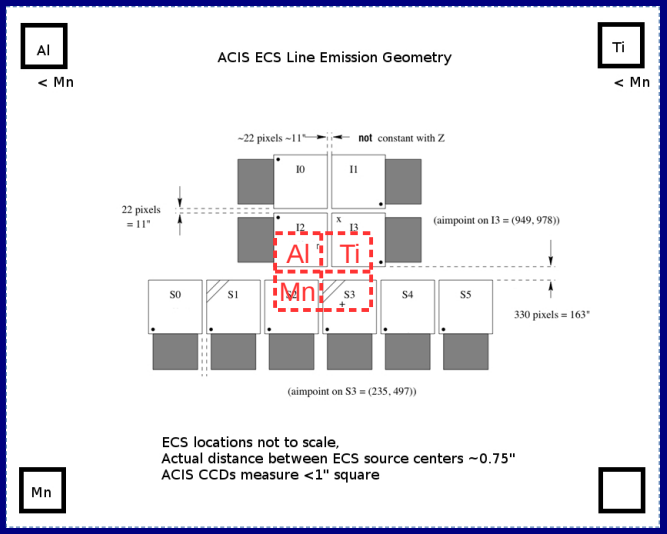
BI 1x16 pixel resolution



Producing the QEU Map

I. Illumination Pattern

cxc.harvard.edu/cal/Acis/Cal_prods/qeu/qeu.pdf



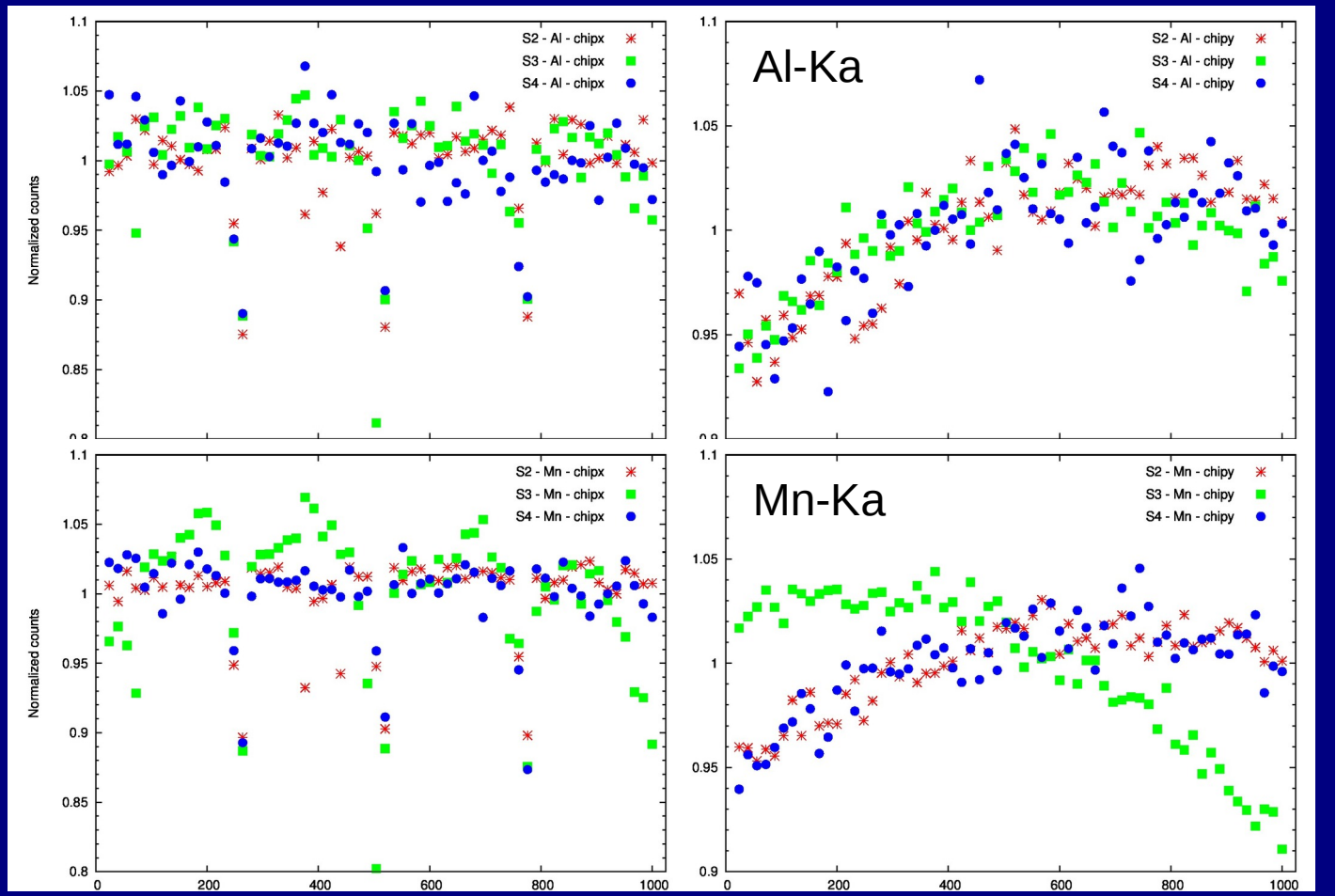
Geometry of ECS source holder generates non-uniform chip illumination.

- S2/4 ChipX ~no dependency
- S2/4 ChipY scales with row#

- S3 illumination = S2/4

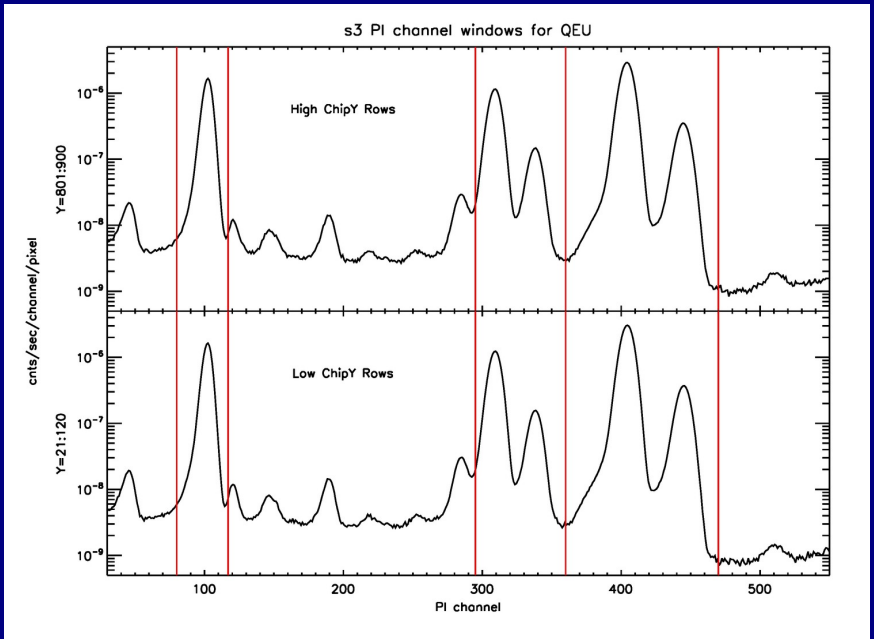
Ground calibration ECS obs
(minimal processing)

counts vs column# **counts vs row#**



Producing the QEU Map

II. PI line count windows



S3 High & Low row spectra

III. Enhance S/N by using only flight grades susceptible to grade migration: *"bad-good"* grades

IV. Flux vs row# for Al, Ti, Mn to establish energy dependence:

$QEU_{BI}(E) \sim \log(flux)/E$

$QEU_{FI}(E) \sim \text{constant} \times E$

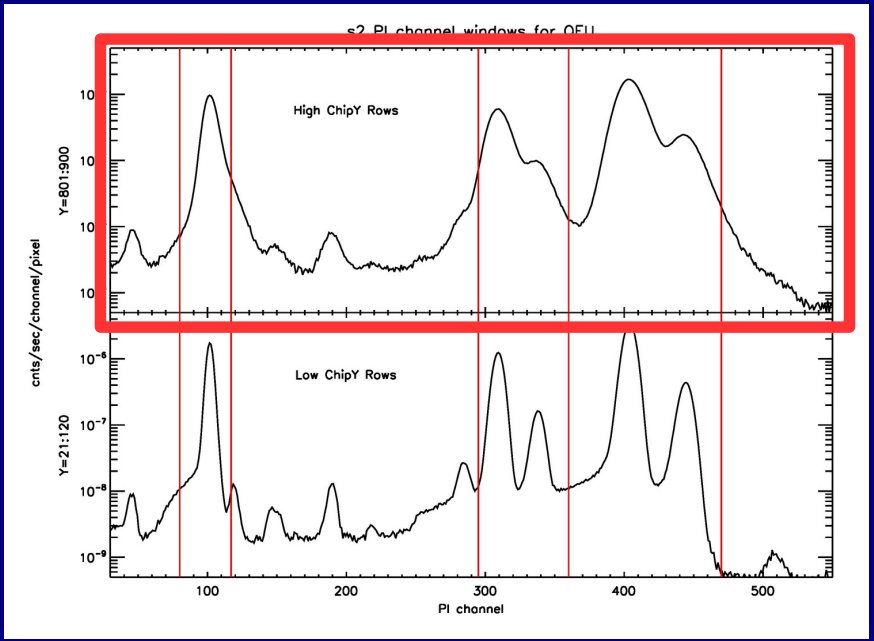
V. Fraction of *"bad-good"* events to total events

VI. Repeat on a biennial basis

= QEU(E,x,y,t)

Producing the QEU Map

II. PI line count windows



S2/FI High & Low row spectra

FI problems:
- Response FWHM at high row# blends nearby features:
  - Al-Ka & Si-Ka
  - Ti-Ka+b & Mn-Ka shoulder
- Line flux broadened outside integration window

FI & BI problems:
- BKG/Signal <<1% at yr2000
  - However, BKG/Signal increases significantly with ECS decay and BKG varies on solar cycle.
- QE(energy) scaling

III. Enhance S/N by using only flight grades susceptible to grade migration: *"bad-good"* grades

IV. Flux vs row# for Al, Ti, Mn to establish energy dependence:

$QEU_{BI}(E) \sim \log(flux)/E$

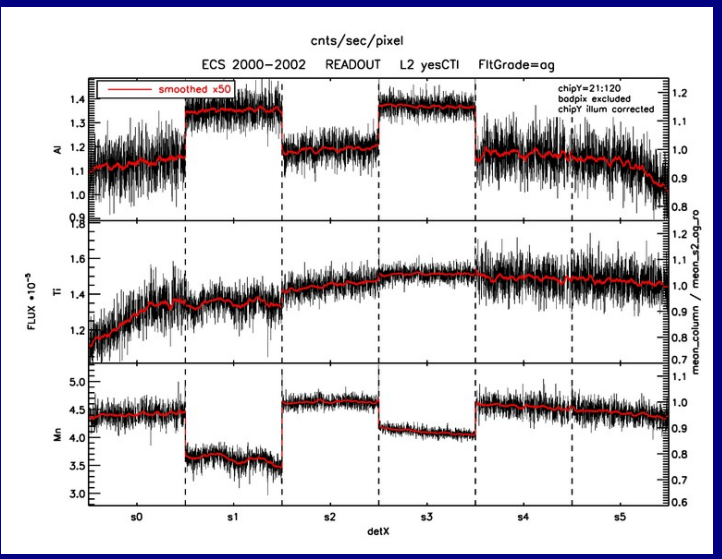
$QEU_{FI}(E) \sim constant \times E$

V. Fraction of *"bad-good"* events to total events

VI. Repeat on a biennial basis to account for slowly increasing CTI

= QEU(E,x,y,t)

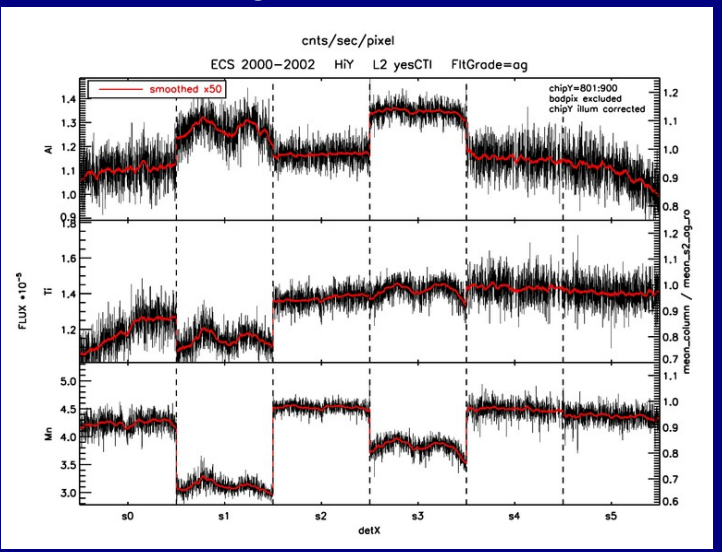
S-Array Flux vs detX



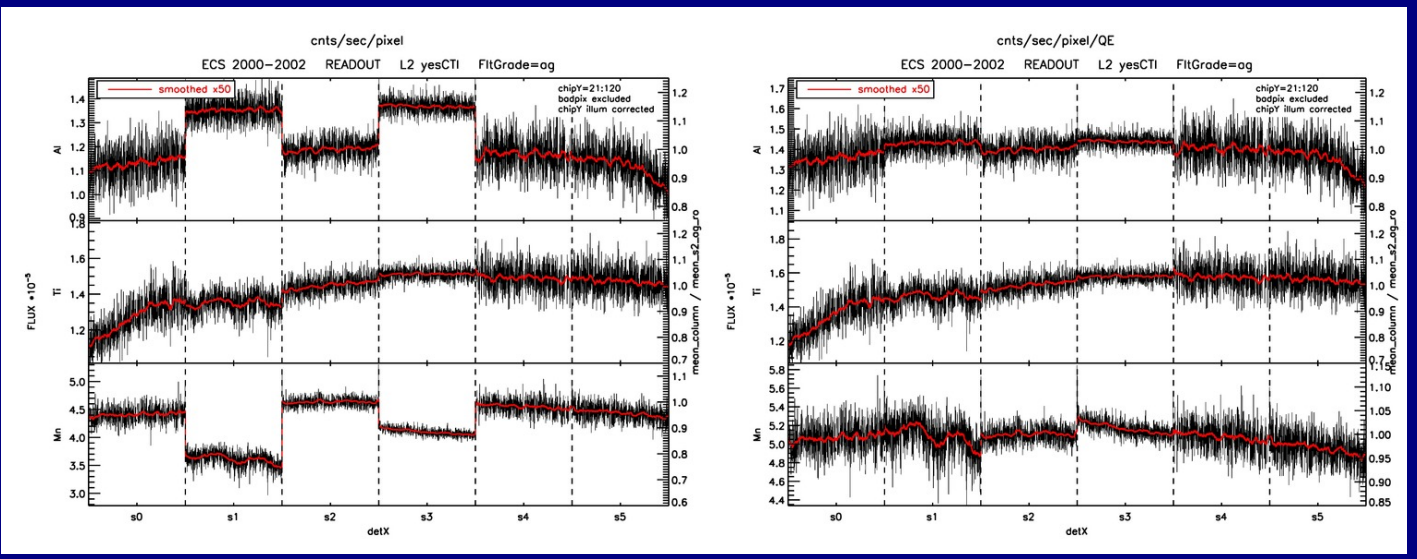
low row# vs detX

counts/sec/pixel

high row# vs detX



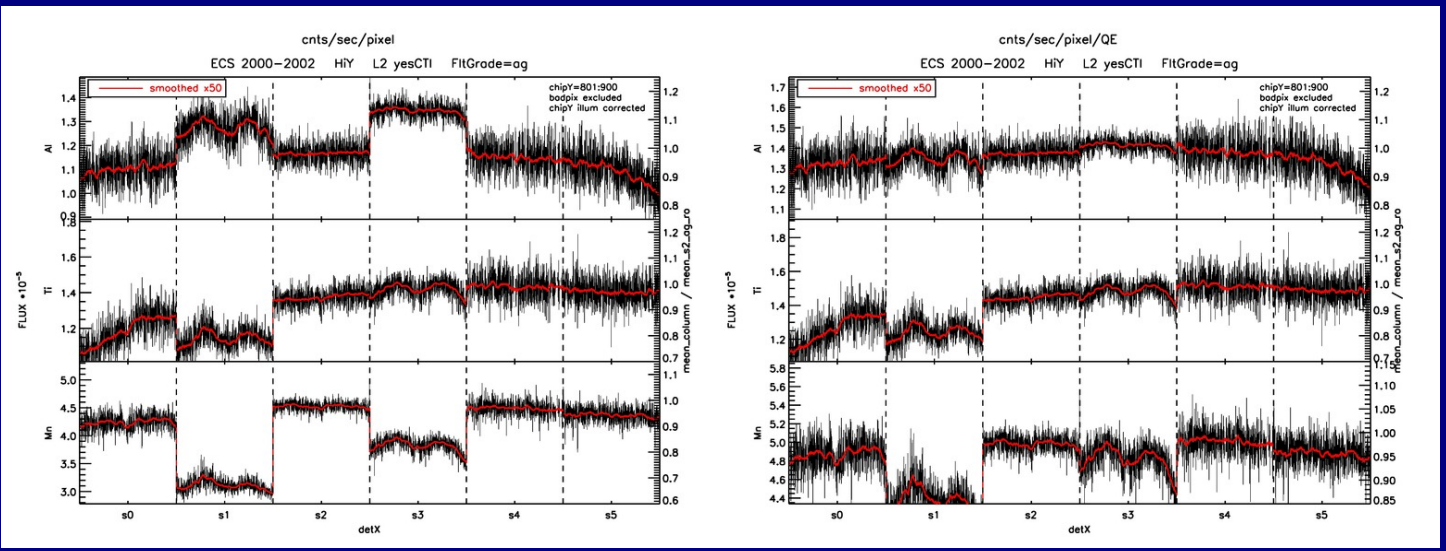
S-Array Flux vs detX



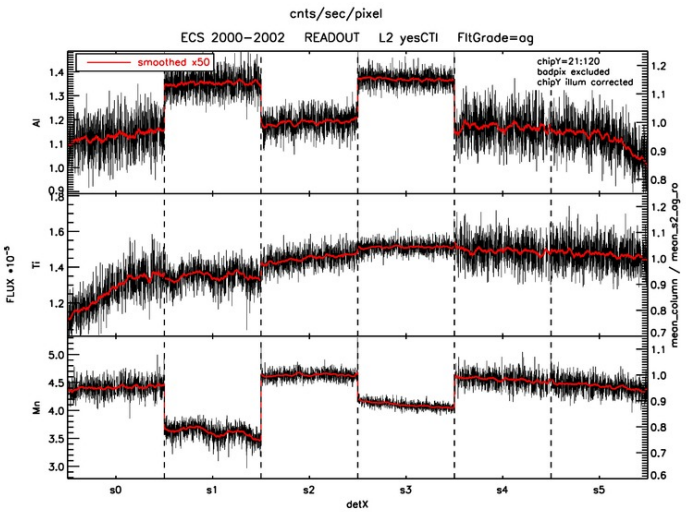
low row# vs detX

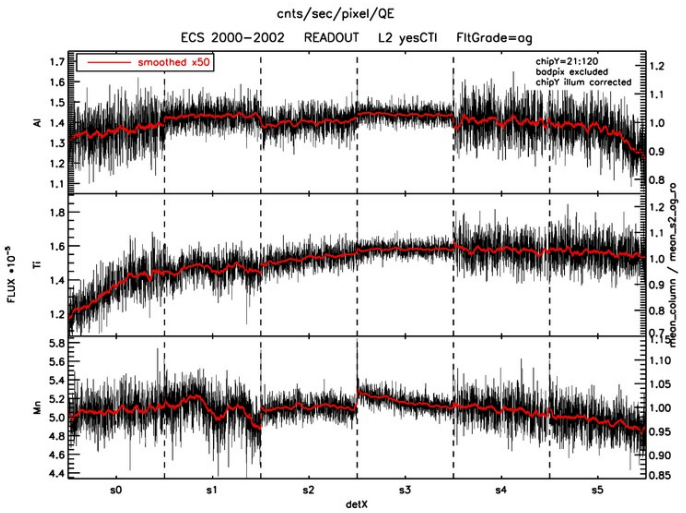
counts/sec/pixel ***counts/sec/pixel/QE***

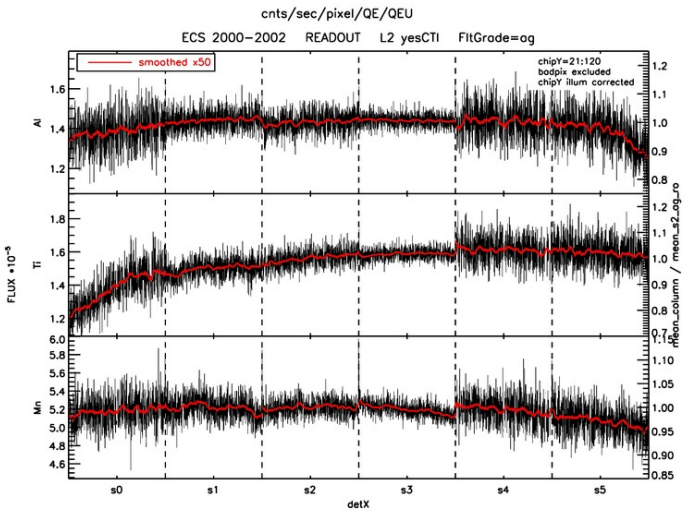
high row# vs detX



S-Array Flux vs detX





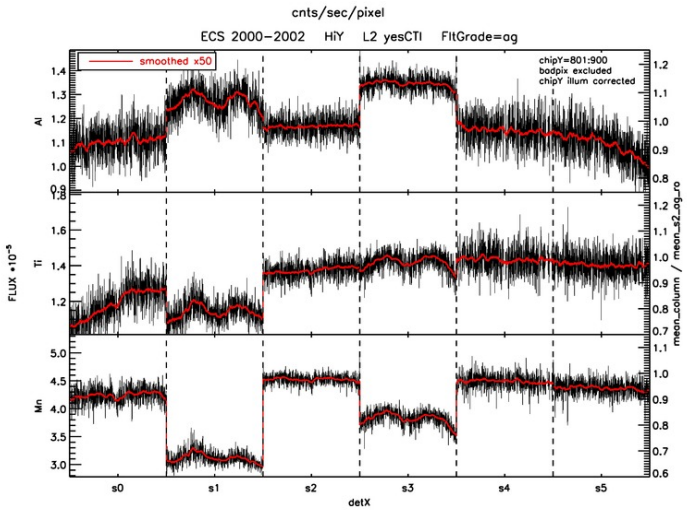


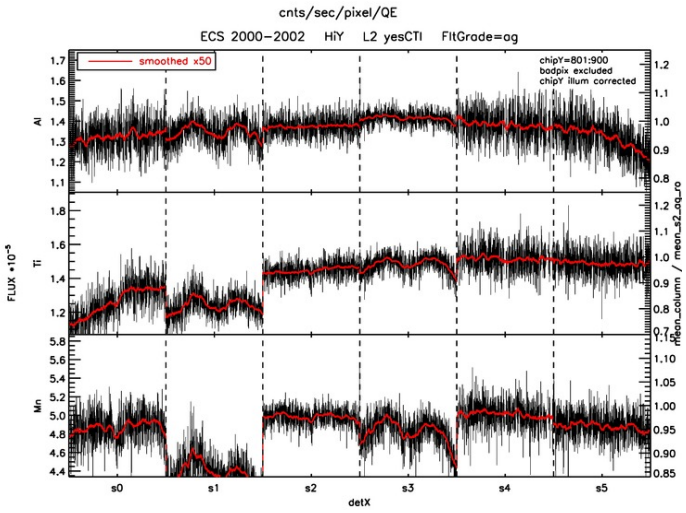
low row# vs detX

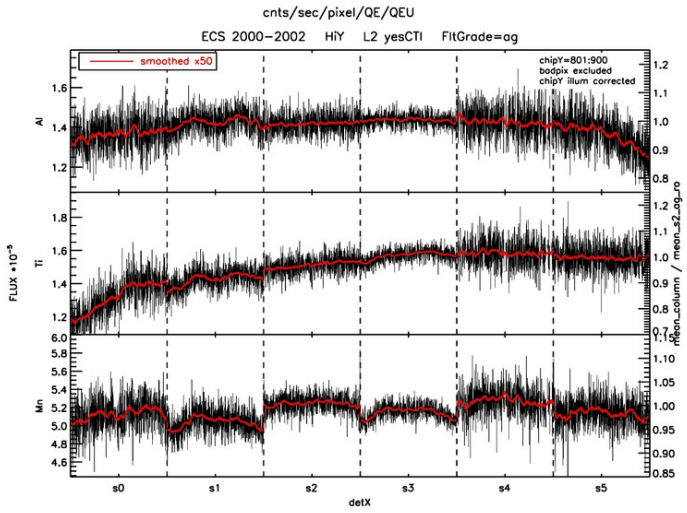
counts/sec/pixel ***counts/sec/pixel/QE*** ***counts/sec/pixel/QE/QEU***

preliminary

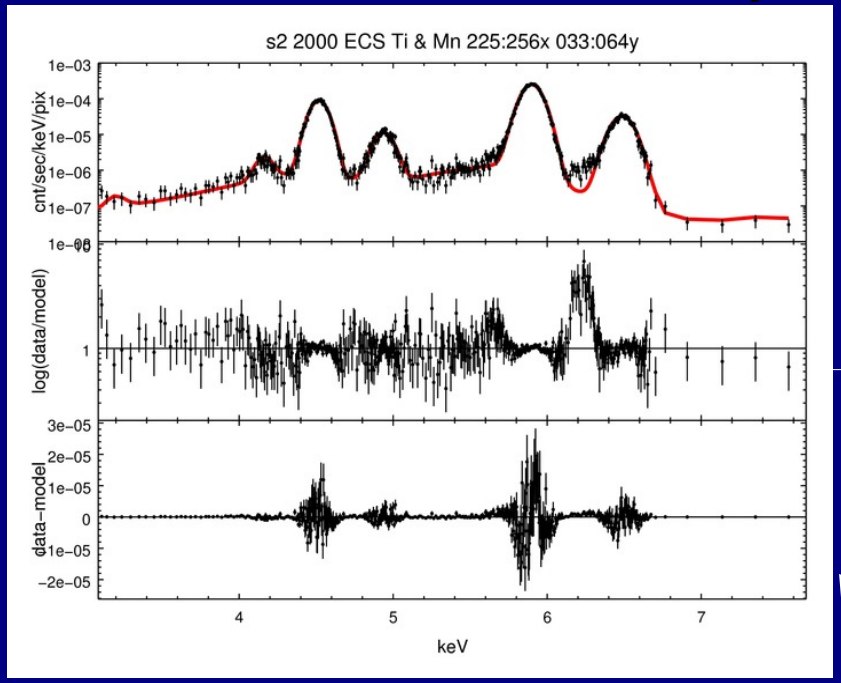
high row# vs detX



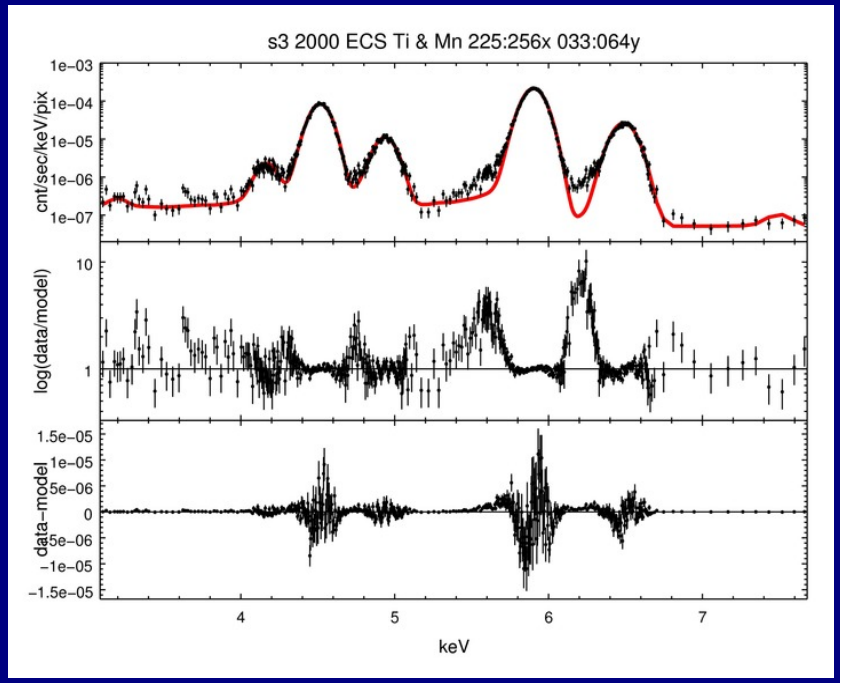




RMF x (Gaussians+BKG) Fitted Flux

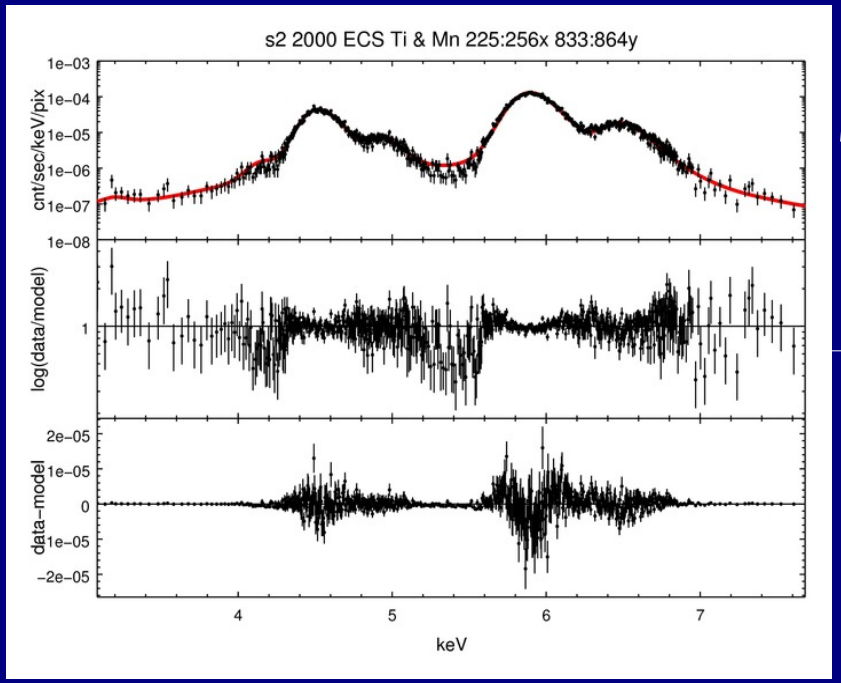


low row#

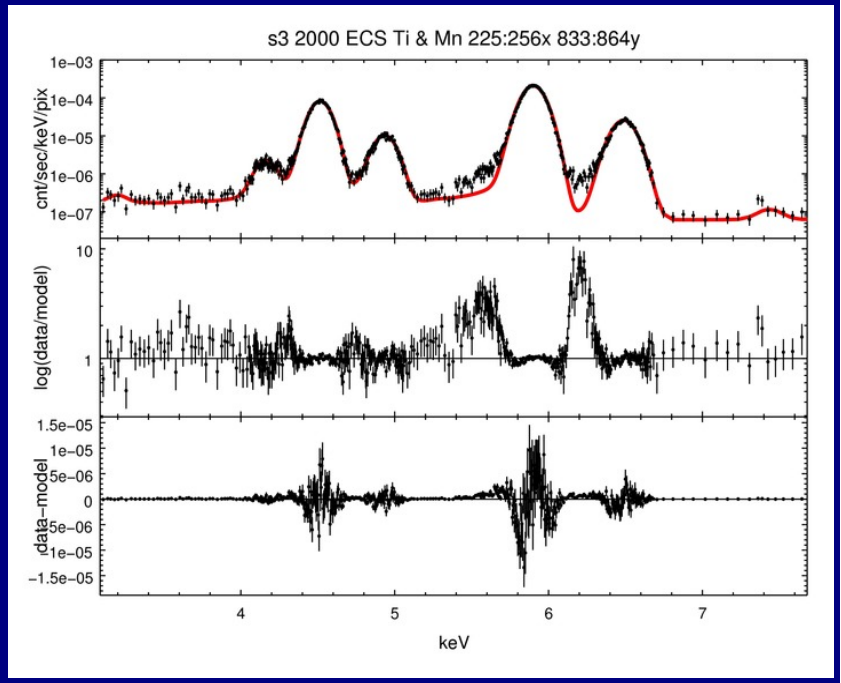


S2

S3

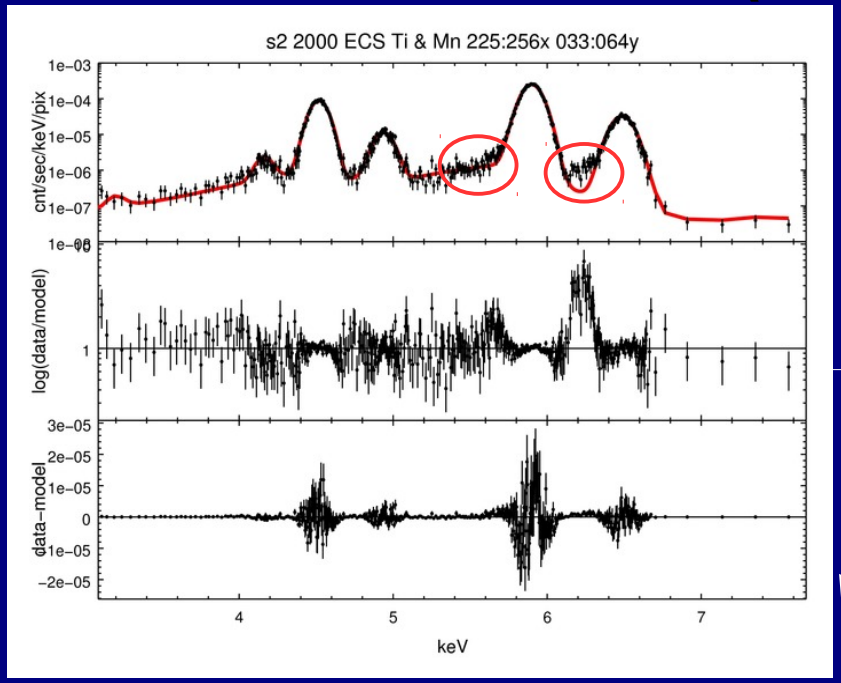


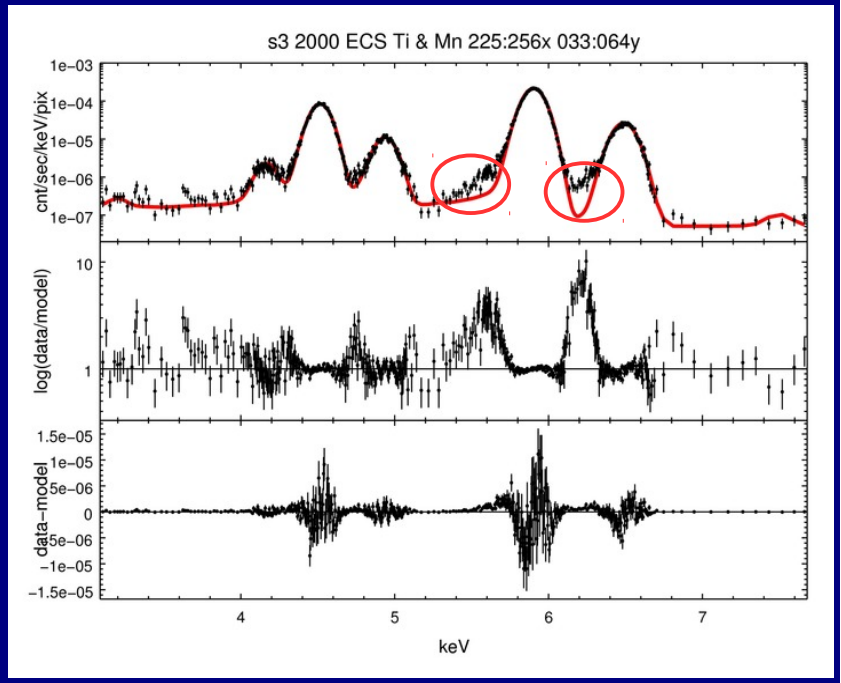
high row#



counts re-grouped to minimum of 6-10 (S2/S3)cnts/bin

RMF x (Gaussians+BKG) Fitted Flux

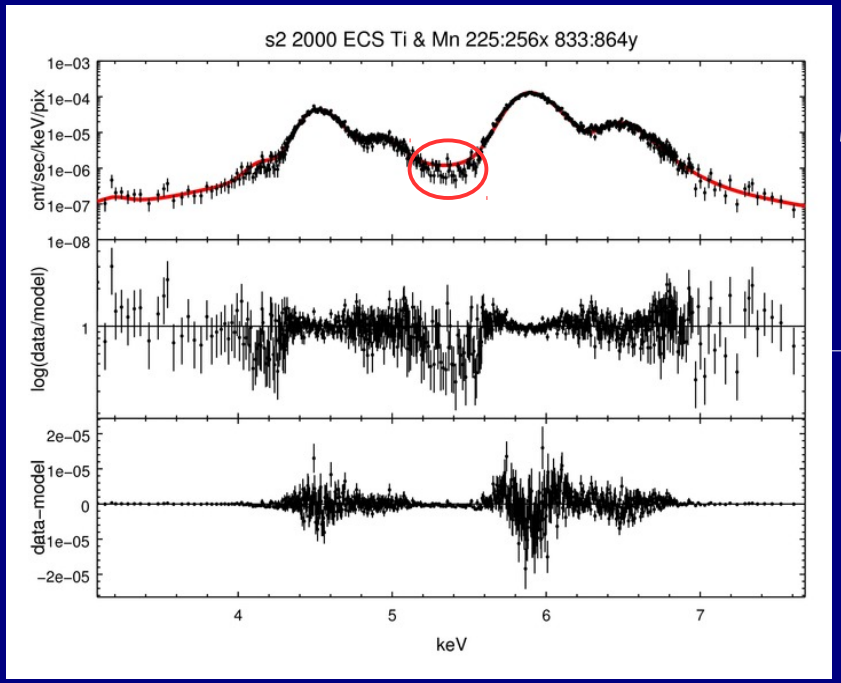


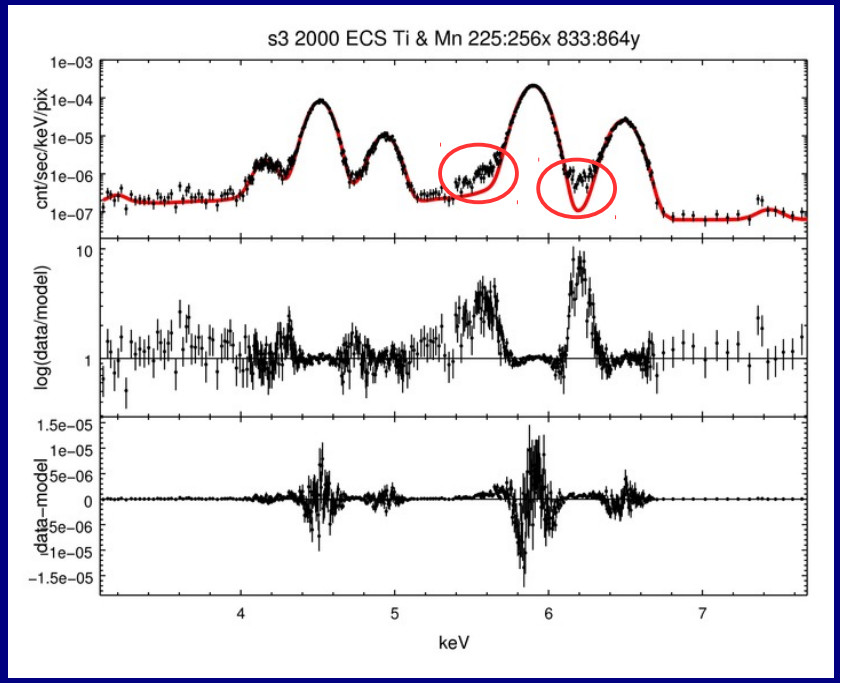


low row#

S2

S3

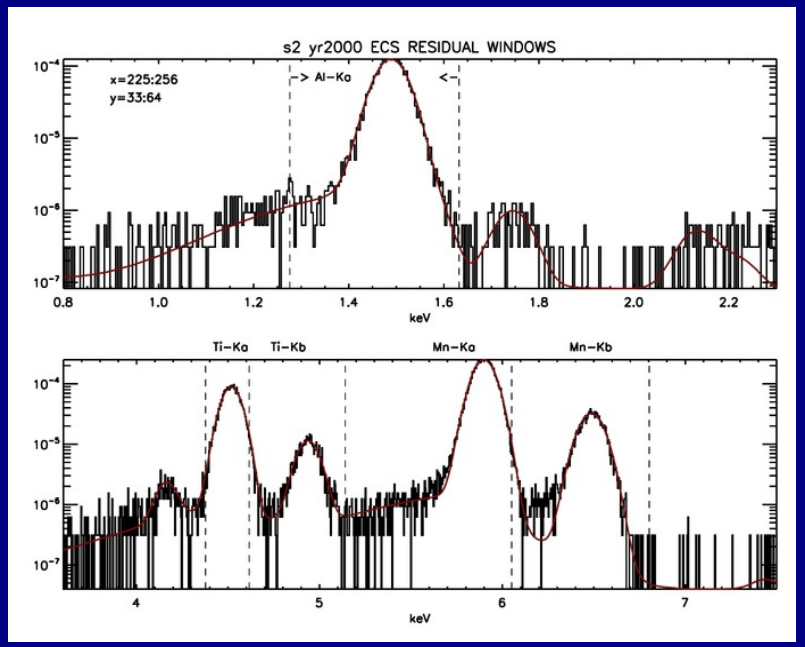




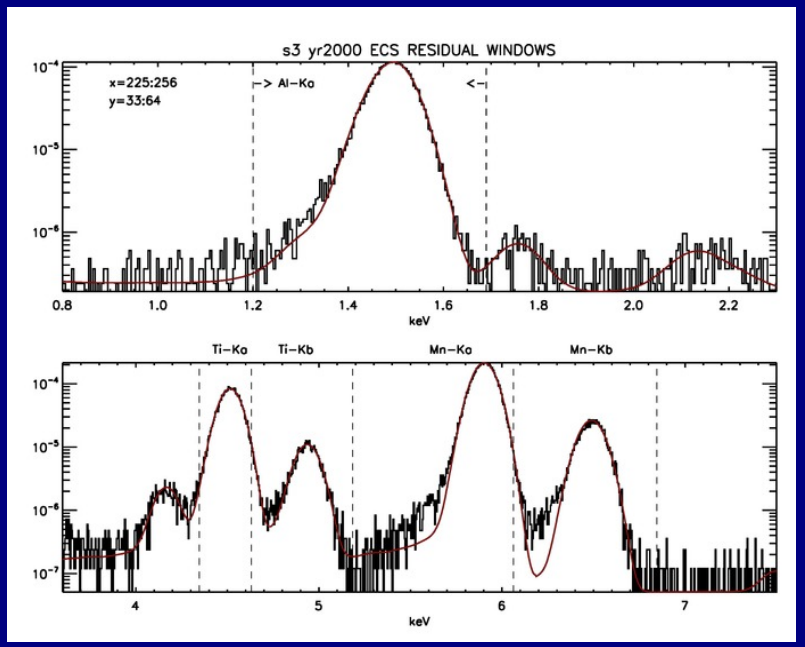
high row#

counts re-grouped to minimum of 6-10 (S2/S3)cnts/bin

RMF x (Gaussians+BKG) Fitted Flux + Residual Correction

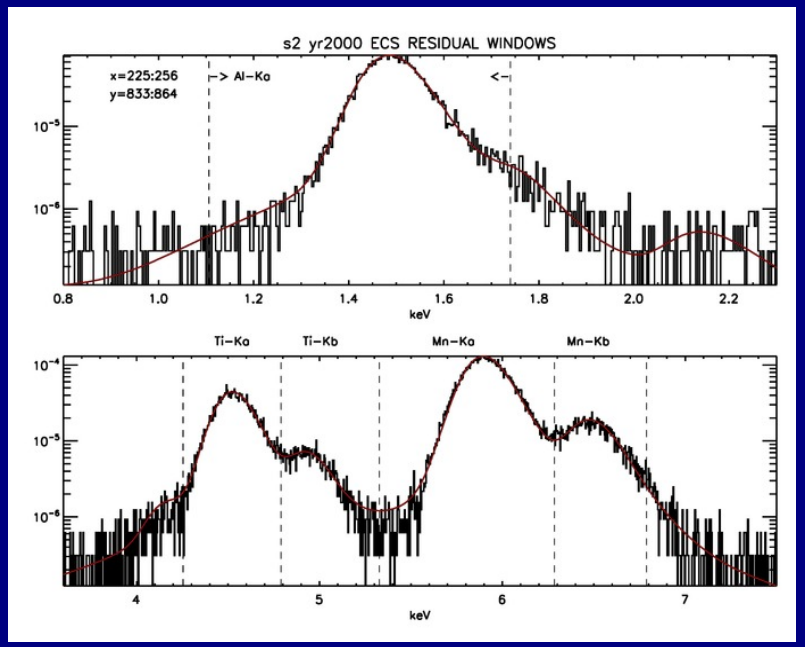


low row#

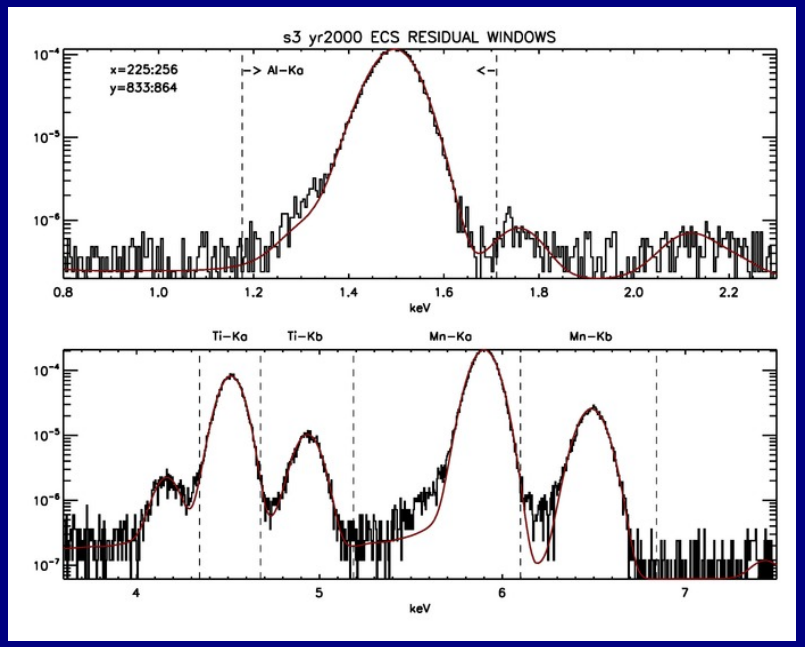


S2

S3



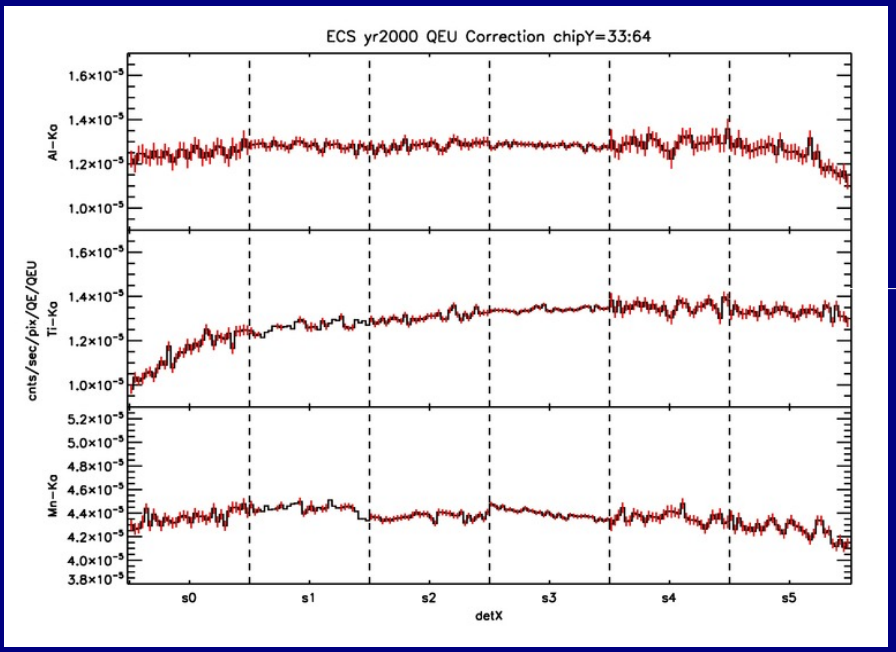
high row#



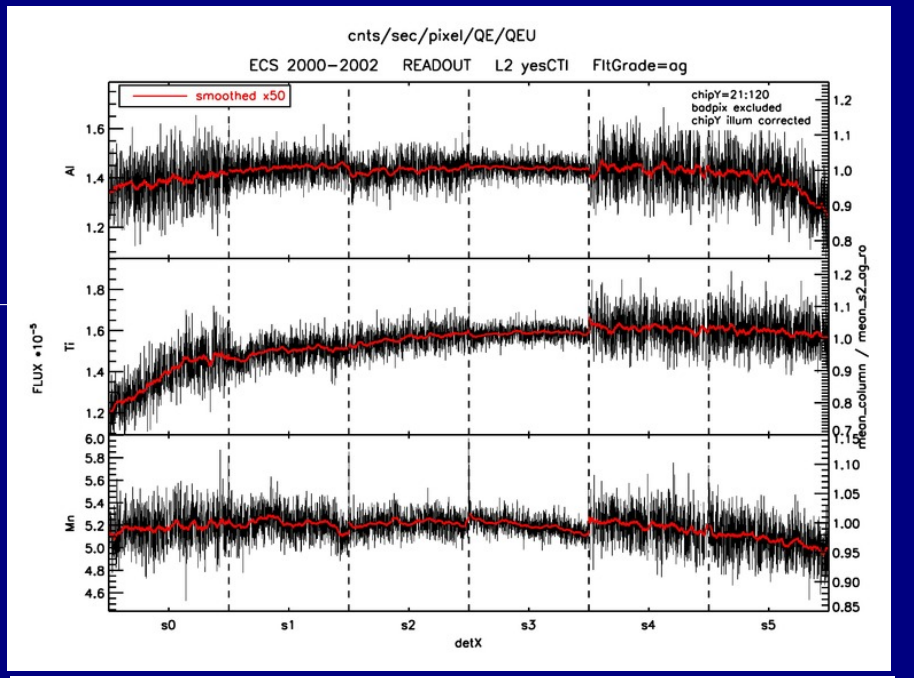
preliminary

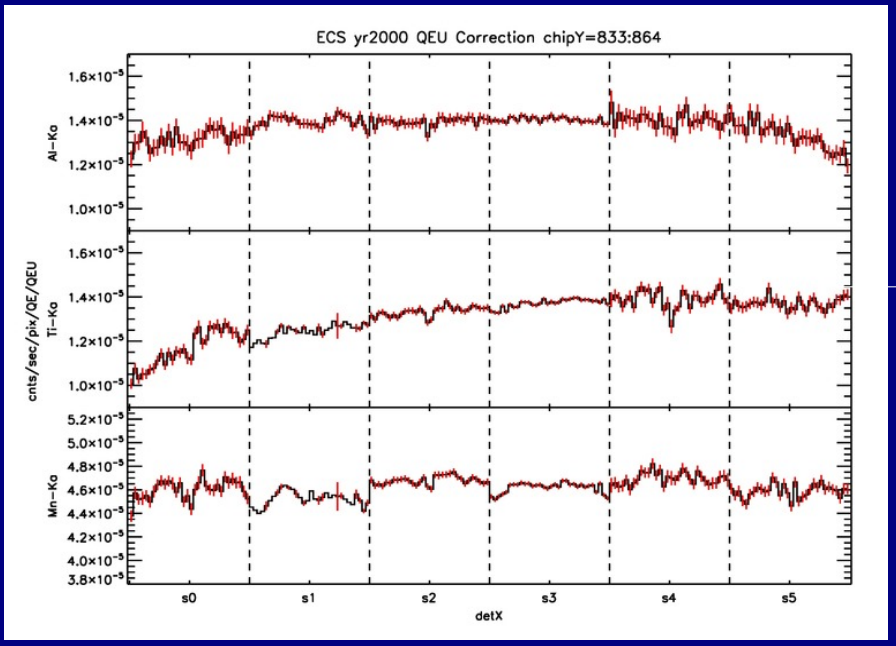
S-Array Flux vs detX
PI window & Fitted Lines+ResidCorr

preliminary



low row#





high row#