JEREMY DRAKE AND THE CXC CALIBRATION GROUP

# CHANDRA CALIBRATION STATUS

LAST CUC MEETING RECOMMENDATIONS

▸ **Continue; continue to provide regular updates (this presentation)**

▸ **Continue to play an active role in IACHEC**

  ▸ The calibration group appreciates the CUC's support for these activities

▸ **Bakeout: report on possible outcomes and risks (Paul's presentation next)**

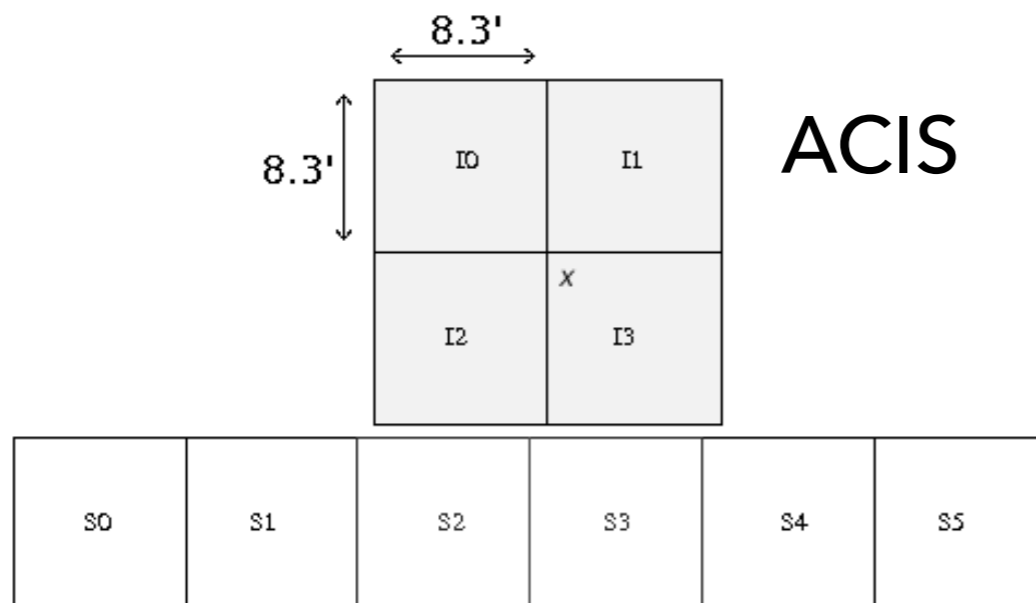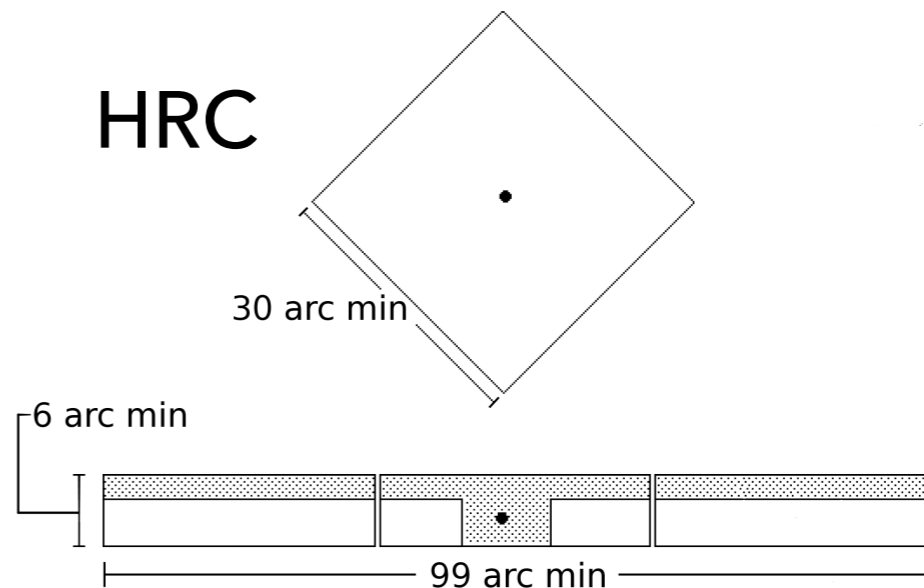# CHANDRA HARDWARE COMPONENTS: ORDER OF PRESENTATION

1

3

2

ACIS

4

HRC
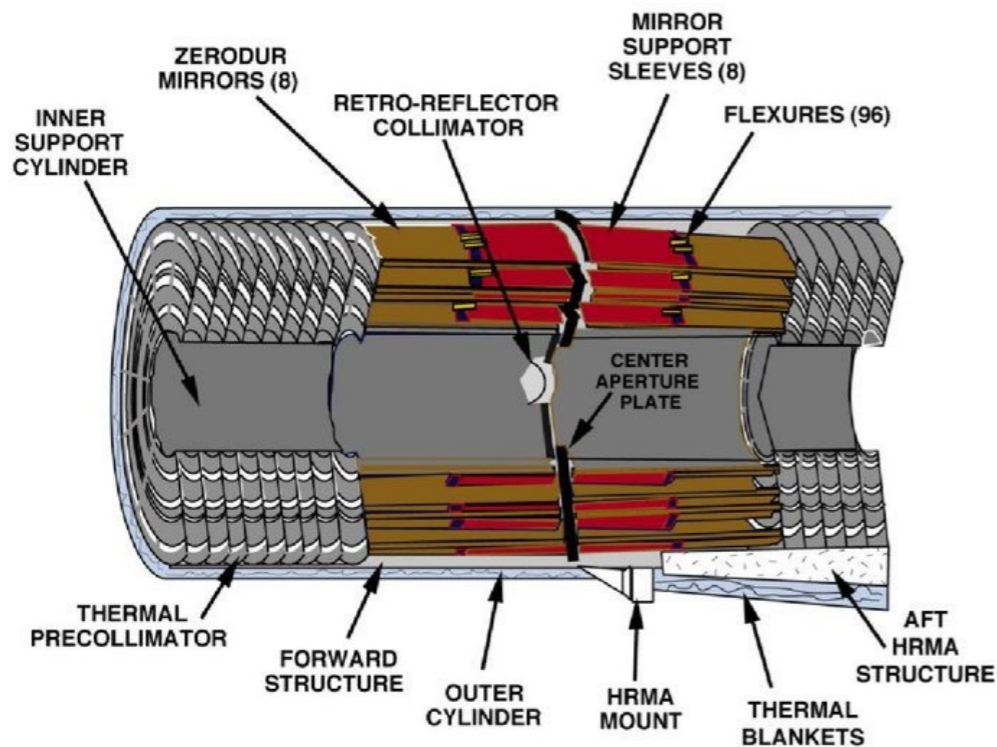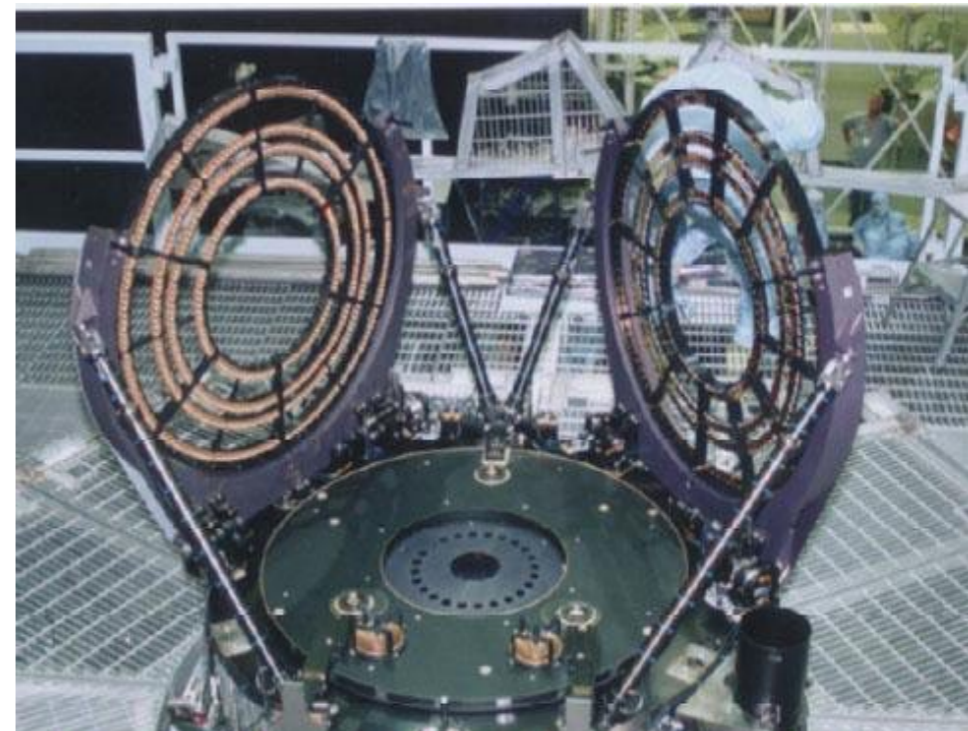
CURRENT IN-FLIGHT CALIBRATION TARGET SUMMARY (~0.9 Ms)

| TARGET	INSTRUMENT	PURPOSE
E0102-72 (SNR)	ACIS	CONTAM, GAIN, CROSS-CAL
A1795 (GAL CLUSTER)	ACIS	CONTAM, GAIN, CROSS-CAL
RXJ1856.5-3754 (ISOLATED NS)	LETG+ACIS	CONTAM
MKN 421 (BLAZAR)	HETGS, LETGS	CONTAM, EFF. AREA, CROSS-CAL
3C 273 (QSO)	HETGS	CROSS-CAL
AR LAC (ACTIVE BINARY)	HRC	PSF, GAIN
HZ43 (HOT WD)	LETG,HRC	EFFECTIVE AREA, QE, GAIN
CAPELLA (ACTIVE BINARY)	HETGS, LETGS	DISPERSION, LINE RESPONSE
VEGA (A0 V)	HRC	UVIS UV LEAK

OUTLINE

▸ **Main concern: secular change in both ACIS and HRC performance**

▸ Point Spread Function

    ▸ calibrating EDSER; empirical PSFs

▸ ACIS

    ▸ mid-chip gain droop; contamination

▸ HETG 0th order throughput

▸ HRC-S,I

   ▸ QE decline; gain decline

HRMA: POINT SPREAD FUNCTION

ACIS EMPIRICAL PSF (V. KASHYAP, P. ZHAO, D. JERIUS)

▸ Verify and calibrate HRMA raytrace model; calibrate EDSER

  ▸ Energy Dependent Subpixel Event Repositioning - ACIS images can be sharpened significantly at sub-pixel resolutions

  ▸ Applies corrections to event locations based on photon energy and event grade (Li et al. 2004, ApJ 610, 1204)

  ▸ <u>BUT</u>: EDSER'd PSFs have not yet been calibrated

▸ Generate an empirical "un-rolled" on-axis PSF using point sources (stars) culled from the CSC
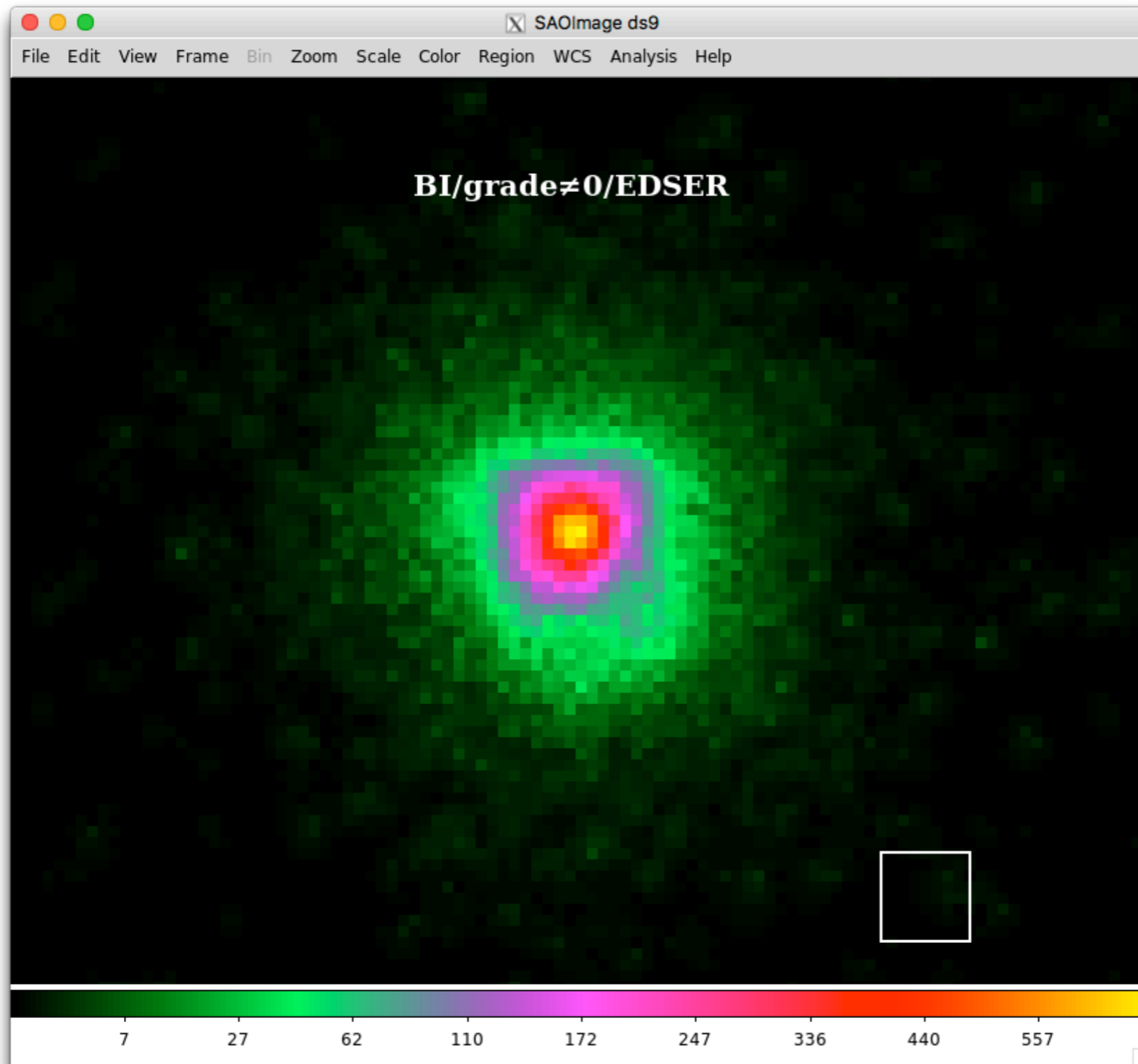
QUANTIFYING EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)

ID: 10528, OBSID:13644, 40_Eri_C, ACIS-S, 5.0000ks, 0.159c/s
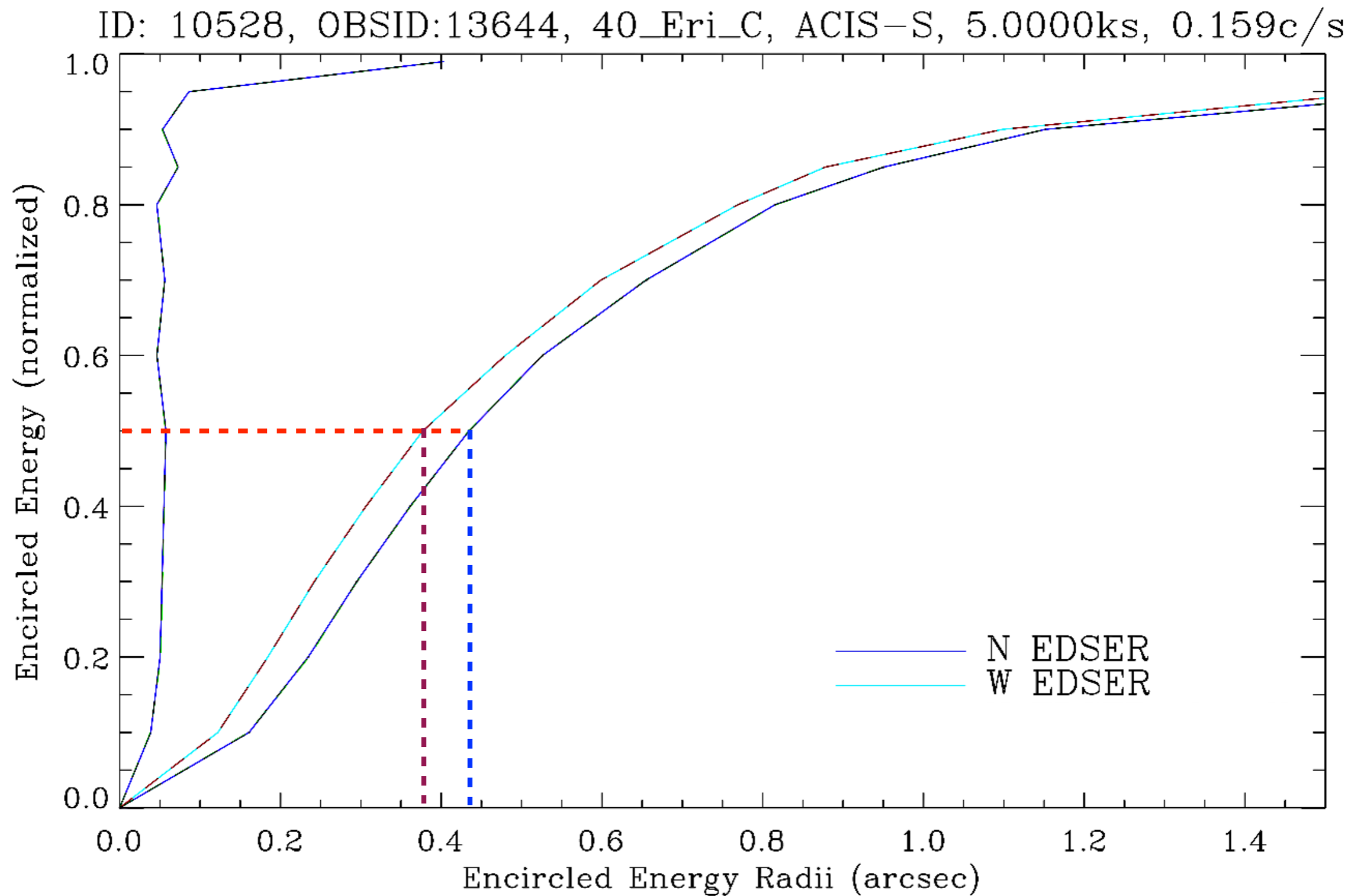
EMPIRICAL PSF WITH EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)
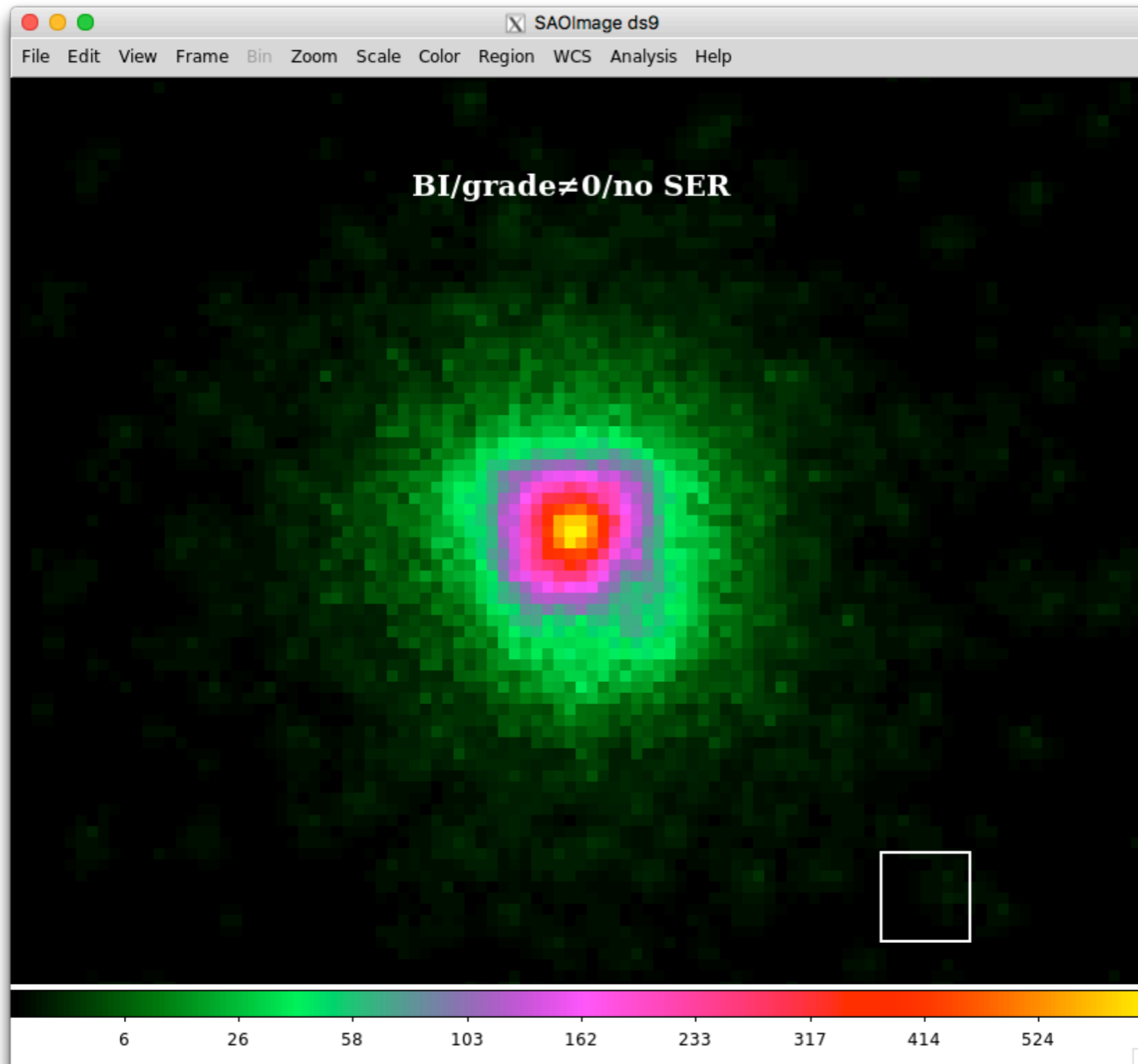
# EMPIRICAL PSF WITH EDSER (V. KASHYAP, P. ZHAO, D. JERIUS)

ACIS EMPIRICAL PSF (V. KASHYAP, P. ZHAO, D. JERIUS)

▸ Currently ~100 verified stars nearly on-axis within right count/frame range (< 0.02)

  ▸ Using Gaia to increase sample size

▸ To be release as FITS images in 3+ energy bands c. Summer 2019

▸ This release limited to on-axis

ADVANCED CCD IMAGING SPECTROMETER (ACIS)

MID-CHIP GAIN DROOP (T. GAETZ)

ECS
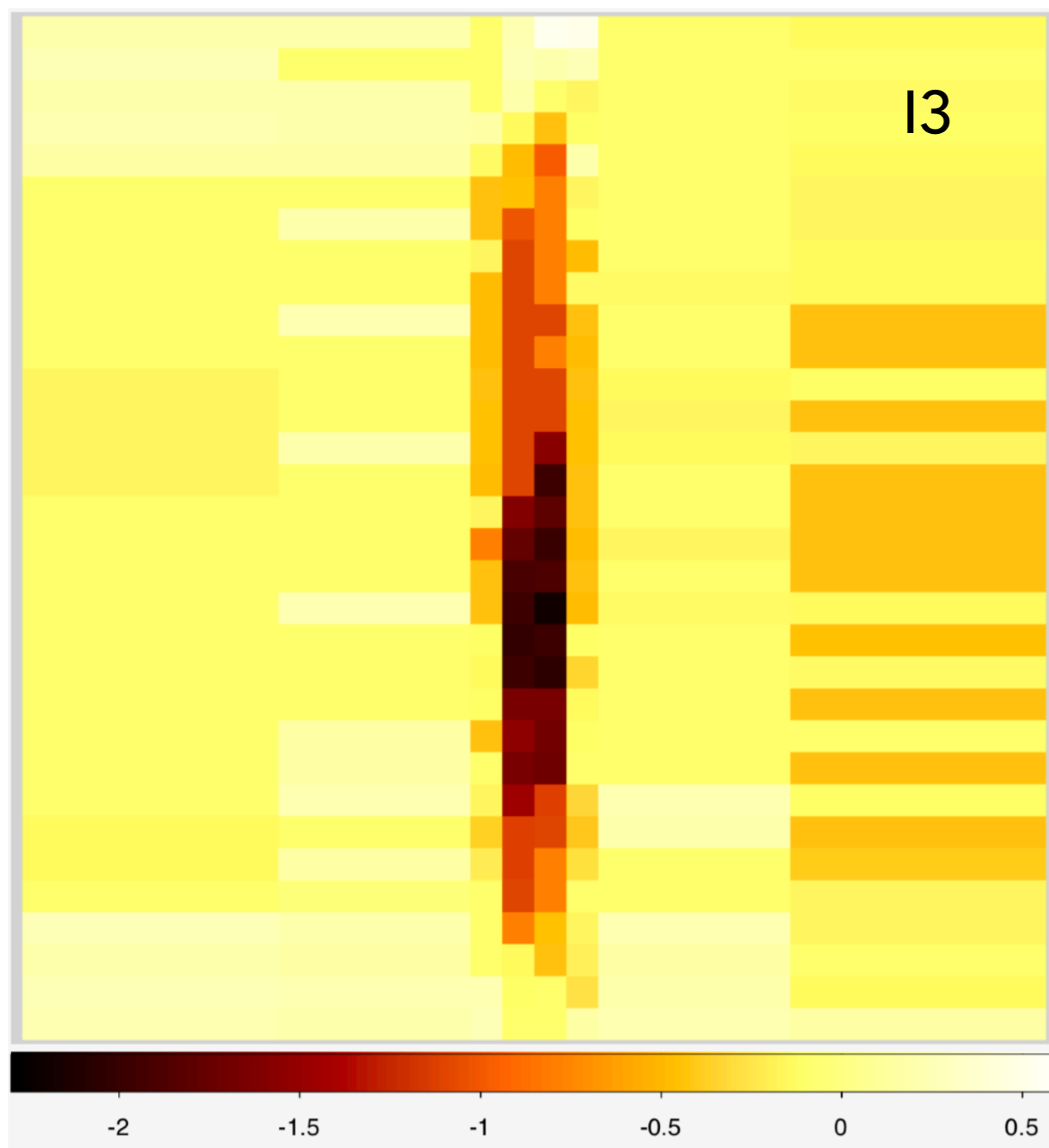
I0   I1

I2   I3
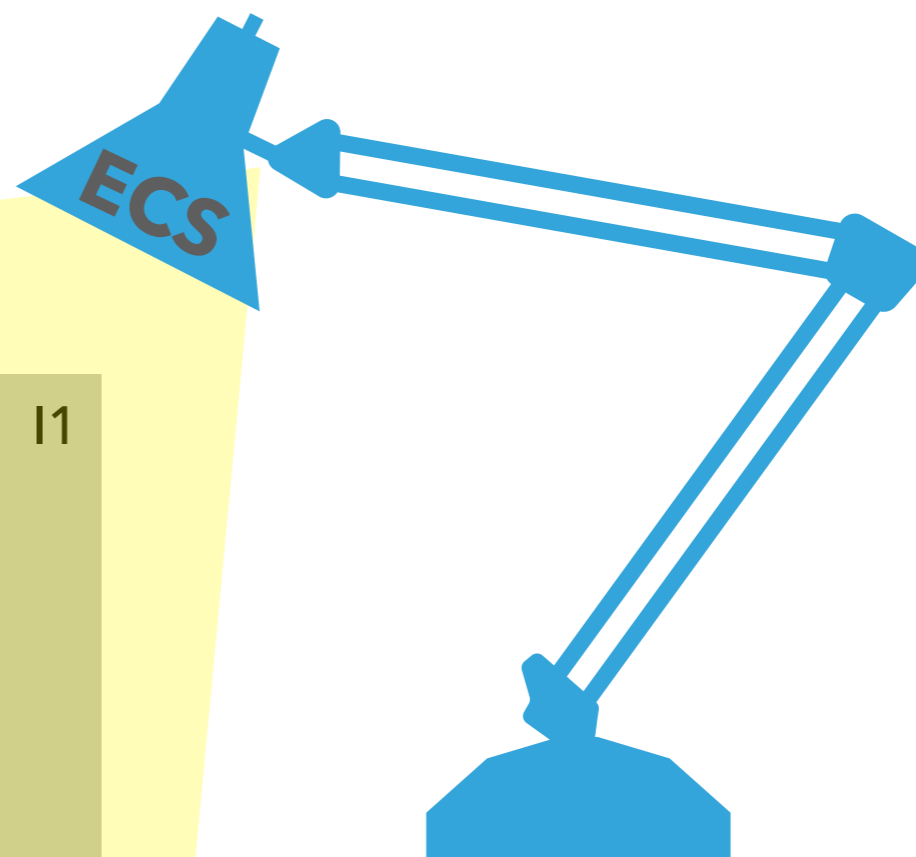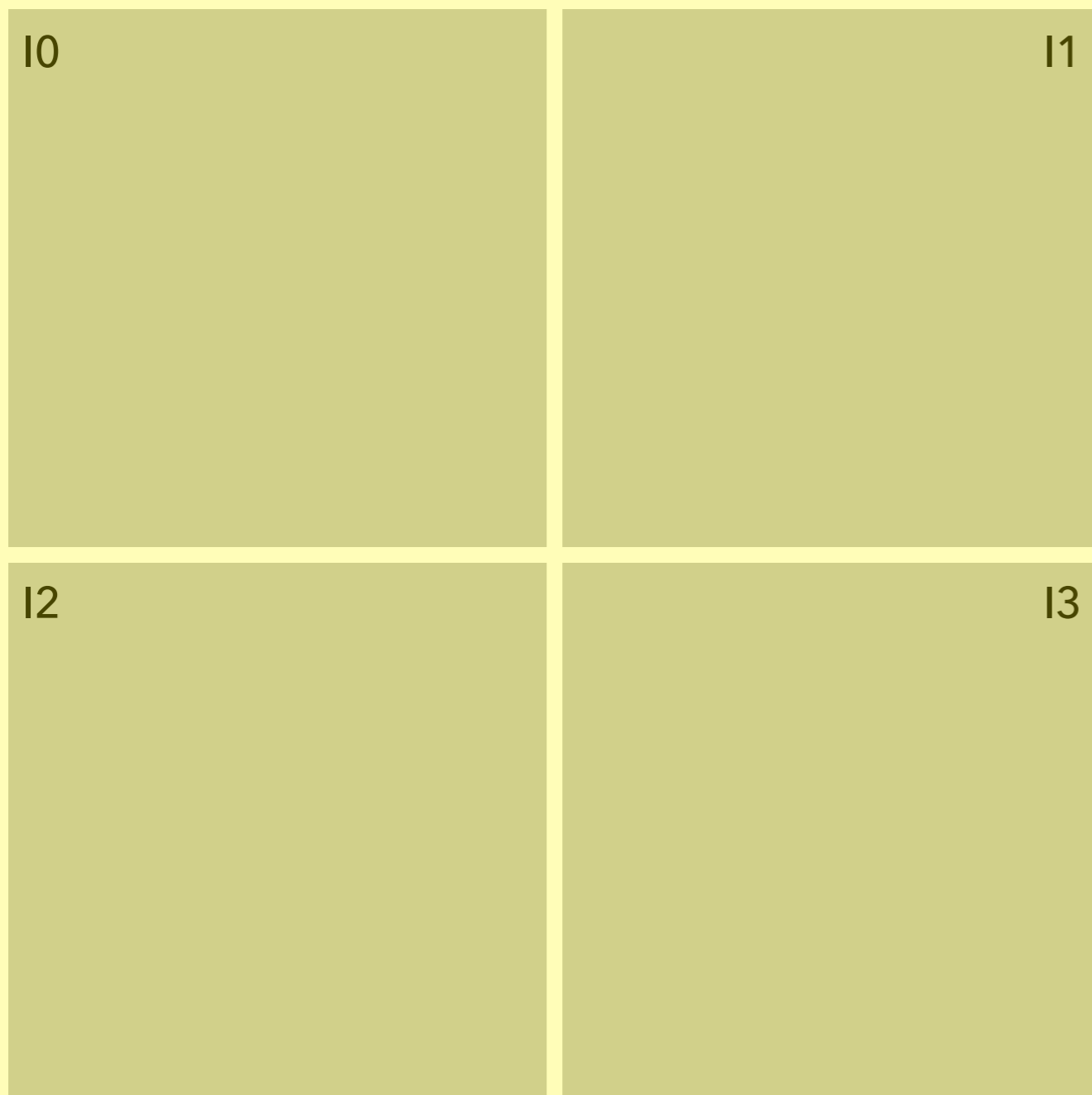
^{55}Fe source +
Al/Ti target

Mn Kα (5.9 keV)
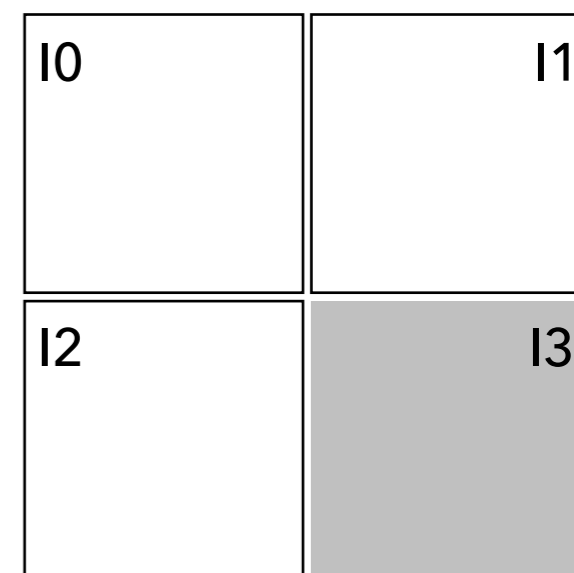
Ti Kα (4.5 keV)

Al Kα (1.5 keV)

MID-CHIP GAIN DROOP (T. GAETZ)

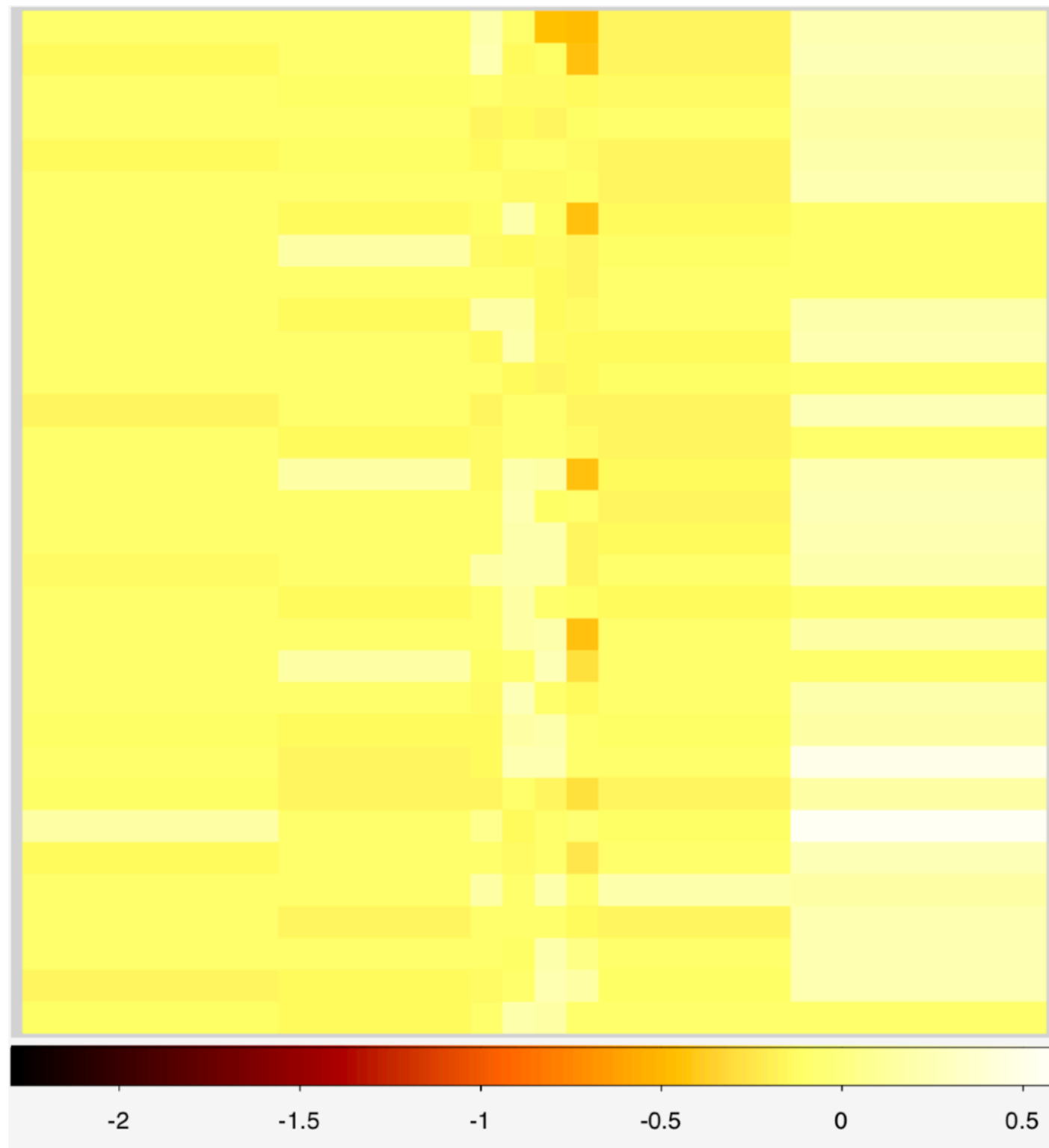Epoch 1, -120.19 to -119.19 C

Current det_gain
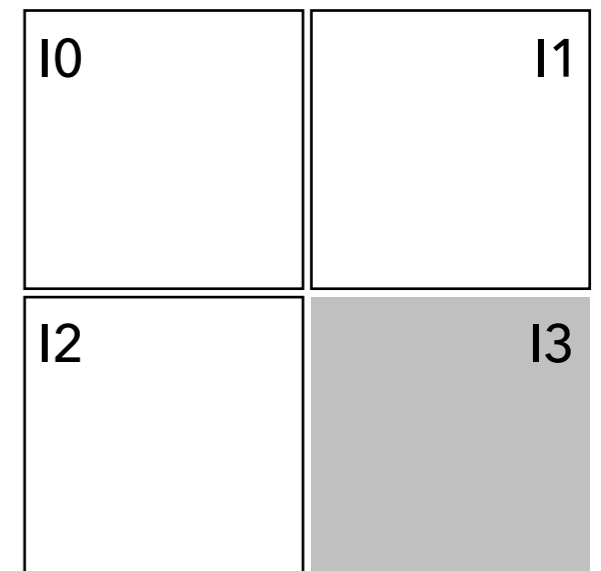
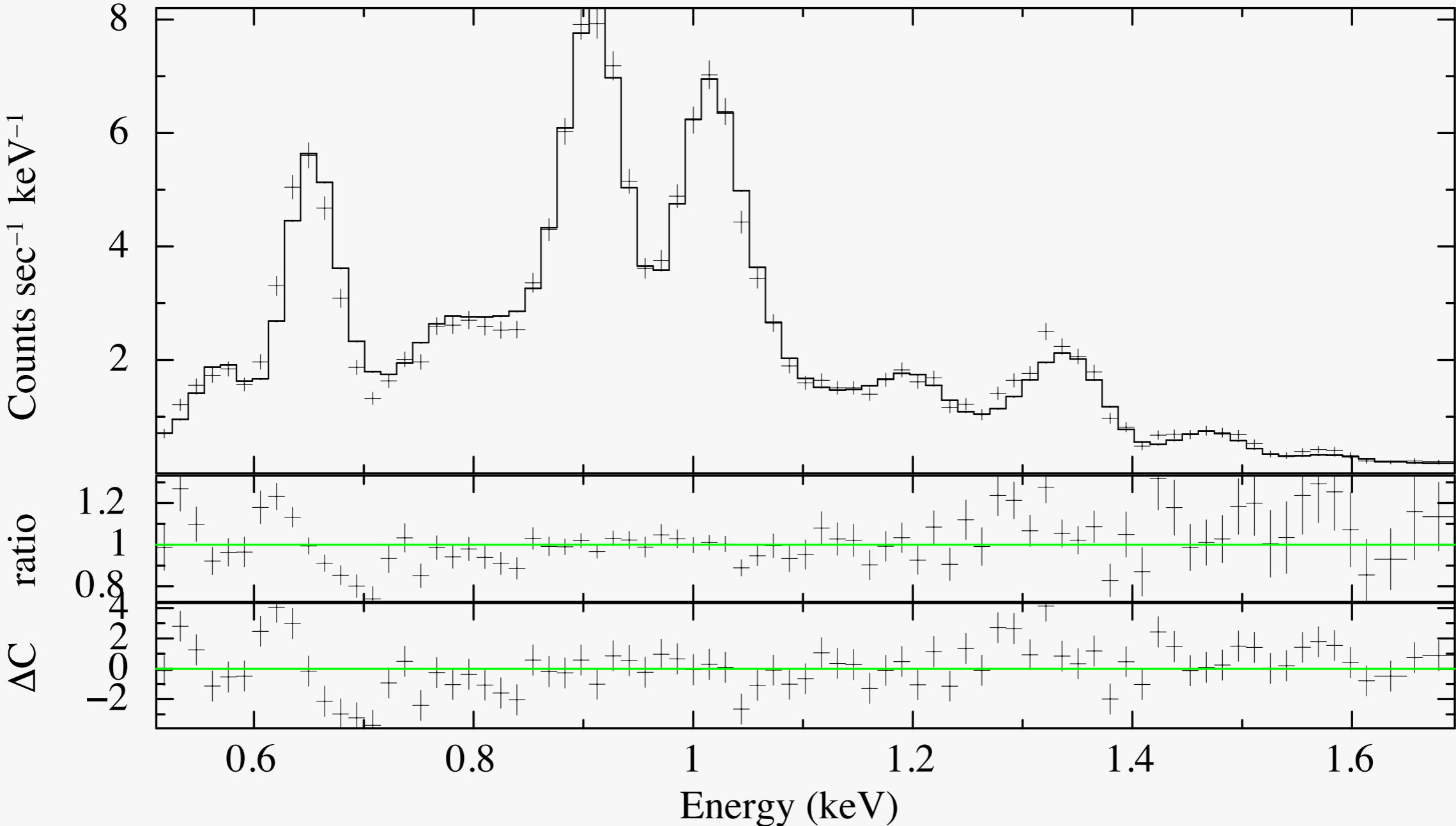# MID–CHIP GAIN DROOP (T. GAETZ)

Epoch 1, -120.19 to -119.19 C

Trial I3 det_gain

Al K

I0	I1
I2	I3

MID-CHIP GAIN DROOP (T. GAETZ)   Extrapolation to lower E
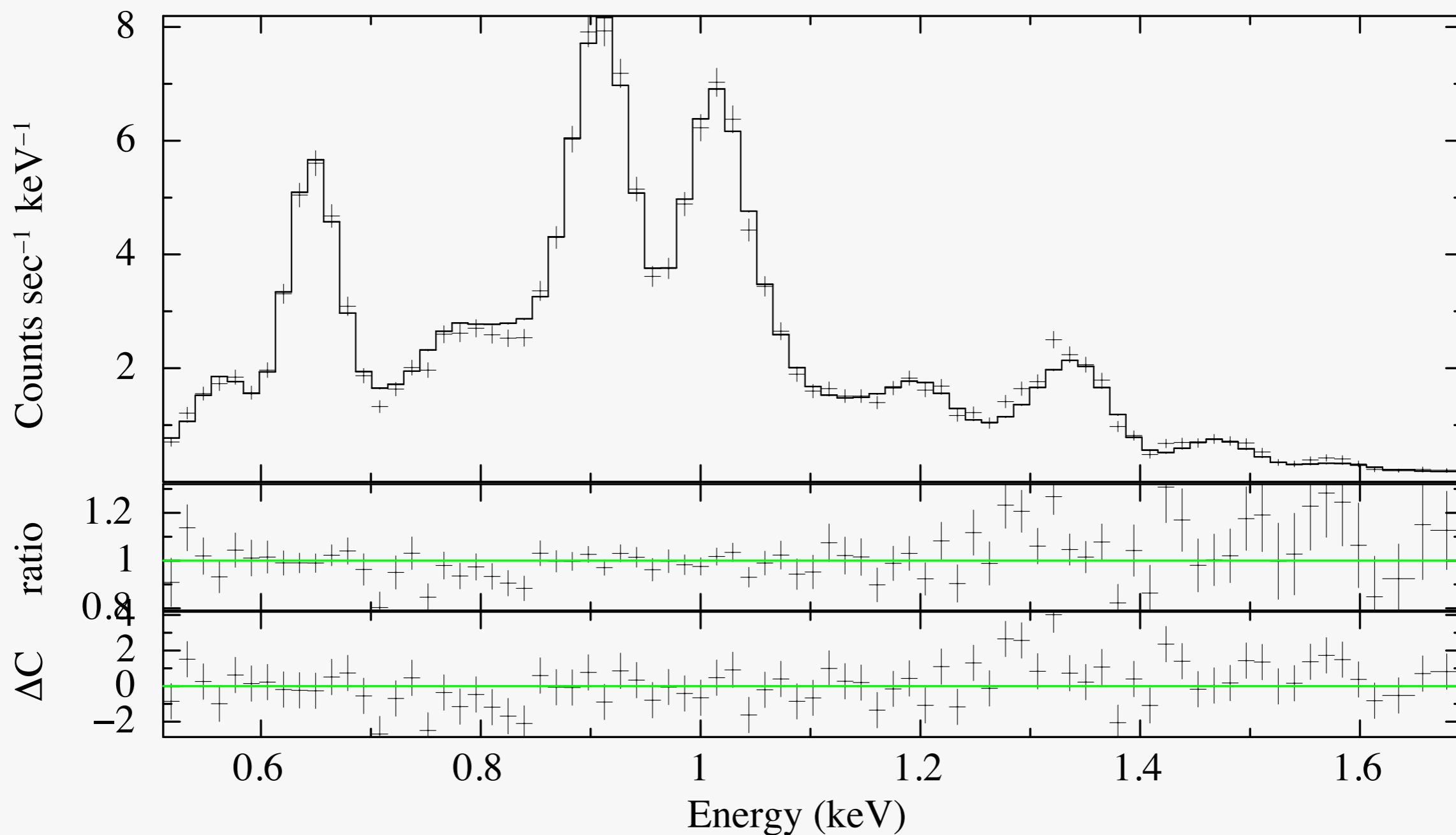

E0102: obs01313: I3: (896.13, 103.20)

MID–CHIP GAIN DROOP (T. GAETZ)   Extrapolation to lower E

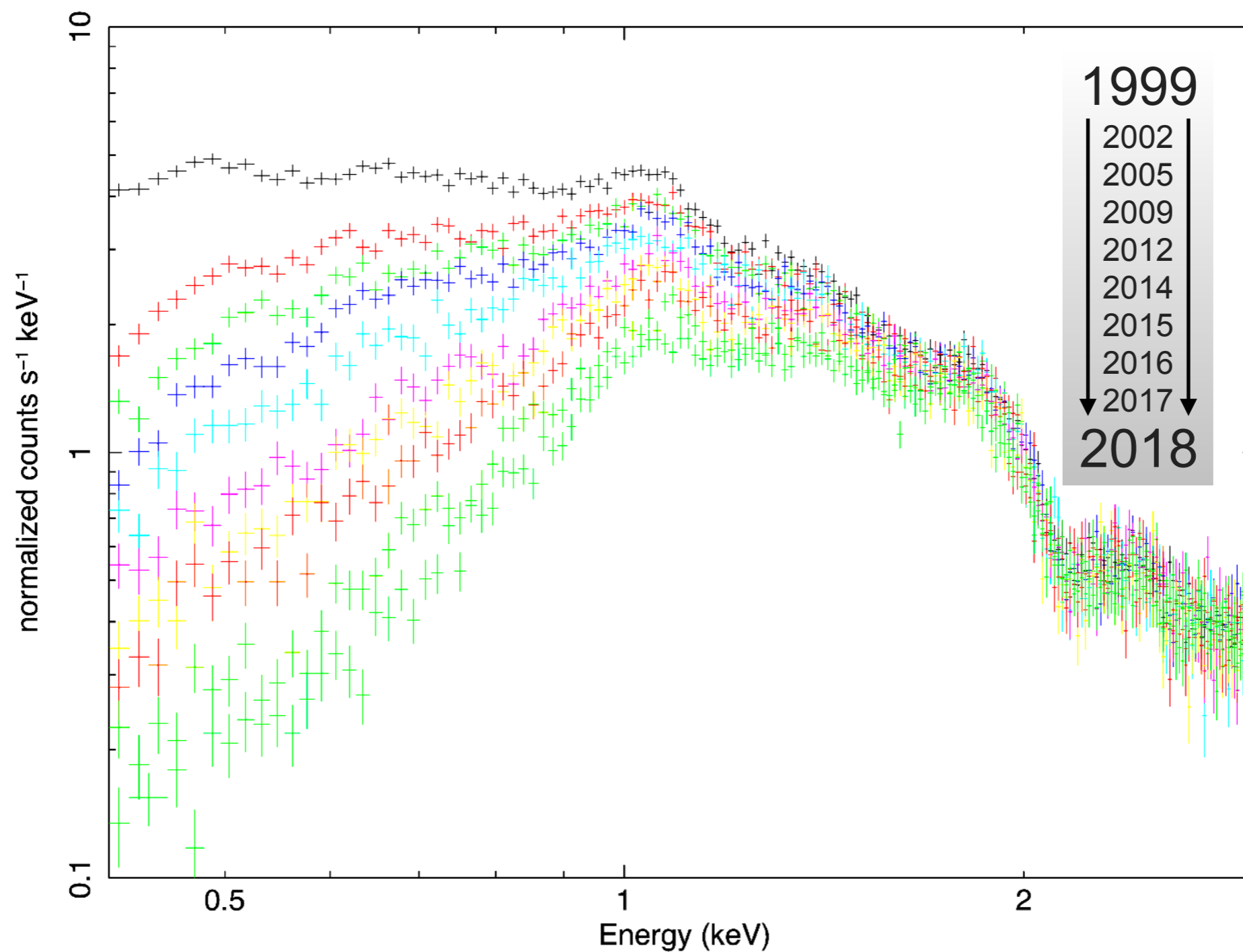E0102: obs01313: I3: (896.13, 103.20): (O, Ne energy thawed)
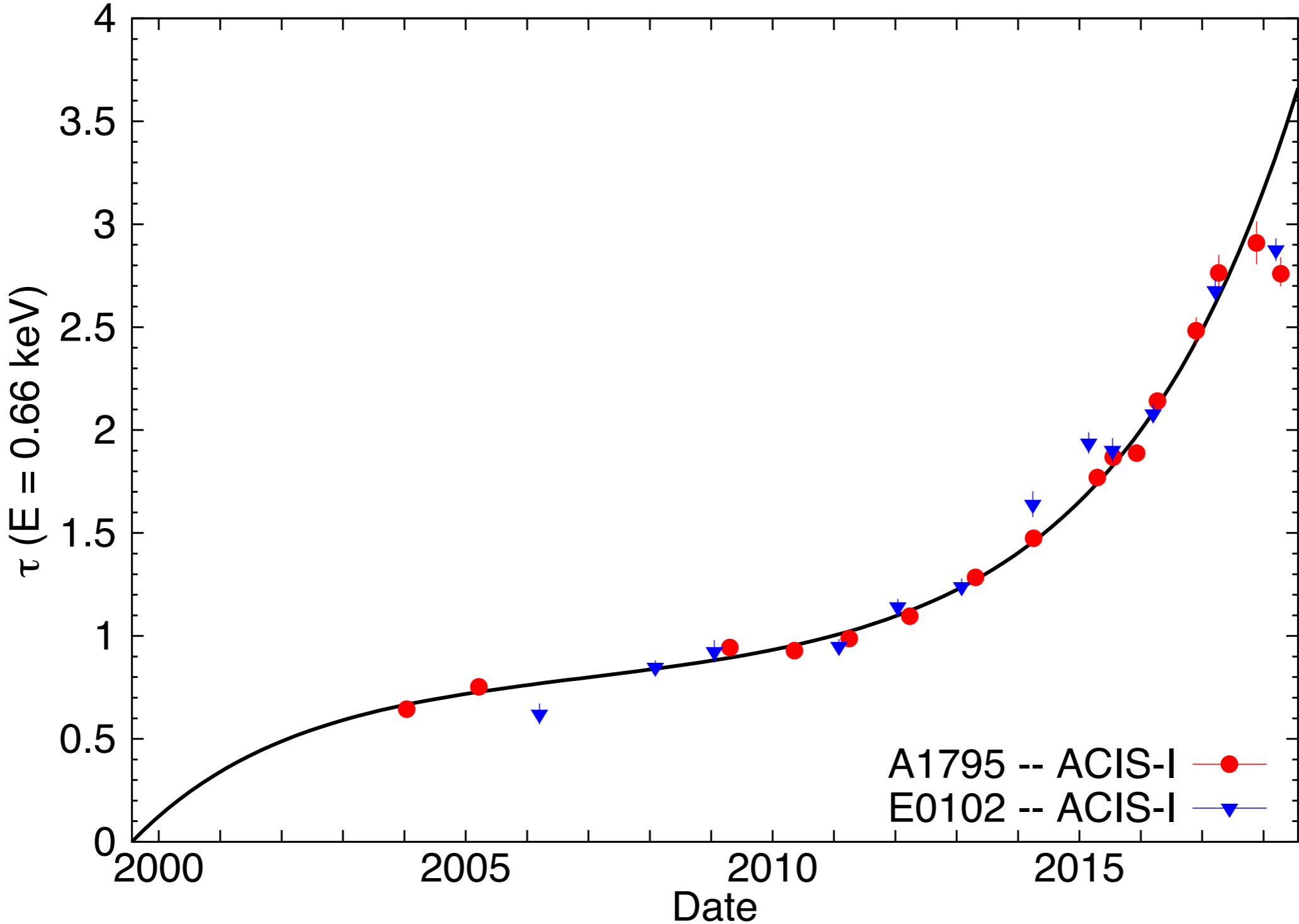
MID-CHIP GAIN DROOP (T. GAETZ)

▸ New trial det_gain for I3 almost ready - proof of concept

▸ Apply same procedure to other FI chips: I0,I1,I2,S2

▸ tdet_gain - time dependence: currently unchanged

▸ Projected release Spring 2019

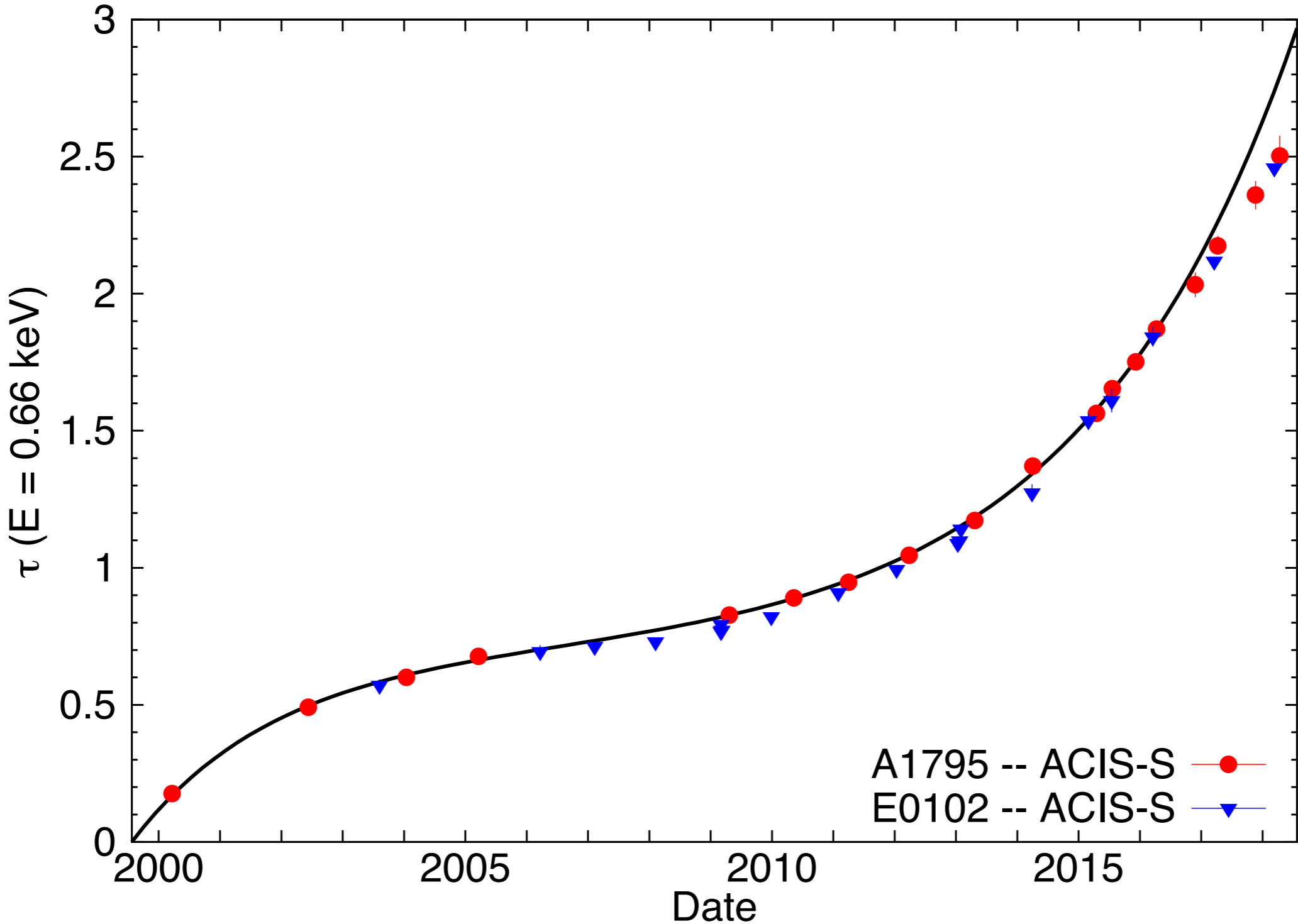# FILTER CONTAMINATION LAYER (A, BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

data and folded model

FILTER CONTAMINATION LAYER (A, BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

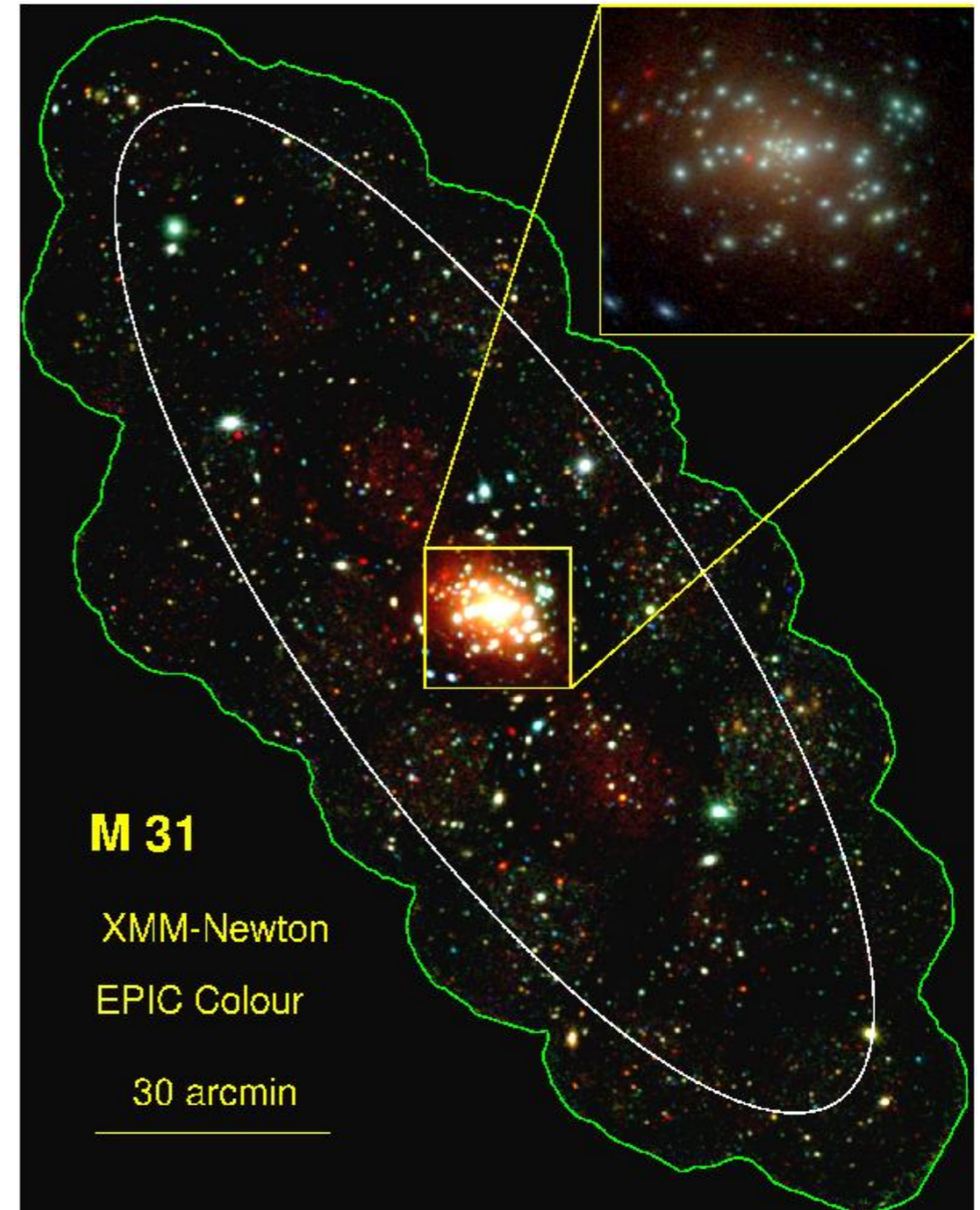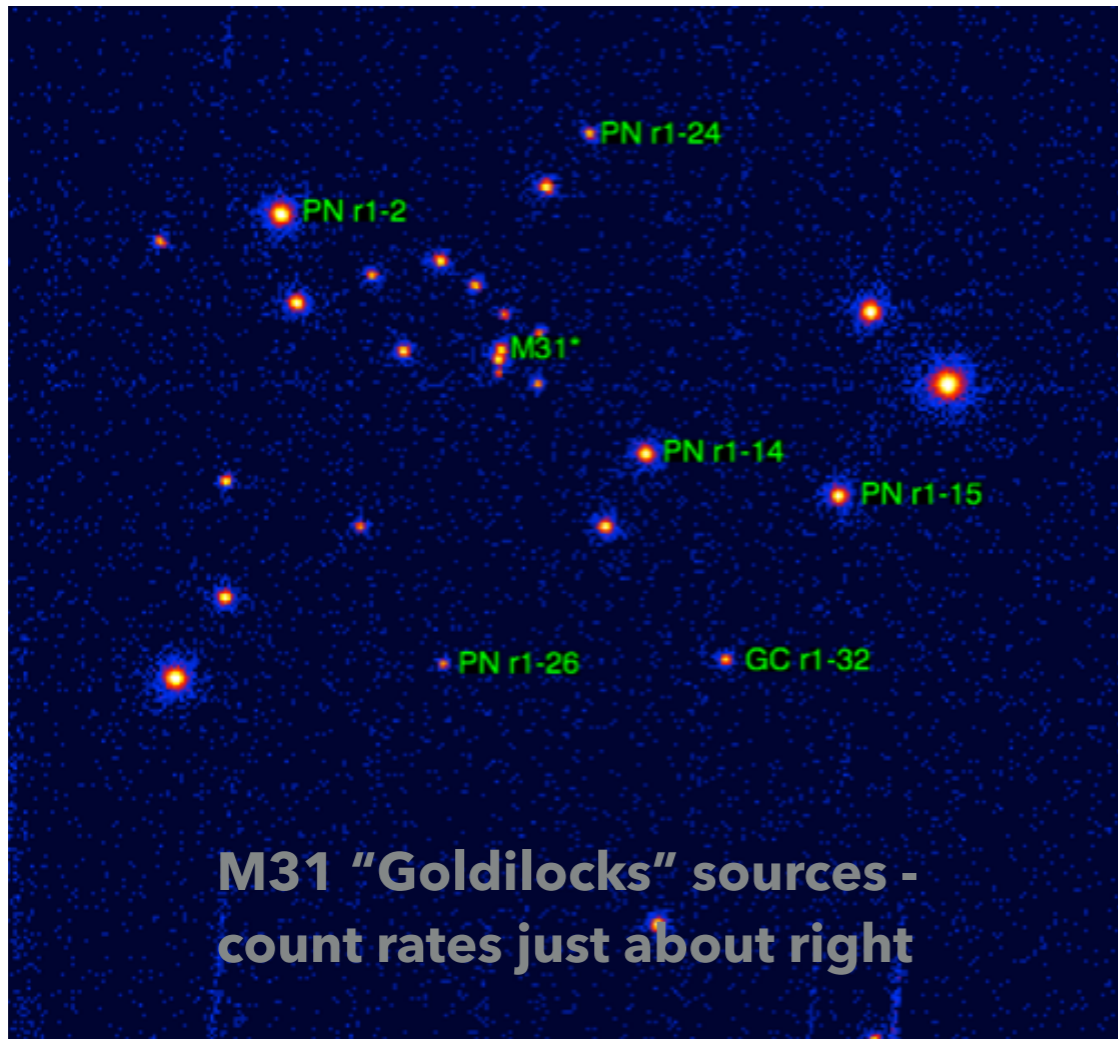# FILTER CONTAMINATION LAYER (A, BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

FILTER CONTAMINATION LAYER (A, BOGDAN, H. MARSHALL, P. PLUCINSKY ET AL)

▸ *Rate of accumulation* on ACIS-I shows significant decrease compared with model prediction - very little since 4/17

  ▸ New contamination model released CalDB 4.7.9

▸ *Rate of accumulation* on ACIS-S is significantly lower than the current model prediction - essentially a linear trend rather than exponential

  ▸ Model spatial variation still being tweaked - new model release within next 3 months

▸ BAKEOUT? - see Paul Plucinsky's presentation

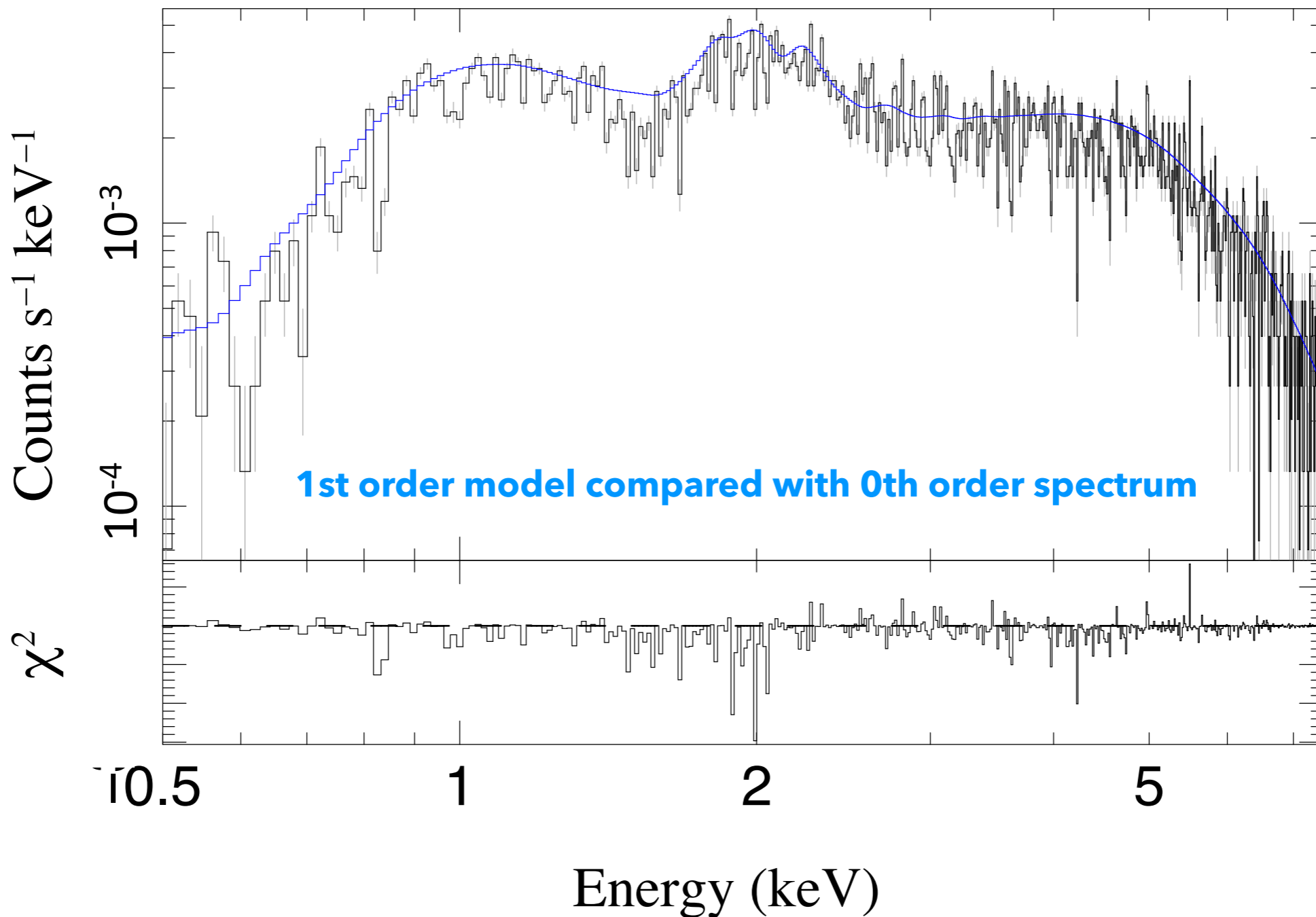# HETG 0TH ORDER (UPDATE)

0TH ORDER EFFECTIVE AREA (NORBERT SCHULZ)

M31 center with Chandra HETG:

M31 "Goldilocks" sources - count rates just about right

M 31
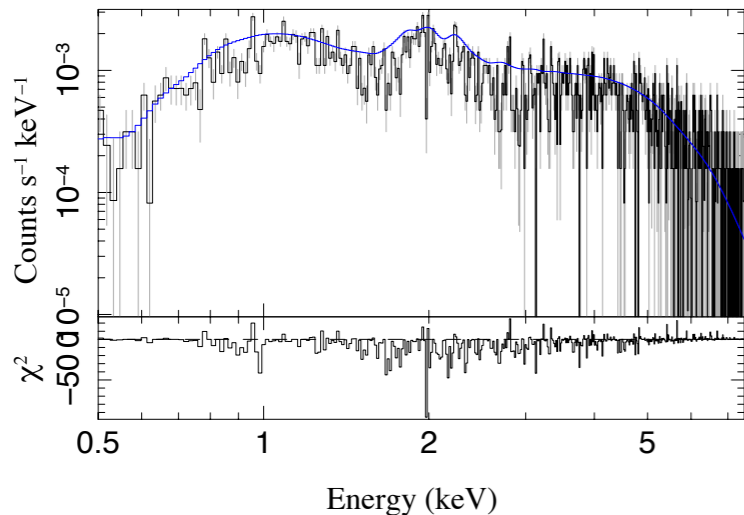
XMM-Newton

EPIC Colour

30 arcmin

R. Supper et al. 2001, A&A, 373, 63: Soft diffuse emission at M31 bulge ($\sim 10^{39}$ erg s^{-1})

0TH ORDER EFFECTIVE AREA (NORBERT SCHULZ)
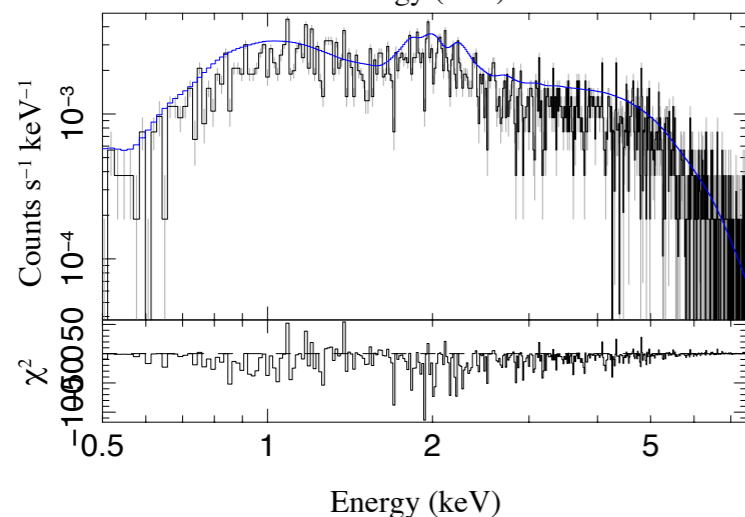
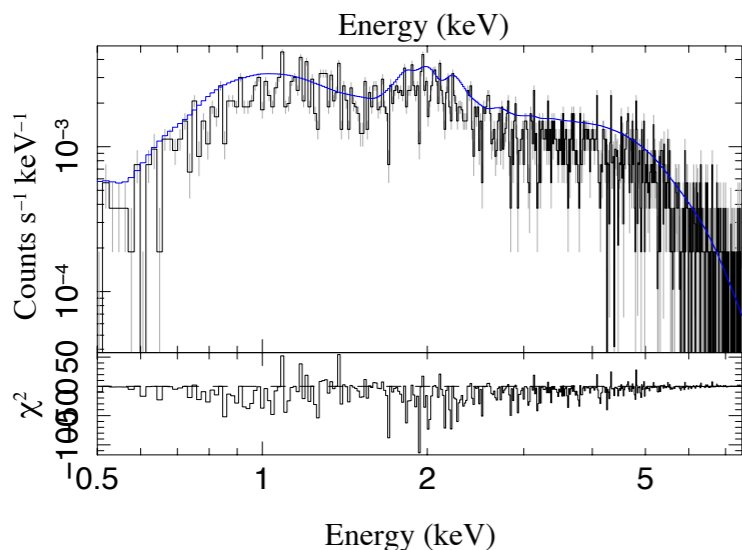M31 source 6, ACIS 0th order , R = 0 to 10 pixel circle extraction

0TH ORDER EFFECTIVE AREA (NORBERT SCHULZ)

M31
source 10

M31
source 3

M31
source 5

▸ More thorough analysis correcting for both pile-up and diffuse X-ray emission

▸ Current constraint is 0th order effective area good to better than 10%

▸ Analysis and full constraints using more sources will be concluded Spring 2019

HIGH RESOLUTION CAMERA

HRC–S DEGAP UPDATE (V. KASHYAP)
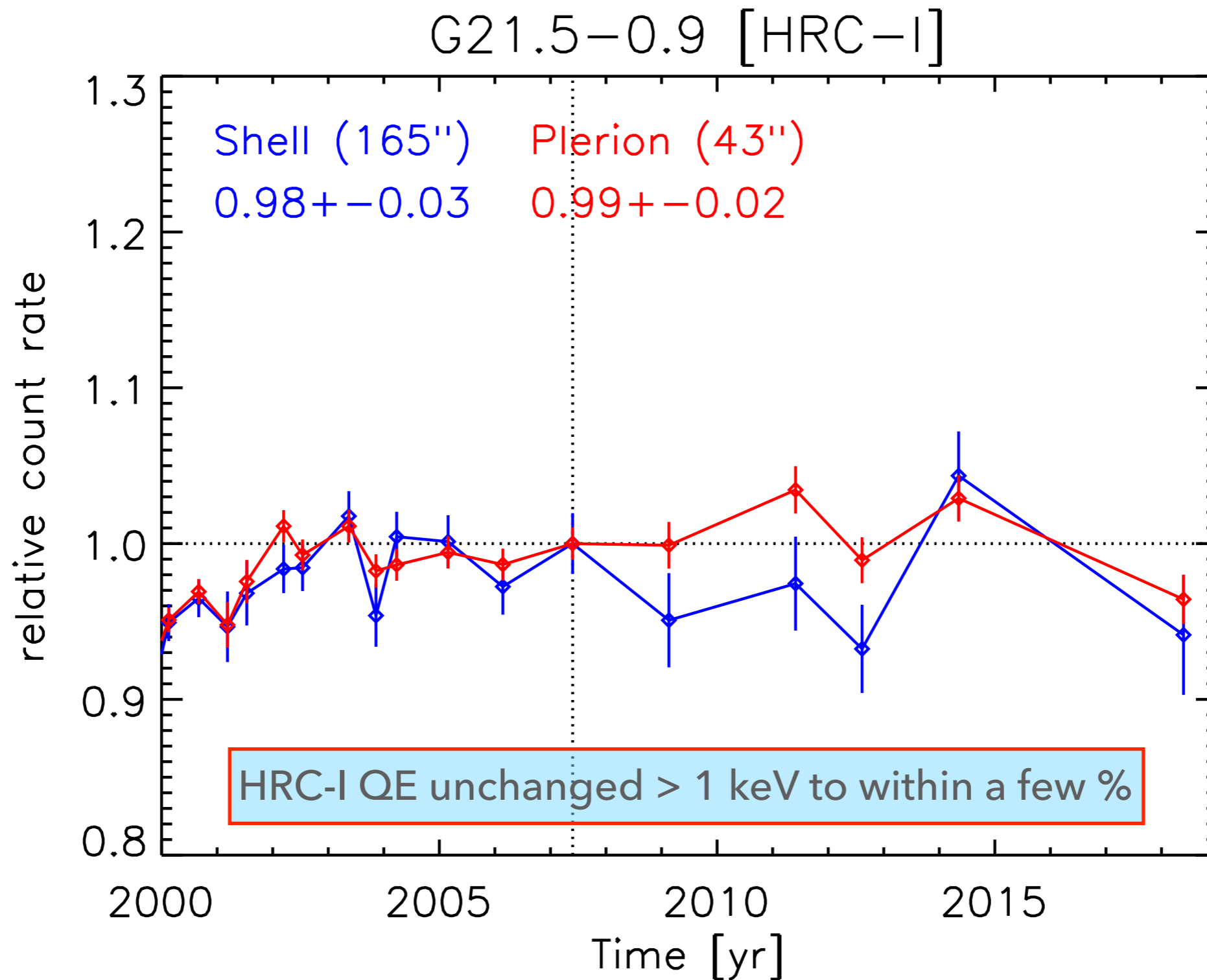
Old line profile difference   New line profile difference
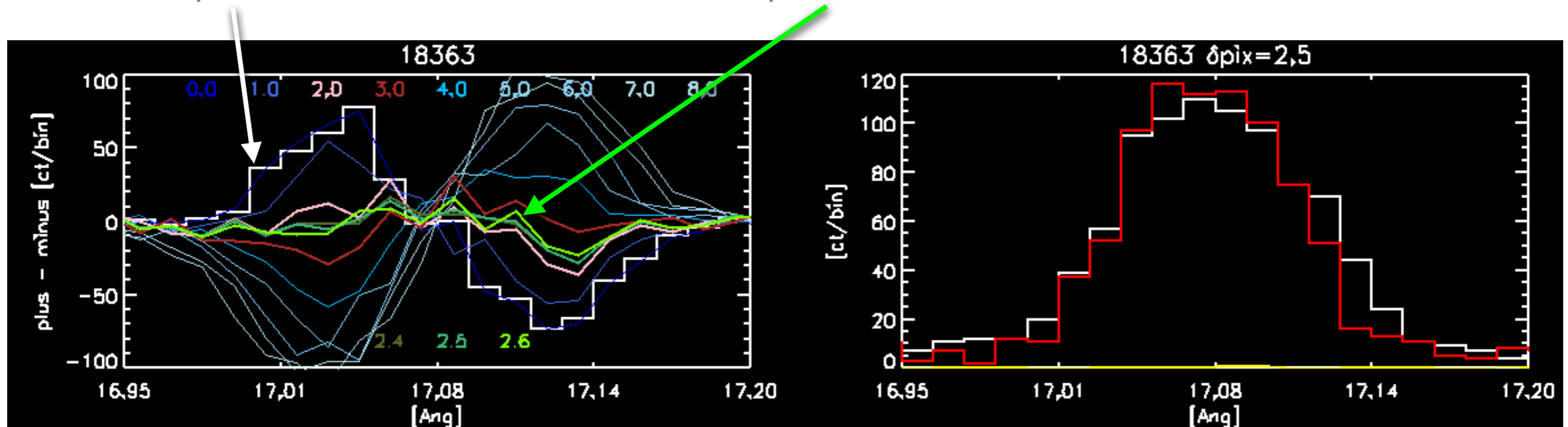
▸ HRC-S aim point degap solution improved in 2012 ==> sharper images
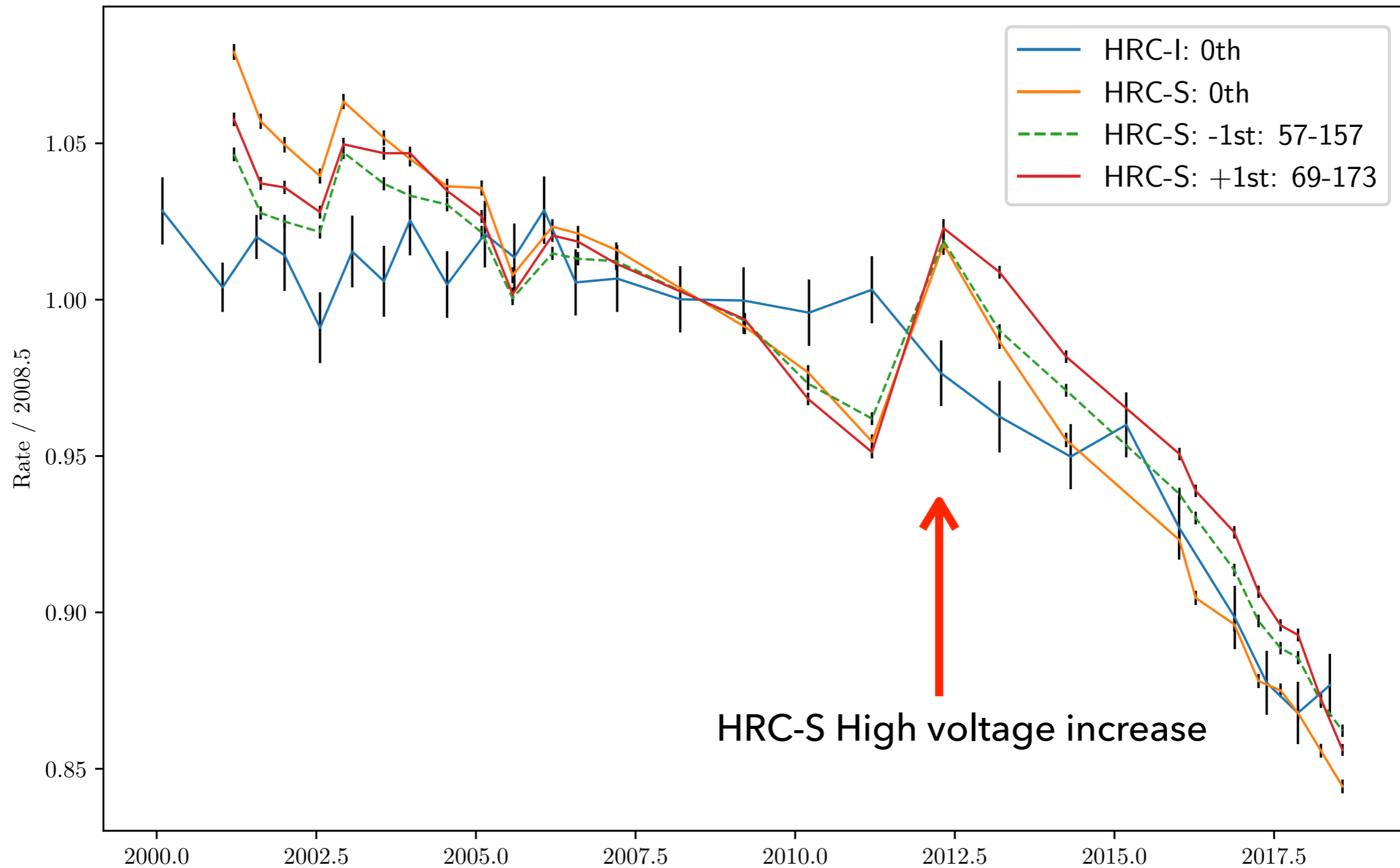
▸ But…! Caused a shift in derived wavelengths relative to 0th order location…

http://cxc.harvard.edu/cal/Hrc/Degap/hrcsdegap_centershift.html

HRC–I HIGH ENERGY QE (V. KASHYAP, P. RATZLAFF)

G21.5−0.9 [HRC−I]

QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)

HZ 43: HRC/LETG Count Rates

HRC-S High voltage increase

QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)

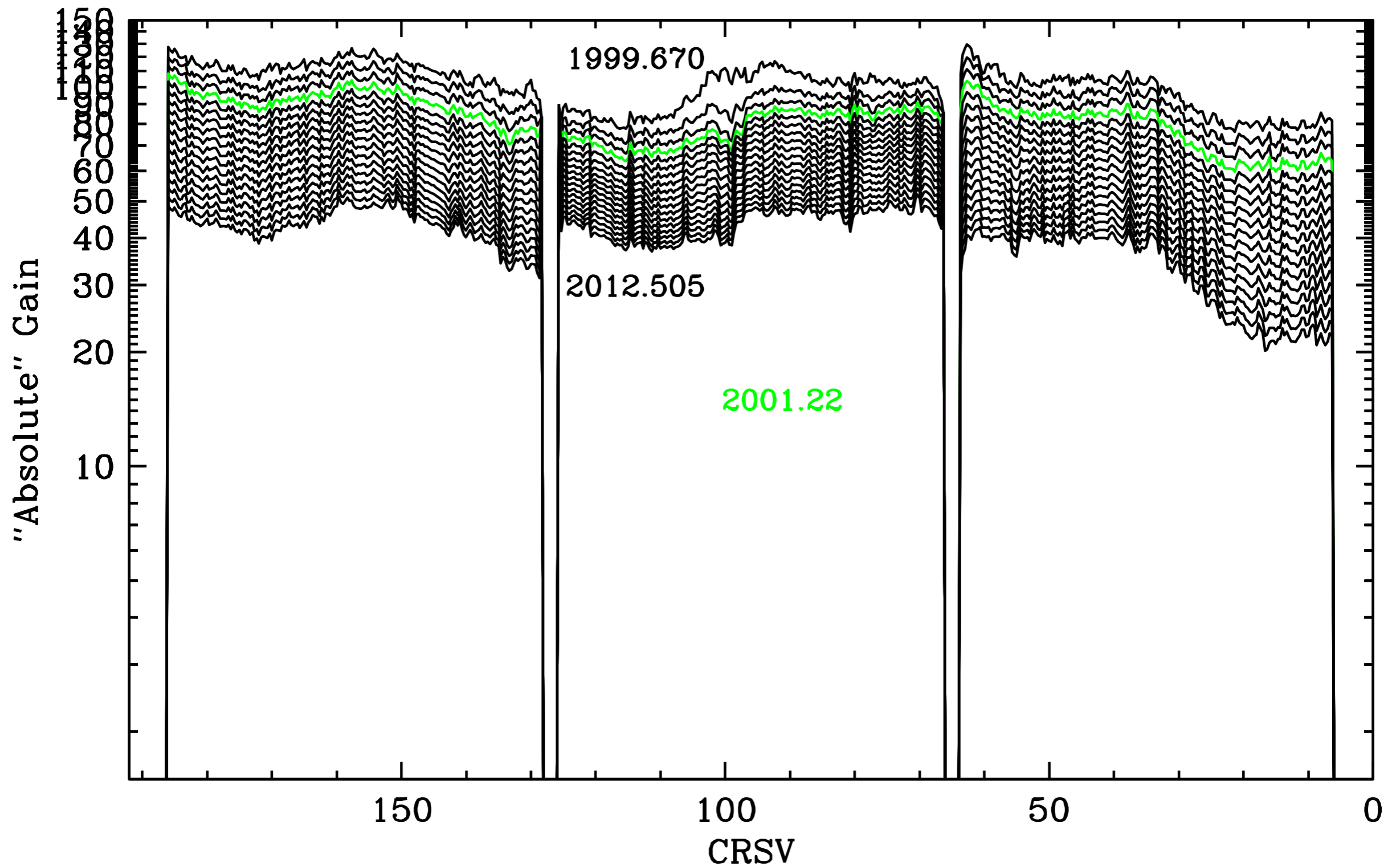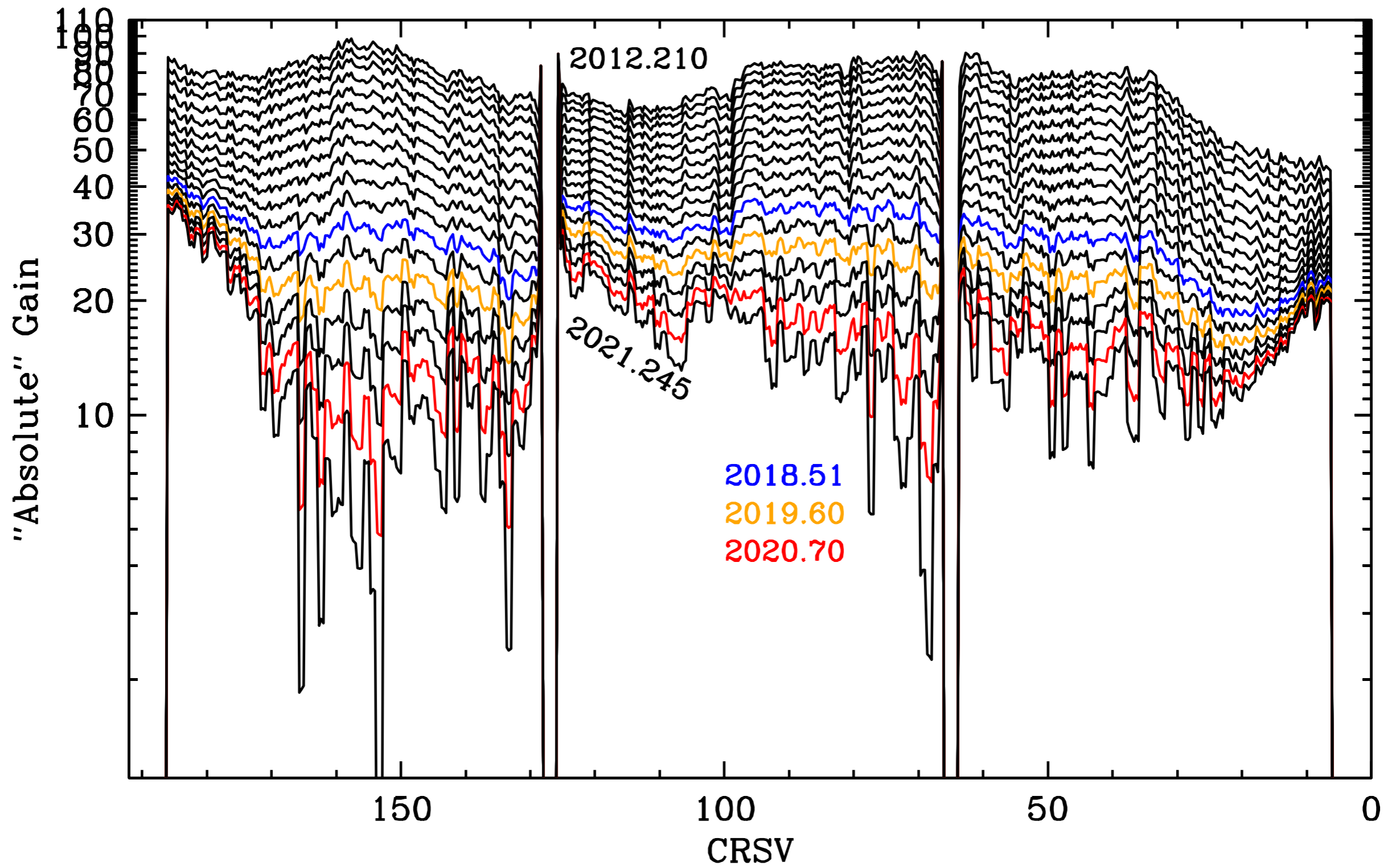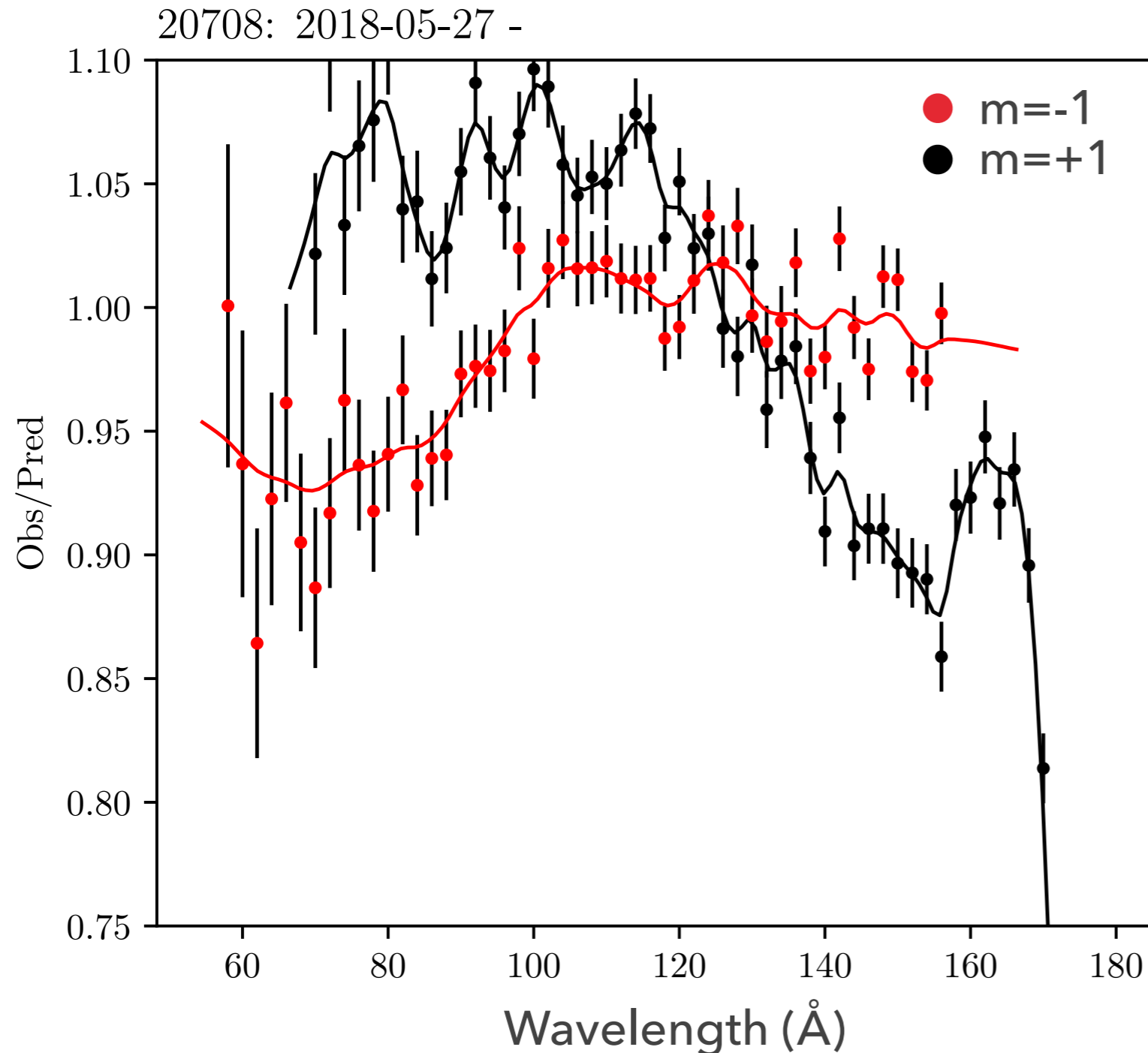# QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)

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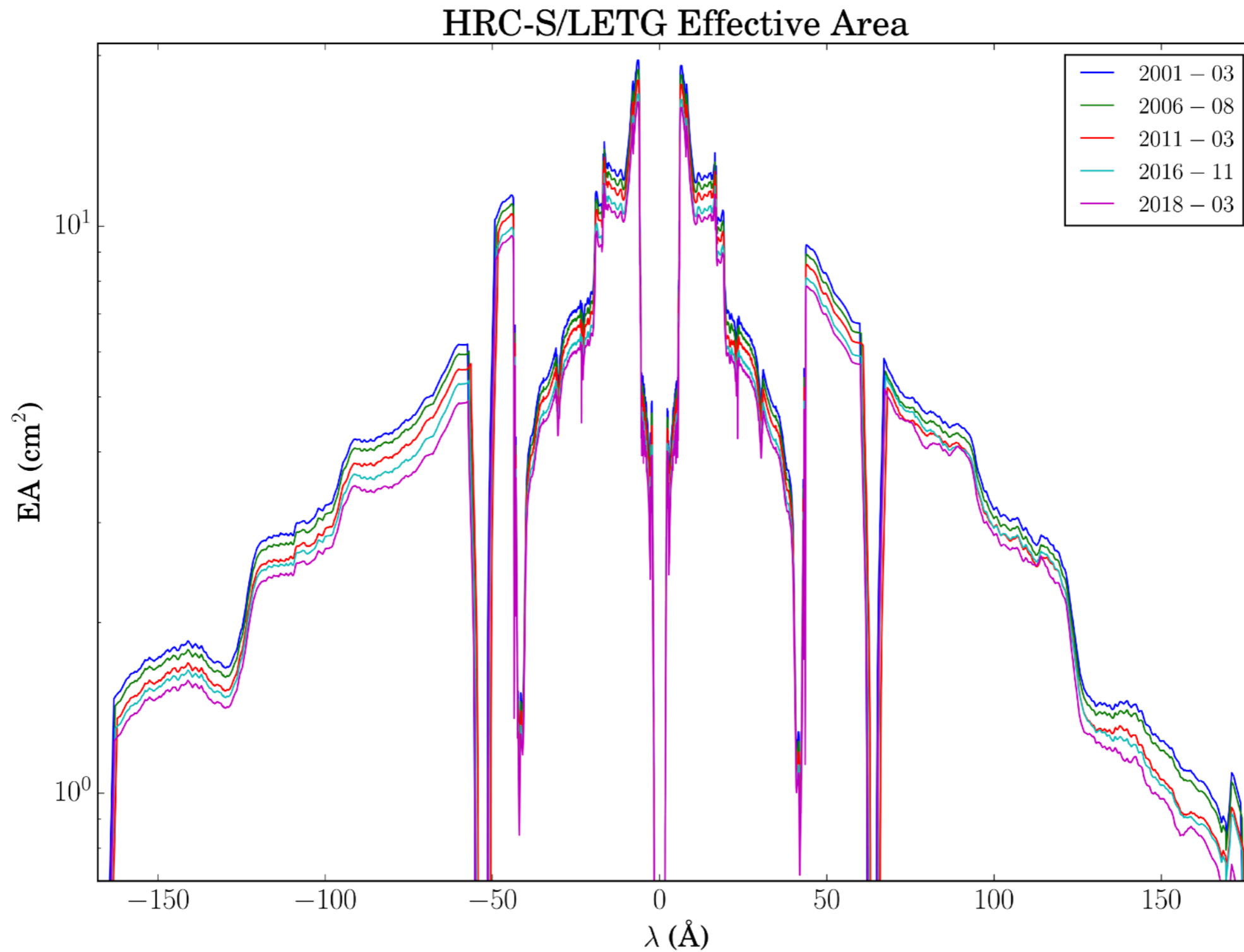

HZ43 Empirical QEU corrections:

▶ Defined relative to 0th order rate

▶ New QEU file every ~4 months (latest in CalDB 4.7.9)

▶ New HRC-I QE files released CalDB 4.7.9

QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)

HZ 43: HRC/LETG Ratios to Predicted

QUANTUM EFFICIENCY DECLINE (B. WARGELIN, P. RATZLAFF, V. KASHYAP, J. DRAKE)

HRC-S/LETG Effective Area

SUMMARY AND FUTURE

▸ On-axis empirical PSF and EDSER calibration well underway; empirical PSF release c. Summer 2019

▸ ACIS mid-chip gain droop new det_gain release c. Spring 2019

▸ ACIS contamination model reflecting slower rate of increase has been updated and released for I; release pending for S.

▸ Continuing HRC-S QE secular changes calibrated

▸ New HRC-I QE released

▸ HV increase on HRC-S…. Only a matter of time

▸ New HRC-S observing mode on thin Al filter being tested