High Energy Transmission Grating (HETG) Spectra in Continuous Clocking Mode

Norbert S. Schulz and the CXC Calibration team

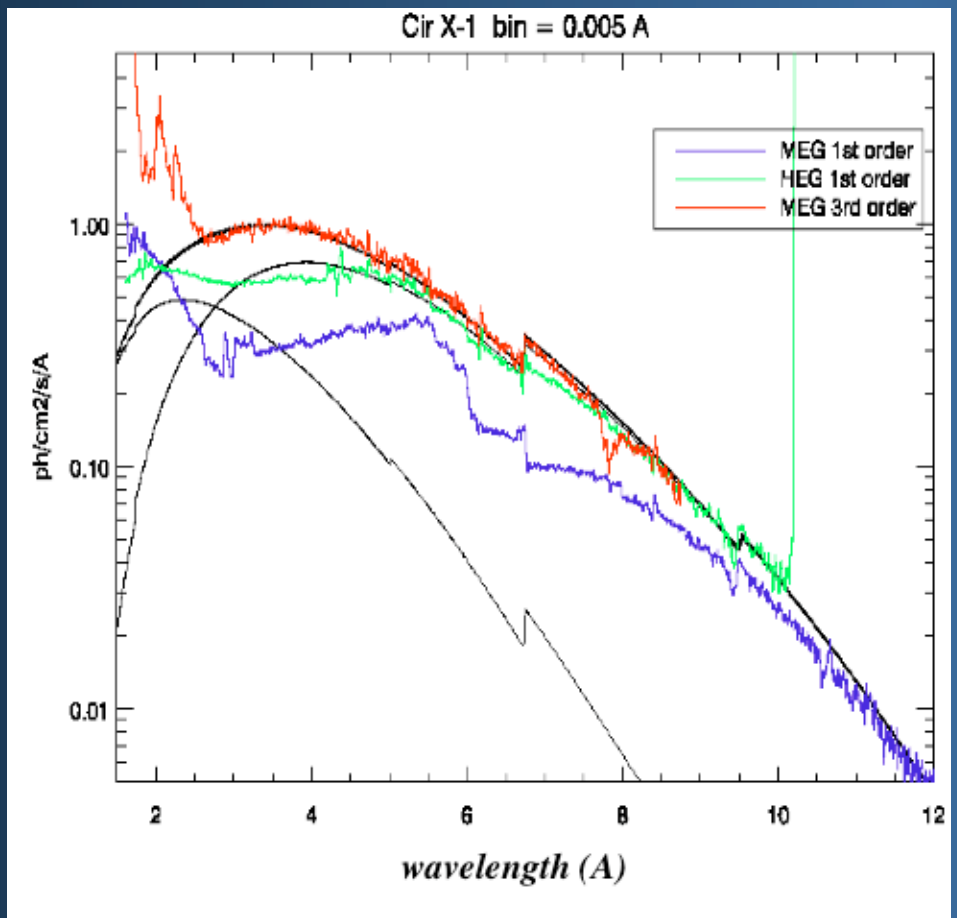
Scope:

- Why use CC-mode for HETG observations
- HETG CC-Mode Observations of X-Ray Binaries
- Trap maps for ACIS CC-mode Calibration
- Problems we recognized so far: OSIPs, Si K, CTI.....
- TE and CC-mode with all Flight Grades Transmitted
- Observations of very bright sources
- Future Actions and Recommendations

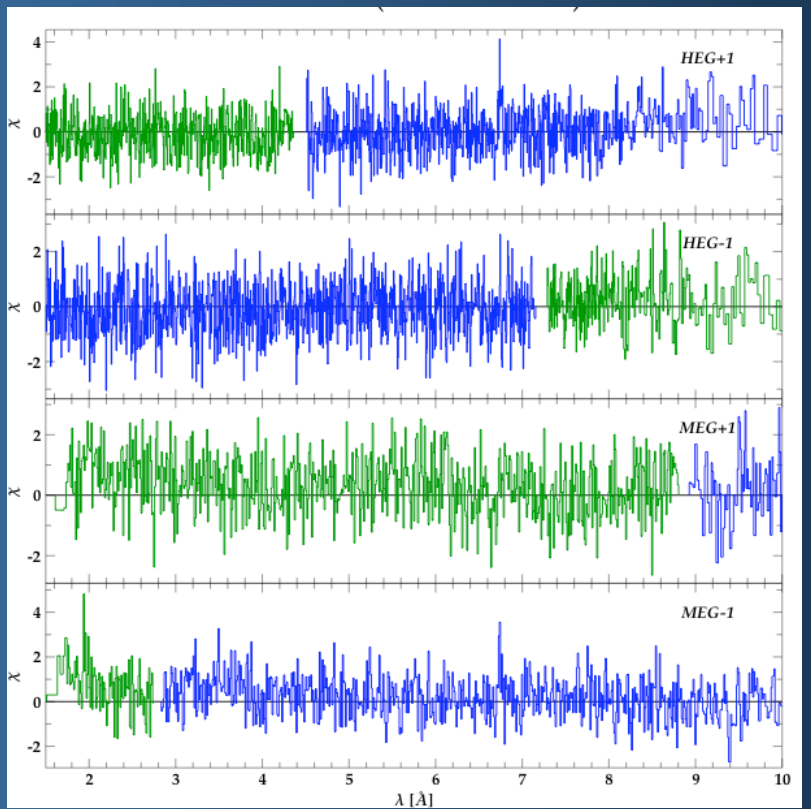
Why use CC-mode for HETG observations

-- Timing studies

-- Pileup mitigation



-- Continuum reconstruction: New pileup model for bright sources (Davis 2008)



X-Ray Binaries observed in HETG CC-Mode

TABLE 1 SOURCES OBSERVED WITH HETG IN CC-MODE

source	Y_{off} arcmin	Z_{SIM} mm	rate cts/s
Sco X-1	0.000	-15.000	1430.0
GX 5-1	0.167	-11.300	505.0
GRO J1655-40	0.330	-7.500	492.0
H 1743-322	0.330	-7.500	492.0
GRS 1915+105	-1.330	-4.000	366.0
Cyg X-2	1.167	-6.140	331.0
Cyg X-1	-1.330	-4.000	266.0
GX 349-2	0.167	-7.500	225.0
XTE J1650-500	-1.330	-4.000	245.0
XTE J1550-564	-1.330	10.000	200.0
4U 1812-12	0.000	-6.040	182.3
4U 1820-30	1.167	-6.140	180.0
4U 1636-53	0.167	-6.140	165.0
4U 1630-472	0.330	-7.500	160.0
GX 339-4	0.330	-7.500	160.0
4U 1735-44	0.167	-7.500	150.0
XTE J1817-330	0.330	-4.500	200.0
PSR B0833-45	0.000	-3.000	88.7
GX 9+1	0.000	-3.000	86.2
4U 1705-44	0.330	-7.490	70.0
GX 340+0	0.330	-7.490	60.0
GX 17+2	0.330	-4.000	58.1
Cyg X-3	0.167	-6.800	40.0
4U 1746-37	-0.330	-4.000	24.9
4U 1728-34	0.167	-4.000	20.3
Her X-1	0.330	-4.000	19.7
SAX J1808.4-3658	0.330	-4.000	20.0
GRS 1747-312	-0.330	-6.140	12.1
RAPID BURSTER	0.000	0.000	5.6
GX 1+4	-0.330	-5.860	4.0
CRAB PULSAR-CC	0.000	0.000	2.0
4U 1323-619	-0.330	-4.000	1.1

35 sources observed so far
mostly X-ray Binaries
total exposure: ~ 2 Msec

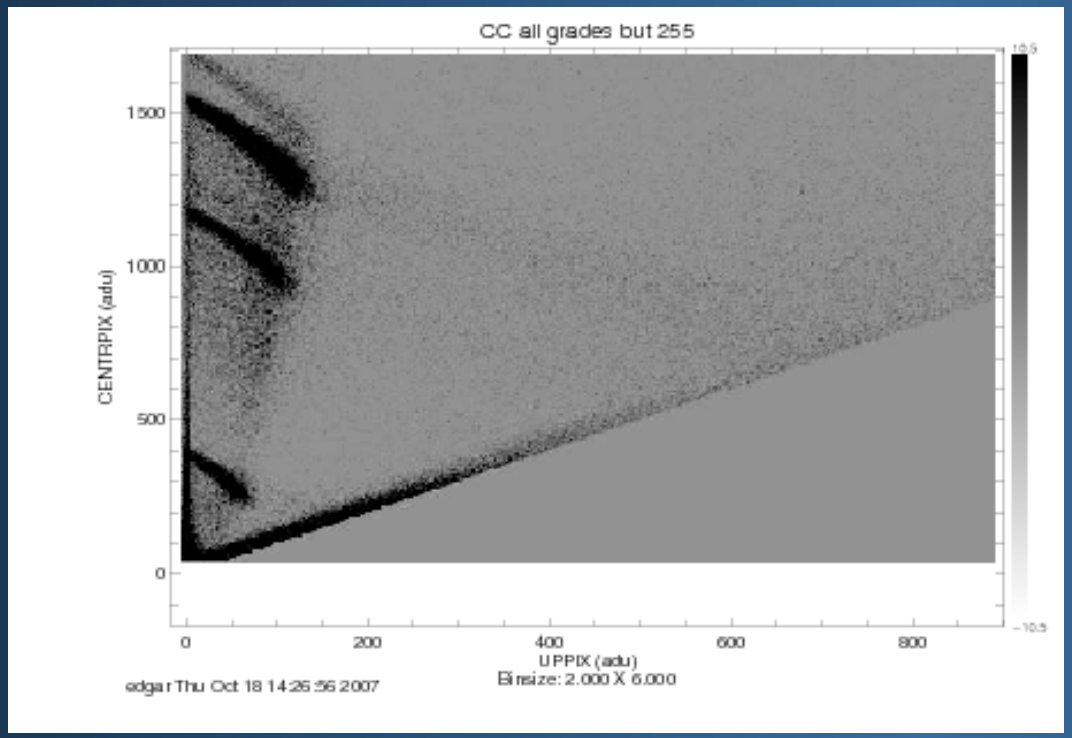
Observe sources the
instruments were NOT designed for

Primary application of cc-mode was
for maximum time resolution

The use of Graded mode heavily
restricts instrument level calibration

Current status of ACIS CC-mode Calibratio

Development of trailing pix. algorithm using ECS data in cc-mode:



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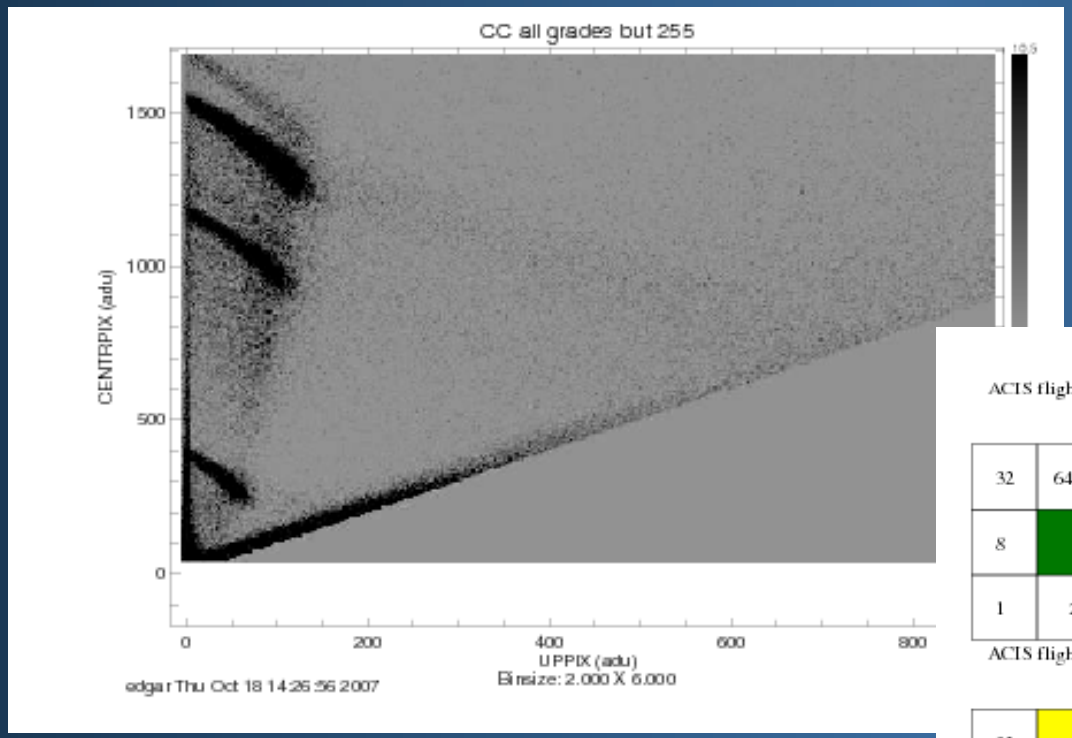
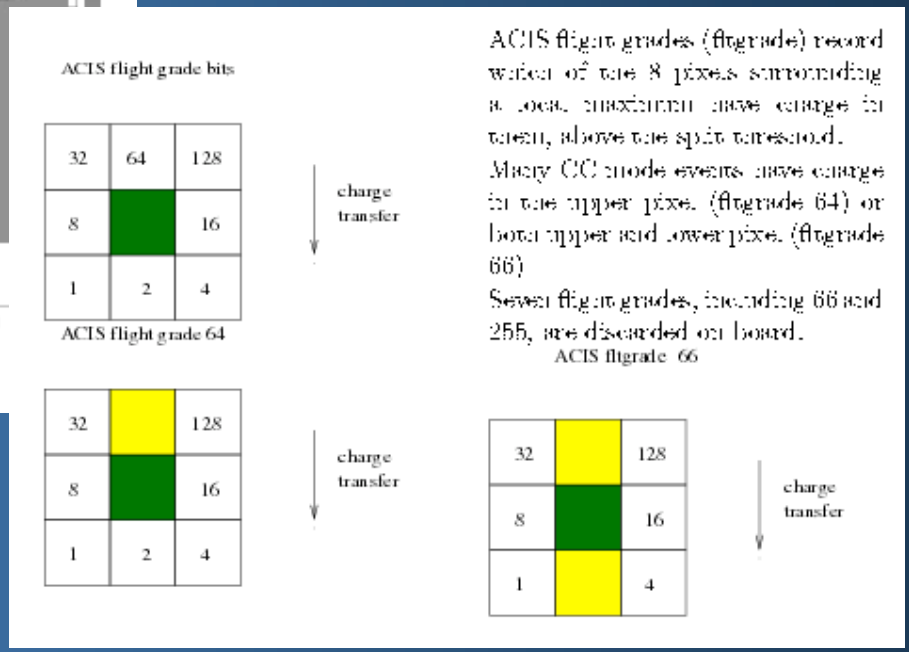
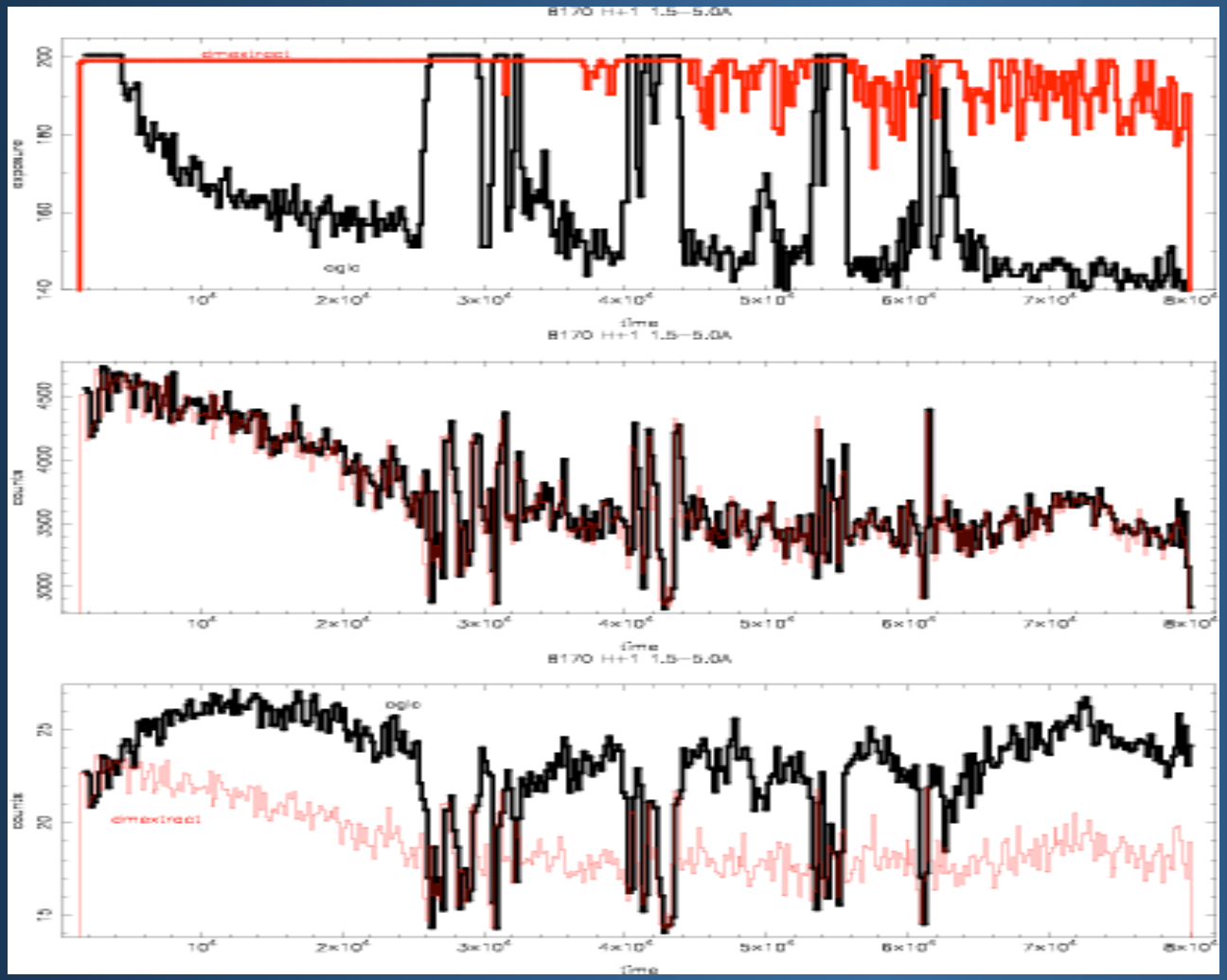




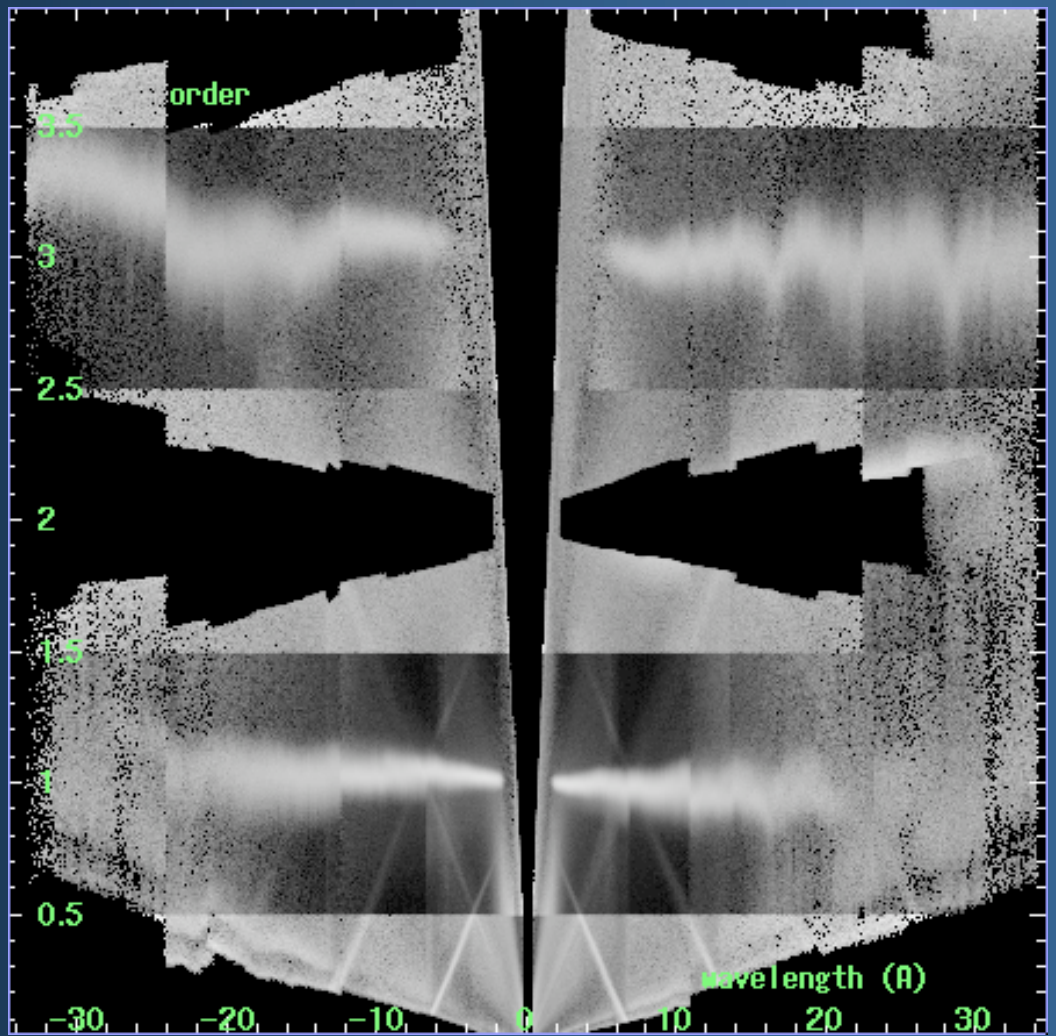
Frame Drops in Bright X-Ray Binaries



Use Graded Mode to minimize diff. exosure loss via frame drops in the telemetry stream

loose flight grades through trailing charge for good

HETG CC-Mode Spectra of X-Ray Binaries



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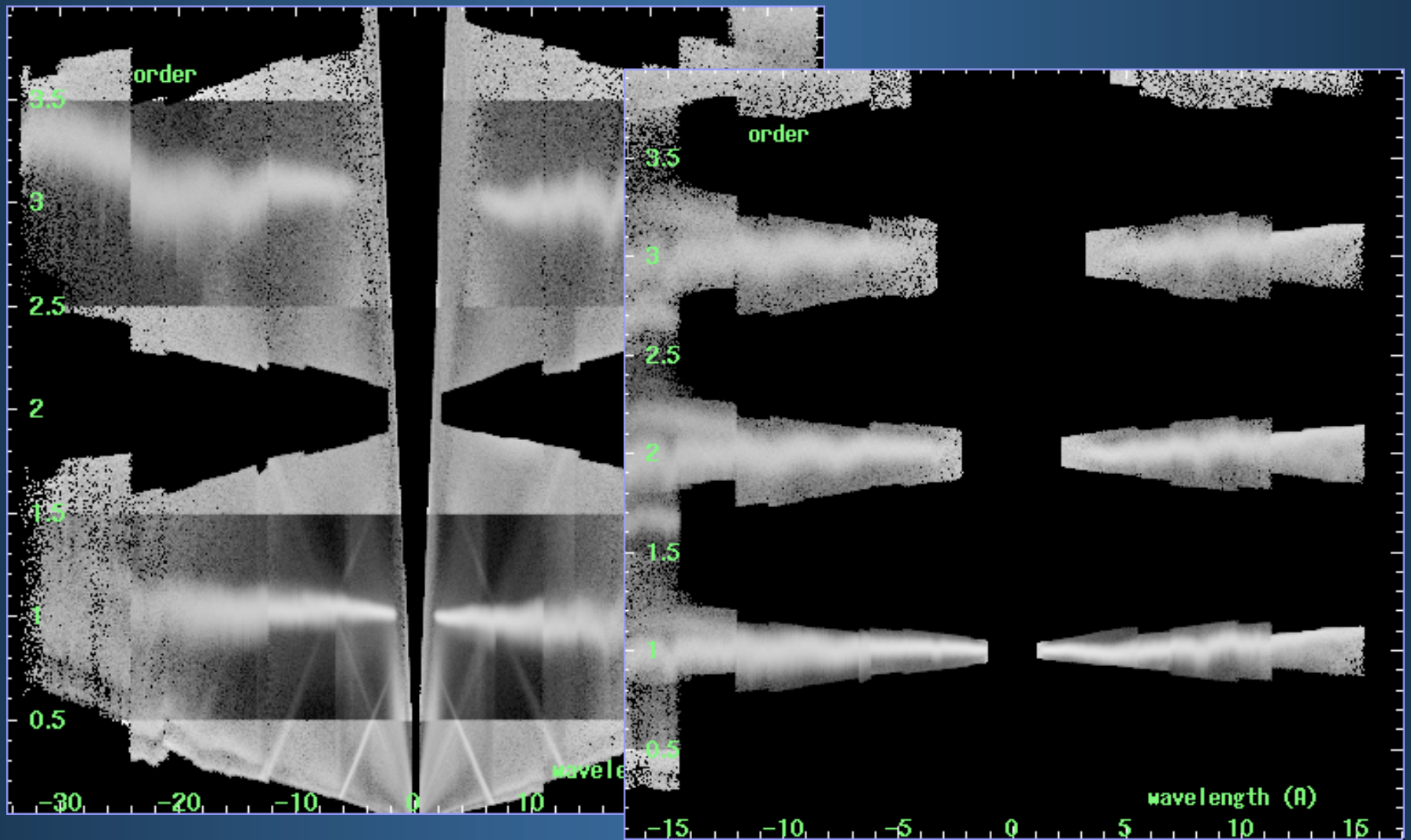

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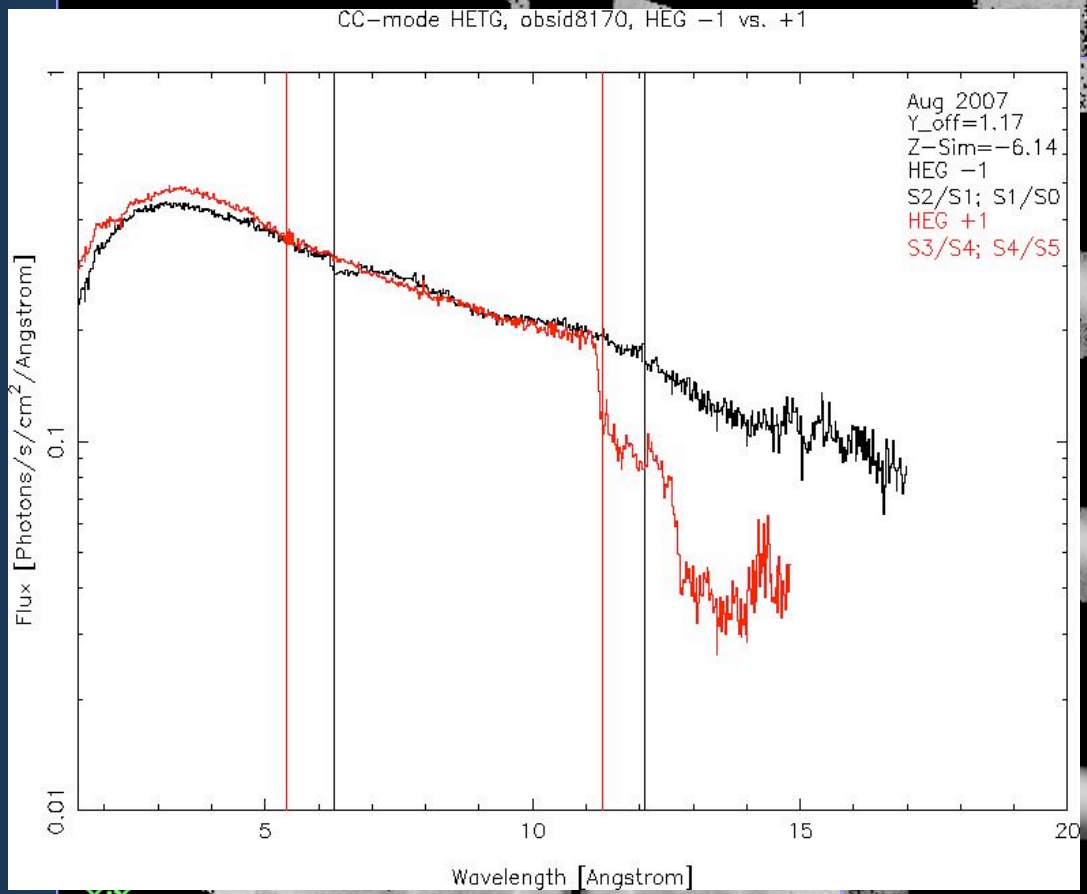

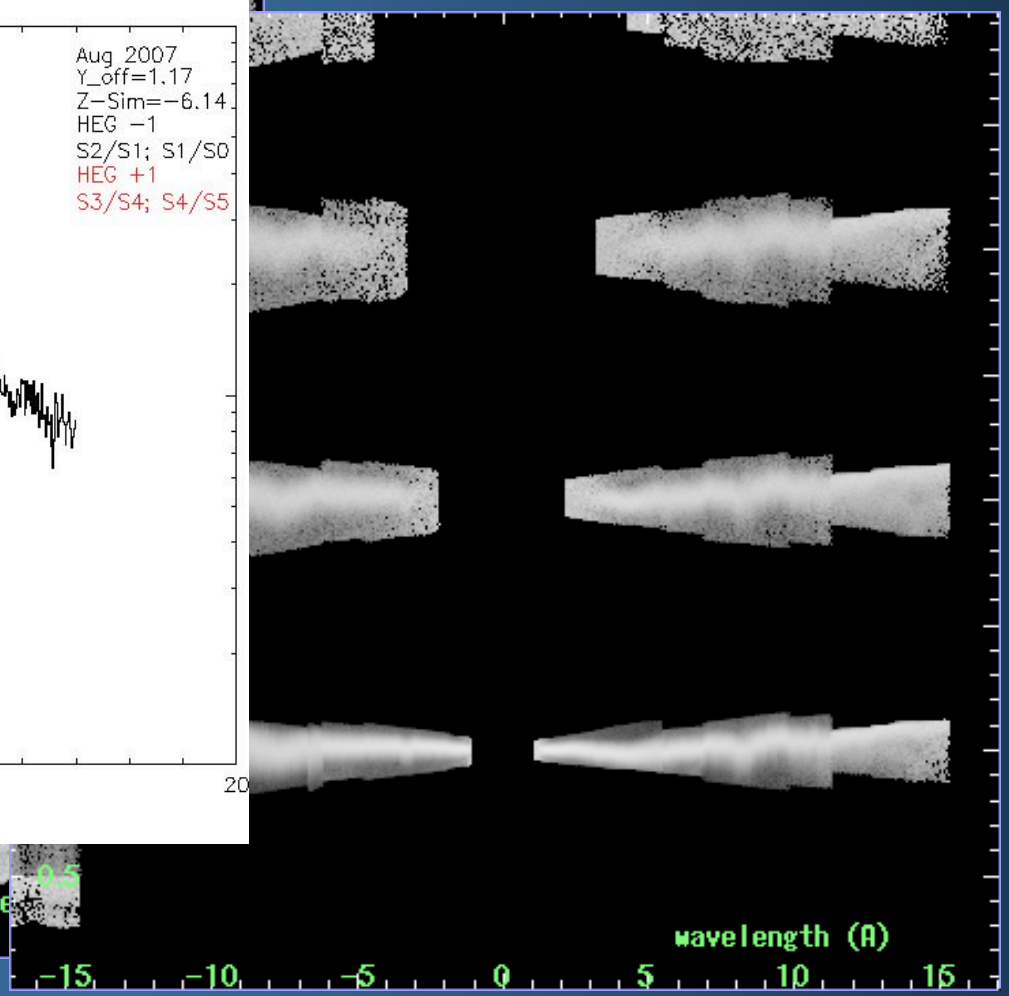

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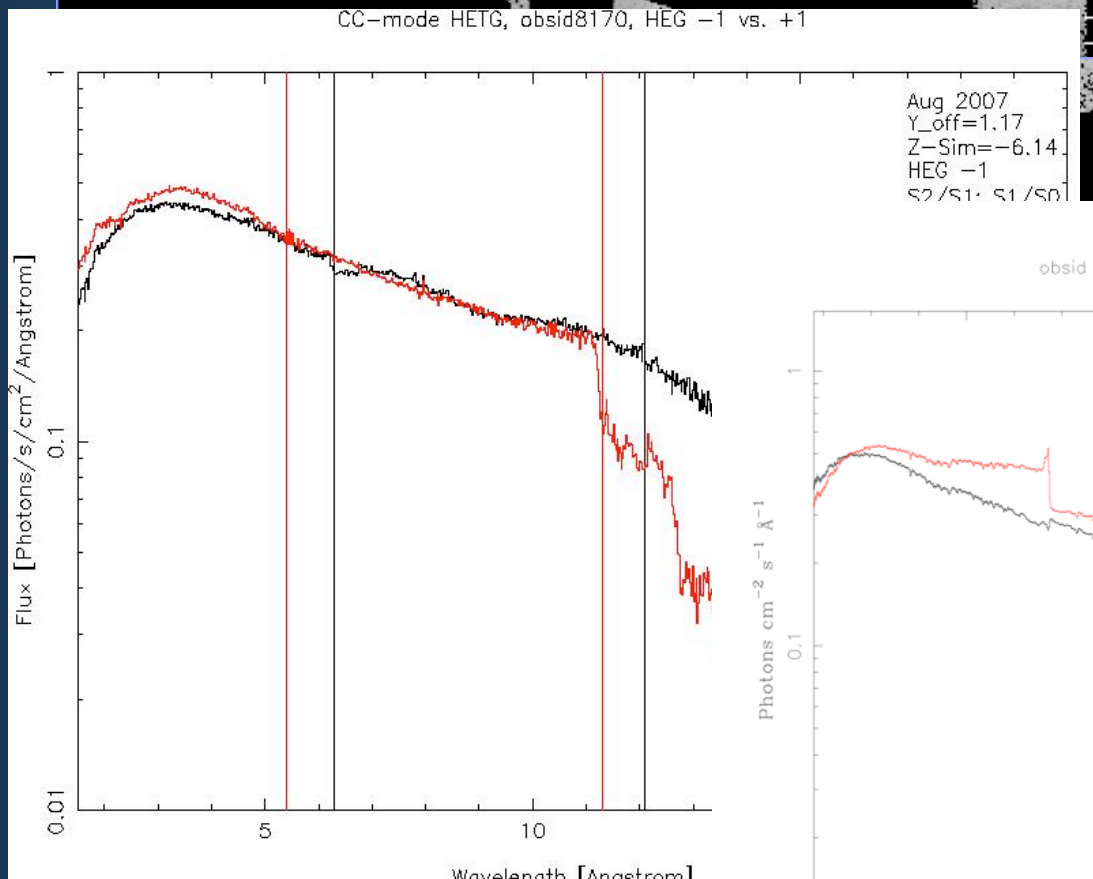

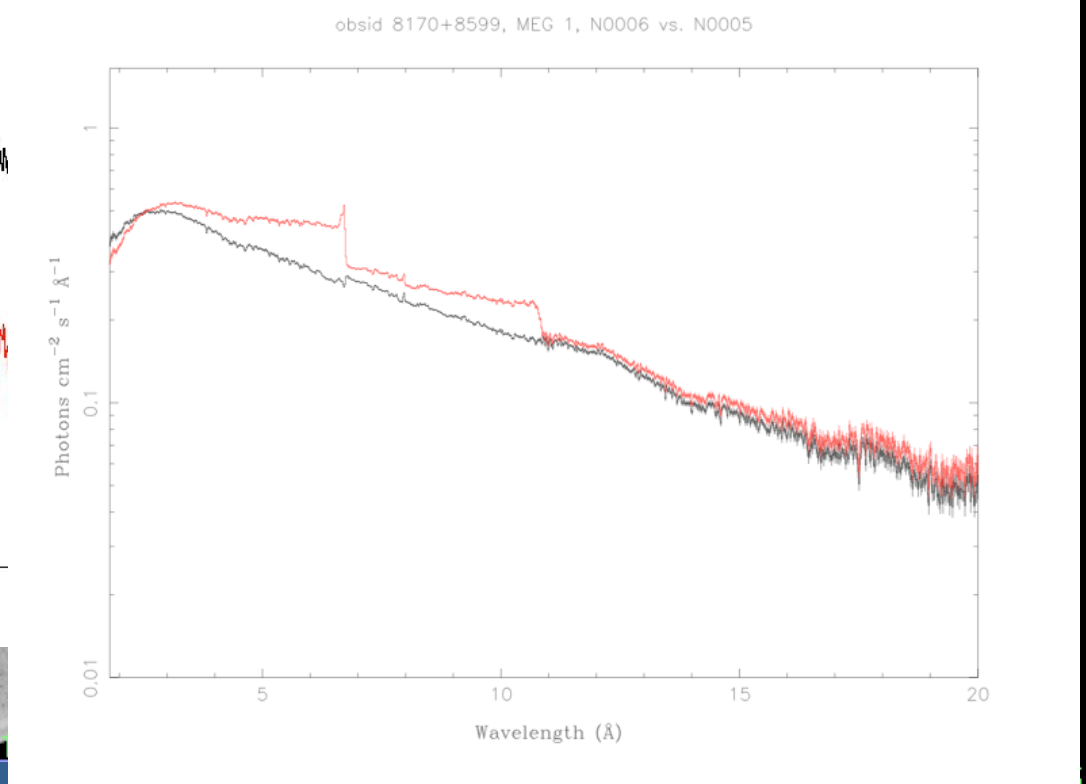

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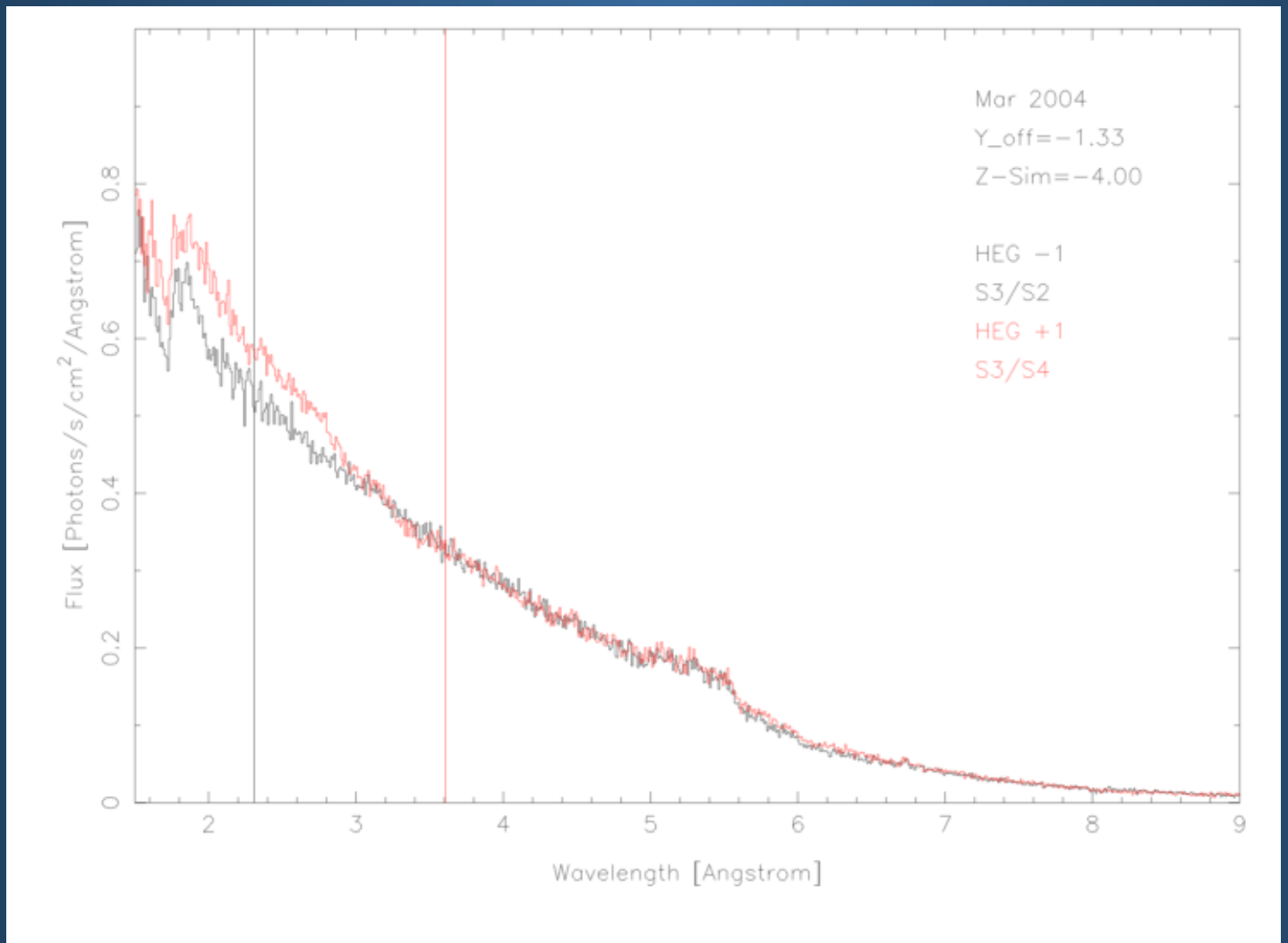

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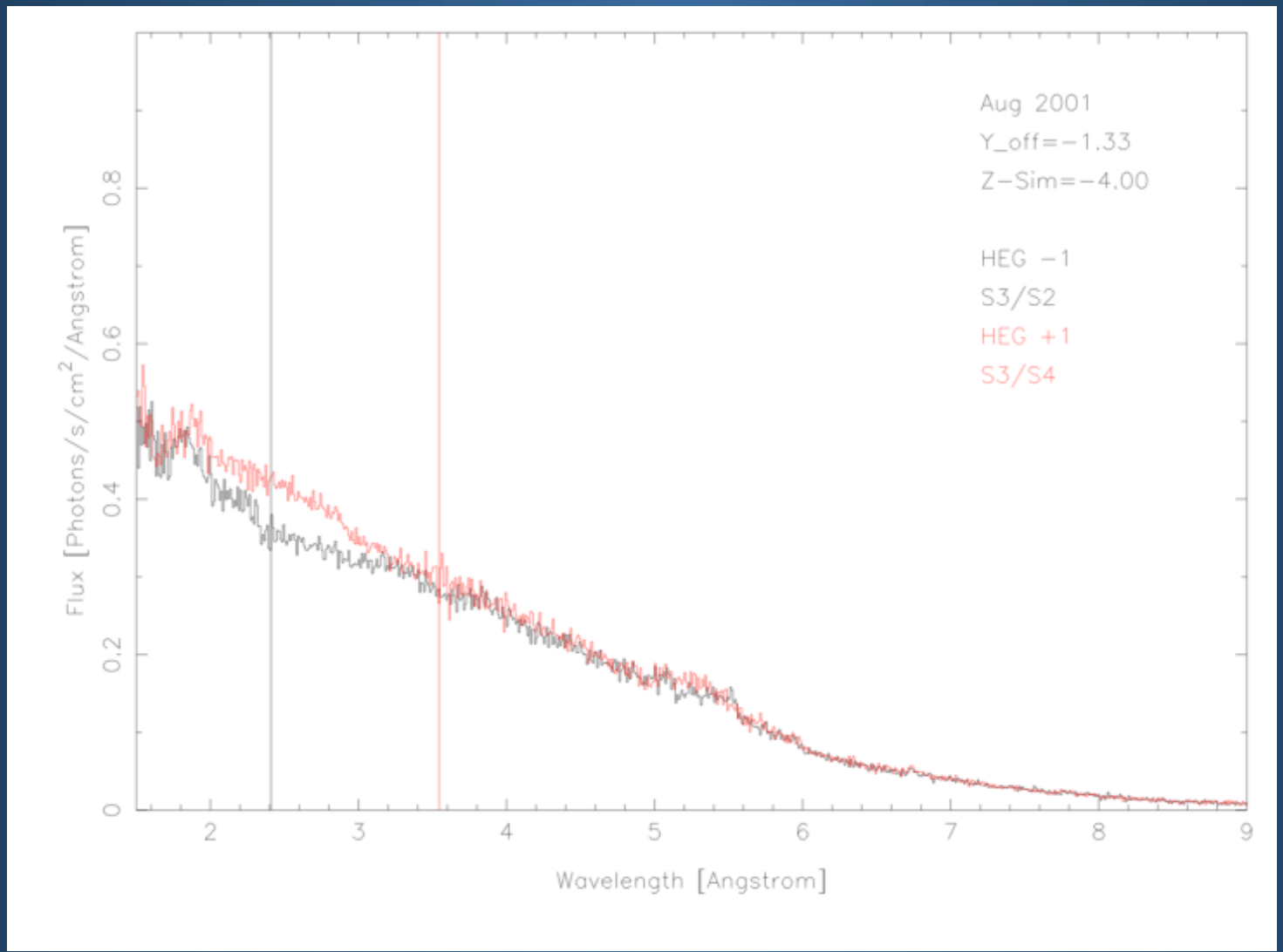

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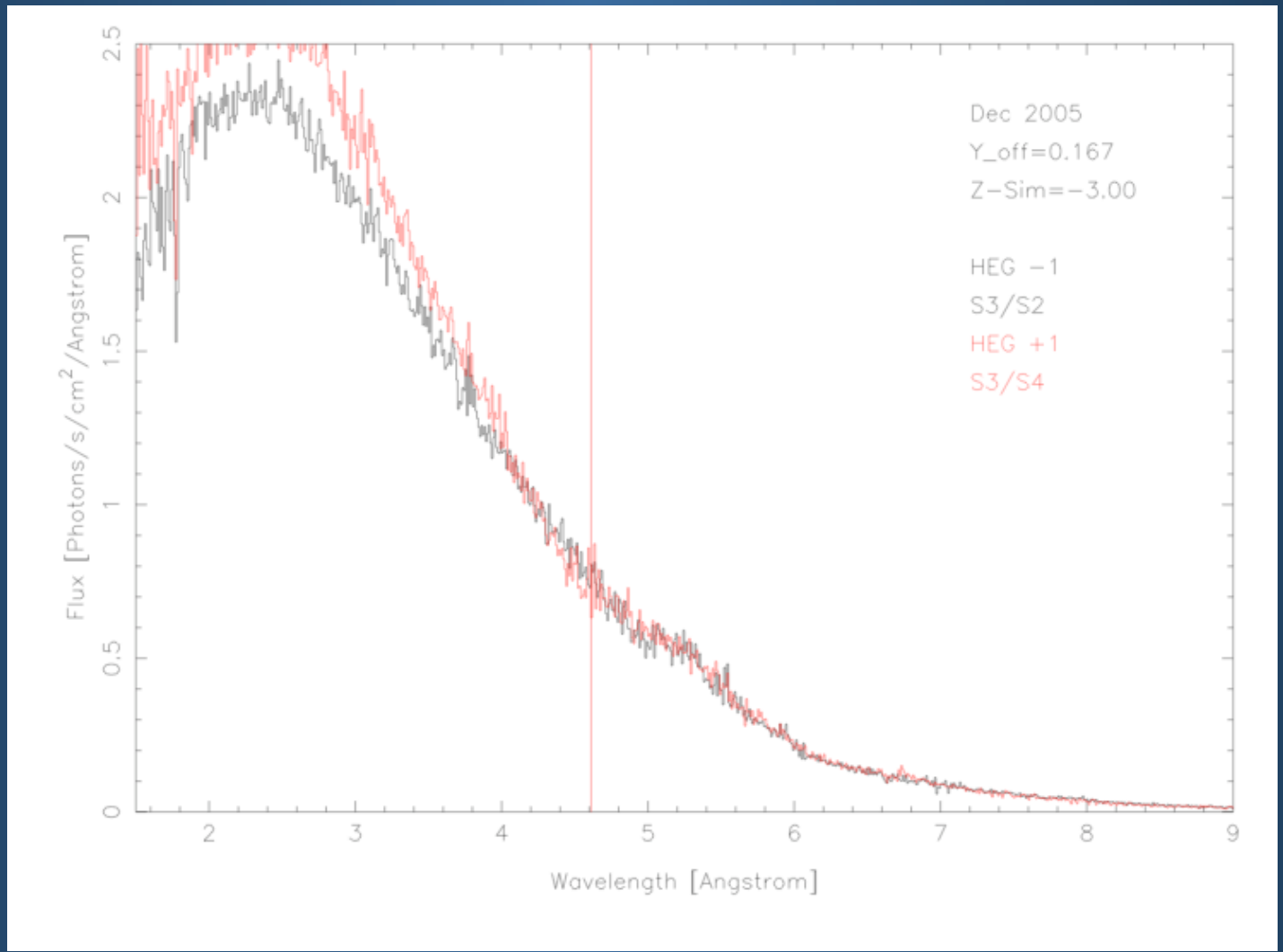
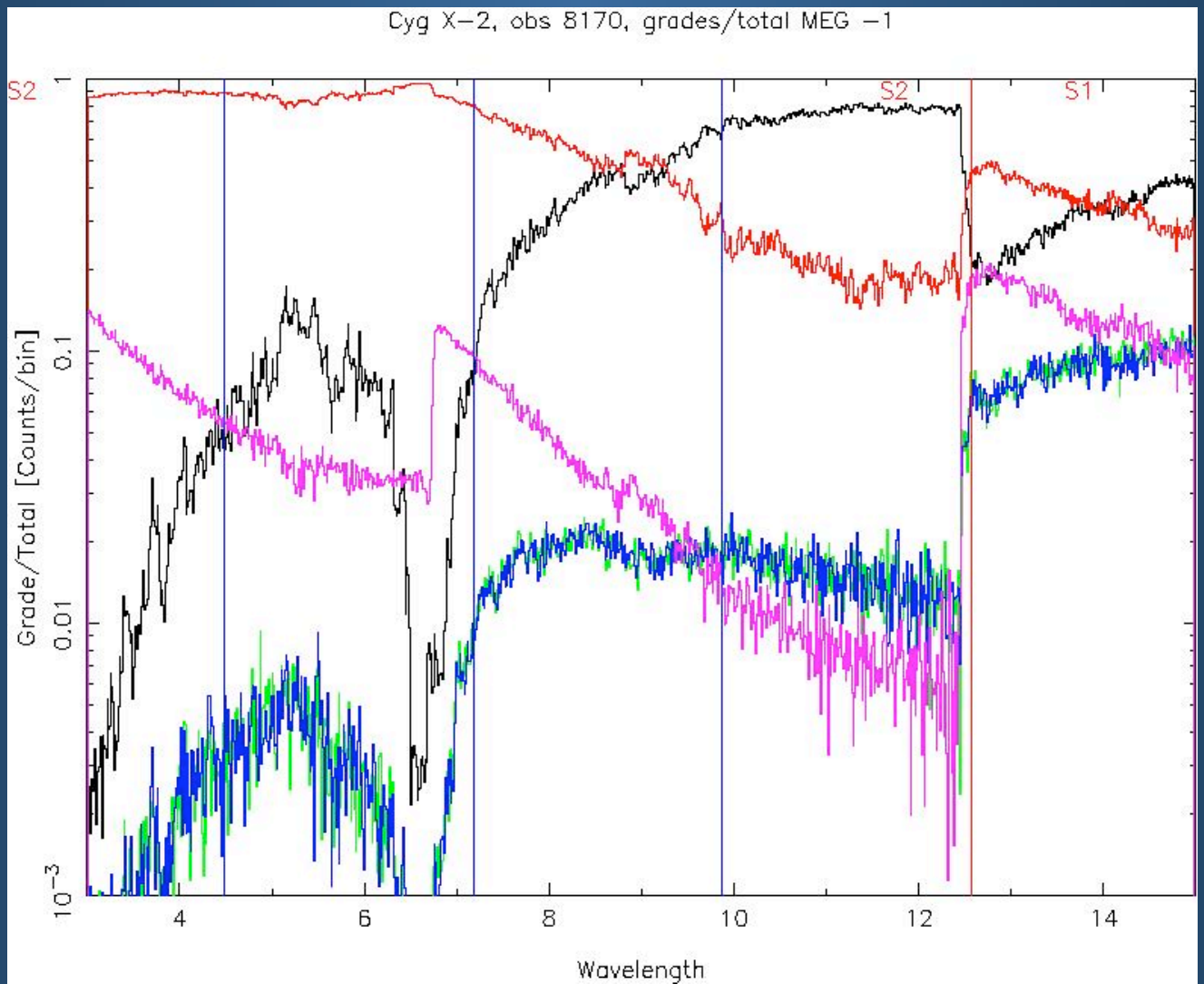


ACIS properties in HETG CC-Mode Spectra



How to Address the Problem

What has been done so far:

-find all descrete changes in the effective area.

----> OSIP problems, Si K edge problem

-find mismatches between HETG flux dispersions

----> Diagnose CTI, CCD, Grade related problems

-cross-correlate observations with other instruments, i.e. RXTE, Suzaku, etc…

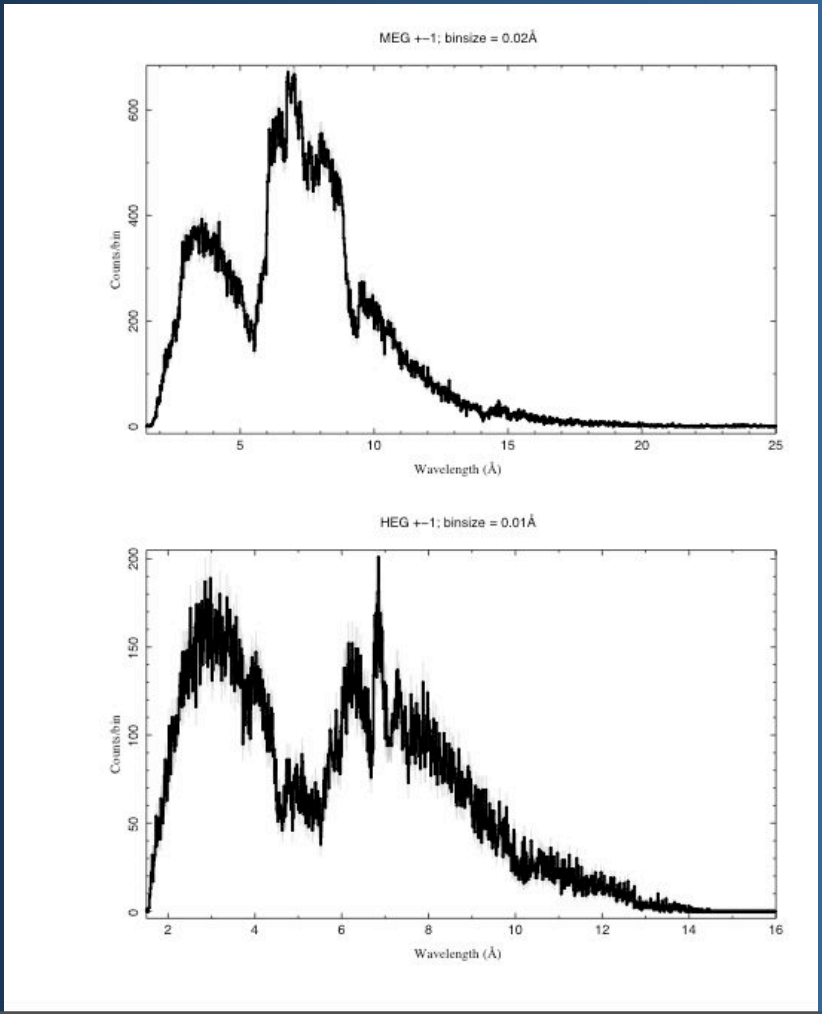
----> Heavyly model dependent, source flux dependent, dependent on external instruments calibrations

What is currently done::

apply current versions of CTI corrections to observations preformed in cc-faint mode

TE and CC-mode with all Flight Grades Transmitted

Obs Sequence: 4U1957-11 ----> 10ks TE ----> 20ks CC ----> 10ks TE



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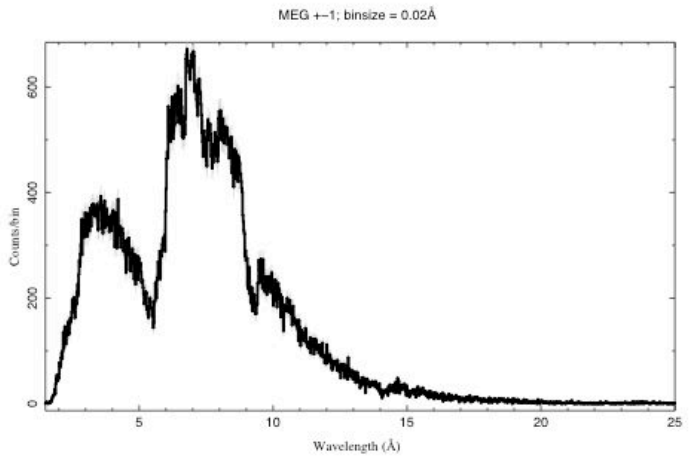

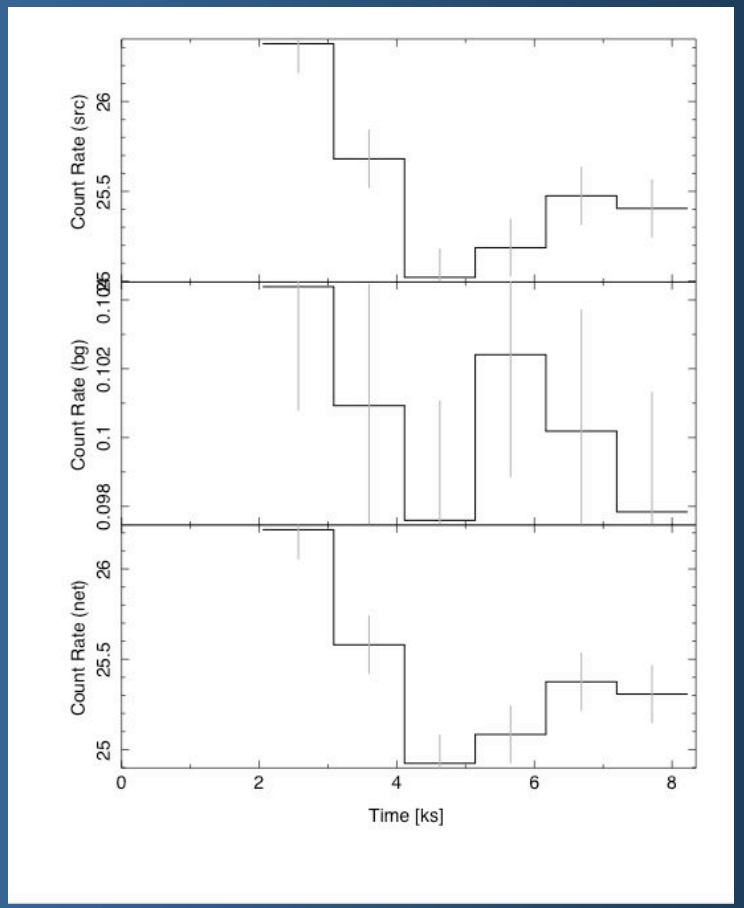

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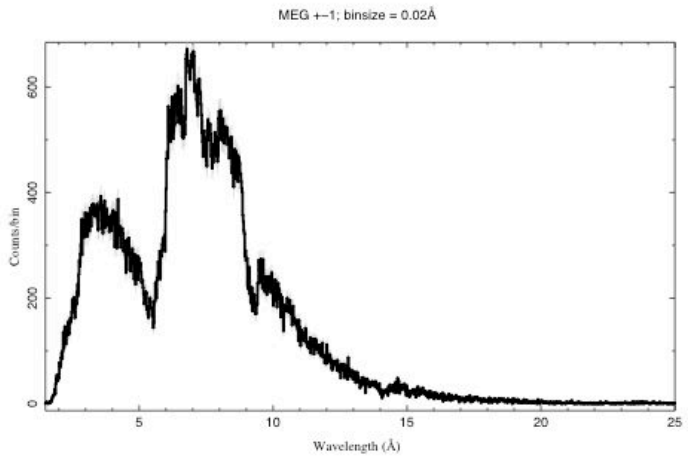

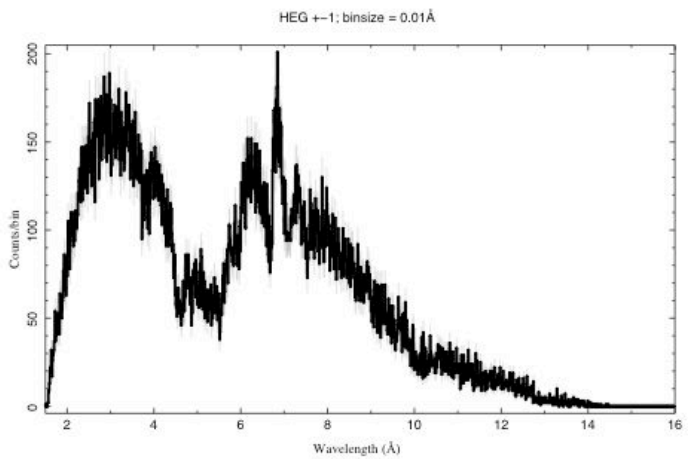

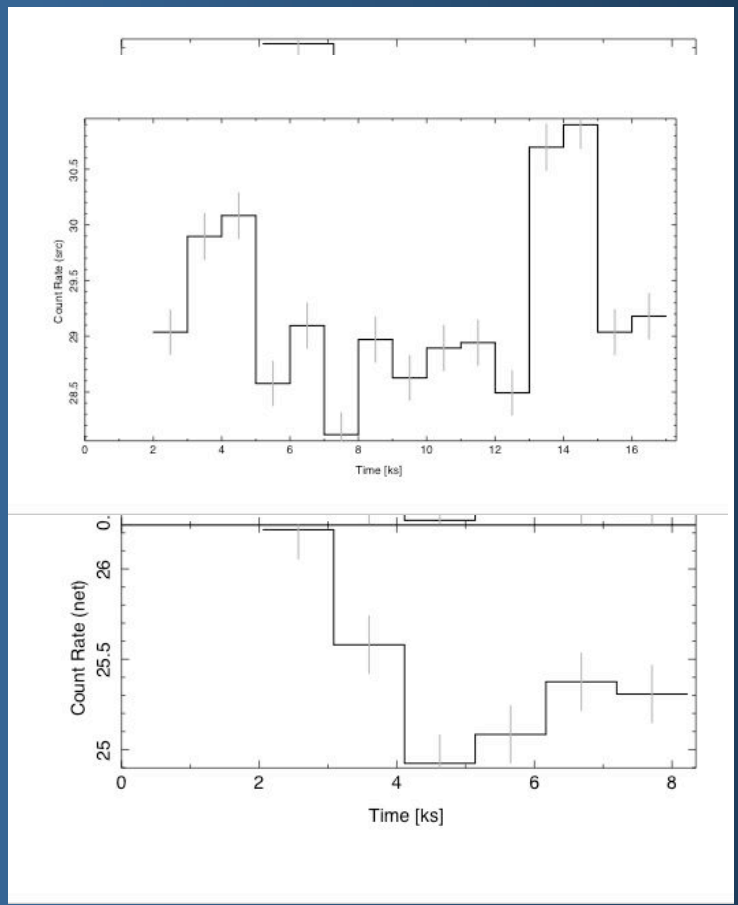

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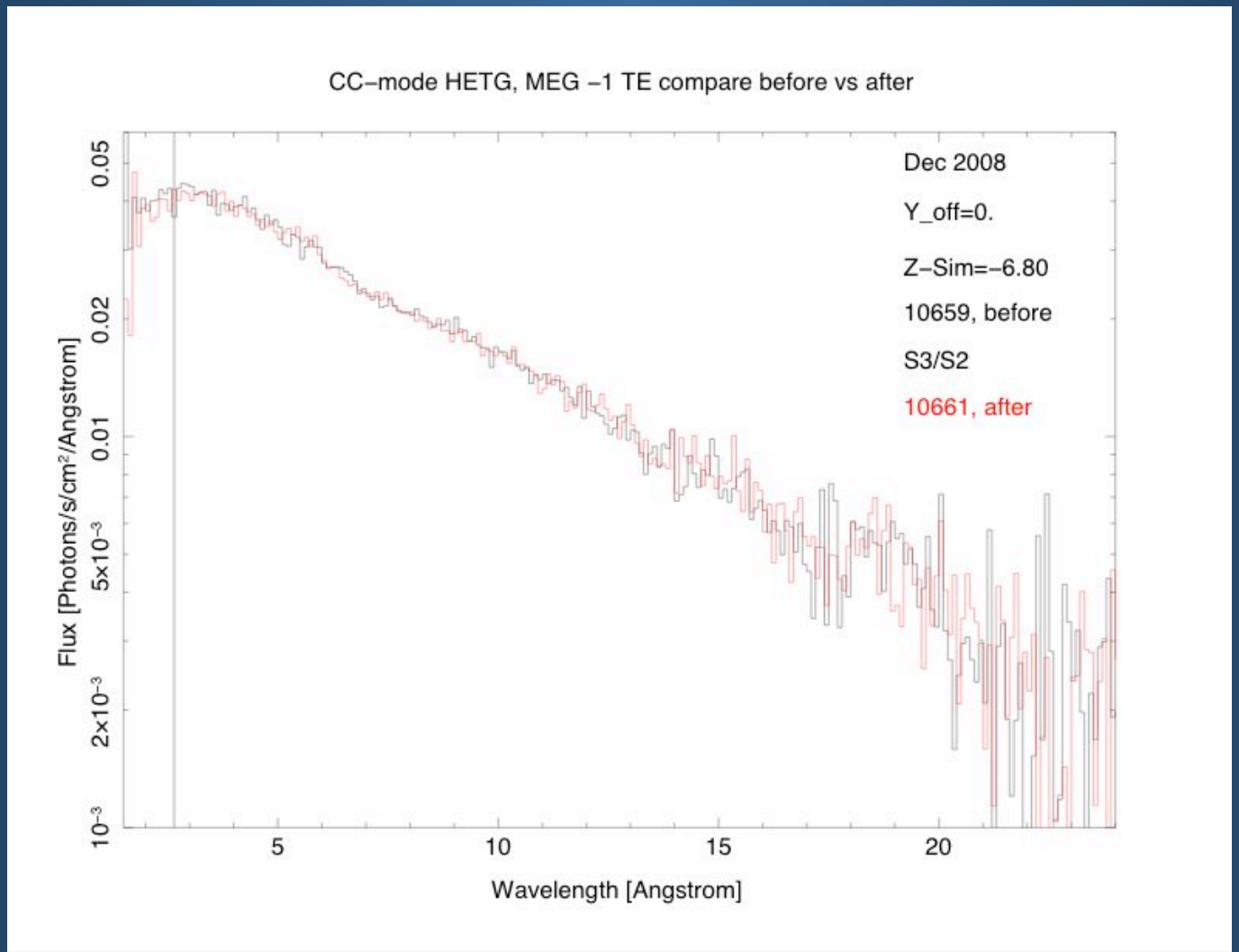

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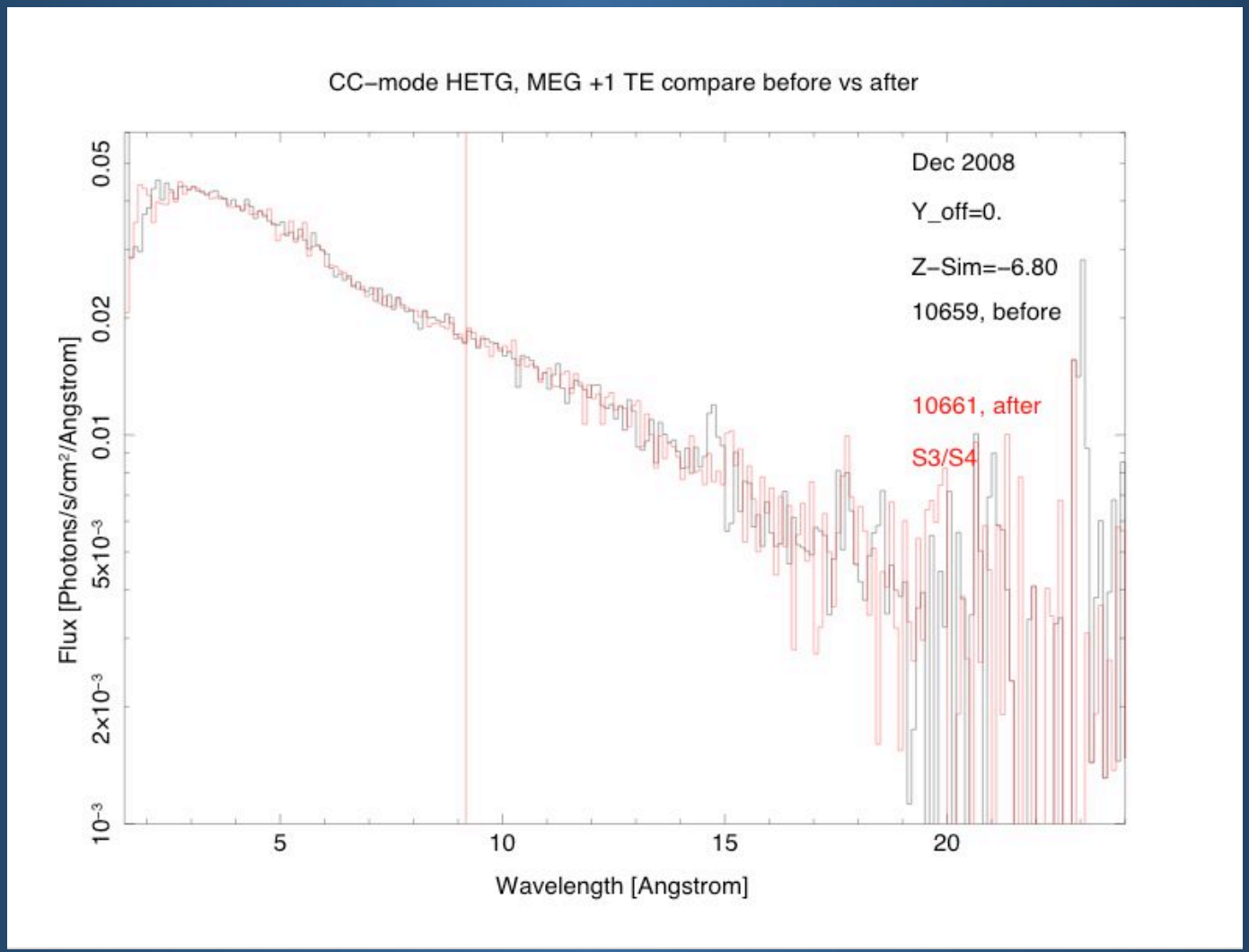

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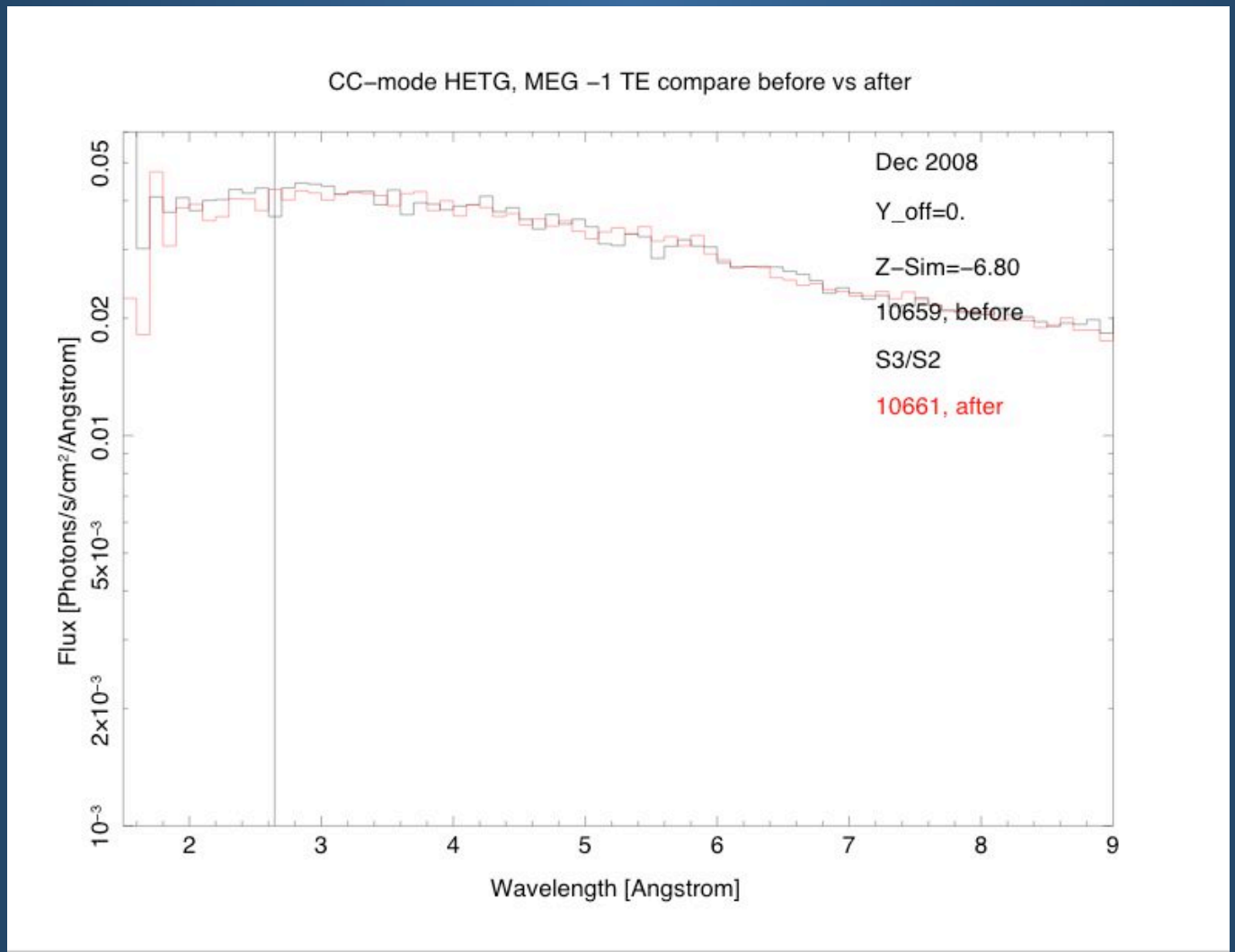

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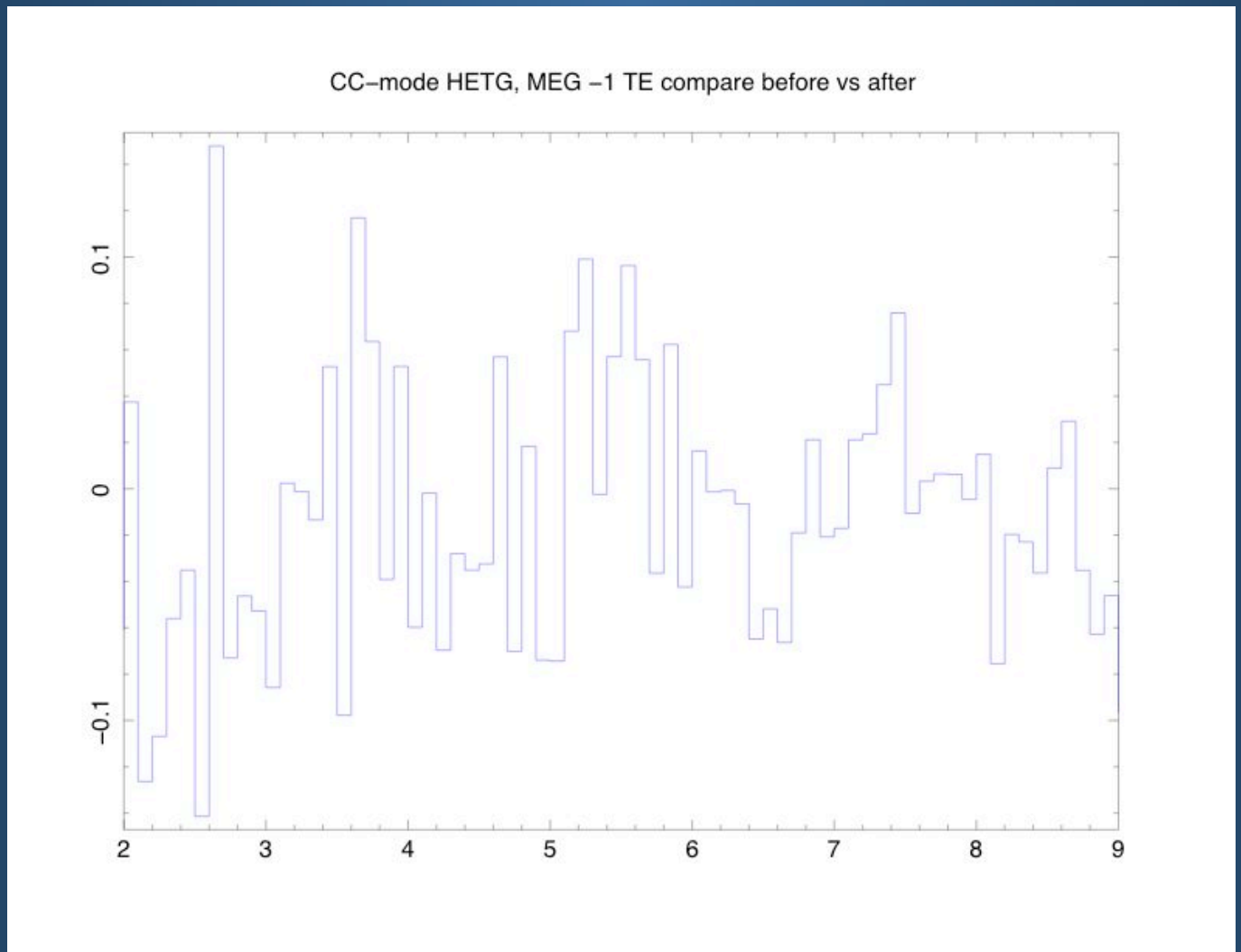

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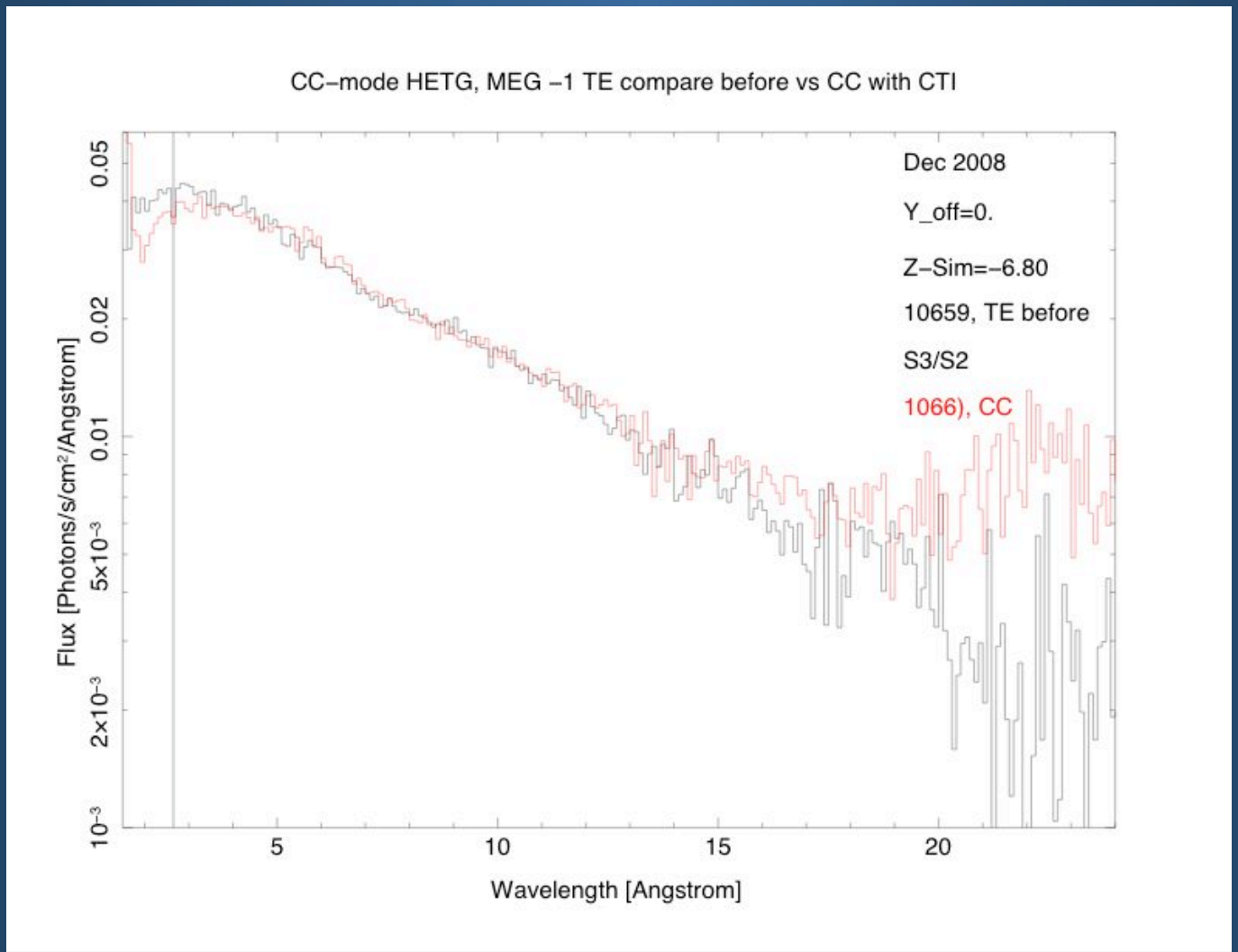

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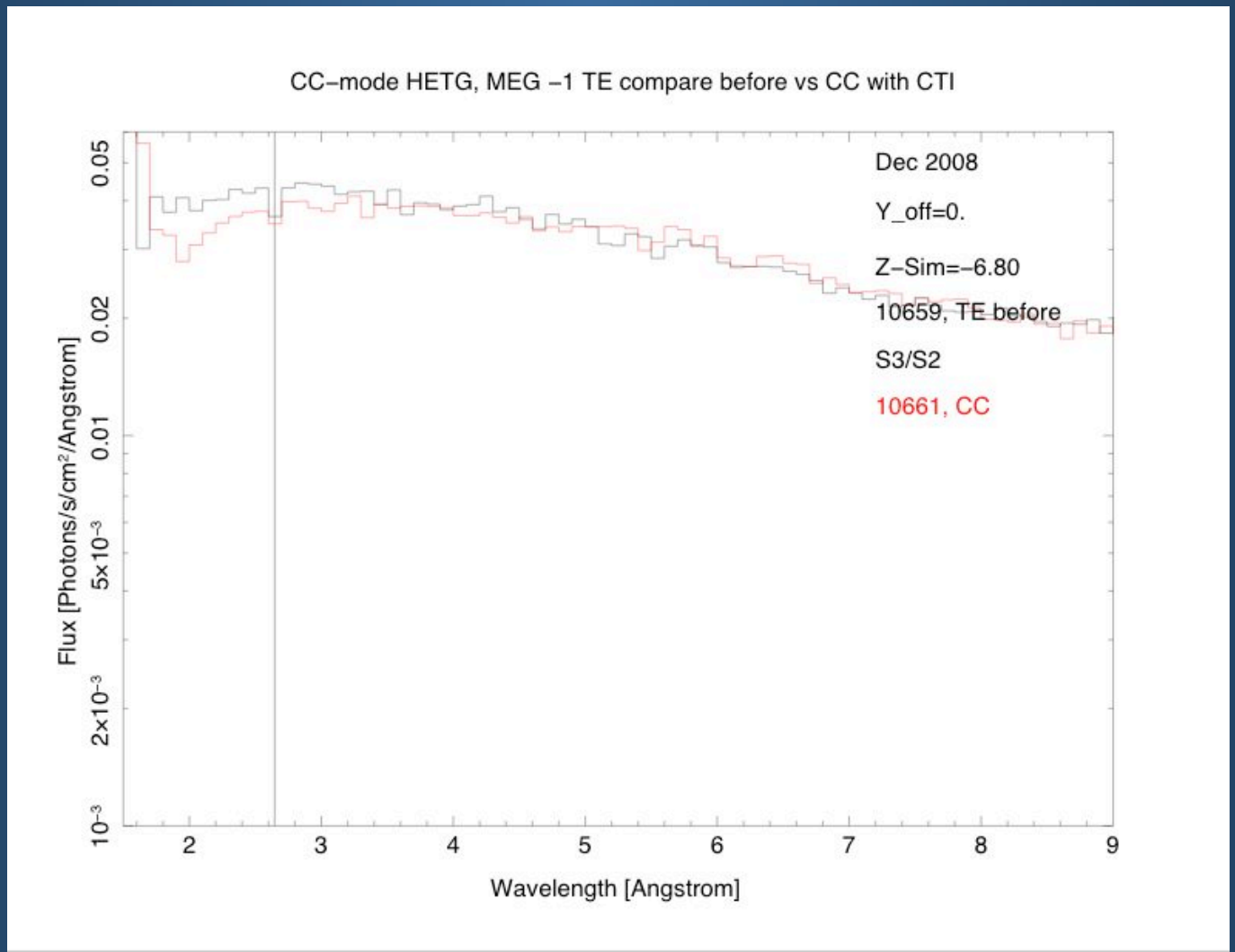

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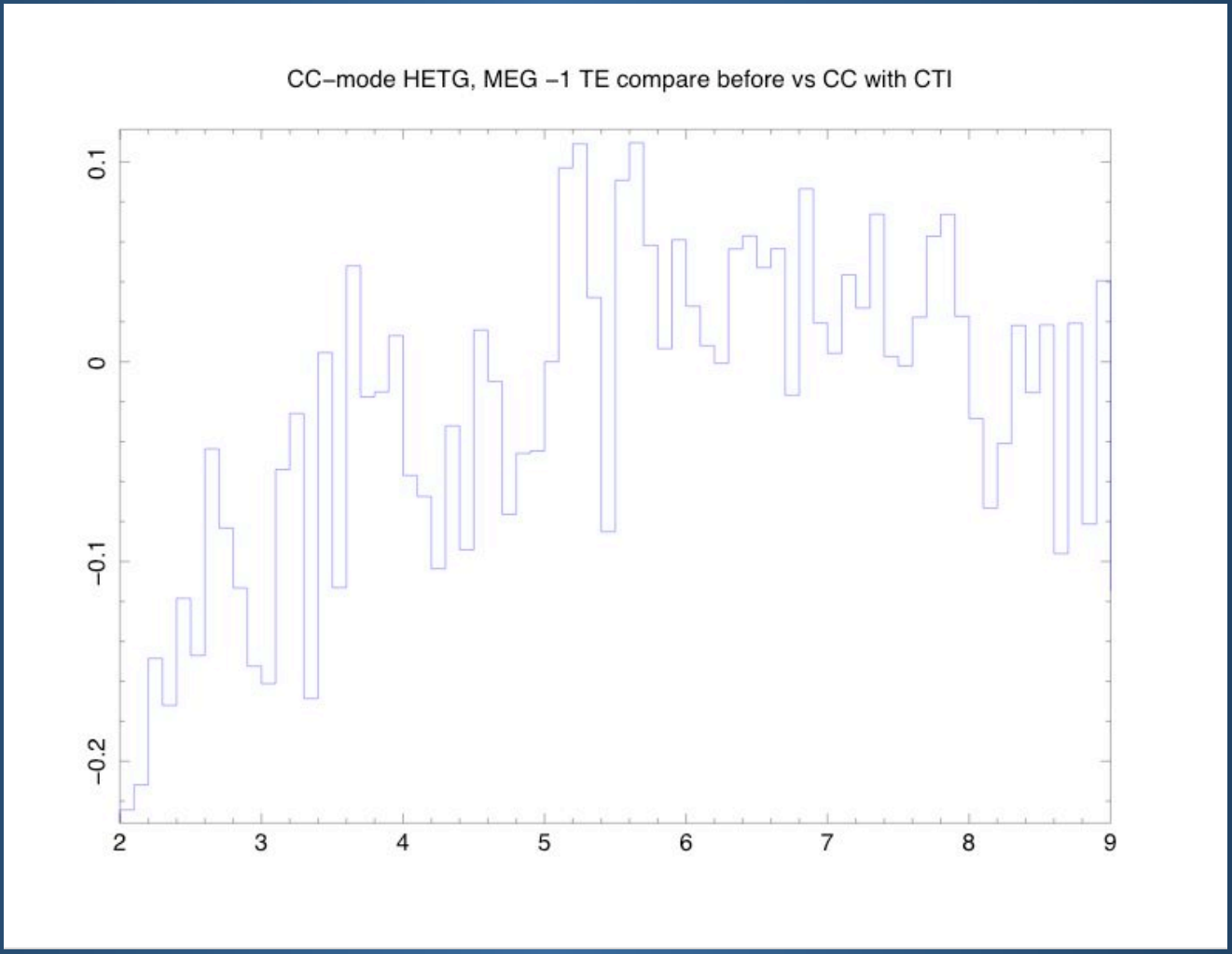

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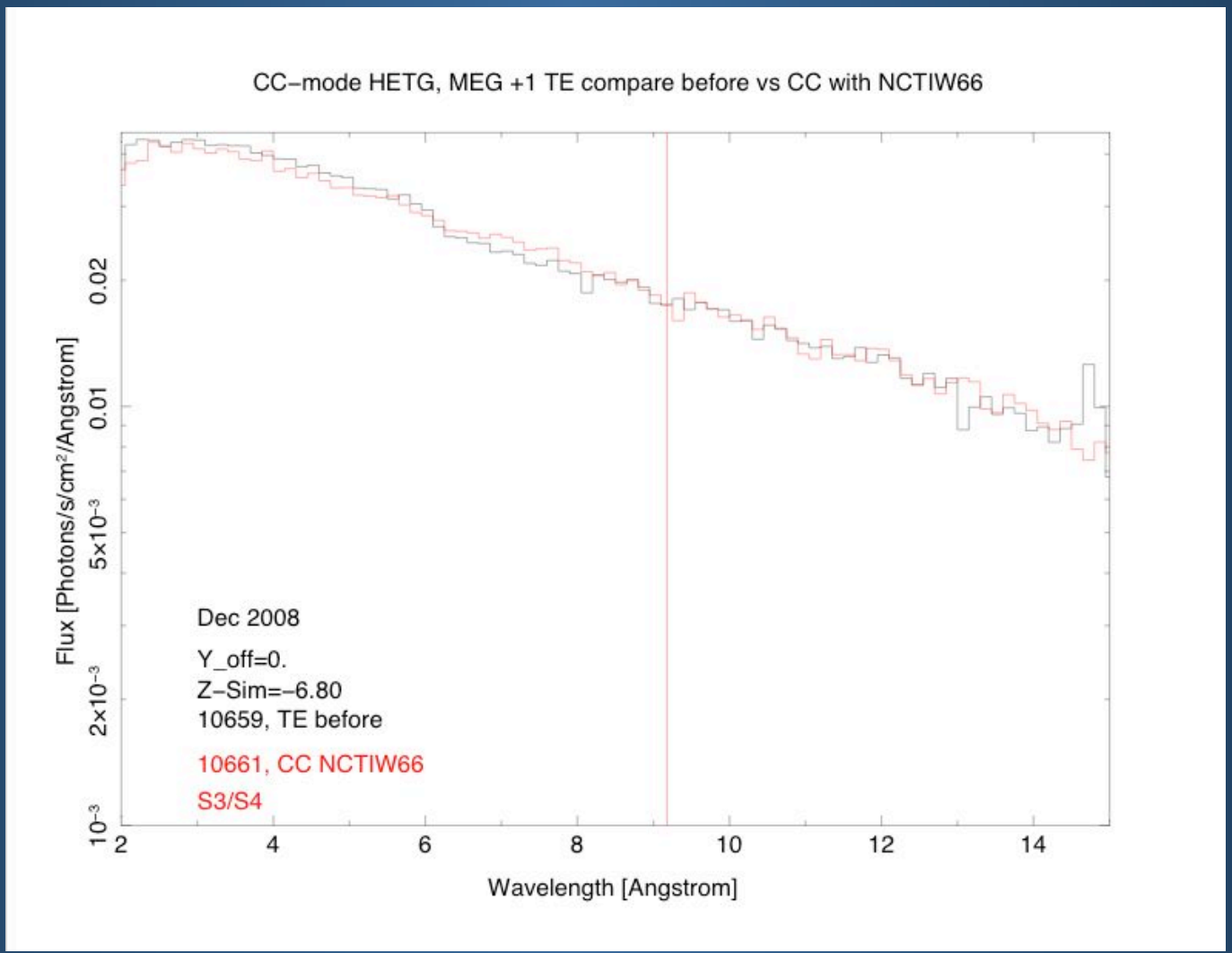

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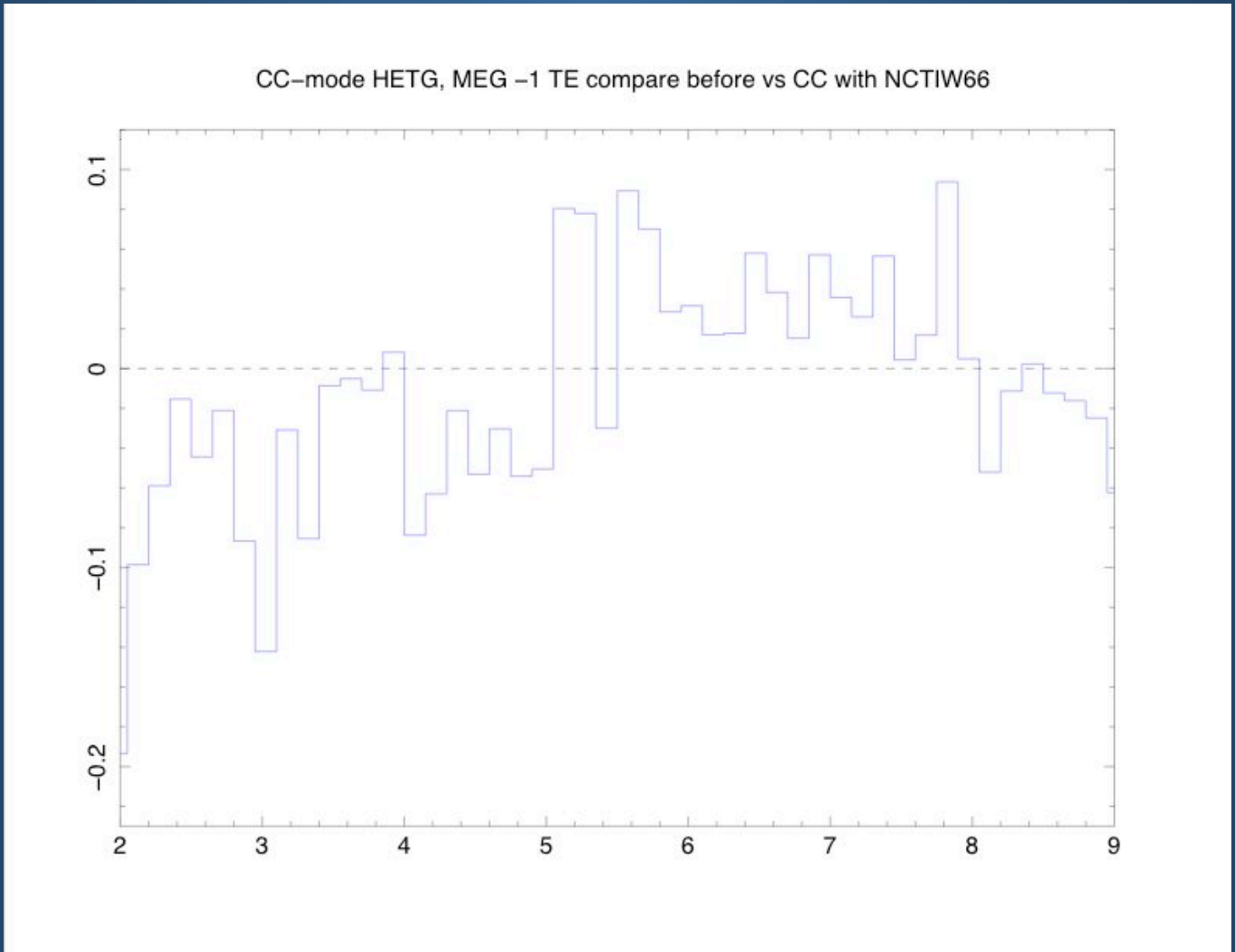

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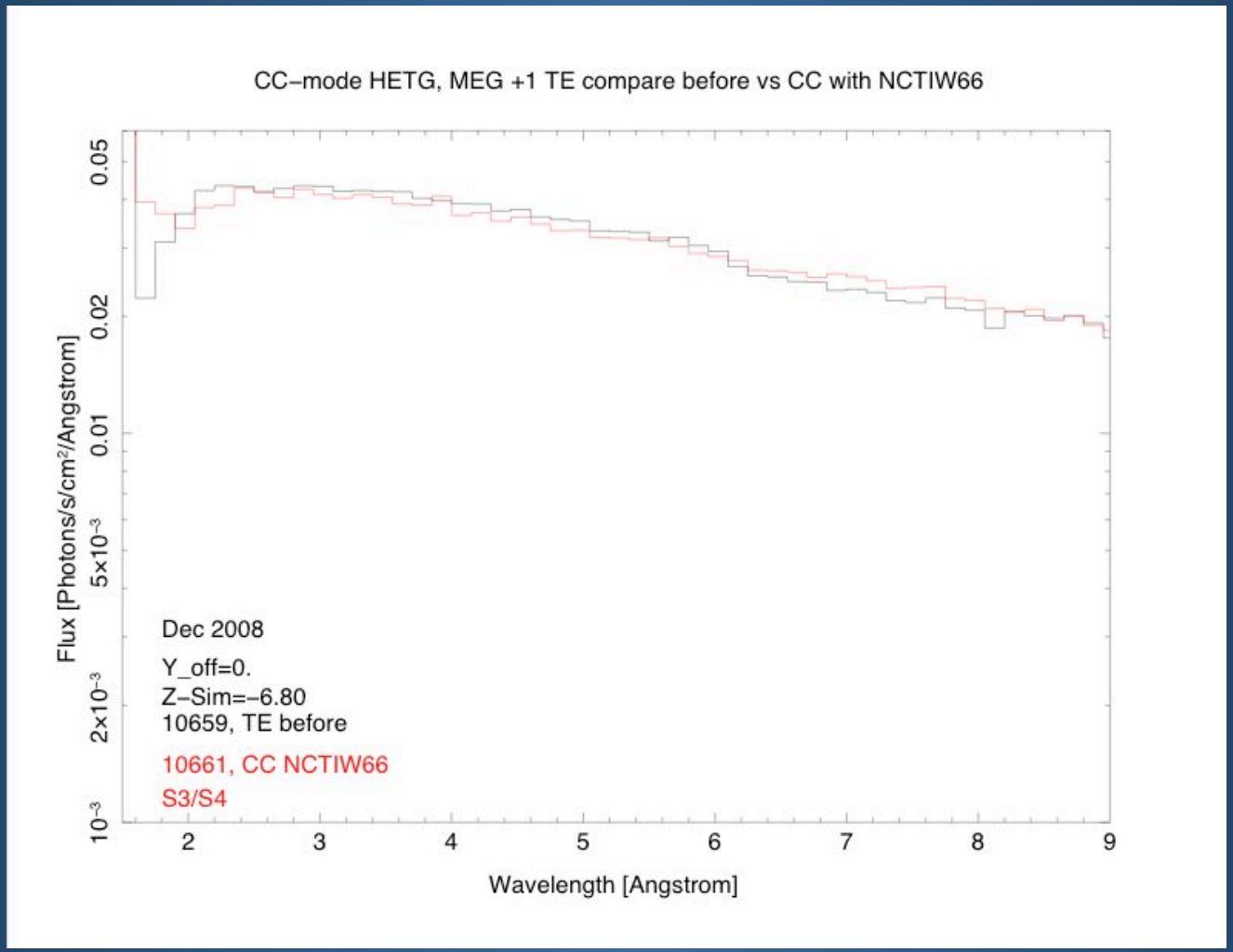

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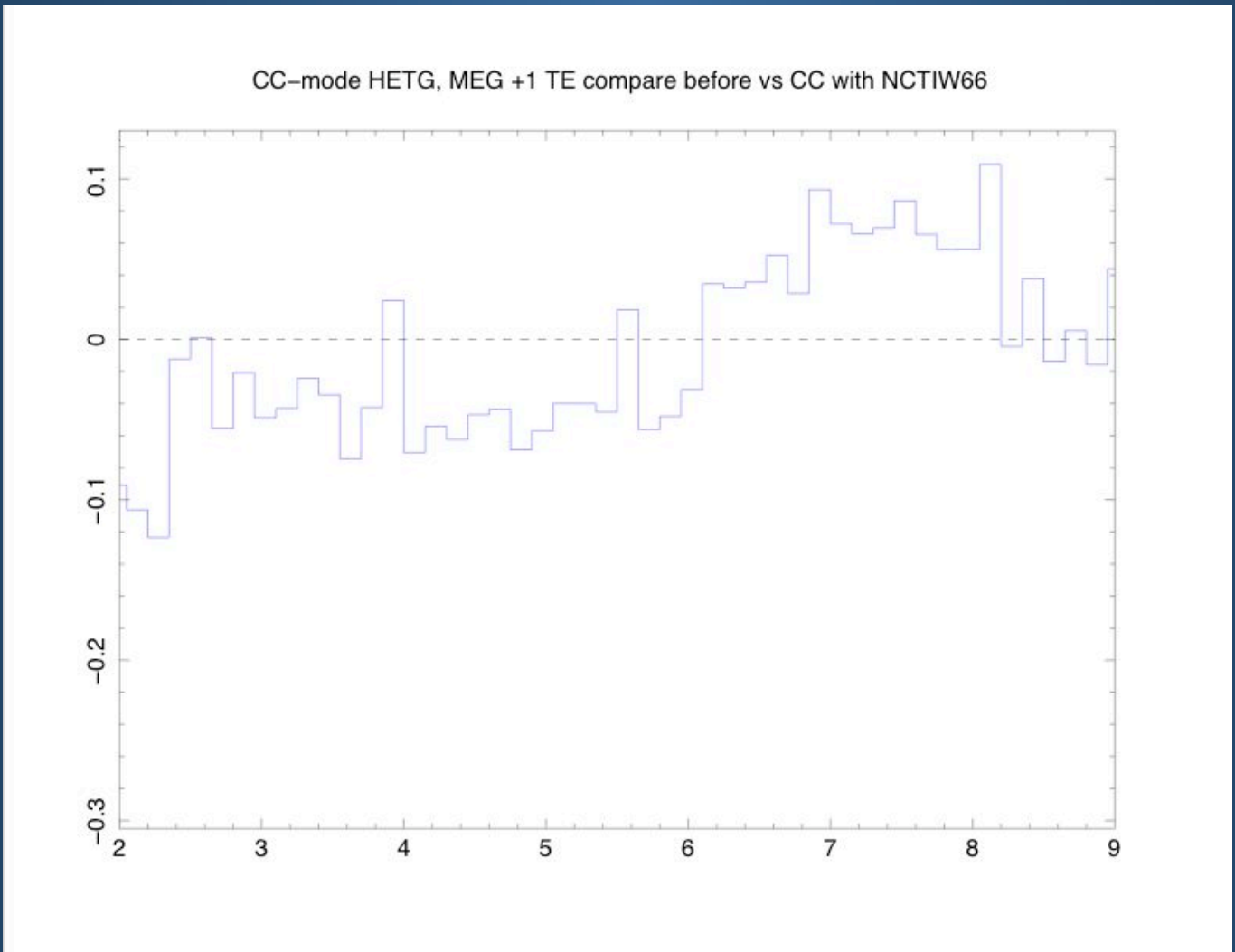


Rate Dependent Issues:

Si K edge problem: > 50 mCrab:

- depression between 6.2 -- 6.74 A (Si K edge) in BI devices

- edge mismatch (shift) in FI devices

HEG +/- vs MEG +/- mismatch:

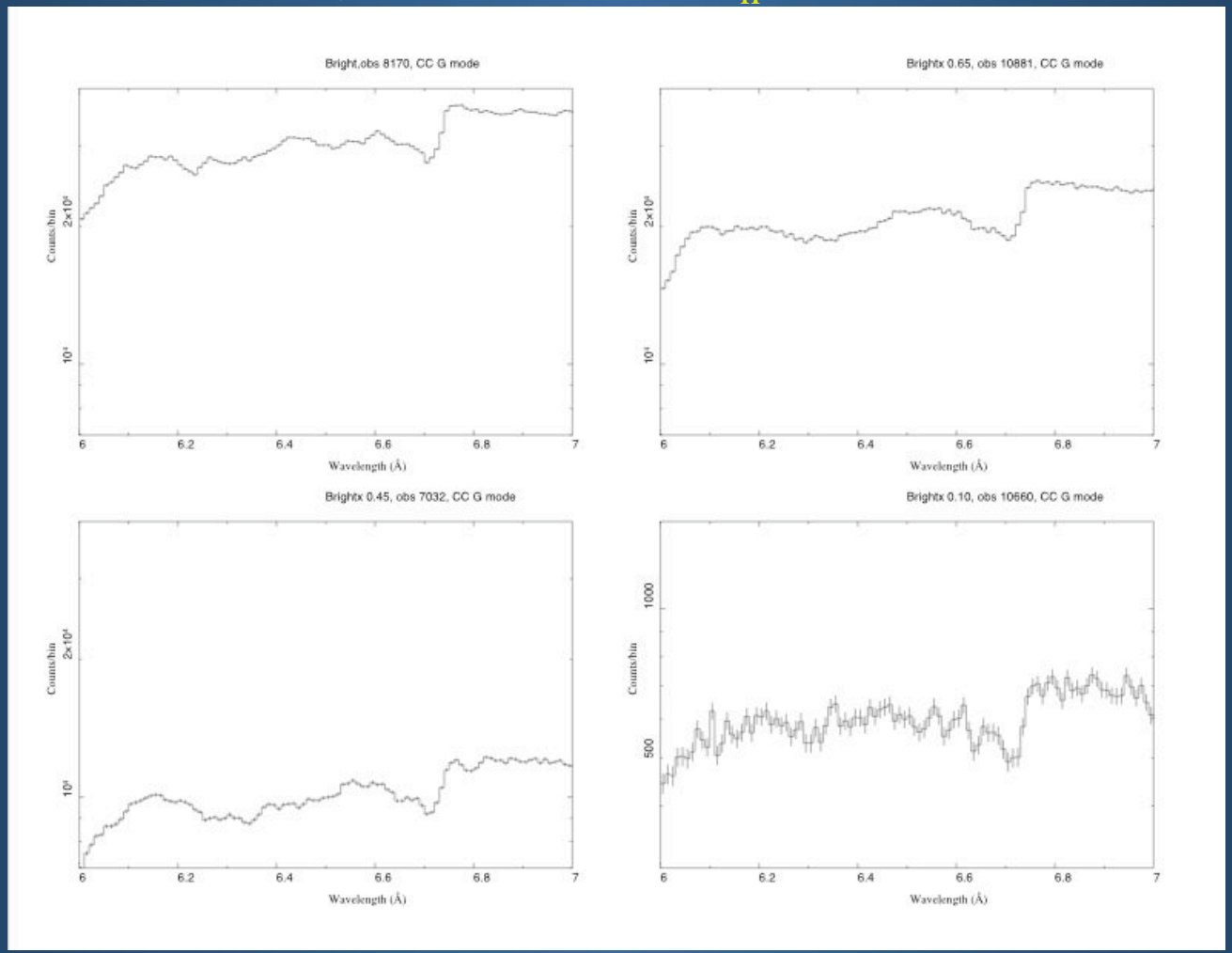
- separate count rate dependence from low rate CTI

What is currently done::

evaluate Si K edge depth vs. source rate

The Si K Edge in CC-Graded Mode

Bright X-ray sources with $N_h < 3 \times 10^{21}$ cm^{-2}



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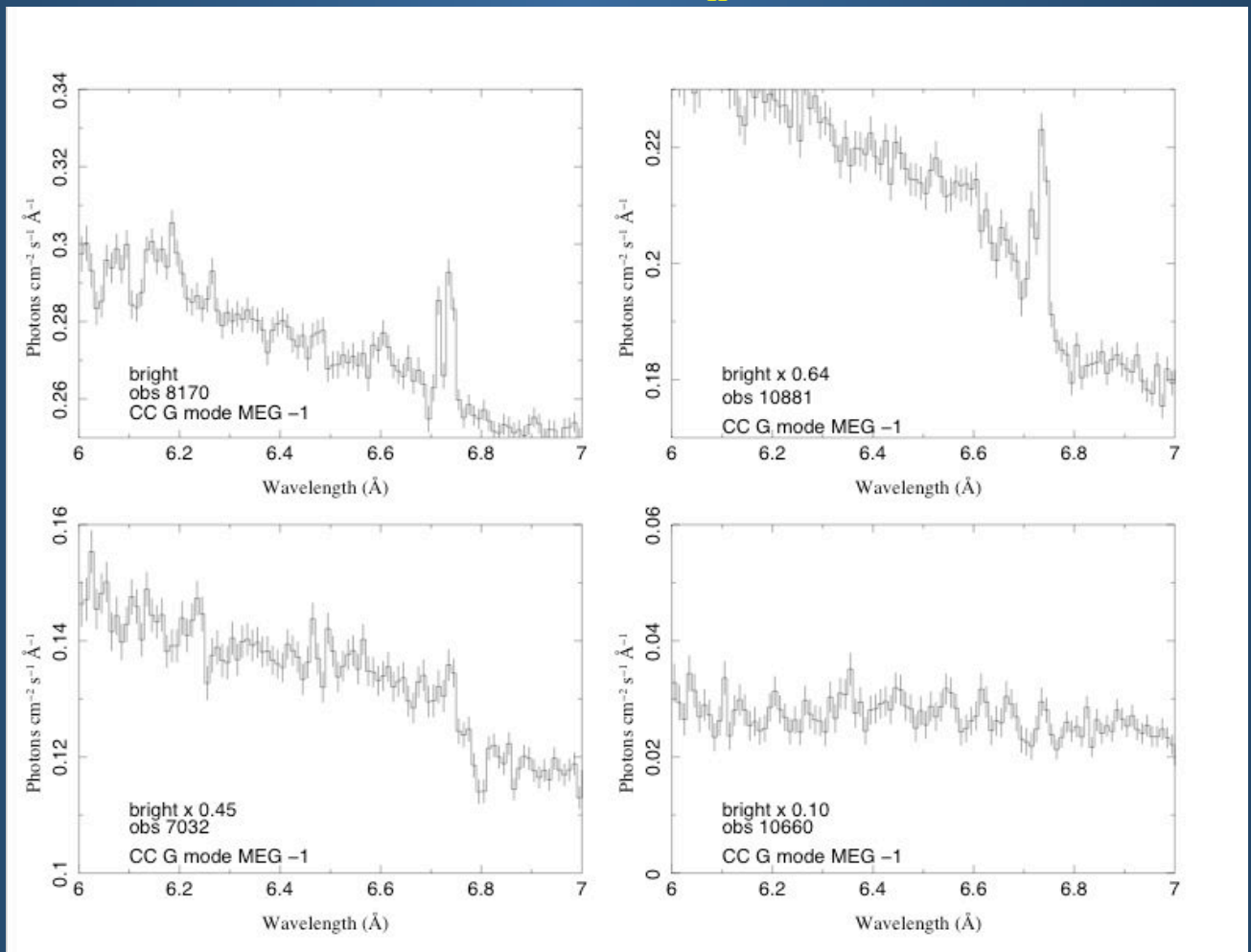

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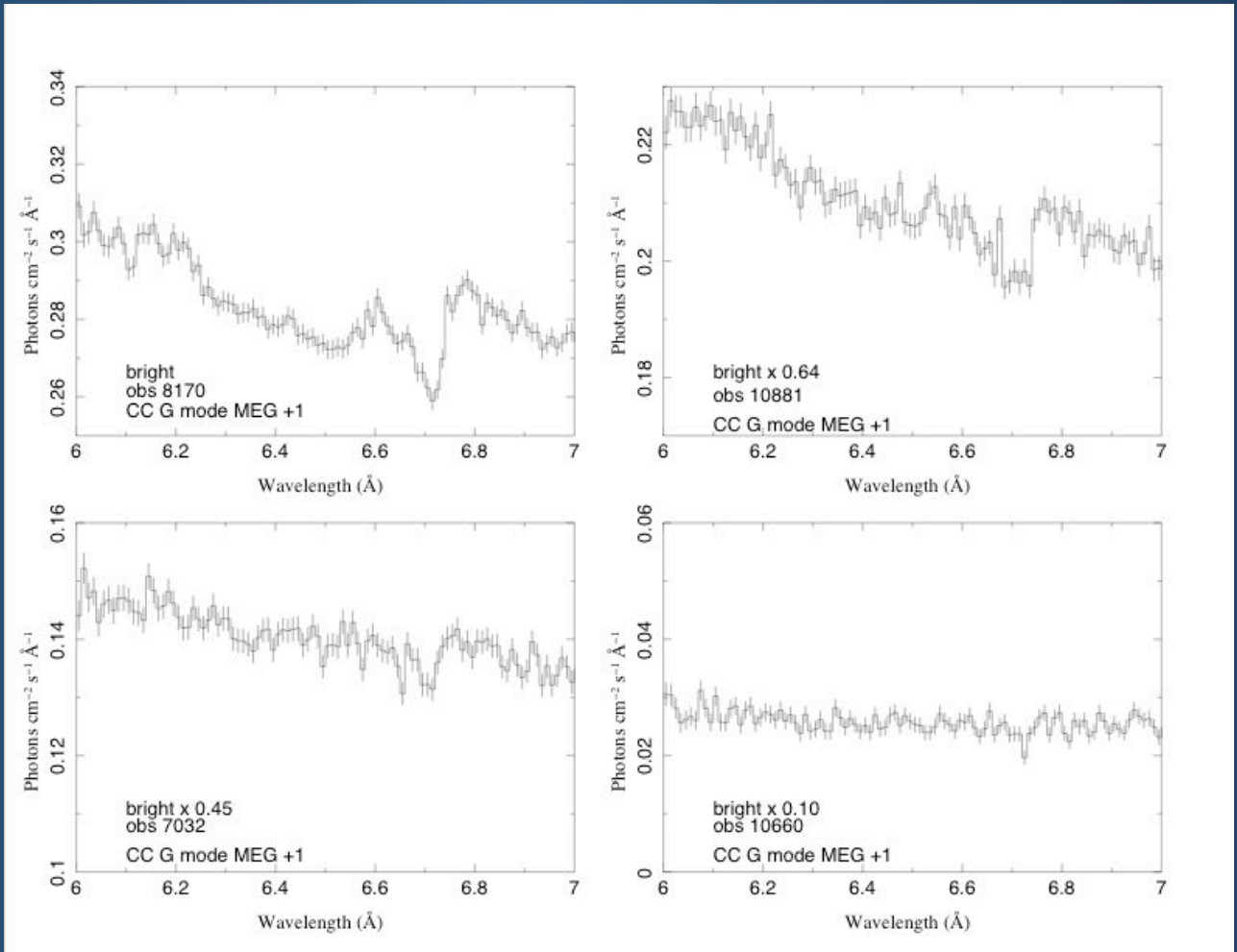

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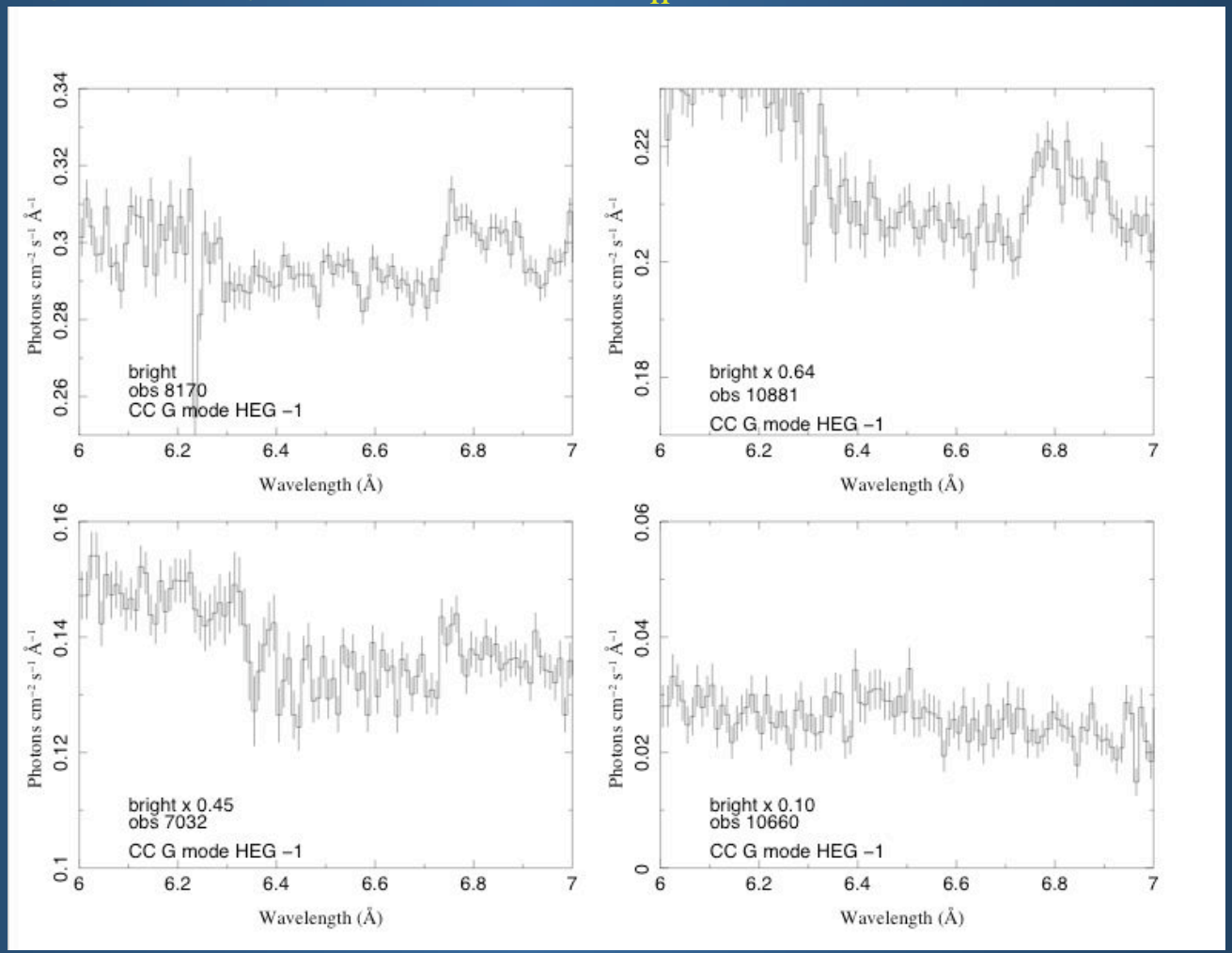

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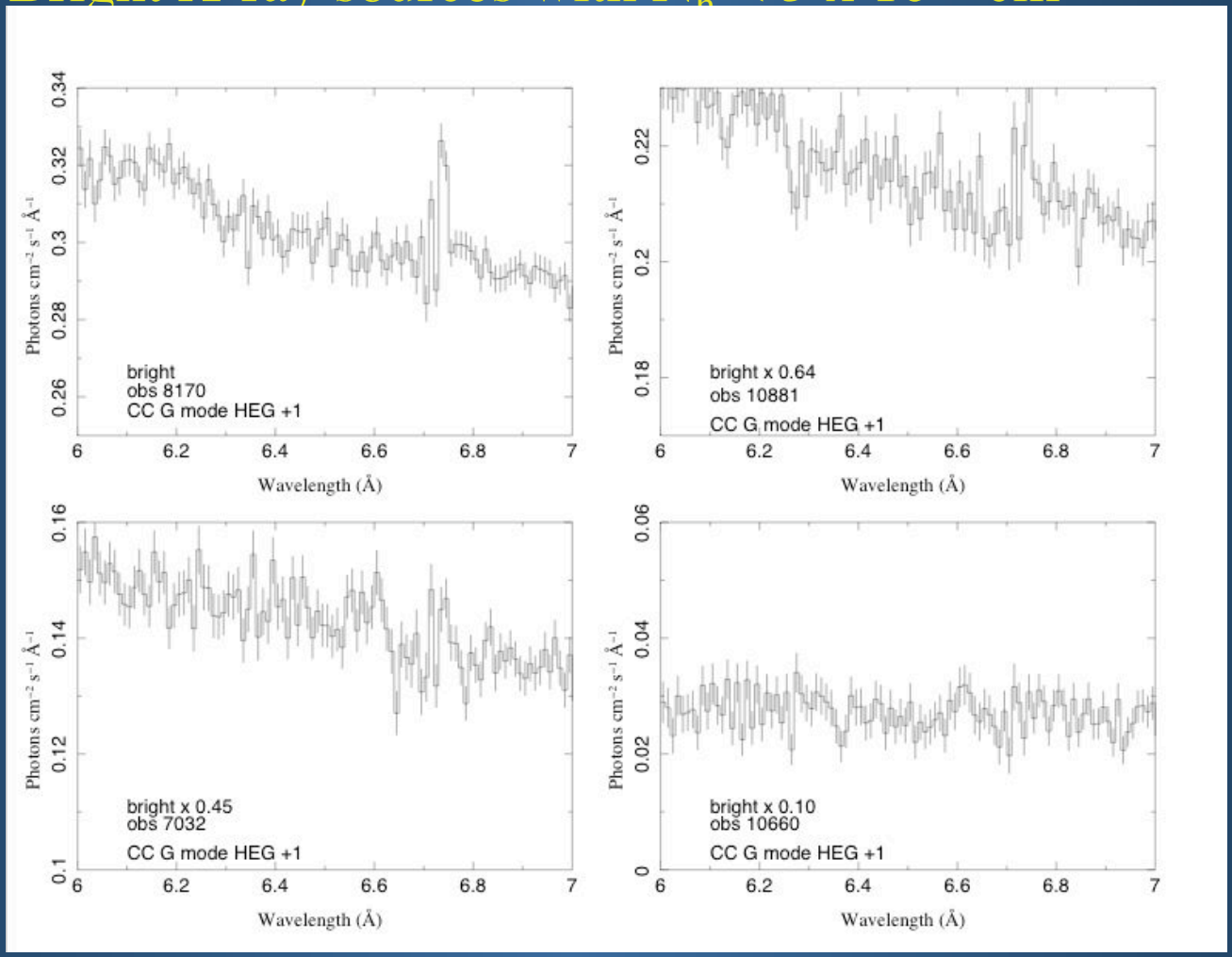
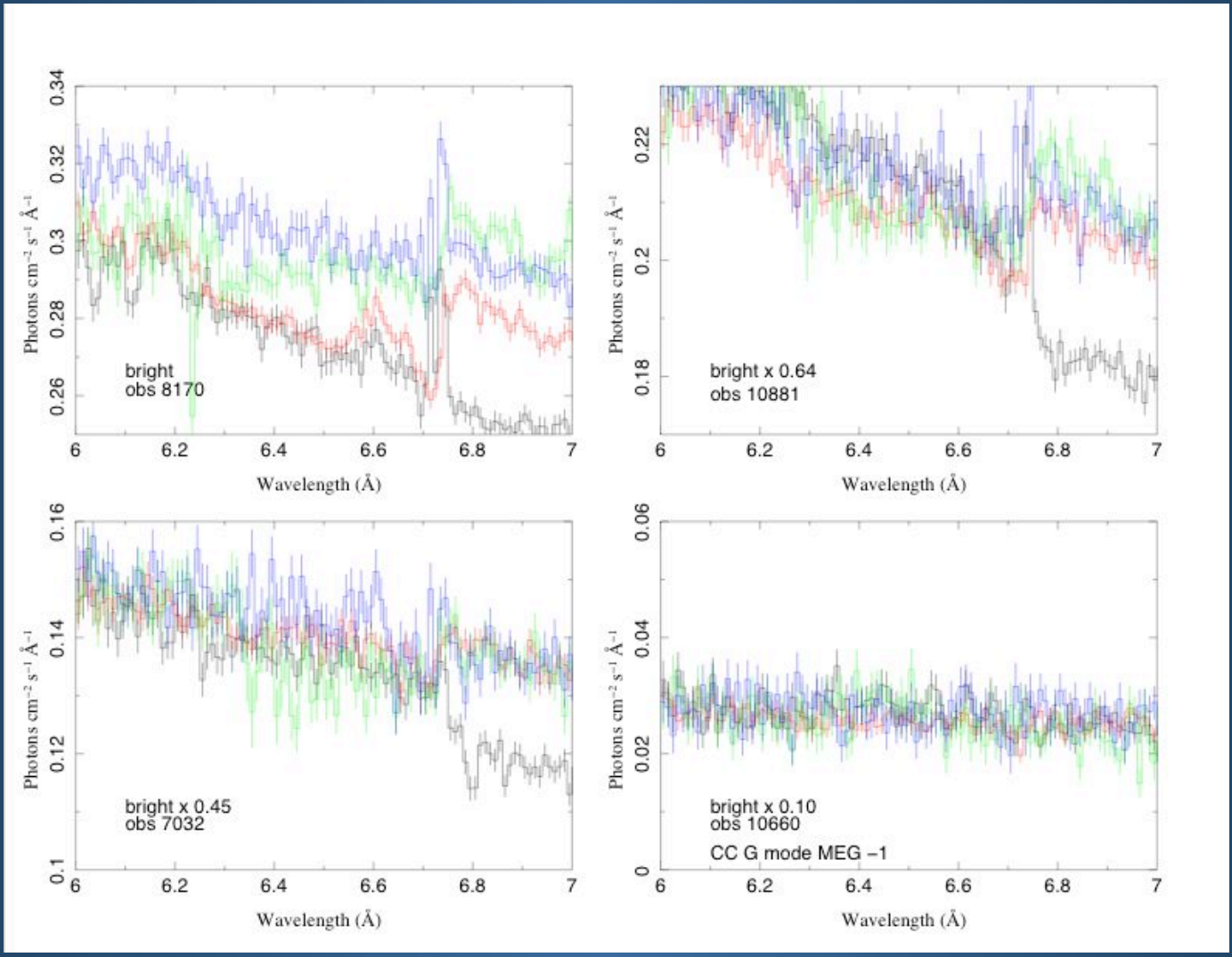
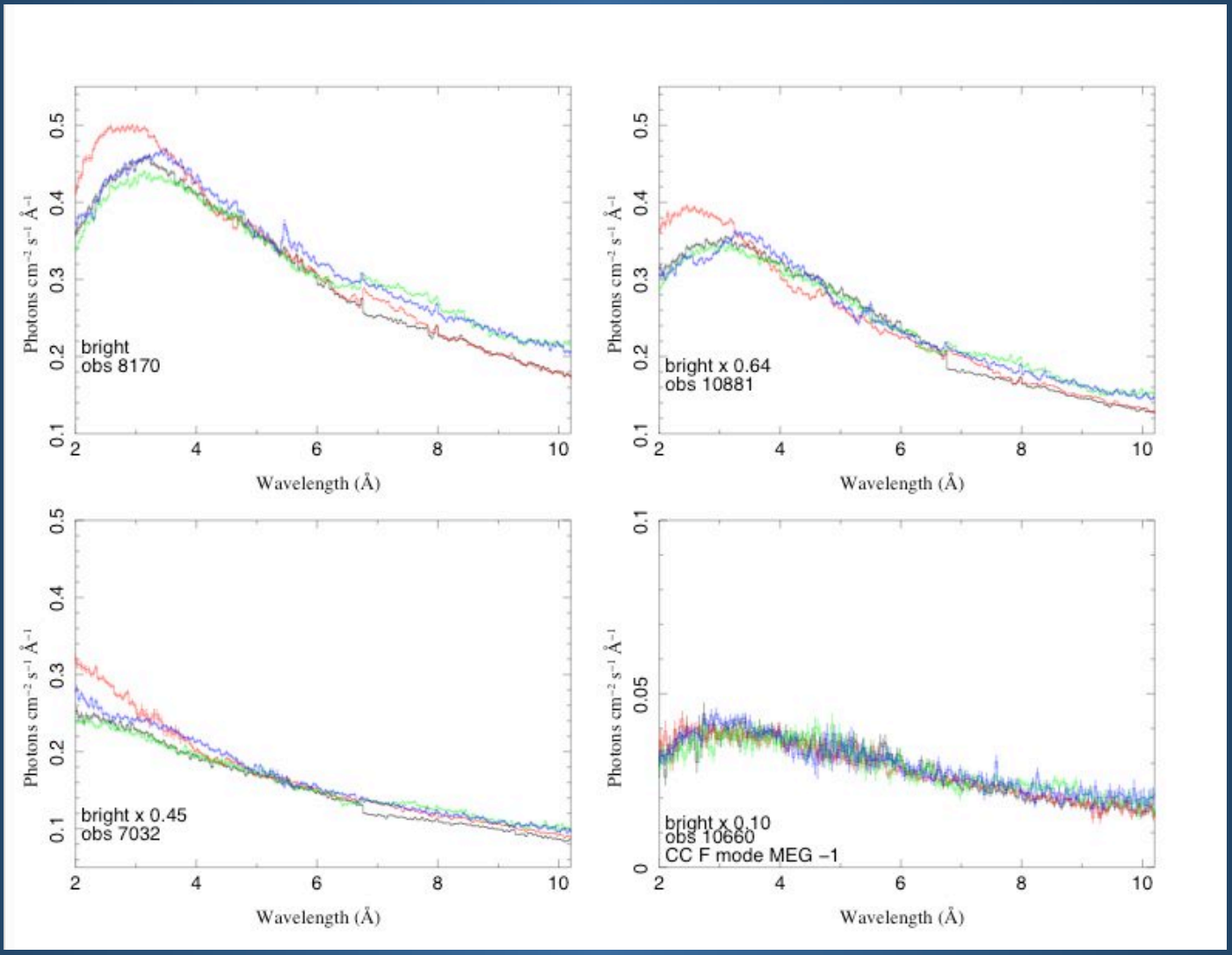


The Si K Edge in CC-Graded Mode: HEG vs MEG



CC-Graded Mode: MEG vs HEG



Future HETG Observations in CC-Mode:

All observations should use "Faint" NOT "Graded"

- **include non-standard flight grades, i.e. g66**

- **consider creating new G+ mode, which includes g66**

- **compensate anticipated loss of data through telemetry saturation via increased exposure rather on-board grading**

Observations ::

-moderately brightsourese in cc-F mode:

4U 1957-11 -- 50 mCrab (CAL, cycle 10, 20 ks)
GX 13+1 -- 90 mCrab (GTO, cycle 11, 40 ks)
GX 17+2 -- 150 mCrab (GO, cycle 11, 10 ks)
?? -- 250 mCrab