Project Tanagra

Timing Analysis of Grating Data

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NCC-1701-D
Darmok


NCC-1701-D
Darmok and Jalad at Tanagra

Lightcurves and spectra with Chandra

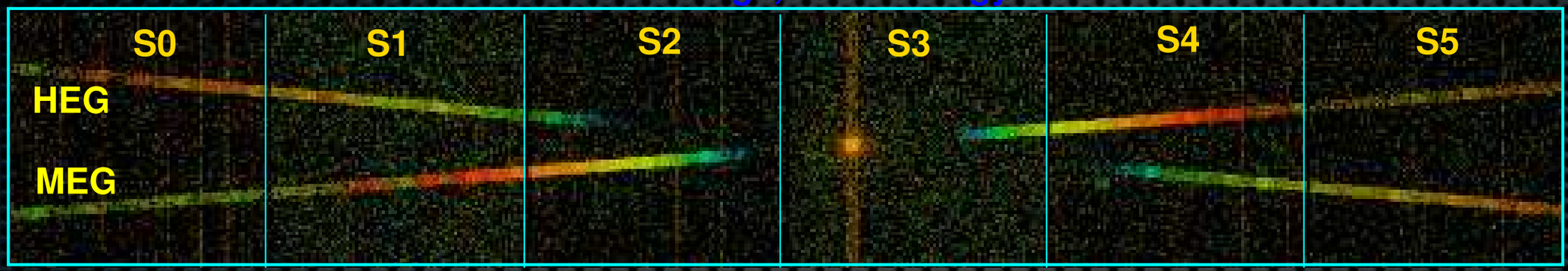
- A different kind of dataset
  - grating observations made with Chandra X-ray Telescope
- A bountiful spectro-temporal mine to dig

A different kind of dataset

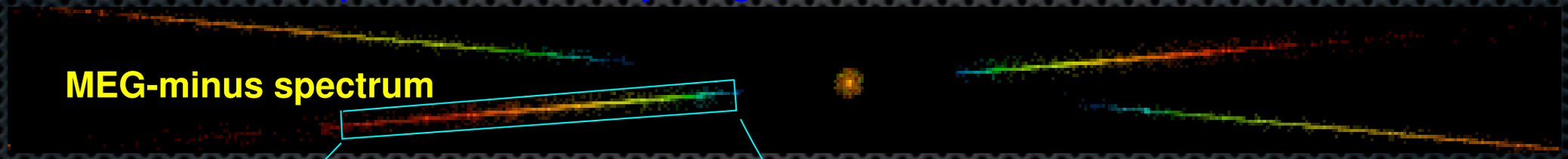
- peer-selected “interesting” bright X-ray sources
- long-duration observations
- photons with wavelength and arrival time attributes
  - excellent spectral *and* timing resolution

HETGS+ACIS-S Grating Spectra

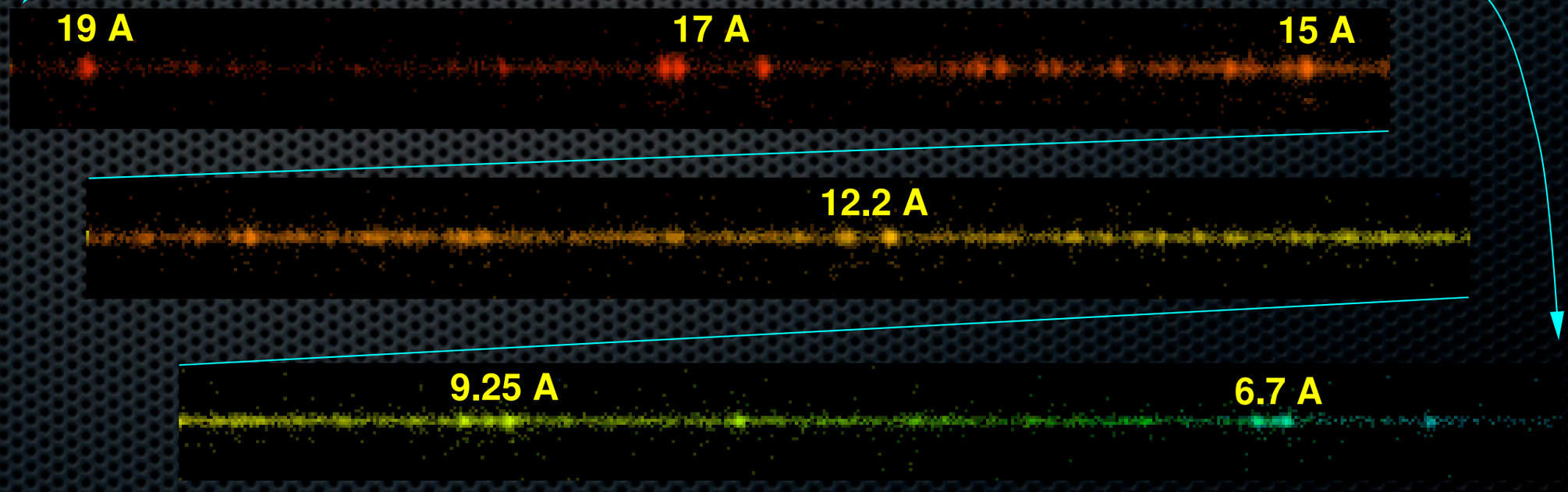
Raw Detector Image, ACIS Energy Color-coded



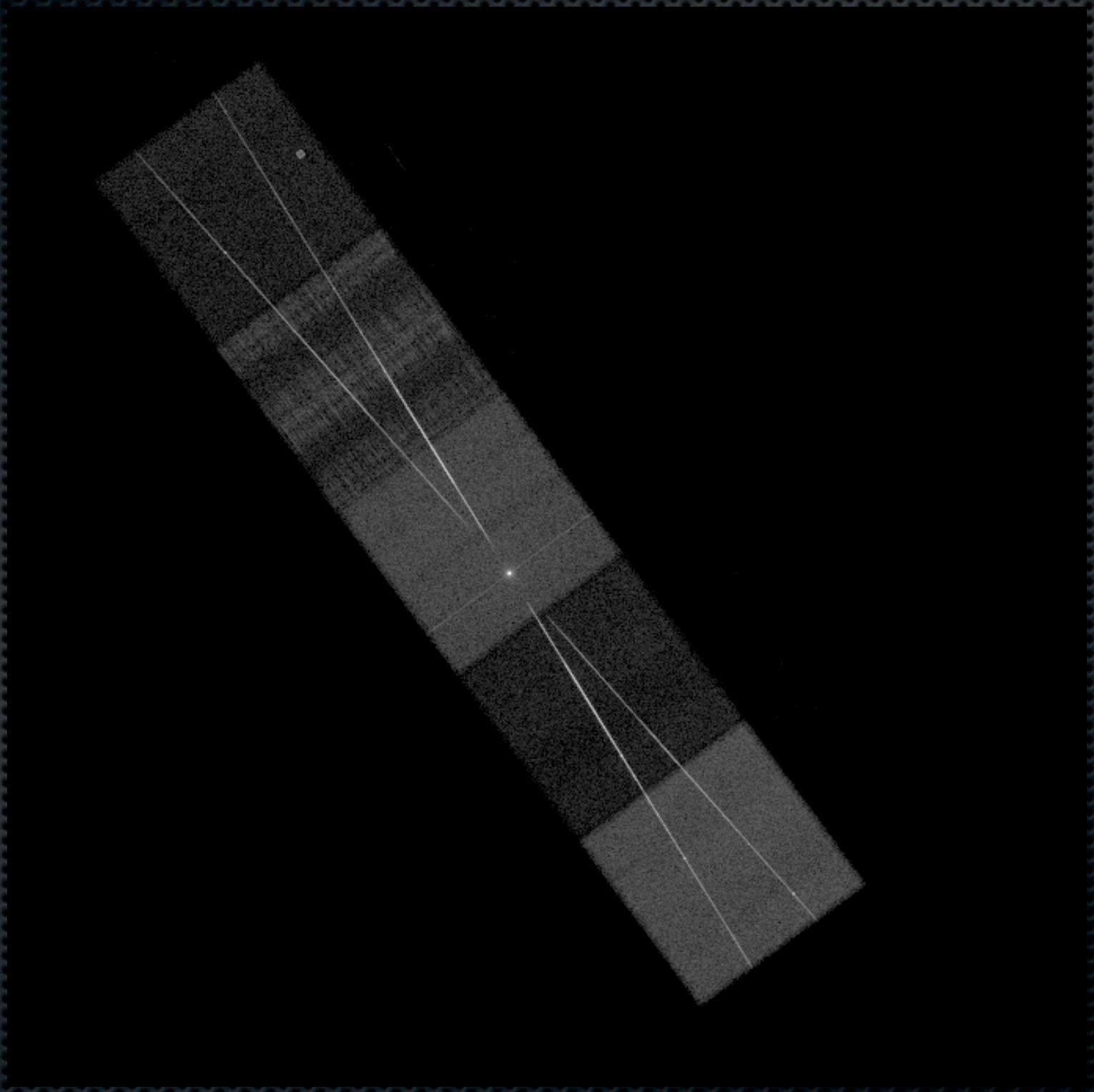
Aspect corrected Sky Image, Zeroth and First Orders Selected



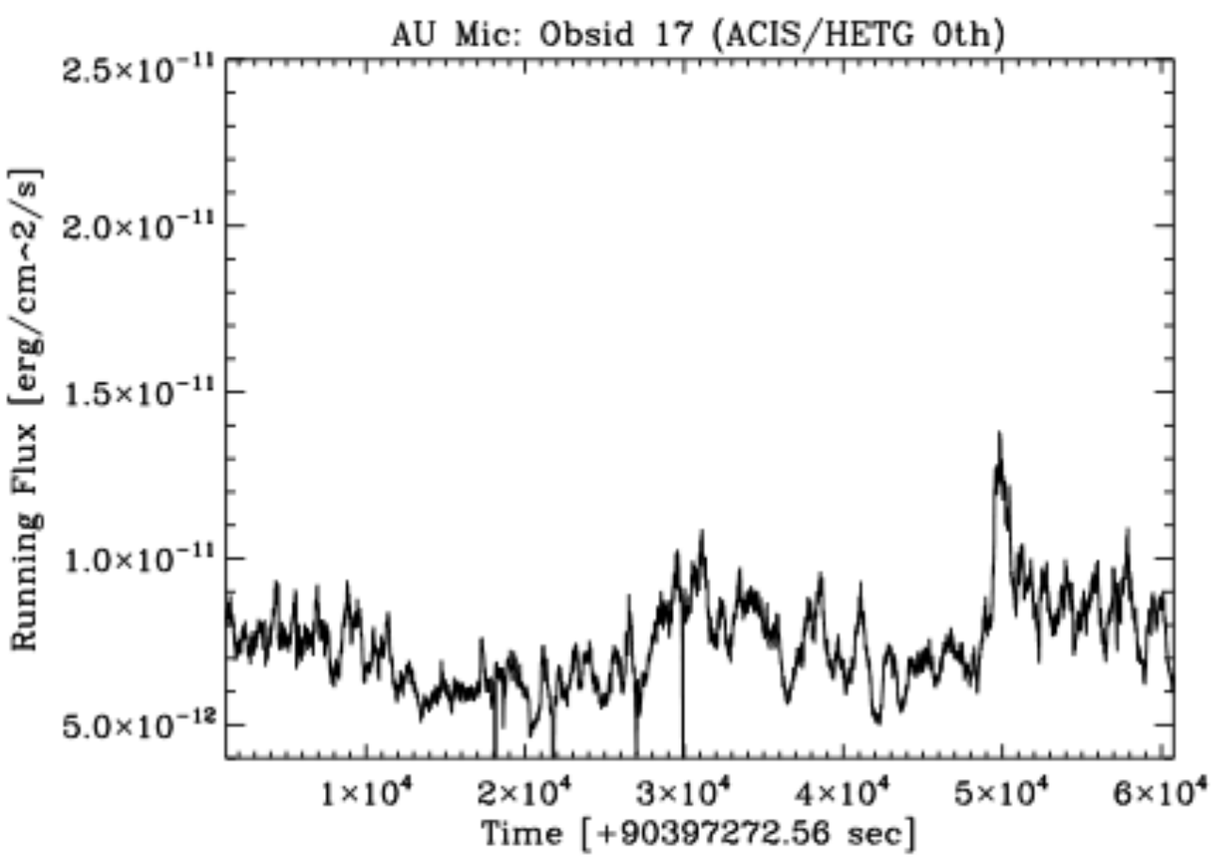
MEG Minus-First Order Spectral Images

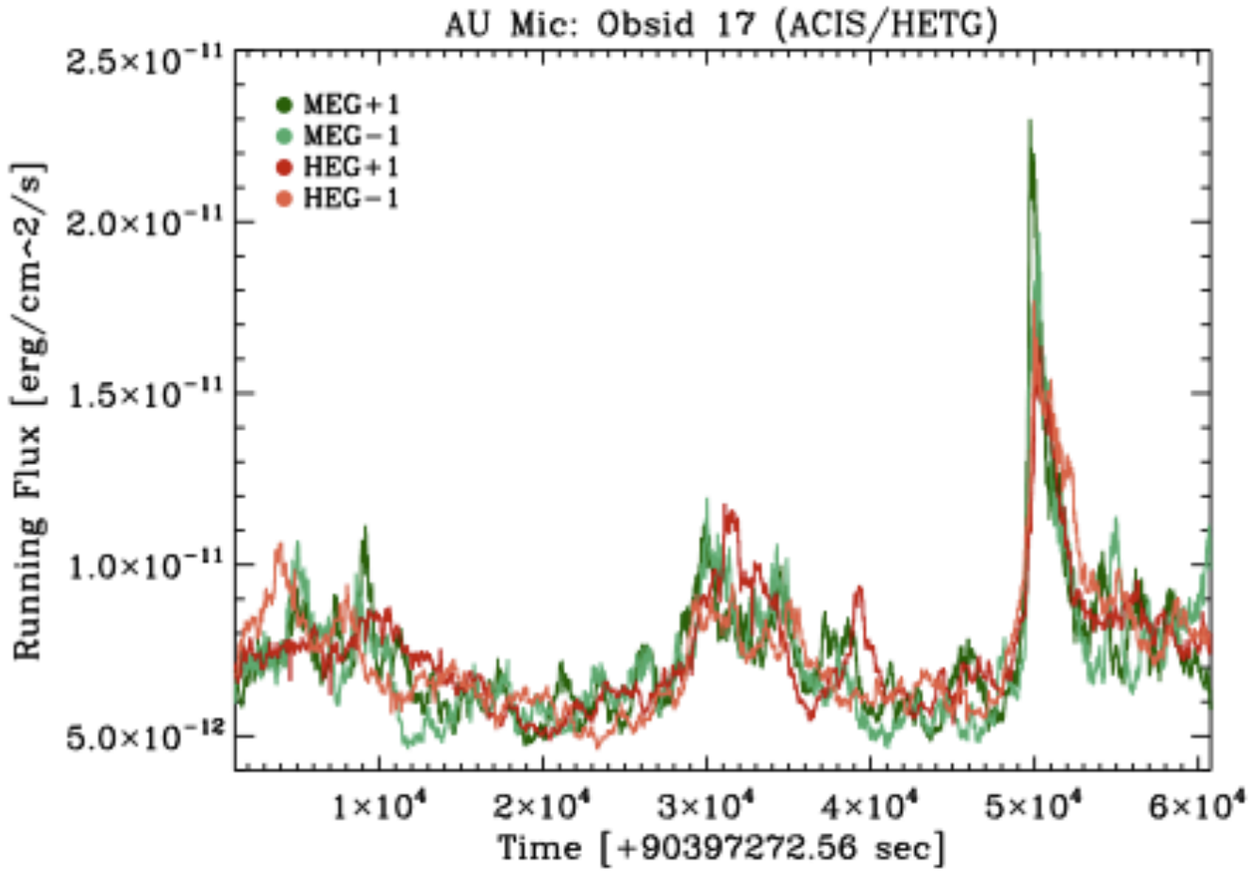


HETGS+ACIS-S Grating Spectra

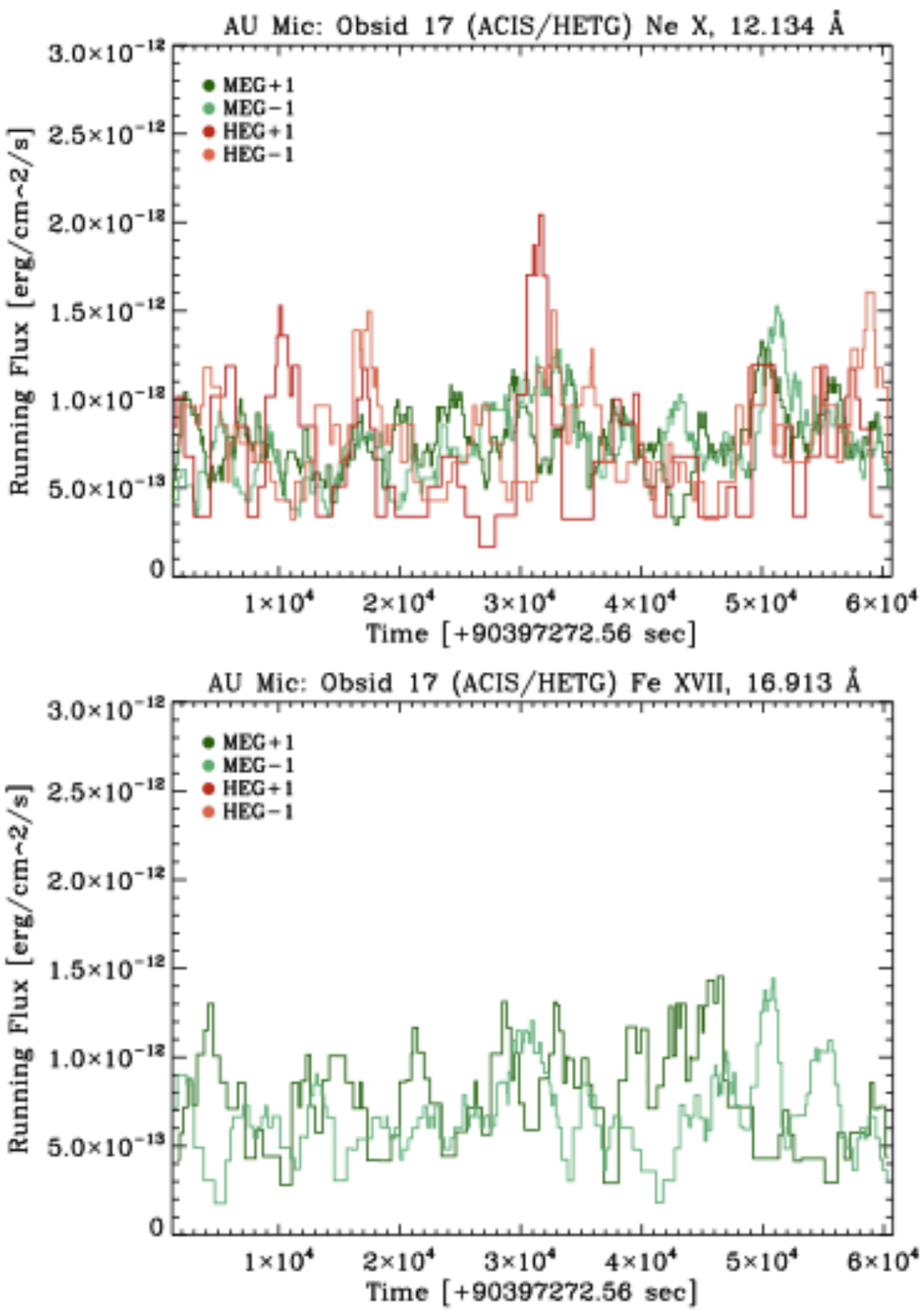


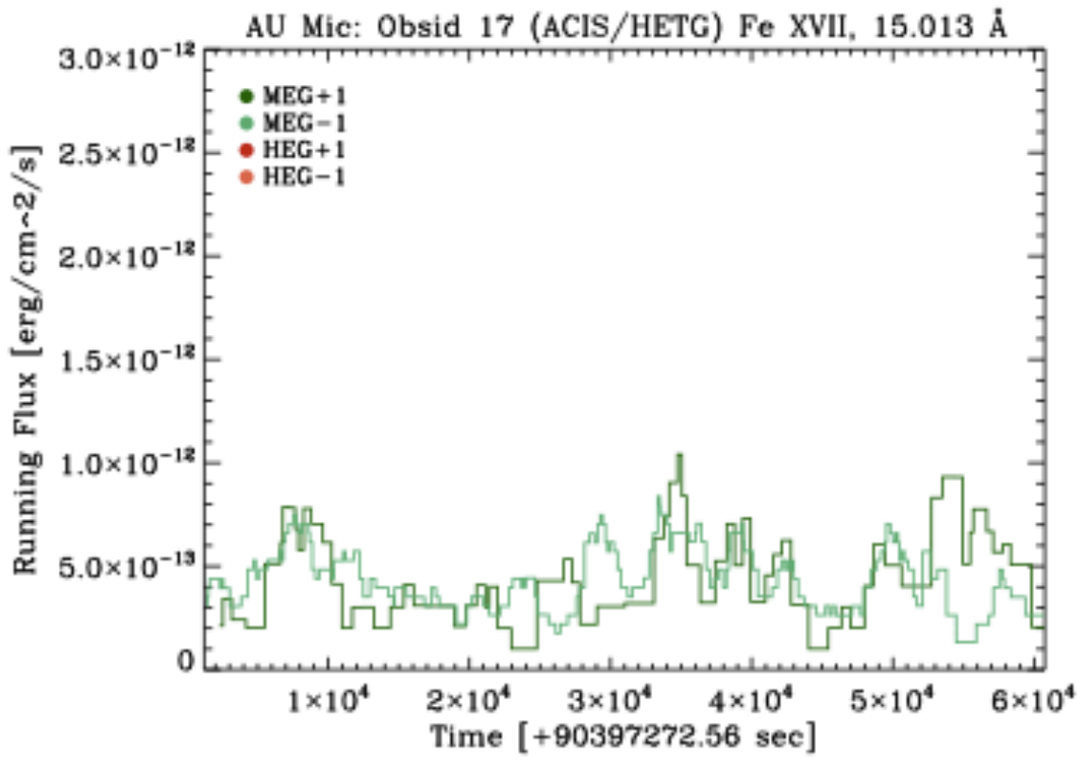
HETGS+ACIS-S lightcurves

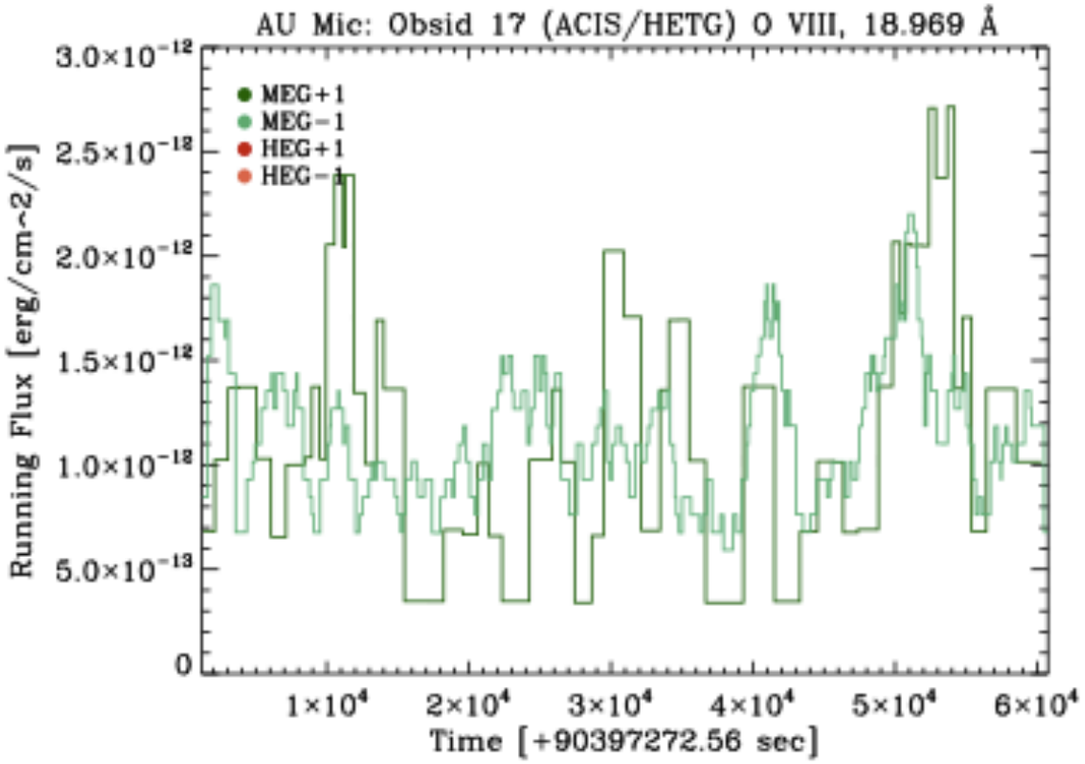




HETGS+ACIS-S lightcurves







Sounds grand.
Why hasn't anyone looked at all this yet?

Barriers to entry

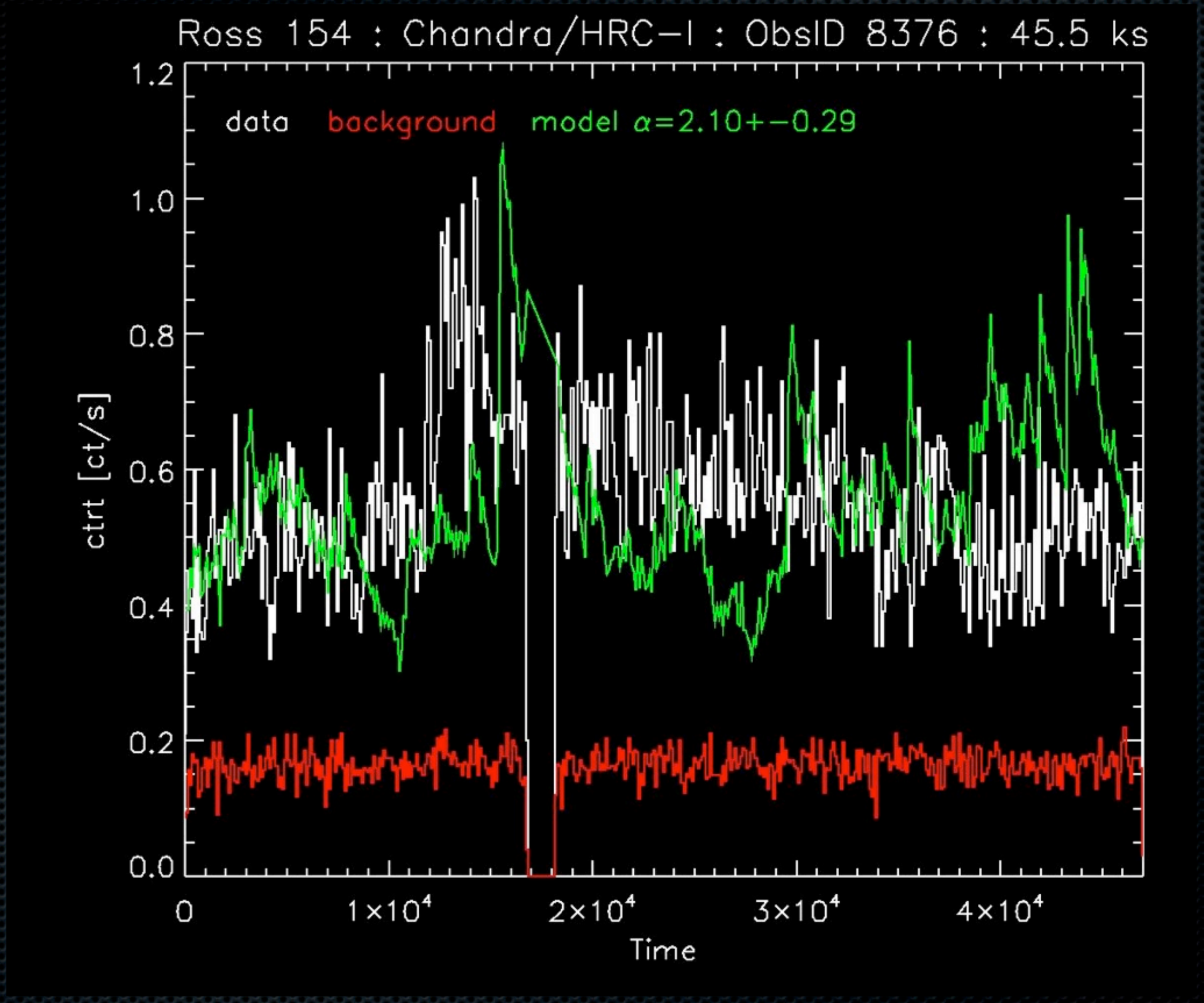
- few to none general algorithms to deal with (t,**λ**)
- no "statistically complete" samples
- all the easy bits already done by PI

do you really have to sit and stare at each observation?

- I am on the lookout for algorithms

My Motivation

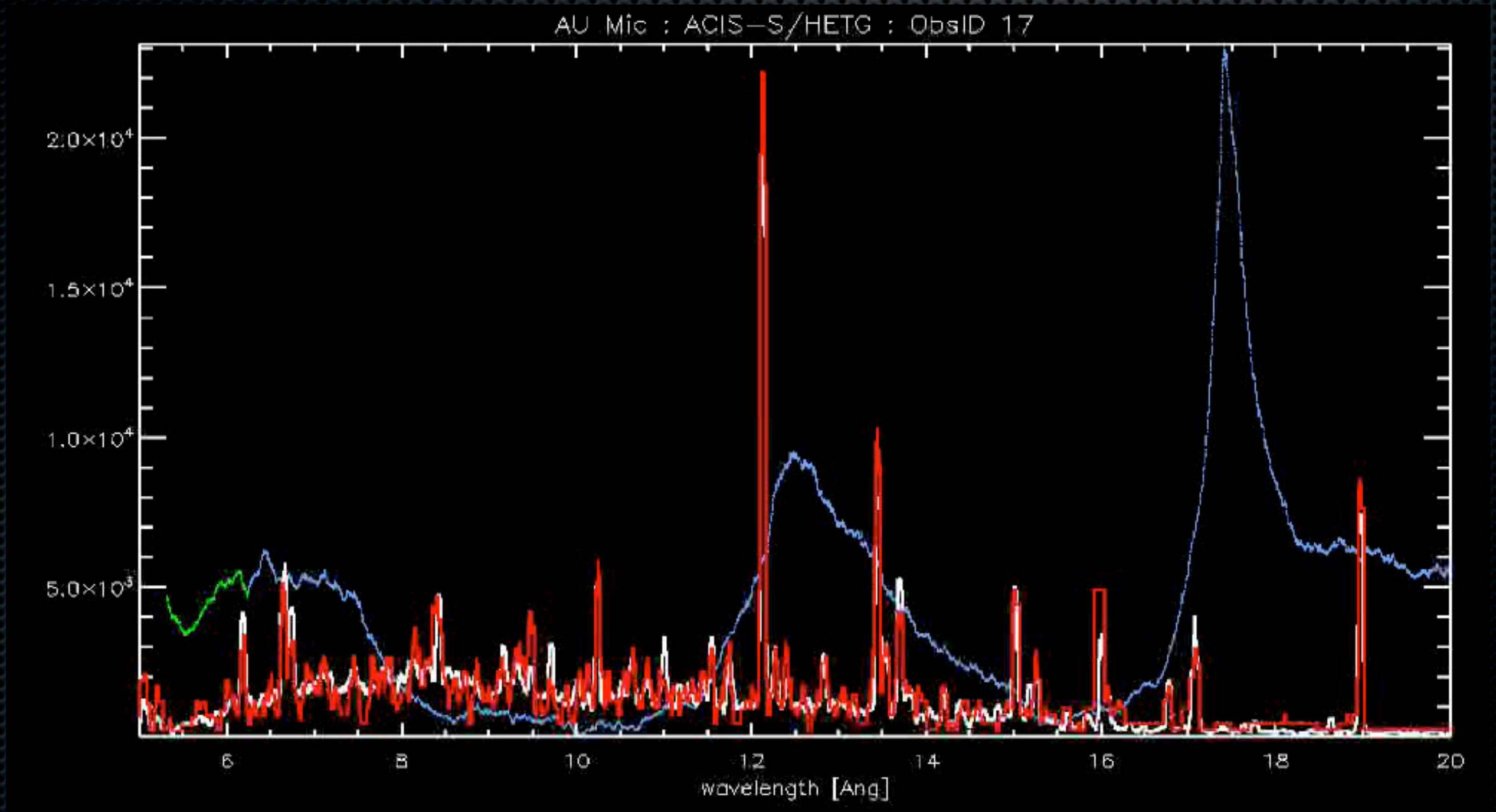
- solar and stellar flare energies are distributed as power-laws, $dN/dE \sim E^{-\alpha}$, with $\alpha<2$ for Sun, and $\alpha>2$ for low-mass stars.
- probably due to self-organized criticality in magnetic field structures
- Questions: is α a function of spectral type? is a single power-law a consistently good description? is there a dependence of α on luminosity or on plasma temperature? where is the lower cut-off to the distribution?


Ross 154 : Chandra/HRC−I : ObsID 8376 : 45.5 ks
data
background
model α=2.10+−0.29
ctrt [ct/s]
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
1×10⁴
2×10⁴
3×10⁴
4×10⁴
Time

Your Motivation

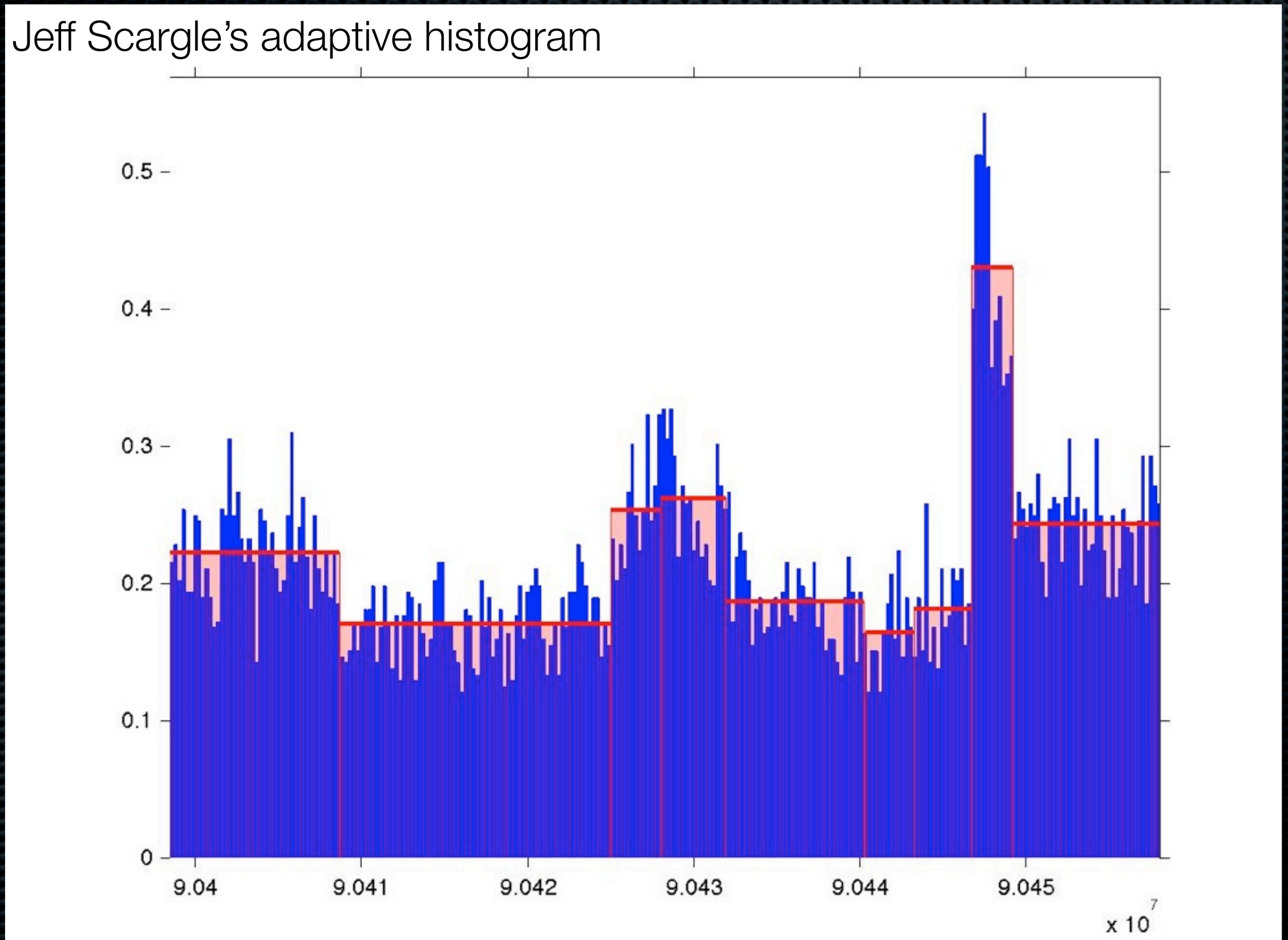
- A different kind of data mining
- Digging deep into a single source

Illustrative example: AU Mic

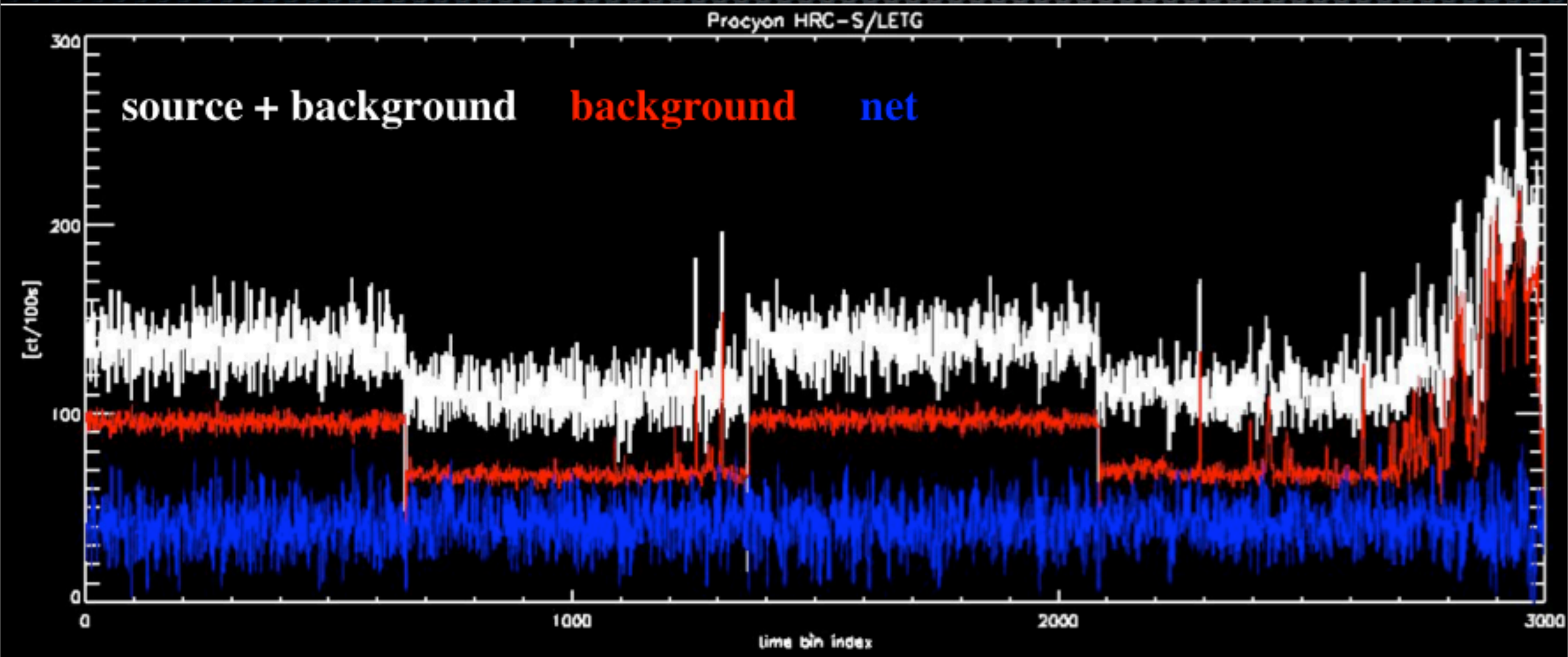


Illustrative example: AU Mic

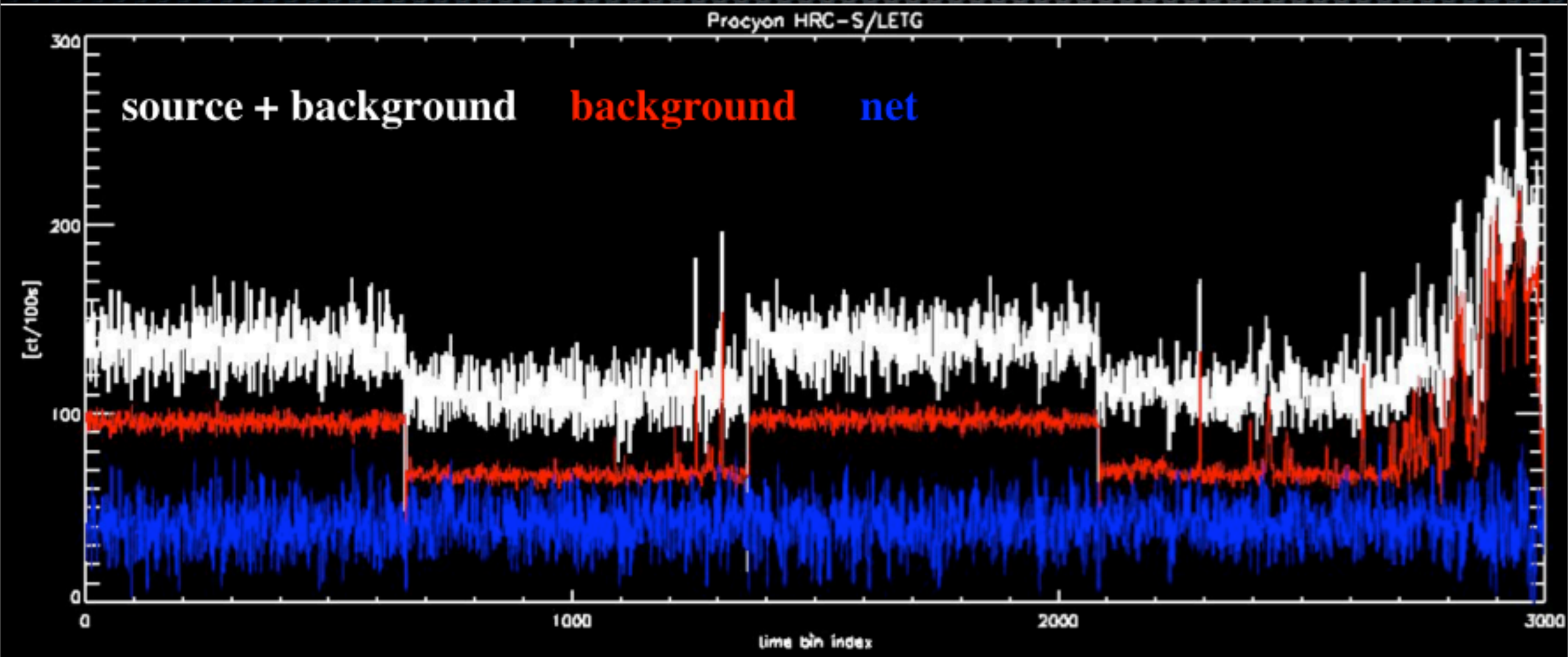
Jeff Scargle's adaptive histogram



Illustrative example: Procyon

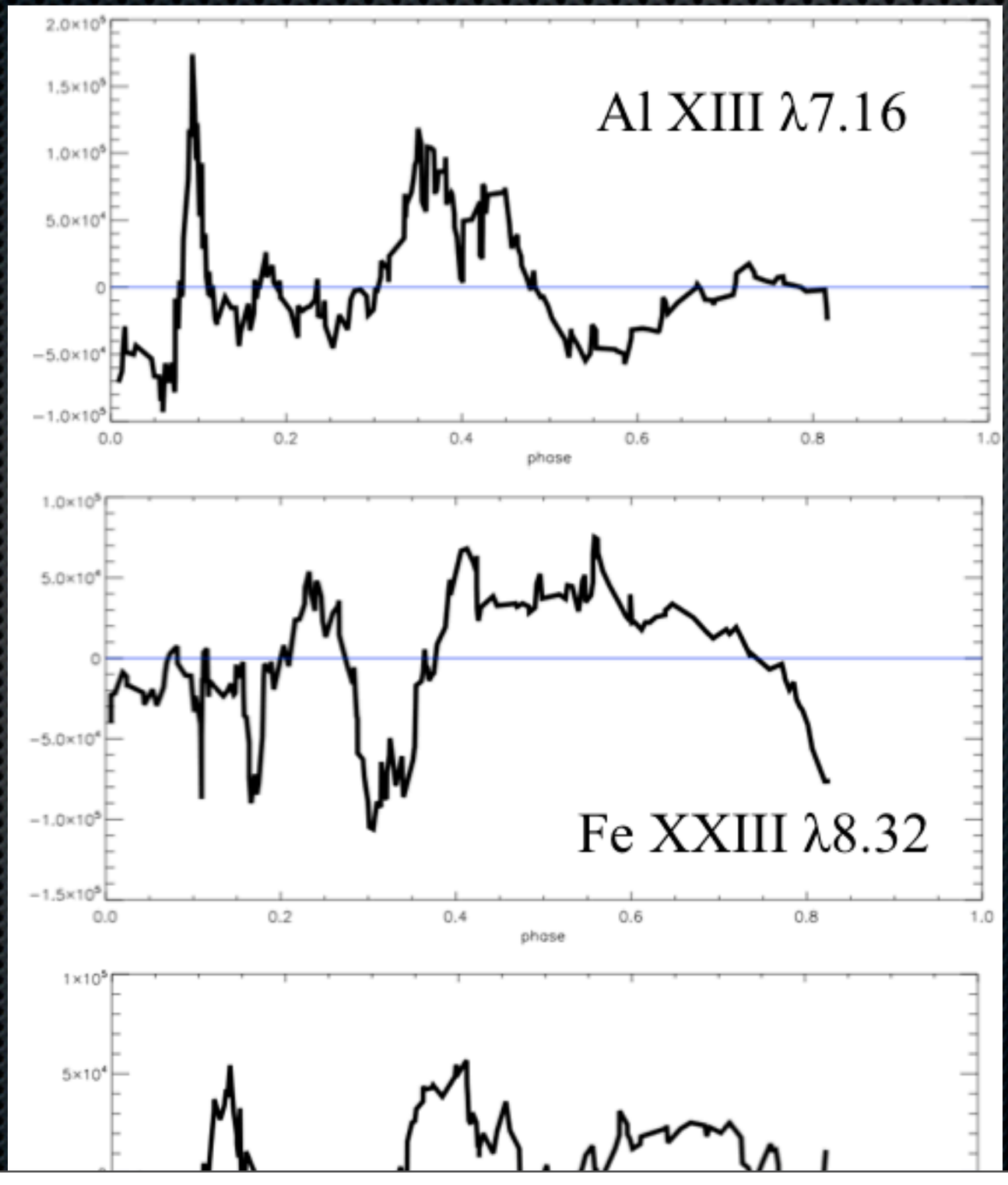


Illustrative example: Procyon



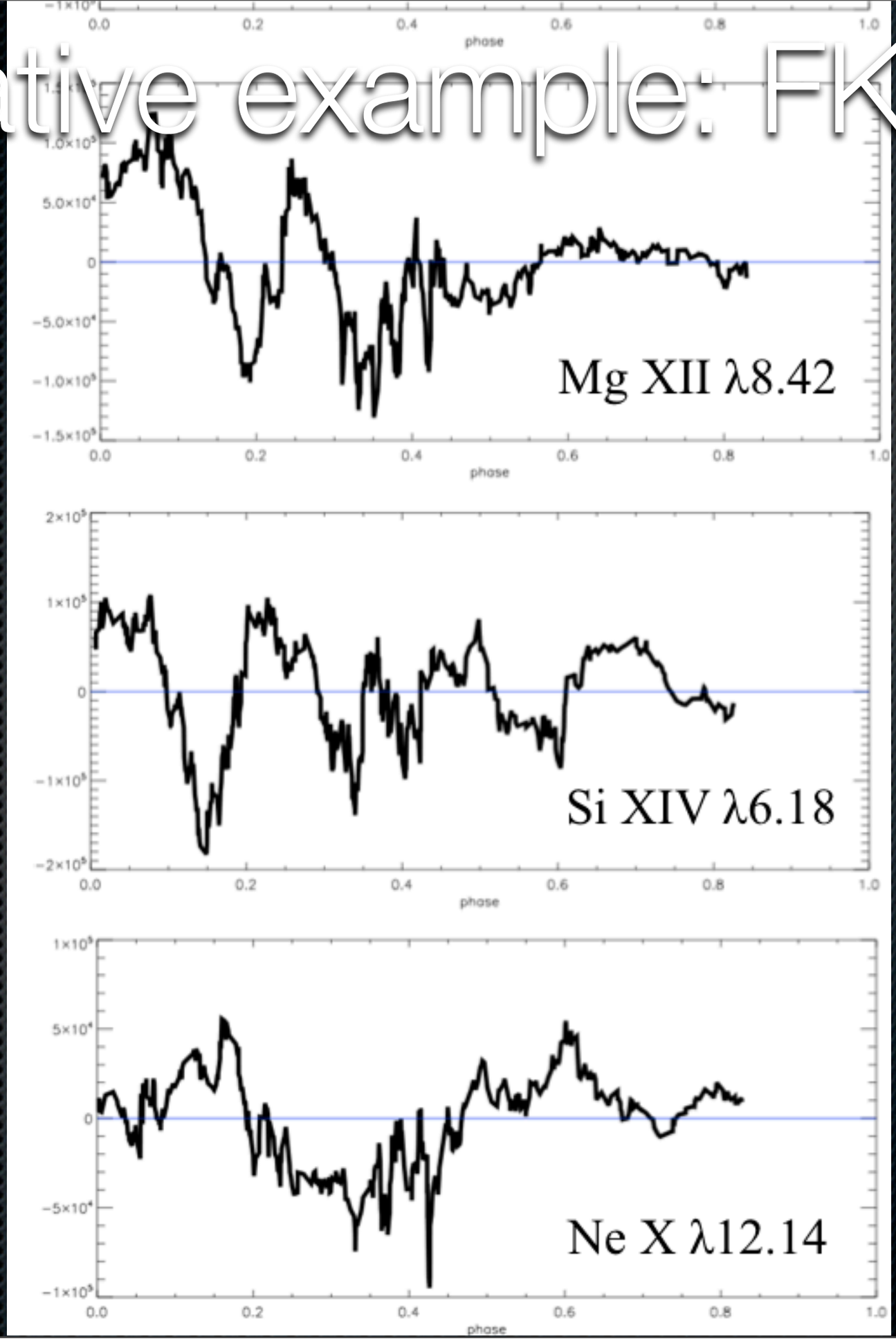
$\alpha \approx 1.7$

Illustrative example: FK Com



line centroid shifts with time

Illustrative example: FK Com



line centroid shifts with time

Summary

- coherently reduced datasets with extraordinarily detailed timing and spectral information
- multiple, independent, simultaneous data streams
- will be extended to other types of objects (e.g., AGNs), observed with other missions (e.g., XMM-*Newton*/RGS)
- test bed for deep (as opposed to broad) analysis methods
  - e.g., not just detect a transient, but study its characteristics in spectral lines formed at different temperatures