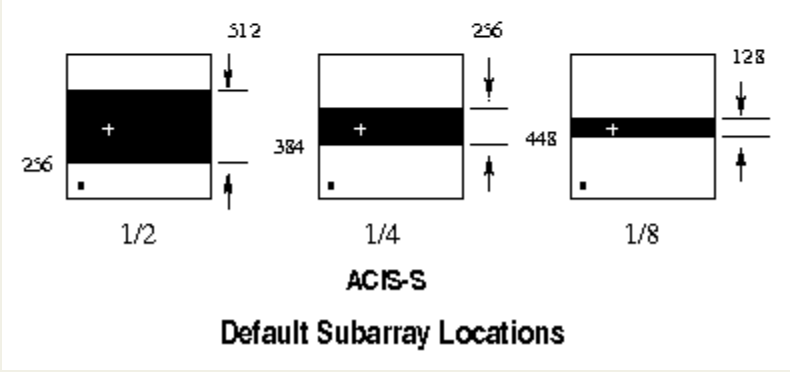
# Calibration of ACIS Timing Modes

Catherine Grant for the ACIS cal team
(primarily Dick Edgar, SAO)

# Definitions:




- Nominal Timed Exposure (TE) mode
  - 3.2 sec frame time, 40 µsec/row transfer speed
  - Can be reduced to 3 sec for single CCD operation
- TE mode with a subarray
  - Same transfer speed
  - Readout fewer rows, efficient frame time as low as 0.3 sec
  - Frame time as low as 0.1 sec with additional dead time
- Continuous Clocking (CC) mode
  - 1-D spatial resolution, 2.85 msec/row transfer speed
- Not timing modes
  - Faint, Very Faint, Graded – telemetry formats
  - Spatial Windows filter events to avoid telemetry saturation

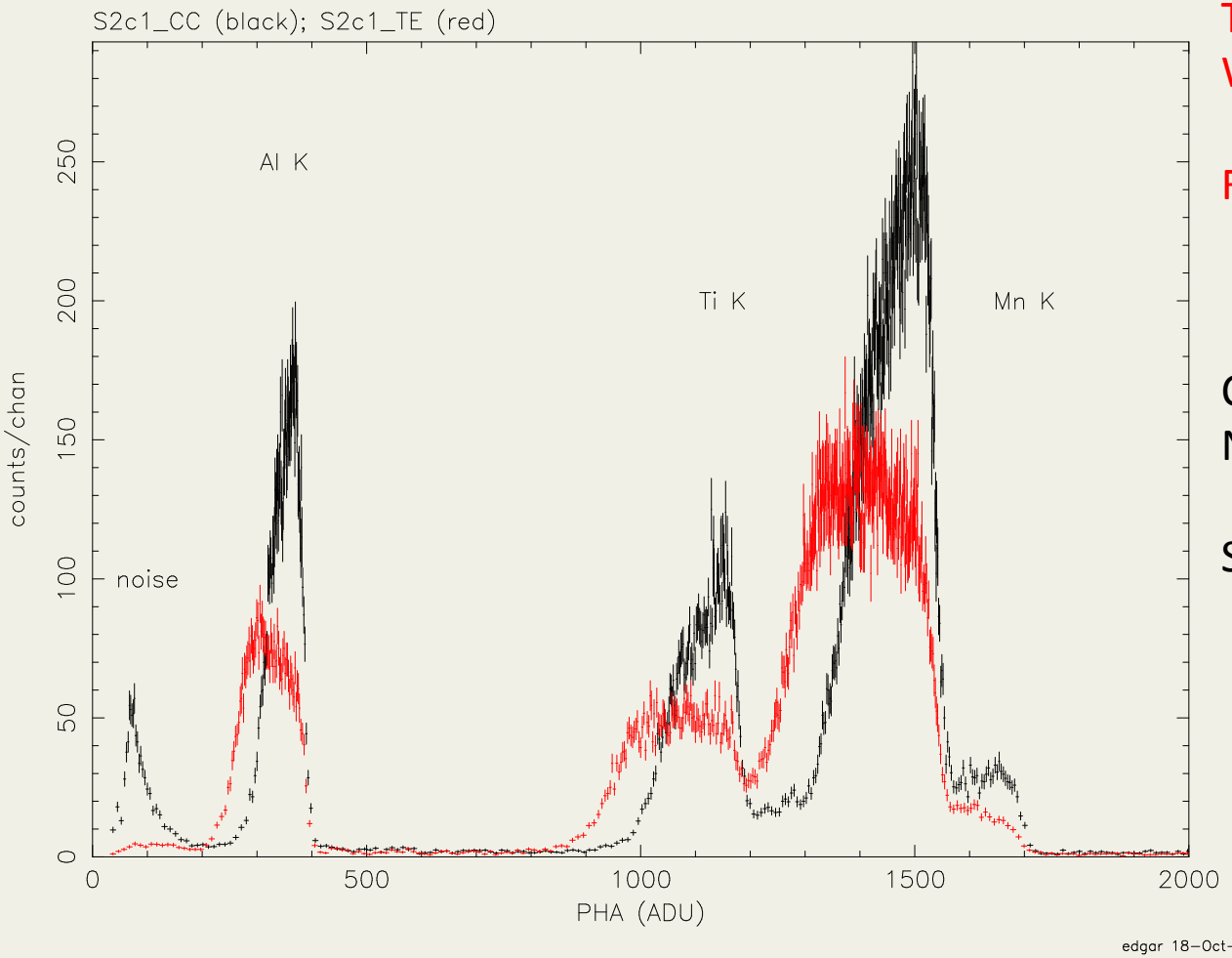
# Status of Timing Mode Calibration

- Subarrays currently not separately calibrated, use standard TE mode products
  - CTI depends on sacrificial charge, will be lower for shorter frame times, impact not known
  - Often used with gratings positioned near readout, where impact should be minimal
- CC mode currently not separately calibrated
  - Pipeline assumes all events are at target position, applies TE mode calibration
  - CC-mode-specific CTI correction is in progress
  - Additional QE correction being measured

# CC Mode vs TE Mode

- Slower transfer speed (2.85 ms vs. 40 μs)
  - Trap time constants (measured in TE mode)
    - 4% 60 μs, 46% 400 μs, 26% 2 ms, 24% > 3 s
  - CTI is lower/better in CC mode than TE mode
  - Much more charge is re-emitted into trailing pixels
- 1-D position information sacrificed for faster timing
  - Source location in CCDY direction cannot be determined from events
  - Must be assumed from target RA, Dec and/or grating order sorting
- Until Nov 2009, more restrictive grade filter used on-board in CC mode, QE loss due to grade morphing

# Uncorrected full CCD calibration source spectra




TE Mode in red
Wider lines
More charge loss
Flat-topped lines
More uniform QE

CC Mode in black
Narrower lines
Less charge loss
Sloped line tops
More QE loss

# CTI Correction in CC Mode

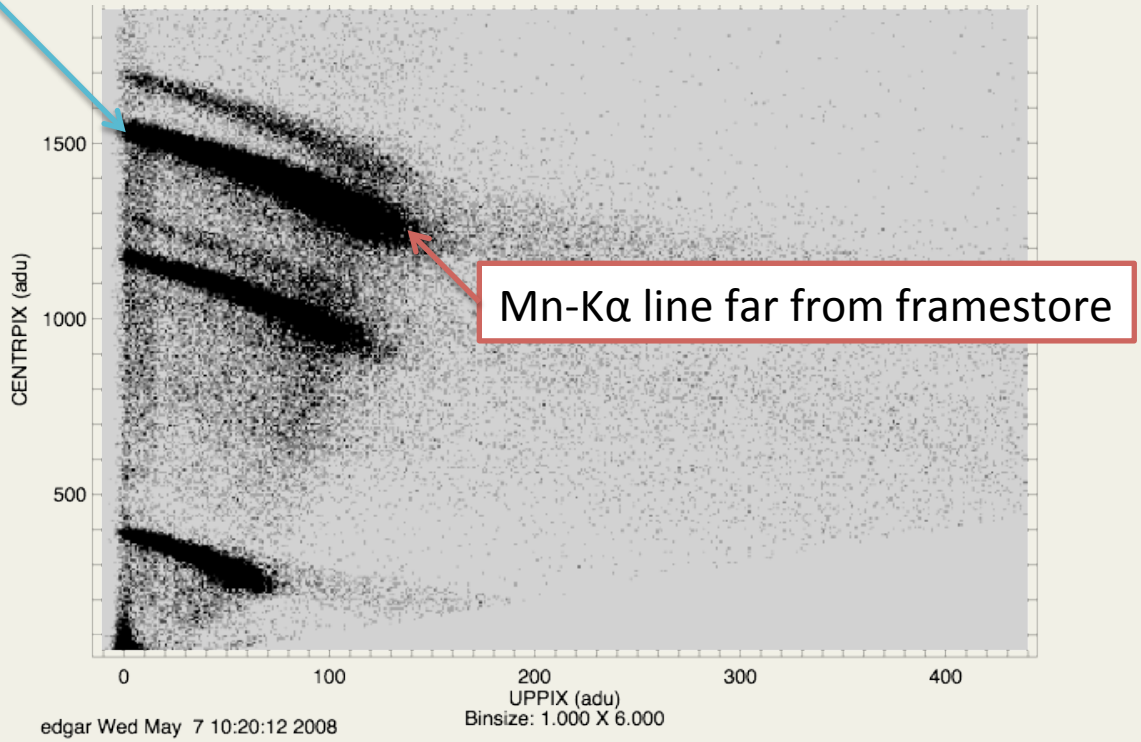
- Same software as TE Mode
  - Different distribution of charge traps, need new trapmaps and trailing fraction
  - Assume same energy dependence
- Primarily concerned with CC + gratings
  - Accurate gain calibration for common setups
  - Precise CCD response calibration not required

# Mapping Charge Loss

- Use pulseheight in the first trailing pixel as a proxy for CCDY

Mn-Kα line near framestore

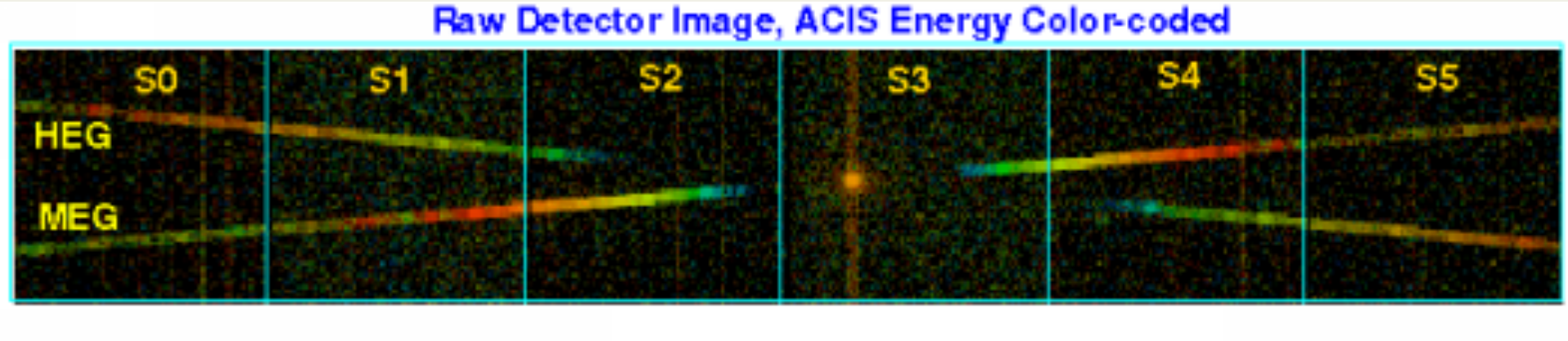
Calibration source observation



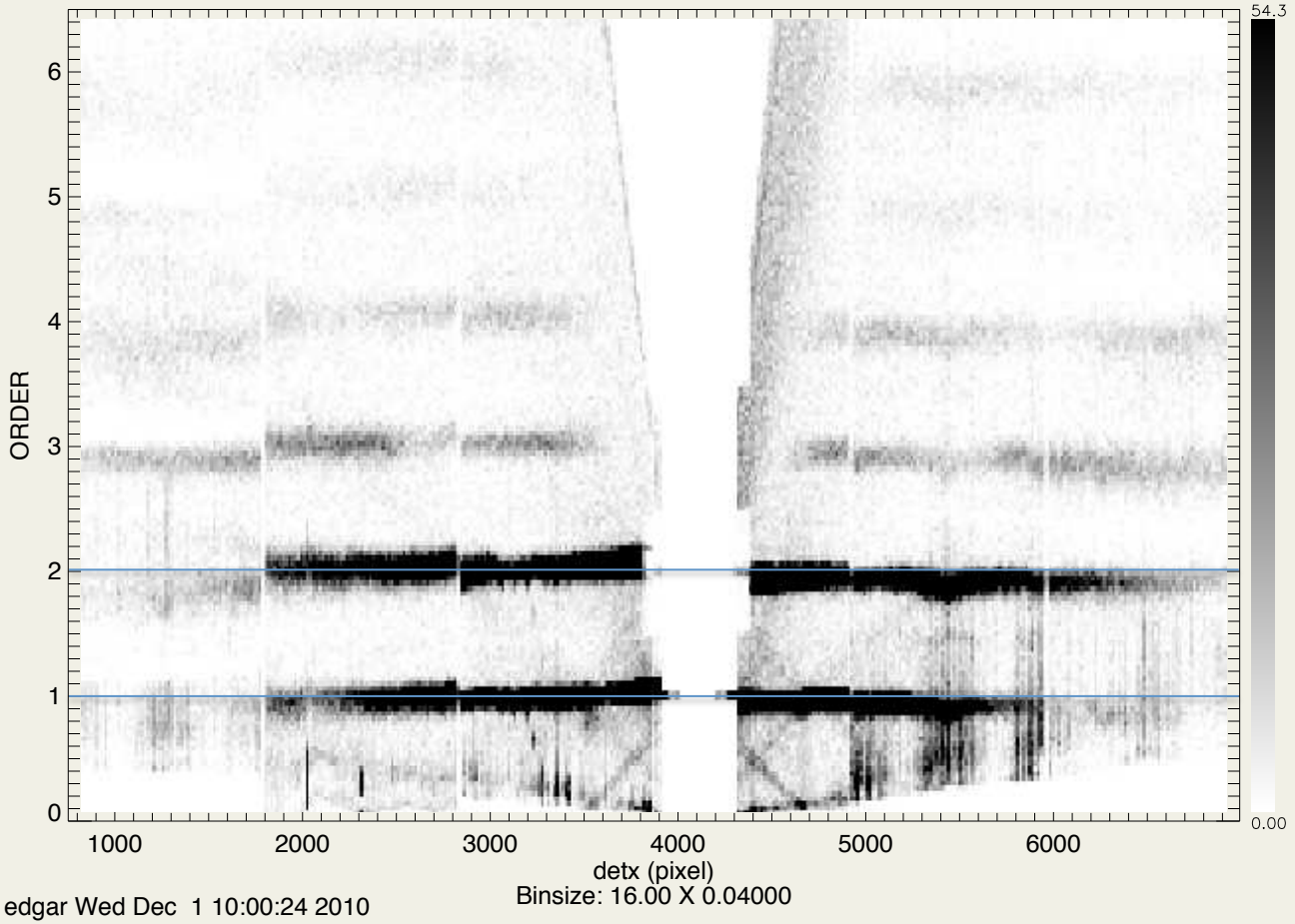

- Fit slope, intercept, endpoint for each column
- Endpoint gives max trap density
- Assuming integrated trap density linear vs chipy, and zero at readout
- Slope gives charge trailing fraction

# Testing with HETG

- Tested using HETG observation of Her X-1
- Use CHIPY coordinates estimated from order sorting



# Her X-1 order sorting plot




2nd order

1st order

# Remaining issues with CC mode QE

- Loss of events due to grade morphing into bad grades is stronger in CC mode than TE mode
- Before Nov 2009, strict onboard grade filter
  - CTI correction cannot recover lost events
- After Nov 2009, more grades telemetered
  - CTI correction recovers many events
- Difficult to measure remaining differences due to pileup and background subtraction issues