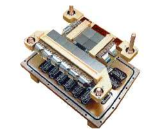
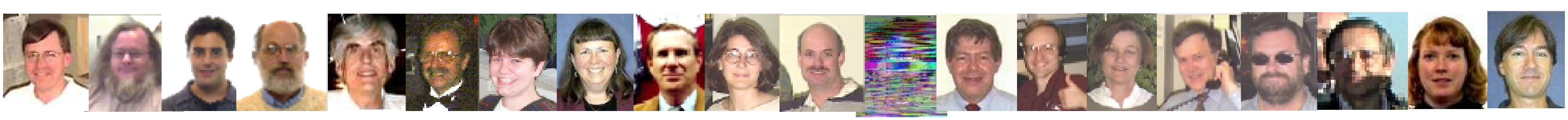
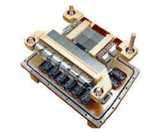


ACIS: Instrument Status and Performance Evolution

Catherine Grant

for the ACIS Instrument Team





Summary

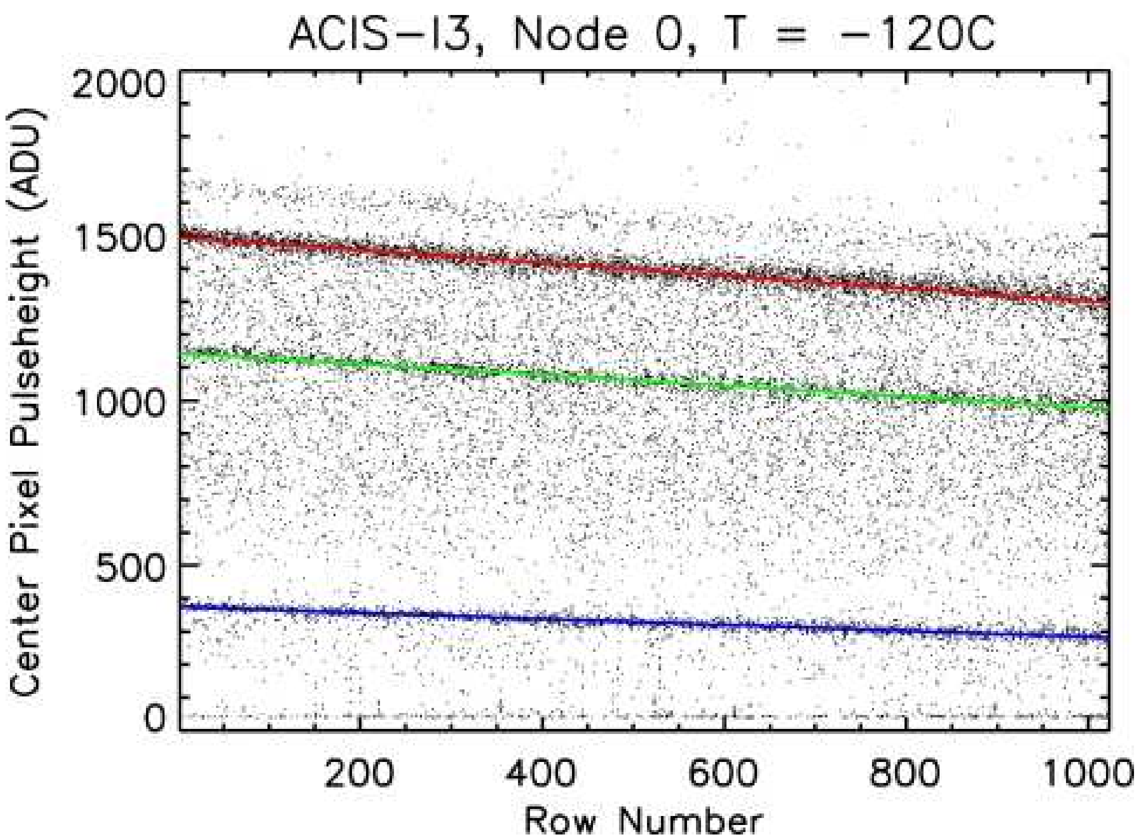
- Slow changes in performance consistent with our expectations of radiation damage and contamination deposition
  - Exception: I0 and I2 anomalous gain
- Focal plane temperature excursions
  - Implications for calibration
- Laboratory testing of cold irradiation and room temperature bakeout

Monitoring Radiation Damage

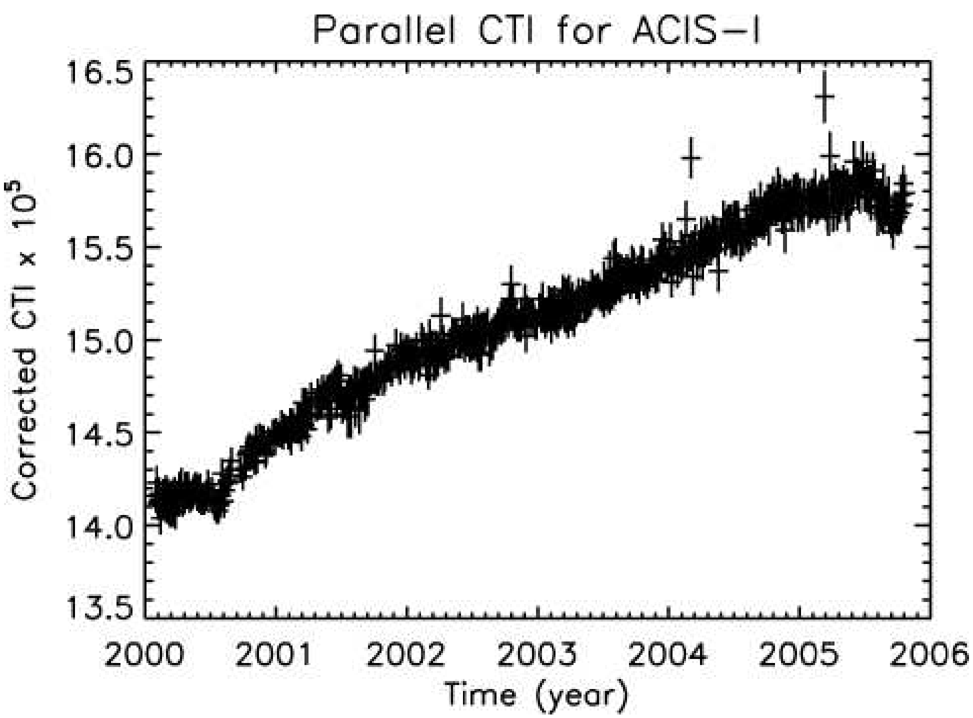
- Radiation damage can
  - Increase density of charge traps
    - Measured by increasing CTI
  - Change distribution of trap properties
    - Measured by changing charge trailing
- Changes to calibrated quantities
  - Lower pulseheights
  - Higher spectral widths
  - Lower detection efficiency

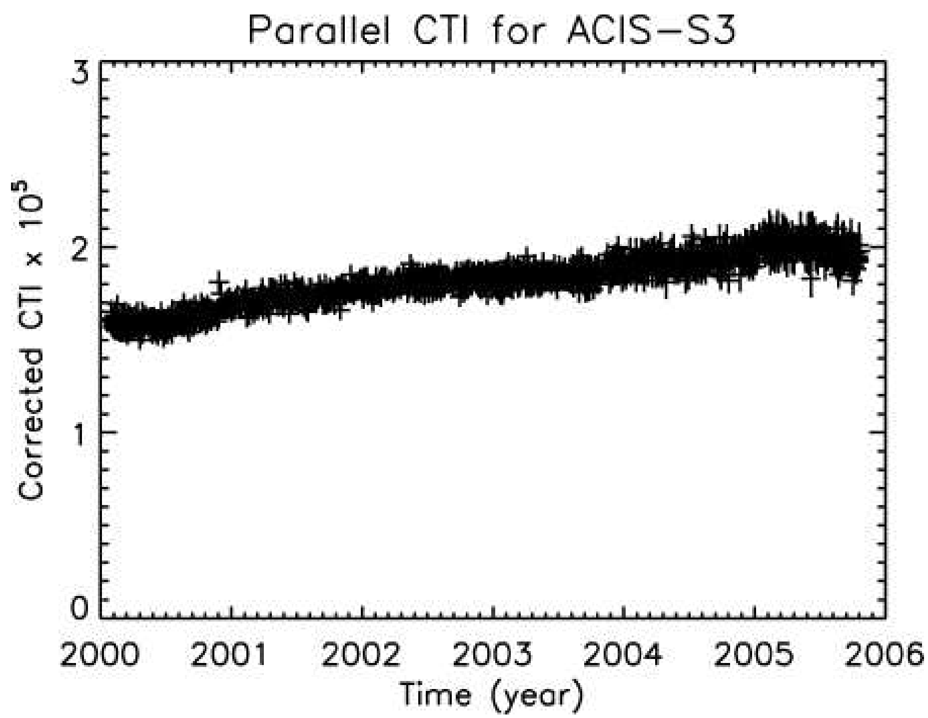
Charge Transfer Inefficiency: A Reminder

- CTI, fractional charge loss per pixel transfer



Change in ACIS CTI





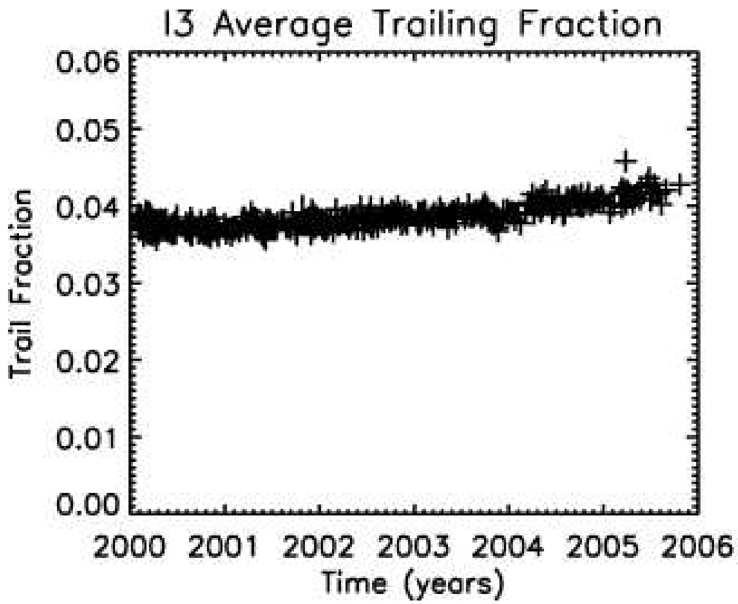
FI parallel increase: $3.15 \pm 0.02 \times 10^{-6}$ / yr

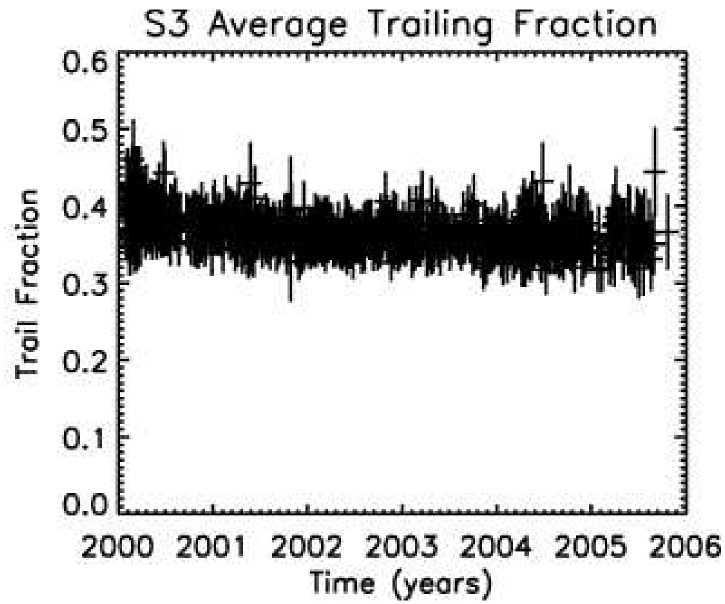
FI serial increase < 3.6×10^{-6} / yr

BI parallel increase: $7.62 \pm 0.09 \times 10^{-7}$ / yr

BI serial increase: $1.13 \pm 0.10 \times 10^{-6}$ / yr

Trailing Charge Monitoring





- Fraction of charge lost to center pixel released into top pixel
- Dependent on distribution of charge trap time constants
- FI slowly increasing ⇒ damaging particles not identical to initial damage

Gain Monitoring

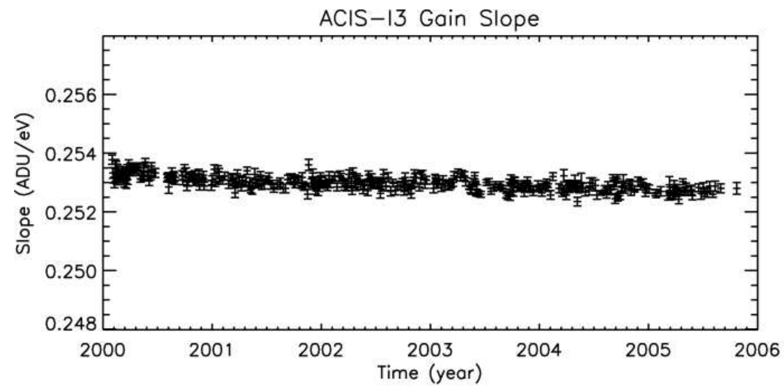
- PHA=Slope*E+Offset
- Bottom 20 rows, no CTI
- Most CCDs slow decay

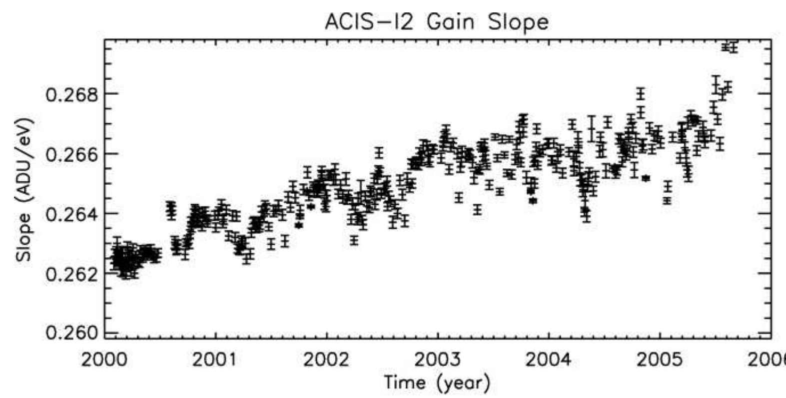
  Δ PHA~0.3-0.5% at 6 keV

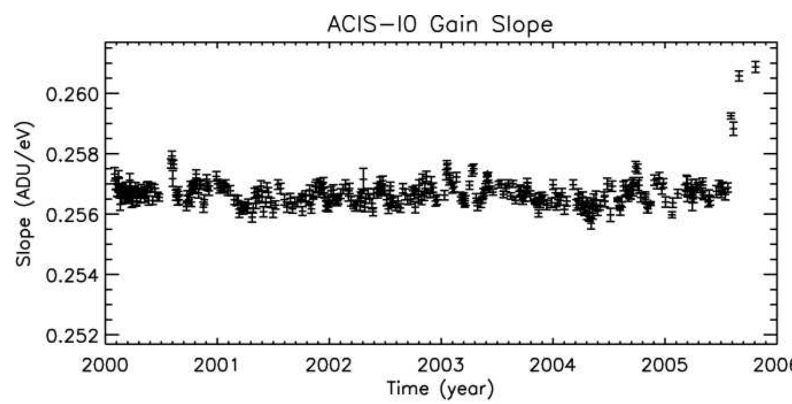
  since Jan 2000
- I2 anomalous increase

  Δ PHA ~2.7% at 6 keV
  since Jan 2000
- I0 anomalous increase

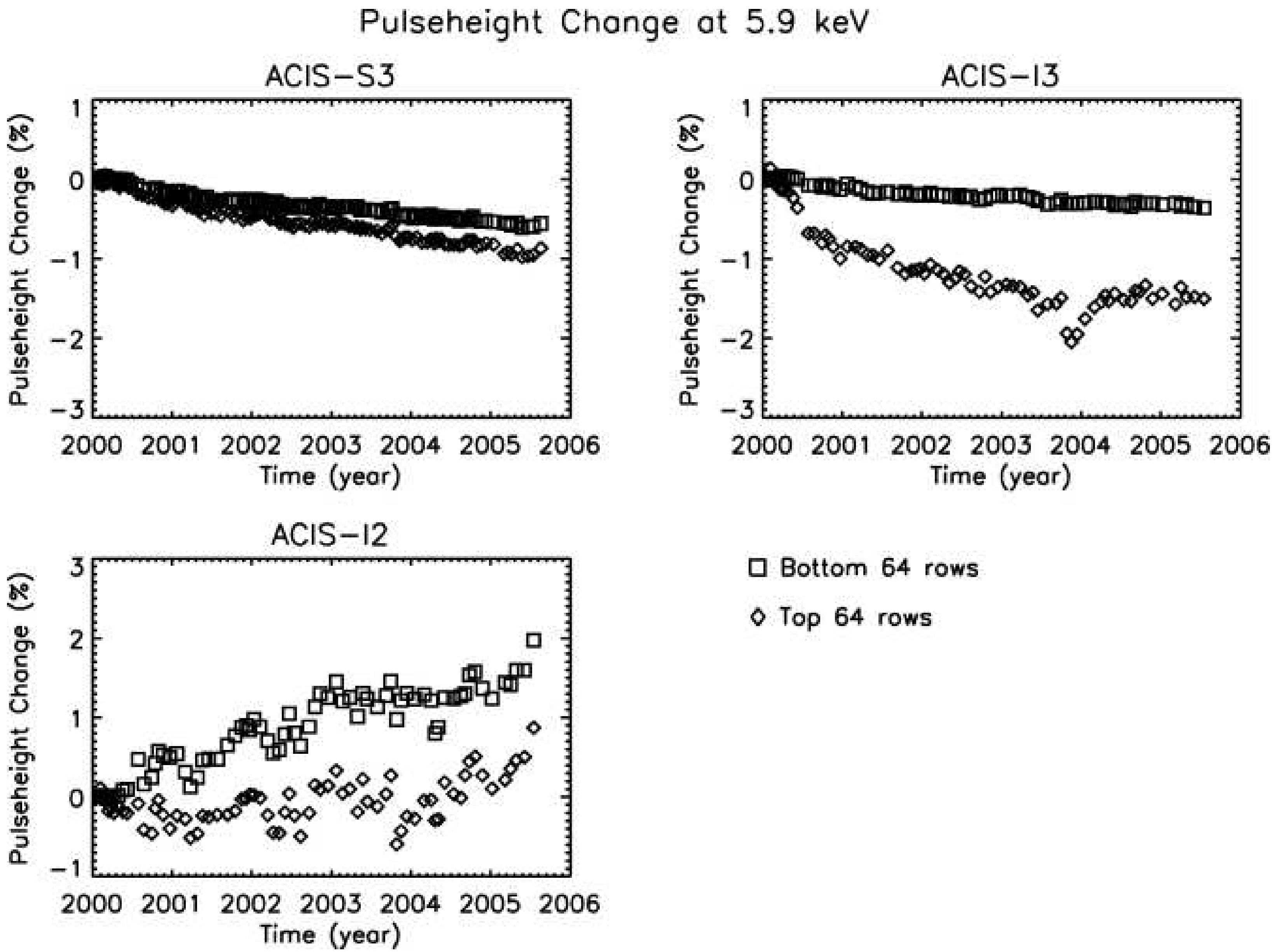
  Δ PHA ~1.5% at 6 keV
  since July 2005





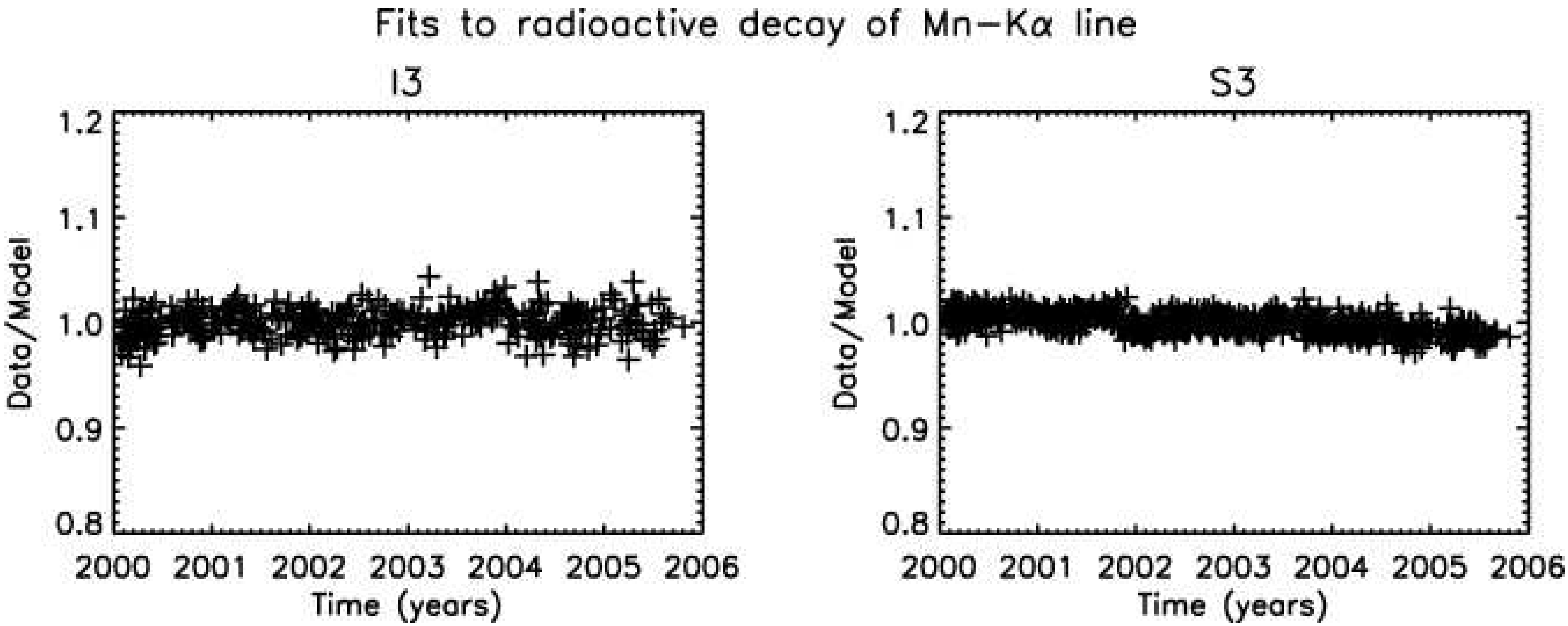


ACIS Instrument Status



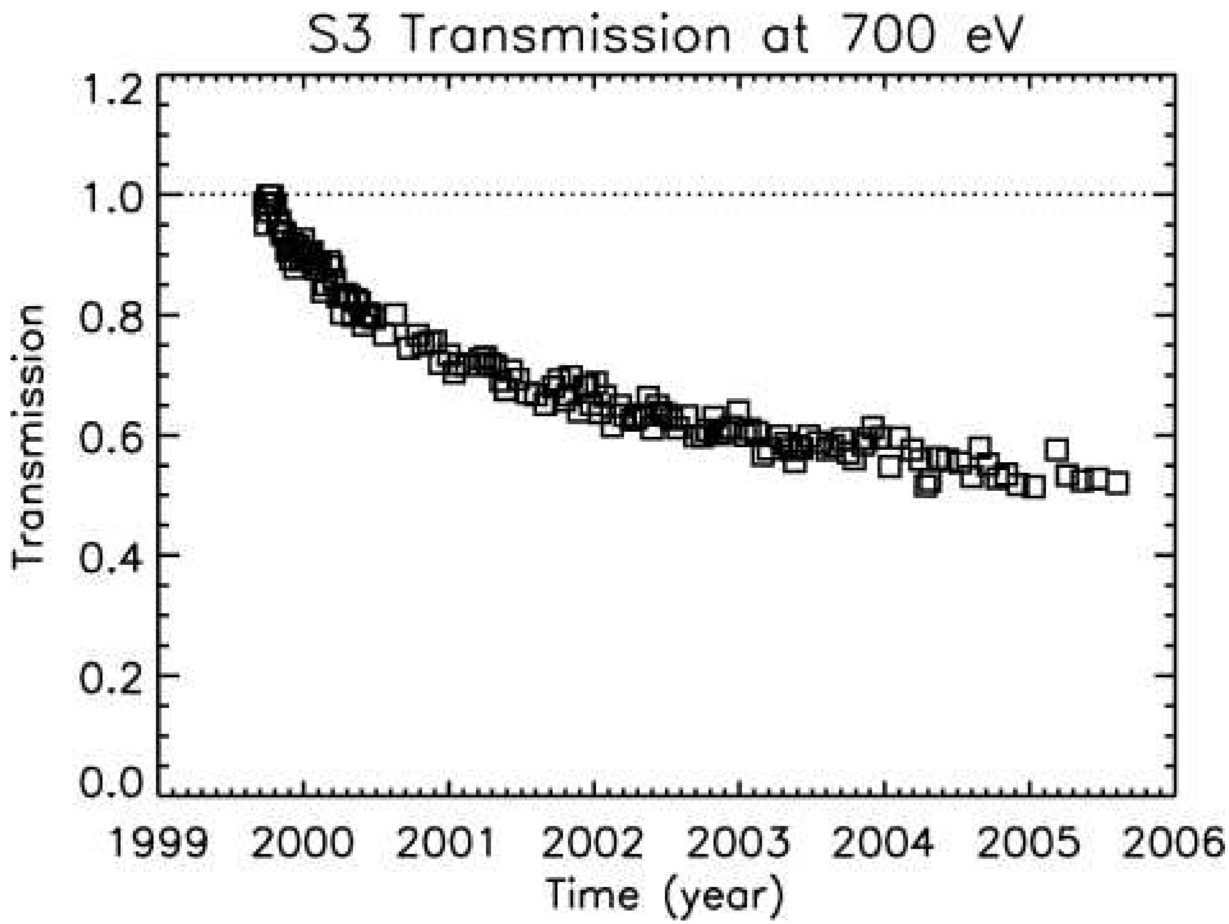
ACIS Instrument Status

No change in Detection Efficiency at 6 keV

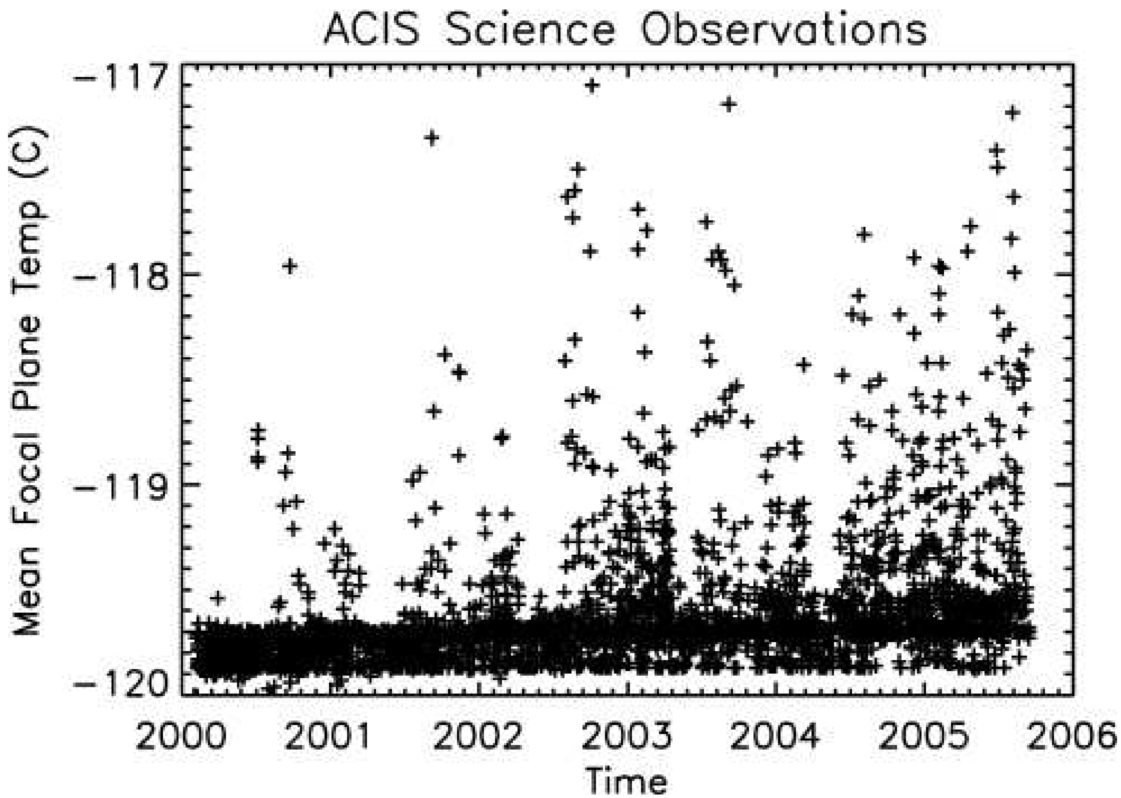


- Half-life of ^{55}Fe calibration source is 2.73 years
- Model fits normalization only, half-life is fixed

Contamination Monitoring

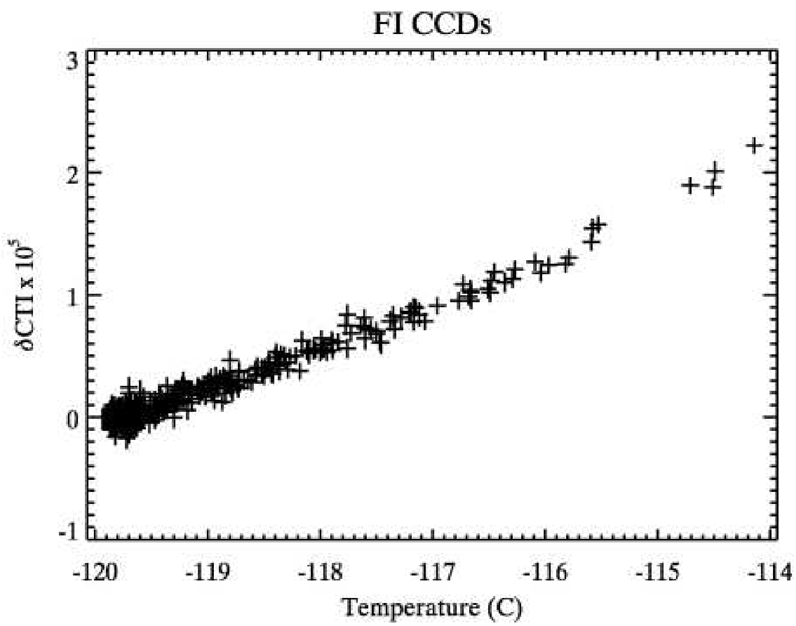


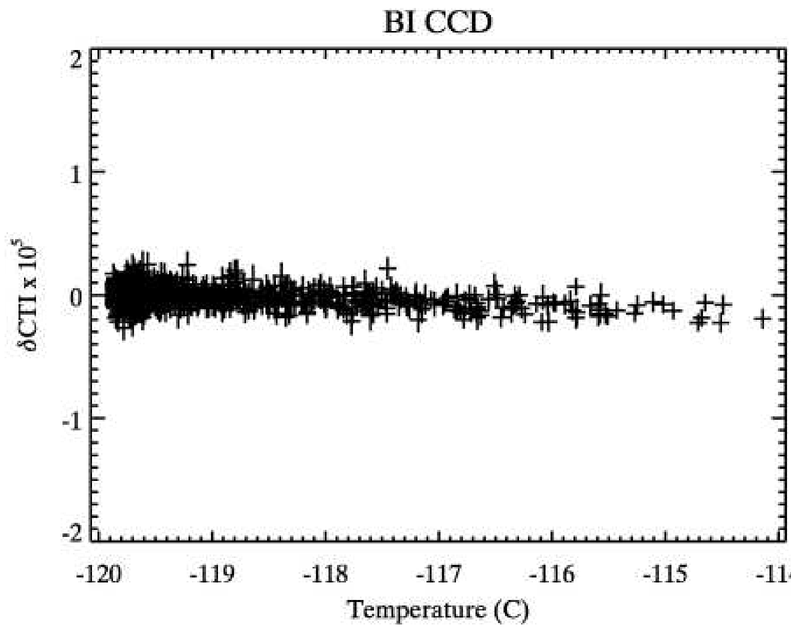
Focal plane temperature excursions



- ACIS cooling is less efficient in some Chandra orientations
  - Other spacecraft constraints not always favorable for ACIS
- Some aging of radiator surfaces, less efficient
- 99% of observations < –119ºC in 2000, 90% in 2005

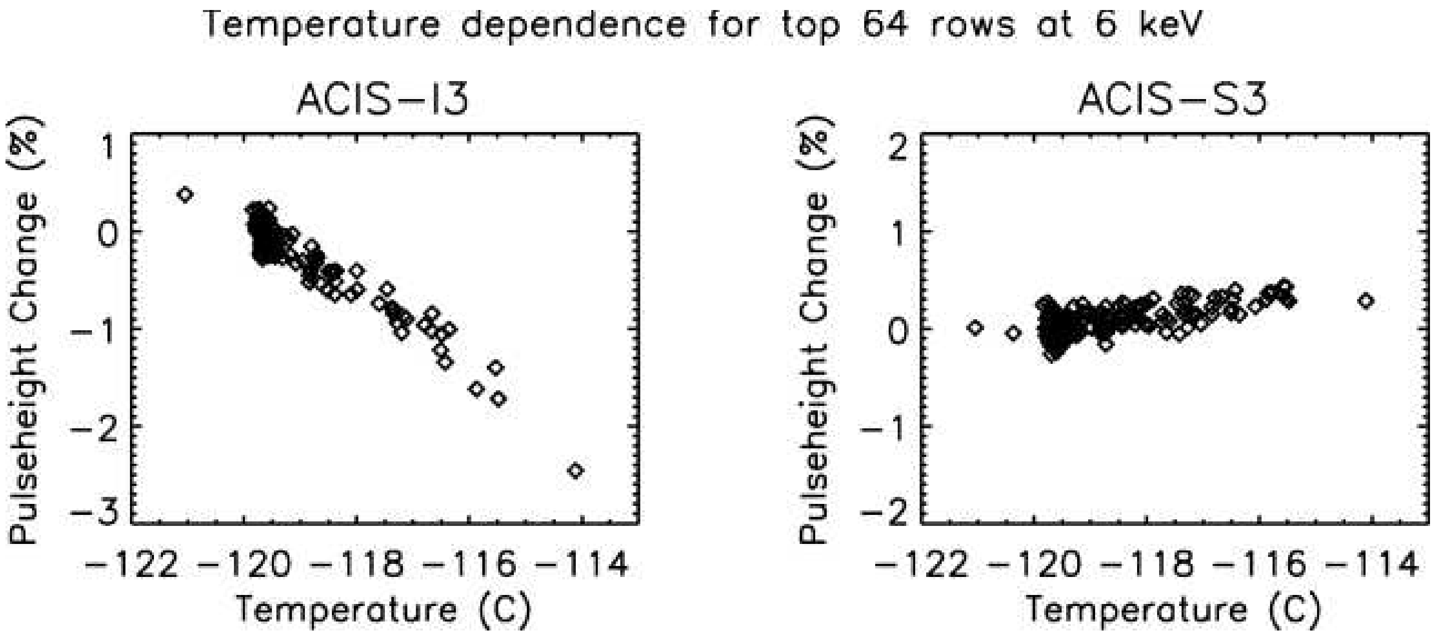
CTI Dependence on Temperature





- 1^{o}C degree increase in temperature yields
  - δCTI ~ +2% (FI), –1% (BI)
- Temperature dependent performance
- More important for FI than BI

Implications for Calibration



Pulseheight change per 1° temperature change

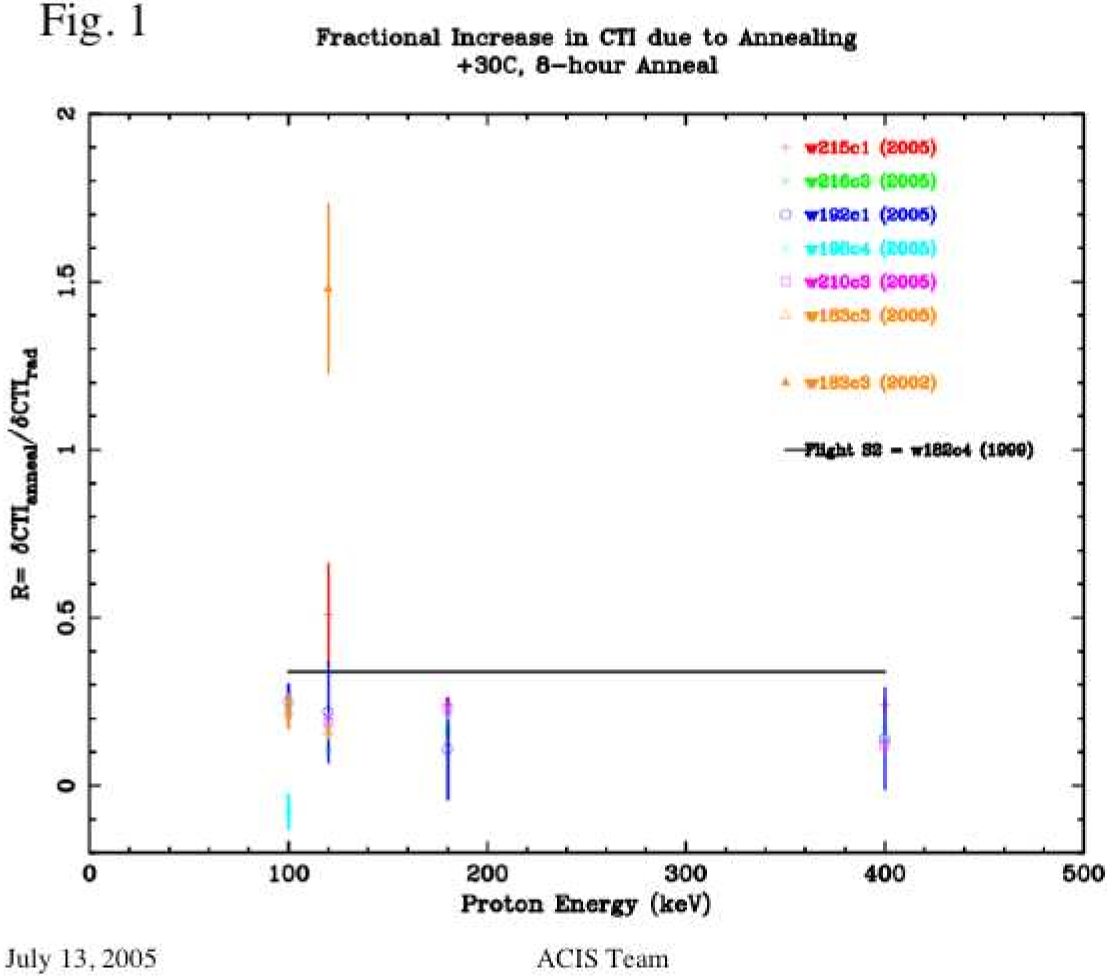
	1.5 keV	6 keV
I3 (FI)	0.7%	0.4%
S3 (BI)	0.2%	0.08%

Implication for Calibration

- Significant gain change within a few degrees for some CCDs/positions
- Line width change is much smaller
- May be able to implement a temperature correction like TGAIN, as a lookup table of pulseheight shifts
- Needs further study
  - At what temperature does width change become important
  - Warmer temperatures are uncontrolled, temperature range in a single observation can reach 3-4ºC

ACIS Ground Radiation Tests

Fig. 1



- Soft proton irradiation (100 - 400 keV) and simulated bakeout of six FI CCDs
- Performance degradation from bakeout independent of proton energy and CCD
- Estimated CTI increase from a proposed flight bakeout ~ 5%
- Increase as large as 30% cannot be ruled out
- Consistent with 1999 flight increase, not with 2002 ground
- Systematics under study

See poster 9.6 by Bev LaMarr at Chandra Science meeting for details

For more information:

- ACIS performance monitoring web pages
  - Updated monthly
  - http://space.mit.edu/~cgrant/monitor.html
- Detailed analysis of ACIS radiation damage
  - Grant et al. 2005, SPIE, 5898, 201
- See poster 9.6 by Bev LaMarr at Chandra Science meeting for more on laboratory irradiation studies