



Evolution of ACIS Performance

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for the ACIS Instrument Team





Summary

- Slow gradual changes in performance due to increasing radiation damage and contamination
- Exceptions:
 - I2 anomalous gain
 - October 2003 solar activity



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

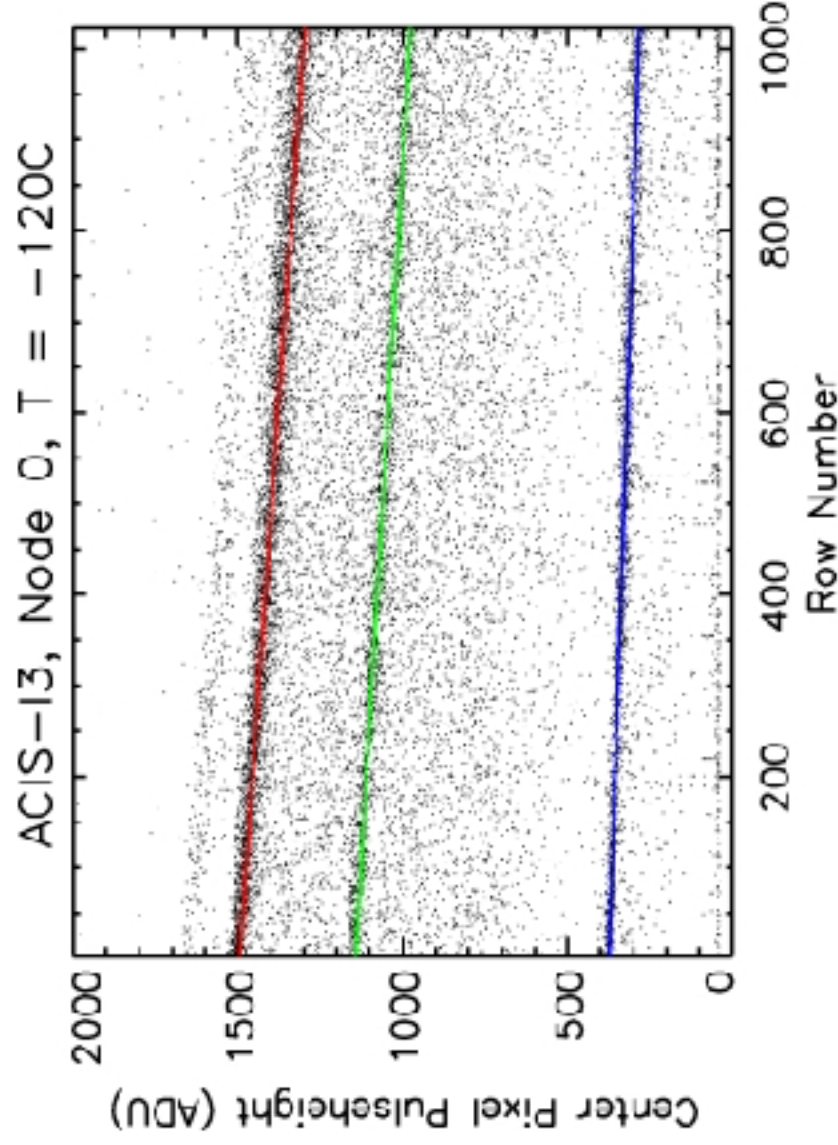


ACIS Performance Evolution



Charge Transfer Inefficiency: A Reminder

- CTI, fractional charge loss per pixel transfer





CTI Monitoring

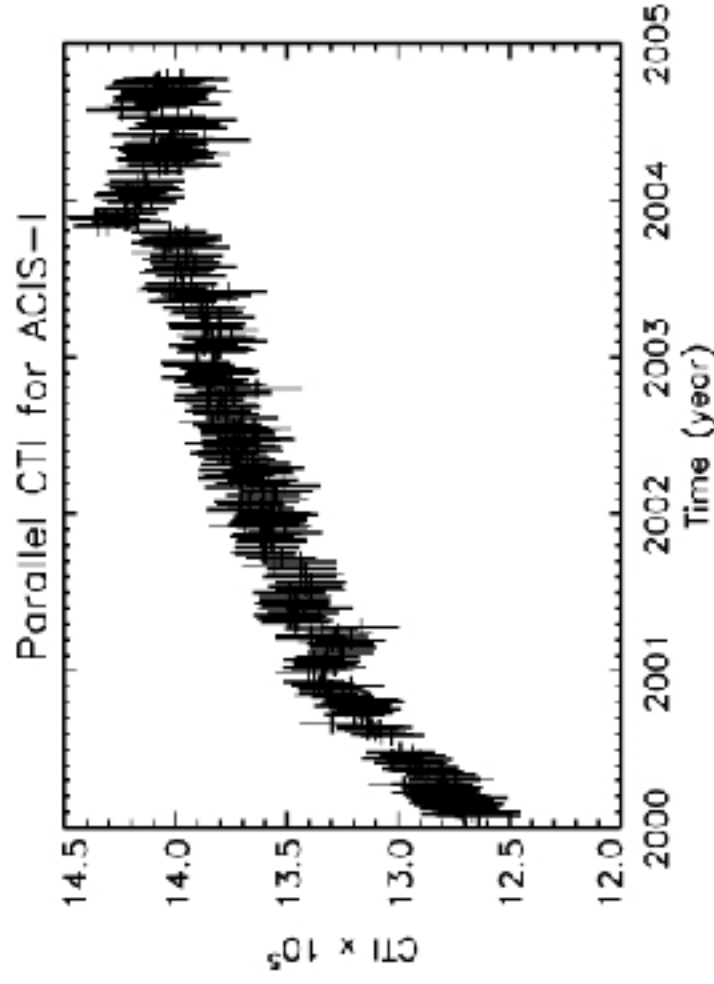
- 5.9 keV CTI at -120C

CTI	Jan 2000	Rate of Change (2000-2004)
FI Parallel	$1-2 \times 10^{-4}$	$3 \times 10^{-6} / \text{yr}$
FI Serial	$< 3 \times 10^{-6}$	$< 5 \times 10^{-7} / \text{yr}$
S3 Parallel	1×10^{-5}	$1 \times 10^{-6} / \text{yr}$
S3 Serial	7×10^{-5}	$< 3 \times 10^{-7} / \text{yr}$



Change in ACIS-I CTI

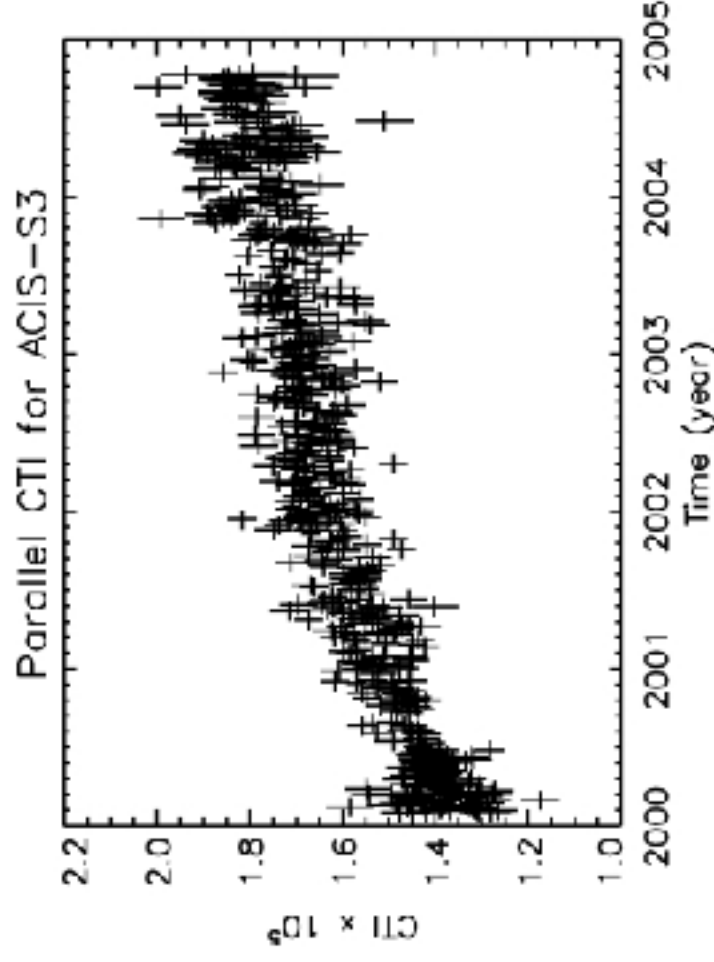
- FI parallel increase: $3.00 \pm 0.06 \times 10^{-6} / \text{yr}$
- FI serial CTI increase $< 5 \times 10^{-7} / \text{yr}$





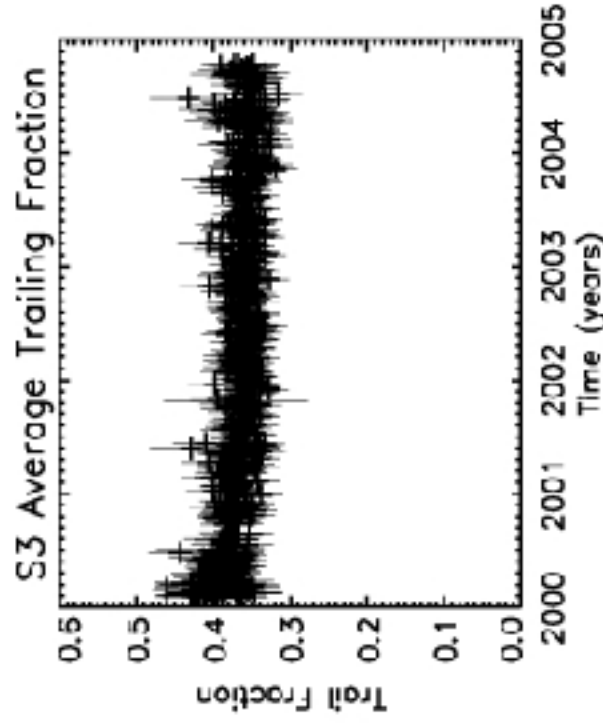
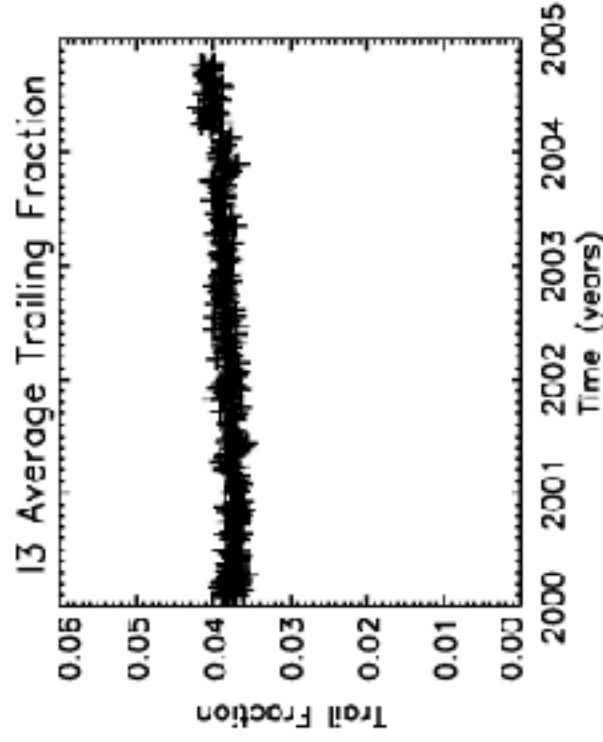
Change in ACIS-S3 CTI

- S3 parallel increase: $0.96 \pm 0.01 \times 10^{-6} / \text{yr}$
- BI serial increase: $< 3 \times 10^{-7} / \text{yr}$





Trailing Charge Monitoring



- Fraction of charge lost to center pixel trailed into top pixel
- Dependent on distribution of charge trap time constants
- Changes are very small

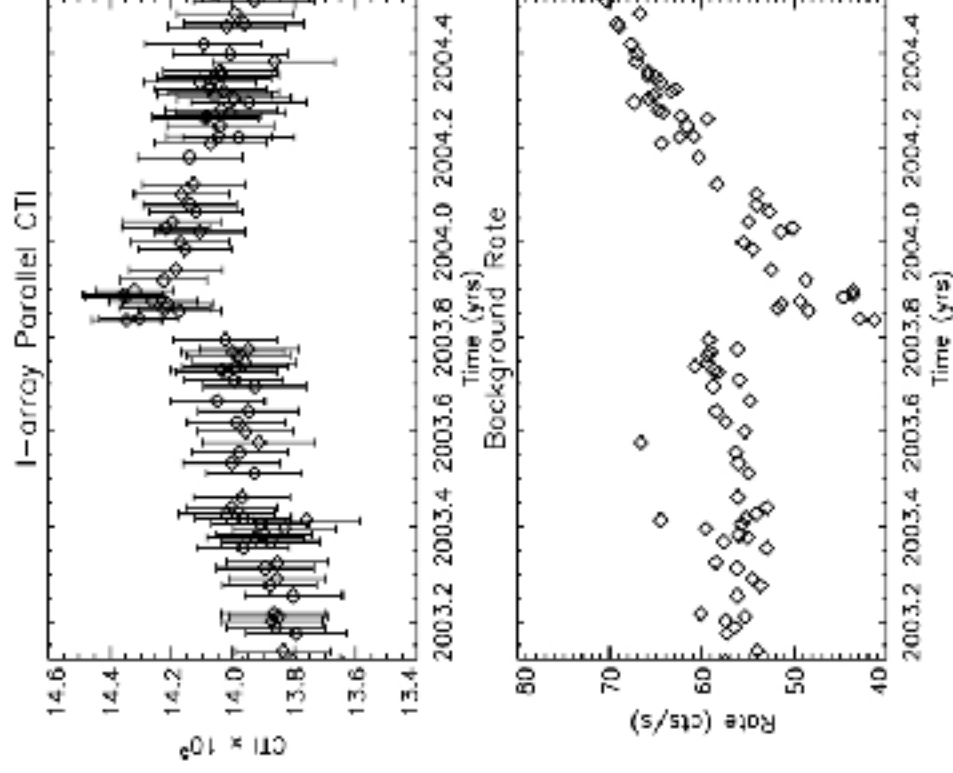


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Oct - Nov 2003 Solar Storm

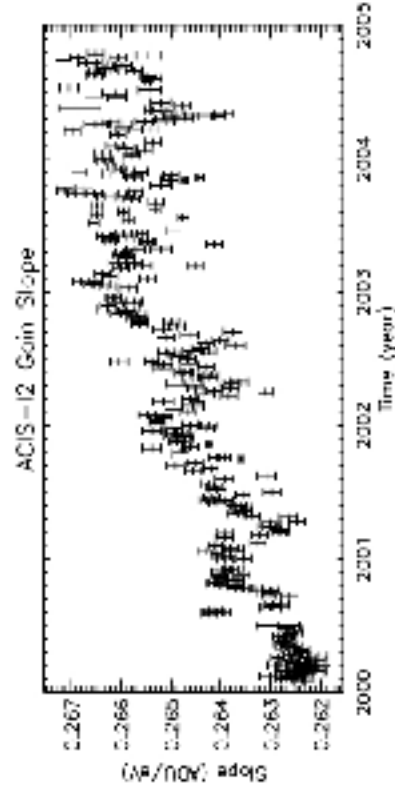
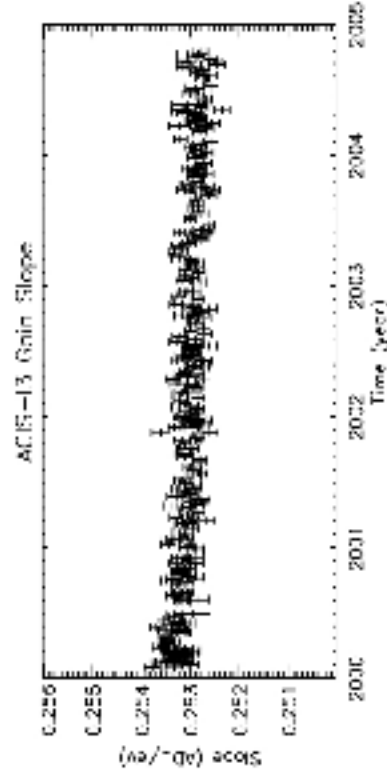
- Multiple coronal mass ejections
- Most powerful X-ray flare ever recorded!
- Hard particles (\geq MeV)
- 0.7 Ms science time lost
- Parallel CTI jump
 - FI CCD: 3×10^{-6}
 - BI CCD: 9×10^{-7}
- XMM reports no change
- Recovery indicates little real radiation damage
- Anomalous background?





Gain Monitoring

- $\text{PHA} = \text{Slope} * \text{E} + \text{Offset}$
- Bottom 20 rows, no CTI
- Most CCDs slow decay
- $\Delta \text{PHA} \sim 0.3\text{-}0.5\%$ at 6 keV since Jan 2000
- I2 anomalous increase
- $\Delta \text{PHA} \sim 1.5\%$ at 6 keV

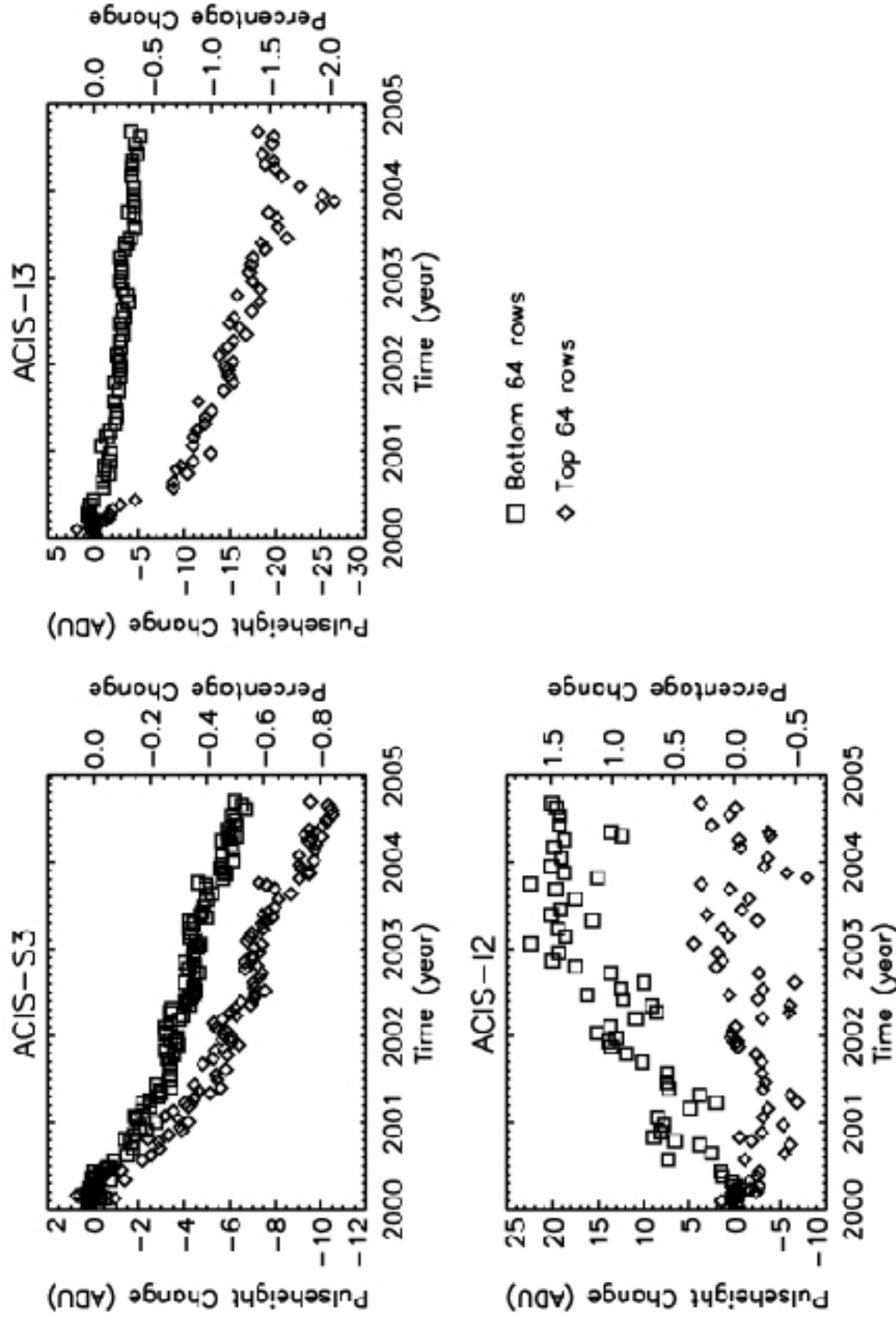




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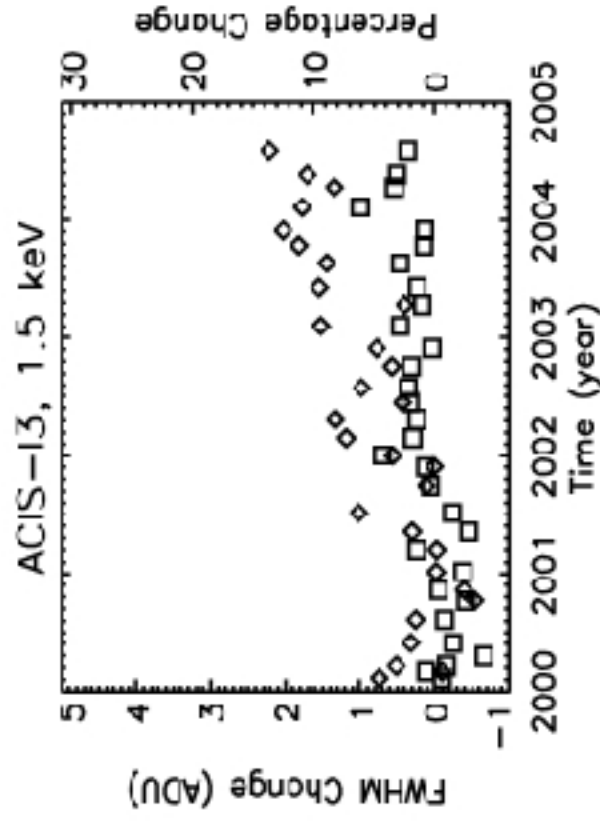
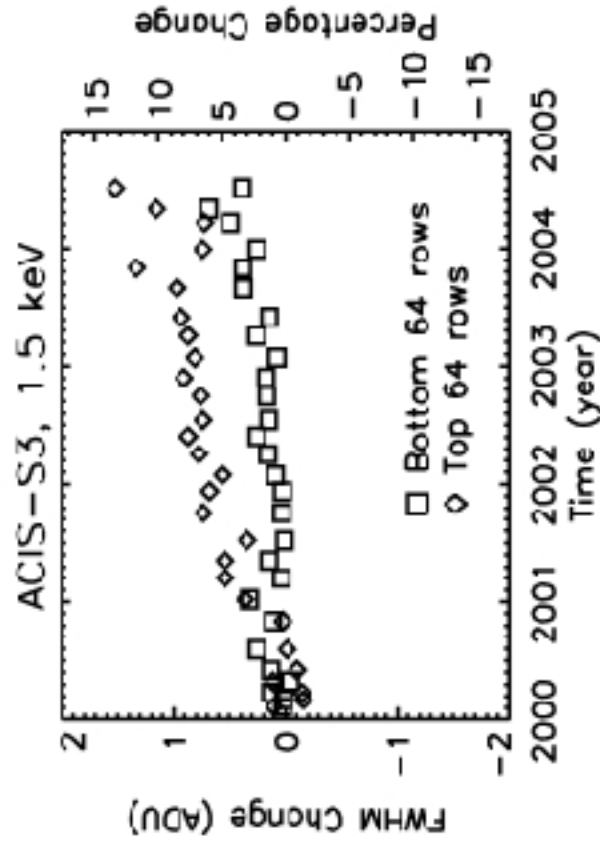
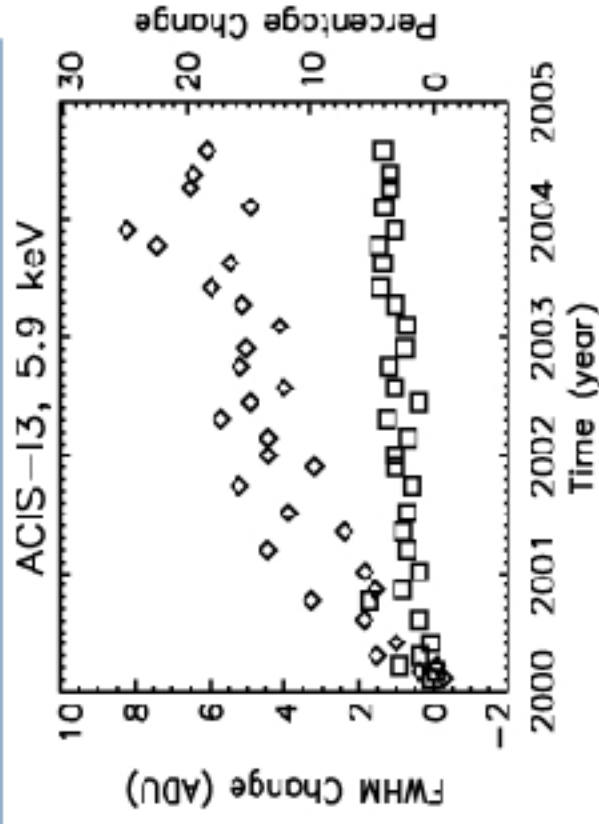
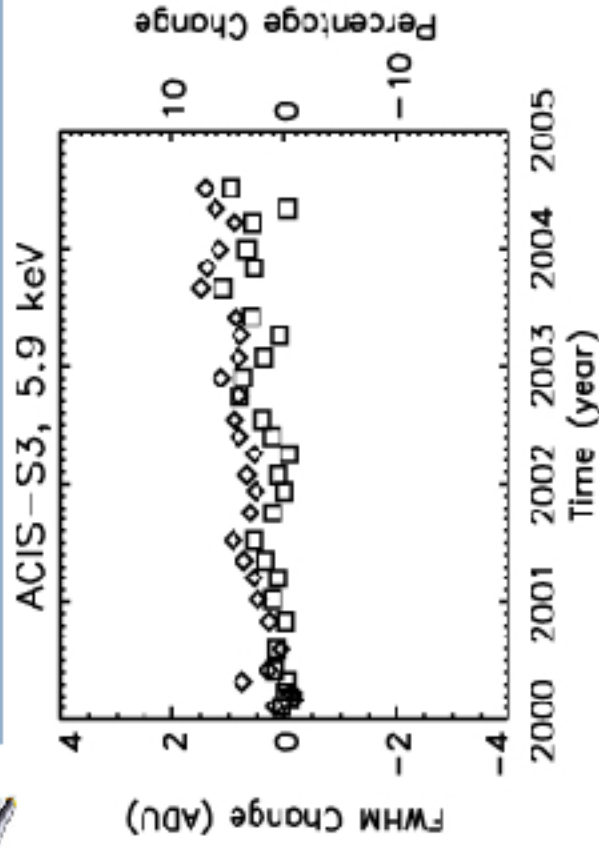


Pulseheight Change at 5.9 keV





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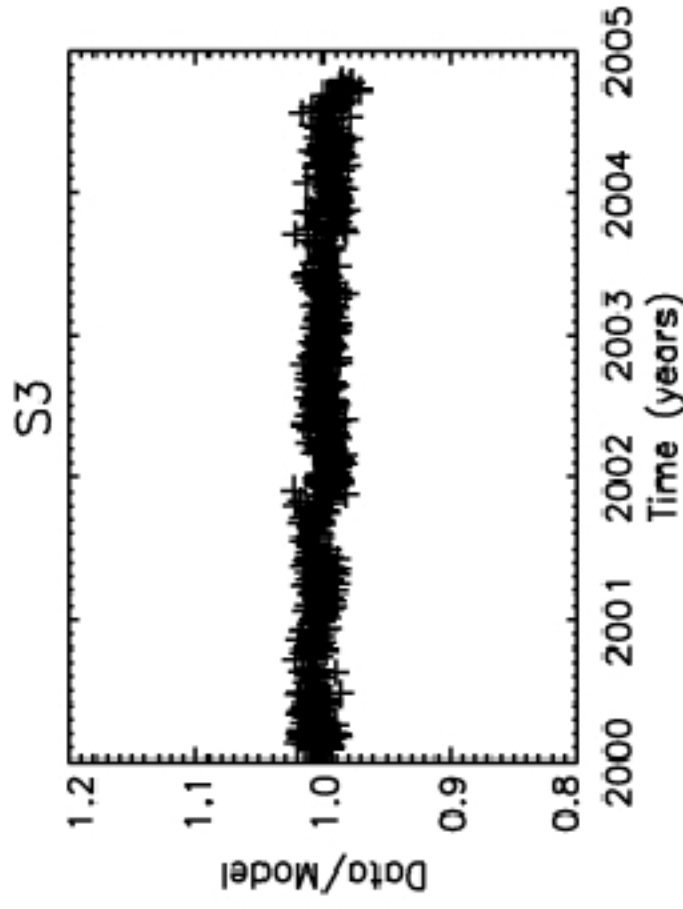
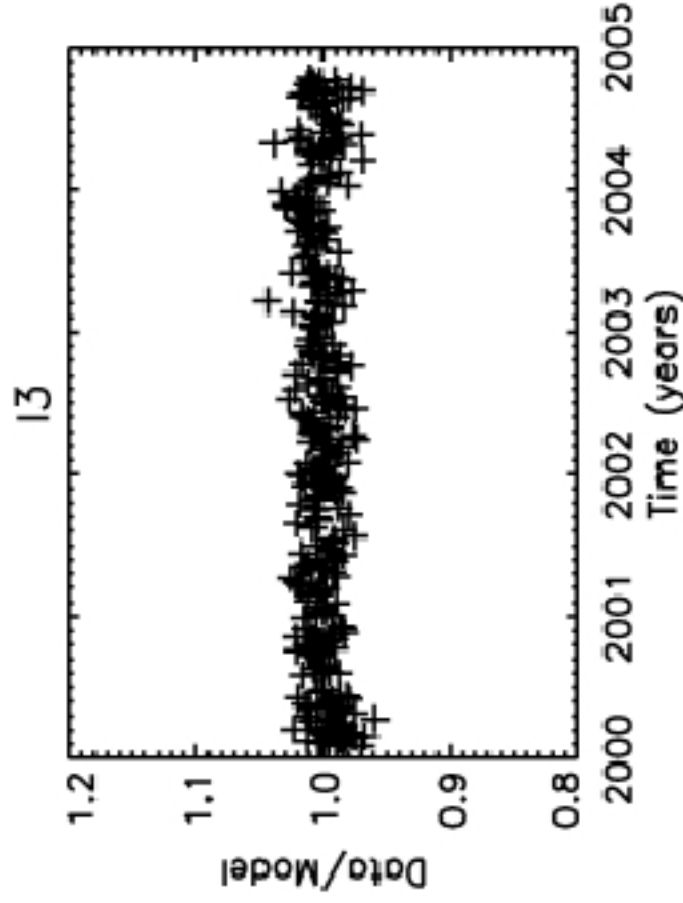


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No change in Detection Efficiency at 6 keV

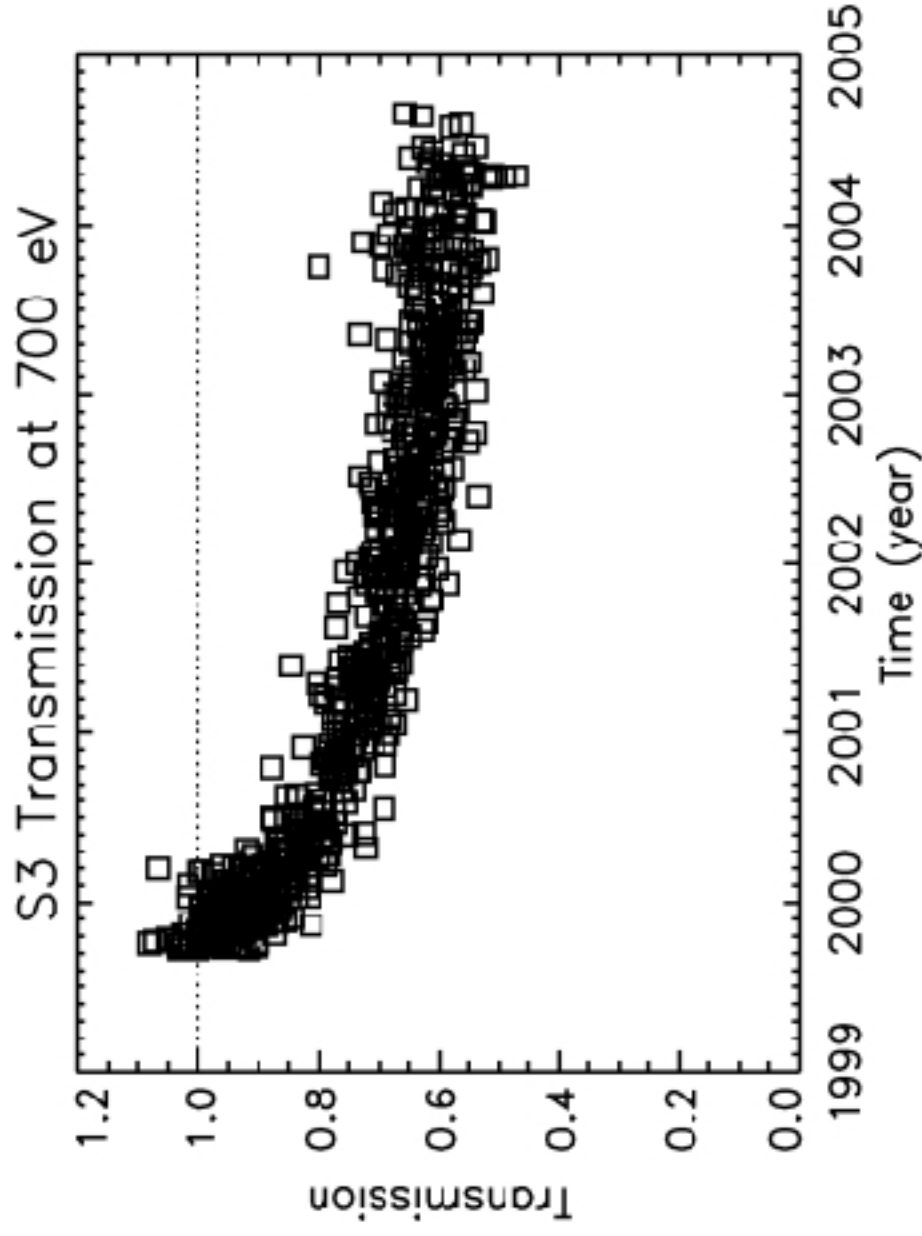
Fits to radioactive decay of Mn-K α line



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



Contamination Monitoring





For more information:

- ACIS performance monitoring web pages
 - Updated monthly
 - <http://space.mit.edu/~cgrant/monitor.html>



Go Sox!

