ACIS after ten years: Detector performance then, now, and into the next decade

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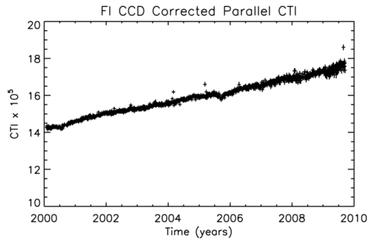
Introduction

ACIS continues to perform well more than a decade after launch. Over the lifetime of Chandra, ACIS detector characteristics have evolved due to increasing radiation damage, molecular contamination and aging in general. Here we present highlights from the instrument team's monitoring program.

Most of the results shown here are from observations of the ACIS External Calibration Source (ECS). Since the discovery of the initial radiation damage, a continuing series of observations have been undertaken just before and after the instruments are safed for perigee passages to monitor the performance of the ACIS CCDs. ACIS is placed in the HRC-S position exposing the CCDs to the ECS which produces many spectral lines the strongest of which is Mn-Kα (5.9 keV).

CTI

- After removing dependence on sacrificial charge and temperature, slow gradual increase from radiation damage
  - dCTI/dt ~ 3×10^{-6} / yr (FI CCDs)
  - dCTI/dt ~ 1×10^{-6} / yr (BI CCDs)



Summary

•Slow changes in performance consistent with our expectations for increasing radiation damage and contamination deposition

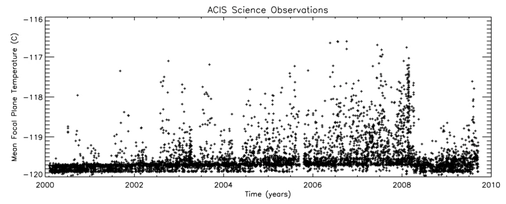
•Quiescent particle background at highest level seen yet – should decrease once solar cycle starts up again

•Focal plane temperature excursions are increasingly a problem for calibration

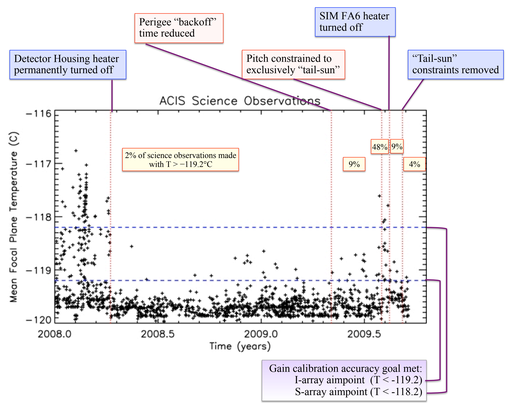
•ACIS should continue to perform well into Chandra's next decade!

Focal Plane Temperature

- ACIS calibration (gain and response) are dependent on temperature
- Focal plane temperature excursions are becoming more frequent as the spacecraft ages
- Some pitch angles particularly bad for ACIS cooling ("tail-sun")
- Cooling less efficient when Earth illuminates the ACIS radiator

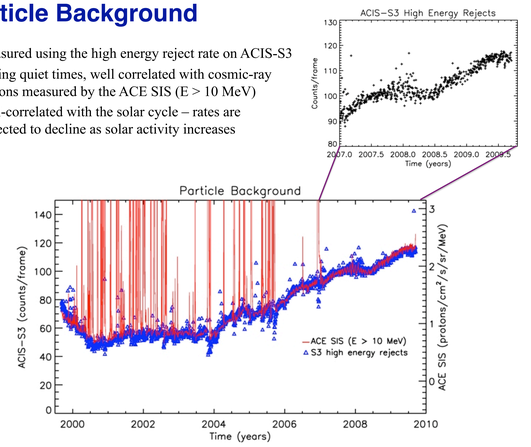


- Possible mitigation strategies include:
  - Turn off detector housing heater (implemented April 2008)
  - Turn off SIM FA6 heater (being tested now)
  - Develop software to partially correct for temperature dependent calibration (See Posson-Brown poster C.19)
  - Add constraints on allowed pitch angles (no immediate plans)
    - Possible conflicts with other constraints, increases complexity of observation scheduling
  - Increase nominal focal plane temperature (no immediate plans)
    - Degrades FI CCD performance, requires lengthy recalibration effort



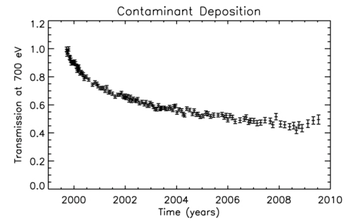
Particle Background

- Measured using the high energy reject rate on ACIS-S3
- During quiet times, well correlated with cosmic-ray protons measured by the ACE SIS (E > 10 MeV)
- Anti-correlated with the solar cycle – rates are expected to decline as solar activity increases



Detection Efficiency

- No change in detection efficiency at 6 keV
- Mn-Kα line count rate well fit by radioactive decay of ^{55}Fe
- Continued slow increase in contaminant layer
- Becoming more difficult to measure due to decrease in source flux and increase in background



Acknowledgments

This research was supported by NASA contracts NAS-8-38252 and NAS-8-37716.