Paper Outline

Goal

We discuss the evolution of CTI and its impact on spectral resolution for X-ray CCDs in different orbital environments. We specifically prepare models of the energy scale and resolution as a function of the background, CCD type (FI vs. BI), and application of charge injection, considering energies spanning the CCD range.

Outline

- about the instruments
  - first describe each separately (label CCDIDs)
  - then similarities/differences between ACIS/XIS that impact CTI (just the instruments and operation, no environment yet) in a **table** and summarize in text
    - initial pre-launch CTI, ACIS BI > XIS BI, XIS FI > ACIS FI
    - Transfer speeds, fast transfer (image-to-framestore) serial transfer not the same
    - Frame time, 3.2s vs 8s
    - Focal plane temperature, -90C vs -120C
    - (insert additions to this list here)

- about the orbits and backgrounds
  - steal from Bev's 2008 SPIE paper
  - steal from O'Dell, Markevitch papers on radiation environments

- about the calibration sources
  - ACIS – Fe55 with Al&Ti (Fe-L), uniform illumination, getting pretty wimpy, only sampled twice per orbit
  - XIS – Fe55 with no targets, no Fe-L, only in corners, getting wimpy, continuously sampled (except SAA)
  - measure Fe55 half-life extremely well

- Measuring CTI, ACIS vs XIS (methodology)
  - ACIS – fit all grades, only center pixel pulseheight vs ccdy/ccdx (binning/fitting details needed)
  - XIS – fit only good grades, summed pulseheight from top cal source corners
  - process ACIS the same way as XIS for comparison? only use center pixels? CTI metric to be decided
  - only use Mn K alpha
  - include checker-flag CTI measurement for XIS, SCI-off (Ozawa 2009)

- CTI evolution, plots of measured CTI vs time
  - for ACIS, apply corrections for temperature and sacrificial charge
  - not done for XIS; temperature is stable, background is integrated over 1 day = 16 orbits
  - decide on time binning
    - not necessary to be the same for ACIS/XIS, and might be misleading given very different cal source duty cycles

- compare differences in rate of CTI increase (and shape?)
  - (no parallel vs serial)
  - FI vs BI
  - low vs high orbit
  - with and without CI (for XIS, when possible)
  - (insert additions to this list here)

- charge trailing vs time
  - trailing fraction shows how initial ACIS from low energy protons is different from ongoing, higher energy particle damage
  - metric is average lost charge of all events divided by average trailed charge of all events

- FWHM evolution, plots of measured FWHM vs time
  - ACIS and XIS can pretty much measure this one the same way
  - (G02346, summed pulseheights, fit Gaussians, etc.)
  - discussion related to all the above stuff
  - somewhat more complicated to link to physical causes w/ charge trailing, multi-pixel events

- relate CTI and FWHM increases
  - depend on BI/FI; are ACIS/XIS different?

- relate CTI/FWHM increase to measures of particle fluence, particle type
  - maybe beyond scope of this paper

- comparison of a celestial source 
  - E0102
    - has been observed extensively over time with ACIS and XIS
    - low energy lines very different from Mn K alpha
    - mostly on ACIS-S3
  - Perseus, other clusters
    - check ACIS time coverage, XIS and ACIS roll angles
    - Fe line centroid changes with kT, location in cluster