# Future ACIS Calibration Work

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A peer research group with contributing members from PSU/MIT IPI teams, MIT CCD research, MSFC/PS, MIT/SAO CXC CAL, SDS, DOSS, and DS.

Including, but not limited to:

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And additional support and interest by many others.

# Future ACIS Calibration Work

## HISTORY

- Trying to Understand the Post-CTI-degradation ACIS.
  - Detective Quantum Efficiency
  - FI/BI QE differences
  - Spatial dependence of CTI
- Needed to Fit a Response Function
- Began with BI function (for S3)
  - Used MIT IPI team ACIS simulator
  - Resulted in release of improved S3 FEF, and derived response matrices
- Parallel Development of a CTI correction process by PSU/MIT IPI teams
  - Version implemented by CXC DS
  - Used new concepts of separating intrinsic and CTI-corrupted response to produce PHA FEF.

# Future ACIS Calibration Work

## CALIBRATION PROJECTS

Immediate priority. Products are needed, and we learn about ACIS

- Time dependent CTI and gain correction
- Quantum efficiency
- Cosmic Ray dead time
- S1 gain and rmf (for gratings OSIP)

Lower priority. Less use of products, and/or lack of infrastructure or on-board Cal source, or need a more detailed ACIS model

- Counting rate dependent products
- RMF refinement for BI chips, esp. for E$\leq$300 eV. (include serial CTI issues. )
- Higher temperature work (-110°)
- CC mode
- CTI corrector for other FI chips? BI chips?

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## TIME DEPENDENT CALIBRATION

- CTI changes with time, therefore the gain (Fig 1.) and resolution change with time, and the full rmf (and maybe arf) must be time dependent.
- Dependence is different in detail for each chip, and the physics effects on BI and FI are distinct.
- Current products for S3, and cti-corrected FEF, are based on Spring 2000 on-board cal source data, at -120°.
- We are in process of compiling on board cal source data summed over 3 month time spans, at 6 month intervals for the mission. We will proceed forward in time, fitting that data with the current RMF. We will assess goodness of fit and change of gain, to determine the time intervals requiring recalibration.
- We will maintain gain within 0.5%.
- Based on goodness of fit, we are prepared to modify the "contamination" matrix.
- Modification of the "unperturbed" response, *if and when needed*, awaits infrastructure developments.

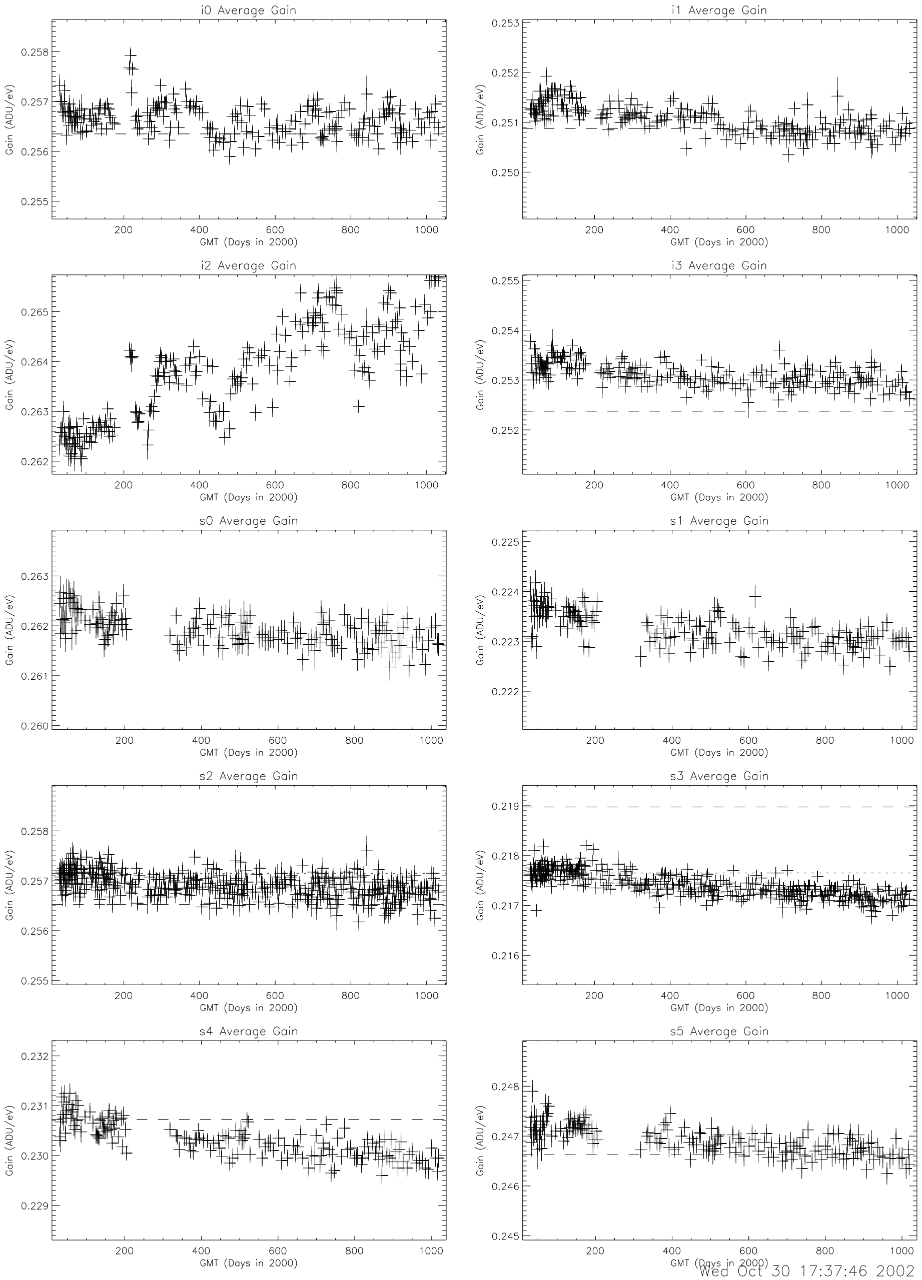


Figure 1: Gain change for each chip throughout the mission. (From http://space.mit.edu/%7ecgrant/gain/plotgain.ps)

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## QUANTUM EFFICIENCY

- Low Energy *Change* of QE is an on-going priority.
- Reconcile BI/FI from XRCF data, i.e., no cti-degradation.
- Propagate to on-orbit QE, with actual cti.
- Compare simultaneous XMM
- Hypothesize and adjust model features.
- Measure dead time from “Cuckoo” data, successive full frame read-outs of 16 adjacent columns. Directly count pixels.

## COUNTING RATE DEPENDENCE: SACRIFICIAL CHARGE

- CTI depends on the extent to which "downstream" traps are already filled with charge, when the X-ray event of interest is transfered (see Figs. 2 and 3, from Bev LaMarr).
- Both the gain and response depend on CTI.
- Therefore, calibration depends on
  - Mode, via the frame integration time
  - Calendar time, via the changing primary cosmic ray flux with solar cycle
  - Celestial X-ray flux concentration in field.

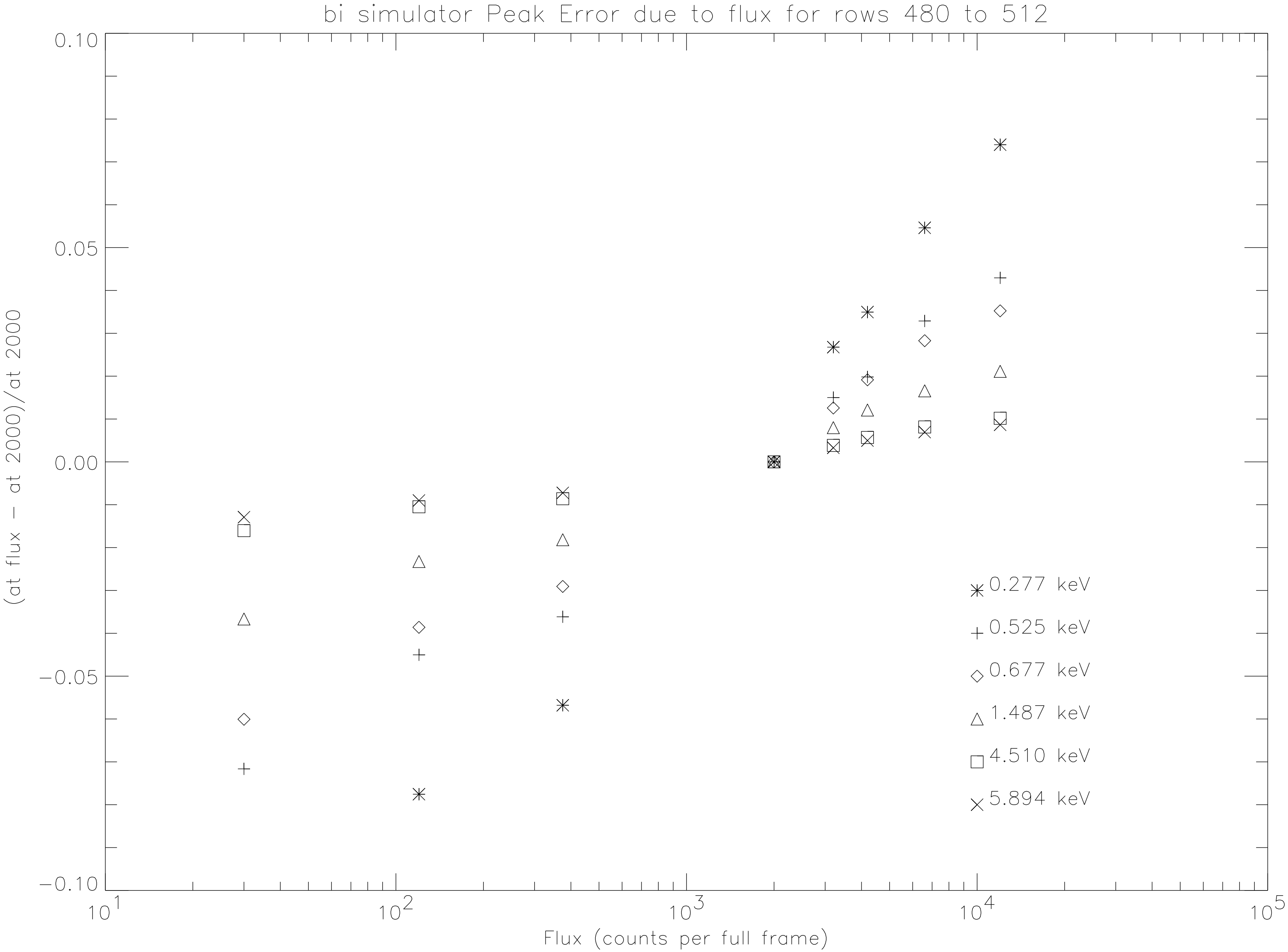


Figure 2: Percentage gain change vs counting rate, from the simulator

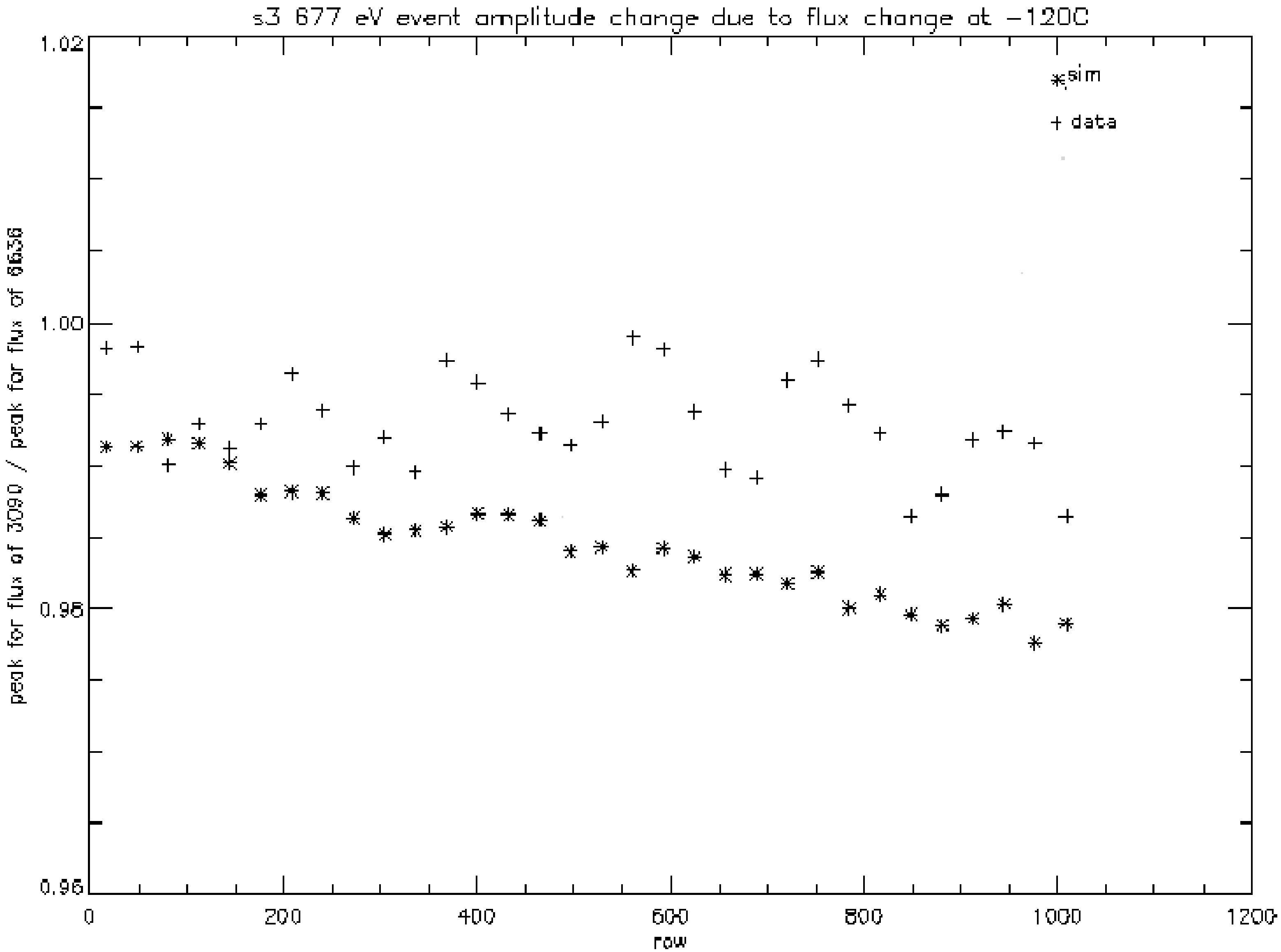


Figure 3: Fractional amplitude change vs row number, for simulation and lab data at 677 eV

# Future ACIS Calibration Work

## ACIS CCD STUDIES

- Trap time constants, densities
- Volume dependence on charge packet size
- Characterizing the serial trap map
- Effect of Bakeout on CTI