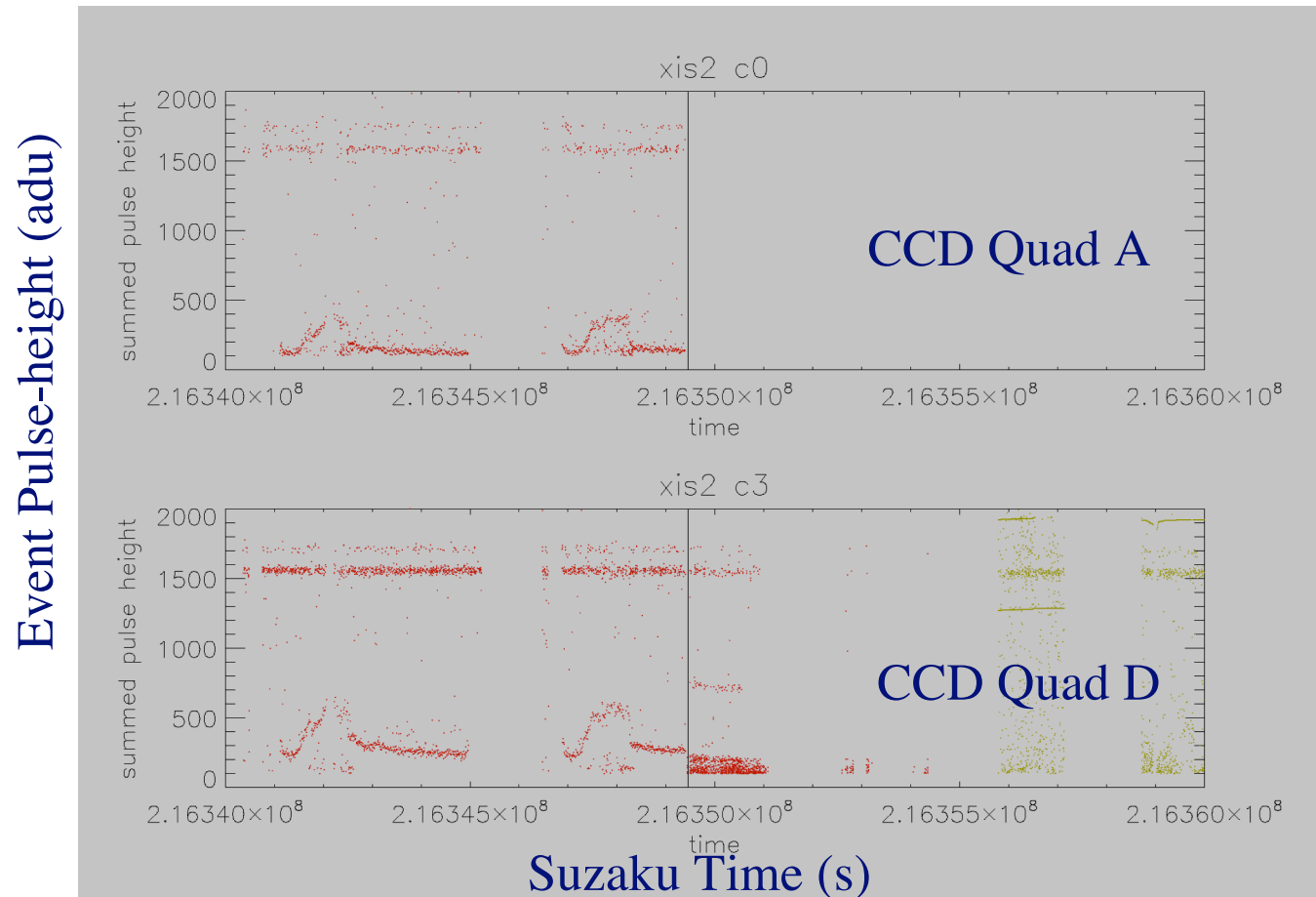# XIS Update
Mark Bautz, MIT Kavli Institute

- ## XIS-2 Anomaly
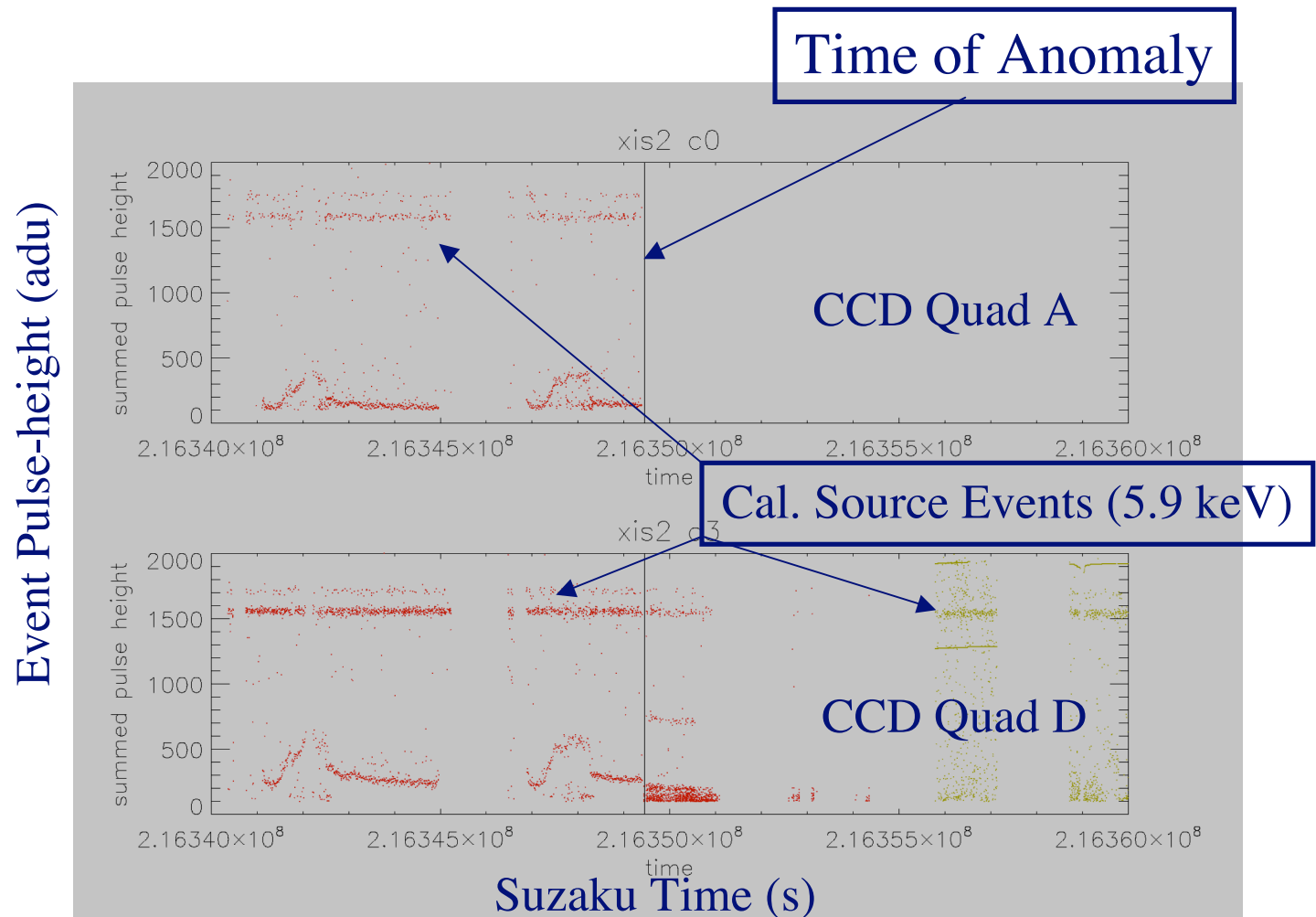
- ## Contamination

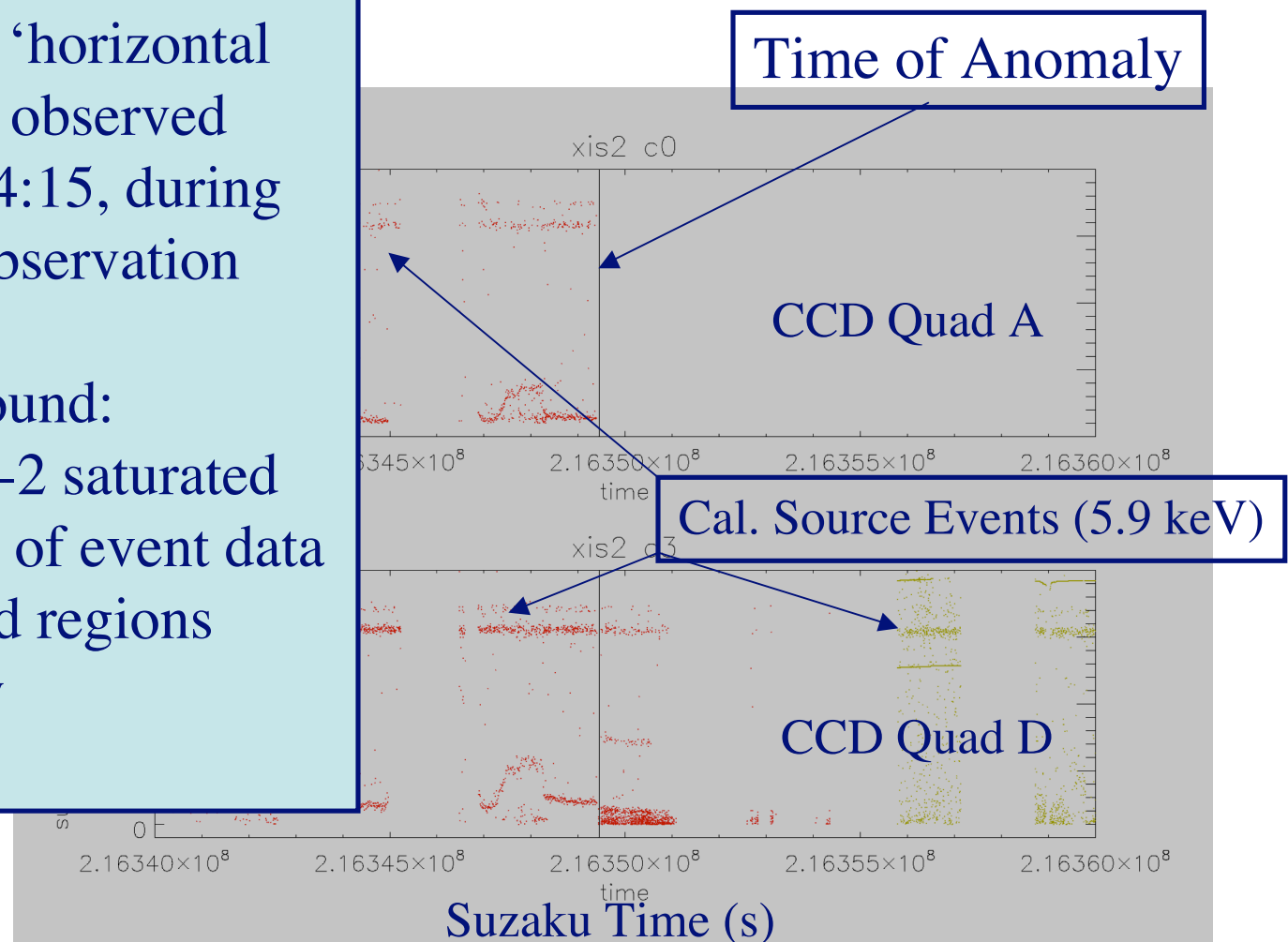# XIS 2 Anomaly

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XIS 2 Anomaly

XIS 2 Anomaly

- Sudden rise in 'horizontal overclock' levels observed 2006 9 Nov 01:04:15, during normal science observation

- Subsequently found:
  * ~2/3 of XIS-2 saturated
  * Sudden loss of event data from saturated regions after anomaly

Time of Anomaly

Cal. Source Events (5.9 keV)

xis2 c0

CCD Quad A

xis2 c3

CCD Quad D

Suzaku Time (s)

XIS2 Raw Frame Mode Data
after anomaly

Quad A   B   C   D

- ~ 2/3 of chip saturated (black)
- Quadrant 'D' (right side) detects X-rays
- Likely source of saturation in quadrant A and/or B
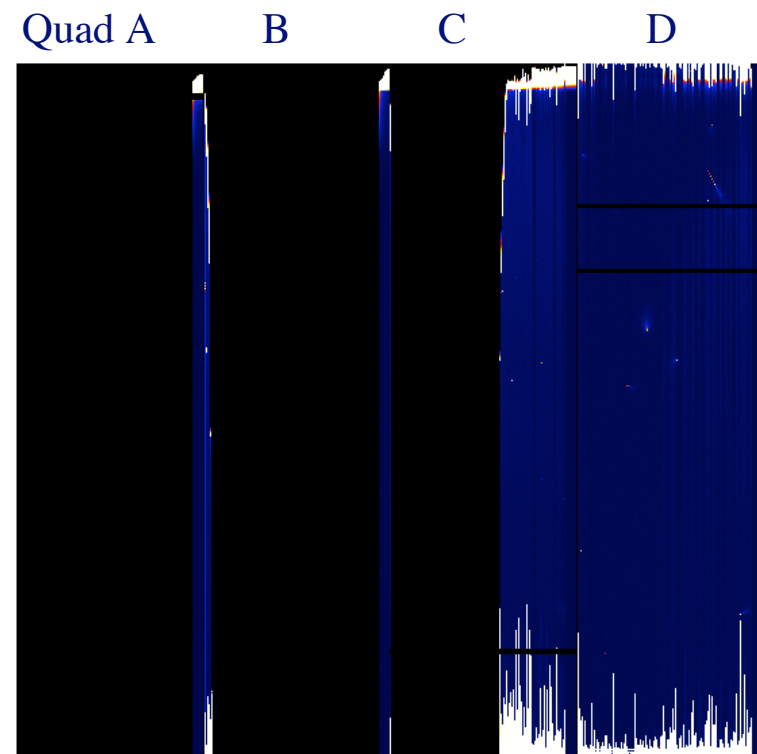
XIS 2 Anomaly

- Experiments with CCD clock levels show likely short between image-area electrodes (gates) and CCD buried channel.

- No other hardware housekeeping or CCD anomalies were found.

- Plausible mechanism is micro-meteoroid impact on CCD as seen on XMM (5 times) and Swift (once).

- Micrometeoroid impact probability enhanced by Suzaku's low-graze-angle (high-energy) mirrors. (Carpenter et al., SPIE 2006)

- Recovery of saturated area of XIS-2 unlikely.

XIS Contamination History
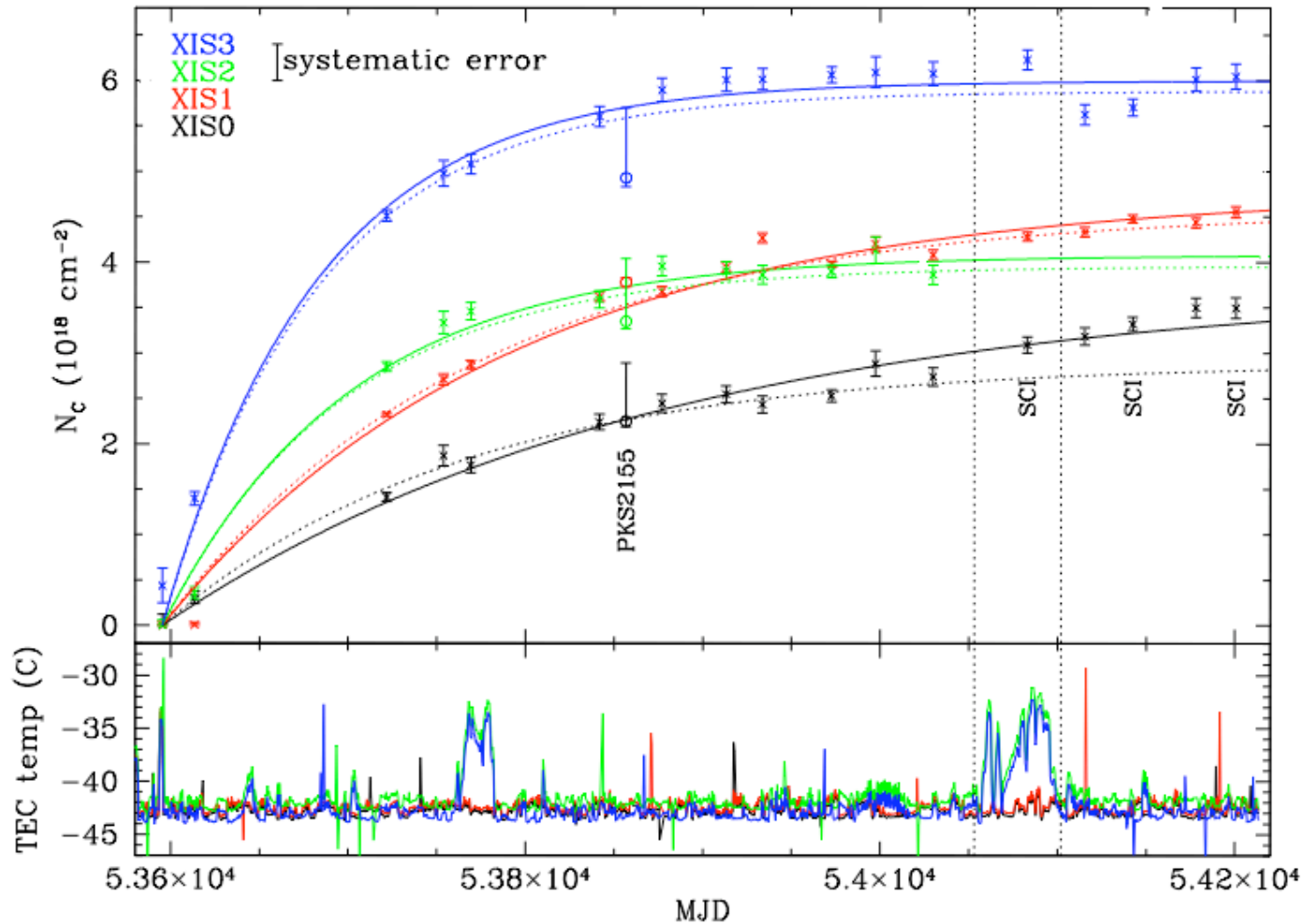
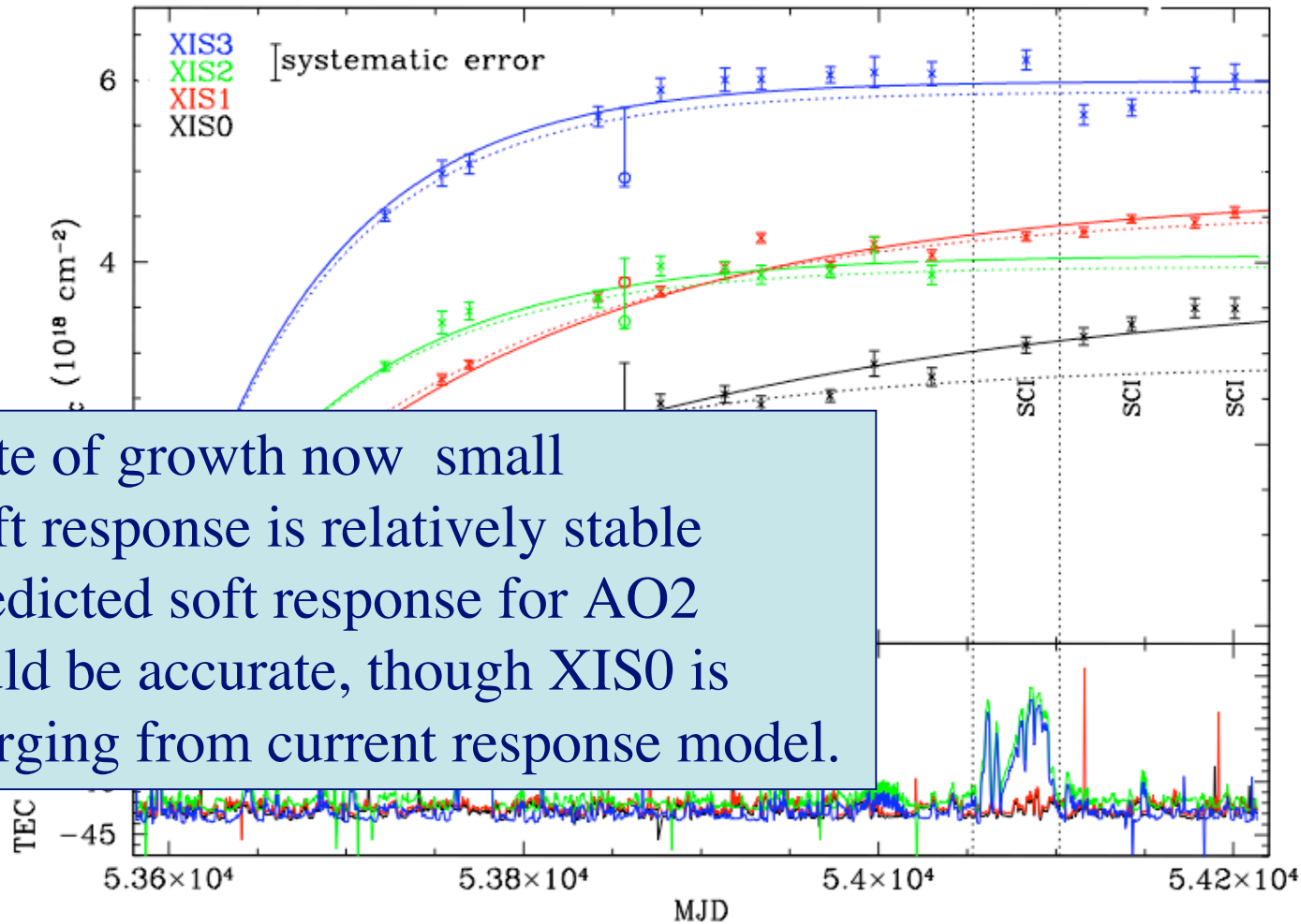Suzaku/XIS contamination history, $N_c/N_0 = 6$ assumed, rev1.2

July 2005   *April 2007*

3 May 2007   mwb MIT/MKI   *E. Miller*
Suzaku Users

XIS Contamination History

Suzaku/XIS contamination history, $N_c/N_0 = 6$ assumed, rev1.2

- Rate of growth now small
- Soft response is relatively stable
- Predicted soft response for AO2 should be accurate, though XIS0 is diverging from current response model.

July 2005   *April 2007*

Charge Injection: Motivation

- Some radiation damage to XIS is inevitable in the Astro-E2 orbit (600 km, 31 deg)

- Charge injection capability mitigates radiation damage two ways:

    * Improves charge transfer efficiency after radiation

    * Allows better ground calibration and correction for damage effects

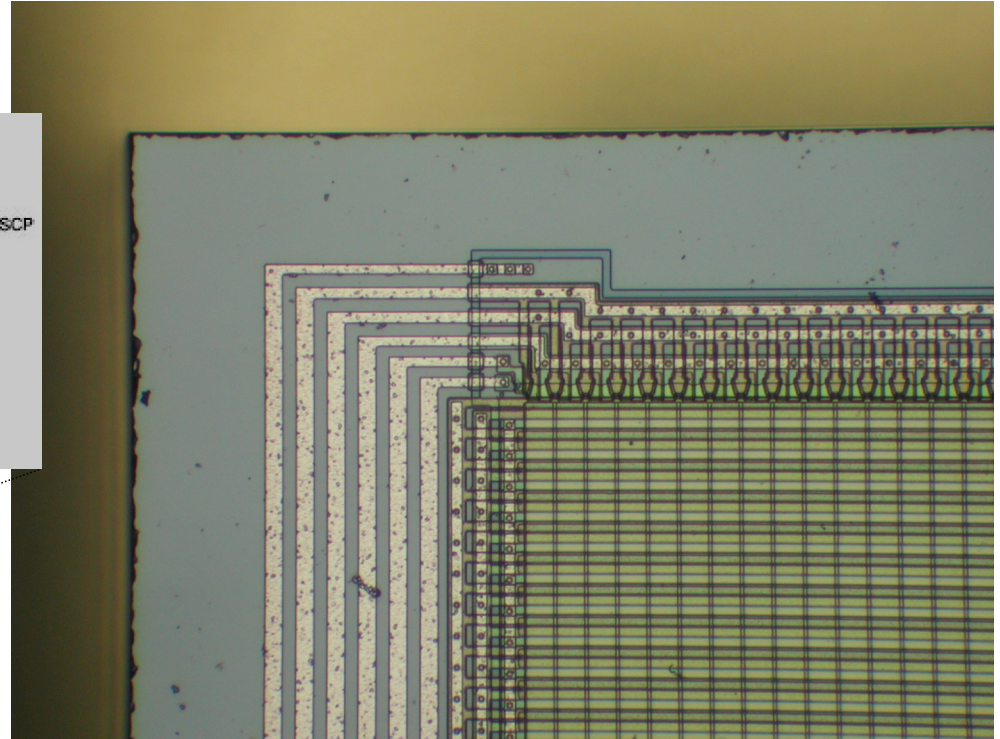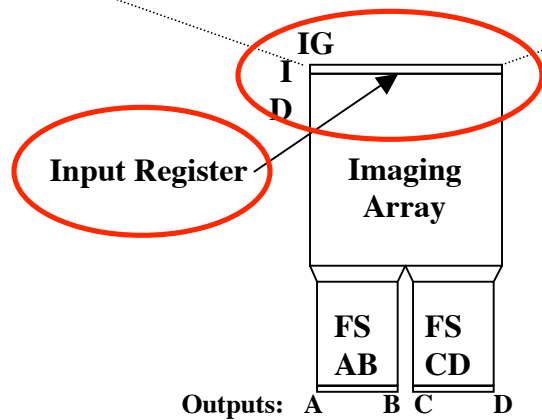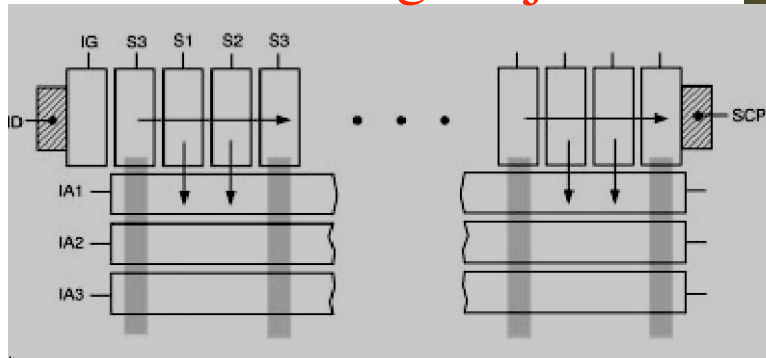# XIS "Gain" and Spectral Resolution Trends Without Charge Injection

http://space.mit.edu/XIS/team/monitor/

B. LaMarr/E. Miller
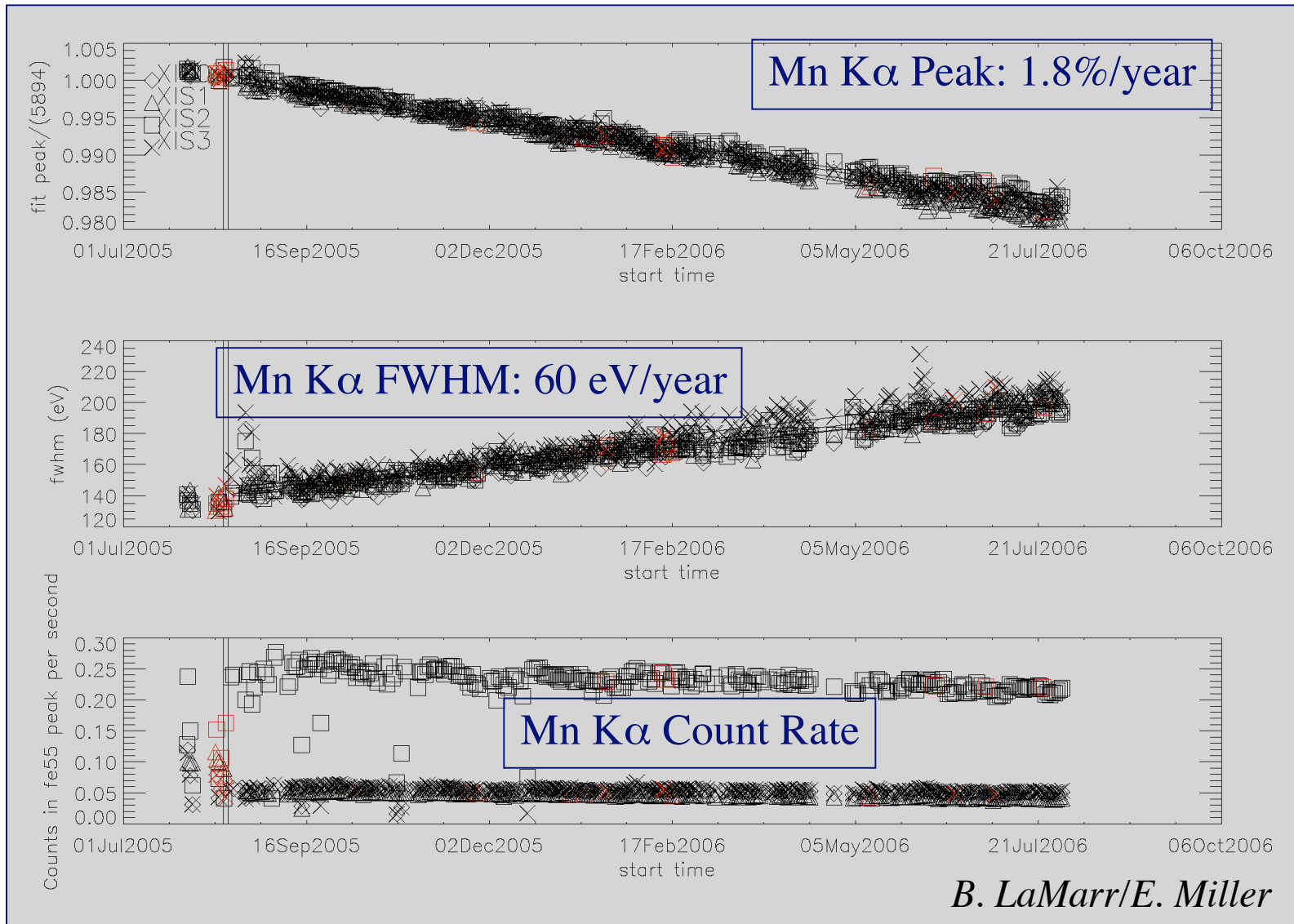
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XIS Charge Injection Structure

Added for Charge Injection:

Prigozhin et al., 2004 &
LaMarr et al. 2004 SPIE v 5501

MIT Lincoln Lab. CCID41

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Charge Injection to Improve Charge Transfer
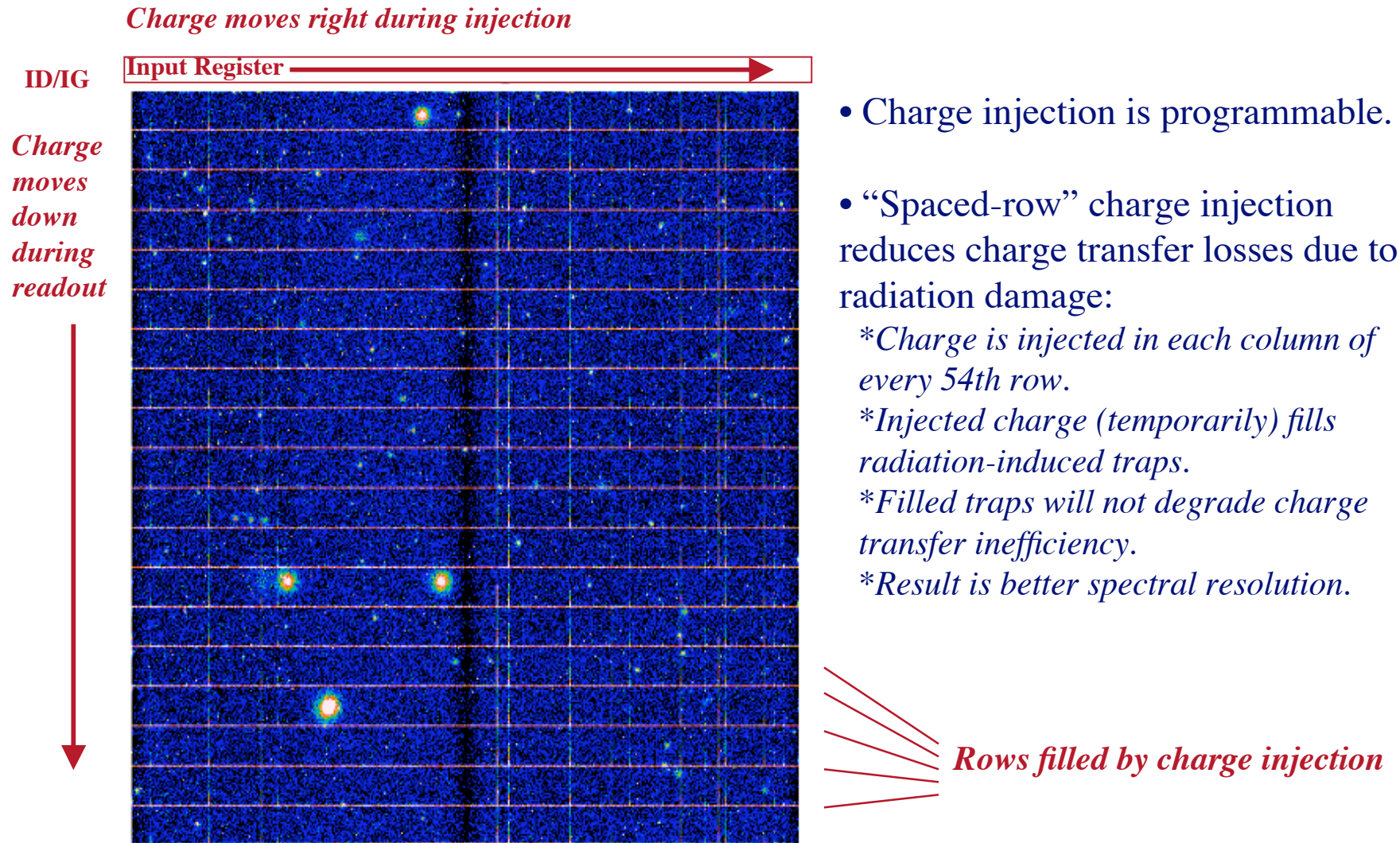
Charge moves right during injection

Input Register →

ID/IG

Charge moves down during readout

Rows filled by charge injection

• Charge injection is programmable.

• "Spaced-row" charge injection reduces charge transfer losses due to radiation damage:

Charge is injected in each column of every 54th row.
Injected charge (temporarily) fills radiation-induced traps.
Filled traps will not degrade charge transfer inefficiency.
Result is better spectral resolution.

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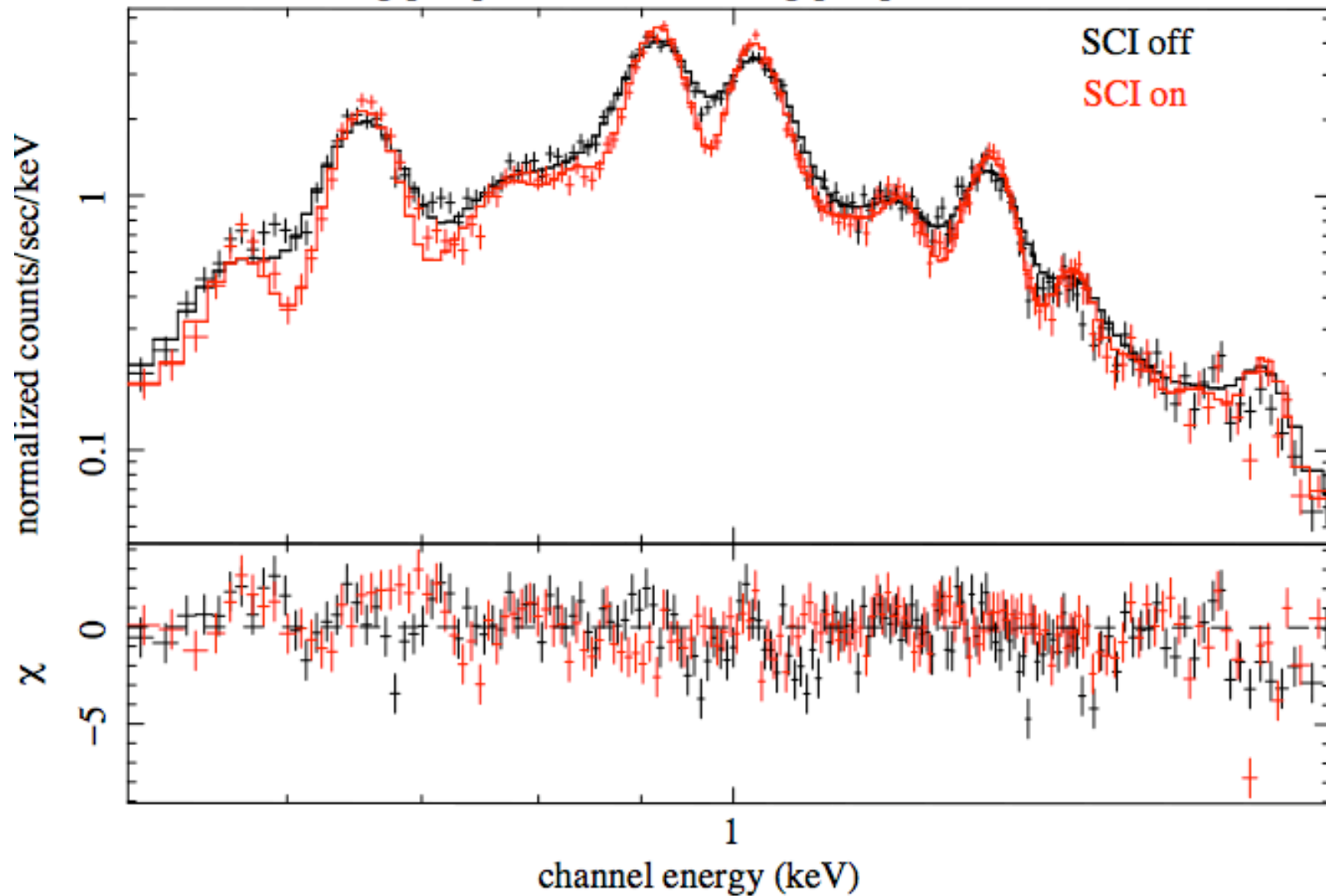# Charge Injection Improves XIS "Gain" and Spectral Resolution Trends

http://space.mit.edu/XIS/team/monitor/

Mn Kα Peak: 0.4-0.7%/year

Mn Kα FWHM: <10 eV/year

Mn Kα Count Rate

B. LaMarr/E. Miller

Charge Injection Improves XIS "Gain" and Spectral Resolution Trends

http://space.mit.edu/XIS/team/monitor/

x 3-4 Improvement in Rate

> x 6 Improvement in Rate

< 2% Reduction in Efficiency

B. LaMarr/E. Miller

Charge Injection Improves XIS Spectral Resolution

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mwb MIT/MKI

E. Miller

XIS Status Summary

- 2/3 of XIS-2 saturated, probably due to micro-meteoroid impact.

- Contamination growth-rate is very small; soft response is stable & AO-2 projections should be accurate, except possibly for XIS0.

- Charge injection has restored spectral resolution, reduced degradation rate by ~x 6.