MOS Charge Injection Tests

- The MOS Charge Injection (CI) structure precedes each integrated frame by a single row of full-well charge, which is intended to fill trapping sites during its transfer.
- The first in-flight tests of CI occurred during rev-329 & 330 (T. Abbey, E. Serpell & SOC).
- We must assess the effect of CI on the data, determining how the current CCF set may be altered, and judge whether the final net effect is beneficial to EPIC MOS.

Paul Bennie
pbe@star.le.ac.uk

Data Quality

- Seven consecutive observations of the calclosed position in rev-330 were analysed, between which CI was modulated off and on. These FF data had nominal EDU and EMDH thresholds, and equal exposures of 14-ksec.

- These data were recorded on the decline from record solar background levels which affected the rev-329 data.

- Note that these high background levels would also act to suppress CTI losses in a manner similar to the use of CI.

Paul Bennie
pbe@star.le.ac.uk

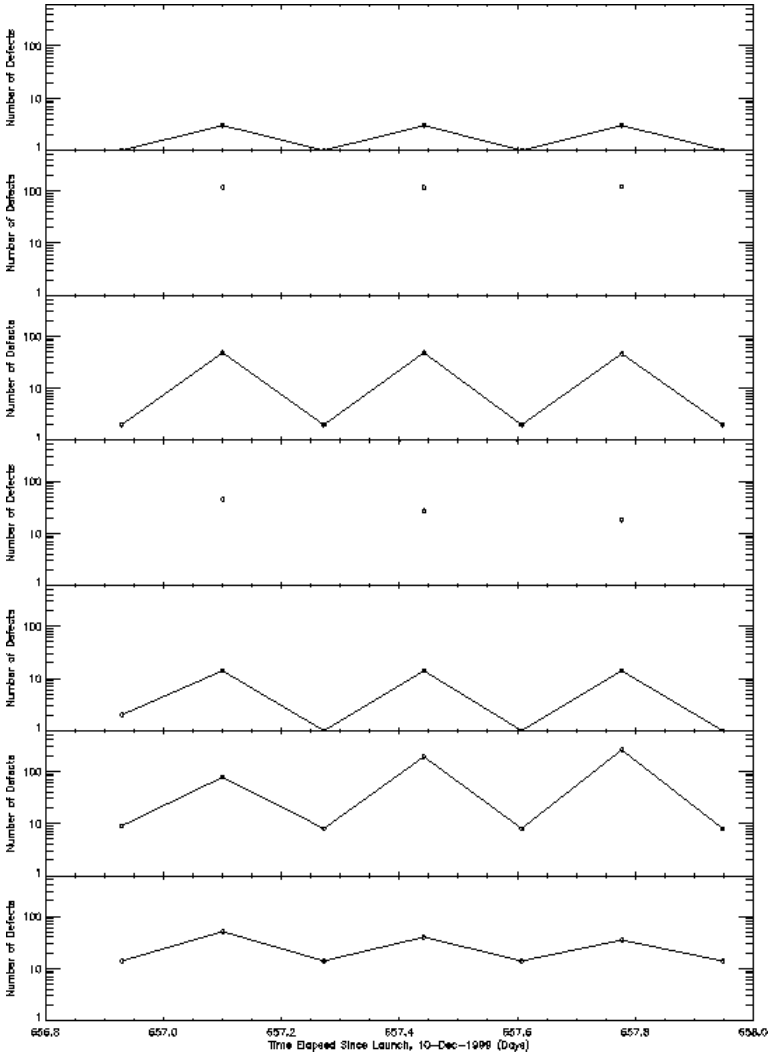
Performance Verification

- Analysis was performed to gauge the effect of CI on the following aspects of the MOS devices.

  - The numbers of bright, recurring pixels in the data.
  - Charge loss during the parallel (column) transfers.
  - Charge loss during the serial register (row) transfer.
  - The resultant line profile (3 Gaussian parameters).
  - The distribution of events by pattern grade.

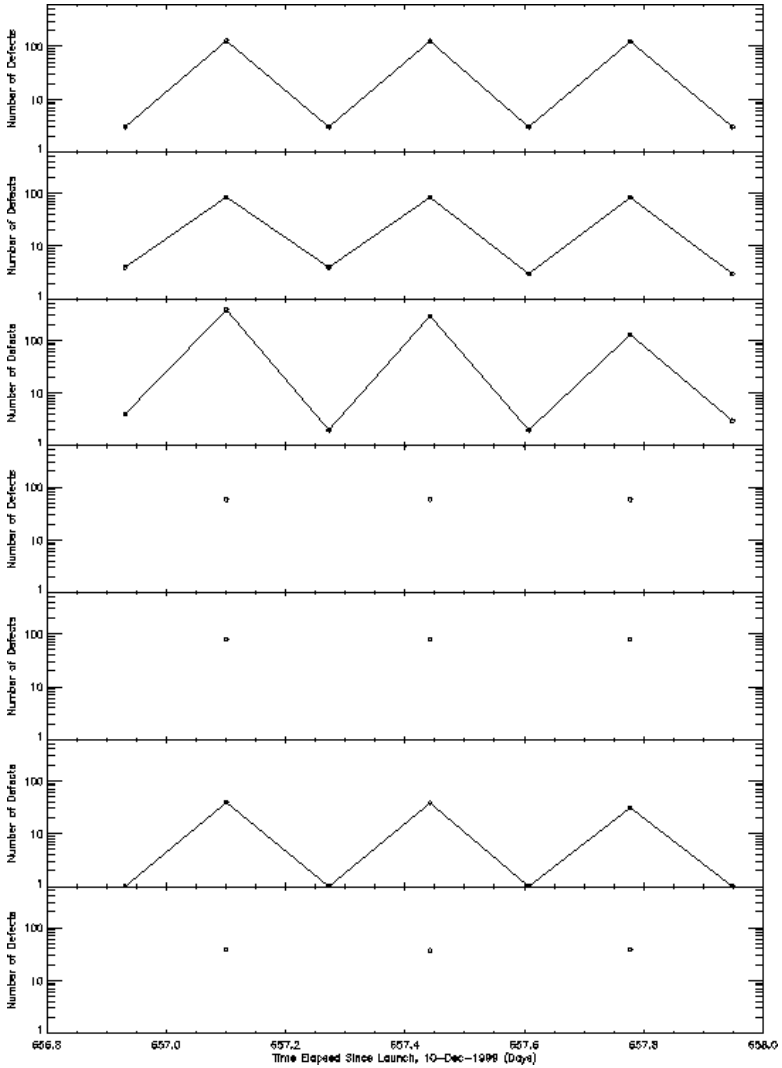
Paul Bennie
pbe@star.le.ac.uk

Bright Pixels in 5% of frames (1)



← MOS 1

MOS 2 →



Paul Bennie
pbe@star.le.ac.uk

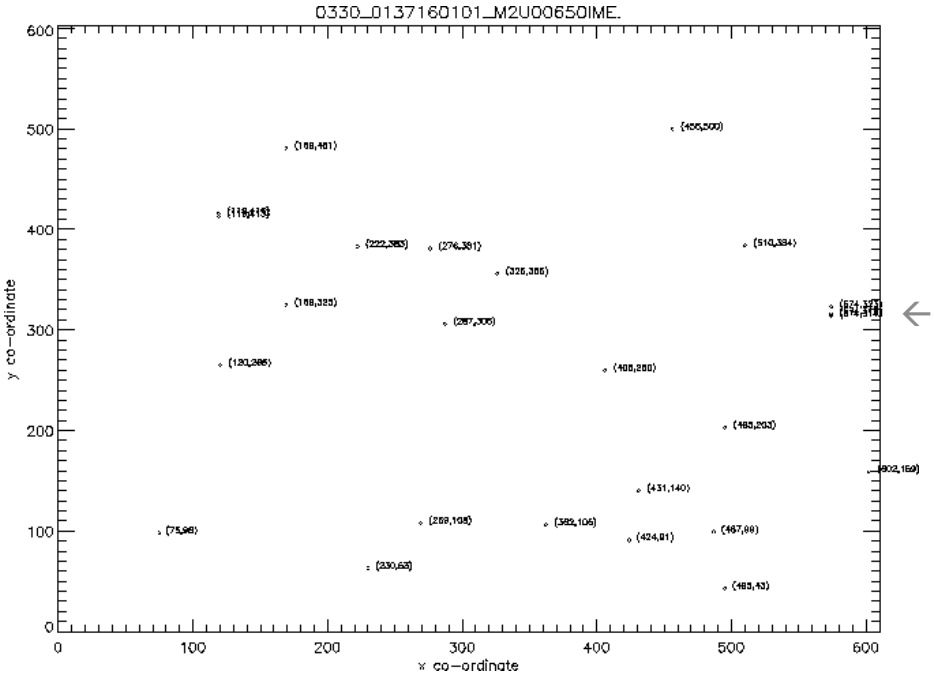
Monday, 12 November 2001

University of Leicester

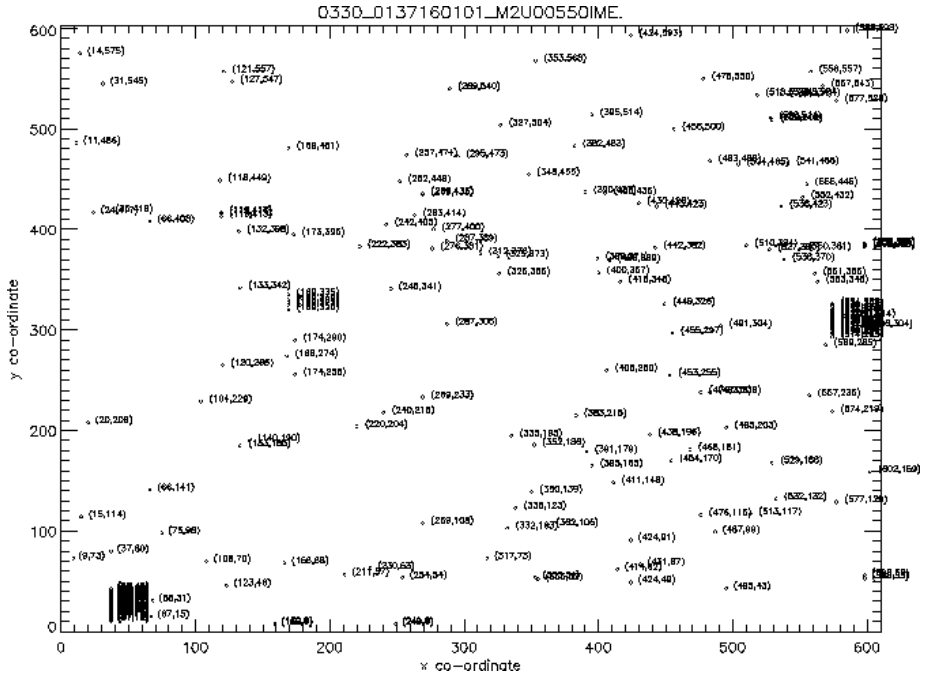
Bright Defects (2)

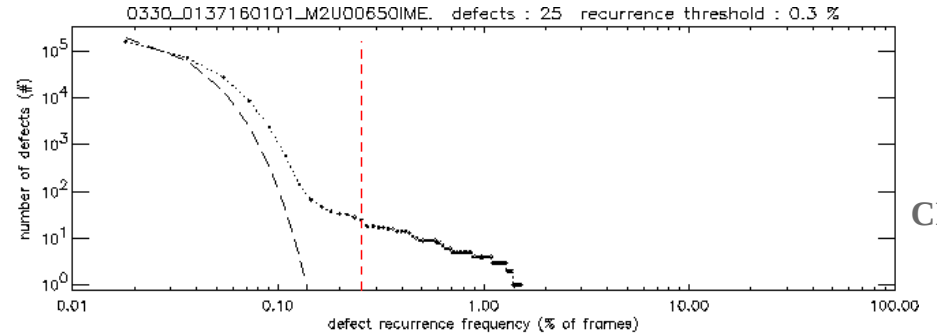
- A significantly large number of *temporary* recurring pixels were induced in the CCDs while CI was in use.
- The number of pixels recurring in > 5% of frames in a CI observation increased from a ‘few‘ to ~ (10-200).
- These pixels were in *addition* to those already identified and vetoed by the onboard rejection tables (max. 50).
- In the following slides we demonstrate some properties of the pixels induced between CI on & off. They can occur grouped with known bad columns or in isolation. They mainly have low PHA, but can extend full range.

Paul Bennie
pbe@star.le.ac.uk

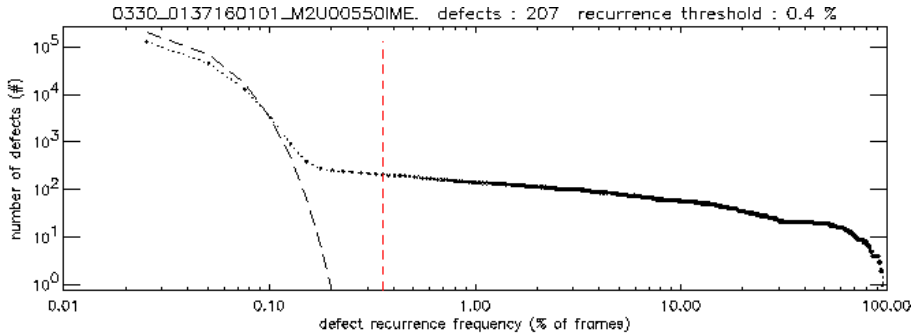


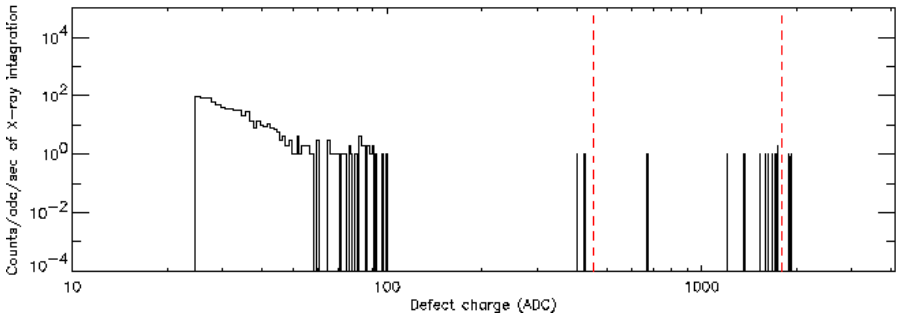
← CI OFF

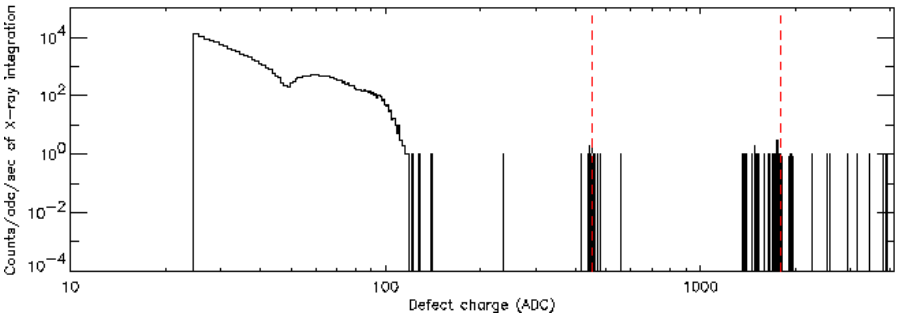




CI ON →



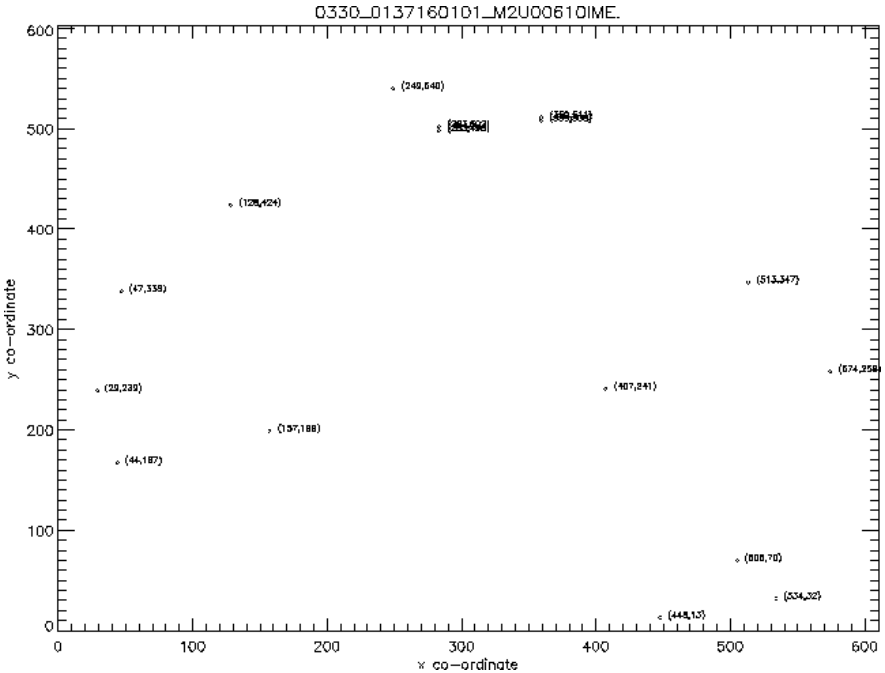




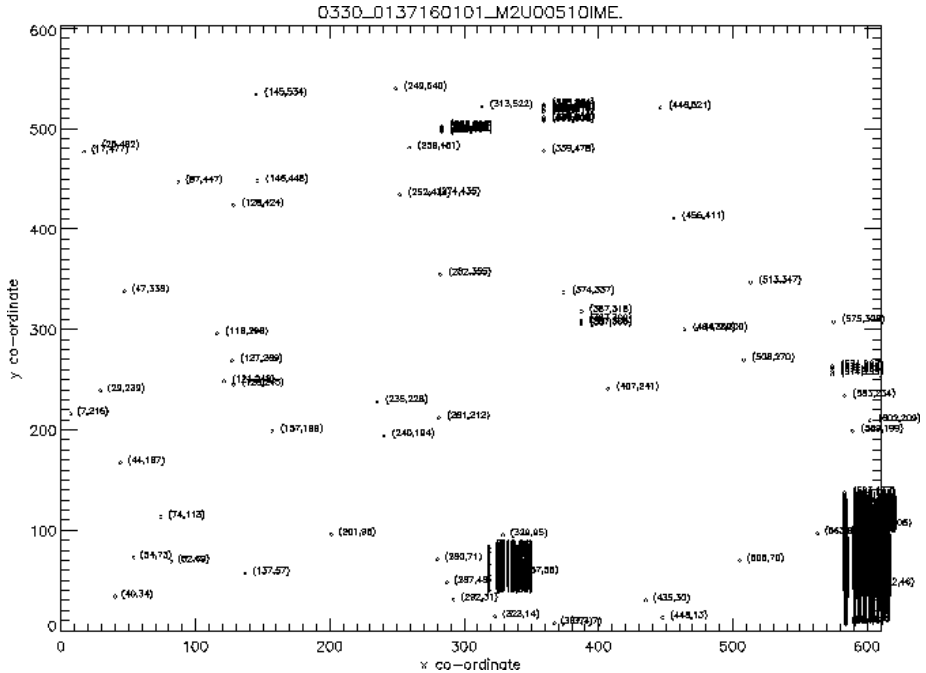
Paul Bennie
pbe@star.le.ac.uk

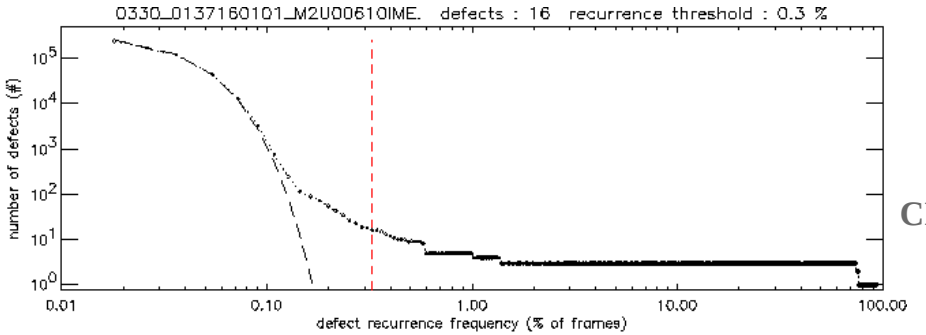
Monday, 12 November 2001

University of Leicester

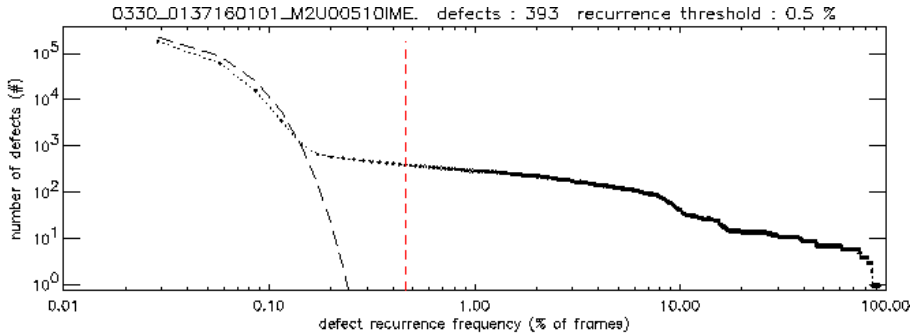


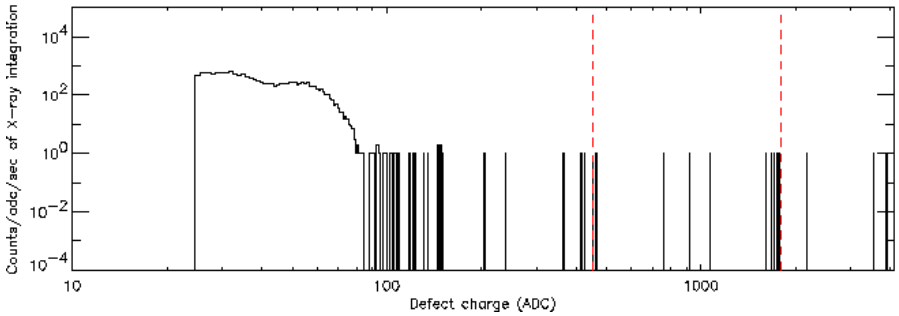
← CI OFF

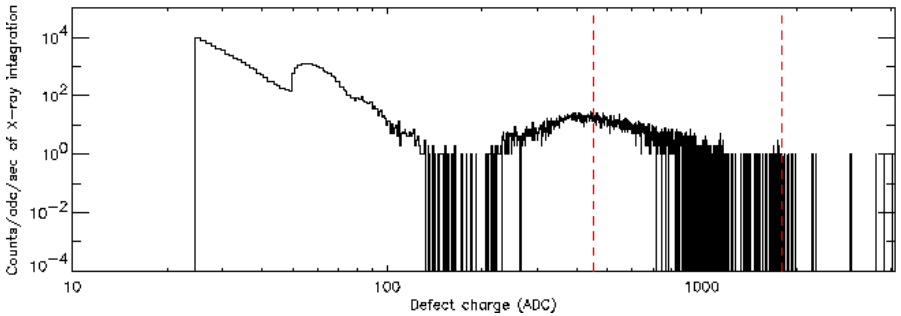




CI ON →





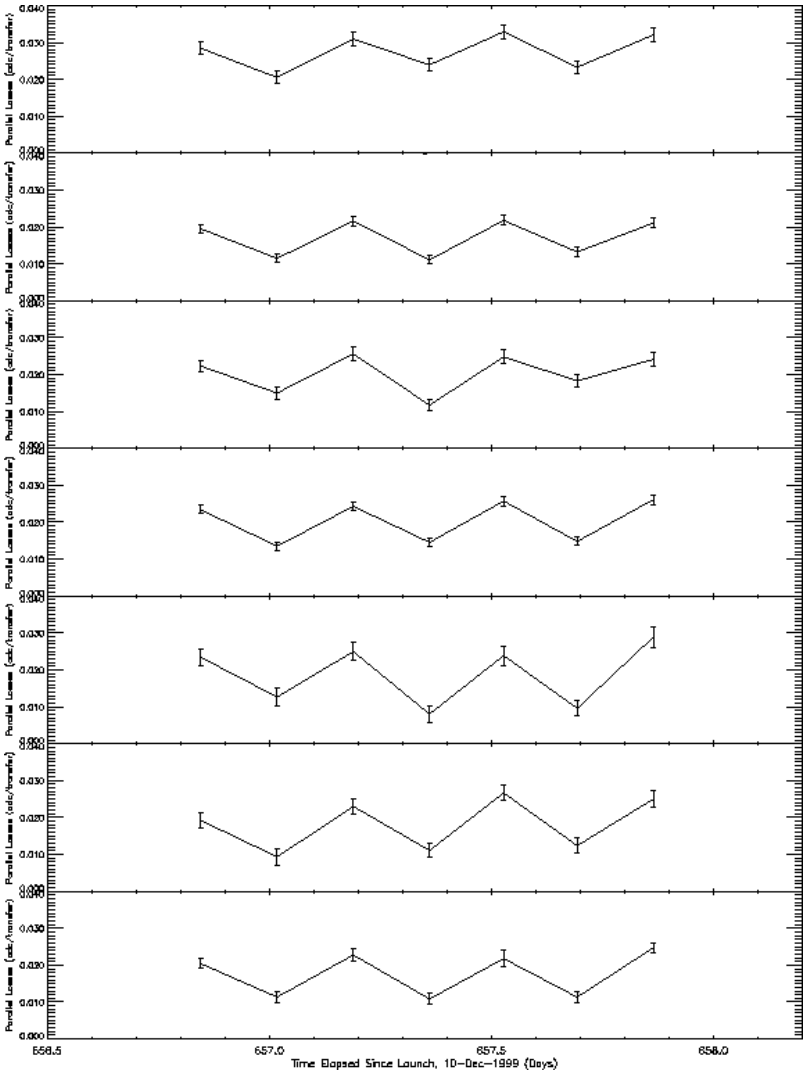


Paul Bennie
pbe@star.le.ac.uk

Monday, 12 November 2001

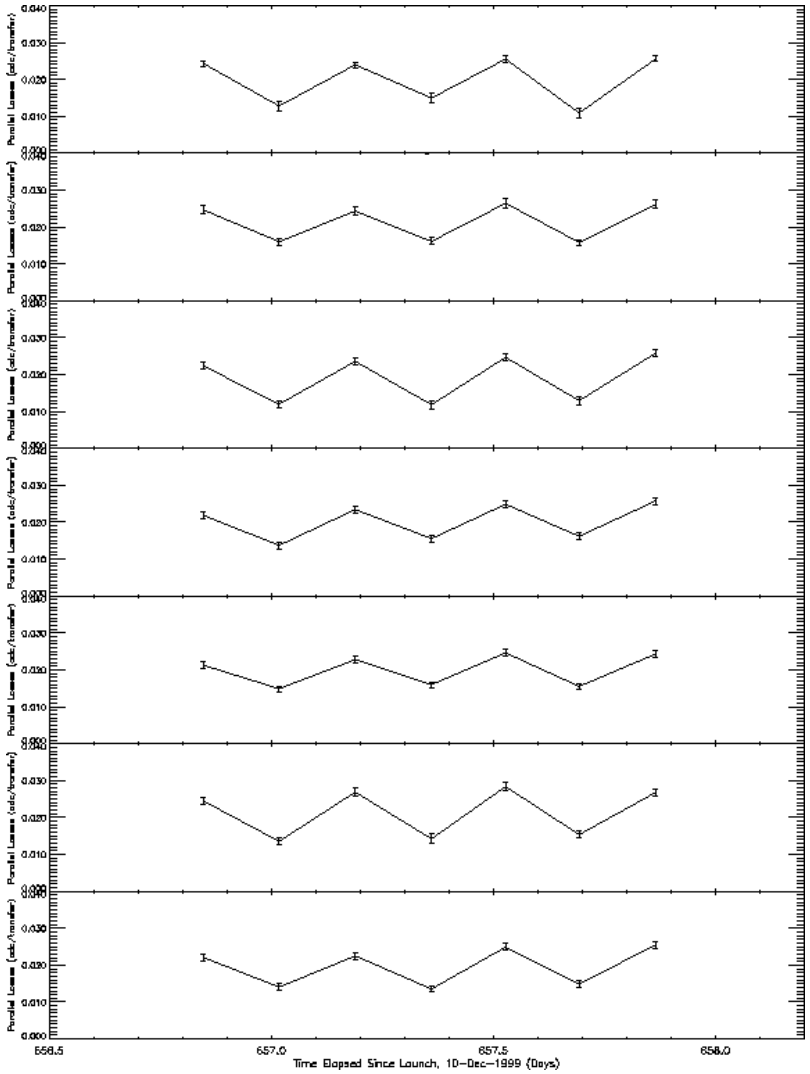
University of Leicester

Parallel CTI (1)



← MOS 1

MOS 2 →



Paul Bennie
pbe@star.le.ac.uk

Monday, 12 November 2001

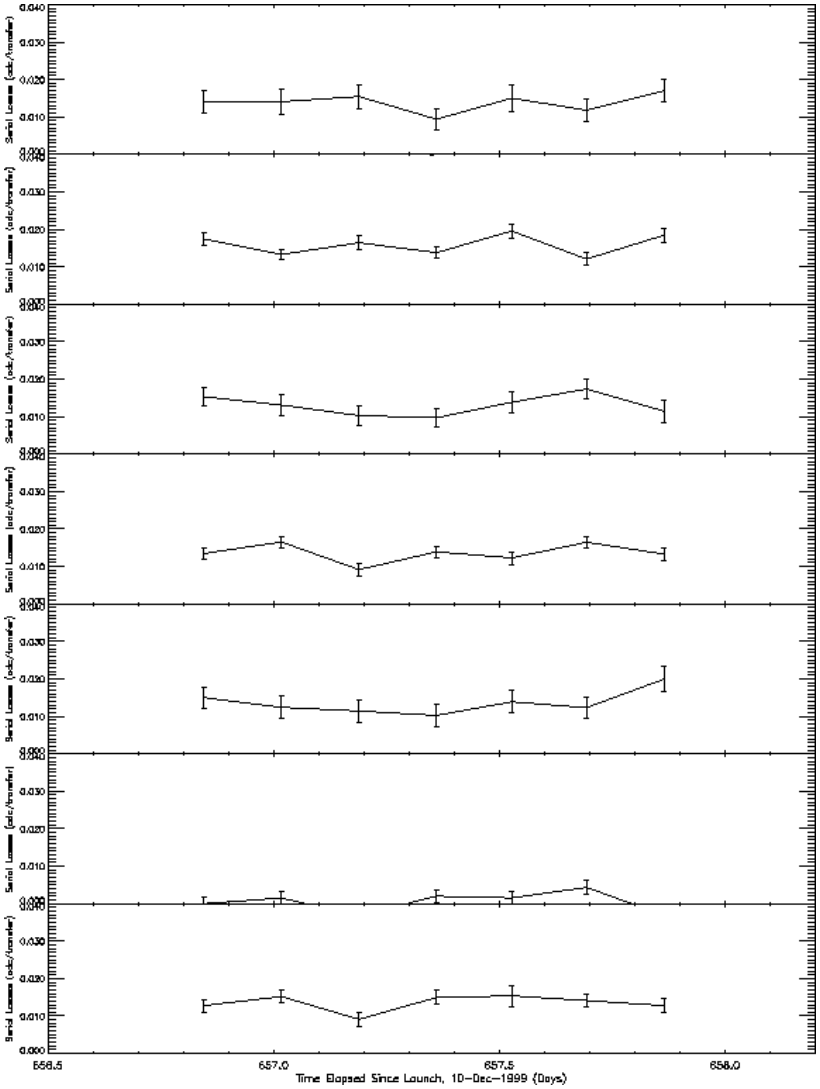
University of Leicester

Parallel CTI (2)

- The parallel CTI losses are significantly reduced when CI is employed, and vice versa when turned off.
- The reduction is ~ 50% when measured at 5899-eV, representing the reduction 0.026 → 0.013 adc/transfer.
- This does not represent a reduction to an undamaged state, where pre-launch values were ~0.003 adc/transfer.
- Therefore, we must conclude that some degree of SAS parallel CTI software correction would still be required.

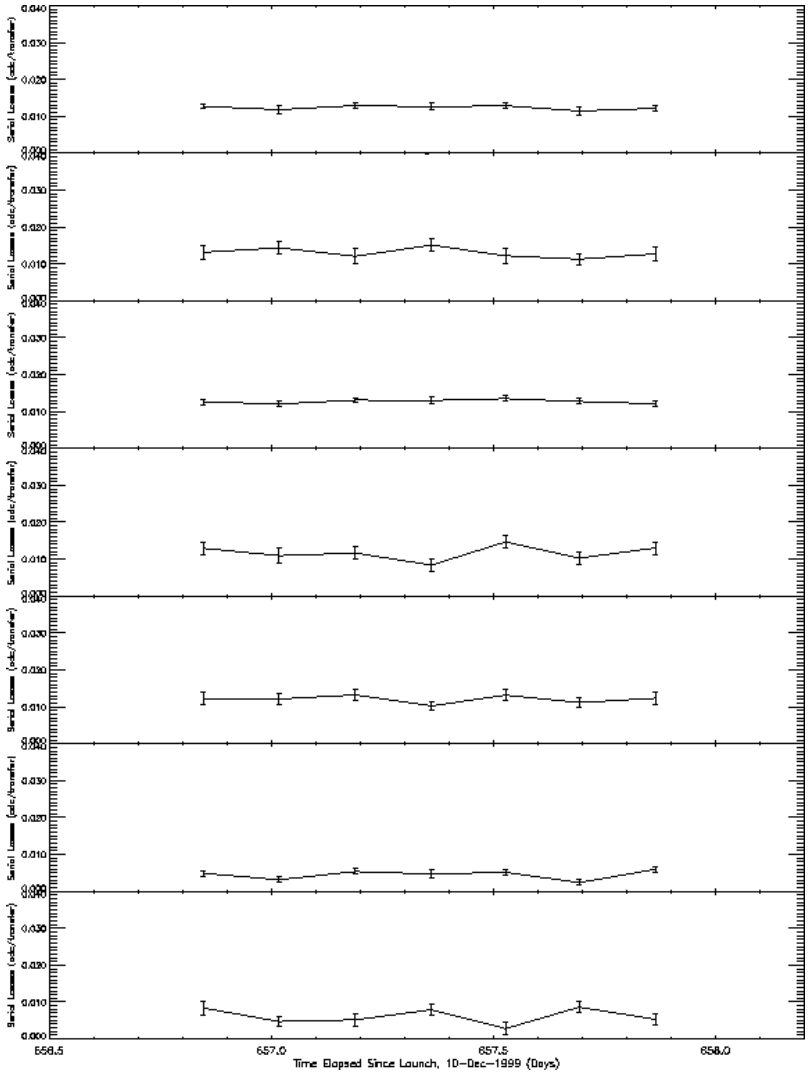
Paul Bennie
pbe@star.le.ac.uk

Serial CTI (1)



← MOS 1

MOS 2 →



Paul Bennie
pbe@star.le.ac.uk

Monday, 12 November 2001

University of Leicester

Serial CTI (2)

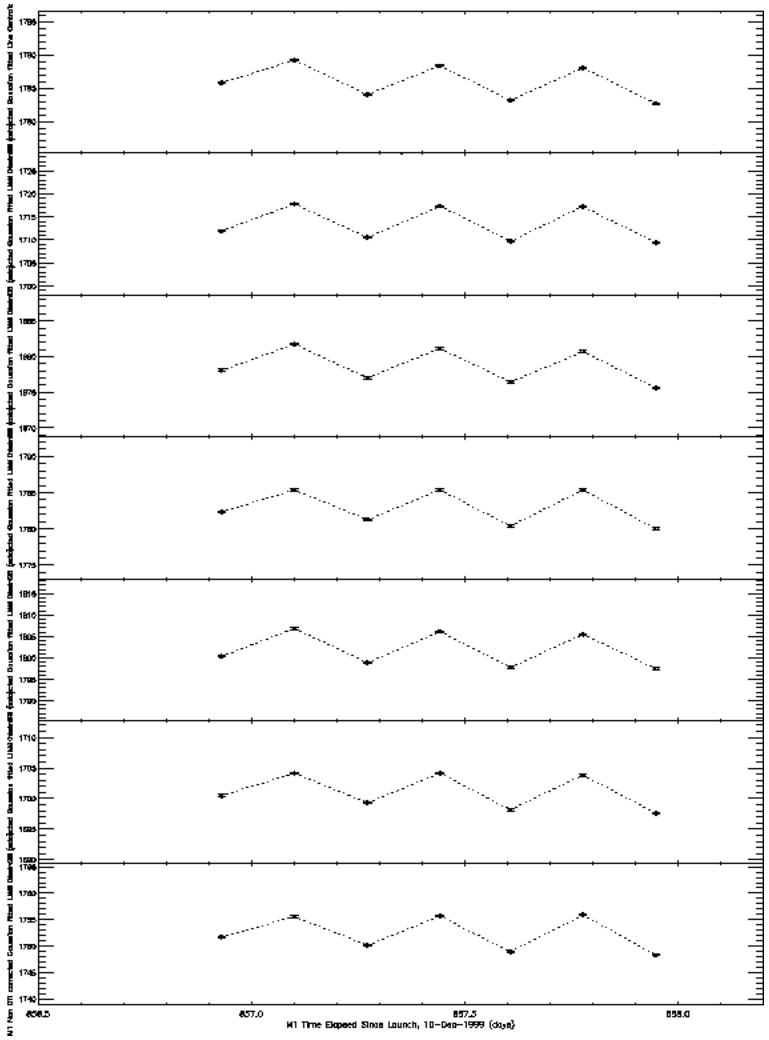
- The serial CTI losses, plotted to the same scale as the parallel, are not clearly modulated by the use of CI.

- Whilst not all points were consistent with an unchanging value, we propose this is an analysis failing.

- Thus, SAS software correction of the serial losses would still need to be maintained even if CI were used.

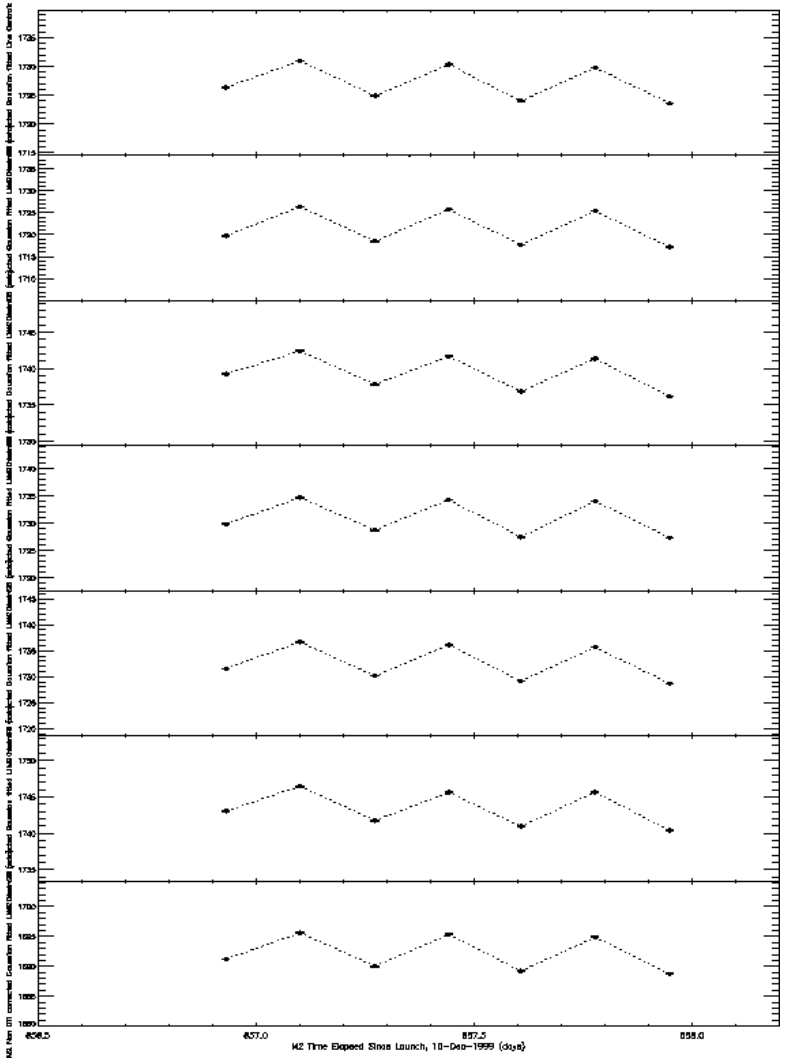
Paul Bennie
pbe@star.le.ac.uk

Gaussian Profile (1) - Centroid



← MOS 1

MOS 2 →



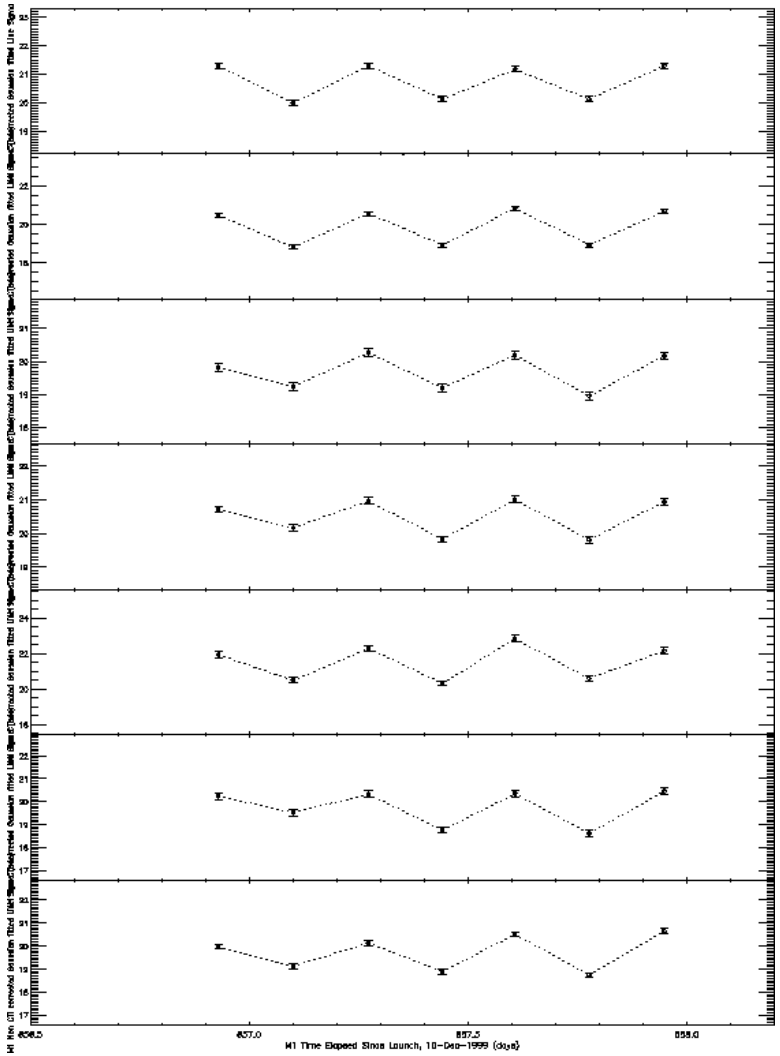
Gaussian Profile (2)

- The centroid parameter from a Gaussian fit to the 5899-eV line is restored by ~7-adc (~23-eV), equivalently ~0.4% of the line energy towards the pre-launch value .

- In the following slide, the sigma parameter from a fit to the 5899-eV line is restored by ~1.2-adc (~4-eV), equivalently a ~6% reduction of the damaged line width.

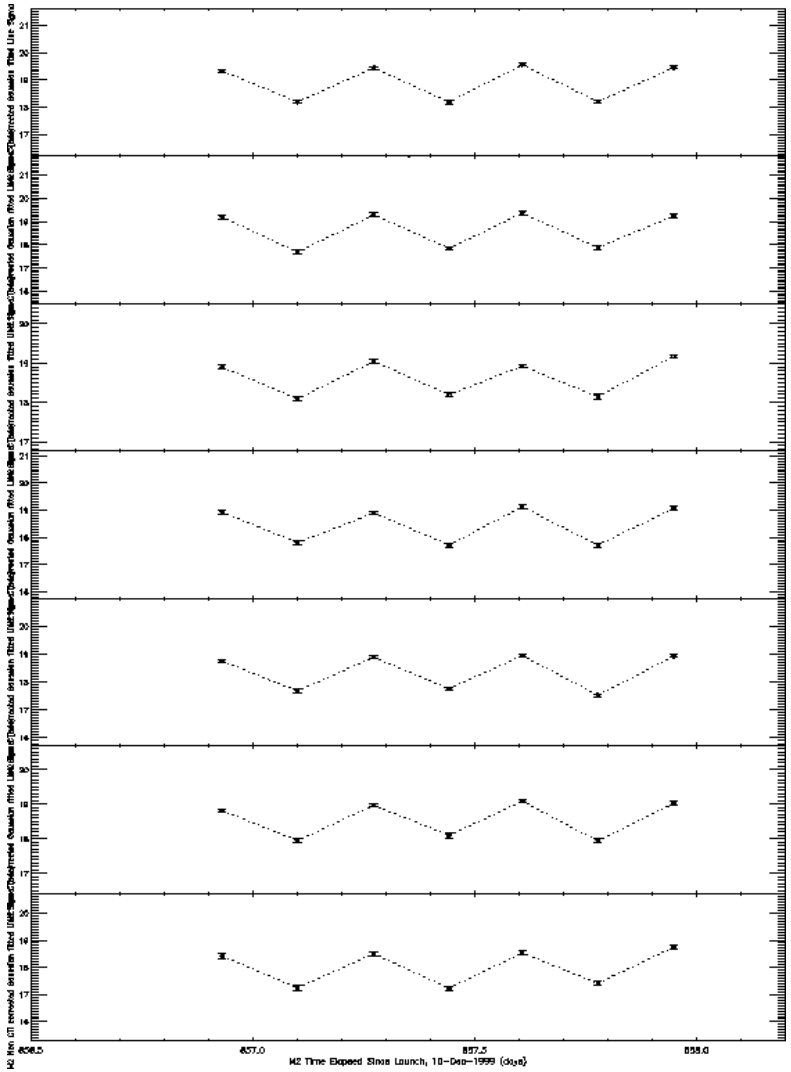
Paul Bennie
pbe@star.le.ac.uk

Gaussian Profile (3) - Sigma



← MOS 1

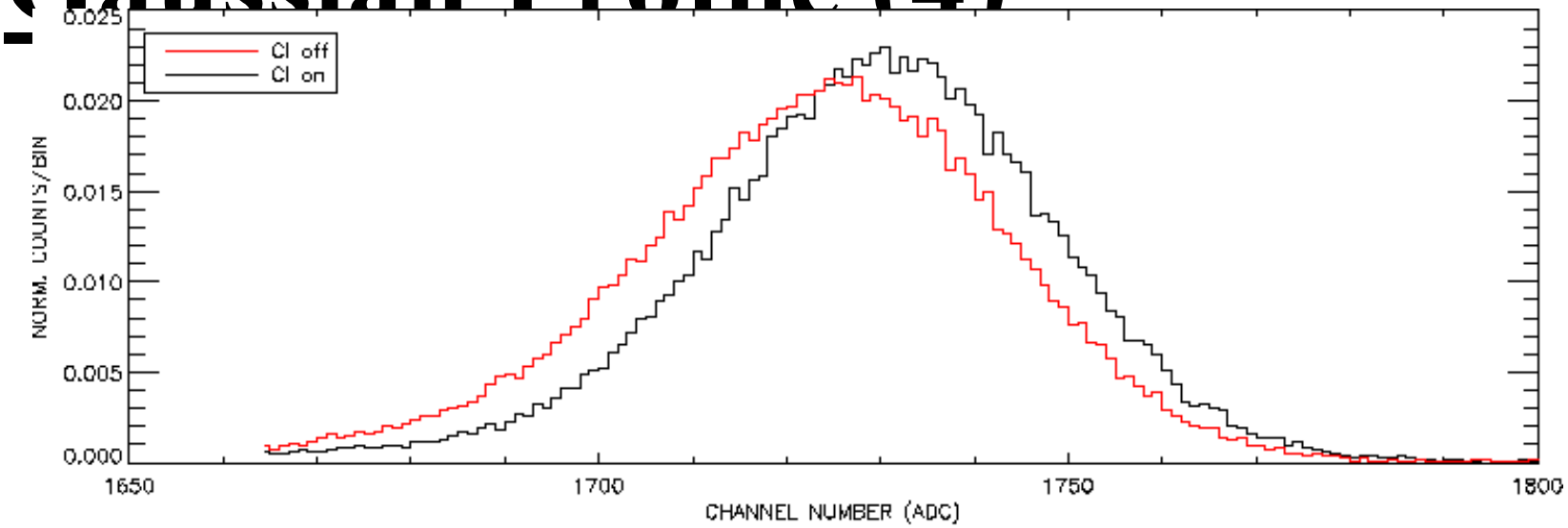
MOS 2 →

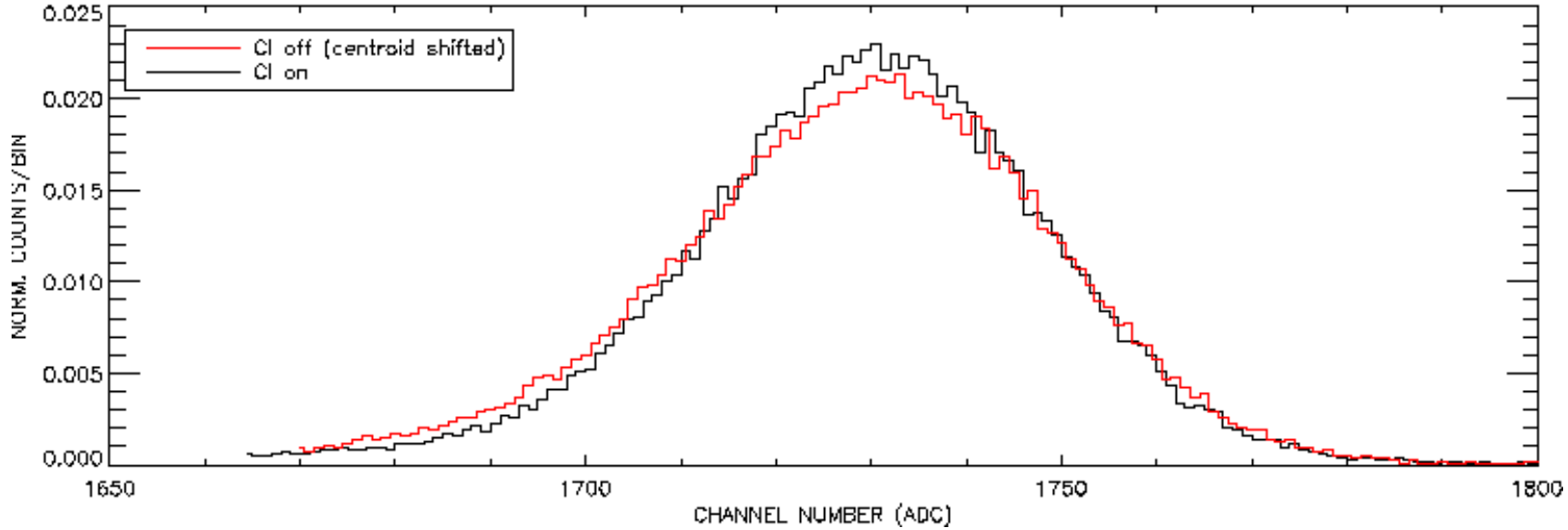


Paul Bennie
pbe@star.le.ac.uk
Monday, 12 November 2001

University of Leicester

Gaussian Profile (4)





Paul Bennie
pbe@star.le.ac.uk

Conclusions for Operation (1)

- We have demonstrated the use of CI in reducing the MOS parallel CTI losses, as measured at one epoch.

- A ~50% reduction in parallel CTI was achieved in losses which are small (~0.026-adc/transfer) compared to other instruments (eg ACIS, ~0.250-adc/transfer), where ACIS and EPIC MOS have similar gain settings.

- However, the numbers of recurring pixels are temporarily increased by up to ~2 orders of magnitude.

Paul Bennie
pbe@star.le.ac.uk

Conclusions for Operation (2)

- If it were decided to employ CI, a strategy would be needed to minimize the effects of these induced defects, most notably their consumption of the BRAT (12 & 16 kbits) and their new demands on the SAS pixel finder.

  - Raise the EMDH lower threshold.
  - Employ CI on only the central two CCDs.
  - Veto whole columns via offset table patches.
  - Each CCD requiring its own specific tuning.

Paul Bennie
pbe@star.le.ac.uk