## ACIS FI Cosmic Ray Induced Dead Area



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## OUTLINE

Vaild celestial X-ray events landing in or on borders of CR 'blooms' are either undetected or assigned bad (eg. $\mathrm{g}=255$ ) and rejected on board or on ground.

Effect much more (factor ~10) important for Fls than Bis

Conventions: 'Instrumental' dead-area vs. 'effective grade-dependent' dead-area

Effect depends on the flight grade of incoming event


Effect also depends on exact PHAs even below split thres. in the nominally inactive border pixels as these low PHAs can conspire with charge present on the chip - even if that too is below split thres. - to make a bad output grade

Effect backgd CR rate dependent

Effect frame-time dependent

## DATASET

‘CUCKOO’ data mode devised by P. Ford (MIT):
16 (+4 overclock) col's $\square 1024$ rows, RAW mode, consecutive 3.2 sec frames
Data analysed here between November 2000 \& May 2002 (94 Obsids) - all on I except 2 Obsids on SO; 4 on IO; 3 on I1. (Included some cuckoo-squeegy runs

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## INSTRUMENTAL DEAD-AREA




| PHA thresh. | cnt. thresh. | mean dead area | $\sigma$ | Notes |
| :--- | :--- | :---: | :--- | :--- |
| 13 ADU | 3-in-a-row | $2.45 \%$ | 0.15 <br> $\%$ |  |
| 13 ADU | 3-in-a-row | $2.49 \%$ | 0.14 <br> $\%$ | non-squeegy only |
| 20 ADU | 3-in-a-row | $1.87 \%$ | 0.12 <br> $\%$ |  |
| 20 ADU | 3-in-a-row | $1.91 \%$ | 0.11 <br> $\%$ | non-squeegy only |
| 13 ADU | 3-in-a-col | $2.51 \%$ | 0.15 <br> $\%$ | counting col direction |


| 20 ADU | 3 -in-a-col | $1.92 \%$ | 0.12 <br> $\%$ | counting col direction |
| :--- | :--- | :--- | :--- | :--- |

GRADE-DEPENDENT EFFECTIVE DEAD-AREA



Grade branching ratios from CTI evt mode data - grades $24,66,107,214,255$ are rejected on board


Summary Table

| Flight <br> Grade | Inactive <br> Border PHAs | mean dead <br> area | $\sigma$ | Grade Branching <br> Ratio |
| :--- | :--- | :--- | :--- | :--- |
| 0 | 0 | $3.68 \%$ | $0.21 \%$ | $48 \%$ |
| $\mathbf{0}$ | -6 | $5.73 \%$ | $0.36 \%$ | $-48 \%$ |
| $\theta$ | -12 | $68 \%$ | $2.9 \%$ | $-48 \%$ |
| $z$ | -6 | $5.53 \%$ | $0.35 \%$ | $-8 \%$ |
| 8 | 0 | $3.57 \%$ | $0.21 \%$ | $5 \%$ |
| 8 | -6 | $5.54 \%$ | $0.35 \%$ | $-5 \%$ |
| 16 | -6 | $5.54 \%$ | $0.35 \%$ | $-5 \%$ |
| $z 2$ | -6 | $5.83 \%$ | $0.37 \%$ | $-2 \%$ |
| 64 | 6 | $5.53 \%$ | $0.35 \%$ | $10 \%$ |
| 104 | -6 | $5.82 \%$ | $0.37 \%$ | $-2 \%$ |
| 208 | -6 | $5.83 \%$ | $0.37 \%$ | $-2 \%$ |

The dead area as computed for the various flight grades


Distribution of border pixel PHAs from


Dead Area Variation w/ Backgd CR Rate
$10 / 22 / 01-04 / 29 / 02$ grade-sensitive thresh $=7$






| ACIS Grades |  | ASCA Grade |
| :---: | :---: | :--- |
| 0 | 0 | Description |
| 64656869 | 2 | Single pixel events |
| 234130162 | 2 | Vertical Split Up |
| 16174849 | 4 | Vertical Split Down |
| 812136140 | 3 | Horizontal Split Right |
| 7276104108 | 6 | "L" \& Quad, upper left |
| 1011138139 | 6 | "L" \& Quad, down left |
| 18225054 | 6 | "L" \& Quad, down right |
| 8081208209 | 6 | "L" \& Quad, up right |
| 14532128 | 1 | Diagonal Split |
| 333637129 | 1 |  |
| 132133160161 | 1 |  |
| 164165 | 1 |  |
| 3692040 | 5 | "L"-shaped split with corners |
| 961441921321 | 5 |  |
| 3538445253 | 5 |  |
| 97100101131 | 5 |  |
| 134137141145 | 5 |  |
| 163166168172 | 5 |  |
| 176177193196 | 5 |  |
| 197 | 5 |  |
| 24 | 7 | 3-pixel horizontal split |
| 66 | 7 | 3-pixel vertical split |
| 255 | 7 | All pixels |
| All other grades | 7 |  |

Implementation Issues
-how different are point-like vs. diffuse srcs? Pile-up?
-border pixel distributions: derived or assumed?
-more raw mode/cuckoo runs?

