URL: http://cxc.harvard.edu/ciao3.4/acis_pileup.html
Last modified: December 2006

*AHELP for CIAO 3.4*

# pileup

Context: chandra

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## Synopsis

An overview of pileup in the Chandra ACIS detector.

## Description

Pileup is a phenomenon that is inherent to CCD detectors, such as those that comprise the ACIS instrument on−board Chandra, which "under−sample" the mirror point spread function (PSF). Simply put, it occurs whenever two or more photons are detected as a single event, and thus it represents a loss of information from these events. The degree to which this information can be "recovered" is described below. Any corrections, however, are necessarily imperfect. Thus, it is often desirable to choose instrumental set−ups that minimize the occurrence of pileup.

The likelihood of pileup occurring is significant whenever source flux levels are high enough such that there is a reasonable probability of two or more photons arriving within the same detector region within a single ACIS frame integration time (or CCD row readout time, for continuous clocking mode). The charge from a single photon event is typically read out from a 3x3 pixel island; therefore, the relevant "detector region" referred to above is larger than a single pixel. Charge clouds from neighboring events can overlap and cause events centered several pixels away from each other to become piled; see Davis 2001 (ApJ, 562, 575) for a more thorough description.

The detected energy of a piled event is approximately equal to the sum of the energies of the individual photon events of which it is comprised. If the summed energy of the piled event exceeds the on−board spacecraft threshold (typically 15 keV), it is rejected by the spacecraft software. For sufficiently bright sources, this can lead to a visible "hole" in the source image. This is because the count rate is sufficiently high that most piled events at the center of the PSF exceed the threshold energy and/or are assigned bad grades, so they are filtered out in data processing.

Piled events also suffer from "grade migration". All events detected by ACIS are assigned grades based upon the shape of their charge cloud distributions in a 3x3 pixel island. These grades are used to determine whether the detected event is from a real photon or from a background event, such as a cosmic ray hit. As the number of photon events making up a piled event increases, it is more and more likely that the grade assigned to this piled event will "migrate" to a value inconsistent with a real photon. The piled event thus will be rejected either by spacecraft software or during subsequent analysis on the ground. This effect of grade migration also contributes to the detection hole described above.

As a simple empirical description of this process of grade migration, one can assign a probability, alpha, that for each photon event beyond the first, the piled event retains a grade consistent with a real photon. Thus, in this simple model, the probability that a piled event is retained as a "real photon" is alpha^(N−1), where N is the number of photons comprising the piled event. It is very important to note here that this is an empirical description of grade migration that has been found useful in some situations. As such, alpha is an uncalibrated quantity, and is likely unsuited for some applications. Grade migration is a complex phenomenon, which in reality will depend upon details of the detector, the incident spectrum, etc. We have found, however, that within the confines of our current understanding of the physics and calibration of the detector, more complex grade migration schemes are not yet warranted.

### Pileup Models

There is one pileup model available in Sherpa: JDPILEUP, developed by John Davis at MIT. The pileup model does not work for pileup in dispersed spectra. Rather, the model was designed for imaging pileup, including pileup by the gratings in zeroth order. See "ahelp jdpileup" for more information on this model.

### Other Resources

The most complete resource on pileup in Chandra data is the Chandra ABC Guide to Pileup; the information in this help file was taken from that manual. Further technical details are available in the paper "Event Pileup in Charge Coupled Devices" by J. E. Davis (2001, ApJ, 562, 575).

For help with pileup analysis in CIAO, see the Fitting Spectral Data: Using A Pileup Model thread. There is also the comparison of the pileup correction in ISIS, Sherpa, and XSPEC webpage.

## See Also

*calibration*
: caldb

*chandra*
: coords, guide, isis, level, times

*chips*
: chips

*concept*
: autoname, parameter, stack, subspace

*dm*
: dm, dmbinning, dmcols, dmfiltering, dmimages, dmimfiltering, dmintro, dmopt, dmregions, dmsyntax

*gui*
: gui

*modules*
: paramio, pixlib, stackio

*slang*
: overview, slang, tips

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