Change ACIS-S and ACIS-I Default Aimpoint Offsets

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1 Overview

The process of cooling the ACA primary focal plane CCD from -15C to -20C in late 2006 resulted in a shift in the ACA alignment of nearly 10 arcsec. In combination with long-term alignment drift due to spacecraft warming, the ACIS target aimpoints have shifted to undesirable locations: the ACIS-S aimpoint is unnecessarily far from the focal point, and the ACIS-I aimpoint is too close to the chip edge.

On 2007-Jan-10 a meeting was held to discuss the data, assess science and operational impacts, and determine a course of action. Participants included FOT (PCAD, MP, SE, FOM), SOT (MP, aspect, USINT, lead, ACIS), and CXC calibration. The group recommendation was to change the default aimpoint offsets for ACIS-S and ACIS-I.

This memo presents data describing the alignment shift, proposes new ACIS default aimpoint offsets, and discusses the steps needed to implement the aimpoint change. The proposed new default aimpoint offsets are (in arcsec):

	Y	**Z**
ACIS-S	0	-15
ACIS-I	-12	-15

2 Definitions

Following the optical axis memo by P. Zhao, first make these definitions:

Focal point
: Point on the focal plane where the sharpest PSF is located

Optical axis
: Axis perpendicular to the focal plan a the focal point.

Aimpoint
: Point on the focal plane where the image of a source with zero Y and Z target offsets is located

ACA boresight
: Direction vector which is imaged by the ACA onto the point at the center of the ACA CCD.

Science Instrument (SI) boresight
: Direction vector which is imaged by the HRMA onto the point at the center of the SIM Translation Frame (STF, see the memo on Chandra coordinate systems by J.McDowell for complete definitions).

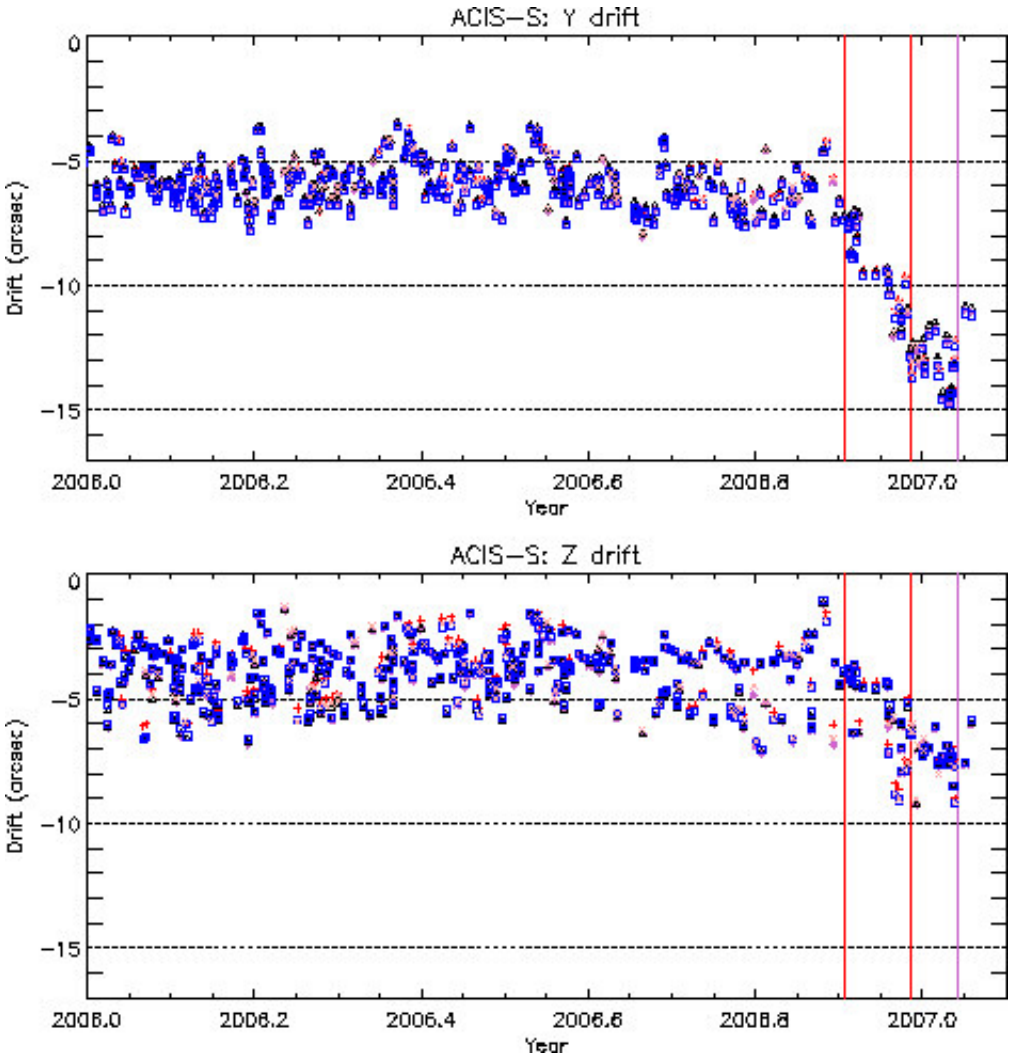
3 ACA alignment data

The primary indication of a shift in the ACA alignment derives from trending of the apparent fid light positions in the ACA field of view. If one assumes that the fiducial transfer system (retro-reflector collimator and periscope) alignment is unchanged, this gives a sensitive measure of the relative alignment of the ACA and SI boresights. Because the pointing of the spacecraft is referenced to the ACA boresight, any shift in that relative alignment results in an identical shift in the aimpoint. The fiducial transfer system is known to be stable to within approximately 0.5 arcsec based on trending of absolute astrometry errors.

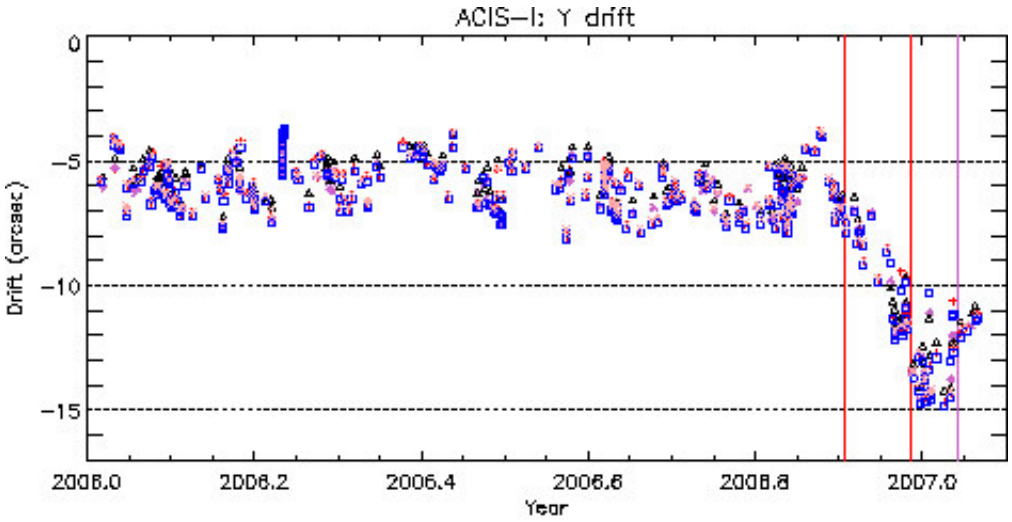
The data indicating a shift in the ACA alignment are presented in detail in the fid alignment drift web page. The key plot showing fid light position data for ACIS-S since the beginning of 2006 is shown below. The vertical red lines indicate the start and end of the ACA cooldown from -15C to -20C.

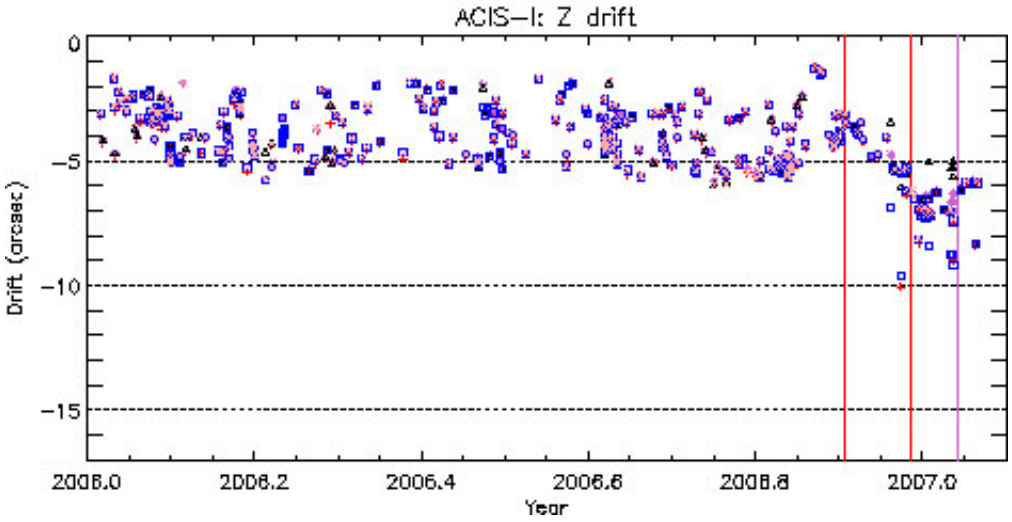
The data for these plots were generated by extracting Aspect L1 centroid data and fid properties data for all archived observations, using only last 2 ksec of data to minimize scatter due to thermal transients. A median centroid position was calculated for each fid light and adjusted for the SIM-Z offset for that observation. Finally the relative "drift" was calculated by removing the mean centroid for that fid light over observations in early 2003.

ACIS-S Fid Drift



ACIS-I Fid Drift





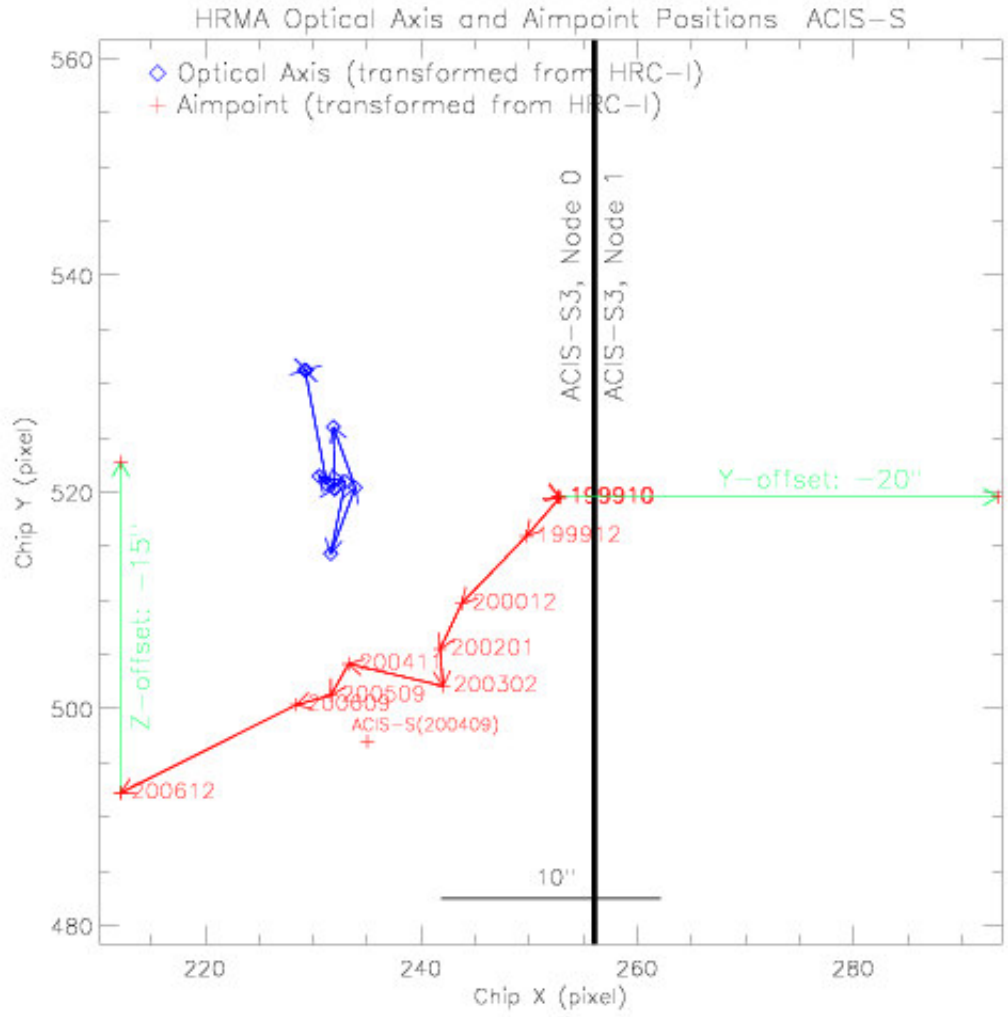
ACA CCD warm-up

These plots cover the time frame including the ACA CCD warmup to -19C that was performed on 2007-Jan-16. The associated alignment change is seen to be approximately 2.5 arcsec in the opposite direction seen in the cooldown. Given the tolerances and uncertainties in aimpoint and optical axis determination, this change alone does not merit a change in the recommended default offsets.

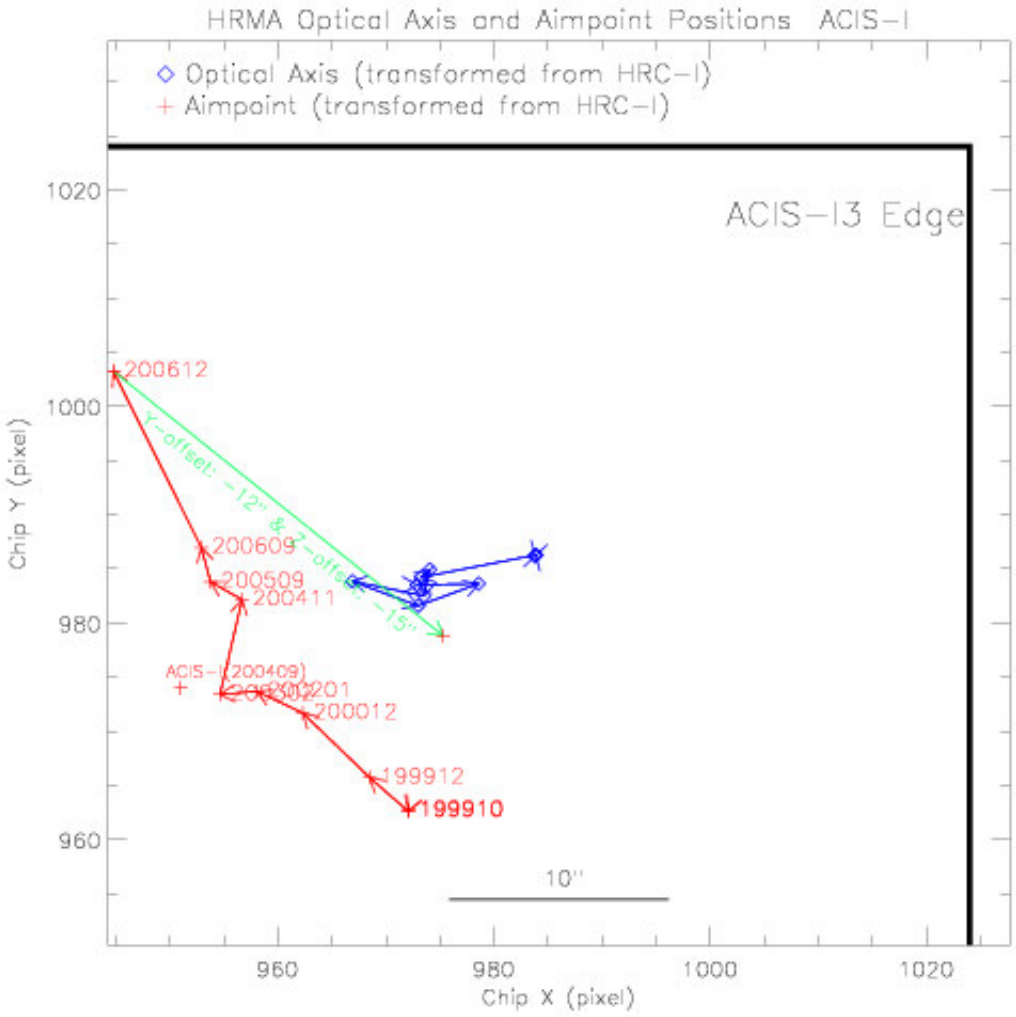
4 Current and proposed aimpoint locations

First, it should be noted that for HRC-S and HRC-I there are no issues that would require introducing default aimpoint offsets, so that is not considered here.

P. Zhao has produced plots that illustrate the time evolution of the aimpoint locations for ACIS-S and ACIS-I. In the plots one sees a red trace that shows the aimpoint location. The blue points and lines show the estimated position of the optical axis (transformed from HRC-I), and the green vectors show the effect of past, and proposed default aimpoint offsets.



The current ACIS-S default offset of +10 arcsec in Y is not shown, but it is apparent that this offset is no longer needed to maintain distance margin against crossing the node boundary. The proposed ACIS-S default offset of (Y,Z) = (0, -15) arcsec will serve to move the aimpoint closer to the optical axis while retaining a reasonable distance from the node boundary.



At present there is no default ACIS-I aimpoint offset, but in this case the aimpoint is approaching a 10 arcsec distance from teh ACIS-I3 chip edge. The proposed default offset of (Y,Z) = (-12, -15) arcsec will move the default aimpoint to within several arcsec of the estimated optical axis.

5 Implementation of change to default offsets

Data Systems

[This information provided by I. Evans]

The default target offsets (currently 0.1667 arcmin y_det_offset for ACIS-S; all others zero) are explicitly encoded in the SQL stored procedure used for ocat ingest. The target offset values (default or otherwise) are stored directly in ocat for each obsid, and that is how they get into the ORs.

The default values are also explicitly listed as the defaults in the RPS help, and also in obsvis - which is released as part of CIAO for proposal planning. The default target offsets are not encoded in any calibration data files or used elsewhere in standard data processing. No impacts to pixlib have been identified by SDS.

The updates will be requested in coordination with SDS and CDO, and the changes will require a DS release to update the stored procedure and RPS, and a CIAO patch to update obsvis.

Operations (USINT and Arcops)

In Oct-2005 the default ACIS-S aimpoint Y-offset was changed from +20 arcsec to -10 arcsec. Following the procedure used at that time, USINT will coordinate with MP and Arcops to determine potentially impacted observations and explicitly confirm with observers in cases where there is ambiguity about the intended aimpoint.

Observations that have already been ingested into ocat but not yet scheduled present a special case since there is no ocat flag to indicate that the default value was used. It is possible to track the cases where the proposer accepted the current default values in RPS by finding those entries in the proposal database that contain null entries for the offset. In some cases observers may have explicitly entered values equal to or close to the defaults.

CDO

User notification of the aimpoint change should be carried out by CDO in coordination with chapter authors. This should include:

- Items in the "Announcement" and "What's New" sections of the CXC Home page.
- Update to relevant sections of the online POG or issuance of errata.

Mission Planning

MP will change several MP tools that use the offset values:

```
make_overlay.pl
dynamic_overlay.pl
cfov.pl
```

6 Appendix

Aimpoint position validation

Listed below are coordinates for two recent (Jan 23, 2007) observations derived with dmcoords. Based on these observations the current aimpoints (with no offset) are somewhat different from Ping's analysis:

	ACIS-I		ACIS-S	
	X	**Y**	**X**	**Y**
Ping	945	1003	213	492
Obs'd	942	991	222	491

(Added +20 to observed CHIP X for ACIS-S).

Obsid 7564 (ACIS-S with Y offset = +10"):

```
ciao-ska-baffin-346: dmcoords infile=acisf07564N001_evt2.fits.gz  asolfile=pcadf285863783N001_asol1.fits.gz

dmcoords>: cel 09:48:54.60 -13:11:42.40
(RA,Dec):     09:48:54.600    -13:11:42.40
(RA,Dec):      147.22750      -13.19511 deg
THETA,PHI            7.5"         53.38 deg
(Logical):        4110.90       4101.29
SKY(X,Y):         4110.90       4101.29
DETX,DETY         4105.55       4108.68
CHIP ACIS-S3       201.63        491.16
TDET              4118.63       2193.16
```

Obsid 6408 (ACIS-I with no aimpoint offset):

```
ciao-ska-baffin-351: dmcoords infile=acisf06408N001_evt2.fits.gz asolfile=pcadf285899809N001_asol1.fits.gz

dmcoords>:  cel 05:22:50.00 +33:28:05.00
(RA,Dec):     05:22:50.000    +33:28:05.00
(RA,Dec):       80.70833       33.46806 deg
THETA,PHI           16.7"         23.02 deg
(Logical):        4079.10       4125.56
SKY(X,Y):         4079.10       4125.56
DETX,DETY         4127.67       4109.74
CHIP ACIS-I3       942.54        991.02
TDET              4140.98       4003.54
```

Obsid 7779 (ACIS-S with Y offset = +10"); ds9.reg corresponds to on-axis point source:

```
ciao-ska-baffin-364: dmstat acisf07779N001_evt2.fits.gz'[sky=region(ds9.reg)][cols chip]'
chip(chipx, chipy)[pixel]
   min:        ( 180 472 )           @:        ( 7 5 )
   max:        ( 215 505 )           @:        ( 12 23 )
  mean:        ( 198.66666667 486.62121212 )
median:        ( 199 484.5 )
 sigma:        ( 11.299414484 10.661123301 )
   sum:        ( 13112 32117 )
  good:        ( 66 66 )
  null:        ( 0 0 )
```