1 acis_process_events

This spec, which is incomplete, describes some of processing steps for continuous-clocking mode data.

1.1 Description

1.2 Input

1.3 Output

1.4 Parameters

1.5 Processing

1.5.1 Error checking

The following steps are performed once prior to the processing of the data for each input ACIS event.

1. obsfile:
   
   (a) Validation:
   
   i. Existence:

   If

   \[
   \text{obsfile} \neq \text{none and}
   \]
   \[
   \text{obsfile} \neq \text{NONE}
   \]  

   \[
   \text{obsfile} \neq \text{none}
   \]  

   and the obsfile does not exist, then obsfile is changed to “none” and acis_process_events produces a warning message.
ii. Permission:
   If
   \[ \text{obsfile} \neq \text{none} \text{ and } (3) \text{obsfile} \neq \text{NONE} \text{ (4)} \]
   and the file permissions do not allow the \text{obsfile} to be read, then \text{obsfile} is changed to “none” and \texttt{acis.process.events} produces a warning message.

iii. OBS MODE:
   If
   \[ \text{obsfile} \neq \text{none} \text{ and } (5) \text{obsfile} \neq \text{NONE} \text{ (6)} \]
   then
   A. If the \text{obsfile} does not include the keyword \texttt{obs.mode}, then OBS MODE is set to “none”.
   B. If the \text{obsfile} includes the keyword \texttt{obs.mode} and
      \[ \text{obs.mode} = \text{pointing or } \texttt{POINTING or } \texttt{secondary or } \texttt{SECONDARY}, \]
      then OBS MODE is set to the value of \texttt{obs.mode}. Hereafter this keyword is referred to as OBS MODE.
   C. If the \text{obsfile} includes the keyword \texttt{obs.mode} and
      \[ \text{obs.mode} \neq \text{pointing and } \texttt{POINTING and } \texttt{secondary and } \texttt{SECONDARY}, \]
      then OBS MODE is set to “none”.

2. infile:
   (a) Existence:
      If the \text{infile} does not exist, then \texttt{acis.process.events} exits with an error message.
   (b) Permission:
      If the \text{infile} exists and the file permissions do not allow it to be read, then \texttt{acis.process.events} exits with an error message.
   (c) Validation:
      i. OBS MODE:
         If OBS MODE = none, then
         A. The OBS MODE is read from the HDU \texttt{h.in} keyword of the same name. Hereafter this keyword is referred to as OBS MODE.
         B. If the HDU \texttt{h.in} does not include the keyword OBS MODE, then OBS MODE is set to “none” and \texttt{acis.process.events} produces a warning message.
C. If the HDU $h_{in}$ includes the keyword $\text{OBS\_MODE}$ and

\[
\begin{align*}
\text{obs\_mode} & \neq \text{pointing and} \quad (15) \\
\text{obs\_mode} & \neq \text{POINTING and} \quad (16) \\
\text{obs\_mode} & \neq \text{secondary and} \quad (17) \\
\text{obs\_mode} & \neq \text{SECONDARY,} \quad (18)
\end{align*}
\]

then $\text{OBS\_MODE}$ is set to “none” and $\text{acis\_process\_events}$ produces a warning message.

ii. DATAMODE:

The $\text{DATAMODE}$ is read from the HDU $h_{in}$ keyword of the same name. If the HDU $h_{in}$ does not include the keyword $\text{DATAMODE}$ or if

\[
\begin{align*}
\text{DATAMODE} & \neq \text{CC33\_FAINT and} \quad (19) \\
\text{DATAMODE} & \neq \text{CC33\_GRADED and} \quad (20) \\
\text{DATAMODE} & \neq \text{FAINT and} \quad (21) \\
\text{DATAMODE} & \neq \text{FAINT\_BIAS and} \quad (22) \\
\text{DATAMODE} & \neq \text{GRADED and} \quad (23) \\
\text{DATAMODE} & \neq \text{VFAINT,} \quad (24)
\end{align*}
\]

then $\text{acis\_process\_events}$ exits with an error message. Hereafter, the value of this keyword is referred to as $\text{DATAMODE}_{in}$.

iii. CONTENT:

If the $\text{infile}$ does not have an HDU $h_{in}$ with the keyword

\[
\begin{align*}
\text{CONTENT} & = \text{EVT0 or} \quad (25) \\
\text{CONTENT} & = \text{EVT1 or} \quad (26) \\
\text{CONTENT} & = \text{TGEVT1 or} \quad (27) \\
\text{CONTENT} & = \text{EVT2,} \quad (28)
\end{align*}
\]

then $\text{acis\_process\_events}$ exits with an error message. Hereafter, the value of this keyword is referred to as $\text{CONTENT}_{in}$.

iv. TIME:

If HDU $h_{in}$ of the $\text{infile}$ does not include the column $\text{TIME}$, then $\text{acis\_process\_events}$ exits with an error message. Hereafter, this column is referred to as $\text{TIME}_{in}$.

v. TIME\_RO:

If

\[
\begin{align*}
\text{DATAMODE}_{in} & = \text{CC33\_FAINT or} \quad (29) \\
\text{DATAMODE}_{in} & = \text{CC33\_GRADED} \quad (30)
\end{align*}
\]

and

\[
\begin{align*}
\text{CONTENT}_{in} & = \text{EVT1 or} \quad (31) \\
\text{CONTENT}_{in} & = \text{TGEVT1 or} \quad (32) \\
\text{CONTENT}_{in} & = \text{EVT2} \quad (33)
\end{align*}
\]

and HDU $h_{in}$ of the $\text{infile}$ does not include the column $\text{TIME\_RO}$, then $\text{acis\_process\_events}$ exits with an error message. Hereafter, this column is referred to as $\text{TIME\_RO}_{in}$.

vi. EXPNO:

If HDU $h_{in}$ the $\text{infile}$ does not include the column $\text{EXPNO}$, then $\text{acis\_process\_events}$ exits with an error message. Hereafter, this column is referred to as $\text{EXPNO}_{in}$.
vii. CCD_ID:
   A. If
   \[
   \text{CONTENT}_{\text{in}} = \text{EVT0} \quad (34)
   \]
   and HDU \( h_{\text{in}} \) of the infile does not include the keyword CCD_ID, then \text{acis\_process\_events} exits with an error message. Hereafter, this keyword is referred to as CCD_ID_{\text{in}}.
   B. If
   \[
   \begin{align*}
   \text{CONTENT}_{\text{in}} &= \text{EVT1 or} \quad (35) \\
   \text{CONTENT}_{\text{in}} &= \text{TGEVT1 or} \quad (36) \\
   \text{CONTENT}_{\text{in}} &= \text{EVT2} \quad (37)
   \end{align*}
   \]
   and HDU \( h_{\text{in}} \) of the infile does not include the column CCD_ID, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as CCD_ID_{\text{in}}.

viii. CCDX:
   A. If
   \[
   \text{CONTENT}_{\text{in}} = \text{EVT0} \quad (38)
   \]
   and HDU \( h_{\text{in}} \) of the infile does not include the column CCDX, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as CCDX_{\text{in}}.

ix. CHIPX:
   A. If
   \[
   \begin{align*}
   \text{CONTENT}_{\text{in}} &= \text{EVT1 or} \quad (39) \\
   \text{CONTENT}_{\text{in}} &= \text{TGEVT1 or} \quad (40) \\
   \text{CONTENT}_{\text{in}} &= \text{EVT2} \quad (41)
   \end{align*}
   \]
   and HDU \( h_{\text{in}} \) of the infile does not include the column CHIPX, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as CHIPX_{\text{in}}.

x. CCDY:
   A. If
   \[
   \text{CONTENT}_{\text{in}} = \text{EVT0} \quad (42)
   \]
   and
   \[
   \begin{align*}
   \text{DATAMODE}_{\text{in}} &= \text{FAINT or} \quad (43) \\
   \text{DATAMODE}_{\text{in}} &= \text{FAINT\_BIAS or} \quad (44) \\
   \text{DATAMODE}_{\text{in}} &= \text{GRADED or} \quad (45) \\
   \text{DATAMODE}_{\text{in}} &= \text{VFAINT} \quad (46)
   \end{align*}
   \]
   and HDU \( h_{\text{in}} \) of the infile does not include the column CCDY, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as CCDY_{\text{in}}.

xi. TROW:
   A. If
   \[
   \text{CONTENT}_{\text{in}} = \text{EVT0} \quad (47)
   \]
   and
   \[
   \begin{align*}
   \text{DATAMODE}_{\text{in}} &= \text{CC33\_FAINT or} \quad (48) \\
   \text{DATAMODE}_{\text{in}} &= \text{CC33\_GRADED} \quad (49)
   \end{align*}
   \]
   and HDU \( h_{\text{in}} \) of the infile does not include the column TROW, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as TROW_{\text{in}}.
xii. **CHIPY:**
A. If  
\[
\begin{align*}
\text{CONTENT}_\text{in} & = \text{EVT1 or} & (50) \\
\text{CONTENT}_\text{in} & = \text{TGEVT1 or} & (51) \\
\text{CONTENT}_\text{in} & = \text{EVT2} & (52)
\end{align*}
\]
and HDU \( h_{in} \) of the infile does not include the column \text{CHIPY}, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as \text{CHIPY}_{in}.

xiii. **TIMEDEL:**
If  
\[
\begin{align*}
\text{DATAMODE}_\text{in} & = \text{CC33\_FAINT or} & (53) \\
\text{DATAMODE}_\text{in} & = \text{CC33\_GRADED} & (54)
\end{align*}
\]
and HDU \( h_{in} \) of the infile does not include the keyword \text{TIMEDEL}, then \text{acis\_process\_events} exits with an error message. Hereafter this keyword is referred to as \text{TIMEDEL}_{in}.

xiv. **RA\_TARG, DEC\_TARG, RA\_NOM, DEC\_NOM, RA\_PNT, DEC\_PNT, CHIPY\_TG, CHIPY\_ZO, and TG\_M:**
If  
\[
\begin{align*}
\text{OBS\_MODE} & = \text{pointing or} & (55) \\
\text{OBS\_MODE} & = \text{POINTING} & (56)
\end{align*}
\]
and  
\[
\begin{align*}
\text{DATAMODE}_\text{in} & = \text{CC33\_FAINT or} & (57) \\
\text{DATAMODE}_\text{in} & = \text{CC33\_GRADED}, & (58)
\end{align*}
\]
then
A. **RA\_TARG, DEC\_TARG, RA\_NOM, DEC\_NOM, RA\_PNT, DEC\_PNT:**
If HDU \( h_{in} \) of the infile does not include the keywords RA\_TARG, DEC\_TARG, RA\_NOM, DEC\_NOM, RA\_PNT, and DEC\_PNT, then \text{acis\_process\_events} exits with an error message. Hereafter these keywords are referred to as RA\_TARG_{in}, DEC\_TARG_{in}, RA\_NOM_{in}, DEC\_NOM_{in}, RA\_PNT_{in}, and DEC\_PNT_{in}, respectively.

B. **CHIPY\_TG, CHIPY\_ZO, and TG\_M:**
If  
\[
\text{CONTENT}_\text{in} = \text{TGEVT1} & (59)
\]
and HDU \( h_{in} \) of the infile does not include the columns CHIPY\_TG, CHIPY\_ZO, and TG\_M, then \text{acis\_process\_events} exits with an error message. Hereafter these columns are referred to as CHIPY\_TG_{in}, CHIPY\_ZO_{in}, and TG\_M_{in}, respectively.

3. **stop:**
(a) Lowercase:
The parameter string is converted to contain only lower case letters.
(b) Validation:
   i. Setting:
      If  
      \[
      \text{stop} \neq \text{none} \quad (60)
      \]
then $\text{stop}$ is changed to “none” and $\text{acis\_process\_events}$ produces a warning message.

ii. $\text{OBS\_MODE}$:

If

\begin{align*}
\text{OBS\_MODE} & \neq \text{pointing and} \quad (66) \\
\text{OBS\_MODE} & \neq \text{POINTING} \quad (67)
\end{align*}

and

\begin{align*}
\text{stop} & \neq \text{none and} \quad (68) \\
\text{stop} & \neq \text{chip and} \quad (69) \\
\text{stop} & \neq \text{tdet}, \quad (70)
\end{align*}

then $\text{stop}$ is changed to “none” and $\text{acis\_process\_events}$ produces a warning message.

4. $\text{acaofffile}$:

(a) Validation for CC mode:

If

\begin{align*}
\text{OBS\_MODE} & = \text{pointing or} \quad (71) \\
\text{OBS\_MODE} & = \text{POINTING} \quad (72)
\end{align*}

and

\begin{align*}
\text{DATAMODE}\text{\_in} & = \text{CC33\_FAINT or} \quad (73) \\
\text{DATAMODE}\text{\_in} & = \text{CC33\_GRADED}, \quad (74)
\end{align*}

then

i. Setting:

If

\begin{align*}
\text{acaofffile} & = \text{none or} \quad (75) \\
\text{acaofffile} & = \text{NONE}, \quad (76)
\end{align*}

then $\text{acis\_process\_events}$ exits with an error message.

ii. Existence:

If the $\text{acaofffile}$ does not exist, then $\text{acis\_process\_events}$ exits with an error message.

iii. Permission:

If the $\text{acaofffile}$ exists and the file permissions do not allow it to be read, then $\text{acis\_process\_events}$ exits with an error message.

iv. CONTENT:

If the $\text{acaofffile}$ does not have an HDU $h_{\text{acaoff}}$ with the keyword

\begin{align*}
\text{CONTENT} & = \text{ASPSOL}, \quad (77)
\end{align*}

then $\text{acis\_process\_events}$ exits with an error message.
v. Keyword:
If HDU $h_{\text{acaoff}}$ of the $\text{acaofffile}$ does not include the keyword \text{TSTART}, then \text{acis\_process\_events} exits with an error message.

vi. Columns:
If HDU $h_{\text{acaoff}}$ of the $\text{acaofffile}$ does not include the columns \text{TIME}, \text{RA}, \text{DEC}, and \text{ROLL} then \text{acis\_process\_events} exits with an error message. Hereafter, these columns are referred to as $\text{TIME}_{\text{acaoff}}$, $\text{RA}_{\text{acaoff}}$, $\text{DEC}_{\text{acaoff}}$, and $\text{ROLL}_{\text{acaoff}}$.

vii. Sequential:
If more than one valid $\text{acaofffile}$ is specified and the values $\text{TSTART}$ are not in increasing order, then \text{acis\_process\_events} exits with an error message.

5. \text{doevtgrade}:
   (a) Lowercase:
The parameter string is converted to contain only lower case letters.
   (b) Validation:
      
      \[
      \begin{align*}
      \text{doevtgrade} &= \text{yes and} \\
      \text{doevtgrade} &= \text{no},
      \end{align*}
      \]

      then \text{acis\_process\_events} exits with an error message.

6. \text{apply\_cti}:
   (a) Lowercase:
The parameter string is converted to contain only lower case letters.
   (b) Validation:
      i. Setting:
      
      \[
      \begin{align*}
      \text{apply\_cti} &= \text{yes and} \\
      \text{apply\_cti} &= \text{no},
      \end{align*}
      \]

      then \text{acis\_process\_events} exits with an error message.
 ii. PHAS:
      
      \[
      \text{apply\_cti} = \text{yes}
      \]

      and the $\text{infile}$ does not include the column \text{PHAS}, then \text{apply\_cti} is changed to “no” and \text{acis\_process\_events} produces a warning message.
      iii. doevtgrade:
      
      \[
      \begin{align*}
      \text{apply\_cti} &= \text{yes and} \\
      \text{doevtgrade} &= \text{no},
      \end{align*}
      \]

      then \text{apply\_cti} is changed to “no” and \text{acis\_process\_events} produces a warning message.

7. \text{alignmentfile}:
(a) Validation for CC mode:
If
\[
\text{OBS\_MODE} = \text{pointing or } \text{OBS\_MODE} = \text{POINTING} \quad (85)
\]
and
\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \text{ or } \text{CC33\_GRADED}, \quad (87)
\]
then
i. Setting:
If
\[
\text{alignmentfile} = \text{none or } \text{alignmentfile} = \text{NONE}, \quad (89)
\]
then \texttt{acis\_process\_events} exits with an error message.
ii. Existence:
If the \text{alignmentfile} does not exist, then \texttt{acis\_process\_events} exits with an error message.
iii. Permission:
If the \text{alignmentfile} exists and the file permissions do not allow it to be read, then \texttt{acis\_process\_events} exits with an error message.
iv. CONTENT:
If the \text{alignmentfile} does not have an HDU $h_{\text{alignment}}$ with the keyword
\[
\text{CONTENT} = \text{ASPSOL}, \quad (91)
\]
then \texttt{acis\_process\_events} exits with an error message.
v. Keyword:
If HDU $h_{\text{alignment}}$ of the \text{alignmentfile} does not include the keyword \text{TSTART}, then \texttt{acis\_process\_events} exits with an error message.
vi. Columns:
If HDU $h_{\text{alignment}}$ of the \text{alignmentfile} does not include the columns \text{DY}, \text{DZ}, and \text{DTHETA} then \texttt{acis\_process\_events} exits with an error message.
vii. Sequential:
If more than one valid \text{alignmentfile} is specified and the values \text{TSTART} are not in increasing order, then \texttt{acis\_process\_events} exits with an error message.

8. badpixfile:
(a) Validation:
i. Existence:
If
\[
\text{badpixfile} \neq \text{none and } \text{badpixfile} \neq \text{NONE} \quad (92)
\]
and the \text{badpixfile} does not exist, then \text{badpixfile} is changed to “none” and \texttt{acis\_process\_events} produces a warning message.
ii. Permission:
   If
   \[
   \text{badpixfile} \neq \text{none and } \text{badpixfile} \neq \text{NONE} \tag{94}
   \]
   and the file permissions do not allow it to be read, then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message.

iii. CONTENT:
   If
   \[
   \text{badpixfile} \neq \text{none and } \text{badpixfile} \neq \text{NONE} \tag{96}
   \]
   and the \text{badpixfile} does not have one or more HDUs \(h_{\text{badpix}}\) with the keyword
   \[
   \text{CONTENT} = \text{BADPIX} \text{ or } \text{CONTENT} = \text{CDB\_ACIS\_BADPIX}, \tag{98}
   \]
   then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message.

iv. Keyword:
   If
   \[
   \text{badpixfile} \neq \text{none and } \text{badpixfile} \neq \text{NONE} \tag{100}
   \]
   and the HDU(s) \(h_{\text{badpix}}\) of the \text{badpixfile} do not include the keyword \text{CCD\_ID}, then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message. Hereafter this keyword is referred to as \text{CCD\_ID}_{\text{badpix}}.

v. Columns:
   If
   \[
   \text{badpixfile} \neq \text{none and } \text{badpixfile} \neq \text{NONE} \tag{102}
   \]
   and the HDU(s) \(h_{\text{badpix}}\) of the \text{badpixfile} do not include the columns \text{CHIP}X, \text{CHIP}Y, \text{TIME}, \text{TIME\_STOP}, and \text{STATUS}, then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message. Hereafter these columns are referred to as \text{CHIP}X_{\text{badpix}}, \text{CHIP}Y_{\text{badpix}}, \text{TIME}_{\text{badpix}}, \text{TIME\_STOP}_{\text{badpix}}, and \text{STATUS}_{\text{badpix}}, respectively.

9. \text{ctifile}:
   (a) Validation:
      If
      \[
      \text{ctifile} \neq \text{caldb and } \text{ctifile} \neq \text{CALDB} \tag{104}
      \]
      then
      i. Existence:
         If the \text{ctifile} does not exist, then \text{apply\_cti} is changed to “no” and \text{acis\_process\_events} produces a warning message.
ii. Permission:
If the ctifile exists and the file permissions do not allow it to be read, then `apply_cti` is changed to “no” and `acis_process_events` produces a warning message.

iii. CONTENT:
If the ctifile does not have one or more HDUs $h_{cti}$ with the keyword
\[
\text{CONTENT} = \text{CDB\_ACIS\_CTI},
\]
then `apply_cti` is changed to “no” and `acis_process_events` produces a warning message.

iv. Columns:
If the first such HDU of the ctifile does not include the columns CCD\_ID, CHIPX\_LO, CHIPX\_HI, CHIPY\_LO, CHIPY\_HI, PHA, VOLUME\_X, VOLUME\_Y, FRCTRLX, FRCTRLY, TCTIX, and TCTIY, then `apply_cti` is changed to “no” and `acis_process_events` produces a warning message.

10. `clobber`:
   (a) Lowercase:
The parameter string is converted to contain only lower case letters.
   (b) Validation:
      i. Setting:
         If
         \[
         \text{clobber} \neq \text{yes and } \text{clobber} \neq \text{no},
         \]
         then `clobber` is changed to “no” and `acis_process_events` produces a warning message.
      ii. Permission:
         If
         \[
         \text{clobber} = \text{yes}
         \]
         and the outfile exists and the file permissions of the outfile do not allow it to be overwritten, then `acis_process_events` exits with an error message.
      iii. Don’t overwrite:
         If
         \[
         \text{clobber} = \text{no}
         \]
         and the outfile exists, then `acis_process_events` exits with an error message.

11. `pix_adj`:
   (a) Lowercase:
The parameter string is converted to contain only lower case letters.
   (b) Validation:
      i. Setting:
         If
         \[
         \text{pix\_adj} \neq \text{centroid and } \text{pix\_adj} \neq \text{edser and } \text{pix\_adj} \neq \text{none and } \text{pix\_adj} \neq \text{randomize},
         \]
         then `pix_adj` is changed to “none” and `acis_process_events` produces a warning message.
ii. OBS.MODE:
   If
   \[
   \text{OBS.MODE} \neq \text{pointing and } \text{OBS.MODE} \neq \text{POINTING}
   \]  
   (115)
   and
   \[
   \text{pix.adj} \neq \text{none}
   \]  
   (117)
   then pix.adj is changed to “none” and acis.process.events produces a warning message.

iii. stop:
   If
   \[
   \text{pix.adj} = \text{centroid or } \text{pix.adj} = \text{edser or } \text{pix.adj} = \text{randomize}
   \]  
   (118)
   (119)
   (120)
   and
   \[
   \text{stop} \neq \text{sky}
   \]  
   (121)
   then pix.adj is changed to “none” and acis.process.events produces a warning message.

iv. PHAS:
   If
   \[
   \text{pix.adj} = \text{centroid}
   \]  
   (122)
   and the infile does not include the column PHAS, then pix.adj is changed to “none” and acis.process.events produces a warning message.

v. FLTGRADE:
   If
   \[
   \text{pix.adj} = \text{edser}
   \]  
   (123)
   and the infile does not include the column FLTGRADE, then pix.adj is changed to “none” and acis.process.events produces a warning message.

12. subpixfile:
   (a) If
   \[
   \text{pix.adj} = \text{edser}
   \]  
   (124)
   then
   i. Existence:
      If the subpixfile does not exist, then pix.adj is changed to “none” and acis.process.events produces a warning message.
   ii. Permission:
      If the subpixfile exists and the file permissions do not allow it to be read, then pix.adj is changed to “none” and acis.process.events produces a warning message.
   iii. Validation:
A. CONTENT:
If the subpixfile does not have one or more HDUs h_subpix with the keyword

\[
\text{CONTENT} = \text{AXAF\_SUBPIX}, \quad (125)
\]
then pix_adj is changed to “none” and acis_process_events produces a warning message.

B. Keyword:
If the HDUs h_subpix of the subpixfile do not include the keyword CCD\_ID, then pix_adj is changed to “none” and acis_process_events produces a warning message.

C. Columns:
If the HDUs h_subpix of the subpixfile do not include binary tables with the columns FLTGRADE, NPOINTS, ENERGY, CHIPX\_OFFSET, and CHIPY\_OFFSET, then pix_adj is changed to “none” and acis_process_events produces a warning message. Hereafter these columns are referred to as FLTGRADE\_subpix, NPOINTS\_subpix, ENERGY\_subpix, CHIPX\_OFFSET\_subpix, and CHIPY\_OFFSET\_subpix, respectively.

1.5.2 Initializations

1. Focal-point CCD:
   If

\[
\text{OBS\_MODE} = \text{pointing or} \quad (126)
\]

\[
\text{OBS\_MODE} = \text{POINTING} \quad (127)
\]

and

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or} \quad (128)
\]

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \quad (129)
\]

then the values of RA\_PNT\_in and DEC\_PNT\_in are used to determine the CCD\_ID associated with the focal point. Hereafter this value is referred to as CCD\_ID\_focus.

2. Zeroth-order coordinates:
   If

\[
\text{OBS\_MODE} = \text{pointing or} \quad (130)
\]

\[
\text{OBS\_MODE} = \text{POINTING} \quad (131)
\]

and

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or} \quad (132)
\]

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \quad (133)
\]

and

\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1}, \quad (134)
\]

then the CHIPY\_ZO\_in coordinates are processed to obtain the median value:

\[
\text{CHIPY\_ZO}_{\text{med}} = \text{median} (\text{CHIPY\_ZO}_{\text{in}}). \quad (135)
\]

*The focal point is the location associated with the optical axis in the absence of dither. This location should not be confused with the aim point, which is the location illuminated by an undithered point source provided that the source is not offset from the target location.
The calculation of this CHIPY\_ZO statistic is performed using only the events for which

\[ \text{CHIPY\_ZO} \neq \text{NULL} \] (136)

and the TIME is in a good-time interval.\(^1\)

3. acaofffile:

   (a) TIME\(_{\text{min}}\) and TIME\(_{\text{max}}\):

      If

      \[
      \begin{align*}
      \text{OBS\_MODE} & = \text{pointing or} \\
      \text{OBS\_MODE} & = \text{POINTING},
      \end{align*}
      \]

      then the acaofffile data are processed to determine the earliest and latest times for which there is aspect information:

      \[
      \begin{align*}
      \text{TIME}_{\text{min}} & = \min (\text{TIME}_{\text{acaoff}}) \text{ and} \\
      \text{TIME}_{\text{max}} & = \max (\text{TIME}_{\text{acaoff}}).
      \end{align*}
      \]

   (b) If

      \[
      \begin{align*}
      \text{OBS\_MODE} & = \text{pointing or} \\
      \text{OBS\_MODE} & = \text{POINTING}
      \end{align*}
      \]

      and

      \[
      \begin{align*}
      \text{DATAMODE} & = \text{CC33\_FAINT or} \\
      \text{DATAMODE} & = \text{CC33\_GRADED},
      \end{align*}
      \]

      then

      i. RA\(_c\) and DEC\(_c\):

      The acaofffile data are processed to determine the right ascension and declination coordinates near the center of the dither pattern:

      \[
      \begin{align*}
      \text{RA}_c & = \text{median (RA}_{\text{acaoff}}) \text{ and} \\
      \text{DEC}_c & = \text{median (DEC}_{\text{acaoff}}).
      \end{align*}
      \]

      ii. TIME\(_c\):

      The acaofffile data are processed to determine the time TIME\(_c\) at which the quantity

      \[
      \cos (\text{DEC}_{\text{acaoff}}) \cos (\text{DEC}_c) \cos (\text{RA}_{\text{acaoff}} - \text{RA}_c) + \sin (\text{DEC}_{\text{acaoff}}) \sin (\text{DEC}_c)
      \]

      is maximized (i.e. the time at which the telescope is pointed the closest to (RA\(_c\), DEC\(_c\)).

      iii. RA\(_{\text{ADJ}1}\), DEC\(_{\text{ADJ}1}\), RA\(_{\text{ADJ}8}\), DEC\(_{\text{ADJ}8}\):

      The effective values of RA and DEC are computed for the ACIS-I and ACIS-S arrays. These coordinates are used to determine the values of TIME and CHIPY\_ADJ.

A. ACIS-I aim point:

   For the ACIS-I array, the values of RA\(_{\text{ADJ}1}\) and DEC\(_{\text{ADJ}1}\) are initialized assuming that the source is at the ACIS-I aim point [i.e. that (TIME\(_c\), CCD\_ID, CHIPX, CHIPY) = (TIME\(_c\), 3, 965, 963)\(^2\).

\(^{1}\)While it would be better to use TIME\(_{\text{RO}}\) = (CHIPY\_ZO + 1028) \times \text{TIMEDEL} to compare to the gtis, the value of TIME\(_{\text{RO}}\) has not yet been read at this point in the code.

\(^{2}\)As described in the Proposers’ Observatory Guide, the location of the aim point on the ACIS-I array has drifted with time. The location used here is within a few dozen pixels of the actual aim point, provided the default SIM\_Y and SIM\_Z offsets are used.
B. ACIS-S aim point:
For the ACIS-S array, the values of RA\_ADJS and DEC\_ADJS are initialized assuming that the source is at the ACIS-S aim point [i.e. that (TIME\_c, CCD\_ID, CHIPX, CHIPY) = (TIME\_c, 7, 227, 509)]\(^8\).

C. Target location:
For the CCD at the focal point (i.e. CCD\_ID\_focus), the values of CHIPY are computed for each row of the acaoofffile, assuming that the source is at the location specified by RA\_TARG\_in and DEC\_TARG\_in. These values of CHIPY are referred to as CHIPY\_TARG. If

\[
\text{median}(\text{CHIPY}\_\text{TARG}) \geq 16.5 \text{ and (148)} \\
\text{median}(\text{CHIPY}\_\text{TARG}) < 1008.5 \text{ and (149)} \\
\text{CCD\_ID}\_\text{focus} \geq 0 \text{ and (150)} \\
\text{CCD\_ID}\_\text{focus} \leq 3, \text{ (151)}
\]

then

\[
\text{RA\_ADJS}_1 = \text{RA\_TARG}_\text{in} \text{ and (152)} \\
\text{DEC\_ADJS}_1 = \text{DEC\_TARG}_\text{in}. \text{ (153)}
\]

If

\[
\text{median}(\text{CHIPY}\_\text{TARG}) \geq 16.5 \text{ and (154)} \\
\text{median}(\text{CHIPY}\_\text{TARG}) < 1008.5 \text{ and (155)} \\
\text{CCD\_ID}\_\text{focus} \geq 4 \text{ and (156)} \\
\text{CCD\_ID}\_\text{focus} \leq 9, \text{ (157)}
\]

then

\[
\text{RA\_ADJS}_S = \text{RA\_TARG}_\text{in} \text{ and (158)} \\
\text{DEC\_ADJS}_S = \text{DEC\_TARG}_\text{in}. \text{ (159)}
\]

1.5.3 Loop over events
The following steps are performed, in sequence, for each event.

1. STATUS:
   (a) Exists:
      If HDU \( h_{in} \) of the infile includes a 32-bit column named STATUS, then
      i. The values of the bits for an event are read from the infile.
      ii. The value of STATUS\([k]\) is set to zero for bits \( k = 1\)–5, 14, 16–19, and 23 (of 0–31), bits that can be set by acis\_process\_events.
      iii. If doevtgrade = yes, then the value of STATUS\([20]\), the other bit that can be set by acis\_process\_events, is set to zero.
   (b) Does not exist:
      If HDU \( h_{in} \) does not include a 32-bit column named STATUS, then

\(^8\)Again, the location used here is within a few dozen pixels of the actual aim point, provided the default SIM\_Y and SIM\_Z offsets are used.
i. A set of 32 bits are allocated for the event.
ii. The values of the 32 bits are initialized to zero.

2. EXPNO:
   (a) Read:
   The value of EXPNO for an event is given by \( \text{EXPNO}_m \).
   (b) Validation:
   If
   \[
   \begin{align*}
   \text{EXPNO} &< 0 \quad \text{or} \quad (161) \\
   \text{EXPNO} &\geq 10^8, \quad (162)
   \end{align*}
   \]
   then \text{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which one or the other of these conditions is true. These values should not occur.

3. CCD_ID:
   (a) Read:
   The value of CCD_ID for an event is given by \( \text{CCD}\_\text{ID}_m \).
   (b) Validation:
   If
   \[
   \begin{align*}
   \text{CCD}\_\text{ID} &< 0 \quad \text{or} \quad (163) \\
   \text{CCD}\_\text{ID} &> 9, \quad (164)
   \end{align*}
   \]
   then \text{acis\_process\_events} exits with an error message because CCD_ID-dependent computations could fail if the value of CCD_ID is unphysical.

4. CHIPX:
   (a) Read:
   i. Level 0:
   If
   \[
   \text{CONTENT}_m = \text{EVT0}, \quad (165)
   \]
   then the value of CHIPX for an event is given by
   \[
   \text{CHIPX} = \text{CCDX}_m + 1. \quad (166)
   \]
   ii. Level 1, 1.5, or 2:
   If
   \[
   \begin{align*}
   \text{CONTENT}_m & = \text{EVT1 or} \quad (167) \\
   \text{CONTENT}_m & = \text{TGEVT1 or} \quad (168) \\
   \text{CONTENT}_m & = \text{EVT2}, \quad (169)
   \end{align*}
   \]
   then the value of CHIPX for an event is given by \( \text{CHIPX}_m \).
   (b) Validation:
i. Unphysical:
   If
   \[ \text{CHIPX} < 1 \text{ or } \text{CHIPX} > 1024, \]  \hspace{1cm} (170)
   then \texttt{acis\_process\_events} exits with an error message because \texttt{CHIPX}-dependent computations could fail if the value of \texttt{CHIPX} is unphysical.

ii. Unexpected:
   If
   \[ \text{CHIPX} = 1 \text{ or } \text{CHIPX} = 1024, \]  \hspace{1cm} (172)
   then \texttt{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which one or the other of these conditions is true. Although these values are not unphysical, they should not occur.

5. \texttt{NODE\_ID}:
   (a) Calculate:
   The \texttt{NODE\_ID} of an event is given by
   \[ \text{NODE\_ID} = \text{int} \left( \frac{\text{CHIPX} - 1}{256} \right), \]  \hspace{1cm} (174)
   where “int” means the integer portion of (i.e. truncate or round down) the quantity in parentheses.

6. \texttt{CHIPY}:
   (a) Read:
   i. Level 0:
   If
   \[ \text{CONTENT}_n = \text{EVT0}, \]  \hspace{1cm} (175)
   then
   A. TE mode:
   If
   \[ \text{DATAMODE}_n = \text{FAINT} \text{ or } \text{DATAMODE}_n = \text{FAINT\_BIAS} \text{ or } \text{DATAMODE}_n = \text{GRADED} \text{ or } \text{DATAMODE}_n = \text{VFAINT}, \]  \hspace{1cm} (176) (177) (178) (179)
   then the value of \texttt{CHIPY} for an event is given by
   \[ \text{CHIPY} = \text{CCDY}_n + 1. \]  \hspace{1cm} (180)
   B. CC mode:
   If
   \[ \text{DATAMODE}_n = \text{CC33\_FAINT} \text{ or } \text{DATAMODE}_n = \text{CC33\_GRADED}, \]  \hspace{1cm} (181) (182)
   then the value of \texttt{CHIPY} for an event is given by
   \[ \text{CHIPY} = \text{TROW}_n + 1. \]  \hspace{1cm} (183)
ii. Level 1, 1.5, or 2:
   If
   
   \[ \text{CONTENT}_{\text{in}} = \text{EVT1 or TGEVT1 or EVT2}, \]

   then the value of CHIPY for an event is given by CHIPY_{\text{in}}.

(b) Validation:
   i. Unphysical:
      A. TE mode:
         If
         
         \[ \text{DATAMODE}_{\text{in}} = \text{FAINT or FAINT\_BIAS or GRADED or VFAINT}, \]

         then acis\_process\_events exits with an error message because CHIPY-dependent computations could fail if the value of CHIPY is unphysical.

      B. CC mode:
         If
         
         \[ \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or CC33\_GRADED}, \]

         then acis\_process\_events exits with an error message because the CHIPY value is out of range and CHIPY-dependent computations could fail if the value of CHIPY is unphysical (especially if it is less than 1).

   ii. Unexpected:
      A. FAINT, FAINT\_BIAS, or GRADED:
         If
         
         \[ \text{DATAMODE}_{\text{in}} = \text{FAINT or FAINT\_BIAS or GRADED}, \]

         then acis\_process\_events produces a warning upon completion with a count of the total number of events for which one or the other of these conditions is true. Although these values are not unphysical, they should not occur.
B. VFAINT:
If

\[ \text{DATAMODE}_{in} = \text{VFAINT} \quad (202) \]

and

\[ \text{CHIPY} = 1 \] or \[ (203) \]
\[ \text{CHIPY} = 2 \] or \[ (204) \]
\[ \text{CHIPY} = 1023 \] or \[ (205) \]
\[ \text{CHIPY} = 1024. \] \[ (206) \]

then \text{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which one or another of these conditions is true. Although these values are not unphysical, they should not occur.

C. CC33\_FAINT or CC33\_GRADED:
If

\[ \text{DATAMODE}_{in} = \text{CC33\_FAINT or} \quad (207) \]
\[ \text{DATAMODE}_{in} = \text{CC33\_GRADED} \quad (208) \]

and

\[ \text{CHIPY} = 1 \] or \[ (209) \]
\[ \text{CHIPY} = 512, \] \[ (210) \]

then \text{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which one or the other of these conditions is true. Although these values are not unphysical, they should not occur.

7. \text{TG}_{M}:
(a) CC mode with gratings:
If

\[ \text{OBS\_MODE} = \text{pointing or} \quad (211) \]
\[ \text{OBS\_MODE} = \text{POINTING} \quad (212) \]

and

\[ \text{DATAMODE}_{in} = \text{CC33\_FAINT or} \quad (213) \]
\[ \text{DATAMODE}_{in} = \text{CC33\_GRADED} \quad (214) \]

and

\[ \text{CONTENT}_{in} = \text{TGEVT1}, \quad (215) \]

then

i. Read:
The value of \text{TG}_{M} for an event is given by \text{TG}_{M}_{in}.

ii. Validation:
A. If
\[ TG_M < -99, \]  
\hspace{1cm} \text{(216)}
then
\[ TG_M = -99 \]  
\hspace{1cm} \text{(217)}
and \texttt{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which this condition is true. These values should not occur.

B. If
\[ TG_M > 99, \]  
\hspace{1cm} \text{(218)}
then
\[ TG_M = 99 \]  
\hspace{1cm} \text{(219)}
and \texttt{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which this condition is true. These values should not occur.

8. \texttt{CHIPY\_TG}:

(a) CC mode with gratings:
  
  If
  \[ \text{OBS\_MODE} = \text{pointing or} \]  
  \hspace{1cm} \text{(220)}
  \[ \text{OBS\_MODE} = \text{POINTING} \]  
  \hspace{1cm} \text{(221)}
  and
  \[ \text{DATAMODE}_{in} = \text{CC33\_FAINT or} \]  
  \hspace{1cm} \text{(222)}
  \[ \text{DATAMODE}_{in} = \text{CC33\_GRADED} \]  
  \hspace{1cm} \text{(223)}
  and
  \[ \text{CONTENT}_{in} = \text{TGEVT1}, \]  
  \hspace{1cm} \text{(224)}
then
  i. Read:
  The value of \texttt{CHIPY\_TG} for an event is given by \texttt{CHIPY\_TG}_{in}.
  ii. Validation:

  A. If
  \[ TG_M > -99 \text{ and} \]  
  \hspace{1cm} \text{(225)}
  \[ TG_M < 99 \text{ and} \]  
  \hspace{1cm} \text{(226)}
  \[ \text{CHIPY\_TG} \neq \text{NULL} \]  
  \hspace{1cm} \text{(227)}
  and
  \[ \text{CHIPY\_TG} \leq 0 \text{ or} \]  
  \hspace{1cm} \text{(228)}
  \[ \text{CHIPY\_TG} \geq 1025, \]  
  \hspace{1cm} \text{(229)}
then \texttt{acis\_process\_events} exits with an error message because \texttt{CHIPY\_TG}-dependent computations could fail if the value of \texttt{CHIPY\_TG} is unphysical.
B. If

\[ \text{TG}_M > -99 \text{ and } \text{TG}_M < 99 \text{ and } \text{CHIPY}_T \neq \text{NULL} \text{ and } \text{CHIPY}_T < 1, \]  

then

\[ \text{CHIPY}_T = 1. \]  

C. If

\[ \text{TG}_M > -99 \text{ and } \text{TG}_M < 99 \text{ and } \text{CHIPY}_T \neq \text{NULL} \text{ and } \text{CHIPY}_T > 1024, \]  

then

\[ \text{CHIPY}_T = 1024. \]  

9. CHIPYZO:

(a) CC mode with gratings:

If

\[ \text{OBS\_MODE} = \text{pointing or } \text{POINTING} \]  

and

\[ \text{DATAMODE}_{in} = \text{CC33\_FAINT or } \text{GRADED} \]  

and

\[ \text{CONTENT}_{in} = \text{TGEVT1}, \]  

then

i. Read:

The value of CHIPYZO for an event is given by CHIPYZO_{in}.

10. TIMERO:

(a) CC mode:

If

\[ \text{DATAMODE}_{in} = \text{CC33\_FAINT or } \text{GRADED}, \]  

then

i. Read:
A. Level 0:
If

\[ CONTENT_{in} = EVT0, \]  
(247)

then the value of TIME\_RO for an event is given by TIME\_in.

B. Level 1, 1.5, or 2:
If

\[ CONTENT_{in} = EVT1 \]  
(248)
\[ CONTENT_{in} = TGEVT1 \]  
(249)
\[ CONTENT_{in} = EVT2 \]  
(250)

and

\[ TIME\_RO_{in} > 0, \]  
(251)

then

\[ TIME\_RO = TIME\_RO_{in}. \]  
(252)

If

\[ CONTENT_{in} = EVT1 \]  
(253)
\[ CONTENT_{in} = TGEVT1 \]  
(254)
\[ CONTENT_{in} = EVT2 \]  
(255)

and

\[ TIME\_RO_{in} = 0, \]  
(256)

then

\[ TIME\_RO = TIME_{in}. \]  
(257)

ii. Validation:
If

\[ TIME\_RO < 0 \]  
(258)
\[ TIME\_RO \geq 3 \times 10^9, \]  
(259)

then acis\_process\_events produces a warning upon completion with a count of the total number of events for which one or the other of these conditions is true. These values should not occur.

11. TIME and CHIPY\_ADJ:

(a) Read or calculate:

i. TE mode:
If

\[ DATAMODE_{in} = FAINT \]  
(260)
\[ DATAMODE_{in} = FAINT\_BIAS \]  
(261)
\[ DATAMODE_{in} = GRADED \]  
(262)
\[ DATAMODE_{in} = VFAIN, \]  
(263)
then

\[
\text{TIME} = \text{TIME}_\text{in} \quad \text{and} \quad \text{CHIPY}_\text{ADJ} = \text{CHIPY}.
\]  

(264)

(265)

ii. Pointing CC mode without grating data:

If

\[
\text{OBS}_\text{MODE} = \text{pointing} \quad \text{or} \quad \text{OBS}_\text{MODE} = \text{POINTING}
\]

(266)

(267)

and

\[
\text{DATAMODE}_\text{in} = \text{CC33}_{, \text{FAINT}} \quad \text{or} \quad \text{DATAMODE}_\text{in} = \text{CC33}_{, \text{GRADED}}
\]

(268)

(269)

and

\[
\text{CONTENT}_\text{in} = \text{EVT0} \quad \text{or} \quad \text{CONTENT}_\text{in} = \text{EVT1} \quad \text{or} \quad \text{CONTENT}_\text{in} = \text{EVT2},
\]

(270)

(271)

(272)

then

A. **TIME**:  
The approximate time of arrival

\[
\text{TIME}' = \text{TIME}_\text{RO} - (512 + 1028) \times \text{TIMEDEL}_\text{in}.
\]

(273)

B. **CHIPY\_ADJ**:  
If

\[
\text{CCD}_\text{ID}_{\text{focus}} \geq 0 \quad \text{and} \quad \text{CCD}_\text{ID}_{\text{focus}} \leq 3,
\]

(274)

(275)

then **CHIPY\_ADJ** (the approximate value of **CHIPY\_ADJ**) is given by the **CHIPY** location (on the focal-point CCD) of the coordinates **RA\_ADJ**\text{I} and **DEC\_ADJ**\text{I} using the orientation of the telescope (i.e. **RA**, **DEC**, and **ROLL**) and the SIM (i.e. **DY**, **DZ**, and **DTHETA**) at the time **TIME**. If **TIME' < TIME\_min** or **TIME' \geq TIME\_max**, then **TIME\_c** is used instead of **TIME'**. If

\[
\text{CCD}_\text{ID}_{\text{focus}} \geq 4 \quad \text{and} \quad \text{CCD}_\text{ID}_{\text{focus}} \leq 9,
\]

(276)

(277)

then **CHIPY\_ADJ** is given by the **CHIPY** location (on the focal-point CCD) of the coordinates **RA\_ADJ**\text{S} and **DEC\_ADJ**\text{S} using the orientation of the telescope (i.e. **RA**, **DEC**, and **ROLL**) and the SIM (i.e. **DY**, **DZ**, and **DTHETA**) at the time **TIME**. If **TIME' < TIME\_min** or **TIME' \geq TIME\_max**, then **TIME\_c** is used instead of **TIME'**.

C. **TIME**:  
The value of **CHIPY\_ADJ** is used to obtain a better estimate of the time of arrival

\[
\text{TIME} = \text{TIME}_\text{RO} - (\text{CHIPY\_ADJ}' + 1028) \times \text{TIMEDEL}_\text{in}.
\]

(278)
D. CHIPY\_ADJ:

If

\[
\begin{align*}
    &\text{CCD\_ID}_{\text{focus}} \geq 0 \quad \text{and} \\
    &\text{CCD\_ID}_{\text{focus}} \leq 3,
\end{align*}
\]

then the value of CHIPY\_ADJ is given by the \text{CHIPY} location (on the focal-point CCD) of the coordinates RA\_ADJ\_I and DEC\_ADJ\_I using the orientation of the telescope (i.e. RA, DEC, and ROLL) and the SIM (i.e. DY, DZ, and DTHETA) at the time \text{TIME}. If \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}}, \quad \text{then} \quad \text{TIME}_c \quad \text{is used instead of} \quad \text{TIME}.

\[
\begin{align*}
    &\text{CCD\_ID}_{\text{focus}} \geq 4 \quad \text{and} \\
    &\text{CCD\_ID}_{\text{focus}} \leq 9,
\end{align*}
\]

then the value of CHIPY\_ADJ is given by the \text{CHIPY} location (on the focal-point CCD) of the coordinates RA\_ADJ\_S and DEC\_ADJ\_S using the orientation of the telescope (i.e. RA, DEC, and ROLL) and the SIM (i.e. DY, DZ, and DTHETA) at the time \text{TIME}. If \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}}, \quad \text{then} \quad \text{TIME}_c \quad \text{is used instead of} \quad \text{TIME}.

iii. Pointing CC mode with ACIS-S grating data:

If

\[
\begin{align*}
    &\text{OBS\_MODE} = \text{pointing} \quad \text{or} \\
    &\text{OBS\_MODE} = \text{POINTING}
\end{align*}
\]

and

\[
\begin{align*}
    &\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \quad \text{or} \\
    &\text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED}
\end{align*}
\]

and

\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1}
\]

and

\[
\begin{align*}
    &\text{CCD\_ID}_{\text{focus}} \geq 4 \quad \text{and} \\
    &\text{CCD\_ID}_{\text{focus}} \leq 9,
\end{align*}
\]

then

A. Source events in GTIs:

If

\[
\begin{align*}
    &\text{TG\_M} > -99 \quad \text{and} \\
    &\text{TG\_M} < 99 \quad \text{and} \\
    &\text{CHIPY\_TG} \neq \text{NULL} \quad \text{and} \\
    &\text{TIME\_RO} - (\text{CHIPY\_TG} + 1028) \times \text{TIMEDEL}_{\text{in}} \geq \text{TIME}_{\text{min}} \quad \text{and} \\
    &\text{TIME\_RO} - (\text{CHIPY\_TG} + 1028) \times \text{TIMEDEL}_{\text{in}} < \text{TIME}_{\text{max}}
\end{align*}
\]

and \text{TIME\_RO} - (\text{CHIPY\_TG} + 1028) \times \text{TIMEDEL}_{\text{in}} \quad \text{is in a good-time interval, then}

\[
\begin{align*}
    &\text{CHIPY\_ADJ} = \text{CHIPY\_TG} \quad \text{and} \\
    &\text{TIME} = \text{TIME\_RO} - (\text{CHIPY\_ADJ} + 1028) \times \text{TIMEDEL}_{\text{in}}.
\end{align*}
\]
B. Source events not in GTIs:
If

\[ TG_M > -99 \quad \text{and} \quad TG_M < 99 \]  \hspace{1cm} (297)

and

\[ CHIPIY_{TG} = \text{NULL or} \]  \hspace{1cm} (299)
\[ TIME_{RO} - (CHIPIY_{TG} + 1028) \times TIMEDEL_{in} < TIME_{min} \quad \text{or} \]  \hspace{1cm} (300)
\[ TIME_{RO} - (CHIPIY_{TG} + 1028) \times TIMEDEL_{in} \geq TIME_{max} \]  \hspace{1cm} (301)

or \( TIME_{RO} - (CHIPIY_{TG} + 1028) \times TIMEDEL_{in} \) is not in a good-time interval, then

\[ CHIPIY_{ADJ} = CHIPIY_{Z0}_{med} \quad \text{and} \]  \hspace{1cm} (302)
\[ TIME = TIME_{RO} - (CHIPIY_{ADJ} + 1028) \times TIMEDEL_{in}. \]  \hspace{1cm} (303)

C. All background events:
If

\[ TG_M = -99 \quad \text{or} \quad TG_M = 99 \]  \hspace{1cm} (304)

then

\[ CHIPIY_{ADJ} = 512 \quad \text{and} \]  \hspace{1cm} (306)
\[ TIME = TIME_{RO} - (CHIPIY_{ADJ} + 1028) \times TIMEDEL_{in}. \]  \hspace{1cm} (307)

iv. Pointing CC mode with ACIS-I grating data:
If

\[ OBS\_MODE = \text{pointing or} \]  \hspace{1cm} (308)
\[ OBS\_MODE = \text{POINTING} \]  \hspace{1cm} (309)

and

\[ DATAMODE_{in} = \text{CC33.FAINT or} \]  \hspace{1cm} (310)
\[ DATAMODE_{in} = \text{CC33.GRADED} \]  \hspace{1cm} (311)

and

\[ CONTENT_{in} = \text{TGEVT1} \]  \hspace{1cm} (312)

and

\[ CCD\_ID_{focus} \geq 0 \quad \text{and} \]  \hspace{1cm} (313)
\[ CCD\_ID_{focus} \leq 3, \]  \hspace{1cm} (314)

then

A. \( TIME' \):
The approximate time of arrival

\[ TIME' = TIME_{RO} - (512 + 1028) \times TIMEDEL_{in}. \]  \hspace{1cm} (315)
B. CHIPY\_ADJ':

CHIPY\_ADJ' (the approximate value of CHIPY\_ADJ) is given by the CHIPY location (on the focal-point CCD) of the coordinates RA\_ADJ\_I and DEC\_ADJ\_I using the orientation of the telescope (i.e. RA, DEC, and ROLL) and the SIM (i.e. DY, DZ, and DTHETA) at the time TIME'. If TIME' is not in a good-time interval or TIME' < TIME\_min or TIME' ≥ TIME\_max, then TIME\_c is used instead of TIME'.

C. TIME:

The value of CHIPY\_ADJ' is used to obtain a better estimate of the time of arrival

\[
\text{TIME} = \text{TIME\_RO} - (\text{CHIPY\_ADJ'} + 1028) \times \text{TIMEDEL\_in}. \tag{316}
\]

D. CHIPY\_ADJ:

The value of CHIPY\_ADJ is given by the CHIPY location (on the focal-point CCD) of the coordinates RA\_ADJ\_I and DEC\_ADJ\_I using the orientation of the telescope (i.e. RA, DEC, and ROLL) and the SIM (i.e. DY, DZ, and DTHETA) at the time TIME. If TIME is not in a good-time interval or TIME < TIME\_min or TIME ≥ TIME\_max, then TIME\_c is used instead of TIME.

v. Secondary CC mode:

If

\[
\begin{align*}
\text{OBS\_MODE} & \neq \text{pointing} \quad \text{(317)} \\
\text{OBS\_MODE} & \neq \text{POINTING} \quad \text{(318)}
\end{align*}
\]

then

A. TIME:

\[
\text{TIME} = \text{TIME\_RO} - (512 + 1028) \times \text{TIMEDEL\_in}. \tag{319}
\]

B. CHIPY\_ADJ:

\[
\text{CHIPY\_ADJ} = 512. \tag{320}
\]

(b) Validation:

i. If

\[
\begin{align*}
\text{TIME} & < 0 \quad \text{(321)} \\
\text{TIME} & \geq 3 \times 10^9 \quad \text{(322)}
\end{align*}
\]

then \texttt{acis\_process\_events} produces a warning upon completion with a count of the total number of events for which one or the other of these conditions is true. These values should not occur.

ii. If

\[
\begin{align*}
\text{CHIPY\_ADJ} & < 0.5 \quad \text{(323)} \\
\text{CHIPY\_ADJ} & \geq 1024.5 \quad \text{(324)}
\end{align*}
\]

then \texttt{acis\_process\_events} exits with an error message because CHIPY\_ADJ-dependent computations could fail if the value of CHIPY\_ADJ is unphysical.

12. Bad pixel:

(a) If

\[
\begin{align*}
\text{badpixfile} & \neq \text{none} \quad \text{(325)} \\
\text{badpixfile} & \neq \text{NONE} \quad \text{(326)}
\end{align*}
\]

and the \texttt{badpixfile} includes a valid HDU \texttt{h\_badpix} where CCD\_ID\_badpix = CCD\_ID, then the HDU \texttt{h\_badpix} is searched as follows to determine if the event should have one or more STATUS bits set to one.
i. If \( \text{DATAMODE}_i = \text{CC33.FAINT} \) or \( \text{DATAMODE}_i = \text{CC33.GRADED} \) and there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0] \quad \text{and} \quad (327) \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1] \quad \text{and} \quad (328) \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r} \quad \text{and} \quad (329) \\
\text{TIME} & < \text{TIME}_{\text{STOP}_{\text{badpix},r}} \quad (330)
\end{align*}
\]

and

\[
\begin{align*}
\text{STATUS}_{\text{badpix},r}[5] & = 1 \quad \text{or} \quad (331) \\
\text{STATUS}_{\text{badpix},r}[6] & = 1 \quad \text{or} \quad (332) \\
\text{STATUS}_{\text{badpix},r}[9] & = 1, \quad (333)
\end{align*}
\]

then

\[\text{STATUS}[0] = 1 \quad (334)\]

for the event. Here \( \text{CCD.ID}_{\text{badpix}} \) is the value of the keyword \( \text{CCD.ID} \) in HDU \( h_{\text{badpix}} \) of the \text{badpixfile}. \( \text{CHIPX}_{\text{badpix},r}[0] \) and \( \text{CHIPX}_{\text{badpix},r}[1] \) are the first and second values in the vector column named \( \text{CHIPX} \) of row \( r \) of HDU \( h_{\text{badpix}} \) of the \text{badpixfile}, and \( \text{TIME}_{\text{badpix},r} \) and \( \text{TIME}_{\text{STOP}_{\text{badpix},r}} \) are the values in the columns named \( \text{TIME} \) and \( \text{TIME}_{\text{STOP}} \), respectively, of row \( r \) of HDU \( h_{\text{badpix}} \) of the \text{badpixfile}.

ii. If \( \text{DATAMODE}_i = \text{CC33.FAINT} \) or \( \text{DATAMODE}_i = \text{CC33.GRADED} \) and there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0] \quad \text{and} \quad (335) \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1] \quad \text{and} \quad (336) \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r} \quad \text{and} \quad (337) \\
\text{TIME} & < \text{TIME}_{\text{STOP}_{\text{badpix},r}} \quad (338)
\end{align*}
\]

and

\[
\begin{align*}
\text{STATUS}_{\text{badpix},r}[0] & = 1 \quad \text{or} \quad (339) \\
\text{STATUS}_{\text{badpix},r}[1] & = 1 \quad \text{or} \quad (340) \\
\text{STATUS}_{\text{badpix},r}[7] & = 1 \quad \text{or} \quad (341) \\
\text{STATUS}_{\text{badpix},r}[11] & = 1 \quad \text{or} \quad (342) \\
\text{STATUS}_{\text{badpix},r}[12] & = 1 \quad \text{or} \quad (343) \\
\text{STATUS}_{\text{badpix},r}[13] & = 1 \quad \text{or} \quad (344) \\
\text{STATUS}_{\text{badpix},r}[14] & = 1 \quad \text{or} \quad (345) \\
\text{STATUS}_{\text{badpix},r}[16] & = 1, \quad (346)
\end{align*}
\]

then

\[\text{STATUS}[4] = 1 \quad (347)\]

for the event.

iii. If \( \text{DATAMODE}_i = \text{CC33.FAINT} \) or \( \text{DATAMODE}_i = \text{CC33.GRADED} \) and there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0] \quad \text{and} \quad (348) \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1] \quad \text{and} \quad (349) \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r} \quad \text{and} \quad (350) \\
\text{TIME} & < \text{TIME}_{\text{STOP}_{\text{badpix},r}} \quad (351)
\end{align*}
\]
and

\[ \text{STATUS}_{\text{badpix},r}[8] = 1 \text{ or } \text{STATUS}_{\text{badpix},r}[10] = 1, \]

then

\[ \text{STATUS}[5] = 1 \]

for the event.

iv. If \( \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \) or \( \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \) and there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where

\[ \text{CHIPX} \geq \text{CHIPX}_{\text{badpix},r}[0] \text{ and } \]
\[ \text{CHIPX} \leq \text{CHIPX}_{\text{badpix},r}[1] \text{ and } \]
\[ \text{TIME} \geq \text{TIME}_{\text{badpix},r} \text{ and } \]
\[ \text{TIME} < \text{TIME\_STOP}_{\text{badpix},r} \]

and

\[ \text{STATUS}_{\text{badpix},r}[3] = 1, \]

then

\[ \text{STATUS}[6] = 1 \]

for the event.

v. If \( \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \) or \( \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \) and there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where

\[ \text{CHIPX} \geq \text{CHIPX}_{\text{badpix},r}[0] \text{ and } \]
\[ \text{CHIPX} \leq \text{CHIPX}_{\text{badpix},r}[1] \text{ and } \]
\[ \text{TIME} \geq \text{TIME}_{\text{badpix},r} \text{ and } \]
\[ \text{TIME} < \text{TIME\_STOP}_{\text{badpix},r} \]

and

\[ \text{STATUS}_{\text{badpix},r}[2] = 1 \text{ or } \text{STATUS}_{\text{badpix},r}[4] = 1, \]

then

\[ \text{STATUS}[8] = 1 \]

for the event.

vi. If \( \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \) or \( \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \) and there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where

\[ \text{CHIPX} \geq \text{CHIPX}_{\text{badpix},r}[0] \text{ and } \]
\[ \text{CHIPX} \leq \text{CHIPX}_{\text{badpix},r}[1] \text{ and } \]
\[ \text{TIME} \geq \text{TIME}_{\text{badpix},r} \text{ and } \]
\[ \text{TIME} < \text{TIME\_STOP}_{\text{badpix},r} \]

and

\[ \text{STATUS}_{\text{badpix},r}[15] = 1, \]

then

\[ \text{STATUS}[16] = 1 \]

for the event.
Table 1: Bad-pixel to event STATUS bit mapping

<table>
<thead>
<tr>
<th>Bad-pixel STATUS bit</th>
<th>Event STATUS bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>16</td>
<td>4</td>
</tr>
</tbody>
</table>

vii. In summary, the mapping between a bad-pixel STATUS bit and the corresponding event STATUS bit is listed in Table 1.

13. PHAS:

(a) If HDU 1 of the infile includes the column PHAS, then
   i. the values of PHAS for an event are read from the infile.
   ii. If PHAS[4] < the split threshold, then STATUS[k] = 1 for bit k = 1.
   iii. If PHAS[4] ≤ PHAS[j] for one or more j = 0–3 or 5–8, then STATUS[k] = 1 for bit k = 1.
   iv. If PHAS[j] > 4095 for one or more j = 0–8, then STATUS[k] = 1 for bit k = 2.

14. PHAS_ADJ:

(a) If HDU 1 of the infile includes DATAMODE = CC33_FAINT and the parameter apply_cti = yes and the ctifile and mtlfile are specified, then the CTI-adjusted pulse heights are computed as follows.
   i. The real-valued arrays for the serial CTI adjustment $\Delta_x$, the parallel CTI adjustment $\Delta_y$, and the adjusted pulse heights PHAS_ADJ are initialized such that

   $\Delta_x[j] = 0$,  \hspace{1cm} (374)

   $\Delta_y[j] = 0$, and  \hspace{1cm} (375)

   $PHAS_{ADJ}[j] = PHAS[j]$,  \hspace{1cm} (376)

   for every element $j = 0–8$, where the starting point for the adjusted pulse heights are the unadjusted pulse heights PHAS. Note that the values of the unadjusted pulse heights PHAS remain unchanged to ensure that it is possible to remove the CTI adjustment or to reapply the adjustment if the algorithm or calibration data are modified.
   ii. The CTI iteration counter $n$ is initialized such that

   $n = 1$.  \hspace{1cm} (377)
iii. The temporary variables $\Delta_x', \Delta_y'$, and PHAS$\_ADJ'$ are set such that

$$\begin{align*}
\Delta_x'[j] &= \Delta_x[j], \\
\Delta_y'[j] &= \Delta_y[j], \text{ and} \\
\text{PHAS$\_ADJ'[j]} &= \text{PHAS$\_ADJ[j]}
\end{align*}$$

for each element $j$.

iv. A. If there is a serial CTI trap-density map in the ctifile for CCD$\_ID$ and NODE$\_ID = 0$ or 2, then the values of $\Delta_x$ are given by

$$\begin{align*}
\Delta_x[0] &= c_x[0] s_x p_x[0] V_x[0], \\
\Delta_x[1] &= c_x[1] s_x p_x[1] V_x[1] - c_x'[0] s_x p_x[0] V_x[0], \\
\end{align*}$$

where

$$\begin{align*}
c_x[j] &= \left\{ \begin{array}{ll}
0 & \text{if PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] < \text{split threshold} \\
& \text{(for all } j), \\
\text{FRCTRLX} & \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \geq \text{split threshold and} \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] < \text{split threshold} \\
& \text{(for } j = 1, 2, 4, 5, 7, 8), \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \geq \text{split threshold} \\
& \text{(for } j = 0, 3, 6) \\
1 & \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \geq \text{split threshold and} \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \geq \text{split threshold} \\
& \text{(for } j = 1, 2, 4, 5, 7, 8), \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \geq \text{split threshold or} \\
& \text{PHAS}[j + 1] + \Delta_x'[j + 1] + \Delta_y'[j + 1] \geq \text{split threshold or} \\
& j \rightarrow \text{CHIPX} = 1, 256, 513, \text{ or } 768 \\
& \text{(for } j = 0, 1, 3, 4, 6, 7), \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] > 0 \\
& \text{FRCTRLX} \text{PHAS}[j + 1] + \Delta_x'[j + 1] + \Delta_y'[j + 1] \geq \text{split threshold} \\
& \text{(for } j = 0, 1, 3, 4, 6, 7), \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \leq 0 \\
& \text{PHAS}[j + 1] + \Delta_x'[j + 1] + \Delta_y'[j + 1] \leq \text{split threshold} \\
& \text{(for } j = 0, 1, 3, 4, 6, 7), \\
1 & \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] > 0 \text{ and} \\
& \text{PHAS}[j + 1] + \Delta_x'[j + 1] + \Delta_y'[j + 1] > 0 \text{ and} \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \geq \text{split threshold} \\
& \text{(for } j = 0, 1, 3, 4, 6, 7), \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \leq 0 \text{ and} \\
& \text{PHAS}[j + 1] + \Delta_x'[j + 1] + \Delta_y'[j + 1] \leq 0 \text{ and} \\
& \text{PHAS}[j] + \Delta_x'[j] + \Delta_y'[j] \leq \text{split threshold} \\
& \text{(for } j = 0, 1, 3, 4, 6, 7),
\end{array} \right.
\end{align*}$$

$$s_x = 1 + \text{TCTIX}(T - \text{FP\_TEMPO}),$$

$s_x$ is a temperature dependent scaling factor,

TCTIX is the CCD$\_ID$ dependent value in the column TCTIX of the ctifile,

FP$\_TEMPO$ is the name of a keyword in the ctifile,
\[
T = \left( \frac{t' - t'_k}{T_{k+1} - t'_k} \right) (FP_{\text{TEMP}}_{k+1} - FP_{\text{TEMP}}_k) + FP_{\text{TEMP}}_k,
\]
(391)

\[
t' = t + \text{TIMEDEL}_m (\text{TIMEPIXR}_{\text{mtl}} - 0.5),
\]
(392)

\[
t'_k = \text{TIME}_k + \text{TIMEDEL}_{\text{mtl}} (\text{TIMEPIXR}_{\text{mtl}} - 0.5),
\]
(393)

\[
t'_{k+1} = \text{TIME}_{k+1} + \text{TIMEDEL}_{\text{mtl}} (\text{TIMEPIXR}_{\text{mtl}} - 0.5),
\]
(394)

\[
\rho_x[j] = \text{serial trap density},
\]
(395)

\[
V_x[j] = \left( \frac{\text{PHAS}_j + \Delta'_x[j] + \Delta'_y[j] - \text{PHA}_i}{\text{PHA}_{i+1} - \text{PHA}_i} \right) (V_{\text{VOLUME}}_{X_{l+1}} - V_{\text{VOLUME}}_{X_{l}}) + V_{\text{VOLUME}}_{X_{l}},
\]
(396)

\[
\text{PHAs}_{l} \text{ is the } l^{\text{th}} \text{ element of the column PHA in the ctifile,}
\]
\[
\text{PHAs}_{l} \text{ (and PHAs}_{l+1} \text{) are CCD_ID dependent,}
\]
\[
\text{PHAs}_{l} \leq \text{PHAs}_{l} + \Delta'_x[j] + \Delta'_y[j],
\]
\[
\text{If PHAs}_{l} > \text{PHAs}_{l} + \Delta'_x[j] + \Delta'_y[j] \text{ for } l = 0, \text{ then } l = 0.
\]
\[
\text{PHAs}_{l+1} \text{ is the } (l + 1)^{\text{th}} \text{ element of the column PHA in the ctifile,}
\]
\[
\text{PHAs}_{l+1} > \text{PHAs}_{l} + \Delta'_x[j] + \Delta'_y[j],
\]
\[
\text{If PHAs}_{l+1} \leq \text{PHAs}_{l} + \Delta'_x[j] + \Delta'_y[j] \text{ for } l = n, \text{ where } n \text{ is the last}
\]
\[
element, \text{ then } l = n.
\]
\[
\text{VOLUME}_{X_{l}} \text{ is the } l^{\text{th}} \text{ element of the column VOLUME}_{X} \text{ in the ctifile,}
\]
\[
\text{VOLUME}_{X_{l}}, \text{ which is CCD_ID dependent, is associated with PHAs}_{l},
\]
\[
\text{VOLUME}_{X_{l+1}} \text{ is the } (l + 1)^{\text{th}} \text{ element of the column VOLUME}_{X} \text{ in the}
\]
\[
\text{ctifile, and}
\]
\[
\text{VOLUME}_{X_{l+1}}, \text{ which is CCD_ID dependent, is associated with PHAs}_{l+1}
\]

B. If there is a serial CTI trap-density map in the ctifile for CCD_ID and NODE_ID = 1 or 3, then the values of \( \Delta_x \) are given by

\[
\Delta_x[0] = c_x[0]s_x \rho_x[0]V_x[0] - c'_x[1]s_x \rho_x[1]V_x[1],
\]
(397)

\[
\]
(398)

\[
\]
(399)

\[
\]
(400)

\[
\]
(401)

\[
\]
(402)
\[
\]
\[
\]
\[
\Delta_x[8] = c_x[8]s_x \rho_x[8]V_x[8],
\]

where

\[
c_x[j] = \begin{cases} 
0 & \text{for } j = 0, 1, 3, 4, 6, 7, \\
1 & \text{for } j = 2, 5, 8 
\end{cases}
\]

\[
c_x'[j] = \begin{cases} 
0 & \text{for } j = 0, 1, 3, 4, 6, 7, \\
1 & \text{for } j = 2, 5, 8 
\end{cases}
\]

and \( s_x, T, t', t_k, t_{k+1}, \rho_x[j], \) and \( V_x[j] \) are given by equations. 390, 391, 392, 393, 394, 395, and 396, respectively.

v. If there is a parallel CTI trap-density map in the \textit{ctifile} for CCD\_ID, then the values of \( \Delta_y \) are given by

\[
\Delta_y[0] = c_y[0]s_y \rho_y[0]V_y[0],
\]
\[
\Delta_y[1] = c_y[1]s_y \rho_y[1]V_y[1],
\]
\[
\]
\[
\]
\[
\]
\[
\]
\[
\]
\[
\]
\[
\]
where

\[
c_p[j] = \begin{cases} 
0 & \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{for all } j, \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \geq \text{split threshold and} \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] < \\
& \text{PHAS}[j-3] + \Delta'_s[j-3] + \Delta'_y[j-3] \\
& \text{for } j = 3, 4, 5, 6, 7, 8, \\
1 & \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \geq \text{split threshold} \\
& \text{for } j = 0, 1, 2, \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \geq \text{split threshold and} \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \geq \\
& \text{PHAS}[j-3] + \Delta'_s[j-3] + \Delta'_y[j-3] \\
& \text{for } j = 3, 4, 5, 6, 7, 8, \\
0 & \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] < \text{split threshold or} \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{for } j = 1, 2, 3, 4, 5, \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] > \\
& \text{PHAS}[j] + \Delta'_s[j+3] + \Delta'_y[j+3] \\
& \text{PHAS}[j] + \Delta'_s[j+3] + \Delta'_y[j+3] \geq \text{split threshold} \\
& \text{for } j = 0, 1, 2, 3, 4, 5, \\
& \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \leq \\
& \text{PHAS}[j] + \Delta'_s[j+3] + \Delta'_y[j+3] \\
& \text{PHAS}[j] + \Delta'_s[j+3] + \Delta'_y[j+3] \geq \text{split threshold} \\
& \text{for } j = 0, 1, 2, 3, 4, 5, \\
\end{cases}
\]

\[
sicc = 1 + \text{TCTIY}(T - \text{FP TEMPO}),
\]

(415)

\[
s_p \text{ is a temperature dependent scaling factor,}
\]
\[
\text{TCTIY is the } \text{CCD ID dependent value in the column TCTIY of the ctifile,}
\]
\[
\text{FP TEMPO is the name of a keyword in the ctifile,}
\]

\[
\rho_p[j] = \begin{cases} 
\text{parallel trap density,} \\
& \text{depends upon the } \text{CCD ID and upon the CHIPX and nint(CHIPY ADJ)} \\
& \text{coordinates associated with element } j \text{ of } \text{PHAS ADJ}[j] \text{ (see Fig. 1),}
\end{cases}
\]

(416)

\[
\text{V}_p[j] = \frac{\text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] - \text{PHA}_t}{\text{PHA}_{t+1} - \text{PHA}_t} (\text{VOLUME}_Y_{l+1} - \text{VOLUME}_Y_l) + \text{VOLUME}_Y_l
\]

(417)

\[
\text{PHA}_t \text{ is the } l^{th} \text{ element of the column PHA in the ctifile,}
\]
\[
\text{PHA}_t \text{ (and PHA}_{l+1} \text{) are } \text{CCD ID dependent,}
\]
\[
\text{PHA}_t \leq \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j],
\]
\[
\text{if } \text{PHA}_t > \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \text{ for } l = 0, \text{ then } l = 0,
\]
\[
\text{PHA}_{l+1} \text{ is the } (l+1)^{th} \text{ element of the column PHA in the ctifile,}
\]
\[
\text{PHA}_{l+1} > \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j],
\]
\[
\text{if } \text{PHA}_{l+1} \leq \text{PHAS}[j] + \Delta'_s[j] + \Delta'_y[j] \text{ for } l = n, \text{ where } n \text{ is the last element, then } l = n,
\]
\[
\text{VOLUME}_Y_l \text{ is the } l^{th} \text{ element of the column } \text{VOLUME}_Y \text{ in the ctifile,}
\]
\[
\text{VOLUME}_Y_l, \text{ which is } \text{CCD ID dependent, is associated with } \text{PHA}_t,
\]
\[
\text{VOLUME}_Y_{l+1} \text{ is the } (l+1)^{th} \text{ element of the column } \text{VOLUME}_Y \text{ in the ctifile,}
\]
\[
\text{VOLUME}_Y_{l+1}, \text{ which is } \text{CCD ID dependent, is associated with } \text{PHA}_{l+1},
\]

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and $T$, $t'$, $t'_k$, and $t'_{k+1}$, are given by equations. 391, 392, 393, and 394, respectively.

vi. The CTI-adjusted pulse heights

$$\text{PHAS} \_\text{ADJ}[j] = \text{PHAS}[j] + \Delta_x[j] + \Delta_y[j]$$  (418)

for all $j$.

vii. A. If

$$|\text{PHAS} \_\text{ADJ}'[j] - \text{PHAS} \_\text{ADJ}[j]| < \text{cticonverge} \text{ (for all } j \text{)} \quad \text{and} \quad n \leq \text{max}_\text{cti}_\text{iter},$$  (419)

then the computation of $\text{PHAS} \_\text{ADJ}$ is complete for the event.

B. If

$$|\text{PHAS} \_\text{ADJ}'[j] - \text{PHAS} \_\text{ADJ}[j]| \geq \text{cticonverge} \text{ (for one or more } j \text{)} \quad \text{and} \quad n < \text{max}_\text{cti}_\text{iter},$$  (420)

then $n = n + 1$ and steps 1.5.14(a)iii–1.5.14(a)vii are repeated.

C. If

$$|\text{PHAS} \_\text{ADJ}'[j] - \text{PHAS} \_\text{ADJ}[j]| \geq \text{cticonverge} \text{ (for one or more } j \text{)} \quad \text{and} \quad n \geq \text{max}_\text{cti}_\text{iter},$$  (421)

then no additional iterations are performed, the values of $\text{PHAS} \_\text{ADJ}[j]$ from the most recent iteration are used as are, and $\text{STATUS}[k] = 1$ for bit $k = 20$ to indicate that the CTI adjustment did not converge.

15. FLTGRADE:

(a) If

$$\text{DATAMODE}_n = \text{CC33}_\text{FAINT} \text{ and } \text{apply}_\text{cti} = \text{yes},$$  (425)

then


where

$$c_1[j] = \begin{cases} 0 & \text{if } \text{PHAS} \_\text{ADJ}[j] < \text{split threshold} \\ 1 & \text{otherwise}, \end{cases}$$  (427)

and the elements $j = 0$–3 and 5–8 of $\text{PHAS} \_\text{ADJ}$ are depicted in Figure 1.

(b) If

$$\text{DATAMODE}_n = \text{CC33}_\text{FAINT} \text{ and } \text{apply}_\text{cti} = \text{no},$$  (428)

then


where

$$c_1[j] = \begin{cases} 0 & \text{if } \text{PHAS}[j] < \text{split threshold} \\ 0 & \text{if } \text{PHAS}[j] > 4095 \\ 0 & \text{if } \text{PHAS}[j] \geq \text{PHAS}[4] \text{ for } j = 0 - 3 \\ 0 & \text{if } \text{PHAS}[j] \geq \text{PHAS}[4] \text{ for } j = 5 - 8 \\ 1 & \text{otherwise}. \end{cases}$$  (430)

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Figure 1: The relative CHIPX and CHIPY coordinates of the nine elements $j = 0$–$8$ of a 3 pixel $\times$ 3 pixel event island PHAS$_{[j]}$ or PHAS$_{ADJ}$$_{[j]}$.

(c) If

$$\text{DATAMODE}_{in} = \text{CC33 GRADED},$$

then the FLTGRADE of an event is equal to the value of FLTGRADE for the event in the infile.

16. GRADE:

(a) If the gradefile is specified, then the GRADE of an event is determined from the FLTGRADE of the event as follows.

i. The appropriate HDU of the gradefile is identified. This HDU is the one where the header keyword CBD10001 includes the DATAMODE of HDU 1 of the infile.

ii. The row $i$ of the appropriate HDU of the gradefile is identified. This row is the one where

$$\text{FLTGRADE}_{grade, i} = \text{FLTGRADE},$$

where $\text{FLTGRADE}_{grade}$ is a column in the gradefile.

iii. The GRADE of the event is given by

$$\text{GRADE} = \text{GRADE}_{grade, i},$$

where $\text{GRADE}_{grade}$ is a column in the gradefile.

17. PHA\_RO:

(a) If

$$\text{DATAMODE}_{in} = \text{CC33 FAINT},$$
then

\[ \text{PHA}_\text{RO} = \sum_{j=0}^{8} \beta[j]p[j], \]  

(437)

where

i. \[ p[j] = \text{PHAS}[j]. \]  

(438)

ii. The elements \( j = 0-8 \) of \text{PHAS} are depicted in Figure 1.

iii. \[ \beta[j] = 0 \text{ if } p[j] < \text{split threshold}. \]  

(439)

iv. \[ \beta[j] = 0 \text{ if } \begin{cases} p[j] > p[4] \text{ (for } j = 0-3) \\ p[j] \geq p[4] \text{ (for } j = 5-8) \end{cases} \]  

(440)

v. If \( \text{CORNERS} = -1 \), then \[ \beta[0] = \beta[2] = \beta[6] = \beta[8] = 0. \]  

(441)

vi. If \( \text{CORNERS} = 0 \), then there are no additional constraints on \( \beta[0], \beta[2], \beta[6], \text{ and } \beta[8] \).

vii. If \( \text{CORNERS} = 1 \), then

\[ \begin{align*}
\beta[0] &= 0 \text{ if } \beta[1] = 0 \text{ and } \beta[3] = 0. \\
\beta[2] &= 0 \text{ if } \beta[1] = 0 \text{ and } \beta[5] = 0. \\
\beta[6] &= 0 \text{ if } \beta[3] = 0 \text{ and } \beta[7] = 0. \\
\beta[8] &= 0 \text{ if } \beta[5] = 0 \text{ and } \beta[7] = 0. 
\end{align*} \]  

(442-445)

viii. If \( \text{CORNERS} = 2 \), then

\[ \begin{align*}
\beta[0] &= 0 \text{ if } \beta[1] = 0 \text{ or } \beta[3] = 0 \text{ or } \text{GRADE} \neq 6. \\
\beta[2] &= 0 \text{ if } \beta[1] = 0 \text{ or } \beta[5] = 0 \text{ or } \text{GRADE} \neq 6. \\
\beta[6] &= 0 \text{ if } \beta[3] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. \\
\beta[8] &= 0 \text{ if } \beta[5] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. 
\end{align*} \]  

(446-449)

(b) If \( \text{DATAMODE}_\text{in} = \text{CC33,GRADED}, \) then

i. If \( \text{CONTENT}_\text{in} = \text{EVT0}, \) then the value of \( \text{PHA}_\text{RO} \) for the event is the value of \( \text{PHA} \) in the infile.

ii. If \( \text{CONTENT}_\text{in} = \text{EVT1 or TGEVT1 or EVT2}, \) then the value of \( \text{PHA}_\text{RO} \) for the event is the value of \( \text{PHA}_\text{RO} \) in the infile.

18. \( \text{PHA} \), including time-dependent gain:
(a) If
\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT},
\]
then
\[
\text{PHA} = \sum_{j=0}^{8} \beta[j]p[j],
\]
where

i. \[
p[j] = \begin{cases} 
\text{PHAS\_ADJ}[j] & \text{if } \text{apply\_cti} = \text{yes} \\
\text{PHAS}[j] & \text{if } \text{apply\_cti} = \text{no}
\end{cases}
\]

ii. The elements \( j = 0\text{--}8 \) of \( \text{PHAS\_ADJ} \) (or \( \text{PHAS} \)) are depicted in Figure 1.

iii. \( \beta[j] = 0 \) if \( p[j] < \text{split threshold} \).

iv. If the CTI adjustment is not performed, then
\[
\beta[j] = 0 \text{ if } \begin{cases} 
p[j] > p[4] & \text{for } j = 0\text{--}3 \\
p[j] \geq p[4] & \text{for } j = 5\text{--}8
\end{cases}
\]

v. If \( \text{CORNERS} = -1 \), then
\[
\]

vi. If \( \text{CORNERS} = 0 \), then there are no additional constraints on \( \beta[0], \beta[2], \beta[6], \text{and } \beta[8] \).

vii. If \( \text{CORNERS} = 1 \), then
\[
\begin{align*}
\beta[0] &= 0 & \text{if } \beta[1] = 0 \text{ and } \beta[3] = 0. \\
\beta[2] &= 0 & \text{if } \beta[1] = 0 \text{ and } \beta[5] = 0. \\
\beta[6] &= 0 & \text{if } \beta[3] = 0 \text{ and } \beta[7] = 0. \\
\beta[8] &= 0 & \text{if } \beta[5] = 0 \text{ and } \beta[7] = 0.
\end{align*}
\]

viii. If \( \text{CORNERS} = 2 \), then
\[
\begin{align*}
\beta[0] &= 0 & \text{if } \beta[1] = 0 \text{ or } \beta[3] = 0 \text{ or } \text{GRADE} \neq 6. \\
\beta[2] &= 0 & \text{if } \beta[1] = 0 \text{ or } \beta[5] = 0 \text{ or } \text{GRADE} \neq 6. \\
\beta[6] &= 0 & \text{if } \beta[3] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. \\
\beta[8] &= 0 & \text{if } \beta[5] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6.
\end{align*}
\]

(b) If
\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED},
\]
then the value of \( \text{PHA} \) for the event is read from the \text{infile}.

(c) If
\[
\text{apply\_tgain} = \text{yes},
\]
then
\[
\text{PHA} = \text{PHA} - \text{int} \left[ \left( \frac{\text{TIME} - \text{EPOCH1}}{\text{EPOCH2} - \text{EPOCH1}} \right) (\delta_2 - \delta_1) + \delta_1 - \epsilon \right],
\]
where

\[
\text{int} = \text{the integer portion of (i.e. truncate or round down)},
\]

\[
\text{TIME} = \text{the time of the event},
\]

\[
\text{EPOCH1} = \text{a keyword in the \textit{tgainfile}},
\]

\[
\text{EPOCH2} = \text{a keyword in the \textit{tgainfile}},
\]

\[
\delta_1 = \left( \frac{\text{PHA} - \text{PHA}_{m[r]}}{\text{PHA}_{m+1[r]} - \text{PHA}_{m[r]}} \right) (\text{DELTPHA1}_{m+1[r]} - \text{DELTPHA1}_m[r]) + \]

\[
\text{DELTPHA1}_m[r],
\]

\[
\delta_2 = \left( \frac{\text{PHA} - \text{PHA}_{m[r]}}{\text{PHA}_{m+1[r]} - \text{PHA}_{m[r]}} \right) (\text{DELTPHA2}_{m+1[r]} - \text{DELTPHA2}_m[r]) + \]

\[
\text{DELTPHA2}_m[r],
\]

\[
\epsilon = \text{is a uniform random deviate in the range}[0, 1),
\]

\[
\text{if rand\_pha = no, then } \epsilon = 0.
\]

(d) If

\[
\text{PHA} \geq 32767,
\]

then \( \text{STATUS}[k] = 1 \) for bit \( k = 3. \)

19. \textbf{CORN\_PHA}:

(a) If

\[
\text{DATAMODE}_n = \text{CC33\_GRADED},
\]

then the value of \textbf{CORN\_PHA} is read from the \textit{infile}.

20. \textbf{ENERGY}:

(a) If the parameter \texttt{calculate.pi} = yes and the parameter \textit{gainfile} is specified and \( \text{PHA} > 0 \), then

i. The row \( i \) in the \textit{gainfile} is identified such that

\[
\text{CCD\_ID} = \text{CCD\_ID}_{\text{gain},i},
\]

\[
\text{CHIPX\_MIN}_{\text{gain},i} \leq \text{CHIPX} \leq \text{CHIPX\_MAX}_{\text{gain},i}, \quad \text{and}
\]

\[
\text{CHIPY\_MIN}_{\text{gain},i} \leq \text{nint(CHIPY\_ADJ)} \leq \text{CHIPY\_MAX}_{\text{gain},i},
\]

where \( \text{CCD\_ID}_{\text{gain}}, \text{CHIPX\_MIN}_{\text{gain}}, \text{CHIPX\_MAX}_{\text{gain}}, \text{CHIPY\_MIN}_{\text{gain}}, \text{and} \text{CHIPY\_MAX}_{\text{gain}} \) are columns in the \textit{gainfile}.
ii. A uniform random deviate $\Delta p$ is computed over the interval from $[-0.5, +0.5)$.

iii. The element $j$ of row $i$ of $\text{PHA}_{\text{gain}}$ is identified such that

$$\text{PHA}_{\text{gain},i}[j] \leq (\text{PHA} + \Delta p) < \text{PHA}_{\text{gain},i}[j+1], \quad (488)$$

where $\text{PHA}_{\text{gain}}$ is a vector column in the gainfile. If $\text{PHA} + \Delta p < \text{PHA}_{\text{gain},i}[0]$, then $j = 0$. If $\text{PHA}_{\text{gain},i}[\text{NPOINTS} - 2] \leq \text{PHA} + \Delta p$, then $j = \text{NPOINTS} - 2$, where NPOINTS is a column in the gainfile.

iv. The ENERGY of an event is computed from the PHA of the event:

$$\text{ENERGY} = \left( \frac{\text{PHA} + \Delta p - \text{PHA}_{\text{gain},i}[j]}{\text{PHA}_{\text{gain},i}[j+1] - \text{PHA}_{\text{gain},i}[j]} \right) (\text{ENERGY}_{\text{gain},i}[j+1] - \text{ENERGY}_{\text{gain},i}[j]) + \text{ENERGY}_{\text{gain},i}[j], \quad (489)$$

where $\text{ENERGY}_{\text{gain}}$ is a vector column in the gainfile.

v. If $\text{ENERGY} < 0$, then $\text{ENERGY} = 0$.

(b) If the parameter calculate $\text{pi} = \text{yes}$ and the parameter gainfile is specified and $\text{PHA} \leq 0$, then $\text{ENERGY} = 0$.

(c) If the parameter calculate $\text{pi} = \text{no}$ or if the parameter gainfile is not specified, then

i. If the infile includes the ENERGY of an event, then the ENERGY of the event is equal to the ENERGY in the infile.

ii. If the infile does not include the ENERGY of an event, then $\text{ENERGY} = 0$.

21. PI:

(a) If

$$\text{calculate} \text{pi} = \text{yes}, \quad (490)$$

then

i. $\text{PI} = \text{int} \left( \frac{\text{ENERGY}}{\text{pi\_bin\_width}} \right) + 1, \quad (491)$

where “int” indicates the integer portion of what is in parentheses (i.e. the value is truncated or rounded down).

ii. If $\text{PI} < 1$, then $\text{PI} = 1, \quad (492)$

iii. If $\text{PI} > \text{pi\_num\_bins}$, then $\text{PI} = \text{pi\_num\_bins}, \quad (493)$

(b) If $\text{calculate} \text{pi} = \text{no} \quad (494)$

and the infile includes the value of PI for an event, then the value of PI is read from the infile.

22. pix$\_\text{adj}$:

(a) centroid:

If

$$\text{pix} \_ \text{adj} = \text{centroid}, \quad (495)$$
then
\[
\text{CHIPX\_ADJ} = \text{CHIPX\_ADJ} - w'[0] + w'[2] - w'[3] + w'[5] - w'[6] + w'[8],
\]  
(496)
where
\[
w'[j] = \frac{w[j]}{\sum_{j=0}^{s} w[j]},
\]  
(497)
\[
w[j] = \begin{cases} 
p[j] & \text{if the pixel is valid} \\
0 & \text{if the pixel is invalid},
\end{cases}
\]  
(498)
\[
p[j] = \begin{cases} 
\text{PHAS\_ADJ}[j] & \text{if apply\_cti = yes} \\
\text{PHAS}[j] & \text{if apply\_cti = no},
\end{cases}
\]  
(499)
and the pixel is invalid if
\[
\beta[j] = 0 \text{ or } \text{STATUS}[0] = 1 \text{ or } \text{STATUS}[1] = 1 \text{ or } \text{STATUS}[2] = 1 \text{ or } \text{STATUS}[3] = 1 \text{ or } \text{STATUS}[4] = 1 \text{ or } \text{STATUS}[11] = 1 \text{ or } \text{STATUS}[13] = 1 \text{ or } \text{STATUS}[14] = 1 \text{ or } \text{STATUS}[15] = 1 \text{ or } \text{STATUS}[16] = 1.
\]  
(500)
If
\[
\text{DATAMODE} = \text{CC33\_FAINT or (511)}
\]  
(511)
\[
\text{DATAMODE} = \text{CC33\_GRADED or (512)}
\]  
(512)
\[
\text{DATAMODE} = \text{FAINT or (513)}
\]  
(513)
\[
\text{DATAMODE} = \text{FAINT\_BIAS or (514)}
\]  
(514)
\[
\text{DATAMODE} = \text{GRADED or (515)}
\]  
(515)
\[
\text{DATAMODE} = \text{VFAINT},
\]  
(516)
then
\[
\text{CHIPY\_ADJ} = \text{CHIPY\_ADJ} - w'[0] - w'[1] - w'[2] + w'[6] + w'[7] + w'[8].
\]  
(517)
If
\[
\text{DATAMODE} = \text{CC33\_FAINT or (518)}
\]  
(518)
\[
\text{DATAMODE} = \text{CC33\_GRADED},
\]  
(519)
then
\[
\text{TIME} = \text{TIME} + (w'[0] + w'[1] + w'[2] - w'[6] - w'[7] - w'[8]) \times \text{TIMEDEL\_in}.
\]  
(520)
Note that it is possible for the centroid algorithm to yield an adjustment to CHIPX\_ADJ and/or CHIPY\_ADJ that is greater than half a pixel. However, the adjustment cannot equal or exceed one pixel.
(b) **edser:**

If

\[ \text{pix}_{\text{adj}} = \text{edser}, \]  \hspace{1cm} (521)

then

\[
\text{CHIPX}_{\text{ADJ}} = \text{CHIPX}_{\text{ADJ}} + \left( \frac{\text{ENERGY} - E[k]}{E[k+1] - E[k]} \right) (\Delta X[k+1] - \Delta X[k]) + \Delta X[k],
\]  \hspace{1cm} (522)

where \( E[k] \) and \( E[k+1] \) and \( \Delta X[k] \) and \( \Delta X[k+1] \) are the \( k \) and \( (k+1) \)th elements of the vector columns \( \text{ENERGY}_{\text{subpix}} \) and \( \text{CHIPX}_{\text{OFFSET}}_{\text{subpix}} \), respectively. These columns are in the HDU of the \text{subpixfile} where the value of the keyword \( \text{CCD}_{\text{ID}} \) is equal to the value of the \( \text{CCD}_{\text{ID}} \) of the event. The appropriate row of these columns is the one where \( \text{FLTGRADE}_{\text{subpix}} = \text{FLTGRADE} \). The values of \( k \) are the ones where

\[
\text{ENERGY} \geq E[k] \text{ and } \text{ENERGY} < E[k+1].
\]  \hspace{1cm} (523, 524)

Note that if

\[
\text{ENERGY} \leq E[0],
\]  \hspace{1cm} (525)

then \( k = 0 \). Similarly, if

\[
\text{ENERGY} \geq E[\text{NPOINTS}_{\text{subpix}} - 2],
\]  \hspace{1cm} (526)

then \( k = \text{NPOINTS}_{\text{subpix}} - 2 \). If

\[
\text{DATAMODE} = \text{CC33\_FAINT} \text{ or } \text{DATAMODE} = \text{CC33\_GRADED} \text{ or } \text{DATAMODE} = \text{FAINT} \text{ or } \text{DATAMODE} = \text{FAINT\_BIAS} \text{ or } \text{DATAMODE} = \text{GRADED} \text{ or } \text{DATAMODE} = \text{VFAINT},
\]  \hspace{1cm} (527, 528, 529, 530, 531, 532)

then

\[
\text{CHIPY}_{\text{ADJ}} = \text{CHIPY}_{\text{ADJ}} + \left( \frac{\text{ENERGY} - E[k]}{E[k+1] - E[k]} \right) (\Delta Y[k+1] - \Delta Y[k]) + \Delta Y[k],
\]  \hspace{1cm} (533)

where \( \Delta Y[k] \) and \( \Delta Y[k+1] \) are the \( k \) and \( (k+1) \)th elements of the vector column \( \text{CHIPY}_{\text{OFFSET}}_{\text{subpix}} \). If

\[
\text{DATAMODE} = \text{CC33\_FAINT} \text{ or } \text{DATAMODE} = \text{CC33\_GRADED},
\]  \hspace{1cm} (534, 535)

then

\[
\text{TIME} = \text{TIME} - \left( \frac{\text{ENERGY} - E[k]}{E[k+1] - E[k]} \right) (\Delta Y[k+1] - \Delta Y[k]) + \Delta Y[k]) \times \text{TIMEDEL}_{\text{in}}.
\]  \hspace{1cm} (536)

(c) **none:**

If

\[ \text{pix}_{\text{adj}} = \text{none}, \]  \hspace{1cm} (537)

then the values of \( \text{CHIPX}_{\text{ADJ}} \) and \( \text{CHIPY}_{\text{ADJ}} \) remain unchanged.
(d) randomize: 
If
\[ \text{pix}_{\text{adj}} = \text{randomize}, \] (538)
then
\[ \text{CHIP}_{\text{X,adj}} = \text{CHIP}_{\text{X,adj}} + \epsilon_x, \] (539)
where \( \epsilon_x \) is a uniform random deviate in the range \([-0.5, +0.5) \) pixel. If
\[
\begin{align*}
\text{DATAMODE} &= \text{CC33_FAINT} \text{ or} \\
\text{DATAMODE} &= \text{CC33_GRADED} \text{ or} \\
\text{DATAMODE} &= \text{FAINT} \text{ or} \\
\text{DATAMODE} &= \text{FAINT_BIAS} \text{ or} \\
\text{DATAMODE} &= \text{GRADED} \text{ or} \\
\text{DATAMODE} &= \text{VFAINT}, \\
\end{align*}
\] (540)
then
\[ \text{CHIP}_{\text{Y,adj}} = \text{CHIP}_{\text{Y,adj}} + \epsilon_y, \] (546)
where \( \epsilon_y \) is a uniform random deviate in the range \([-0.5, +0.5) \) pixel. If
\[
\begin{align*}
\text{DATAMODE} &= \text{CC33_FAINT} \text{ or} \\
\text{DATAMODE} &= \text{CC33_GRADED}, \\
\end{align*}
\] (547)
then
\[ \text{TIME} = \text{TIME} - \epsilon_y \times \text{TIMEDEL}_{\text{in}}. \] (549)
(e) If
\[ \text{CHIP}_{\text{X,adj}} < 0.5, \] (550)
then
\[ \text{CHIP}_{\text{X,adj}} = 1. \] (551)
(f) If
\[ \text{CHIP}_{\text{X,adj}} \geq 1024.5, \] (552)
then
\[ \text{CHIP}_{\text{X,adj}} = 1024. \] (553)
(g) If
\[ \text{CHIP}_{\text{Y,adj}} < 0.5, \] (554)
then
\[ \text{CHIP}_{\text{Y,adj}} = 1. \] (555)
(h) If

\[ \text{CHIPY}_\text{ADJ} \geq 1024.5, \quad (556) \]

then

\[ \text{CHIPY}_\text{ADJ} = 1024. \quad (557) \]

23. TDETX and TDETY:

(a) If

\[ \text{stop} = \text{tdet or} \quad (558) \]
\[ \text{stop} = \text{det or} \quad (559) \]
\[ \text{stop} = \text{tan or} \quad (560) \]
\[ \text{stop} = \text{sky} \quad (561) \]

then

i. If

\[ \text{CONTENT} = \text{EVT0 or} \quad (562) \]
\[ \text{CONTENT} = \text{EVT1 or} \quad (563) \]
\[ \text{CONTENT} = \text{EVT2}, \quad (564) \]

and

\[ \text{TIME} \geq \text{TIME}_\text{min} \text{ and } \quad (565) \]
\[ \text{TIME} < \text{TIME}_\text{max} \quad (566) \]

and TIME is in a good-time interval, then the values of TDETX and TDETY are computed using the values of nint(CHIPX\_ADJ) and nint(CHIPY\_ADJ). Here, “nint” indicates that the real-valued coordinate is rounded to the nearest integer.

ii. If

\[ \text{CONTENT} = \text{EVT0 or} \quad (567) \]
\[ \text{CONTENT} = \text{EVT1 or} \quad (568) \]
\[ \text{CONTENT} = \text{EVT2}, \quad (569) \]

and

\[ \text{TIME} < \text{TIME}_\text{min} \text{ or } \quad (570) \]
\[ \text{TIME} \geq \text{TIME}_\text{max} \quad (571) \]

or TIME is not in a good-time interval, then the values of TDETX and TDETY are set to NULL.

iii. If

\[ \text{CONTENT} = \text{TGEVT1}, \quad (572) \]

and

\[ \text{CHIPY}_\text{ZO} \neq \text{NULL}, \quad (573) \]
and

\[ \text{TIME} \geq \text{TIME}_{\text{min}} \quad \text{and} \quad \text{TIME} < \text{TIME}_{\text{max}} \] (574)

and \( \text{TIME} \) is in a good-time interval, then the values of \( TDETX \) and \( TDETY \) are computed using the values of \( \text{nint(CHIPX\_ADJ)} \) and \( \text{nint(CHIPY\_ZO)} \).  

iv. If

\[ \text{CONTENT} = \text{TGEVT1}, \] (576)

and

\[ \text{CHIPY\_ZO} = \text{NULL or} \] (577)
\[ \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}} \] (578)

or \( \text{TIME} \) is not in a good-time interval, then the values of \( TDETX \) and \( TDETY \) are set to NULL.

24. \( \text{DETX} \) and \( \text{DETY} \):

(a) If

\[ \text{stop} = \text{det or} \] (580)
\[ \text{stop} = \text{tan or} \] (581)
\[ \text{stop} = \text{sky}, \] (582)

then

i. If

\[ \text{CONTENT} = \text{EVT0 or} \] (583)
\[ \text{CONTENT} = \text{EVT1 or} \] (584)
\[ \text{CONTENT} = \text{EVT2}, \] (585)

and

\[ \text{TIME} \geq \text{TIME}_{\text{min}} \quad \text{and} \quad \text{TIME} < \text{TIME}_{\text{max}} \] (586)

and \( \text{TIME} \) is in a good-time interval, then the values of \( \text{DETX} \) and \( \text{DETY} \) are computed using the real-valued coordinates \( \text{CHIPX\_ADJ} \) and \( \text{CHIPY\_ADJ} \) and the orientation of the SIM (i.e. \( \text{DY}, \text{DZ}, \text{and DTHETA} \)) at the time \( \text{TIME} \).

ii. If

\[ \text{CONTENT} = \text{EVT0 or} \] (588)
\[ \text{CONTENT} = \text{EVT1 or} \] (589)
\[ \text{CONTENT} = \text{EVT2}, \] (590)

and

\[ \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}} \] (591)

or \( \text{TIME} \) is not in a good-time interval, then the values of \( \text{DETX} \) and \( \text{DETY} \) are set to NaN.

As requested, these coordinates for gratings observations are computed using the \( \text{CHIPY} \) location of zeroth order, not the \( \text{CHIPY} \) location of the gratings arms.

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iii. If

\[
\text{CONTENT} = \text{TGEVT1,} \tag{593}
\]

and

\[
\text{CHIPY}_ZO \neq \text{NULL}, \tag{594}
\]

and

\[
\text{TIME} \geq \text{TIME}_{\text{min}} \quad \text{and} \quad \text{TIME} < \text{TIME}_{\text{max}} \tag{595}
\]

\[
\text{and TIME} \quad \text{is in a good-time interval, then the values of DETX and DETY are computed using the real-valued coordinates Chipx}_{\text{adj}} \quad \text{and Chipy}_ZO^* \quad \text{and the orientation of the SIM (i.e. DY, DZ, and DTHETA) at the time TIME.}
\]

iv. If

\[
\text{CONTENT} = \text{TGEVT1,} \tag{597}
\]

and

\[
\text{CHIPY}_ZO = \text{NULL or} \tag{598}
\]

\[
\text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}} \tag{599}
\]

\[
\text{or TIME is not in a good-time interval, then the values of DETX and DETY are set to NaN.}
\]

25. X and Y:

   (a) If

   \[
   \text{stop} = \text{sky,} \tag{601}
   \]

   then

   i. If

   \[
   \text{CONTENT} = \text{EVT0 or} \tag{602}
   \]

   \[
   \text{CONTENT} = \text{EVT1 or} \tag{603}
   \]

   \[
   \text{CONTENT} = \text{EVT2,} \tag{604}
   \]

   and

   \[
   \text{TIME} \geq \text{TIME}_{\text{min}} \quad \text{and} \quad \text{TIME} < \text{TIME}_{\text{max}} \tag{605}
   \]

   \[
   \text{and TIME is in a good-time interval, then the values of X and Y are computed using the real-valued coordinates Chipx}_{\text{adj}} \quad \text{and Chipy}_{\text{adj}} \quad \text{and the orientation of the telescope (i.e. RA, DEC, and ROLL) at the time TIME.}
   \]

   ii. If

   \[
   \text{CONTENT} = \text{EVT0 or} \tag{607}
   \]

   \[
   \text{CONTENT} = \text{EVT1 or} \tag{608}
   \]

   \[
   \text{CONTENT} = \text{EVT2,} \tag{609}
   \]
and
\[ \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}} \]  

or \( \text{TIME} \) is not in a good-time interval, then the values of \( X \) and \( Y \) are set to NaN.

iii. If

\[ \text{CONTENT} = \text{TGEVT1}, \]

and

\[ \text{CHIPY}_Z0 \neq \text{NULL}, \]

and

\[ \text{TIME} \geq \text{TIME}_{\text{min}} \quad \text{and} \quad \text{TIME} \leq \text{TIME}_{\text{max}} \]

and \( \text{TIME} \) is in a good-time interval, then the values of \( X \) and \( Y \) are computed using the real-valued coordinates \( \text{CHIPX}_{\text{ADJ}} \) and \( \text{CHIPY}_Z0 \) and the orientation of the telescope (i.e. \( \text{RA}, \text{DEC}, \text{and ROLL} \)) at the time \( \text{TIME} \).

iv. If

\[ \text{CONTENT} = \text{TGEVT1}, \]

and

\[ \text{CHIPY}_Z0 = \text{NULL} \quad \text{or} \quad \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}} \]

or \( \text{TIME} \) is not in a good-time interval, then the values of \( X \) and \( Y \) are set to NaN.

**SKY\_1D:**

(a) If

\[ \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \quad \text{or} \quad \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \]

and

\[ \text{stop} = \text{sky}, \]

then

i. If

\[ \text{TIME} \geq \text{TIME}_{\text{min}} \quad \text{and} \quad \text{TIME} < \text{TIME}_{\text{max}} \]

and \( \text{TIME} \) is in a good-time interval, then the value of \( \text{SKY\_1D} \) is computed using the real-valued coordinates \( \text{CHIPX}_{\text{ADJ}} \) and \( \text{CHIPY}_{\text{ADJ}} \) and using the orientation of the telescope (i.e. \( \text{RA}, \text{DEC}, \text{and ROLL} \)) at the time \( \text{TIME} \).

ii. If

\[ \text{TIME} < \text{TIME}_{\text{min}} \quad \text{or} \quad \text{TIME} \geq \text{TIME}_{\text{max}} \]

or \( \text{TIME} \) is not in a good-time interval, then the value of \( \text{SKY\_1D} \) is set to NaN.
1.5.4 Write outfile

1. **PIX\_ADJ:**
   
   (a) If
   \[
   \text{pix}\_\text{adj} = \text{centroid},
   \]
   then
   \[
   \text{PIX}\_\text{ADJ} = \text{CENTROID}.
   \]
   
   (b) If
   \[
   \text{pix}\_\text{adj} = \text{edser},
   \]
   then
   \[
   \text{PIX}\_\text{ADJ} = \text{EDSER}.
   \]
   
   (c) If
   \[
   \text{pix}\_\text{adj} = \text{none},
   \]
   then
   \[
   \text{PIX}\_\text{ADJ} = \text{NONE}.
   \]
   
   (d) If
   \[
   \text{pix}\_\text{adj} = \text{randomize},
   \]
   then
   \[
   \text{PIX}\_\text{ADJ} = \text{RANDOMIZE}.
   \]

2. **RAND\_SKY:**
   
   (a) If
   \[
   \text{pix}\_\text{adj} = \text{centroid},
   \]
   then
   \[
   \text{RAND}\_\text{SKY} = 0.0.
   \]
   
   (b) If
   \[
   \text{pix}\_\text{adj} = \text{edser},
   \]
   then
   \[
   \text{RAND}\_\text{SKY} = 0.0.
   \]
   
   (c) If
   \[
   \text{pix}\_\text{adj} = \text{none},
   \]
   then
   \[
   \text{RAND}\_\text{SKY} = 0.0.
   \]
(d) If

\[ \text{pix}_{\text{adj}} = \text{randomize}, \quad (641) \]

then

\[ \text{RAND}_{\text{SKY}} = 0.5. \quad (642) \]

3. TIME\_ADJ:

(a) TE mode:

If

\[ \text{DATAMODE}_{\text{in}} = \text{FAINT or} \quad (643) \]
\[ \text{DATAMODE}_{\text{in}} = \text{FAINT\_BIAS or} \quad (644) \]
\[ \text{DATAMODE}_{\text{in}} = \text{GRADED or} \quad (645) \]
\[ \text{DATAMODE}_{\text{in}} = \text{VFAINT}, \quad (646) \]

then

\[ \text{TIME\_ADJ} = \text{NONE.} \quad (647) \]

(b) Pointing CC mode without grating data:

i. If

\[ \text{OBS\_MODE} = \text{pointing or} \quad (648) \]
\[ \text{OBS\_MODE} = \text{POINTING} \quad (649) \]

and

\[ \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or} \quad (650) \]
\[ \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \quad (651) \]

and

\[ \text{CONTENT}_{\text{in}} = \text{EVT0 or} \quad (652) \]
\[ \text{CONTENT}_{\text{in}} = \text{EVT1 or} \quad (653) \]
\[ \text{CONTENT}_{\text{in}} = \text{EVT2} \quad (654) \]

and

\[ \text{CCD\_ID}_{\text{focus}} \geq 0 \text{ and} \quad (655) \]
\[ \text{CCD\_ID}_{\text{focus}} \leq 3 \quad (656) \]

and

\[ \cos(\text{DEC\_ADJ}_1) \cos(\text{DEC\_TARG}_{\text{in}}) \cos(\text{RA\_ADJ}_1 - \text{RA\_TARG}_{\text{in}}) + \quad (657) \]
\[ \sin(\text{DEC\_ADJ}_1) \sin(\text{DEC\_TARG}_{\text{in}}) < 4.855 \times 10^{-11}, \quad (658) \]

then

\[ \text{TIME\_ADJ} = \text{TARGET.} \quad (660) \]

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ii. If

\[
\begin{align*}
\text{OBS \_MODE} & = \text{pointing or} \quad (661) \\
\text{OBS \_MODE} & = \text{POINTING} \quad (662)
\end{align*}
\]

and

\[
\begin{align*}
\text{DATAMODE}_{in} & = \text{CC33\_FAINT or} \quad (663) \\
\text{DATAMODE}_{in} & = \text{CC33\_GRADED} \quad (664)
\end{align*}
\]

and

\[
\begin{align*}
\text{CONTENT}_{in} & = \text{EVT0 or} \quad (665) \\
\text{CONTENT}_{in} & = \text{EVT1 or} \quad (666) \\
\text{CONTENT}_{in} & = \text{EVT2} \quad (667)
\end{align*}
\]

and

\[
\begin{align*}
\text{CCD\_ID}_{focus} & \geq 4 \quad (668) \\
\text{CCD\_ID}_{focus} & \leq 9 \quad (669)
\end{align*}
\]

and

\[
\begin{align*}
\cos (\text{DEC\_ADJ}_S) \cos (\text{DEC\_TARG}_{in}) \cos (\text{RA\_ADJ}_S - \text{RA\_TARG}_{in}) & + \\
\sin (\text{DEC\_ADJ}_S) \sin (\text{DEC\_TARG}_{in}) & < 4.855 \times 10^{-11}, \quad (671)
\end{align*}
\]

then

\[
\text{TIME\_ADJ} = \text{TARGET}. \quad (673)
\]

iii. If

\[
\begin{align*}
\text{OBS \_MODE} & = \text{pointing or} \quad (674) \\
\text{OBS \_MODE} & = \text{POINTING} \quad (675)
\end{align*}
\]

and

\[
\begin{align*}
\text{DATAMODE}_{in} & = \text{CC33\_FAINT or} \quad (676) \\
\text{DATAMODE}_{in} & = \text{CC33\_GRADED} \quad (677)
\end{align*}
\]

and

\[
\begin{align*}
\text{CONTENT}_{in} & = \text{EVT0 or} \quad (678) \\
\text{CONTENT}_{in} & = \text{EVT1 or} \quad (679) \\
\text{CONTENT}_{in} & = \text{EVT2} \quad (680)
\end{align*}
\]

and

\[
\begin{align*}
\text{CCD\_ID}_{focus} & \geq 0 \quad (681) \\
\text{CCD\_ID}_{focus} & \leq 3 \quad (682)
\end{align*}
\]
and

\[
\cos(DEC_{\textsc{adj}}) \cos(DEC_{\textsc{targ in}}) \cos(RA_{\textsc{adj}} - RA_{\textsc{targ in}}) + \sin(DEC_{\textsc{adj}}) \sin(DEC_{\textsc{targ in}}) \geq 4.855 \times 10^{-11},
\]

then

\[
\text{T\textsc{ime}_{\textsc{adj}} = a\text{impoint}.}
\]

iv. If

\[
\text{OBS\_MODE} = \text{pointing or } \text{OBS\_MODE} = \text{POINTING}
\]

and

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED}
\]

and

\[
\text{CONTENT}_{\text{in}} = \text{EVT0 or } \text{CONTENT}_{\text{in}} = \text{EVT1 or } \text{CONTENT}_{\text{in}} = \text{EVT2}
\]

and

\[
\text{CCD\_ID}_{\text{focus}} \geq 4 \text{ and } \text{CCD\_ID}_{\text{focus}} \leq 9
\]

and

\[
\cos(DEC_{\textsc{adj}}) \cos(DEC_{\textsc{targ in}}) \cos(RA_{\textsc{adj}} - RA_{\textsc{targ in}}) + \sin(DEC_{\textsc{adj}}) \sin(DEC_{\textsc{targ in}}) \geq 4.855 \times 10^{-11},
\]

then

\[
\text{T\textsc{ime}_{\textsc{adj}} = a\text{impoint}.}
\]

(c) Pointing CC mode with ACIS-S grating data:

If

\[
\text{OBS\_MODE} = \text{pointing or } \text{OBS\_MODE} = \text{POINTING}
\]

and

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED}
\]

and

\[
\text{CONTENT}_{\text{in}} = \text{T\textsc{gevt1}}
\]
and
\[
\begin{align*}
\text{CCD\_ID}_\text{focus} & \geq 4 \quad \text{and} \\
\text{CCD\_ID}_\text{focus} & \leq 9,
\end{align*}
\tag{705}\tag{706}
\]
then
\[
\text{TIME\_ADJ} = \text{GRATING}.
\tag{707}
\]

(d) Pointing CC mode with ACIS-I grating data:

i. If
\[
\begin{align*}
\text{OBS\_MODE} & = \text{pointing or} \\
\text{OBS\_MODE} & = \text{POINTING}
\end{align*}
\tag{708}\tag{709}
\]
and
\[
\begin{align*}
\text{DATAMODE}_{\text{in}} & = \text{CC33\_FAINT or} \\
\text{DATAMODE}_{\text{in}} & = \text{CC33\_GRADED}
\end{align*}
\tag{710}\tag{711}
\]
and
\[
\begin{align*}
\text{CONTENT}_{\text{in}} & = \text{TGEVT1}
\end{align*}
\tag{712}
\]
and
\[
\begin{align*}
\text{CCD\_ID}_\text{focus} & \geq 0 \quad \text{and} \\
\text{CCD\_ID}_\text{focus} & \leq 3
\end{align*}
\tag{713}\tag{714}
\]
and
\[
\begin{align*}
\cos (\text{DEC\_ADJ}_1) \cos (\text{DEC\_TARG}_{\text{in}}) \cos (\text{RA\_ADJ}_1 - \text{RA\_TARG}_{\text{in}}) + \\
\sin (\text{DEC\_ADJ}_1) \sin (\text{DEC\_TARG}_{\text{in}}) < \\
4.855 \times 10^{-11},
\end{align*}
\tag{715}\tag{716}\tag{717}
\]
then
\[
\text{TIME\_ADJ} = \text{TARGET}.
\tag{718}
\]

ii. If
\[
\begin{align*}
\text{OBS\_MODE} & = \text{pointing or} \\
\text{OBS\_MODE} & = \text{POINTING}
\end{align*}
\tag{719}\tag{720}
\]
and
\[
\begin{align*}
\text{DATAMODE}_{\text{in}} & = \text{CC33\_FAINT or} \\
\text{DATAMODE}_{\text{in}} & = \text{CC33\_GRADED}
\end{align*}
\tag{721}\tag{722}
\]
and
\[
\begin{align*}
\text{CONTENT}_{\text{in}} & = \text{TGEVT1}
\end{align*}
\tag{723}
\]
and

\[ \text{CCD}_{\text{ID focus}} \geq 0 \text{ and } \text{CCD}_{\text{ID focus}} \leq 3 \]  

(724)  

(725)  

and

\[
\begin{align*}
\cos (\text{DEC}_{\text{ADJ I}}) \cos (\text{DEC}_{\text{TARG in}}) \cos (\text{RA}_{\text{ADJ I}} - \text{RA}_{\text{TARG in}}) + \\
\sin (\text{DEC}_{\text{ADJ I}}) \sin (\text{DEC}_{\text{TARG in}}) & \geq 4.855 \times 10^{-11}, \\
\end{align*}
\]

(726)  

(727)  

(728)

then

\[ \text{TIME}_{\text{ADJ}} = \text{AIMPOINT}. \]  

(729)  

(e) Secondary CC mode:

If

\[ \text{OBS}_{\text{MODE}} \neq \text{pointing} \text{ and } \text{OBS}_{\text{MODE}} \neq \text{POINTING} \]  

(730)  

(731)

and

\[ \text{DATAMODE}_{\text{in}} = \text{CC33}_{\text{FAINT or }} \]  

(732)  

(733)

then

\[ \text{TIME}_{\text{ADJ}} = \text{MIDCHIP}. \]  

(734)

2 TBD

- Complete the spec to include all of the timed exposure mode processing.
- Complete sections 1.1, 1.2, 1.3, and 1.4.
- Should CONTENTs other than EVT0, EVT1, TGEVT1, and EVT2 be included?
- Should CONTENT = EVT2 be dropped?
- Should DATAMODEs other than CC33_{FAINT, CC33_{GRADED, FAINT, FAINT_BIAS, GRADED, and VFAINT be included?}
- Are the RA_{TARG, DEC_{TARG, RA_{NOM, DEC_{NOM, and TIMEDEL keywords in the output of afe (need obsfile sometimes)?
- What if TIME_{RO is not in the infile (output of afe? EVT2 files?)?
- What if a small fraction of the values of CHIPY_{TARG are off the chip due to bad aspect?
- Make sure that the STATUS bits are unset and reset properly.
- What about aoff and soff files instead of asol files?
- Are the \( \beta \) in PHA_{RO the same as the \( \beta \) in PHA?
- Should something be done about SKY_{1D}?