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

1 acis_process_events

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

1. infile:

   (a) Existence:
       If the infile does not exist, then acis_process_events exits with an error message.

   (b) Permission:
       If the infile exists, but the file permissions do not allow it to be read, then acis_process_events exits with an error message.

   (c) Validation:
i. CONTENT:
   If the *infile* does not have an HDU $h_{\text{in}}$ with the keyword
   \[
   \begin{align*}
   \text{CONTENT} &= \text{EVT0} \text{ or} \quad (1) \\
   \text{CONTENT} &= \text{EVT1} \text{ or} \quad (2) \\
   \text{CONTENT} &= \text{TGEVT1} \text{ or} \quad (3) \\
   \text{CONTENT} &= \text{EVT2}, \quad (4)
   \end{align*}
   \]
   then *acis_process_events* exits with an error message. Hereafter, the value of this keyword is referred to as $\text{CONTENT}_{\text{in}}$.

ii. DATAMODE:
    The DATAMODE is read from the HDU $h_{\text{in}}$ keyword of the same name. If the HDU $h_{\text{in}}$ does not include the keyword DATAMODE or if
    \[
    \begin{align*}
    \text{DATAMODE} &\neq \text{CC33\_FAINT} \text{ and} \quad (5) \\
    \text{DATAMODE} &\neq \text{CC33\_GRADED} \text{ and} \quad (6) \\
    \text{DATAMODE} &\neq \text{FAINT} \text{ and} \quad (7) \\
    \text{DATAMODE} &\neq \text{FAINT\_BIAS} \text{ and} \quad (8) \\
    \text{DATAMODE} &\neq \text{GRADED} \text{ and} \quad (9) \\
    \text{DATAMODE} &\neq \text{VFAINT}, \quad (10)
    \end{align*}
    \]
    then *acis_process_events* exits with an error message. Hereafter, the value of this keyword is referred to as $\text{DATAMODE}_{\text{in}}$.

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

iv. TIME\_RO:
    If
    \[
    \begin{align*}
    \text{DATAMODE}_{\text{in}} &= \text{CC33\_FAINT} \text{ or} \quad (11) \\
    \text{DATAMODE}_{\text{in}} &= \text{CC33\_GRADED}, \quad (12)
    \end{align*}
    \]
    if
    \[
    \begin{align*}
    \text{CONTENT}_{\text{in}} &= \text{EVT1} \text{ or} \quad (13) \\
    \text{CONTENT}_{\text{in}} &= \text{TGEVT1} \text{ or} \quad (14) \\
    \text{CONTENT}_{\text{in}} &= \text{EVT2}, \quad (15)
    \end{align*}
    \]
    and if HDU $h_{\text{in}}$ of the *infile* does not include the column TIME\_RO, then *acis_process_events* exits with an error message. Hereafter, this column is referred to as $\text{TIME\_RO}_{\text{in}}$.

v. EXPNO:
    If HDU $h_{\text{in}}$ the *infile* does not include the column EXPNO, then *acis_process_events* exits with an error message. Hereafter, this column is referred to as $\text{EXPNO}_{\text{in}}$.

vi. CCD\_ID:
    A. If
    \[
    \begin{align*}
    \text{CONTENT}_{\text{in}} &= \text{EVT0} \quad (16)
    \end{align*}
    \]
    and if HDU $h_{\text{in}}$ of the *infile* does not include the keyword CCD\_ID, then *acis_process_events* exits with an error message. Hereafter, this keyword is referred to as $\text{CCD\_ID}_{\text{in}}$.  

2
B. If

\[
\begin{align*}
\text{CONTENT}_\text{in} & = \text{EVT1 or} \quad (17) \\
\text{CONTENT}_\text{in} & = \text{TGEVT1 or} \quad (18) \\
\text{CONTENT}_\text{in} & = \text{EVT2} \quad (19)
\end{align*}
\]

and if HDU \(h_{\text{in}}\) of the \textit{infile} does not include the column \texttt{CCD_ID}, then \texttt{acis\_process\_-\_events} exits with an error message. Hereafter, this column is referred to as \texttt{CCD\_ID}_{in}.

\[\text{vii. CCDX:} \]
A. If

\[
\text{CONTENT}_\text{in} = \text{EVT0} \quad (20)
\]

and if HDU \(h_{\text{in}}\) of the \textit{infile} does not include the column \texttt{CCDX}, then \texttt{acis\_process\_-\_events} exits with an error message. Hereafter, this column is referred to as \texttt{CCDX}_{in}.

\[\text{viii. CHIPX:} \]
A. If

\[
\begin{align*}
\text{CONTENT}_\text{in} & = \text{EVT1 or} \quad (21) \\
\text{CONTENT}_\text{in} & = \text{TGEVT1 or} \quad (22) \\
\text{CONTENT}_\text{in} & = \text{EVT2} \quad (23)
\end{align*}
\]

and if HDU \(h_{\text{in}}\) of the \textit{infile} does not include the column \texttt{CHIPX}, then \texttt{acis\_process\_-\_events} exits with an error message. Hereafter, this column is referred to as \texttt{CHIPX}_{in}.

\[\text{ix. CCDY:} \]
A. If

\[
\text{CONTENT}_\text{in} = \text{EVT0,} \quad (24)
\]

if

\[
\begin{align*}
\text{DATAMODE}_\text{in} & = \text{FAINT or} \quad (25) \\
\text{DATAMODE}_\text{in} & = \text{FAINT\_BIAS or} \quad (26) \\
\text{DATAMODE}_\text{in} & = \text{GRADED or} \quad (27) \\
\text{DATAMODE}_\text{in} & = \text{VFAINT,} \quad (28)
\end{align*}
\]

and if HDU \(h_{\text{in}}\) of the \textit{infile} does not include the column \texttt{CCDY}, then \texttt{acis\_process\_-\_events} exits with an error message. Hereafter, this column is referred to as \texttt{CCDY}_{in}.

\[\text{x. TROW:} \]
A. If

\[
\text{CONTENT}_\text{in} = \text{EVT0,} \quad (29)
\]

if

\[
\begin{align*}
\text{DATAMODE}_\text{in} & = \text{CC33\_FAINT or} \quad (30) \\
\text{DATAMODE}_\text{in} & = \text{CC33\_GRADED} \quad (31)
\end{align*}
\]

and if HDU \(h_{\text{in}}\) of the \textit{infile} does not include the column \texttt{TROW}, then \texttt{acis\_process\_-\_events} exits with an error message. Hereafter, this column is referred to as \texttt{TROW}_{in}.

\[\text{xi. CHIPY:} \]

A. If

\[
\text{CONTENT}_{\text{in}} = \text{EVT1} \text{ or (32)}
\]
\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1} \text{ or (33)}
\]
\[
\text{CONTENT}_{\text{in}} = \text{EVT2} \text{ (34)}
\]

and if HDU \( h_{\text{in}} \) of the infile does not include the column CHIPY, then \text{acis\_process\_events} exits with an error message. Hereafter, this column is referred to as CHIPY_{\text{in}}.

xii. RA\_TARG, DEC\_TARG, RA\_NOM, DEC\_NOM, RA\_PNT, DEC\_PNT, TIMEDEL, CHIPY\_TG, CHIPY\_ZO, and TG\_M:

If

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \text{ or (35)}
\]
\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \text{ (36)}
\]

then

A. RA\_TARG, DEC\_TARG, RA\_NOM, DEC\_NOM, RA\_PNT, DEC\_PNT, and TIMEDEL:

If HDU \( h_{\text{in}} \) of the infile does not include the keywords RA\_TARG, DEC\_TARG, RA\_NOM, DEC\_NOM, RA\_PNT, DEC\_PNT, and TIMEDEL, then \text{acis\_process\_events} exits with an error message. Hereafter these keywords are referred to as RA\_TARG_{\text{in}}, DEC\_TARG_{\text{in}}, RA\_NOM_{\text{in}}, DEC\_NOM_{\text{in}}, RA\_PNT_{\text{in}}, DEC\_PNT_{\text{in}}, and TIMEDEL_{\text{in}}, respectively.

B. CHIPY\_TG, CHIPY\_ZO, and TG\_M:

If

\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1} \text{ (37)}
\]

and if HDU \( h_{\text{in}} \) 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_{\text{in}}, CHIPY\_ZO_{\text{in}}, and TG\_M_{\text{in}}, respectively.

2. stop:

(a) Lowercase:
The parameter string is converted to contain only lower case letters.

(b) Validation:

If

\[
\text{stop} \neq \text{none and (38)}
\]
\[
\text{stop} \neq \text{chip and (39)}
\]
\[
\text{stop} \neq \text{tdep and (40)}
\]
\[
\text{stop} \neq \text{det and (41)}
\]
\[
\text{stop} \neq \text{tan and (42)}
\]
\[
\text{stop} \neq \text{sky, (43)}
\]

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

3. acaofffile:

(a) Validation for CC mode:

If

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT} \text{ or (44)}
\]
\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \text{, (45)}
\]

then
1. Setting:
   If
   \[
   \text{acaofffile} = \text{none or } (46) \\
   \text{acaofffile} = \text{NONE}, (47)
   \]
   then \texttt{acis\_process\_events} exits with an error message.

2. Existence:
   If the \texttt{acaofffile} does not exist, then \texttt{acis\_process\_events} exits with an error message.

3. Permission:
   If the \texttt{acaofffile} exists, but the file permissions do not allow it to be read, then \texttt{acis\_process\_events} exits with an error message.

4. CONTENT:
   If the \texttt{acaofffile} does not have an HDU \(h_{\text{acaoff}}\) with the keyword
   \[
   \text{CONTENT} = \text{ASPSOL}, (48)
   \]
   then \texttt{acis\_process\_events} exits with an error message.

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

6. Columns:
   If HDU \(h_{\text{acaoff}}\) of the \texttt{acaofffile} does not include the columns \(\text{TIME}\), \(\text{RA}\), \(\text{DEC}\), and \(\text{ROLL}\) then \texttt{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 \(\text{ROLL}_{\text{acaoff}}\).

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

4. \texttt{doevtgrade}:
   (a) Lowercase:
      The parameter string is converted to contain only lower case letters.
   (b) Validation:
      If
      \[
      \text{doevtgrade} \neq \text{yes and } (49) \\
      \text{doevtgrade} \neq \text{no}, (50)
      \]
      then \texttt{acis\_process\_events} exits with an error message.

5. \texttt{apply\_cti}:
   (a) Lowercase:
      The parameter string is converted to contain only lower case letters.
   (b) Validation:
      i. Setting:
         If
         \[
         \text{apply\_cti} \neq \text{yes and } (51) \\
         \text{apply\_cti} \neq \text{no}, (52)
         \]
         then \texttt{acis\_process\_events} exits with an error message.
ii. PHAS:
   If
   
   \[ \text{apply\_cti} = \text{yes} \]  
   \text{(53)}
   
   and if the infile does not include the column PHAS, then apply\_cti is changed to “no” and acis\_process\_events produces a warning message.

iii. doevtgrade:
   If
   
   \[ \text{apply\_cti} = \text{yes} \text{ and} \]
   \[ \text{doevtgrade} = \text{no} \]  
   \text{(54)}
   \text{(55)}
   
   then apply\_cti is changed to “no” and acis\_process\_events produces a warning message.

6. alignmentfile:
   
   (a) Validation for CC mode:
   If
   
   \[ \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or} \]  
   \[ \text{(56)} \]
   \[ \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED}, \]  
   \text{(57)}
   
   then acis\_process\_events exits with an error message.

i. Setting:
   If
   
   \[ \text{alignmentfile} = \text{none or} \]  
   \[ \text{(58)} \]
   \[ \text{alignmentfile} = \text{NONE}, \]  
   \text{(59)}
   
   then acis\_process\_events exits with an error message.

ii. Existence:
   If the alignmentfile does not exist, then acis\_process\_events exits with an error message.

iii. Permission:
   If the alignmentfile exists, but the file permissions do not allow it to be read, then acis\_process\_events exits with an error message.

iv. CONTENT:
   If the alignmentfile does not have an HDU \text{h}\text{alignment} with the keyword
   
   \[ \text{CONTENT} = \text{ASPSOL}, \]  
   \text{(60)}
   
   then acis\_process\_events exits with an error message.

v. Keyword:
   If HDU \text{h}\text{alignment} of the alignmentfile does not include the keyword TSTART, then acis\_process\_events exits with an error message.

vi. Columns:
   If HDU \text{h}\text{alignment} of the alignmentfile does not include the columns DY, DZ, and DTHETA then acis\_process\_events exits with an error message.

vii. Sequential:
   If more than one valid alignmentfile is specified, but the the values TSTART are not in increasing order, then acis\_process\_events exits with an error message.

7. badpixfile:
(a) Validation:
If
\[
\text{badpixfile} \neq \text{none and} \quad \text{badpixfile} \neq \text{NONE},
\]
then

i. Existence:
If the \text{badpixfile} does not exist, then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message.

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

iv. Keyword:
If the HDU(s) \(h_{\text{badpix}}\) of the \text{badpixfile} do not include the keyword CCD\_ID, then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message.

v. Columns:
If the HDU(s) \(h_{\text{badpix}}\) of the \text{badpixfile} do not include the columns CHIPX, CHIPY, TIME, TIME\_STOP, and STATUS, then \text{badpixfile} is changed to “none” and \text{acis\_process\_events} produces a warning message. Hereafter these columns are referred to as \(CHIPX_{\text{badpix}}, \text{CHIPY}_{\text{badpix}}, \text{TIME}_{\text{badpix}}, \text{TIME\_STOP}_{\text{badpix}}, \text{and STATUS}_{\text{badpix}}, \) respectively.

8. \text{ctifile}:

(a) Validation:
If
\[
\text{ctifile} \neq \text{caldb and} \quad \text{ctifile} \neq \text{CALDB},
\]
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 \text{ctifile} exists, but the file permissions do not allow it to be read, then \text{apply\_cti} is changed to “no” and \text{acis\_process\_events} produces a warning message.

iii. CONTENT:
If the \text{ctifile} does not have one or more HDUs \(h_{\text{cti}}\) with the keyword
\[
\text{CONTENT} = \text{CDB\_ACIS\_CTI},
\]
then \text{apply\_cti} is changed to “no” and \text{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.

9. clobber:
   (a) Lowercase:
      The parameter string is converted to contain only lower case letters.
   (b) Validation:
      i. Setting:
         If

            clobber ≠ yes and
            clobber ≠ no,            (68)

         then clobber is changed to “no” and acis_process_events produces a warning message.
      ii. Permission:
         If

            clobber = yes            (70)

         and the outfile exists, but 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

            clobber = no            (71)

         and the outfile exists, then acis_process_events exits with an error message.

10. pix_adj:
    (a) Lowercase:
        The parameter string is converted to contain only lower case letters.
    (b) Validation:
        i. Setting:
           If

           pix_adj ≠ centroid and
           pix_adj ≠ edser and
           pix_adj ≠ none and
           pix_adj ≠ randomize,        (72, 73, 74, 75)

           then pix_adj is changed to “none” and acis_process_events produces a warning message.
        ii. stop:
           If

           pix_adj = centroid or
           pix_adj = edser or
           pix_adj = randomize        (76, 77, 78)
and if
\[
\text{stop} \neq \text{sky}, \quad (79)
\]
then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

iii. PHAS:
If
\[
\text{pix}\_\text{adj} = \text{centroid} \quad (80)
\]
and if the \text{infile} does not include the column PHAS, then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

iv. FLTGRADE:
If
\[
\text{pix}\_\text{adj} = \text{edser} \quad (81)
\]
and if the \text{infile} does not include the column FLTGRADE, then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

11. subpixfile:

(a) If
\[
\text{pix}\_\text{adj} = \text{edser}, \quad (82)
\]
then

i. Existence:
If the \text{subpixfile} does not exist, then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

ii. Permission:
If the \text{subpixfile} exists, but the file permissions do not allow it to be read, then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

iii. Validation:
A. \text{CONTENT}:
If the \text{subpixfile} does not have one or more HDUs \text{h}\_\text{subpix} with the keyword
\[
\text{CONTENT} = \text{AXAF\_SUBPIX}, \quad (83)
\]
then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

B. Keyword:
If the HDUs \text{h}\_\text{subpix} of the \text{subpixfile} do not include the keyword \text{CCD\_ID}, then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message.

C. Columns:
If the HDUs \text{h}\_\text{subpix} of the \text{subpixfile} do not include binary tables with the columns FLTGRADE, NPOINTS, ENERGY, CHIPX\_OFFSET, and CHIPY\_OFFSET, then \text{pix}\_\text{adj} is changed to “none” and \text{acis\_process\_events} produces a warning message. Hereafter these columns are referred to as \text{FLTGRADE}\_\text{subpix}, \text{NPOINTS}\_\text{subpix}, \text{ENERGY}\_\text{subpix}, \text{CHIPX}\_\text{OFFSET}\_\text{subpix}, and \text{CHIPY}\_\text{OFFSET}\_\text{subpix}, respectively.
1.5.2 Initializations

1. Focal-point CCD:
The values of RA_PNT\textsubscript{in} and DEC_PNT\textsubscript{in} are used to determine the CCD\_ID associated with the focal point. Hereafter this value is referred to as CCD\_ID\textsubscript{focus}.*

2. Zeroth-order coordinates:
If
\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT \ or \ CC33\_GRADED},
\]
and if
\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1},
\]
then the CHIPY\_ZO\textsubscript{in} coordinates are processed to obtain the minimum, median, and maximum values:
\[
\begin{align*}
\text{CHIPY\_ZO}_{\text{min}} &= \text{minimum} (\text{CHIPY\_ZO}_{\text{in}}), \\
\text{CHIPY\_ZO}_{\text{med}} &= \text{median} (\text{CHIPY\_ZO}_{\text{in}}), \text{ and} \\
\text{CHIPY\_ZO}_{\text{max}} &= \text{maximum} (\text{CHIPY\_ZO}_{\text{in}}).
\end{align*}
\]
Only events in the good-time intervals are included in the computation of the values of CHIPY\_ZO\textsubscript{min}, CHIPY\_ZO\textsubscript{med}, and CHIPY\_ZO\textsubscript{max}.

3. acaofffile:
If
\[
\text{DATAMODE} = \text{CC33\_FAINT \ or \ CC33\_GRADED},
\]
then

(a) \(\text{TIME}_{\text{min}}, \text{TIME}_{\text{max}}, \text{RA}_c, \text{ and } \text{DEC}_c: \)
The acaofffile data are processed to determine the earliest and latest times for which there is aspect information and to determine the right ascension and declination coordinates near the center of the dither pattern:
\[
\begin{align*}
\text{TIME}_{\text{min}} &= \text{min} (\text{TIME}_{\text{acaoff}}), \\
\text{TIME}_{\text{max}} &= \text{max} (\text{TIME}_{\text{acaoff}}), \\
\text{RA}_c &= \text{median} (\text{RA}_{\text{acaoff}}), \text{ and} \\
\text{DEC}_c &= \text{median} (\text{DEC}_{\text{acaoff}}).
\end{align*}
\]

(b) \(\text{TIME}_c: \)
The acaofffile data are processed to determine the time \(\text{TIME}_c\) 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 \((\text{RA}_c, \text{DEC}_c)\)).

(c) \(\text{RA}_{\text{ADJ}_I}, \text{DEC}_{\text{ADJ}_I}, \text{RA}_{\text{ADJ}_S}, \text{DEC}_{\text{ADJ}_S}: \)
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.

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

ii. ACIS-S aim point:
For the ACIS-S array, the values of RA\_ADJ\_S and DEC\_ADJ\_S are initialized assuming that the source is at the ACIS-S aim point [i.e. that \((\text{TIME}, \text{CCD\_ID}, \text{CHIPX}, \text{CHIPY}) = (\text{TIME}_c, 7, 227, 509)\)\(^\ddagger\)].

iii. 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 acaofffile, 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

\[
\text{median}(\text{CHIPY\_TARG}) \geq 16.5 \quad \text{and} \quad \text{median}(\text{CHIPY\_TARG}) < 1008.5,
\]

then

A. ACIS-I:
If

\[
\begin{align*}
\text{CCD\_ID\_focus} & \geq 0 \quad \text{and} \quad (99) \\
\text{CCD\_ID\_focus} & \leq 3, \quad (100)
\end{align*}
\]

then

\[
\begin{align*}
\text{RA\_ADJ\_I} &= \text{RA\_TARG\_in} \quad \text{and} \quad (101) \\
\text{DEC\_ADJ\_I} &= \text{DEC\_TARG\_in}. \quad (102)
\end{align*}
\]

B. ACIS-S:
If

\[
\begin{align*}
\text{CCD\_ID\_focus} & \geq 4 \quad \text{and} \quad (103) \\
\text{CCD\_ID\_focus} & \leq 9, \quad (104)
\end{align*}
\]

then

\[
\begin{align*}
\text{RA\_ADJ\_S} &= \text{RA\_TARG\_in} \quad \text{and} \quad (105) \\
\text{DEC\_ADJ\_S} &= \text{DEC\_TARG\_in}. \quad (106)
\end{align*}
\]

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 \(k = 1\text{–}5, 14, 16\text{–}19, \text{and } 23\) (of 0–31), bits that can be set by acis\_process\_events.

\(^\dagger\)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.

\(^\ddagger\)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.
iii. If

$$\text{doevtgrade} = \text{yes},$$  \hspace{1cm} (107)

then the value of $\text{STATUS}_{[26]}$, the other bit that can be set by $\text{acis\_process\_events}$, is set to zero.

(b) Does not exist:
If HDU $h_{\text{in}}$ does not include a 32-bit column named $\text{STATUS}$, then
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 $\text{EXPNO}$ for an event is given by $\text{EXPNO}_{\text{in}}$.

(b) Validation:

If

$$\begin{align*}
\text{EXPNO} &< 0 \text{ or} \\
\text{EXPNO} &\geq 10^8,
\end{align*}$$  \hspace{1cm} (108)\hspace{1cm} (109)

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 $\text{CCD\_ID}$ for an event is given by $\text{CCD\_ID}_{\text{in}}$.

(b) Validation:

If

$$\begin{align*}
\text{CCD\_ID} &< 0 \text{ or} \\
\text{CCD\_ID} &> 9,
\end{align*}$$  \hspace{1cm} (110)\hspace{1cm} (111)

then $\text{acis\_process\_events}$ exits with an error message because $\text{CCD\_ID}$-dependent computations could fail if the value of $\text{CCD\_ID}$ is unphysical.

4. CHIPX:

(a) Read:

i. Level 0:
If

$$\text{CONTENT}_{\text{in}} = \text{EVT0},$$  \hspace{1cm} (112)

then the value of $\text{CHIPX}$ for an event is given by

$$\text{CHIPX} = \text{CCDX}_{\text{in}} + 1.$$  \hspace{1cm} (113)

ii. Level 1, 1.5, or 2:
If

$$\begin{align*}
\text{CONTENT}_{\text{in}} &= \text{EVT1}, \text{ or} \\
\text{CONTENT}_{\text{in}} &= \text{TGEVT1}, \text{ or} \\
\text{CONTENT}_{\text{in}} &= \text{EVT2},
\end{align*}$$  \hspace{1cm} (114)\hspace{1cm} (115)\hspace{1cm} (116)

then the value of $\text{CHIPX}$ for an event is given by $\text{CHIPX}_{\text{in}}$. 

(b) Validation:
i. Unphysical:
   If
   \[ \text{CHIPX} < 1 \text{ or } \text{CHIPX} > 1024, \]
   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
   \[ \text{CHIPX} = 1 \text{ or } \text{CHIPX} = 1024, \]
   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
   \[ \text{NODE\_ID} = \text{int}\left(\frac{\text{CHIPX} - 1}{256}\right), \]
   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
      \[ \text{CONTENT}_{in} = \text{EVT0}, \]
      then
      A. TE mode:
      If
      \[ \text{DATAMODE}_{in} = \text{FAINT or FAINT\_BIAS or GRADED or VFAINT}, \]
      then the value of \texttt{CHIPY} for an event is given by
      \[ \text{CHIPY} = \text{CCDY}_{in} + 1. \]
      B. CC mode:
      If
      \[ \text{DATAMODE}_{in} = \text{CC33\_FAINT or CC33\_GRADED}, \]
      then the value of \texttt{CHIPY} for an event is given by
      \[ \text{CHIPY} = \text{TROW}_{in} + 1. \]

ii. Level 1, 1.5, or 2:
   If
   \[
   \text{CONTENT}_{in} = \text{EVT1} \text{ or } \text{CONTENT}_{in} = \text{TGEVT1} \text{ or } \text{CONTENT}_{in} = \text{EVT2},
   \]
   then the value of CHIPY for an event is given by CHIPY_{in}.

(b) Validation:
   i. Unphysical:
      A. TE mode:
         If
         \[
         \text{DATAMODE}_{in} = \text{FAINT} \text{ or } \text{DATAMODE}_{in} = \text{FAINT\_BIAS} \text{ or } \text{DATAMODE}_{in} = \text{GRADED} \text{ or } \text{DATAMODE}_{in} = \text{VFAINT},
         \]
         and if
         \[
         \text{CHIPY} < 1 \text{ or } \text{CHIPY} > 1024,
         \]
         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
         \[
         \text{DATAMODE}_{in} = \text{CC33\_FAINT} \text{ or } \text{DATAMODE}_{in} = \text{CC33\_GRADED},
         \]
         and if
         \[
         \text{CHIPY} < 1 \text{ or } \text{CHIPY} > 512,
         \]
         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
         \[
         \text{DATAMODE}_{in} = \text{FAINT} \text{ or } \text{DATAMODE}_{in} = \text{FAINT\_BIAS} \text{ or } \text{DATAMODE}_{in} = \text{GRADED},
         \]
         and if
         \[
         \text{CHIPY} = 1 \text{ or } \text{CHIPY} = 1024,
         \]
         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
\[ \text{DATAMODE}_{\text{in}} = \text{VFAINT} \] (149)
and if
\[ \text{CHIPY} = 1 \text{ or } 2 \text{ or } 1023 \text{ or } 1024, \] (150-153)
then \texttt{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
\[ \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{CC33\_GRADED} \] (154-155)
and if
\[ \text{CHIPY} = 1 \text{ or } 512, \] (156-157)
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.

7. \textit{TG}M:
(a) CC mode with gratings:
If
\[ \text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{CC33\_GRADED} \] (158-159)
and if
\[ \text{CONTENT}_{\text{in}} = \text{TGEVT1}, \] (160)
then
i. Read:
The value of \textit{TG}M for an event is given by \textit{TG}M_{\text{in}}.
ii. Validation:
A. If
\[ \textit{TG}M < -99, \] (161)
then
\[ \textit{TG}M = -99 \] (162)
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
\[ TG_{M} > 99, \]  
then
\[ TG_{M} = 99 \]  
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
\[ \text{DATAMODE}_{in} = \text{CC33\_FAINT} \text{ or } \text{DATAMODE}_{in} = \text{CC33\_GRADED} \]  
and if
\[ \text{CONTENT}_{in} = \text{TGEVT1}, \]  
then
i. Read:  
The value of \texttt{CHIPY\_TG} for an event is given by \texttt{CHIPY\_TG}_{in}.
ii. Validation:
A. If
\[ TG_{M} > -99 \text{ and } TG_{M} < 99, \]  
and if
\[ \text{CHIPY\_TG} \leq 0 \text{ or } \text{CHIPY\_TG} \geq 1025, \]  
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
\[ TG_{M} > -99, \]  
\[ TG_{M} < 99, \text{ and } \]  
\[ \text{CHIPY\_TG} < 1, \]  
then
\[ \text{CHIPY\_TG} = 1. \] 
C. If
\[ TG_{M} > -99, \]  
\[ TG_{M} < 99, \text{ and } \]  
\[ \text{CHIPY\_TG} > 1024, \]  
then
\[ \text{CHIPY\_TG} = 1024. \]
9. \textbf{CHIPY,Z0}: 

(a) CC mode with gratings:

If 

\begin{align*}
\text{DATAMODE}_{\text{in}} & = \text{CC33,FAINT \ or} & (180) \\
\text{DATAMODE}_{\text{in}} & = \text{CC33,GRADED} & (181)
\end{align*}

and if

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

then

i. Read:

The value of \text{CHIPY,Z0} for an event is given by \text{CHIPY,Z0}_{\text{in}}.

10. \textbf{TIME,RO}:

(a) CC mode:

If 

\begin{align*}
\text{DATAMODE}_{\text{in}} & = \text{CC33,FAINT \ or} & (183) \\
\text{DATAMODE}_{\text{in}} & = \text{CC33,GRADED} & (184)
\end{align*}

then

i. Read:

A. Level 0:

If 

\text{CONTENT}_{\text{in}} = \text{EVT0}, 

then the value of \text{TIME,RO} for an event is given by \text{TIME}_{\text{in}}.

B. Level 1, 1.5, or 2:

If 

\begin{align*}
\text{CONTENT}_{\text{in}} & = \text{EVT1, or} & (186) \\
\text{CONTENT}_{\text{in}} & = \text{TGEVT1, or} & (187) \\
\text{CONTENT}_{\text{in}} & = \text{EVT2}, & (188)
\end{align*}

then the value of \text{TIME,RO} for an event is given by \text{TIME,RO}_{\text{in}}.

ii. Validation:

If 

\begin{align*}
\text{TIME,RO} & < 0 \ or & (189) \\
\text{TIME,RO} & \geq 3 \times 10^9, & (190)
\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.

11. \textbf{TIME and CHIPY,ADJ}:

(a) Read or calculate:
i. TE mode:
If
\[
\text{DATAMODE}_{\text{in}} = \text{FAINT or (191)}
\]
\[
\text{DATAMODE}_{\text{in}} = \text{FAINT_BIAS or (192)}
\]
\[
\text{DATAMODE}_{\text{in}} = \text{GRADED or (193)}
\]
\[
\text{DATAMODE}_{\text{in}} = \text{VFAINT, (194)}
\]
then
\[
\text{TIME} = \text{TIME}_{\text{in}} \quad \text{and (195)}
\]
\[
\text{CHIPY}_{\text{ADJ}} = \text{CHIPY. (196)}
\]

ii. CC mode without grating data:
If
\[
\text{DATAMODE}_{\text{in}} = \text{CC33_FAINT or (197)}
\]
\[
\text{DATAMODE}_{\text{in}} = \text{CC33_GRADED} (198)
\]
and if
\[
\text{CONTENT}_{\text{in}} = \text{EVT0 or (199)}
\]
\[
\text{CONTENT}_{\text{in}} = \text{EVT1 or (200)}
\]
\[
\text{CONTENT}_{\text{in}} = \text{EVT2, (201)}
\]
then
A. \text{TIME}':
The approximate time of arrival
\[
\text{TIME}' = \text{TIME}_{\text{RO}} - (512 + 1028) \times \text{TIMEDEL}_{\text{in}}. (202)
\]

B. \text{CHIPY}_{\text{ADJ}}':
If
\[
\text{CCD}_{\text{ID}}_{\text{focus}} \geq 0 \quad \text{and (203)}
\]
\[
\text{CCD}_{\text{ID}}_{\text{focus}} \leq 3, (204)
\]
then \text{CHIPY}_{\text{ADJ}}' (the approximate value of \text{CHIPY}_{\text{ADJ}}) is given by the \text{CHIPY} location (on the focal-point CCD) of the coordinates \text{RA}_{\text{ADJ}}_{I} and \text{DEC}_{\text{ADJ}}_{I} at the time \text{TIME}'. If \text{TIME}' < \text{TIME}_{\text{min}} \text{ or } \text{TIME}' > \text{TIME}_{\text{max}}, then \text{TIME}_{c} is used instead of \text{TIME}'.
If
\[
\text{CCD}_{\text{ID}}_{\text{focus}} \geq 4 \quad \text{and (205)}
\]
\[
\text{CCD}_{\text{ID}}_{\text{focus}} \leq 9, (206)
\]
then \text{CHIPY}_{\text{ADJ}}' is given by the \text{CHIPY} location (on the focal-point CCD) of the coordinates \text{RA}_{\text{ADJ}}_{S} and \text{DEC}_{\text{ADJ}}_{S} at the time \text{TIME}'. If \text{TIME}' < \text{TIME}_{\text{min}} \text{ or } \text{TIME}' > \text{TIME}_{\text{max}}, then \text{TIME}_{c} is used instead of \text{TIME}'.

C. \text{TIME}:
The value of \text{CHIPY}_{\text{ADJ}}' is used to obtain a better estimate of the time of arrival
\[
\text{TIME} = \text{TIME}_{\text{RO}} - (\text{CHIPY}_{\text{ADJ}}' + 1028) \times \text{TIMEDEL}_{\text{in}}. (207)
\]
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 CHIPY location (on the focal-point CCD) of the coordinates RA\_ADJ\_I and DEC\_ADJ\_I at the time TIME. If TIME < TIME\_min or TIME > TIME\_max, then TIME\_c is used instead of TIME. If

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

then the value of CHIPY\_ADJ is given by the CHIPY location (on the focal-point CCD) of the coordinates RA\_ADJ\_S and DEC\_ADJ\_S at the time TIME. If TIME < TIME\_min or TIME > TIME\_max, then TIME\_c is used instead of TIME.

iii. CC mode with ACIS-S grating data:

If

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

if

\[
\begin{align*}
\text{CONTENT}_{\text{in}} & = \text{TGEVT1},
\end{align*}
\]

and if

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

then

A. Source events:

If

\[
\begin{align*}
\text{TG}_M & > -99 \quad \text{and} \\
\text{TG}_M & < 99,
\end{align*}
\]

then

\[
\begin{align*}
\text{CHIPY\_ADJ} & = \text{CHIPY}_T G \\
\text{TIME} & = \text{TIME}_R O - (\text{CHIPY\_ADJ} + 1028) \times \text{TIMEDEL}_{\text{in}}.
\end{align*}
\]

If the event does not occur during a good-time interval, then CHIPY\_ADJ = CHIPY\_Z0\_med instead of CHIPY\_T G in equation 219.

B. Background events with zeroth order on the array:

If

\[
\begin{align*}
\text{TG}_M & = -99 \quad \text{or} \\
\text{TG}_M & = 99
\end{align*}
\]

and if

\[
\begin{align*}
\text{CHIPY\_Z0}_{\text{min}} & \geq 0.5 \quad \text{and} \\
\text{CHIPY\_Z0}_{\text{max}} & < 1024.5,
\end{align*}
\]

19
then
\[
\text{CHIPY\_ADJ} = \text{CHIPY\_ZO} \quad \text{and} \quad \text{TIME} = \text{TIME\_RO} - (\text{CHIPY\_ADJ} + 1028) \times \text{TIMEDEL\_in}. (225)
\]

If the event does not occur during a good-time interval, then \(\text{CHIPY\_ADJ} = \text{CHIPY\_ZO}_{\text{med}}\) instead of \(\text{CHIPY\_ZO}\) in equation 225.

C. Background events with zeroth order off the array:
If
\[
\begin{align*}
\text{TG\_M} &= -99 \quad \text{or} \\
\text{TG\_M} &= 99
\end{align*} (227)
\]
and if
\[
\begin{align*}
\text{CHIPY\_ZO}_{\text{max}} &< 0.5 \quad \text{or} \\
\text{CHIPY\_ZO}_{\text{min}} &\geq 1024.5,
\end{align*} (230)
\]
then
\[
\begin{align*}
\text{CHIPY\_ADJ} &= 512 + (\text{CHIPY\_ZO} - \text{CHIPY\_ZO}_{\text{med}}) \quad \text{and} \\
\text{TIME} &= \text{TIME\_RO} - (\text{CHIPY\_ADJ} + 1028) \times \text{TIMEDEL\_in}. (231)
\end{align*}
\]

If the event does not occur during a good-time interval, then \(\text{CHIPY\_ADJ} = 512\) instead of \(512 + \text{CHIPY\_ZO} - \text{CHIPY\_ZO}_{\text{med}}\) in equation 231.

iv. CC mode with ACIS-I grating data:
If
\[
\begin{align*}
\text{DATAMODE\_in} &= \text{CC33\_FAINT} \quad \text{or} \\
\text{DATAMODE\_in} &= \text{CC33\_GRADED},
\end{align*} (233, 234)
\]
if
\[
\begin{align*}
\text{CONTENT\_in} &= \text{TGEVT1}, \quad (235)
\end{align*}
\]
and if
\[
\begin{align*}
\text{CCD\_ID}_{\text{focus}} &\geq 0 \quad \text{and} \\
\text{CCD\_ID}_{\text{focus}} &\leq 3, \quad (236, 237)
\end{align*}
\]
then
A. \(\text{TIME}'\):
\[
\text{TIME}' = \text{TIME\_RO} - (512 + 1028) \times \text{TIMEDEL\_in}. (238)
\]

B. \(\text{CHIPY\_ADJ}'\):
\(\text{CHIPY\_ADJ}'\) (the approximate value of \(\text{CHIPY\_ADJ}\)) is given by the \(\text{CHIPY}\) location (on the focal-point CCD) of the coordinates \(\text{RA\_ADJ}_I\) and \(\text{DEC\_ADJ}_I\) at the time \(\text{TIME}'\). If the event does not occur during a good-time interval, then \(\text{TIME}_c\) is used instead of \(\text{TIME}'\).

C. \(\text{TIME}\):
The value of \(\text{CHIPY\_ADJ}'\) is used to obtain a better estimate of the time of arrival
\[
\begin{align*}
\text{TIME} &= \text{TIME\_RO} - (\text{CHIPY\_ADJ}' + 1028) \times \text{TIMEDEL\_in}. \quad (239)
\end{align*}
\]
D. CHIPY_ADJ:
The value of CHIPY_ADJ is given by the CHIPY location (on the focal-point CCD) of the coordinates RA_ADJ and DEC_ADJ at the time TIME. If the event does not occur during a good-time interval, then TIME_c is used instead of TIME.

(b) Validation:
   i. If
      \[ \text{TIME} < 0 \quad \text{or} \quad \text{TIME} \geq 3 \times 10^9, \]
      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.
   ii. If
      \[ \text{CHIPY_ADJ} < 0.5 \quad \text{or} \quad \text{CHIPY_ADJ} \geq 1024.5, \]
      then 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
      \[ \text{badpixfile} \neq \text{none} \quad \text{and} \quad \text{badpixfile} \neq \text{NONE} \]
      and if the badpixfile includes a valid HDU \( h_{\text{badpix}} \) where CCD_ID_{badpix} = CCD_ID, then the HDU \( h_{\text{badpix}} \) is searched as follows to determine if the event should have one or more STATUS bits set to one.
   i. If DATAMODE_{in} = CC33_FAINT or DATAMODE_{in} = CC33_GRADED and if there are one or more rows \( r \) in HDU \( h_{\text{badpix}} \) where
      \[ \text{CHIPX} \geq \text{CHIPX}_{\text{badpix},r}[0], \quad (246) \]
      \[ \text{CHIPX} \leq \text{CHIPX}_{\text{badpix},r}[1], \quad (247) \]
      \[ \text{TIME} \geq \text{TIME}_{\text{badpix},r}, \quad (248) \]
      \[ \text{TIME} < \text{TIME}_{STOP_{\text{badpix},r}} \quad \text{and where} \]
      \[ \text{STATUS}_{\text{badpix},r}[5] = 1 \quad \text{or} \quad (250) \]
      \[ \text{STATUS}_{\text{badpix},r}[6] = 1 \quad \text{or} \quad (251) \]
      \[ \text{STATUS}_{\text{badpix},r}[9] = 1, \quad (252) \]
      then
      \[ \text{STATUS}[0] = 1 \quad \text{(253)} \]
      for the event. Here CCD_ID_{badpix} is the value of the keyword CCD_ID in HDU \( h_{\text{badpix}} \), CHIPX_{badpix,r}[0] and CHIPX_{badpix,r}[1] are the first and second values in the vector column named CHIPX of row \( r \) of HDU \( h_{\text{badpix}} \) of the badpixfile, and TIME_{badpix,r} and TIME_STOP_{badpix,r} are the values in the columns named TIME and TIME_STOP, respectively, of row \( r \) of HDU \( h_{\text{badpix}} \) of the badpixfile.
ii. If $\text{DATAMODE}_{in} = \text{CC33\_FAINT}$ or $\text{DATAMODE}_{in} = \text{CC33\_GRADED}$ and if there are one or more rows $r$ in HDU $h_{\text{badpix}}$ where

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0], \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1], \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r}, \\
\text{TIME} & < \text{TIME\_STOP}_{\text{badpix},r}
\end{align*}
\]

and where

\[
\begin{align*}
\text{STATUS}_{\text{badpix},r}[0] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[1] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[7] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[11] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[12] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[13] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[14] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[16] & = 1,
\end{align*}
\]

then

\[
\text{STATUS}[4] = 1
\]

for the event.

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

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0], \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1], \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r}, \\
\text{TIME} & < \text{TIME\_STOP}_{\text{badpix},r}
\end{align*}
\]

and where

\[
\begin{align*}
\text{STATUS}_{\text{badpix},r}[8] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[10] & = 1,
\end{align*}
\]

then

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

for the event.

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

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0], \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1], \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r}, \\
\text{TIME} & < \text{TIME\_STOP}_{\text{badpix},r}
\end{align*}
\]

and where

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

22
then

\[ \text{STATUS}[6] = 1 \] (279)

for the event.

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

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0], \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1], \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r}, \\
\text{TIME} & < \text{TIME}_{\text{STOP}}_{\text{badpix},r}
\end{align*}
\] (280) (281) (282) (283)

and where

\[
\begin{align*}
\text{STATUS}_{\text{badpix},r}[2] & = 1 \text{ or } \\
\text{STATUS}_{\text{badpix},r}[4] & = 1,
\end{align*}
\] (284) (285)

then

\[ \text{STATUS}[8] = 1 \] (286)

for the event.

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

\[
\begin{align*}
\text{CHIPX} & \geq \text{CHIPX}_{\text{badpix},r}[0], \\
\text{CHIPX} & \leq \text{CHIPX}_{\text{badpix},r}[1], \\
\text{TIME} & \geq \text{TIME}_{\text{badpix},r}, \\
\text{TIME} & < \text{TIME}_{\text{STOP}}_{\text{badpix},r}
\end{align*}
\] (287) (288) (289) (290)

and where

\[ \text{STATUS}_{\text{badpix},r}[15] = 1, \] (291)

then

\[ \text{STATUS}[16] = 1 \] (292)

for the event.

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 \( \text{PHAS}[4] < \) the split threshold, then \( \text{STATUS}[k] = 1 \) for bit \( k = 1 \).

iii. If \( \text{PHAS}[4] \leq \text{PHAS}[j] \), for one or more \( j = 0–3 \) or \( 5–8 \), then \( \text{STATUS}[k] = 1 \) for bit \( k = 1 \).

iv. If \( \text{PHAS}[j] > 4095 \), for one or more \( j = 0–8 \), then \( \text{STATUS}[k] = 1 \) for bit \( k = 2 \).

14. PHAS_ADJ:

(a) If HDU 1 of the infile includes \( \text{DATAMODE}_{\text{in}} = \text{CC33}_\text{FAINT} \), if the parameter apply_cti = yes, and if 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 $\text{PHAS}_{\text{ADJ}}$ are initialized such that

$$\Delta_x[j] = 0,$$
$$\Delta_y[j] = 0, \text{ and}$$
$$\text{PHAS}_{\text{ADJ}}[j] = \text{PHAS}[j]$$

for every element $j = 0$–$8$, where the starting point for the adjusted pulse heights are the unadjusted pulse heights $\text{PHAS}$. Note that the values of the unadjusted pulse heights $\text{PHAS}$ 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

$$n = 1.$$  

iii. The temporary variables $\Delta_x'$, $\Delta_y'$, and $\text{PHAS}_{\text{ADJ}}'$ are set such that

$$\Delta_x'[j] = \Delta_x[j],$$
$$\Delta_y'[j] = \Delta_y[j], \text{ and}$$
$$\text{PHAS}_{\text{ADJ}}'[j] = \text{PHAS}_{\text{ADJ}}[j]$$

for each element $j$.

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

$$\Delta_x[0] = c_x[0]s_x\rho_x[0]V_x[0],$$
$$\Delta_x[1] = c_x[1]s_x\rho_x[1]V_x[1] - c_x'[0]s_x\rho_x[0]V_x[0],$$
\[ \Delta_x[6] = c_x[6]s_x\rho_x[6]V_x[6], \]

where

\[ c_x[j] = \begin{cases} 0 & \text{if } \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{(for all } j), \\
\text{FRCTRLX} & \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \geq \text{split threshold and} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold} \\
1 & \text{(for } j = 1, 2, 4, 5, 7, 8), \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \geq \text{split threshold} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \geq \text{split threshold and} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > \text{split threshold} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < 0 \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > 0 \text{ (for } j = 0, 1, 3, 4, 6, 7), \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > 0 \text{ (for } j = 0, 1, 3, 4, 6, 7), \}
\]

\[ c'_x[j] = \begin{cases} 0 & \text{if } \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold or} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold or} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > \text{split threshold} \\
1 & \text{split threshold or} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > \text{split threshold} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > 0 \text{ (for } j = 0, 1, 3, 4, 6, 7), \}
\]

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

\[ \text{FP TEMPO} \text{ is the name of a keyword in the cfile}, \]

\[ T = \left( \frac{t' - t'_k}{t'_{k+1} - t'_k} \right) (\text{FP TEMP}_{k+1} - \text{FP TEMP}_k) + \text{FP TEMP}_k, \]

\[ t' = t + \text{TIMEDEL}_\text{in}(\text{TIMEPIXR}_\text{cvt} - 0.5), \]

\[ t'_k = \text{TIME}_k + \text{TIMEDEL}_\text{in}(\text{TIMEPIXR}_\text{in} - 0.5), \]
\[
\begin{align*}
\Delta_x[0] &= c_x[0]s_x\rho_x[0]V_x[0] - c_x'[1]s_x\rho_x[1]V_x[1], \\
\Delta_x[8] &= c_x[8]s_x\rho_x[8]V_x[8],
\end{align*}
\]
where

\[
c_x[j] = \begin{cases} 
0 & \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold} \\
& \text{for all } j, \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \geq \text{split threshold and} \\
& \text{PHAS}[j + 1] + \Delta'_x[j + 1] + \Delta'_y[j + 1] \\
& \text{for } j = 0, 1, 3, 4, 6, 7, \\
1 & \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \geq \text{split threshold and} \\
& \text{PHAS}[j + 1] + \Delta'_x[j + 1] + \Delta'_y[j + 1] \\
& \text{for } j = 0, 1, 3, 4, 6, 7, \\
0 & \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] < \text{split threshold or} \\
& \text{PHAS}[j - 1] + \Delta'_x[j - 1] + \Delta'_y[j - 1] < \text{split threshold or} \\
& j \rightarrow \text{CHIPX} = 257, 512, 769, \text{or } 1024 \\
& \text{for } j = 1, 2, 4, 5, 7, 8, \\
1 & \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] > \\
& \text{PHAS}[j - 1] + \Delta'_x[j - 1] + \Delta'_y[j - 1] \text{ and} \\
& \text{PHAS}[j - 1] + \Delta'_x[j - 1] + \Delta'_y[j - 1] \geq \text{split threshold} \\
& \text{for } j = 1, 2, 4, 5, 7, 8, \\
0 & \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \leq \\
& \text{PHAS}[j - 1] + \Delta'_x[j - 1] + \Delta'_y[j - 1] \text{ and} \\
& \text{PHAS}[j] + \Delta'_x[j] + \Delta'_y[j] \geq \text{split threshold} \\
& \text{for } j = 1, 2, 4, 5, 7, 8,
\end{cases}
\]

and \(s_x, T, t', t'_k, \rho_x[j],\) and \(V_y[j]\) are given by equations. 309, 310, 311, 312, 313, 314, and 315, respectively.

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

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

\(325\)
where

\[
c_y[j] = \begin{cases} 
0 & \text{if } PHAS[j] + \Delta'_y[j] + \Delta'_y[j] < \text{ split threshold}, \\
& \text{(for all } j), \\
& PHAS[j] + \Delta'_y[j] + \Delta'_y[j] \geq \text{ split threshold} \\
& \text{and } PHAS[j] + \Delta'_y[j] + \Delta'_y[j] < \\
& PHAS[j - 3] + \Delta'_y[j - 3] + \Delta'_y[j - 3] \\
& \text{(for } j = 3, 4, 5, 6, 7, 8), \\
1 & \text{if } PHAS[j] + \Delta'_y[j] + \Delta'_y[j] \geq \text{ split threshold} \\
& \text{and } PHAS[j] + \Delta'_y[j] + \Delta'_y[j] < \\
& PHAS[j - 3] + \Delta'_y[j - 3] + \Delta'_y[j - 3] \\
& \text{(for } j = 3, 4, 5, 6, 7, 8), \\
0 & \text{if } PHAS[j] + \Delta'_y[j] + \Delta'_y[j] < \text{ split threshold or} \\
& PHAS[j + 3] + \Delta'_y[j + 3] + \Delta'_y[j + 3] < \text{ split threshold or} \\
& j \rightarrow \text{CHIPY = 1 or 1024} \\
& \text{(for } j = 1, 2, 3, 4, 5), \\
& PHAS[j] + \Delta'_y[j] + \Delta'_y[j] > \\
& PHAS[j + 3] + \Delta'_y[j + 3] + \Delta'_y[j + 3] \text{ and} \\
& PHAS[j + 3] + \Delta'_y[j + 3] + \Delta'_y[j + 3] \geq \text{ split threshold} \\
& \text{(for } j = 0, 1, 2, 3, 4, 5), \\
1 & \text{if } PHAS[j] + \Delta'_y[j] + \Delta'_y[j] \leq \\
& PHAS[j + 3] + \Delta'_y[j + 3] + \Delta'_y[j + 3] \text{ and} \\
& PHAS[j] + \Delta'_y[j] + \Delta'_y[j] \geq \text{ split threshold} \\
& \text{(for } j = 0, 1, 2, 3, 4, 5), \\
\end{cases}
\]

\[
s_y = 1 + \text{TCTIY}(T - \text{FP_TEMPO}) \tag{334}
\]

$s_y$ is a temperature dependent scaling factor,
TCTIY is the CCD_ID dependent value in the column TCTIY of the ctifile,
FP_TEMPO is the name of a keyword in the ctifile,

\[
\rho_y[j] = \frac{\text{PHAS}[j] + \Delta'_y[j] + \Delta'_y[j] - \text{PHA}_l}{\text{PHA}_{l+1} - \text{PHA}_l} \tag{335}
\]

\[
\rho_y[j] \text{ depends upon the CCD_ID and upon the CHIPX and nint(CHIPY_ADJ) coordinates associated with element } j \text{ of PHAS_ADJ}[j] \text{ (see Fig. 1),}
\]

\[
V_y[j] = \frac{\text{PHAS}[j] + \Delta'_y[j] + \Delta'_y[j] - \text{PHA}_l}{\text{PHA}_{l+1} - \text{PHA}_l} (\text{VOLUME}_y_{l+1} - \text{VOLUME}_y_{l}) + \text{VOLUME}_y_{l} \tag{336}
\]

\[
\text{VOLUME}_y_{l+1} \text{, which is CCD_ID dependent, is associated with } \text{PHA}_{l+1},
\]

\[
\text{VOLUME}_y_{l} \text{, which is CCD_ID dependent, is associated with } \text{PHA}_l,
\]

\[
\text{VOLUME}_y_{l+1} \text{ is the } (l+1)^{th} \text{ element of the column VOLUME_Y in the ctifile,}
\]

\[
\text{VOLUME}_y_{l} \text{, which is CCD_ID dependent, is associated with } \text{PHA}_l,
\]

\[
\text{VOLUME}_y_{l+1} \text{ is the } (l+1)^{th} \text{ element of the column VOLUME_Y in the ctifile,}
\]

\[
\text{VOLUME}_y_{l}, \text{ which is CCD_ID dependent, is associated with } \text{PHA}_l,
\]
and $T$, $t'$, $t'_k$, and $t'_{k+1}$ are given by equations 310, 311, 312, and 313, respectively.

vi. The CTI-adjusted pulse heights

$$PHAS_{ADJ}[j] = PHAS[j] + \Delta_x[j] + \Delta_y[j]$$  \hspace{1cm} (337)

for all $j$.

vii. A. If

$$|PHAS_{ADJ}'[j] - PHAS_{ADJ}[j]| < \text{cticonverge} \text{ (for all } j) \text{ and } n \leq \text{max$_{cti}$iter},$$  \hspace{1cm} (338)

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

B. If

$$|PHAS_{ADJ}'[j] - PHAS_{ADJ}[j]| \geq \text{cticonverge} \text{ (for one or more } j) \text{ and } n < \text{max$_{cti}$iter},$$  \hspace{1cm} (340)

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

C. If

$$|PHAS_{ADJ}'[j] - PHAS_{ADJ}[j]| \geq \text{cticonverge} \text{ (for one or more } j) \text{ and } n \geq \text{max$_{cti}$iter},$$  \hspace{1cm} (342)

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

15. FLTGRADE:

(a) If

$$\text{DATAMODE}_n = \text{CC33\_FAINT and}$$

$$\text{apply\_cti} = \text{yes},$$  \hspace{1cm} (344)

then


where

$$c_i[j] = \begin{cases} 0 & \text{if } PHAS_{ADJ}[j] < \text{split threshold} \\ 1 & \text{otherwise}, \end{cases}$$  \hspace{1cm} (347)

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

(b) If

$$\text{DATAMODE}_n = \text{CC33\_FAINT and}$$

$$\text{apply\_cti} = \text{no},$$  \hspace{1cm} (348)

then


where

$$c_i[j] = \begin{cases} 0 & \text{if } PHAS[j] < \text{split threshold} \\ 0 & \text{if } PHAS[j] > 4095 \\ 0 & \text{if } PHAS[j] > PHAS[4] \text{ for } j = 0 - 3 \\ 0 & \text{if } PHAS[j] > PHAS[4] \text{ for } j = 5 - 8 \\ 1 & \text{otherwise}. \end{cases}$$  \hspace{1cm} (351)
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$_{in}$ 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 FLTGRADE$_{grade}$ is a column in the gradefile.

iii. The GRADE of the event is given by

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

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

17. PHA$_{RO}$:

(a) If

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

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then
\[
\text{PHA} = \sum_{j=0}^{8} \beta[j] p[j],
\]
where
i. \( p[j] = \text{PHAS}[j] \).

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

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

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

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

vi. If \( \text{CORNERS} = 1 \), then
\[
\begin{align*}
\beta[0] &= 0 \text{ if } \beta[1] = 0 \text{ and } \beta[3] = 0. \quad (361) \\
\beta[2] &= 0 \text{ if } \beta[1] = 0 \text{ and } \beta[5] = 0. \quad (362) \\
\beta[6] &= 0 \text{ if } \beta[3] = 0 \text{ and } \beta[7] = 0. \quad (363) \\
\beta[8] &= 0 \text{ if } \beta[5] = 0 \text{ and } \beta[7] = 0. \quad (364)
\end{align*}
\]

vii. If \( \text{CORNERS} = 2 \), then
\[
\begin{align*}
\beta[0] &= 0 \text{ if } \beta[1] = 0 \text{ or } \beta[3] = 0 \text{ or } \text{GRADE} \neq 6. \quad (365) \\
\beta[2] &= 0 \text{ if } \beta[1] = 0 \text{ or } \beta[5] = 0 \text{ or } \text{GRADE} \neq 6. \quad (366) \\
\beta[6] &= 0 \text{ if } \beta[3] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. \quad (367) \\
\beta[8] &= 0 \text{ if } \beta[5] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. \quad (368)
\end{align*}
\]

(b) If \( \text{DATAMODE}_{\text{in}} = \text{CC33}\_\text{GRADED}, \) then
i. If \( \text{CONTENT}_{\text{in}} = \text{EVT0}, \) then the value of \( \text{PHA}_0 \) for the event is the value of \( \text{PHA} \) in the infile.

ii. If \( \text{CONTENT}_{\text{in}} = \text{EVT1}, \text{TGEVT1}, \text{or EVT2}, \) then the value of \( \text{PHA}_0 \) for the event is the value of \( \text{PHA}_0 \) in the infile.

18. \( \text{PHA} \) including time-dependent gain:

(a) If \( \text{DATAMODE}_{\text{in}} = \text{CC33}\_\text{FAINT}, \) then
\[
\text{PHA} = \sum_{j=0}^{8} \beta[j] p[j],
\]
where
i. 
\[ p[j] = \begin{cases} 
\text{PHAS}_\text{ADJ}[j] & \text{if } \text{apply}_\text{cti} = \text{yes} \\
\text{PHAS}[j] & \text{if } \text{apply}_\text{cti} = \text{no} 
\end{cases} \] (374)

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

iii. 
\[ \beta[j] = 0 \text{ if } p[j] < \text{split threshold}. \] (375)

iv. If the CTI adjustment is not performed, then
\[ \beta[j] = 0 \text{ if } \begin{cases} 
p[j] > p[4] \text{ (for } j = 0 - 3) \\
p[j] \geq p[4] \text{ (for } j = 5 - 8) 
\end{cases} \] (376)

v. If \( \text{CORNERS} = -1 \), then
\[ \beta[0] = \beta[2] = \beta[6] = \beta[8] = 0. \] (377)

vi. If \( \text{CORNERS} = 1 \), then
\[ \beta[0] = 0 \text{ if } \beta[1] = 0 \text{ and } \beta[3] = 0. \] (378)
\[ \beta[2] = 0 \text{ if } \beta[1] = 0 \text{ and } \beta[5] = 0. \] (379)
\[ \beta[6] = 0 \text{ if } \beta[3] = 0 \text{ and } \beta[7] = 0. \] (380)
\[ \beta[8] = 0 \text{ if } \beta[5] = 0 \text{ and } \beta[7] = 0. \] (381)

vii. If \( \text{CORNERS} = 2 \), then
\[ \beta[0] = 0 \text{ if } \beta[1] = 0 \text{ or } \beta[3] = 0 \text{ or } \text{GRADE} \neq 6. \] (382)
\[ \beta[2] = 0 \text{ if } \beta[1] = 0 \text{ or } \beta[5] = 0 \text{ or } \text{GRADE} \neq 6. \] (383)
\[ \beta[6] = 0 \text{ if } \beta[3] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. \] (384)
\[ \beta[8] = 0 \text{ if } \beta[5] = 0 \text{ or } \beta[7] = 0 \text{ or } \text{GRADE} \neq 6. \] (385)

(b) If 
\[ \text{DATAMODE}_m = \text{CC33}_\text{GRADED}, \] (386)
then the value of \( \text{PHA} \) for the event is read from the \text{infile}.

(c) If
\[ \text{apply}_\text{tgain} = \text{yes}, \] (387)
then
\[ \text{PHA} = \text{PHA} + \text{int} \left[ \frac{\text{TIME} - \text{EPOCH1}}{\text{EPOCH2} - \text{EPOCH1}} \right] (\delta_2 - \delta_1) + \delta_1 + \epsilon, \] (388)

where
\[ \text{int} = \text{the integer portion of (i.e. truncate or round down)}, \] (389)
\[ \text{TIME} = \text{the time of the event}, \] (390)
\[ \text{EPOCH1} = \text{a keyword in the } \text{tgainfile}, \] (391)
\[ \text{EPOCH2} = \text{a keyword in the } \text{tgainfile}, \] (392)
\[ \delta_1 = \frac{\text{PHA} - \text{PHA}_m[r]}{\text{PHA}_{m+1}[r] - \text{PHA}_m[r]} (\text{DELTPHA}_1_{m+1}[r] - \text{DELTPHA}_1_m[r]) + \text{DELTPHA}_1_m[r], \] (393)
(d) If 

\[ \text{PHAm}[r] \leq \text{PHAm} \text{ and} \]

\[ \text{PHAm+1}[r] > \text{PHAm}. \]

then \( \text{PHAm+1}[r] \) for \( m = 0 \), then \( m = 0 \).

If \( \text{PHAm} \leq \text{PHAm}[r] \) for \( m ) = M \text{ and } M \text{ is the last element of } \text{PHA}[r] \),

then \( m = M - 1 \).

The \( \text{tgainfile} \) includes a binary table with columns named

\( \text{CCD}, \text{CHIPX}, \text{CHIPX}, \text{CHIPY}, \text{CHIPY}, \text{CHIPX}, \text{CHIPY}, \text{PHA}, \text{DELPHA2}, \text{ADJ} \).

\[ \delta_2 = \left( \frac{\text{PHA} - \text{PHA}_m[r]}{\text{PHA}_m+1[r] - \text{PHA}_m[r]} \right) (\text{DELPHA2}_m+1[r] - \text{DELPHA2}_m[r]) + \]  

(396)

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

(397)

\{ \text{If } \text{rand} \text{pha} = \text{no}, \text{ then } \epsilon = 0. \}

(398)

(399)

(d) If \( \text{PHA} \geq 32767, \)

(400)

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

19. \text{CORN_PHA}:

(a) If

\[ \text{DATAMODE}_{m} = \text{CC33_GGRADED}, \]

then the value of \( \text{CORN_PHA} \) is read from the \( \text{infile} \).

20. \text{ENERGY}:

(a) If the parameter \( \text{calculate} \text{pix} = \text{yes} \), if the parameter \( \text{gainfile} \) is specified, and if \( \text{PHA} > 0 \), then

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

\[ \text{CCD}, \text{CHIPX}, \text{CHIPX}, \text{CHIPY}, \text{CHIPY}, \text{CHIPX}, \text{CHIPY}, \text{PHA}, \text{DELPHA2}, \text{ADJ} \]

(401)

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

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

(402)

where \( \text{PHA}_{\text{gain}} \) is a vector column in the \( \text{gainfile} \). 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 \( \text{NPOINTS} \) is a column in the \( \text{gainfile} \).
iv. The ENERGY of an event is computed from the PHA of the event:

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

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

v. If ENERGY < 0, then ENERGY = 0.

(b) If the parameter calculate,pi = yes, if the parameter gainfile is specified, and if PHA ≤ 0, then ENERGY = 0.

c) If the parameter calculate,pi = 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 ENERGY = 0.

21. PI:

(a) If

\[\text{calculate,pi} = \text{yes},\]

then

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

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 \[\text{PI} = 1,\]

iii. If \[\text{PI} > \text{pi\_num\_bins},\]

then \[\text{PI} = \text{pi\_num\_bins}.

(b) If \[\text{calculate,pi} = \text{no}\]

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

22. pix_adj:

(a)

\[\text{CHIPX\_ADJ} = \text{CHIPX}.\]

(b) If \[\text{pix\_adj} = \text{centroid},\]

then

\[\text{CHIPX\_ADJ} = \text{CHIPX\_ADJ} - w'[0] + w'[2] - w'[3] + w'[5] - w'[6] + w'[8].\]
and if

\[
\text{DATAMODE} = \text{FAINT} \text{ or } (415)
\]

\[
\text{DATAMODE} = \text{FAINT\_BIAS} \text{ or } (416)
\]

\[
\text{DATAMODE} = \text{GRADED} \text{ or } (417)
\]

\[
\text{DATAMODE} = \text{VFAINT}, \quad (418)
\]

then

\[
\text{CHIPY\_ADJ} = \text{CHIPY\_ADJ} - w'[0] - w'[1] - w'[2] + w'[6] + w'[7] + w'[8] \quad (419)
\]

and if

\[
\text{DATAMODE} = \text{CC33\_FAINT} \text{ or } (420)
\]

\[
\text{DATAMODE} = \text{CC33\_GRADED}, \quad (421)
\]

then

\[
\text{TIME} = \text{TIME} + (w'[0] + w'[1] + w'[2] - w'[6] - w'[7] - w'[8]) \times \text{TIMEDEL}_\text{in}, \quad (422)
\]

where

\[
w'[j] = \frac{w[j]}{\sum_{j=0}^{8} w[j]}, \quad (423)
\]

\[
w[j] = \begin{cases} 
  p[j] & \text{if the pixel is valid} \\
  0 & \text{if the pixel is invalid}, 
\end{cases} \quad (424)
\]

\[
p[j] = \begin{cases} 
  \text{PHAS\_ADJ}[j] & \text{if apply\_cti = yes} \\
  \text{PHAS}[j] & \text{if apply\_cti = no}, 
\end{cases} \quad (425)
\]

and the pixel is invalid if

\[
\beta[j] = 0 \text{ or } \quad (426)
\]

\[
\text{STATUS}[0] = 1 \text{ or } \quad (427)
\]

\[
\text{STATUS}[1] = 1 \text{ or } \quad (428)
\]

\[
\text{STATUS}[2] = 1 \text{ or } \quad (429)
\]

\[
\text{STATUS}[3] = 1 \text{ or } \quad (430)
\]

\[
\text{STATUS}[4] = 1 \text{ or } \quad (431)
\]

\[
\text{STATUS}[11] = 1 \text{ or } \quad (432)
\]

\[
\text{STATUS}[13] = 1 \text{ or } \quad (433)
\]

\[
\text{STATUS}[14] = 1 \text{ or } \quad (434)
\]

\[
\text{STATUS}[15] = 1 \text{ or } \quad (435)
\]

\[
\text{STATUS}[16] = 1. \quad (436)
\]

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.

(c) If

\[
\text{pix\_adj} = \text{edser}, \quad (437)
\]

then

\[
\text{CHIPX\_ADJ} = \text{CHIPX\_ADJ} + \left( \frac{\text{ENERGY} - E[k]}{E[k+1] - E[k]} \right) (\Delta X[k + 1] - \Delta X[k]) + \Delta X[k] \quad (438)
\]
and if
\[
\text{DATAMODE} = \text{FAINT} \quad \text{or} \quad \text{DATAMODE} = \text{FAINT_BIAS} \quad \text{or} \quad \text{DATAMODE} = \text{GRADED} \quad \text{or} \quad \text{DATAMODE} = \text{VFAINT},
\]
then
\[
\text{CHIPY\_ADJ} = \text{CHIPY\_ADJ} + \left( \frac{\text{ENERGY} - E[k]}{E[k+1] - E[k]} \right) \left( \Delta Y[k+1] - \Delta Y[k] \right) + \Delta Y[k]
\]
and if
\[
\text{DATAMODE} = \text{CC33\_FAINT} \quad \text{or} \quad \text{DATAMODE} = \text{CC33\_GRADED},
\]
then
\[
\text{TIME} = \text{TIME} - \left( \frac{\text{ENERGY} - E[k]}{E[k+1] - E[k]} \right) \left( \Delta Y[k+1] - \Delta Y[k] \right) + \Delta Y[k] \times \text{TIMEDEL}_\text{int},
\]
where $E[k]$ and $E[k+1]$, $X[k]$ and $X[k+1]$, and $Y[k]$ and $Y[k+1]$ are the $k$ and $(k+1)^{th}$ elements of the vector columns $\text{ENERGY}_{\text{subpix}}$, $\text{CHIPX\_OFFSET}_{\text{subpix}}$, and $\text{CHIPY\_OFFSET}_{\text{subpix}}$, respectively. These columns are in the HDU of the $\text{subpixfile}$ where the value of the keyword $\text{CCD\_ID}$ is equal to the value of the $\text{CCD\_ID}$ 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
\[
\text{ENERGY} \geq E[k] \quad \text{and} \quad \text{ENERGY} < E[k+1].
\]
Note that if
\[
\text{ENERGY} \leq E[0],
\]
then $k = 0$. Similarly, if
\[
\text{ENERGY} \geq E[\text{NPOINTS}_{\text{subpix}} - 2],
\]
then $k = \text{NPOINTS}_{\text{subpix}} - 2$.

(d) If $\text{pix\_adj} = \text{none}$,
\[
\text{CHIPX\_ADJ} = \text{CHIPX\_ADJ} + \epsilon_x
\]
then the values of $\text{CHIPX\_ADJ}$ and $\text{CHIPY\_ADJ}$ remain unchanged.

(e) If $\text{pix\_adj} = \text{randomize}$,
\[
\text{CHIPX\_ADJ} = \text{CHIPX\_ADJ} + \epsilon_x
\]
and if
\[
\text{DATAMODE} = \text{FAINT} \quad \text{or} \quad \text{DATAMODE} = \text{FAINT\_BIAS} \quad \text{or} \quad \text{DATAMODE} = \text{GRADED} \quad \text{or} \quad \text{DATAMODE} = \text{VFAINT},
\]
then

\[
\text{CHIPY}_{\text{ADJ}} = \text{CHIPY}_{\text{ADJ}} + \epsilon_y
\]  

(458)

and if

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

(459)

(460)

then

\[
\text{TIME} = \text{TIME} - \epsilon_y \times \text{TMEDELin},
\]  

(461)

where \(\epsilon_x\) and \(\epsilon_y\) are uniform random deviates in the range \([-0.5, +0.5]\) pixel.

(f) If

\[
\text{CHIPX}_{\text{ADJ}} < 0.5,
\]  

(462)

then

\[
\text{CHIPX}_{\text{ADJ}} = 1.
\]  

(463)

(g) If

\[
\text{CHIPX}_{\text{ADJ}} \geq 1024.5,
\]  

(464)

then

\[
\text{CHIPX}_{\text{ADJ}} = 1024.
\]  

(465)

(h) If

\[
\text{CHIPX}_{\text{ADJ}} < 0.5,
\]  

(466)

then

\[
\text{CHIPX}_{\text{ADJ}} = 1.
\]  

(467)

(i) If

\[
\text{CHIPX}_{\text{ADJ}} \geq 1024.5,
\]  

(468)

then

\[
\text{CHIPX}_{\text{ADJ}} = 1024.
\]  

(469)

23. TDETX and TDETY:

(a) If

\[
\text{stop} = \text{tdet or det or tan or sky}.
\]  

(470)

then the values of TDETX and TDETY are computed using the values of \(\text{nint(CHIPX}_{\text{ADJ}})\) and \(\text{nint(CHIPY}_{\text{ADJ}})\). Here, “\text{nint}” indicates that the real-valued coordinate is rounded to the nearest integer before the computation of the TDET coordinate.
24. **DETX and DETY:**

(a) If

\[
\begin{align*}
\text{stop} & = \text{det or} \\
\text{stop} & = \text{tan or} \\
\text{stop} & = \text{sky,}
\end{align*}
\]

(474) (475) (476)

then the values of DETX and DETY are computed using the real-valued coordinates CHIPX\_ADJ and CHIPY\_ADJ.

25. **X and Y:**

(a) If

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

(477)

then the values of X and Y are computed using the real-valued coordinates CHIPX\_ADJ and CHIPY\_ADJ.

26. **SKY\_1D:**

(a) If

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

(478) (479)

and if

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

(480)

then the value of SKY\_1D is computed.

1.5.4 Write outfile

1. **PIX\_ADJ:**

(a) If

\[
\text{pix\_adj} = \text{centroid,}
\]

(481)

then

\[
\text{PIX\_ADJ} = \text{CENTROID,}
\]

(482)

(b) If

\[
\text{pix\_adj} = \text{edser,}
\]

(483)

then

\[
\text{PIX\_ADJ} = \text{EDSER,}
\]

(484)

(c) If

\[
\text{pix\_adj} = \text{none,}
\]

(485)

then

\[
\text{PIX\_ADJ} = \text{NONE,}
\]

(486)
(d) If
\[ \text{pix}_\text{adj} = \text{randomize}, \] 
then
\[ \text{PIX}\_\text{ADJ} = \text{RANDOMIZE}, \] 

2. \text{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
\[ \text{pix}_\text{adj} = \text{randomize}, \] 
then
\[ \text{RAND}\_\text{SKY} = 0.5, \] 

3. \text{TIME\_ADJ}:
(a) If
\[ \text{DATAMODE}_{\text{in}} = \text{FAINT} \text{ or } \text{DATAMODE}_{\text{in}} = \text{FAINT\_BIAS} \text{ or } \text{DATAMODE}_{\text{in}} = \text{GRADED} \text{ or } \text{DATAMODE}_{\text{in}} = \text{VFAINT}, \] 
then
\[ \text{TIME\_ADJ} = \text{NONE}. \]
(b) i. If

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

\[\begin{align*}
\text{if} & \quad \text{CONTENT}_\text{in} = \text{EVT0} \text{ or } \\
\text{if} & \quad \text{CONTENT}_\text{in} = \text{EVT1} \text{ or } \\
\text{if} & \quad \text{CONTENT}_\text{in} = \text{EVT2},
\end{align*}\]

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

and if

\[
\cos (\text{DEC}_{\text{ADJ}}) \cos (\text{DEC}_{\text{TARG}}) \cos (\text{RA}_{\text{ADJ}} - \text{RA}_{\text{TARG}}) + \\
\sin (\text{DEC}_{\text{ADJ}}) \sin (\text{DEC}_{\text{TARG}}) < \\
4.855 \times 10^{-11},
\]

then

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

ii. If

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

\[\begin{align*}
\text{if} & \quad \text{CONTENT}_\text{in} = \text{EVT0} \text{ or } \\
\text{if} & \quad \text{CONTENT}_\text{in} = \text{EVT1} \text{ or } \\
\text{if} & \quad \text{CONTENT}_\text{in} = \text{EVT2},
\end{align*}\]

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

and if

\[
\cos (\text{DEC}_{\text{ADJ}}) \cos (\text{DEC}_{\text{TARG}}) \cos (\text{RA}_{\text{ADJ}} - \text{RA}_{\text{TARG}}) + \\
\sin (\text{DEC}_{\text{ADJ}}) \sin (\text{DEC}_{\text{TARG}}) < \\
4.855 \times 10^{-11},
\]

then

\[
\text{TIME}_{\text{ADJ}} = \text{TARGET}.
\]
(c) i. If

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

if

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

if

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

and if

\[ \cos(\text{DEC\_ADJ}_I) \cos(\text{DEC\_TARG}_{in}) \cos(\text{RA\_ADJ}_I - \text{RA\_TARG}_{in}) + \sin(\text{DEC\_ADJ}_I) \sin(\text{DEC\_TARG}_{in}) \geq 4.855 \times 10^{-11}, \]

then

\[ \text{TIME\_ADJ} = \text{AIMPOINT}. \]

ii. If

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

if

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

if

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

and if

\[ \cos(\text{DEC\_ADJ}_S) \cos(\text{DEC\_TARG}_{in}) \cos(\text{RA\_ADJ}_S - \text{RA\_TARG}_{in}) + \sin(\text{DEC\_ADJ}_S) \sin(\text{DEC\_TARG}_{in}) \geq 4.855 \times 10^{-11}, \]

then

\[ \text{TIME\_ADJ} = \text{AIMPOINT}. \]
(d) If

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \quad (546)
\]

if

\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1} \quad (548)
\]

and if

\[
\text{CCD\_ID}_{\text{focus}} \geq 4 \text{ and } \text{CCD\_ID}_{\text{focus}} \leq 9 \quad (549)
\]

then

\[
\text{TIME\_ADJ} = \text{GRATING}. \quad (551)
\]

(e) If

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \quad (552)
\]

if

\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1} \quad (554)
\]

if

\[
\text{CCD\_ID}_{\text{focus}} \geq 0 \text{ and } \text{CCD\_ID}_{\text{focus}} \leq 3 \quad (555)
\]

and if

\[
\cos (\text{DEC\_ADJ}) \cos (\text{DEC\_TARG}_{\text{in}}) \cos (\text{RA\_ADJ} - \text{RA\_TARG}_{\text{in}}) + \\
\sin (\text{DEC\_ADJ}) \sin (\text{DEC\_TARG}_{\text{in}}) < 4.855 \times 10^{-11}, \quad (557)
\]

then

\[
\text{TIME\_ADJ} = \text{TARGET}. \quad (560)
\]

(f) If

\[
\text{DATAMODE}_{\text{in}} = \text{CC33\_FAINT or } \text{DATAMODE}_{\text{in}} = \text{CC33\_GRADED} \quad (561)
\]

if

\[
\text{CONTENT}_{\text{in}} = \text{TGEVT1} \quad (563)
\]

if

\[
\text{CCD\_ID}_{\text{focus}} \geq 0 \text{ and } \text{CCD\_ID}_{\text{focus}} \leq 3 \quad (564)
\]

\[42\]
and if
\[
\cos(\text{DEC}_{\text{ADJ}1}) \cos(\text{DEC}_{\text{TARG}in}) \cos(\text{RA}_{\text{ADJ}1} - \text{RA}_{\text{TARG}in}) + \\
\sin(\text{DEC}_{\text{ADJ}1}) \sin(\text{DEC}_{\text{TARG}in}) \geq 4.855 \times 10^{-11}, \tag{567}
\]
then
\[
\text{TIME}_{\text{ADJ}} = \text{AIMPOINT}. \tag{569}
\]

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?