rgsframes

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Abstract

rgsframes extracts from the ODF (Observation Data File) all data required to analyze a single CCD and combines these into a single dataset. Subsequent RGS tasks modify this dataset.
Frame timestamps and exposure times are added. Frames are flagged bad according to certain criteria. A Good Time Interval (GTI) table is produced from this.

1 Instruments/Modes

Instrument	Mode	
RGS	Spectroscopy, Resolution	High-Time-

2 Use

pipeline processing	yes
interactive analysis	yes

3 Description

Input to **rgsframes** are the RGS pixel files (R*SPE.FIT and R*HTE.FIT) and auxiliary file (R*AUX.FIT) in the ODF. From this it produces a single dataset per CCD which contains all the information needed for further processing. The `PIXELS` table contains the raw pixel data. The `EXPOSURE` table contains exposure relevant information per frame readout for the CCD.

The following corrections are applied to the pixel data:

1. The pixel coordinates are transformed into CAL coordinates `RAWX`, `RAWY`. (In practice this means adding 1 to the values in the ODF) The same correction is applied to the keywords related to the windowing.
2. Frame counter is corrected for 'wrap around problems' using saslib routine `CorrectWrapAround()`
3. find and remove duplicate records by checking the following columns: `FRAME`, `CCDNODE`, `RAWX`, `RAWY`

4. The SER column is replaced by a GRADE and SHAPE column. The algorithm for this depends on the version of the DPP software running on board. The DPP version number is obtained from the CAL (CAL_getMiscellaneousDataValue("DPPVERS")). SER values not listed in the table below will result in an fatal error.

DPP version 16			DPP version 16.2 or 19.0		
SER	SHAPE	GRADE	SER	SHAPE	GRADE
0	0	1	0	0	1
1	null	2	1	1	4
2	null	3	2	2	2
3	1	4	3	3	2
			4	4	3
			5	5	3
			6	6	3
			7	7	3

   Note this is not applied for HTR processing.

For HTR now processing related to the Y-column data is performed.

The following processing is done on the frame data to create the EXPOSURE table:

1. The table is sorted on increasing frame numbers.
2. The frame time stamp is calculated using the OAL calls OAL_frameCounterToObt and OAL_obtToTimeTag. The value is written to a newly added column TIME
3. The exposure times of each frame is calculated based on elapsed time since the previous readout of same sequence ID. Readout times are calculated from eoscoars and eosfine clock values. If no previous readout exists, the exposure time is set to the average exposure time estimated by also considering the position of the readout in the readout circle (thus producing the correct result for duplicate readouts). The first frame of every exposure has zero exposure time. Exposure times are written into the newly added column TIMEDEL
4. find and remove duplicate records by checking the FRAME number
5. Find missing frames by checking if the frame number and CCD sequence IDs match the the length of a readout sequence. The readout sequence is obtained from the RnAUX2 ($n = 1, 2$) table in the ODF AUX file.
6. An optional column PIXELRATE is added which contains the number of pixels in the PIXELS table for each frame.
7. Frames are flagged 'bad' in a FRAMEFLAG column according to a series of criteria. See below.
8. corrections of the exposure time due to the number of pixels exceeding upper threshold are calculated by

$$\texttt{FRACEXP} = 1 - \frac{\texttt{REJPIX}}{\texttt{WINDOWDX} \times \texttt{WINDOWDY} - uplinked_b ad_p ixels}$$

   FRACEXP is calculated and stored per readout node. REJPIX is the number of pixels above upper threshold, and WINDOWDX/Y is the number of pixels read per node in CCD-X & CCD-Y.

Frames flagged 'bad' are excluded from the GTI (Good Time Interval).
Criteria for bad frames implemented at the moment are:

- frames having a zero exposure time.
- the first frame
- frames with lost events (`NLOSTEVT` /= 0 in AUX table)
- frames with abortflag set (`ABORTFLG` /= 2 in AUX table)
- frames with non processed pixels (`NDPP` /= windowdx*windowdy)
- (optional) frames with more pixels per frame than a given value.
- (optional) frames with a pixel rate (pixels/sec) above a given value.

Finally a `GTI` table is produced based on the `FRAMEFLAG` column. If all frames are flagged bad a `GTI` table with zero rows is produced.

4 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
set	yes	e		

Input set containing spectroscopy or high-resolution timing data for each CCD.

ccdset	yes	e		

This output set contains all collected data necessary for future analysis. Need write access.

minexposuretime	no	r	0.001	

frame exposuretimes below this value are flagged as bad (sec)

withratecolumn	no	b	Yes	

Add column with number of raw pixels per frame to `EXPOSURE` table

withmaxrawpixels	no	b	No	

mark frames with more pixels above given level as bad

maxrawpixels	no	i	9999	0

frames with more pixels than this level are flagged bad

withmaxrawpixelrate	no	b	no	

mark frames with pixelrate above given level bad

maxrawpixelrate	no	r	9999.	0.

frames with a raw pixelrate above this level are flagged bad (pixels/sec)

processall	no	b	no	

internally loop over all event lists of all exposures; this is important for efficiency improvements of the HTR processing.

instrument	no	s	RGS1	RGS1—RGS2

specify instrument for `processall=true`

5 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS documentation.

instIdNotFoundExposure *(error)*
instrument string not RGS1 or RGS2. Wrong input file or CAL could not determine instrument string correctly.

instIdNotFoundPixels *(error)*
instrument string not RGS1 or RGS2. Wrong input file or CAL could not determine instrument string correctly.

wrongSER1 *(error)*
SER value < 0 found. Problem in ODF. should never happen

wrongSER2 *(error)*
SER value > 3 found. SER must be in range [0-3] for version v16 of DPP software.

dppIdNotFound *(error)*
DPP version string. DPP version returned by CAL is not coded in rgsframes

frameExposureTimes *(error)*
Frame numbers not increasing. Somehow frame numbers are not increasing. Should not happen on a sorted exposure table

createGTI *(error)*
array sizes "time" "good" and "exposuretime" do not match. Should not happen.

sequenceIndexMismatch *(error)*
Sequence index and CCDid do not match. There is a problem with the ODF. Frame integration times cannot be calculated.

windowSize *(error)*
The values held in the keywords `WINDOWXO`, `WINDOWDX`, `WINDOWYO`, `WINDOWDY` are inconsistent with telemetry. There is a problem with this ODF.

missingCCDinAUX2 *(error)*
The ID of the current CCD could not be found in the table `AUX2` of the AUXiliary file. There is a problem with this ODF.

frameExposureTimes:HTR *(error)*
First value of SEQINDEX column is zero. This probably resulted from an HTR mode file (*HTE.FIT). The task cannot yet used to calculate exposuretimes for High Time Resolution mode observations.

selectedAddnCopyColumn:missingType *(error)*
A new column type was encountered that was not yet implemented in this subroutine. This is probably due to a change in the definition of the ODF. A new version of the SAS should be obtained from the SOC.

allFramesBad *(warning)*
All the frames were found to be unsuitable for one reason or another. This means that there is no GTI for this ccd.
corrective action: No action.

wrapAround *(warning)*

corrective action: Frame numbers were corrected for int16 wrap around

grade1ser0 *(warning)*
The DPP version string was set to a wrong value. A new set of CCF's should be obtained.
corrective action: Default value for GRADE and SER set:

allFramesTooManyPixels *(warning)*
All the frames were found to have a number of pixels greater than that set by `maxrawpixels`. This means that there is no GTI for this ccd.
corrective action: No action.

allFramesTooRapidPixels *(warning)*
All the frames were found to have a pixel rate greater than that set by `maxrawpixelrate`. This means that there is no GTI for this ccd.
corrective action: No action.

badAbortFlagAllFrames *(warning)*
None of the frames in the exposure extension had the correct value of `ABORTFLG` (should be 2). This means that there is no GTI for this ccd.
corrective action: No action.

eventsLostAllFrames *(warning)*
All the frames in the exposure extension have > 0 lost events. This means that there is no GTI for this ccd.
corrective action: No action.

badNdppAllFrames *(warning)*
All frames in table R?AUX1 of the aux file have `NDPP` values different from `WINDOWDX`×`WINDOWDY` in table R?AUX2 of the same file. This means that there is no GTI for this ccd.
corrective action: No action.

htrEventsLostAllFrames *(warning)*
All the frames in the exposure extension have > 2 lost events. This means that there is no GTI for this ccd.
corrective action: No action.

allFramesTooShort *(warning)*
All the frames were found to have `TIMEDEL` shorter than that specified in `minexposuretime`. This means that there is no GTI for this ccd.
corrective action: No action.

HTRAUXCCDID *(warning)*
The CCDID of a given frame number contains a value of a CCD, which is not active. This is an error in the processing of the telemetry by the SOC.
corrective action: None

HTRDataError *(warning)*
The instrument telemetry indicates that a readout error on the instrument had occurred.
corrective action: None

missingDeltaT *(warning)*
For HTR processing a gep in the telemetry is detected. This warning indicates that the following offsets of event times are estimated from an average value. A small shift of the absolute event times may be the consequence.
corrective action: None

htrAllFramesTooShort *(warning)*
All the frames were found to have `TIMEDEL` shorter than that specified in `minexposuretime`. This means that there is no GTI for this ccd.
corrective action: No action.

6 Input Files

1. name of events file from ODF. (ODF must be specified using -odf or enviroment variable SAS_ODF)
2. the AUXiliray data file of the same instrument from the ODF

7 Output Files

The only output is a single dataset containing all information needed to process a CCD. The structure of this intermediate event list is described in the **rgsproc**.

It also sets the following attributes:

- `TIMESYS` = `TT`
- `MJDREF` = `50814`
- `TIMEZERO` = `0`
- `TIMEUNIT` = `s`
- `CLOCKAPP` = `T`
- `TIMEREF` = `LOCAL`
- `TASSIGN` = `SATELLITE`
- `SUBMODE`
- `CCDMODE`

8 Algorithm

```
Make local copy of the events set

Open AUX file belonging to input set.

if mode == 'HTR' {
    Subroutine calculateHTRFrameTimes
        open event lists of all CCD
        sum of all Delta_T to create times per frame
}

Subroutine addExposureTable
    find rows of AUX1 table with CCDID = current CCD
    copy only these rows of columns from AUX1 to EXPOSURE table
    close AUX1 table
    find and delete duplicate rows of EXPOSURE table
    sort and check EXPOSURE table
    set BAD_FRAME flag

if mode == 'SPECTROSCOPY' {
   Subroutine processFrameTimes
       calculate frame integration times
       calculate frame event time by setting time to mid of exposure period
}
else mode == 'HTR' {
   Subroutine fillHTRFrameTimes
       per frame, find corresponding time
       calculate frame integration time
       set BAD_FRAME flag based on minexposuretime
}

Subroutine processPixelTable
    add standard attributes
    correct frame numbersof PIXEL table for int16 wrap around
    rename RAWX/RAWY to TELX/TELY
    find and delete duplicate rows of PIXEL table
    create new RAWX/Y and shift pixel number by +1
    if more /= 'HTR'
         add SHAPE and GRADE columns based on dpp software version

Subroutine addFracExposure
    start loop Nodes
       get number of uplinked bad pixels from CAL
       calculate FRACEXP
    end loop Nodes

    if mode == 'HTR' set FRACEXP = 1 (no processing)

Subroutine Pixels_and_Frames
    optional: add frame rate column
    optional: set BAD_FRAME flag for number of pixels per frame > maxrawpixels
    optional: set BAD_FRAME flag for number of pixels per second > maxrawpixelrate

Subroutine createGTI
```

```
    add GTI table

Subroutine cleanupExposureTable
    delete unwanted columns from EXPOSURE table
```

9 Comments

- OAL and CAL are both initialized from the input set. The OAL is used to find the ODF auxiliary file belonging to the input file. Instrument Id (RGS1 RGS2) and CCDnr come from CAL.

10 Future Developments

- a change of the structure of the ODF is pending, which will make processing on a per event list basis more efficient; the change will mainly affect the subroutine `calculateHTRFrameTimes`
- more precise calculation of `TIMEDEL` should be performed by reading CCF `ModeParam`
- the warnings called from the HTR processing should really be error; however at this state, where HTR analysis is being developed, having this task stop, is not helpful.
- selection criteria for bad frames may be obtained from the CAL and user supplied selection expression.
- The conversion of SER into GRADE and SHAPE could be performed by a CAL function.

References