AGILE Scientific Analysis: Calibration matrix production

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Change history:

Version	Date	Notes
1.0	April 15nd, 2014	

1. Introduction and aim

The present technical document describes the software and the related instructions required to produce the AGILE [1] calibration matrices on the basis of the filtered simulated data. A. Chen and A. Giuliani (INAF/IASF Milano) have made the calibration scripts available for the present software organization and the future release to the AGILE team.

The calibration source for the production of AGILE calibration matrices is **Vela**.

2. Software requirements

In order to run the calibration pipeline, the following software is required:

- IDL 6.2 or later
- IDL NASA/Goddard Astronomy library
- HEASoft
- AGILE scientific analysis pipeline

Environment variables:

- CALIB_DATA = path to the input .flg and .dat files
  On bash:
  `export CALIB_DATA=<path>`
- CALIB_AE_RSP = path to the output .ae and .dat files
  On bash:
  `export CALIB_AE_RSP =<path>`
- ADC_PATH = path to the ADC scientific analysis pipeline
  On bash in calib@gtbbkp.giano.iasfbo:
  `export ADC_PATH=$HOME/ADC`

3. Effective area and response files production

The following scripts are intended for effective area and response matrix files production in **ENERGY BANDS**, not in monochromatic channels [2]. All scripts can be found in */resp_ae_BAND*.

The production of the calibration files starts from two mandatory files, for each type of simulation:

- <filename1>.flg = the AGILE output filter file [3]
- <filename2>.dat = the AGILE GAMS [4] simulation file

The user must copy the Vela input files from /data1/agile/AGILE_SIM/Calib/Kali08/dati into a dedicated directory and setting the path to the data directory as CALIB_DATA.

We note that all the files must be decompressed in order to run the pipeline.

3.1 Simulated data organization

In $CALIB_DATA the simulations data is organized as:

- short = /CALIB_SHORT
- long = /CALIB
- **currently operative simulations = /Calib/Kali08/dati**

- DHSim output files = /SIM.LV1

In the *short* simulations directory, files are organized according to the theta and filter type (only the Vela source is present in this case):

- /vela_T01F00
- /vela_T01F45
- /...

In the *long* simulations directory, simulations are first divided according to the calibration source:

- /vela_long
- /crab_long

and then according to theta and filter type:

- /vela_T01F00
- /vela_T01F45
- /...

In the present case, $CALIB_DATA=/data1/agile/AGILE_SIM/Calib/Kali08/dati.

3.2 Processing one single file

In */resp_ae_BAND*, the main script (IDL) is *AGILE_mat_ae_band.pro*.
The user must select the following parameters:

- filter type: FM, F4, FT3ab
- theta = 30, 35, 45, 50, 60, 01
- phi = 00, 45

Run instructions:

```
IDL> .r AGILE_mat_ae_band
% Compiled module: $MAIN$.
% - Enter filter type [0 = FM, 1 = F4, 2 = FT3ab]:0
% - Enter theta [30, 35, 45, 50, 60, 01]:30
% - Enter phi [00, 45]:0
% Compiled module: PICKFILE.
% Compiled module: MRDFITS.
% Compiled module: FXPOSIT.
% Compiled module: FXMOVE.
% Compiled module: MRD_HREAD.
% Compiled module: FXPAR.
% Compiled module: GETTOK.
% Compiled module: VALID_NUM.
% Compiled module: MRD_SKIP.
% Compiled module: MATCH.
% Compiled module: MRD_STRUCT.
MRDFITS: Binary table.  42 columns by  260039 rows.
% Compiled module: LEGGIV.
FIELD01
% Compiled module: AEFFI.
% Compiled module: CANALI.
% LOADCT: Loading table STD GAMMA-II
% Compiled module: FITS_WRITE.
% Compiled module: FITS_OPEN.
% Compiled module: SXPAR.
% Compiled module: SXDELPAR.
% Compiled module: SXADDPAR.
% Compiled module: FITS_CLOSE.
```

```
% Compiled module: MARIS.
% Compiled module: MATMAKE16.
Fatto:/Users/fioretti/Projects/AGILE/CalibDATA/dati/SIM000000_3901_1_Vela_30_00
```

Output (in $CALIB_DATA):

- <filename>.ae
- <filename>.rsp
- <filename>.ps

The output files are generated in the same directory of the .dat and .flg files.

3.3 Processing all files

It is also possible to process all the files at the same .
The main script is *AGILE_mat_ae_mono_band.pro*.

Run instructions:

```
IDL> .r AGILE_mat_ae_band_loop
% Compiled module: $MAIN$.
Processing file ... SIM000000_3901_1_Vela_30_00_FT3ab.flg
% Compiled module: MRDFITS.
% Compiled module: FXPOSIT.
% Compiled module: FXMOVE.
% Compiled module: MRD_HREAD.
% Compiled module: FXPAR.
% Compiled module: GETTOK.
% Compiled module: VALID_NUM.
% Compiled module: MRD_SKIP.
% Compiled module: MATCH.
% Compiled module: MRD_STRUCT.
MRDFITS: Binary table.  42 columns by  260038 rows.
% Compiled module: LEGGIV.
FIELD01
% Compiled module: AEFFI.
% Compiled module: CANALI.
% LOADCT: Loading table STD GAMMA-II
% Compiled module: FITS_WRITE.
% Compiled module: FITS_OPEN.
% Compiled module: SXPAR.
% Compiled module: SXDELPAR.
% Compiled module: SXADDPAR.
% Compiled module: FITS_CLOSE.
% Compiled module: MARIS.
% Compiled module: MATMAKE16.
Fatto:/Users/fioretti/Projects/AGILE/CalibDATA/dati/SIM000000_3901_1_Vela_30_00
Processing file ... SIM000000_3901_1_Vela_30_00_F4.flg
MRDFITS: Binary table.  42 columns by  260039 rows.
FIELD01
% LOADCT: Loading table STD GAMMA-II
……
```

Output (in $CALIB_DATA):

- <filename>.ae
- <filename>.rsp
- <filename>.ps

The script processes all the .flg files with the following parameters:

- filter = FT3ab,F4,FM

- theta = 30,35,45,50,60,01
- phi = 00,45

4. Calibration matrices production

The AGILE calibration matrices pipeline is divided in three steps:

1. Effective area (.sar.gz)
    a. Step 1
    b. Step 2
2. Energy dispersion (.edp.gz)
3. Point spread function (.psd.gz)

4.1 Effective area – Step 1

All scripts can be found in */eff_area.*

The user must move the *.ae and *.rsp files created from Section 3 to two dedicated directories: /aref and /resp.
The set-up profile must contain the root directory of choice. In this case, we set:

- CALIB_AE_RSP =/data1/agile/AGILE_SIM/Calib/Kali08/
- In $CALIB_AE_RSP:

```
> mkdir aref
> mkdir resp
> mv $CALIB_DATA/*.ae $CALIB_AE_RSP/aref/.
> mv $CALIB_DATA/*.rsp $CALIB_AE_RSP/resp/.
```

In */eff_area*, the main script is *AGILE_mksar_loop.pro*, processing in loop all the files.
The script calls *area.pro* (in the same directory of *AGILE_mksar_loop.pro*).
Input files:

- $CALIB_AE_RSP/aref/SIM000000_3901_1_Vela_${theta}_${phi}_${filter}.ae

Output files:

- $CALIB_AE_RSP/aref/${filter}_${theta}_${phi}.txt

Run instructions:

```
IDL> .r AGILE_mksar_loop
```

4.2 Effective area – Step 2

In /eff_area, the main script for the step 2 is *AGILE_write_all_sar_I0023.pro*.
It calls (in the same directory of *AGILE_write_all_sar_I0023.pro*) :

- *readaeff_I0023.pro*
- *interp_sar_I0023.pro*
- *initheads.pro*

Input files:

- AG_GRID_G0017_S0001_I0007_template.sar.gz
- $CALIB_AE_RSP /aref/${filter}_${theta}_${phi}.txt

Output file:

- $CALIB_AE_RSP/sar/AG_GRID_G0017_S${filter}${eventtype}_I0023.sar.gz

The user must save the */data1/agile/AGILE_SIM/Calib/AG_GRID_G0017_S0001_I0007_template.sar.gz* into the directory /sar that must be created in the same path of the /aref and /sar directories:

```
> cd $CALIB_AE_RSP
> mkdir sar
> mv <path>/AG_GRID_G0017_S0001_I0007_template.sar.gz $CALIB_AE_RSP/sar
```

Run instructions:

```
IDL> .r AGILE_write_all_sar_I0023
```

4.3 Energy dispersion

All scripts can be found in */energy_disp*.
The main script is *AGILE_write_all_edp_I0023.pro* and it calls (in the same directory) :

- readedp_I0023.pro
- interp_edp6.pro
- initheads.pro

Input files:

- $CALIB_AE_RSP/edp/edptest_2.edp
- $CALIB_AE_RSP/resp/SIM000000_3901_1_Vela_${theta}_${phi}_${filter}.rsp

Output files:

- $CALIB_AE_RSP/AG_GRID_G0017_S${filter}${eventtype}_I0023.edp.gz

In $CALIB_AE_RSP, the user creates the directory /edp. The file */data1/agile/AGILE_SIM/Calib/Kali08/ edptest_2.edp* must be copied to */edp*:

```
> mkdir $CALIB_AE_RSP/edp
> mv <path>/edptest_2.edp $CALIB_AE_RSP/edp/.
```

Run instructions:

```
IDL> .r AGILE_write_all_edp_I0023
```

Bug alert:
The script produces the *.edp.gz files looping on a list of parameters, but some of these combinations are not present in the input files. Despite the error message reporting that some files are not found, all the input files are processed, and the bug does not affect the pipeline.

4.4 Point Spread Function

All scripts can be found in */psf*.
The main bash script is *createpsd.sh* which calls *fitpsf3.sh*.

Input files:

- $CALIB_DATA/*.flg
- $CALIB_DATA/*.dat

Output files:

- $CALIB_AE_RSP/psdfit/AG_GRID_G0017_SF*_I0023.psd.gz
- $CALIB_AE_RSP/psdfit/psdfit_F*_table.fits.gz
- $CALIB_DATA/ SIM000000_3901_1__${theta}_${phi}_${filter}.out

Under $CALIB_AE_RSP, the working directory */psdfit* is created and the file */data1/agile/AGILE_SIM/Calib/AG_GRID_G0017_SFMG_I0007.psd.gz* must be copied in the working directory:

```
> mkdir $CALIB_AE_RSP/psdfit
> mv <path>/ AG_GRID_G0017_SFMG_I0007.psd.gz $CALIB_AE_RSP/psdfit/.
```

Run instructions:

```
> sh createpsd.sh
```

5. References

1. M. Tavani et al., A&A 502, 995, 2009
2. Private discussion with A. Giuliani and A. Chen
3. A. Bulgarelli et al. in prep.
4. V.Cocco, F.Longo, A.Pellizzoni & A.Giuliani, “GAMS and KALMAEX” manual