GammaLib - Action #3919

Reproduce Werner Collmar's Crab data

12/02/2021 09:15 PM - Knödlseder Jürgen

Status:	Closed	**Start date:**	12/02/2021
Priority:	Normal	**Due date:**	
Assigned To:	Knödlseder Jürgen	**% Done:**	100%
Category:		**Estimated time:**	0.00 hour
Target version:	2.0.0		

Description

The GammaLib code should reproduce the DRIs derived by Werner Collmar for VP 221 as accurate as possible.

Here is a summary of the SKYDR3 runs that Werner Collmar used to derive the data:

```
--- Summary File fuer DREs von VP 221 (erstellt Dez. 2018) ----

MPE SKYDR3 300627
VP  221.0  DRE  0.75-1  #ALSKGOa+00a1a  EHS173  MPE006
04     ICOSYS:   1
22     ENGRP1:  0.75     1.0
35     XYDA01:     0.0   0.0   0.0   0.0
64     FPMDIN:  COMPASS.FPM.M0000004
65     EHSDIN:  COMPASS.EHS.M0000173
66     EVPDIN:  COMPASS.EVP.M0021899
67     EVPSEL:  MPE006
68     OADLIS:  COMPASS.OAL.M0023884
70     SWITCH:  00000000000000000010
72     DREOUT:  COMPASS.DRE.O0300285
SETET: number of superpackets read:       36973
SETET: number of superpackets used:       30001
Start:        9120   469767168
End  :        9131   433484991
event accepted                                19357
==============================================================

MPE SKYDR3 300628
VP  221.0  DRE  1-3  #ALSKGOa+00a1a  EHS173  MPE006
04     ICOSYS:   1
22     ENGRP1:  1.0      3.0
35     XYDA01:     0.0   0.0   0.0   0.0
64     FPMDIN:  COMPASS.FPM.M0000004
65     EHSDIN:  COMPASS.EHS.M0000173
66     EVPDIN:  COMPASS.EVP.M0021899
67     EVPSEL:  MPE006
68     OADLIS:  COMPASS.OAL.M0023884
70     SWITCH:  00000000000000000010
72     DREOUT:  COMPASS.DRE.O0300286
SETET: number of superpackets read:       36973
SETET: number of superpackets used:       30001
Start:        9120   469767168
End  :        9131   433484991
event accepted                               130624
==============================================================

MPE SKYDR3 300629
VP  221.0  DRE  3-10  #ALSKGOa+00a1a  EHS173  MPE006
04     ICOSYS:   1
22     ENGRP1:  3.0     10.0
35     XYDA01:     0.0   0.0   0.0   0.0
64     FPMDIN:  COMPASS.FPM.M0000004
65     EHSDIN:  COMPASS.EHS.M0000173
```

```
66     EVPDIN:  COMPASS.EVP.M0021899
67     EVPSEL:  MPE006
68     OADLIS:  COMPASS.OAL.M0023884
70     SWITCH:  00000000000000000010
72     DREOUT:  COMPASS.DRE.O0300287
SETET: number of superpackets read:       36973
SETET: number of superpackets used:       30001
Start:        9120   469767168
End  :        9131   433484991
event accepted                                66908
============================================================

MPE SKYDR3 300630
VP  221.0  DRE  10-30  #ALSKGOa+00a1a  EHS173  TST005
04     ICOSYS:   1
22     ENGRP1:  10.0    30.0
35     XYDA01:     0.0   0.0   0.0   0.0
64     FPMDIN:  COMPASS.FPM.M0000004
65     EHSDIN:  COMPASS.EHS.M0000173
66     EVPDIN:  COMPASS.EVP.M0021899
67     EVPSEL:  TST005
68     OADLIS:  COMPASS.OAL.M0023884
70     SWITCH:  00000000000000000010
72     DREOUT:  COMPASS.DRE.O0300288
SETET: number of superpackets read:       36973
SETET: number of superpackets used:       30001
Start:        9120   469767168
End  :        9131   433484991
event accepted                                8825
============================================================
```

History

#1 - 12/02/2021 09:59 PM - Knödlseder Jürgen

Here the time intervals of the different files:

Source	TJD start	Tics start	TJD stop	Tics stop	Comment
SKYDR3	9120	469767168	9131	433484991	
m21899_evp.fits header	9120	489600000	9131	440200000	
m21899_evp.fits events	9120	489602484	9131	433429992	
vp0221_0_tim.fits	9120	489602484	9131	433429992	Times shown by GCOMEventList::print() and GCOMTim::print()
m14033_tim.fits	9120	469736000	9131	440200000	
OAD header	9120	0	9131	673477823	
OAD superpackets	9120	0	9131	673346752	Times shown by GCOMOads::print()
GammaLib DRE	9120	489690112	9131	673477823	
GammaLib DRG	9120	489690112	9131	673477823	

The SKYDR3 validity intervals are set from the start of the first OAD and the stop of the last OAD superpacket that is used:

```
C          set the start and end validity interval
          IF(INIT.EQ.1) THEN
            INIT=0
            VALSTA(1)=OATSRT(1)
            VALSTA(2)=OATSRT(2)
```

```
          VALEND(1)=OATEND(1)
          VALEND(2)=OATEND(2)
        ELSE
          VALEND(1)=OATEND(1)
          VALEND(2)=OATEND(2)
C           avoid ticks > 1 day
          IF(VALEND(2).GT.691 199 999)VALEND(2)=691 199 999
        ENDIF
```

with

```
        OATEND(1)=CURTIM(1)
        OATEND(2)=CURTIM(2) + 131071
```

The GammaLib DRE and DRG times are set by the GCOMDri::use_superpacket() method and reflect the start time of the first and the stop time of the last superpacket that is used, hence the times should be equivalent to those of SKYDR3 is the same OAD files are used.

The SKYDR3 start time corresponds to row 2132 of m22366_oad.fits, while the stop time corresponds to row 2152 of m22387_oad.fits, hence in principle the same OAD records are accessible to GammaLib. The method GCOMOads::read() sets the OAD stop time in the same manner as SKYDR3, hence in principle identical times should be achievable. It is possible a difference in the TIM that can explain the difference.

#2 - 12/02/2021 10:06 PM - Knödlseder Jürgen

Using m14033_tim.fits instead of the GammaLib database TIM produces the exact same start and stop times. However it turns out that the number of superpackets read is smaller than for the SKYDR3 run, and that the OAD file for TJD 9125 is missing.

After Werner sent me the missing OAD dataset I reprocessed the data with the full list of OAD files.

Result	**SKYDR3**	**GammaLib**
Number of superpackets read	36973	38162
Number of superpackets used	30001	29901
0.75-1 MeV events accepted	19357	19357
1-3 MeV events accepted	130624	130627
3-10 MeV events accepted	66908	66922
10-33 MeV events accepted	8825	12299
Start	9120:469767168	9120:469767168
Stop	9131:433484991	9131:433484991

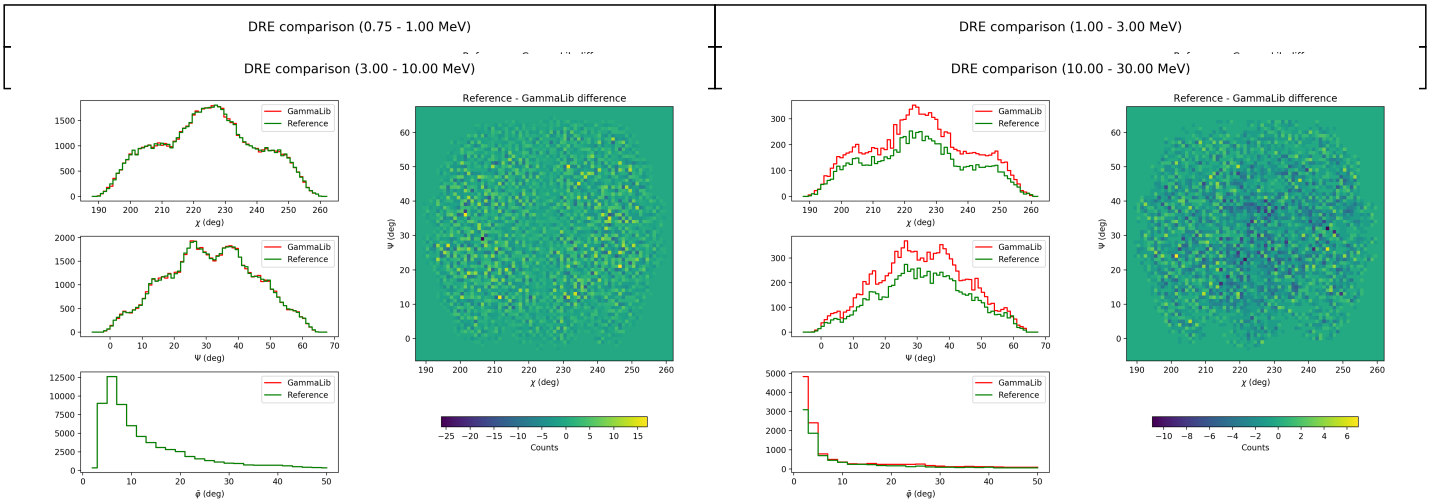
An initial comparison of the SKYDR3 and GammaLib DRIs showed some structure that indicated some difference in the WCS projection between the DRIs. Reproducing the coordinate transformations in SKYDR3 and GammaLib using the script check_dri_projection.py confirmed that the script dri2fits.py that I used to add WCS projection information to the FITS header was not correct. After correcting the FITS headers (and after replicating the same logic in check_dri_projection.py) the script produced the result below. Each row corresponds to one event. Columns with CO correspond to

COMPASS (i.e. SKYDR3), columns with GA to GammaLib. The first step of columns show the X/Y pixel index for both code followed by the difference. Pixel indices are now identical. The second set of columns shows the Galactic longitude and latitude of the events, also here the results are very close. Note that while GammaLib exploits directly the Galactic longitude and latitude information in the EVP file, SKYDR3 performs coordinate transformations, using the event's theta and phi angles.

```
************************
* Check DRI projection *
************************

  #    CO_X     CO_Y     GA_X     GA_Y  CO-GA_X  CO-GA_Y |    CO_L    CO_B    GA_L    GA_B  CO-GA_L  CO-GA_B
====  ======== ======== ======== ======== ======== ======== | ======== ======== ======== ======== ======== ========
  0:  43.6003  34.0330  43.5958  34.0331  0.00443 -0.00004 | 194.1003  -8.4670 194.0958  -8.4669  0.00443 -0.00004
  1:  53.5884  35.6523  53.5826  35.6512  0.00579  0.00109 | 204.0884  -6.8477 204.0826  -6.8488  0.00579  0.00109
  2:  38.5077  31.6222  38.5036  31.6225  0.00408 -0.00032 | 189.0077 -10.8778 189.0036 -10.8775  0.00408 -0.00032
  3:  29.6426  16.8326  29.6371  16.8324  0.00545  0.00017 | 180.1426 -25.6674 180.1371 -25.6676  0.00545  0.00017
  4:  45.0548  31.9575  45.0500  31.9575  0.00480 -0.00003 | 195.5548 -10.5425 195.5500 -10.5425  0.00480 -0.00003
  5:  28.6003  63.7477  28.6017  63.7496 -0.00131 -0.00192 | 179.1003  21.2477 179.1017  21.2496 -0.00131 -0.00192
  6:  27.4380  20.9859  27.4332  20.9856  0.00482  0.00031 | 177.9380 -21.5141 177.9332 -21.5144  0.00482  0.00031
  7:  36.0730  58.9957  36.0722  58.9962  0.00078 -0.00049 | 186.5730  16.4957 186.5722  16.4962  0.00078 -0.00049
  8:  50.3808  44.0255  50.3761  44.0242  0.00476  0.00127 | 200.8808   1.5255 200.8761   1.5242  0.00476  0.00127
  9:  38.2415  19.7424  38.2361  19.7428  0.00537 -0.00037 | 188.7415 -22.7576 188.7361 -22.7572  0.00537 -0.00037
 10:  57.5948  11.2286  57.5868  11.2291  0.00796 -0.00048 | 208.0948 -31.2714 208.0868 -31.2709  0.00796 -0.00048
```

Finally the plots below show a comparison of the DREs for the four energy bands. Since the projects of the DREs are not identical I did some random resampling of the events into the same projection, which of course can not reproduce an identity. Nevertheless the agreement is very satisfactory. Only the 10-30 MeV band shows a significant difference, which comes from the different ToF selections used by Werner and myself.



#3 - 12/02/2021 11:21 PM - Knödlseder Jürgen

- File drgcmp_vp0724_5.png added

- File drecmp_vp0724_5_0.75-1MeV.png added

- File drecmp_vp0724_5_1-3MeV.png added

- File drecmp_vp0724_5_3-10MeV.png added

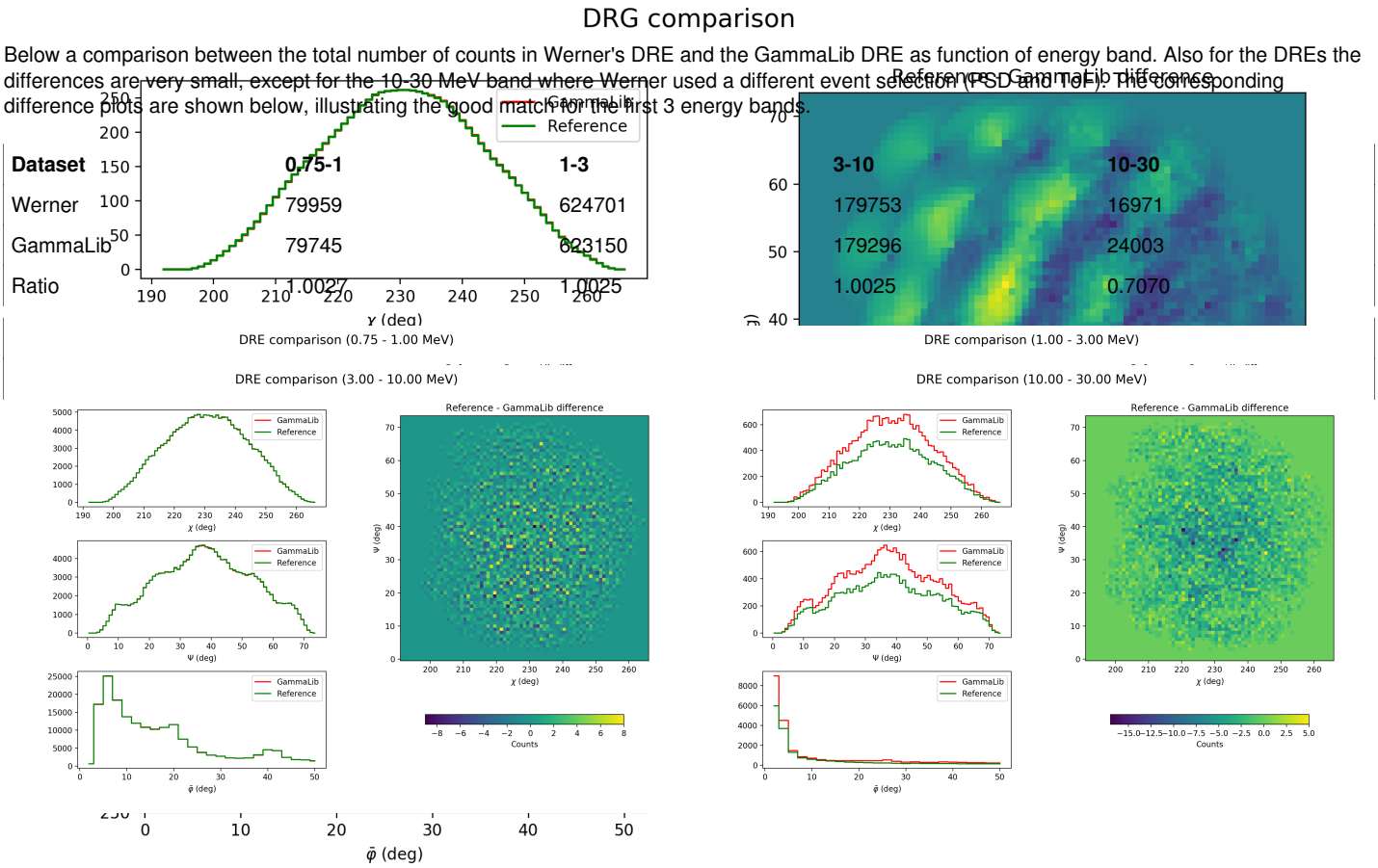
- File drecmp_vp0724_5_10-30MeV.png added

- Status changed from New to In Progress

- % Done changed from 0 to 20

Since the OAD for TJD 9125 is missing I moved to the second dataset that Werner Collmar sent. This is a Crab observation performed during VP 0724.5.

The plot below shows a comparison of the DRG computed using GammaLib (red) with the DRG computed using SKYDR3. Obviously, the differences are tiny. Summing over Werner's DRG gives 9325, while summing over the GammaLib DRG gives 9331, hence a difference of 0.06%!



#4 - 12/02/2021 11:42 PM - Knödlseder Jürgen

Here are the comlixfit results for the four energy band in comparison to the SRCFIX results. While for SRCFIX the results are not corrected for ToF and lifetime, GammaLib includes these corrections. I therefore applied the corresponding corrections to Werner's results for comparison (1.40, 1.27, 1.17 and 1.05 for the ToF correction of the four energy bands, 1.03 for the lifetime). For the analysis, the UNH simulated response files were used.

Analysis	**0.75-1**	**1-3**	**3-10**	**10-30**		**0.75-1**	**1-3**	**3-10**	**10-30**
Werner	31.47 ± 6.93	118.0 ± 7.04	30.28 ± 2.59	8.11 ± 0.87		-28.33 ± 6.62	12.98 ± 6.96	4.02 ± 2.57	0.66 ± 0.79
Werner (corr.)	43.23 ± 9.99	154.36 ± 9.21	36.49 ± 3.12	8.77 ± 0.94		-40.85 ± 9.55	16.98 ± 9.10	4.84 ± 3.10	0.71 ± 0.85
GammaLib	29.98 ± 7.98	141.53 ± 7.92	36.07 ± 2.72	8.82 ± 0.90		-56.30 ± 7.37	-2.39 ± 7.73	4.86 ± 2.68	0.43 ± 0.80

Below a comparison of the number of counts that were attributed to both sources.

Analysis	**0.75-1**	**1-3**	**3-10**	**10-30**		**0.75-1**	**1-3**	**3-10**	**10-30**
Werner	1632 ± 359	11975 ± 714	3230 ± 276	527 ± 56		-1428 ± 334	1301 ± 697	420 ± 268	42 ± 50
GammaLib	1068	11047	3366	631		-1952	-184	445	30

#5 - 12/04/2021 12:41 AM - Knödlseder Jürgen

- File drecmp_vp0221_0.75-1MeV.png added

- File drecmp_vp0221_1-3MeV.png added

- File drecmp_vp0221_3-10MeV.png added

- File drecmp_vp0221_10-30MeV.png added

#6 - 12/04/2021 01:52 PM - Knödlseder Jürgen

- Status changed from In Progress to Closed

- % Done changed from 20 to 100

The above examples show that the SKYDR3 DRIs for the Crab are well reproduced by GammaLib once the same input data are specified. I therefore close this issue now.

Files

drgcmp_vp0724_5.png	176 KB	12/02/2021	Knödlseder Jürgen
drecmp_vp0724_5_0.75-1MeV.png	177 KB	12/02/2021	Knödlseder Jürgen
drecmp_vp0724_5_1-3MeV.png	182 KB	12/02/2021	Knödlseder Jürgen
drecmp_vp0724_5_3-10MeV.png	190 KB	12/02/2021	Knödlseder Jürgen
drecmp_vp0724_5_10-30MeV.png	184 KB	12/02/2021	Knödlseder Jürgen
drecmp_vp0221_0.75-1MeV.png	178 KB	12/03/2021	Knödlseder Jürgen
drecmp_vp0221_1-3MeV.png	187 KB	12/03/2021	Knödlseder Jürgen
drecmp_vp0221_3-10MeV.png	187 KB	12/03/2021	Knödlseder Jürgen
drecmp_vp0221_10-30MeV.png	182 KB	12/03/2021	Knödlseder Jürgen