

GammaLib - Action #3919

Reproduce Werner Collmar's Crab data

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

Status:	Closed	Start date:	12/02/2021
Priority:	Normal	Due date:	
Assigned To:	Knödseder 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: 0000000000000000010

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

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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: 0000000000000000010

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

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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

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66  EVPDIN: COMPASS.EVP.M0021899
67  EVPSEL: MPE006
68  OADLIS: COMPASS.OAL.M0023884
70  SWITCH: 0000000000000000010
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
=====

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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: 0000000000000000010
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 - Knödseder 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 if 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 - Knödlseher 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

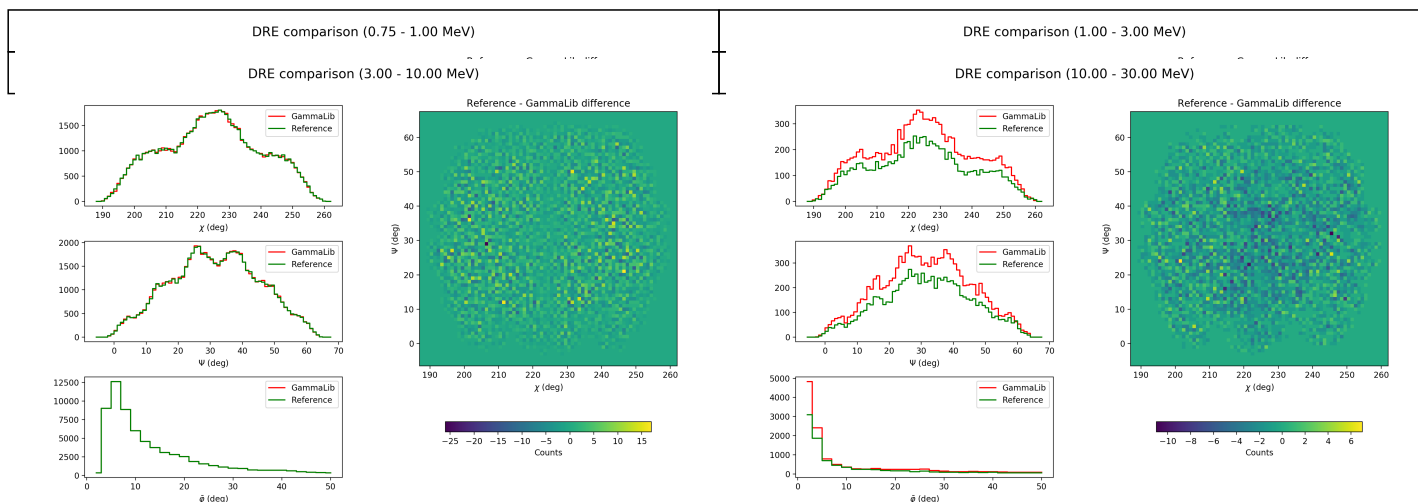
An initial comparison of the SKYDR3 and GammaLib DRIs showed some structure that indicated some difference in the WCS projection between the DRIs. Reproducing the coordinate transformations in SKYDR3 and GammaLib using the script check_dri_projection.py confirmed that the script dri2fits.py that I used 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 - Knödseder 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

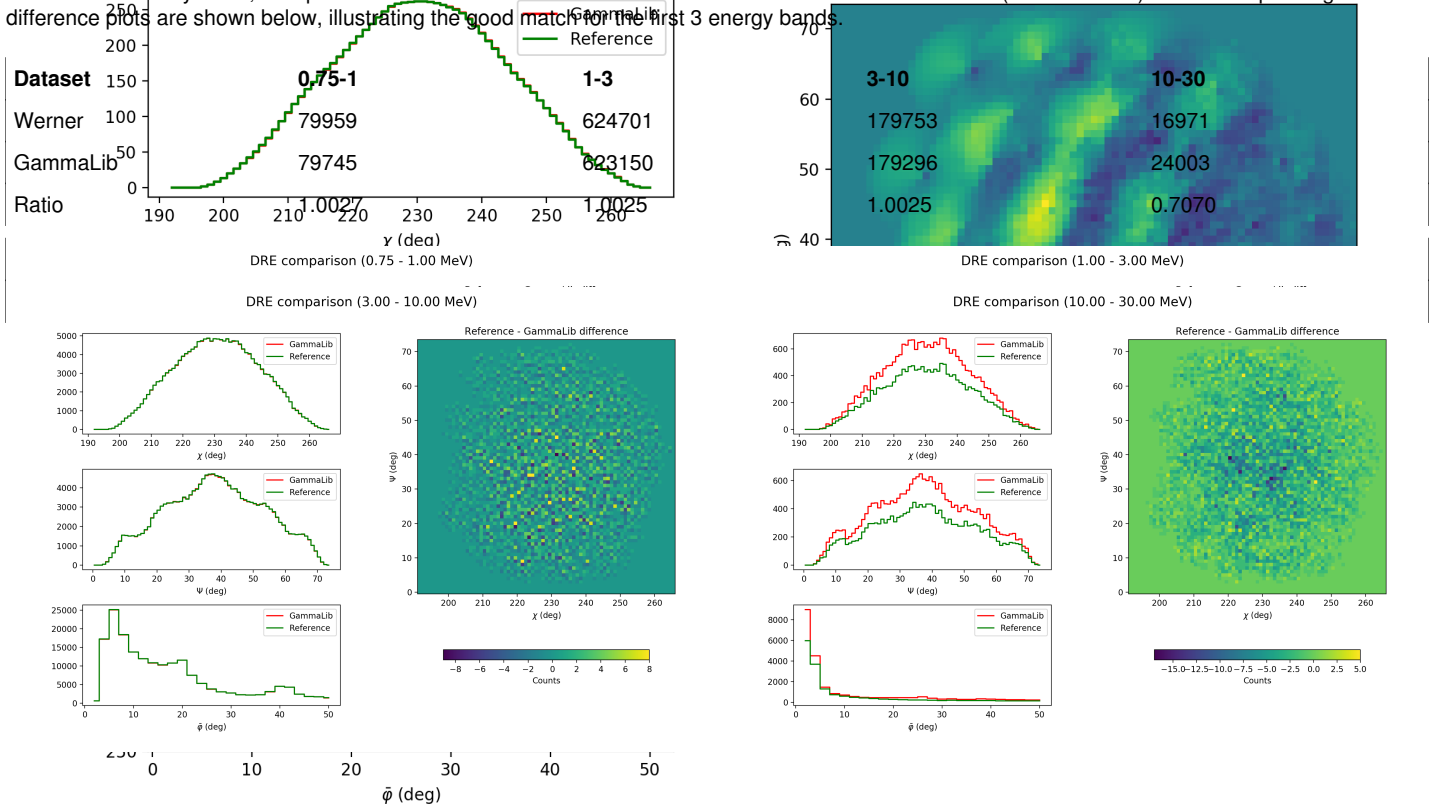
- File drecmp_vp0724_5_10-30MeV.png added
- Status changed from New to In Progress
- % Done changed from 0 to 20

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%!

DRG comparison

Below a comparison between the total number of counts in Werner's DRE and the GammaLib DRE as function of energy band. Also for the DREs the differences are very small, except for the 10-30 MeV band where Werner used a different event selection (PSD and ToF). The corresponding difference plots are shown below, illustrating the good match for the first 3 energy bands.



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

Here are the comlifix 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 - Knödseder 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 - Knödseder 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	Knödseder Jürgen
drecmp_vp0724_5_0.75-1MeV.png	177 KB	12/02/2021	Knödseder Jürgen
drecmp_vp0724_5_1-3MeV.png	182 KB	12/02/2021	Knödseder Jürgen
drecmp_vp0724_5_3-10MeV.png	190 KB	12/02/2021	Knödseder Jürgen
drecmp_vp0724_5_10-30MeV.png	184 KB	12/02/2021	Knödseder Jürgen
drecmp_vp0221_0.75-1MeV.png	178 KB	12/03/2021	Knödseder Jürgen
drecmp_vp0221_1-3MeV.png	187 KB	12/03/2021	Knödseder Jürgen
drecmp_vp0221_3-10MeV.png	187 KB	12/03/2021	Knödseder Jürgen
drecmp_vp0221_10-30MeV.png	182 KB	12/03/2021	Knödseder Jürgen