

GammaLib - Feature #2187

Implement COMPTEL DRI computation software

08/27/2017 10:59 PM - Knödlseider Jürgen

Status:	Closed	Start date:	08/27/2017
Priority:	Normal	Due date:	
Assigned To:	Knödlseider Jürgen	% Done:	100%
Category:		Estimated time:	0.00 hour
Target version:	1.5.0		
Description			
A software should be implement for COMPTEL that converts an event list into a DRI dataset. In COMPASS this job is done using the skydri software. Here the layout of skydrs12: <pre>skydir +-- UITPBG (initialise user shell) +-- SETSW (set global switches) +-- RDTPT (read TPT) +-- AUTOCD (generate automatically coordinates) +-- PNDRD (print DRI definitions) +-- SETX (generate DRX dataset) +-- ZERO (zero array) +-- SETXT (generate DRX for one response group, i.e. energy) +-- GALCEL (coordinate conversion) +-- P7OPEN (open TIM dataset) +-- POADOS (open OAD dataset) +-- POADRS (read OAD data) +-- P7TIME (check against time in TIM dataset) +-- COORD1 (coordinate conversion) +-- EXPOLM (compute exposure array) +-- COORD1 (coordinate conversion) +-- SENSAR (compute exposure summed over all D1) +-- P7CLOS (close TIM dataset) +-- DRXOUT (output DRX array to FITS file) +-- SETE (generate DRE dataset) +-- EVSTUP (initialise event statistics) +-- ZERO (zero array) +-- SETET (generate DRE dataset for one response group, i.e. energy) +-- GALCEL (coordinate conversion)</pre>			

```

| | |
| | +-- P7OPEN (open TIM dataset)
| | +-- POADOS (open OAD dataset)
| | +-- PEVPOR (open EVP dataset)
| | +-- POADRS (read OAD data)
| | +-- P7TIME (check against time in TIM dataset)
| | |
| | +-- COORD1 (coordinate conversion)
| | |
| | +-- GEOANG (compute angle subtended by Earth)
| | |
| | +-- MODSTA (update module status table)
| | |
| | +-- PMODST (??? read module status from FPM ???)
| | |
| | +-- EVENLM (bin events)
| | |
| | +-- COORD1 (coordinate conversion)
| | |
| | +-- PEVPSR (read next event)
| | |
| | +-- PSSEVP (apply event selection) ??? where is this code ???
| | |
| | +-- COORD1 (coordinate conversion)
| | |
| | +-- EVSTUP (update event statistics)
| | |
| | +-- P7CLOS (close TIM dataset)
| | +-- PEVPCR (close EVP dataset)
| | |
| +-- DREOUT (output DRE array to FITS file)
|
+-- SETG (generate DRE dataset)
|
+-- UITPND (terminate user shell)

```

History

#1 - 09/04/2017 10:35 PM - Knödlseider Jürgen

- Status changed from New to In Progress
- Assigned To set to Knödlseider Jürgen
- Target version set to 1.5.0
- % Done changed from 0 to 50

The issue makes good progress. I have added GCOMEventAtom, @GCOMEventList and GCOMRoi classes to have EVP files, and I also added the GCOMTim class to handle TIM files. Now need the OAD file classes and things are in place. Since an EVP and TIM files typically covers 14 days, but OAD files cover only one day I decided to implement the following XML file structure for an unbinned analysis:

```

<?xml version="1.0" standalone="no"?>
<observation_list title="observation library">
  <observation name="Crab" id="000001" instrument="COM">
    <parameter name="EVP" file="m16992_evp.fits"/>
    <parameter name="TIM" file="m10695_tim.fits"/>
    <parameter name="OAD" file="m20039_oad.fits"/>
    <parameter name="OAD" file="m20041_oad.fits"/>
  </observation>
</observation_list>

```

This allows to append an arbitrary list of OAD files to a given observation.

#2 - 09/06/2017 01:20 AM - Knödseder Jürgen

I made good progress, a first event binning method is now in GCOMObservation. Running on the entire VP1, using the following XML file

```
<?xml version="1.0" standalone="no"?>
<observation_list title="observation library">
  <observation name="Crab" id="000001" instrument="COM">
    <parameter name="EVP" file="/project-data/comptel/old.2/phase01/vp0001_0/m16992_evp.fits"/>
    <parameter name="TIM" file="/project-data/comptel/old.2/phase01/vp0001_0/m10695_tim.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20037_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20039_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20041_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20045_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20048_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20050_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20054_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20058_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20064_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20066_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20068_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20071_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20073_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20078_oad.fits"/>
    <parameter name="OAD" file="/project-data/comptel/old.2/phase01/vp0001_0/m20081_oad.fits"/>
  </observation>
</observation_list>
```

I obtain the following result for the 1-3 MeV DRE:

```
GCOMObservation::compute_dre
=====
Used superpackets .....: 52873
Skipped superpackets .....: 26210
Used events .....: 483723
Events outside superpacket ...: 135838
Energy too low .....: 78054
Energy too high .....: 294900
Phibar too low .....: 0
Phibar too high .....: 0
Outside D1 selection .....: 0
Outside D2 selection .....: 0
Outside TOF selection .....: 0
Outside PSD selection .....: 0
Outside rejection flag sel. ...: 0
Outside DRE cube .....: 0
No scatter angle .....: 0
Bad module combination .....: 0
Earth horizon angle too small : 31853
```

with the following event cube

```
=== GCOMEventCube ===
Number of events .....: 483723
Number of elements .....: 140600
Size (Chi x Psi x Phi) .....: 76 x 74 x 25
Energy range .....: 1 - 3 MeV
Mean energy .....: 1.73205080756888 MeV
Energy bin width .....: 2 MeV
MJD interval .....: 48392.9035427778 - 48406.7861383319 days
Mean time .....: -587274271.960063 s (TT)
Ontime .....: 1199456.25587511 s
```

For reference, the file m50439_dre.fits gives the following result:

```
=== GCOMEventCube ===
Number of events .....: 316141
Number of elements .....: 140600
Size (Chi x Psi x Phi) .....: 76 x 74 x 25
```

Energy range: 1 - 3 MeV
Mean energy: 1.73205080756888 MeV
Energy bin width: 2 MeV
MJD interval: 48392.9035427778 - 48406.7861383319 days
Mean time: -587274271.960063 s (TT)
Ontime: 1199456.25587511 s

Maybe the difference comes from the module status. Here the number of events per module after accumulating 20000 event for each time step:

((3418, 3240, 3106, 3502, 3830, 2905, 0), [0, 0, 1761, 1872, 0, 1925, 1880, 1755, 1866, 1855, 1912, 1697, 1641, 1837])
((3301, 3325, 2996, 3523, 3879, 2977, 0), [0, 0, 1799, 1833, 0, 1882, 1946, 1793, 1719, 1791, 1990, 1808, 1662, 1778])
((3417, 3378, 2917, 3435, 3881, 2973, 0), [0, 0, 1850, 1911, 0, 1797, 1820, 1853, 1799, 1711, 1995, 1813, 1671, 1781])
((3372, 3157, 2942, 3554, 4024, 2952, 0), [0, 0, 1902, 1819, 0, 1879, 1943, 1801, 1683, 1783, 2047, 1694, 1646, 1804])
((3356, 3147, 3000, 3556, 4027, 2915, 0), [0, 0, 1890, 1834, 0, 1858, 1972, 1726, 1815, 1837, 1928, 1694, 1623, 1824])
((3375, 3422, 3142, 3423, 3840, 2799, 0), [0, 0, 1852, 1899, 0, 1821, 1898, 1834, 1701, 1810, 1900, 1827, 1699, 1760])
((3386, 3389, 2966, 3440, 3881, 2939, 0), [0, 0, 1860, 1913, 0, 1801, 1934, 1862, 1728, 1737, 2007, 1783, 1639, 1737])
((3310, 3059, 2978, 3656, 4073, 2925, 0), [0, 0, 1980, 1762, 0, 1823, 1992, 1710, 1782, 1772, 2040, 1729, 1582, 1829])
((3508, 3258, 2968, 3449, 3788, 3030, 0), [0, 0, 1796, 1874, 0, 1807, 1777, 1840, 1809, 1891, 1932, 1756, 1703, 1816])
((3369, 3457, 3068, 3395, 3779, 2933, 0), [0, 0, 1765, 1913, 0, 1858, 1916, 1861, 1846, 1732, 1927, 1737, 1681, 1765])
((3368, 3448, 2888, 3470, 3909, 2918, 0), [0, 0, 1815, 1882, 0, 1785, 1831, 1927, 1773, 1857, 1915, 1809, 1717, 1690])
((3326, 3123, 2895, 3613, 4052, 2992, 0), [0, 0, 2011, 1755, 0, 1921, 2095, 1707, 1664, 1768, 2145, 1586, 1545, 1804])
((3416, 3315, 3021, 3465, 3899, 2885, 0), [0, 0, 1849, 1864, 0, 1909, 1869, 1808, 1788, 1786, 1974, 1725, 1601, 1828])
((3491, 3464, 3095, 3256, 3755, 2940, 0), [0, 0, 1766, 1970, 0, 1772, 1778, 2037, 1801, 1741, 1916, 1749, 1678, 1793])
((3529, 3327, 2957, 3358, 3897, 2933, 0), [0, 0, 1936, 1815, 0, 1836, 1966, 1748, 1759, 1802, 2019, 1761, 1605, 1754])
((3413, 3082, 2828, 3717, 4016, 2945, 0), [0, 0, 1977, 1762, 0, 1915, 2149, 1679, 1654, 1798, 2119, 1621, 1596, 1731])
((3452, 3303, 2988, 3563, 3822, 2873, 0), [0, 0, 1807, 1951, 0, 1908, 1891, 1793, 1756, 1816, 1927, 1768, 1587, 1797])
((3504, 3377, 3079, 3377, 3753, 2911, 0), [0, 0, 1936, 1907, 0, 1798, 1856, 1836, 1797, 1674, 1946, 1816, 1663, 1772])
((3458, 3480, 2942, 3419, 3856, 2846, 0), [0, 0, 1861, 1898, 0, 1776, 1914, 1909, 1794, 1673, 1937, 1769, 1654, 1816])
((3338, 3084, 2899, 3654, 4116, 2910, 0), [0, 0, 2044, 1800, 0, 1869, 2144, 1535, 1664, 1822, 2116, 1579, 1612, 1816])
((3428, 3315, 3033, 3506, 3803, 2916, 0), [0, 0, 1771, 1881, 0, 1840, 1951, 1824, 1807, 1818, 1987, 1734, 1642, 1746])
((3476, 3461, 3032, 3414, 3678, 2940, 0), [0, 0, 1803, 1890, 0, 1819, 1872, 1945, 1762, 1692, 1941, 1829, 1683, 1765])
((3461, 3331, 2959, 3401, 3933, 2916, 0), [0, 0, 1927, 1906, 0, 1812, 1940, 1776, 1735, 1710, 1936, 1814, 1637, 1808])
((3355, 3021, 2913, 3635, 4218, 2859, 0), [0, 0, 1988, 1801, 0, 1916, 2050, 1610, 1744, 1838, 2192, 1592, 1622, 1648])
((3434, 3297, 2926, 3363, 3972, 3009, 0), [676, 0, 1917, 2069, 0, 1941, 2011, 1876, 1850, 1913, 2062, 1921, 1765, 0])
((3423, 3315, 3029, 3422, 3877, 2935, 0), [1818, 0, 1758, 1936, 0, 1802, 1886, 1923, 1780, 1715, 1936, 1807, 1640, 0])
((3287, 3179, 2747, 3605, 4163, 3020, 0), [1781, 0, 2062, 1812, 0, 1771, 2039, 1744, 1644, 1732, 2107, 1729, 1580, 0])
((3362, 3021, 2878, 3586, 4053, 3101, 0), [1833, 0, 1929, 1738, 0, 1971, 2014, 1643, 1740, 1811, 2081, 1640, 1601, 0])
((3404, 3394, 2945, 3533, 3672, 3053, 0), [1883, 0, 1793, 1872, 0, 1720, 1831, 1927, 1786, 1801, 1814, 1776, 1798, 0])
((3415, 3330, 2792, 3499, 3864, 3101, 0), [1787, 0, 1956, 1893, 0, 1873, 1940, 1783, 1765, 1757, 1871, 1751, 1625, 0])
((3422, 3061, 2719, 3602, 4225, 2972, 0), [1774, 0, 1959, 1743, 0, 1902, 2117, 1710, 1727, 1725, 2097, 1669, 1578, 0])
((3436, 3193, 2864, 3656, 3910, 2942, 0), [1738, 0, 1924, 1799, 0, 1866, 1943, 1717, 1768, 1887, 2024, 1649, 1686, 0])
((3453, 3421, 3000, 3419, 3776, 2932, 0), [1841, 0, 1776, 1946, 0, 1745, 1802, 1905, 1774, 1730, 2028, 1793, 1661, 0])
((3445, 3422, 2946, 3399, 3852, 2937, 0), [1817, 0, 1777, 1856, 0, 1822, 1870, 1895, 1771, 1777, 1879, 1781, 1756, 0])
((3395, 3007, 2868, 3591, 4130, 3010, 0), [1781, 0, 1997, 1717, 0, 1863, 2053, 1669, 1685, 1844, 2155, 1629, 1608, 0])
((3433, 3161, 2907, 3549, 3925, 3026, 0), [1804, 0, 1788, 1911, 0, 1829, 1786, 1816, 1827, 1962, 1994, 1668, 1616, 0])
((3376, 3282, 2952, 3463, 3981, 2947, 0), [1809, 0, 1834, 1763, 0, 1811, 1841, 1914, 1747, 1759, 2032, 1792, 1699, 0])
((3375, 3358, 2899, 3437, 3979, 2953, 0), [1737, 0, 1824, 1861, 0, 1802, 1855, 1829, 1785, 1842, 2039, 1799, 1628, 0])
((3503, 3401, 2851, 3433, 3927, 2886, 0), [1802, 0, 1728, 1871, 0, 1835, 1768, 1948, 1806, 1809, 1971, 1748, 1715, 0])
((3406, 3287, 2967, 3398, 3951, 2992, 0), [1810, 0, 1838, 1897, 0, 1829, 1806, 1770, 1767, 1747, 1985, 1812, 1740, 0])
((3457, 3112, 2814, 3519, 4144, 2955, 0), [1801, 0, 1889, 1705, 0, 1845, 2033, 1754, 1687, 1755, 2124, 1783, 1625, 0])
((3422, 3091, 2903, 3570, 3992, 3023, 0), [1771, 0, 1836, 1768, 0, 1940, 1907, 1727, 1779, 1802, 2130, 1690, 1651, 0])
((3490, 3364, 2904, 3318, 4000, 2925, 0), [1785, 0, 1825, 1855, 0, 1840, 1906, 1806, 1764, 1750, 1981, 1818, 1671, 0])
((3505, 3382, 2953, 3440, 3837, 2884, 0), [1915, 0, 1746, 1832, 0, 1730, 1835, 1860, 1751, 1795, 1954, 1860, 1723, 0])
((3367, 3020, 2719, 3663, 4248, 2984, 0), [1789, 0, 2046, 1655, 0, 1934, 2083, 1596, 1620, 1889, 2175, 1582, 1632, 0])
((3415, 3258, 2963, 3481, 3930, 2954, 0), [1807, 0, 1795, 1884, 0, 1816, 1847, 1890, 1723, 1838, 1916, 1802, 1683, 0])
((3390, 3350, 2868, 3523, 3950, 2920, 0), [1786, 0, 1893, 1879, 0, 1790, 1808, 1859, 1763, 1806, 1906, 1824, 1687, 0])
((3344, 3262, 2921, 3514, 4011, 2949, 0), [1845, 0, 1986, 1718, 0, 1834, 1922, 1882, 1704, 1770, 2068, 1674, 1598, 0])
((3384, 3020, 2910, 3650, 4107, 2930, 0), [1833, 0, 1266, 1819, 0, 1991, 2134, 1789, 1723, 1910, 2184, 1691, 1661, 0])
((3324, 3466, 2959, 3385, 4011, 2856, 0), [2018, 0, 0, 2010, 0, 1983, 2052, 2034, 1969, 2005, 2060, 1979, 1891, 0])
((3105, 3106, 2736, 3272, 3860, 2708, 1214), [2006, 0, 0, 2069, 0, 1985, 2077, 1991, 1952, 1975, 2231, 1904, 1811, 0])
((2924, 2818, 2487, 3107, 3450, 2515, 2700), [1934, 0, 0, 2023, 0, 2104, 2126, 1954, 1908, 2011, 2196, 1907, 1838, 0])

For D1, module 7 was dead most of the time. For D2 there is quite some intermittence in modules 1, 2, 3, 5 and 14. Excluding all these modules gives 396509 events, closer to the 316141 in the reference DRE dataset, but still too large.

- % Done changed from 50 to 60

I just received the D1 & D2 module status table:

```
// 8392,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,1
// 8393,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,1
// 8394,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,1
// 8395,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,1
// 8396,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,1
// 8397,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,1
// 8398,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,0
// 8399,1,1,1,1,1,0, 0,0,1,1,0,1,1,1,1,1,1,1,0
// 8400,1,1,1,1,1,0, 1,0,1,1,0,1,1,1,1,1,1,1,0
// 8401,1,1,1,1,1,0, 1,0,1,1,0,1,1,1,1,1,1,1,0
// 8402,1,1,1,1,1,0, 1,0,1,1,0,1,1,1,1,1,1,1,0
// 8403,1,1,1,1,1,0, 1,0,1,1,0,1,1,1,1,1,1,1,0
// 8404,1,1,1,1,1,0, 1,0,1,1,0,1,1,1,1,1,1,1,0
// 8405,1,1,1,1,1,0, 1,0,1,1,0,1,1,1,1,1,1,1,0
// 8406,1,1,1,1,1,1, 1,0,1,1,0,1,1,1,1,1,1,1,0
```

Implementing this table hard-wired for the moment leads to a rejection of 3734 events, this is a minor correction.

I forgot however that the TOF selection is more stringent when compared to the EVP data. The data comprise the window 110 - 150, the standard selection is 115 - 130. Here the summary of the standard selection criteria that are now hard-wired:

Parameter	Selection Interval
E1	70 - 20000 keV
E2	650 - 30000 keV
Phibar	0 - 50 deg
TOF	115 - 130
PSD	0 - 110
Zeta	> 5 deg

And here the number of events in the standard VP1 DRE, compared to the numbers I get:

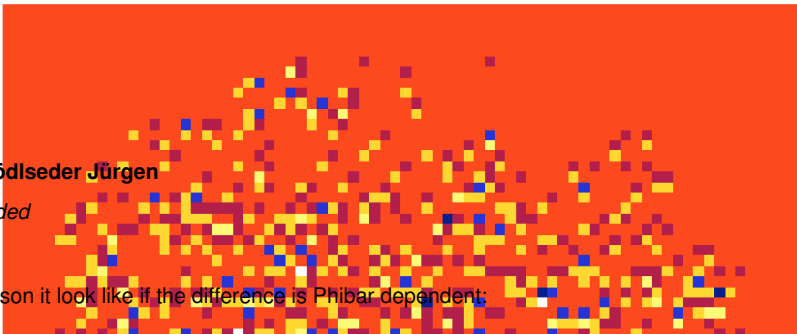
Energy	Standard	GCOMObservation::compute_dr e	Difference
0.75 - 1 MeV	48806	40788	-16.4%
1 - 3 MeV	316141	290487	-8.1%
3 - 10 MeV	140395	123601	-12.0%
10 - 30 MeV	22253	21473	-3.5 %

Interestingly, there is an energy dependent difference.

#4 - 09/06/2017 10:18 AM - Knödseder Jürgen

- File dre-difference.png added

Interestingly, the difference is statistical in the sense that for some pixels there are more events in the standard DRE, in other there are more events in the GammaLib DRE. See image below as an example.

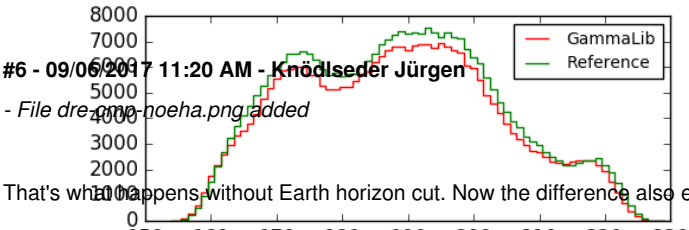


#5 - 09/06/2017 11:18 AM - Knödseder Jürgen

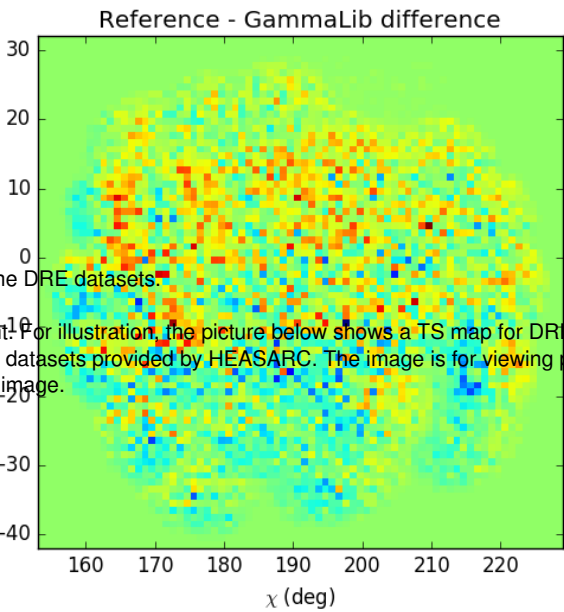
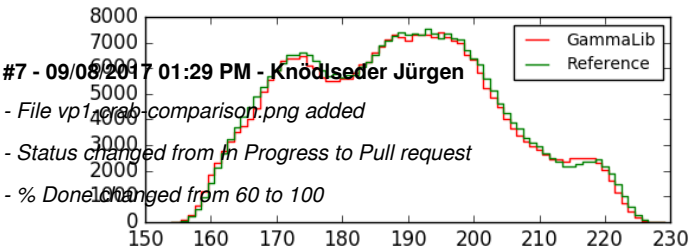
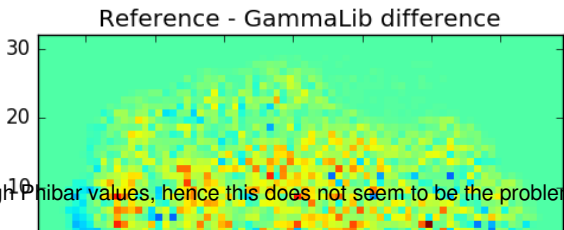
- File dre-difference-plot.png added

Making a more detailed comparison it looks like if the difference is Phibar dependent:

DRE comparison (1.00 - 3.00 MeV)

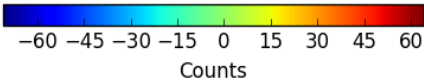
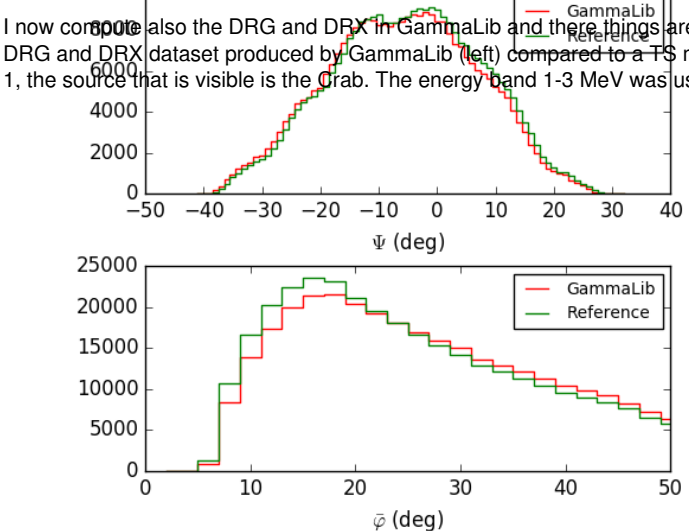


DRE comparison (1.00 - 3.00 MeV)

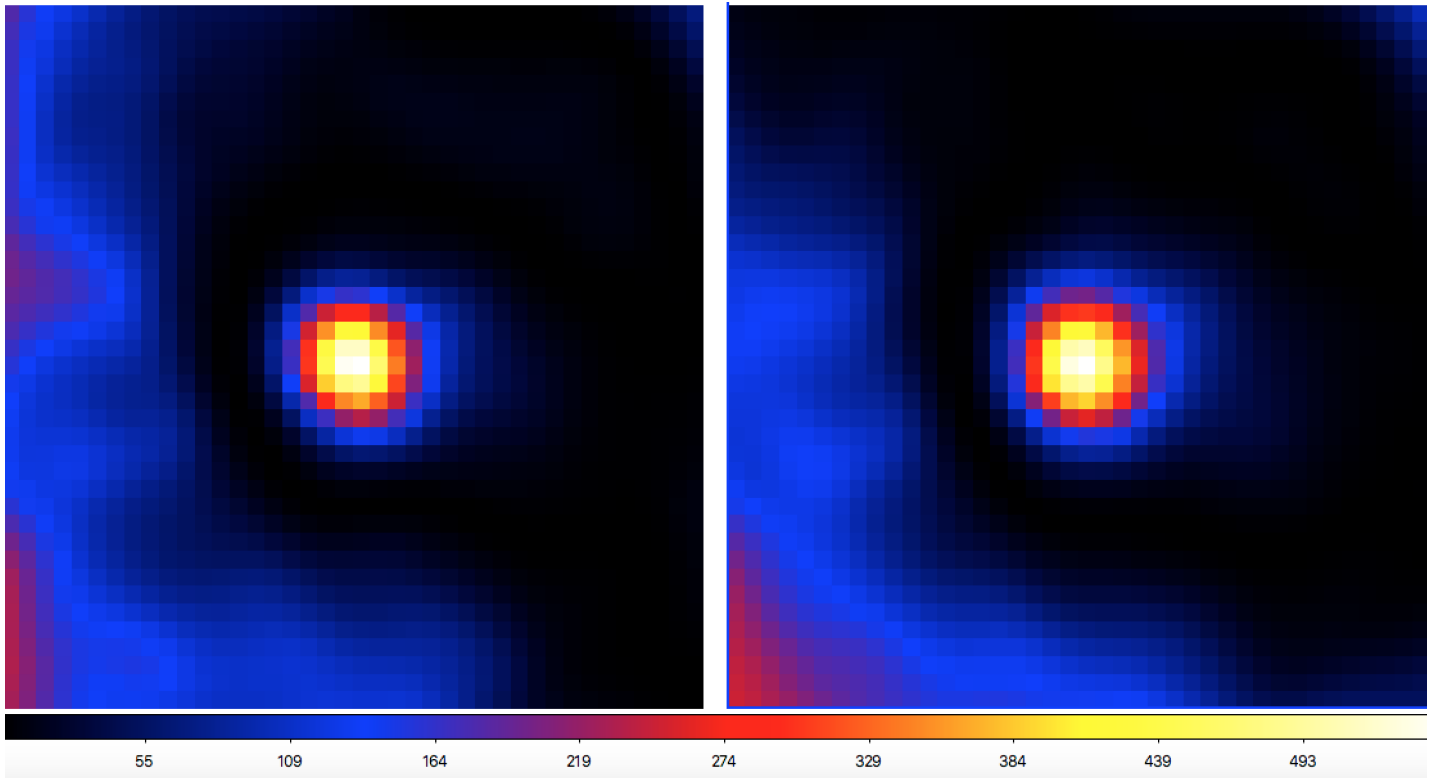


Got it. The event data shipped with HEASARC are apparently not compatible with the DRE datasets.

I now compare also the DRG and DRX in GammaLib and there things are consistent. For illustration, the picture below shows a TS map for DRE, DRG and DRX dataset produced by GammaLib (left) compared to a TS map for the datasets provided by HEASARC. The image is for viewing period 1, the source that is visible is the Crab. The energy band 1-3 MeV was used for the image.



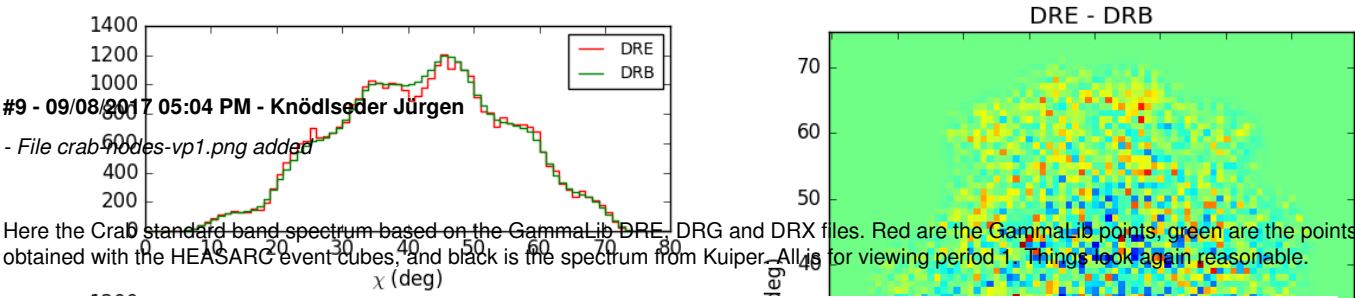
Counts



#8 - 09/08/2017 04:57 PM - Knödseder Jürgen
- File dre-drp-vp5-1.8MeV.png added

Here the comparison of a DRE and a DRG (used as DRB) for the viewing period 5 and the 1.8 MeV line band. There was an issue with a sign reversion in the Earth horizon computation, but now things seem to be okay.

DRE comparison (1.70 - 1.90 MeV)



#9 - 09/08/2017 05:04 PM - Knödseder Jürgen
- File crab-nodes-vp1.png added

Here the Crab standard band spectrum based on the GammaLib DRE, DRG and DRX files. Red are the GammaLib points, green are the points obtained with the HEASARC event cubes, and black is the spectrum from Kuiper. All is for viewing period 1. Things look again reasonable.

