GLAST Burst Monitor

The calibration of the GLAST Burst Monitor NaI- and BGO-detectors

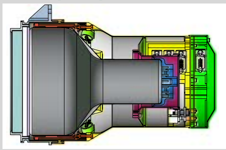
*by **Andreas von Kienlin[1]**, Julia Wagner[1], Helmut Steinle[1], Narayana Bhat[2], Michael S. Briggs[2], Roland Diehl[1], Gerald J. Fishman[3], Jochen Greiner[1], R. Marc Kippen[4], Chryssa Kouveliotou[5], Giselher G. Lichti[1], Charles A. Meegan[3], William S. Paciesas[2], Robert D. Preece[2], Robert B. Wilson[2]*

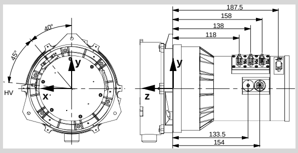
[1] Max-Planck-Institut für extraterrestrische Physik (MPE); [2] University of Alabama (UAH); [3] NASA/Marshall Space-Flight Center (MSFC), [4] Los Alamos National Laboratory (LANL), [5] USRA

Introduction:

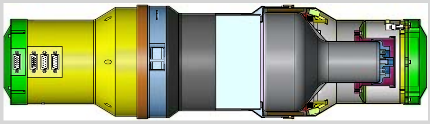
The next large NASA mission in the field of gamma-ray astronomy, GLAST, is scheduled for launch in September 2007. Aside from the main instrument LAT, a gamma-ray telescope for the energy range between ~20 MeV and ~300 GeV, a secondary instrument, the GLAST burst monitor (GBM), is foreseen. Its task is to increase the detection rate of gamma-ray bursts for the LAT and to extend the energy range of the main instrument to lower energies (from ~10 keV to ~30 MeV). The GBM consists of 12 thin NaI-plates, which allow the determination of the angle of incidence of the gamma radiation. These crystals are sensitive in the energy range between ~10 keV and ~1 MeV. Two additional BGO detectors, which are able to detect gamma-rays in the energy range between ~150 keV and ~30 MeV, are responsible for the overlap in energy measurement with the LAT main instrument and the NaI detectors. All flight detectors were already delivered to NASA. This poster gives an overview of the calibration measurements performed by MPE at the detector level before delivery.

The GBM-NaI(Tl) Detectors (12 x):





The GBM-BGO Detectors (2 x):

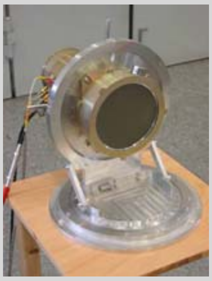


Purpose of Calibration:

- provide performance verification of the GBM detectors.
- provide benchmark data to compare with calculated detector response data.
- provide accurate, well-characterized data for subsequent scientific analysis.

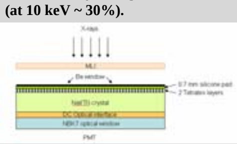
The Calibration Setup:

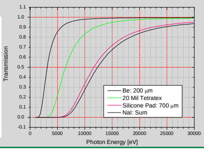
- allowes the acquisition of spectra at different angles of incidence.
- high accuracy due to laser adjustment.



X-ray Transmission of the NaI Entrance Window:

The installation of an 0.7 mm thick silicon pad between the Beryllium entrance window and the crystal was necessary so that the brittle NaI crystal is able to survive the environmental conditions during launch. This additional silicon layer caused unfortunately a degradation of the transmissivity at low energies (at 10 keV ~ 30%).



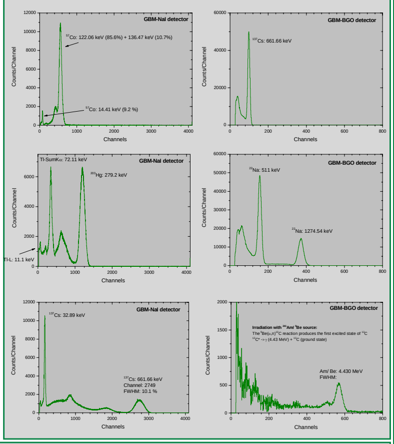


List of Calibration Sources:

Nuclide	Half-life	Decay	Line energies [keV]	Transition Probability	Weighted Mean [keV]	Prob.	Line for Calibration of
^{55}Fe	1001.0 (23) d / 2.741 (8) y	Mn-SumK	5.90	0.283 (10)			NaI(Tl)
^{241}Am	432.2 (7) y	Np-Lα1	13.97	0.1193 (11)			-
		Np-Lβ	17.54	0.1881 (17)			-
		Np-Lγ	21.01	0.0482 (4)			-
		γ	26.34	0.02400 (20)			-
		γ	59.4	0.359 (4)			NaI(Tl)
^{109}Cd	462.1 (14) d	Ag-SumKα	22.1	0.838 (8)	22.61	1.014	NaI(Tl)
		Ag-SumKβ	25	0.1777 (19)			NaI(Tl)
		γ	88.03	0.03626 (20)			NaI(Tl)
^{57}Co	271.83 (8) d	Fe-SumK	6.40	0.779 (8)			NaI(Tl)
		γ	14.41	0.0916 (15)			NaI(Tl)
		γ	122.06	0.8560 (17)	124.39	0.963	NaI(Tl),BGO
		γ	136.47	0.1068 (8)			NaI(Tl),BGO
^{203}Hg	46.604 (17) d	Tl-L	11.1	0.0990 (12)			NaI(Tl)
		Tl-SumKα	72.11	0.102 (3)			NaI(Tl)
		γ	279.2	0.8146 (13)			NaI(Tl),BGO
^{137}Cs	11000 (90) d / 30.13 (24) y	Ba-SumKα	32.06	0.0711 (20)	32.89	0.069	NaI(Tl)
		Ba-SumKβ	36.6	0.01421 (27)			NaI(Tl)
		Ba-137m	661.66	0.8500 (20)			NaI(Tl),BGO
^{54}Mn	312.15 (8) d	Cr-SumK	5.47	0.258 (4)			NaI(Tl)
		γ	834.84	0.999750 (12)			NaI(Tl),BGO
^{60}Co	1925.3 (4) d / 5.2712(11) y	γ	1173.23	0.9985 (3)			BGO
		γ	1332.49	0.999826 (6)			BGO
^{22}Na	950.5 (4) d	Annih.	511	1.798			NaI(Tl),BGO
		γ	1274.54	0.9994			BGO
^{24}Na	0.62328 (21) d /14.959(4) h	γ	1368.63	0.999936 (?)			BGO
		γ	2754.01	0.99871 (8)			BGO
^{88}Y	106.630 (25) d	Sr-SumKα	14.14	0.522 (8)	14.39	0.616	NaI(Tl)
		Sr-SumKβ	15.8	0.094 (2)			
		γ	898.04	0.940 (3)			NaI(Tl),BGO
		γ	1836.06	0.9933 (3)			BGO
^{241}Am/^{9}Be	432.2 (7) y	γ	4430	0.00			BGO

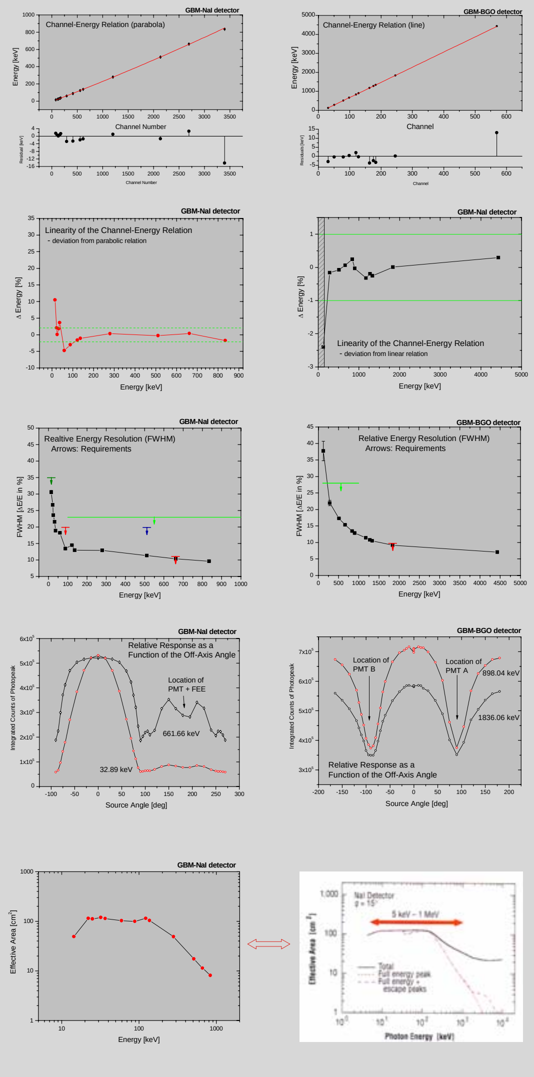
Typical Spectra:

Background-subtracted NaI- and BGO-spectra, recorded at an angle where the detector effective area is maximal (0°).



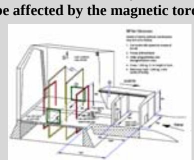
Calibration Results:

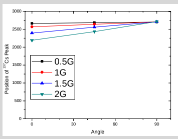
The figures below summarize the main measurements performed with the flight detectors. All detectors of the same type showed nearly the same performance and all fulfilled the specified requirements.



Detector Magnetic Susceptibility:

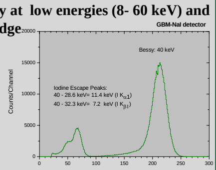
The effect of magnetic fields on the shielded NaI-EQM module was tested from -2 G to + 2 G in 0.5 G steps at the IABG's MFSA facility. <u>Result:</u> The GBM response will not be affected by the magnetic torquers of the GLAST S/C

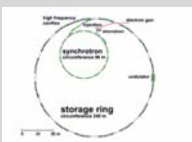




NaI Low Energy Calibration:

Performed at the BESSY synchrotron in Berlin with 4 FM-NaIs: Determination of absolute efficiency at low energies (8- 60 keV) and test of response around Iodine K-Edge





For further information, please contact: azk@mpe.mpg.de