Background measurements with open IGEX and ANG 2 detectors: effective masses.

**O. Chkvorets (MPI-K), E.Demidova (ITEP), K. Gusev (RRC 'KI'-JINR),
M. Junker (LNGS), I. Kirpichnikov (ITEP), V. Lebedev (RRC 'KI'), P.Pfeifer (MPI-K),
S. Schoenert (MPI-K), M. Shirchenko (RRC 'KI'-JINR)), A.Vasenko (ITEP).**

The three IGEX detectors were delivered from Canfranc underground laboratory to LNGS on November 18, 2005. The detectors were warm and out of liquid nitrogen for a long time, and demanded a full cycle of a restoration. Results of the procedure were given in a note GSTR-06-004, February 2006 . As the changes of the effective volumes were also possible, measurements of them seemed to be necessary. The procedure of comparative measurements was used for this purpose .

It included simultaneous measurements of background with open (without any shielding) detectors. A comparison of the collected spectra provided information about relative effective masses of the IGEX and one of HM (ANG-2) detectors.

SUMMARY

Effective volumes of the RG1, RG2 and ANG2 detectors were found being some less (up to ~10 %) then it has been estimated from the passport values of their dead layers (M_{eff}/M_{tot}=0,95 corresponded approximately 800 μ dead layer). For RG2, and partially for RG1, it could be attributed to some increasing of thickness of the dead layer on their surfaces . Detector RG1 had noticeably smaller value of the M_{eff}/M_{tot}, which was in agreement with measurements in Homestake in 1994. A possible explanation could be connected with not full collection of the charge (operation voltage as high as 4800 volts).

The difference between the passport values and results of measurements can be even higher, as the estimations were made supposing maximum possible value of M_{eff}/M_{tot}=0,98 for RG3 detector (500 μ dead layer). Preliminary estimation indicated that this value has increased up to ~ (800-1000) μ .

	M_{total}	M_{eff} passport	M_{eff} experiment	experiment/ passport
RG1	2149	2042	1860	0,91
RG2	2194	2084	2020	0,97
RG3	2121	2079	2079*	1,0
ANG2	2906	2761	2460	0,89

*) passport value

Comparative Technique in Measurements of Effective Volumes of Ge Detectors

E.V.Demidova, I.V.Kirpichnikov, and A.A.Vasenko - ITEP

The procedure included simultaneous measurements of backgrounds in an underground laboratory with several opened (without any shielding) detectors. A comparison of the collected spectra provided information about кelative effective masses of the detectors.

The calculation were performed to check up the procedure which was used for measurements of germanium detectors effective masses.

Numbers of events in (500-1000) keV interval in K-40 gamma-spectra were calculated for Ge detectors of different configurations and masses, 0.26 kg to 3.3 kg. The K-40 gamma-source was homogeneously distributed in a silicon sphere Ø1300 mm, with a central hole Ø300mm (the detectors in the center of the hole). The calculations included 3x10^7 starts for each version.

New Technique in Measurements of Effective Volumes of Ge Detectors

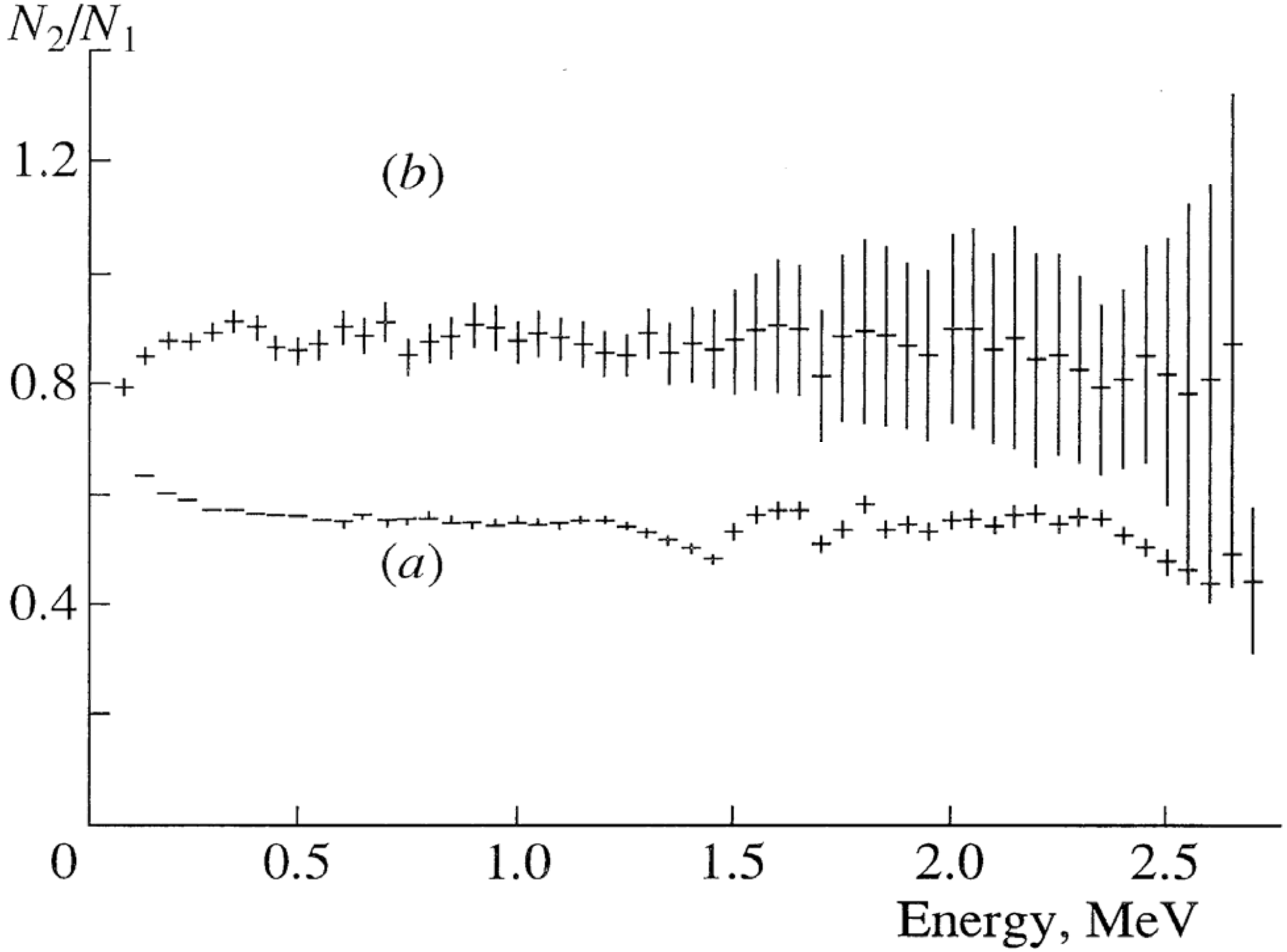
E.V.Demidova, I.V.Kirpichnikov, and A.A.Vasenko

Physics of Atomic Nuclei, V.61, No.7,1998, pp.128-1240.

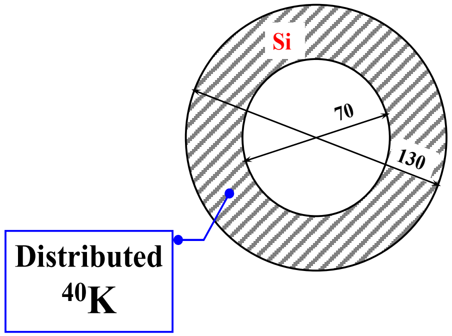
A comparison of the open detectors background spectra in Homestake: ratios of numbers of events in the spectra versus gamma-quanta energies

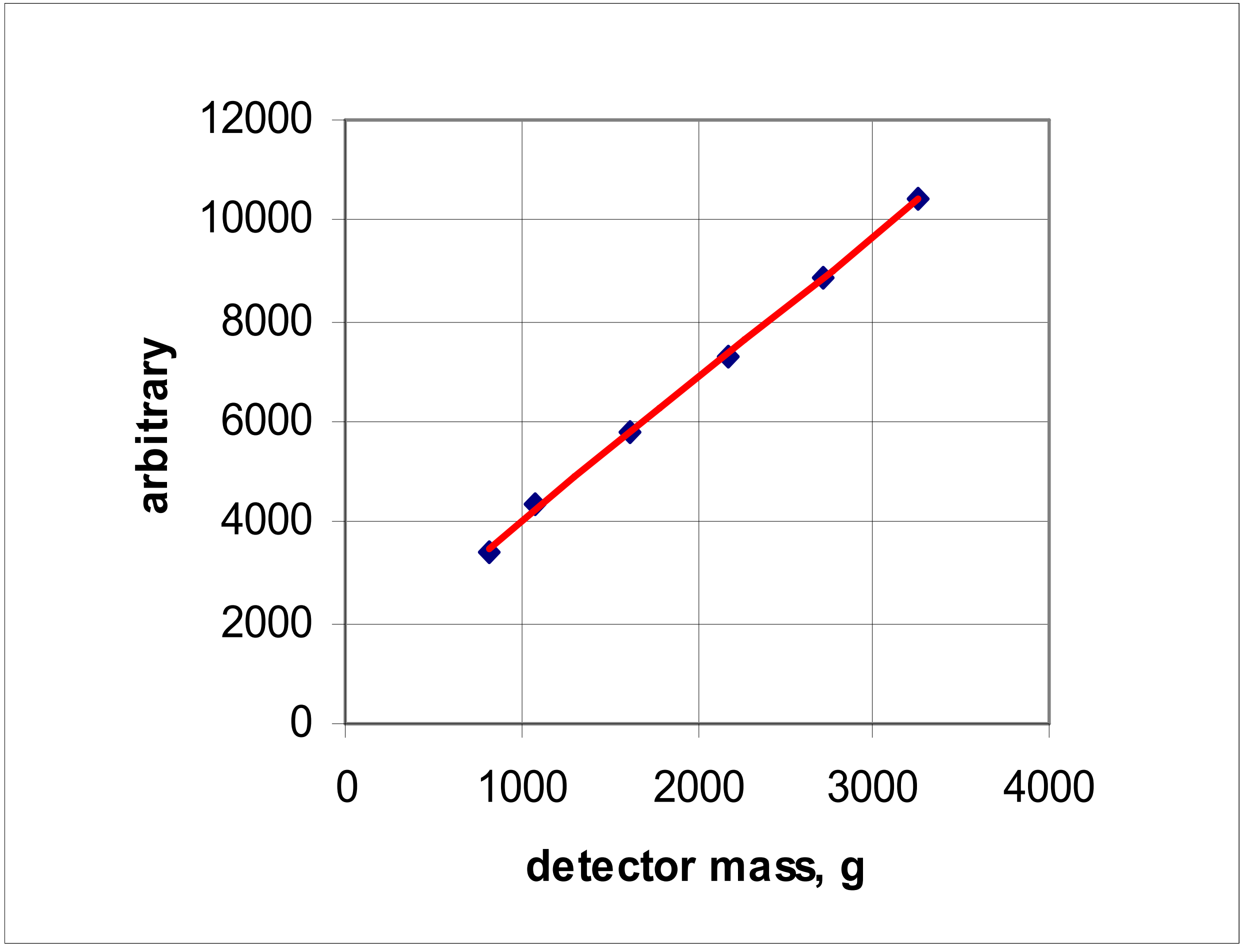
a) M(1)=2.15 kg, M(2)= 1.13 kg   b) M(1)=2.19 kg, M(2)=2.15 kg

Δt=22 hours. <N2/N1>=0.555   Δt=1 hour. <N2/N1>=0.89



Number of events in (500-1000)KeV energy interval:
a distributed K-40 gamma-source (Eγ =1461 KeV)
Diameters of the crystals 80mm, lengths 30-120 mm





Level of corrections (Homestake, 1994)

Detector	RG1	RG2	TWIN
	Passport, $M_{eff}(passp)=0.95 \cdot M_{tot}$		
M_{tot}, kg	2.149	2.194	1.13
M_{eff}, passport	2.042	2.084*	1.074
	Experiment		
$N_i/N(RG2)$	0.89	1.00	0.556
M_{eff}, without Correction	1855	2.084*	1.031
M_{eff}, with Correction	1806	-	0.86
Correction,%%	- 3%	-	- 17%

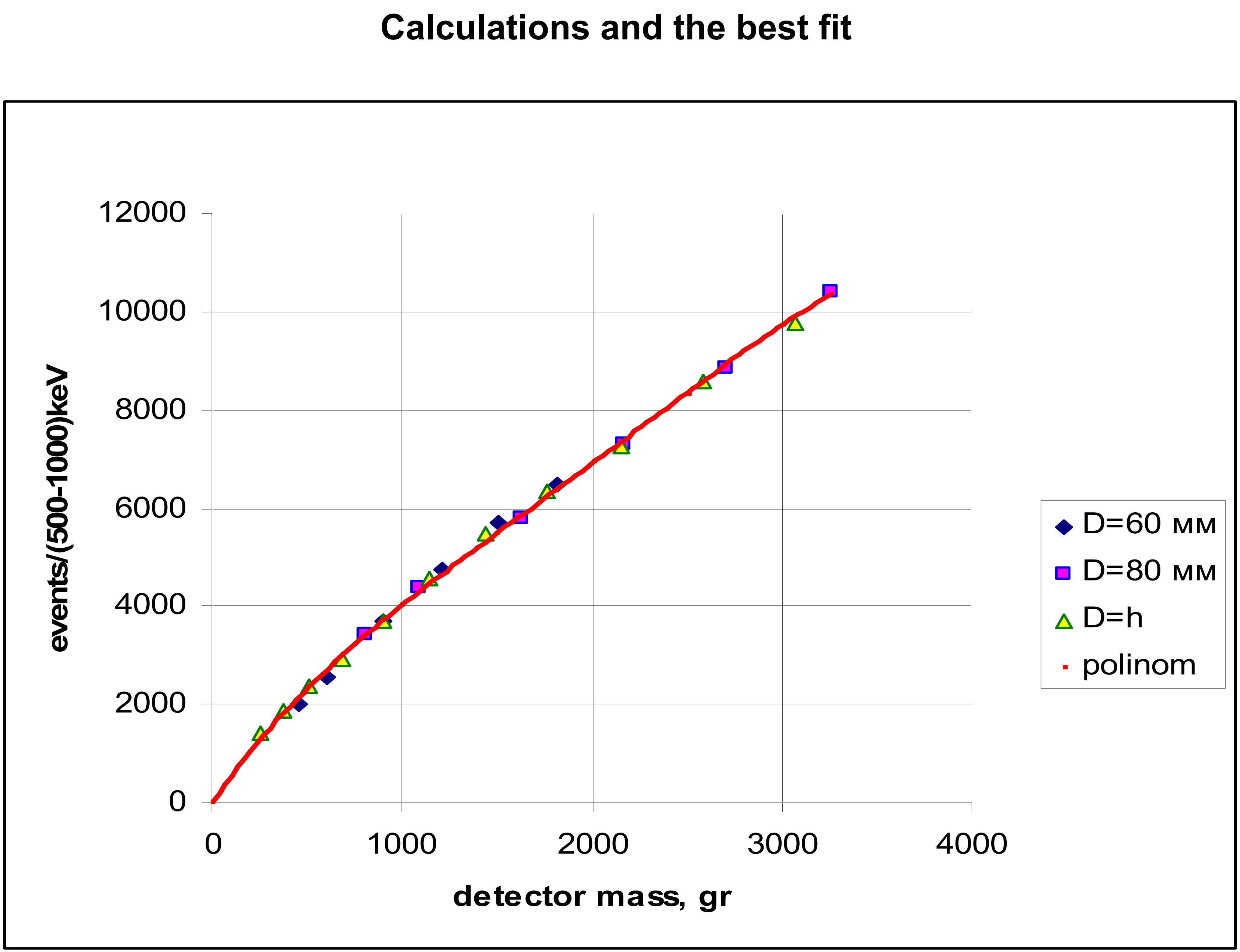
Calculatons – the input parameters

The next table presented numbers of counts in (500-1000) KeV energy Interval versus detector dimensions and masses:

D – diameter of the crystal [mm], h – height of the crystal [mm].

Mass range 0.25 to 3.3 kg was covered for three configurations of the crystals:

1. Diameter equal to height, D=H = (40 – 90) mm, masses (0,26-3,07) kg
2. D = 60 mm, h = (30-120) mm, masses (0.45 – 1.81) kg
3. D = 80 mm, h = (30 – 120) mm, masses (0.81 – 3.25) kg



Calculations and the best fit
events/(500-1000)keV
12000
10000
8000
6000
4000
2000
0
0
1000
2000
3000
4000
detector mass, gr
D=60 мм
D=80 мм
D=h
polinom

mass	D = h		D = 60 мм		D = 80 мм		ratio
gr	h,мм	N	h,мм	N	h,мм	N	fit/M-C
260.3	40	1 411					0,942
374.2	45	1 856					0,980
453.7			30	2 030			1,052
516.2	50	2 365					1,004
605.0			40	2 557			1,056
690.7	55	2 921					1,027
813.1					30	3 424	0,994
899.6	60	3 683					1,002
907.4			60	3 680			1,009
1084.6					40	4 370	0,977
1146.4	65	4 576					0,973
1210.0			80	4 728			0,982
1435.3	70	5 473					0,970
1512.4			100	5 692			0,971
1626.3					60	5 794	1,011
1768.0	75	6 334					0,989
1814.9			120	6 474			0,988
2148.7	80	7 256					1,012
2168.6					80	7 285	1,016
2580.1	85	8 559					0,999
2710.8					100	8 867	1,006
3066.1	90	9 761					1,016
3253.1					120	10 411	1,002

Conclusion

Results of the calculations indicated that numbers of events in (500-1000) kev energy interval was practically independent of the detector configurations, and all the points could be fitted with the same curve. Accuracy of the fit was Illustrated in the last column of the table, where ratios of the fit numbers to the Monte-Carlo calculated numbers were given for all the points. It seemed to be better then 2%. For masses above 1 kg one could use a linear approximation. A deviation from linearity was less then 3% for masses above 1 kg .

Parameters of IGEX and HM detectors – version I

		Masses, passport			Masses, experiment		
		Mt	M_eff	M_eff / Mt	counts Di / RG3	M_eff	M_eff/Mt
RG1	II.06	2149	2042	0,95	0,913	1855	0,863
RG2	-‘’-	2194	2084	0,95	1,007	2095	0,955
RG3*)	-‘’-	2121	2079	0,98*	1,00*	2078	0,980
ANG2	-‘’-	2906	2758	0,949	1,153	2466	0,849
Treatment of the data from GERDA Scientific Technical Report GSTR-05, Lebedev at al							
ANG1	2005	980	920	0,939	0,503	990	1,011
ANG2*)	-‘’-	2906	2758	0,949	1,124	2671	0,919
ANG3	--‘’-	2446	2324	0,950	1,000*	2324	0,950
ANG4	-‘’-	2400	2295	0,956	0,978	2263	0,943
ANG5	-‘’-	2781	2666	0,959	1,069	2517	0,905

Parameters of IGEX and HM detectors – version II

		Masses, passport			Masses, experiment		
		Mt	M_eff	M_eff / Mt	counts Di / RG3	M_eff	M_eff/Mt
RG1	II.06	2149	2042	0,95	0,913	1855	0,863
RG2	-‘’-	2194	2084	0,95	1,007	2095	0,955
RG3*)	-‘’-	2121	2079	0,98*	1,00*	2078	0,980
ANG2	-‘’-	2906	2758	0,949	1,153	2466	0,849
Treatment of the data from GERDA Scientific Technical Report GSTR-05, Lebedev at al.							
ANG1	2005	980	920	0,939	0,517	901	0,919
ANG2*)	-‘’-	2906	2758	0,949	1,153*	2466	0,849
ANG3	--‘’-	2446	2324	0,950	1,027	2145	0,877
ANG4	-‘’-	2400	2295	0,956	1,003	2083	0,868
ANG5	-‘’-	2781	2666	0,959	1,133	2415	0,869