KERNFORSCHUNGSZENTRUM

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Tables of Experimental Absolute Total Absorption Probabilities, Intrinsic Efficiencies and Peak-to-Total Ratios for Lithium-Drifted Germanium Diodes

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Tables of Experimental Absolute Total Absorption Probabilities, Intrinsic Efficiencies and Peak-to-Total Ratios for Lithium-Drifted Germanium Diodes

by

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This report presents a set of tables containing experimental values for the absolute total absorption probability, absolute intrinsic efficiency and peak-to-total ratio of lithium-drifted germanium diodes for gamma rays between 0.1 and 2 MeV in several detector and irradiation geometries. The sensitive volume of the crystals considered ranges from 3.8 to 28 cm^3. Increasing attenuation is given to the application of such devices in gamma-ray spectroscopy. The results may be used as a guide in determining the optimum experimental conditions for a given gamma-ray energy.

The detector dimensions and irradiation geometries are summarized in Fig. 1. Detector 1 and 3 were true coaxial devices with two open ends. Diode 2 was a single open-ended coaxially drifted crystal. Detector 4 was a planar device with rectangular cross section. Crystal 1 and 2 were irradiated both from the frontface (closed end in case 2) with the source located on the crystal axis and from the cylindrical surface with the detector axis oriented perpendicular to the gamma-ray beam. Measurements with diode 3 and 4 were performed only with the source located centrally in front of the crystals. In order to investigate the influence of a collimator on the response of detector 4 an additional run was made with this device using a lead collimator of 21 cm length and 1.0 cm internal diameter. The source was located 2.5 cm from the collimator entrance.

The measurements were performed with a set of absolutely calibrated point sources. The data have been corrected for interfering gamma rays and X-rays emitted by the source, for photons scattered from the material surrounding the detector and for attenuation

of both primary and scattered gamma rays by photoelectric absorption and scattering. Thus the data refer to pure gamma rays of energy E and to detectors without surrounding material. The distance values quoted in the tables correspond to the spacing source-detector surface. A detailed description of the experimental procedure and treatment of data as well as a discussion of the results are given in Ref. [1].

The author gratefully acknowledges the help of Mr. H. Küpfer in recording the spectra and in evaluating the data.

References:

1) W. Michaelis, Nuclear Instruments and Methods (in press)

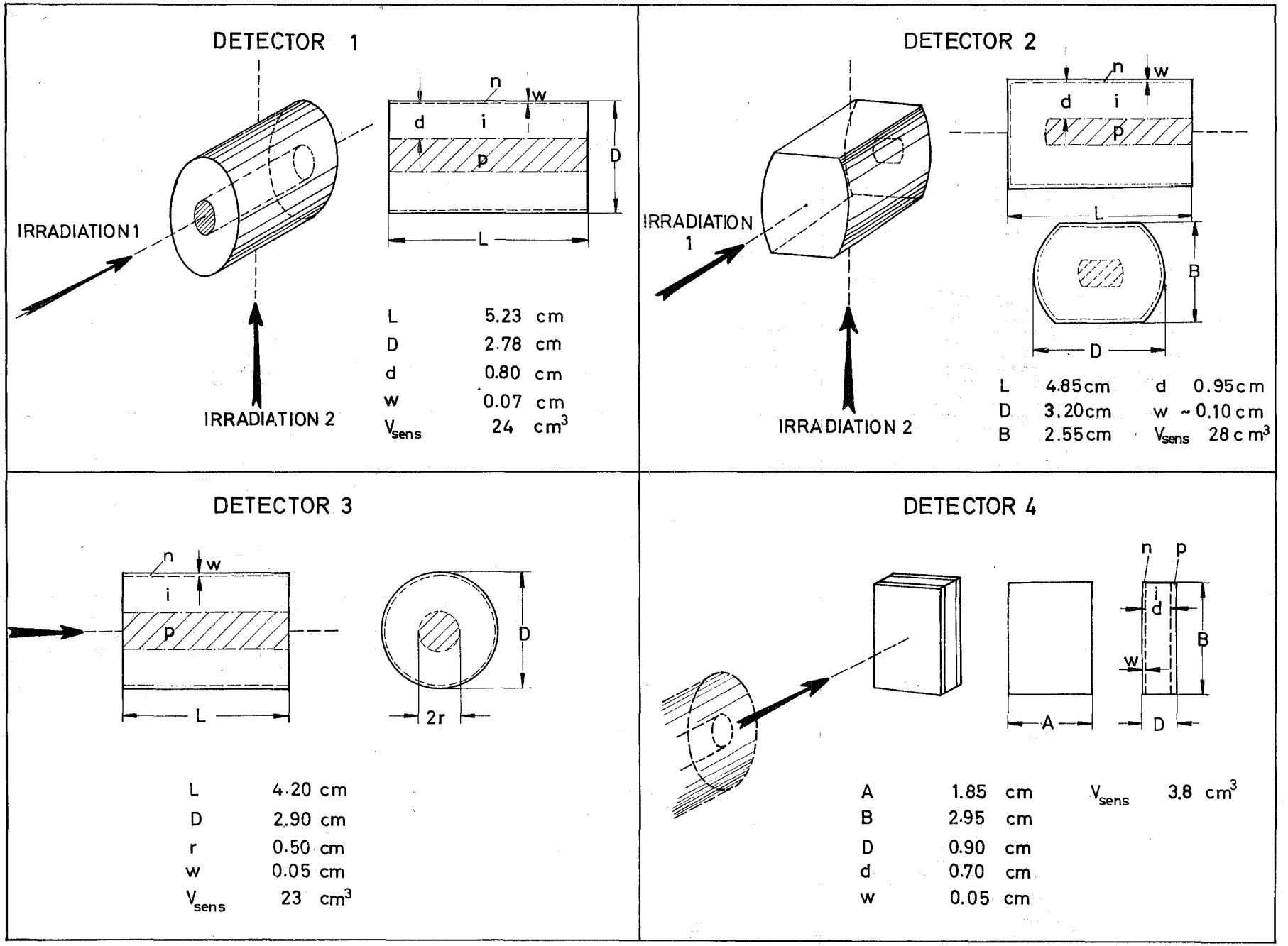

Fig. 1 Detector dimensions and irradiation geometries

Table I

Detector 1. Sensitive volume 24 cm^3. Irradiation geometry 1. Source-detector distance 21.6 cm

Gamma-Ray Energy [keV]	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.497 ± 0.025	0.87 ± 0.11	0.57 ± 0.10
279	Hg^{203}	0.174 ± 0.009	0.84 ± 0.13	0.21 ± 0.04
511	Na^{22}	0.0784 ± 0.0040	0.77 ± 0.06	0.102 ± 0.013
662	Cs^{137}	0.0578 ± 0.0029	0.74 ± 0.07	0.078 ± 0.011
835	Mn^{54}	0.0427 ± 0.0022	0.70 ± 0.04	0.061 ± 0.006
898	Y^{88}	0.0407 ± 0.0021	0.70 ± 0.07	0.058 ± 0.009
1173	Co^{60}	0.0279 ± 0.0014	0.65 ± 0.05	0.043 ± 0.005
1274	Na^{22}	0.0260 ± 0.0013	0.68 ± 0.05	0.038 ± 0.004
1332	Co^{60}	0.0246 ± 0.0013	0.64 ± 0.05	0.038 ± 0.004
1836	Y^{88}	0.0174 ± 0.0009	0.57 ± 0.07	0.031 ± 0.005

Table II

Detector 1. Sensitive volume 24 cm^3. Irradiation geometry 2. Source-detector distance 21.1 cm

Gamma-Ray Energy /keV/	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.473 ± 0.027	0.76 ± 0.08	0.62 ± 0.10
279	Hg^{203}	0.155 ± 0.008	0.56 ± 0.09	0.28 ± 0.06
511	Na^{22}	0.0550 ± 0.0027	0.56 ± 0.05	0.097 ± 0.013
662	Cs^{137}	0.0378 ± 0.0019	0.54 ± 0.04	0.070 ± 0.009
835	Mn^{54}	0.0268 ± 0.0013	0.50 ± 0.03	0.054 ± 0.005
898	Y^{88}	0.0256 ± 0.0013	0.47 ± 0.04	0.054 ± 0.008
1173	Co^{60}	0.0178 ± 0.0009	0.45 ± 0.04	0.040 ± 0.005
1274	Na^{22}	0.0155 ± 0.0008	0.47 ± 0.04	0.033 ± 0.005
1332	Co^{60}	0.0151 ± 0.0008	0.44 ± 0.04	0.034 ± 0.005
1836	Y^{88}	0.0103 ± 0.0008	0.38 ± 0.04	0.027 ± 0.005

Table III

Detector 2. Sensitive volume 28 cm^3. Irradiation geometry 1. Source-detector distance 22.0 cm

Gamma-Ray Energy [keV]	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.363 ± 0.020	0.60 ± 0.06	0.61 ± 0.09
279	Hg^{203}	0.297 ± 0.015	0.95 $^{+0.05}_{-0.09}$	0.31 ± 0.04
511	Na^{22}	0.104 ± 0.005	0.85 ± 0.07	0.122 ± 0.014
662	Cs^{137}	0.0783 ± 0.0040	0.81 ± 0.06	0.097 ± 0.011
835	Mn^{54}	0.0585 ± 0.0030	0.78 ± 0.05	0.075 ± 0.008
898	Y^{88}	0.0553 ± 0.0028	0.80 ± 0.05	0.069 ± 0.007
1173	Co^{60}	0.0398 ± 0.0020	0.72 ± 0.04	0.055 ± 0.005
1274	Na^{22}	0.0348 ± 0.0018	0.74 ± 0.05	0.047 ± 0.005
1332	Co^{60}	0.0344 ± 0.0018	0.70 ± 0.04	0.049 ± 0.005
1836	Y^{88}	0.0231 ± 0.0012	0.59 ± 0.04	0.039 ± 0.004

Table IV
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Detector 2. Sensitive volume 28 cm^3. Irradiation geometry 2. Source-detector distance 21.0 cm

Gamma-Ray Energy /keV/	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.599 ± 0.030	0.85 ± 0.08	0.70 ± 0.09
279	Hg^{203}	0.214 ± 0.011	0.70 ± 0.07	0.31 ± 0.04
511	Na^{22}	0.0772 ± 0.0038	0.60 ± 0.05	0.129 ± 0.015
662	Cs^{137}	0.0566 ± 0.0028	0.55 ± 0.04	0.103 ± 0.011
835	Mn^{54}	0.0410 ± 0.0019	0.53 ± 0.04	0.077 ± 0.008
898	Y^{88}	0.0388 ± 0.0019	0.51 ± 0.03	0.076 ± 0.007
1173	Co^{60}	0.0270 ± 0.0013	0.48 ± 0.03	0.056 ± 0.005
1274	Na^{22}	0.0236 ± 0.0011	0.51 ± 0.04	0.046 ± 0.005
1332	Co^{60}	0.0228 ± 0.0011	0.45 ± 0.03	0.051 ± 0.005
1836	Y^{88}	0.0147 ± 0.0007	0.37 ± 0.03	0.040 ± 0.004

Table V

Detector 3. Sensitive volume 23 cm^3. Source centrally located in front of detector. Source-detector distance 5.85 cm.

Gamma-Ray Energy (keV)	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.418 ± 0.022	0.54 ± 0.04	0.77 ± 0.08
279	Hg^{203}	0.169 ± 0.009	0.53 ± 0.05	0.32 ± 0.04
511	Na^{22}	0.0645 ± 0.0032	0.40 ± 0.03	0.161 ± 0.018
662	Cs^{137}	0.0482 ± 0.0025	0.37 ± 0.03	0.130 ± 0.015
835	Mn^{54}	0.0355 ± 0.0018	0.36 ± 0.02	0.099 ± 0.010
898	Y^{88}	0.0330 ± 0.0017	0.35 ± 0.02	0.094 ± 0.009
1173	Co^{60}	0.0210 ± 0.0011	0.33 ± 0.02	0.064 ± 0.006
1274	Na^{22}	0.0203 ± 0.0011	0.34 ± 0.02	0.060 ± 0.006
1332	Co^{60}	0.0196 ± 0.0011	0.30 ± 0.02	0.065 ± 0.006
1836	Y^{88}	0.0113 ± 0.0006	0.30 ± 0.02	0.038 ± 0.004

Table VI

Detector 4. Detector area 2.95 cm x 1.85 cm. Sensitive depth 0.7 cm.
Source centrally located in front of detector. Source-detector distance 21.7 cm

Gamma-Ray Energy (keV)	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.322 ± 0.016	0.56 ± 0.06	0.58 ± 0.08
279	Hg^{203}	0.0572 ± 0.0029		
511	Na^{22}	0.0172 ± 0.0009	0.26 ± 0.02	0.066 ± 0.008
662	Cs^{137}	0.0106 ± 0.0006	0.223 ± 0.016	0.048 ± 0.006
835	Mn^{54}	0.00659 ± 0.00031	0.214 ± 0.014	0.031 ± 0.003
898	Y^{88}	0.00588 ± 0.00030	0.187 ± 0.013	0.031 ± 0.003
1173	Co^{60}	0.00440 ± 0.00022	0.193 ± 0.013	0.0228 ± 0.0025
1274	Na^{22}	0.00358 ± 0.00019	0.188 ± 0.013	0.0190 ± 0.0020
1332	Co^{60}	0.00353 ± 0.00018	0.187 ± 0.013	0.0189 ± 0.0020
1836	Y^{88}	0.00164 ± 0.00009		

Table VII

Detector 4. Detector area 2.95 cm x 1.85 cm. Sensitive depth 0.7 cm.
Source centrally located in front of detector. Collimated gamma-ray beam.
Cylindrical collimator. Irradiated area 1.8 cm^2. Source-detector distance 35.7 cm

Gamma-Ray Energy [keV]	Source	Total Absorption Probability	Intrinsic Efficiency	Peak-to-Total Ratio
122	Co^{57}	0.348 ± 0.018	0.46 ± 0.05	0.76 ± 0.10
279	Hg^{203}	0.0790 ± 0.0040	0.41 ± 0.05	0.19 ± 0.02
511	Na^{22}			
662	Cs^{137}	0.0148 ± 0.0008	0.243 ± 0.020	0.061 ± 0.007
835	Mn^{54}	0.0104 ± 0.0006	0.240 ± 0.018	0.043 ± 0.004
898	Y^{88}	0.00946 ± 0.00050	0.254 ± 0.020	0.037 ± 0.004
1173	Co^{60}	0.00639 ± 0.00035	0.237 ± 0.017	0.0270 ± 0.0030
1274	Na^{22}	0.00582 ± 0.00030	0.231 ± 0.016	0.0252 ± 0.0025
1332	Co^{60}	0.00536 ± 0.00027	0.212 ± 0.015	0.0253 ± 0.0025
1836	Y^{88}	0.00324 ± 0.00020	0.191 ± 0.014	0.0170 ± 0.0020