Natural Radioactivities in Materials Used for Low Background Detectors

S.Yoshida[a], T.Kishimoto[b], K.Matsuoka[b], I.Ogawa[b], and K.Takahisa[a]

[a] *Research Center for Nuclear Physics (RCNP), Ibaraki, Osaka 567-0047, Japan*
[b] *Faculty of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan*

The new NaI(Tl) detector, which was a component of ELEGANT V system, is under development in order to improve the sensitivity for WIMPs search[1]. The WIMPs signals, which induced by the elastic scattering with nuclei in the detector, is a extremely rare with the order of 1 cpd/kg/keV. Thus the measurement with low background condition is required for WIMPs search.

The natural radioactivities in materials used for the detectors might be a main source of background. The detector consutructing materials should be carefully selected by the measurement of residual radioactivities.

A low-background γ -ray and X-ray detector system, ELEGANT III [2], which consists of a High Purity Ge detector, was used to measure radioactivities in various kind of materials.

The Ge detector is surround by 10 cm thick OFHC(Oxygen Free High Conductive Copper) and 10 cm thick lead shield. The OFHC is known to be quite free from radioactive contamination, namely below the observable limit of 0.2 ppb. In order to avoid backgrounds from daughters of ^{222}Rn in the air, the Ge detector and the OFHC shields are covered with the air tight container, which is filled with nitrogen gas. The whole system is covered with 15mm thick plastic scintillators which are used as veto counters agaianst cosmic-rays.

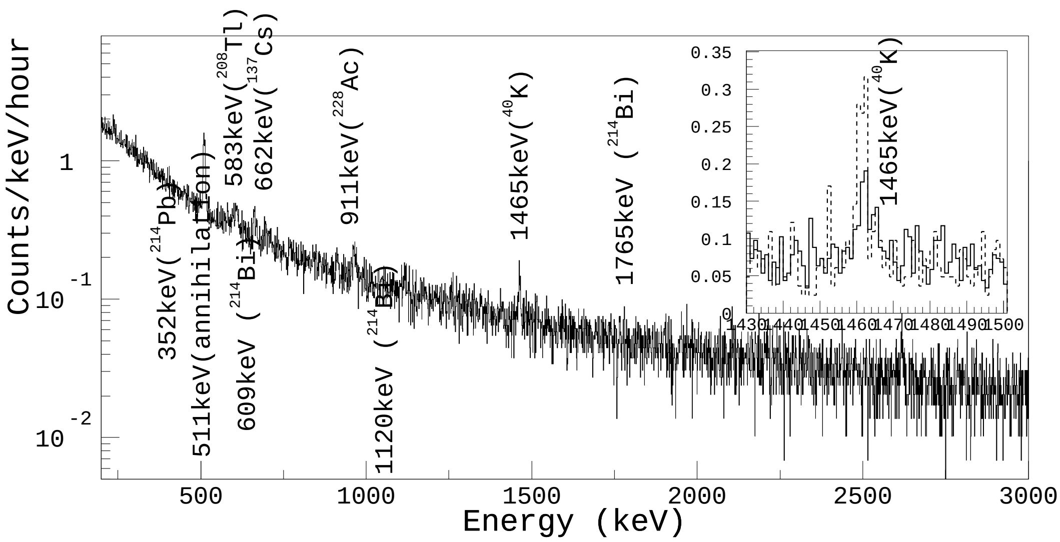

Figure 1: Background energy spectrum observed by ELEGANT III. Energy spectrum at sub window shows a example of difference between foreground(sample,dotted line) and background(null,solid line) spectrum.

The system has been installed in the laboratory at sea-level of the RIRC (Osaka University Radio Isotope Reseach Center). A sample material has been set in front of the Ge cap. Radioactivities in a sample material are identified from the energy spectrum after subtracting that of background. The observed background spectrum is shown in Figure 1.

The radioactivities concerned are ^{214}Bi and ^{214}Pb, in U chain, ^{208}Tl,^{212}Pb and ^{228}Ac in Th chain, ^{40}K, ^{137}Cs, ^{60}Co. The absolute efficiency is obtained by the Monte Carlo calcuration and are consistent with the experiment by using of standard γ sources with known intensities [3]. Many kinds of material have been measured. The obtained data of sample materials are listed in Table 1.

Table 1: Measured radioactive contaminations in materials.

Material	Contamination [Bq/kg]				
	U-chain	Th-chain	^{40}K	^{137}Cs	^{60}Co
OFHC Cu A(1mm^t)	<0.12	<0.19	<0.23	<0.085	<0.060
OFHC Cu B(1mm^t)	<0.12	<0.092	<0.39	<0.053	<0.024
OFHC Cu C(20mm^t)	<0.04	<0.05	<0.07	NA	<0.01
OFHC Cu C(0.1mm^t)	<0.03	<0.06	<0.15	<0.02	<0.01
Polishing Compound(CeO_2)	37±2	38±2	434±7	2.9±0.3	NA
Almina A	<0.30	<0.31	<2.1	<0.30	<0.16
Almina B	0.03±0.02	0.07±0.03	<0.18	<0.01	<0.01
Sandpaper A	7.5±0.4	6.5±0.2	146±4	<0.65	<0.35
Sandpaper B	10 ±0.4	7.2±0.2	60±2	<0.67	<0.47
Clothes A	<0.94	<0.91	<4.4	<0.24	<0.28
Glue A(Torr Seal)	1.3±0.2	0.42±0.04	8.1±0.4	<0.05	<0.08
Glue B(Epoxy)	<0.10	<0.08	<0.56	<0.04	<0.02
Silicon Oil	<0.17	<0.10	<0.78	<0.24	<0.02
Silicon Gel	<0.08	<0.05	<0.22	<0.02	<0.02
Optical Interface	0.20±0.07	<0.07	<0.72	NA	<0.06
Optical Cement	<0.08	<0.07	<0.71	<0.07	<0.05
Al Myler	<0.07	<0.06	<0.37	<0.04	<0.06
Teflon A(200μm^t)	<0.12	<0.06	<0.55	<0.05	<0.03
Teflon B(250μm^t)	0.27±0.04	<0.09	0.39±0.18	<0.03	<0.01
Teflon C(100μm^t)	0.14±0.04	0.20±0.03	0.32±0.19	<0.05	<0.01
Teflon D(130μm^t)	0.13±0.06	<0.13	<0.26	<0.03	<0.07
Teflon E(130μm^t)	0.61±0.09	0.10±0.07	<1.14	<0.09	0.06±0.03
Teflon F(85μm^t)	0.38±0.07	<0.12	<0.78	<0.22	<0.06
Quartz A	<0.06	<0.03	<0.11	NA	<0.01
Quartz B	<0.05	<0.02	<0.04	NA	<0.01
Polishing Pich	<0.04	<0.03	<0.09	<0.01	<0.01

References

[1] reference therein.

[2] N. Kamikubota *et al*, Nucl. Instr. and Meth.**A245** (1986) 379.

[3] S. Shiomi, Master Thesis at Osaka university (1999)