1 Scanning the prototype detector

1.1 Overall setup

The global setup uses three detectors: two scintillator detectors, placed on the sides (black squared boxes on the picture, Figure 1) and one semi conductor detector - hyperpure germanium detector - below the collimated source (grey cylinder on the picture). The source is placed on the top lead brick which contains a hole in the middle to collimate the radioactive source. In that position, the source is 97mm from the top of the crystal, which is 5mm from the top of the cryostat (grey cylinder), and collimated in a 5mm hole through an 80mm lead brick. the source is covered by a little lead brick and the setup is shielded by lead to avoid propagation of gamma radiation away from the setup (see Figure 2).

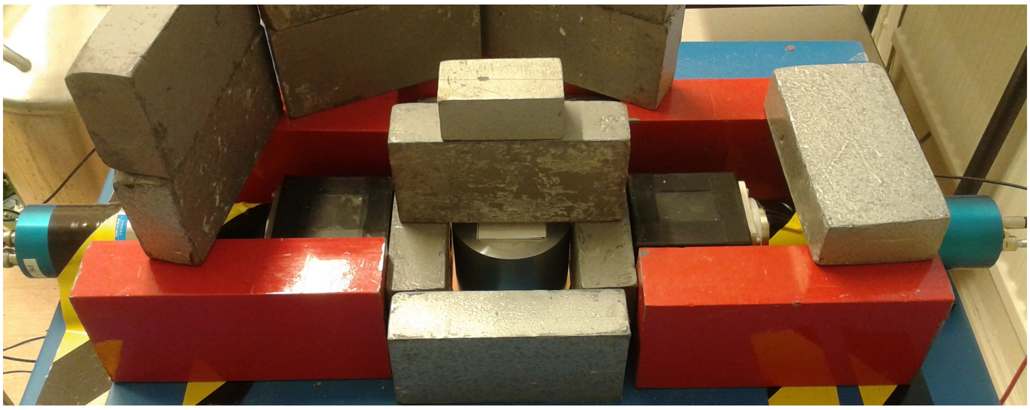

Figure 1: Back of the original setup. The scintillator detectors are the black squared boxes on the sides of the germanium detector, placed in a cryostat (grey cylinder in the middle).

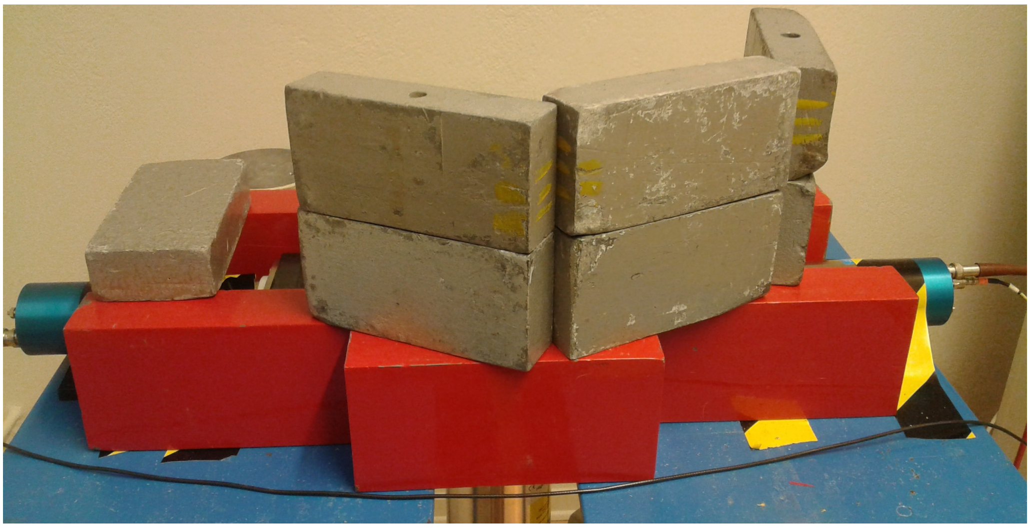

Figure 2: Front side of the original setup (with the lead shielding).

1.2 Process of measurement

For this first set of measurements, we did not use the scintillator detectors but only the germanium detector. The goal of this experiment was to determine some properties of the detector depending on the location of the collimated source such as the resolution of the crystal. Therefore, we collimated the source in five different places on the top of the crystal: one measurement was performed with the collimator in the center of the crystal surface, and four were performed with the collimator in the corners of the crystal surface. The scanning went as described below (see scheme Figure 3) and we used two different cobalt sources: one of ^{60}Co and one of ^{57}Co (the decay schemes are shown in Figure 4).

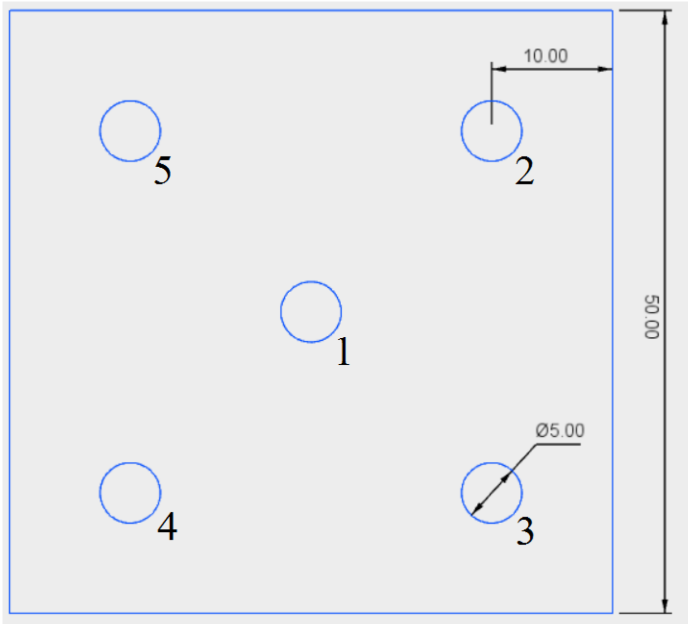

Figure 3: Scheme of the top of the germanium crystal and how it was scanned. Each circle represents a position of the collimated source to which we associate a number (distances are in mm).

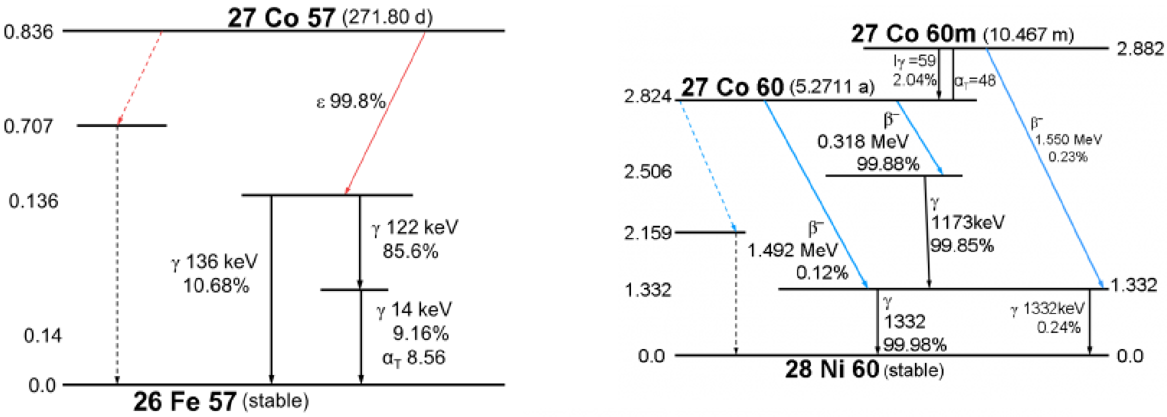

Figure 4: Decay schemes of ^{60}Co and ^{57}Co.

In the case of ^{60}Co, the source was held in one of the positions until the net area of the studied peak (peak at 1332keV) contained at least 100 000 counts. The ^{57}Co source being way less active, the measurement was stoped when the net area of the studied peak (peak at 122keV) contained around 1 000 counts.

The calibration was done using the source of ^{60}Co and collimating it in the middle of the crystal to get a reference and study an eventual deviation in energy. For this purpose we used the two peaks present in the spectrum of ^{60}Co and associated to each of them a channel in the 8192 channels that the multichannel analyzer contains. The result of the calibration is shown in Figure 5 with the equation of the linear fit. The data was then analyzed using a Python program to fit the peaks in the spectra with Gaussians (the code is given in appendix).

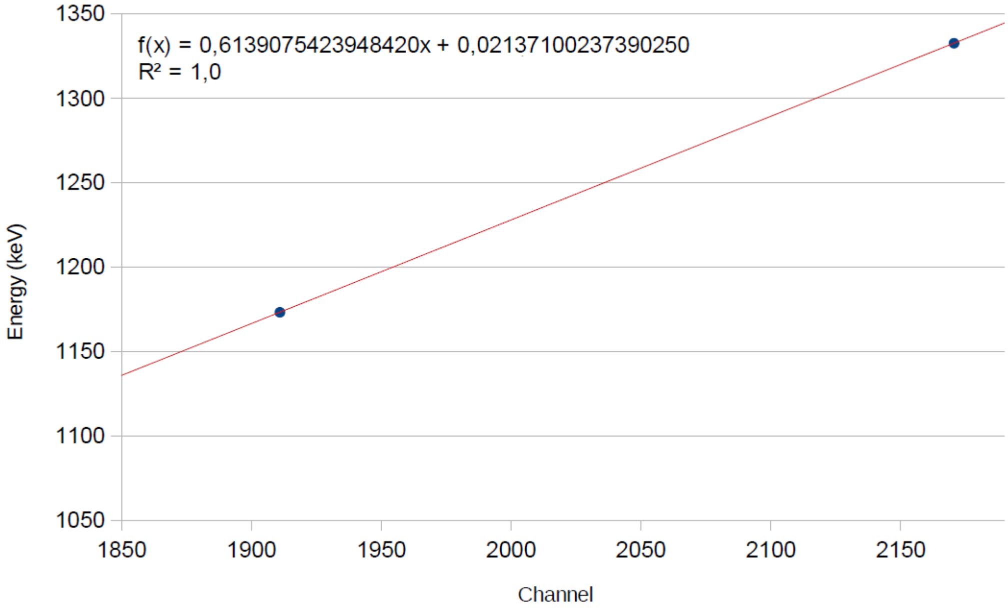

Figure 5: Calibration plot representing energy as a function of channel number, using the two peaks of ^{60}Co spectrum.

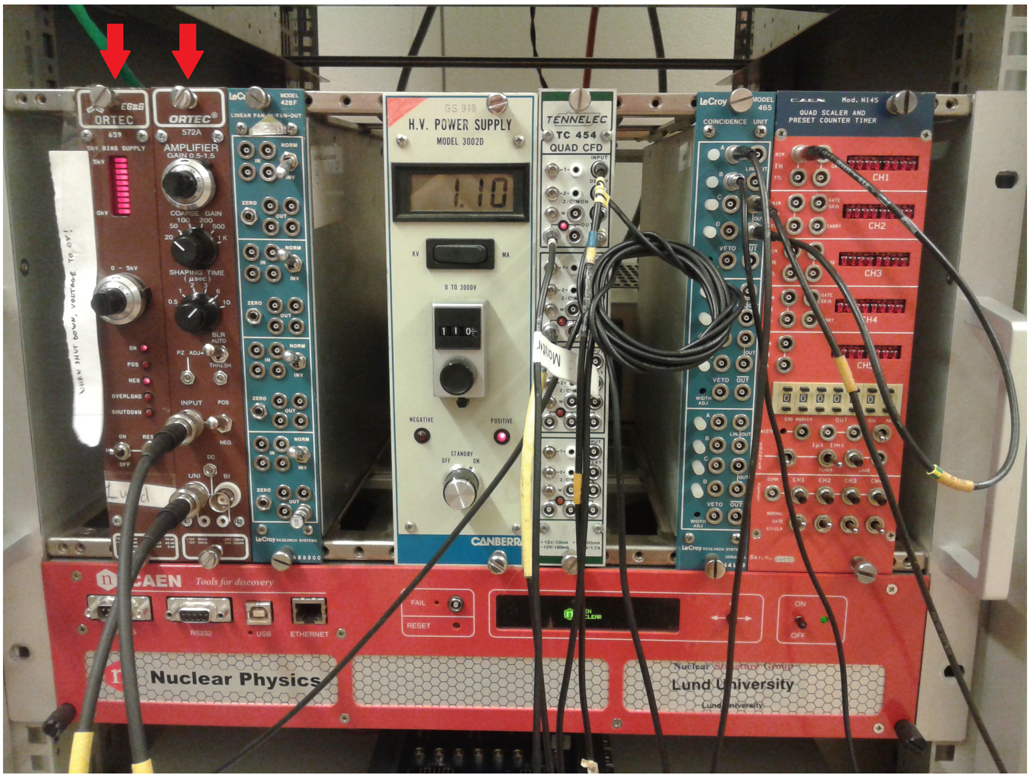

Figure 6: Picture of the electronics used in this measurements. The two modules that were used are the two first on the left (red arrow) and, from left to right, are the high voltage supply and the amplifier.

1.3 Electronics

For this set of measurements, we did not use the scintillator detectors or the coincidence setup, thus the electronics are relatively simple. The detector is alimented by a high voltage supply which delivers a bias voltage (negative) of 5000kV, necessary to the well-functionning of the crystal. After going through a preamplifier (in the crystal), the signal is send to an amplifier that also shapes it. It is then digitized by a multichannel analyzer and send to the computer that collects the data using the Maestro software. Both the high voltage supply and the amplifier are NIM modules and are placed in a NIM crate, represented on Figure 6.

1.4 Results and analysis

For each of the position of interest, we collected the data and used the Python program to treat it. We looked at the resolution of the detector, given by the full width at half maximum (FWHM), along with the shape of the peak, emphasized by the ratios between the full width at tenth and fifteenth maximum and the FWHM. All these results are shown in the two tables below, both for the ^{60}Co and ^{57}Co source (Figure 7).

	Cobalt 60				
	Center	Top right	Bottom right	Bottom left	Top left
Energy (keV)	1 332,50	1 332,01	1 331,91	1 331,73	1 332,22
FWHM (keV)	2,49	2,76	2,87	2,98	2,62
FWTM (keV)	4,71	5,26	5,53	5,70	5,01
FWFM (keV)	6,34	6,97	7,08	7,32	6,67
FWTM/FWHM	1,89	1,91	1,93	1,91	1,91
FWFM/FWHM	2,55	2,53	2,47	2,46	2,55

	Cobalt 57				
	Center	Top right	Bottom right	Bottom left	Top left
Energy (keV)	121,38	121,57	121,49	121,48	121,56
FWHM (keV)	1,59	1,59	1,62	1,70	1,58
FWTM (keV)	2,90	3,13	3,17	3,29	3,08
FWFM (keV)	4,19	4,07	4,19	4,07	3,71
FWTM/FWHM	1,82	1,97	1,96	1,94	1,95
FWFM/FWHM	2,64	2,56	2,59	2,39	2,35

Figure 7: Recapitulative tables of the obtained results using the ^{60}Co and ^{57}Co sources.