Corso di Laboratorio di Fisica Medica
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Gamma spectroscopy with scintillator detectors

Experimental set-up

Detector
-NaI(Tl) scintillator ORTEC 905-3
-PMT + preamplifier, ORTEC
-NIM HV power supply
- linear amplifier ORTEC 450
-Multichannel Analizer ORTEC Easy-MCS
-PC with software MAESTRO

Table I: Radioactive sources

Isotopo	Emivita(y)	Energia g (keV)	BR
Am241	432.2	60	0.359
Na22	2.60	511	1.78
Na22	2.60	1274	0.9998
Cs137	30.17	662	0.851
Co60	5.27	1174	0.9986
Co60	5.27	1332	0.9986
Ba133	10.52	31	0.99
Ba133	10.52	356	0.62
Ba133	10.52	81	0.34
Ba133	10.52	303	0.18

More info https://www-nds.iaea.org/
http://nucleardata.nuclear.lu.se/toi/

Technical documents at
https://elearning.df.unipi.it/mod/folder/view.php?id=4177

Tasks

1. Linearity, calibration and energy resolution

- After the HV has been set and the detector signal connected to the MCA, acquire spectra with a number of different sources in turn, *with the same settings*! Ensure that sufficient statistics are obtained.
- What about the linearity? Make a plot of peak position against incident gamma ray energy. Use the gamma-ray energy values from Table I.
- Calibrate the MCA scale—find E(Chn.)
- Make a table detailing the energy of each peak you observe and the corresponding energy resolution (calculated after subtracting the

continuum under the peak).

2. Spectra characterization

- Find Compton Edge
- Backscatter peaks
- Other peaks
- Compare with theory

3. Estimation of source activity

- Put the Cs 137 source at 20 cm from the detector
- Take a spectrum for a known time
- Take the number of counts in the spectrum (N_{net}), once subtracted the background and the continuum under the peak.
- Consider the live time for each acquisition *T*
- Calculate the geometrical acceptance $^{4\pi}/_{\Omega}$
- Consider the detector intrinsic peak efficiency ε_{ip} (using the plot in figure 1)
- Consider the branching ratio (*BR*) for the detected gammas (Table 1)
- The source activity (decays/second) can be then calculated and compared with the expected (74 kBq at 2/2005 for all sources):

$$A = \frac{N_{net}}{T}\frac{4\pi}{\Omega\varepsilon_{ip}BR}$$

- **□/□ of Lead**
- Acquire spectra of Cs137 with different thicknesses of lead and aluminum between the detector and source for a fixed time.
- The number of counts in the spectra can be used with equation:

$$I = I_0 e^{-\mu t}$$

  to solve for □.

- Compare fit results with http://www.nist.gov/pml/data/xray_gammaray.cfm

4. Background acquisition

- Start an overnight acquisition without any source
- Analyze the resulting spectrum, classify the observed peaks and find the corresponding unknown radionuclides

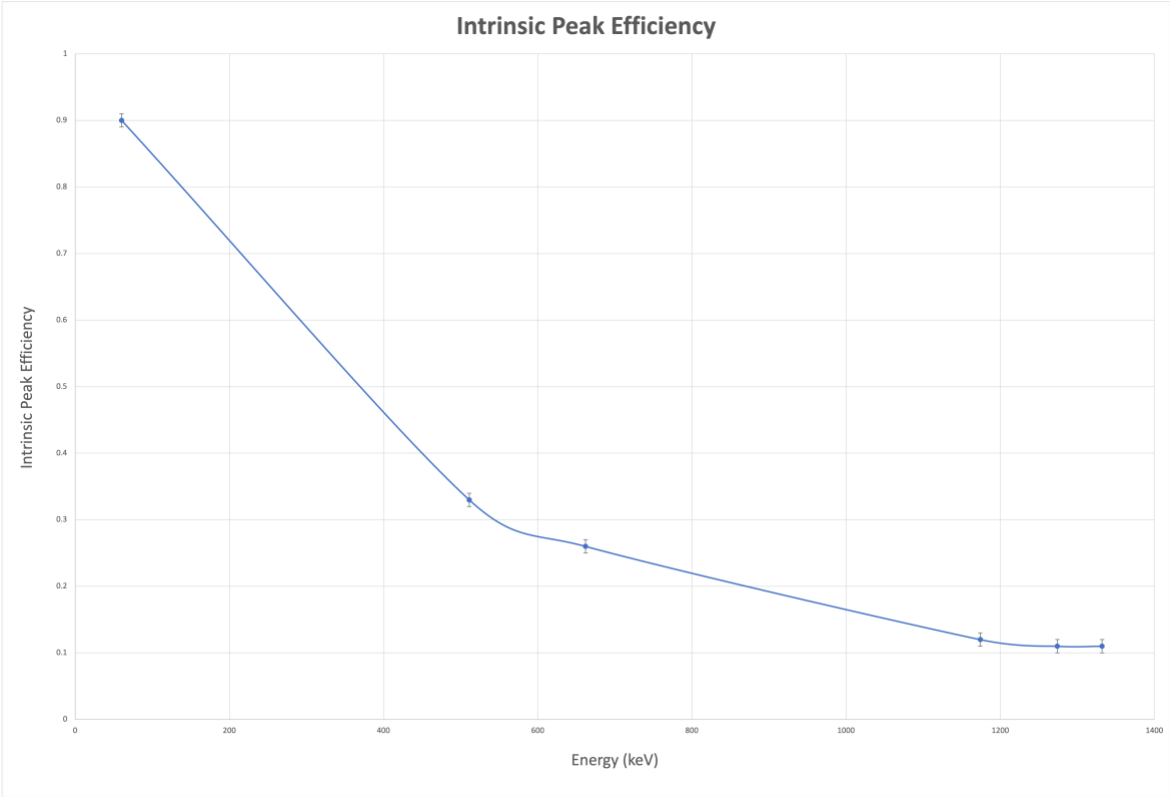
Intrinsic Peak Efficiency
Intrinsic Peak Efficiency
Energy (keV)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
200
400
600
800
1000
1200
1400

Figure 1