Study of a low-background gamma spectrometry system

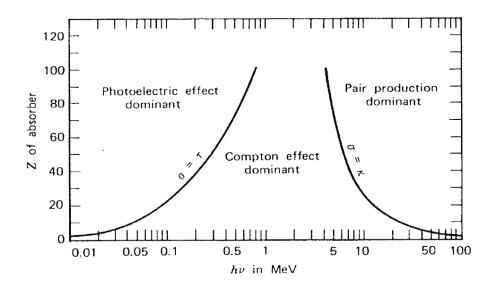
Practical work 2, 2017.08.22.

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> European Summer School 2017 «Radiochemistry and Nuclear Instrumentation (Low Level Radioactivity», August 21-25, 2017, Strasbourg, France

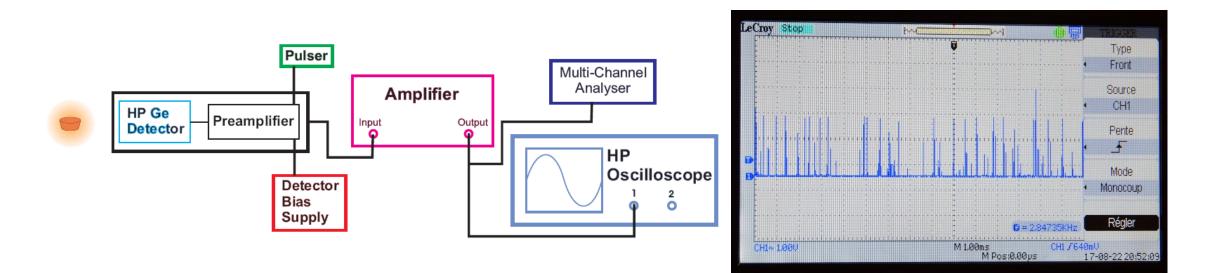
Introduction

- Interaction of EM radiation with matter
 - Photoelectric effect
 - Compton scattering
 - Pair production
- Detector Materials
 - High-purity Germanium (HPGe)
 - Thallium-activated Sodium iodide [NaI(TI)]
- Anti-Compton System
 - Use coincidence measurement to veto signal
 - Reduces background of signal



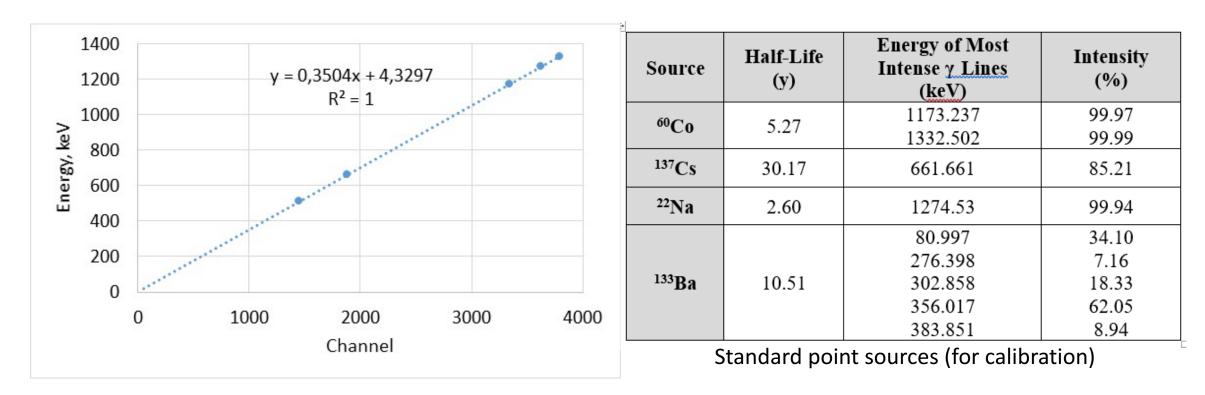
Materials and Procedure

 Pulse adjustment using oscilloscope for multi-channel analyser (MCA) and ¹³⁷Cs source.



Materials and Procedure

• Energy calibration using ¹³⁷Cs, ⁶⁰Co and ²²Na sources.



Materials and Procedures

• Efficiency calibration using ¹⁵²Eu and a certificate file.

Courbe d'étalonnage en efficacité	Courbe	<u> </u>
Basse énergie 🔲 Mesurée —— Haute énergie	C APOLOG	C APOCOPE
0.0025	C Empirique	C Interpolation
0.002	Echelle —	
0.0015	APOCOPE	C Log
0.001	Ordre poly.	
0.0005	Basse énergie	+ -
	Ordre du polynôme	4 +
Energie (keV)	Pic :	Gupprimer
Source MP2 MCA1		
In(Eff) = -6.782e+001 + 3.866e+001*In(E) - 8.783e+000*In(E)^2 + 8.602 - 3.120e-002*In(E)^4	e-001*lh(E)^3	
Ok Abandon Aide	Liste des points	Imprimer

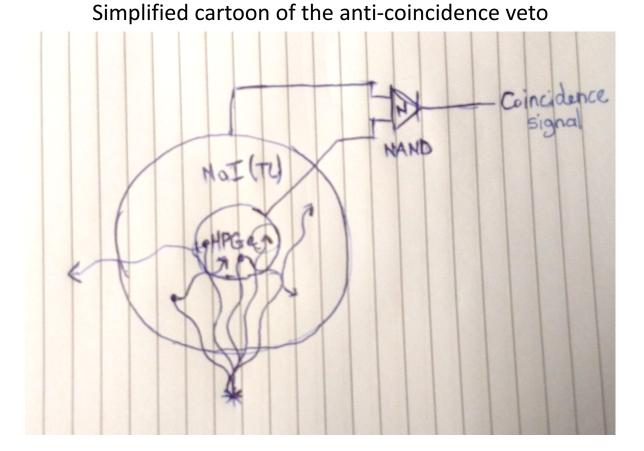
^					EU152EGMA15	Identification 50297	Radionuc
A					LUIDELUINII	00201	
APE	ET72 CHAI	UP			3.2 Flux photonique c	atauté	
AREVA	LABO	VE D'ETALON INEMENT IONISA VO RADIATION	NT .	1	Energie en keV (*)	Nombre de photons émis pour 100 désintégrations (*)	Flux phot en γ.s ⁻¹ 4π :
AREVA NP - LEA	ACCR	DITATION Nº 2-1	ION LABORATION		121.7817 ± 0,0003	28.41 ± 0.13	1,1658
Let Laboratore Elators d'Activité an Antexa de Treasta ap 72 - 2010 Particles Cedex Tel. (2010 4 75 80 46 00 Frances) de 16 46 40 Internet: was les cessa con	SCOP	E DISPONBLE S	ICH LABORATORY 29 IR WWW.COFRAC.FR WWW.COFRAC.FR		244.6974 ± 0.0008	7,55 ± 0,04	3,097
Internet : ware lea-cesca.com		IN THE REAL PROPERTY OF	WWW.COFRAC.FR		295,9387 ± 0,0017	0.442 ± 0.003	1,813
- 100 La COM			The Part of State		344,2785 ± 0.0012	26,59 ± 0,12	1,091
		A	and the second s		367,7891 ± 0,0020	0,862 ± 0,005	3,536
		RADOWICI BUCK	BARRA		411,1165 ± 0,0012	2,238 ± 0,010	9,18
		DENTFICATOR	Run Ballomann Number		443,965 ± 0,003	3,12 ± 0,028	1,28
055-		Name of the U.T.C.	Property and		488,6792 ± 0,002	0,4139 ± 0,0024	1,69
CERTIFICA	T D'ETALONNAG				563,990 ± 0,007	0,457 ± 0,013	1,8
CALIBRAT	ID'ETALONNAG	E			678,623 ± 0,005	0,470 ± 0,004	1,9
N° CT/	150308/15/0598				688,670 ± 0,005	0.841 ± 0.006	3,4
Vélivré à ; L p. u	10/0298				778,9045 ± 0,0024	12,97 ± 0,06	5,
BIVYÉ à : L.P. H. CCNRS -DPT RECH. S Sued for : 67037 STRASBOURG CEDEX	SUBATOMICINE				867,380 ± 0,003	4,243 ± 0,023	1,
mmande	FRANCE				919,337 ± 0,004	0,429 ± 0,005	1,
rder : 4500236808					964,079 ± 0,018	14,50 ± 0,06	
STRUMENT					1005,272 ± 0,0017	0,665 ± 0,023	2
TRUMENT ETALONNE					1085,837 ± 0,010	10,13 ± 0,06	
LIGHTINS TRUMENT					1089,737 ± 0,005	1,73 ± 0,01	
signation : Etalon multigamma Eu152					1112,076 ± 0,003	13,41 ± 0.06	
Source multigamma P	u152				1212,948 ± 0,011	1,416 ± 0,009	
nstructeur : hufacturer : LEA					1212,948 ± 0,001 1299,142 ± 0,008	0000	
					1299,142 ± 0,000 1408,013 ± 0,003		
férence : EU152EGMA15	Identification :					0,498 ± 0,004	
	Serial number : 50	297			1457,643 ± 0,011	Land (http://	www.radionucl
entificat comprend certificate includes 3 pages pages under site basistered in a success but starters to the success and page starters and a success but starters and page at the success of the success but starters and success and success of the success but starters and success at the success of the succes	RESPONSAE TECHNIQU AREVA NP- Lavethia MARCH A ET FILAC DE RECONVINSIANCE DE OF EA ARE LAC RECONVINSIANCE DE		cofrac Cofrac Cofrac		Les incertitudes élar type composée. Les composantes d'ince d'environnement, co	economandees par le LNHB (http:// gies mentionnées sont celles inortitudes types ont été ca ritudes. étalos de réferenc nitribution de l'instrument de seruitas d'étalonnage portan ésuitats d'étalonnage au syn rutificat fait foi.	liculées en t e, moyens lionné, répé

Certificate of Eu-152

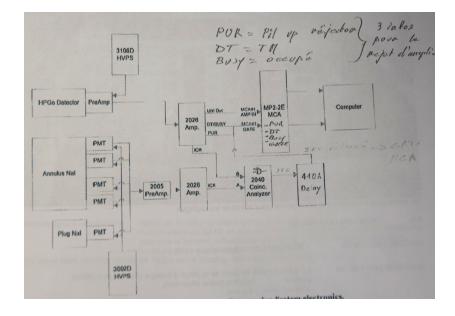
 $\ln(Effiecency) = -67,82 + 38,66 * \ln(E) - 8,783 * \ln(E)^2 + 0,8602 * \ln(E)^3 - 0,0312 * \ln(E)^4$

Materials and Procedures

• Digital logic and using a veto system to reduce Compton contribution.

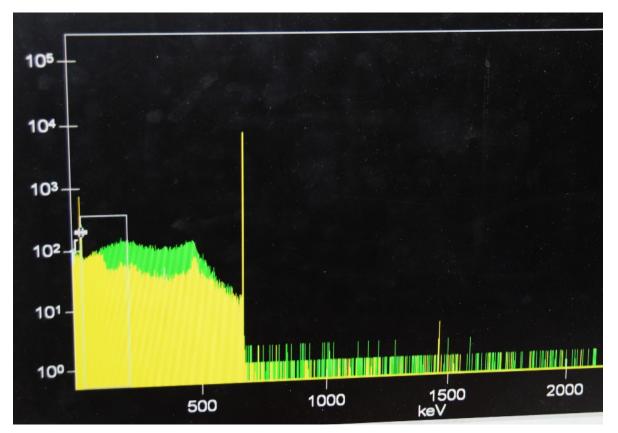


Acquisition system schematic



Results

 Comparison of ¹³⁷Cs spectra with (yellow) and without (green) the anti-Compton system.



Results

• Determination of a ¹³³Ba source's activity vs calculated activity:

$$A = \frac{C/t}{\varepsilon \cdot P_{\gamma}}$$

Energy, keV	Activity, Bq
305	27450(392)
358	28350(232)

Measured A = $28,1 \pm 0,7\%$ kBq

Calculated A = 25,8 kBq

Discrepancy: 8%

Conclusions

- System results in ~30% decrease in Compton events
- Discrepancy results from uncertainty in efficiency, limited peak information, noise and remaining Comptons.
- Thanks for your attention! Questions?

