



Total Absorption Spectroscopy (TAS)

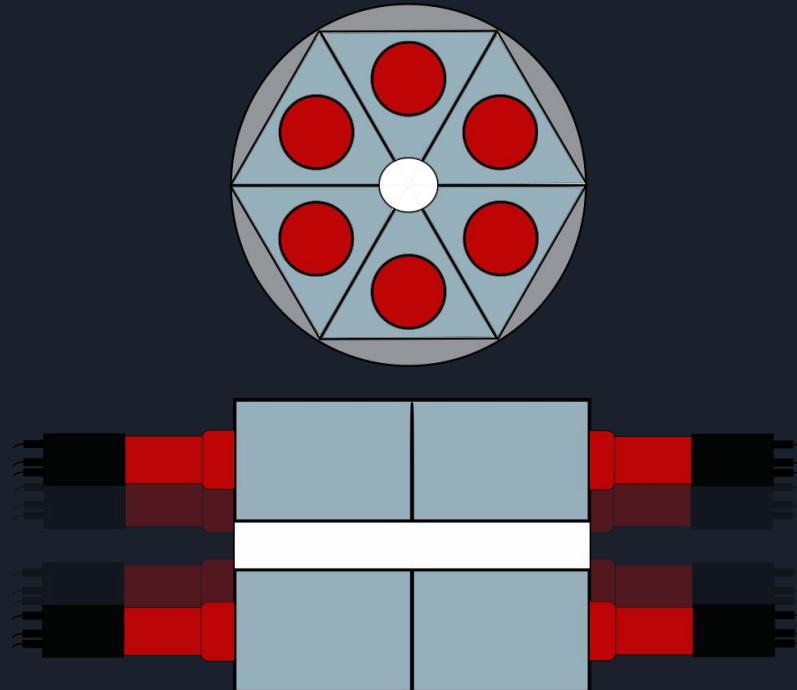
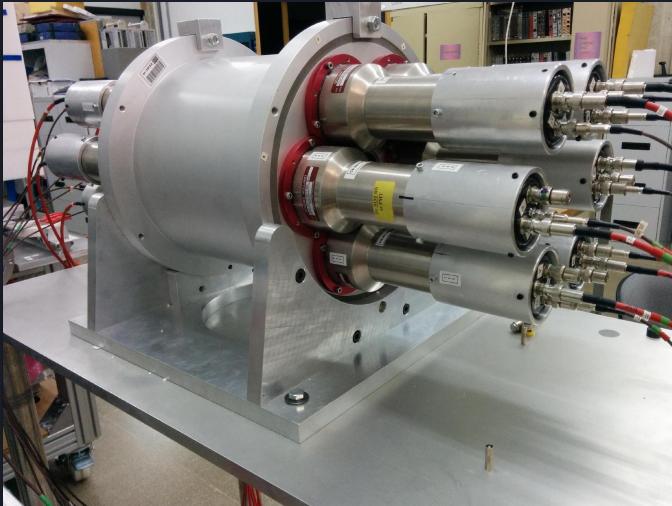
Dr Berta Rubio
Dr Alejandro Algora
Selene Parra

Plan de la práctica

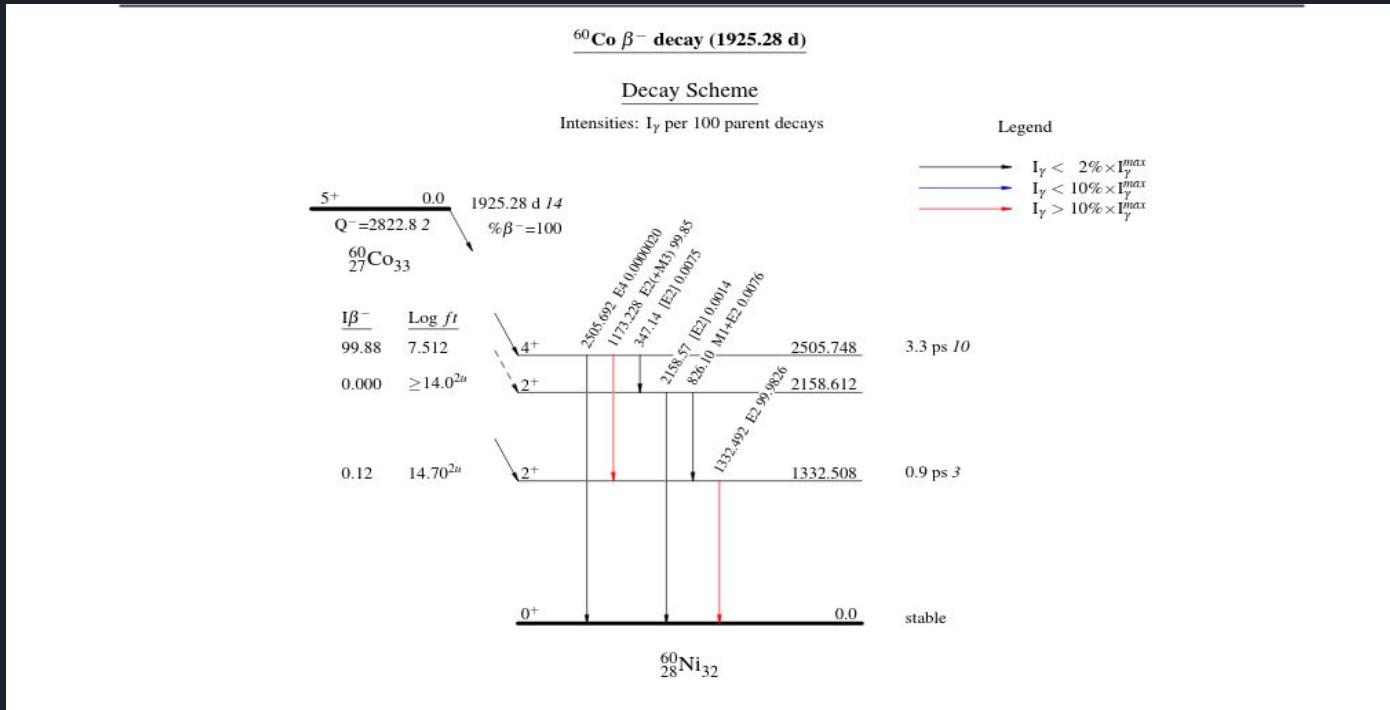
- Detectores Centelladores
- Cristales de BaF₂
- Tubo Fotomultiplicador
- Señal emitida por un detector
- Alineamiento de los detectores
- Calibración de los detectores
- Multiplicidad



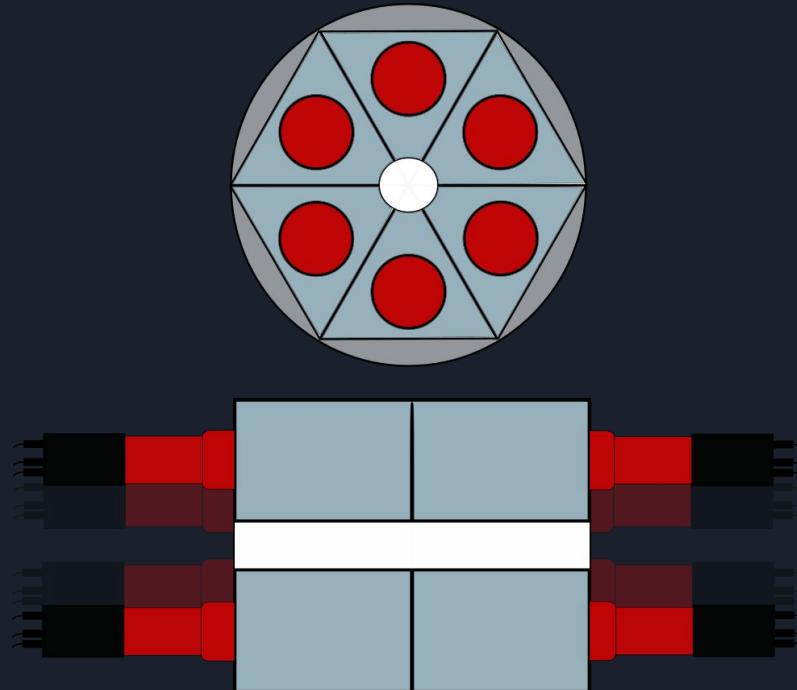
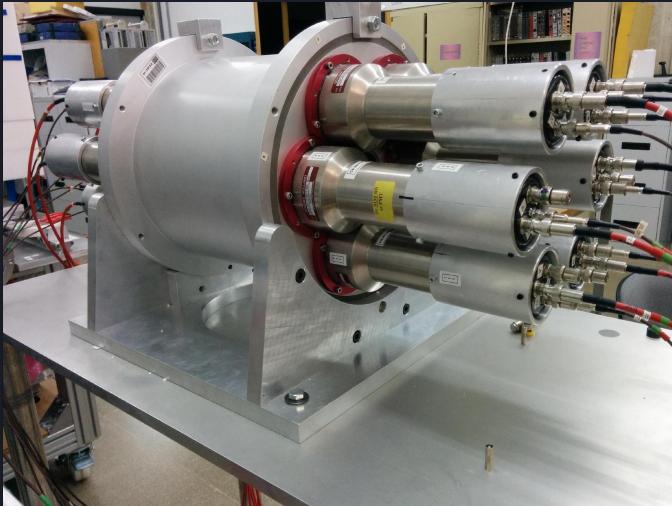
Detector Reginante



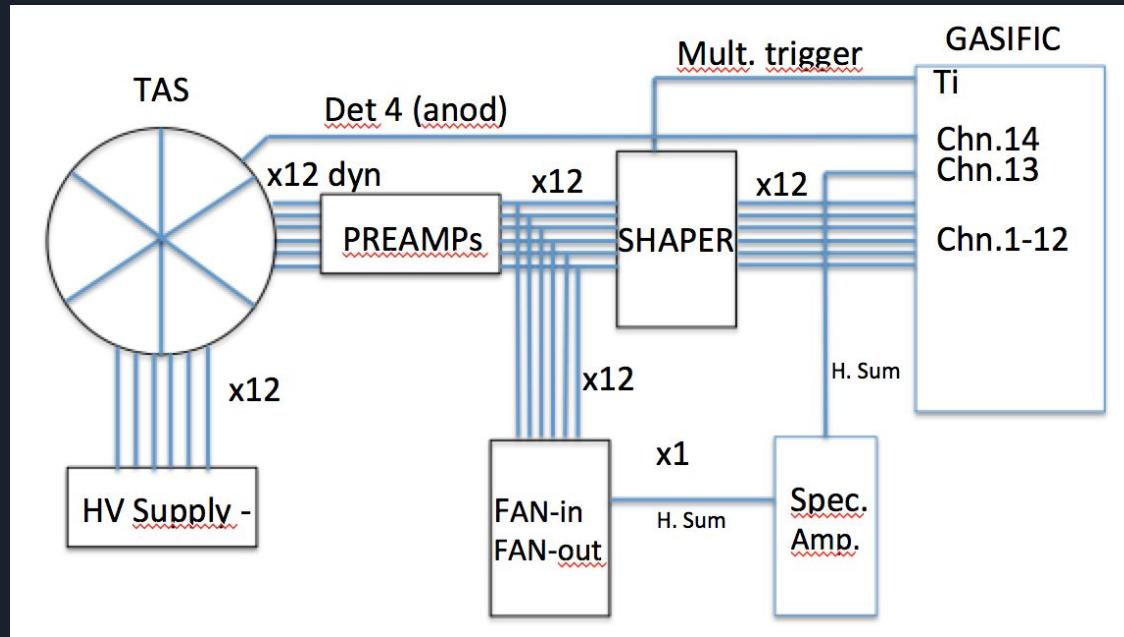
Esquema de desintegración de una fuente de ^{60}Co

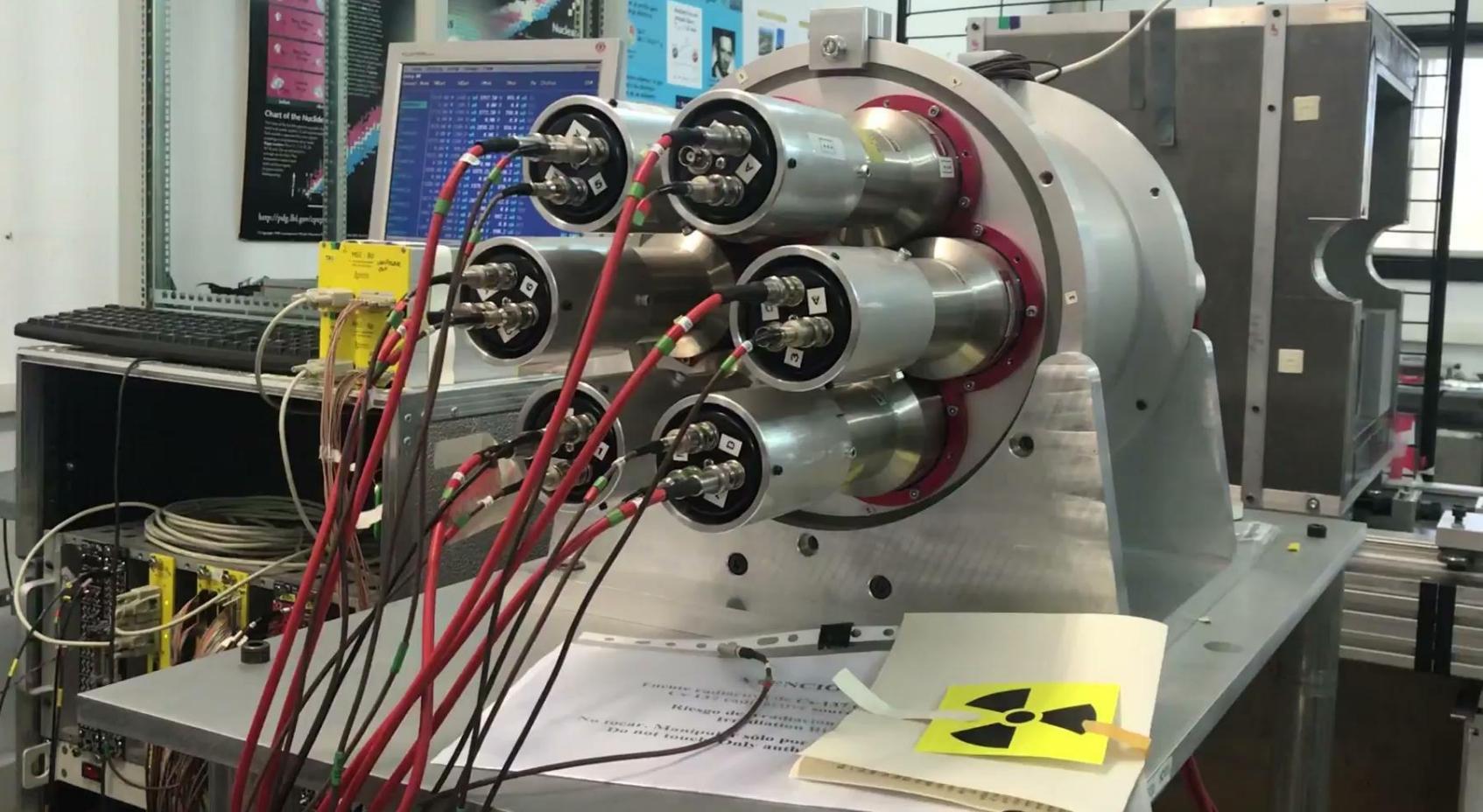


Detector Reginante



Esquema electrónico

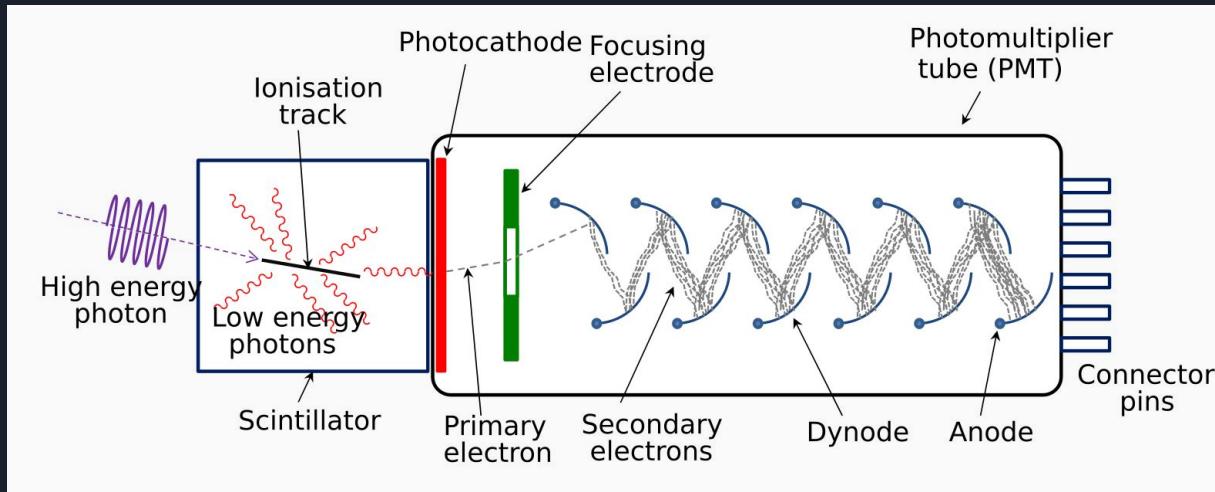


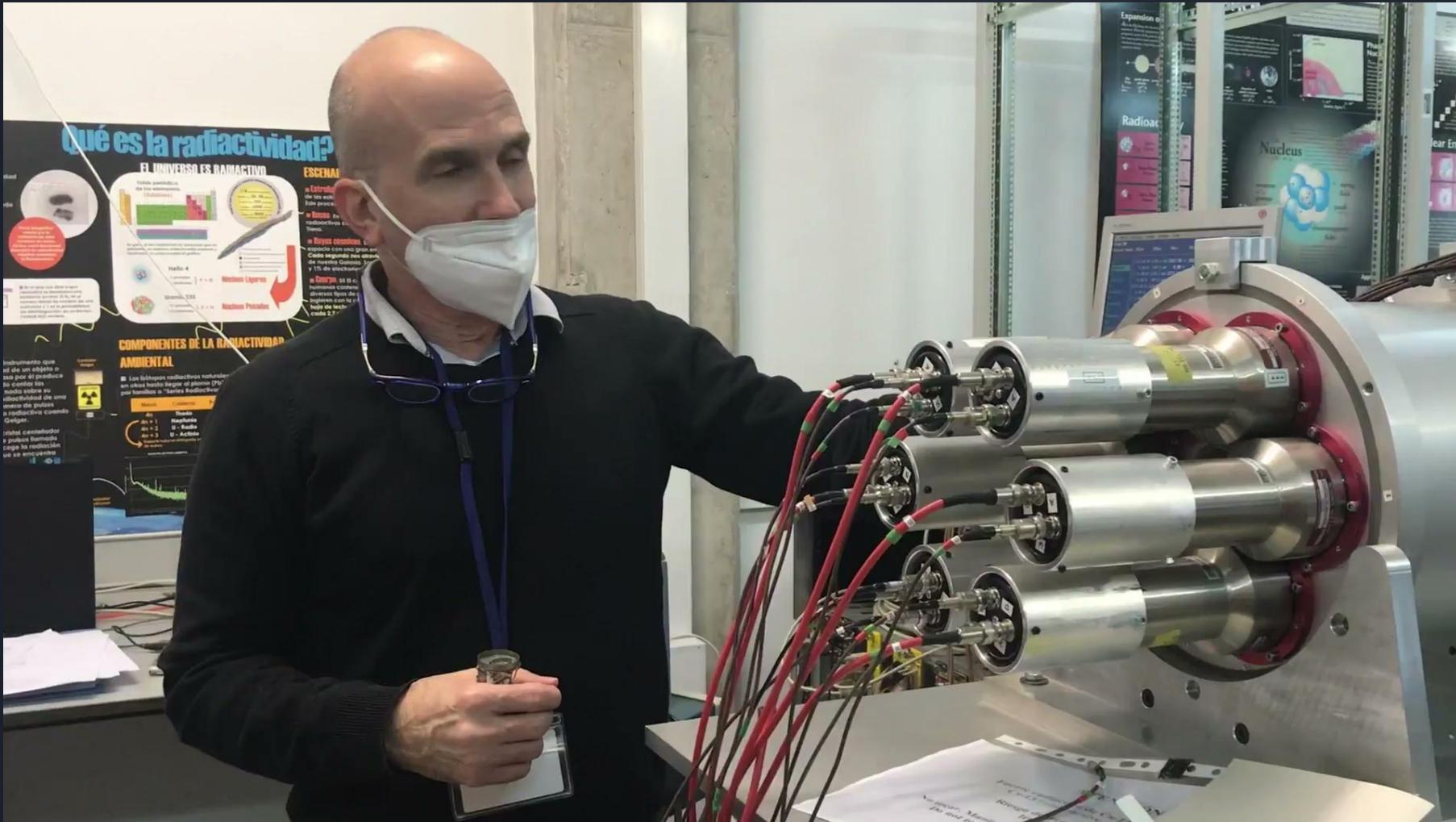


Fumar radiactiva de Ca-47 causa
riesgo de radiación
Exposición a la radiación
No fumar. Monitorear sólo por
No touch. Only touch.

Producción de Luz en un fotomultiplicador

La radiación gamma incidente en el centelador (Para nuestro caso un cristal de BaF₂) produce luz UV cuya intensidad o número de fotones es proporcional a la energía del gamma que es captada por un photocátodo. Este photocátodo libera electrones proporcionales al número de fotones UV que le llegan. Estos electrones son multiplicados por distintos dinodos resultando un factor final típico de 10⁶







Fuente de Alto Voltaje



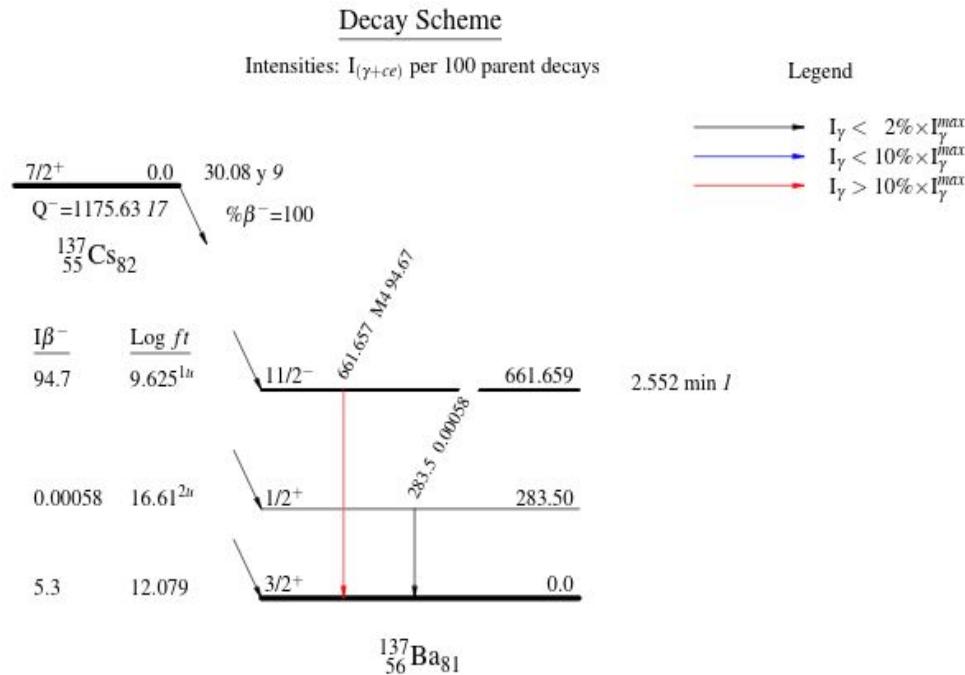


Si queremos observar un espectro con un pico bien definido debemos utilizar una fuente conocida. En este caso usaremos una fuente de ^{137}Cs , que se colocara en el interior del detector aproximadamente en el centro



Esquema de desintegración de una fuente de ^{137}Cs

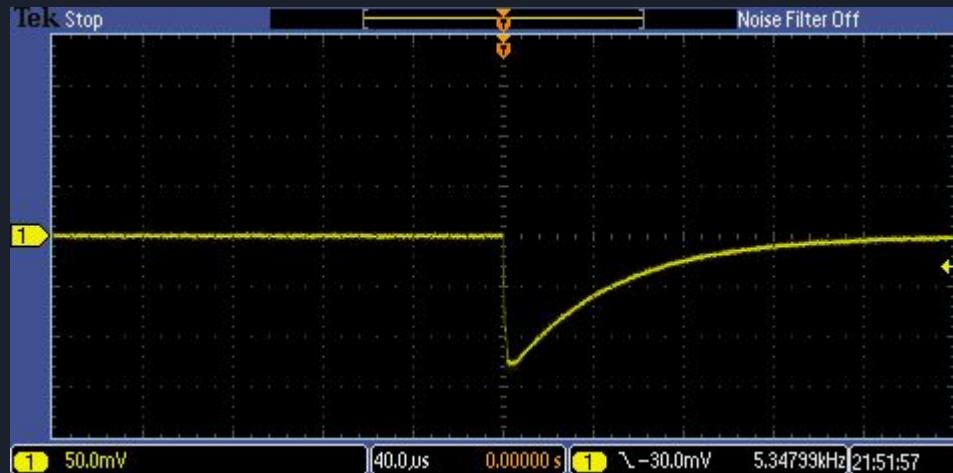
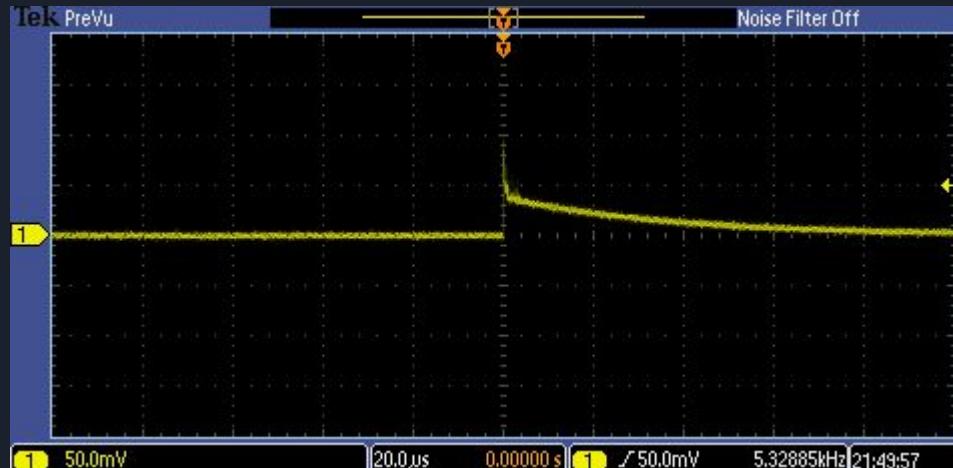
$^{137}\text{Cs} \beta^- \text{ decay} \quad 1983\text{Be}18, 1996\text{Bi}23, 1997\text{WaZZ}$



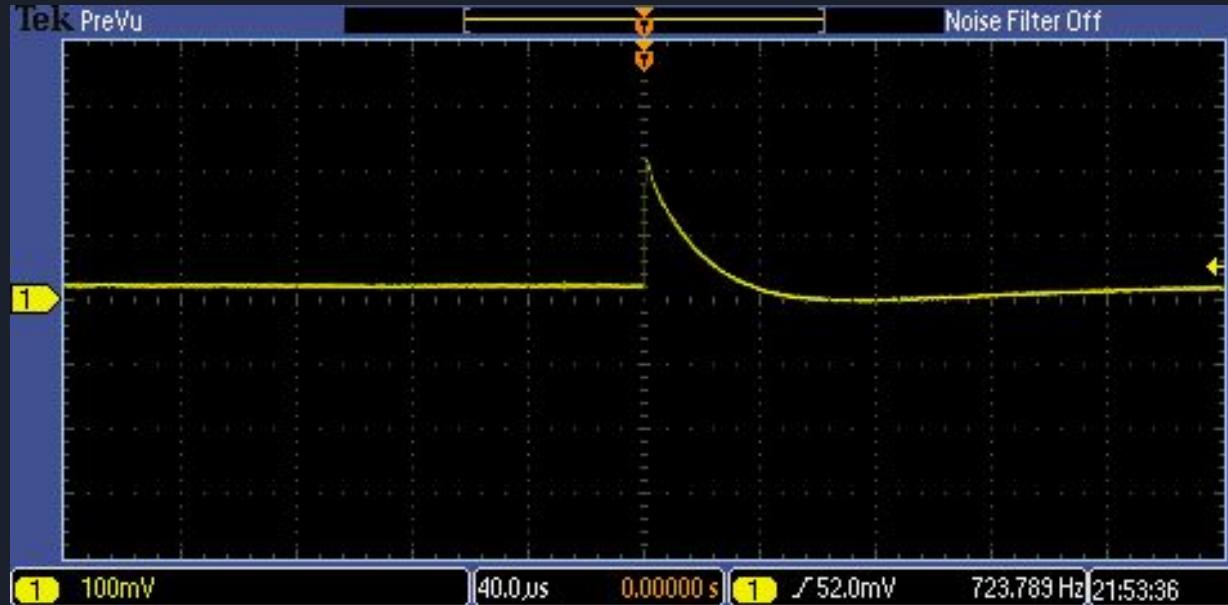


PM2

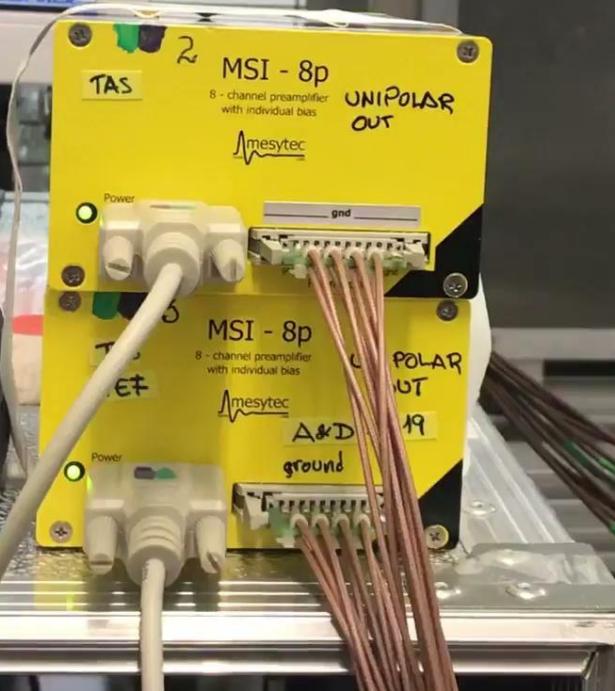
A pesar de que la radiación incidente es amplificada por un fotomultiplicador sigue siendo muy pequeña y debe pasar por un pre-amplificador

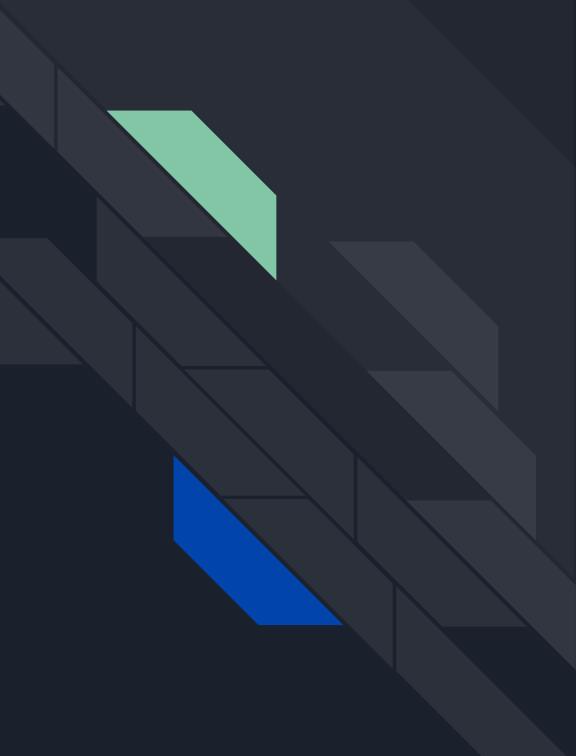
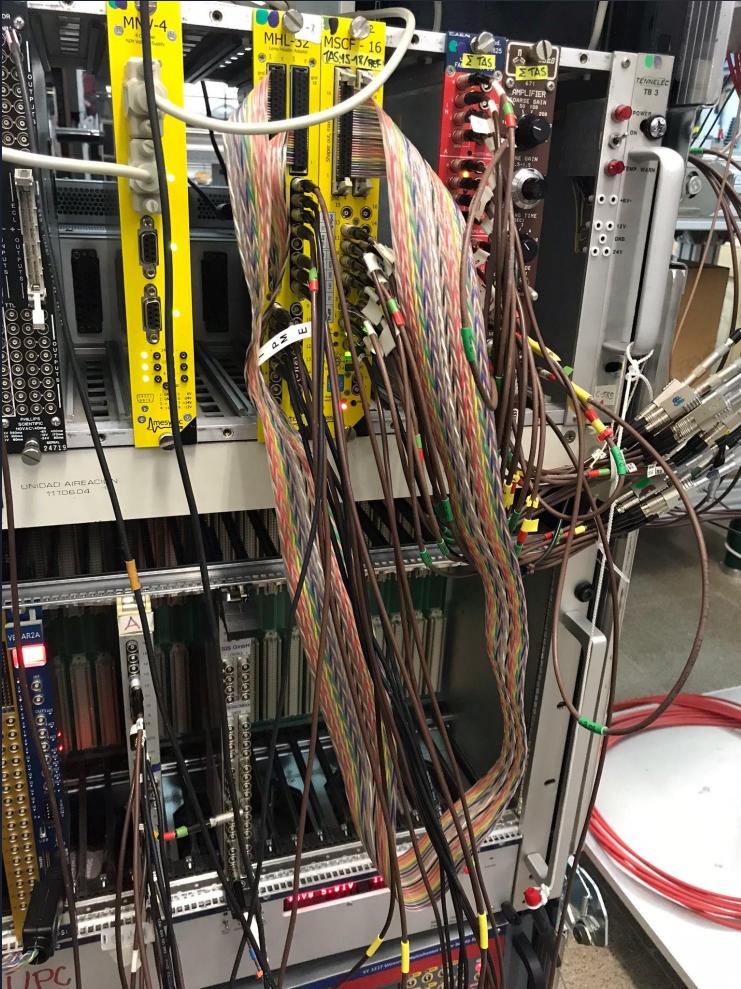


Señal obtenida al pasar por el pre-amplificador

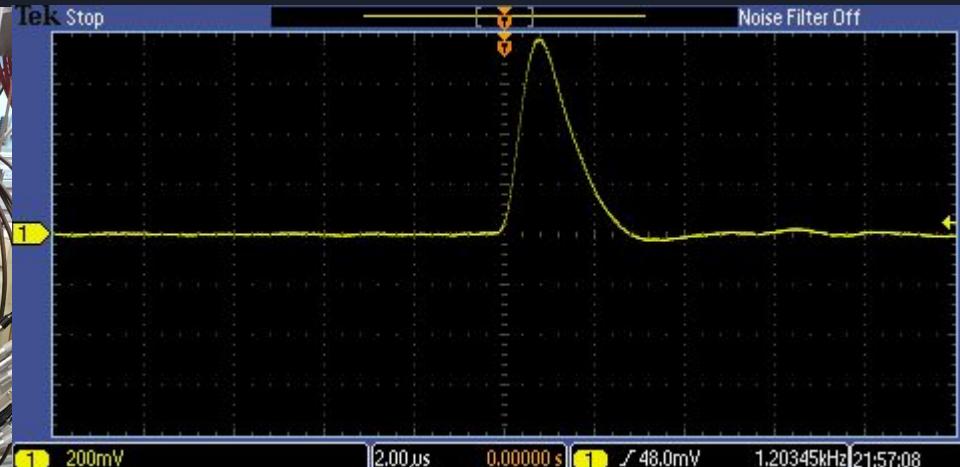


LG

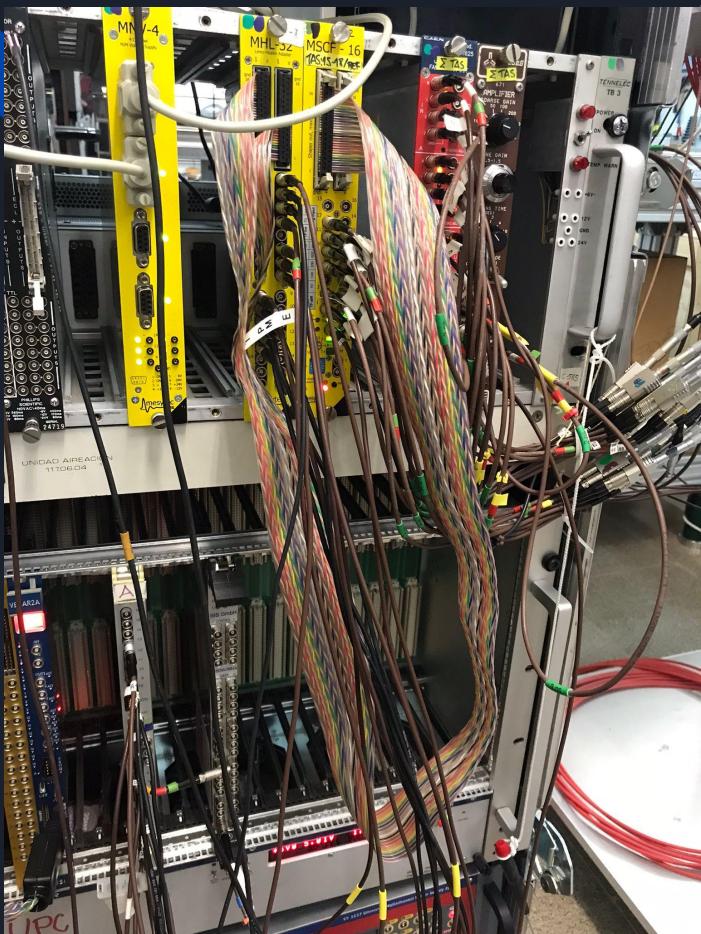
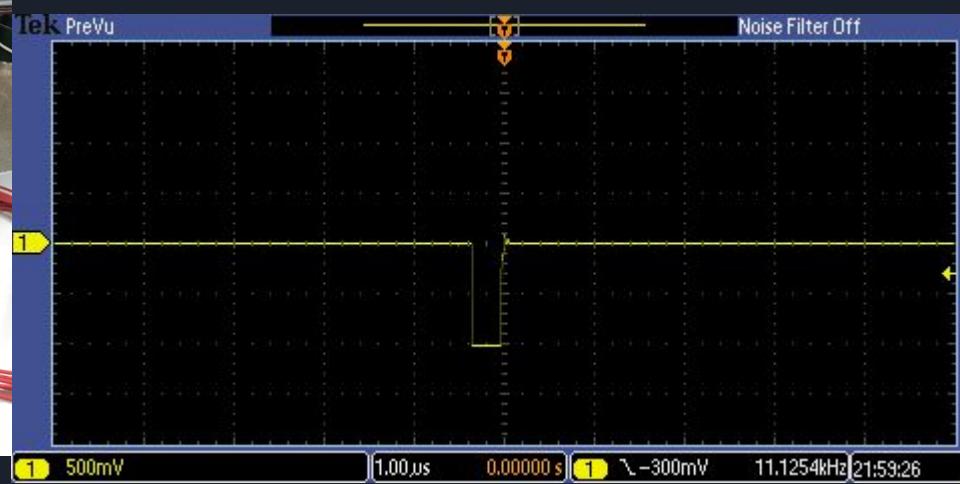




Amplificador

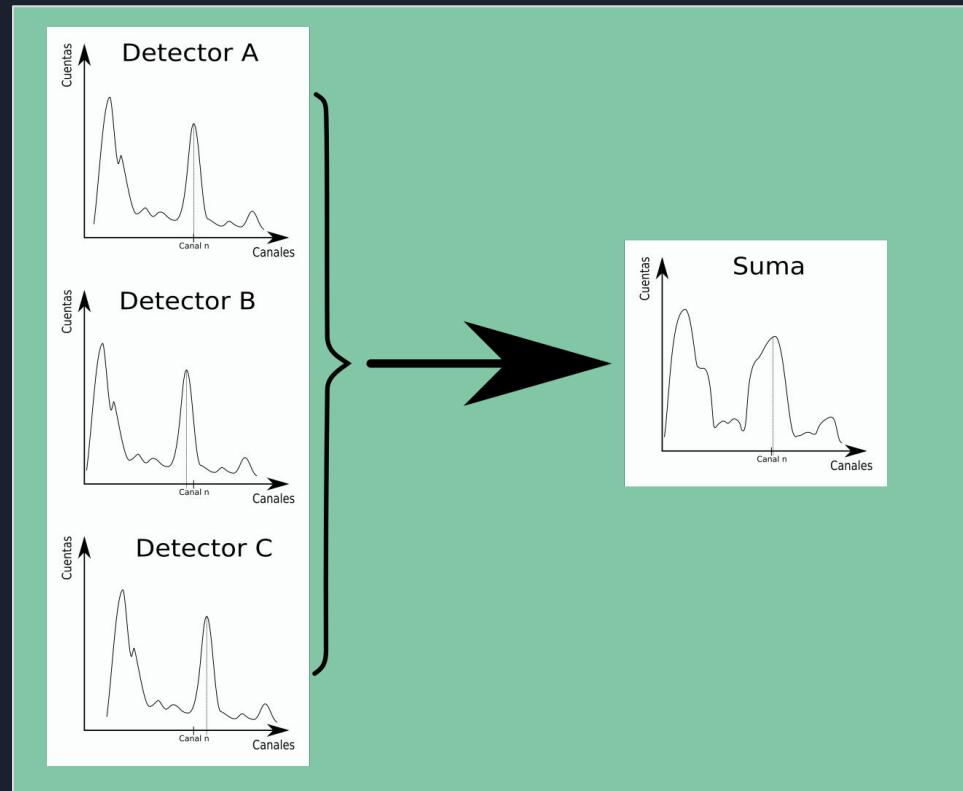


Señal lógica



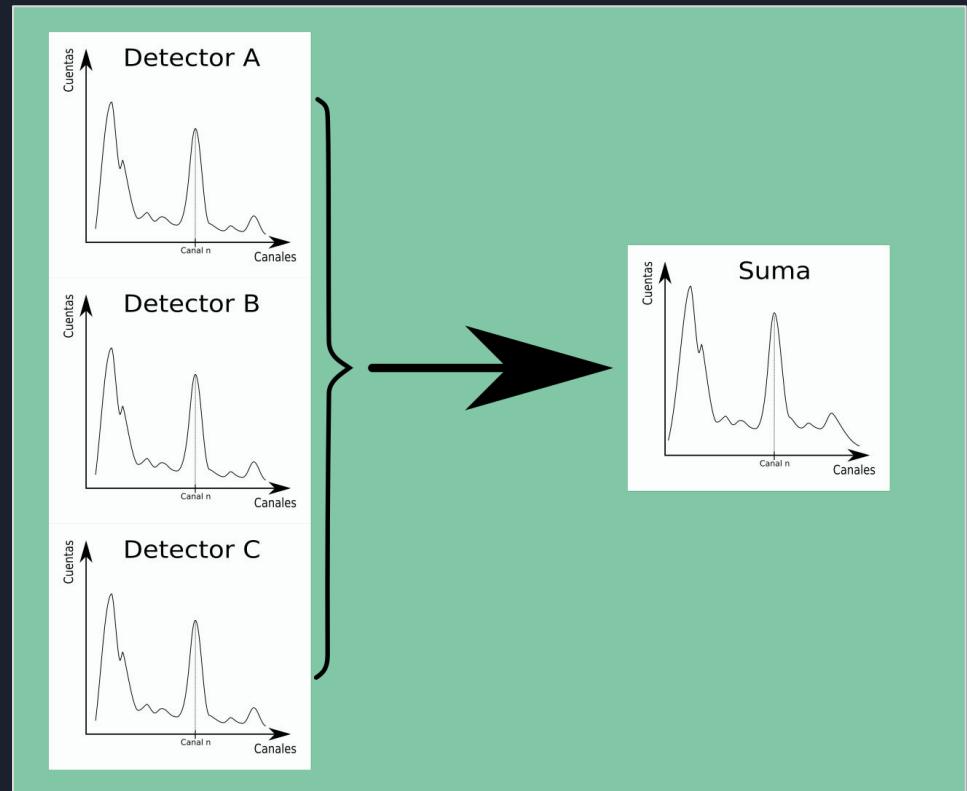
Alineamiento de los detectores

Si los detectores no están alineados unos respecto de otros, aunque midan el mismo fenómeno físico, la suma de sus señales podría dar un resultado distorsionado



Alineamiento de los detectores

Al estar alineados entre si la suma de las señales mantiene la forma del espectro permitiendo tener más estadística sin perder resolución

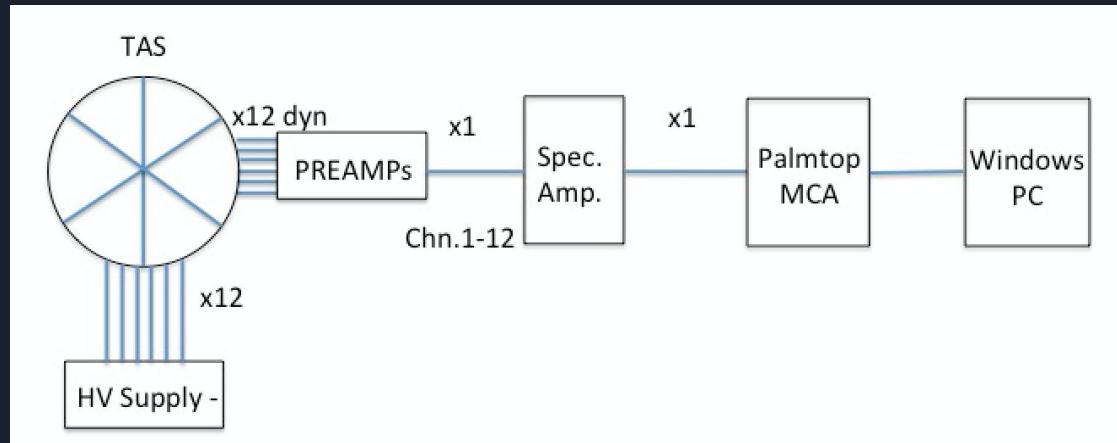


Para alinear los detectores utilizamos la misma cadena electrónica

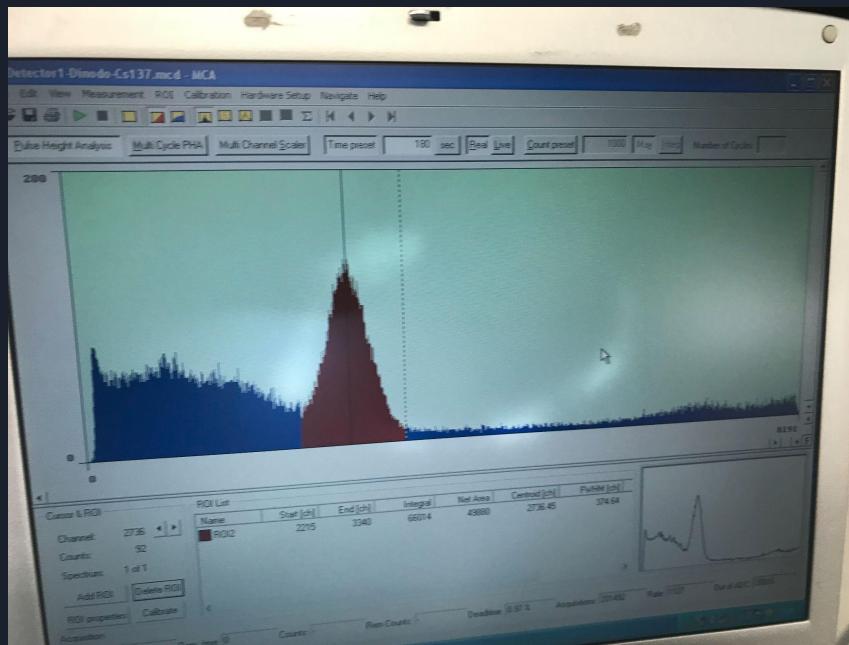


Alineamiento de los detectores

- fijar un detector como referencia
 - marcar centro del pico de la señal
- revisar los siguientes detectores uno por uno
- si el centro del pico de la señal no está en el mismo lugar cambiar el Alto Voltaje
 - Si el centro es menor al centro referencia aumentar el Alto Voltaje
 - Si el centro es mayor al centro referencia bajar el Alto Voltaje

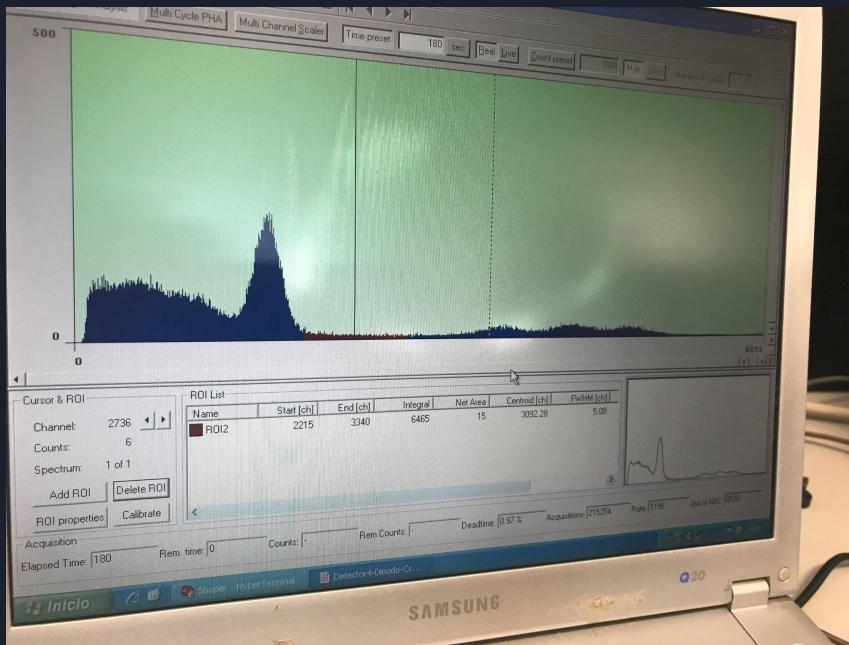


● Fijar un detector como referencia



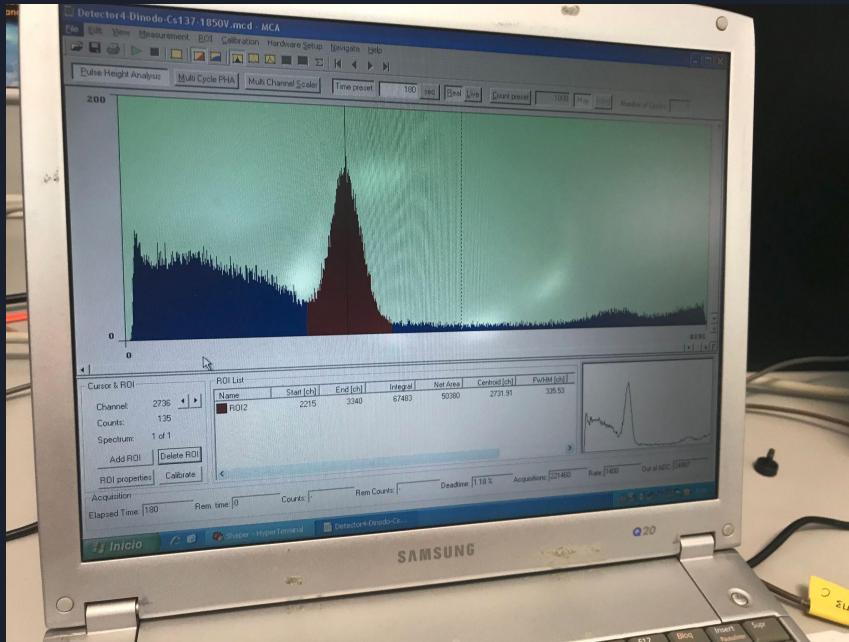
- Fijamos el detector 1 como referencia
- Centro del pico en el canal 2436
 - El valor del Alto Voltaje es de **1958 V**

● Comprobamos el detector 4



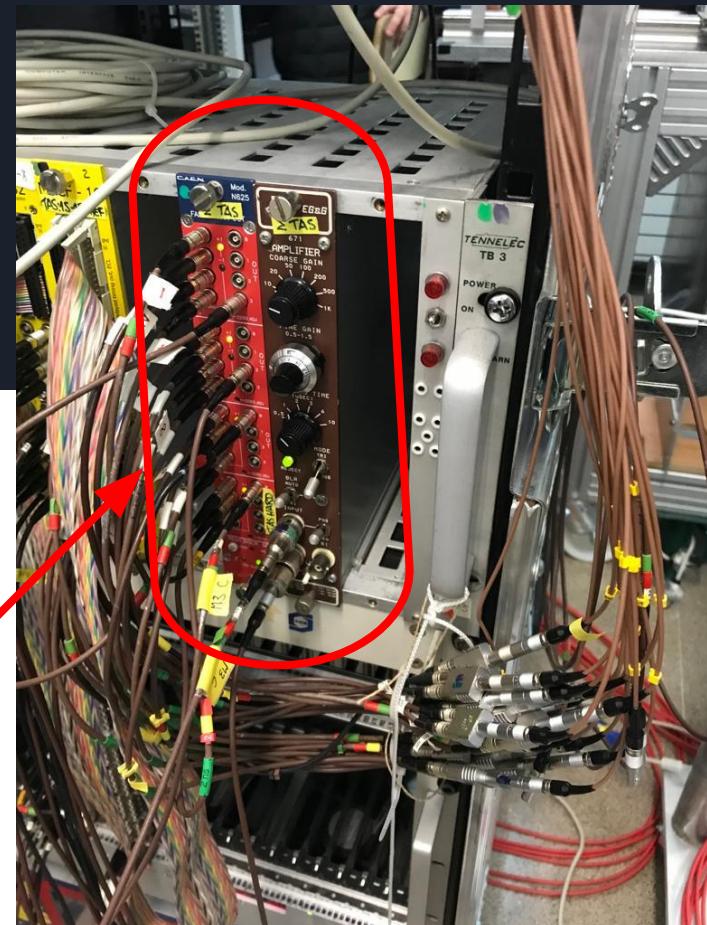
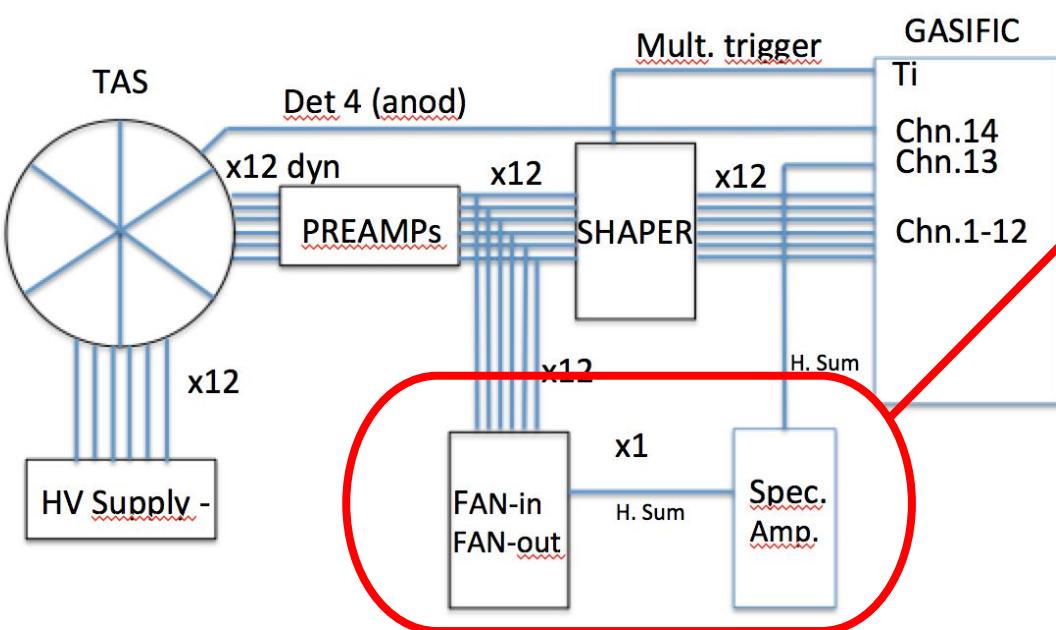
- centro del pico se encuentra en un canal menor al fijado anteriormente
 - al ser menor se procede a aumentar el Alto Voltaje hasta llegar al lugar deseado
 - Como referencia el Alto Voltaje en esta medición tiene un calor de **1773 V**

● Comprobamos el detector 4



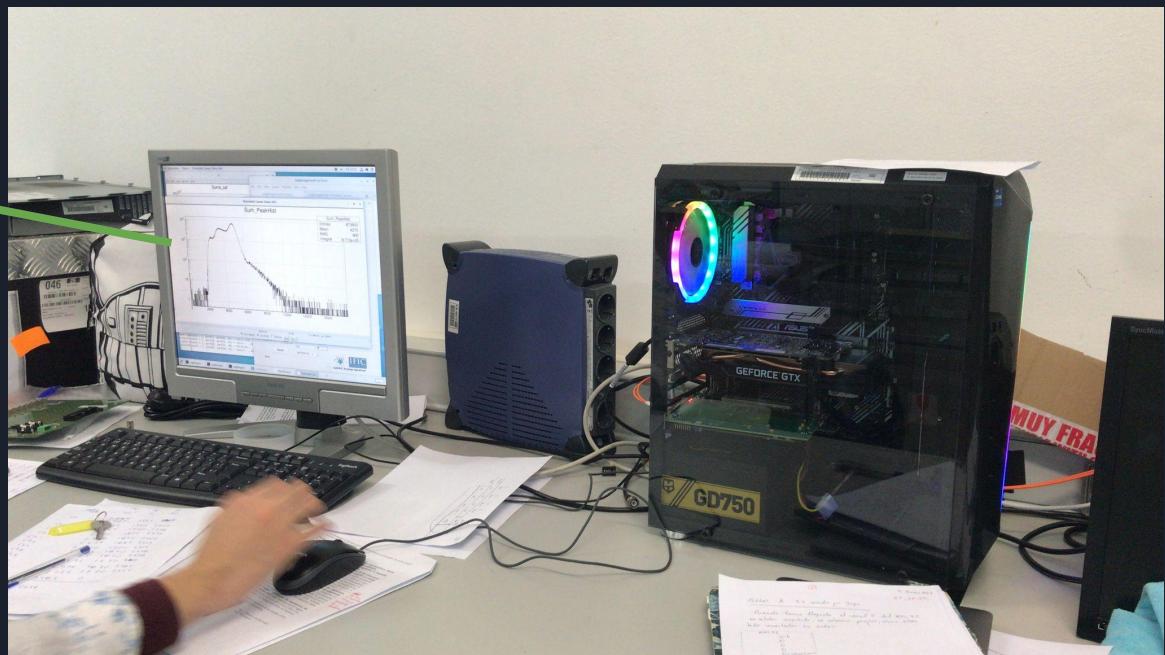
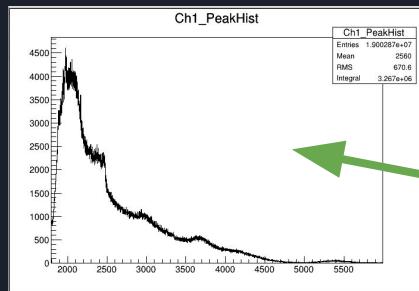
- Al aumentar progresivamente el voltaje se logra posicionar el pico en el canal previamente escogido
 - el nuevo valor para el Alto Voltaje es de **1850 V**

Suma Hardware de señales de los 12 cristales





Sistema GASIfic



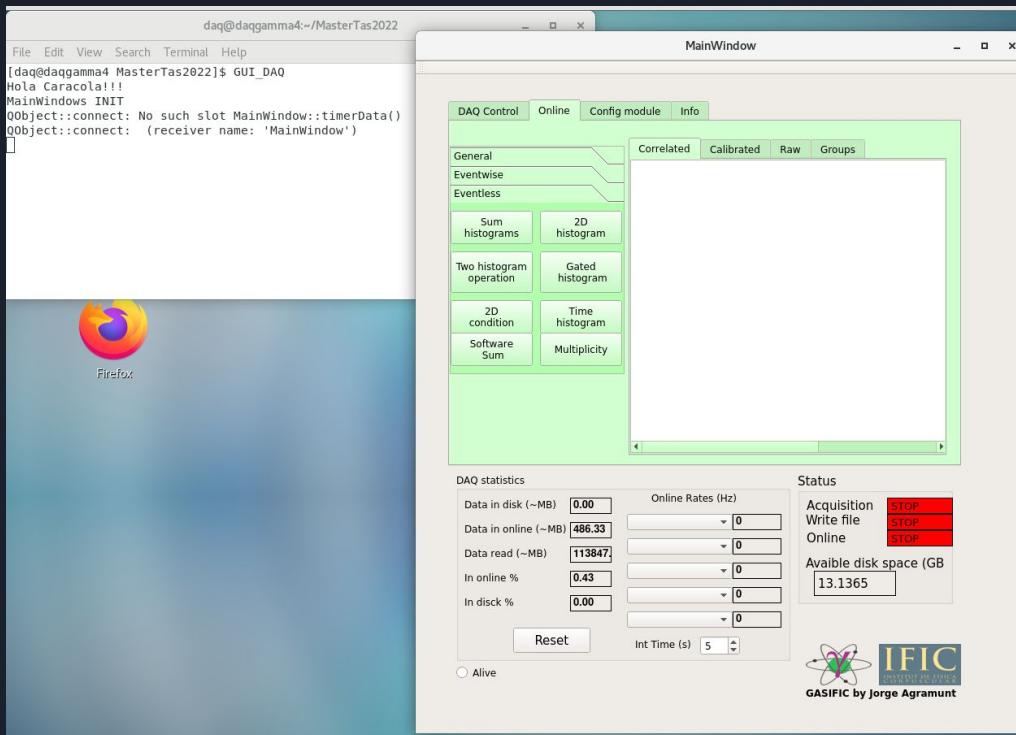
Sistema de adquisición y
digitalizador

GASIfic

```
daq@daqgamma4:~/MasterTas2022
File Edit View Search Terminal Tabs Help
daq@daqgamma4:~/MasterTas2022 x dacq@daqgamma3:~ x
++++++AcqReadSim:HardReadout:LAM : ++++++
1 Buff Id 20 at position 0
1 Buff Id 21 at position 1
1 Buff Id 22 at position 2
1 Buff Id 23 at position 3
AcqReadSim: HardReadout: ArmBank : 2
AcqReadSim: HardReadout: ReadBank : 1
+++++Hardware Buff Blocked 0
1
Num od Mod to read: 0
+++++Hardware Buff released 0
Buffer status
Buffer pos 0 Block Id 0x18
Buffer pos 1 Block Id 0x15
Buffer pos 2 Block Id 0x16
Buffer pos 3 Block Id 0x17
Nex Buff 0 max buff 4
Data Read 4
Buffer Size: 0
Buffer Lost: 0
Buffer Used: 0
Stat Total data : 4
...Readout Timeout
+++++AcqReadSim:HardReadout:LAM : ++++++
1 Buff Id 24 at position 0
1 Buff Id 21 at position 1
1 Buff Id 22 at position 2
1 Buff Id 23 at position 3
AcqReadSim: HardReadout: ArmBank : 1
AcqReadSim: HardReadout: ArmBank : 1
AcqReadSim: HardReadout: ReadBank : 2
+++++Hardware Buff Blocked 1
1
Num od Mod to read: 0
+++++Hardware Buff released 1
Buffer status
Buffer pos 0 Block Id 0x18
Buffer pos 1 Block Id 0x19
Buffer pos 2 Block Id 0x16
Buffer pos 3 Block Id 0x17
Nex Buff 1 max buff 4
Data Read 4
Buffer Size: 0
Buffer Lost: 0
Buffer Used: 0
Stat Total data : 4
```

Comunicación del ordenador con el digitalizador

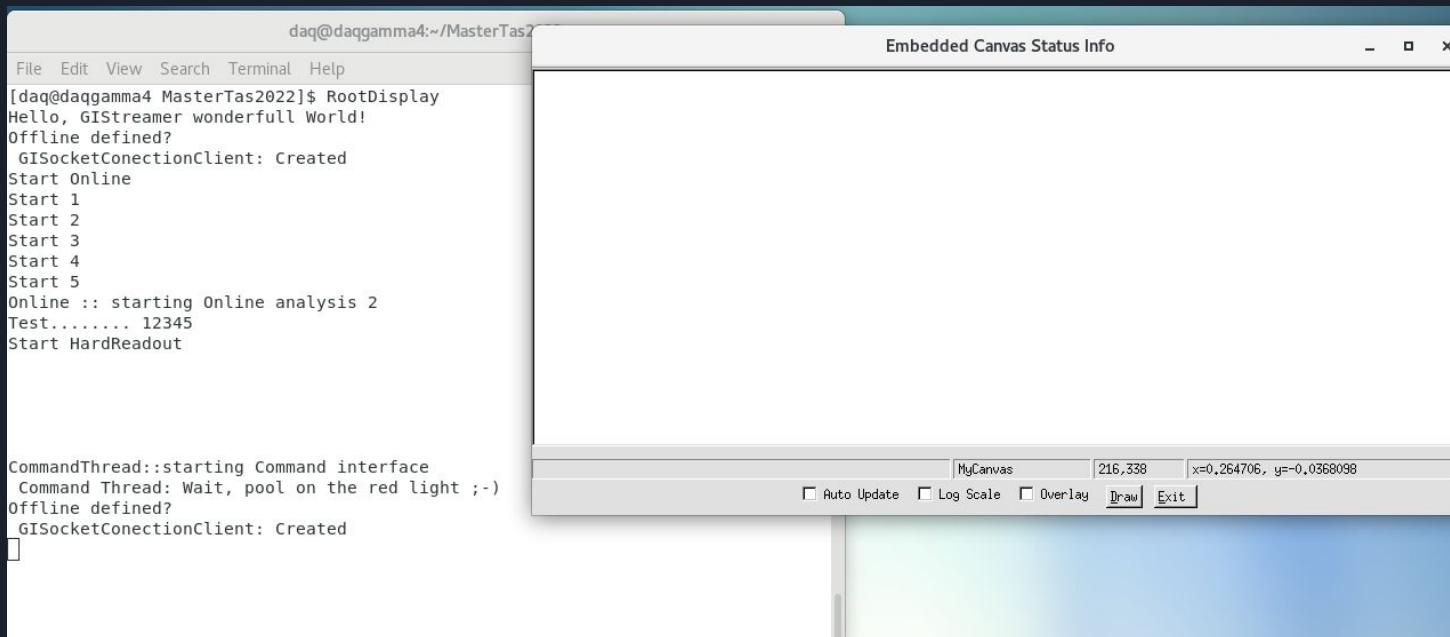
GASIfic



Interfaz de Usuario

GASIfic

Controlador del visualizador



```
daq@daqgamma4:~/MasterTas2022
File Edit View Search Terminal Help
Order in group 12 Name Sum Par PeakHigh GMod Mod1
Grooup 2 Spec in group 13
Order in group 0 Name Ch1_cal Par GMod
Order in group 1 Name Ch2_cal Par GMod
Order in group 2 Name Ch3_cal Par GMod
Order in group 3 Name Ch4_cal Par GMod
Order in group 4 Name Ch5_cal Par GMod
Order in group 5 Name Ch6_cal Par GMod
Order in group 6 Name Ch7_cal Par GMod
Order in group 7 Name Ch8_cal Par GMod
Order in group 8 Name Ch9_cal Par GMod
Order in group 9 Name Ch10_cal Par GMod
Order in group 10 Name Ch11_cal Par GMod
Order in group 11 Name Ch12_cal Par GMod
Order in group 12 Name Suma_cal Par GMod
```

```
daq@daqgamma4:~/MasterTas2022 - x
File Edit View Search Terminal Help
Draw
Command Thread: New command 4
Command Thread:Online On
Command Thread: Wait, pool on the red light ;-)
event = 1, px=74, py=290, obj = MyCanvas:: , kk x=-714.883, y=0.5
42617
event = 1, px=84, py=560, obj = MyCanvas:: , kk x=-558.11, y=0.00
332539
Command Thread: New command 8
Command Thread 2: Send Confg to Hardware
Command Thread: Send Confg to Hardware 1
Send Conf to Hardware
Send Conf to Hardware
End : Send Conf to Hardware
Command Thread: Send Confg to Hardware 2
Command Thread: Wait, pool on the red light ;-)
event = 1, px=178, py=394, obj = TFrame::Pad graphics frame , kk
x=915.552, y=3.07846
Draw
event = 1, px=210, py=439, obj = TFrame::Pad graphics frame , kk
x=1417.22, y=2.77875
```

```
daq@daqgamma4:~/MasterTas2022
File Edit View Search Terminal Tabs Help
daq@daqgamma4:~/MasterTas2022 x dacq@daqgamma3:~
Num od Mod to read: 1
Read Mod SIS3316 @Mod1
Mod1 Sample threshold :212999999
Mod1 chan 0 BlockMark 0xba07c000
Mod1 0x1e0009
Mod1 0x64315caa
Mod1 0xf006cd
Mod1 0x6be
Mod1 0x6be
Mod1 0x6be
Mod1 0x6be
Mod1 0x6be
Mod1 chan 1 BlockMark 0xba07c001
Mod1 chan 2 BlockMark 0xba07c002
Mod1 chan 3 BlockMark 0xba07c003
Mod1 chan 4 BlockMark 0xba07c004
Mod1 chan 5 BlockMark 0xba07c005
Mod1 chan 6 BlockMark 0xba07c006
Mod1 chan 7 BlockMark 0xba07c007
Mod1 chan 8 BlockMark 0xba07c008
Mod1 chan 9 BlockMark 0xba07c009
Mod1 chan a BlockMark 0xba07c00a
Mod1 chan b BlockMark 0xba07c00b
Mod1 chan c BlockMark 0xba07c00c
Mod1 chan d BlockMark 0xba07c00d
Mod1 chan e BlockMark 0xba07c00e
Mod1 chan f BlockMark 0xba07c00f
+++++++++++++++++ Hardware Buff released 0
Buffer status
Buffer pos 0 Block Id 0x934
Buffer pos 1 Block Id 0x931
Buffer pos 2 Block Id 0x932
Buffer pos 3 Block Id 0x933
Nex Buff 0 max buff 4
Data Read 1604
Buffer Size: 0
Buffer Lost: 0
Buffer Used: 0
Stat Total data : 1604
```

Dialog

Module Data

ME ID	7	Name	Mod1	Type	SIS3316	Mem length for LAM	1000.00
				Clock source	Internal		
				Clock frequency	250		
				Communication:	VME	/dev/sis1100_00remote	
				Crat Number	0		

Generic Module Commands

Add Command	Command	Data
-------------	---------	------

Channel Data

Channel n°	1	Name	Ch1	Enable
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Fast filter (trigger)

Integration length	10	Flat-top length	10
Pretrigger delay	200	Threshold	10
Trigger gate length	2000		

Slow filter (EFIR)

Integration length	100	Flat-top length	100
Tau correction (ns)	517	Averaging/ Decimation	
Energy Pickup	0		

Configuration logic

<input type="radio"/> External veto	<input type="radio"/> External gate	<input checked="" type="radio"/> Internal trigger
<input type="radio"/> Internal gate 1	<input type="radio"/> Internal gate 2	
<input type="radio"/> Int sum trigger	<input checked="" type="radio"/> External trigger	

Input channel

<input type="radio"/> Negative signal	
Input range	5V
Input impedance	500Ω
Signal offset	60000

Output

<input checked="" type="radio"/> Save energy (slow filter)	<input type="radio"/> Save pulse height, Accum 1-6	<input type="radio"/> Save fast filter samples
<input type="radio"/> Save CFD values	<input type="radio"/> Save Accum 7-8	<input type="radio"/> Save slow filter samples

Histogram range

EFIR	10000000
Pulse height	14000
CFD time	0
Time stamp	0

Set Channel

Signal sample range

Signal length	0
Start sample	0

Accumulators

	Length	Start sample	Hist range
Accum 1	0	0	0
Accum 2	0	0	0
Accum 3	0	0	0
Accum 4	0	0	0
Accum 5	0	0	0
Accum 6	0	0	0
Accum 7	0	0	0
Accum 8	0	0	0

Slow filter start sample

MainWindow

DAQ Control Online Config module Info

Name	Hard Address	Crate	Type
1 Mod1	7	0	SIS3316

Add Module
Save Config
Load Config
Send to Hard
Conf Online

DAQ statistics

Data in disk (~MB)	Online Rates (Hz)
0.00	Ch1 0
77.73	Ch1 0
77.73	Ch1 0
100.00	Ch1 0
0.00	Ch1 0
	Ch1 0

Reset Int Time (s) 5

Alive

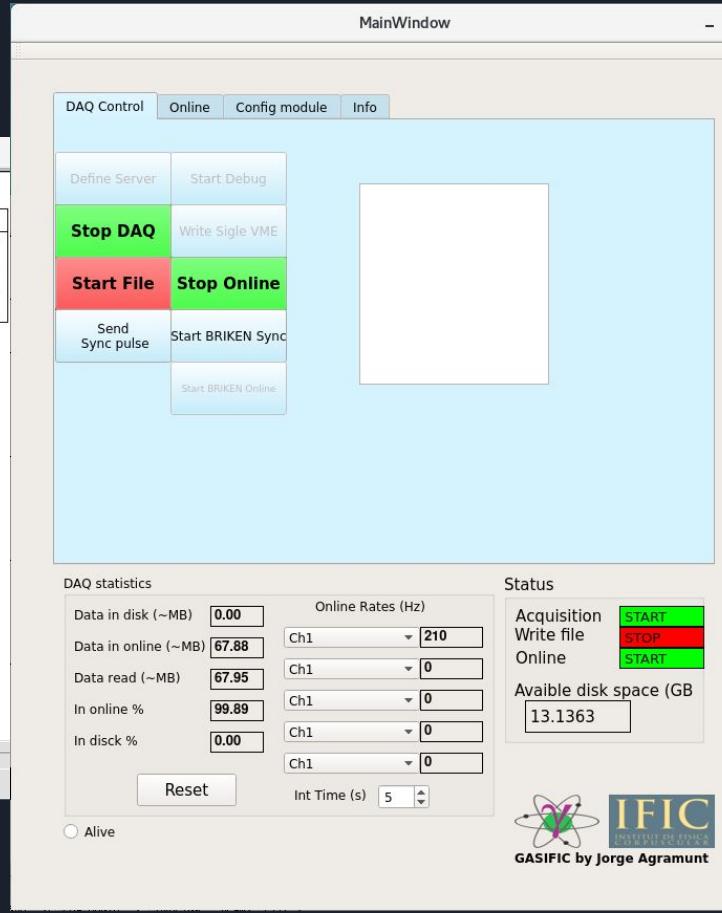
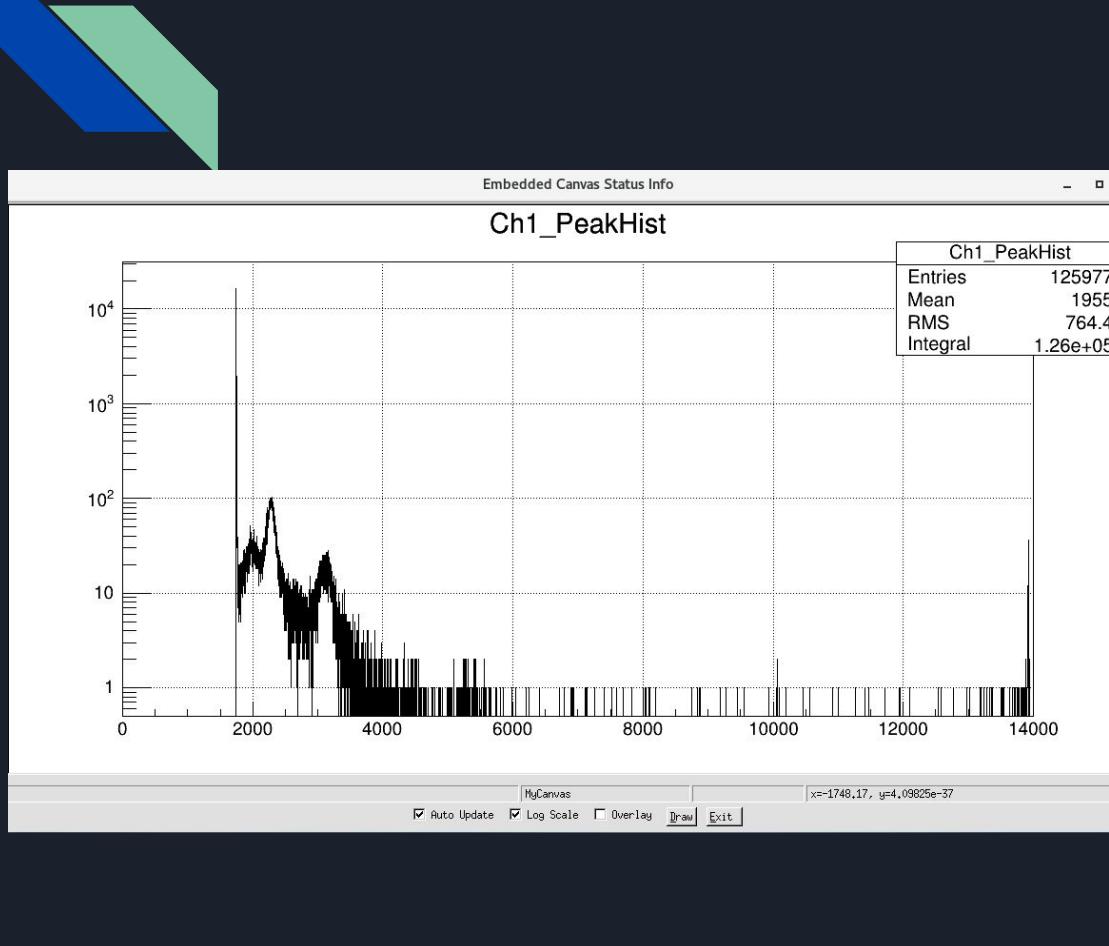
Status

Acquisition	Write file	Online
STOP	STOP	STOP

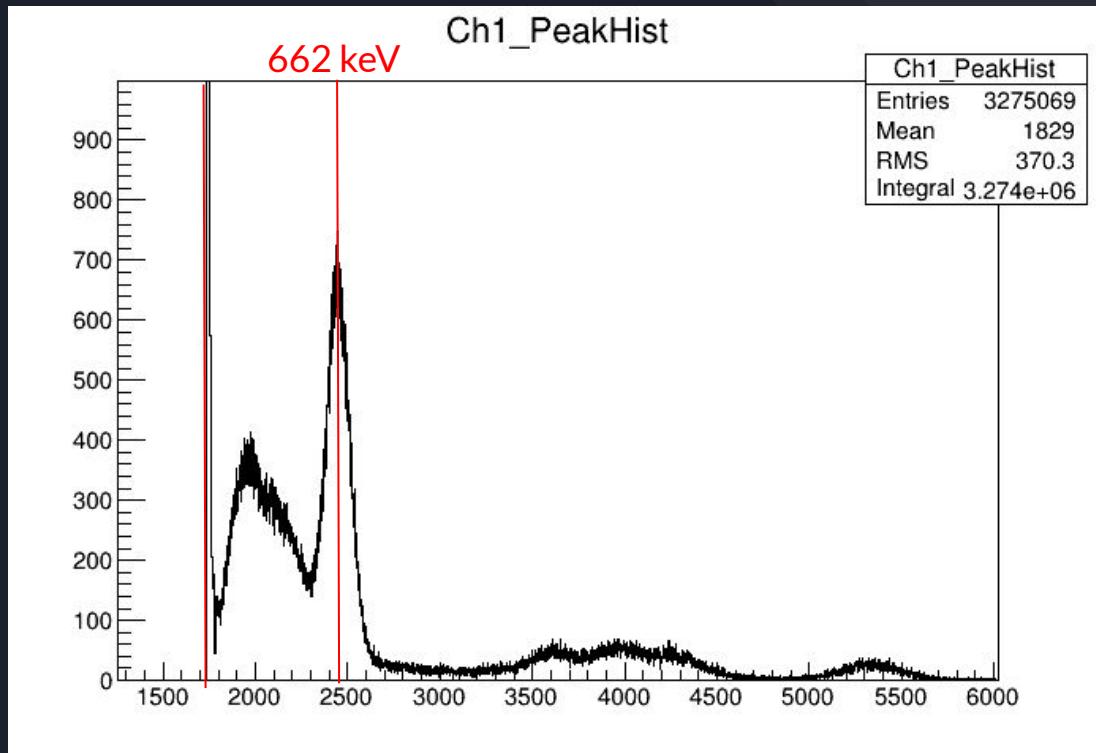
Available disk space (GB)
13.1363

 IFIC
INSTITUTO DE FÍSICA
COSTA RICA
GASIC by Jorge Agramunt

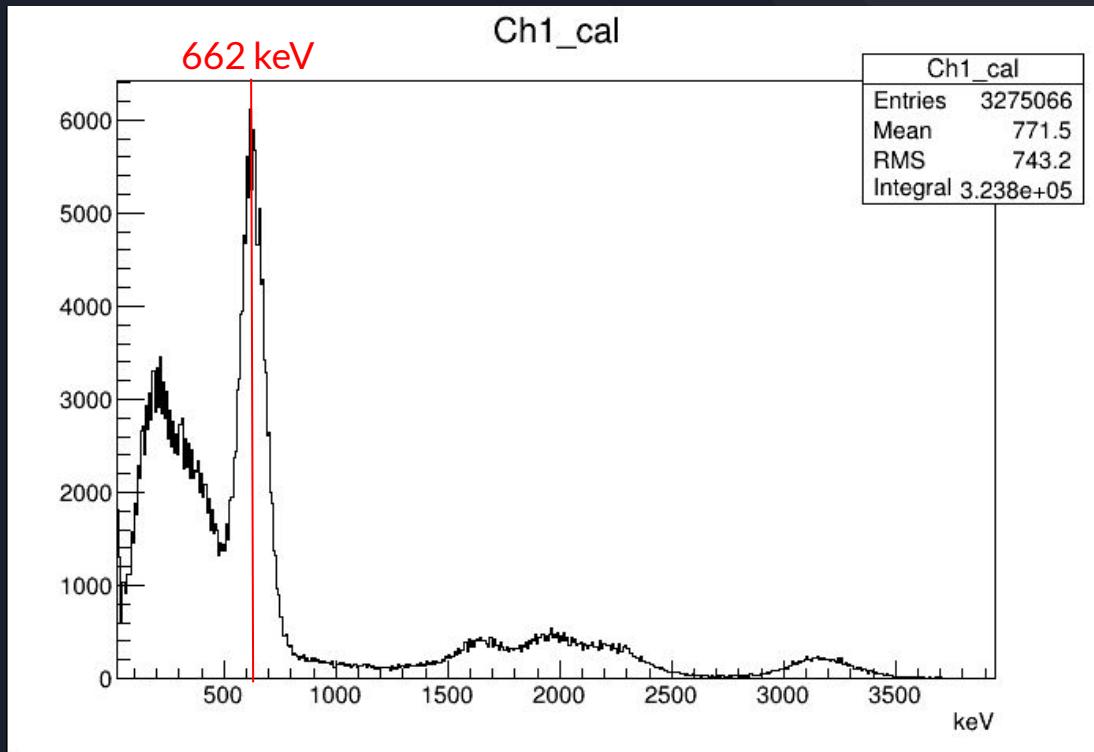




Calibración Cristales Individuales

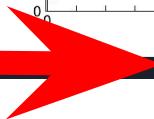
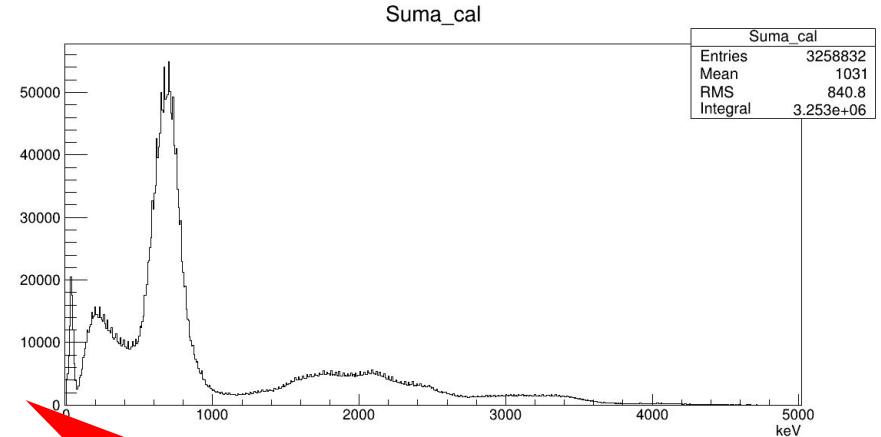
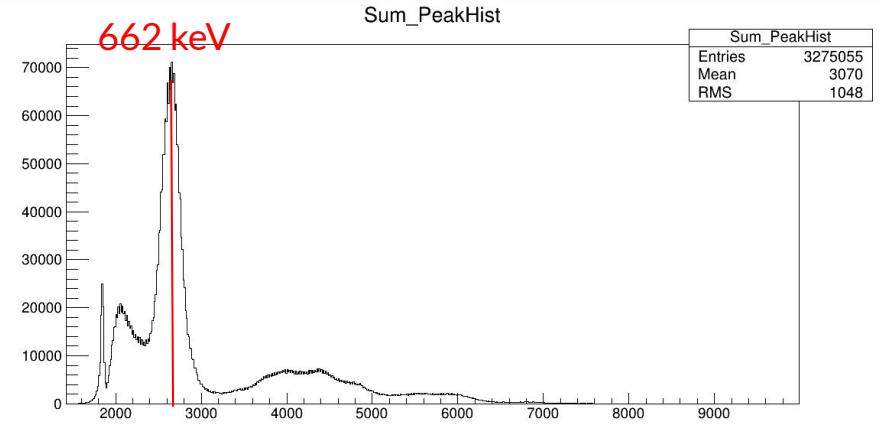


Calibración Cristales Individuales

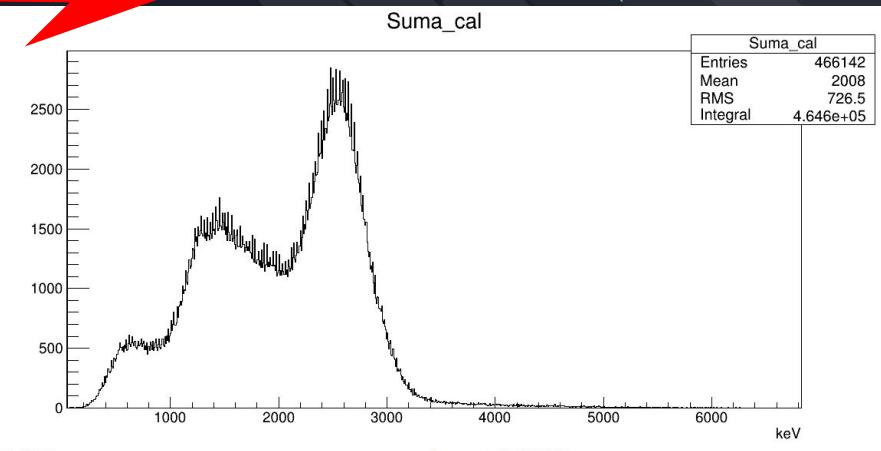
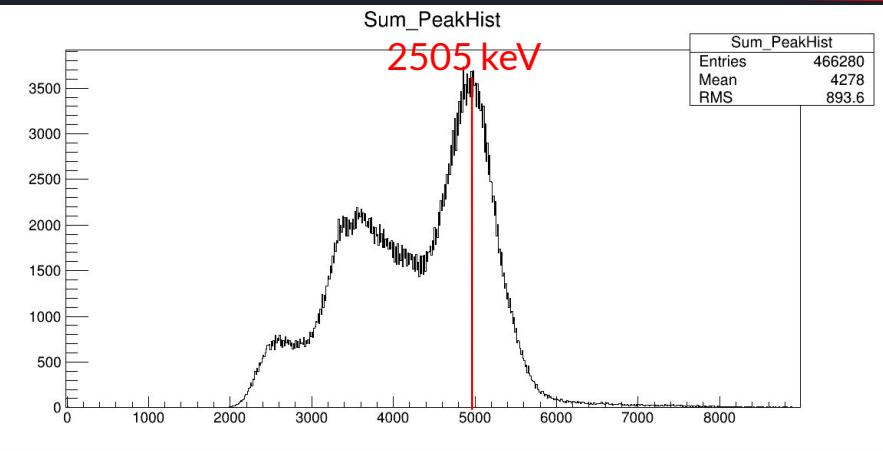


Calibración Suma Hardware

662 keV

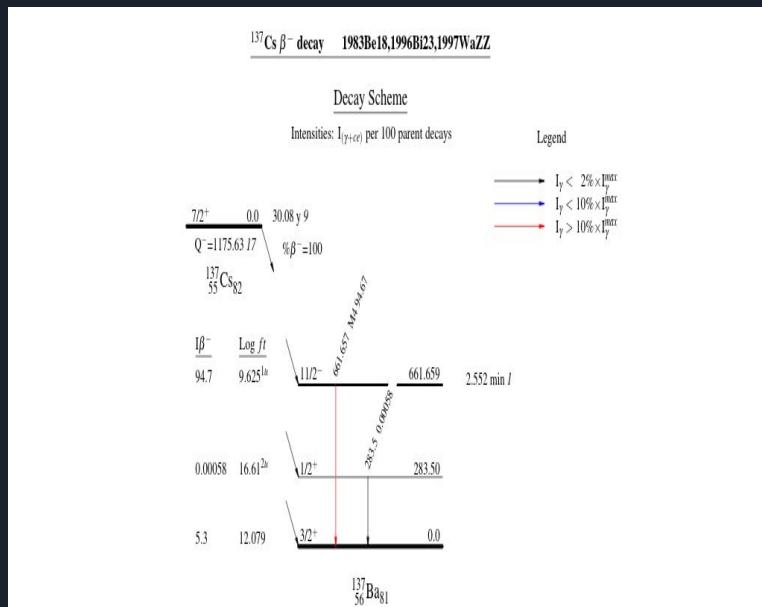
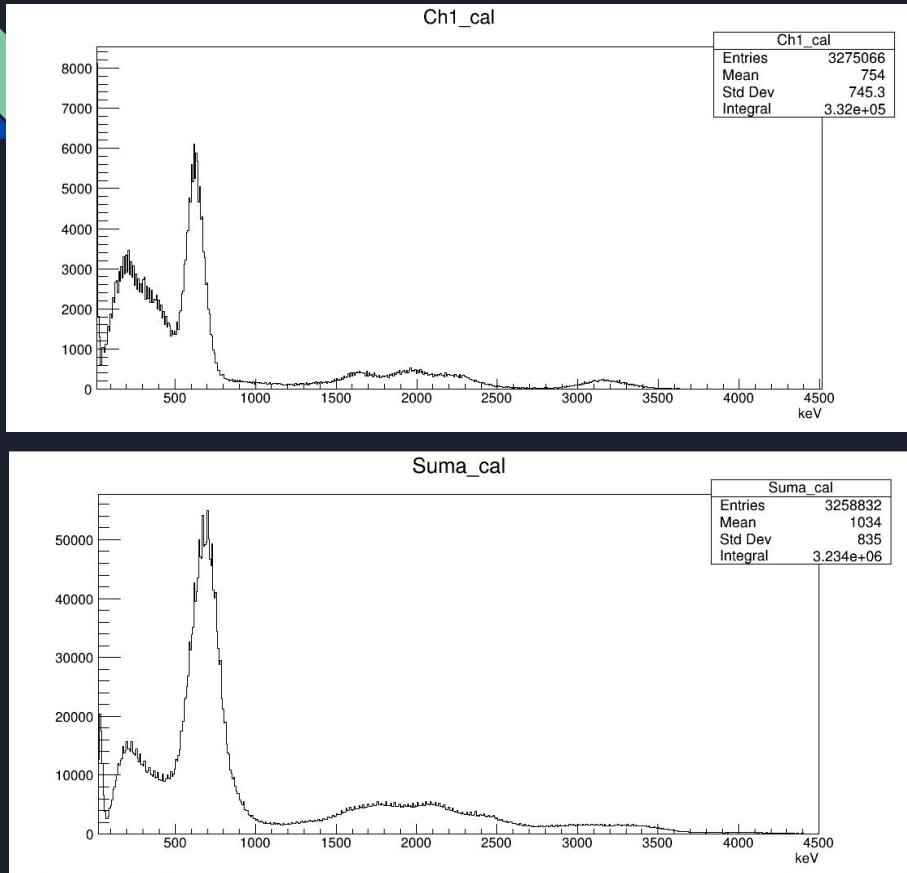


2505 keV



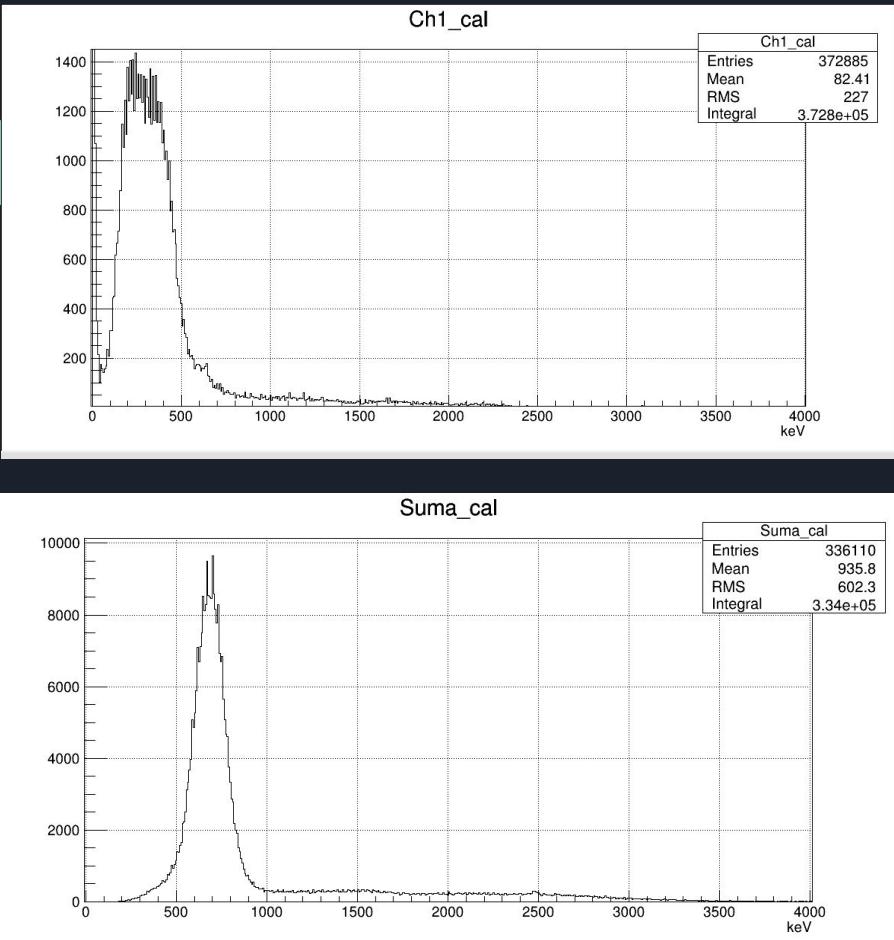
Multiplicidad Open

^{137}Cs



Multiplicidad 2

^{137}Cs

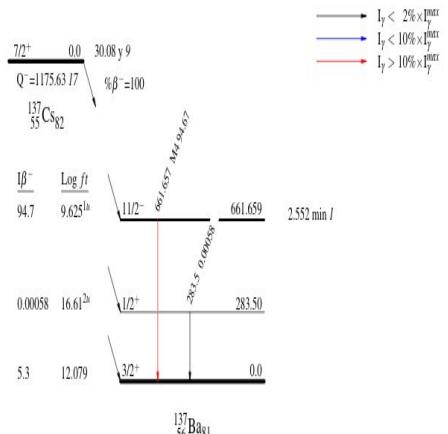


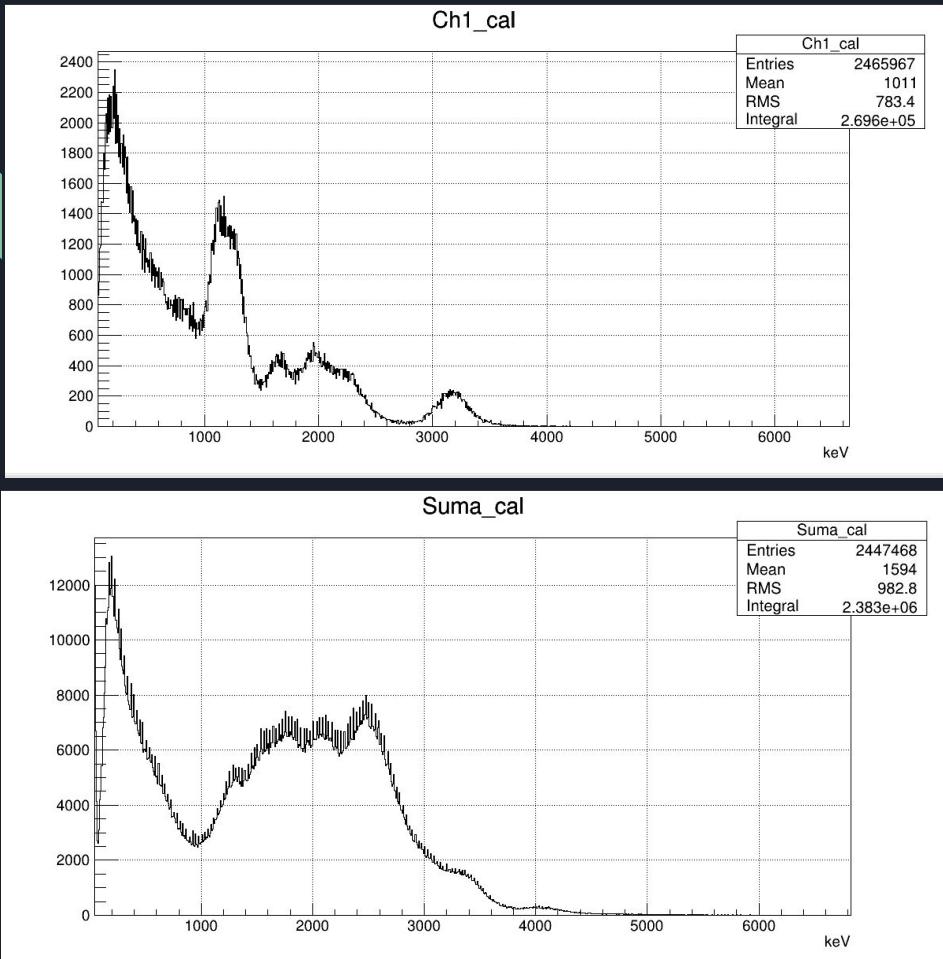
$^{137}\text{Cs} \beta^-$ decay 1983Be18,1996Bi23,1997WaZZ

Decay Scheme

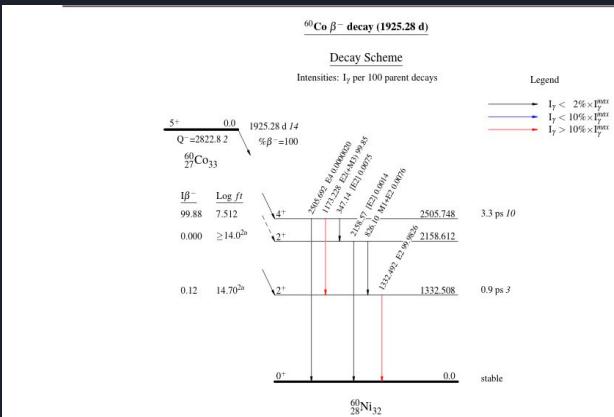
Intensities: $I_{(\gamma+\nu)}$ per 100 parent decays

Legend

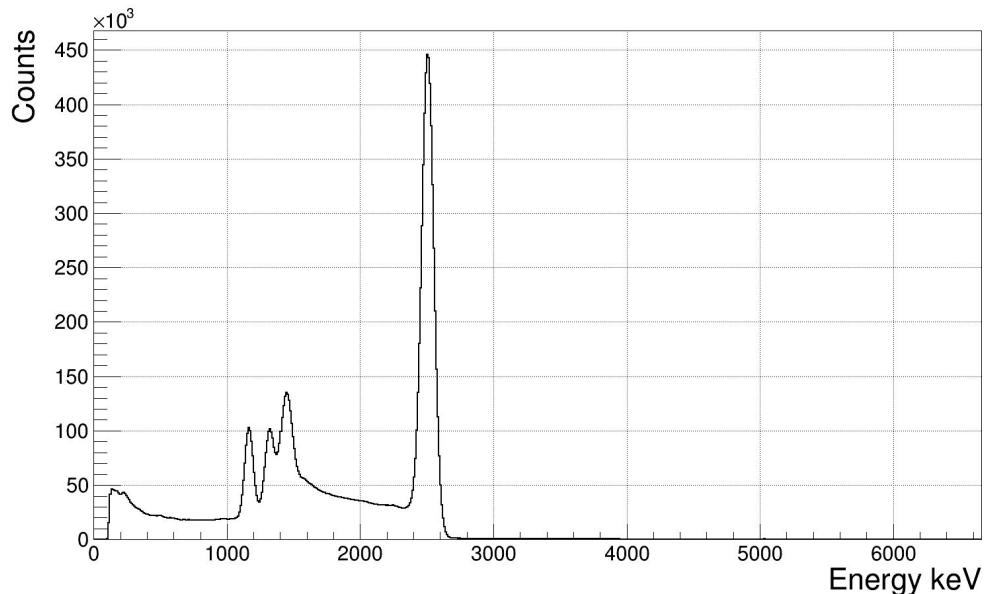




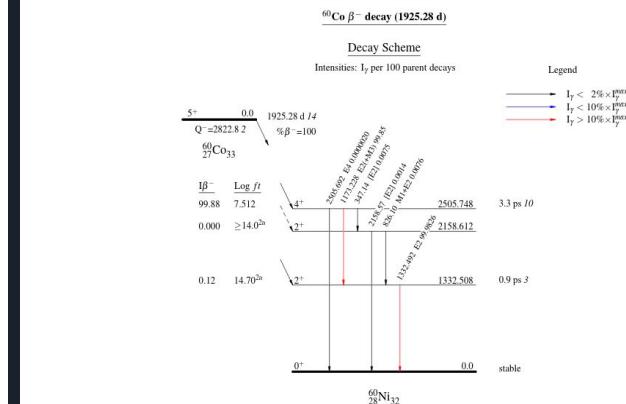
Multiplicidad Open ^{60}Co



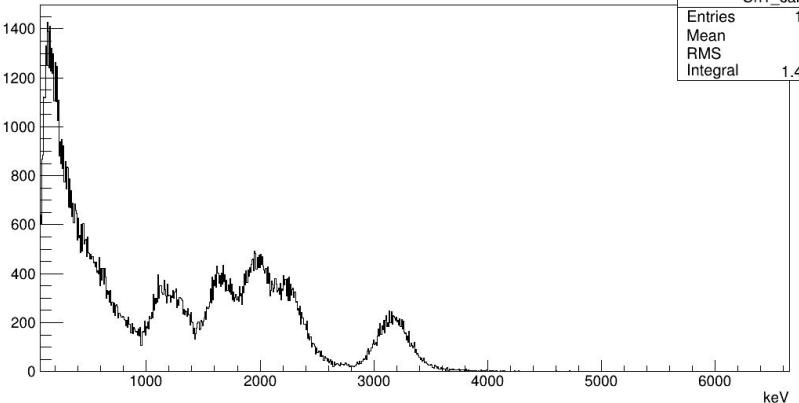
Espectro de ^{60}Co obtenido por un cristal de NaI



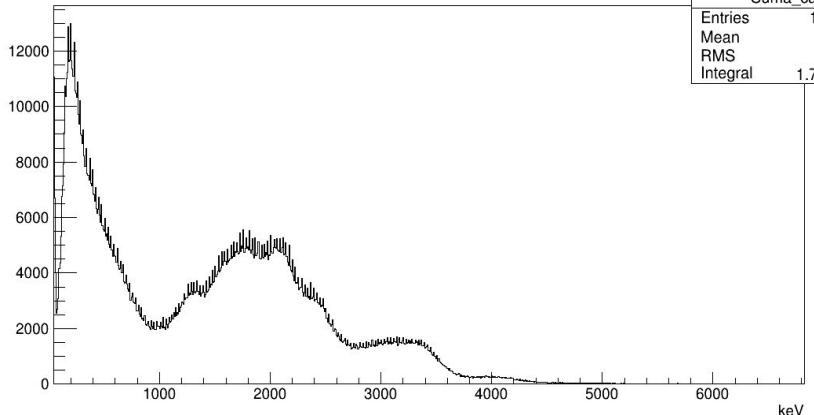
Multiplicidad Open ^{60}Co



Ch1_cal



Suma_cal

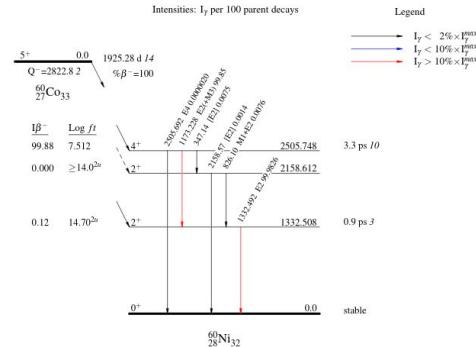


Multiplicidad 1

^{60}Co

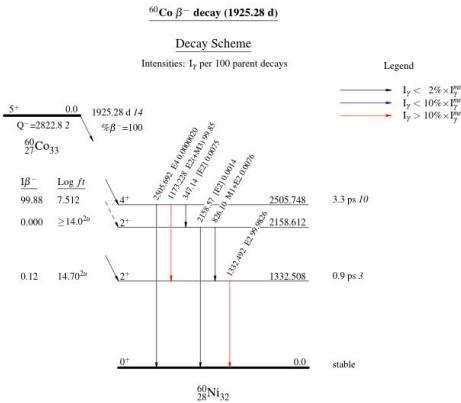
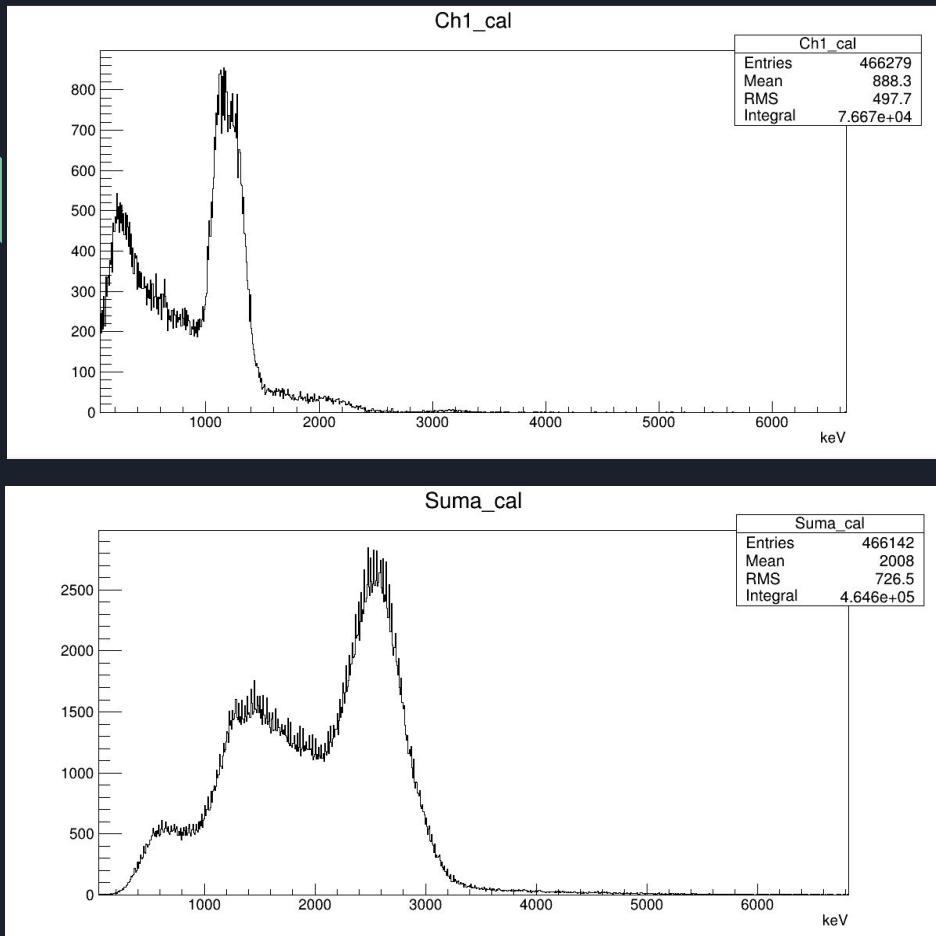
 $^{60}\text{Co} \beta^-$ decay (1925.28 d)

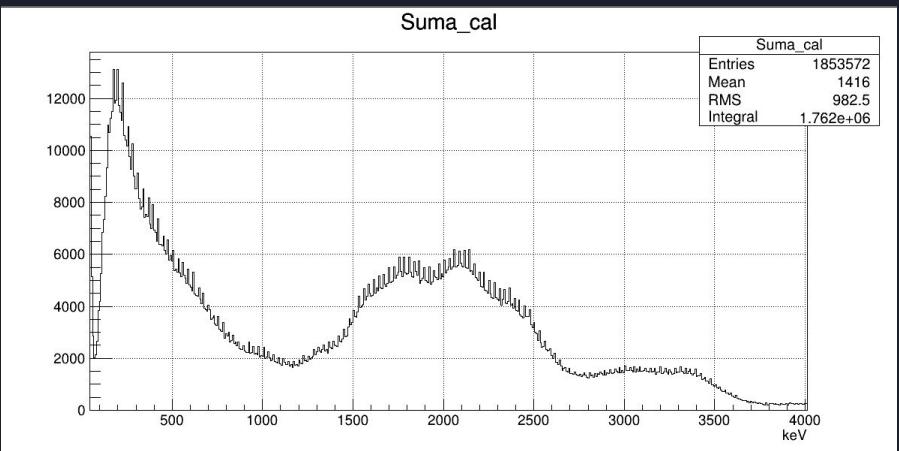
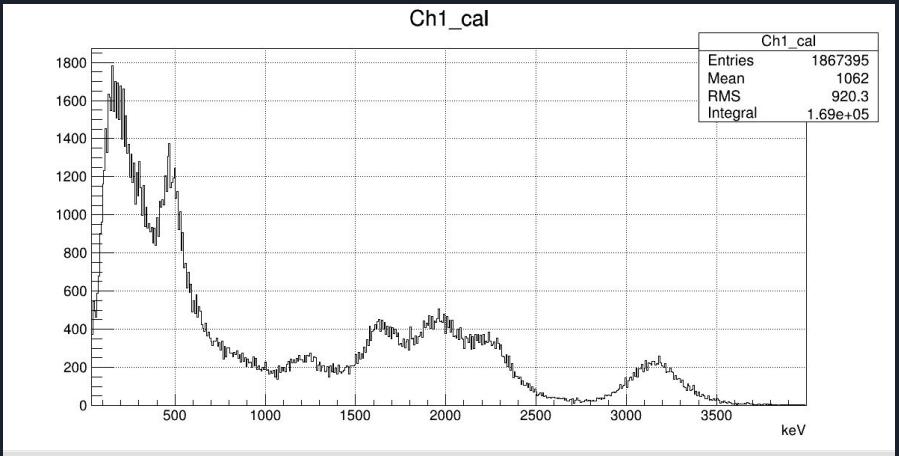
Decay Scheme

Intensities: I_γ per 100 parent decays

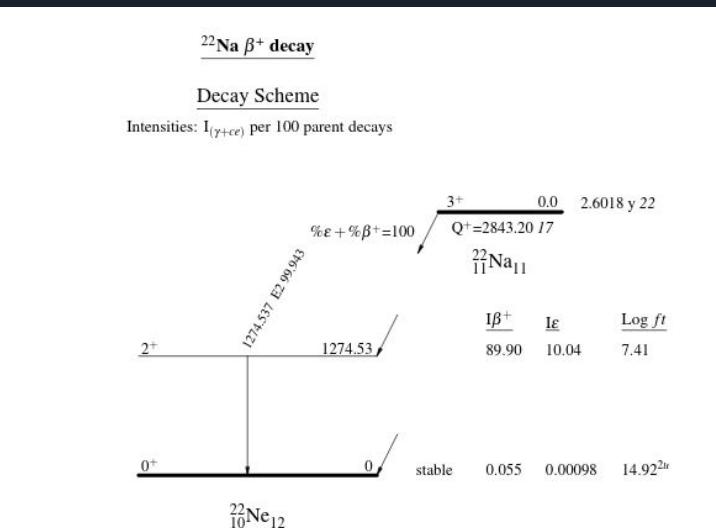
Multiplicidad 2

^{60}Co



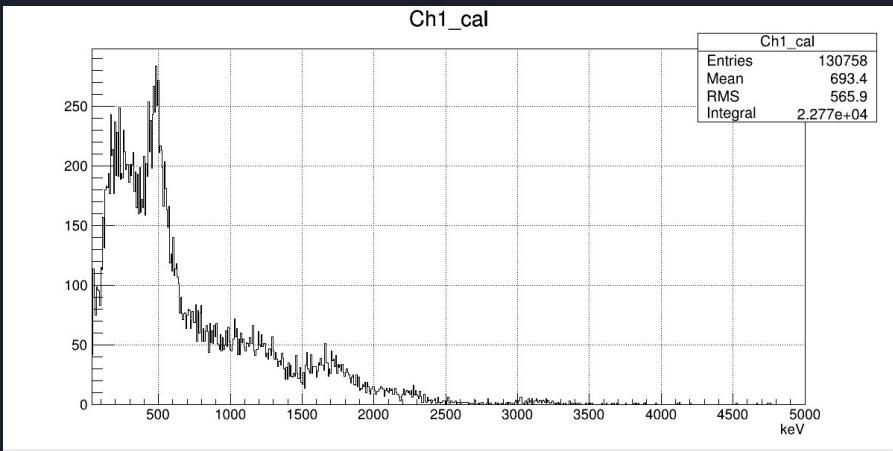


Multiplicidad open ^{22}Na



Multiplicidad 2

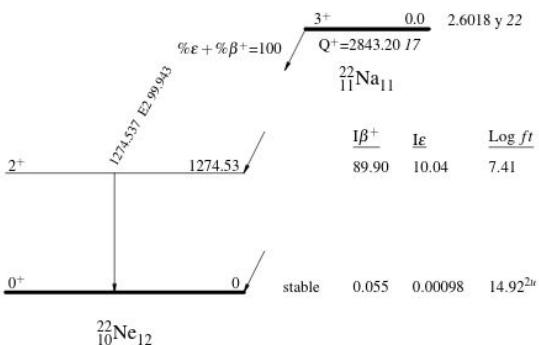
^{22}Na



$^{22}\text{Na} \beta^+ \text{ decay}$

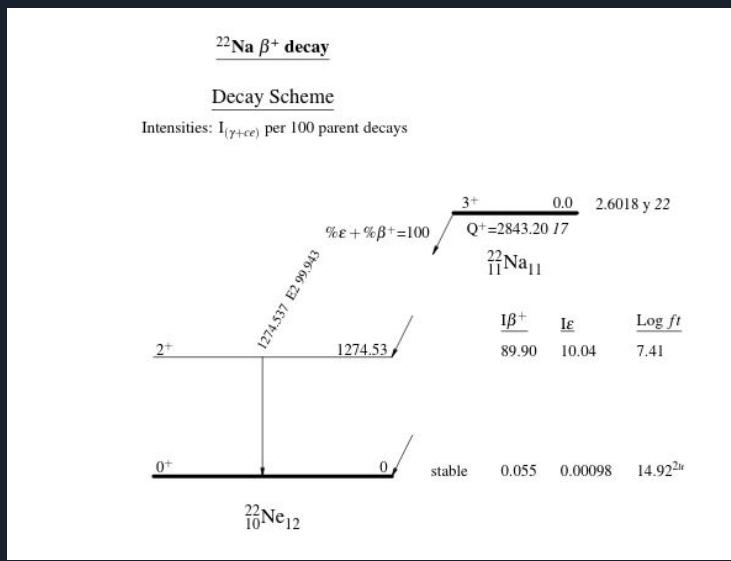
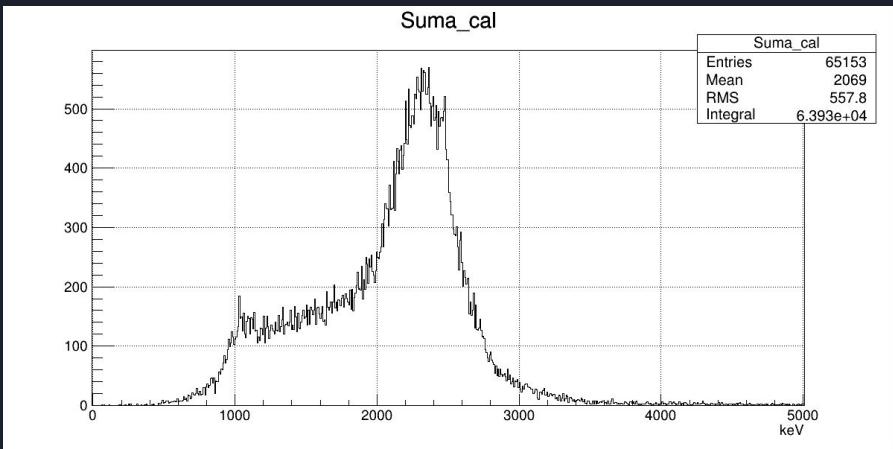
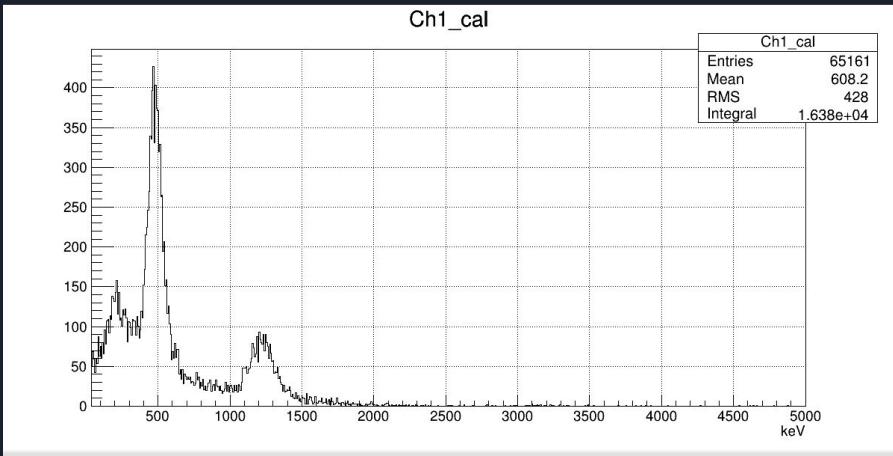
Decay Scheme

Intensities: $I_{(\gamma+\epsilon)}$ per 100 parent decays

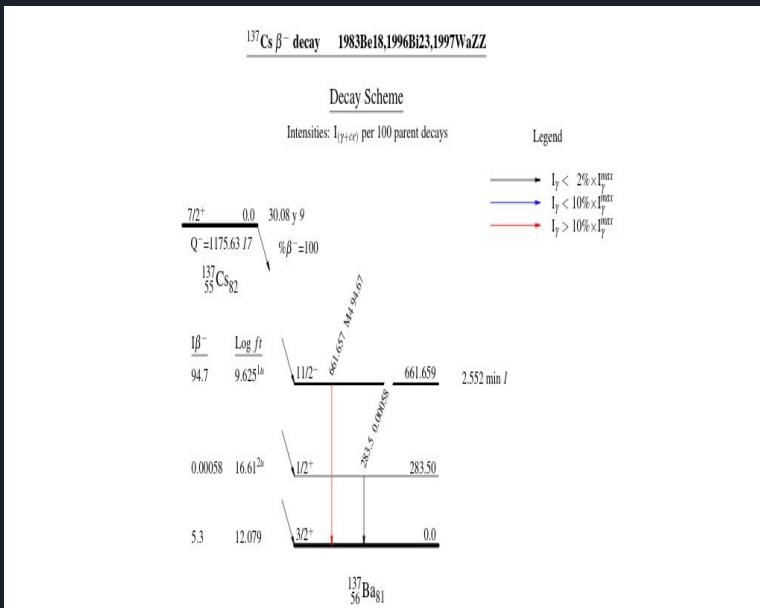
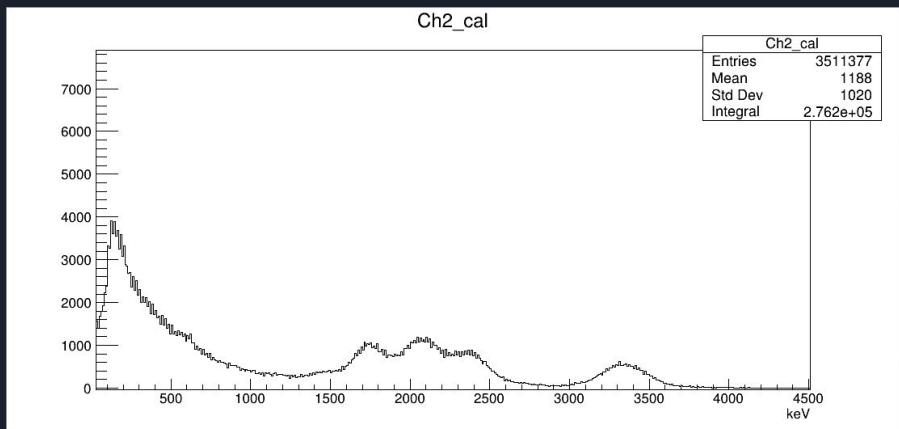
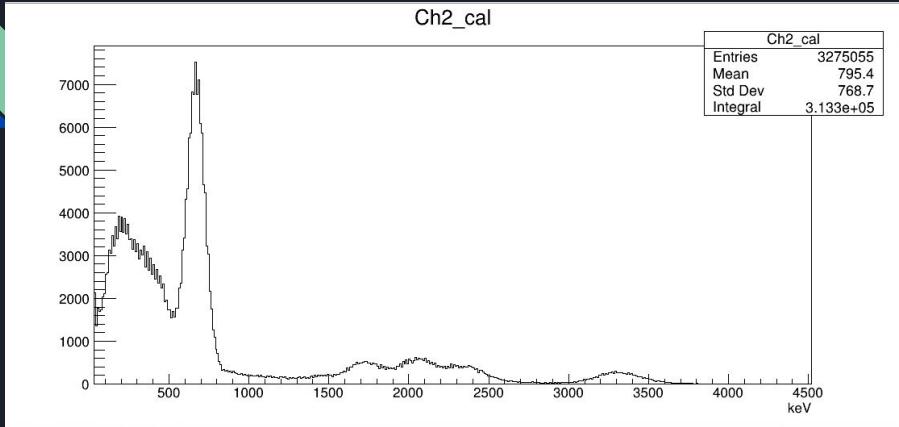


Multiplicidad 3

^{22}Na



Multiplicidad Open ^{137}Cs y Background



Instrucciones para elaborar la Memoria

Punto 1:

Definir qué es un detector de absorción total y describir brevemente el detector usado y la cadena electrónica de la práctica.

Punto 2:

Describir las señales observadas en el osciloscopio con figuras.

Punto 3:

Explicar porqué es necesario alinear las señales de los detectores individuales usando el voltaje aplicado a los PMs.

Punto 4:

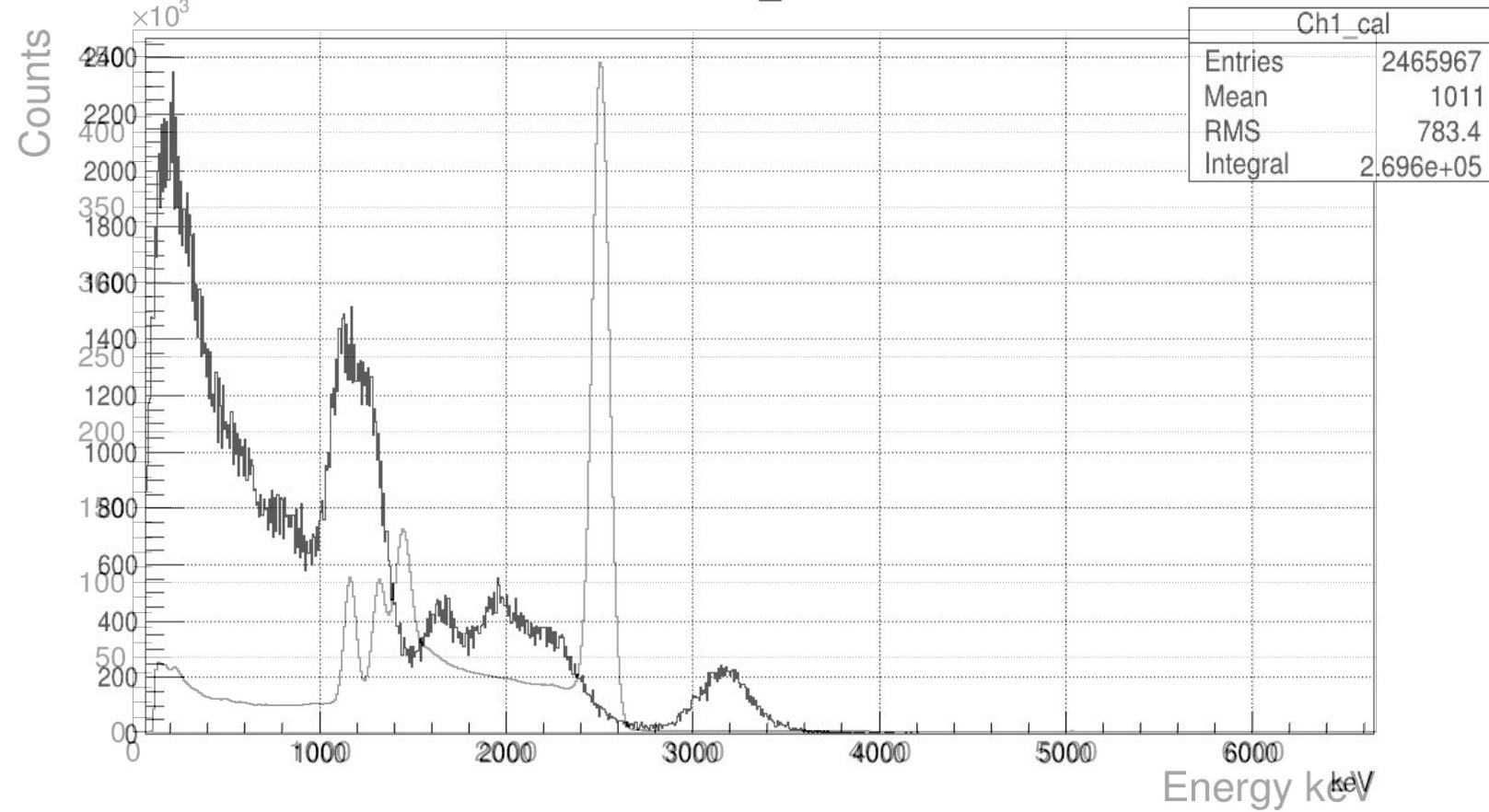
Usar los histogramas proporcionados en formato root. Mostrar los espectros calibrados del chan1 (ch1_cal) y del canal suma (Suma_cal) para los espectros de:

1. 137Cs multiplicidad open y mult 2. Marcando los picos del 137Cs y las alfas cuando sean visibles.
2. 60Co multiplicidad open, 1, y 2. Marcando los picos del 60Ca individuales o suma cuando sean visibles.
3. 22Na multiplicidad open, 2 y 3. Marcando los picos individuales y suma cuando sean visibles.

Punto 5:

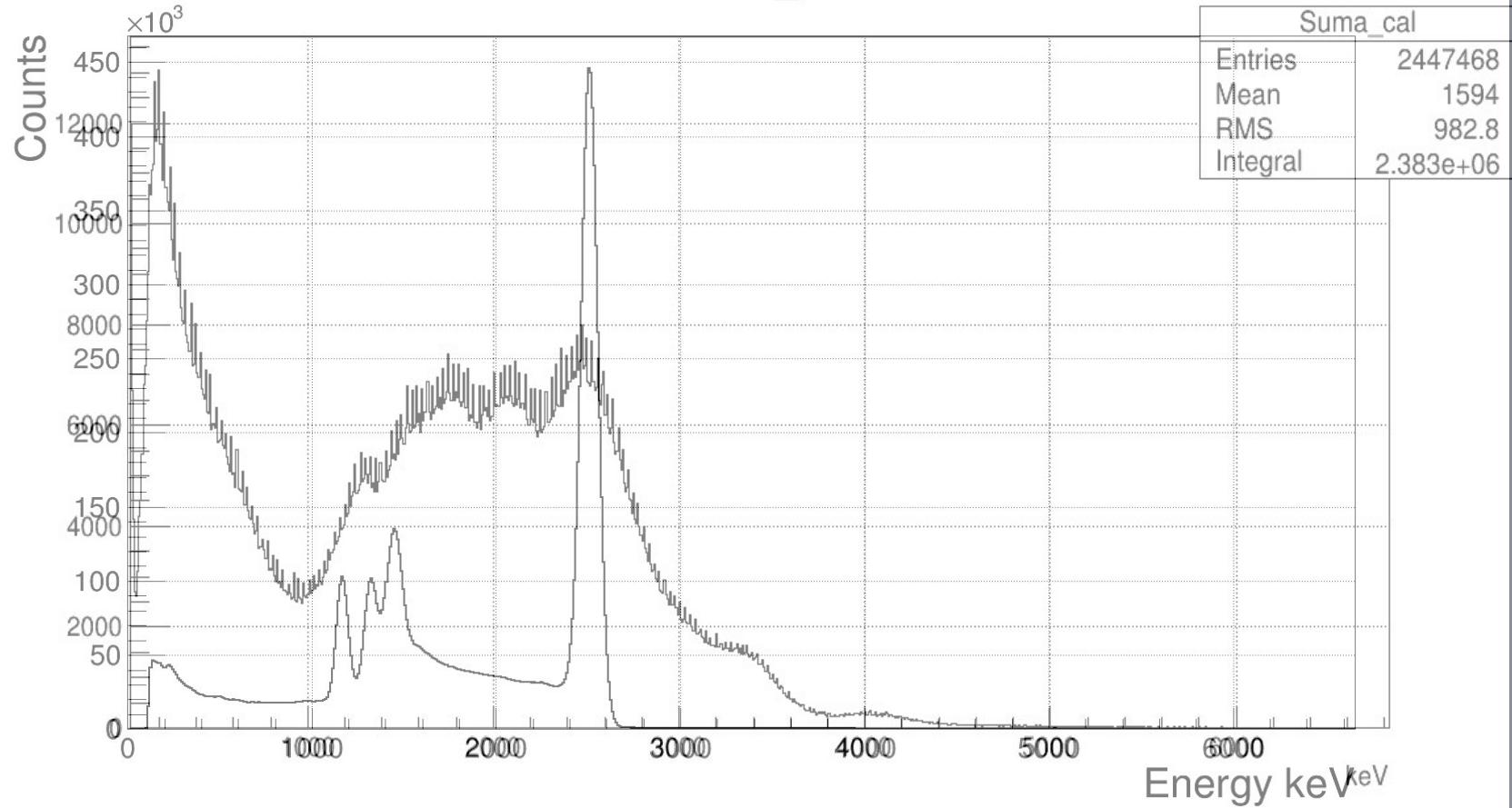
Obtener en el espectro TAS Reginante sin fondo para el 137Cs. Usando las medidas de 137Cs multiplicidad open (5 min) y de fondo (10min). Comparar con el espectro 137Cs, mult 2, suma.

Ch1_cal

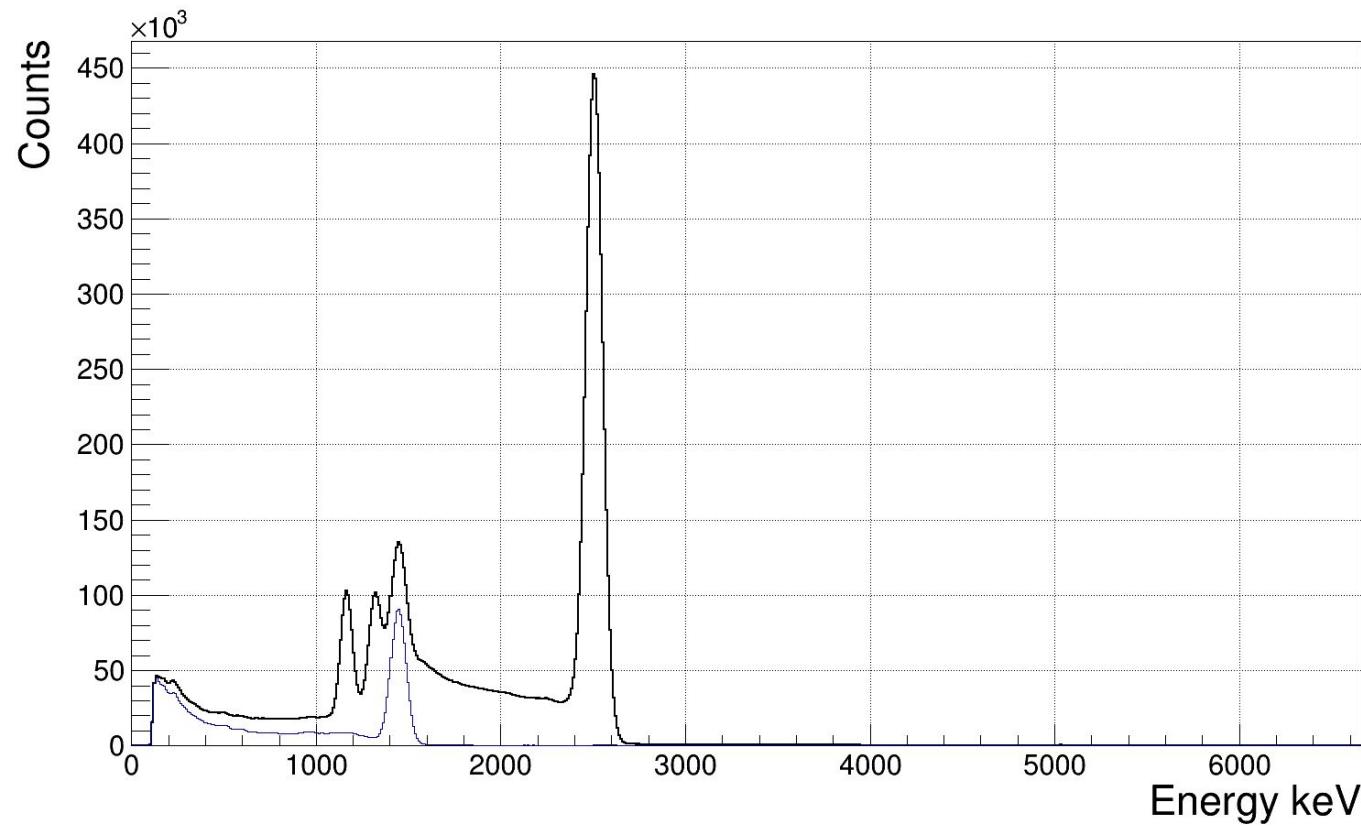


Comparación de espectros obtenidos por un cristal de NaI y otro de BaF₂ para una muestra de ⁶⁰Co

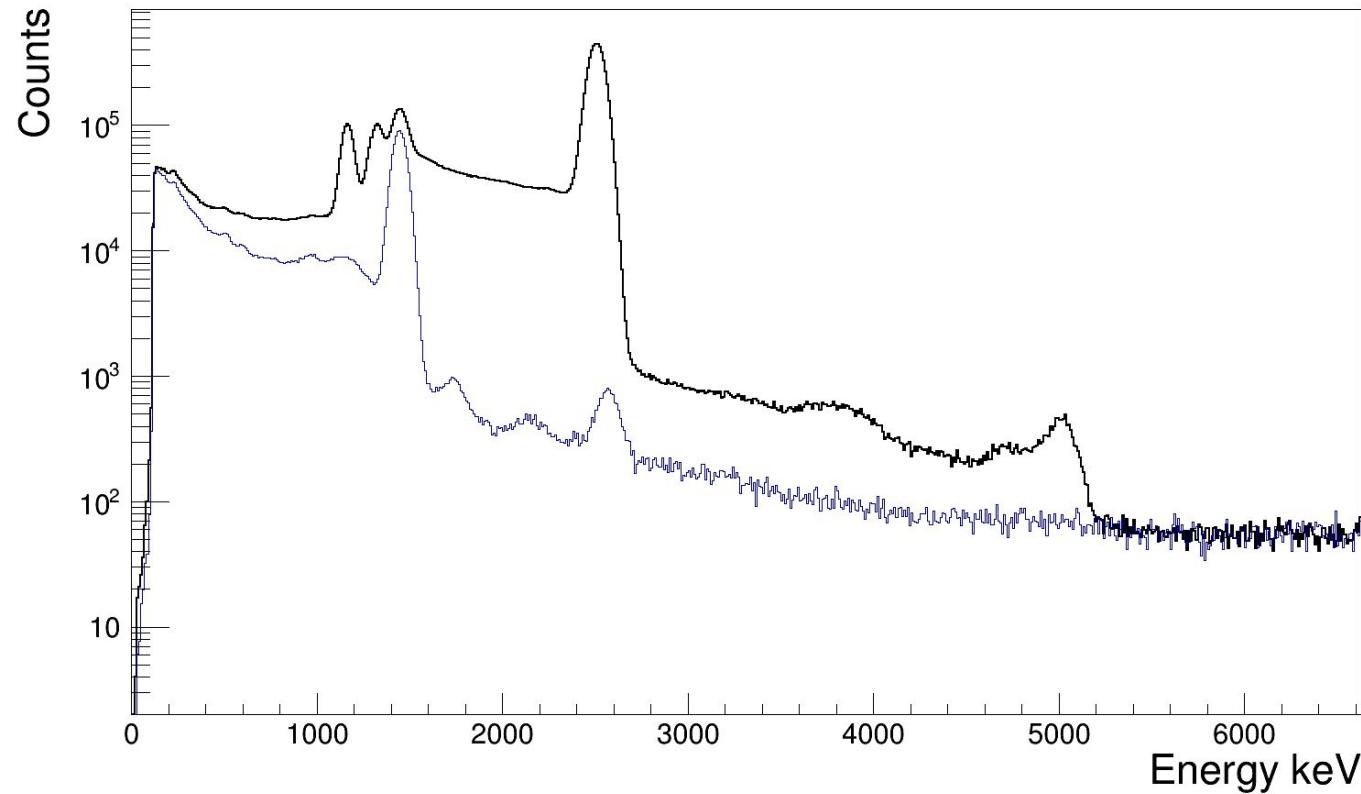
Suma_cal



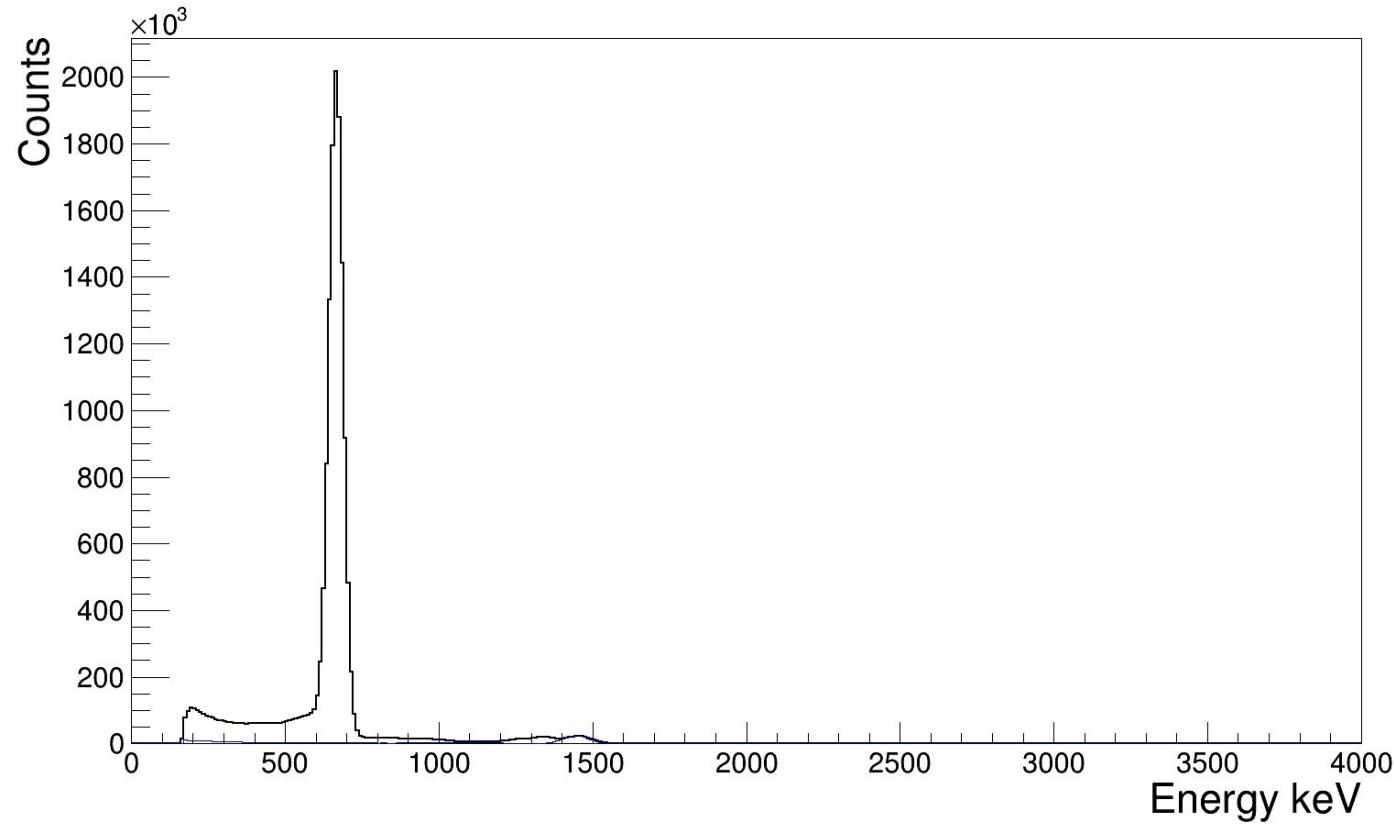
Comparación de espectros obtenidos por un cristal de NaI y otro de BaF₂ para una muestra de ^{60}Co



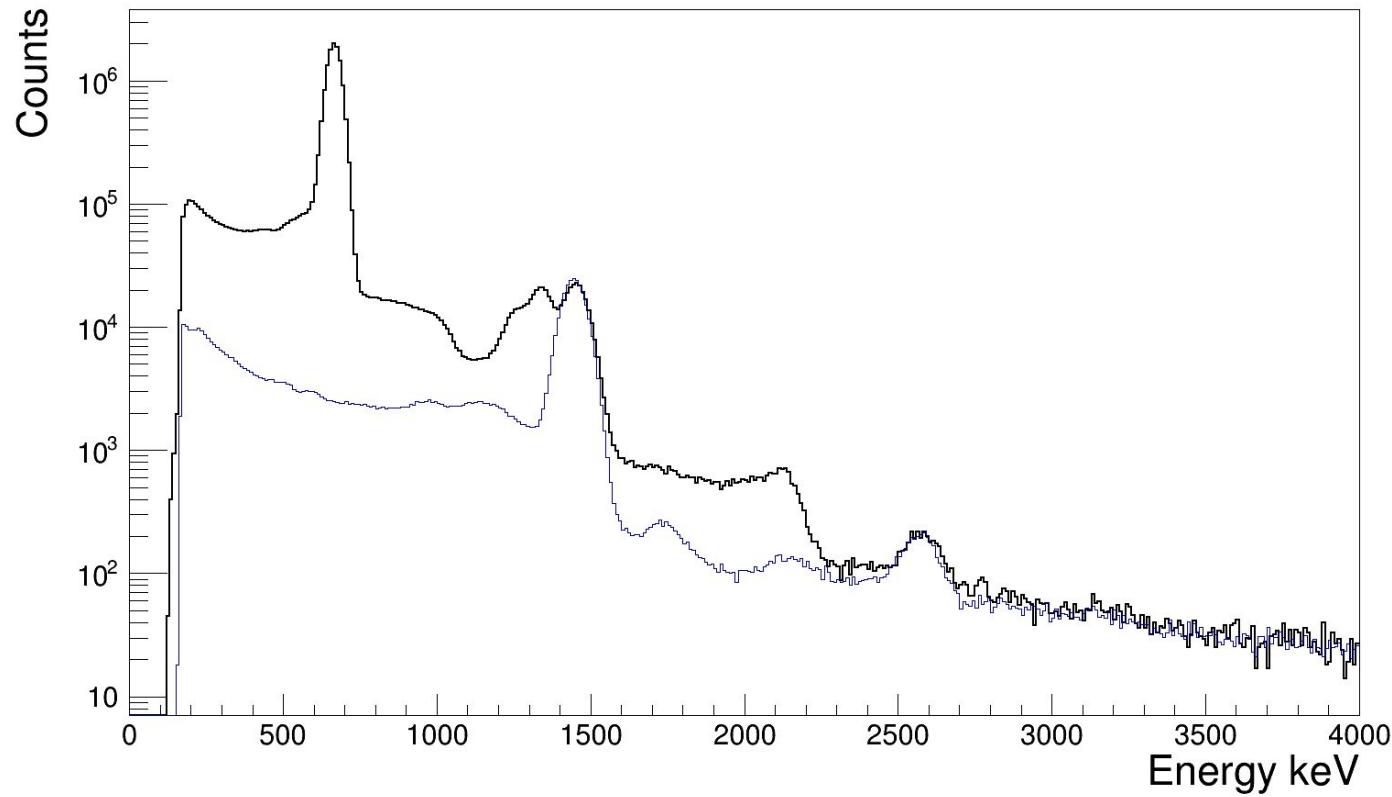
Espectro de ^{60}Co obtenido con un cristal de NaI, superpuesto se encuentra la medición de Background en las mismas condiciones experimentales



Espectro de ⁶⁰Co obtenido con un cristal de NaI, superpuesto se encuentra la medición de Background en las mismas condiciones experimentales



Espectro de ^{137}Cs obtenido con un cristal de NaI, superpuesto se encuentra la medición de Background en las mismas condiciones experimentales



Espectro de ¹³⁷Cs obtenido con un cristal de NaI, superpuesto se encuentra la medición de Background en las mismas condiciones experimentales

Ch1_PeakHist

Ch12_PeakHist

Entries	2.746546e+08
Mean	2426
RMS	230.5
Integral	6.454e+07

