INTEREST – INTErnational Remote Student Training Wave 3

Radiation Protection and the Safety of the Radiation Sources

08 February - 19 March 2021

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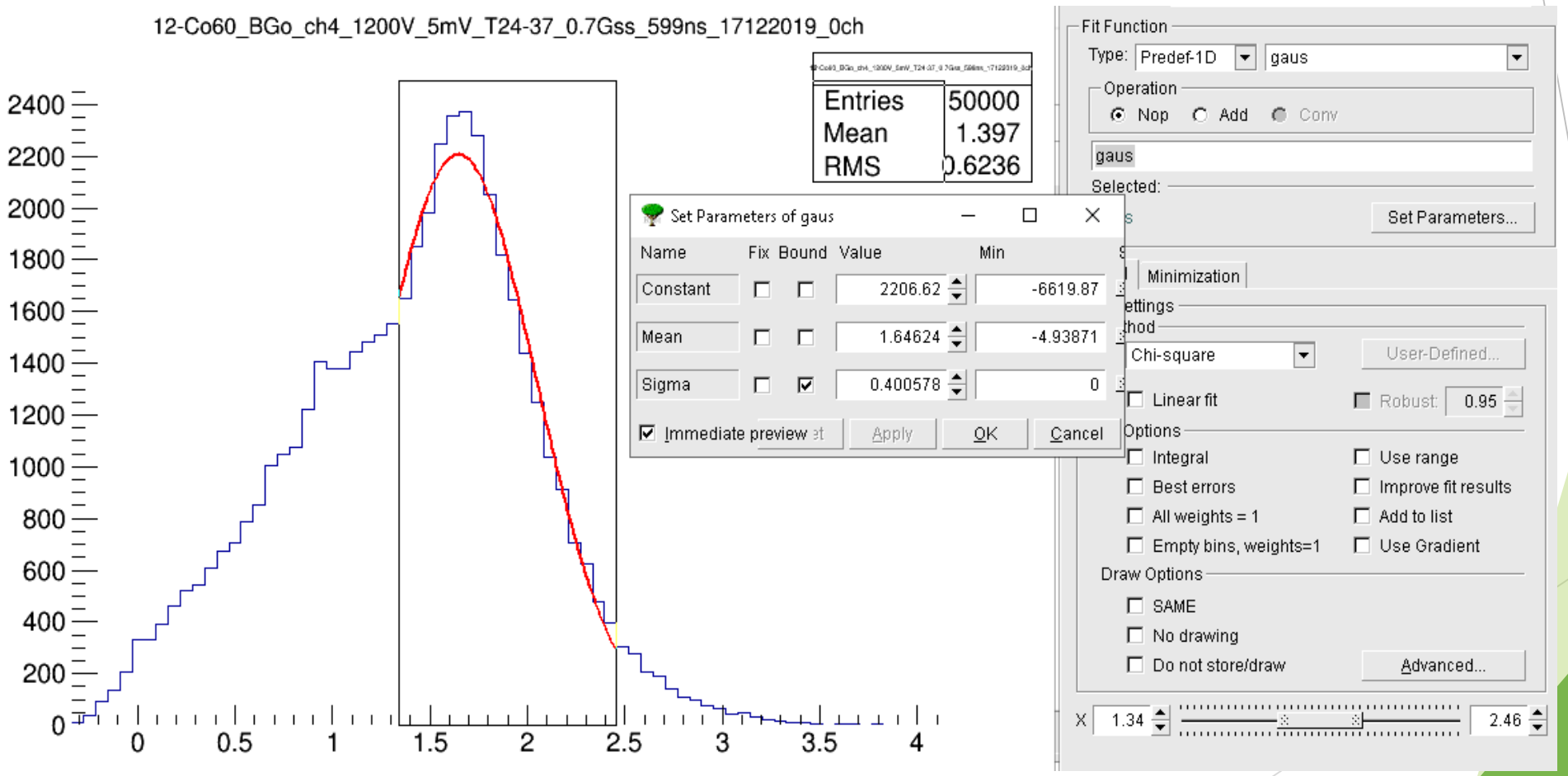
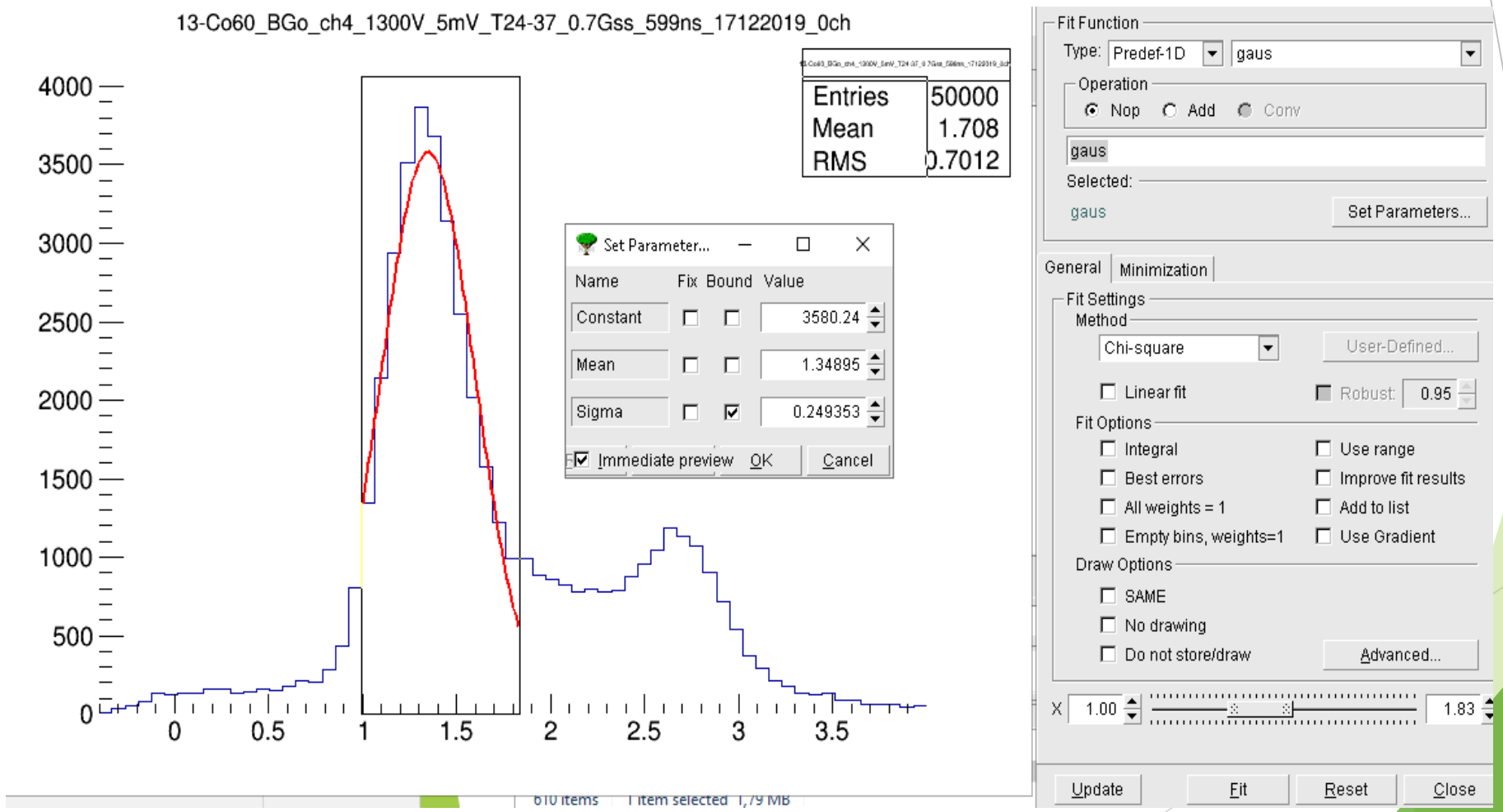
TASK 1

Dependence of resolution on applied voltage for BGO detector

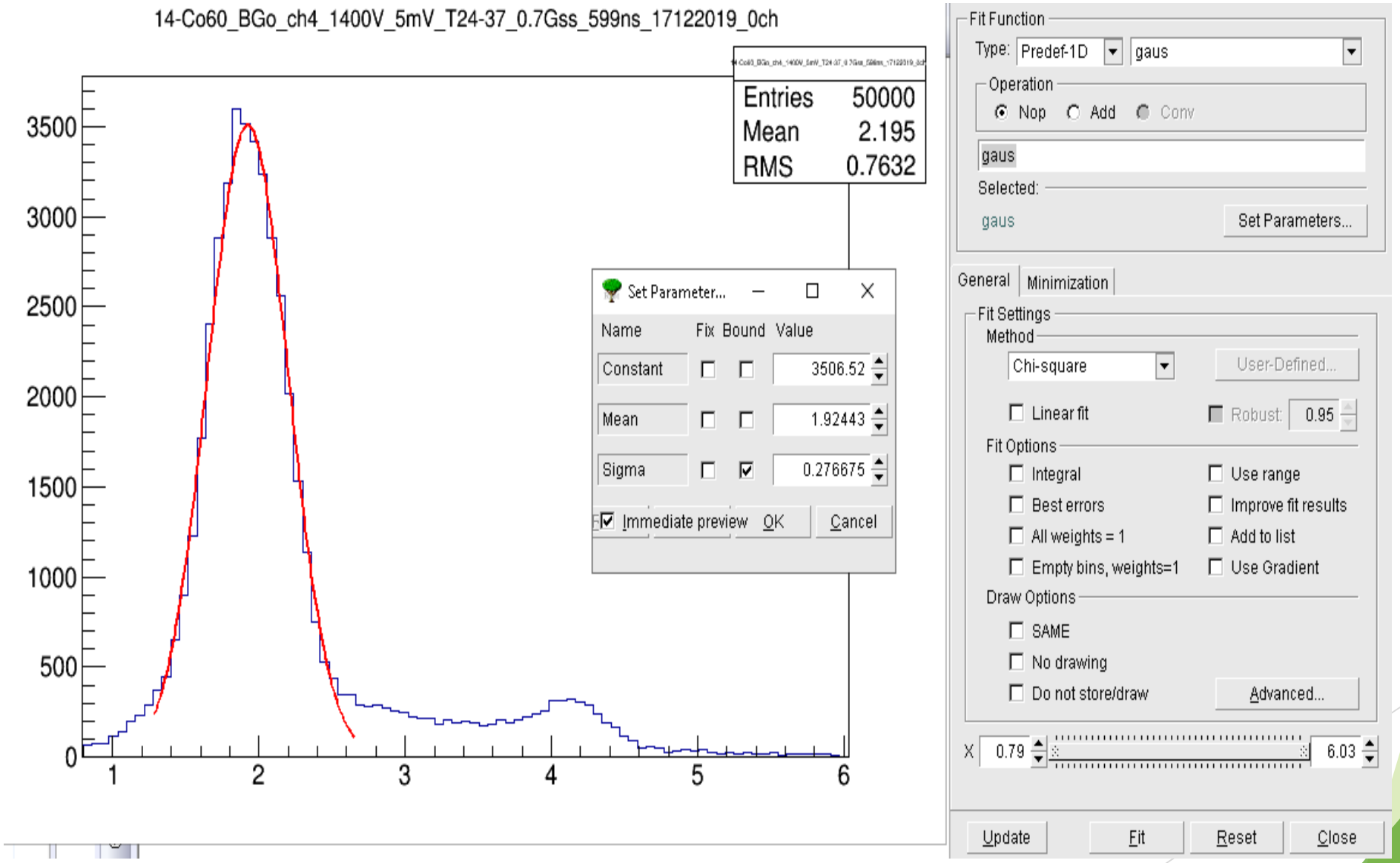
Resolution=(sigma/mean)*2,35=0,57



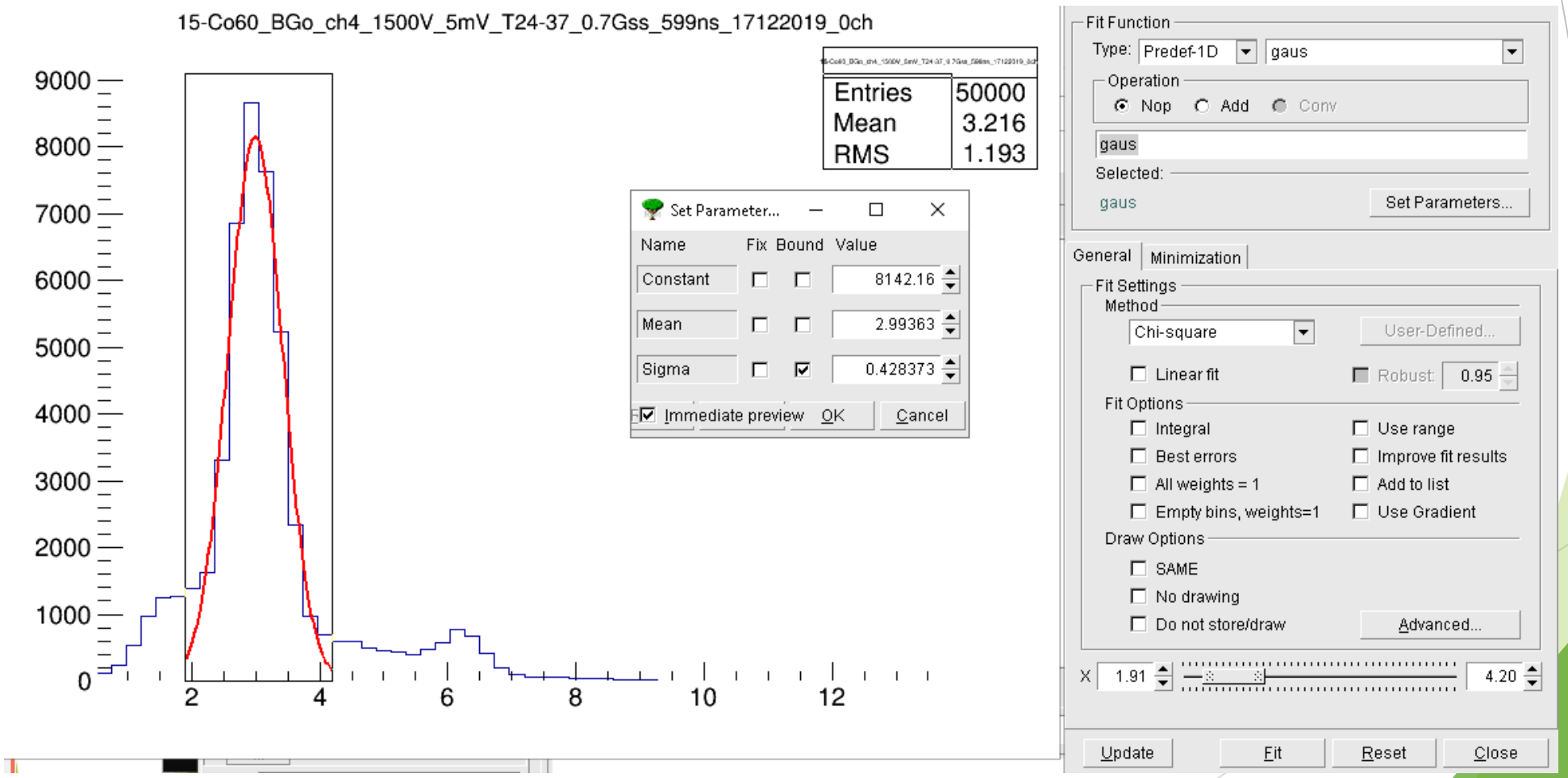
Resolution=(sigma/mean)*2,35=0,43



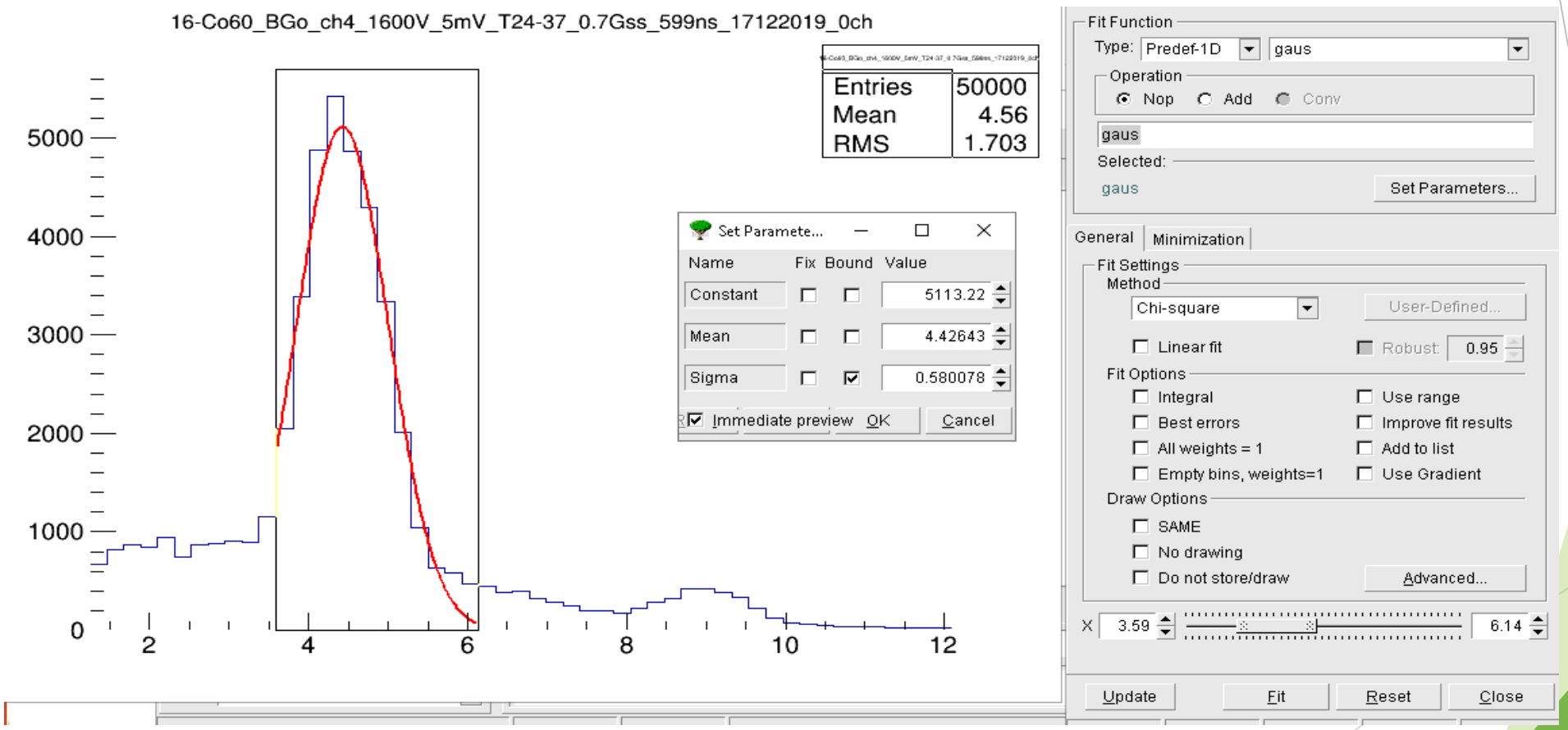
Resolution=(sigma/mean)*2,35=0,337



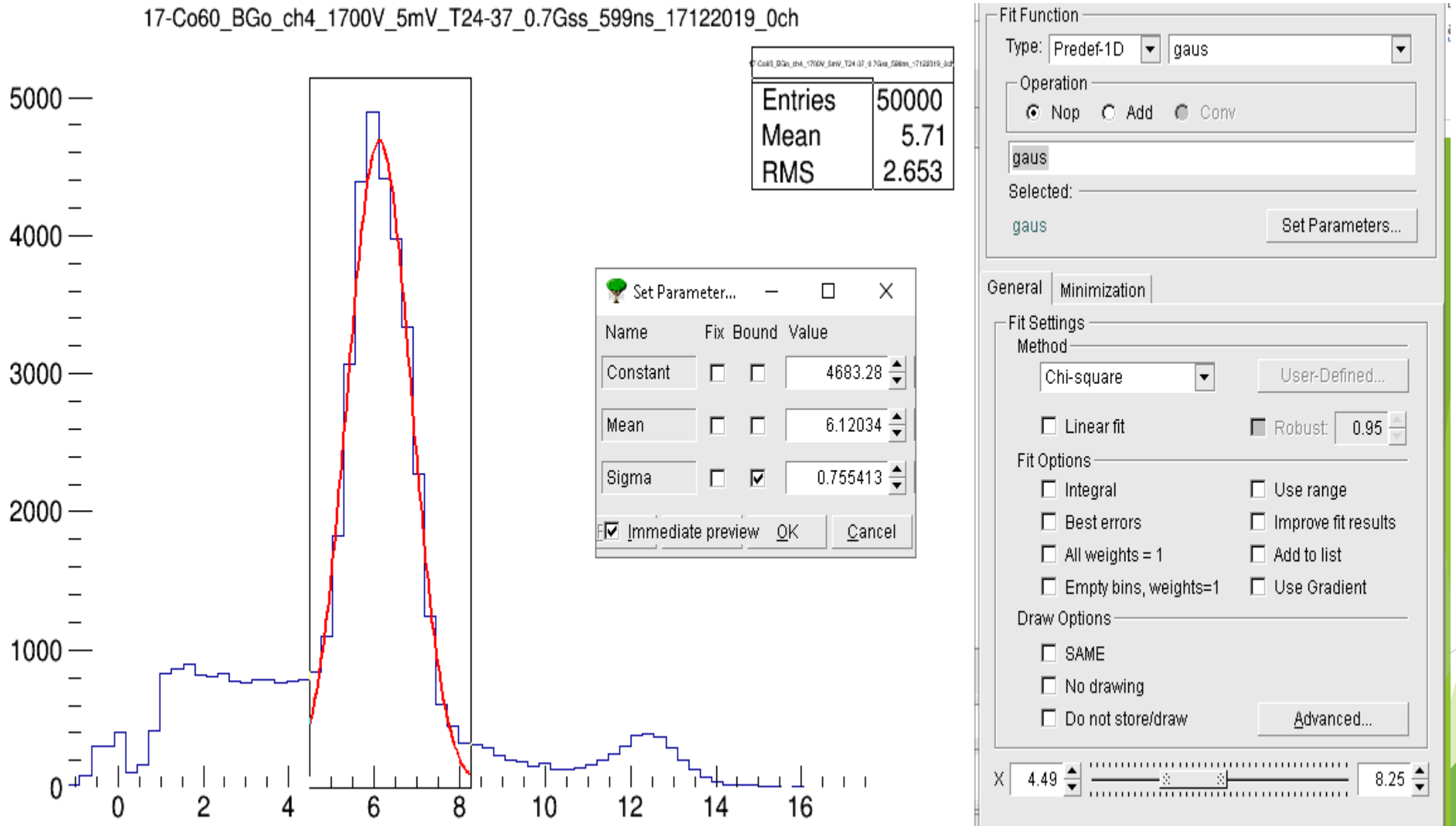
Resolution=(sigma/mean)*2,35=0,335



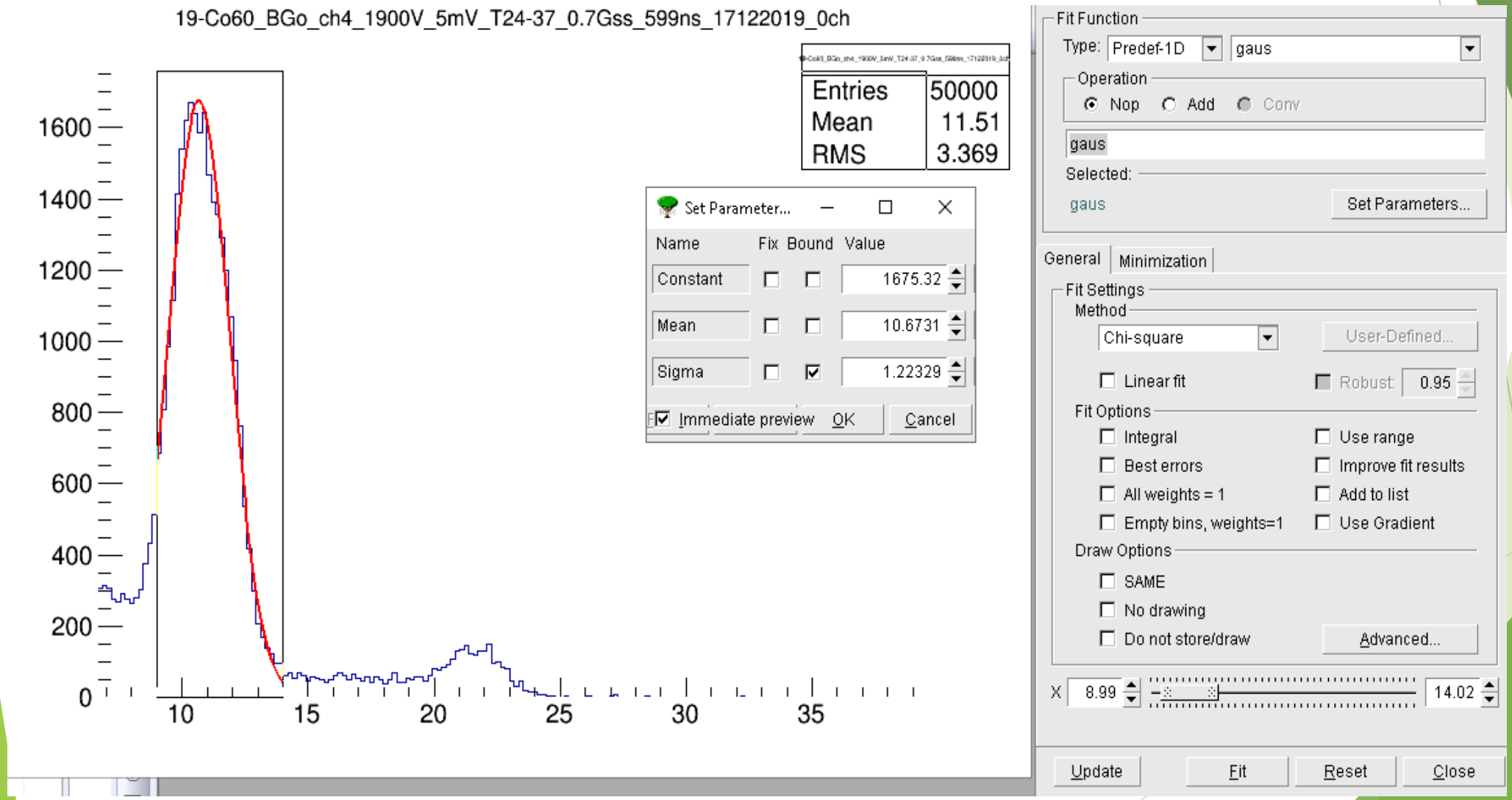
Resolution=(sigma/mean)*2,35=0,308



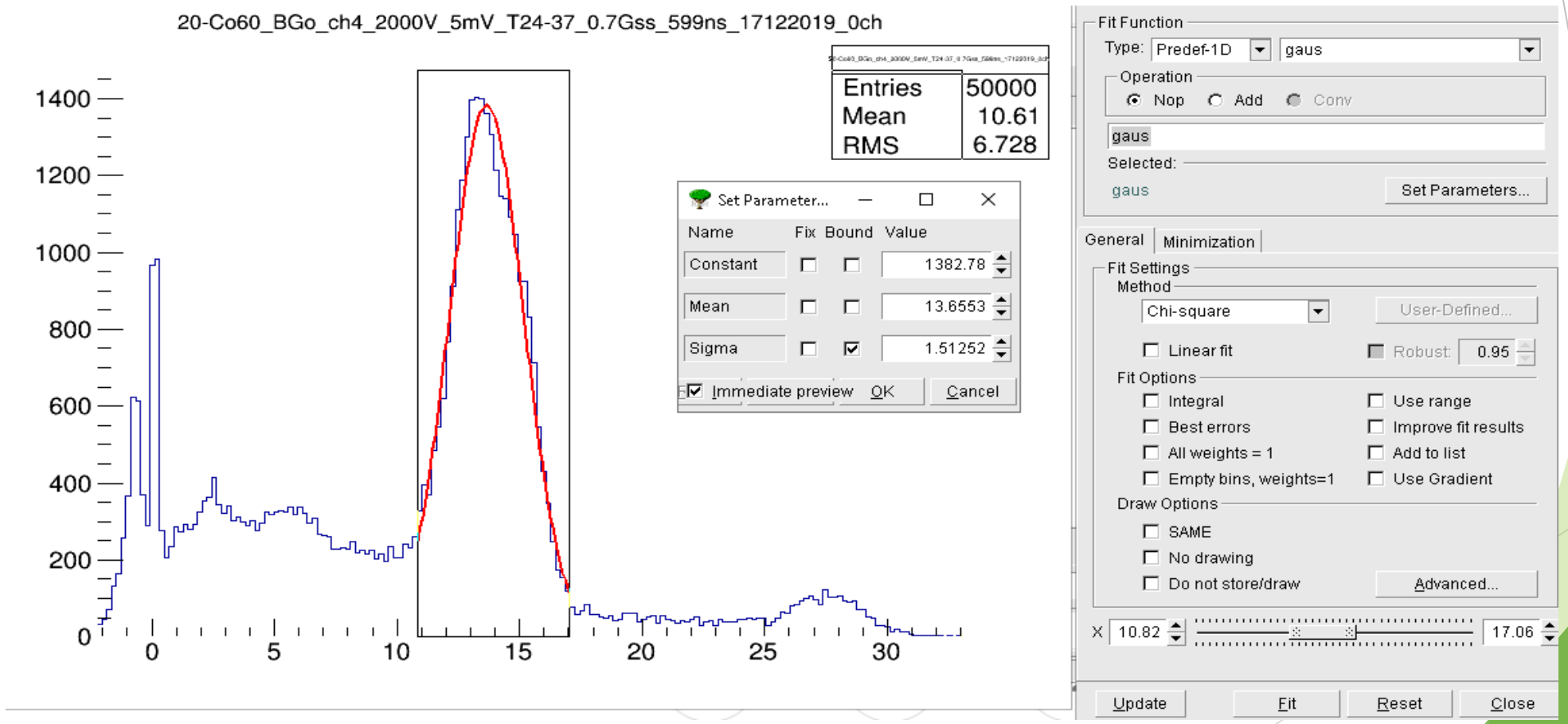
Resolution=(sigma/mean)*2,35=0,29



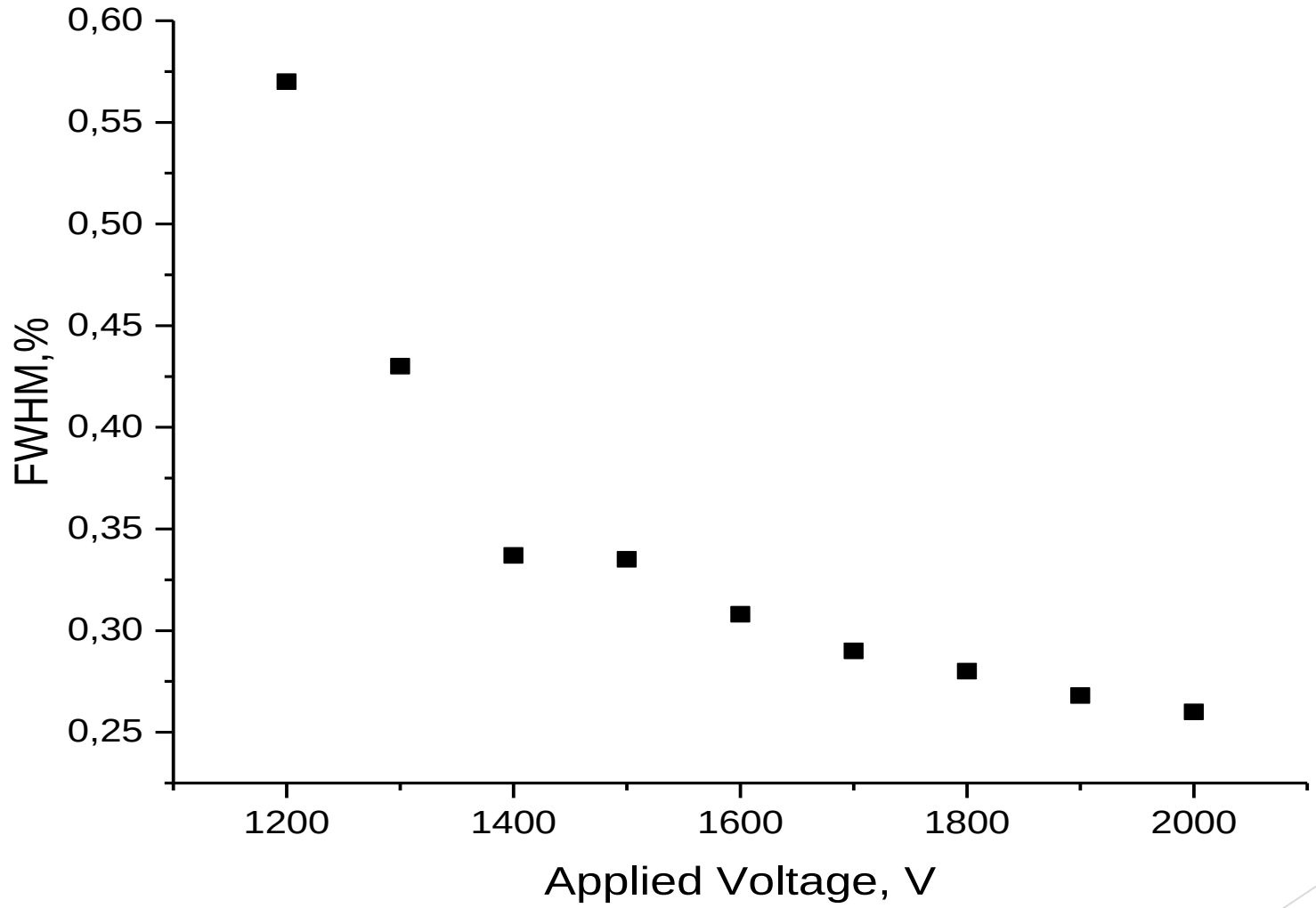
Resolution=(sigma/mean)*2,35=0,268



Resolution=(sigma/mean)*2,35=0,26



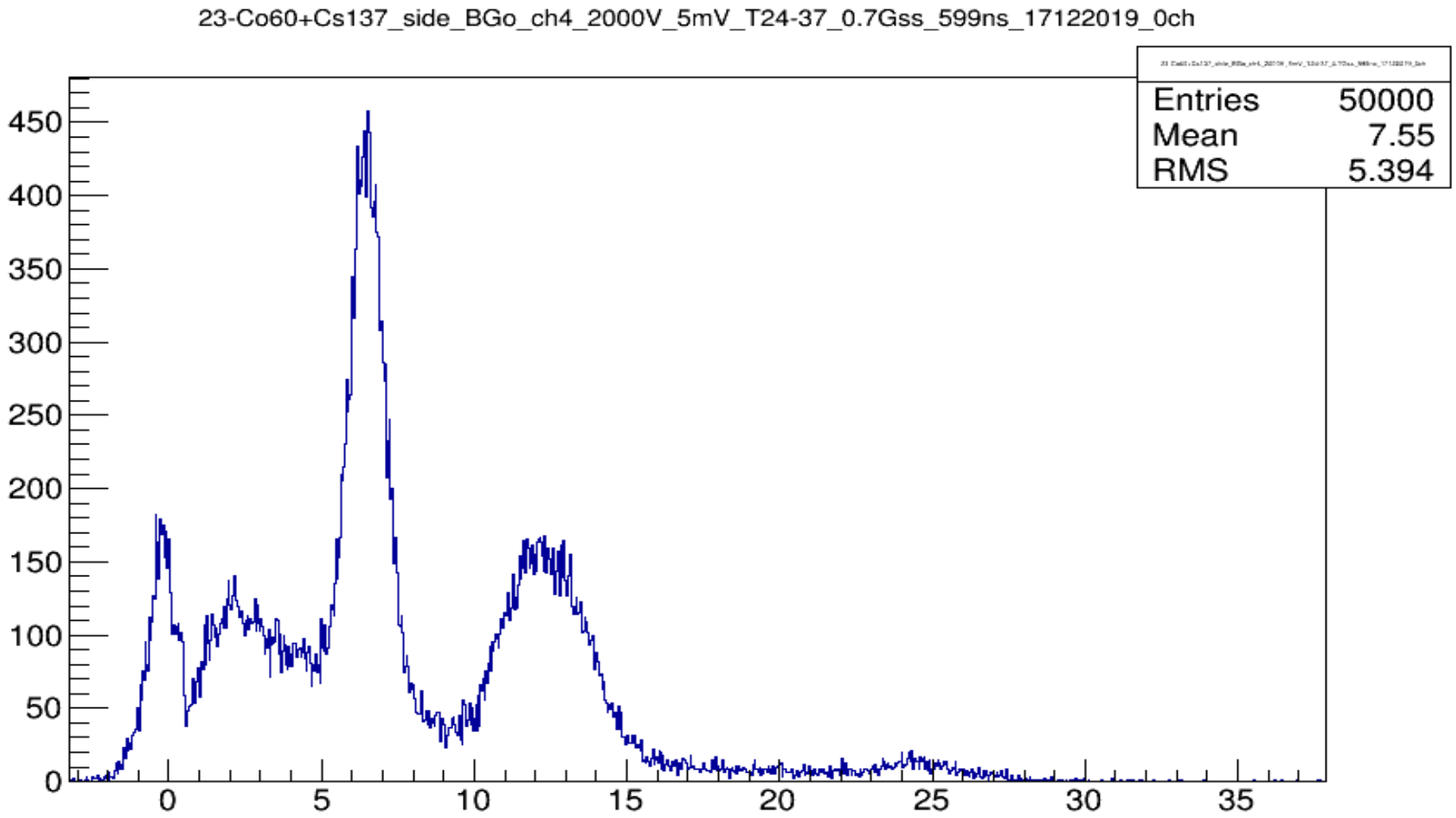
Dependence of resolution on applied voltage for BGO detector



TASK 2

The calibration spectra for BGO detector

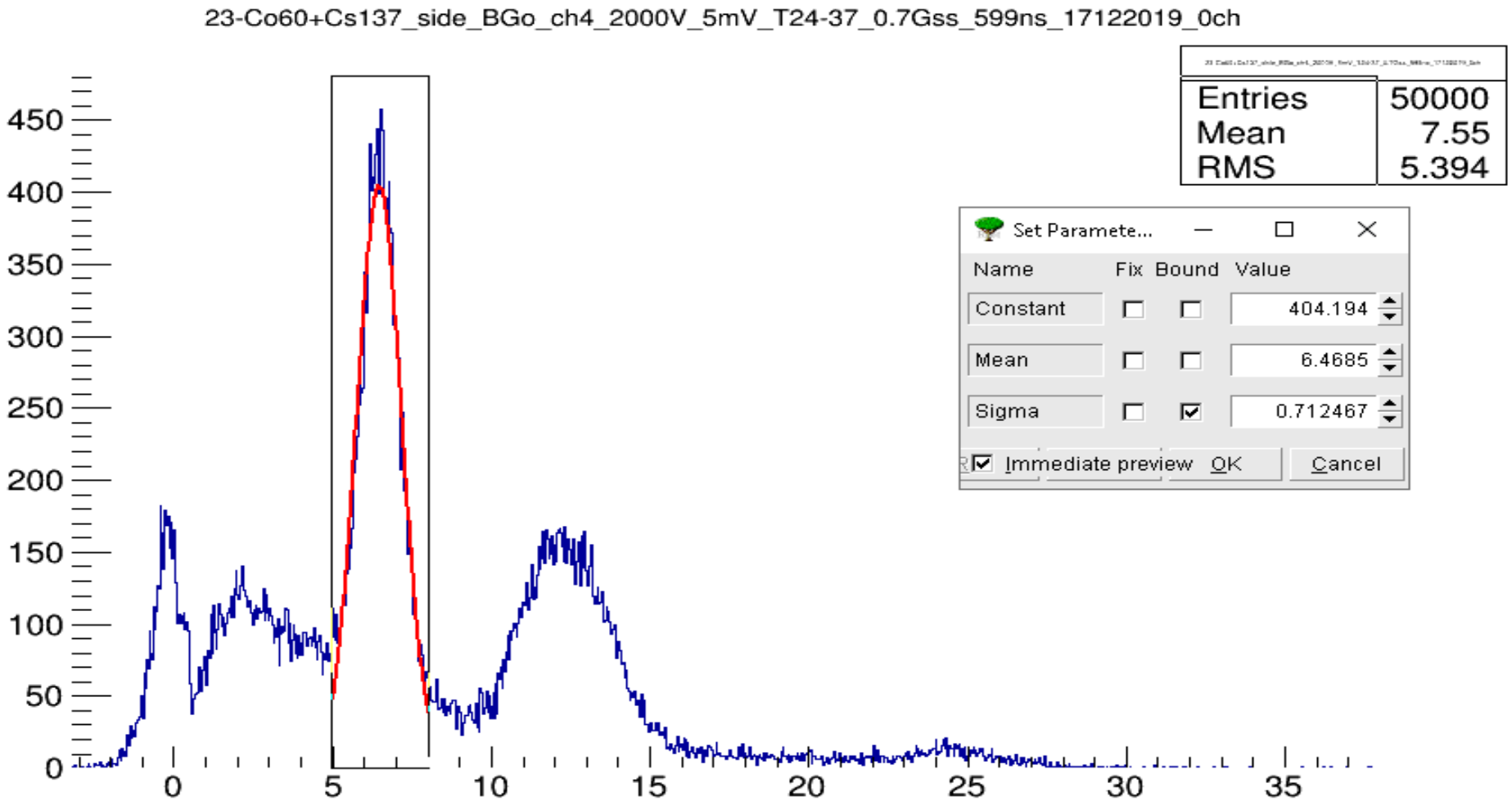
BGO-Co60+Cs137-2000V



Gaus FIT –first peak

Cs137 energy spectra=0,662MeV

Mean=6,4685

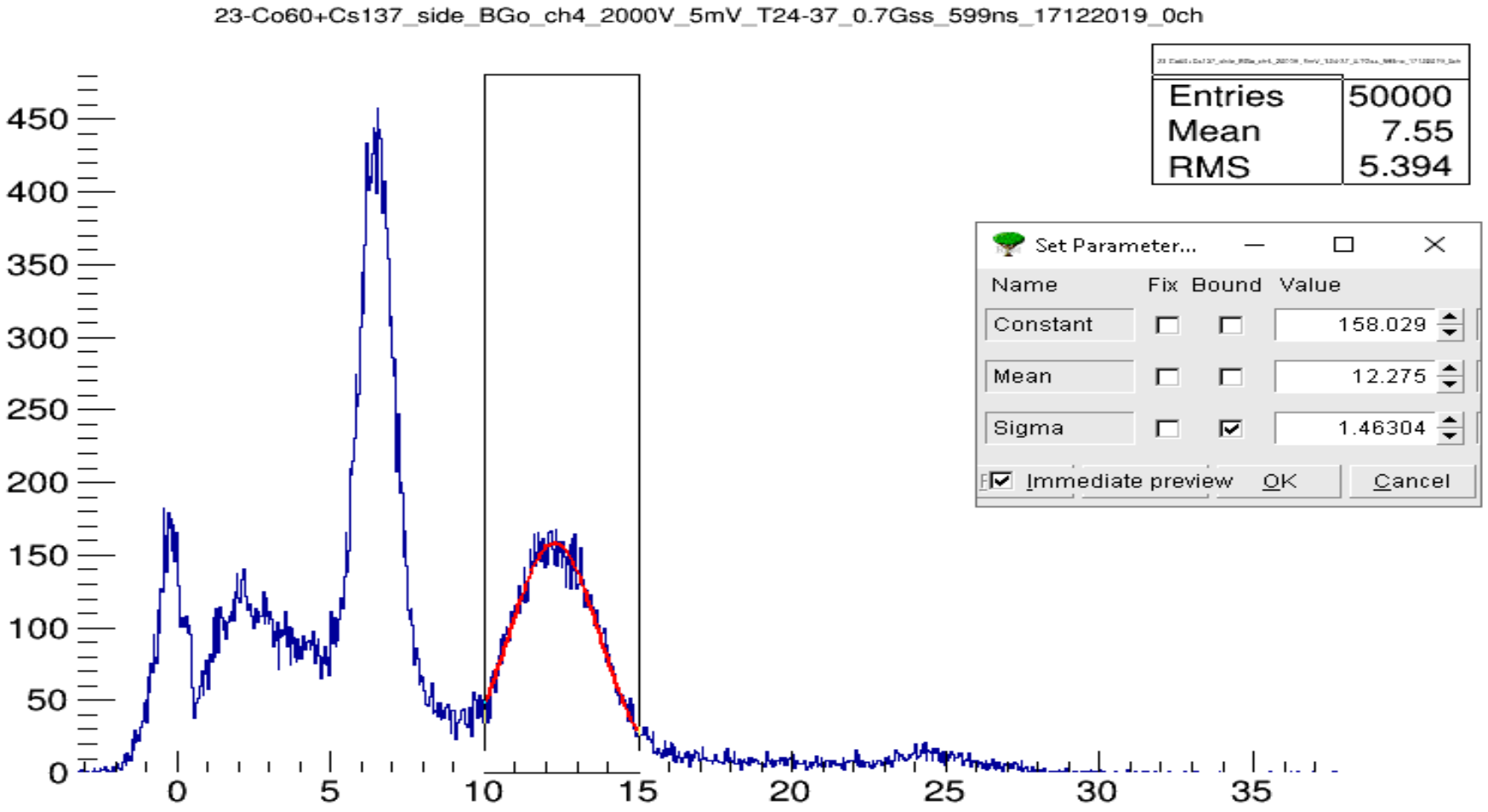


Gaus FIT –second peak

Co60 energy spectra=1,17MeV and 1,33MeV

The average is =1,25MeV

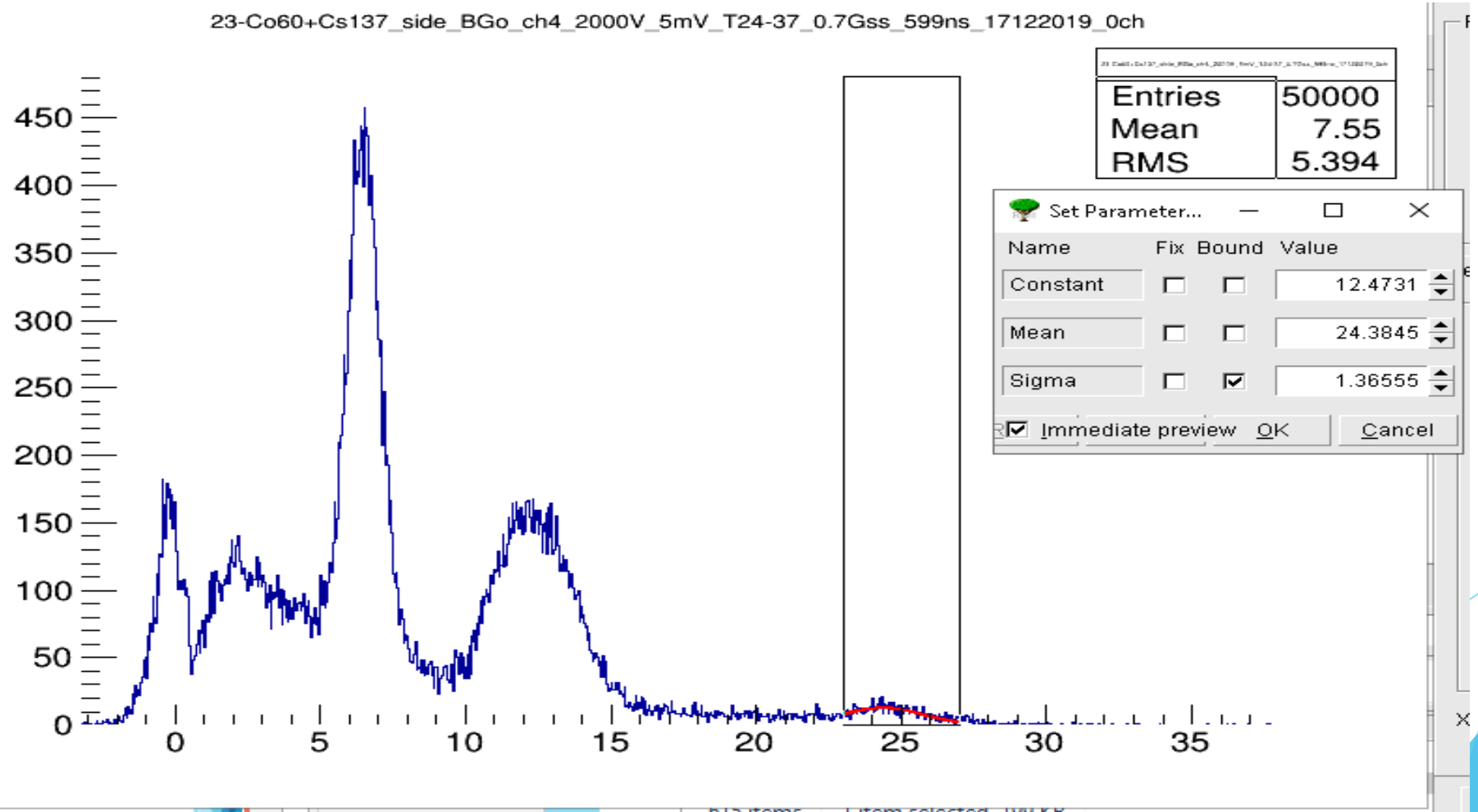
Mean=12,275



Gaus FIT –third peak

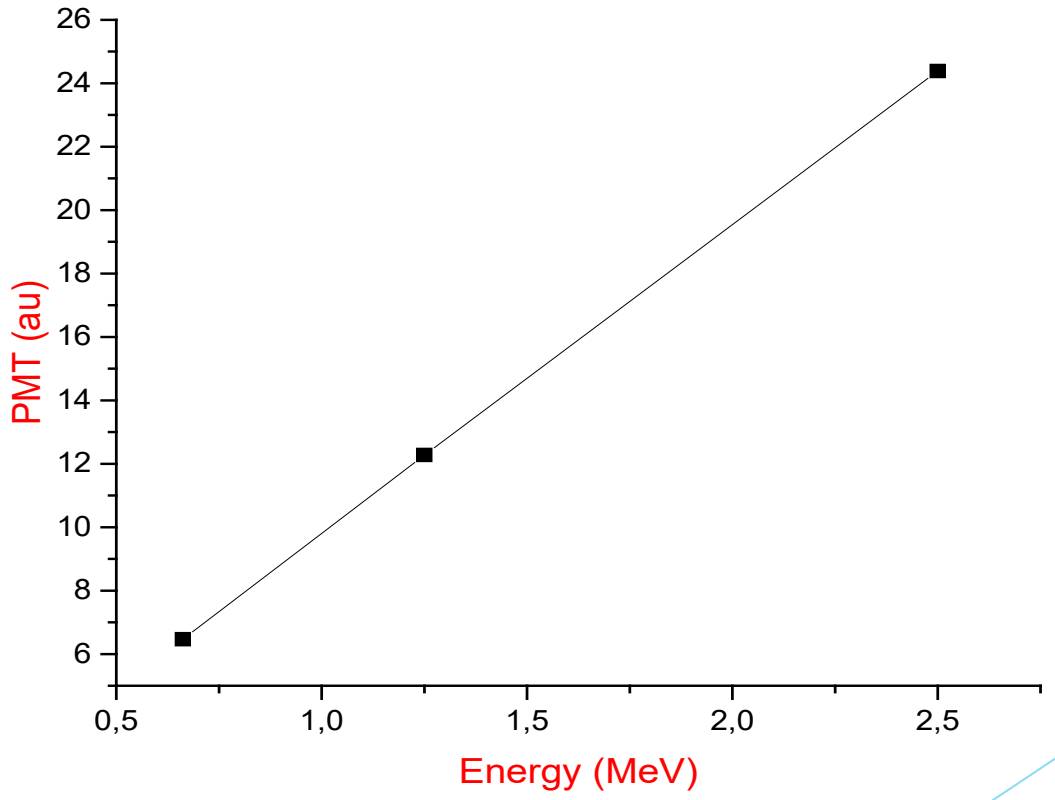
Co60 energy spectra (last peak)=2,5MeV

Mean=24,3845



The calibration spectra for BGO detector

Energy (MeV)	PMT (au)
0,662	6,4685
1,25	12,275
2,5	24,3845



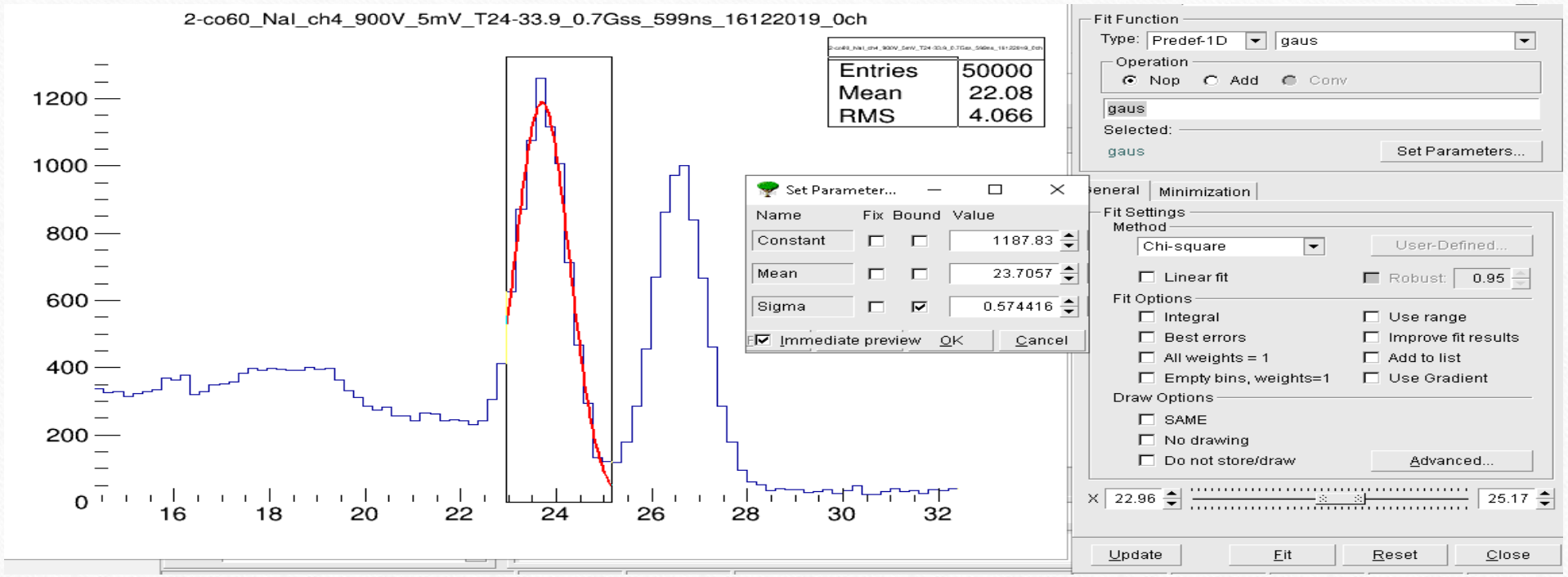
Task 3

NaI

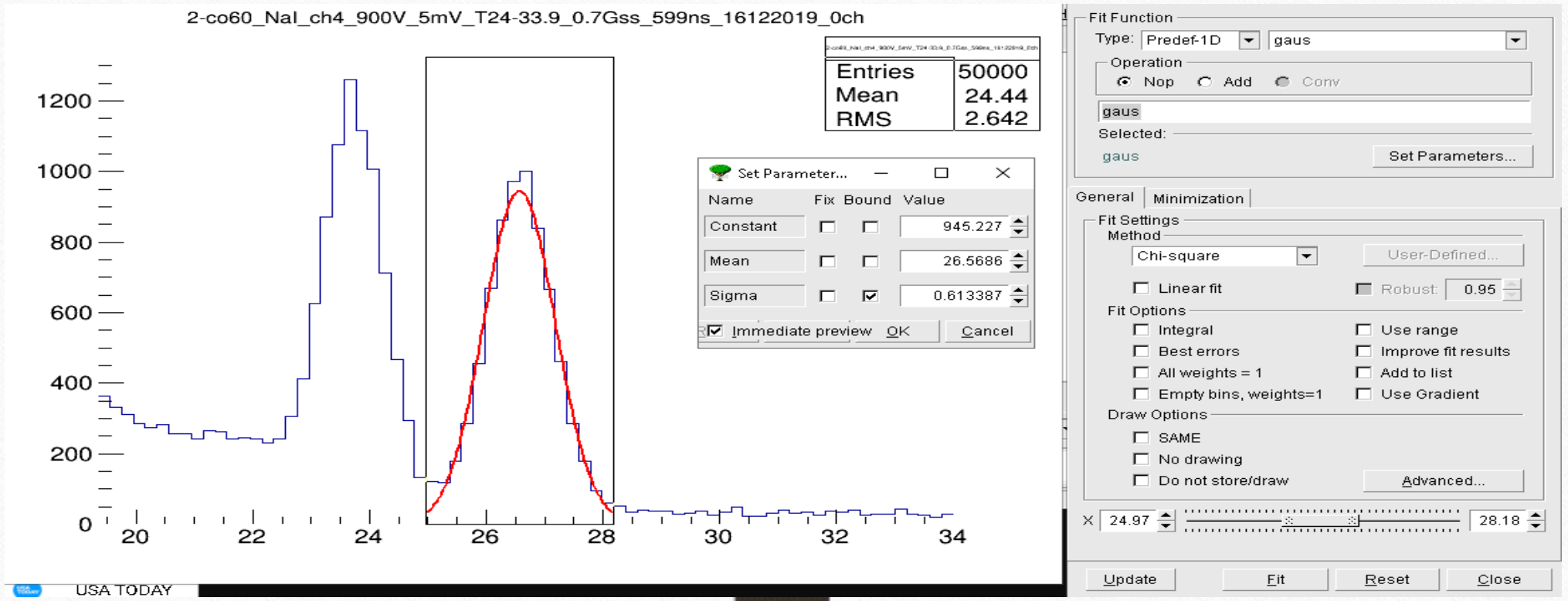
- **Part 1-Dependence of resolution on applied voltage for NaI**

For first peak (900V)

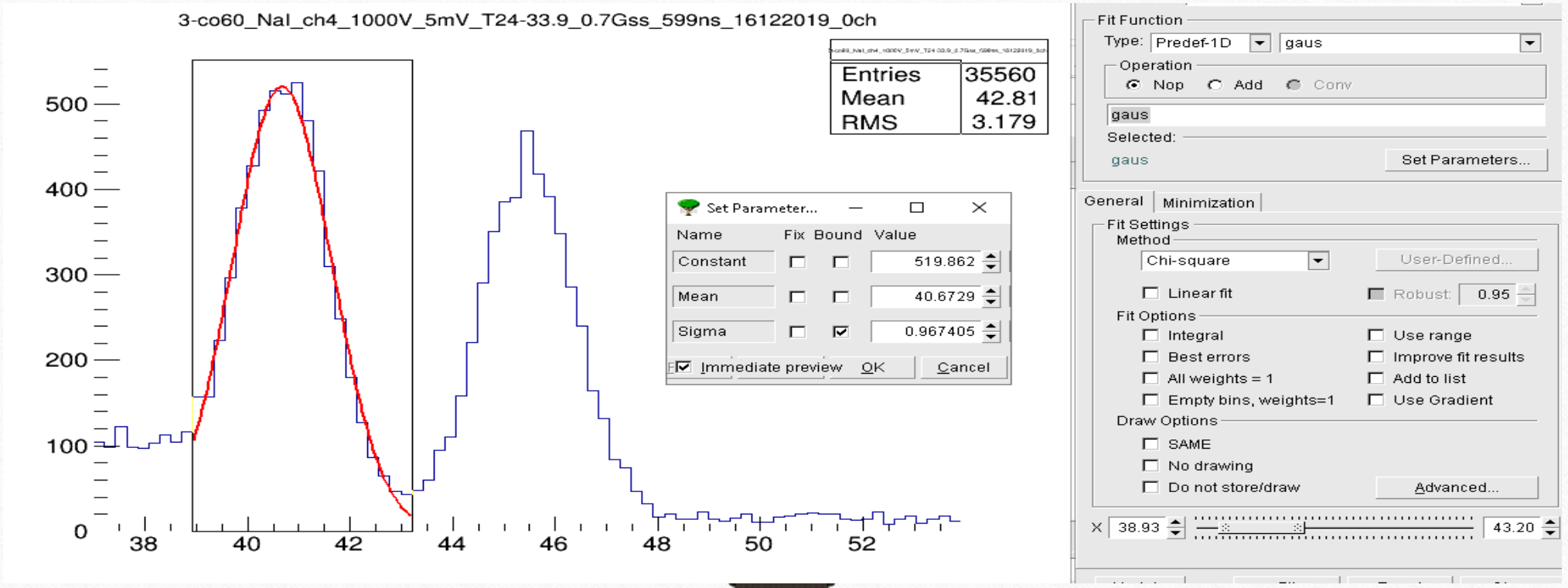
Resolution=(sigma/mean)*2,35=0,0565



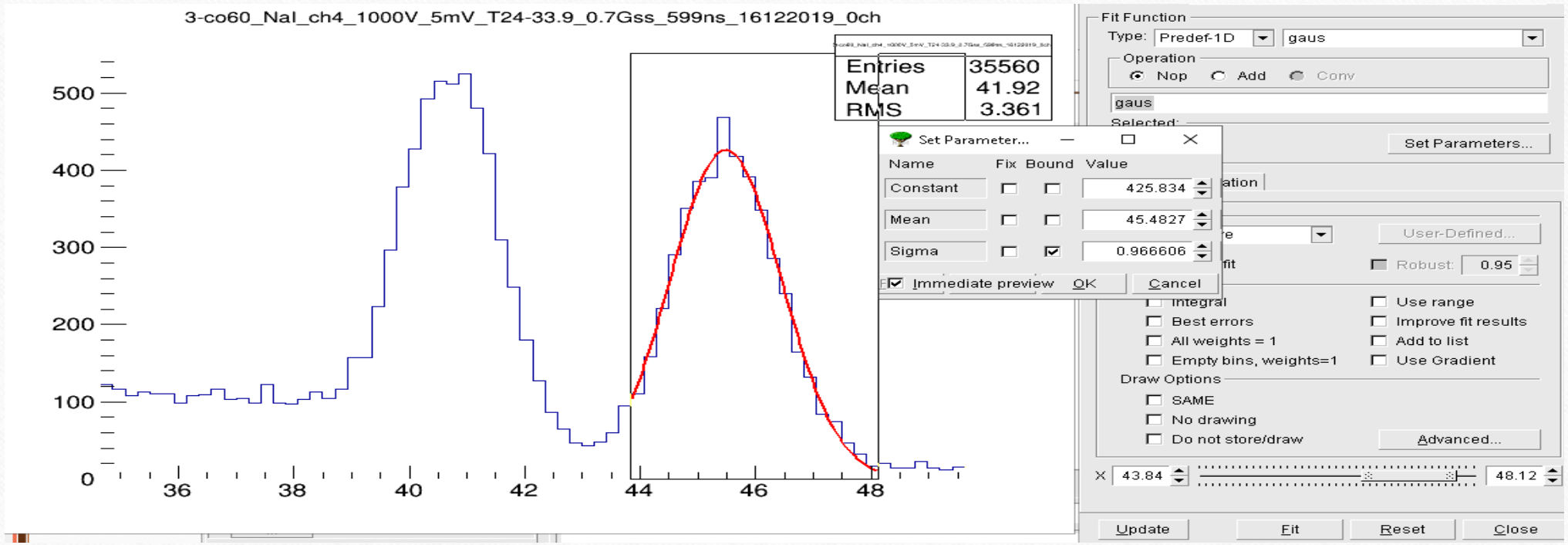
for Second peak (900V)
Resolution=(sigma/mean)*2,35=0,0539



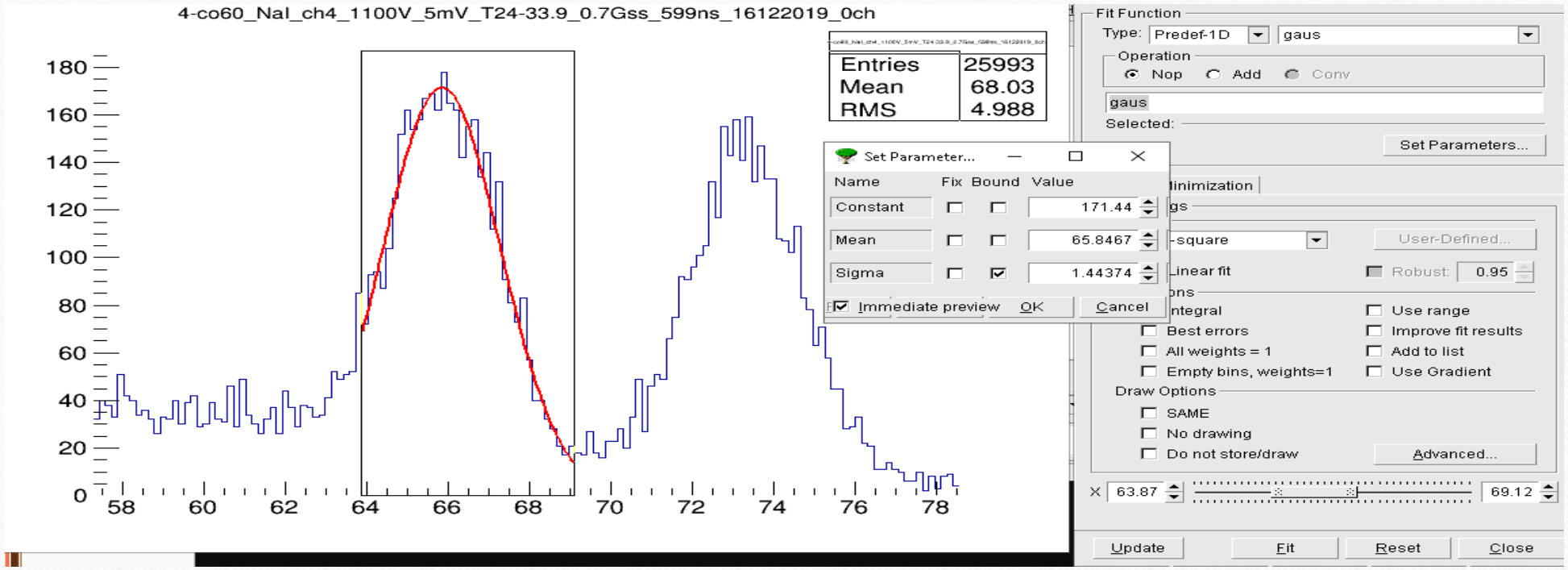
For first peak (1000V)
Resolution=(sigma/mean)*2,35=0,0554



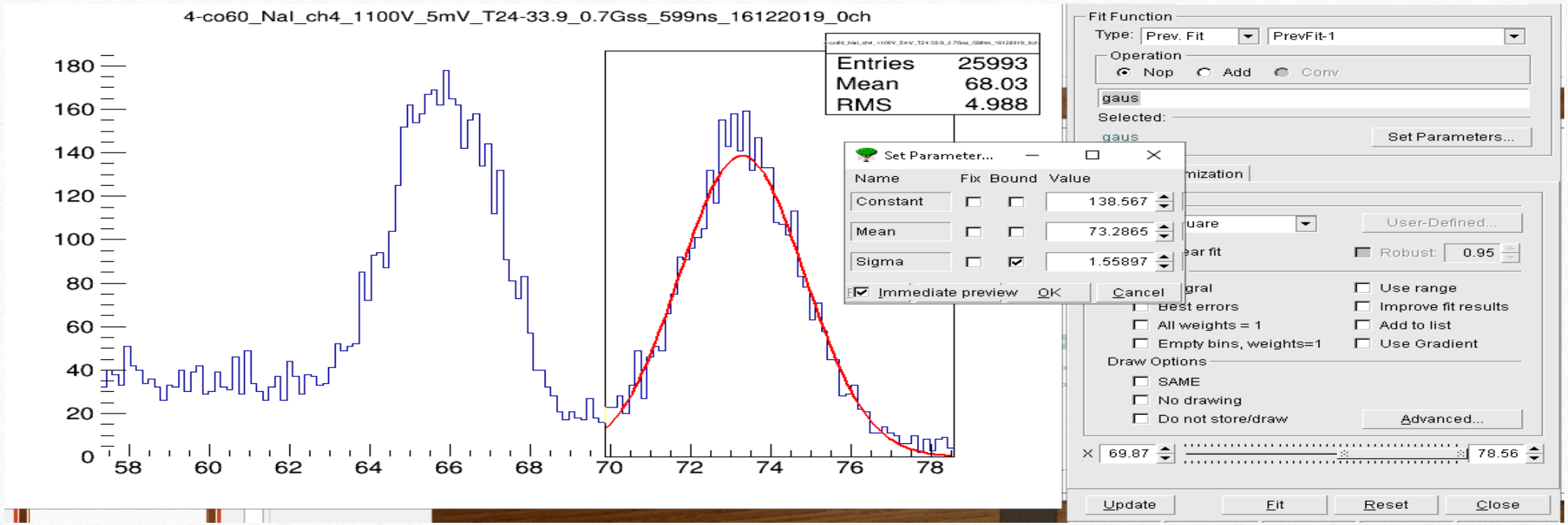
for Second peak (1000V)
Resolution=(sigma/mean)*2,35=0,0499



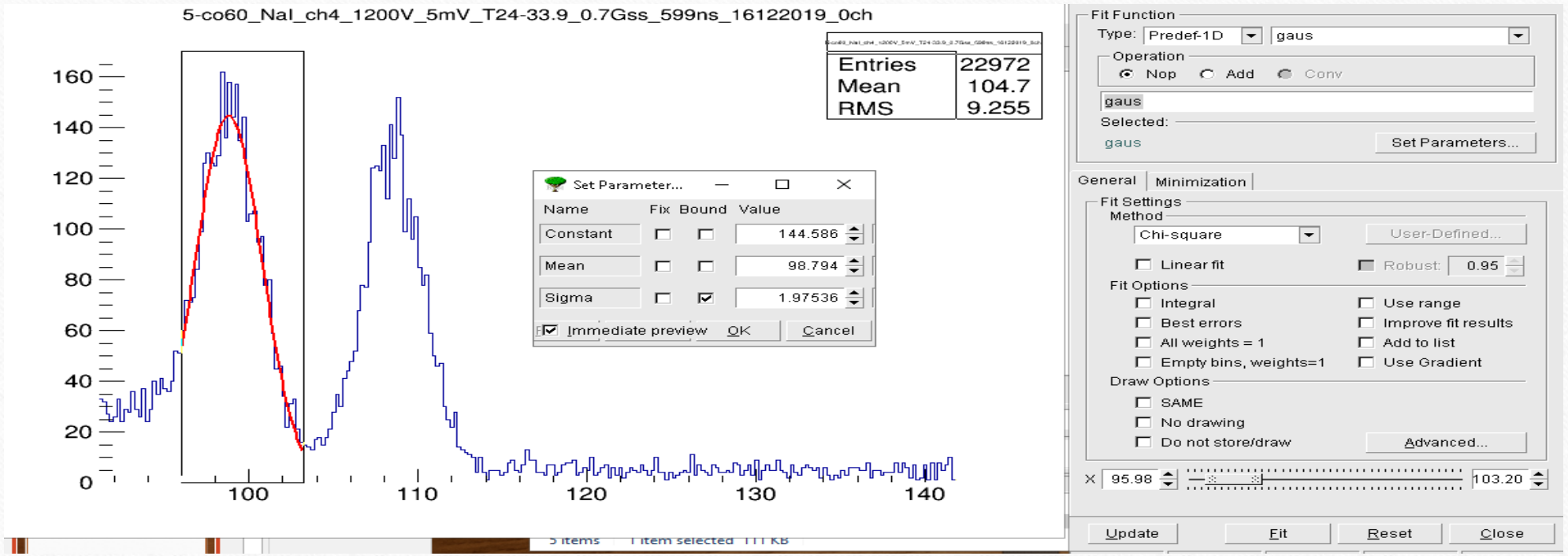
For first peak (1100V)
Resolution=(sigma/mean)*2,35=0,0513



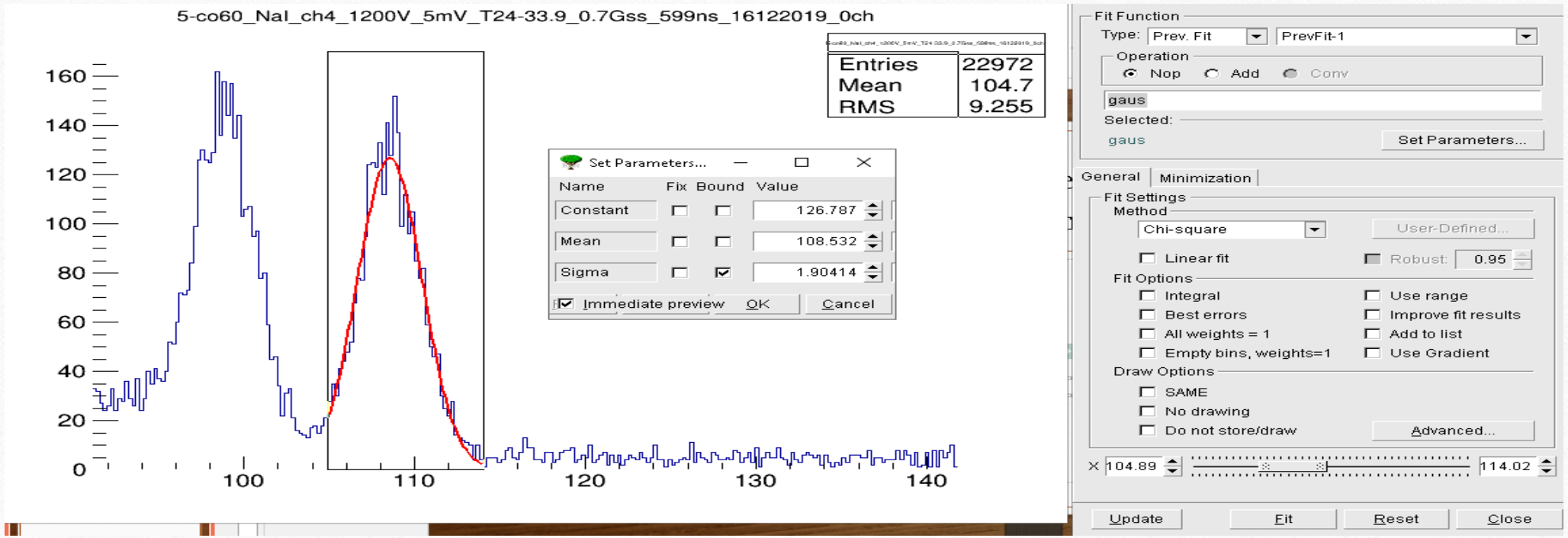
for Second peak (1100V)
Resolution=(sigma/mean)*2,35=0,0459



For first peak (1200V)
Resolution=(sigma/mean)*2,35=0,0468

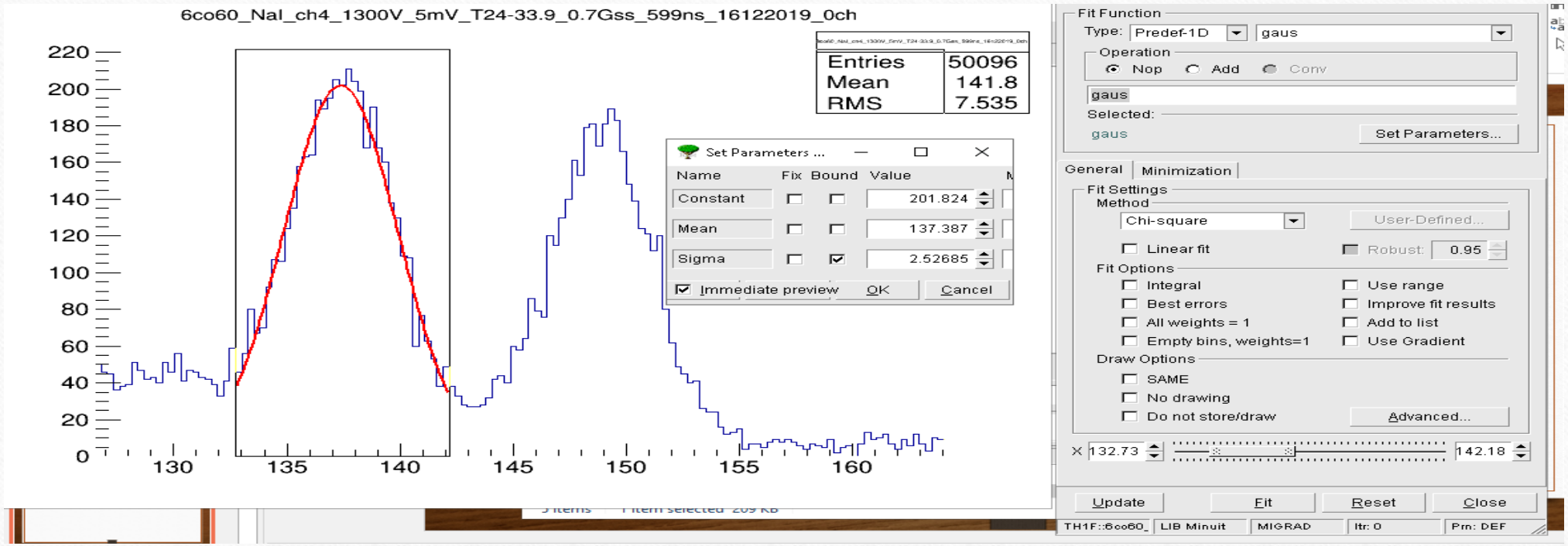


for Second peak (1200V)
Resolution=(sigma/mean)*2,35=0,0411

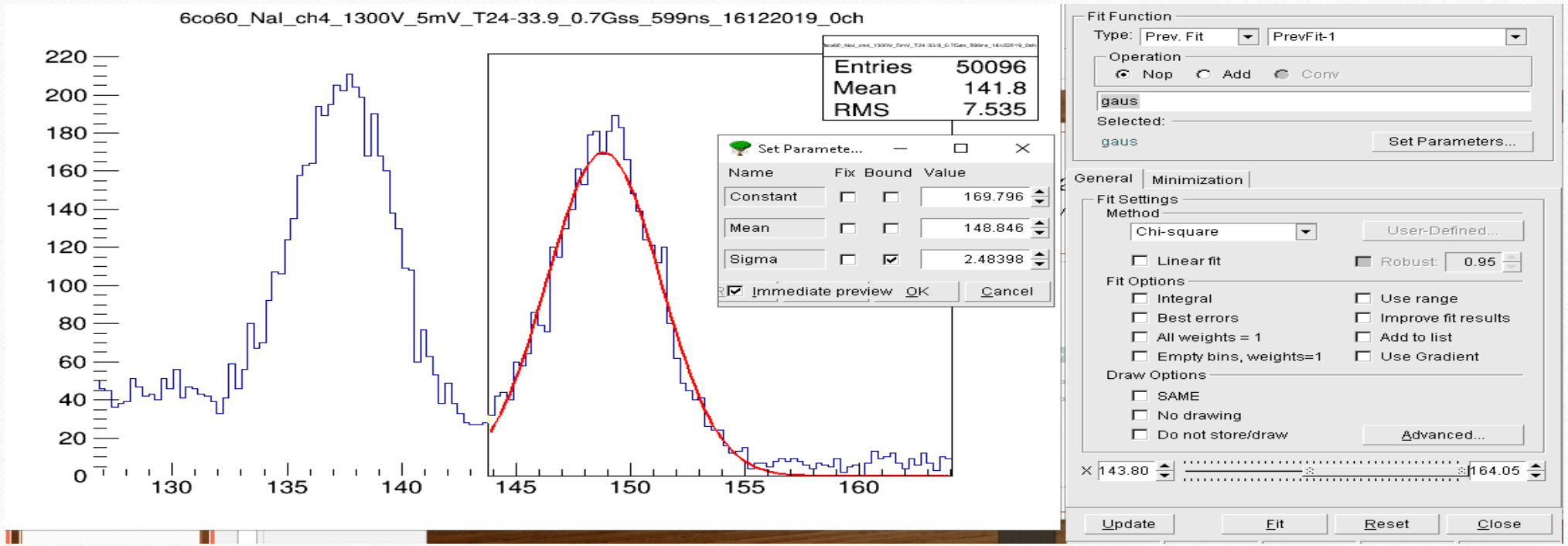


For first peak (1300V)

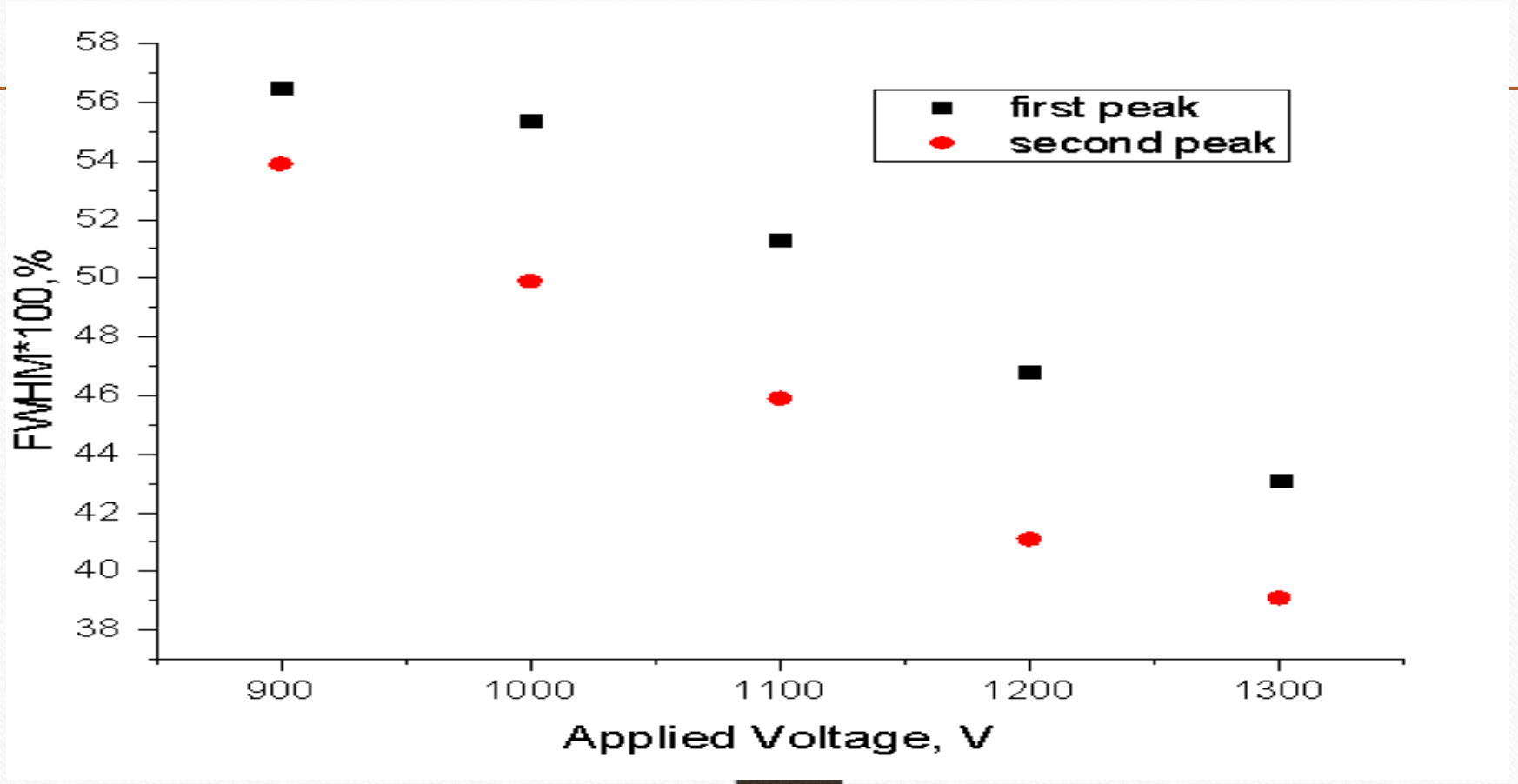
Resolution=(sigma/mean)*2,35=0,0431



for Second peak (1300V)
Resolution=(sigma/mean)*2,35=0,0391



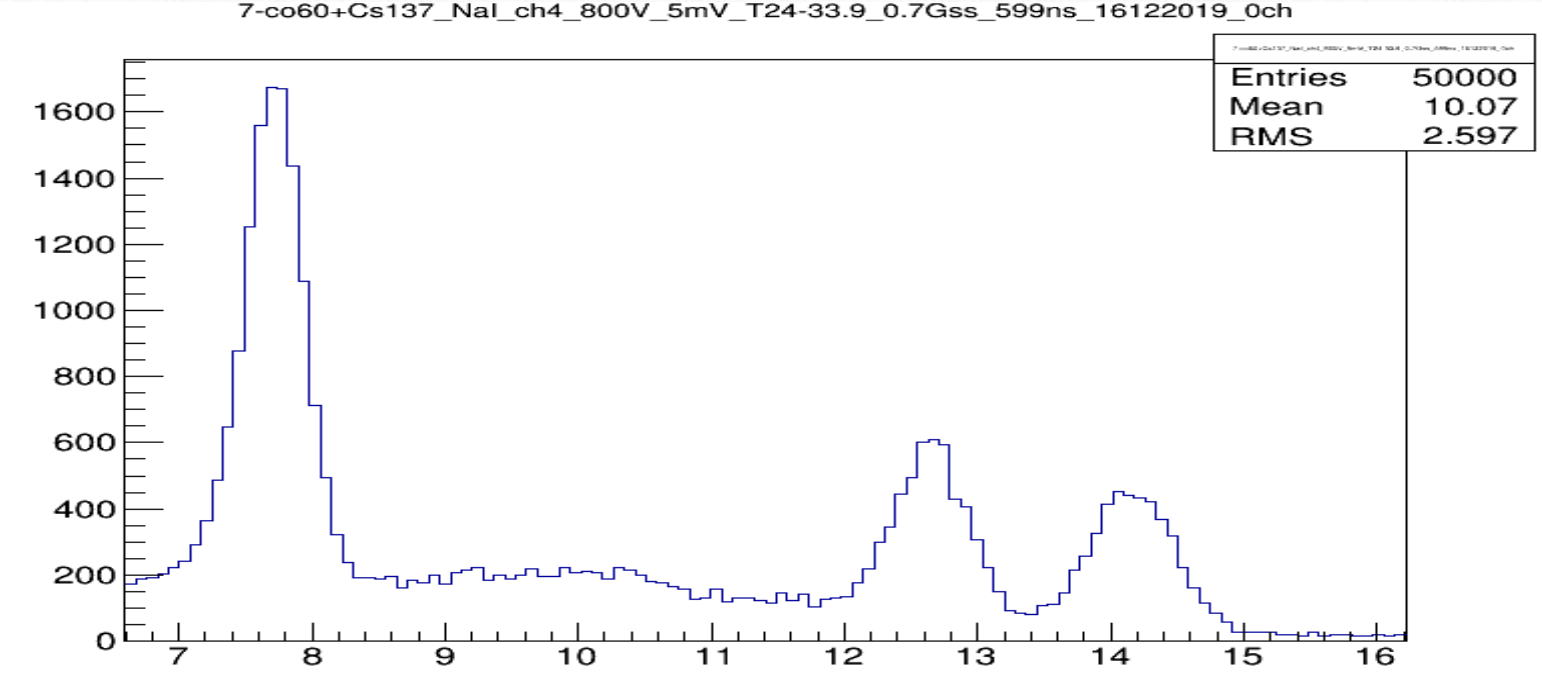
Dependence of resolution on applied voltage for NaI



TASK 2

The calibration spectra for NaI

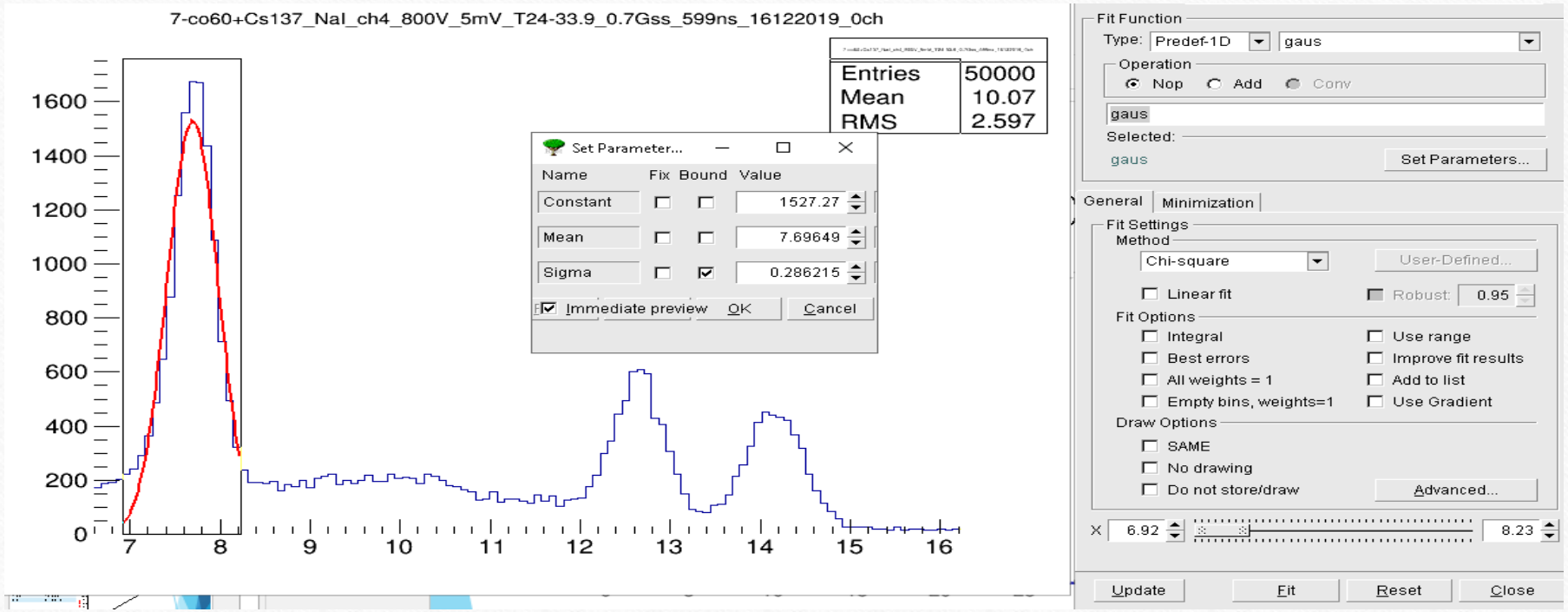
Co60+Cs137-NaI-800V



Gaus FIT –first peak

Cs137 energy spectra=0,662MeV

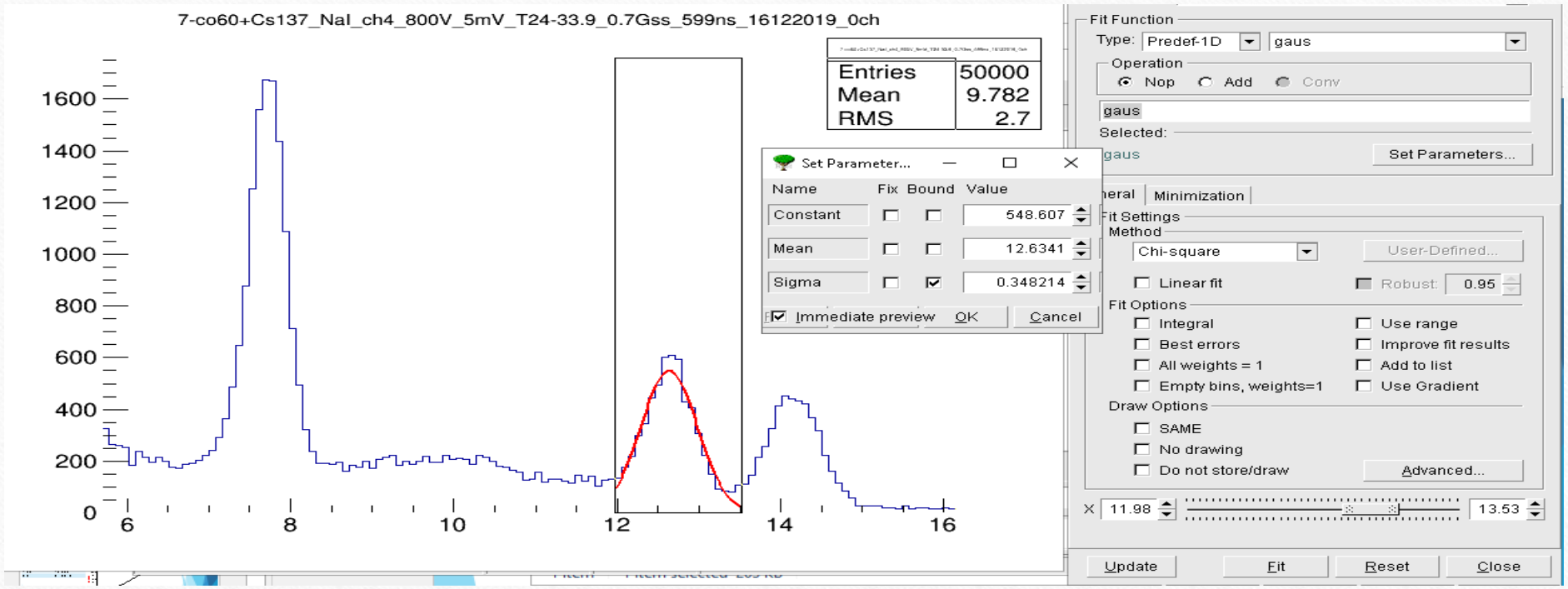
Mean=7,696



➢ Gaus FIT –second peak

Co60 energy spectra=1,25MeV

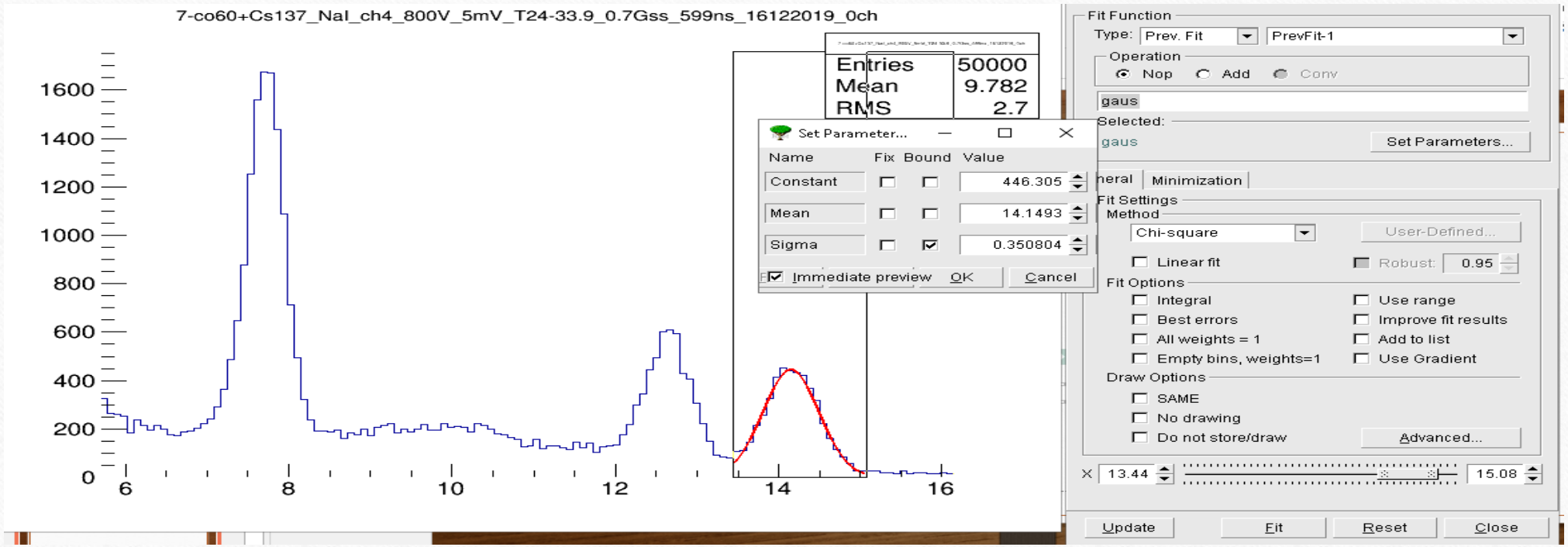
Mean=12,63



Gaus FIT –third peak

Co60 energy spectra=1,33MeV

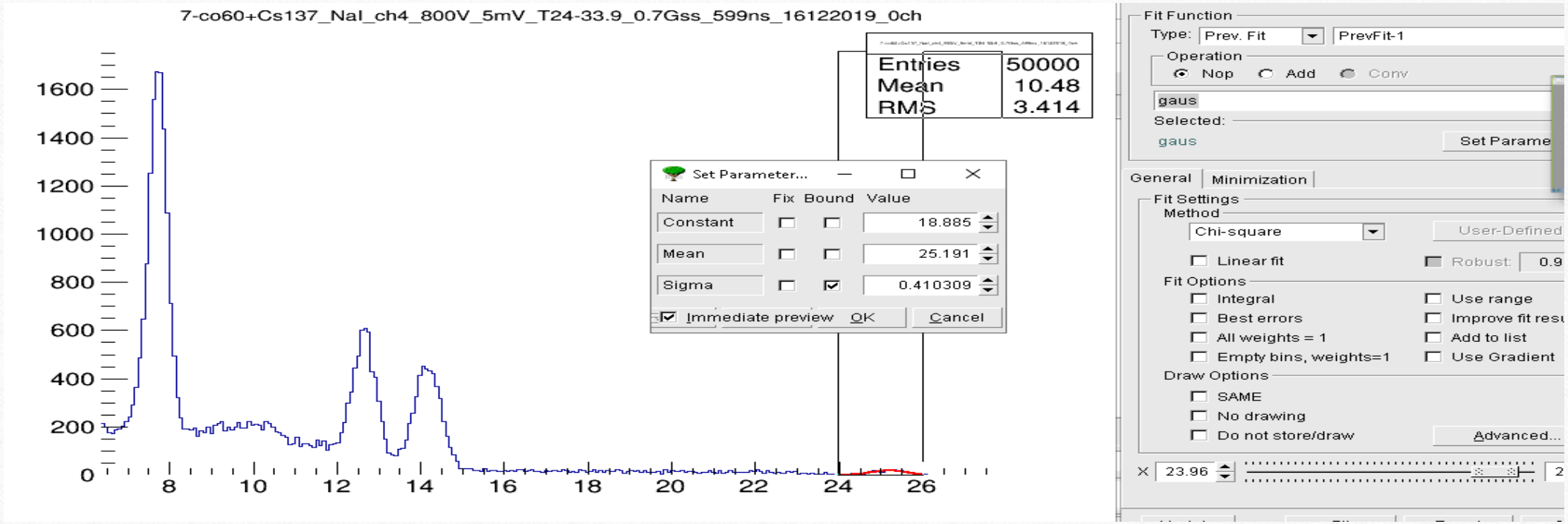
Mean=14,149



➢ Gaus FIT –fourth peak

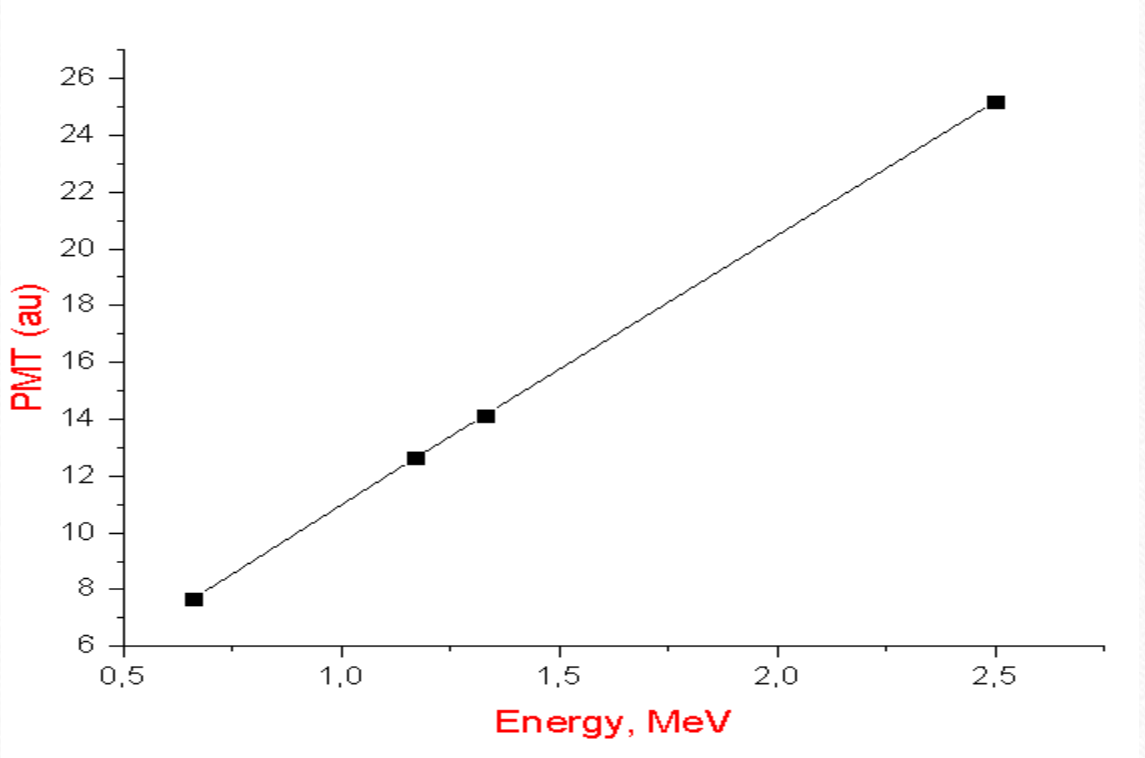
Co60 energy spectra (last peak)=2,5MeV

Mean=25,191



The calibration spectra for NaI

Energy (MeV)	PMT (au)
0,662	7,696
1,17	12,63
1,33	14,149
2,5	25,191



Unknown source

- We have the spectra of the unknown source
- We make gaus fit at the biggest peak
- We find MEAN (y)
- We have the calibration for NaI detector
- We find the energy (x) with equation from calibration

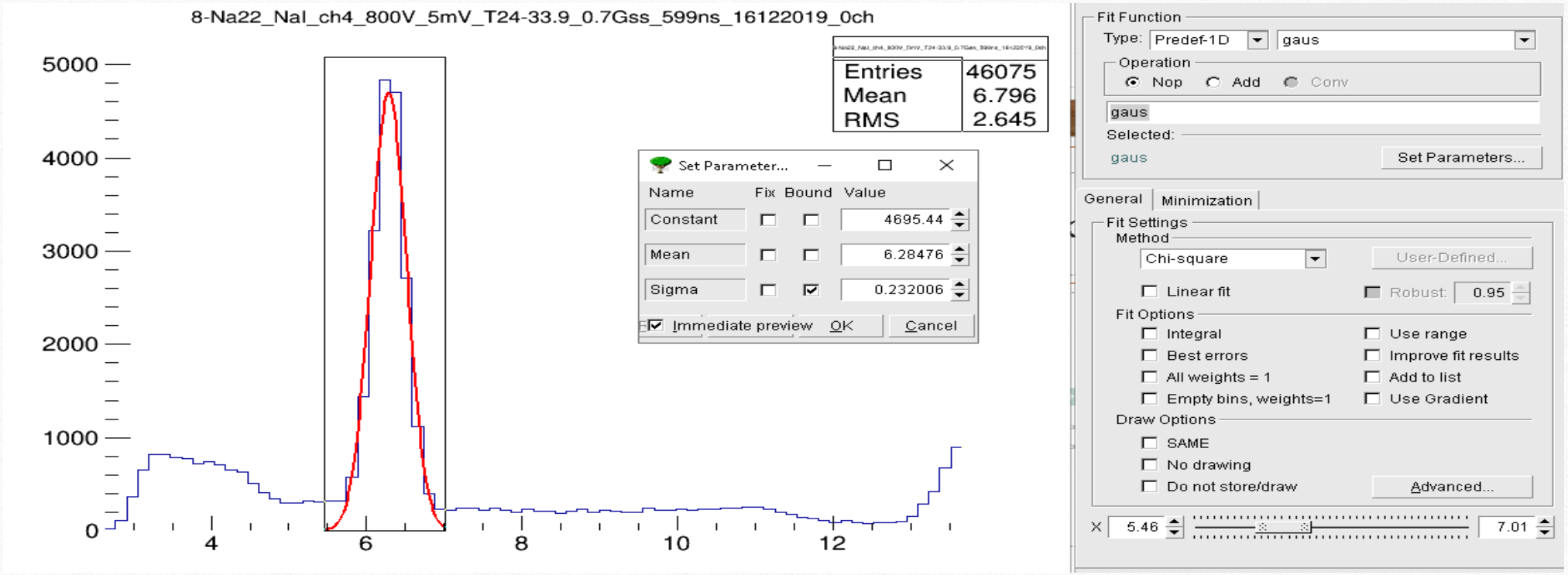
$$y=9{,}5078x+1{,}458$$

Unknown source 1

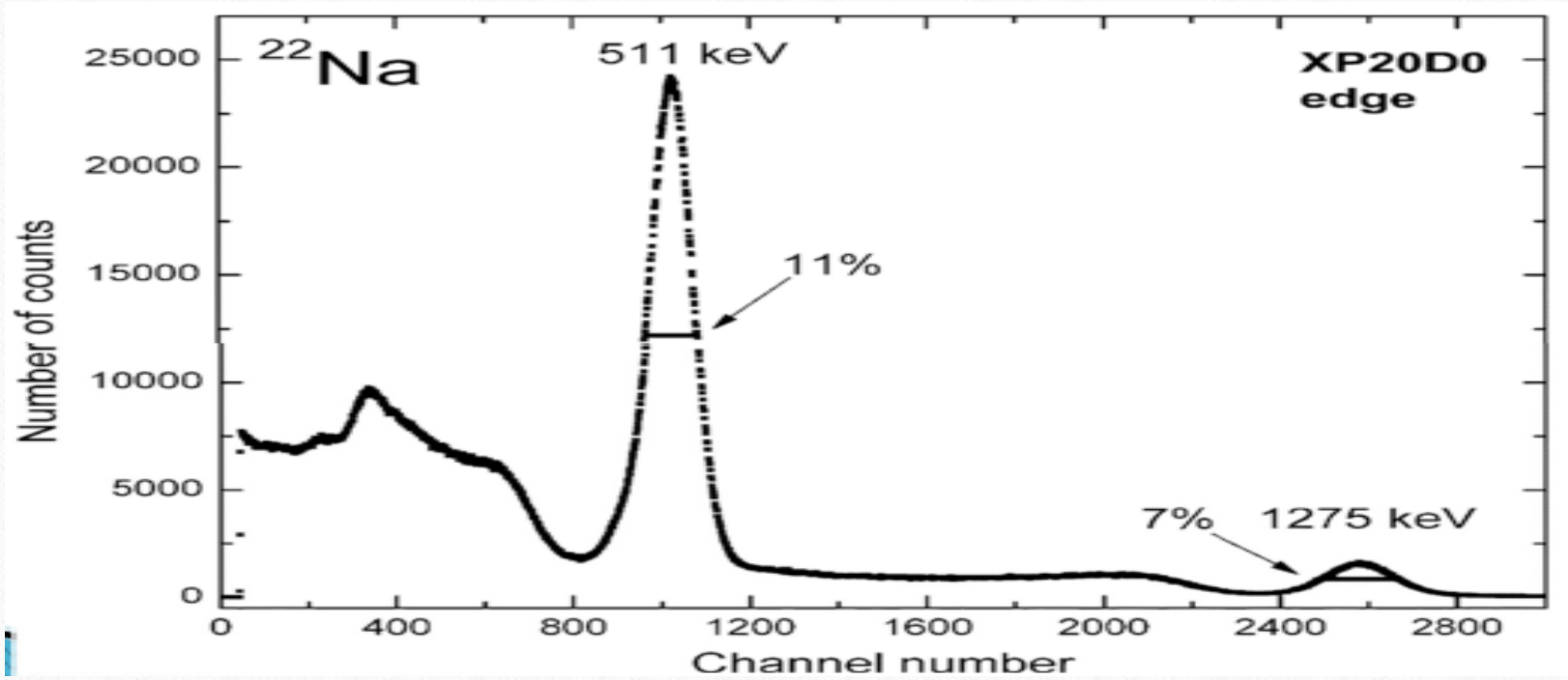
Mean=y=6,284

y=9,5078x+1,458, x=(y-1,458)/9,5078=(6,284-1,458)/9,5078=0,507

E=0,507MeV



Unknown source 1=Na22

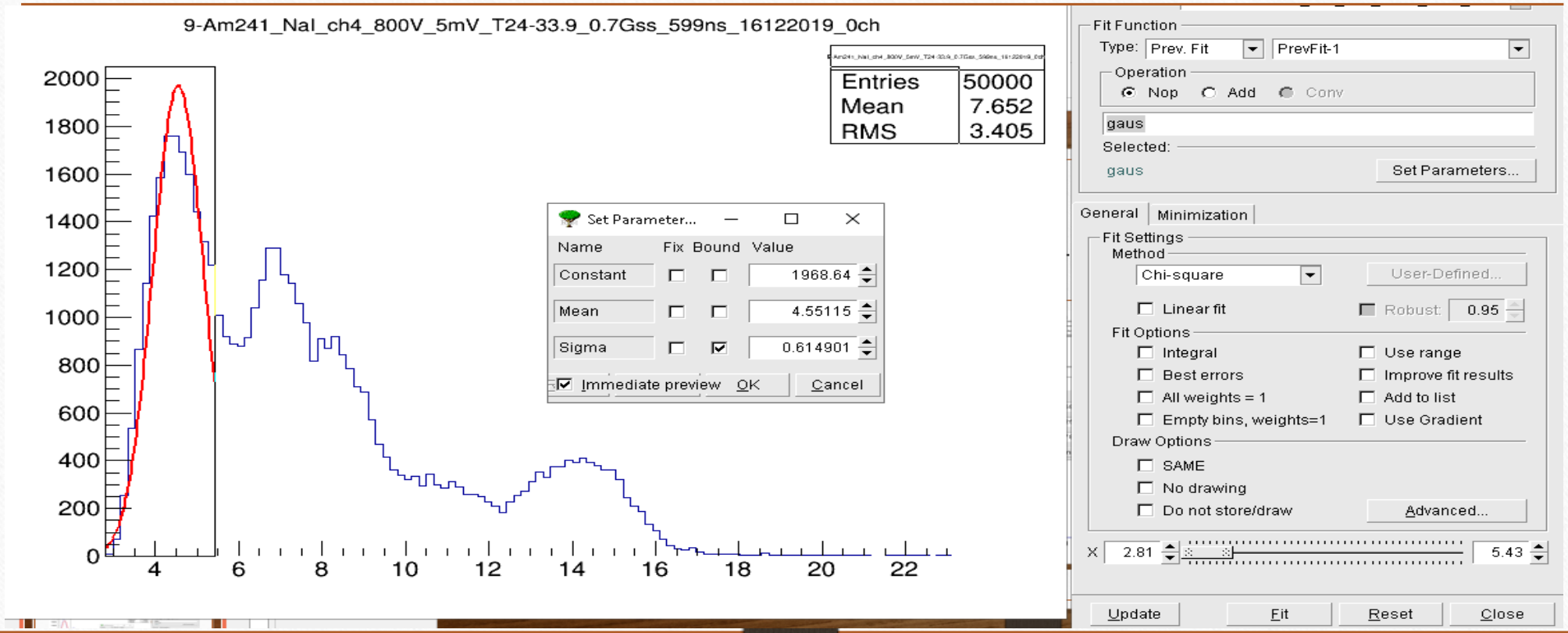


Unknown source 2

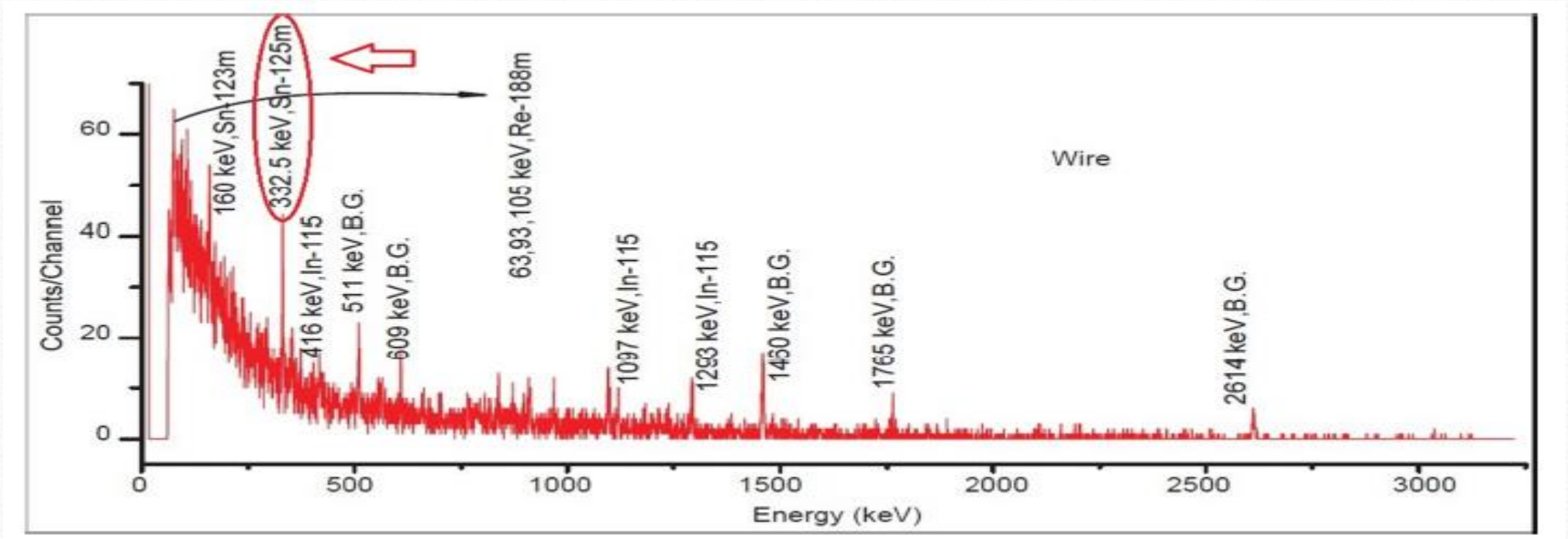
Mean=y=4,551

y=9,5078x+1,458, x=(y-1,458)/9,5078=(4,551-1,458)/9,5078=0,325

E=0,325MeV



Unknown source 2=Sn-125m



Task4

Attenuation Coefficient

Finding Attenuation Coefficient

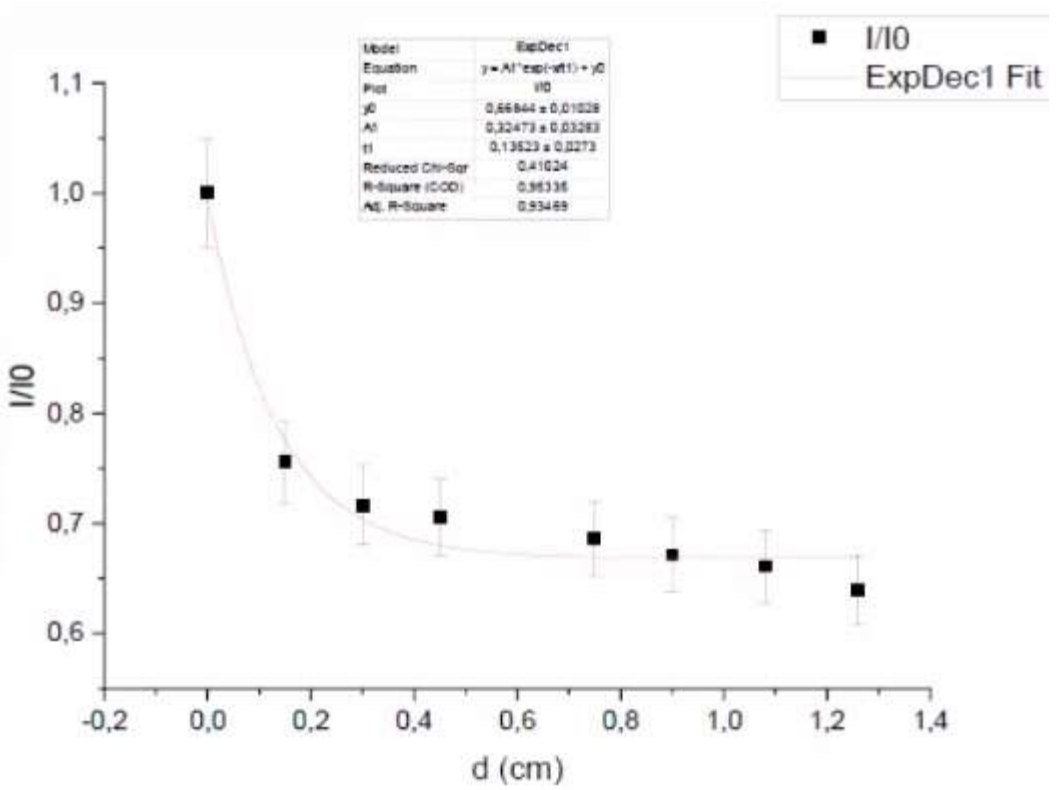
- We want to determine the attenuation coefficient μ

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

- We have shields of different thikness. For each shield we determine I/I_0
- We make a graph where we have I/I_0 on Oy and Thikness on Ox
- We make exponential fit and we find μ

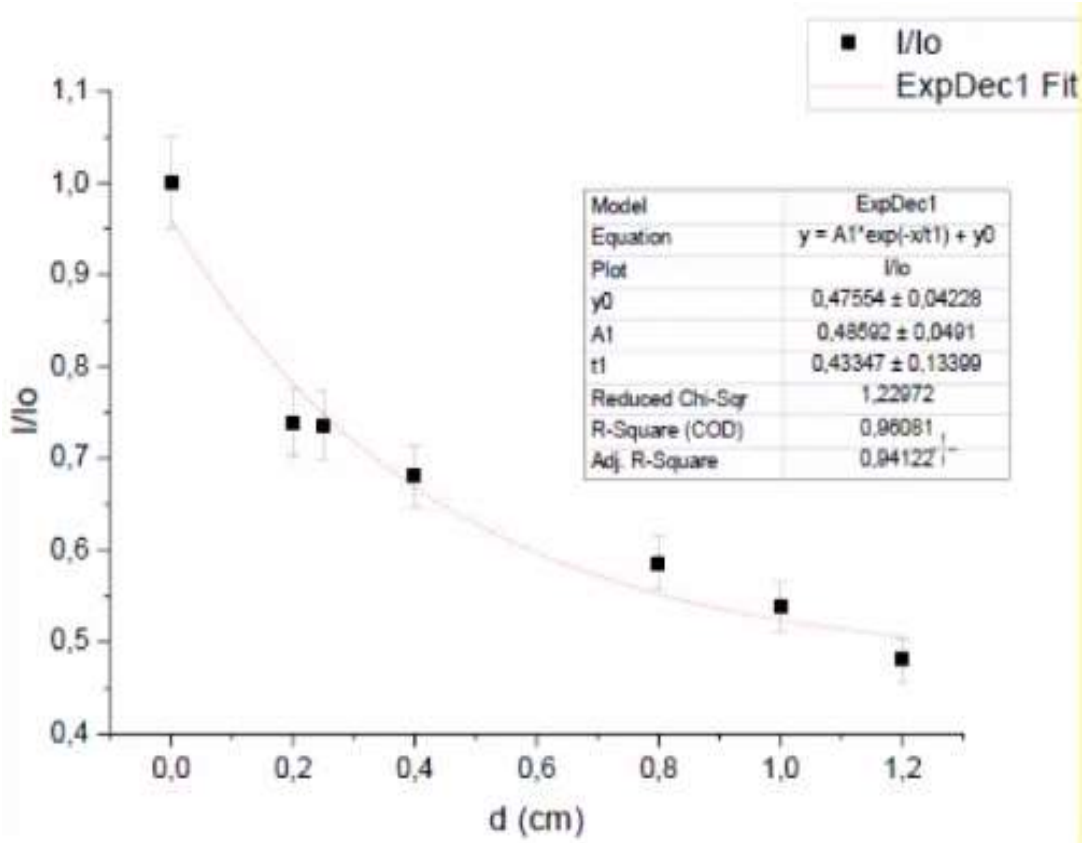
Al

	A(X)	B(Y)
Long Name		
Units		
Comments		
F(x)	Thikness, cm	I/I0
1	0	1
2	0,15	0,75573
3	0,3	0,71623
4	0,45	0,70569
5	0,75	0,68596
6	0,9	0,67155
7	1,08	0,66103
8	1,26	0,63939



Cu

	A(X)	B(Y)
Long Name		
Units		
Comments		
F(x)	Thikness, cm	I/I0
1	0	1
2	0,2	0,73931
3	0,25	0,7357
4	0,4	0,68065
5	0,8	0,58611
6	1	0,53827
7	1,2	0,48042

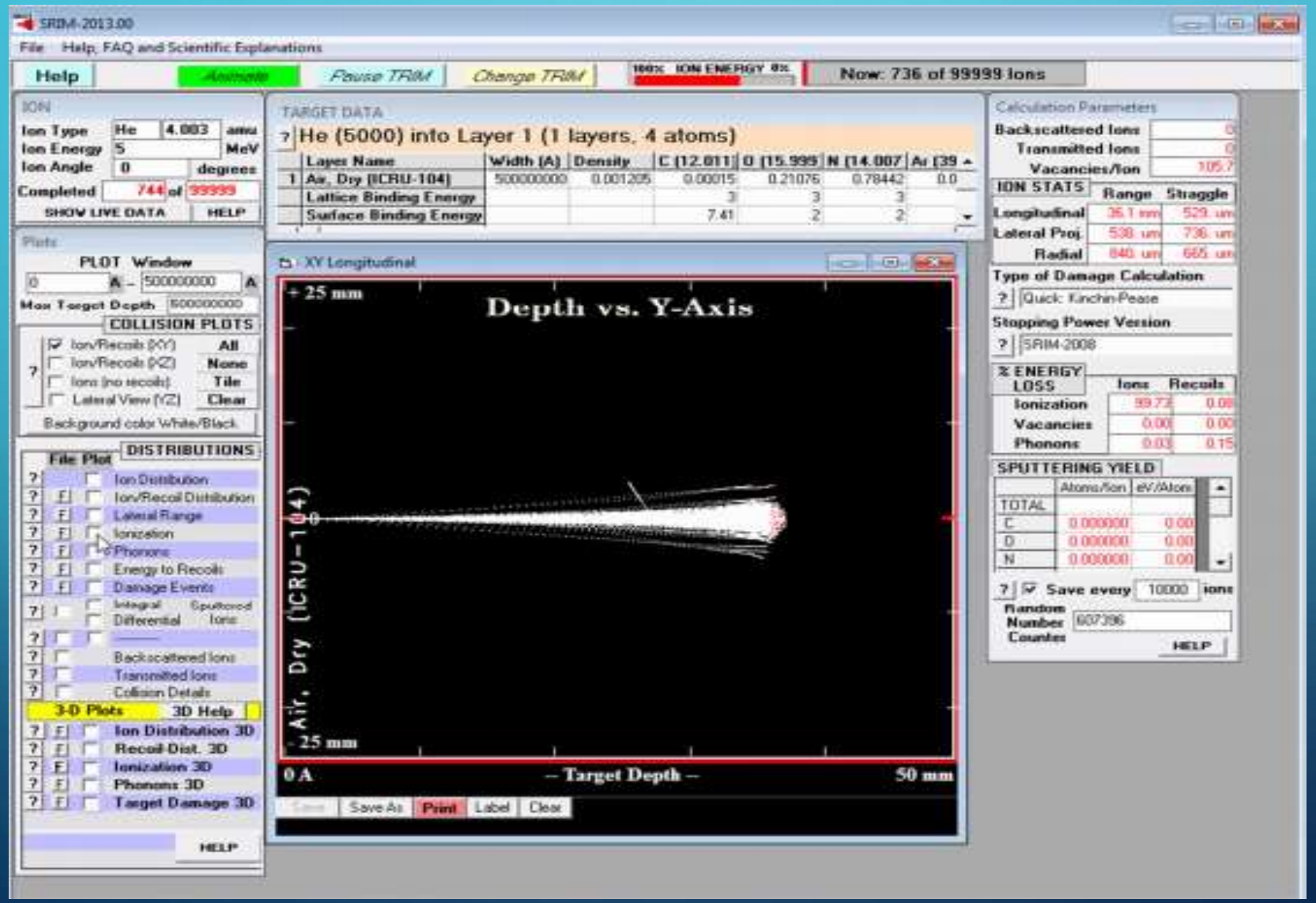


TASK5

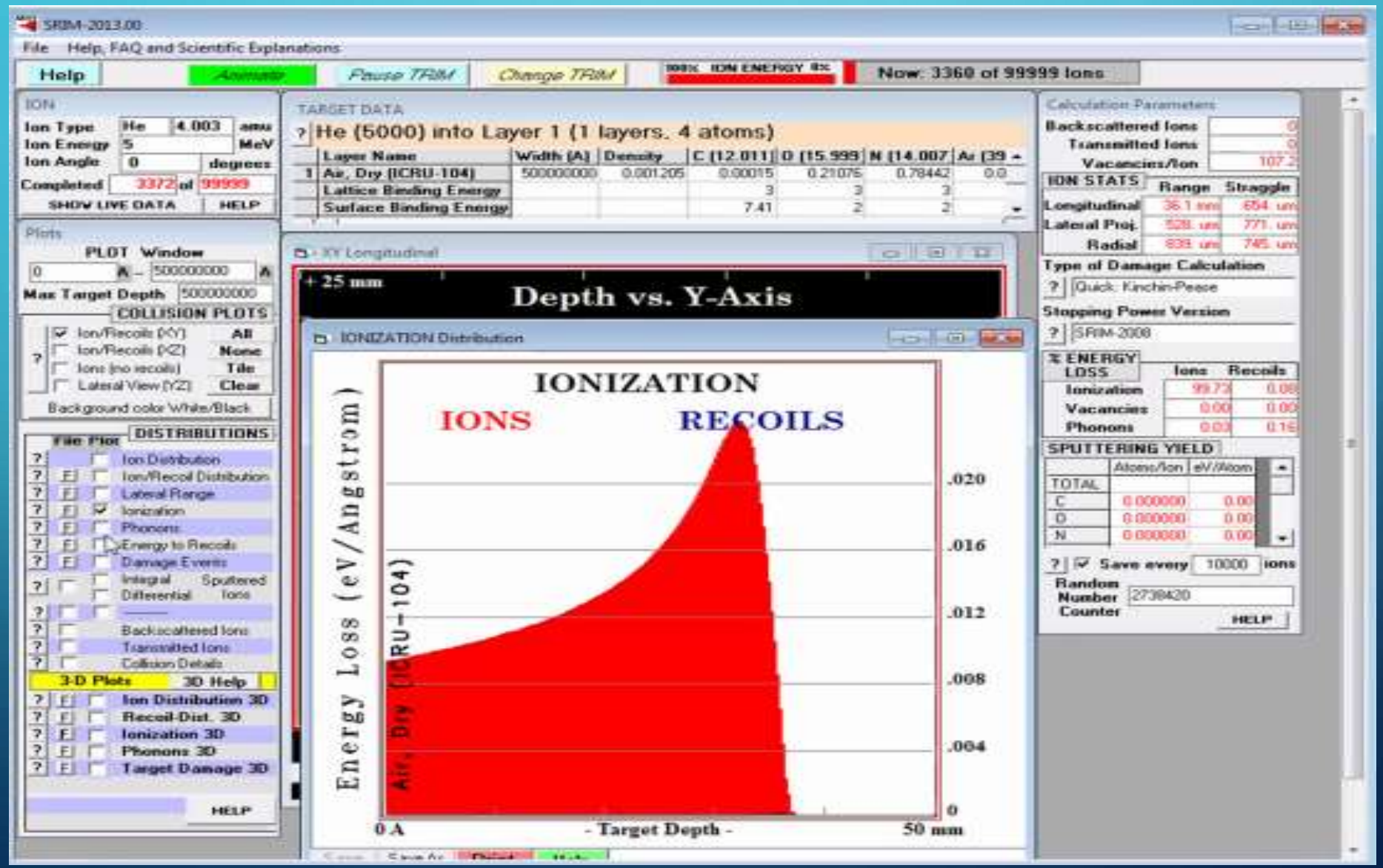
SRIM PROGRAM + CALCULATION OF He RANGE IN AIR

- We use plastic detector to calculate the alpha particle range in the air using Plutonium 239 source with energy=5MeV

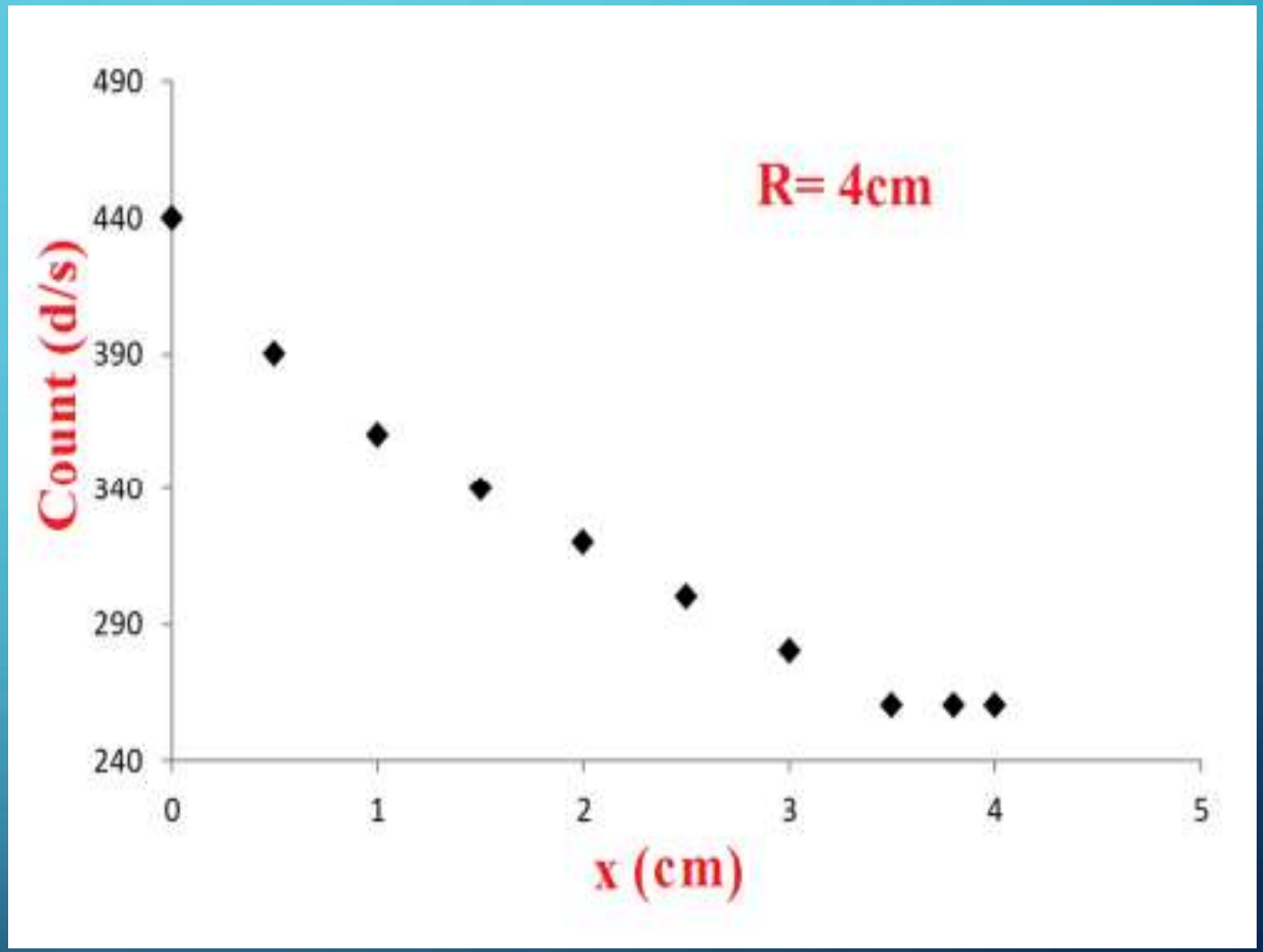
SRIM PROGRAM-SIMULATION



SRIM PROGRAM-SIMULATION



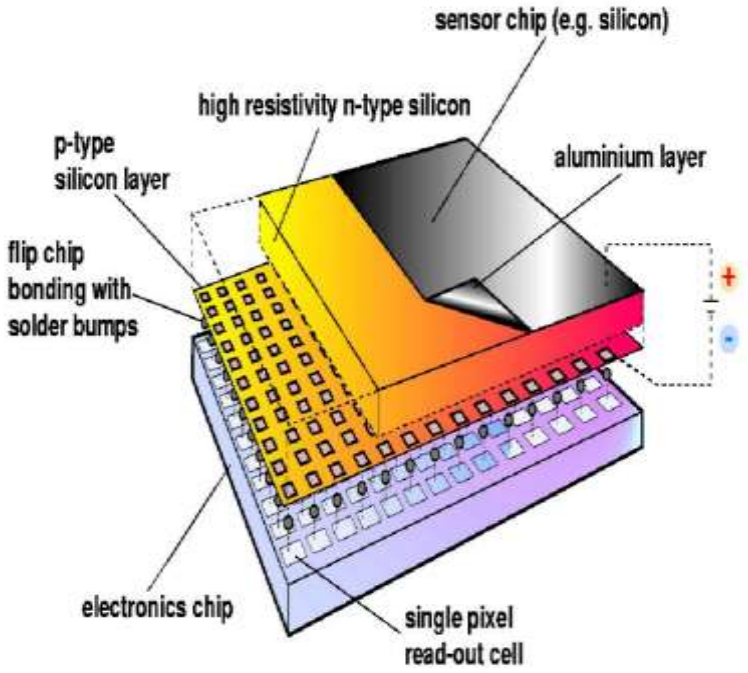
	A(X)	B(Y)
Long Name		
Units		
Comments		
F(x)		
1	440	0
2	390	0,5
3	360	1
4	340	1,5
5	320	2
6	300	2,5
7	280	3
8	260	3,5
9	260	3,8
10	260	4
11		

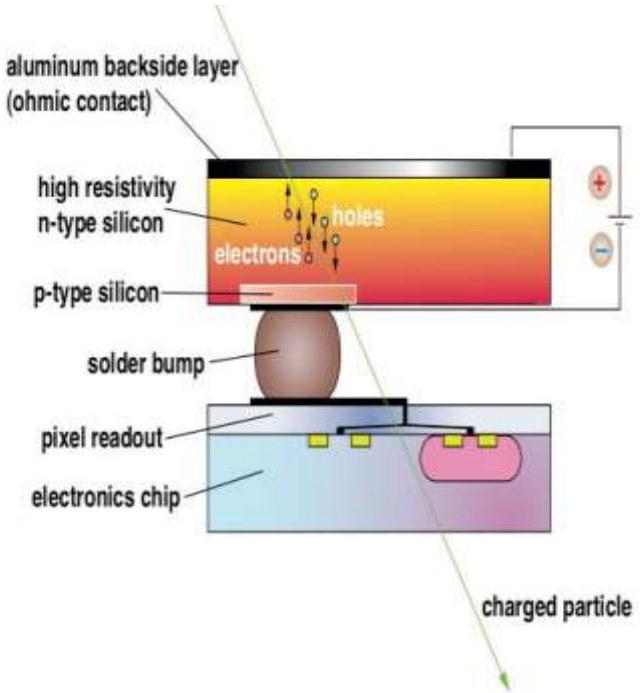


TASK6

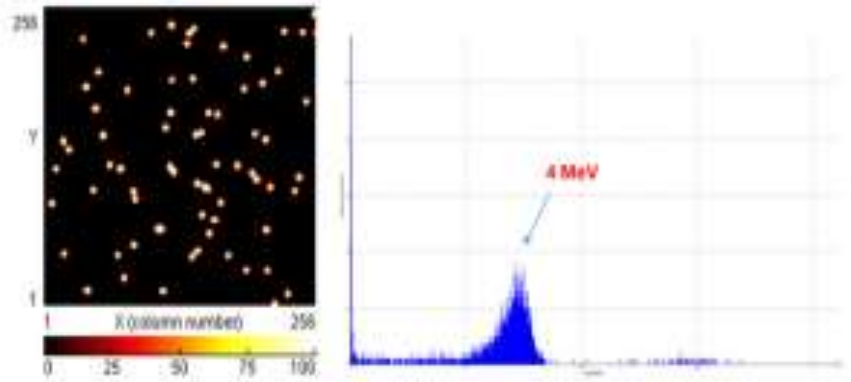
PIXEL DETECTOR

- It is an advanced detector like a digital camera
- It has 3 parts -sensor, electronic cip and Usb
- The size of the sensor is 1.5x1.5 cm.
- It has 256 x 256 pixels (65.536 pixel).
- The pixel size is 55µm x 55µm
- The pixel size is 55µm x 55µm
- It has high resolution and It is used for regestration different types of radiation

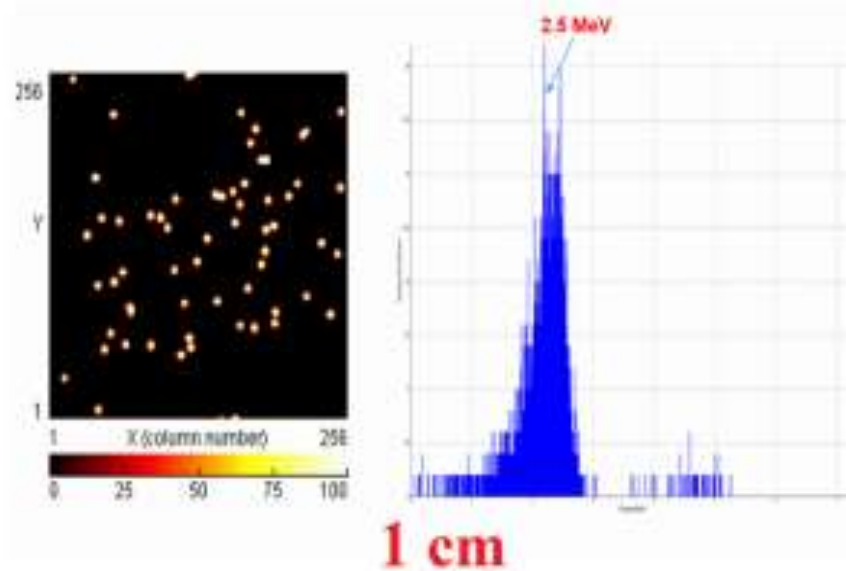

sensor chip (e.g. silicon)
high resistivity n-type silicon
p-type
silicon layer
aluminium layer
flip chip
bonding with
solder bumps
+
-
electronics chip
single pixel
read-out cell


aluminum backside layer
(ohmic contact)
high resistivity
n-type silicon
holes
electrons
p-type silicon
solder bump
pixel readout
electronics chip
charged particle

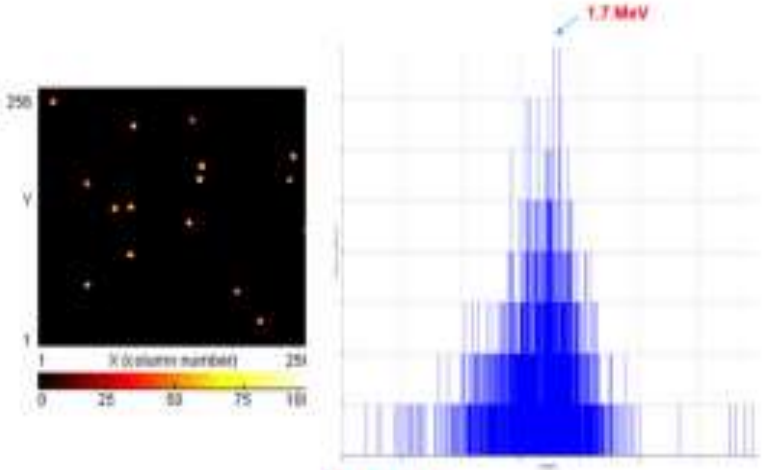
- Determination the range of Alpha partcles with (Am-241) energy about 4 MeV in air using pixel detector



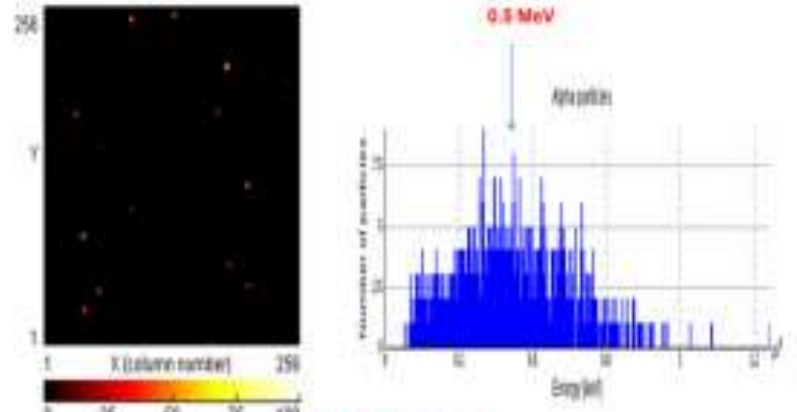
0 cm



1 cm



2 cm

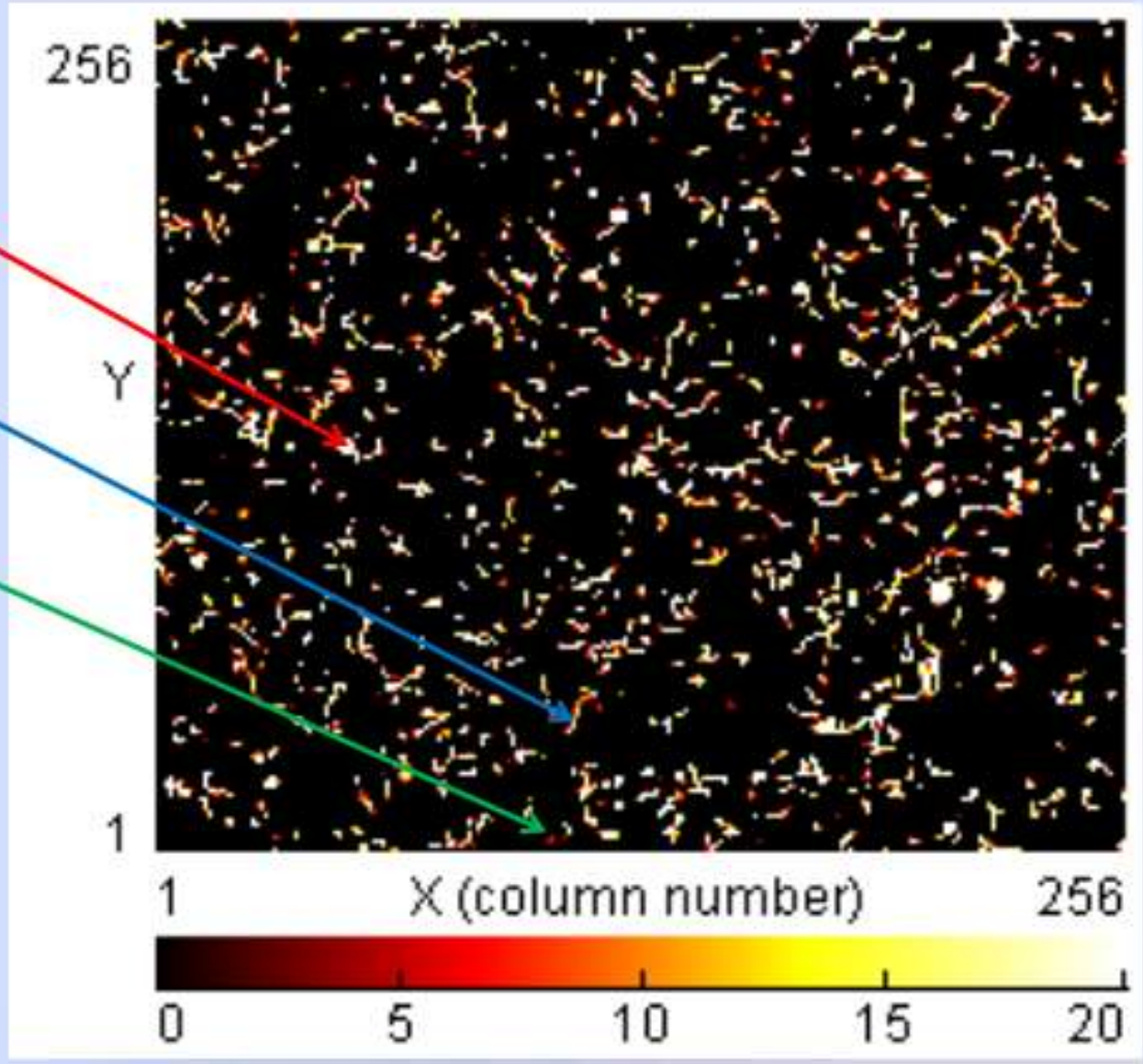


2.5 cm

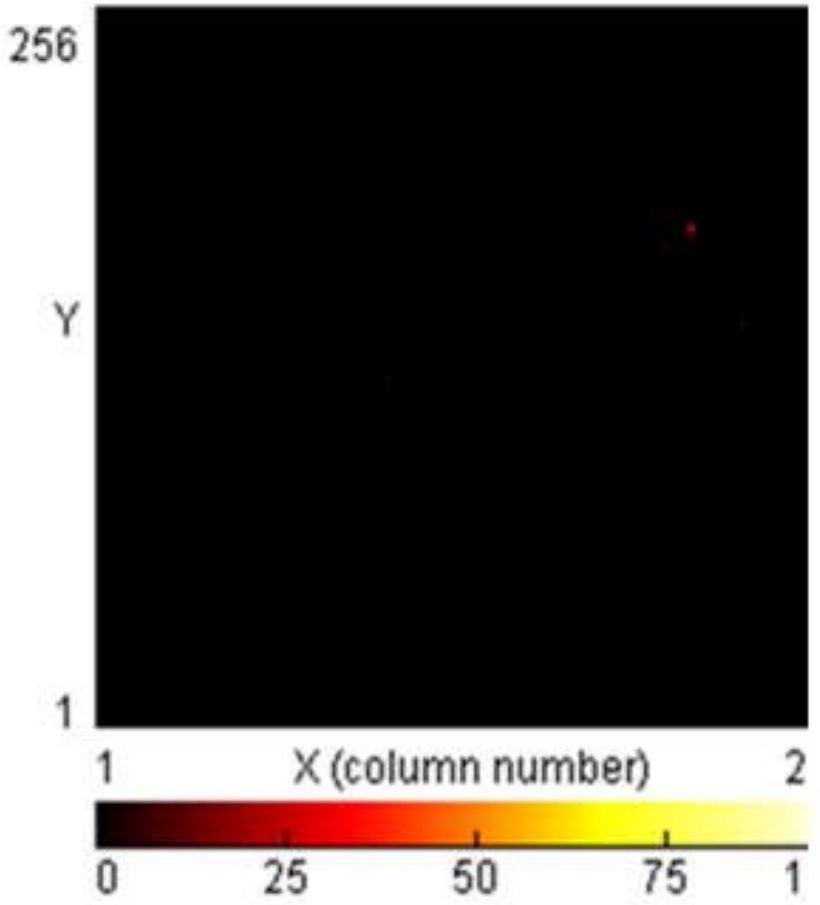
Alpha particle

Beta particle

Gamma quanta



- no alpha particles are detected
- Maximum of alpha particle range is 3 cm
- R=3 cm



Conclusion

This practice helped us to gain experience in:

- Different types of radiation sources, and detection of radiation.
- Radioactivity and naturally occurring radioactive materials
- Calculation of ***Resolution*** diffrent scintillation detectors (BGO and NaI).
- ***Energy calibration*** of some scintillation detectors by using standard sources.
- Identify of ***unknown source*** by using energy calibration curve.
- Determination of ***Attenuation coefficient*** for different materials (Al and Cu).
- Determination of ***alpha range in air*** using Pixel and Plastic detectors.
- Monto Carlo simulation SIRM software.

References

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