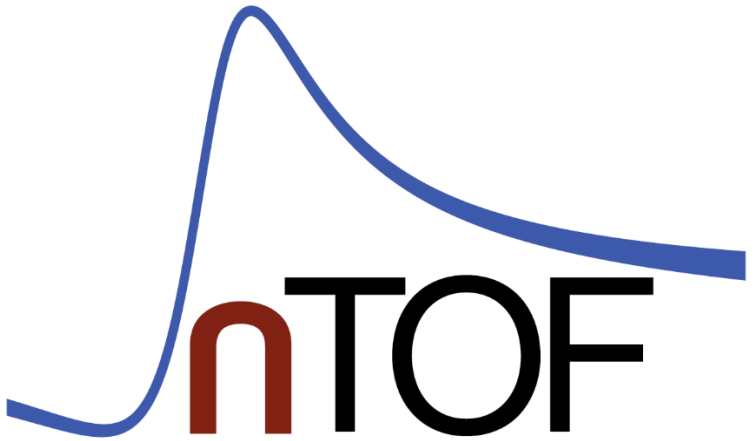


Neutron Detectors Characterization for FOOT experiment

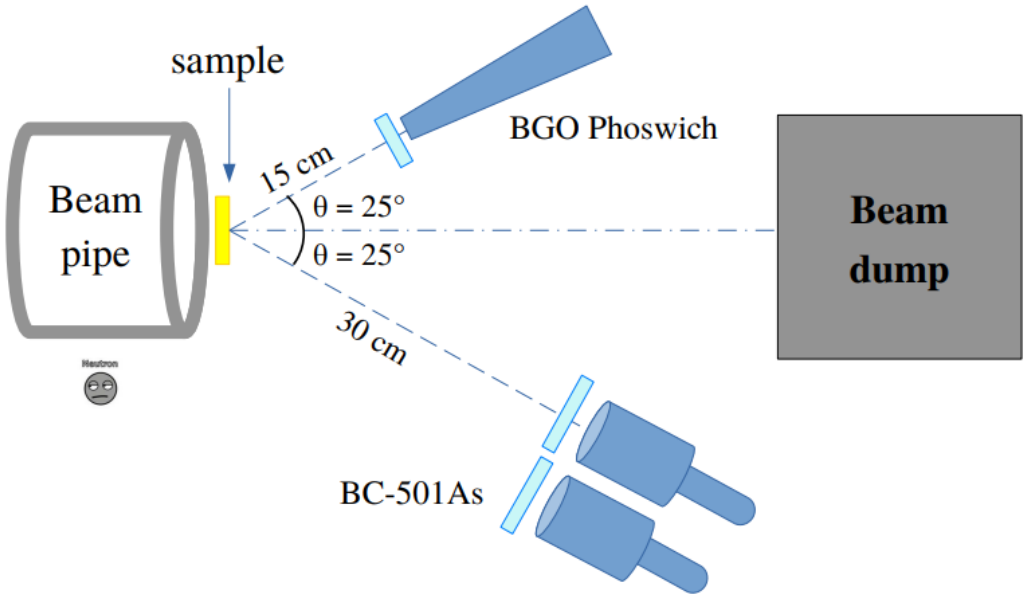
Chiara D'Orazio

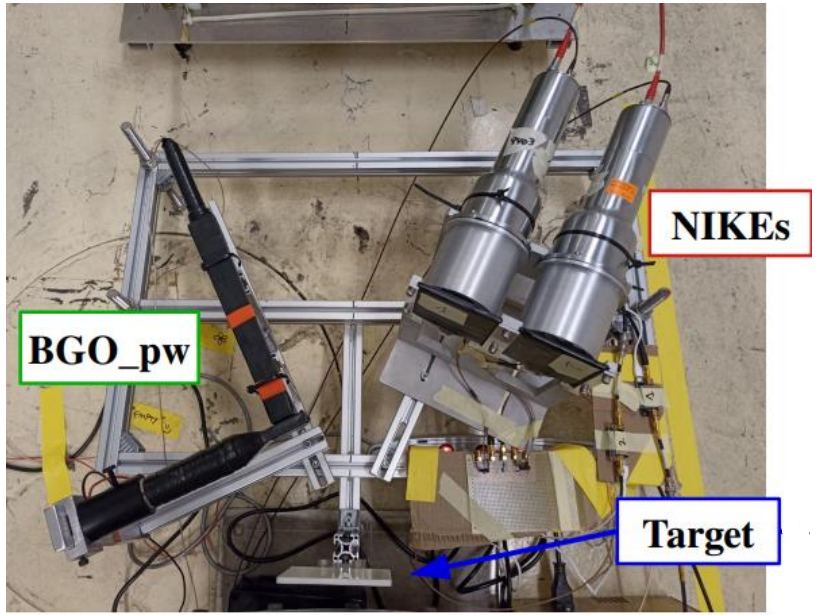
13/12/2022

Outline of the presentation:

- SECTION 1: PSA software
- SECTION 2: BC501A response with sources for preliminary studies on n-γ discrimination
- SECTION 3: preliminary study of BC501A and BGO response with beam data

n_TOF setup





1.PSA (Pulse Shape Analysis)

PSA = Software for signals identification: raw data → .root file

Main Variables:
TOF
Amplitude
Area
FWHM
FWTM
Risetime
…

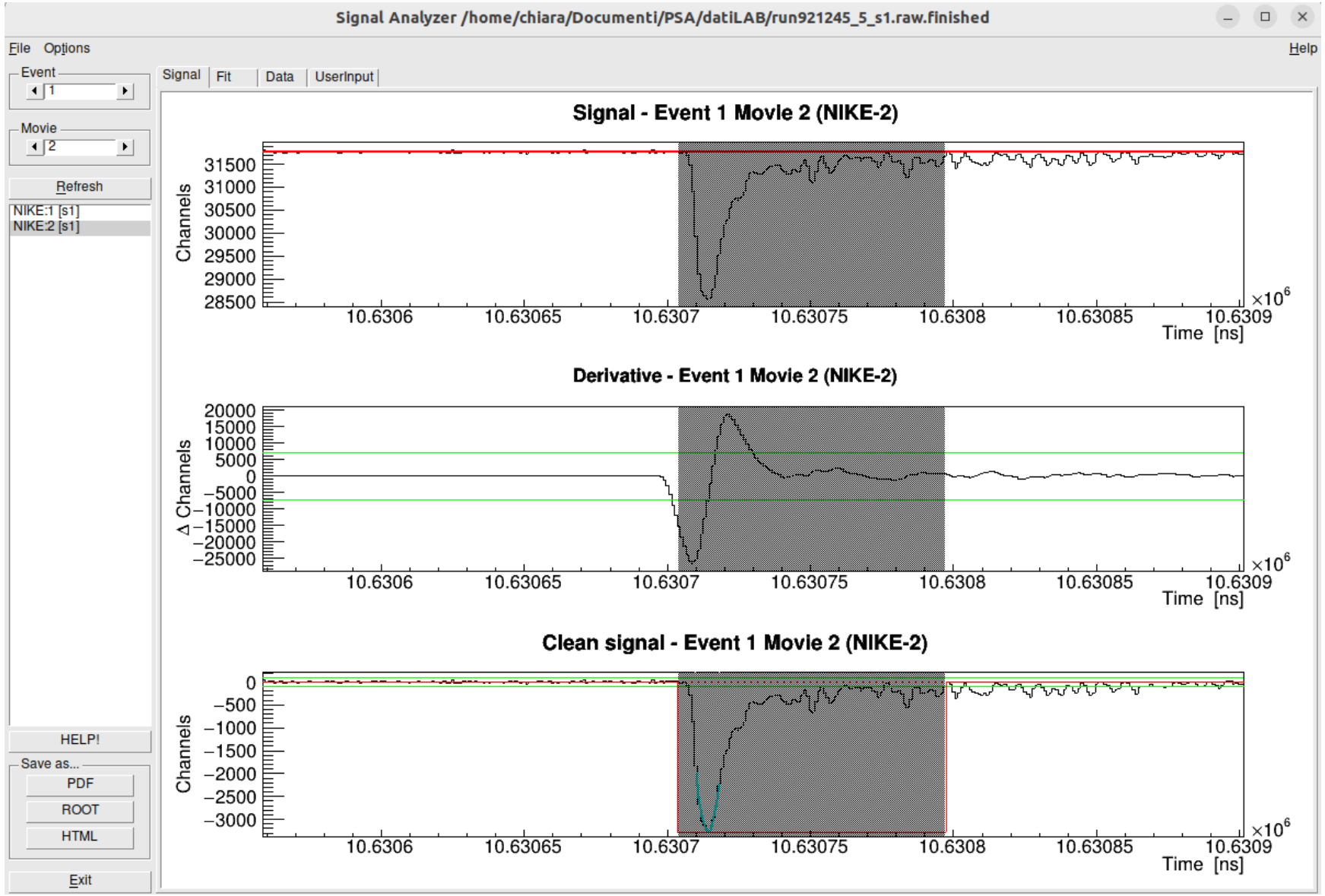
From one week:
Area Fast and Area Slow

Setting different parameters inside «UserInput.h» file

DETECTOR NAME	DETECTOR NUMBER	DETECTOR CLASS	STEP SIZE	TIMING FILTER	MIXED POLARITY
NIKE	1	PSA	10/30	0	0
NIKE	2	PSA	10/30	0	0

And others

1.PSA (Pulse Shape Analysis)



Main Parameters:
STEP SIZE
EXPANDED PULSES
BASELINE OPTION
AMPLITUDE OPTION
AMPLITUDE TRESHOLD
AREA/AMP. LOW THR.
AREA/AMP. HIGH THR.
SIGNAL WIDTH LOW THR.
SIGNAL WIDTH HIGH THR.

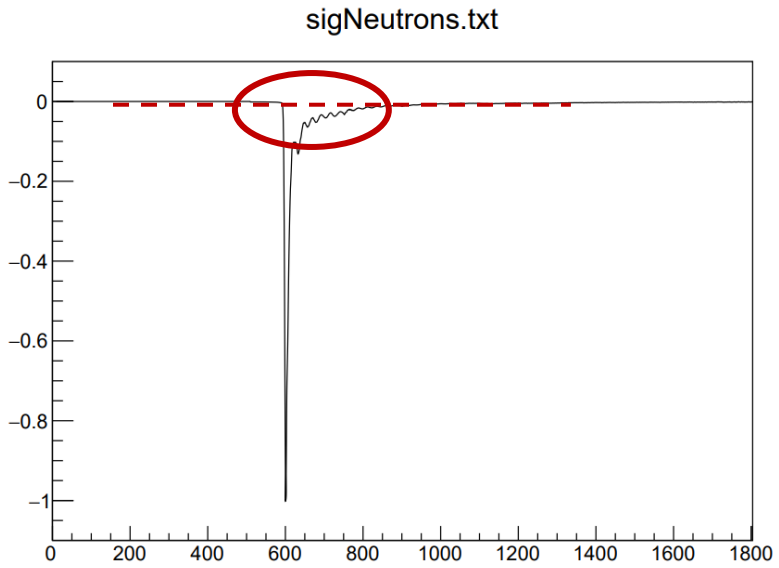
2.BC501A detector characterization with sources n/ γ

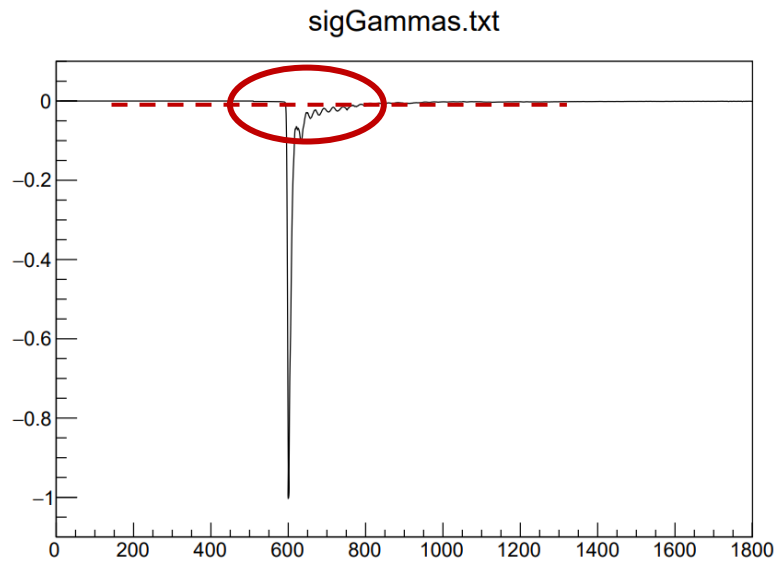
Sources' categories :

	E_γ	E_n
AmBe	4.4 MeV	Da 1.0 a 10.0 MeV
AmBePb	4.4 MeV	Da 1.0 a 10.0 MeV
Y88	0.898 MeV - 1.836 MeV	
Cf252		Da 0.003 a 15.0 MeV
Cs137	662 keV	

Goal:

n/γ discrimination



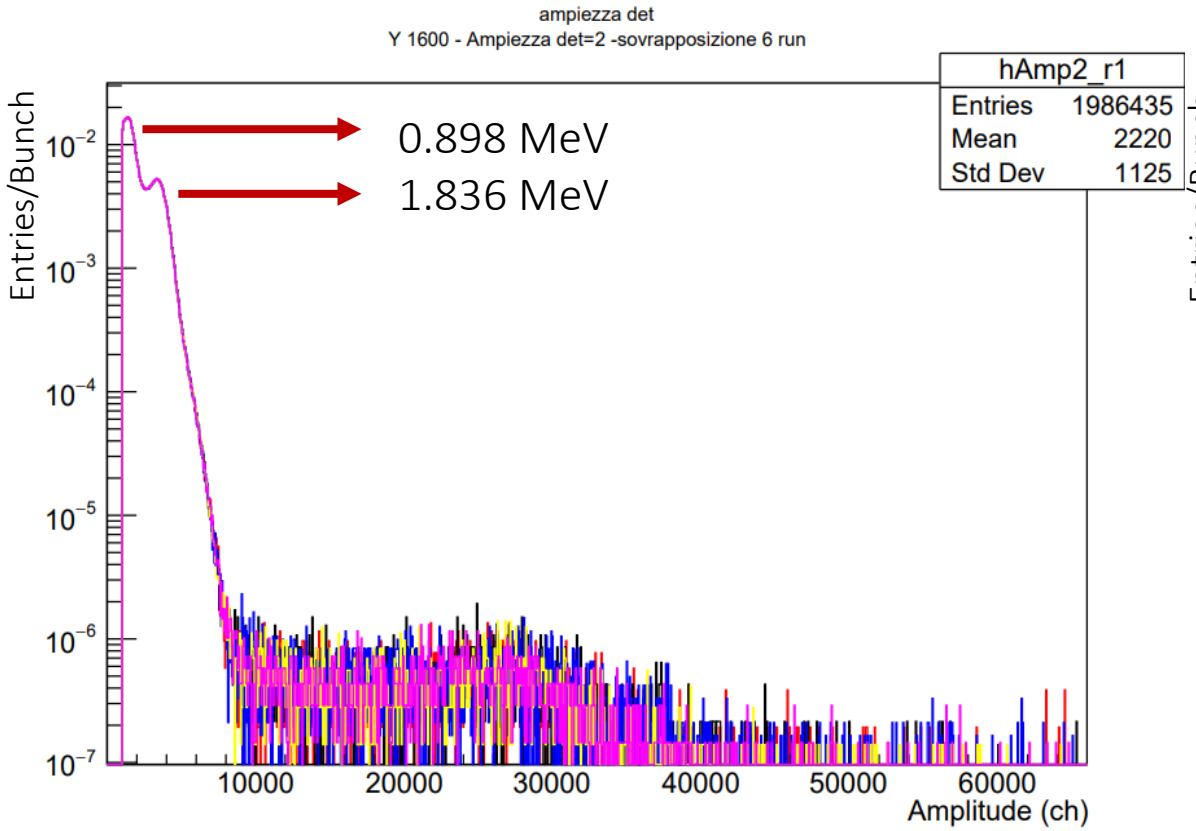


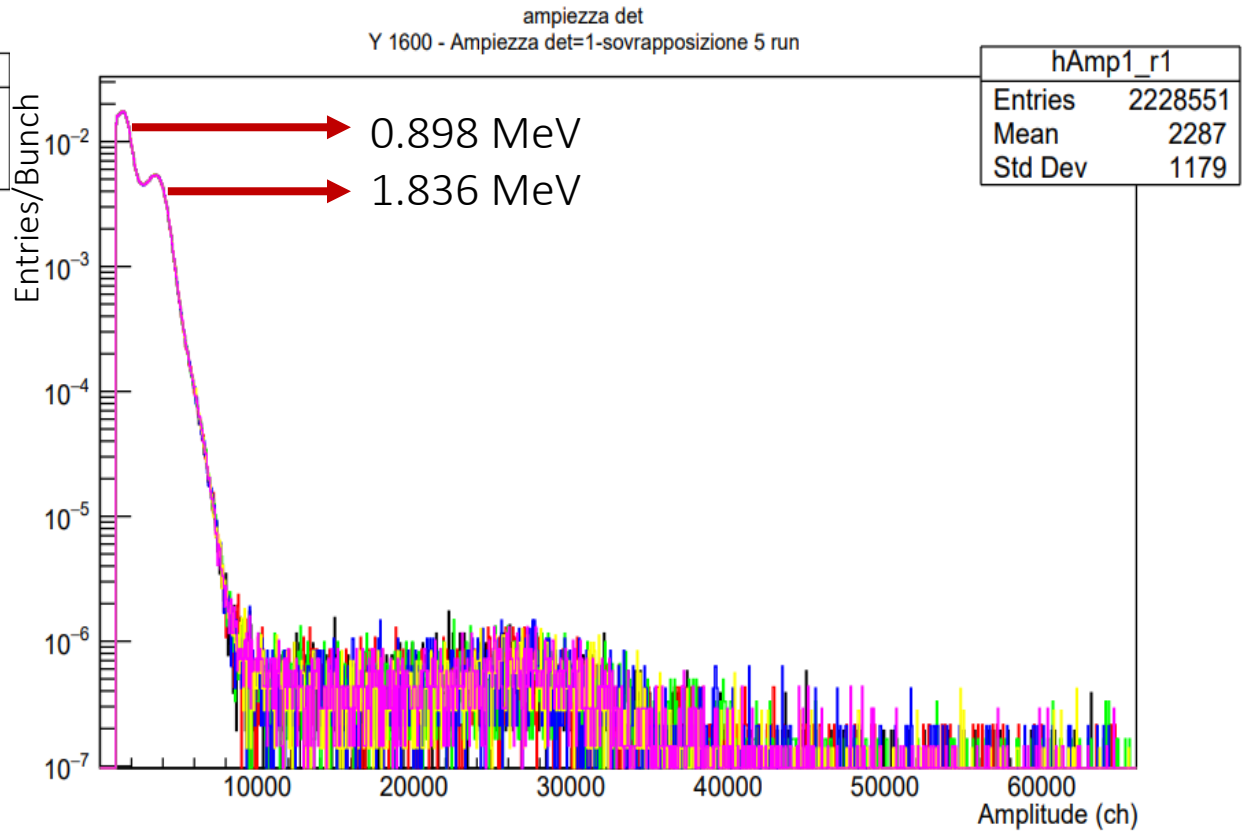
2.Summary of calibration runs

Summary		
Sources	HV	Runs
Cs	1700	921214
AmBe	1400	921399 - 921412
AmBe	1600	921240 - 921247 || 921286 - 921287 || 921380 - 921398
AmBe	1800	921215 - 921239
AmBe	2000	921270 - 921285
AmBe-Pb	1400	921413 - 921437
AmBe-Pb	1600	921326 - 921379
Y-88	1400	921438 - 921451
Y-88	1600	921288 - 921296
Y-88	1800	921297 - 921308
Y-88	2000	921309 - 921316
Cf-252	1400	921646 - 921654
Cf-252	1500	921639 - 921645
Cf-252	1600	921634 - 921638
Cf-252	1700	921630 - 921633 || 921655 - 921659

2.Check of the detectors' BC501A response

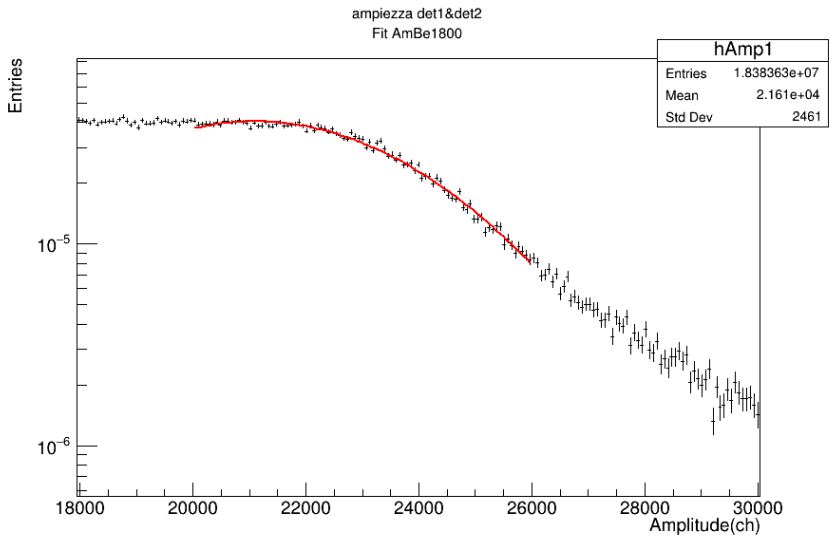
Superimposition of 5 amplitude spectra for Y1600



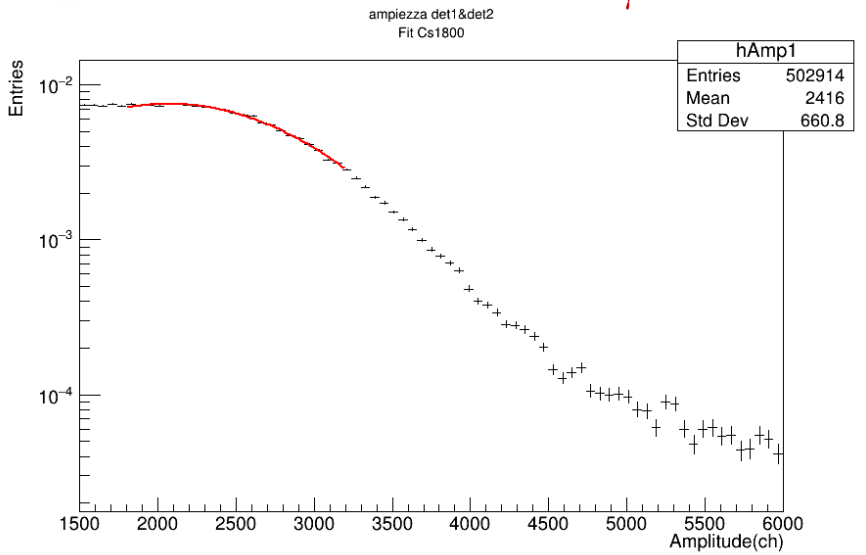


2.Calibration at 1800V

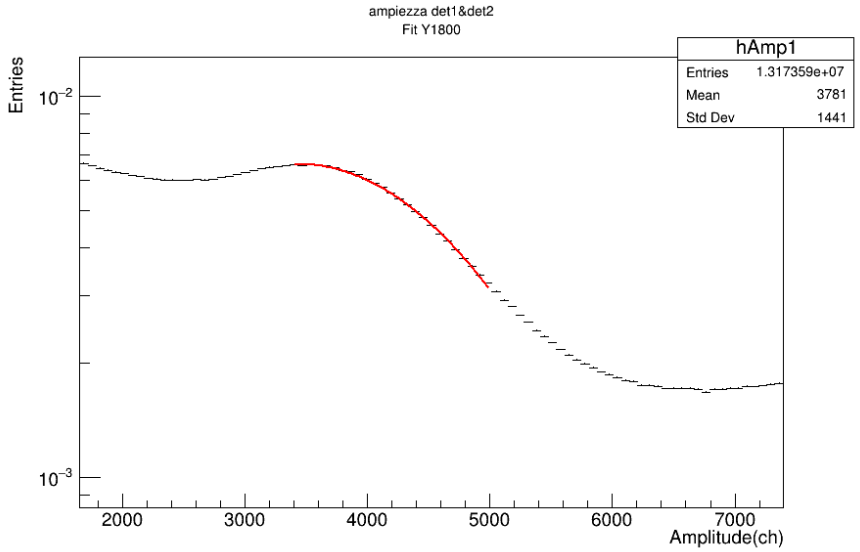
AmBe_1800 Compton Edge → E_γ=4.4 MeV



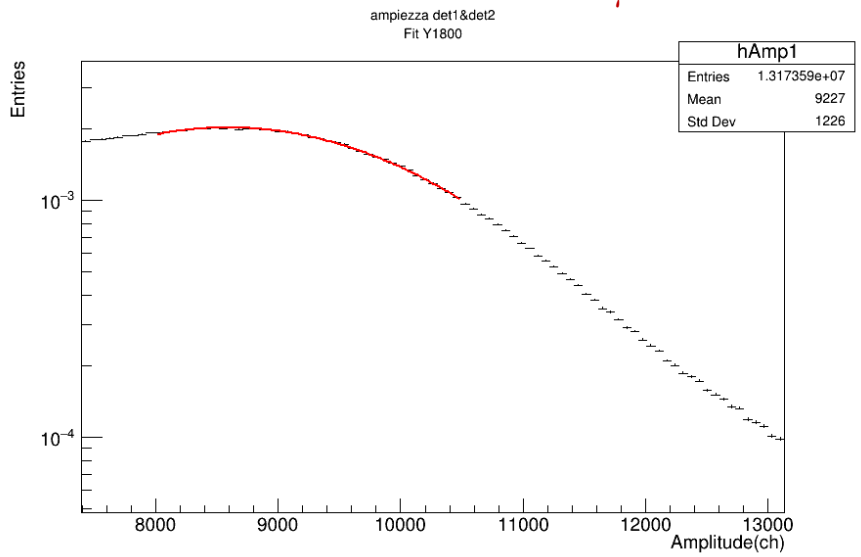
Cs_1800 Compton Edge → E_γ=0.662 MeV



Y_1800 Compton Edge → E_γ=0.8 MeV



Y_1800 Compton Edge → E_γ=1.8 MeV



From amplitude spectrum

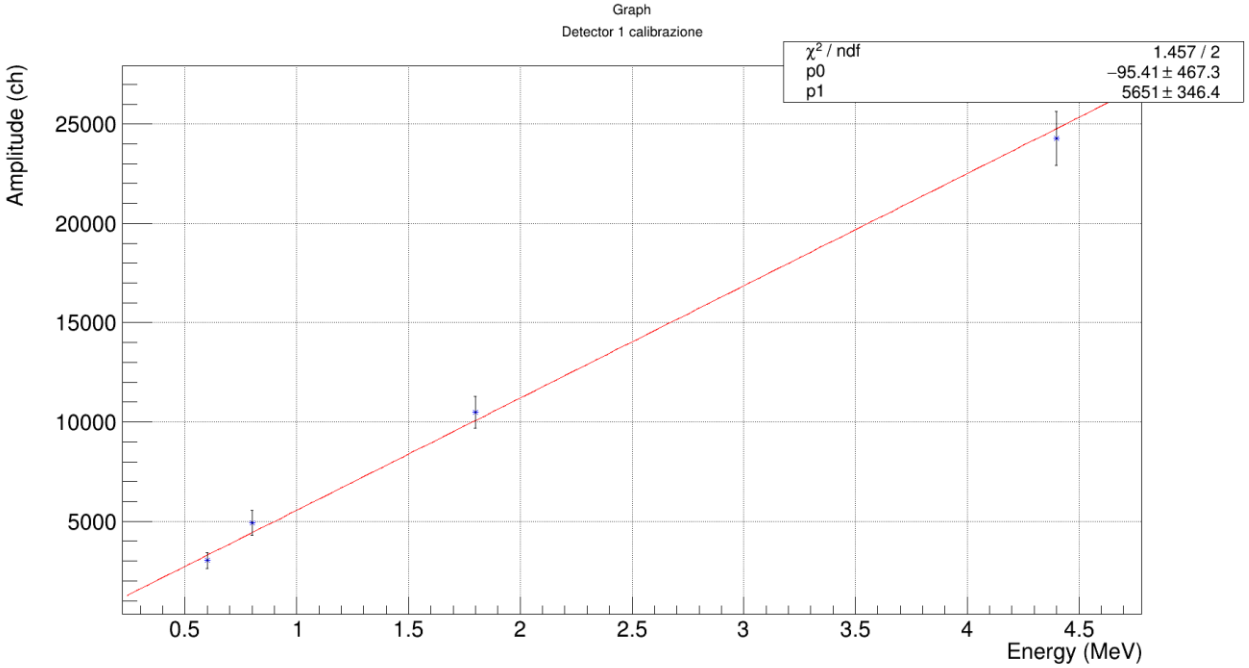
Fit at the peak

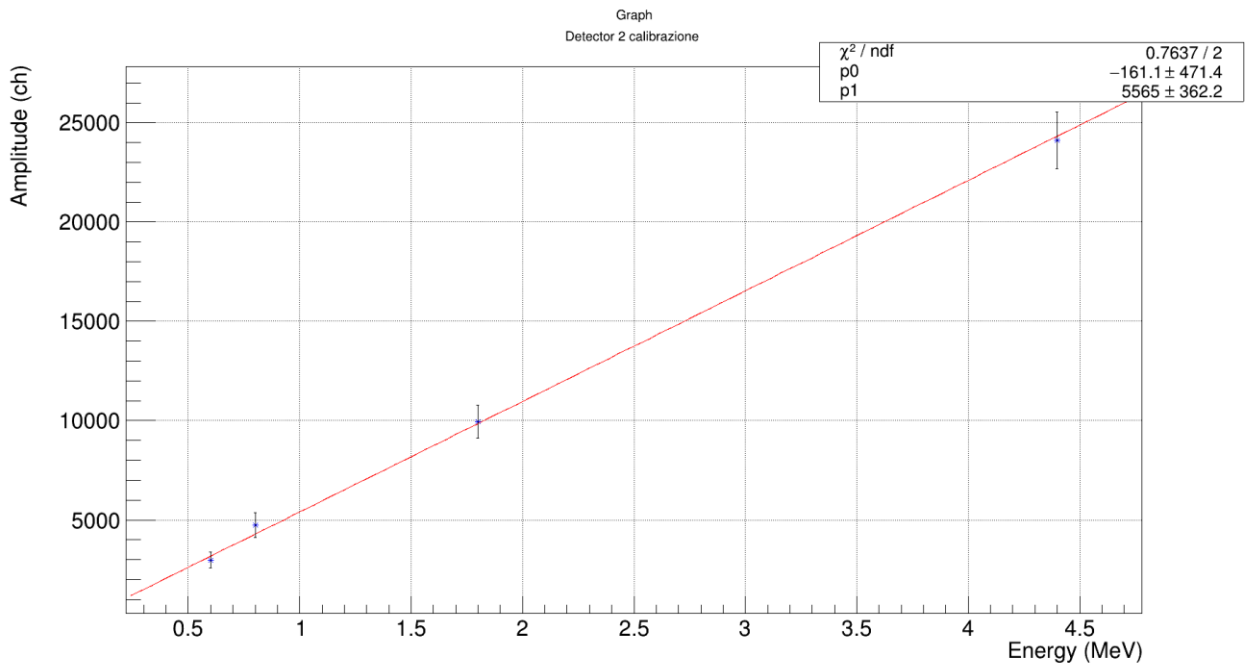
$$C.E \sim \mu + \frac{2.35\,\sigma}{2}$$

(Whole amplitude spectra in **BACKUP SLIDE)**

2.Calibration

$$C.E \sim \mathrm{p0} + \mathrm{p1} \cdot \mathrm{E}$$



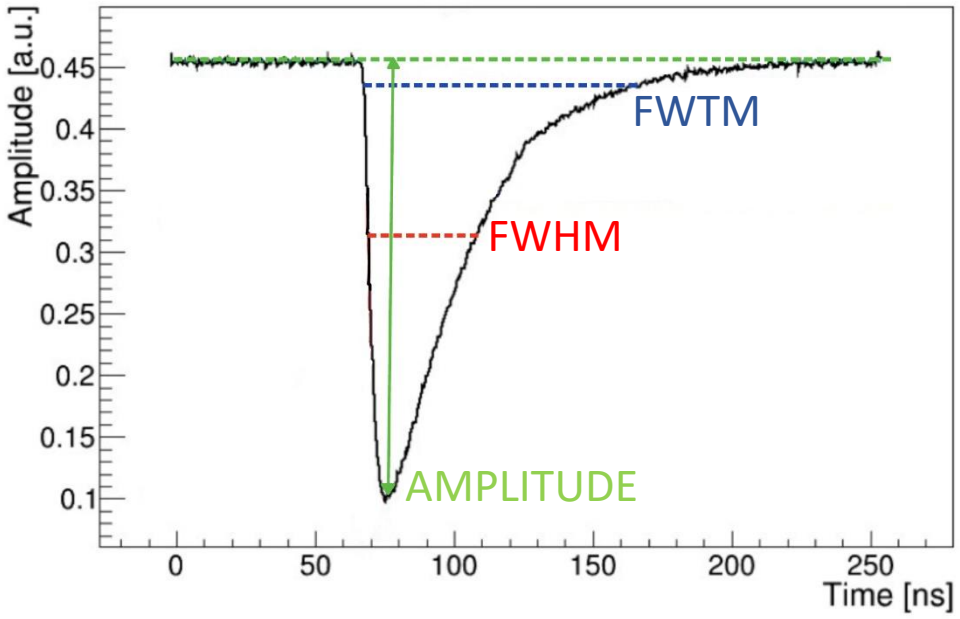


Parameters determined for:

run AmBe –Y88 – AmBePb – Cf at 1600V

run AmBe –Y88 – Cs at 1800V

2.Plot realized for detector 1 and detector 2:



- Amplitude spectra
- FWHM (10 ns)
- FWTM (20 ns)
- Risetime (5 ns)
- Area fast
- Area slow

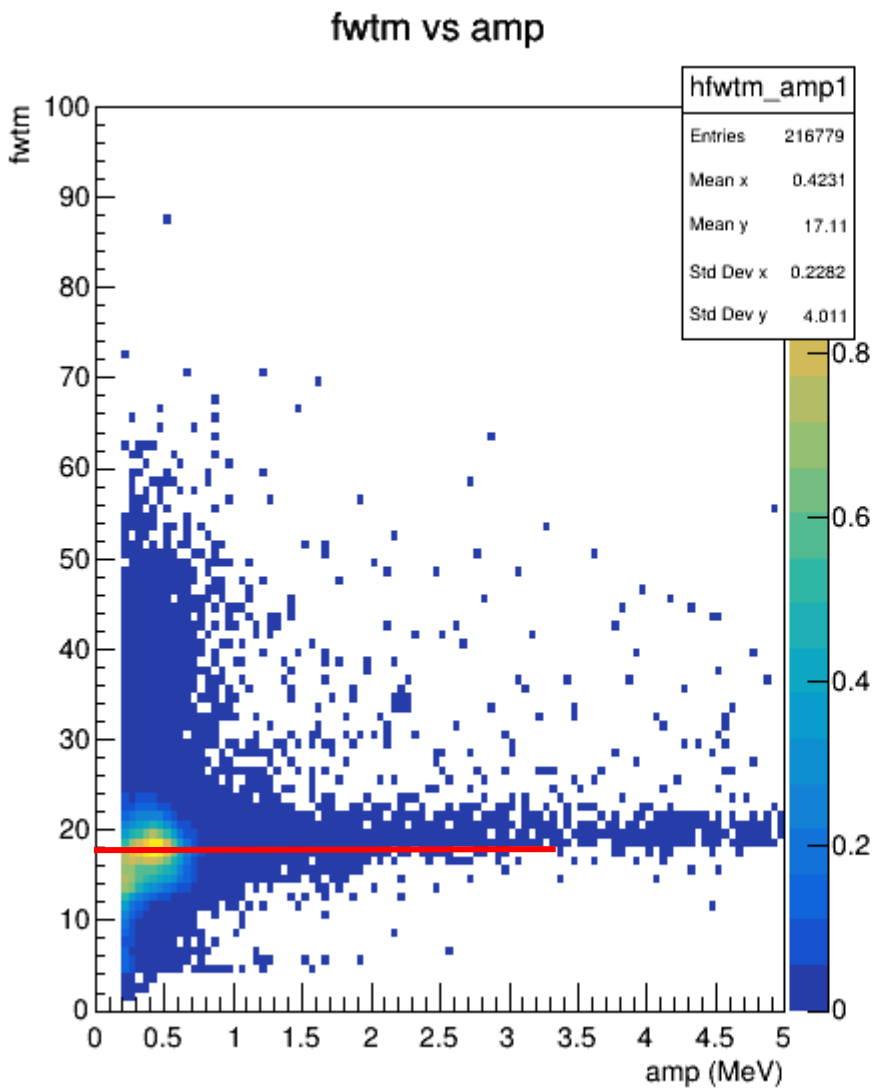
1 Dim.

- Area vs Amplitude
- FWHM vs Amplitude
- FWTM vs Amplitude
- Risetime vs Amplitude
- $\frac{Area}{Amplitude}$ vs Amplitude
- Area fast vs Area slow
- $\frac{Area\ slow}{Area\ fast}$ vs Amplitude

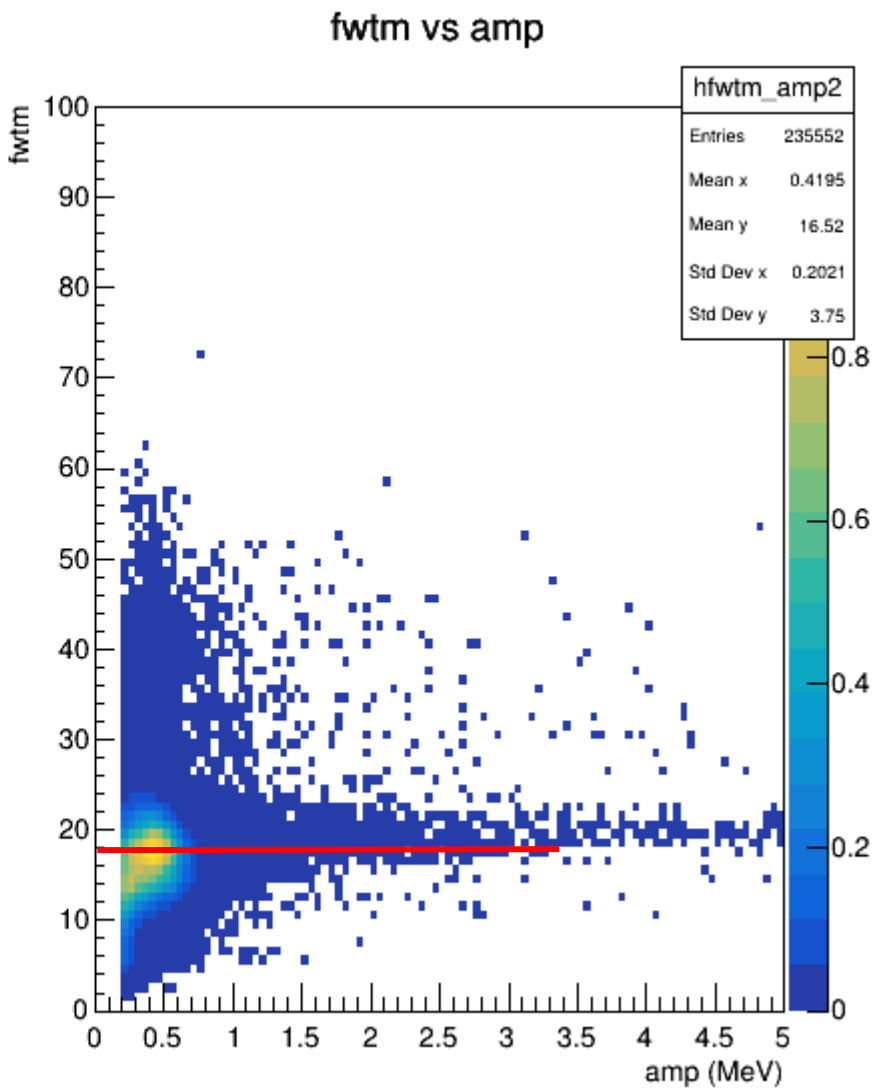
2 Dim.

BC501A: FWTM vs Amplitude– Cs

Detector 1

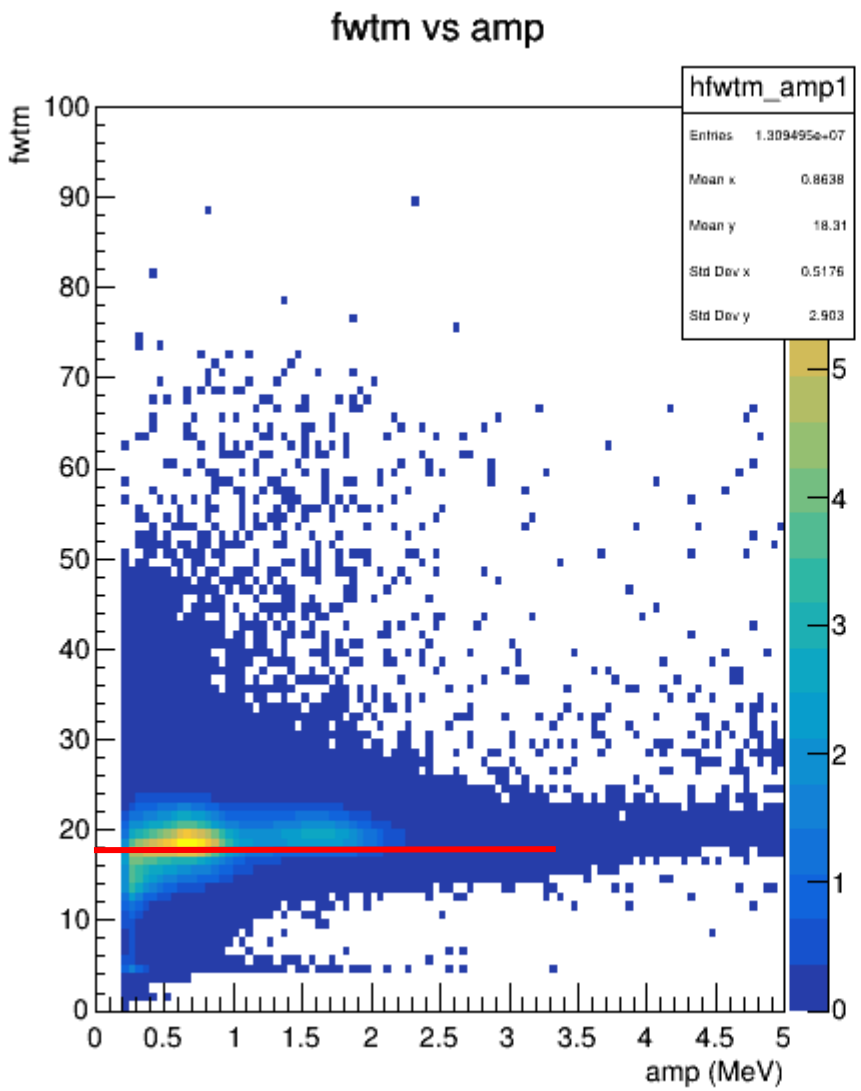


Detector 2

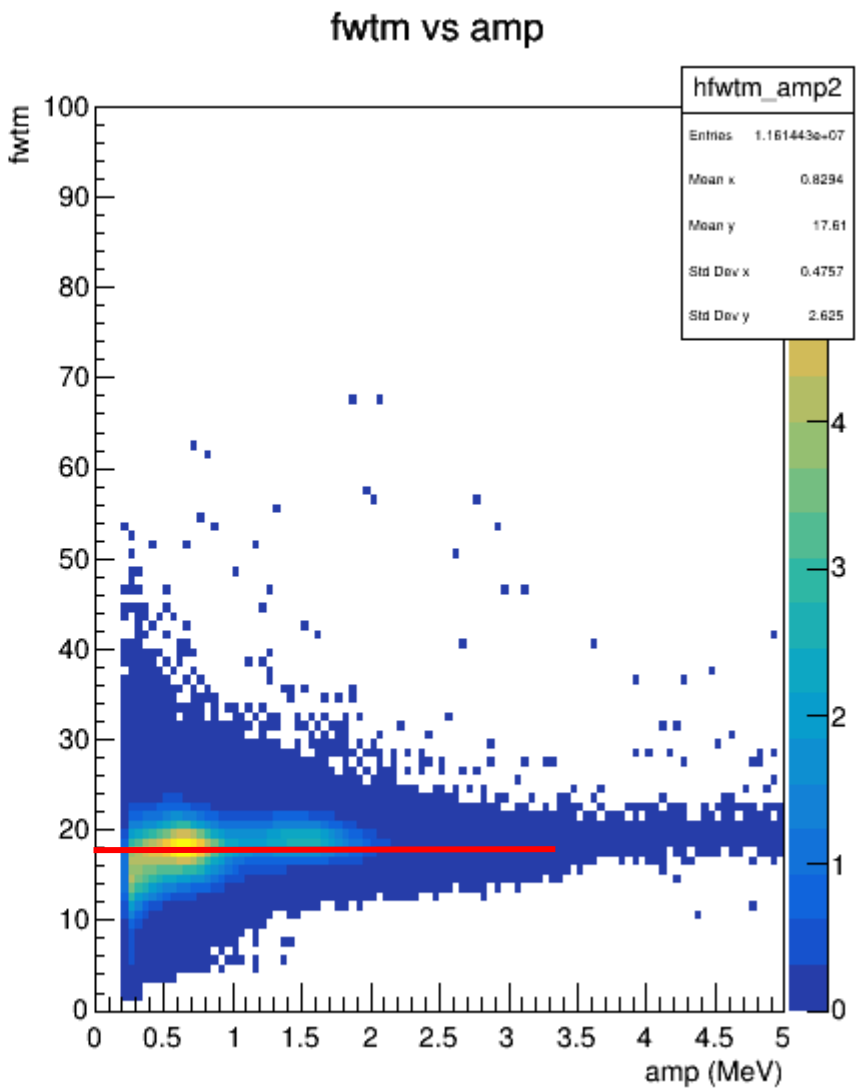


BC501A: FWTM vs Amplitude– Y

Detector 1

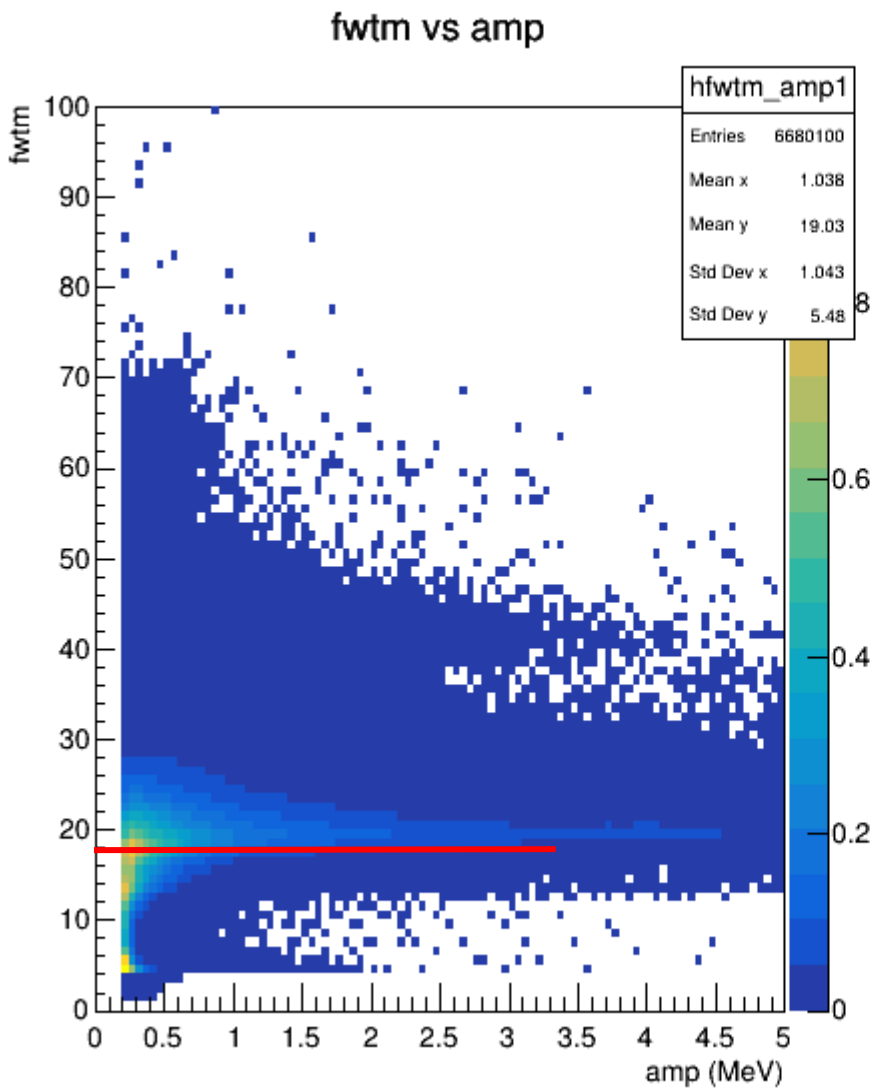


Detector 2

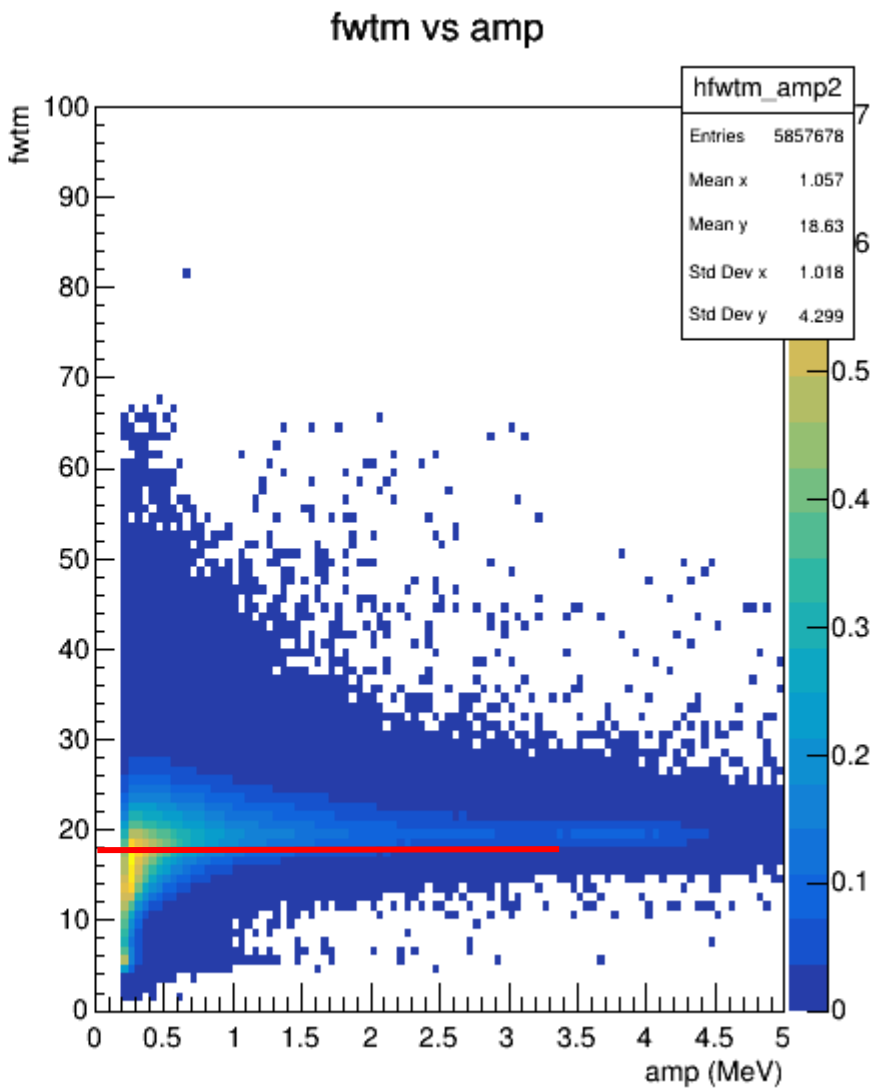


BC501A: FWTM vs Amplitude– AmBe

Detector 1

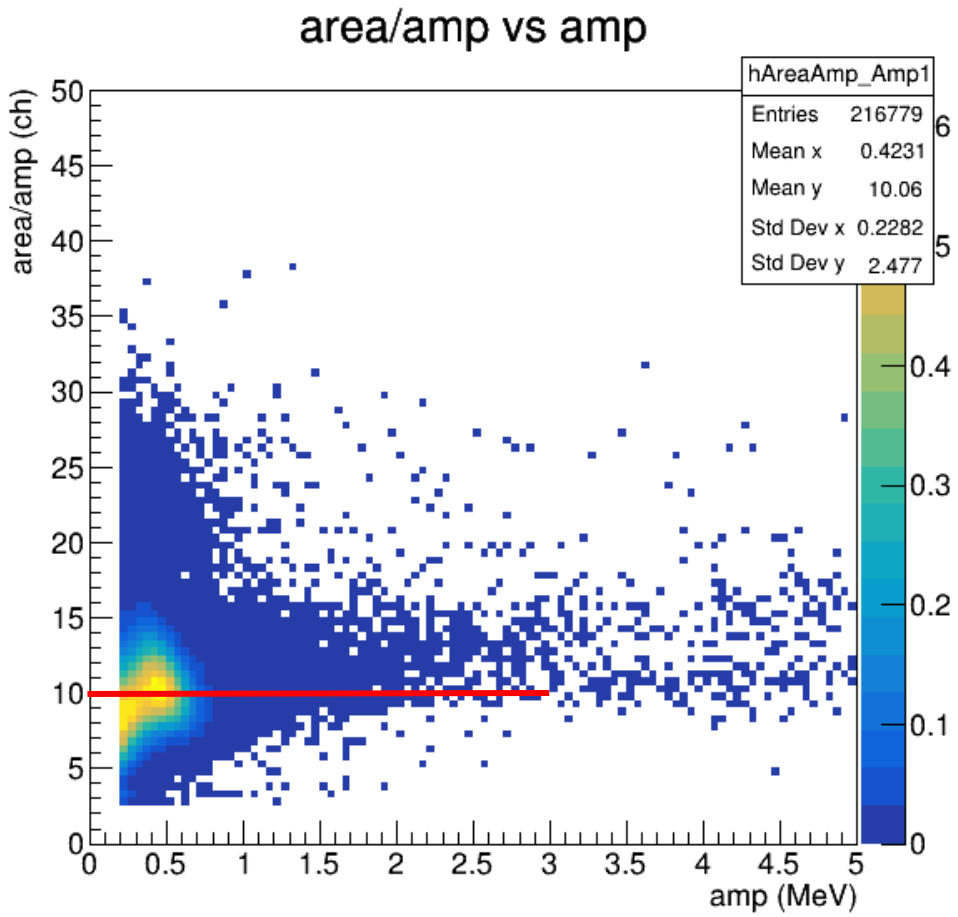


Detector 2

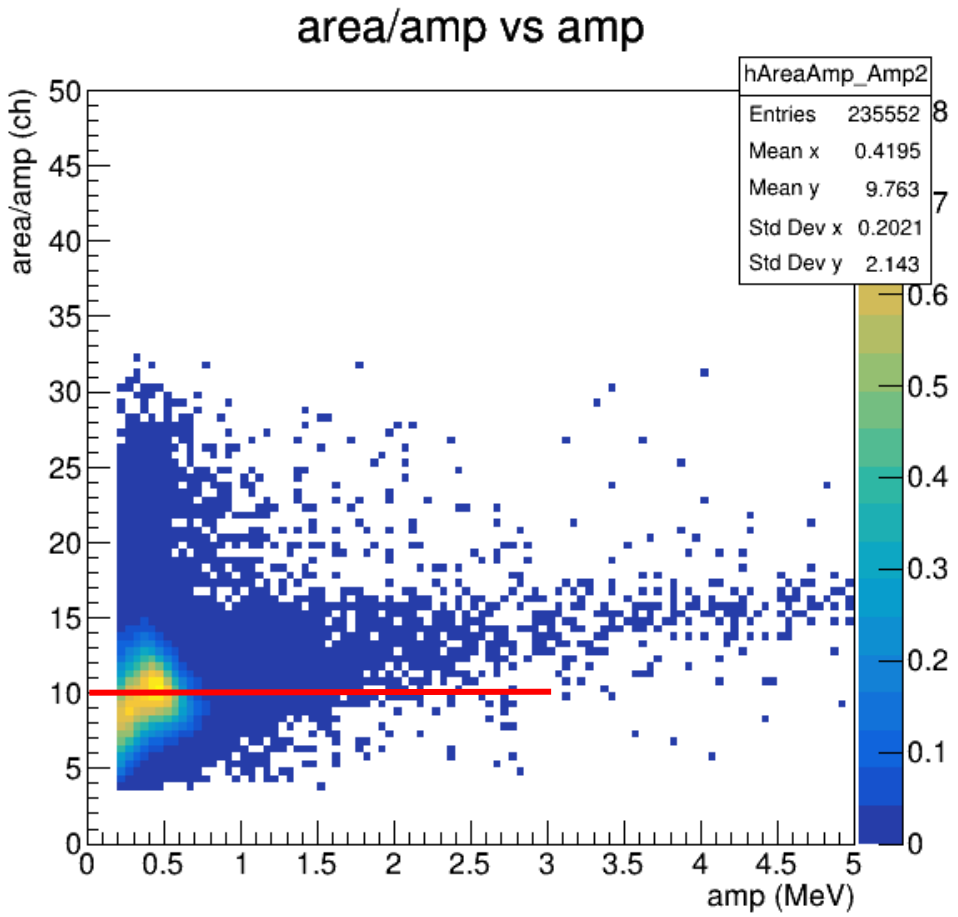


BC501A: Area/Amplitude vs Amplitude– Cs

Detector 1

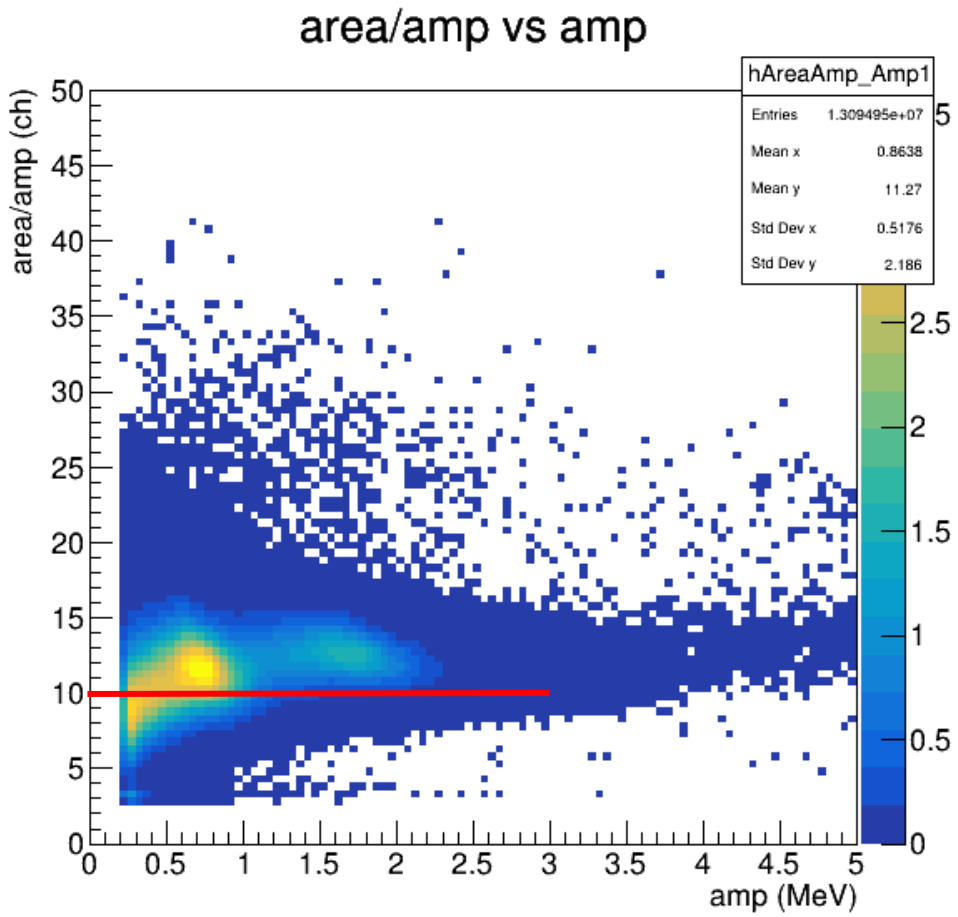


Detector 2

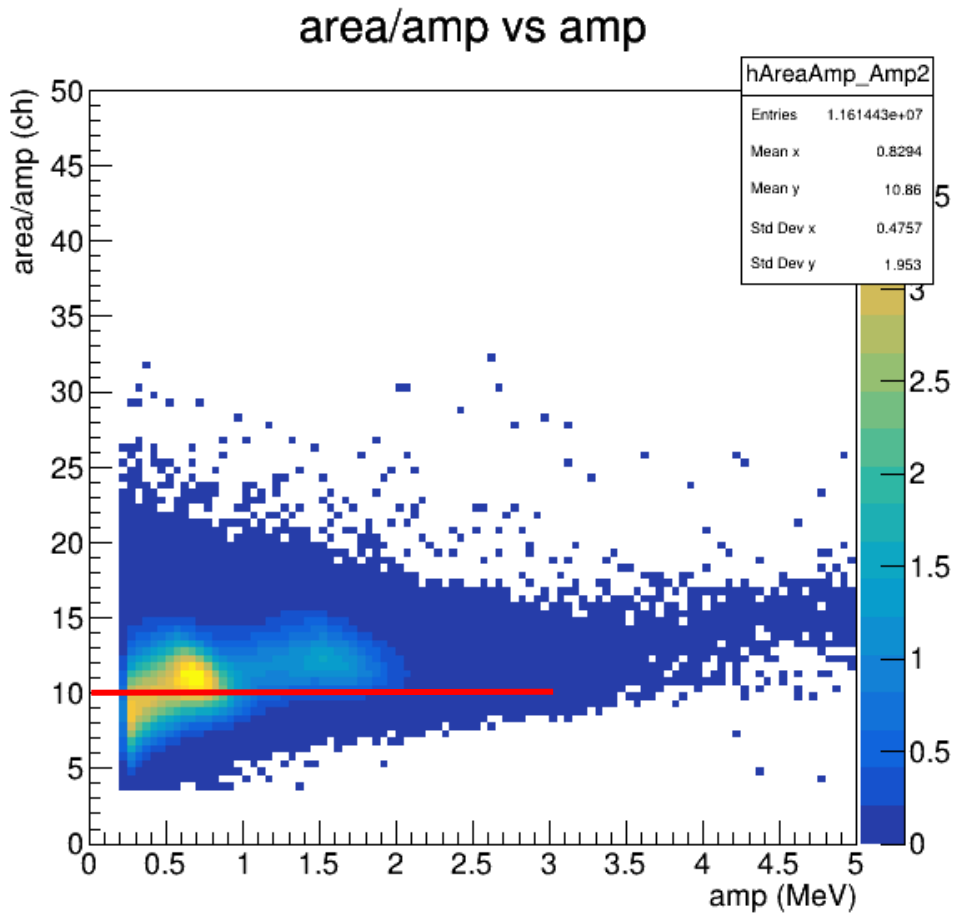


BC501A: Area/Amplitude vs Amplitude– Y

Detector 1

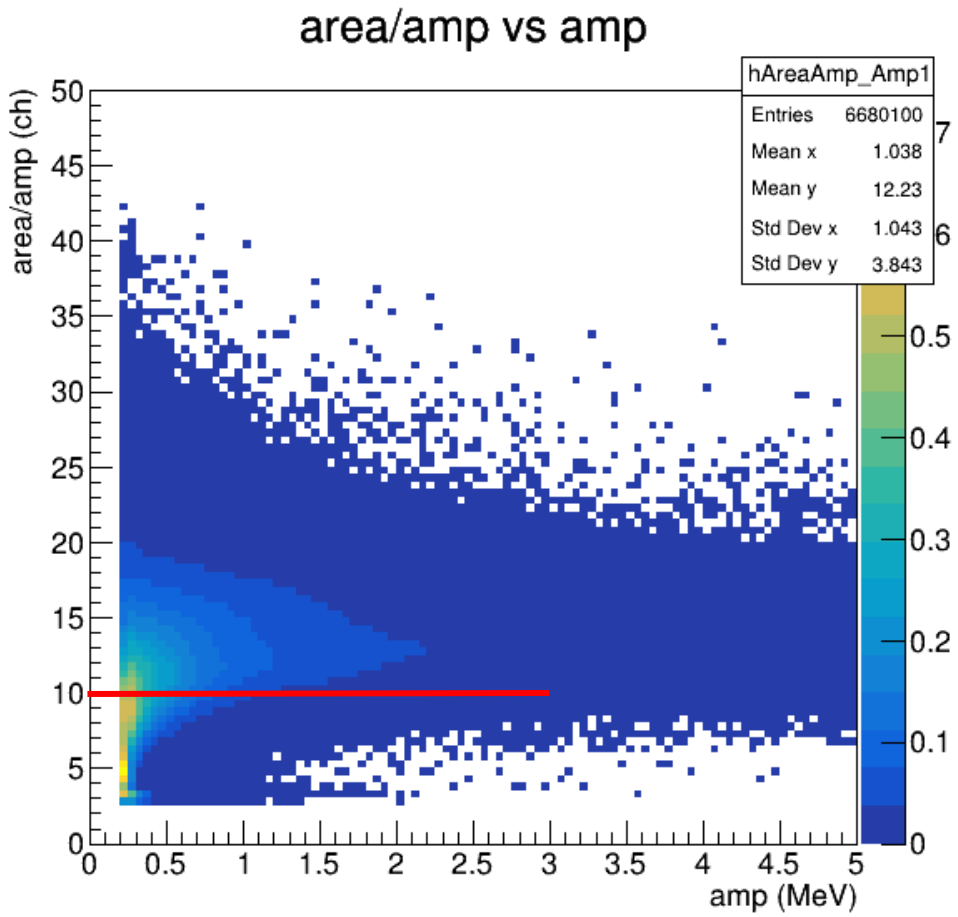


Detector 2

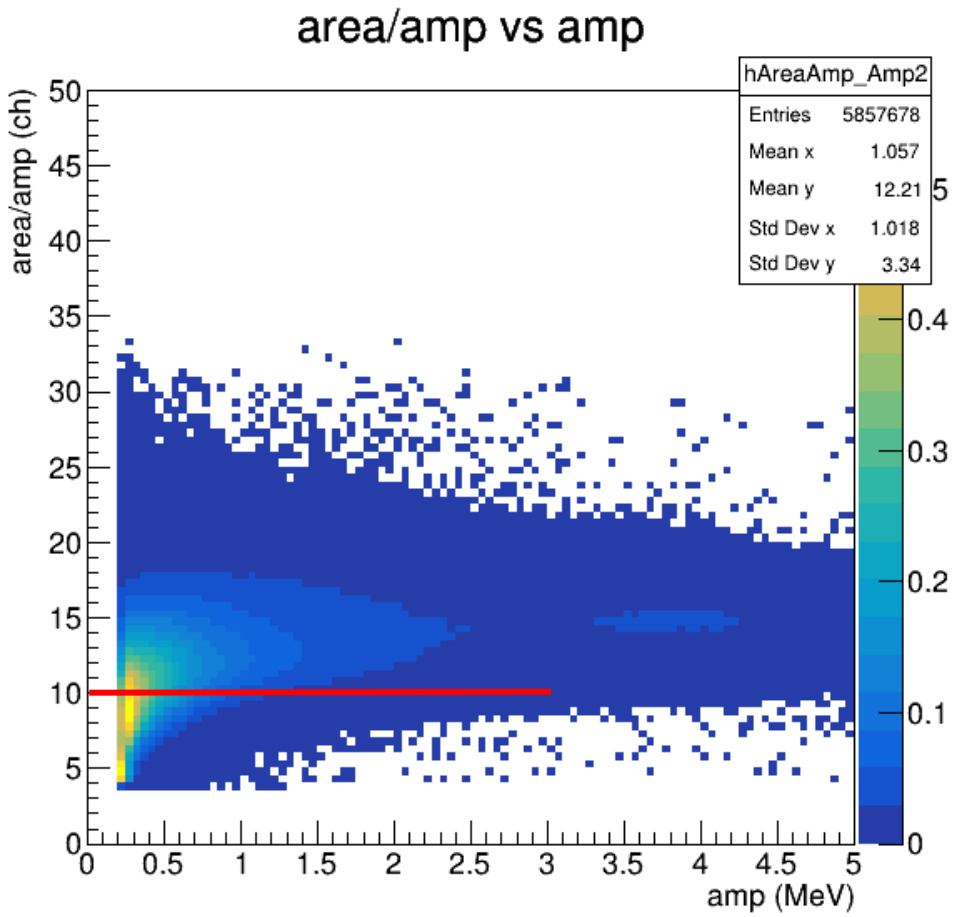


BC501A: Area/Amplitude vs Amplitude– AmBe

Detector 1

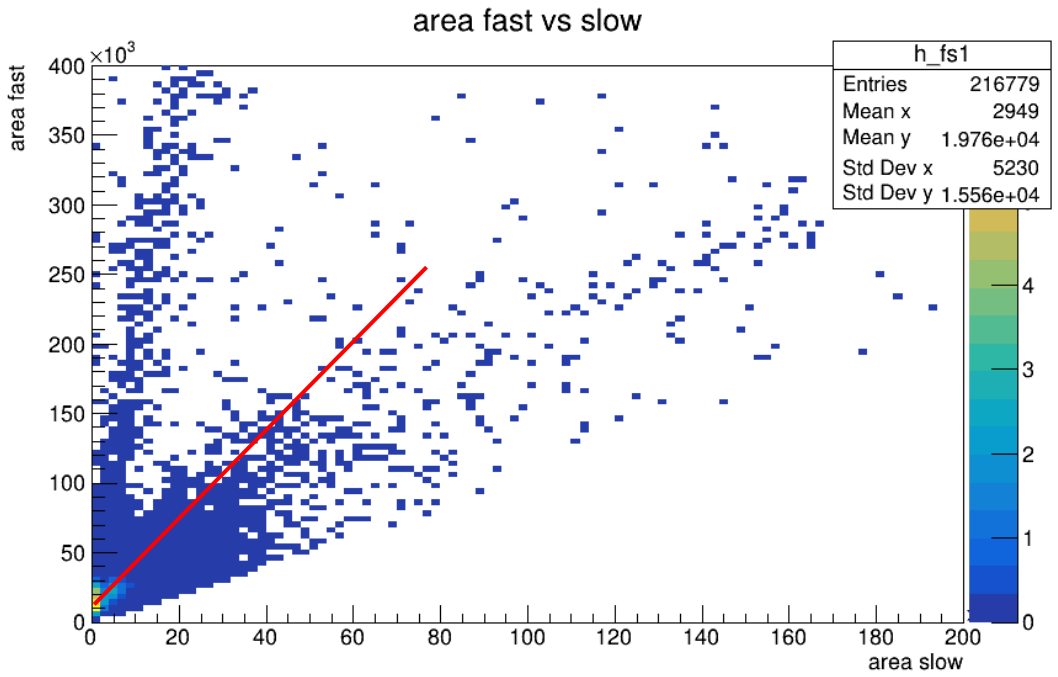


Detector 2

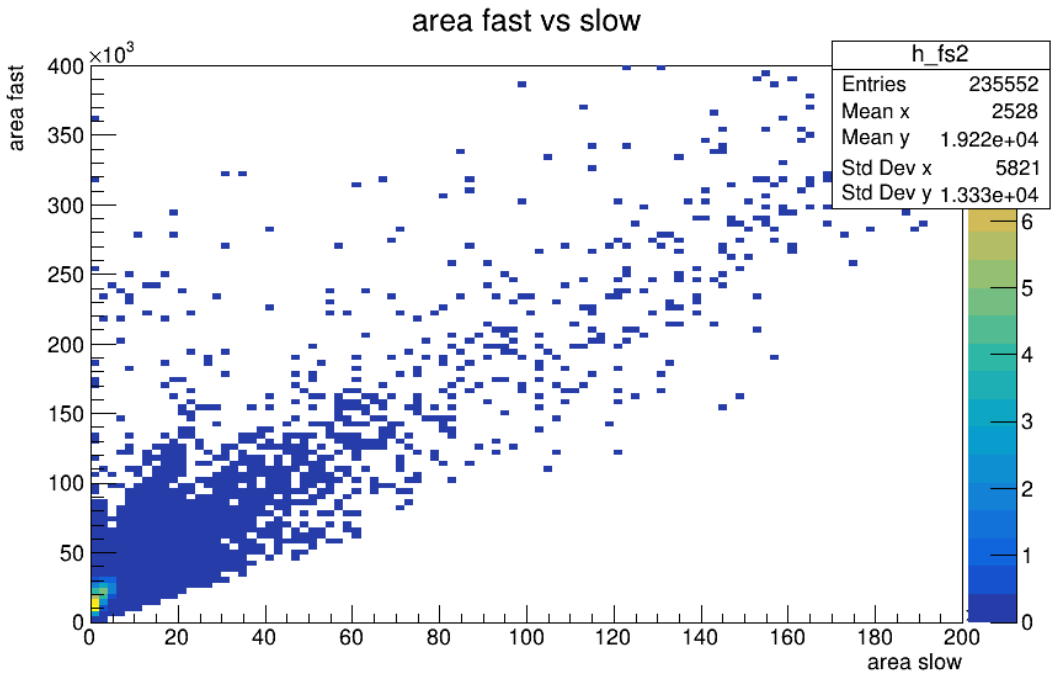


BC501A: Area fast vs Area slow– Cs

Detector 1

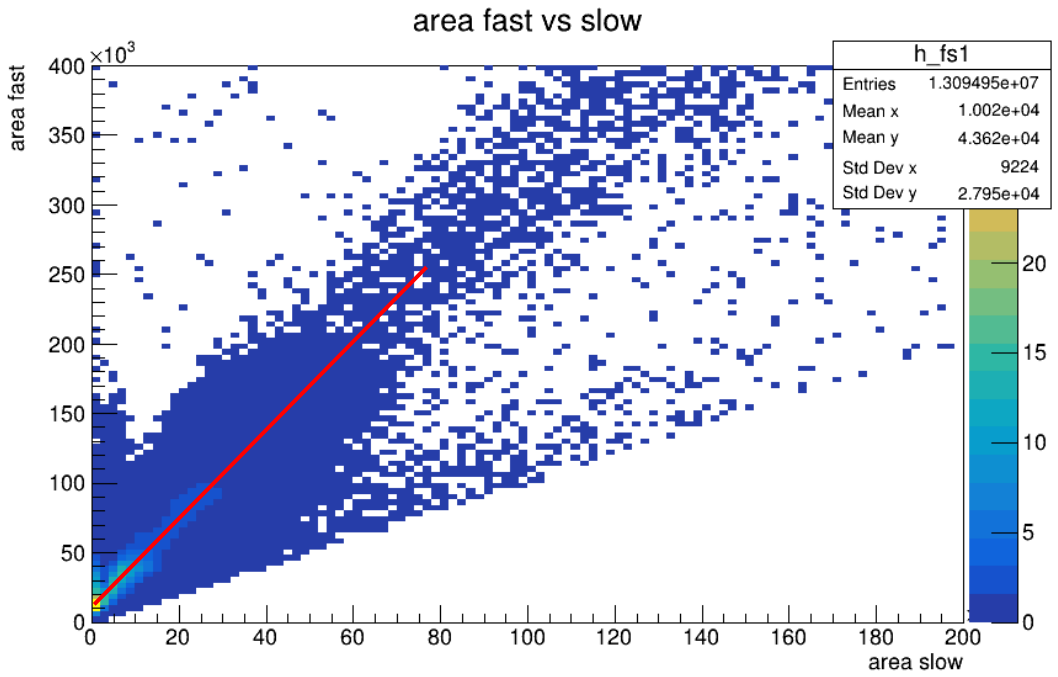


Detector 2

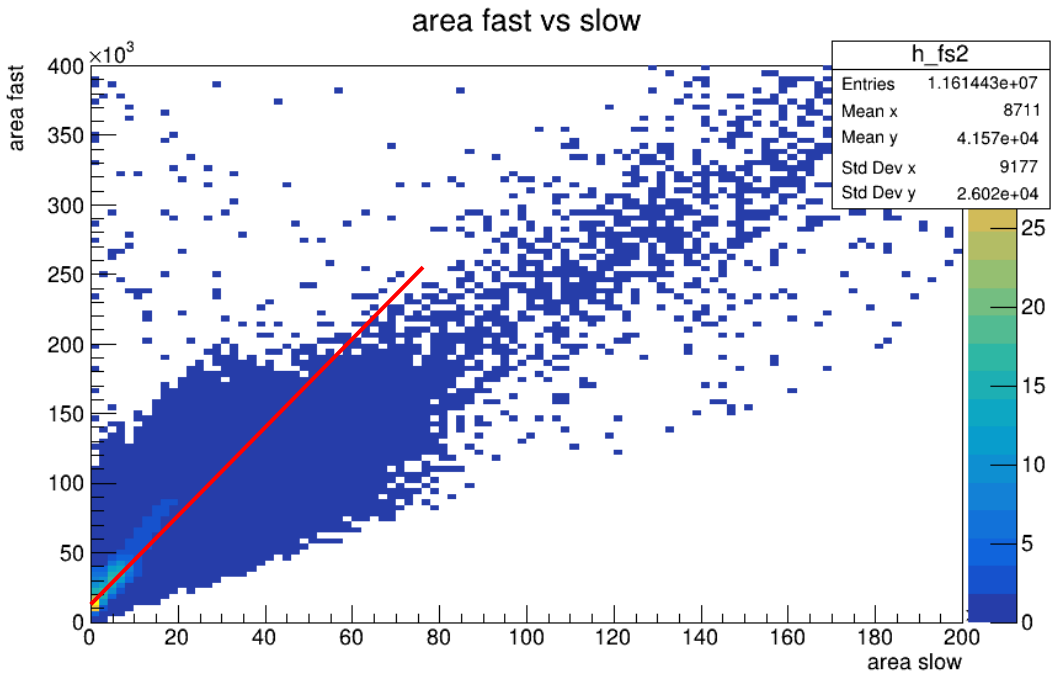


BC501A: Area fast vs Area slow– Y

Detector 1

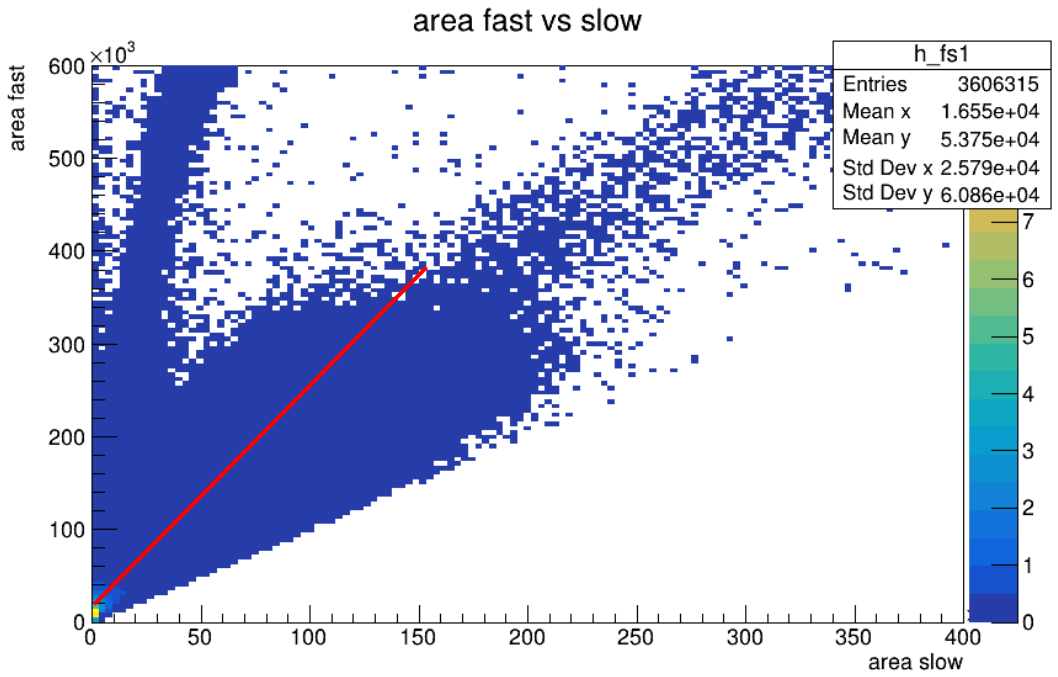


Detector 2

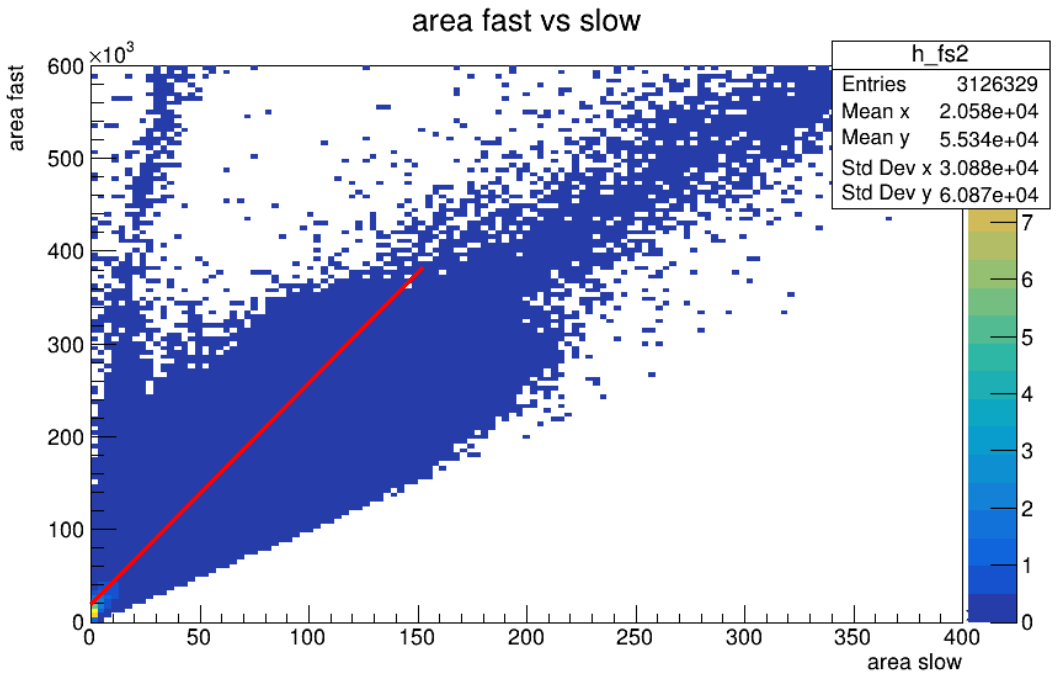


BC501A: Area fast vs Area slow– AmBe

Detector 1

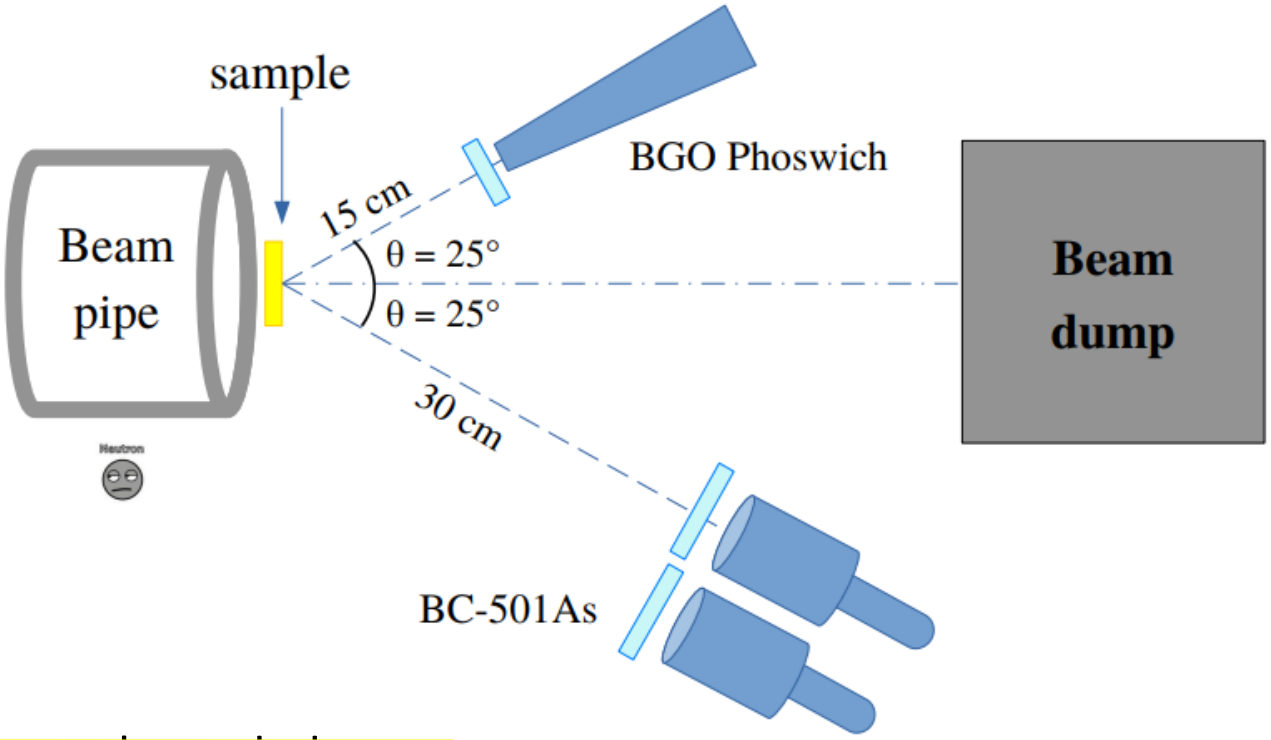


Detector 2



3. Data with beam

Setup:

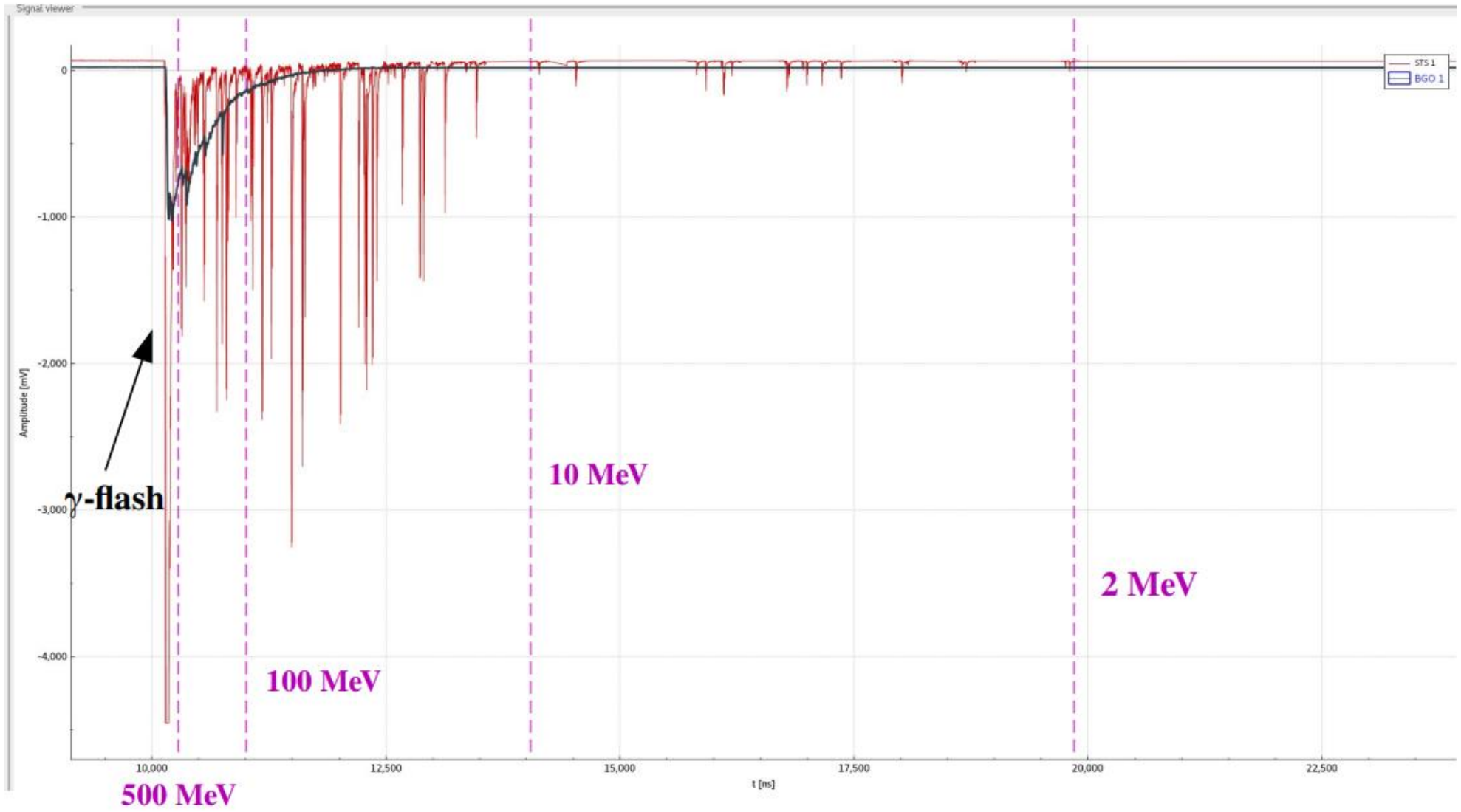


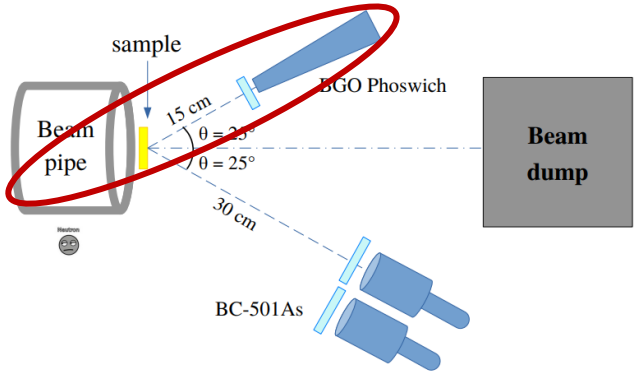
Aspects of the analyzed data:

Target	BC501A det1 [HV]	BC501A det1 [HV]	BGO [HV]	$VETO_{BGO}$ [HV]
Polyethylene 2mm	1700	1700	1300	1100

from Dott.
R.Zarrella
presentation
(XII FOOT meeting)

3.Signals: $VETO_{BGO}$ & BGO

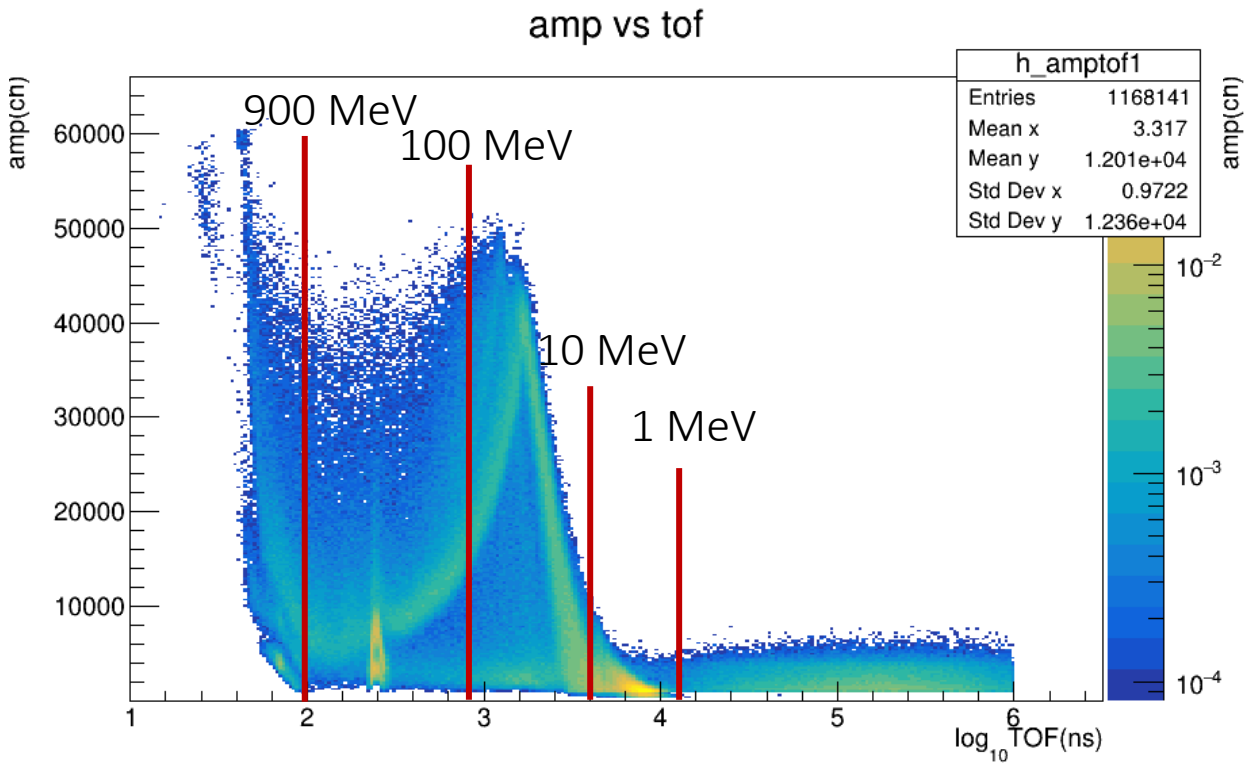




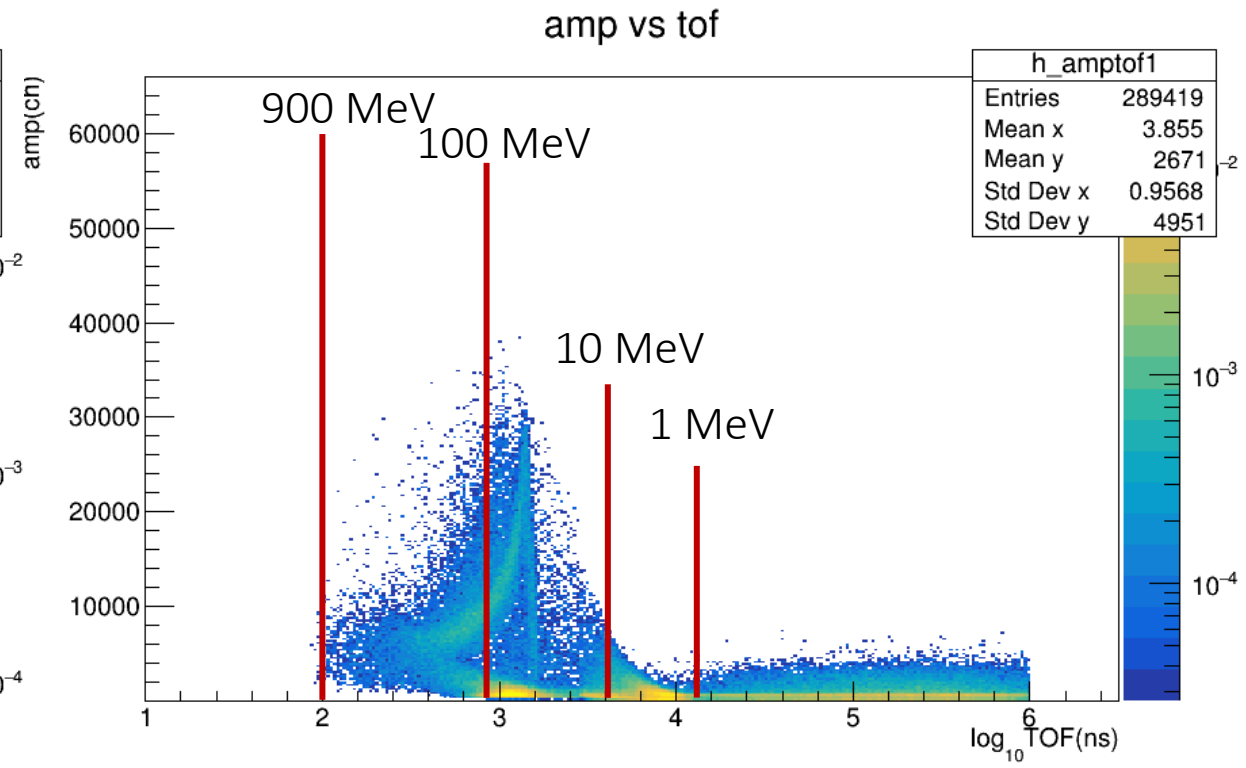
. Data with beam: $VETO_{BGO}$ & BGO

Amplitude vs TOF

$VETO_{BGO}$

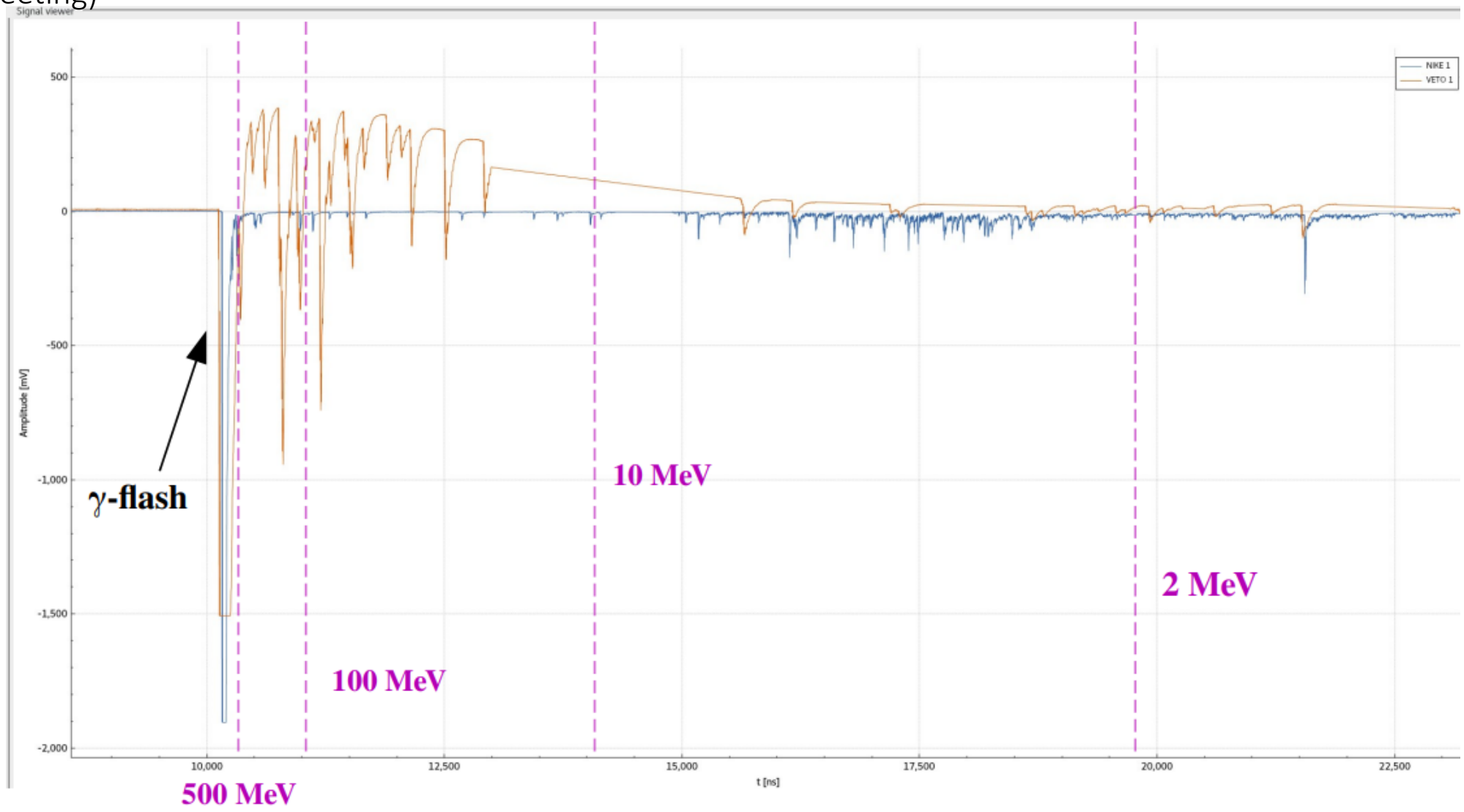


BGO

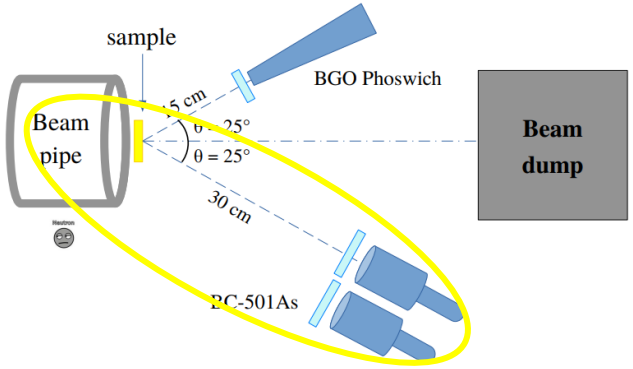


from Dott. R.Zarrella presentation (XII FOOT meeting)

3.Signals: BC501A detector1 + VETO1

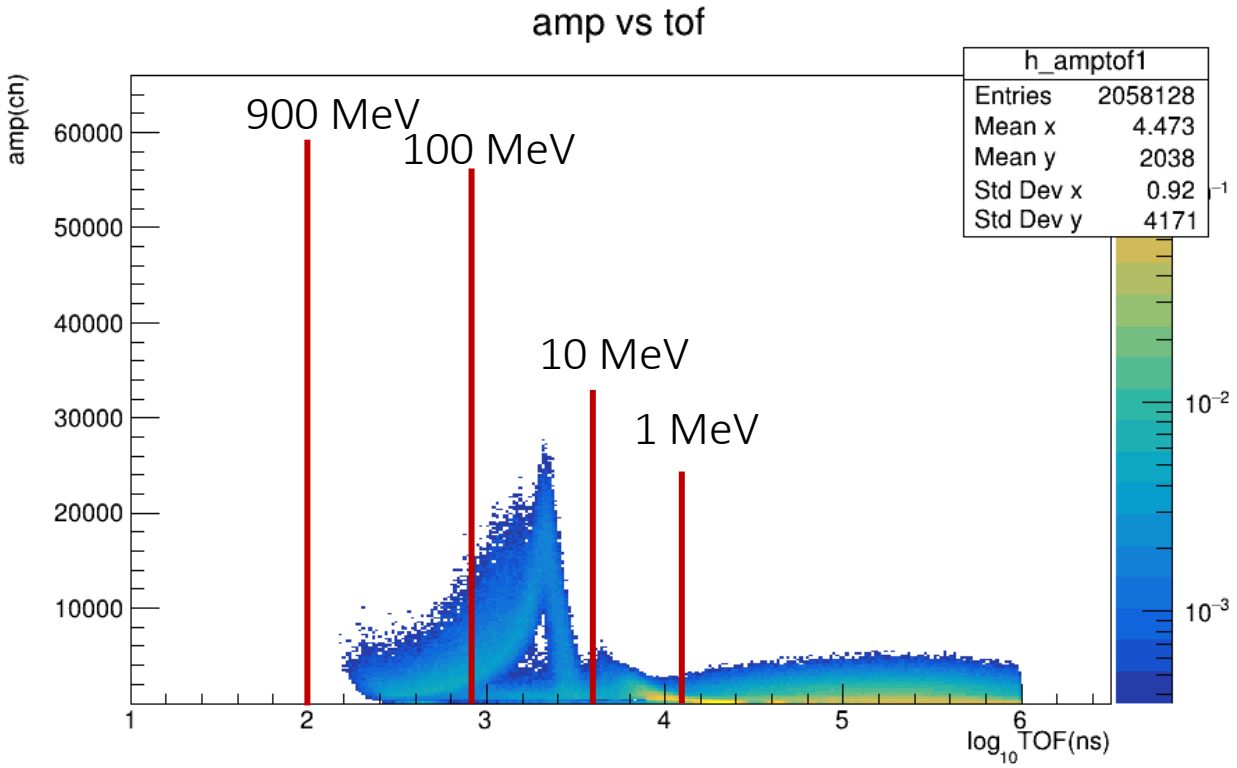


3.VETO

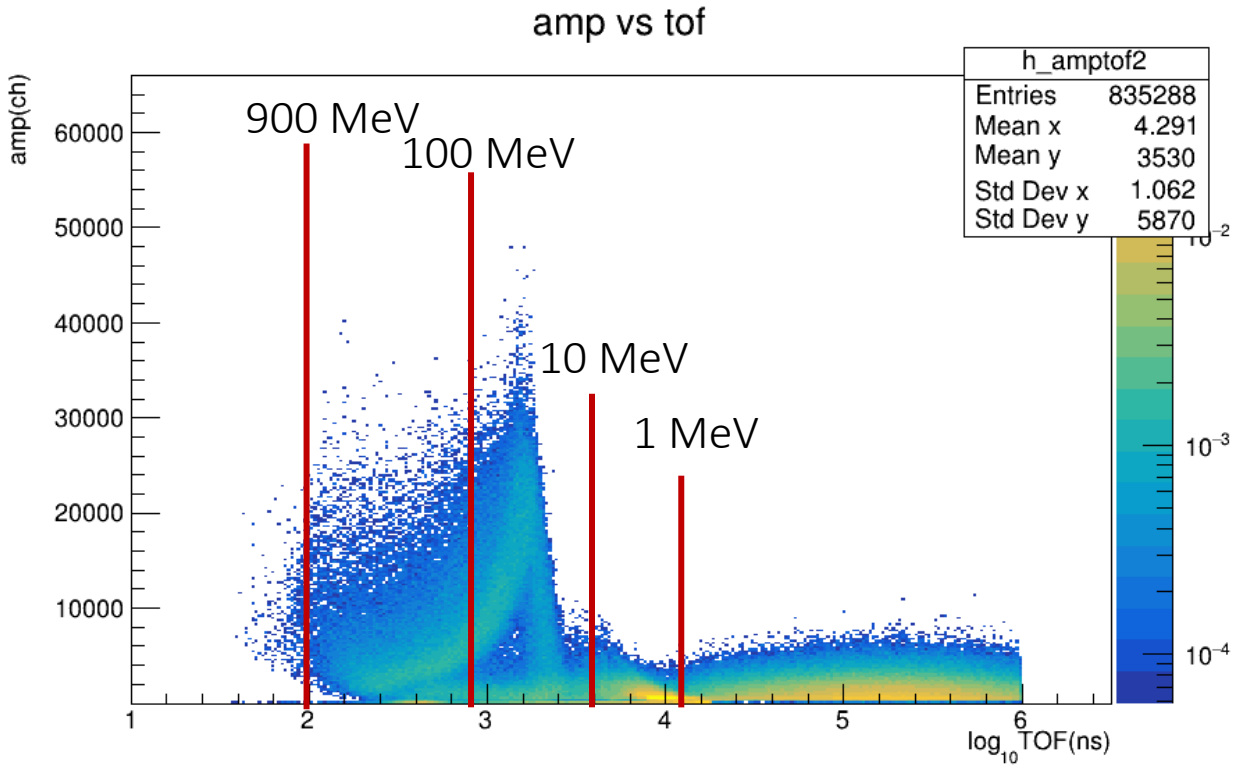


Amplitude vs TOF

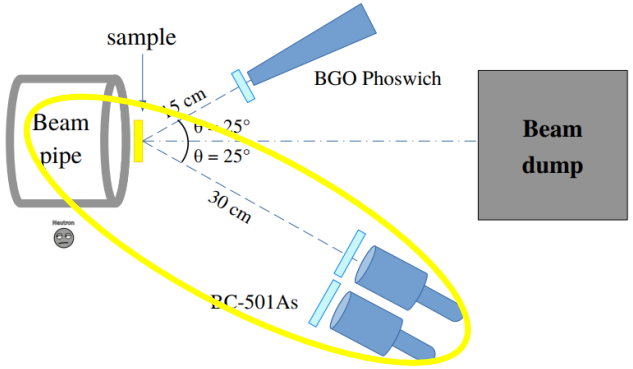
Detector 1



Detector 2

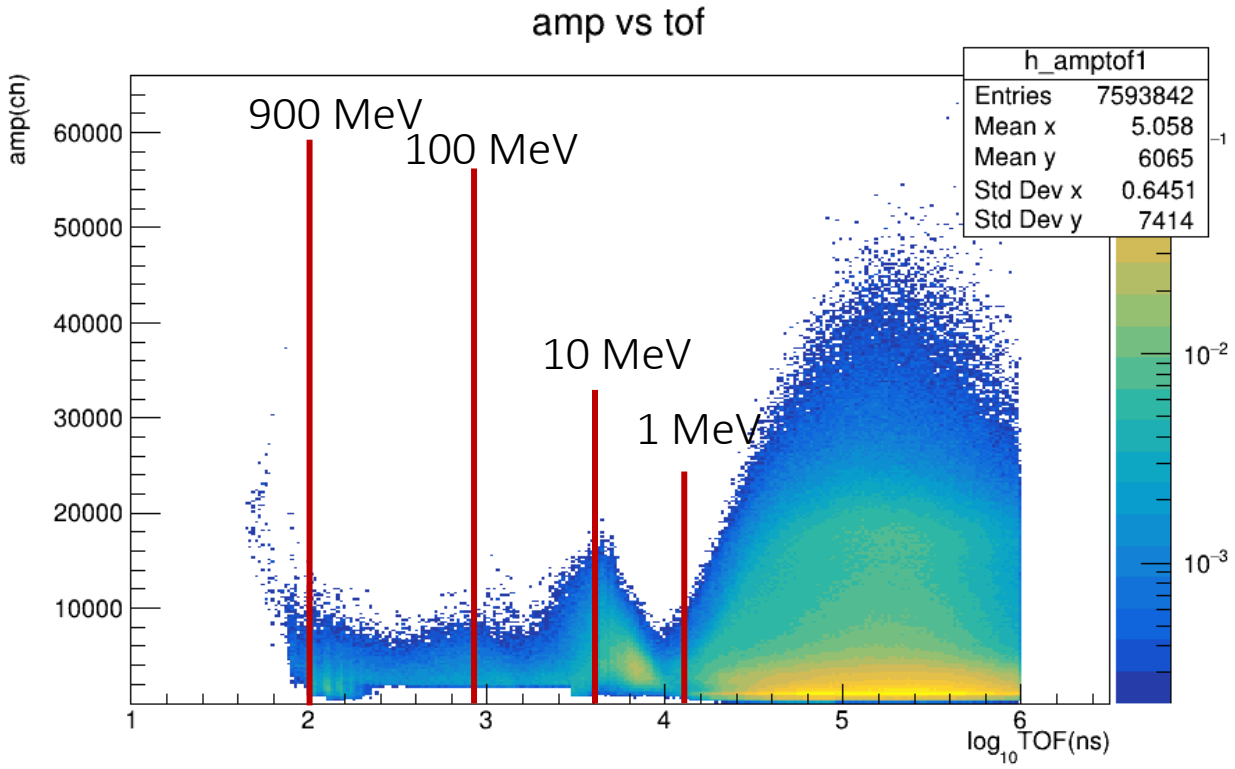


3.BC501A

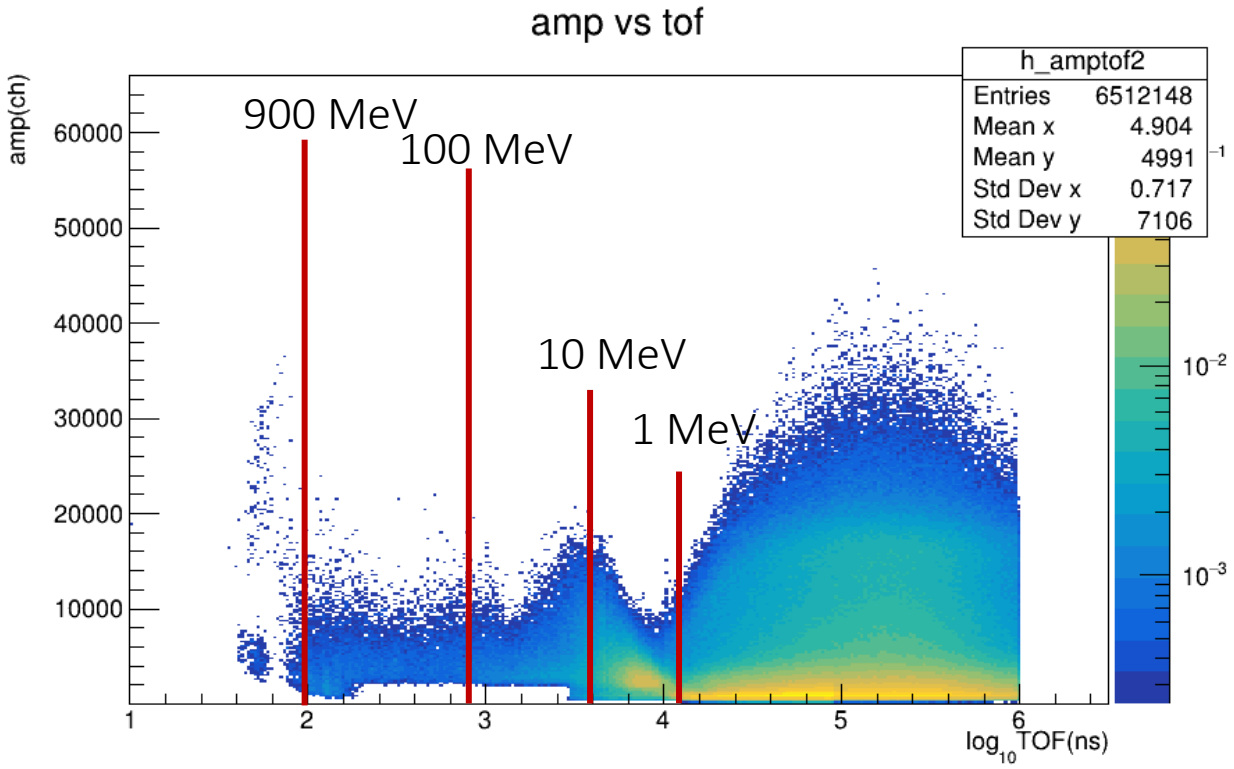


Amplitude vs TOF

Detector 1



Detector 2



Conclusions:

- Evidence of particle discrimination capabilities using radioactive sources.
- Well-characterized beam data.

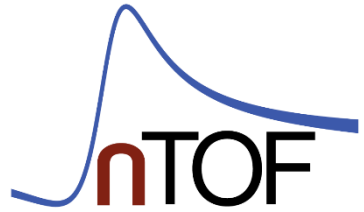
Next step:

- Continue to study the signal's area fast and area slow characteristic parameters.
- Start introducing coincidence signals in the analysis of beam data.

VERY FAR FUTURE… determine neutron detection efficiency for detectors under study

STAY TUNED

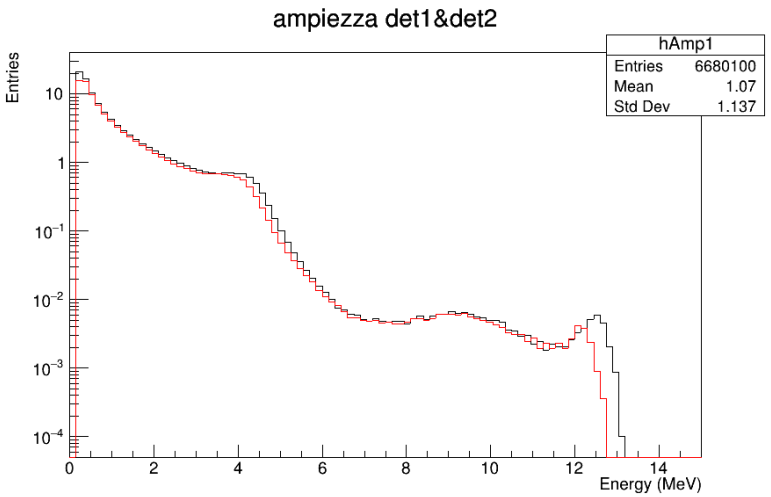
Thank you for your attention



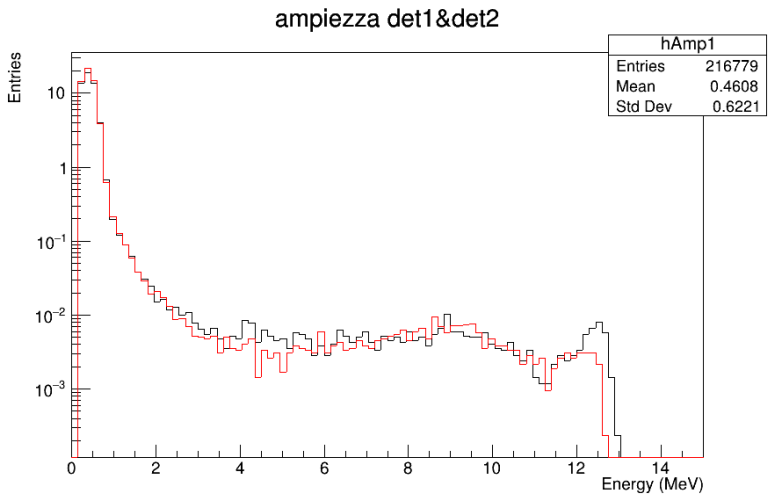
backup slide

Amplitude spectra

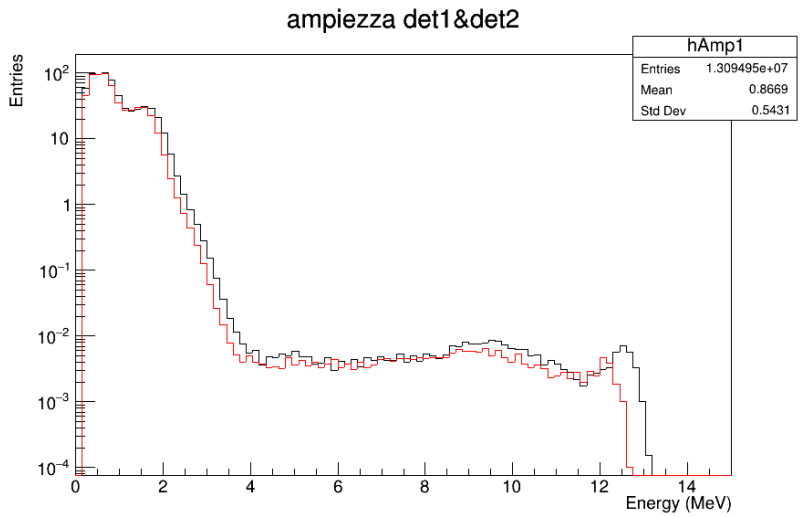
AmBe1800



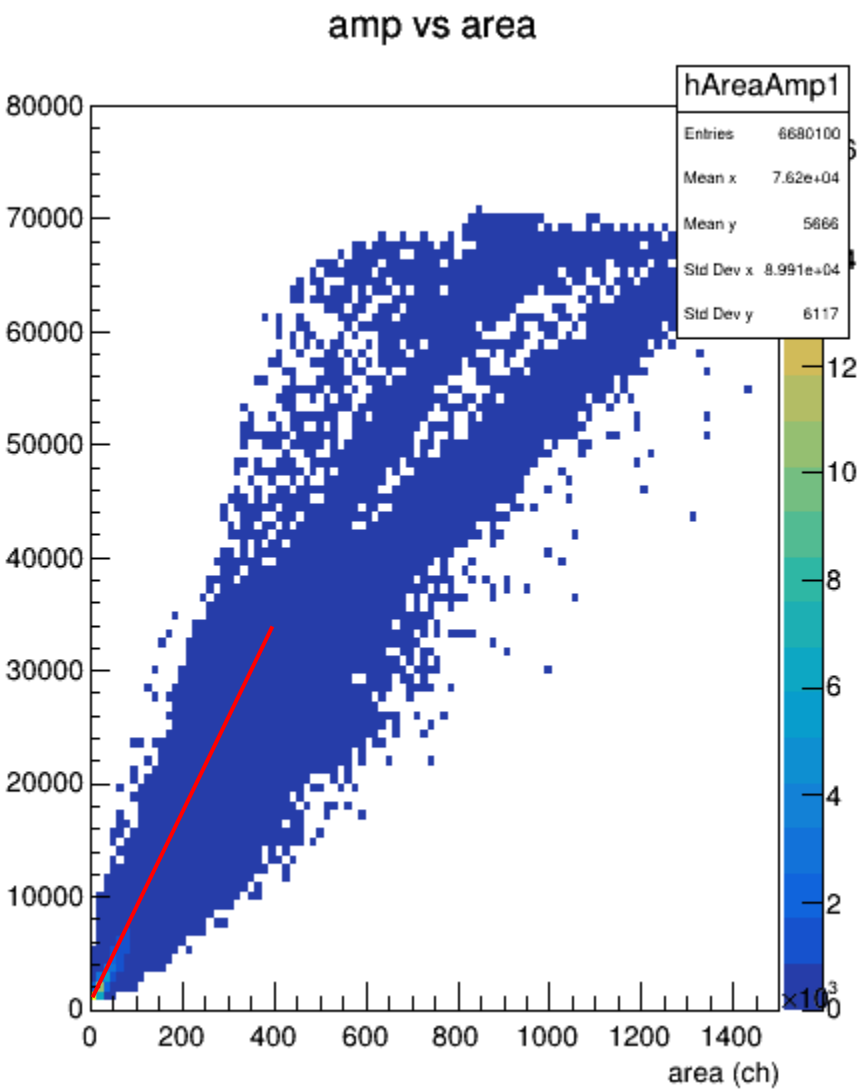
Cs1800

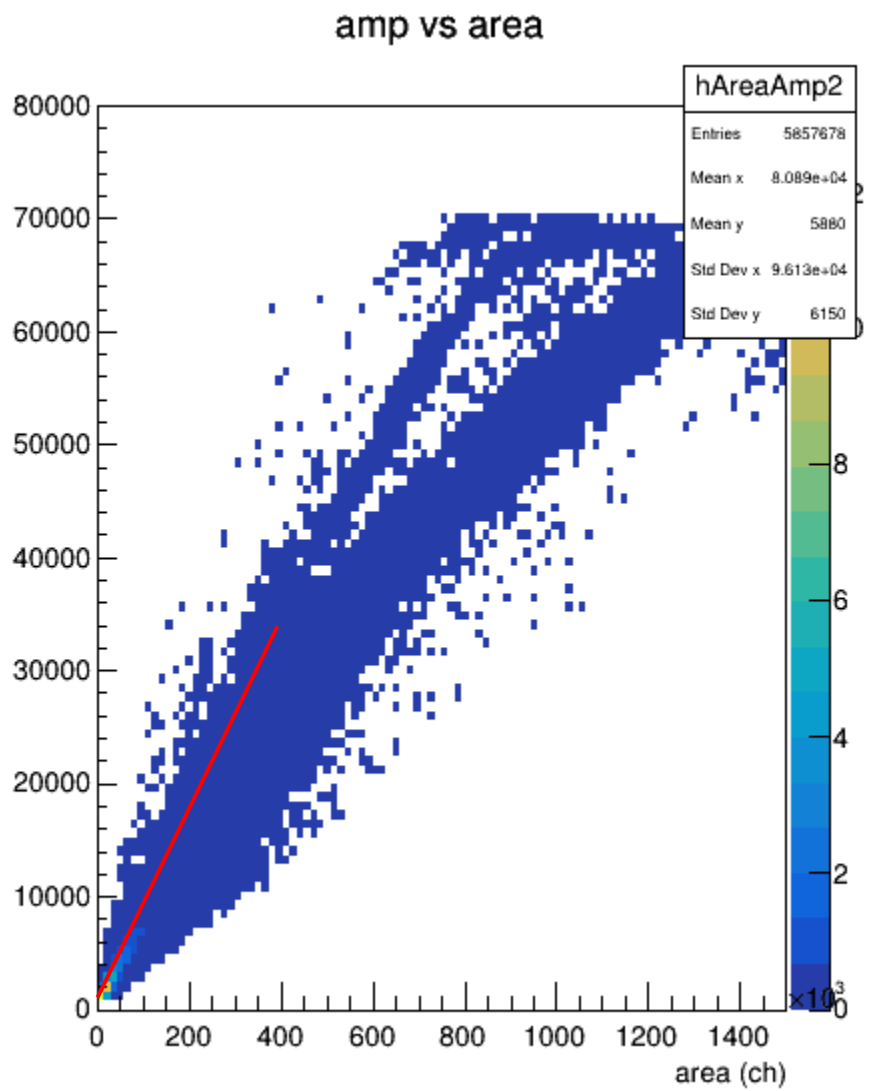


Y1800

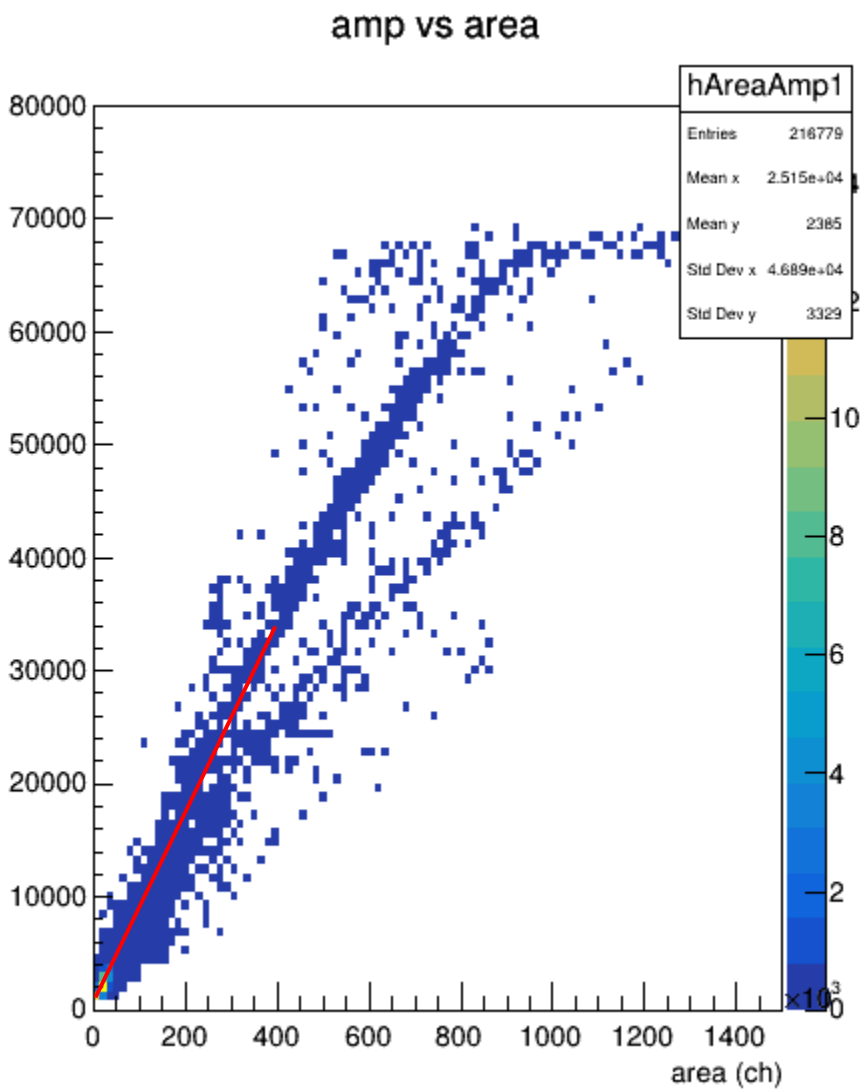


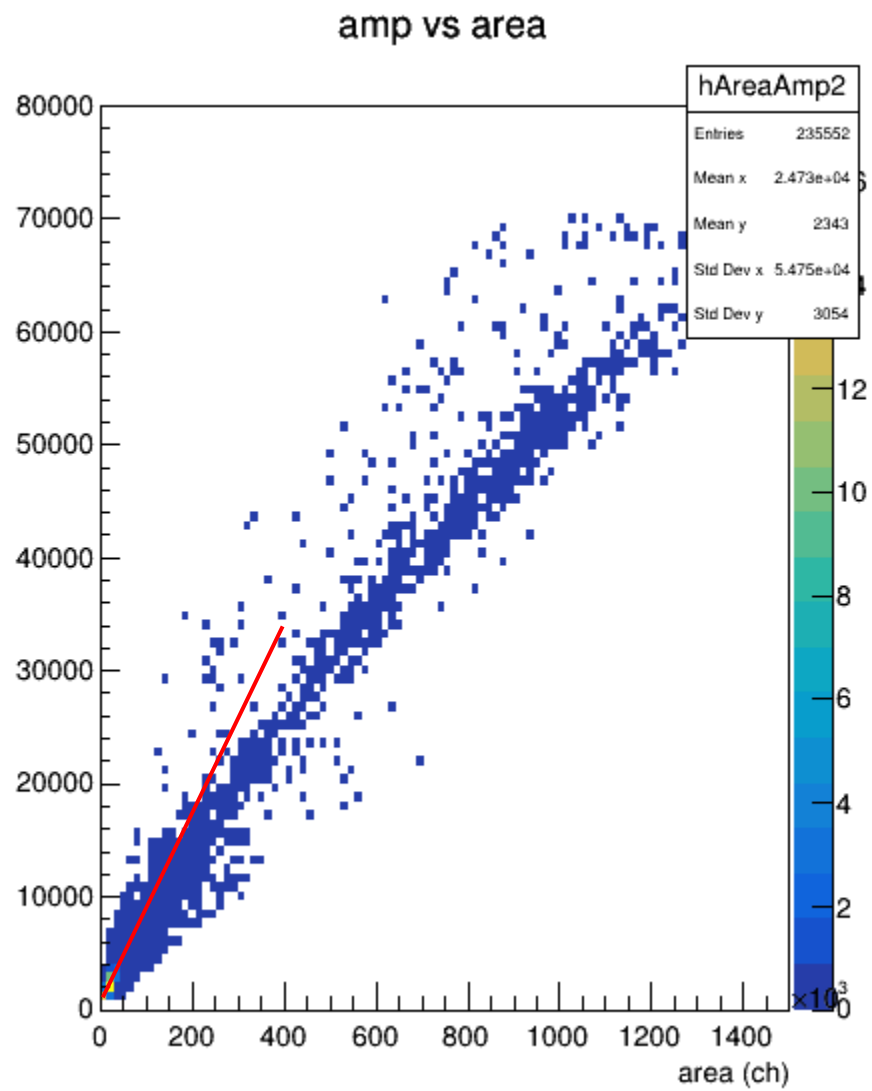
AmBe1800


amp vs area
hAreaAmp1
Entries 6680100
Mean x 7.62e+04
Mean y 5666
Std Dev x 8.991e+04
Std Dev y 6117
80000
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400
area (ch)
12
10
8
6
4
2
×10³
0

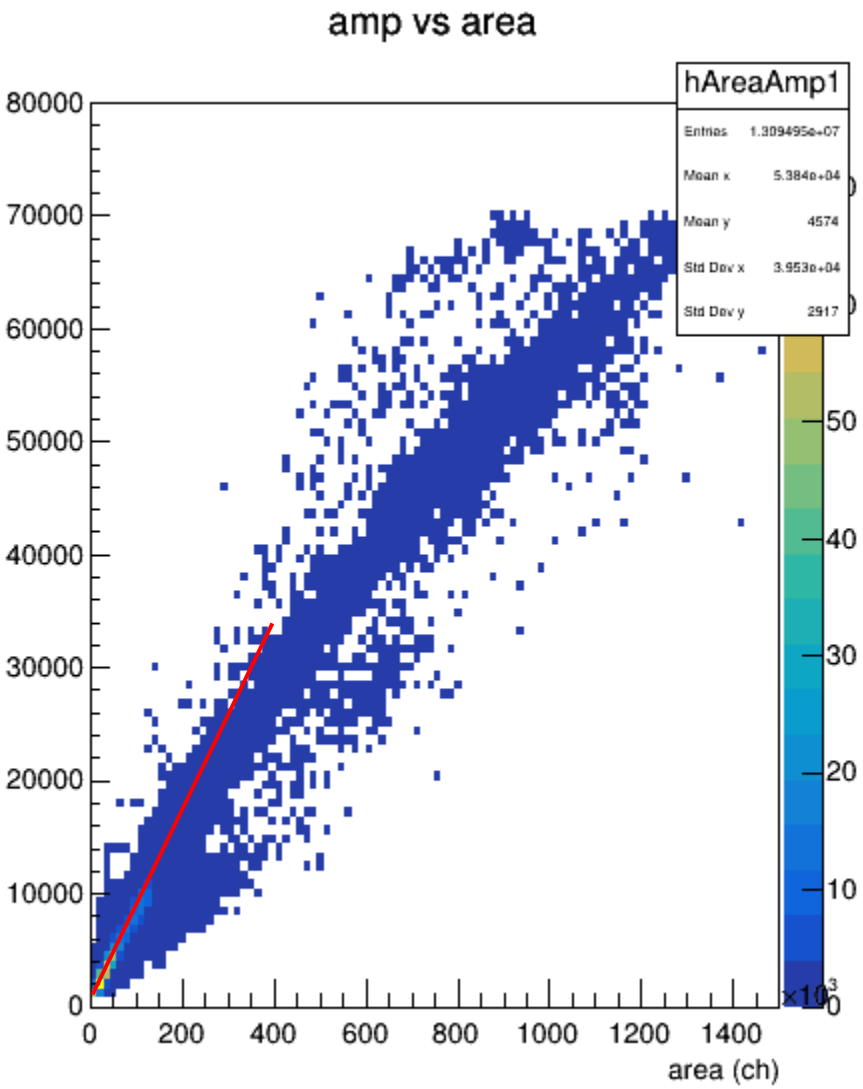

amp vs area
hAreaAmp2
Entries 5857678
Mean x 8.089e+04
Mean y 5880
Std Dev x 9.613e+04
Std Dev y 6150
80000
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400
area (ch)
8
6
4
2
×10³
0

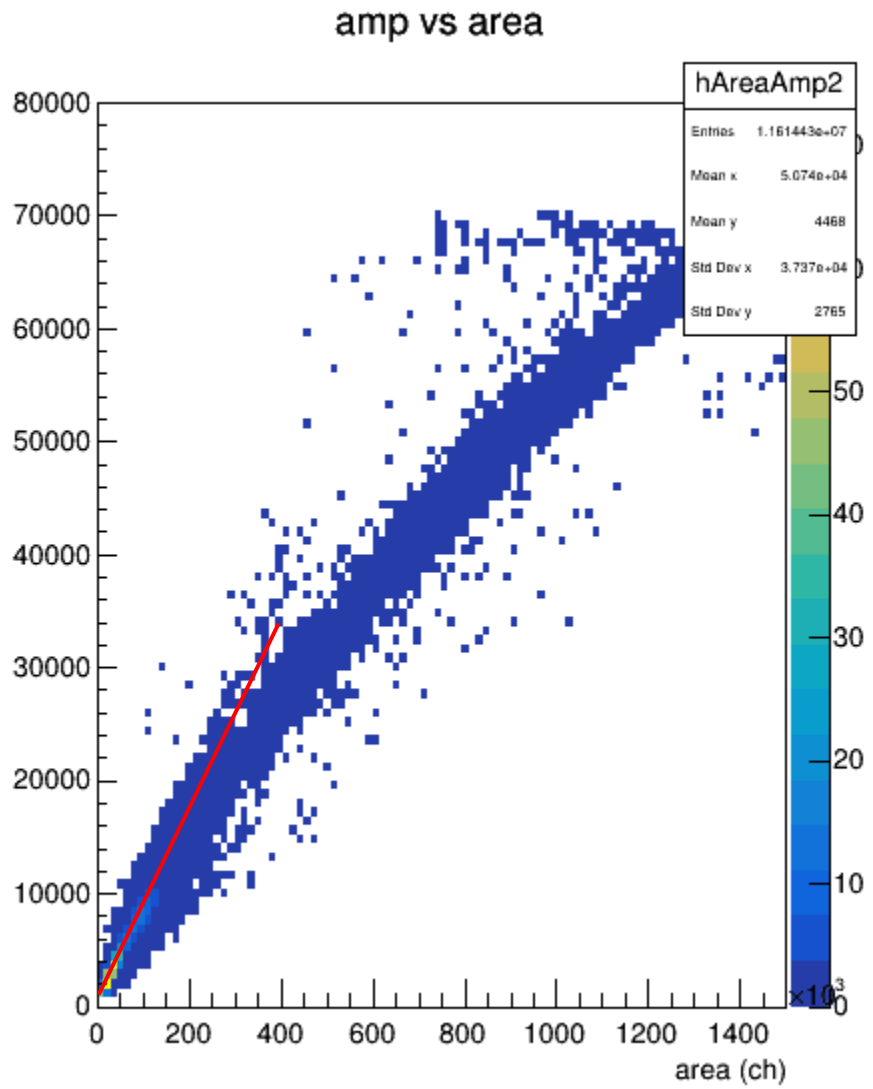
Y1800


amp vs area
hAreaAmp1
Entries 216779
Mean x 2.515e+04
Mean y 2385
Std Dev x 4.689e+04
Std Dev y 3329
80000
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400
area (ch)
10
8
6
4
2
0
×10³

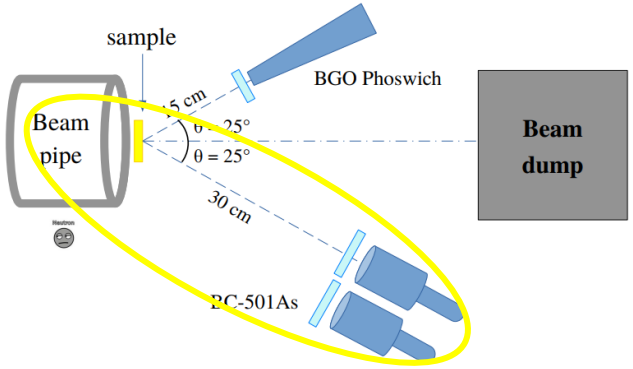

amp vs area
hAreaAmp2
Entries 235552
Mean x 2.473e+04
Mean y 2343
Std Dev x 5.475e+04
Std Dev y 3054
80000
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400
area (ch)
12
10
8
6
4
2
0
×10³

Cs1800


amp vs area
hAreaAmp1
Entries 1.309495e+07
Mean x 5.384e+04
Mean y 4574
Std Dev x 3.953e+04
Std Dev y 2917
80000
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400
area (ch)
50
40
30
20
10
0
×10³

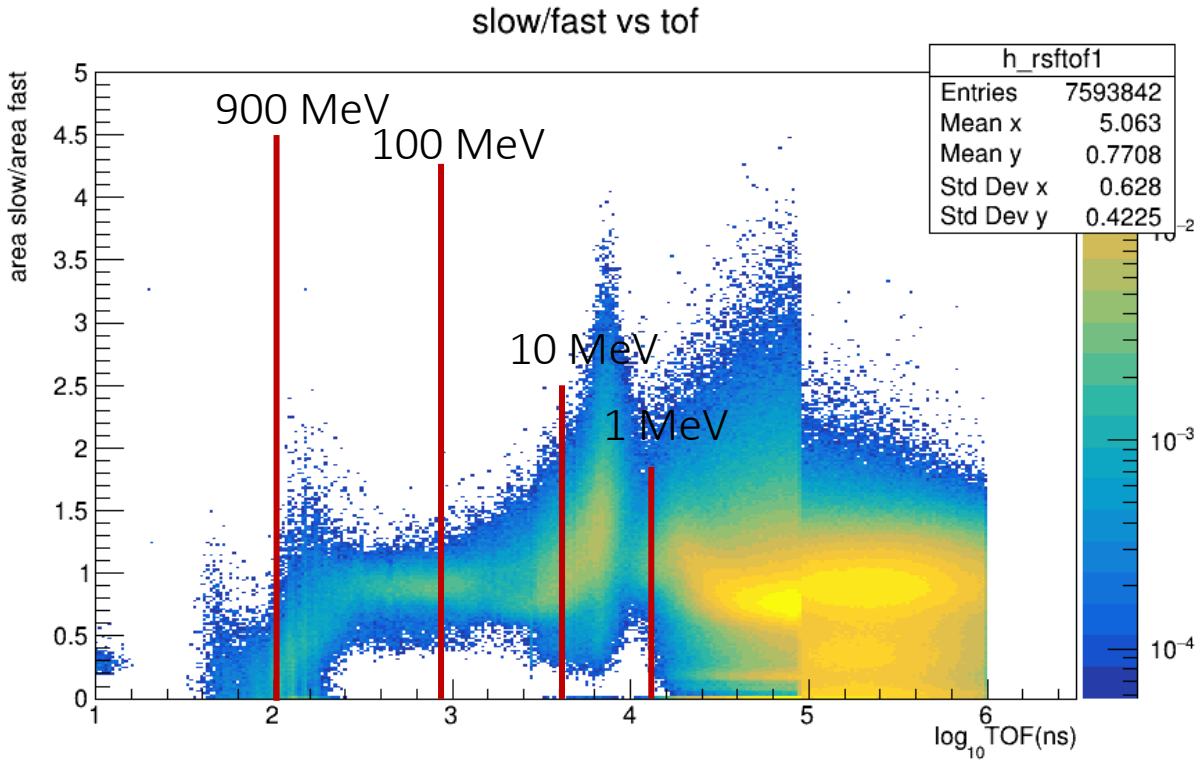

amp vs area
hAreaAmp2
Entries 1.161443e+07
Mean x 5.074e+04
Mean y 4468
Std Dev x 3.737e+04
Std Dev y 2765
80000
70000
60000
50000
40000
30000
20000
10000
0
0 200 400 600 800 1000 1200 1400
area (ch)
50
40
30
20
10
0
×10³

3.BC501A

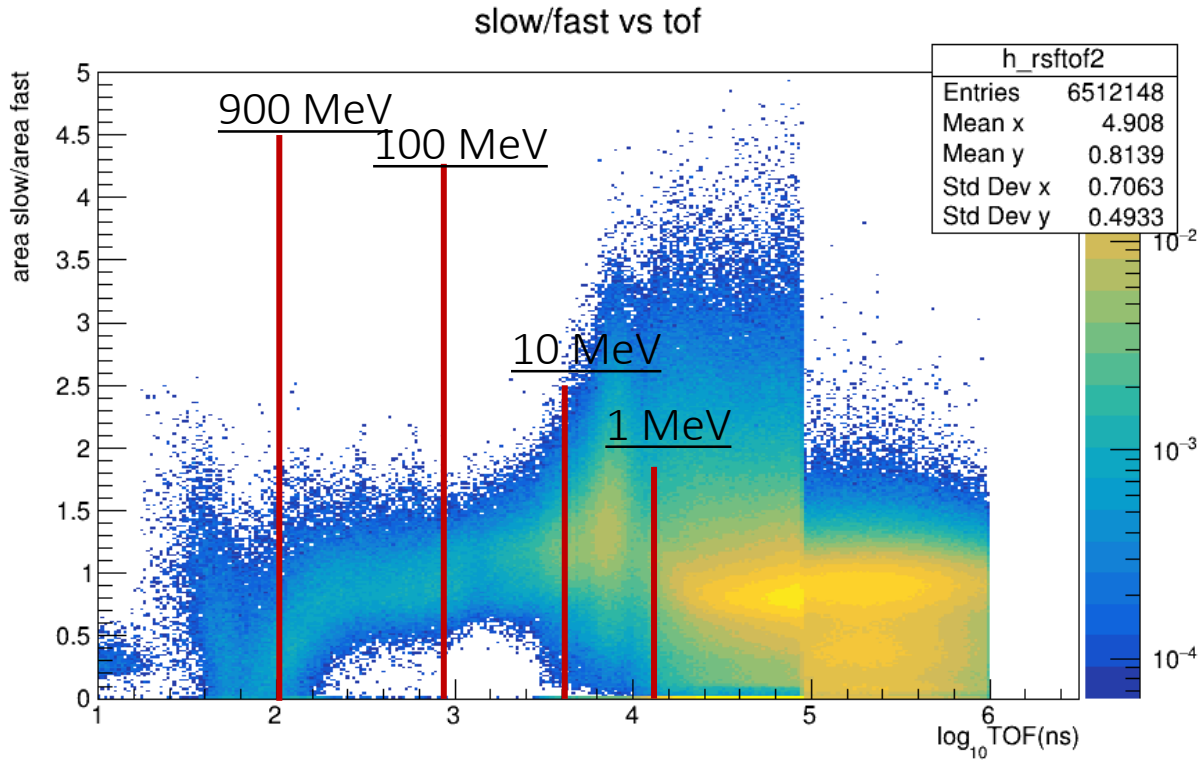


Area slow/Area fast vs TOF

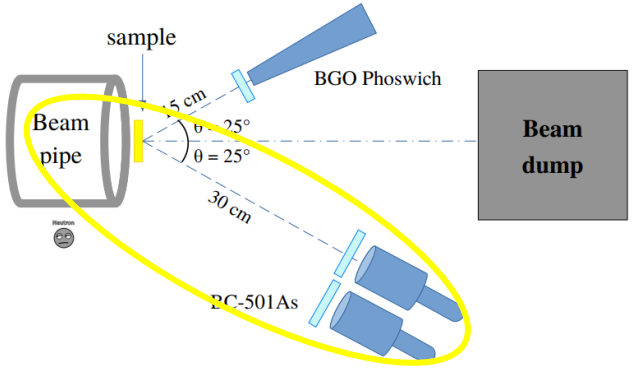
Detector 1



Detector 2

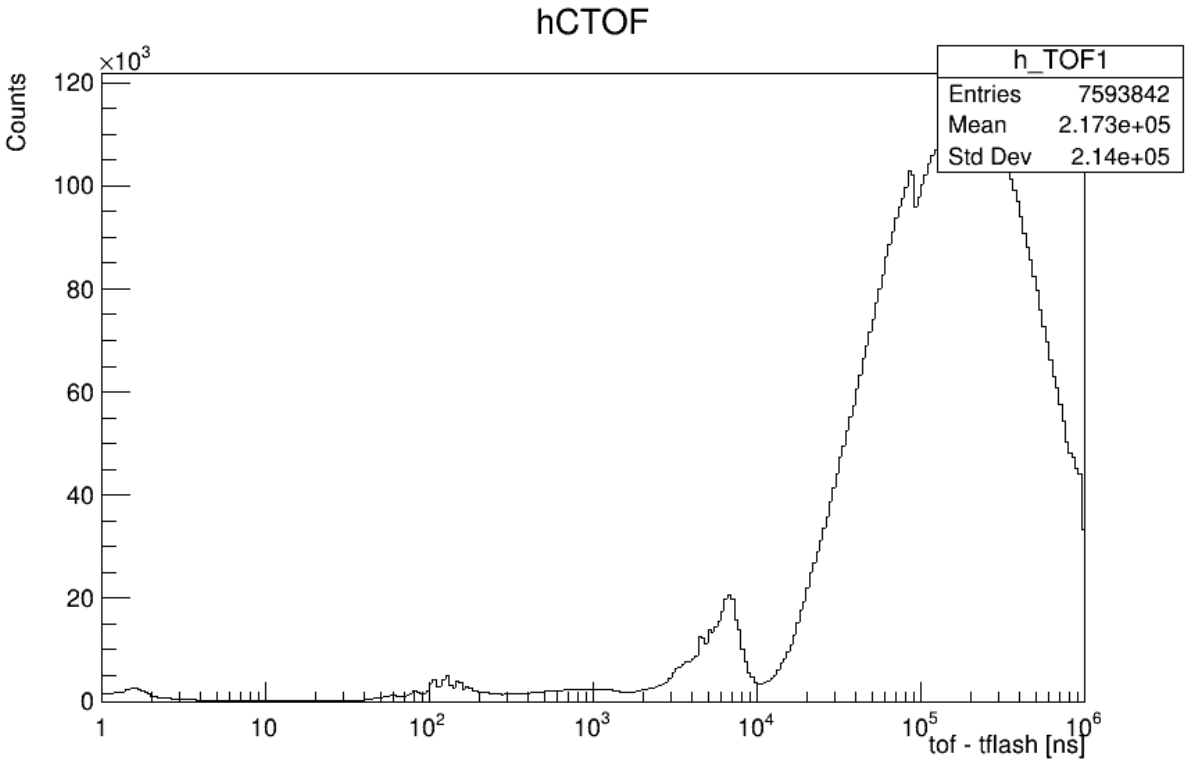


3.BC501A

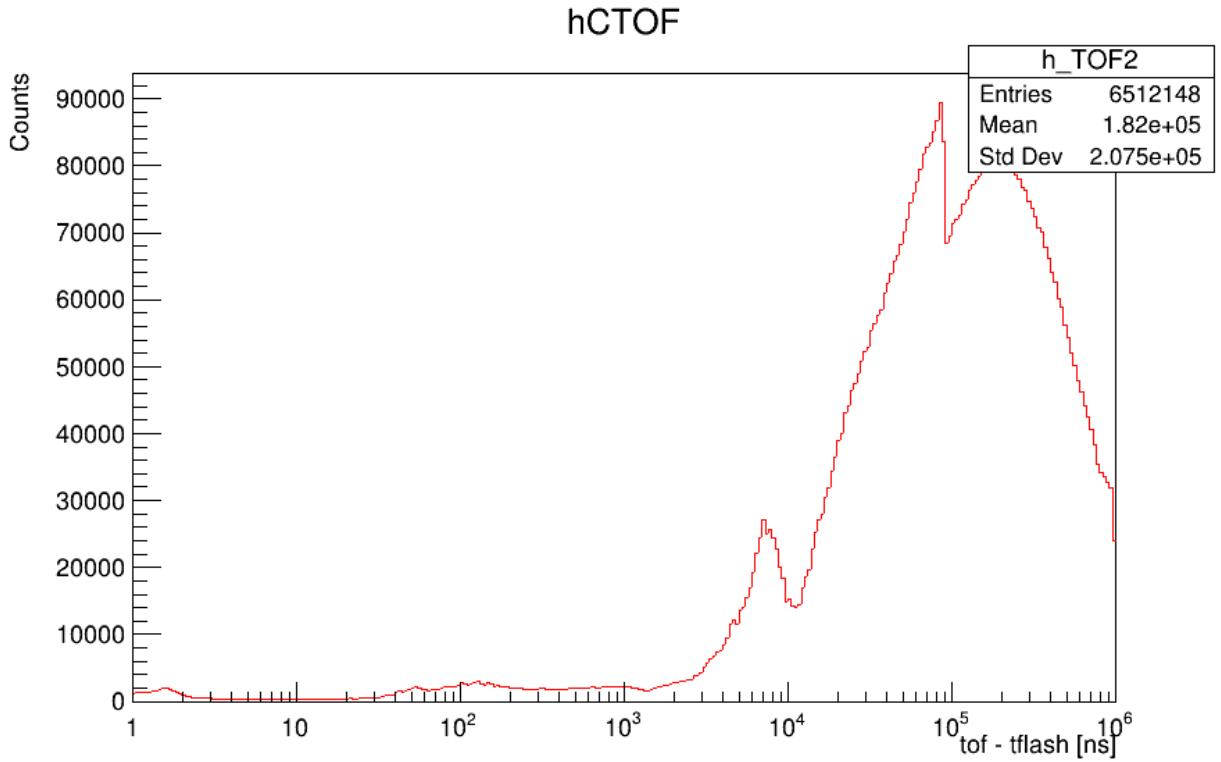


TOF

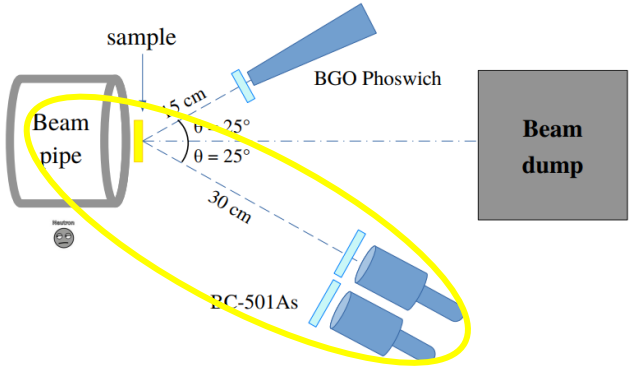
Detector 1



Detector 2

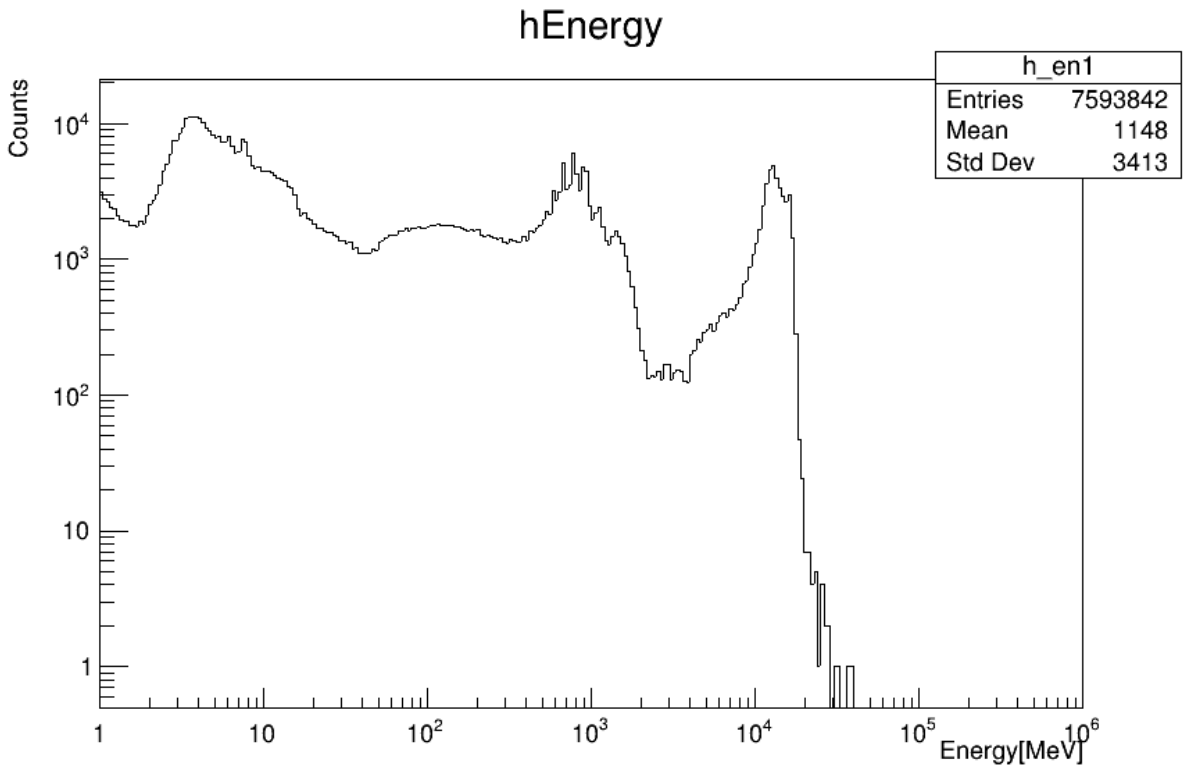


3.BC501A



Energy

Detector 1



Detector 2