



CUPID China Collaboration Meeting

Data analysis workflow with Octopus

Speaker: Keyu Shang, Shihong Fu

Supervisor: Prof. Huang

2024/12/19



Outline



Octopus



Data analysis



Outlook



1. Octopus

Thanks to **Prof. Benato**

What is Octopus?

General framework for data processing

- Started as small software to process Berkeley TES data
- Expanded to process continuous data with any raw data format
- Expanded to process triggered waveforms
- Use case:
 - Berkeley data
 - CROSS
 - Gio's neutron detector
 - leti's data
 - CUPID



1. Octopus

Thanks to **Prof. Benato**

What can Octopus do?

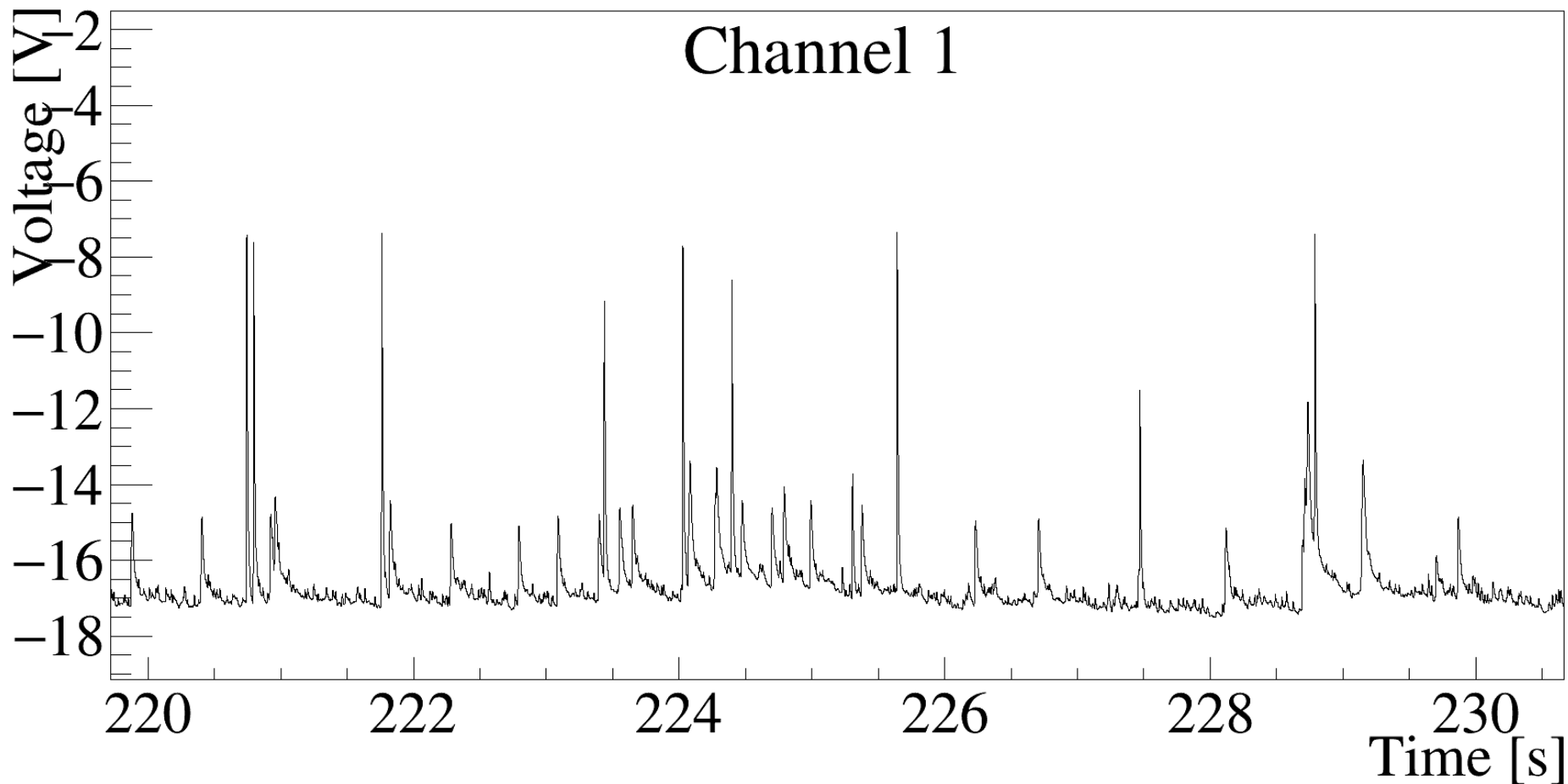
4 main functions:

- Plot data stream of channel in user-defined time window
- Apply threshold trigger on original or differentiated waveform
- Save trigger flag and read raw data
- Different channels in parallel
- Reconstructed coincidences and any other multi-channel variable (STILL WORKING)

1. Octopus

① Check Stream Data

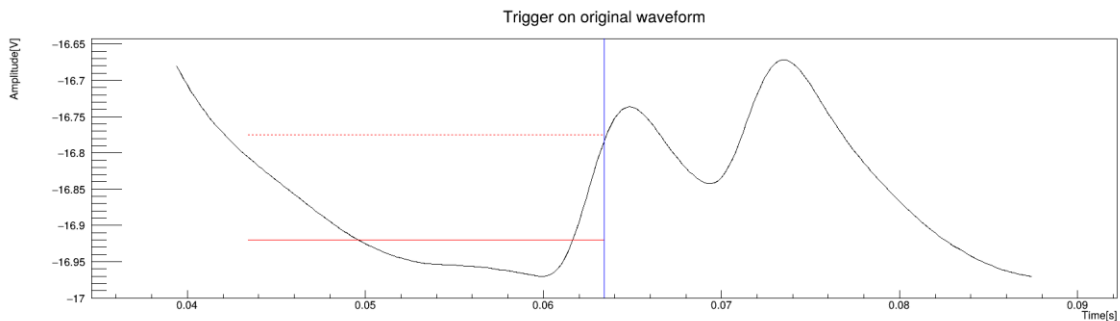
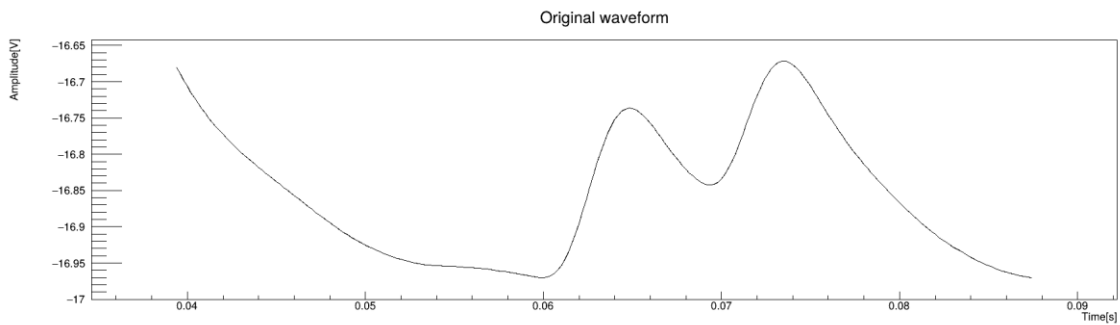
RUN240820_SB12_Am241



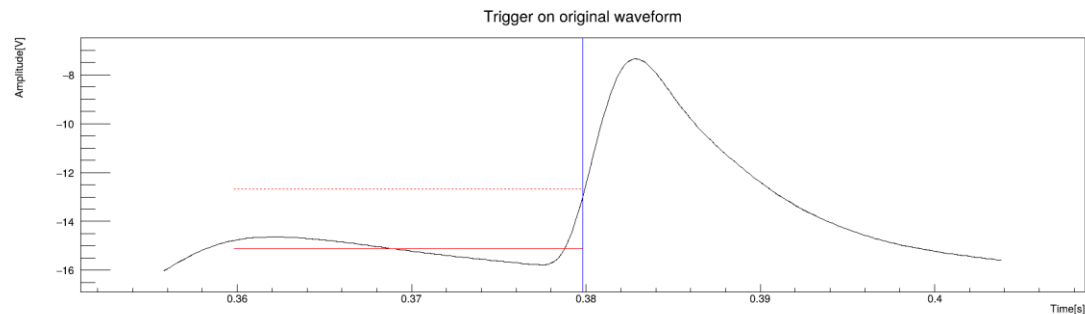
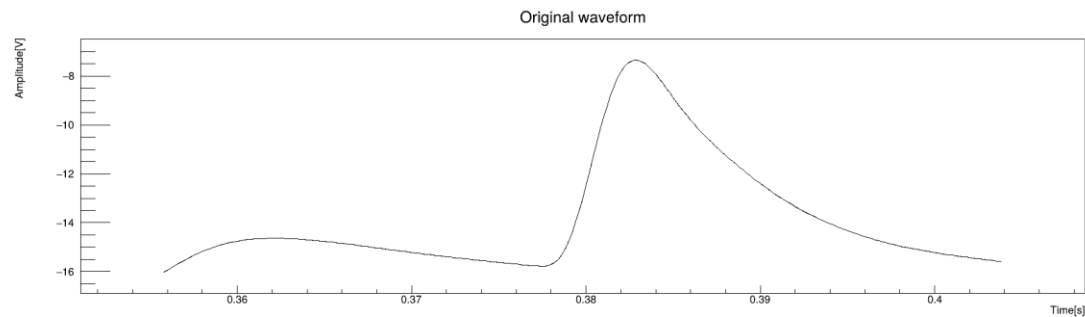


1. Octopus

② Trigger Setting



bufferLength=0.02
RMS=3
nAbove=3



bufferLength=0.02
RMS=5
nAbove=5

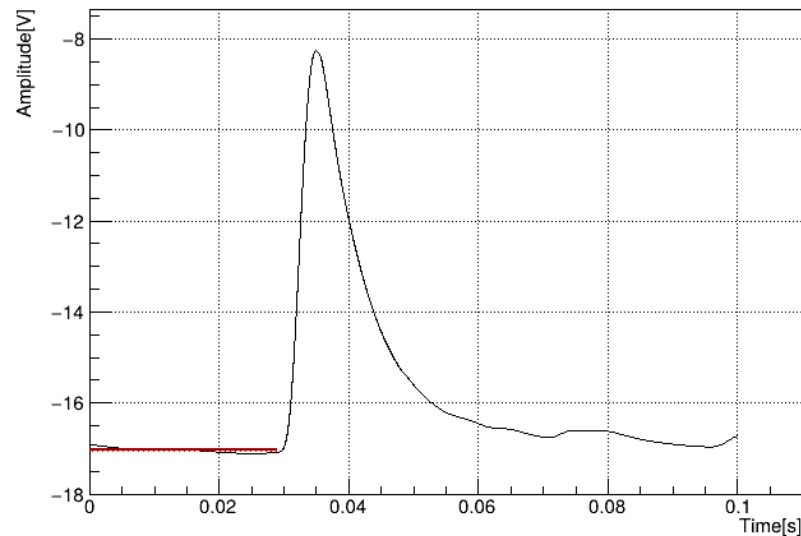


1. Octopus

Number of triggers
Baseline slope
.....

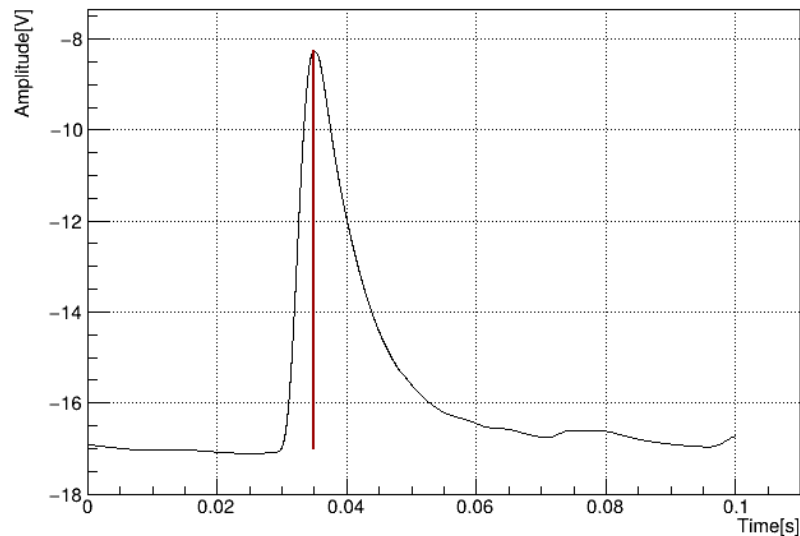
③ Parameter setting

baseline



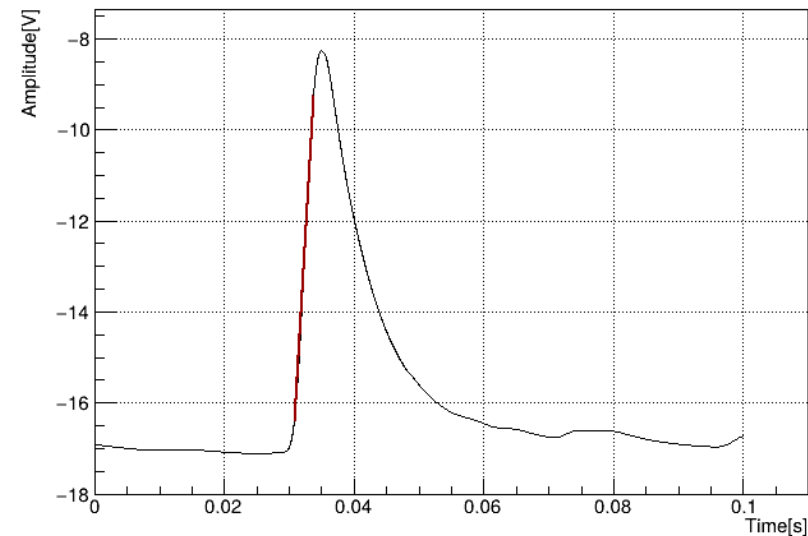
StartTime=0
StopTime=0.029

maxminusbaseline



SearchWindow=0.015
Reduce pile-up events

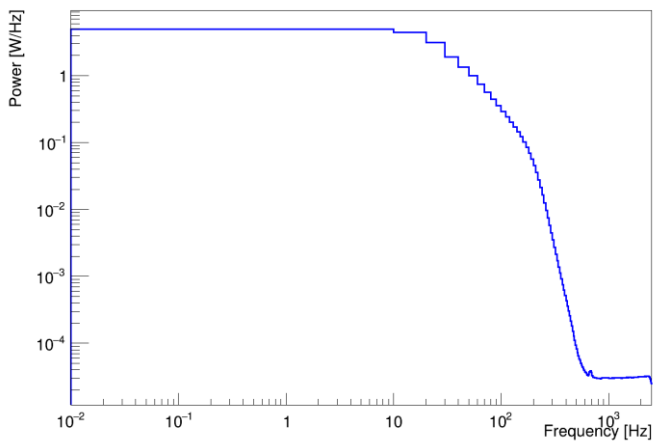
risetime



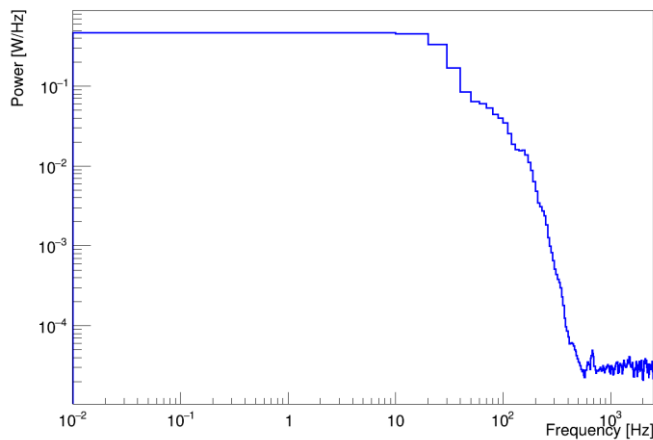
StartPercentage=10%
StopPercentage=90%

1. Octopus

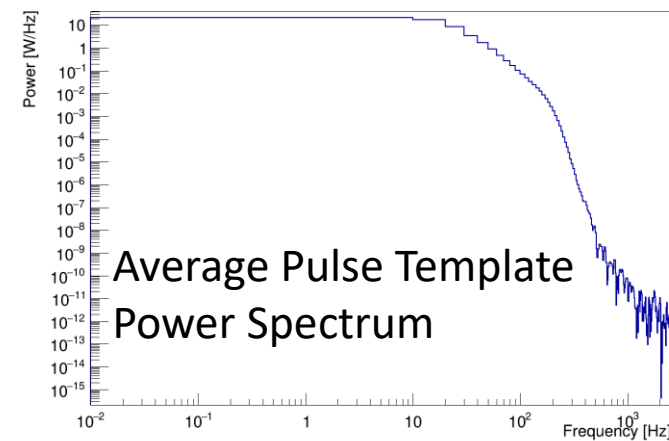
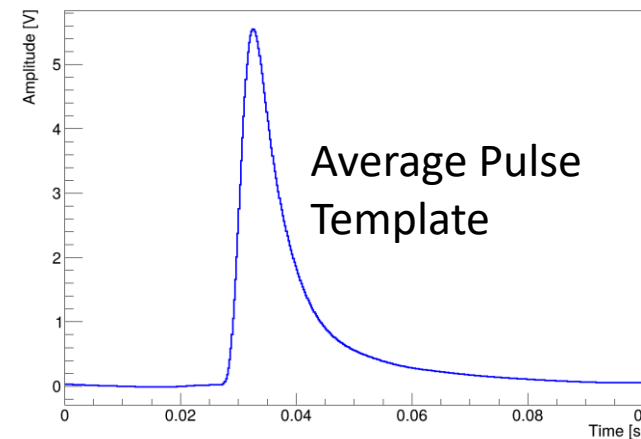
④ Spectrums for OF



Average Signal
Power Spectrum



Average Noise
Power Spectrum



Average Pulse Template
Power Spectrum



1. Octopus

⑤ Other modules in Octopus

- AveragePowerSpectrum
- AveragePulse
- Baseline
- BaselineSlope
- BaselineSlopeSubtraction
- BaselineSubtraction
- Calibration
- Chi2
- Convolution
- Decaytime
- FourierTransform
- Integral
- InverseFourierTransform
- MaxMinusBaseline
- NumberOfTriggers
- OptimumFilter
- PolarityFlip
- PoleZeroCorrection
- PowerIntegral
- PulserFinder
- Risetime
- Stabilization
- SynteticPulse
- Timestamp
- TriggerDelayCorrection
- TriggerDelay



Outline



Octopus



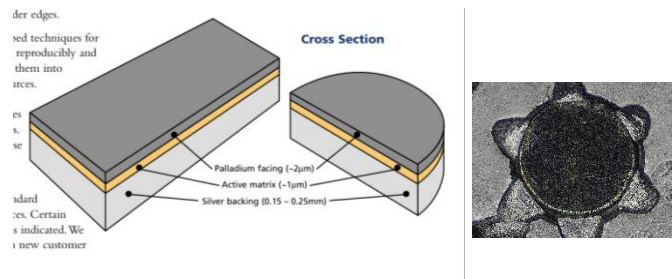
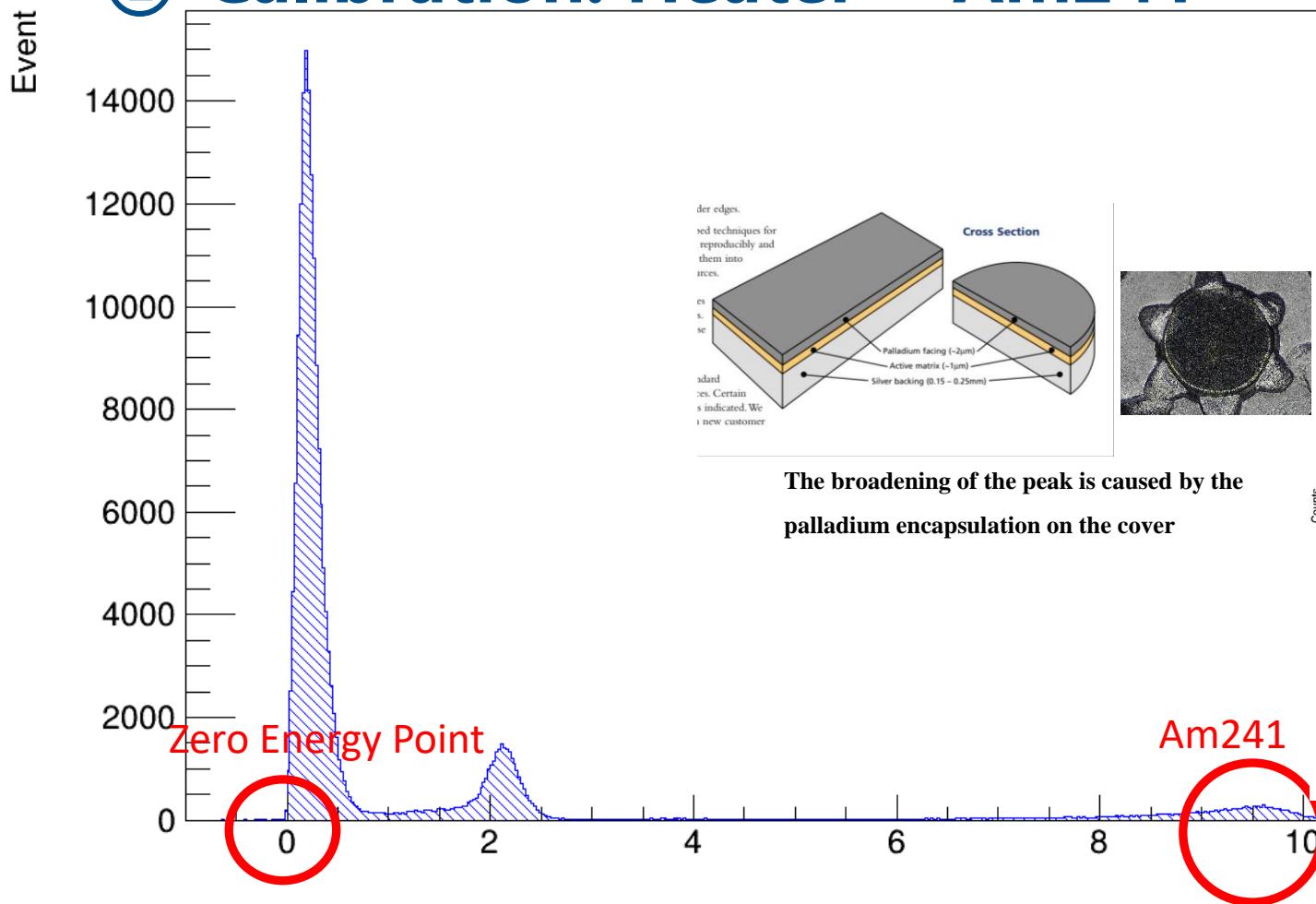
Data analysis



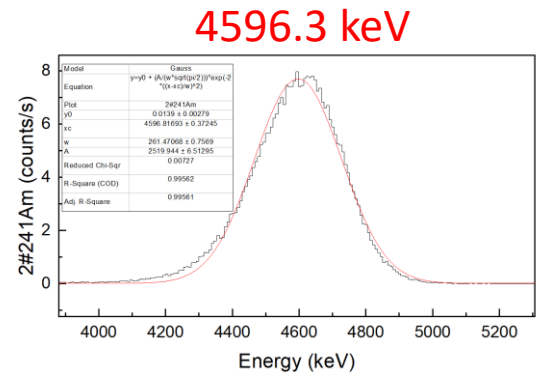
Outlook

2. Data analysis

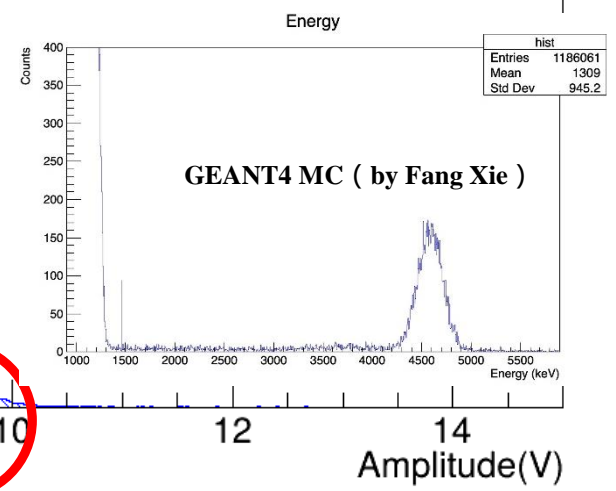
① Calibration: Heater + Am241



The broadening of the peak is caused by the palladium encapsulation on the cover

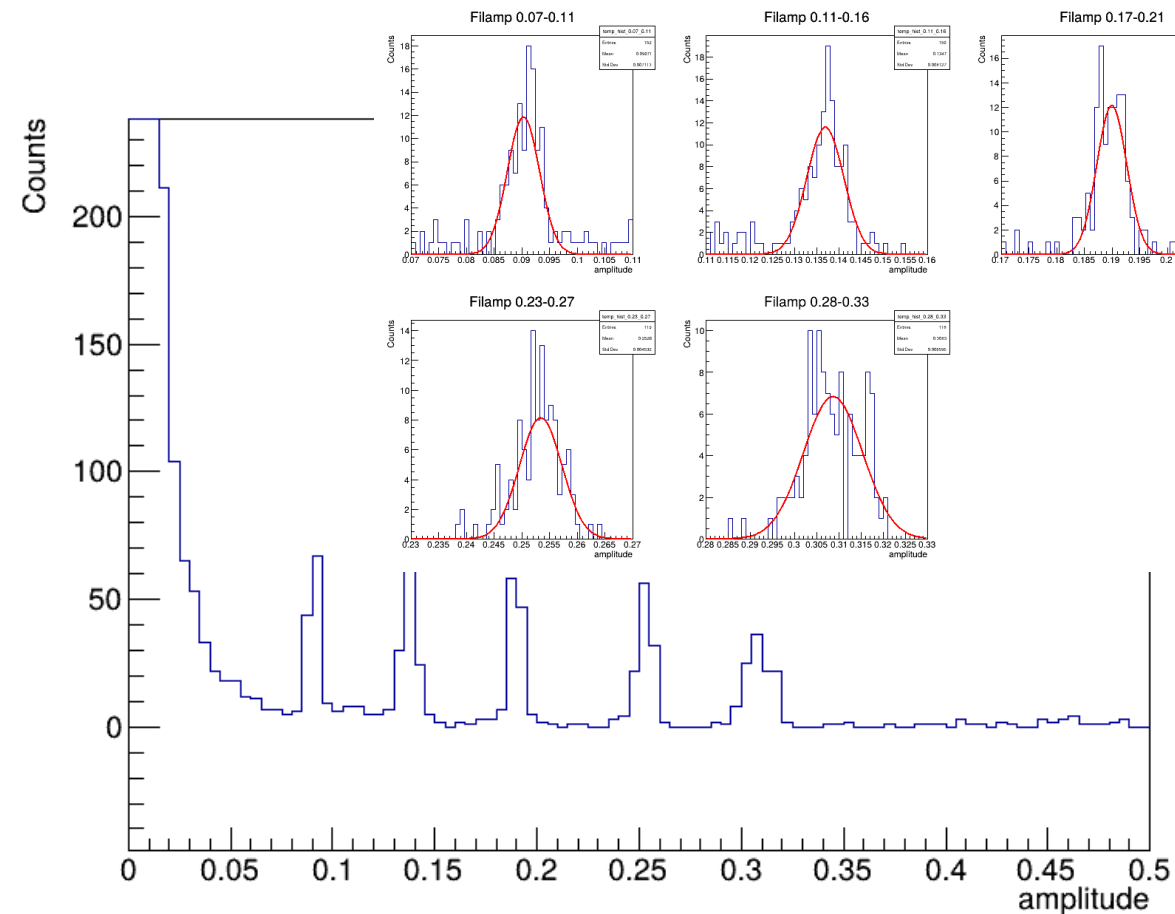


The Am241 energy spectrum measured by a gold-silicon barrier detector

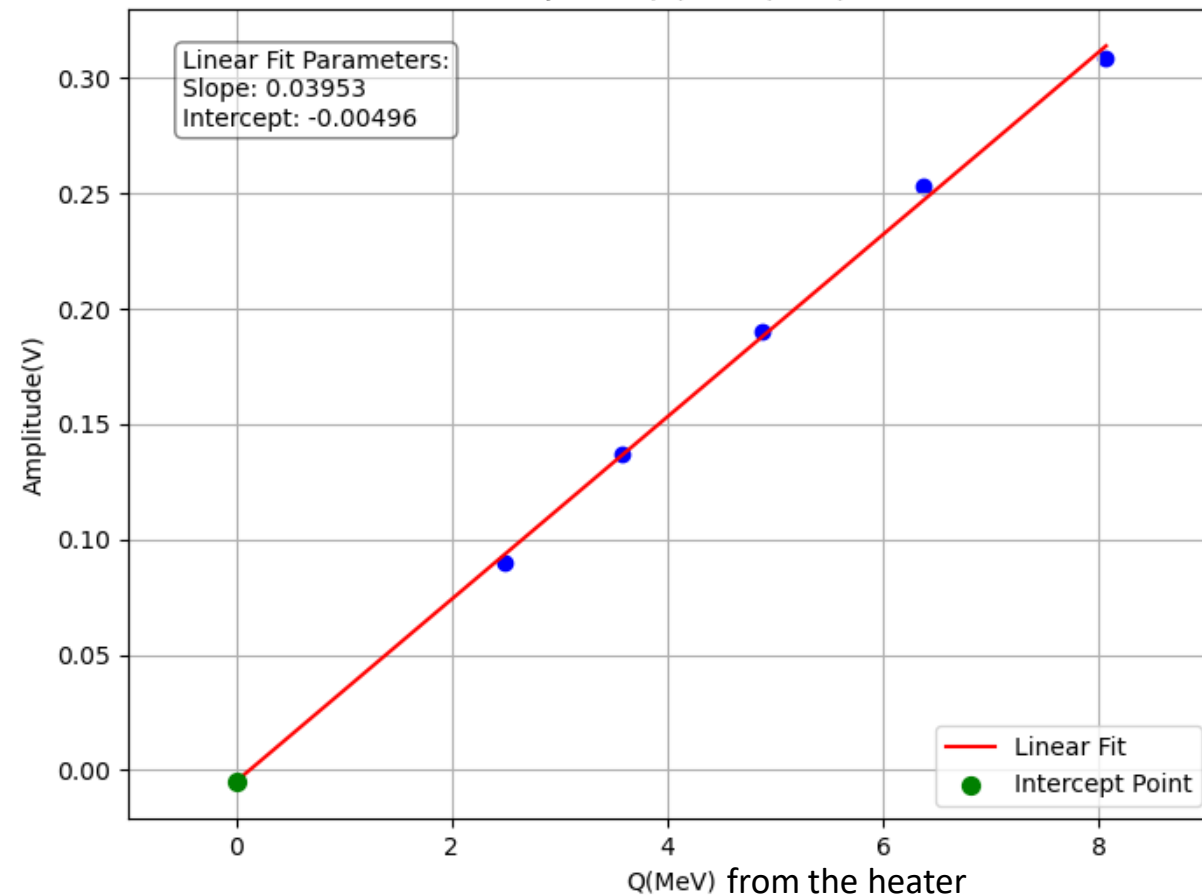


2. Data analysis

① Calibration: Heater(for zero energy point)



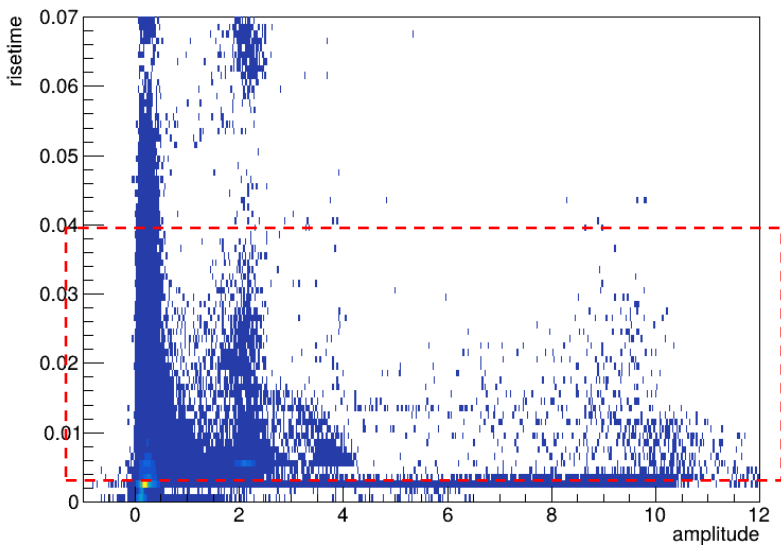
Amplitude(V) vs Q(MeV)



2. Data analysis

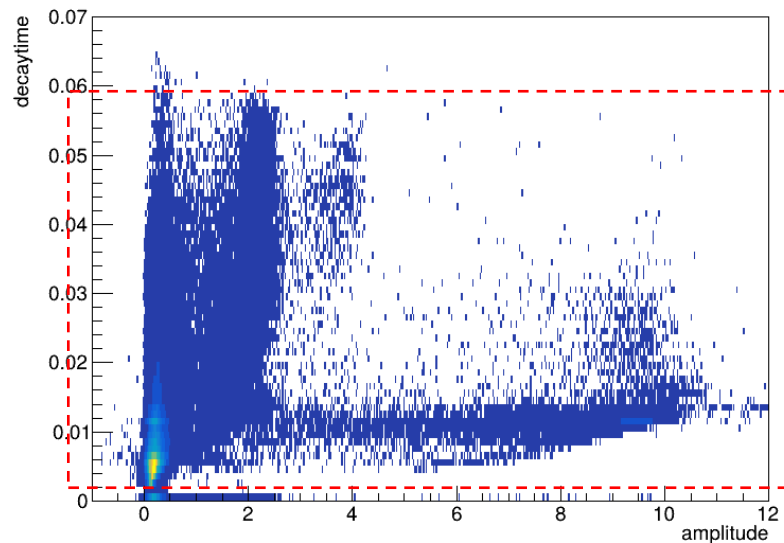
② Event selection

amplitude vs risetime



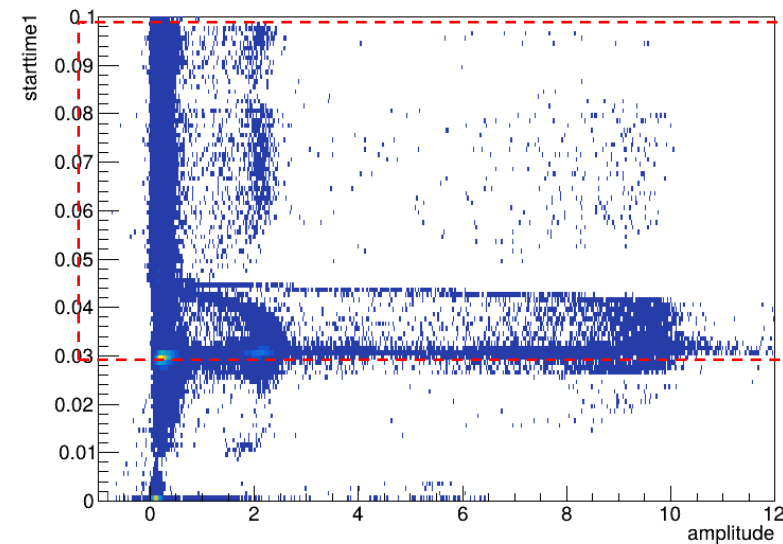
0.002-0.04

amplitude vs decaytime



0.004-0.06

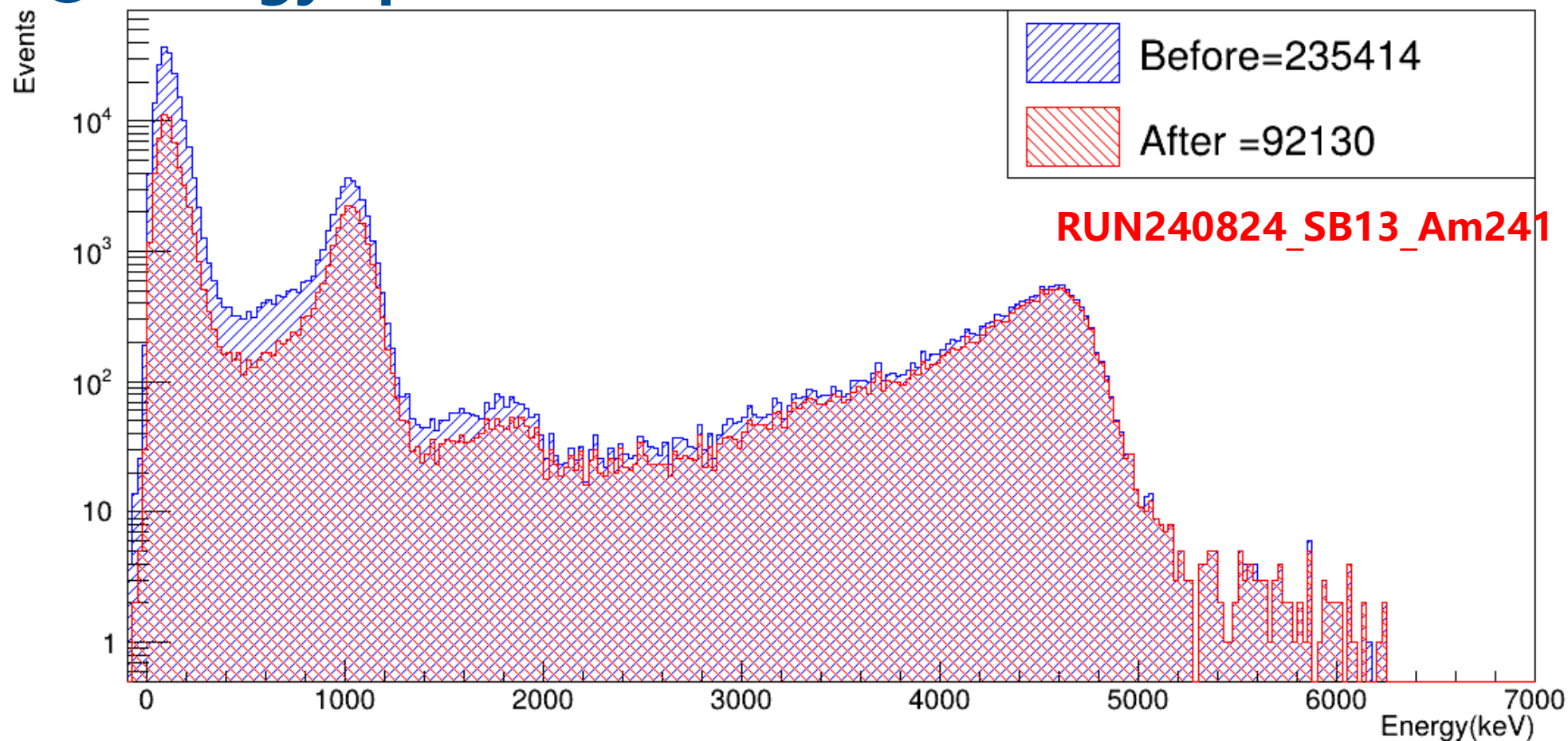
amplitude vs starttime1



0.03-0.1

2. Data analysis

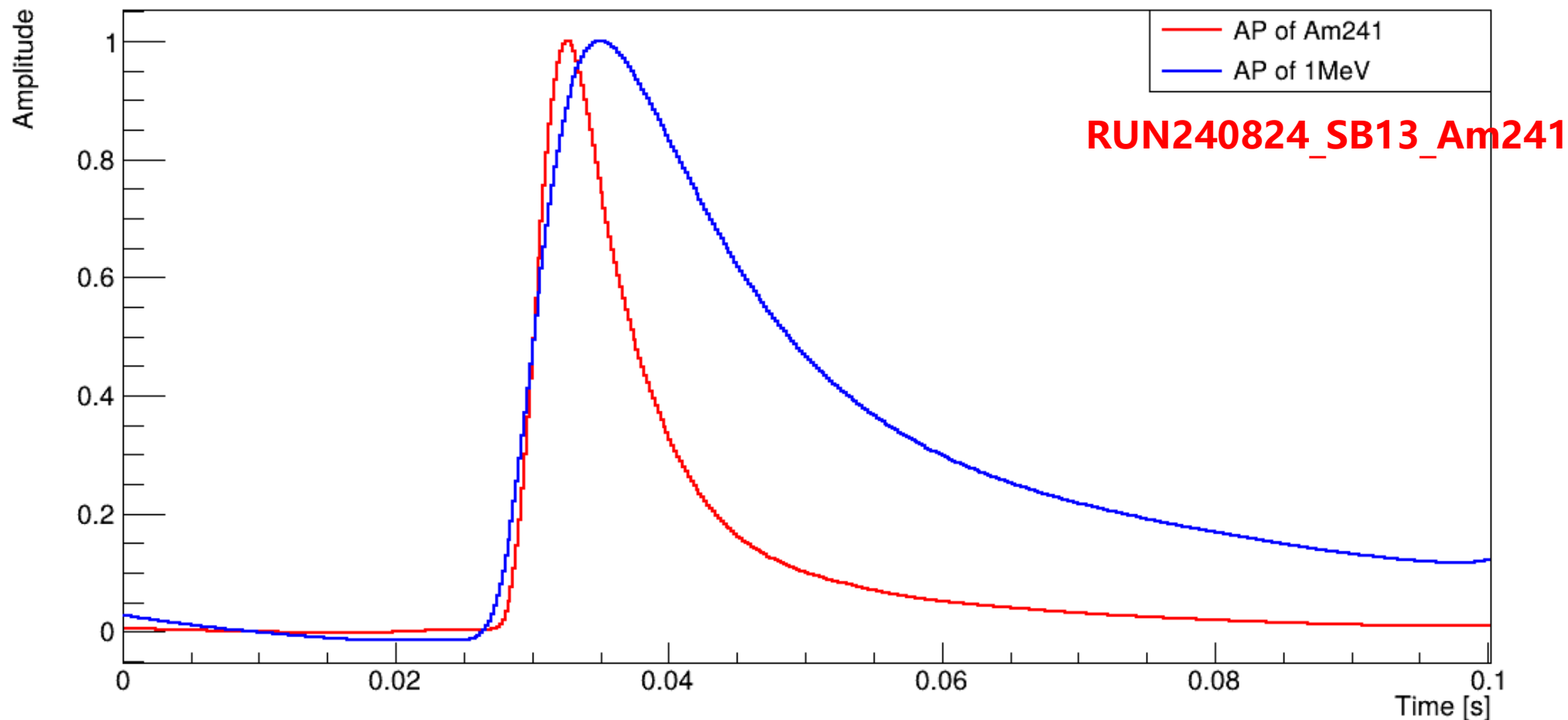
③ Energy spectrum after calibration and event selection





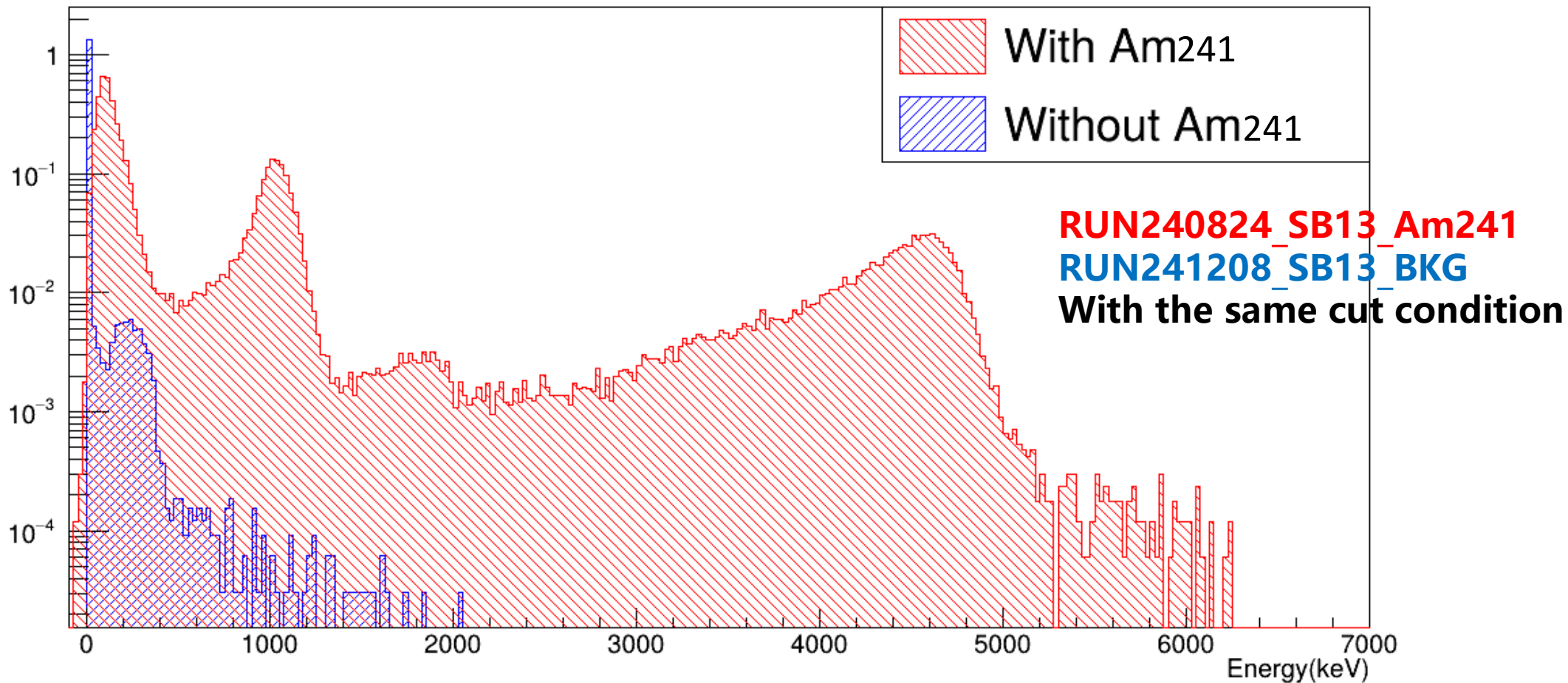
2. Data analysis

③ Average pulse



2. Data analysis

④ Am241 VS BKG (normalized by time)





Outline



Octopus



Data analysis



Outlook



3. Outlook

1

Deploy Optimal Filter in Octopus

2

Add light channel into analysis

3

Use other sources for calibration

4

Test various Crystals

5

Establish crystal thermal model for gain correction

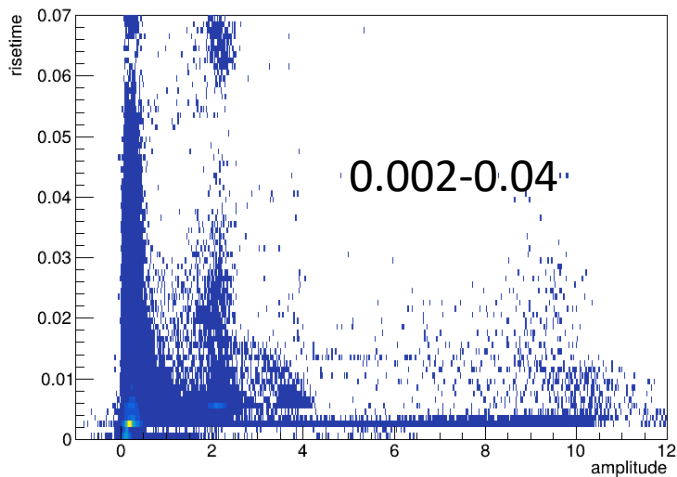
Thanks for your listening



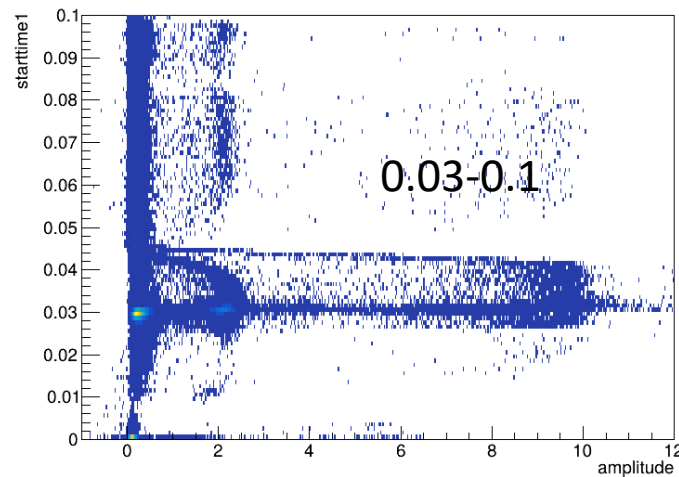
Backup

Parameters of Am241 pulse shape

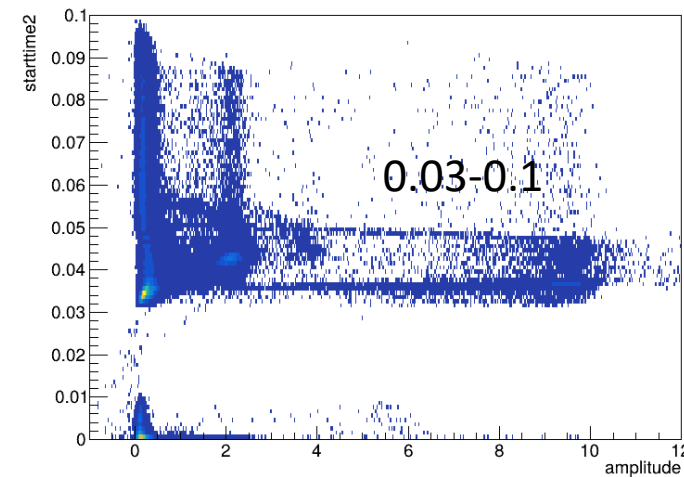
amplitude vs risetime



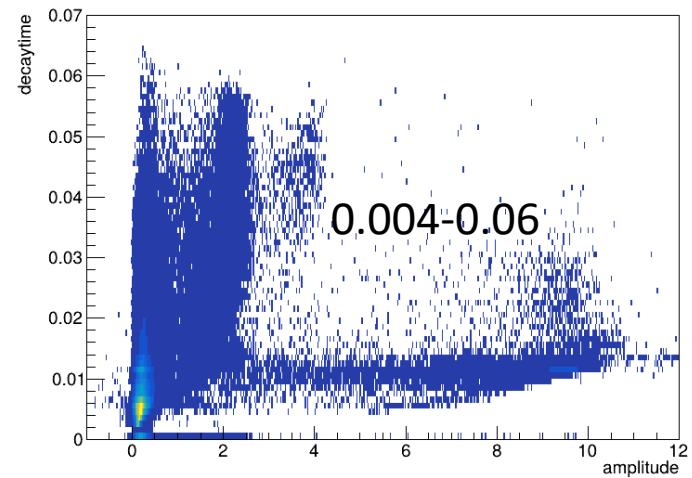
amplitude vs starttime1



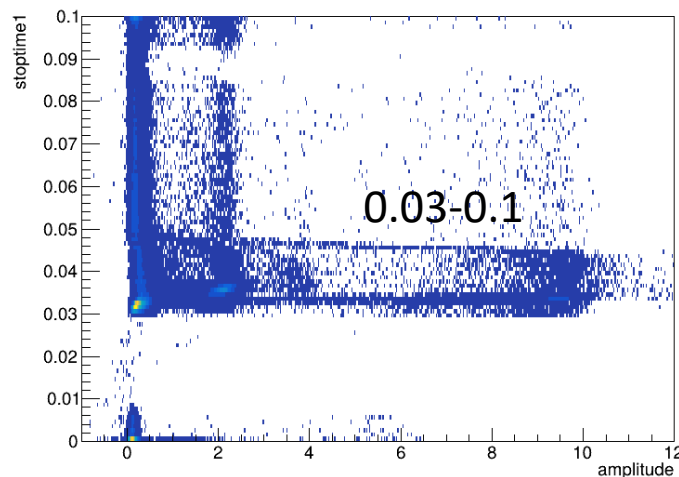
amplitude vs starttime2



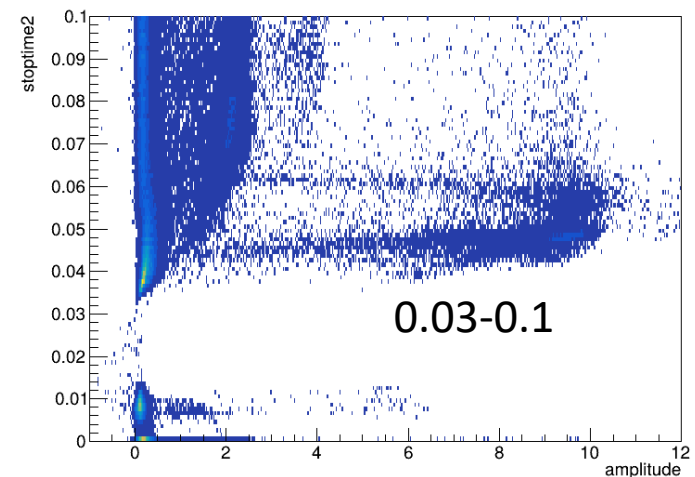
amplitude vs decaytime



amplitude vs stoptime1



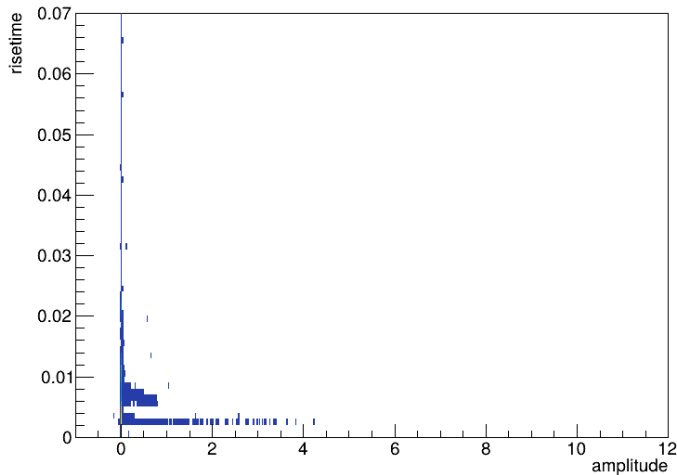
amplitude vs stoptime2



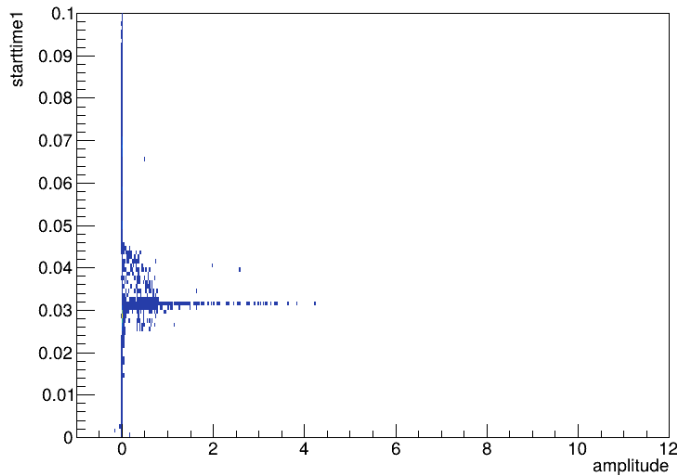


Parameters of bkg pulse shape

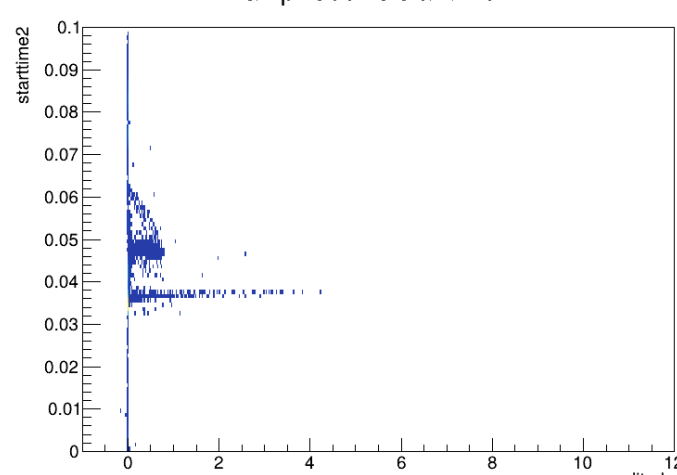
amplitude vs risetime



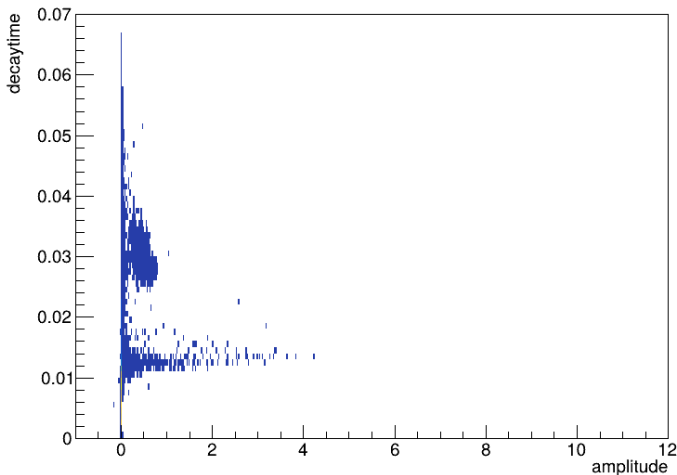
amplitude vs starttime1



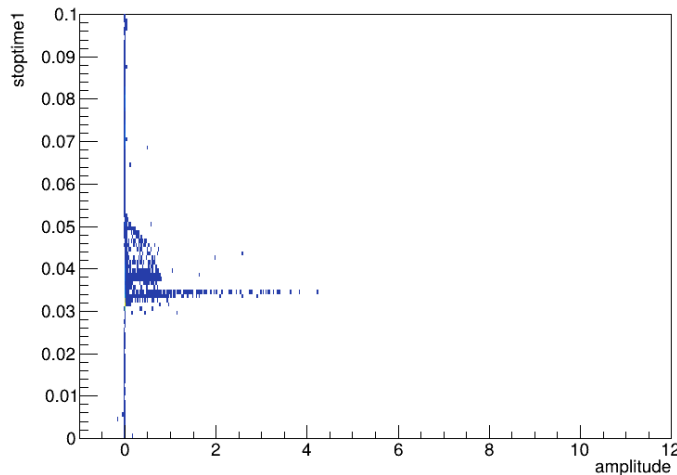
amplitude vs starttime2



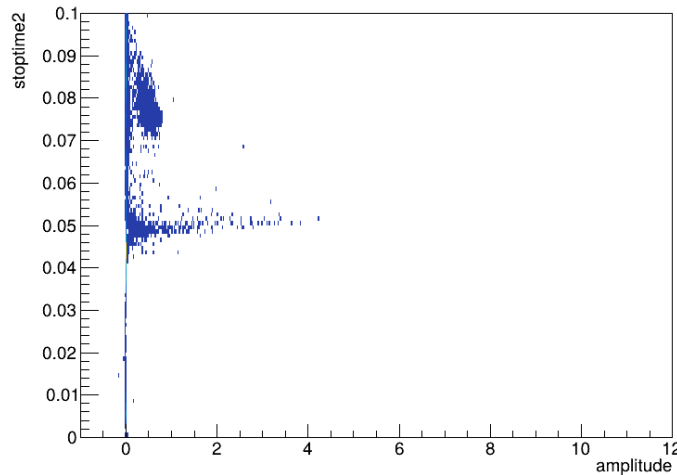
amplitude vs decaytime



amplitude vs stoptime1



amplitude vs stoptime2





Cutflow of parameters

	Cumulative Cut	Events	Eff Loss(%)
	1	235414	
decaytime > 0.004 && decaytime < 0.06		168822	28.29
risetime > 0.002 && risetime < 0.04		147714	12.50
starttime1 > 0.03 && starttime1 < 0.1		92803	37.17
stoptime1 > 0.03 && stoptime1 < 0.1		92803	0.00
starttime2 > 0.03 && starttime2 < 0.1		92130	0.73
stoptime2 > 0.03 && stoptime2 < 0.1		91847	0.31

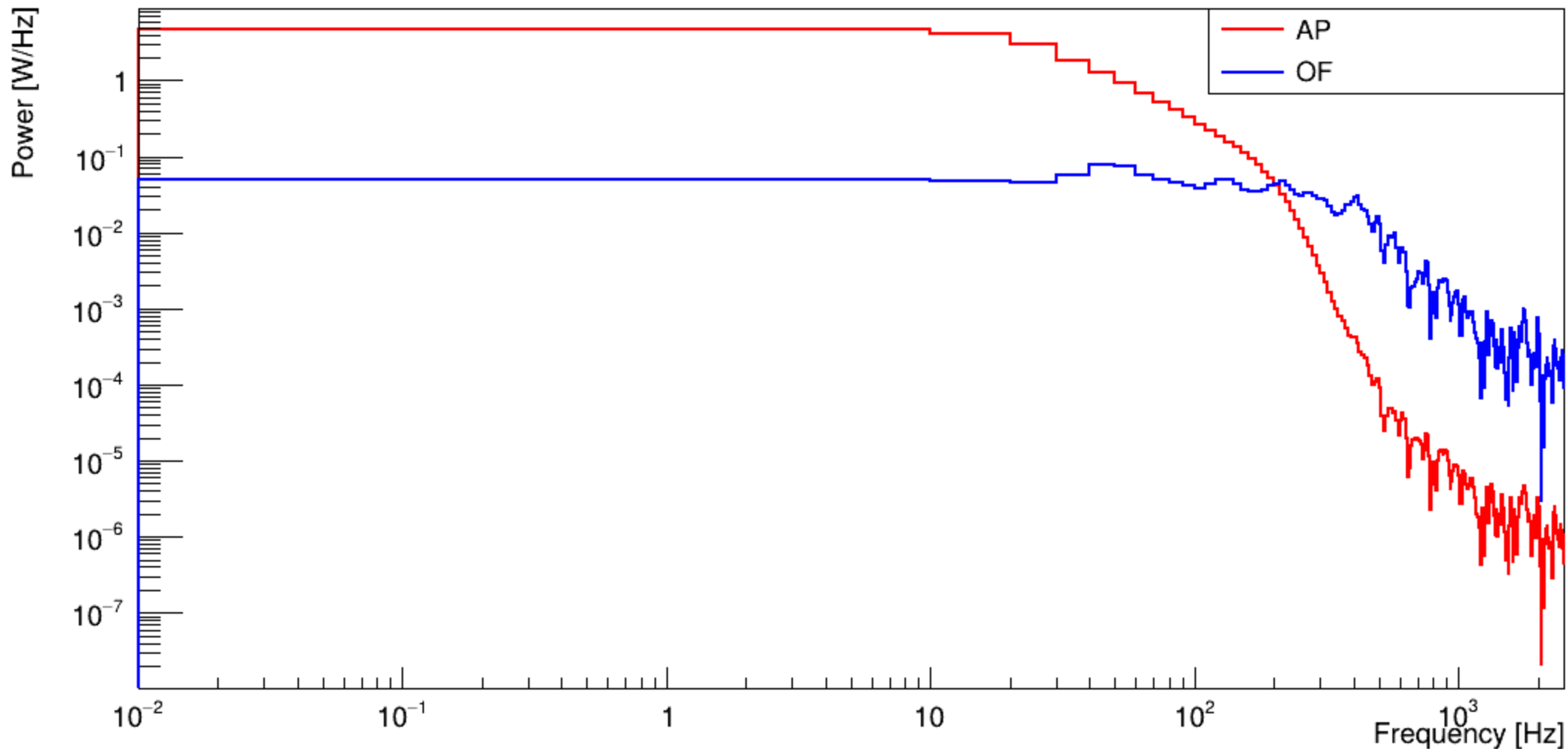
With Am241

	Cumulative Cut	Events	Eff Loss(%)
	1	193286	
decaytime > 0.004 && decaytime < 0.06		132061	31.68
risetime > 0.002 && risetime < 0.04		119965	9.16
starttime1 > 0.03 && starttime1 < 0.1		44934	62.54
stoptime1 > 0.03 && stoptime1 < 0.1		44934	0.00
starttime2 > 0.03 && starttime2 < 0.1		44711	0.50
stoptime2 > 0.03 && stoptime2 < 0.1		44560	0.34

Without Am241

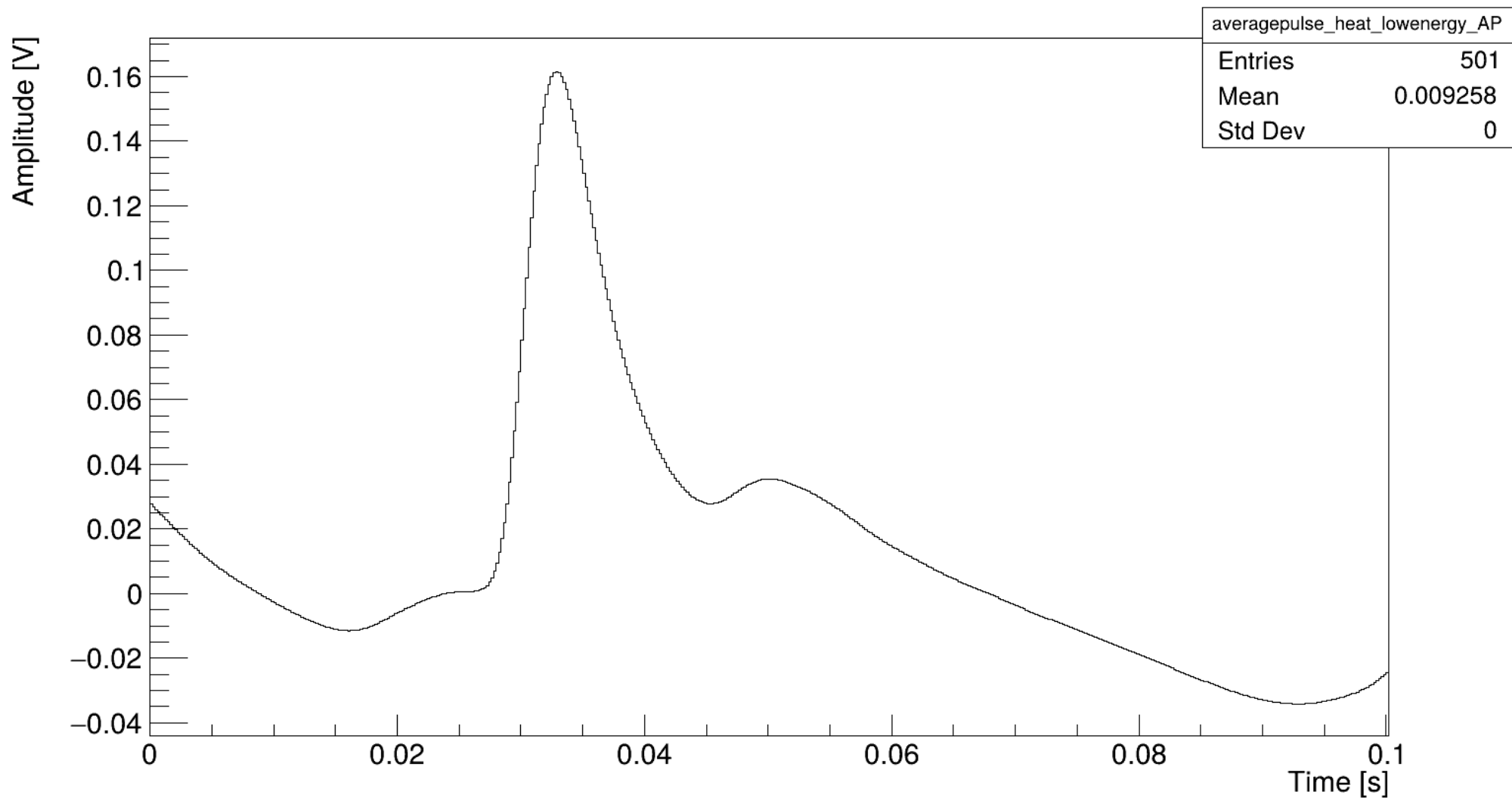


OF power spectrum



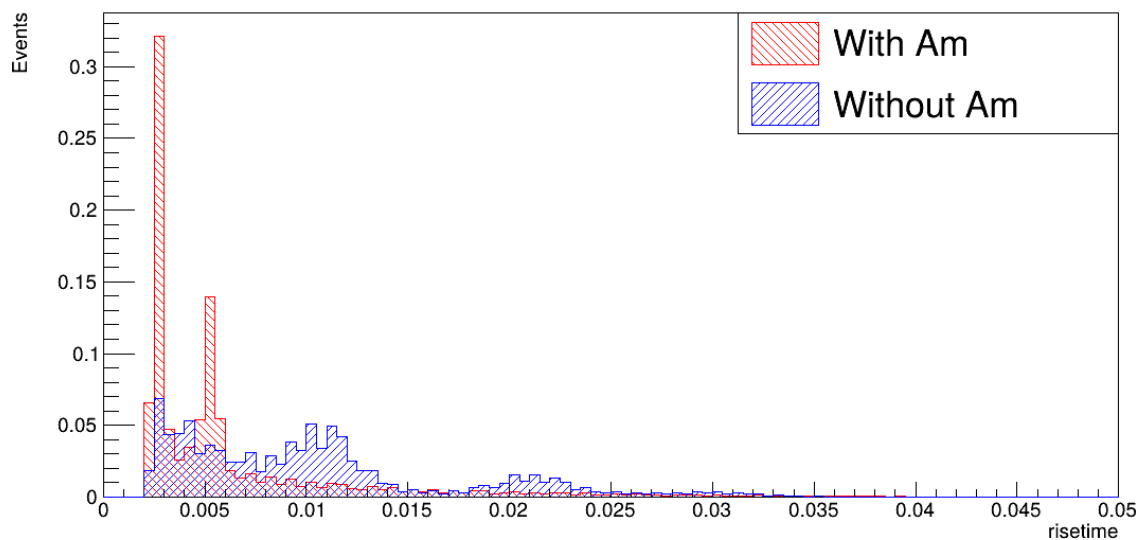


Pulse shape in Low energy region

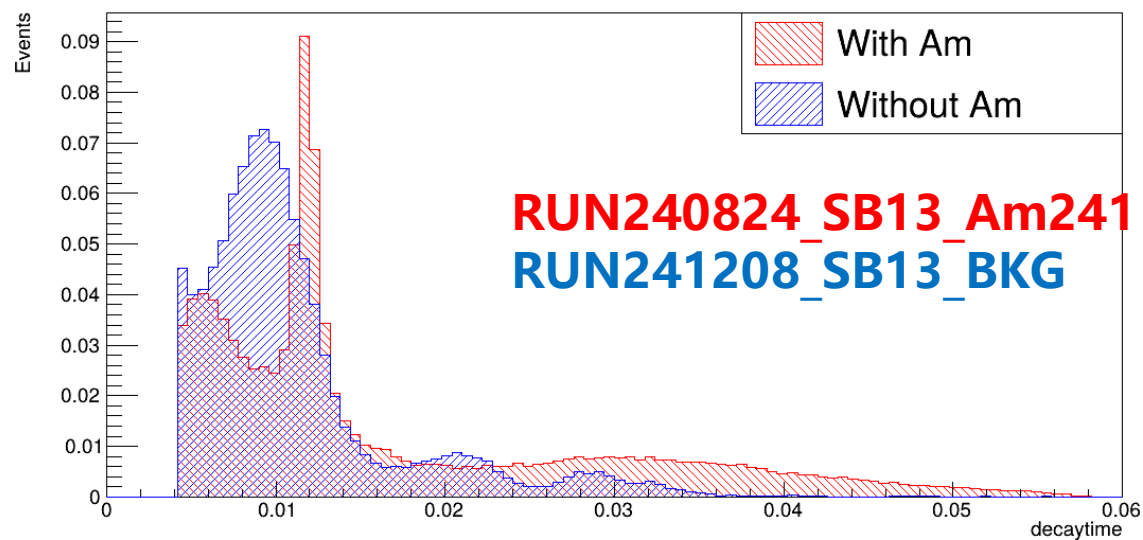




Am241 VS BKG (normalized by area)



Risetime



Decaytime