2023-Test beam data analysis updates

Optimization of the Derivatives algorithm for peak finding

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21 June 2024

Configurations

configuration	runs	gas	angle	momentum	events	MB
1	tbdata_1, _2, _3 run1,2	90/10	3°	10	18800 6987	460,4 3382
2	tbdata_4 run4	90/10	45°	10	4800 2585	119,3 1240
3	tbdata_10 run10	90/10	5°	8	4709 3413	118,2 ?
4	tbdata_5,_6,_7,_8,_9 run5,7,8	90/10	45°	8	8100 + 4548 +	67,1 + 2190 +
5	tbdata_11 run11	90/10	0°	6	4618 4973	115,3 2390
6	tbdata_12 run12	90/10	45°	6	3041 ?	83,9 ?
7	tbdata_14 run14	90/10	0°	4	1001 4365	25,2 ?
8	tbdata_13 run13	90/10	45°	4	1700 5355	42,7 ?
9	tbdata_15 run15	90/10	0°	2	6947 3516	184,6 ?
10	tbdata_16 run16	90/10	45°	2	? 4023	43,9 ?
11	tbdata_17 run17	85/15	0°	10	10400 4000	268,4 ?
12	tbdata_18 run18	85/15	45°	10	2000 2500	117 ?
13	tbdata_26 run26	85/15	0°	8	19814 5039	
14	tbdata_25 run25	85/15	45°	8	10000 ?	
15	tbdata_20 run20	85/15	0°	6	9800 5019	247,5 ?
16	tbdata_19 run19	85/15	45°	6	4112 3767	104 ?
17	tbdata_21 run21	85/15	0°	4	2827 3760	70,3 ?
18	tbdata_24 run24	85/15	45°	4	2900 4215	104,9 ?
19	tbdata_22 run22	85/15	0°	2	923 2691	23,2 ?
20	tbdata_23 run23	85/15	45°	2	2000 4000	83,9 ?

The set up

DRS16 channels	HV channels	Tubes
0	0	1.0cm-20µm
1	1	1.0cm-20µm
2	2	1.0cm-20µm
3	3	1.0cm-20µm
4	4	1.0cm-20µm
5	5	1.0cm-20µm
6	12	1.5cm-20µm
7	13	1.5cm-20µm
8	14	1.5cm-20µm
9	15	1.5cm-20µm
10	-	-
11	-	-
12	-	-
13	-	-
14	-	Sipm Scintillator upstream
15	-	Sipm Scintillator downstream

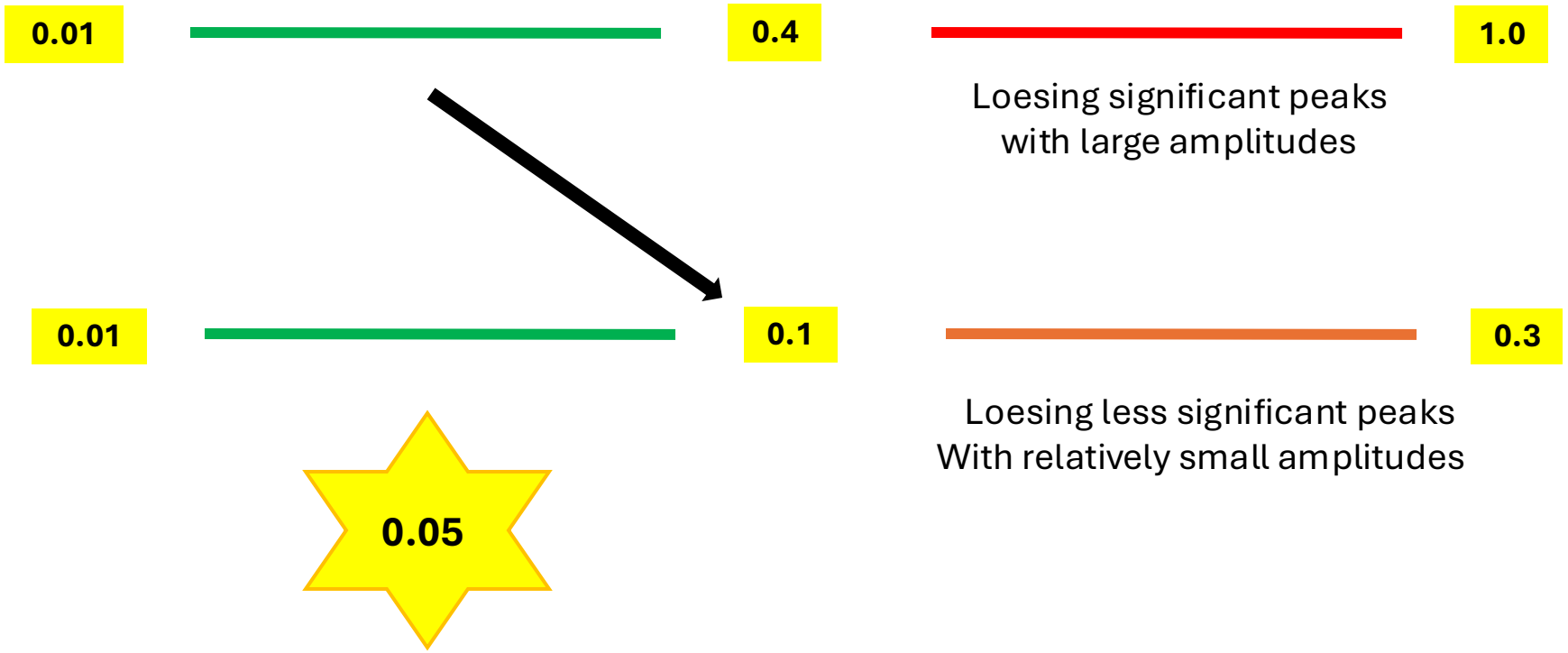
Oscilloscope	HV channels	Tubes
1	16	1.5cm-20µm
2	17	1.5cm-20µm
3	18	1.5cm-20µm
4	19	1.5cm-20µm
5	8	1.0cm-20µm
6	6	1.0cm-20µm
7	9	1.0cm-20µm
8	10	1.0cm-20µm

The Find Peak algorithm formula

```
if (amplitude[ip]>(float)(N_1*rms) && (amplitude[ip] - (float) (amplitude[ip-1]+amplitude[ip+1])/2 > (float) N_2*rms) && ((abs(fderiv[ip])< (float) (2.0 * N_3 * sigd1)) ||
                                (fderiv[ip-1] >  (float) N_3 * sigd1 || fderiv[ip+1] < (float) (-1.0 *(float) N_3 * sigd1))) && sderiv[ip] < (float)( -1.0 * N_4 * sigd2 )
```

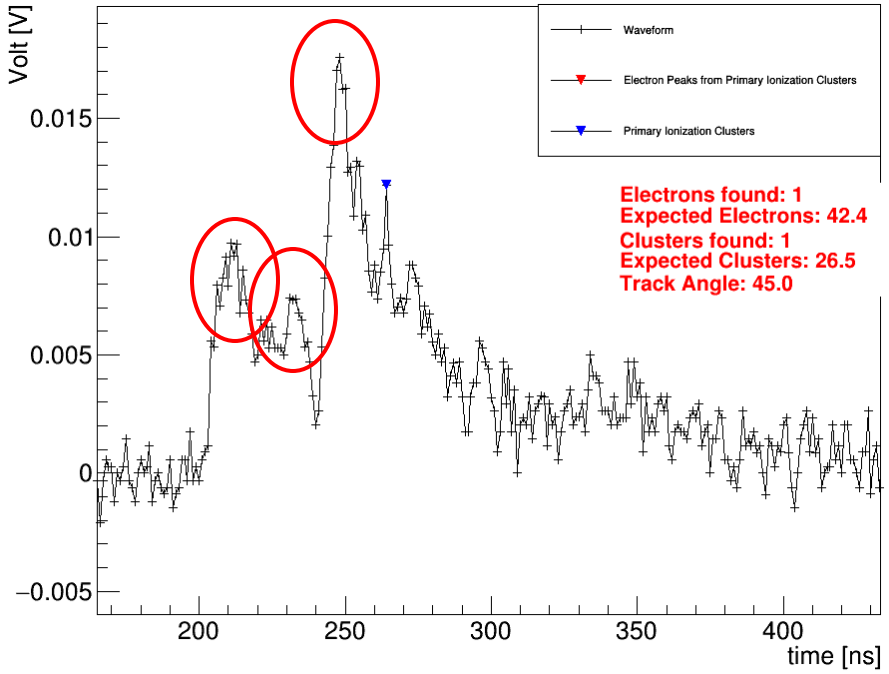
scan on the 2nd derivative cut

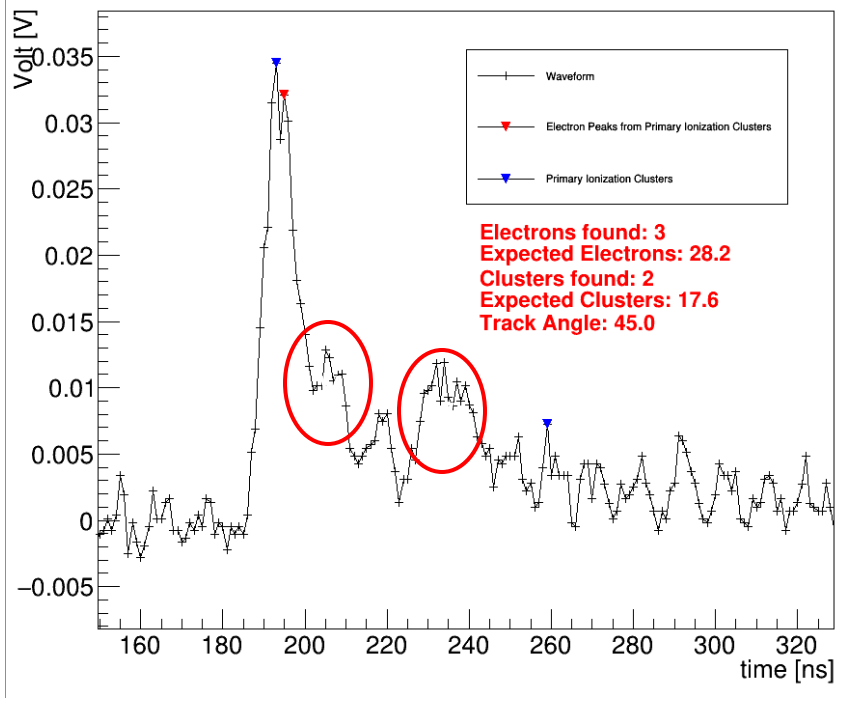
[run number]	[first event]	[last event]	[sampling rate]	[Bsl]	[cut on amplitude]	[1st der.]	[2nd der.]	[Bsln time]	[n bins]	[clusterization]
4	0	-100	1.0	4	0	0.5	?	25.0	1024	0.24



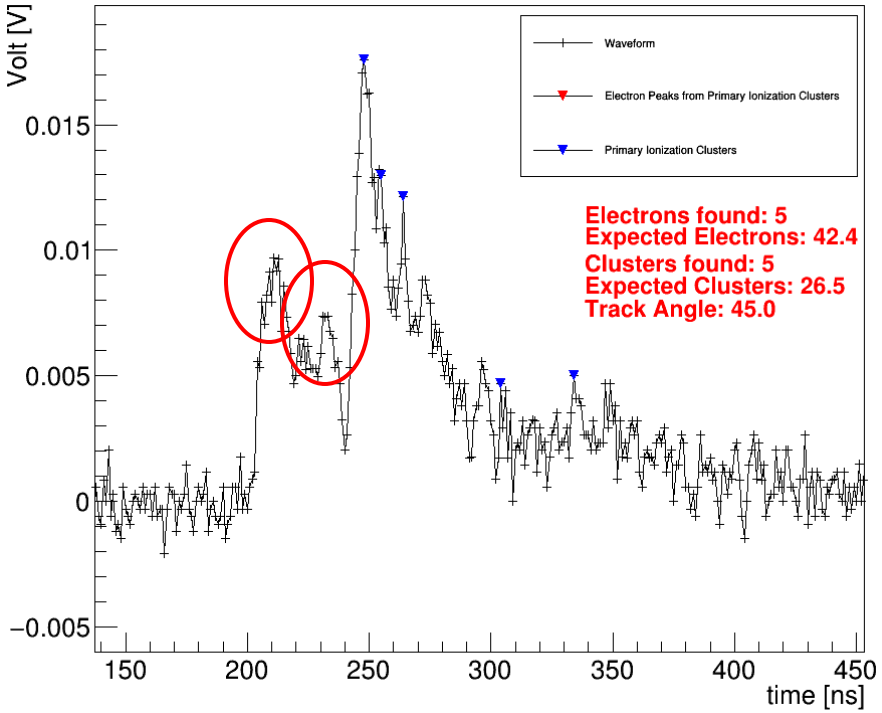
Applied to example run no. 4
(Gas mix. 90/10, angle 45, momentum 10 GeV) collected by DRS16

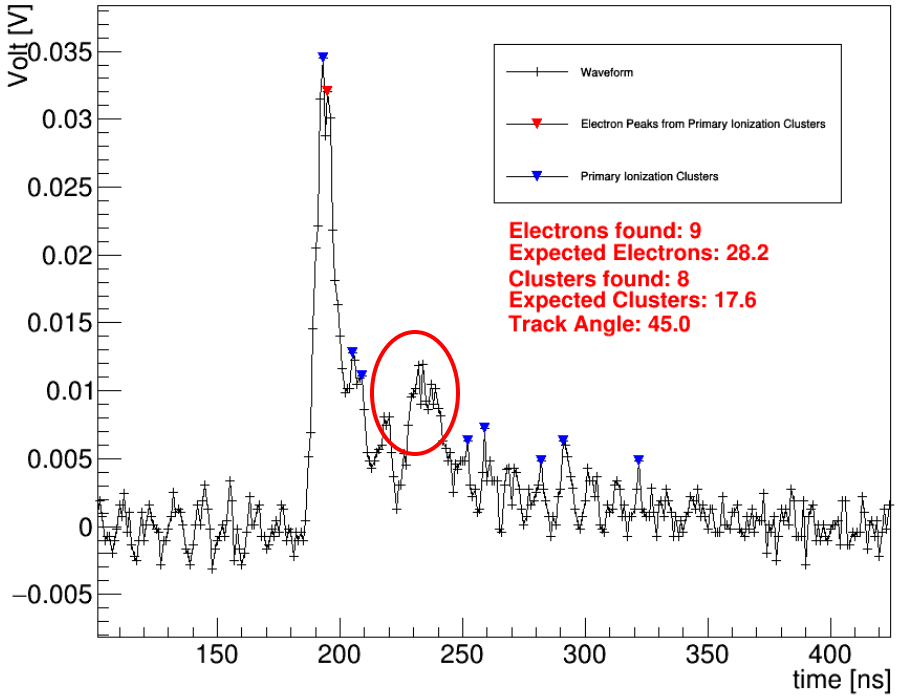
0.8


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 1
Expected Electrons: 42.4
Clusters found: 1
Expected Clusters: 26.5
Track Angle: 45.0

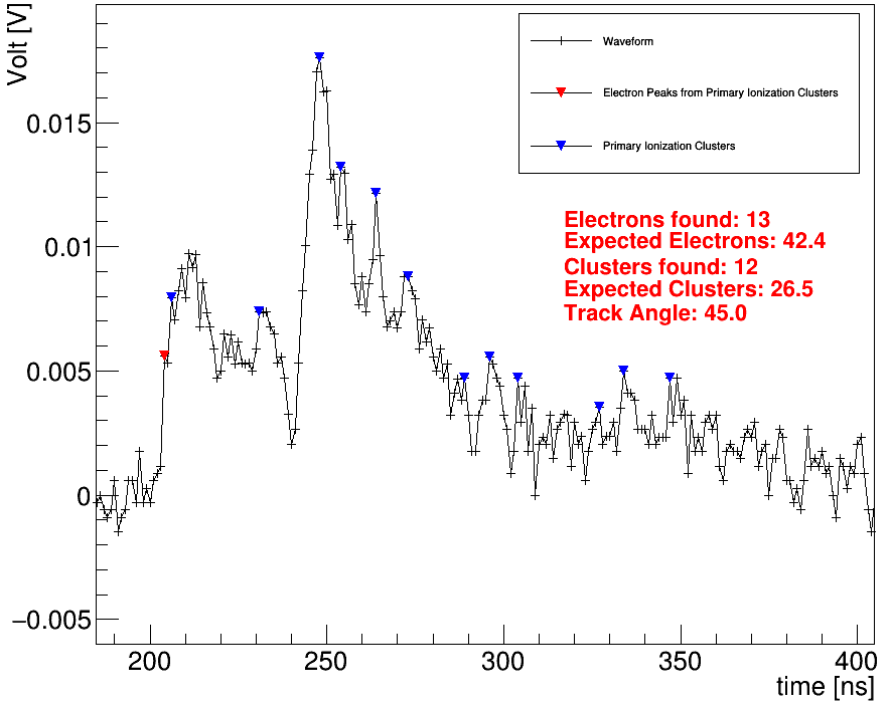

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 3
Expected Electrons: 28.2
Clusters found: 2
Expected Clusters: 17.6
Track Angle: 45.0

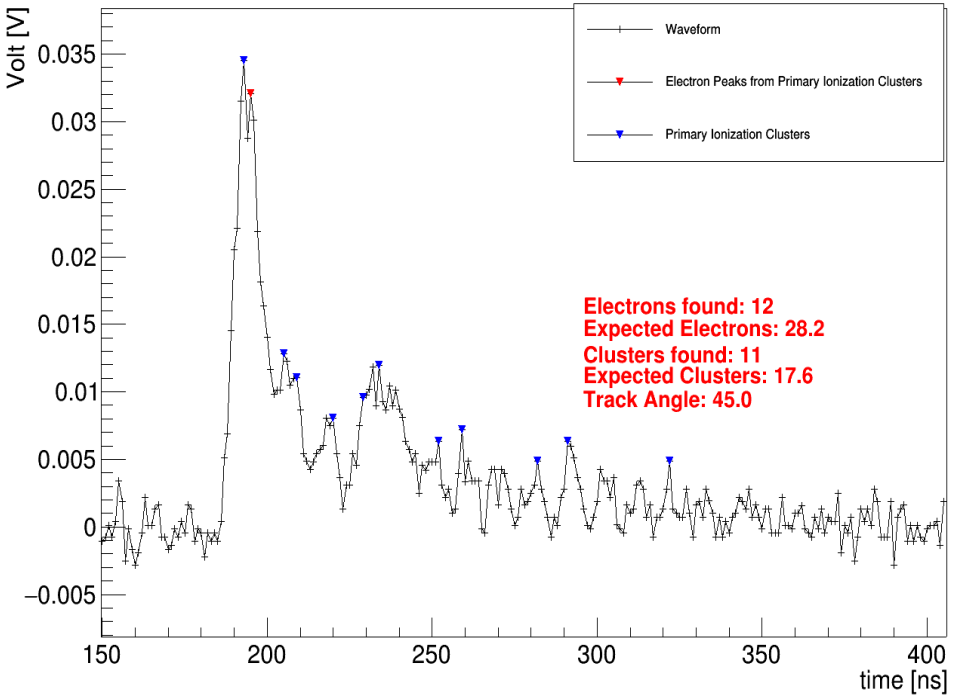
0.5


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 5
Expected Electrons: 42.4
Clusters found: 5
Expected Clusters: 26.5
Track Angle: 45.0

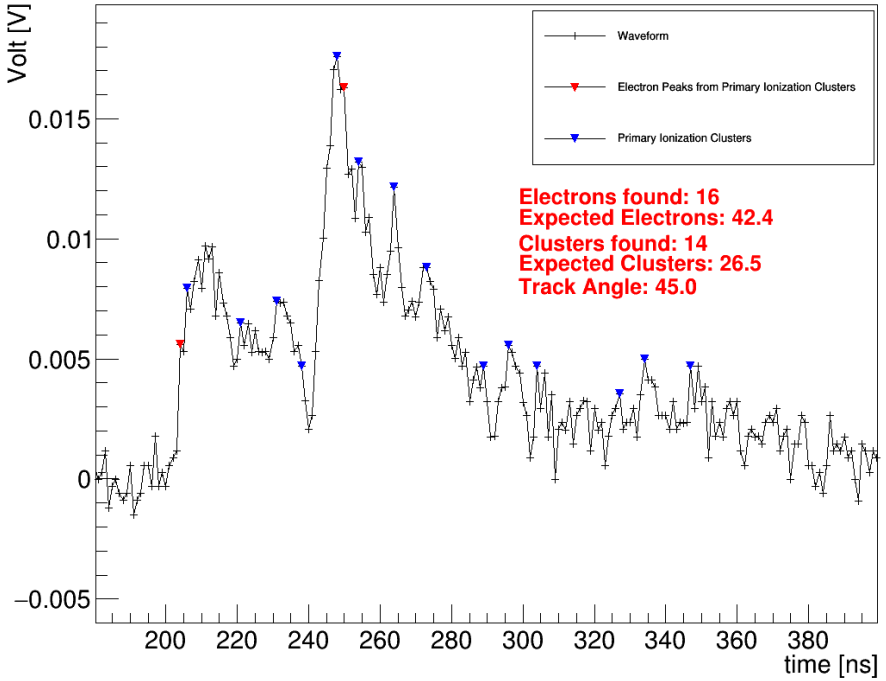

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 9
Expected Electrons: 28.2
Clusters found: 8
Expected Clusters: 17.6
Track Angle: 45.0

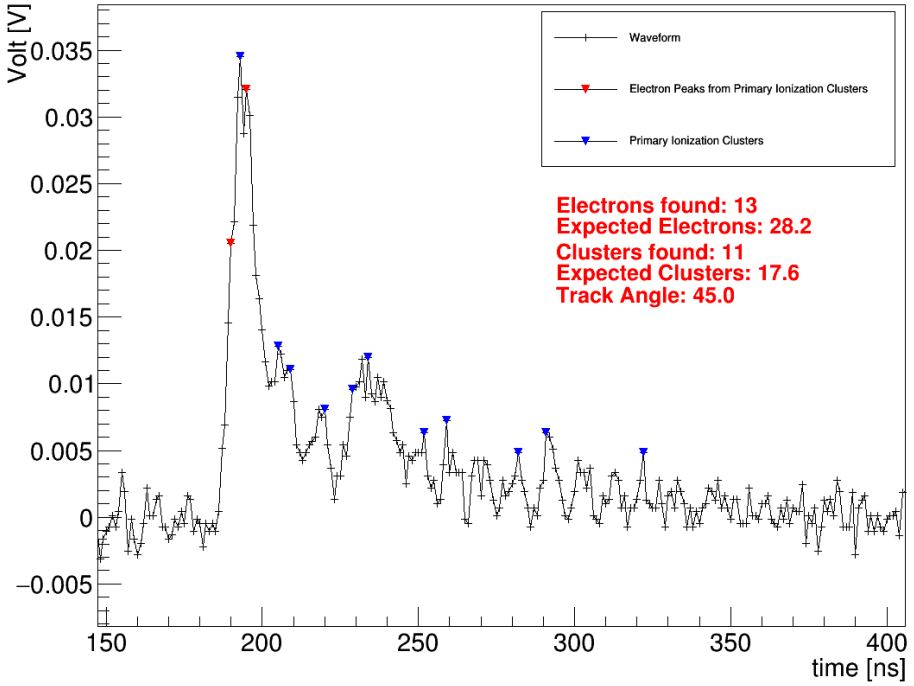
0.3


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 13
Expected Electrons: 42.4
Clusters found: 12
Expected Clusters: 26.5
Track Angle: 45.0

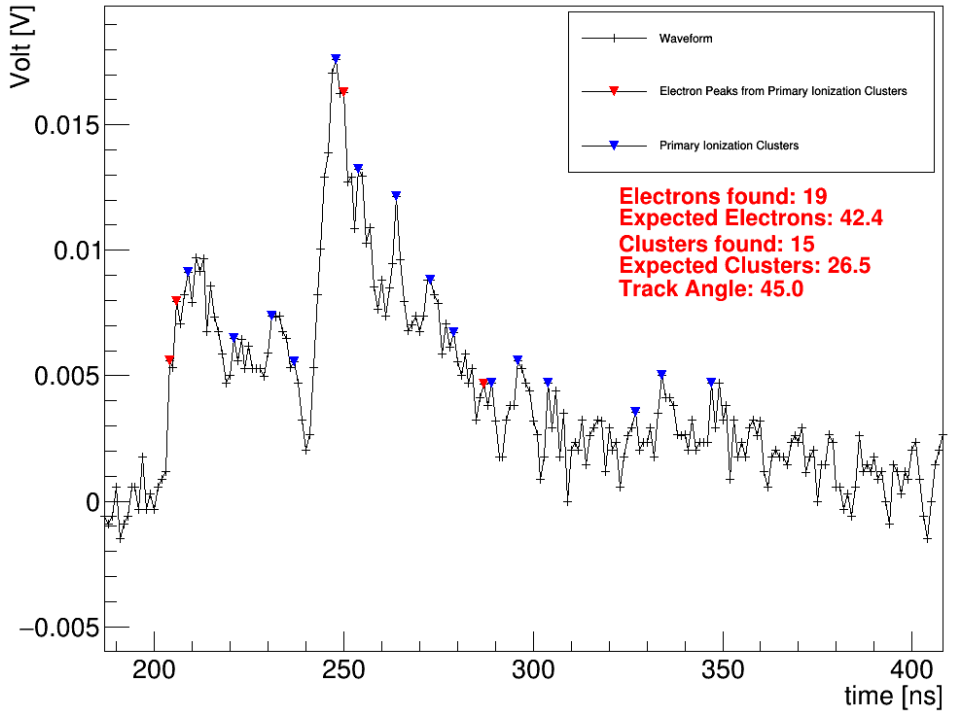

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 12
Expected Electrons: 28.2
Clusters found: 11
Expected Clusters: 17.6
Track Angle: 45.0

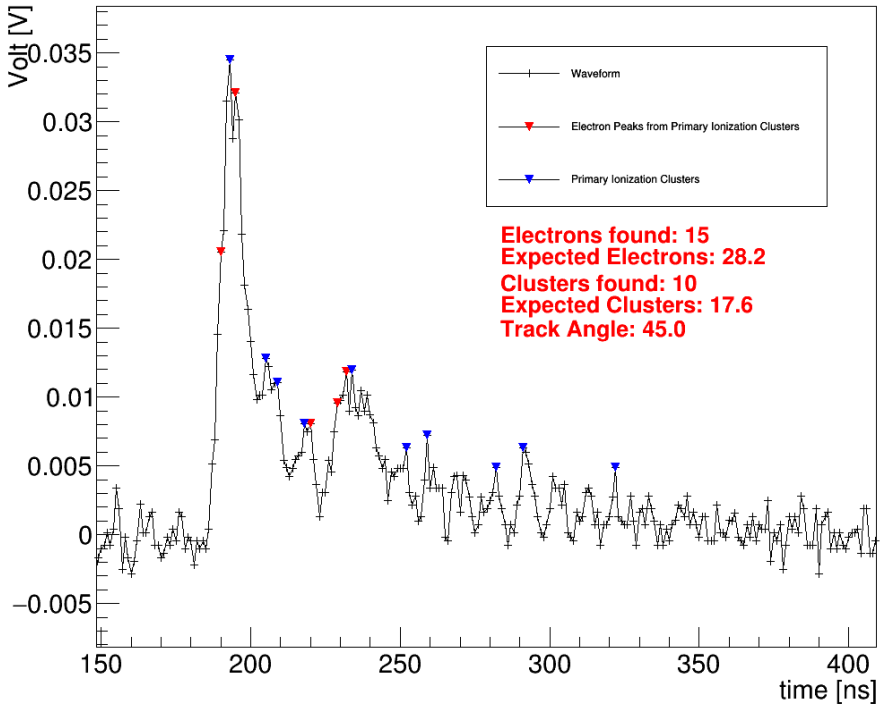
0.25


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 16
Expected Electrons: 42.4
Clusters found: 14
Expected Clusters: 26.5
Track Angle: 45.0

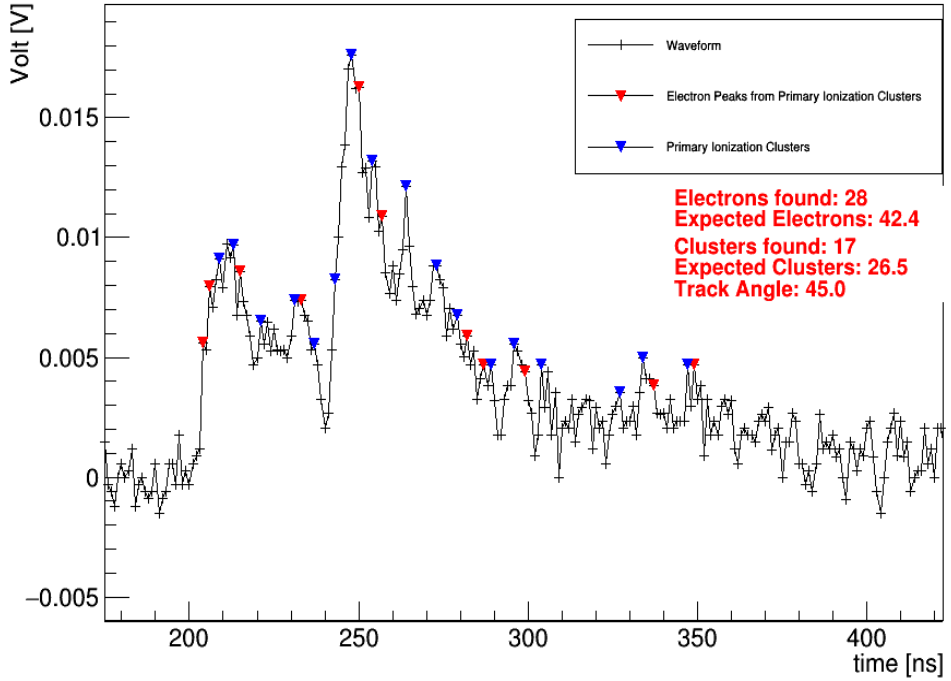

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 13
Expected Electrons: 28.2
Clusters found: 11
Expected Clusters: 17.6
Track Angle: 45.0

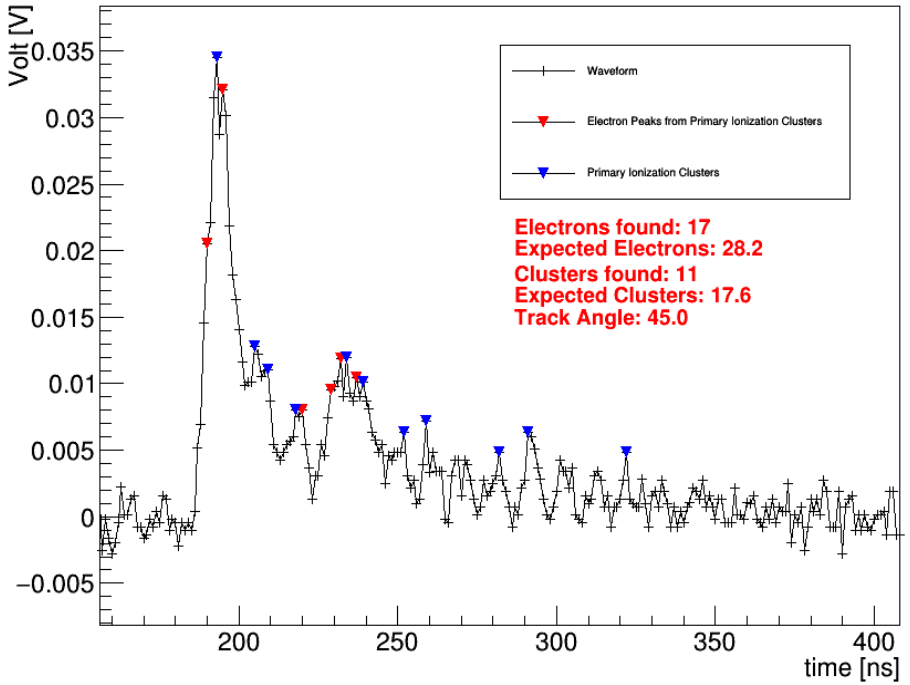
0.20


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 19
Expected Electrons: 42.4
Clusters found: 15
Expected Clusters: 26.5
Track Angle: 45.0

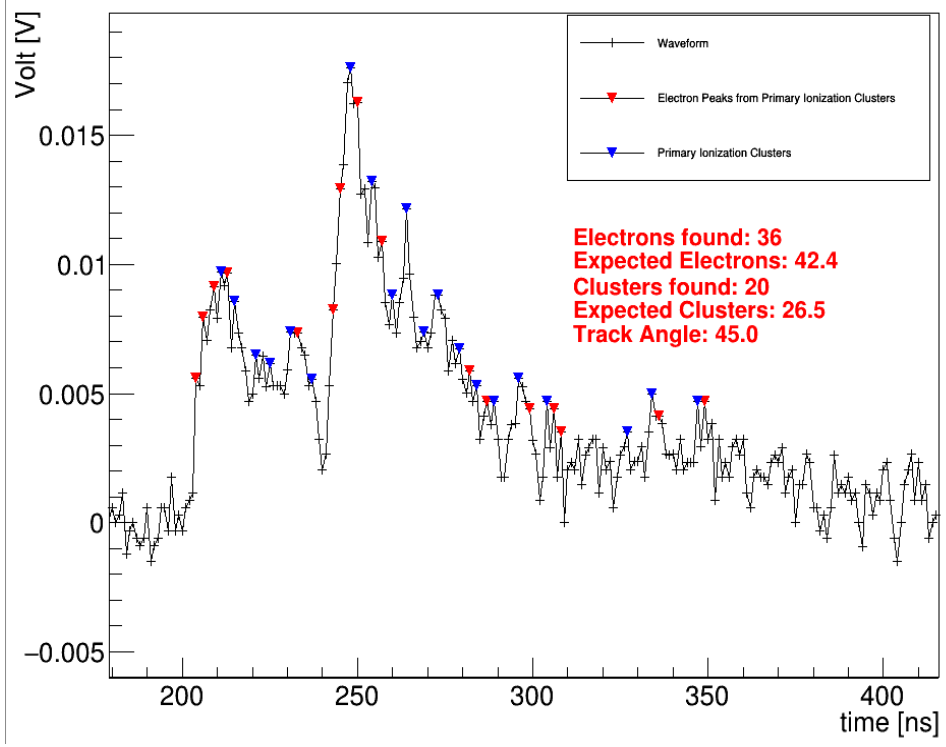

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 15
Expected Electrons: 28.2
Clusters found: 10
Expected Clusters: 17.6
Track Angle: 45.0

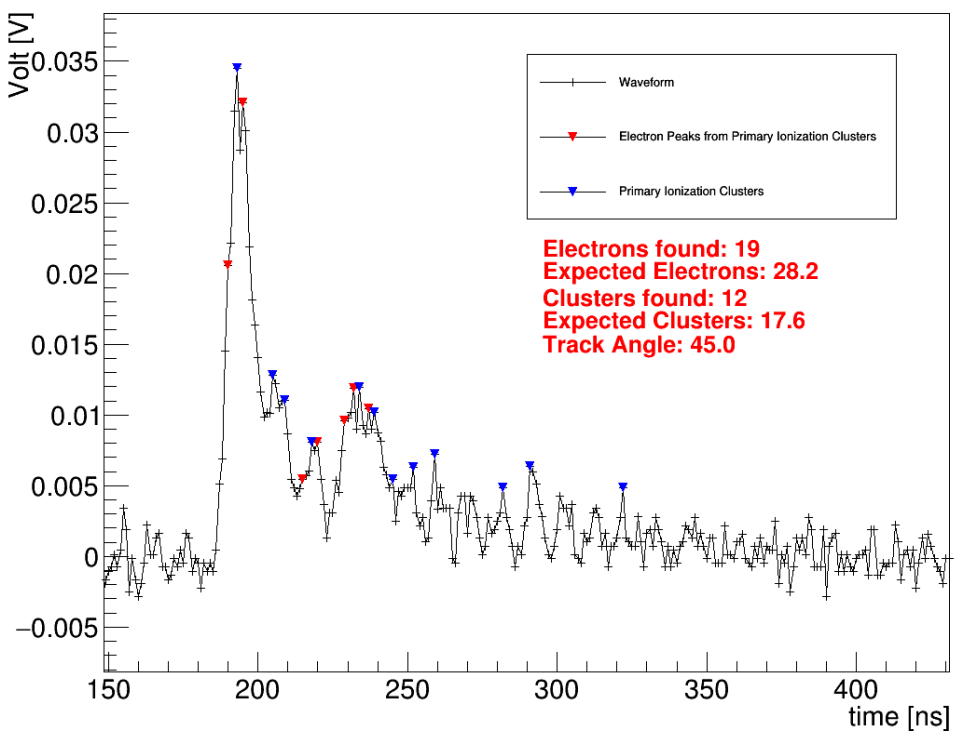
0.1

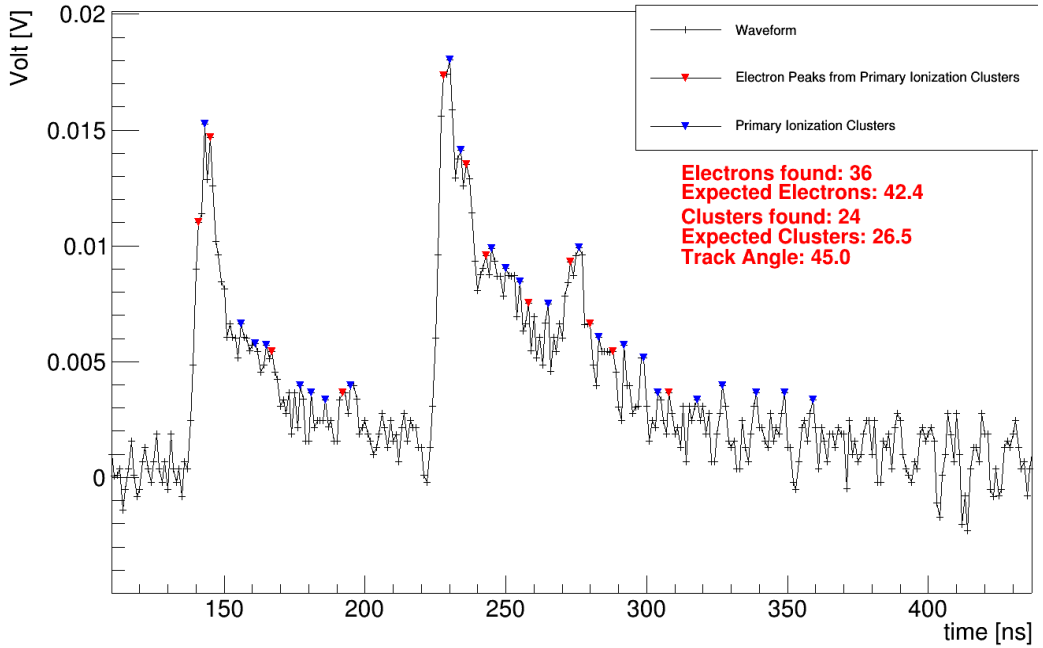

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 28
Expected Electrons: 42.4
Clusters found: 17
Expected Clusters: 26.5
Track Angle: 45.0

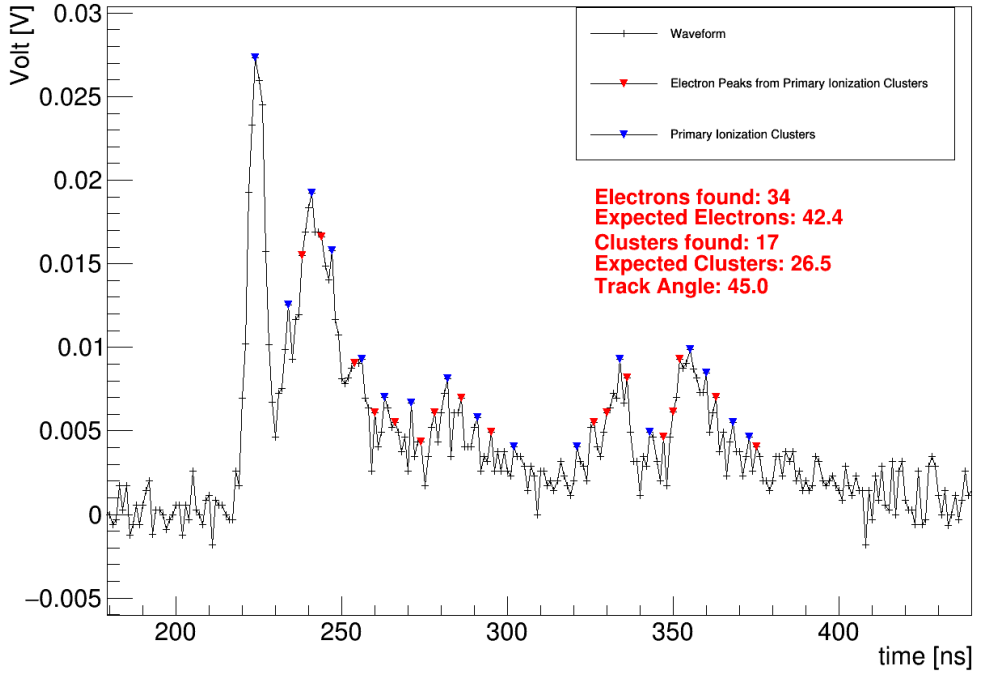

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 17
Expected Electrons: 28.2
Clusters found: 11
Expected Clusters: 17.6
Track Angle: 45.0

0.05

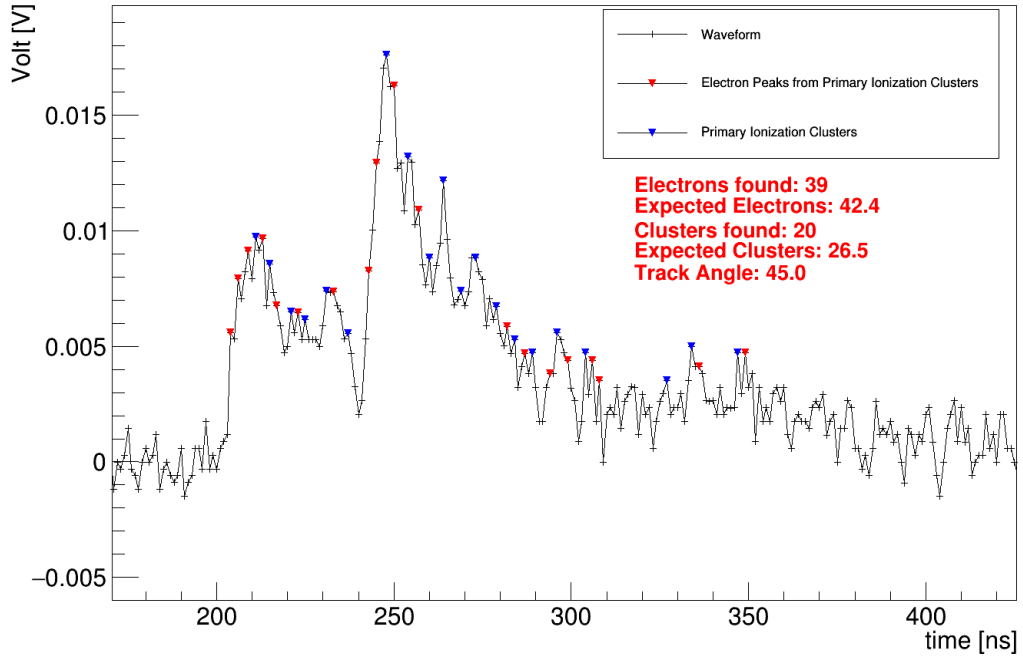

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 36
Expected Electrons: 42.4
Clusters found: 20
Expected Clusters: 26.5
Track Angle: 45.0

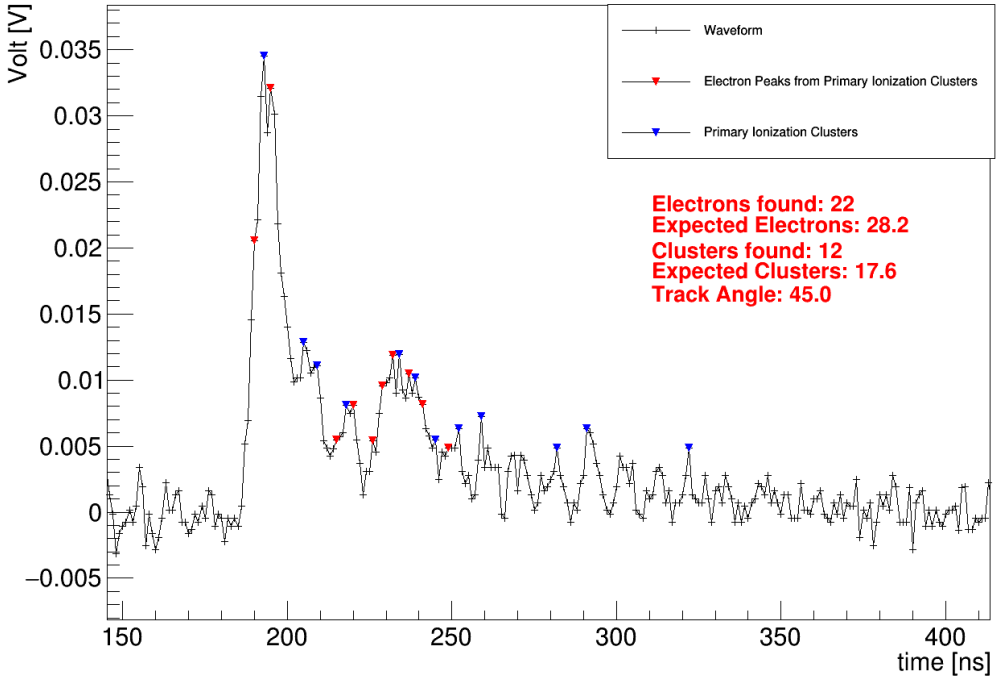

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 19
Expected Electrons: 28.2
Clusters found: 12
Expected Clusters: 17.6
Track Angle: 45.0

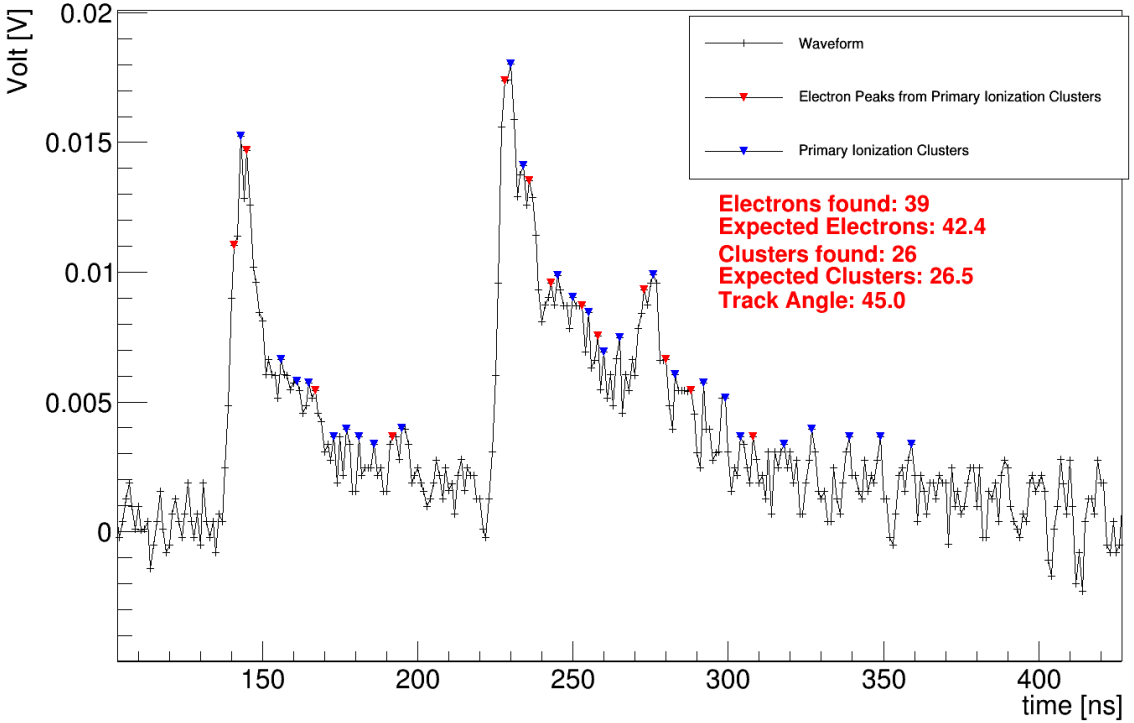

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 36
Expected Electrons: 42.4
Clusters found: 24
Expected Clusters: 26.5
Track Angle: 45.0

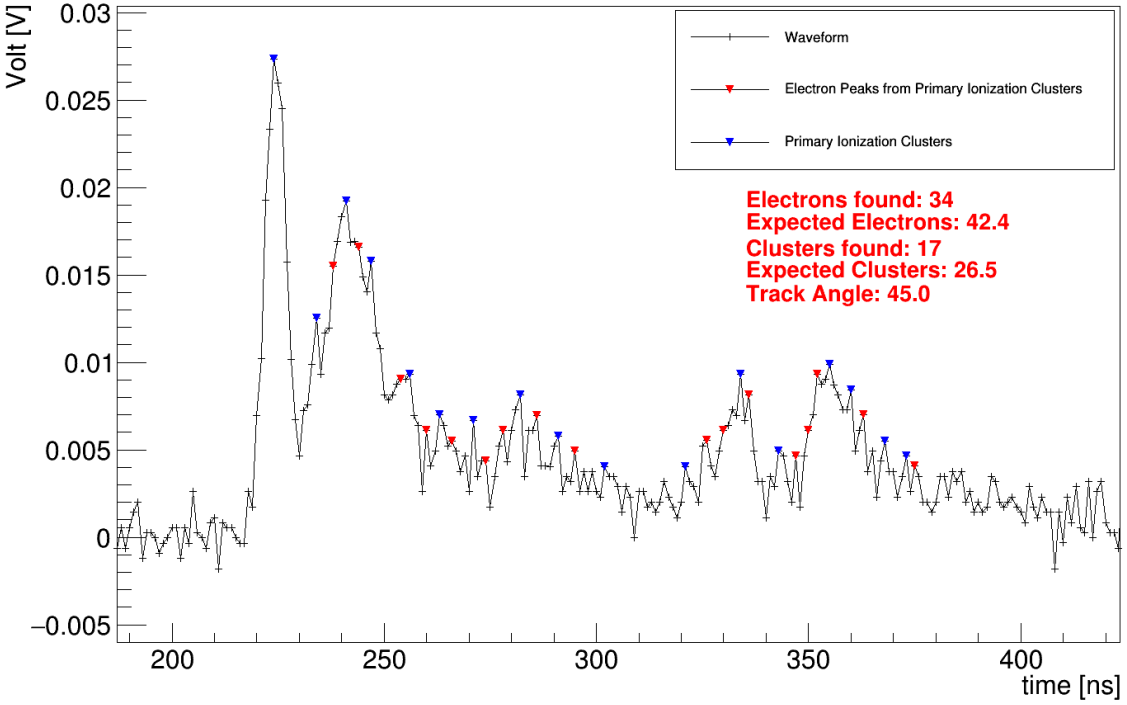

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 34
Expected Electrons: 42.4
Clusters found: 17
Expected Clusters: 26.5
Track Angle: 45.0

0.01


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 39
Expected Electrons: 42.4
Clusters found: 20
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 22
Expected Electrons: 28.2
Clusters found: 12
Expected Clusters: 17.6
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 39
Expected Electrons: 42.4
Clusters found: 26
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 34
Expected Electrons: 42.4
Clusters found: 17
Expected Clusters: 26.5
Track Angle: 45.0

scan on the cut on BSL

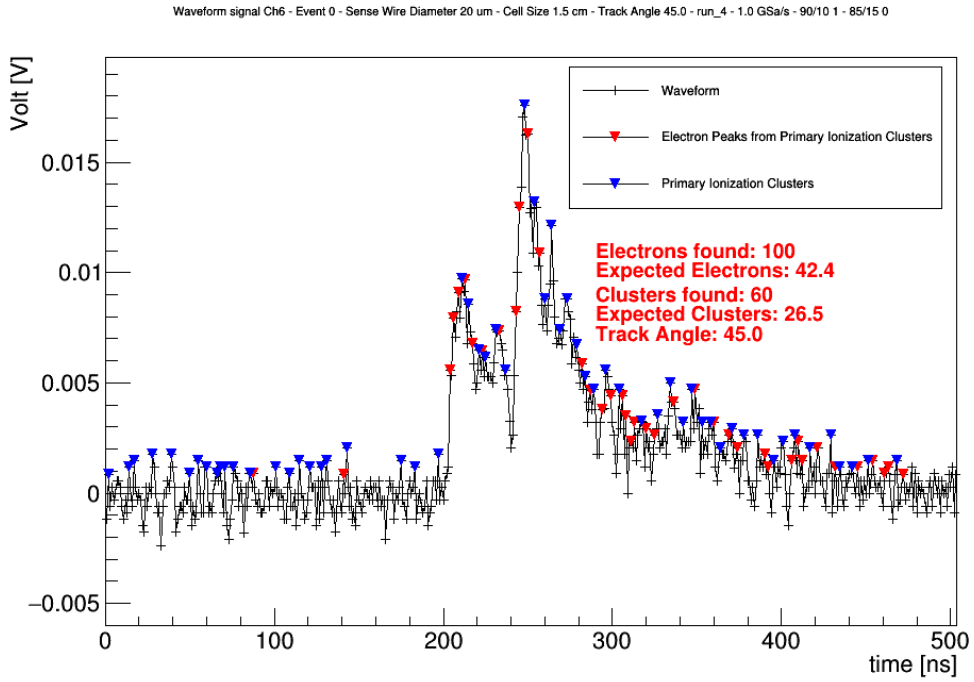
[run number]	[first event]	[last event]	[sampling rate]	[Bsl]	[cut on amplitude]	[1st der.]	[2nd der.]	[Bsln time]	[n bins]	[clusterization]
4	0	-100	1.0	?	0	0.5	0.05	25.0	1024	0.24

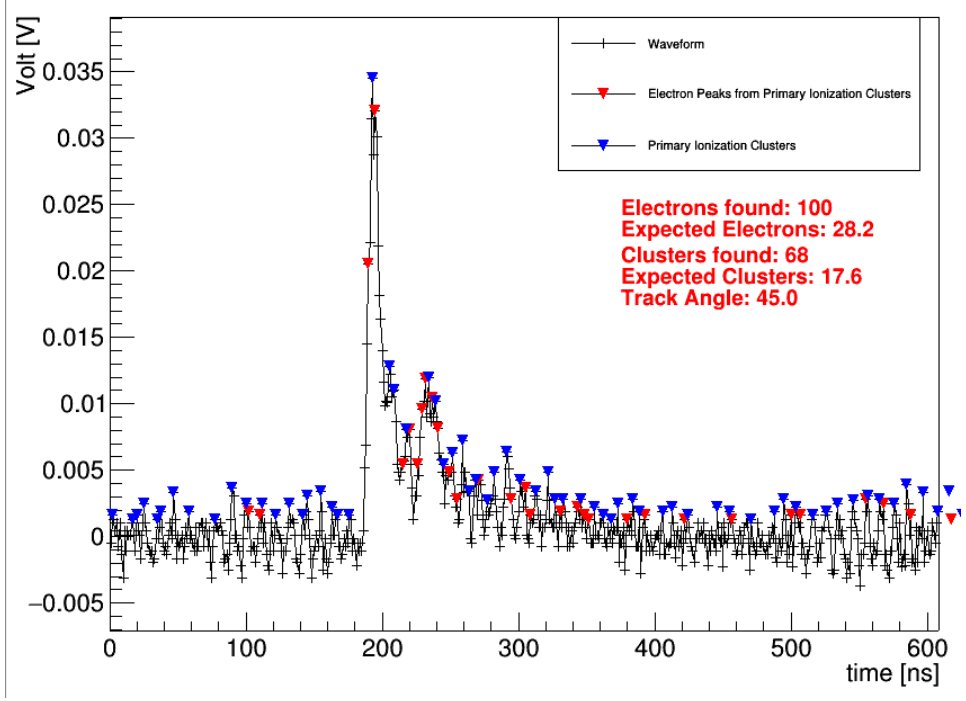
Reconstruct noise fluctuations as peaks

Loesing less significant peaks
With relatively small amplitudes

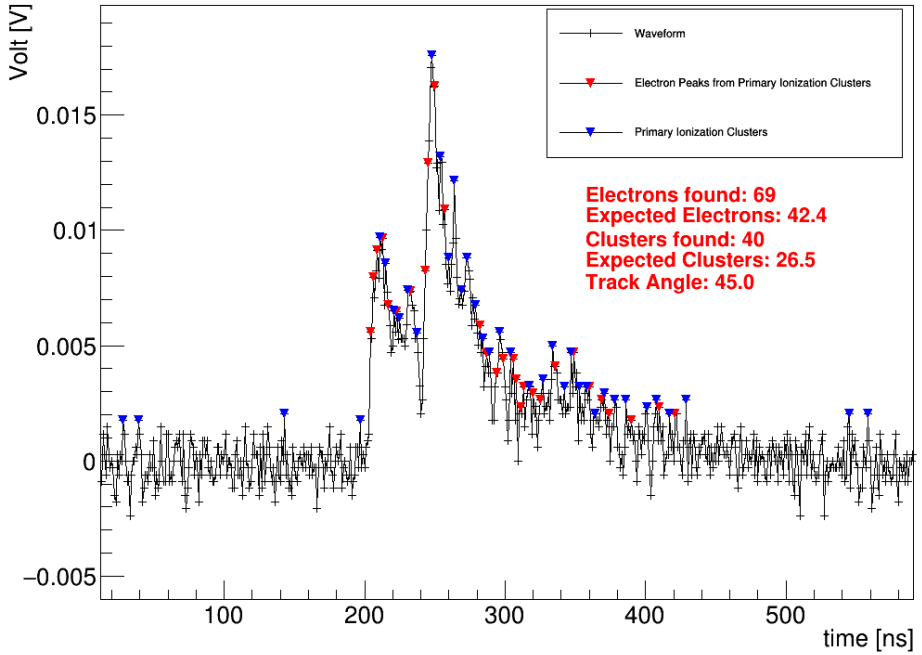
Applied to example run no. 4
(Gas mix. 90/10, angle 45, momentum 10 GeV) collected by DRS16

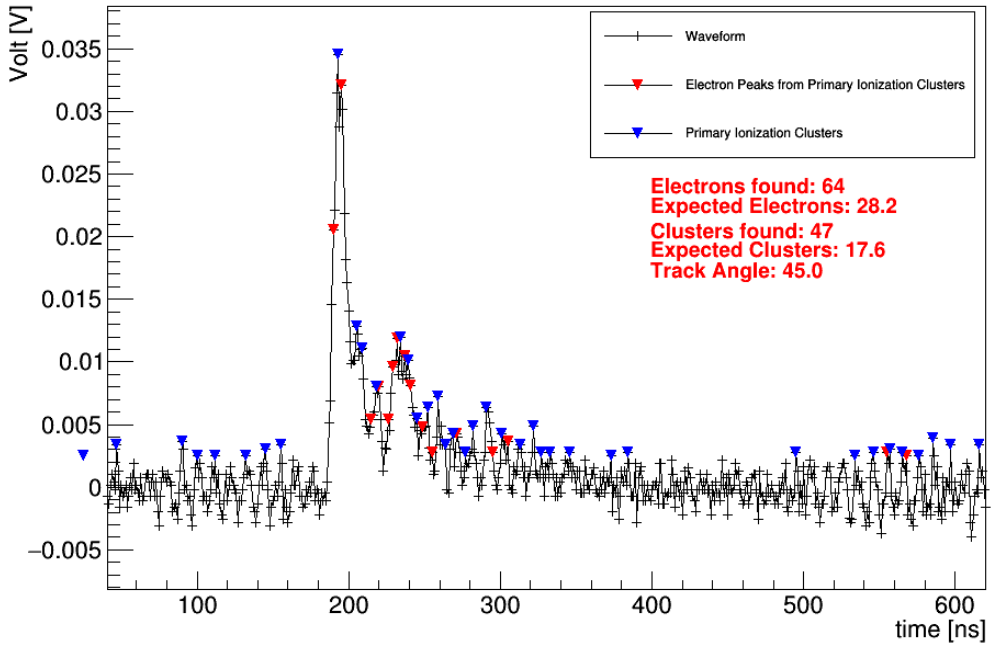
1


Waveform signal Ch6 - Event 0 - Sense Wire Diameter 20 um - Cell Size 1.5 cm - Track Angle 45.0 - run_4 - 1.0 GSa/s - 90/10 1 - 85/15 0
Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 100
Expected Electrons: 42.4
Clusters found: 60
Expected Clusters: 26.5
Track Angle: 45.0

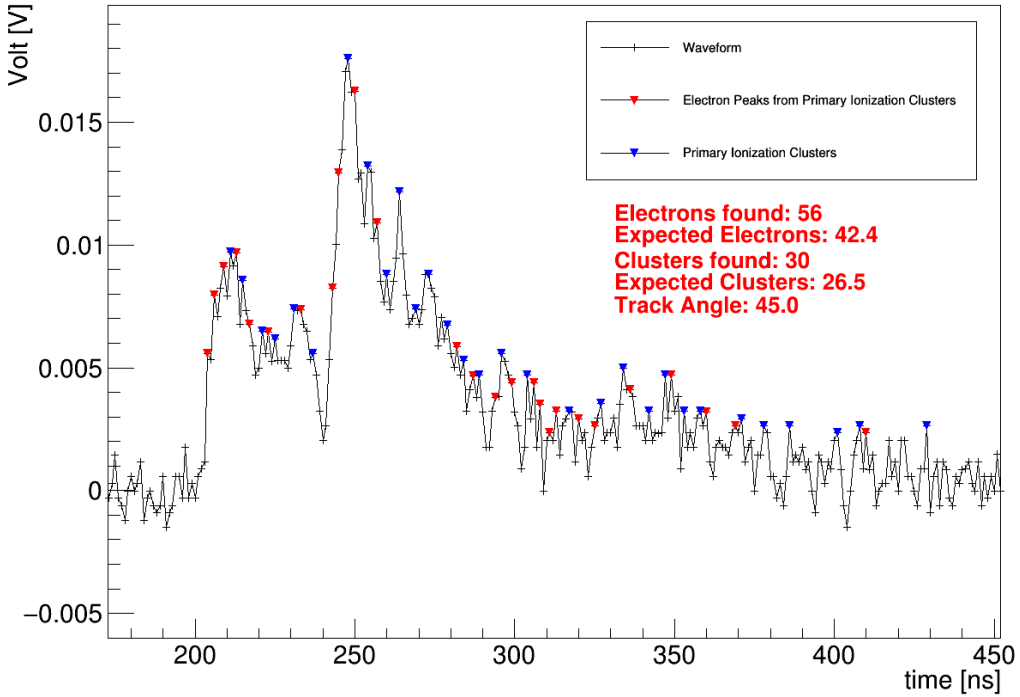

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 100
Expected Electrons: 28.2
Clusters found: 68
Expected Clusters: 17.6
Track Angle: 45.0

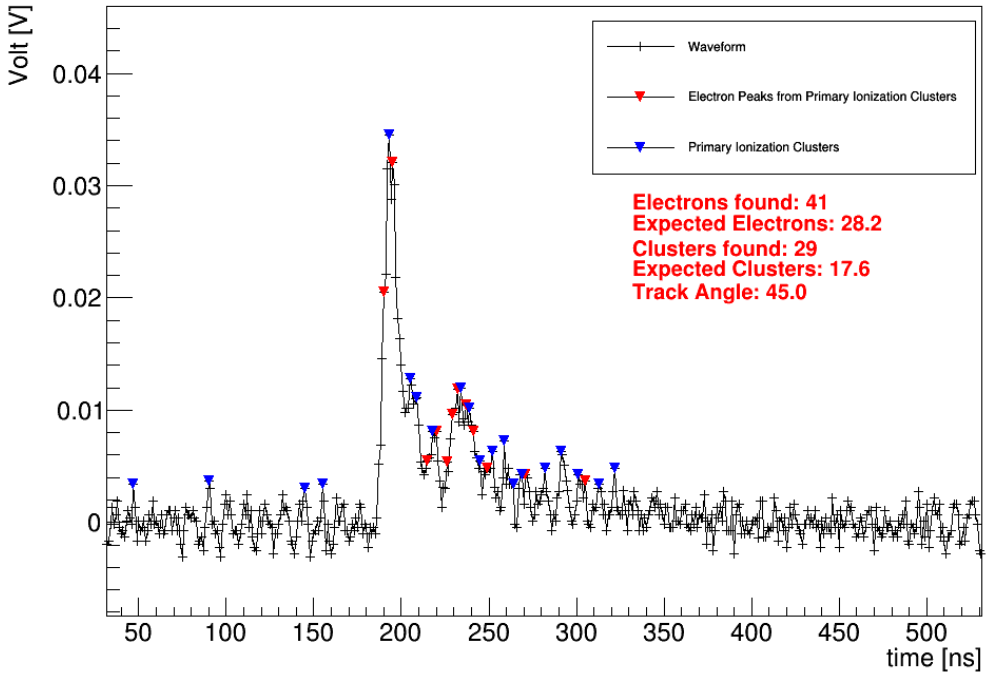
2


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 69
Expected Electrons: 42.4
Clusters found: 40
Expected Clusters: 26.5
Track Angle: 45.0

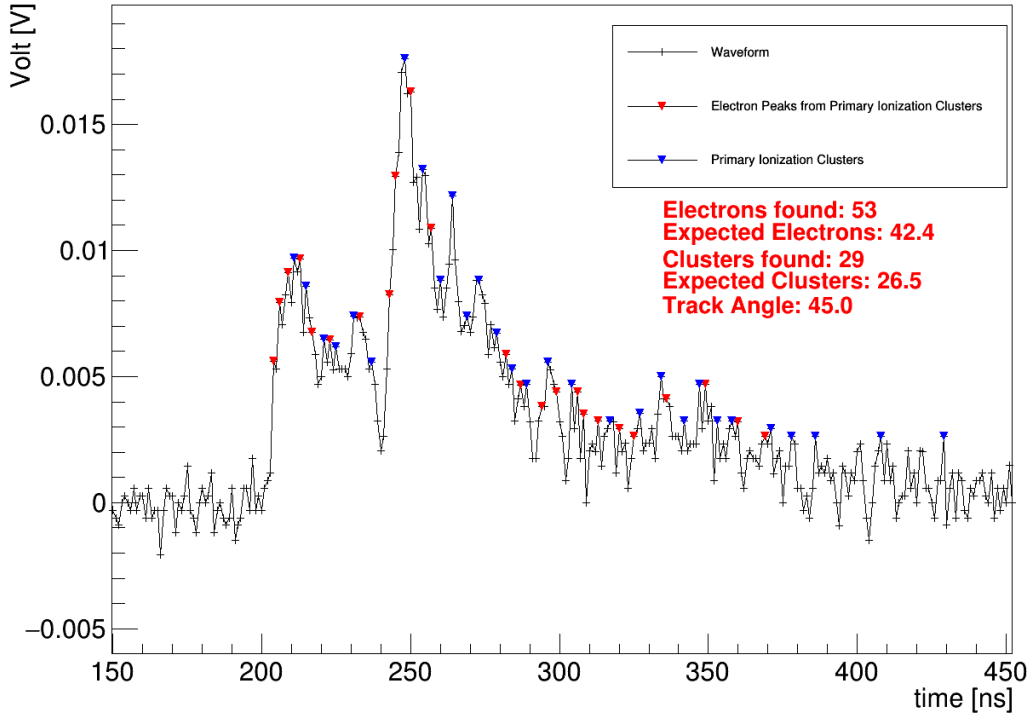

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 64
Expected Electrons: 28.2
Clusters found: 47
Expected Clusters: 17.6
Track Angle: 45.0

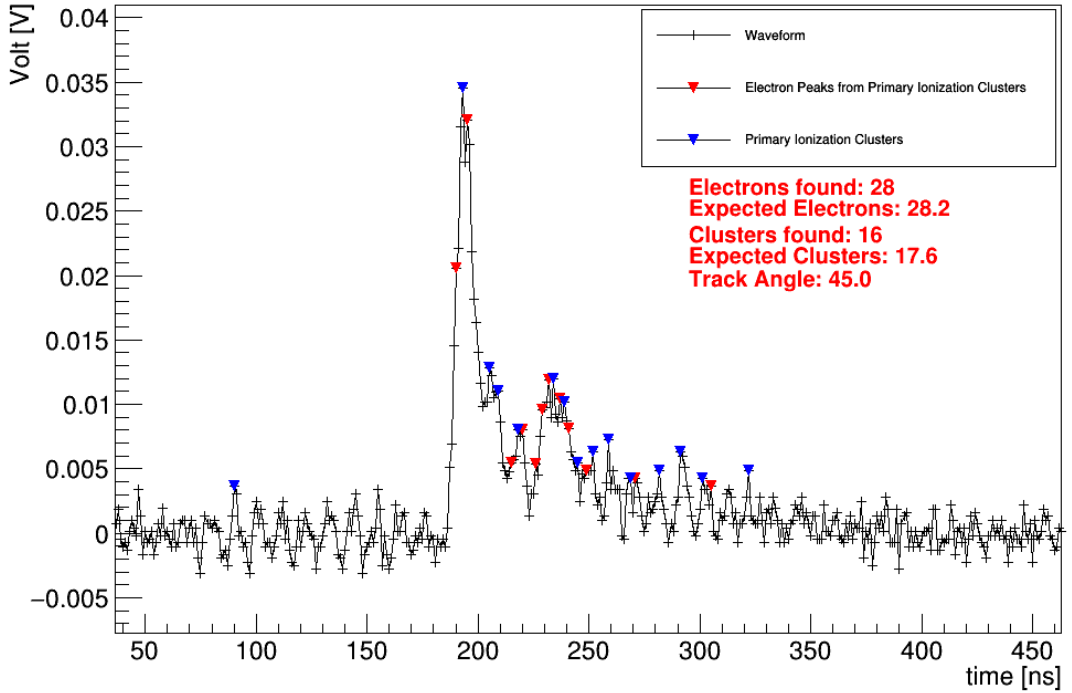
2.5


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 56
Expected Electrons: 42.4
Clusters found: 30
Expected Clusters: 26.5
Track Angle: 45.0

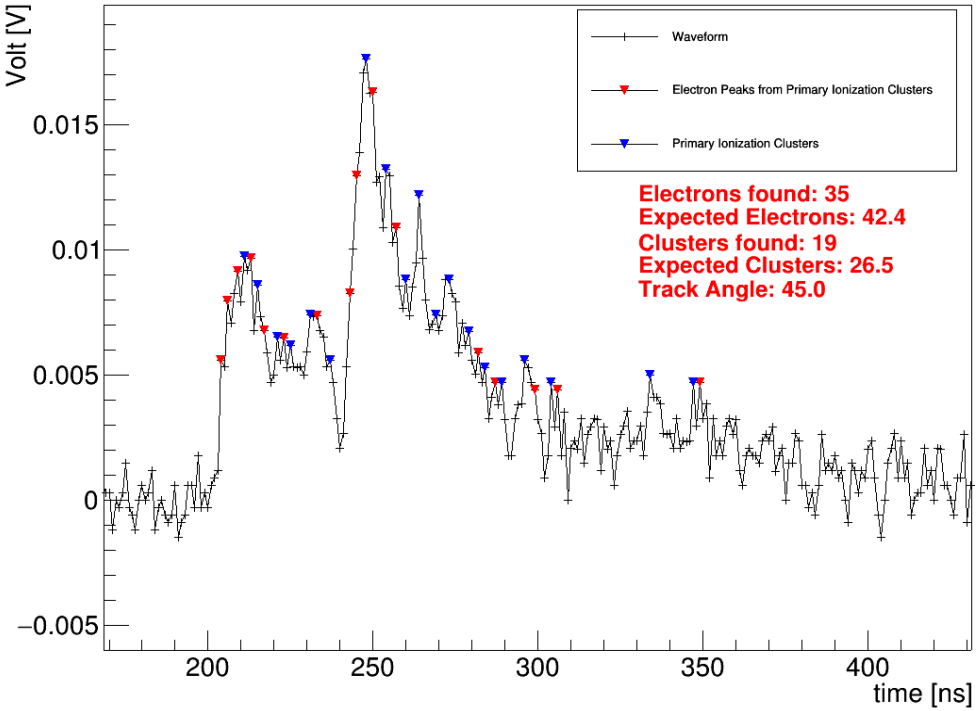

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 41
Expected Electrons: 28.2
Clusters found: 29
Expected Clusters: 17.6
Track Angle: 45.0

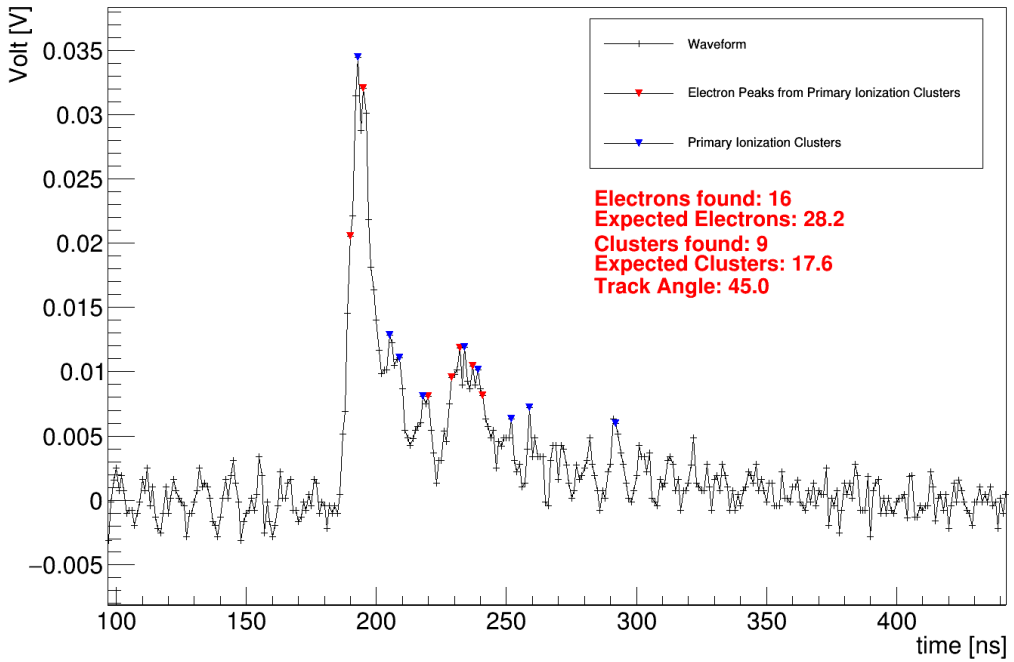
3


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 53
Expected Electrons: 42.4
Clusters found: 29
Expected Clusters: 26.5
Track Angle: 45.0

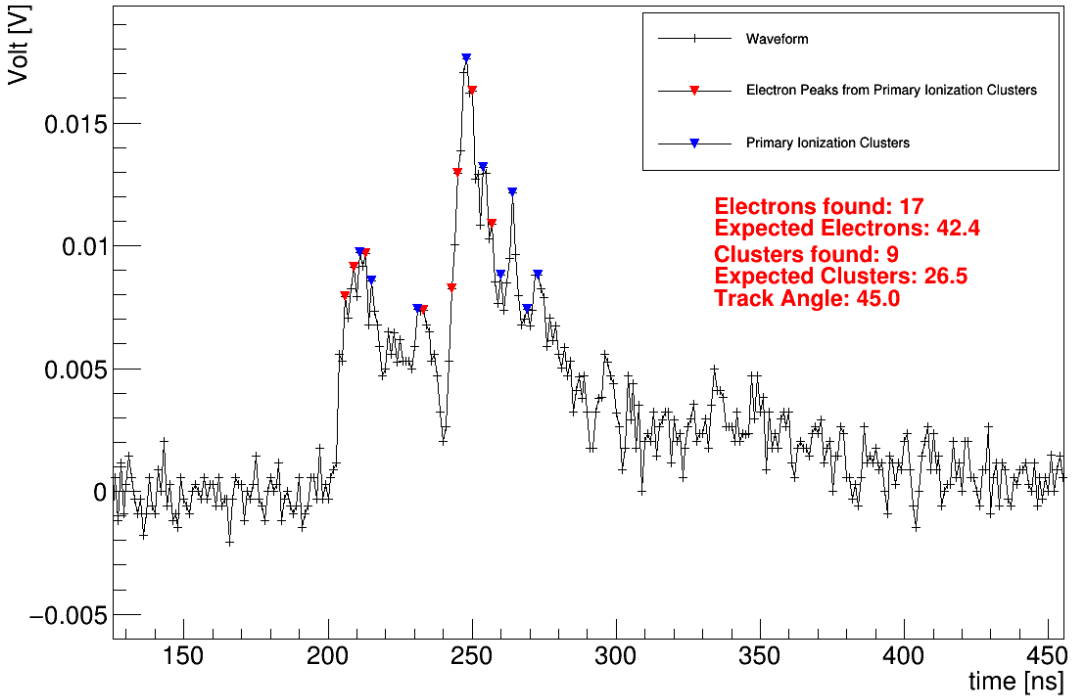

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 28
Expected Electrons: 28.2
Clusters found: 16
Expected Clusters: 17.6
Track Angle: 45.0

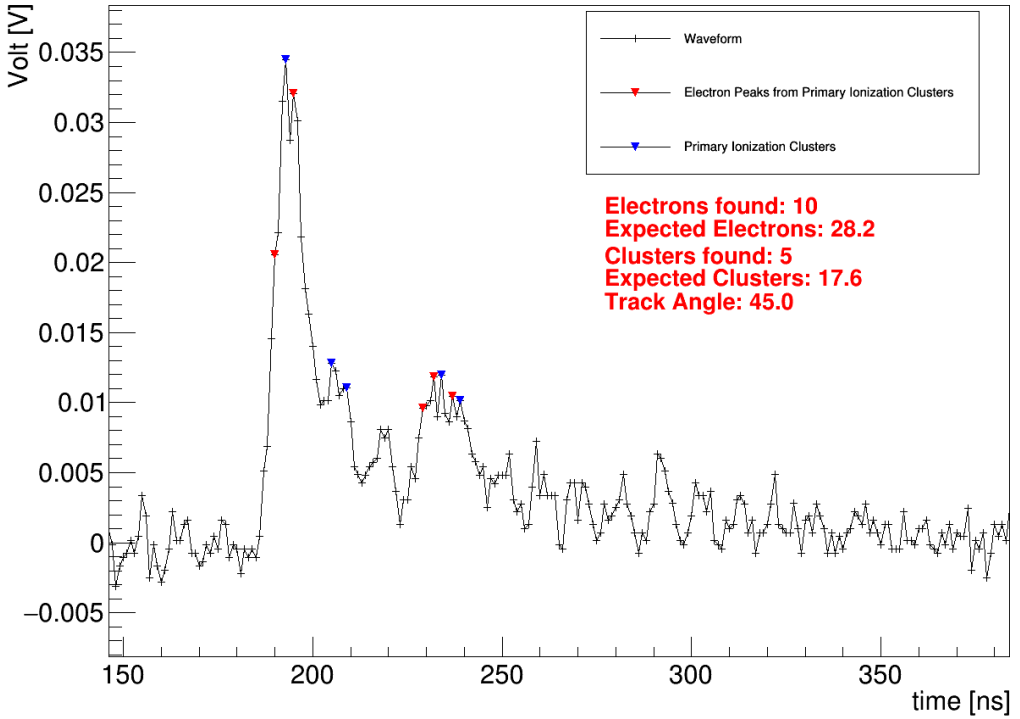
5

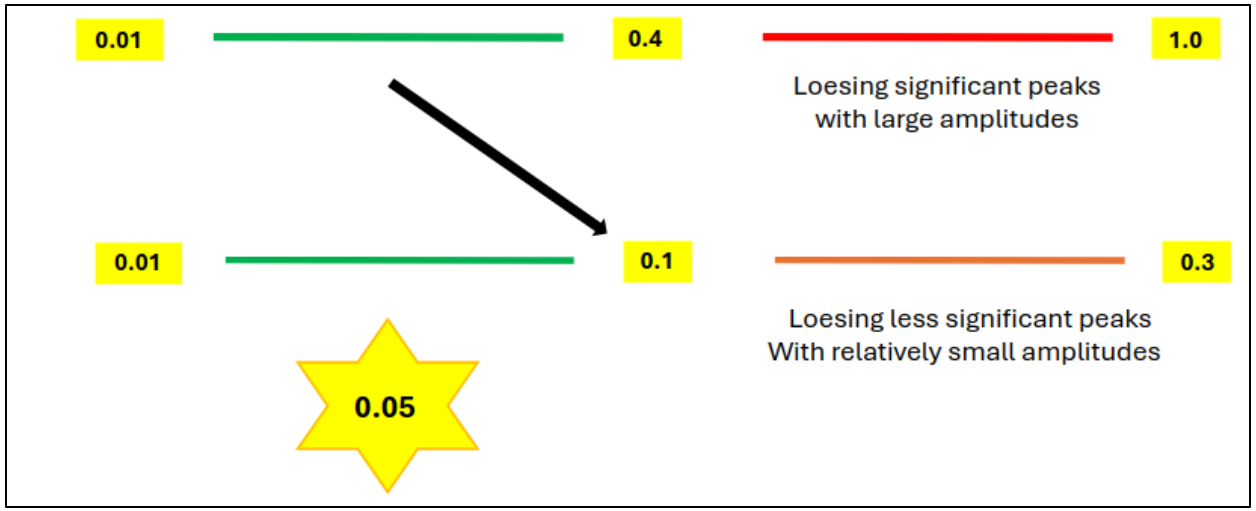

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 35
Expected Electrons: 42.4
Clusters found: 19
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 16
Expected Electrons: 28.2
Clusters found: 9
Expected Clusters: 17.6
Track Angle: 45.0

8

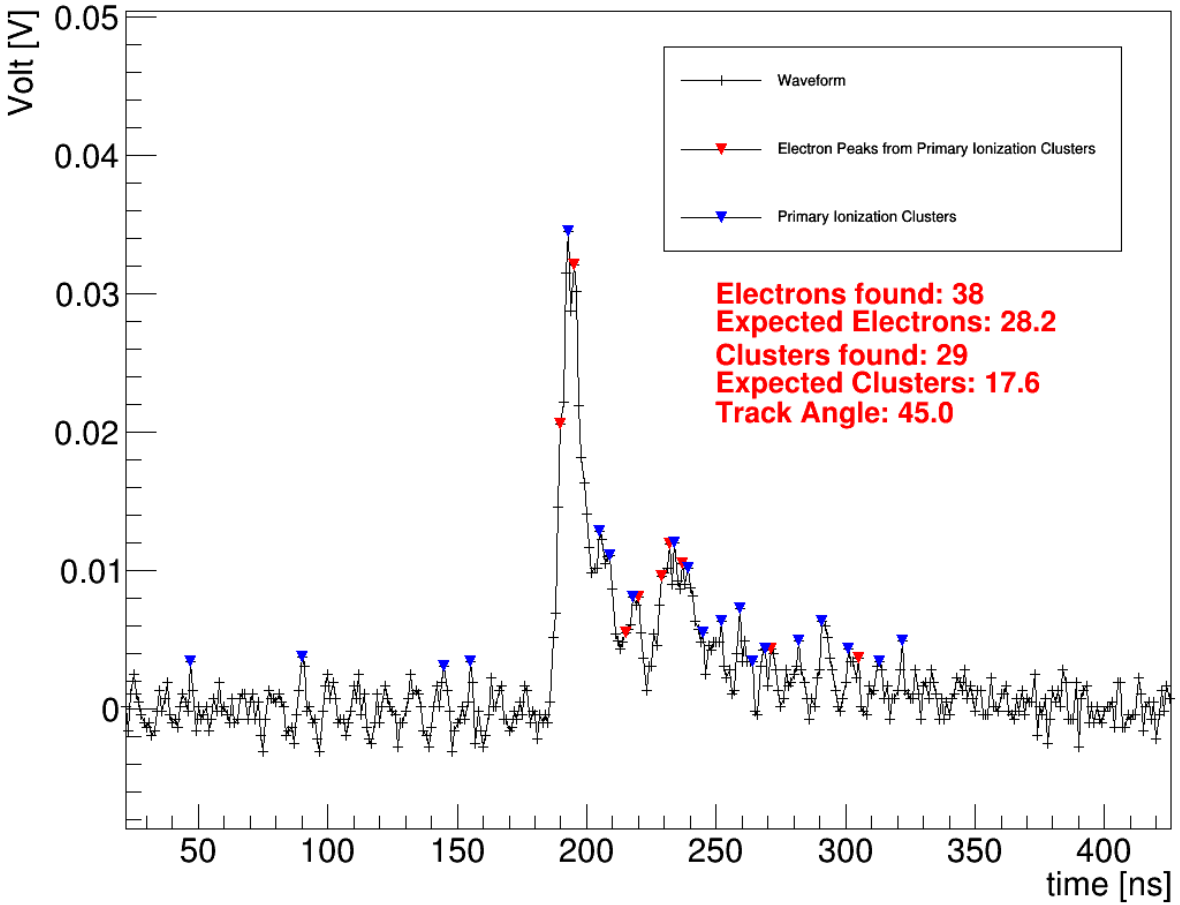

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 17
Expected Electrons: 42.4
Clusters found: 9
Expected Clusters: 26.5
Track Angle: 45.0

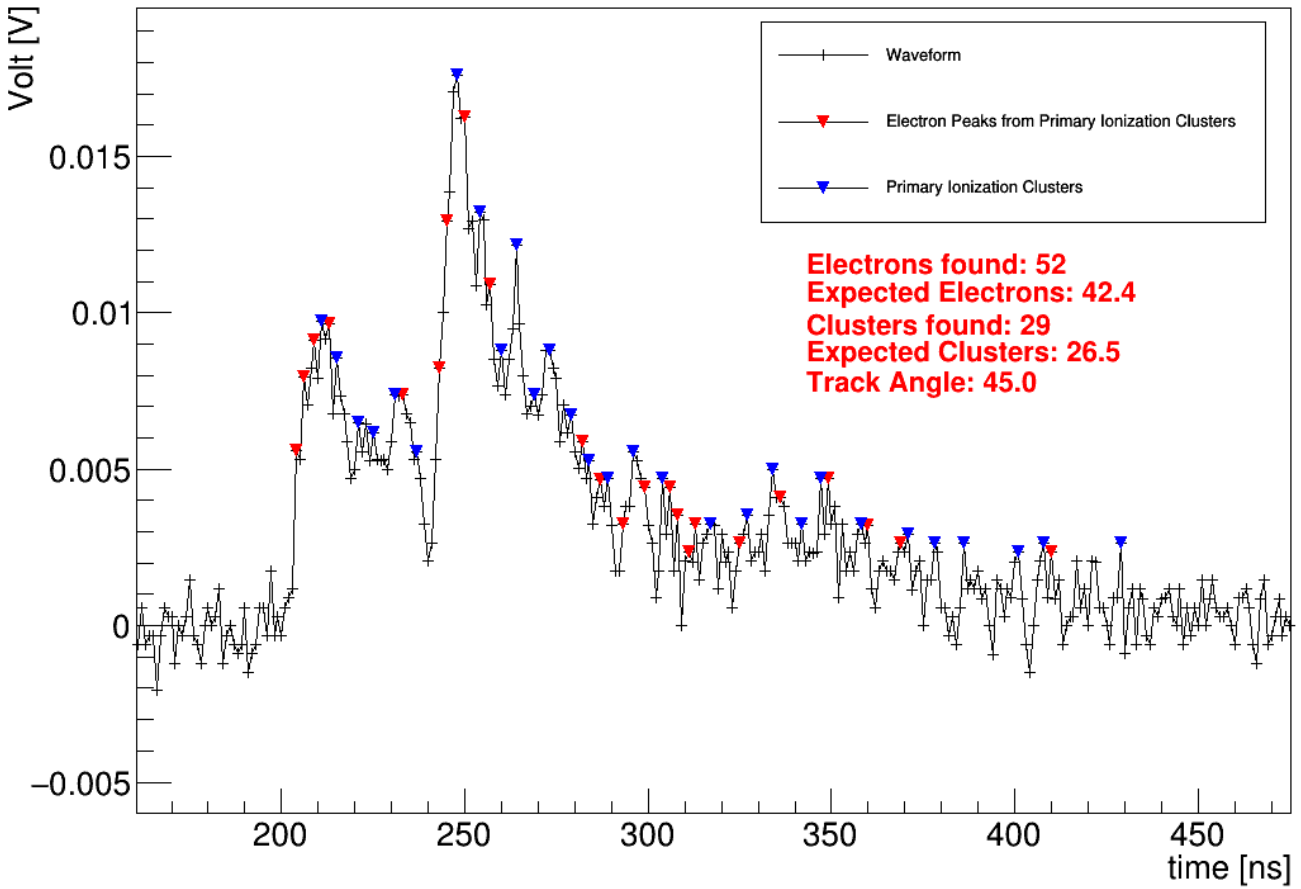

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 10
Expected Electrons: 28.2
Clusters found: 5
Expected Clusters: 17.6
Track Angle: 45.0

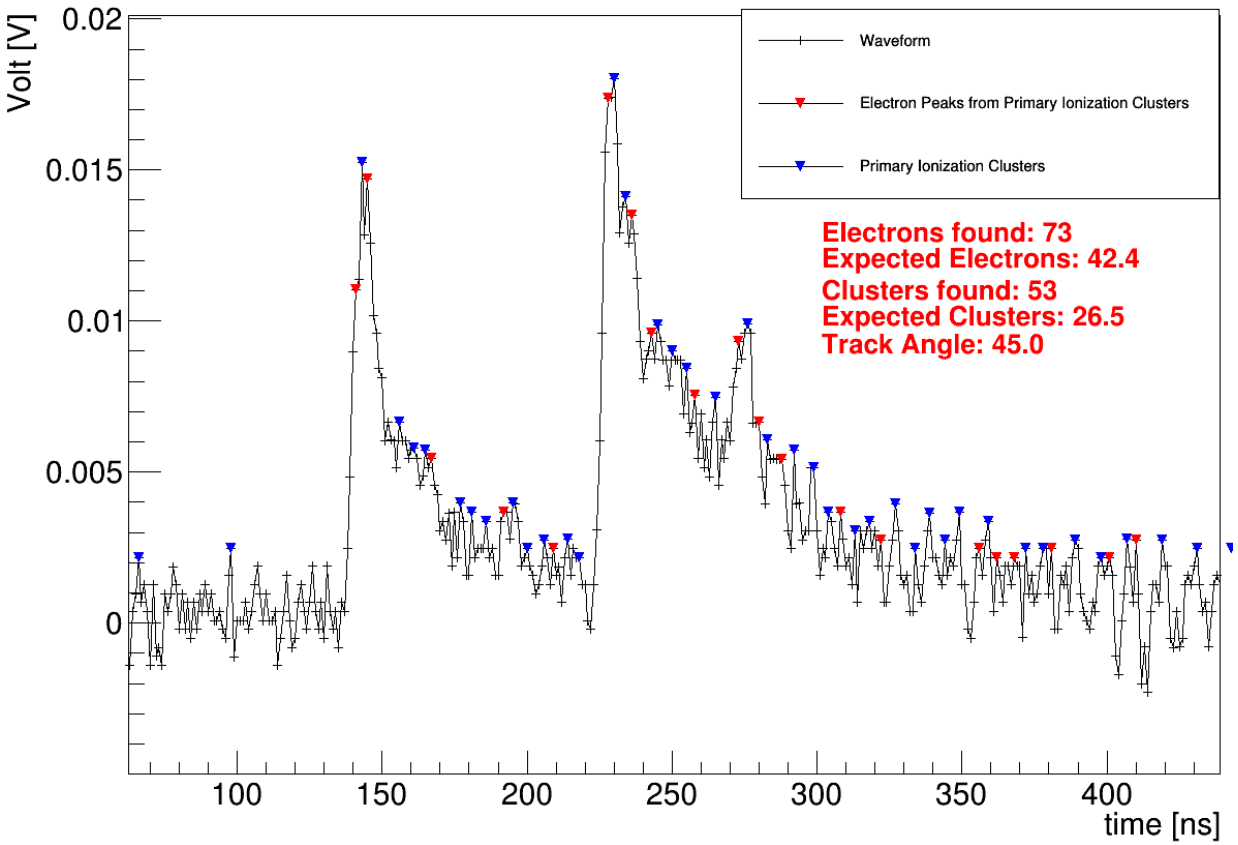


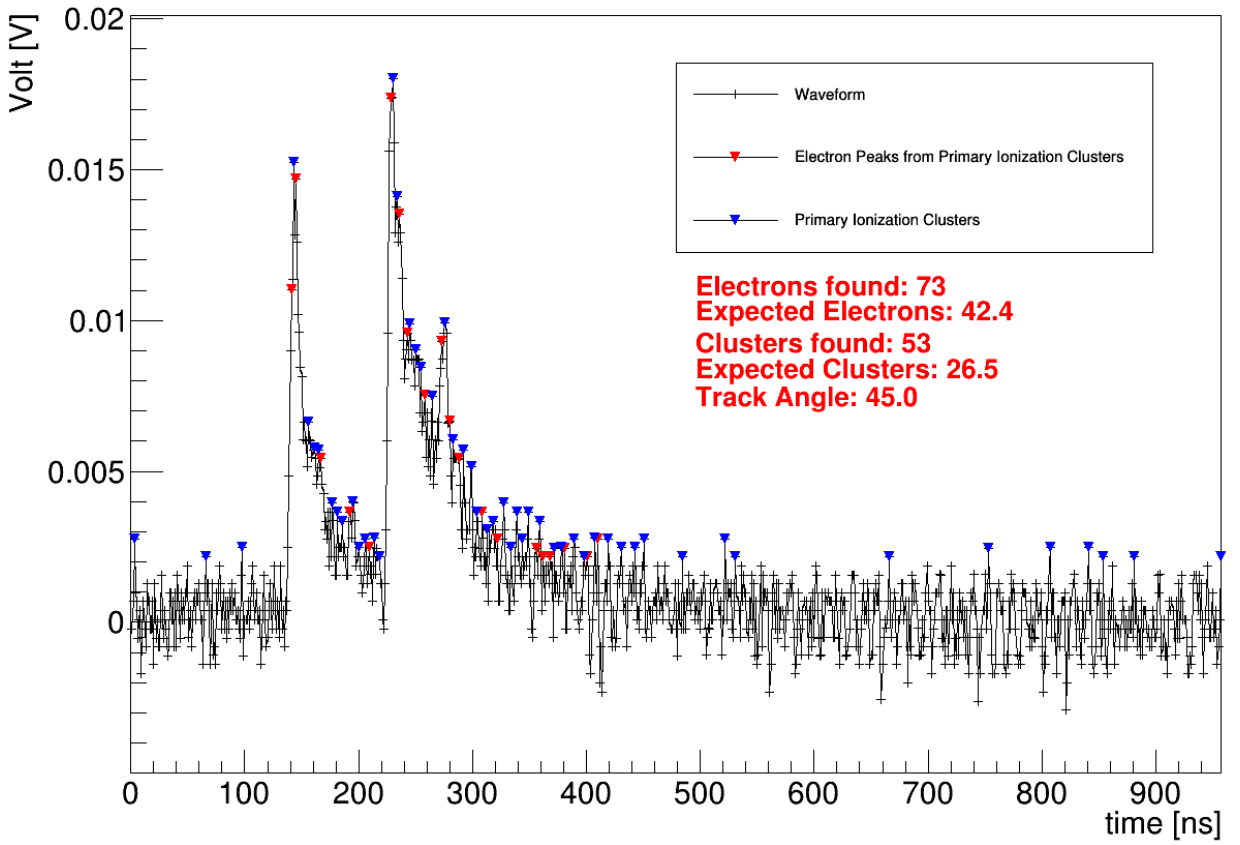
Results using the current WP

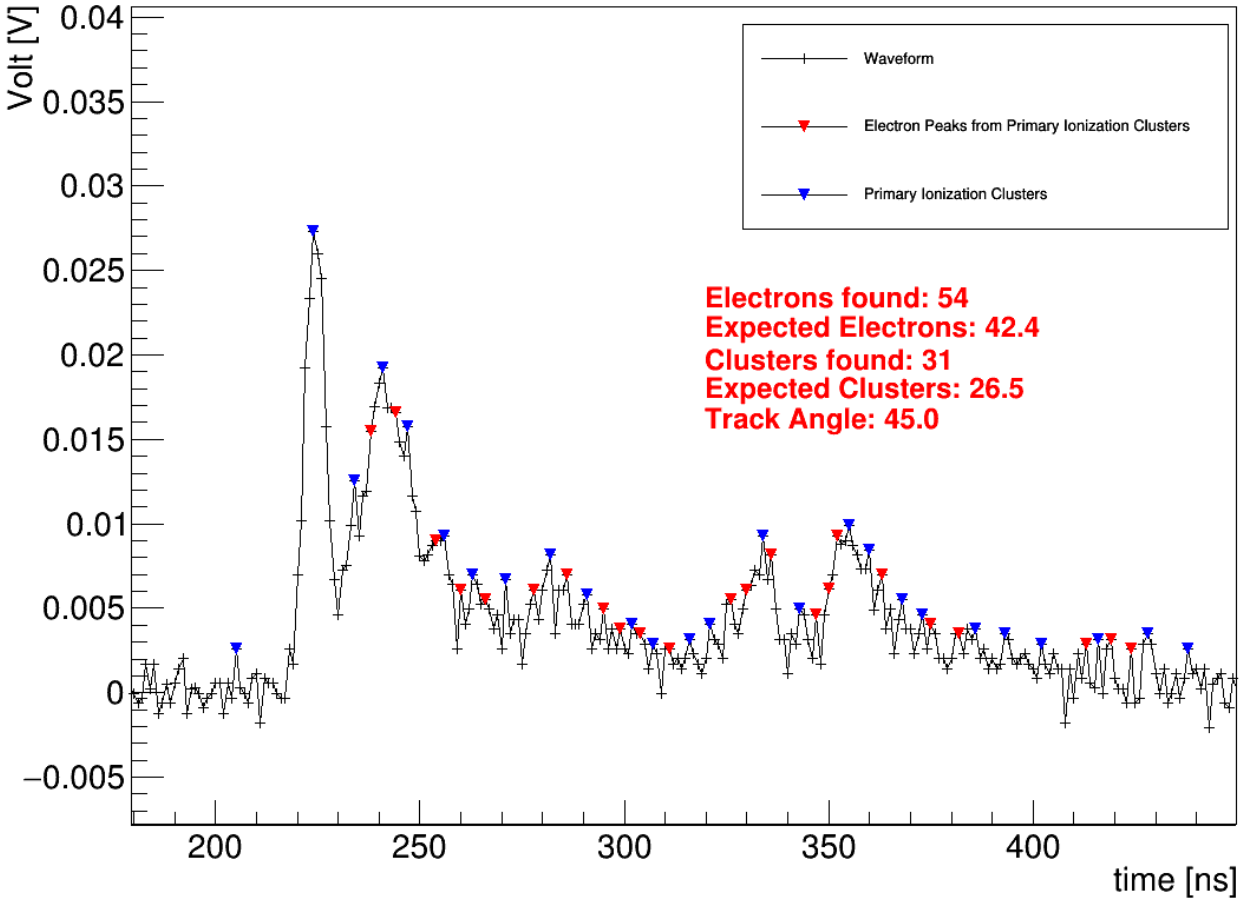
[run number]	[first event]	[last event]	[sampling rate]	**[Bsl]**	[cut on amplitude]	[1st der.]	**[2nd der.]**	[Bsln time]	[n bins]	[clusterization]
4	0	-100	1.0	**2.5**	0	0.5	**0.05**	25.0	1024	0.24

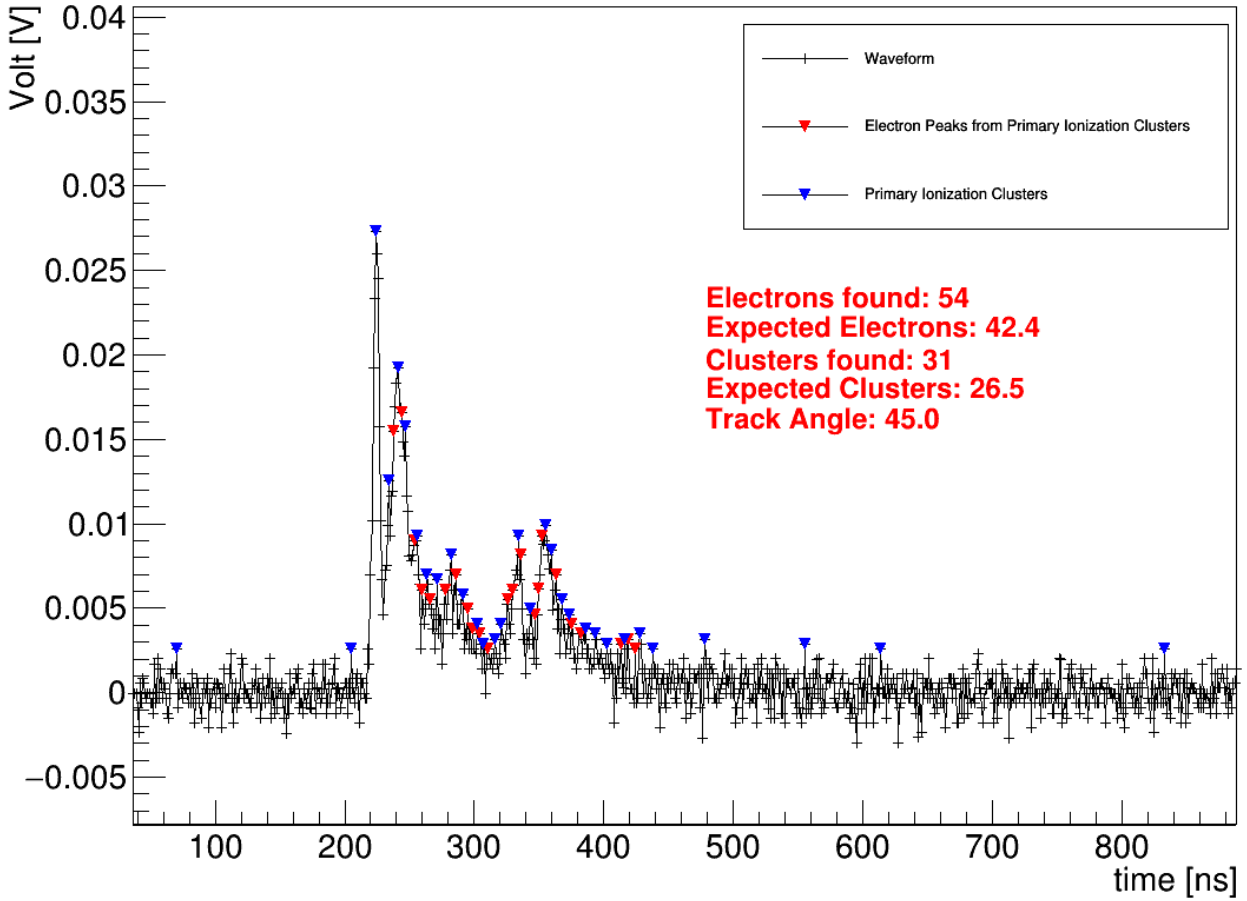

Volt [V]
0.05
0.04
0.03
0.02
0.01
0
50
100
150
200
250
300
350
400
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 29
Expected Clusters: 17.6
Track Angle: 45.0


Volt [V]
0.015
0.01
0.005
0
−0.005
200
250
300
350
400
450
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 29
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
0.02
0.015
0.01
0.005
0
100
150
200
250
300
350
400
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 73
Expected Electrons: 42.4
Clusters found: 53
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
0.02
0.015
0.01
0.005
0
0
100
200
300
400
500
600
700
800
900
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 73
Expected Electrons: 42.4
Clusters found: 53
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
−0.005
200
250
300
350
400
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 54
Expected Electrons: 42.4
Clusters found: 31
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
−0.005
100
200
300
400
500
600
700
800
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 54
Expected Electrons: 42.4
Clusters found: 31
Expected Clusters: 26.5
Track Angle: 45.0

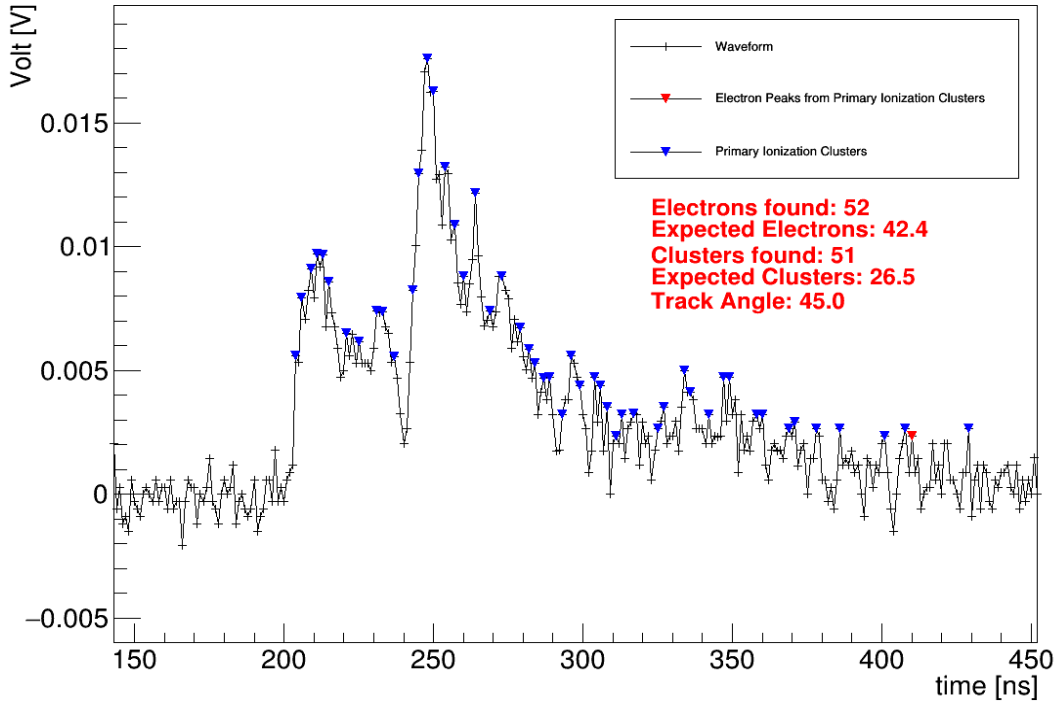
scan on the cut on Clusterization

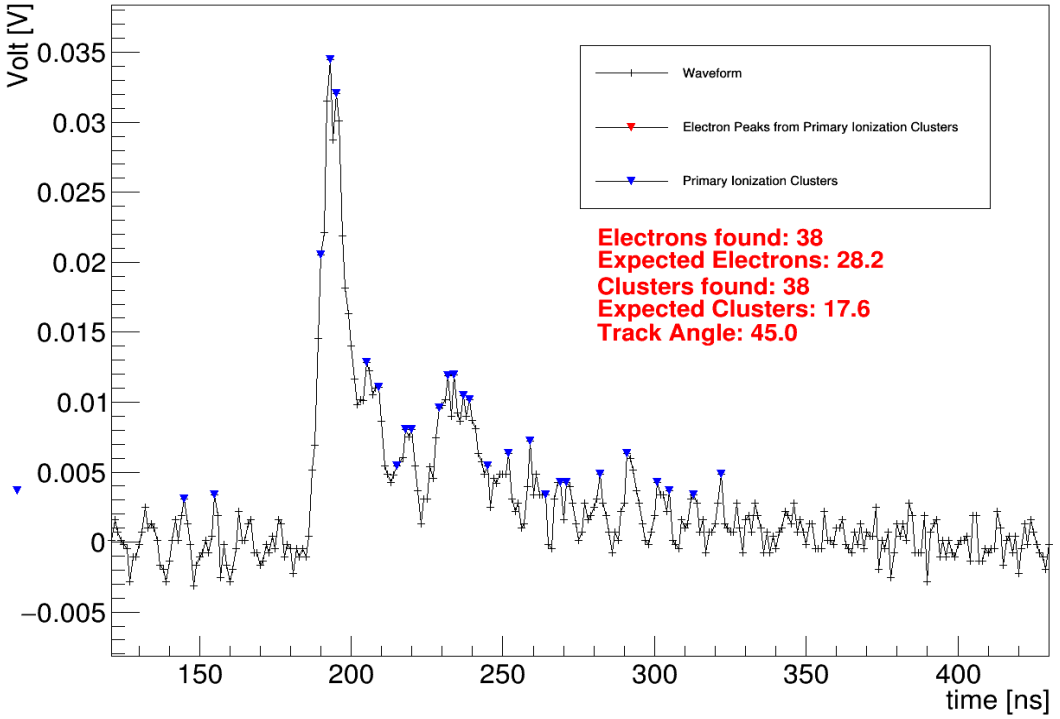
[run number]	[first event]	[last event]	[sampling rate]	**[Bsl]**	[cut on amplitude]	[1st der.]	**[2nd der.]**	[Bsln time]	[n bins]	[clusterization]
4	0	-100	1.0	**2.5**	0	0.5	**0.05**	25.0	1024	?

Very close clusters
within the same peak

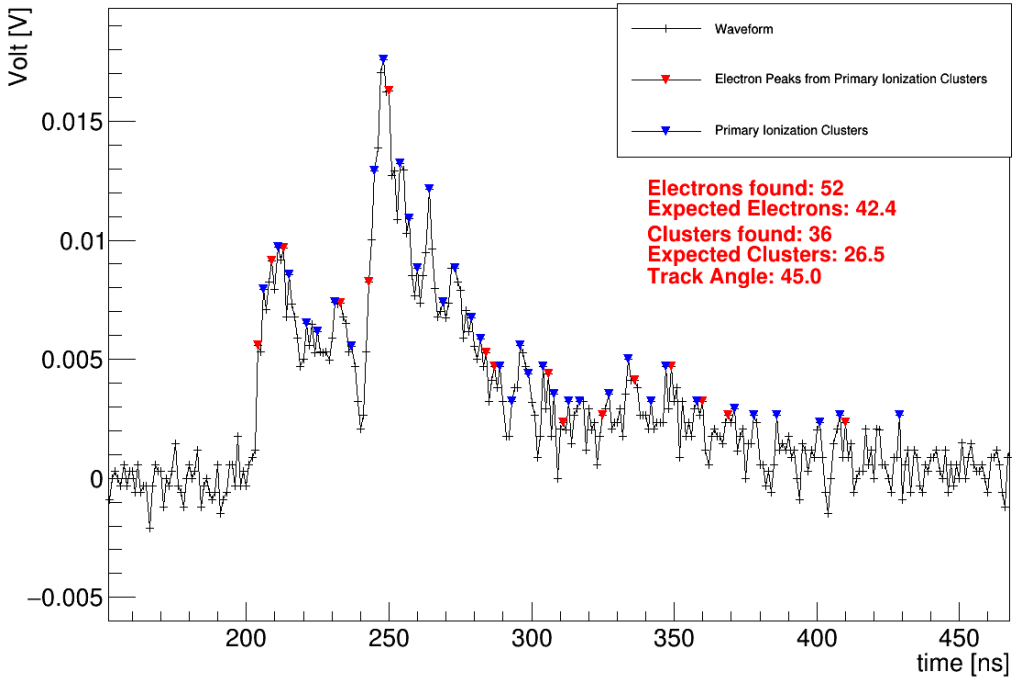
Applied to example run no. 4
(Gas mix. 90/10, angle 45, momentum 10 GeV) collected by DRS16

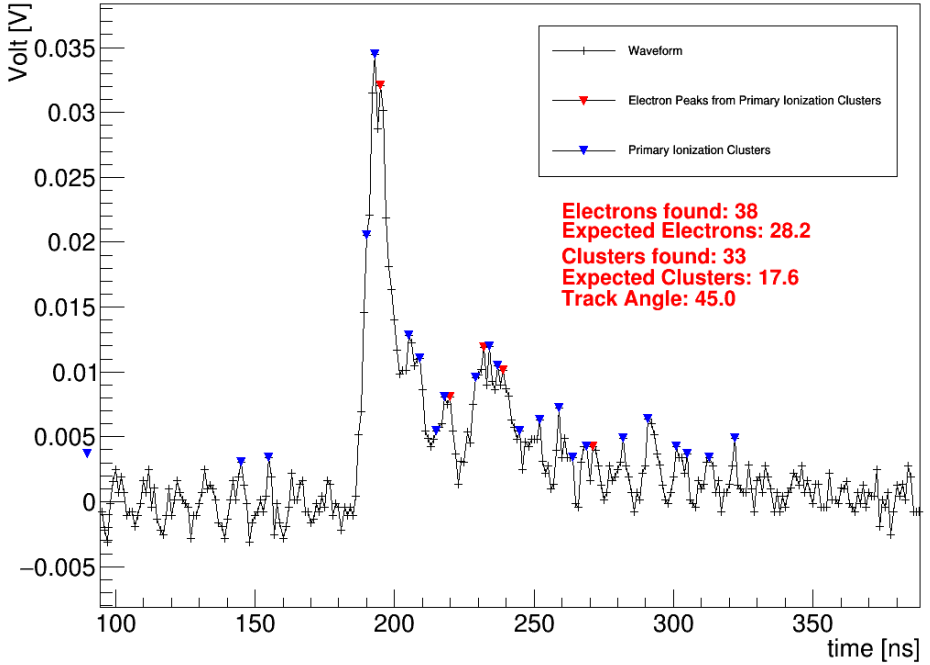
0.1


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 51
Expected Clusters: 26.5
Track Angle: 45.0

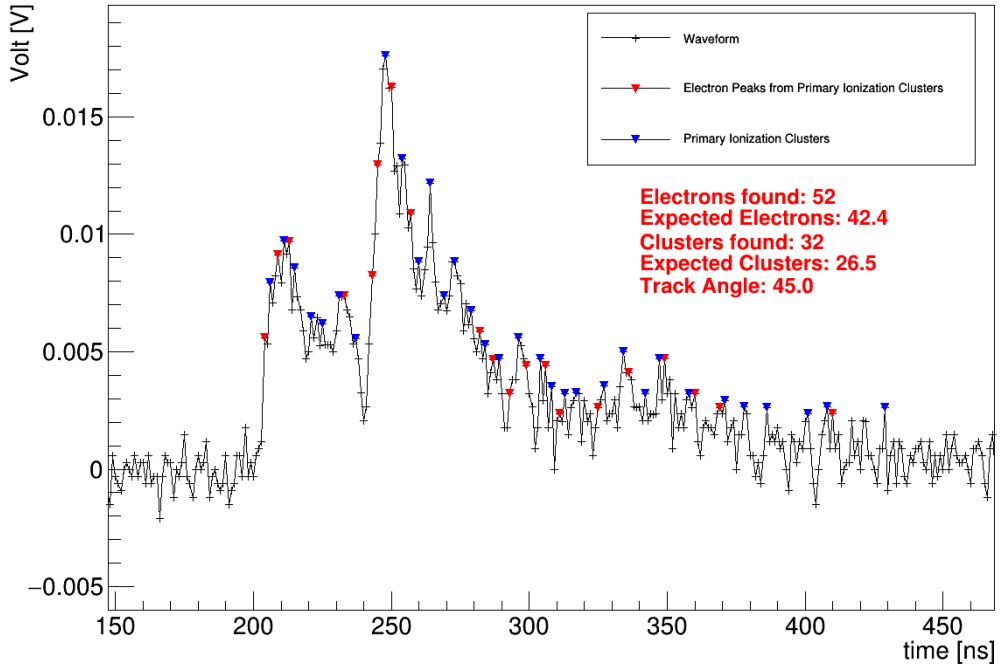

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 38
Expected Clusters: 17.6
Track Angle: 45.0

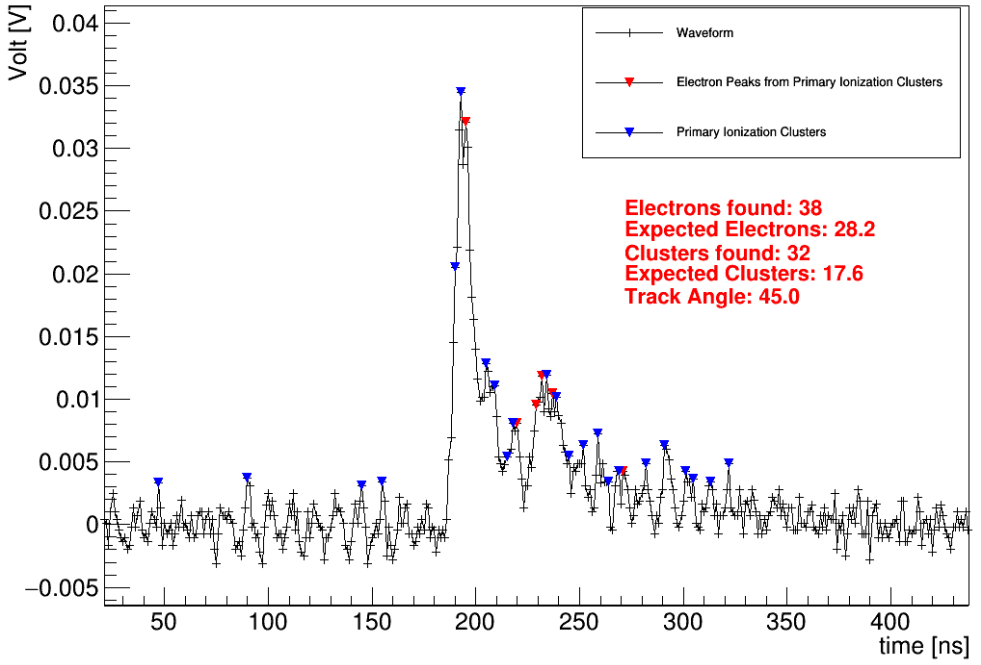
0.15


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 36
Expected Clusters: 26.5
Track Angle: 45.0

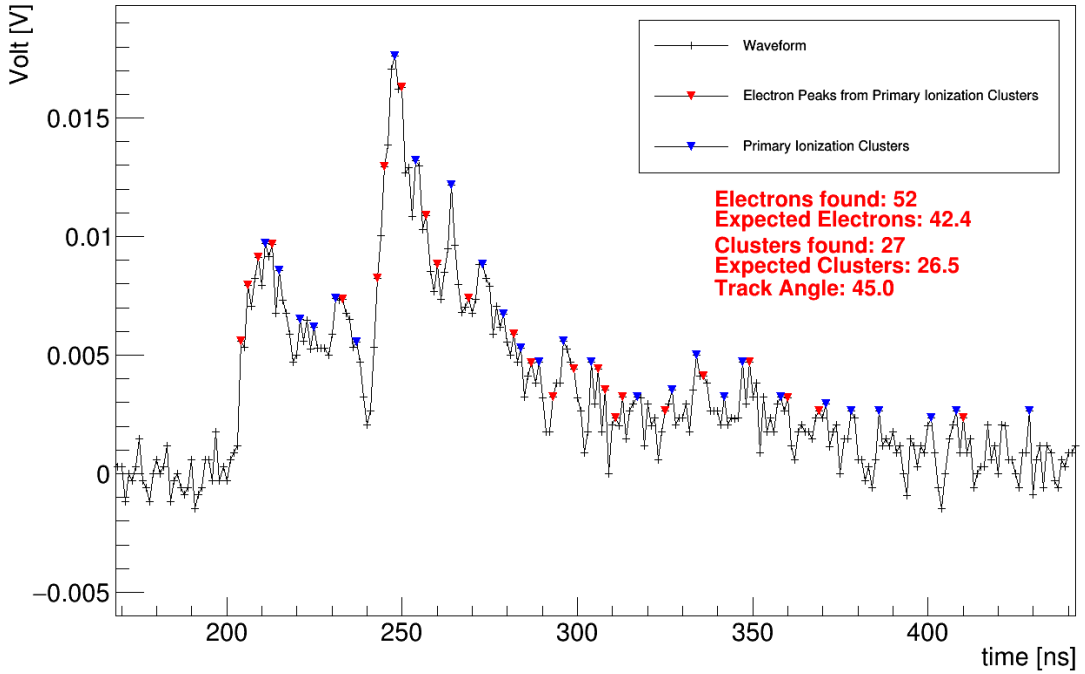

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 33
Expected Clusters: 17.6
Track Angle: 45.0

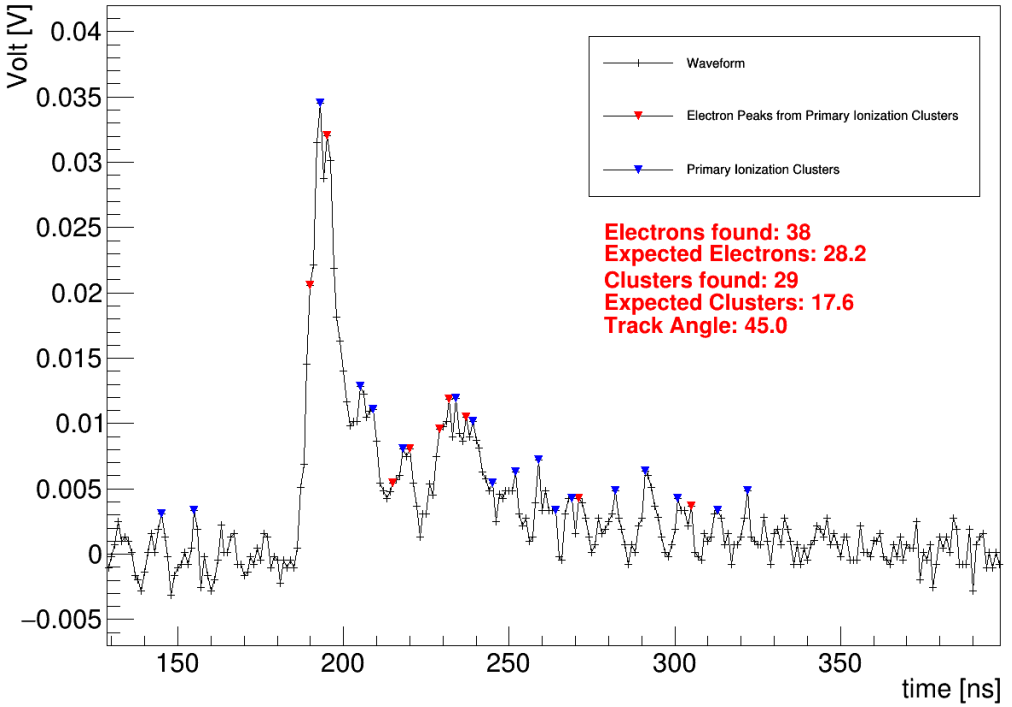
0.2


Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 32
Expected Clusters: 26.5
Track Angle: 45.0
Volt [V]
time [ns]

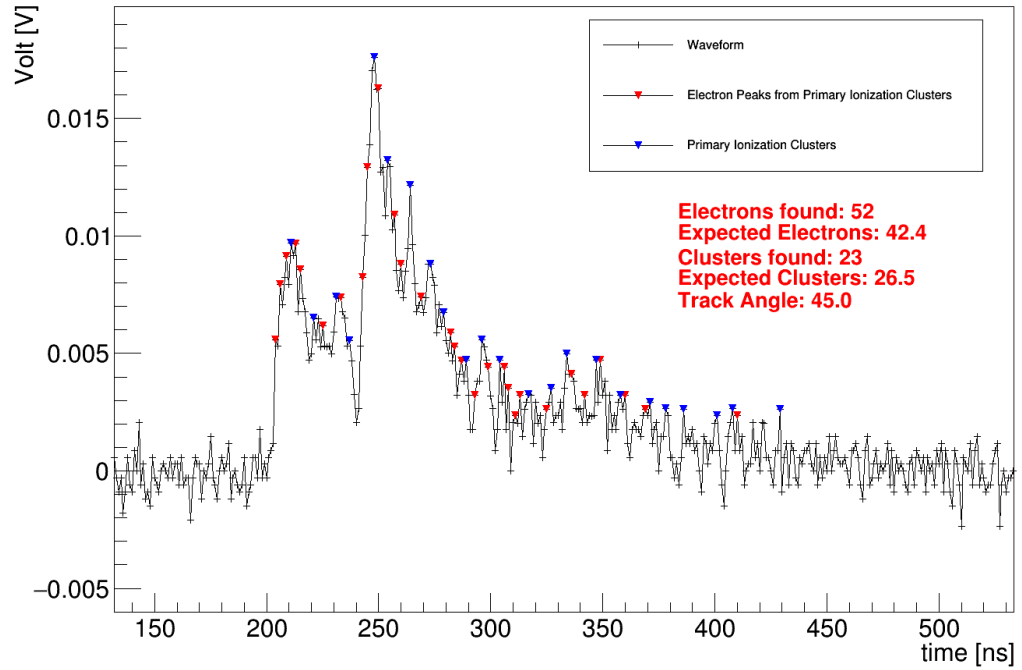

Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 32
Expected Clusters: 17.6
Track Angle: 45.0
Volt [V]
time [ns]

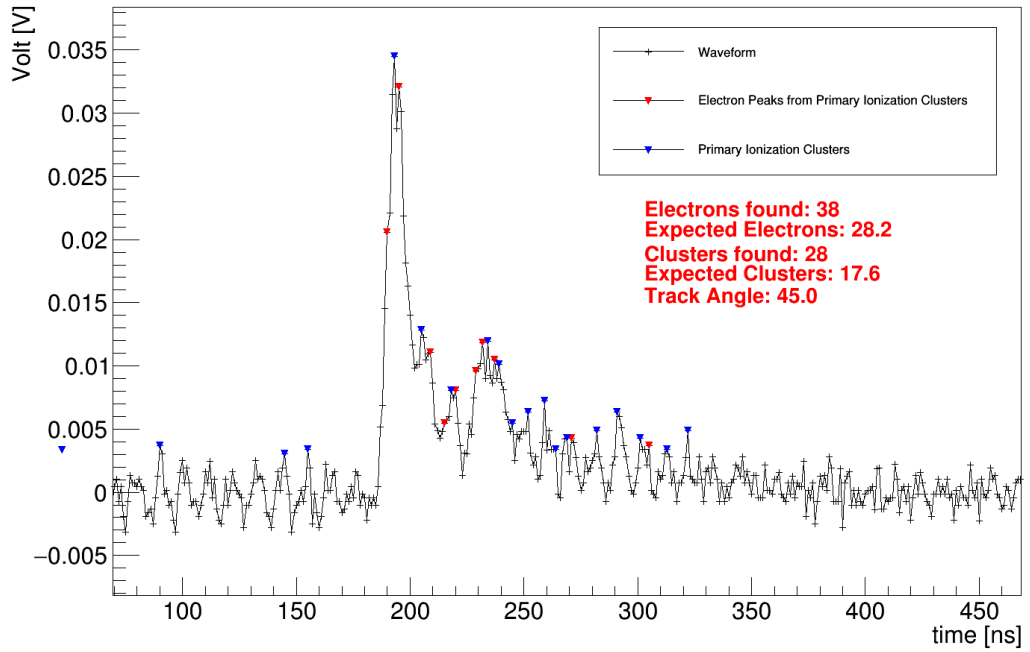
0.25


Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 27
Expected Clusters: 26.5
Track Angle: 45.0
Volt [V]
time [ns]

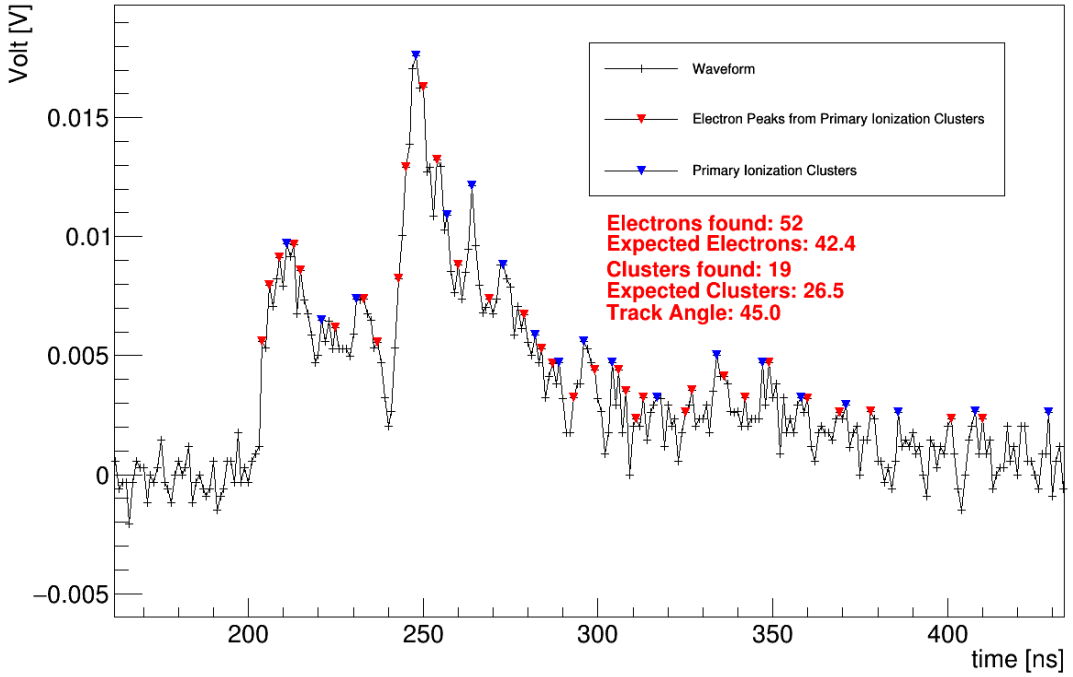

Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 29
Expected Clusters: 17.6
Track Angle: 45.0
Volt [V]
time [ns]

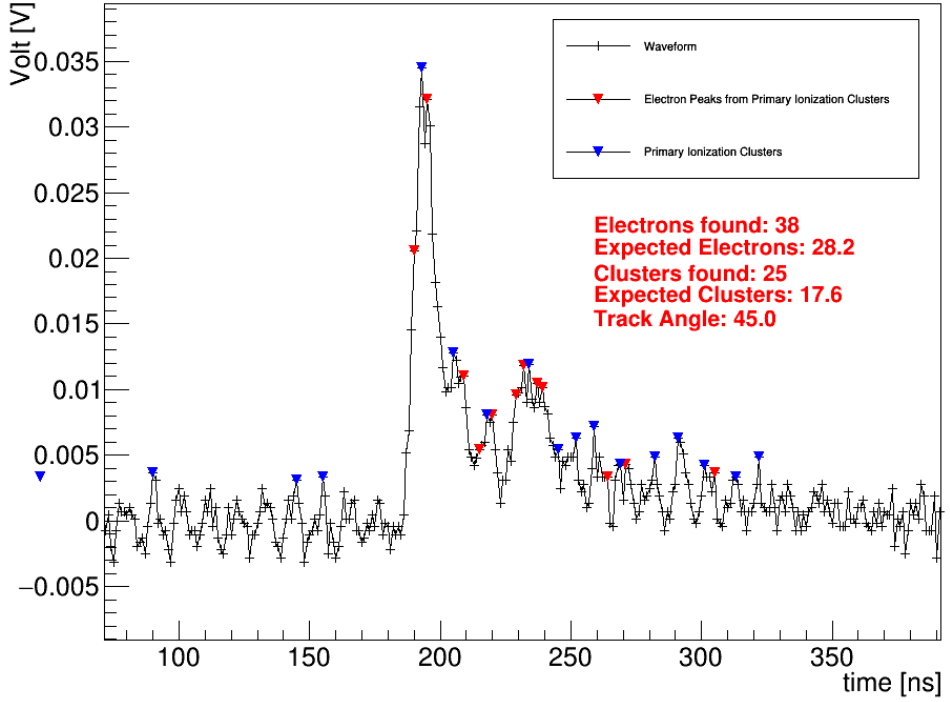
0.3


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 23
Expected Clusters: 26.5
Track Angle: 45.0

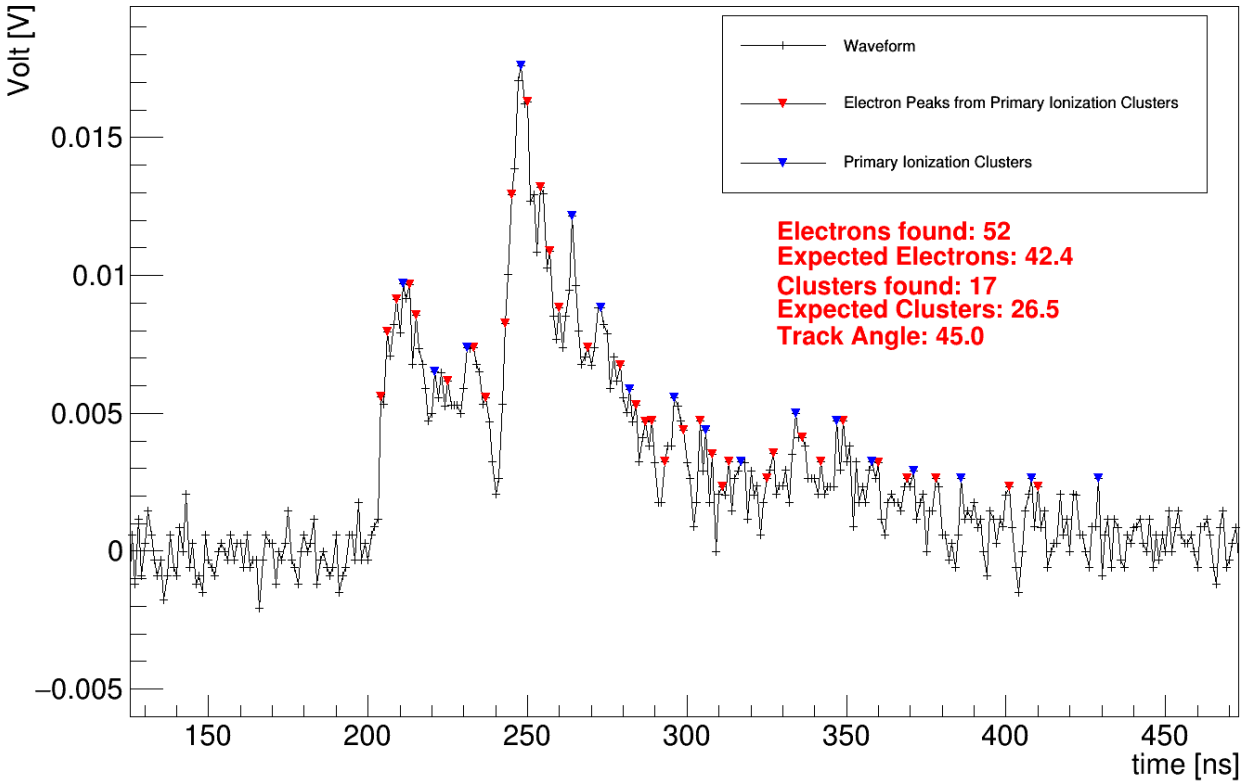

Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 28
Expected Clusters: 17.6
Track Angle: 45.0

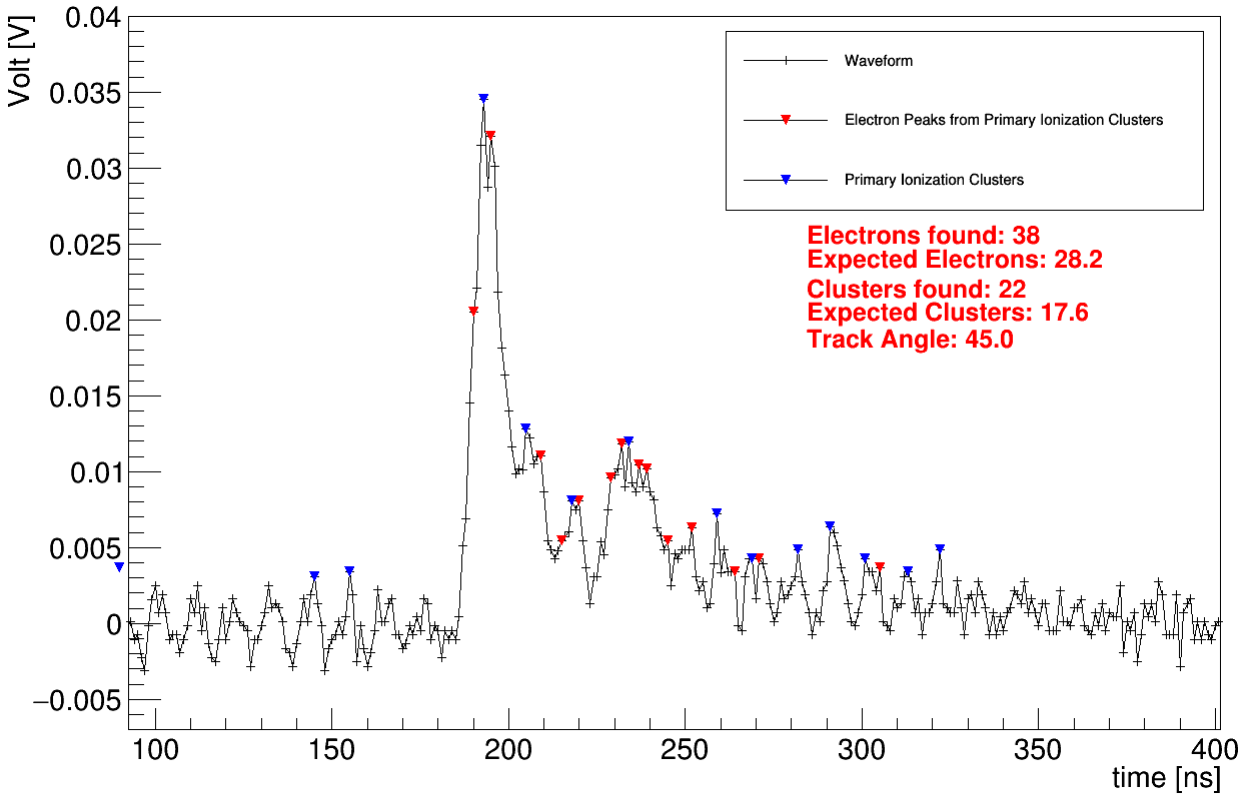
0.4


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 19
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 25
Expected Clusters: 17.6
Track Angle: 45.0

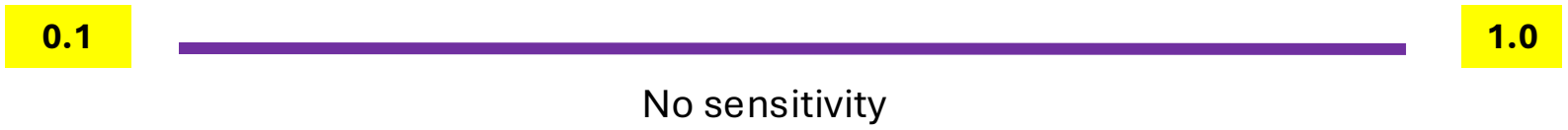
0.5


Volt [V]
0.015
0.01
0.005
0
−0.005
150
200
250
300
350
400
450
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 17
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
−0.005
100
150
200
250
300
350
400
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 22
Expected Clusters: 17.6
Track Angle: 45.0

scan on the cut on the 1st der.

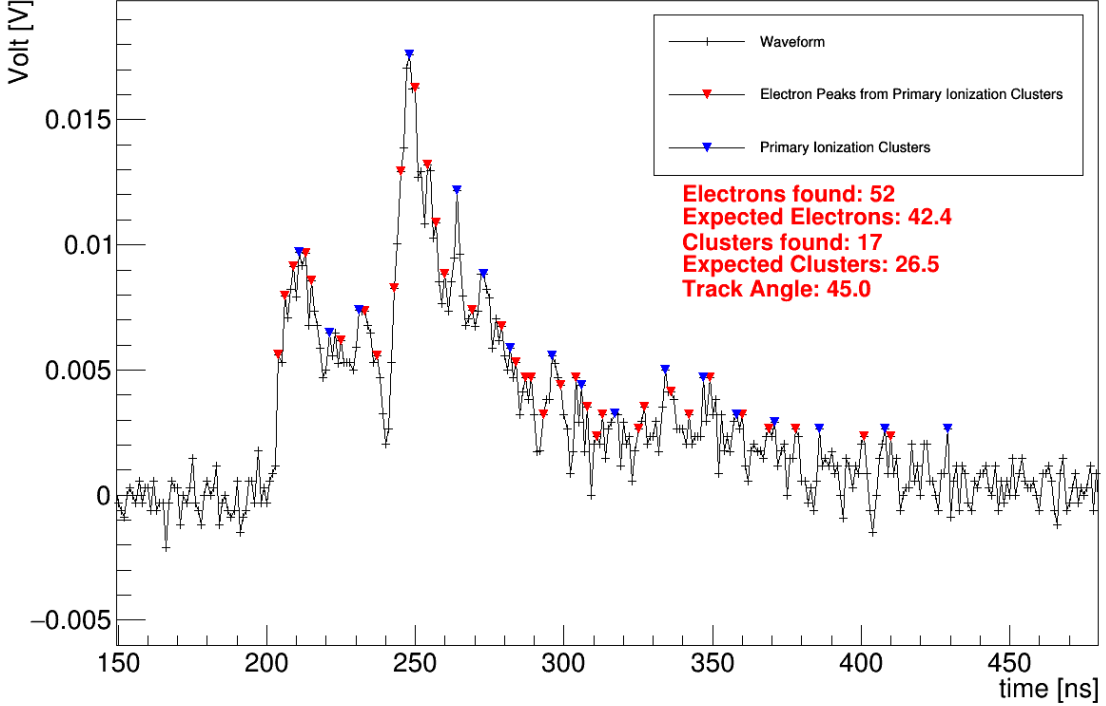
[run number]	[first event]	[last event]	[sampling rate]	**[Bsl]**	[cut on amplitude]	[1st der.]	**[2nd der.]**	[Bsln time]	[n bins]	**[clusterization]**
4	0	-100	1.0	**2.5**	0	0.5	**0.05**	25.0	1024	**0.5**

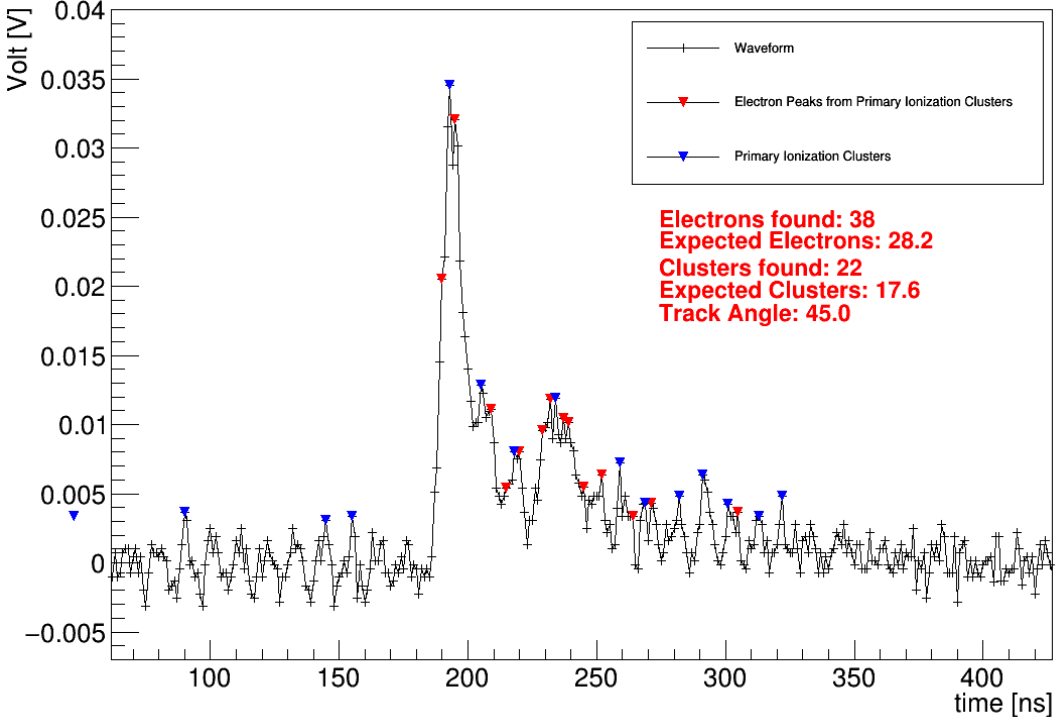


No sensitivity

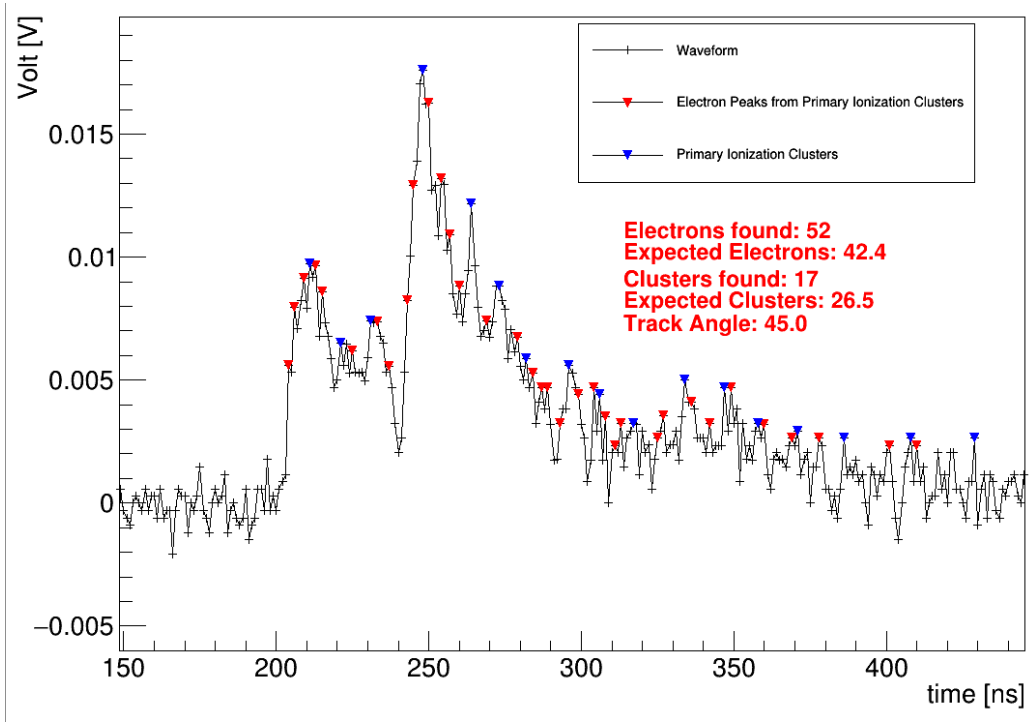
Applied to example run no. 4
(Gas mix. 90/10, angle 45, momentum 10 GeV) collected by DRS16

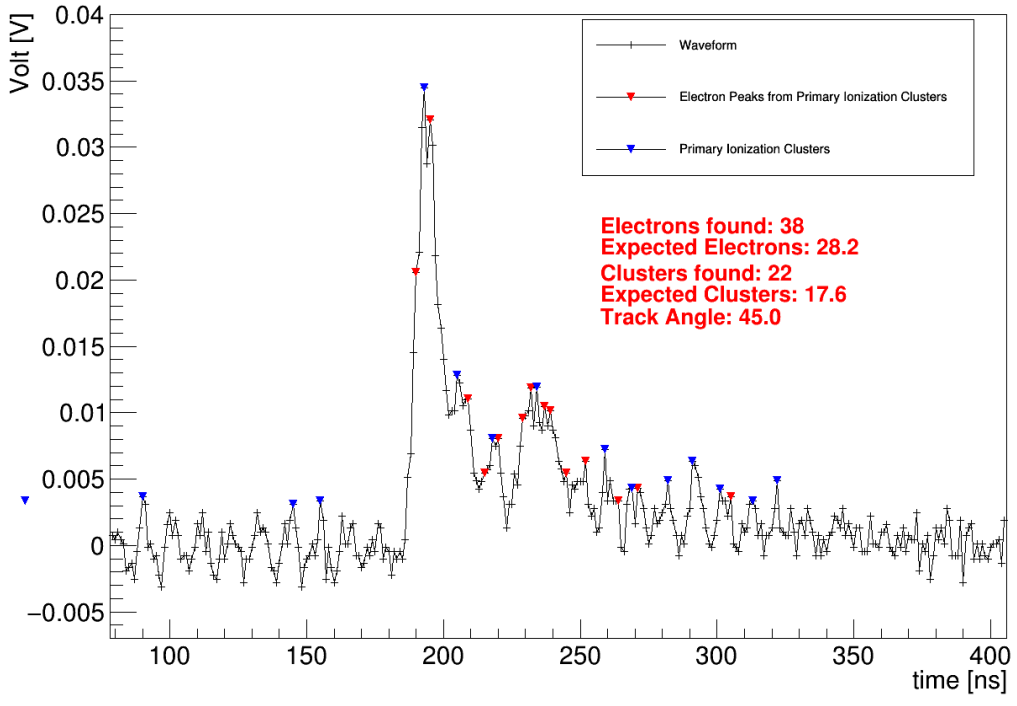
0.1


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 17
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 22
Expected Clusters: 17.6
Track Angle: 45.0

1.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 52
Expected Electrons: 42.4
Clusters found: 17
Expected Clusters: 26.5
Track Angle: 45.0


Volt [V]
time [ns]
Waveform
Electron Peaks from Primary Ionization Clusters
Primary Ionization Clusters
Electrons found: 38
Expected Electrons: 28.2
Clusters found: 22
Expected Clusters: 17.6
Track Angle: 45.0