GARFIELD++ & LTSpice simulation

30,12,2022

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Main questions

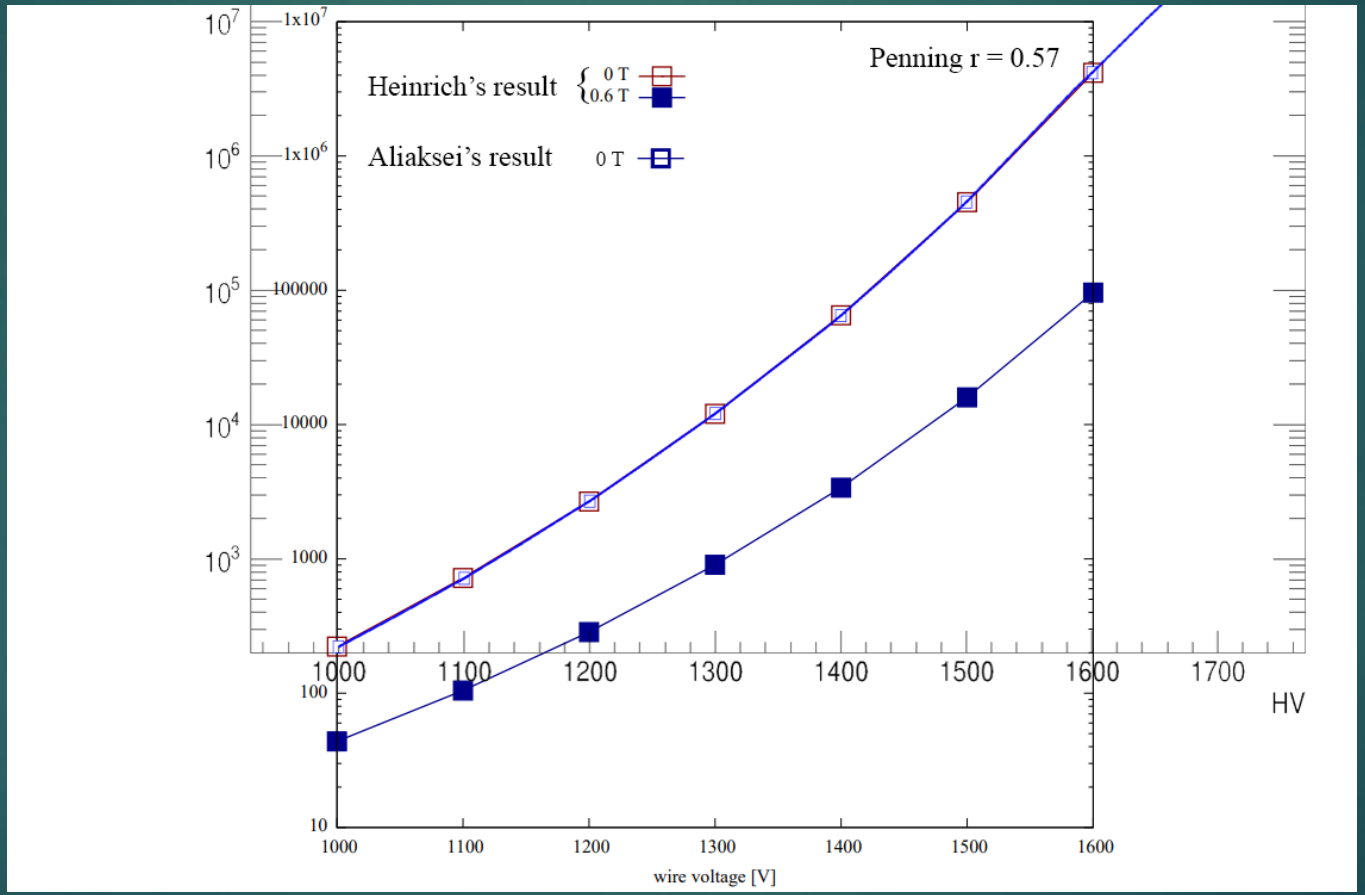
Issue			Status	Description
01	Gas Gain	Exact value	Not fixed	**17.12.2022** After discussion with Garfield & Garfield++ devs. Heinrich sent a source C++ file with RKF Gas gain modeling. My results matched Heinrich's, but still the gas gain is different from ATLAS TRT. **23.12.2022** Incorrect gas gain plots for the RKF method **30.12.2022** Add plots from Garfield simulation. Choice between gas gain distribution.
		Shape of gas gain distribution	done	
02	Signal different between visualization and data output		Not fixed	**17.12.2022** Difference between signal amplitude in inner class and output data
03	~~Difference between signal output after LTSpice simulation~~		~~in progress~~	~~**17.12.2022** The difference between the amplitudes of Aliaksei (1.5 mm point) and Assel (1 & 2 mm points), after LTSpice processing. Additional point generated by me (2 mm) -> the results matched with Assel.~~
~~04~~	~~Comparing drift path/time distributions~~		~~almost completed~~	~~**17.12.2022** Answer the question why the sigma of time is practically independent of the presence of a magnetic field. Need to update for 1.5 T magnetic field.~~

Main questions

Issue		Status	Description
05	Final TDR plots update	done	**17.12.2022** Update pictures for the arrival time of the first and second clusters at the anode. GARFIELD & GARFIELD++. **23.12.2022** Updates plots according to Katerina's edits. **30.12.2022** Save to PDF file.
06	Strange behavior of time distribution	In progress	**30.12.2022** For the DUNE setup. To achieve the maximum temporal resolution, a simulation was carried out for different pressures (1, 2, 3 atm) at the same voltage 1750 V. There is fix Mean() of gas gain ~4.5 * 10^4.

01 Gas gain problem
with exact value

Cross check with Heinrich's results



01 Gas gain problem
with exact value

Cross check with ATLAS TRT from TDR

UPDATE

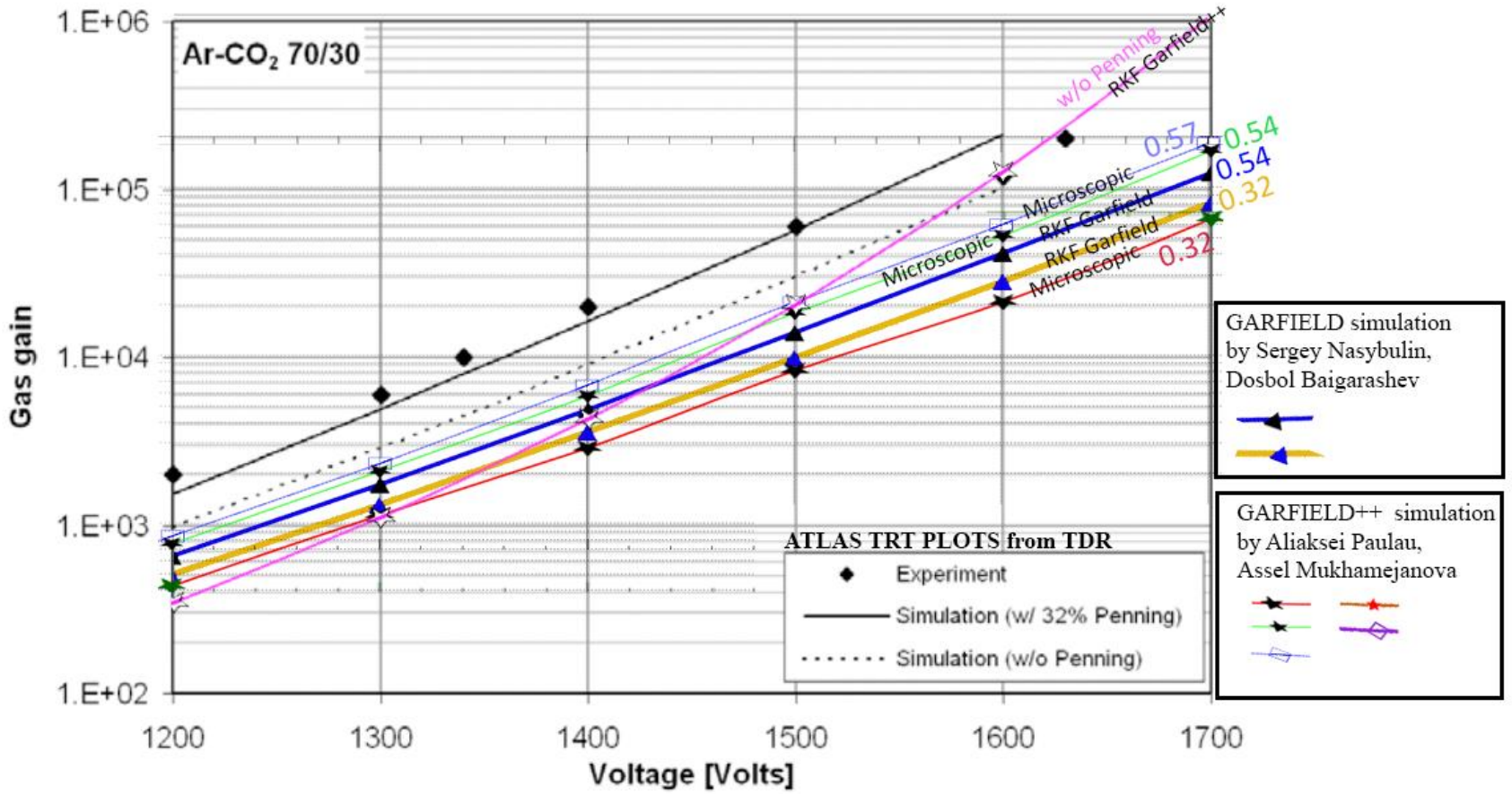
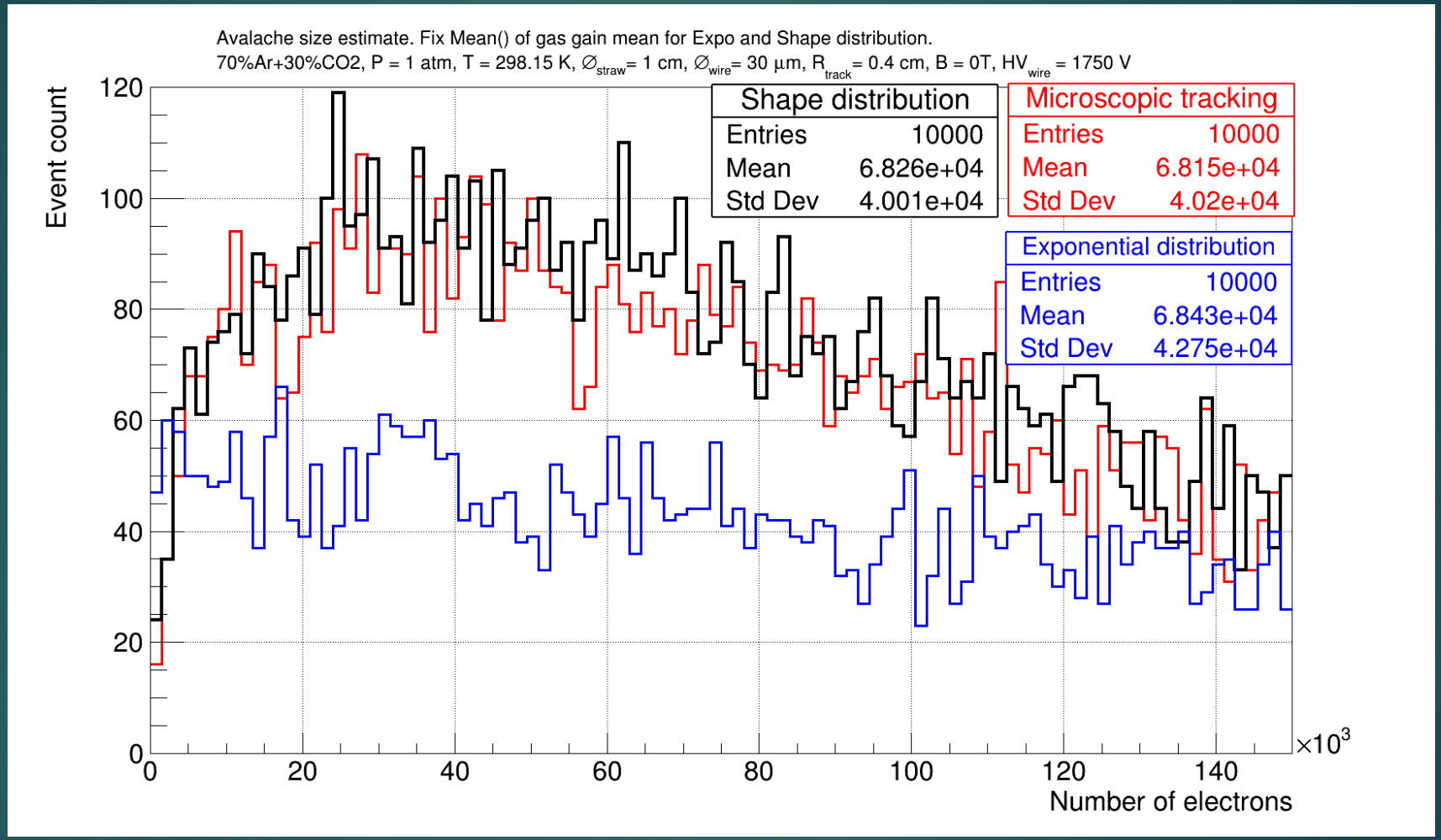


Figure 4-21 Gas gain in Ar/CO_2 70/30 (experimental data and simulation).

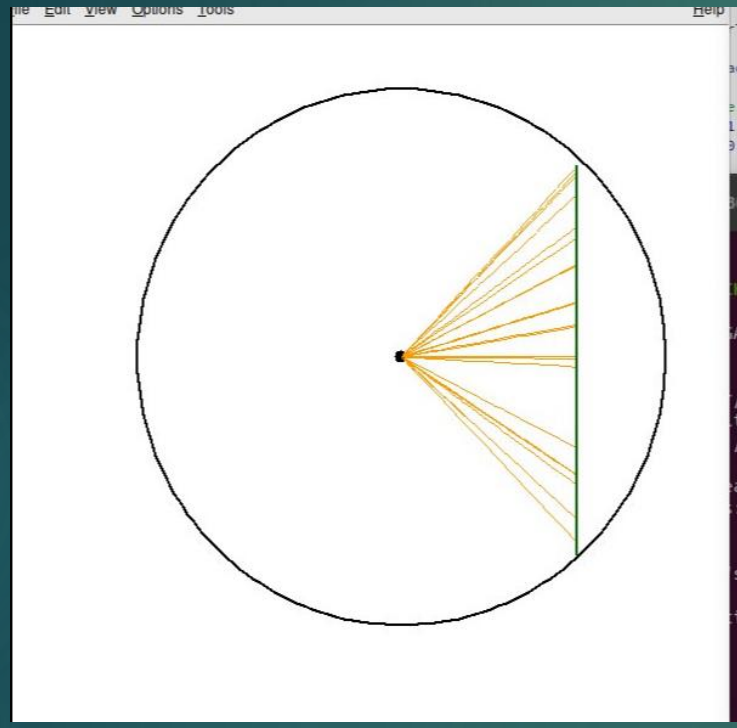
01 Gas gain
shape of distribution

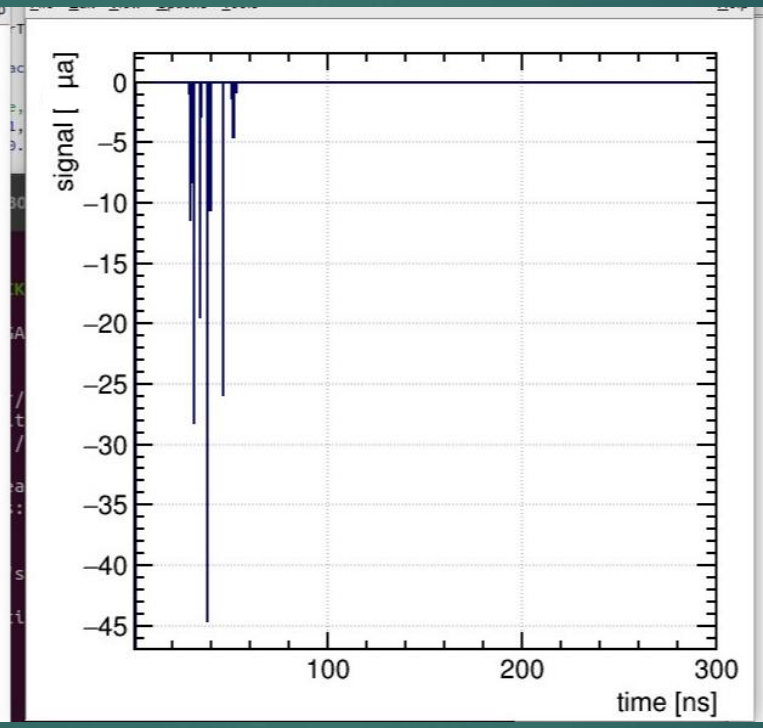
Choice between gas gain distribution.



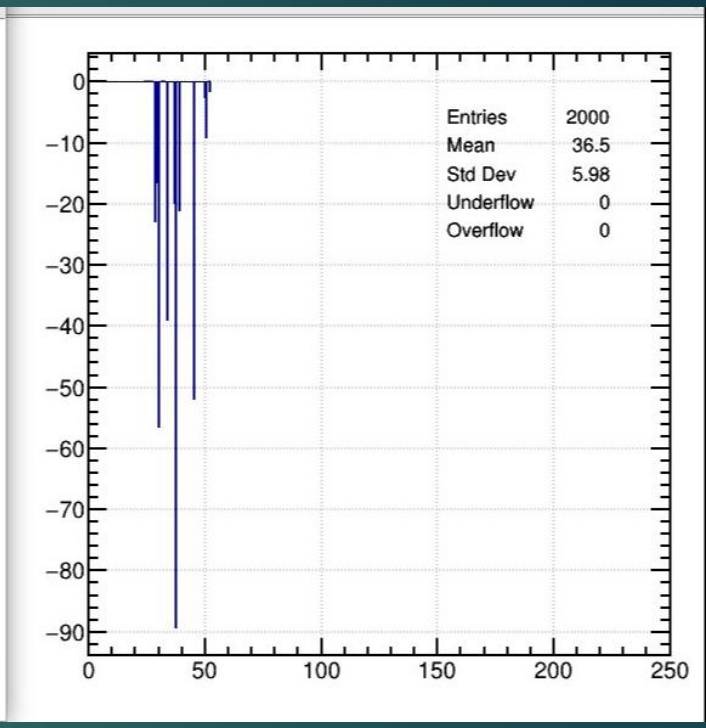
Because the shape distribution agrees well with the Microscopic distribution .
It is recommended to use a Shape distribution with a sigma = 0.5

02 Signal difference between visualization and data output





Visualization data from GARFIELD++

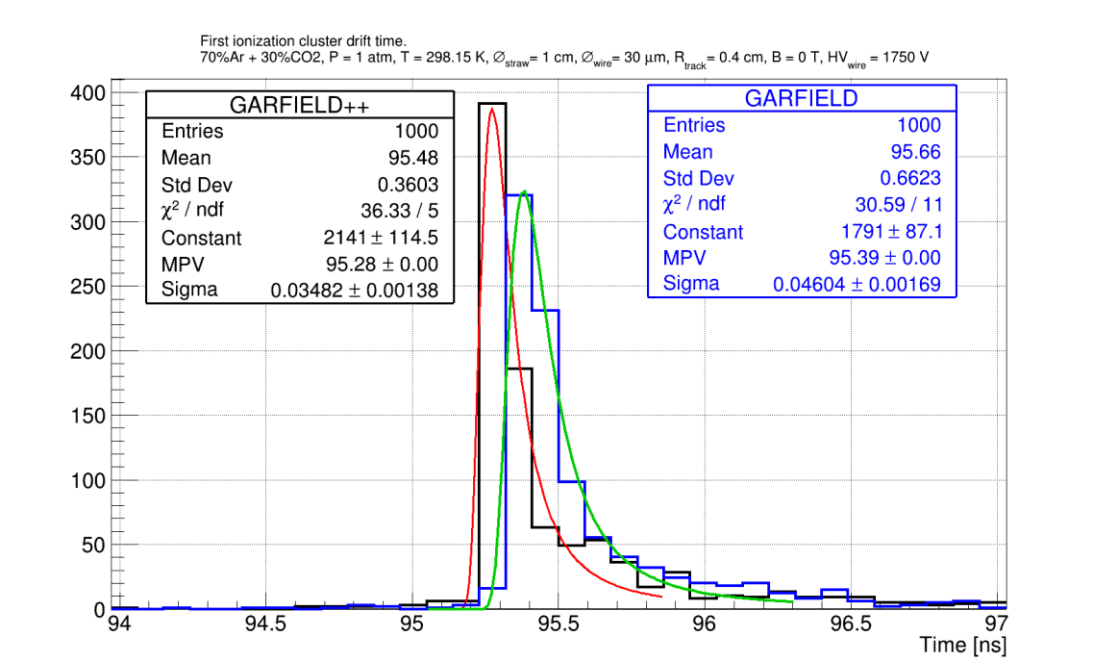


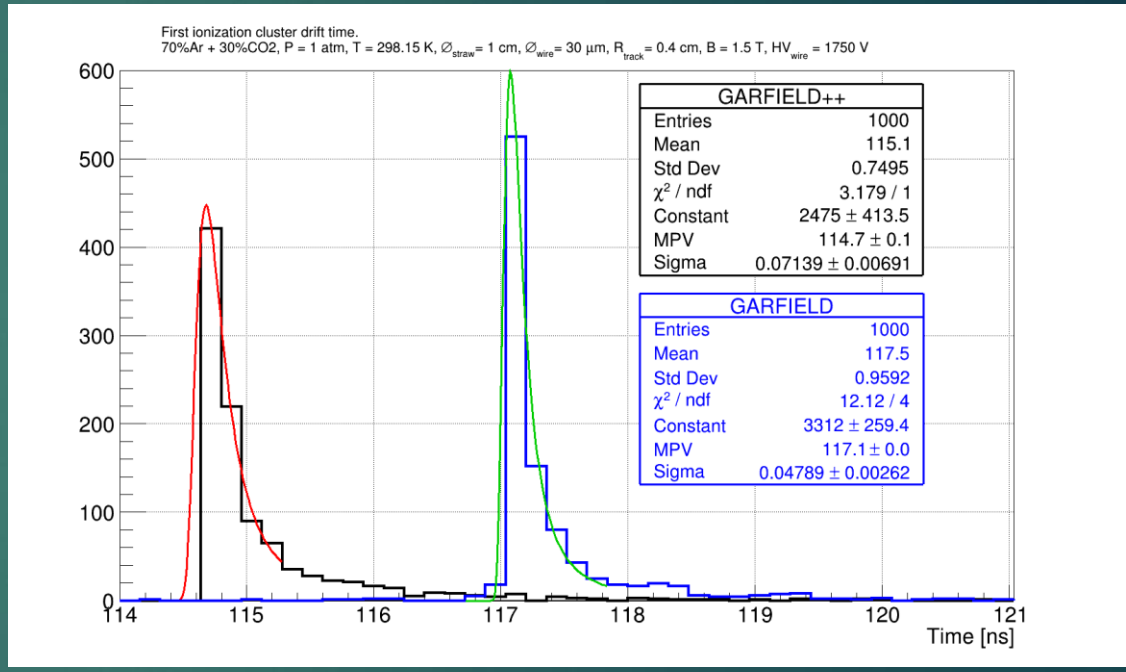
OUTPUT data from GARFIELD++

Not solved, need to think about it

TDR plots update

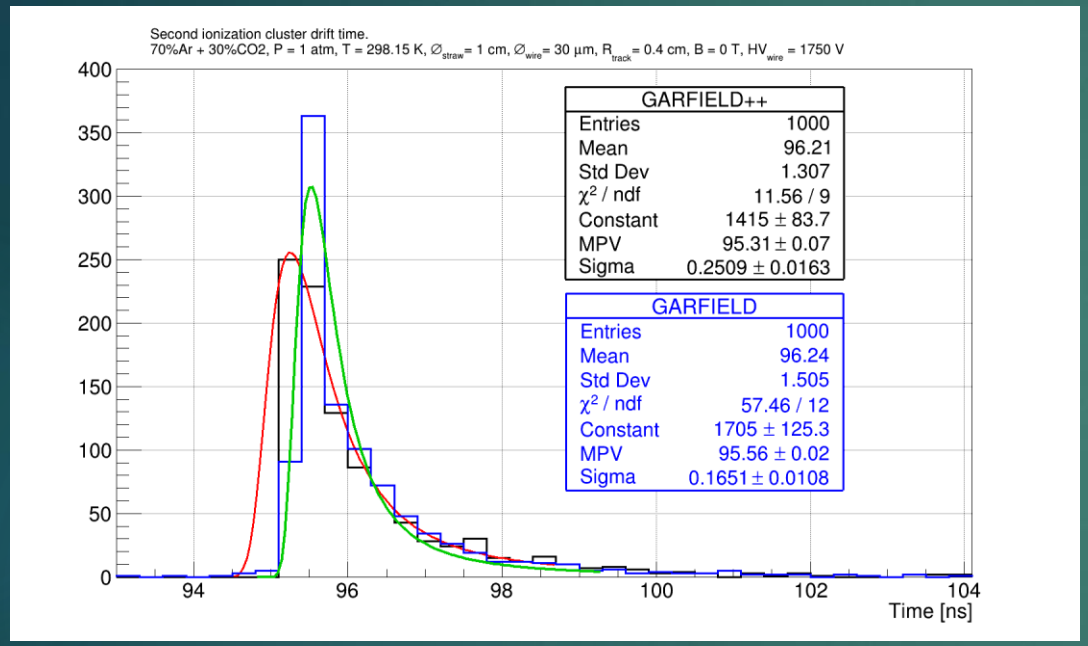
Final TDR plots

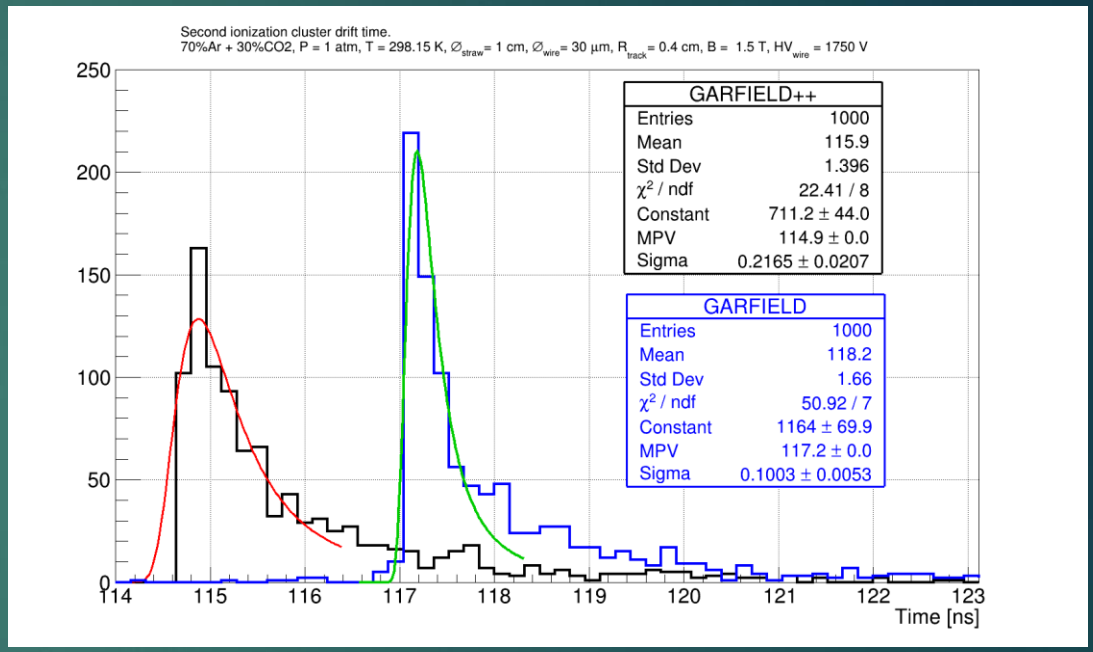




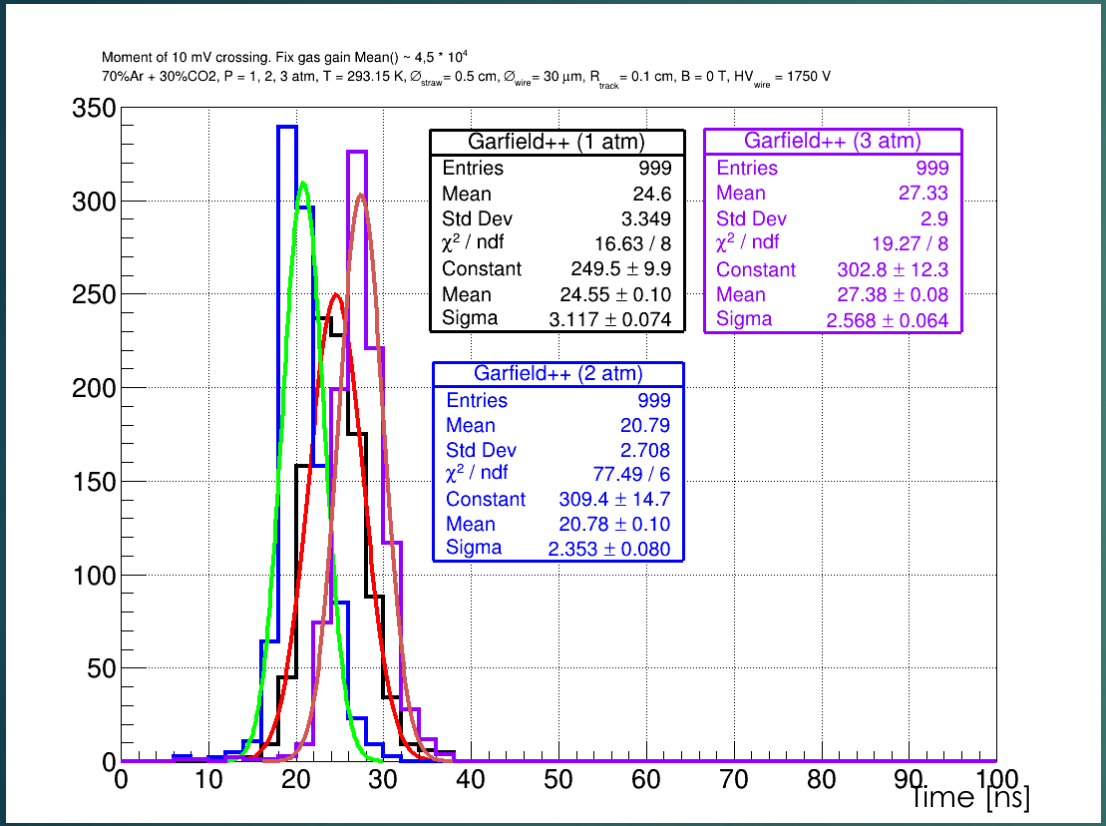
TDR plots update

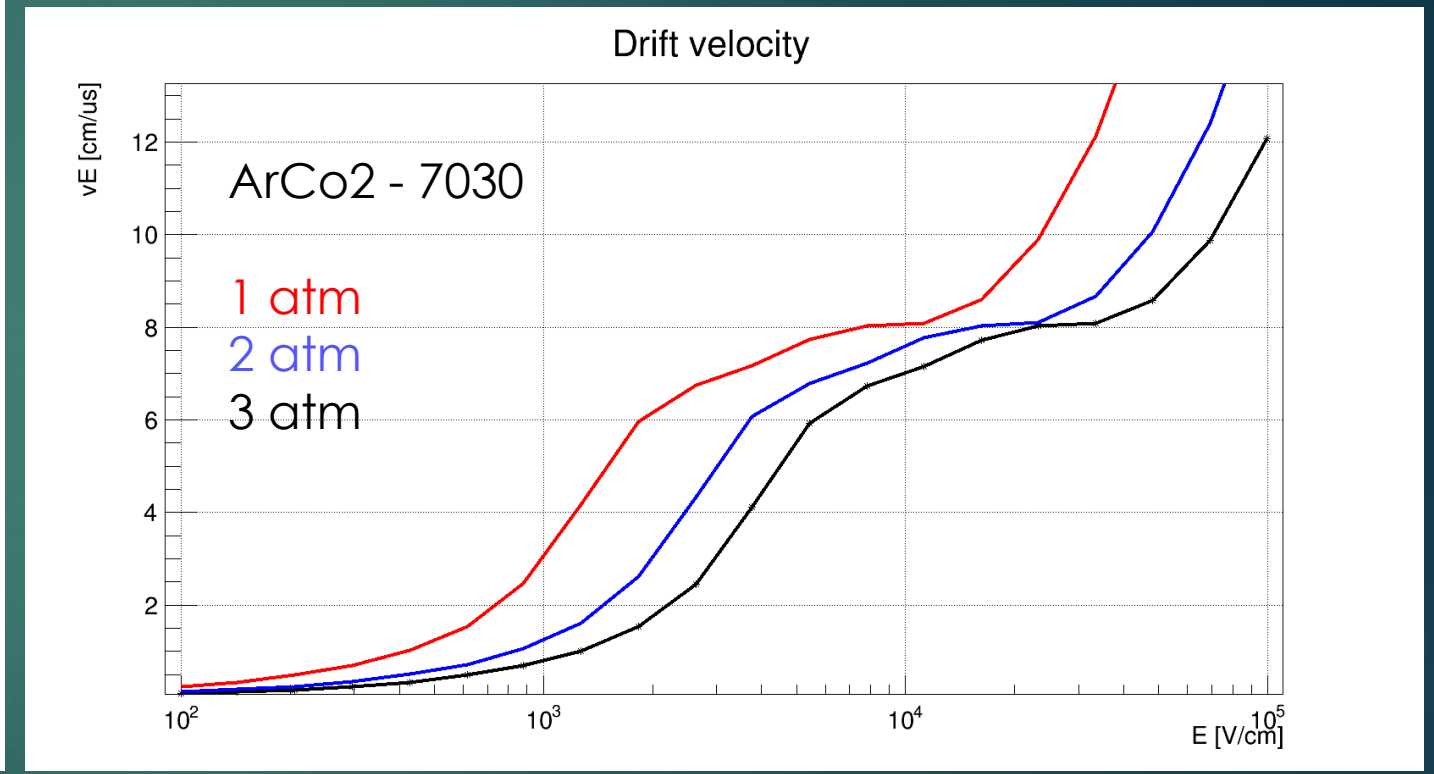
Final TDR plots





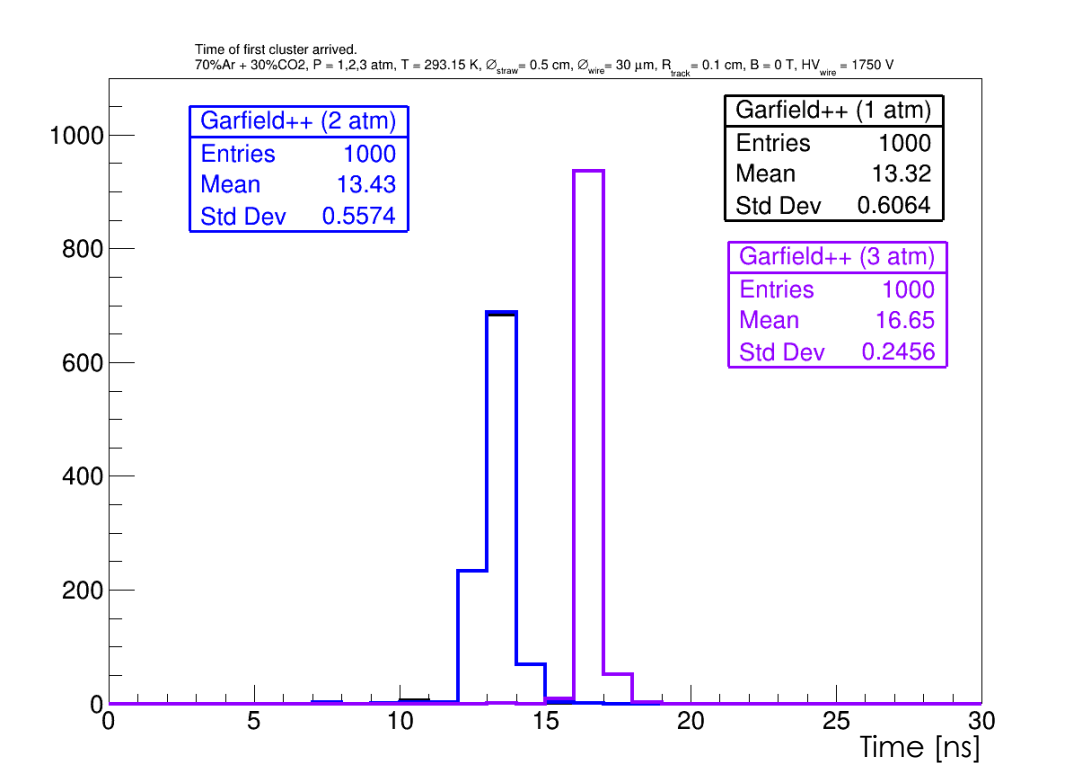
Strange behavior of time distribution

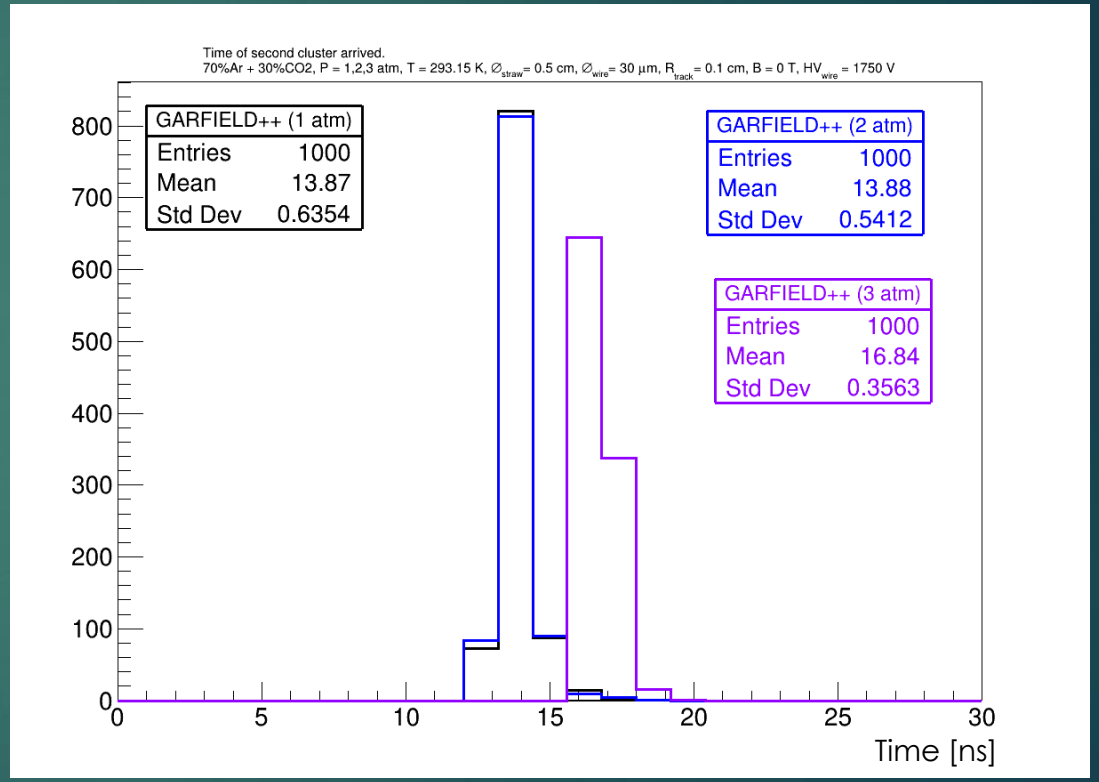




Strange behavior of time distribution

First & Second cluster arrived time



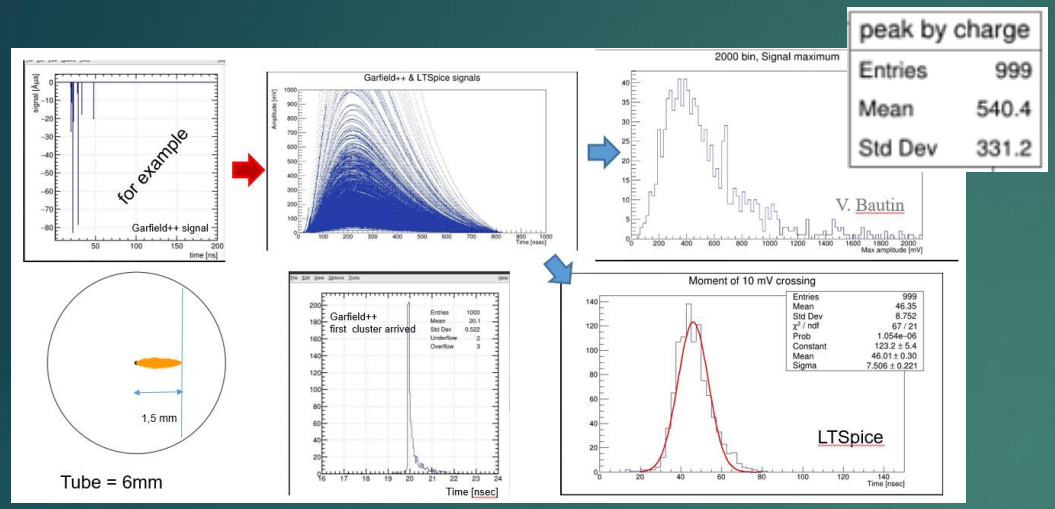


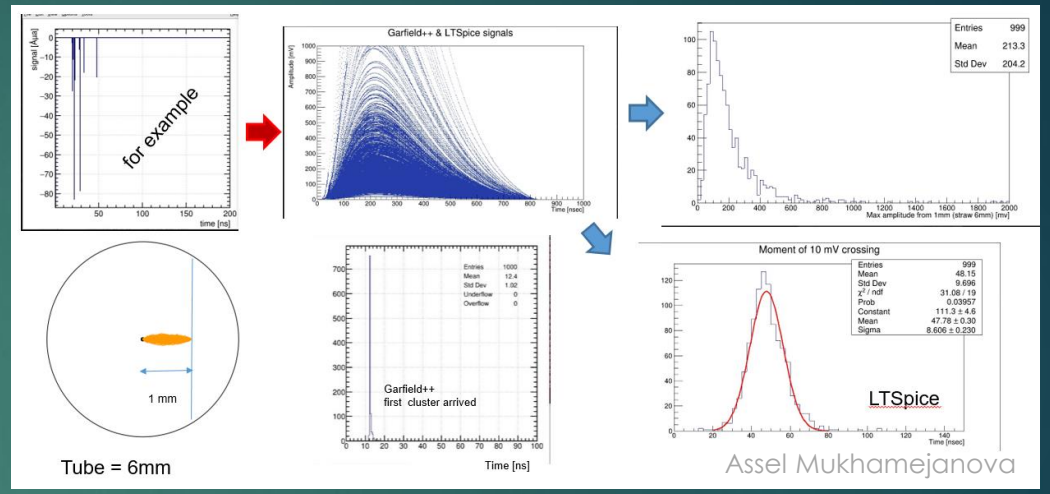
END

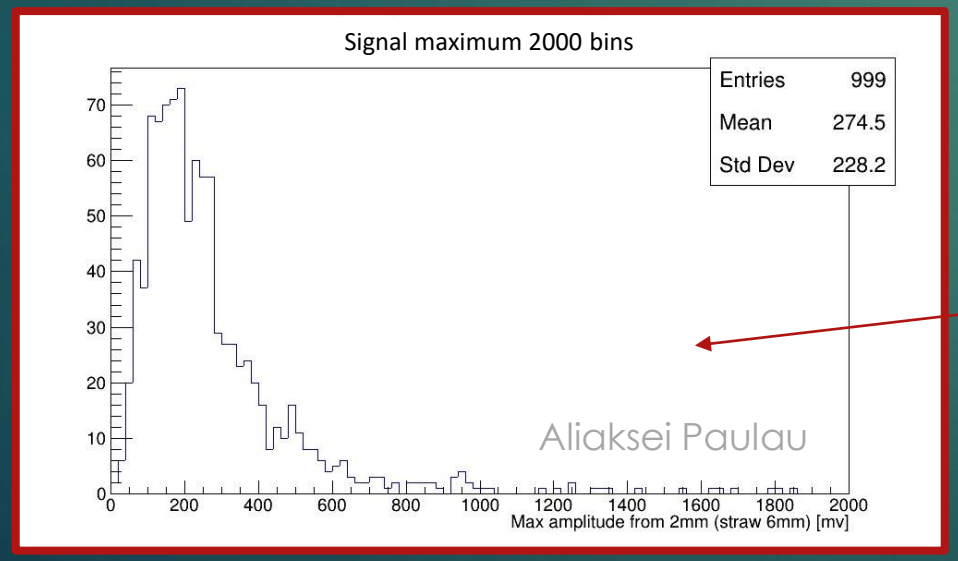
background

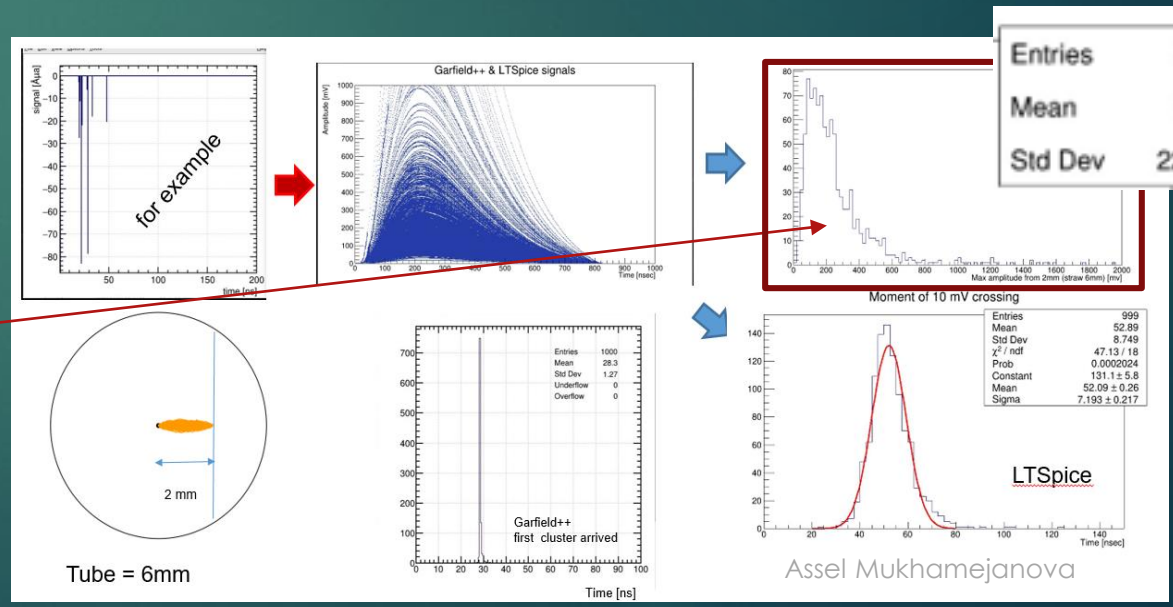
0 3 Difference between signal output Aliaksei and Assel, after LTSpice simulation

Garfield++ & LTSpice



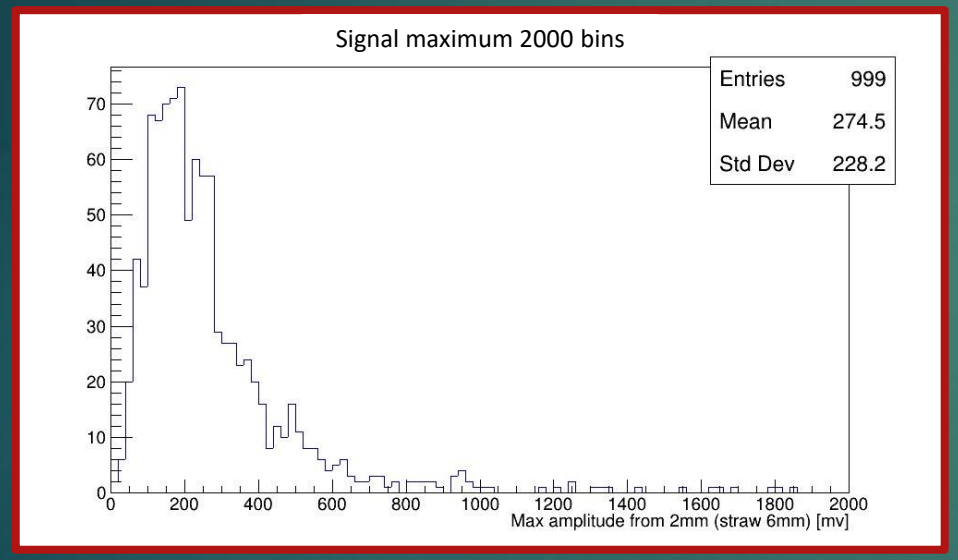


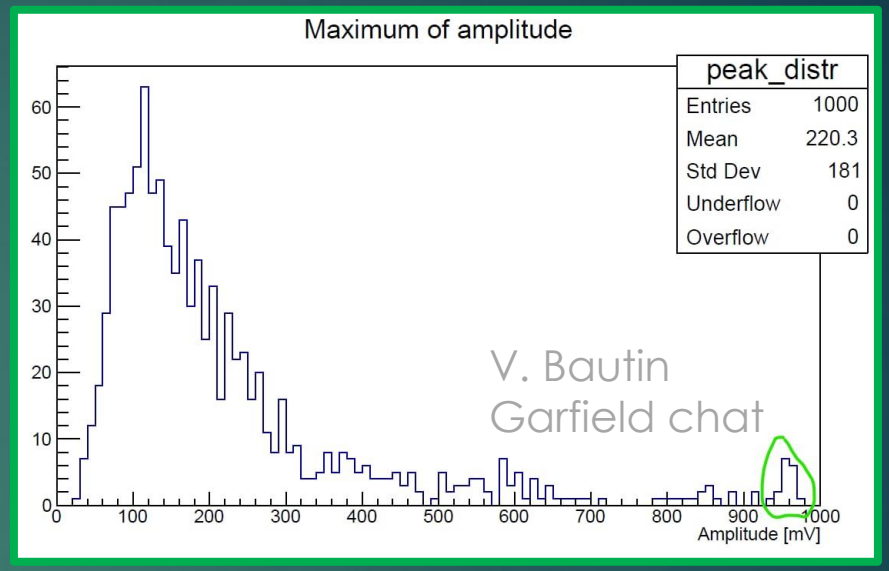


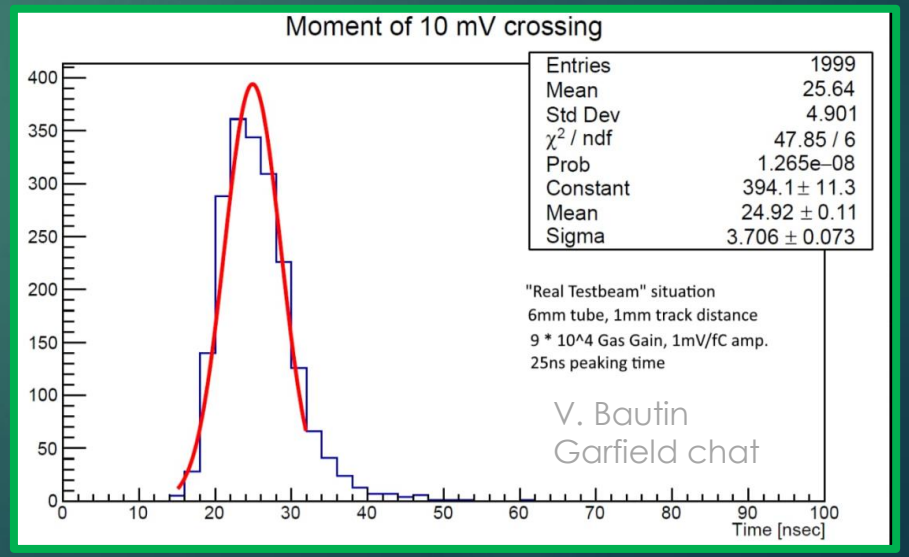


03 Difference between signal output Aliaksei and Assel, after LTSpice simulation

Garfield++ & LTSpice





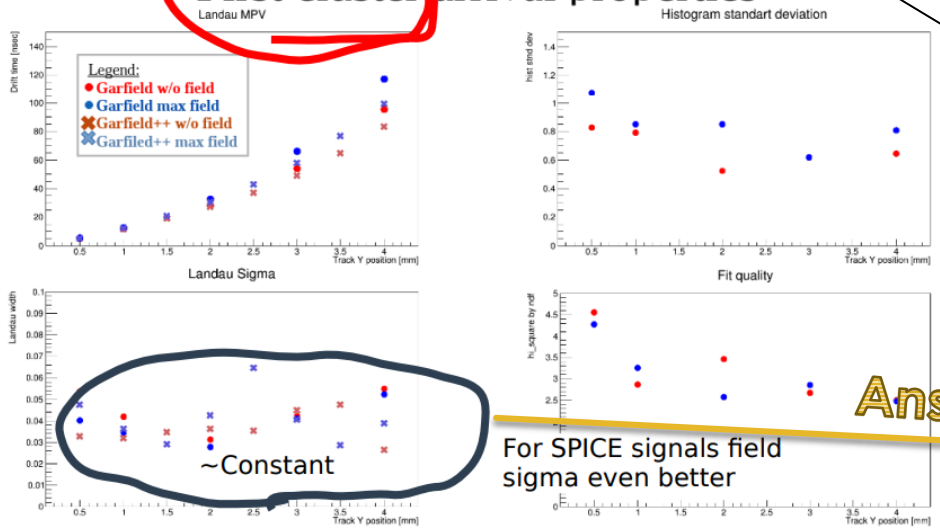


04 Comparing drift path/time distributions

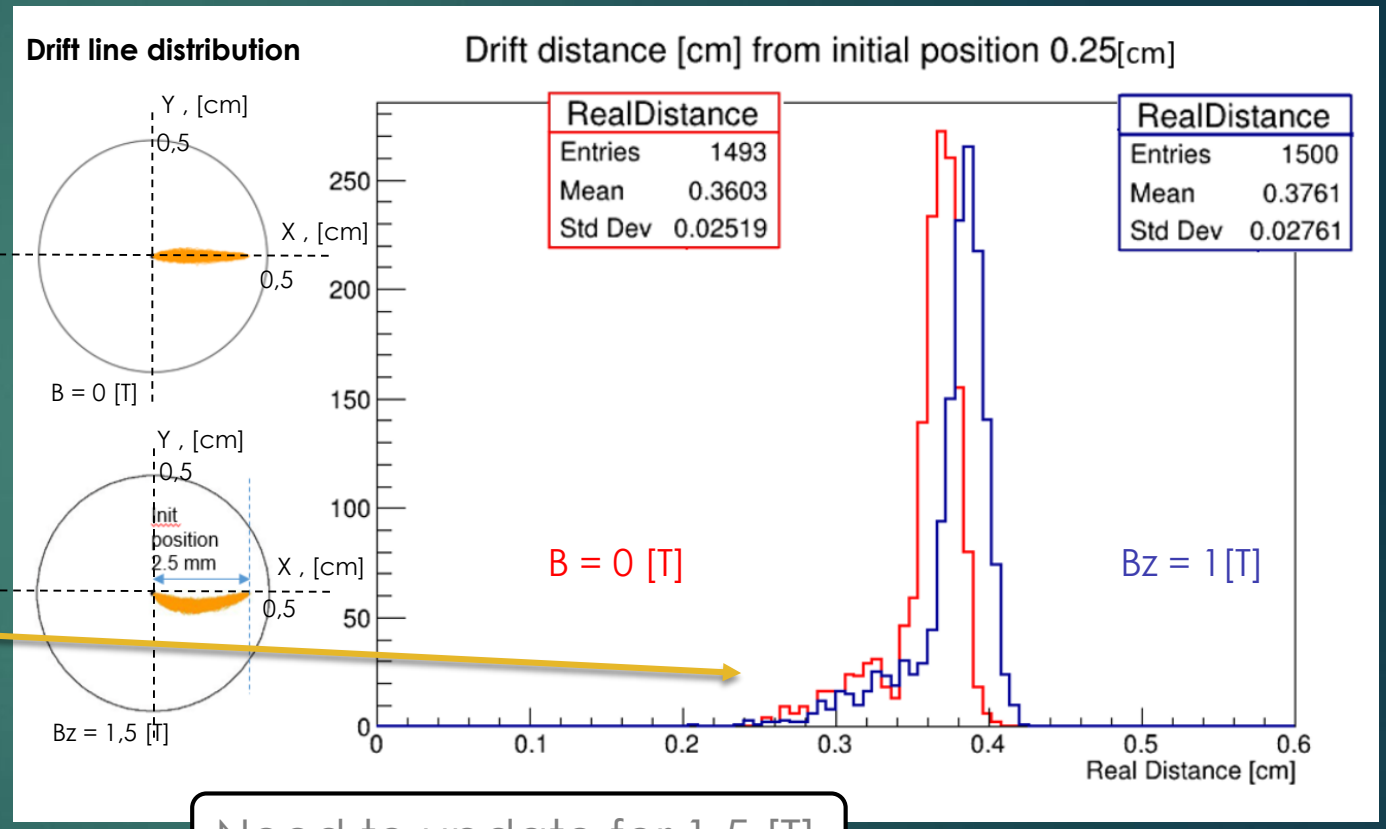
Magnetic field problem

Sergey's slide

First cluster arrival properties



Answer



Need to update for 1.5 [T]

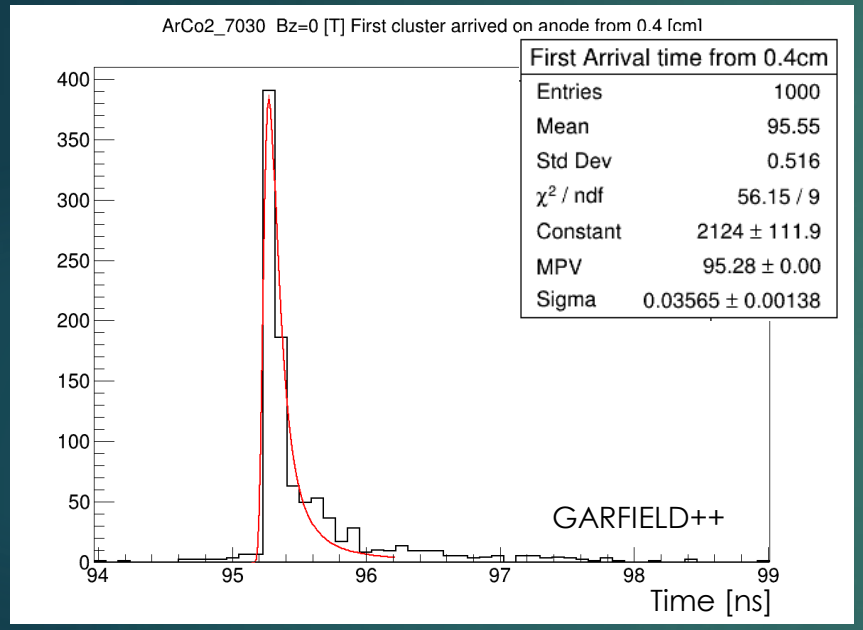
5 | TDR Garfield known problems | 10.11.22

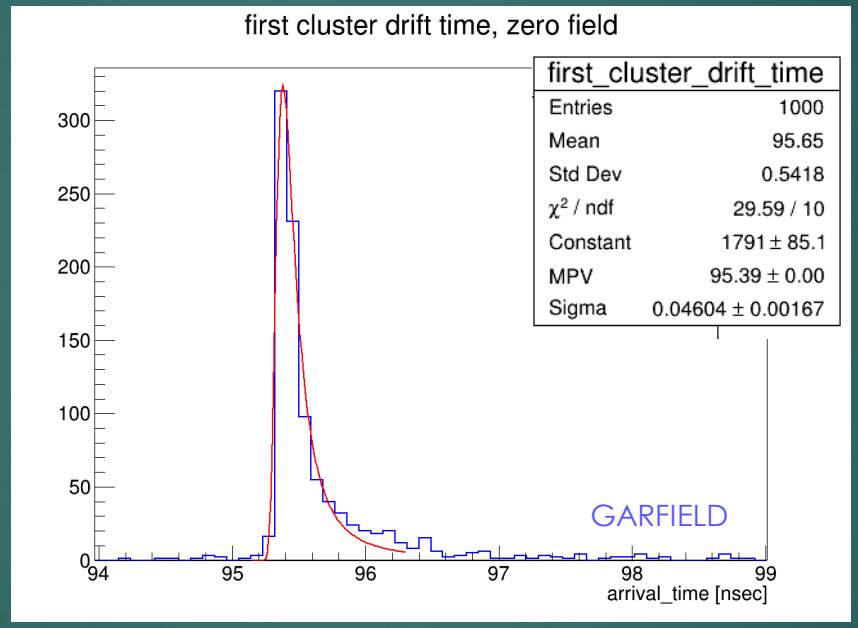
Что-то умное дописать…

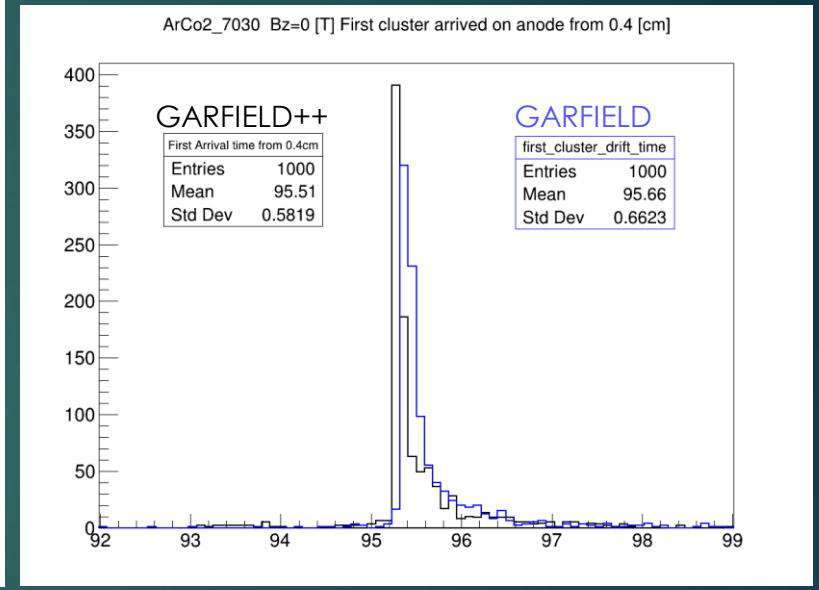
05 TDR plots update

First cluster arrived Bz= 0 [T]. Garfield & Garfield++ plots.

straw d = 10 [mm], radius track = 4[mm]



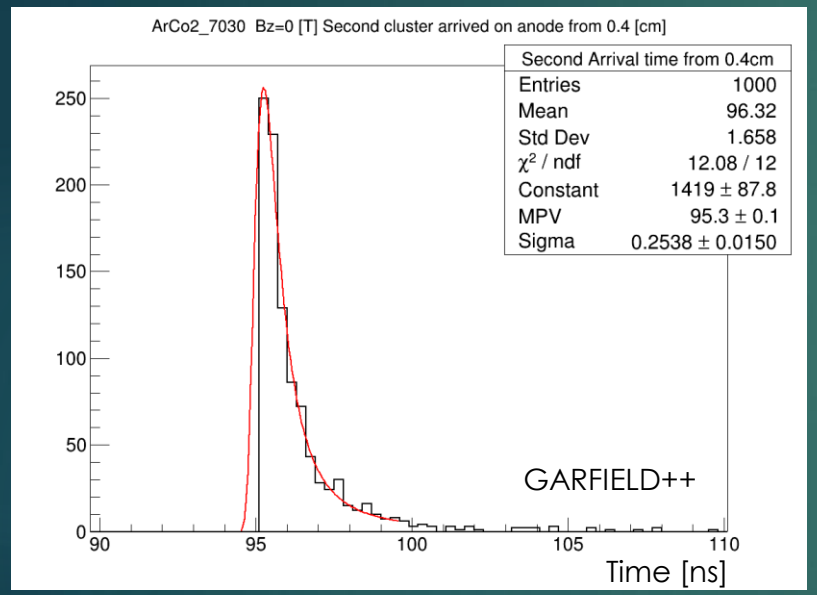


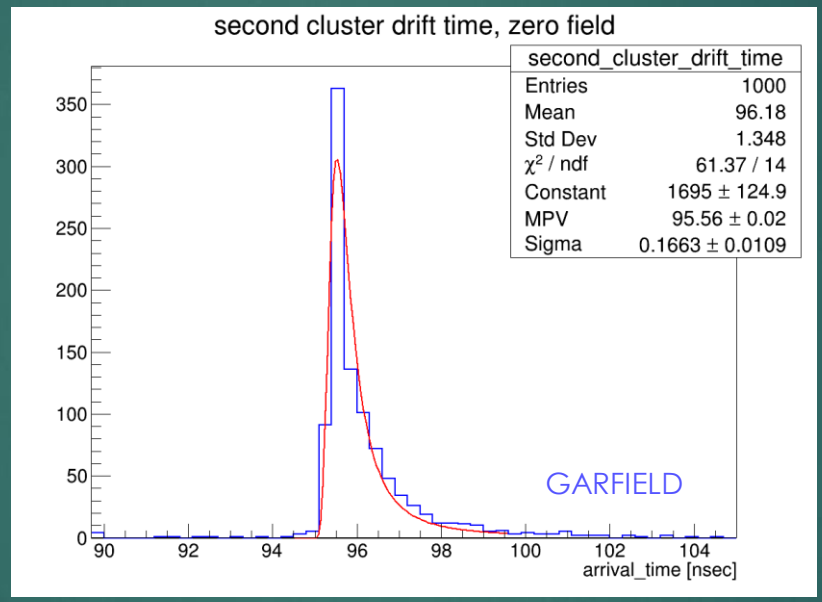


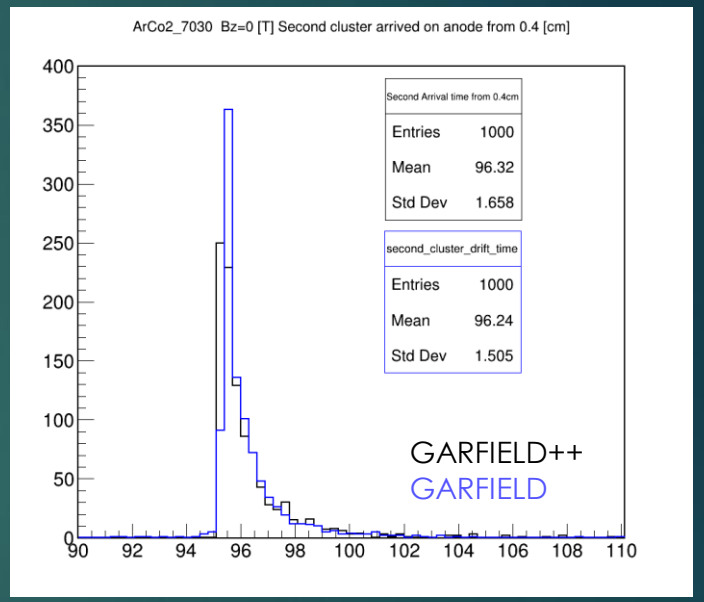
05 TDR plots update

Second cluster arrived Bz= 0 [T]. Garfield & Garfield++ plots.

straw d = 10 [mm], radius track = 4[mm]



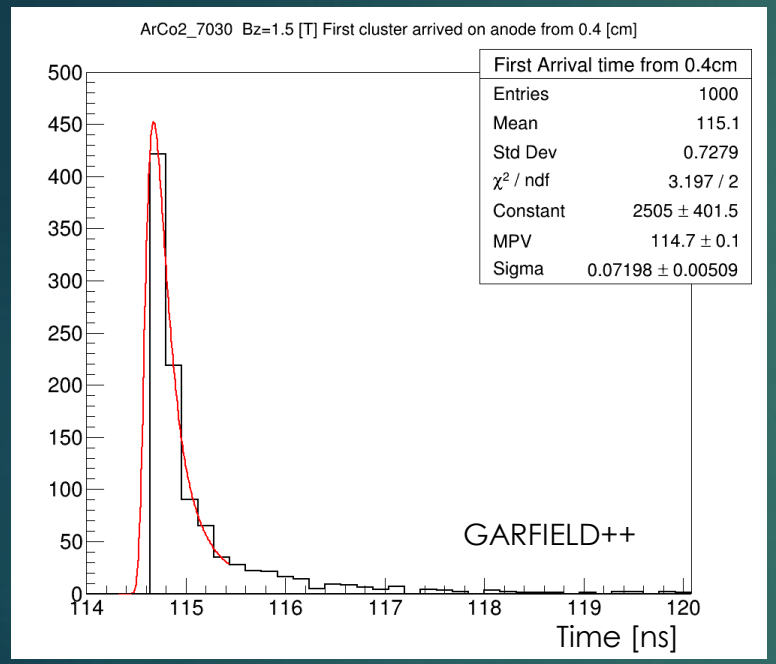


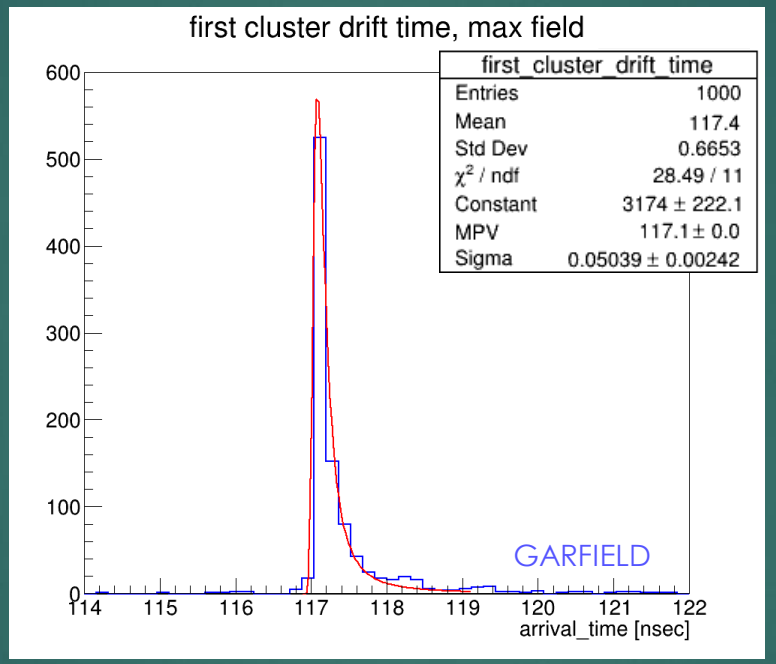


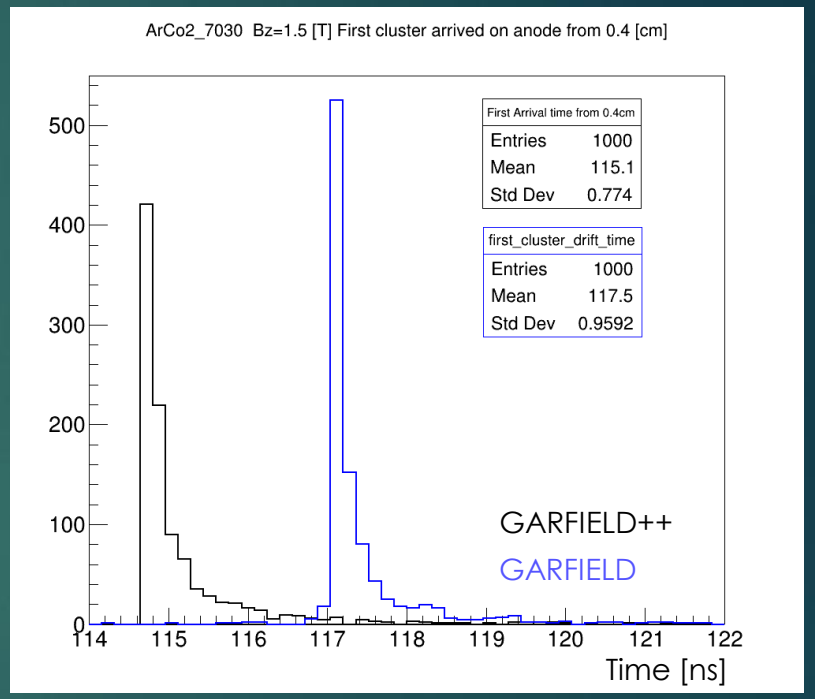
05 TDR plots update

Garfield & Garfield++ plots. First cluster arrived Bz= 1.5 [T].

Straw d = 10 [mm], radius Track = 4[mm]



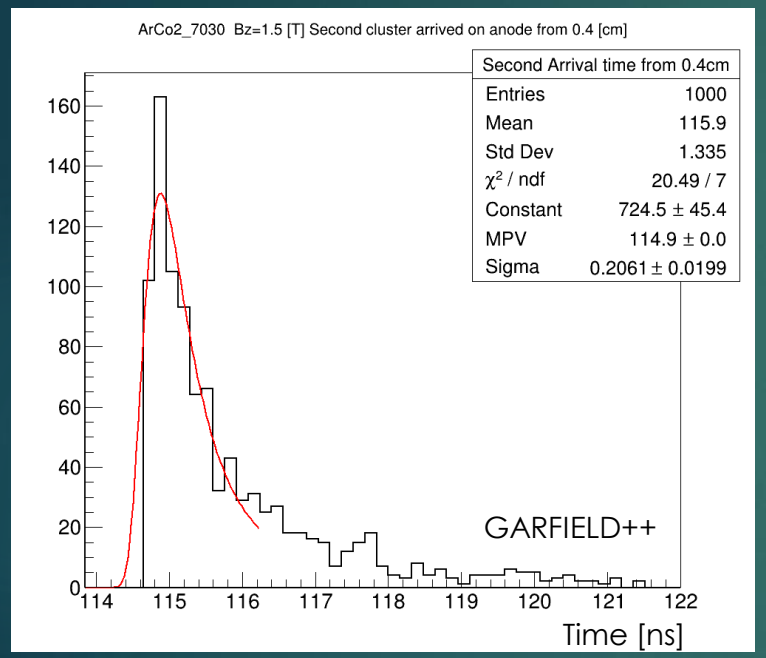


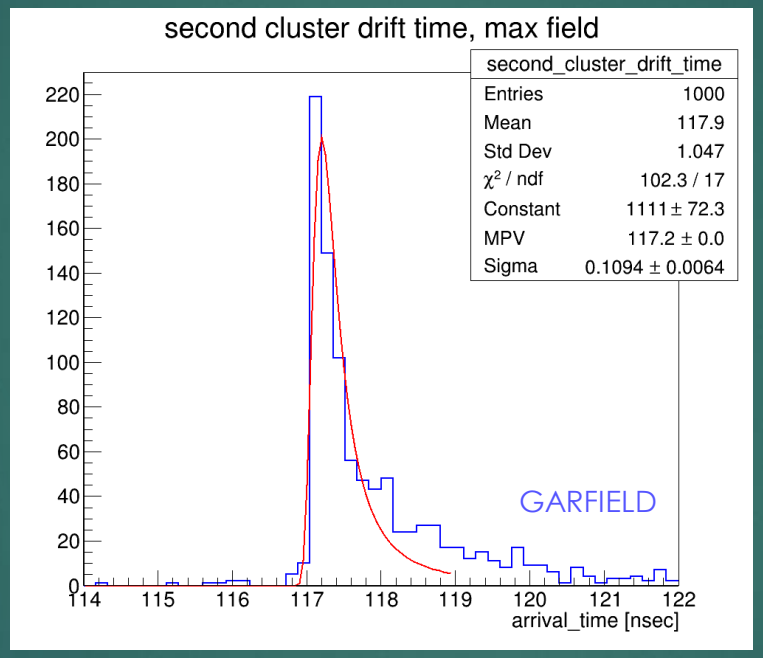


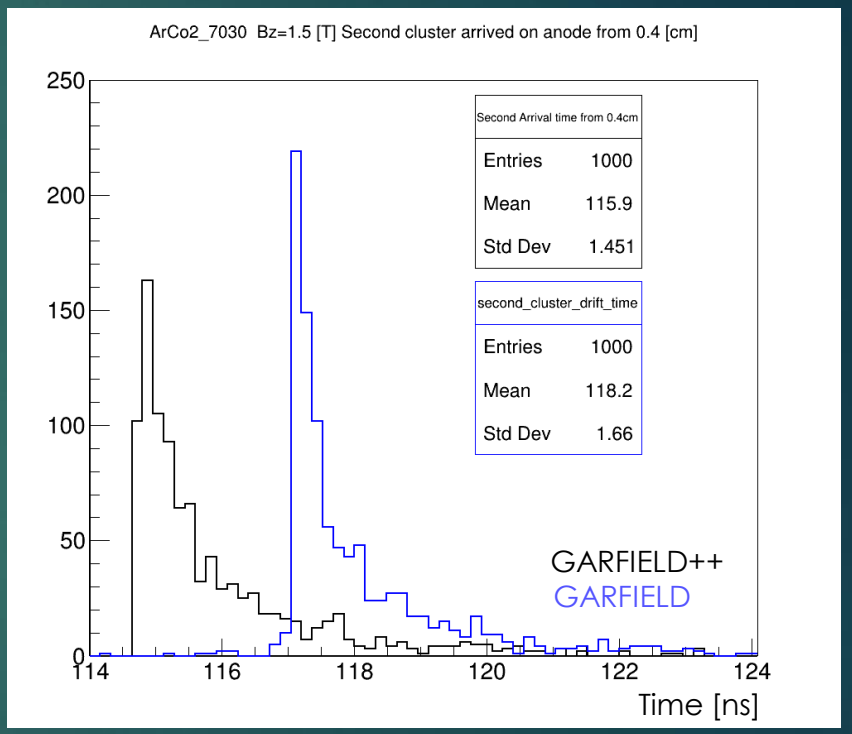
05 TDR plots update

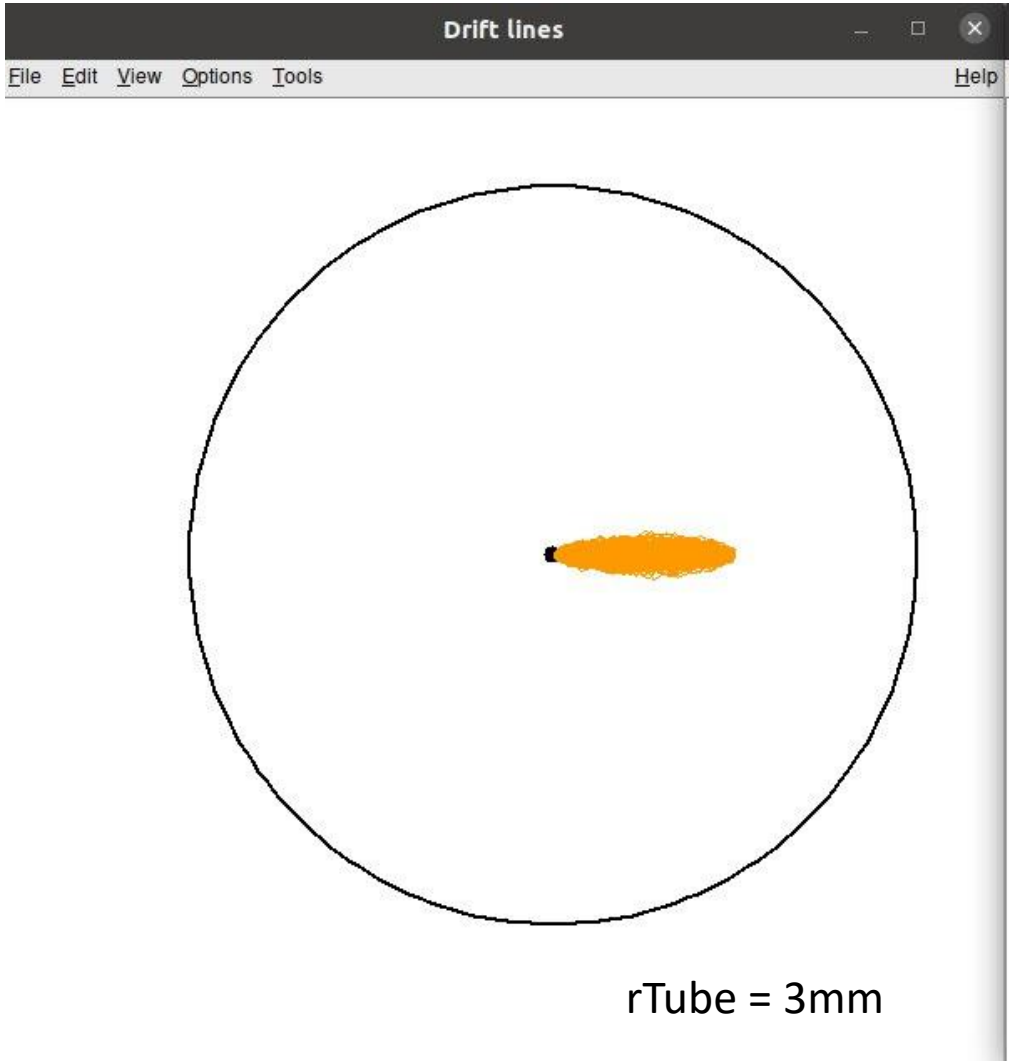
Second cluster arrived Bz= 1.5 [T]. Garfield & Garfield++ plots.

straw d = 10 [mm], radius track = 4[mm]

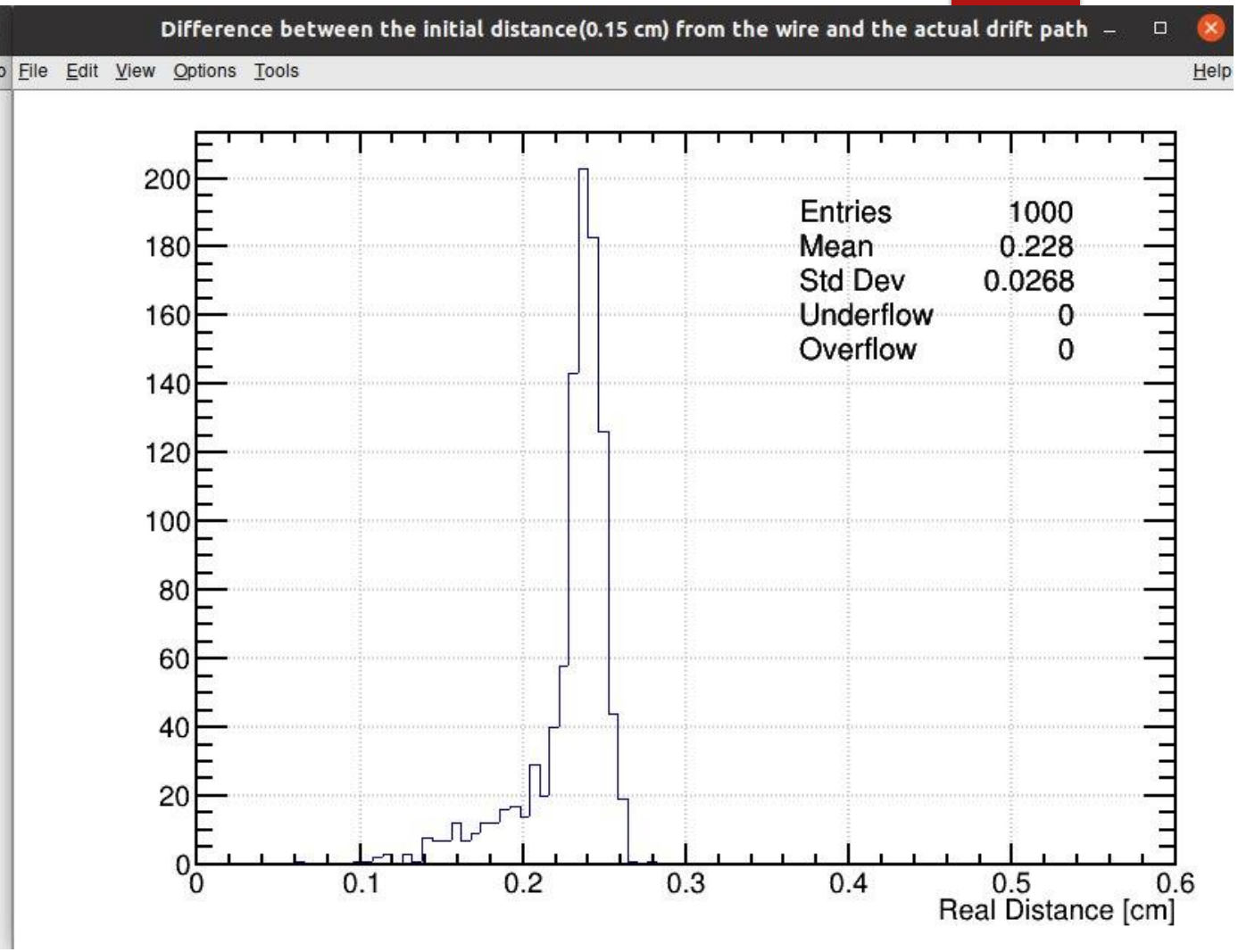




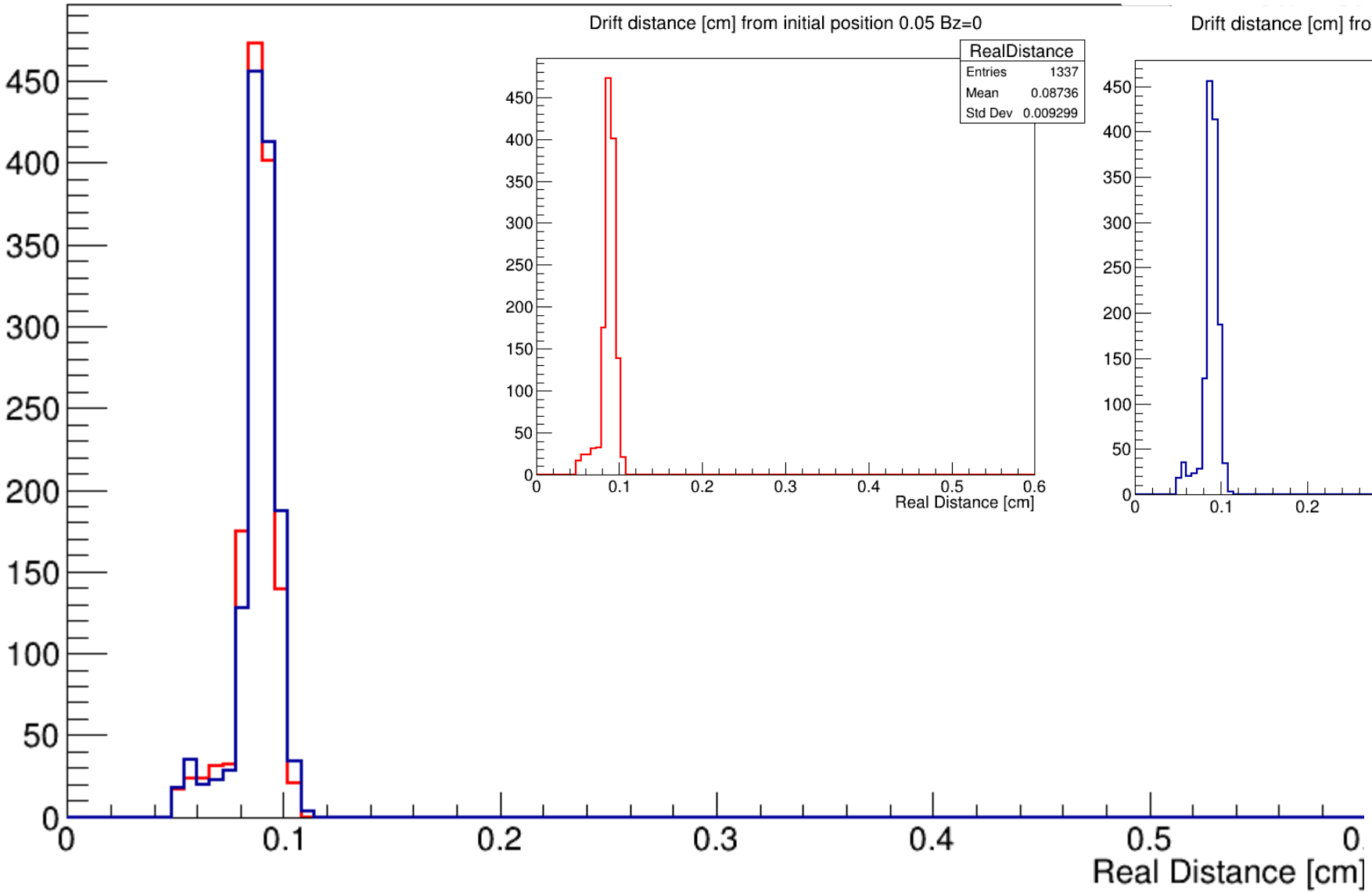


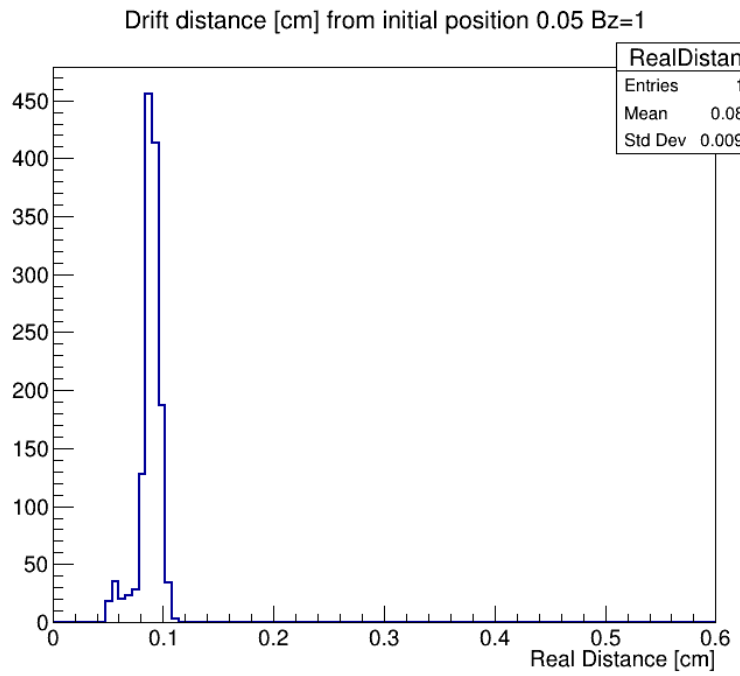

Drift lines
File Edit View Options Tools Help

rTube = 3mm

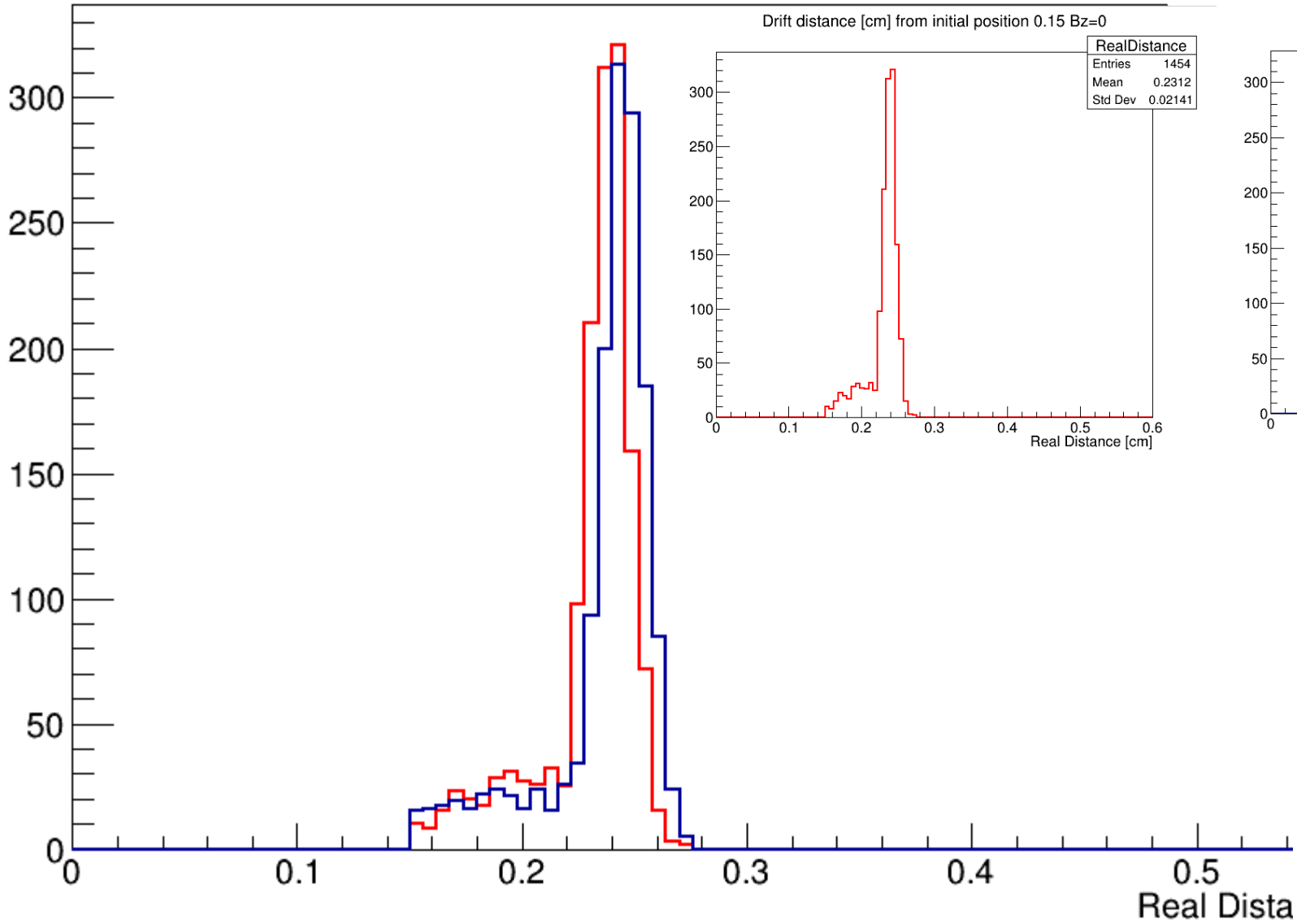

Difference between the initial distance(0.15 cm) from the wire and the actual drift path
File Edit View Options Tools Help
Entries 1000
Mean 0.228
Std Dev 0.0268
Underflow 0
Overflow 0
200
180
160
140
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Real Distance [cm]

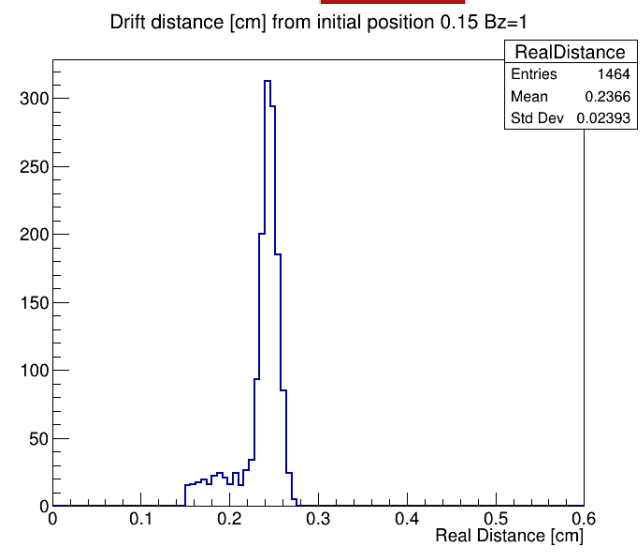
Drift distance [cm] from initial position 0.05[cm]

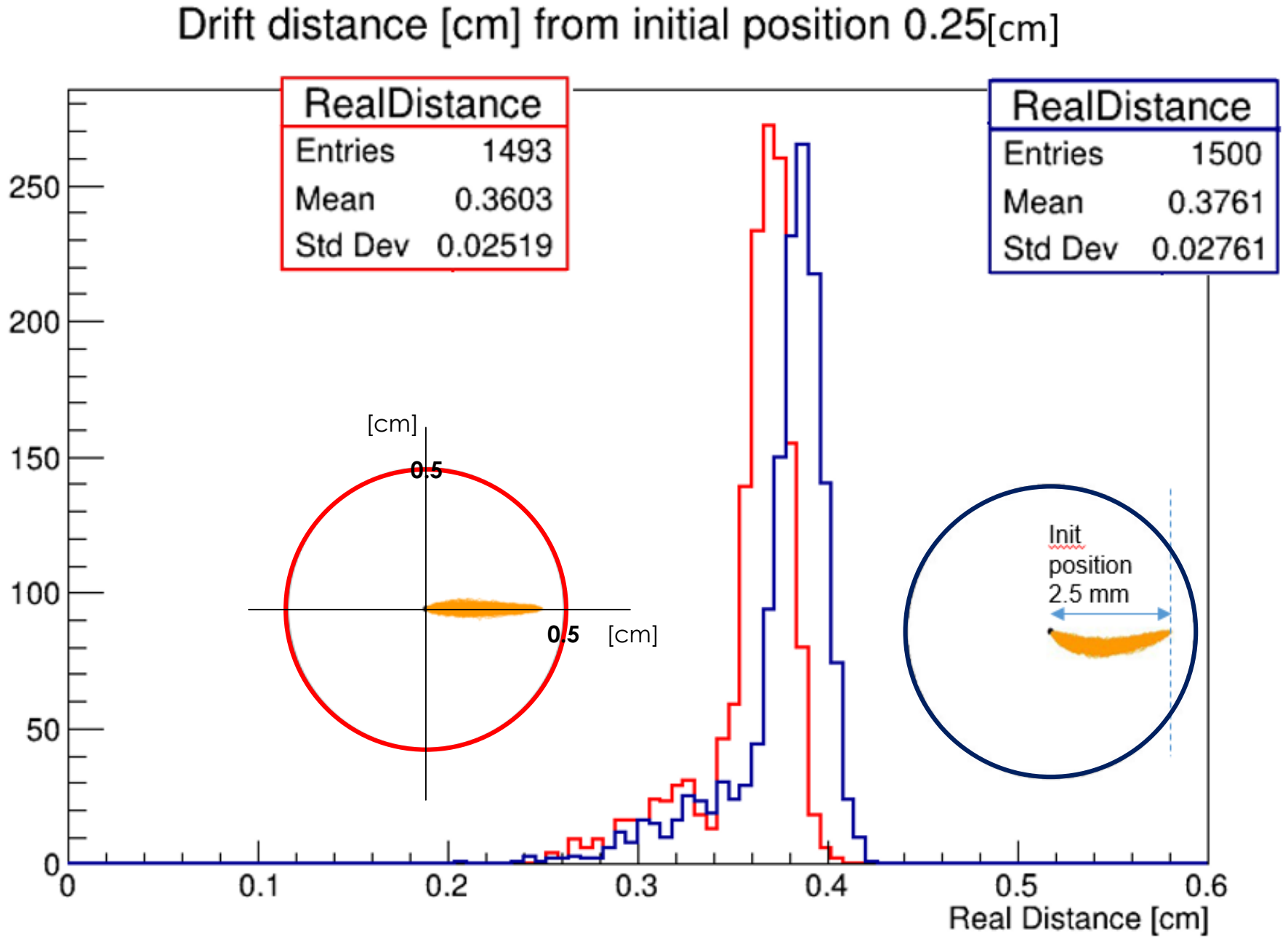


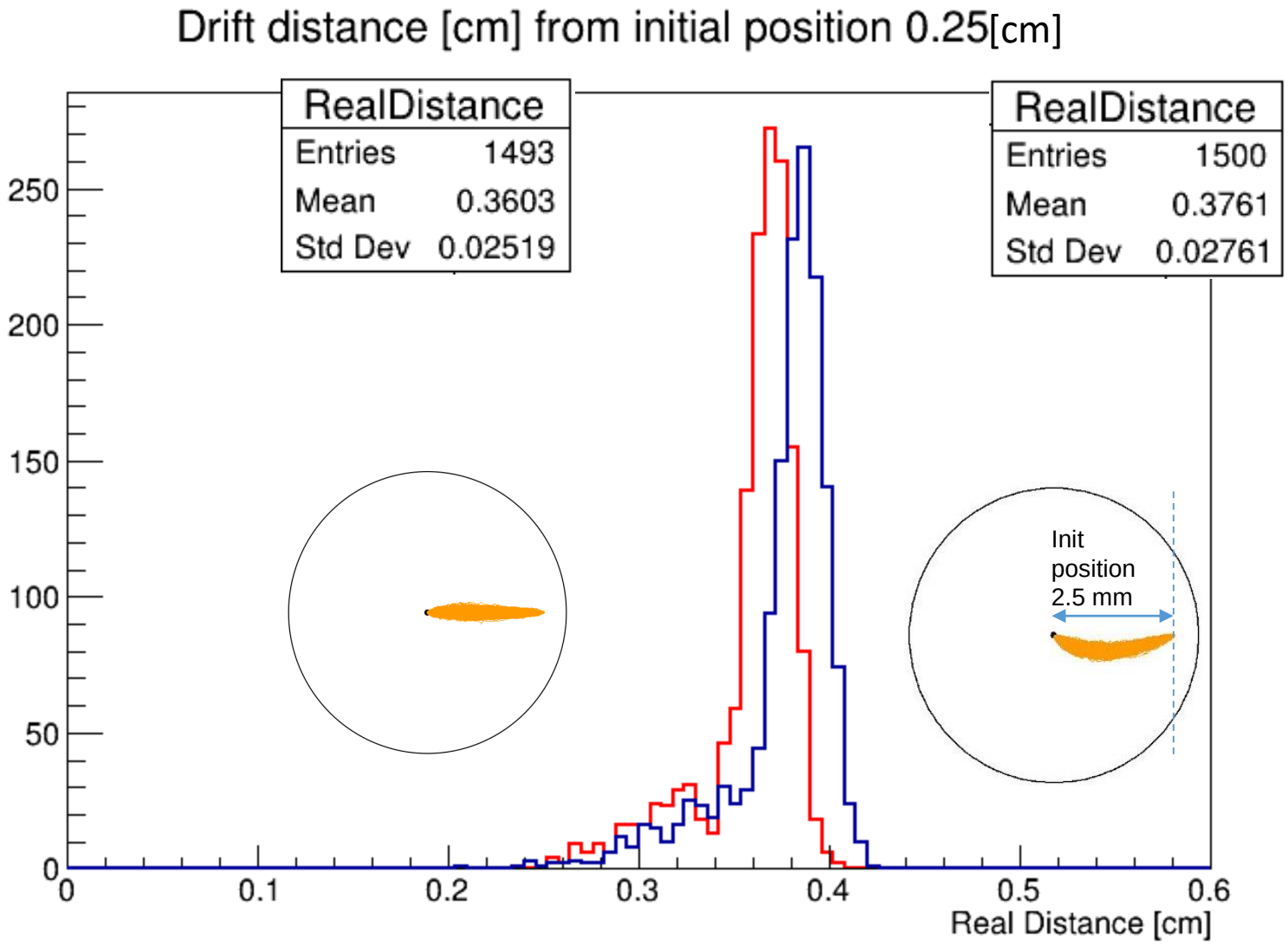


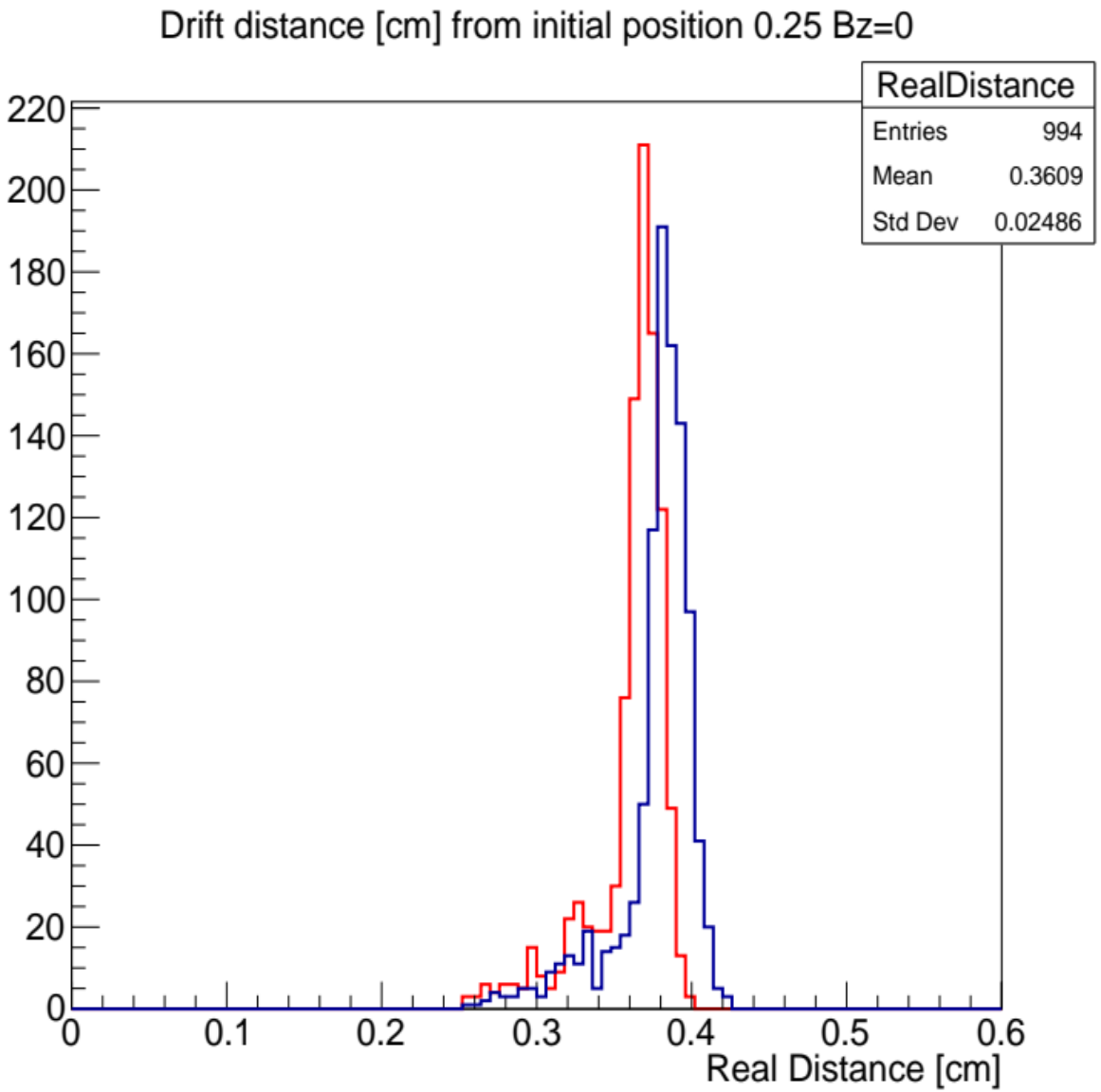
Drift distance [cm] from initial position 0.15[cm]

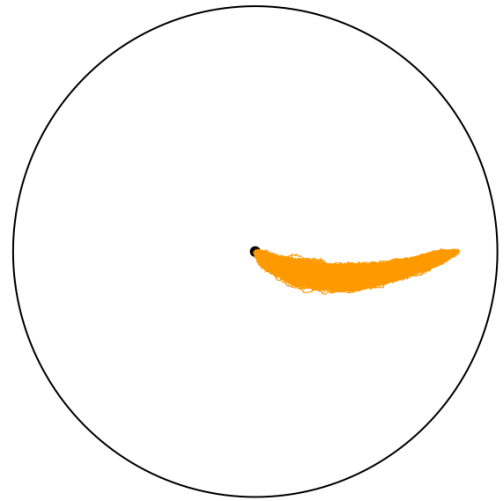


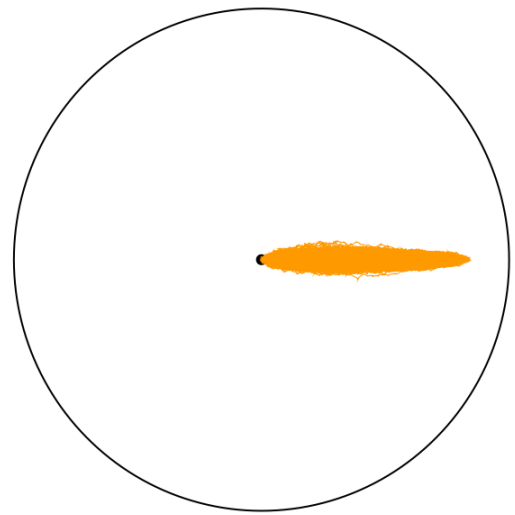


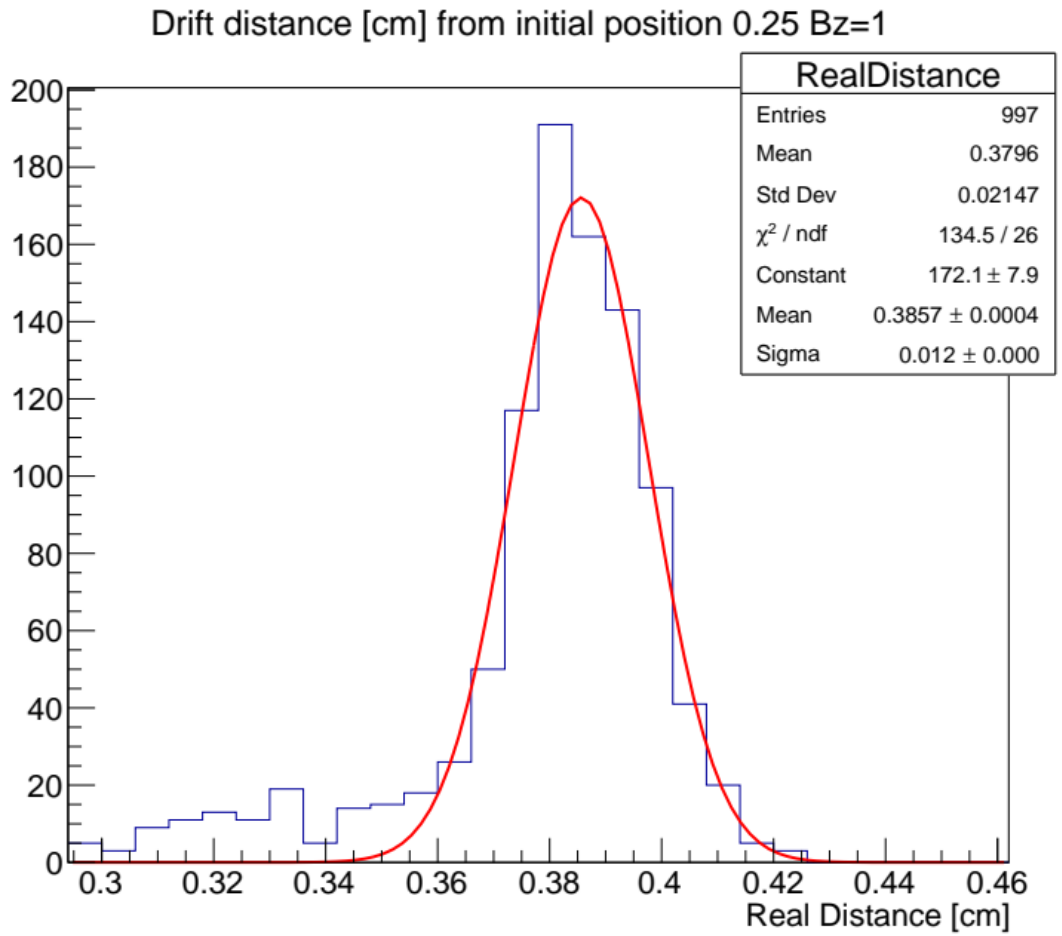

Drift distance [cm] from initial position 0.25[cm]
RealDistance
Entries 1493
Mean 0.3603
Std Dev 0.02519
RealDistance
Entries 1500
Mean 0.3761
Std Dev 0.02761
[cm]
0.5
0.5
[cm]
Init
position
2.5 mm
250
200
150
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Real Distance [cm]

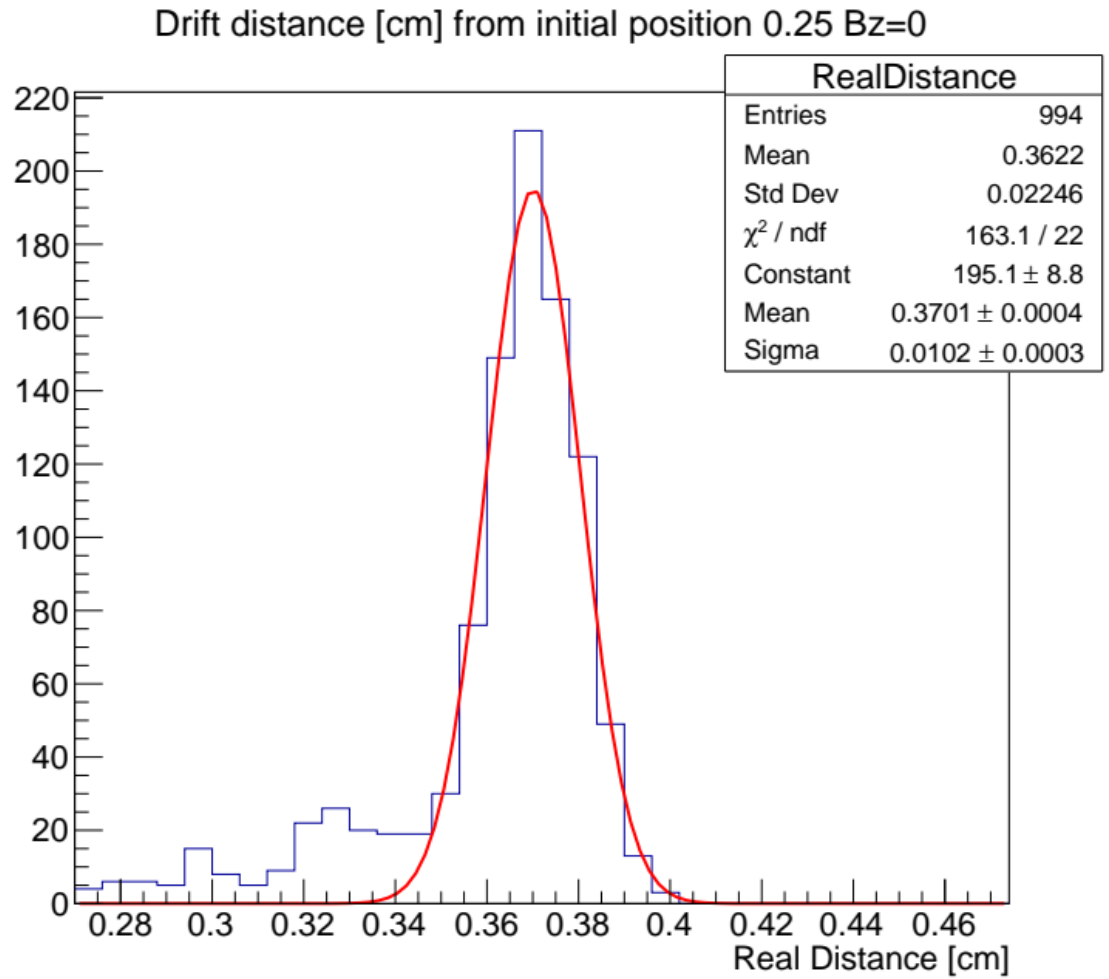

Drift distance [cm] from initial position 0.25[cm]
RealDistance
Entries 1493
Mean 0.3603
Std Dev 0.02519
RealDistance
Entries 1500
Mean 0.3761
Std Dev 0.02761
Init
position
2.5 mm
250
200
150
100
50
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Real Distance [cm]

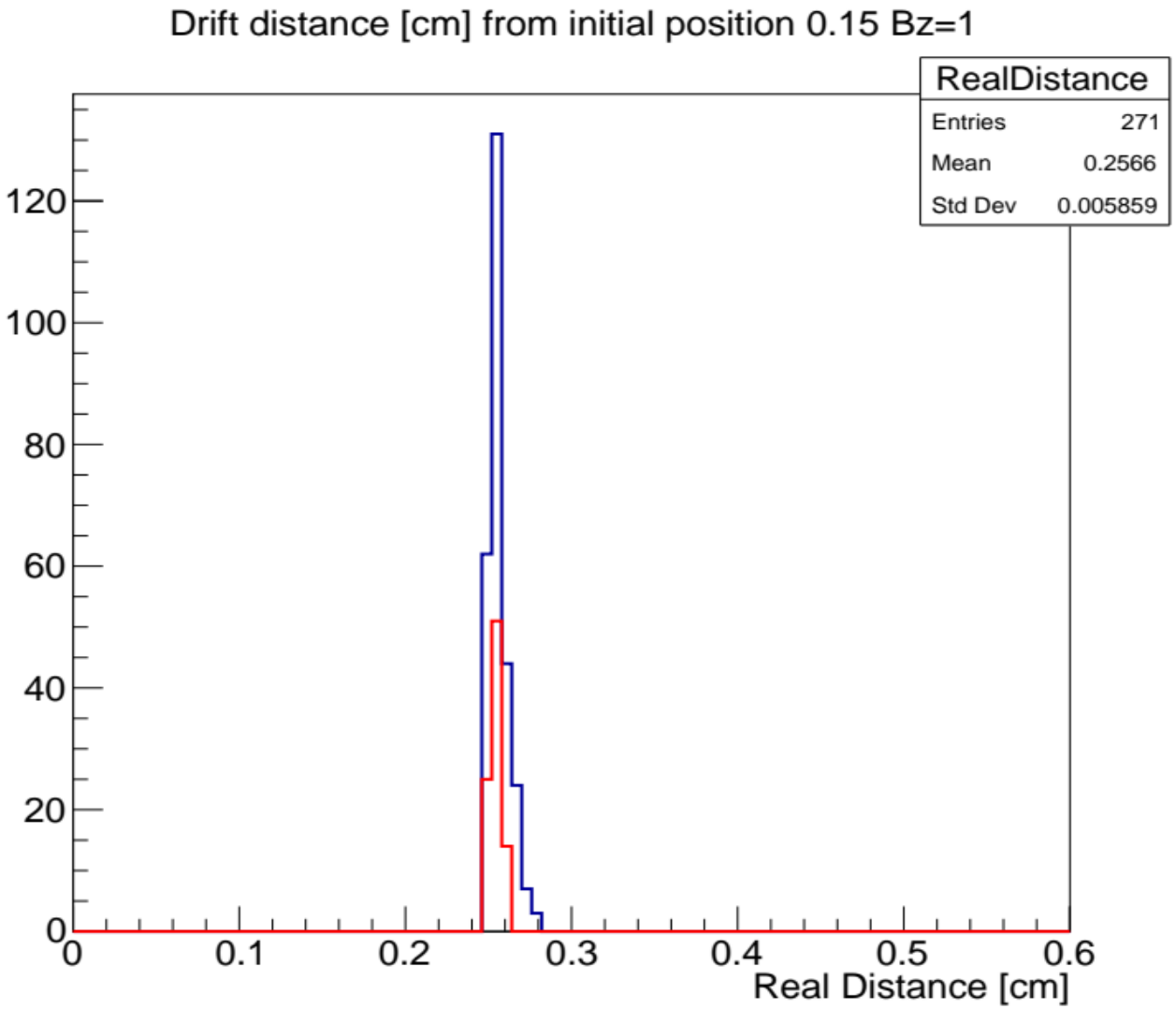

Drift distance [cm] from initial position 0.25 Bz=0
RealDistance
Entries 994
Mean 0.3609
Std Dev 0.02486
220
200
180
160
140
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Real Distance [cm]

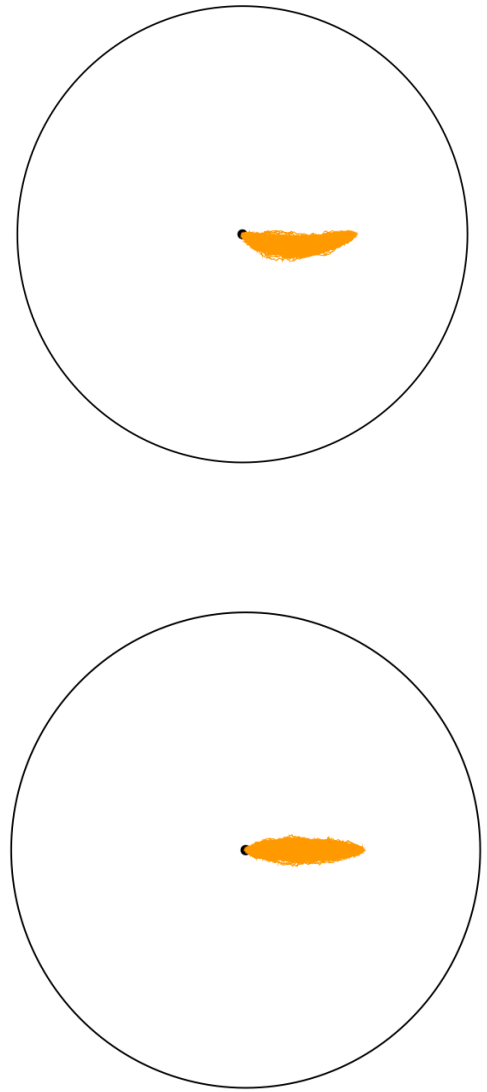


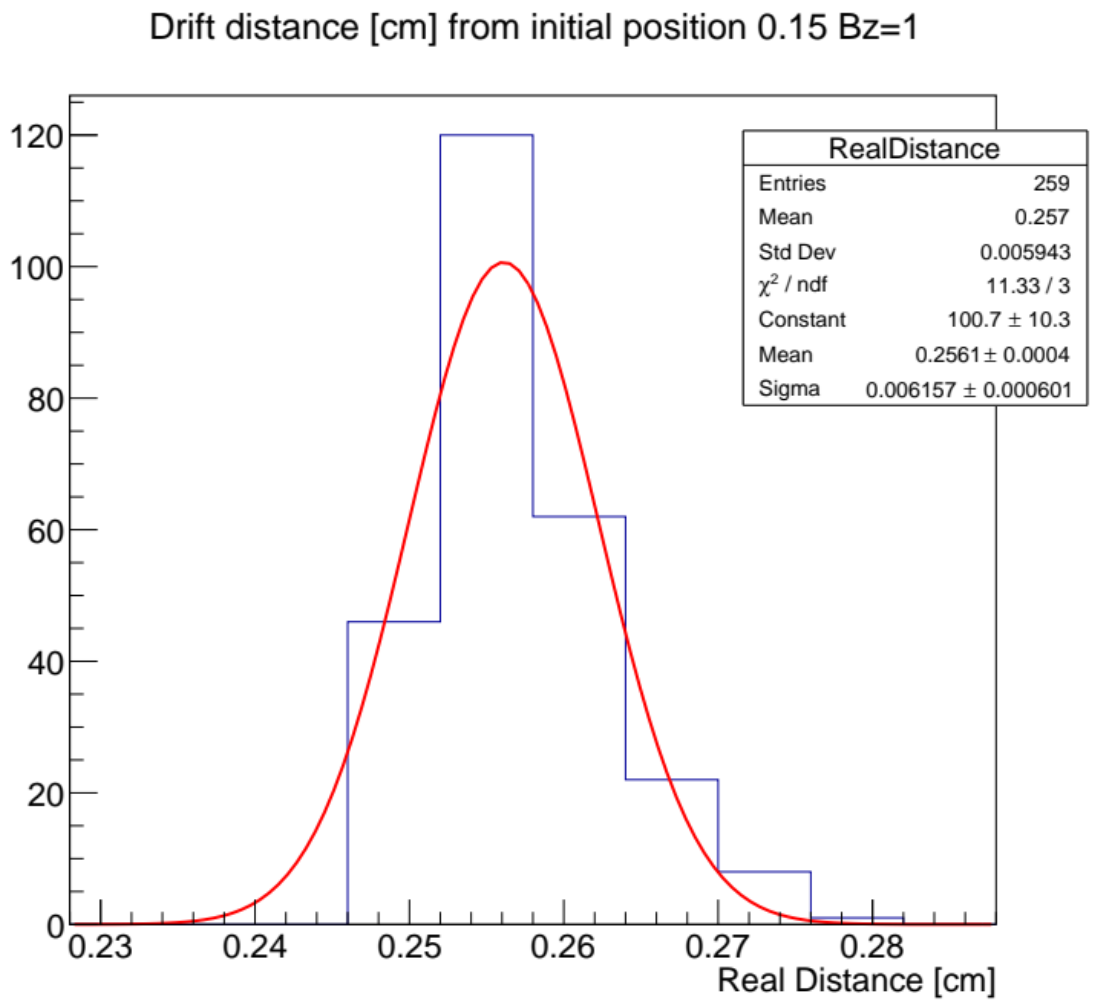


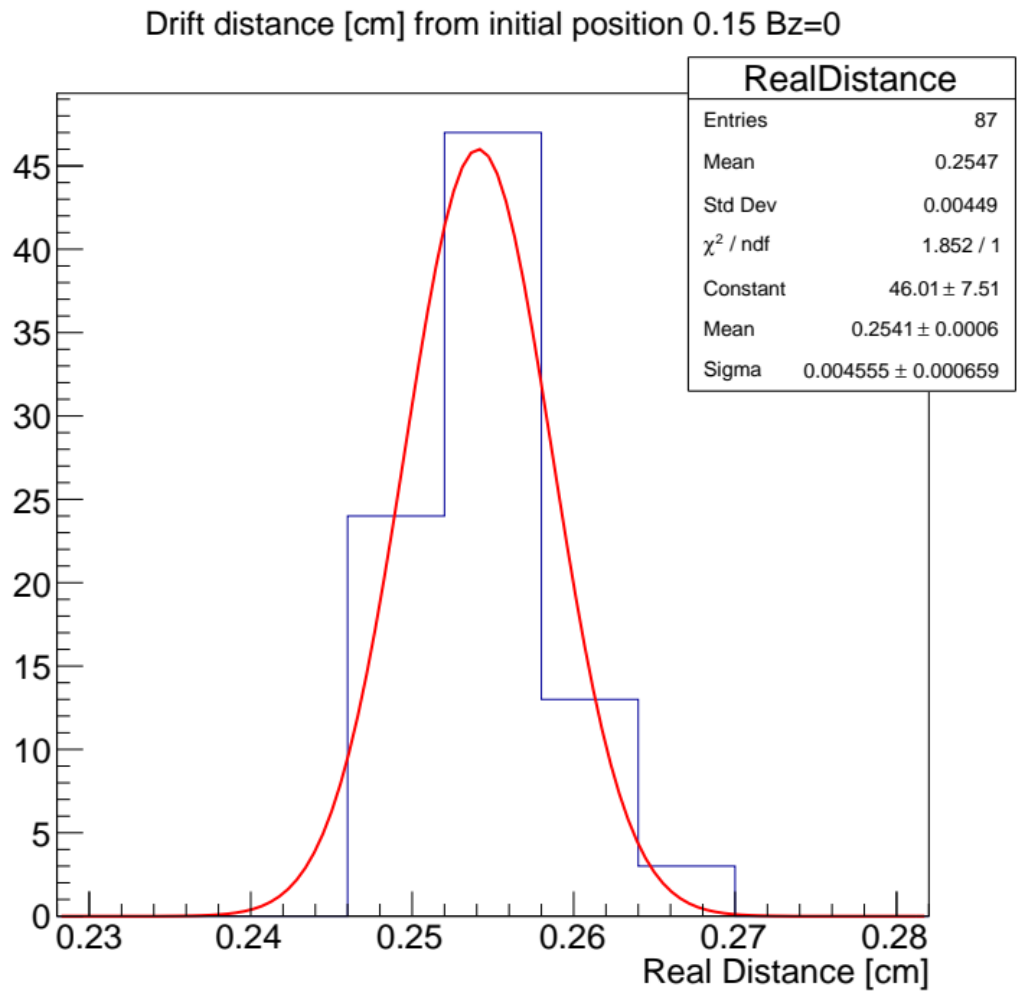

Drift distance [cm] from initial position 0.25 Bz=1
RealDistance
Entries 997
Mean 0.3796
Std Dev 0.02147
χ² / ndf 134.5 / 26
Constant 172.1 ± 7.9
Mean 0.3857 ± 0.0004
Sigma 0.012 ± 0.000
Real Distance [cm]


Drift distance [cm] from initial position 0.25 Bz=0
RealDistance
Entries 994
Mean 0.3622
Std Dev 0.02246
χ² / ndf 163.1 / 22
Constant 195.1 ± 8.8
Mean 0.3701 ± 0.0004
Sigma 0.0102 ± 0.0003
Real Distance [cm]

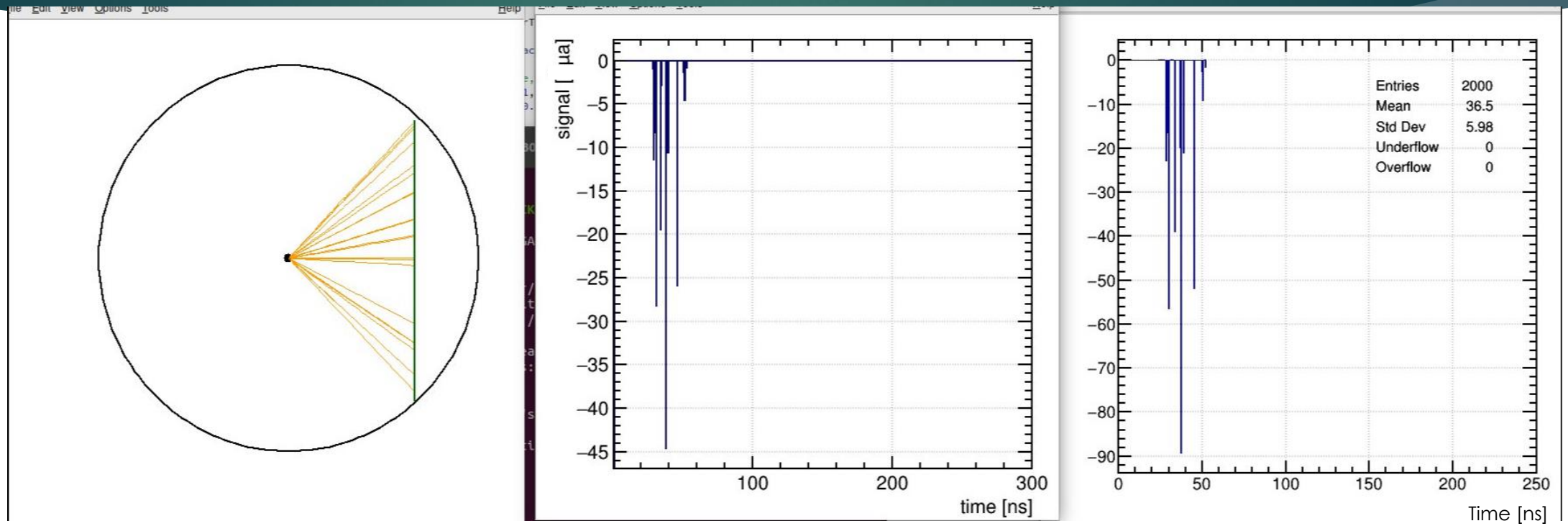

Drift distance [cm] from initial position 0.15 Bz=1
RealDistance
Entries 271
Mean 0.2566
Std Dev 0.005859
120
100
80
60
40
20
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Real Distance [cm]

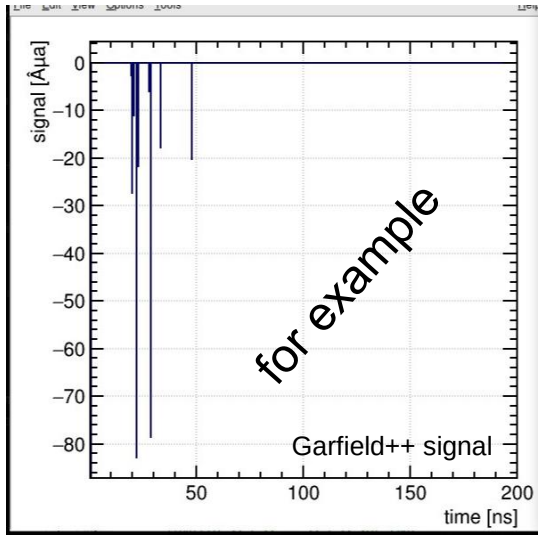


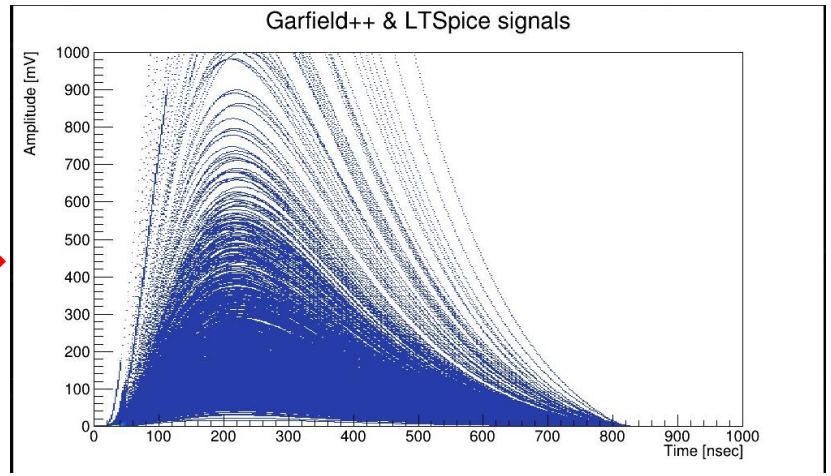

Drift distance [cm] from initial position 0.15 Bz=1
RealDistance
Entries 259
Mean 0.257
Std Dev 0.005943
χ² / ndf 11.33 / 3
Constant 100.7 ± 10.3
Mean 0.2561 ± 0.0004
Sigma 0.006157 ± 0.000601
120
100
80
60
40
20
0
0.23
0.24
0.25
0.26
0.27
0.28
Real Distance [cm]

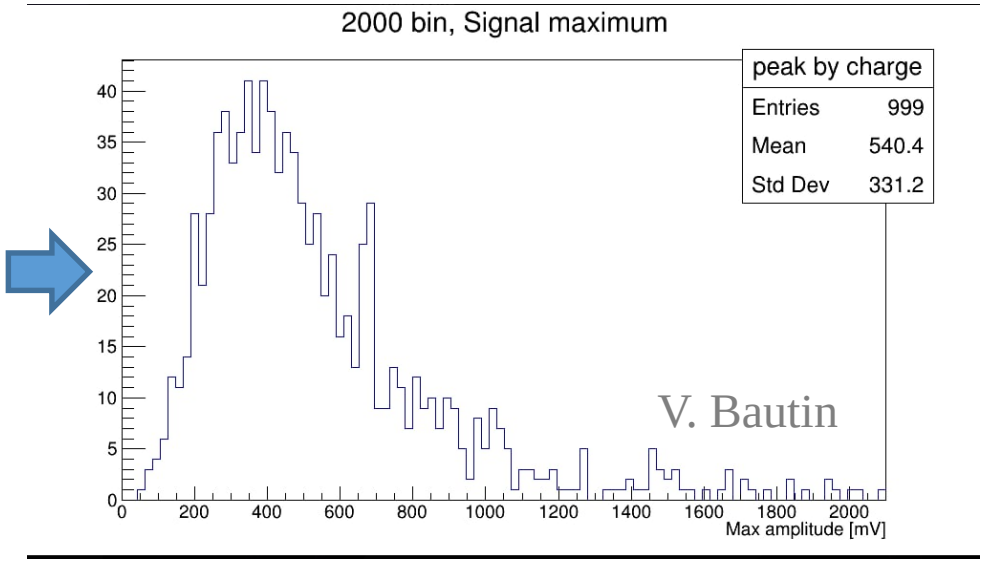

Drift distance [cm] from initial position 0.15 Bz=0
RealDistance
Entries 87
Mean 0.2547
Std Dev 0.00449
χ² / ndf 1.852 / 1
Constant 46.01 ± 7.51
Mean 0.2541 ± 0.0006
Sigma 0.004555 ± 0.000659
45
40
35
30
25
20
15
10
5
0
0.23
0.24
0.25
0.26
0.27
0.28
Real Distance [cm]

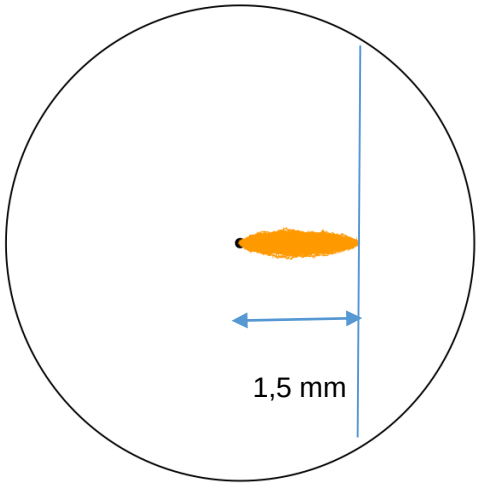
Garfield++ Amplitude BUG



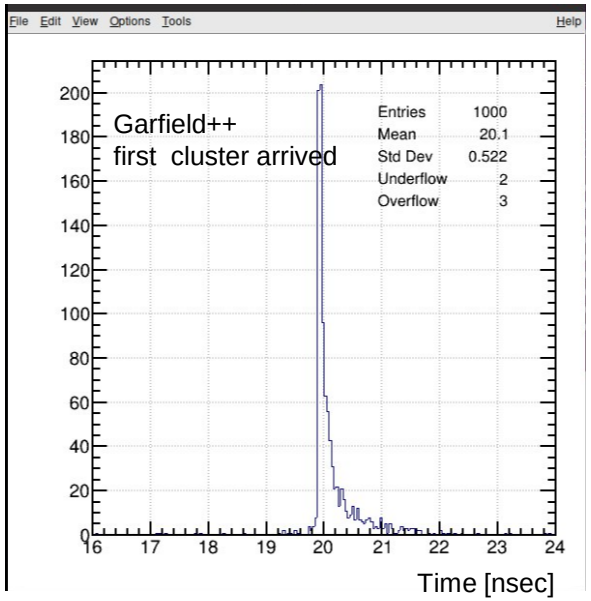

signal [Âµa]
time [ns]
for example
Garfield++ signal

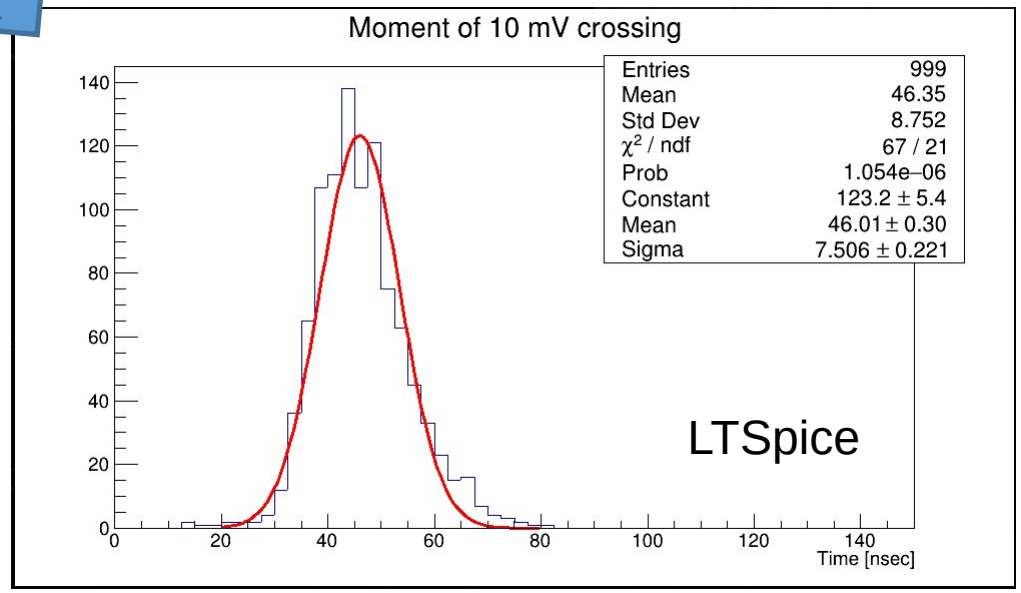

Garfield++ & LTSpice signals
Amplitude [mV]
Time [nsec]


2000 bin, Signal maximum
peak by charge
Entries 999
Mean 540.4
Std Dev 331.2
V. Bautin
Max amplitude [mV]

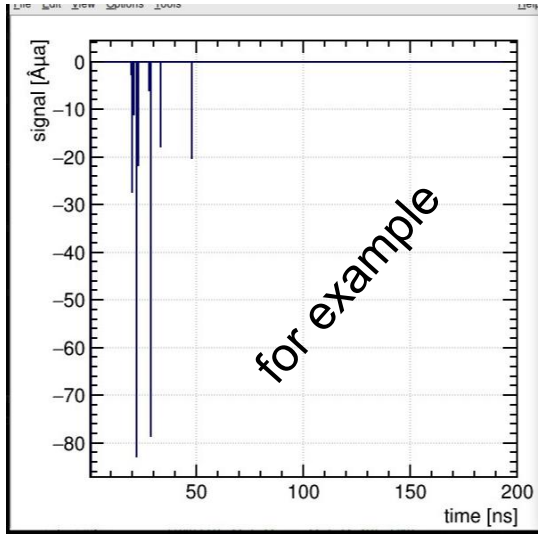

1,5 mm

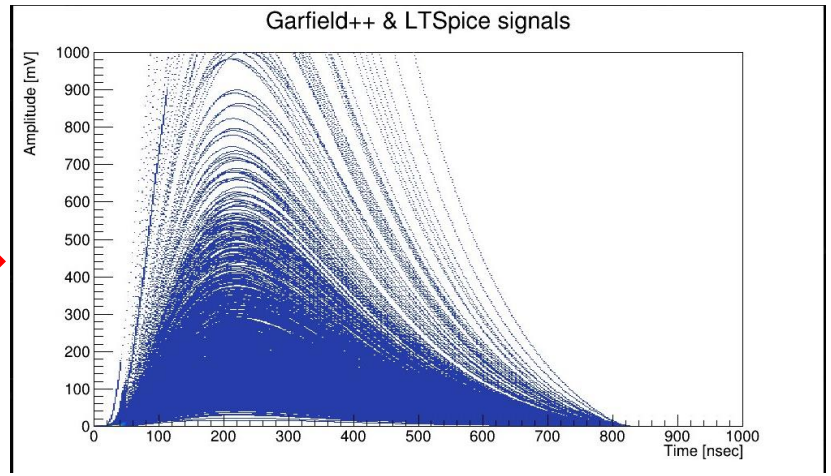
Tube = 6mm

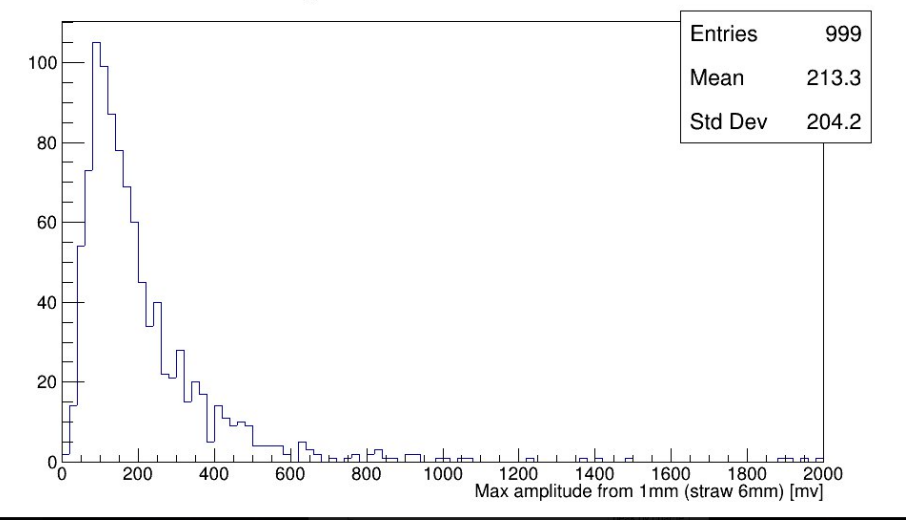

File Edit View Options Tools Help
Garfield++
first cluster arrived
Entries 1000
Mean 20.1
Std Dev 0.522
Underflow 2
Overflow 3
Time [nsec]

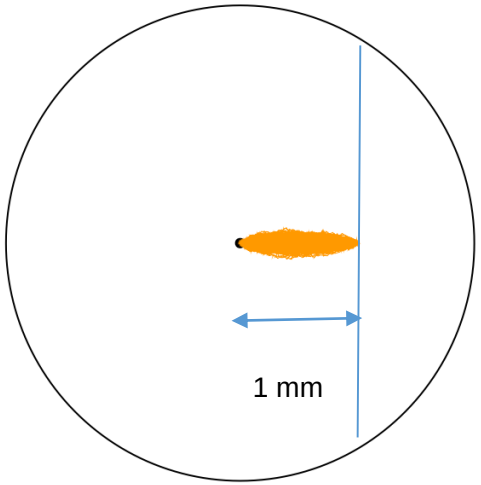

Moment of 10 mV crossing
Entries 999
Mean 46.35
Std Dev 8.752
χ² / ndf 67 / 21
Prob 1.054e−06
Constant 123.2 ± 5.4
Mean 46.01 ± 0.30
Sigma 7.506 ± 0.221
LTSpice
Time [nsec]

Assel Mukhamejanova

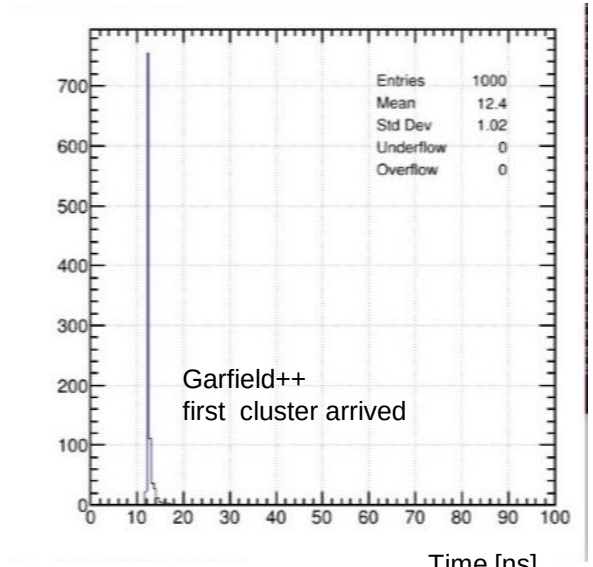


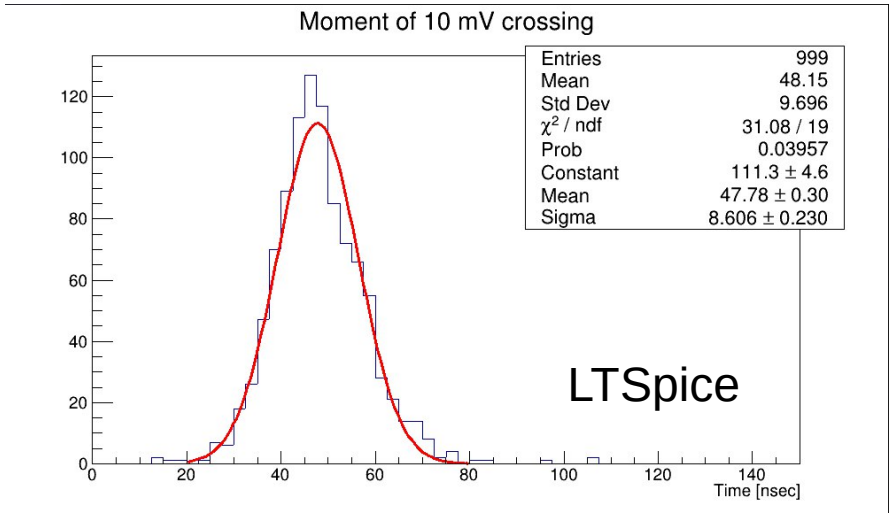


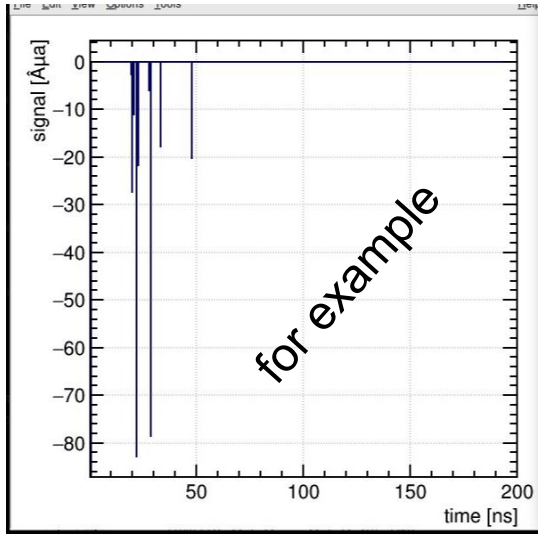


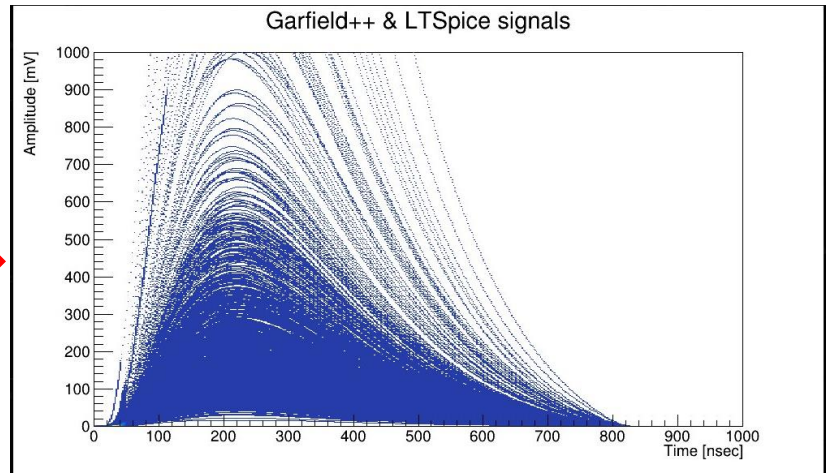


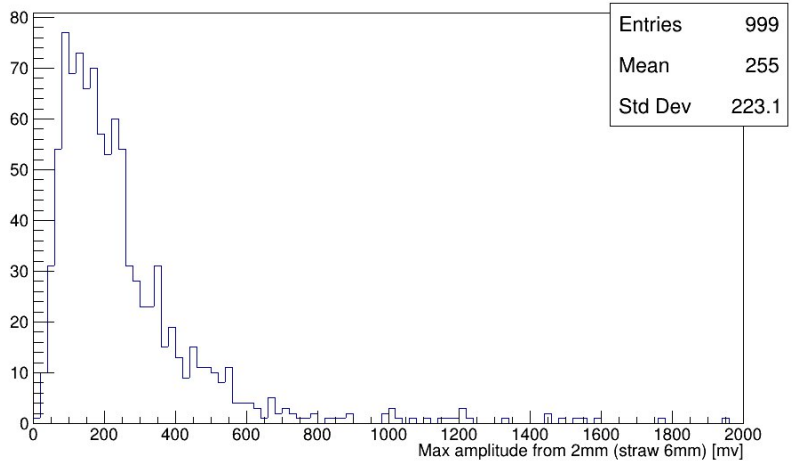
Tube = 6mm



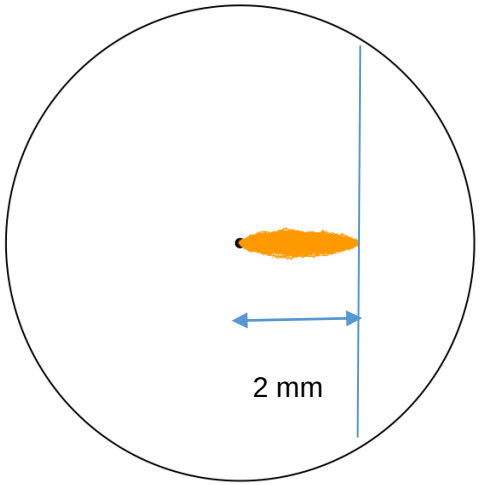




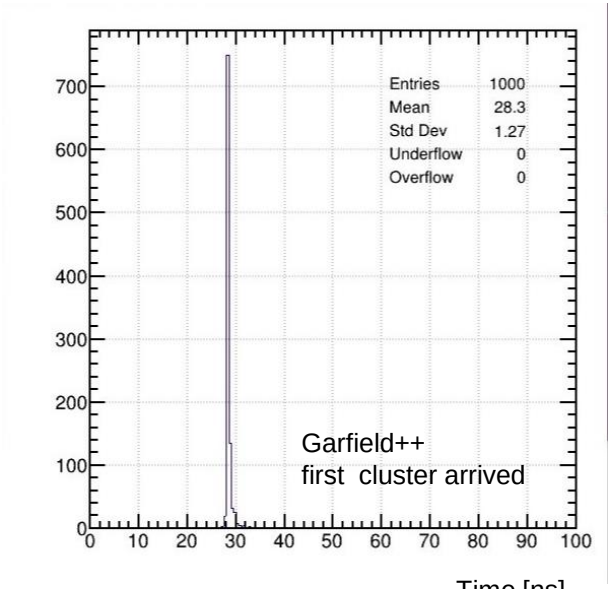


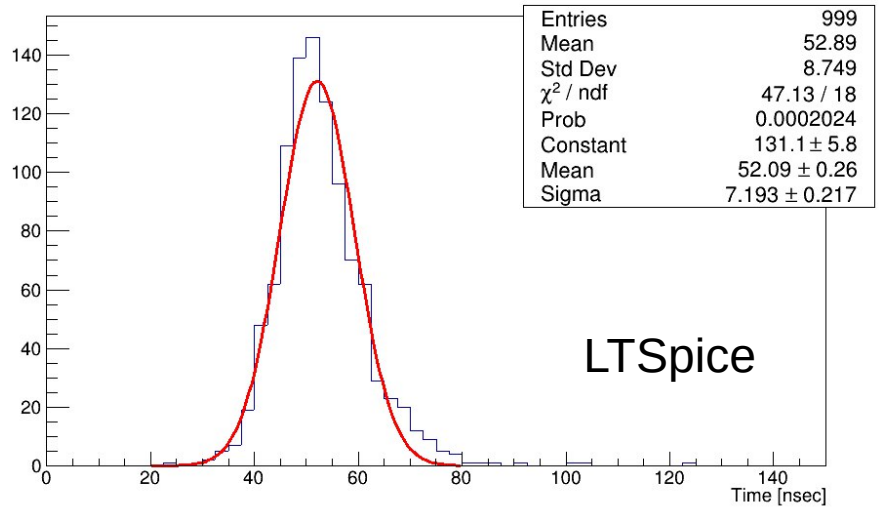


Moment of 10 mV crossing



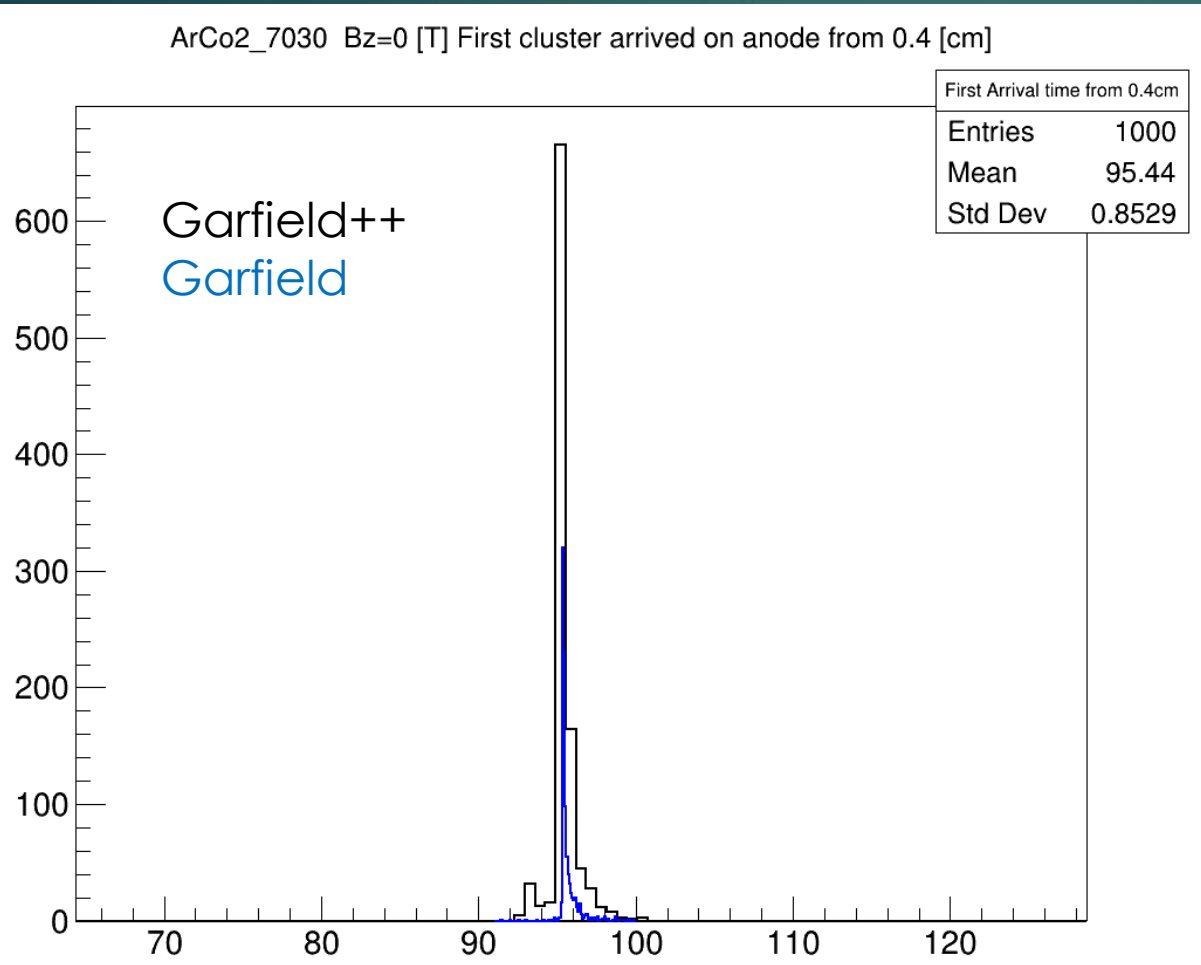
Tube = 6mm

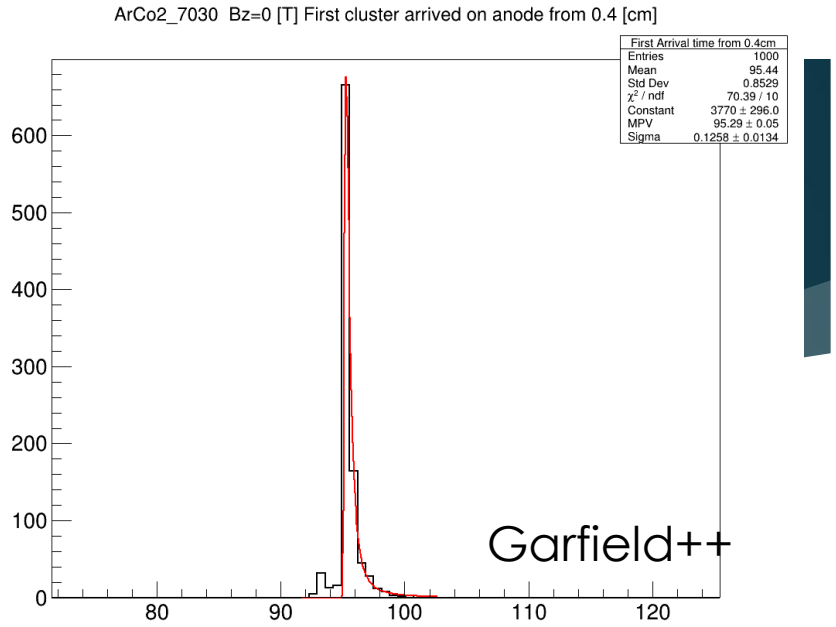


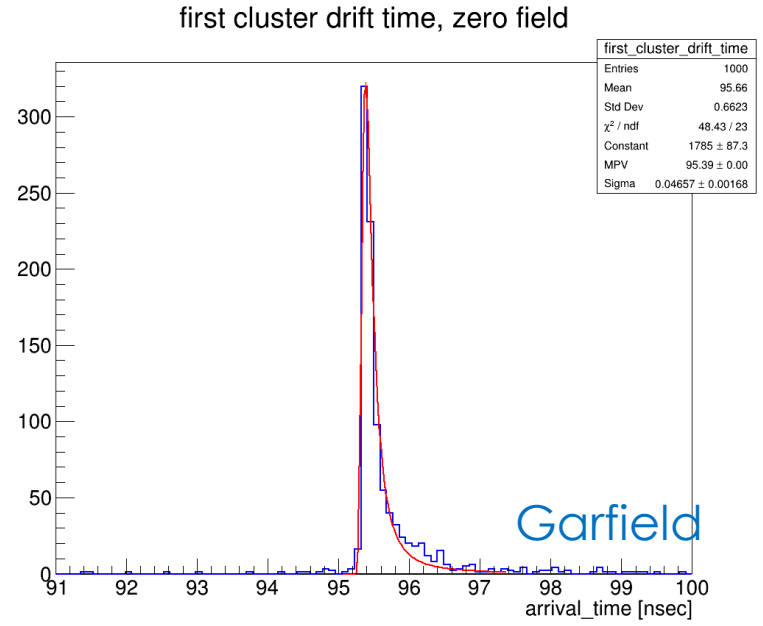


TDR Garfield & Garfield++

comparison of XT relation

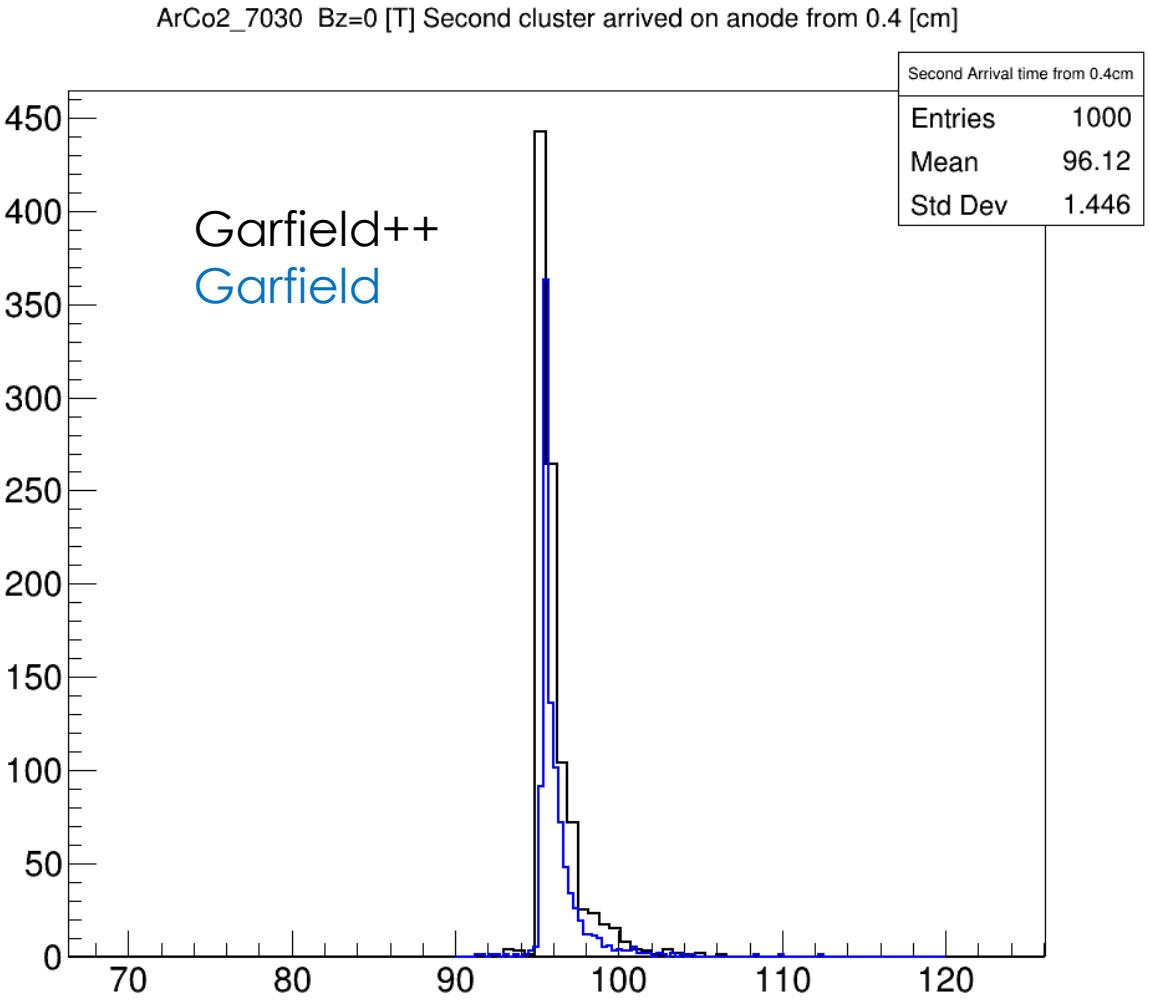


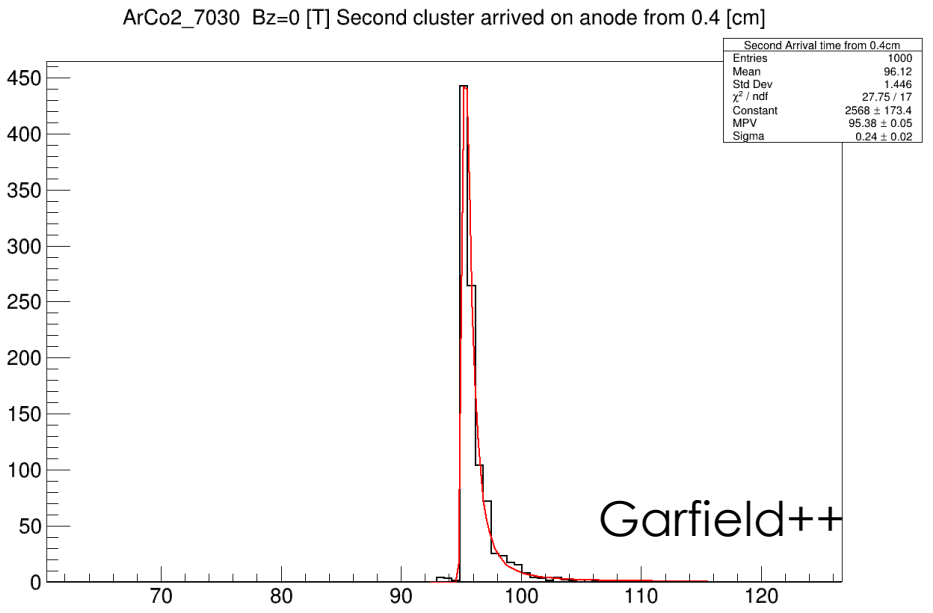


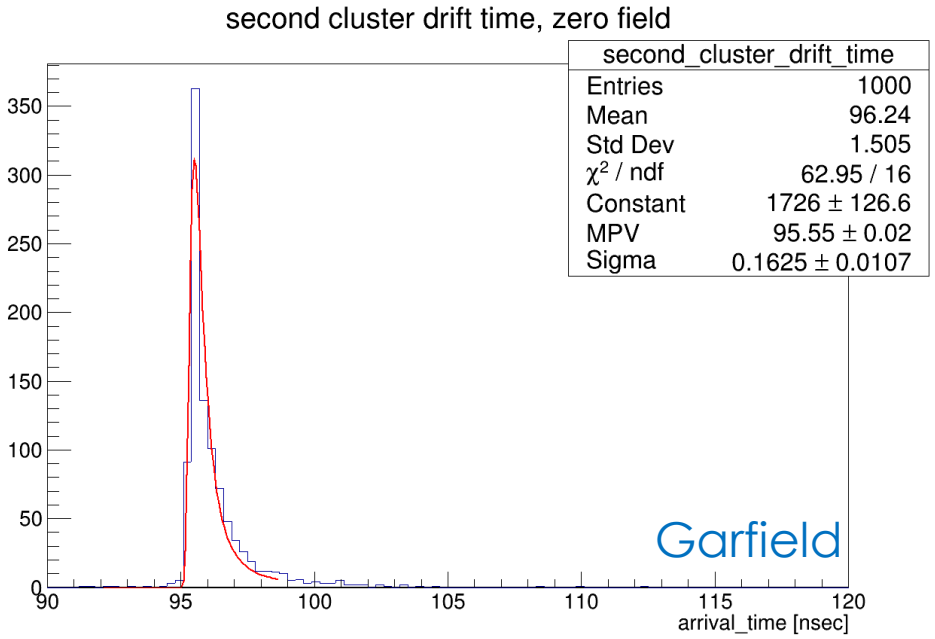


TDR Garfield & Garfield++

comparison of XT relation

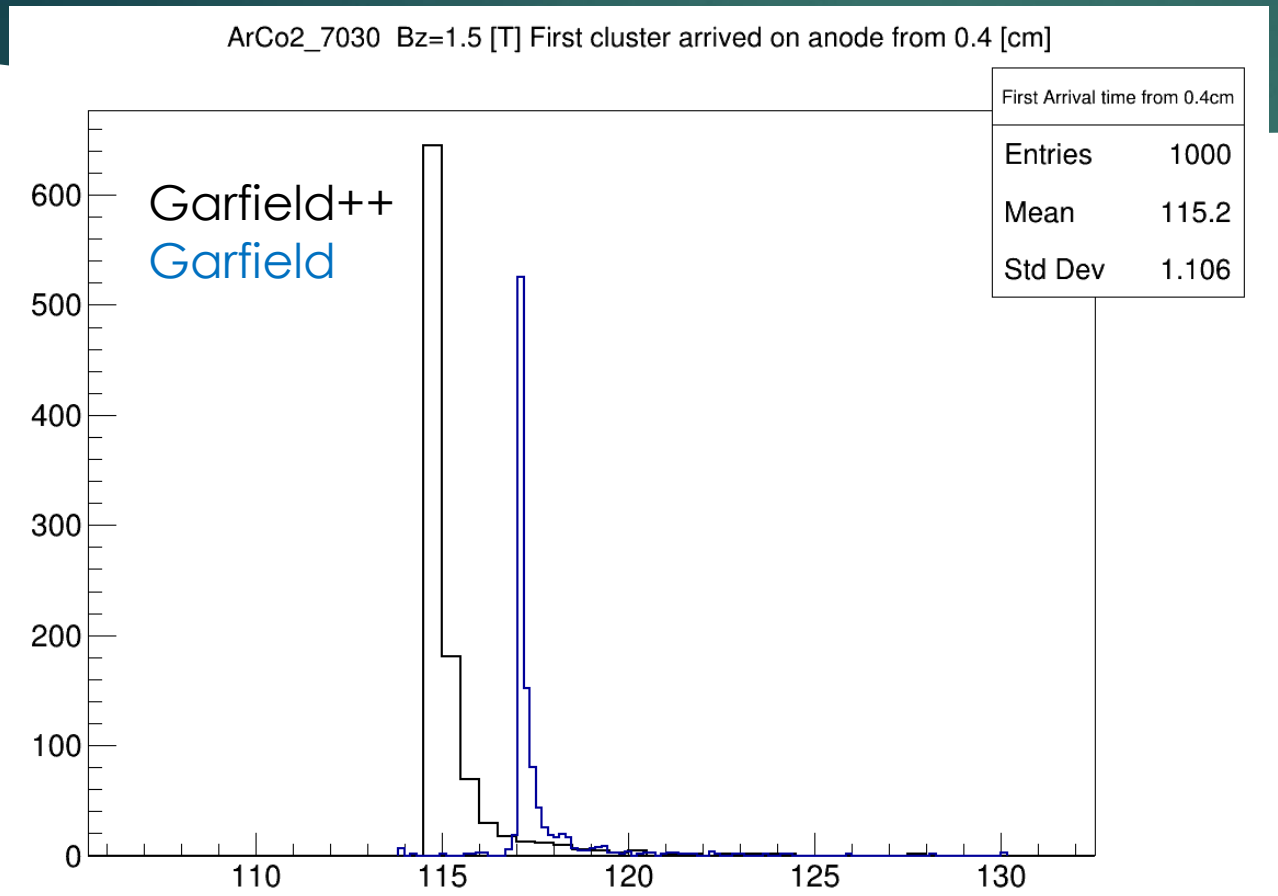


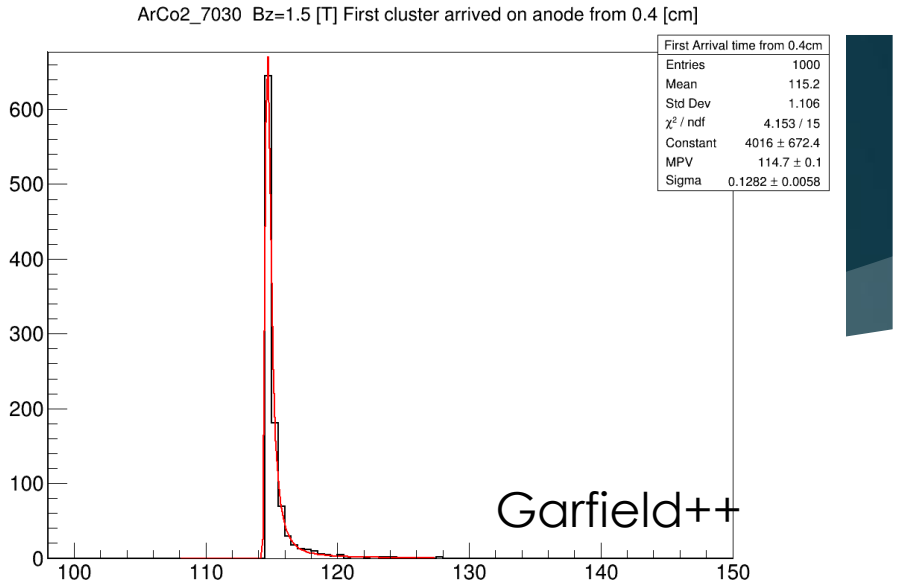


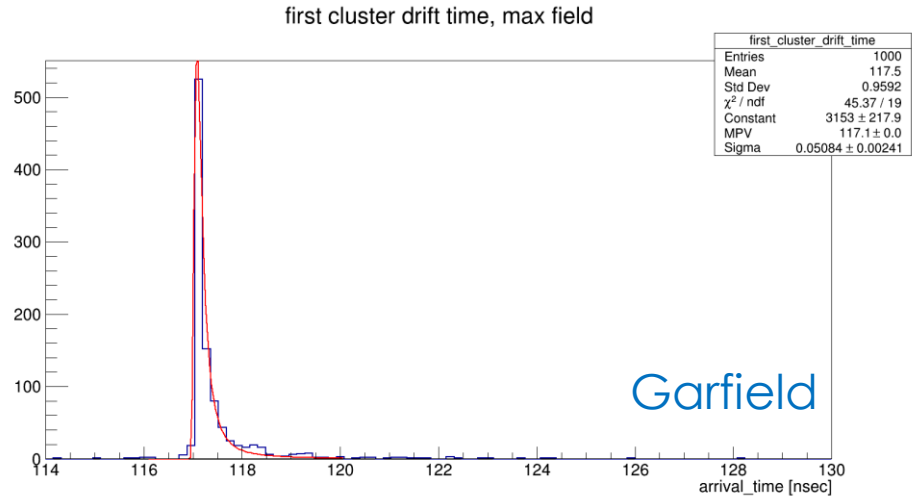


TDR Garfield & Garfield++

comparison of XT relation

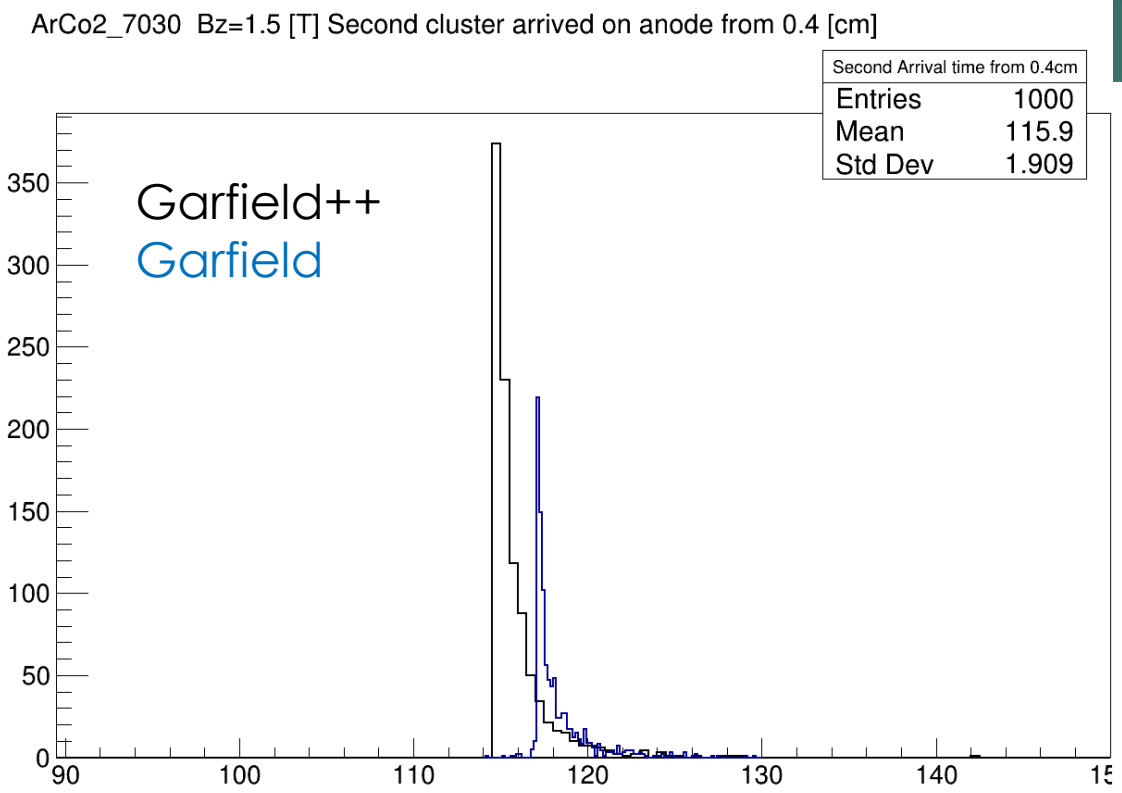


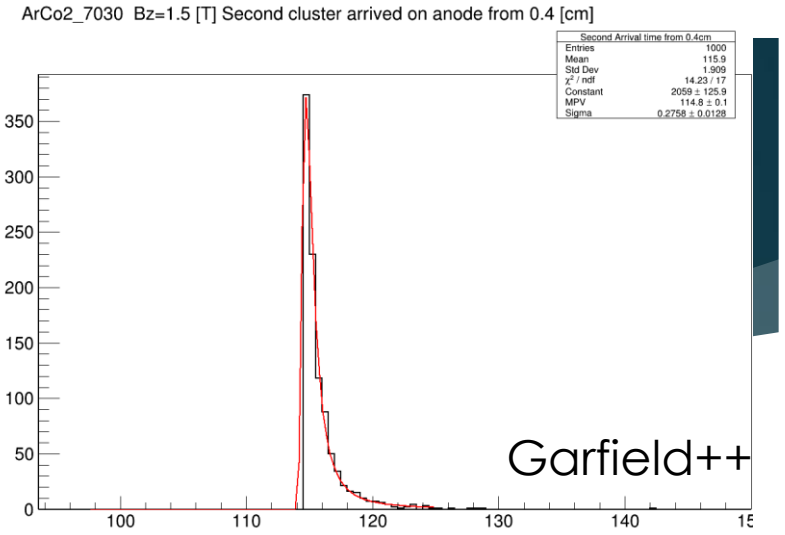


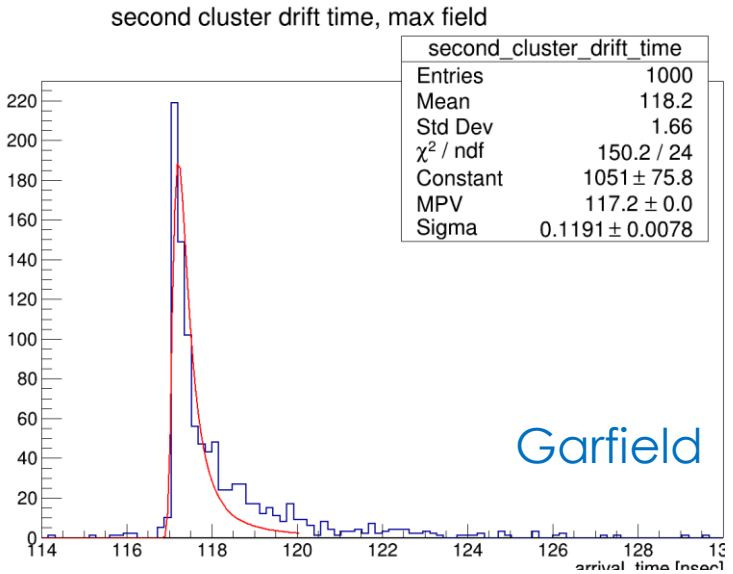


TDR Garfield & Garfield++

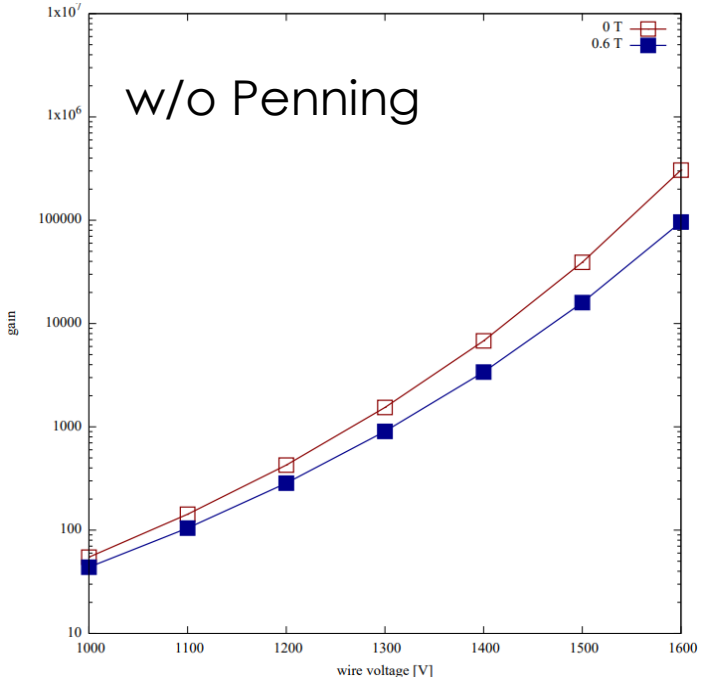
comparison of XT relation

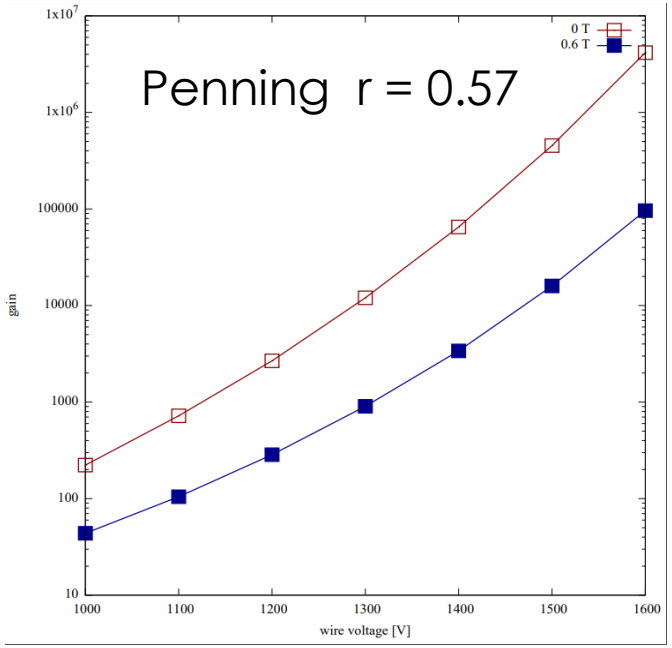






Gas gain problem. Garfield & Garfield++





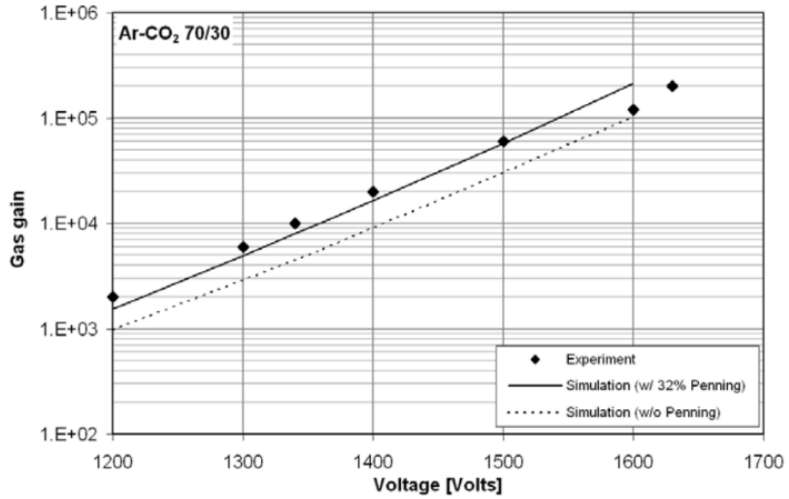


Figure 4-21 Gas gain in Ar/CO_2 70/30 (experimental data and simulation).

Issues:

01 Gas gain

02 Signal different between visualization and data output

03 Difference between signal output after LTSpice simulation

04 Comparing drift path/time distributions

05 TDR plots