LUT UPGRADE

LUT upgrade

Informations inside the LUT:

- Geometry (ROC,FEB,CHIP, strip X/V, side, sheet, layer)
- Noise (rate and mean charge)
- Threshold (effective value and opening width)
- Signal (mean charge, rising and falling time)

Now several runs can be studied together.
Two dataset have been create:
run 10-11-12-13-14-15-16-17
run 18-19-20-21

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- Signal (mean charge, rising and falling time)

Starting from the ROC/TIGER/channel it is possible to define layer, side, sheet and strip (X or V)

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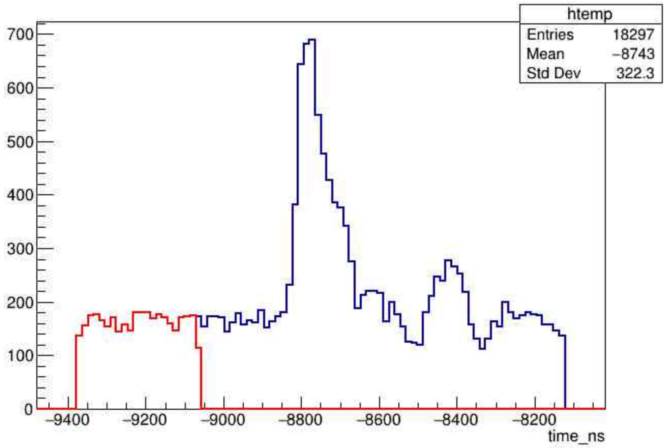
- Threshold (effective value and opening width)
- Signal (mean charge, rising and falling time)



A time slot before the signal is considered to measure the noise rate and the mean charge of the noise

rate = # hits / (time width * # events)

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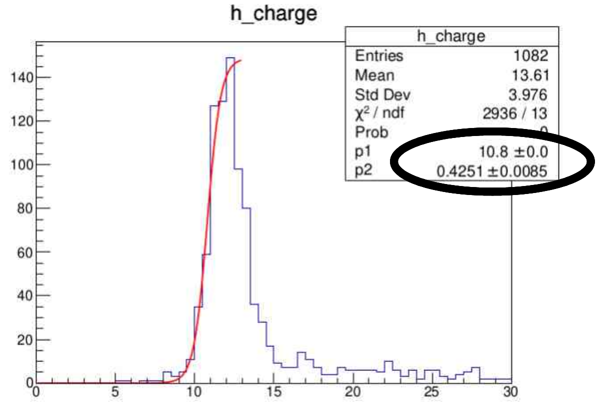
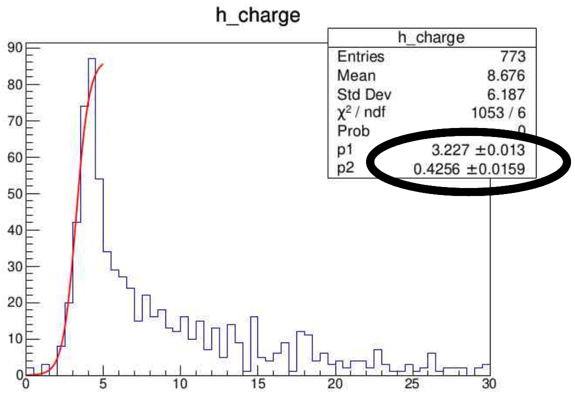
- Noise (rate and mean charge)
- **Threshold (effective value and opening width)**
- Signal (mean charge, rising and falling time)

A Fermi-Dirac fit is used to measure the starting point of the charge distribution. Mean value and sigma are reported to understand the channel performance





LUT upgrade

Informations inside the LUT:

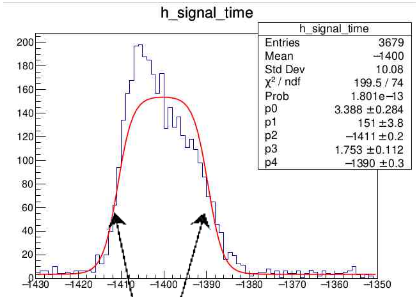
- Geometry (ROC,FEB,CHIP, strip X/V, side, sheet, layer)
- Noise (rate and mean charge)
- Threshold (effective value and opening width)
- **Signal (mean and max charge, rising and falling time)**

Taking into account the hits in the correct time window, the mean charge and the shape of the time distribution are measured

Time fit test

method 1
two Fermi-Dirac

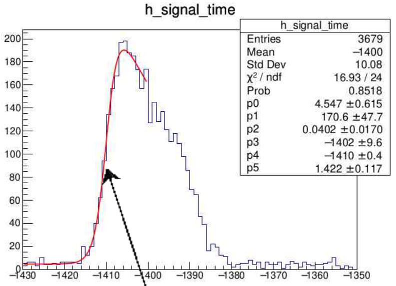
$$par0 + par1*(-\frac{1}{1+exp(-\frac{x-par2}{par3})} + \frac{1}{1+exp(\frac{x-par4}{-par3})}) - par1$$



t_start = par 2
t_stop = par 4

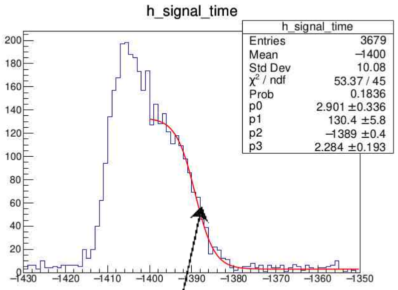
method 2
one FD with exponential
+ one FD

$$par0 + \frac{par1*exp(-par2*(x-par3))}{1+exp(-\frac{x-par4}{par5})}$$



t_start = par 4

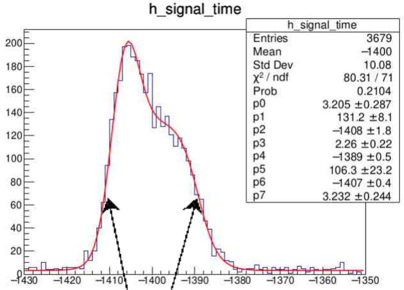
$$par0 + \frac{par1}{1+exp(-\frac{x-par2}{-par3})}$$



t_start = par 2

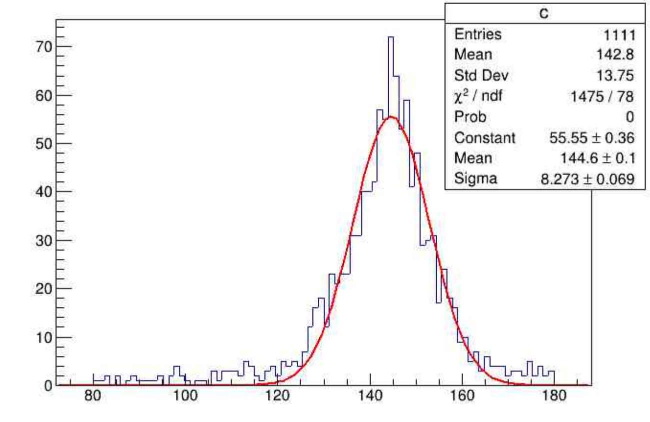
method 3
two FD with
a gaussian

$$par0 + par1*(-\frac{1}{1+exp(-\frac{x-par2}{par3})} + \frac{1}{1+exp(\frac{x-par4}{-par3})}) - par1 + \text{gaus}$$



t_start = par 2
t_stop = par 4

Full statistic HV std - Time test



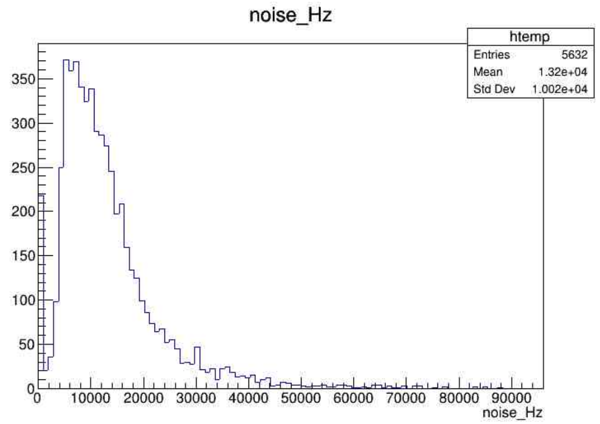
real drift velocity: 37.8 um/ns

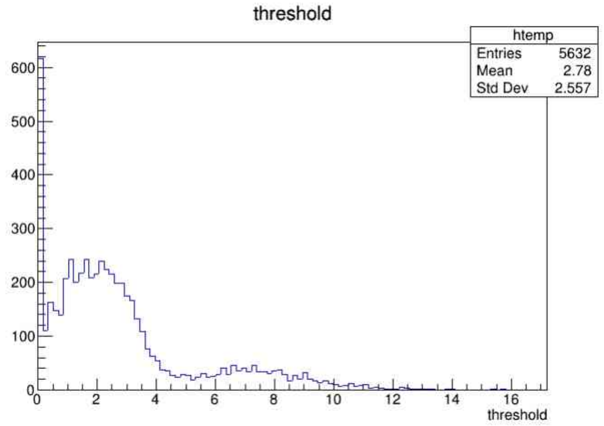
tested channel: 1990

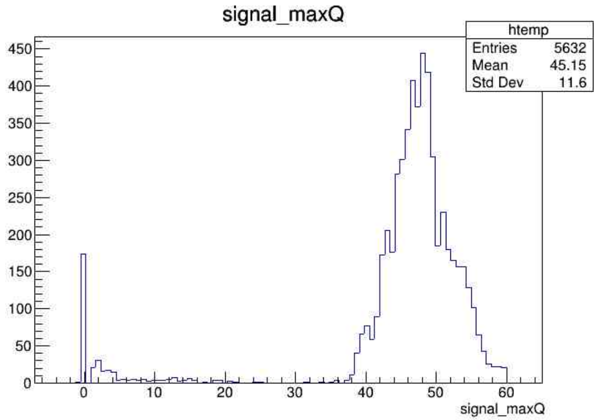
```
root [4] tree->Draw("time_stop1-time_start1>>c","noise_Hz>100 && threshold >0.5 && noise_Hz<10000 && threshold<10 && noise_Q>0.5 && time_sigma1!=0 && abs
(long long) 1102
c->root [5] c->Fit("gaus","W")
 FCN=1486.89 FROM MIGRAD    STATUS=CONVERGED      79 CALLS          80 TOTAL
                     EDM=2.75036e-07    STRATEGY= 1      ERROR MATRIX ACCURATE
  EXT PARAMETER                                   STEP         FIRST
  NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
   1  Constant     5.55592e+01   3.65820e-01   5.30622e-03  -8.14614e-04
   2  Mean         1.44627e+02   5.93444e-02   1.11374e-03   1.18082e-02
   3  Sigma        8.24429e+00   6.92315e-02   3.13638e-05  -1.39824e-02
(TFitResultPtr) <nullptr TFitResult>
root [6] 5000./144.6
(double) 34.578147
root [7]
root [7] tree->Draw("time_stop2-time_start2>>c","noise_Hz>100 && threshold >0.5 && noise_Hz<10000 && threshold<10 && noise_Q>0.5 && time_sigma2!=0 && abs(time_
(long long) 775
root [8] c->Fit("gaus","W")
 FCN=1211.52 FROM MIGRAD    STATUS=CONVERGED      67 CALLS          68 TOTAL
                     EDM=3.64947e-07    STRATEGY= 1      ERROR MATRIX ACCURATE
  EXT PARAMETER                                   STEP         FIRST
  NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
   1  Constant     2.83743e+01   2.94468e-01   3.97971e-03   9.37728e-04
   2  Mean         1.34866e+02   1.40401e-01   2.36952e-03  -1.75675e-03
   3  Sigma        1.19443e+01   1.50391e-01   4.99982e-05  -1.75129e-01
(TFitResultPtr) <nullptr TFitResult>
^[[A^[[A^[[A^[[A^[[Aroot [9] 5000./134.86
(double) 37.075486
root [10]
root [10] tree->Draw("time_stop3-time_start3>>c","noise_Hz>100 && threshold >0.5 && noise_Hz<10000 && threshold<10 && noise_Q>0.5 && time_sigma3!=0 && abs(time
(long long) 1111
root [11] c->Fit("gaus","W")
 FCN=1474.53 FROM MIGRAD    STATUS=CONVERGED      77 CALLS          78 TOTAL
                     EDM=9.50624e-08    STRATEGY= 1      ERROR MATRIX ACCURATE
  EXT PARAMETER                                   STEP         FIRST
  NO.   NAME      VALUE            ERROR          SIZE      DERIVATIVE
   1  Constant     5.55532e+01   3.64831e-01   5.27477e-03  -9.55964e-04
   2  Mean         1.44631e+02   5.94637e-02   1.11121e-03  -4.83808e-03
   3  Sigma        8.27310e+00   6.91961e-02   3.05427e-05  -2.06093e-01
(TFitResultPtr) <nullptr TFitResult>
root [12] 5000./144.63
(double) 34.570974
```

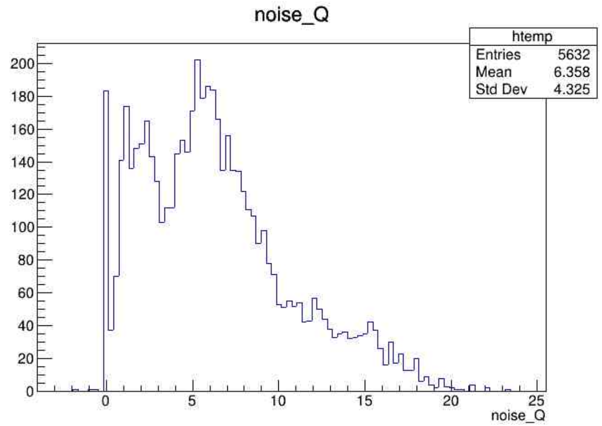
method 1:
#success = 1102
drift. veloc. = 34.58
method 2:
#success = 775
drift. veloc. = 37.07
method 3:
#success = 1111
drift. veloc. = 34.57

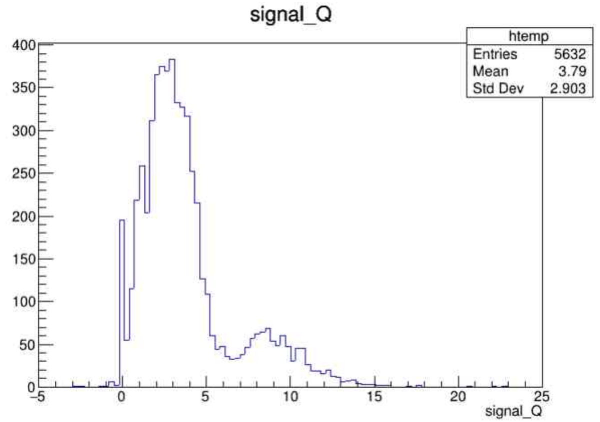
LUT - results







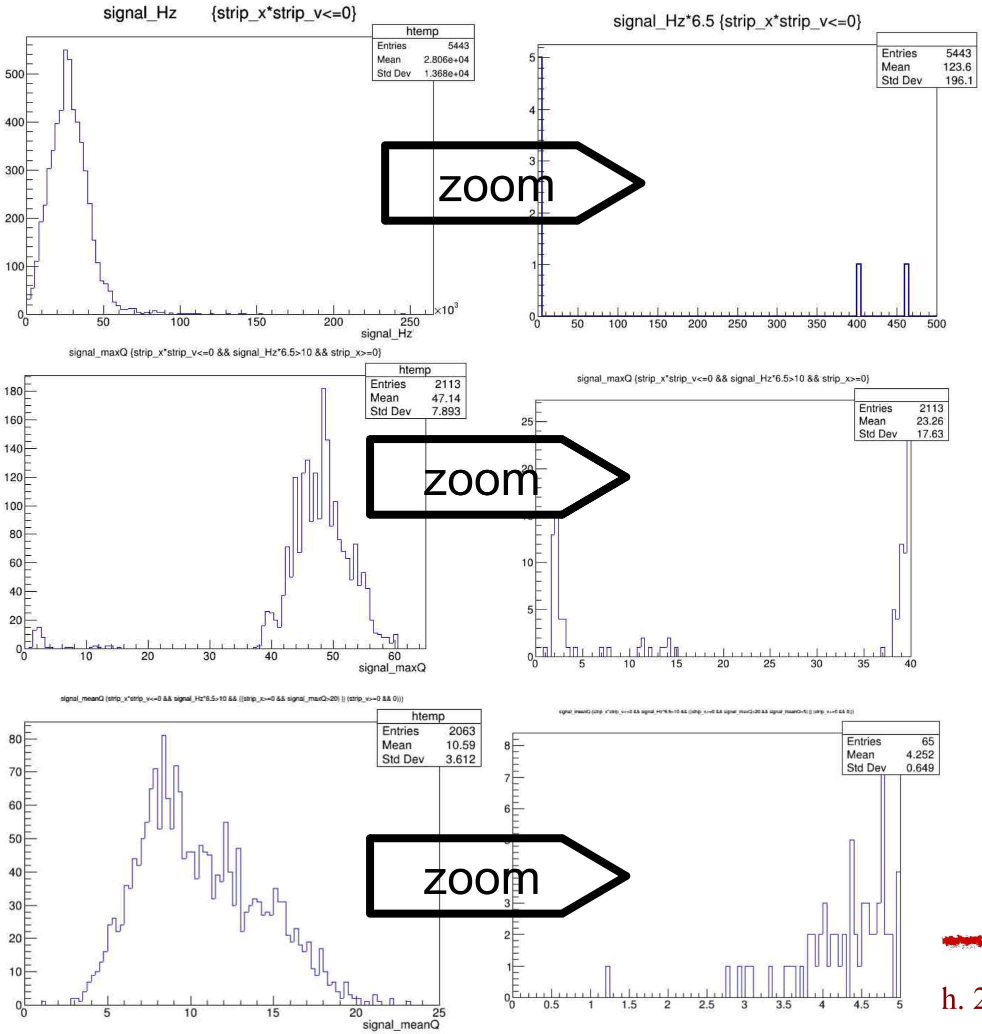




Results for all the channels summarized here.
The studies can be divided channel-by-channel
or view-by-view
or FEB-by-FEB

The results can be used to determine the channel quality

Channel Quality



Good -> **flag 0**
Disconnected -> **flag 1**

Rate in time signal region < 10 Hz
+5 bad channels -> **flag 2**

Max charge measured < 20 fC
(no L1)
+50 bad channels -> **flag 3**

Mean charge measured < 3 fC
(no L1)
+3 bad channels -> **flag 4**

LUT delivery

Release the new LUT with the time information channel by channel and the new flag data goodness where the bad channel will have a flag.

The variables list is:

GENERAL SETTING
runs
high voltage values
energy mode

GEOMETRY
ROC id, FEB id, TIGER id
strip, side, layer

CALIBRATION
qdc slope, constant and saturation value

THRESHOLD
voltage thr. E and T branches
voltage baseline E and T branches
charge cut (fC) E and T branches
effective charge cut (fC) on the channel

NOISE (out of time)
rate (Hz) , mean charge (fC)

SIGNAL (in-time)
rate (Hz), mean chare (fC), max charge (fC)
leading and falling time (ns)
quality

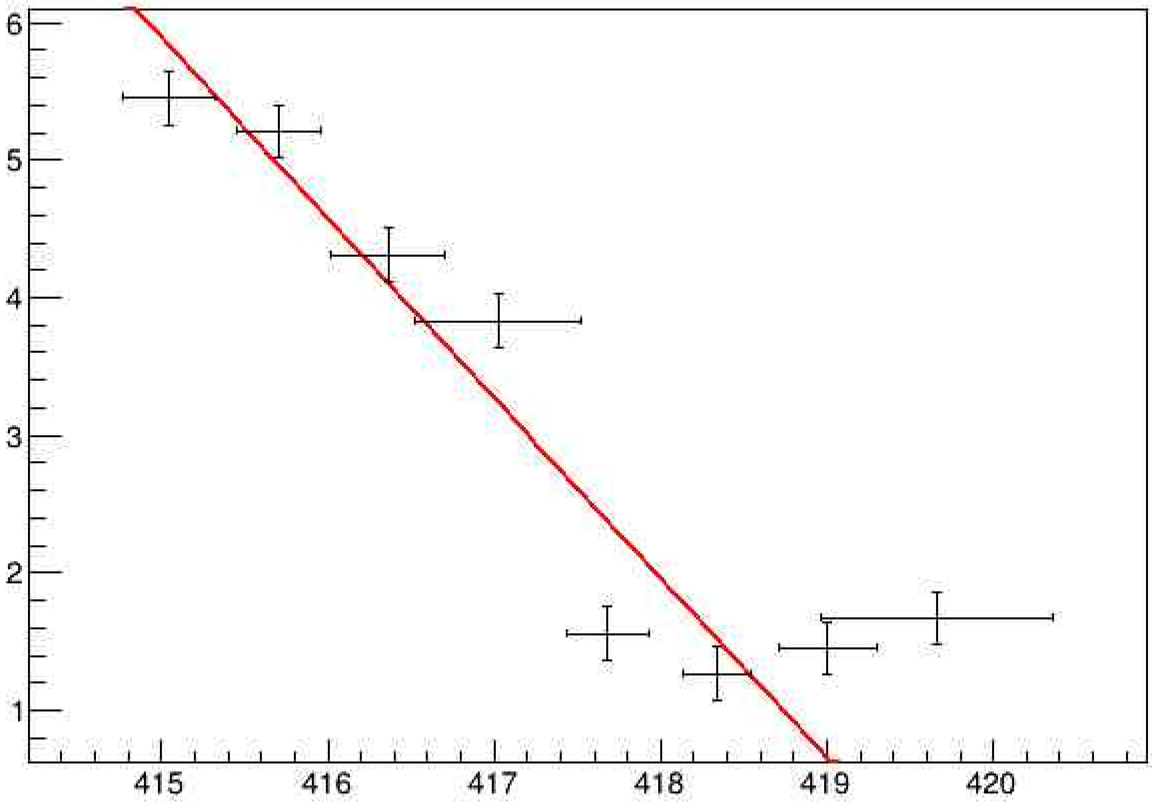
LUT delivery

Time information channel by channel needs more statistic.
A proposal is to measure the leading time and the falling time for each TIGER instead of channel-by-channel.

Is CGEMBOSS ready to read this variable?
Is it possible to use this information in the uTPC reconstruction?

UPGRADE IN CGEMBOSS

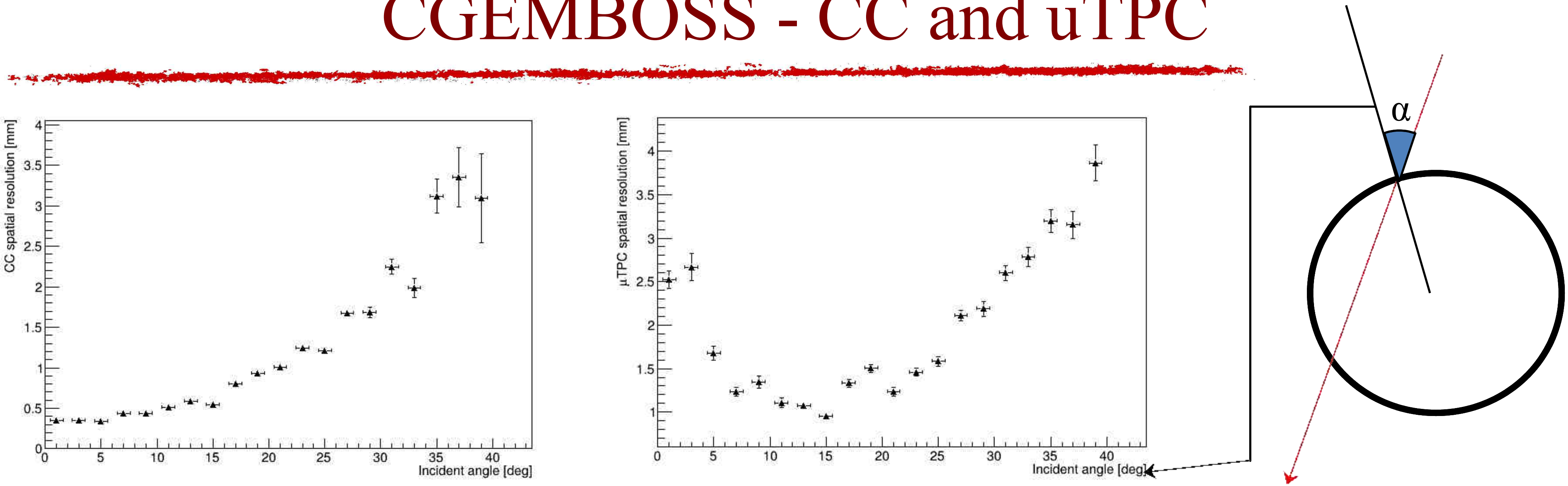
CGEMBOSS - uTPC



Implementation of the error bars in the uTPC reconstruction mode=2

The error on the time is fixed while the error on the position is weighted with the hit charge

CGEMBOSS - CC and uTPC

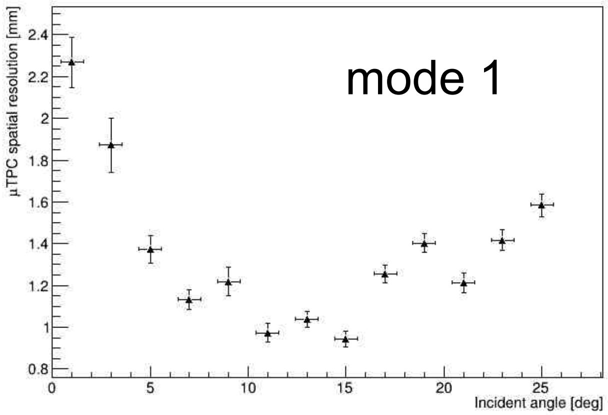


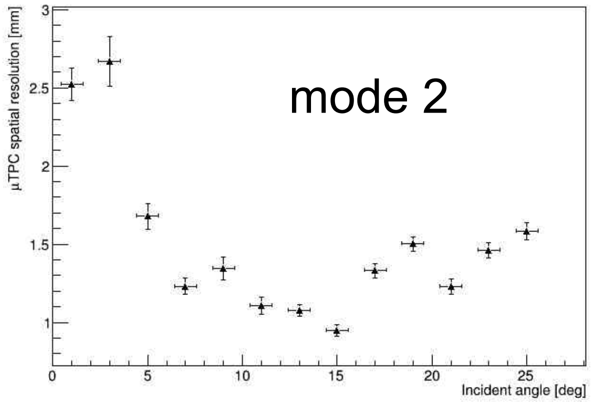
The behavior of the CC and uTPC as a function of the incident angle is evaluated.
The reported value (Y axis) is the sigma of the Gaussian fit of the residual distribution.
The value includes the spatial resolution of the detector plus the contribution of the tracking system.

As expected the CC degrades as the incident angle increases, while uTPC reaches a minimum at around 10-15° and then it gets worsen.

It is important to understand if the behaviour of the uTPC after 20° is related to the tracking system that uses the CC only.
The merge procedure is needed in the tracking system to study incident angles larger than 20°

CGEMBOSS - uTPC



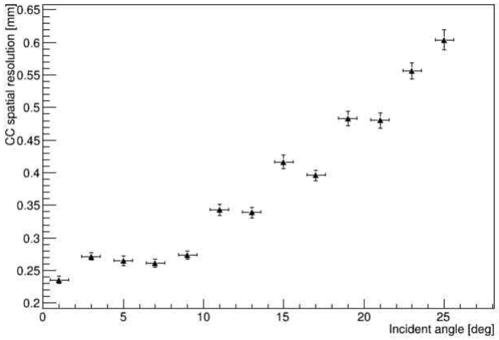


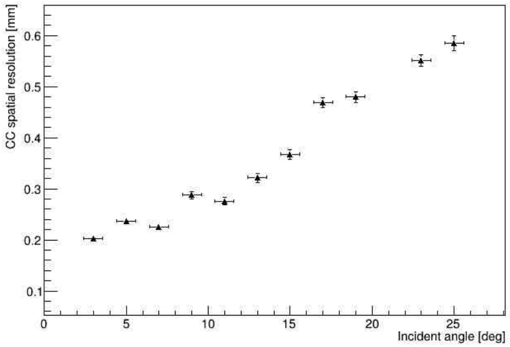
Two methods are implemented in CGEMBOSS:
mode 1: it does not consider the drift velocity and it measures with a linear fit the position corresponding to the time in the middle of the time distribution

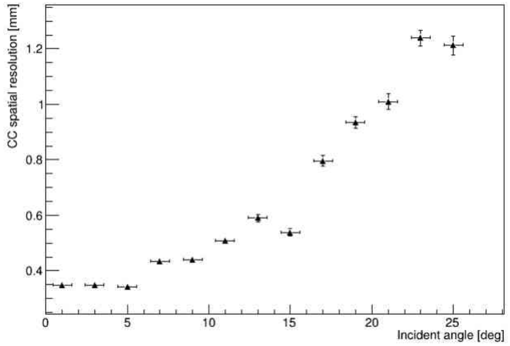
mode 2: it measure with a linear fit the position corresponding to the middle of the drift gap

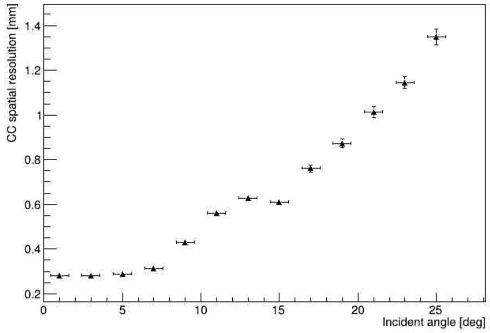
Consideration: the mode 1 is new and it should be tested. If the drift velocity is measured correctly by the detector, then there are no differences between the two procedures.

CGEMBOSS - CC + uTPC

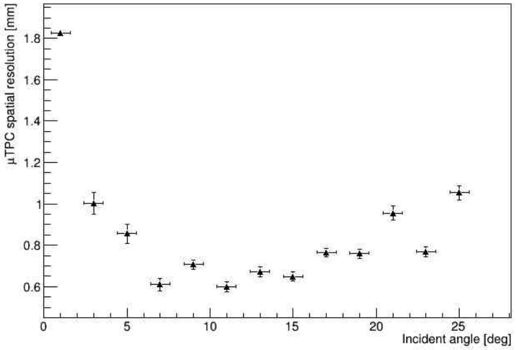


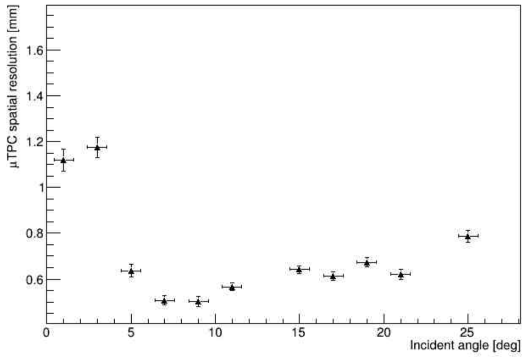


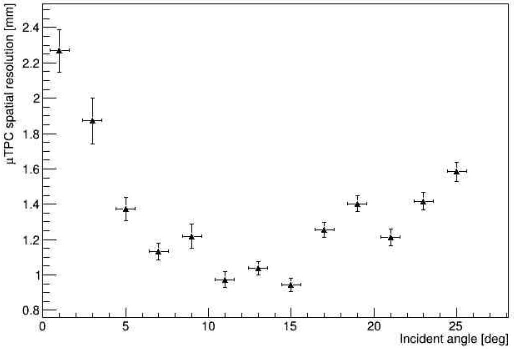


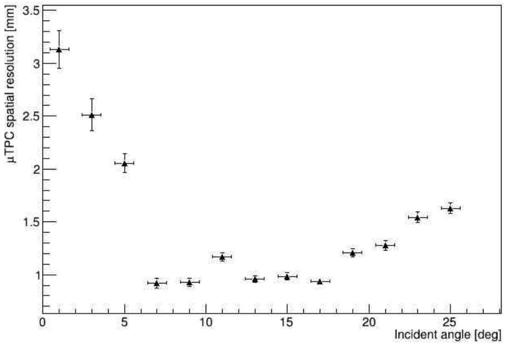


L1bot | L1top | L2bot | L2top

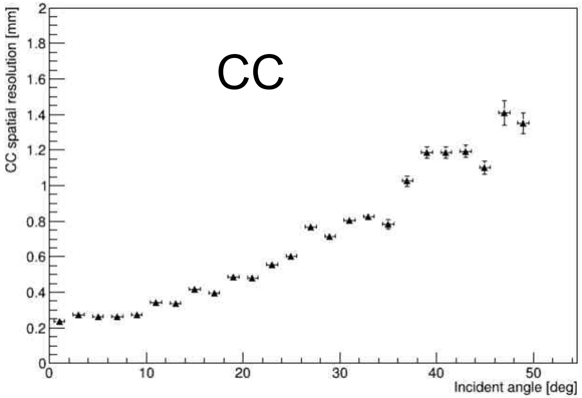


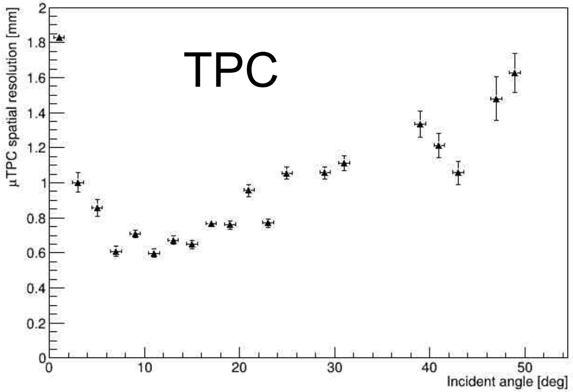


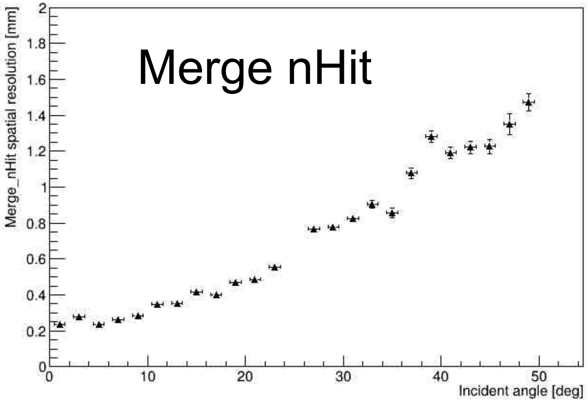


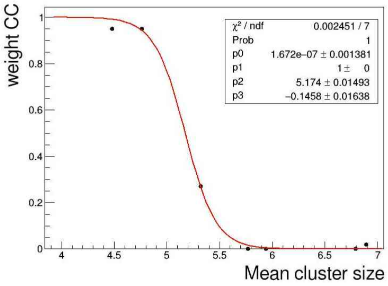


CGEMBOSS - Res on L1bot **w/o** merge on TRK







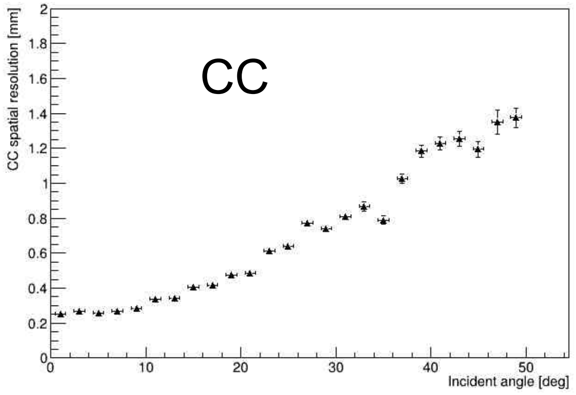


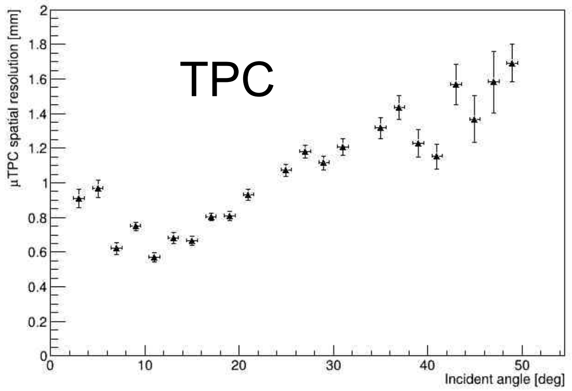
Test the merge as a function of the incident angle:

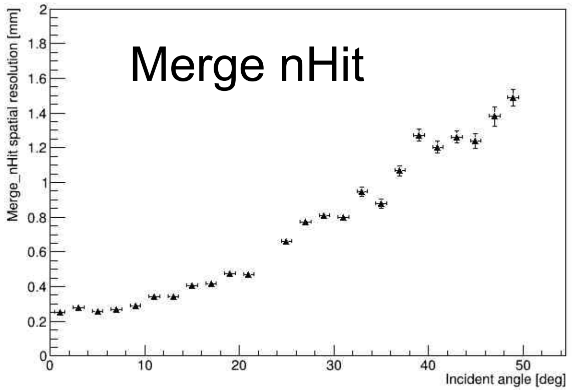
x_merge = x_cc * w_cc + x_tpc * (1-w_cc)

Now let’s test the reconstruction using the merged position on the tracking system

CGEMBOSS - Res on L1bot **w/** merge on TRK







The performance of the CC, TPC and merge are the same of the previous slide.
Then the merge needs to be improved.
The reason of the failure are due to the smaller cluster size in the CGEM w.r.t. the one in the planar GEM used to develope the merging function.

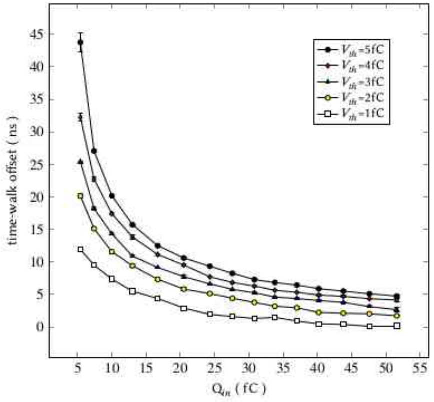
This introduces some problem in the study of the uTPC for large angles.

CC and uTPC considerations

Layer 1 performs better than Layer 2 despite larger threshold levels.
Is this due to the tracking system contributions?

The uTPC does not reach a flat behavior as a function of the incident angle, contrary to the expectetion from the planar studies

The uTPC does not performe better than 0.6-1 mm
--> it requires more code development to improves the performance
--> a better time reference is needed. LUT informations can be included in the reconstruction, as discussed in the past
--> time walk-effect can shift the measured time up to 40 ns and we needs to include this correction in CGEMBOSS



The merging procedure has been implement in CGEMBOSS and now it could be relased.