Time plans

Riccardo Farinelli
On behalf of Integration Group

Outlook

1) Time-reference summary

2) Time-walk summary

3) Signal shape effect

4) Validation

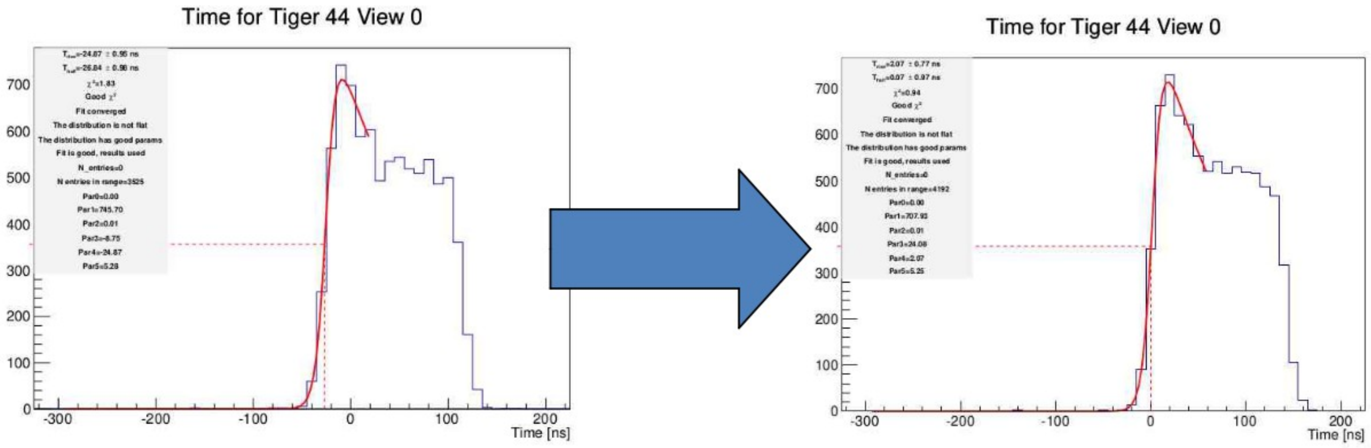
Time reference

Time-reference measures the leading edge of the time distribution and it aligns it to zero.

We developed the following modes to measure the time-reference:

1. Only TIGER & Q>30fC
2. Only TIGER
3. TIGER & Channels

--> TIGER & Channels & Q>30fC is missing. Do we need it?



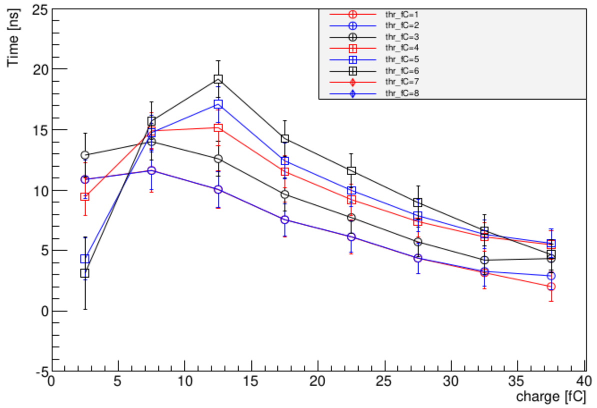
Time-walk

The correlation between the charge and time at different threshold has been measured with different methods.

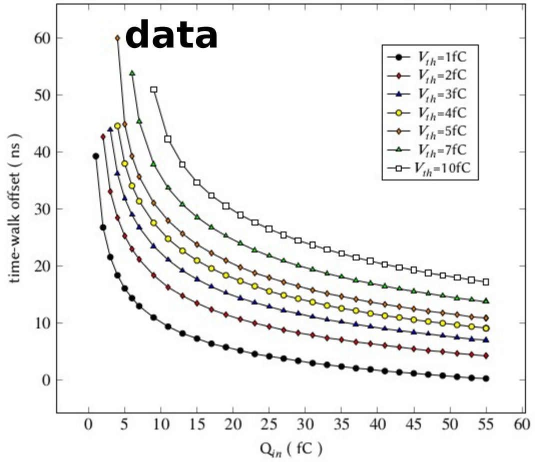
1. Simulation and on-chip calibration inject a known charge in the electronic channel with a fixed signal shape. This technique allows to measure the time-walk of the electronics
2. Experimental approaches show a similar method but the signal shape used is different. This technique depends on the signal shape: duration, amplitude, multi peaks, etc …

The two methods are differents and they do not measure the same physics quantity.

experimental



simulation data



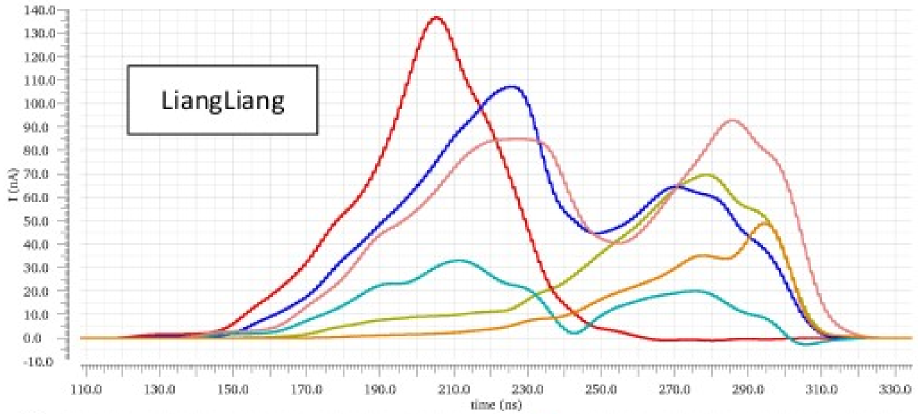
Signal shape

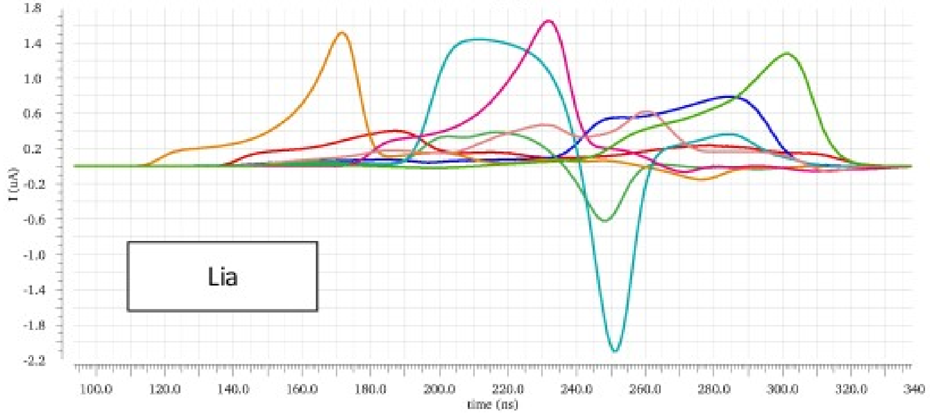
Simulations from the CGEM group show several signal shapes.

Further studies on these simulations shown that the signal length as an impact on the charge measured due to ballistic effect: from 0% to 20% charge loss for signal from 10ns to 250ns

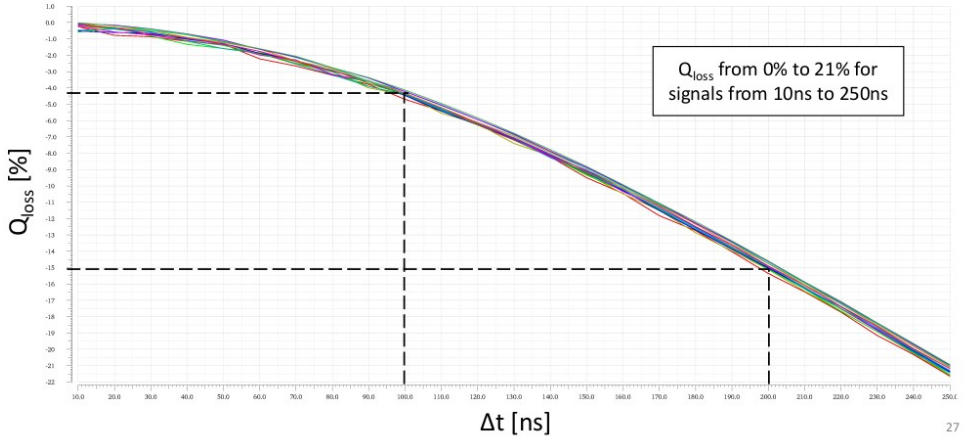
Signal length has an impact on the charge, but what is the impact on the time? What is the proper time to use with the µTPC?

Charge and time measurement depend on the signal shape. This contribution is not time-walk, it is a separeted contribution to be studied and to be added to the time-walk.





Ballistic deficit vs signal duration (E-branch)

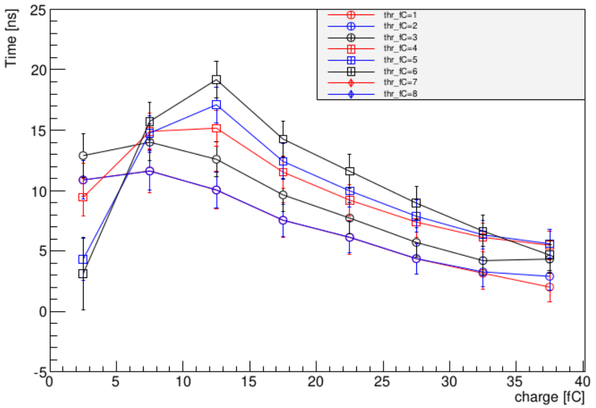


Time-walk

TIME-WALK+
SIGNAL SHAPE EFFECT

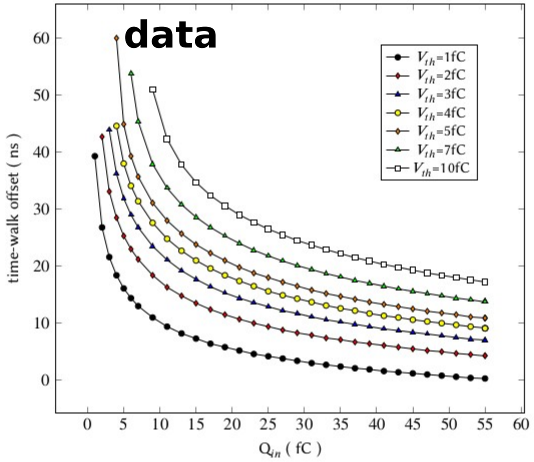
TIME-WALK
ONLY

experimental



simulation

data

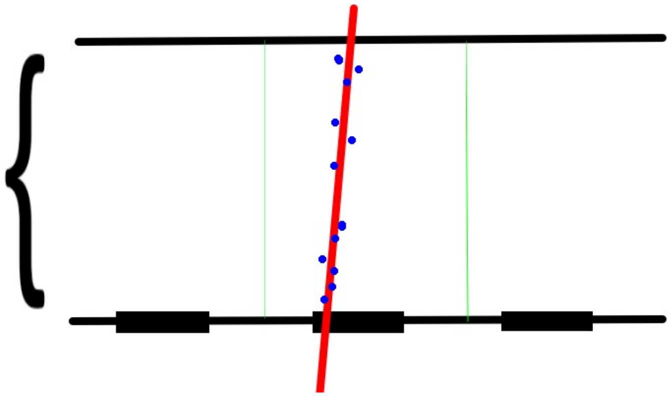


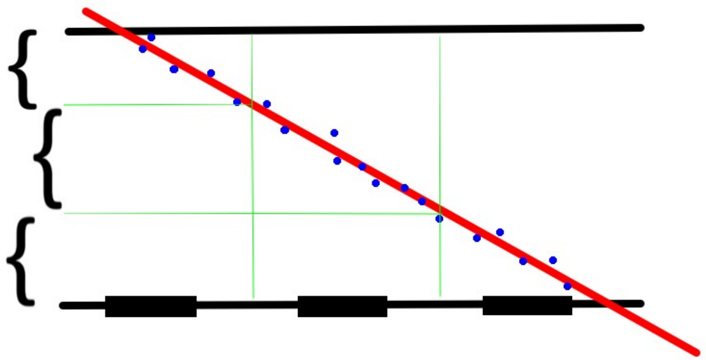
Signal duration

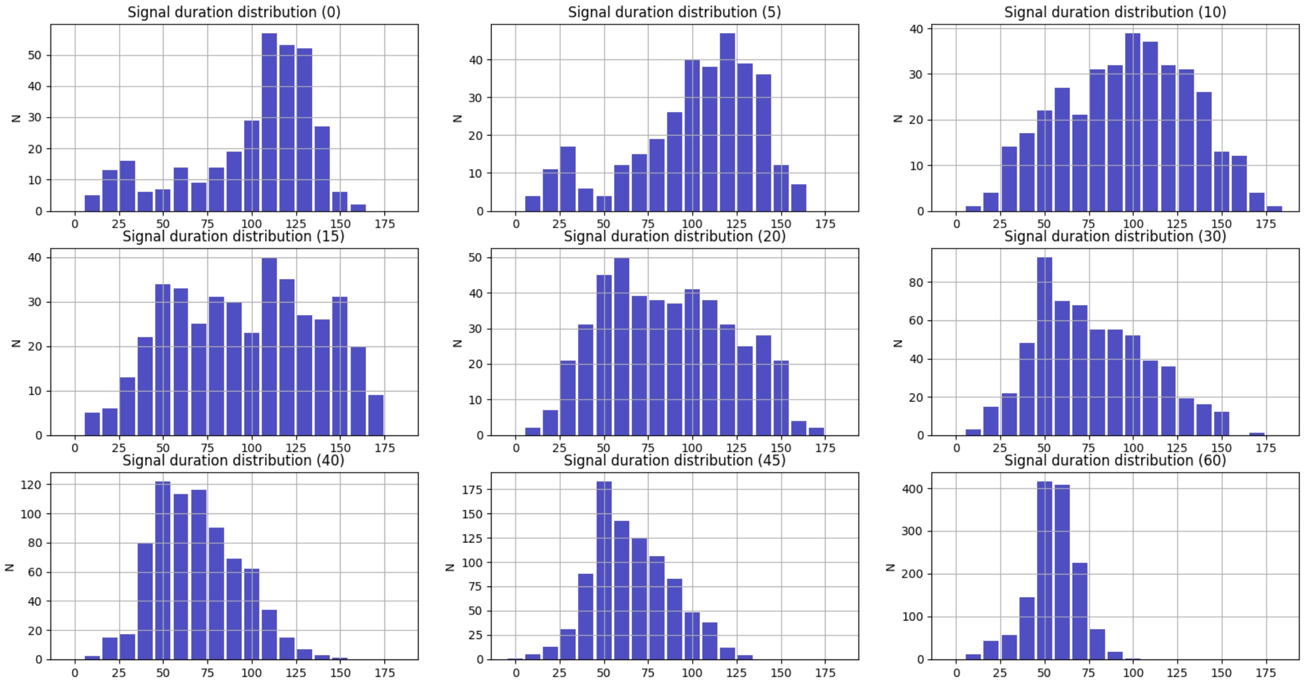
Starting from the simulations as a function of the incident angle we can mesaure the signal duration between 5% and 95% of the charge integration.

The signal duration depends strictly on the incident angle: if the track is orthogonal then the duration length is maximum, then its impact on the charge and the time measurements.

If the track is 45° the signal duration is shorter and there the contribution of the signal shape on the charge and time measurements is smaller.







- HV = 275 / 275 / 275 V
- campi = 1.5 / **2.75** / **2.75** / 5 kV/cm
- gas = Ar-Iso 90-10
- velocità di drift ~ 35 micron/ns

Validation

How can we decide the goodness of our time calibrations?

1. Time-reference -> convergence

2. Time-walk -> it depends on the chip architecture only

3. Signal shape effect -> ??? some information can be extracted from the so-called “Time-walk from measurement” but this effects needs more comprehension from the integration and the software group

4. uTPC resolution should be the best benchmark for the validation but the contribution of the tracking system is too large

Next steps

Since the “signal shape effects” affects mainly the orthogonal tracks but the µTPC is an algortihm used if the tracks has an impinging angle larger than 15°, at this stage we suggest to neglet it and to apply the time-walk correction from on-chip measurement.

This method has to be validated with a measurement of the so-called Time-Walk from the data with a selection on the impinging angle to observe if the behavior in the low charge region becames closer to the one measured on-chip.

Mass production of the time-calibration:

1. Time-reference (only high charge?)
2. Time-walk from on-chip measurement
3. Validation of the time-calibrations
4. Capacitive and diffusion studies

Spatial resolution improvement:

1. Studies with the CC on the trackers
2. Studies with the µTPC on the trackers
3. Developement of the merge
4. Improvement of tracking system and goodness validation


Thanks

μTPC and CC residuals from standalone to QA

1. Reconstruct the μTPC with time-walk and time-reference using the QA.
   -> Test the new alignment

2. Evaluate the contribution of the tracking system using the μTPC instead of the CC on the trackers

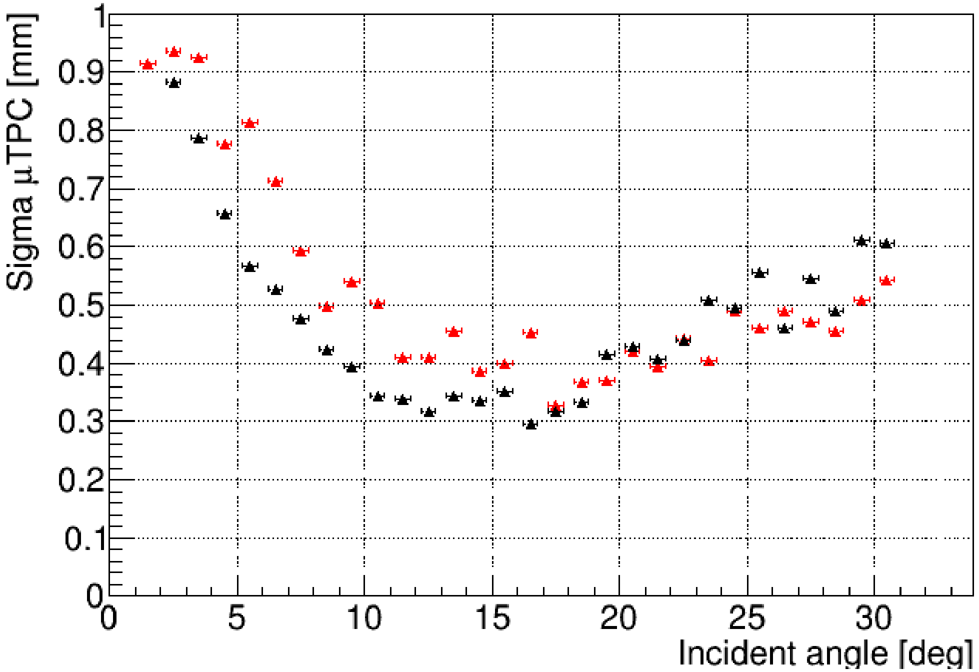
3. Start preliminary studies of the merge?

Consideration on the time calibrations

No significant improvement are visible from the residual behavior as a function of the angle.

We have to figure out a different way to establish the goodness of the time corrections.

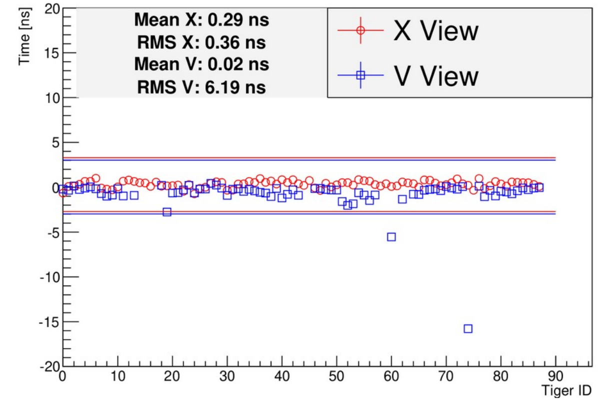
Some improvement can be observed in the incident angle region [0-15] where the tracking system has its smallest contribution

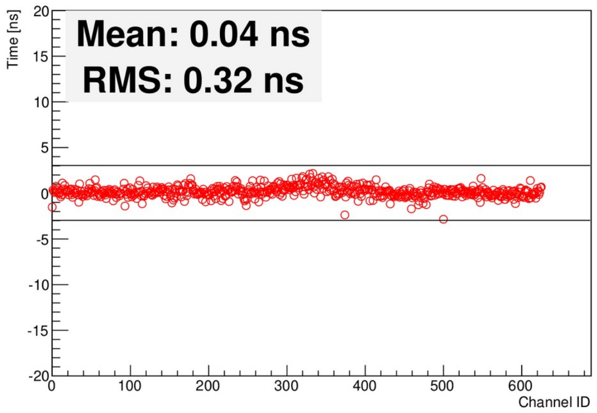


Time calibration: results and monitor tools

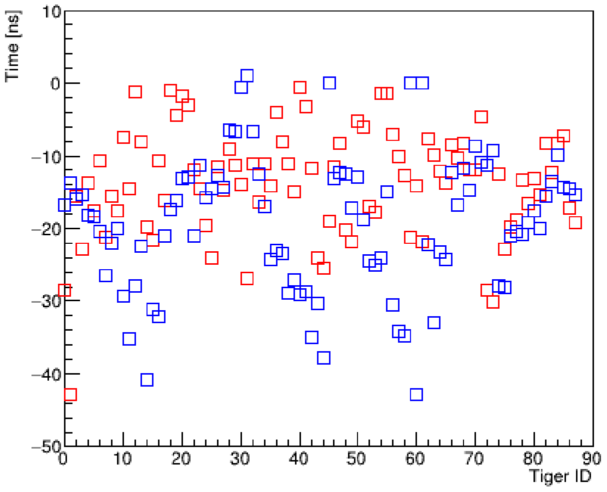
time-reference

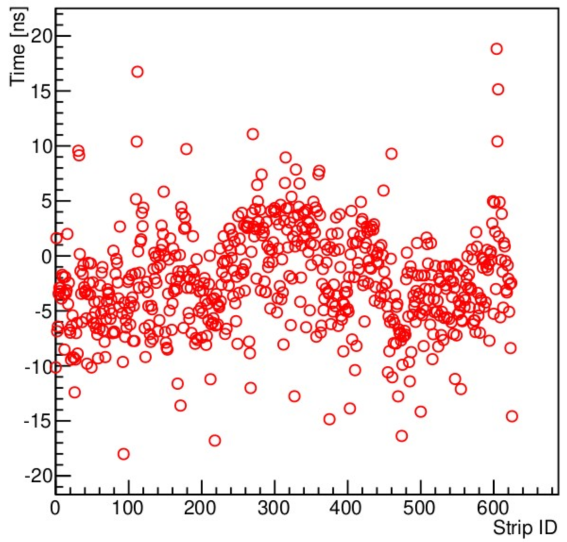
CONVERGENCE TEST





FULL CORRECTIONS



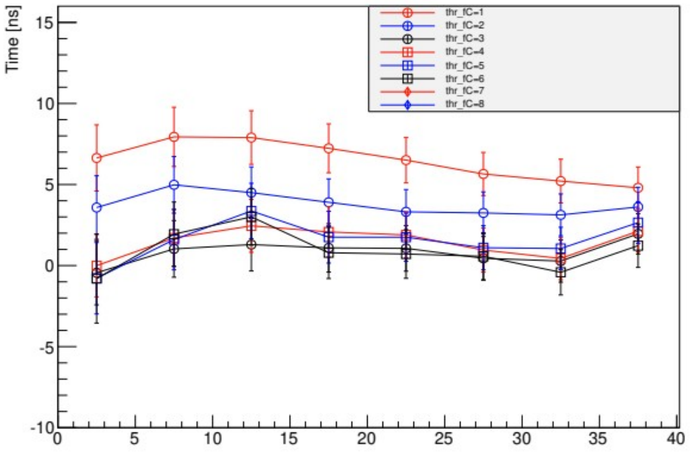


Mass production: first test on run 17

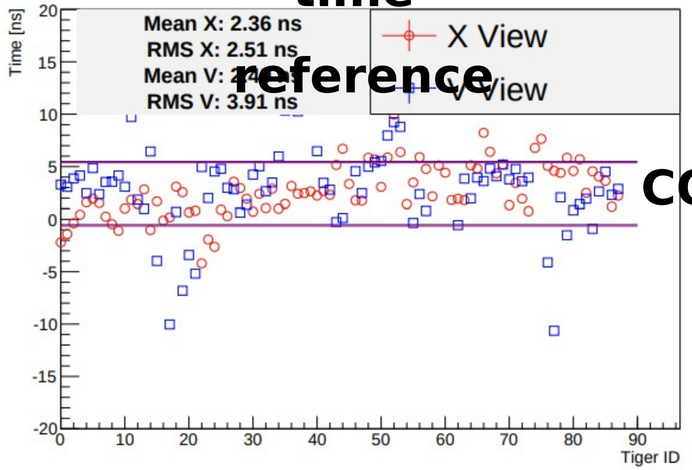
Time-walk and Time-Reference values have been studied. The new values for a different run are close from the initial one, whitin 10 ns.

We plan to develop a tool to perform the time calibration to each run acquired from December 2019 up to now. This is needed to complete further studies on the µTPC, such as the capacitive corrections.

time-walk



time-reference



CONVERGENCE TEST

Mass production: the capacitive corrections

Do we need to fix the time calibration to start this study?

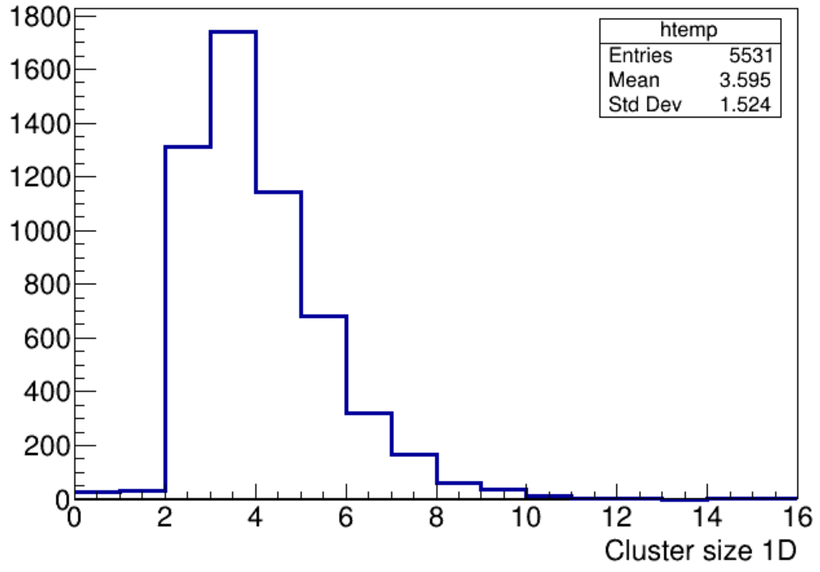
Do we need to update my code in CgemClusterCreate?

To start these studies we need to implement some variables in the CgemDigi Collection or something similar.

Is it possible to perform those studies in a data-driven way?

> The statistic and the cluster size range is small

> we need to define the calibration to merge different runs



Mass production: the capacitive corrections

Time calibrations depends on:

1. cluster size
2. position inside the cluster
3. charge

The impact on the µTPC resolution is significant but it needs a large training of the algorithm from the CGEM-IT data.

A first test using the capacitive and diffusion correction from the planar GEM did not shown improvements.