Time Calibration
and
µTPC studies

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Outlook

ASD

Time calibration summary

time-walk

The shape of the signal affects the measured time. The correlation between time and charge is studied.

time-reference

The TIGER chips are synchronized but the time measurement of the same event can differ due to geometrical differences (i.e. routing, strip length, etc).

time-propagation

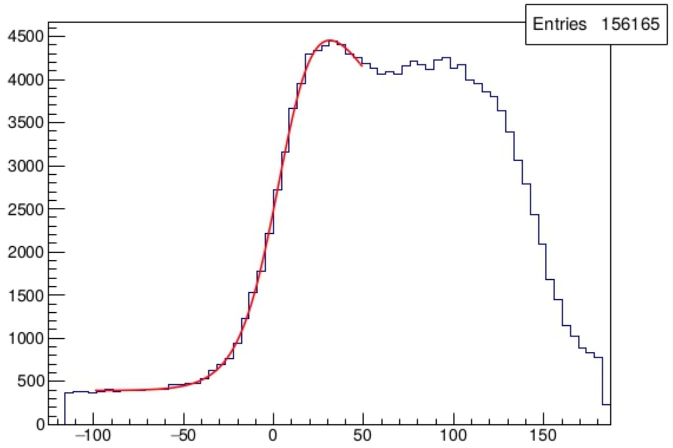
The signal propagation from the induction place on the strip and the chip affects the time measurement.

Time calibration: time measurement

The time distribution of the hits can be studied to extact the starting time of a certain group of recorded signal (i.e. all the hits of a TIGER or all the hits measured by a channel with a certain threshold).

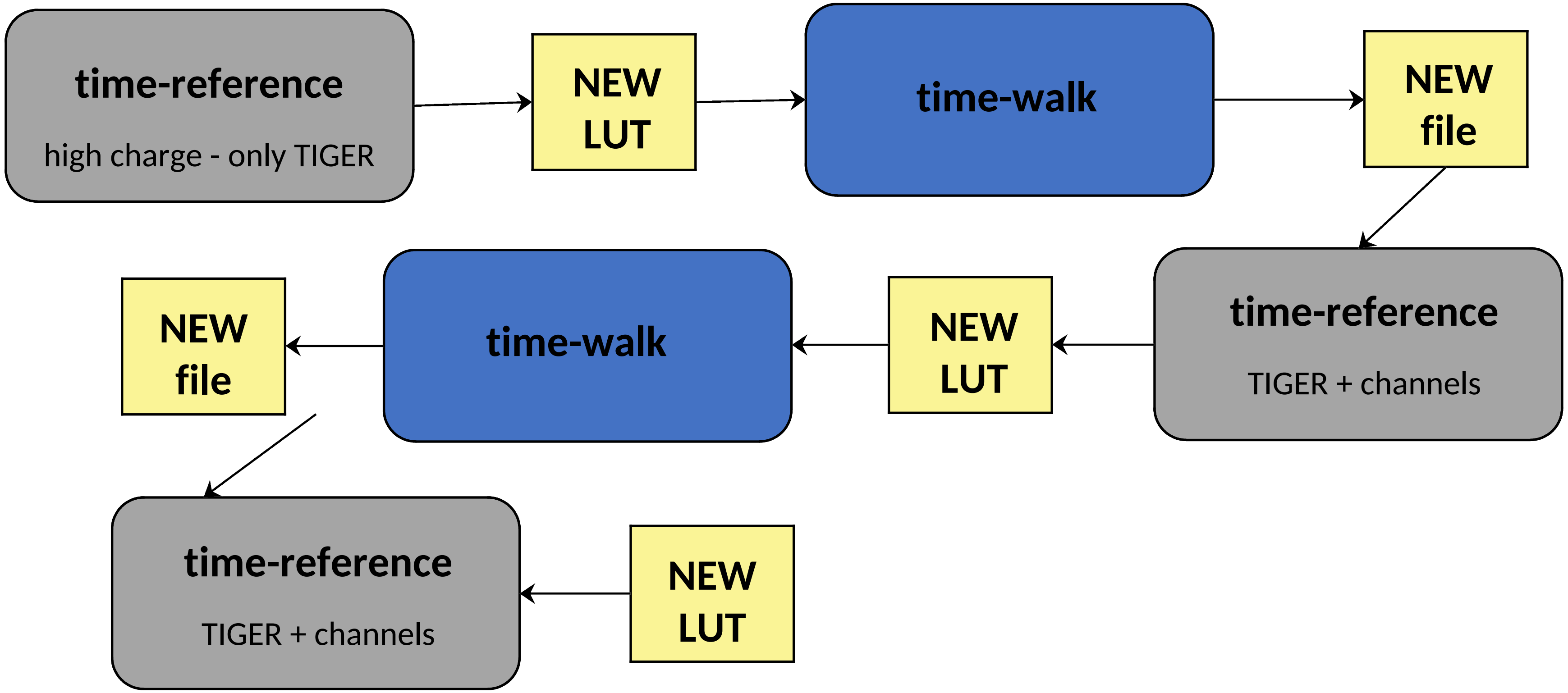
The function used to fit the rising edge is:

$$[0] + \frac{[1]\, e^{-[2]\,(x-[3])}}{1 + e^{-\frac{(x-[4])}{[5]}}}$$



time distribution [ns]

Time calibration: calibration procedure

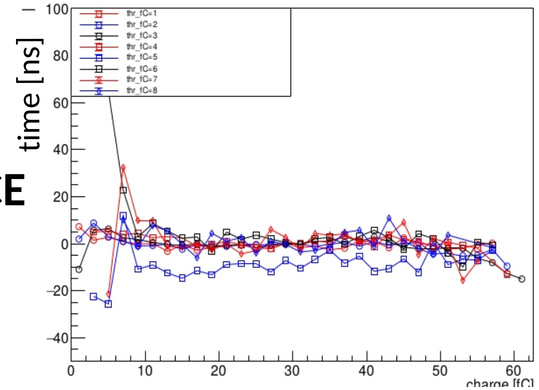


RESULTS FROM WILL

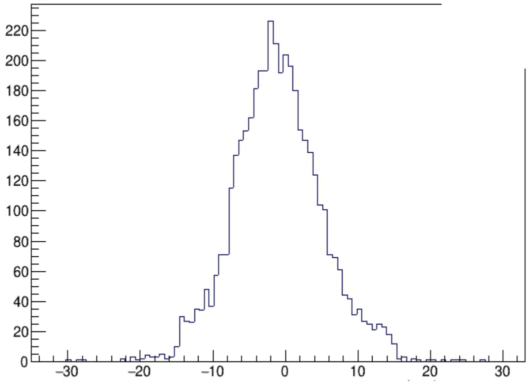
time-walk

time-reference

CONVERGENCE TEST



charge [fC]

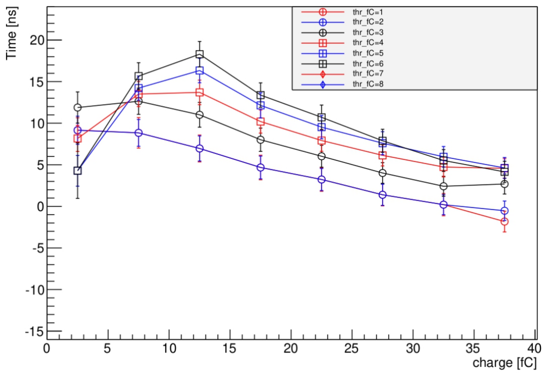


channel time reference [ns]

missing plot

TIGER time reference [ns]

FULL CORRECTION



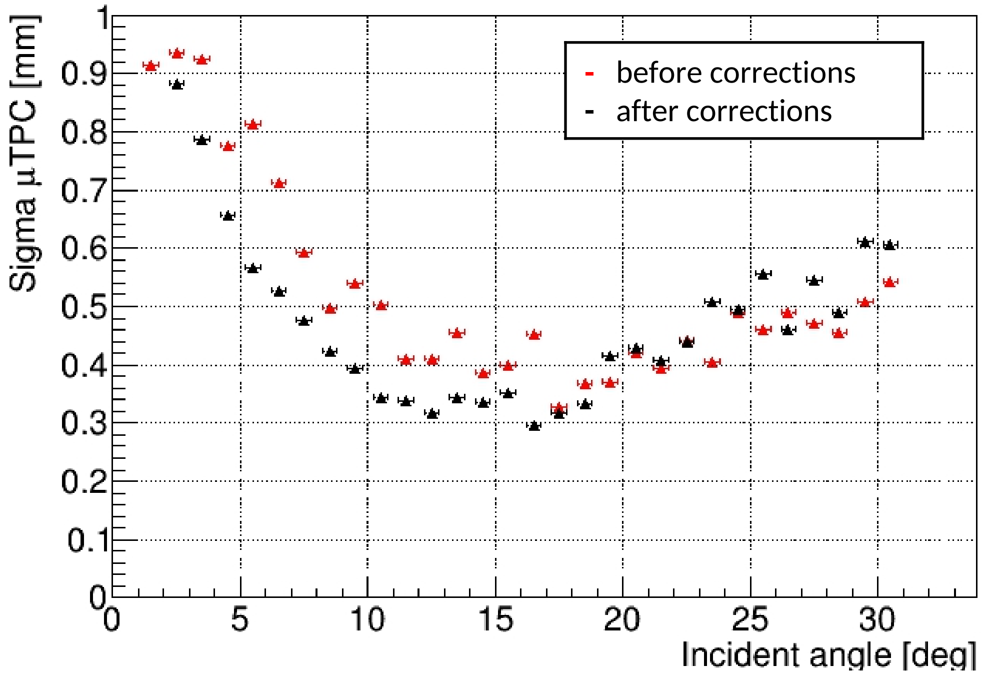
missing plot

channel time reference [ns]

missing plot

TIGER time reference [ns]

Time calibration: corrections impact on µTPC

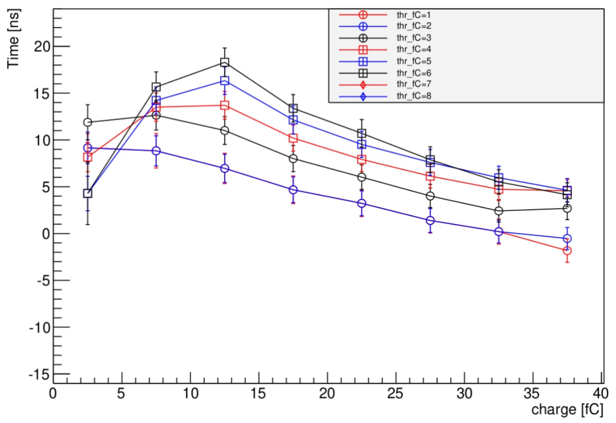


The time calibrations introduce an improvement of the **sigma µTPC** in the region below 20° incident angle. The time calibrations are successful.

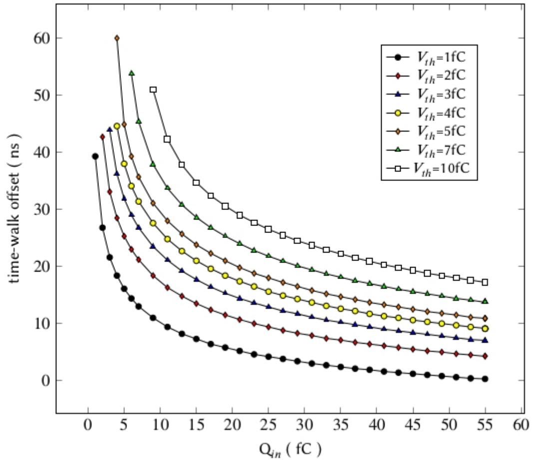
The fluctuations above 20° are due to low statistic in the sigma evaluation. In this range the µTPC should be flat.

Consideration on the time-walk

experimental data



simulation data



Experimental data are evaluated for different charge intervals and channel thresholds [run 11-16] using the mehod shown in slide 4. Simulation data are evaluated from triangular waves injected in the TIGER asic.

A strong dependency of the time a a function of the charge is evident. The discrepancy between the two methods is given by the different signal shapes considered.

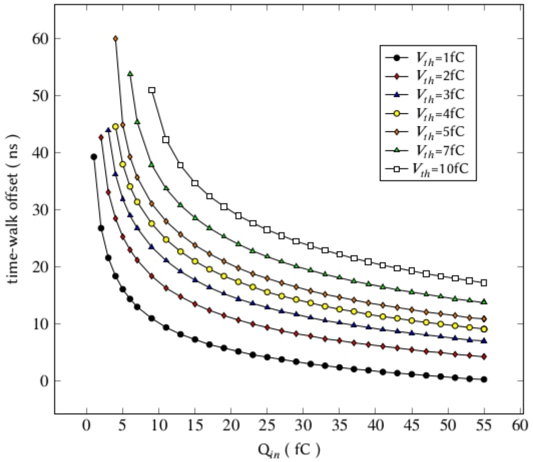
Use simulated TW and calibration on TR only

time-reference

high charge - only TIGER

→ **NEW LUT**

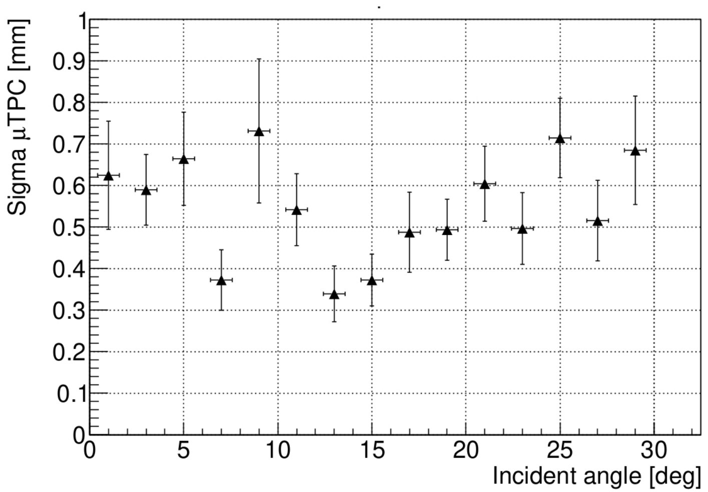
simulation data



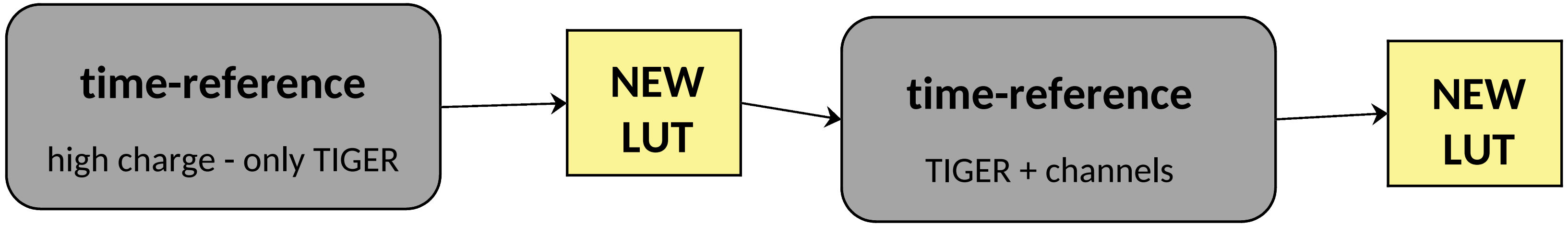
We check the behavior of the time reference if we do not use any time-walk calibration from data.

The first test focus the studies on super clean sample: only high charge hits, only TIGER time-reference correction.

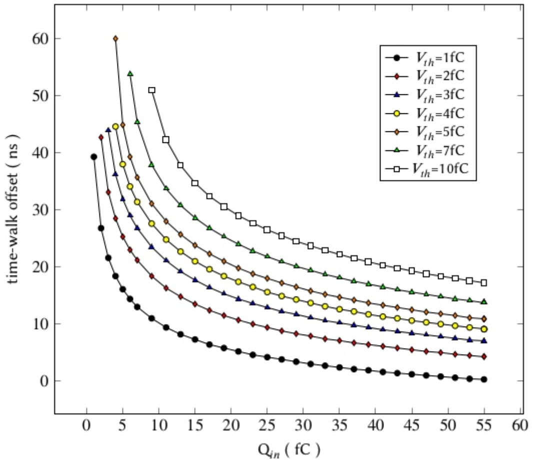
Resolution does not improve so much.



Use simulated TW and calibration on TR only



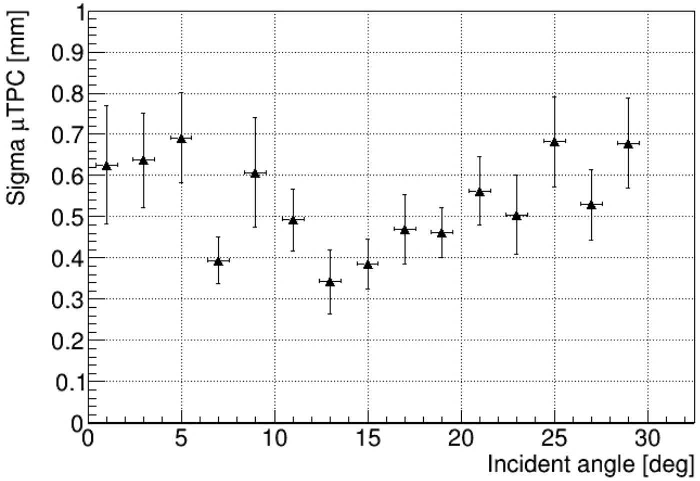
simulation data



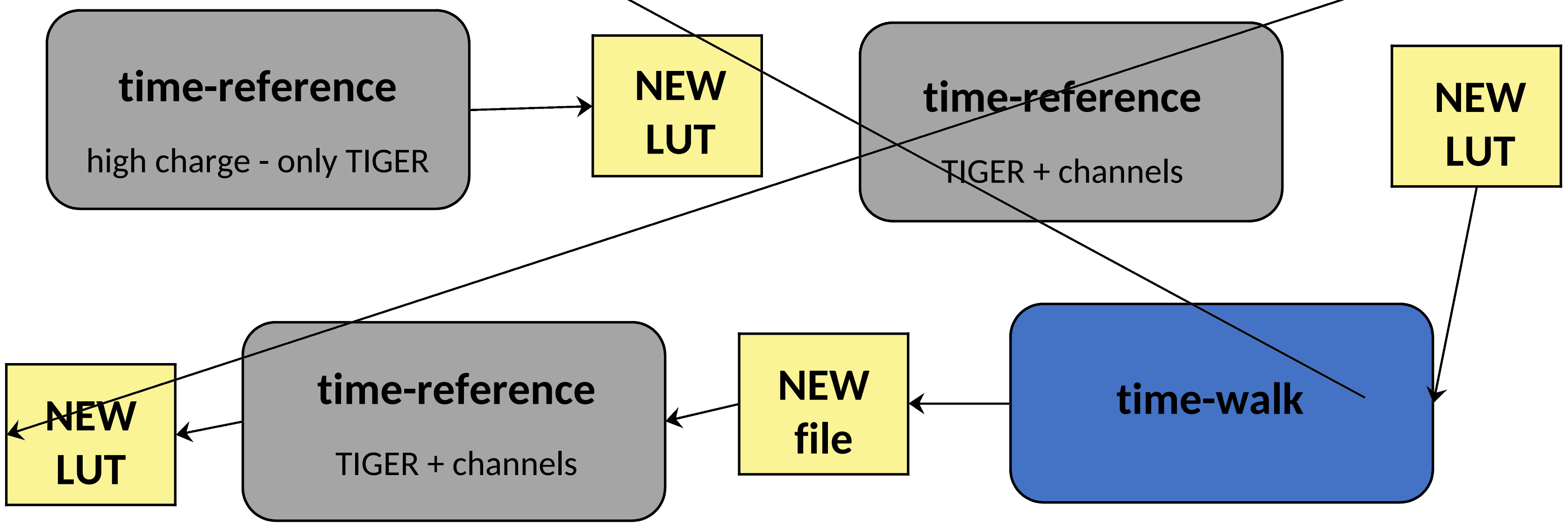
We check the behavior of the time reference if we do not use any time-walk calibration from data.

The second test focus the studies includes also the Time-Reference channel by channel with all the hits.

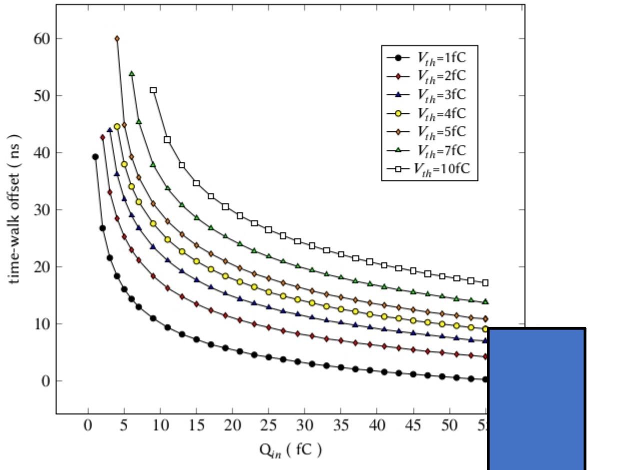
Resolution does not improve so much.



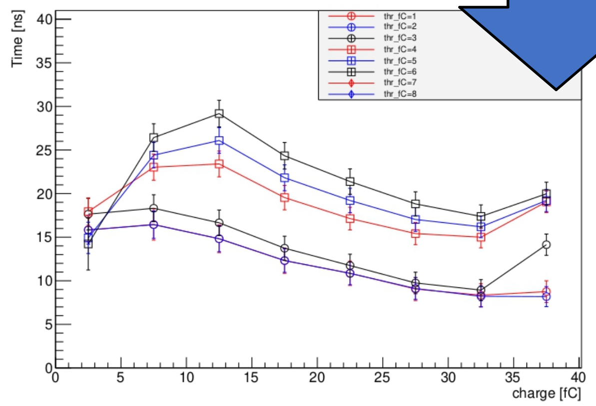
Use simulated TW and calibration on TR and TW



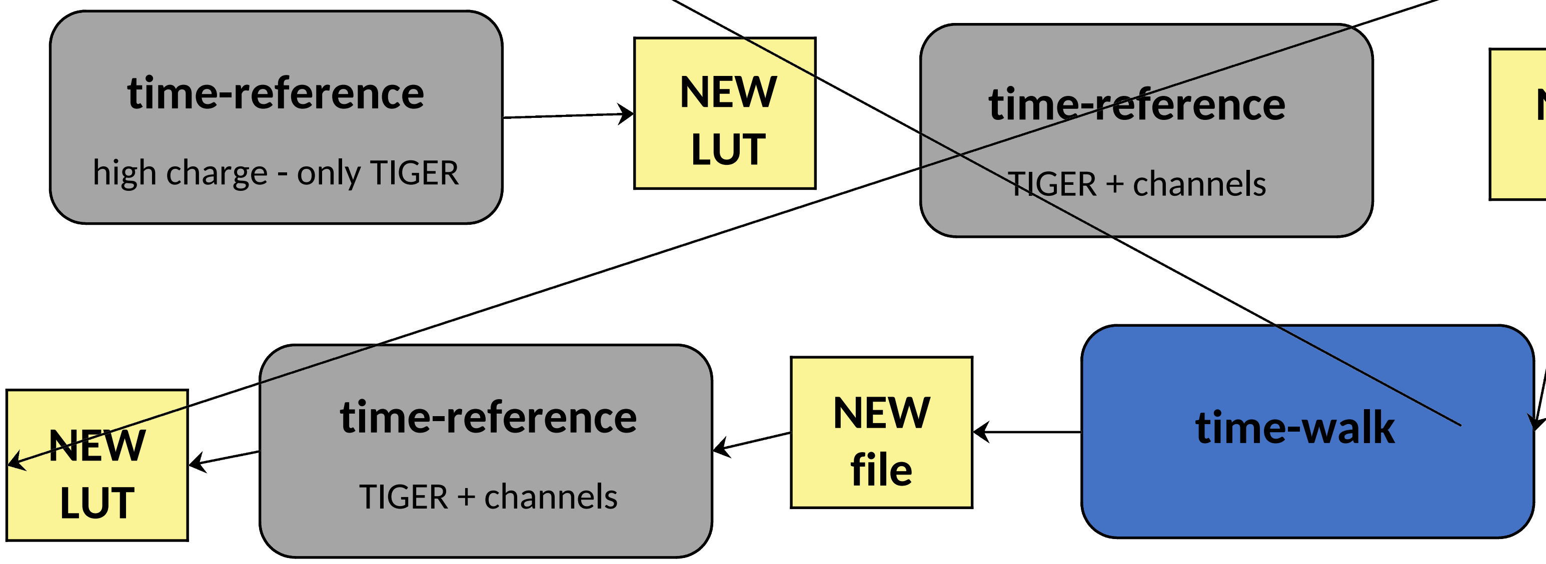
FROM simulation data



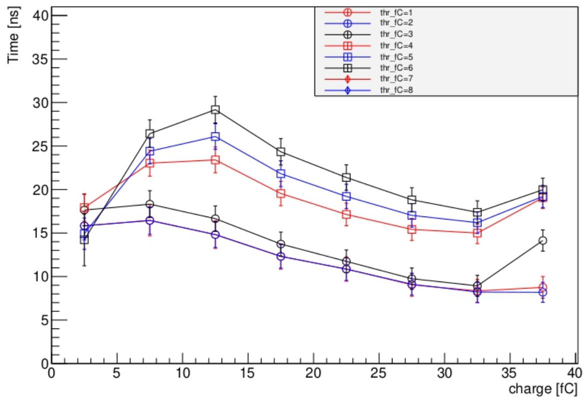
TO experimental data

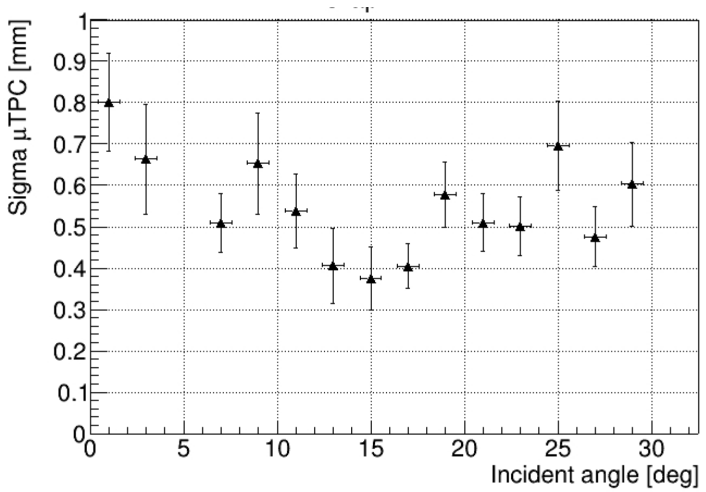


Use simulated TW and calibration on TR and TW



TO experimental data





We started from the simulated TW and we used the standard time calibration

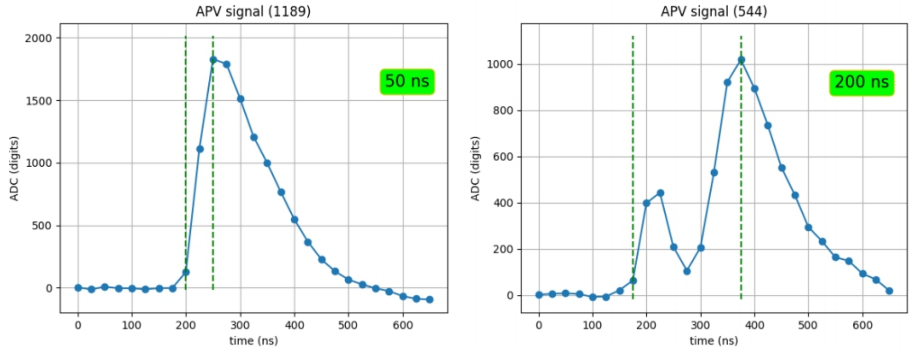
procedures. At the end the TW has a different shape.

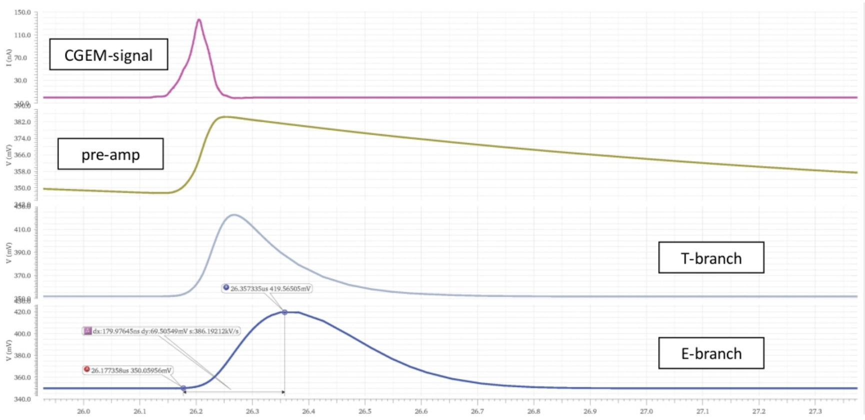
Resolution does not improve so much.

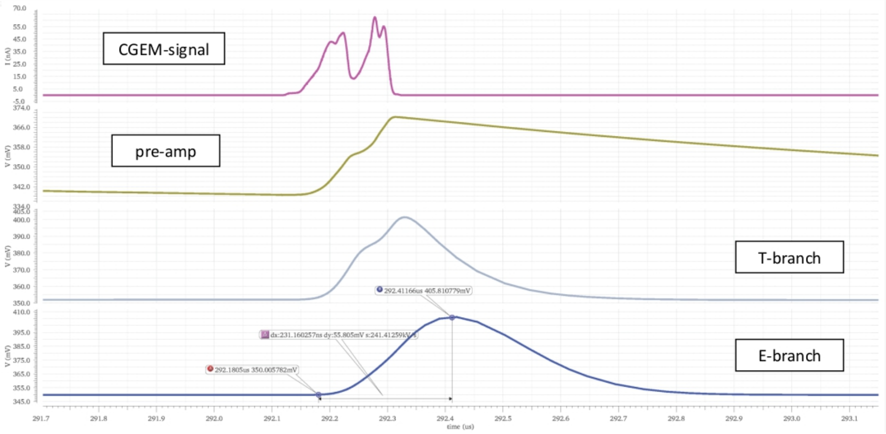
Consideration on the simulated TW

APV signal are used to understand the signal shape.
APV signal and simulations show the the signal shape differs from the triangular one due to multi-peak structures.

More detailed simulations from simulation and/or APV signals can be studied to understand the impact of different signal shapes on the time-walk



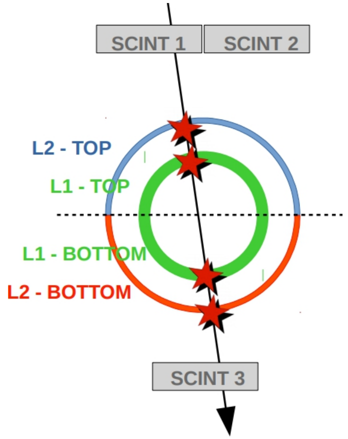


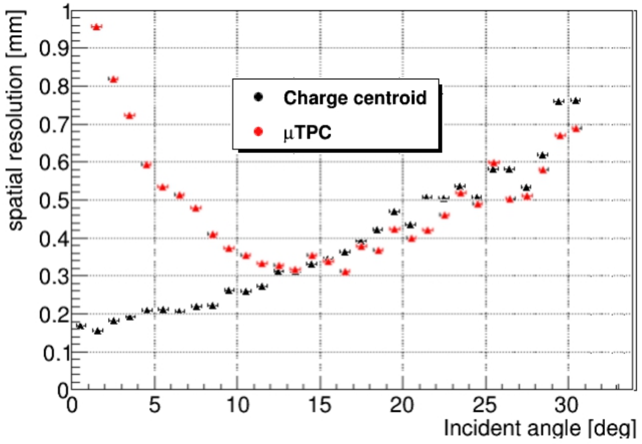


Consideration on the residual

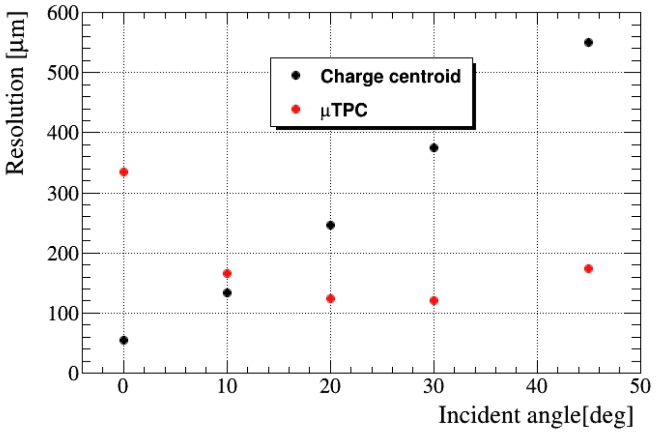
The CGEM-IT has been used as a tracker and a test chamber it-self to measure the spatial performance of the Charge Centroid and the micro-TPC.

Even if the **contribution of the tracking** system has been measured through a toy-MC and removed from the sigma estimated in the data; a component is still present (see behavior above 15°).





Cosmics CGEM-IT



TB planars

Studies on the CC & µTPC resolution of the CGEM-IT are not completed: the differences from the TB planar results are visible.

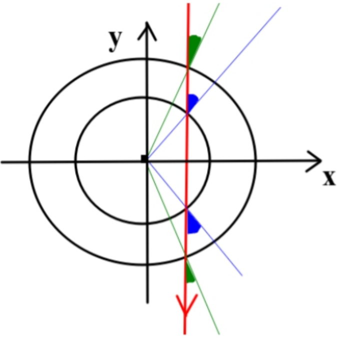
Conclusion

ASD

Thanks

Backup: TOY-MC

Toy simulation



1. Randomize the position of the cosmic ray [0, R_L1]

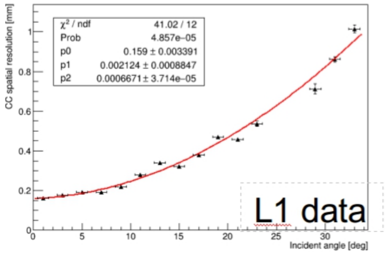
2. Smear the track incident angle of 0.36 deg (from Marco's calculation) for L1down and L2down

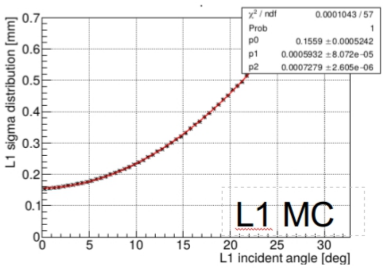
3. Evaluate the expected CC resolution at the impact point using the function
CC_res = 80 µm + 3.0 µm/deg * angle + 0.65 µm/deg^2 * angle^2

4. Smear the four point on the X direction and extract the corresponding Y

5. Use three point to reconstruct the track and measure the residual distribution and the constribution of the tracking system = sqrt(sigma_recon^2 - sigma_true^2)

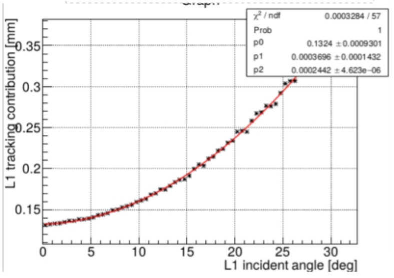
The function used to evaluate the CC_res has been calculated in order to match the reconstructed CC_res in the MC data with the experimental data below 20µm





Toy results

Contribution of the tracking system on L1



1. The thrend of the constribution of the tracking system now is reasonable with respect to the one shown on April 8

2. This results is important to understand the behavior of the µTPC once the incident angle is larger than 15° but it does not explain the difference between µTPC resolution of the CGEM and the planar GEM.
(See next slide.)

3. The MC resolution for L1 matchs the experimental data but the MC resolution of L2 does not. L2 seems to be different from L1 or the systematic are not measured properly. A different function could be used to estimate the CC resolution as a function of the angle for L2.
(Compare the plot of the previous slide with the one in the next.)

4. The CGEM CC resolution has a parabolic behavior as a function of the angle while in the planar GEM it has a linear behavior. This is not understood.