Time calibrations

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Outlook

- A new code inside CGEMBOSS
- The fitting procedure
- Time-walk and time-reference
- Iteration test
- Preliminary results

A new code inside CGEMBOSS

A new package to measure the time calibrations is under development in a package inside CGEMBOSS

/CgemBossCvs/Cgem/CgemTimeCalibration

Starting from a run (or more runs) it can measure the time-walk and the time-reference values.

These corrections are data-driven. If the setup does not change, those corrections could be on other data-sets.

A new code inside CGEMBOSS

The code can operate through two main modes corresponding to the two **outputs**:

- a LUT for the time-reference
- a time-walk table

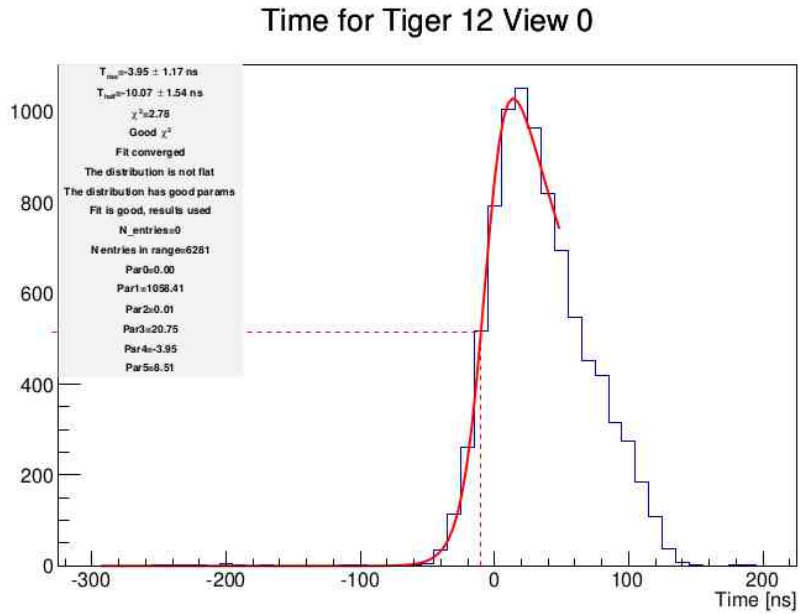
Despite the two modes, the code shares many functions:

- retrieve the hit time and applay the time corrections
- fill an array for each sub-sample of hits, then an histogram (i.e. 1fC<threshold<2fC; 5fC<charge<10fC)
- time fit procedure and goodness evaluation

Fitting procedure: first analysis

At first the histogram is analyzed to extract the parameter of interest without a fit:

- time at maximum
- time at half maximum
- baseline in the time region [**-325**,-100] ns

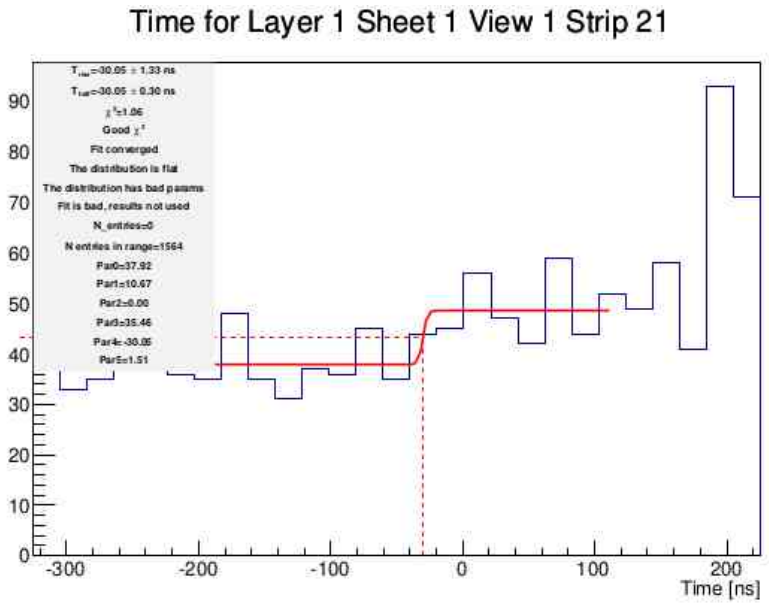


- range fit for the function [0]+[1]*TMath::Exp(-[2]*(x-[3]))/(1+TMath::Exp(-(x-[4])/[5]))

Fitting procedure: first analysis

At first the histogram is analyzed to extract the parameter of interest without a fit:

- time at maximum
- time at half maximum
- baseline in the time region **[-310,-210]** ns

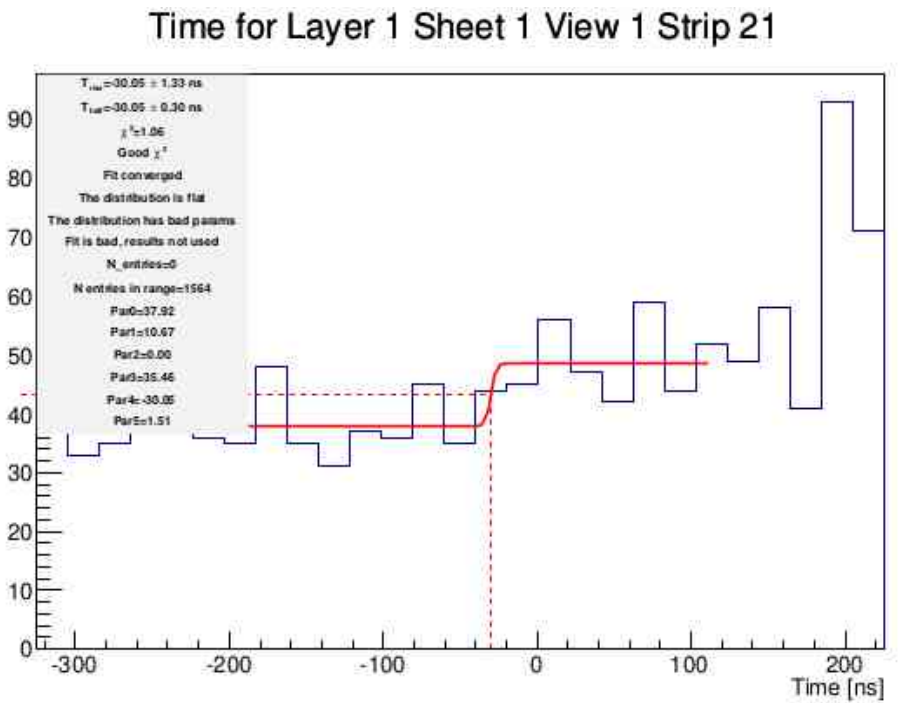


- range fit for the function [0]+[1]*TMath::Exp(-[2]*(x-[3]))/(1+TMath::Exp(-(x-[4])/[5]))

Fitting procedure: removing flatness

Then a line is used to fit the time range **[-310,50]** ns.

The Chi2R is used to discriminate flat distributions to the proper ones.



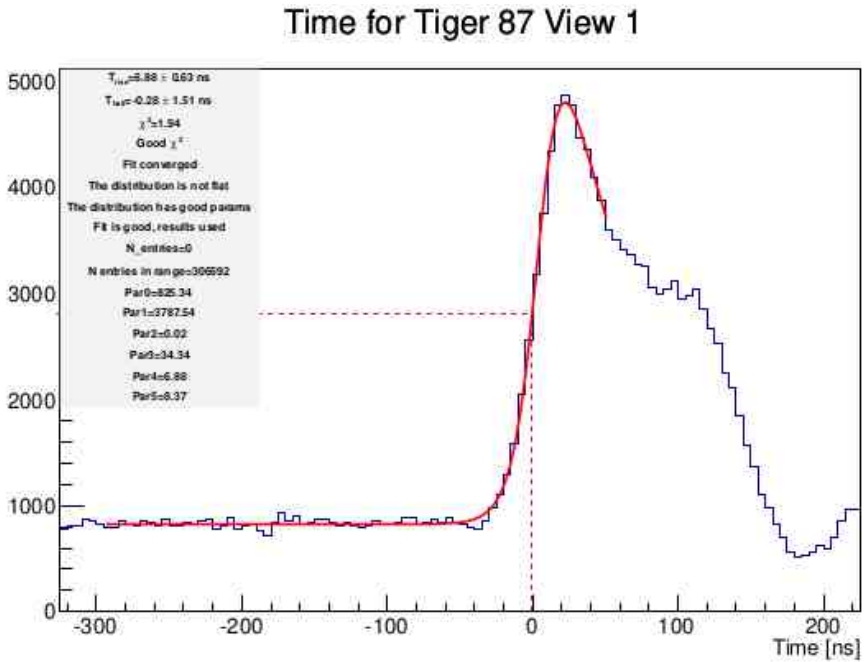
Fitting procedure: Chi2R and parameters

The plot is fitted using Minos fitting algorithm.

Only par0 is fixed and par1 is constrained.

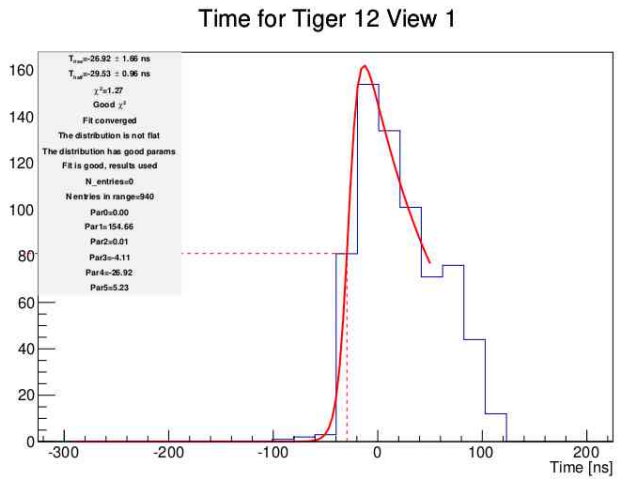
Fits with a Chi2R larger than **10** are rejected.

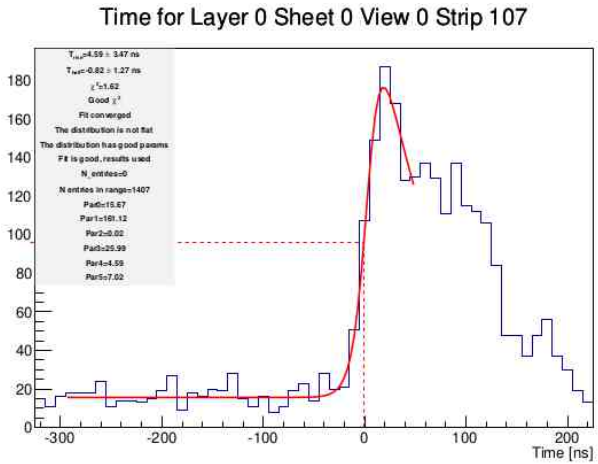
Fit with parameters outside the average ranges are rejected.

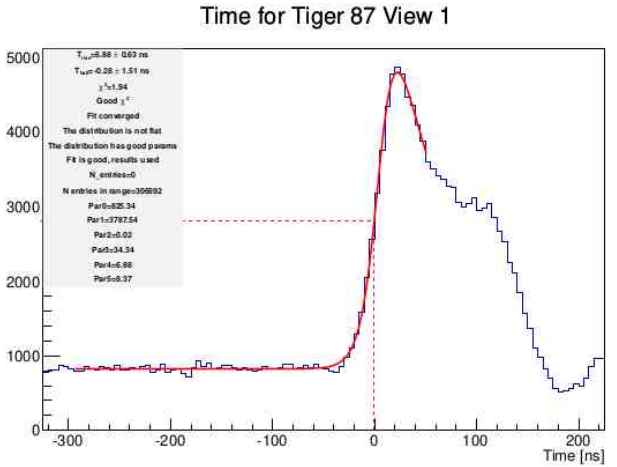


Fitting procedure: **binning**

The number of bins in the histograms depends on the number of entries inside the fitting range

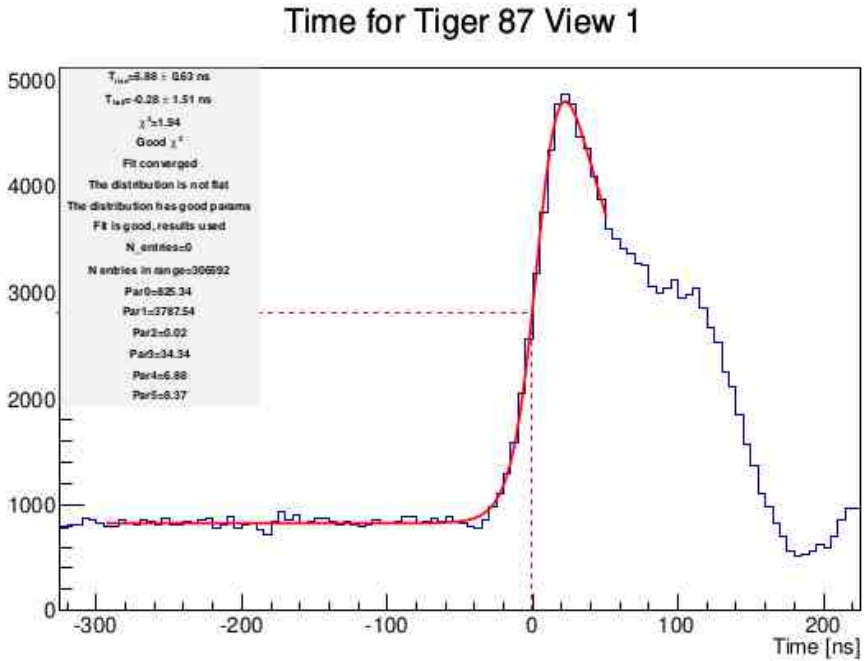






Fitting procedure: time value

The used time value is the one measured at the half maximum.



Time-Walk and Time-Reference

Several loops are used to fill the array concerning those corrections:

- time-walk --> loop on T_branch threshold and hit charge
- time-reference --> loop on the tiger
- time-reference --> loop on the channels
- time-reference --> loop on the channels/tigers with Q_hits > 30fC

Fit goodness and success rate

Time-walk:

```
N time-walk fit          :     48
N time-walk badFit       :     0
N time-walk badChi2      :     0
N time-walk badPar       :     0
N time-walk flat         :     0
N time-walk(all - flat) :     48
N time-walk good         :     48
% bad Fit/all           :     0
% bad Chi2/all          :     0
% bad Par/all           :     0
% flat/all            :     1.136
% bad/(all - flat)      :     0
% good/(all - flat)     :     100
```

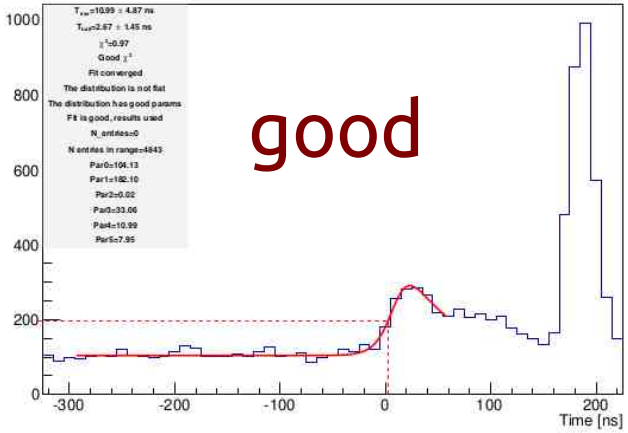
Fit goodness and success rate

Time-reference:

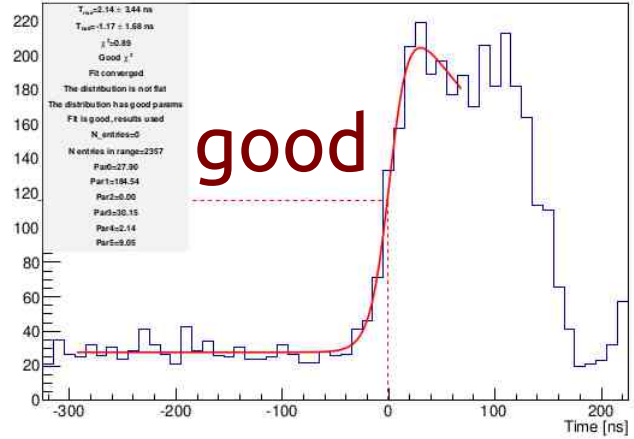
N tiger all	:	176	N channel fit	:	5438
N tiger badFit	:	1	N channel badFit	:	267
N tiger badChi2	:	3	N channel badChi2	:	66
N tiger flat	:	2	N channel flat	:	900
N tiger(all - flat)	:	174	N channel(all - flat)	:	4538
N tiger good	:	165	N channel good	:	4316
% bad Fit/all	:	0.574	% bad Fit/all	:	5.883
% bad Chi2/all	:	1.724	% bad Chi2/all	:	1.454
% bad Par/all	:	6.321	% bad Par/all	:	19.45
% flat/all	:	1.136	% flat/all	:	16.55
% bad/(all - flat)	:	5.172	% bad/(all - flat)	:	4.892
% good/(all - flat)	:	**94.83**	**% good**/(all - flat)	:	**95.11**

Fit goodness and success rate (good)

Time for Layer 0 Sheet 0 View 1 Strip 510



Time for Layer 0 Sheet 0 View 0 Strip 18



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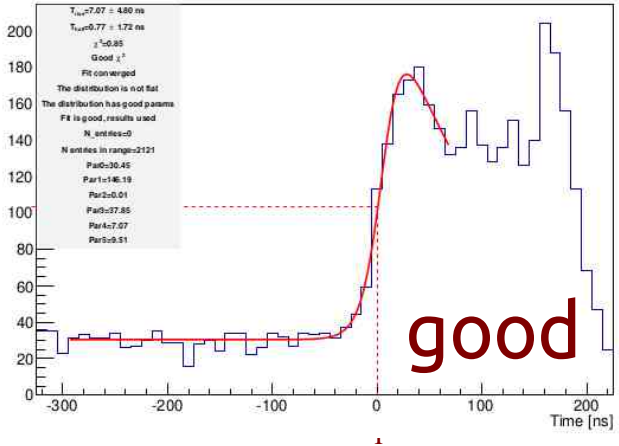
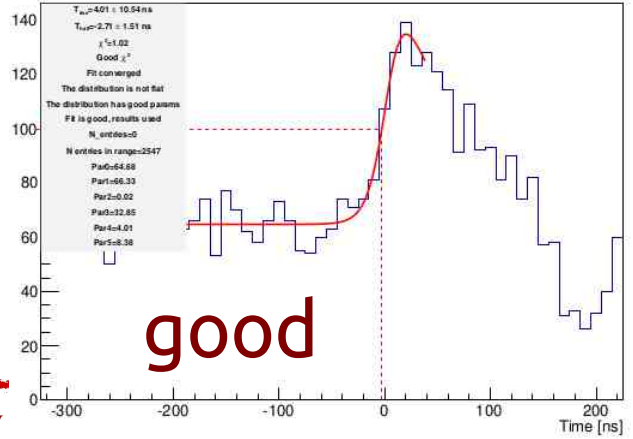
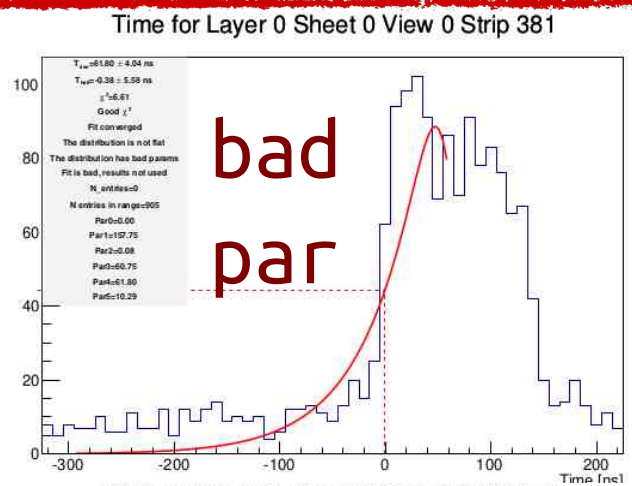
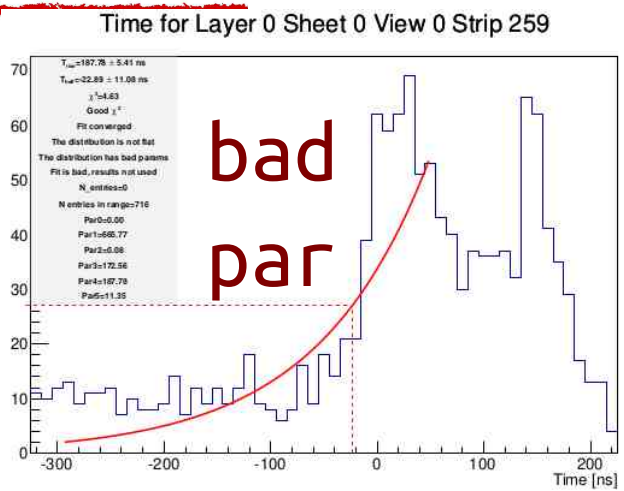


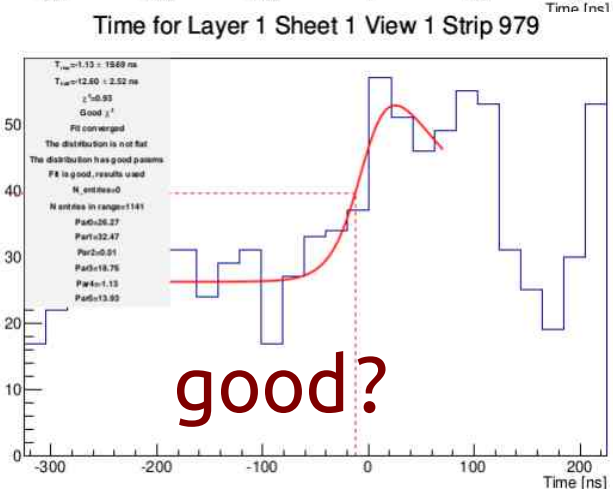
Time for Layer 0 Sheet 0 View 1 Strip 184

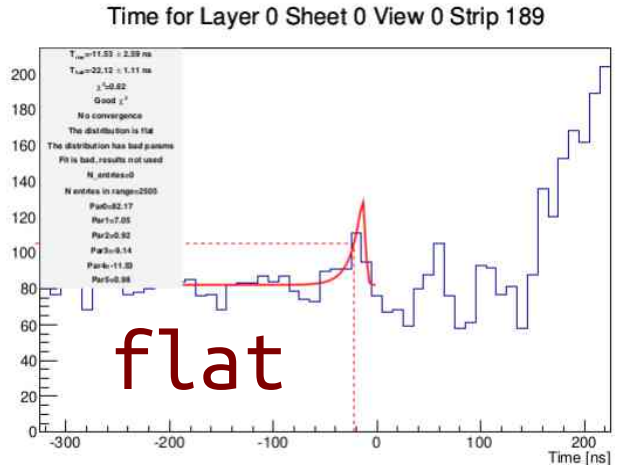


Fit goodness and success rate (bad)

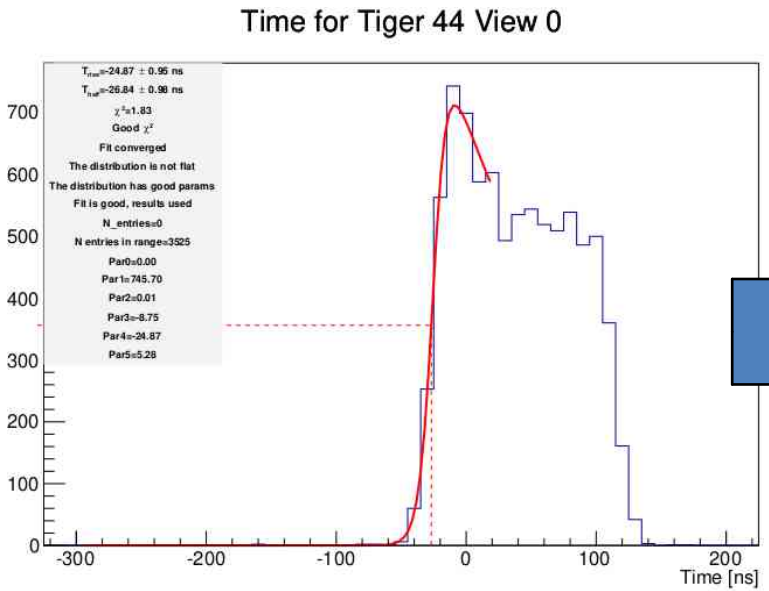


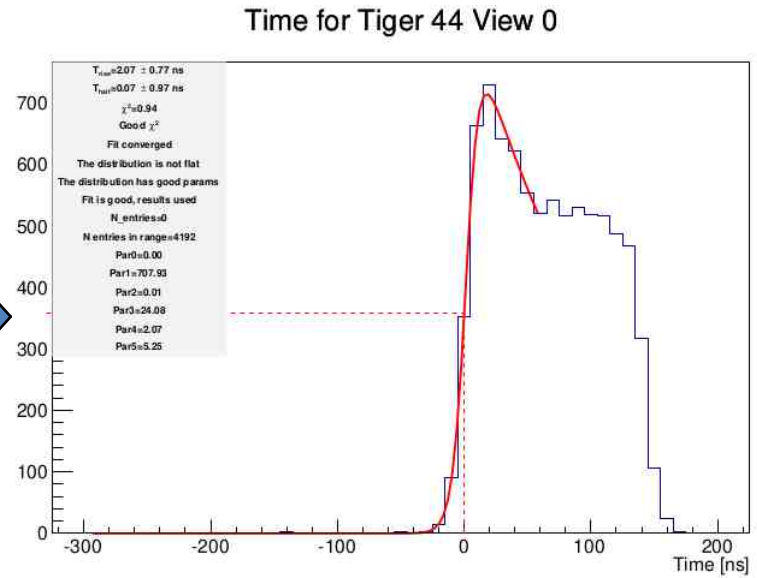






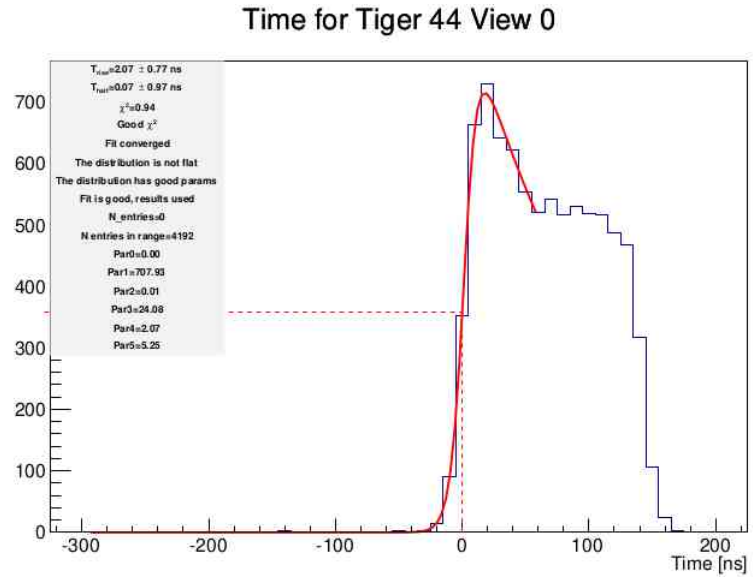
Convergence test: time-reference & high charge





Convergence test: time-reference & high charge

If the fit of the plot is good in each iteration then the time correction to apply in each round goes to zero and the time at half maximum goes to zero too.



Convergence: Time-Walk and Time-Reference

Several loops are used to fill the array concerning those corrections:

converged - time-walk --> loop on T_branch threshold and hit charge

converged - time-reference --> loop on the tiger

converged - time-reference --> loop on the channels

converged - time-reference --> loop on the channels/tigers with Q_hits > 30fC

The histograms with a convergent correction need only 2 iterations.

The convergence has been tested up to 20 iterations for each case.

Road-map to the final time corrections

1° Step:
only tiger & Q>30fC

Time reference
for each tiger
Q>30 fC

Time walk

2° Step:
only tiger

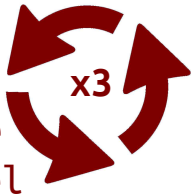
Time reference
for each tiger

Time walk

3° Step:
also channels

Time reference
for each tiger

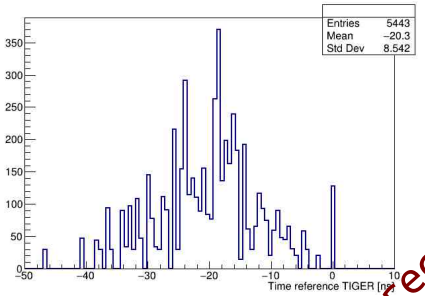
Time reference
for each channel



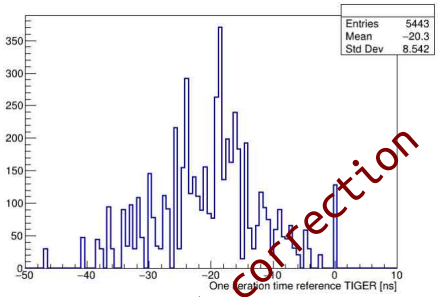
Time walk

Preliminary results: time-reference

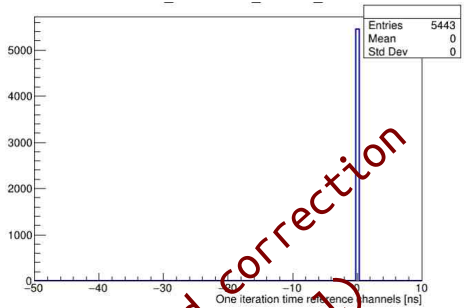
First round



Total correction (tiger)

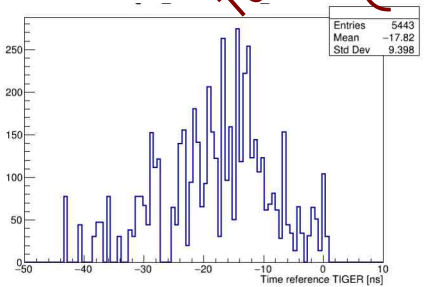


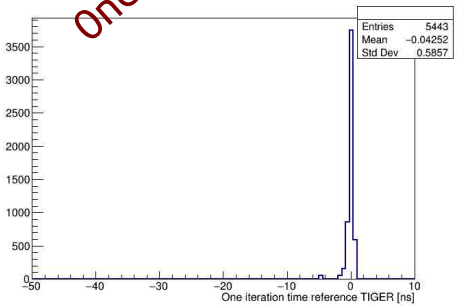
One round correction (tiger)

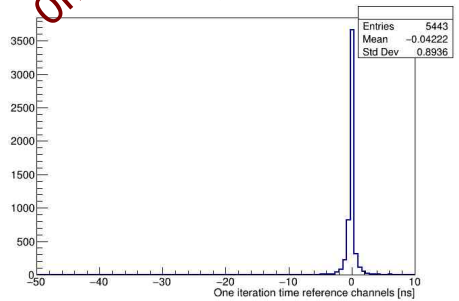


One round correction (channel)

Last round

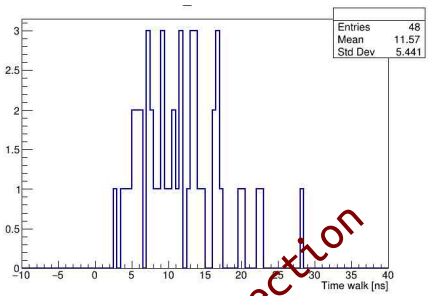


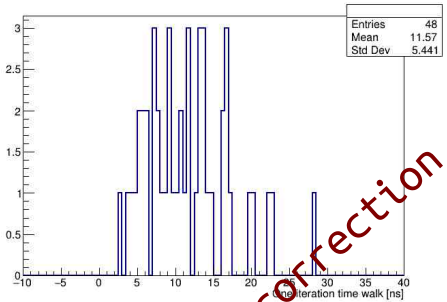




Preliminary results: time-walk

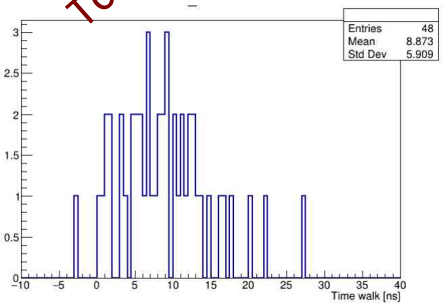
First round



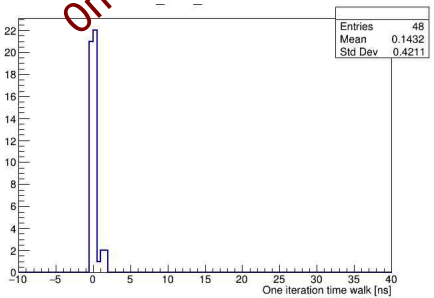


Last round

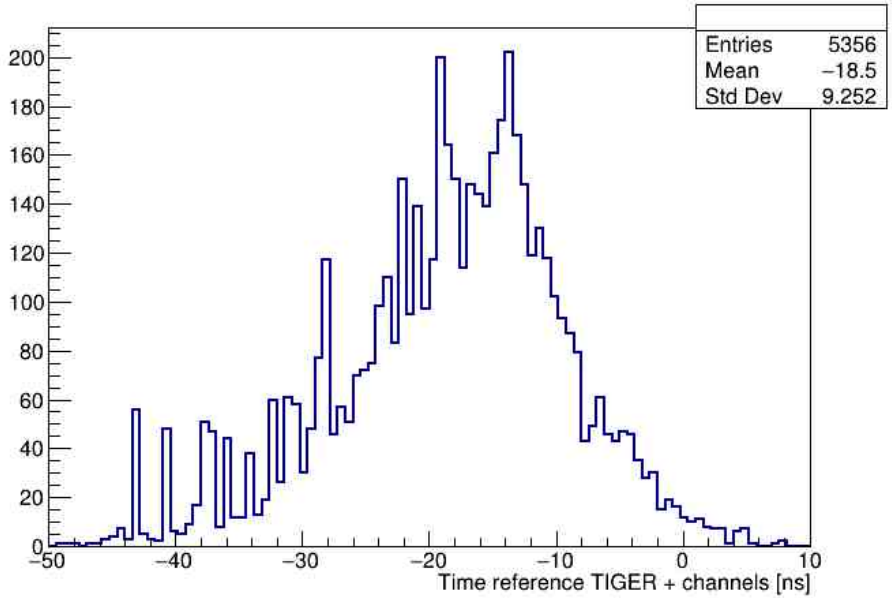
Total correction



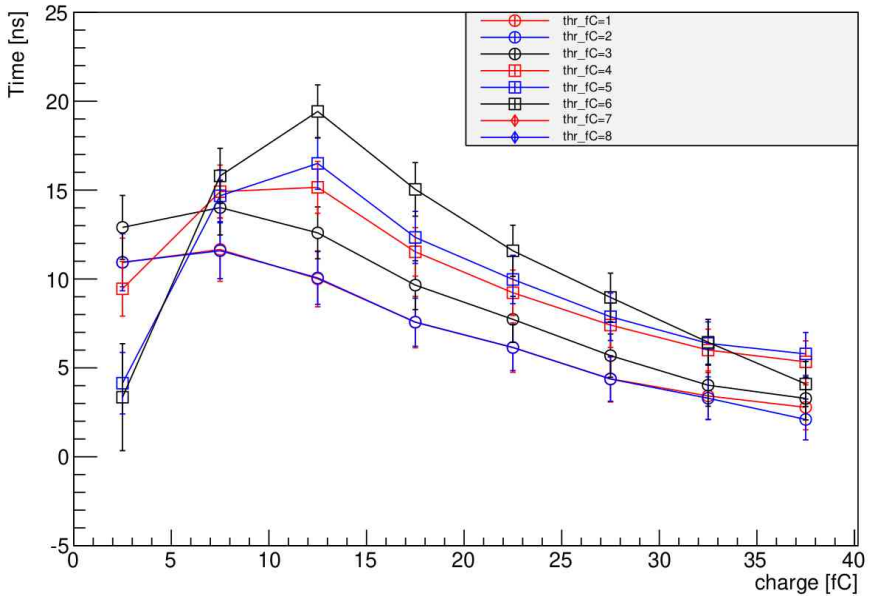
One round correction



Preliminary results: time-reference & time-walk



time-reference



time-walk

Consideration

Time-reference differs from X and V view in the same TIGER.

The corrections of each iterations are smaller than 5-10 ns.

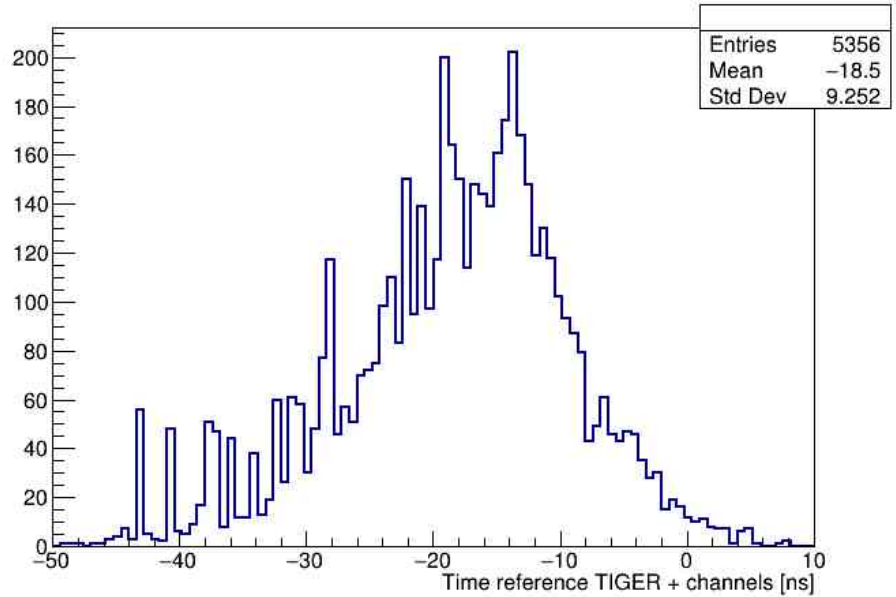
The total time-reference corrections ranges from -50 to 10 ns.

The time-reference fitting procedure has a 95% success rate.

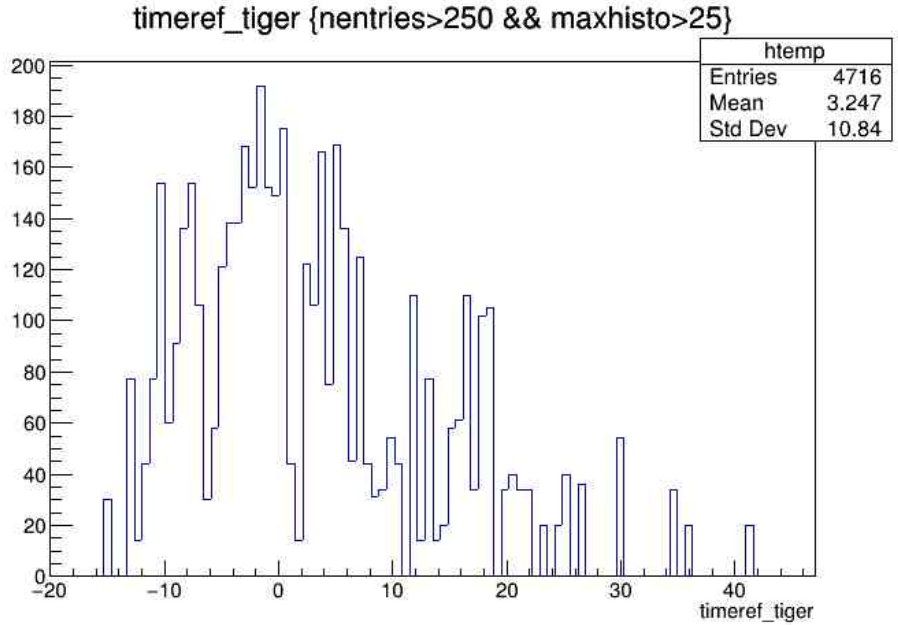
The current fitting procedure is precise enough to describe the rising edge but there is room to improve it.

The time-walk final results are NOT flat o decreasing.

Comparison with the previous results

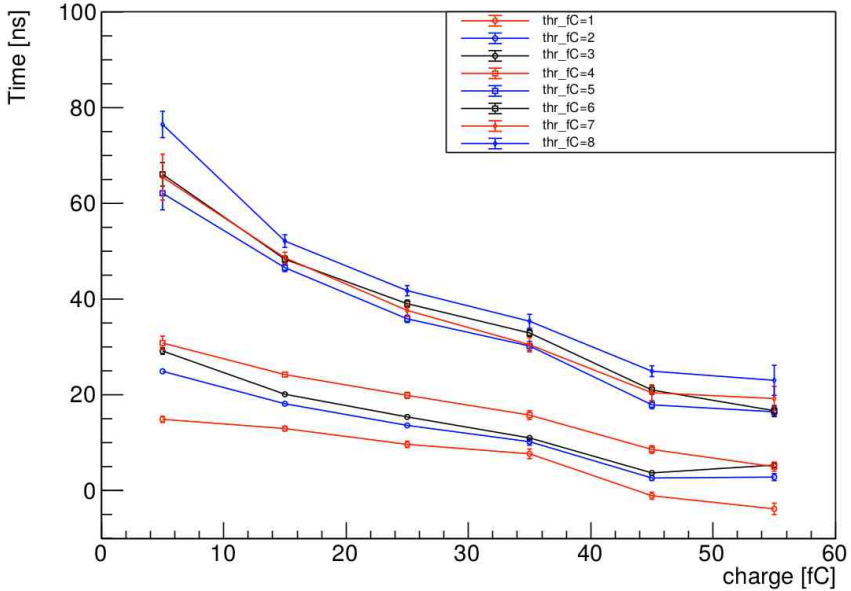


time-reference NOW

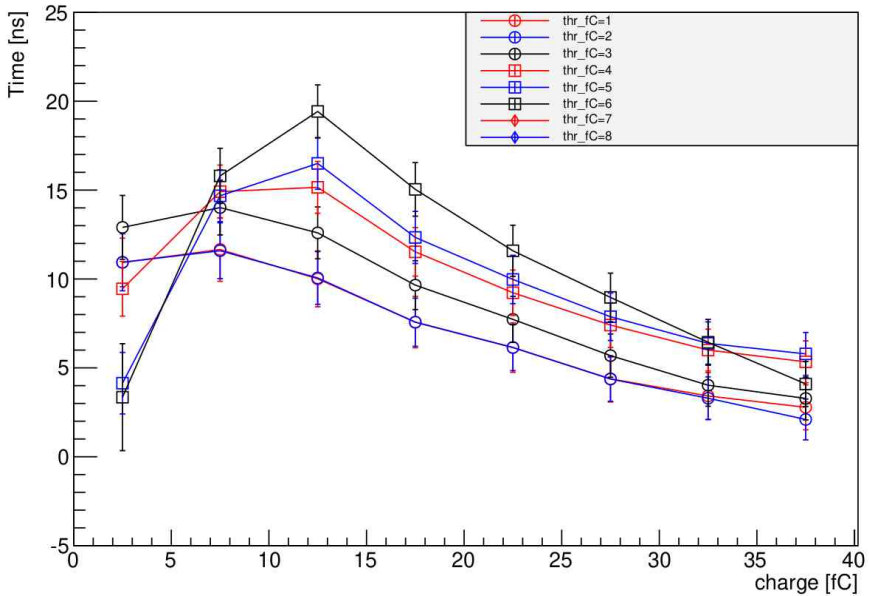


time-reference before

Comparison with the previous results

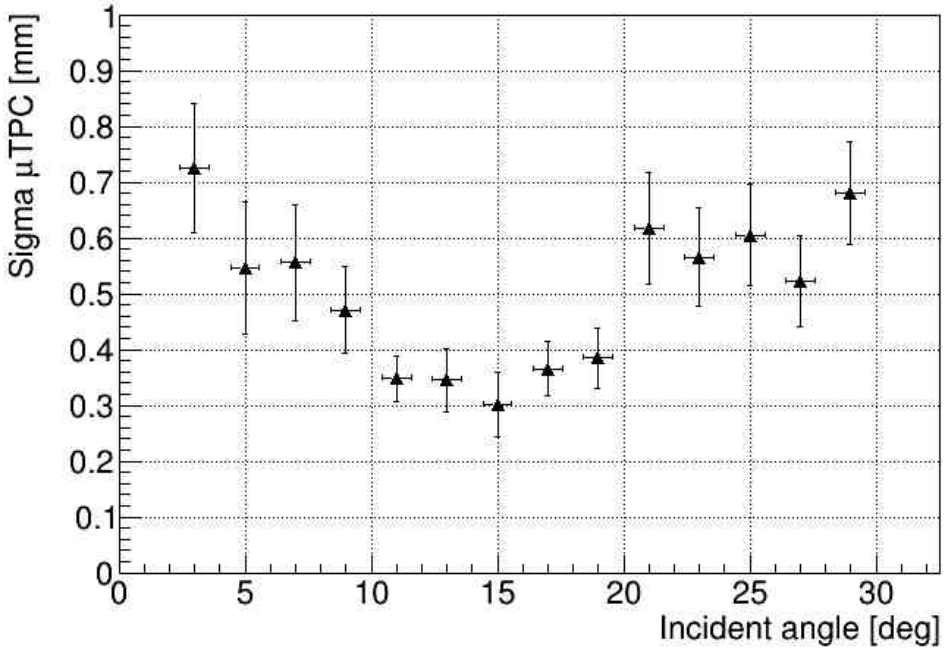


time-walk before

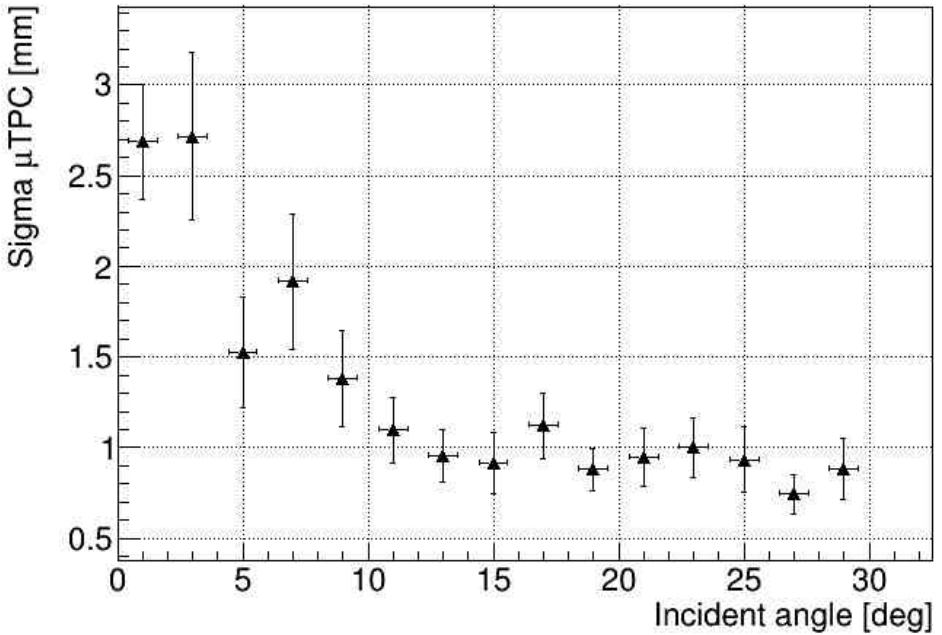


time-walk NOW

Comparison with the previous results

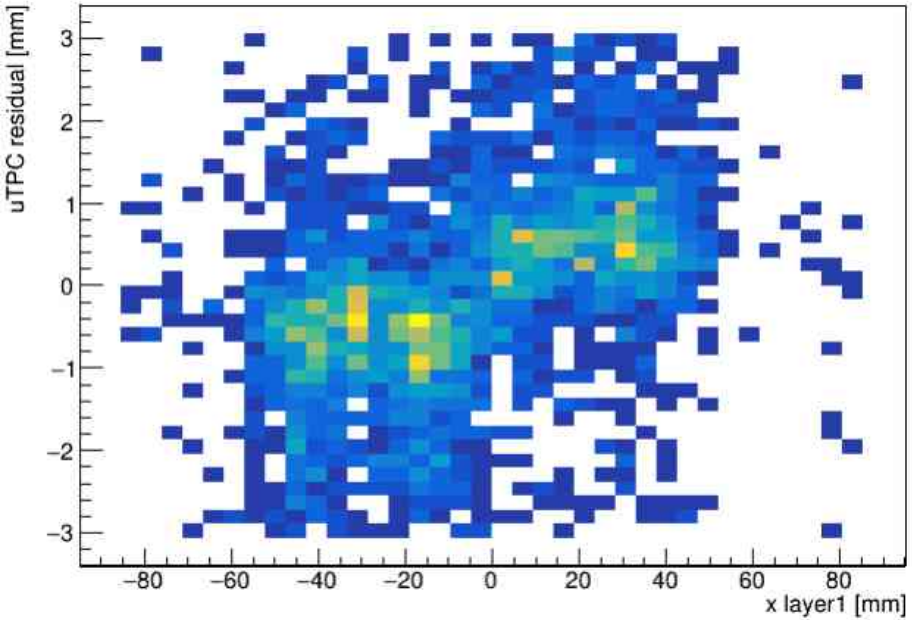


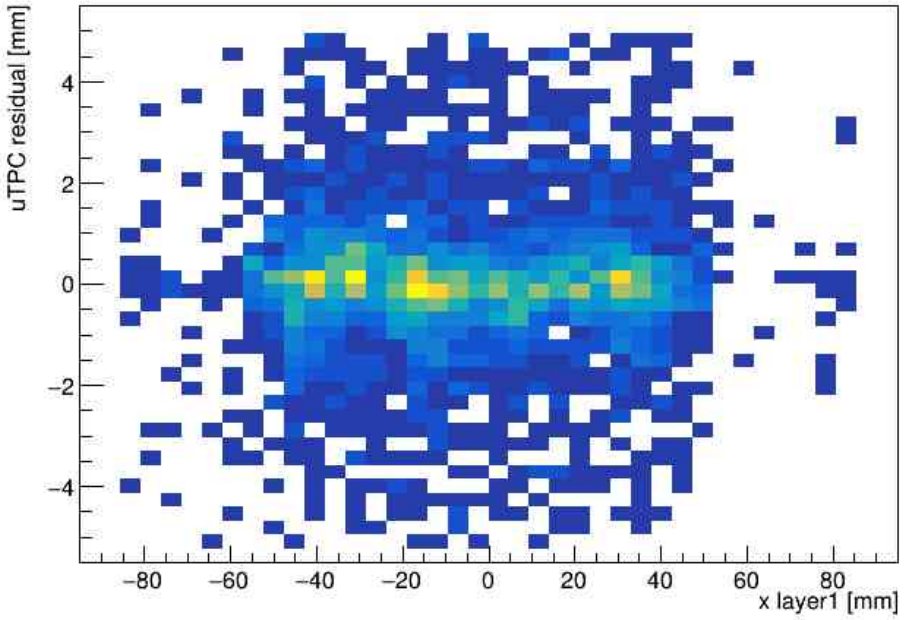
old time corrections



new time corrections

Comparison with the previous results

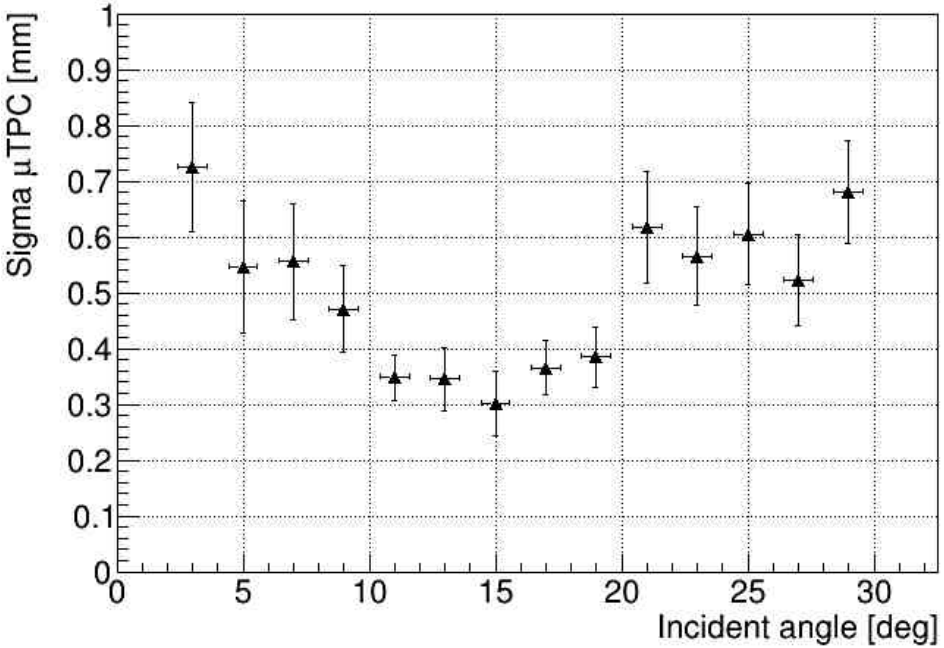




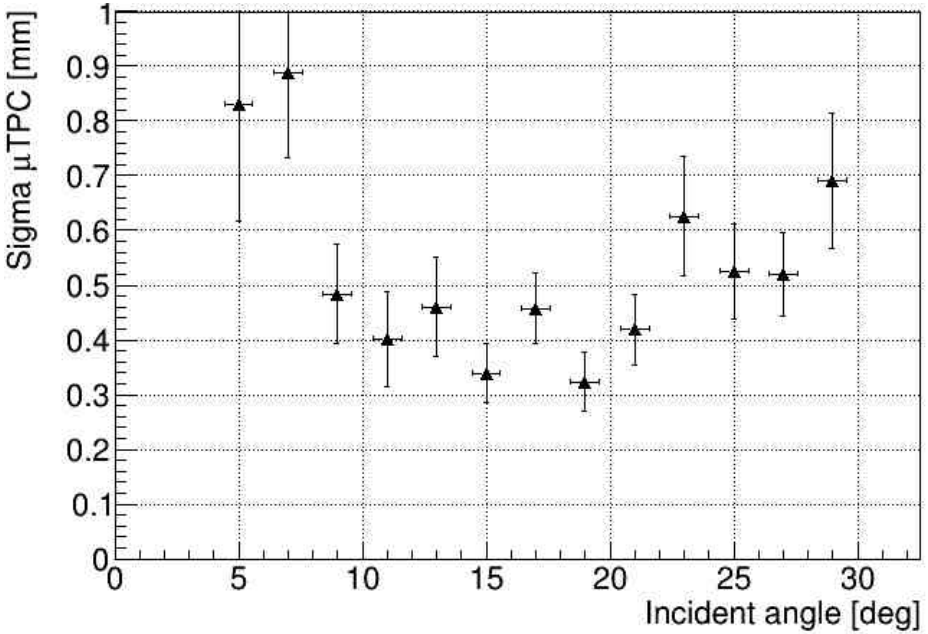
A global shift is needed to align the μTPC reconstruction.
It is important to change the file in the **CgemCalibFunSvc**

```
CgemCalibFunSvc.TimeFitFile="/bes3fs/cgemCosmic/data/timeFitCalibConst/timeFit_Run10.txt";
```

Comparison with the previous results



old time corrections



new time corrections

Conclusion

A new code to measure the time correction for each run of our data-sets is under development inside CGEMBOSS.

The algorithm take care about time-reference and time-walk. The time-propagation will be investigated in a second time.

The number of fits to perform is large then a very nice fitting procedure and goodness evaluation is needed, 95% right now.

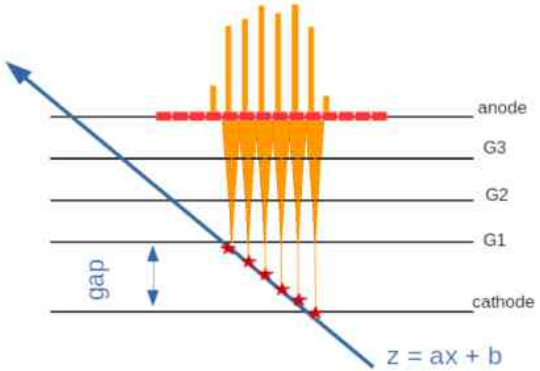
Now the success rate of the fit is optimal and the convergence of the procedure is reached.

The results reached up to now are in agreement with the previous ones but it mandatory to change the file used in the CgemCalibFunSvc.


Thanks

Status of the reconstruction @ CGEM-IT

$$x_{CC} = \frac{\sum_{i=0}^{\text{cl.size}} x_i\, q_i}{\sum_{i=0}^{\text{cl.size}} q_i}$$



$$t'_{hit} = t_{hit} - t_0$$

$$z_{hit} = t'_{hit} \cdot v_{drift}$$

$$x_{\mu TPC} = \frac{\text{gap}/2 - b}{a}$$