

FT performance in the proton beam

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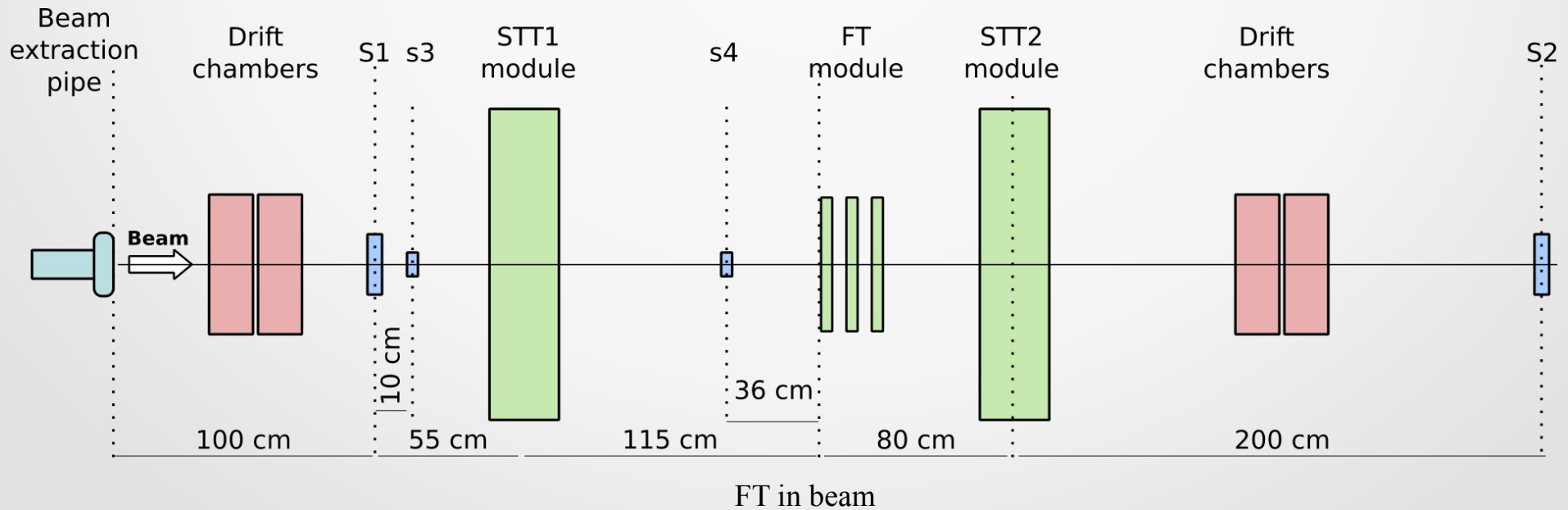
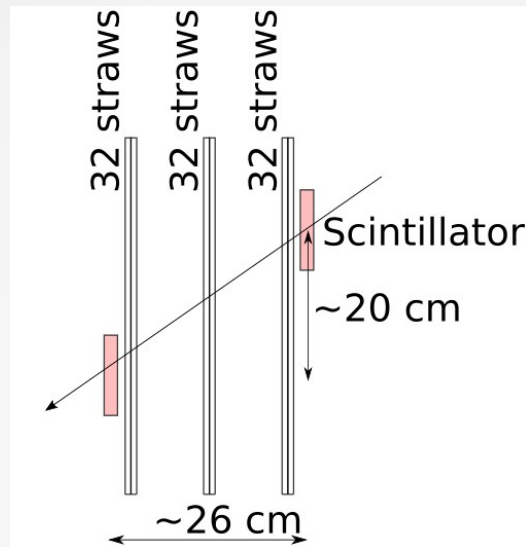
7 June 2016

Plan

- 1) FT prototype in beam setup
- 2) General system performance
- 3) Data analysis conditions
- 4) Results and conclusions

Set up configuration

Configuration for the cosmic rays measurements.



Data collection conditions

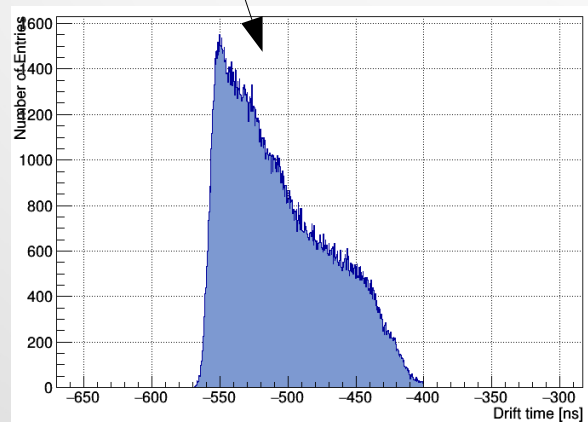
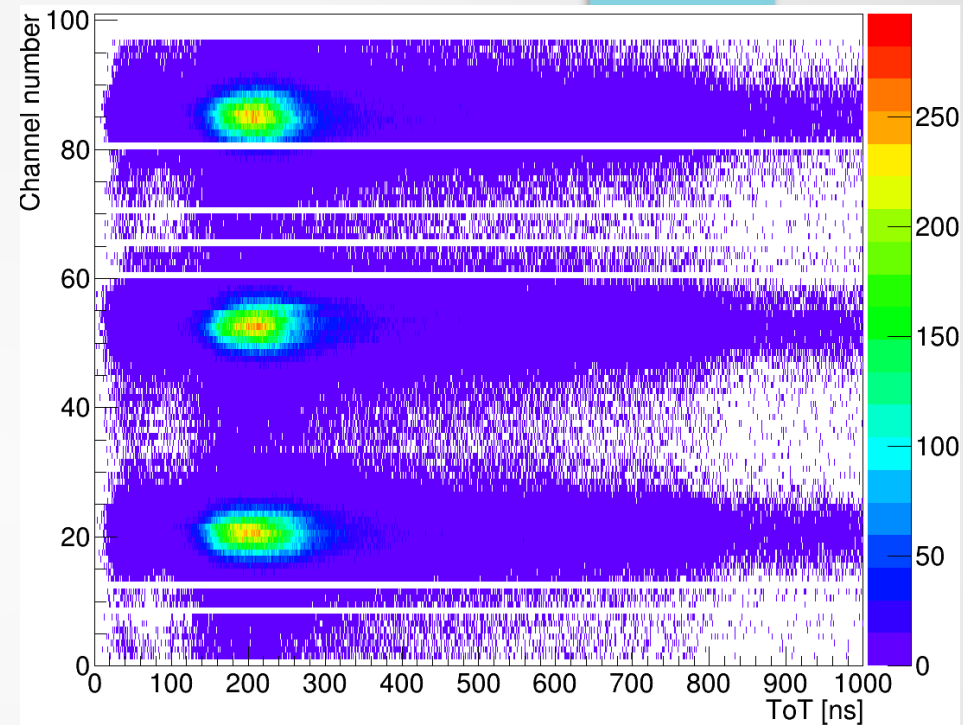
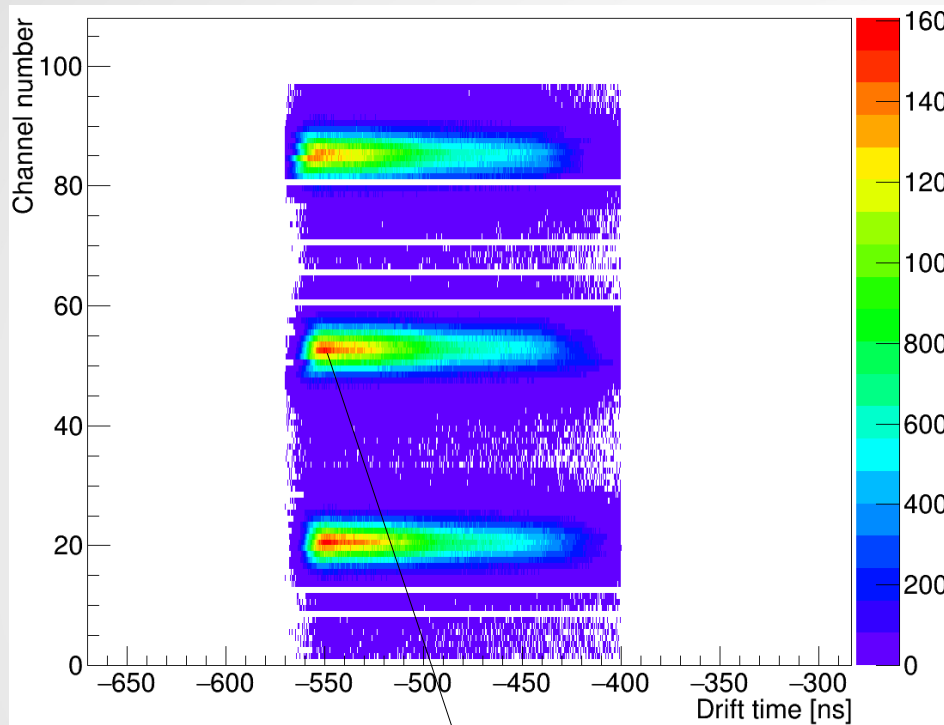
- The data was taken with 6 FEBs and one single TRBv3,
- The baseline tuning of the PASTTRECs were done with the beam,
- The standard gas mixture was used (Ar/CO₂ 90:10)
- The trigger was done mainly with single scintillator (S1)

Collected data

During the beam test the following data sets were collected:

- 3 different PASTTREC settings (1 gain and 3 different peaking times)
- 2 different high voltages (1700 and 1800 V)
- 4 different thresholds (10, 20, 30, 40 mV)

Drift time and TOT spectra (750 MeV)

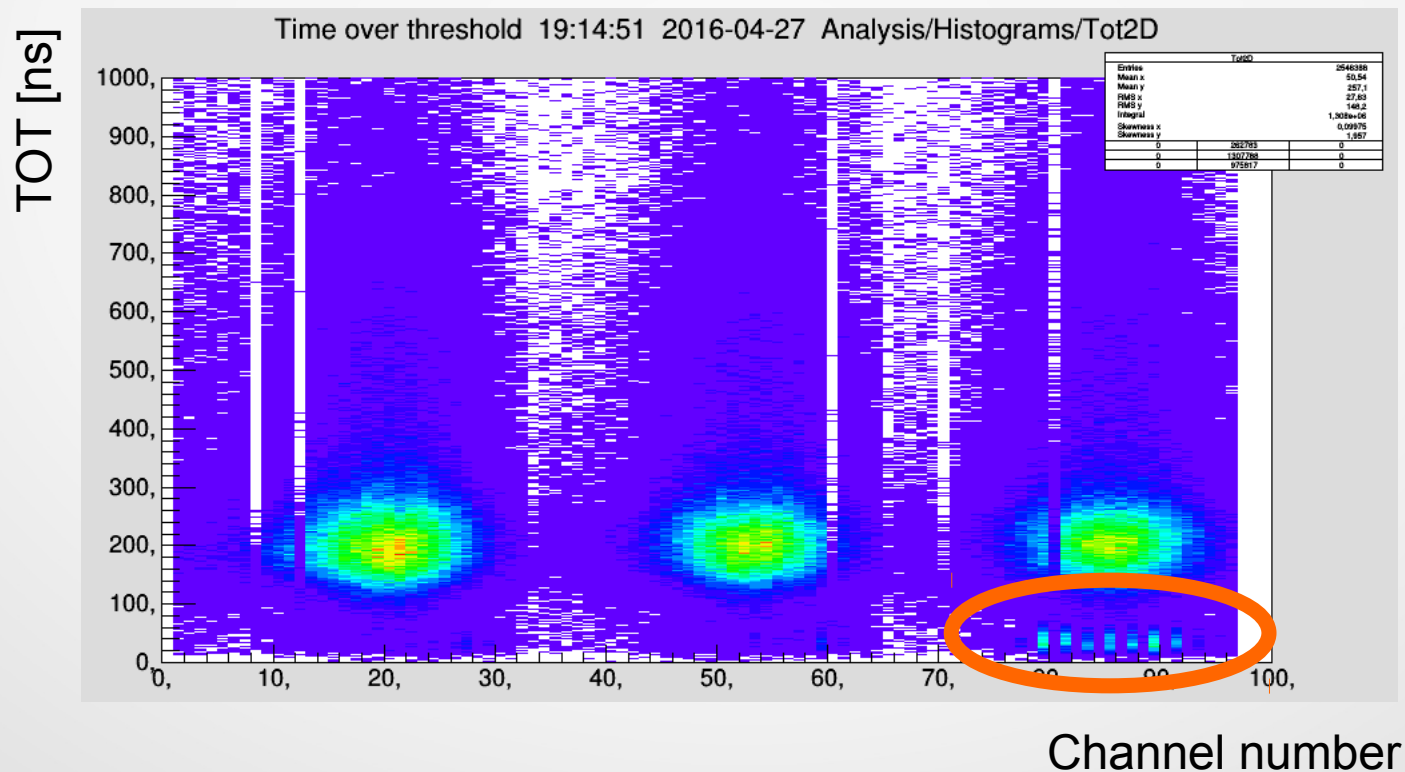


On the drift time spectrum one can see the hits correlated with the trigger signal. The TOT spectra have similar distribution over channels (uniform baseline).
Very low threshold (10mV!).

Problems

Some straws were showing signals even without the beam.

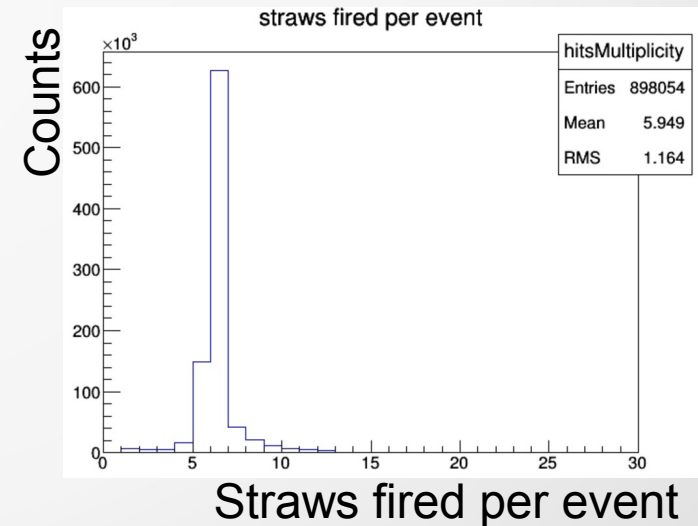
Hypothesis: gas problems. To be check in the laboratory with the irradiation sources.



FT in beam

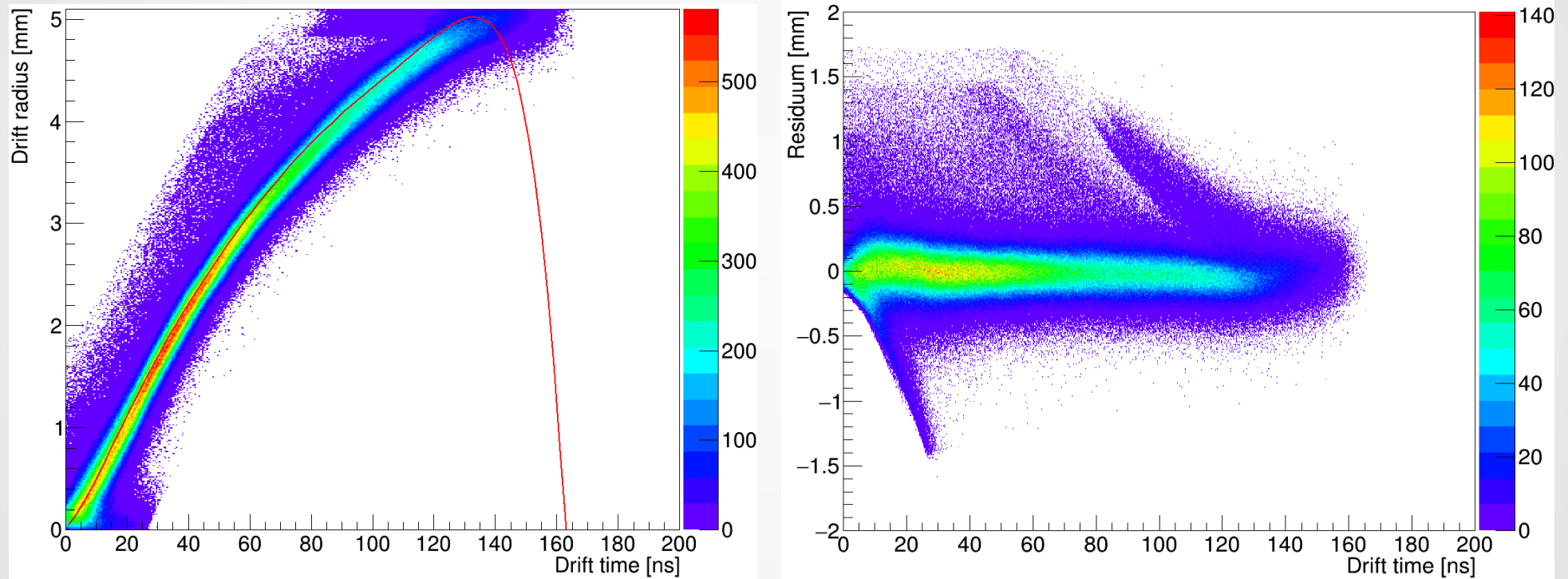
Data analysis - preparation

- For the presented data analysis the runs with peaking time 20 ns, gain 1 (~4 mV/fC), HV 1800V and threshold 10 mV were taken.
- Time window on the hits was applied.
- Drift time to radius calibration with uniform illumination method was performed.
- Drift time offsets elimination (different cable length compensation) was done.
- Data filtration (events with exactly one hit per layer selected – 6 hits per events) was performed.
- Track finding:
 - Prefit to the center of straws using TlinearFitter,
 - Fit to the drift radius using TMinuit,
 - Criteria for successful track finding : $\text{Chi}^2/(\text{degree of freedom}) < 10$.



Calibration

The drift time to radius calibration was done with the uniform illumination method.



The calibration curve was crossed check with the drift time and radius obtained from reconstructed tracks. Also residuals distribution around zero value, for whole drift time range, indicates that the calibration was performed correctly.

Reconstruction efficiency

$$\text{Efficiency} = N_{\text{rec}}/N_{\text{tot}}$$

N_{rec} :

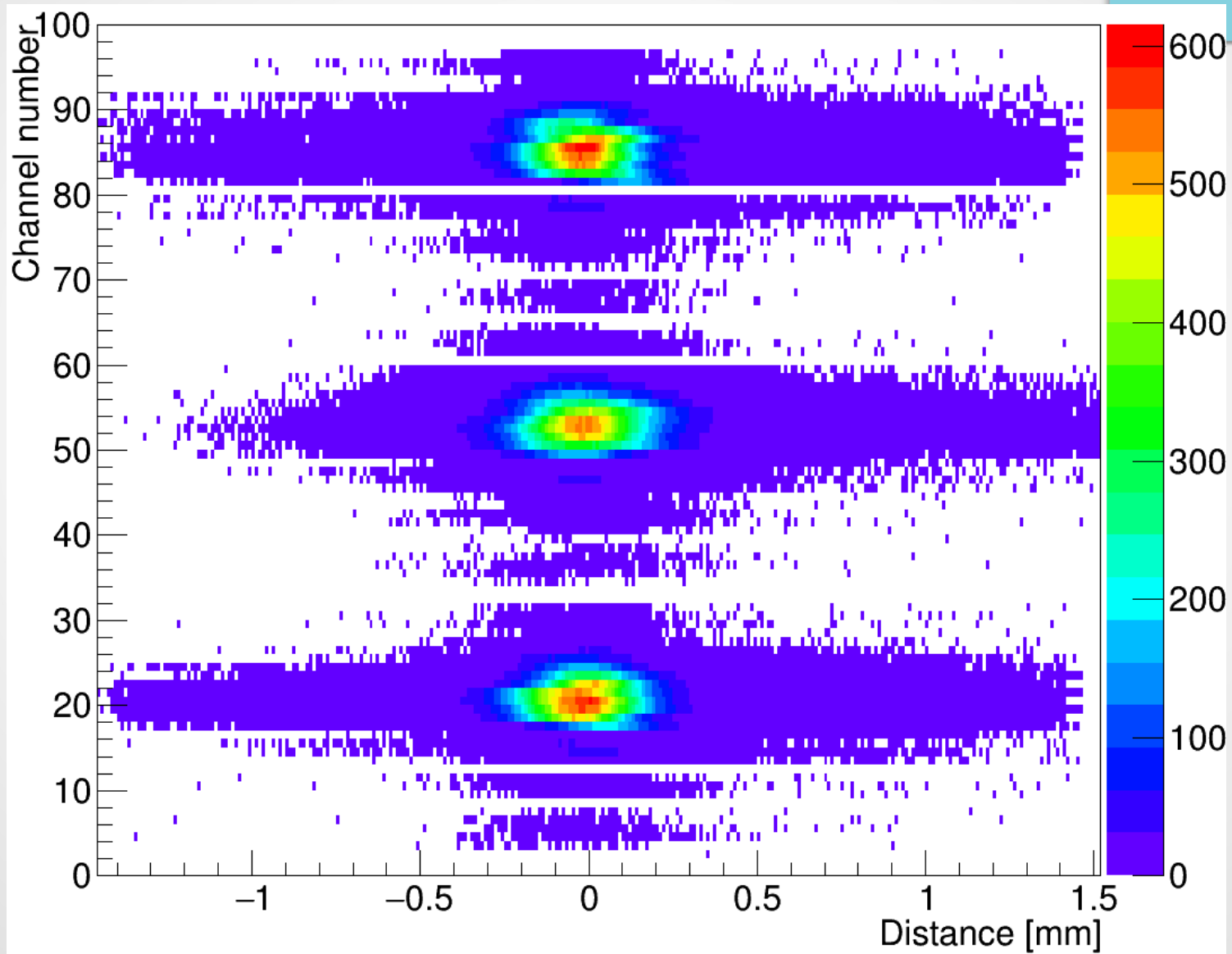
The track is considered as well reconstructed if the χ^2 per degree of freedom < 10 .
Percentage of tracks which have met the χ^2 criteria.

N_{tot} :

Exactly one hit per layer (6 hits per event).

Beam momentum	550 MeV	750 MeV	1 GeV	3 GeV
Reconstruction efficiency	91,7%	92,5%	93,2%	94,7%

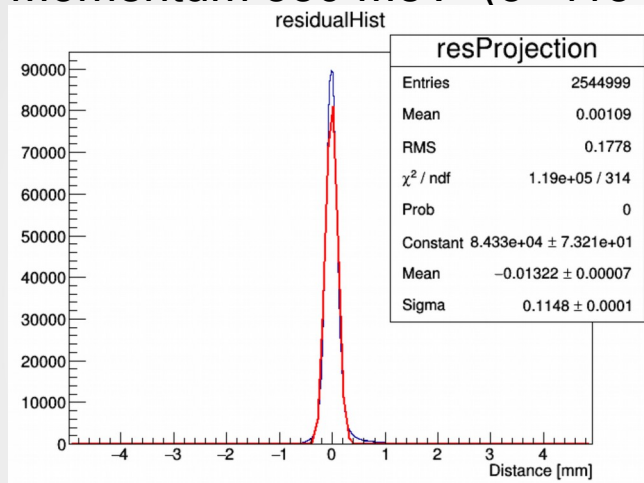
Residuals distribution



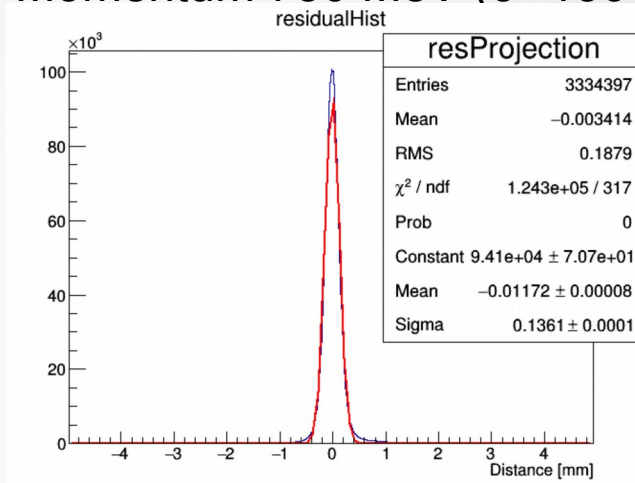
Spatial resolution

threshold 10 mV, 1800V, peaking time setting 20, gain setting 1

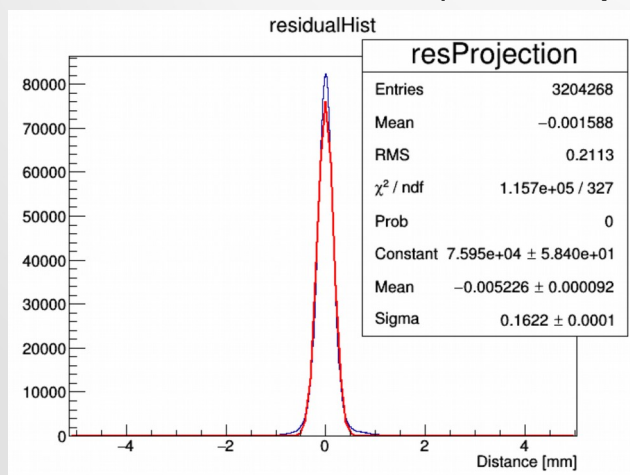
Momentum 550 MeV ($\sigma=115 \mu\text{m}$)



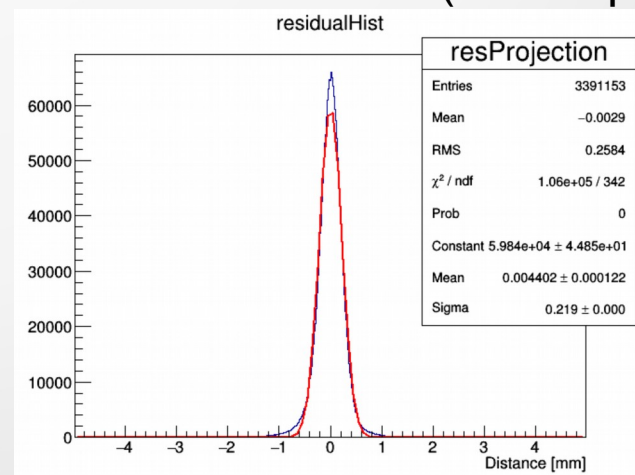
Momentum 750 MeV ($\sigma=136 \mu\text{m}$)



Momentum 1GeV ($\sigma=162 \mu\text{m}$)



Momentum 3GeV ($\sigma=219 \mu\text{m}$)



FT in beam

TOT analysis

Two different approaches to the TOT analysis:

- 1) Calculation of the TOT/dx and application of the truncated mean,
- 2) Correction of the TOT values for dependance on r and then calculation of the truncated mean.

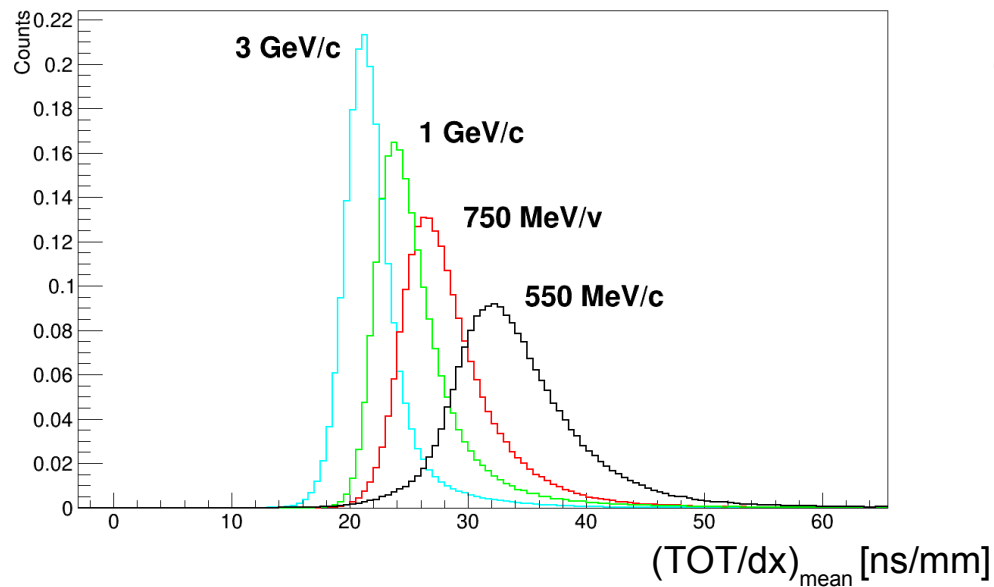
The results of the both methods will be presented below.

Truncated mean of TOT/dx

Mean TOT/dx coming from reconstructed tracks.

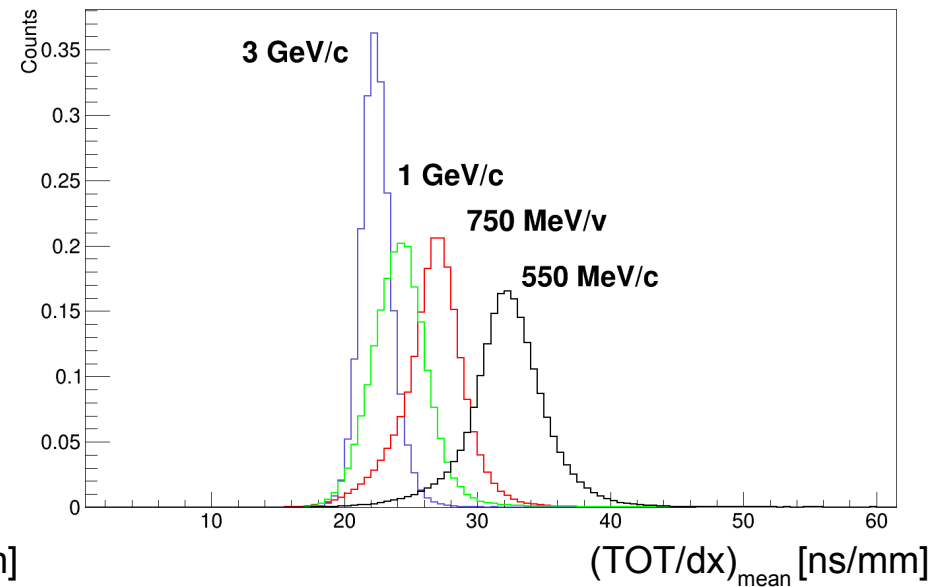
FT (6 straw tube layers)

Mean ToT/dx for each track with 20% truncation



STT (24 straw tube layers)

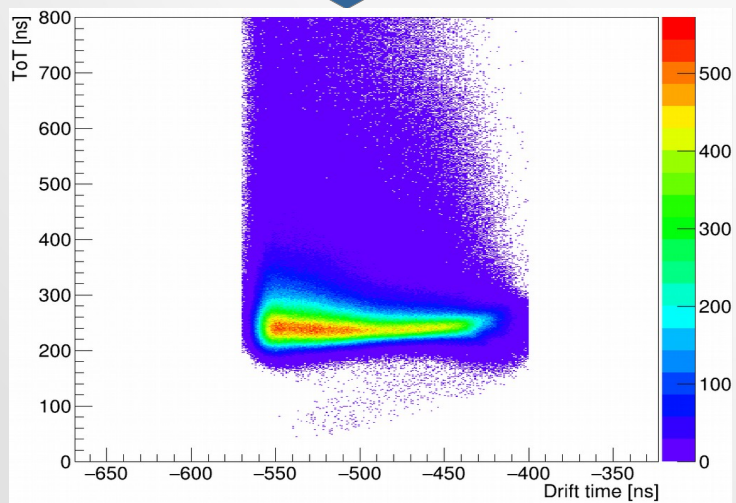
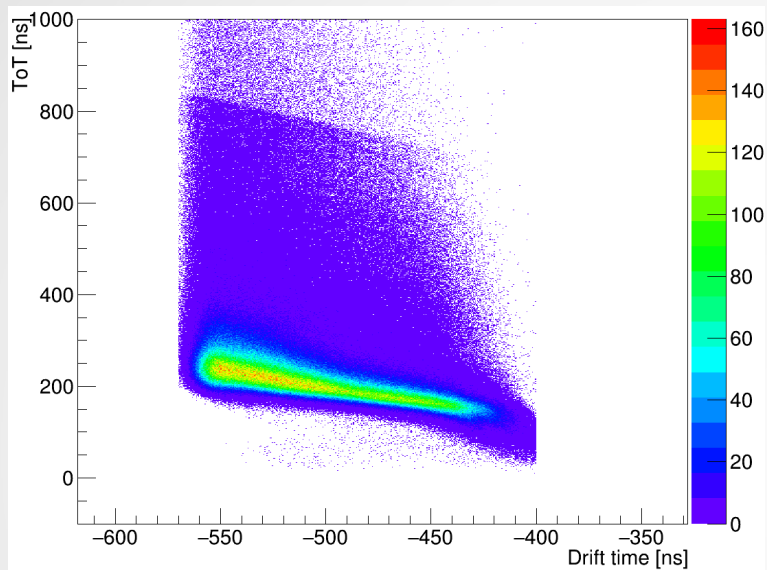
Mean ToT/dx for each track with 20% truncation



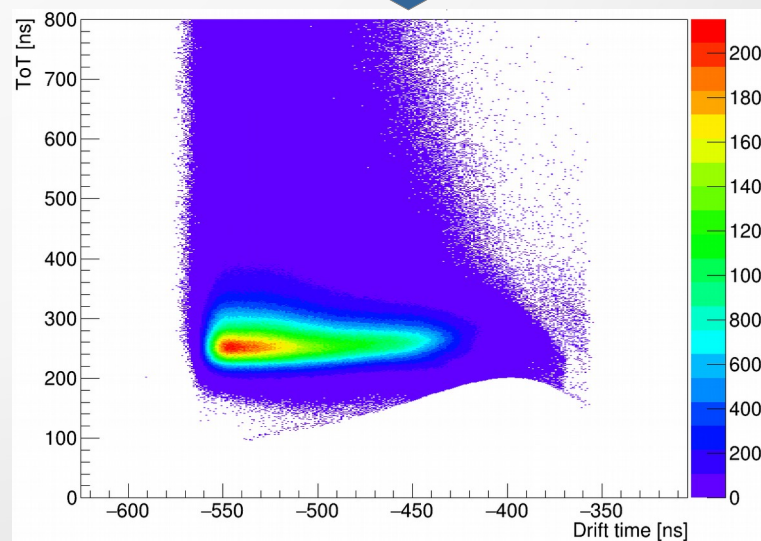
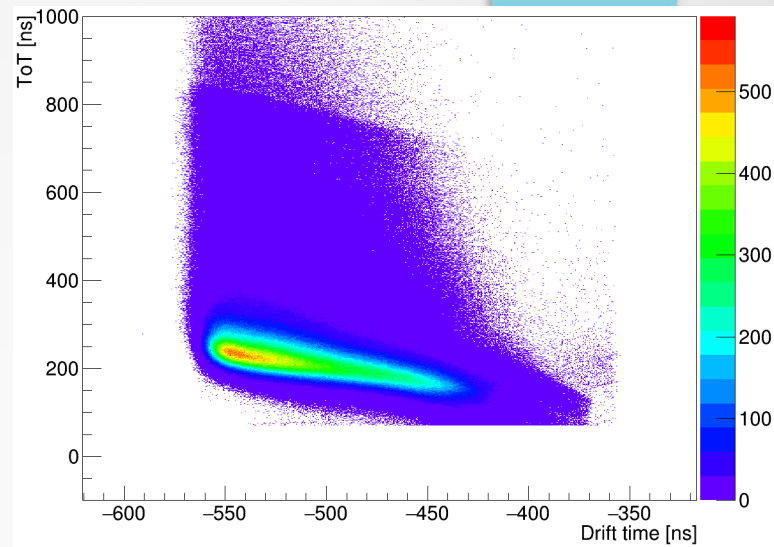
1GeV results ?

Correction of TOT for r dependance

FT 750 MeV



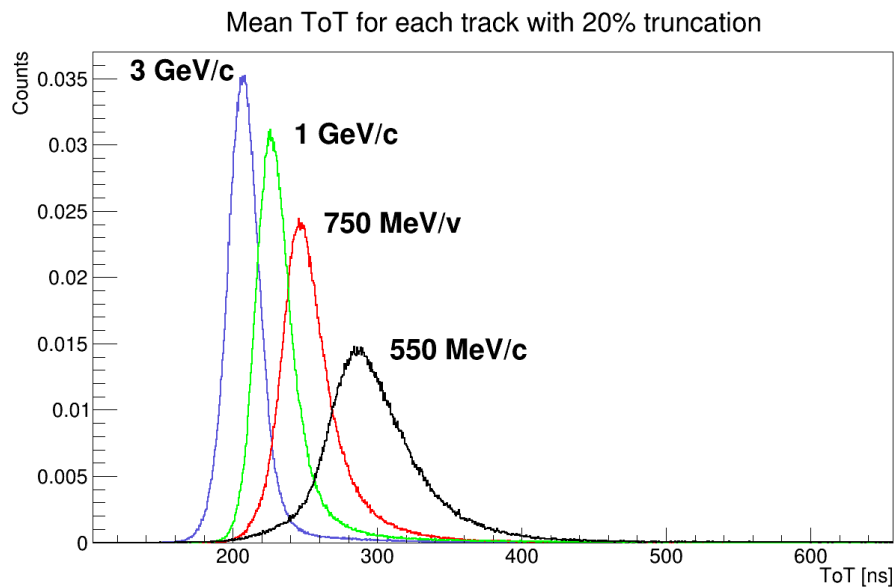
STT 750 MeV



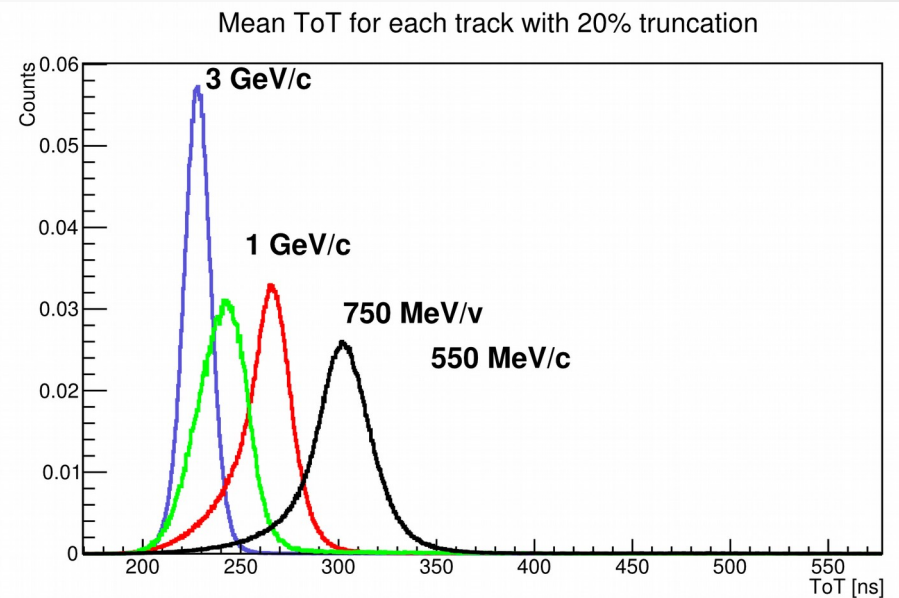
FT in beam

Truncated mean TOT

FT (6 straw tube layers)



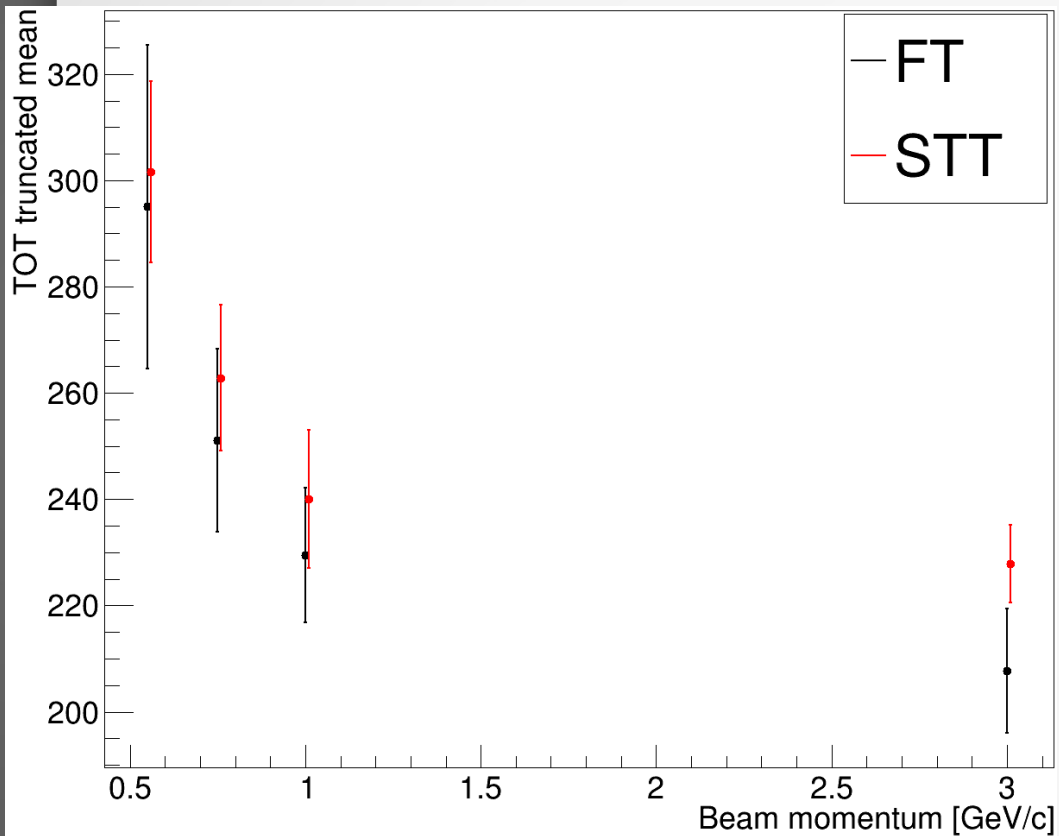
STT (24 straw tube layers)



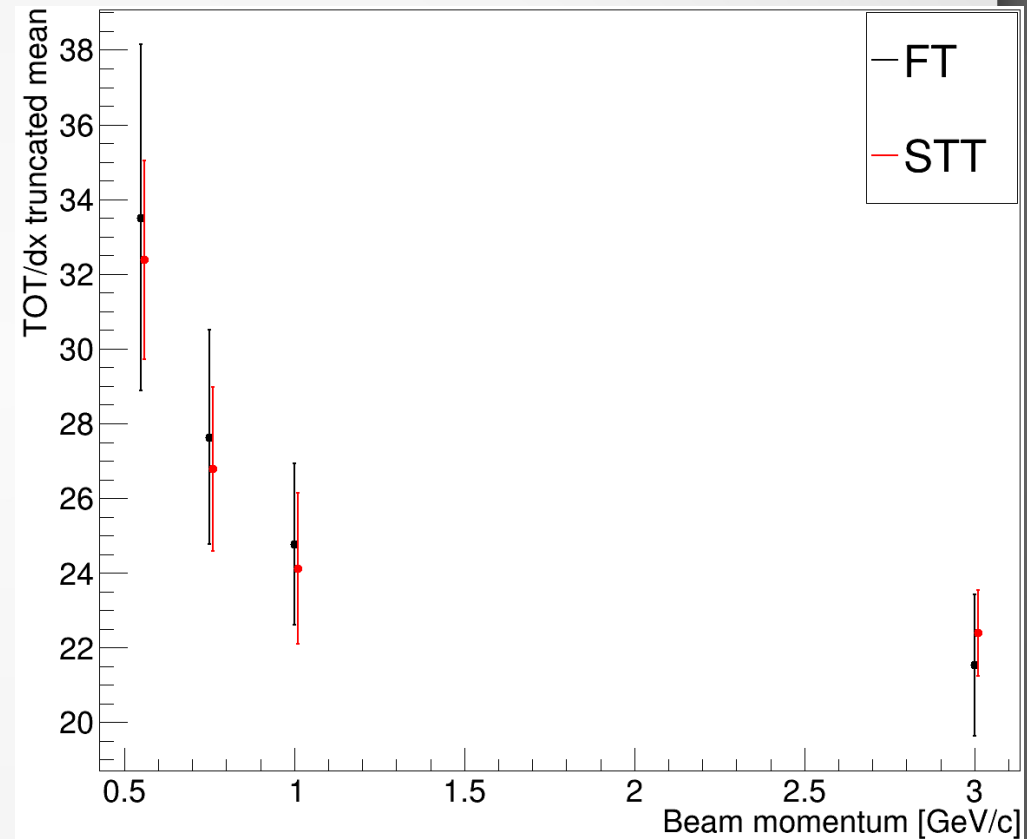
1GeV results ?

TOT analysis

Calibration method



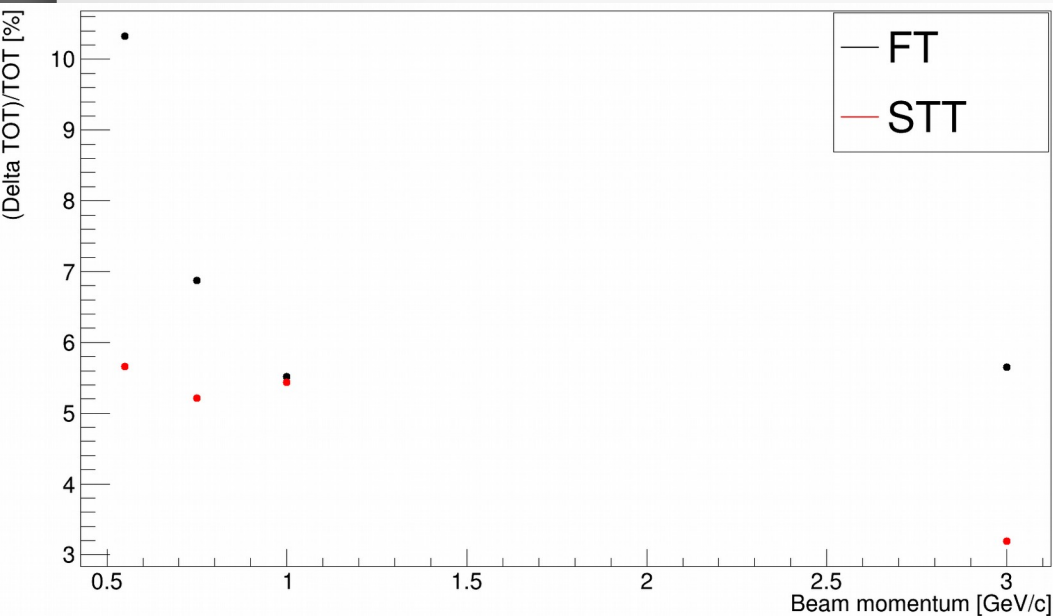
dx method



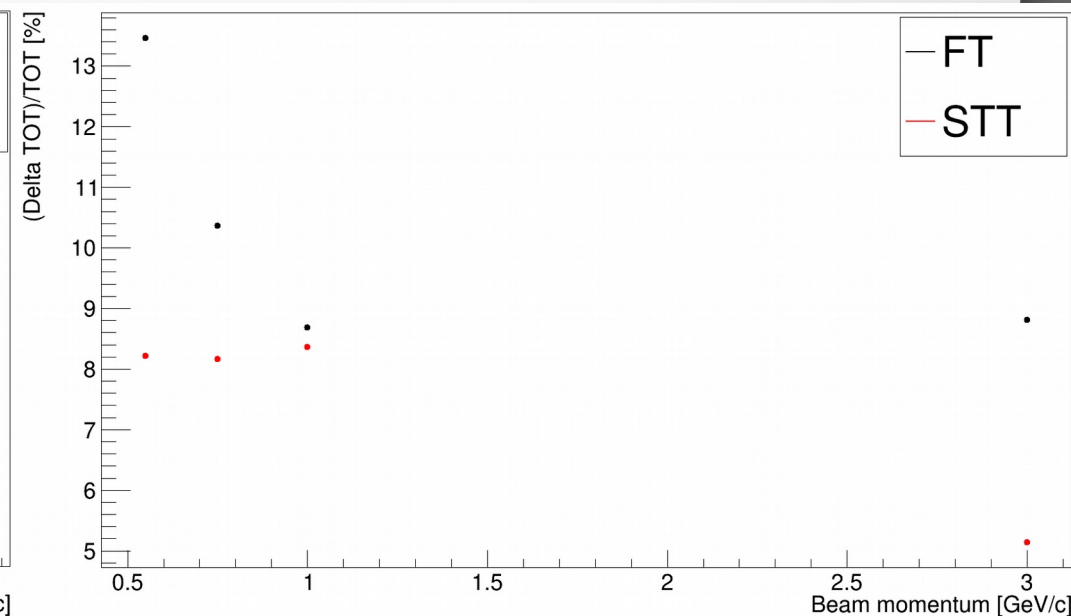
Mean value marked as data point, error bar indicates the sigma of the distribution.
Two different systems (STT and FT) show good agreement in TOT data.

Resolution ($\Delta\text{ToT}/\text{ToT}_{\text{mean}}$)

Calibration method



TOT/dx method



The more layers (STT) the better resolution can be obtained.
4 times more layers 2 times better resolution.

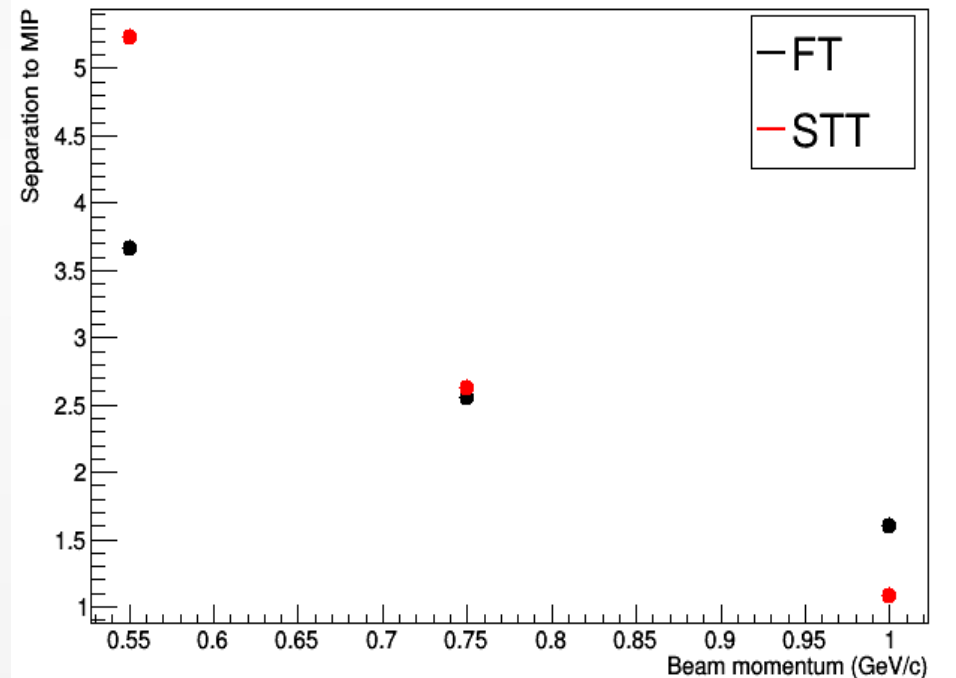
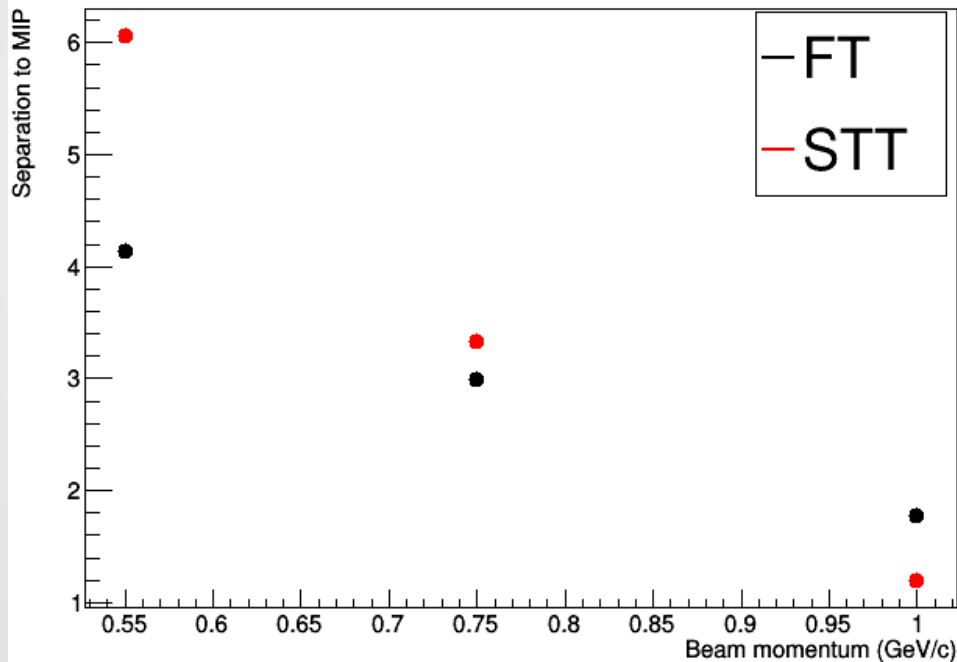
Separation

$$sep = \frac{ToT 1 - ToT 2}{(\Delta ToT 1)/2 + (\Delta ToT 2)/2}$$

Separation calculated for each beam momenta in respect to the 3 GeV protons (MIP)

Calibration method

TOT/dx method



Conclusions and outlook

- The FT systems shown stable performance during the proton beam time,
- The data analysis indicates that the required spatial resolution was achieved, except 3 GeV, with 1800 V. Low threshold!
- TOT analysis must be performed for the higher threshold together with efficiency analysis to determine if the second threshold is needed in the PASTTREC chip.

Thank you for your attention!

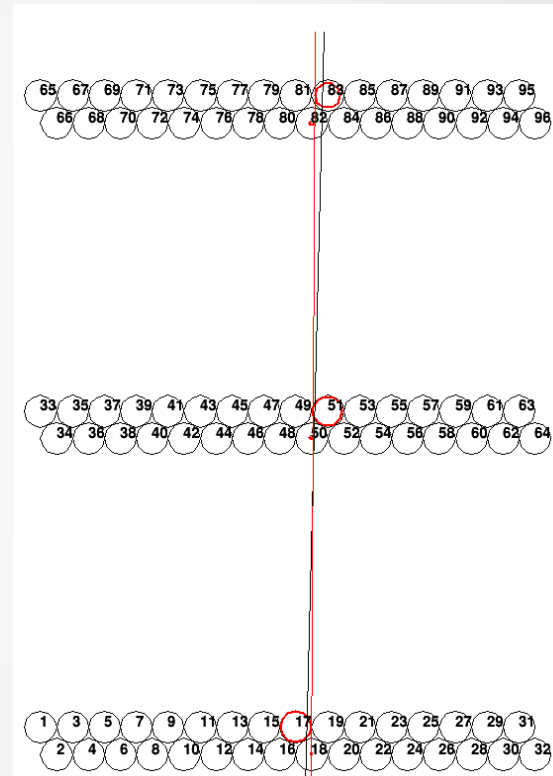
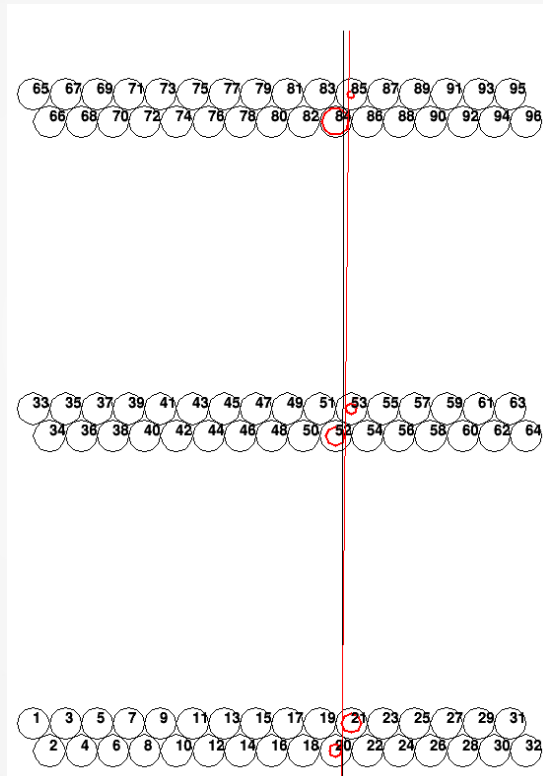
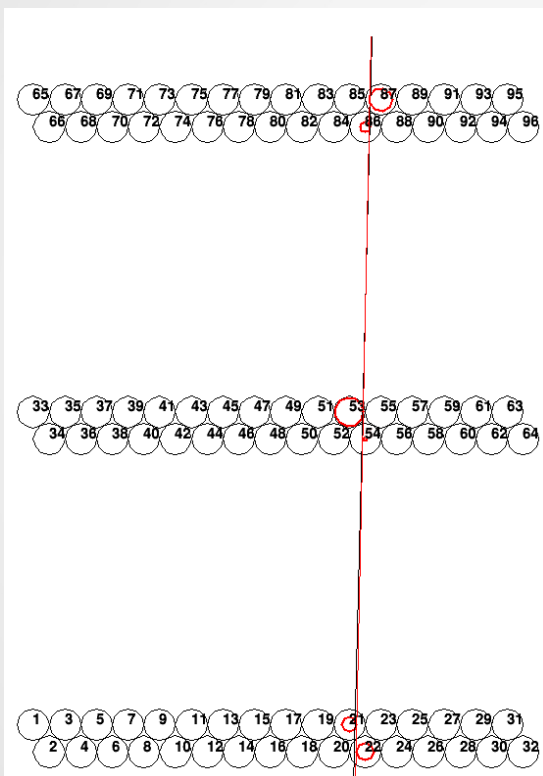
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Acknowledgments:

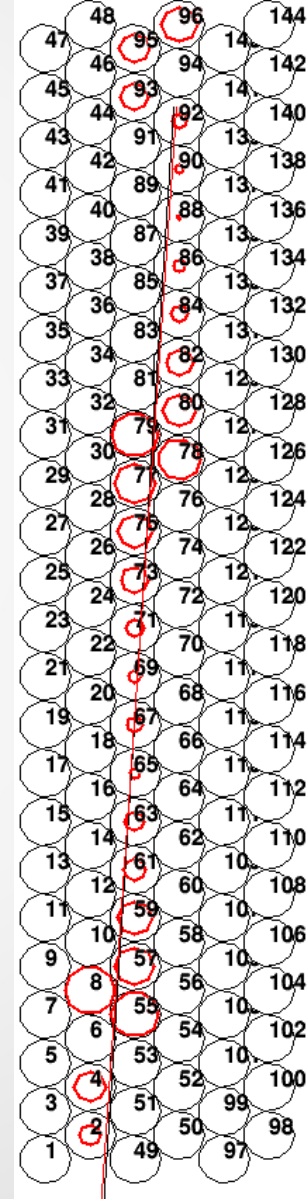
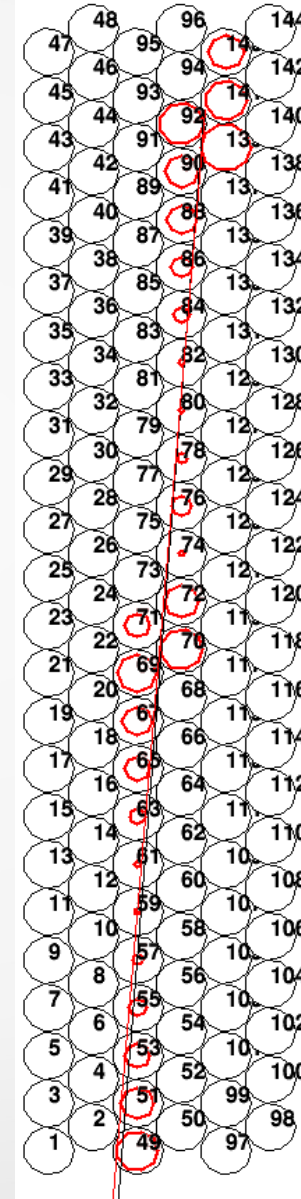
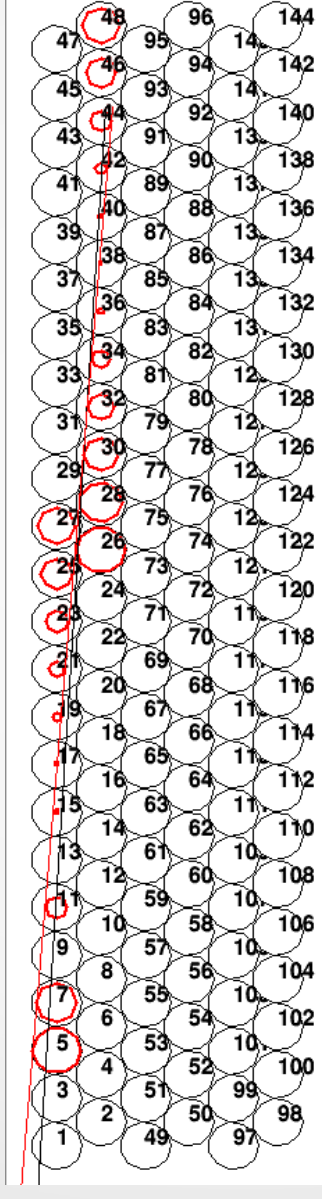
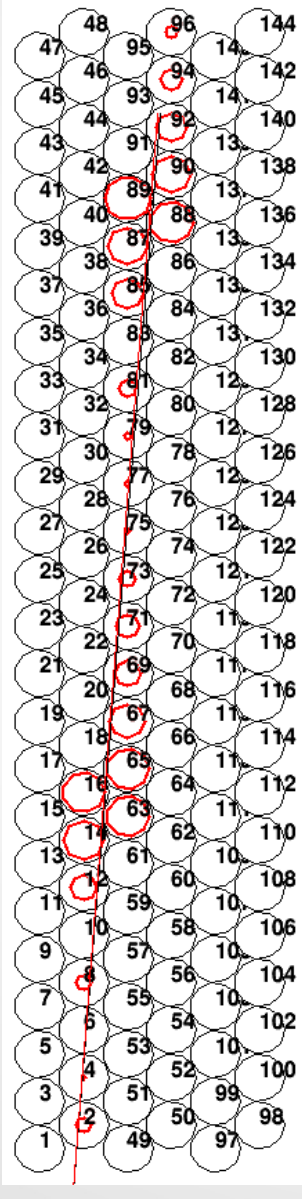
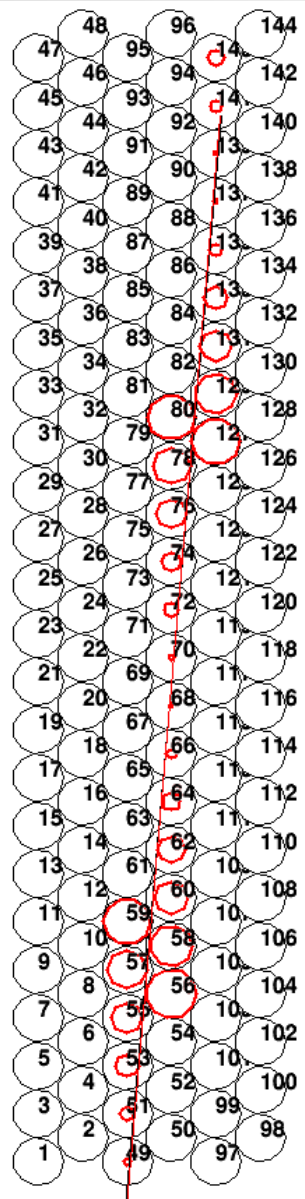
Project is supported by NCN [DEC-2013/09/N/ST2/02180]

Back-up

FT exemplar events (750 MeV)



STT exemplar events (750 MeV)



Gain of the PASTTREC

