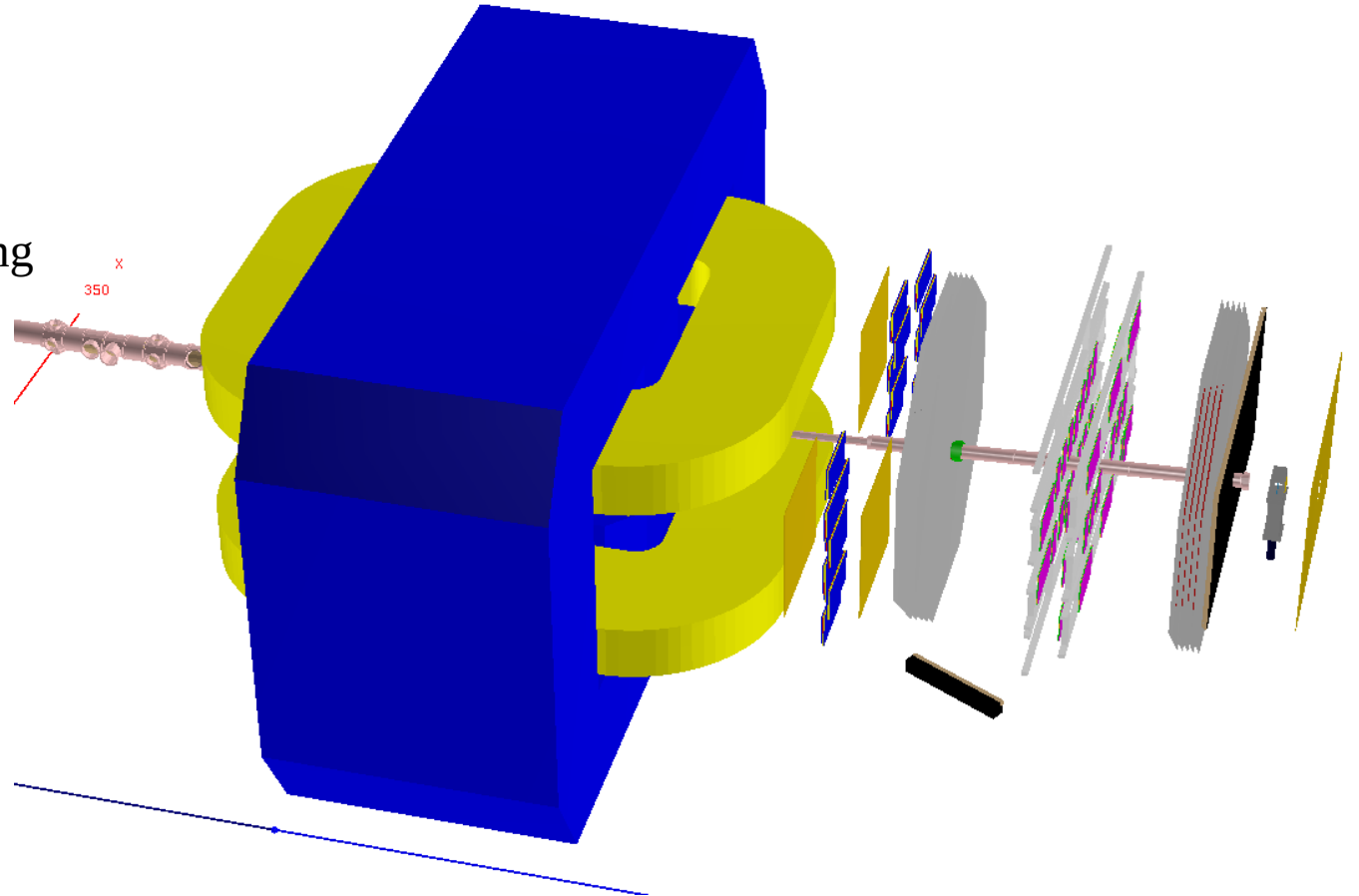
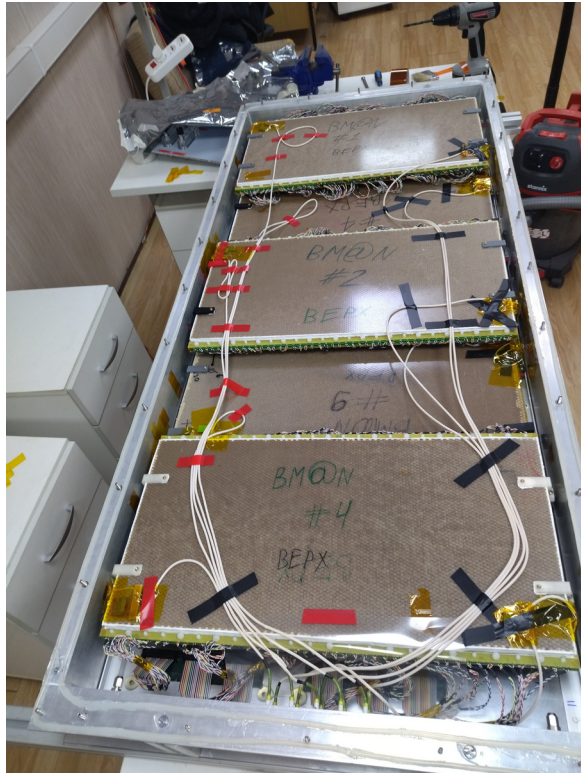


# Performance of the TOF400 system in Xe run

Rumyantsev M., Babkin V., Buryakov M., Buzin S.,  
Dulov P., Golovatyuk V., Dmitriev A., Zhavoronkova I.

- TOF400 system overview
- Coordinate resolution
- Time resolution
- Efficiency
- Stability during the data taking
- Extension of the TOF400
- Conclusion





- mRPC detector with active area  $30 \times 60 \text{ cm}^2$ .
- 48 readout strips of  $1 \times 30 \text{ cm}^2$  in one mRPC.
- $90\% \text{C}_2\text{H}_2\text{F}_4 + 5\% \text{SF}_6 + 5\% \text{i-C}_4\text{H}_{10}$
- 11.5 kV working point



- Two arms of 10 mRPC detectors each.
- Active area  $2 \times 1,1 \times 1,3 \text{ m}^2$
- 960 Readout strips.
- 1920 channel of FEE.

The coordinate resolution of the detector itself was measured in 2016 on a deuterons test beam.

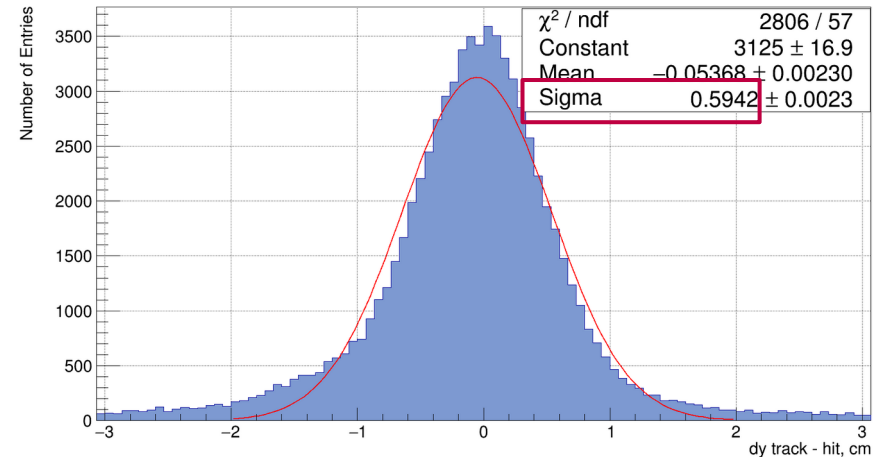
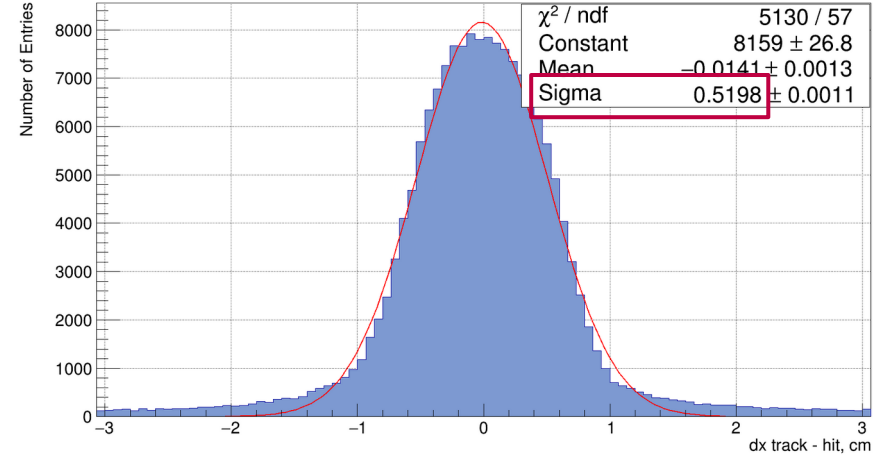
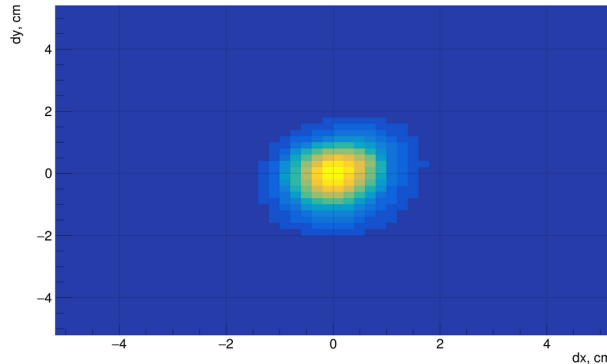
- $\sigma_x(\text{itself}) = 3,6 \text{ mm}$
- $\sigma_y(\text{itself}) = 5 \text{ mm}$

In the experiment, we can only measure the combined coordinate resolution (track extrapolation accuracy, alignment and calibration quality, detectors resolution).

Cuts for track:

- $N_{\text{hits}} (\text{STS} + \text{GEM}) > 5$
- $|\text{PV}_x| < 2$
- $|\text{PV}_y| < 2$

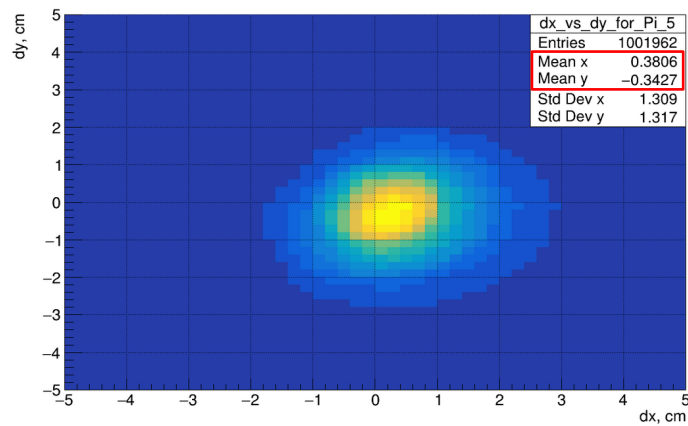
- $\sigma_x(\text{track-hit}) = 5,2 \text{ mm}$
- $\sigma_y(\text{track-hit}) = 6 \text{ mm}$



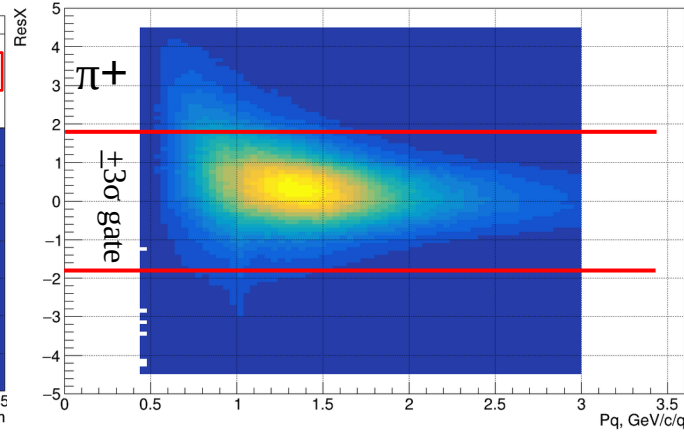
# Coordinate resolution.

Residuals dx and dy depend from the charge and momentum of the particle.

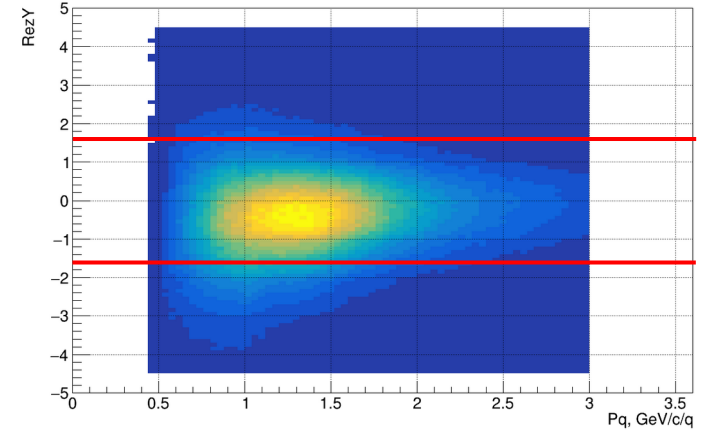
dx\_vs\_dy\_for\_Pi\_5



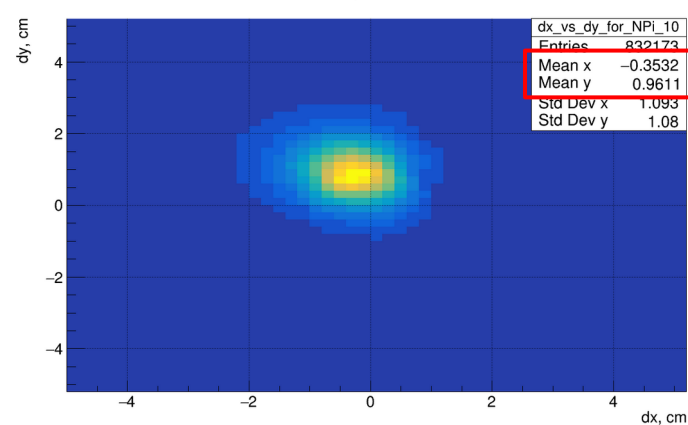
h\_dx\_vs\_Mom\_Pi\_5



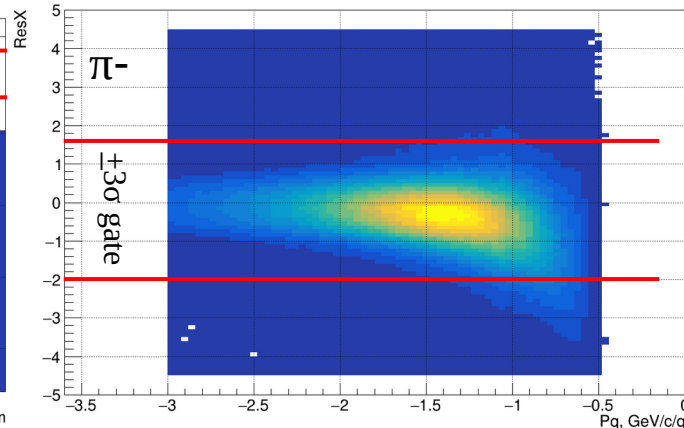
h\_dy\_vs\_Mom\_Pi\_5



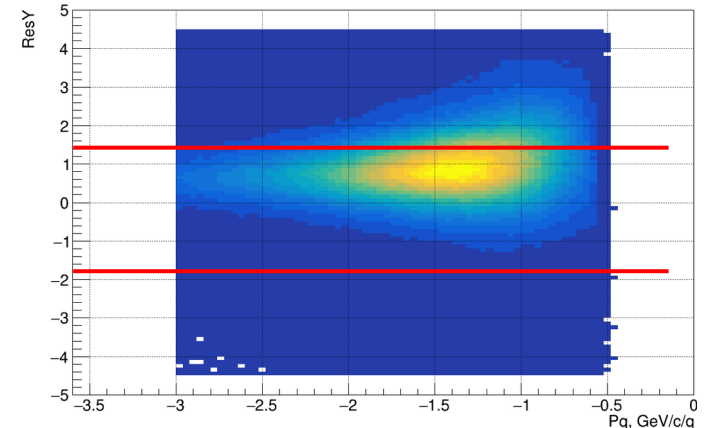
dx\_vs\_dy\_for\_NPi\_10



h\_dx\_vs\_Mom\_NPi\_10



h\_dy\_vs\_Mom\_NPi\_10



The time resolution of the detector with full readout chain was measured in 2016 on a deuterons test beam.

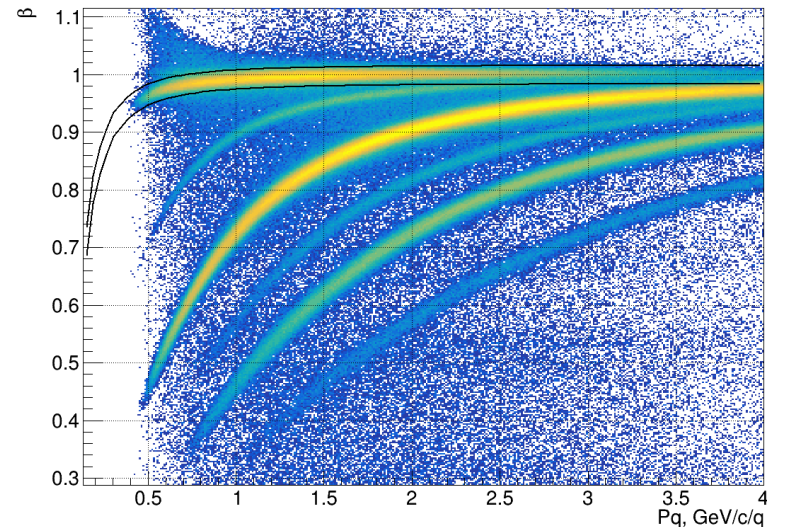
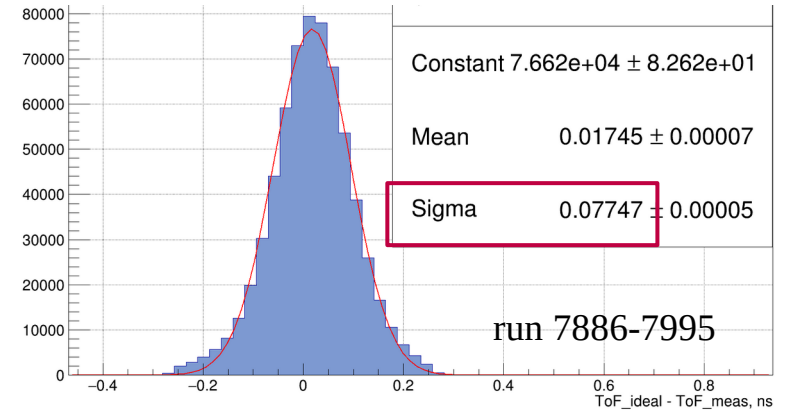
- $\sigma_{\text{time}}(\text{mRPC}+\text{FEE}+\text{TDC}) = 50 \text{ ps}$

Cuts for track:

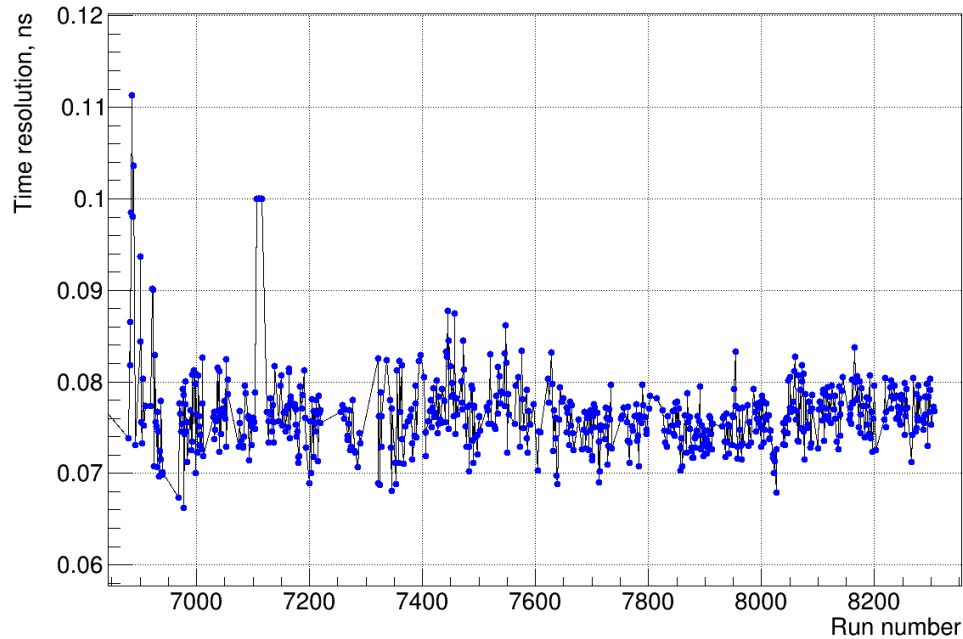
- $N_{\text{hits}}(\text{STS} + \text{GEM}) > 5$
- $|PV_x| < 2; |PV_y| < 2$
- $1 < P < 2 \text{ GeV}/c$
- $|X_{\text{trak}} - X_{\text{hit}}| < 3 \text{ cm}; |Y_{\text{trak}} - Y_{\text{hit}}| < 3 \text{ cm}$
- The particles are in the  $\pi$  band on  $\beta$ \_vs\_ $P$  plot
- The band for  $\pi$  selection is calculated for 3 sigma of time res (80 ps) and 1 sigma of momentum res (5%)

In the experiment, we can only evaluate the full system time resolution (T0, TOF, all electronics, synchronization, calibration quality, momentum resolution).

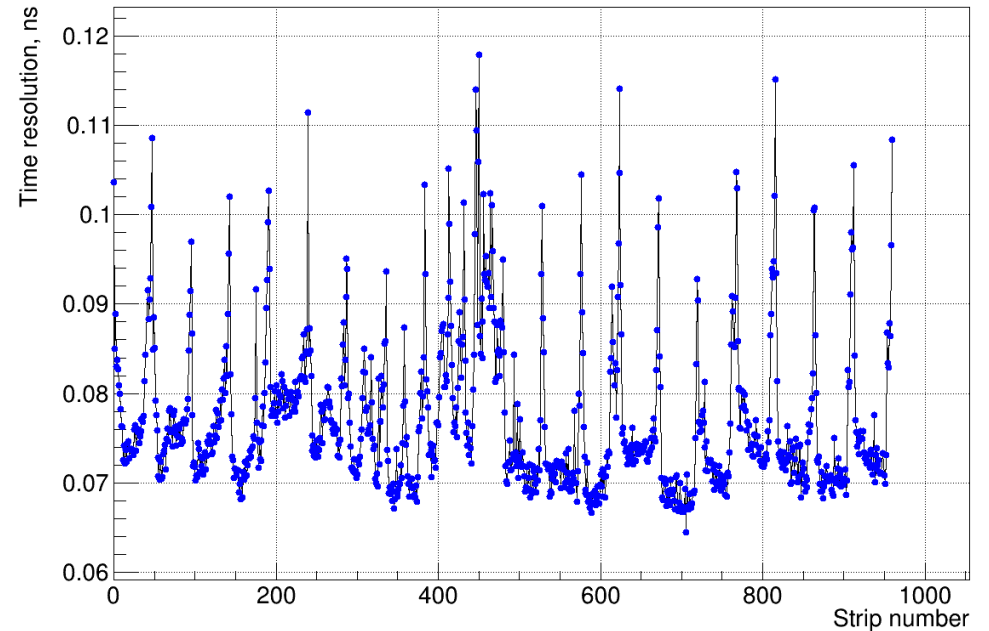
- $\sigma_{\text{time}}(\text{FullSystem}) = \sigma_{\text{time}}(\text{ToF\_ideal} - \text{ToF\_meas}) = 78 \text{ ps}$



# Time resolution.



Average time resolution of the full system (T0+TOF400) during data taking



Average time resolution of each strip of TOF400 System

The efficiency of the detector itself depends on gas mixture, HV and FEE threshold. For the TOF system settings used in the Xe run we expect efficiency of particles registration is  $\sim 96\%$ .

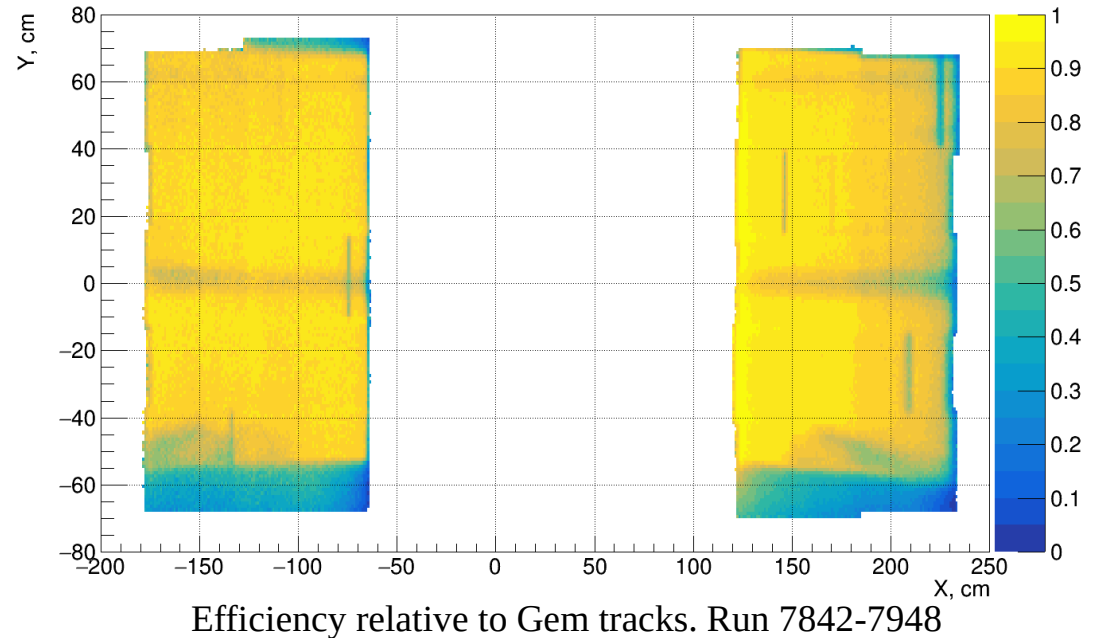
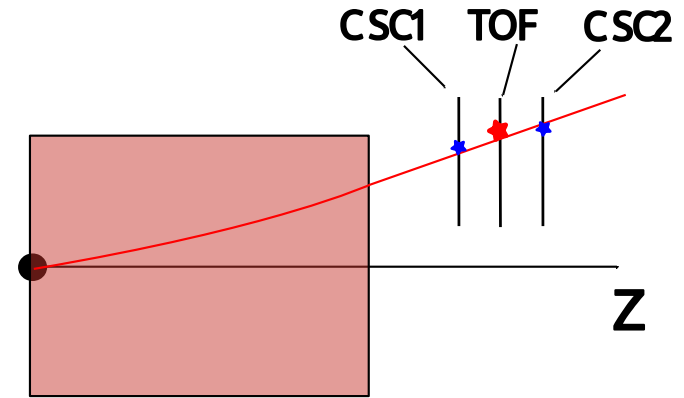
In the experiment we can calculate the «matching» efficiency with respect to Gem Tracks, or Gem+CSC(1,2) Tracks.

Cuts for Track (denominator):

- $N_{\text{hits}} (\text{STS} + \text{GEM}) > 5$
- $|PV_x| < 2; |PV_y| < 2$
- $|X_{\text{trak}} - X_{\text{csc}}| < 3 \text{ cm}; |Y_{\text{trak}} - Y_{\text{csc}}| < 3 \text{ cm}$

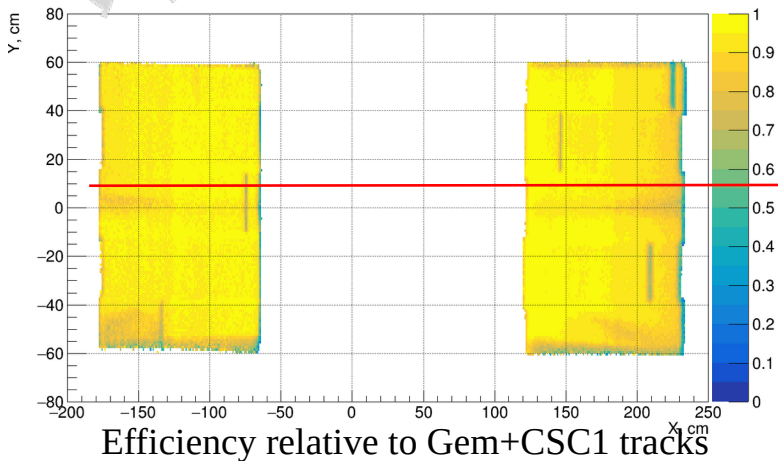
Cuts for TOF matching (numerator):

- $|X_{\text{trak}} - X_{\text{hit}}| < 3\sigma_x (1,8 \text{ cm}); |Y_{\text{trak}} - Y_{\text{hit}}| < 3\sigma_y (1,8 \text{ cm})$

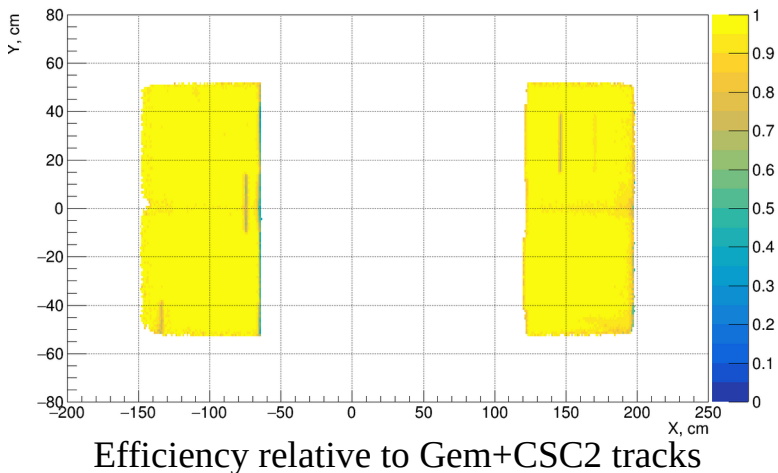




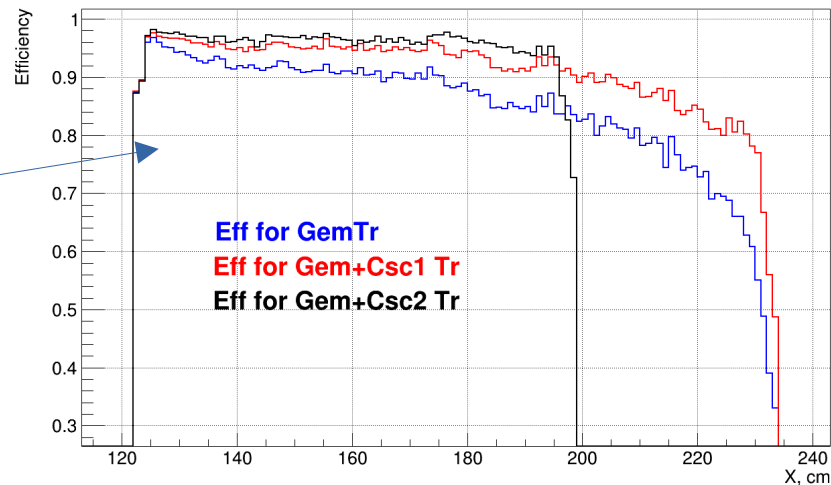
hEff\_tr\_Csc1



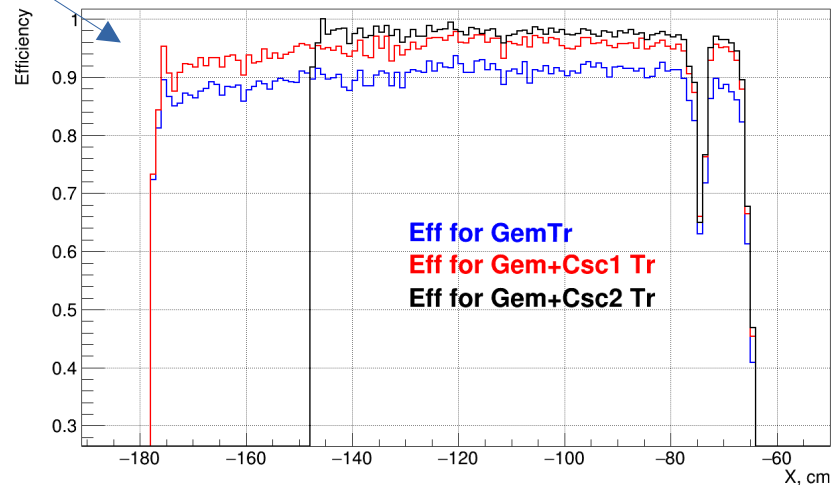
hEff\_tr\_Csc2



The efficiency is uniform along the active area of the TOF.



1 cm width slice along X



# Efficiency.

Run 7842-7948

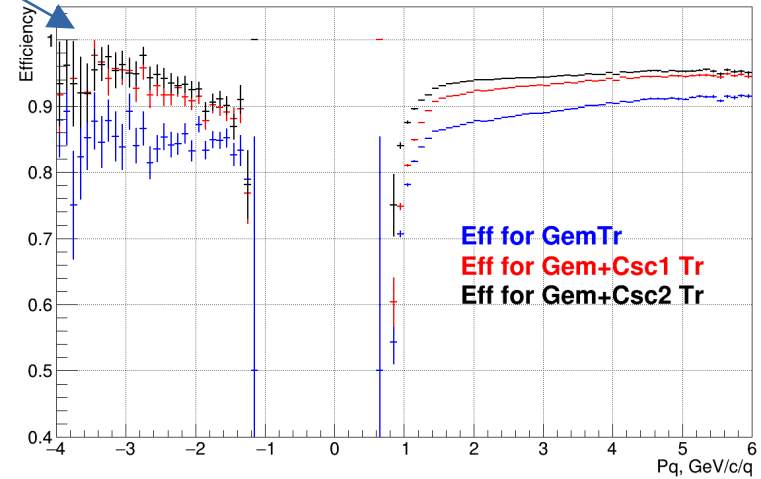
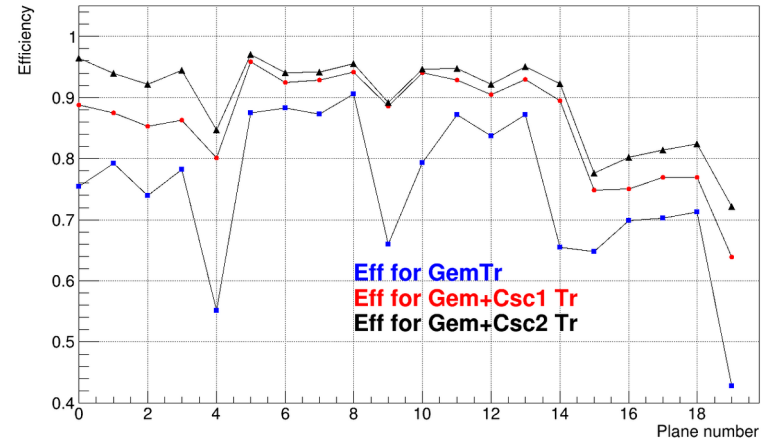
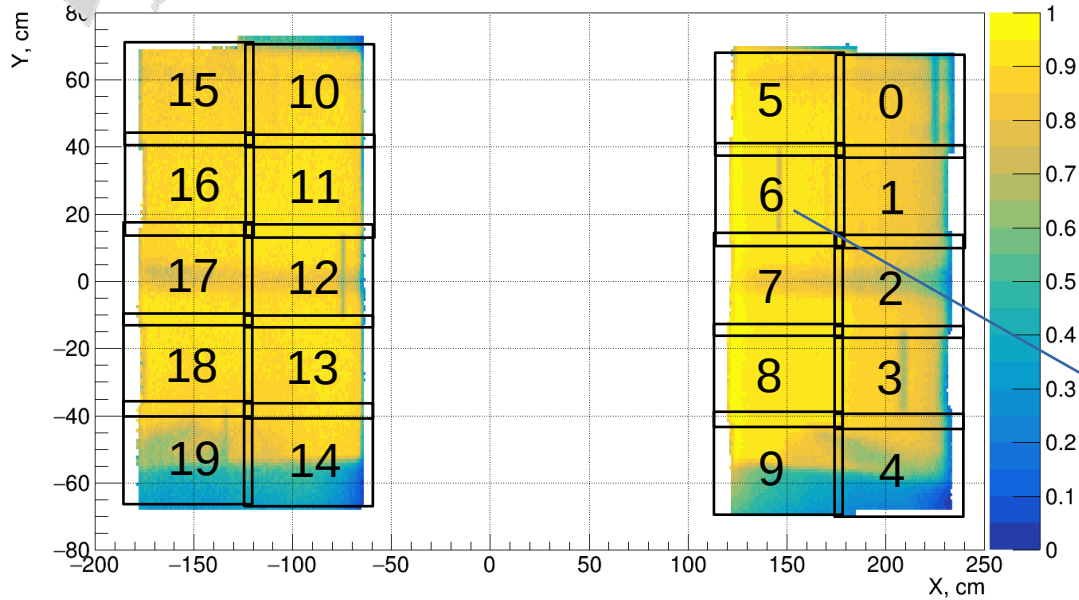
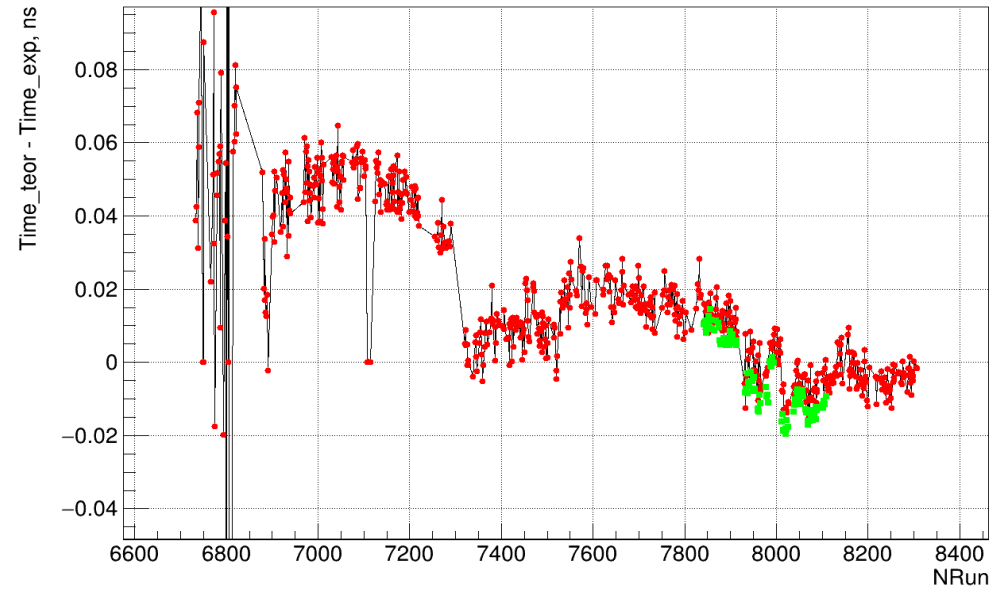


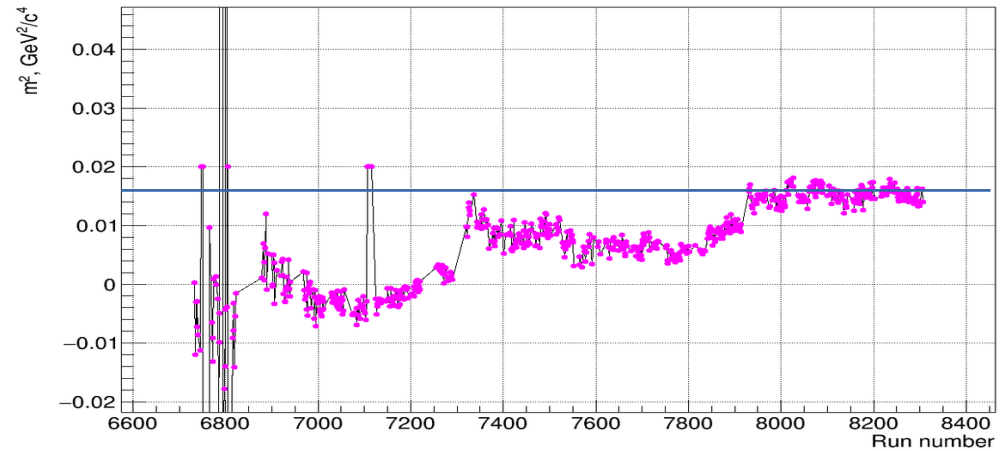
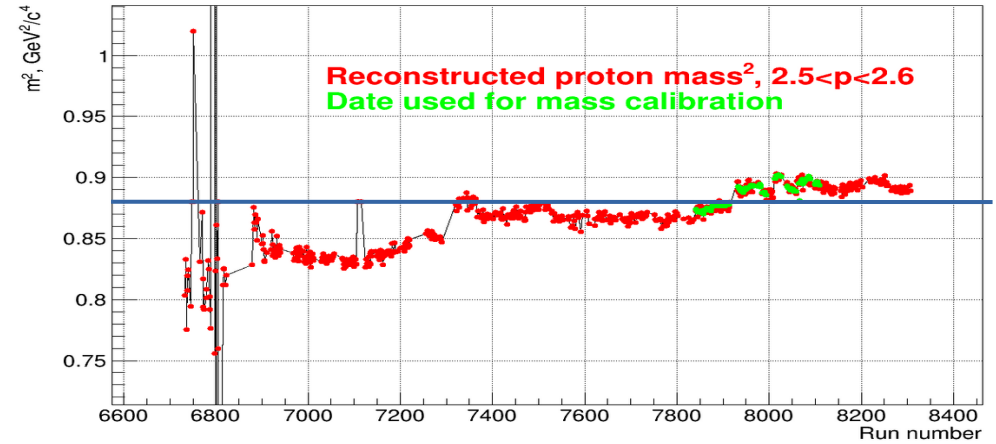
Table of «average» efficiency of the TOF400 system

	GemTr	Gem+Csc1 Tr	Gem+Csc2 Tr	Gem+Csc1+Csc2 Tr
Efficiency	83.4%	93.7%	96.5%	96.7%
Statistic	100.0%	70.7%	45.6%	44.5%

# Stability during the data taking.



The time-of-flight change up to 50 ps during the Xe run. It has big influence on mass reconstruction. The reasons for this are still unclear.



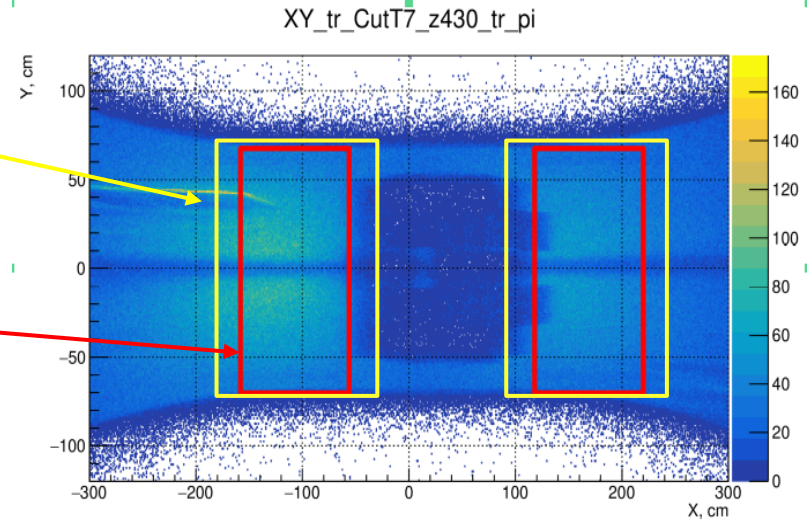
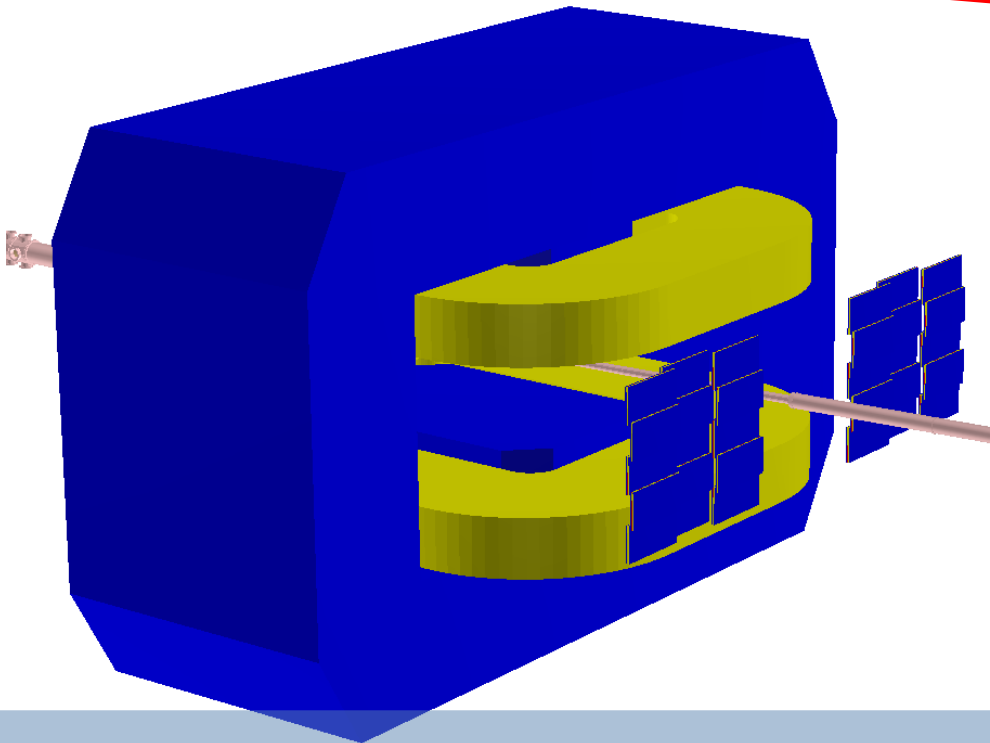
# Extension of the TOF400 system.

old configuration:

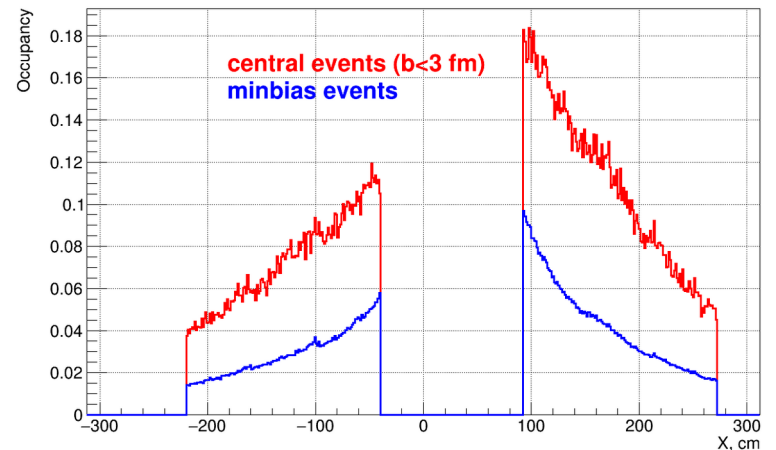
- 2 x 1.15x1.3 m<sup>2</sup>
- 20 detectors
- 1920 channels of FEE

new configuration:

- 2 x 1.7x1.3 m<sup>2</sup>
- 30 detectors
- 2880 channels of FEE

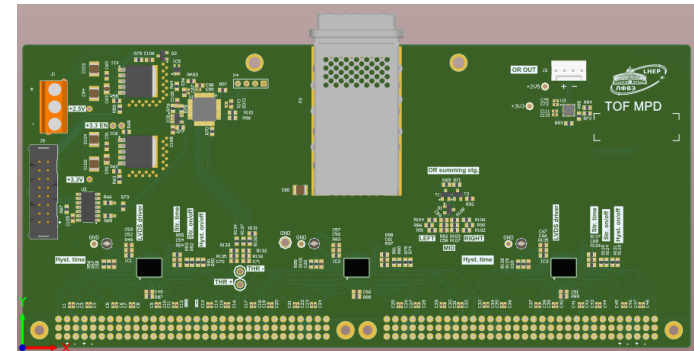
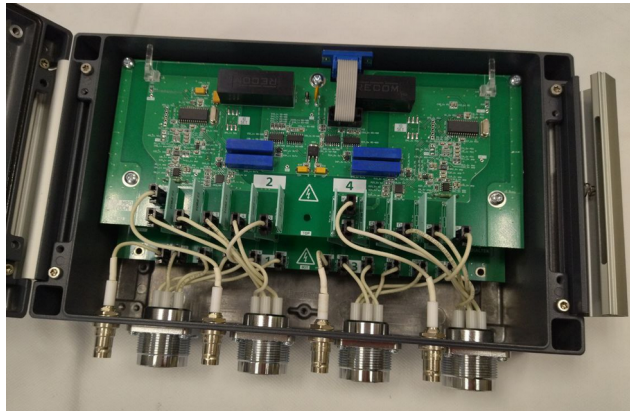


Au+Au 3.8GeV DCM\_SMM



# Extension of the TOF400 system.

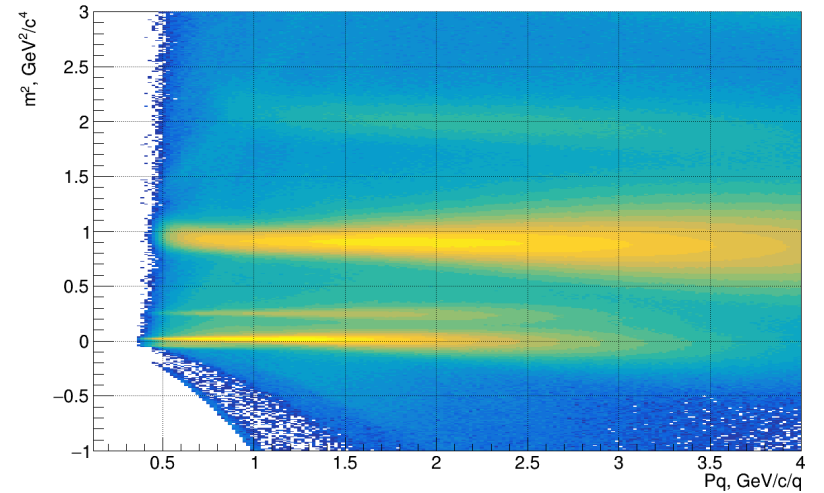
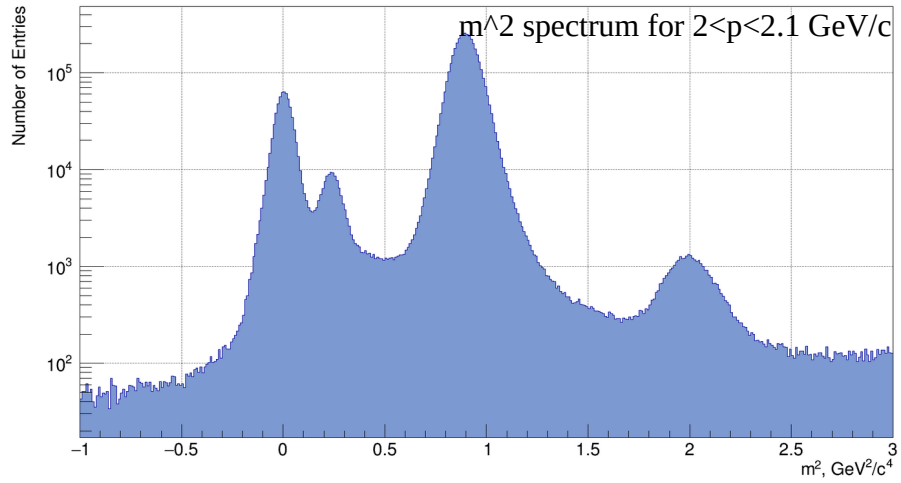
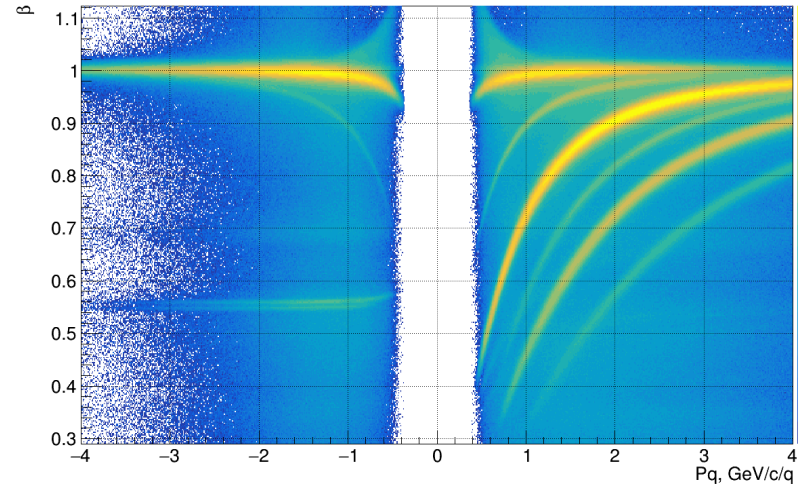
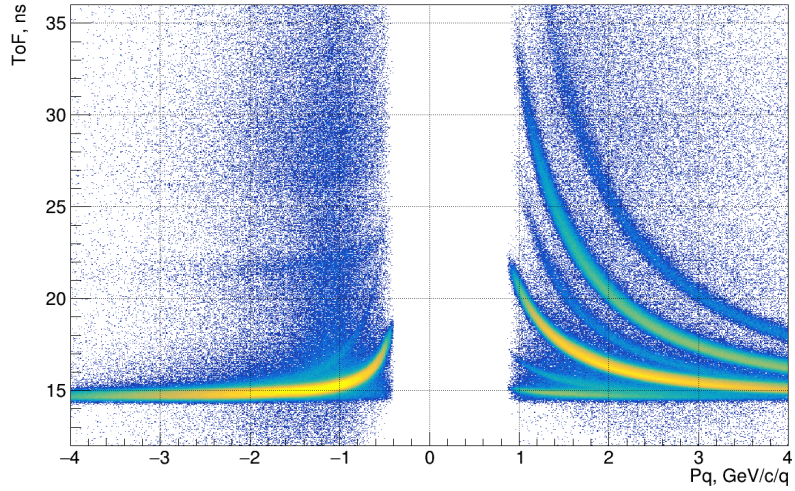
	Current system	Extended system	In stock	
Detectors	20	30	30	
Gas box	4	2 (new design)	2	
FEE	80	120	140	
TDC	28	42	42	
HV	40	60	40+24	
LV	16	24	24	
HV cable	40	60	60	
LV cable	8	12	12	
HV distributor	-	10	0	In designe
Signal cable	40	60	60	



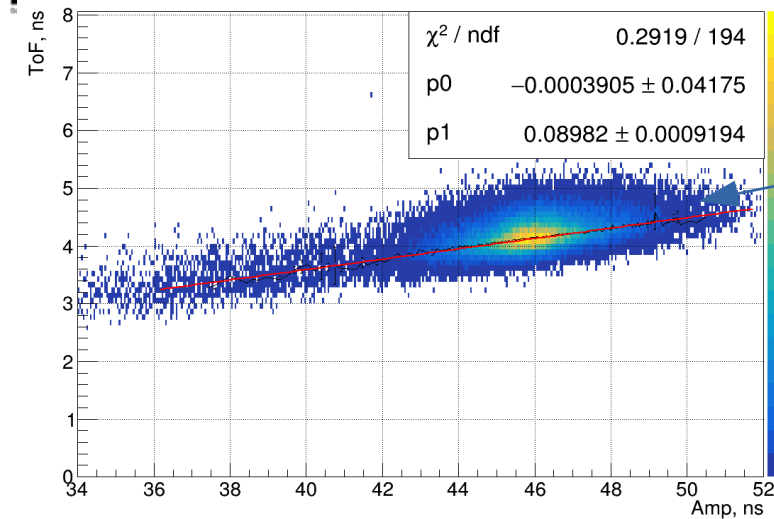
- The main work of calibration of TOF400 system are finished. The new TOF400 hits available in /eos/nica/bmn/exp/dst/run8/24.04.0
- The time resolution of the full chain of identification (T0+TOF+Calibration+Tracking) is about 80 ps. There is some possibility to improve it on some «bad» strips.
- The evaluation of the detector's efficiency corresponds to the expected value of 96%.
- The matching efficiency can be improved by adjustment of the matching gate as function of momentum/charge of the particle.
- All materials are available to start assembling the extended version of the TOF400 system.

Thank You for attention.

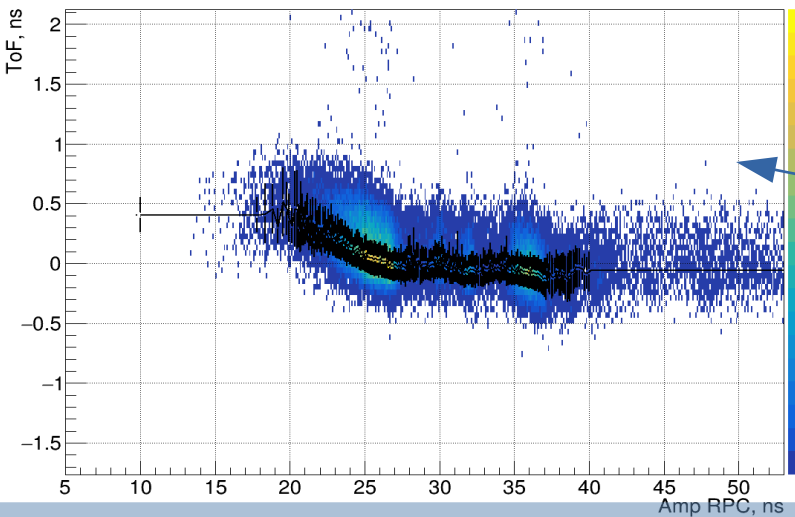
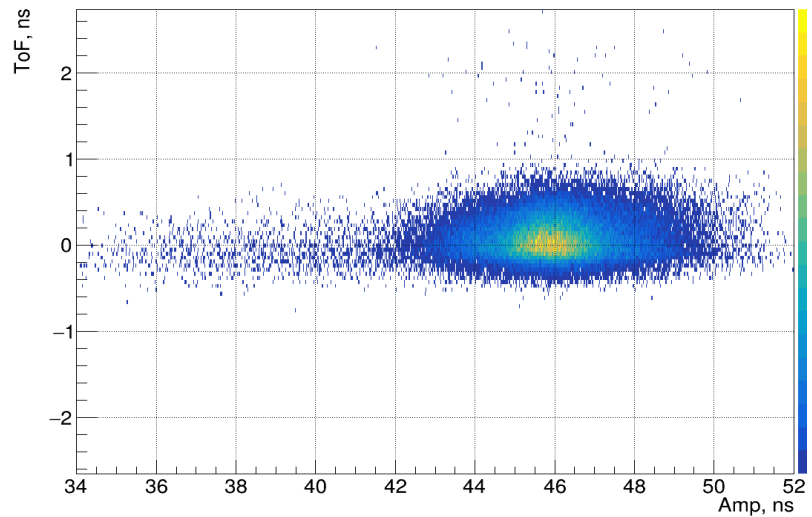
# Beackup.



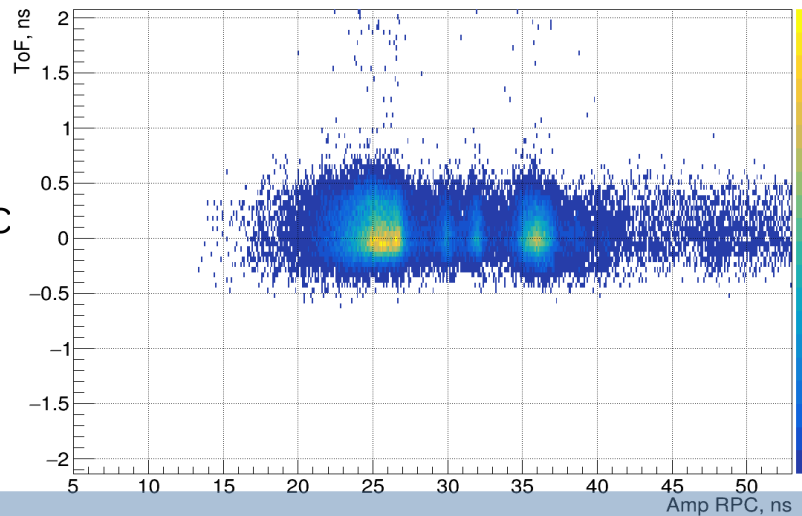
# Slewing correction of the TOF400 by $\pi^{+(-)}$ particles.



Step 1:  
Correction for T0  
by line

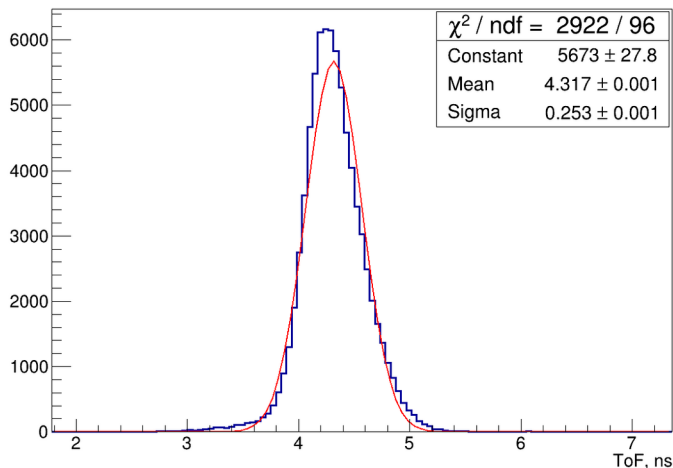


Step 2:  
Correction for RPC

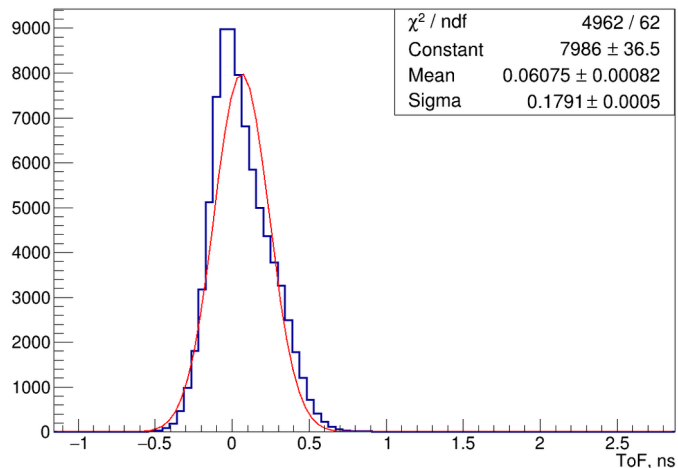




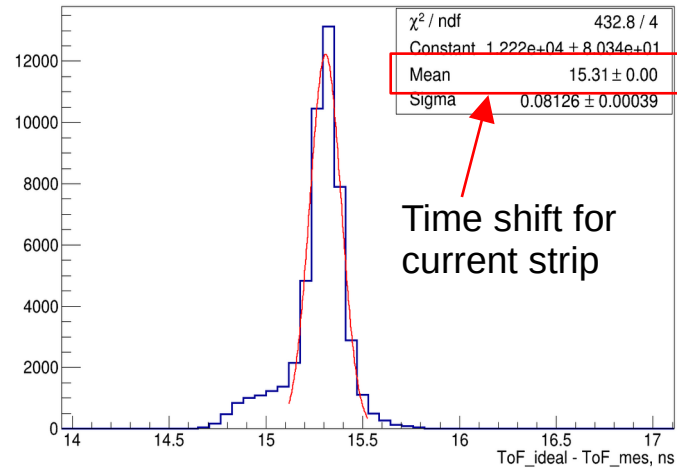
# Time shift correction of the TOF400.



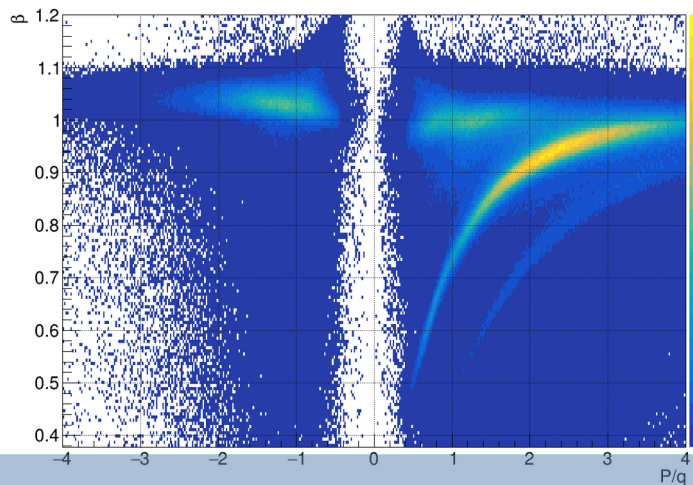
ToF for  $\pi^+$  band w/o Slewing



ToF for  $\pi^+$  band with Slewing



ToF<sub>ideal</sub> — ToF<sub>mes</sub> for  $\pi^+$  band



After all corrections

