Straw Tube Trackes readout and FT performance in April beam time

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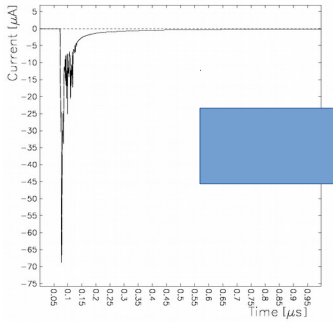
Plan of presentation

- Readout concept for the Straw Tube Trackers (PASTTREC and TRBv3)
- Results for the FT operation in the proton beam
- Readout architecture based on the TRBv3

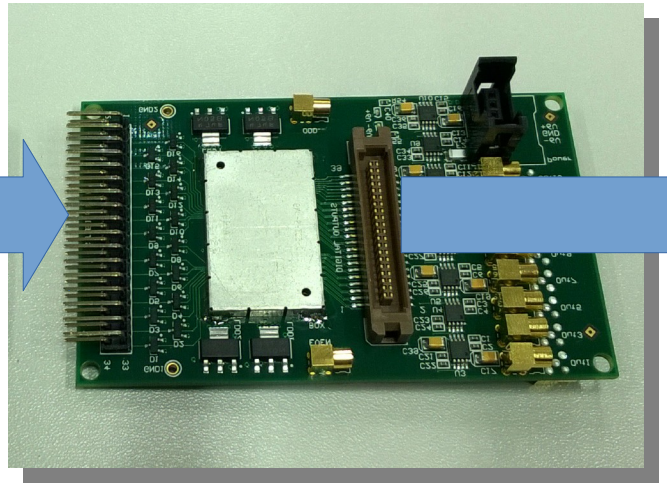
Front end electronics - PASTTREC

Straw tube signal

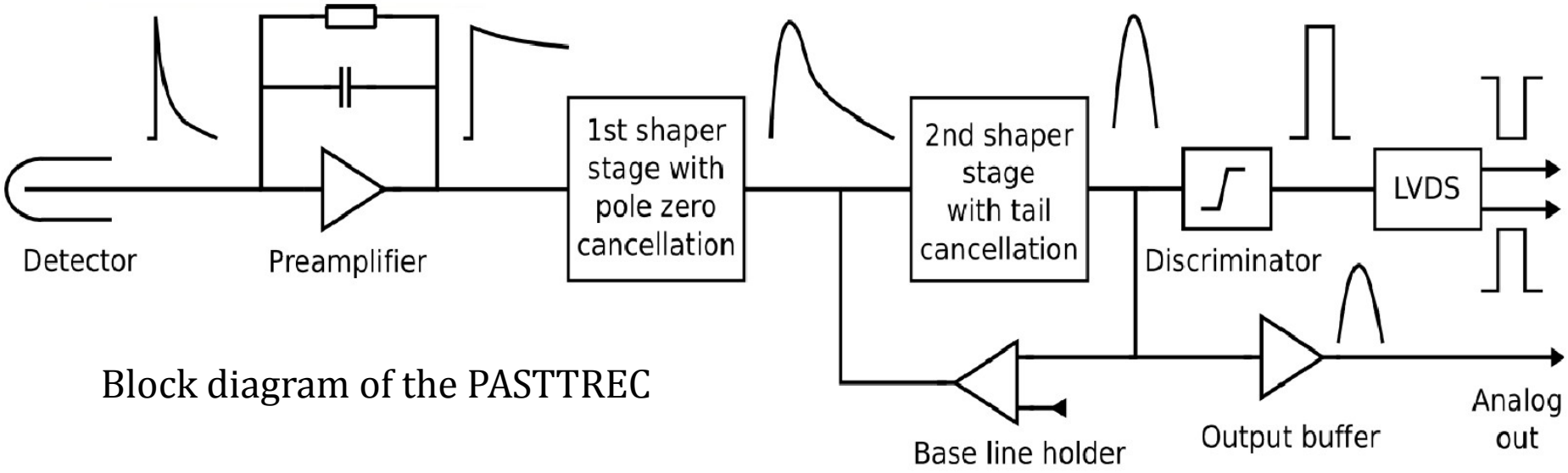


RC board (HV de-coupler)

Front end electronics PCB



Digital signal

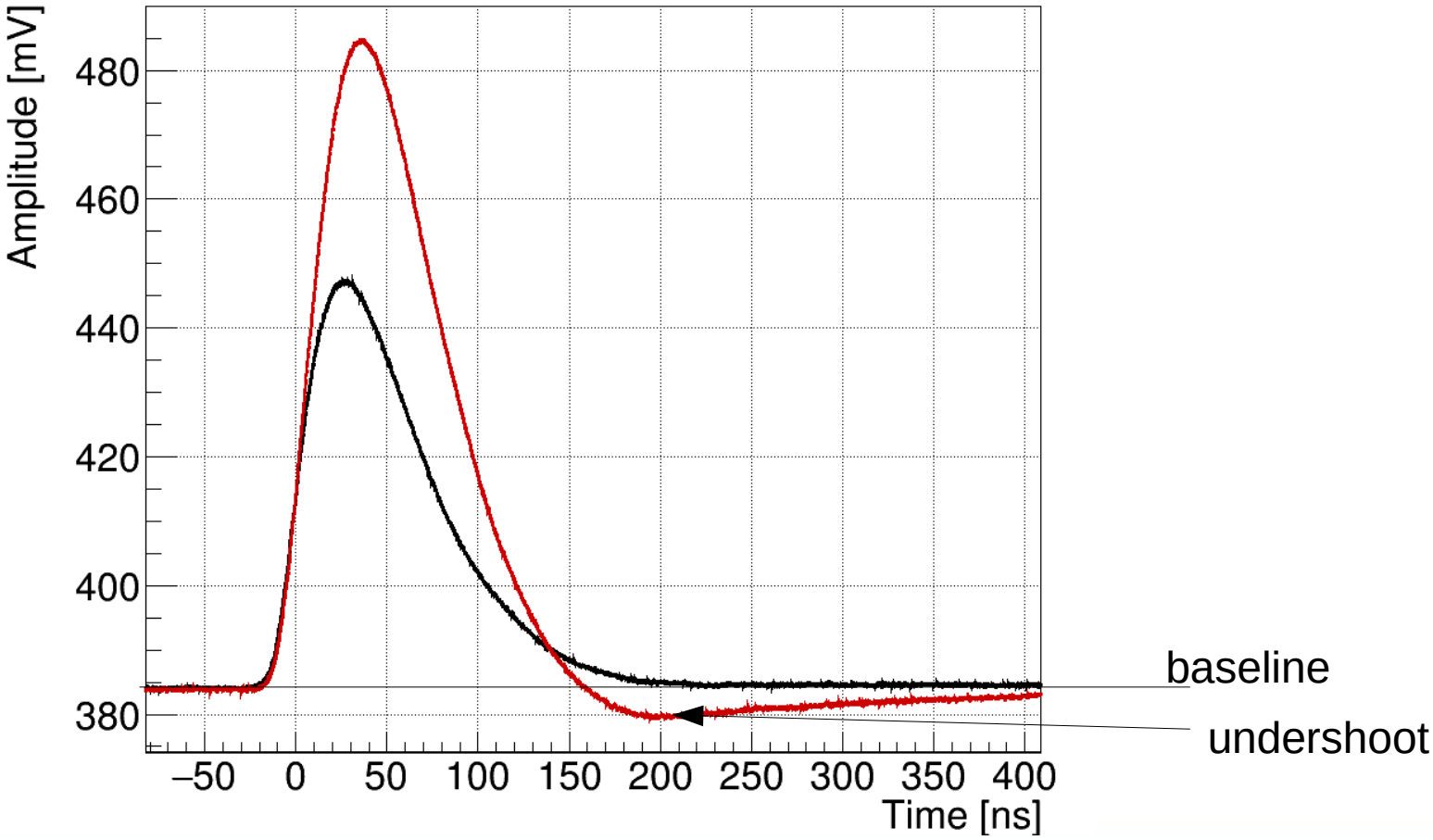


Block diagram of the PASTTREC

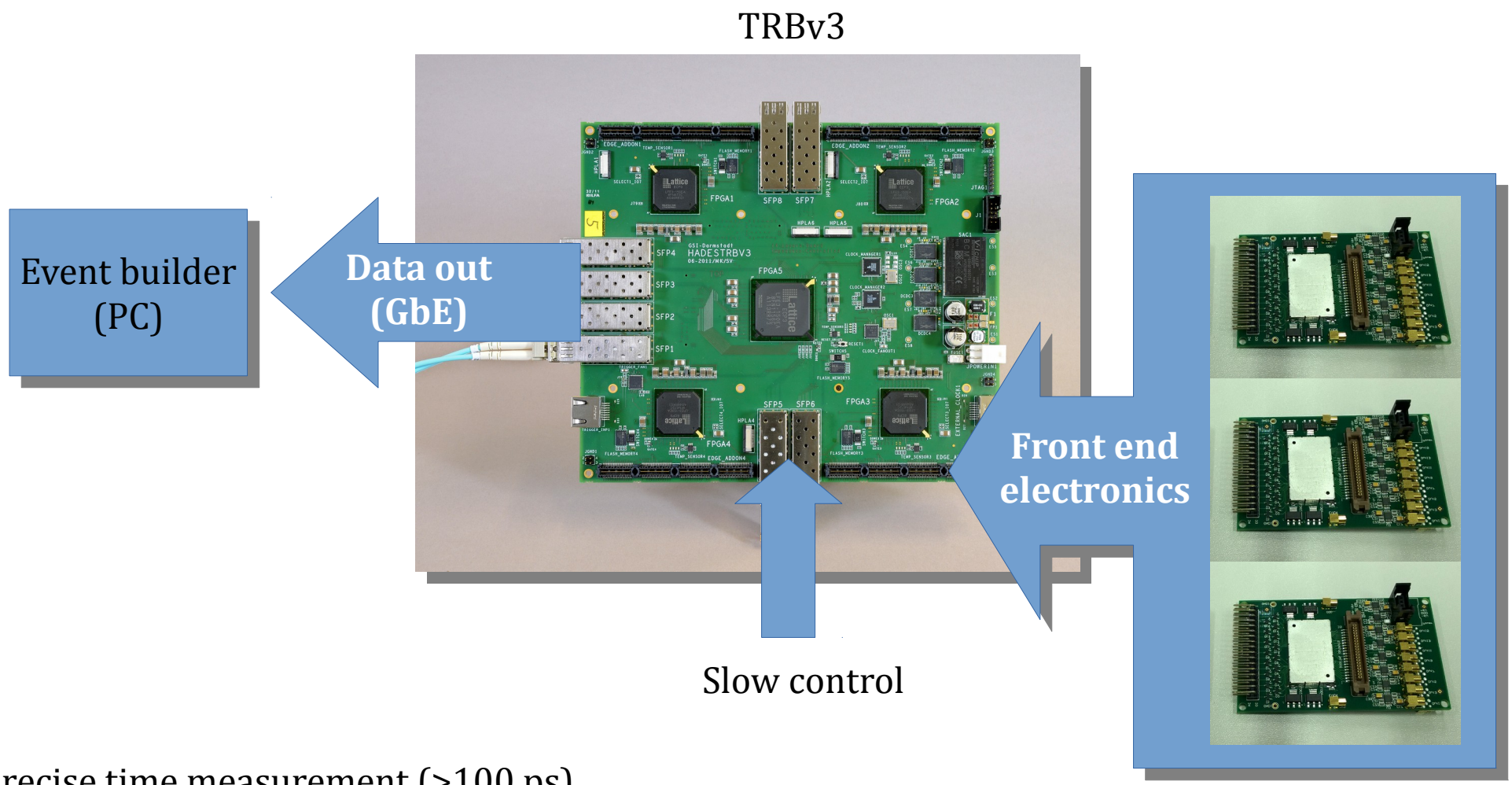
PASTTREC = amplification, shaping and discrimination.

PASSTREC configuration

- The total amount of all settings for the PASTTREC is 65536 (gain, peaking time and tail cancellation).
- For the gain = 1 and 2 mV/fC and peaking time 15, 20 and 35 the optimal tail cancellation settings found.



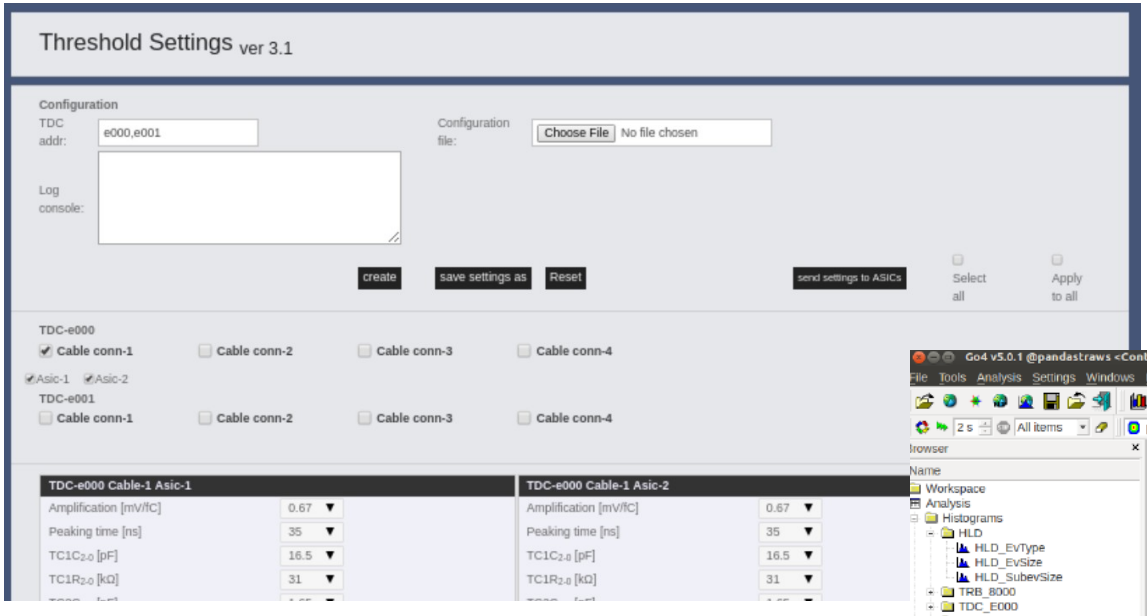
TRBv3 – readout platform

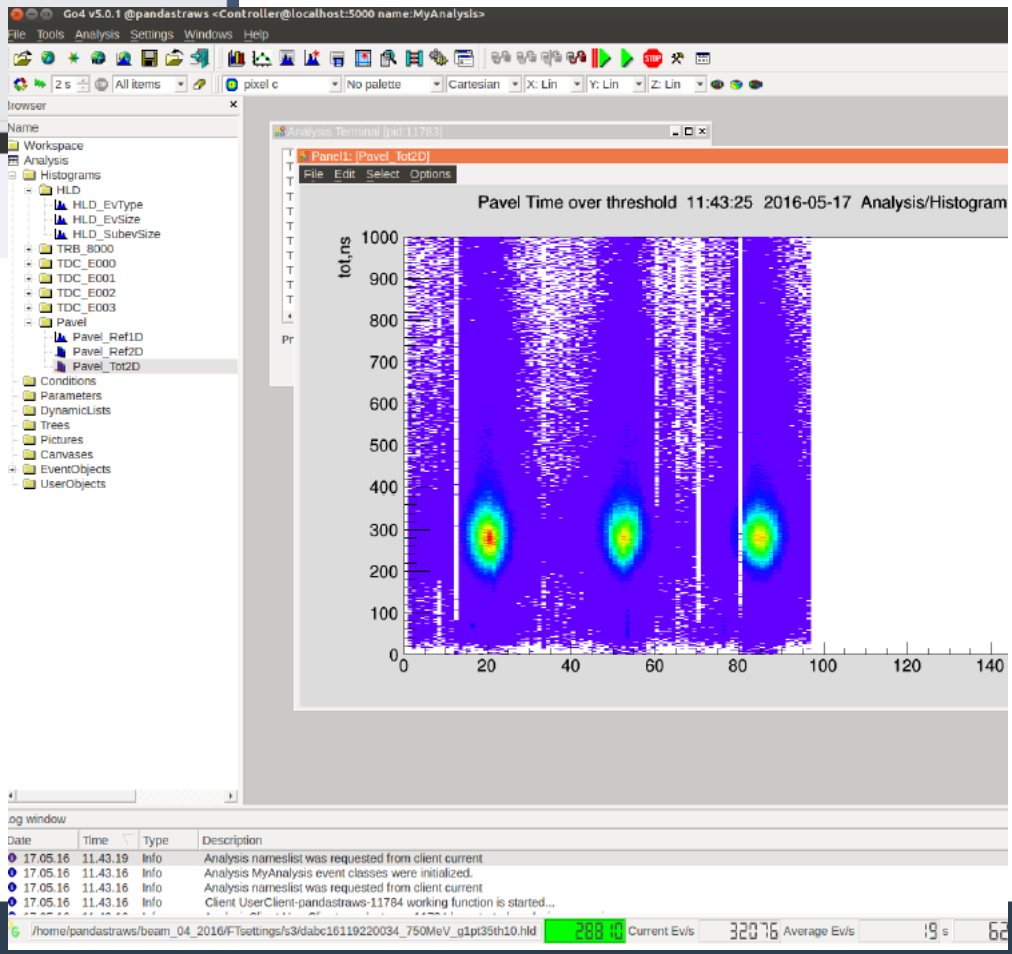


- Precise time measurement (>100 ps).
- 192 TDC channels.
- Time of arrival and TOT measurement.

TRBv3 – readout platform

Slow control of the PASTTREC integrated with the TRBv3 system.

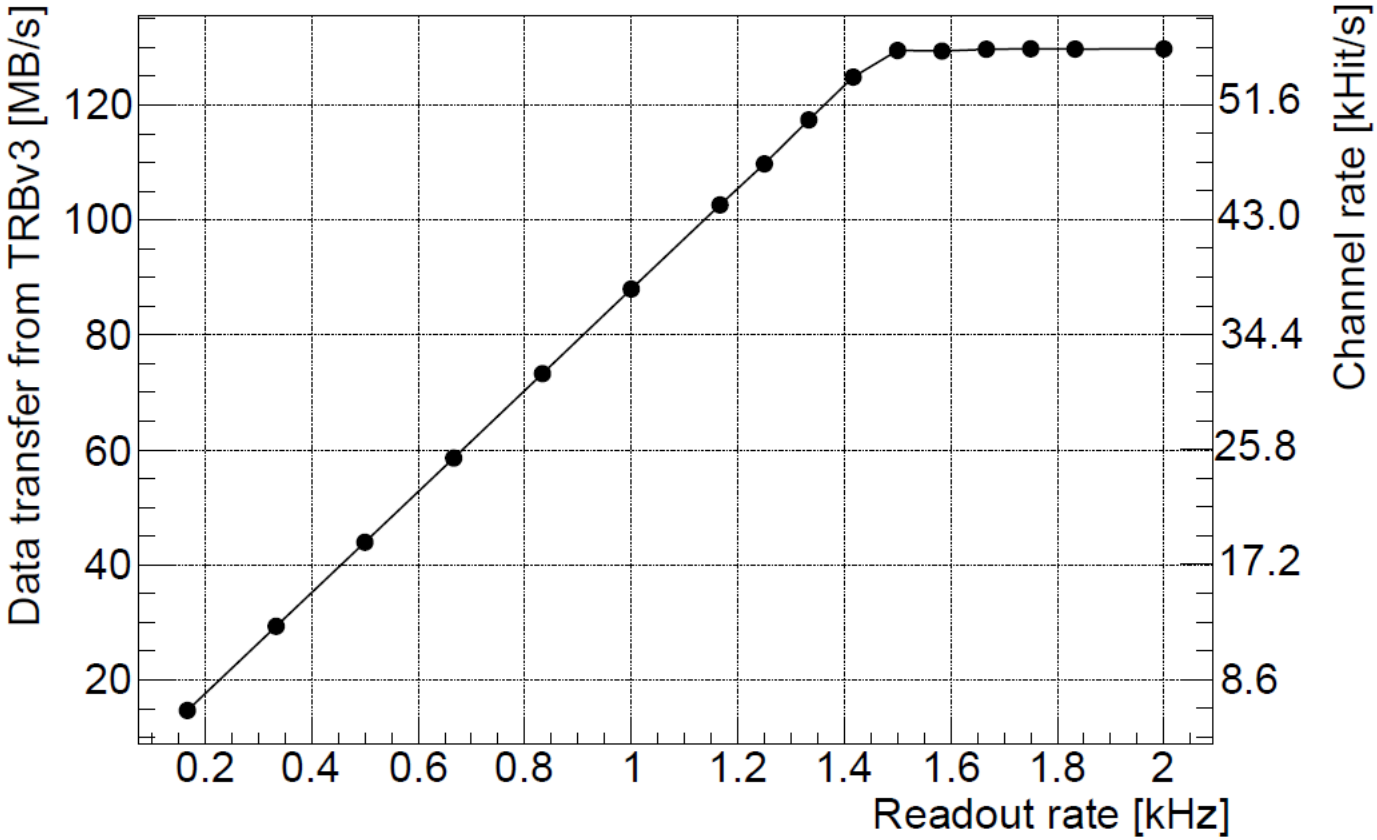




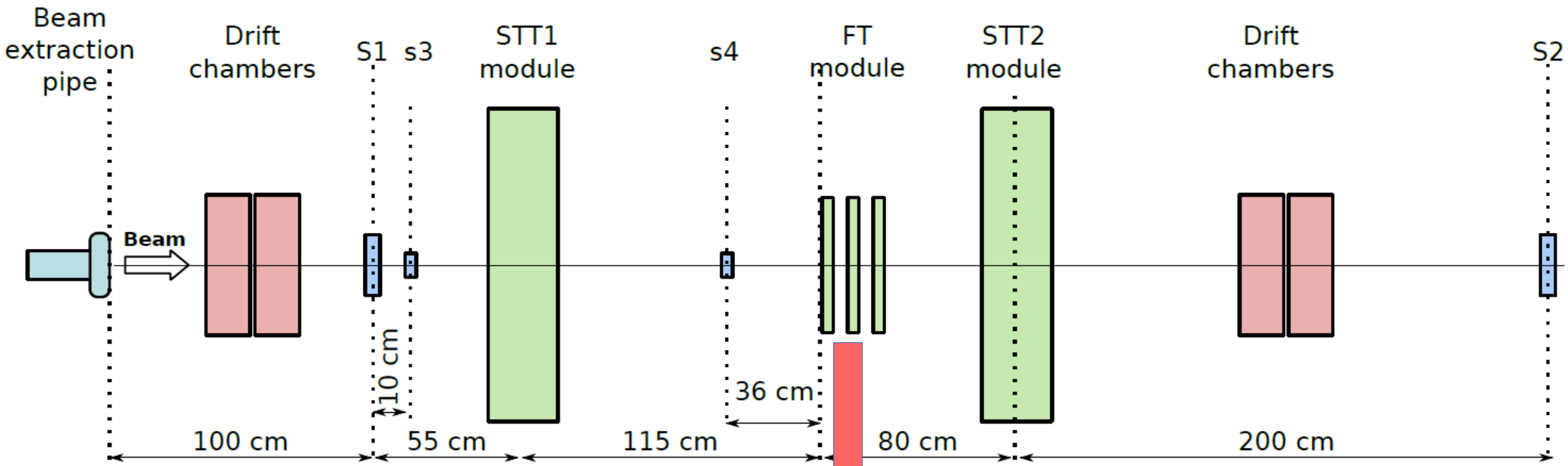
TRBv3 is delivered with the software for data unpacking and online QA – go4.

TRBv3 – performance

- 35 hits between consecutive triggers (read requests)
- 55 kHits/s/channel with all channels equally loaded.



In beam measurement



FEE → TRBv3 → PC

In beam measurement

Collected data sets:

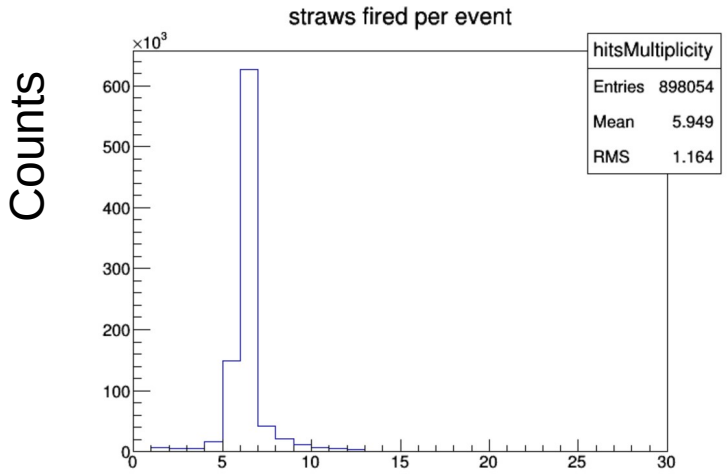
- 3 different PASTTREC settings (1 gain and 3 different peaking times)
- 2 different high voltages (1700 and 1800 V)
- 4 different thresholds (10, 20, 30, 40 mV)

Measurement conditions:

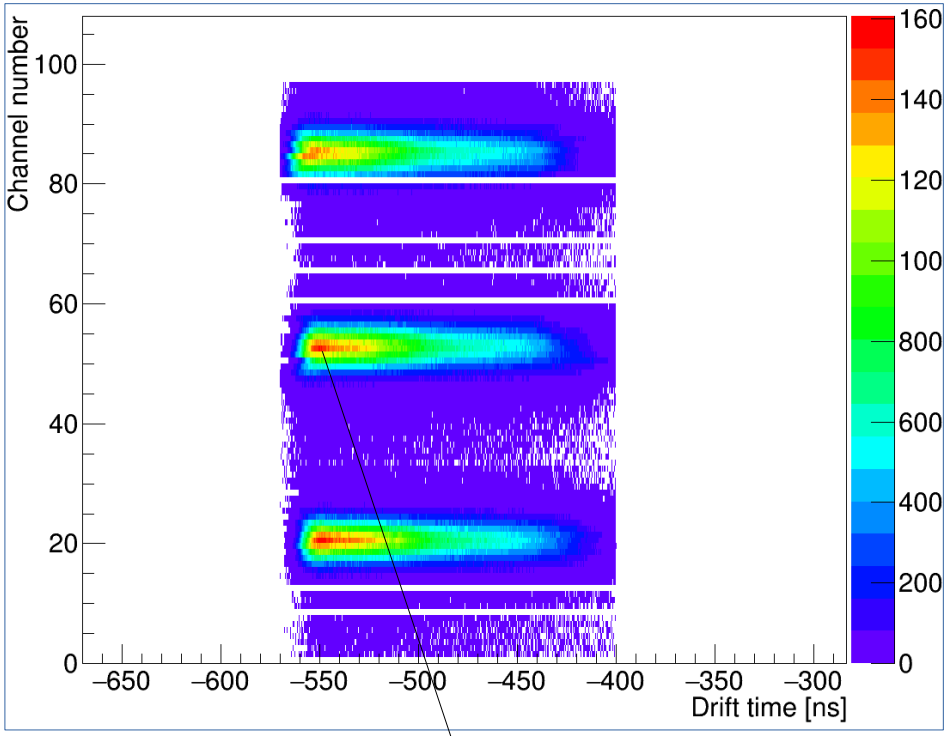
- 6 FEBs and one single TRBv3,
- Baseline tuning of the PASTTRECs done with the beam,
- Standard gas mixture was used (Ar/CO2 90:10)
- Trigger with S1

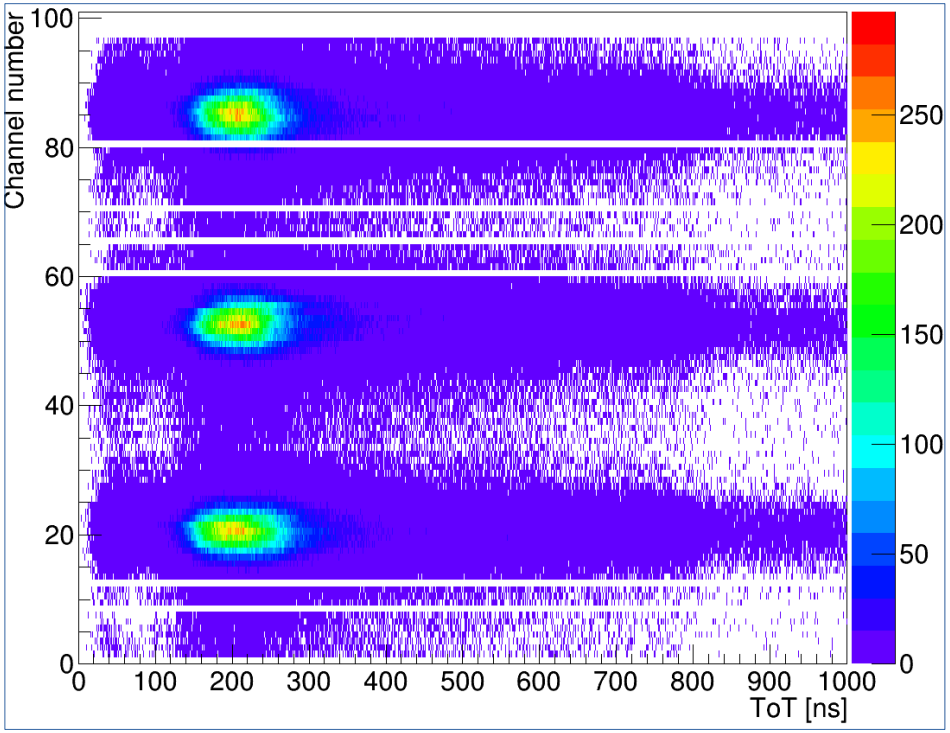
Data analysis conditions

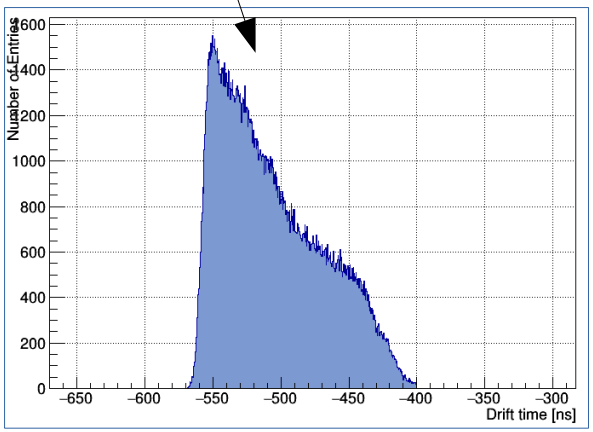
- Gain = 1 mV/fC, peaking time = 15, 20 and 35 ns, HV 1800V and threshold 10 mV were taken.
- Time window on the hits was applied.
- Drift time to radius calibration with uniform illumination method was performed.
- Drift time offsets elimination (different cable length compensation) was done.
- Data 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 : Chi2/(degree of freedom) < 10.



Drift time and TOT spectra (750 MeV)





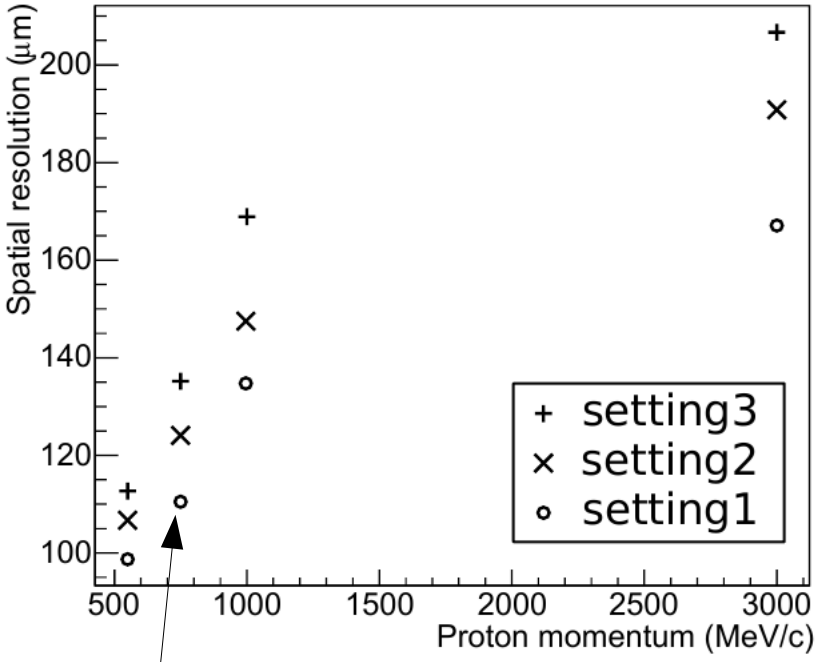


On the drift time spectrum one can see the hits correlated with the trigger signal. The TOT spectra have similar distribution over channels (uniform baseline).

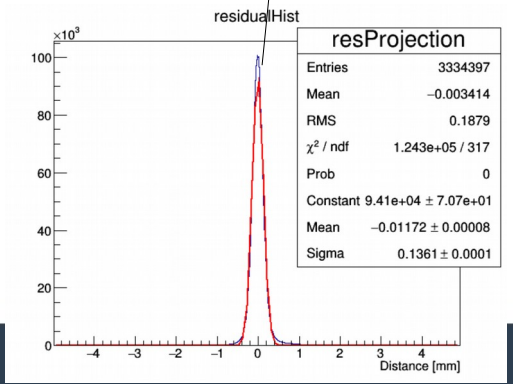
Very low threshold (10mV!).

Spatial resolution

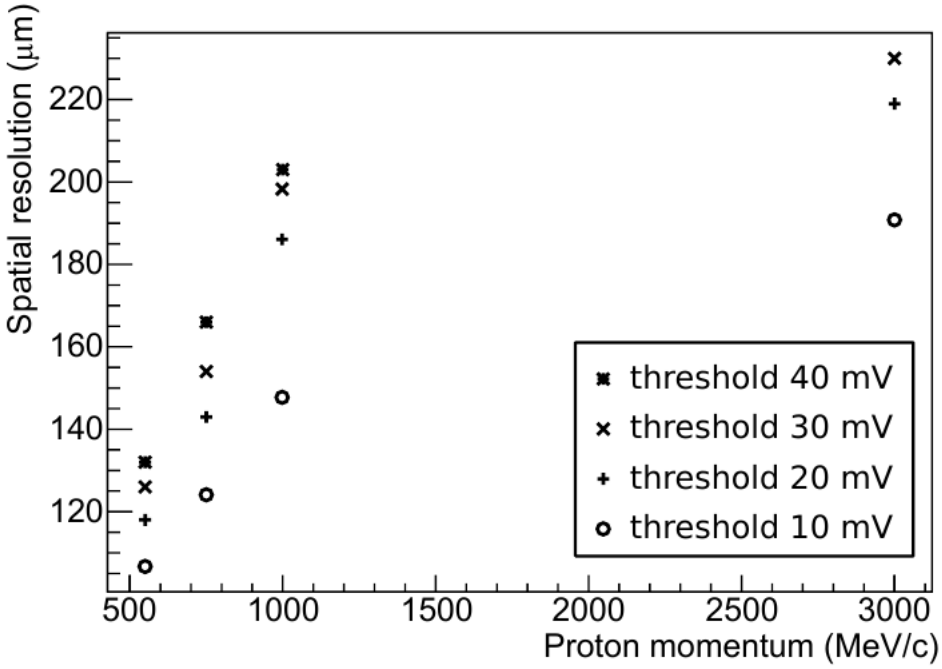
Setting1 = Gain 1mV/fC, 15 ns peaking time
Setting2 = Gain 1mV/fC, 20 ns peaking time
Setting3 = Gain 1mV/fC, 35 ns peaking time
Threshold = 10 mV



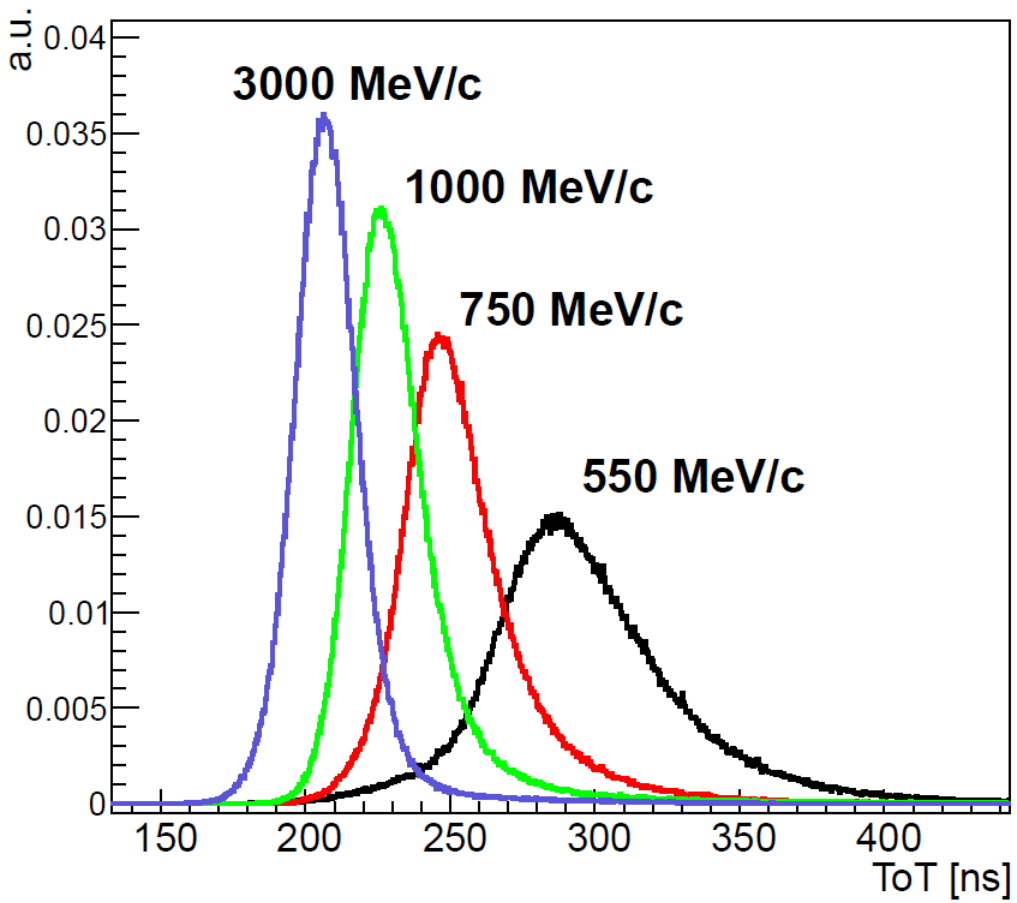
Sigma of residual distribution



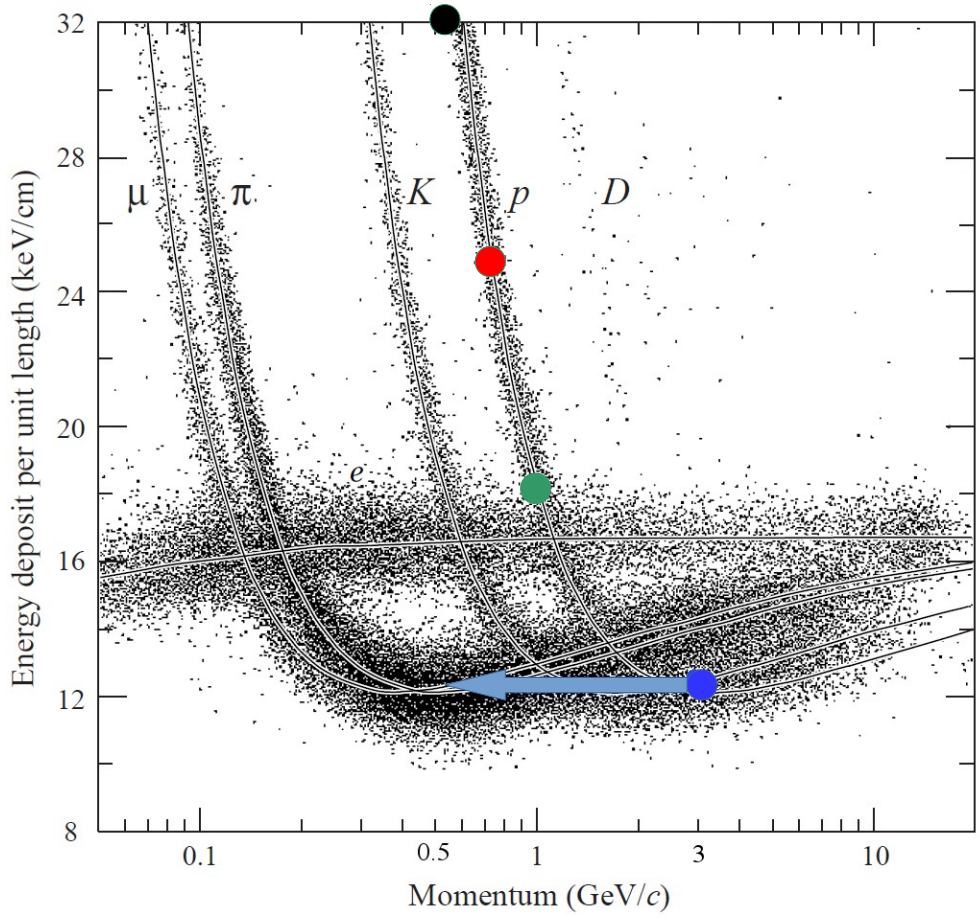
Threshold = 10 mV, 20 mV, 30 mV and 40 mV
Setting2 = Gain 1mV/fC, 20 ns peaking time



Energy loss measurement



TOT truncated mean 20 %.



Source: K. Olive and P. D. Group, "Review of particle physics", Chinese Physics C, vol. 38, no. 9,

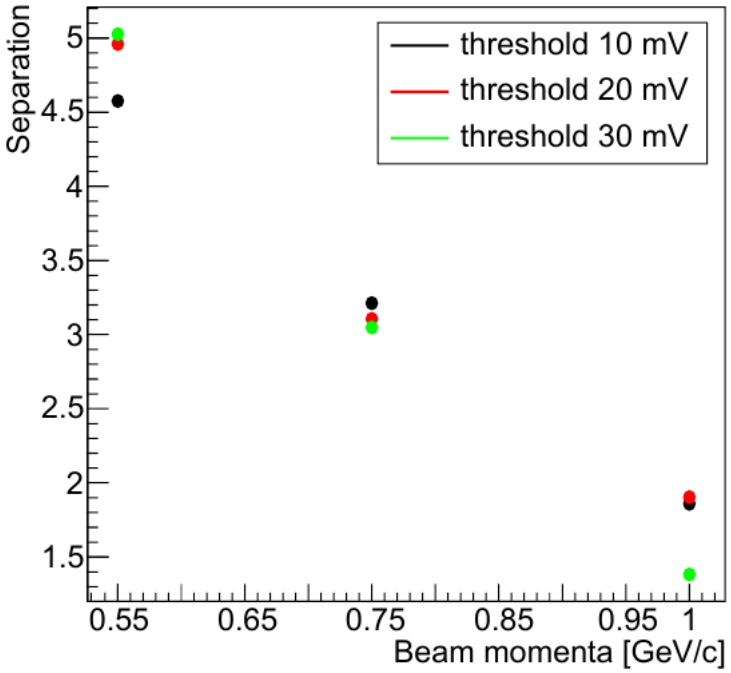
Energy loss for different particles.

Correction of the TOT values for dependence on r and then calculation of the truncated mean.

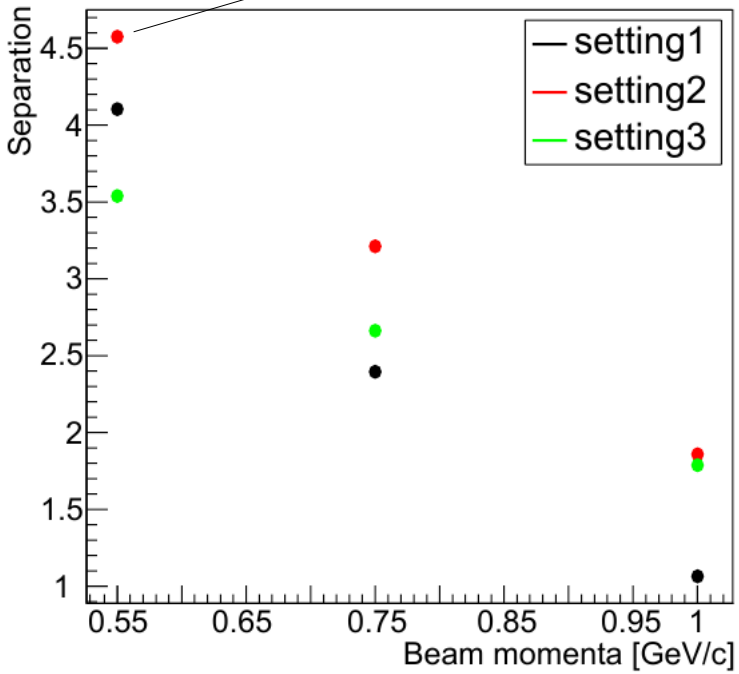
Separation power

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

Separation power calculated with respect to protons p= 3GeV/c.

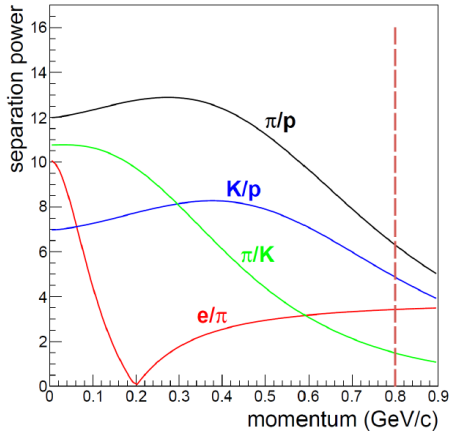


Threshold dependence

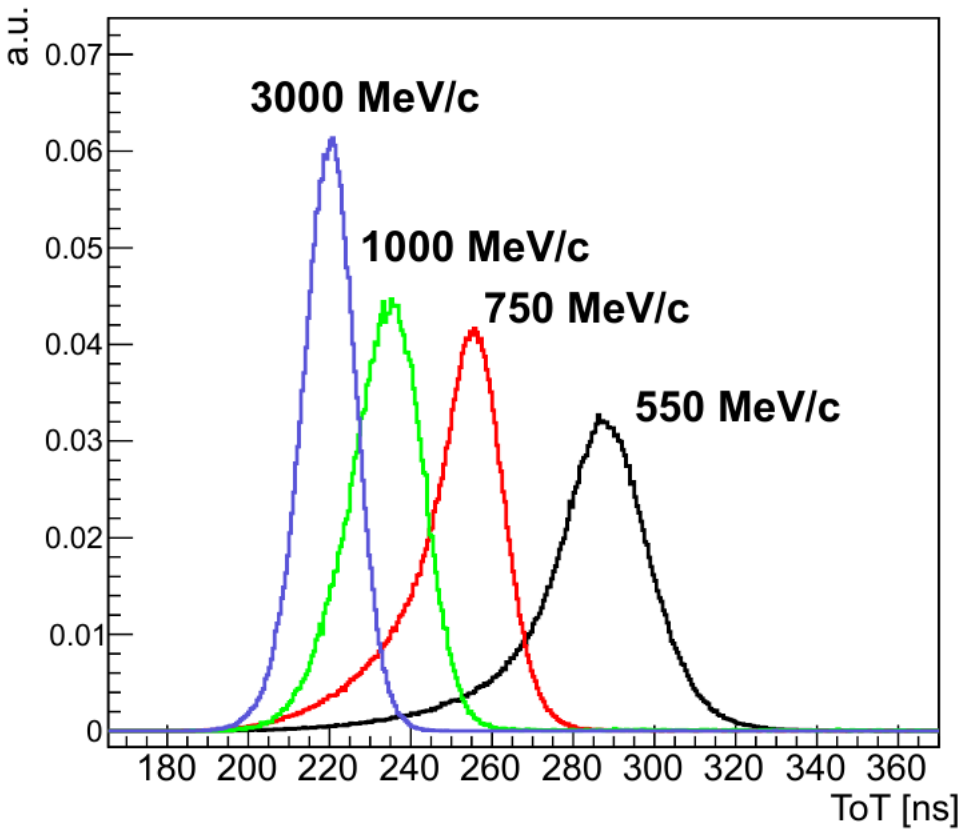


Peaking time dependence

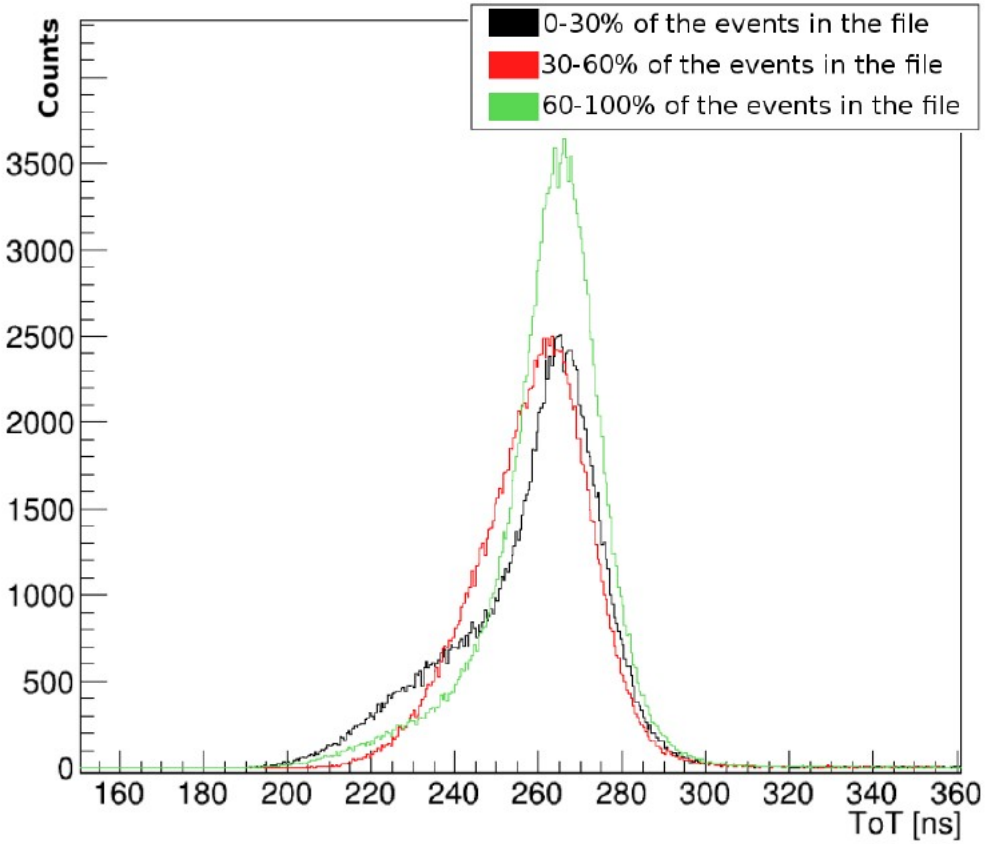
STT TDR simulation for
proton (p=550 MeV/c)
pion (p=550 MeV/c)
returns separation ≈ 10.



Quick look at the STT

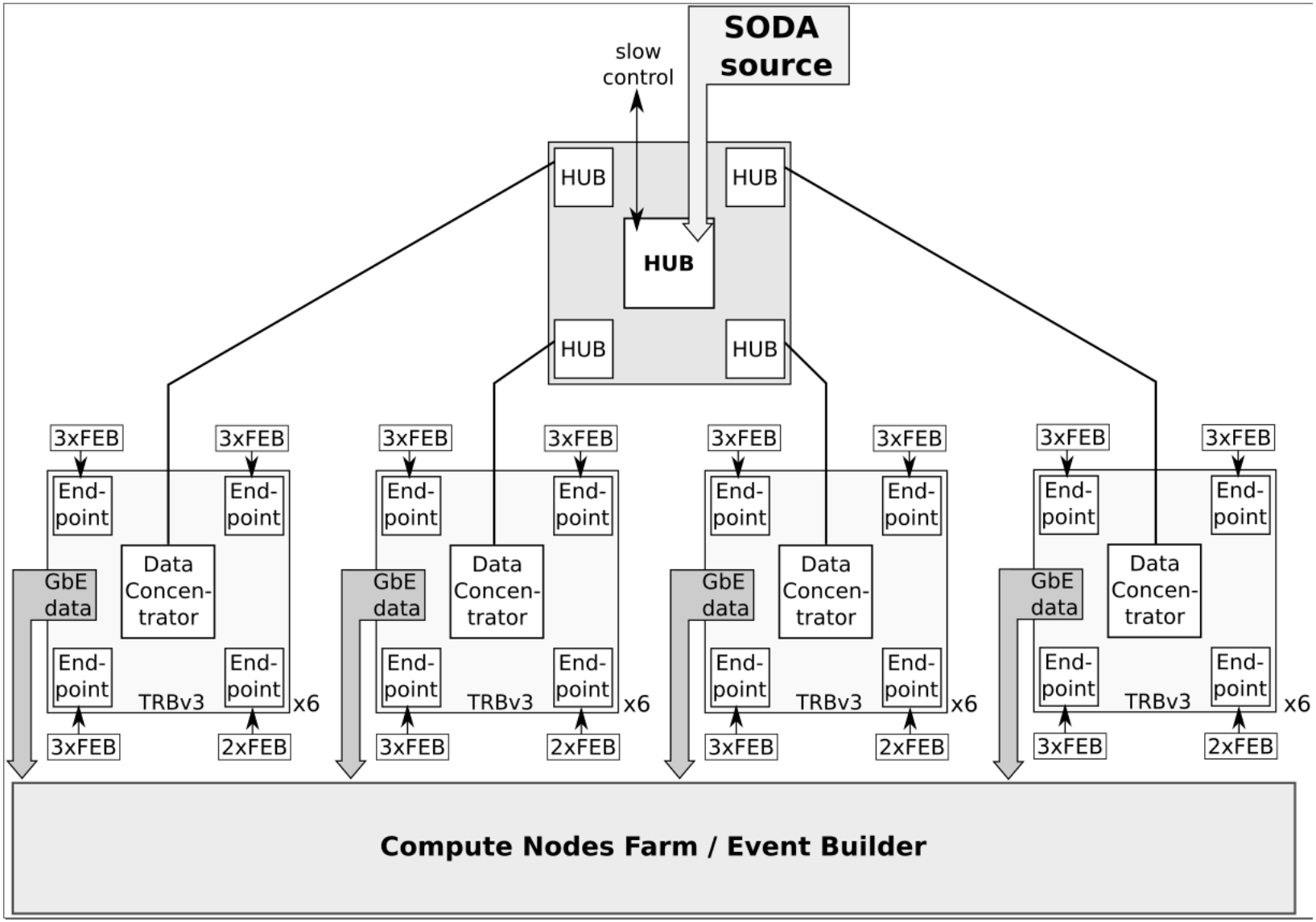


TOT truncated mean 40 %.
Long tails towards short TOTs.



Measuring conditions not stable?

Straw Tube Trackers Readout with TRBv3



System architecture

Limitations and solutions

	STT	FT
Number of channels	4224	12224
Hit rate (High Resolution Mode - HRM)	90 kHz/straw	35 kHz/straw
Hit rate (High Luminosity Mode - HLM)	0.9 MHz/straw	0.35 MHz/straw
Number of TRBs required for HRM	4224/**176** = 24 + 1 TRBs	12224/176 = 64 + 4 TRBs

Solutions:

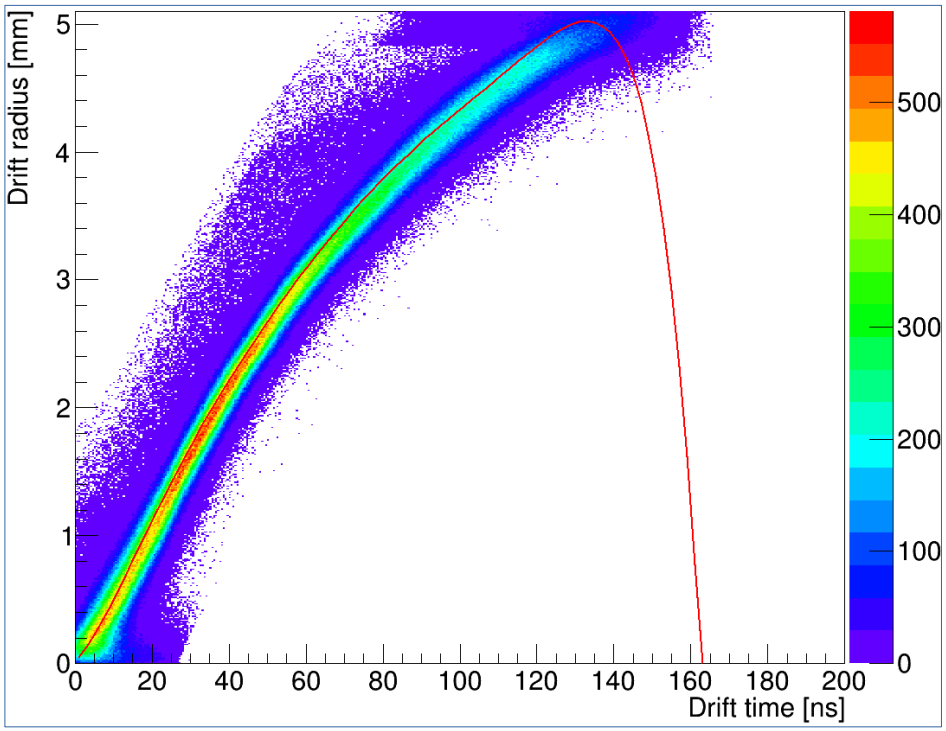
- Implementation of the low resolution TDC (500 ps)
- Changing data format of the TDC word
- Need of new hardware platform

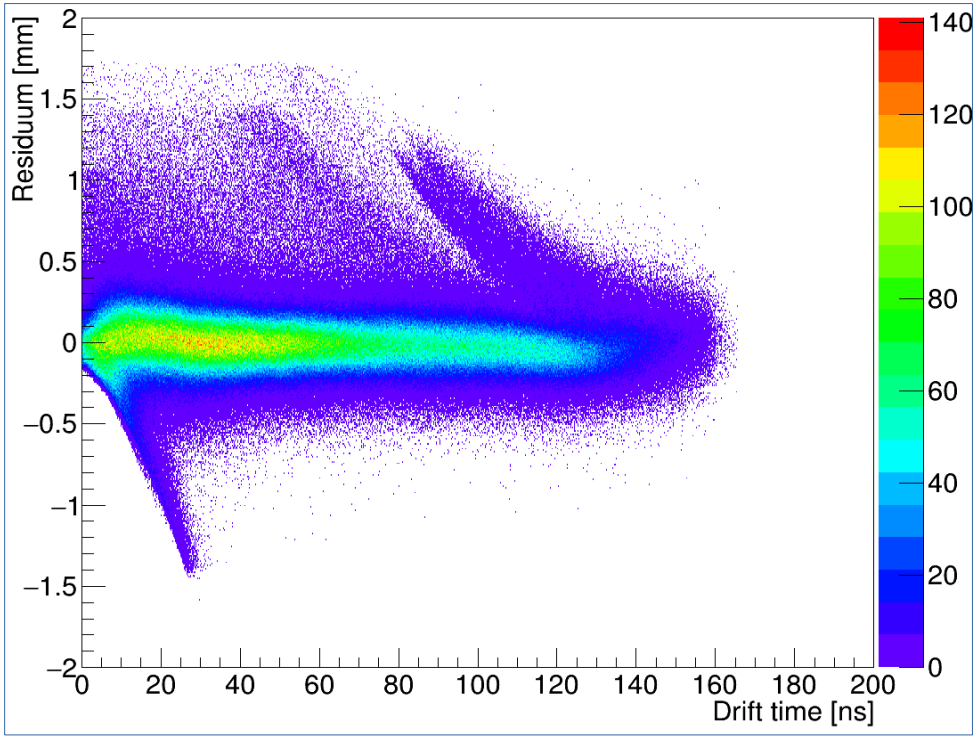
Summary

- Readout of the straw tubes based on PASTTREC and TRBv3 was presented.
- Requirements for spatial resolution achieved. As expected, resolution strongly depends on primary electron detection.
- PID based on TOT is possible, separation power depends on settings. Threshold dependence seems to be weak.
- TRBv3 suitable for the HRM but not good enough for HLM.

Back up

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

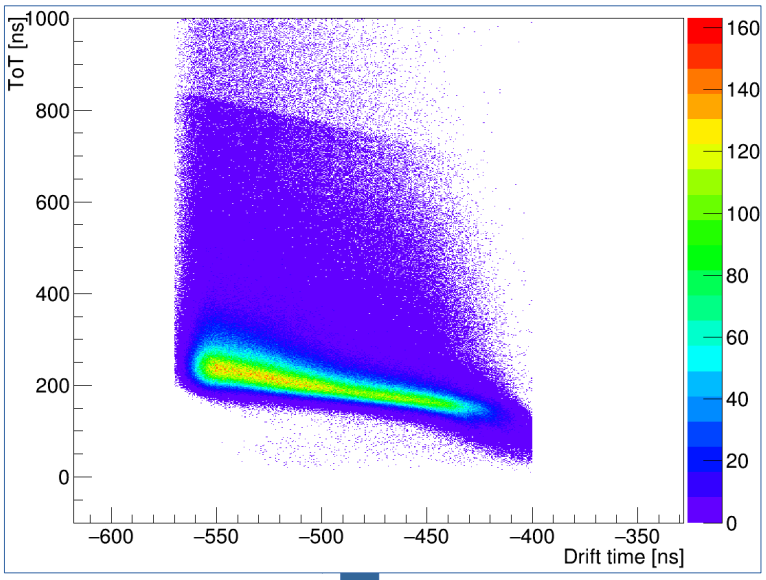


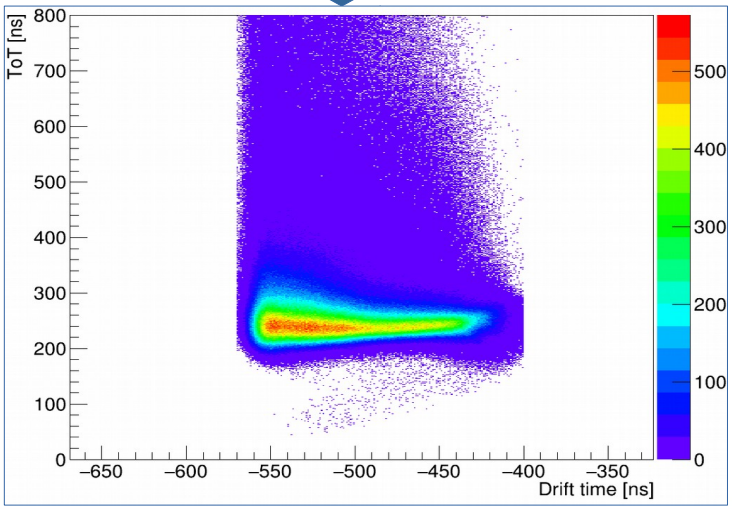


Back up

Correction of TOT for r dependence

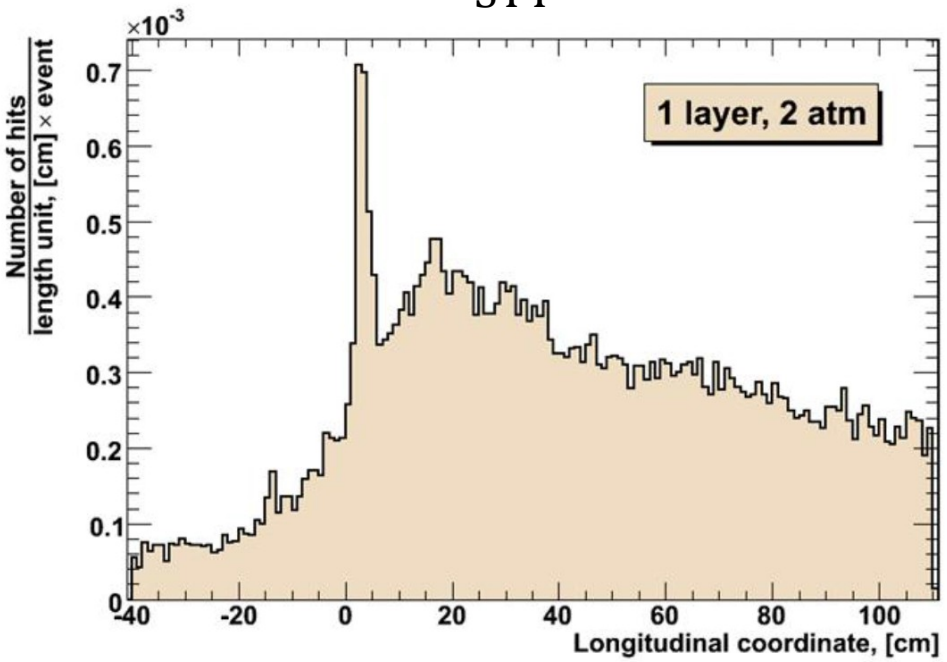
FT 750 MeV



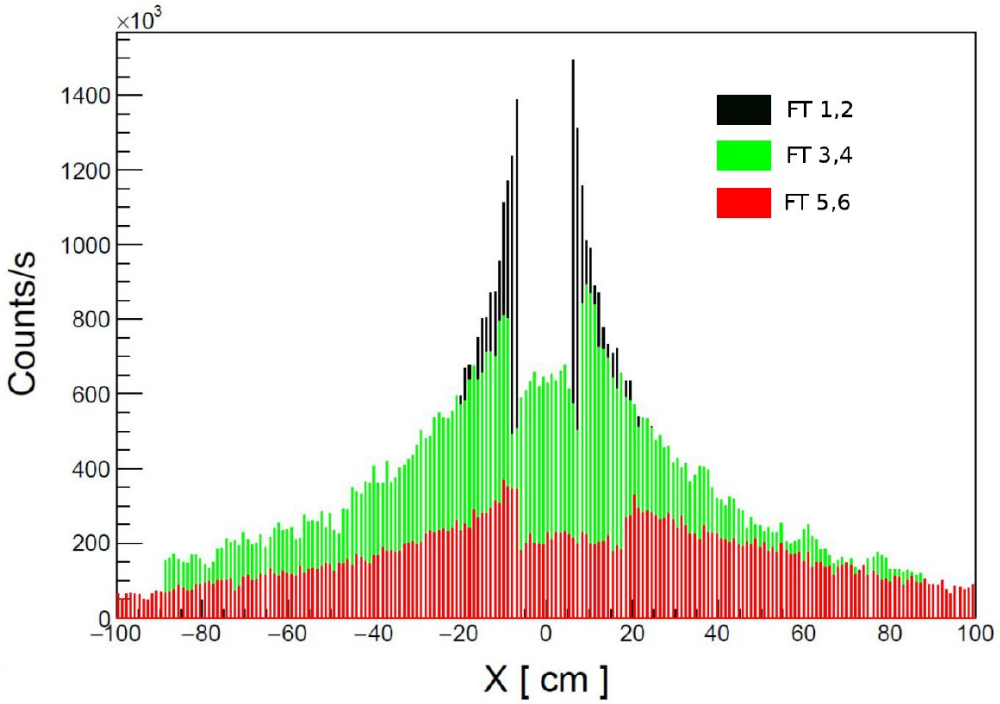


Back up

STT



FT



Average hit rates:

STT = 0.9 Mhz/straw in high luminosity mode

FT = 0.35 Mhz/straw in high luminosity mode