PANDA LV. Collaboration Meeting

PASTTREC ASIC and TRB3 Readout Status

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1 December 2015

Plan

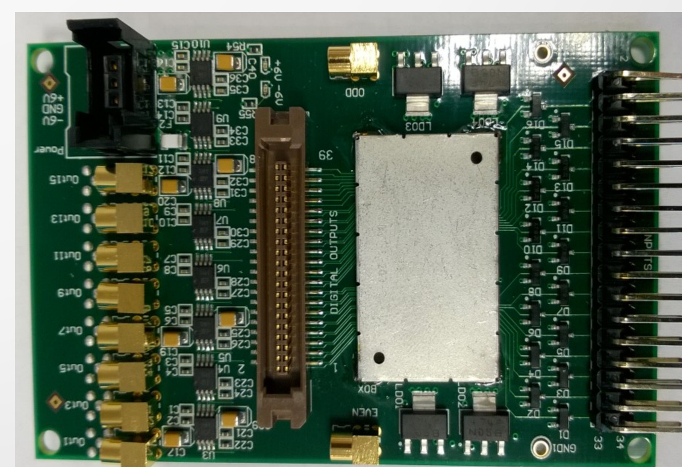
1) The PASTTREC tests and the results
2) The STT and FT readout possibilities
3) Future plans

Reminder/status

The set-up in Krakow

What we have:

- ~20 front end electronics with ASIC bonded
- 2 PASTTREC ASIC on one PCB
- 2x8 digital and 2x8 analog channels
- Each FEB has 2 test inputs – odd and even channels
- +/- 6 V power supply (due to fast analog amplifiers which will be removed in final version of the FEE)
- Ribbon cable (10 pairs) to connect to TRB3 slow control and data transmission
- Fully operational set-up in Krakow with 96 FT straws

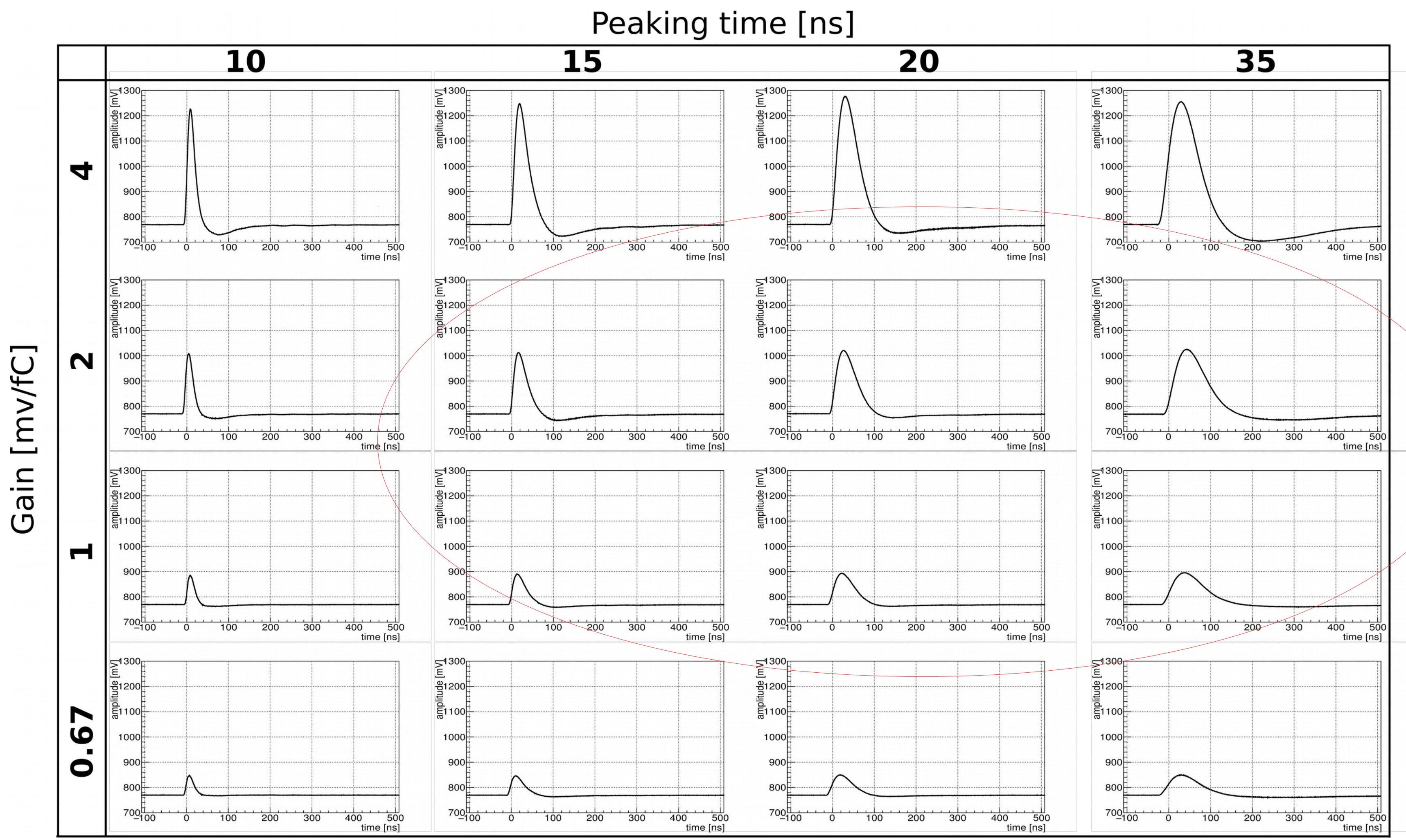


The PASTTREC tests and the results

Searching for optimal configuration

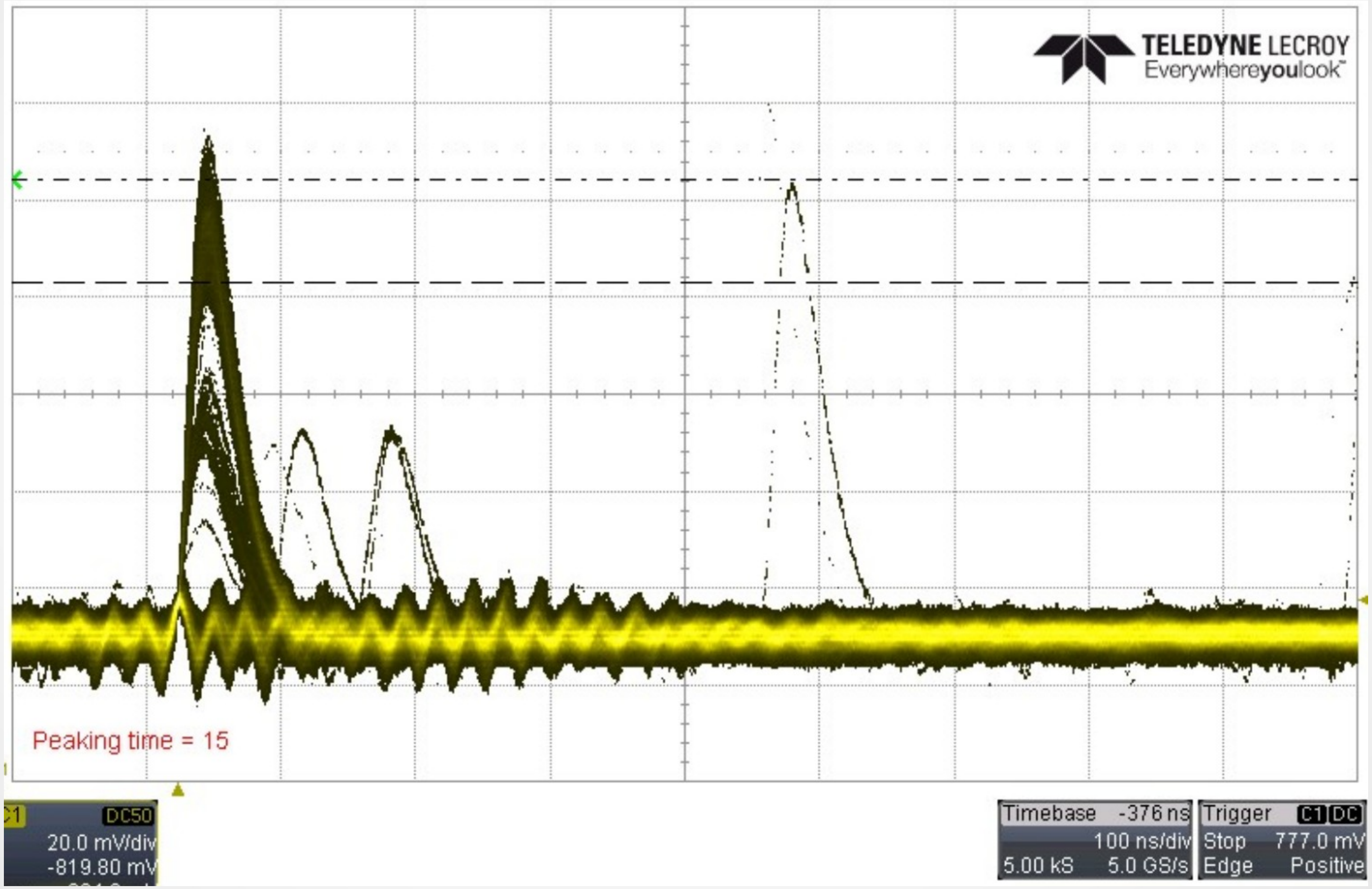
The PASTTREC chip has 4 different preamplifier gains **(G)** and 4 different peaking time **(PT)** settings. The tail cancellation functionality is tuned with 4 different parameters of which each can have up to 8 different values. The tail cancellation parameters can influence not only signal shape but also its amplitude. Total amount of settings is 16 PT-G and 4095 tail cancellation configuration.

Searching for optimal configuration



Not all gain and peaking time configurations are reasonable for our straws.

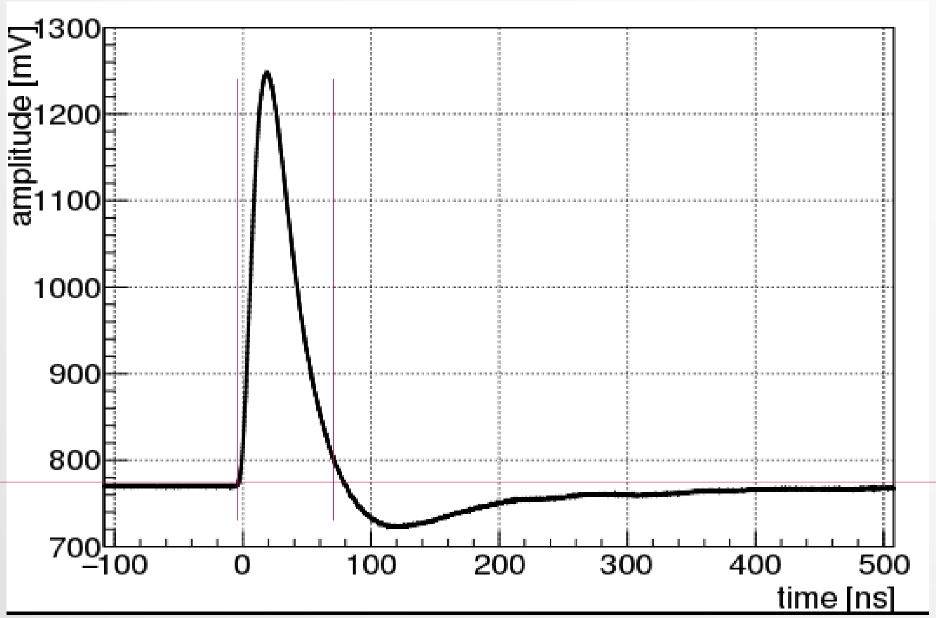
Oscillations



The oscillations from an unknown source made use of the fastest shaping impossible (at the moment - improve grounding?).

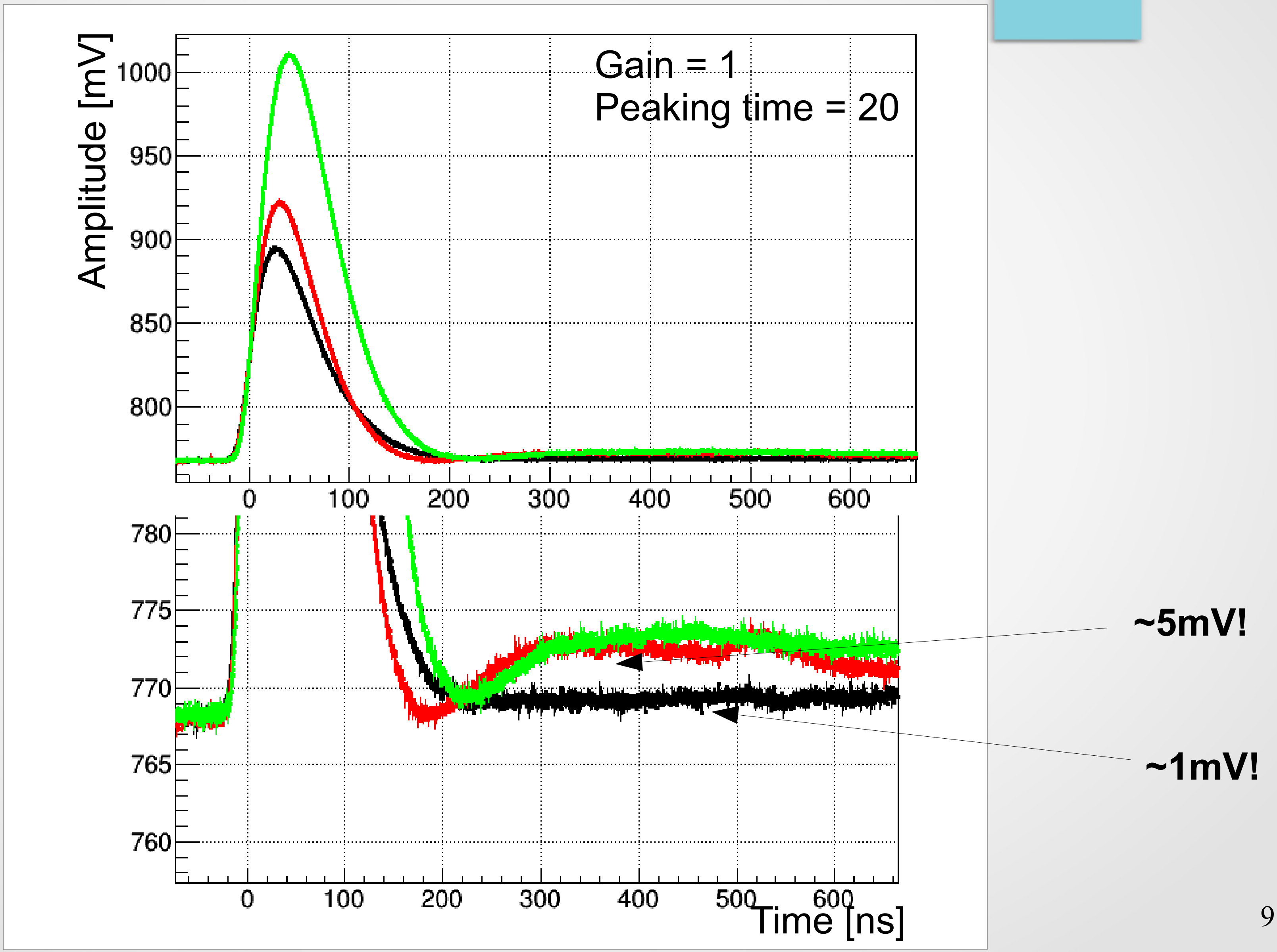
4095 scan

For 6 combinations of the gain and the peaking time all 4095 settings of tail cancellation parameters has been checked. For each configuration average of 100 55Fe pulses has been saved (1700V) and analyzed as follow:

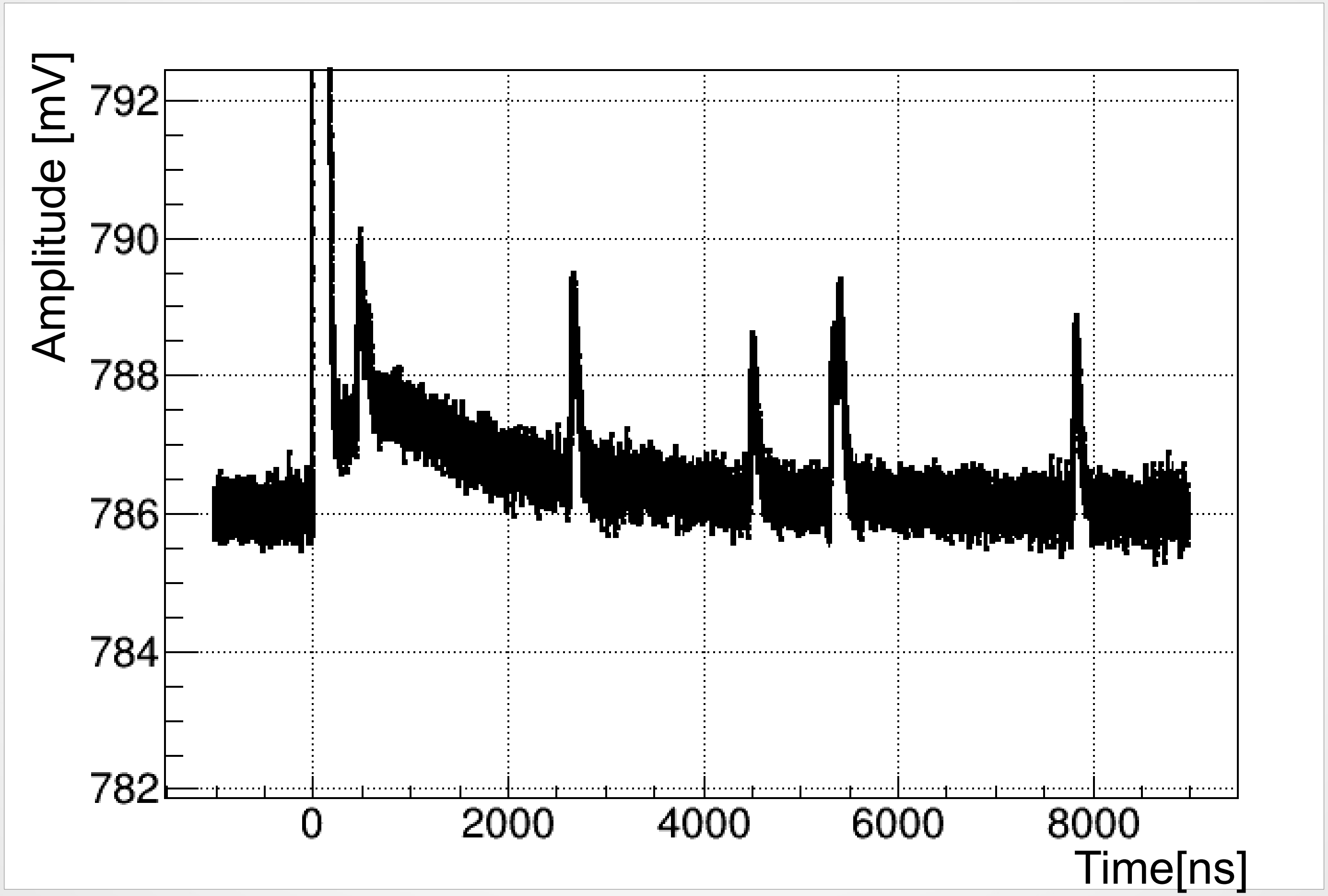


1. No undershoot
2. Short peaking time
3. No overshoot
4. The biggest amplitude

Settings found



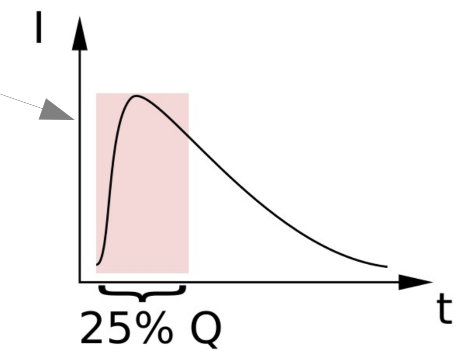
Overshoot



Average of 100 waveforms of iron source together with the hit rate on the straw ~10kHz simulates 1MHz hit rate per straw. Voltage 1700V.

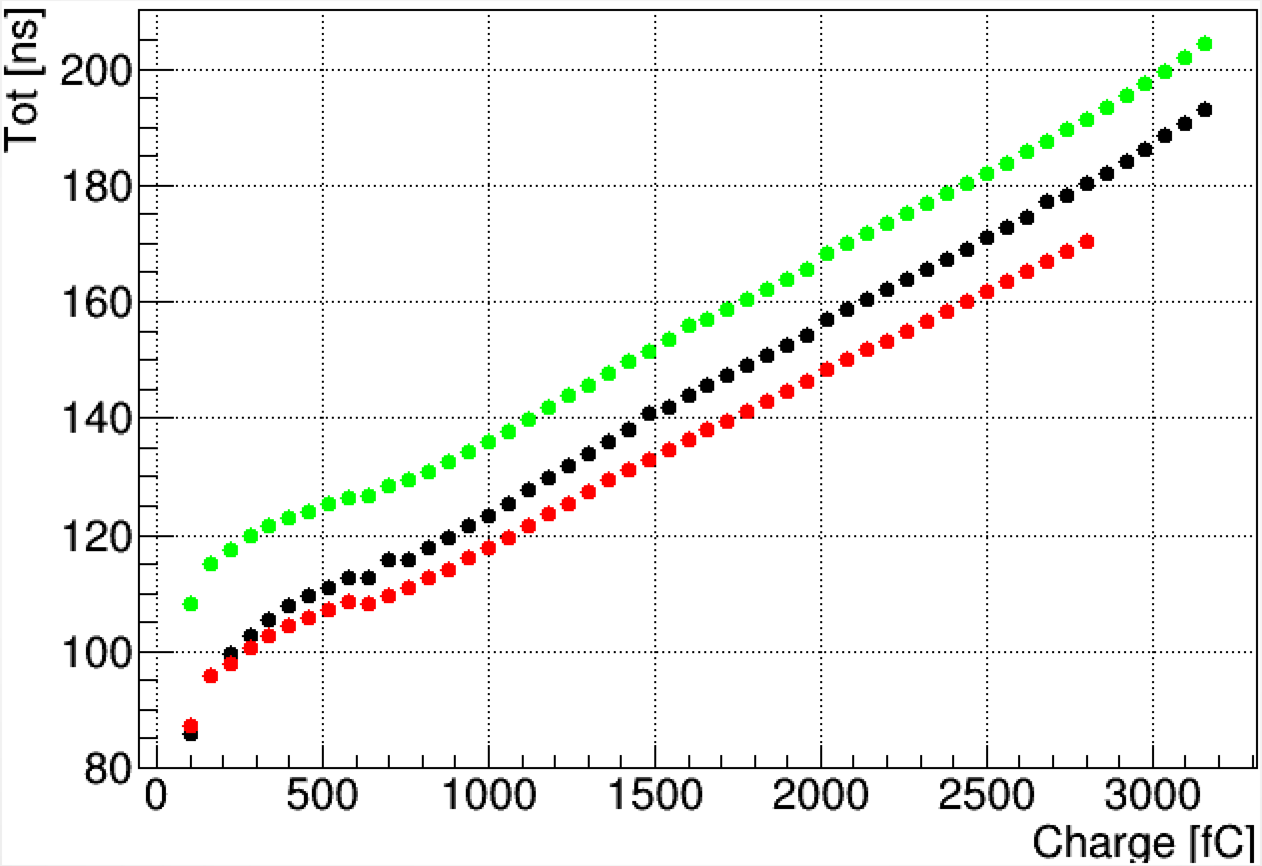
ToT and charge correlation

- The data taken with the generator. A charge was calculated as: Q = 2pF*Amplitude [mV]
- The data taken with the detector and 55Fe. The charge calculated as:
  $Q = primary\_electron*gas\_gain*0.25*q = 200*G*0.25*1,6*10^{-19}$
  where $G=\exp(0.009xU – 5.3525)$,
  U – voltage.



E.g. 1800V gives charge for MIP = 400 fC (the particles crossing close to the anode wire).

Generator data

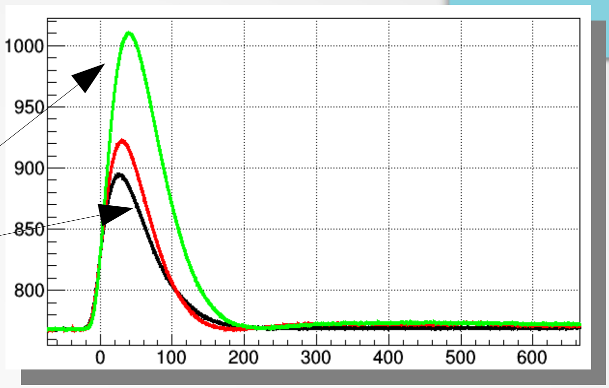


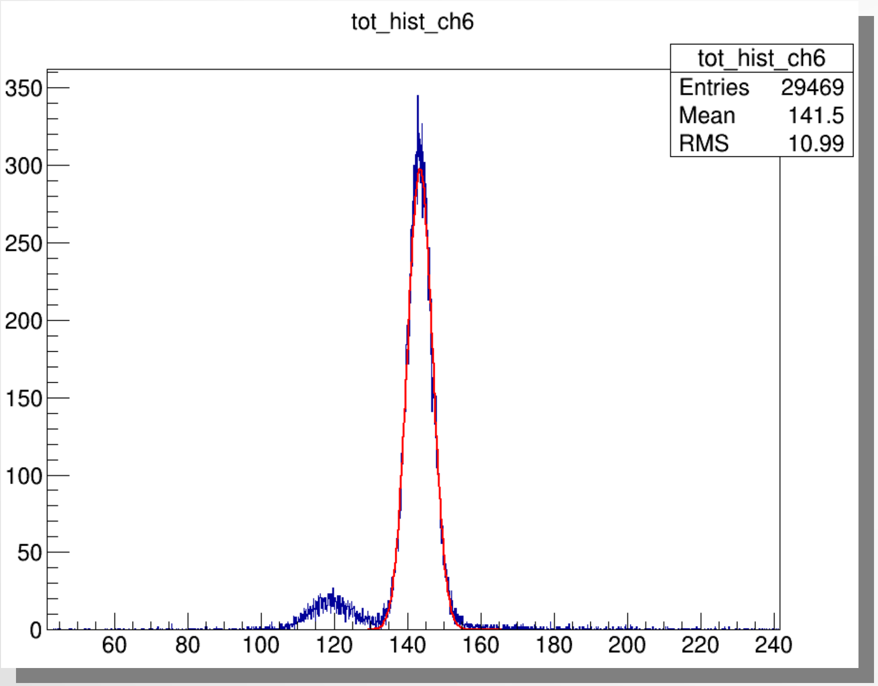
Checking all three configurations. The threshold set 10 mV.

Detector data with ^{55}Fe

The ToT vs charge correlation was done for two different tail cancellation settings.

High amplitude setting
Low amplitude setting

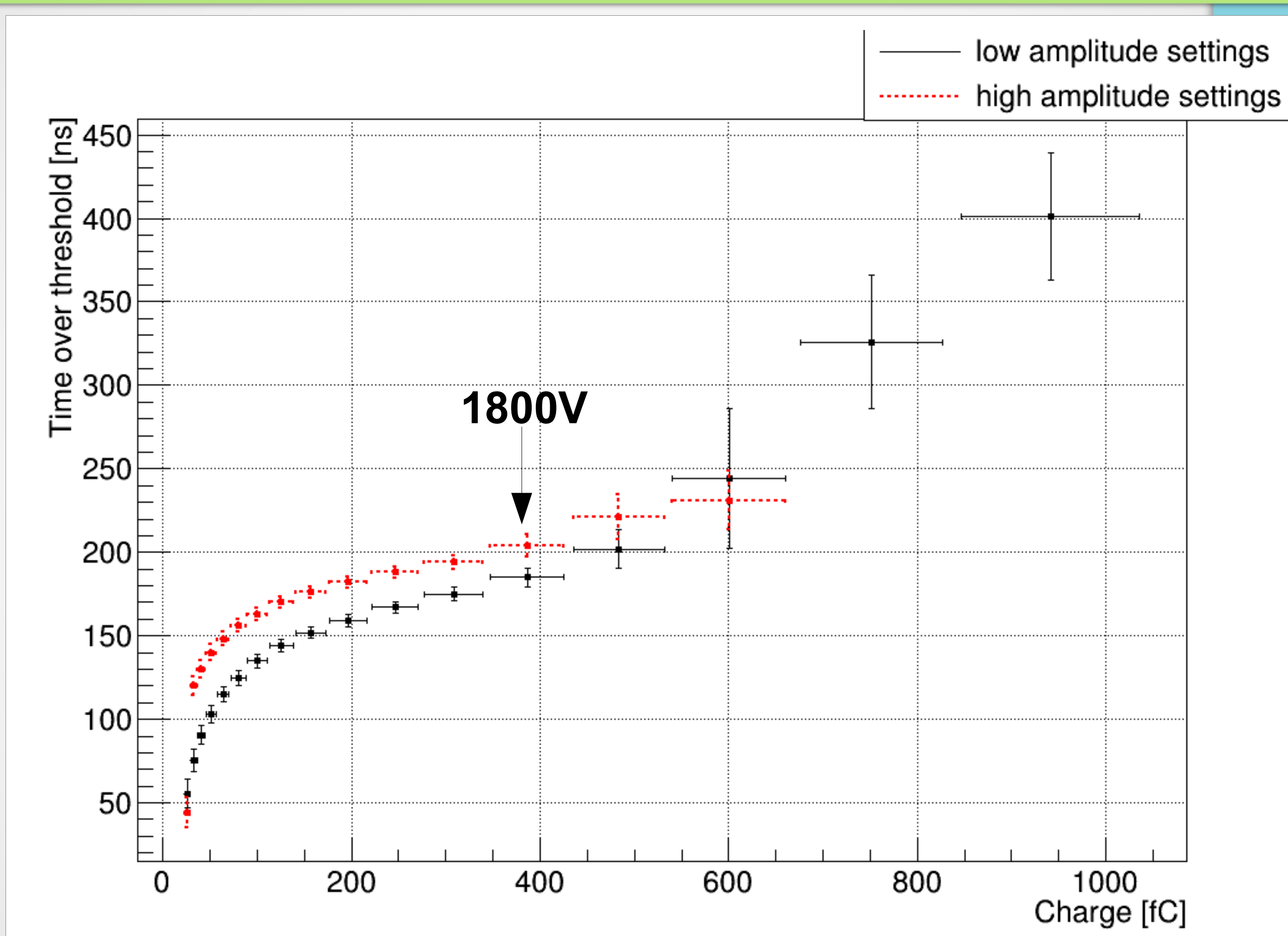




EXT PARAMETER

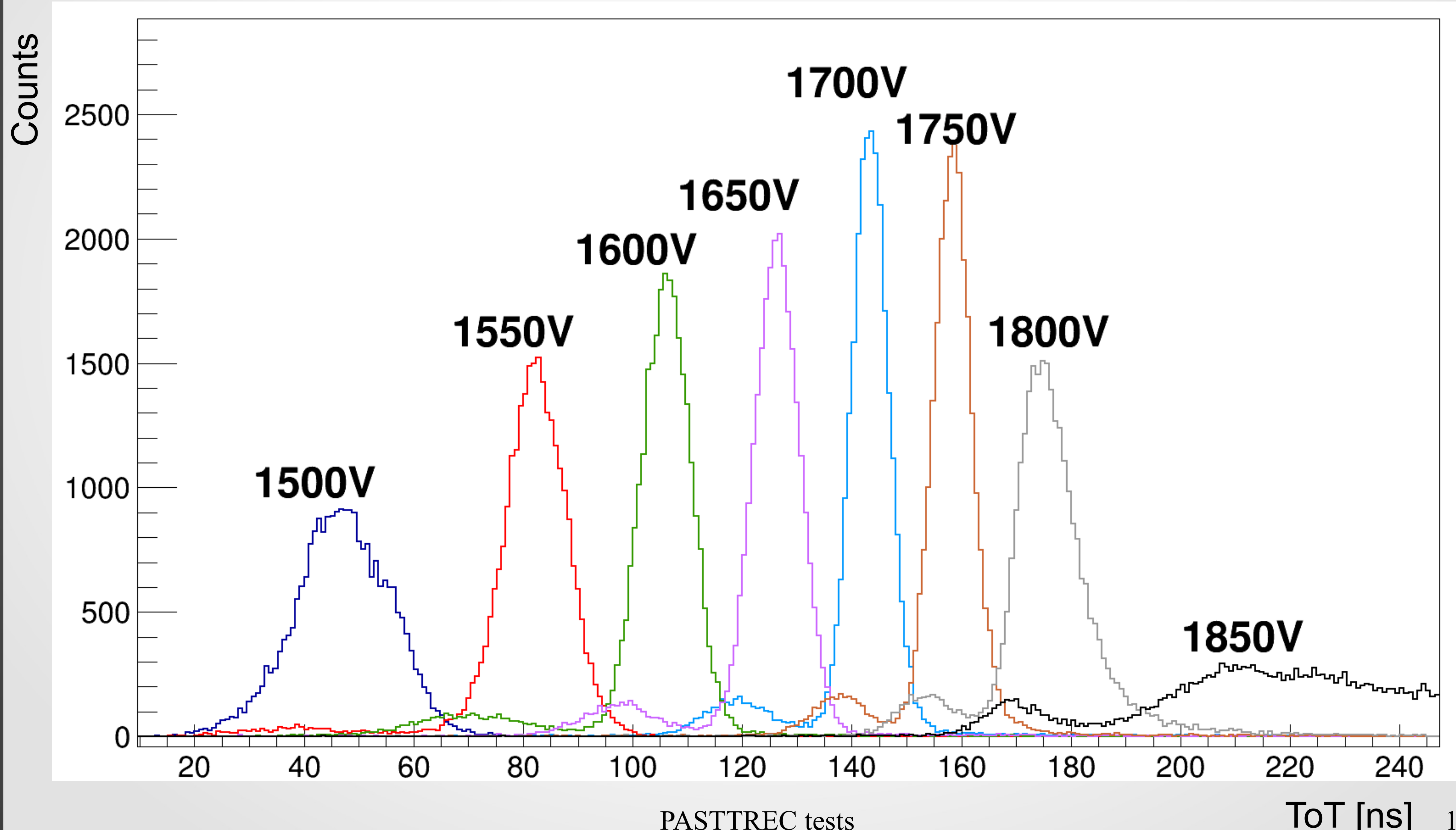
NO.	NAME	VALUE	ERROR
1	Constant	2.98056e+02	2.38772e+00
2	Mean	1.43407e+02	2.14715e-02
3	Sigma	3.42980e+00	1.72149e-02

Detector data with ^{55}Fe

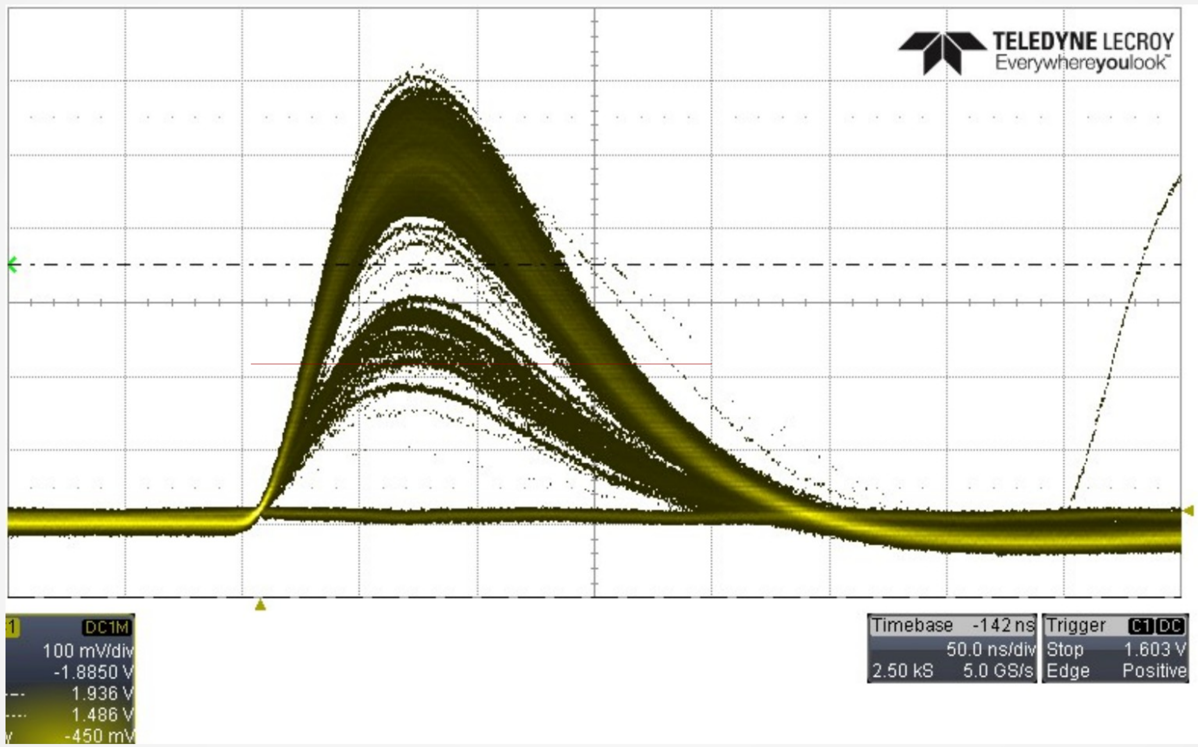


Each point corresponds to different voltage on the straws. 400 fC =1800V. Step 25V.
Errors are represented by the sigmas of the gaus fit to the ToT distribution.
The analog signal ~130 mV, threshold 20 mV.

ToT spectra with ^{55}Fe for different voltages

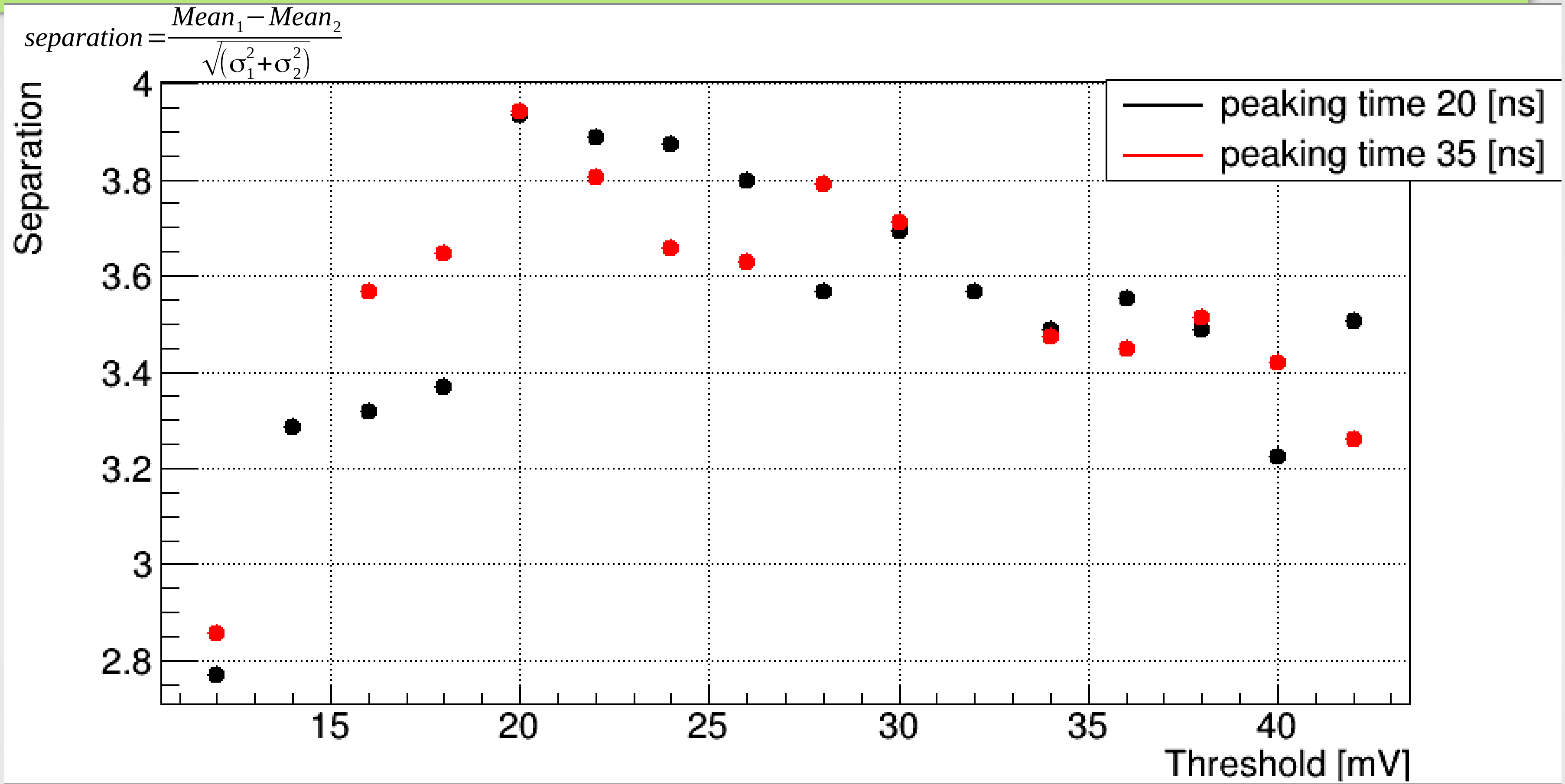


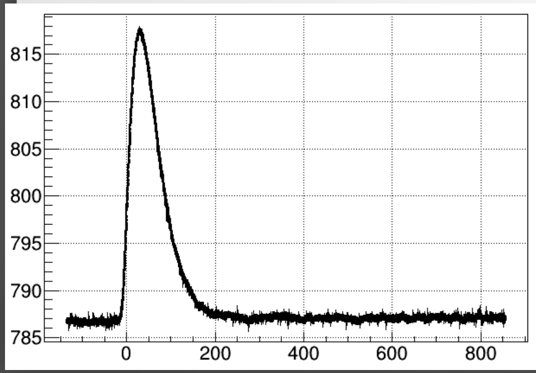
Threshold position



On the on hand placing threshold high we can reach better ToT resolution for the particles with high energy deposition but on the other hand we lose efficiency.

Threshold position

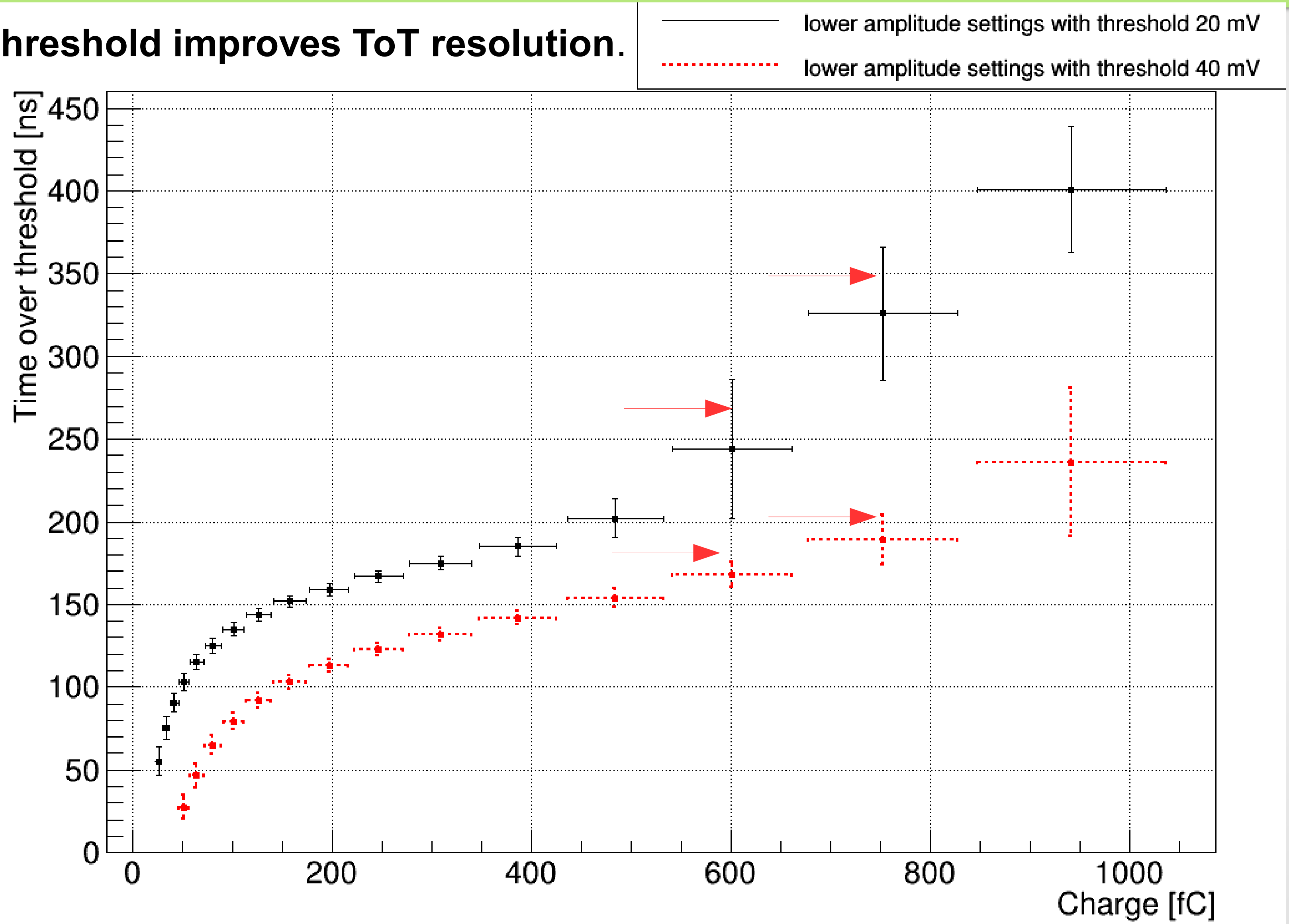




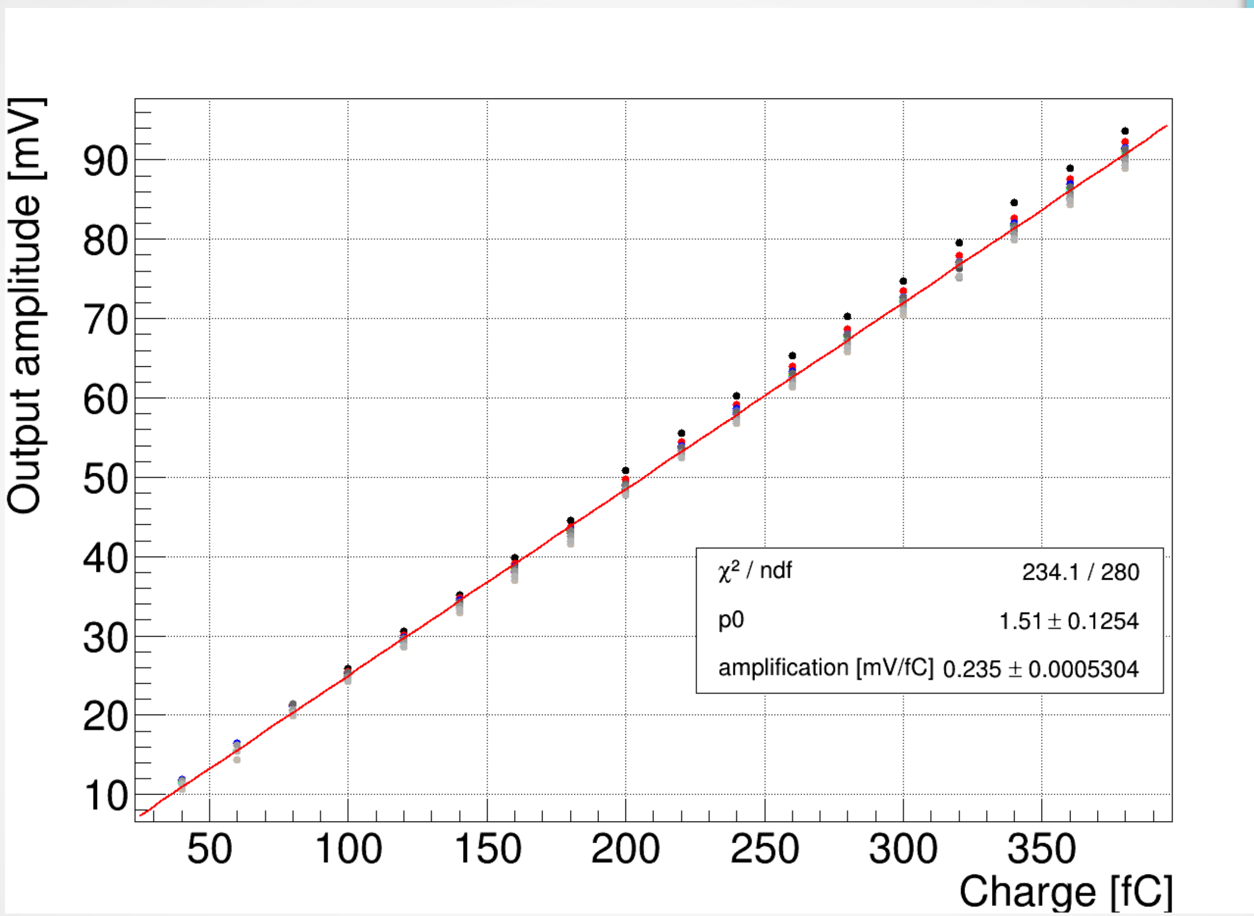
We want to register particles which leaves 10 % of MIP energy – it corresponds to threshold of 40 fC (for 1800 V). This charge is seen with iron source at voltage 1550 V (picture to the left). Such charge corresponds to 30mV threshold.

Threshold position

Higher threshold improves ToT resolution.



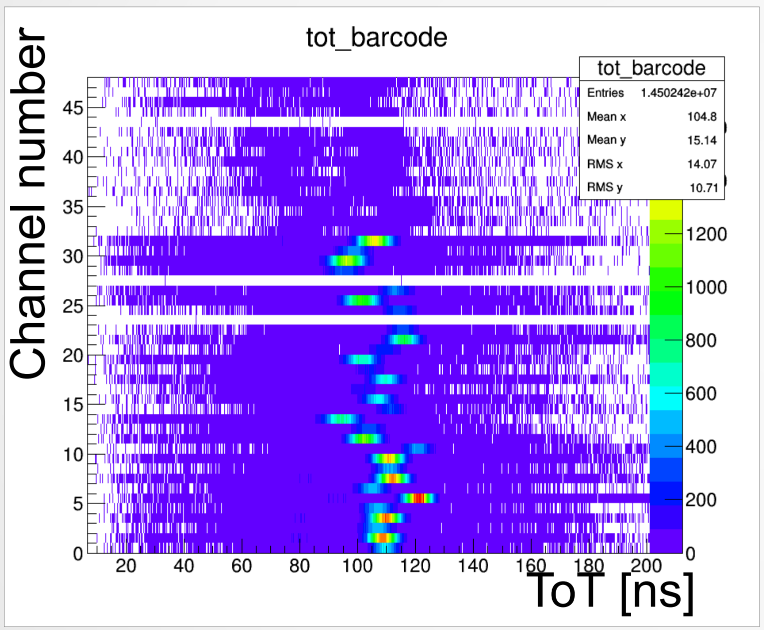
Amplification dispersion



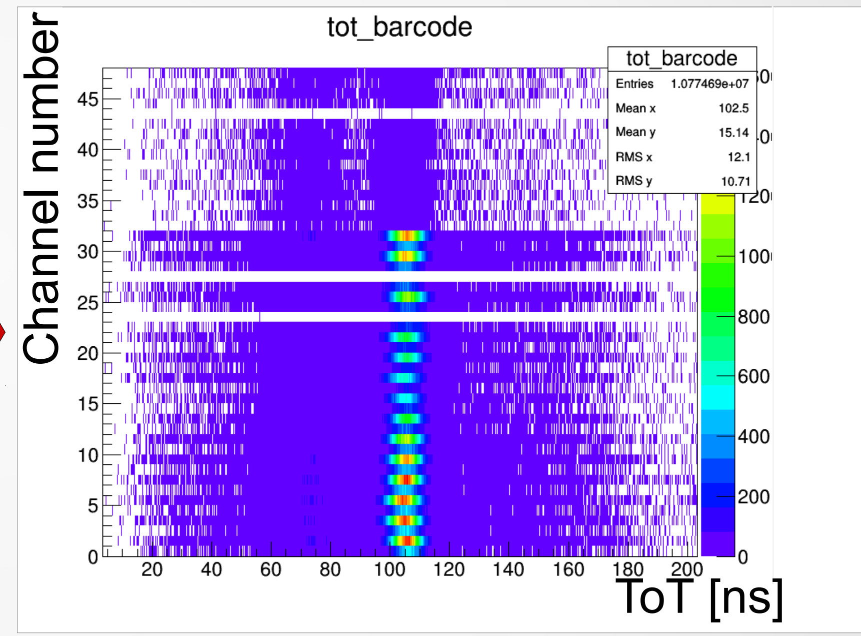
For each of 16 FEB channels the input charge and output amplitude correlation has been made. The mean amplification parameter was 0.235+/- 0.003. The gain dispersion between channels amounts to 1,3%.

Baseline tune

The PASTTREC has possibility to tune baseline position for individual channels. The tuning is done in automatic procedure which results are shown below.



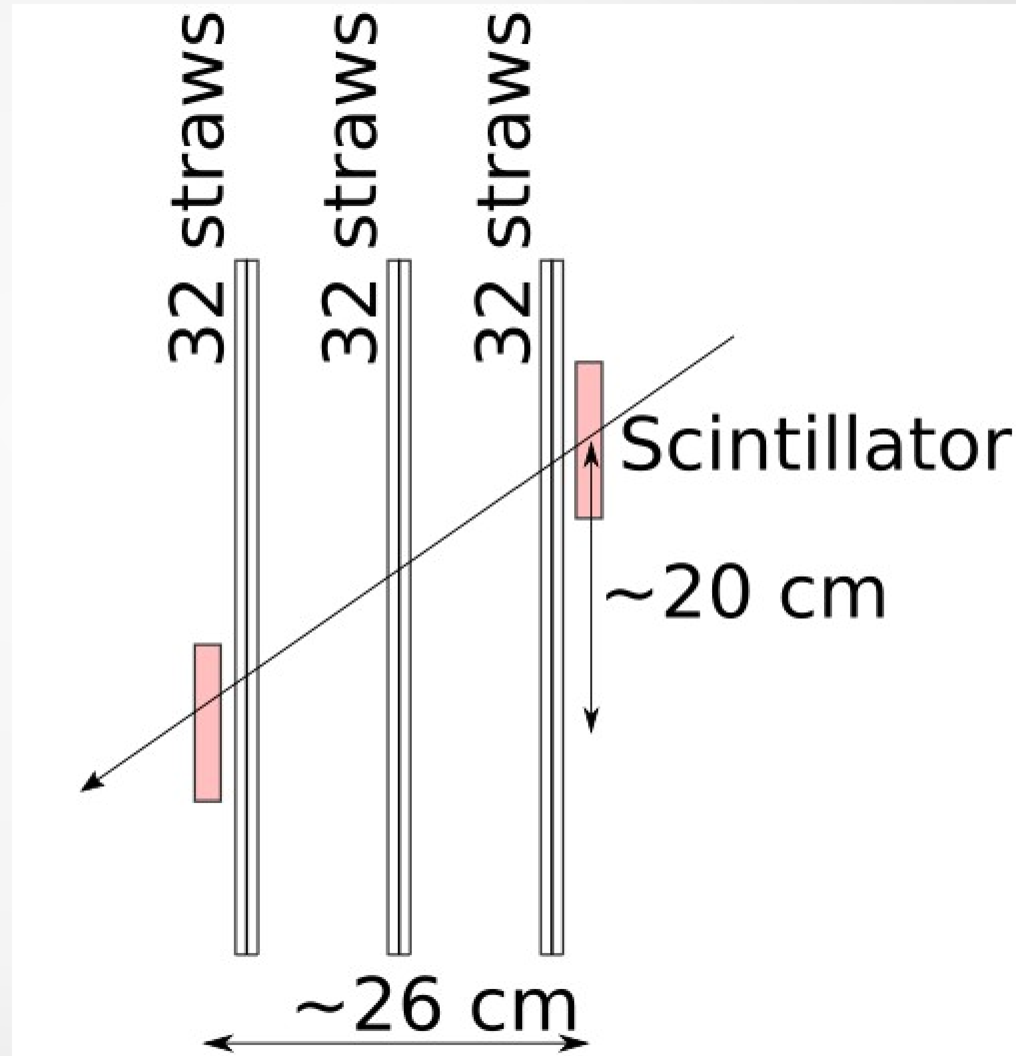
Before baseline tune procedure



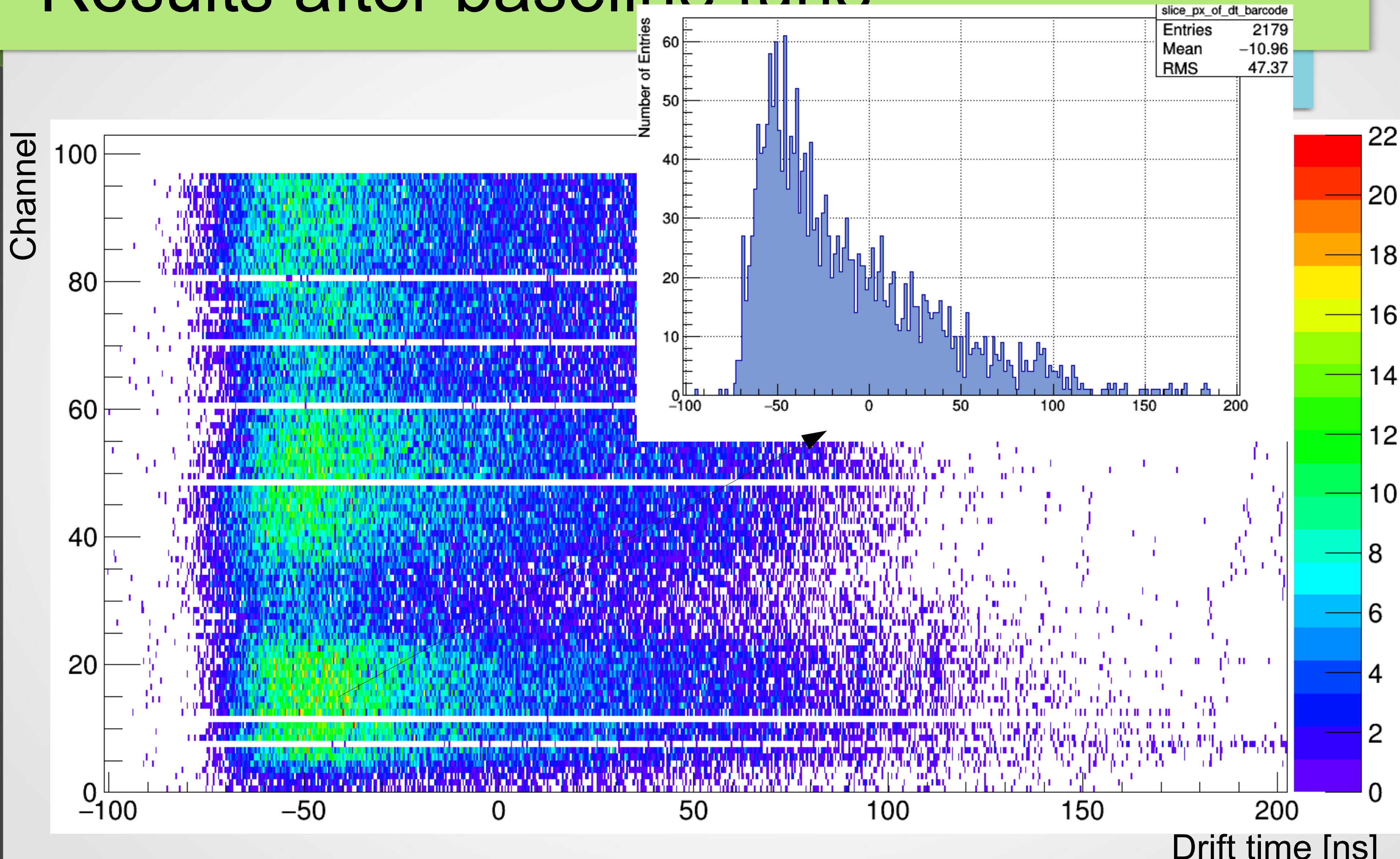
After baseline tune procedure

The same PASTTREC settings and threshold. The data taken with ^{55}Fe at 1700V.
Question: how should we do such a calibration during experiment? (cosmic rays?)

Cosmic ray set-up

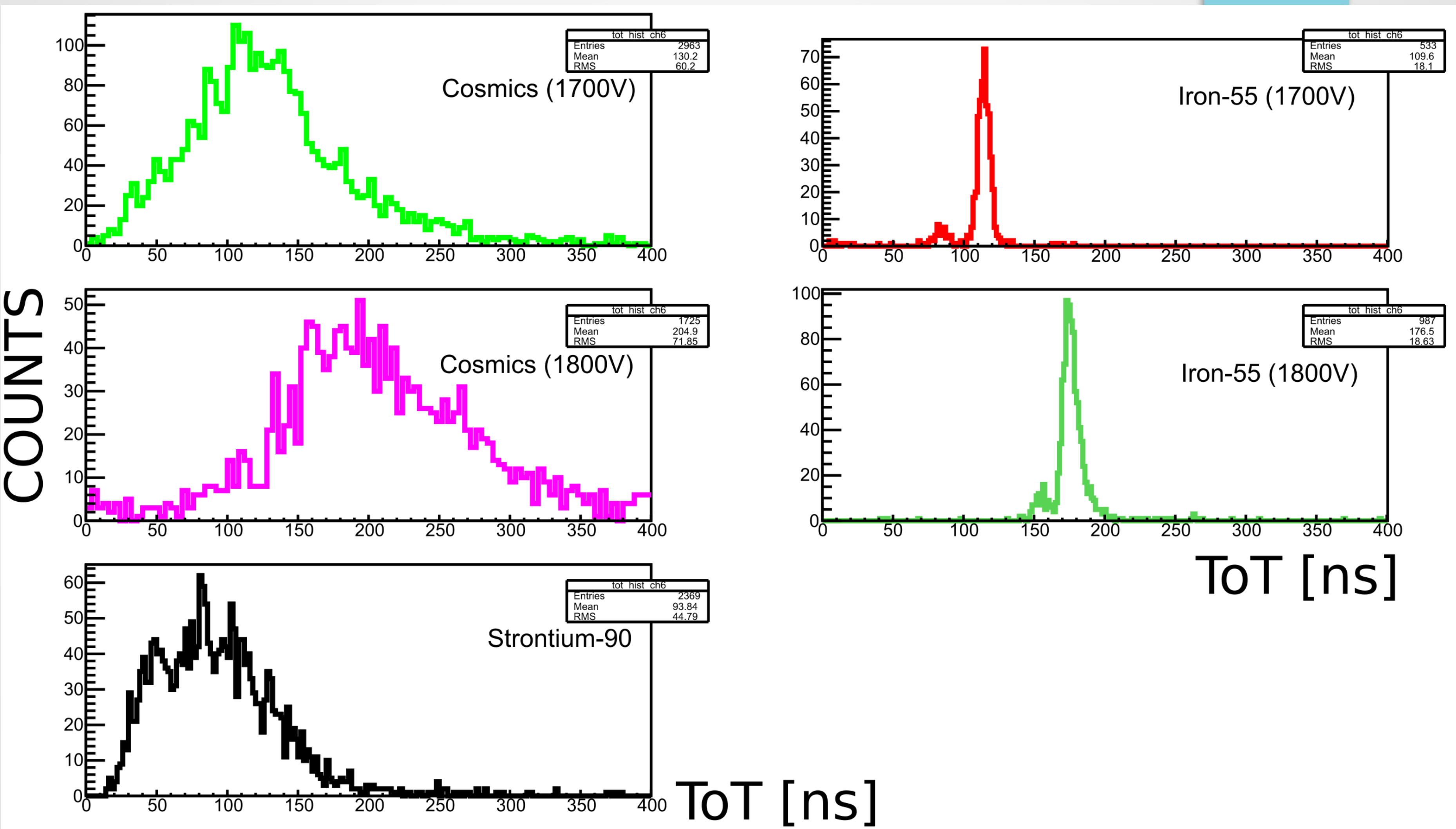


Results after baseline tune



Cosmic rays

ToT for different sources (1700V)



STT and FT readout possibilities

Expected data rate (high luminosity)

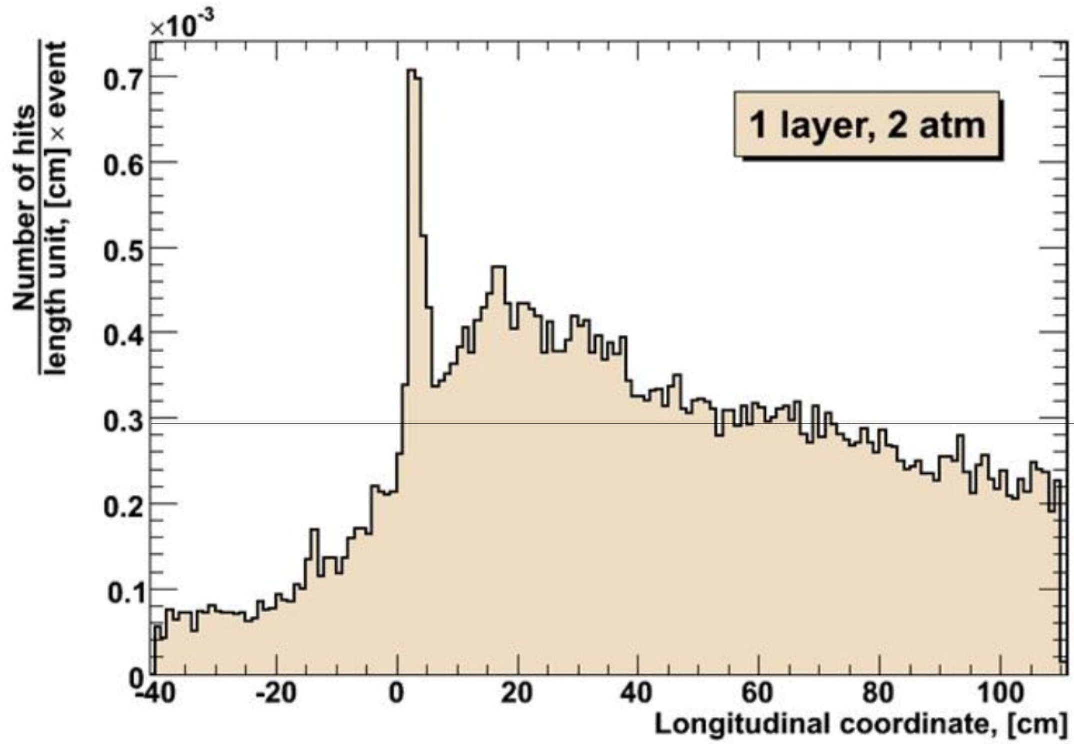


Figure 5.24: Simulation of $\bar{p}p$ reactions giving the number of hits per event and per cm along the tubes in the innermost layer of the $\overline{\text{P}}$ANDA straw tube tracker. The target position is at z=0 cm.

Event rate of $2x10^7$ s^{-1} during the high luminosity mode **(HLM).**

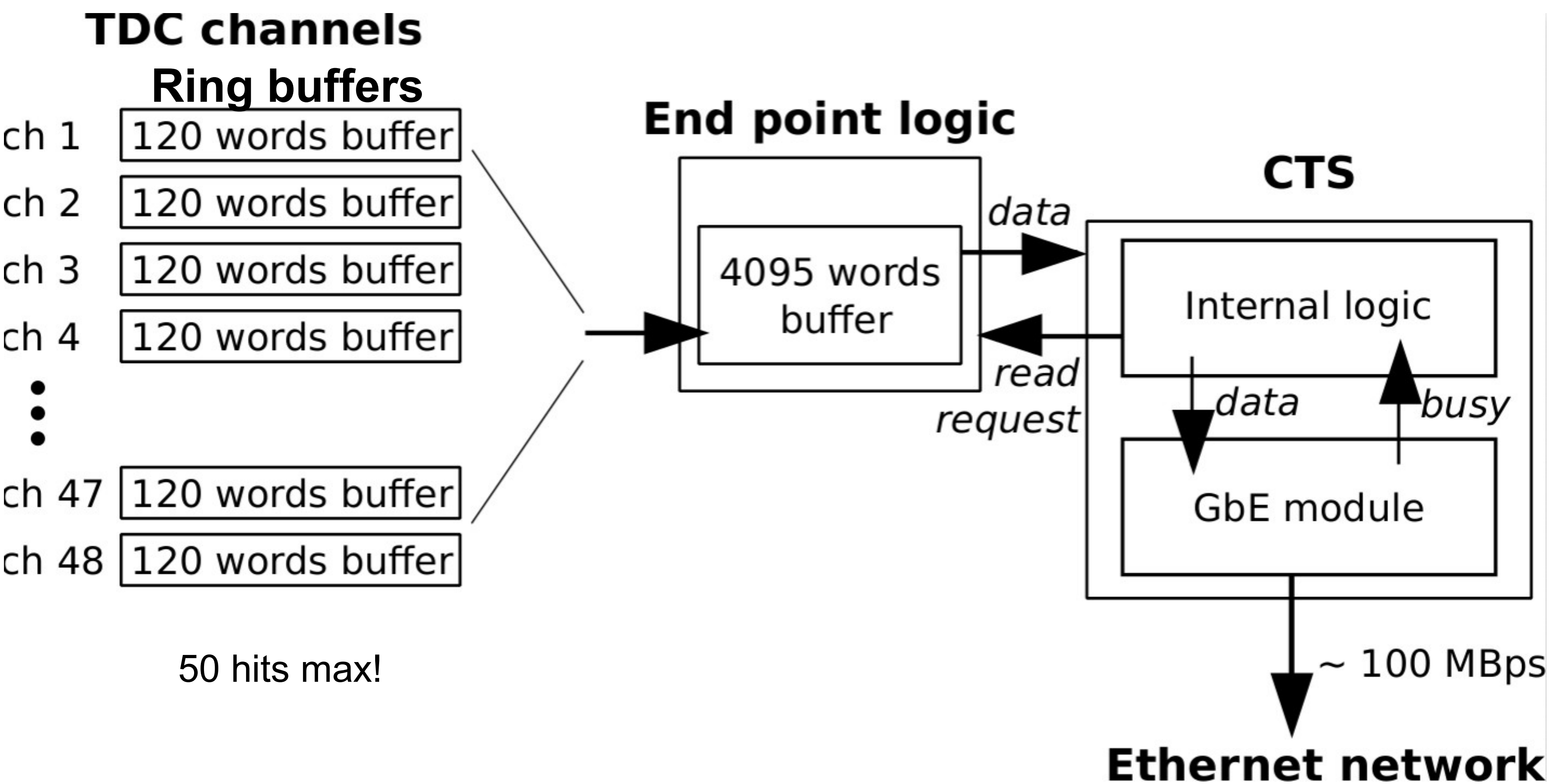
The hit rate per straw in the most inner layer:
$150cmx0.3x10^{-3}x2x10^7$=**0.9 MHz**

Assuming the above hit rate per channel we can calculate data which should be send by 1 TRB:
1 hit * 0.9MHz * 192 channels =
8B * 9 * 10^5 *192 = ~1.3 GB/s and with headers up to 1.5 GB/s

For the FT maximal hit rate is also ~1MHz.

Ref: Technical design report for the PANDA (AntiProton Annihilations at Darmstadt) Straw Tube Tracker (arXiv:1205.5441 [physics.ins-det])

TRB 3



50 hits max!

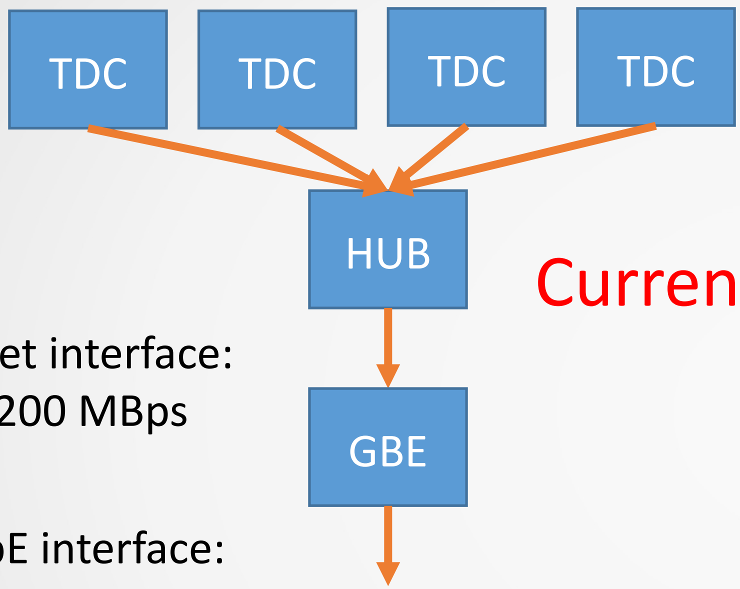
TRB3 limitations

- The ring buffer limit (can store up to 50 hits between triggers)
- The end point buffer (storing hits from all TDC channels – 1920 hits)
- TRB3 output (GbE ~100MB/s)

HIT RATE PER CHANNEL	NUMBER OF CHANNELS PER TRB	READOUT RATE*	DATA RATE PER SECOND	PERCENTAGE OF TOTAL INCOMING DATA PROCESSED BY READOUT
1MHz	192	1.6kHz	100 MB	6.4 % (for 100% 1.5GB bandwidth required)
200kHz	128	4kHz	260 MB	~40%
100kHz	192	2.5kHz**	150 MB	67% **(low luminosity PANDA)**

* - requested for reading data without buffers overflow
** - SODA trigger = 2kHz

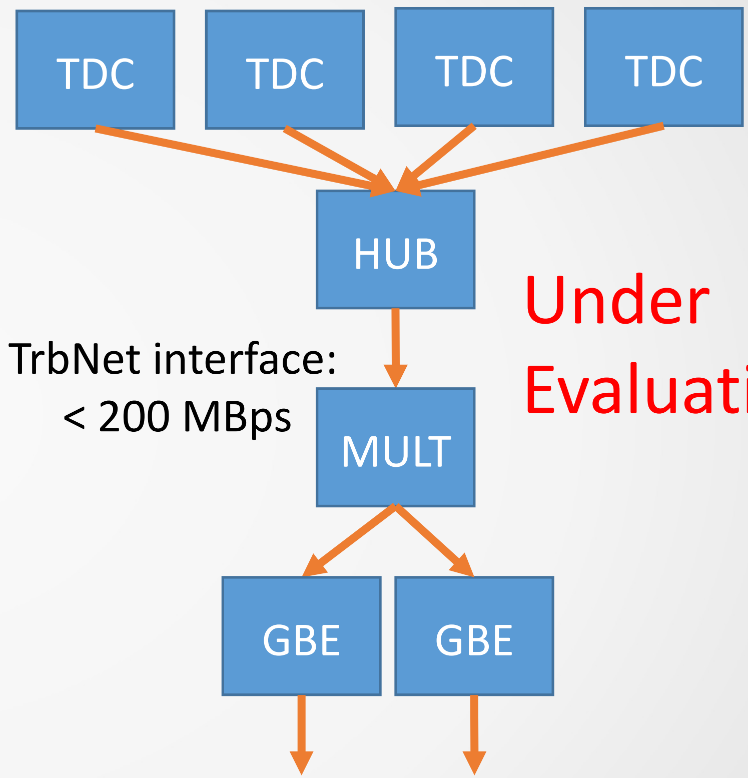
Get the most out of the TRB3



Current

TrbNet interface:
< 200 MBps

GbE interface:
~ 100 MBps



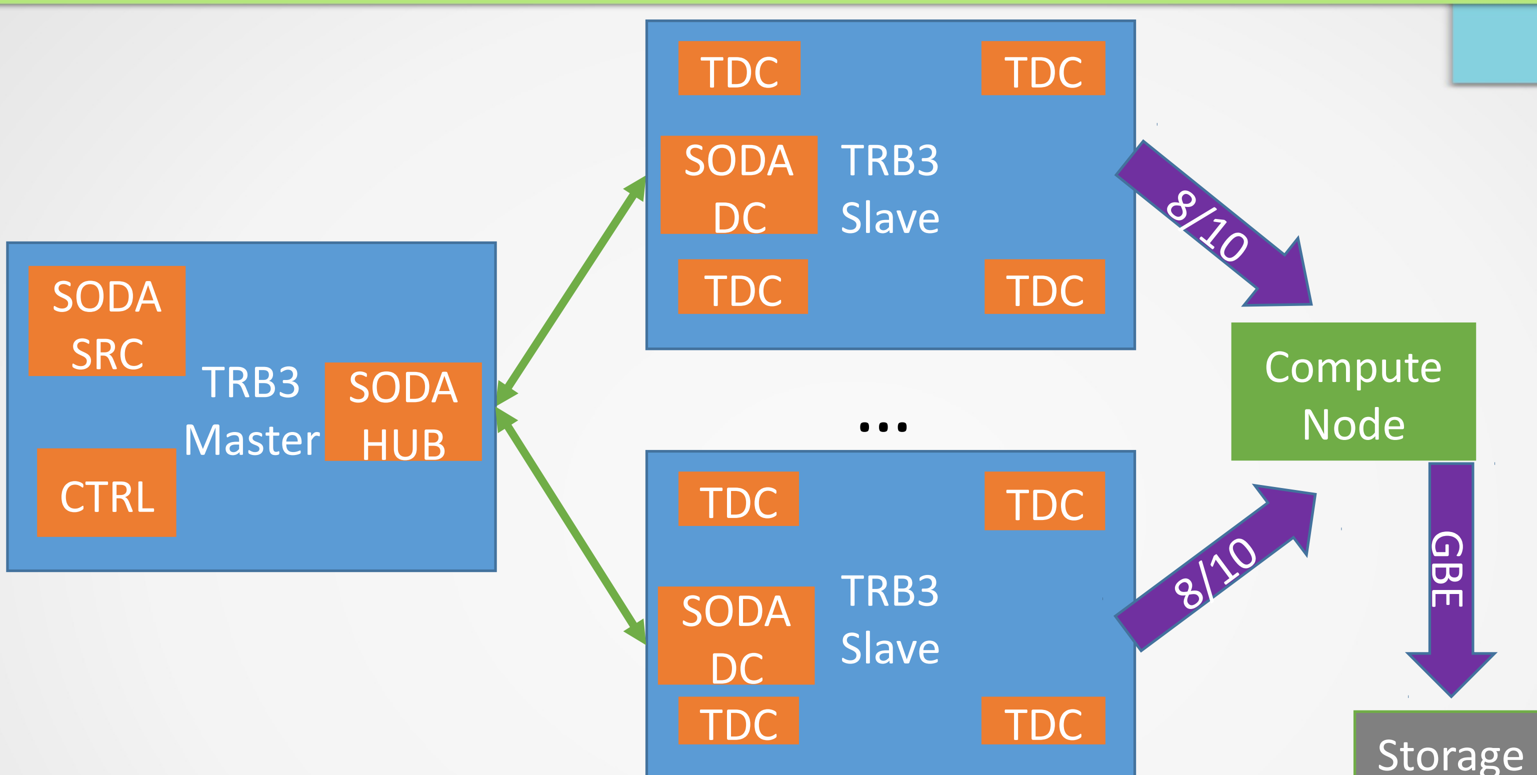
Under Evaluation

TrbNet interface:
< 200 MBps

GbE interface: 2x 100 MBps

Sufficient for the STT and FT at low luminosity at PANDA!

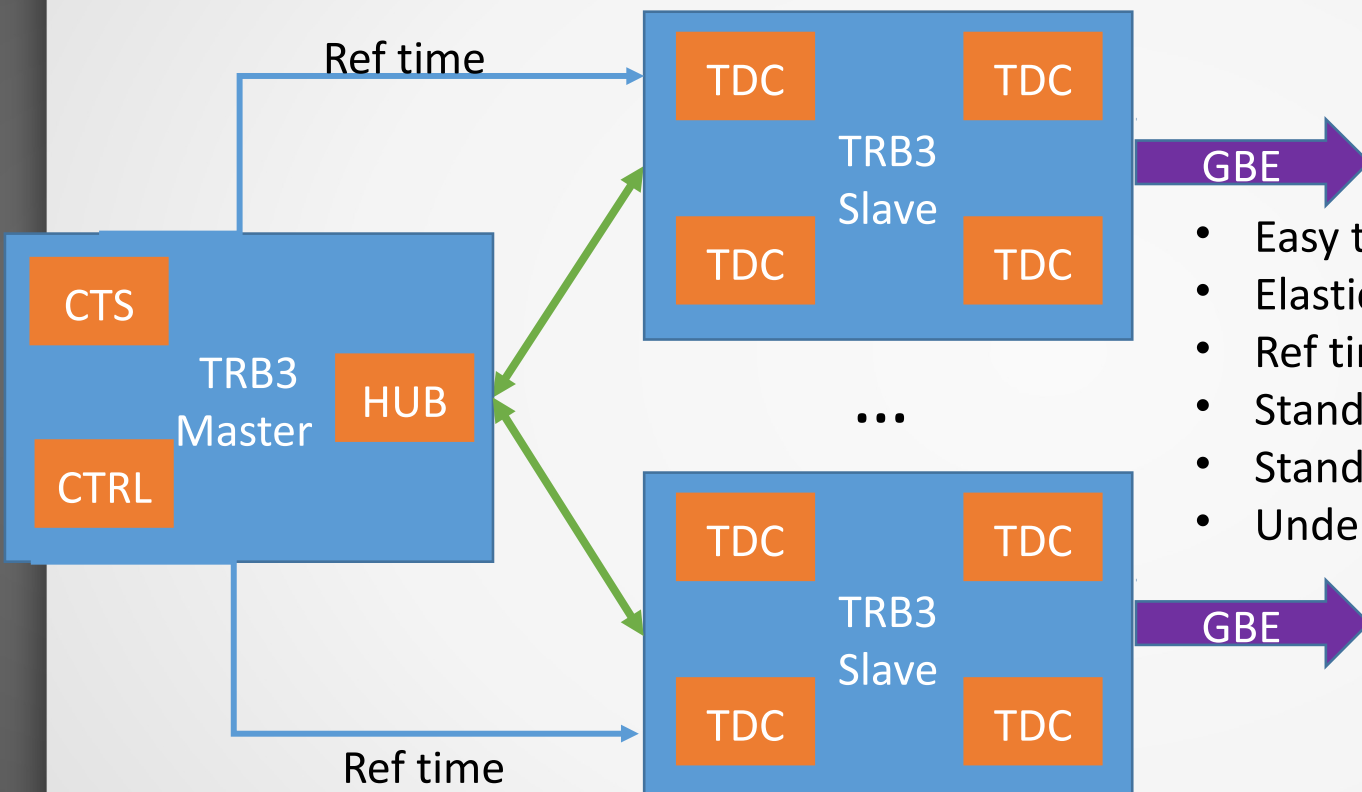
Integration with PANDA DAQ



- Fixed SODA trigger rate 2kHz (256 bursts, each 2us)
- 2kHz => 500 hits per channel in high luminosity mode => Extended buffering needed !
- Synchronization through SODA super burst update and number
- Event building in the Compute Node From CN to storage through GbE
- Bottleneck: n x TRBs -> 1xGbE
- Slight data format change
- Slow Control remains the same
- Integration with PANDA DAQ!

Multi TRB3s – Master & Slave

The set-up foreseen for the future beam test in Juelich.



- Easy to setup
- Elastic triggering schemes
- Ref time + TrbNet LVL1 synchronization
- Standard event building software
- Standard analysis software
- Under evalution in JPET project

Readout conclusions

- TRB with 2 GbE links can take a data for the FT and the STT in the low luminosity mode
- In order to take a data at the high luminosity mode one should consider:
  - Reducing the number of channels per TRB
  - Implementation low resolution TDC with a different data format
  - Increase of the TDC buffer sizes – hardware investigation needed
  - 8/10b communication with Compute Node instead of GbE
- Grzegorz Korcyl works on the STT and the FT readout integration with the PANDA DAQ system (SODA)

Outlook

- Data taking with cosmic rays in Krakow
- Preparation set-up in Juelich (cosmic rays)
- Preparation for the beam test (15-21.02.2016)
  - Measuring at different beam momenta (single TRB)
  - Measuring with different thresholds (single TRB)
  - Checking different PASTTREC settings (single TRB)
  - Combining STT and FT in one set-up multi-TRB
- Test of TRB and Compute Node set-up with a real data

Thank you for your attention!

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