Signal properties:
results of the tests with straw tubes

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Energy loss measurement in Straw Tube Tracker

MOTIVATION

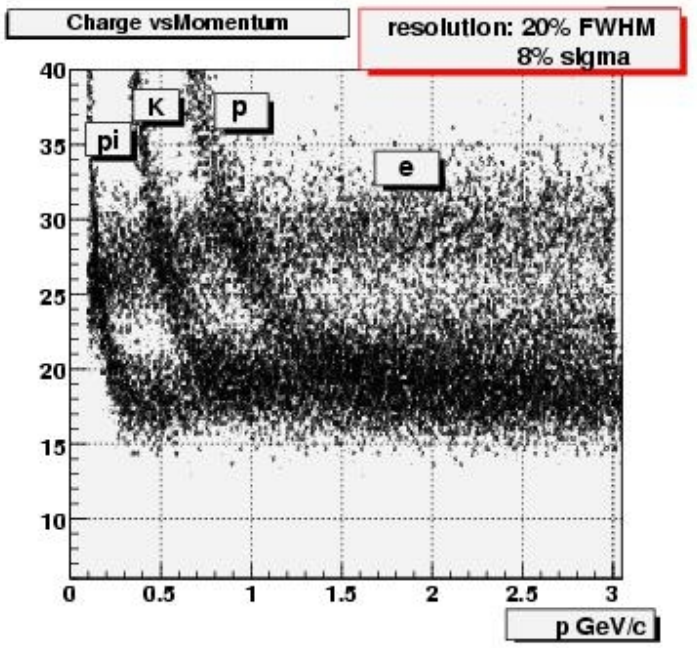
Straw Tube Tracker (STT) is an option for the central tracker in PANDA@FAIR experiment

Demands:

- measurement of particles momenta,
- particle identification by means of dE/dx in low momentum range (below 1 GeV/c)

STT must present simultaneously:

- excellent 3D tracking performance
- sufficient energy resolution

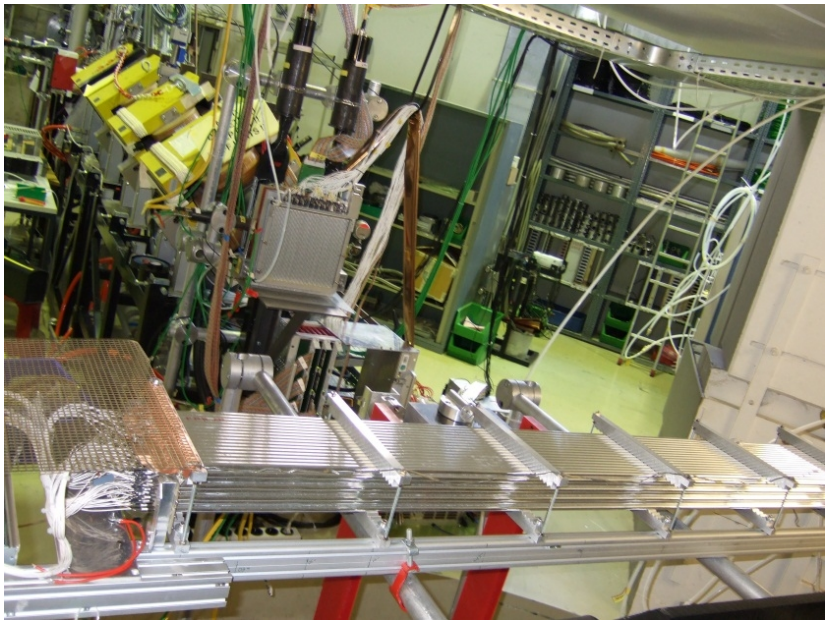


Simulation: (A. Rotondi et al.)

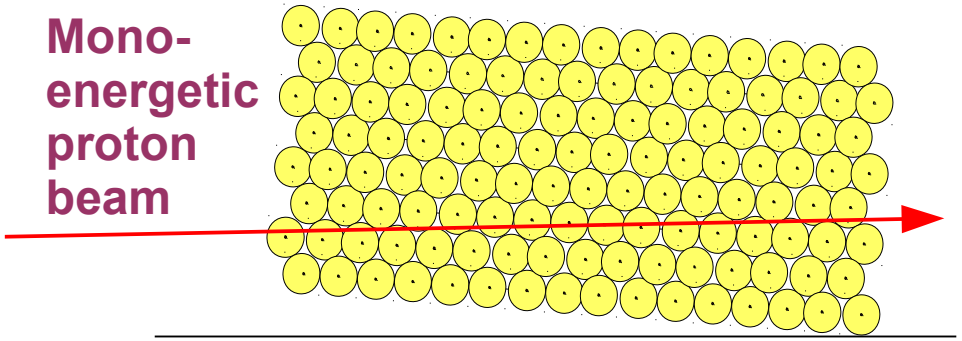
Measurements in Juelich

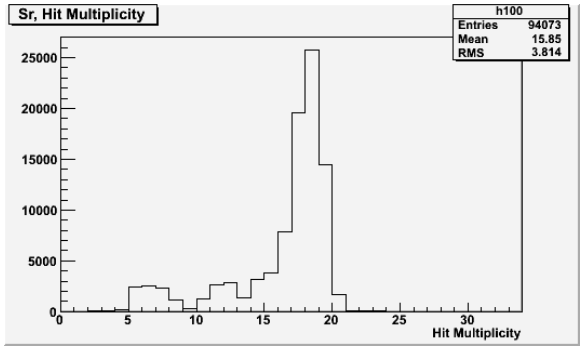
8 layers with 16 tubes each

- 1.5 m long
- Φ 10 mm
- 30 µm wall thickness
- 20 µm anode wire
- 1 bar overpressure
- mixture: Ar/CO2 (90/10)
- gas gain about 5 * 10^4



Mono-energetic proton beam





Test performed at:

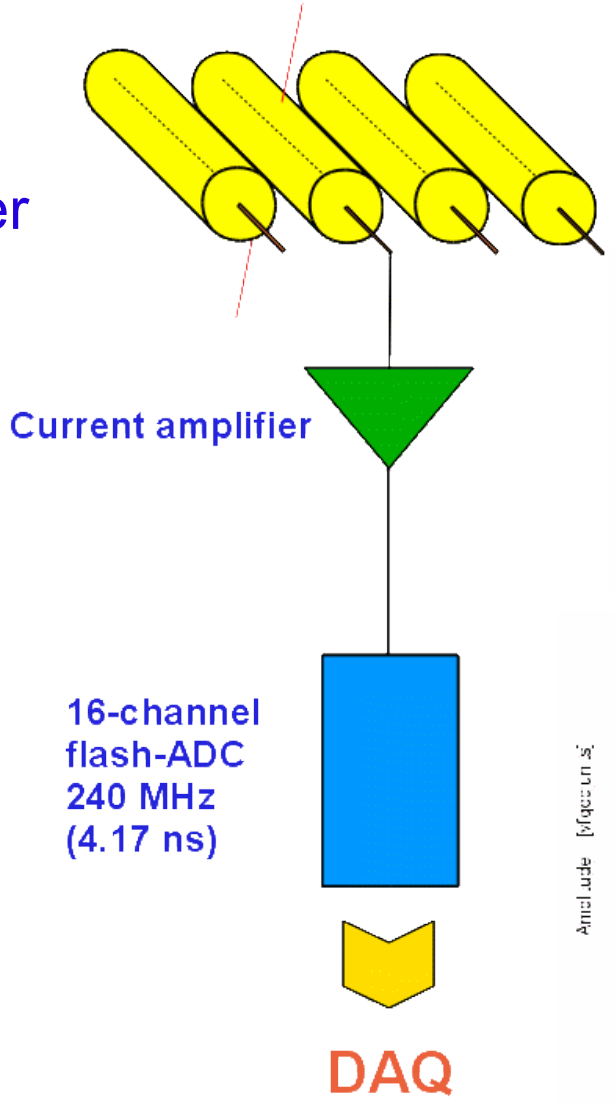
- 2.95 GeV/c,
- 1.0 GeV/c,
- 0.64 GeV/c

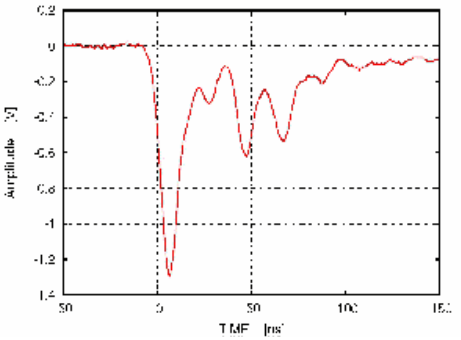
Signal readout

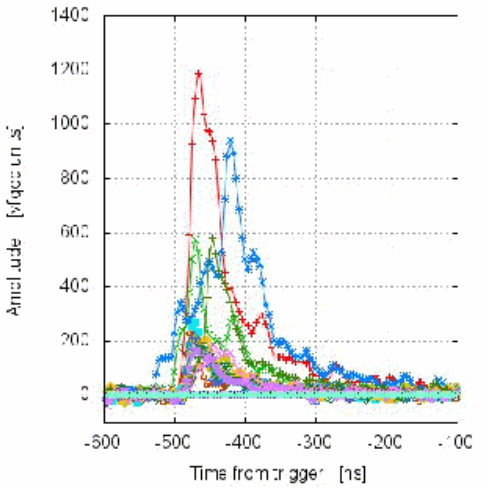
Front-end: current amplifier composed of:

- transresistance amplifier
  - 8 ns rise-time,
  - gain factor 10,
  - differential output
- booster amplifier
  - gain factor 2,
  - single-ended output

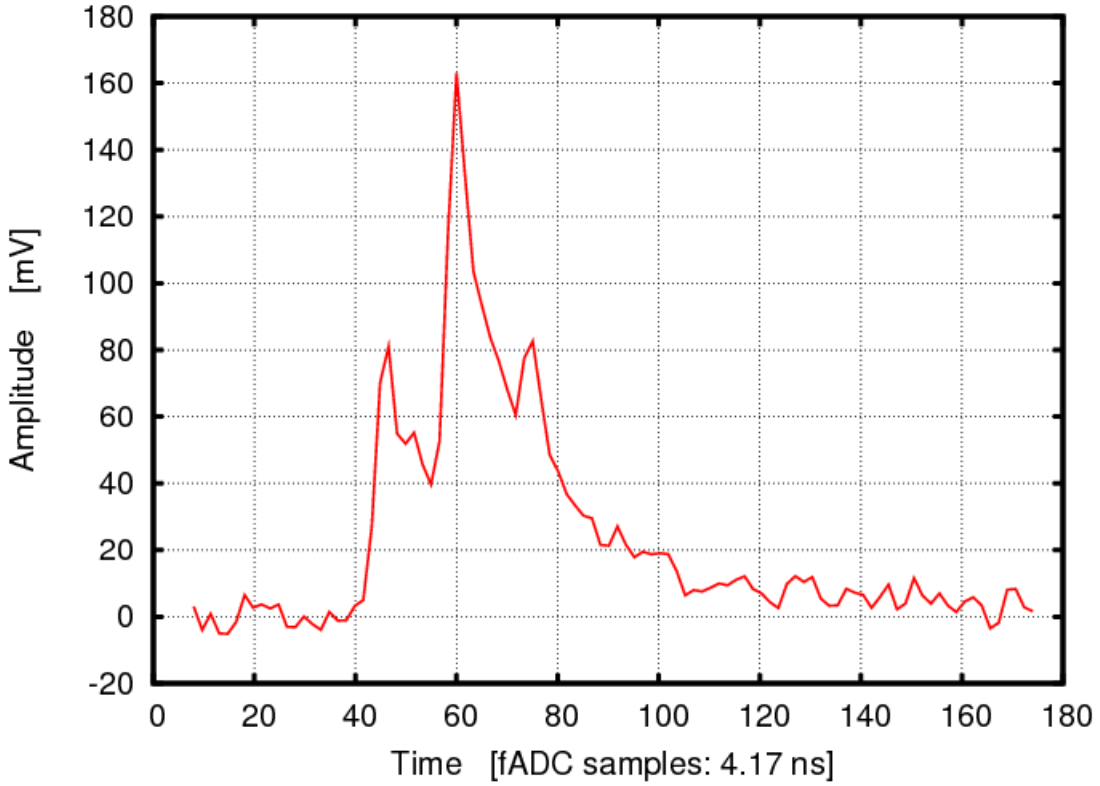
Total integration time ~ 7 ns







Present analysis and results



Response of detector and electronic is proportional to the primary ionization

Thus:

The total charge of the signal is a measure of an energy loss.

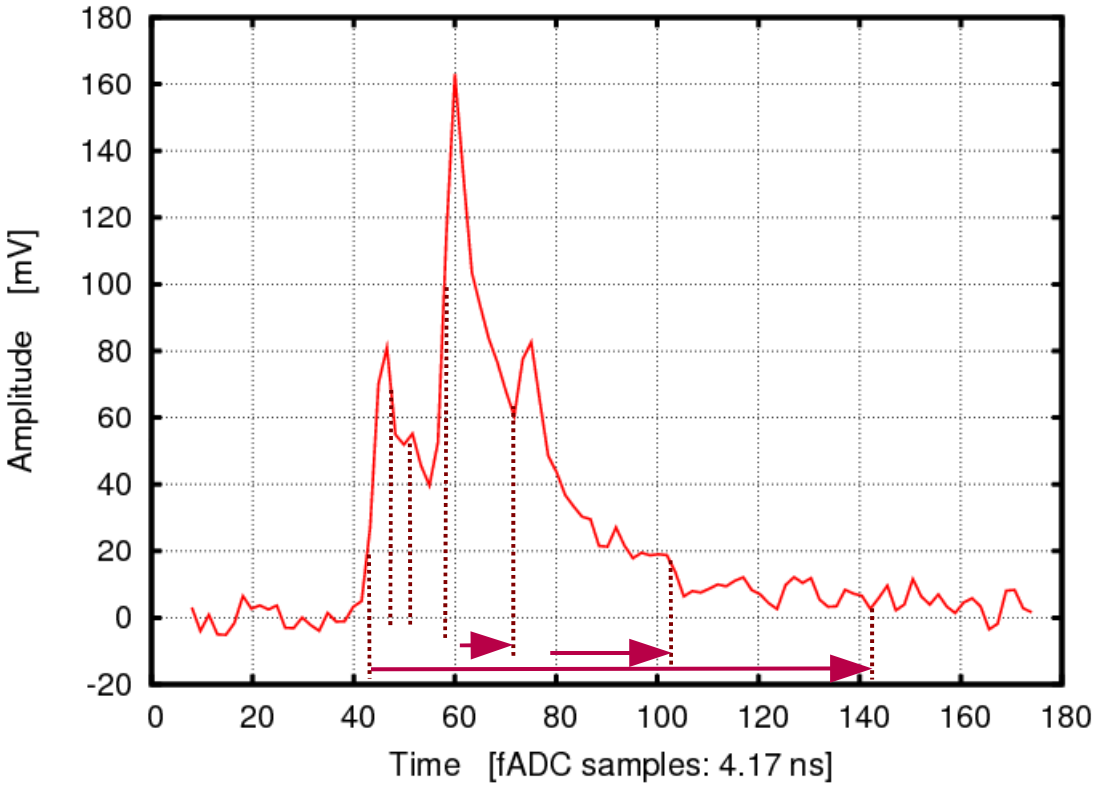
Present analysis: signal integration → truncation of the high energy tail → path length correction → final energy loss distributions.

Achievable resolution: ~ 8 % for 16 straws in track

Various fractions of charge

In experiment, due to expected high counting rate, charge integration over long drift time is not affordable.

Which fraction of the signal charge has to be collected in order to estimate the energy loss with sufficient precision ?



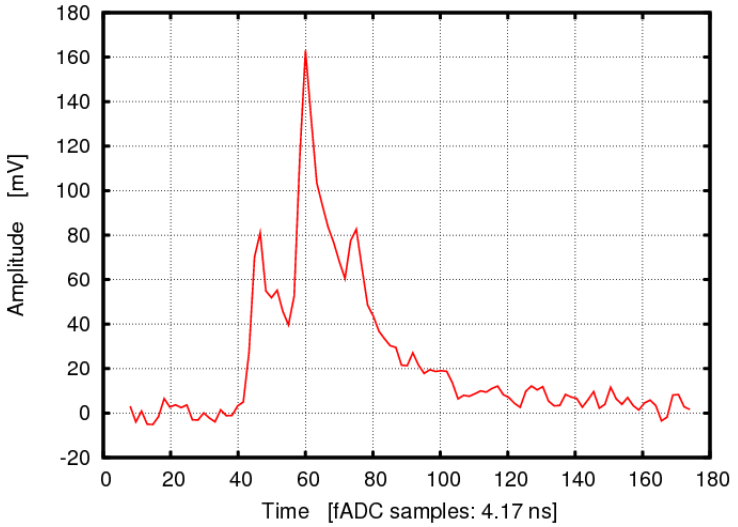
Check for integration over:

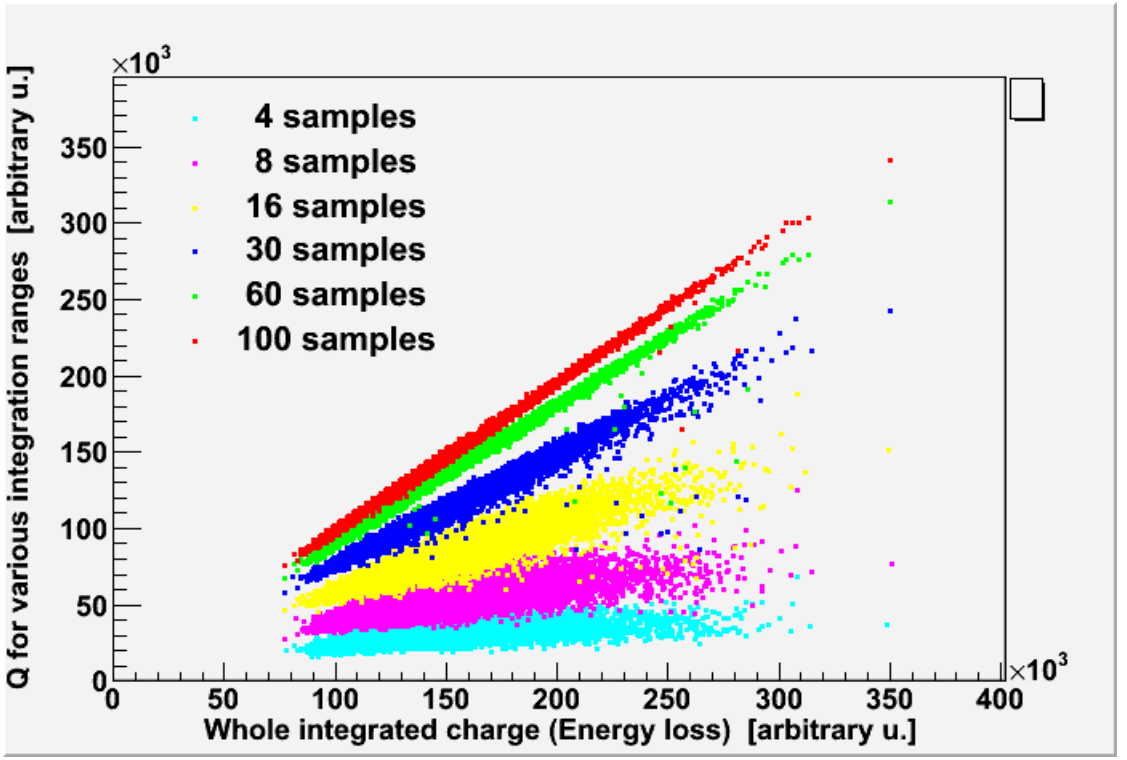
- 4 samples,
- 8 samples,
- 16 samples,
- 30 samples,
- 60 samples,
- 100 samples

1 sample = 4.17 ns

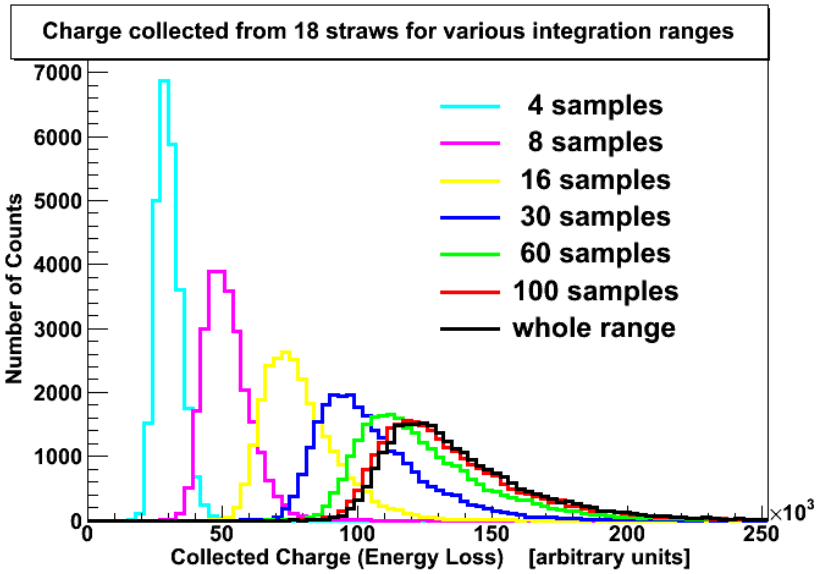
Various fractions of charge - cont.

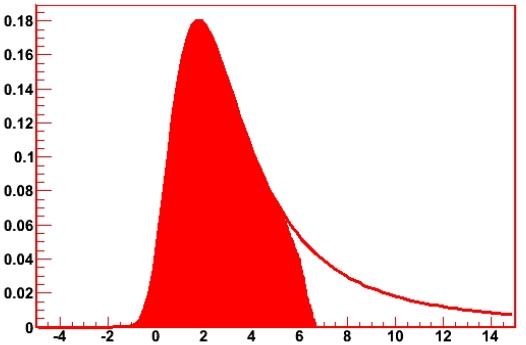
Results for proton beam of 1.0 GeV/c and for track containing 18 straw tubes

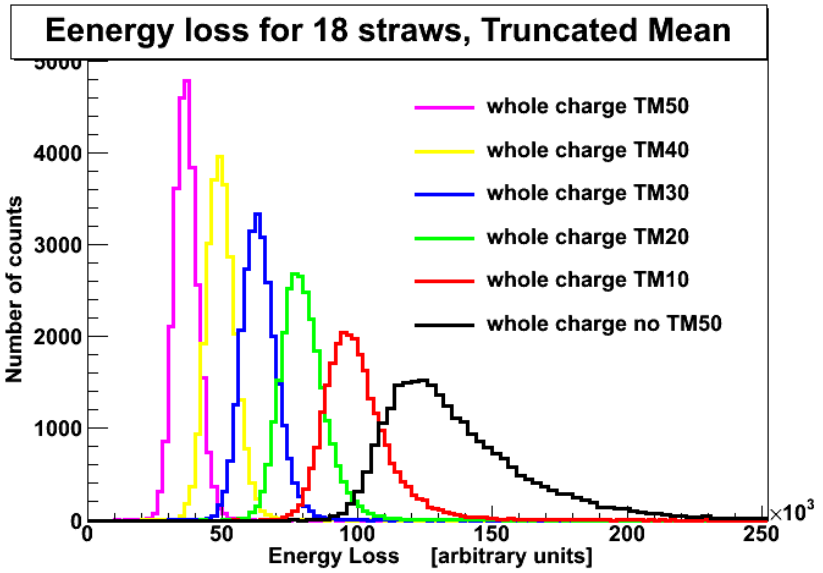


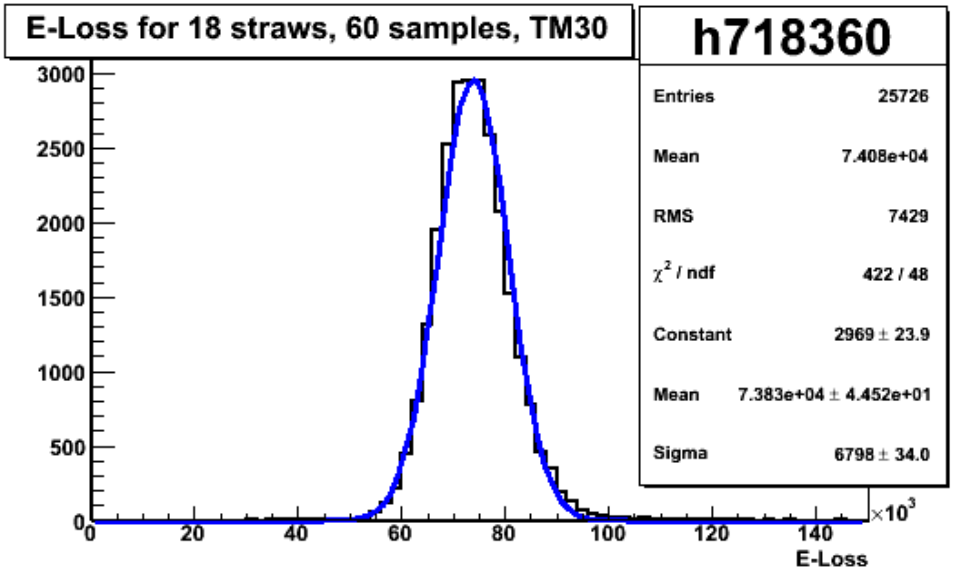


Various fractions of charge - cont.

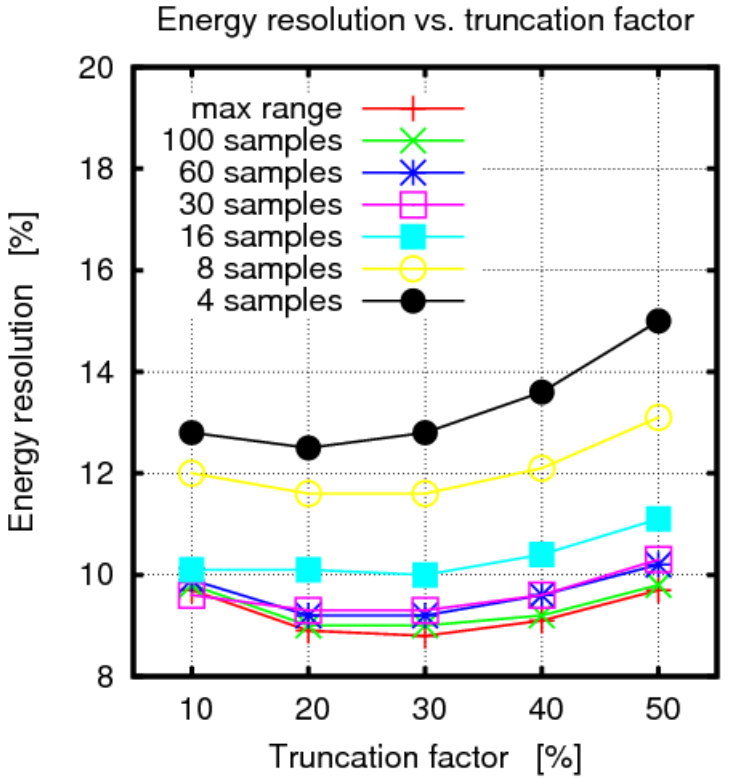


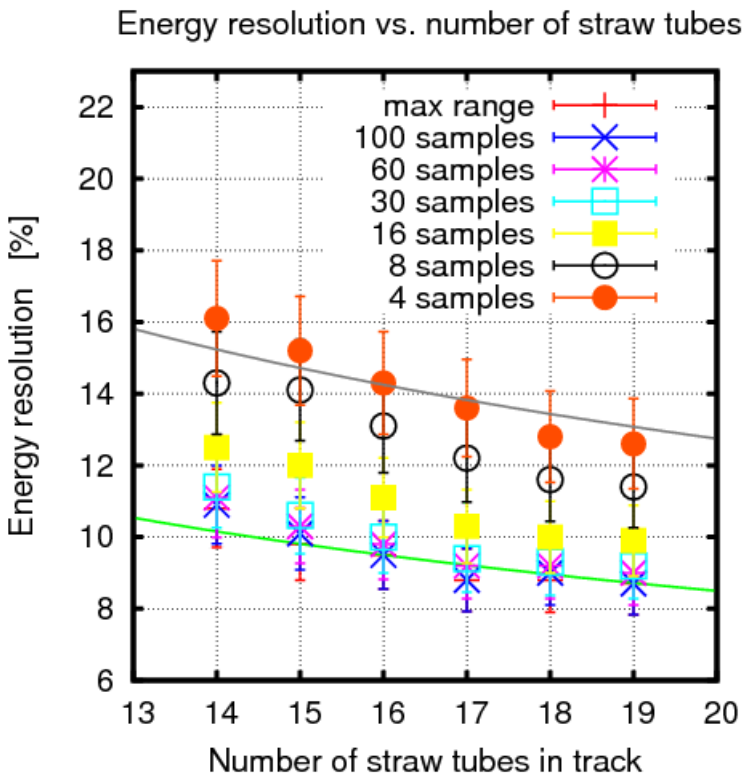






Various fractions of charge - results

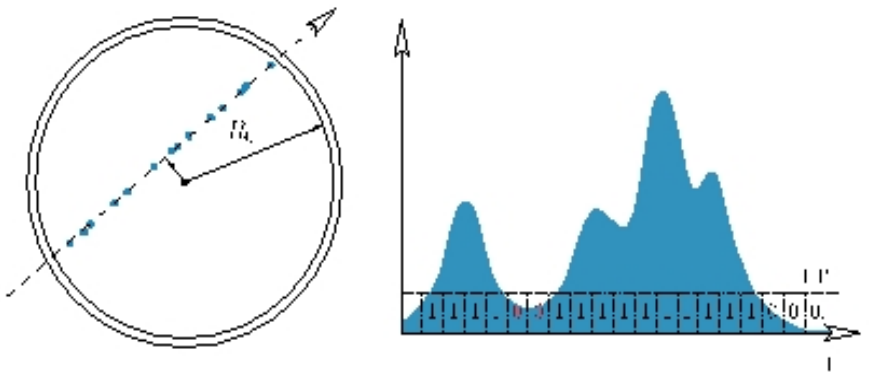




Since almost whole charge is comprised in the first 40 – 60 samples shortening of the integration up to 30 samples causes only minimal deterioration of the energy resolution.

Integration over first 16 samples (~ 67 ns) spoils resolution from 9 % to 10 % .
For 8 samples (~ 33 ns) resolution is worse by additional 2 % .
Charge contained within the first 4 samples only (~ 17 ns) allows for resolution of 13 % .

Time over Threshold ?

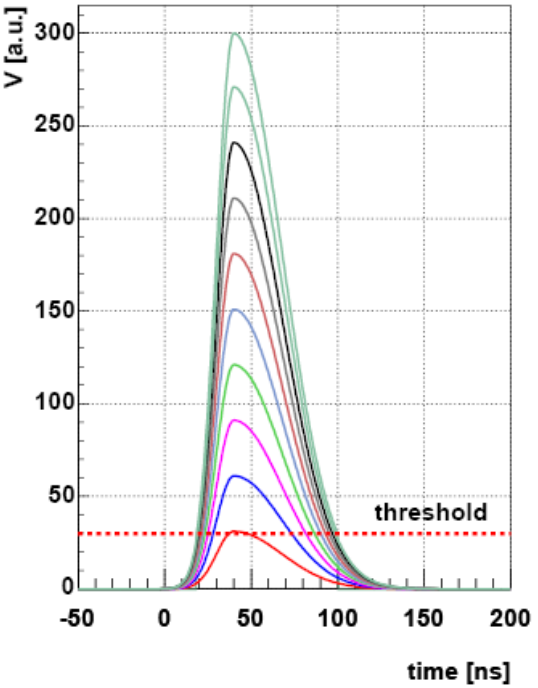


Direct measurement of ToT:

- needs to follow the signal over whole drift time,
- needs very fast (noisy ?) electronics,
- week relation between time and charge.

Does not work !

HADES:



- integration of the fraction of the signal,
- measurement of the duration of the signal, over the selected threshold (0.5 ns precision),
- careful calibration and parametrization,
- achievable resolution ~ 6 %

Integration time : ~ 40 ns ??