Resolution of dE/dx measurement with the use of Straw Tubes

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In collaboration with:

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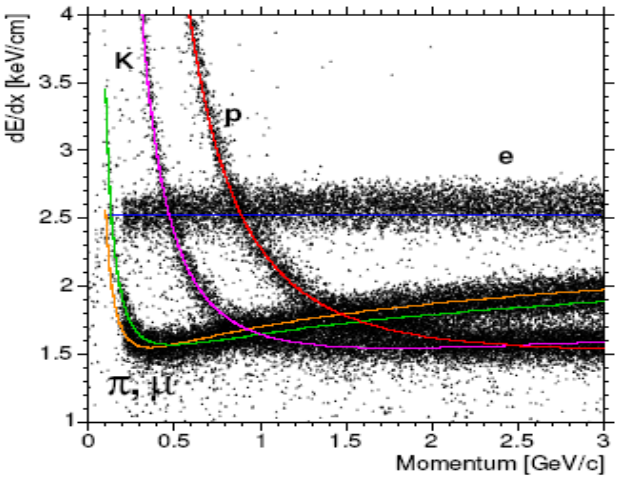
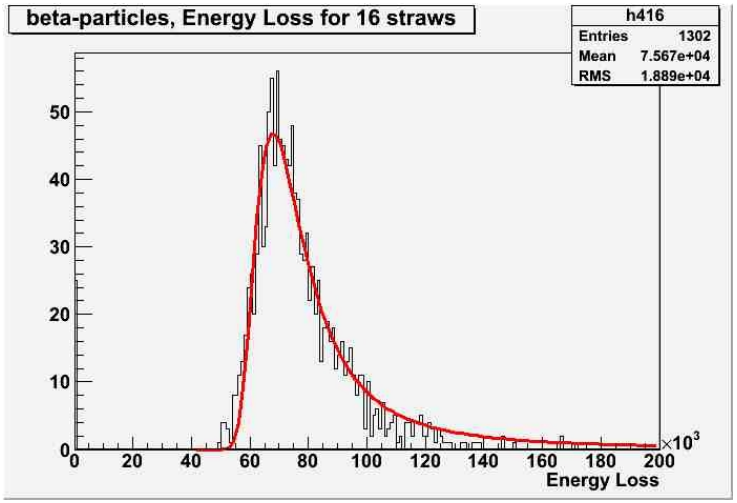
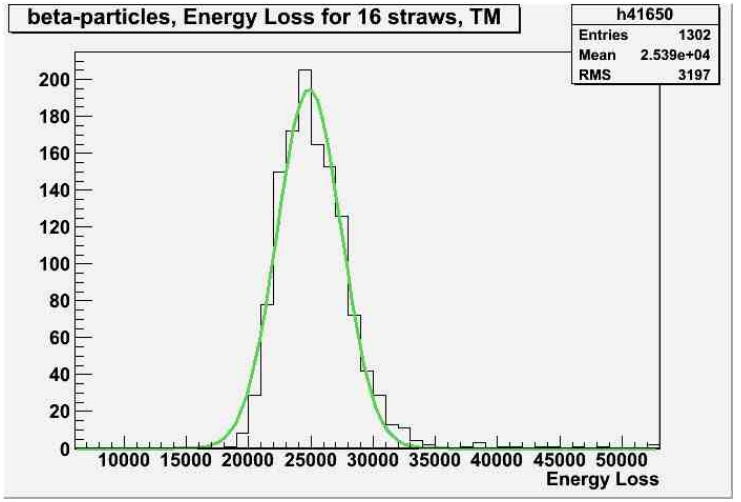
REMINDER

Is it possible to identify particles in lower energy range (< 1 GeV) on the base of their specific energy-losses in Straw Tube Tracker ?



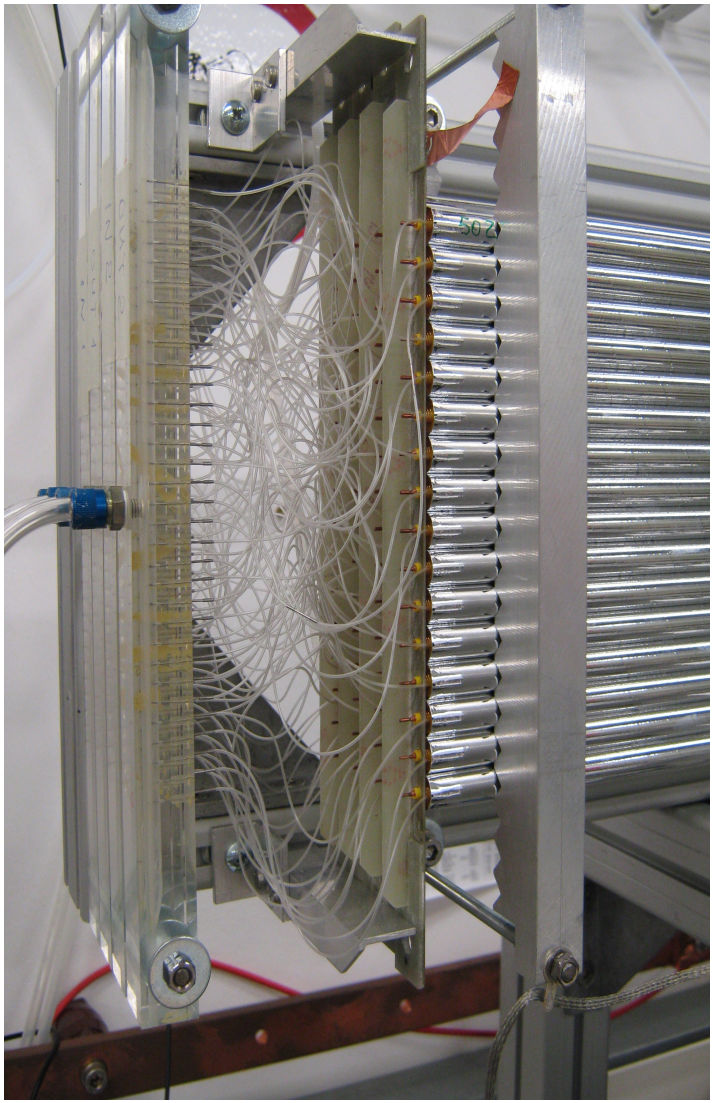




How to convert from Landau to Gaussian-like distribution ?

What will be the resulting resolution ?

SETUP

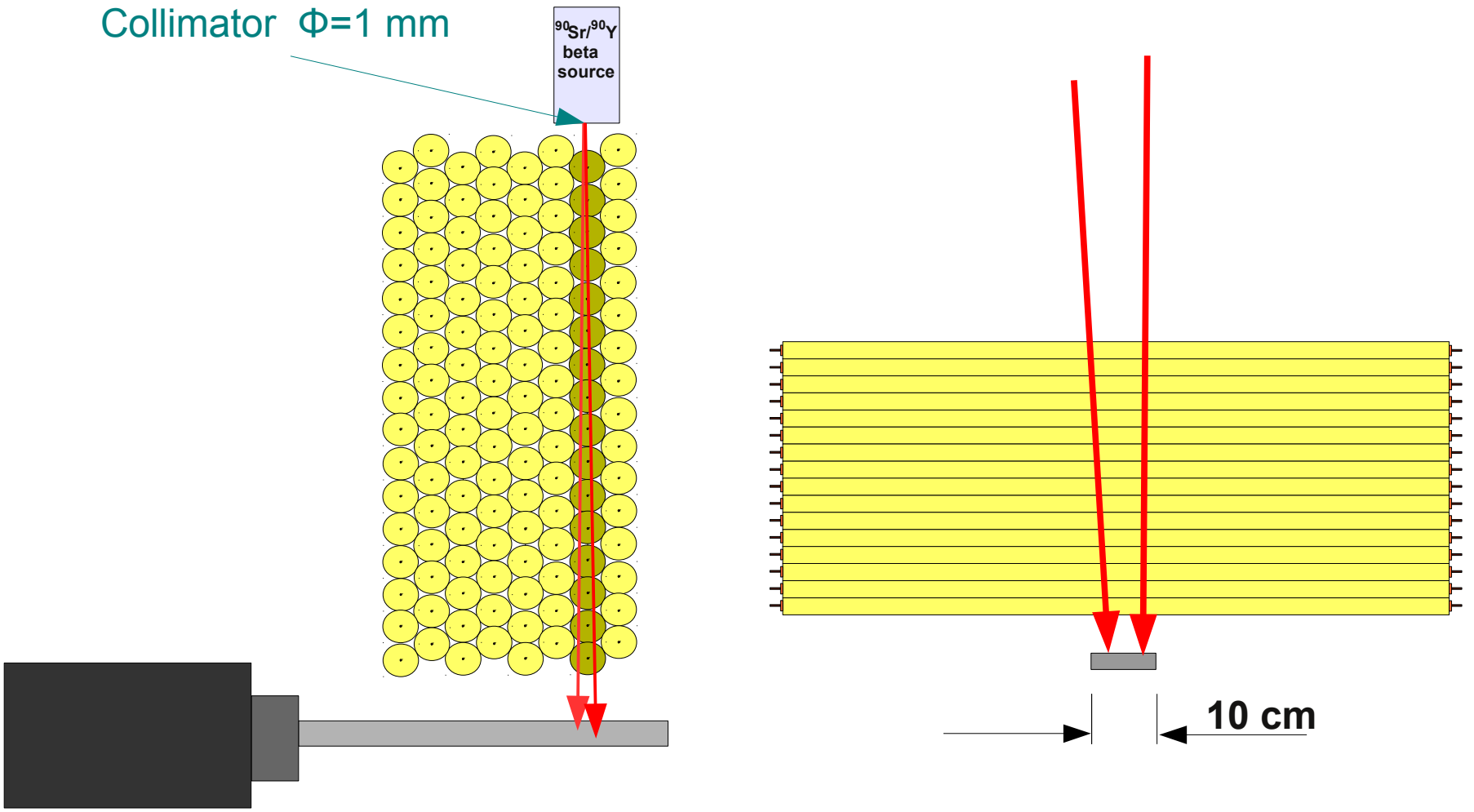


Measurement with 128 straws
(8 layers with 16 tubes each)
of the STT type:

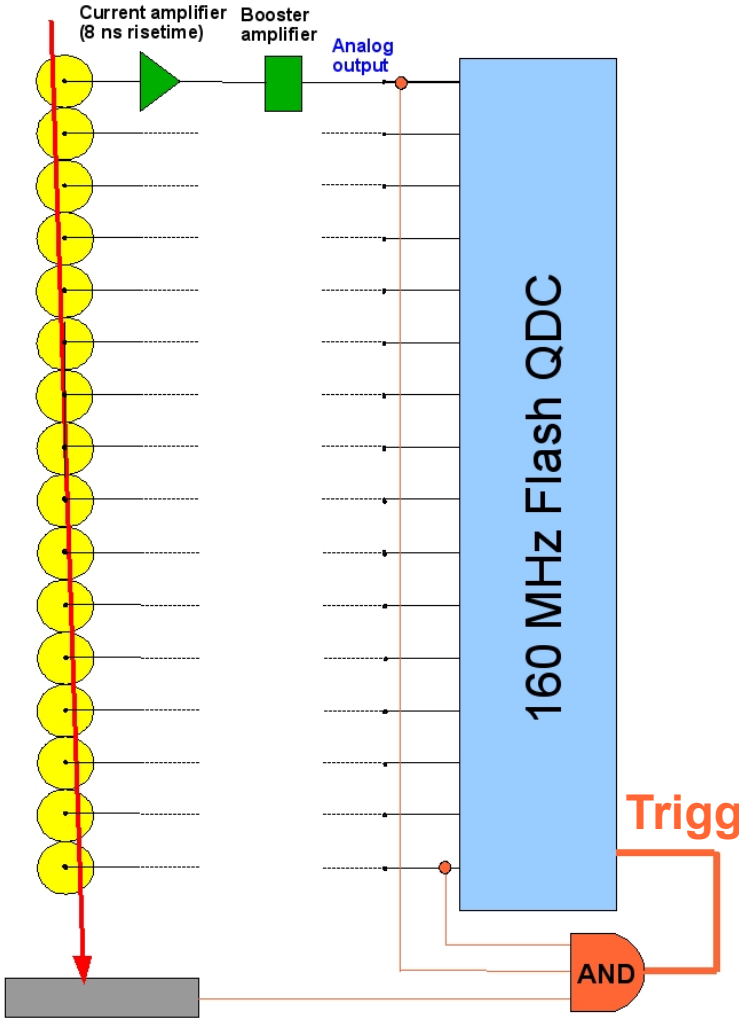
- **1.5 m long**
- **Φ 10 mm**
- **30 µm wall thickness**
- **20 µm anode wire**
- **operated at overpressure (1 bar)**
- **mixtures: Ar/CO2 (90/10), Ar/C2H6 (80/20)**

Designed for COSY-TOF and PANDA (P. Wintz)

MEASUREMENT

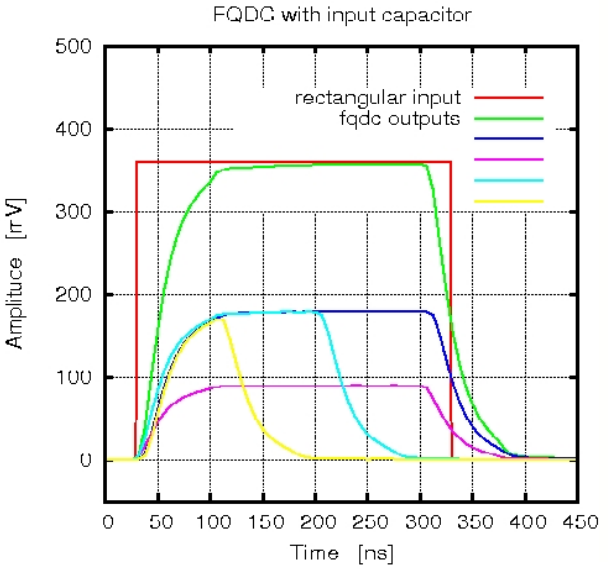


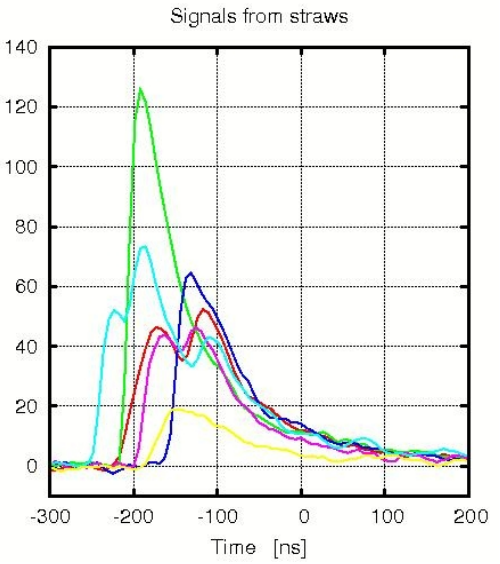
DAQ



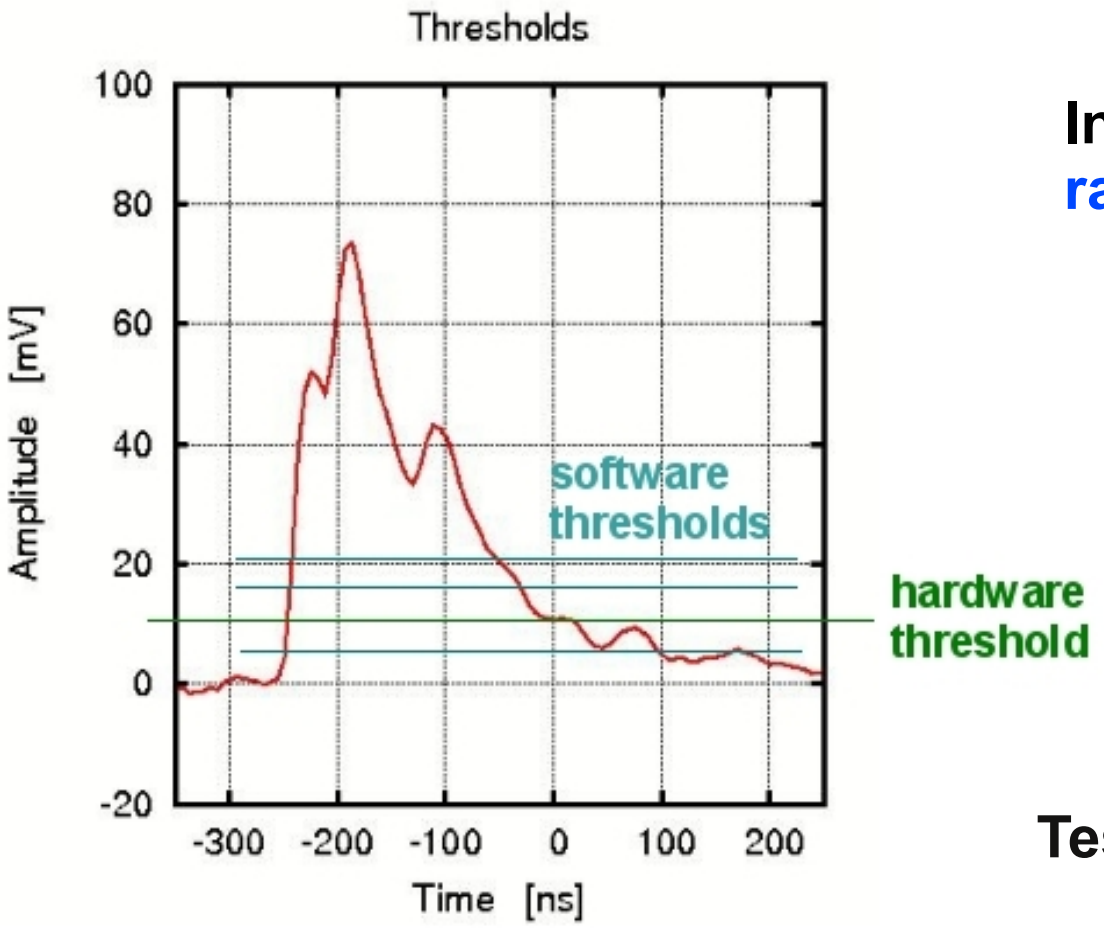
16-channel, 160 MHz flash-ADC
6.25 ns sampling time

drawback: input capacitor smears the signals





ANALYSIS



Integration of the signals →
raw energy-loss distributions

Selection of events →
truncation methods

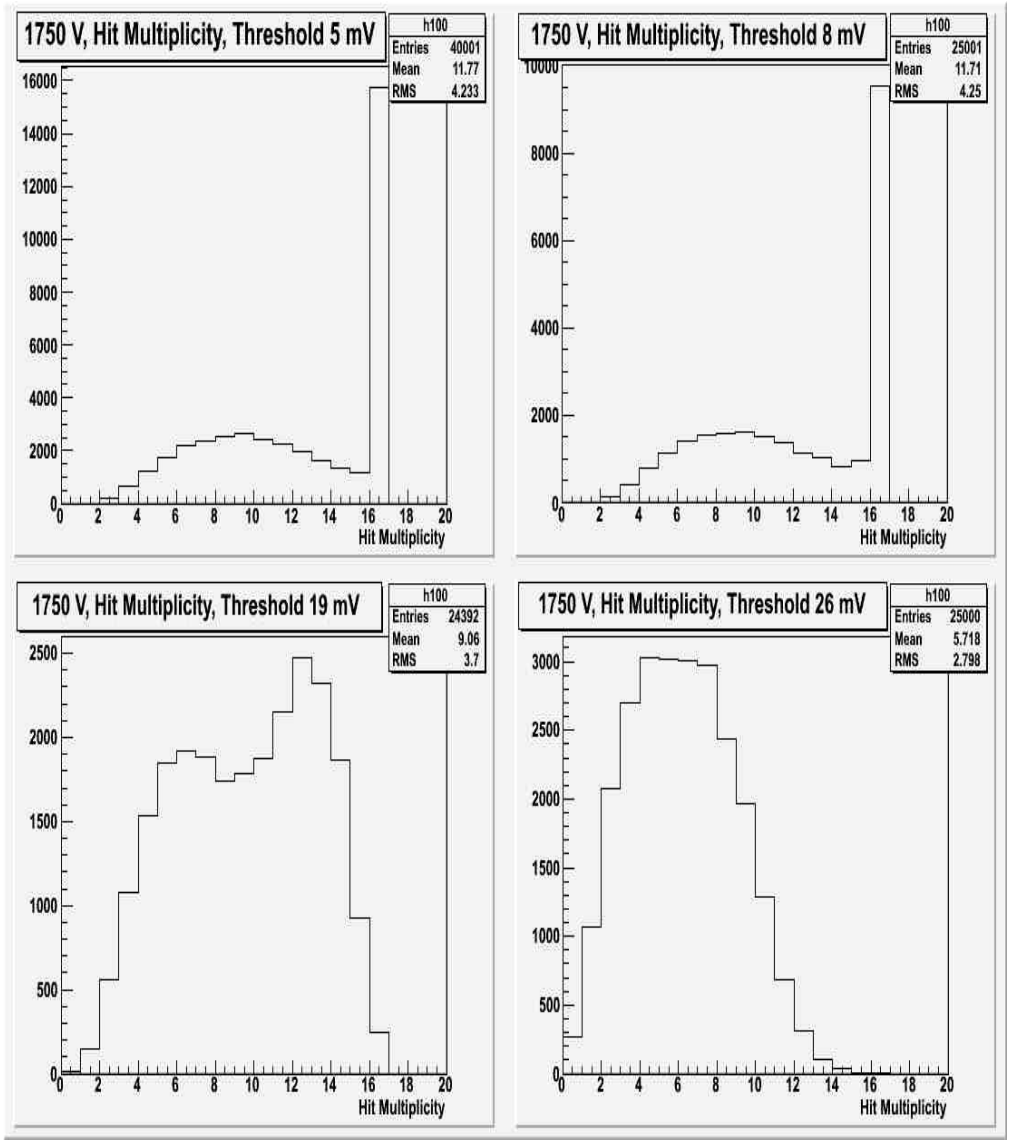
Drift-time spectra →
track length

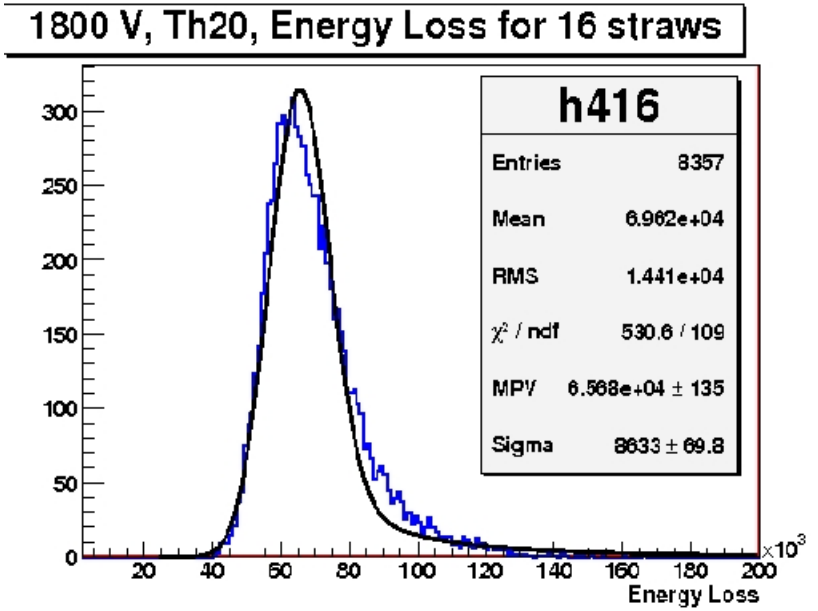
Test of Time-over-Threshold

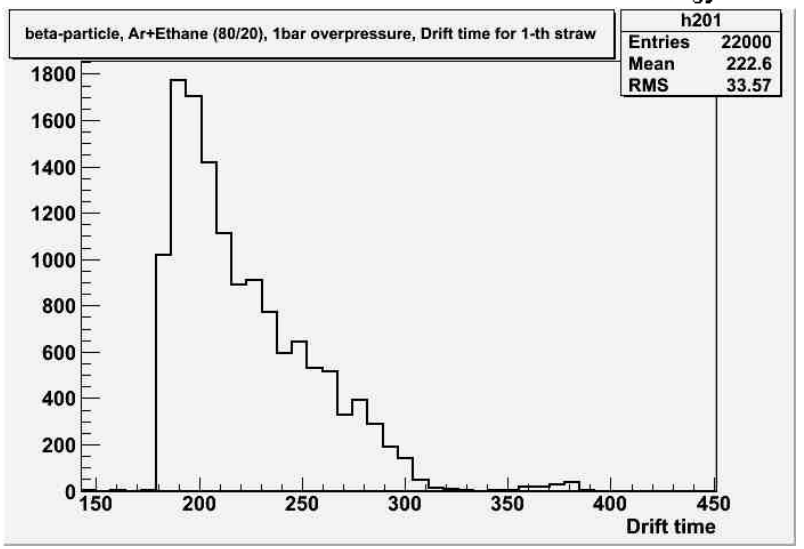
Noise level : 4 mV (RMS)
15 mV (max)

Number of cluster – not possible

RESULTS


1750 V, Hit Multiplicity, Threshold 5 mV
h100
Entries 40001
Mean 11.77
RMS 4.233
Hit Multiplicity
1750 V, Hit Multiplicity, Threshold 8 mV
h100
Entries 25001
Mean 11.71
RMS 4.25
Hit Multiplicity
1750 V, Hit Multiplicity, Threshold 19 mV
h100
Entries 24392
Mean 9.06
RMS 3.7
Hit Multiplicity
1750 V, Hit Multiplicity, Threshold 26 mV
h100
Entries 25000
Mean 5.718
RMS 2.798
Hit Multiplicity

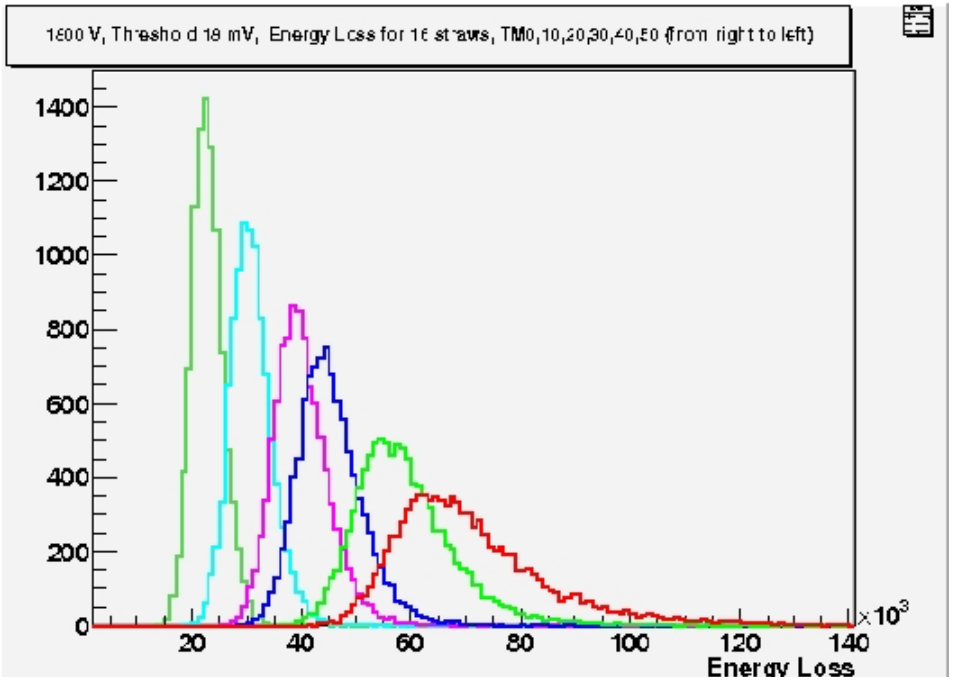

1800 V, Th20, Energy Loss for 16 straws
h416
Entries 8357
Mean 6.962e+04
RMS 1.441e+04
χ² / ndf 530.6 / 109
MPV 6.568e+04 ± 135
Sigma 8633 ± 69.8
×10³
Energy Loss

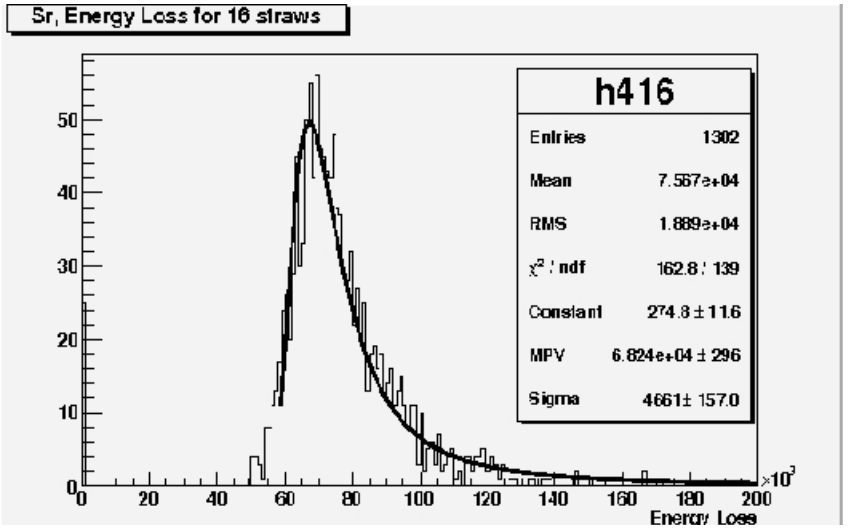

beta-particle, Ar+Ethane (80/20), 1bar overpressure, Drift time for 1-th straw
h201
Entries 22000
Mean 222.6
RMS 33.57
Drift time

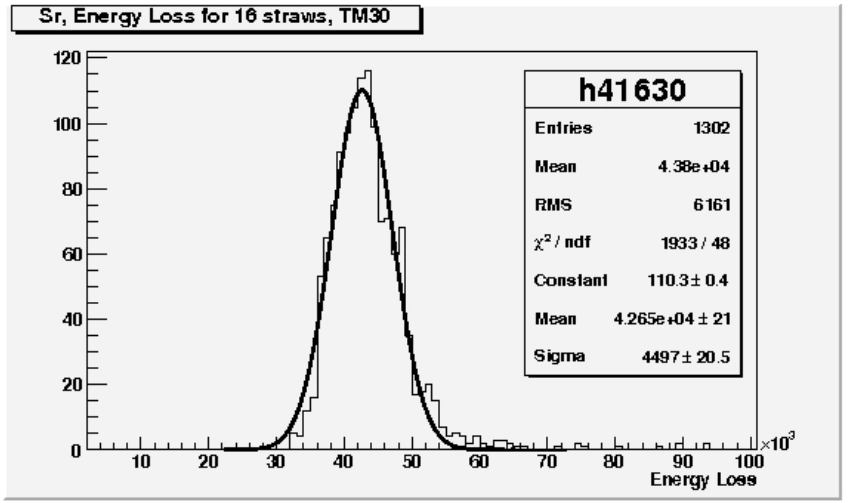
TRUNCATION MEAN

Aim: cutting of a high energy tail from the energy-loss distribution

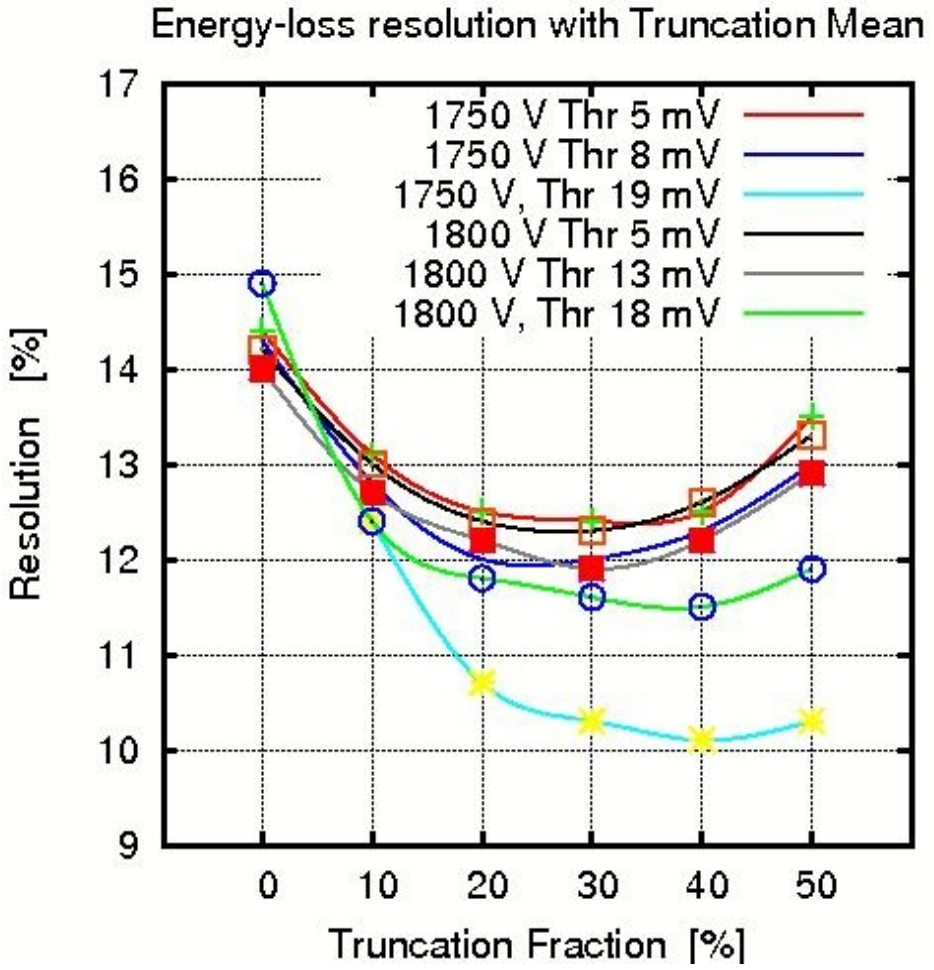
Done by rejecting of the fixed fraction of highest energy contributions i.e. individual straw signals, for each reconstructed track.







TRUNCATION MEAN - RESULTS



Resolution: here σ/mean

Noise level – important factor, has to be kept low due to energy-loss resolution as well as for good efiiciency

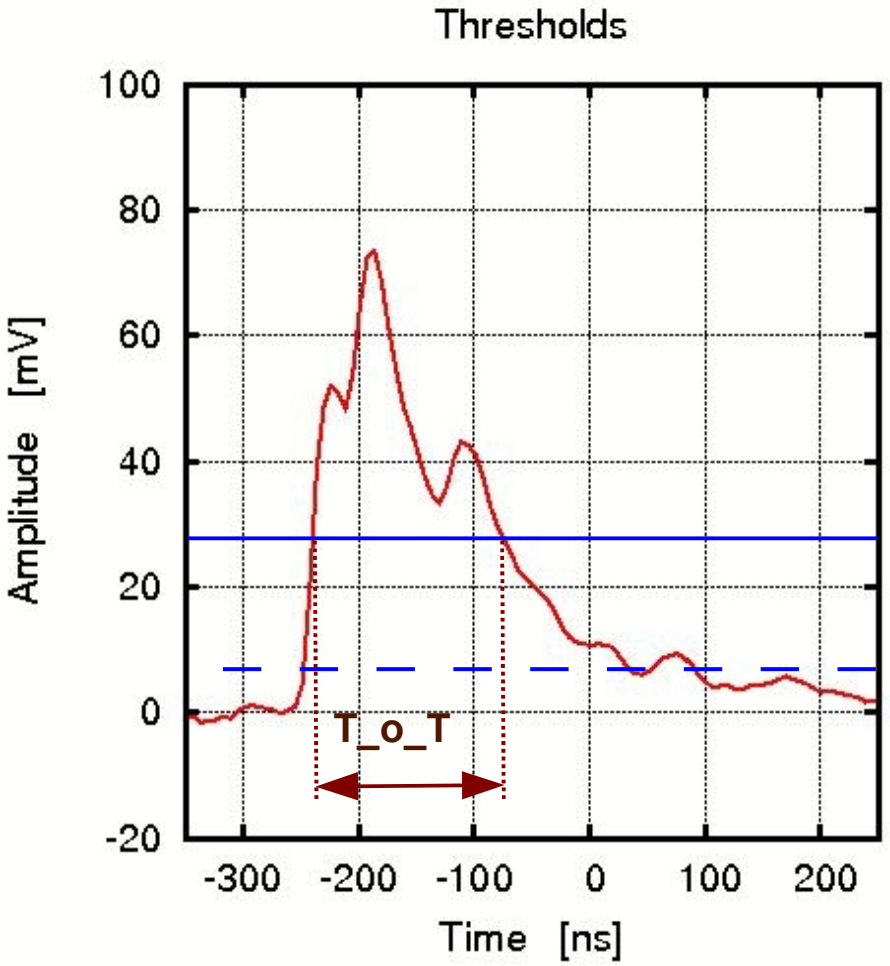
Possibilities of further improvement:

- calibration of the straws and readout,

- path-length correction,

- noise level reduction.

TIME OVER THRESHOLD



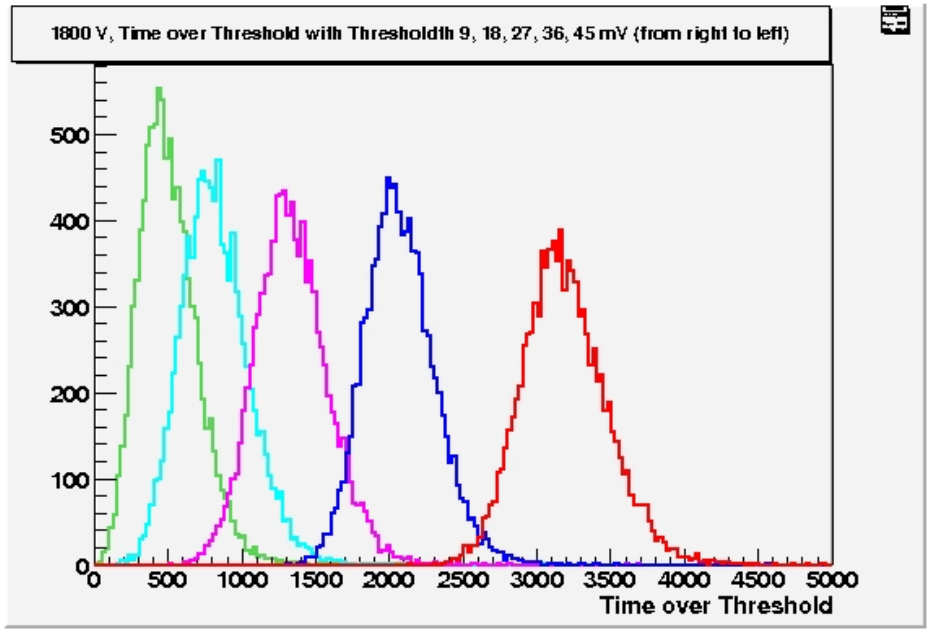
Attractive ! **(if works ??)**

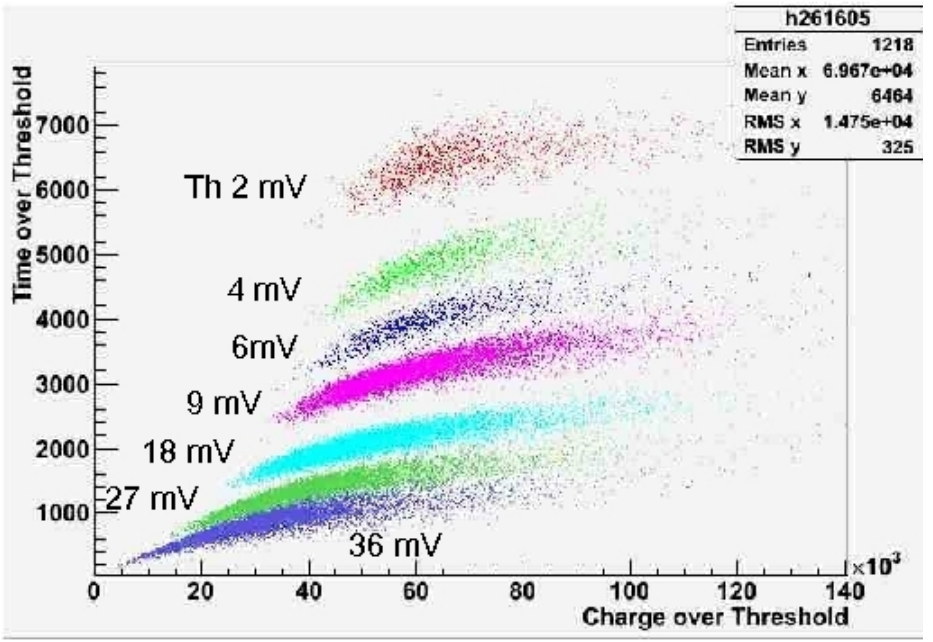
- can be applied "online"

- needs only timing electronics

In order to assure sufficient dependence of T_o_T to the charge inside T_o_T window most likely a signal preshaping is needed.

TIME OVER THRESHOLD - RESULTS

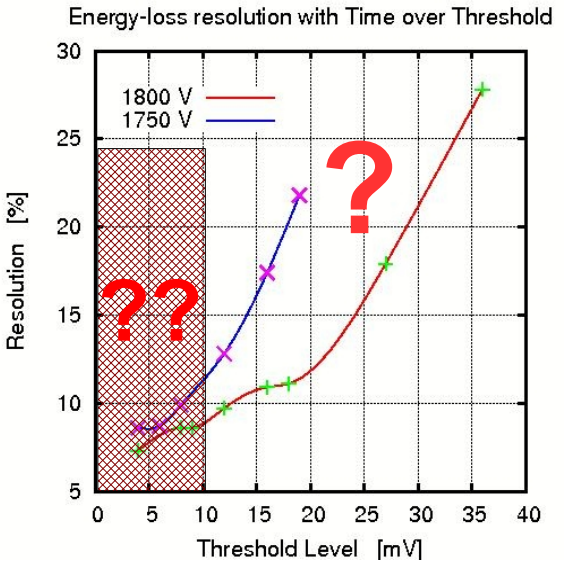




With no preshaping:

- **σ/mean rapidly gets worse with increasing the threshold**
- **but with low threshold**
  - **only week dependence on the charge**
  - **dominance of the signal tail**
  - **contamination with noise**

RESULTS VERY DOUBTFUL !



CONCLUSIONS

Test done with:
- **16 straws filled with Ar-Ethane (8/2) at overpressure of 1 bar,**
- **minimum ionizing beta-particles,**
- **16-ch 160 MHz flash QDC for signals readout and record.**

Truncation Mean method applied:
- **10 % resolution (sigma/mean) achieved,**
- **TM 40% seems to be optimal,**
- **there is space for further improvement (calibration, path length correction),**
- **low noise level - very important.**

Time over Threshold:
- **applicability tested,**
- **results very doubtful,**
- **further studies with signal preshaping needed.**

Drift time spectra recorded: opens possibility for path length correction.

Cluster counting not feasible with present electronics.

OUTLOOK

Dedicated 240 MHz f-QDC (4.17 ns sampl.) is foreseen soon:

- signals record without unfavorable shaping (for Truncation Mean),
- application of signals preshaping for Time over Threshold,
- aplication of path length corection,
- data taking with whole setup (128 straws) → track reconstruction (Susana)

Readout electronics development - test of applicability of MSGCROC-type ASIC

When electronics ready → beam test with fixed energies of particles (protons at COSY)

MSGCROC

- Chip developed for Micro-Strip Gas Chambers
- 32 channels with variable gain
- Positive and negative input signals
- Channel-wise self triggering
- 2 ns digital time stamps
- Analogue energy (amplitude) readout
- Rate up to 900 kHz per channel

- design of dedicated PCB for one chip is ready, prototype production

- HV-decoupling board almost ready

- "slow control" is available (supplied by Zentral Elektronk Labor FZJ)

Supported by Zentral Elektronik Labor FZJ (G. Kemmerling)
IKP Electronics Workshop (R. Nellen)