Measurement of dE/dx with the use of Straw Tubes

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In collaboration with:

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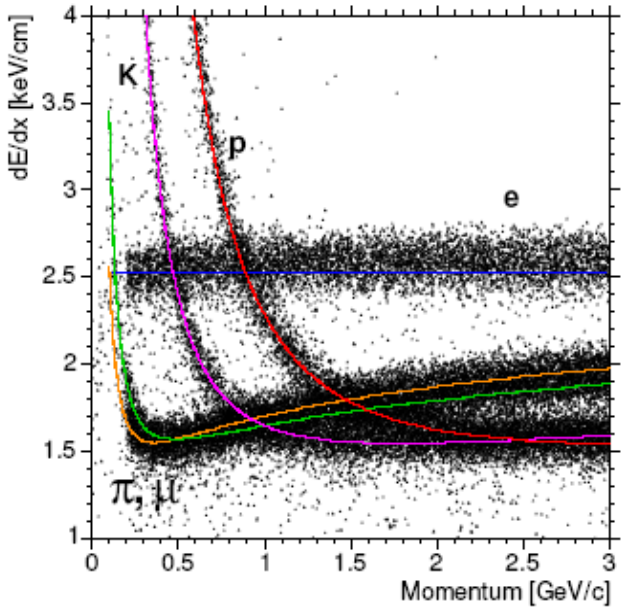
AIMS

Enhancement of the applicability of discrete gaseous trackers (e.g. Straw Tube Tracker) by measurement of particles energy losses and construction of dE/dx(p) identification curves.



Difficulties:

1. Small "displacement" of the curves → energies (and momenta) must be measured precisely

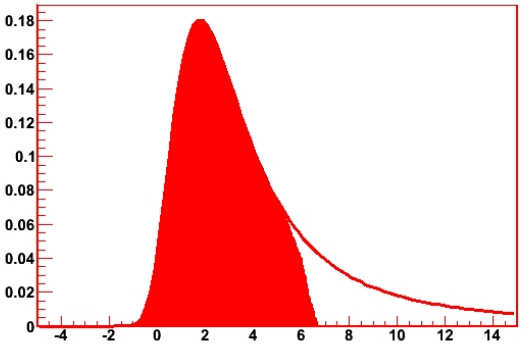
   But on the other side: energy loss is statistical process of the Landau distribution

2. Main task of SST is a precise determination of the tracks → fast response, short time signal

   On the other side: energy measurement requires longer charge collection time and signal processing

METHODS

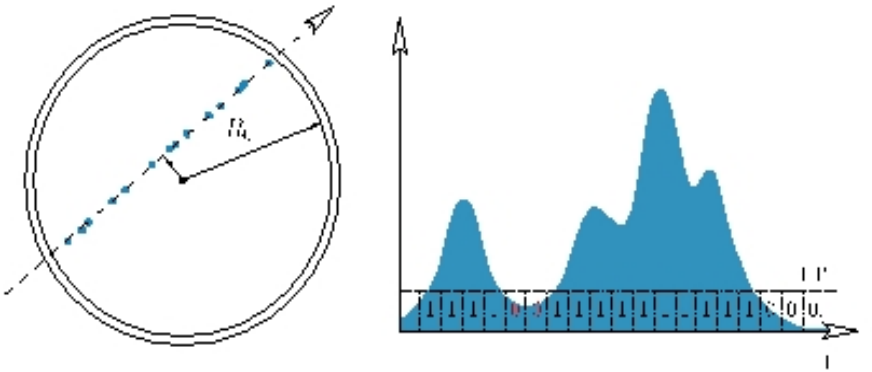
- Direct measurement of energy-loss (by collecting of the total output charge)



- Selective measurement of the energy-looses with rejection of the high energy events (truncation method)

- Counting of the numbers of created ionization clusters

- Deducing of the energy-losses from the timing signals – Time over Threshold



For all methods accurate determination of the actual path length in each straw is needed, as well as a uniform gain calibration of all channels.

PURPOSES OF THE PRESENT WORK

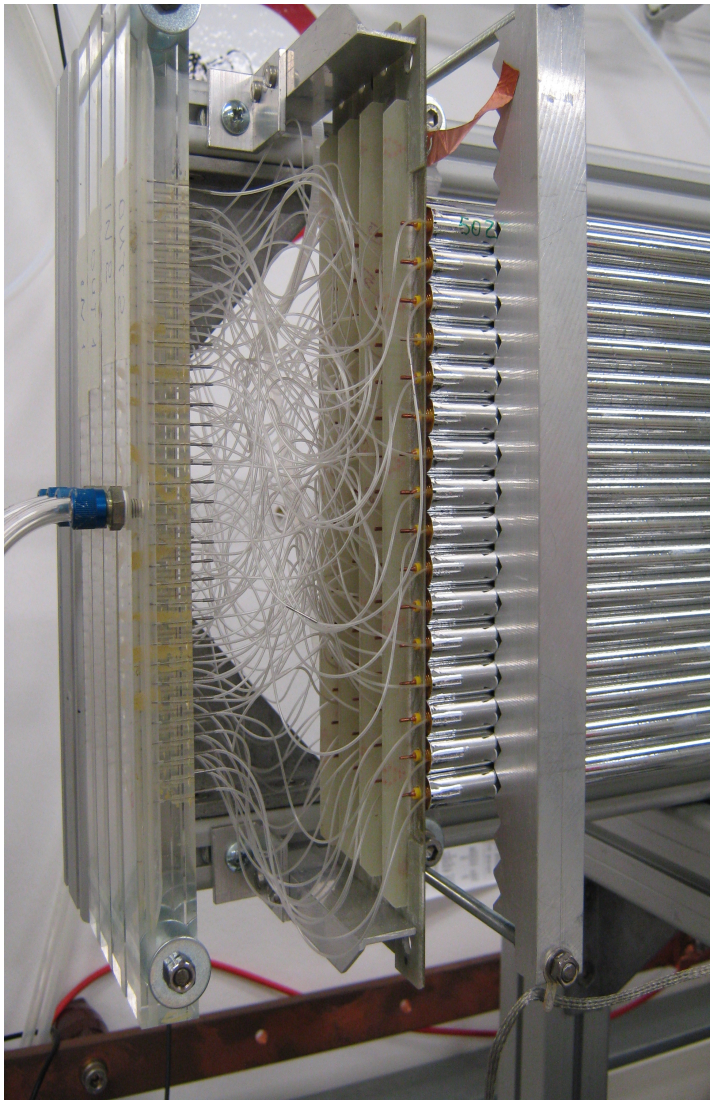
Experimental check of the achievable energy resolution for straw detector planned as a PANDA STT:

→ delivering of experimental distributions for simulation of the "separation power"

→ hints for optimal selection of the final read-out electronic for STT

→ knowledge about most suitable "environmental" conditions (coupling, noise suppression, pressure stability …)

SETUP



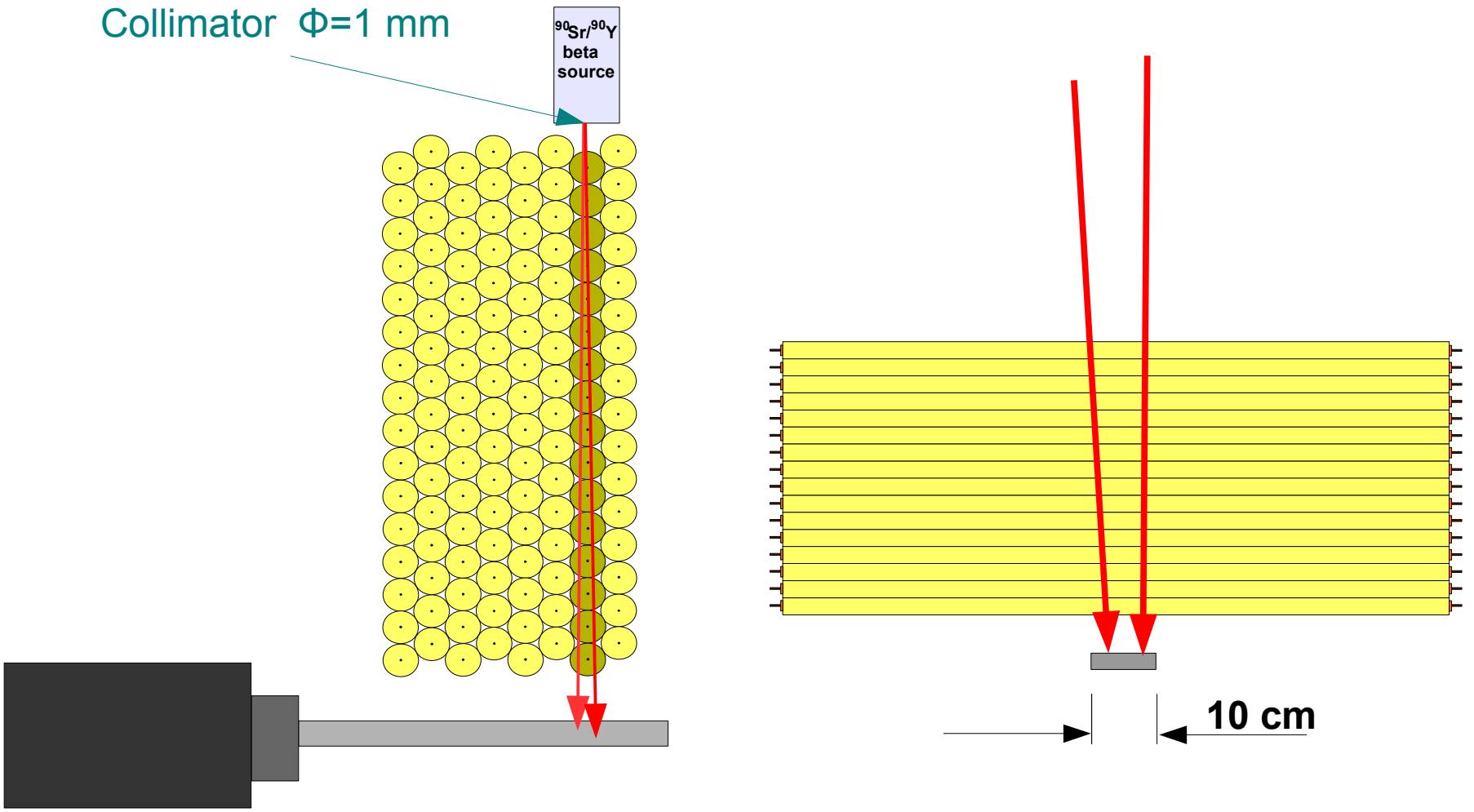
4 x (16 x 2) = 128 straws

(4 self-supporting double layers, 16 tubes each)

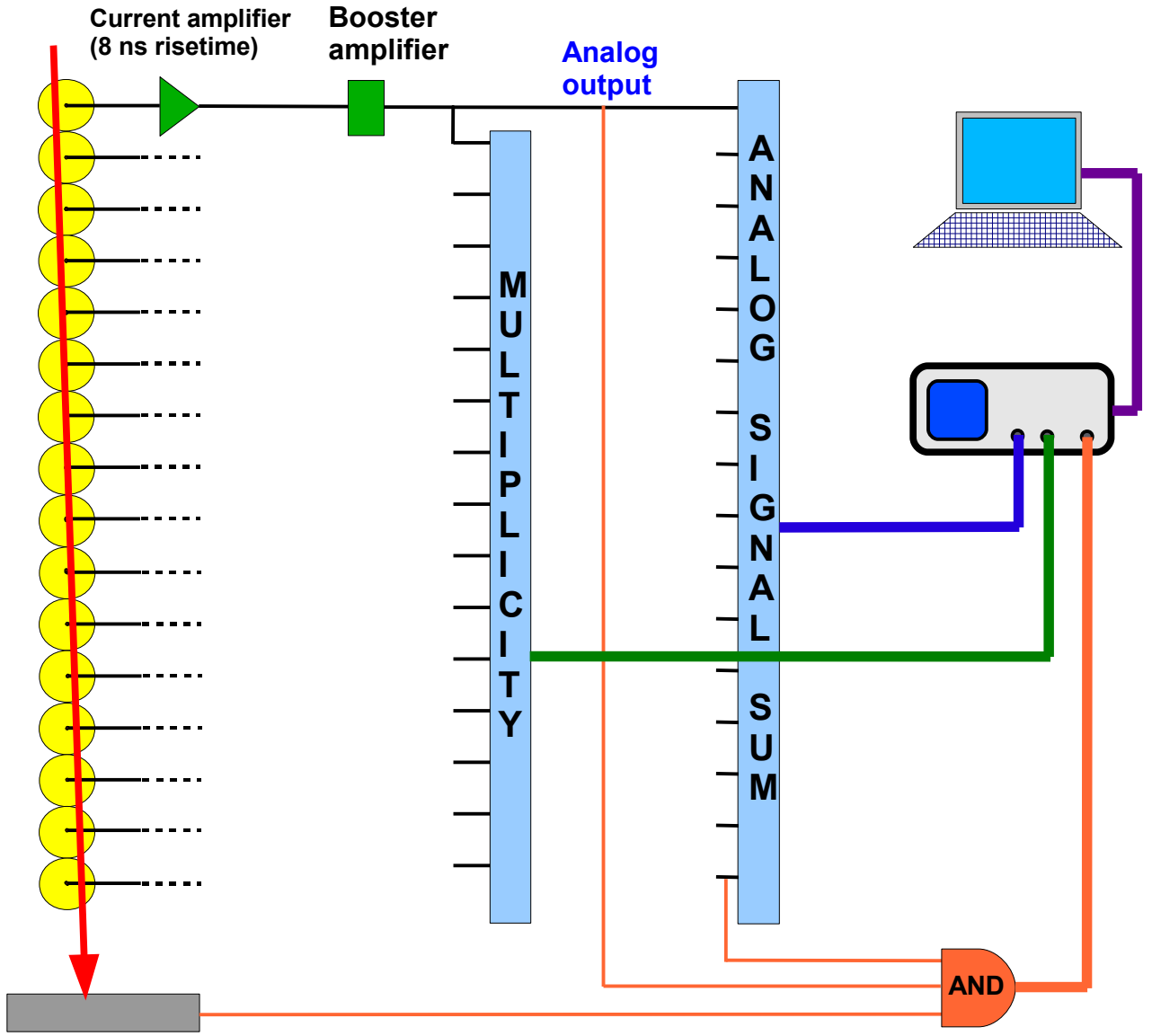
- 1.5 m long
- Φ 10 mm
- 30 μm wall thickness
- 20 μm anode wire
- operated at overpressure (1 bar)
- mixtures: Ar/CO2 (90/10), Ar/C2H6 (80/20)

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

METHOD OF MEASUREMENT

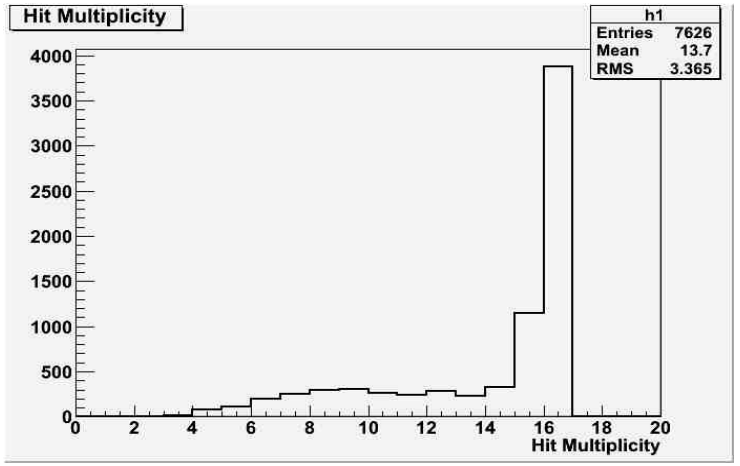


METHOD OF MEASUREMENT

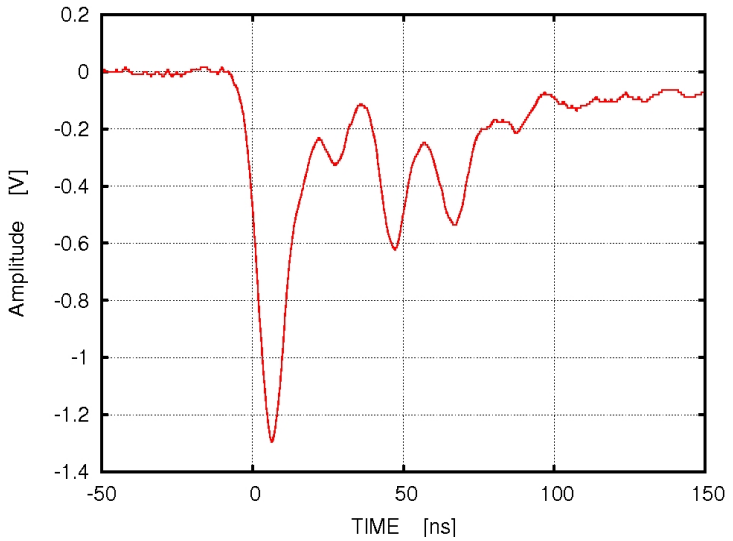


RESULTS

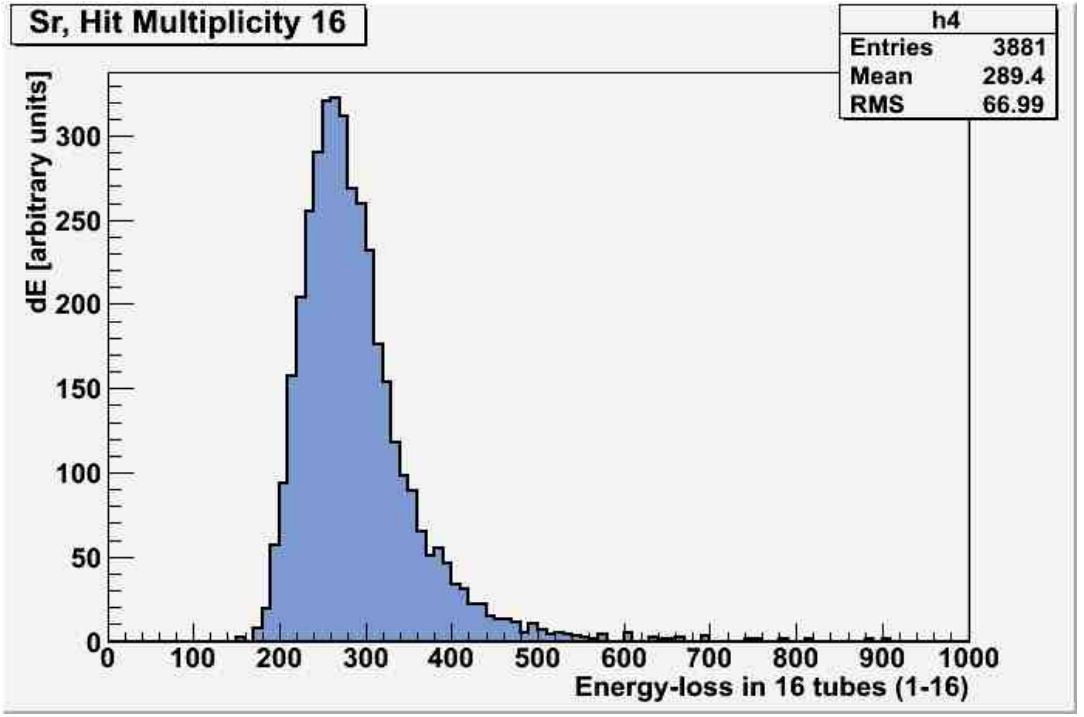
Straw multiplicity



Signal shape



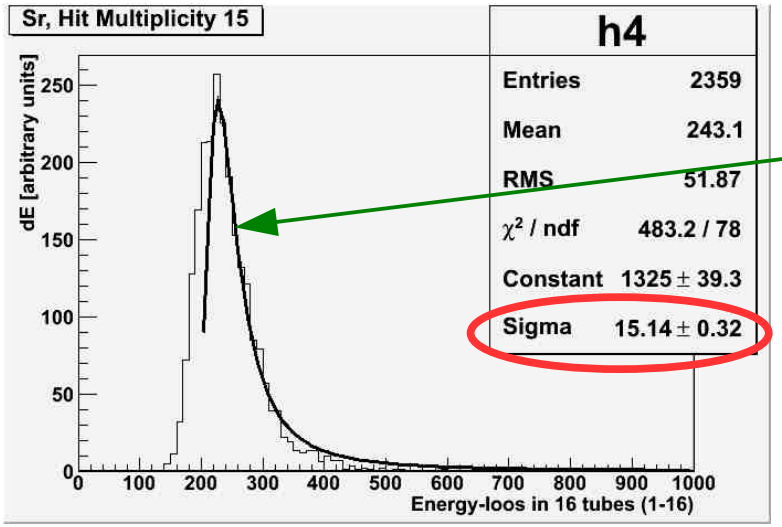
Total charge – energy-loss distribution



Raw distributions – no calibration,
no any corrections for path length,
particle energy spread,
gas stability, energy straggling, ...

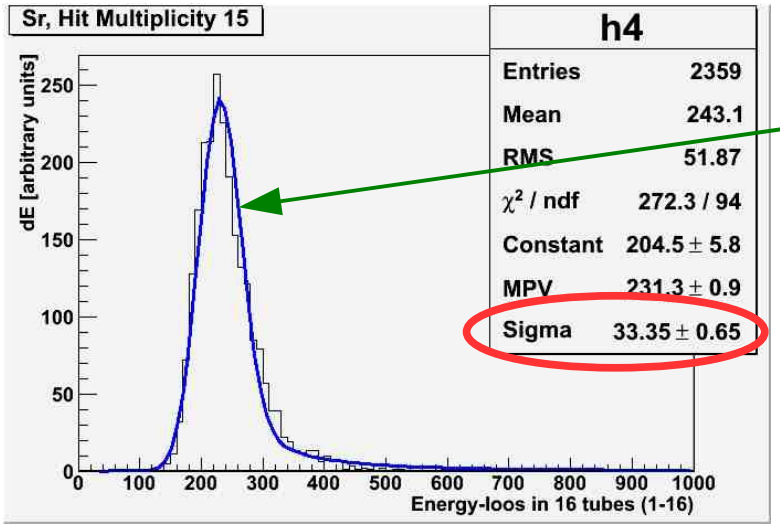
RESULTS

Argon + Carbon Dioxide (90/10)



Landau only

7 %

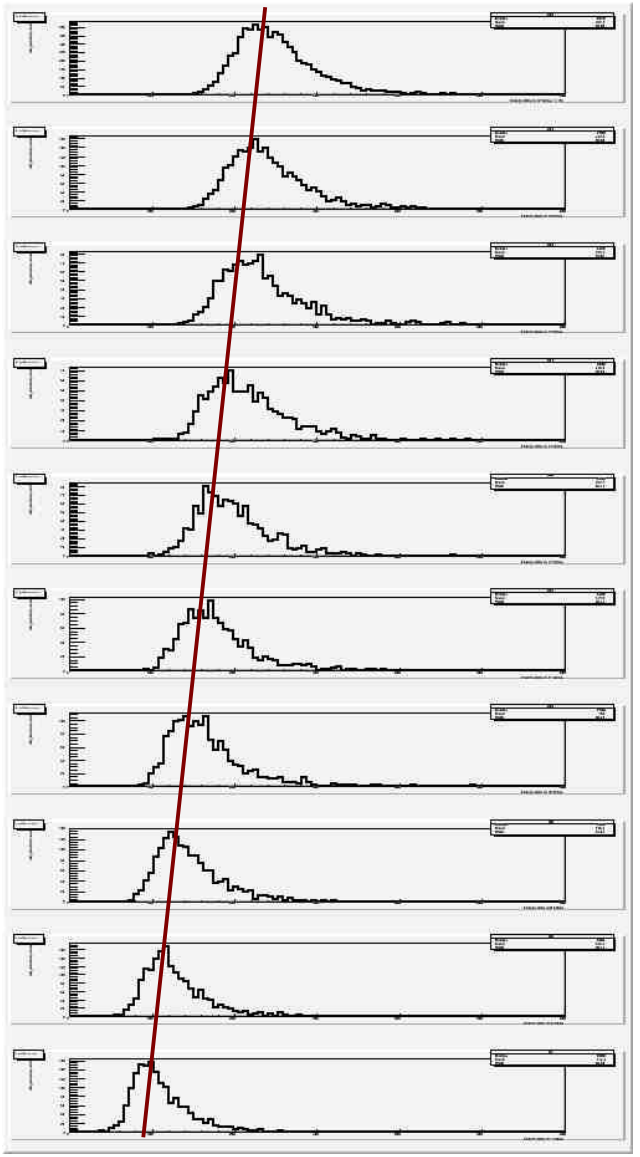


Landau + Gauss

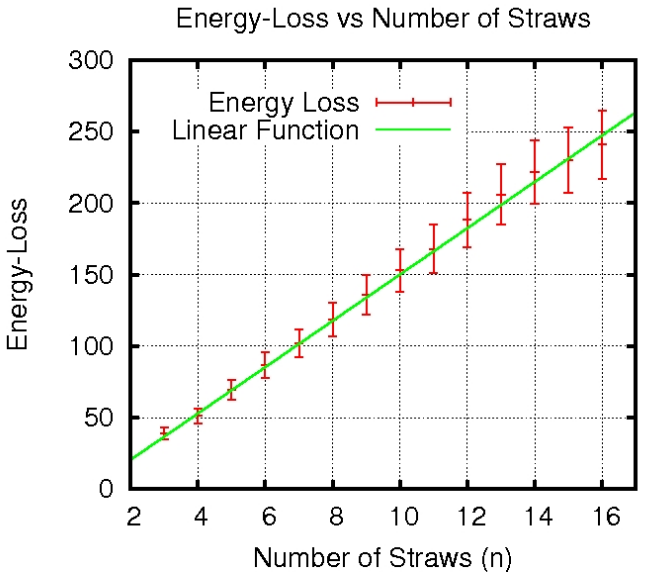
15 %

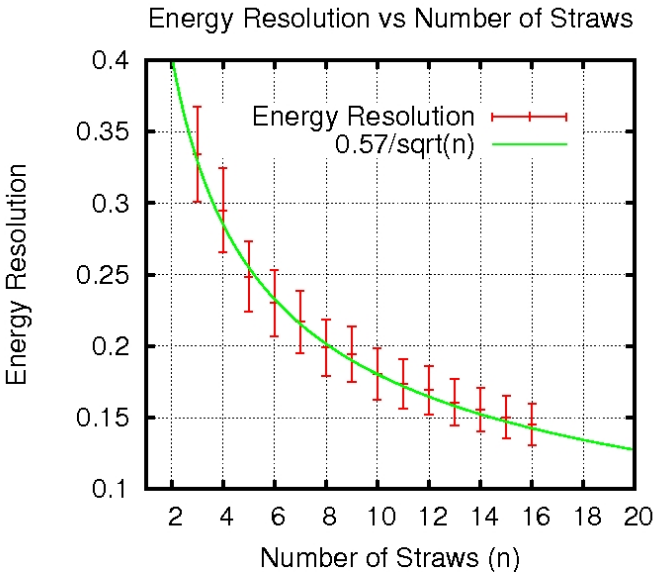
RESULTS

16 straws



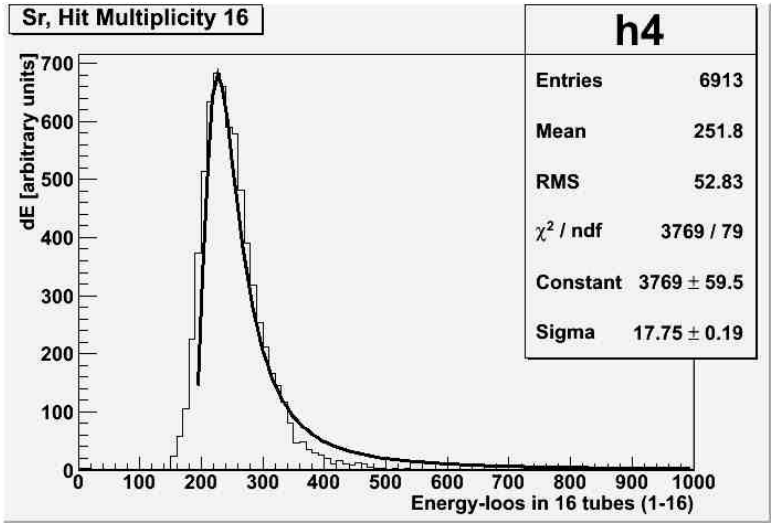
7 straws

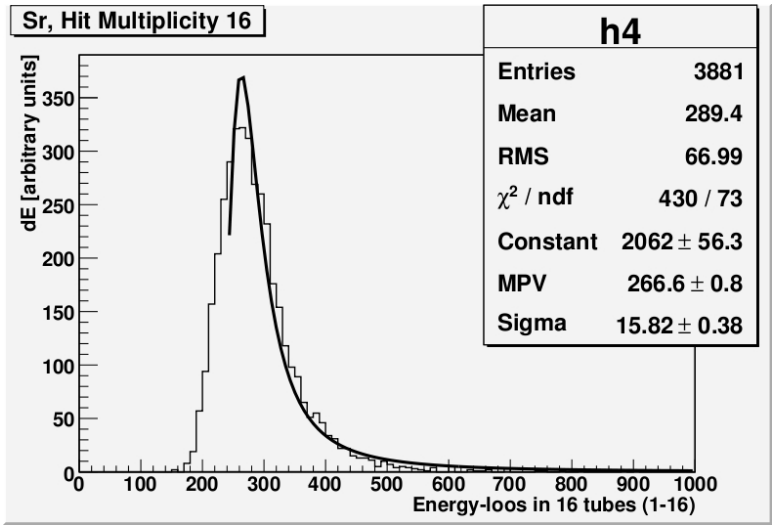




RESULTS

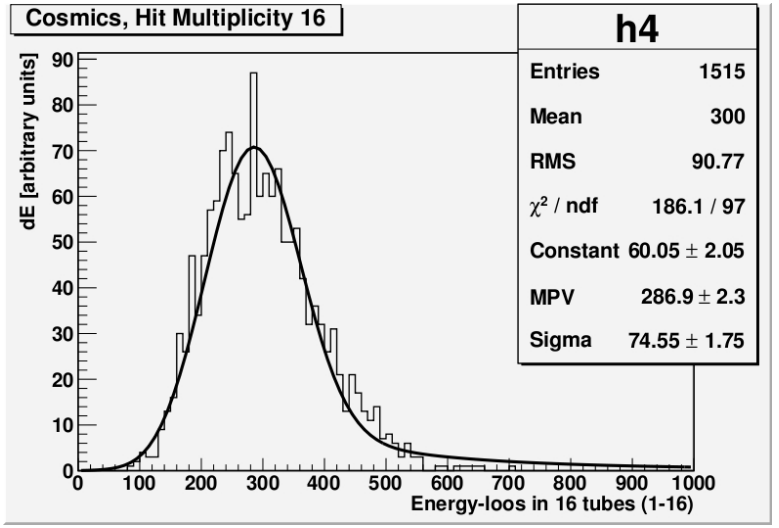
beta-particles

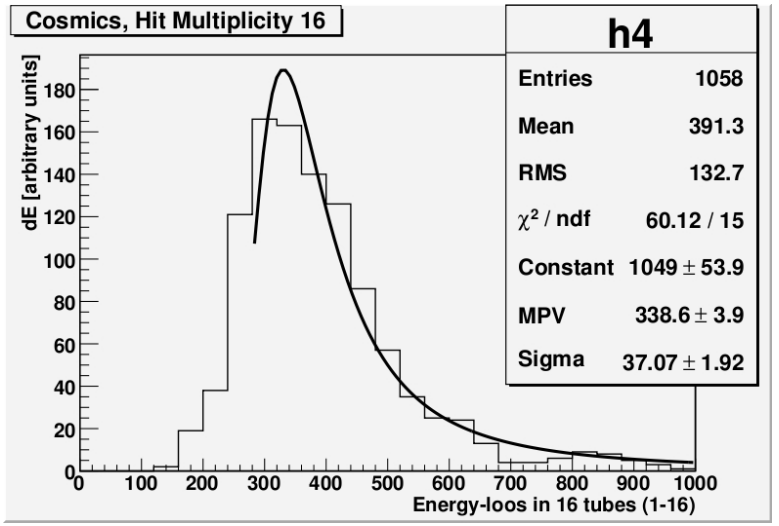




FWHM: ~ 30 %

cosmics





FWHM: ~ 55 %

Argon + Carbon Dioxide (90/10)

Argon + Ethane (80/20)

SUMMARY and OUTLOOK

Energy loss of minimum-ionizing beta-particles from 90(Sr/Y) source was measured in the set of 16 straws at the overpressure of 1 bar;

ΔE/E ~ 30 % (FWHM) for both tested gas mixtures – Ar+C2H6 (80/20) and Ar+CO2 (90/10). Contribution of undesirable components in energy distributions is visible. They should be significantly suppressed with the use of more sophisticated data treatment.

Measurements with the use of DAQ allowing for individual signal recording, track reconstruction (path correction) is foreseen;

Experimental test of "identification power" of various energy estimation methods: truncation, cluster-counting, time-over-threshold will be possible and performed;

Selection of the most optimal front-end-electronics - it seems that n-XYTER may be suitable device for STT working as energy detector (a piece for tests is needed);

In future a test at the beam is indispensable. Possibility are at COSY (TOF, GEM ?) or at CERN;

Feedback from "simulations" is needed.

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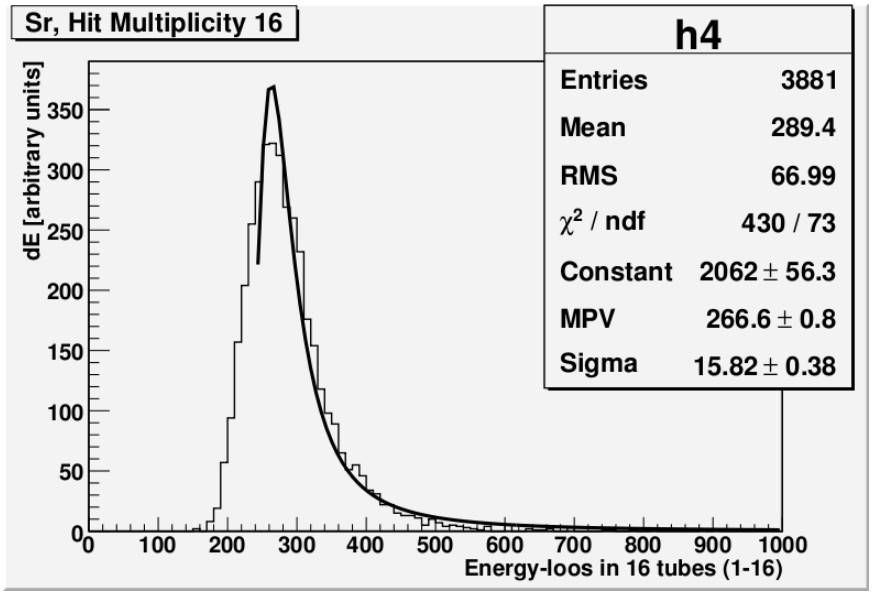
THANK YOU !

RESULTS

Argon + Ethane (80/20)

beta-particles



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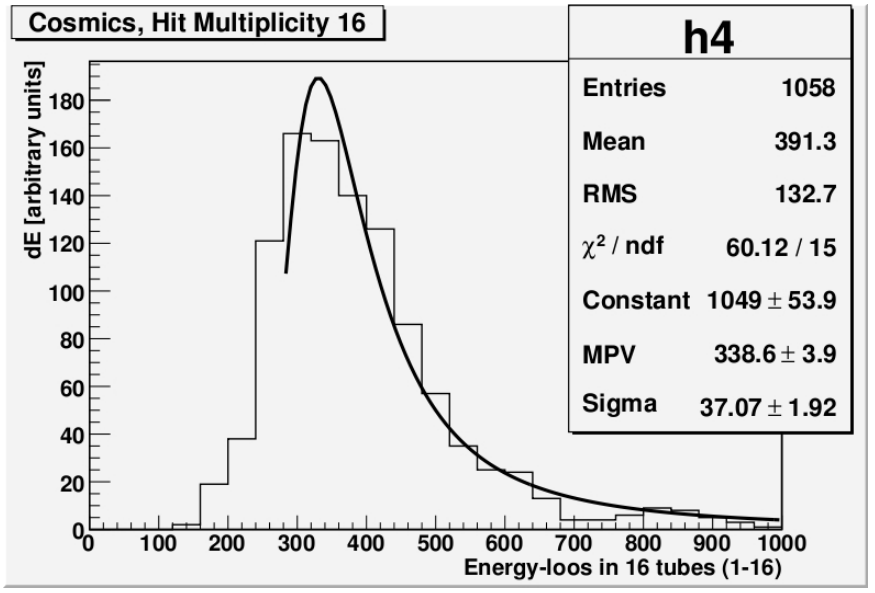

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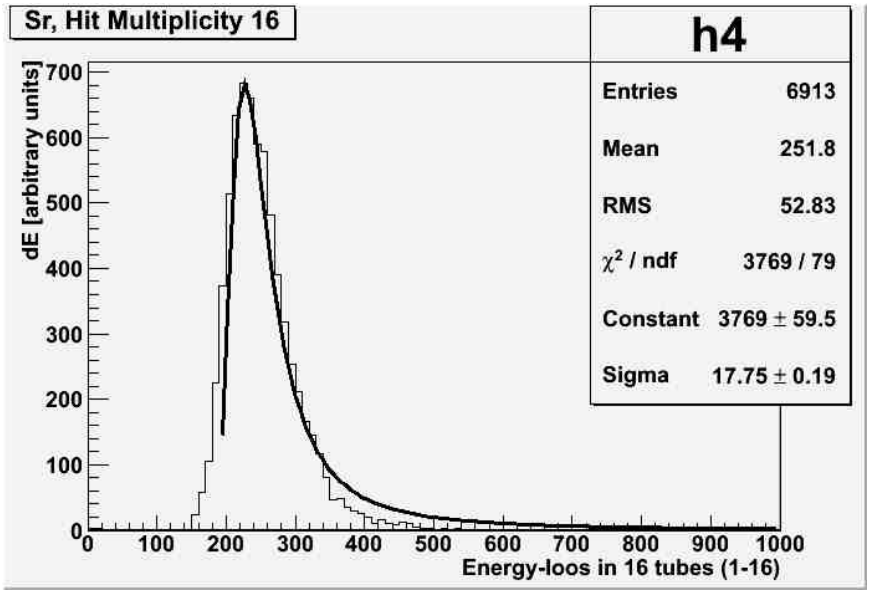

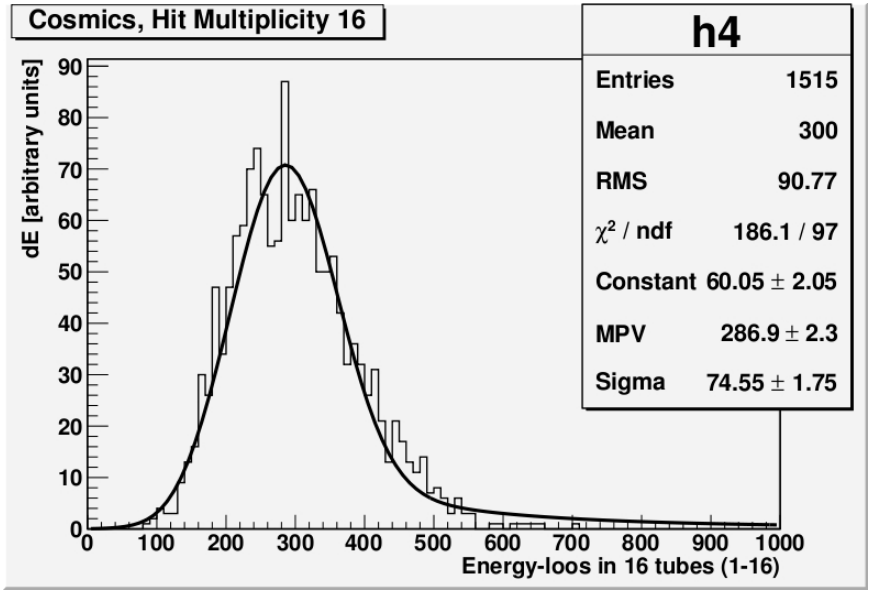

RESULTS

Argon + Ethane (80/20)

One straw only

beta-particles