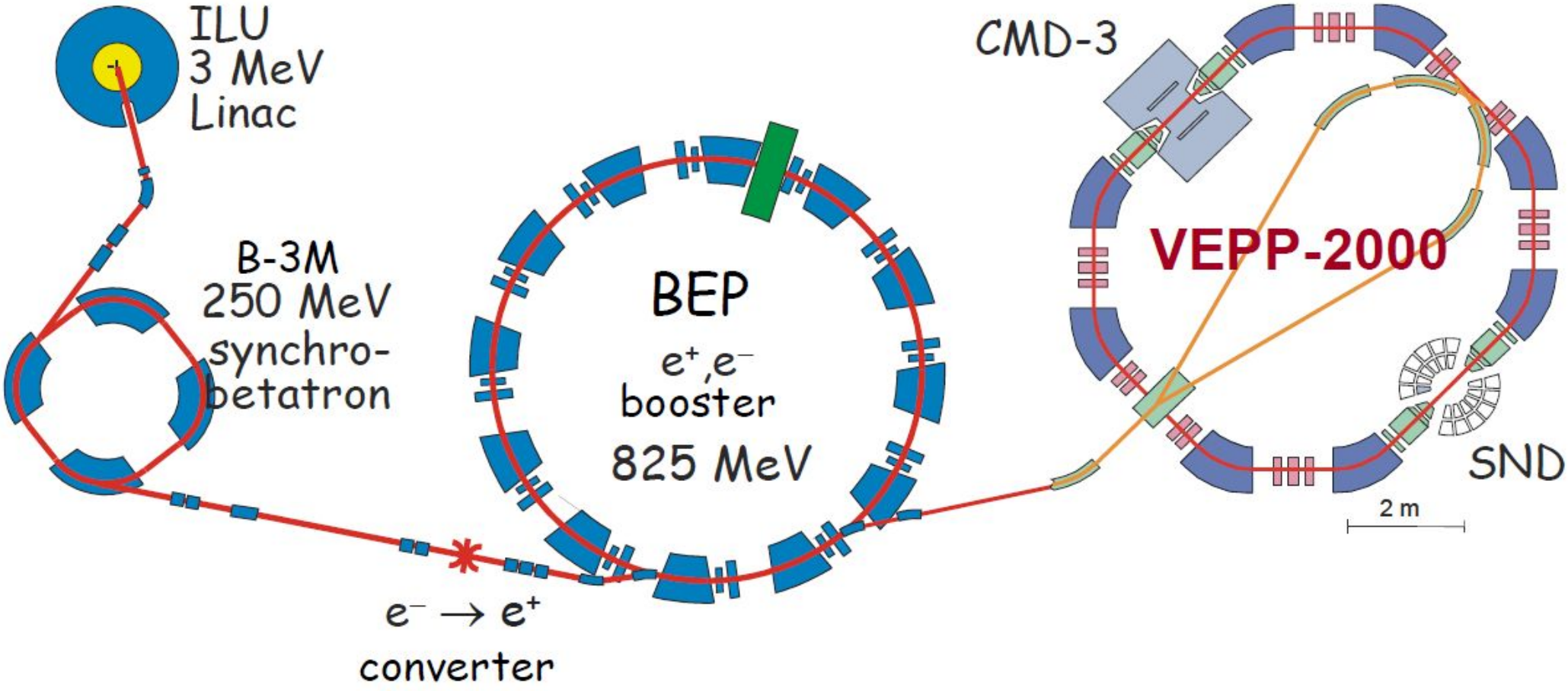
Tracking system of CMD-3 detector and kaon identification

Dmitry Shemyakin
(on behalf of the CMD-3 Collaboration)
Budker INP SB RAS and Novosibirsk State University, Novosibirsk

CERN-BINP workshop for young scientists in e+e- colliders
23 August 2016

VEPP-2000

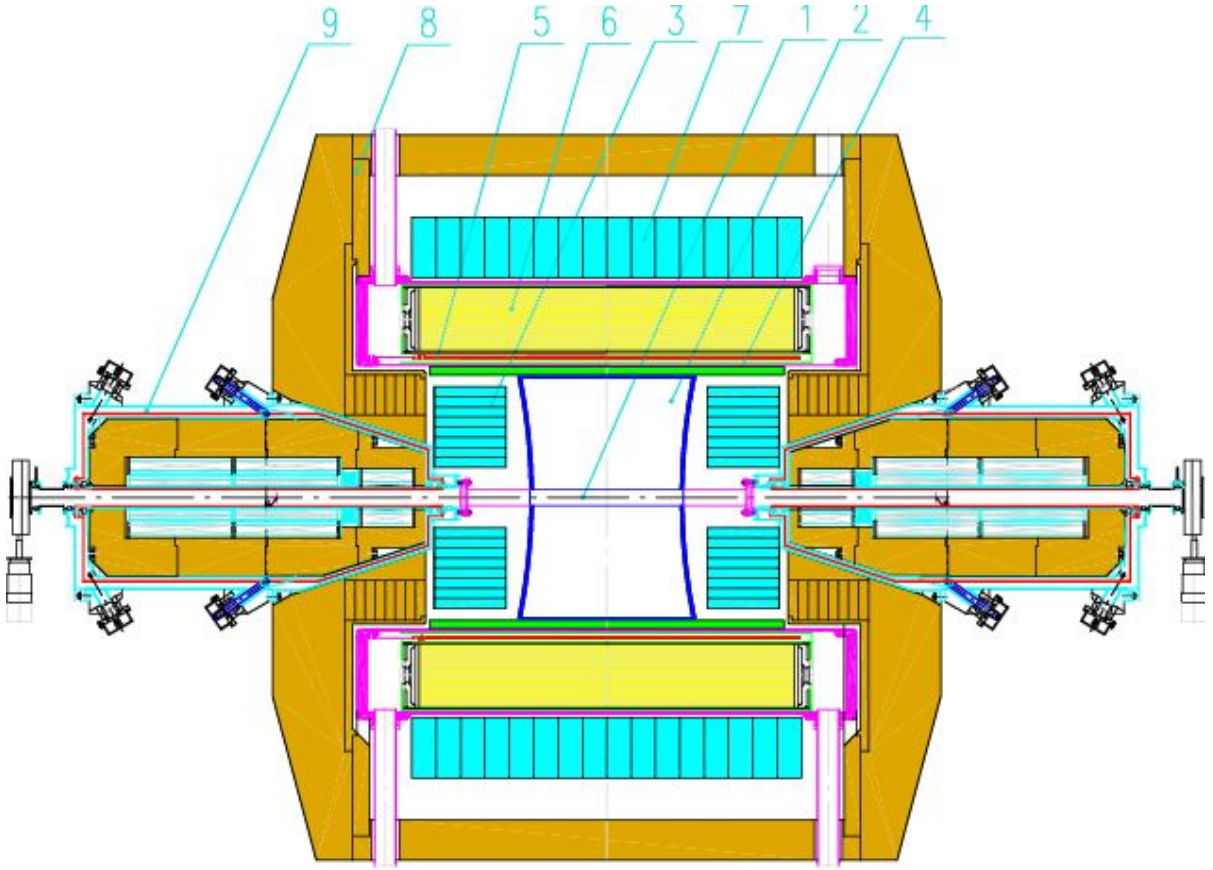


Maximum c.m. energy is 2 GeV, design luminosity is $L = 10^{32} 1/cm^2 s$ at $\sqrt{s} = 2$ GeV

Unique optics, "round beams", allows to reach higher luminosity

Experiments with two detectors, CMD-3 and SND, started by the end of 2010

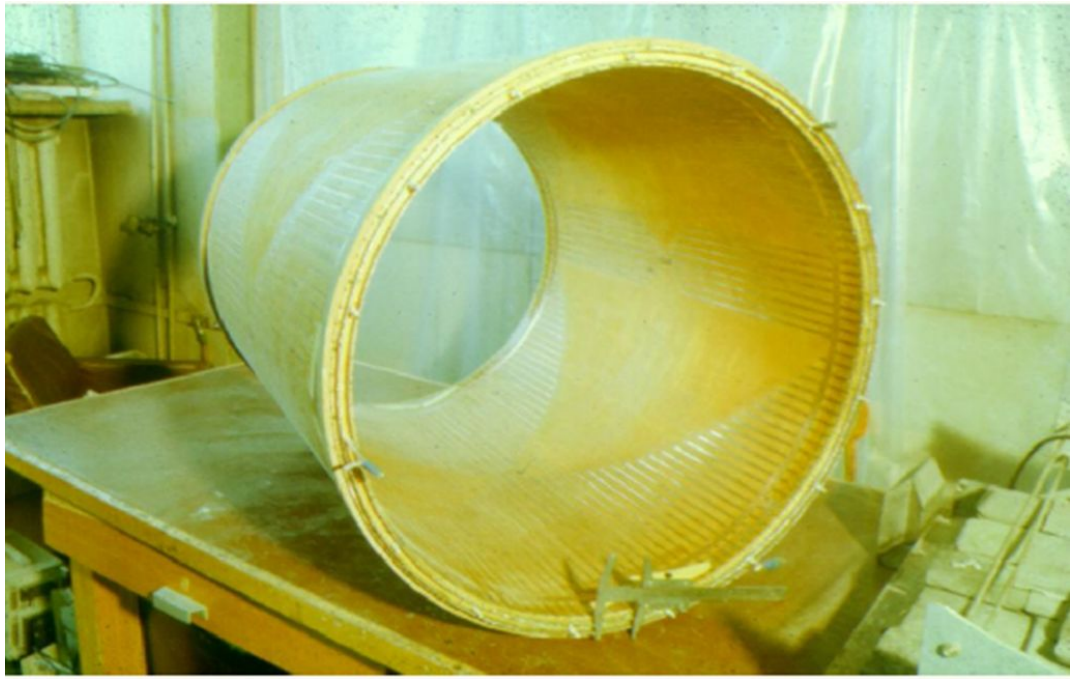
CMD-3 detector

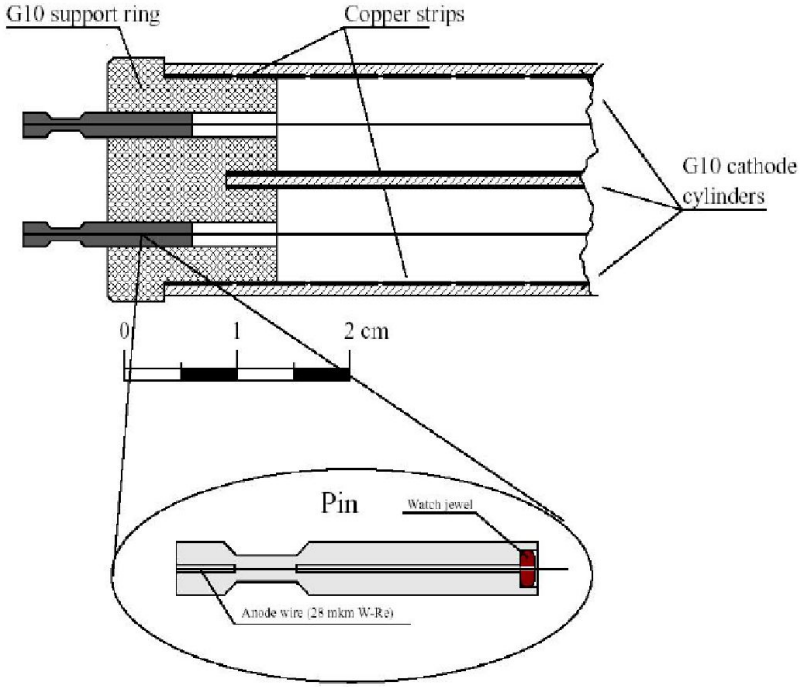


1 – beam pipe,
2 – drift chamber,
3 – electromagnetic BGO calorimeter,
4 – Z – chamber,
5 – CMD SC solenoid(1.3 Tl),
6 – electromagnetic LXe calorimeter,
7 – electromagnetic CsI calorimeter,
8 – yoke,
9 – VEPP-2000 solenoid,
(not shown) muon range system and TOF system

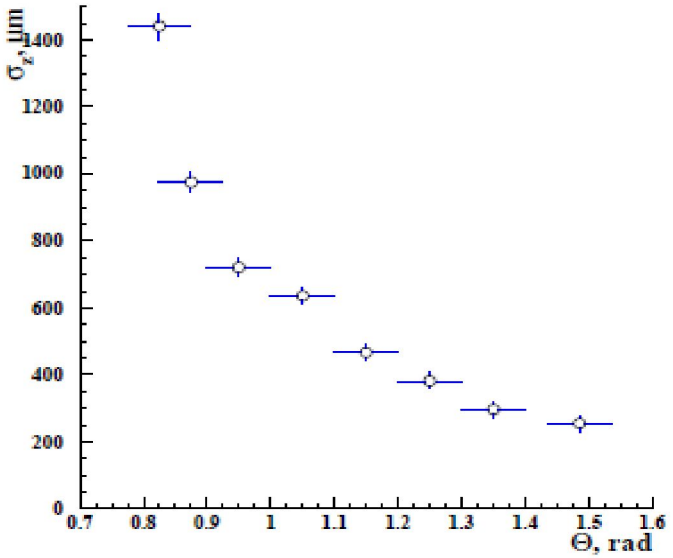
~ 64 pb^{-1} has been collected in the center-of-mass energy region from 0.3 to 2 GeV

Z–chamber

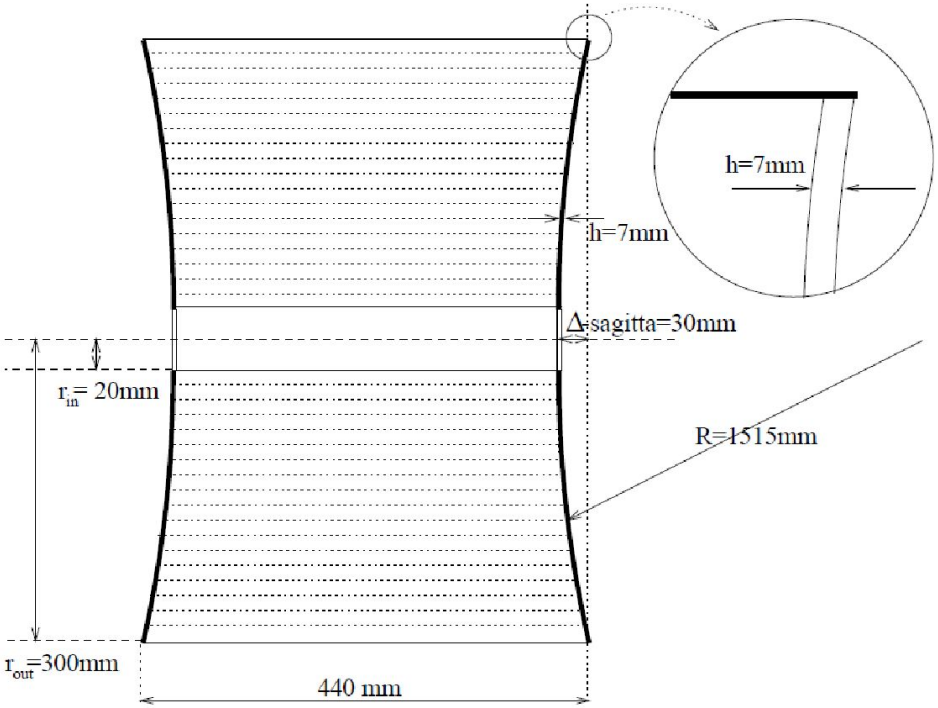


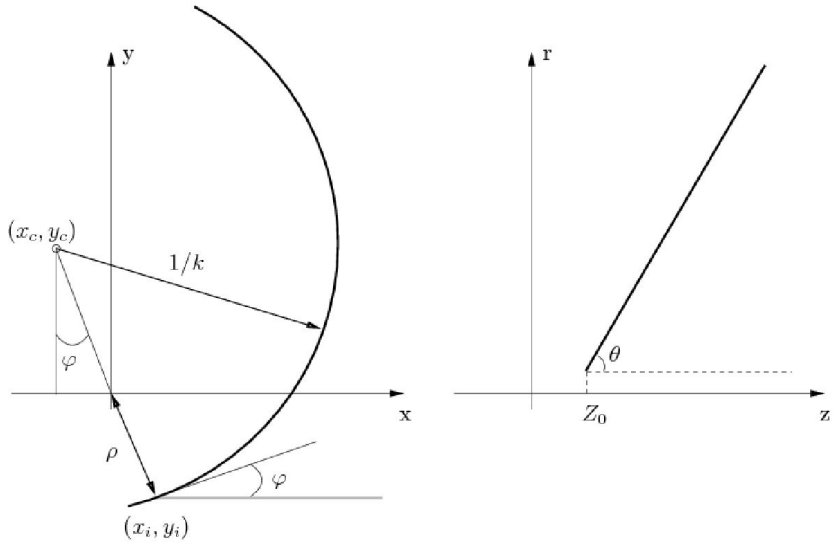


- 2 x 704 wires
- 2 x 24 sectors (ϕ measurement)
- 2 x 256 strips (Z measurement)
- Fr14: C_4H_{10} = 80:20
- σ_z = 600 μm
- σ_t = 4.5 ns



Drift chamber





1218 hexagon cells

Ar : C_4H_{10} = 80:20

orthogonal ~ 0.015 X_0

Z - plane ~ 0.05 X_0

σ_z = 2 – 3 mm

σ_ρ = 0.3 – 0.18 mm

σ_{t0} = 1 – 1.5 ns

τ_{drift} < 600 ns

σ_θ = 15 – 30 mrad

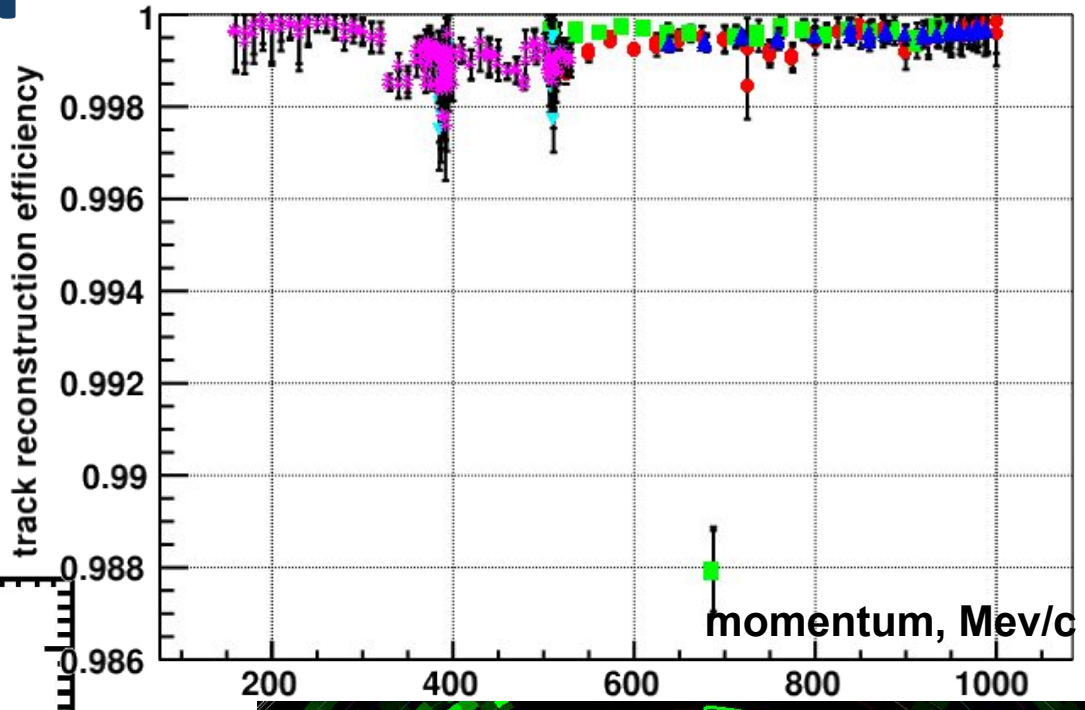
σ_ϕ = 9 – 3.5 mrad (0.2 – 1 GeV)

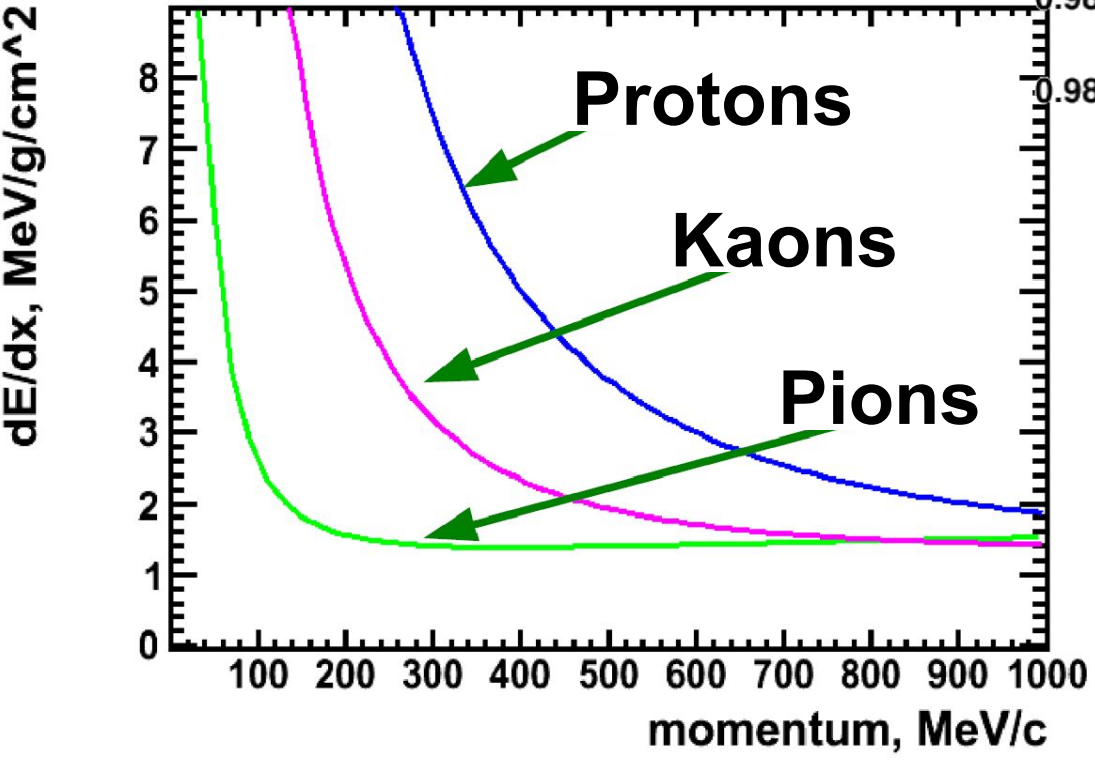
σ_p = 1.3 – 4.5 % (0.2 – 1 GeV)

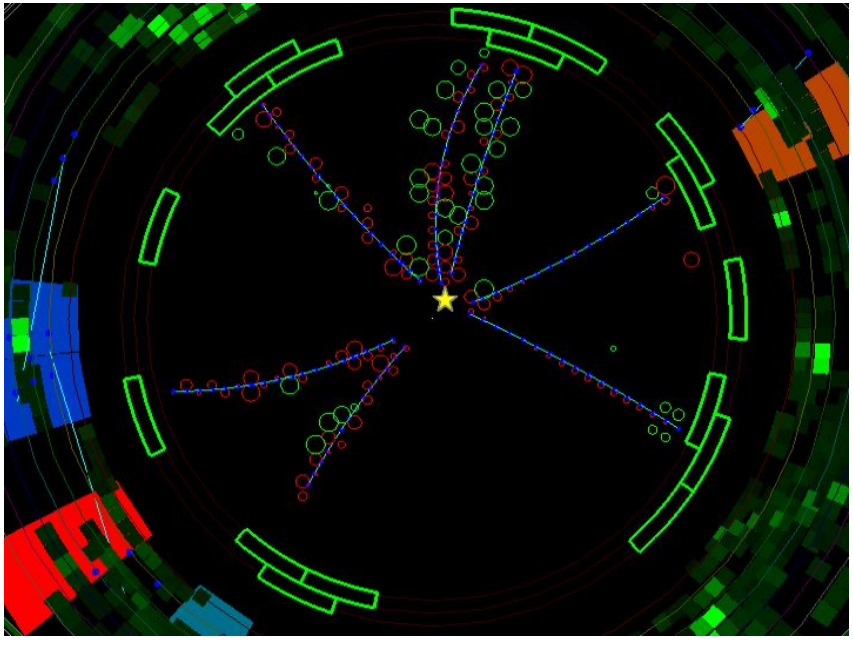
$\sigma_{dE/dx}$ = 10 – 13 %

Drift chamber

Track inefficiency 0.05-0.1%
(1<θ<π-1, Bhabha events)

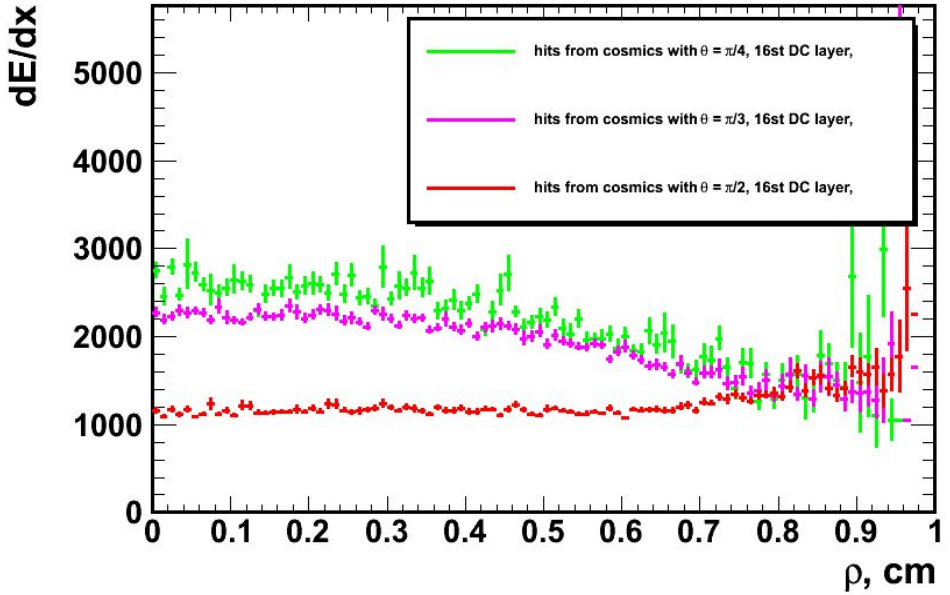


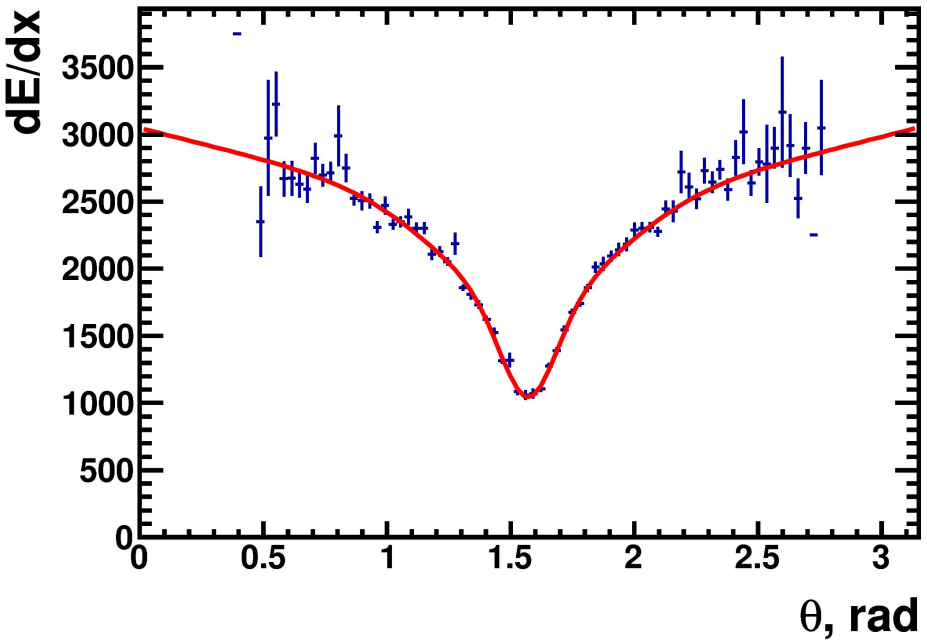


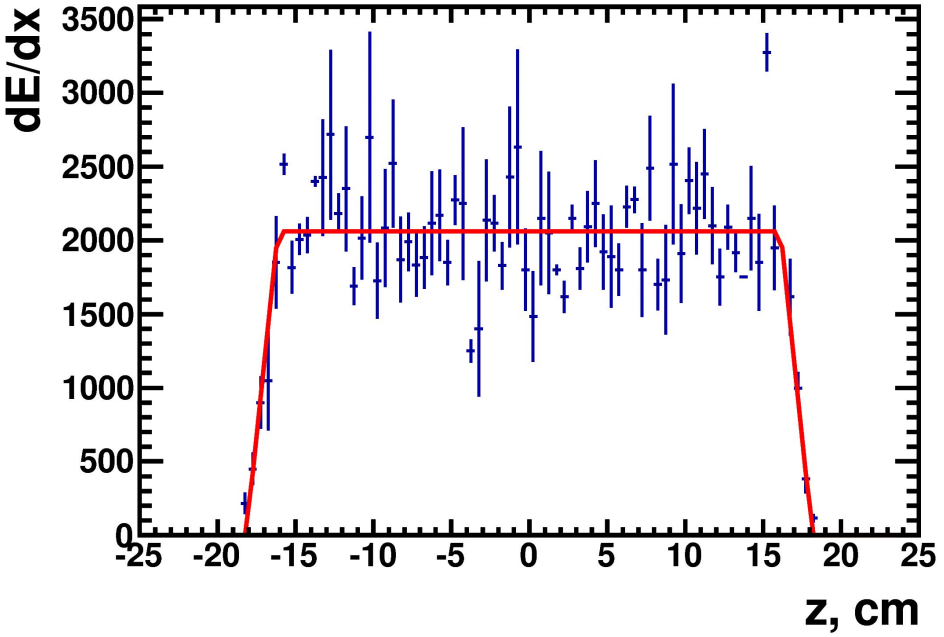


dE/dx offline calibrations

- distance track <-> wire
- correction on track theta
- longitude position of track
- amplitude difference between wires

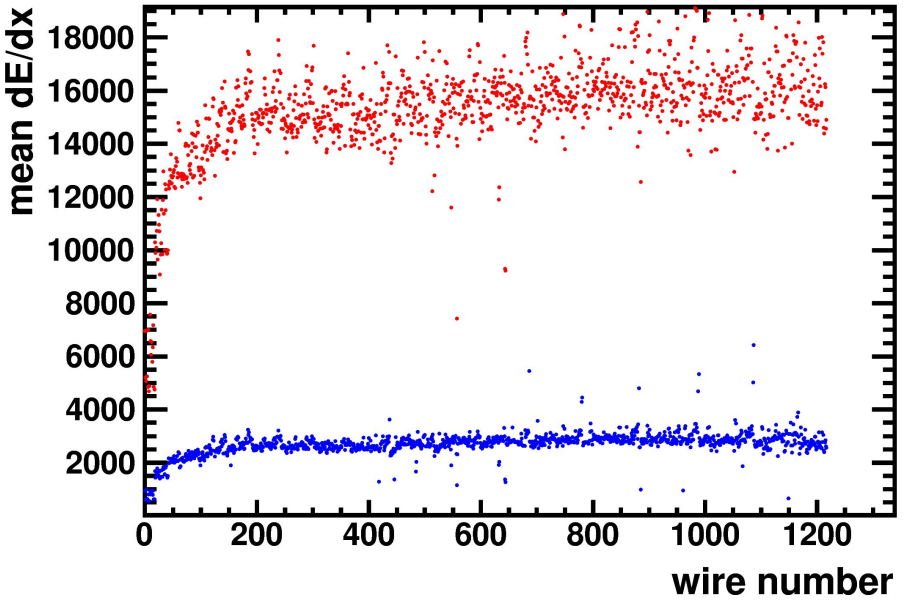




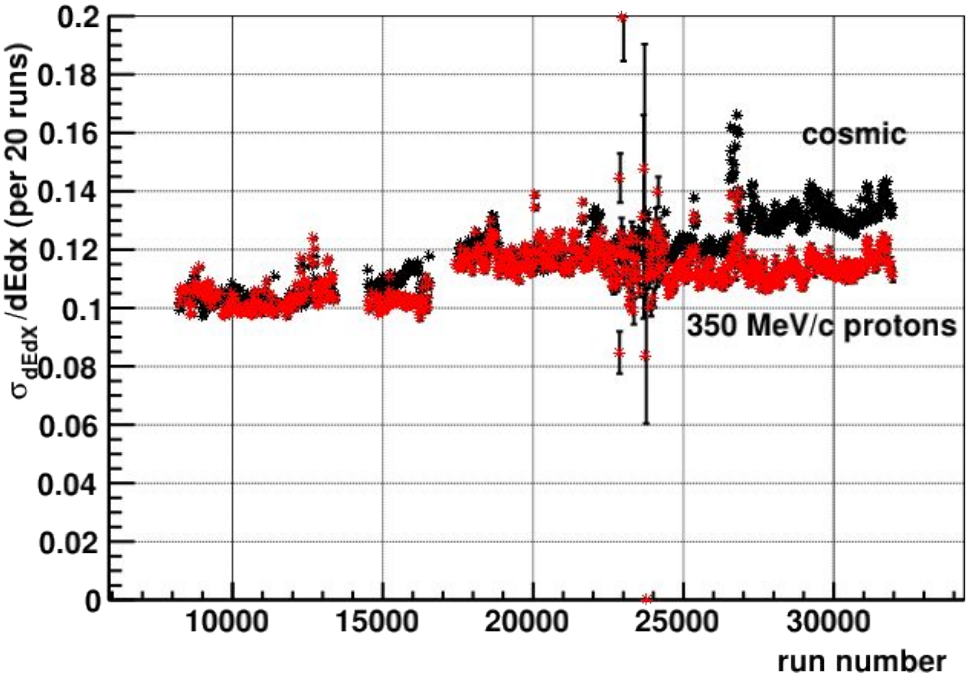


dE/dx offline calibrations

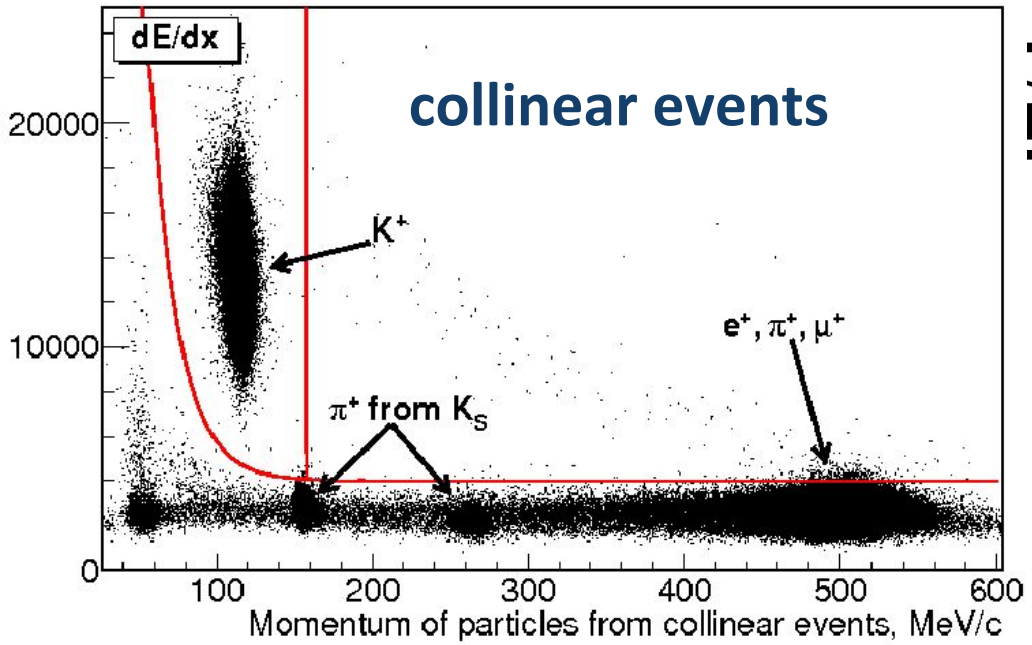
Calibration of mean ionization losses of proton and cosmic events (each 1-2 hours)

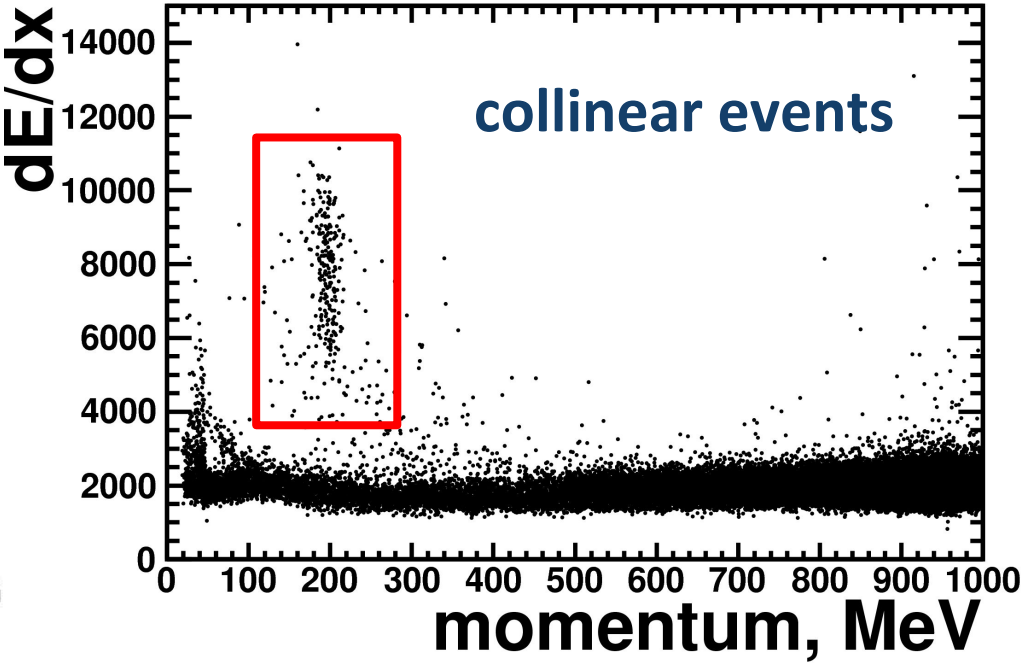


Final dE/dx resolution is about 10-13 %.



$e^+e^- \to \varphi \to K^+K^-$ $e^+e^- \to p^+p^-$

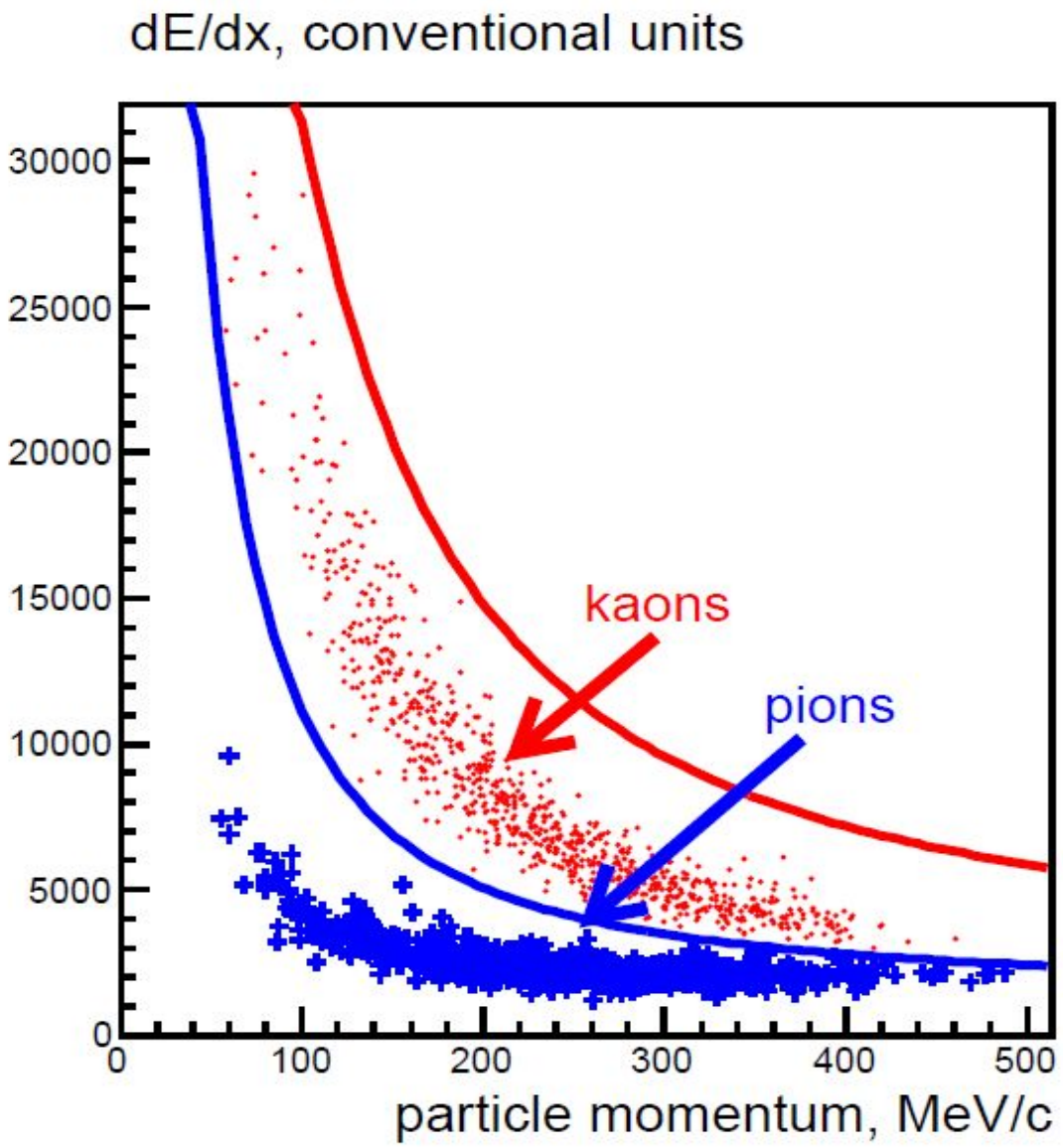




Phys.Atom.Nucl. 78 (2015) no.3, 358-362

Phys.Lett. B759 (2016) 634-640

$e^+e^- \to K^+K^-\eta$



Phys.Atom.Nucl. 79 (2016) no.2, 251-259

$e^+e^- \to K^+K^-\pi^+\pi^-$

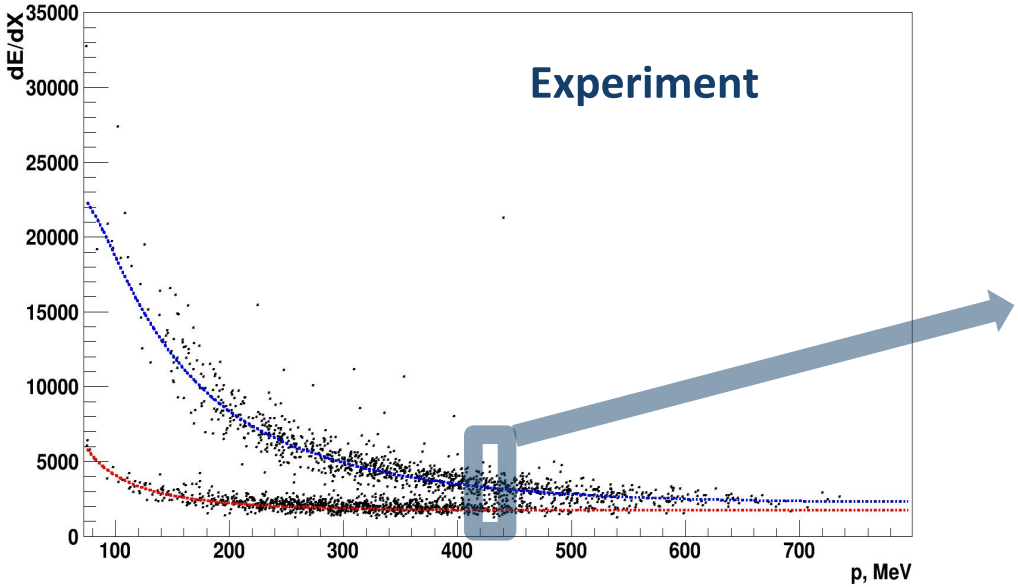
Particle separation is based on minimization of the maximum likelihood function.

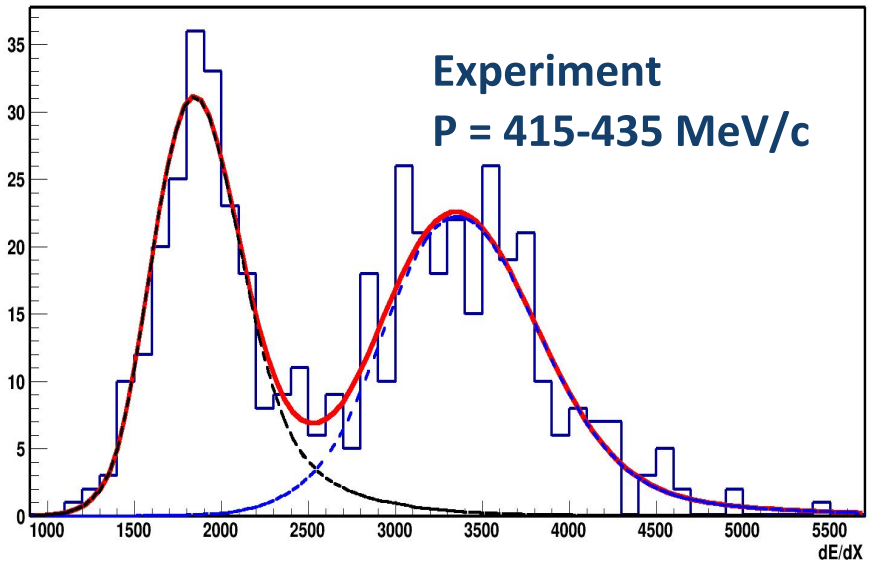
Probability density function with momentum and dE/dx as parameters is constructed for kaons $f_K(p,dE/dx)$ and pions $f_\pi(p,dE/dx)$.

Likelihood function $L_{KK\pi\pi}$ is probability that a four-track event is $K^+K^-\pi^+\pi^-$ and defined as:

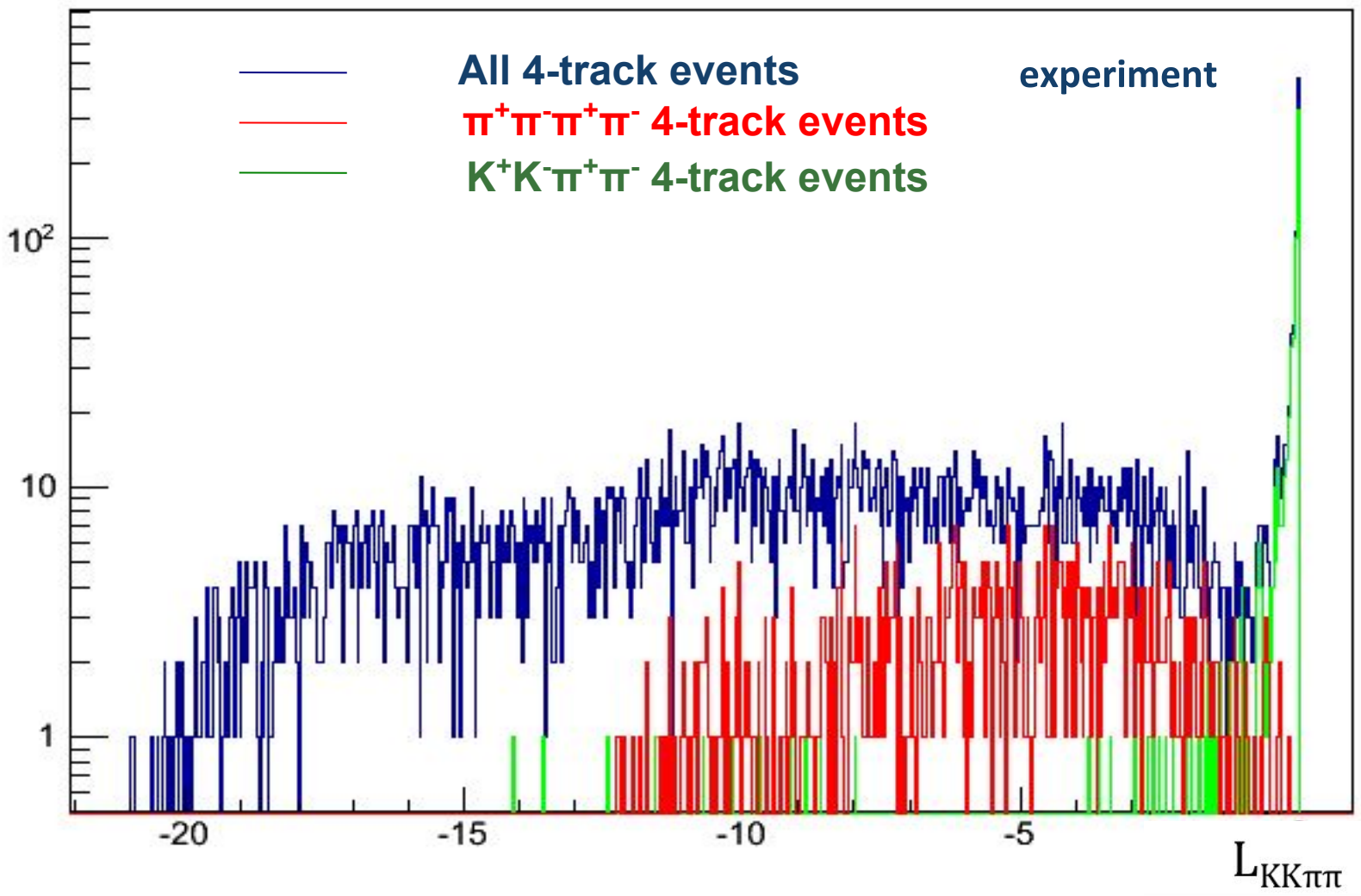
$$L_{KK\pi\pi}\left(p,\frac{dE}{dX},ai\right) = Ln\left(\prod_i \frac{f_{ai}\left(p_i,\frac{dE}{dX_i}\right)}{f_\pi\left(p_i,\frac{dE}{dX_i}\right)+f_K\left(p_i,\frac{dE}{dX_i}\right)}\right),$$ i – track index, alpha_i (α_i) – type of particle for i-track.

$L_{KK\pi\pi}$ maximum corresponds to the most probable alpha_i (α_i) combination.





$e^+e^- \to K^+K^-\pi^+\pi^-$



Phys.Lett. B756 (2016) 153-160

Conclusion

The tracking system have been installed into the CMD-3 detector and participated for data taking since 2010.

The calibration procedures of the dE/dx have been developed and used during all 3 physical seasons.

The DC ionisation losses resolution is 10-13%.

The dE/dx information is successfully used in different analysis.

Thank you!