Selection of incoming Kaons
in the high energetic hadron beam
of the
COMPASS-experiment

CEDAR N 05

Spin Praha 2009
Prometeusz Jasinski
for the
COMPASS-collaboration

Diffractive scattering of Kaons on protons

K^-

K^-

π^+

π^-

X

p_{target}

p_{recoil}

Resonances of big interest such as
K(1460), K1(1650), K2(1580)
still need to be confirmed

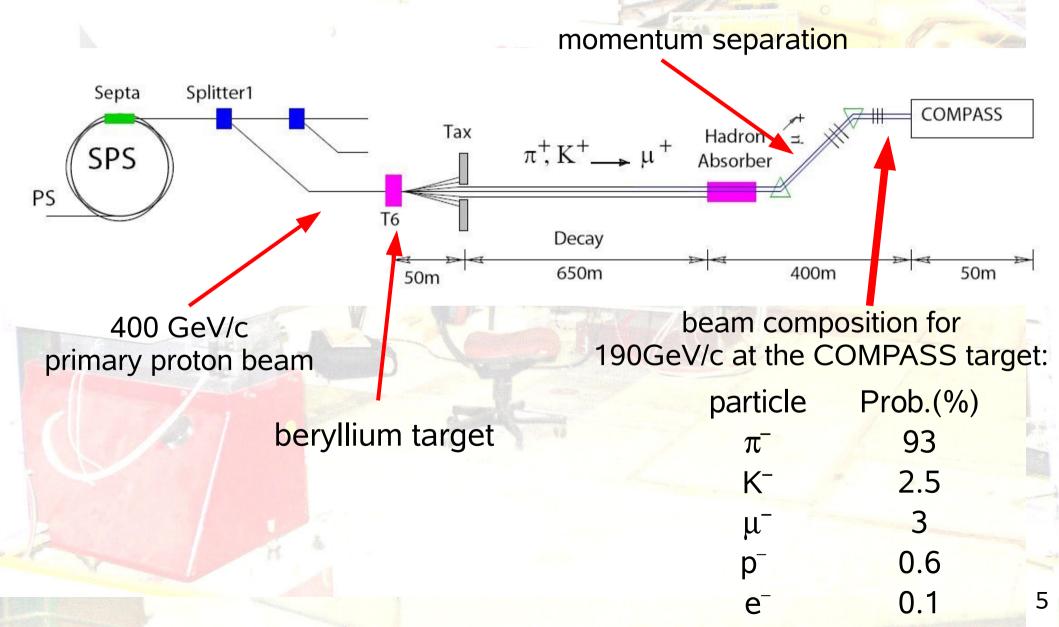Was already analyzed by ACCMOR collaboration (WA03)
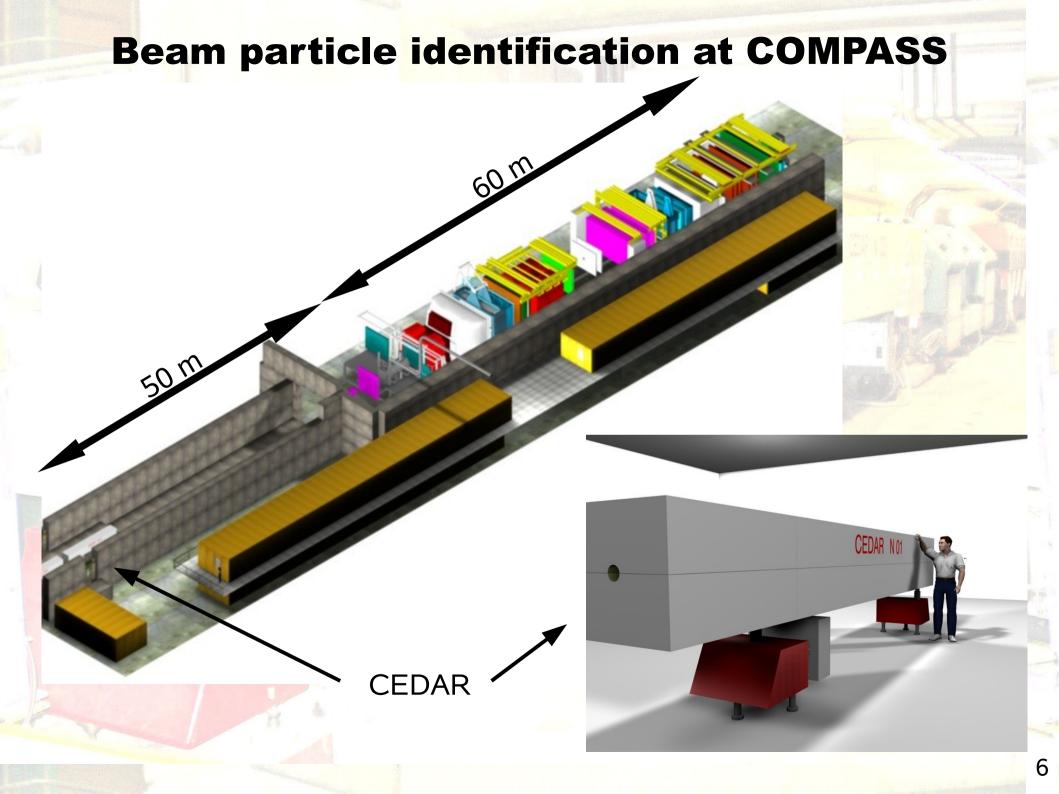
topics

1. Beam particle identification at COMPASS

2. Analysis of a channel with strageness
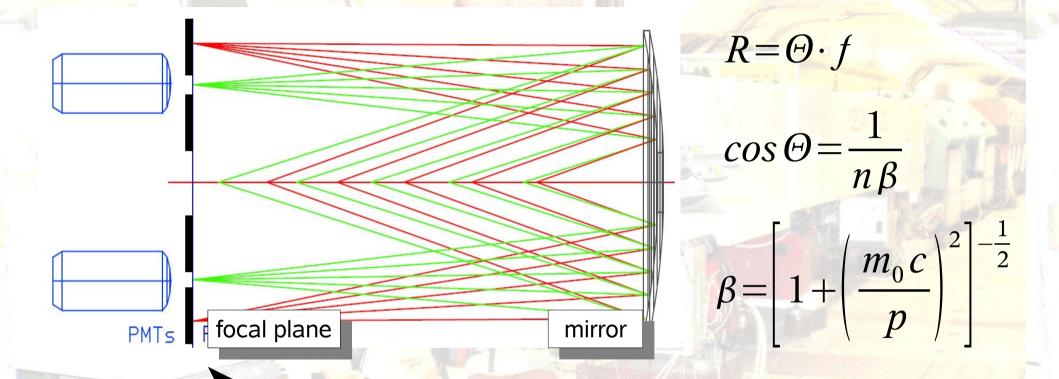
Beam particle identification at COMPASS

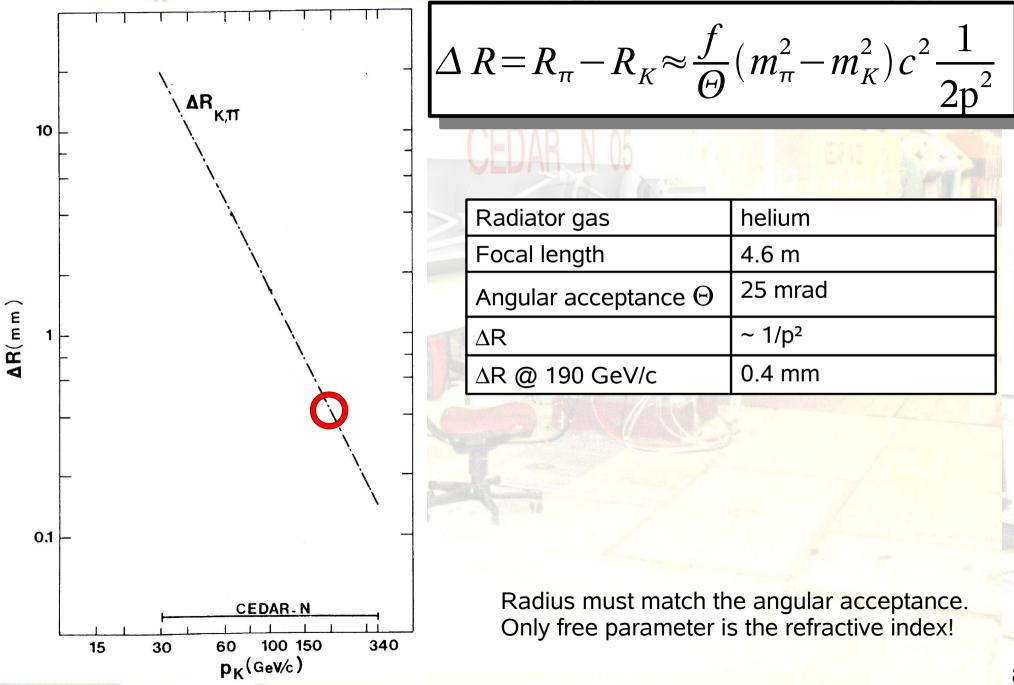# Production of the secondary hadron beam for COMPASS: the M2 beamline

momentum separation

Septa   Splitter1

SPS

PS

Tax

T6

$\pi^+, K^+ \longrightarrow \mu^+$

Hadron Absorber

COMPASS

Decay

50m   650m   400m   50m

400 GeV/c
primary proton beam

beryllium target

beam composition for
190GeV/c at the COMPASS target:

particle	Prob.(%)
π^-	93
K^-	2.5
μ^-	3
p^-	0.6
e^-	0.1

Beam particle identification at COMPASS

60 m

50 m

CEDAR

CEDAR N 01

CEDAR, how does it work?

ChErenkov Differential counter with Achromatic Ring focus

$$R = \Theta \cdot f$$

$$\cos \Theta = \frac{1}{n\beta}$$

$$\beta = \left[1 + \left(\frac{m_0 c}{p} \right)^2 \right]^{-\frac{1}{2}}$$

PMTs

focal plane

mirror
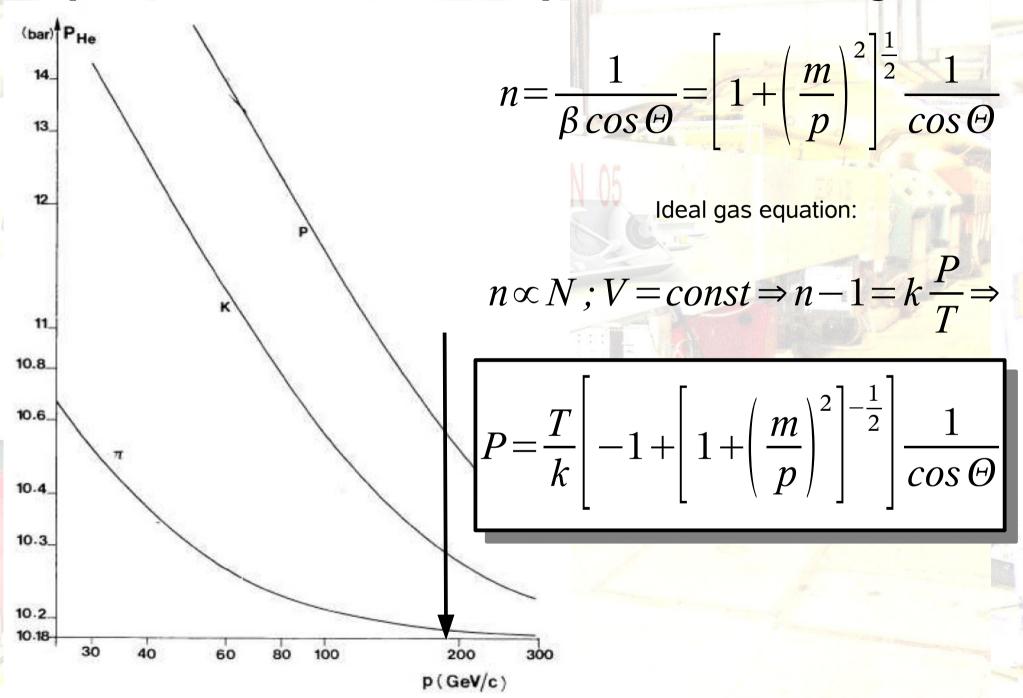
diaphragm in the focal plane to
separate particles of different masses

$$\Delta R = R_\pi - R_K \approx \frac{f}{\Theta} (m_\pi^2 - m_K^2) c^2 \frac{1}{2p^2}$$

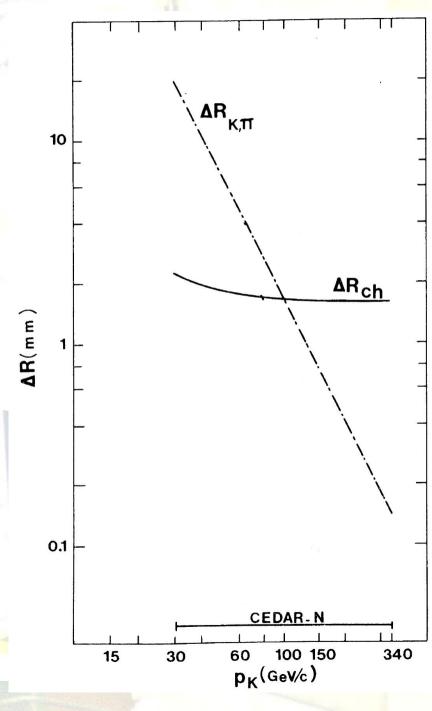# Ring radius difference over beam momentum

$$\Delta R = R_\pi - R_K \approx \frac{f}{\Theta}(m_\pi^2 - m_K^2)c^2\frac{1}{2p^2}$$

Radiator gas	helium
Focal length	4.6 m
Angular acceptance Θ	25 mrad
ΔR	~ 1/p²
ΔR @ 190 GeV/c	0.4 mm

Radius must match the angular acceptance.
Only free parameter is the refractive index!

8

pressure for the fixed accepted Cherenkov angle
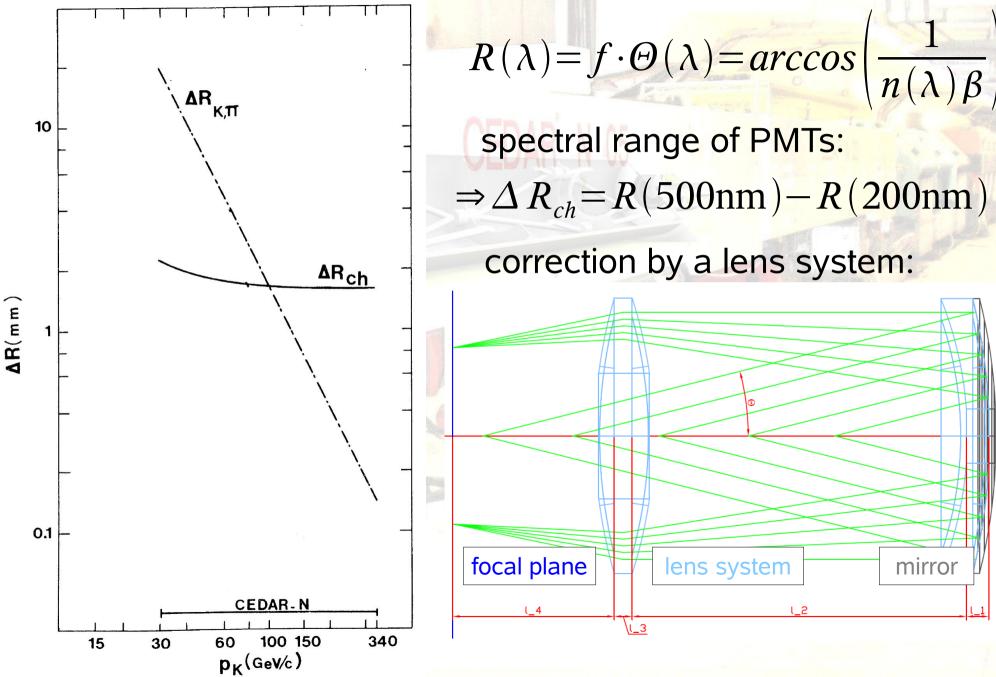
$$n = \frac{1}{\beta \cos \Theta} = \left[1 + \left(\frac{m}{p} \right)^2 \right]^{\frac{1}{2}} \frac{1}{\cos \Theta}$$

Ideal gas equation:

$$n \propto N \; ; V = const \Rightarrow n - 1 = k \frac{P}{T} \Rightarrow$$

$$P = \frac{T}{k} \left[-1 + \left[1 + \left(\frac{m}{p} \right)^2 \right]^{-\frac{1}{2}} \right] \frac{1}{\cos \Theta}$$

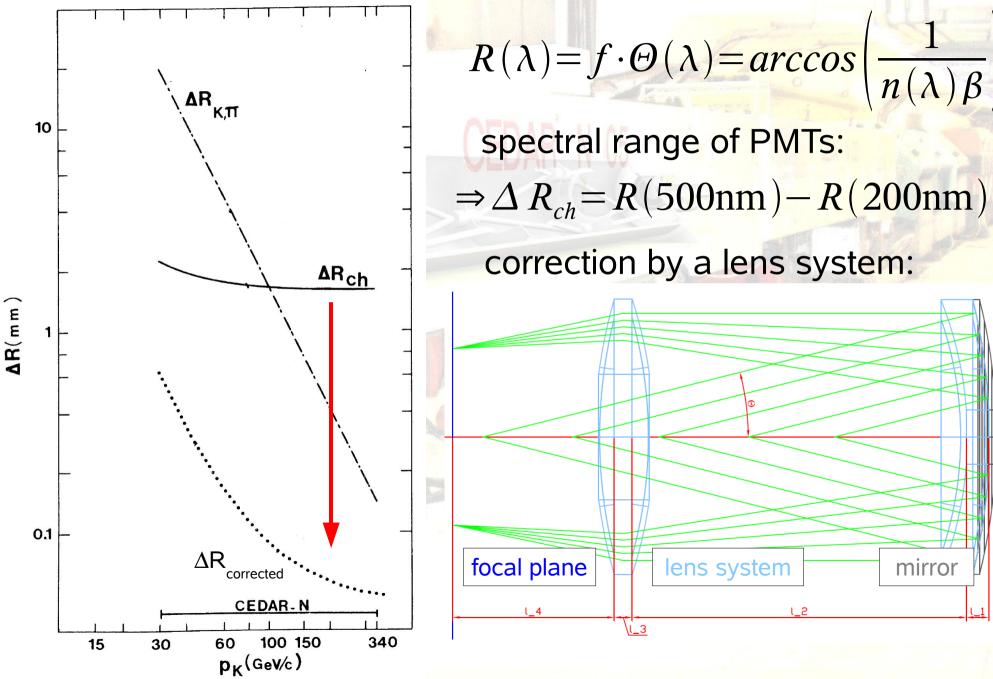# impact of the natural dispersion on the ring focus

$$R(\lambda) = f \cdot \Theta(\lambda) = arccos\left(\frac{1}{n(\lambda)\beta}\right)$$

spectral range of PMTs:

$$\Rightarrow \Delta R_{ch} = R(500\text{nm}) - R(200\text{nm})$$

impact of the natural dispersion on the ring focus

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correction by a lens system:

impact of the natural dispersion on the ring focus

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spectral range of PMTs:

$$\Rightarrow \Delta R_{ch} = R(500\text{nm}) - R(200\text{nm})$$

correction by a lens system:

focal plane   lens system   mirror

mechanical layout of the CEDAR

mechanical layout of the CEDAR

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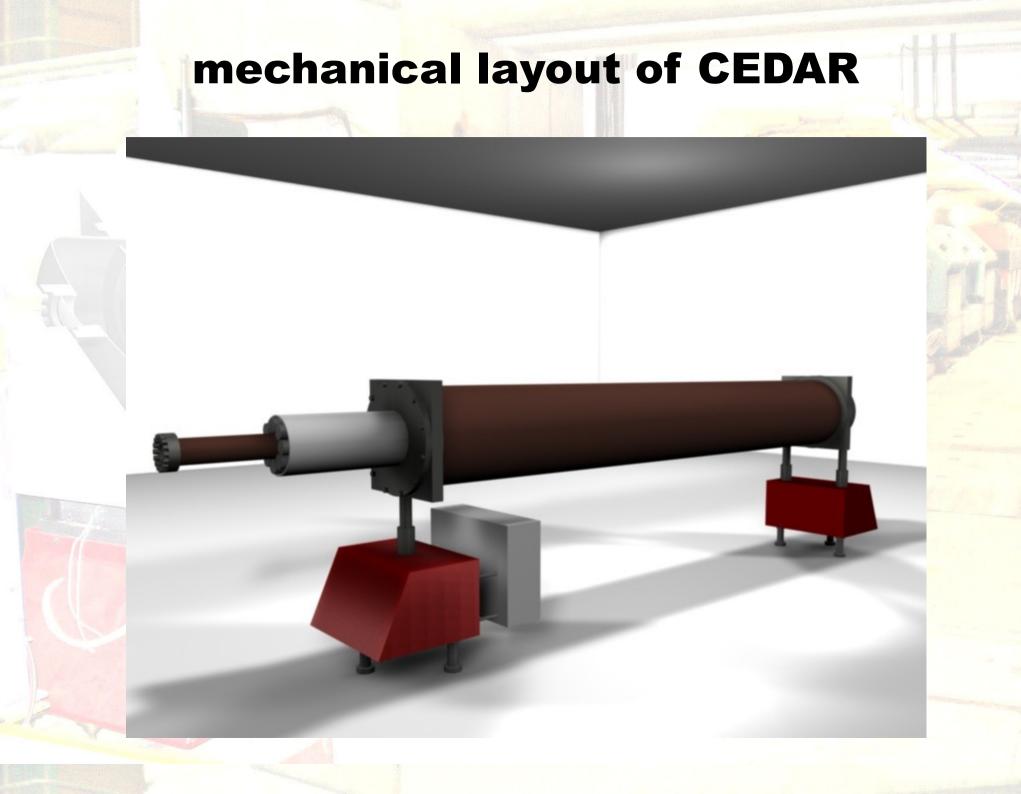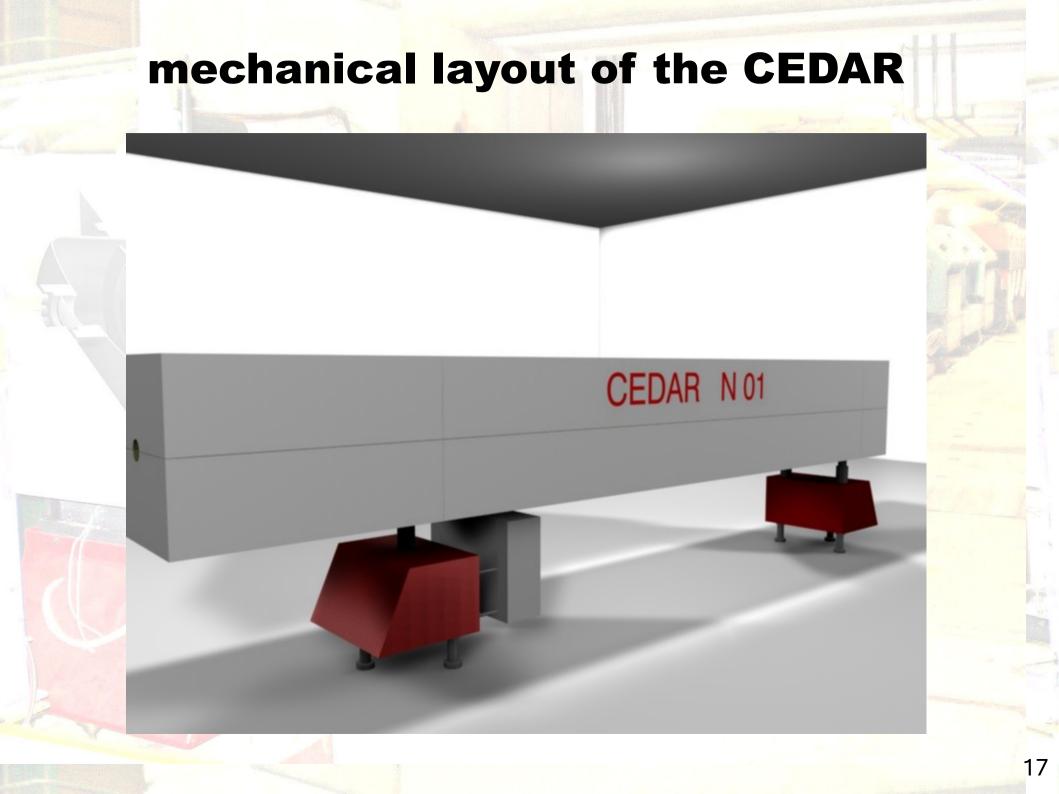
mechanical layout of the CEDAR

CEDAR N 01

CEDAR detector setup in the hadron run 2008

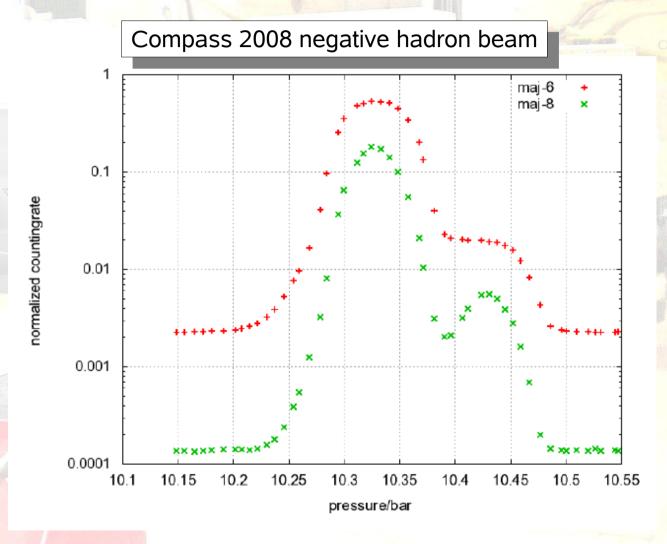Light detection with 8 PMTs

Most of the beam time set on Kaons

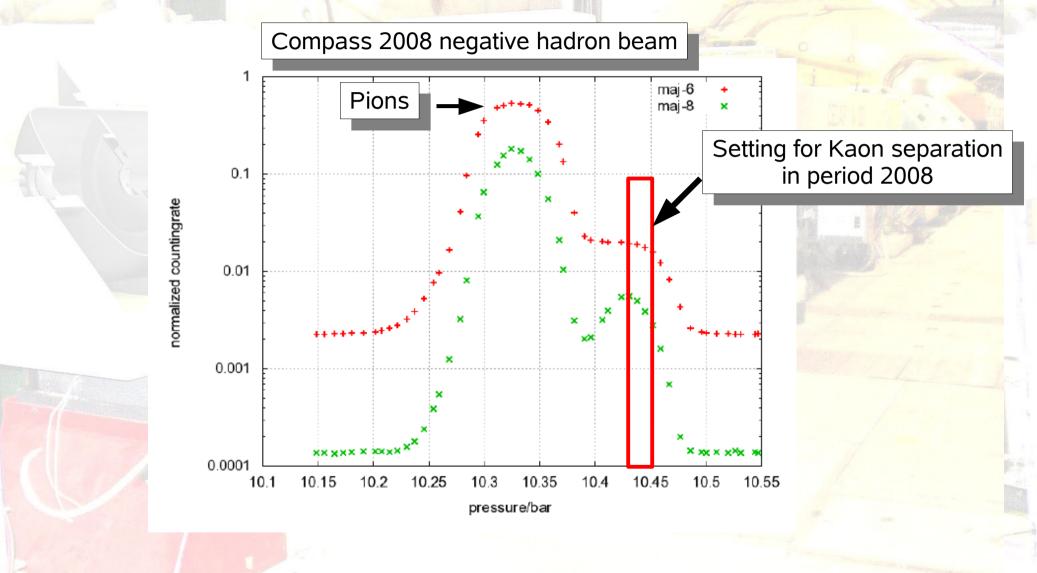About 10 cherenkov photons per PMT equal 3-4 mean photoelectrons

All PMT hits recorded for offline analysis

Trigger: majority of 6 PMTs in one CEDAR and
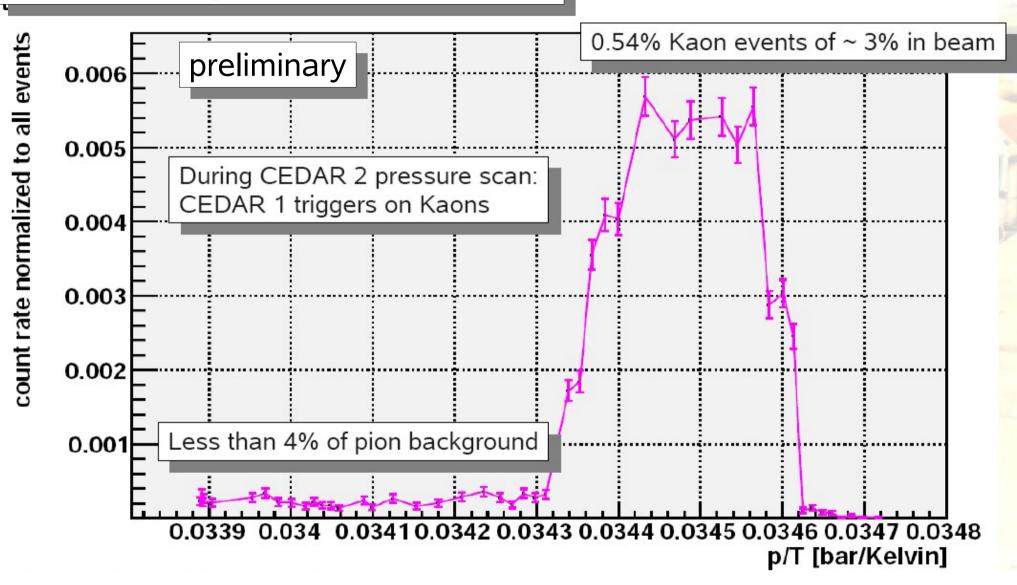CEDAR 1 && CEDAR 2

Setting the pressure: pressure scans

Compass 2008 negative hadron beam

Setting the pressure: pressure scans

Compass 2008 negative hadron beam

Pions

Setting for Kaon separation in period 2008

maj-6 +
maj-8 ×

normalized countingrate

pressure/bar
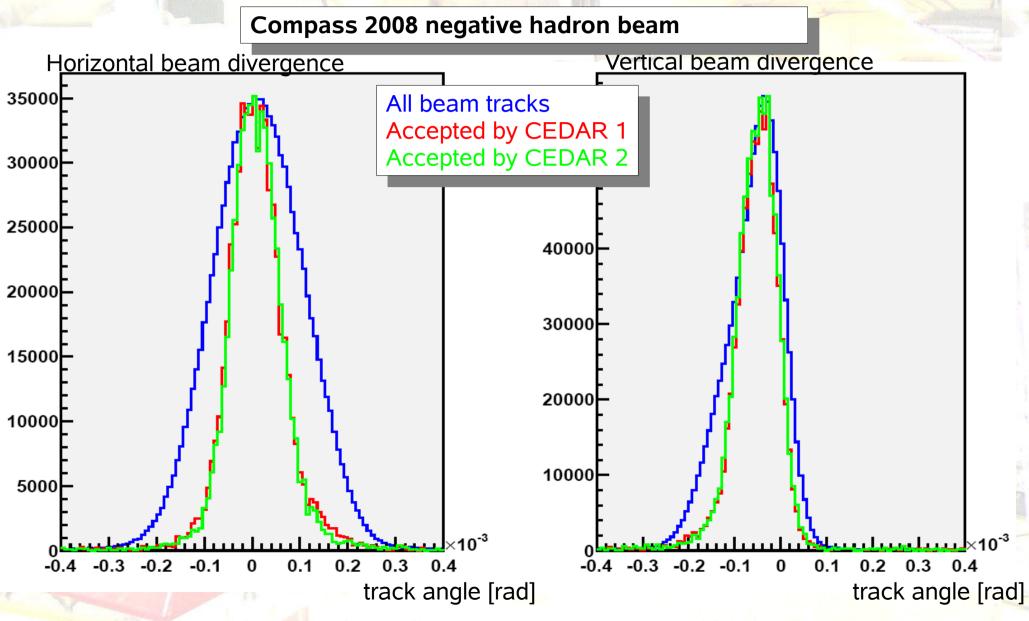
Offline purity and efficiency analysis

Study of beam divergence

Compass 2008 negative hadron beam

Horizontal beam divergence

Vertical beam divergence

All beam tracks
Accepted by CEDAR 1
Accepted by CEDAR 2

track angle [rad]

track angle [rad]

beam tracks with a large divergence are not accepted by the CEDARs.

Analysis of a channel with strageness

Diffractive scattering of Kaons on protons

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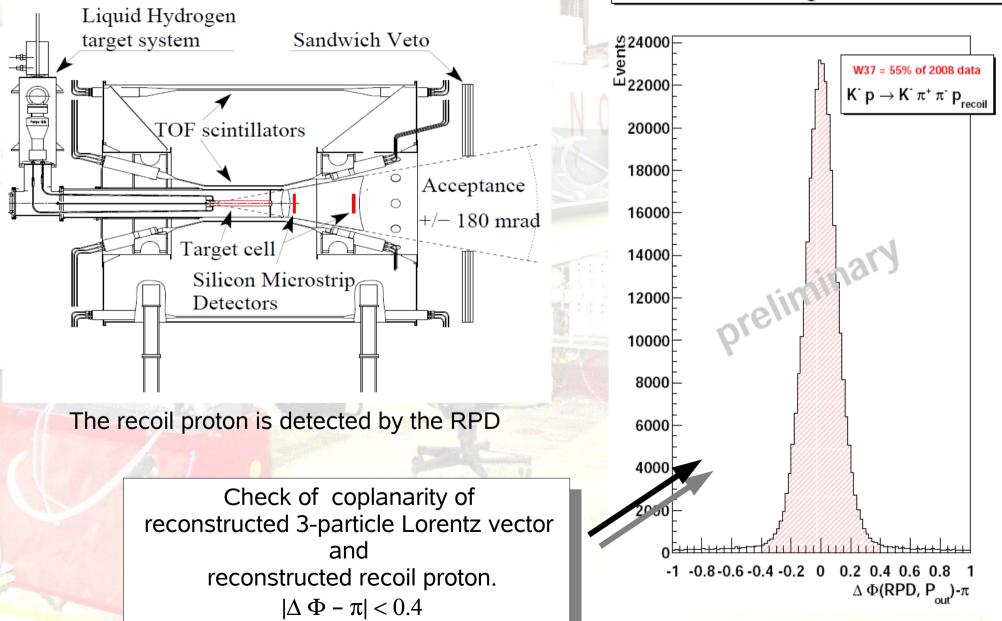
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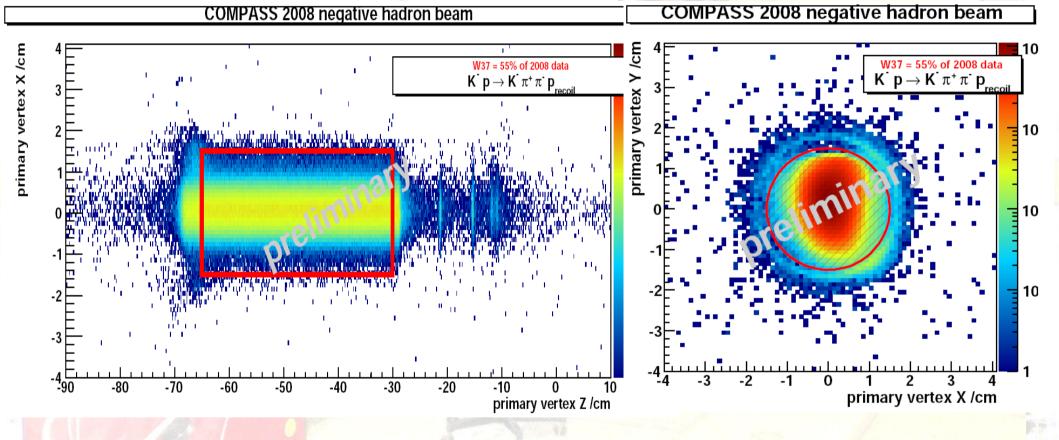
Vertices with 3 outgoing charged particles

COMPASS 2008 negative hadron beam

W37 = 55% of 2008 data
$K^- p \rightarrow K^- \pi^+ \pi^- p_{recoil}$

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A cut is applied to select the target region

event coplanarity

Liquid Hydrogen target system

Sandwich Veto

TOF scintillators

Acceptance +/- 180 mrad

Target cell

Silicon Microstrip Detectors

The recoil proton is detected by the RPD

Check of coplanarity of reconstructed 3-particle Lorentz vector and reconstructed recoil proton.

$|\Delta \Phi - \pi| < 0.4$

COMPASS 2008 negative hadron beam

W37 = 55% of 2008 data

$K^- p \rightarrow K^- \pi^+ \pi^- p_{recoil}$

preliminary

$\Delta \Phi(RPD, P_{out}) - \pi$
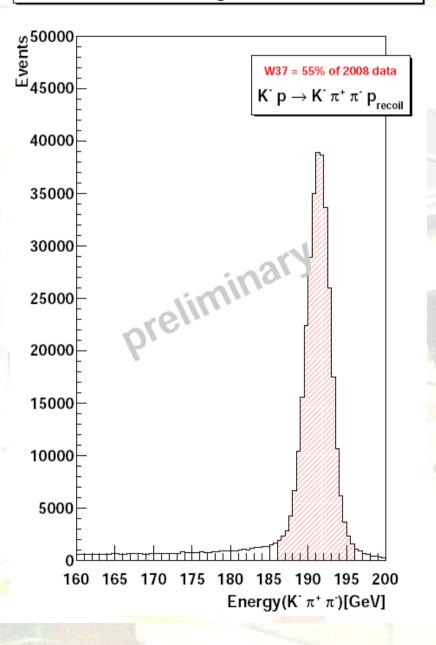
Searching for exclusive events

COMPASS 2008 negative hadron beam

W37 = 55% of 2008 data

$K^- p \to K^- \pi^+ \pi^- p_{recoil}$
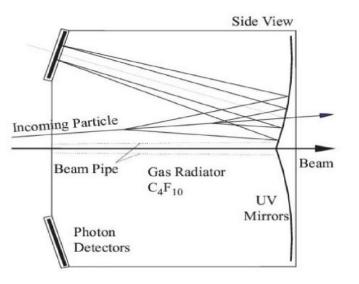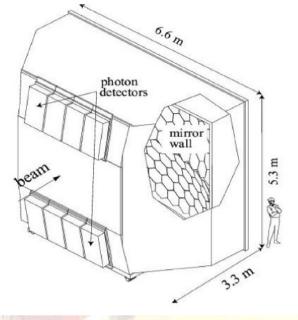
preliminary

Energy($K^- \pi^+ \pi^-$)[GeV]

The incoming beam momentum is not measured!
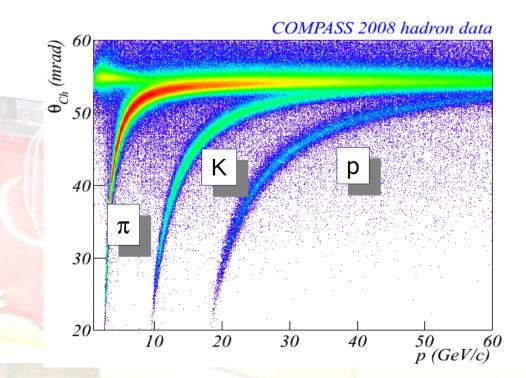
The exclusivity of the event is given by
a cut on the total energy of the reconstructed tracks

Reduction of combinatorial background

Particle identification by using the RICH
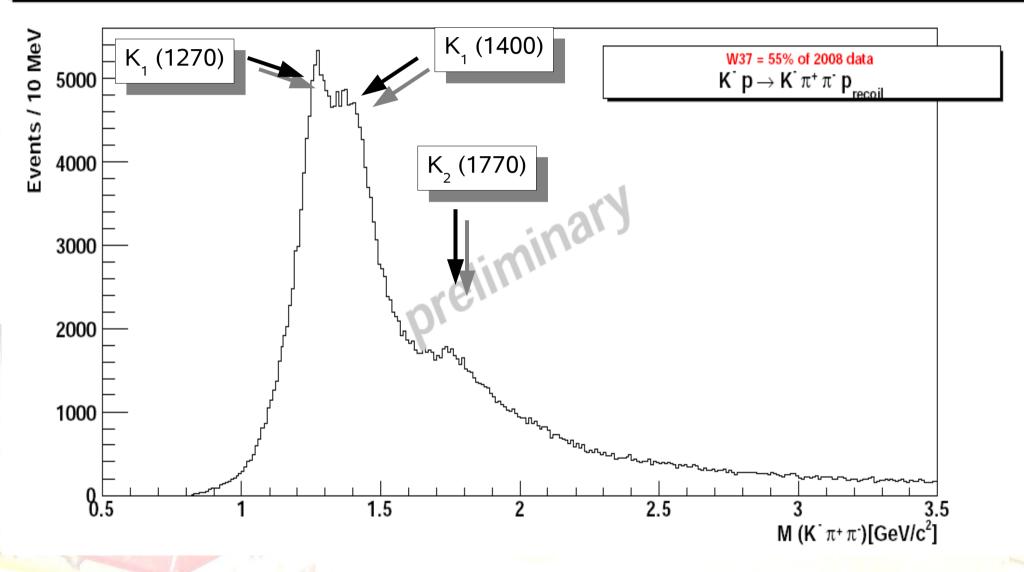

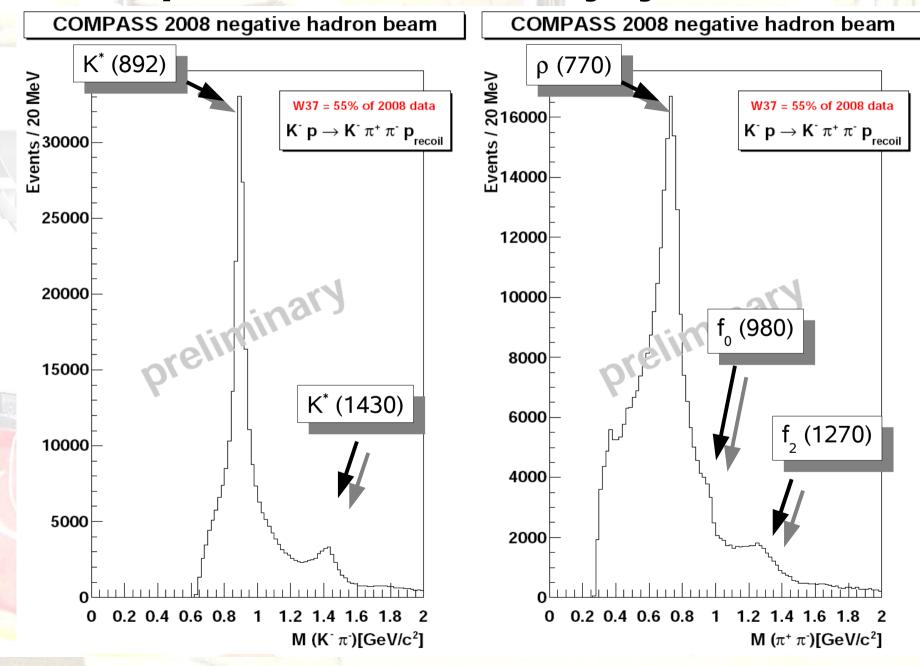K/π seperation up to ~55 GeV particle momentum

RICH is used as a VETO

~1/2 of all wrong particle combinations are rejected

Invariant mass distributions for diffractively produced K⁻ π^- π^+ 3-body systems

COMPASS 2008 negative hadron beam

K₁ (1270)

K₁ (1400)

K₂ (1770)

W37 = 55% of 2008 data
$K^- p \to K^- \pi^+ \pi^- p_{recoil}$

Events / 10 MeV

$M (K^- \pi^+ \pi^-)[\text{GeV}/c^2]$

preliminary

Invariant mass distributions for diffractively produced K⁻ π⁻ π⁺ 3-body systems

Summary and outlook

A CEDAR is a very good detector to trigger one kind of beam particles

The 30 years old CEDAR devices had been successfully used in the 2008 run on the CERN M2 beamline

The K p -> K p $\pi\pi$ channel was investigated. Only 55% of 2008 data were analyzed. More to come.

A full PWA will be performed in the near future.

Thank you for your attention!

Backup slides

Evaluating the purity