



Preliminary Test Beam Results for the Muon Range System Prototype

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PANDA/FAIR Setup



Topics of research: hadron structure and spectroscopy, strange and charm physics, hypernuclear physics with anti-proton beams.



- ppbar, pbarA collisions
 p = 1.5 15 GeV/c ,
 (√s from 2.25 up to 5.46 GeV)
- Luminosity up to 2·10³² cm⁻²s⁻¹
- Nearly 4π solid angle for large acceptance
- Tracking : ~50 µm vertex resolution
- Different PID techniques for π±, K±, e±, μ±, γ identification, good momentum resolution



Muon System indicated in blue

Muon System as PID

- PANDA/FAIR (SPD/NICA) Muon System based on range system technique is a good PID system for muon-to-hadron separation.
- It works in full energy range of secondary particles at PANDA (0.5 ÷ 10 GeV).
- It resolves muons and hadrons with ~ 100% efficiency (zero hadron contamination) above ~ 1 GeV by obviously different response pattern.
- Separation of muons vs pions (the main rival) below 1 GeV is less efficient and requires test beam measurements for calibration.
- Important feature of range system is possibility to be used as coarse sampling (30 mm to 60 mm of Fe in our case) hadron calorimeter – > very important for neutron registration!

Mini-Drift Tube (MDT) Detector as Basis for the Muon System



PANDA Range System Prototype



The absorber structure in horizontal position

PANDA Muon System Prototype @ PS/T9/CERN Beam Line



Event Examples (Run 822, P = 1 GeV/c)

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Event Examples (Run 829, P = 5 GeV/c)

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Event Examples (Run 835, P = 10 GeV/c)

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Selection Criteria for protons and antiprotons

For Calorimetry we estimate the energy of protons (antiprotons) by measuring the number of hits in event

- 1) Two scintillation counters of the TOF system (up to 5 GeV/c)
- 2) Cherenkoff counters (> 5 GeV/c)
 Cher(A): 2 bar of CO₂ <-> reject electron/pion/muon
- 3) Beam entrance spot





Calorimetry: PANDA FRS Structure



Sampling: 60 mm / Fe Nuclear interaction length $\lambda_1 \approx 5.2$

Calorimetry: PANDA MF+EC Structure



Sampling: 60 mm / Fe Nuclear interaction length $\lambda_{l} \approx 3.4$

Calorimetry: PANDA Barrel Structure



Sampling: 30 mm / Fe Nuclear interaction length $\lambda_1 \approx 2.3$

Protons vs Antiprotons



PANDA FRS Structure, T = 3.1 GeV

Summary and Plans

• Calorimetry of PANDA Muon System Prototype for protons is performed using test beam data.

Plans:

- Developing 3D mechanical model of Muon System (detector geometry).
- Transferring the detector geometry from Computer-Aided Design system to particle transport Monte Carlo code like GEANT4 / ROOT.
- Digitization / pattern recognition of hadrons and muons.
- Calibration of the SPD system's response to the different particles and energies.
- Test of algorithms for μ/π separation (at low energies ~0.5 GeV).