Prototype test for the PANDA Barrel DIRC

Roman Dzhygadlo
for the PANDA Cherenkov Group

- PANDA Barrel DIRC
- Test beam setup
- Results
- Summary

The PANDA Cherenkov Group:
PANDA Barrel DIRC

Facility for Antiproton and Ion Research

Goal: 3 s.d. $\pi/K$ separation up to 3.5 GeV/c

(see HK 39.1)
**DIRC Prototype Test 2018**

**Goal:**
- evaluate performance of the 4x2 MCP-PMTs layout
- test different optical couplings

**Highlights of the geometry:**
- 33 degree prism as expansion volume
- narrow bar as radiator
- 3-layer spherical lens as focusing
- 4x2 MCP-PMTs (vs. 4x3 in 2017)

**Test conditions:**
- CERN PS/T9 area
- beam type: protons and pions
- beam momentum: 10, 9, 8, 7, 6, 5, 4, 3, 2 GeV/c
- TOF PID
- different configurations of the DIRC prototype
- different DIRC prototype angles

Most of the data taken at 7 GeV/c (7 GeV/c π/p sep. ≈ 3.5 GeV/c π/K)
Beam Test at CERN 2018

TOF particle identification

Beam profiling

Trigger

π/p beam

Barrel DIRC prototype

HODOSCOPE

CERN PS/T9 area

External TOF PID

7 GeV/c

CAD drawing of the Barrel DIRC prototype
Beam Test at CERN 2018

33° prism

PHOTONIS Planacon MCP-PMT array

Optical grease coupling

narrow bar (35 mm width)

Spherical 3-layer lens
Pilas Laser Calibration

time distribution of one channel

two diffusers

Pilas laser + TRB time resolution ~190ps
Examples of the Hit Pattern

- 20 degree polar angle
- pions and protons @ 7 GeV/c
- bar + 3 layer spherical lens

- beam data with proton tag
- beam data with pion tag
- geant simulation for pions
Hit Pattern for Asymmetric Bar Position

beam data

generate simulation
Hit Pattern for Different Layouts

4x2 MCP-PMTs

4x3 MCP-PMTs

beam data with pion tag @ 20 degree

Expecting ~33% fewer photons comparing to 4x3 layout
Photon Yield @ 7 GeV/c

30-40% fewer photons compared to 4x3 layout
PID Performance Results

SPR = 8.6 mrad
π/p @ 7 GeV/c

beam data
- pions
- protons

single photon resolution (SPR)

beam data @ 20°
4.8 s.d.

p separation power @ 7 GeV/c

good performance
good agreement with geant simulations
Momentum Scan @ 20 Degree Polar Angle

Examples of the likelihood distribution

3.0 s.d. @ 8 GeV/c
7.7 s.d. @ 4 GeV/c

good performance @ different beam momenta
Summary

- Test beam is successful
- 4x2 MCP-PMT layout validated in test beam
- Reconstructed photon yield is in a range of 10-70 with SPR ~9 mrad => up to 5 s.d. @ 7 GeV/c in forward region
- Momentum scan shows good performance for different momenta
- Excellent agreement between data and simulations
- Switch to 4x2 MCP-PMT layout for PANDA Barrel DIRC

Thank you for the attention
Backup 01: Expected Performance

- Track-by-track maximum likelihood fit
- \( N_{\text{sep}} = \frac{|\mu_1 - \mu_2|}{0.5(\sigma_1 + \sigma_2)} \)
- Time imaging reconstruction
- Geant simulation

- Barrel DIRC PID 3 s.d. goal
- From earlier: kaon phase space for 7 GeV/c

Design meets and exceeds PID requirements
Backup 02: Reconstruction Methods

Geometrical
- BABAR-like
- Needs Look-Up Tables

Time imaging
- Belle II TOP-like
- Needs Probability Density Functions of the propagation time

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