

Particle Identification with Disc DIRC at PANDA

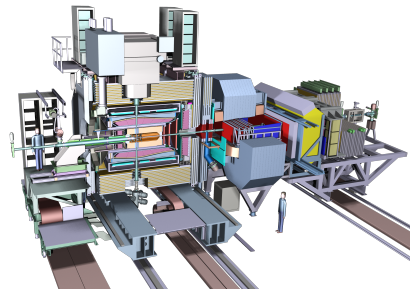
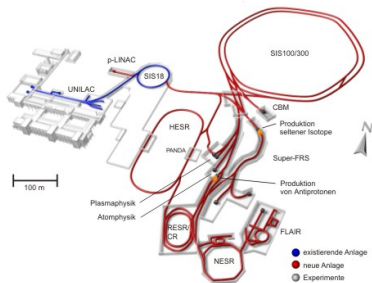
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Etzelmüller, Klaus Föhl, Avetik Hayrapetyan, Julian Rieke

TIPP 2017

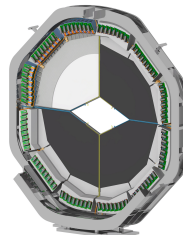
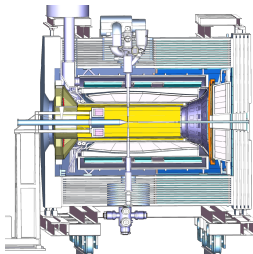
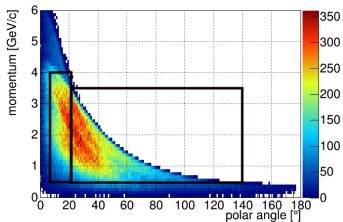
Outline

- 1 Detector Concept
- 2 Detector Performance
- 3 DESY Testbeam 2016
- 4 Summary & Outlook

PANDA Spectrometer



Kaon phase space:



Detector Overview

Opening angle of Cherenkov Cone:

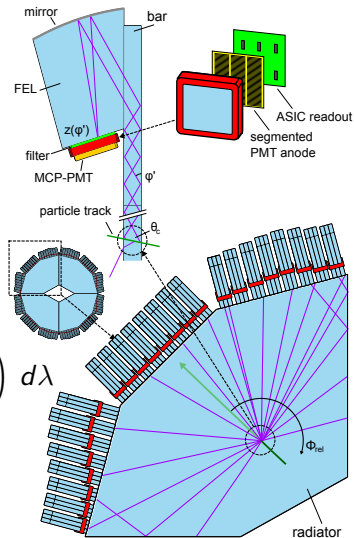
$$\theta_C = \arccos\left(\frac{1}{n(\lambda)\beta}\right)$$

with $\beta = p/(m_0^2 + p^2)$.

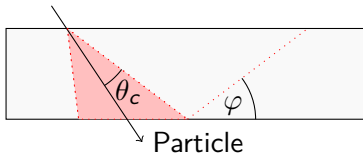
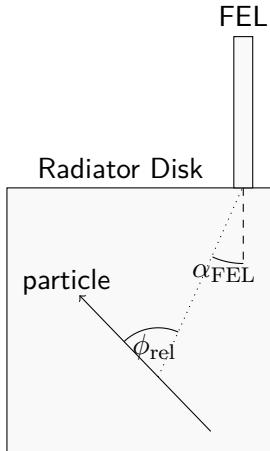
Number of photons per track length according to Frank-Tamm-Formula:

$$\frac{dN}{dx} = 2\pi\alpha z^2 \int_{\lambda_1}^{\lambda_2} \left(\frac{1}{\lambda^2} - \frac{1}{n^2(\lambda)\beta^2\lambda^2} \right) d\lambda$$

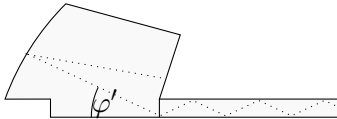
≈ 1000 Photons/Event for $\pi^\pm$
with 4 GeV/c momentum



Geometrical Model for Reconstruction

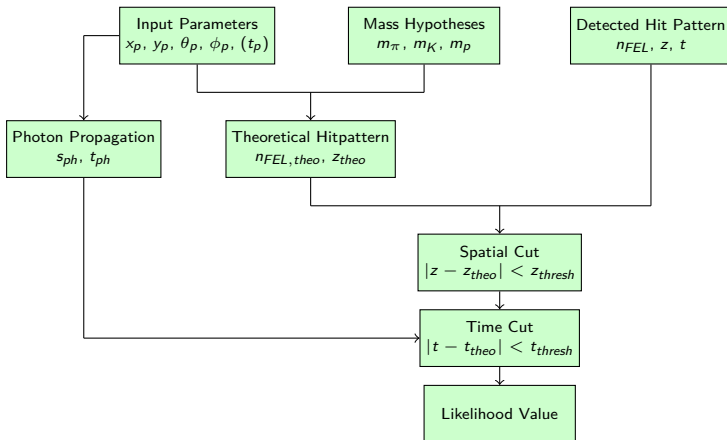


$$\tan \varphi' = \frac{\tan \varphi}{\tan \alpha_{FEL}}$$



$$\theta_c = \arccos(\sin \theta_p \cos \phi_{rel} \cos \varphi + \cos \theta_p \sin \varphi)$$

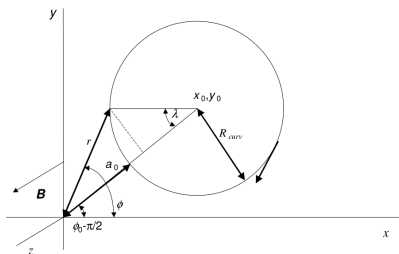
Reconstruction Algorithm



$$\ln \mathcal{L} = \sum_{i=0}^N (\ln \mathcal{G}(z_i | z_{pred,i}; \sigma_z) + \ln \mathcal{G}(t_i | t_{pred,i}; \sigma_t)) \quad (1)$$

Tracking Information

Helix Parameters:

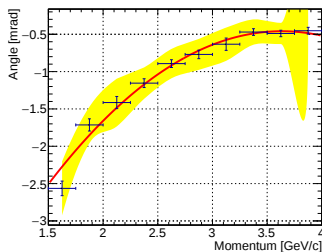
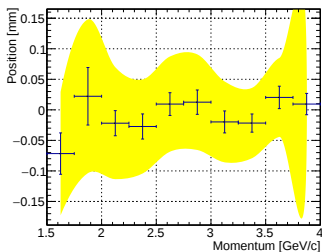


Calculation of curvature from magnetic field:

$$\rho[m] = \frac{p_T[\text{GeV}]}{0.3B[\text{T}]}$$

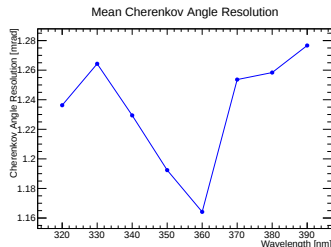
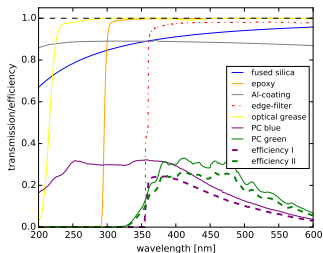
$$x'(\lambda) = x_0 + Q\rho \cos(Q\lambda - \phi_0)$$

$$y'(\lambda) = y_0 + Q\rho \sin(Q\lambda - \phi_0)$$

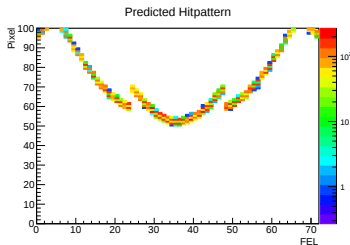
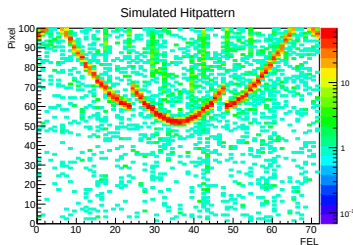


Monte-Carlo Simulation

Optical parameters in Monte-Carlo simulations:

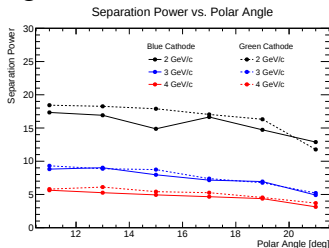
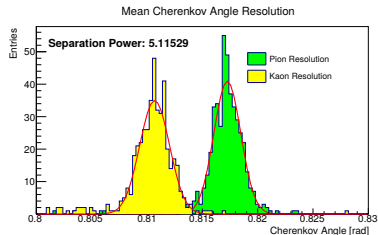


1000 events with π^+ at $p = 4 \text{ GeV}/c$, $\theta = 12^\circ$, $\phi = 45^\circ$:

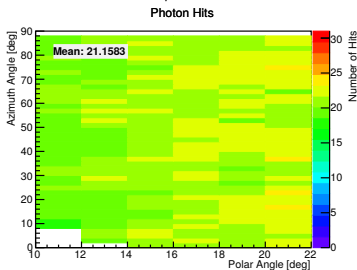
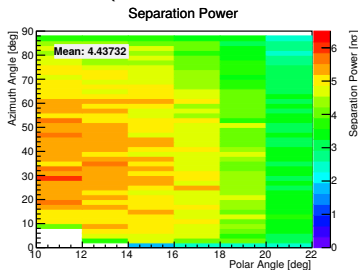


Performance Analysis

Separation power for different polar angles and momenta:

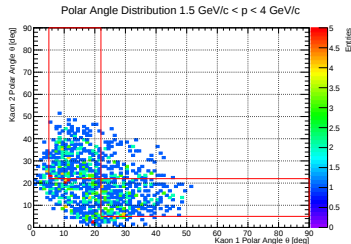
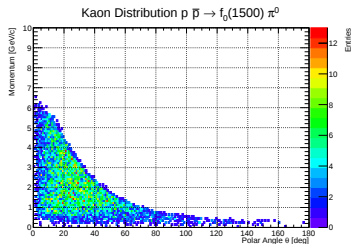


2D scan (polar and azimuth angles) for $p = 4 \text{ GeV}/c$:

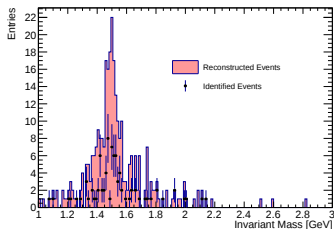


Benchmark Channel Analysis

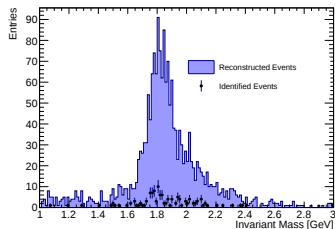
Benchmark Channel: $p\bar{p} \rightarrow f_0\pi^0 \rightarrow \pi^0 K^+ K^-$:



Kaon identification:

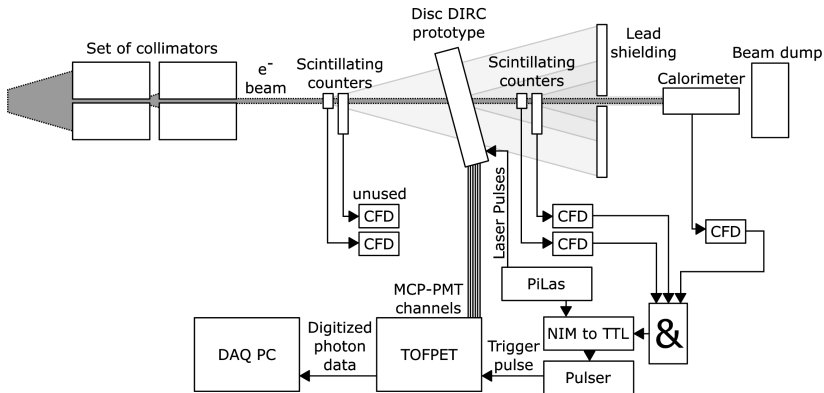


Pion misidentification:



Testbeam Setup

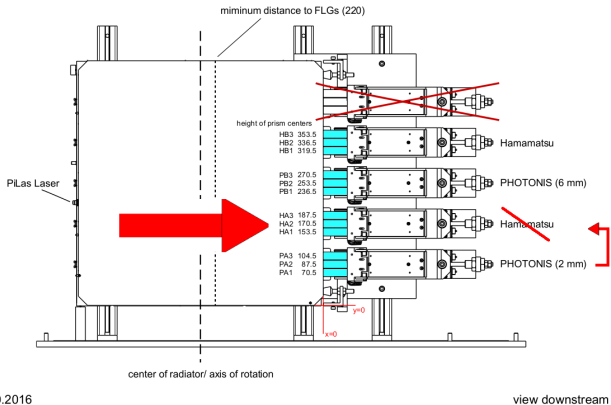
DESY testbeam setup for T24/1 hall:



TOFPET: Free running readout device with 50 ps time resolution

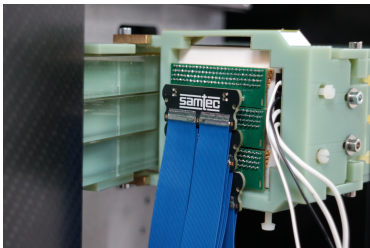
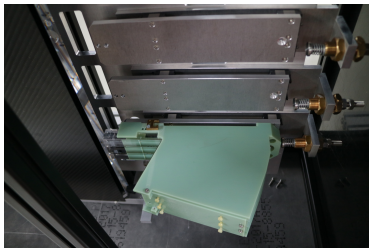
Radiator Setup

2016 DISC DIRC PROTOTYPE available setup



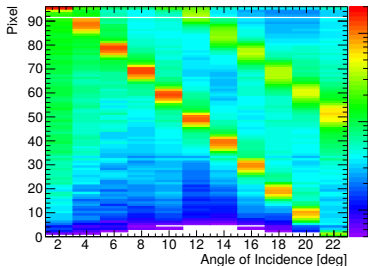
Testbeam radiator: Fused silica plate (50 cm $\times$ 50 cm fused silica plate with 1 nm surface roughness)

Testbeam Fotos

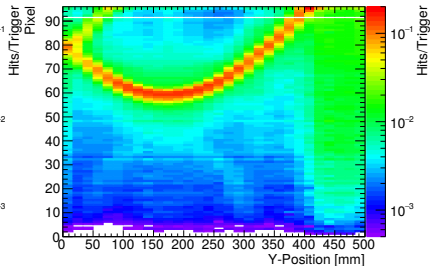


Measured Hitpattern

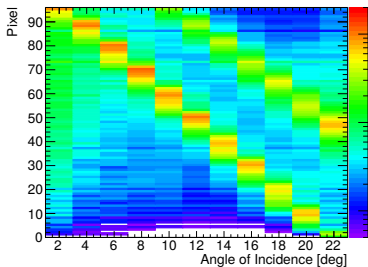
Angle Scan FEL1



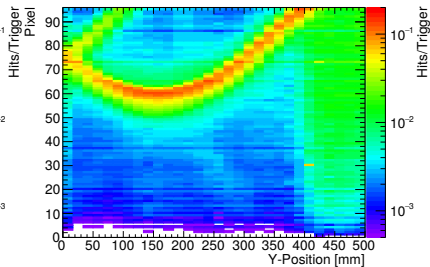
Y-Scan FEL1



Angle Scan FEL2

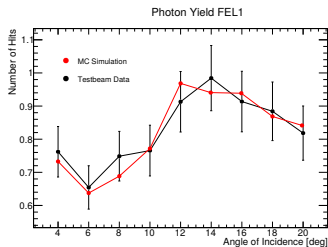
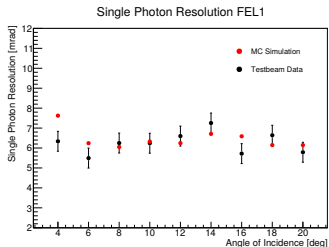


Y-Scan FEL2

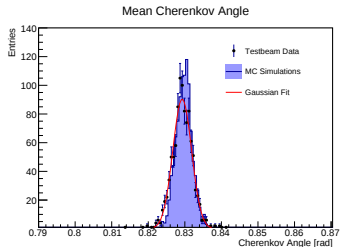
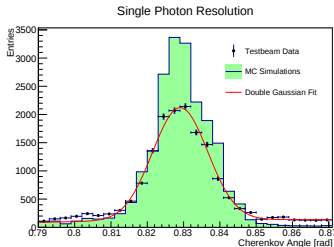


Testbeam Results

Single photon resolution and photon yield:



Event combination for vertical scan:



- Monte-Carlo studies for TDR regarding detector performance completed
- Reconstruction & PID algorithms ready and tested
- Successful Disc DIRC test in October 2016 at DESY testbeam
- Further tests for photon yield and single photon resolution in cosmics test stand possible
- Benchmark channel analysis in progress
- Studies regarding online reconstruction promising and ongoing

**Thank you very much for
your attention!**