Status of Barrel DIRC Prototype Test Beam Data Analysis

Grzegorz Kalicy

GSI, Darmstadt
Goethe Universität Frankfurt

PANDA Collaboration Meeting
at GSI
March 6, 2012

Andreas Gerhardt, Klaus Götzen, Dorothee Lehmann, Maria Patsyuk, Klaus Peters, Georg Schepers, Carsten Schwarz, Jochen Schwiening, Marko Zühlsdorf

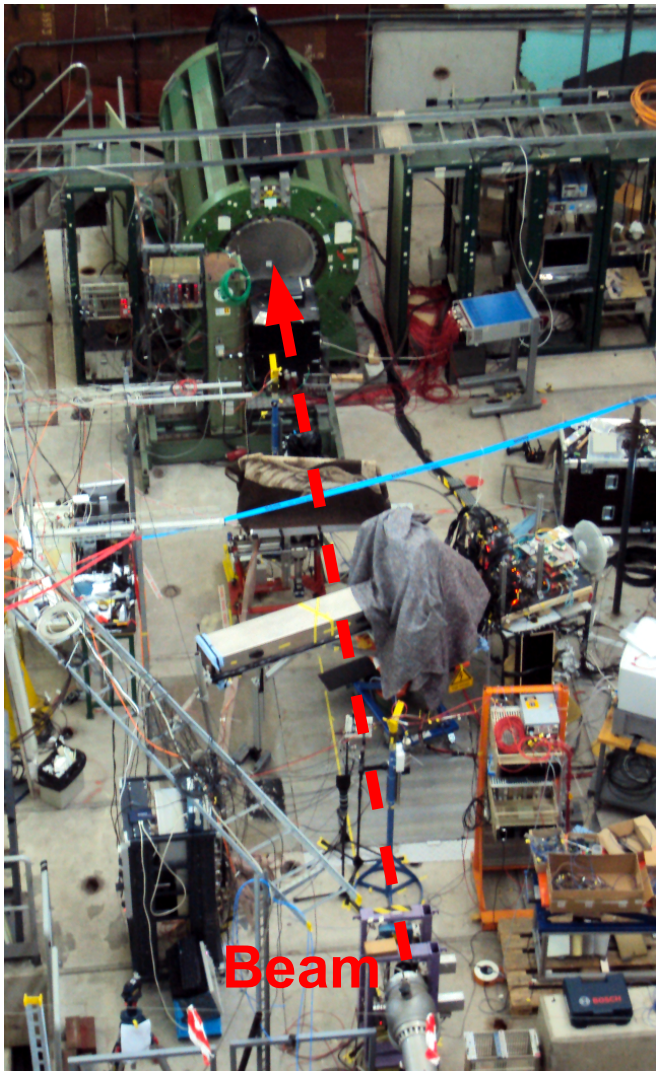
CERN Test Beam July 9-21, 2011

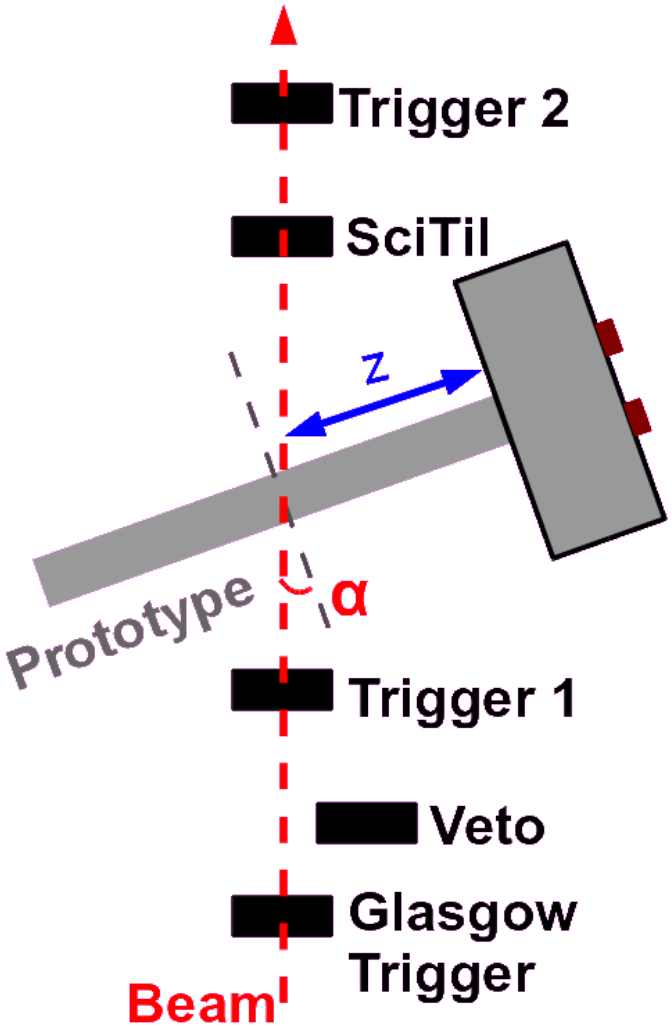
Activities:

- 3 Prototypes:
  - CLAS 12 RICH
  - PANDA Disc DIRC
  - PANDA Barrel DIRC
- 25 participants from 8 institution

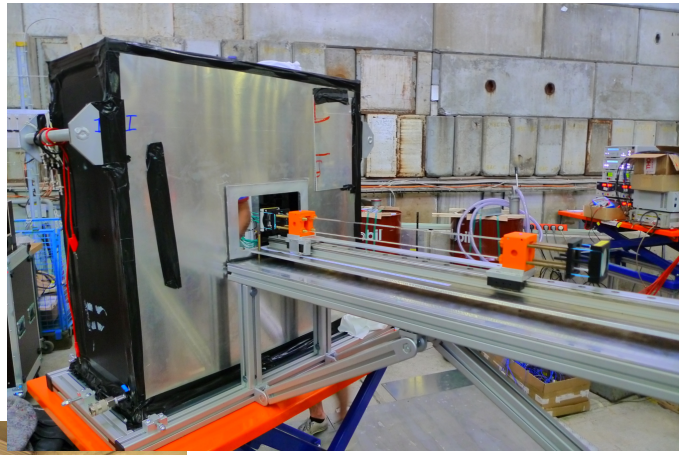
Beam in T9 Test Facility:

- 24h per day
- Electron or hadron rich
- Momentum 1.5–10 GeV/c
- 3 pulses per supercycle





Barrel DIRC Prototype Setup



- **Prototype:**

· Fused silica radiator bar in aluminum container
· Expansion volume (800 mm x 800 mm x 300 mm) filled with 190 liter Marcol 82 oil

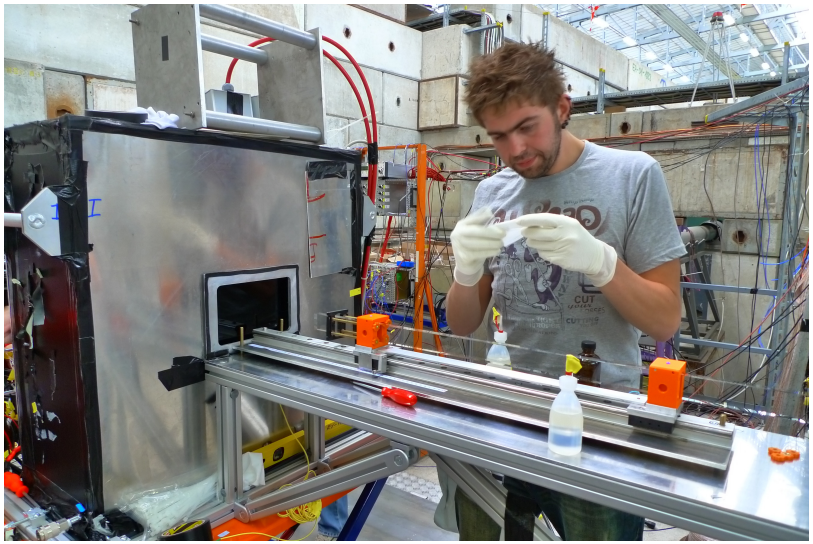
- **Movable masks for Sensors:**

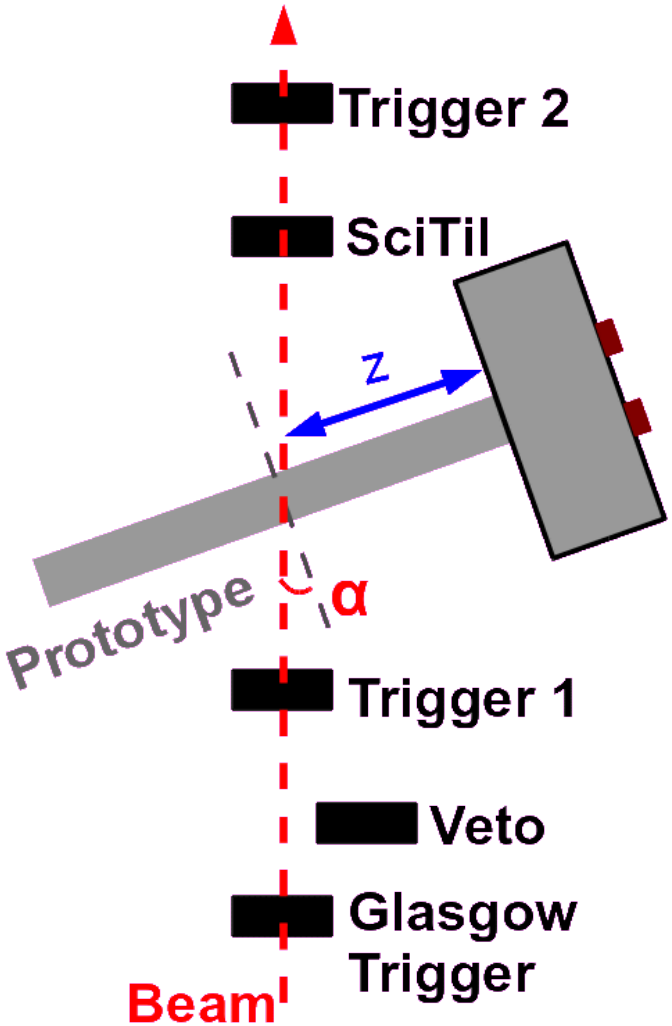
· 13 different detectors
(7x Photonis XP85012,
1x Photonis XP85112, 1x Hamamatsu H8500,
1x Hamamatsu H9500, 2x Hamamatsu SL10,
1x SiPM)

- **Read-out electronics:**

· 5 HADES trigger & readout boards (TRB) with TOF-addon (NINO)
· Three new boards (no additional amplifiers required)
· Total 640 channels

Barrel DIRC Prototype Goals





- **Study Cherenkov angle resolution**
- **Test new data acquisition system**
- **Verify that pattern is Cherenkov-like:**
  Different incidence angles (-30°, 20°, 0°, 30°)
- **Check timing:**
  Different **Z** beam position (110 mm, 183 mm, 365mm)

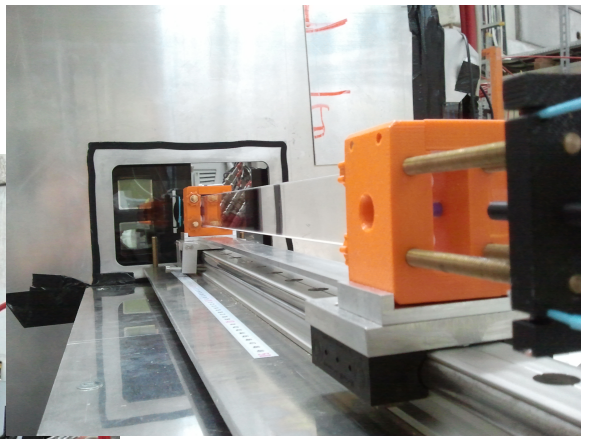
- **Today: only preliminary results**

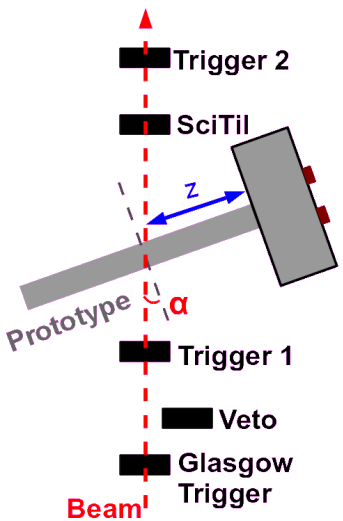
Barrel DIRC Prototype Setup changes during test beam

130M triggers (coincidence of two scintillating counters)

- Started with 30°
- First rings seen immediately
- Changed to -30° and back to 30°
- Changed to 0° (different mask)
- Improvement by coupling MCPs with optical grease
- Changed bar
- Changed prototype position in **z** (110 mm, 183 mm, 365 mm)
- Moved to 20°

- Used mostly 10 GeV/c beam (only short time with lower momentum)



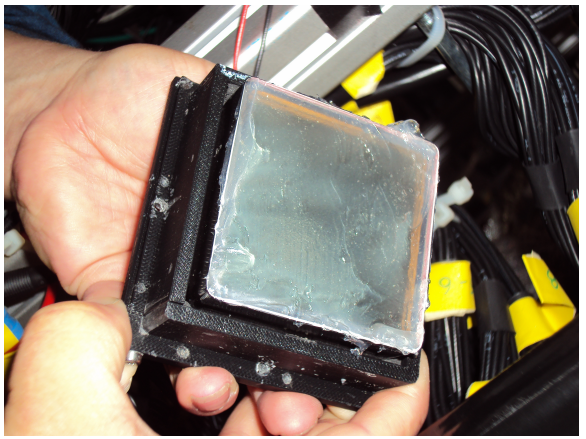


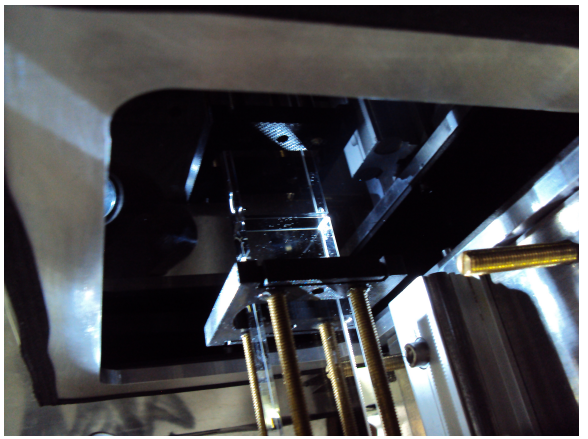
Barrel DIRC Prototype Setup changes during test beam

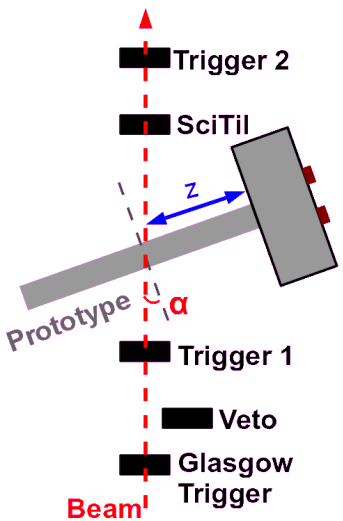
130M triggers (coincidence of two scintillating counters)

- Started with 30°
- First rings seen immediately
- Changed to -30° and back to 30°
- Changed to 0° (different mask)
- Improvement by coupling MCPs with optical grease
- Changed bar
- Changed prototype position in **z** (110 mm, 183 mm, 365 mm)
- Moved to 20°

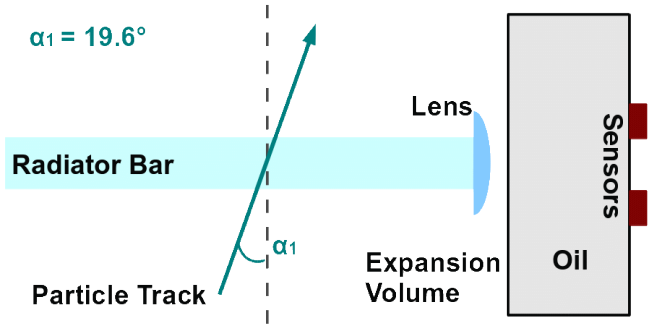
- Used mostly 10 GeV/c beam (only short time with lower momentum)



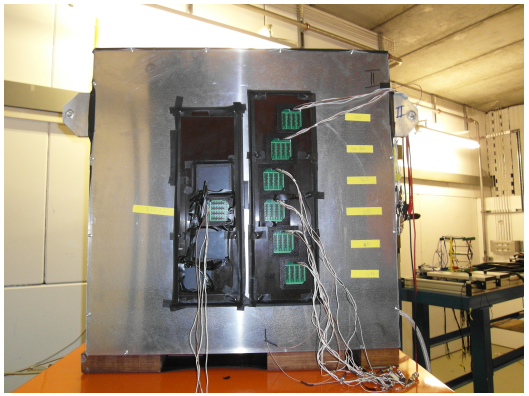


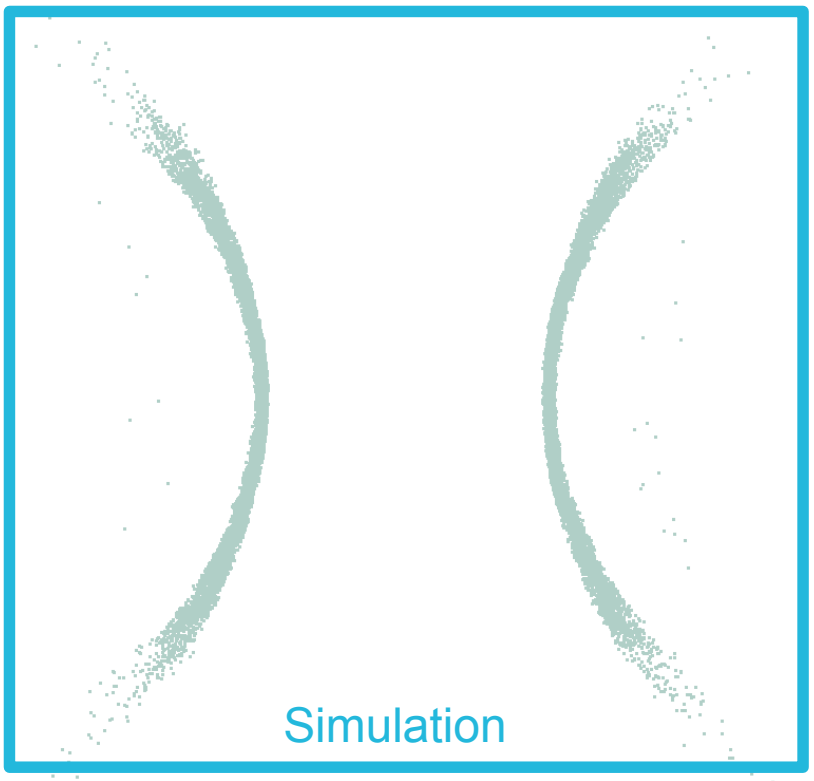


Barrel DIRC Prototype Mask preparation

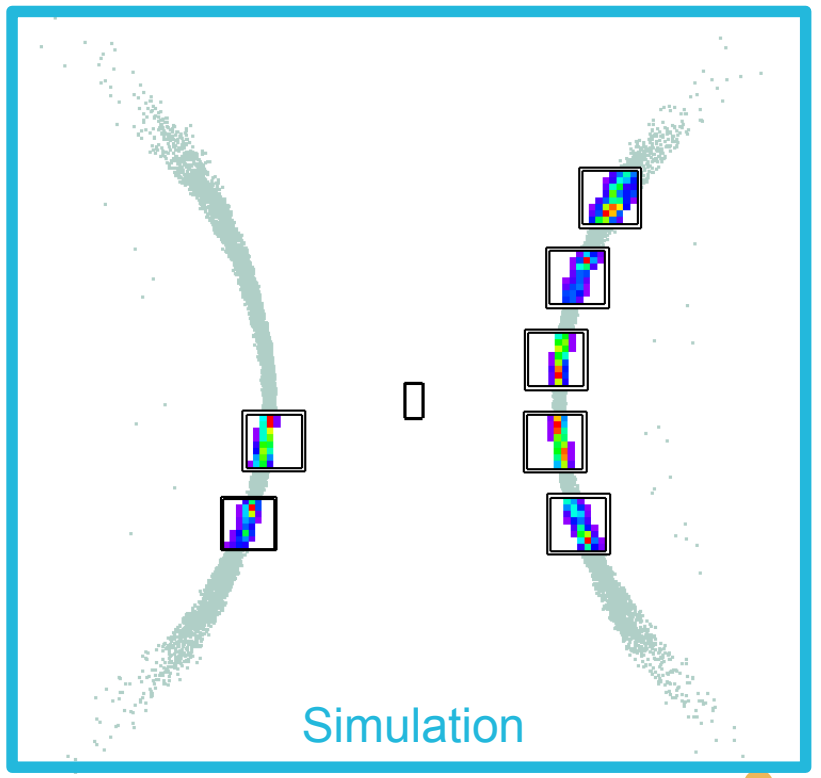


- Simulation using drcprop
- Expected pattern on imaging plane (y:x)

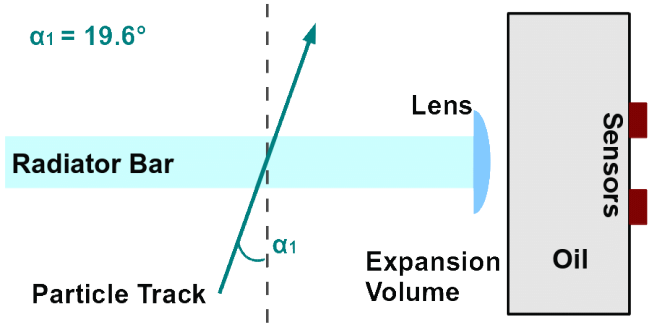




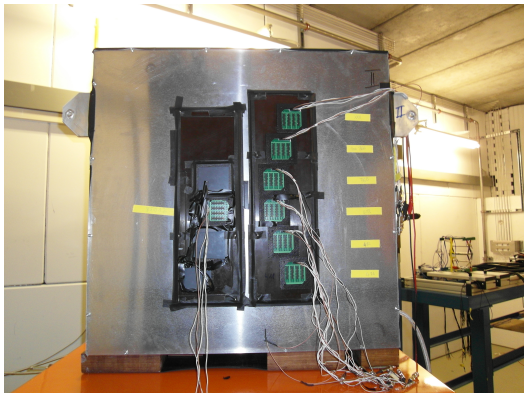
pixelization

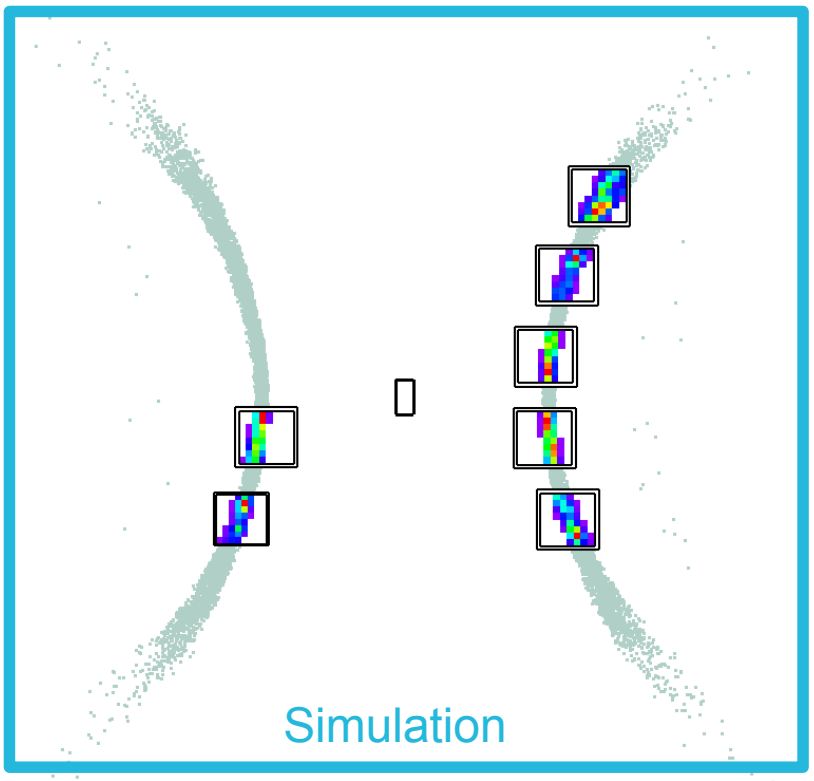


Data Analysis Occupancy plots



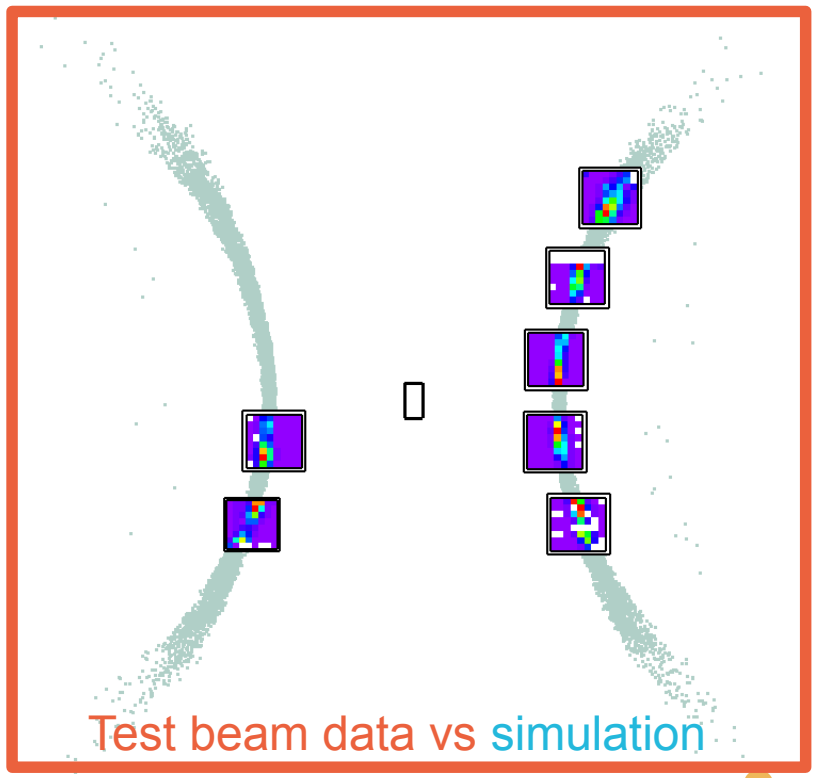
- Observed occupancy for example run compared to pattern from simulation





Comparison

simulation to test beam data

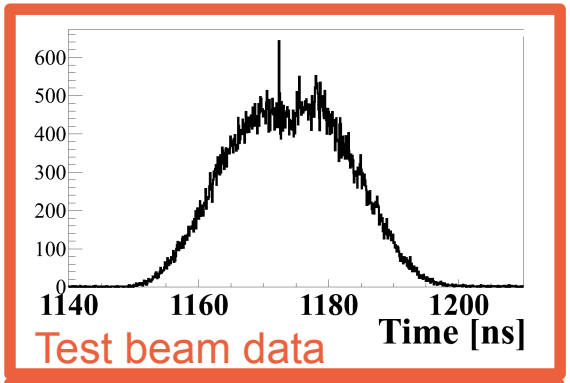


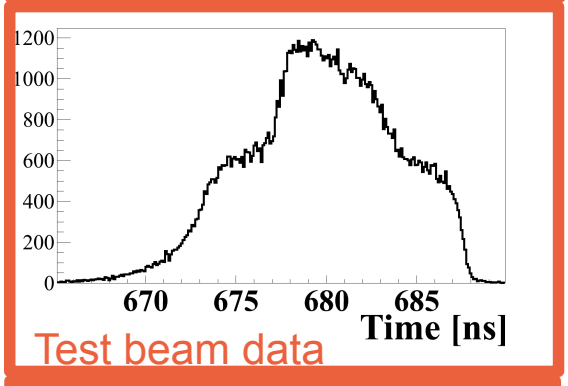
Data Analysis Typical time resolution for one pixel

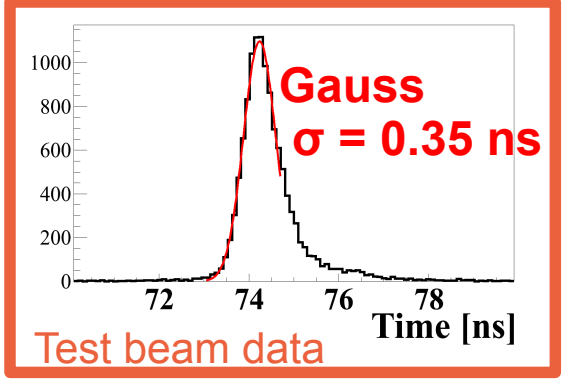
- **Raw signal:**
  RMS ~ 9 ns

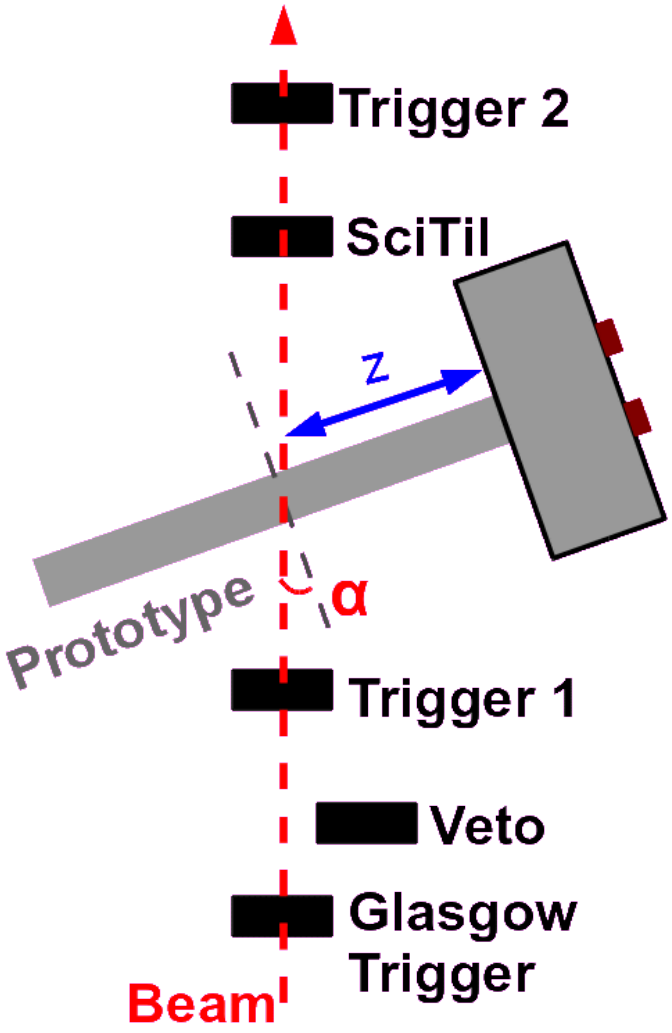
- **Raw signal minus TRBs reference time:**
  RMS ~ 4 ns

- **Using beam counter as reference:**
  RMS ~ 400 – 600 ps

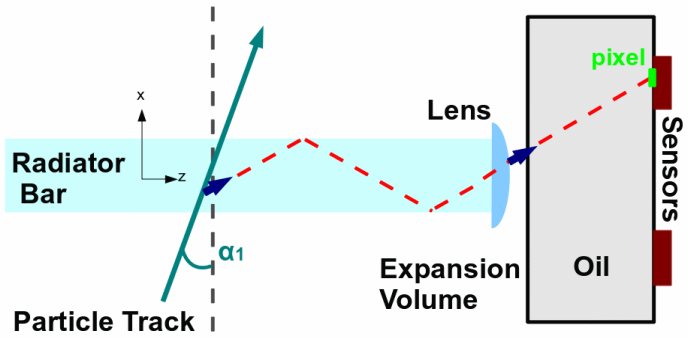


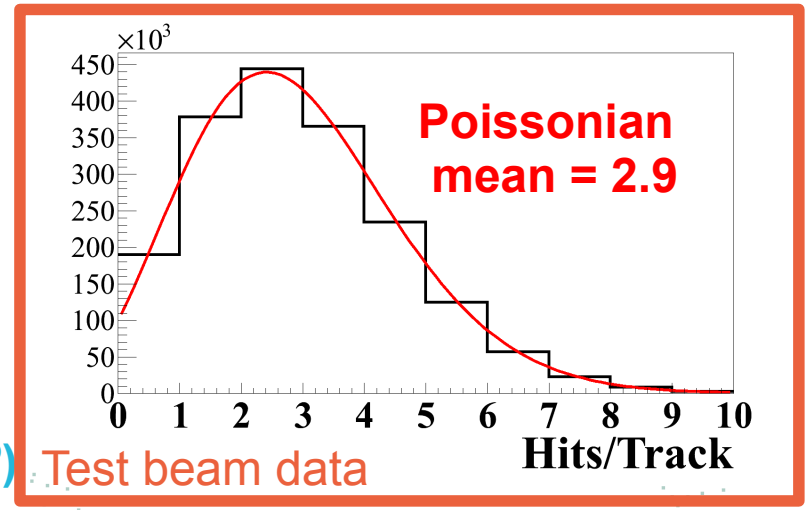




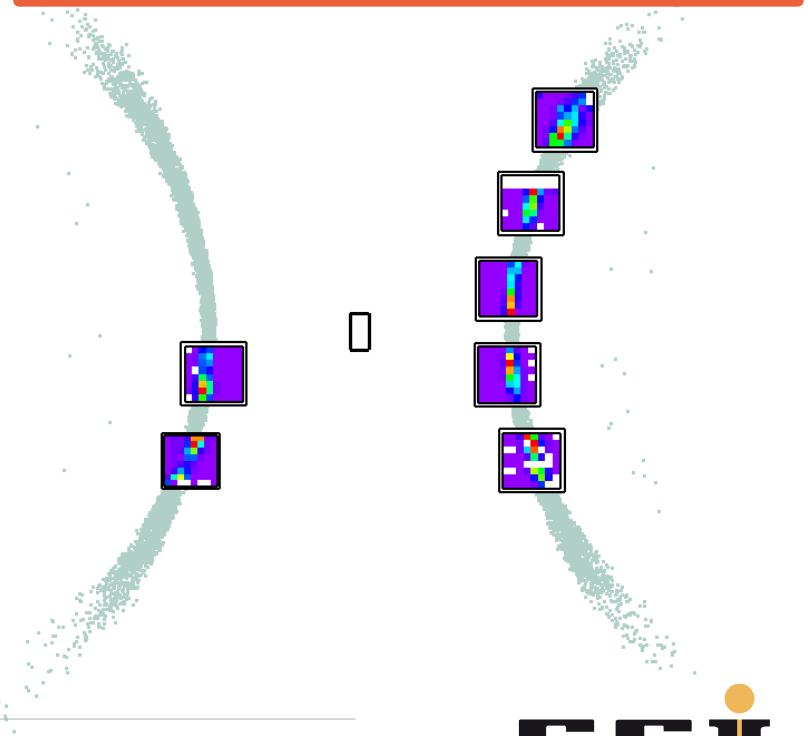


Data Analysis Number of hits per track

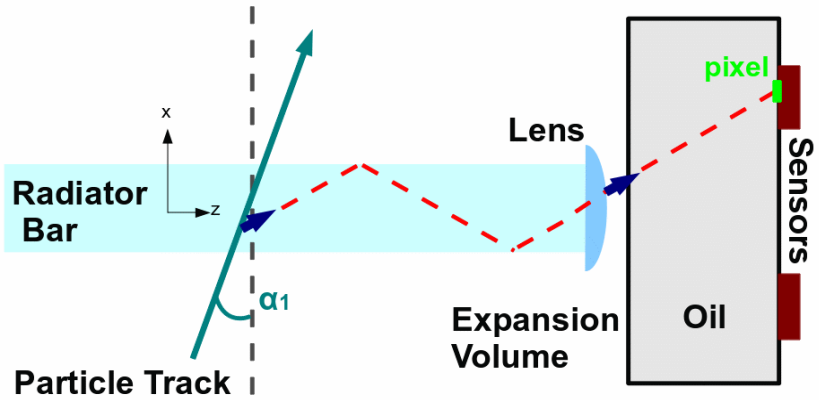


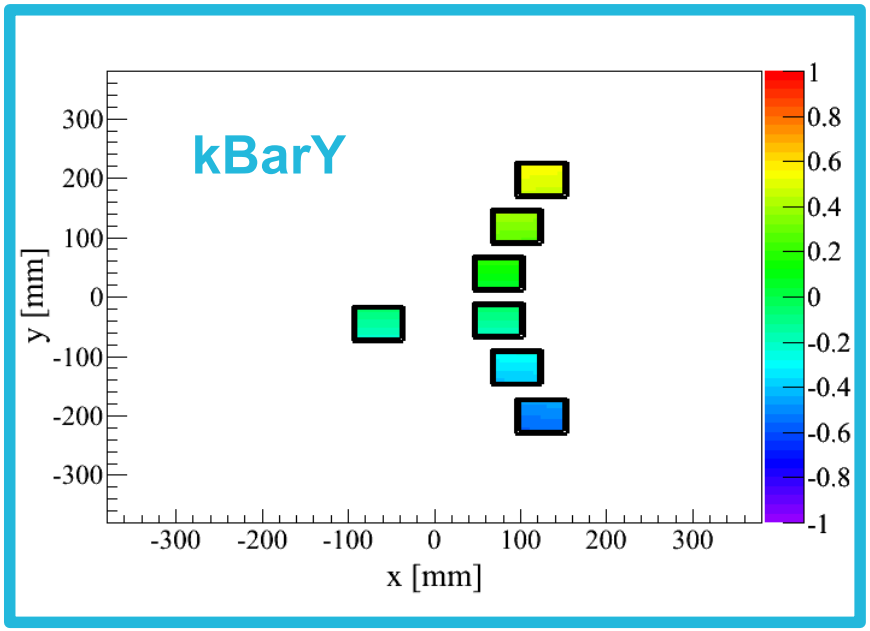


- **Simulation: 800 photons generated per track (19.6°)** (as given by Frank-Tamm equation)
- **~ 7.8 photons detected in simulation**
  - ~59% of photons propagate until bar end
  - ~25% enters expansion volume
  - ~20% hit detector plane
  - ~9.2% hit MCPs
  - ~0.9% measured
- **Test beam data ~ 2.9 photons measured**
- Difference between test beam data and simulation not yet understood (gain variation, detection efficiency, oil/coupling quality...)



Data Analysis Cherenkov angle reconstruction method

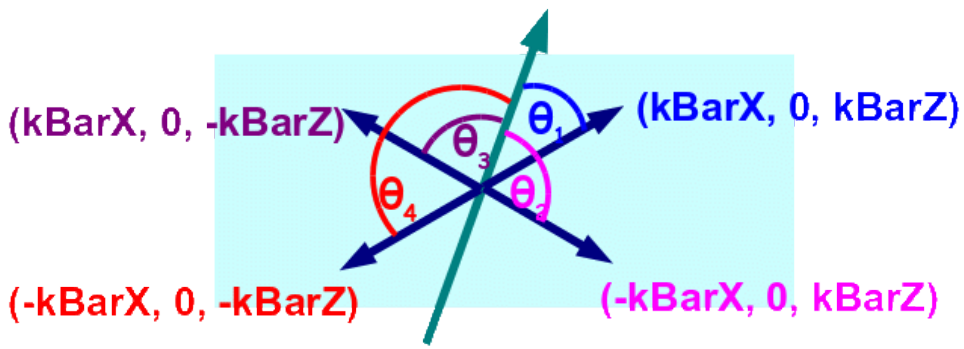




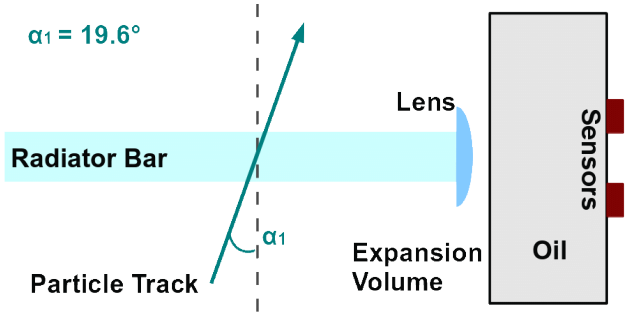
Standard BaBar method:

- Pixel position + bar location defines photon direction at bar end (kBar), stored in “Look-up table”, combined with particle track to calculate Θ_C

- Dealing with ambiguities:
  - Physical angle range
  - Expected time of photon arrival

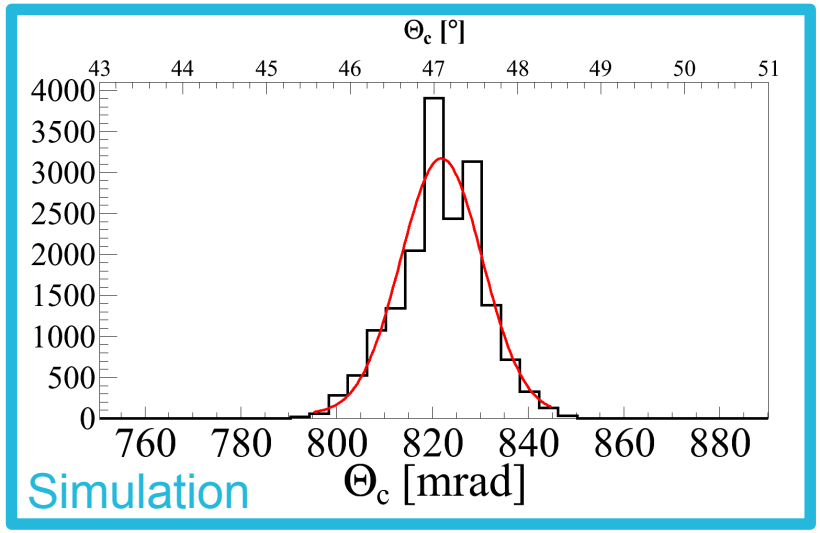


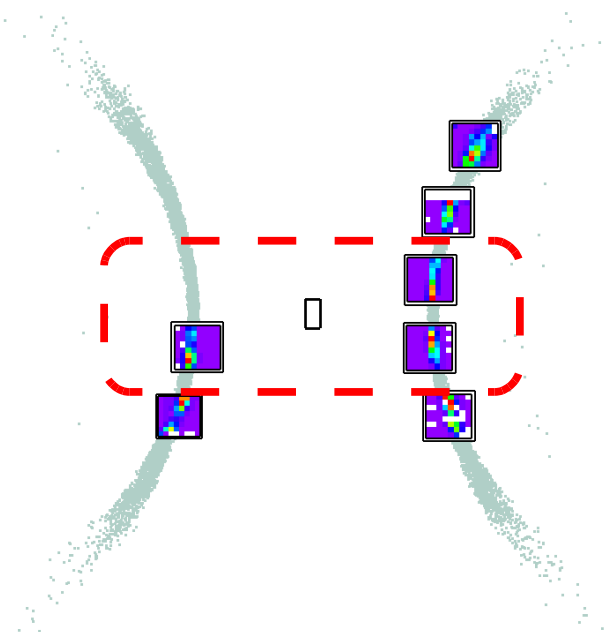
Data Analysis Single photon Cherenkov angle reconstruction



- 10 GeV/c pions
- **Expected Θ_C = 821.9 mrad**

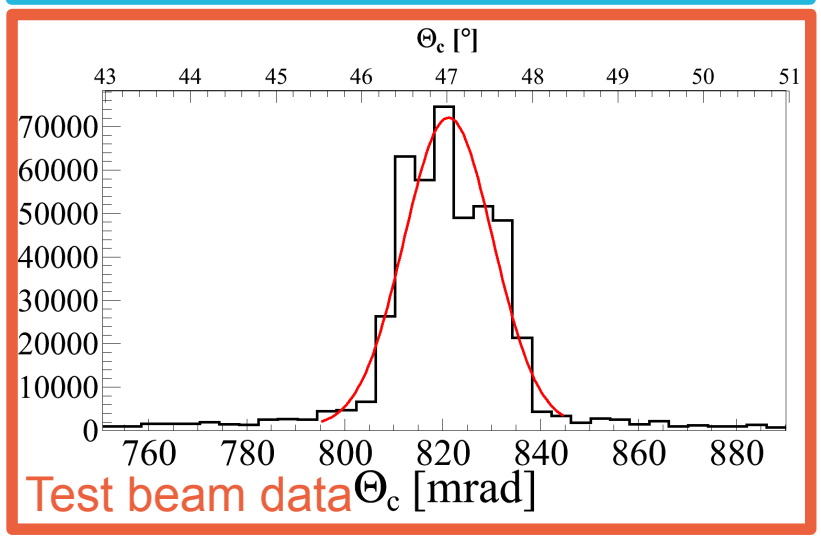
- **Simulation:**
  - **Θ_C = 821.9 mrad**
  - **$\sigma_{\Theta C}$ = 8.5 mrad**



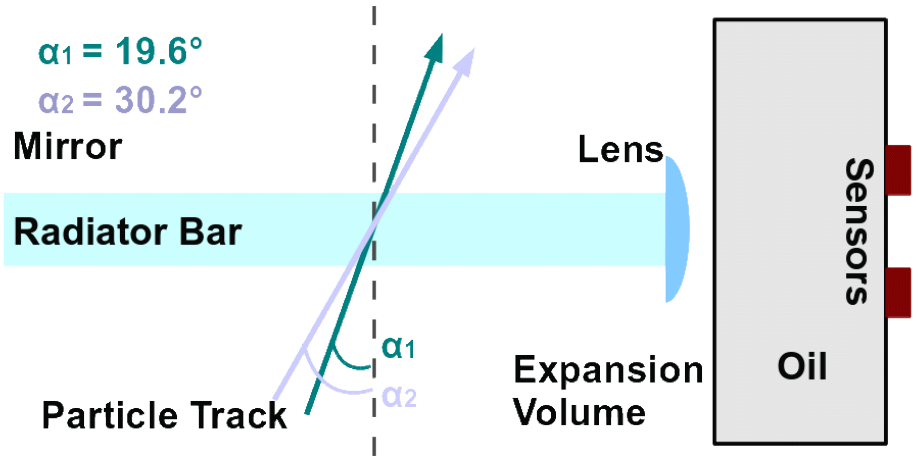


- **Test Beam Data:**
  - **Θ_C = 821.8 mrad**
  - **$\sigma_{\Theta C}$ = 9.0 mrad**

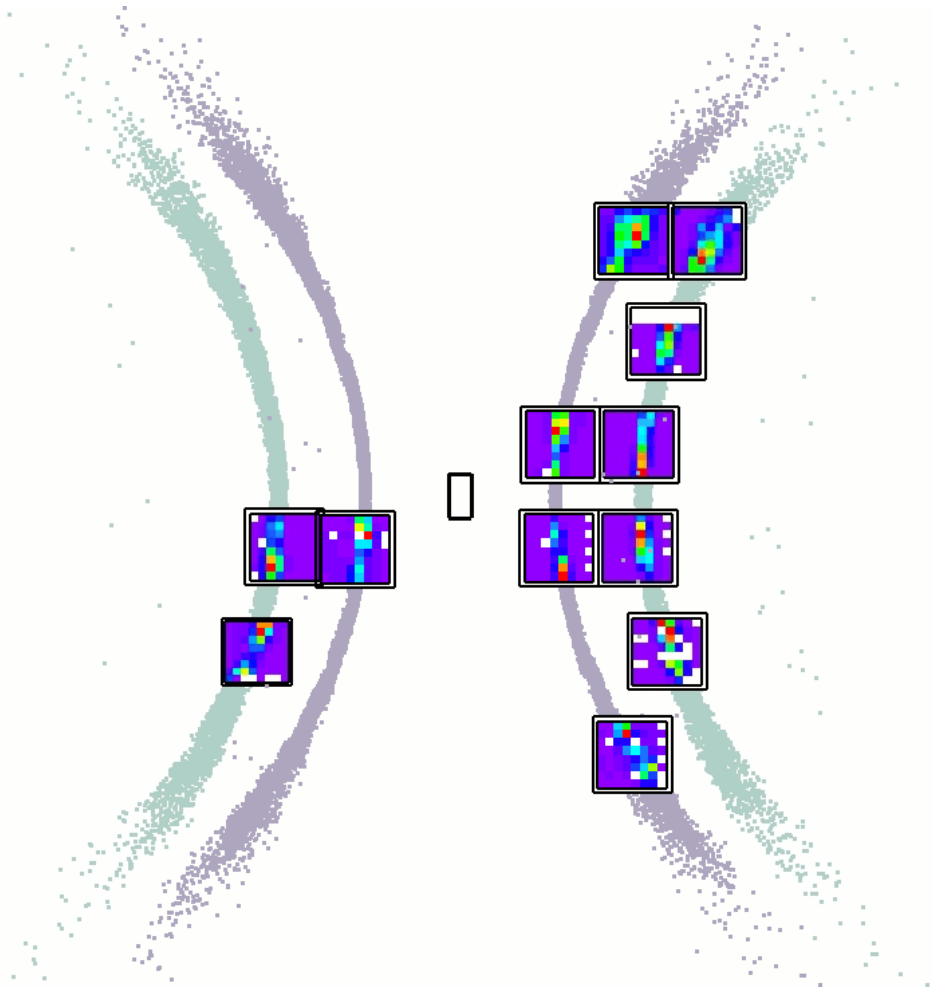
- Errors to be determined



Data Analysis Different incidence angle – Cherenkov ring

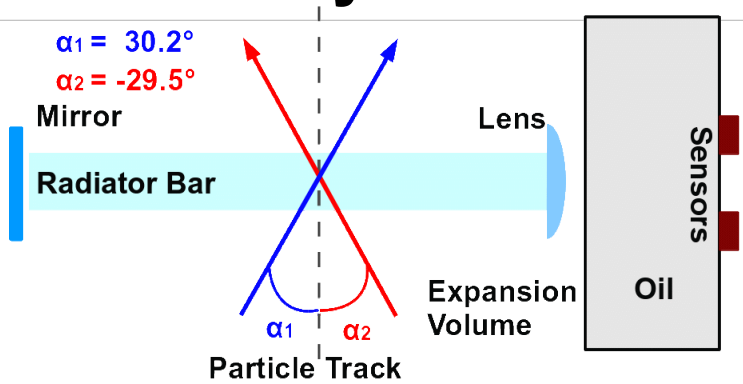


- 19.6º track angle
  - Θ_C = 821.8 mrad
  - $\sigma_{\Theta c}$ = 9.0 mrad
- 30.2º track angle
  - Θ_C = 821.2 mrad
  - $\sigma_{\Theta c}$ = 9.0 mrad

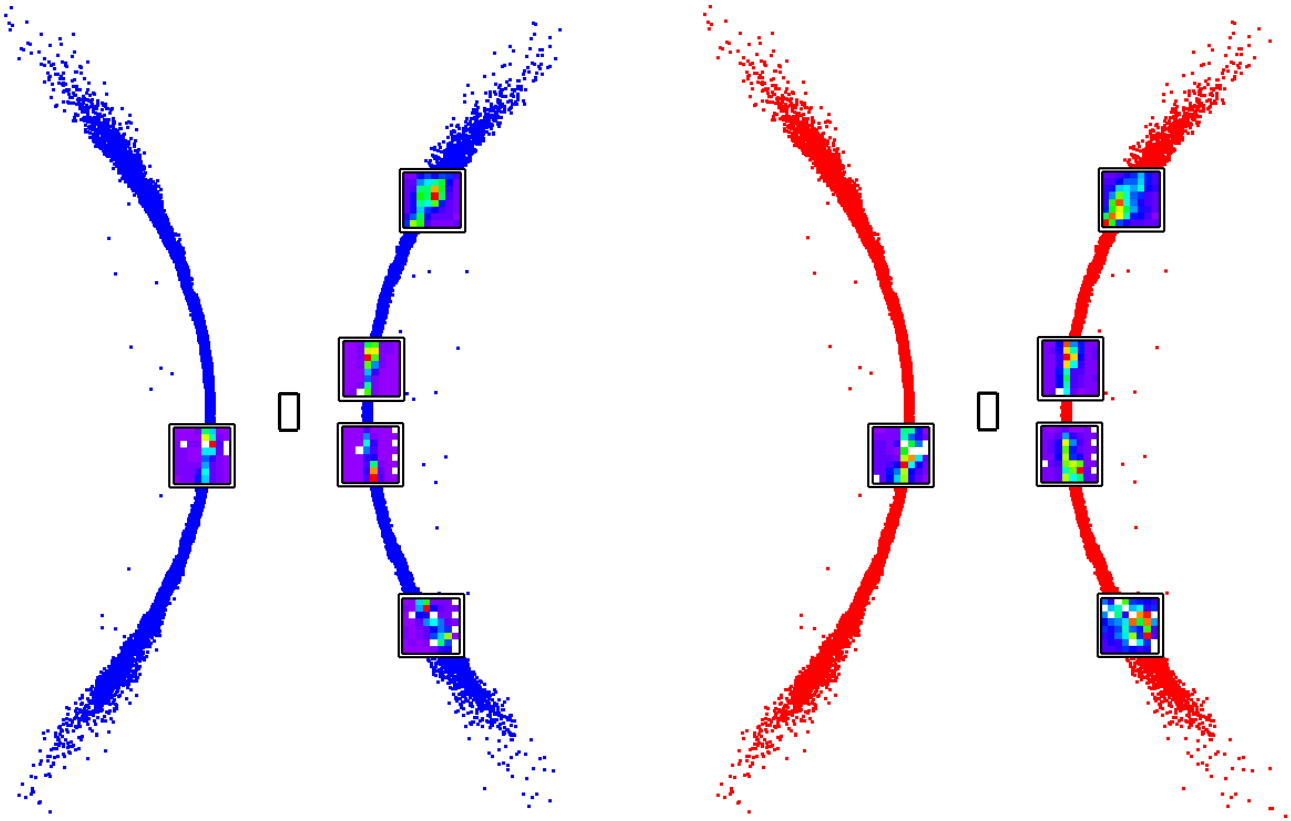


Composite view

Data Analysis Different incidence angle – occupancy plots

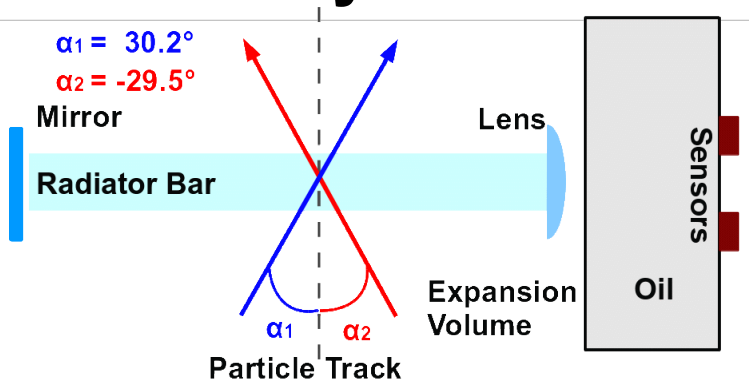


- Same mask – rings end up in the same location
- Reconstruction to be continued

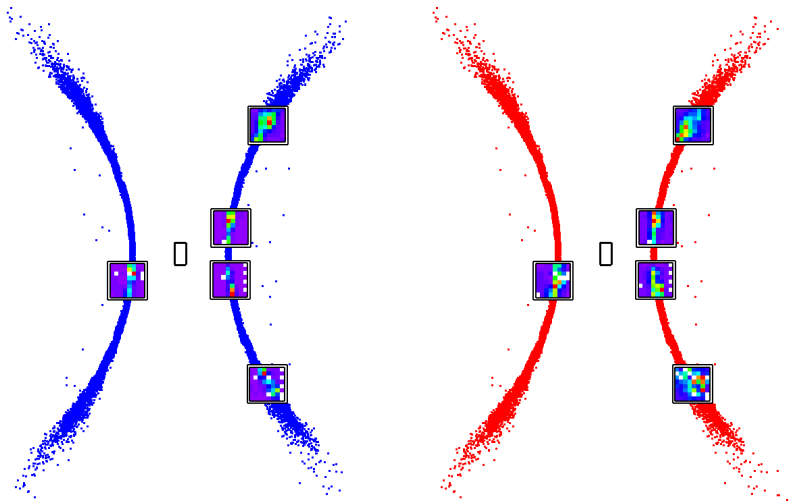


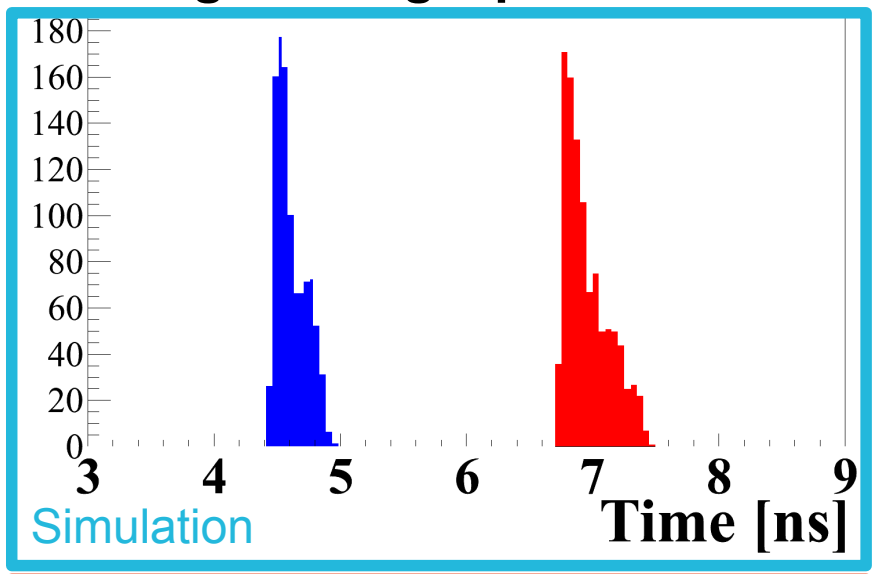
Data Analysis

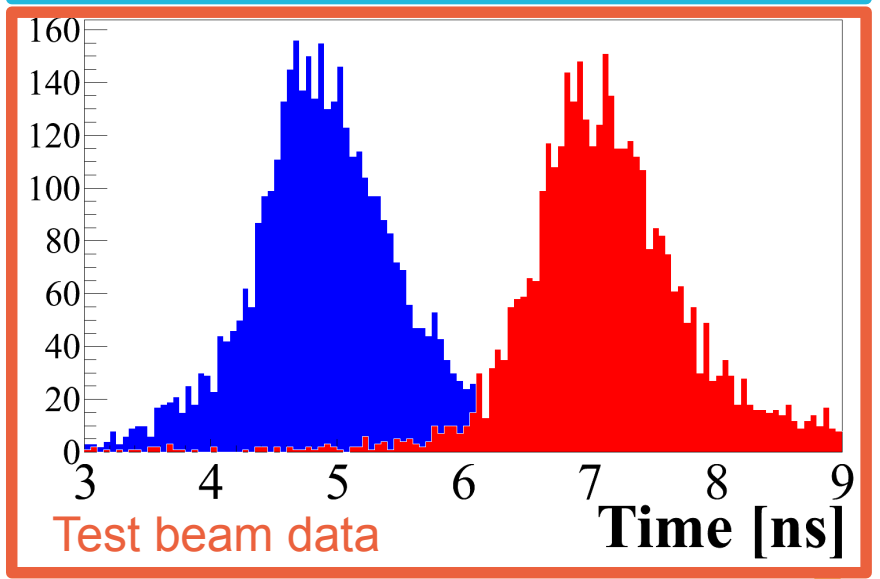
Different incidence angle – timing for single pixel



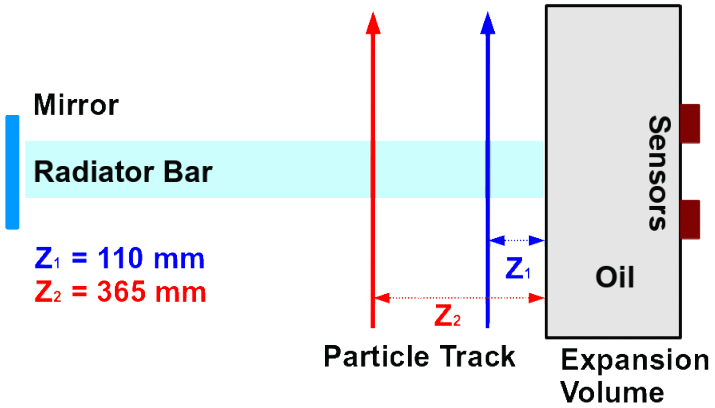
No trigger smearing in simulation

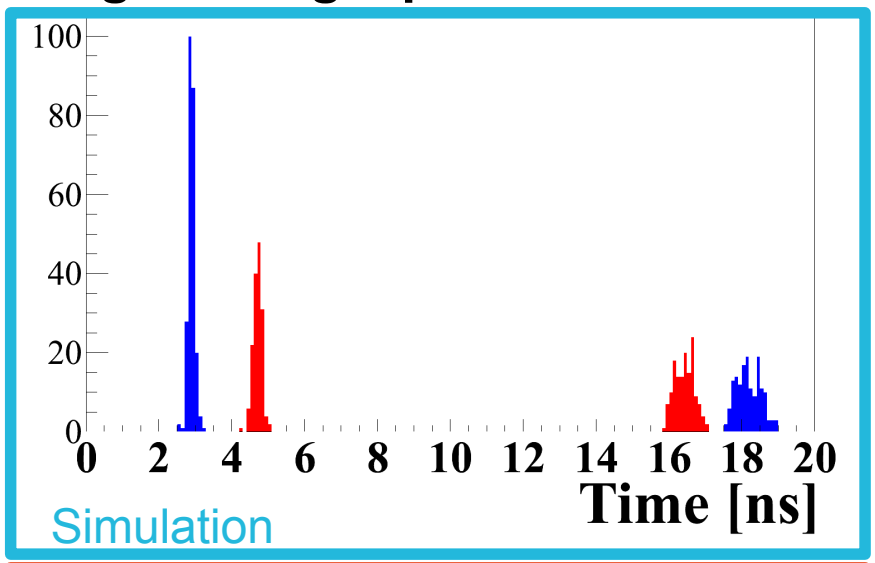




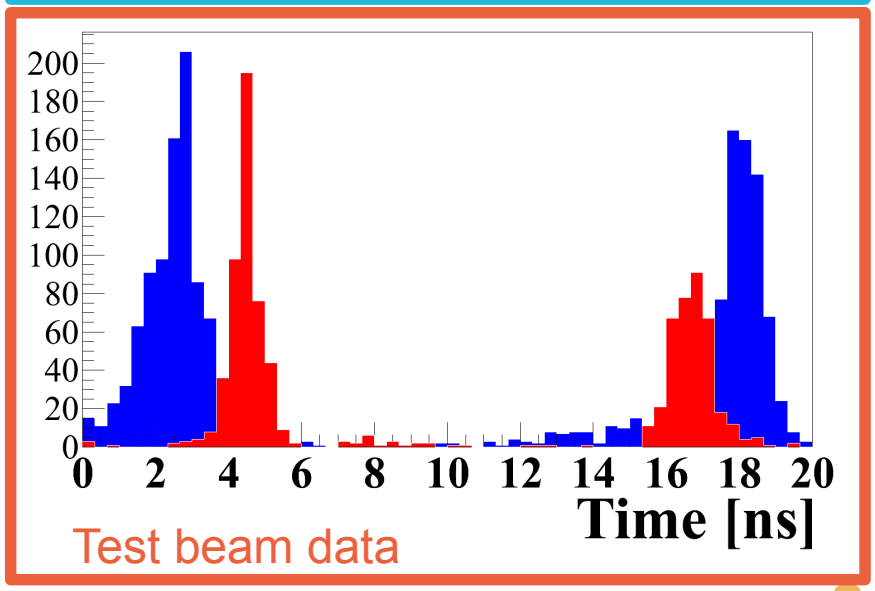


Data Analysis Different hit position – timing for single pixel





- Test beam data consistent with simulation
- Direct - reflected amplitude difference not yet understood



CERN Test Beam Data Summary & Outlook

- Verified that pattern is Cherenkov-like for different incidence angles (-30°, 20°, 0°, 30°)
- Observed 2.9 hits per track in data (7.8 in simulation)
- Checked timing with different Z beam positions (110 mm, 183 mm, 365mm)
- Measured single photon resolution $\sigma_{\Theta c}$= 9 mrad ($\sigma_{\Theta c}$= 8.5 mrad in simulation)

To do:

- Complete analysis
- Study charge sharing
- Prepare for 2012 Test Beam