Reconstruction Methods - PANDA FL-Disc DIRC

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Workshop on Fast Cherenkov Detectors - Justus-Liebig-Universität Giessen

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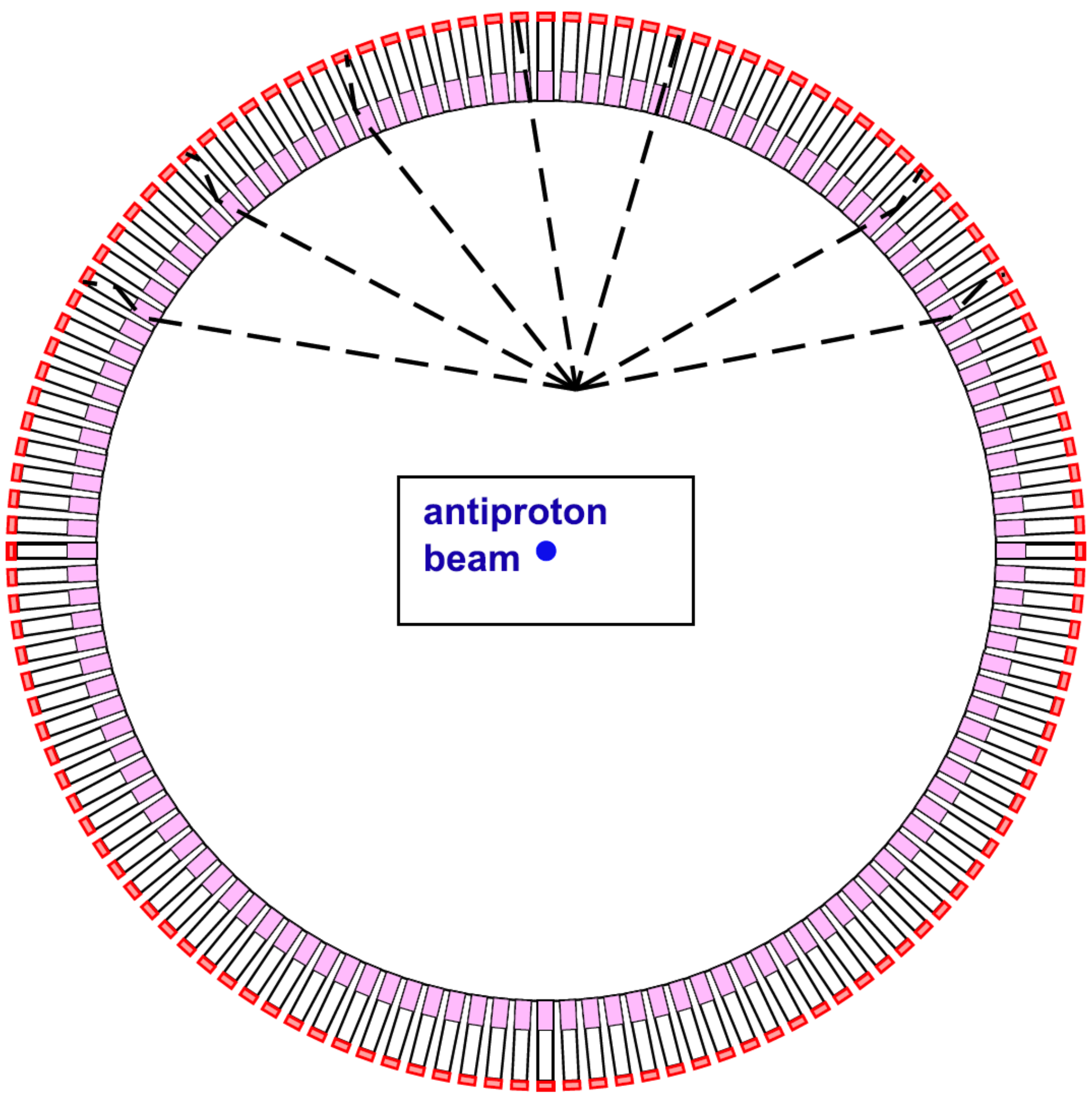
Talk Outline

- PID Overview in The Focussing Lightguide Disc DIRC
- Reconstruction Methods
  - Track Independent
  - Track Dependent
- PandaROOT Software Status
- Future Plans

PID in the Focussing Lightguide Disc DIRC



- Main task π/K/p separation
- High interaction rates, high magnetic field
- Trigger-less operation
- Improve on existing DIRC designs
    - ➡ Chromatic dispersion of Cherenkov light
- Pattern recognition for PID

PID in the Focussing Lightguide Disc DIRC

- Good PID requires 3 properties:
  - Reasonable number of photons - more photons gives a clearer pattern
  - Accurate pattern matching - degree obtained geometric object matches expected shape

  ➡ Accurate reconstruction of Cherenkov Angle used to identify particle

Chromatic dispersion   Multiple scattering   Radiator thickness

Cherenkov Angle Resolution

PID in the Focussing Lightguide Disc DIRC

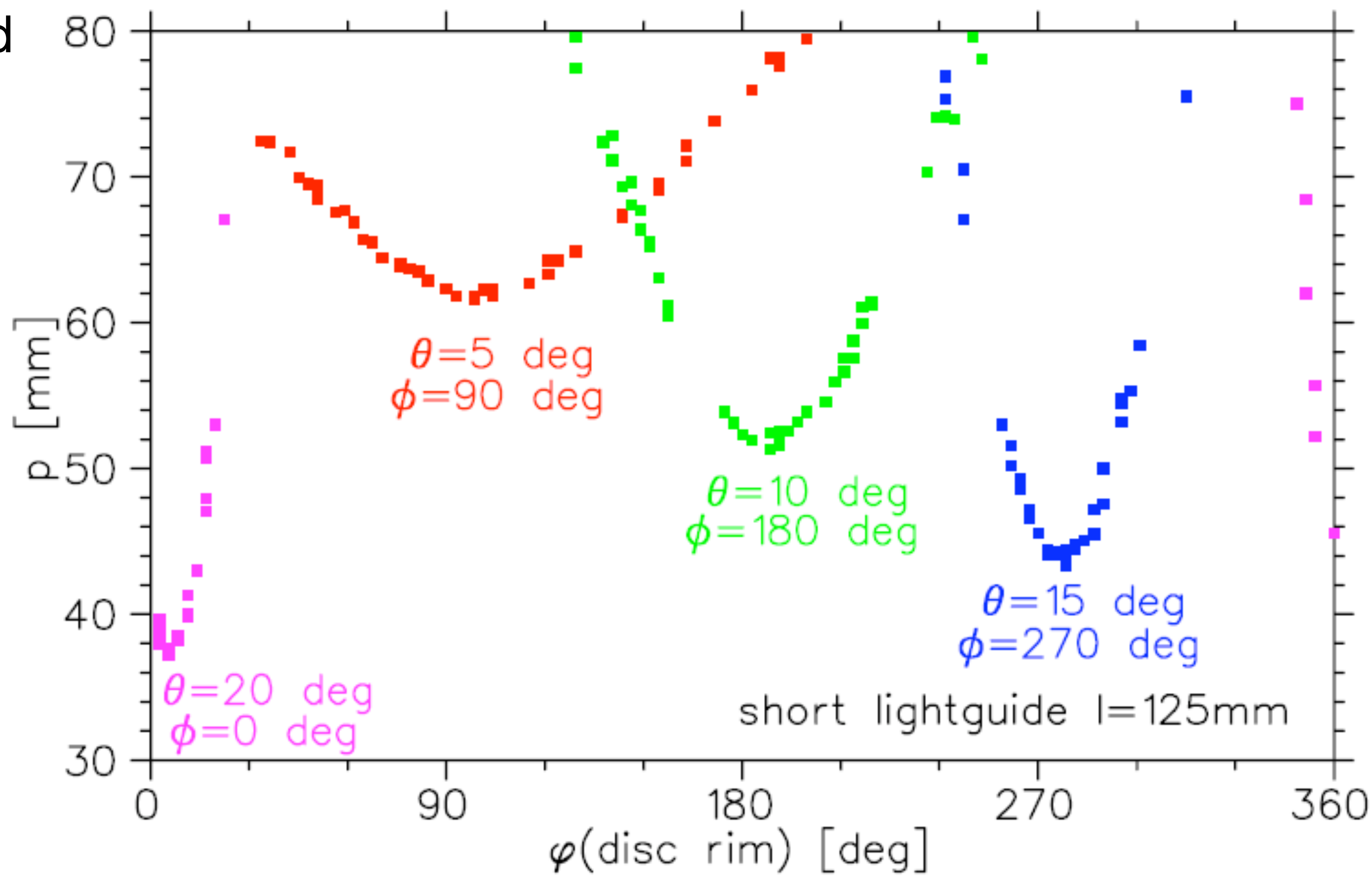
- 2D + t reconstruction information available
- Only 2D (ϕ + θ) needed
- Restrictions on pattern recognition:
    - Multiplicities
    - Expected pattern parameterisation
    - Noise - use time information to reduce background

Expected Patterns in the FL Disc DIRC

- Shape can parameterised as a hyperbola
- Most information in apex of pattern

  ➡ Use simplified shape parameterisation?

- Use time information to separate shapes



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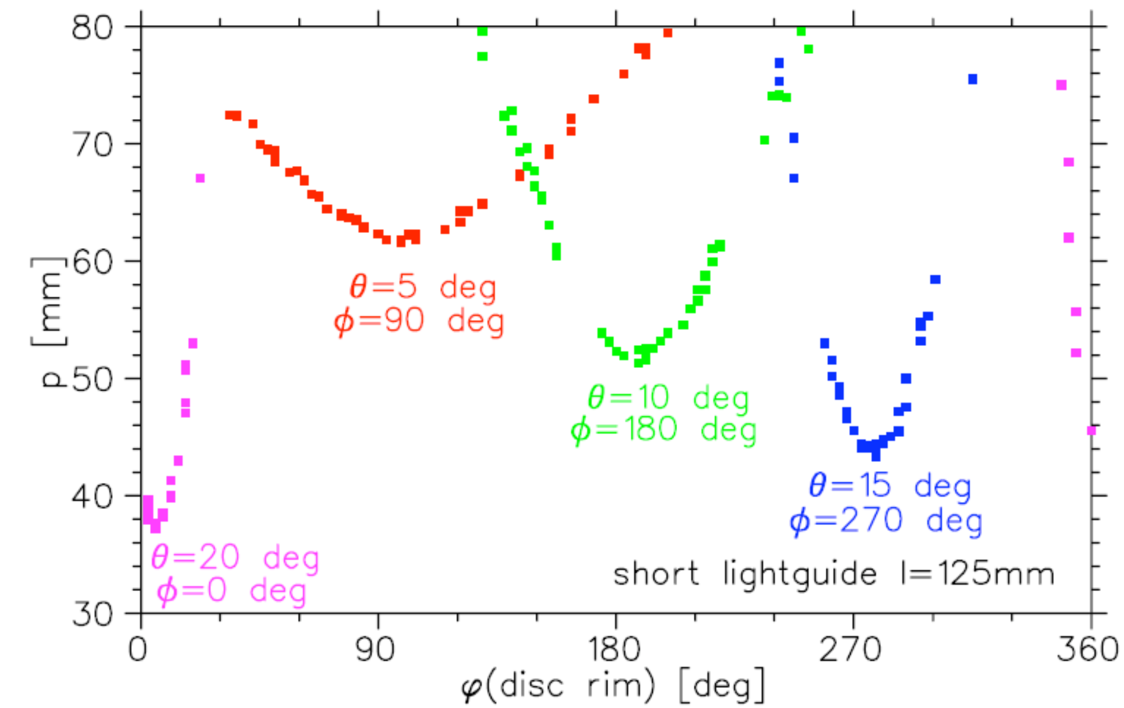
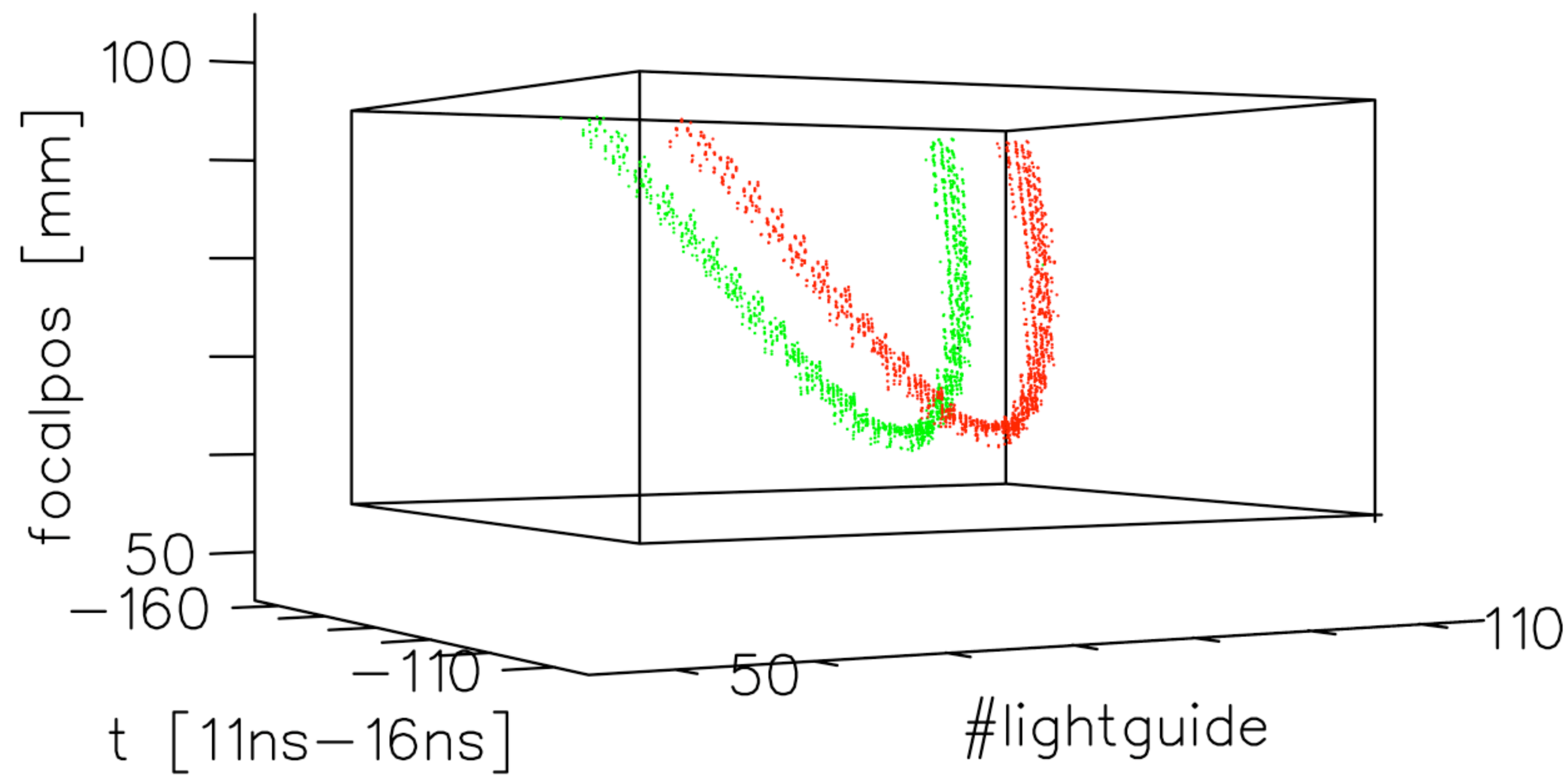




PID - Reconstruction Methods

- Need 2 reconstruction methods
  - Simple - fast, use for detector performance studies and commissioning
  - Complex - high performance, best PID results
- Things to consider:
  - Online or offline reconstruction?
  - Track independent or dependent?

Reconstruction Methods - Track Independent

- No reconstructed track information (vertex, angles, momentum...) used in PID
- Advantages: can run online and be used to reduce data rates
- Disadvantages:
  complex readout required - fast timing
  fast and accurate method needed
  limited space for onboard electronics for reconstruction
  requires good knowledge of detector and expected pattern shape
  difficult to seperate overlapping patterns
  noise - high likelihood of false PID results
- Example methods: Spatial Hough Transform, Elastic Net, Statistical Searches...

Reconstruction Methods - Track Dependent

- Reconstructed track information from the rest of the PANDA experiment (vertex, angles, momentum...) used in PID

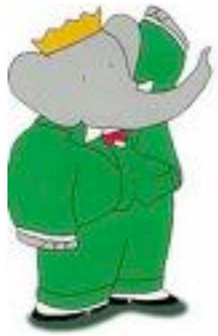
- Generally: possible Cherenkov angles for each particle type (usually generated from MC) are compared to measured Cherenkov angle
  ➔ most probable result gives identified particle

- Advantages: track parameters can limit search area, help reject noise
  fast algorithms
  parameterisation of expected pattern less important

- Disadvantages: must be carried out offline

- Example methods: (In)Direct Ray Tracing, Yield Determination, Pattern Comparison, Angular Hough Transform...

BABAR DIRC Maximum Likelihood Fit Method



- Following reconstruction of Cherenkov angle for each detected photon, maximum likelihood method used to identify particle

- 2 algorithms:
  local track-based ML - each track fitted individually, use for alignment

  global event-based ML - event fitted globally, highest performance
  - can also take into account noise, alignment

- ML easy to implement in PandaRoot framework

- Applicable to FL DISC DIRC?

PandaRoot Software Status

- Software framework for simulation and reconstruction of the PANDA experiment

- Code development for FL Disc DIRC started by Derek Glazier, University of Edinburgh

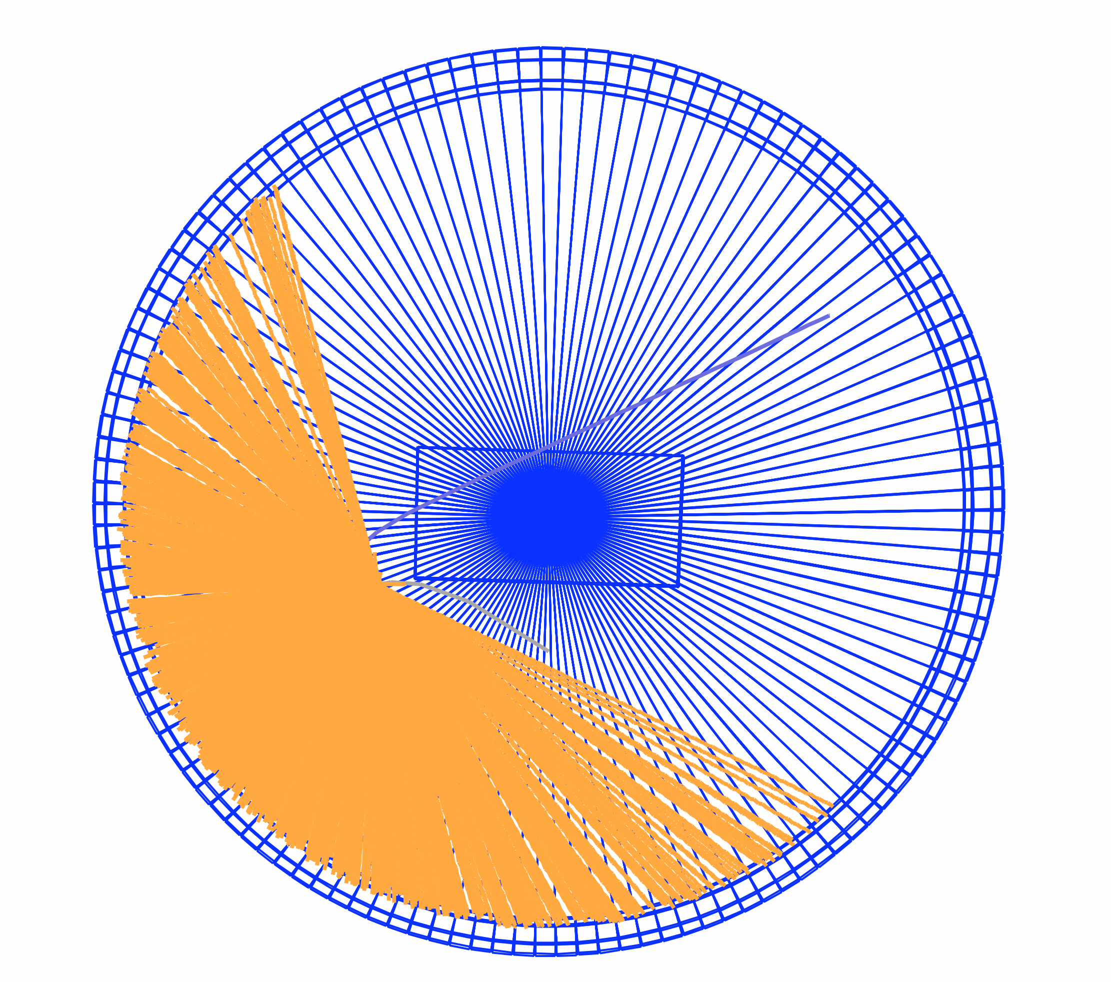
    ➡ Now taken over

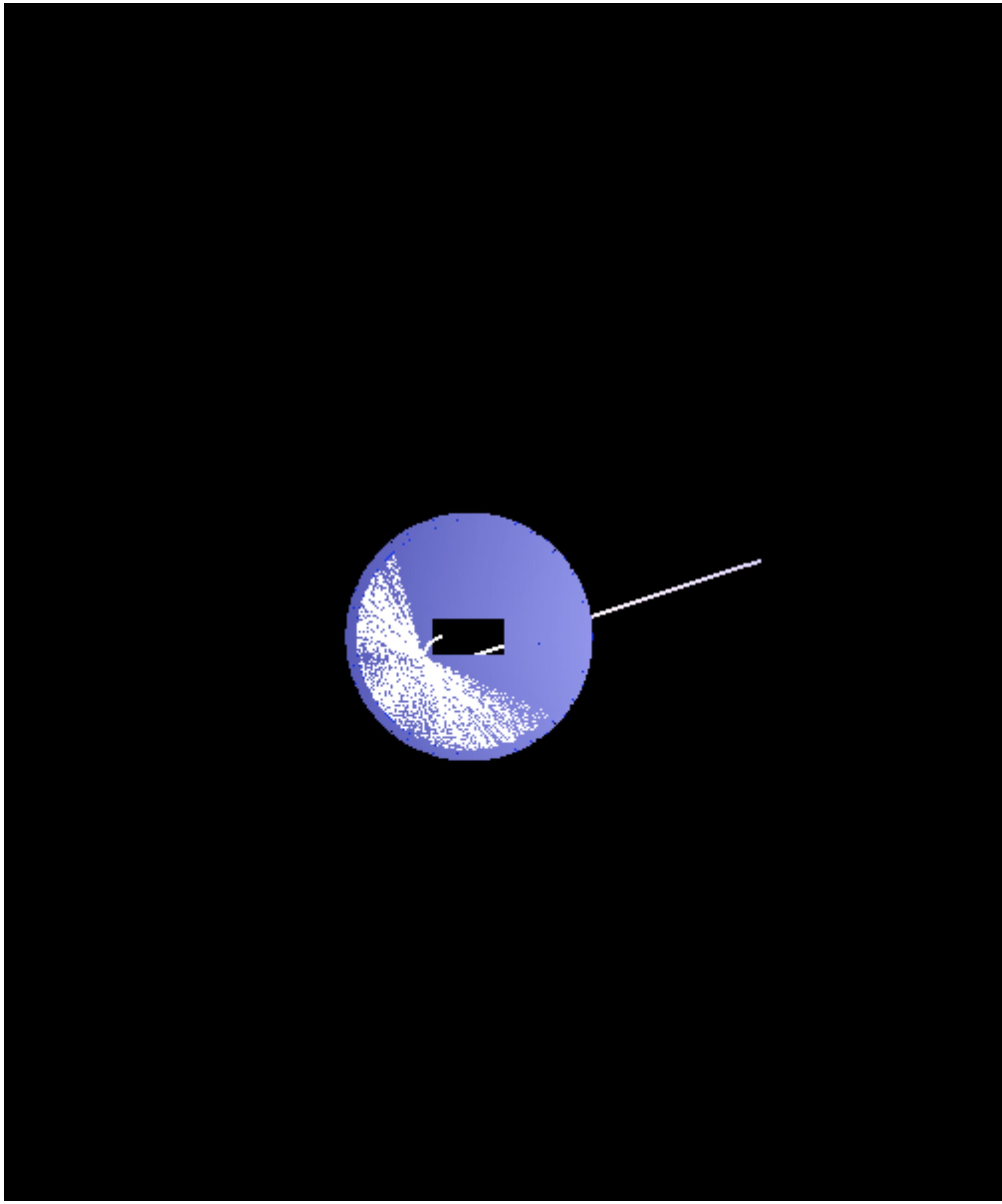
- Current status:

    ✓ Integrated into SVN repository

    - First MC description of detector written

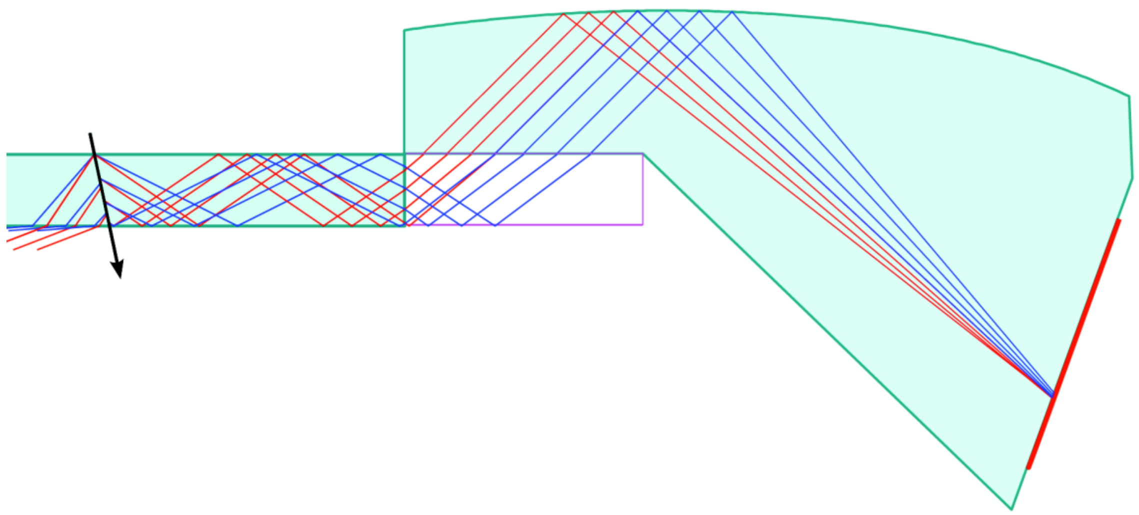
PandaRoot Software Status





Future Plans

- Decide on track independent or track dependent approach
- Choose optimum reconstruction method - ML Fit?
- Improve PandaRoot MC implementation
    - Implement finalised lightguide design



    - Improve simulation for reconstruction software development
- Pattern predictions for test experiments