JUSTUS-LIEBIG-UNIVERSITÄT GIESSEN

Updates of DISC Software

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HIC for FAIR
Helmholtz International Center

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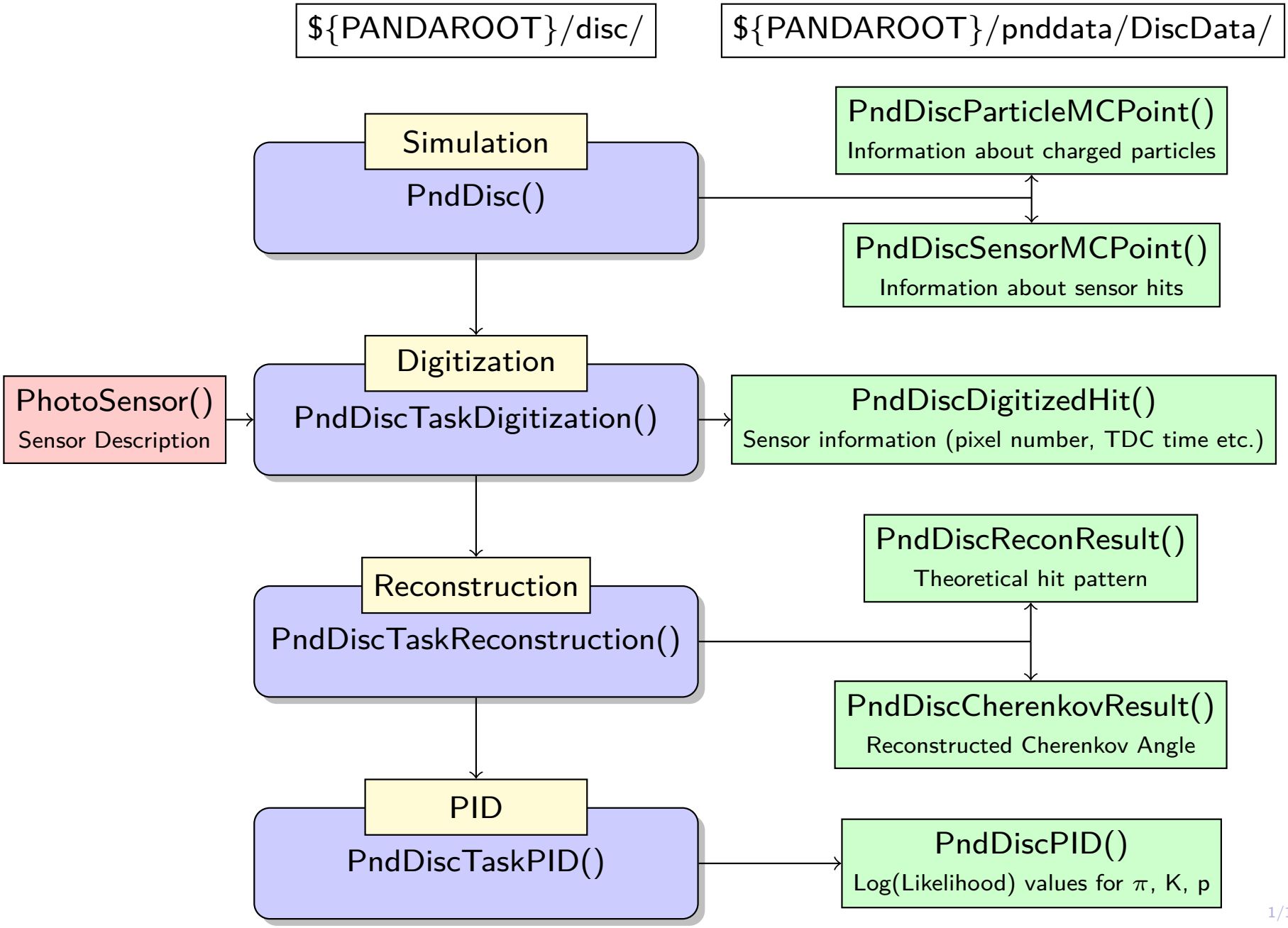
HGS-HIRe for FAIR
Helmholtz Graduate School for Hadron and Ion Research

Full Simulation Chain



Simulation Output

PndDiscSensorMCPoint()

- Photon Hit Position: fX, fY, fZ
- Photon Entering Position: photon_entering_pos (fX, fY, fZ)
- Photon Hit Momentum: fPx, fPy, fPz
- Photon Entering Momentum: photon_entering_mom (fX, fY, fZ)
- Reflection Angle: internal_reflecting_angle

PndDiscParticleMCPoint()

- Particle Incoming Position: fX, fY, fZ
- Particle Outgoing Position: pos_out (fX, fY, fZ)
- Particle Incoming Momentum: fPx, fPy, fPz
- Particle Outgoing Momentum: mom_out (fX, fY, fZ)
- PDG Code: pdgCode
- Particle Charge: charge
- Particle Mass: mass

Digitization, Reconstruction, PID Output

PndDiscTaskDigitization()

- Detector ID: detector_id
- Readout ID: readout_id
- Sensor ID: sensor_id
- Pixel Number: pixel_number
- Pixel Position: pixel_position
- TDC Time: tdc_time

PndDiscReconResult()

- Sensor ID: sensor
- Pixe ID: pixel
- Time: time
- Hypothesis: hypothesis

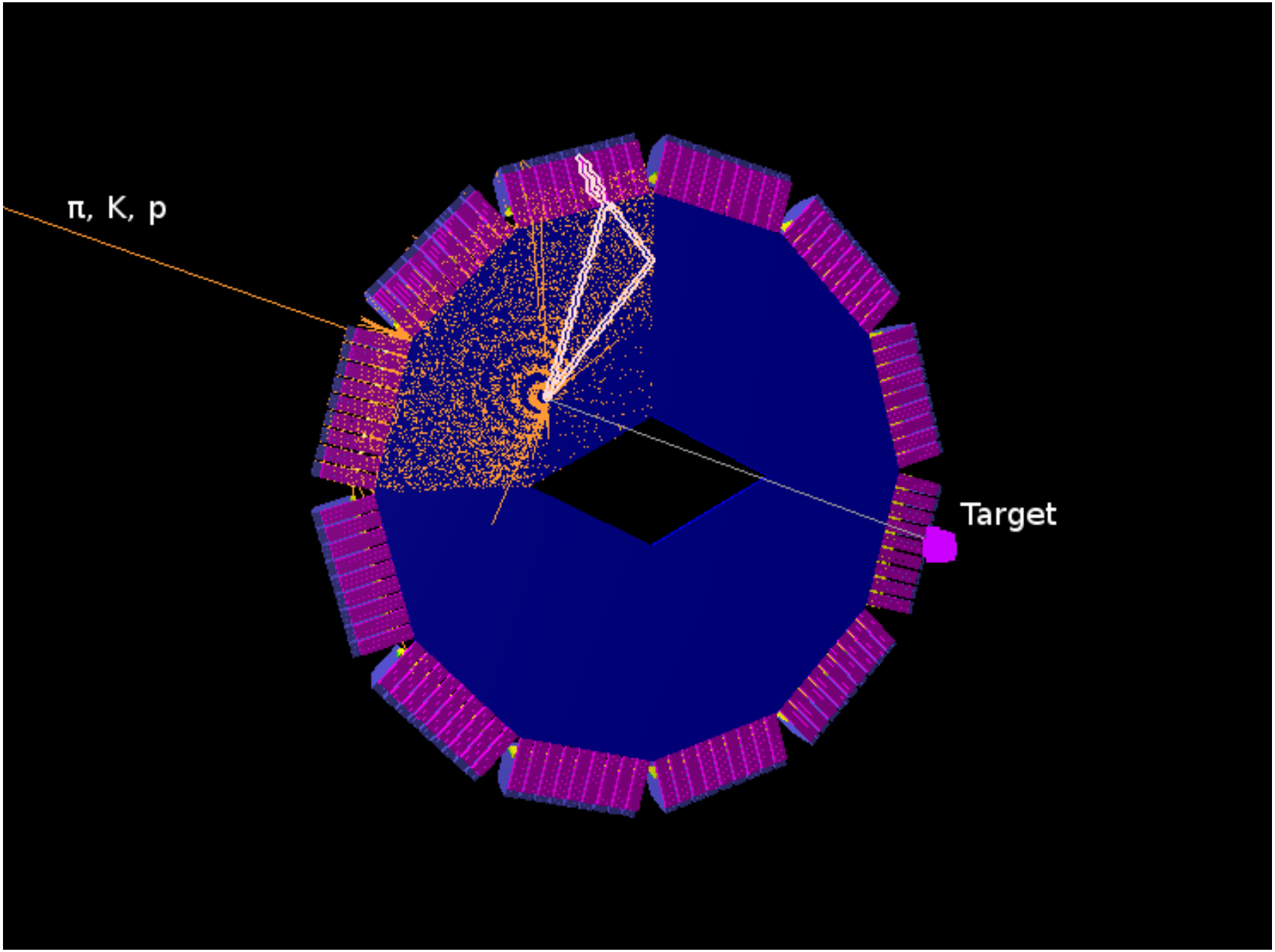
PndDiscCherenkovResult()

- Cherenkov angle: cherenkov_angle

PndDiscPID()

- Likelihood π: loglikepion
- Likelihood K: loglikekaon
- Likelihood p: loglikeproton

Adding Event Display

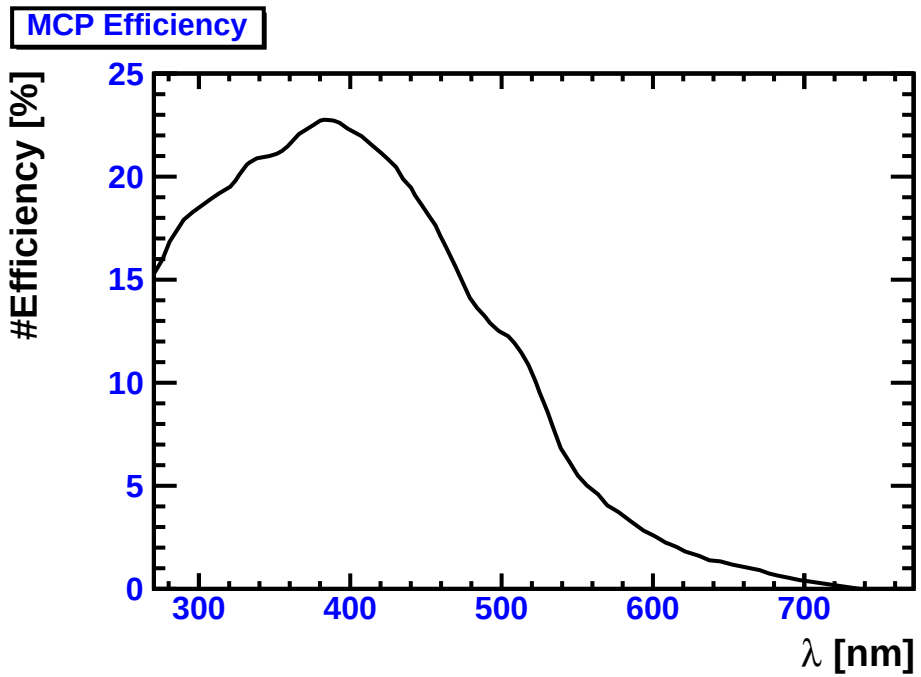


Fixed Problems

- Problem in `ROOT::Math::Interpolation::kLINEAR` → PDE inside digitization could not be used until now
- Library **libMathMore** added to the dependencies in CMakeLists.txt

Other Problems:

- **DEPENDENCIES** was written wrong in CMakeLists.txt



Changes in Track Reconstruction

- Possibility to use Monte-Carlo tracks or reconstructed tracks with GenFit:

  PndDiscTaskReconstruction :: *UseTrueTracks*(*kTRUE*/*kFALSE*)

- Getting **position** and **momentum** information with:

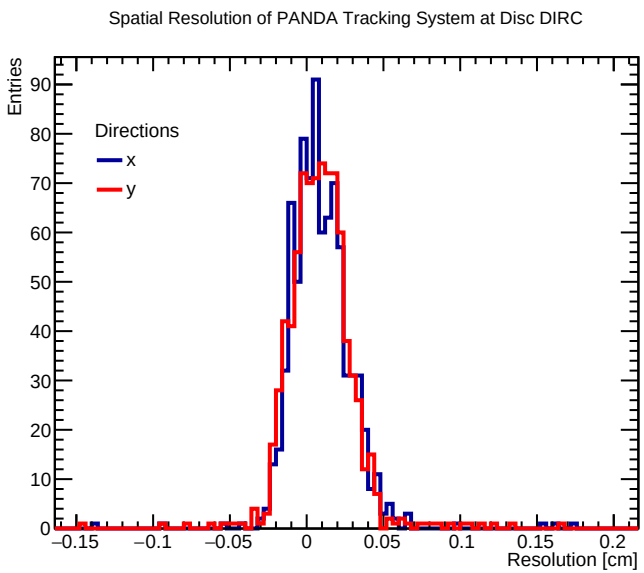
```
TClonesArray *tclarr_track (TClonesArray*)
    io_manager->GetObject("SttMvdGemGenTrack");
PndTrack *track = (PndTrack*)tclarr_track->At(i);
FairTrackParP par = track->GetParamLast();
```

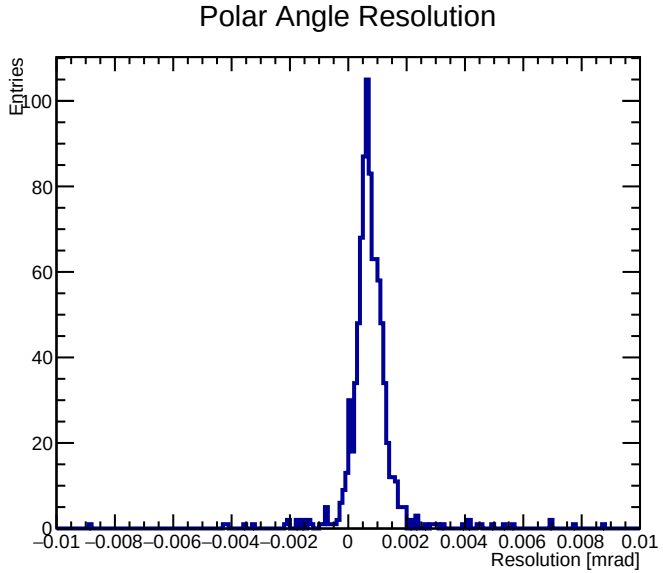
- Calculating position on radiator disk assuming straight line:

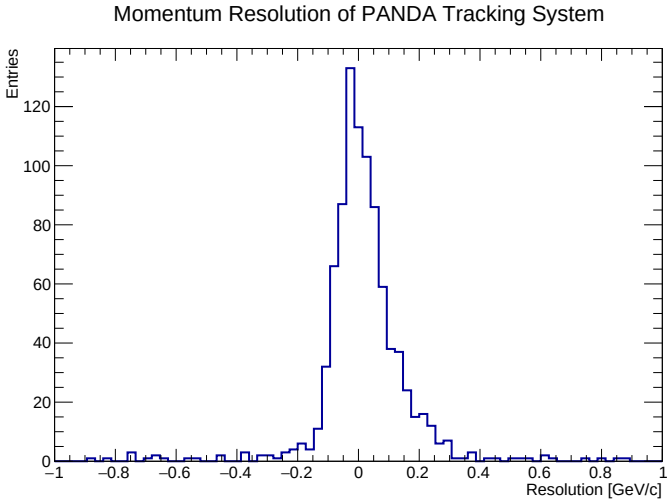
$$\begin{pmatrix} x_{Disc} \\ y_{Disc} \end{pmatrix} = \frac{z_{Track} - z_{Disc}}{p_z} \cdot \begin{pmatrix} p_x \\ p_y \end{pmatrix}$$

Resolution Studies for GenFit

Spatial and momentum resolution of Protons with $p = 4\,\mathrm{GeV/c}$ and $\theta = 15°$

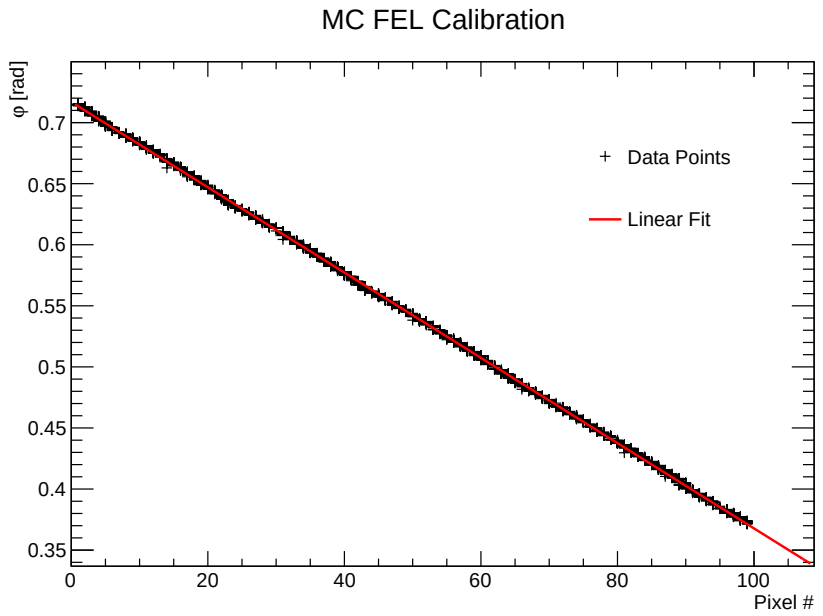


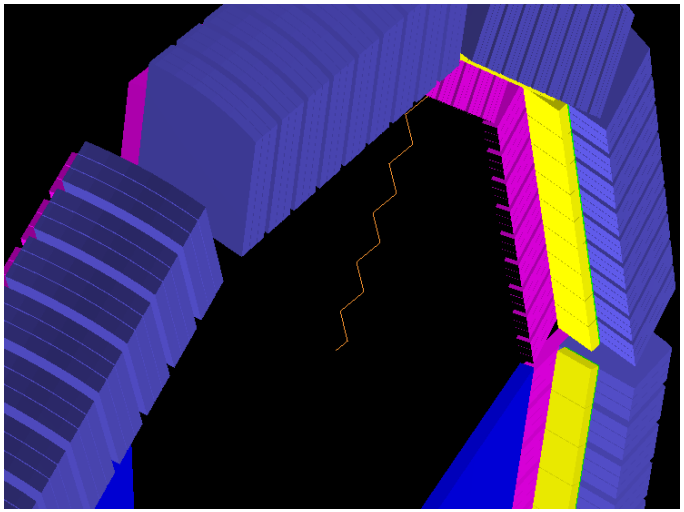




Adding Calibration Script

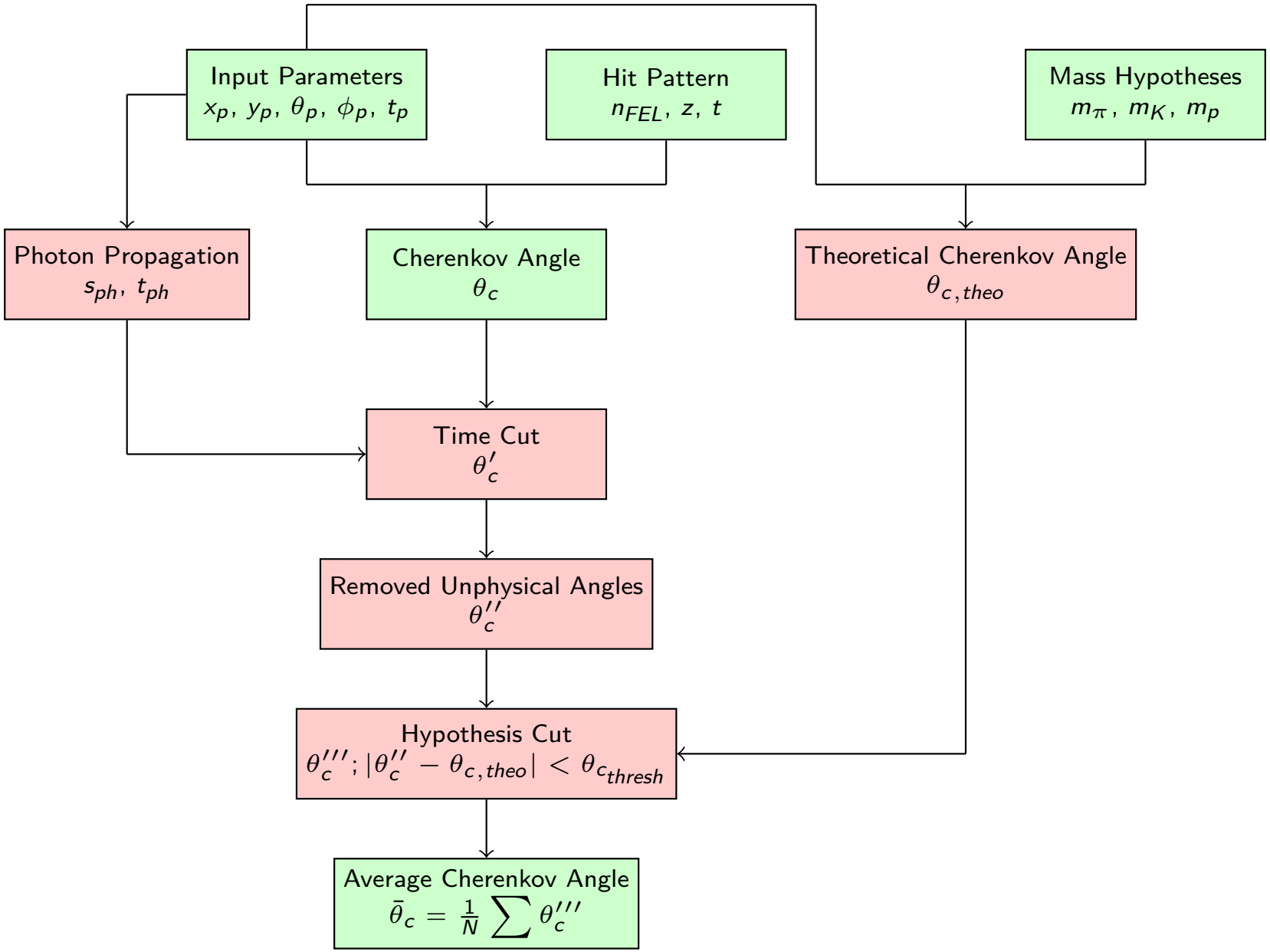
Script added for calibration of Focusing Elements using Monte-Carlo hits with random φ angles:





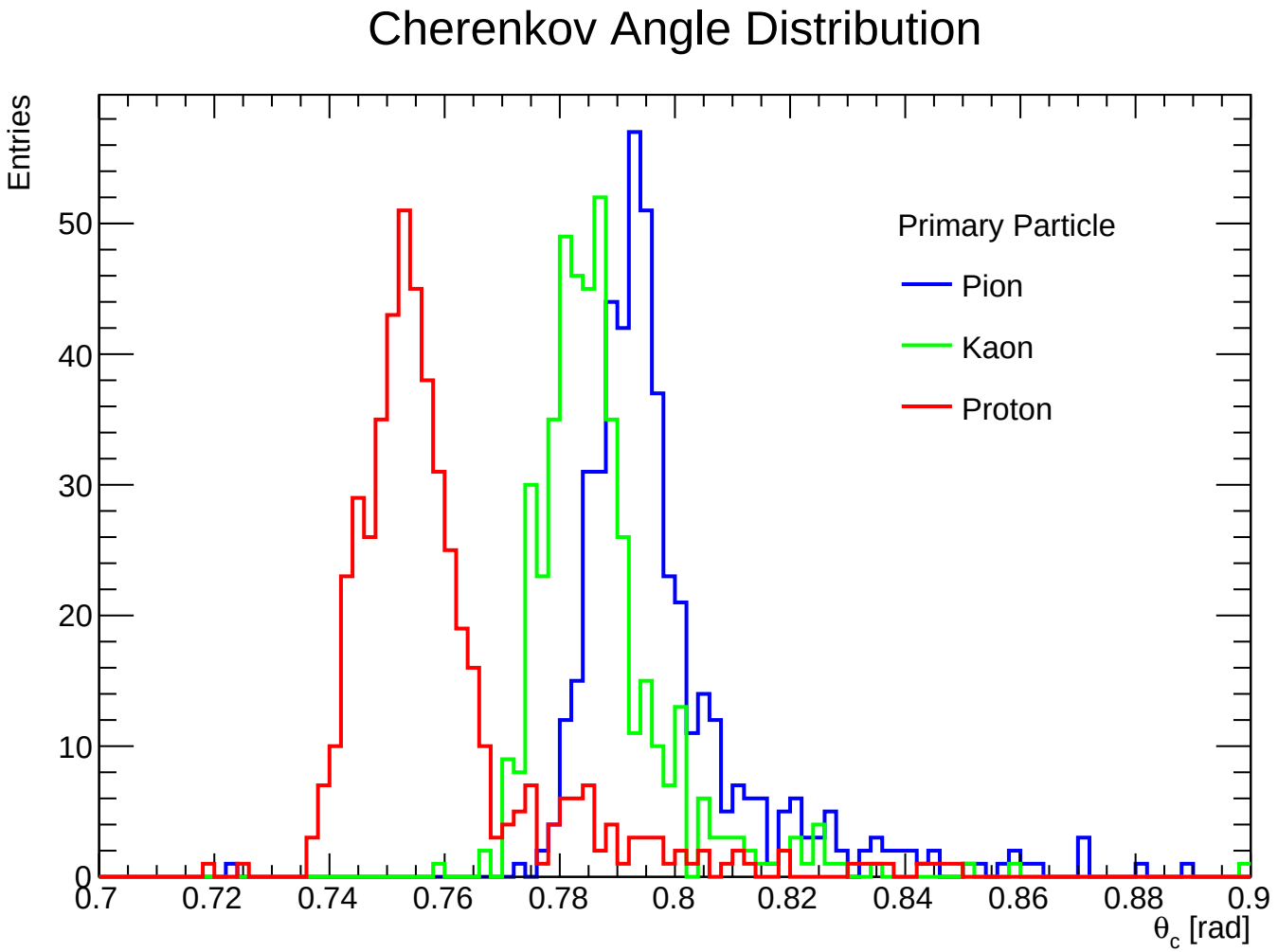
Values are used for the hit pattern calculation

Cherenkov Angle Reconstruction

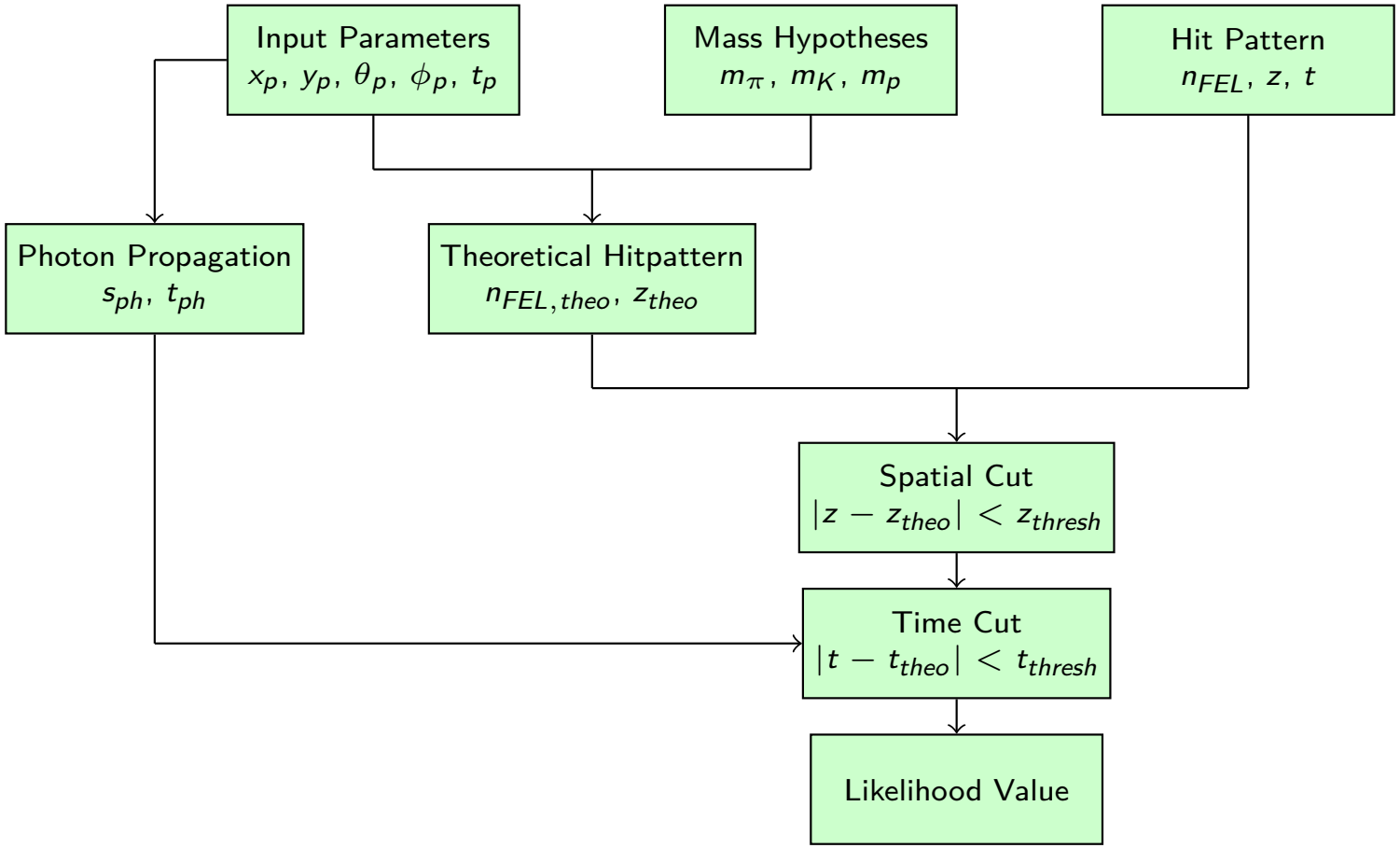


Reconstructed Chernekov Angle

Particle momentum $p = 3\,\mathrm{GeV/c}$, polar angle $\theta = 15°$

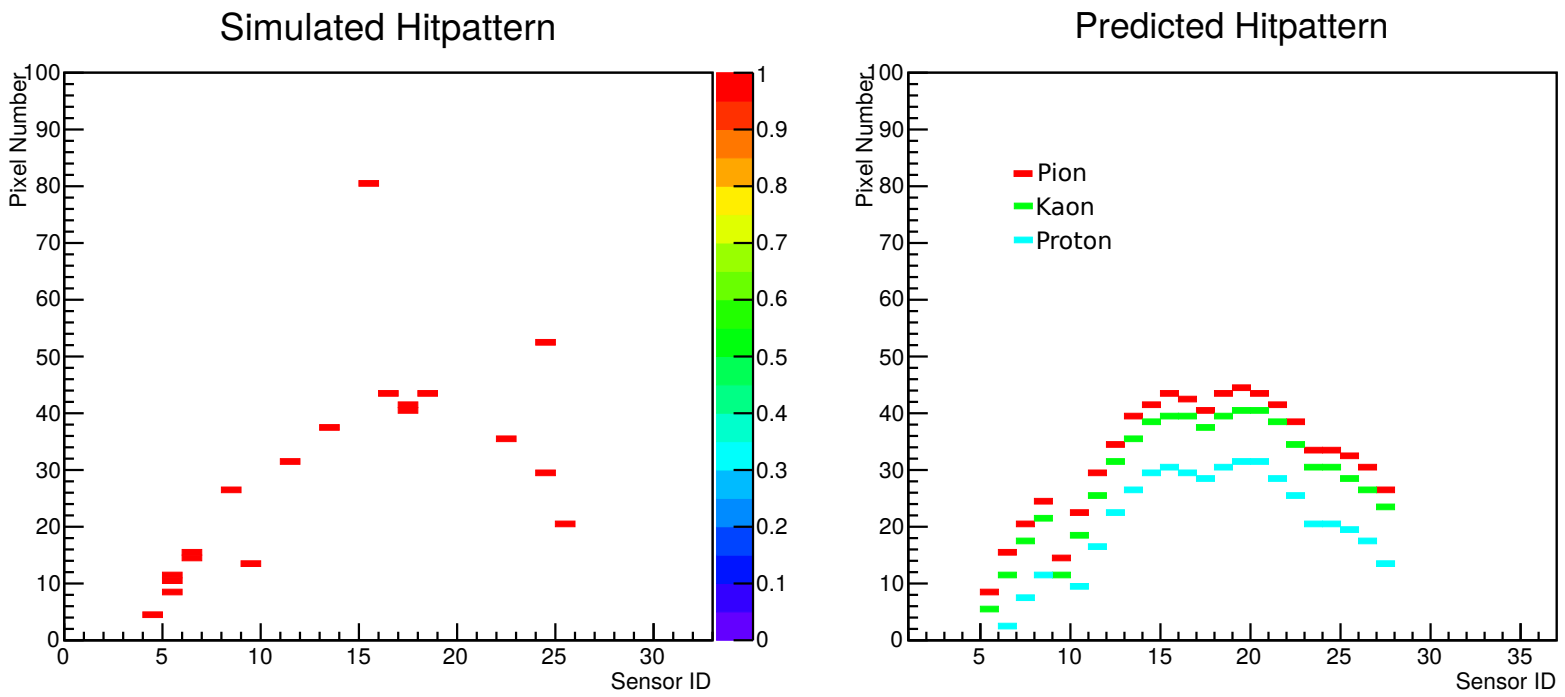


Hitpattern Matching



Reconstruction Results

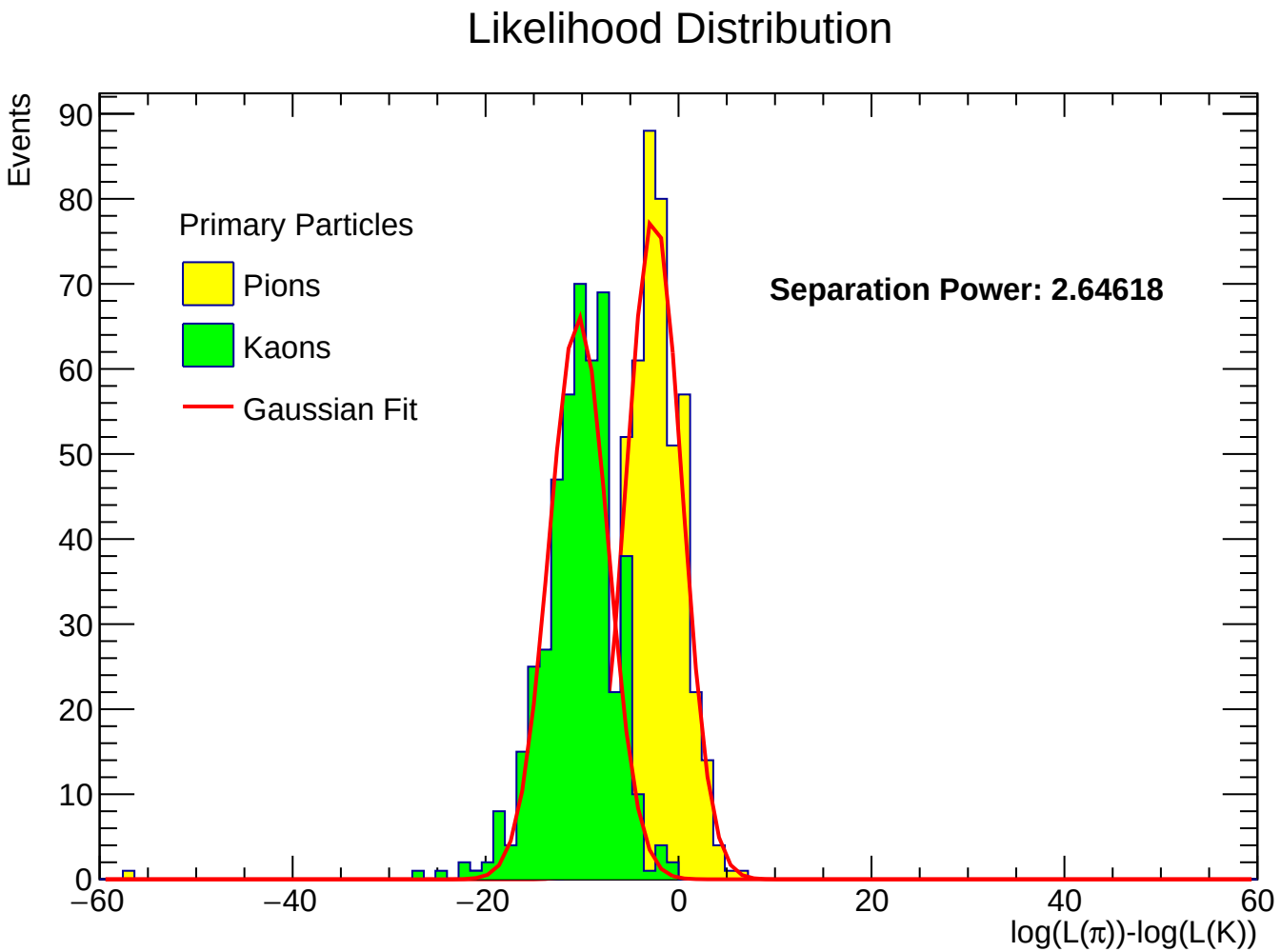
Hit pattern matching for particle momentum $p = 3\,\text{GeV}$ and polar angle $\theta = 15°$:



Used bandpass filter 360–465 nm including PDE

Particle Identification

Momentum $p = 4\,\mathrm{GeV/c}$, polar angle $\theta = 15^\circ$



Conclusion & Outlook

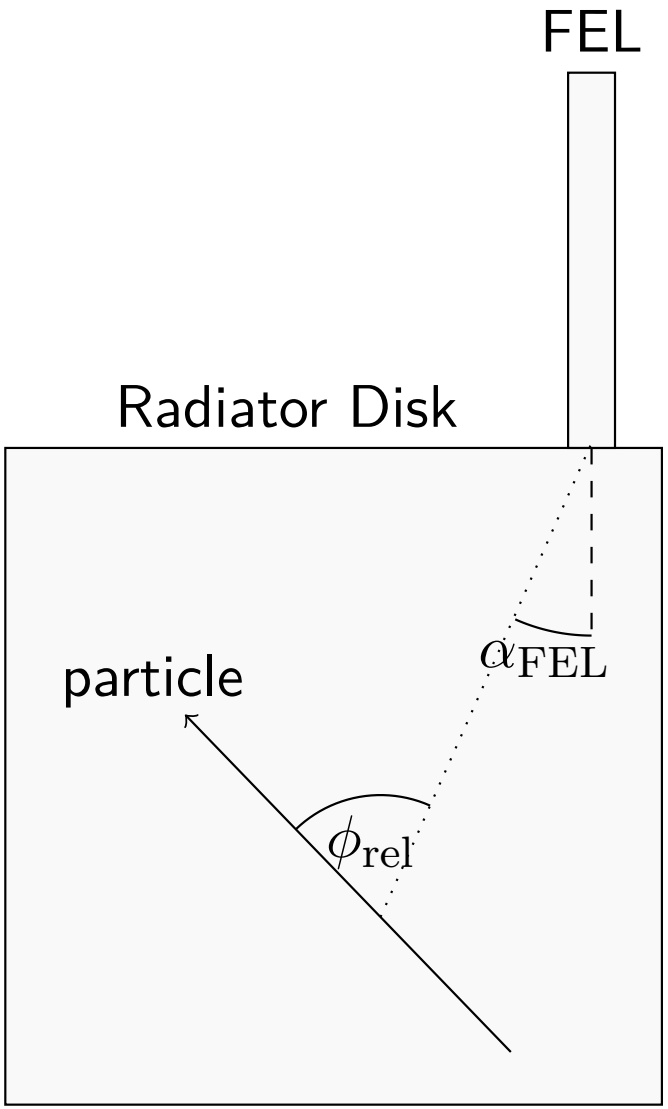
- PID in principle working in PandaRoot (results not sufficient until now)
- Cleaning of unnecesary code
- Better implementation of code into PandaRoot framework
- Improvement of reconstruction algorithm
- Testing PID with specific benchmark channel

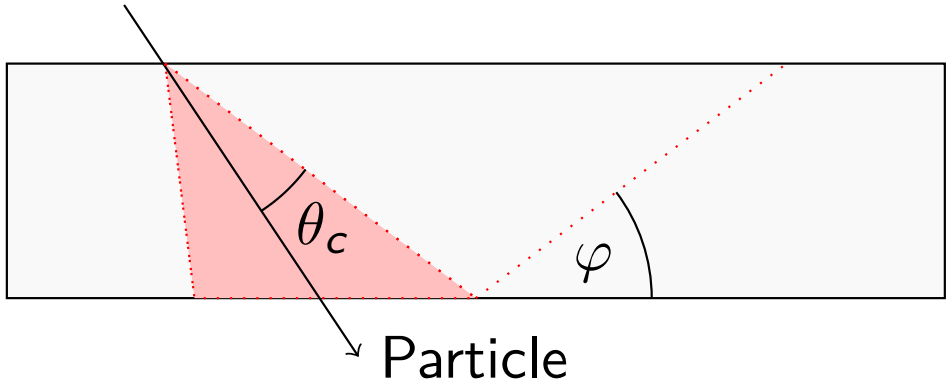
Thank you very much for your attention!

Backup Slides

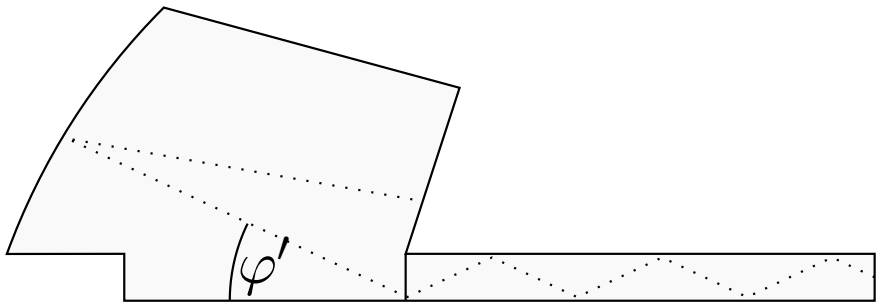
Theoretical Model

Angle Definitions:





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



Theoretical Model

Calculation of the Cherenkov angle:

$$\theta_c = \arccos(\sin\theta_p \cos\phi_{rel} \cos\varphi + \cos\theta_p \sin\varphi) \tag{1}$$

- θ_p: θ angle of particle
- ϕ_{rel}: angular difference between ϕ angle of particle and photon
- φ: Angle between total reflected photon and radiator disk surface

Calculation of φ if θ_c is known:

$$\cos\varphi = \frac{A\cos\theta_c}{B} \pm \sqrt{\frac{\cos^2\theta_p - \cos^2\theta_c}{B} + \left(\frac{A\cos\theta_c}{B}\right)} \tag{2}$$

with $A = \sin\theta_p \cos\phi_{\mathrm{rel}}$ and $B = A^2 + \cos^2\theta_p$