EIC dRICH Simulation Studies

Chandradoy Chatterjee, Jinky Agarwala - INFN -TS
On behalf of ePIC collaboration

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Outline

- Resolution of Cherenkov angle residual ($\sigma\_\Delta\theta_R$) as a function of η
- Average number of Cherenkov photons (<npe>) as a function of η
- Single photon resolution ($\sigma\_\Delta\theta_{Ph}$) as a function of η

Studies shown are for Gas

Some definition of Cherenkov θ

Event by event

- $\theta_{Resid} = \Delta\theta = \theta_{Ring.} - \theta_{Exp.}$
- $\theta_{Ring} = \Sigma\, \theta_{Rec} / N_{Ph}$
- $\theta_{Exp} = \cos^{-1} \sqrt{(p^2 + m^2)/(n*p)}$; n = refractive index

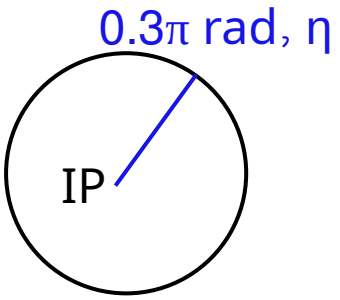
  n = 1.00076 (Gas)

  n = 1.02 (Aerogel)

dRICH hepmc file

root -l drich-hepmc-writer.C'("drich.hepmc", 50000)'

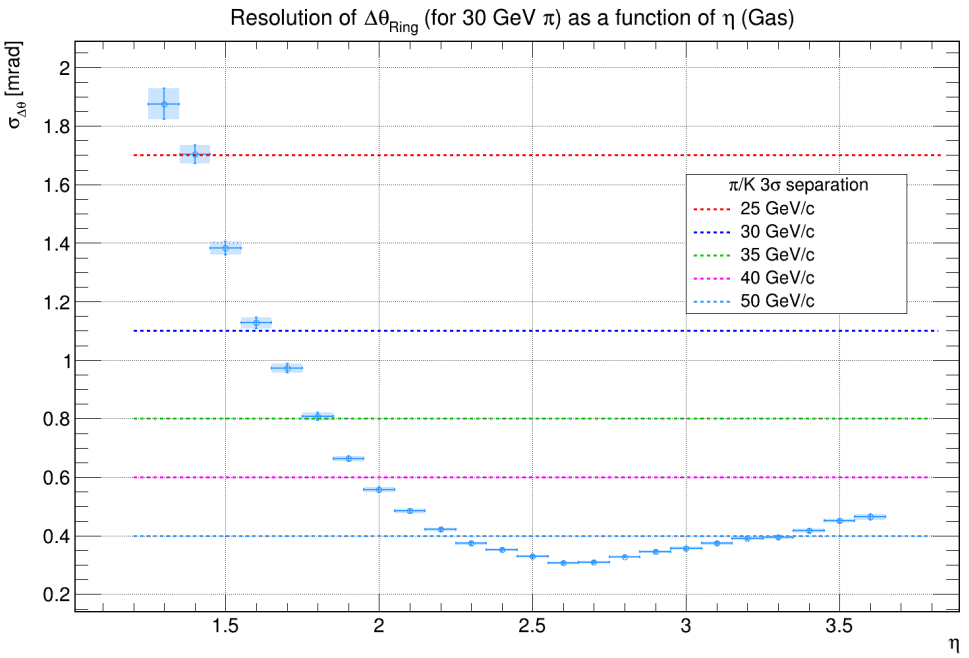
- e^- (12 GeV/c) – p (100 GeV/c) interaction
- **30 GeV/c Pion+** as detected particle
- Pseudorapidity range 1.1 to 4.0
- 50k events
- Fixed Track Phi (0.29π to 0.31π)

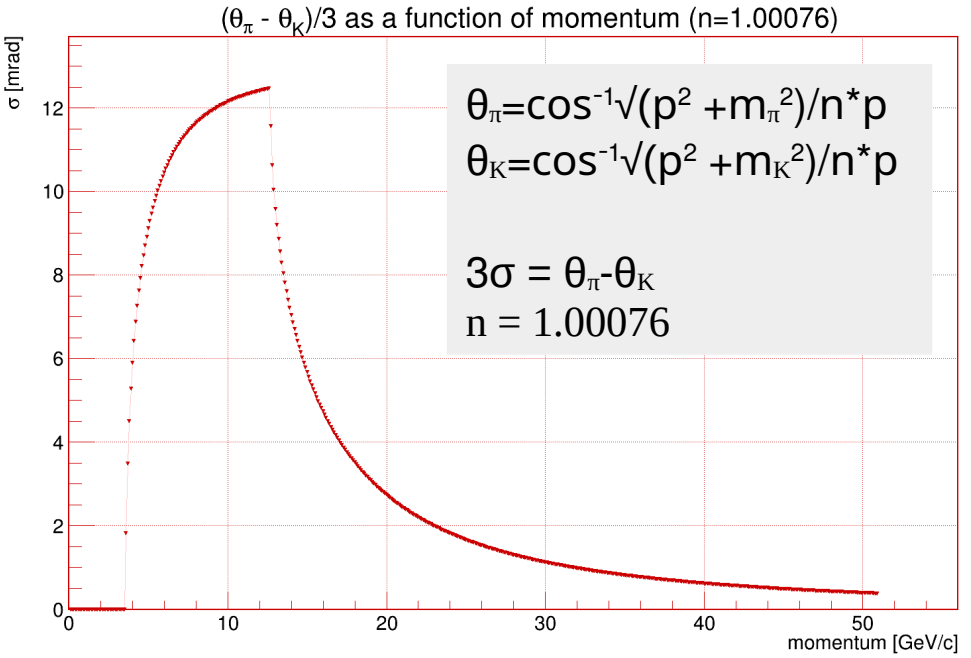


simulate.py -i drich.hepmc -n 50000

- Simulation
- Reconstruction
- Analysis

Resolution of $\Delta\theta_{ch,\,Ring}$ vs. η

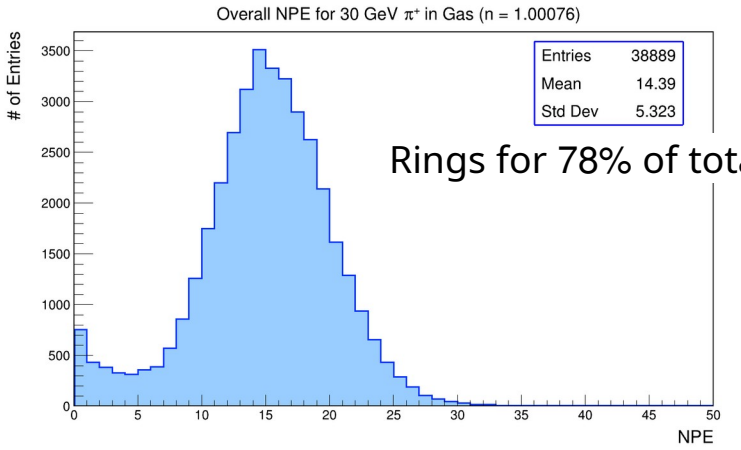




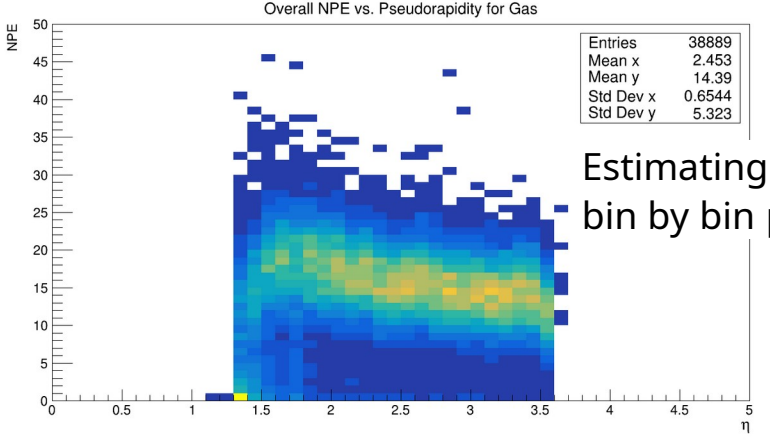
- Resolution decreases at higher η (2.8 and above)
- Horizontal lines are corresponding **maximum** momentum for which 3σ separation of π/K peak is possible

Analytical calculation of resolution required for 3σ separation of π/K peak

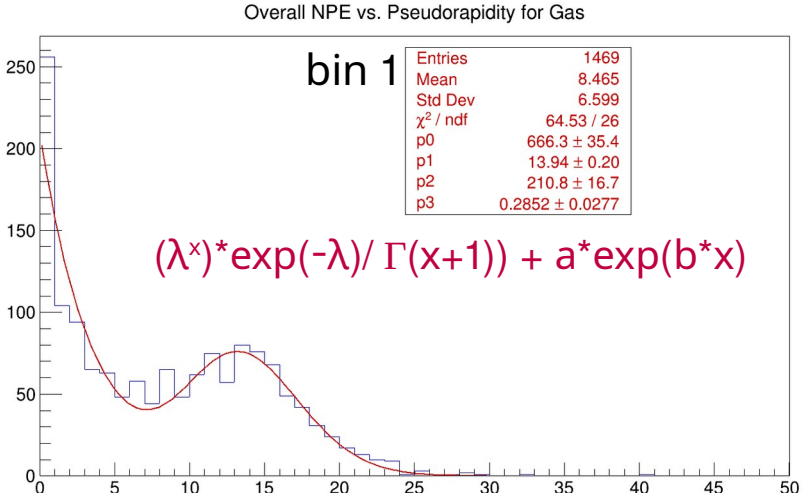
NPE vs. η

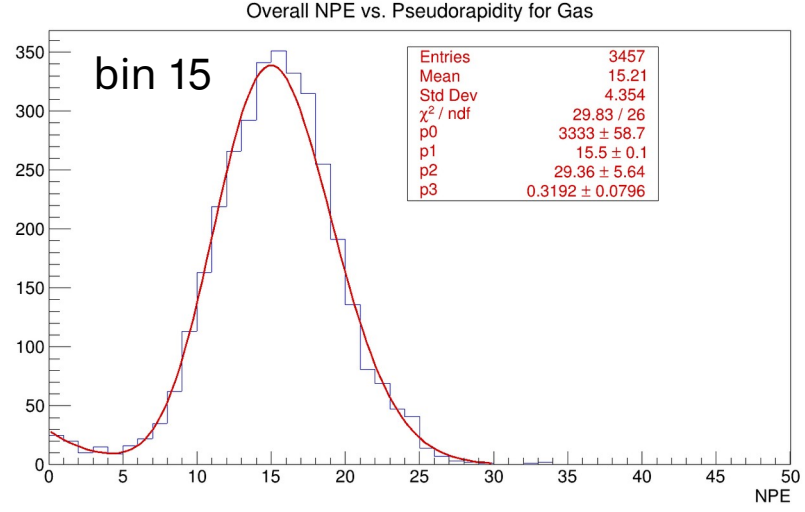


Rings for 78% of total tracks

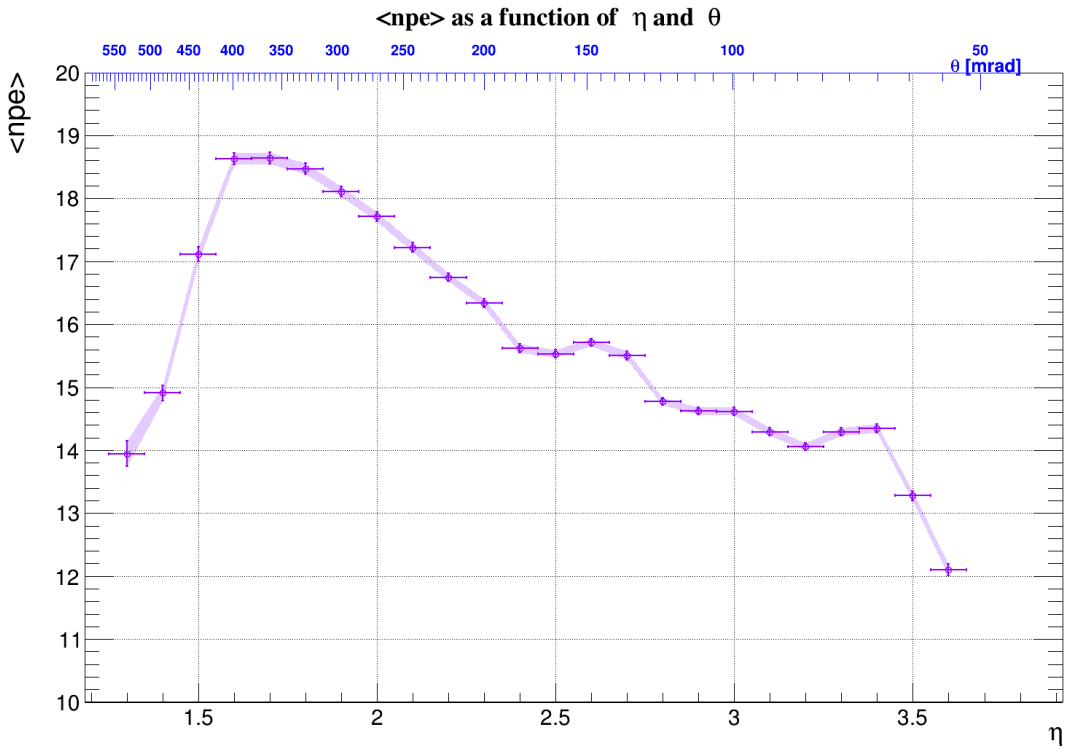


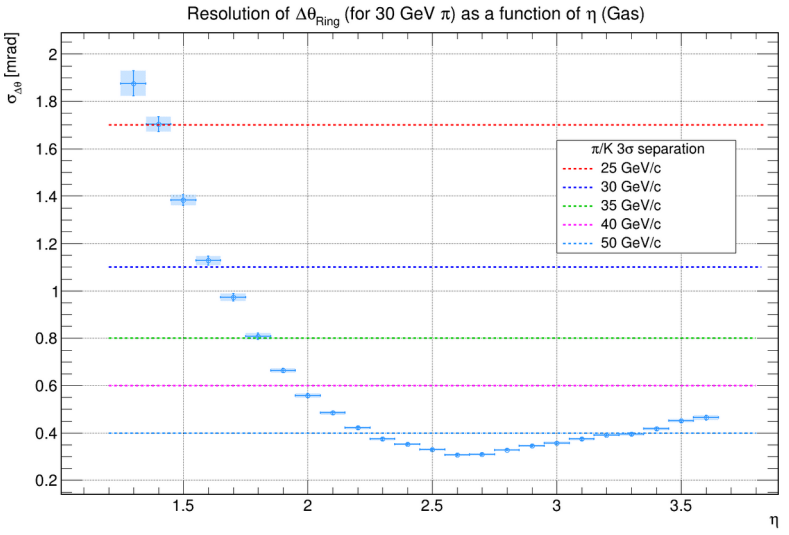
Estimating <npe> bin by bin projection





<NPE> vs. η



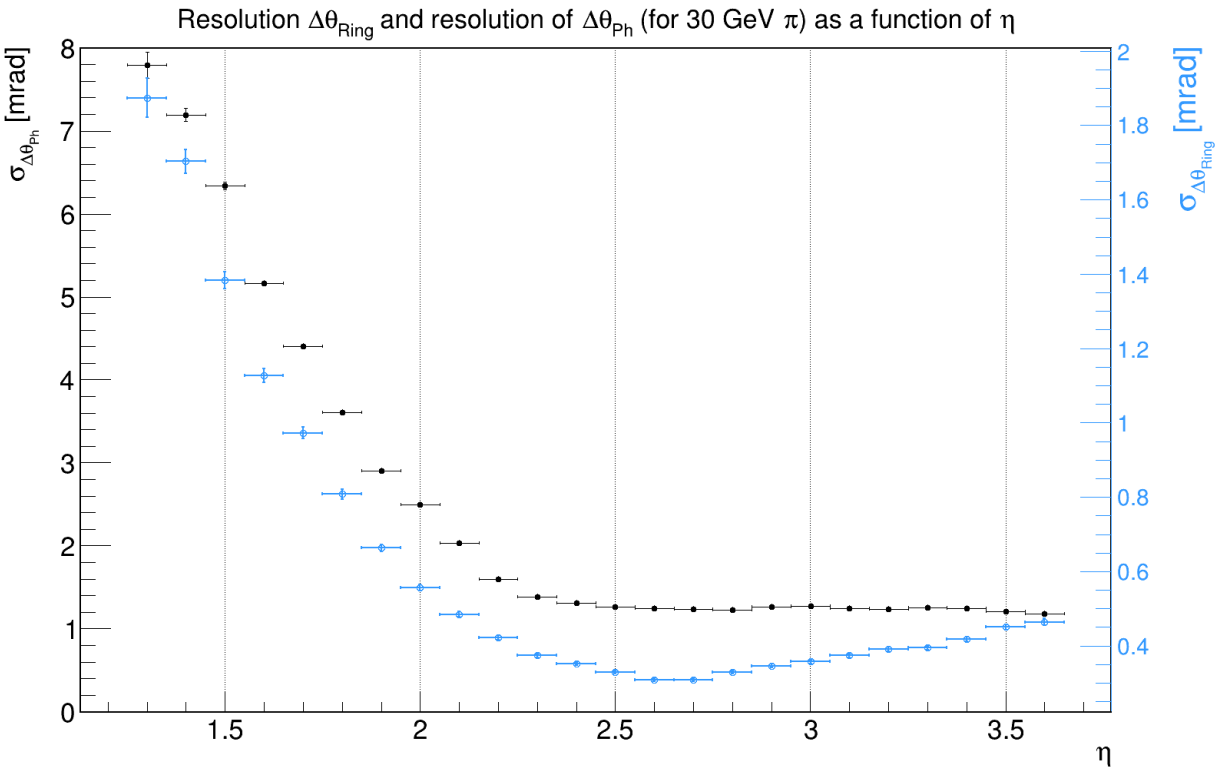


From η = 2.8

- Resolution of $\Delta\theta_{Ring}$ decreases as <NPE> drops
  - due to beam-pipe effect (at η = 3.5, 3.6)
  - shorter track-length

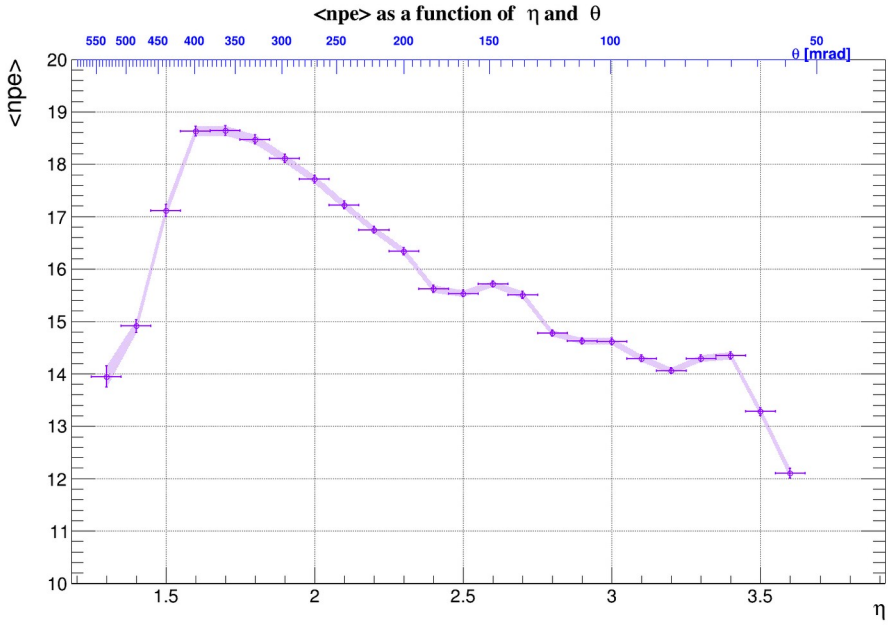
Slight increase in <npe> around η = 2.6 can be explained as better focalisation

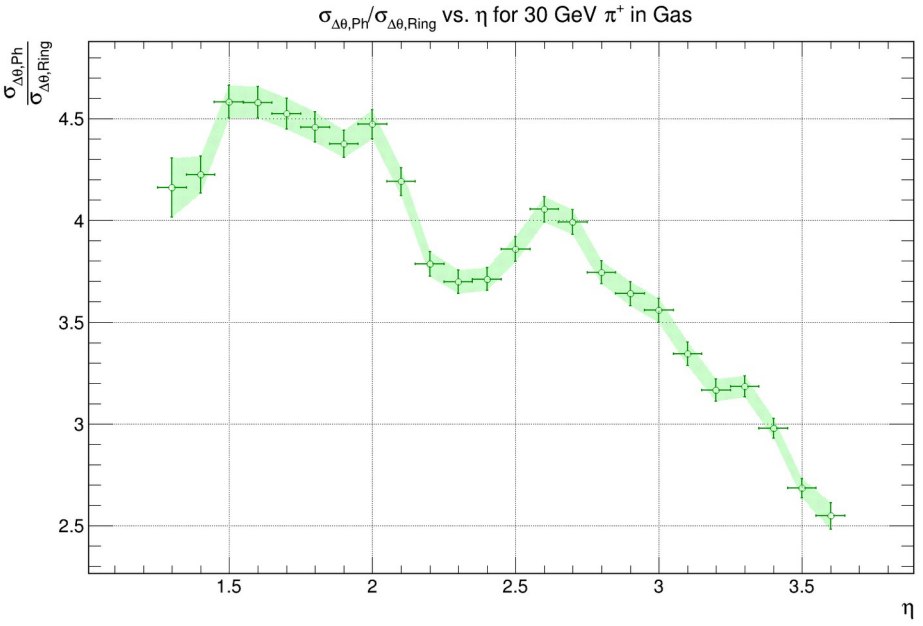
Single photon resolution



- Optimization of optics performed in simulation geometry for high η range
  - As a result single photon resolution remains constant from η ~ 2.4 to 3.5

Ring resolution mostly due to drop in <npe>



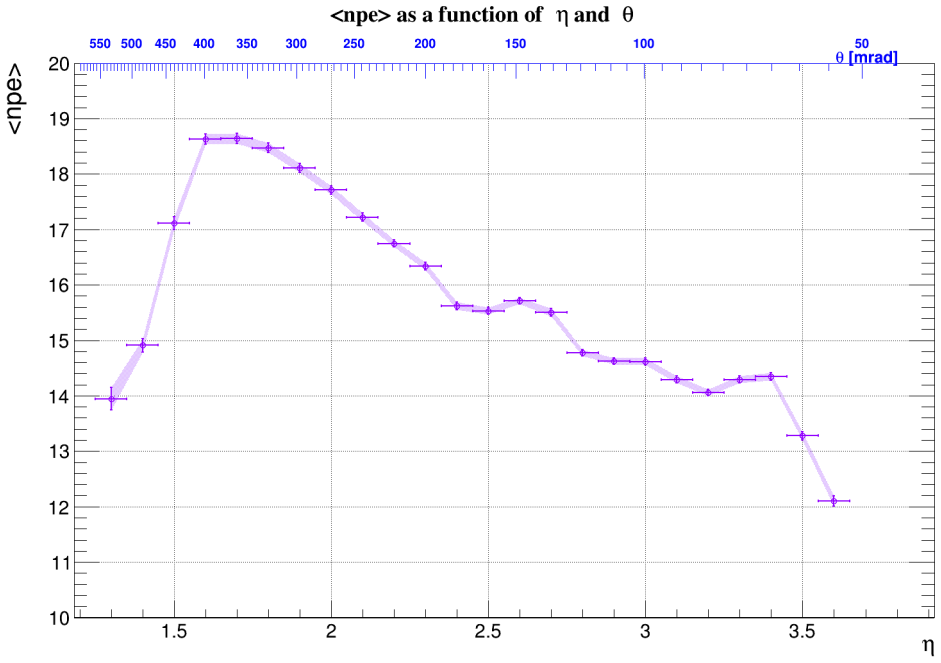


Similar trend

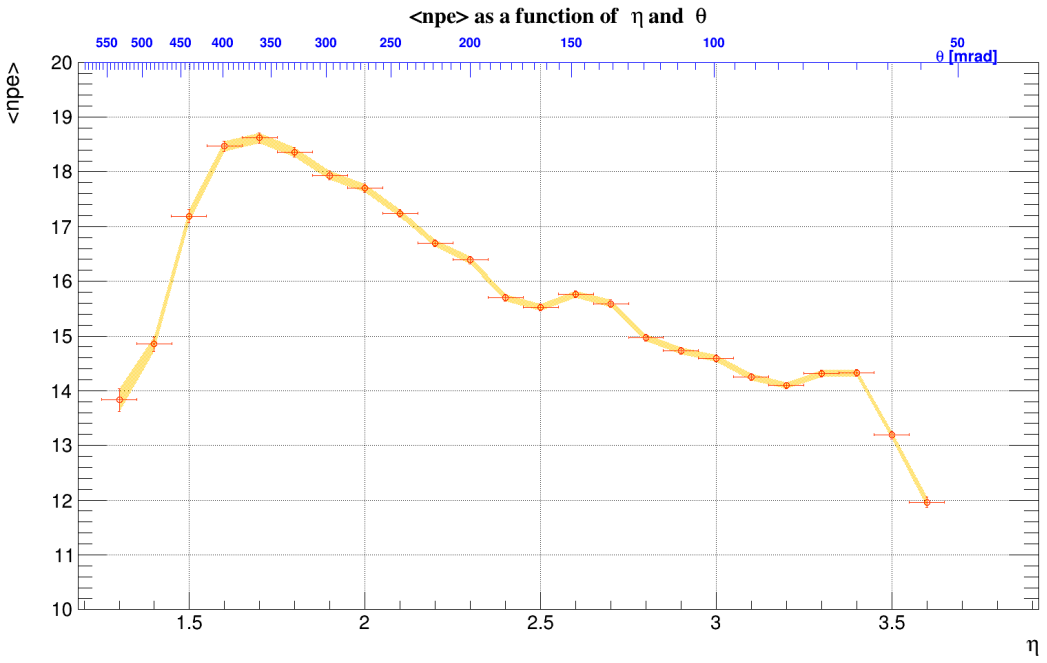
$(\sigma_{\Delta\theta,Ring})^2 = (\sigma_{\Delta\theta,Ph}/\sqrt{N_{ph}})^2 + x^2$ Coming from track

Contribution from x^2 is NOT significant

Integration over full track-phi range



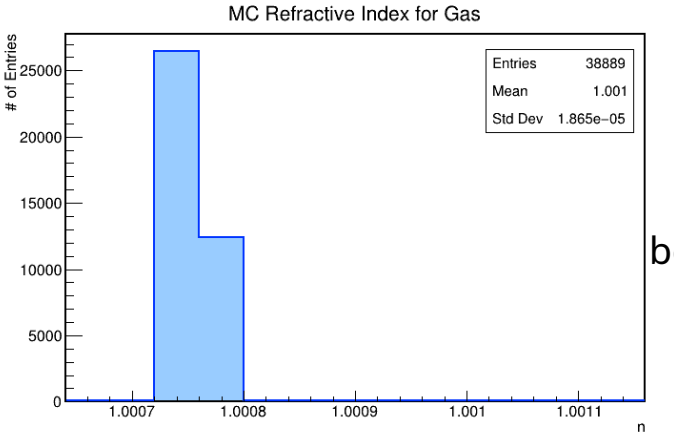
0.3π radian



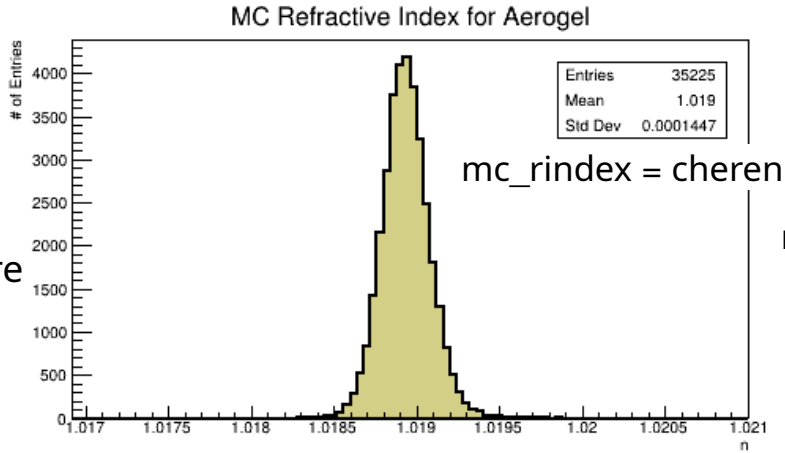
0 to 2π radian

Exactly same results

Source code modified

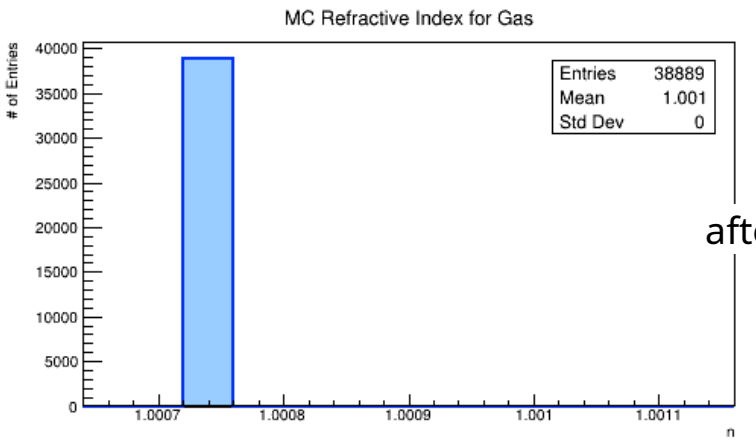


before

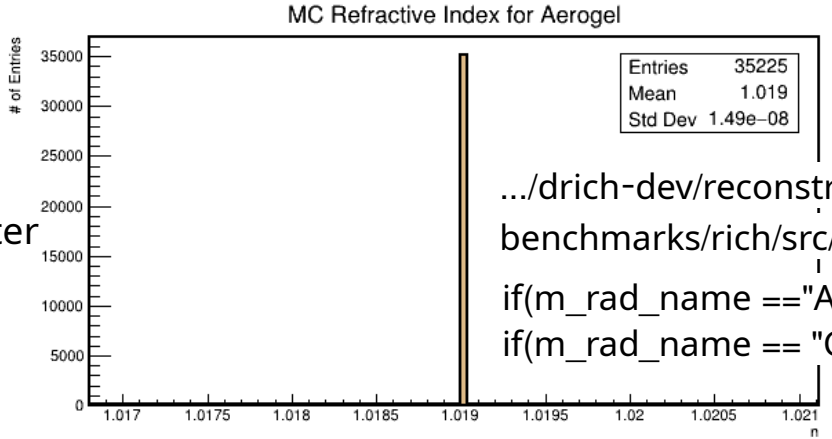


mc_rindex = cherenkov_pid.getRefractiveIndex();

n fluctuates



after



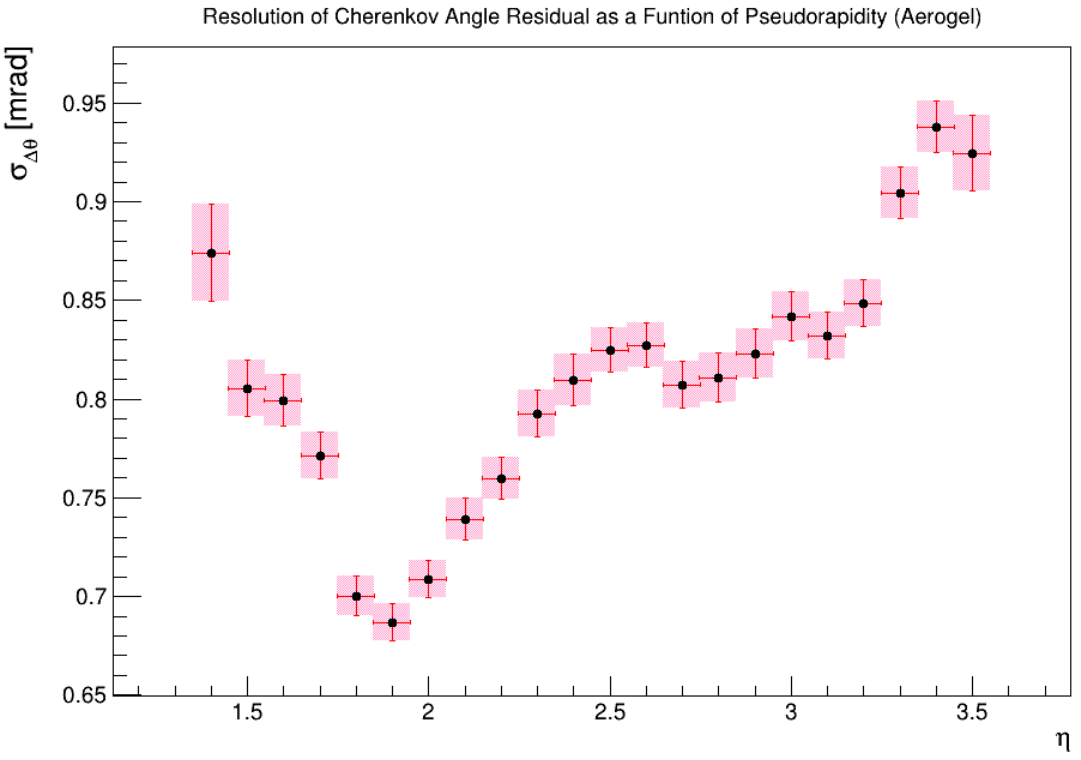
.../drich-dev/reconstruction_benchmarks/benchmarks/rich/src/**CherenkovPIDAnalysis.cc**

if(m_rad_name =="Aerogel") mc_rindex =1.019;
if(m_rad_name == "Gas") mc_rindex = 1.00076;

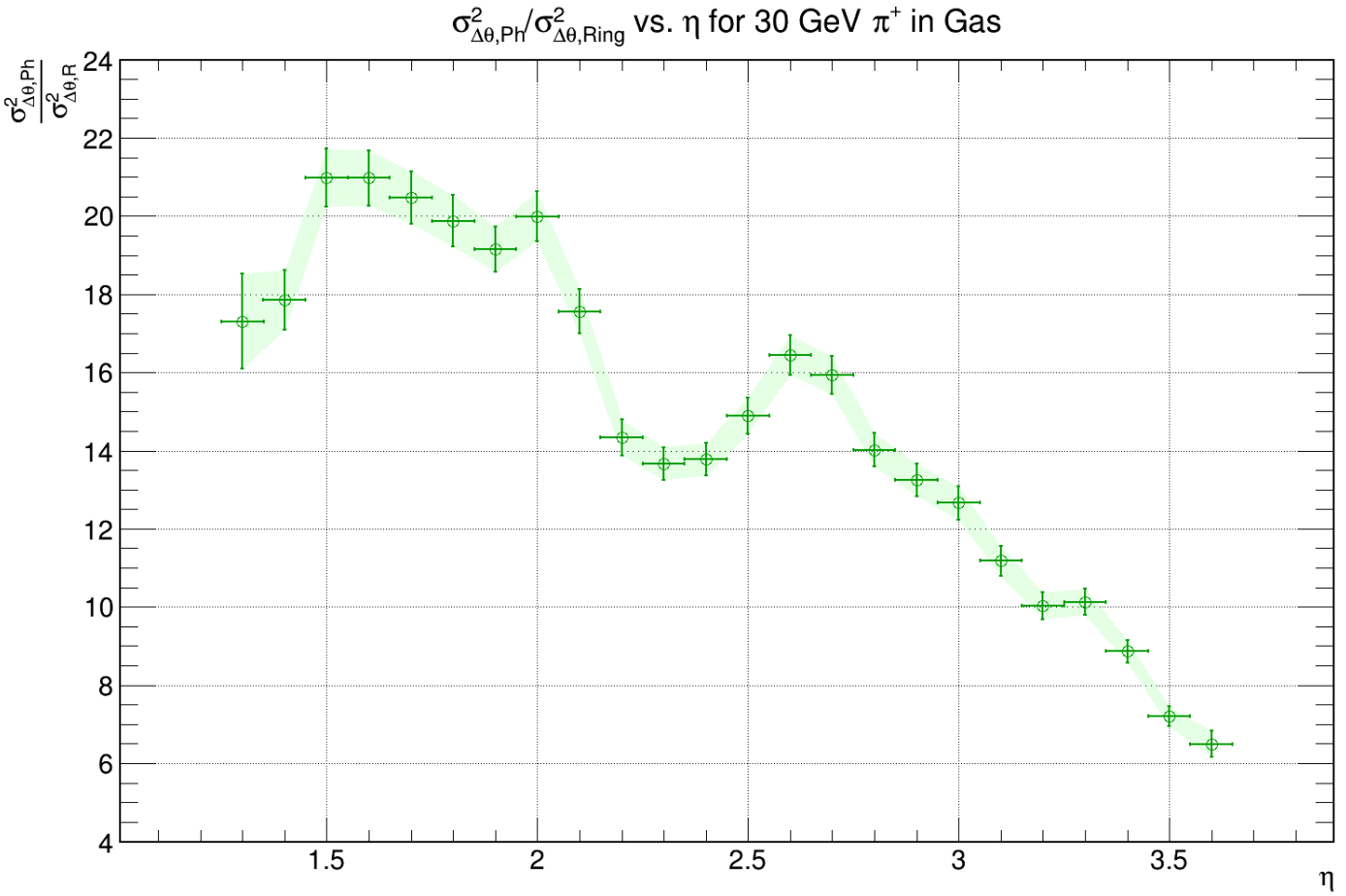
Thank you!

Back up

Resolution of $\Delta\theta_{ch,\,Ring}$ vs. η (Aerogel)



Modified after fixing the source code


$\sigma^2_{\Delta\theta,Ph}/\sigma^2_{\Delta\theta,Ring}$ vs. η for 30 GeV π^+ in Gas
$\frac{\sigma^2_{\Delta\theta,Ph}}{\sigma^2_{\Delta\theta,R}}$
24
22
20
18
16
14
12
10
8
6
4
1.5
2
2.5
3
3.5
η