

EIC dRICH simulation

Preliminary studies

Chandra, Jinky
INFN Trieste

Outline

- Cherenkov angle residual vs. η
 - Gas
 - Aerogel
- Resolution of Cherenkov angle residual vs. η
 - Gas
 - Aerogel

Definition of θ

- $\theta_{\text{resid}} = \theta_{\text{Ring.}} - \theta_{\text{exp.}}$; (event by event)
- $\theta_{\text{Ring, Gas}} = \Sigma \theta_{\text{rec}} / N_{\text{ph}}$; (event by event)
- $\theta_{\text{Ring, Aerogel}} = \Sigma \theta_{\text{rec}} / N_{\text{ph}}$; (event by event)
- $\theta_{\text{exp.}} = \cos^{-1} \sqrt{(p^2 + m^2)/(n^2 p^2)}$; 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

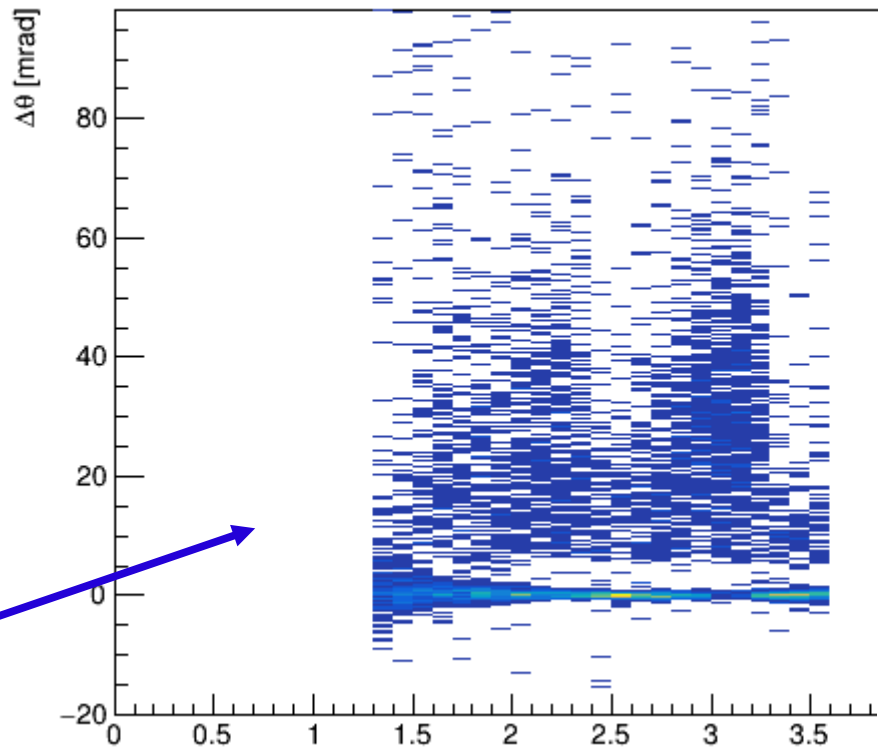
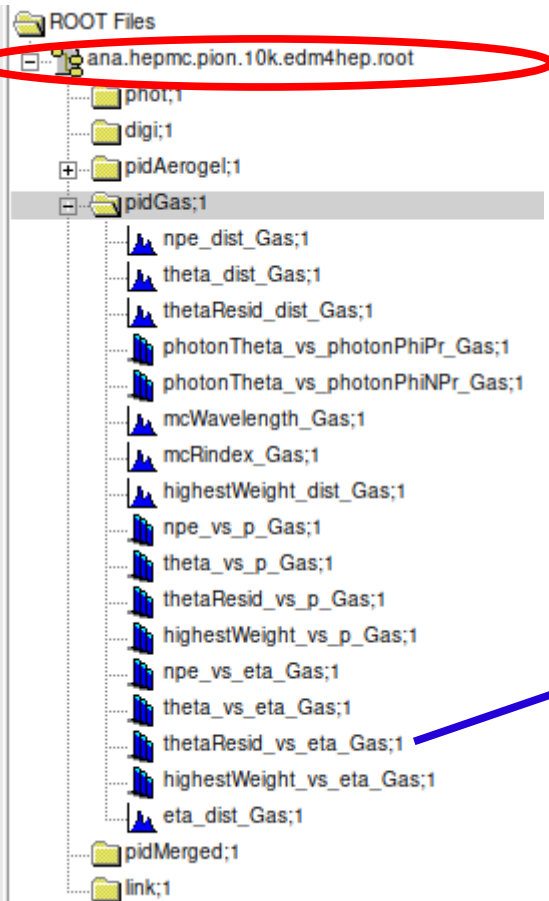


- Simulation `simulate.py -i drich.hepmc -n 50000`
- Reconstruction
- Analysis

Output root file

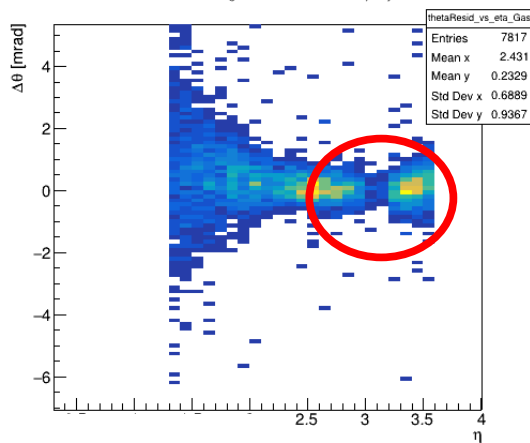
θ_{resid} vs. η , Gas, 10k

Estimated Cherenkov Angle Residual vs. Pseudorapidity for Gas



thetaResid_vs_eta_Gas	
Entries	7817
Mean x	2.478
Mean y	11.77
Std Dev x	0.6495
Std Dev y	17.45

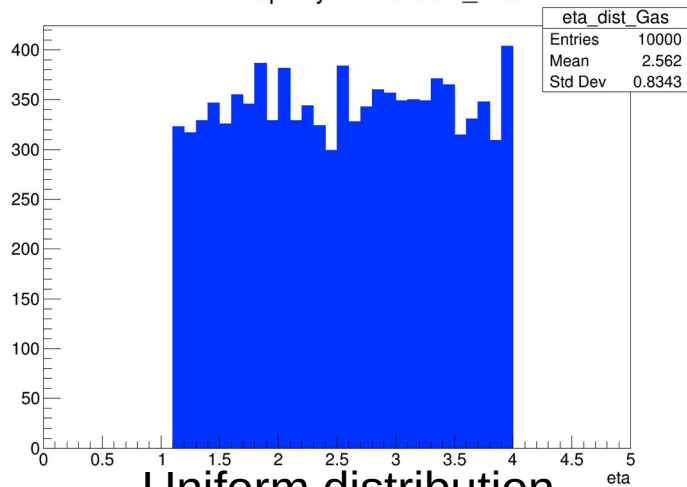
Estimated Cherenkov Angle Residual vs. Pseudorapidity for Gas



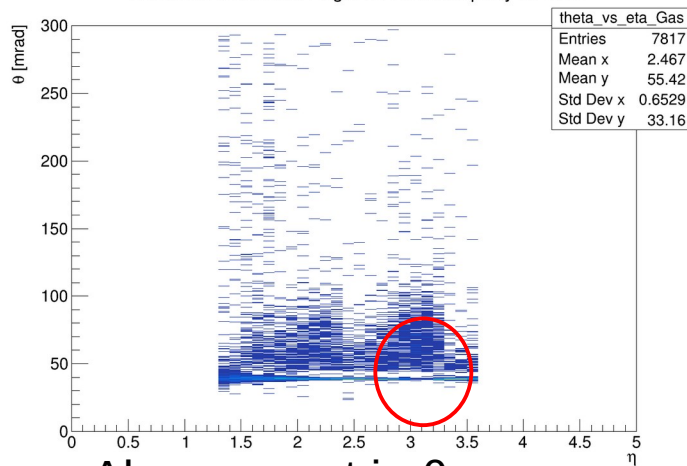
- Dip at $\eta \sim 3$
- Events scattered at $+\Delta\theta$ upto 100 mrad

Output root file

PseudoRapidity distributioni_Gas



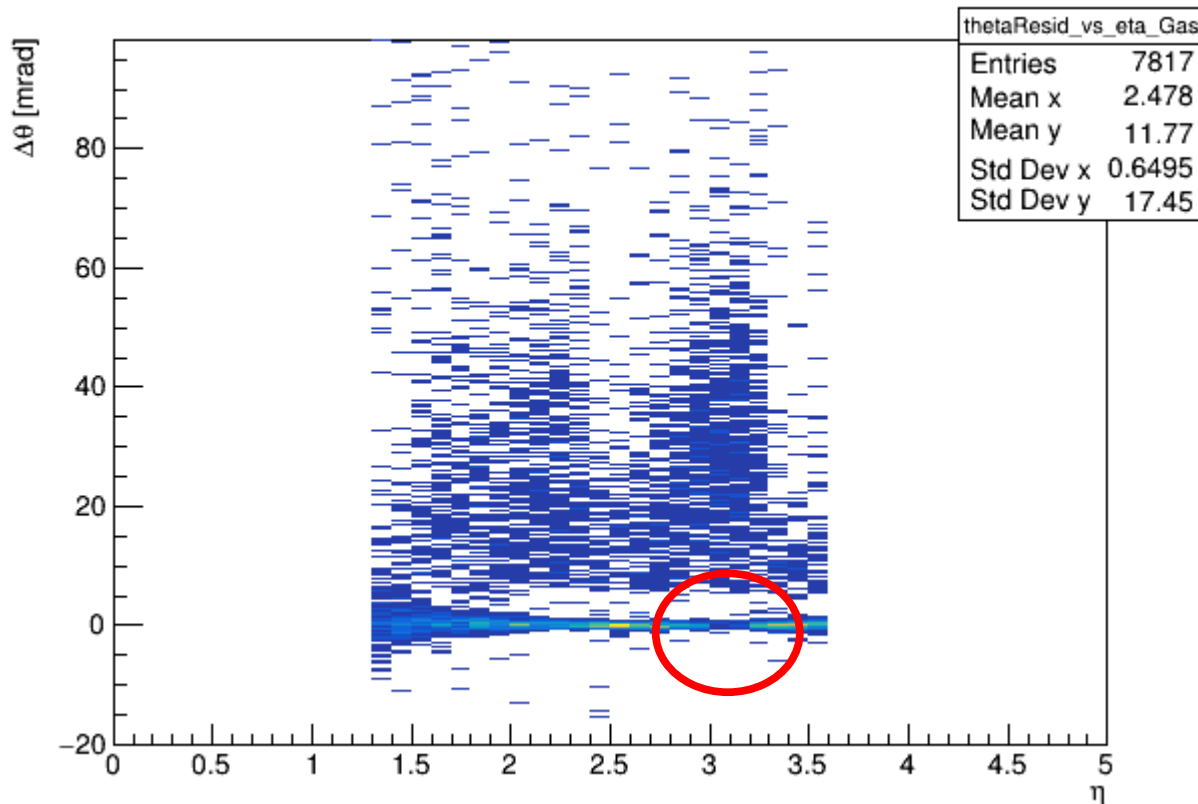
Estimated Cherenkov Angle vs. Pseudorapidity for Gas



Also present in θ_{Ring} vs. η

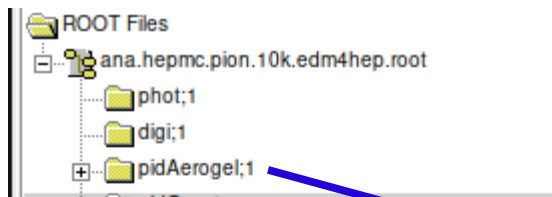
θ_{resid} vs. η , Gas, 10k

Estimated Cherenkov Angle Residual vs. Pseudorapidity for Gas



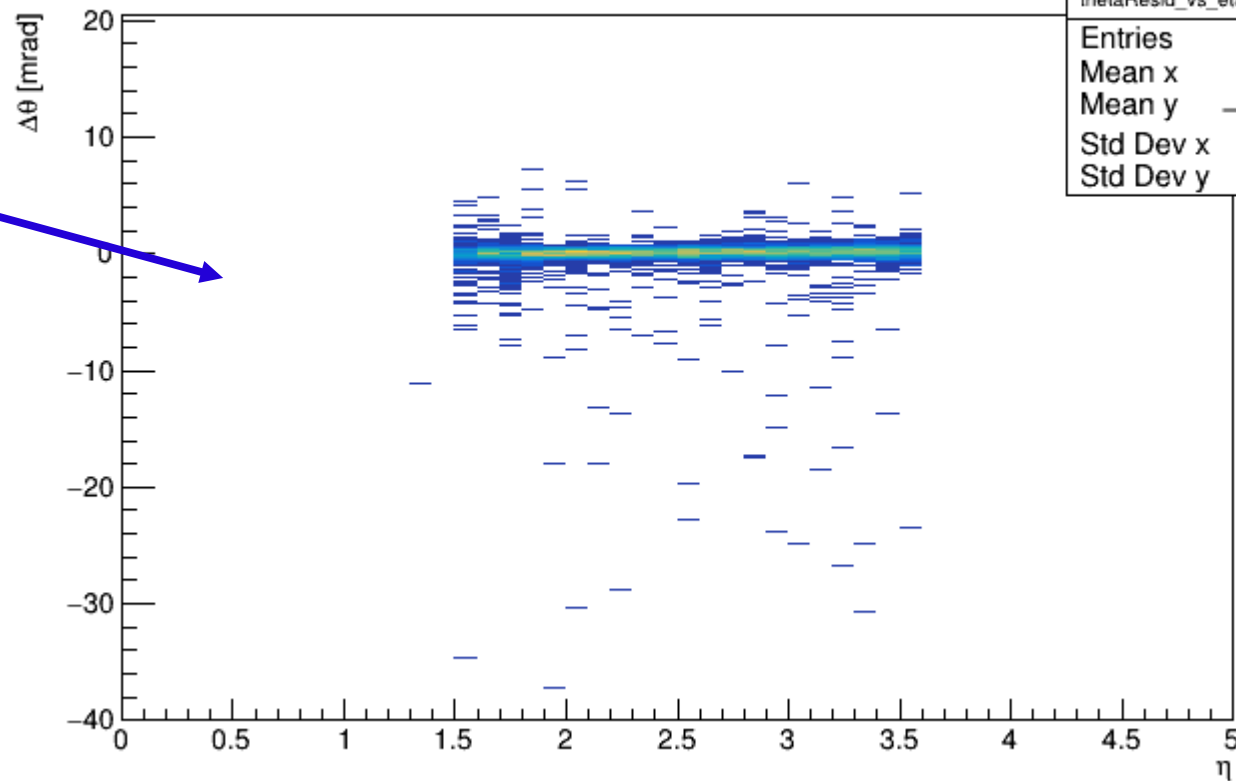
- Dip at $\eta \sim 3$
- Events scattered at $+\Delta\theta$ upto 100 mrad

Output root file



Aerogel, 10k

Estimated Cherenkov Angle Residual vs. Pseudorapidity for Aerogel



thetaResid_vs_eta_Aerogel	
Entries	7109
Mean x	2.561
Mean y	-0.0695
Std Dev x	0.5968
Std Dev y	1.508

Similar pattern absent
for θ in Aerogel

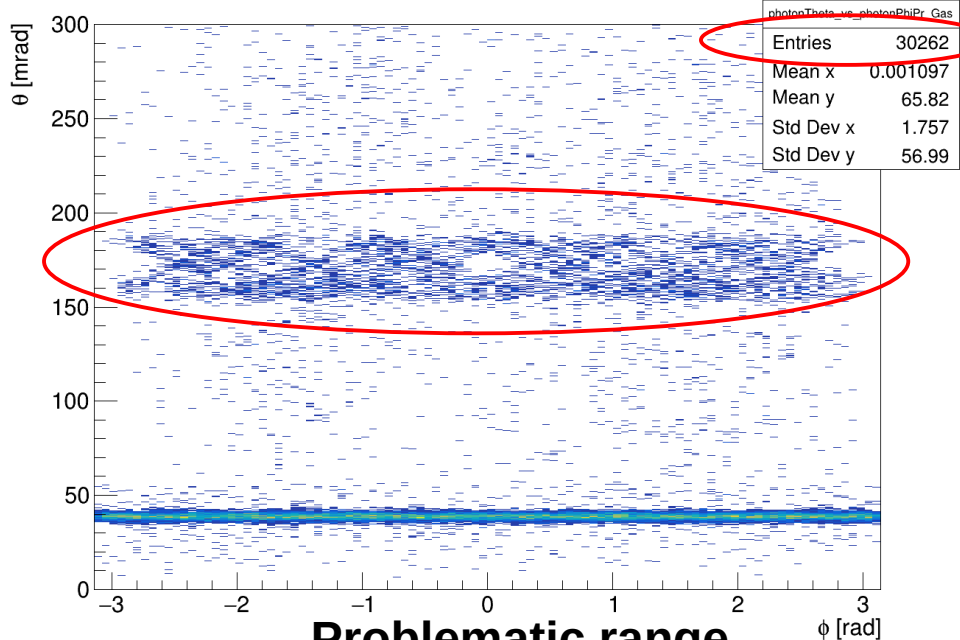
Events mostly limited to $-10 \text{ mrad} < \Delta\theta < +10 \text{ mrad}$

Output root file

$\theta_{\text{rec.}}$ vs. azimuthal angle, 10k

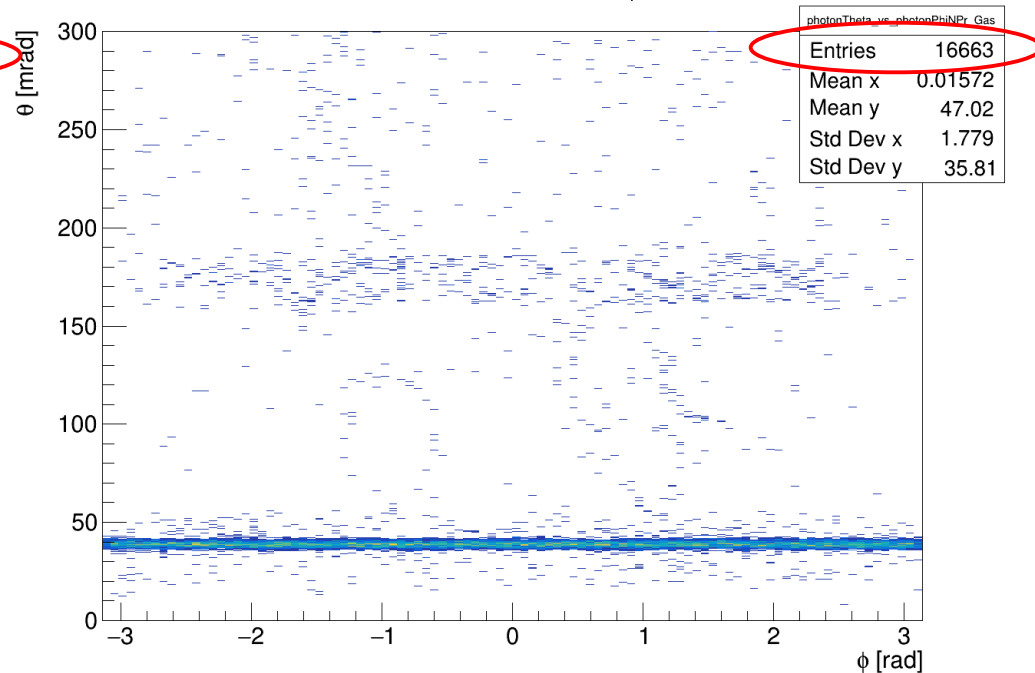
$\theta_{\text{rec.}}$ not θ_{Ring}

Estimated Photon θ vs ϕ for Gas



Problematic range
 $\eta > 2.8 \ \&\& \ \eta < 3.3$

Estimated Photon θ vs ϕ for Gas



$\eta > 2.5 \ \&\& \ \eta < 2.8$

- $\theta_{\text{rec.}}$ Cher. photons produced in Aerogel misunderstood as $\theta_{\text{rec.}}$ Cher. photons produced in Gas
- Sub-optimization of θ_{Ring} definition

Source code modified

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

Before

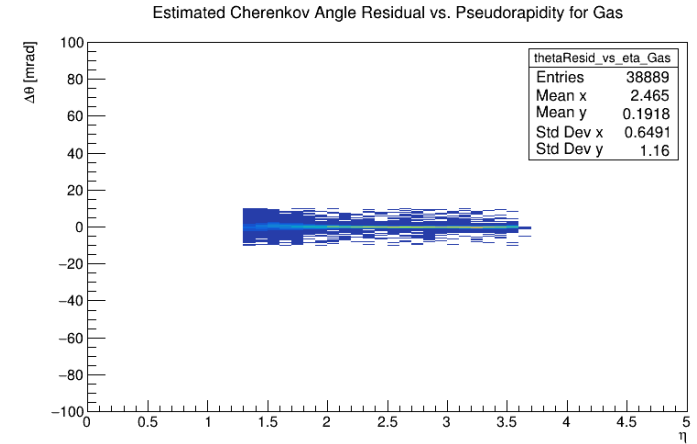
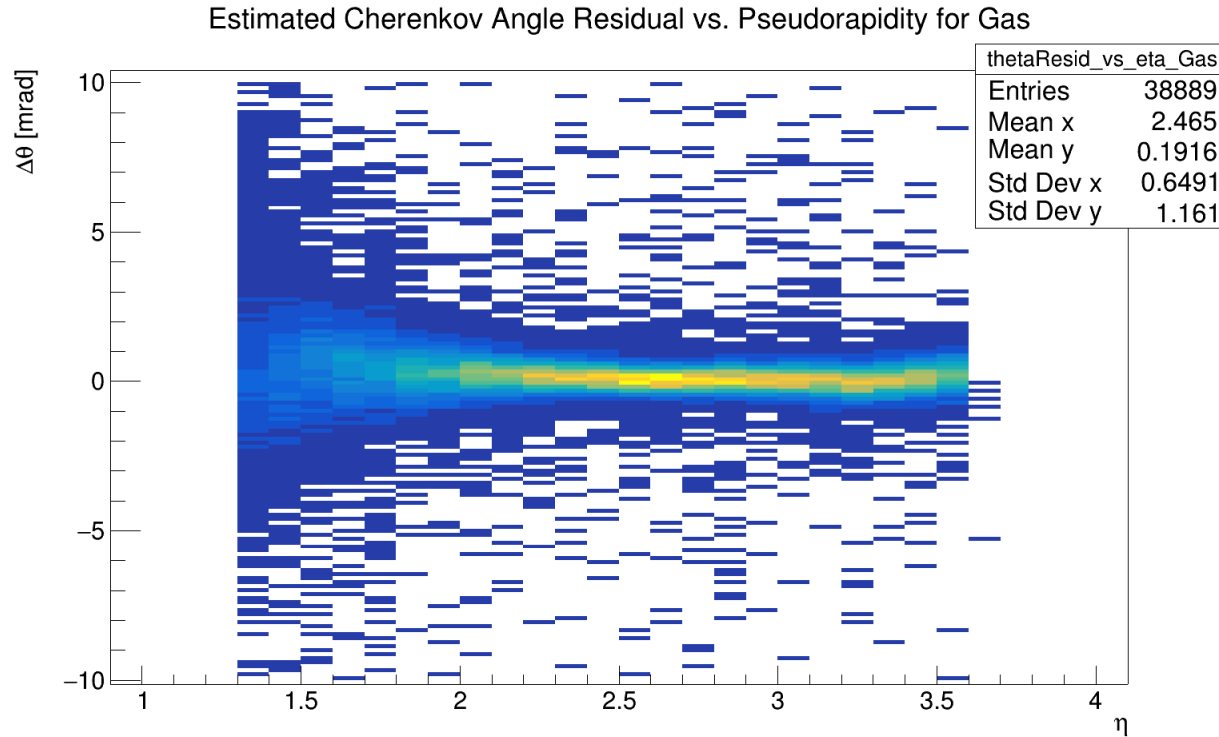
```
for(const auto& [theta,phi] : cherenkov_pid.getThetaPhiPhotons()){//UNCOMMENTING FROM HERE
    theta_rec += theta;
}
theta_rec /= cherenkov_pid.getNpe(); ----->  $\theta_{\text{Ring}}$ 
```

After

```
for(const auto& [theta,phi] : cherenkov_pid.getThetaPhiPhotons()){
    if(TMath::Abs(theta-theta_exp)<0.010){ //modified, in rad
        theta_rec += theta;
        Npe++;
    }
    else theta_rec+=0;
}
theta_rec /= Npe; ----->  $\theta_{\text{Ring}}$ 
```

Output root file - modified

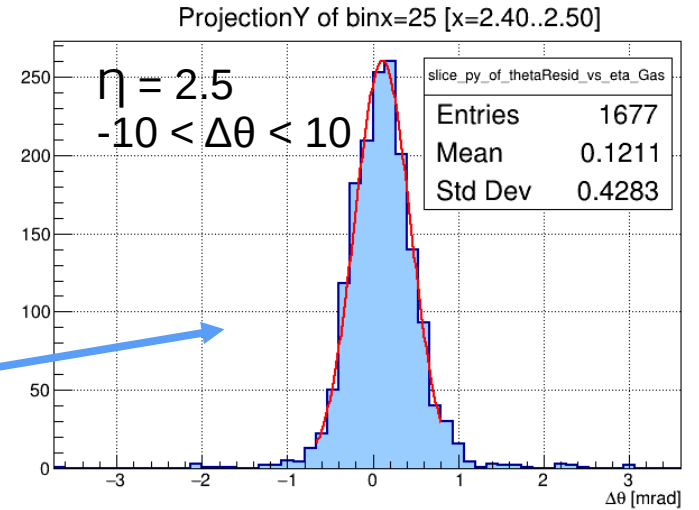
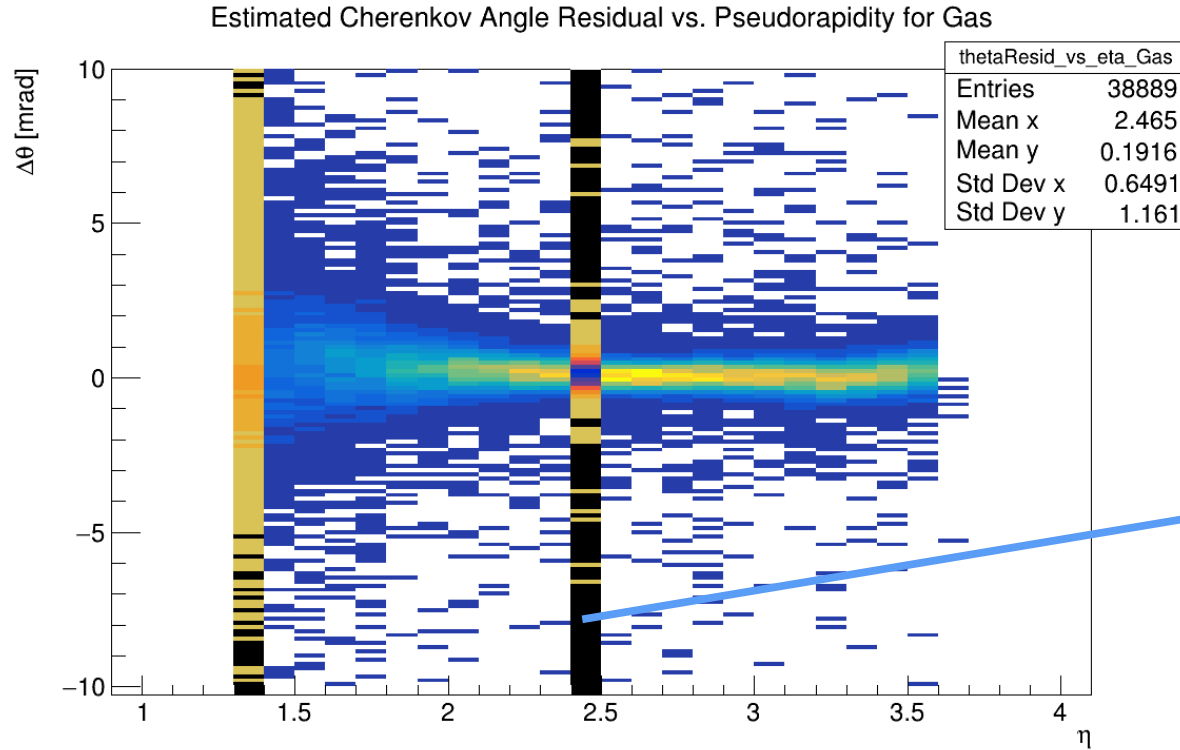
Gas, 50k



- Scatter plot of Cherenkov angle residual, $\Delta\theta$ and η
- $\Delta\theta = \theta_{\text{resid}} = (\theta_{\text{Ring}} - \theta_{\text{exp}})$
- $\Delta\theta$ broad for $\eta < 1.8$

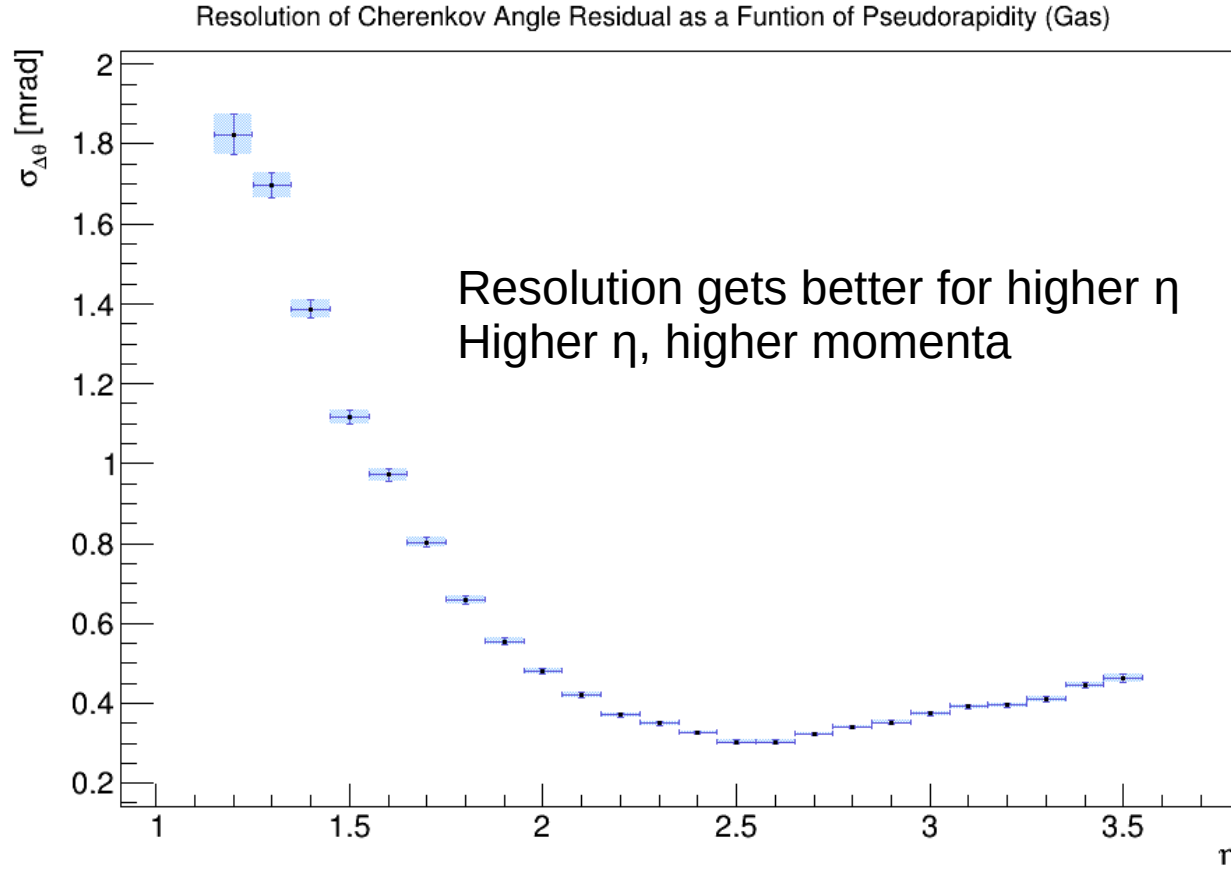
Resolution θ_{resid} vs. η (Gas)

Slice by slice evaluation of σ

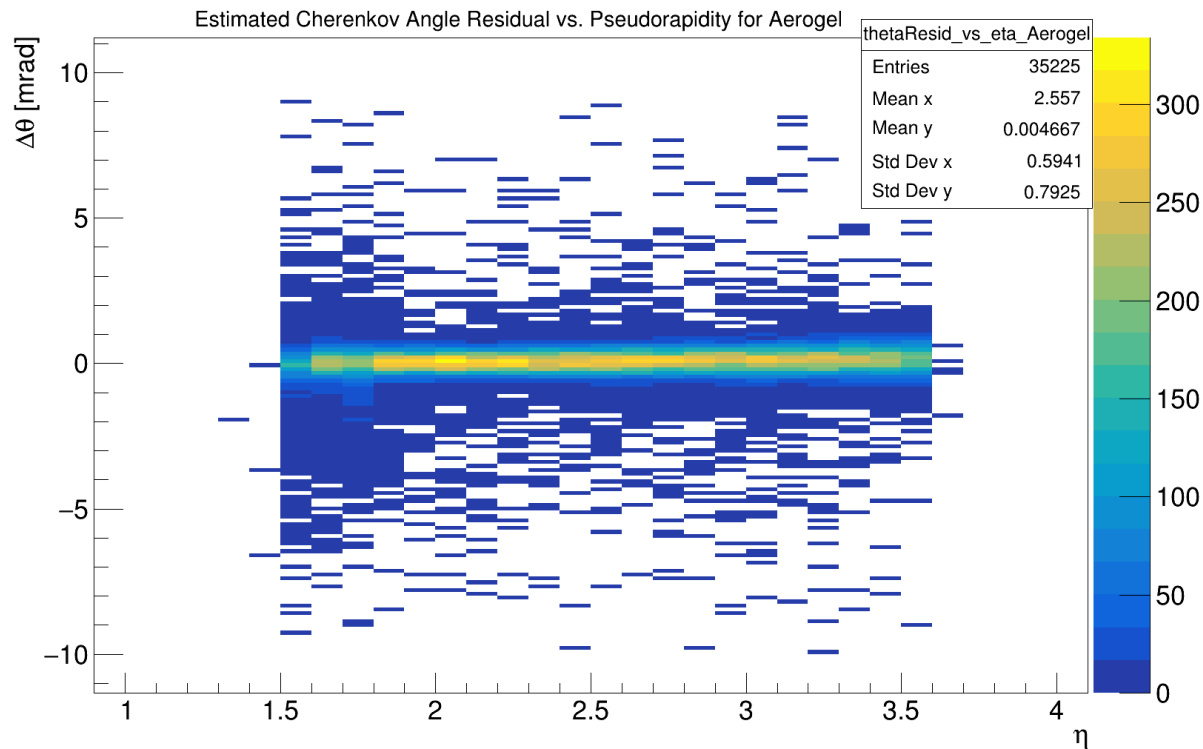


$\sigma_{\Delta\theta, \text{slice}}$ extracted from fitting parameter

Resolution θ_{resid} vs. η (Gas)



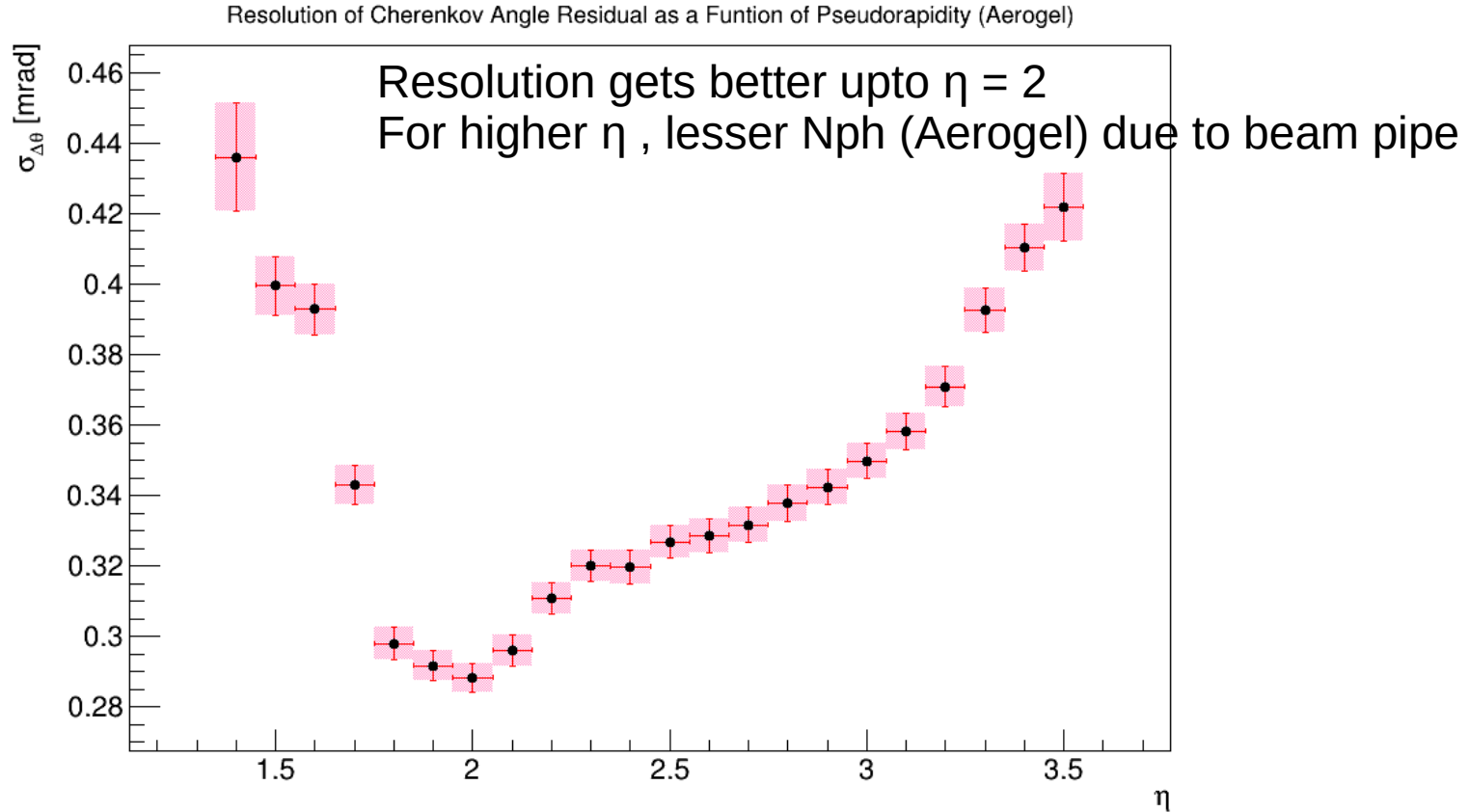
Output root file



Aerogel, 50k

- Scatter plot of Cherenkov angle residual, $\Delta\theta$ and η
- $\Delta\theta = \theta_{\text{resid}} = (\theta_{\text{Ring}} - \theta_{\text{exp}})$

Resolution θ_{resid} vs. η (Aerogel)



Thank you!