EIC Yellow Report PID meeting

Focusing RICH for High momentum PID: preliminary results from simulation

31/07/2020

Giacomo Volpe

University and INFN, Bari, Italy

Motivation

High-momentum
h- PID at colliders

- Gaseous radiator
- Focusing system (mirrors)
- Wide phase space acceptance
- Detector in B-field region

Gaseosus radiator: currently, large use of fluorocarbons

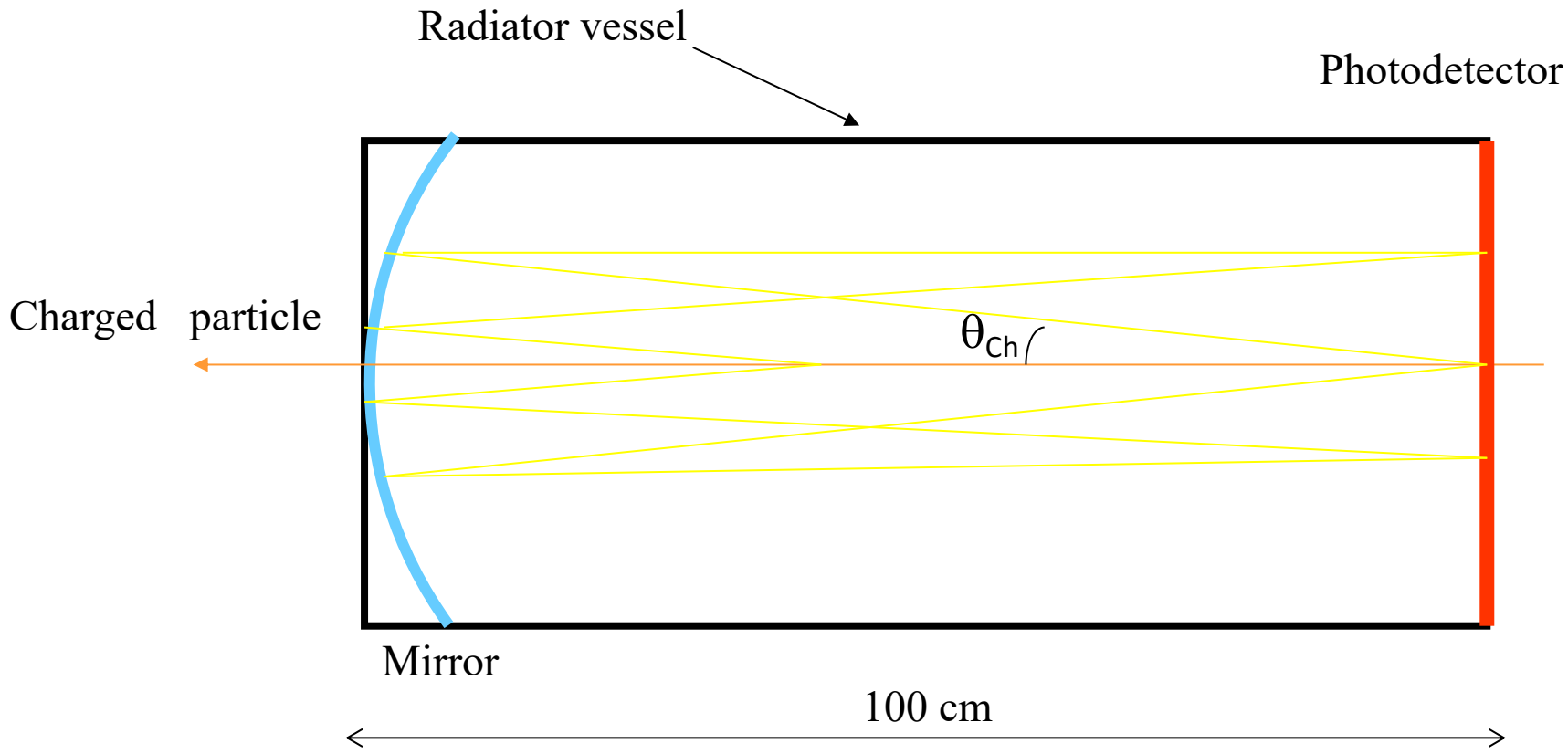
- Offering large Cherenkov photon rate with limited chromatic dispersion
- Not eco-friendly!!!

Other gas options?!

- ALICE-VHMPID (Very High Momentum PID, proposed upgrade for ALICE in 2012) concept: take a “light gas” with limited chromaticity and make it “heavy” (P > 1 atm)

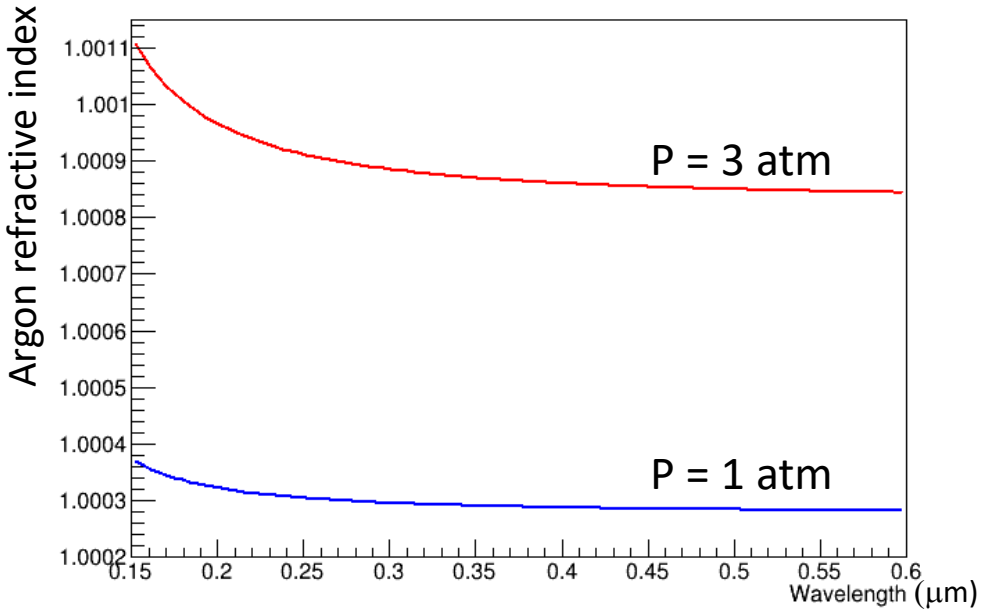
A fast simulation tool has been implemented to study a focusing RICH setup, using pressurized argon gas as Cherenkov radiator

Geometry


Radiator vessel
Photodetector
Charged particle
θ_{Ch}
Mirror
100 cm

Optical properties

- Cherenkov radiator → Argon gas at P = 3 atm



Argon refractive index vs wavelength (at atmospheric pressure)

$$n - 1 = \frac{2.50141\times10^{-3}}{91.012 - \lambda^{-2}} + \frac{5.00283\times10^{-4}}{87.892 - \lambda^{-2}} + \frac{5.22343\times10^{-2}}{214.02 - \lambda^{-2}}$$

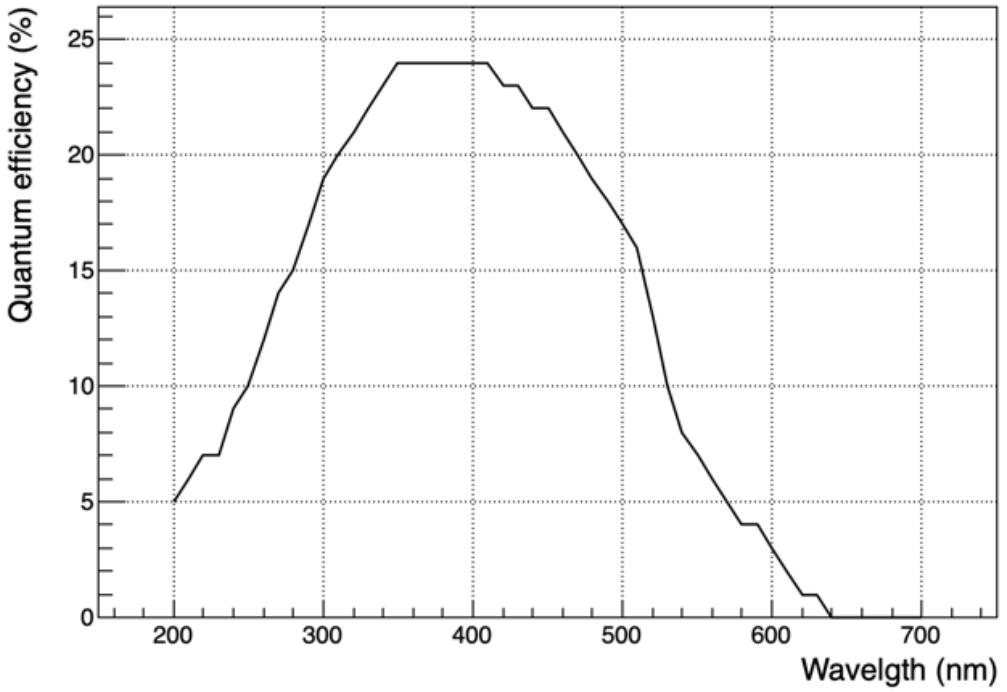
- Mean number of produced Cherenkov photons per [cm] and [eV] → $N = 370 * \sin^2\theta_{ch}$ (spread according to a Poisson distribution)

- Photons absorption in argon is considered negligible

- Reflectivity of the mirror in the given photon energy range assumed about 100%

Photons detector

- As starting point, for the photons detector we consider MAPMT



- Spatial resolution → 3 x 3 mm2
- Collection efficiency → ≅ 70 %
- Dead zone → ≅ 30%

Simulation tool

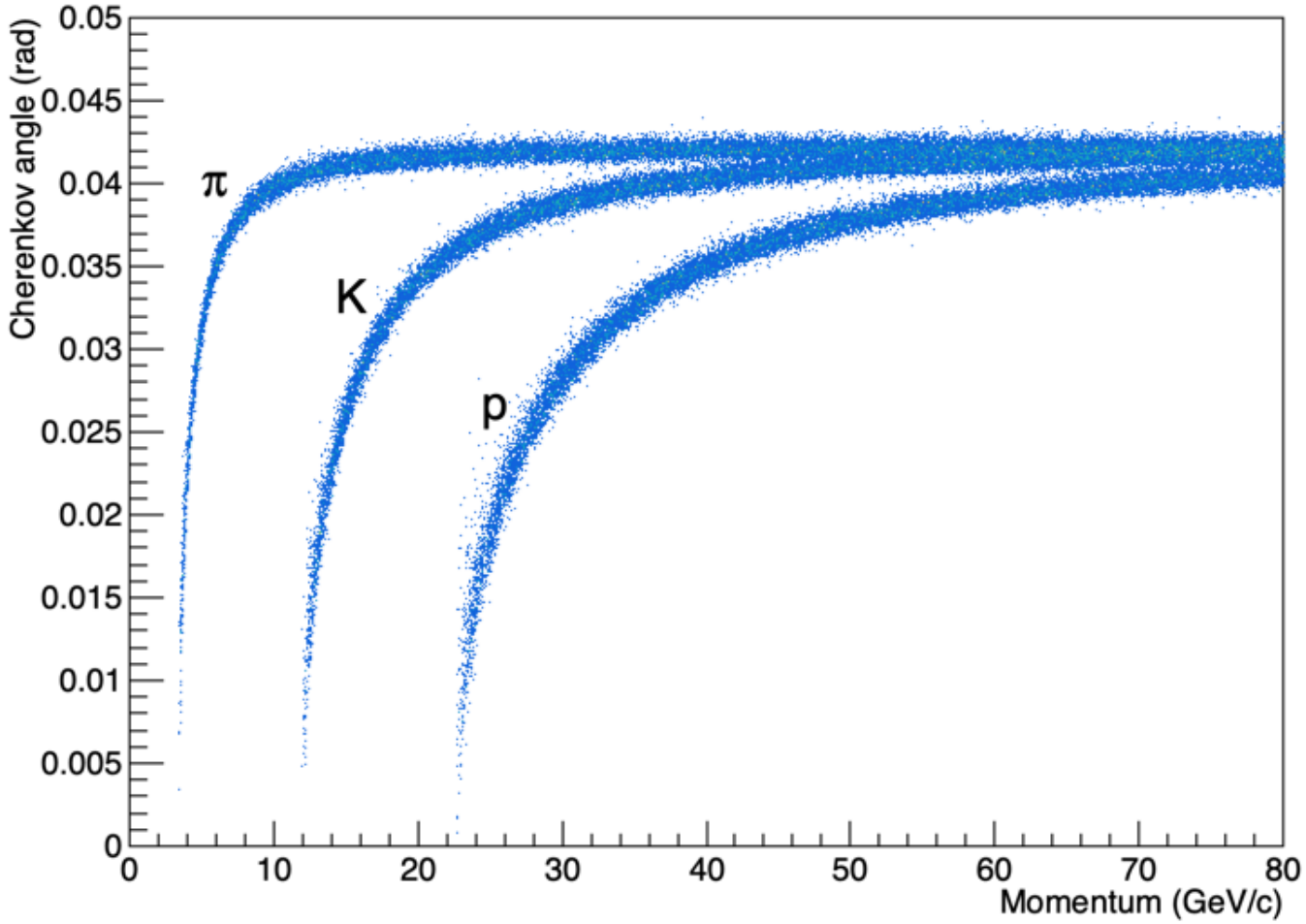
- The simulation is based on a standalone ROOT macro that takes into account the geometrical and optical parameters of the detector to be studied.

- The photon emission angles are reconstructed using a backtracing loop method [ALICE HMPID TDR, CERN/LHCC/98-19], as in the ALIDE-HMPID (proximity focusing) and ALICE-VHMPID design (focusing).

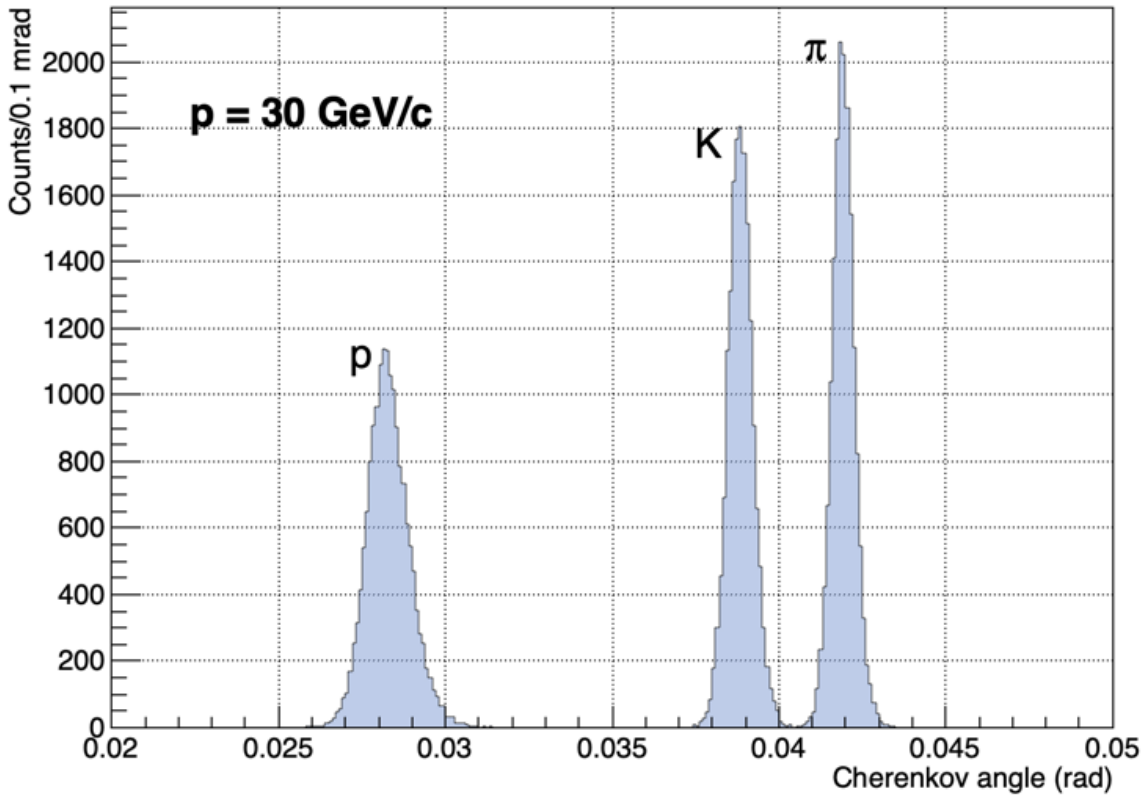
- The geometrical and optical parameters can be easily modified

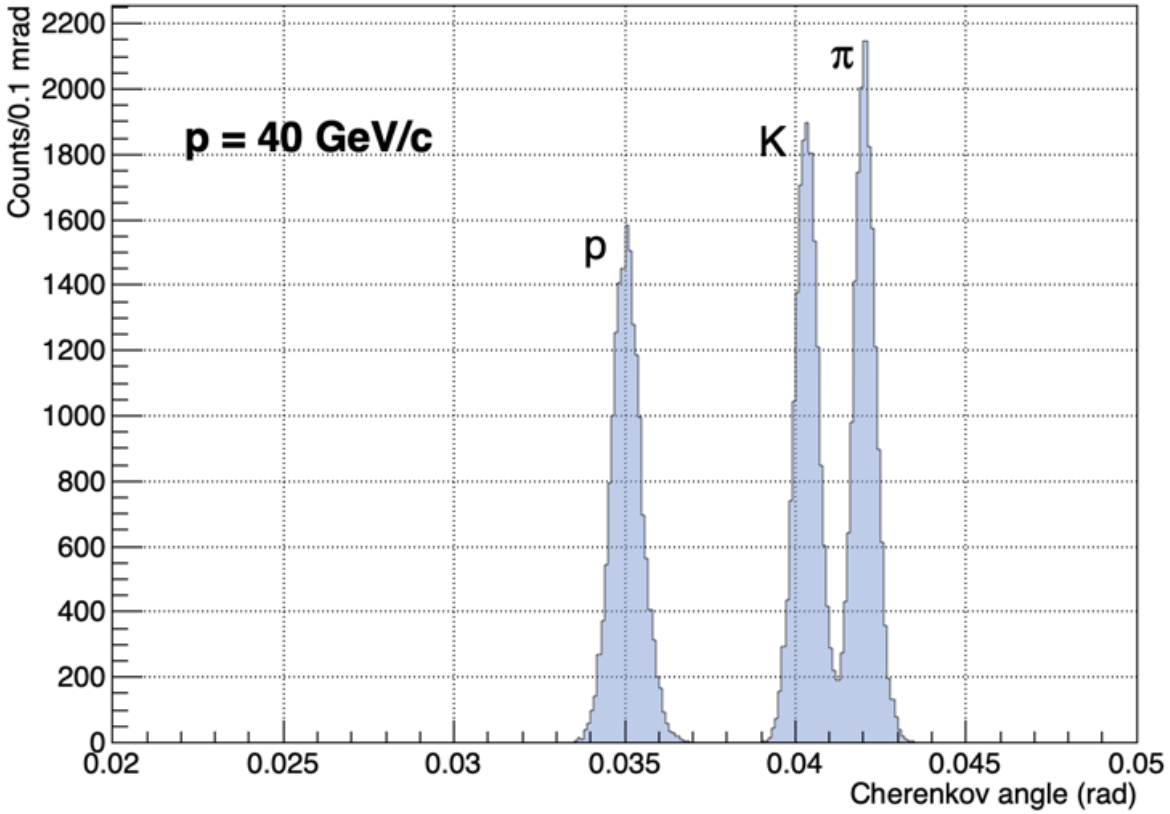
Preliminary results

Reconstructed Cherenkov angle vs momentum (maximum inclination track angle w.rt. the detector axis is θ_{trk} = 8°)



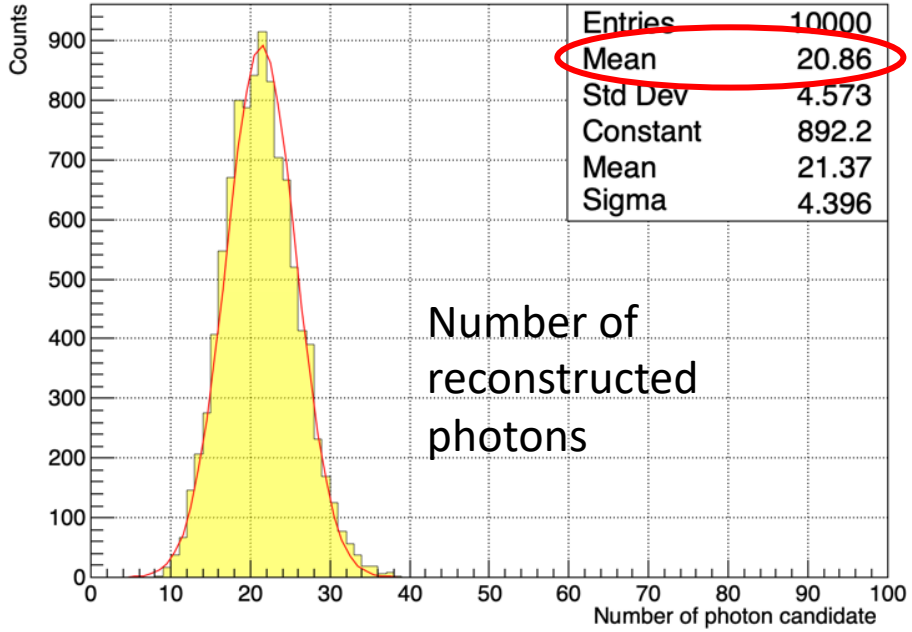
Preliminary results



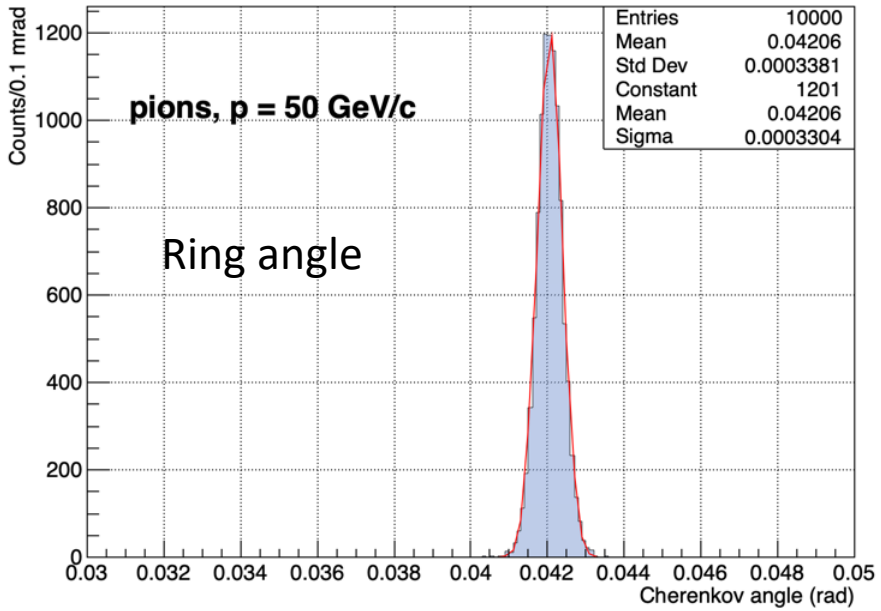


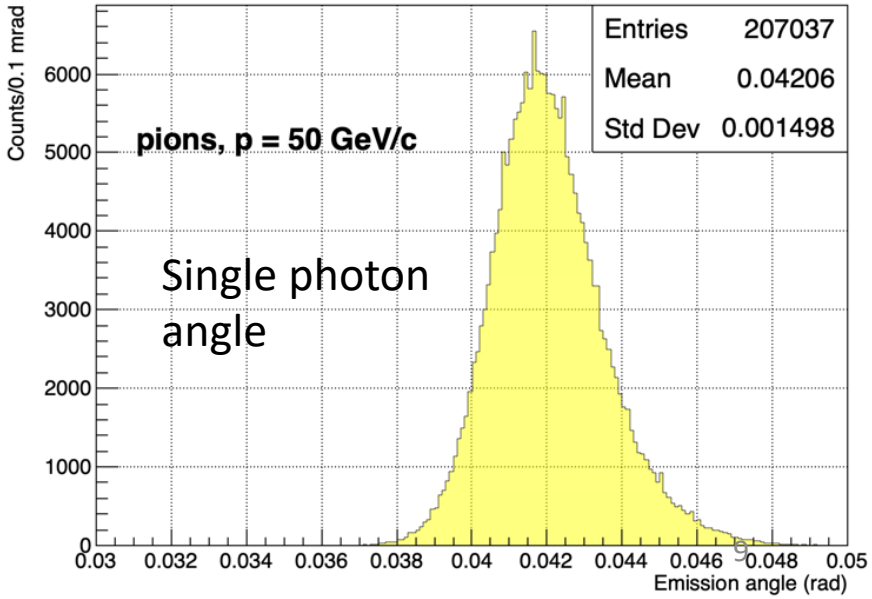
Preliminary results: resolution study

50 GeV/c pions



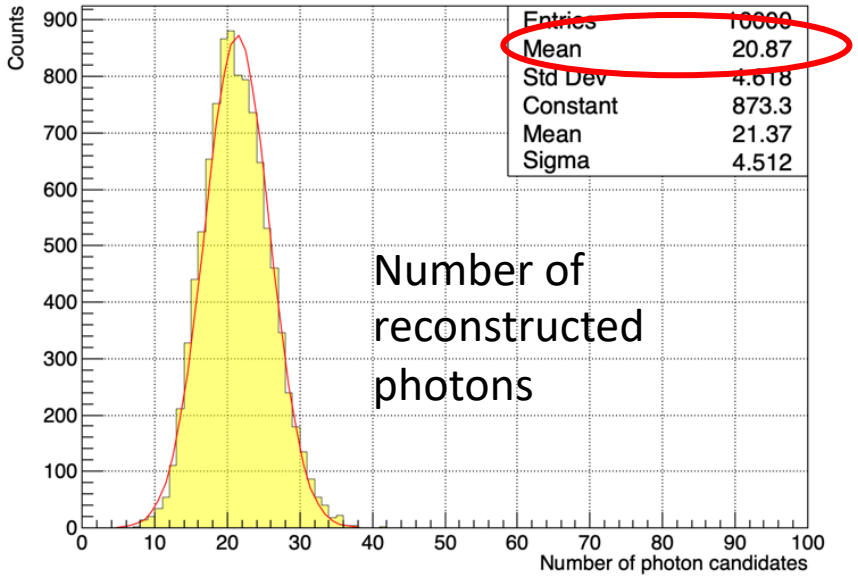
Total uncertainty



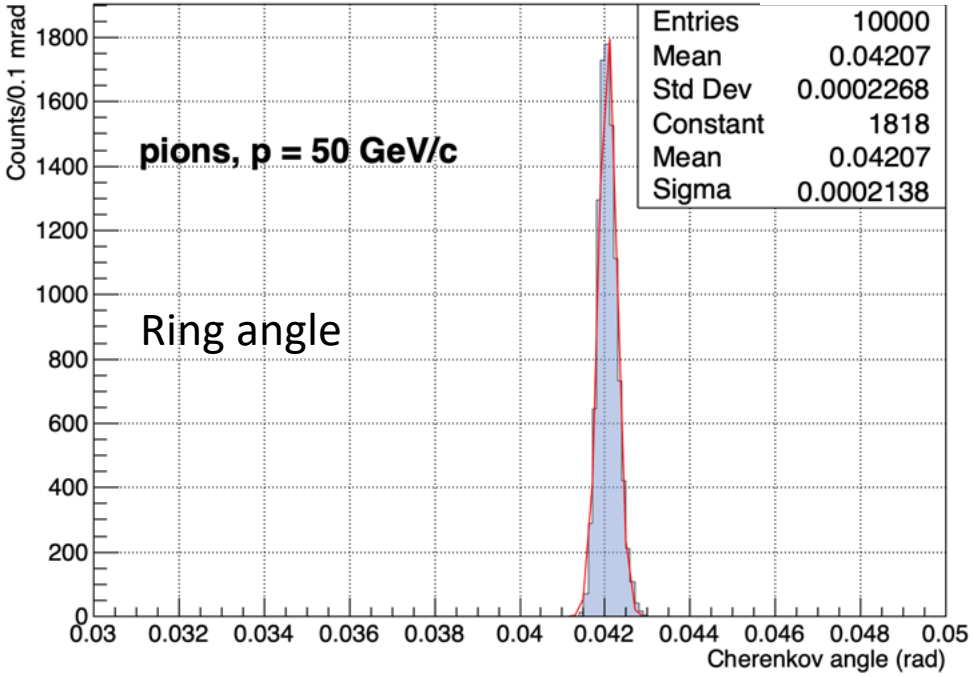


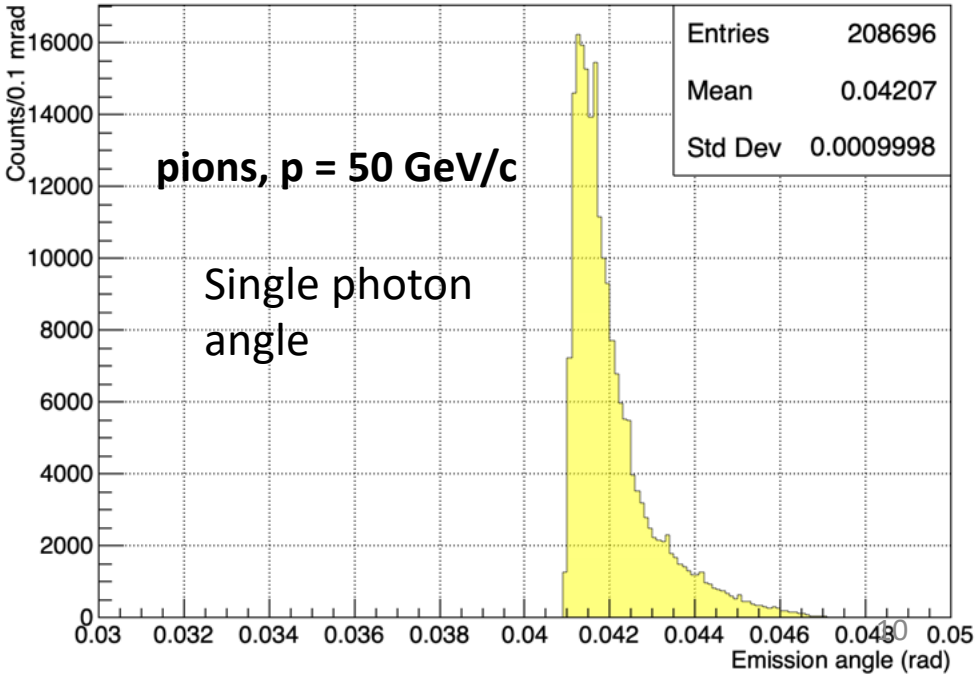
Preliminary results: resolution study

50 GeV/c pions



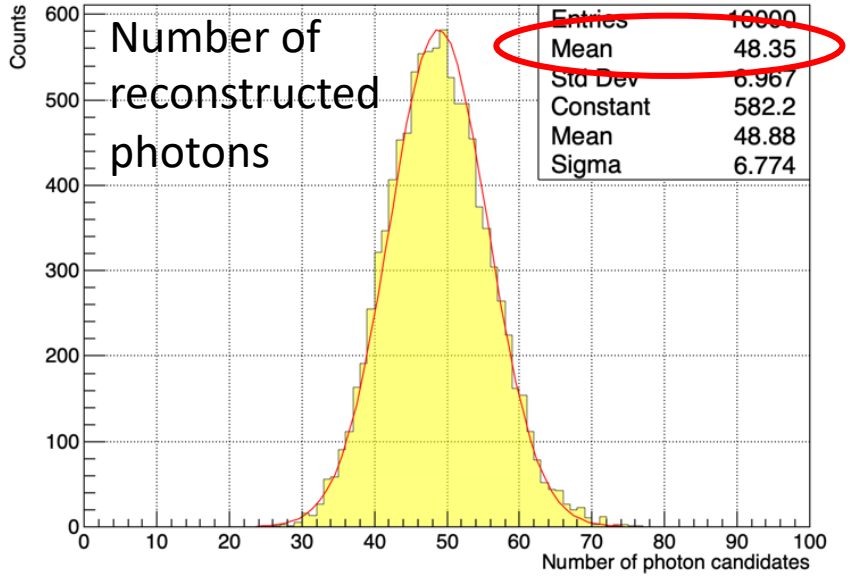
Chromatic uncertainty



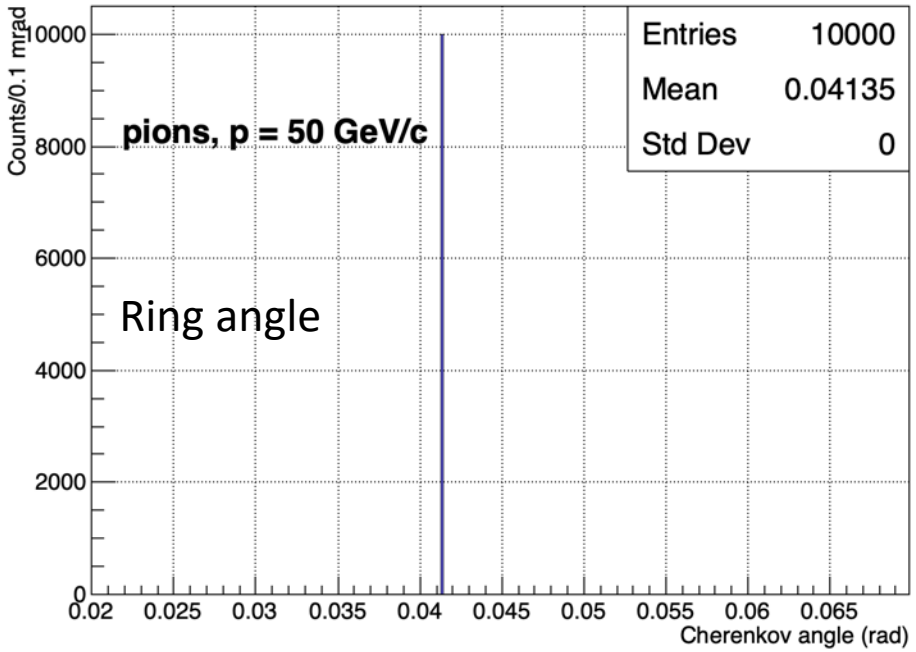


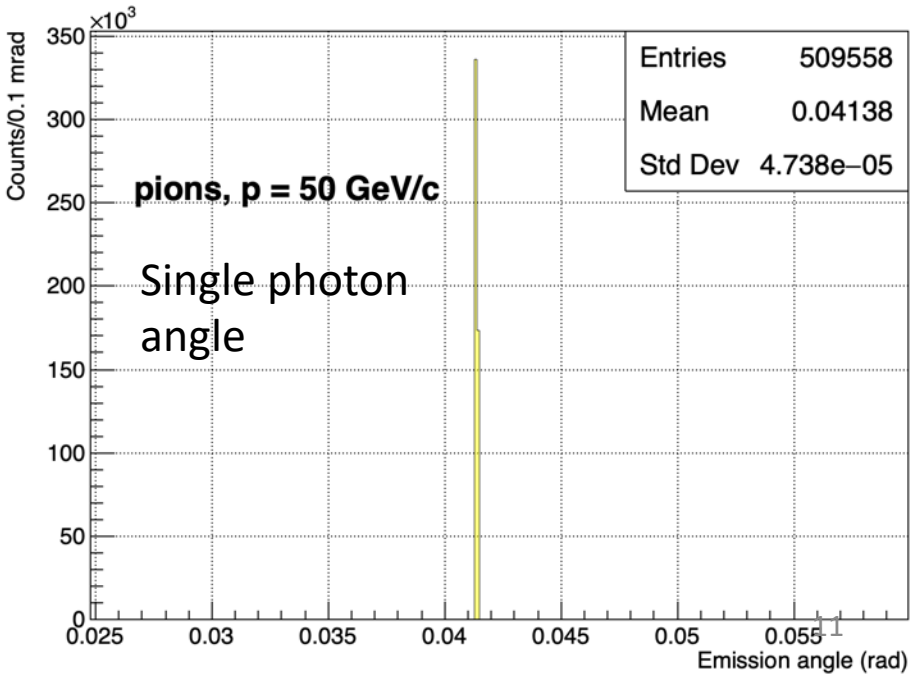
Preliminary results: resolution study

50 GeV/c pions



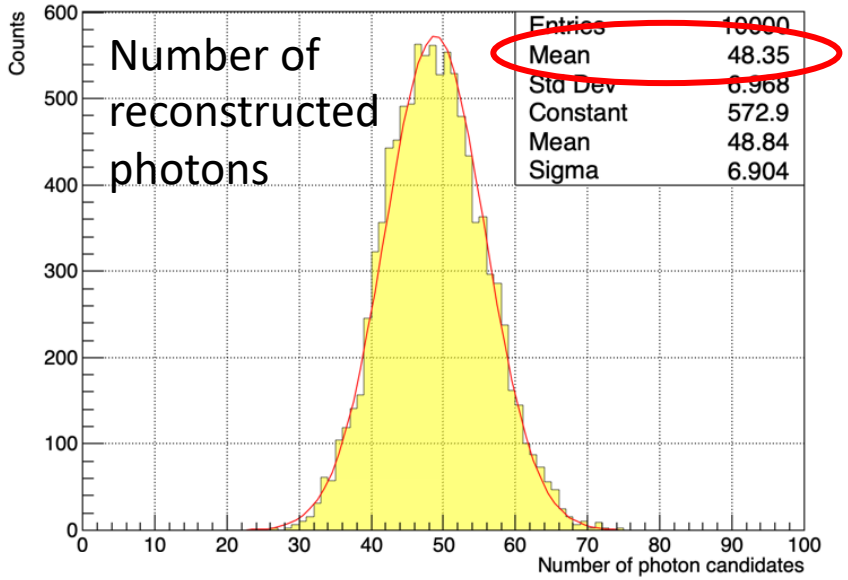
Geometric uncertainty



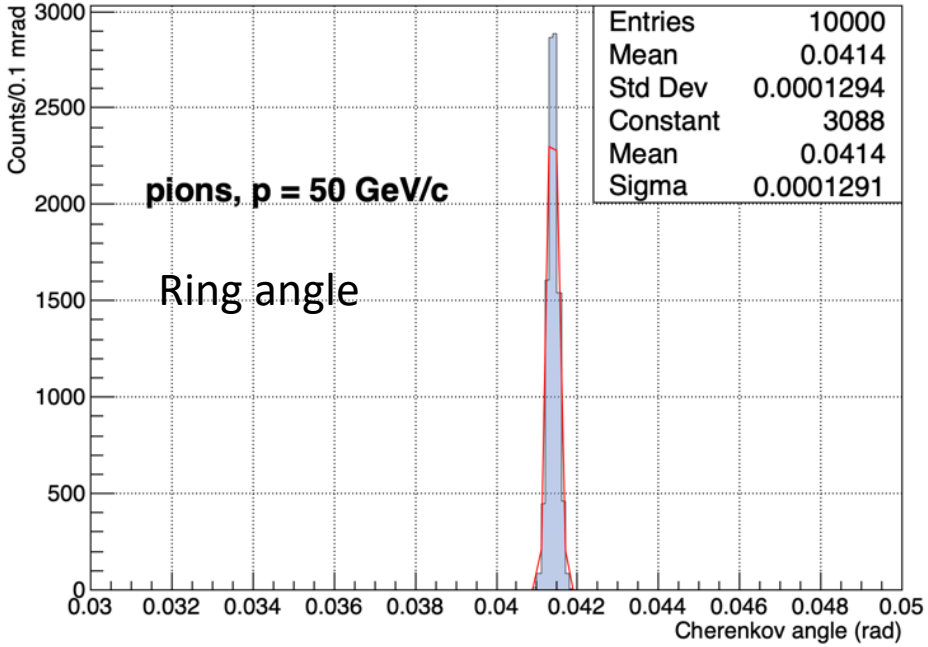


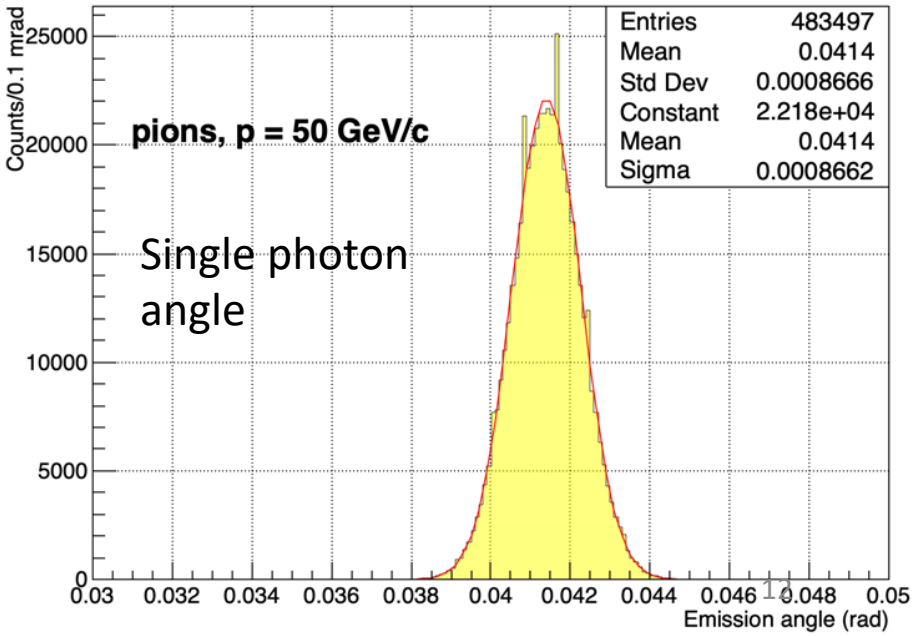
Preliminary results: resolution study

50 GeV/c pions



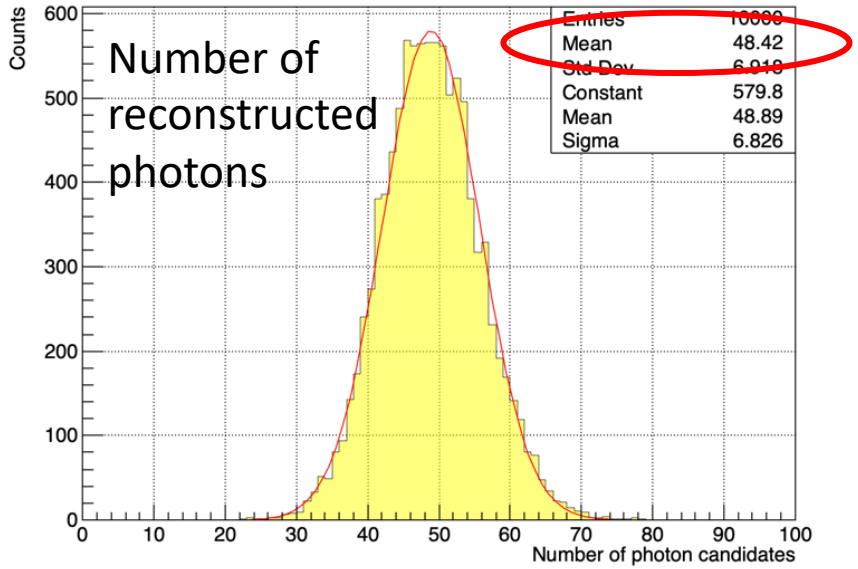
Localization uncertainty



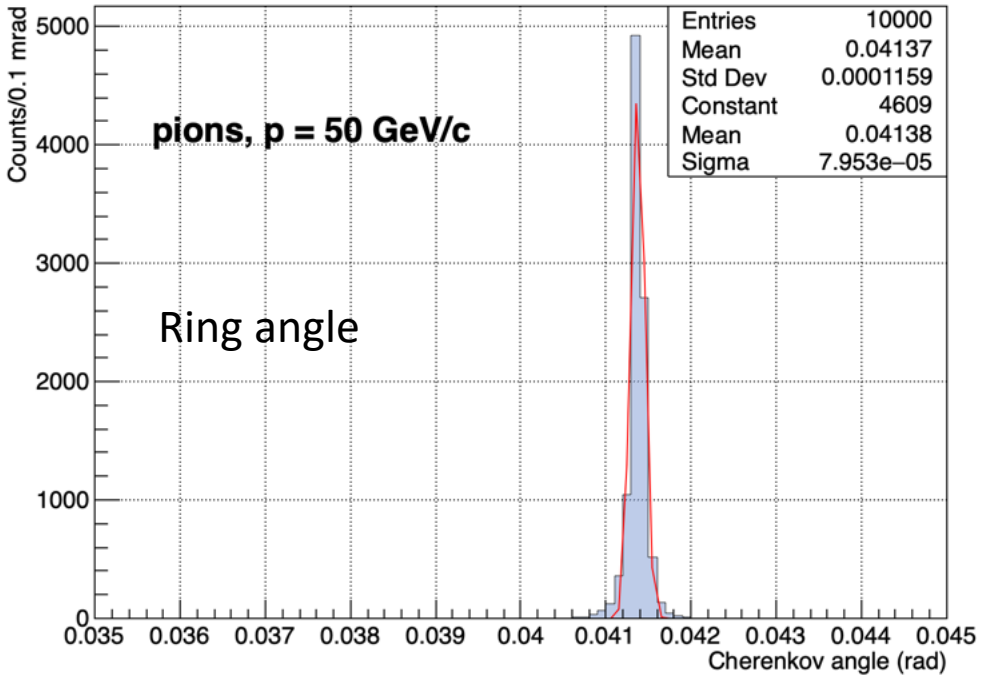


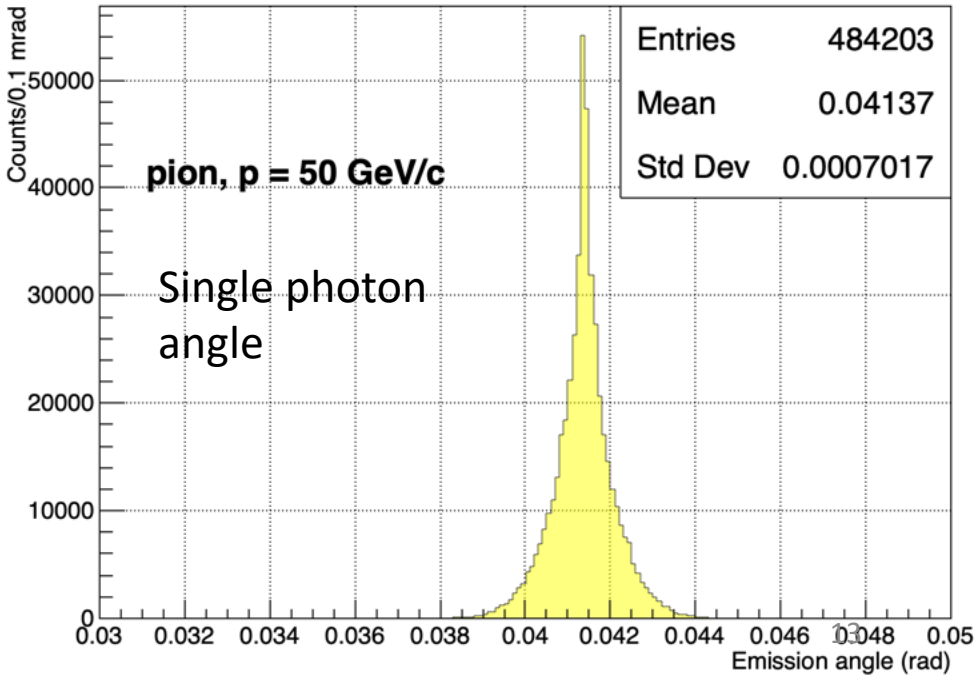
Preliminary results: resolution study

50 GeV/c pions



Tracking uncertainty





Preliminary results: resolution study

Summary table

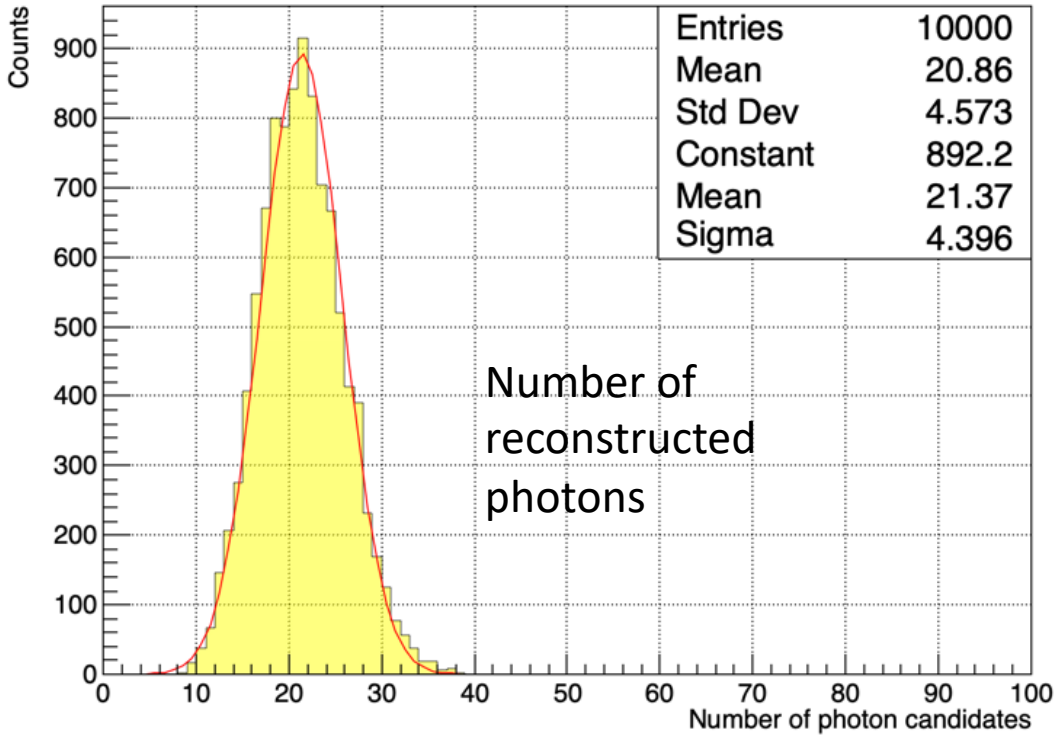
Contribution	Single photon angular resolution (mrad) at $\beta \cong 1$
Total	1.49
Chromatic	1.00
Geometrical	negligible
Localization (3x3 mm^2 pad size)	0.87
Tracking (1 mrad resolution on track angles)	0.70

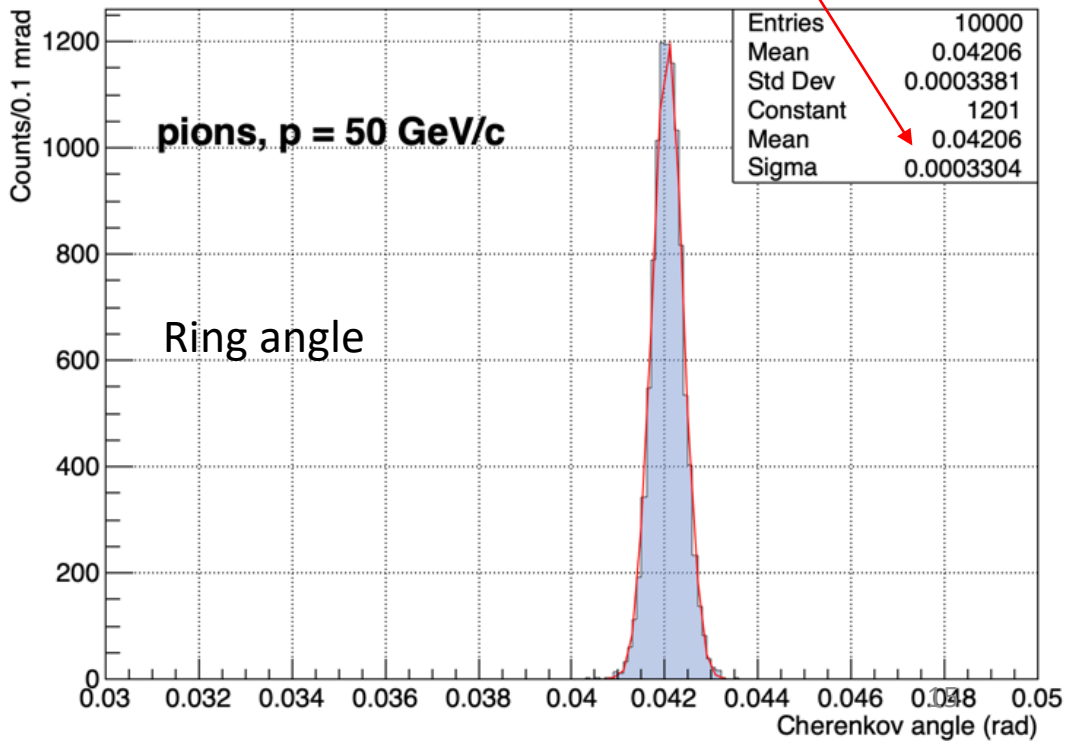
$$\sigma_{tot} = \sqrt{\sigma_{chrom} + \sigma_{geom} + \sigma_{loc} + \sigma_{track}} =$$

$$= \sqrt{(1.00\ mrad)^2 + (0.87\ mrad)^2 + (0.7\ mrad)^2} \approx 1.49 \text{ mrad}$$

Preliminary results: resolution study

$$\sigma_{tot}^{ring} = \frac{\sigma_{tot}}{\sqrt{N_{photons}}} = \frac{1.49\ mrad}{\sqrt{21}} \approx 0.33\ mrad$$





Conclusions

- A fast simulation tool has been implemented for focusing RICH studies
  - Preliminary results from simulation has been presented → reliable tool

What next

- Simulate a geometry with mirror inclined w.rt. detector axis
- Include track bending in the magnetic field
- Evaluate π/K and K/p separation in sigma unit vs momentum
- On a later stage: include the detector geometry in the EIC official simulation framework