Physics Channels for CEPC RICH Studies

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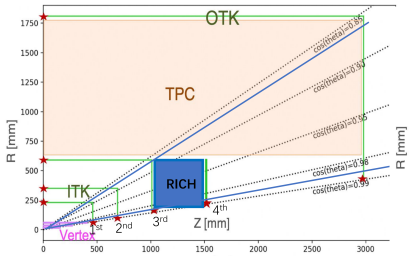
Recap: Proposed RICH Layout

- A possible RICH detector layout has been proposed (Zhonghua Qin).
- This study evaluates the impact of the RICH on PID performance, using the **location 1** RICH geometry.

Possible location of the Cherenkov detector at CEPC

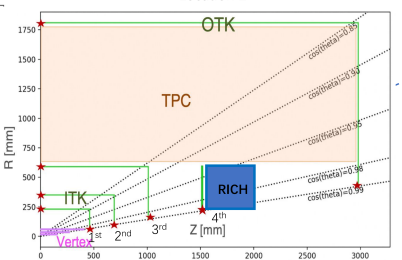
- Two possible locations without changing the other detector design in ref-TDR
- Depending on physics requirement, Cherenkov detector performance and also material budget

Location 1



Coverage: 9.3° <θ <28.8°
or 0.88<cos θ< 0.99

Location 2

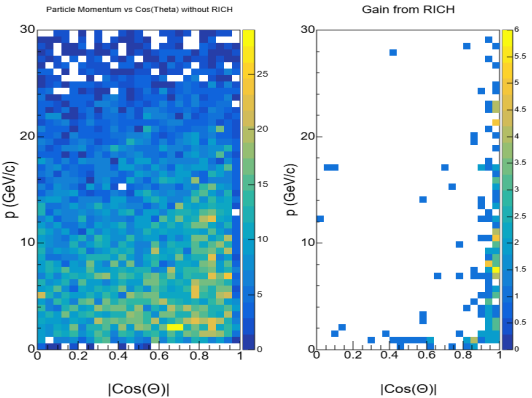


Coverage: 8.8° <θ < 20.3°
or 0.94<cos θ< 0.99

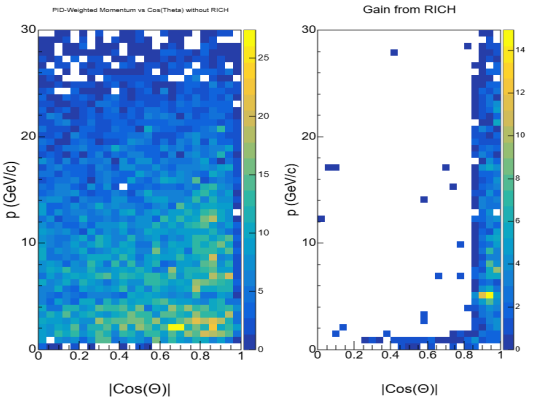
Study Goal

- Evaluate the impact of the RICH detector in addition to the TPC-only setup.
- Quantify the gain at two levels:
  - **Geometric acceptance:** accepted tracks / events
  - **PID-weighted yield:** correctly identified effective yield
- In the current study:
  - TPC-only tracks use baseline PID efficiency (from Xiaotian Ma)
  - tracks hitting the RICH are assigned ideal PID efficiency (eff RICH $= 1$)

$D^0 \to K^-\pi^+$: Acceptance and Correctly identified events Gain

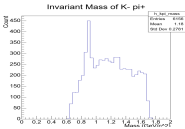


Geometric gain: 2.00%

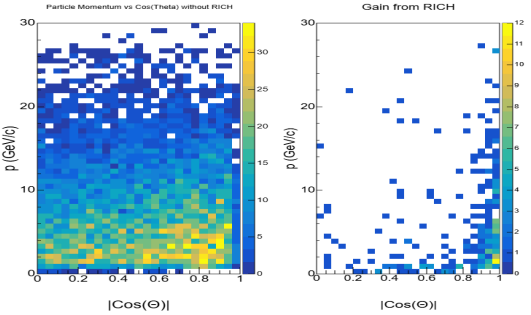


Correctly identified events gain: 11.34%

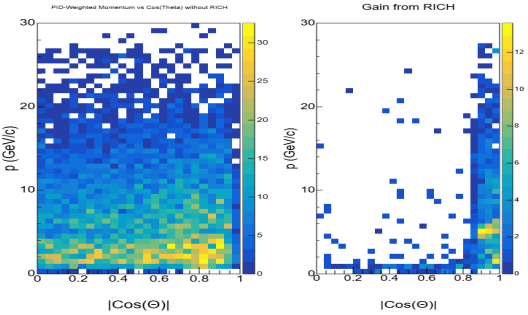
$D^+ \to K^-\pi^+\pi^+$: Geometric vs Correctly identified events Gain



A clear $K\pi$ resonance structure is visible in the selected $D^+ \to K^-\pi^+\pi^+$ sample.

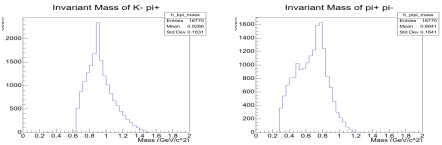


Geometric gain: 3.05%

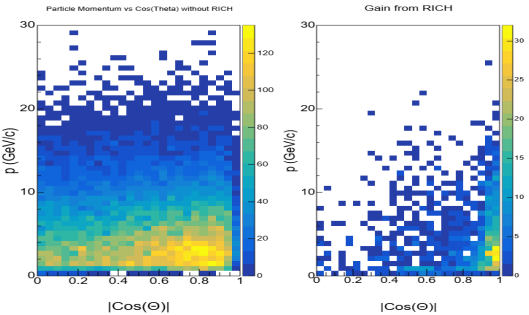


Correctly identified events gain: 14.25%

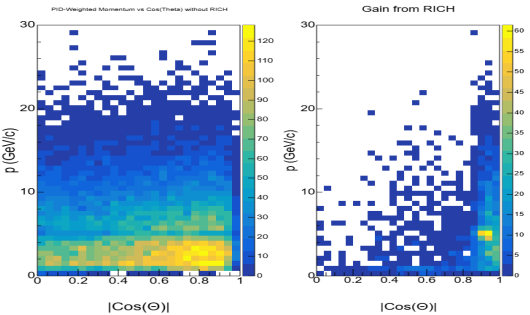
$D^0 \to K^-\pi^+\pi^+\pi^-$: Geometric vs Correctly identified events Gain



$K^*(892)$ and $\rho(770)$ structures are visible in the selected $D^0 \to K^-\pi^+\pi^+\pi^-$ sample.



Geometric gain: 3.86%



Correctly identified events gain: 16.66%

Summary

- After accounting for the PID efficiency loss in the high-$|\cos\theta|$ region, the number of correctly identified events can gain by about 10–20% under the ideal RICH assumption.
- The gain becomes larger for decay channels with more final-state particles.

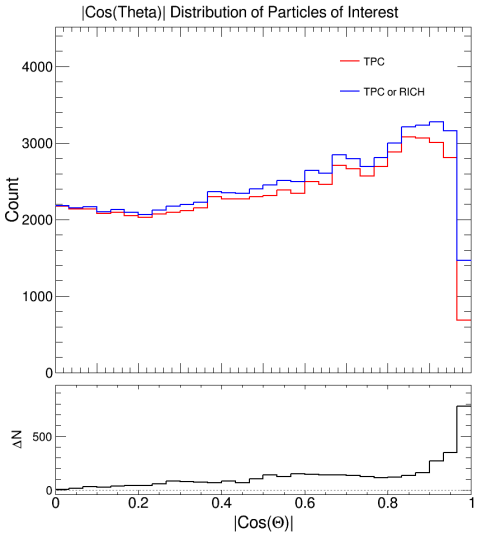
p/K/π Acceptance Gain

- Comparison:
  - TPC only
  - TPC or RICH
- Lower panel:

$$\Delta N = N(\text{TPC or RICH}) - N(\text{TPC})$$

- The gain is visible over the full angular range.
- The largest improvement appears at large $|\cos\theta|$.

Summary:
N(TPC only): 70,411
N(TPC or RICH): 74,238
Relative gain: 5.44%



Thank you