

Time of Flight (ToF) simulation status

Honey Khindri (IIT Madras)

September 17, 2026

- ▶ Goal : quantify how TOF configurations affect $D^0 \rightarrow K^- \pi^+$ tagging/reconstruction efficiency.
- ▶ Study : PID separation of K and π .

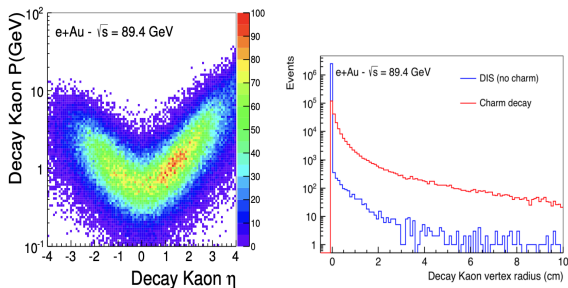


FIG. 5. Left: The distribution of the momentum of a decay K from $c\bar{c}$ production events versus pseudo-rapidity. Right: The vertex position of K in inclusive DIS (*blue line*) compared to $c\bar{c}$ production events (*red line*).

DD4HEP Simulations (FToF)

- ▶ **Sample** - epic:/RECO/26.04.1/epic_craterlake_without_zdc/SIDIS/D0_ABCONV/HFsim-BeAGLE/BeAGLE1.03.01-2.0/eAu/10x100/q2_1to10000
- ▶ No. of files : 10
- ▶ All the 10 files : 3687 $D^0 \rightarrow K^- \pi^+$ events ,

Monte carlo $D^0 \rightarrow K^- \pi^+$

- ▶ MC truth information is used to validate the $D^0 \rightarrow K\pi$ decay topology. Mass of $D^0 = 1.865 \text{ GeV}/c^2$.
- ▶ D^0 and $\bar{D}^0$ candidates are identified using the PDG codes:

$$D^0 : 421, \quad \bar{D}^0 : -421$$

- ▶ Require exactly two daughters corresponding to:

$$D^0 \rightarrow K^- \pi^+, \quad \bar{D}^0 \rightarrow K^+ \pi^-$$

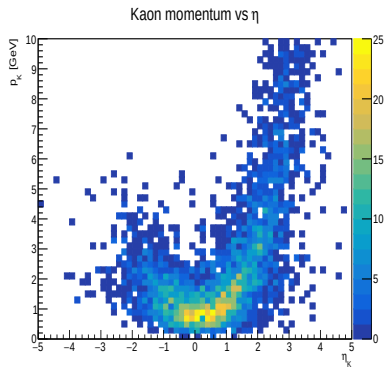
- ▶ Daughter momenta are obtained from the MC particle momentum branches.

Monte carlo $D^0 \rightarrow K^- \pi^+$

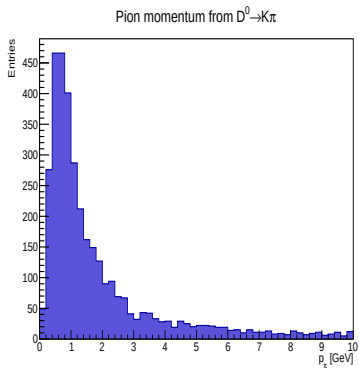
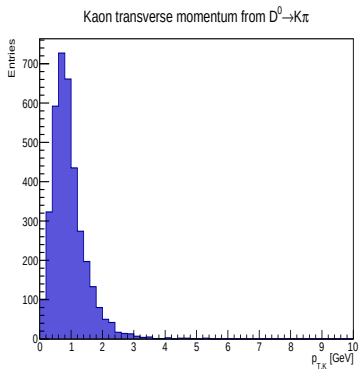
Branches used:-

- ▶ MCParticles.PDG
- ▶ MCParticles.momentum.x
- ▶ MCParticles.momentum.y
- ▶ MCParticles.momentum.z
- ▶ MCParticles.daughters_begin
- ▶ MCParticles_daughters.index

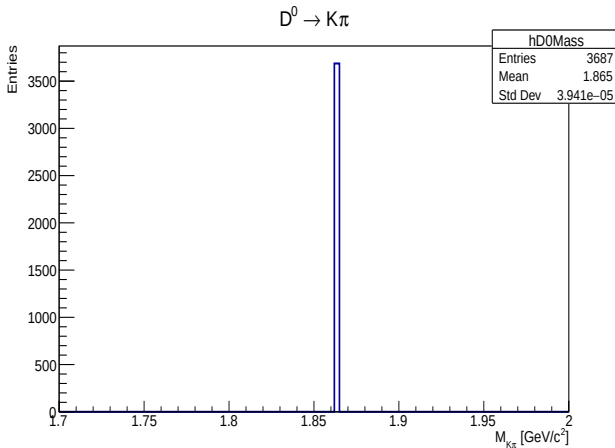
Monte carlo $D^0 \rightarrow K^- \pi^+$



Monte carlo $D^0 \rightarrow K^- \pi^+$



Monte carlo $D^0 \rightarrow K^- \pi^+$



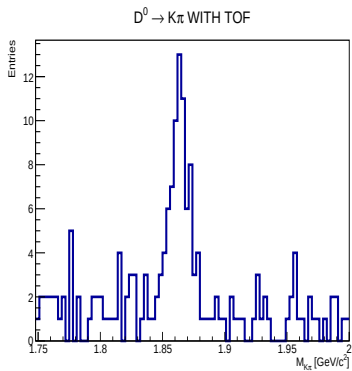
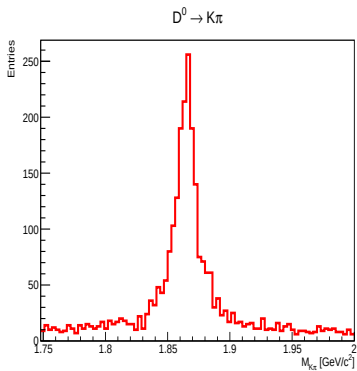
Reconstruction $D^0 \rightarrow K^- \pi^+$

- ▶ Select reconstructed charged-particle candidates from ReconstructedChargedParticles
- ▶ Identify kaon and pion candidates using particle-identification information.
- ▶ Combine opposite-sign $K\pi$ pairs to form D^0 candidates.
- ▶ Calculate the invariant mass:

$$M_{K\pi} = \sqrt{(E_K + E_\pi)^2 - |\vec{p}_K + \vec{p}_\pi|^2}.$$

- ▶ Study the D^0 mass peak and compare reconstruction with and without ToF PID.

Reconstructed $D^0 \rightarrow K^- \pi^+$



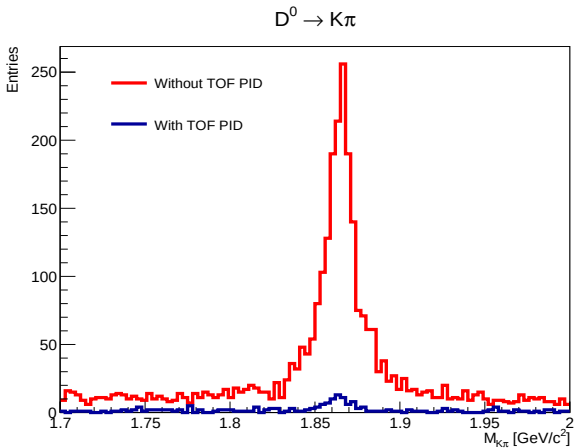
Reconstruction $D^0 \rightarrow K^- \pi^+$

Branches used:-

- ▶ ReconstructedChargedParticles.momentum.x , y and z.
- ▶ ReconstructedChargedParticles.charge
- ▶ ReconstructedChargedParticles.PDG - Does it contain ToF PID info?
- ▶ ReconstructedChargedParticles.particleIds_begin, end.
- ▶ CombinedTOFParticleIds.PDG, CombinedTOFParticleIds.likelihood

```
TOF PID index = 8  PDG = 11  likelihood = 0.48
TOF PID index = 9  PDG = -211 likelihood = 0.3
TOF PID index = 10 PDG = -321 likelihood = 0.23
TOF PID index = 11 PDG = -2212 likelihood = 0
TOF PID index = 12 PDG = 11  likelihood = 0.26
TOF PID index = 13 PDG = -211 likelihood = 0.74
TOF PID index = 14 PDG = -321 likelihood = 0
TOF PID index = 15 PDG = -2212 likelihood = 0
```

With and without ToF information



► Is it because of efficiency?