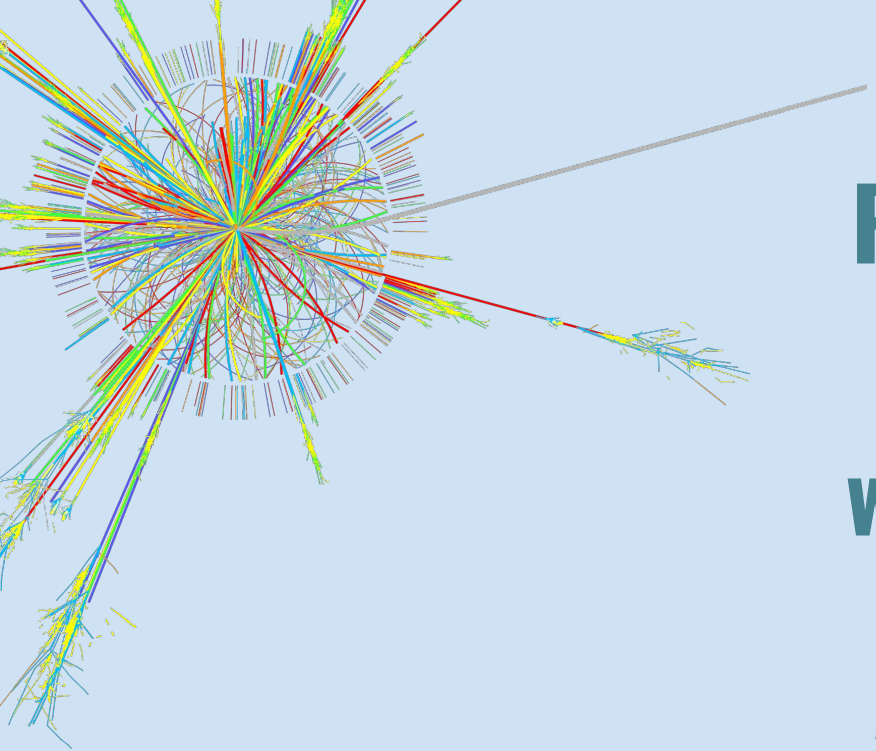

PID performances and the $B_s \rightarrow D_s K$ analysis with the IDEA detector

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7th FCC Physics Workshop - Jan 2024 - Annecy

INFN GENOVA

Introduction

Inclusive PID studies and performances

- MC-based selection of the bachelor kaon or pion using the $D_s K$ and $D_s \pi$ samples

$B_s \rightarrow D_s K$ analysis, with $D_s \rightarrow \phi\pi$, $\phi \rightarrow KK$

- Benchmark channel included in the mid-term review
- Pre-selection based on Phi and D_s mass
- 1.5 GeV as minimum momentum for all tracks
- B/(S+B) defined in the region under the B_s peak [5.358,5.375] GeV
- PID studies application

PID studies

Possible options

- Likelihood ratio on dN/dx
- Likelihood ratio on velocity
- Combined likelihood ratio
- Also tested standard and x2 worse resolution in dN/dx and standard and improved TOF resolution

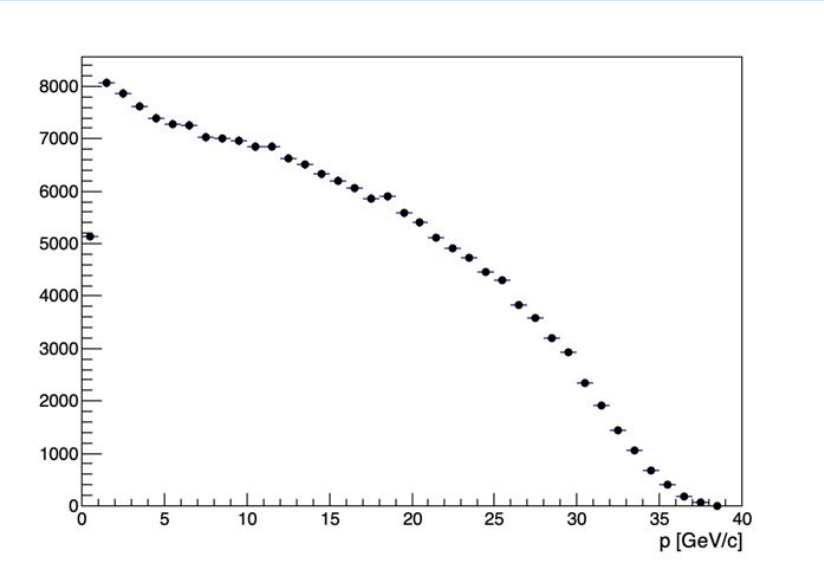
To be noted

- Velocity is being used instead of TOF to have an observable independent of detector geometry
- The selection for each option is tuned for 95% efficiency with respect to the initial selection

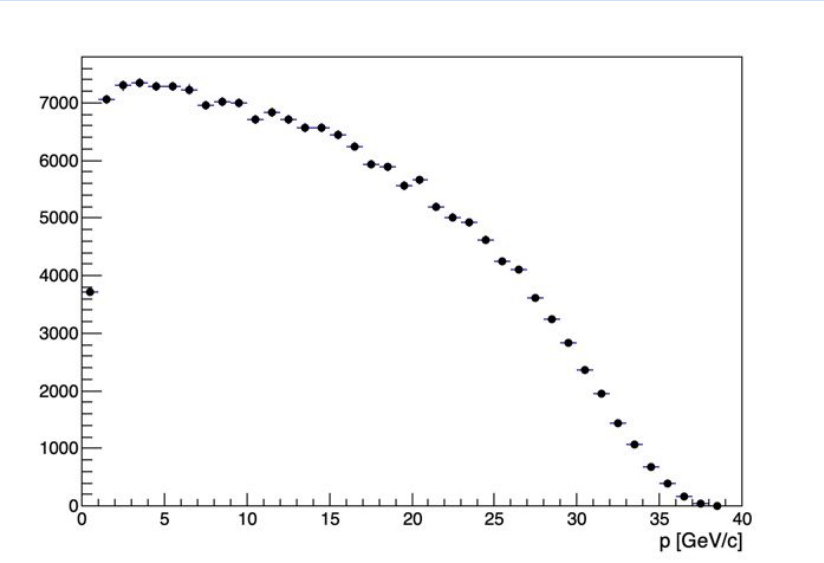
PID studies

- The bachelor kaon or pion is selected using the D_sK and $D_s\pi$ samples

Pion



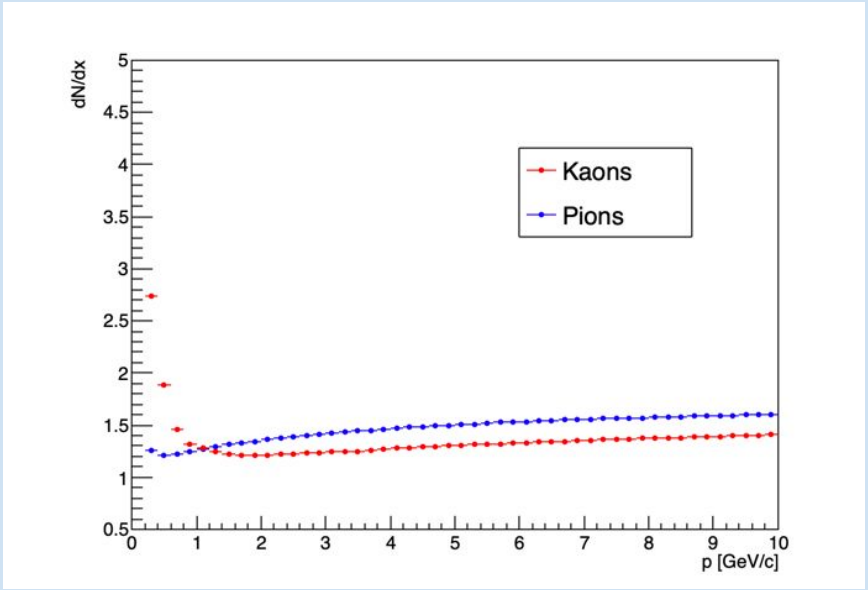
Kaon



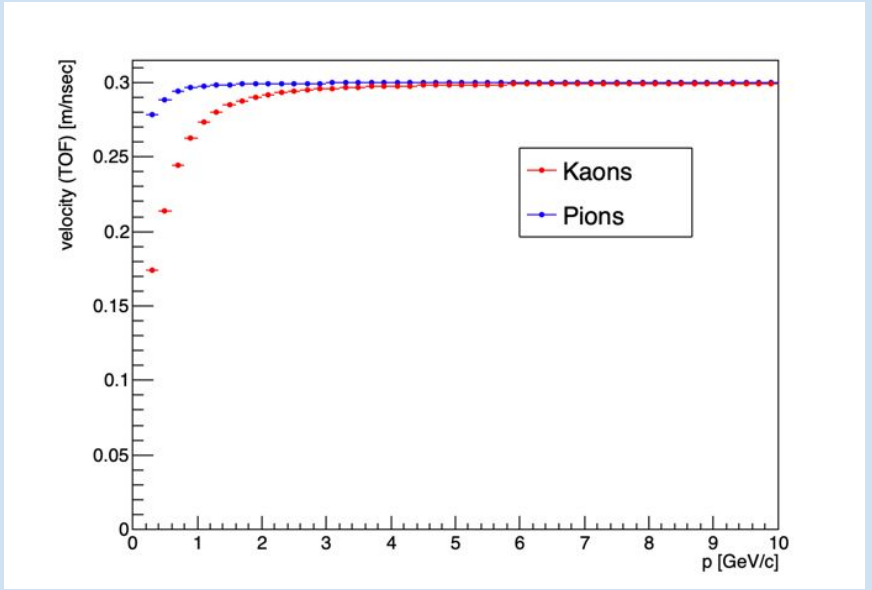
PID studies

- The bachelor kaon or pion is selected using the D_sK and $D_s\pi$ samples

dN/dx

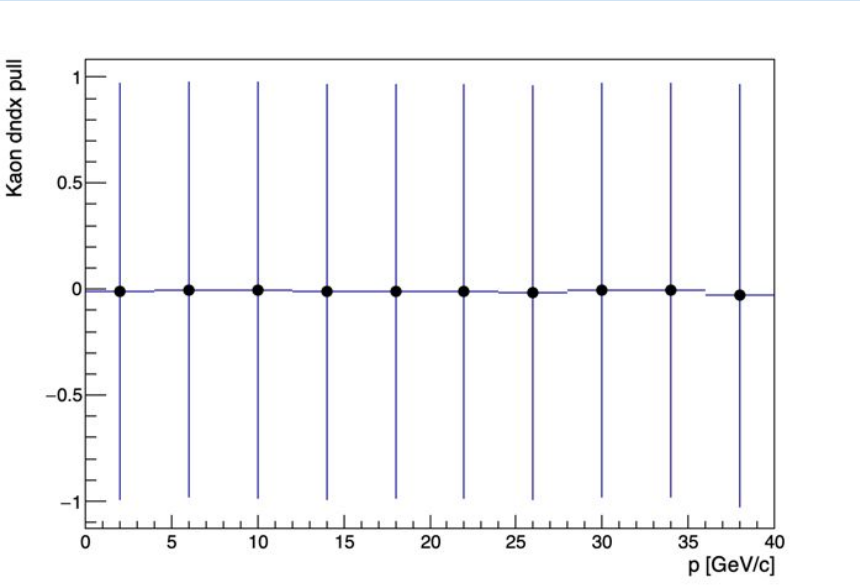


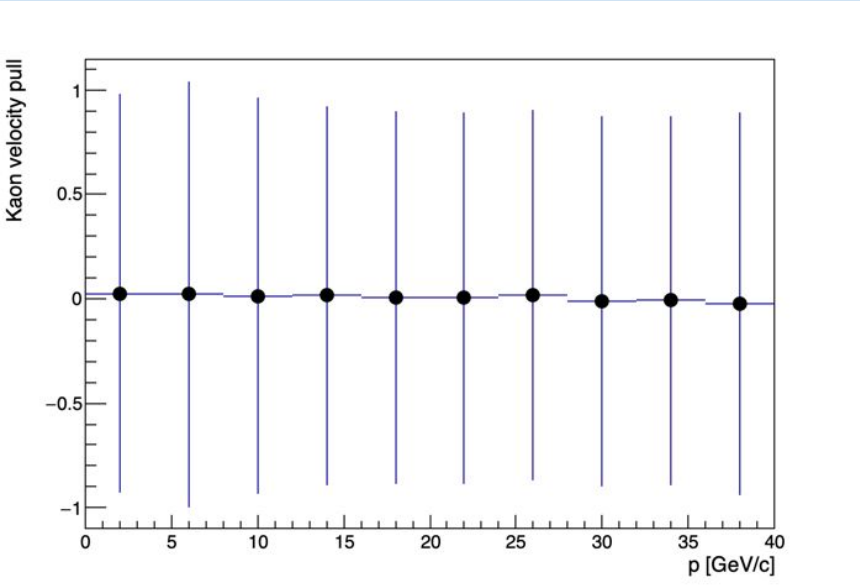
velocity



PID studies

- Pulls well under control for both variables

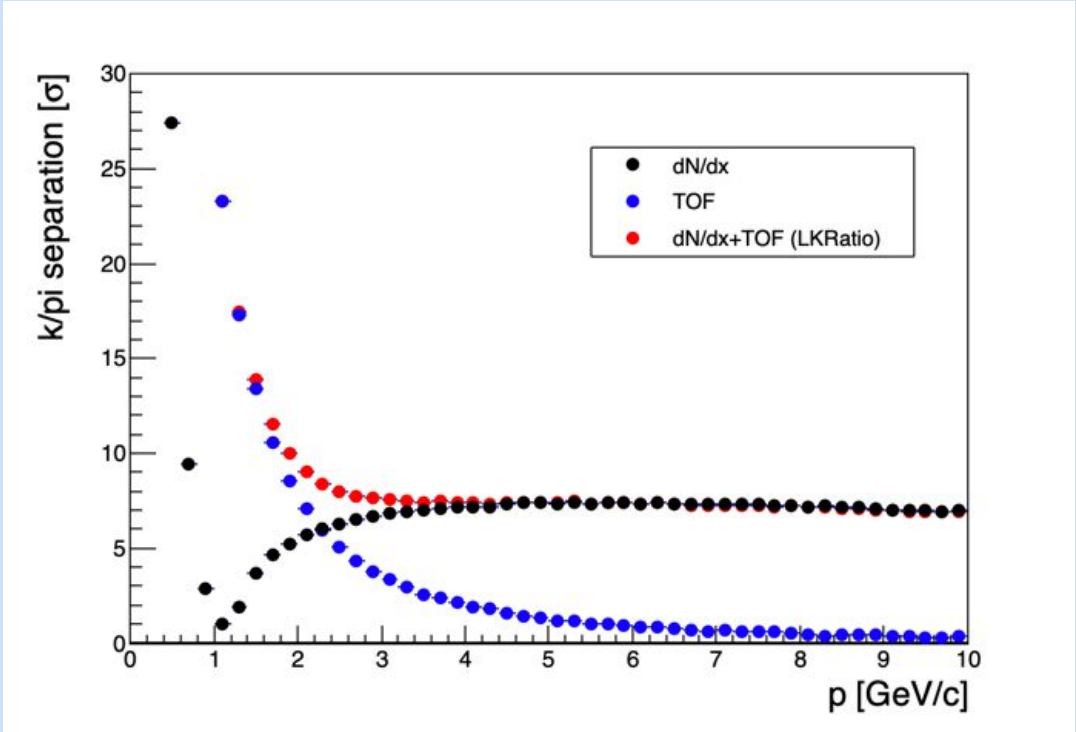




PID studies

- K/π separation in dN/dx, velocity and combined approach
- The combined separation in terms of sigmas is obtained with

Separation [σ] = √ -2ln(LKRatio)

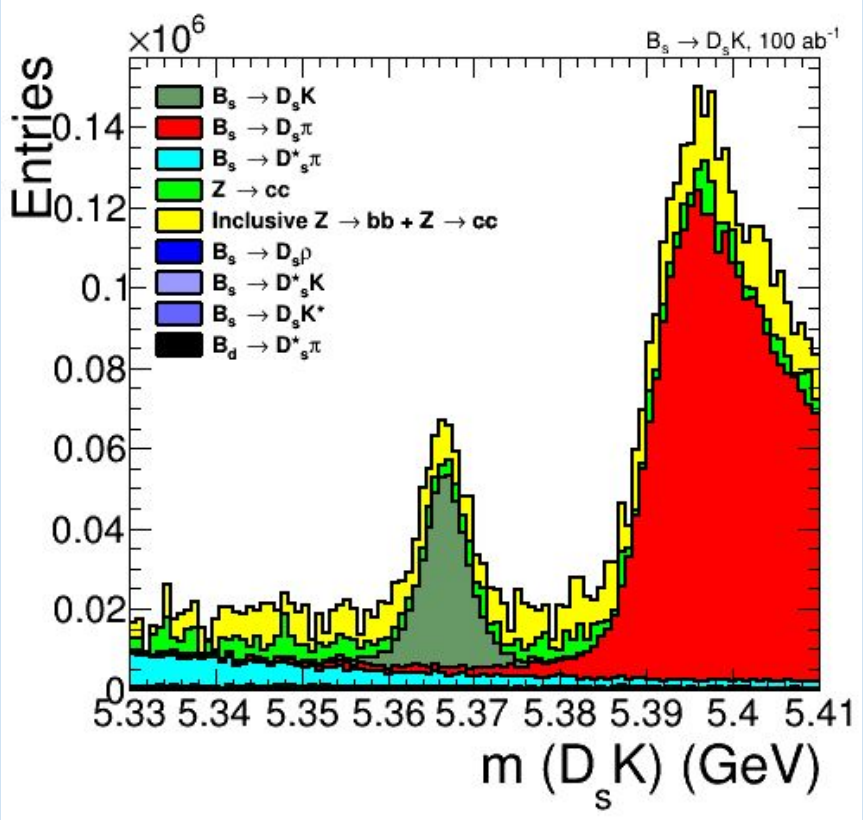


Mass spectrum without PID

Kinematic cuts

- 5.33 GeV < $m(B_s)$ < 5.41 GeV
- Vertex χ^2 < 5
- $\cos(\theta)\_B_s$ - $\cos(\theta)$_bachelor < 0.5

B/(S+B) = 48%



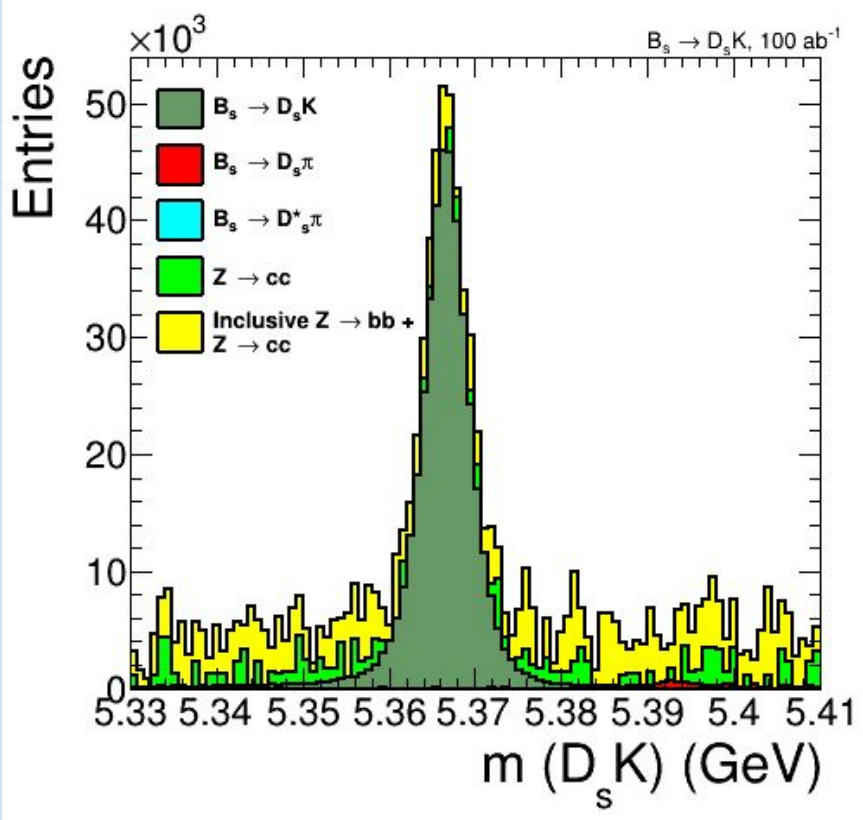
Mass spectrum with dN/dx likelihood ratio

Kinematic cuts

- 5.33 GeV < m(B_s) < 5.41 GeV
- Vertex χ^2 < 5
- cos(θ)_B_s - cos(θ)_bachelor < 0.5

B/(S+B) = 19%

$D_s\pi$ efficiency = 0.27%

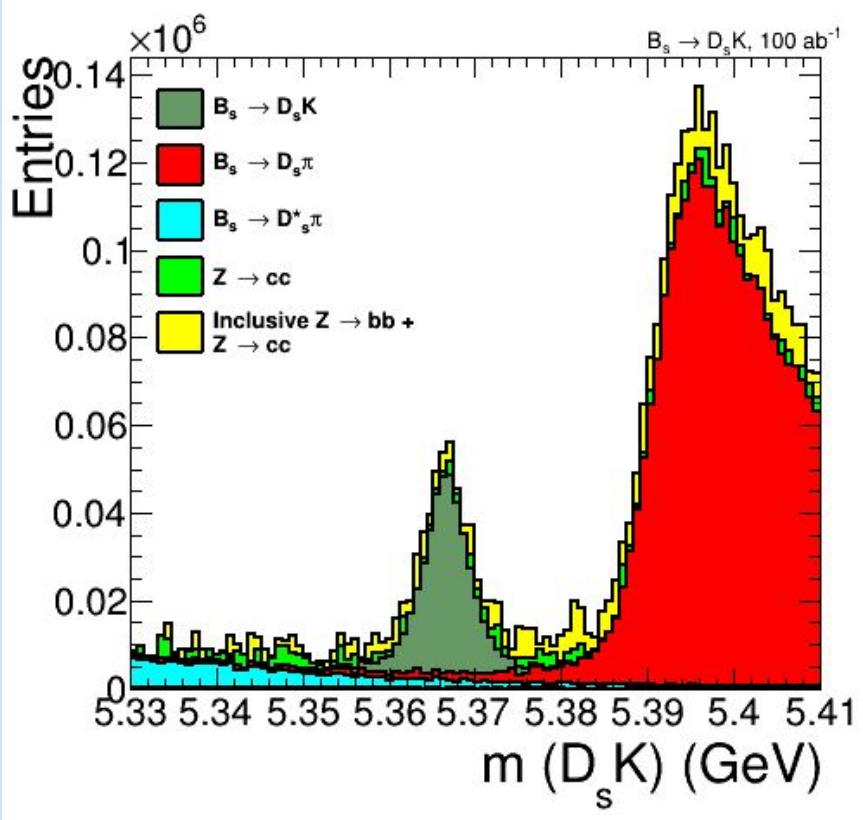


Mass spectrum with velocity likelihood ratio

Kinematic cuts

- 5.33 GeV < m(B_s) < 5.41 GeV
- Vertex χ^2 < 5
- cos(θ)_B_s - cos(θ)_bachelor < 0.5

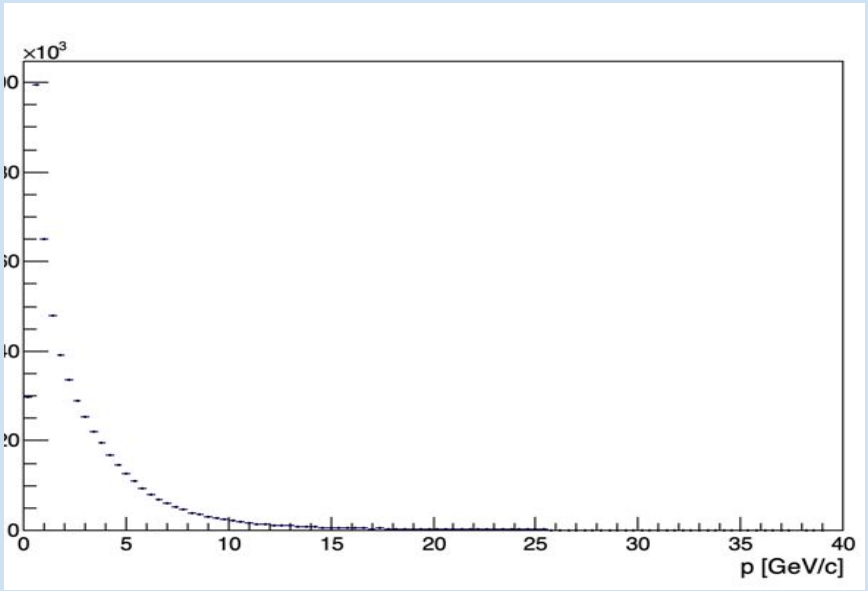
B/(S+B) = 33%



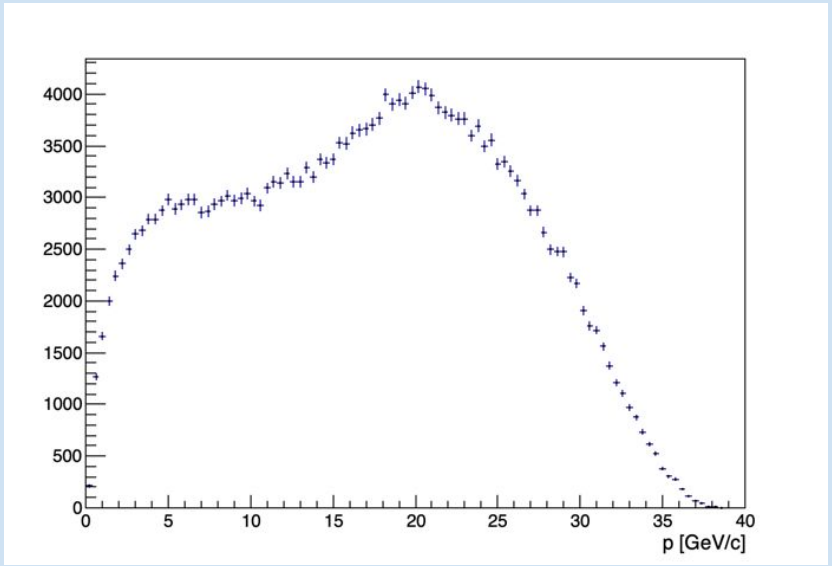
Focus on likelihood ratio with velocity

- Likelihood ratio based on velocity has very low impact on signal but still reduces the inclusive Z→bb background by a factor of 2
- Directly related to the bachelor momentum spectrum in the two samples and the momentum-dependent PID performance with velocity

Z→bb



$D_s K$ && $D_s \pi$



Mass spectrum with combined likelihood

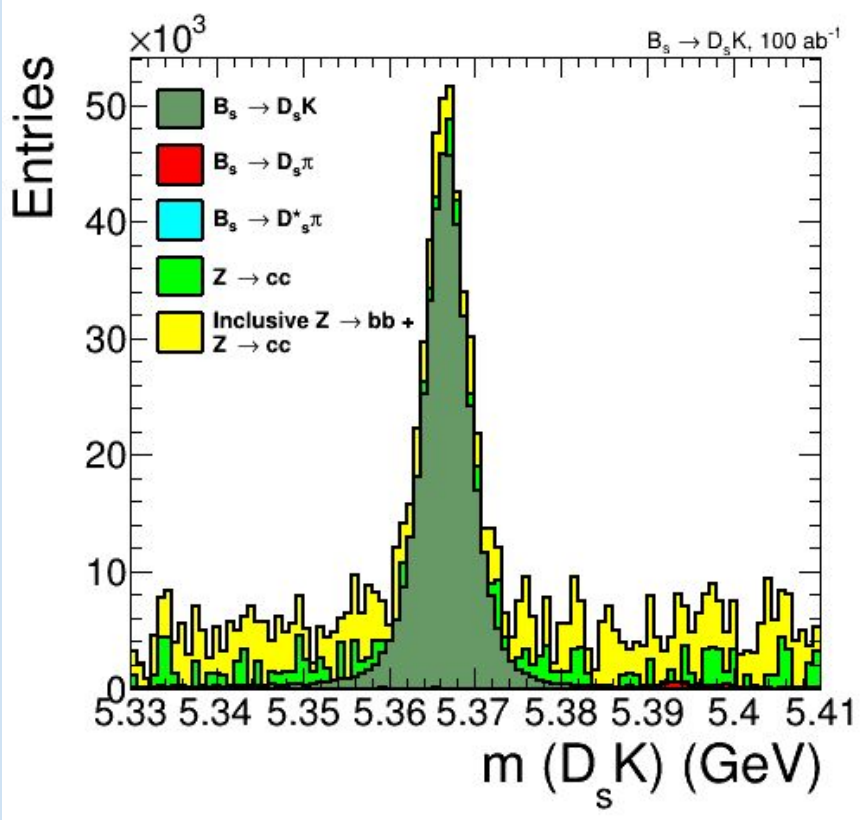
Kinematic cuts

- 5.33 GeV < m(B_s) < 5.41 GeV
- Vertex χ^2 < 5
- cos(θ)_B_s - cos(θ)_bachelor < 0.5

B/(S+B) = 19%

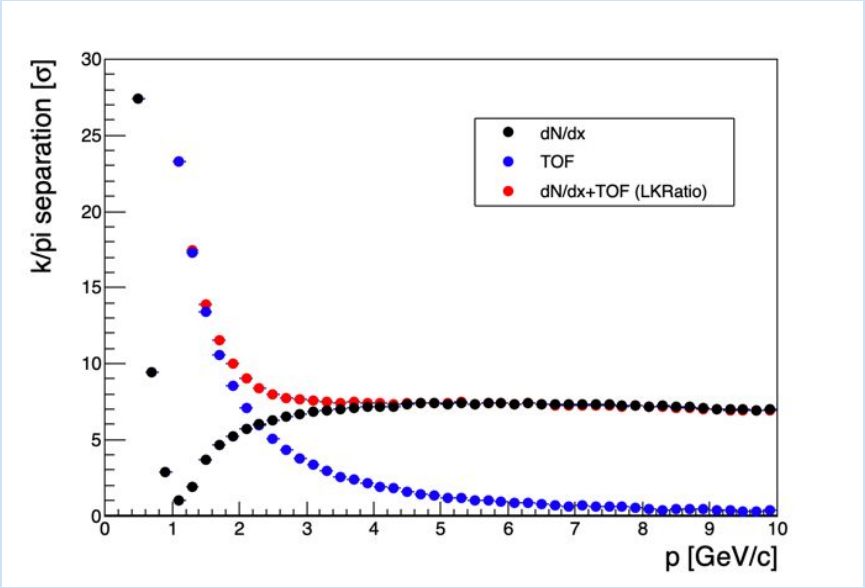
$D_s\pi$ efficiency = 0.22%

As proven in previous slide, the PID based on combined likelihood is only marginally improving over dN/dx because of the bachelor momentum

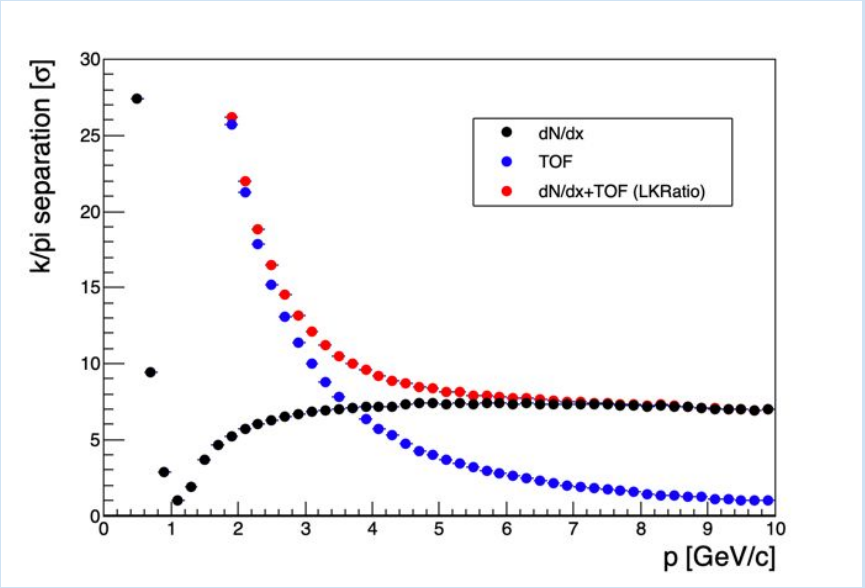


TOF resolution

Standard – 30 ps



Improved – 10 ps



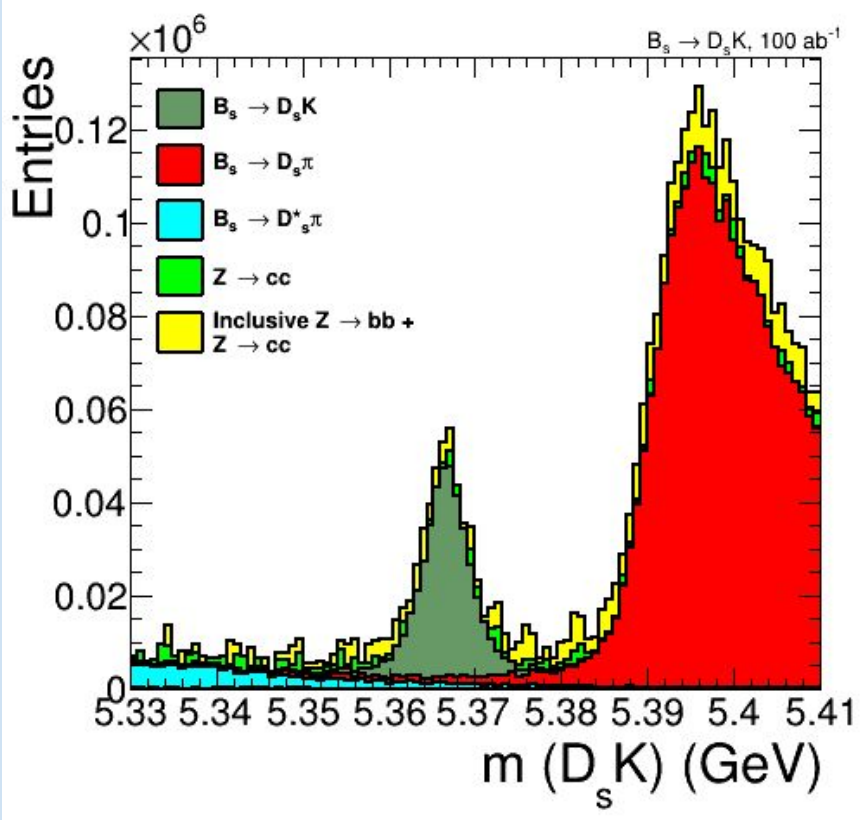
Test #1: velocity likelihood ratio with 10 ps TOF resolution

Kinematic cuts

- 5.33 GeV < m(B_s) < 5.41 GeV
- Vertex χ^2 < 5
- cos(θ)_B_s - cos(θ)_bachelor < 0.5

B/(S+B) = 29%

With 30 ps TOF resolution B/(S+B) = 33%

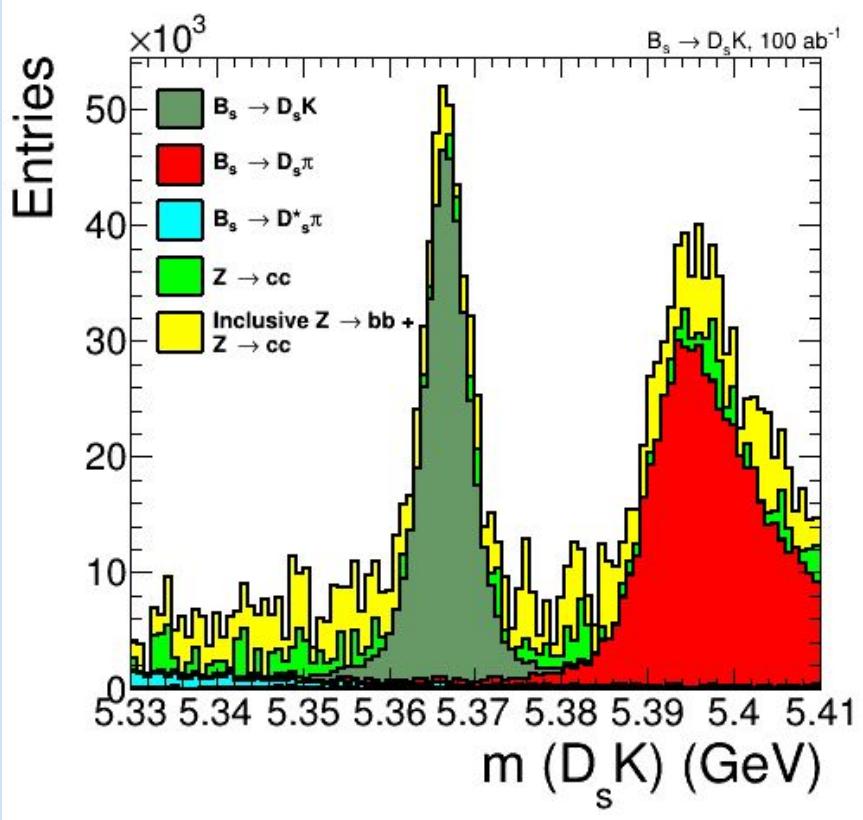


Test #2: combined likelihood with x2 dN/dx worse resolution

Kinematic cuts

- 5.33 GeV < m(B_s) < 5.41 GeV
- Vertex χ^2 < 5
- cos(θ)_B_s - cos(θ)_bachelor < 0.5

B/(S+B) = 24%



Conclusions and Outlook

PID is crucial to reduce the combinatorics in exclusive decays

- Combined likelihood-based PID with dN/dx and TOF grants a 7-sigma K/π separation for tracks with momentum in between 3 and 10 GeV
- Given the kinematics of the chosen $B_s \rightarrow D_s K$ benchmark channel dN/dx is more effective but TOF represents a valid complement and a valuable backup

Next steps

- Extend the studies to other exclusive channels, i.e. $B_s \rightarrow D_s K$, with $D_s \rightarrow \phi\rho$
- Explore inclusive PID, i.e. PID particles whose origin is not known a priori