Status of the $B^0_s \to D^{\pm}_s K^{\mp}$ benchmark analysis

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IDEA Physics and Software Meeting

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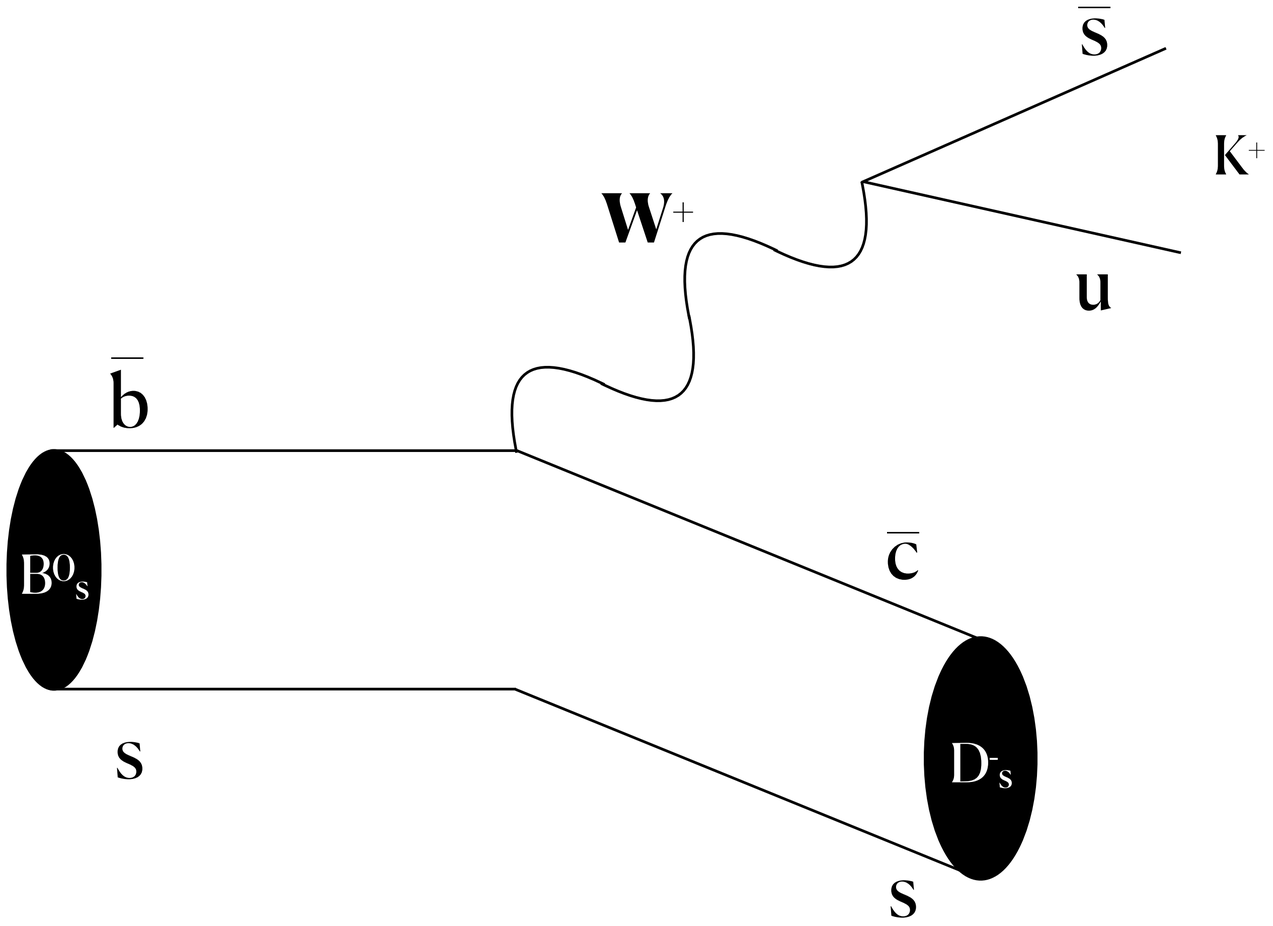
$B^0_s \to D^{\pm}_s K^{\mp} \to (KK\pi^{\pm})\, K^{\mp}$



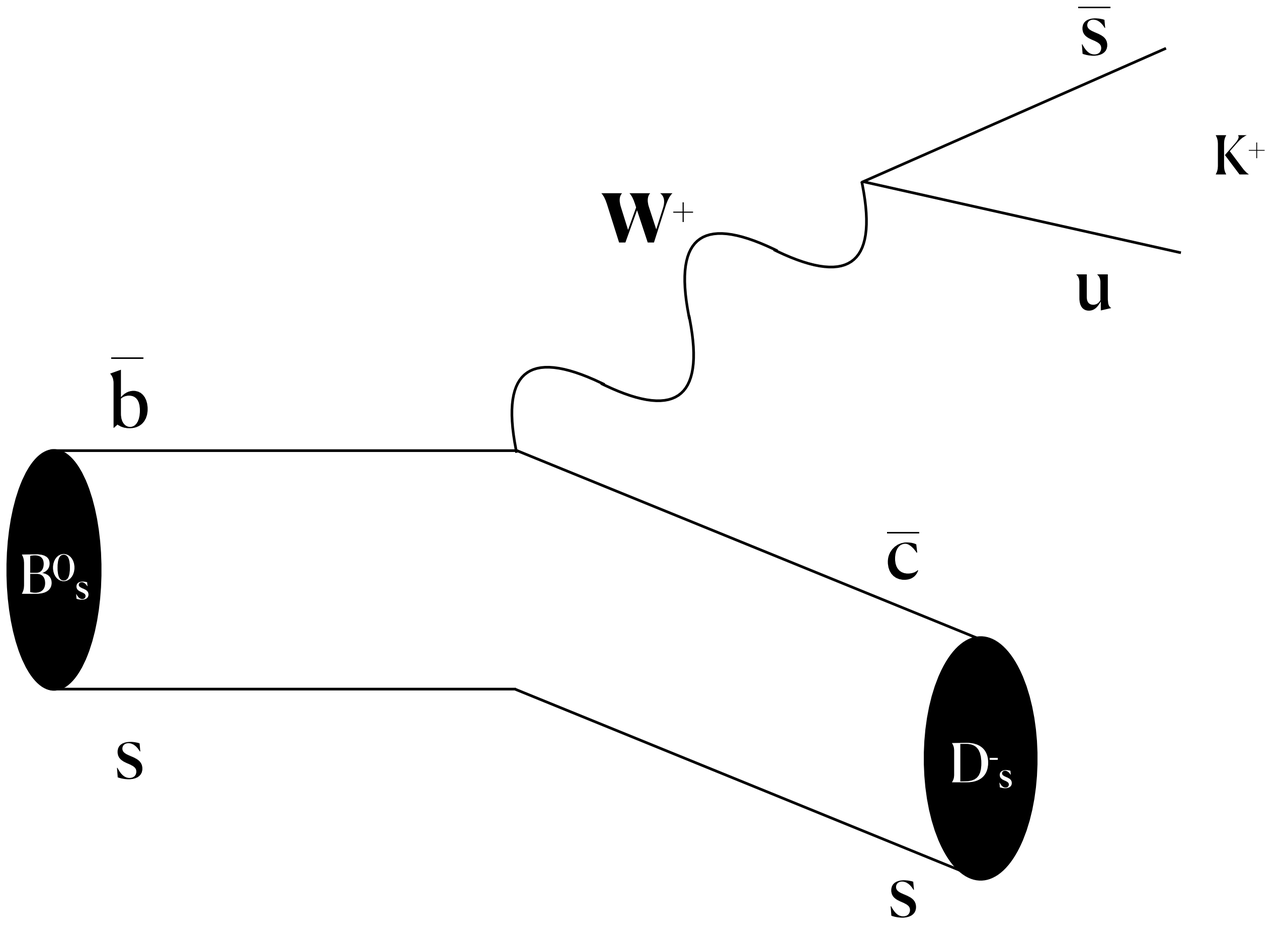
Signal MC samples

$$B^0_s \to D^{\pm}_s K^{\mp} \to (KK\pi^{\pm})\, K^{\mp}$$

{ Exclusive $Z \to b\bar{b}$ with
  10k events @ $\sqrt{s} = 91.188$ GeV

```
#
Decay B_s0
  1.000 MyD_s- K+ PHSP;
Enddecay
CDecay anti-B_s0
#
Decay MyD_s-
  1.000 Myphi pi- PHSP;
Enddecay
CDecay MyD_s+
#
Decay Myphi
      1.000  K+ K-  VSS;
Enddecay
#
End
```

$B^0_s \to D^{\pm}_s K^{\mp} \to (KK\pi^{\pm})\, K^{\mp}$



MC
Truth Matching

Status

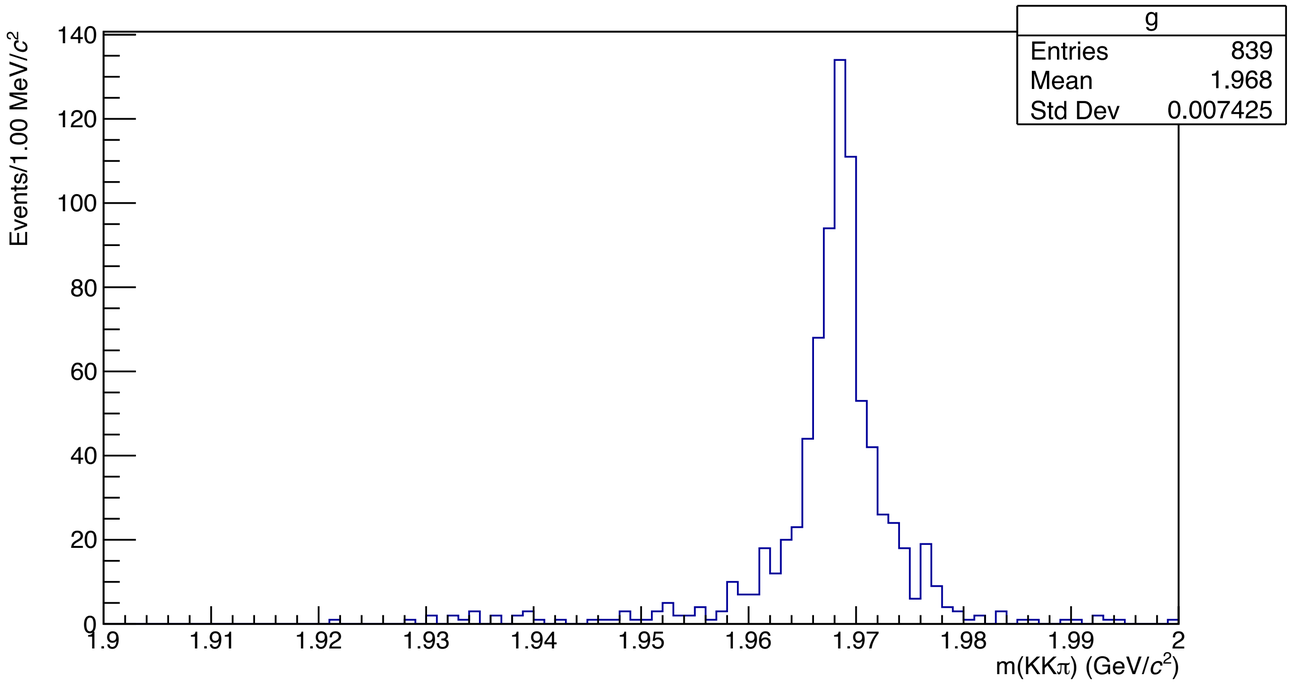
$$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$$

Identification the D^-_s state

~~D_s identification through the KKπ vertex reconstruction~~

PID is 100%
(i.e. made via PDGid)

Reconstructed $D^{\pm}_s$ mass



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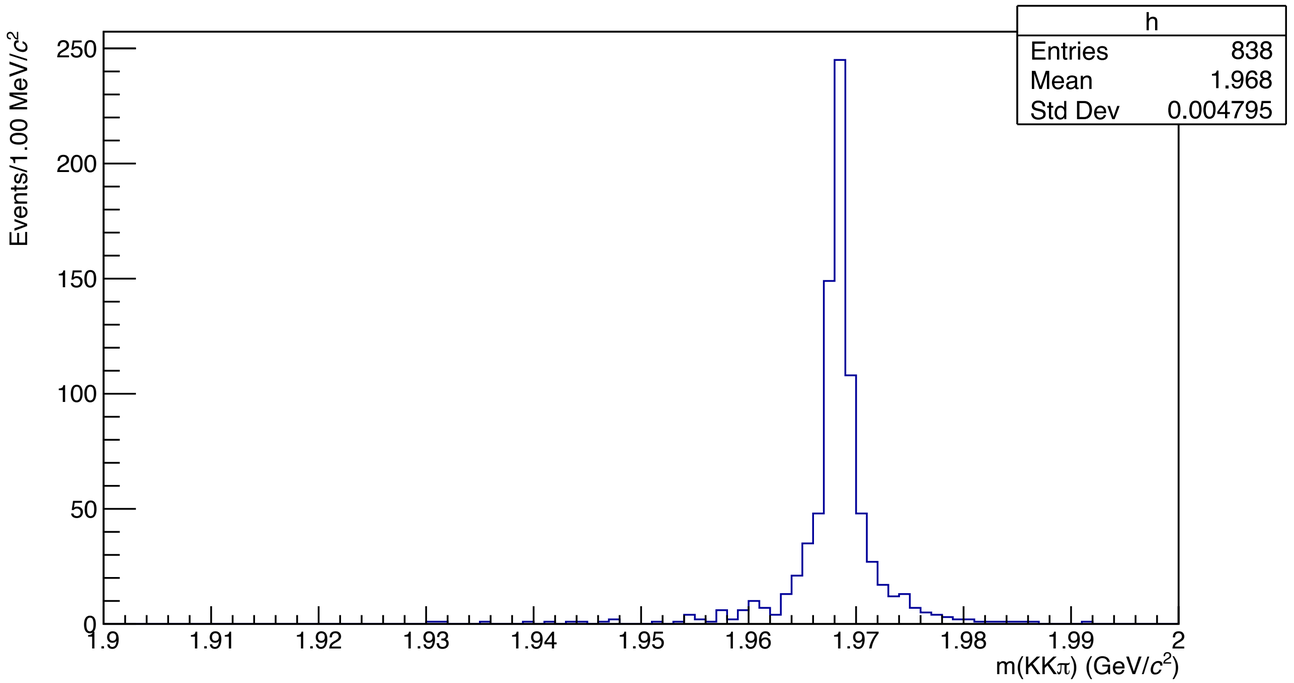


MC
Truth Matching

Status

$$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$$

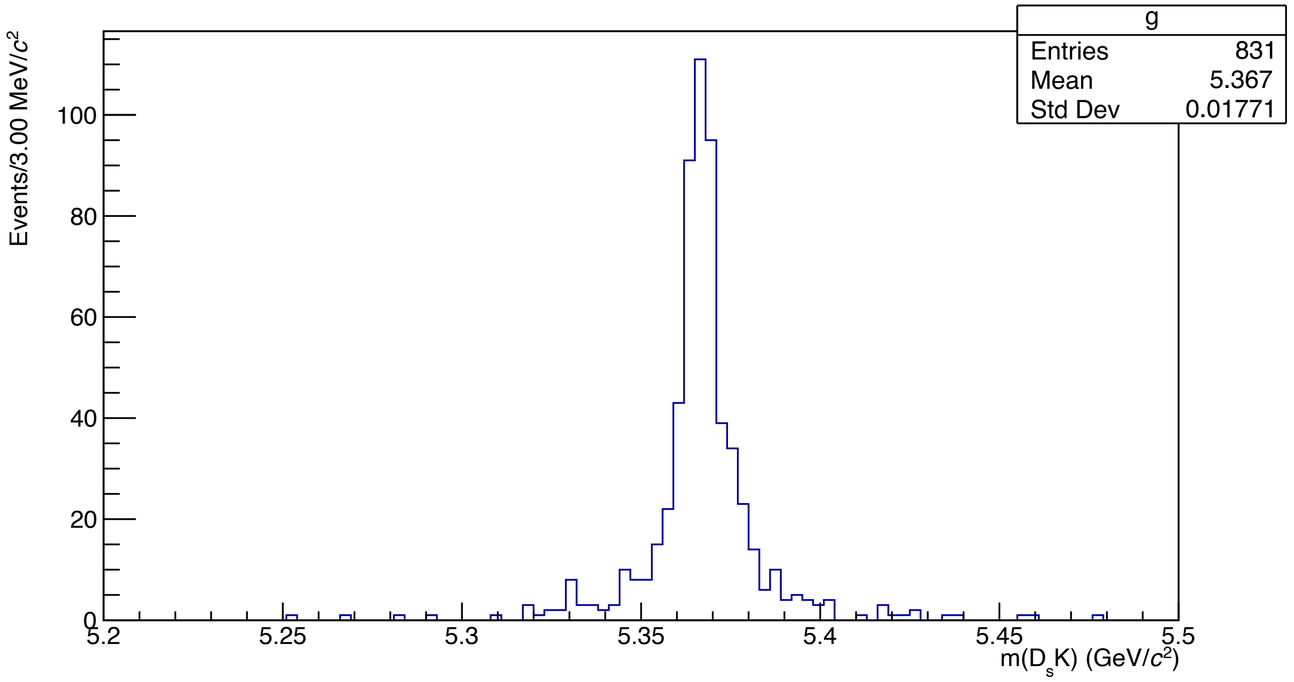
Identification the **B^0_s** state

Combine the **D^-_s** candidates with the bachelor **K^+**

~~B^0_s identification through the D_sK vertex reconstruction~~

PID is 100%
(i.e. made via PDGid)

Reconstructed B^0_s mass



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Identification the **B^0_s** state

Combine the **D^-_s** candidates with the bachelor **K^+**

B^0_s identification through the $D_s K$ vertex reconstruction

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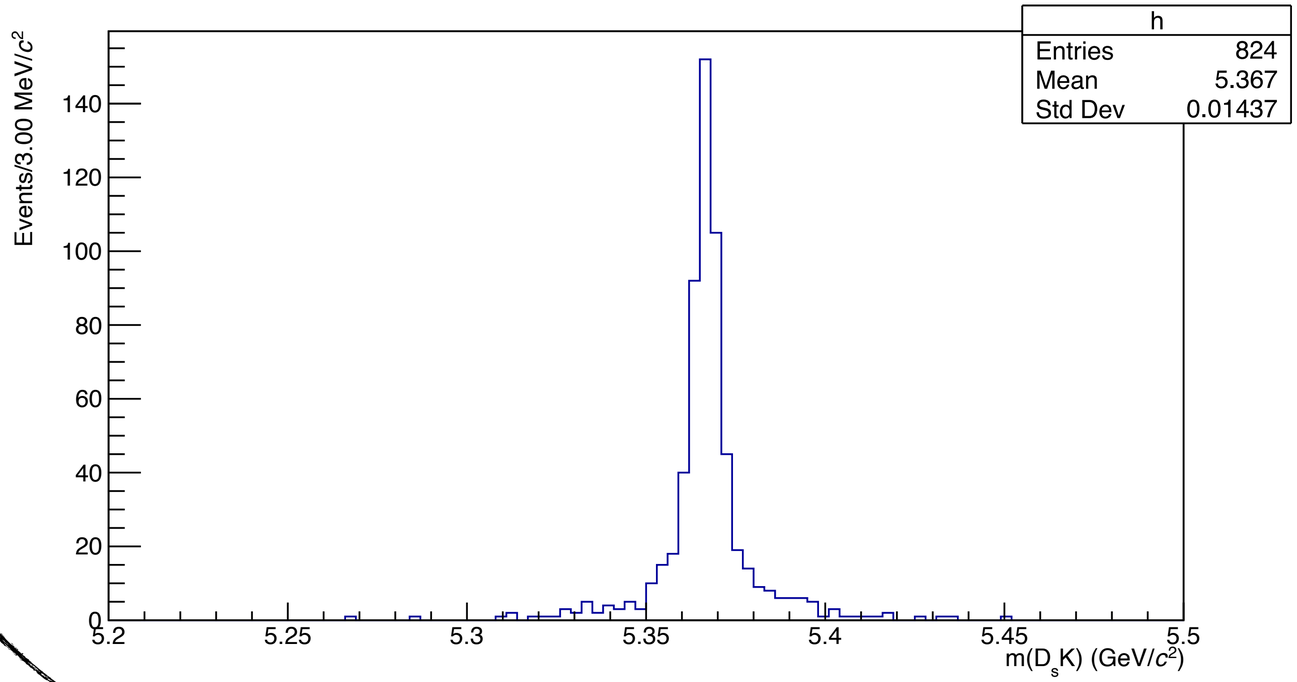
Reconstructed B^0_s mass



NB Not back propagated to **B^0_s** vertex

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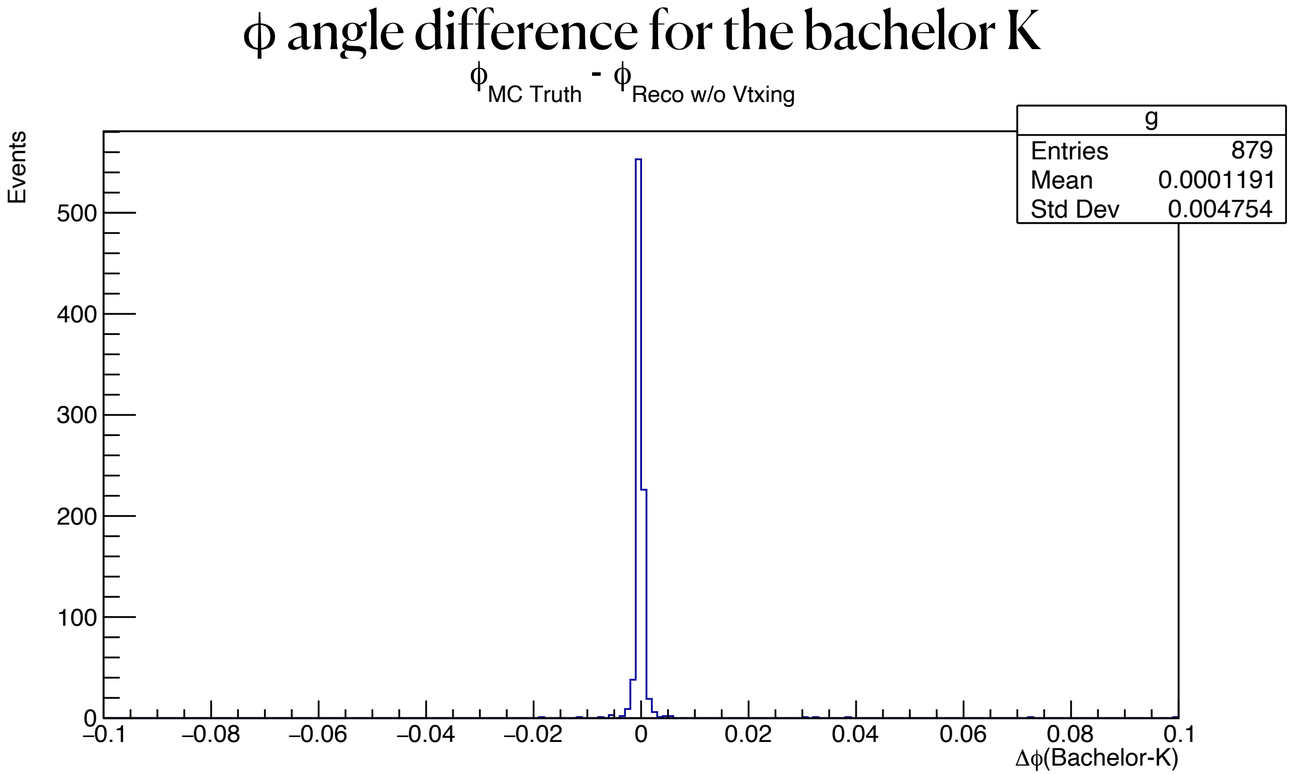

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Combine the **D^-_s** candidates with the bachelor **K^+**

B^0_s identification through the D_sK vertex reconstruction

PID is 100%
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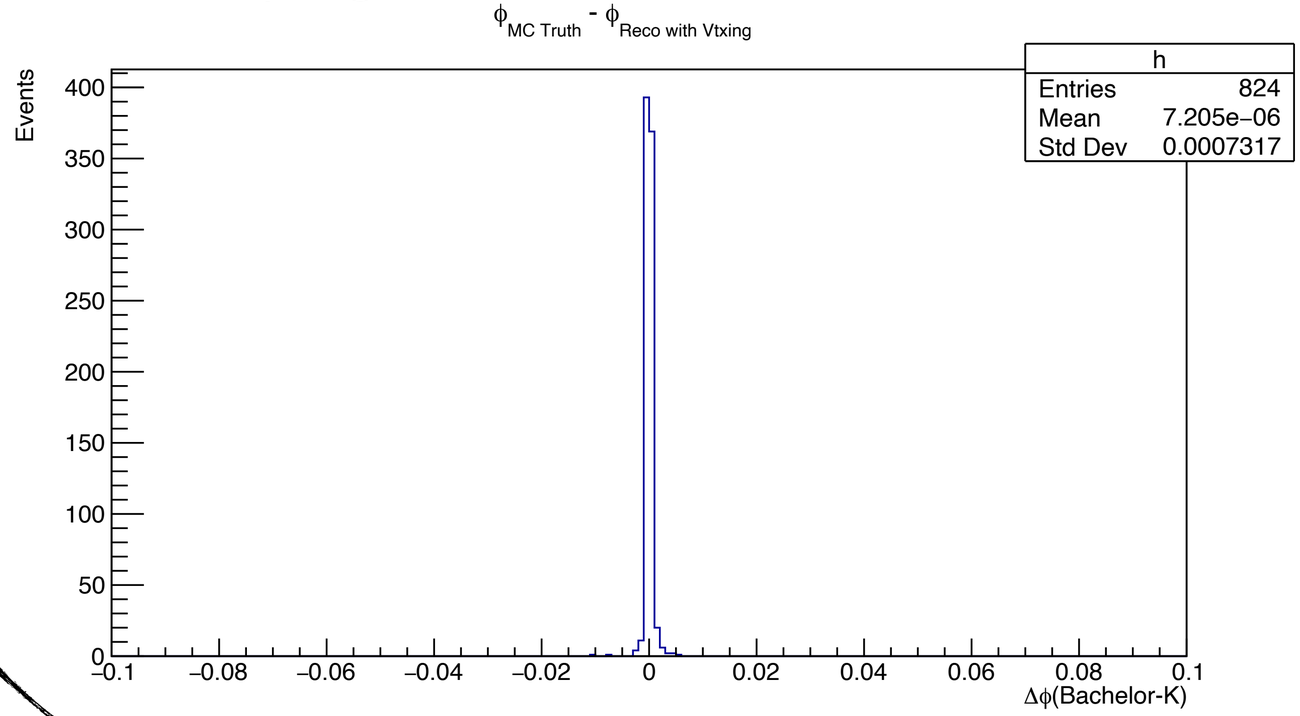
ϕ angle difference for the bachelor K



NB Not back propagated to **B^0_s** vertex

MC
Truth Matching

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Combine the **D^-_s** candidates with the bachelor **K^+**

B^0_s identification through the D_sK vertex reconstruction

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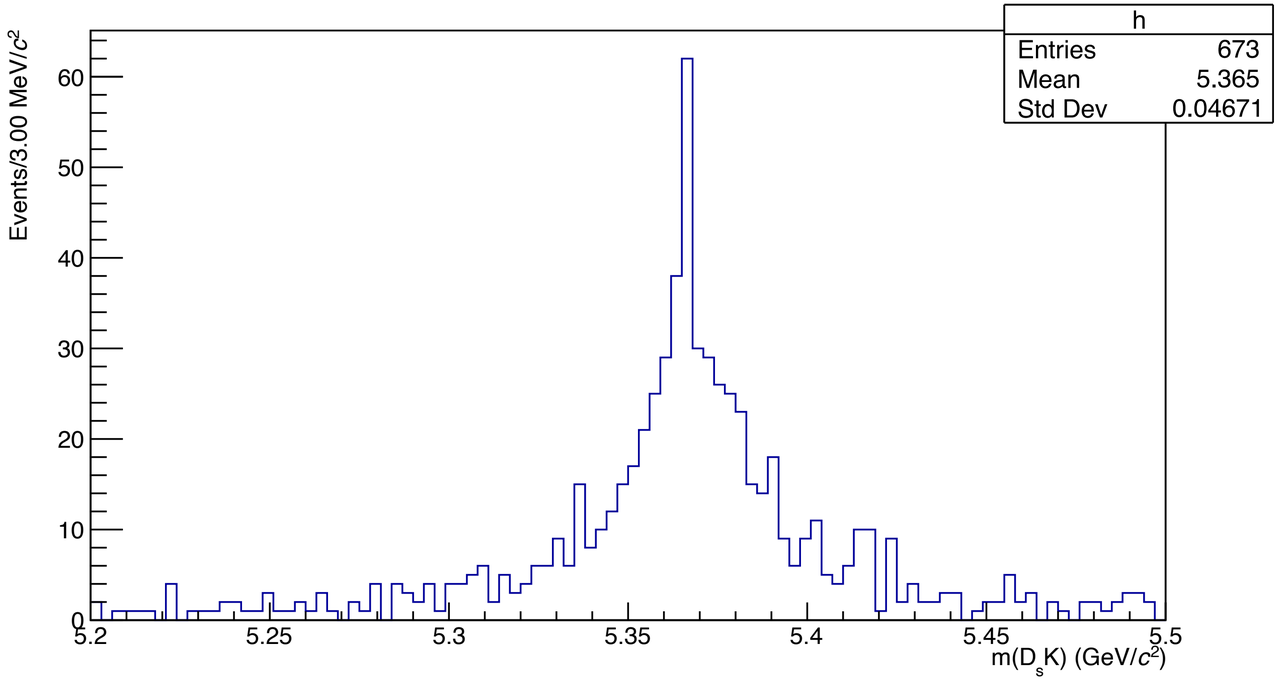
Reconstructed B^0_s mass



MC
Truth Matching

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$$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$$

Identification the **B^0_s** state

Combine the **D^-_s** candidates with the bachelor **K^+**

B^0_s ID through the $D_s K$ vertex reco, but the D_s CovMat is re-estimated via a ToyMC

PID is 100%
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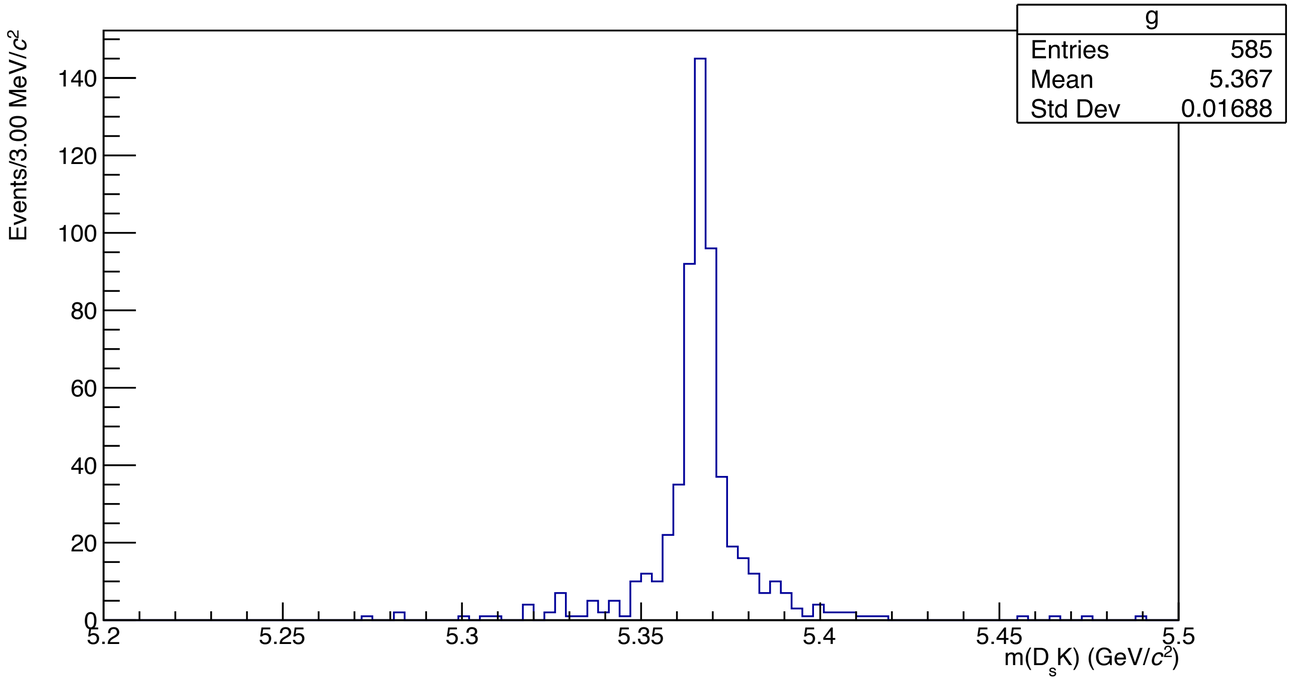
Reconstructed B^0_s mass



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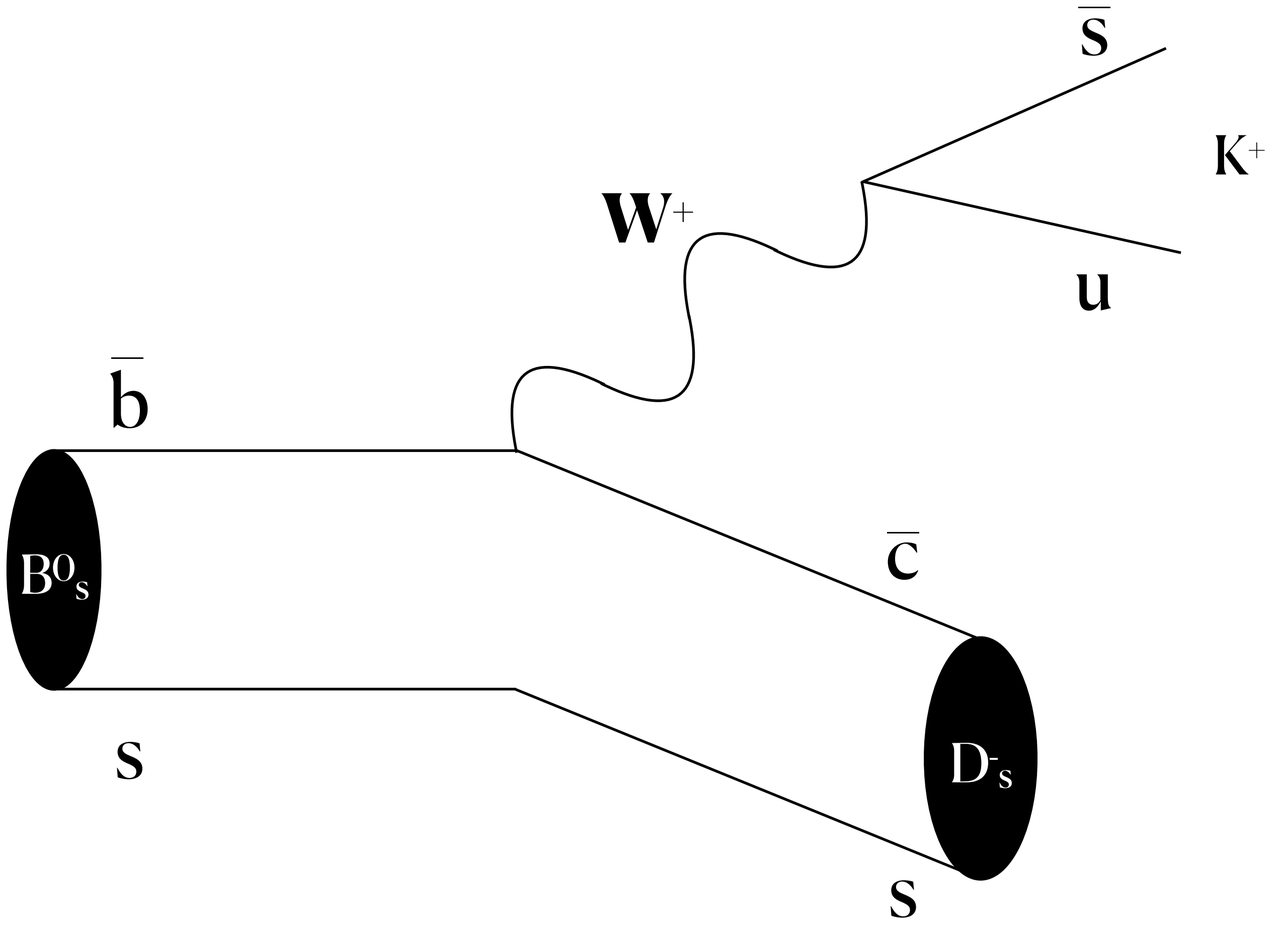


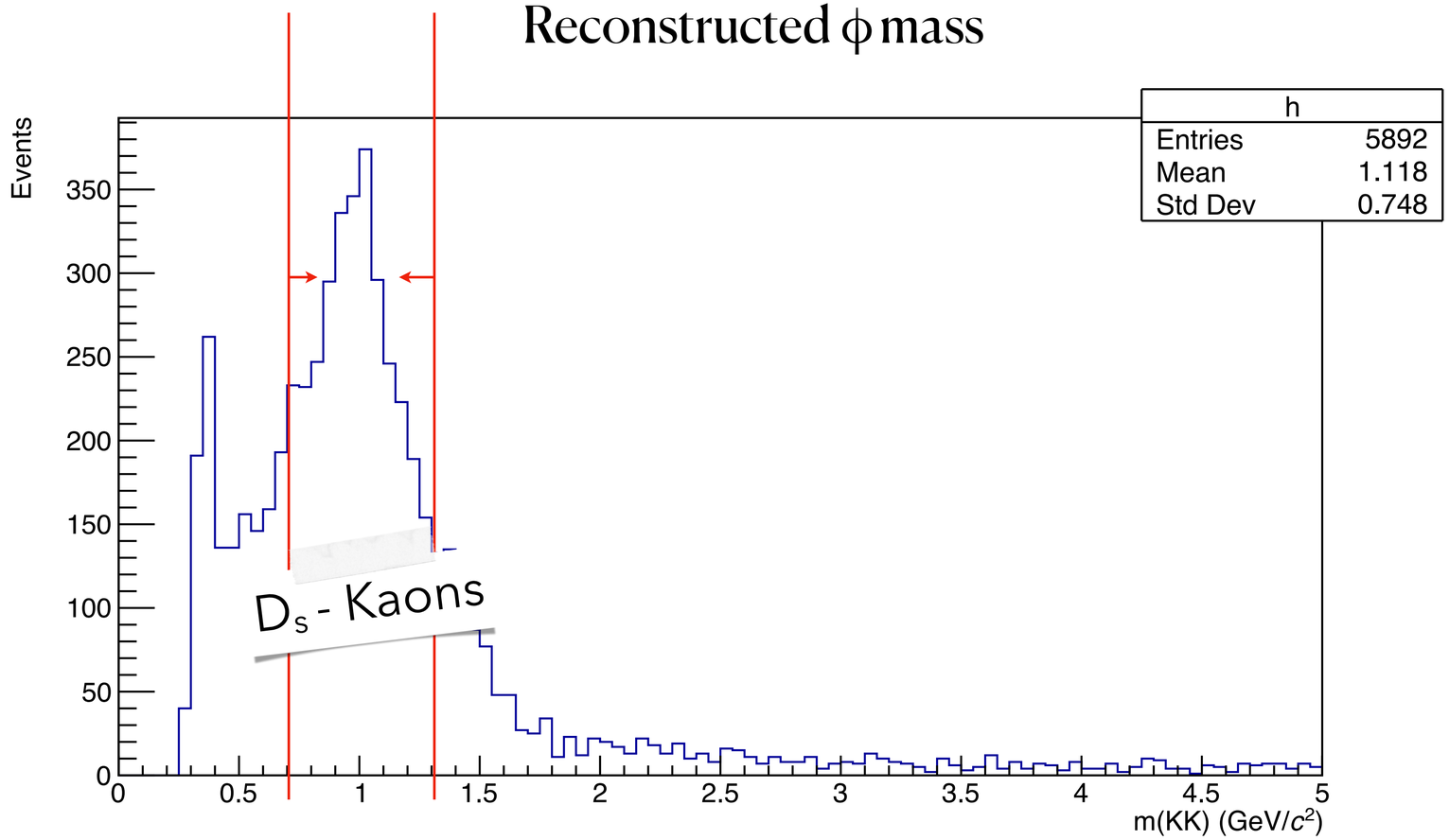
Status

$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$

Divide the K
into 2 sub-groups

D_s - Kaons
Bachelor-Kaons

Using φ(1020) mass as
discriminating values



Status

$$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$$

Identification the $\mathbf{D^-_s}$ state

$Q_{Tot} = -1$

D_s identification through the KKπ vertex reconstruction

PID is 100%
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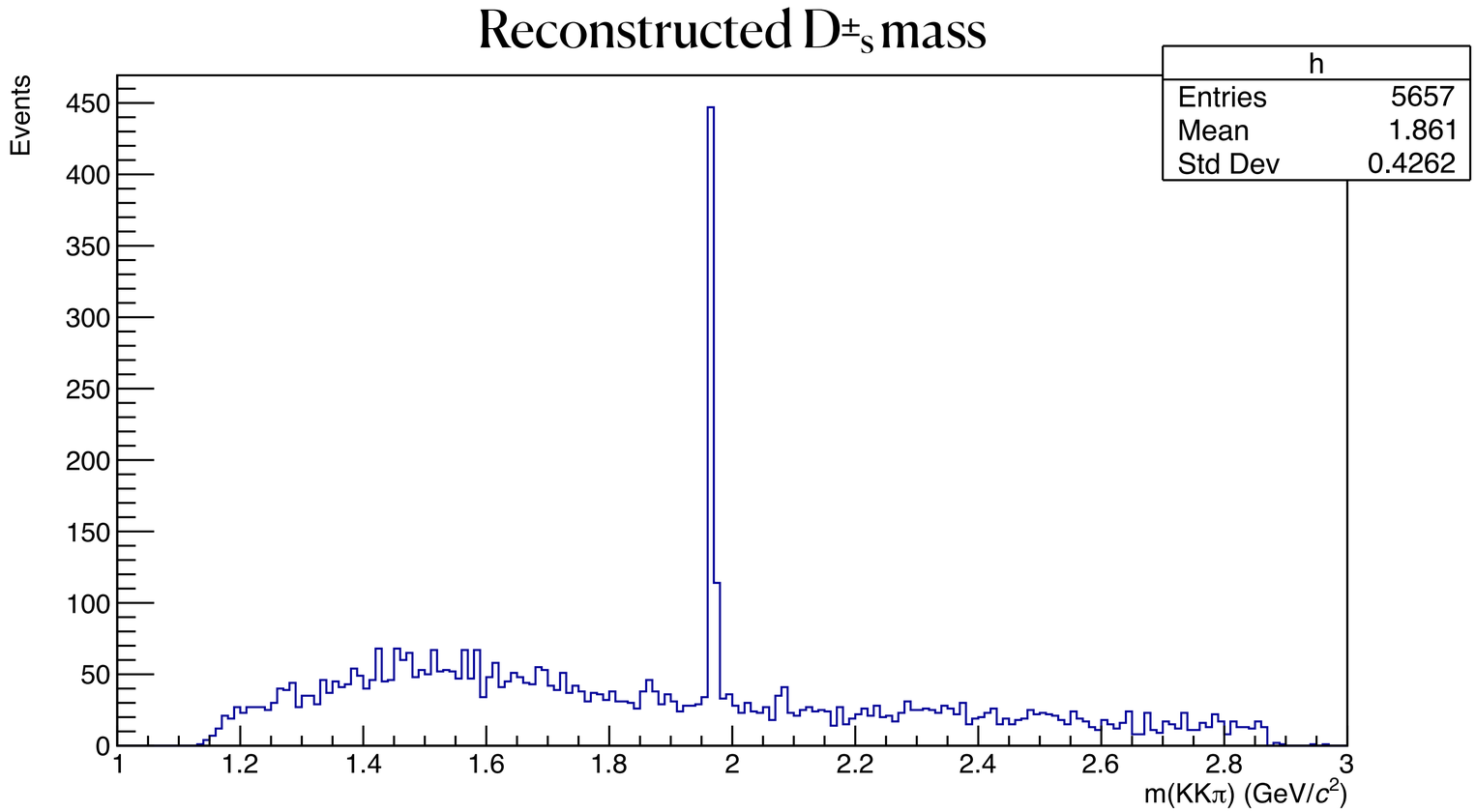

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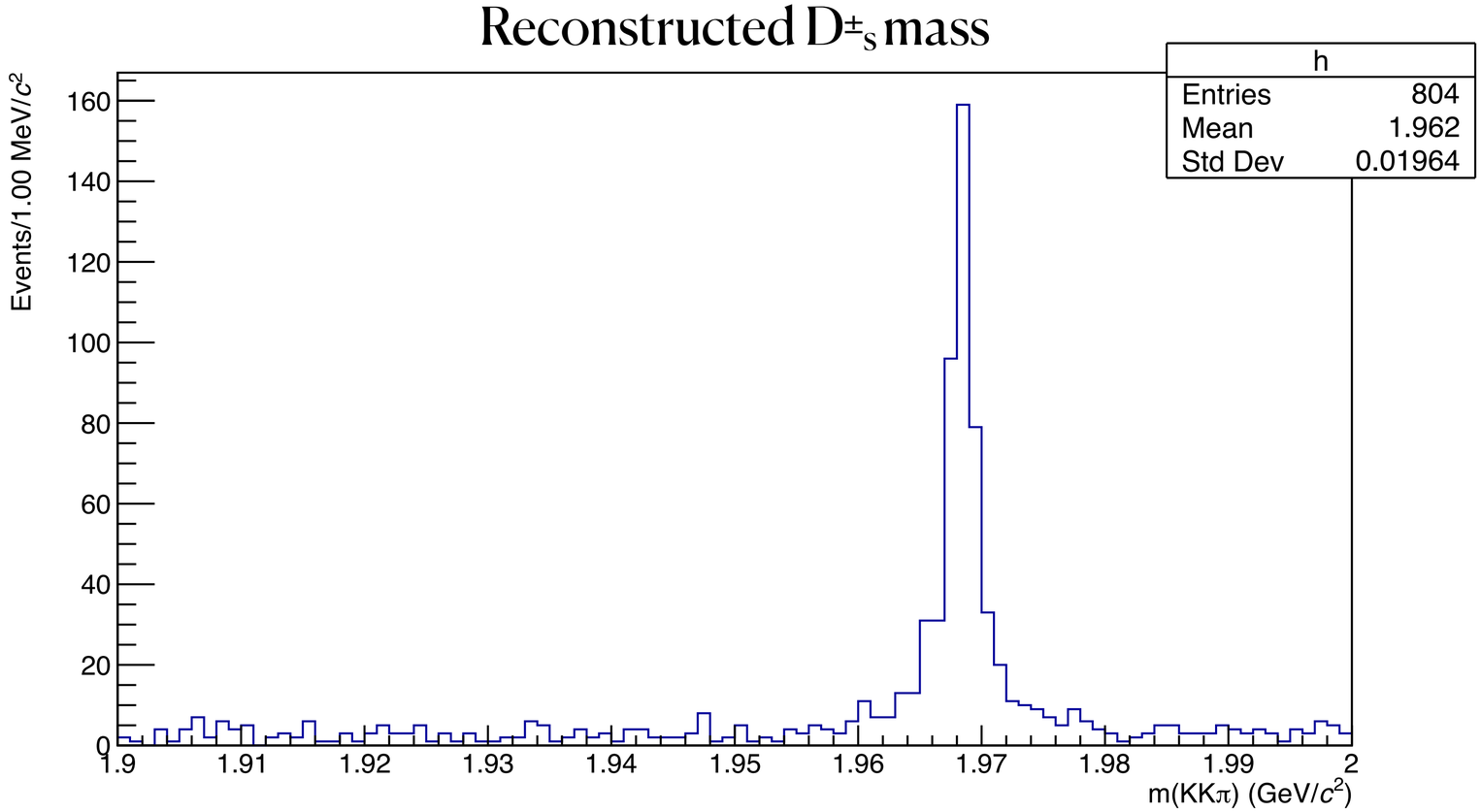


Status

$$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$$

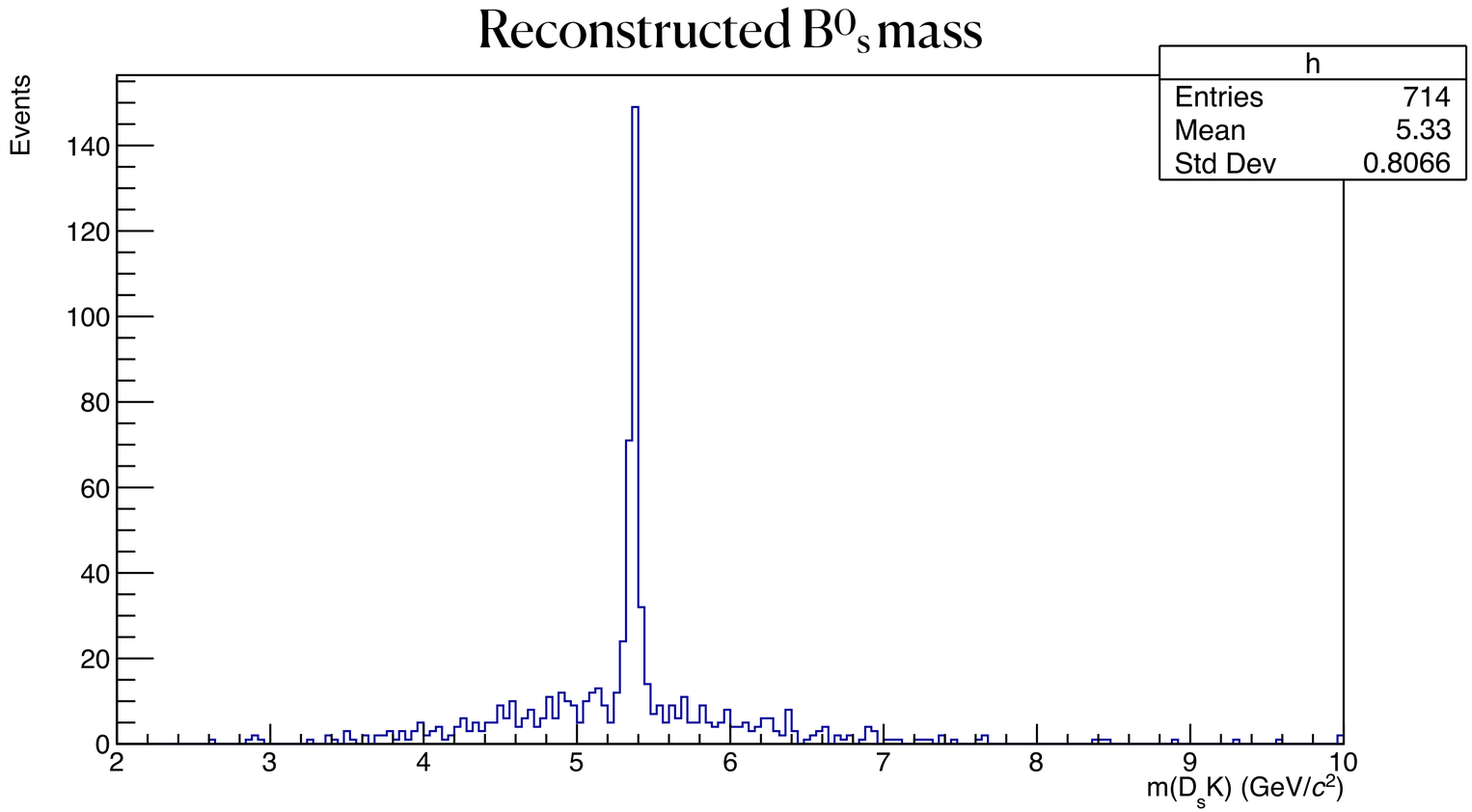
Identification the **B^0_s** state

Combine the **D^-_s** candidates with the bachelor **K^+**

B^0_s identification through the D_sK vertex reconstruction and requesting

$1.9\ \text{GeV}/c^2 < m(D_s) < 2.0\ \text{GeV}/c^2$

PID is 100%
(i.e. made via PDGid)



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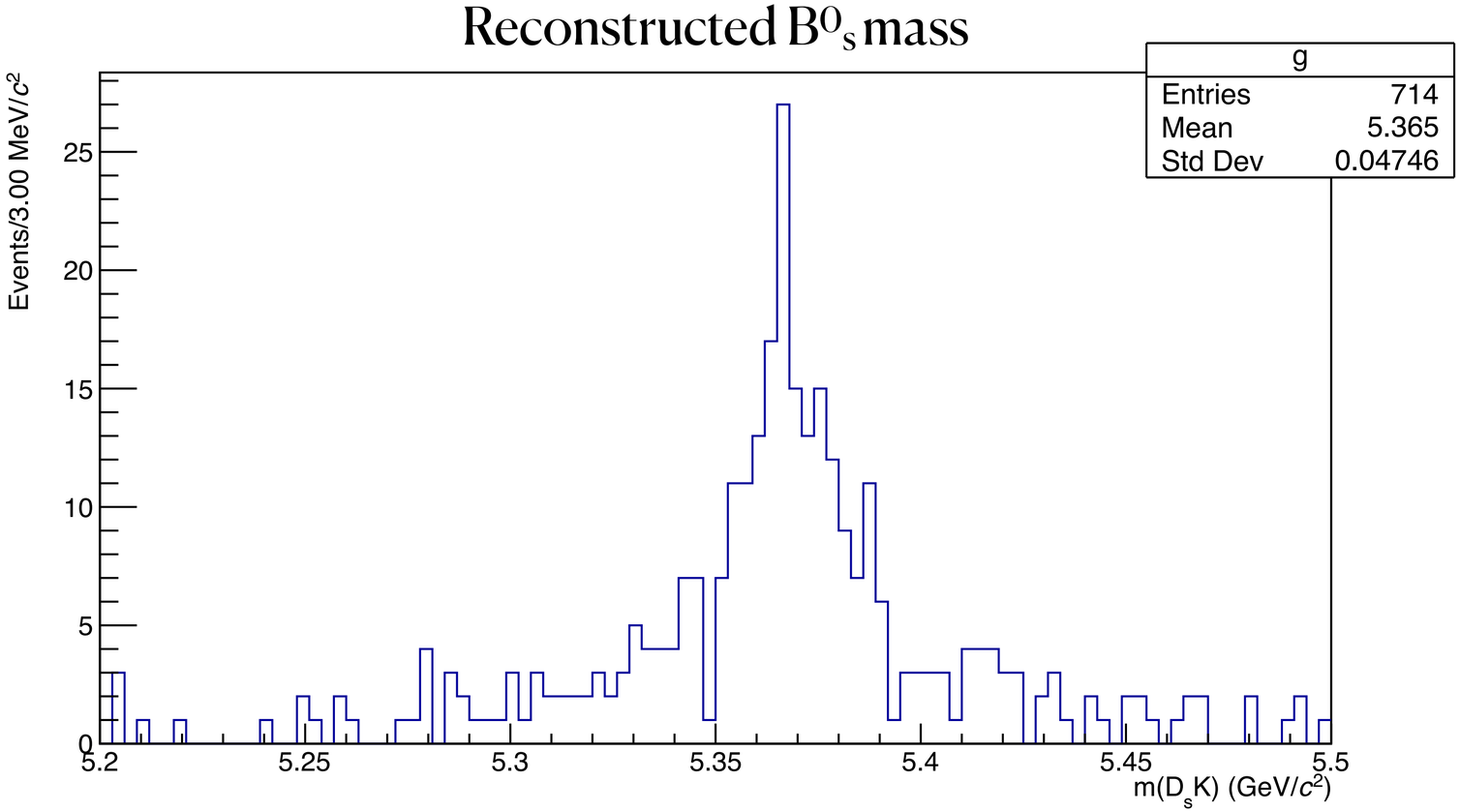


Conclusion and Outlook

PID is 100% correct

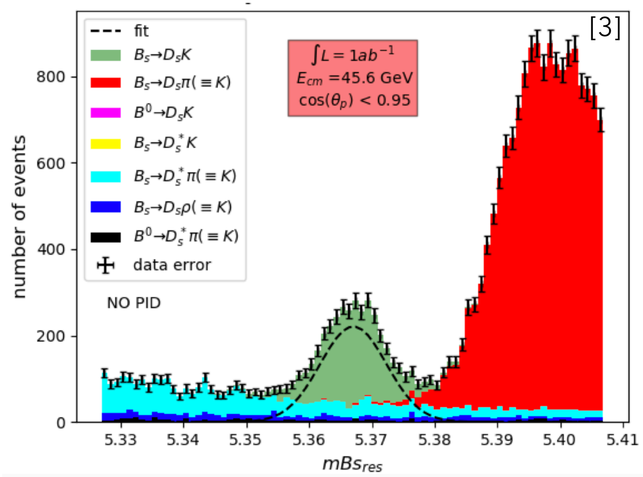
Fine tuning (in Truth-Match) is needed, but **B^0_s & $D^{\pm}_s$** masses are **reconstructed**

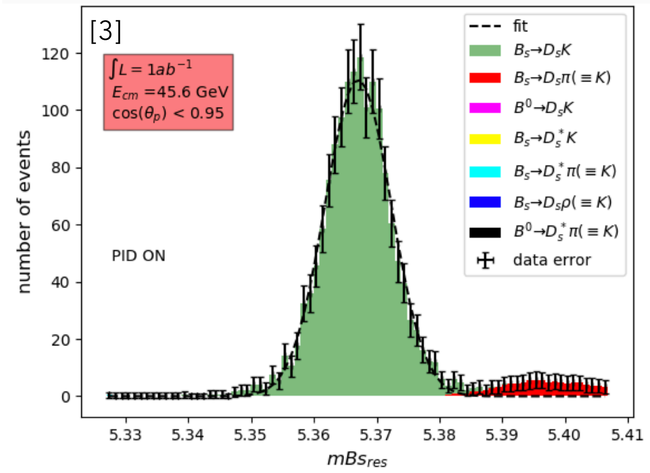
Next Steps

Fine tuning
Run over Inclusive MC
(Run over the full stats)
Add the **PID**

Reproduce the plots of the **B^0_s reconstructed mass** on the right[1]

Ref. [1] describes a generic FCC scenario, so it would be useful to see them within EDM4hep





[1] R. Aleksan, L. Oliver, and E. Perez, arXiv:2107.02002

Thank you for the attention!

Backup Slides

Status

Full MC

$B^0_s \rightarrow D^{\pm}_s K^{\mp} \rightarrow (KK\pi^{\pm})\, K^{\mp}$

http://fcc-physics-events.web.cern.ch/fcc-physics-events/Delphesevents_dev_IDEA.php

NB

These data sets
can be good for 100% PID

Will be re-run
with FC's PID

Main mode	Decay chain	Background mode	Decay chain
$\boldsymbol{B_s \rightarrow D_s^{\pm} K^{\mp}}$	$D_s^{\pm} \rightarrow \phi\pi^{\pm}, \phi \rightarrow K^+K^-$	$\boldsymbol{B_s \rightarrow D_s^{*\pm} K^{\mp}}$	$D_s^{*\pm} \rightarrow \gamma\phi\pi^{\pm}, \phi \rightarrow K^+K^-$
"	$D_s^{\pm} \rightarrow \phi\rho^{\pm}, \phi \rightarrow K^+K^-$	"	$D_s^{*\pm} \rightarrow \gamma\phi\rho^{\pm}, \phi \rightarrow K^+K^-, \rho^{\pm} \rightarrow \pi^{\pm}\pi^0$
		$\boldsymbol{B_s \rightarrow D_s^{\pm} K^{*\mp}}$	$D_s^{\pm} \rightarrow \phi\pi^{\pm}, \phi \rightarrow K^+K^-, K^{*\mp} \rightarrow K^{\mp}\pi^0$
		"	$D_s^{\pm} \rightarrow \phi\rho^{\pm}, \phi \rightarrow K^+K^-, \rho^{\pm} \rightarrow \pi^{\pm}\pi^0, K^{*\mp} \rightarrow K^{\mp}\pi^0$
		$\boldsymbol{B_s \rightarrow D_s^{\pm} \pi^{\mp}}$	$D_s^{\pm} \rightarrow \phi\pi^{\pm}, \phi \rightarrow K^+K^-$
		"	$D_s^{\pm} \rightarrow \phi\rho^{\pm}, \phi \rightarrow K^+K^-, \rho^{\pm} \rightarrow \pi^{\pm}\pi^0$
		$\boldsymbol{B_s \rightarrow D_s^{\pm} \rho^{\mp}}$	$D_s^{\pm} \rightarrow \phi\pi^{\pm}, \phi \rightarrow K^+K^-, \rho^{\mp} \rightarrow \pi^{\mp}\pi^0$
		$\boldsymbol{B^0 \rightarrow D_s^{\pm} K^{\mp}}$	$D_s^{\pm} \rightarrow \phi\pi^{\pm}, \phi \rightarrow K^+K^-$
		"	$D_s^{\pm} \rightarrow \phi\rho^{\pm}, \phi \rightarrow K^+K^-, \rho^{\pm} \rightarrow \pi^{\pm}\pi^0$
		$\boldsymbol{\Lambda_b^0 \rightarrow D_s^{-} p^{+}}$	$D_s^{\pm} \rightarrow \phi\pi^{\pm}, \phi \rightarrow K^+K^-$
		"	$D_s^{\pm} \rightarrow \phi\rho^{\pm}, \phi \rightarrow K^+K^-, \rho^{\pm} \rightarrow \pi^{\pm}\pi^0$
		$\boldsymbol{\Lambda_b^0 \rightarrow D_s^{*-} p^{+}}$	$D_s^{\pm} \rightarrow \gamma\phi\pi^{\pm}, \phi \rightarrow K^+K^-$
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