Evaluation of the PANDA Barrel DIRC particle identification efficiency using physical events

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Overview

- Fast simulation and reconstruction of simple event.
- Study the improvement of the Barrel Dirc to the signal to background ratio.
- Calculate the efficiency of the reconstruction for pion and kaon tracks.
- Summary and further analysis ideas.

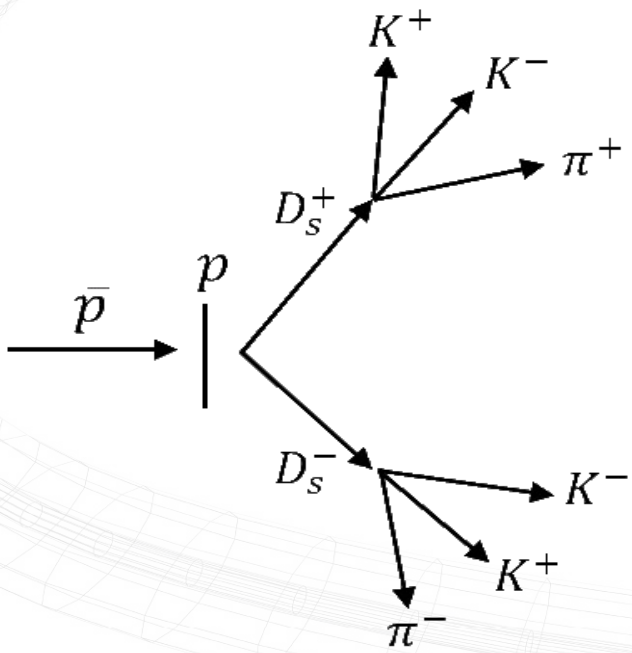
Fast simulation and reconstruction

Event type

- First step: simulation of the events (*generate a _sim.root file with the data from the simulation*)

  - Full simulation of the Panda detector: **10000** events run with **Geant3** for a Beam Momenta of **10 GeV/c**.

- My example event type:



- Decay file used as input for the simulation:

```
noPhotos

Decay pbarpSystem
  1.0      D_s+ D_s- PHSP;
Enddecay

Decay D_s+
  1.0      K+ K- pi+          PHSP;
Enddecay

Decay D_s-
  1.0    K+ K- pi-       PHSP;
Enddecay

End
```

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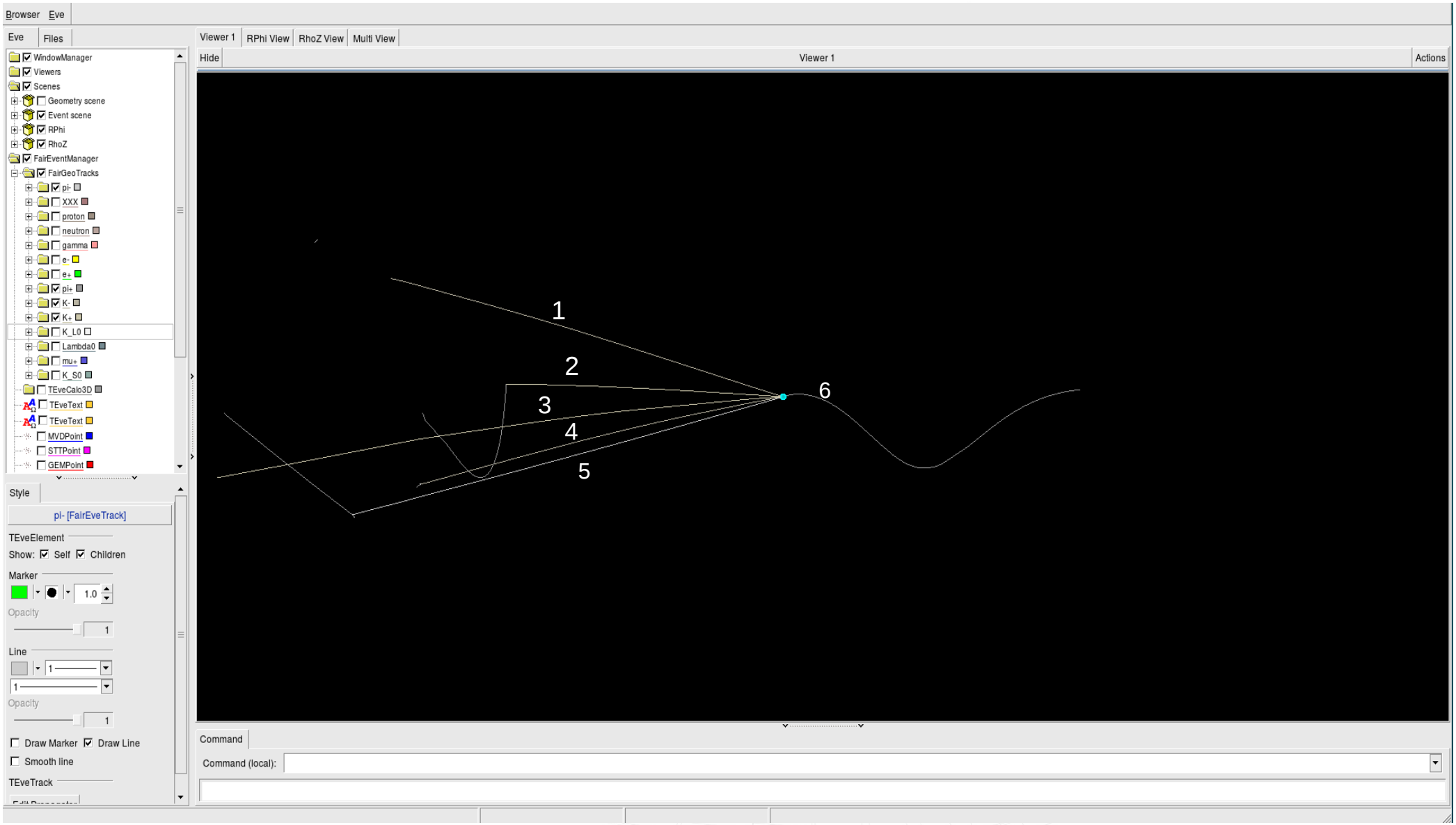
Fast simulation and reconstruction

Event display



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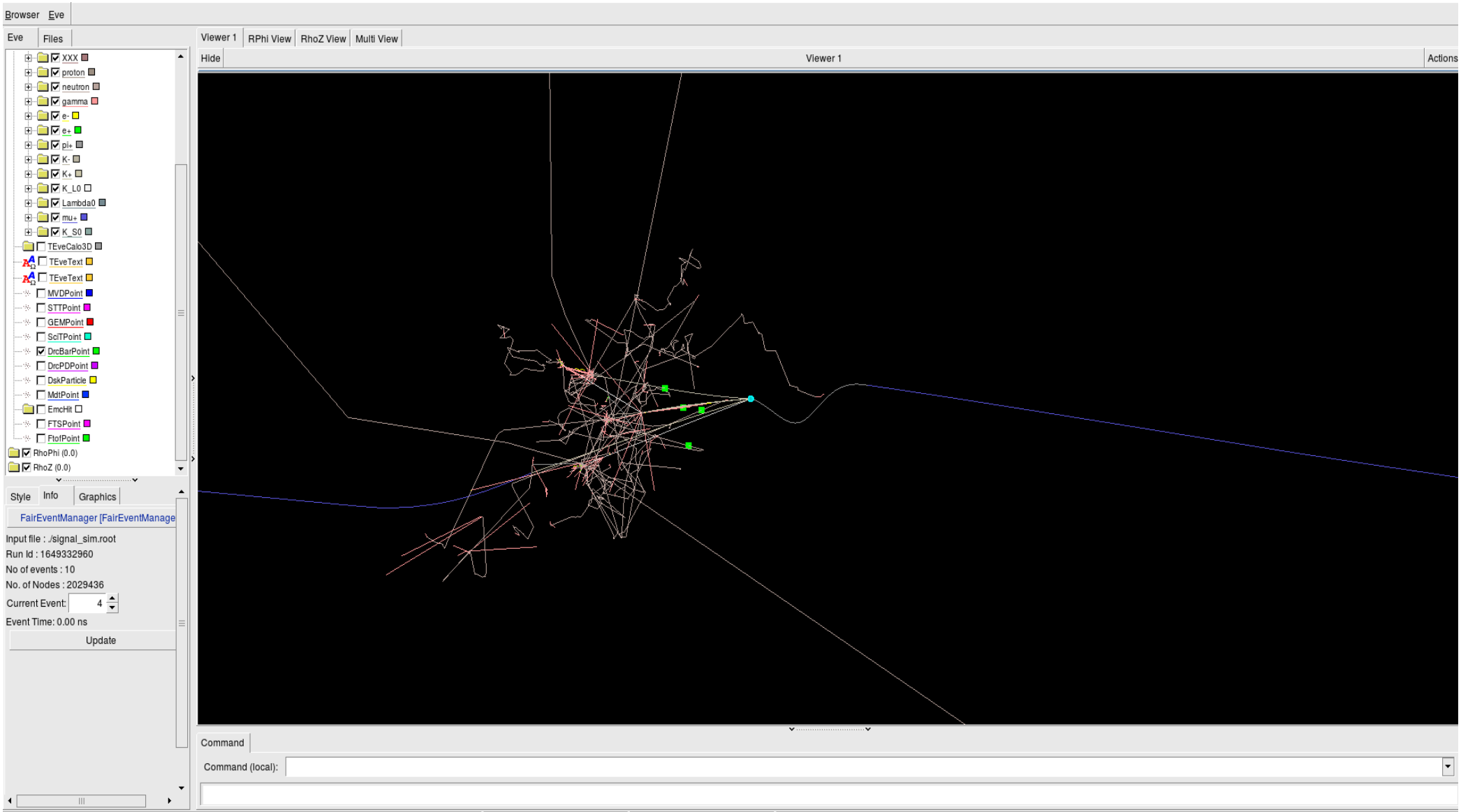
Fast simulation and reconstruction

Event display



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Fast simulation and reconstruction

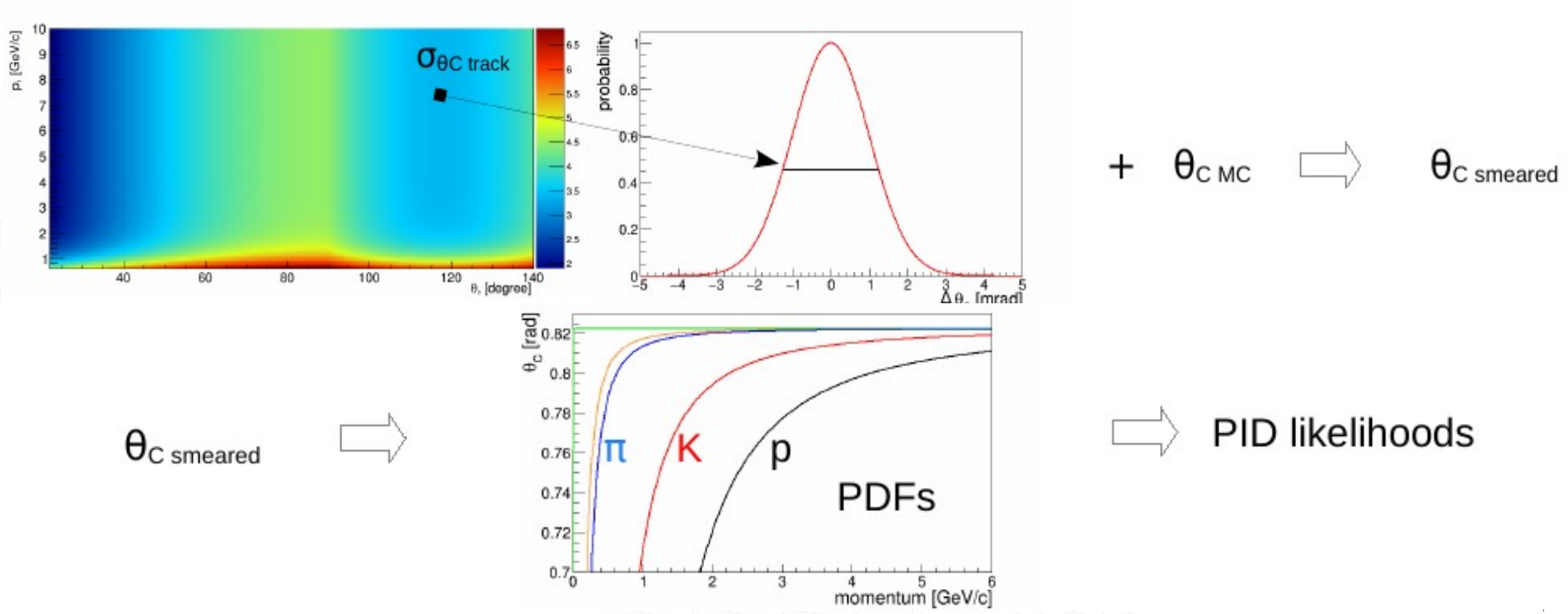
Fast reconstruction

- Second step: perform Panda reconstruction, digitalization and PID tasks.

  - Now reconstructed tracks with associated PID info are available.

  - Several detectors' algorithms are used for setting the PID probabilities.

  - This is how data coming from the simulation is smeared in the case of the Barrel Dirc:



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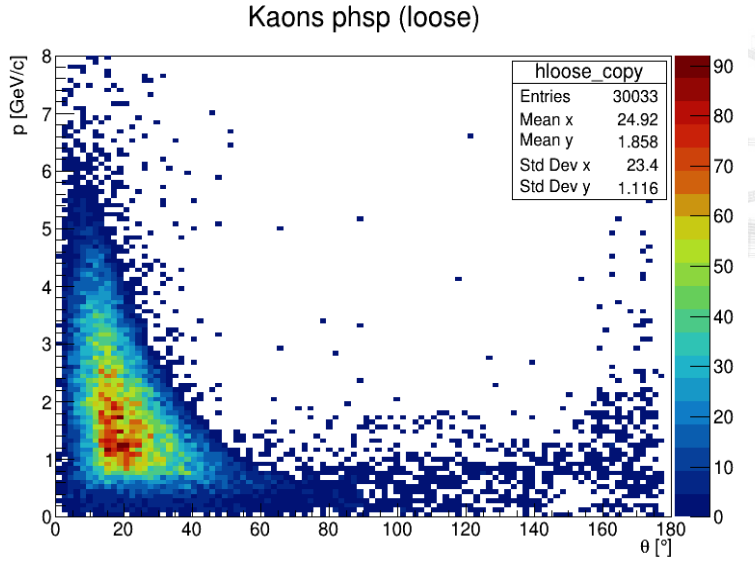
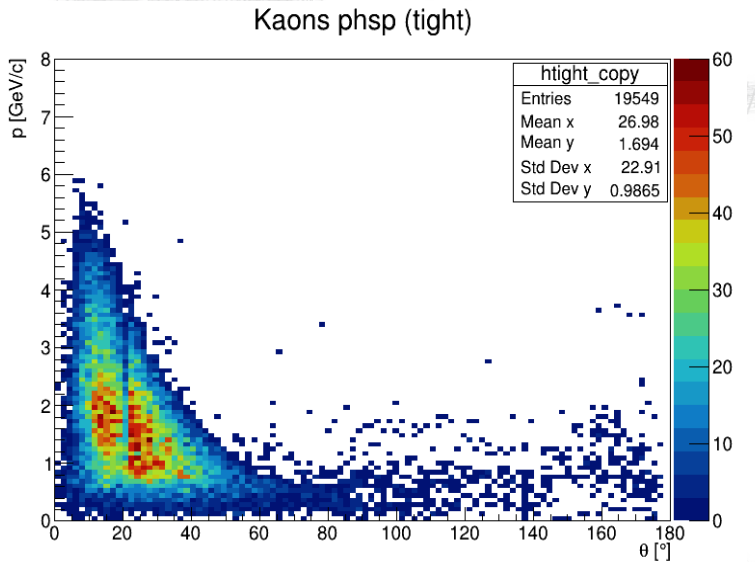
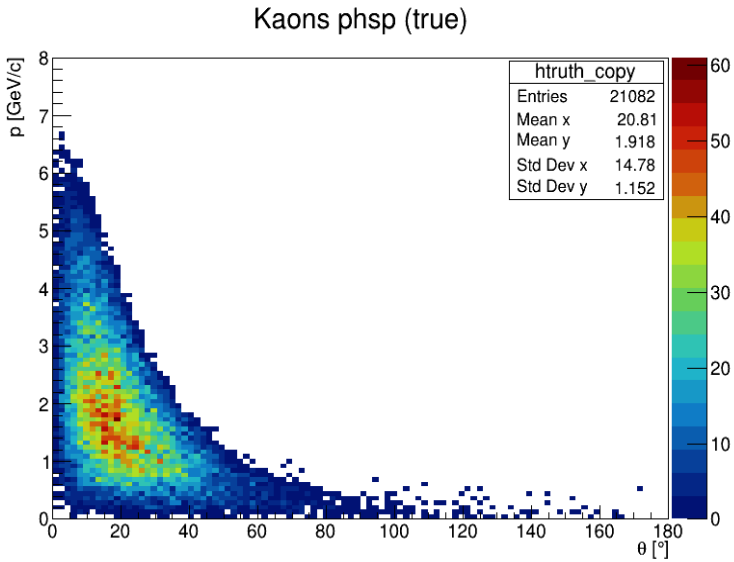
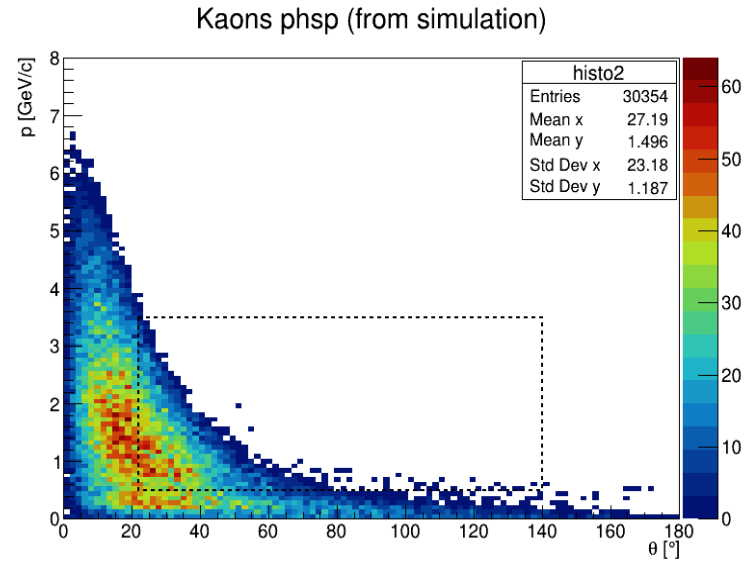
Fast simulation and reconstruction

Phase space distribution of kaons









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Ds meson's invariant mass

First analysis

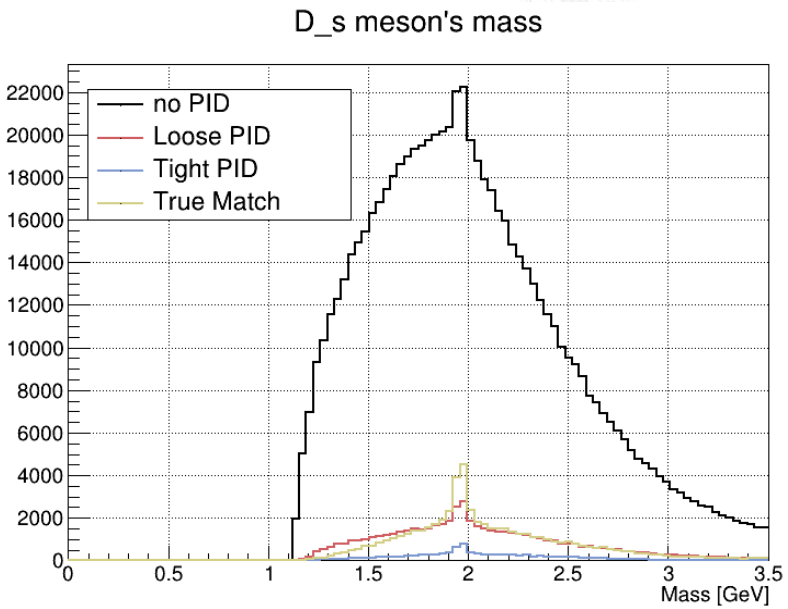
- The **D_s meson's mass** (1968.30 ± 0.11 MeV/ c^2) is studied, combining tracks of FS particles (KKπ).

- The cuts and PID algorithms are the same as before.

- In this case it is needed to distinguish between positive and negative charged kaons.

Remember: $\bar{p}p \longrightarrow D_s^{\pm} \longrightarrow K^{\pm} K^{\mp} \pi^{\pm}$

- True tracks combinatorics are also done (yellow)



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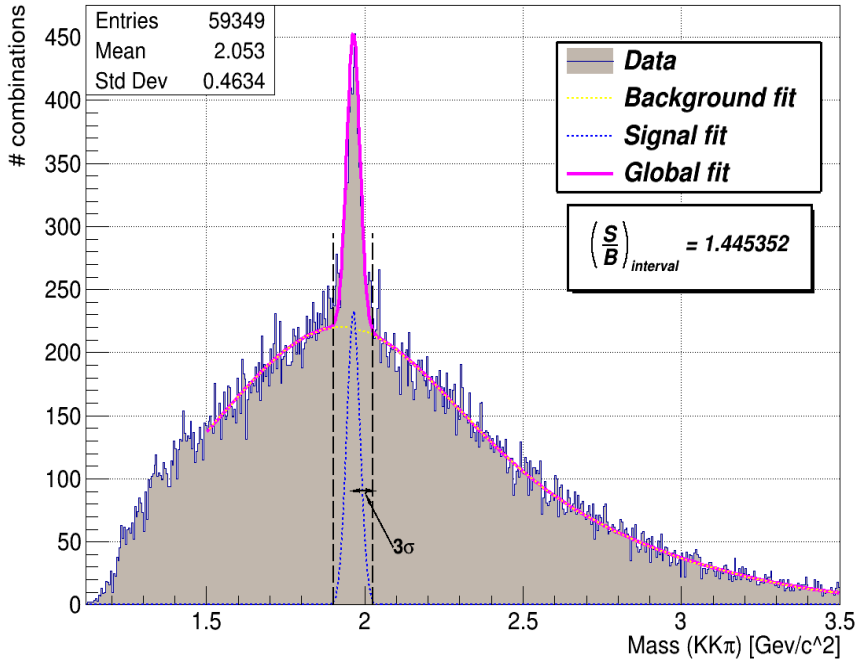
Ds meson's invariant mass

Data fitting

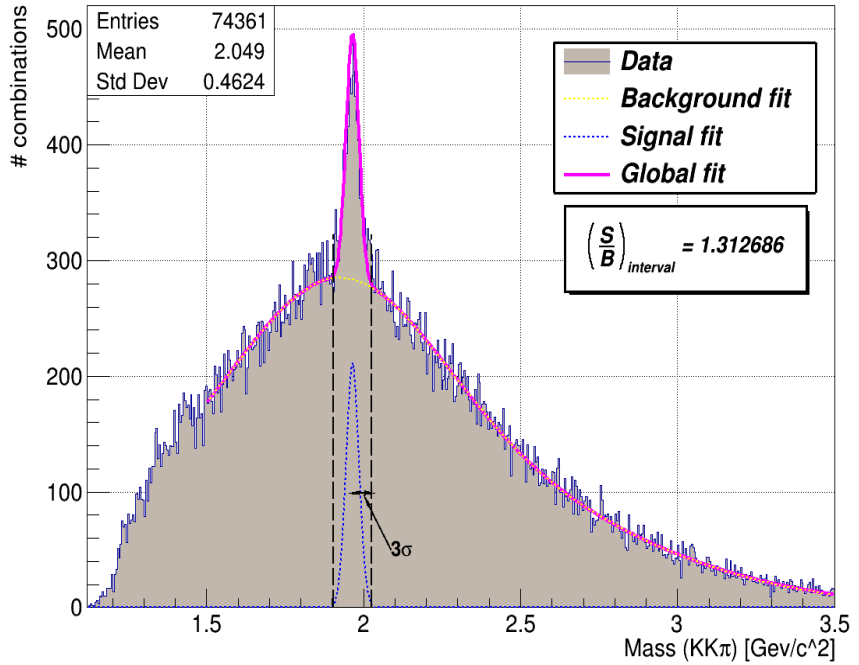
- The next step is the data fitting. Signal to background, S/B, ratio is calculated.

- The same analysis and combinatorics have been done but without Barrel DIRC information.

loose PID



loose PID (no DIRC)



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Ds meson's invariant mass

Data fitting

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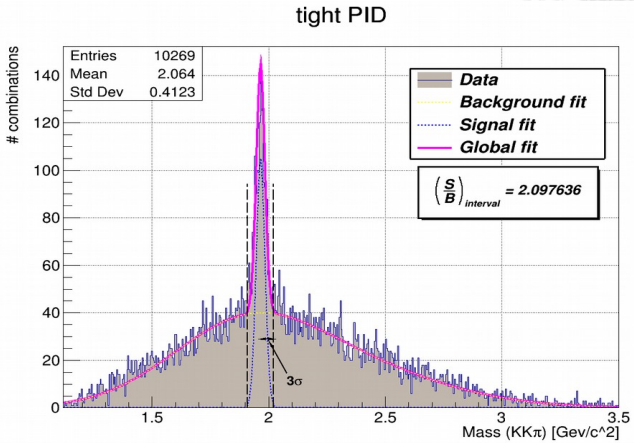
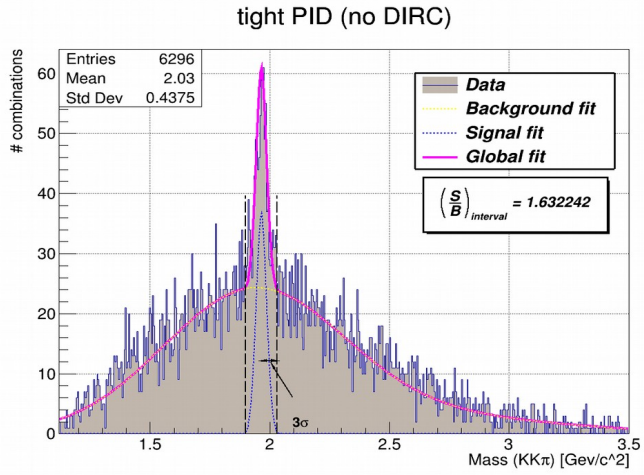
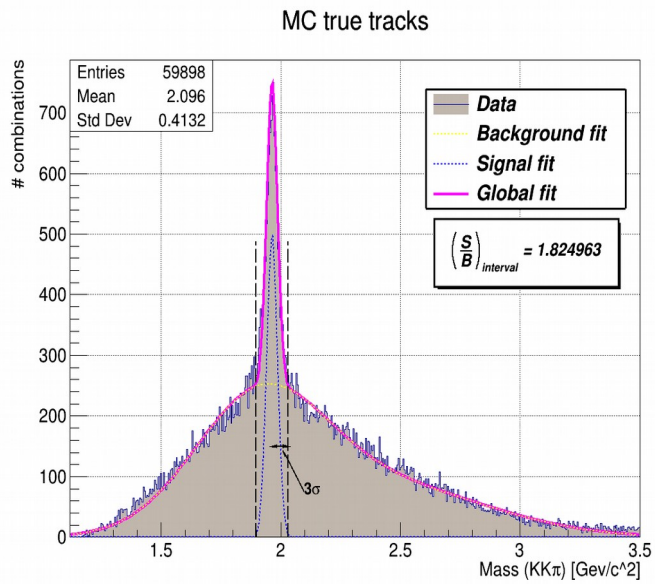
- The same analysis and combinatorics have been done but without Barrel DIRC information.





-Using “true” tracks:



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Ds meson's invariant mass with background

Event type

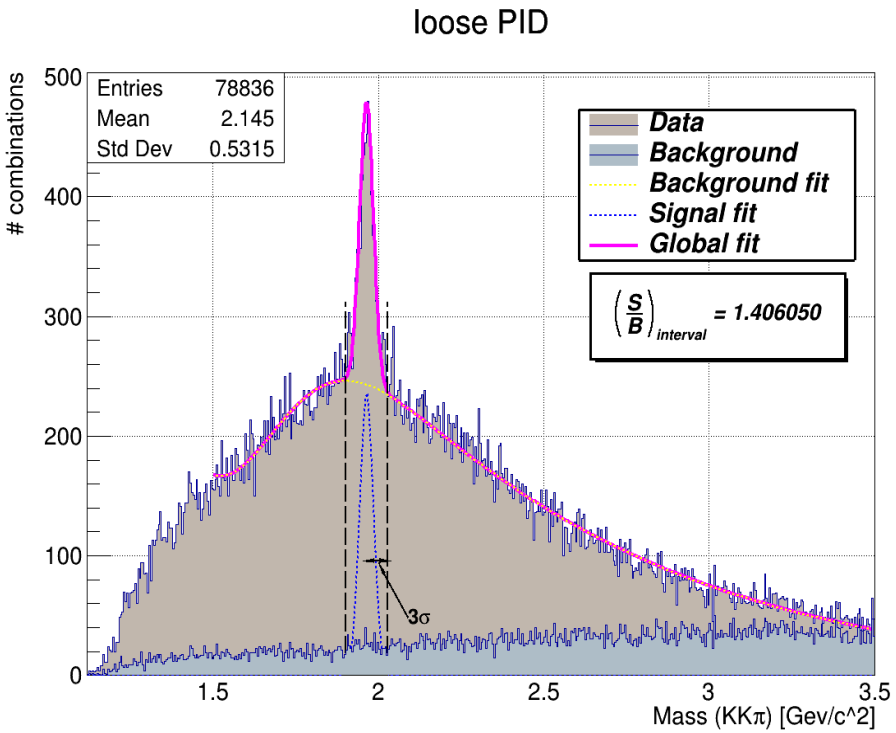
- A new simulation is run to serve as background for the previous event type.
- Background event type: $\bar{p}p \longrightarrow K^+K^-\pi^+\pi^-$

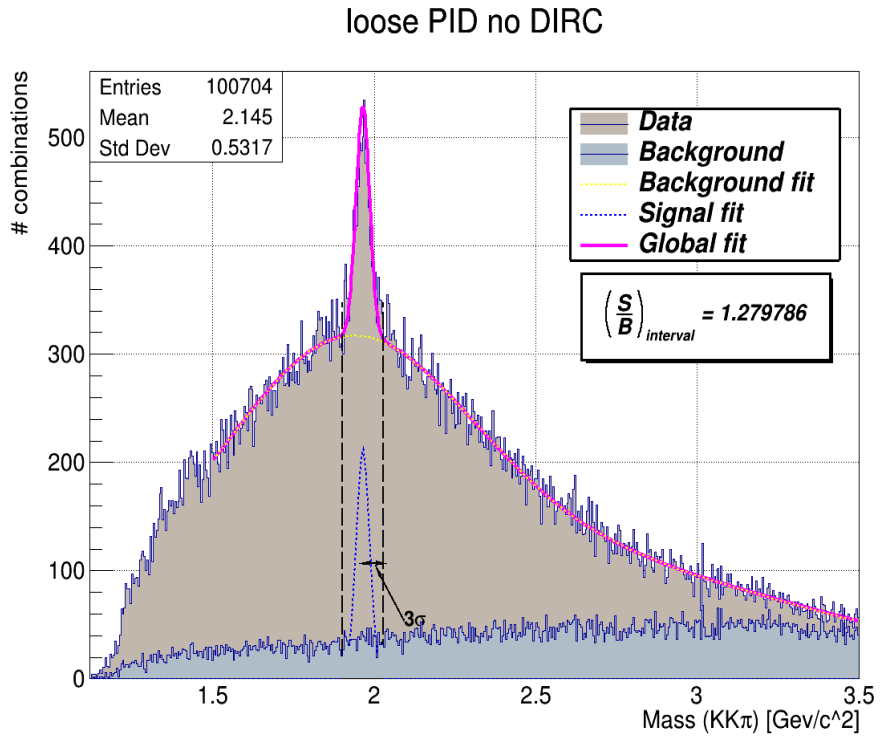
```
noPhotos

Decay pbarpSystem
  1.0     K+ K- pi+ pi-    PHSP;
Enddecay

End
```

- 10000 events are simulated for a BM of 10 GeV/c.
- Same analysis and combinatorics for the Ds meson are done.

Ds meson's invariant mass with background

Data fitting





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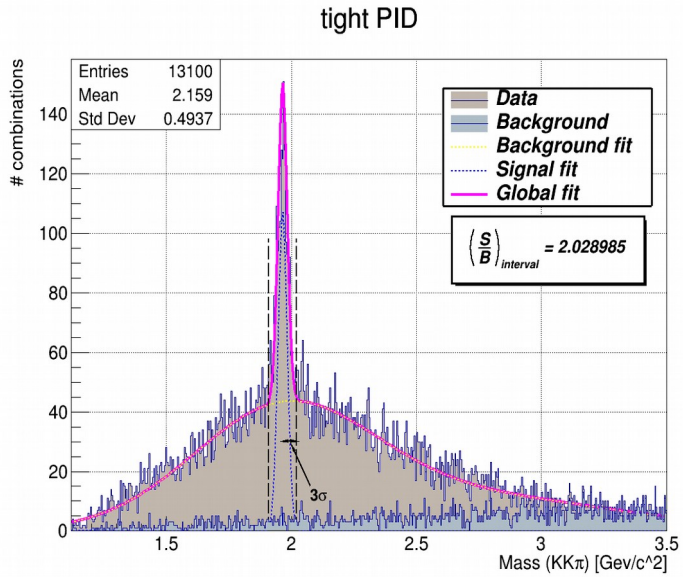
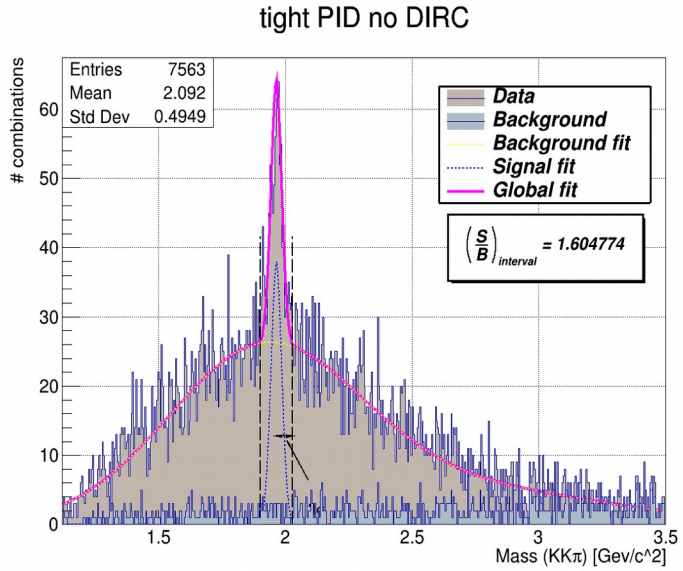
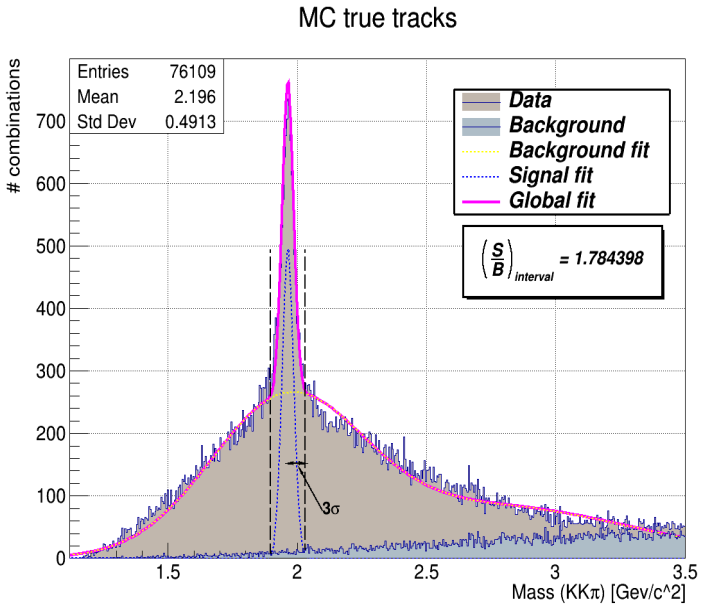
Ds meson's invariant mass with background

Data fitting





- Using MC true info:



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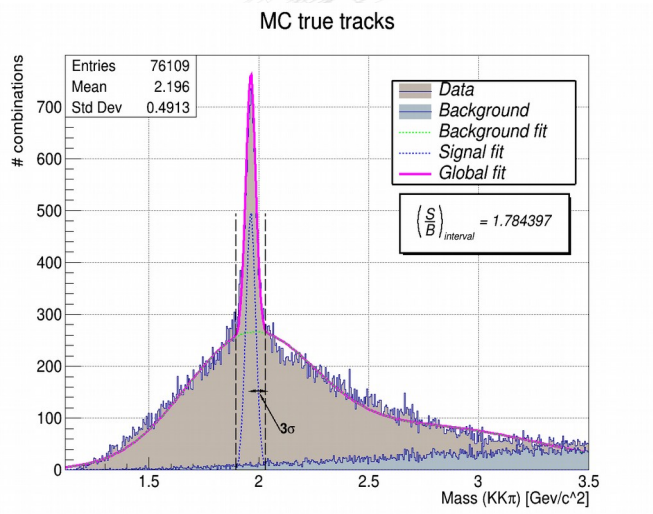
Ds meson's invariant mass with background

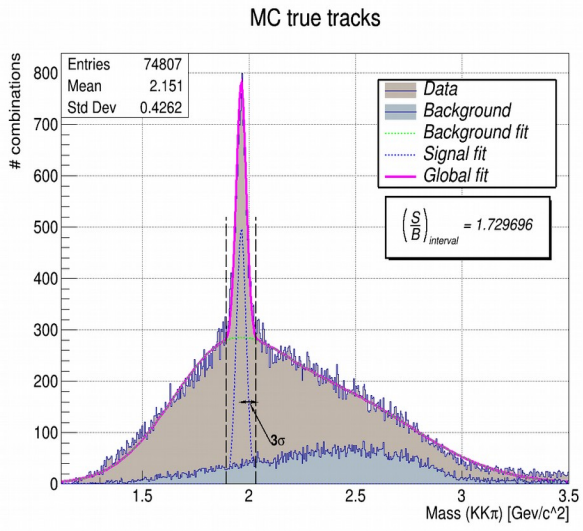
Data fitting

- The background beam momenta is lowered so as to match the signal peak when combinatorics are done.
- This is how the resulting combinatorics look like with several background BM:

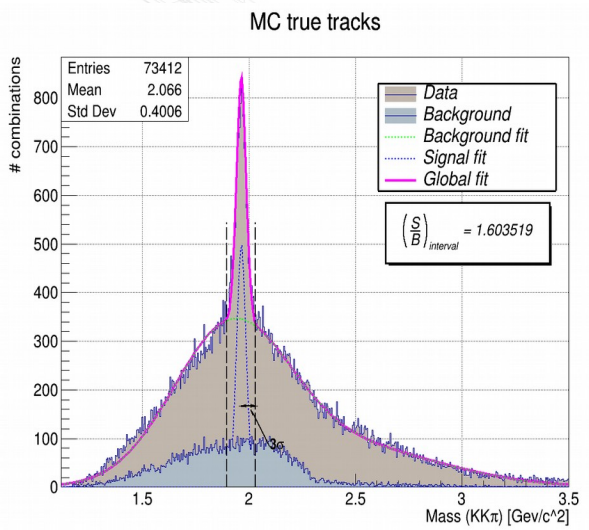
- For **10 GeV** BM:



- For **4 GeV** BM:



- For **2 GeV** BM:



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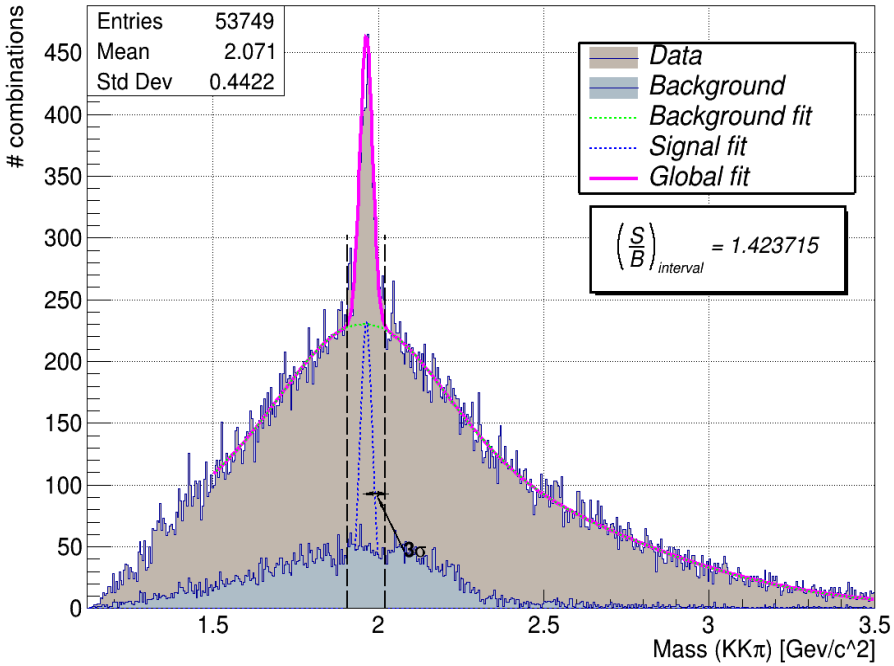
Ds meson's invariant mass with background

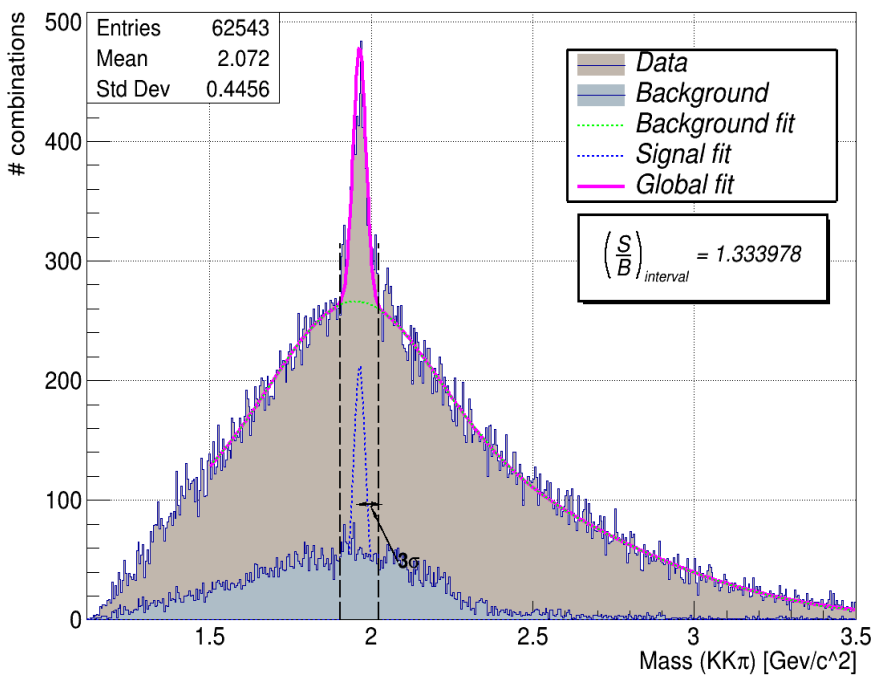
Data fitting

Again, how the Barrel DIRC information improves the results is studied for the 2 GeV BM background:

loose PID



loose PID no DIRC



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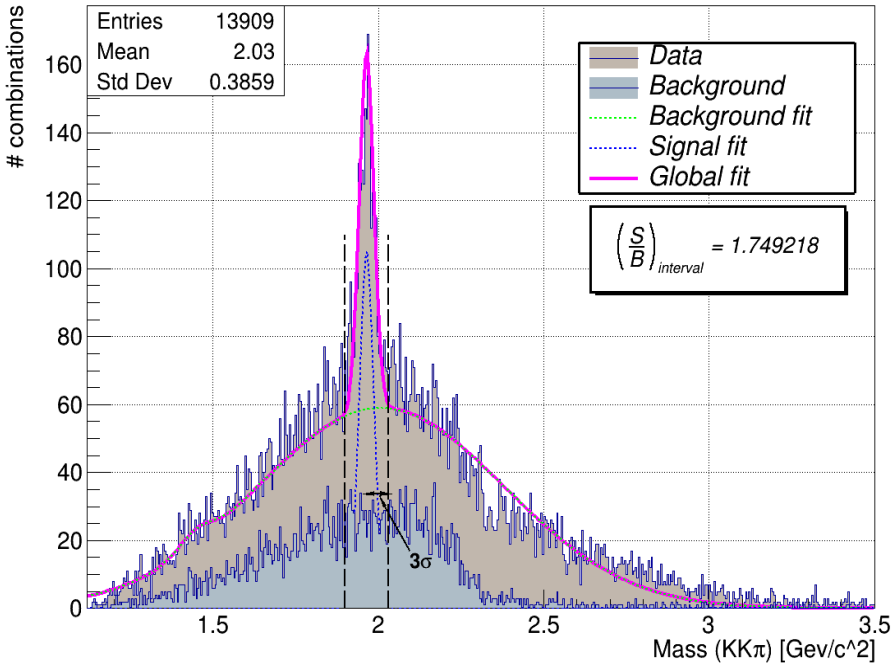
Ds meson's invariant mass with background

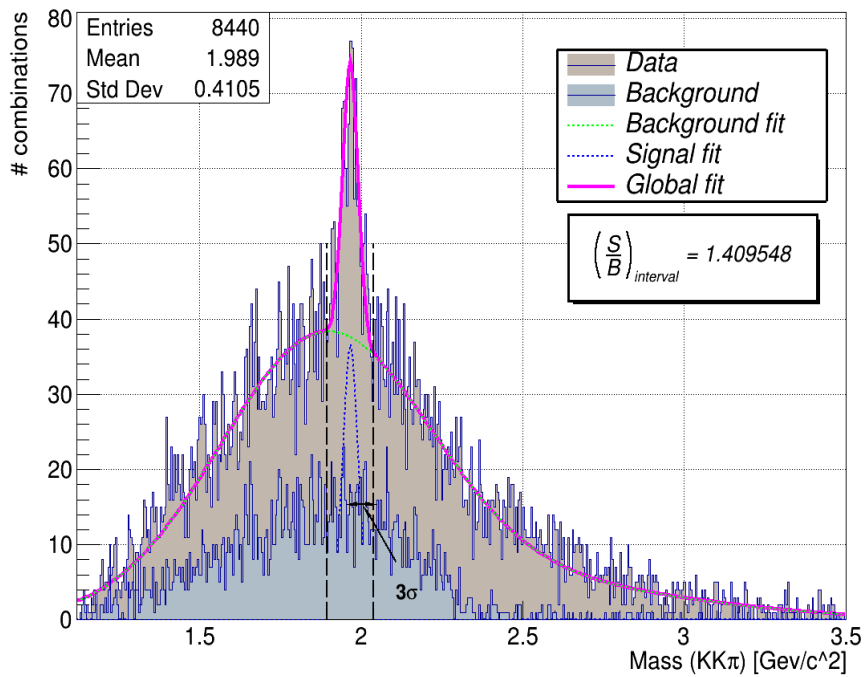
Data fitting

Again, how the Barrel DIRC information improves the results is studied for the 2 GeV BM background:

tight PID



tight PID no DIRC



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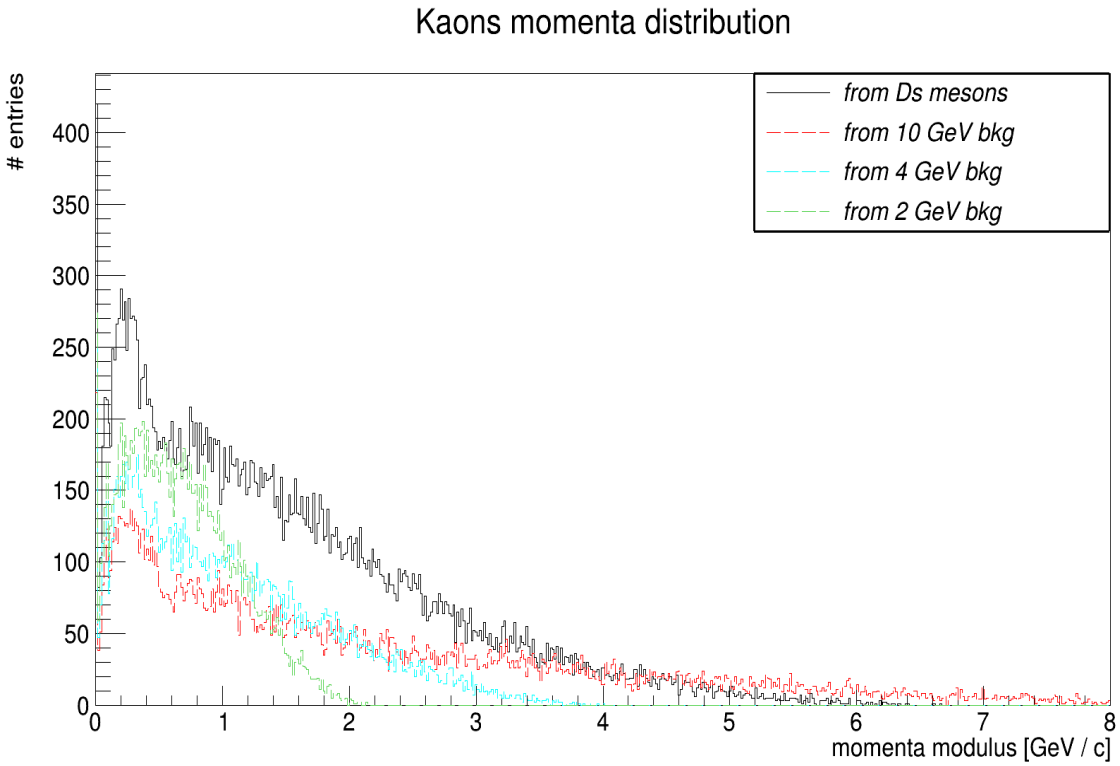
Ds meson's invariant mass with background

Kaons momenta distribution

-The momenta modulus distribution of FS kaons for the simulated background events is shown together with the momenta distribution of FS kaons from the “signal” events.



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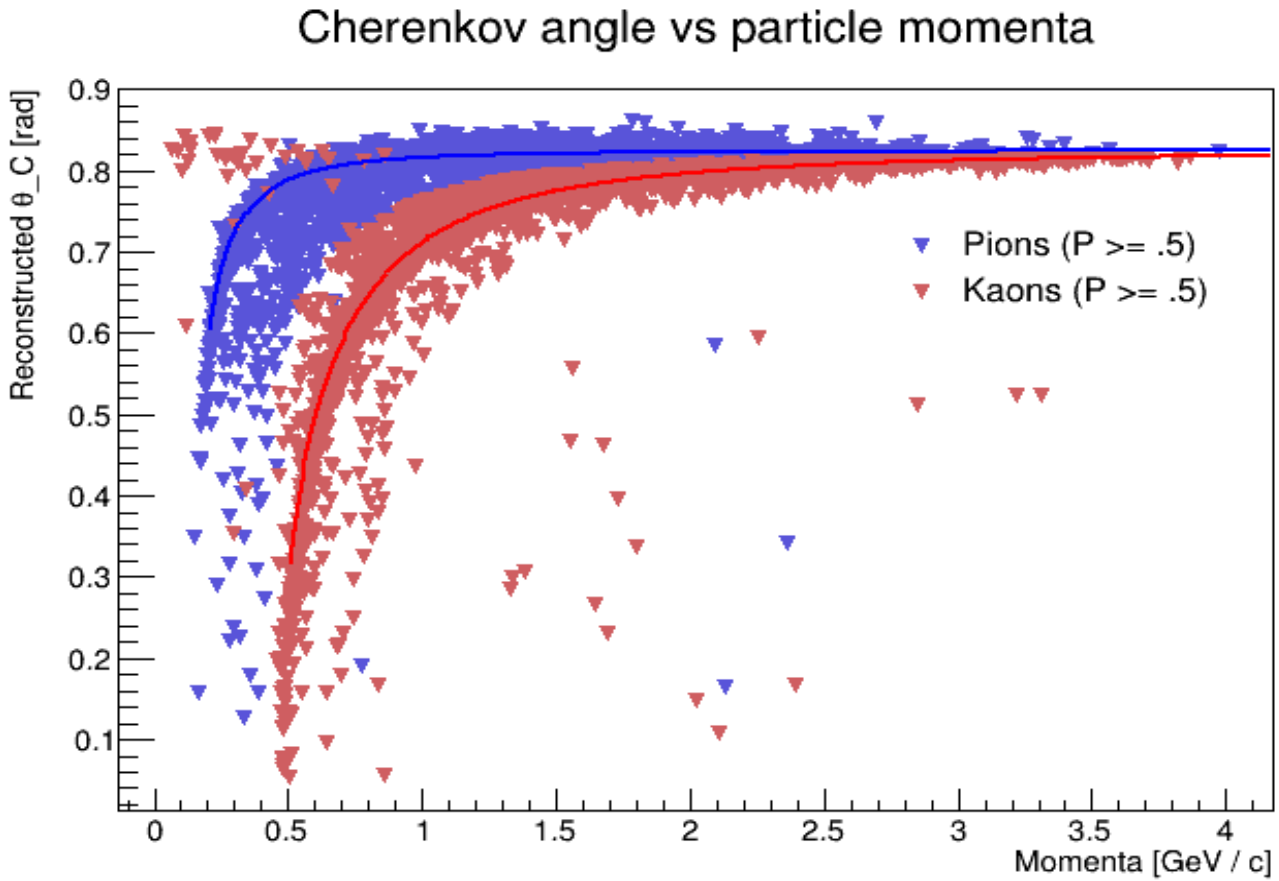
Reconstructed Cherenkov angle

- Reconstructed Cherenkov angle and expected curves.



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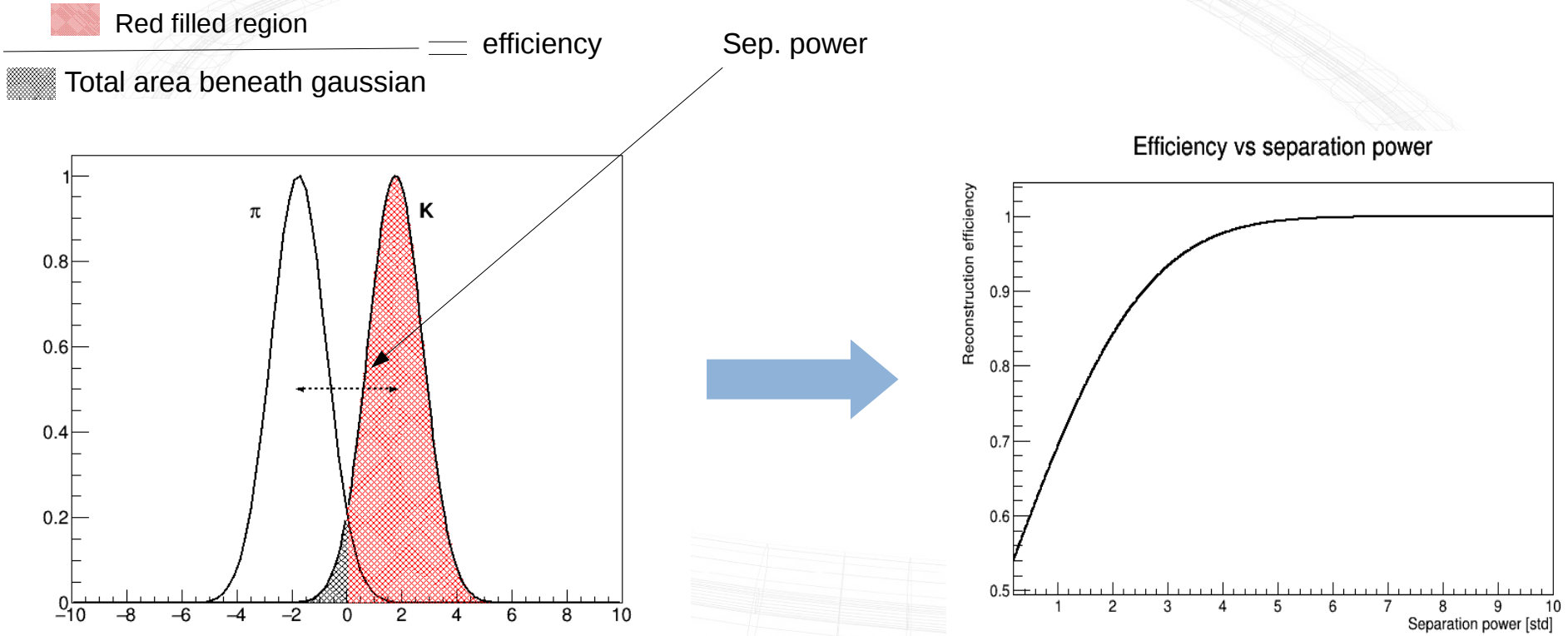
Reconstruction efficiency

-**Reconstruction efficiency**: #true particle tracks / #selected particle tracks

- This number is calculated after the tight cuts (prob. > 0.5) on the reco tracks. Also cuts on the Barrel Dirc polar region (22º < theta < 140º) are done.

- To relate this reconstruction efficiency to the expected separation power:



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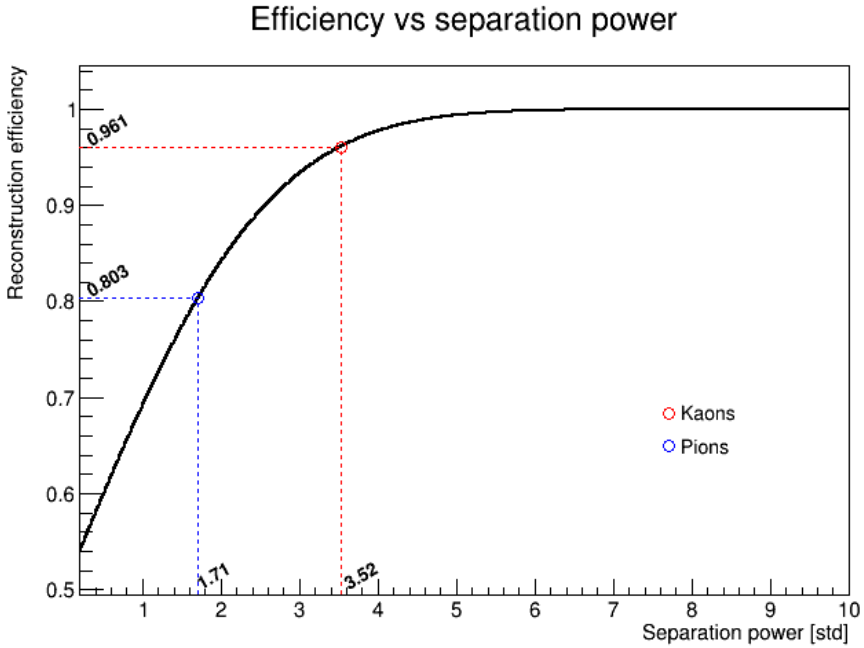
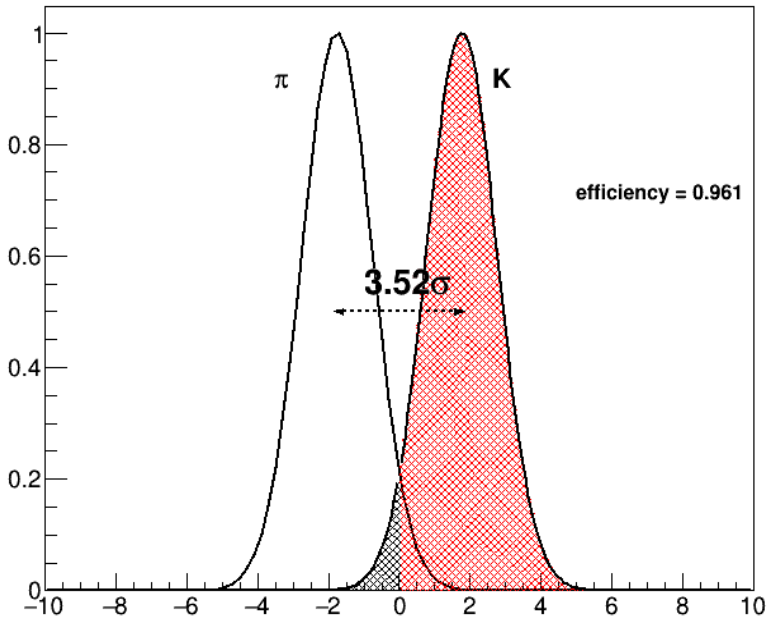
Reconstruction efficiency

- Perfect gaussian signal expected because of gaussian smearing when performing reconstruction.

Kaon expected separation power: 3.52
Pion expected separation power: 1.71



- Result for kaons:



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Summary

- Fast simulation and reconstruction of a simple event.
- Addition of background to the previous data.
- Visible improvement of the background to signal ratio when using the Barrel Dirc.

  Probably not as high as expected due to dominance of combinatorial background over physical background.
- Calculation of the reconstruction efficiency assuming perfect gaussian smearing of the pions and kaons signals.

Outline

- Next step: see how reco efficiency changes when adding tails to the gaussian signals

- Open question yet: lower than expected pion separation power

Thanks for your attention