Criteria to select D+ decays by the online filter

Mikhail Zhabitsky, JINR

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Minimum-bias events

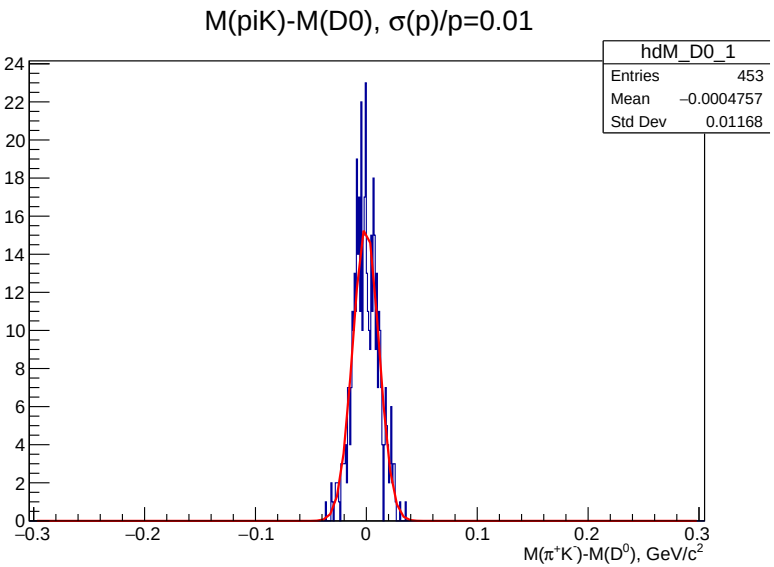
- pythia8.303 ($p + p$, $\sqrt{s} = 27$ GeV, SoftQCD=on)
- Channels of interest:

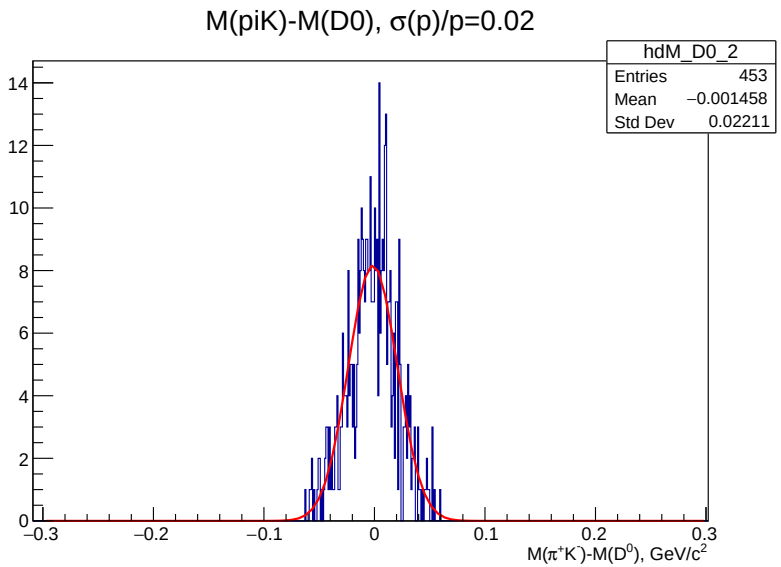
  $D^0 \to \pi^+ K^-$ (0.0395 ± 0.0003) at $x_F > 0.2$

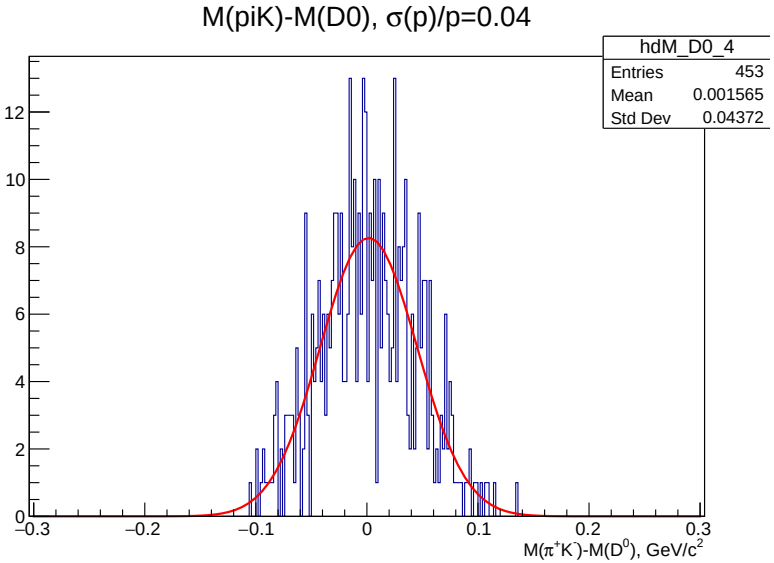
  $D^+ \to 2\pi^+ K^-$ (0.094 ± 0.002) at $x_F > 0.2$

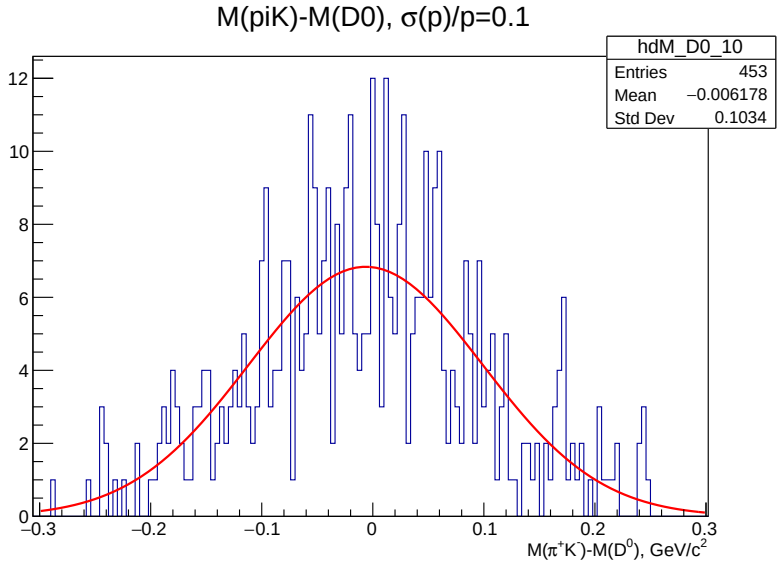
  $D^+ \to \pi^+ K^0_S$ (0.0156 ± 0.0003) at $x_F > 0.2$
- PID in endcaps
- Kinematic cuts in D^0 center-of-mass system
- Charge multiplicities
- Study is focused on data-reduction by the online-filter

$D^0 \to K^-\pi^+$: resolution



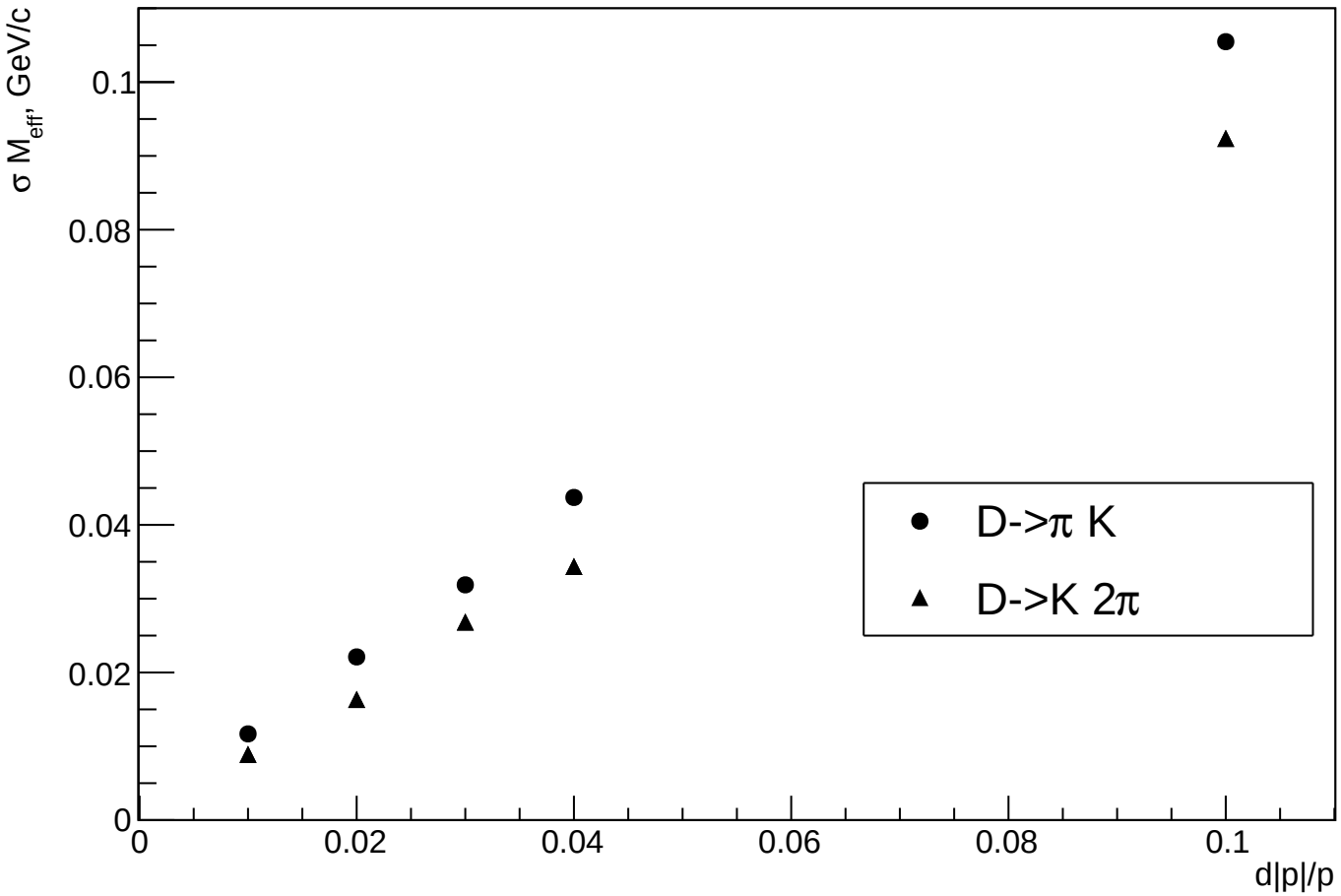




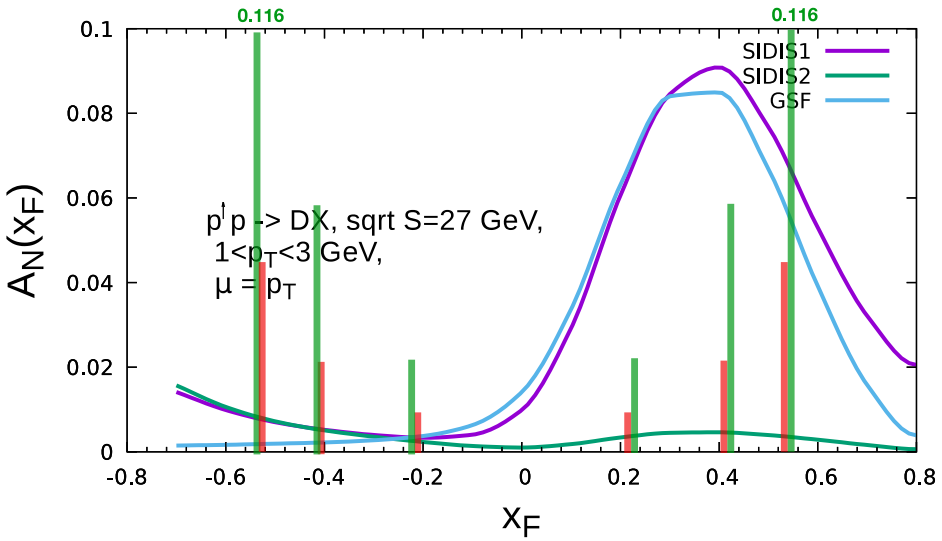


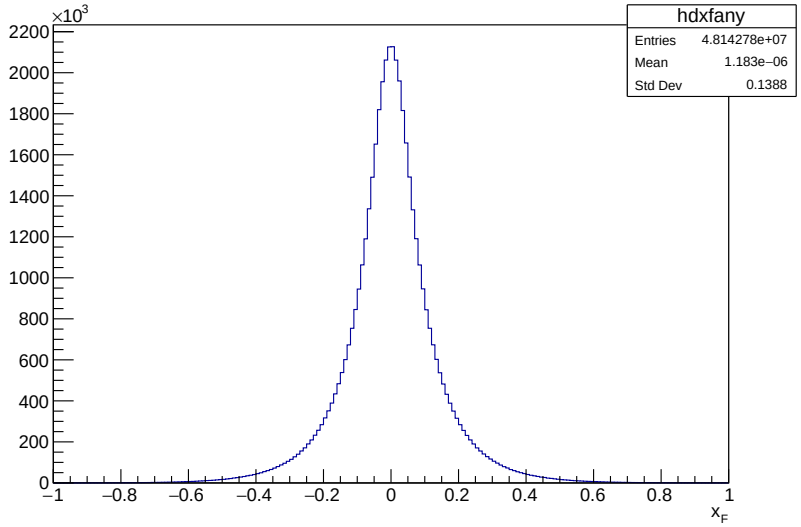
100M pp-interactions

$D^0 \to K^-\pi^+$: resolution



$D^0 \to K^-\pi^+$: x_F



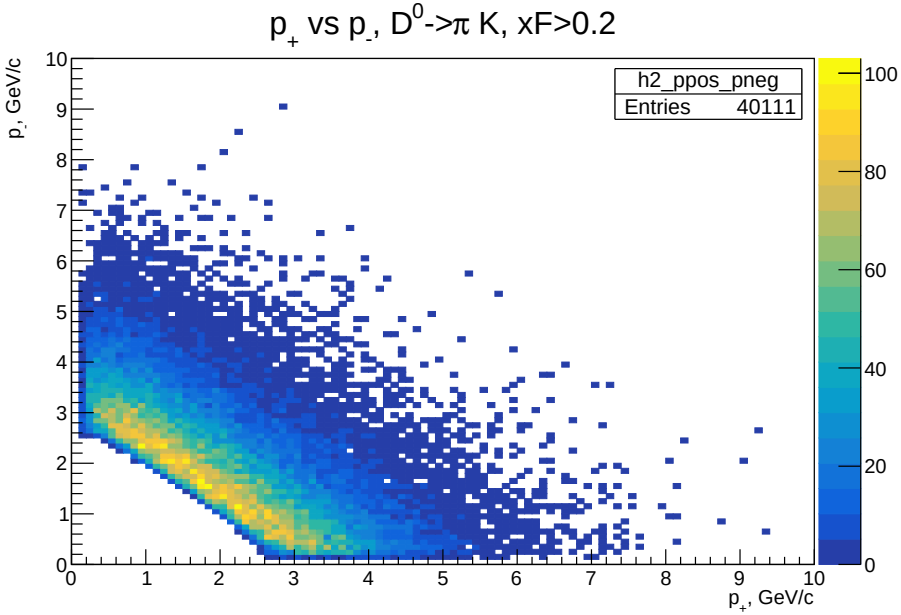


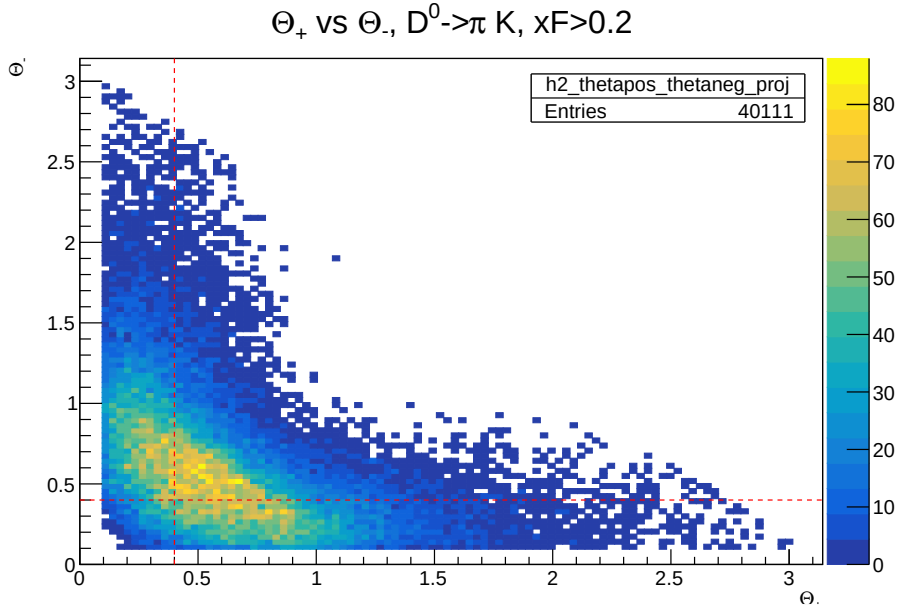
Events of interest: $x_F = \frac{p_z}{p_{z,\mathbf{max}}} > 0.2$

Probability of pos. trigger decision:
any x_F: 0.56
$|x_F| > 0.2$: 0.29

$D^0 \to K\pi$: kinematics

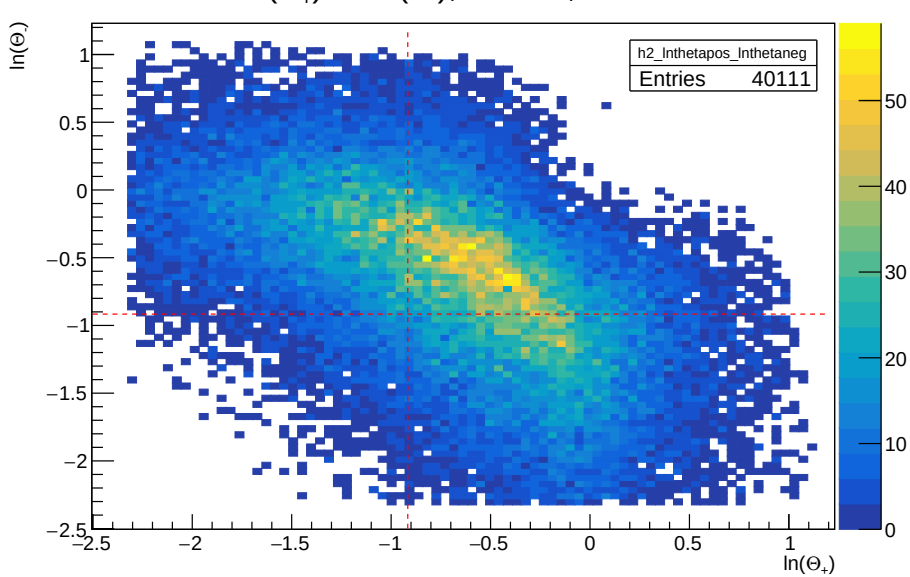
tracks selection: $p > 0.15$ GeV/c, $p_T/p > 0.1$, $x_F > 0.2$





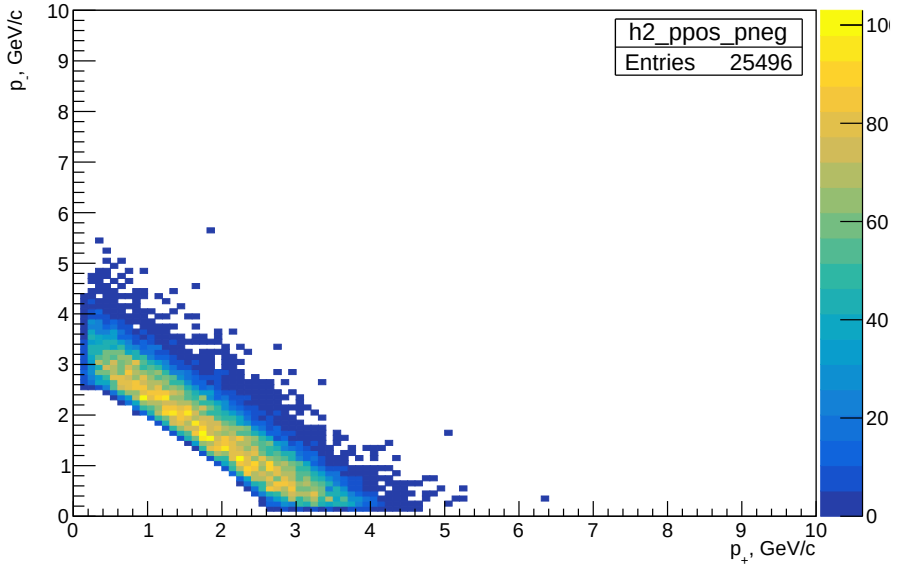
Statistics:

$3.6 \cdot 10^{10}$ pp-interactions
(approx. 3 hours at 3 MHz)

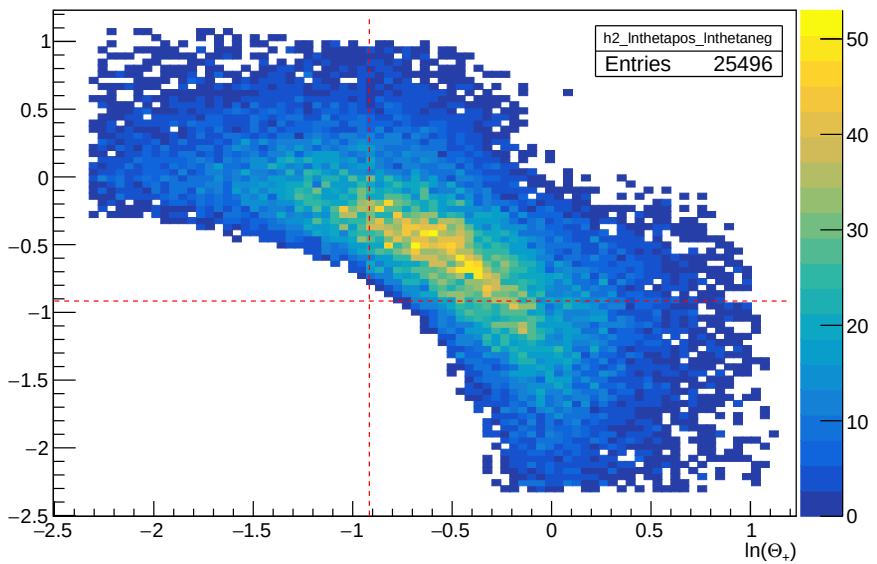


$D^0 \to K\pi$: kinematics

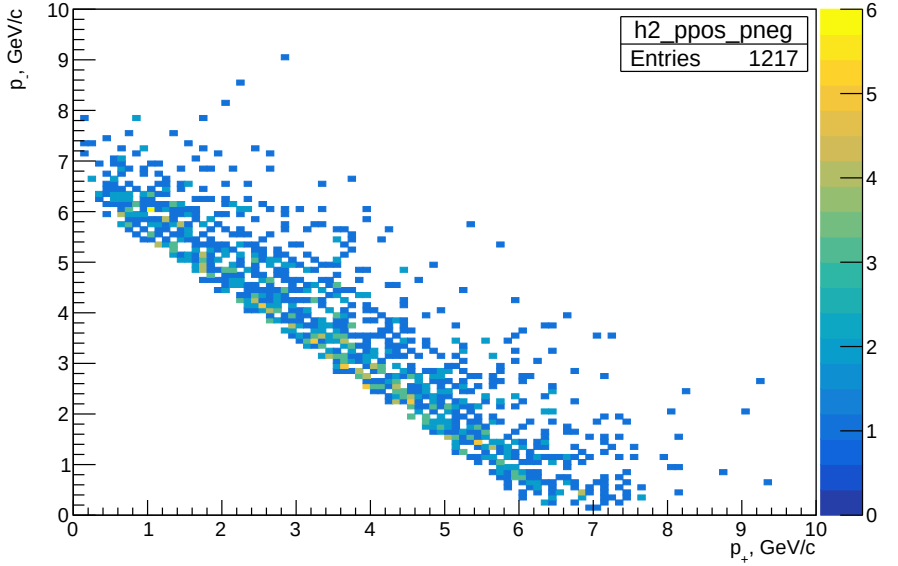
p_+ vs p_-, D^0->π K, xF∈(0.2, 0.3)



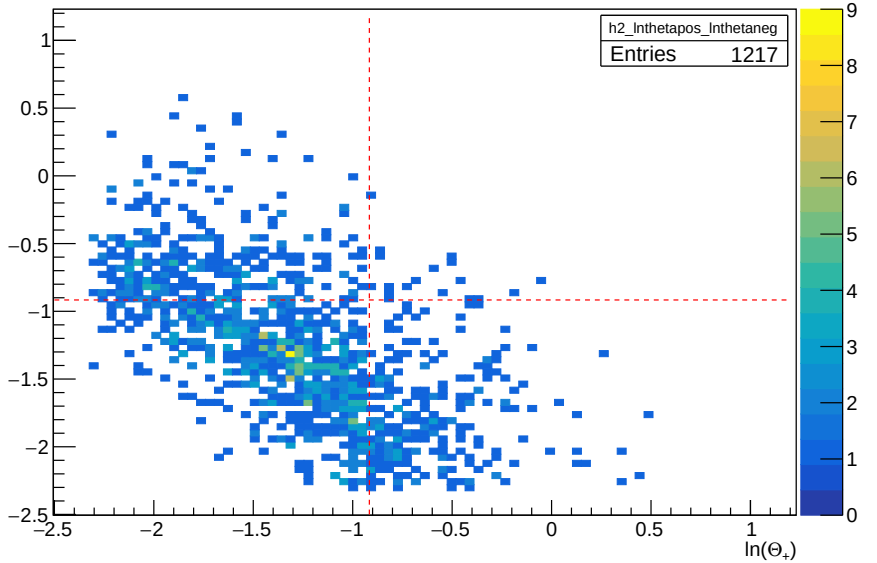
$\ln(\Theta_+)$ vs $\ln(\Theta_-)$, D^0->πK, xF∈(0.2, 0.3)



p_+ vs p_-, D^0->π K, xF>0.5



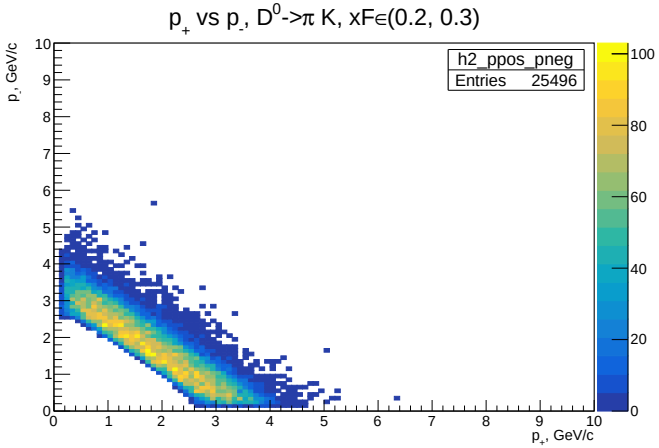
$\ln(\Theta_+)$ vs $\ln(\Theta_-)$, D^0->πK, xF>0.5

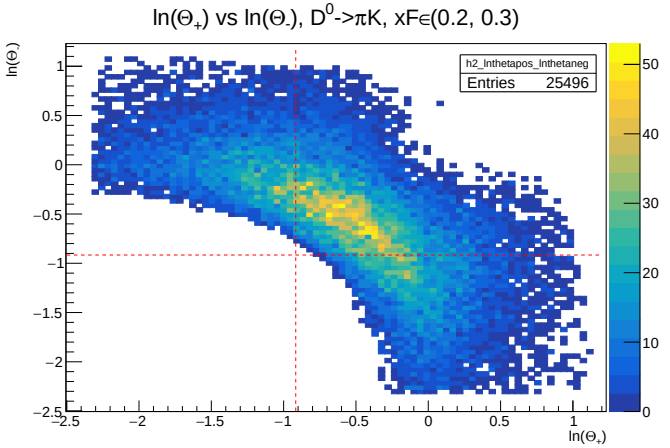


$D^0 \to K\pi$: signal vs combinatorial background

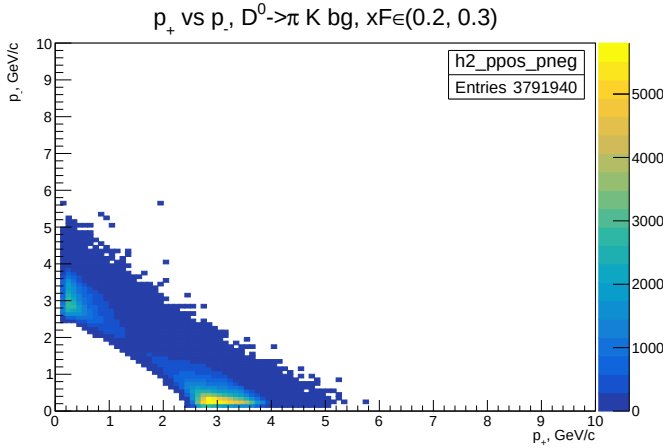
$x_F \in (0.2, 0.3)$:

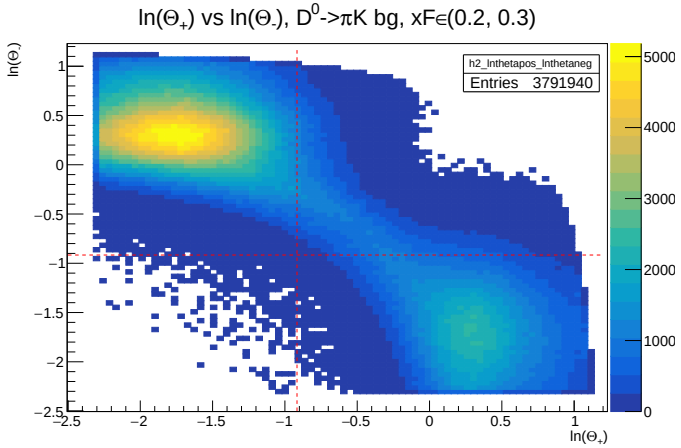
Signal ($3.6 \cdot 10^{10}$)





bg (10M pp-collisions)





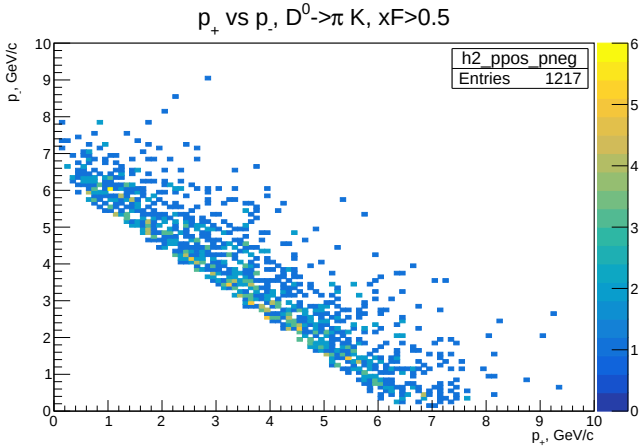
Trigger rate: 0.20

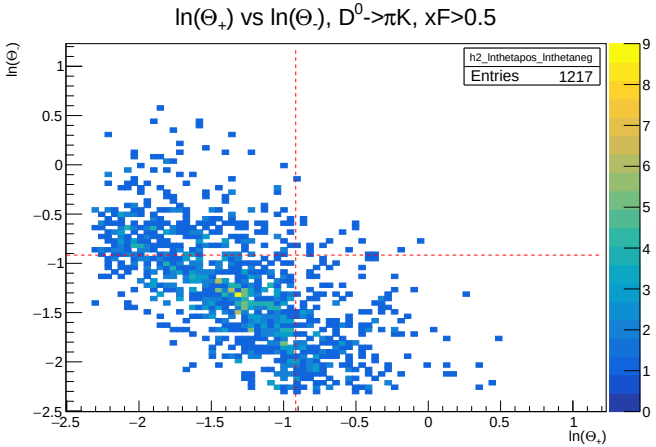
Main Bg combinations:
$p\pi^-$: 1.1M
$\pi^+\pi^-$: 1.9M
πK: 0.4M
other: 0.4M

$D^0 \to K\pi$: signal vs combinatorial background

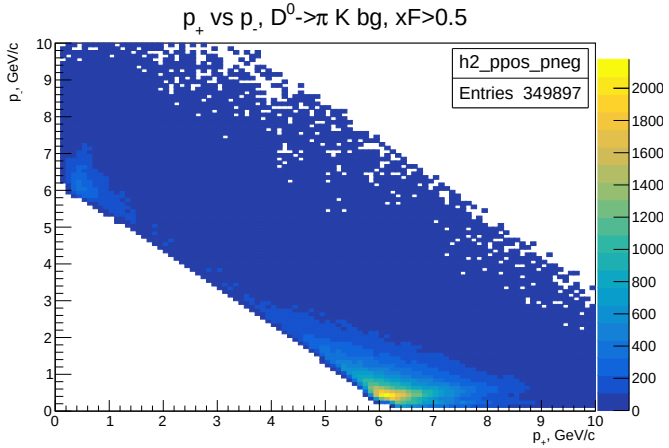
$x_F > 0.5$:

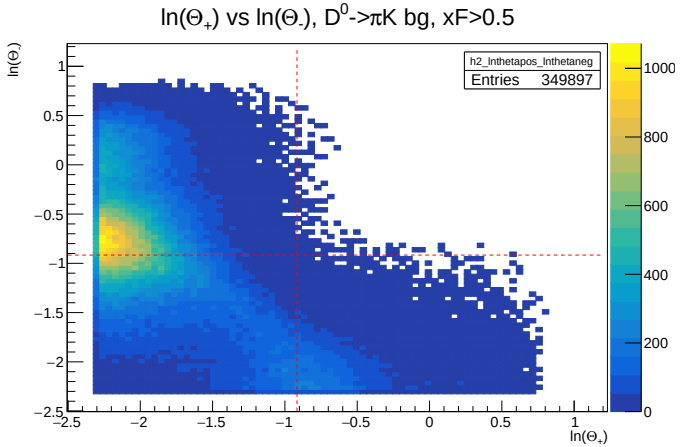
Signal ($3.6 \cdot 10^{10}$)





bg (10M pp-collisions)

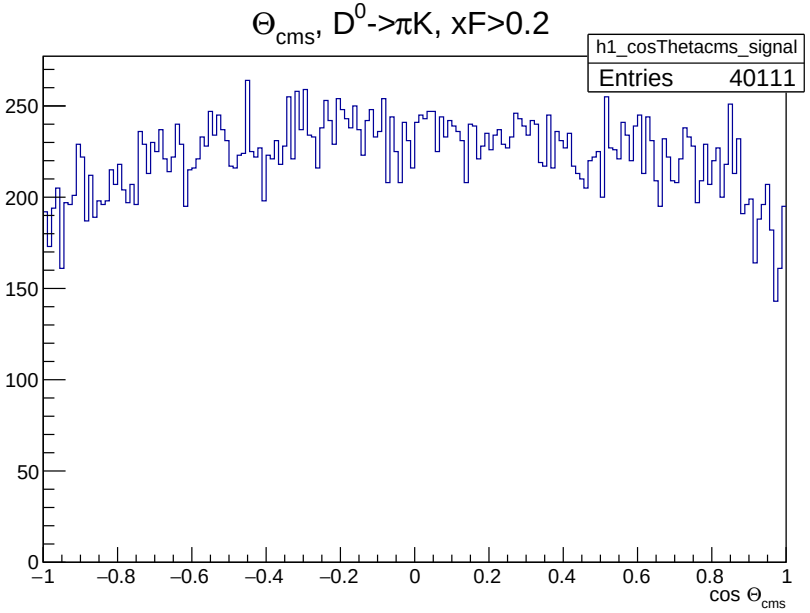


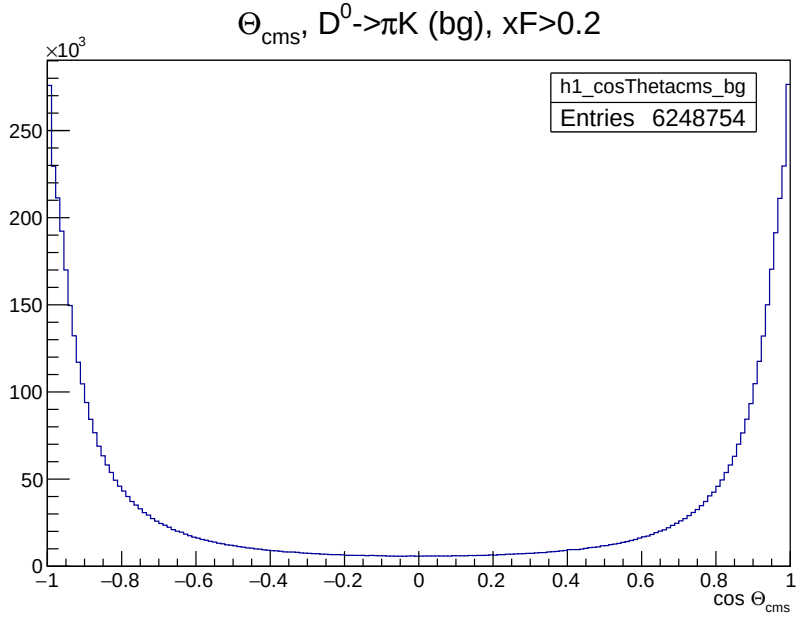


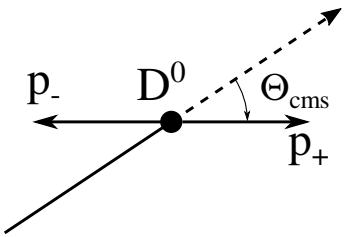
Trigger rate: 0.026

Main Bg combinations:
$p\pi^-$: 0.21M
$\pi^+\pi^-$: 0.09M
πK: 0.02M
other: 0.03M

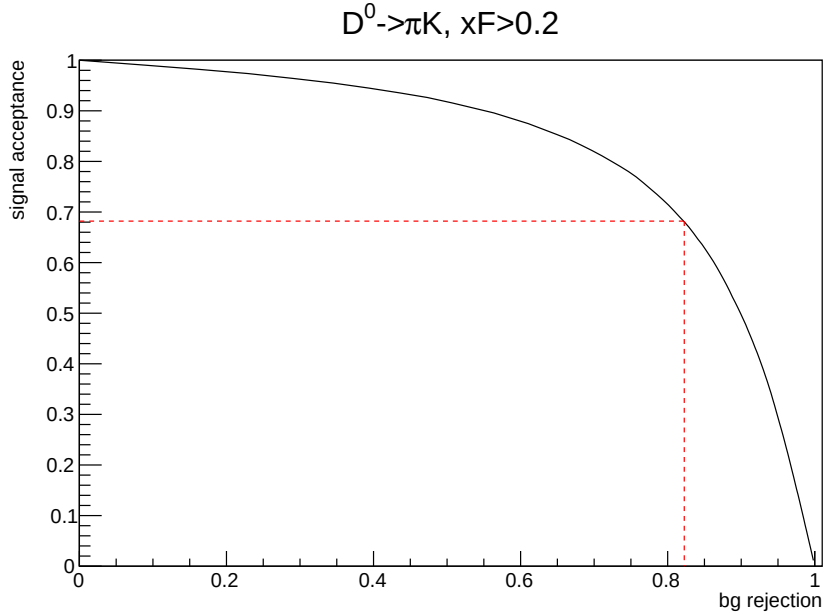
$D^0 \to K\pi$: CMS kinematics







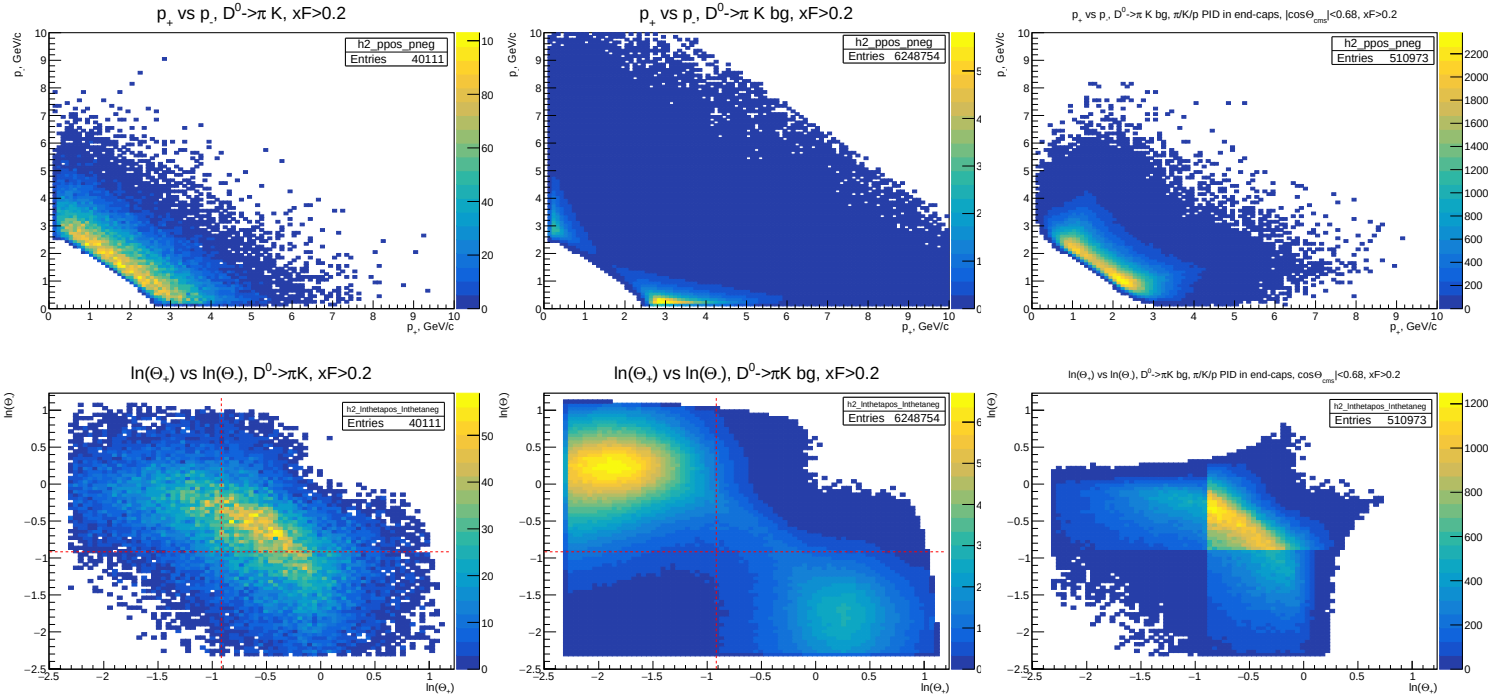
$\sigma(\cos(\Theta_{cms})) \approx 0.02$



Suppress forward/backward kinematics in CMS

$x_F > 0.2, \quad |\cos\Theta_{cms}| < 0.68$:

Signal ($3.6 \cdot 10^{10}$) bg (10M pp-collisions)



Trigger rate: 0.039

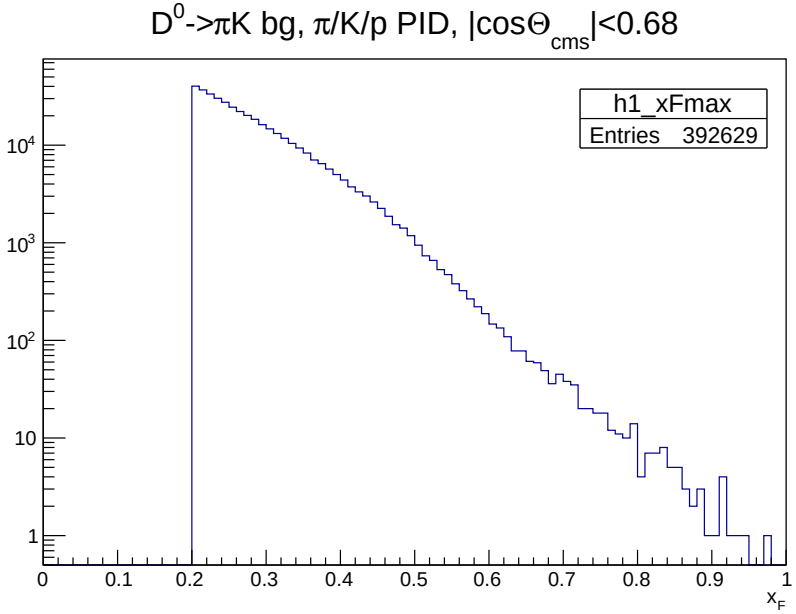
Main Bg combinations:
$p\pi^-$: 0.1M
$\pi^+\pi^-$: 0.3M
πK: 0.08M
other: 0

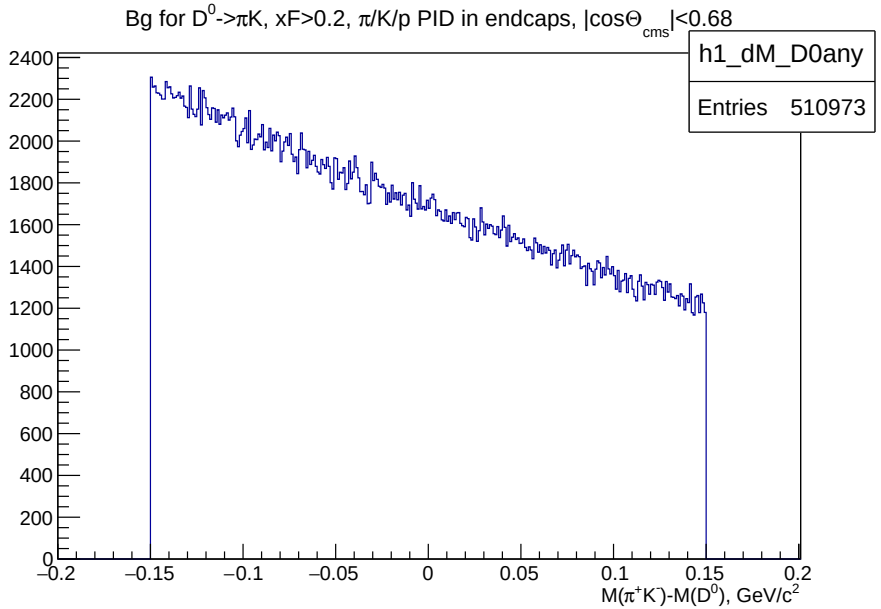
Approx. 0.5 of events: both tracks are in the barrel

Trigger rate for $x_F > 0.2$, Cherenkov ID in end-caps

	no ID	no protons	$\pi/K/p$
$\forall \cos\Theta_{cms}$	0.29	0.20	0.15
$\lvert\cos\Theta_{cms}\rvert < 0.68$	0.074	0.053	0.039

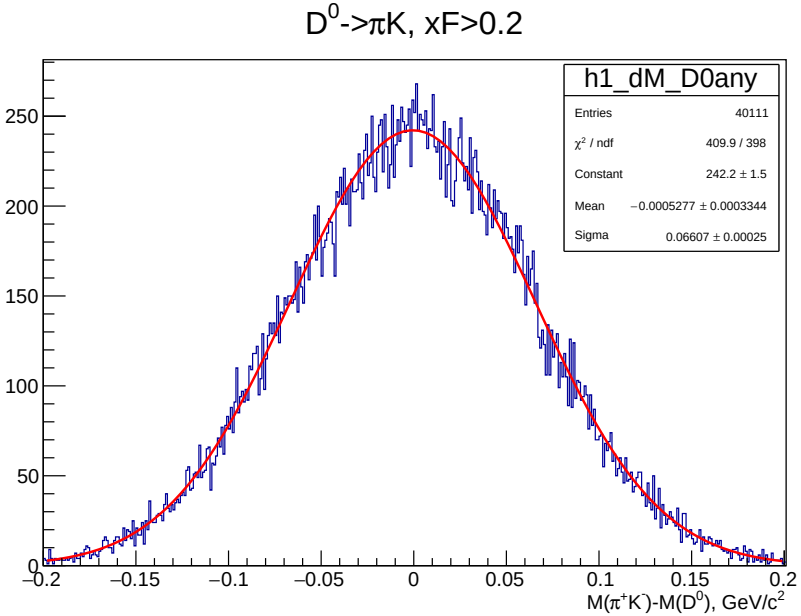
$M_{\pi K}$ for survived bg events



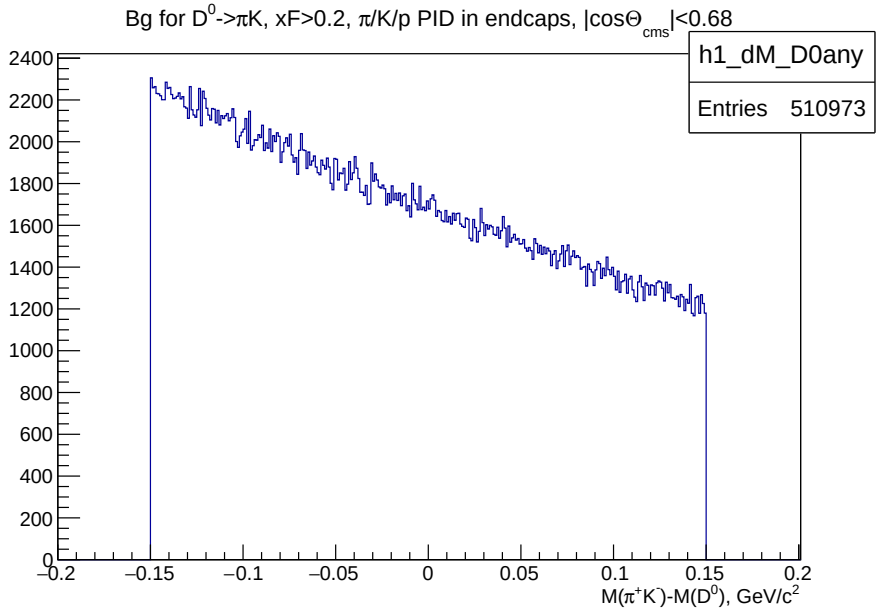


Range of accepted $\lvert M_{\pi K} - M_{D^0} \rvert$	1.5σ	3σ	6σ
Rate of pos. triggers	0.022	0.039	0.073

$M_{\pi K}$: signal vs bg



3 hours



3 seconds

$D^{\pm} \to K^{\mp}2\pi^{\pm}$

- Combinatorial bg is increased by a factor n_+ (or n_-).
- For three-body decay Criteria on the CMS angle between the decay axis and momentum of D is less selective
- For ($x_F > 0.2$) bg flux reduction:

  0.62

  0.49 ($|M_{2\pi K} - M(D^+)| < 3\sigma$)

  0.23 ($|M_{2\pi K} - M(D^+)| < 3\sigma$ & ideal PID in end-caps)

  0.13 (. . . & $|\cos\Theta^*| < 0.68$)

$D^+ \to \pi^+ K^0_S$

$D^+ \to 2\pi^+ K^-$ (0.094 ± 0.002) at $x_F > 0.2$

$D^+ \to \pi^+ K^0_S$ (0.0156 ± 0.0003) at $x_F > 0.2$

$c\tau \approx 3$ cm

Conclusions

- Resolution on $M_{\pi K}$ or $M_{2\pi K}$ is not sufficient to reduce flux of bg events
- Background for three-body decays $D^{\pm} \to K^{\mp} 2\pi^{\pm}$ is difficult to suppress only by kinematics. PID in barrel and end-caps is required.
- Two-body decays $D^0 \to \pi^+ K^-$ and $D^+ \to \pi^+ K^0_S$ are much cleaner. Background can be suppressed by Criteria on the CMS angle between the decay axis and momentum of D.
- Analysis of bg reduction for $D^{\pm} \to K^{\mp} 2\pi^{\pm}$ and $D^{\pm} \to (K^0_S)\pi^{\pm}$ is ongoing.