Criteria for selection of D-meson events by the online filter

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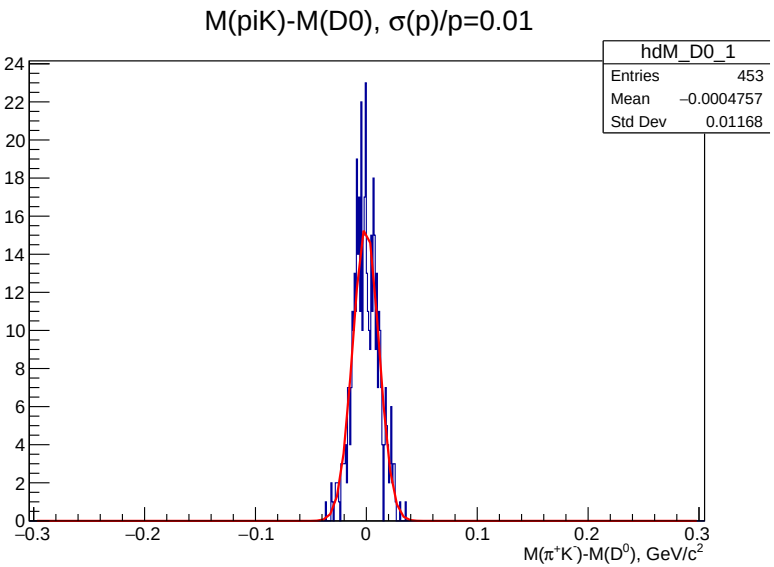
Minimum-bias events

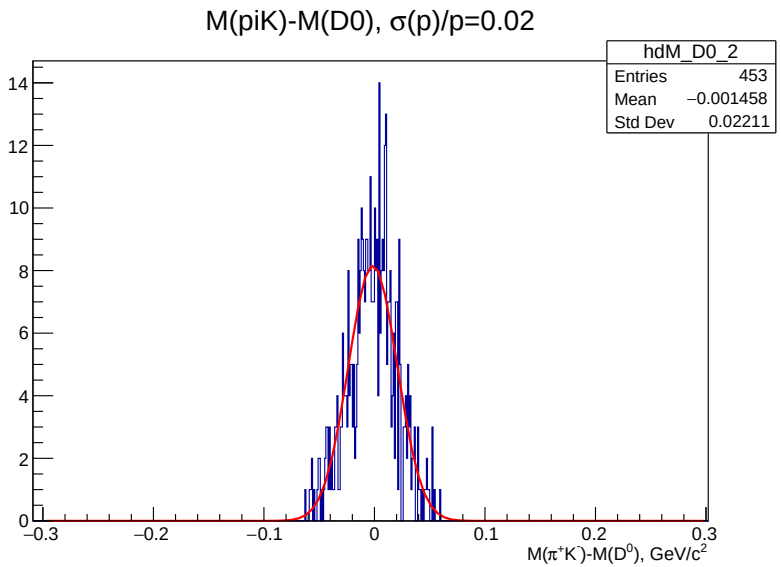
- pythia8.303 ($p + p$, $\sqrt{s} = 27$ GeV, SoftQCD=on)
- Channels of interest:

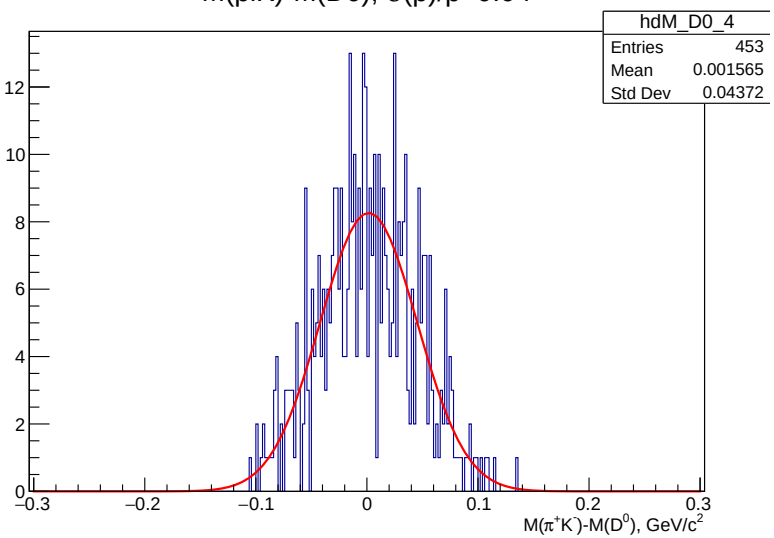
  $D^0 \to \pi^+ K^-$ (0.0395 ± 0.0003)

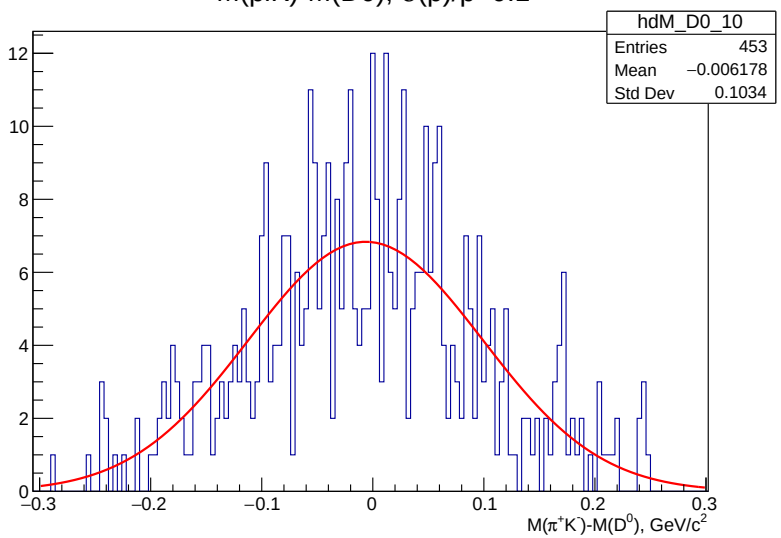
  $D^+ \to 2\pi^+ K^-$ (0.094 ± 0.002)
- D-meson events tagging:
  1. $D\bar{D}$-pairs
  2. $D^{*+} \to D^0 \pi^+$
  3. $\Lambda_c^+ \bar{D}$
- Charge multiplicities
- Study is focused on a data-reduction by the online-filter

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



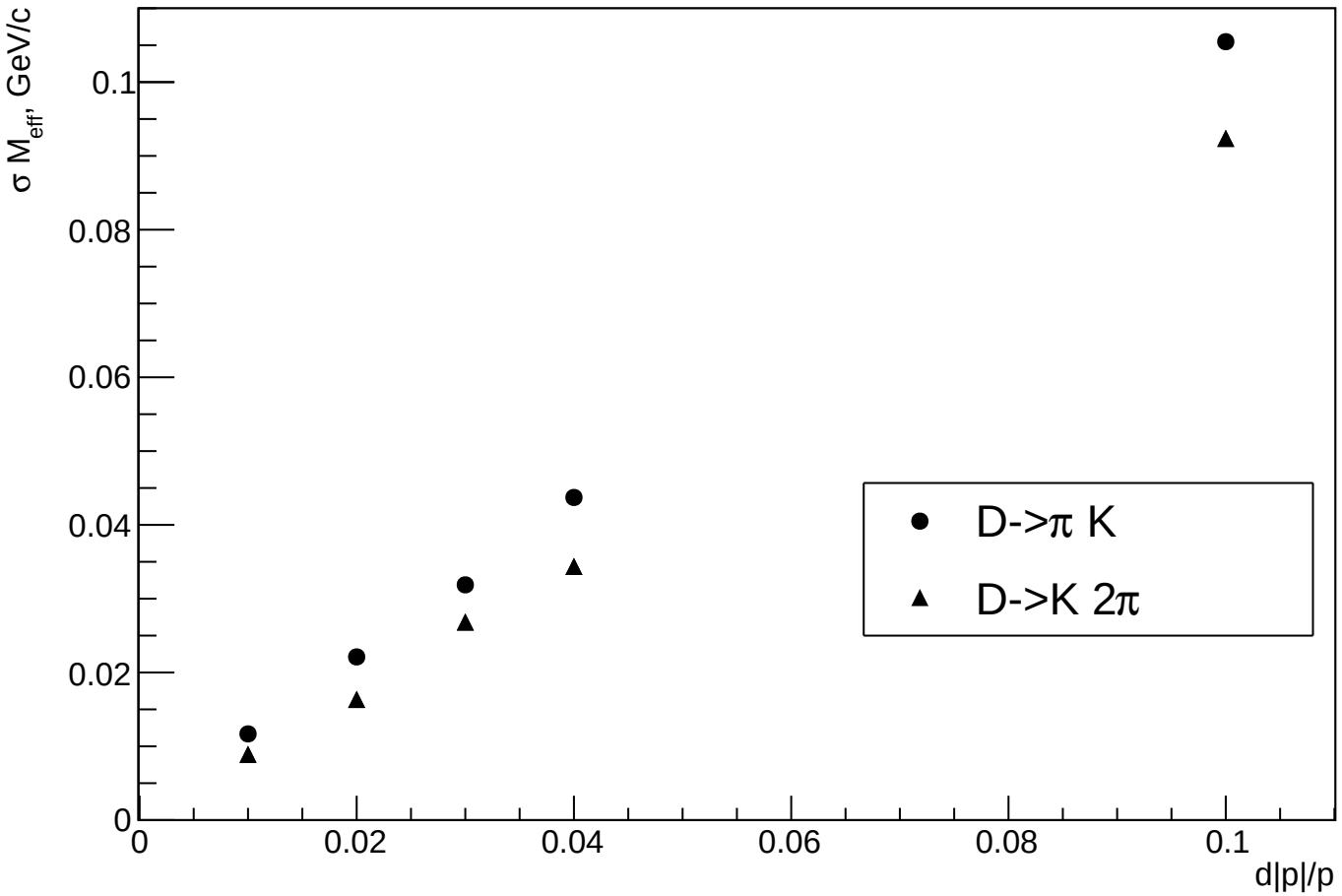






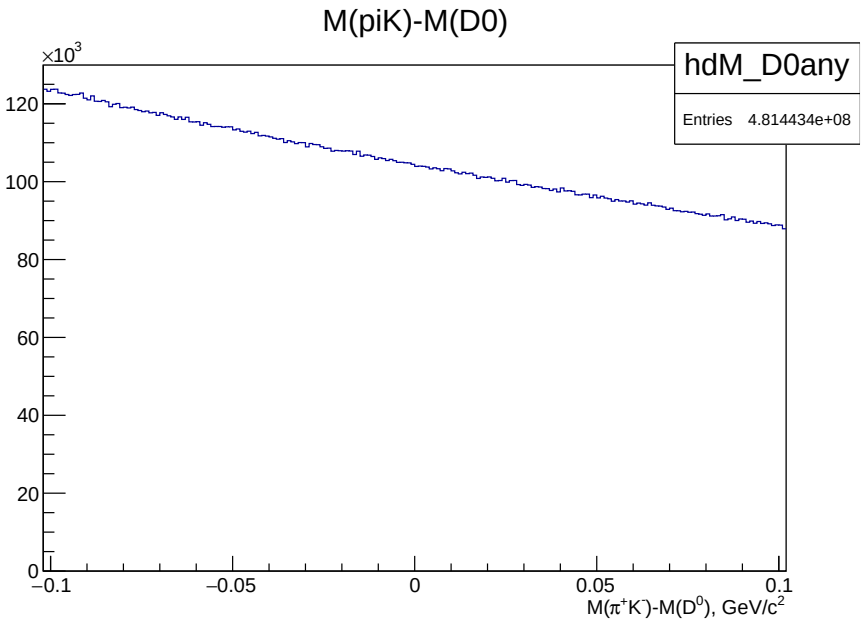
100M pp-interactions

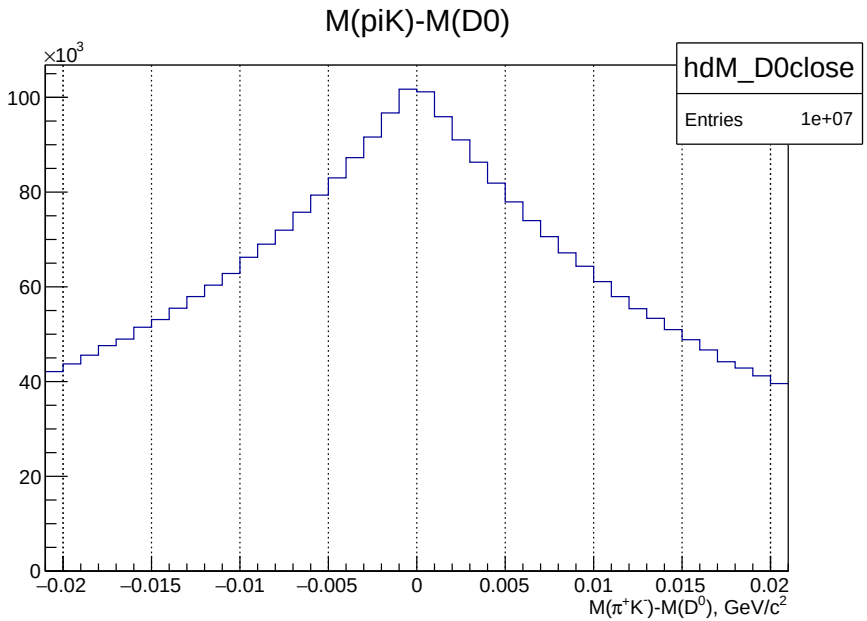
$D^0 \to K^-\pi^+$: resolution



$D^0 \to K^-\pi^+$: combinatorial background

Worst-case scenario: only pos/neg charges are distinguished:
Any x^+y^- are treated as π^+K^-
tracks selection: $p > 0.15$ GeV/c, $p_T/p > 0.1$



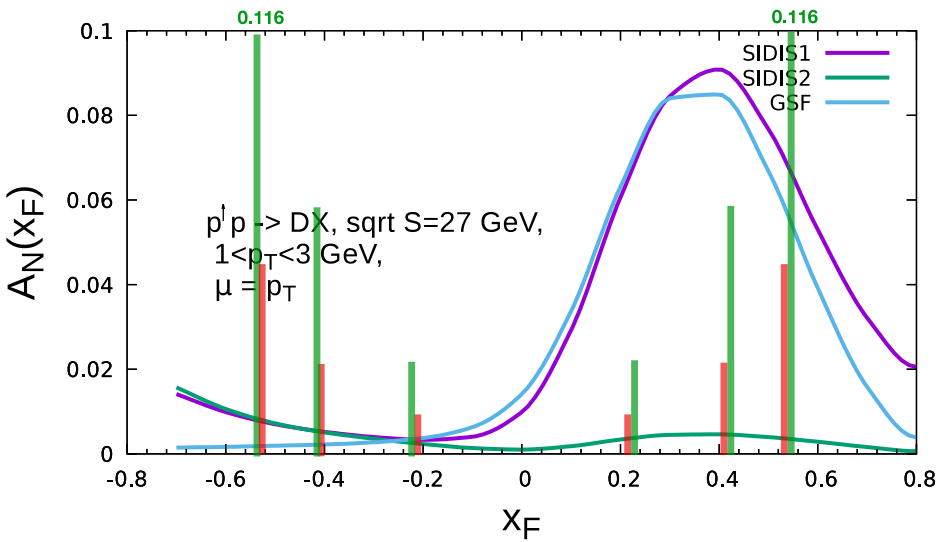


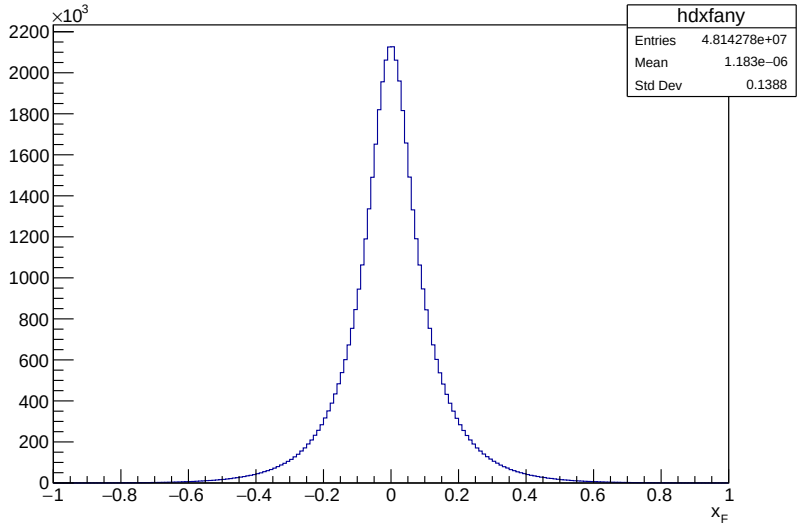
Probability of pos. trigger decision

$\Delta m(D^0 \to \pi K)$, MeV	$P(\pi^+K^-)$	$P(K^+\pi^-)$	$P(K\pi)$
< 10	0.09	0.10	0.16
< 40	0.27	0.28	0.39
< 100	0.44	0.45	0.52

10M pp-interactions

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





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

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

Events of interest: $x_F = \frac{p_z}{p_{z,\mathrm{max}}} > 0.2$
means $|p_z| > 2.5$ GeV/c

Probability of pos. trigger decision (Δm & $|x_F|$)

$\Delta m(D^0 \to \pi K)$, MeV	$\lvert x_F \rvert$	$P(\pi^+K^-)$	$P(K^+\pi^-)$	$P(K\pi)$
< 10	any	0.09	0.10	0.16
< 40	any	0.27	0.28	0.39
< 100	any	0.44	0.45	0.52
< 10	> 0.2	0.018	0.021	0.038
< 40	> 0.2	0.07	0.08	0.13
< 100	> 0.2	0.15	0.16	0.24

D-Event-tagging:

Channels of interest:

$D^0 \to \pi^+ K^-$ (0.0395 ± 0.0003)

$D^+ \to K^- 2\pi^+$ (0.094 ± 0.002)

- $pp \to D\bar{D}X$: complete reconstruction of D-mesons
- $D^{*+} \to D^0 \pi^+$ (0.677)

  D^{*+} width: 83.4 ± 1.8 keV
- $pp \to \Lambda_c^+ \bar{D} X$ with $\Lambda_c^+ \to p + X$ (≈ 0.5)

Rate of charmed events

Rate of charmed events per 1M pp-collisions at 27 GeV/c

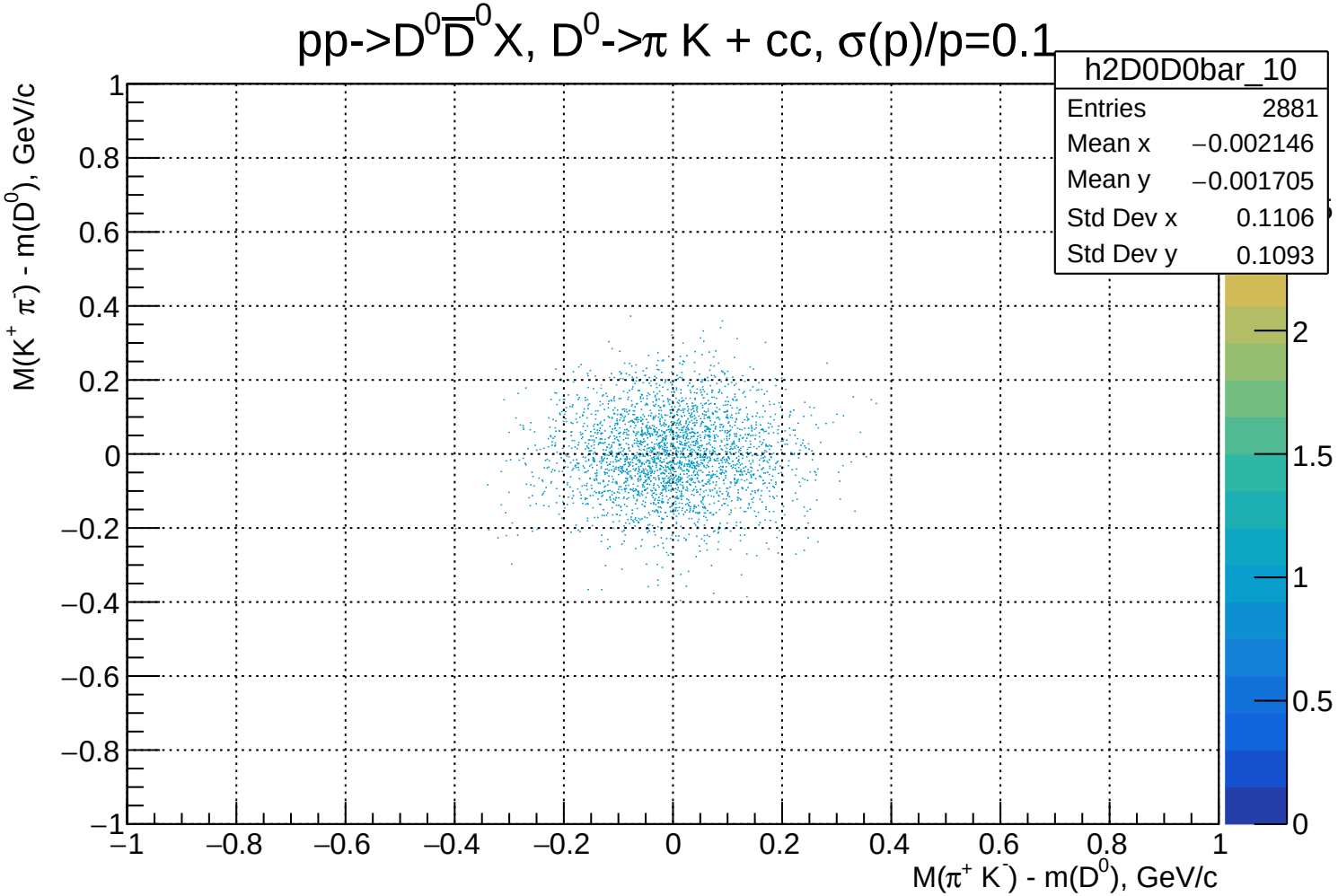
D^+X	24.0	$D^{*+}X$	16.7
D^-X	30.8	$D^{*-}X$	19.9
D^0X	48.5	$D^{*0}X$	16.2
$\bar{D}^0X$	59.2	$\bar{D}^{*0}X$	21.4
D_s^+X	7.2		
D_s^-X	10.4		
Λ_c^+X	22.7		
Λ_c^-X	2.5		

Associated D-meson production:

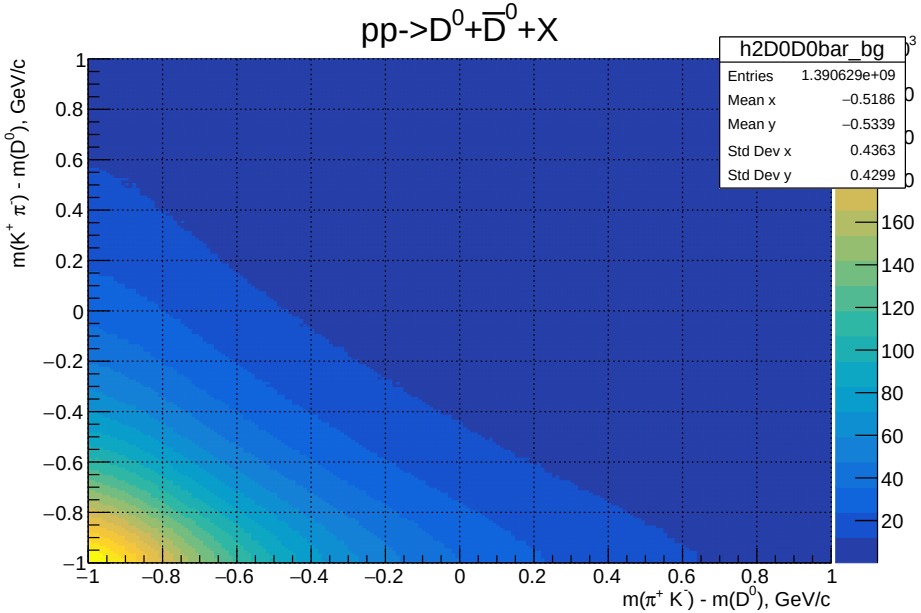
D^+D^-X	8.5		
$D^+\bar{D}^0X$	12.5		
D^0D^-X	14.3	$\Lambda_c^+D^-X$	5.8
$D^0\bar{D}^0X$	29.2	$\Lambda_c^+\bar{D}^0X$	12.6

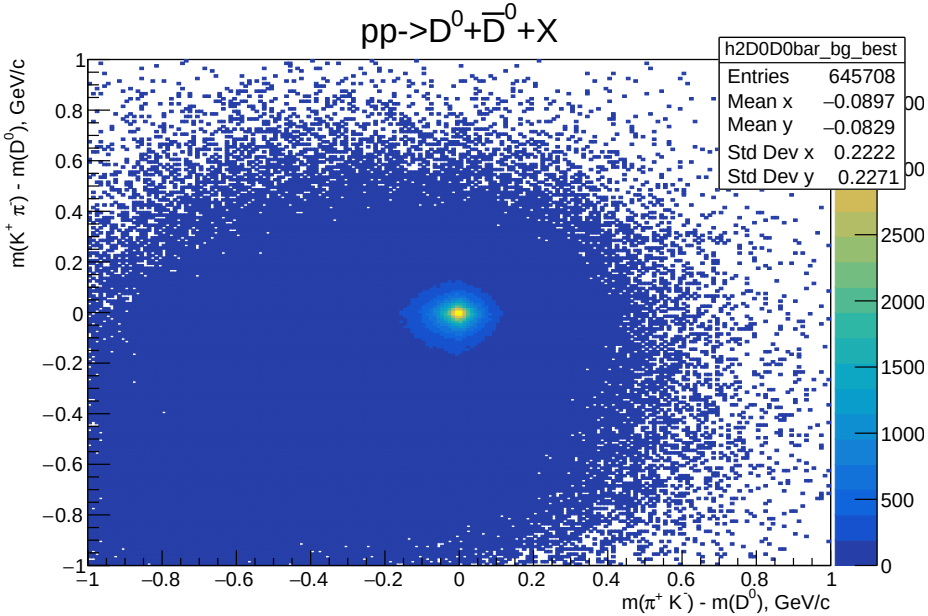
Note: expected rate of inelastic collisions 3 MHz

$pp \to D^0 \bar{D}^0 X$: true events



$pp \to D^0 \bar{D}^0 X$: combinatorial background

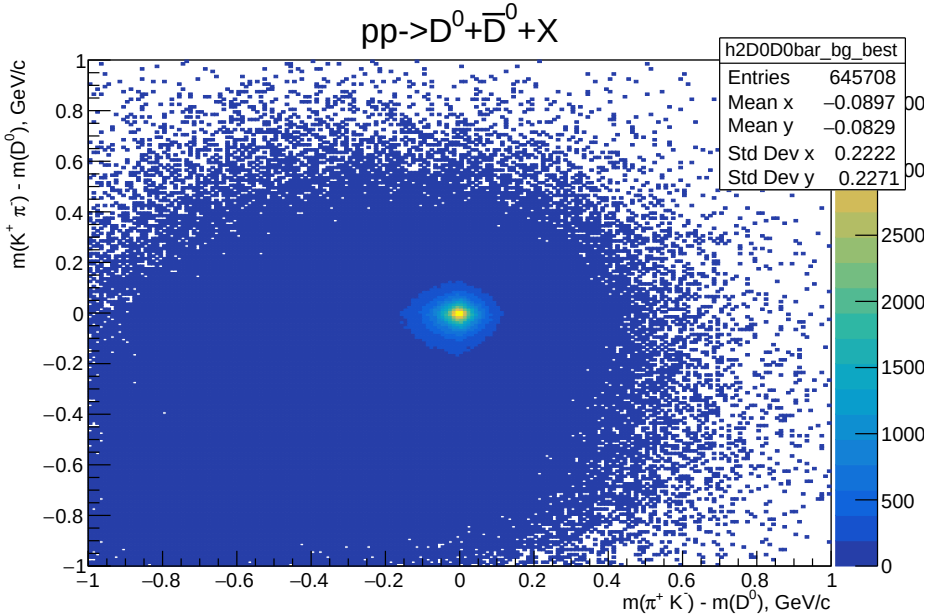




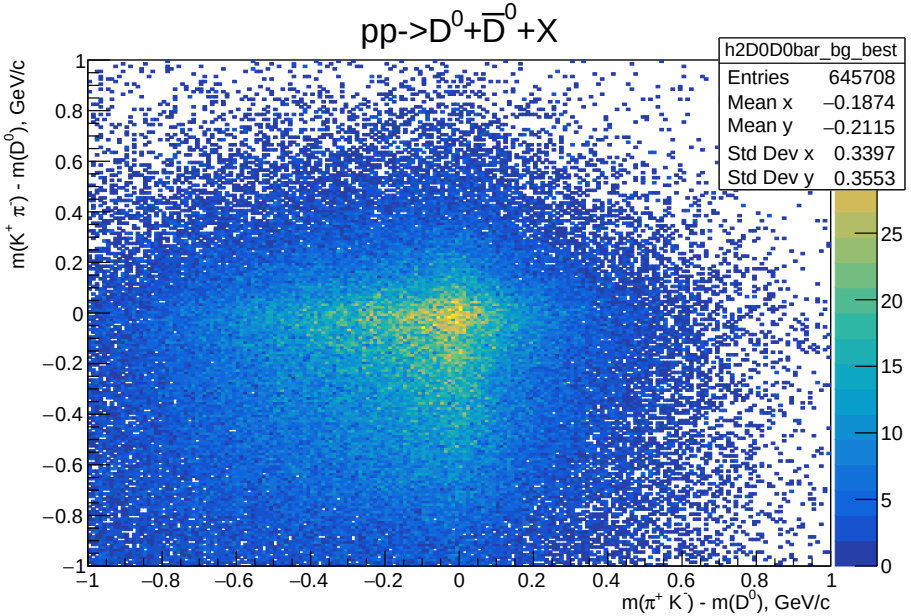
No PID, resolution $\frac{\sigma_p}{p} = 0.1 \quad \Rightarrow \quad 0.32$ — probability to find bg $(\pi^+ K^- \& \pi^- K^+)$

$pp \to D^0 \bar{D}^0 X$: combinatorial background

no PID



ideal PID



	$\frac{\sigma_p}{p} = 0.1$	$\frac{\sigma_p}{p} = 0.02$
no PID	0.32	0.05
ideal PID	0.01	0.0005

$pp \to D^0 \bar{D}^0 X$ (signal vs bg)

Use of $\bar{D}^0(D^0)$ coincidencies

- Signal

  $P(pp \to \bar{D}^0 X) = 6.0 \cdot 10^{-5}$

  $\frac{P(pp \to \bar{D}^0 D^0 X)}{P(pp \to \bar{D}^0 X)} = 0.5$

  $P(D^0 \to \pi^+ K^-) = 0.04$

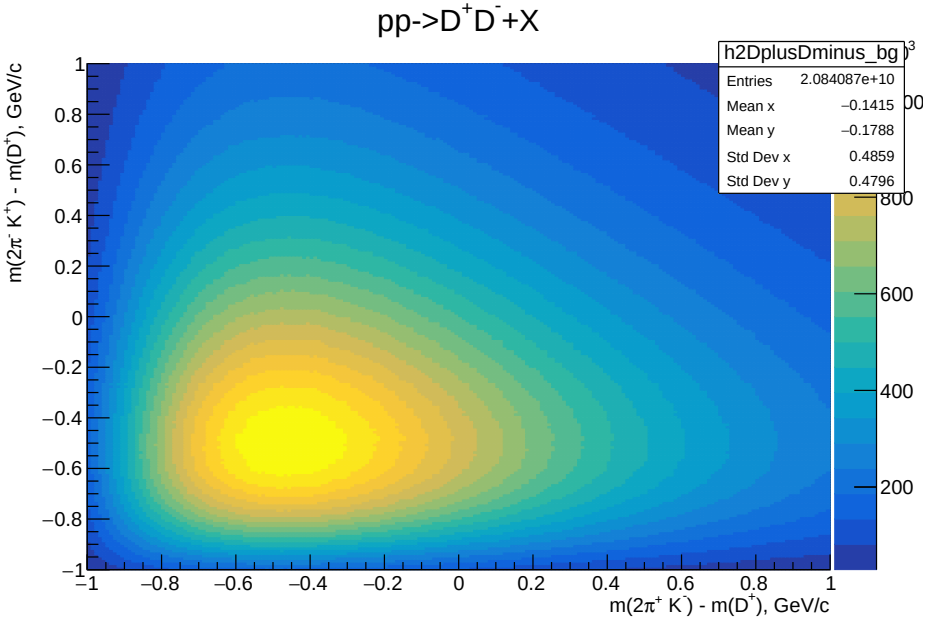
  Geometrical acceptance $pp \to \bar{D}^0 D^0 X$: 0.94

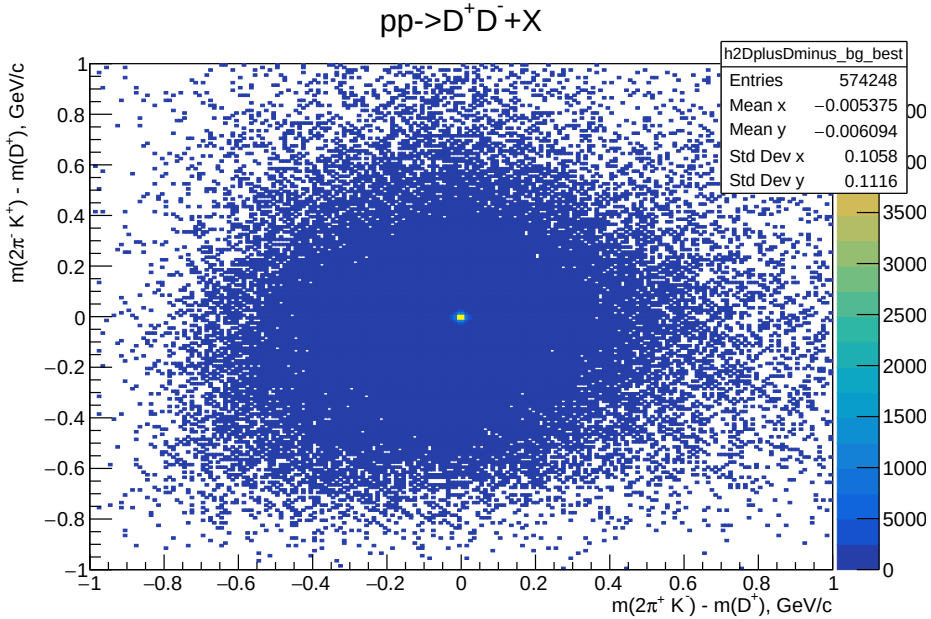
  Signal events' reduction factor is about 50.

- Background

$\frac{\sigma_p}{p}$	$P(\lvert m(h^+h^-) - m(D^0)\rvert < \Delta M)$	both comb.$< \Delta M$	reduction factor
0.1	0.52	0.32	1.6
0.01	0.17	0.018	9

$pp \to D^+D^-X$: combinatorial background





$pp \to D^+D^-X$ (signal vs bg)

Use of $D^-(D^+)$ coincidencies

- Signal

  $P(pp \to D^-X) = 3.1 \cdot 10^{-5}$

  $\frac{P(pp \to D+D^-X)}{P(pp \to D^-X)} = 0.3$

  $P(D^+ \to 2\pi^+K^-) = 0.094$

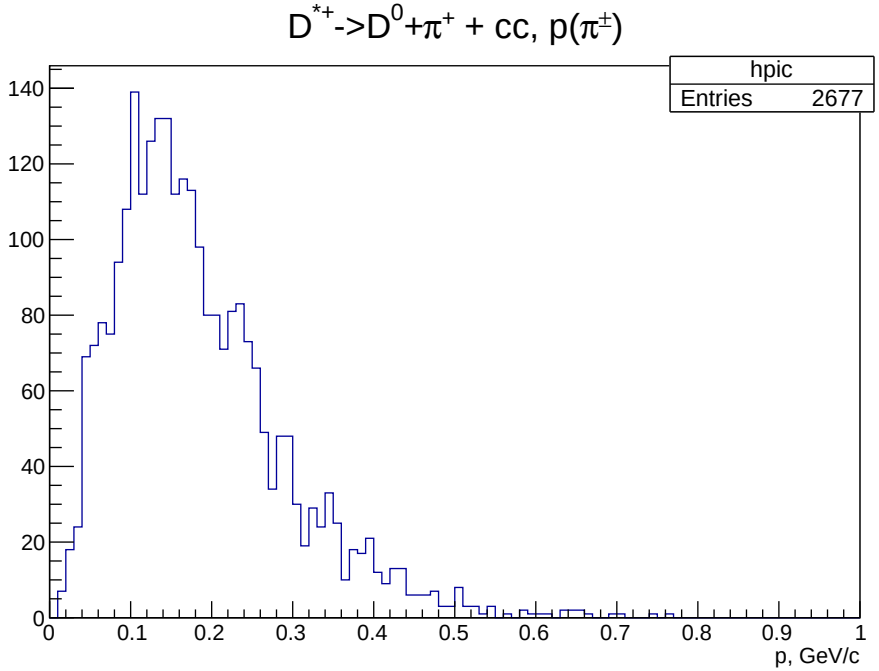
  Geometrical acceptance $pp \to D^+D^-X$: 0.92

  Signal events' reduction factor is about 30.

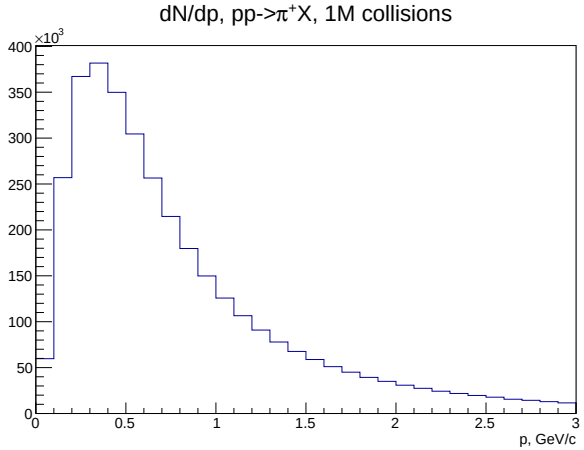
- Background

$\frac{\sigma_p}{p}$	both comb.$< \Delta M$
0.1	0.46
0.01	0.18

$D^* \to D + \pi^{\pm}$ chains



Spectra of bg π^+:



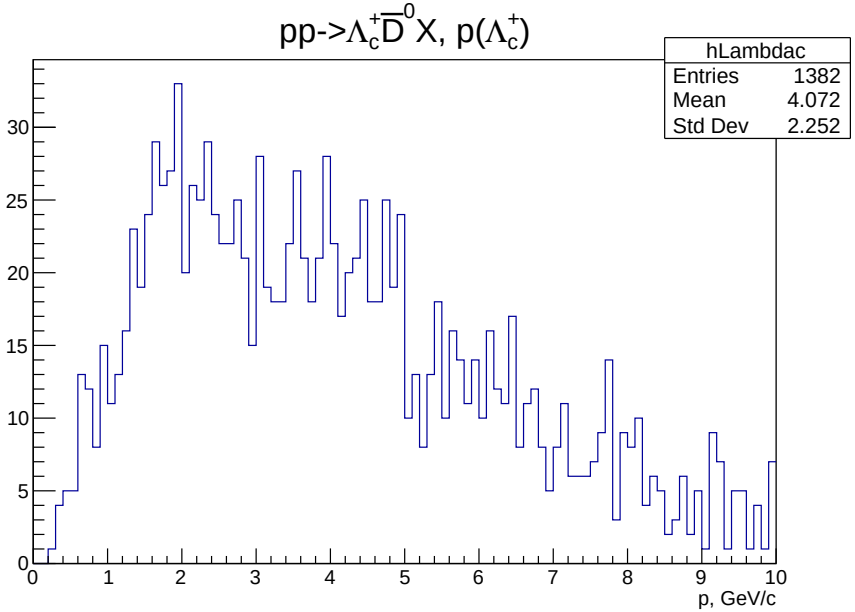
$D^{*+} \to D^0 + \pi^+$

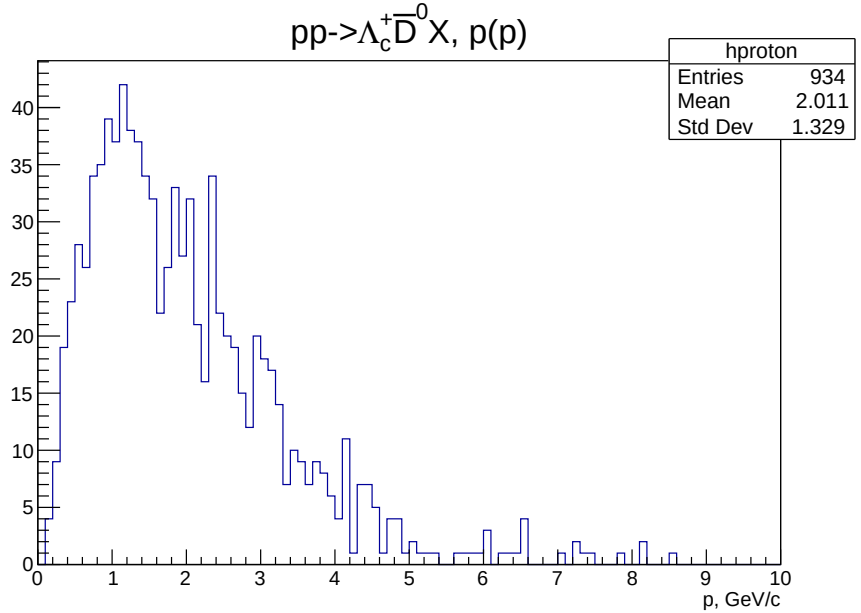
- D^* are abundant
- $\Gamma \sim 0.1$ MeV
- But outgoing charged pion is too soft

$D^{*0} \to D^0 + \pi^0 (\text{or } \gamma)$?

$pp \to \Lambda_c^+ \bar{D} X$ with $\Lambda_c^+ \to p + X$

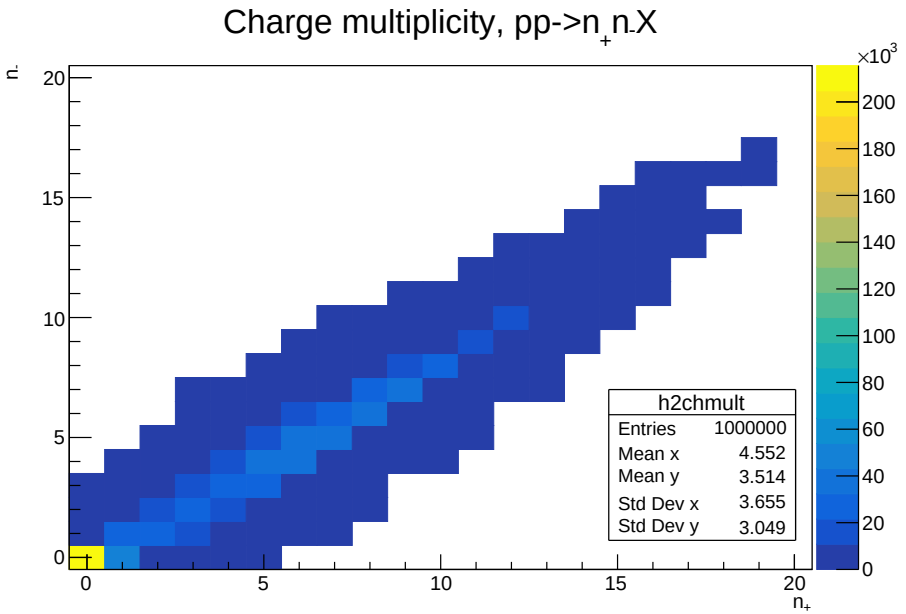
$pp \to \Lambda_c^+ \bar{D}^0 X$ with $\Lambda_c^+ \to p + X$ (≈ 0.5)

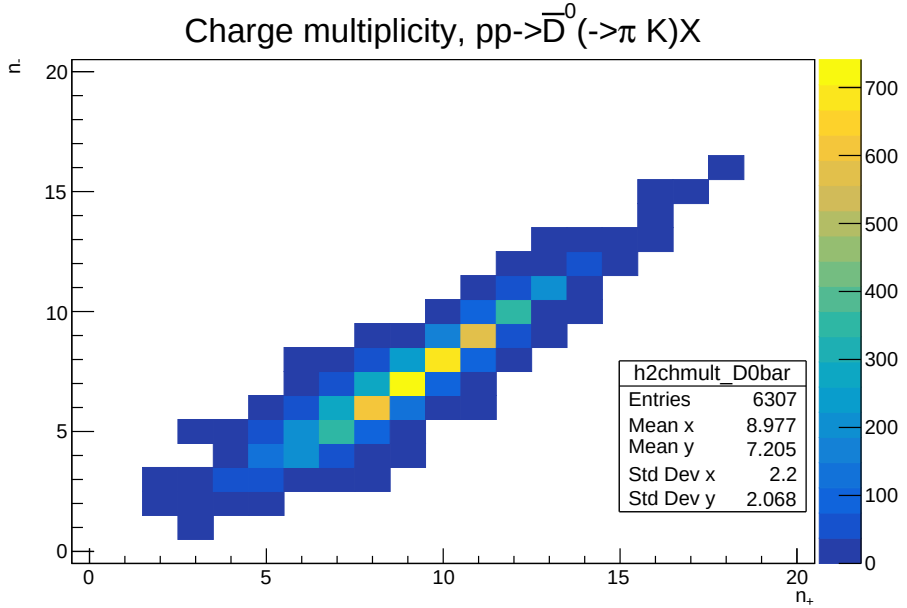


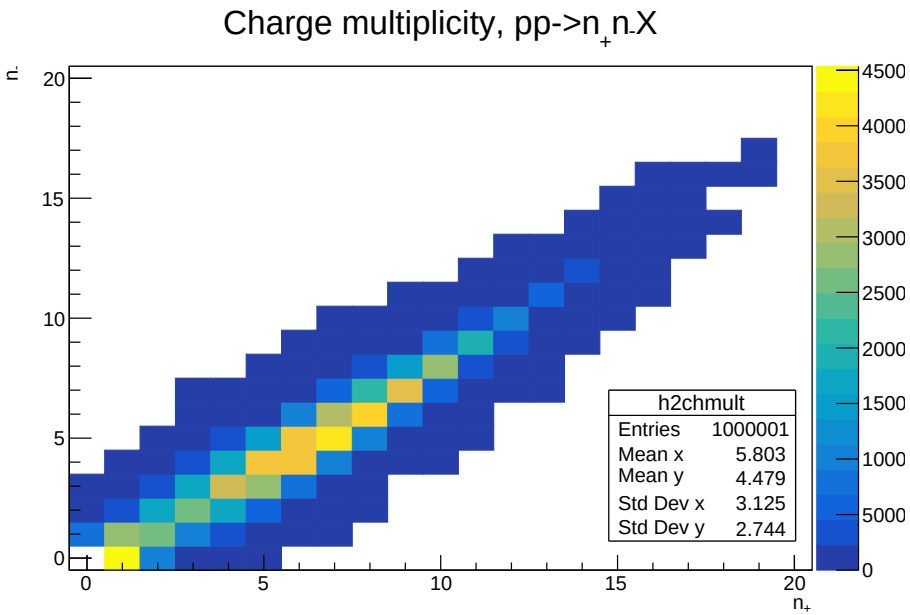


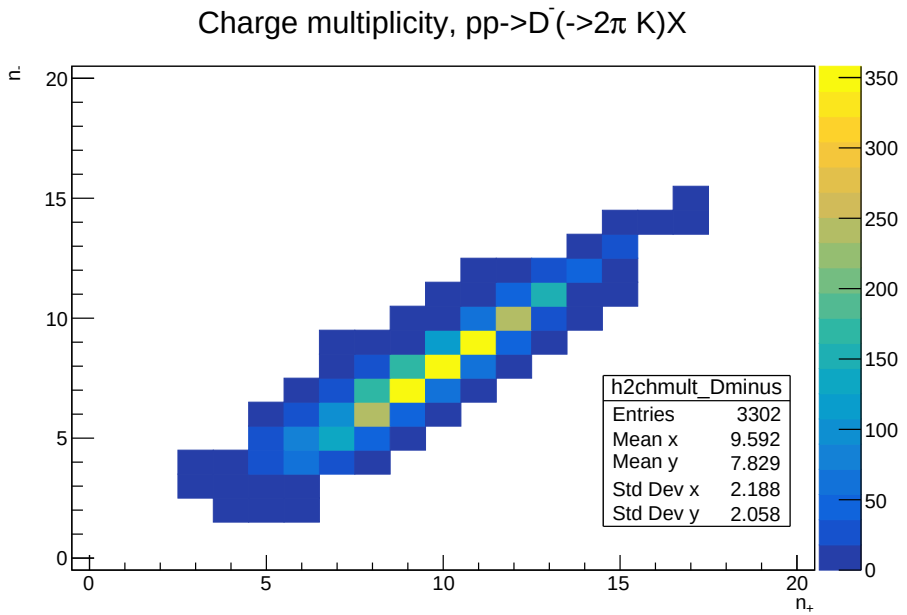
Λ_c^+ are concentrated to the beam axis

Charged tracks (charge multiplicities)



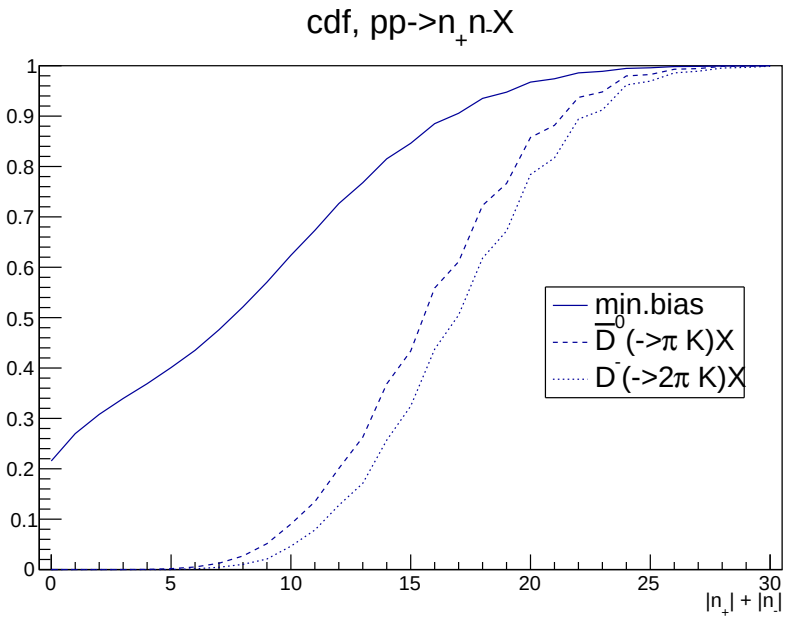


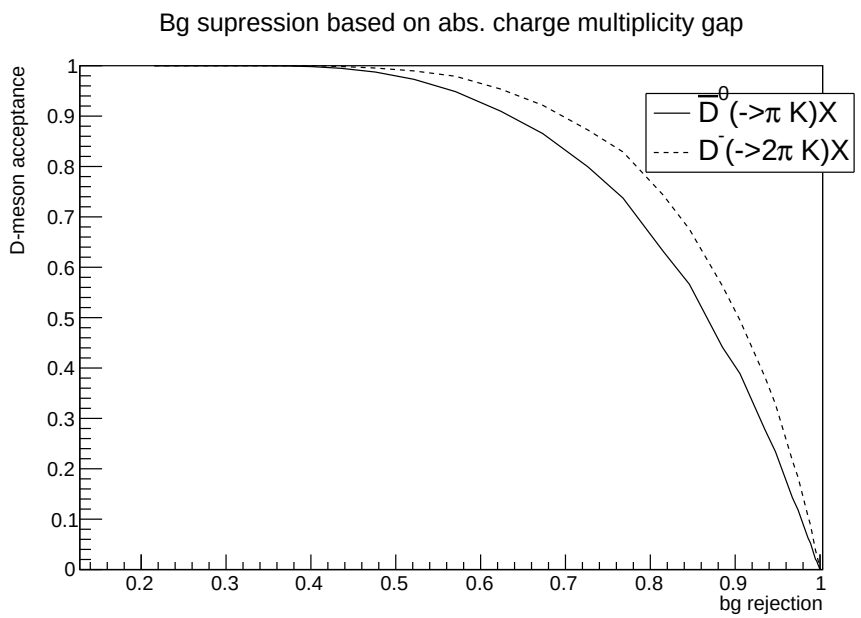




Charge multiplicities

$$n_{\mathrm{ch}} = |n_+| + |n_-|$$





Note: in min.bias no charged tracks within acceptance = 0.22 of events

Bg suppression by factor (3 . . . 4) while keeping (0.9 . . . 0.8) of D-meson events

Conclusions

- D-meson events tagging:

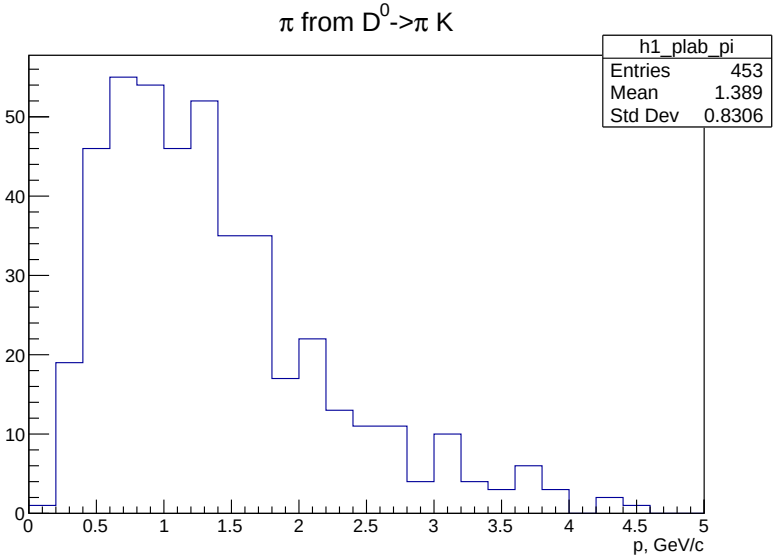
  doesn't seem promising within the online-filter

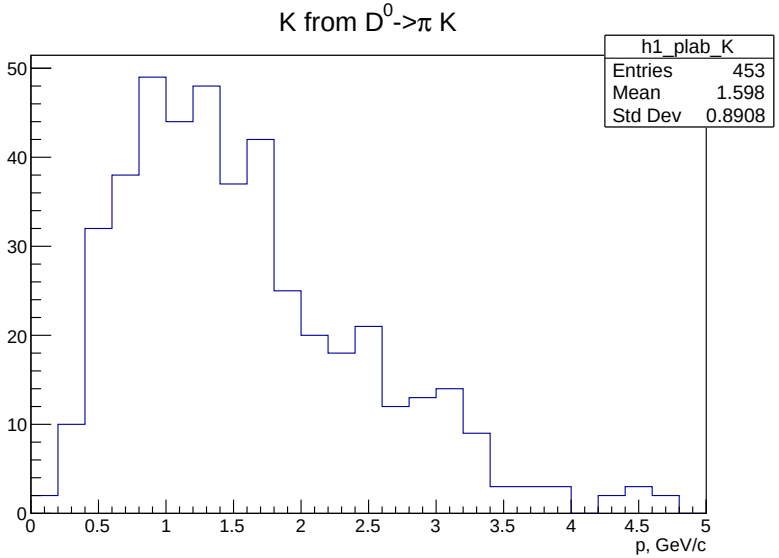
- Criteria on charge multiplicity ($|n_+| + |n_-|$) suppresses combinatorial background by factor 3 or 4 while keeping most of signal events

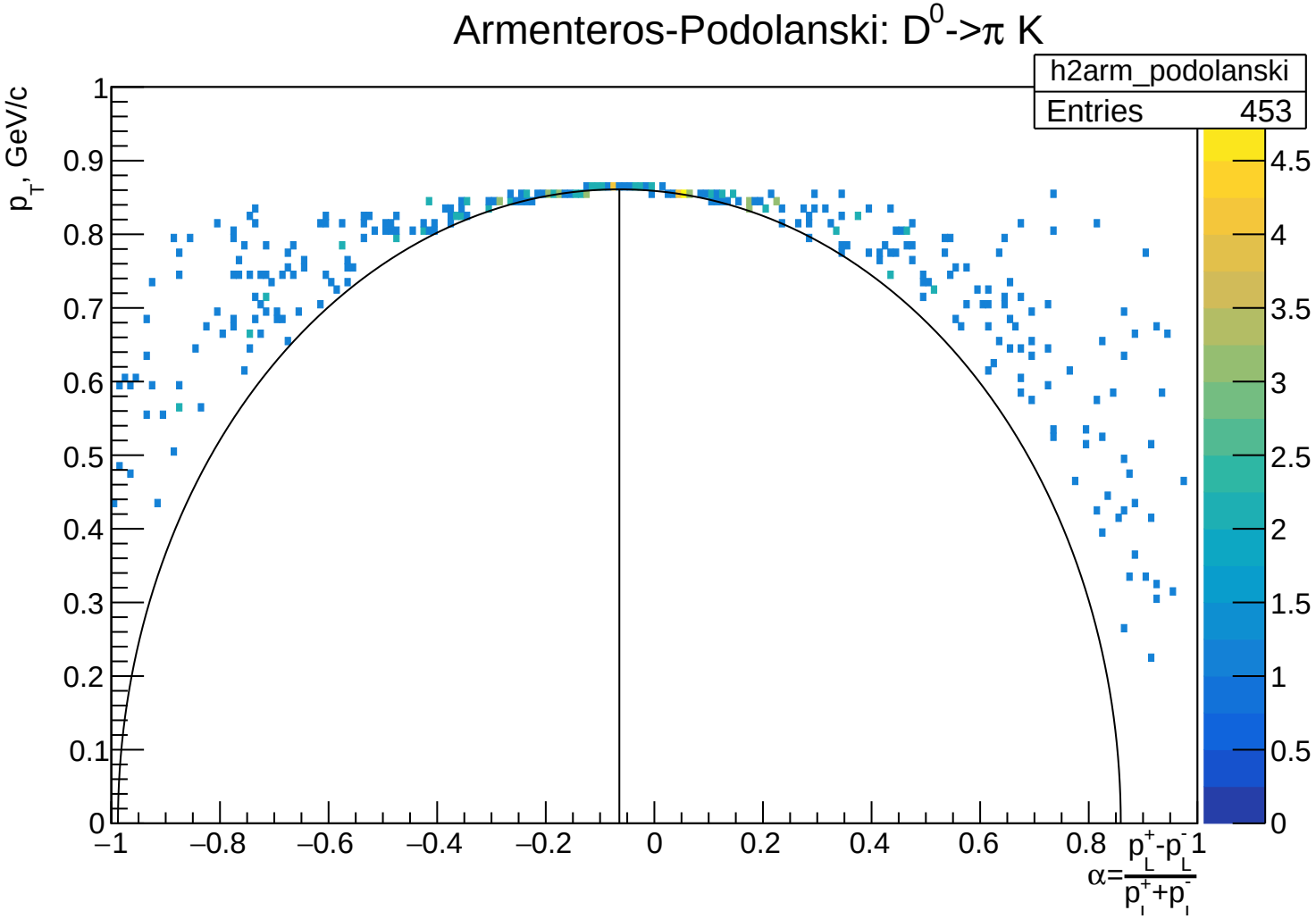
- Selection of high x_F events (e.g. $x_F > 0.2$) reduces rate of input events

- Particle identification (π/K)?

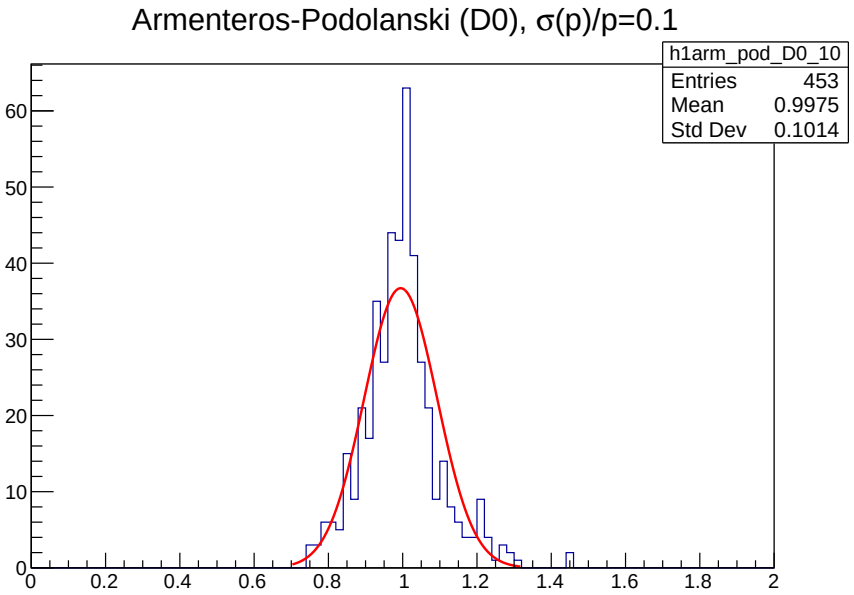
$D^0 \to \pi K$: π/K spectra

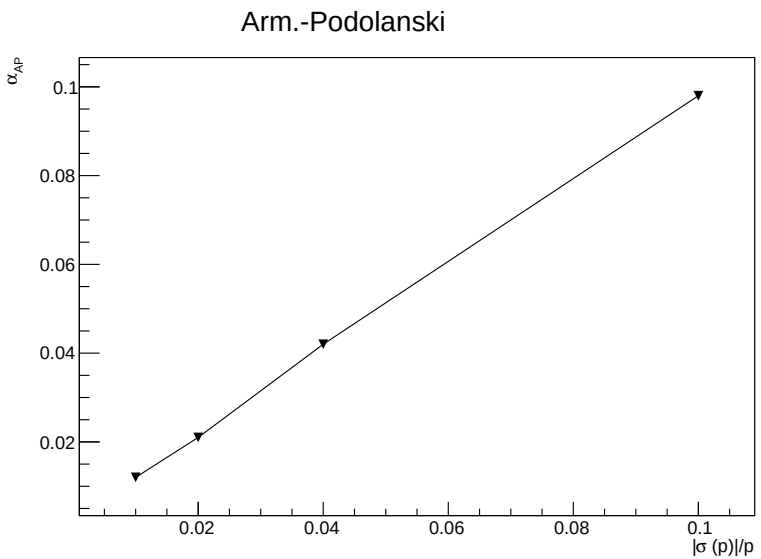




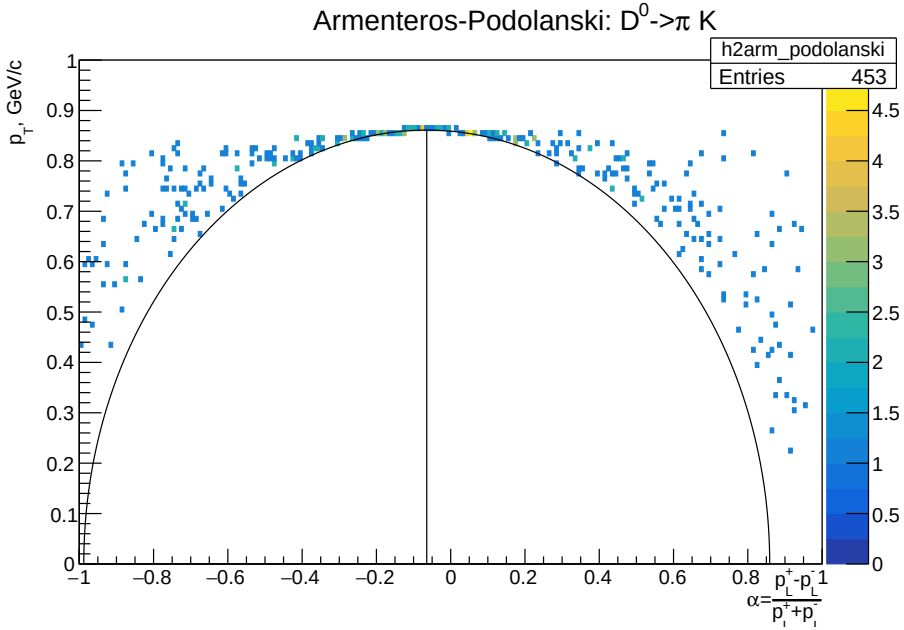

Armenteros-Podolanski: D0->π K
h2arm_podolanski
Entries 453
pT, GeV/c
α=(pL+-pL-)/(pl+-pl-)

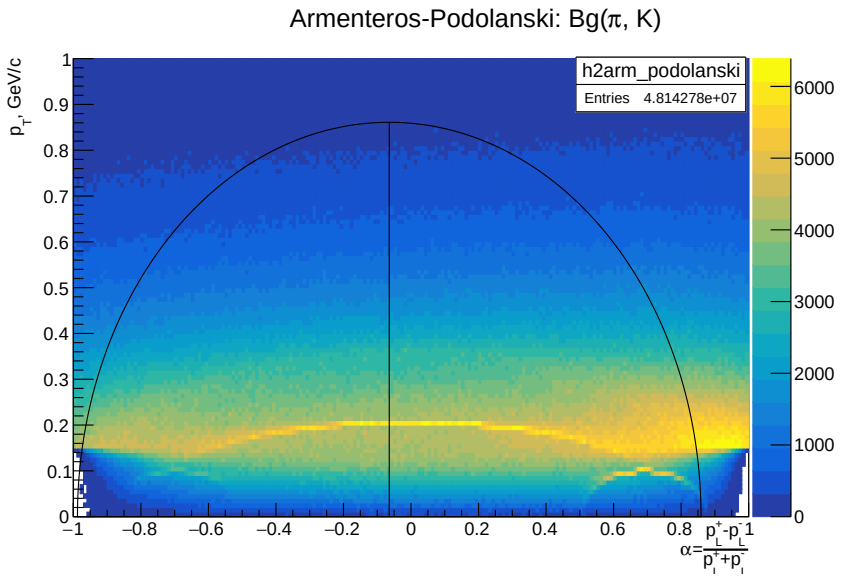
$D^0 \to \pi K$


Armenteros-Podolanski (D0), σ(p)/p=0.1
h1arm_pod_D0_10
Entries 453
Mean 0.9975
Std Dev 0.1014
0 10 20 30 40 50 60
0 0.2 0.4 0.6 0.8 1 1.2 1.4 1.6 1.8 2


Arm.-Podolanski
α_{AP}
0.02 0.04 0.06 0.08 0.1
0.02 0.04 0.06 0.08 0.1
|σ (p)|/p

$D^0 \to \pi K$


Armenteros-Podolanski: D0->π K
h2arm_podolanski
Entries 453
pT, GeV/c
α=(pL+-pL-)/(pl+pl-)


Armenteros-Podolanski: Bg(π, K)
h2arm_podolanski
Entries 4.814278e+07
pT, GeV/c
α=(pL+-pL-)/(pl+pl-)