$D\bar{D}$ benchmark channels

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Outline

Overview

Motivation - (not a complete list)

- D reconstruction ability cruicial for many aspects of the physics program:
  - charmonium above $D\bar{D}$ threshold
  - open charm spectroscopy
  - charm in medium
  - $D\bar{D}$ mixing, ...
- good performance test for the detector setup - focus on tracking
- only 'charged' decays chosen

- of resonant production using Breit-Wigner approach

$$\sigma_R(s) = \frac{4\pi\hbar^2c^2}{s-2m_p^2c^4}\frac{B_{in}B_{out}}{1+\left(2(\sqrt{s}-M_Rc^2)/\Gamma_R\right)^2}$$

- cross section ratio signal/background in case of resonant production: $\approx 10^{-10}$
- proper cross section estimation for nonresonant production?
- therefore at least 10^7 background events, more if possible, DPM background generator
- other background sources?

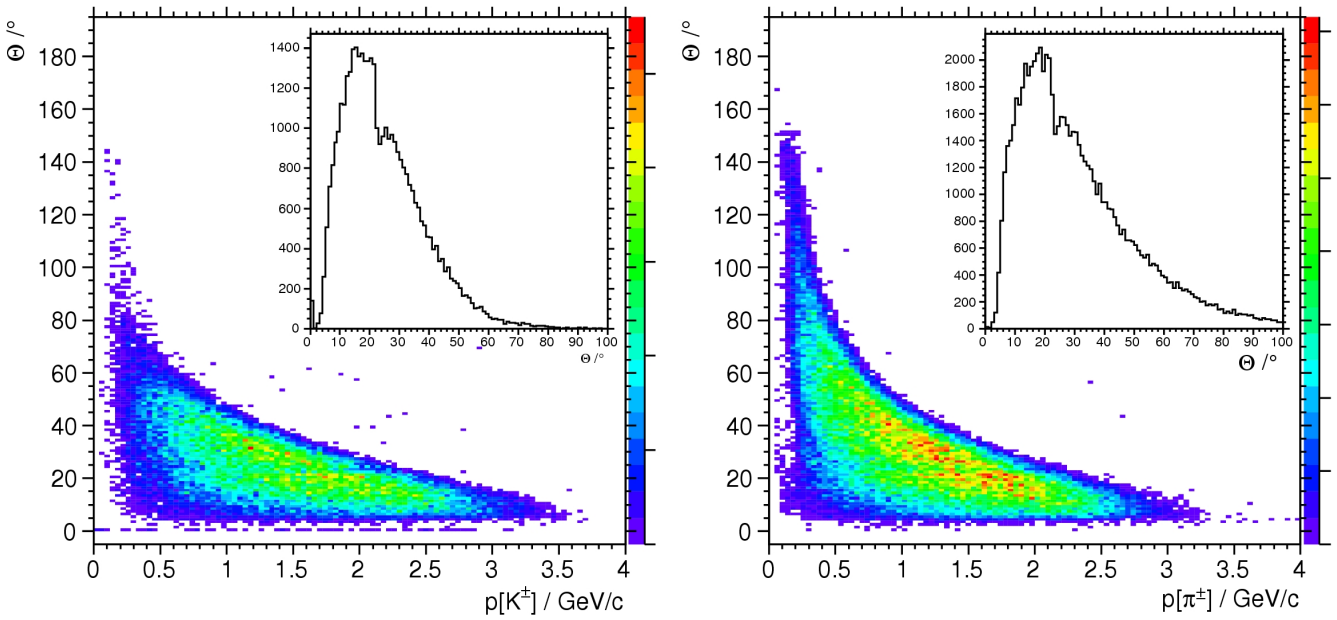
Overview

Overview about $\bar{p}p \longrightarrow D^+D^-$

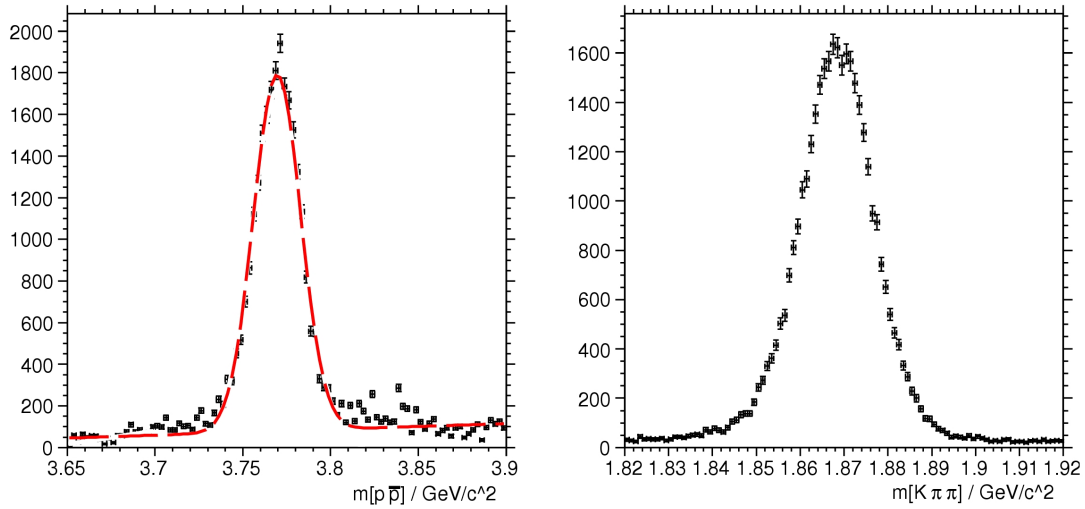
- only charged decay considered $D^+ \to K^-\pi^+\pi^+$ (+cc., BR:9.51 ± 0.34)
- non resonant production at $\sqrt{s} = 3.77 GeV$

selection criteria

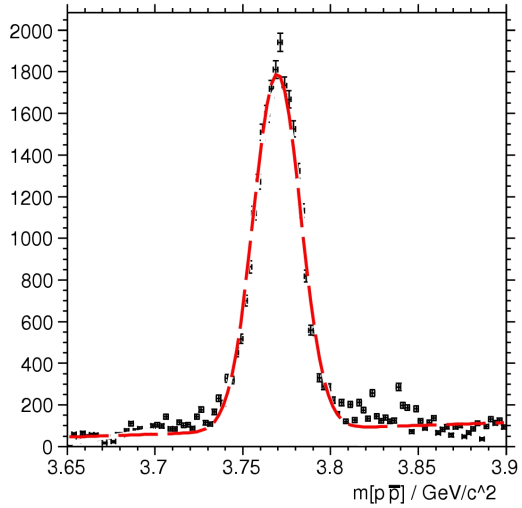
- loose mass window cut before vertex fitting ($m_D = 1.7 \ldots 2.1 GeV/c^2$)
- exactly 6 charged tracks
- using PID information to distinguish between K/π
- constraints: decay particles have to form a common vertex

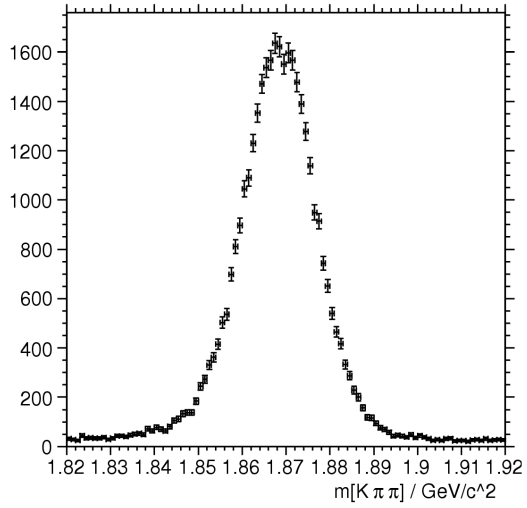


- using PID to distinguish between $K^{\pm}$, $\pi^{\pm}$ (not only tracking)
- both distributions show low momentum component → challenging for tracking in TS



- resolution of the initial system $\sigma = 13.55 MeV/c^2$
- compare reconstructed mass of the $D^{\pm}$ with the PDG mass ($1.8693 \pm 0.0004 GeV/c^2$)





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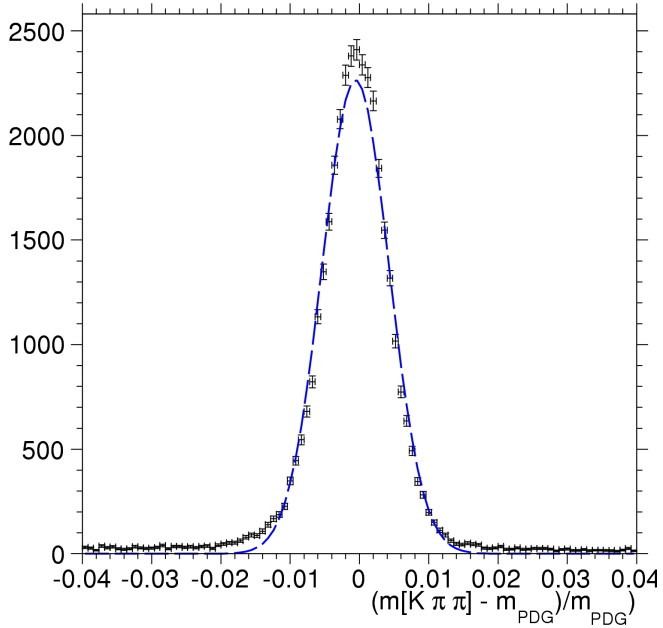
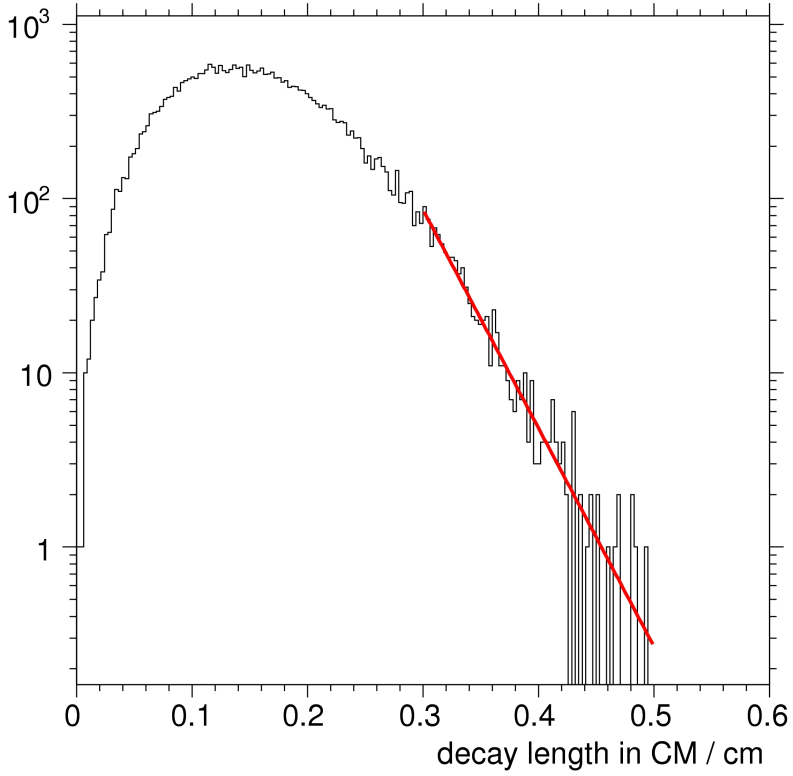
- fit of the signal: $m_{D^\pm} = 1.8683 \pm 5.3 \times 10^{-5} GeV/c^2$
- resolution of the $D^\pm$ mass candidates $\sigma = 4.7 \times 10^{-3}$
- used sample of 5×10^4 events $\to$ over 27000 $D^\pm$'s reconstructed: $\epsilon \approx 27.2\%$



Lifetime estimation

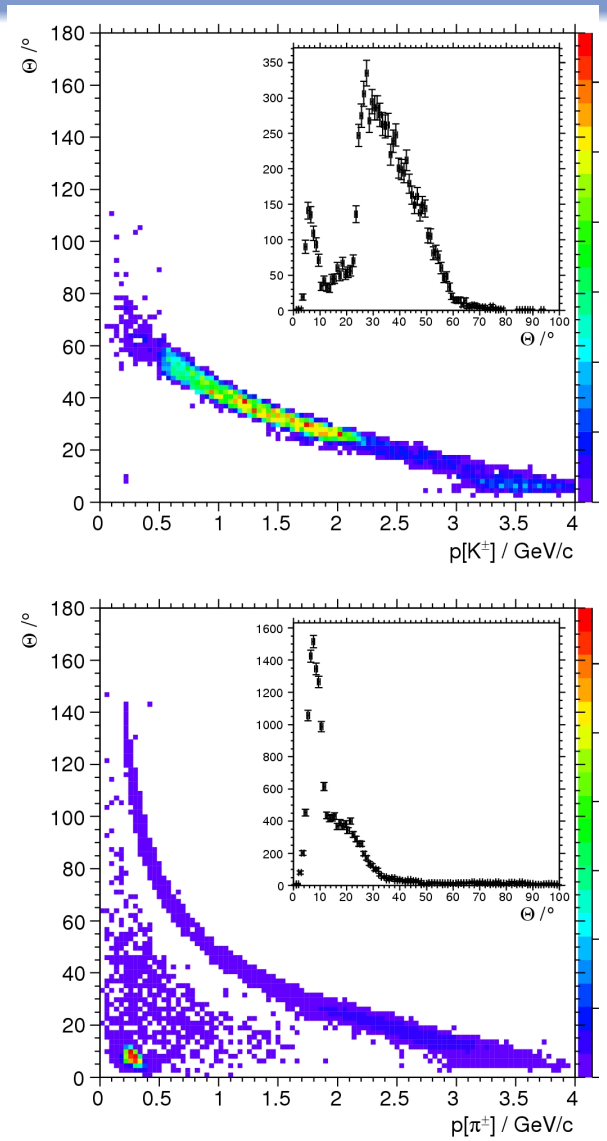
- using reconstructed decay vertex of the $D^{\pm}$
- no handle on IP so far - extended region of beam/target interaction $\rightarrow$ cross section of beam in order of mm
- using arbitrary IP (0,0,0) and fitting just the long living part of distribution
- transform in rest frame of the D to calculate 'decay length' $\rightarrow$ 346.6 μm (PDG: $c\tau = 311.8\mu m$)



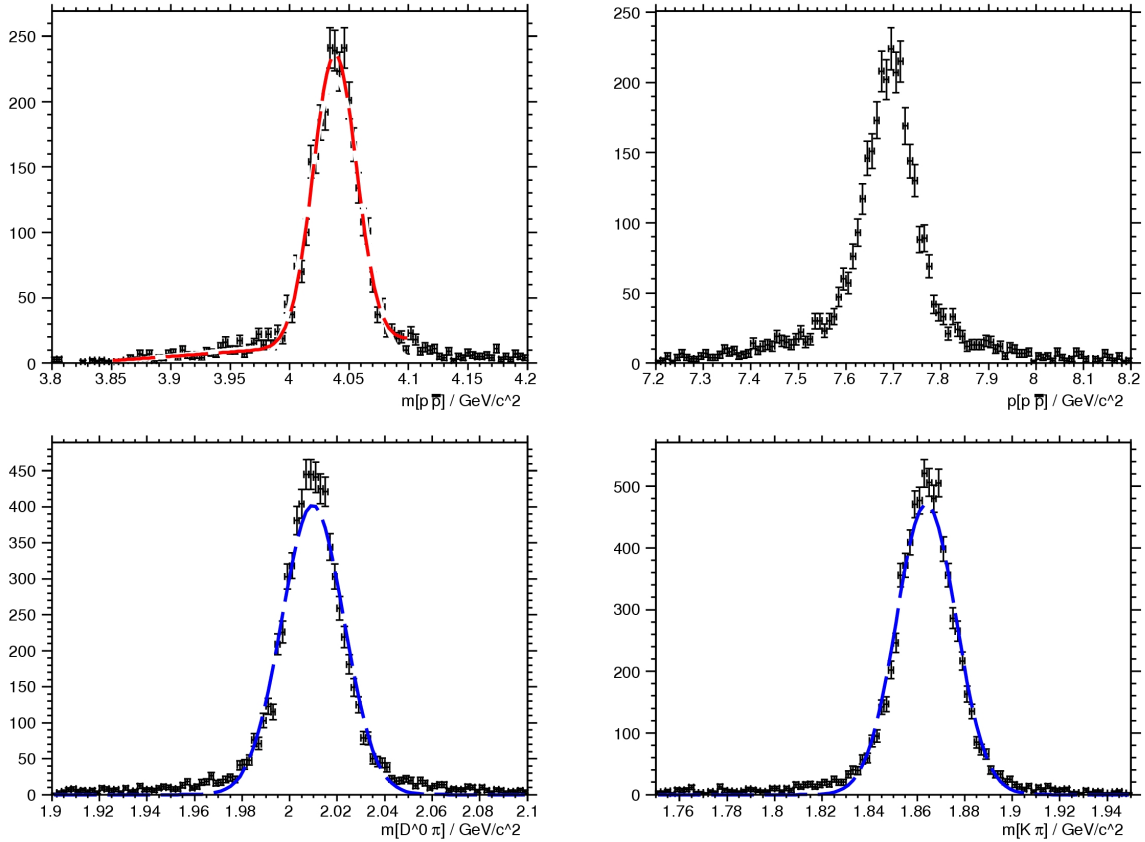
Overview

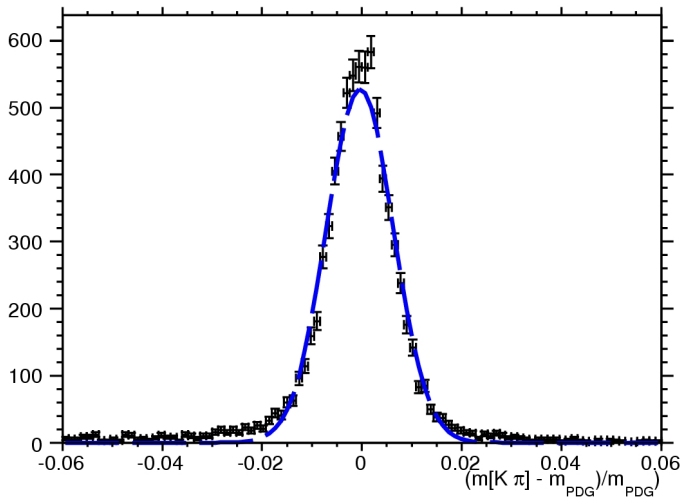
$\bar{p}p \longrightarrow D^{*+}D^{*-}$

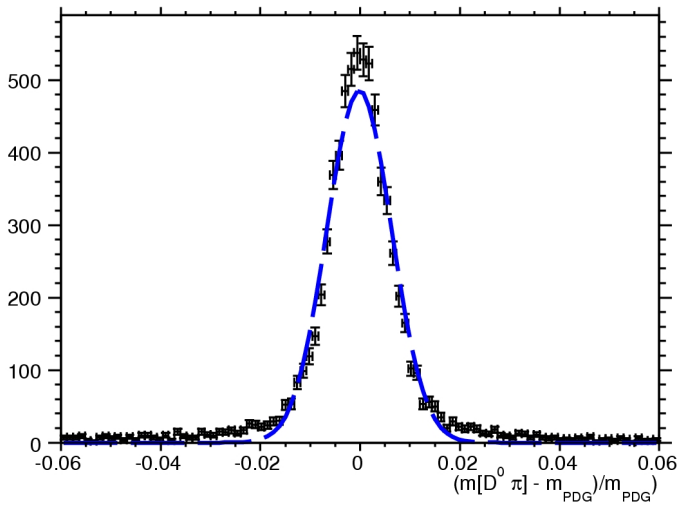
- reconstruction of whole decay tree
- $D^{*+} \longrightarrow D^{0}\pi^{+}$, $D^{0} \longrightarrow K^{-}\pi^{+}$
- only charged decay considered $\longrightarrow$ 6 charged tracks in event
- non resonant production at $\sqrt{s} = 4.04 GeV$
- slow pion from D^{*+} decay, D's carring half of the beam momentum



- initial system: mass: $\sigma = 18.2 MeV/c^2$
- $D^{*\pm}$ mass candidates at $m = 2.00974 \pm 0.00016 GeV/c^2$ [PDG mass: $m = 2.01 \pm 0.00004 GeV/c^2$]
- D^0 mass candidates at $m = 1.86381 \pm 0.00015 GeV/c^2$ [PDG mass: $m = 1.8645 \pm 0.00004 GeV/c^2$]







- comparing the reconstructed candidate masses with nominal PDG masses:
  $D^0 : \sigma = 6.72 \times 10^{-3}$
  $D^{*\pm} : \sigma = 6.50 \times 10^{-3}$
- efficiencies: used sample of 5×10^4 events
  $D^0 : \approx 7500$ candidates found $\to 7.5\%$
  $D^{*\pm}$: 6775 candidates found $\to \approx 6.8\%$

- DPM background events produced so far: $\approx 5 \times 10^5$

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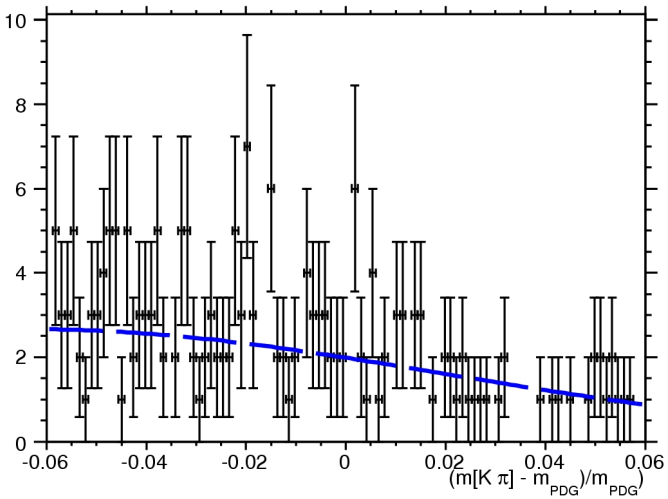
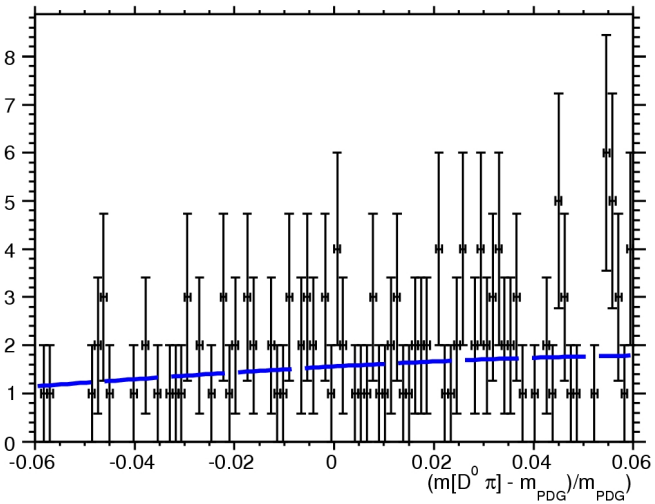
- using same selection criteria $\longrightarrow$ background remains in signal window
- without any aditional cuts: D^0 candidates: 71 events, $D^{*\pm}$: 54 events, where the signal should appear





- momentum vs. polar angle of $\pi^{\pm}$ shows separated band comming from the D^0 decay

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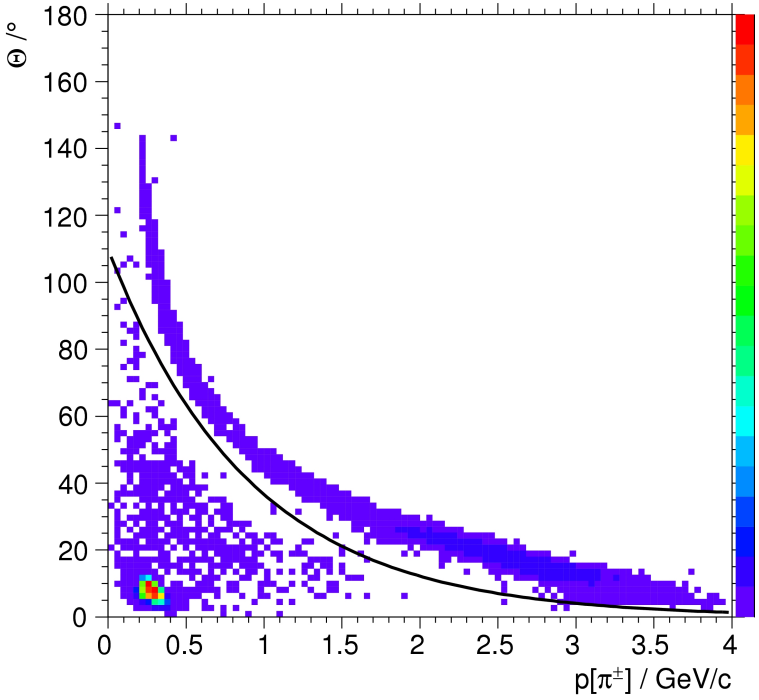
- use a simple function to reject slow pions under small angles
- keeps the D^0 signal



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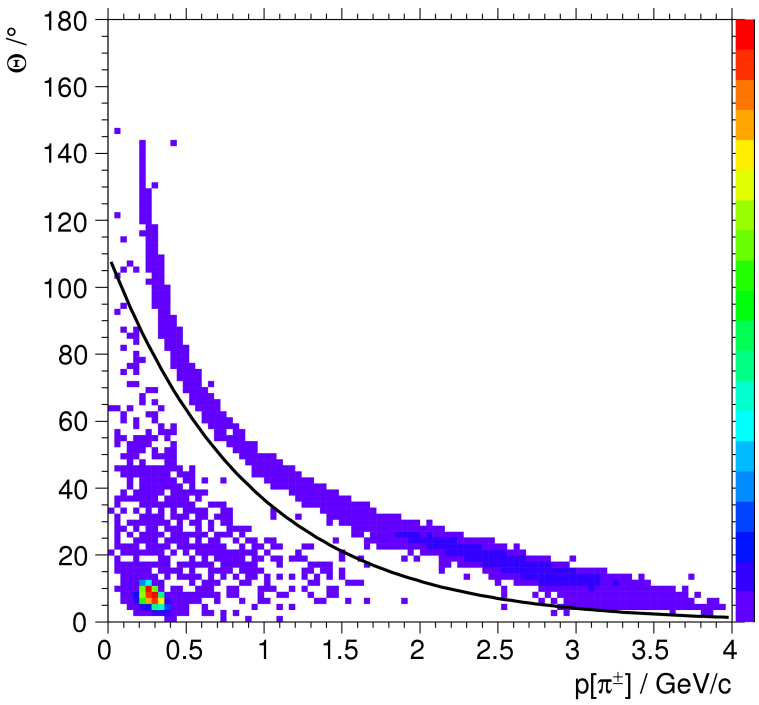
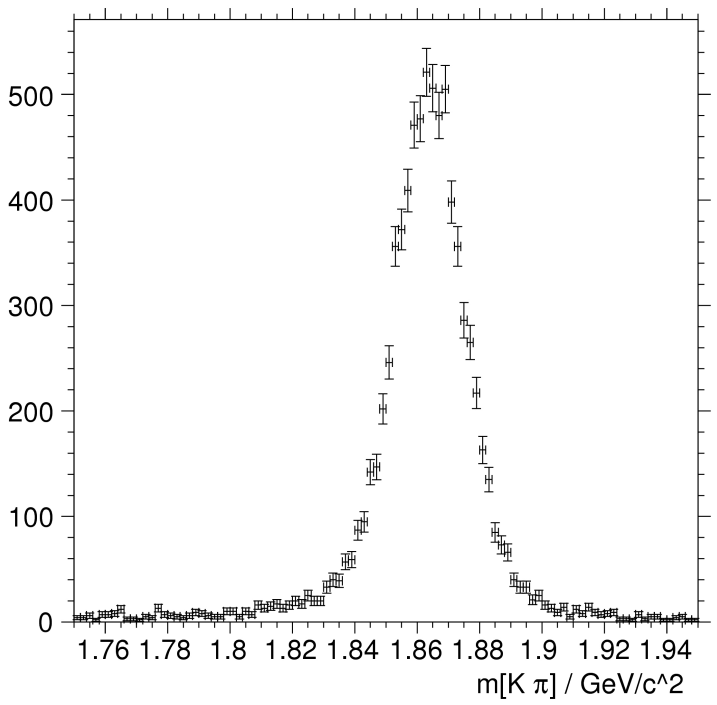
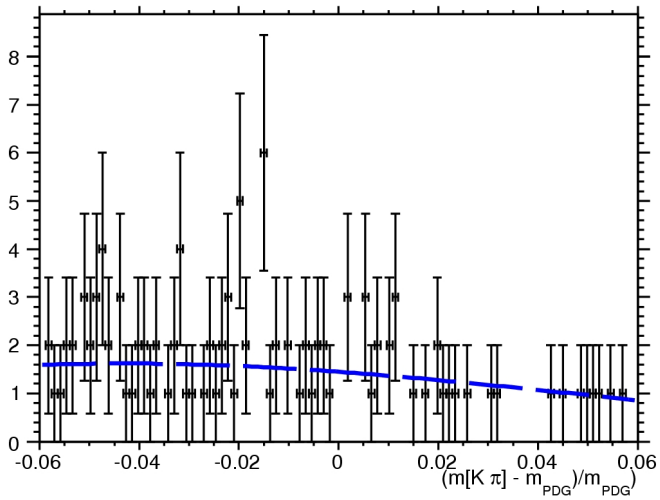
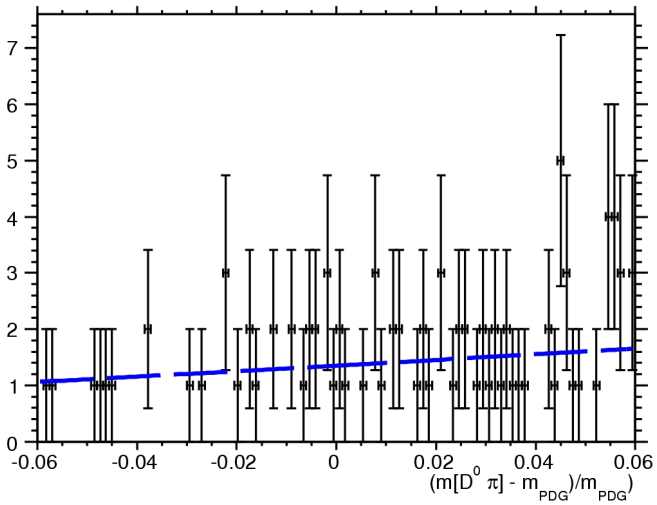




- momentum vs. polar angle of $\pi^{\pm}$ shows separated band comming from the D^0 decay
- use a simple function to reject slow pions under small angles
- keeps the D^0 signal
- reduces the background events in signal region by factor 2





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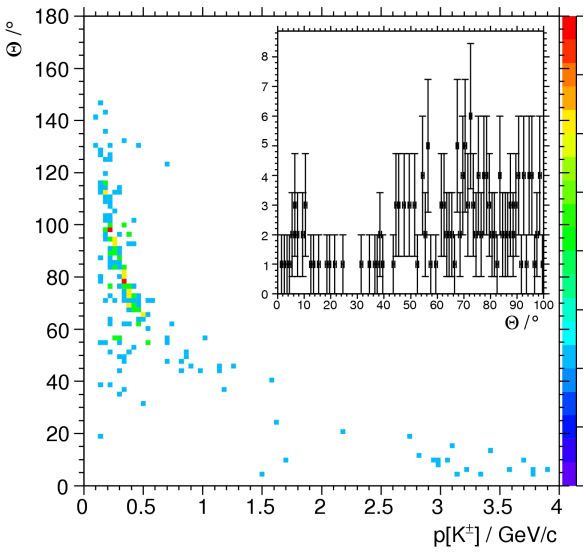
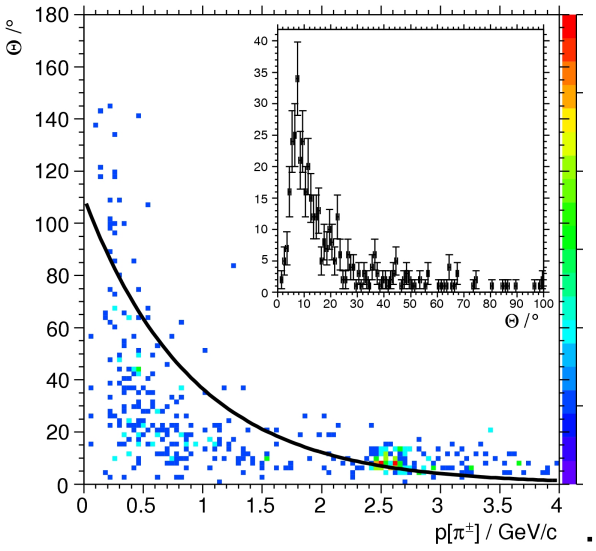
DPM background



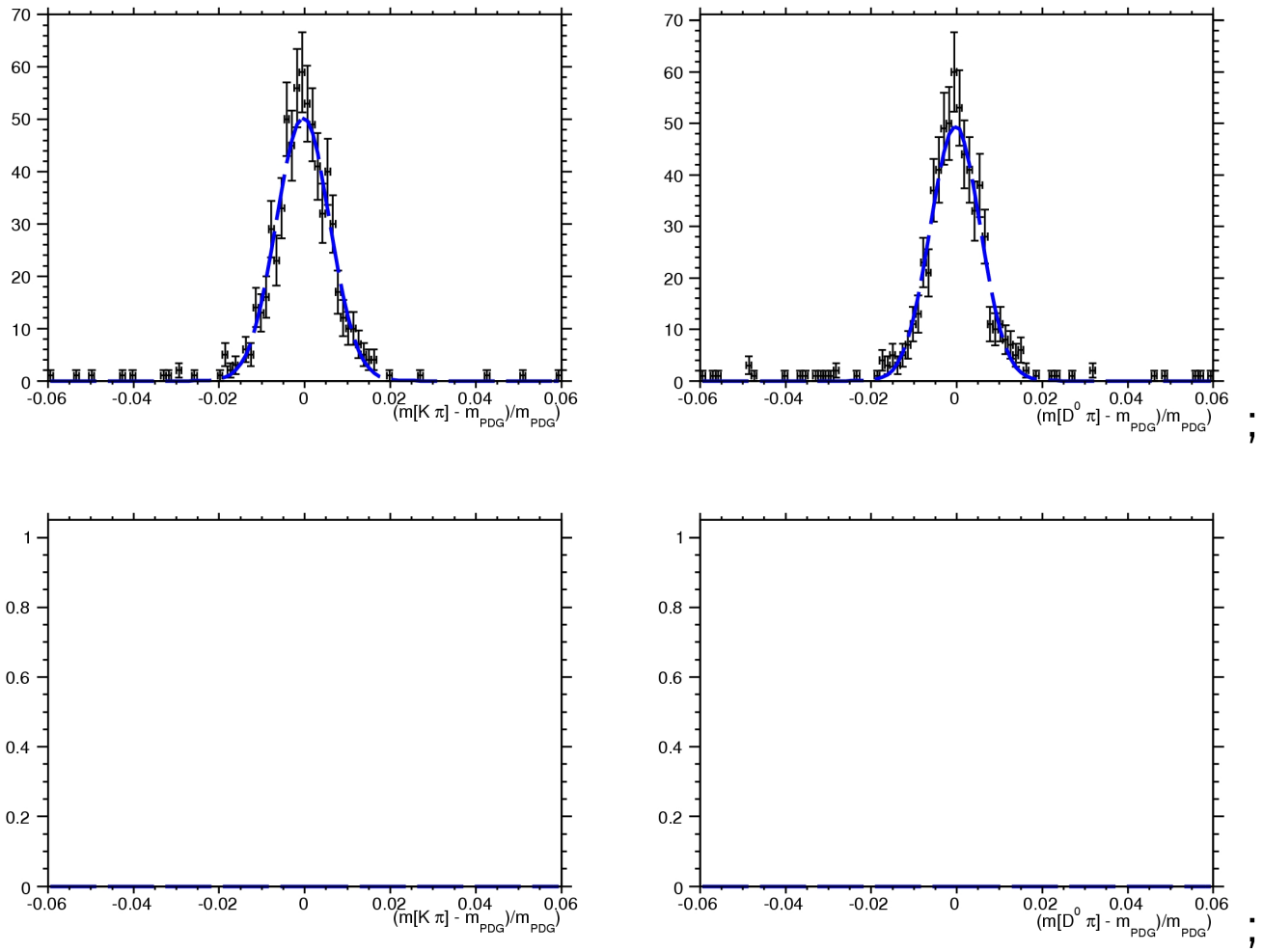


- still DPM background in signal region
- spots in the K/π distributions $\longrightarrow$ misinterpretation of inelastic events? problems in PID?
- to check with MC truth

- only 2 $K^{\pm}$, 4 $\pi^{\pm}$ and no photon at all

DPM background

- only 2 $K^{\pm}$, 4 $\pi^{\pm}$ and no photon at all
- efficiency drops by factor of ≈ 10
- no background event in signal region



Overview

Summary and Further Optimizations

- still the forward part (dipol part) not jet included in the analysis $\rightarrow$ should improve resolution/efficiency
- check K/π separation in the low momentum region (below $500 MeV/c$)
- using vertex information of the delayed D^0 decay to reduce background