Update - $D\bar{D}$ benchmark channels

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Meson 2008, 07.06.2008

Selection criteria

common selection criteria for both channels

- loose mass window cut before vertex fitting
  - D^+D^-: $m_D = 1.7 \ldots 2.1 GeV/c^2$
  - $D^{*+}D^{*-}$: $m_{D^*} = 1.8 \ldots 2.3 GeV/c^2$
- minimum 6 charged tracks
- constraints: decay particles have to form a common vertex
- kinematic fit to constrain beam energy and momentum (c.l.> 5×10^{-2})
- K/π selection (LH >= 0.3), different PID cuts can be used to reject background
- additional constraint on D meson momentum

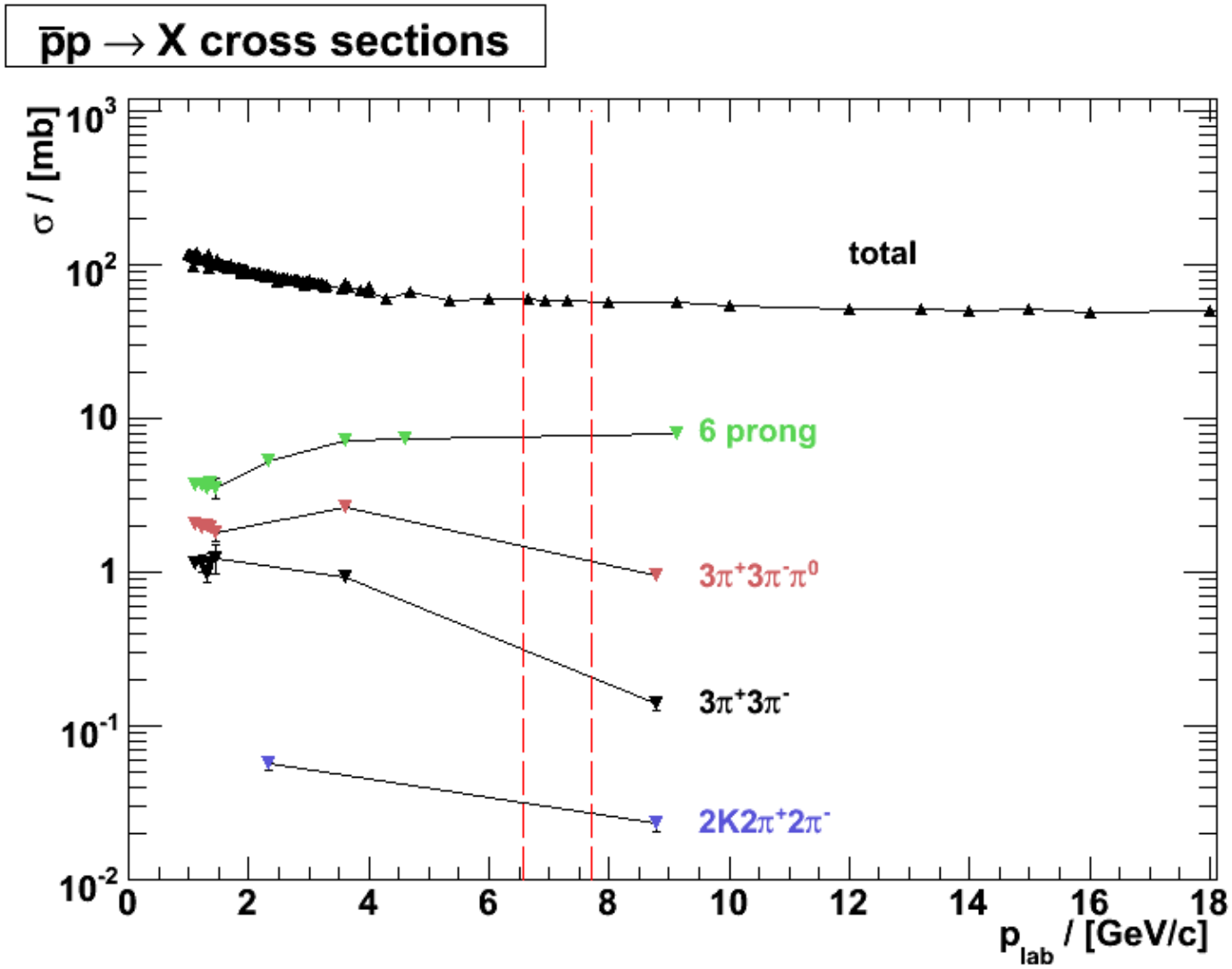
estimation of $\bar{D}D$ cross sections

- cross section of a resonance (e.g. charmonium $\rightarrow D\bar{D}$)

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

- worst case: cross section for direct production of $D\bar{D}$ pair assumed to be in the same order of magnitude at the resonant position, close to threshold (no data yet)
- cross section ratio signal/background: $\approx 10^{-10}$:
- using decays: $D^{\pm} \rightarrow K^{\mp}\pi^{\pm}\pi^{\pm}$ (9.2%), $D^{*+} \rightarrow D^0\pi^+$ (67.7 %) and $D^0 \rightarrow K^-\pi^+$ (3.8 %)
  - D^+D^-: $\sigma \approx 30pb$, with $\sigma(\bar{p}p \rightarrow X) = 60mb$, BR $= 5 \times 10^{-10}$
  - $D^{*+}D^{*-}$: $\sigma \approx 0.7pb$, with $\sigma(\bar{p}p \rightarrow X) = 60mb$, BR $= 1 \times 10^{-11}$

some data from the 70's and early 80's for possible background reactions



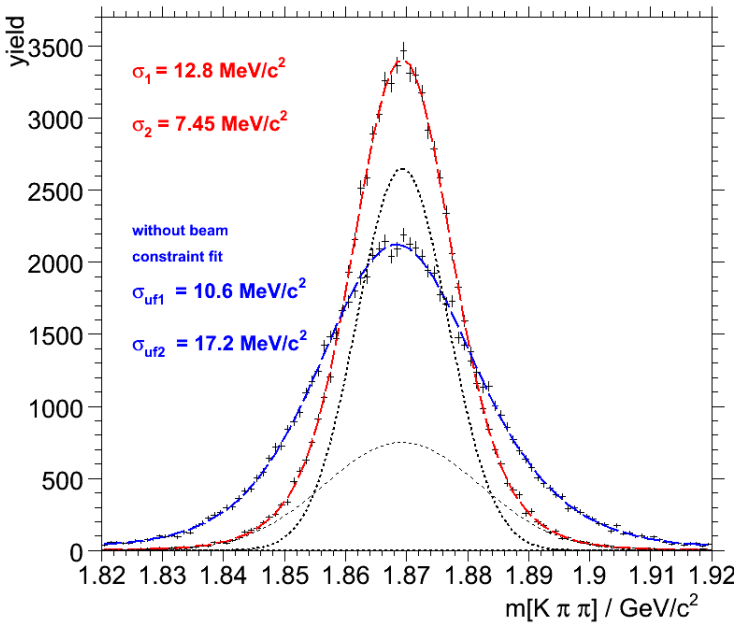
- general background
  - DPM (dual parton model) describes $\bar{p}p$ annihilation processes generating $10^{10} - 10^{11}$ DPM events not applicable,
  - test for apparative effects
- specific background reactions
  - $\frac{\sigma(\bar{p}p \to 3\pi^+ 3\pi^- \pi^0)}{\sigma(\bar{p}p \to X)} \approx 2.5 \times 10^{-2}$
  - $\frac{\sigma(\bar{p}p \to 3\pi^+ 3\pi^-)}{\sigma(\bar{p}p \to X)} \approx 5 \times 10^{-3}$
  - $\frac{\sigma(\bar{p}p \to 2K^{\mp} 4\pi^{\pm})}{\sigma(\bar{p}p \to X)} \approx 5 \times 10^{-4}$

only for internal use

events per channels

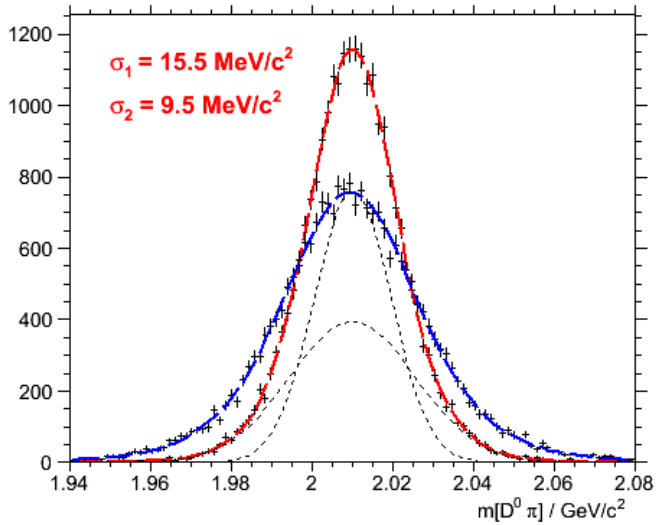
channel	D^+D^- (without filter)	$D^{*+}D^{*-}$ (using filter)
$\bar{p}p \longrightarrow 3\pi^+3\pi^-\pi^0$	50M	(400M)
$\bar{p}p \longrightarrow 3\pi^+3\pi^-$	10M	75M
$2K^{\mp}4\pi^{\pm}$	1M	10M
DPM	a.m(uch)a.p.	a.m.a.p.

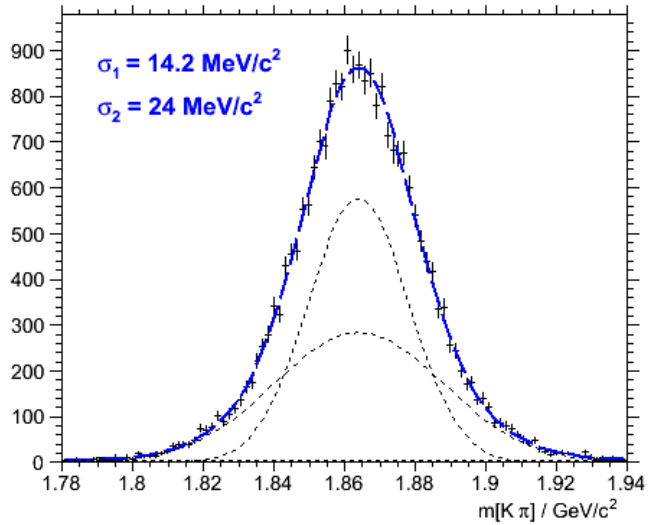
Signal efficiency



$\bar{p}p \to D^+D^-$

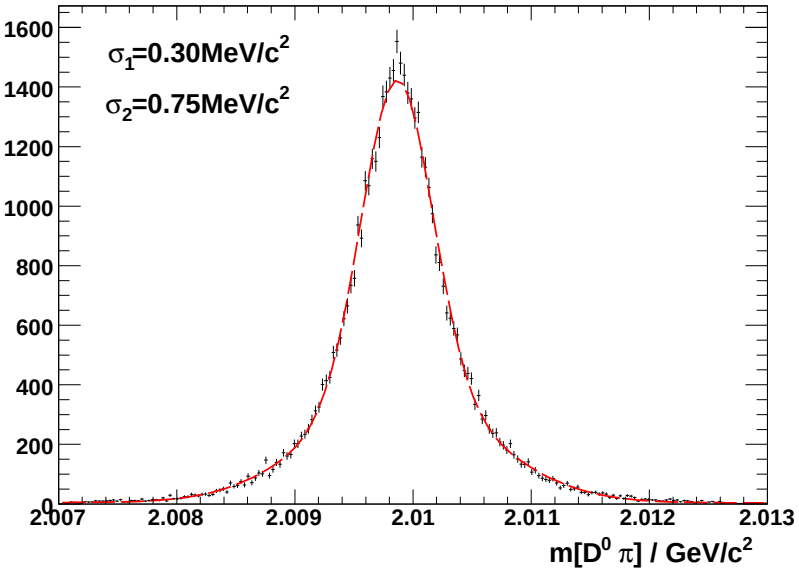
- efficiency $\epsilon = 40\%$
- 4C-fit improves resolution by $\approx 50\%$ (red curve)
- $\Delta m_D = 0.5 \times 10^{-4}$





$\bar{p}p \rightarrow D^{*+}D^{*-}$, $D^{*\pm} \rightarrow D^0\pi^{\pm}$

- efficiency $\epsilon = 27\%$
- 4C-fit improves resolution by $\approx 50\%$ (red curve)
- if whole tree is fitted: $m_{D^0} = m_{D^0,pdg}$



Suppression of non strange background

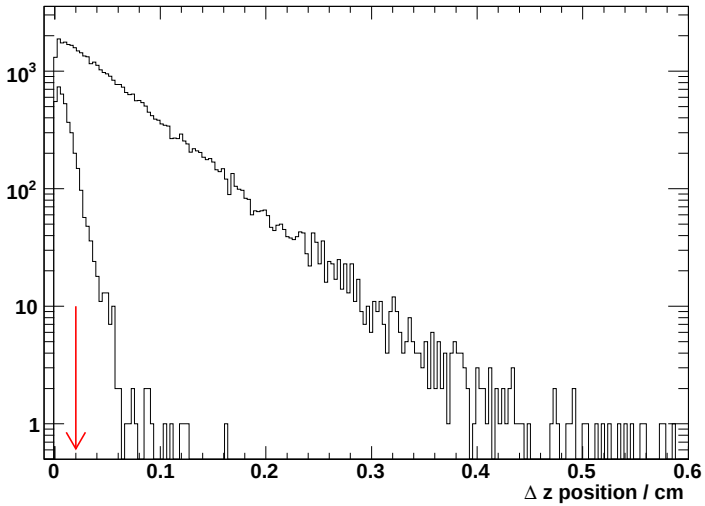
$3\pi^+3\pi^-$, $3\pi^+3\pi^-\pi^0$

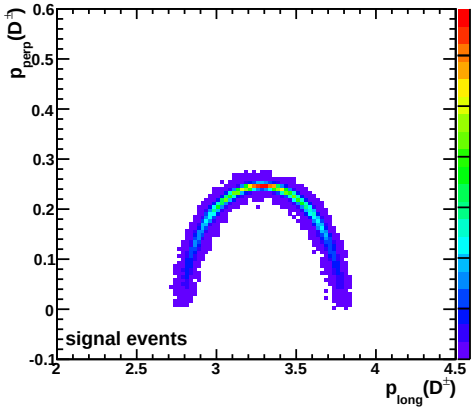
- distribution of K, π momenta from D decay in range from hundreds of MeV/c to few GeV/c
- using dE/dx informations from the tracking system for low momentum tracks
- DIRC, RICH informations for higher momentum particles
- without using higher levels of PID only a few events remain
  $\longrightarrow$ kinematics very restrictive

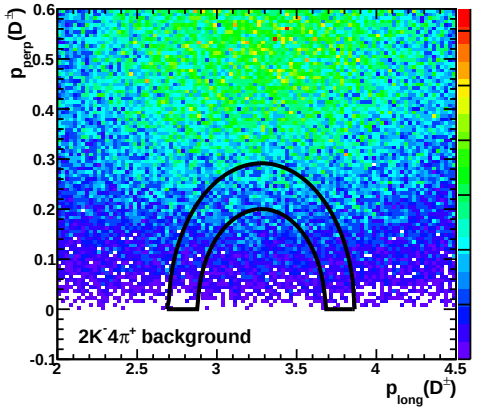
$\longrightarrow$ good PID neccessary to reject non strange background

	signal efficencies [%]		S/N	
LH cut	D^+D^-	$D^{*+}D^{*-}$	D^+D^-	$D^{*+}D^{*-}$
0.2	39.9	27.4	1:5	tbc
0.3	25.4	14.3	1:1 (or better)	tbc
0.55	9.1	-	1:1 (or better)	-

$2K^{\mp}4\pi^{\pm}$ background







D^+D^-

- constraining allowed momentum region for $D^{\pm}$ candidate
- cut on $D^{\pm}$ momentum rejects over 90% of the $2K^{\mp}4\pi^{\pm}$ background
- further cut on Δz of $D^{\pm}$ decay vertex

Δz cut $[\mu m]$	S/N
200	1:160
400	1:20
600	1:2

$2K^{\mp}4\pi^{\pm}$ background II

$D^{*+}D^{*-}$ channel

- better background suppression due to kinematics
  - additional vertex constraint from D^0 decay
  - slow pion from the $D^{*\pm}$ decay
- without D^0 mass constraint in $D^{*\pm}$ fit: background suppression worse
- no additional explicit vertex cut used

D^0 mass	signal efficiency	S/N
no mass constraint	27.4	1:200
$M_{PDG}(D^0)$	24.9	$\approx$ 1:1 (or better)