Study of $\mathbf{D^0 \to \pi^+\pi^-\pi^+\pi^-}$ @ 4178

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Outline

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- Data Set
- Event Selection
- Background Study
- Summary and Next to do

Motivation

- Study of $\mathrm{D}^0 \to \pi^+\pi^-\pi^+\pi^-$ can provide important input for the determination of CKM unitarity triangle angle γ in $B^{\pm} \to DK^{\pm}$ process.

CLEO-c
Phys. Lett. B747 (2015)
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- CLEO-c and FOCUS have studied the resonance structure of $\mathrm{D}^0 \to \pi^+\pi^-\pi^+\pi^-$, more precise result can be got by using the large and clean D^0 sample in BESIII .

Data Set

- Boss Version: 703
- Data: 4178 data (~3.19fb^{-1})
- Generic MC (round01 - round04):
  - Open charm
  - qqbar
  - tt
  - ISR Psi

Component	Cross section(pb)	Size(M)
$D^0\bar{D}^0$	179	0.57
D^+D^-	197	0.62
$D^{*0}\bar{D}^0$	1211	3.83
$D^{*+}D^-$	1296	4.10
$D^{*0}\bar{D}^{*0}$	2173	6.87
$D^{*+}D^{*-}$	2145	6.78
$D_s^+D_s^-$	7	0.02
$D_s^{*+}D_s^-$	889	2.81
$DD^*\pi^+$	383	1.21
$DD^*\pi^0$	192	0.61
$DD\pi^+$	25	0.08
Component	Cross section(nb)	Size(M)
$q\bar{q}$	13.8	43.62
$\gamma J/\psi$	0.40	1.26
$\gamma\psi(3686)$	0.42	1.33
$\gamma\psi(3770)$	0.06	0.19
$\tau\tau$	3.45	10.91
$\mu\mu$	5.24	16.56
ee	423.99	13.40(0.01x)
$\gamma\gamma$	1.7	5.1

Event Selection

Single Flavor Tag from D*+-
Dominated channel: D*+D- and D*+D*-

- **Good charged tracks**:
  |Rz|≤10cm, |Rxy| ≤ 1cm, |cosθ| ≤0.93 ;

- **Good Photons:**
  - Barrel : $E_\gamma > 0.025\text{GeV}$, |cosθ |≤ 0.8
  - Endcap : $E_\gamma > 0.05\text{GeV}$, 0.84≤|cos θ |≤ 0.92
  - Time cut: 0≤ T≤ 14 (in unit of 50 ns);
  - |dang|> 20^o;

- **PID :**
  - Use dE/dx and TOF
  - Pion: prob(π) > prob(K);
  - Kaon: prob(K) > prob(π);

- **Tag D* Reconstruction:**
  - Loop 5 pi and require |M(5pi)-1.865|<0.1 GeV
  - Define Mrec and require |Mrec – M(D*+/D+)|<0.07GeV
  - Min | Mrec – M(D*/D)| is used to select best 5 pi.
  - Min |M(4pi) – M(D0)| is used to choose the pi from D0
  - Deal with D*D and D*D* sample respectively

$$M_{rec} = \sqrt{\left(E_{cm} - \sqrt{p_{tag}^2 + M_{D_s}^2}\right)^2 - p_{tag}^2}$$

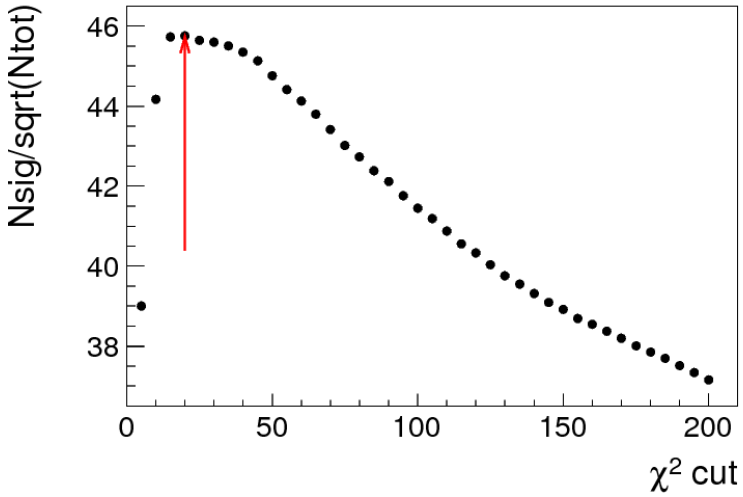
- **Kinematic Fit (2C):**
  1C for D0 mass and 1C for recoiled mass (D*+/D+), χ^2_{2C}<200

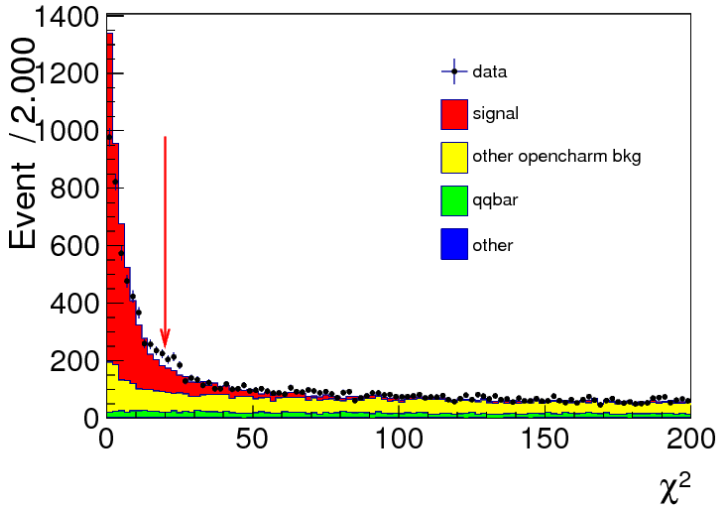
- **K_S^0 Veto :**

$$|M(\pi^+\pi^-) - 0.4976| > 0.03\ \text{GeV}/c^2$$

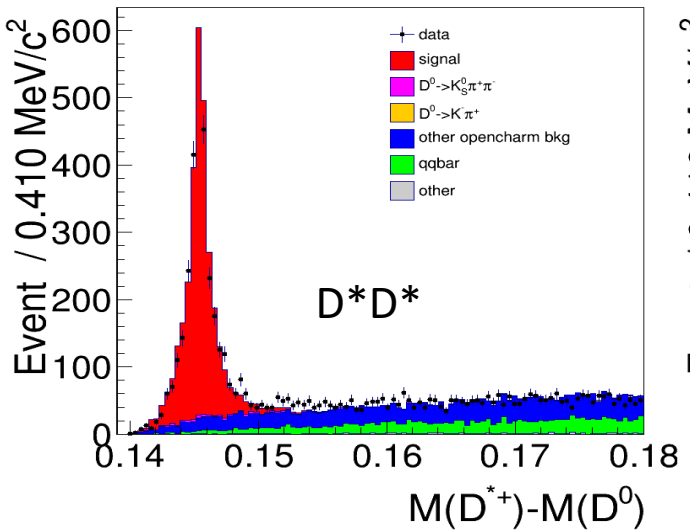
Event Selection (χ^2_{2C} cut optimization)

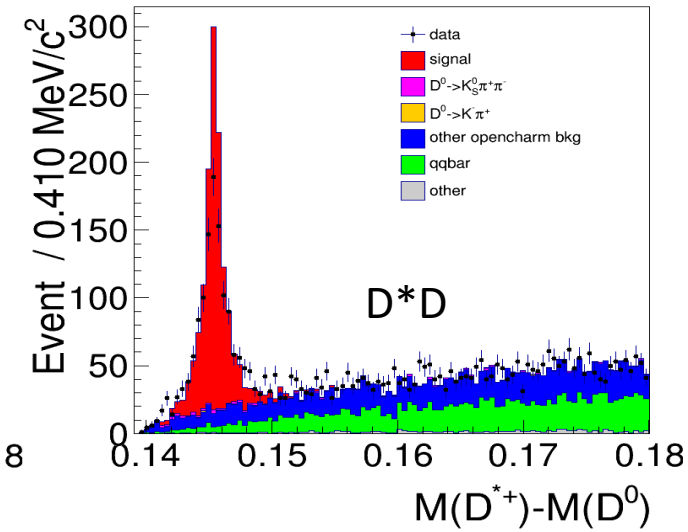
- χ^2_{2C} cut is determined by S/sqrt(S+B)
  - signal region: M(5pi)-M(4pi) < 0.15 GeV/c^2
  - S+B is get from data
  - S is get from inclusive MC
  - Signal efficiency: 76.2% in MC
  - Background rejection: 82.4% in MC

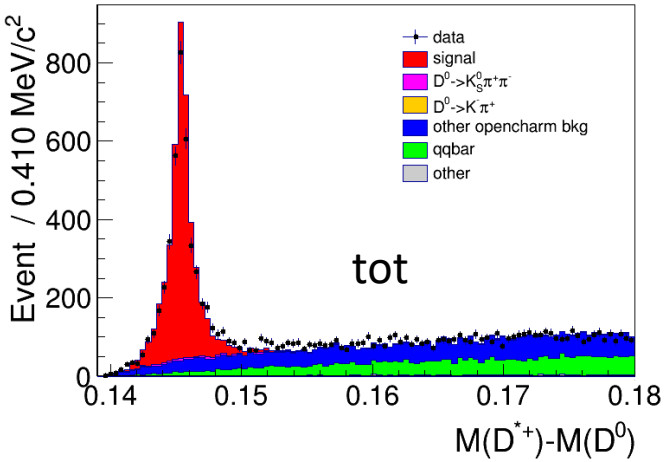




Background Study

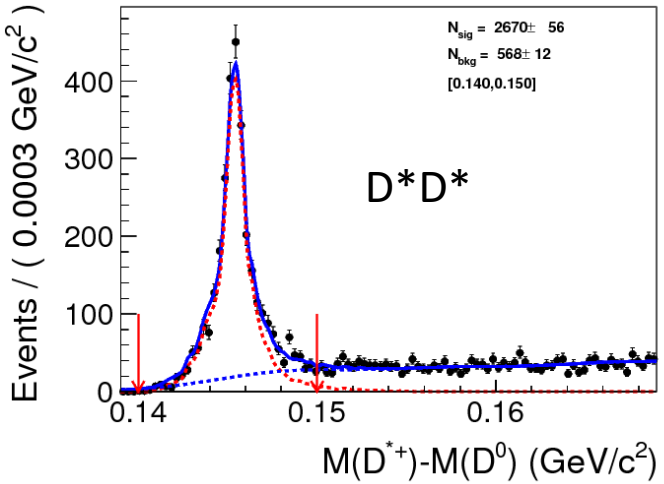


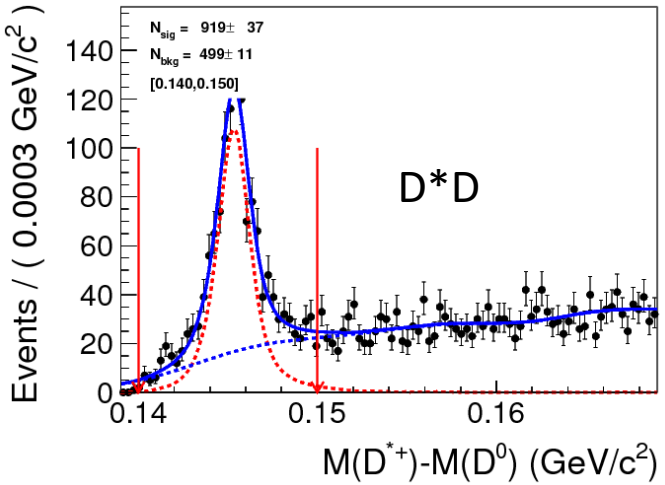


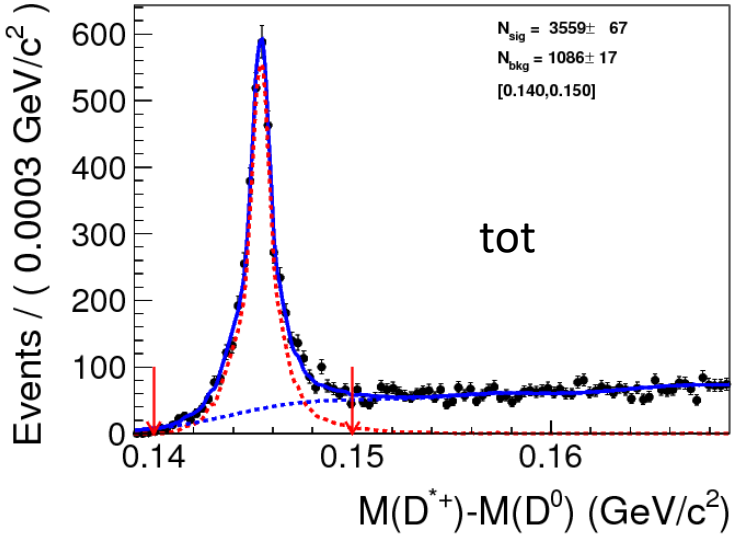


- Peaking background in MC (signal region)
  - $D^0 \to K^0_S\pi^+\pi^-$ ~1.3%
  - $D^0 \to K^-\pi^+$ ~0.2%

Background Study (fit to data)







2D Fit to M_{BC}

- Signal Pdf:
  - $a(x) \otimes g(x; \mu_x, \sigma_x)$
  - $a(x)$ is MC shape (HistPdf)
  - g(x) are Gaussian function
- Background Pdf:
  - MC shape (KeysPdf rho=2, MirrorRight)
- Purity
  - For D*D*: ~82%
  - For D*D : ~65%
  - Total: ~76%