Measurement of $D \to \omega\pi\pi$

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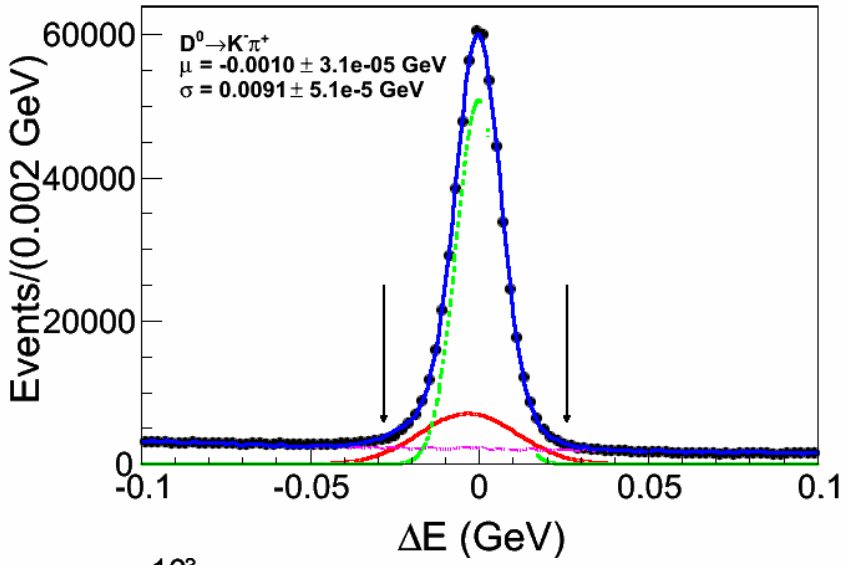
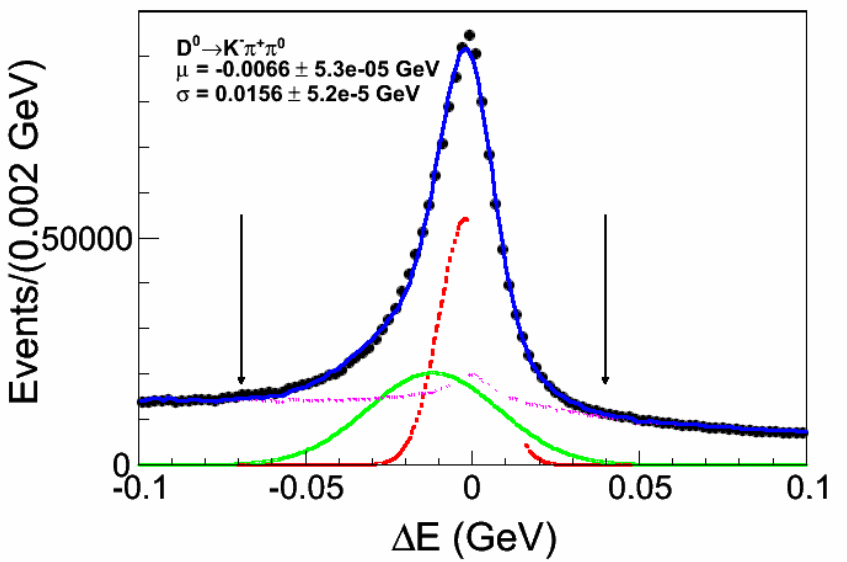
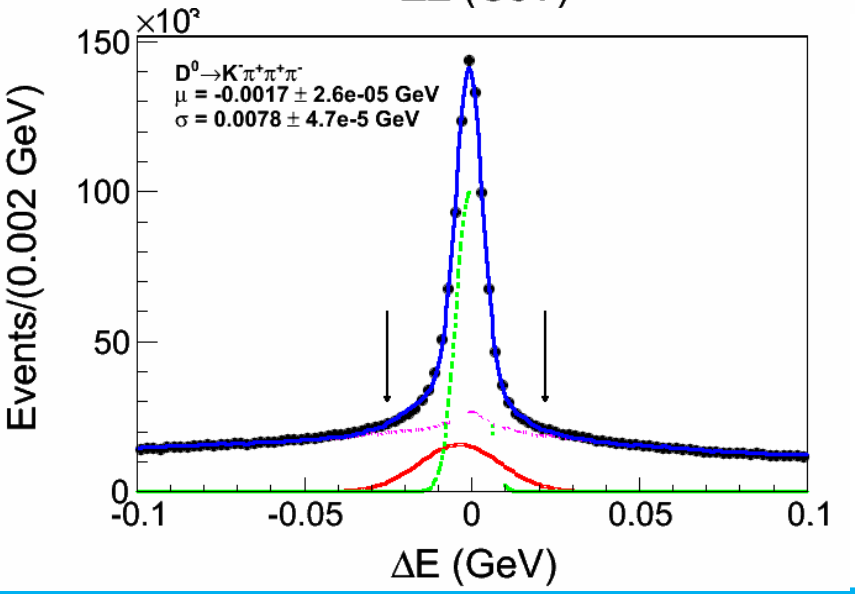
ΔE distributions: single tag

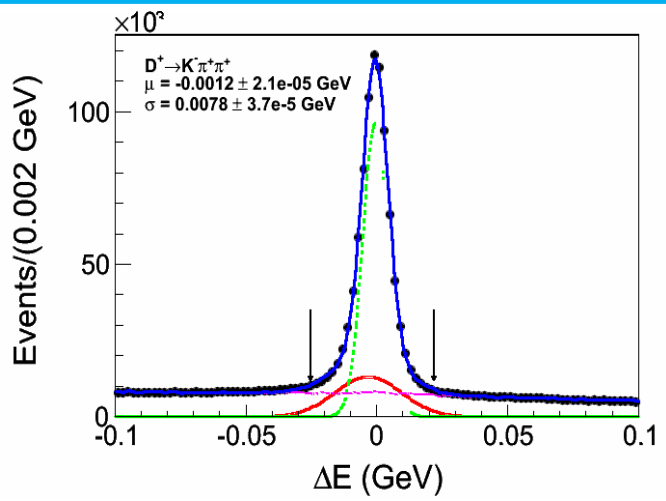


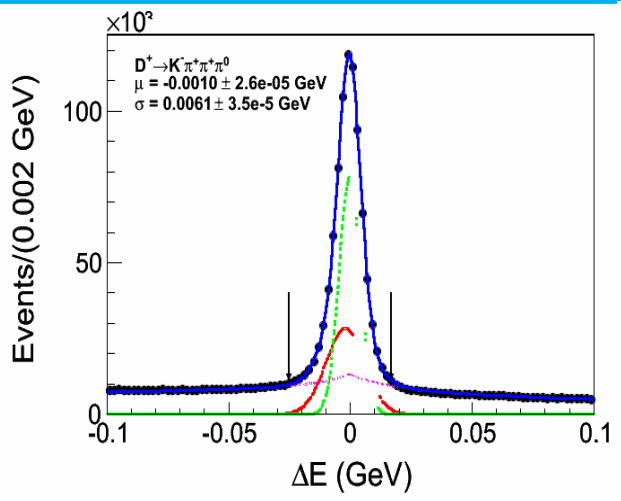


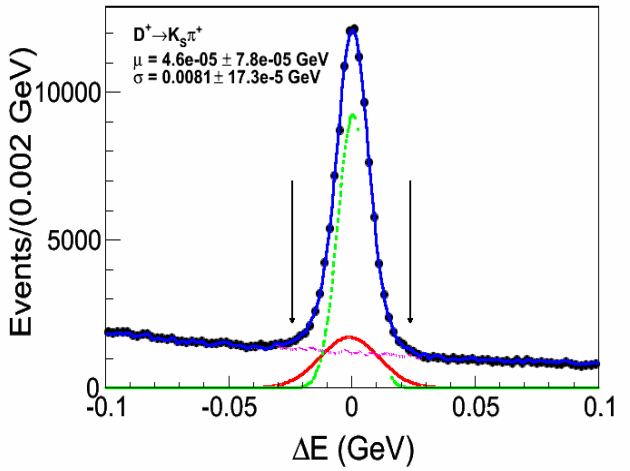


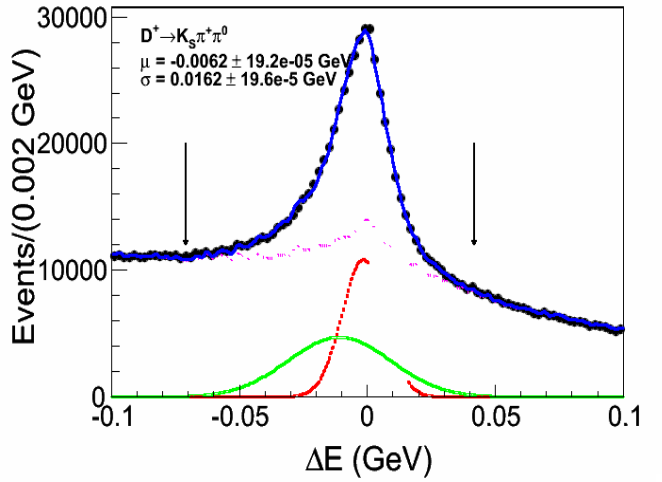
Describe the signal PDF by sum of two Gaussian functions.

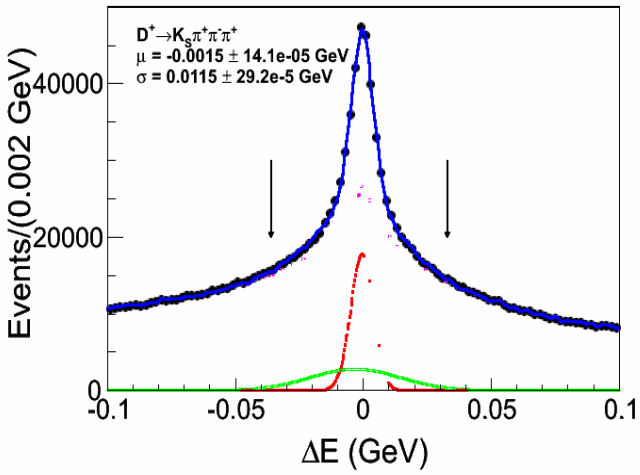
Background PDF is described by the sideband data of $m_{BC} < 1.855$ GeV/c^2.

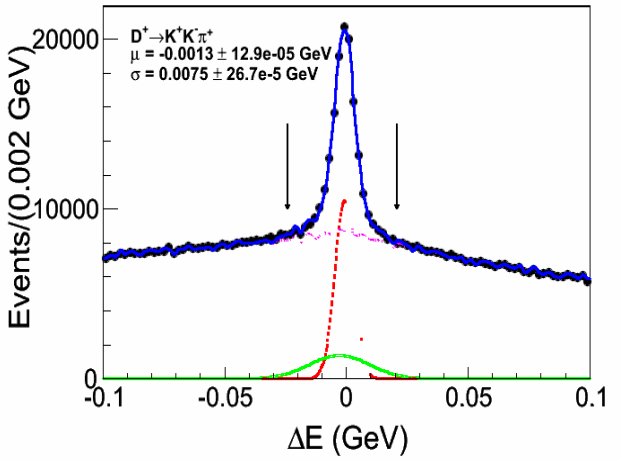

×10²
$D^+ \to K^-\pi^+\pi^+$
μ = -0.0012 ± 2.1e-05 GeV
σ = 0.0078 ± 3.7e-5 GeV
Events/(0.002 GeV)
ΔE (GeV)


×10²
$D^+ \to K^-\pi^+\pi^+\pi^0$
μ = -0.0010 ± 2.6e-05 GeV
σ = 0.0061 ± 3.5e-5 GeV
Events/(0.002 GeV)
ΔE (GeV)


$D^+ \to K_S\pi^+$
μ = 4.6e-05 ± 7.8e-05 GeV
σ = 0.0081 ± 17.3e-5 GeV
Events/(0.002 GeV)
ΔE (GeV)

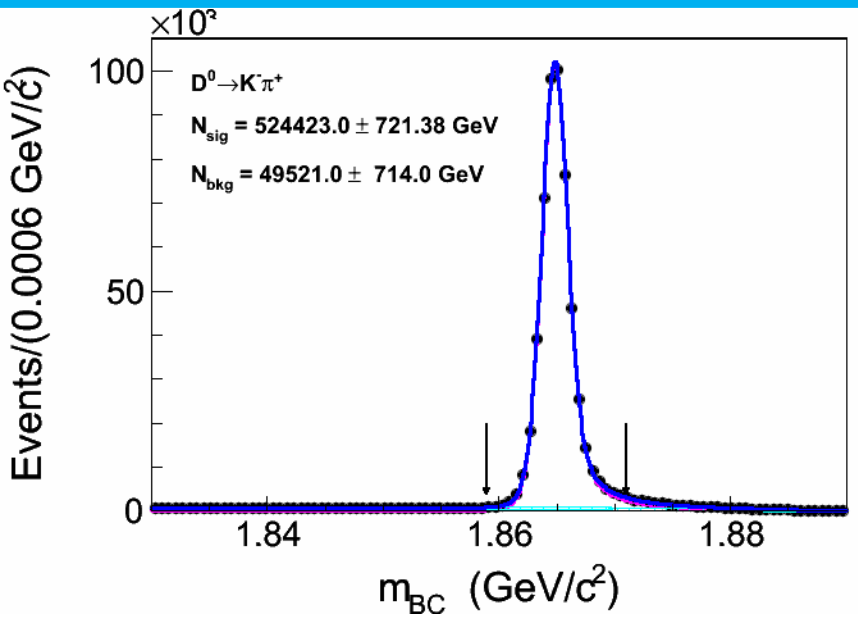

$D^+ \to K_S\pi^+\pi^0$
μ = -0.0062 ± 19.2e-05 GeV
σ = 0.0162 ± 19.6e-5 GeV
Events/(0.002 GeV)
ΔE (GeV)

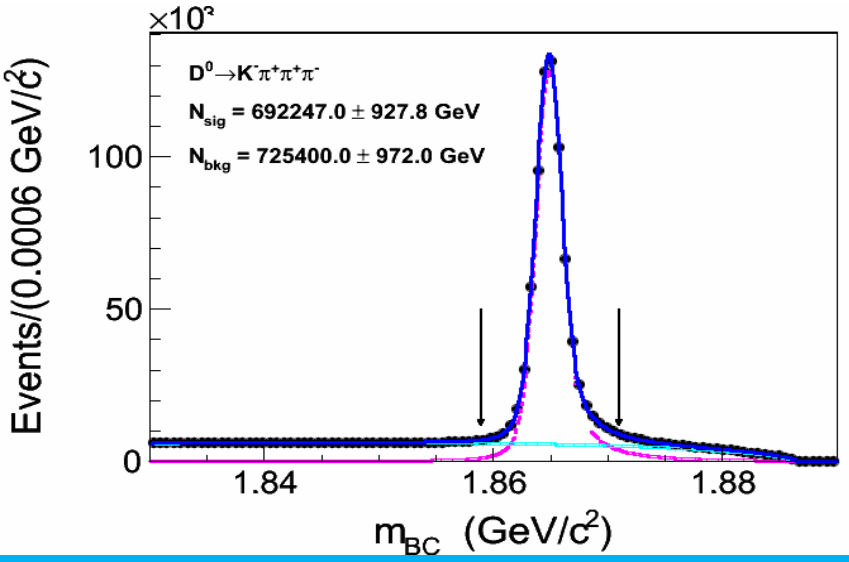

$D^+ \to K_S\pi^+\pi^-\pi^+$
μ = -0.0015 ± 14.1e-05 GeV
σ = 0.0115 ± 29.2e-5 GeV
Events/(0.002 GeV)
ΔE (GeV)

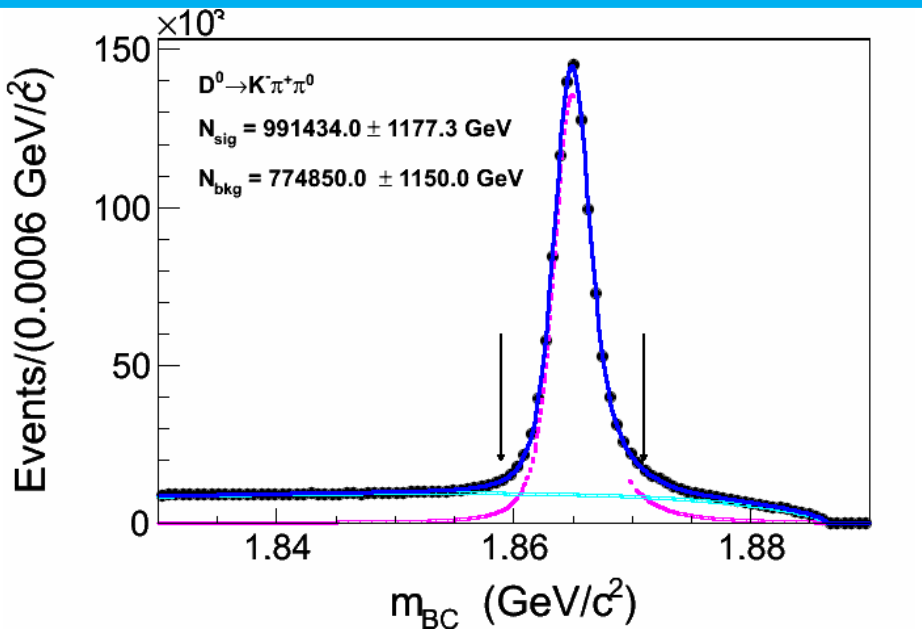

$D^+ \to K^+K^-\pi^+$
μ = -0.0013 ± 12.9e-05 GeV
σ = 0.0075 ± 26.7e-5 GeV
Events/(0.002 GeV)
ΔE (GeV)

Decay modes	μ (MeV)	σ (MeV)	Requirement (GeV)
$D^0 \to K^-\pi^+$	-1.0	9.1	[-0.028, 0.026]
$D^0 \to K^-\pi^+\pi^0$	-6.8	15.8	[-0.069, 0.040]
$D^0 \to K^-\pi^+\pi^+\pi^-$	-1.7	7.9	[-0.025, 0.022]
$D^+ \to K^-\pi^+\pi^+$	-1.2	7.8	[-0.025, 0.022]
$D^+ \to K^-\pi^+\pi^+\pi^0$	-1.0	6.1	[-0.025, 0.017]
$D^+ \to K_S\pi^+$	0.1	8.1	[-0.024, 0.024]
$D^+ \to K_S\pi^+\pi^0$	-6.2	16.2	[-0.071, 0.042]
$D^+ \to K_S\pi^+\pi^-\pi^+$	-1.5	11.5	[-0.036, 0.033]
$D^+ \to K^+K^-\pi^+$	-1.3	7.5	[-0.024, 0.021]

m_{BC} distributions of data: single tag

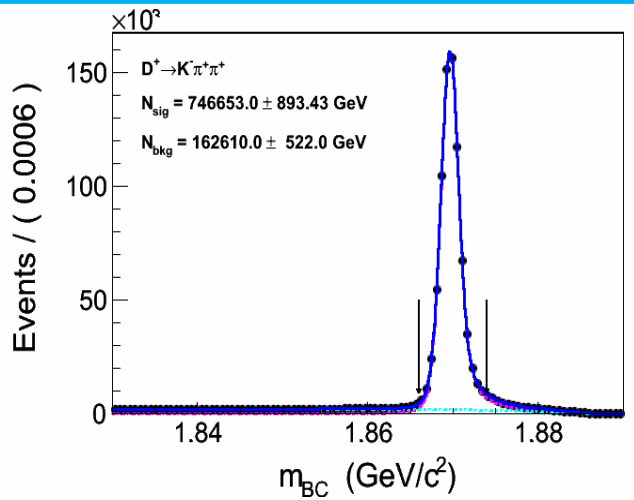


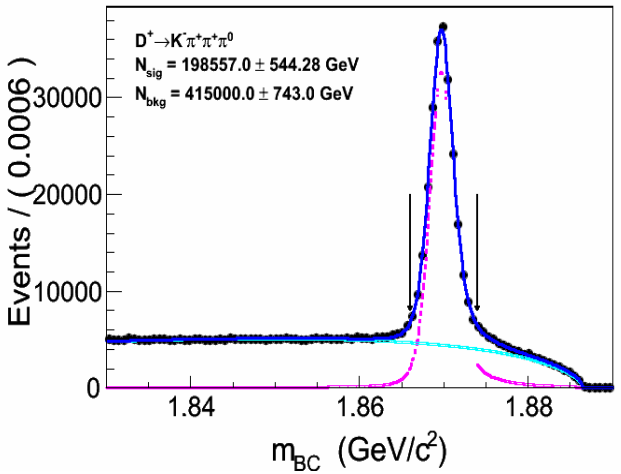


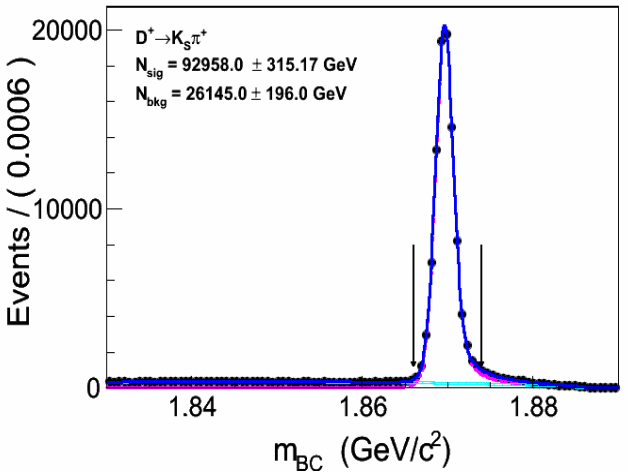


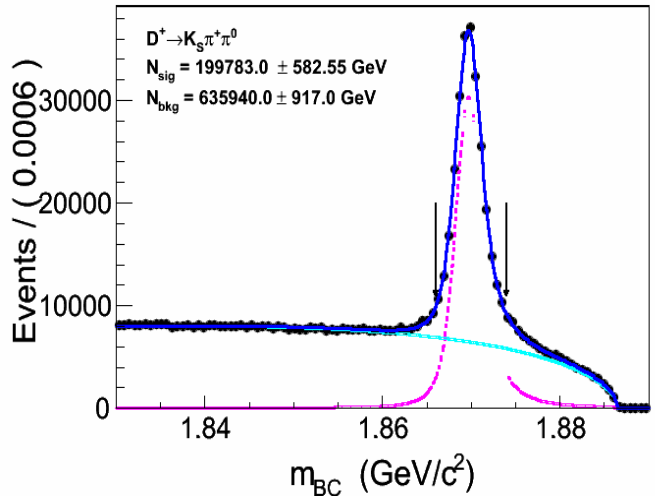
- Signal PDF is described by simulated signal MC shape convoluted with a Gaussian function.
- Background PDD is described by an Argus function.
- Signal yield numbers are calculated in the m_{BC} range of [1.859, 1.871] GeV/c^2.

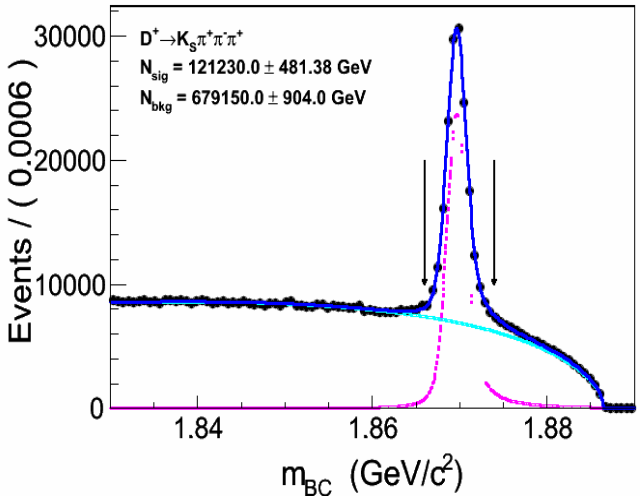
m_{BC} distributions of data: single tag

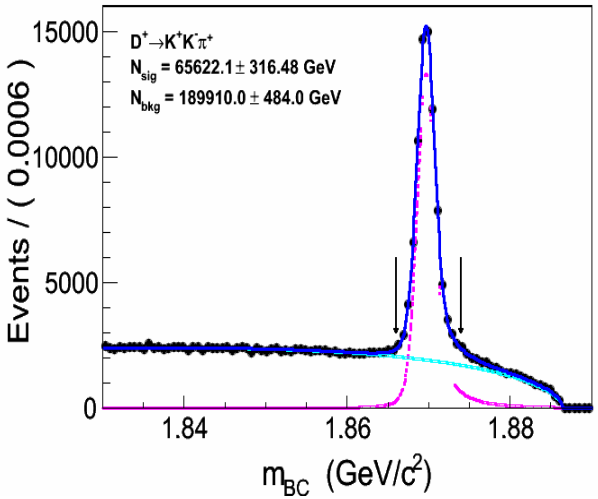




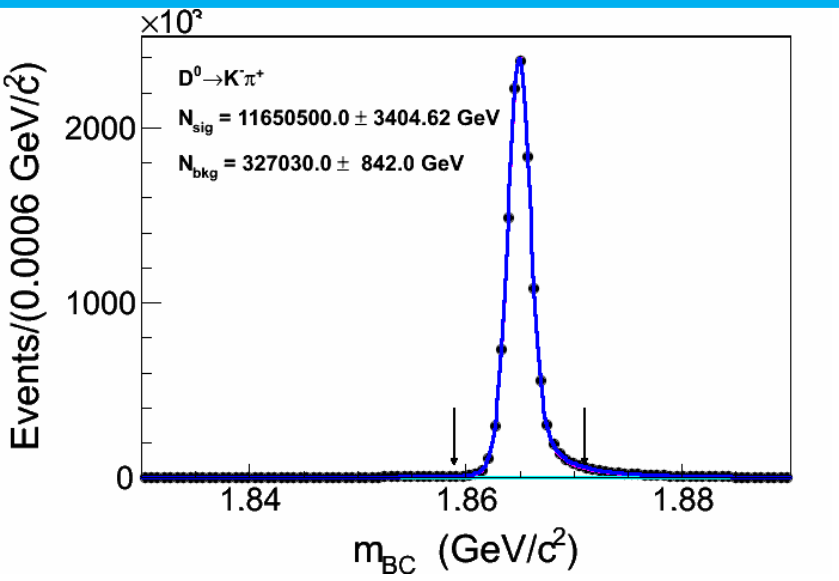


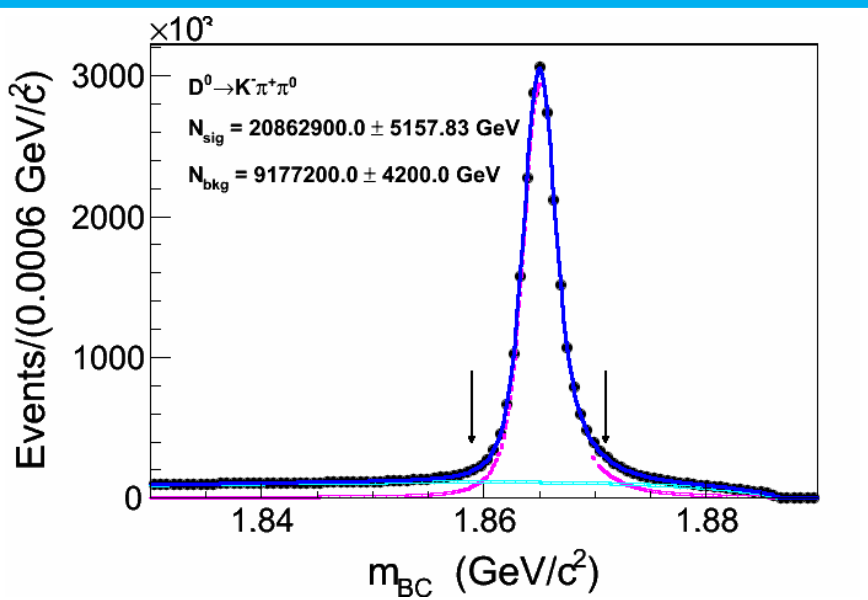


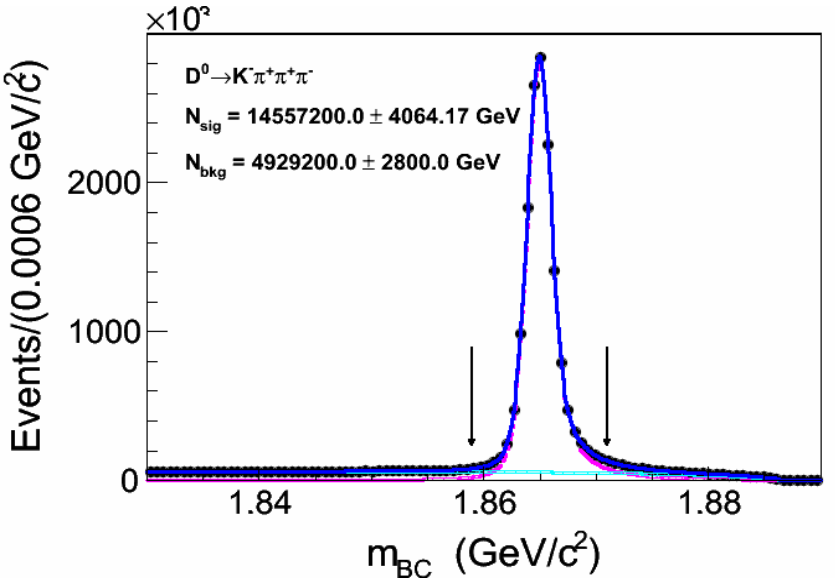




m_{BC} distributions of cocktail MC: single tag







- Signal PDF is described by simulated signal MC shape convoluted with a Gaussian function.
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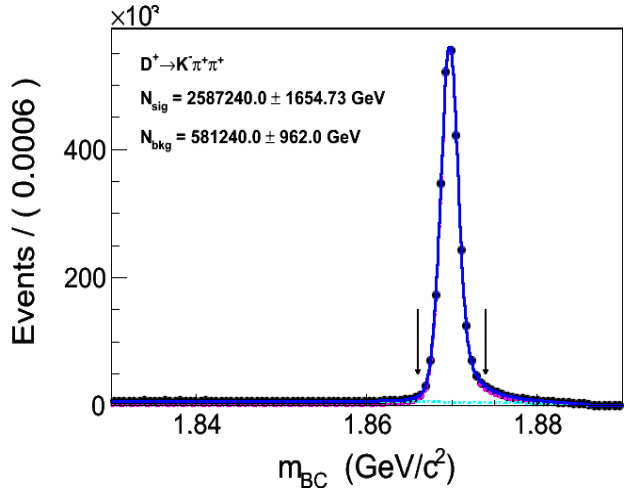
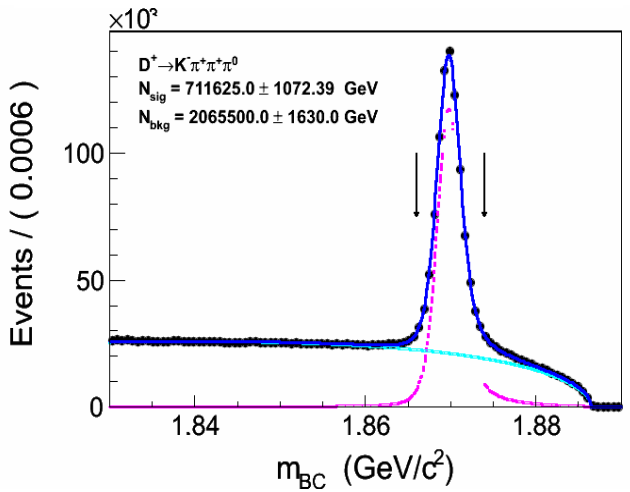
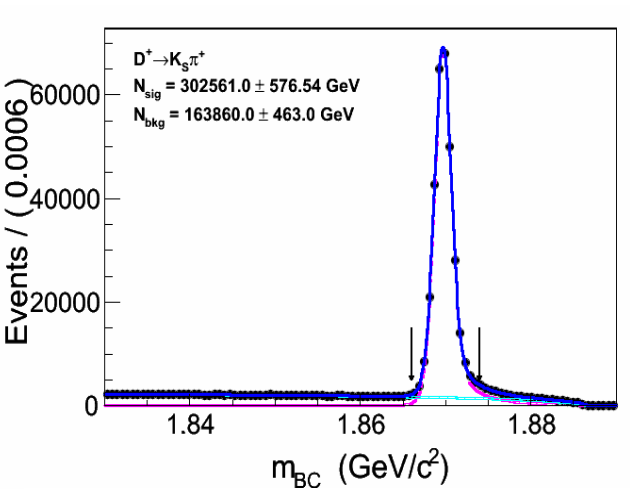
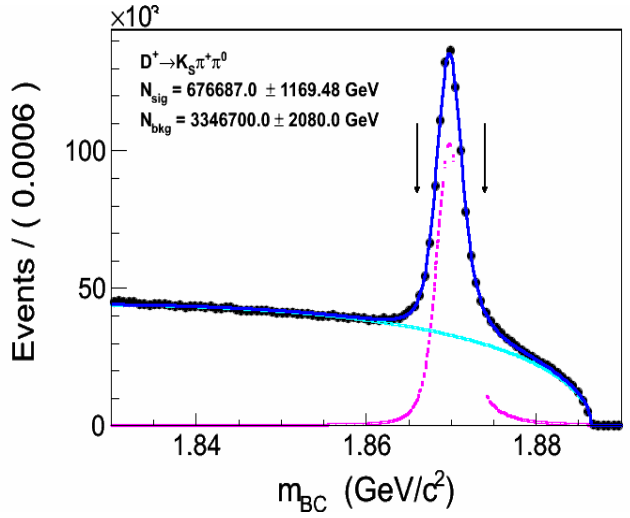
- Signal yield numbers are calculated in the m_{BC} range of [1.859, 1.871] GeV/c^2.

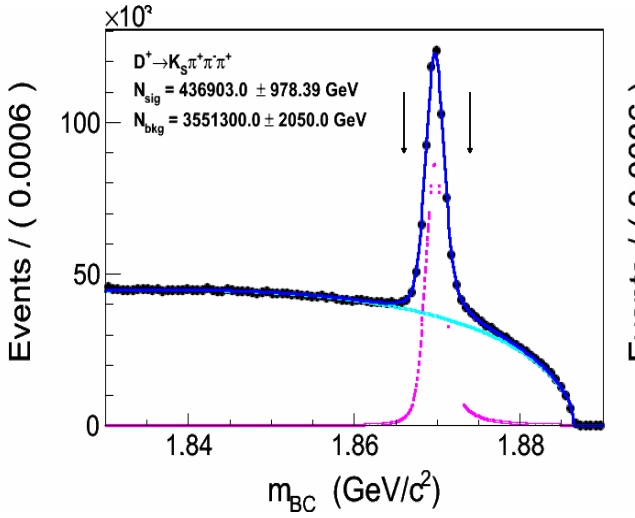
m_{BC} distributions of cocktail MC: single tag

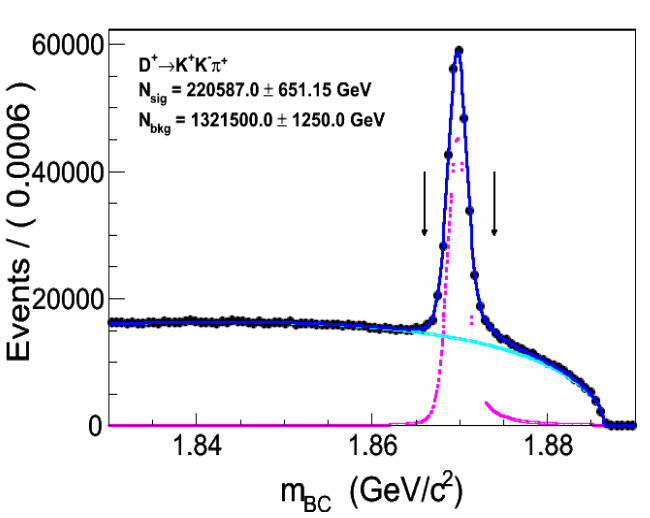












Single tag yields and efficiencies

Decay modes	Signal tag yields (data)	Signal tag yields (MC)	Single tag efficiency %
$D^0 \to K^-\pi^+$	524423.0 ±721.38	11650500.0 ±3404.62	64.45 ± 0.019
$D^0 \to K^-\pi^+\pi^0$	991434.0 ±1177.30	20862900.0 ±5157.83	32.69 ± 0.008
$D^0 \to K^-\pi^+\pi^+\pi^-$	692247.0 ± 927.80	14557200.0 ±4064.17	39.09 ± 0.011
$D^+ \to K^-\pi^+\pi^+$	746653.0 ± 893.43	2587240.0 ± 1654.73	47.43 ± 0.030
$D^+ \to K^-\pi^+\pi^+\pi^0$	198557.0 ± 544.28	711625.0 ± 1072.39	20.42 ± 0.031
$D^+ \to K_S\pi^+$	92958.9 ± 315.17	302561.0 ± 576.54	50.54 ± 0.096
$D^+ \to K_S\pi^+\pi^0$	199783.0 ± 582.55	676687.0 ± 1169.48	24.74 ± 0.043
$D^+ \to K_S\pi^+\pi^-\pi^+$	121230.0 ± 481.38	436903.0 ± 978.39	34.46 ± 0.077
$D^+ \to K^+K^-\pi^+$	65622.1 ± 316.48	220587.0 ± 651.15	38.52 ± 0.114

Double tag: $D^0 \to \omega\pi^+\pi^-$

Double tag: selection criteria

- Select the events of interests with exactly four charged tracks and at least two photons from other charged tracks and neutral tracks , respectively.

Good charged tracks

$|V_r| < 1.0$ cm, $|V_z| < 10$ cm and $|\cos\theta| \leq 0.93$

PID requirement

prob(π) > prob(K), prob(π)>0

Good photons

Barrel region ($\cos\theta_\gamma < 0.8$): $E_\gamma > 25$ MeV
End-cap region ($0.86 < \cos\theta_\gamma < 0.92$): $E_\gamma > 50$ MeV
EMC timing: [0,14]×(50) ns, $\theta_{\gamma,x}\pm > 10$ degrees.

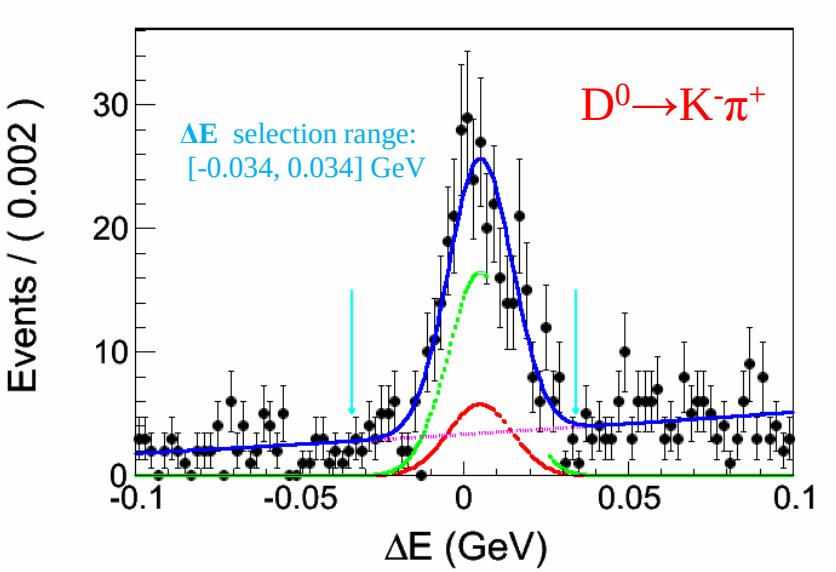
$\pi \rightarrow \gamma\gamma$ selection
$m_{\gamma\gamma} = [0.03, 0.30]$ GeV/c^2
Mass constraint fit on π^0 ($\gamma\gamma$)

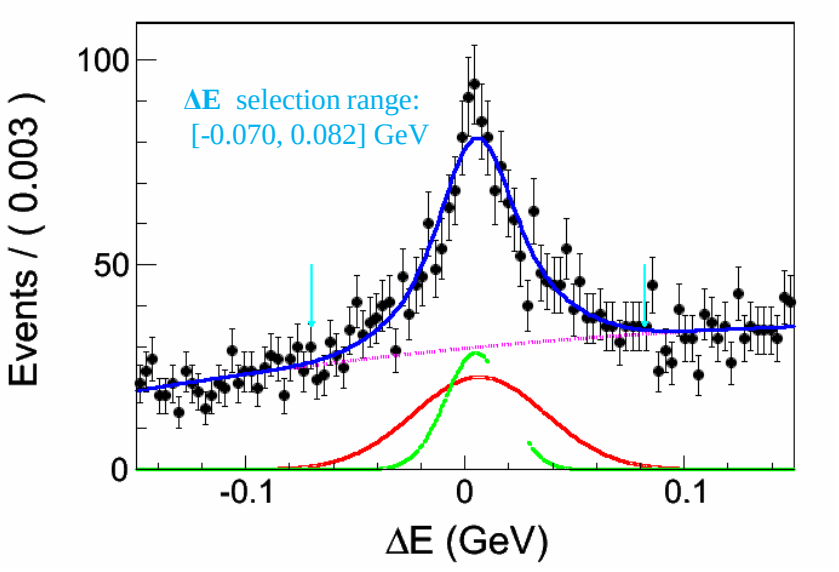
- Veto of K_S background: reject the events from the di-pion invariant mass region of $0.475 < m_{\pi^+\pi^-} < 0.520$ GeV/c^2 in each combination of the di-pion system.

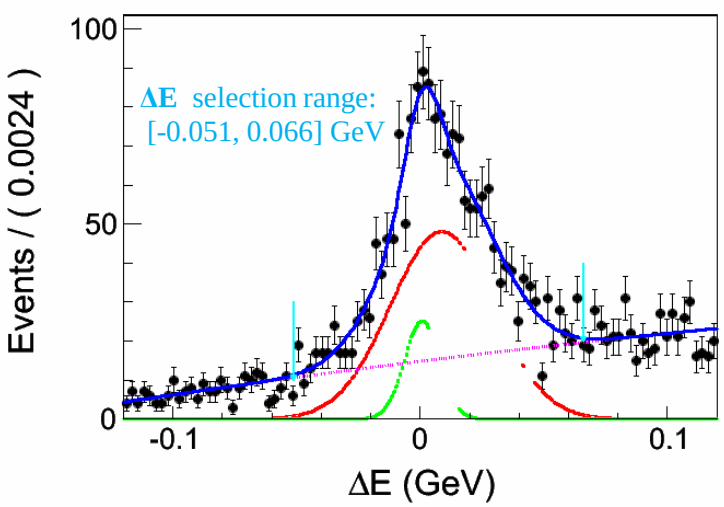
- Selection of ω signal:

$$\Delta m^2_{\pi^+\pi^-\pi^0} = (m_\omega^{PDG} - m_{\pi^+\pi^-\pi^0})^2/\sigma^2_\omega$$

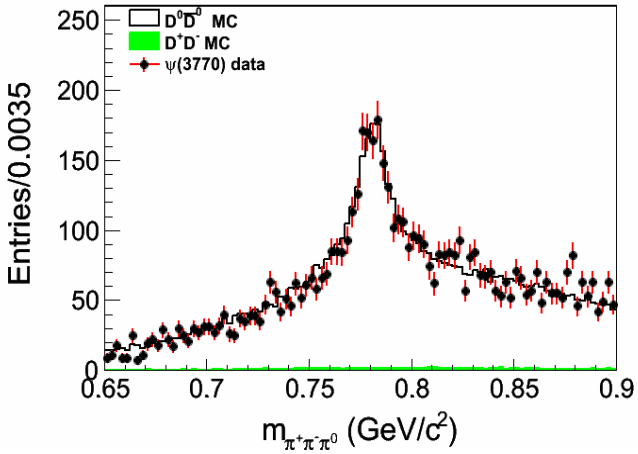
ΔE distribution: double tag

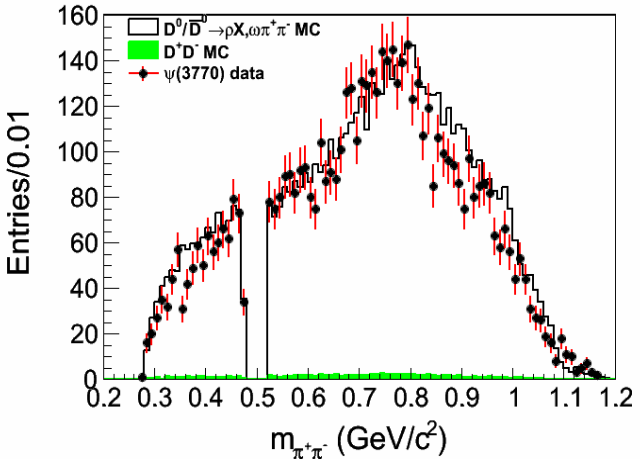


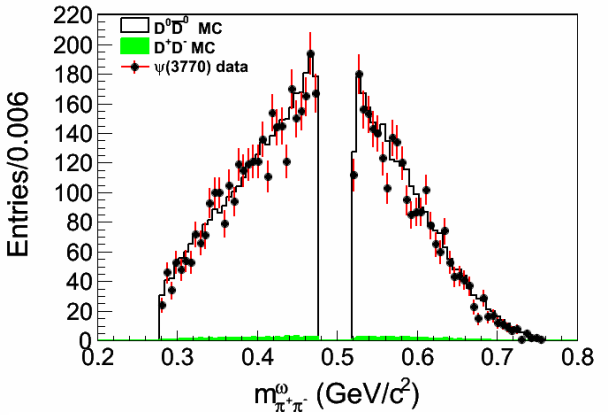


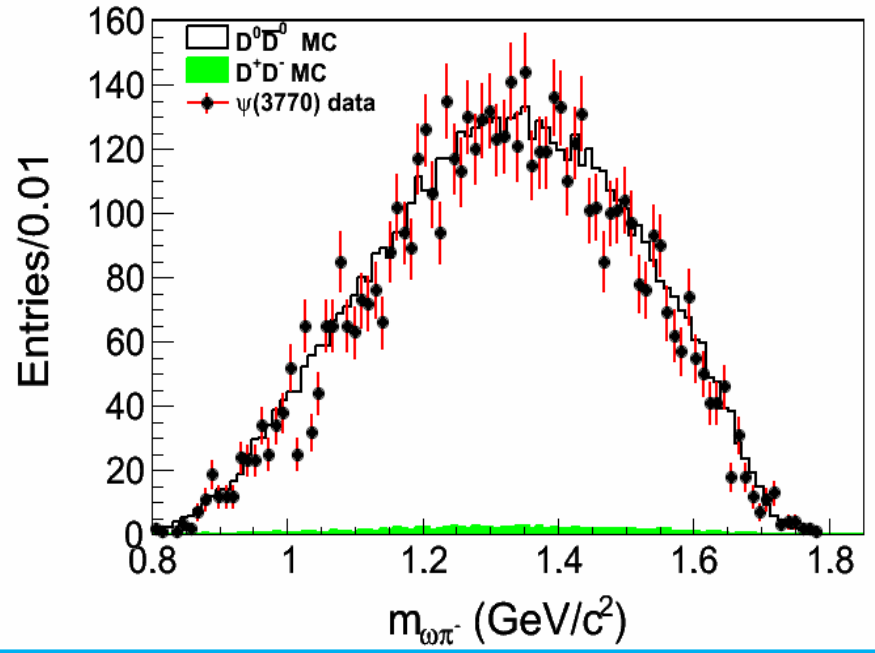


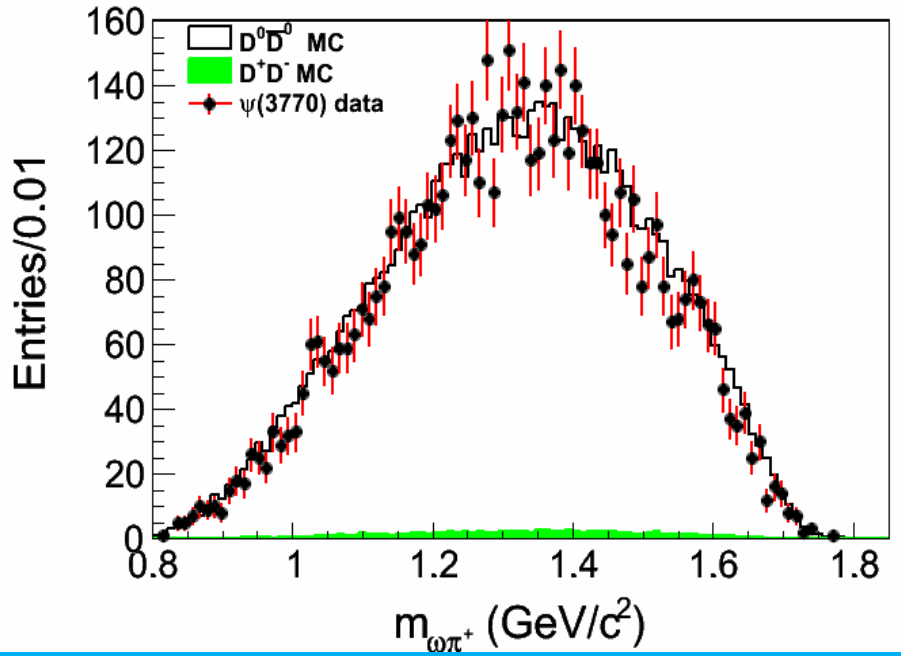
Data vs. MC


$D^0\bar{D}^0$ MC
D^+D^- MC
ψ(3770) data
Entries/0.0035
$m_{\pi^+\pi^-\pi^0}$ (GeV/c^2)

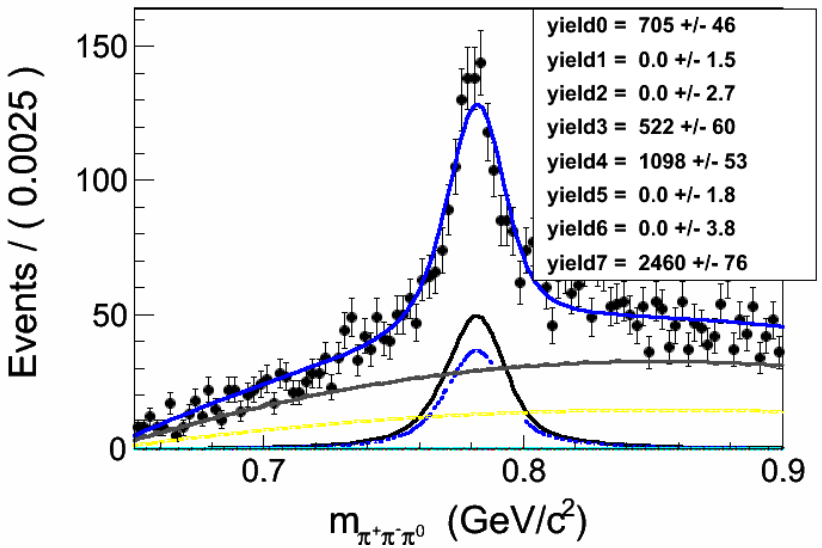

$D^0/\bar{D}^0 \to \rho X, \omega\pi^+\pi^-$ MC
D^+D^- MC
ψ(3770) data
Entries/0.01
$m_{\pi^+\pi^-}$ (GeV/c^2)

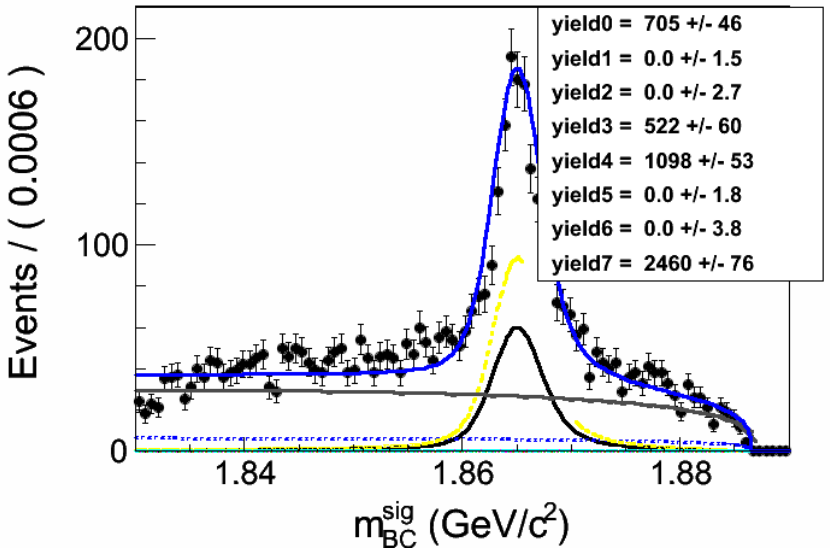

$D^0\bar{D}^0$ MC
D^+D^- MC
ψ(3770) data
Entries/0.006
$m^{\omega}_{\pi^+\pi^-}$ (GeV/c^2)

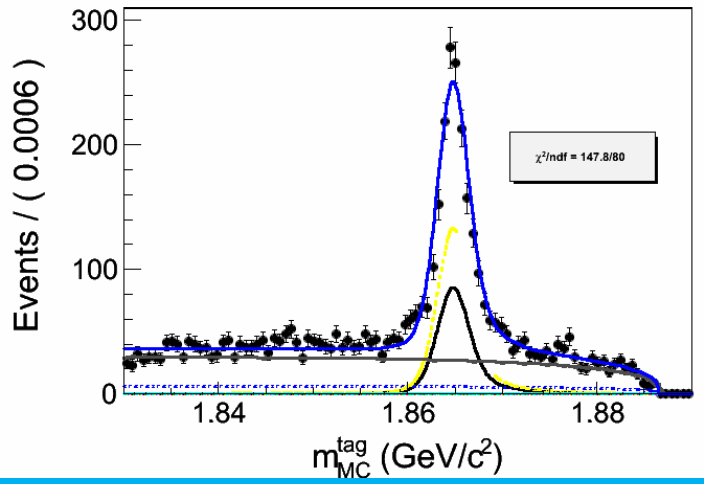

$D^0\bar{D}^0$ MC
D^+D^- MC
ψ(3770) data
Entries/0.01
$m_{\omega\pi^-}$ (GeV/c^2)


$D^0\bar{D}^0$ MC
D^+D^- MC
ψ(3770) data
Entries/0.01
$m_{\omega\pi^+}$ (GeV/c^2)

Signal Yield extraction: 3D ML fit







1	1	1
1	1	0
1	0	1
1	0	0
0	1	1
0	1	0
0	0	1
0	0	0

Double tag: $D^+ \to \omega\pi^+\pi^0$

Double tag: selection criteria

- Select the events of interests with exactly three charged tracks (two positive charged tracks and a negative charged track) and at least four photons from other charged tracks and neutral tracks , respectively.

Good charged tracks

$|V_r| < 1.0$ cm, $|V_z| < 10$ cm and $|\cos\theta| \leq 0.93$

PID requirement

prob(π) > prob(K), prob(π)>0

Good photons

Barrel region ($\cos\theta_\gamma < 0.8$): $E_\gamma > 25$ MeV
End-cap region ($0.86 < \cos\theta_\gamma < 0.92$): $E_\gamma > 50$ MeV
EMC timing: [0,14]×(50) ns, $\theta_{\gamma,x}\pm > 10$ degrees.

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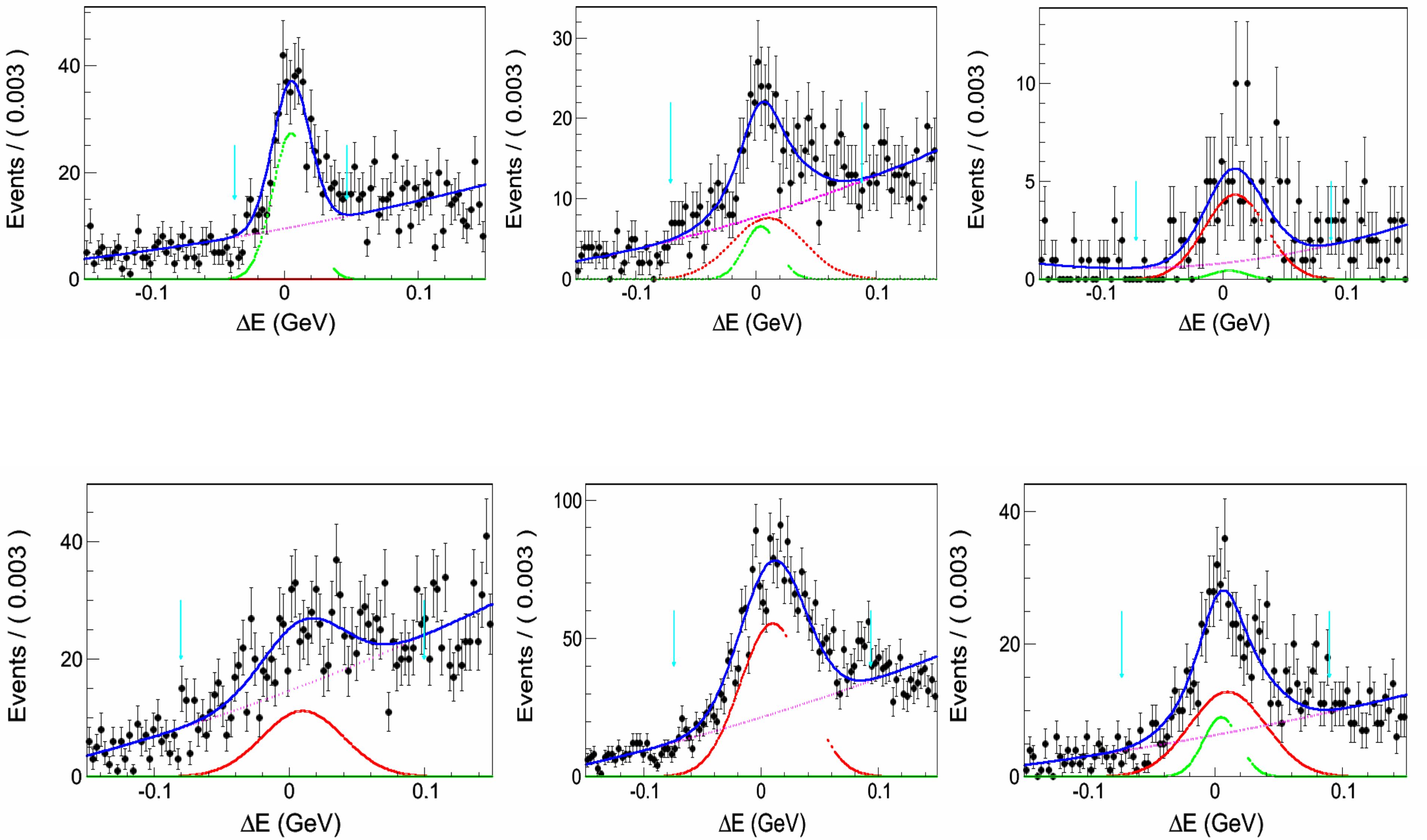
$m_{\gamma\gamma} = [0.03, 0.30]$ GeV/c^2
Mass constraint fit on π^0 ($\gamma\gamma$)

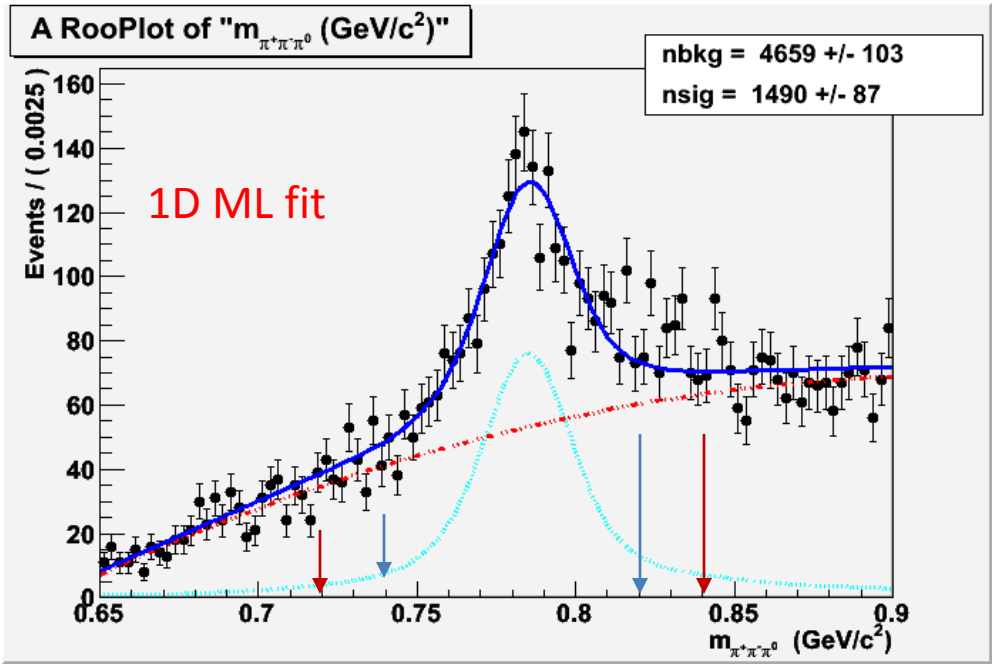
- Veto of K_S background: reject the events from the di-pion invariant mass regions of $0.475 < m_{\pi^+\pi^-} < 0.520$ GeV/c^2 and $0.478 < m_{\pi^0\pi^0} < 0.548$ GeV/c^2 in each combination of the di-pion system.

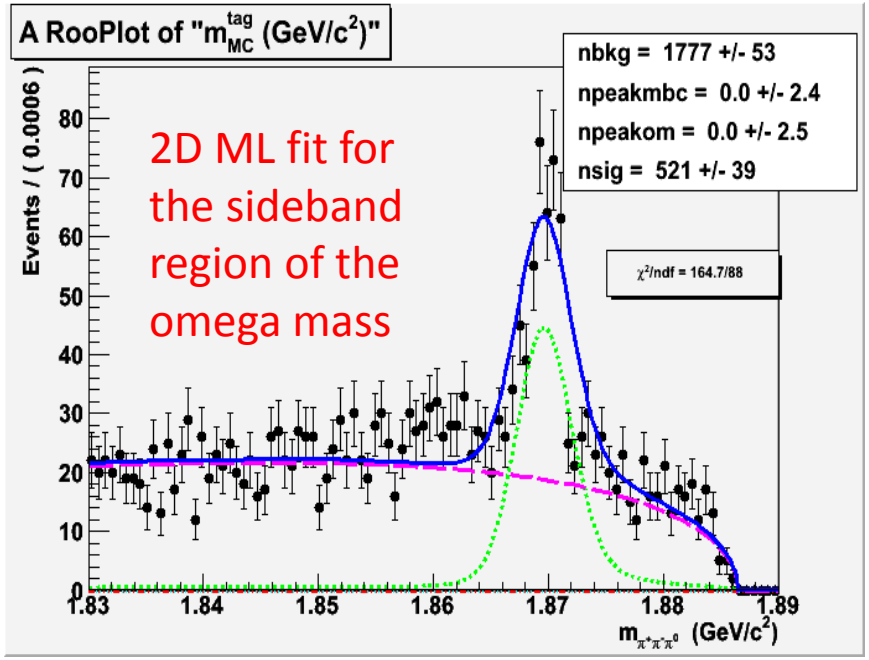
- Selection of ω signal: $\Delta m^2_{\pi^+\pi^-\pi^0} = (m_\omega^{PDG} - m_{\pi^+\pi^-\pi^0})^2/\sigma^2_\omega$

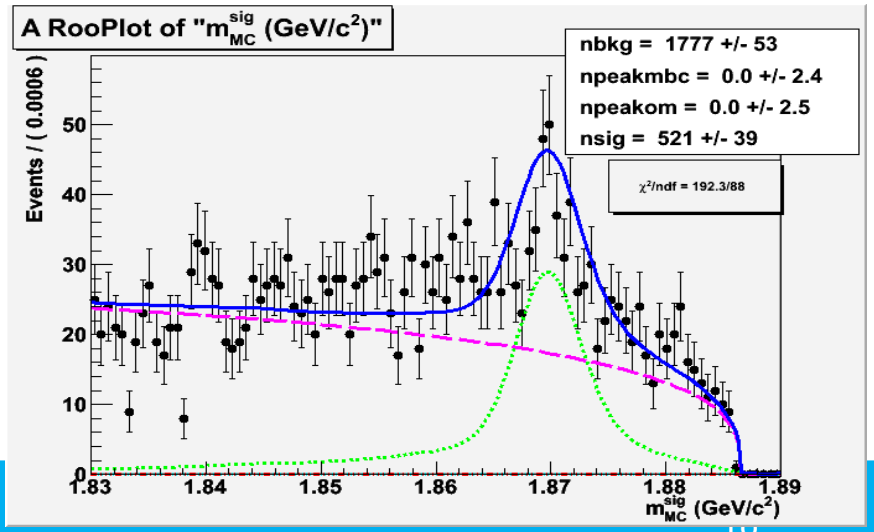
ΔE distribution: double tag



Signal Yield extraction: ML fit







Double tag: $D^0 \to \omega\pi^0\pi^0$

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Barrel region ($\cos\theta_\gamma < 0.8$): $E_\gamma > 25$ MeV
End-cap region ($0.86 < \cos\theta_\gamma < 0.92$): $E_\gamma > 50$ MeV
EMC timing: [0,14]×(50) ns, $\theta_{\gamma,x}\pm > 10$ degrees.

$\pi \rightarrow \gamma\gamma$ selection
$m_{\gamma\gamma} = [0.03, 0.30]$ GeV/c^2
Mass constraint fit on π^0 ($\gamma\gamma$)

- Veto of K_S background: reject the events from the di-pion invariant mass regions of $0.475 < m_{\pi^+\pi^-} < 0.520$ GeV/c^2 and $0.478 < m_{\pi^0\pi^0} < 0.548$ GeV/c^2 in each combination of the di-pion system.

- Selection of ω signal:

$$\Delta m^2_{\pi^+\pi^-\pi^0} = (m_\omega^{PDG} - m_{\pi^+\pi^-\pi^0})^2/\sigma^2_\omega$$

Signal Yield extraction: ML fit