

Analysis of $D^0 \rightarrow K_S^0 \pi^+ \pi^- \pi^0$

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Data Sample and MC Simulation

- BOSS version: 6.6.4.p02
- 2.93 fb⁻¹ data set @ $\psi(3770)$
- Inclusive MC

Physical Process	N _{evt}	Lum. Scale	
$e^+e^- \rightarrow \psi(3770) \rightarrow D^0D^0$ (QCMC)	87 M	10.8X	
$e^+e^- \rightarrow \psi(3770) \rightarrow D^+D^-$	91 M	10.8X	
$e^+e^- \rightarrow \psi(3770) \rightarrow \text{non-DD}$	15 M	10.8X (2010)	10.1X (2011)
$e^+e^- \rightarrow qq$ (KKMC),	366 M	7.8X (2010)	7.3X (2011)
$e^+e^- \rightarrow \gamma\psi(2S)$ (ISR)	102 M	10.8X (2010)	10.1X (2011)
$e^+e^- \rightarrow \gamma J/\psi$ (ISR)	33 M	10.8X (2010)	10.1X (2011)
$e^+e^- \rightarrow \tau^+\tau^-$	90 M	10.8X (2010)	10.1X (2011)
$e^+e^- \rightarrow \mu^+\mu^-$	92 M	5X	

Event Selection

Tracking:

$$V_r < 1 \text{ cm}, |V_z| < 10 \text{ cm}, \\ |\cos\theta| < 0.93.$$

PID:

$$P(K) > 0.00 \text{ and } P(K) > P(\pi) \text{ for } K. \\ P(\pi) > 0.00 \text{ and } P(\pi) > P(K) \text{ for } \pi.$$

K_S^0 reconstruction:

$$\text{Mass window: } M_{\pi^+\pi^-} (0.487, 0.511) \text{ GeV}/c^2, \\ \chi^2 \text{ of vertex fit} < 100, \\ \chi^2 \text{ of second vertex fit} < 500, \\ L(\text{decay}) / \sigma(\text{decay}) > 2.$$

π^0 reconstruction:

$$\text{Mass window: } M(\gamma\gamma) (0.115, 0.150) \text{ GeV}/c^2, \\ \chi^2 \text{ of 1C Kinematic fit} < 200.$$

Seven-Constraint (7C) Kinematic fit:

$$(p_i = \sum_f p_{fi}) + M(K_S^0) + M(\pi^0) + M(D^0), \\ \chi^2 \text{ of 7C} < 60.$$

Double Tag Method

Three golden tag modes:

$$D^0 \rightarrow K^- \pi^+$$

$$D^0 \rightarrow K^- \pi^+ \pi^0$$

$$D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-$$

If multiple candidates of D^0 ,
the one with $|\Delta E|_{\min}$ is selected.

Event Selection

Peaking background suppression:

if $|M(\pi^+\pi^-) - M_{K_0}| < 0.03 \text{ GeV}/c^2$, veto events satisfying:

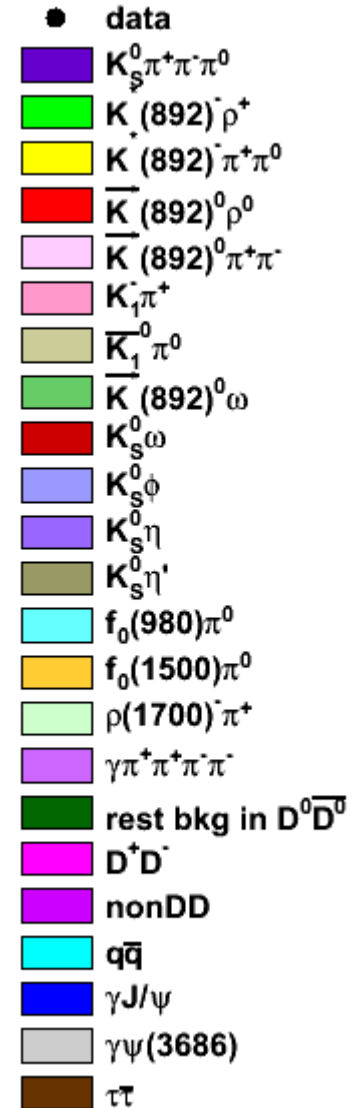
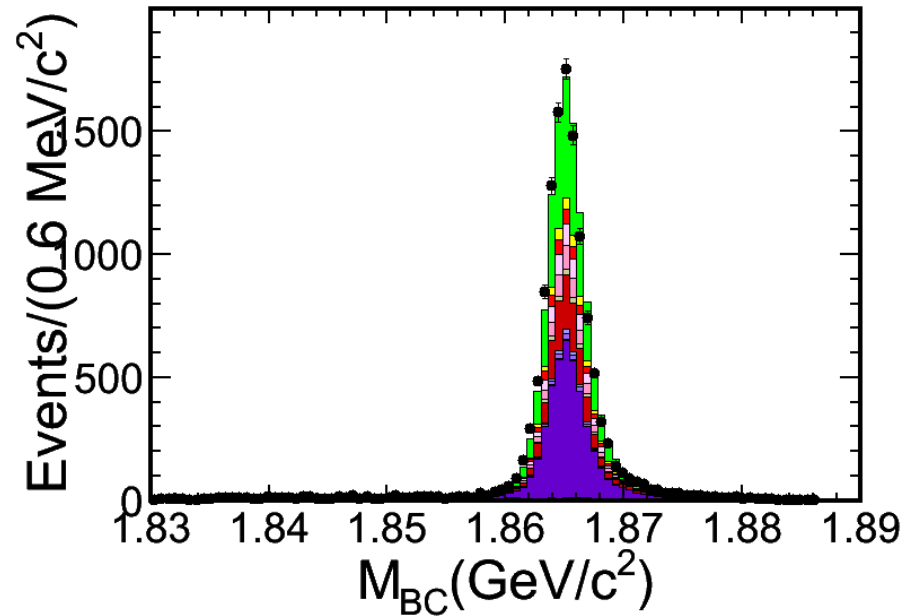
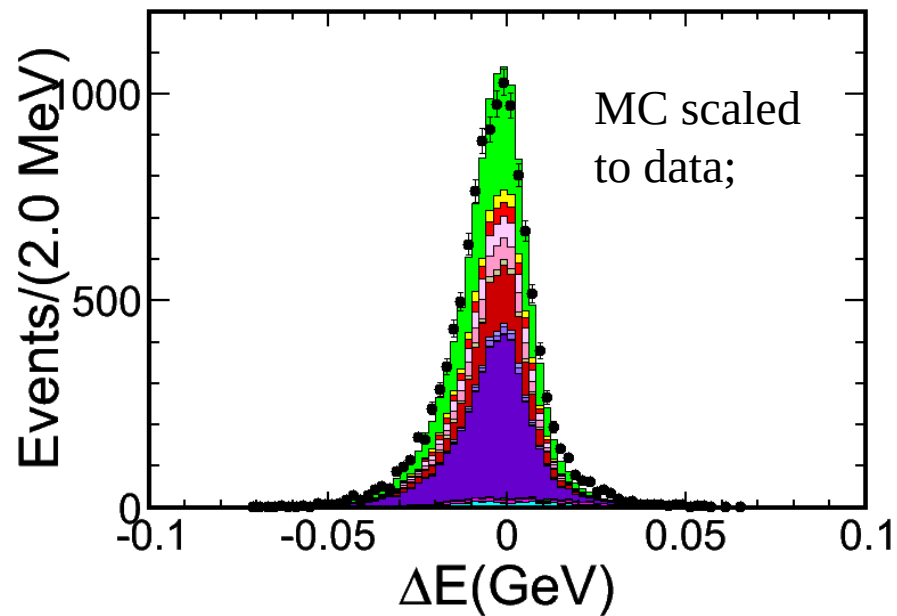
χ^2 of vertex fit < 1000 ,

χ^2 of second vertex fit < 500 ,

$L(\text{decay}) / \sigma(\text{decay}) > 2$.

ΔE and M_{BC} :

$$\Delta E = E_D - E_{\text{beam}}, M_{BC} = \sqrt{E_{\text{beam}}^2 - P_D^2}$$



Background Study

Peaking background

including K_S^0

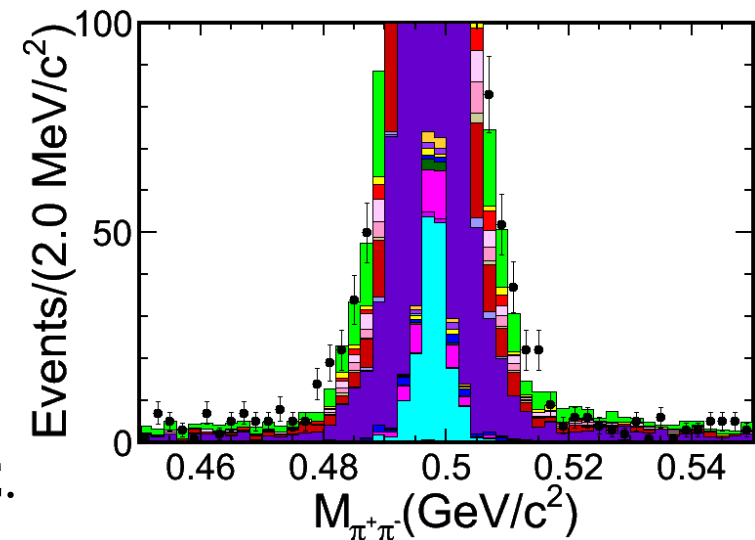
1. $D^0 \rightarrow K_S^0 K_S^0 \pi^0$: generic MC scaled to data: 8.1 evts; use MC sample to estimate this background;
2. $D^0 \rightarrow K_S^0 \eta' \rightarrow K_S^0 \gamma \pi^+ \pi^-$ final states, generic MC scale to data: 6.0 evts;
3. Negative weight likelihood to subtract;

non- K_S^0 :

K_S^0 sideband to estimate this background, the scaled magnitude ~ 48 ;

Non-peaking background:

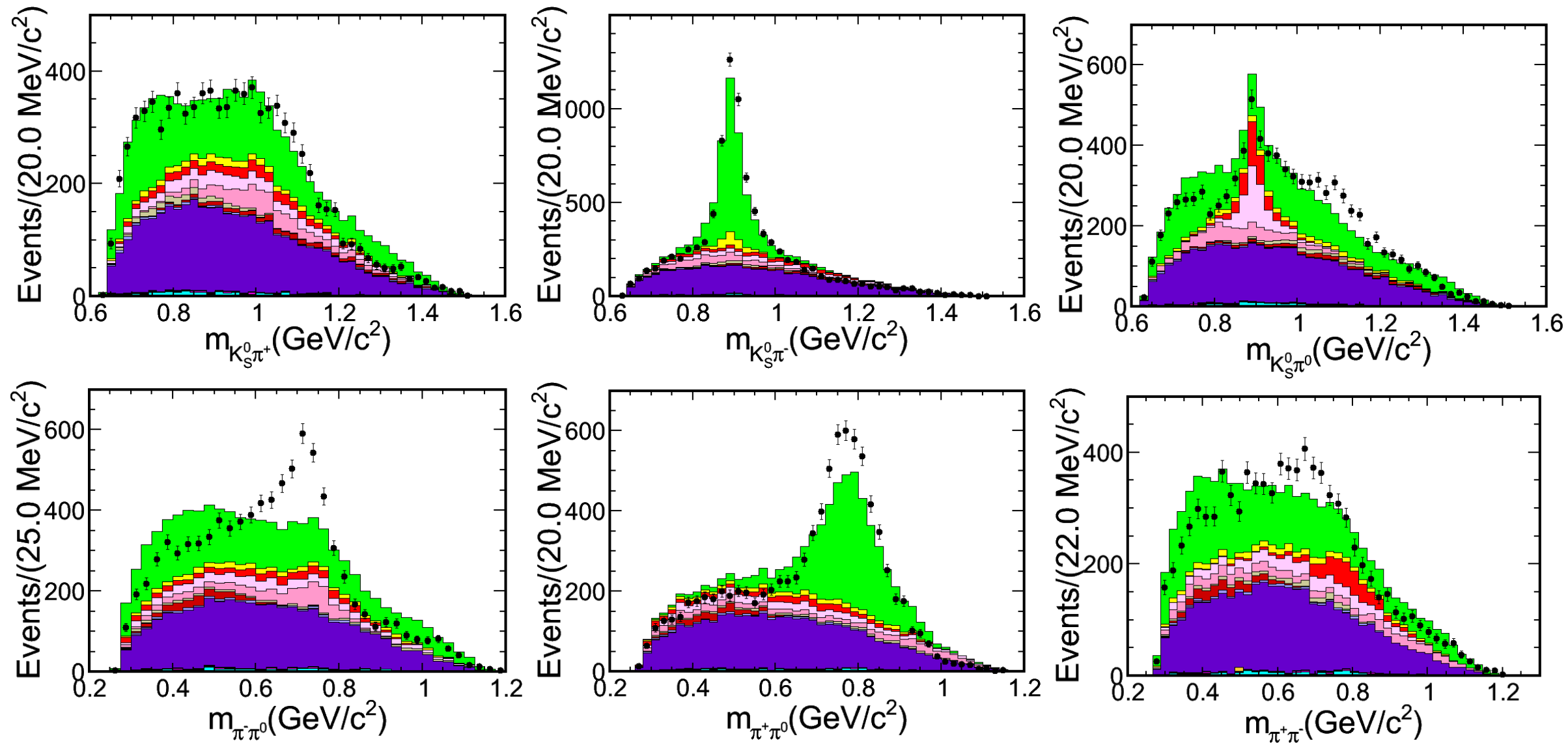
1. Study the possible non-peaking background using the generic MC.
2. Estimate this background from 2-D sideband.



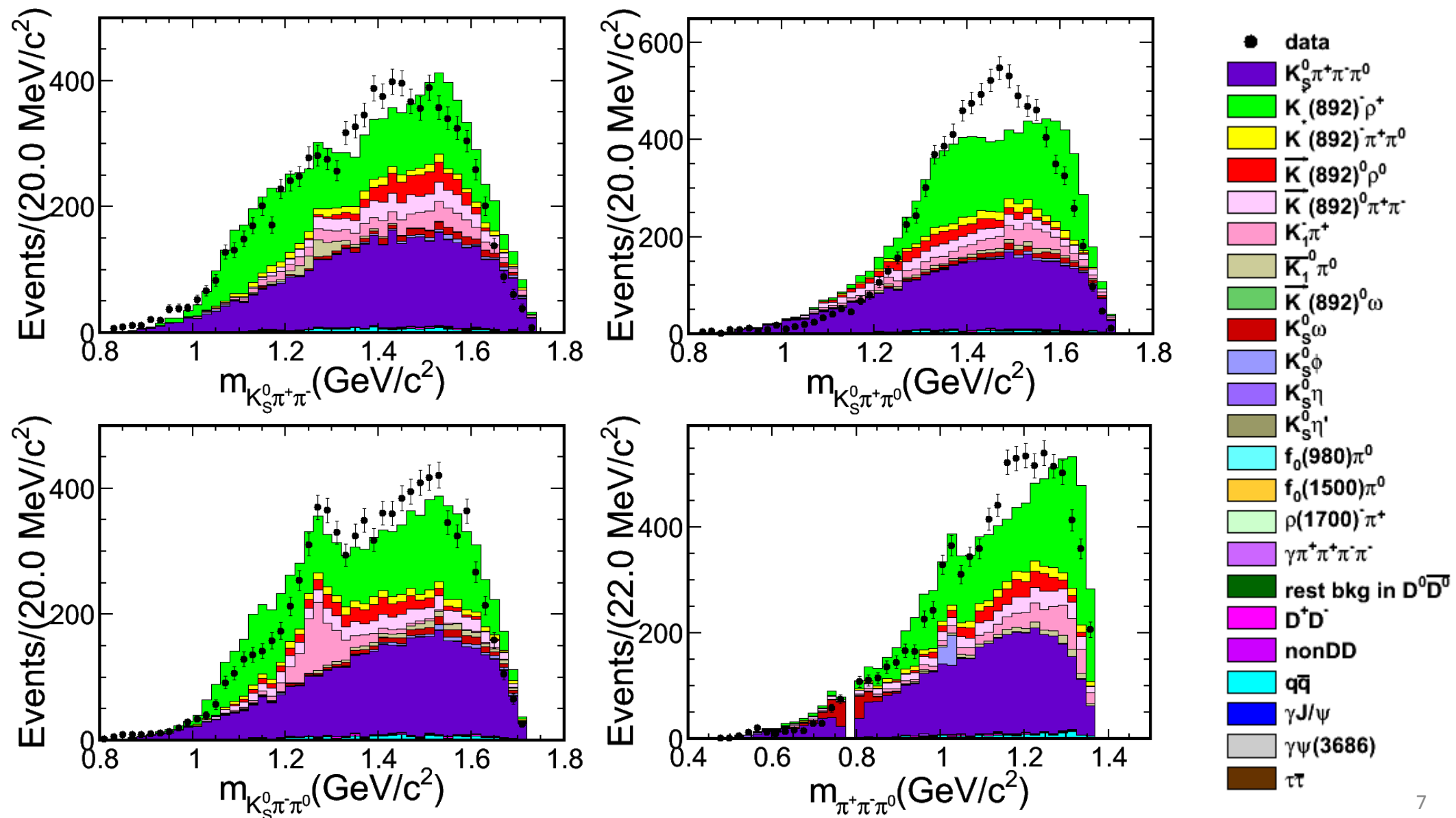
QCMC	D+D-	nonDD	qqbar	Radiative, $\mu^+\mu^-$, $\tau^+\tau^-$
6.4	41.2	3.5	178	~ 0

signal	bkg	Bkg ratio
10659	254	2.4%

Data & MC Comparison



Data & MC Comparison



Propagators

- BW or RBW propagators.
- For $K\pi$ S-wave, use LASS model extracted from scattering data, consisting of a $K_0^*(1430)$ BW together with an effective range non-resonant component with a phase shift.

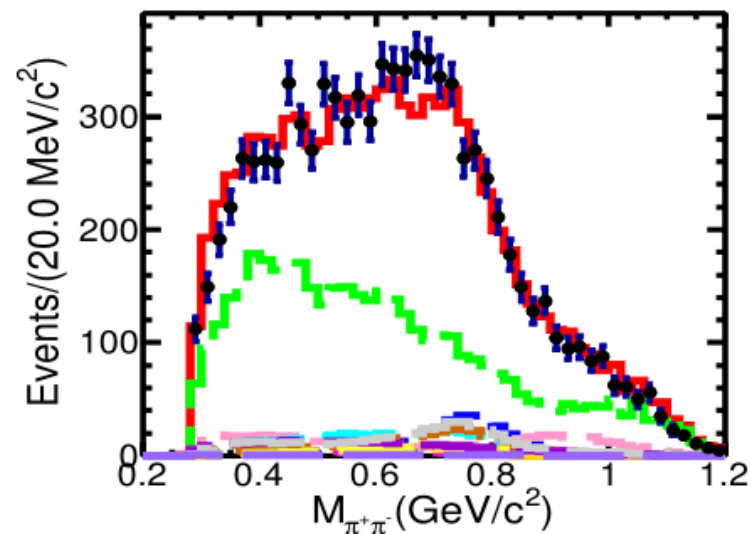
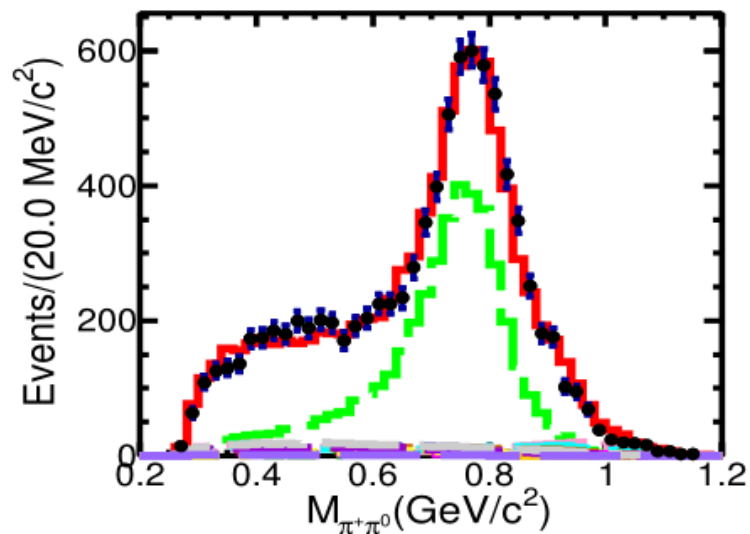
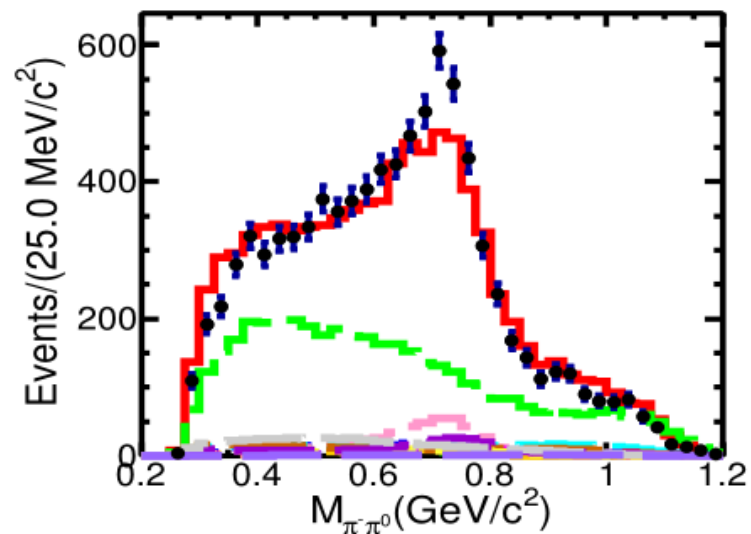
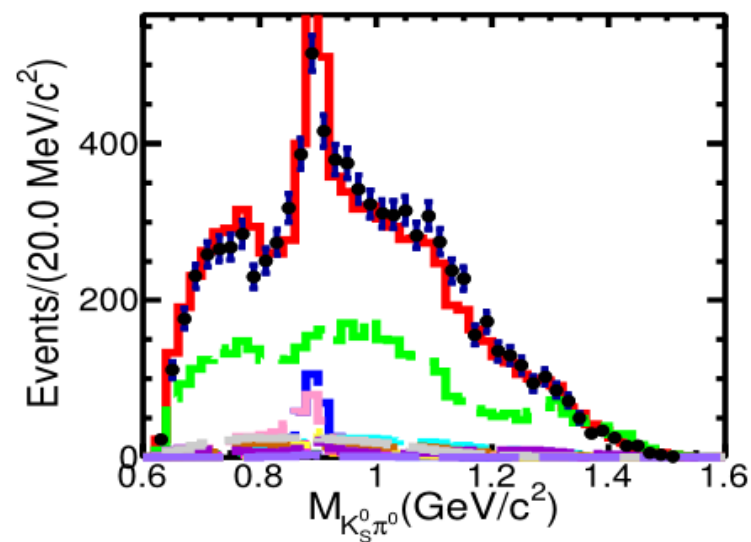
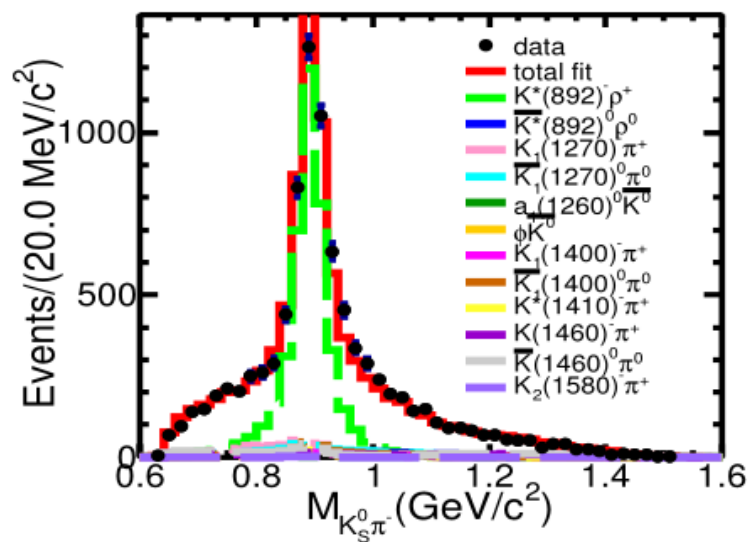
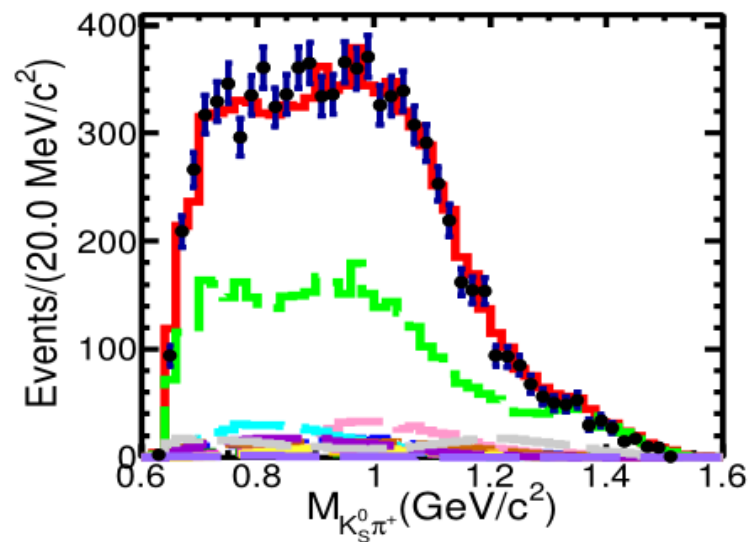
$$A(m) = F \sin \delta_F e^{i\delta_F} + R \sin \delta_R e^{i\delta_R} e^{i2\delta_F}$$

$$\delta_F = \phi_F + \cot^{-1} \left[\frac{1}{aq} + \frac{rq}{2} \right], \quad \delta_R = \phi_R + \tan^{-1} \left[\frac{M\Gamma(m_{K\pi})}{M^2 - m_{K\pi}^2} \right].$$

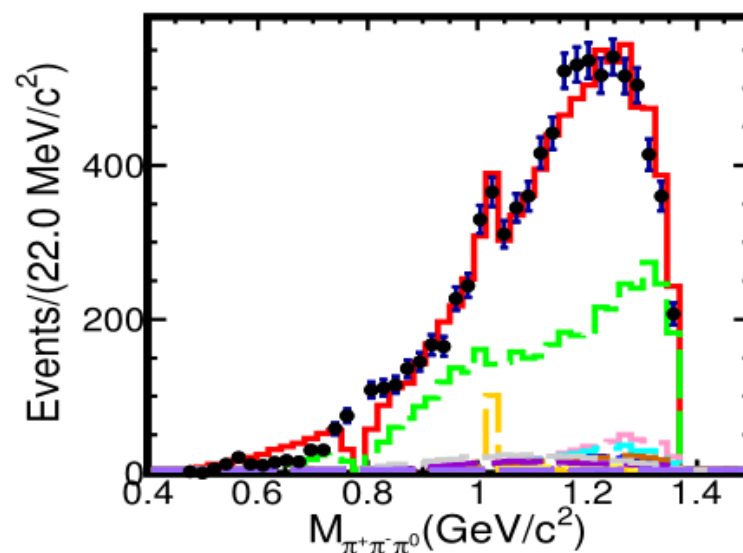
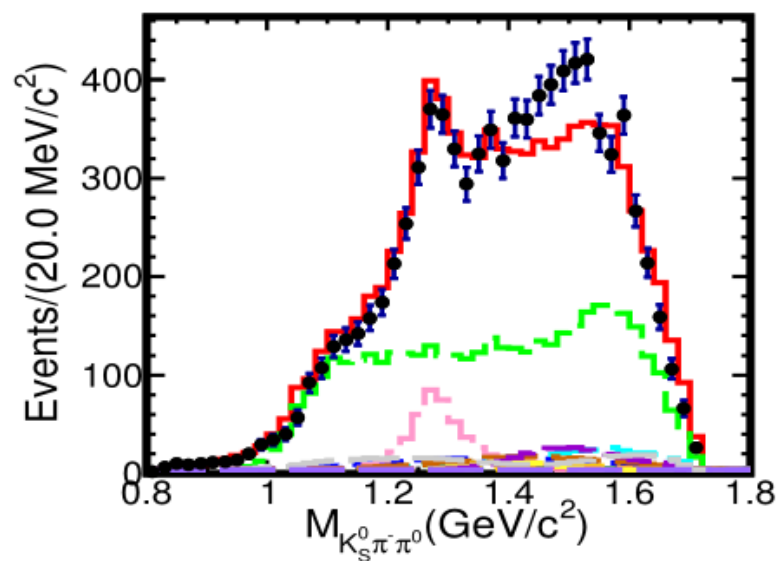
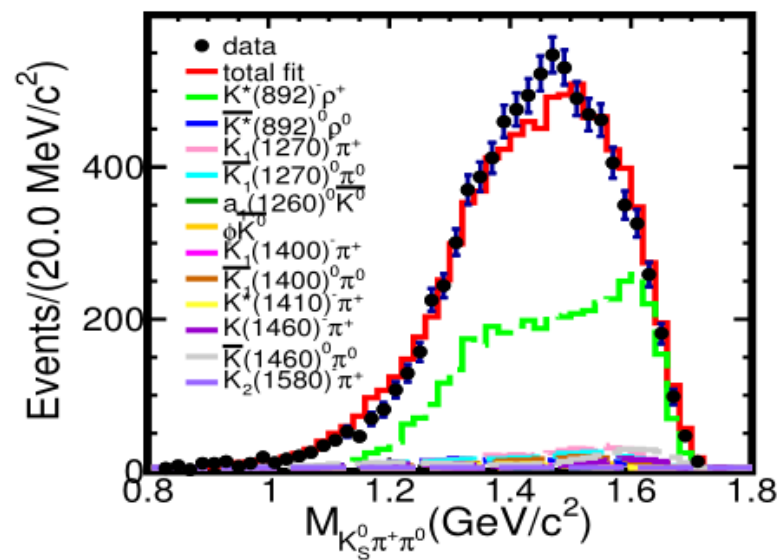
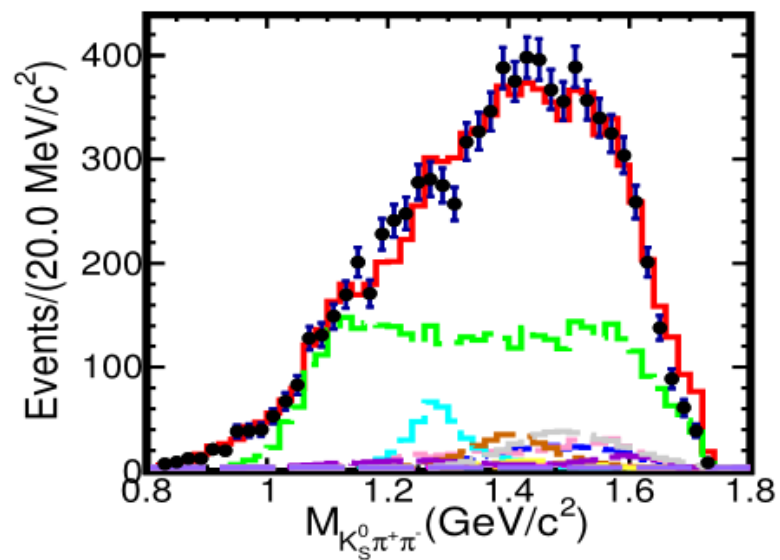
parameters $M, \Gamma, F, \phi_F, R, \phi_R, a$ and r , use the result from a fitting to a sample of $D^0 \rightarrow K_S^0 \pi \pi$ by BABAR.

- For ρ^0 , GS formula, consider the ρ - ω mixing.

Projection



Projection



Backup

