PWA of $e^+e^- \rightarrow K^+K^-\pi^0\pi^0$

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Amplitude

Φ+anything

$\Phi\sigma$

$\Phi f_0(980)$

$\Phi f_0(1370)$

$\Phi f_2(1270)$

$\Phi\pi^0\pi^0$

$\Phi(1600)\pi^0$

$K^{*+}K^{*-}$

$K^{*\pm}K^{\mp}\pi^0$

$K^*(1410)K$

$K_1(1400)K$

$K_1(1270)K$ ($K_1(1270)$->$K^*(892)\pi$

$K_1(1270)K$ ($K_1(1270)$->$K^*(1430)\pi$)

$K^{*+}{}_0(1430)K^{*-}$

$K^{*+}{}_2(1430)K^{*-}$ (|23> |43>)

$K^*{}_2$K ($K^*{}_2$-> $K^*\pi^0$)

$K^{*\pm}{}_2K^{\mp}\pi^0$

$K^{*\pm}{}_0K^{\mp}\pi^0$

R($\pi^0\pi^0$)+K^+K^-

$K^+K^-f_0(980)$

$K^+K^-\sigma$

$K^+K^-f_0(1370)$

$K^+K^-f_2(1270)$

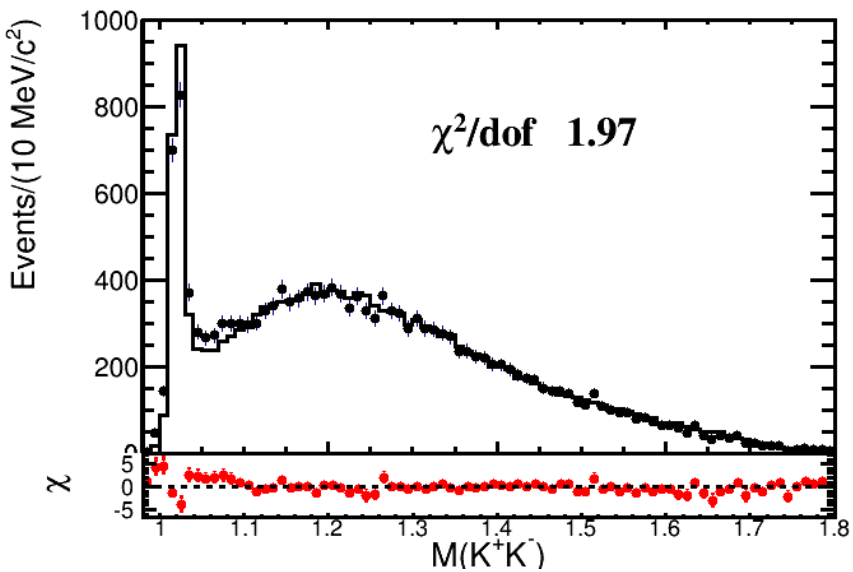
PHSP

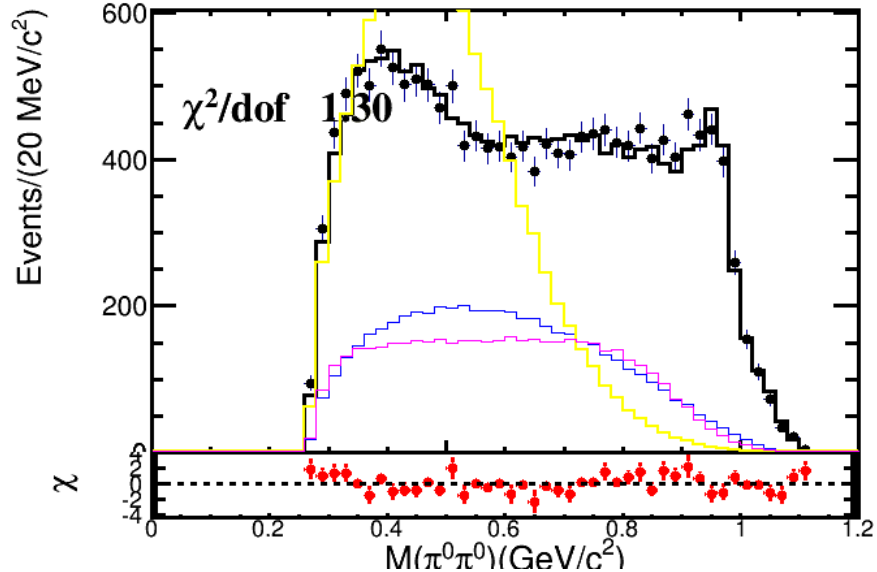
$K^+K^-\pi^0\pi^0$

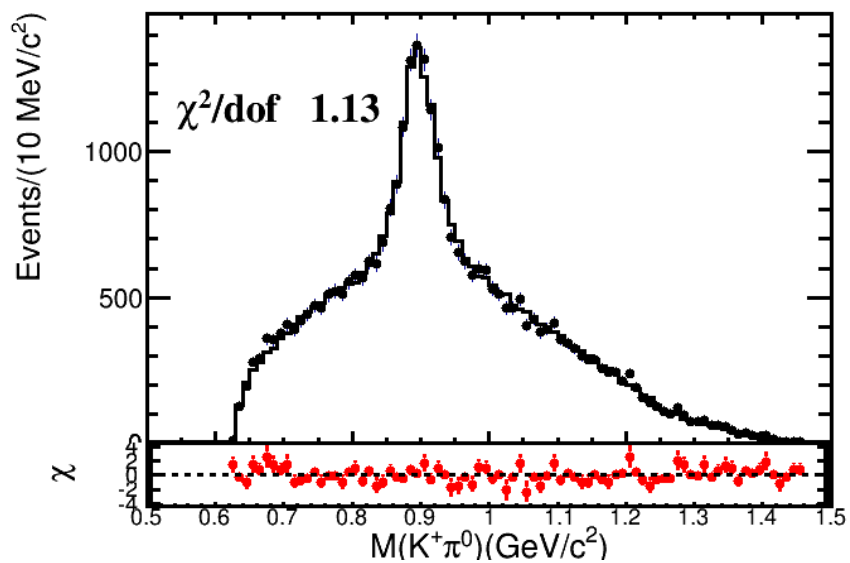
Phi mass window region:

|M(KpKm)-1.02|<0.02 GeV

Two Body

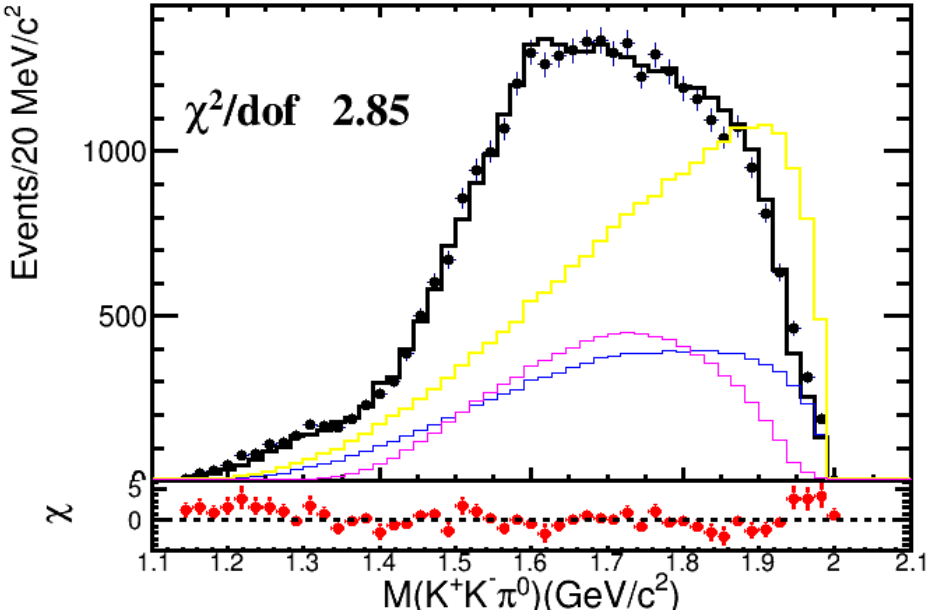


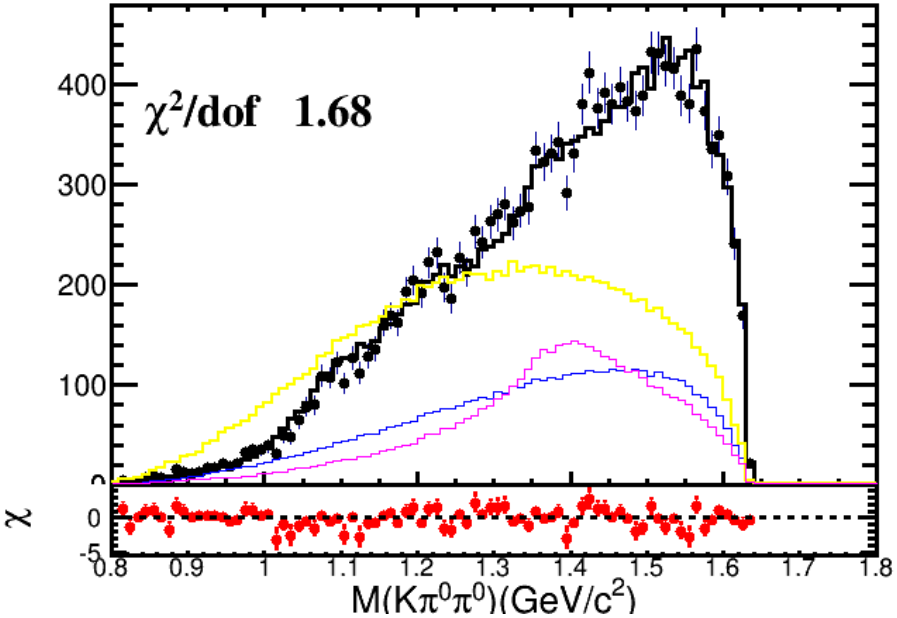




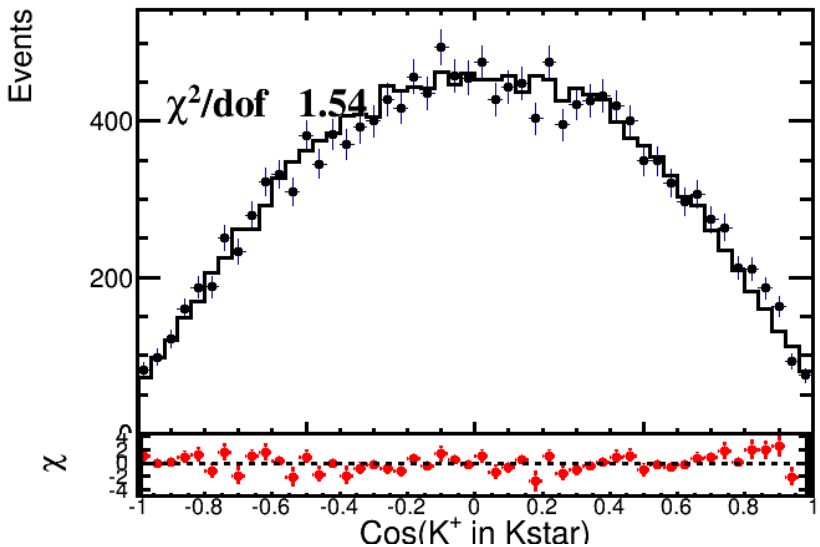
- Data
- Total Fit
- KK f0(1370)
- KK Sigma
- K11400K

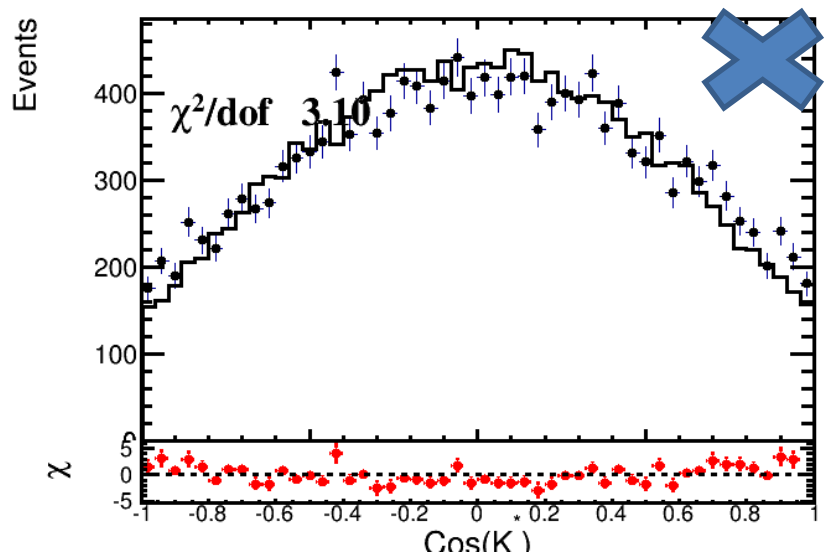
Three body

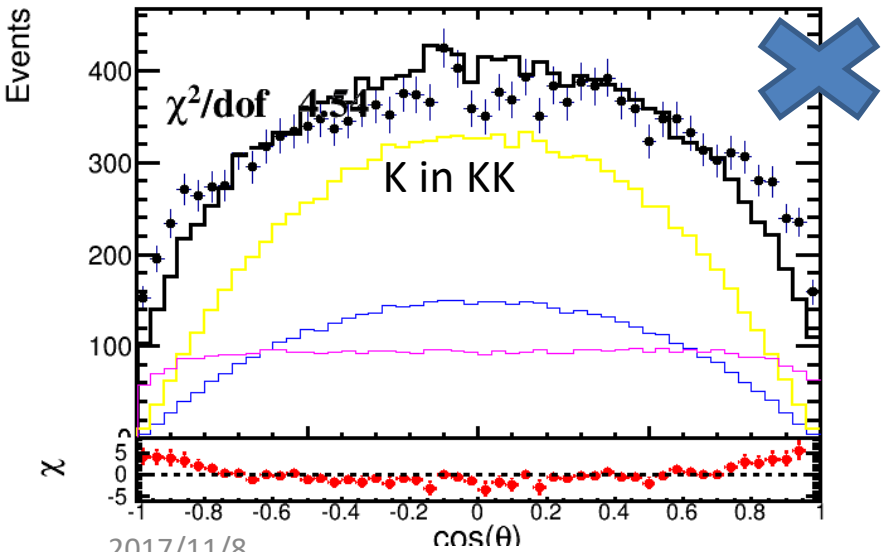

Events/20 MeV/c²
χ²/dof 2.85
1000
500
0
χ
5
0
1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2 2.1
M(K⁺K⁻π⁰)(GeV/c²)


χ²/dof 1.68
400
300
200
100
0
χ
0
-5
0.8 0.9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8
M(Kπ⁰π⁰)(GeV/c²)

Angle distribution







Data

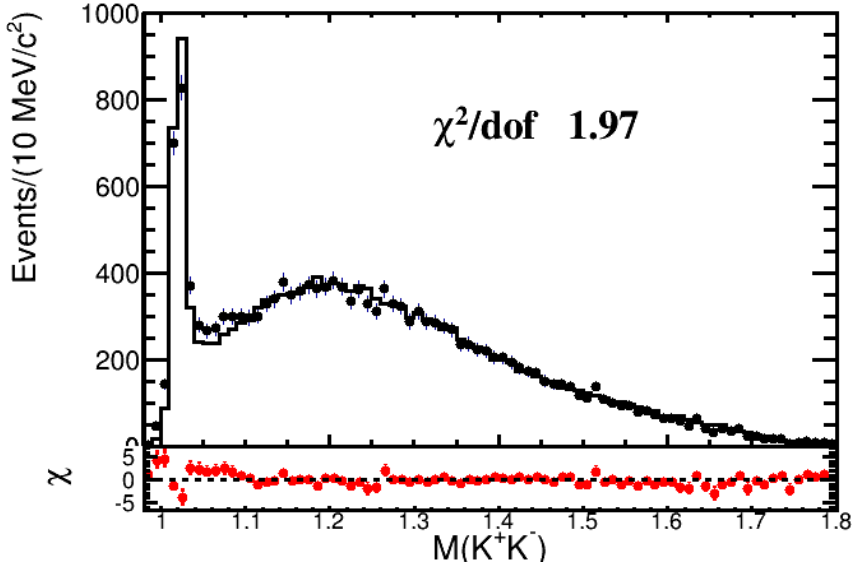
Total Fit

KK f0(1370)

KK Sigma

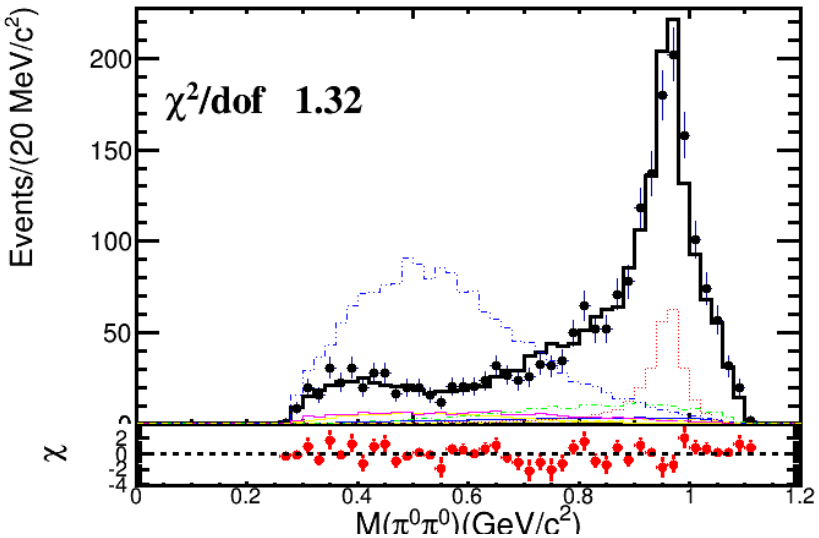
K11400K

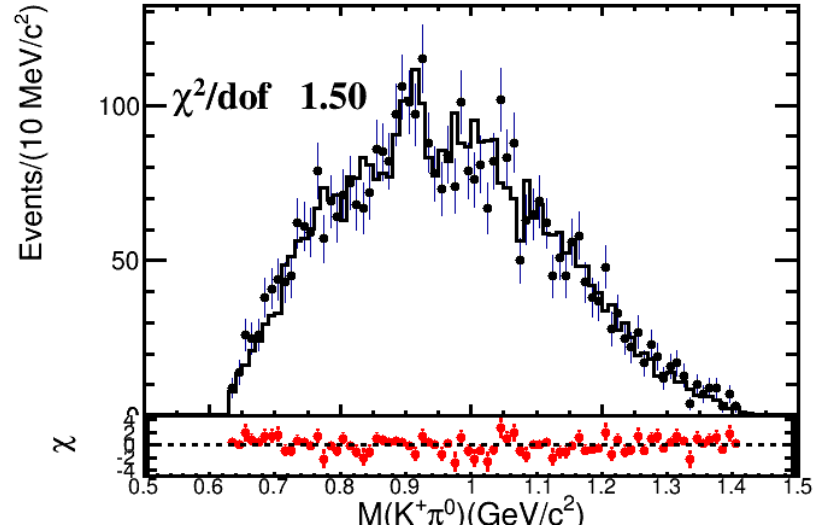
Phi mass window requirement

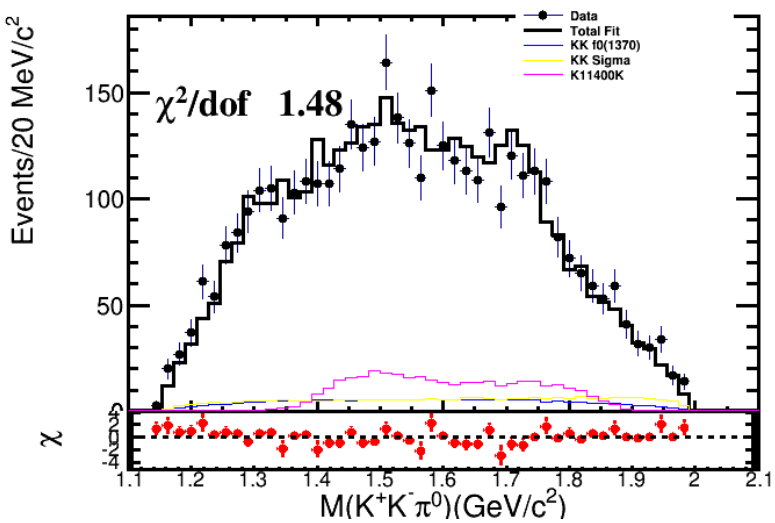


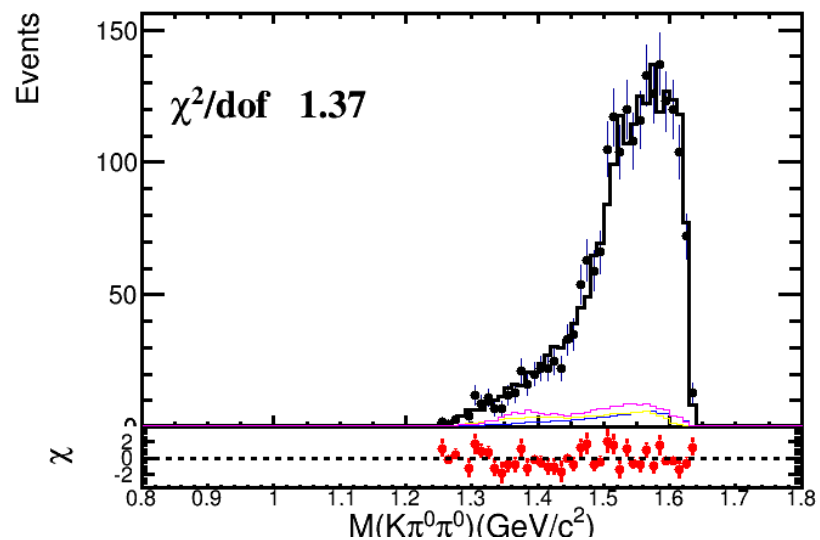
$$|\phi(1020) - 1.02| < 0.02\ \mathrm{GeV}$$

$|\phi(1020) - 1.02| < 0.02$ GeV

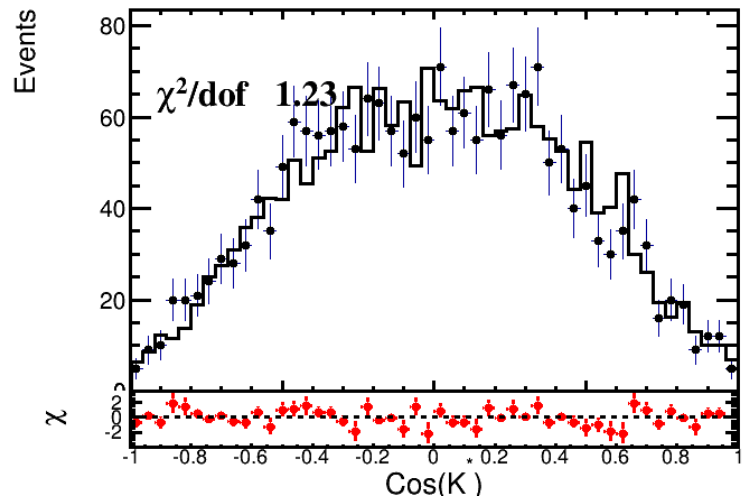


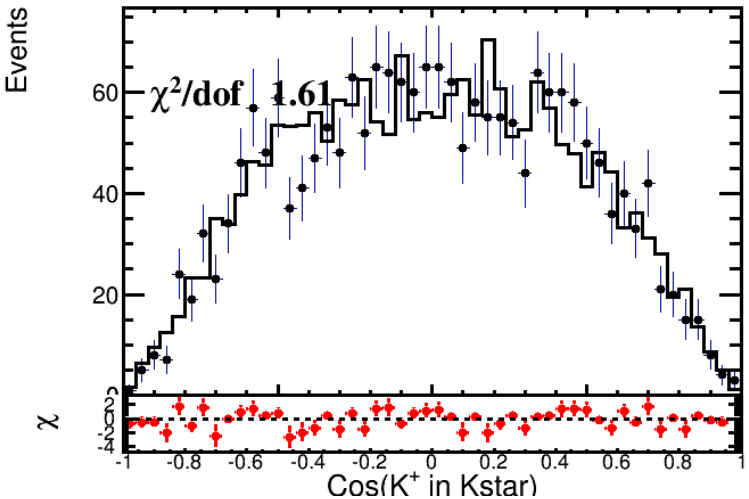


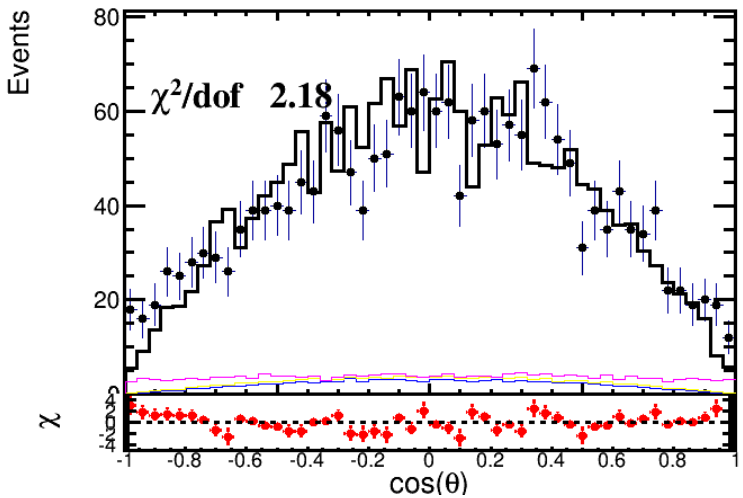




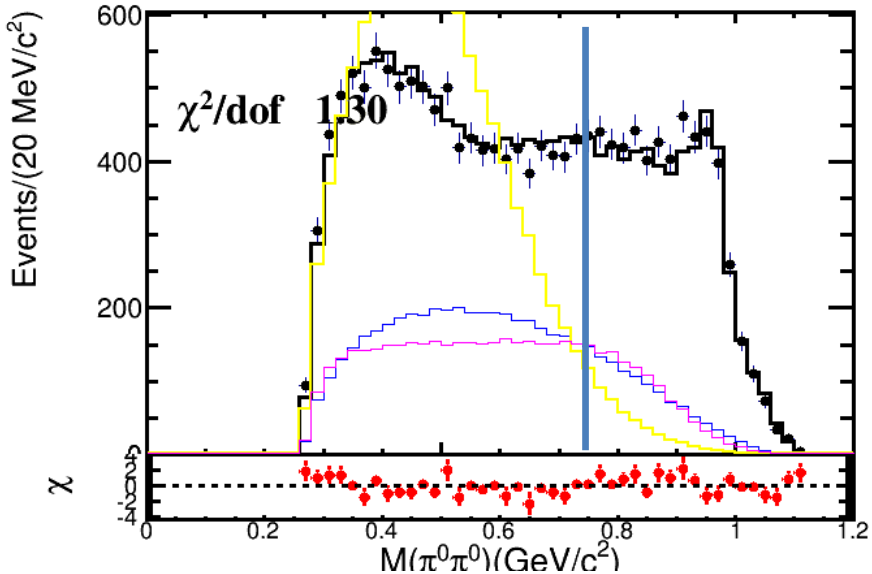
$|\phi(1020) - 1.02| < 0.02$ GeV



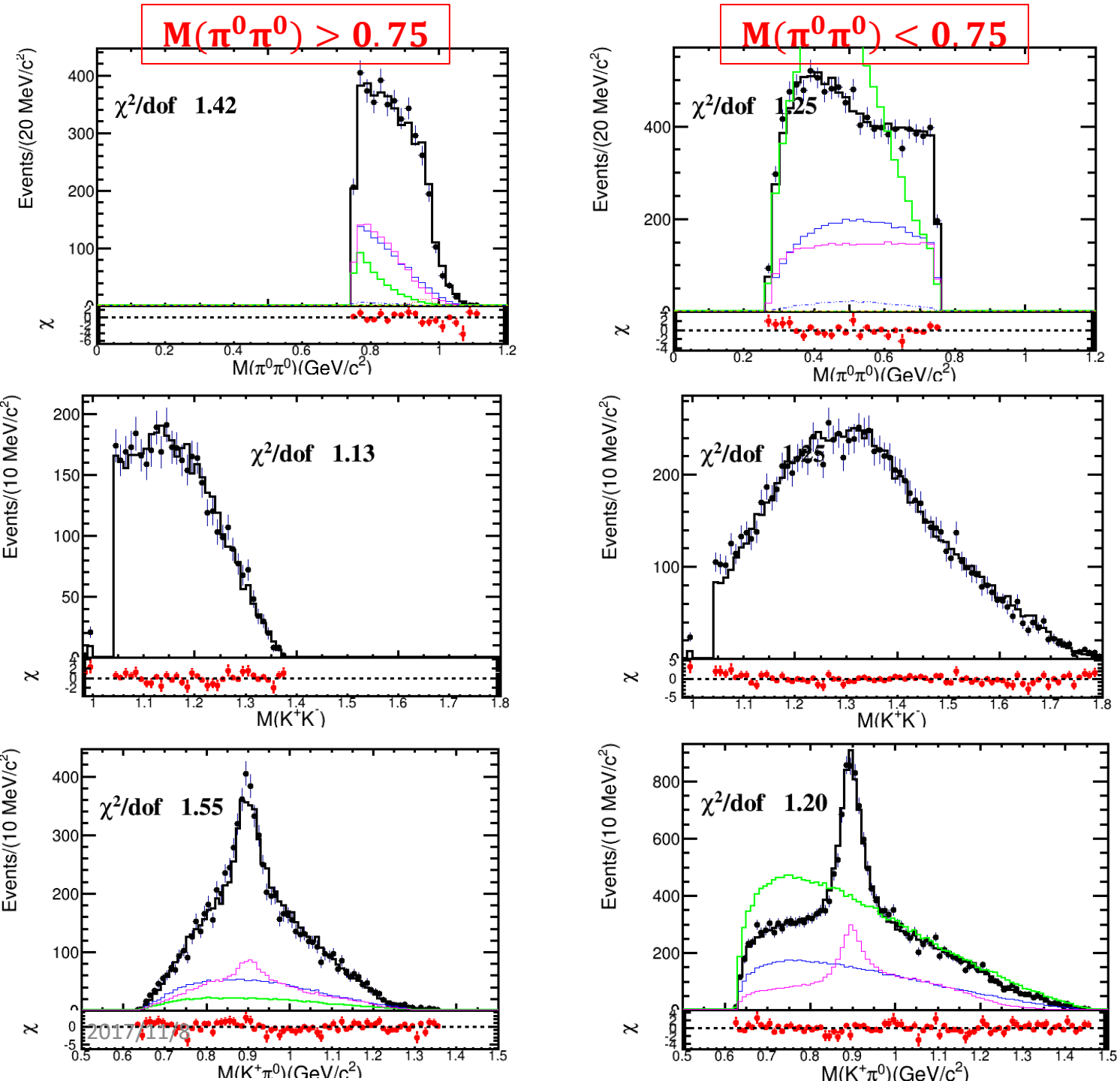




$M(\pi^0\pi^0)$ mass window requirement

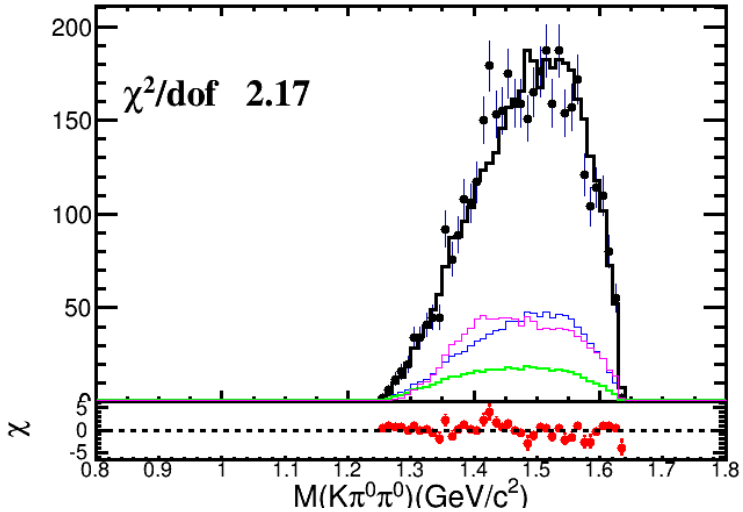


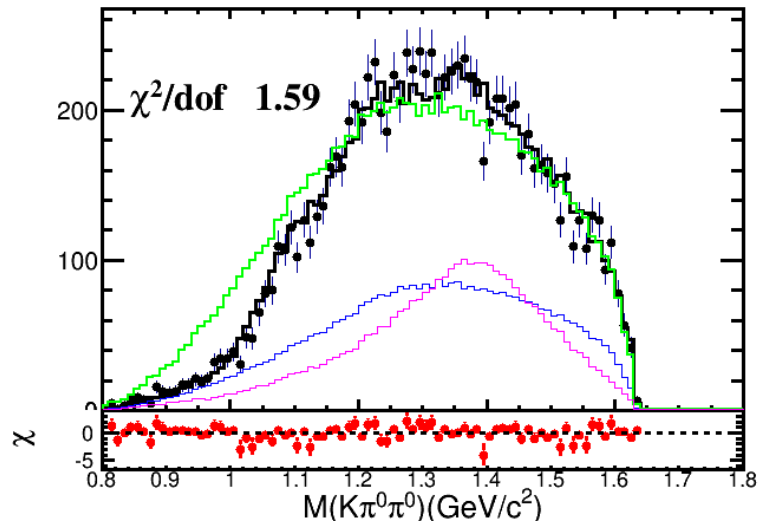
$$\mathbf{M(\pi^0\pi^0) < 0.75}$$

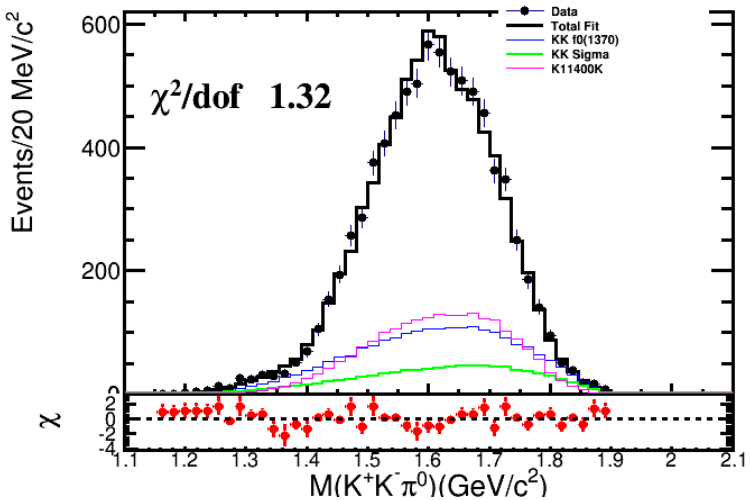

$M(\pi^0\pi^0) > 0.75$
$M(\pi^0\pi^0) < 0.75$
χ^2/dof 1.42
χ^2/dof 1.25
χ^2/dof 1.13
χ^2/dof 1.25
χ^2/dof 1.55
χ^2/dof 1.20
Events/(20 MeV/c^2)
Events/(10 MeV/c^2)
χ
$M(\pi^0\pi^0)$(GeV/c^2)
$M(K^+K^-)$
$M(K^+\pi^0)$(GeV/c^2)

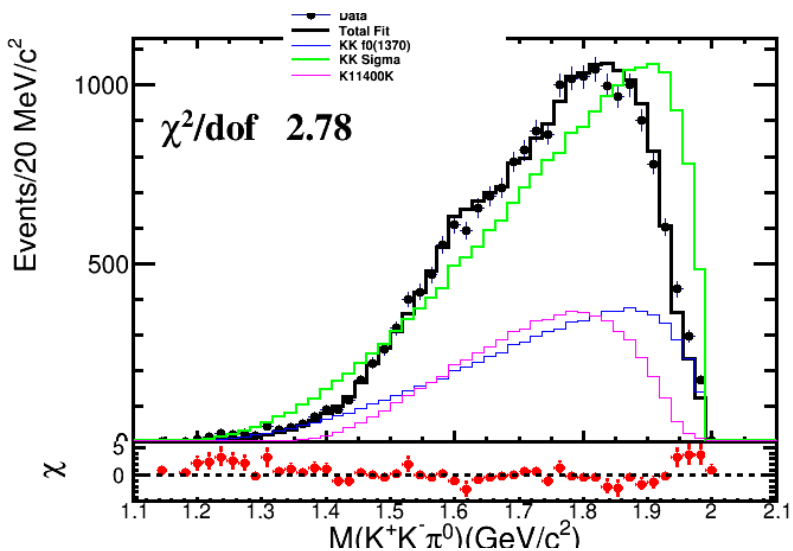
$M(\pi^0\pi^0) > 0.75$

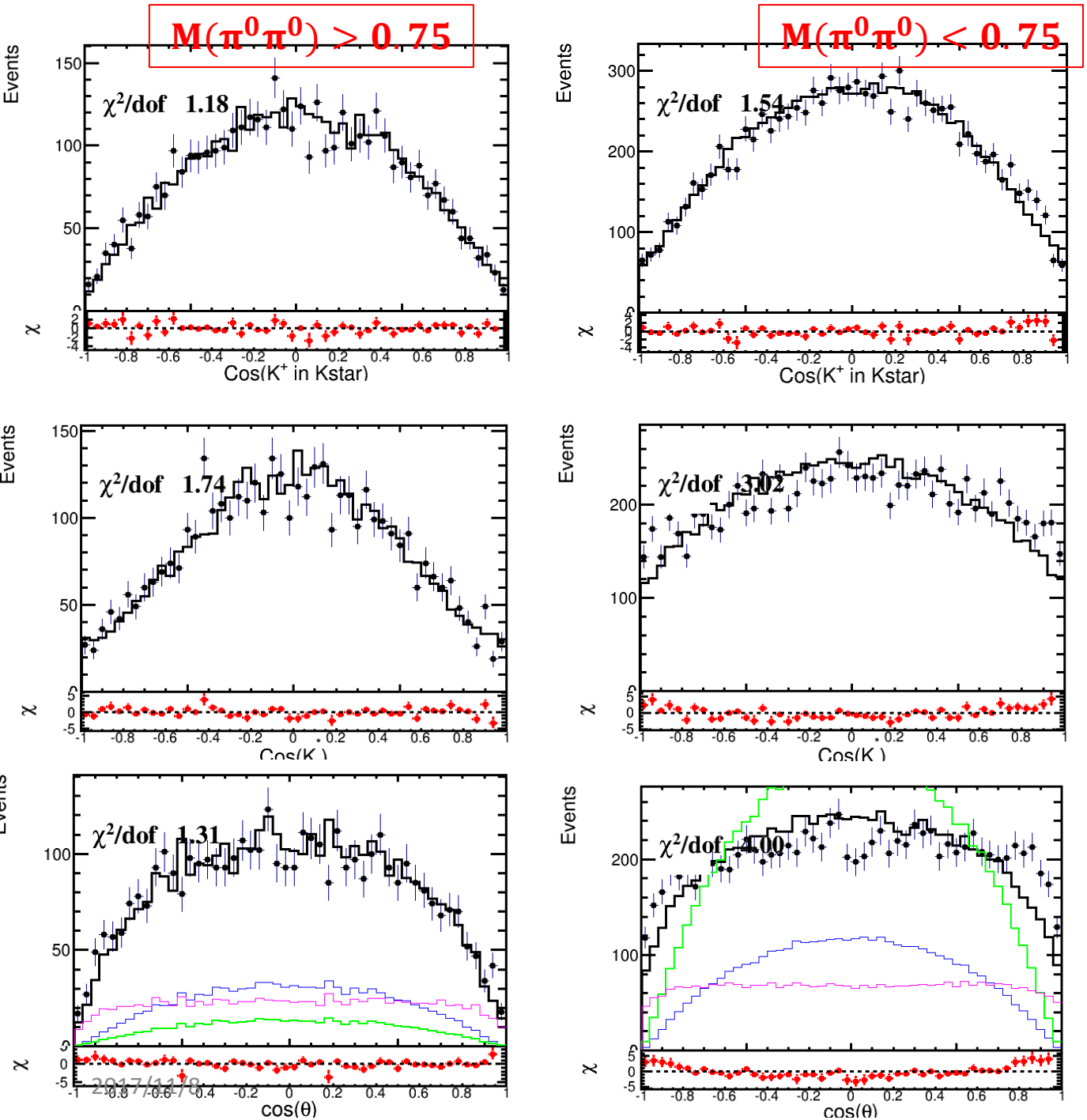
$M(\pi^0\pi^0) < 0.75$





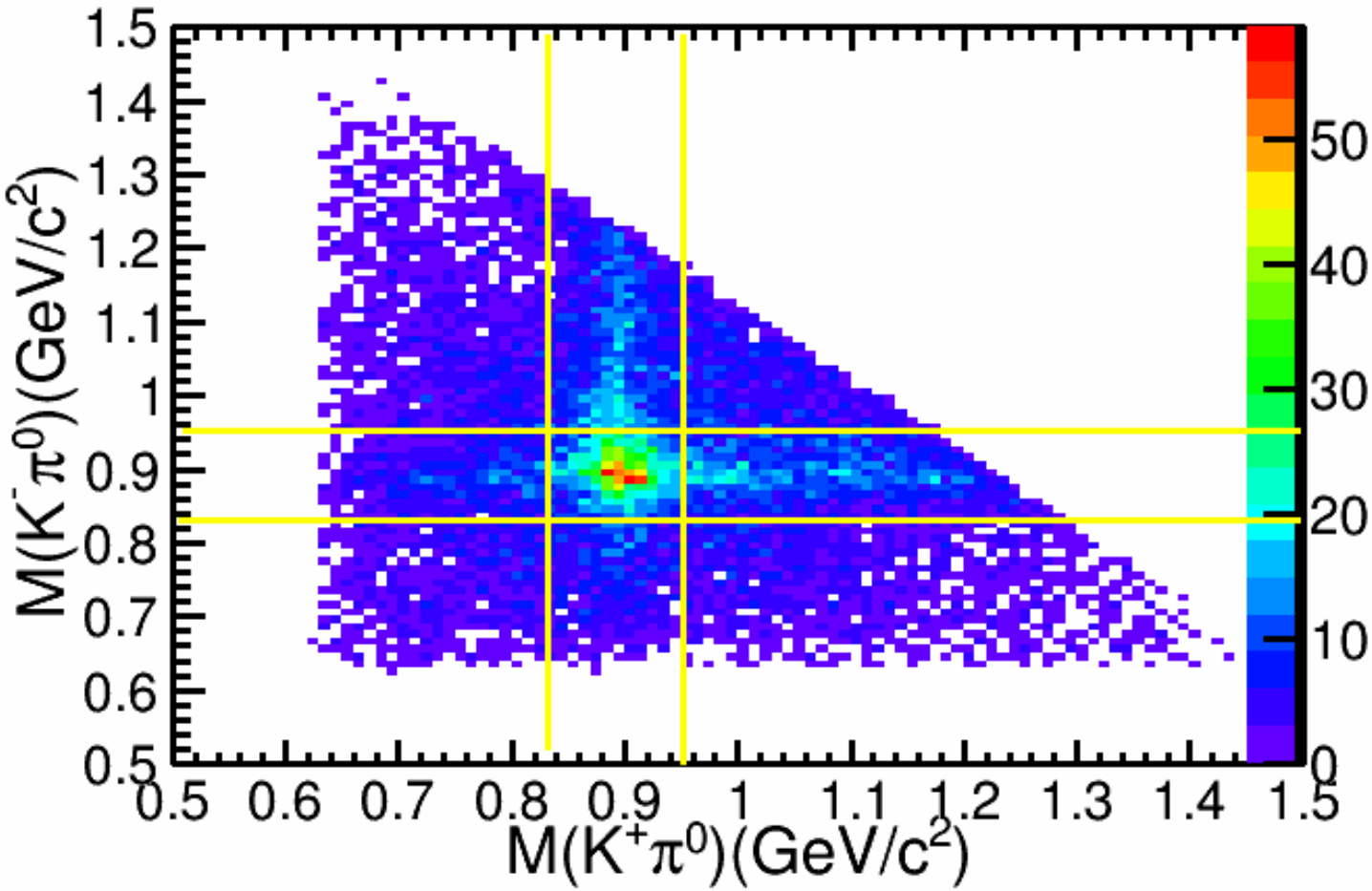


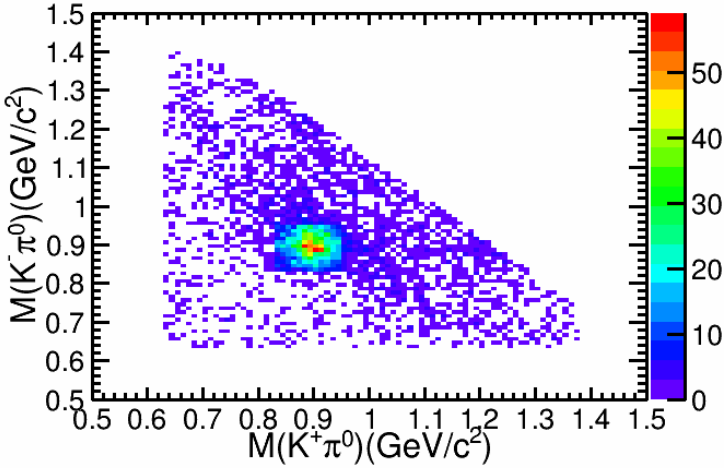



$M(\pi^0\pi^0) > 0.75$
$M(\pi^0\pi^0) < 0.75$
Events
χ^2/dof 1.18
χ^2/dof 1.54
χ^2/dof 1.74
χ^2/dof 3.02
χ^2/dof 1.31
χ^2/dof 4.00
χ
Cos(K$^+$ in Kstar)
Cos(K*)
cos(θ)

2D Distribution

$$M(K^+\pi^0) vs M(K^-\pi^0)$$





Region 1

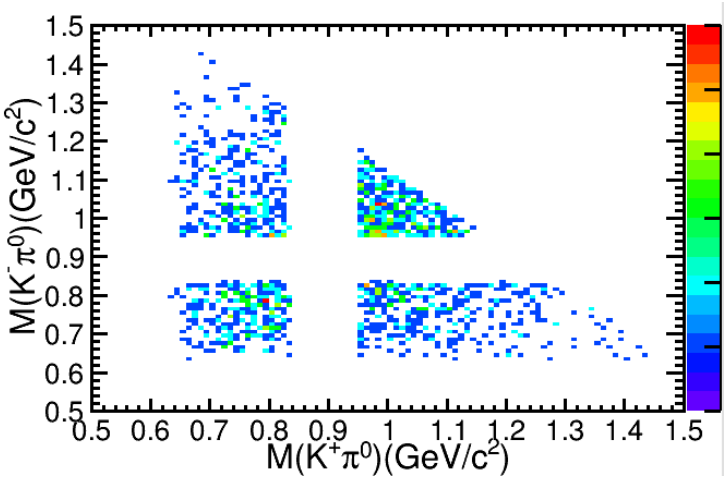
$$|K^+\pi_1 - 0.892| < 0.06\ \text{GeV}\ \&\&\ |K^-\pi_2 - 0.892| < 0.06\ \text{GeV}$$

or $$|K^+\pi_2 - 0.892| < 0.06\ \text{GeV}\ \&\&\ |K^-\pi_1 - 0.892| < 0.06\ \text{GeV}$$

Region 2

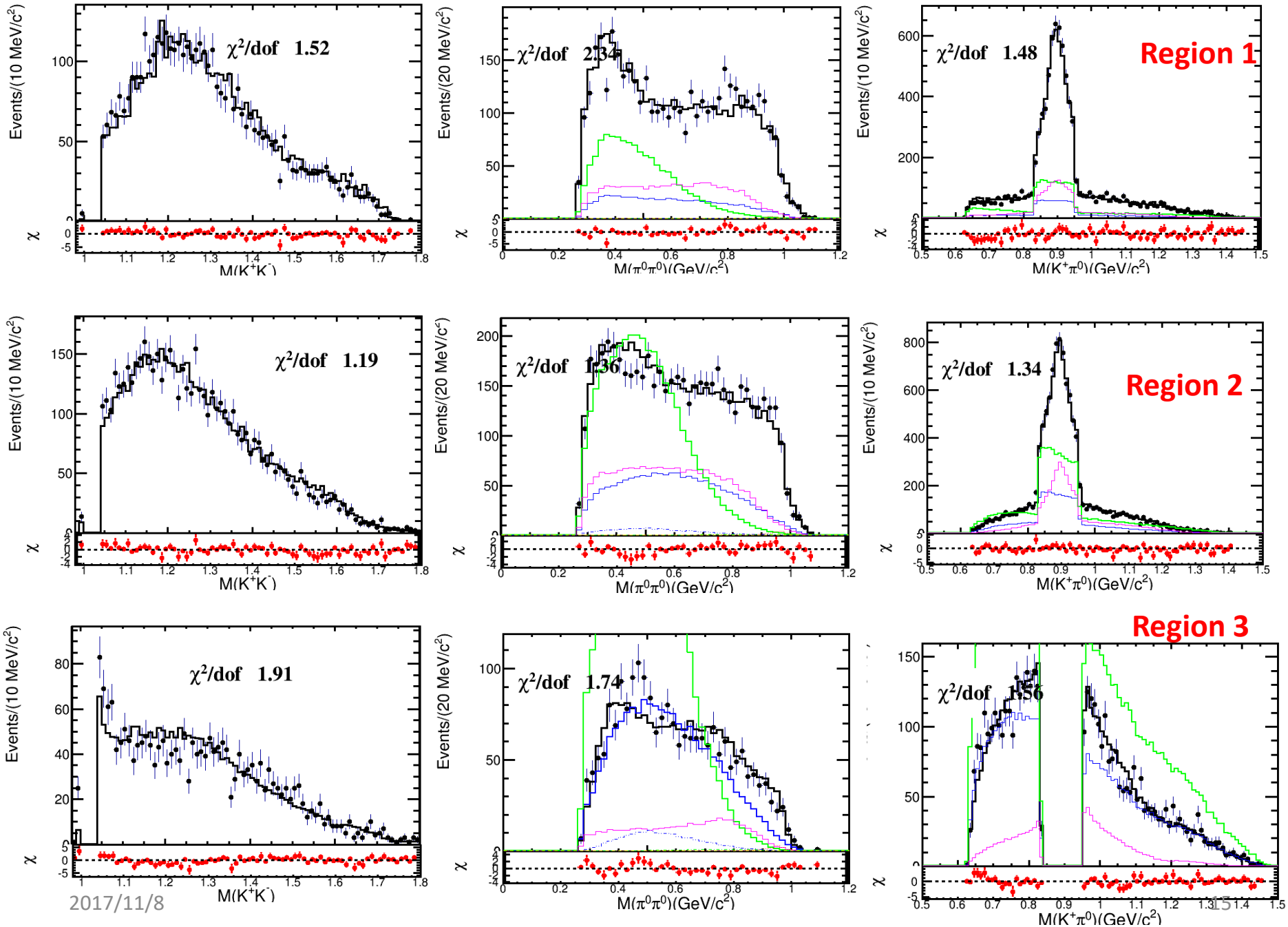
$$|K^+\pi_1 - 0.892| < 0.06\ \text{GeV}\ \&\&\ |K^-\pi_2 - 0.892| > 0.06\ \text{GeV}$$

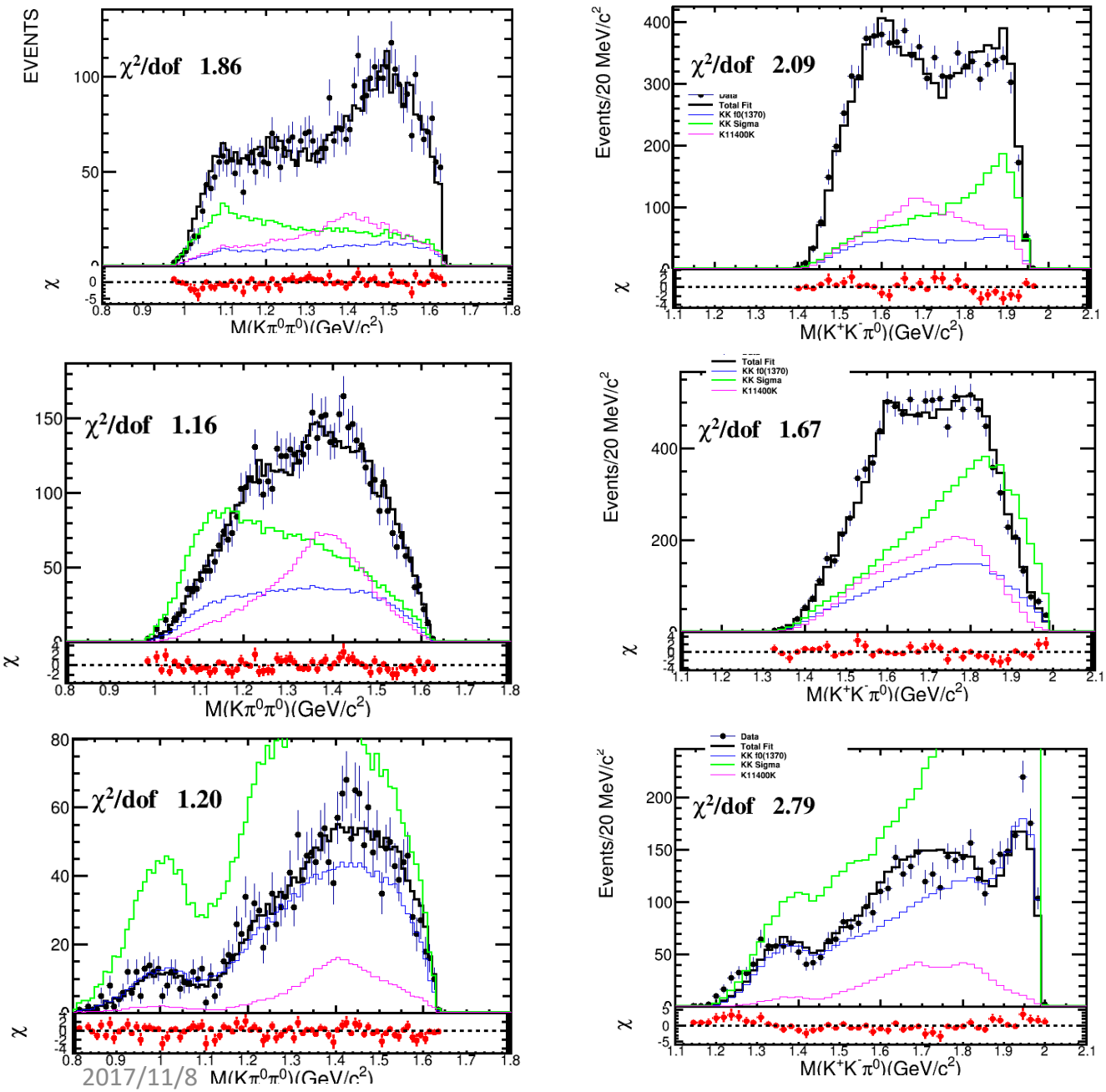
or $$|K^+\pi_2 - 0.892| < 0.06\ \text{GeV}\ \&\&\ |K^-\pi_1 - 0.892| > 0.06\ \text{GeV}$$



Region 3

$$!(|K^+\pi_1 - 0.892| < 0.06\ \text{GeV}\ ||\ |K^-\pi_2 - 0.892| < 0.06\ \text{GeV}\ ||\ |K^+\pi_2 - 0.892| < 0.06\ \text{GeV}\ ||\ |K^-\pi_1 - 0.892| < 0.06\ \text{GeV})$$

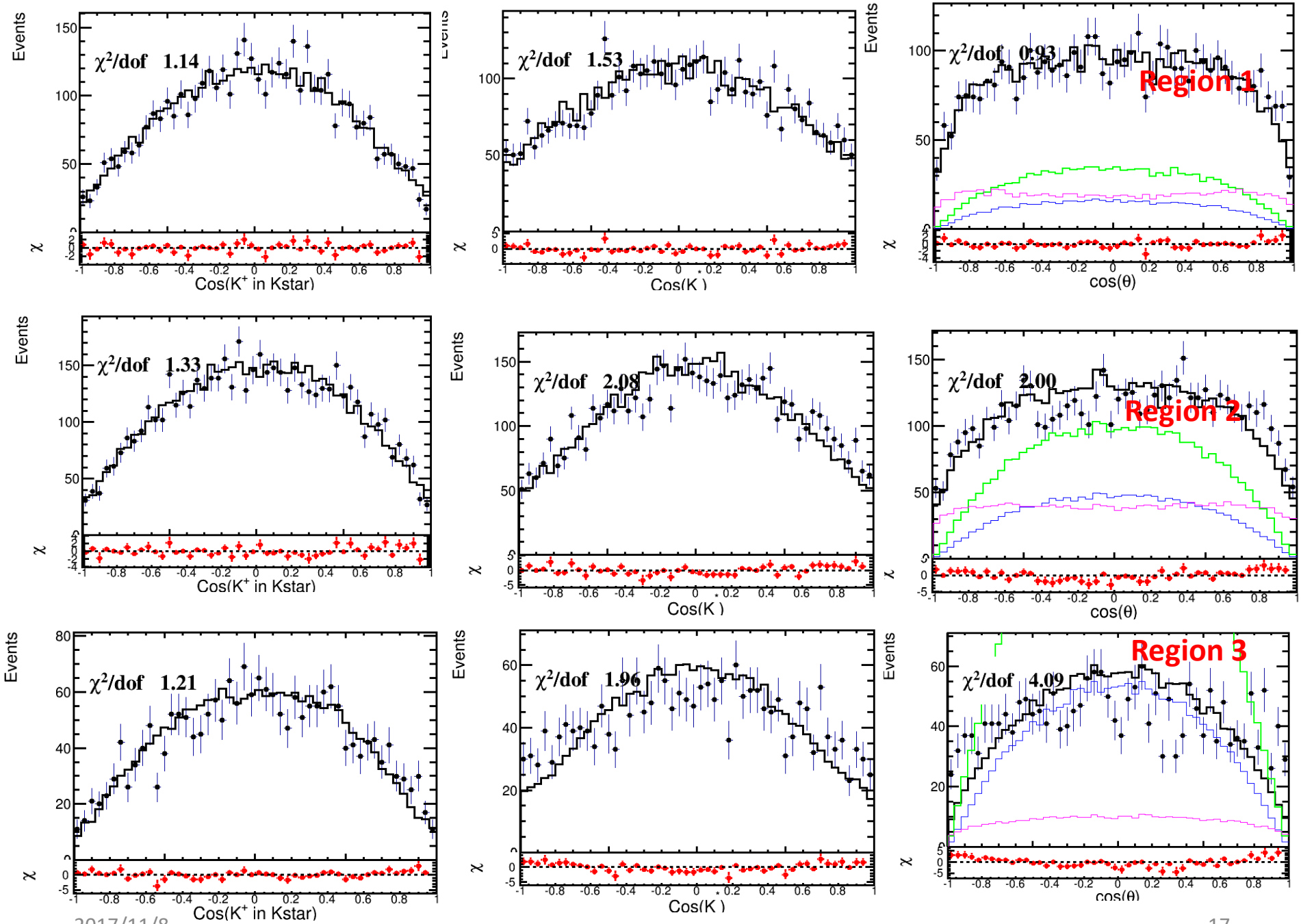

Region 1
Region 2
Region 3
χ²/dof 1.52
χ²/dof 2.34
χ²/dof 1.48
χ²/dof 1.19
χ²/dof 1.36
χ²/dof 1.34
χ²/dof 1.91
χ²/dof 1.74
χ²/dof 1.56
Events/(10 MeV/c²)
Events/(20 MeV/c²)
M(K⁺K⁻)
M(π⁰π⁰)(GeV/c²)
M(K⁺π⁰)(GeV/c²)
χ



Region 1

Region 2

Region 3


Region 1
Region 2
Region 3
χ²/dof 1.14
χ²/dof 1.53
χ²/dof 0.93
χ²/dof 1.33
χ²/dof 2.08
χ²/dof 2.00
χ²/dof 1.21
χ²/dof 1.96
χ²/dof 4.09
Events
χ
Cos(K⁺ in Kstar)
Cos(K)
cos(θ)

Background level

2.125 inclusive MC study

No.	decay chain	final states	iTopo	nEvt	nTot
0	$e^+e^- \to K^{*-}\pi^0K^+,\ K^{*-} \to K^-\pi^0$	$e^+e^- \to K^+\pi^0\pi^0K^-$	2	1920	1920
1	$e^+e^- \to K^-\pi^0K^{*+},\ K^{*+} \to \pi^0K^+$	$e^+e^- \to K^+\pi^0\pi^0K^-$	0	1869	3789
2	$e^+e^- \to K^-\pi^0\pi^0K^+$	$e^+e^- \to K^+\pi^0\pi^0K^-$	1	1464	5253
3	$e^+e^- \to K^-\pi^0K^{*+},\ K^{*+} \to \pi^0K^+$	$e^+e^- \to K^+\pi^0\pi^0K^-$	3	218	5471
4	$e^+e^- \to \phi f_0(980),\ \phi \to K^-K^+,\ f_0(980) \to \pi^0\pi^0$	$e^+e^- \to K^+\pi^0\pi^0K^-$	6	212	5683
5	$e^+e^- \to K^{*-}\pi^0K^+,\ K^{*-} \to K^-\pi^0$	$e^+e^- \to K^+\pi^0\pi^0K^-$	5	195	5878
6	$e^+e^- \to K^-\pi^0\pi^0K^+$	$e^+e^- \to K^+\pi^0\pi^0K^-$	8	139	6017
7	$e^+e^- \to K^-\pi^0\pi^0K^+$	$e^+e^- \to K^+\pi^0\pi^0K^-$	10	72	6089
8	$e^+e^- \to K^{*-}\pi^0K^+,\ K^{*-} \to \pi^-K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to K^+\pi^0\pi^0\pi^0\pi^-$	4	39	6128
9	$e^+e^- \to K^-\pi^0K^{*+},\ K^{*+} \to \pi^+K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to \pi^+\pi^0\pi^0\pi^0K^-$	24	34	6162
10	$e^+e^- \to \pi^-K^*K^+,\ K^* \to \pi^0K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to K^+\pi^0\pi^0\pi^0\pi^-$	12	29	6191
11	$e^+e^- \to K^-\pi^+K^*,\ K^* \to \pi^0K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to \pi^+\pi^0\pi^0\pi^0K^-$	23	23	6214
12	$e^+e^- \to K^-\eta K^+,\ \eta \to \pi^0\pi^0\pi^0$	$e^+e^- \to K^+\pi^0\pi^0\pi^0K^-$	19	20	6234
13	$e^+e^- \to \phi f_0(980),\ \phi \to K^-K^+,\ f_0(980) \to \pi^0\pi^0$	$e^+e^- \to K^+\pi^0\pi^0K^-$	17	15	6249
14	$e^+e^- \to \pi^-K_SK^+,\ K_S \to \pi^0\pi^0$	$e^+e^- \to K^+\pi^0\pi^0\pi^-$	28	14	6263
15	$e^+e^- \to \eta\phi,\ \eta \to \pi^0\pi^0\pi^0,\ \phi \to K^-K^+$	$e^+e^- \to K^+\pi^0\pi^0\pi^0K^-$	21	12	6275
16	$e^+e^- \to K^-\pi^+K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to \pi^+\pi^0\pi^0K^-$	15	11	6286
17	$e^+e^- \to K^-\pi^0K^{*+},\ K^{*+} \to \pi^+K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to \pi^+\pi^0\pi^0\pi^0K^-$	26	8	6294
18	$e^+e^- \to K^-\pi^+K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to \pi^+\pi^0\pi^0K^-$	16	8	6302
19	$e^+e^- \to K^-\pi^+K^*,\ K^* \to \pi^0K_S,\ K_S \to \pi^0\pi^0$	$e^+e^- \to \pi^+\pi^0\pi^0\pi^0K^-$	29	7	6309

Table 1: The possible background channels extracted from Inclusive MC sample

Background level: ~4%

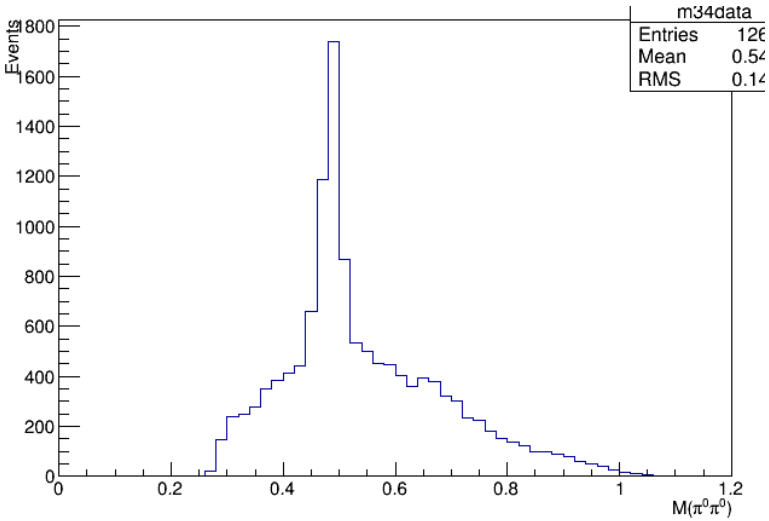
Dominant process: K*Kpi ~57%

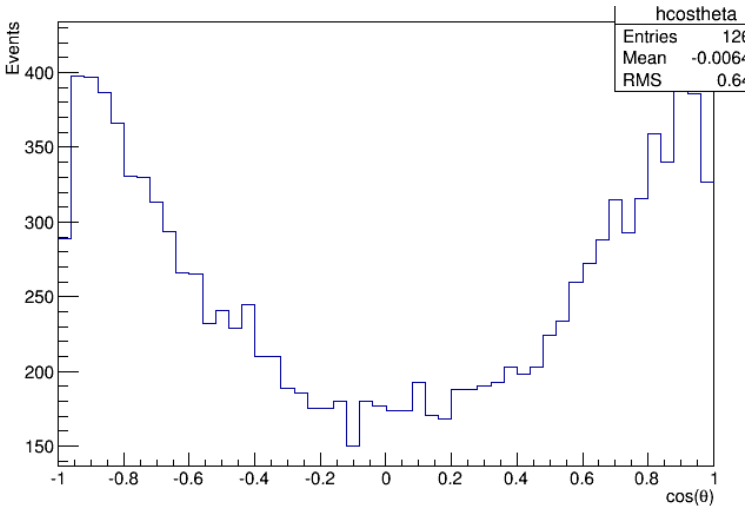
KKeta ~12%

KSKpi ~19%

Background level

```
Decay gamma*
0.3333    K*- K+  pi0            PHSP;
0.3333    K*+ K-  pi0            PHSP;
0.165    K*0 K-  pi+            PHSP;
0.165    K*0 K+  pi-            PHSP;
Enddecay
```





In the region M(pi0pi0)<0.75 , the background level is about **10%**

Background level

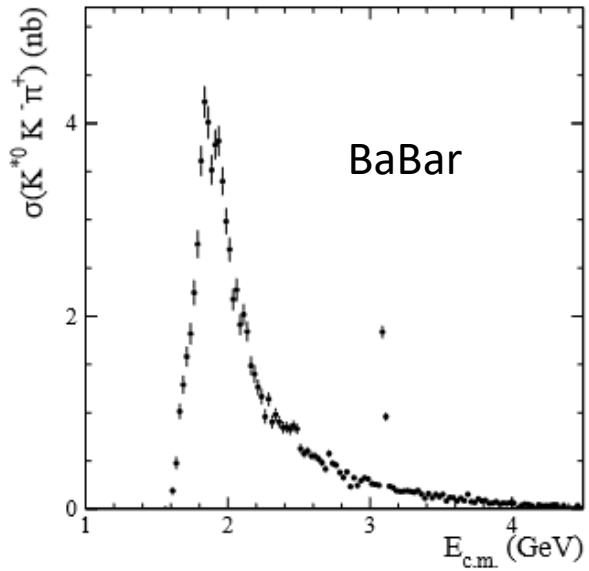


FIG. 9: The $e^+e^- \to K^*(892)^0 K^- \pi^+$ cross section, obtained from the $K^*(892)^0$ signal of Fig. 5(b).

K*0(892) K+ pi- PHSP;
K*0->Ks pi0;
1000k 13887 efficiency: 1.3887%
Cross section:2 nb

0.013887*108*2000*0.333*0.3*0.98^3=282 X 2

K*+K-pi0