Study of K_s^0 efficiency in $\psi(3770)$ data

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USTC

Outline

- Tag mode
- Event selection
- Comparison of information of K_S^0
- Efficiency of K_S^0 vertex fit

Tag mode

- Tag mode:
  - $D^0 \to K^-\pi^+$
  - $D^0 \to K^-\pi^+\pi^0$
  - $D^0 \to K^-\pi^+\pi^+\pi^-$
  - $D^+ \to K^-\pi^+\pi^+$
- Signal mode:
  - $D^0 \to K_S^0\pi^+\pi^-$
  - $D^0 \to K_S^0\pi^+\pi^-\pi^0$
  - $D^0 \to K_S^0\pi^0$
  - $D^+ \to K_S^0\pi^+$
  - $D^+ \to K_S^0\pi^+\pi^0$
  - $D^+ \to K_S^0\pi^+\pi^+\pi^-$

Event Selection

Based on DTagAlg Package in BOSS 710

- **Good charged tracks**:
  - $|V_z| \leq 10cm$, $|V_{xy}| \leq 10cm$, $|cos\theta| \leq 0.93$
- **Good Photons:**
  - Barrel : $E_\gamma > 0.025GeV, |cos\theta| \leq 0.8$
  - Endcap : $E_\gamma > 0.05GeV$, $0.84 \leq |cos\theta| \leq 0.92$
  - Time cut: 0≤ T≤ 14 (in unit of 50 ns);
  - |dang|> 10^o;
- **PID (Particle ID Package):**
  - TOF + dE/dx
  - Pion : prob(π) > prob(K);
  - Kaon: prob(K) > prob(π);
- **π^0 Candidates :**
  - **π^0** : 0.115<M(γγ)<0.150 GeV/c^2, X^2_{1c}<200;
- **Tag D Reconstruction:**
  - $\Delta E = E_D - E_{beam}$, $M_{bc} = \sqrt{E^2_{beam} - \overrightarrow{P}^2_D}$
  - ΔE cut: no π^0: $(-0.025, 0.025)$ GeV
    with π^0: $(-0.055, 0.040)$ GeV
  - D^0: $1.86 \leq M_{bc} \leq 1.87$ GeV/c^2
  - D^+: $1.865 \leq M_{bc} \leq 1.875$ GeV/c^2
- **Missing K^0_S Candidates :**
  - $P_{sigD} = \sqrt{E^2_{beam} - M^2_D}$; $\hat{\vec{P}}_{sigD} = -\hat{\vec{P}}_D$;
  - P_{trk}: track in signal mode except K^0_S (such as $\pi^\pm\pi^0$)
  - $M_{miss} =$

$$\sqrt{\left(E_{beam} - \sum E_{trk}\right)^2 - \left(\vec{P}_{sigD} - \sum \vec{P}_{trk}\right)^2}$$

  - $\Delta M = M_{miss} - M_{K^0_S}$
  - Minimum ΔM is used to select best candidate
- **Selection of K^0_S :**
  - Reconstructed by $\pi^+\pi^-$;
  - (Refine-) Vertex fit and second vertex fit

Comparison of information of K_S^0

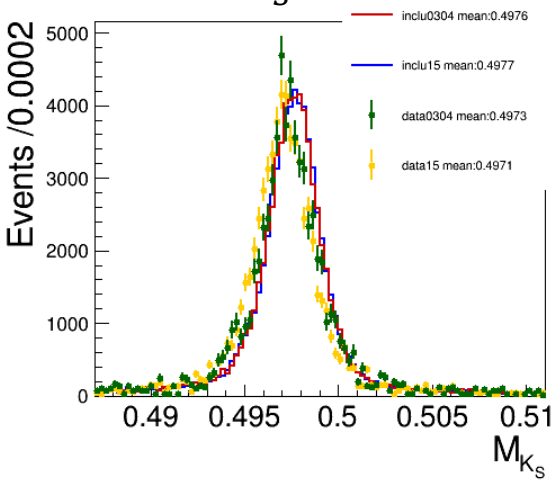
Comparison between round0304 and round15

M_{K_S} with Vertex Fit

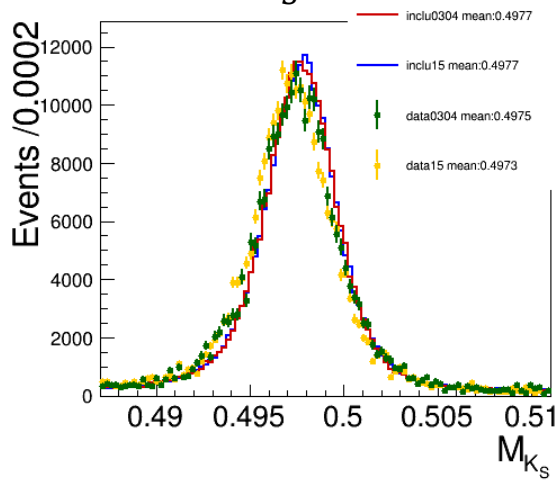
- **Deviation of M_{K_S} between data and MC**

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $L/err > 2$

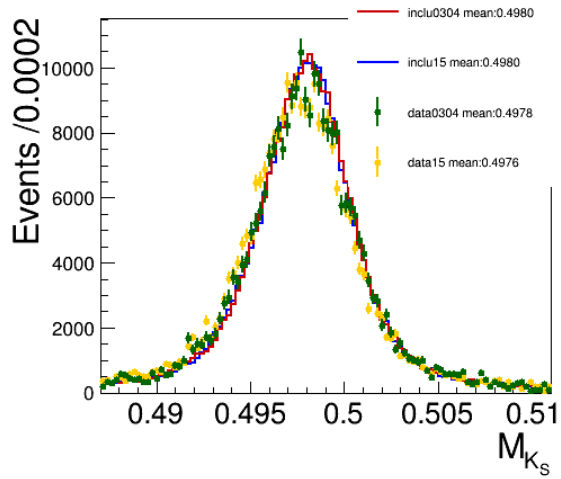
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



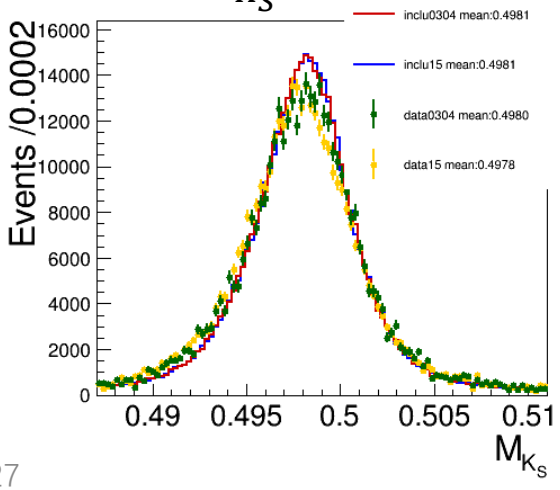
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



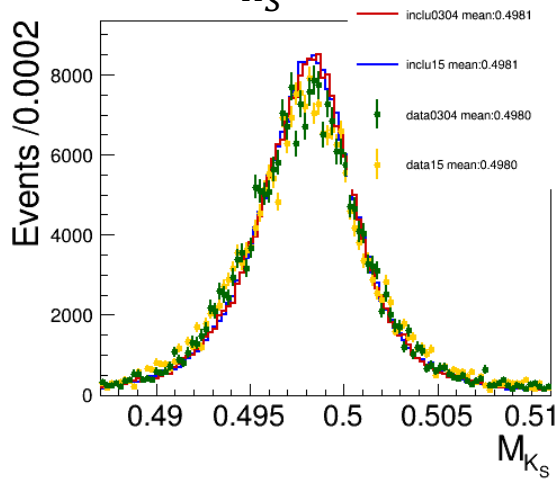
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



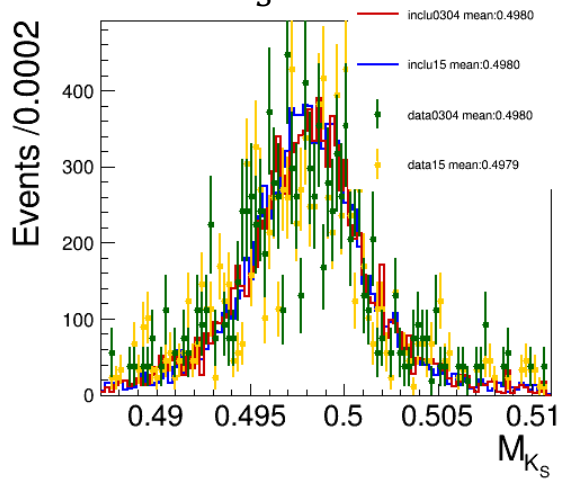
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$

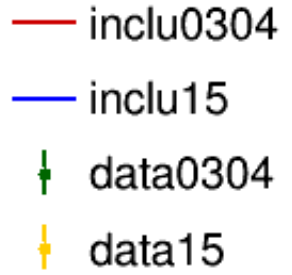


$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$



$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$



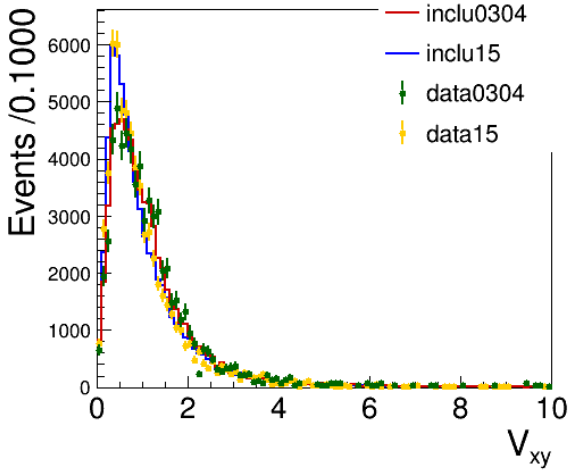


V_{xy} with Vertex Fit

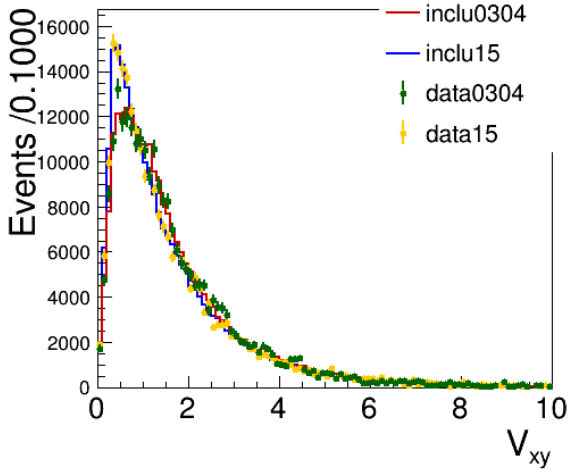
- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$
- $L/err > 2$

- **Difference between round0304 and 15**

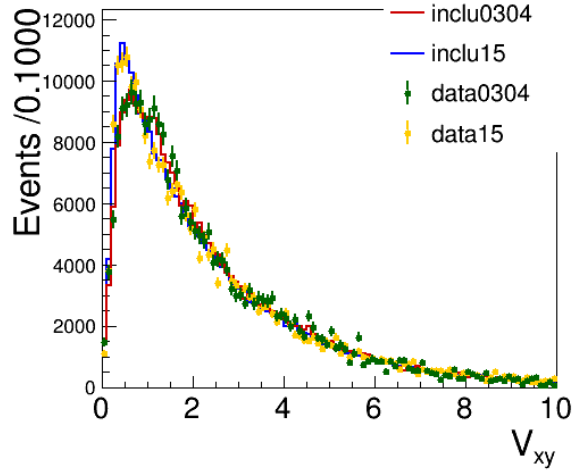
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



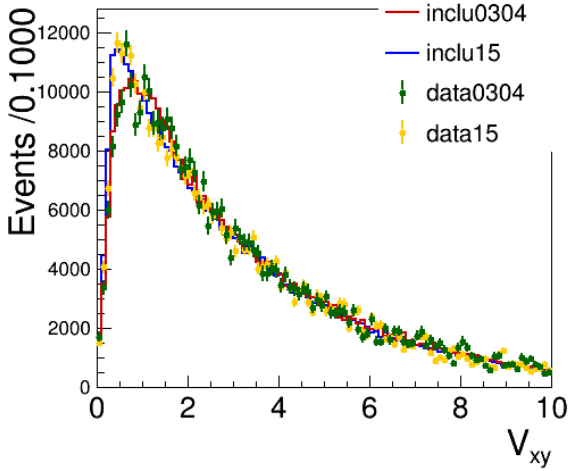
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



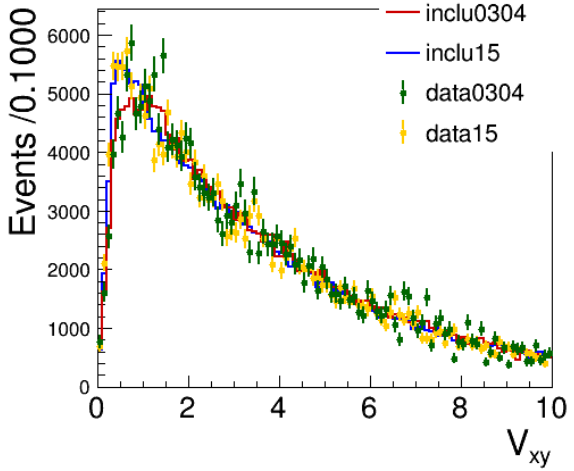
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



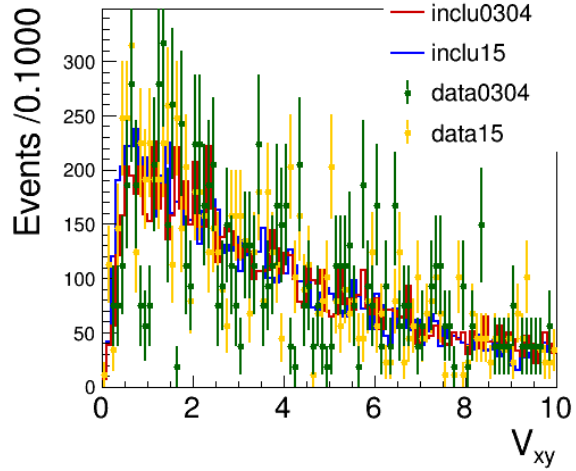
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$



$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$

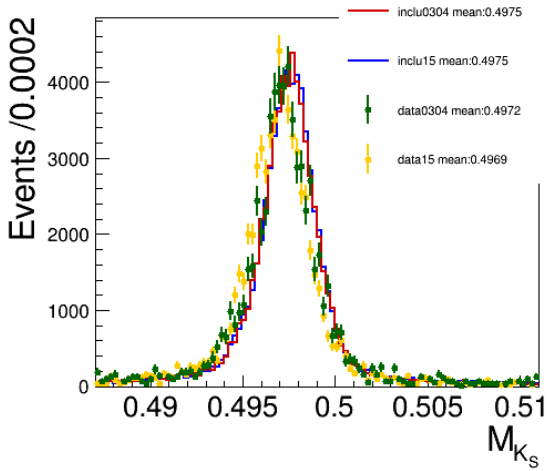


M_{K_S} with Refine Vertex Fit

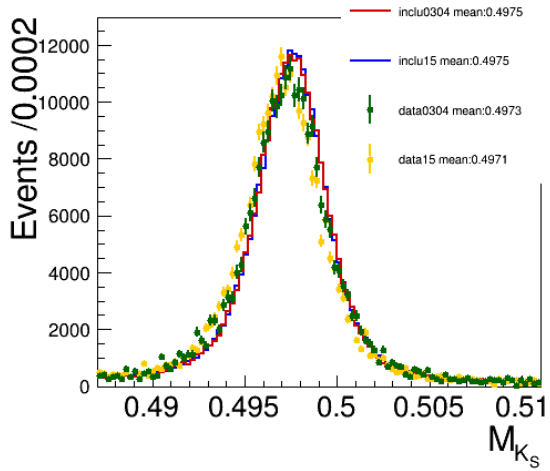
- **Deviation of M_{K_S} between data and MC**

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $L/err > 2$

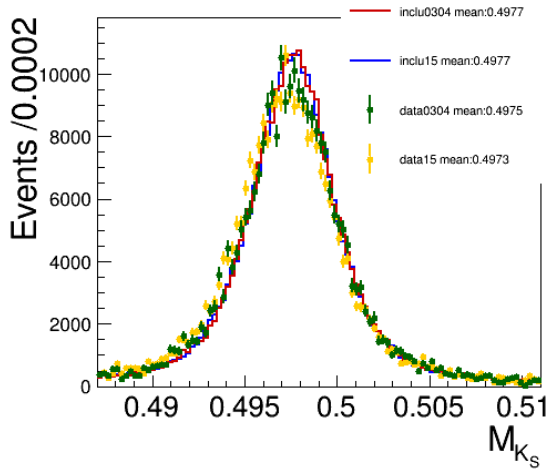
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



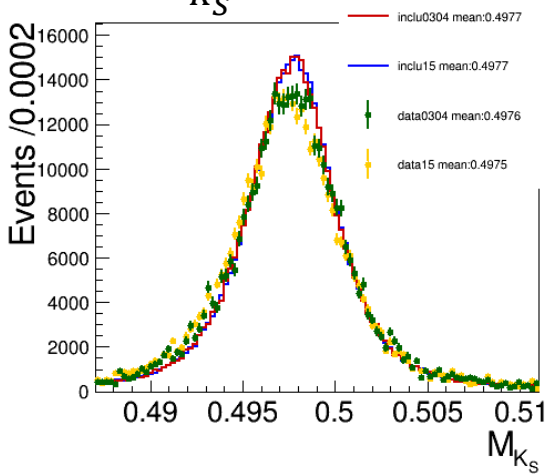
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



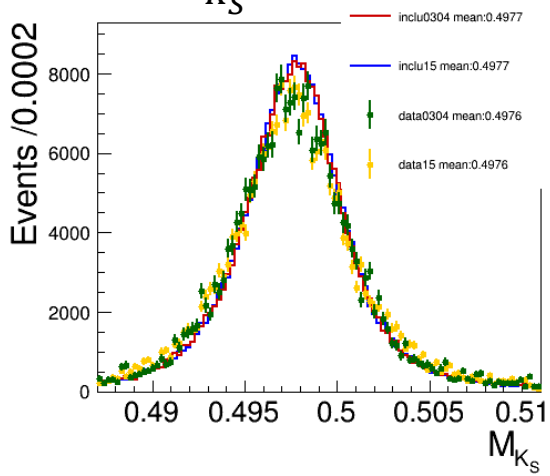
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



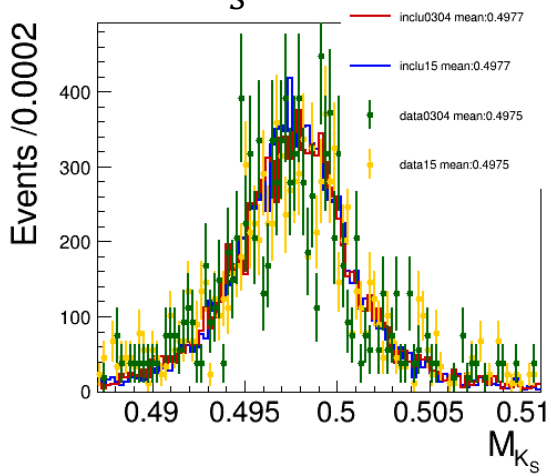
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$



$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$

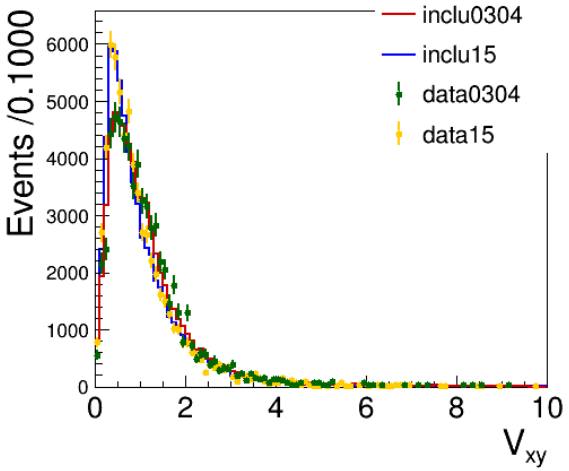


V_{xy} with Refine Vertex Fit

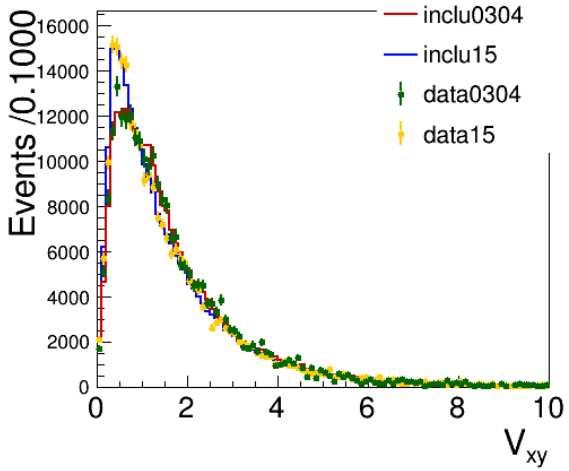
- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$
- $L/err > 2$

- **Difference between round0304 and 15**

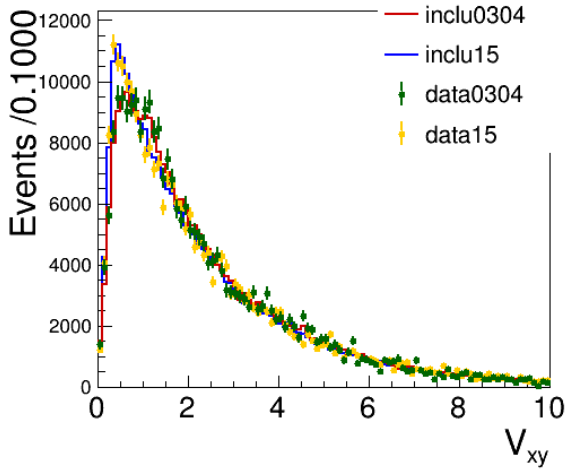
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



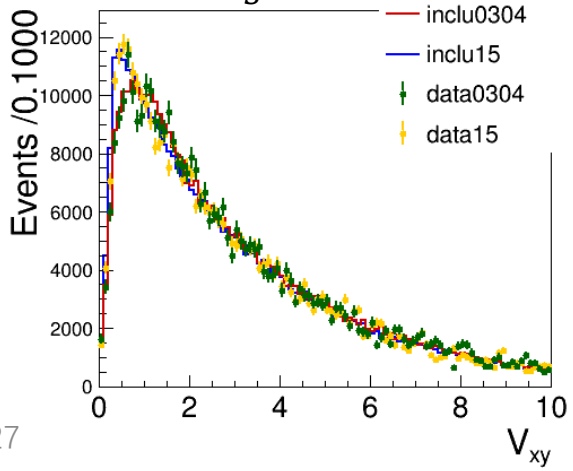
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



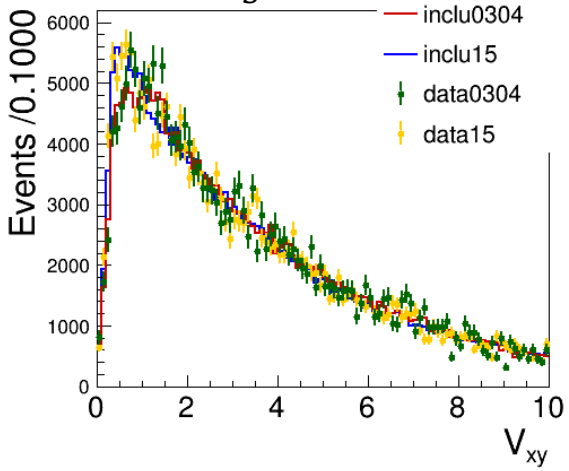
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



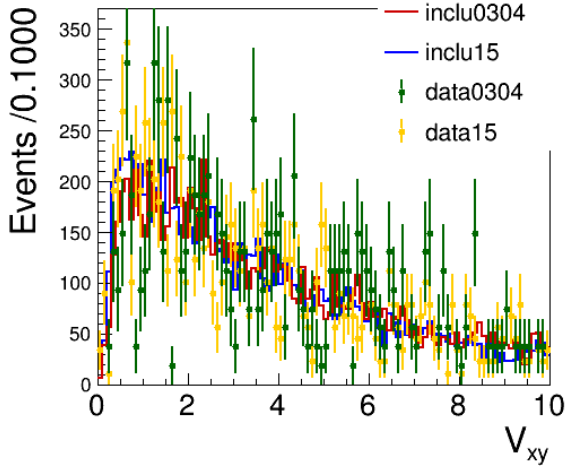
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$



$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$

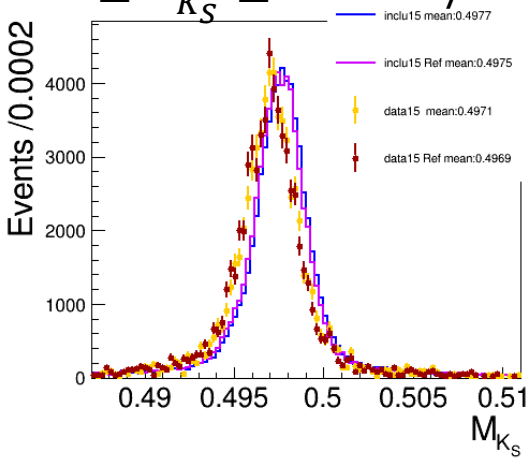


Comparison of two vertex fit of M_{K_s}

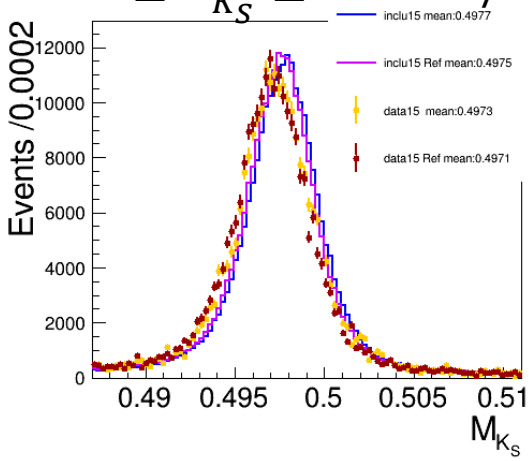
- Deviation of M_{K_s} between data and MC
- M_{K_s} in MC with refine vertex fit is more correct

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $L/err > 2$

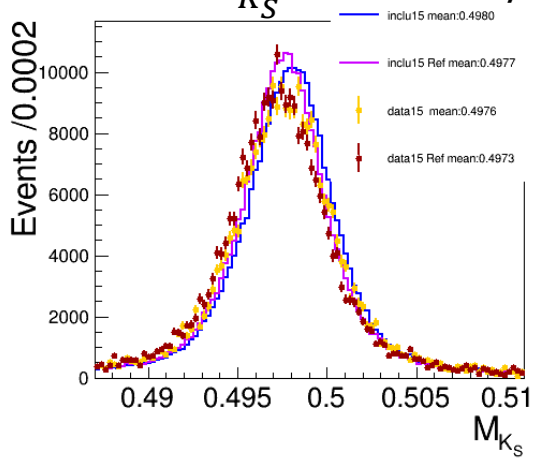
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



inclu15
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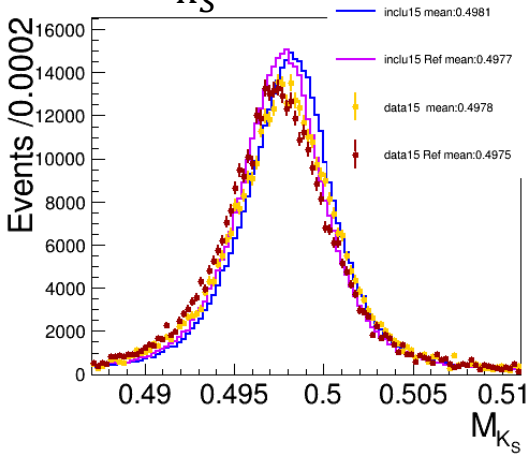
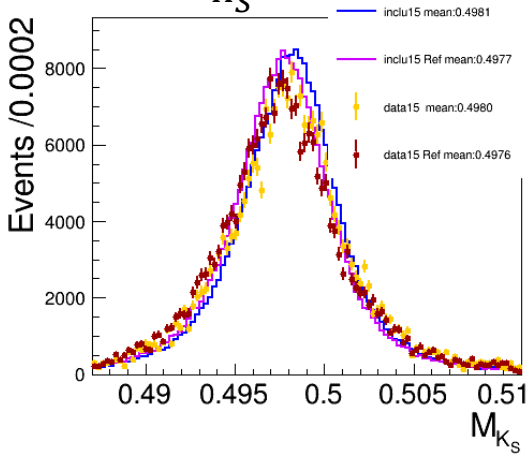
data15 Ref

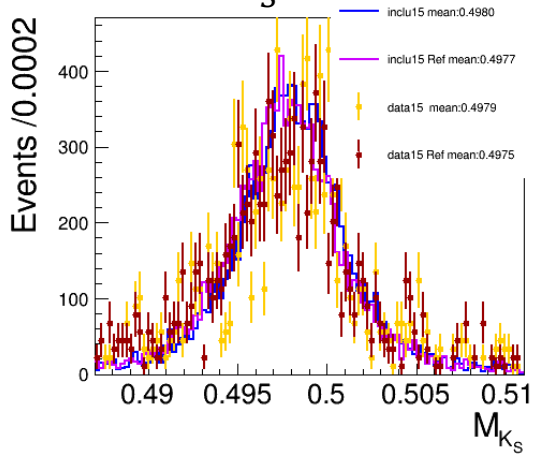
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$



$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$



Efficiency of K_S^0 Selection

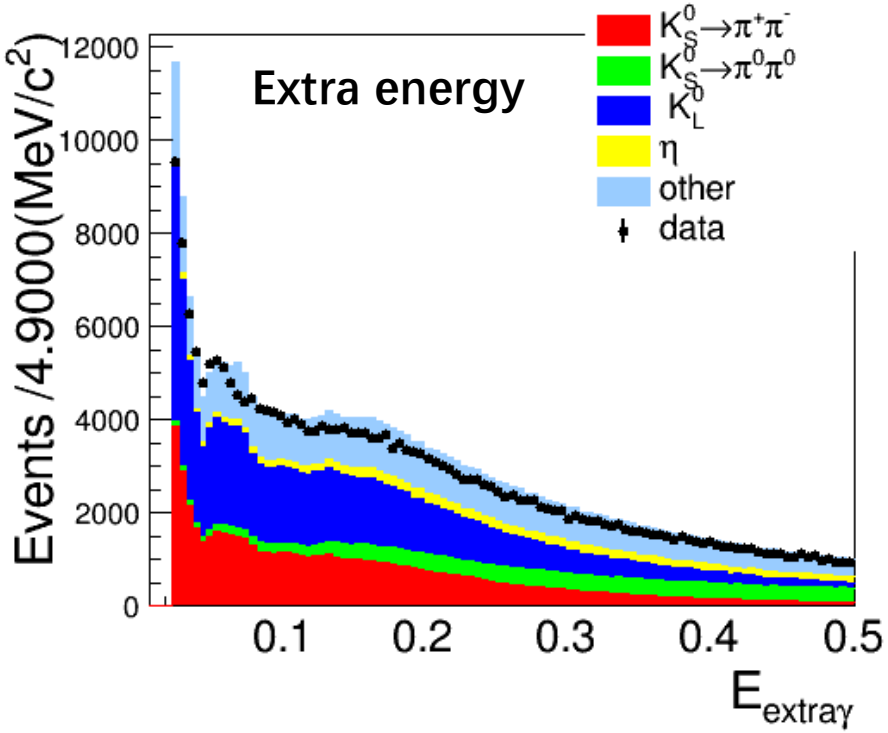
Event Selection

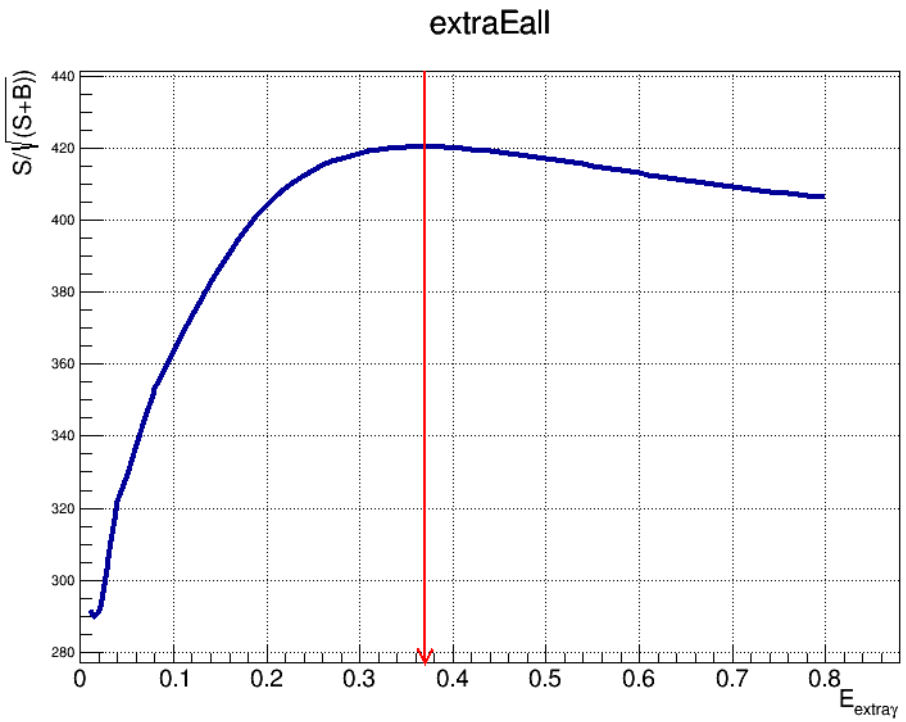
- **Missing $\mathbf{K_S^0}$ Candidates :**
  - $P_{sigD} = \sqrt{E_{beam}^2 - M_D^2}$; $\hat{\vec{P}}_{sigD} = -\hat{\vec{P}}_D$;
  - P_{trk}: track in signal mode except K_S^0 (such as $\pi^{\pm}\pi^0$)
  - $M_{miss} =$
  - $\sqrt{(E_{beam} - \sum E_{trk})^2 - \left(\vec{P}_{sigD} - \sum \vec{P}_{trk}\right)^2}$
  - $\Delta M = M_{miss} - M_{K_S^0}$
  - Minimum ΔM is used to select best candidate
- $\boldsymbol{N_{extra\_trk} \leq 2}$

- **Find $\boldsymbol{K_S^0}$:**
  - Reconstructed by $\pi^+\pi^-$;
  - (Refine-)Vertex fit and secondary vertex fit;
  - $0.511 > M_{K_s} > 0.487\ M_{K_s}$;
  - $L/err > 2$;
  - $\chi^2_{1st} \& \chi^2_{2nd} < 200$;
- **Not find $\boldsymbol{K_S^0}$:**
  - Others;
- **Control sample: only $\boldsymbol{D^+D^-}$**

Background rejection

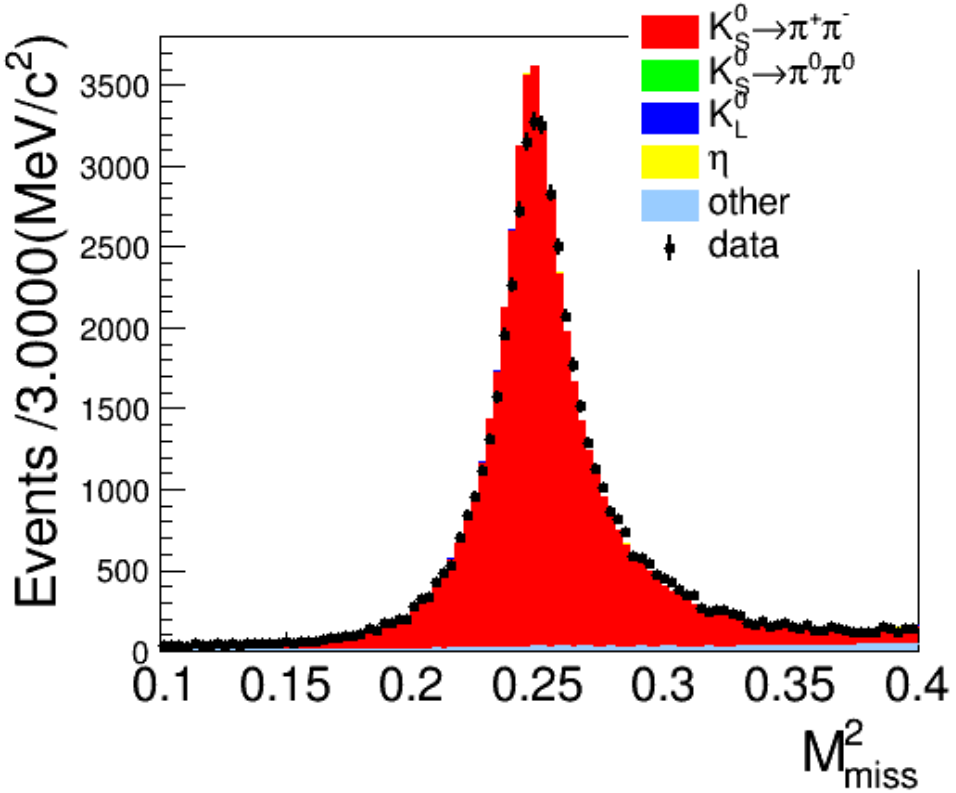
- Remove background with more photons
- Angle between γ and recoil K_S^0 is more than $15°$
- Cut: $E_{extra\gamma} \leq 0.37GeV$



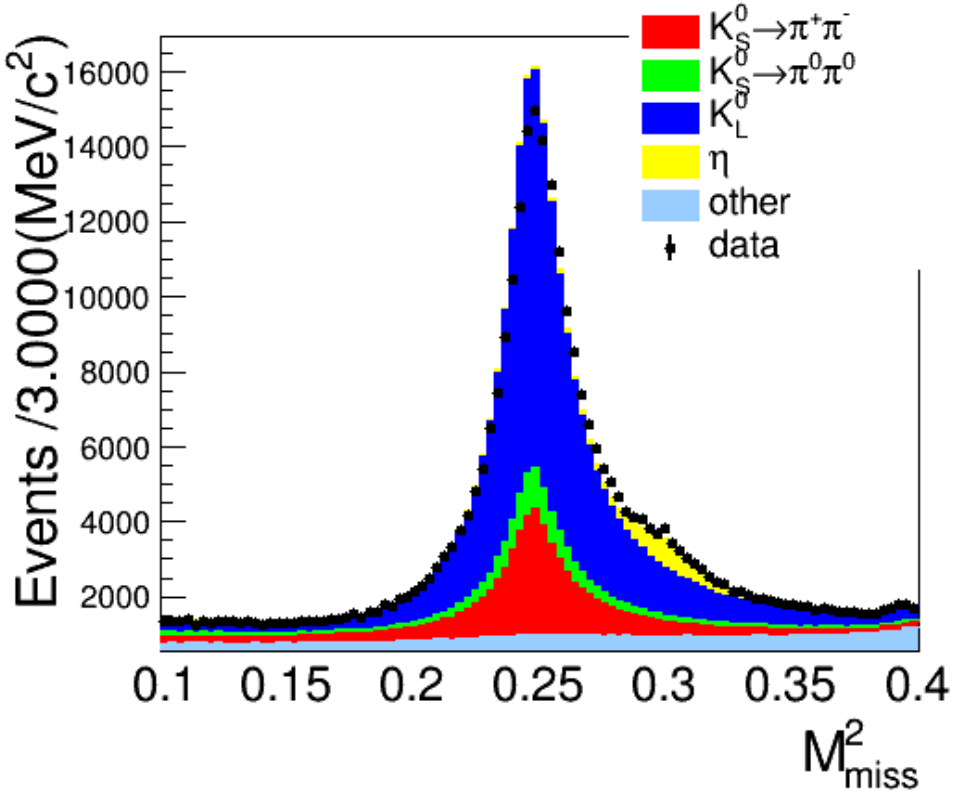


D^+D^- M^2_{miss} distribution

Find K^0_S



Not Find K^0_S



Fit strategy

- Simultaneous fit (share convolved gauss) in five momentum bins (bin size 200MeV)
- The ratio of $K_S^0 \to \pi^+\pi^-$ and $K_S^0 \to \pi^0\pi^0$ is fixed and is estimated from inclusive MC
- The ratio of K_S^0 and K_L^0 is floated with a constrain of Gauss, and the mean and error are estimated from inclusive MC with correction by PDG

Find:

- Signal shape:
  - $K_S^0 \to \pi^+\pi^-$: MC shape ⊗ Gauss
- Background shape:
  - Others in D^+D^- inclusive MC
  - Data sideband in tag D M_{bc}

Not Find:

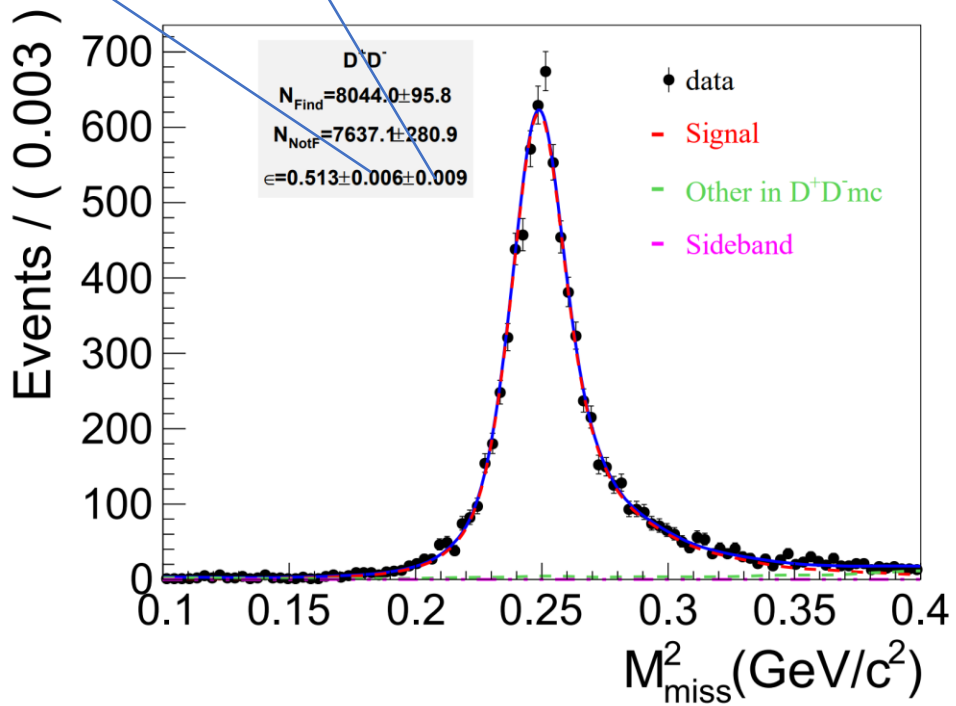
- Signal shape:
  - $K_S^0 \to \pi^+\pi^-$: MC shape ⊗ Gauss
- Peaking background shape:
  - $K_S^0 \to \pi^0\pi^0$: MC shape ⊗ Gauss
  - K_L^0 : MC shape ⊗ Gauss
  - η : MC shape ⊗ Gauss
- Background shape:
  - Others in D^+D^- inclusive MC
  - Data sideband in tag D M_{bc}

D^+D^- M^2_{miss}: $0.4 < P_{miss} < 0.6\ GeV/c$

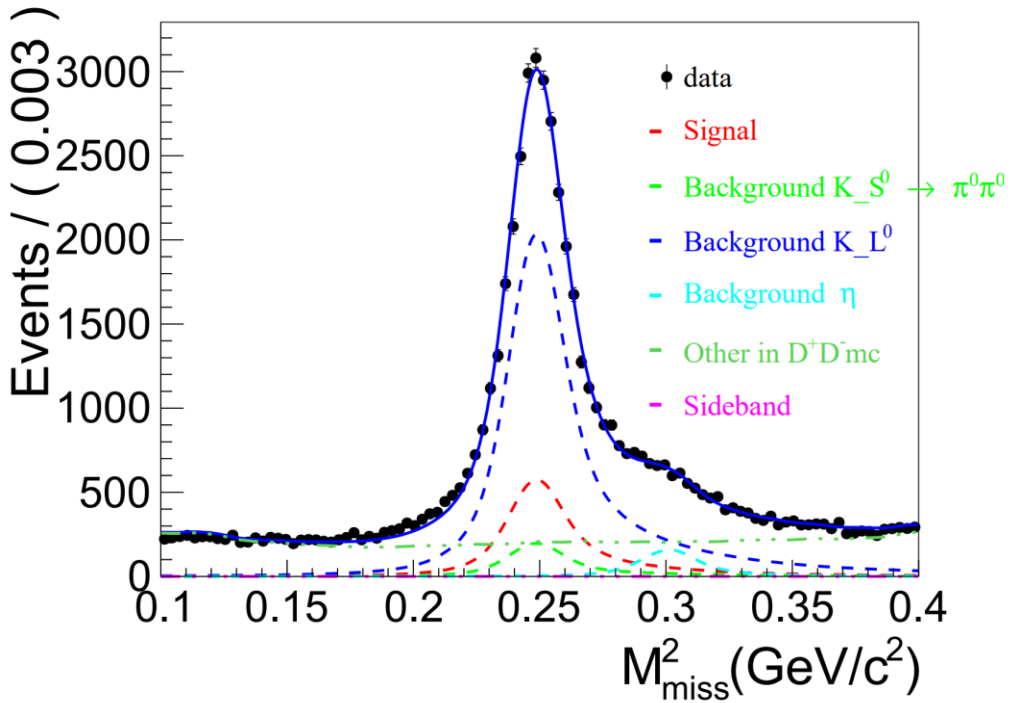
Fitting error

Error from K^0_L ratio

Find K^0_S



Not Find K^0_S

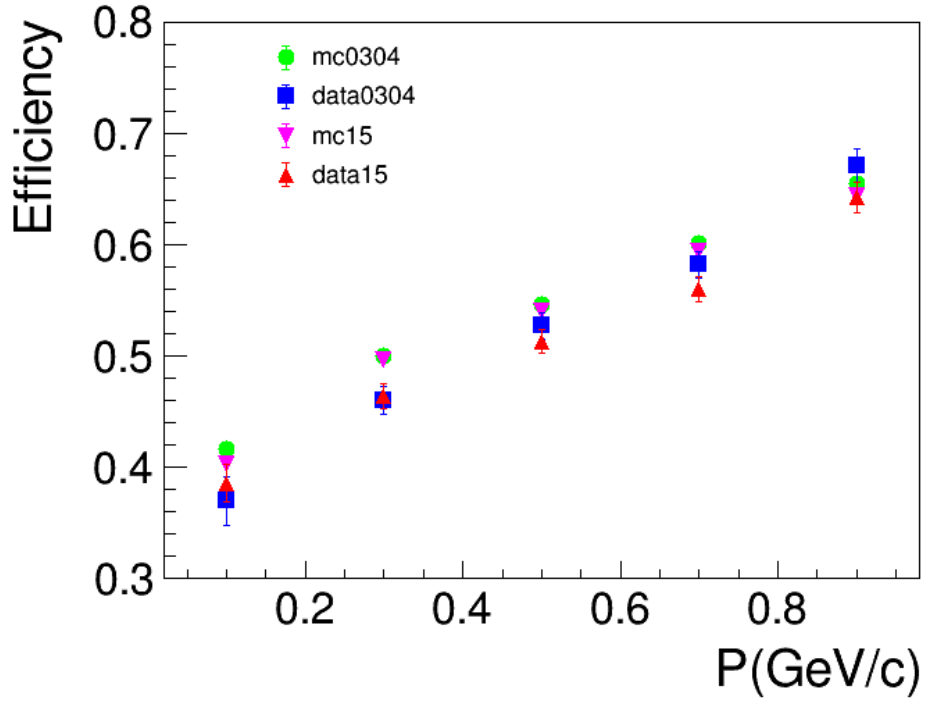


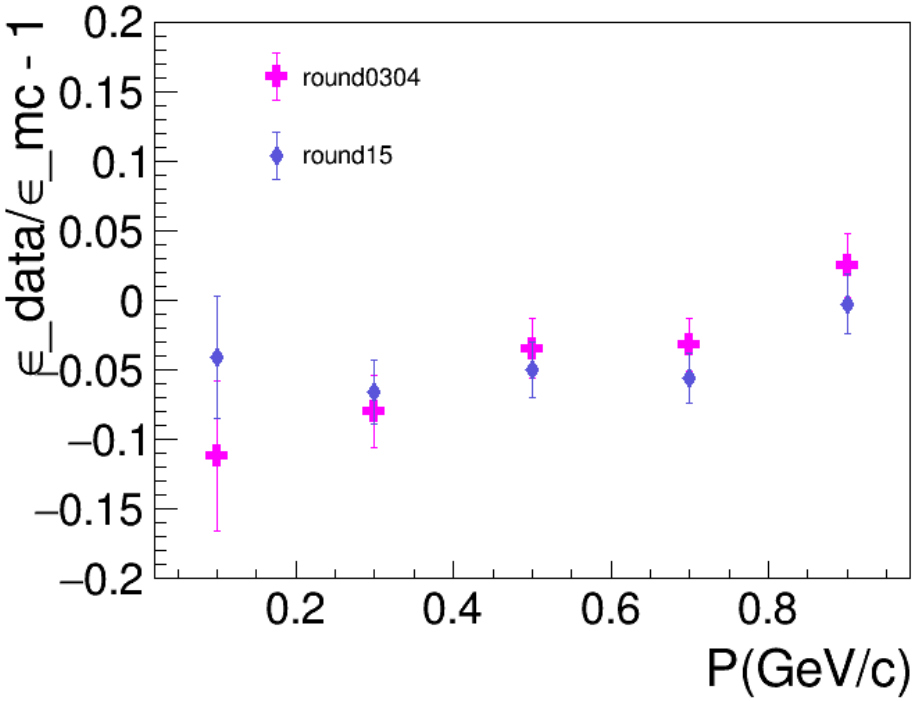
Vertex fit

round15

D^+D^- : K_S^0 efficiency

MC efficiency calculated by the number of $K_S^0 \to \pi^+\pi^-$ in inclusive MC

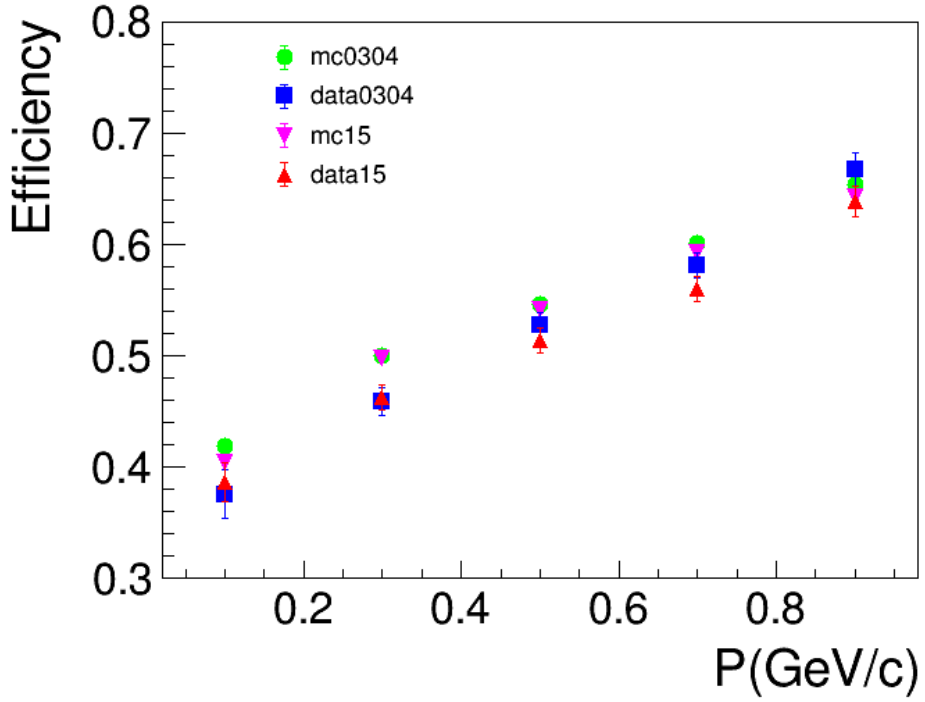


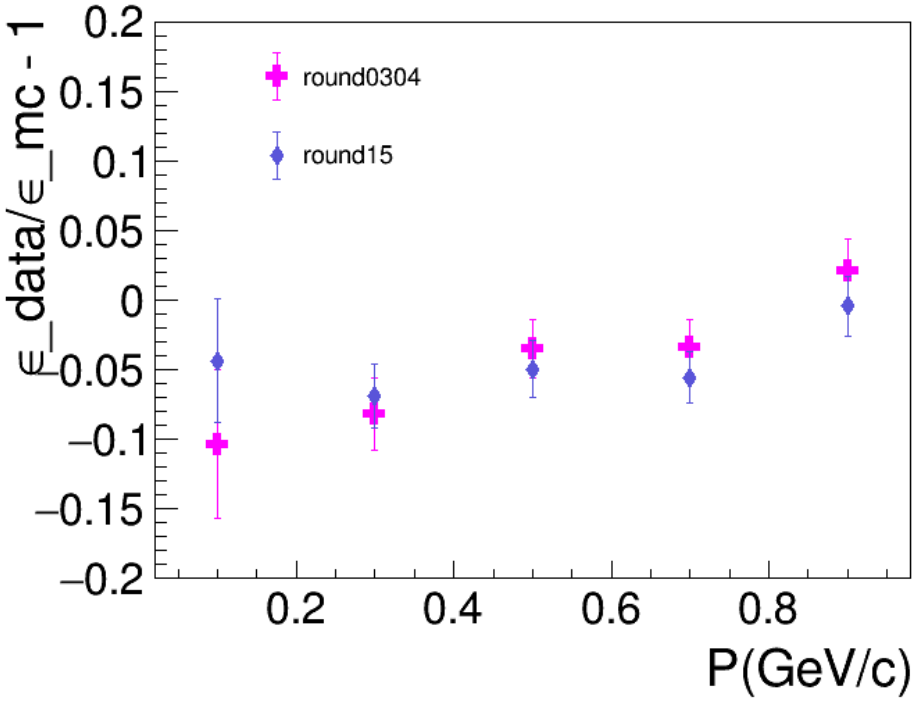


Vertex fit

D^+D^- : K_S^0 efficiency

MC efficiency calculated by the number of $K_S^0 \to \pi^+\pi^-$ in inclusive MC

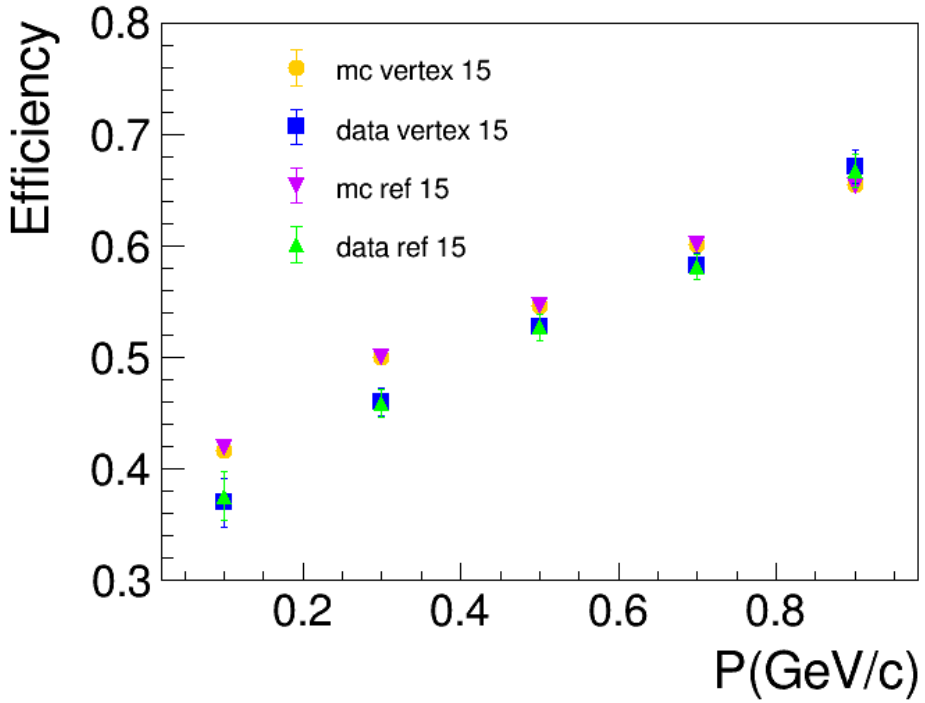


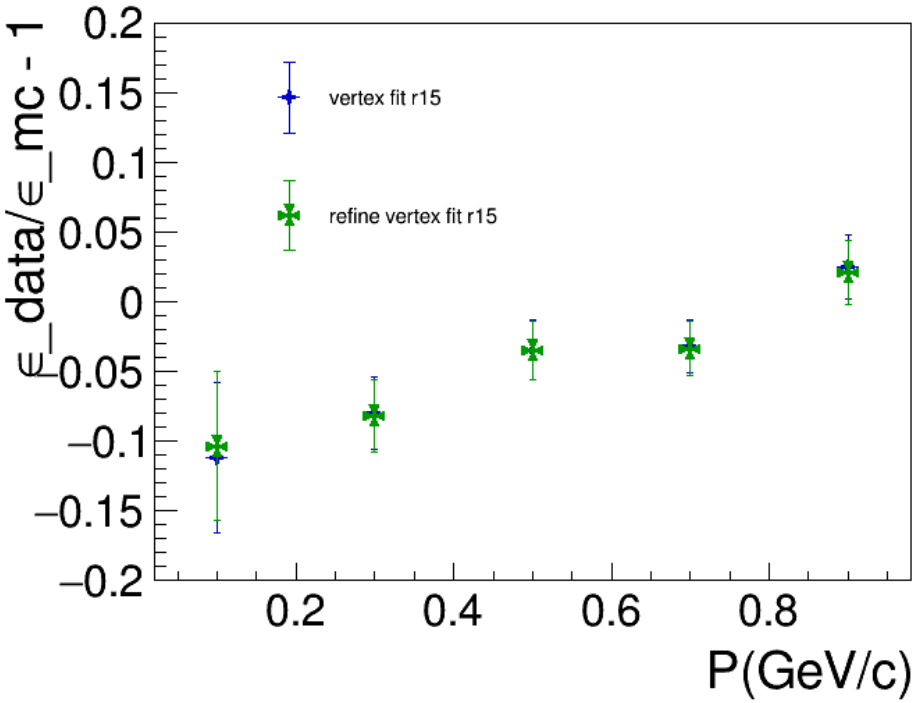


Refine vertex fit

D^+D^- : K_S^0 efficiency

MC efficiency calculated by the number of $K_S^0 \to \pi^+\pi^-$ in inclusive MC

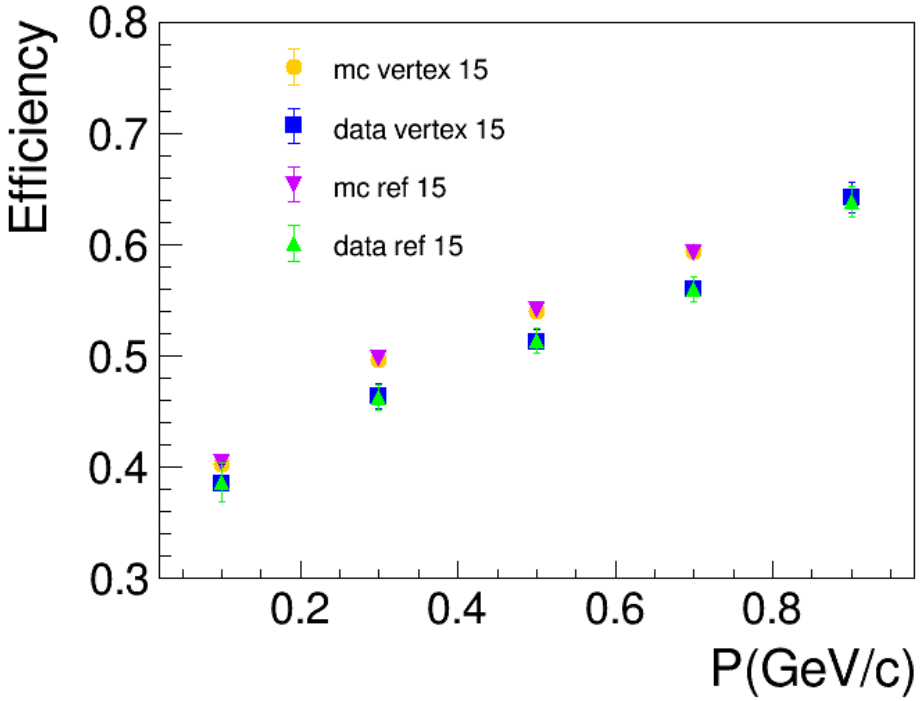


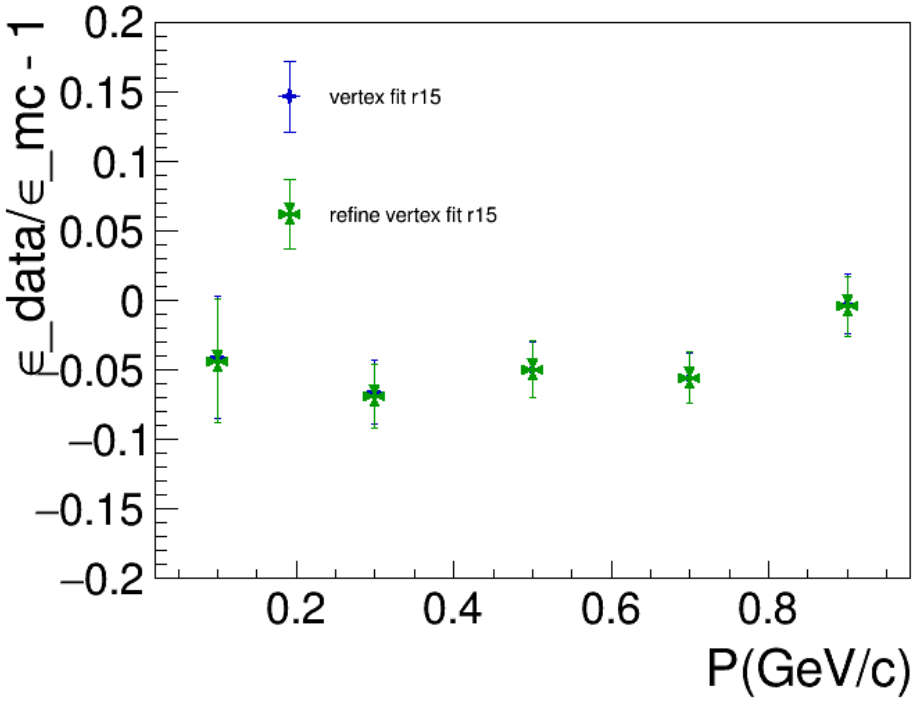


Vertex fit with refine vertex fit in round 0304

D^+D^- : K_S^0 efficiency

MC efficiency calculated by the number of $K_S^0 \to \pi^+\pi^-$ in inclusive MC





Vertex fit with refine vertex fit in round 15

D^+D^- : K_S^0 efficiency

	Vertex fit						Refine vertex fit					
	Round 0304			Round 15			Round 0304			Round 15		
	ϵ_{mc}	ϵ_{data}	$\epsilon_{data}/\epsilon_{mc}$ -1	ϵ_{mc}	ϵ_{data}	$\epsilon_{data}/\epsilon_{mc}$ -1	ϵ_{mc}	ϵ_{data}	$\epsilon_{data}/\epsilon_{mc}$ -1	ϵ_{mc}	ϵ_{data}	$\epsilon_{data}/\epsilon_{mc}$ -1
(0.0,0.2)	0.417 ± 0.006	$0.370 \pm 0.021 \pm 0.006$	-0.112 ± 0.054	0.402 ± 0.005	$0.386 \pm 0.016 \pm 0.006$	-0.041 ± 0.044	0.419 ± 0.006	$0.376 \pm 0.021 \pm 0.006$	-0.103 ± 0.054	0.405 ± 0.005	$0.387 \pm 0.016 \pm 0.007$	-0.044 ± 0.045
(0.2,0.4)	0.500 ± 0.003	$0.460 \pm 0.010 \pm 0.008$	-0.079 ± 0.026	0.497 ± 0.002	$0.464 \pm 0.008 \pm 0.008$	-0.066 ± 0.023	0.500 ± 0.003	$0.459 \pm 0.010 \pm 0.008$	-0.081 ± 0.026	0.497 ± 0.002	$0.463 \pm 0.008 \pm 0.008$	-0.069 ± 0.023
(0.4,0.6)	0.546 ± 0.002	$0.527 \pm 0.007 \pm 0.009$	-0.035 ± 0.021	0.540 ± 0.001	$0.513 \pm 0.006 \pm 0.009$	-0.050 ± 0.020	0.546 ± 0.002	$0.527 \pm 0.007 \pm 0.009$	-0.035 ± 0.026	0.541 ± 0.001	$0.514 \pm 0.006 \pm 0.009$	-0.049 ± 0.020
(0.6,0.8)	0.601 ± 0.001	$0.582 \pm 0.007 \pm 0.009$	-0.032 ± 0.019	0.593 ± 0.001	$0.560 \pm 0.006 \pm 0.009$	-0.056 ± 0.018	0.601 ± 0.001	$0.581 \pm 0.007 \pm 0.009$	-0.033 ± 0.019	0.593 ± 0.001	$0.560 \pm 0.006 \pm 0.009$	-0.055 ± 0.018
(0.8,1.0)	0.655 ± 0.002	$0.671 \pm 0.010 \pm 0.011$	0.025 ± 0.023	0.644 ± 0.002	$0.642 \pm 0.008 \pm 0.011$	-0.003 ± 0.021	0.653 ± 0.002	$0.667 \pm 0.010 \pm 0.011$	0.021 ± 0.023	0.642 ± 0.002	$0.0639 \pm 0.008 \pm 0.011$	-0.004 ± 0.021

Summary

- The information of K_S^0 in $\psi(3770)$ data (round03,04,15) has been checked. There is deviation in $M_{K_S^0}$ between data and MC and in V_{xy} between round 0304 and 15.
- Efficiency of K_S^0 in D^+D^- of (refine-) vertex fit in $\psi(3770)$ data is calculated. The results of refine vertex fit and vertex fit are similar but all have a deviation between data and MC where MC efficiency is larger. And there is also difference of efficiency between round0304 and 15.

Next to do

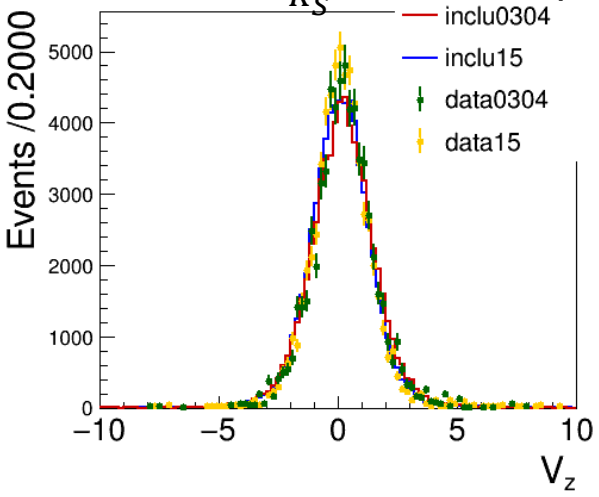
- Study K_S^0 efficiency from $D^0\overline{D}^0$ sample
- Check K_S^0 efficiency with another method ($\boldsymbol{N_{extra\_trk} = 2}$)

Back up

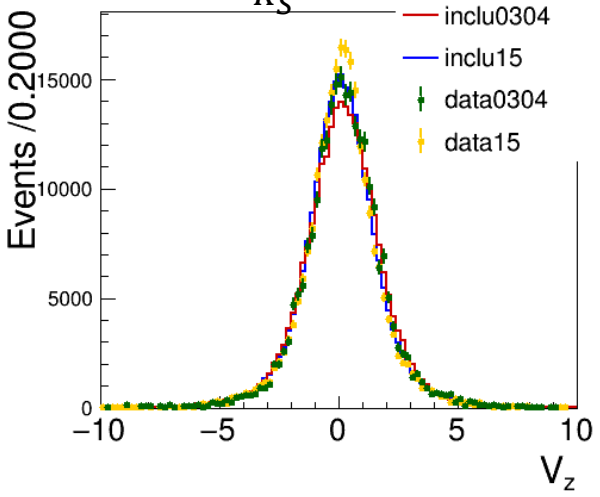
V_z with Vertex Fit

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$
- $L/err > 2$

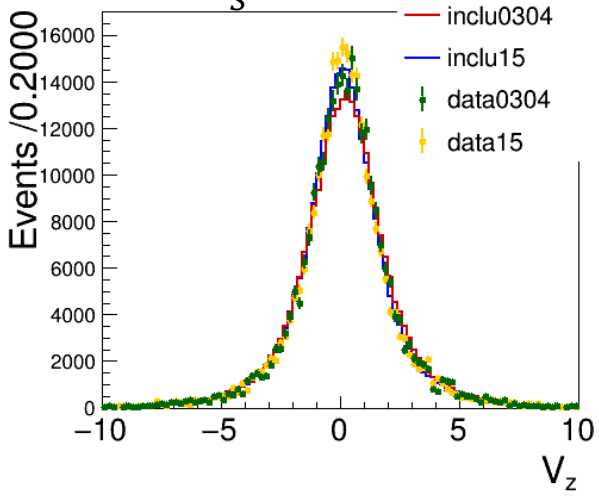
$0.0 \leq P_{K^0_S} \leq 0.2\ GeV/c^2$



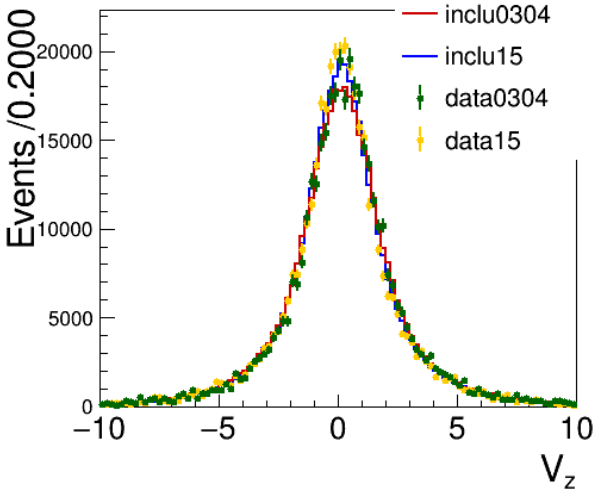
$0.2 \leq P_{K^0_S} \leq 0.4\ GeV/c^2$



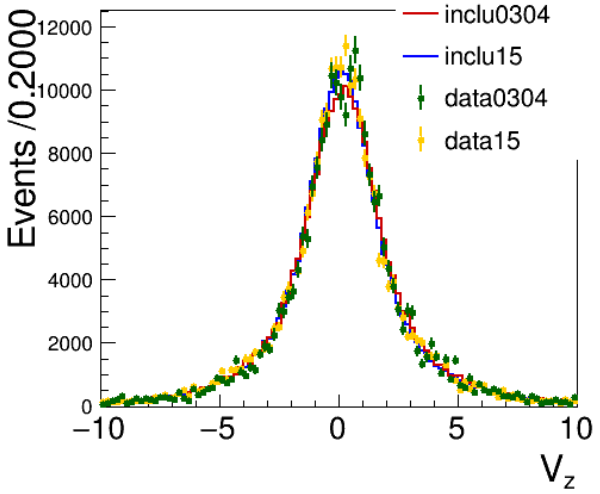
$0.4 \leq P_{K^0_S} \leq 0.6\ GeV/c^2$



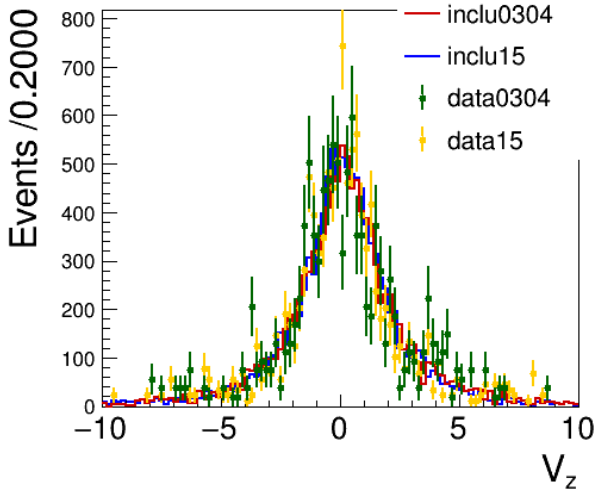
$0.6 \leq P_{K^0_S} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K^0_S} \leq 1.0\ GeV/c^2$



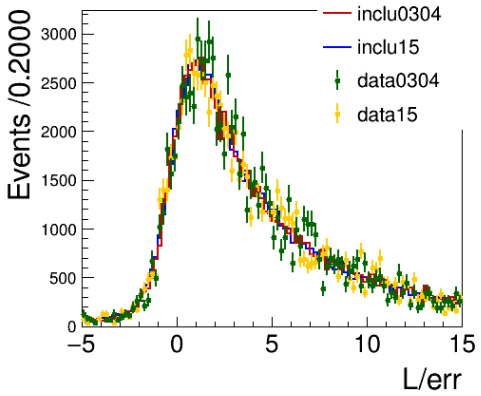
$1.0 \leq P_{K^0_S} \leq 1.2\ GeV/c^2$



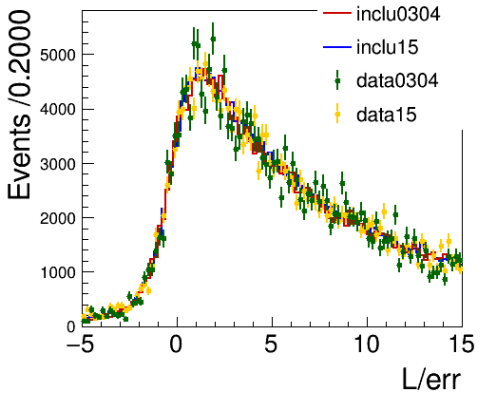
L/err with Vertex Fit

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$

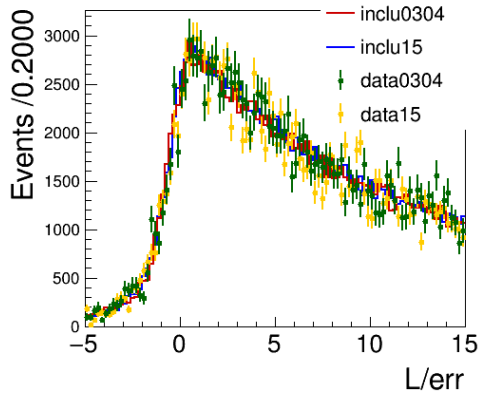
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



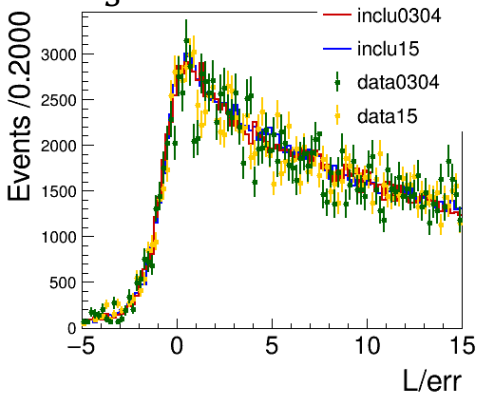
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



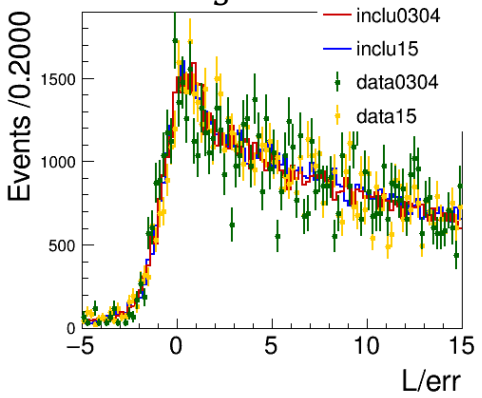
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



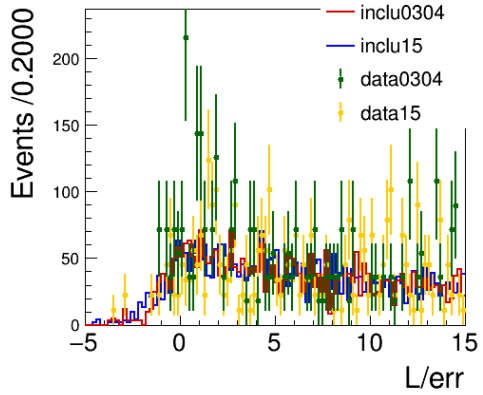
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$



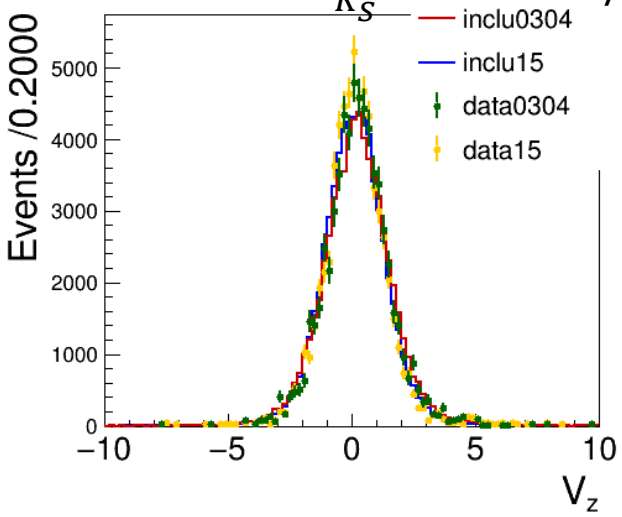
$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$



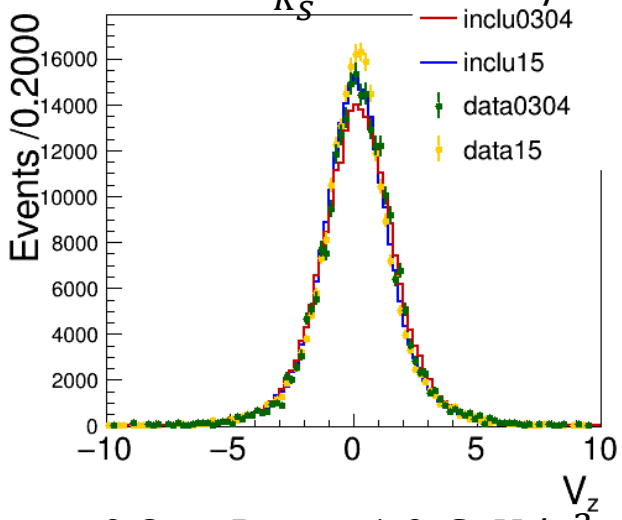
V_z with Refine Vertex Fit

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$
- $L/err > 2$

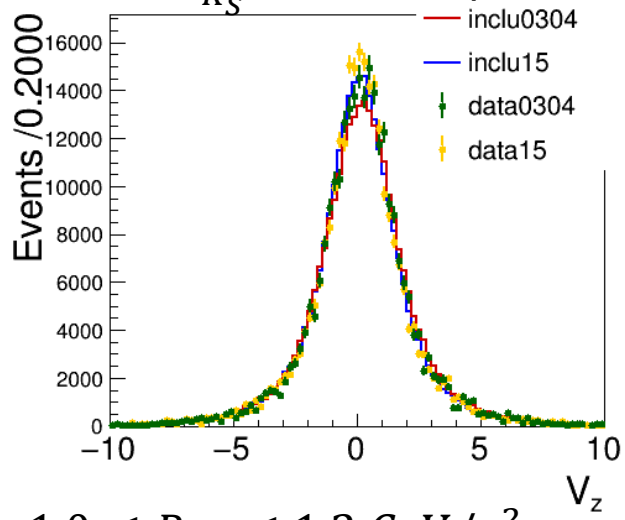
$0.0 \leq P_{K^0_S} \leq 0.2\ GeV/c^2$



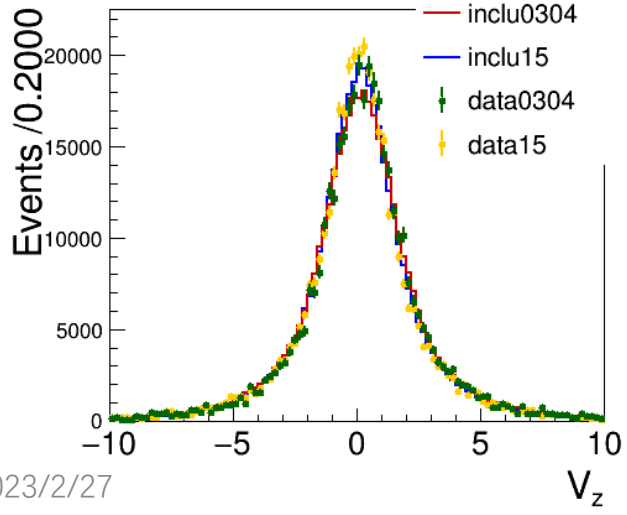
$0.2 \leq P_{K^0_S} \leq 0.4\ GeV/c^2$



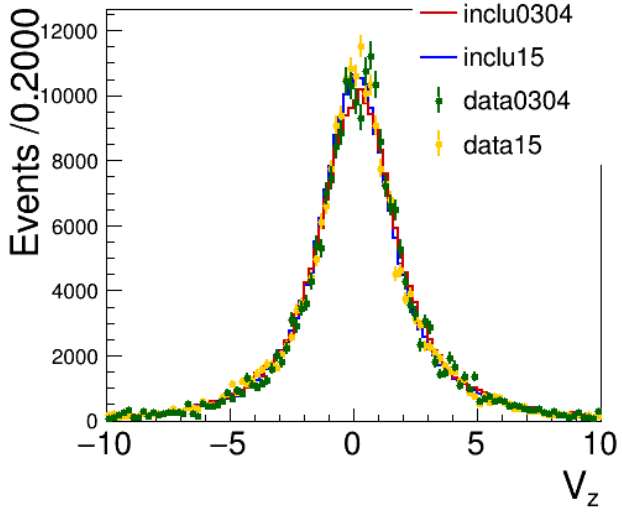
$0.4 \leq P_{K^0_S} \leq 0.6\ GeV/c^2$



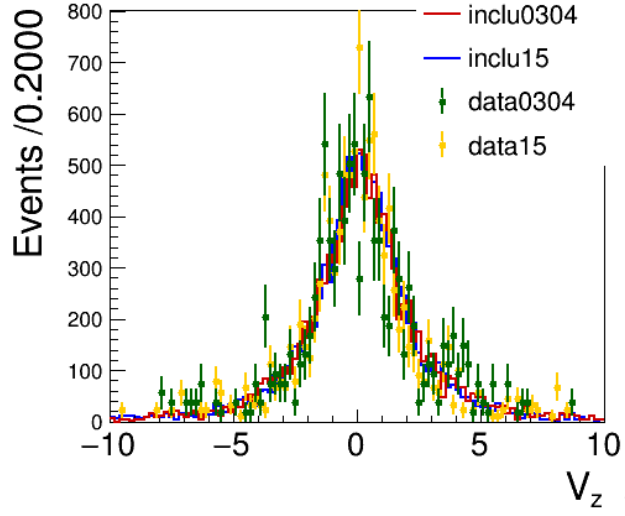
$0.6 \leq P_{K^0_S} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K^0_S} \leq 1.0\ GeV/c^2$



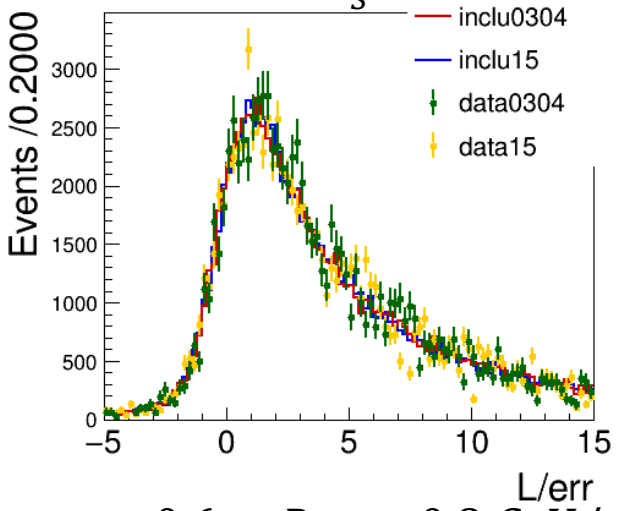
$1.0 \leq P_{K^0_S} \leq 1.2\ GeV/c^2$



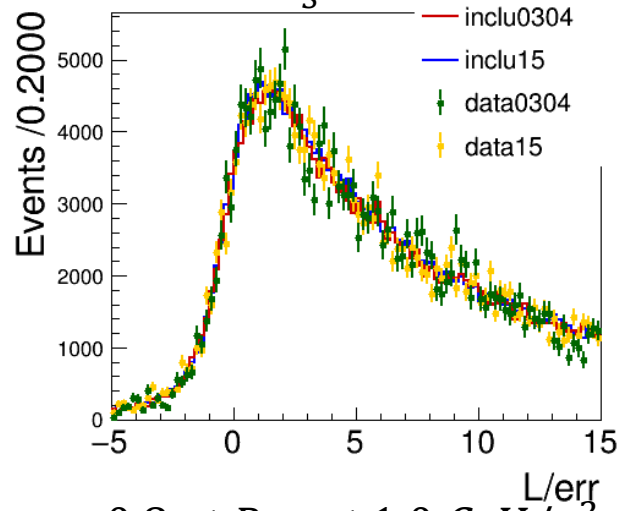
L/err with Vertex Fit

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$

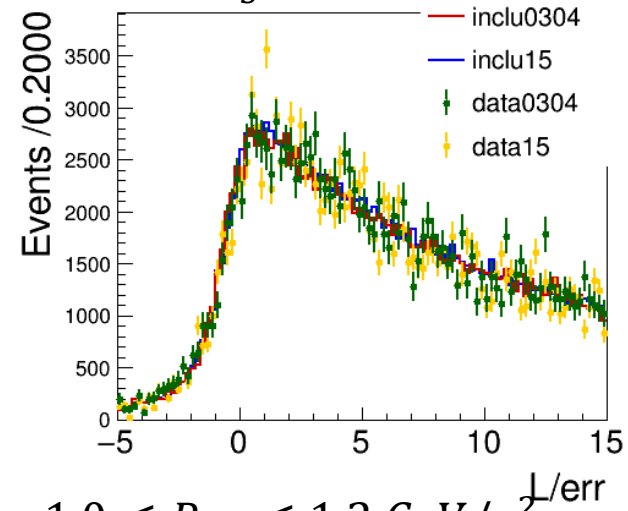
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



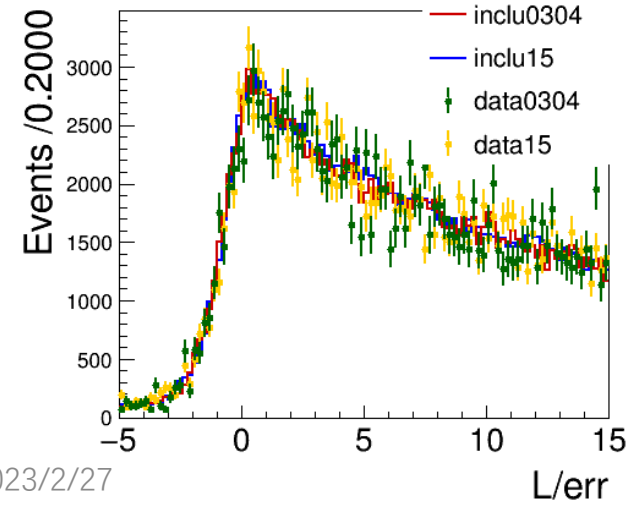
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



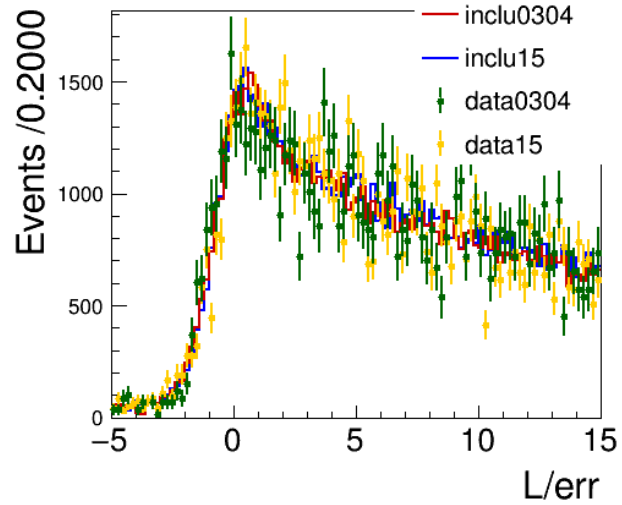
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



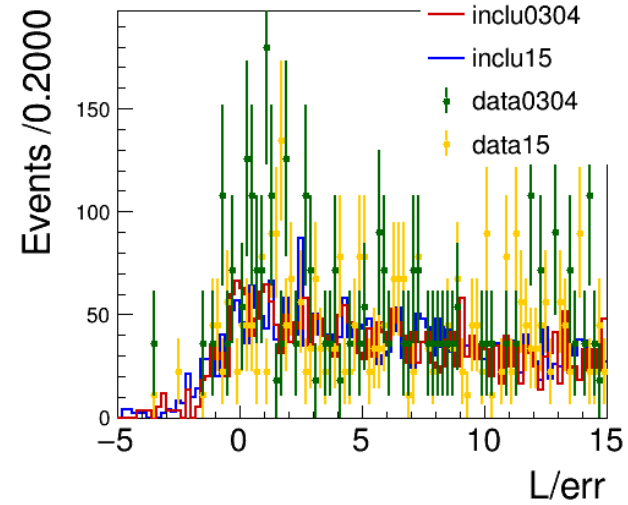
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$

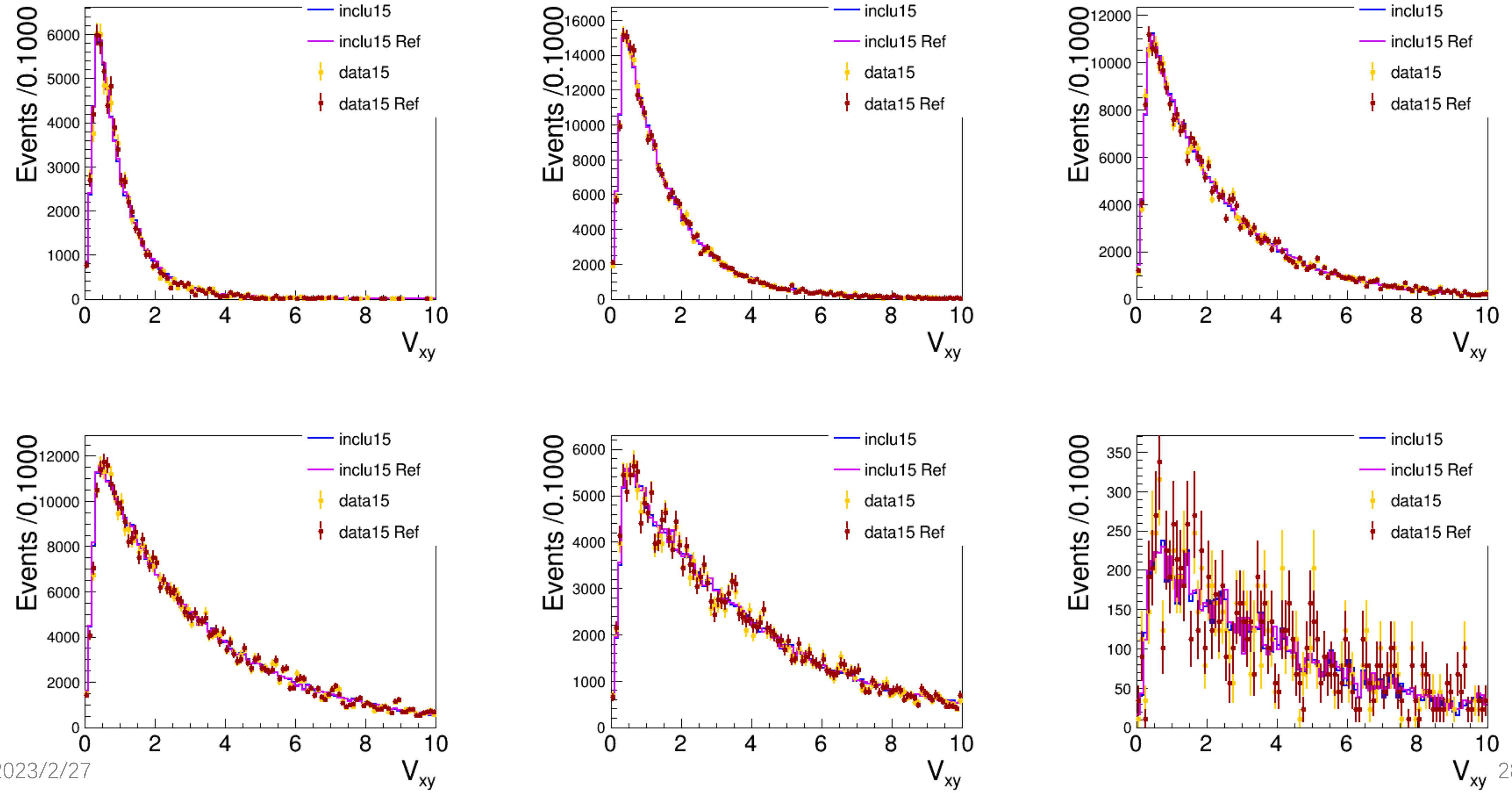


$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$



Comparison of two vertex fit of V_{xy}

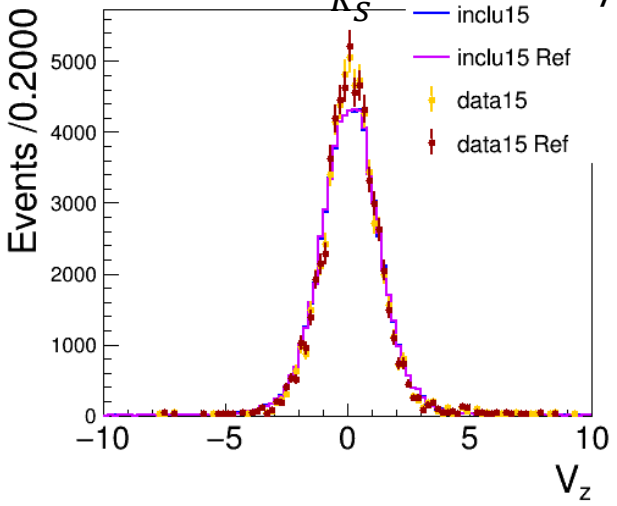
- $\chi^2_{1st} \& \chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$
- $L/err > 2$



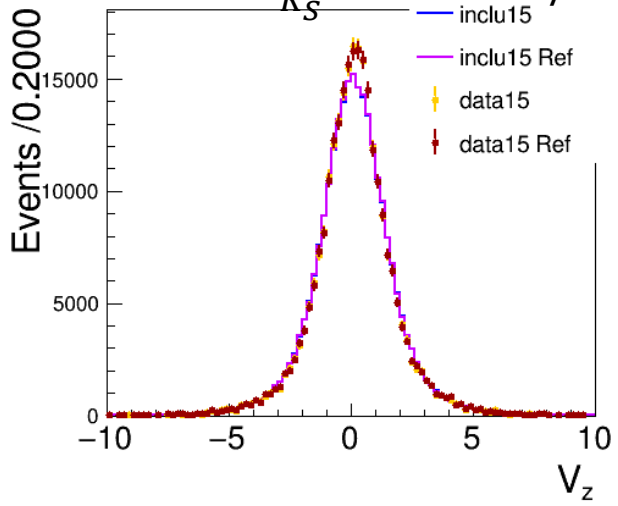
Comparison of two vertex fit of V_z

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$
- $L/err > 2$

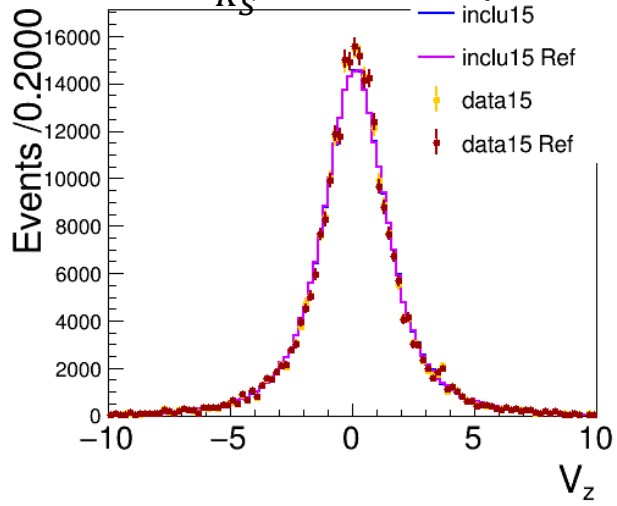
$0.0 \leq P_{K^0_S} \leq 0.2\ GeV/c^2$



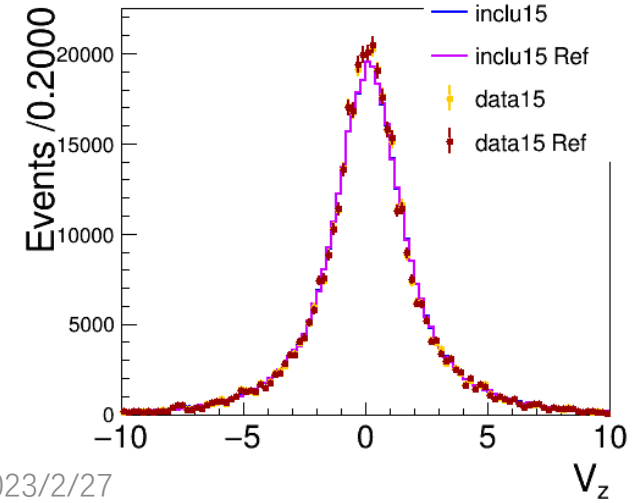
$0.2 \leq P_{K^0_S} \leq 0.4\ GeV/c^2$



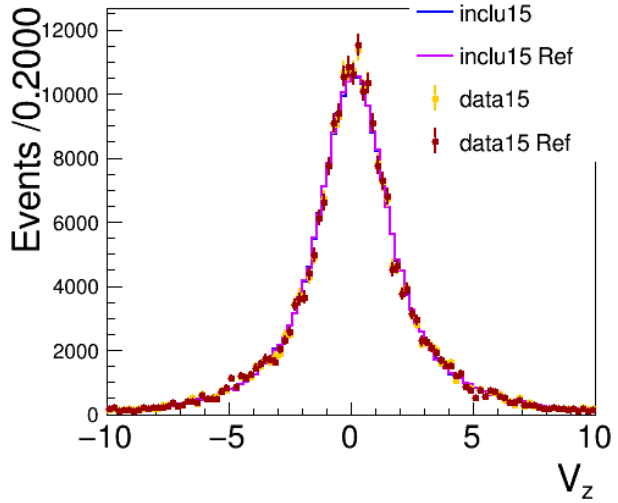
$0.4 \leq P_{K^0_S} \leq 0.6\ GeV/c^2$



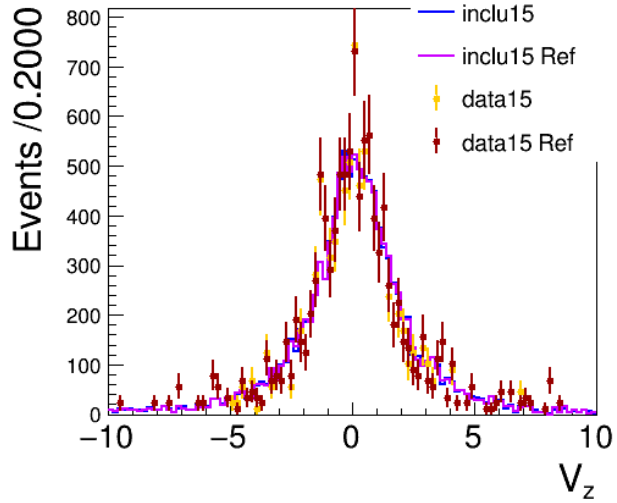
$0.6 \leq P_{K^0_S} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K^0_S} \leq 1.0\ GeV/c^2$



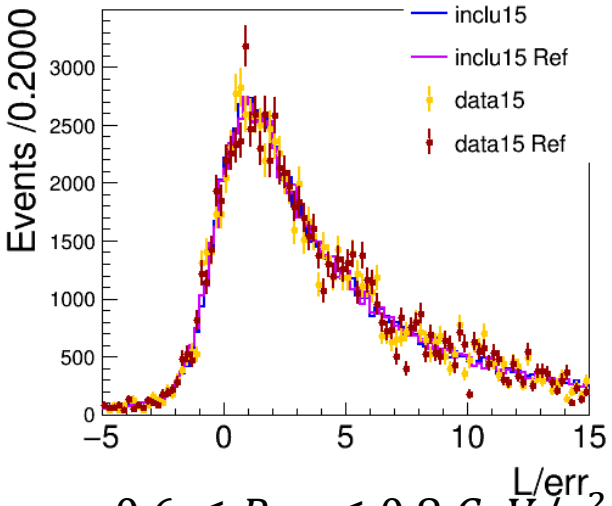
$1.0 \leq P_{K^0_S} \leq 1.2\ GeV/c^2$



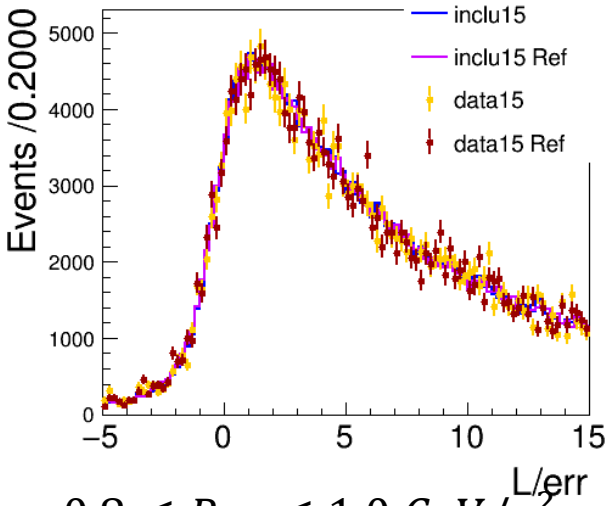
Comparison of two vertex fit of L/err

- $\chi^2_{1st}\&\chi^2_{2rd} < 200$
- $0.511 > M_{K_s} > 0.487$

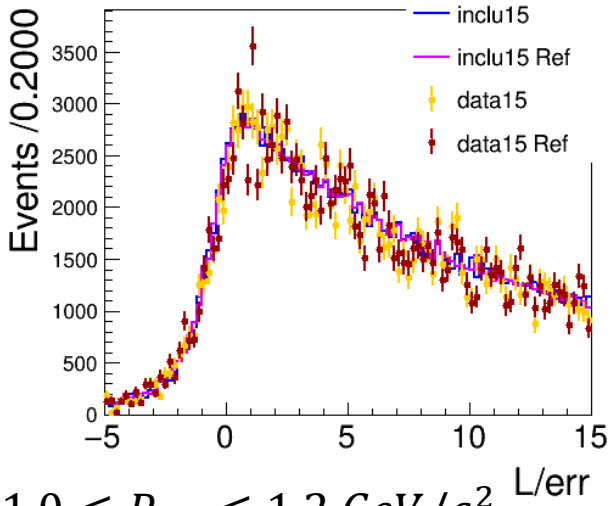
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



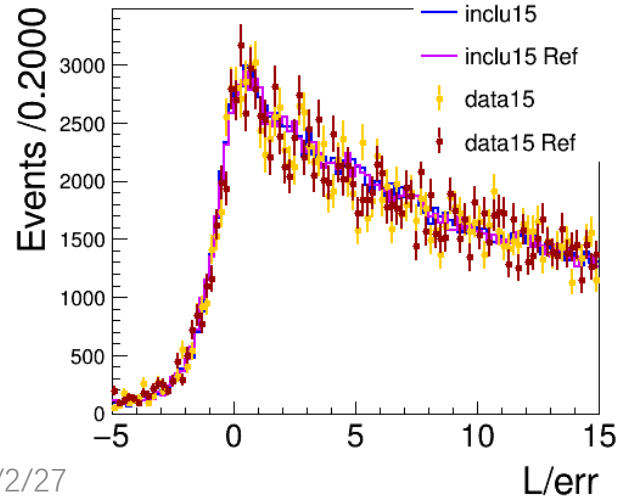
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



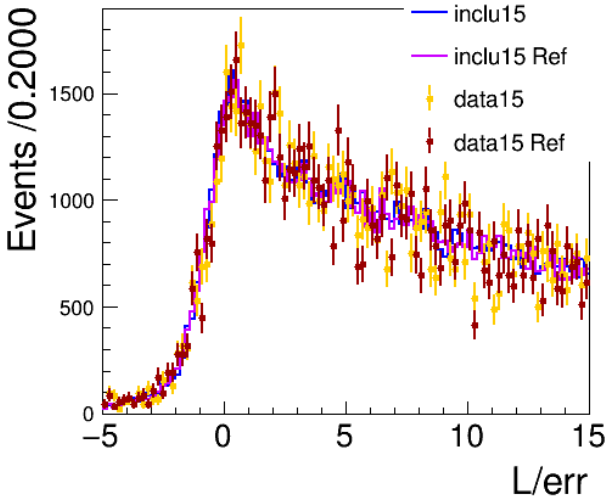
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



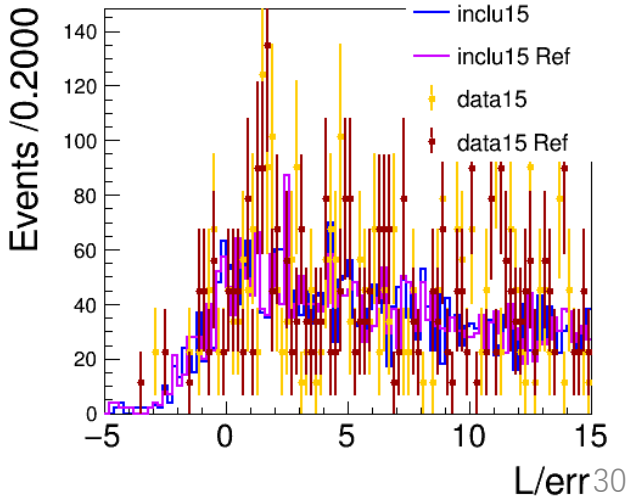
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



$0.8 \leq P_{K_S^0} \leq 1.0\ GeV/c^2$

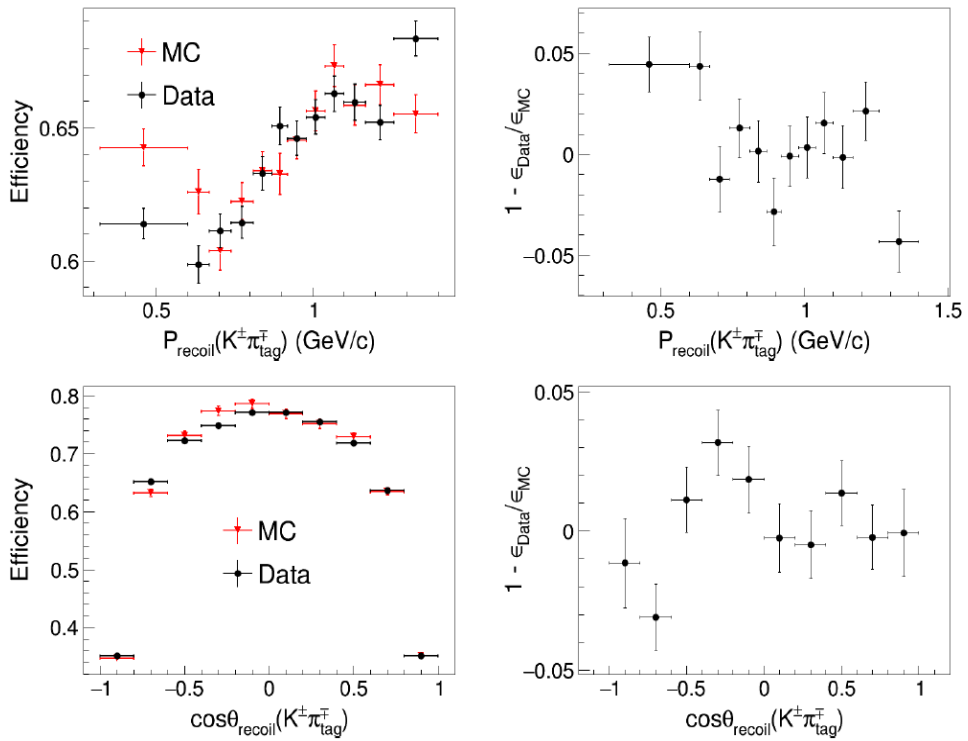


$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$

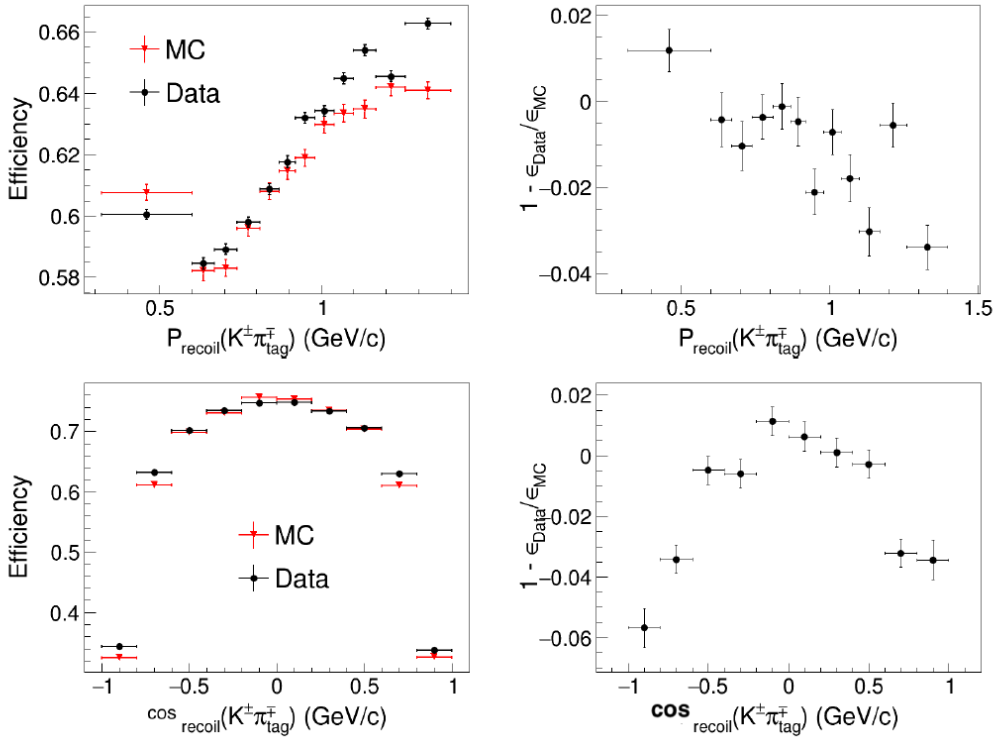


J/ψ result

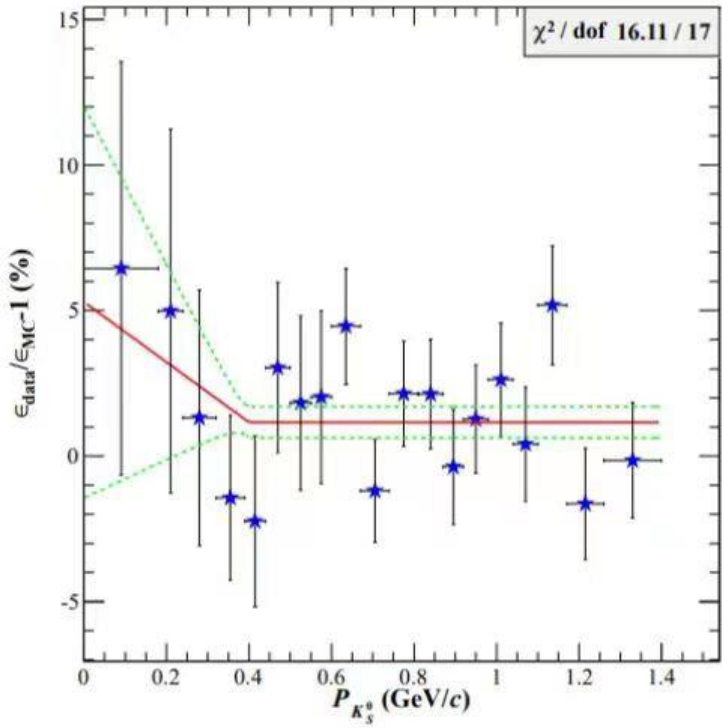
09+12 Results

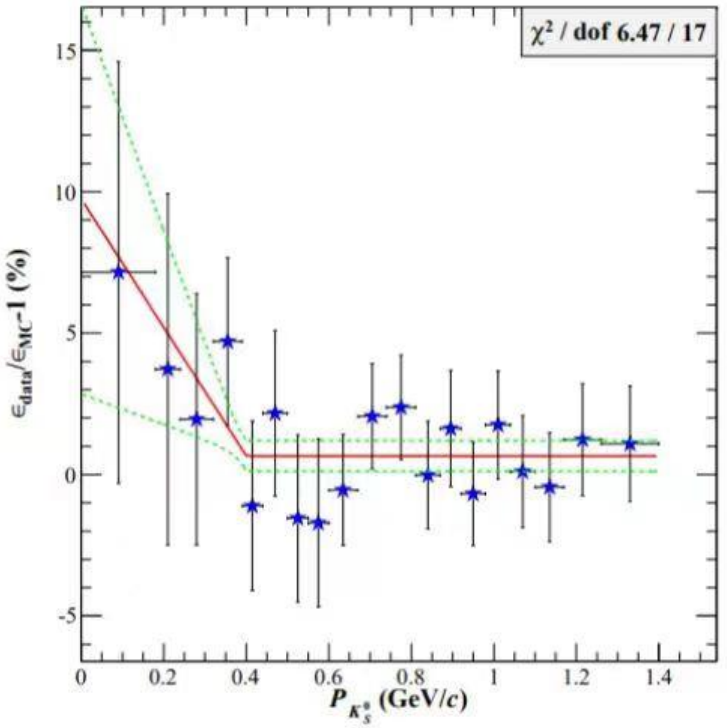


18+19 Results

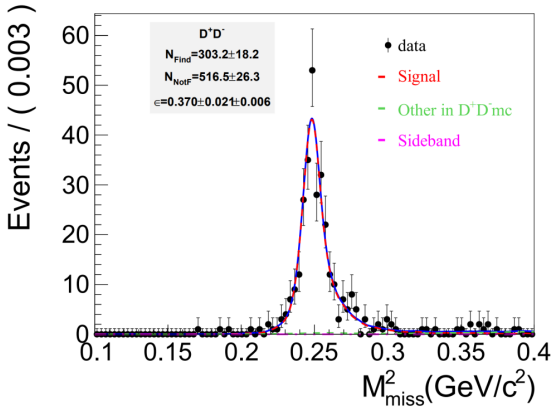


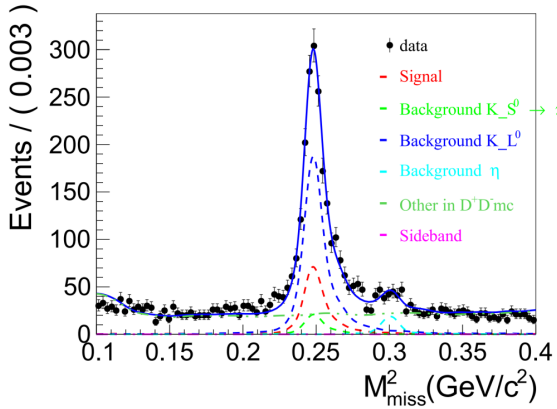
J/ψ result

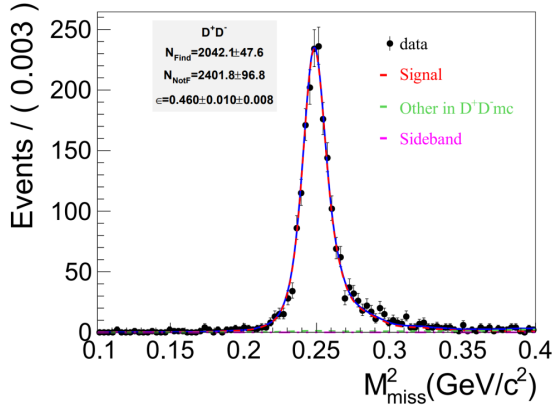

χ² / dof 16.11 / 17
$\epsilon_{data}/\epsilon_{MC}$-1 (%)
$P_{K_S^0}$ (GeV/c)

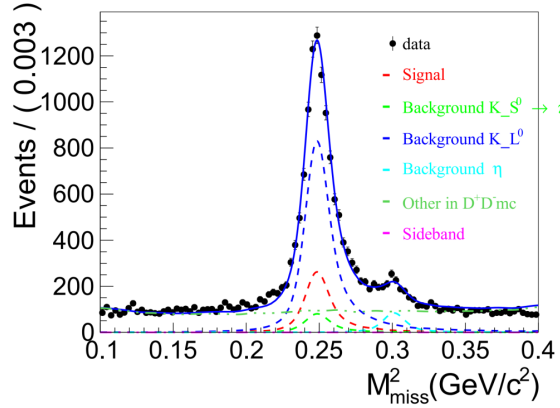

χ² / dof 6.47 / 17
$\epsilon_{data}/\epsilon_{MC}$-1 (%)
$P_{K_S^0}$ (GeV/c)

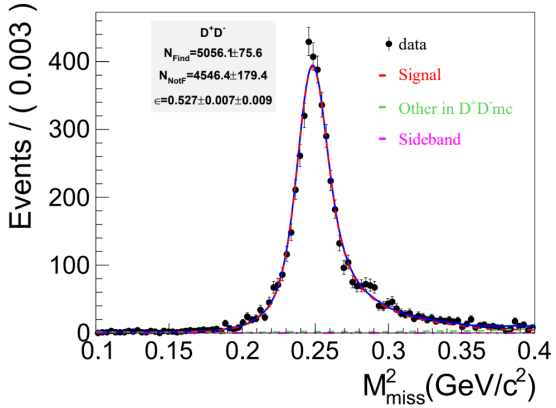
Fit result

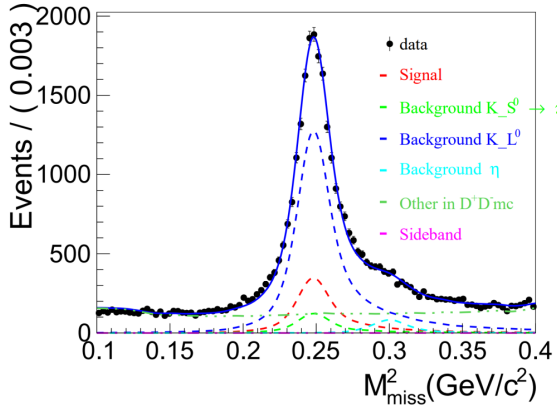


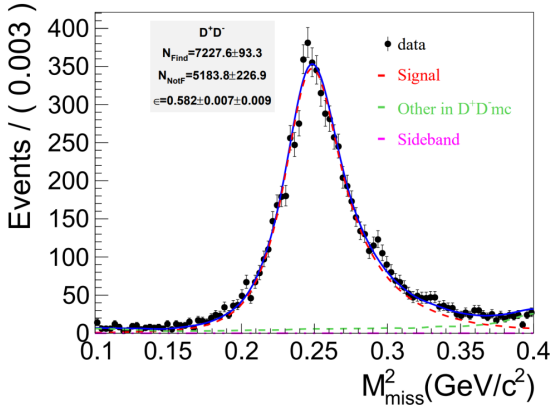


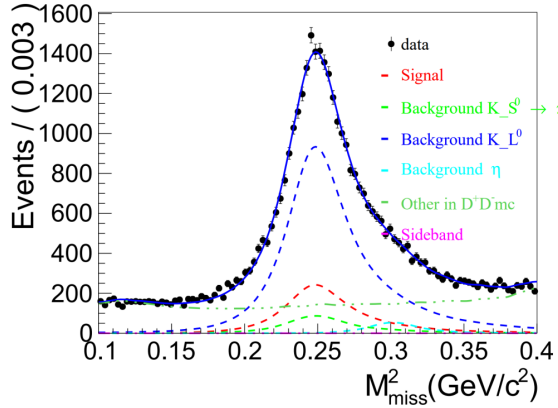


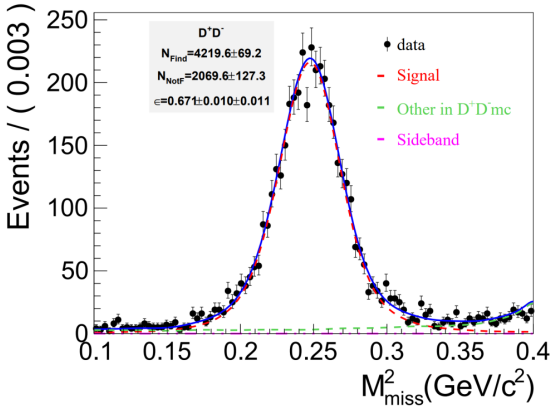


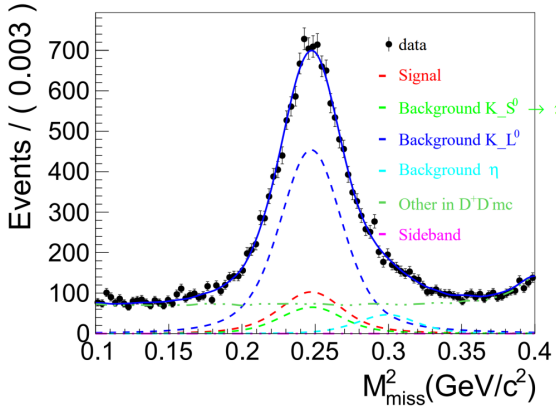




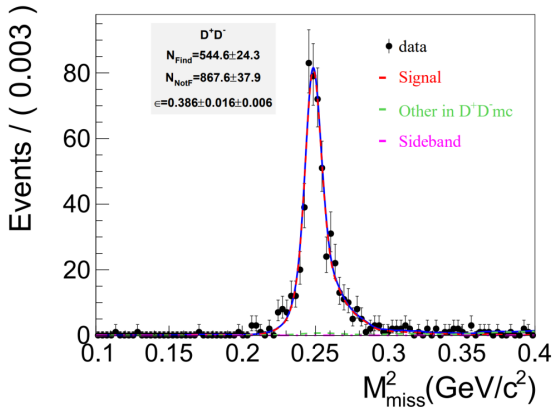


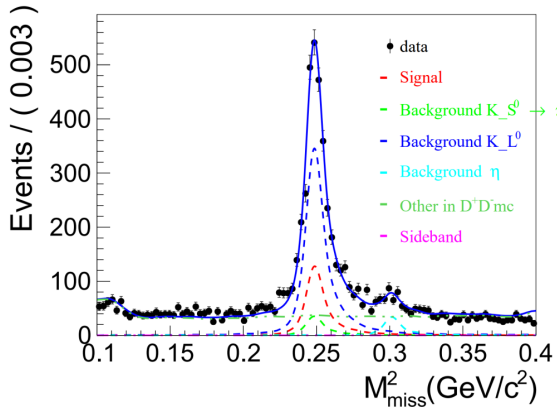


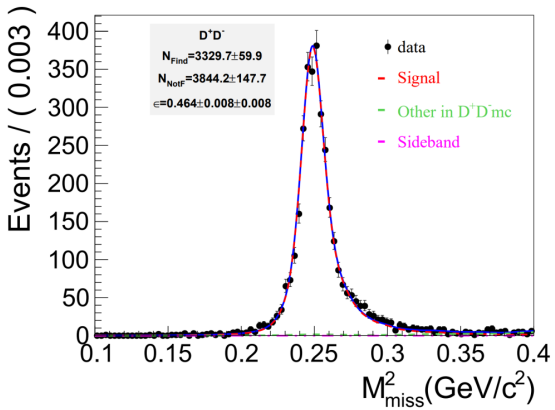


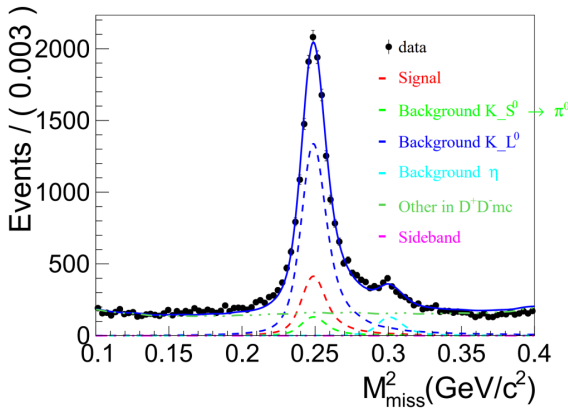


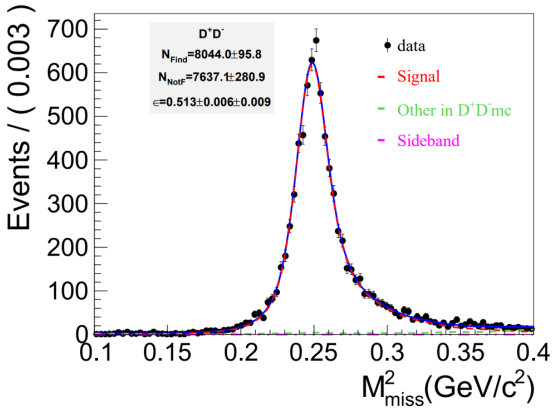
D^+D^-
Round 0304
Vertex fit

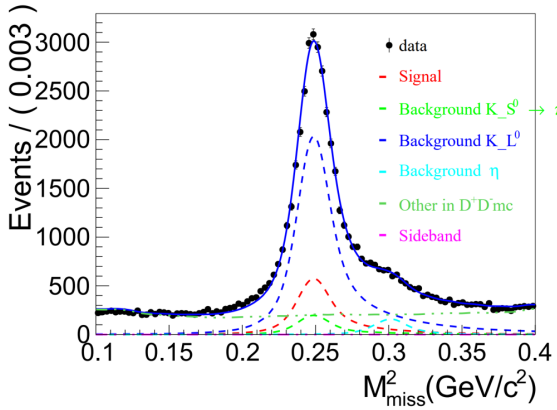


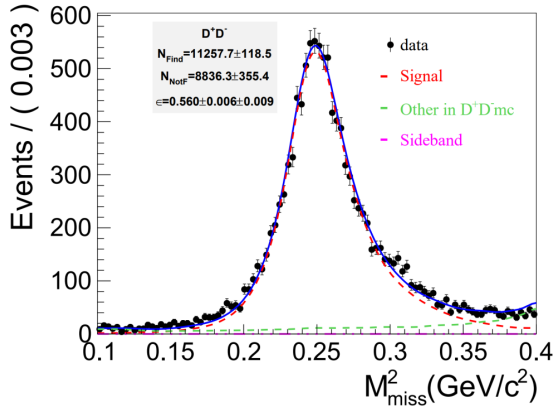


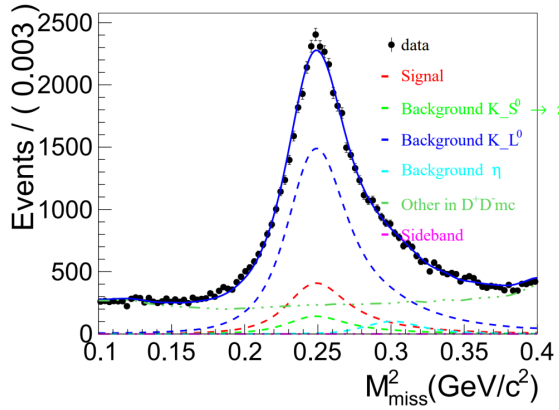


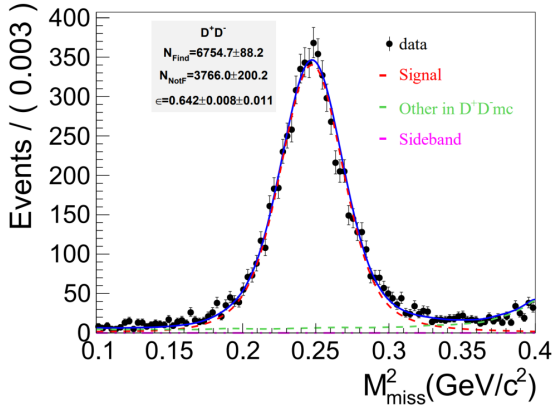


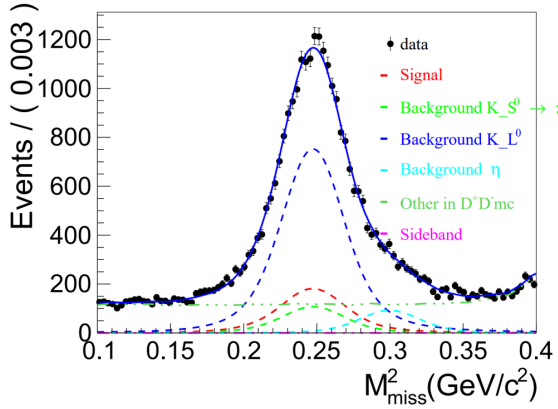




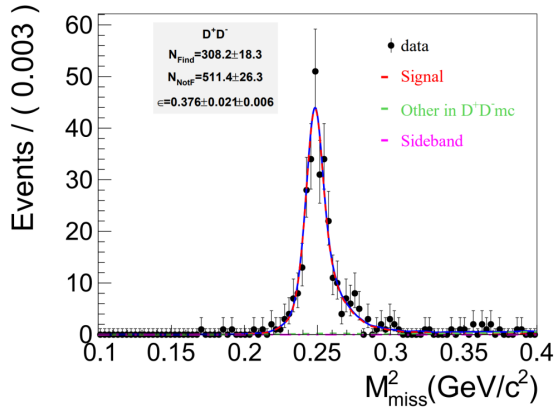


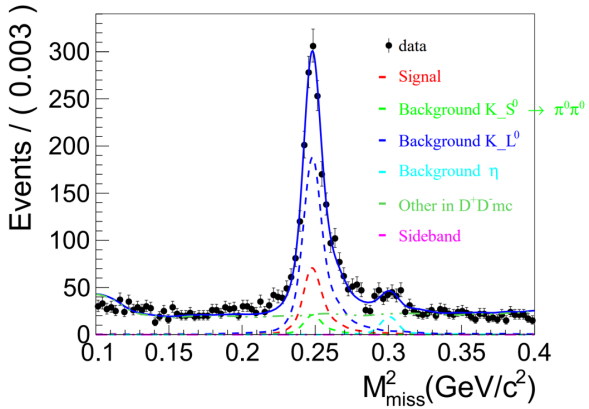


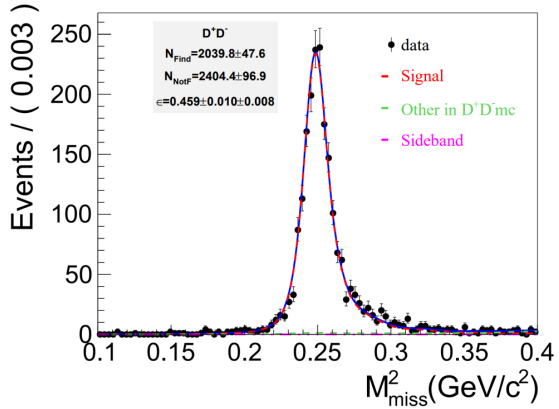


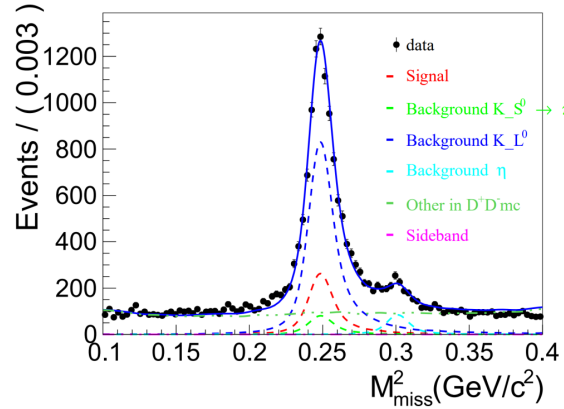


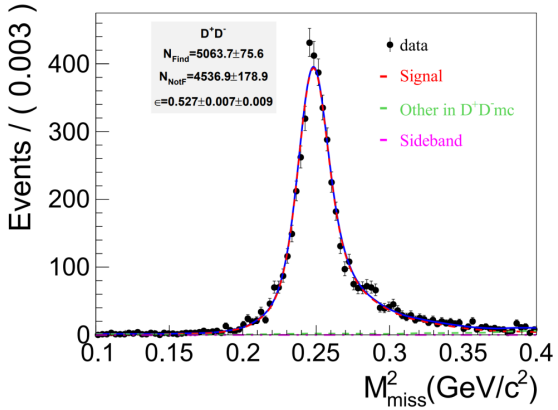
D^+D^- Round 15 Vertex fit

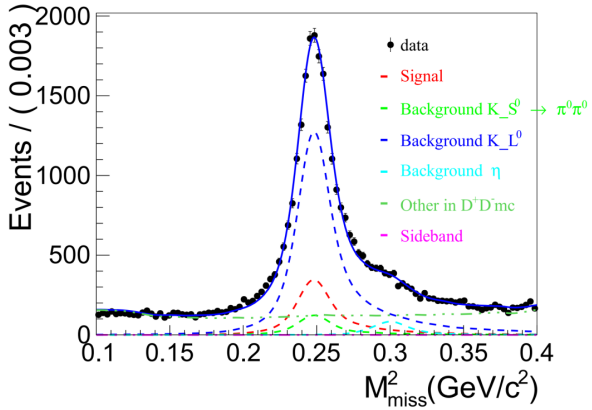


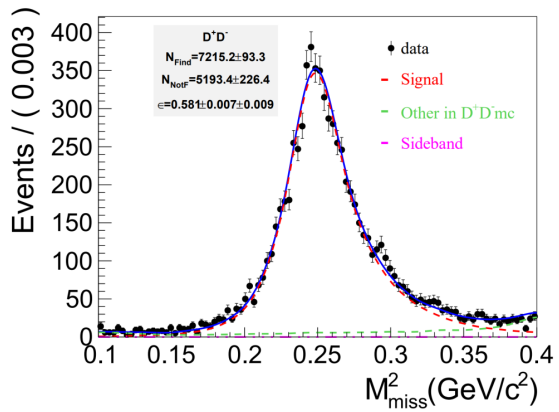


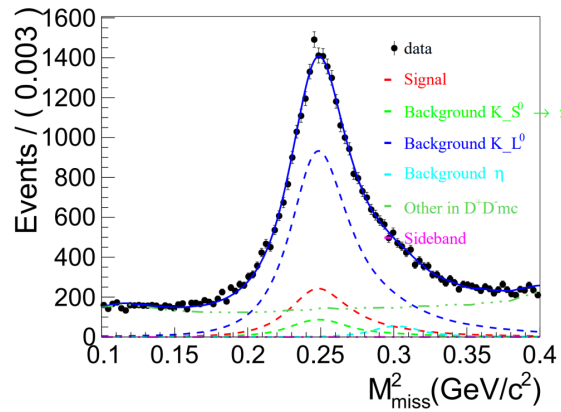


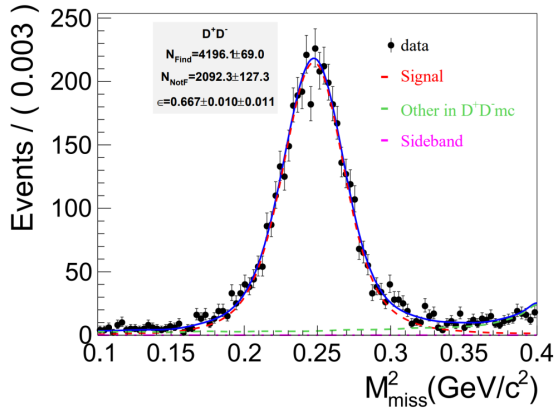


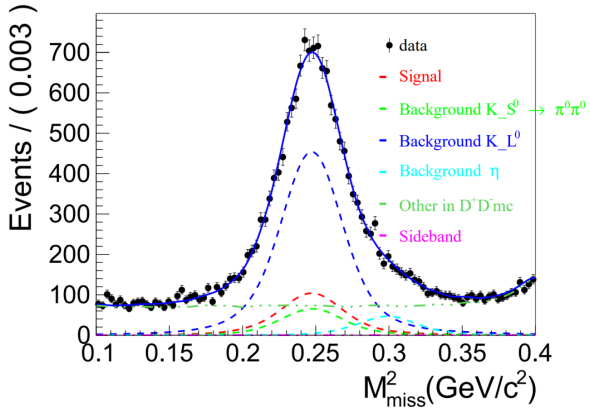








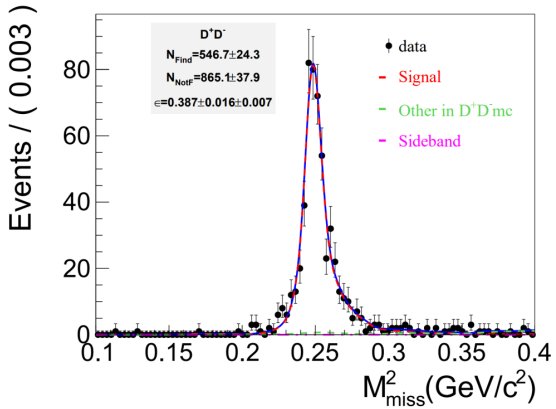


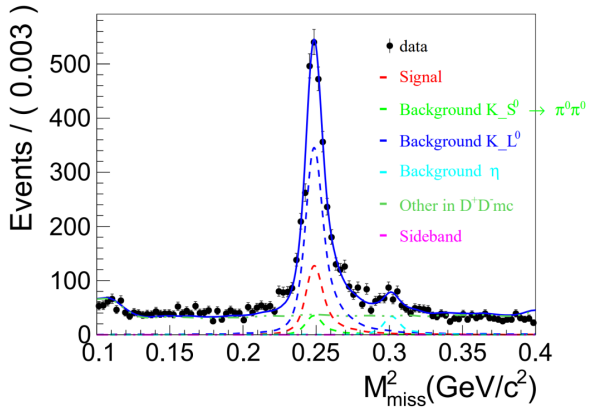


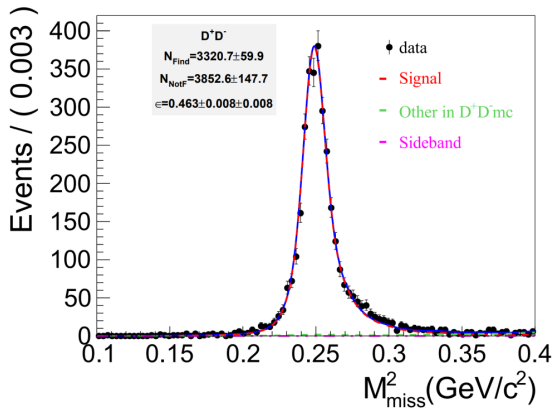
D^+D^-

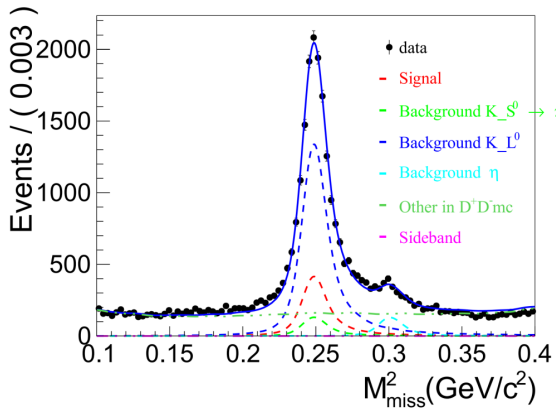
Round 0304

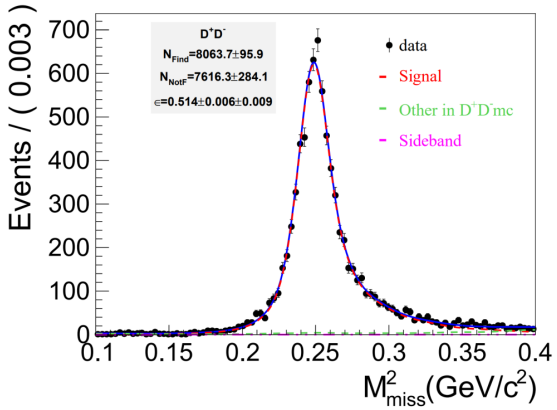
Refine vertex fit

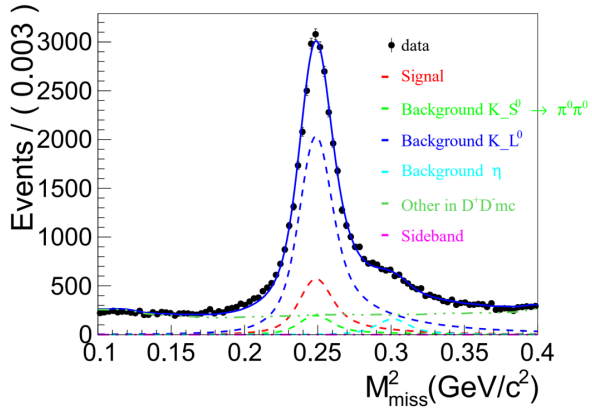


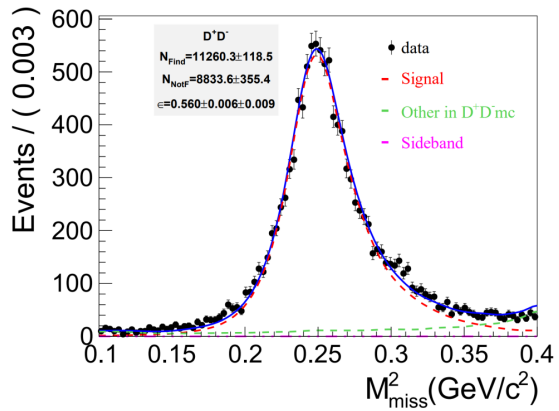


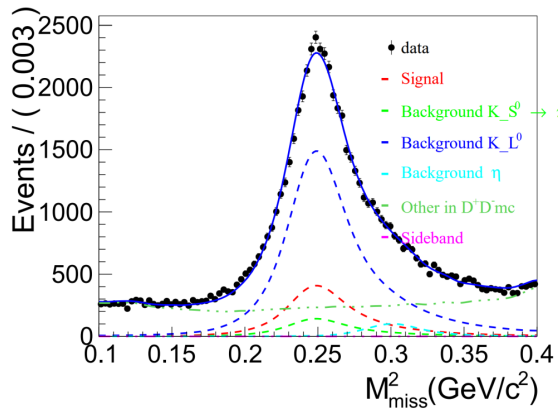


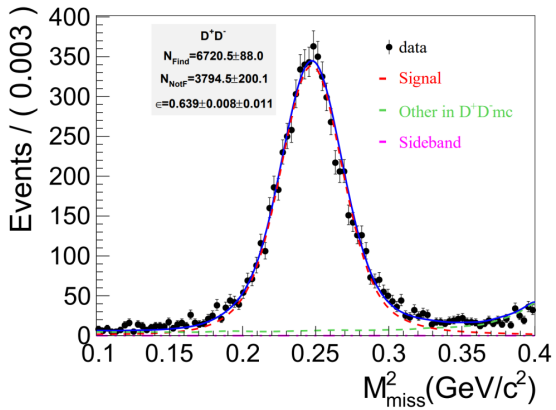


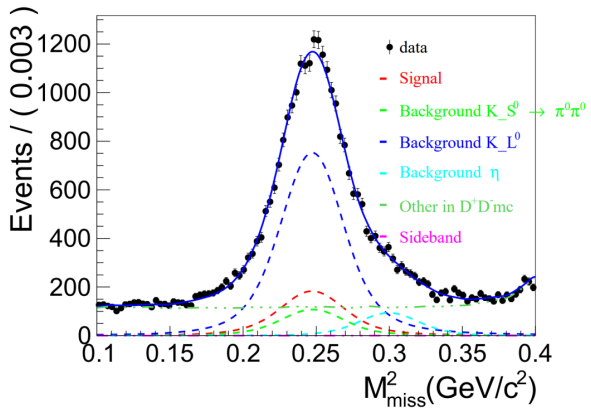












D^+D^-

Round 15

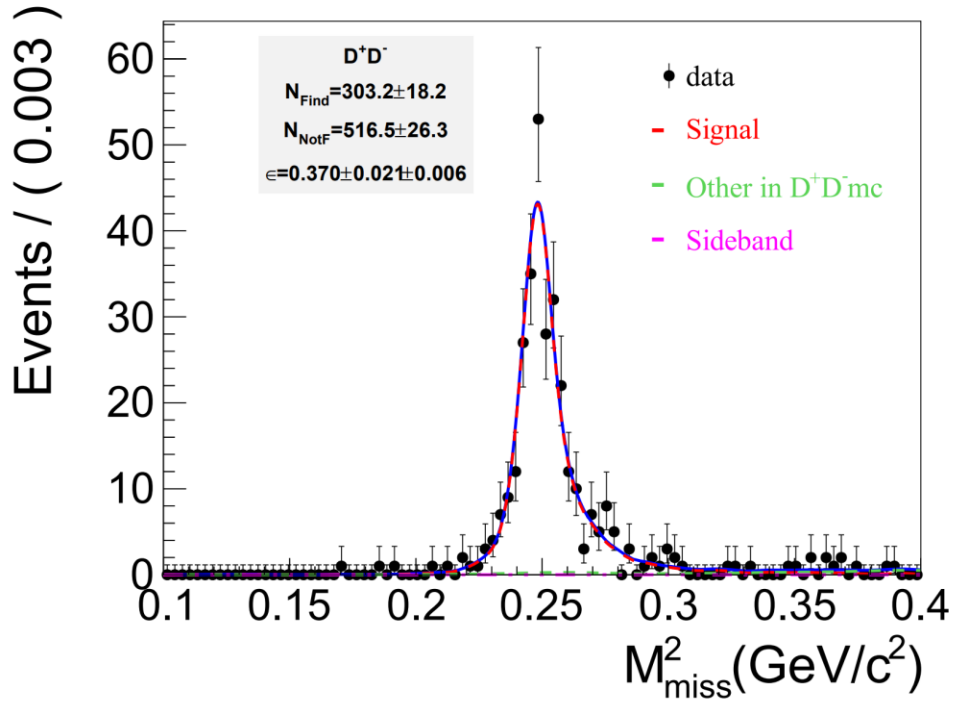
Refine vertex fit

Method 1

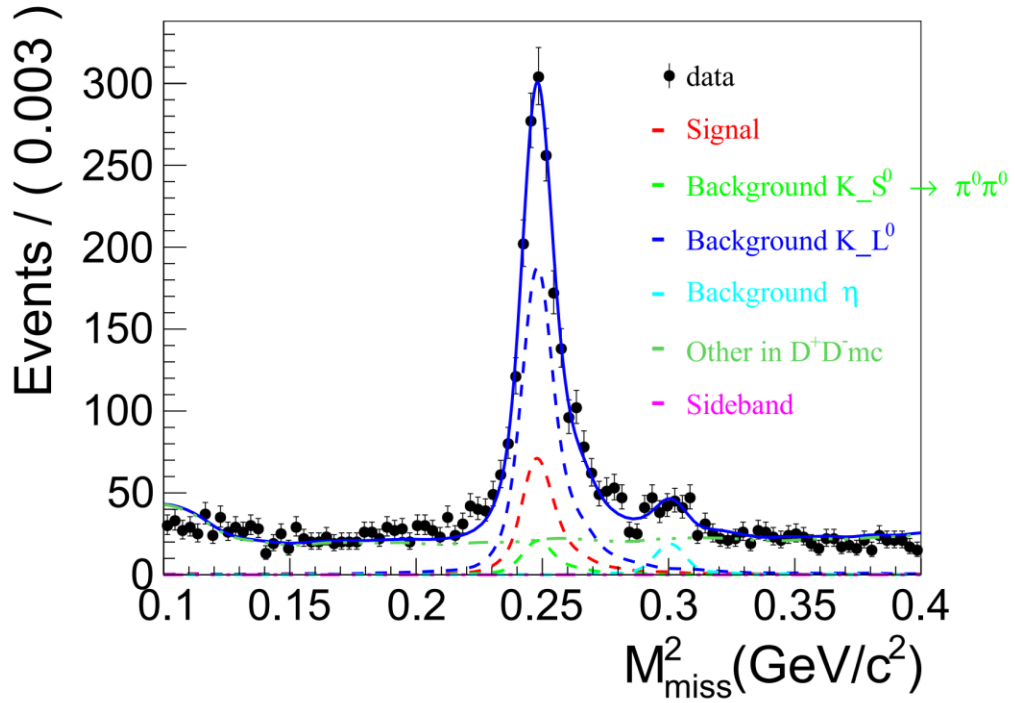
Vertex fit

D^+D^- M^2_{miss}: $0 < P_{miss} < 0.2\ GeV/c$

Find K^0_S



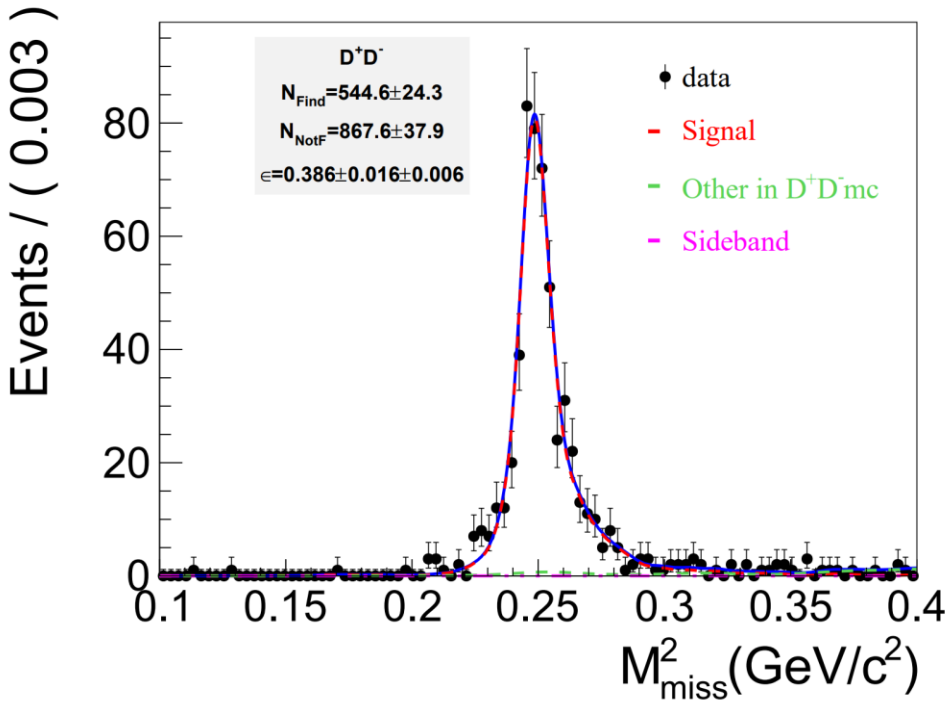
Not Find K^0_S



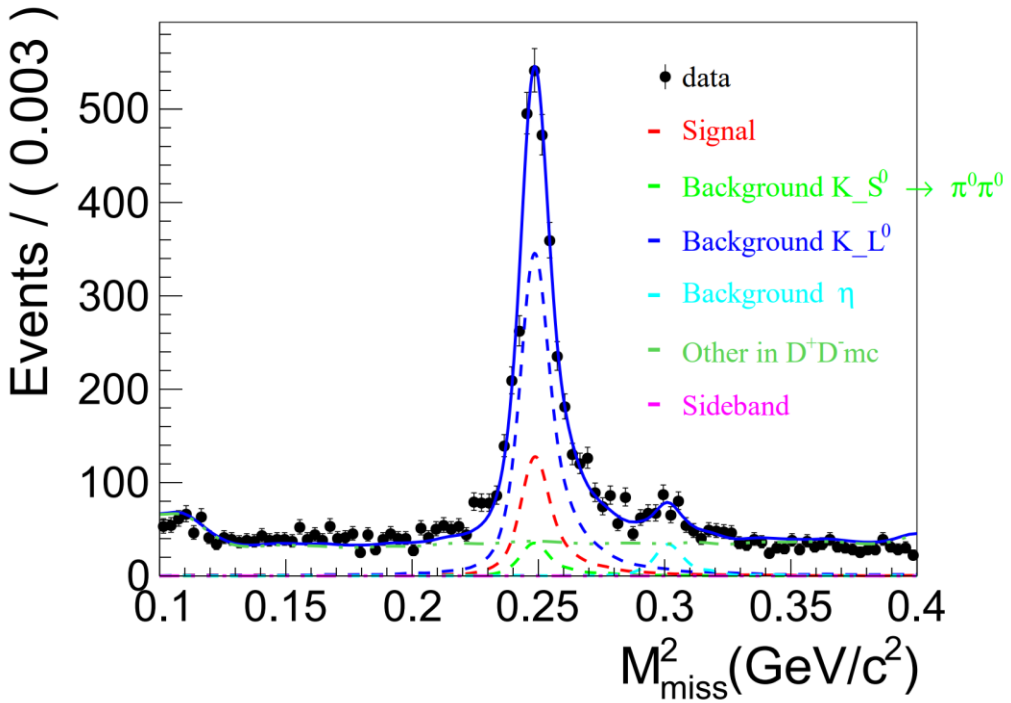
round0304

D^+D^- M^2_{miss}: $0 < P_{miss} < 0.2\ GeV/c$

Find K^0_S



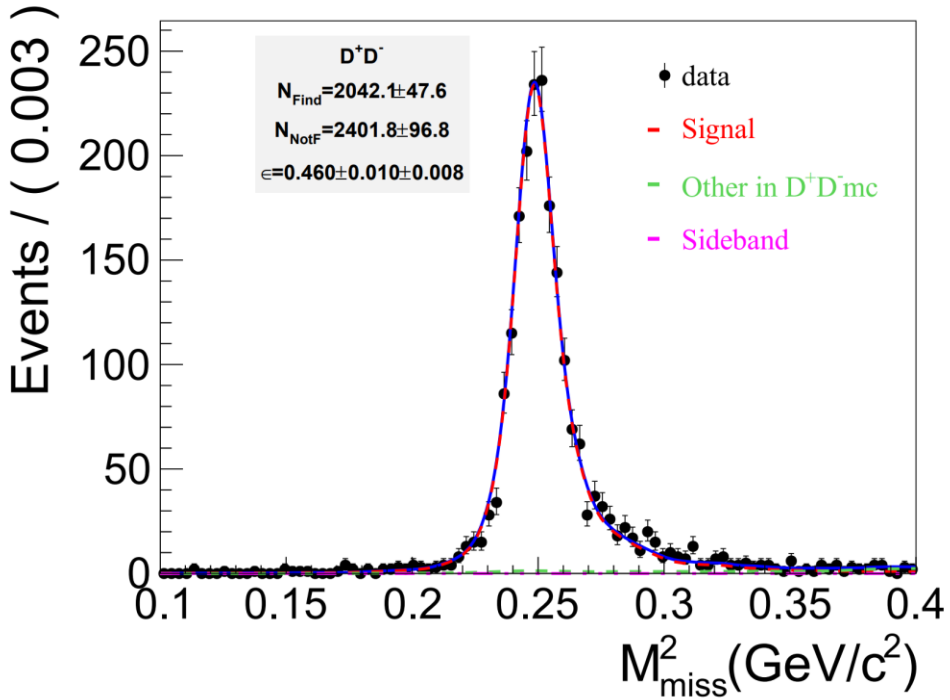
Not Find K^0_S



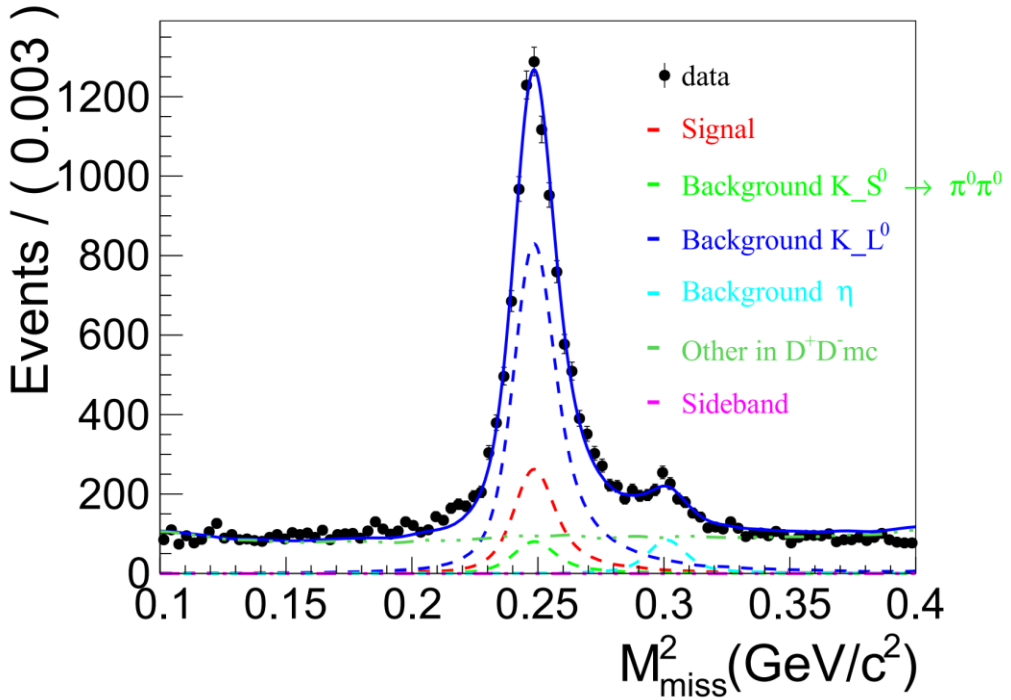
round15

D^+D^- M^2_{miss}: $0.2 < P_{miss} < 0.4\ GeV/c$

Find K^0_S



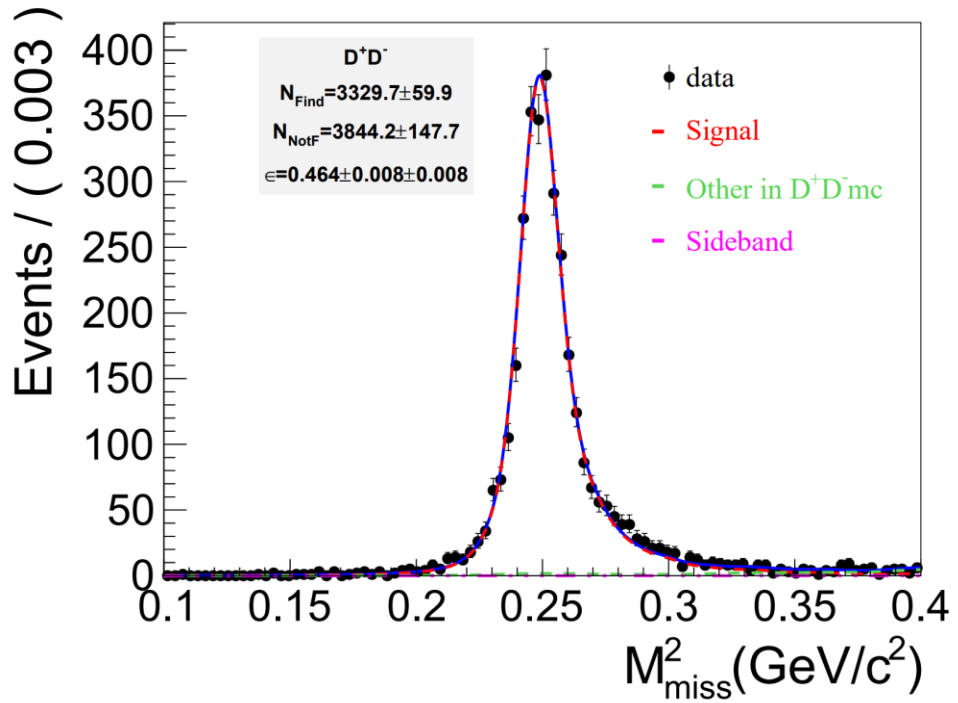
Not Find K^0_S



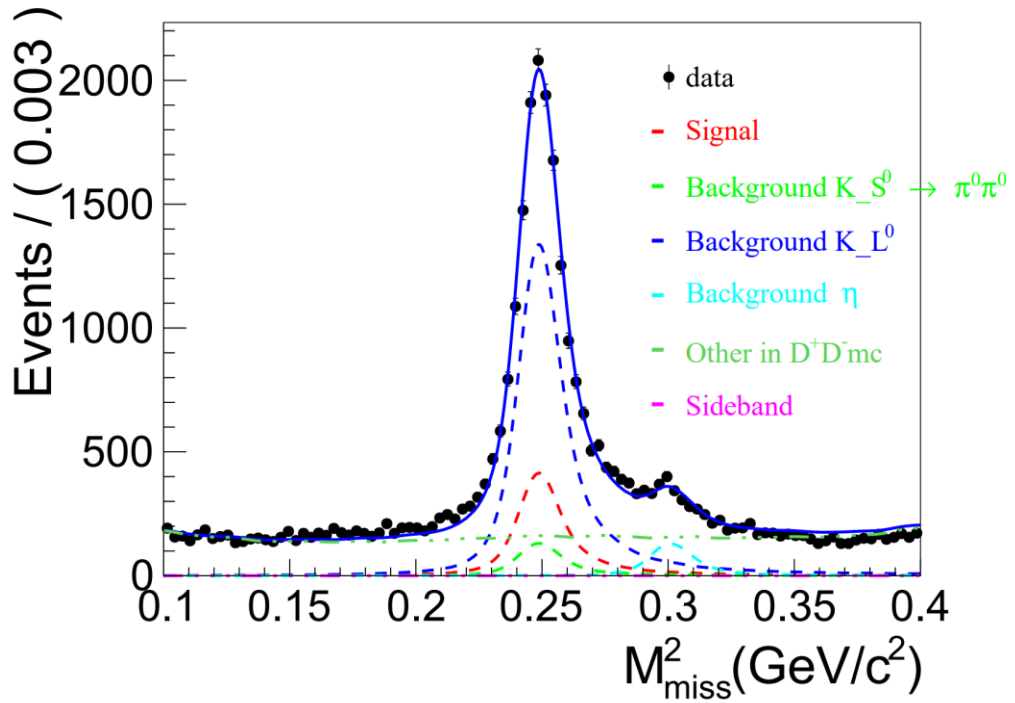
round0304

D^+D^- M^2_{miss}: $0.2 < P_{miss} < 0.4\ GeV/c$

Find K^0_S



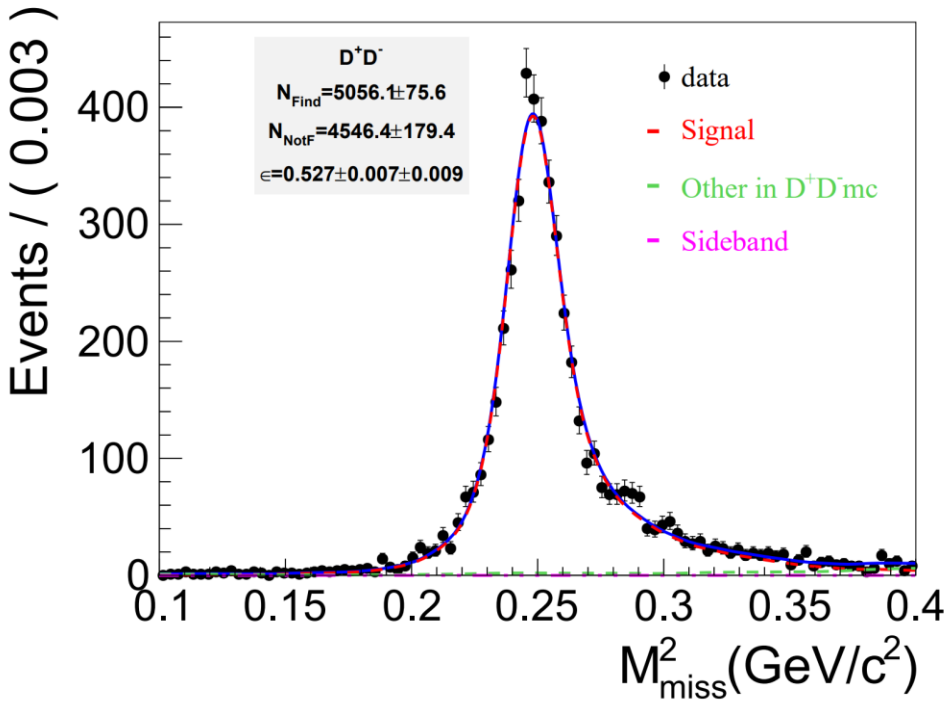
Not Find K^0_S



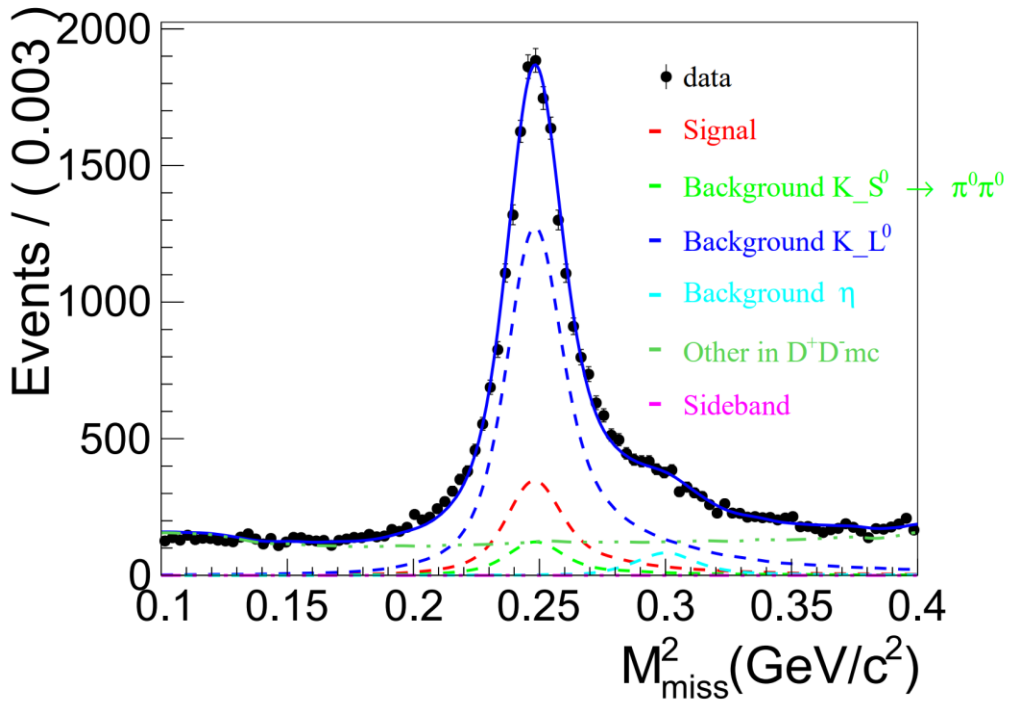
round15

D^+D^- M^2_{miss}: $0.4 < P_{miss} < 0.6\ GeV/c$

Find K^0_S



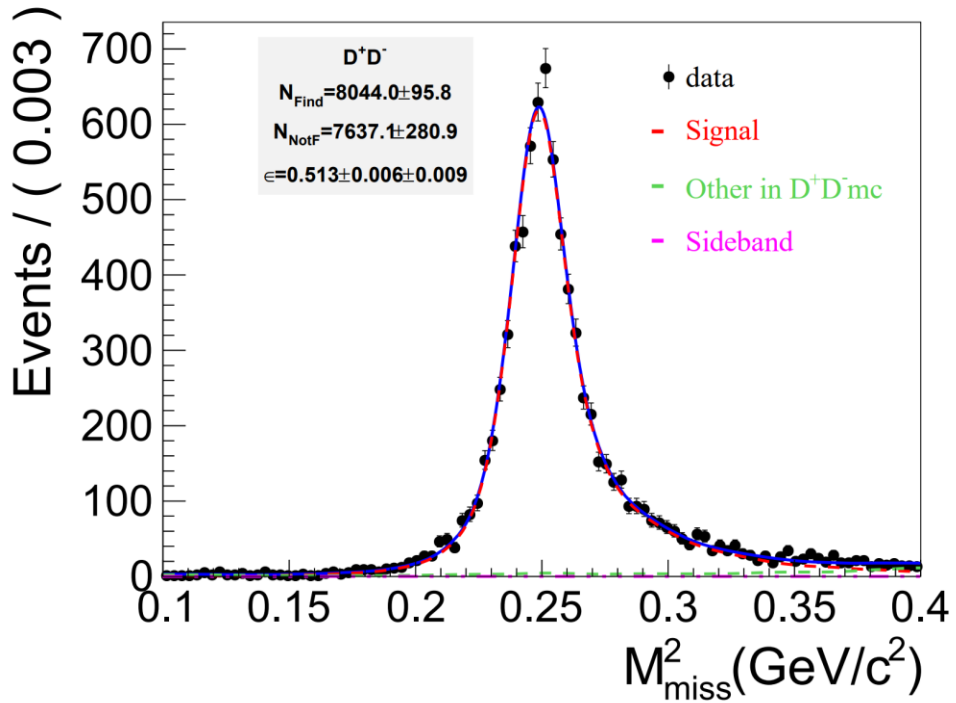
Not Find K^0_S



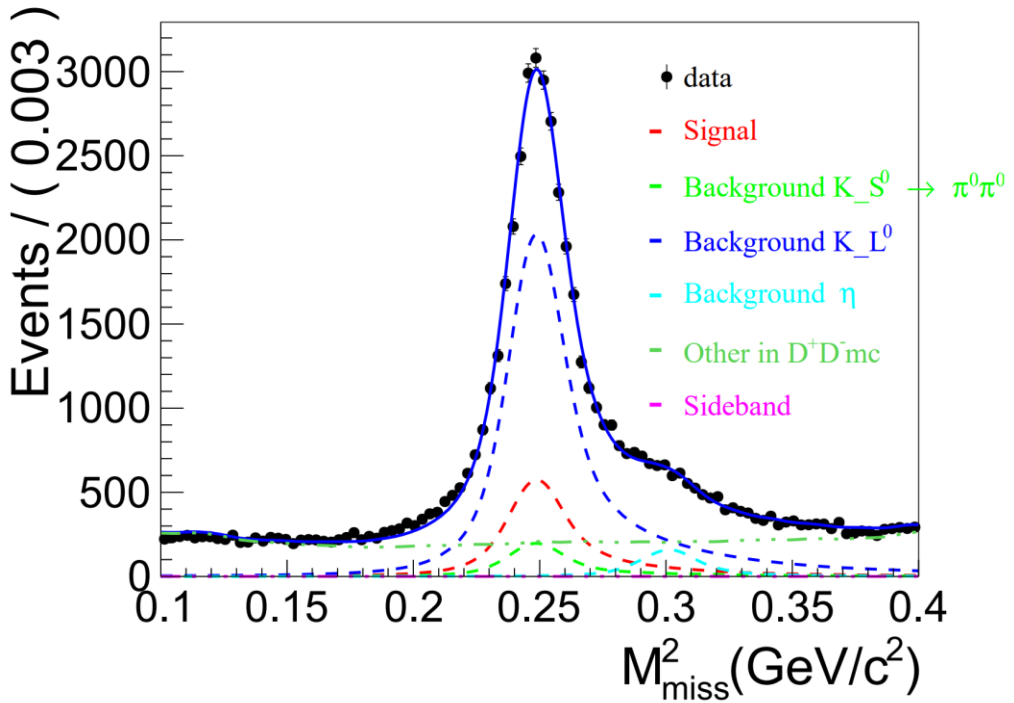
round0304

D^+D^- M^2_{miss}: $0.4 < P_{miss} < 0.6\ GeV/c$

Find K^0_S



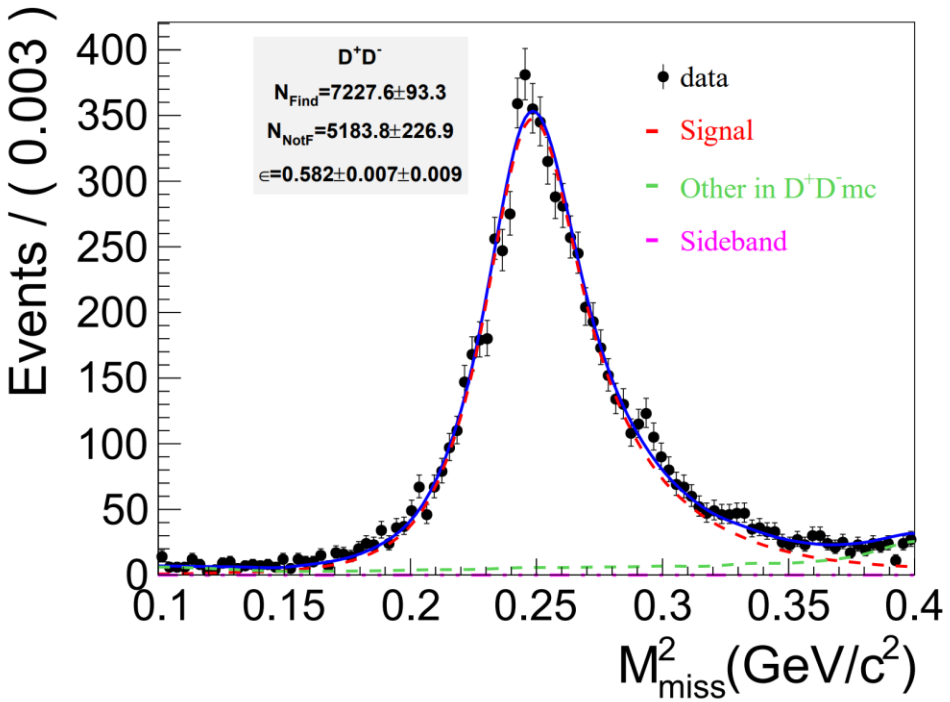
Not Find K^0_S



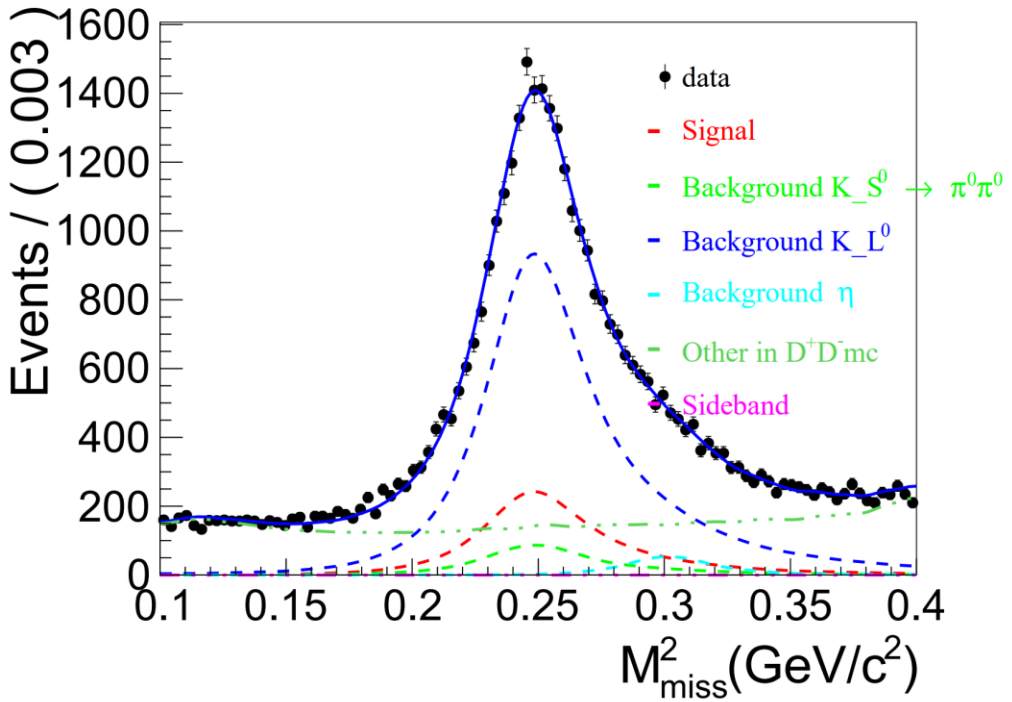
round15

D^+D^- M^2_{miss}: $0.6 < P_{miss} < 0.8\ GeV/c$

Find K^0_S



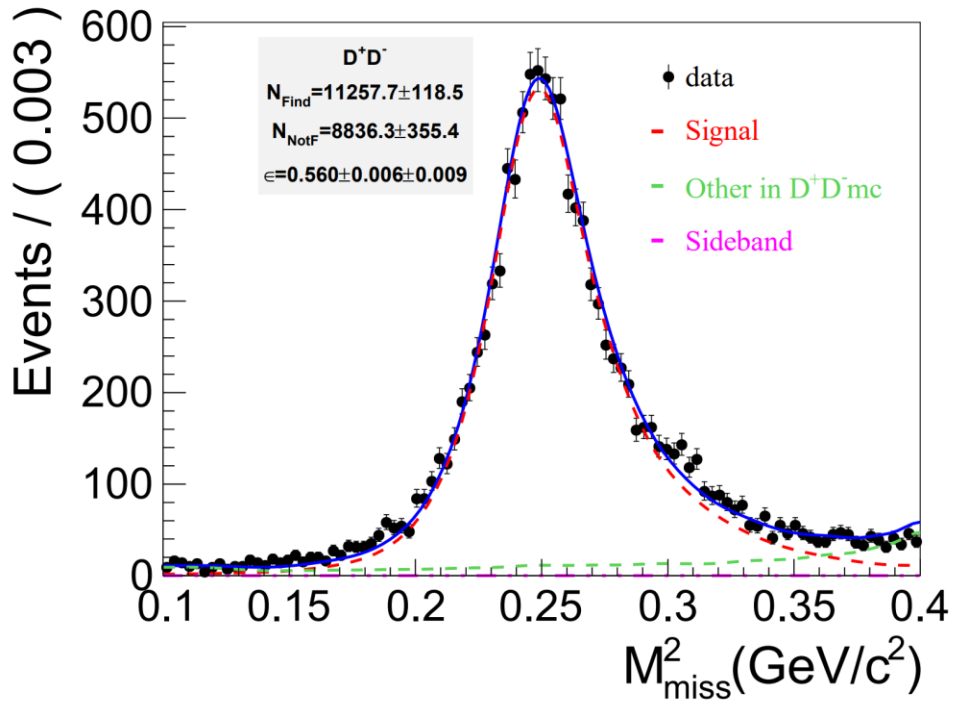
Not Find K^0_S



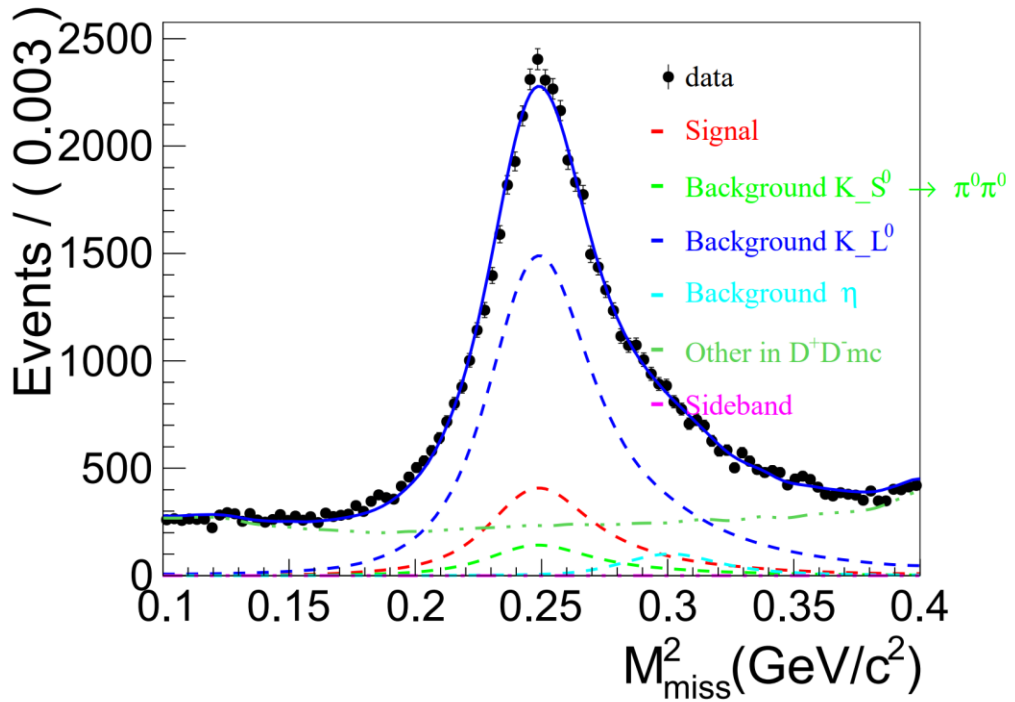
round0304

D^+D^- M^2_{miss}: $0.6 < P_{miss} < 0.8\ GeV/c$

Find K^0_S



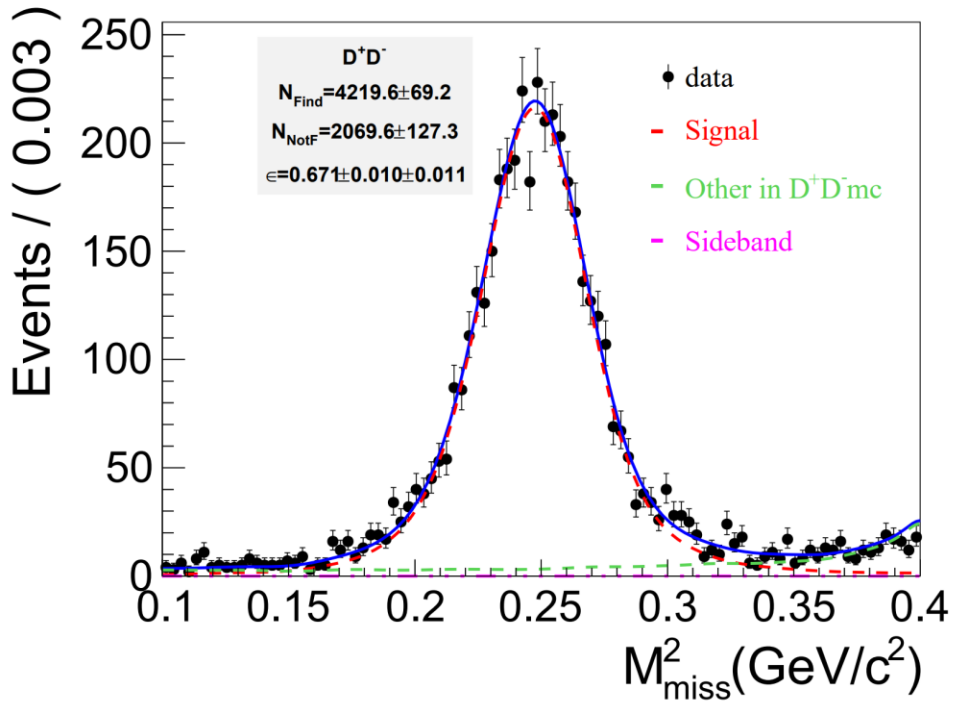
Not Find K^0_S



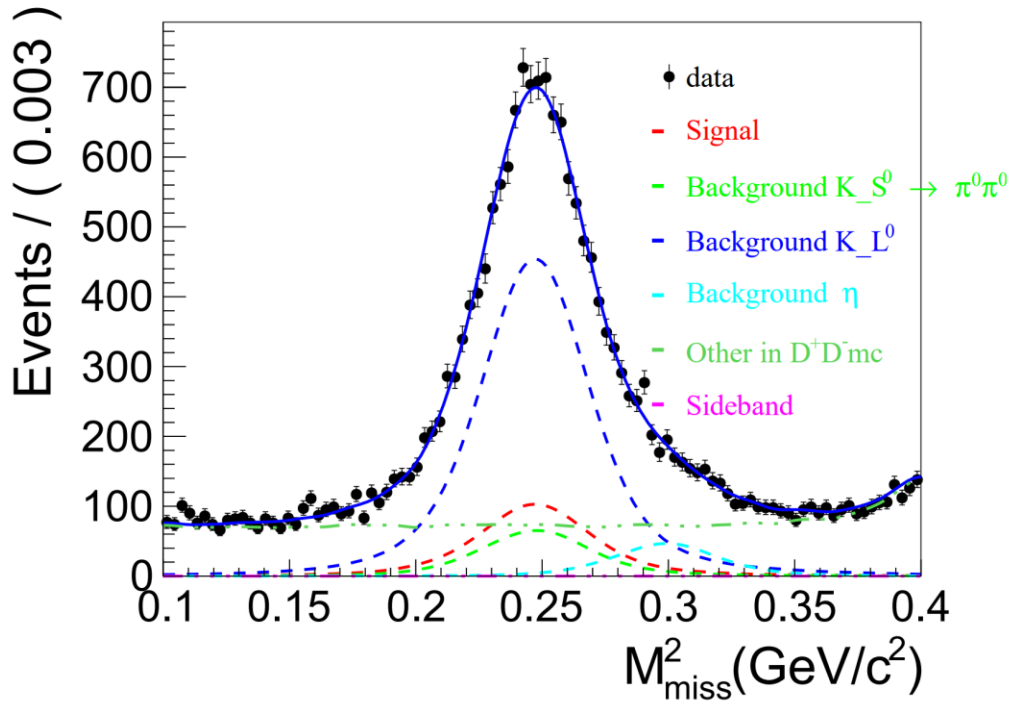
round15

D^+D^- M^2_{miss}: $0.8 < P_{miss} < 1.0\ GeV/c$

Find K^0_S



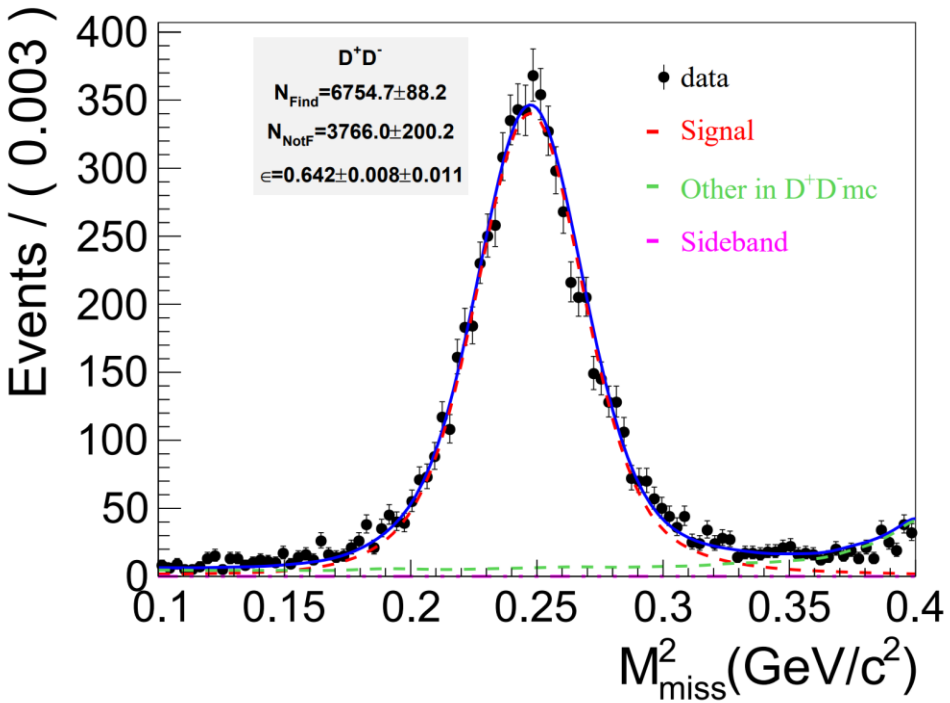
Not Find K^0_S



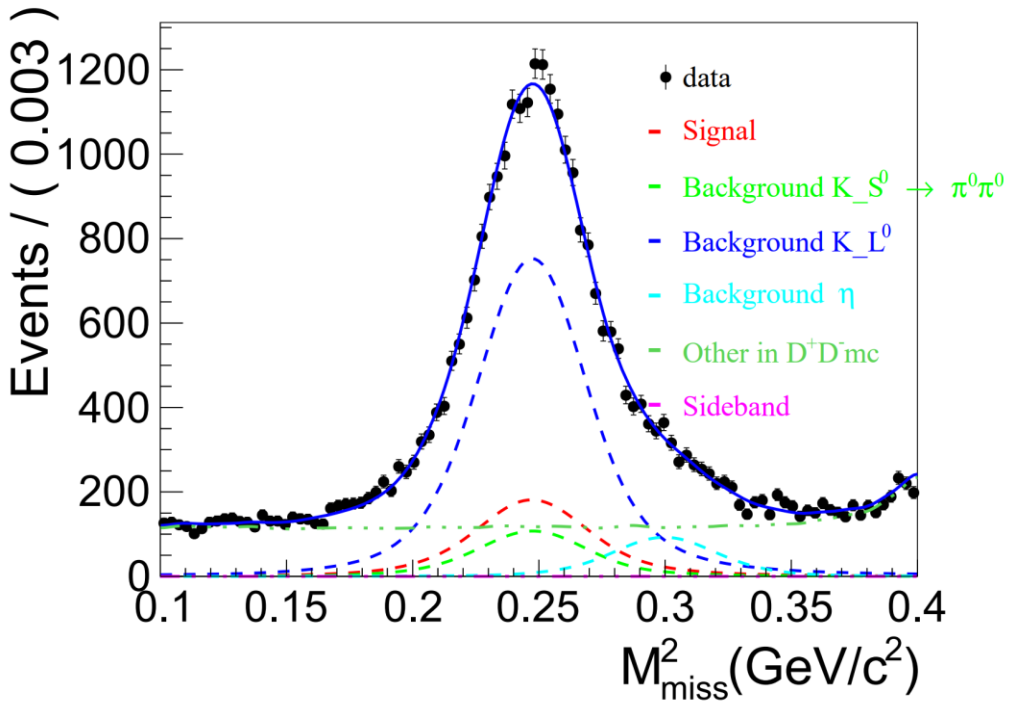
round0304

D^+D^- M^2_{miss}: $0.8 < P_{miss} < 1.0\ GeV/c$

Find K^0_S



Not Find K^0_S



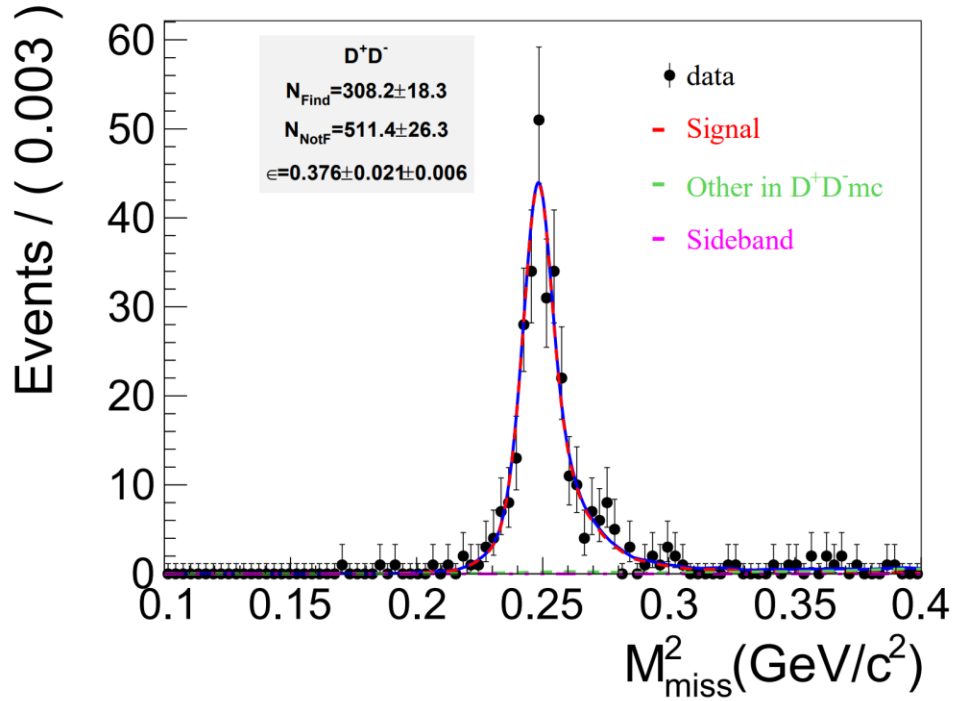
round15

Method 1

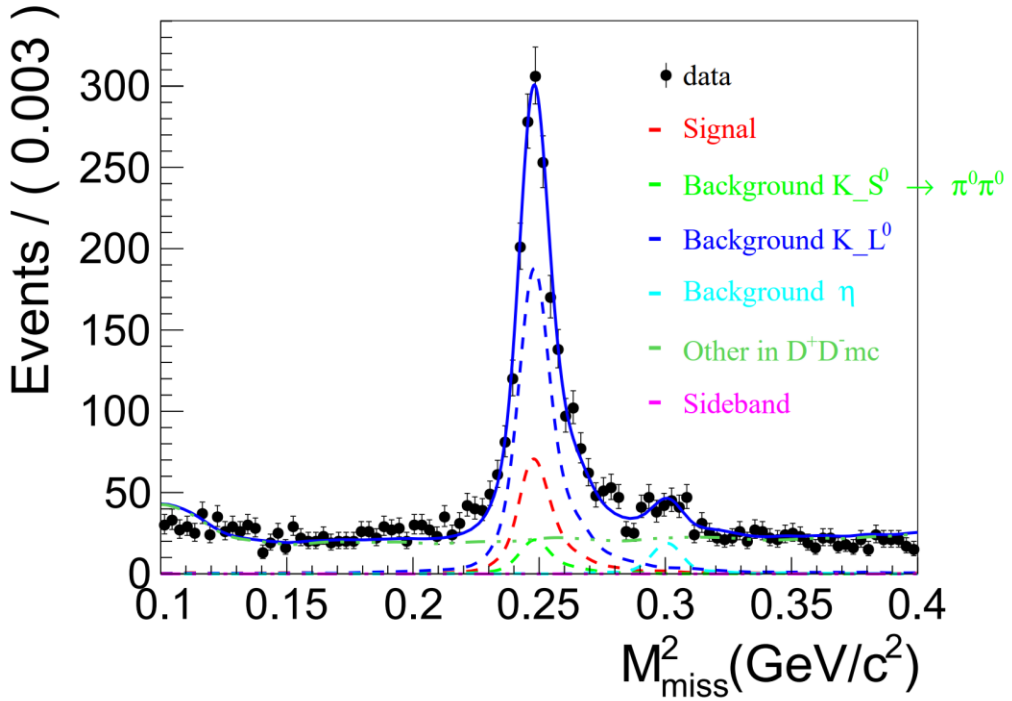
Refine vertex fit

D^+D^- M^2_{miss}: $0 < P_{miss} < 0.2\ GeV/c$

Find K^0_S



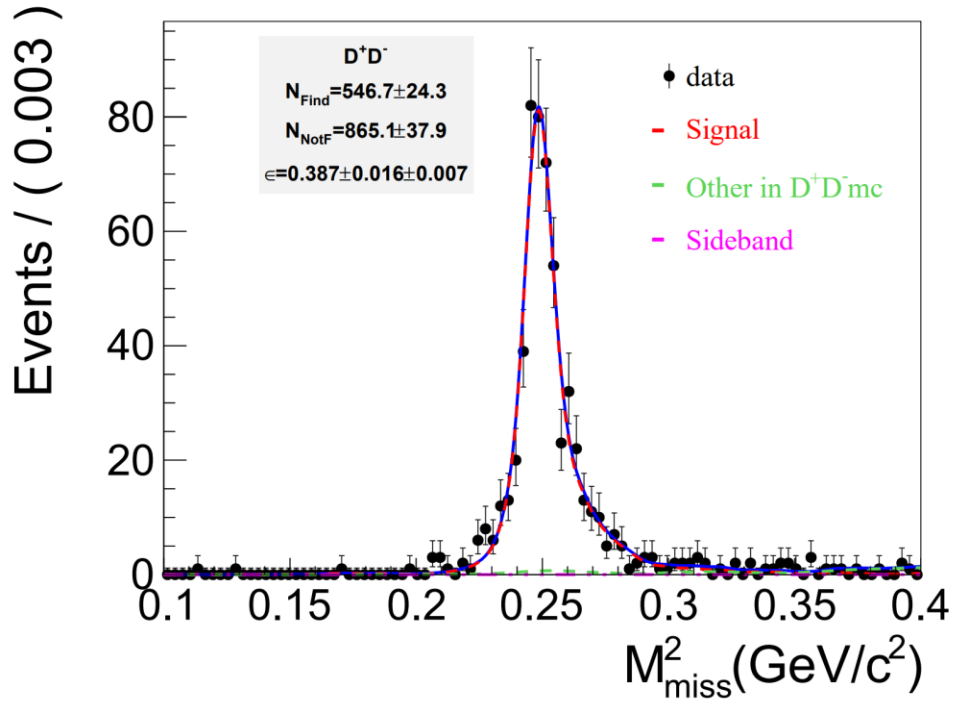
Not Find K^0_S



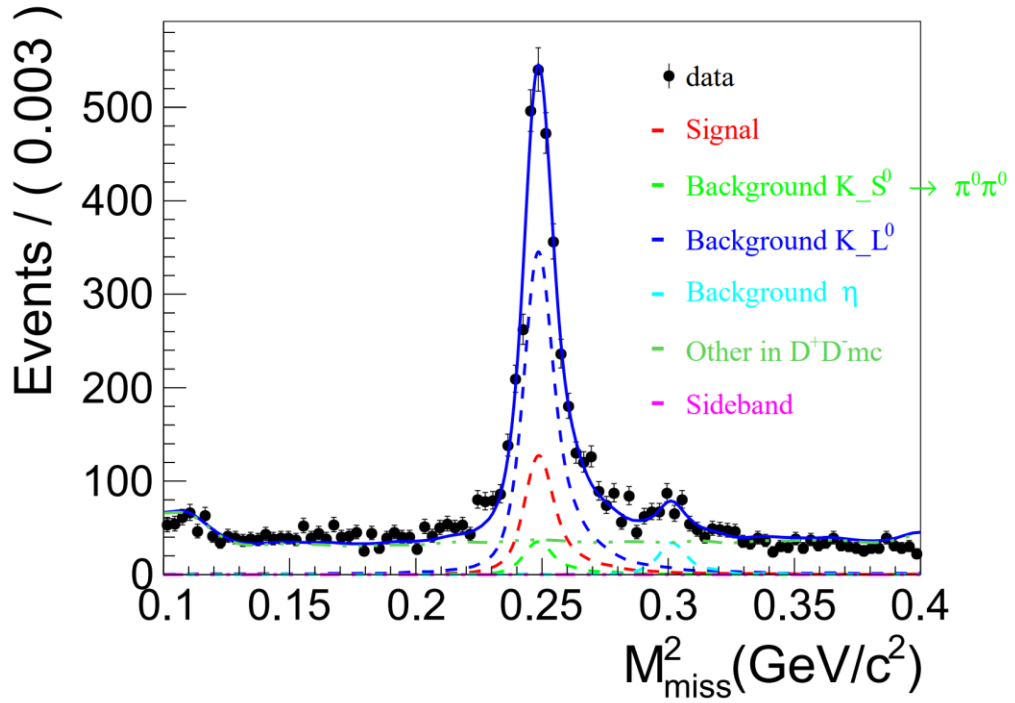
round0304

D^+D^- M^2_{miss}: $0 < P_{miss} < 0.2\ GeV/c$

Find K^0_S



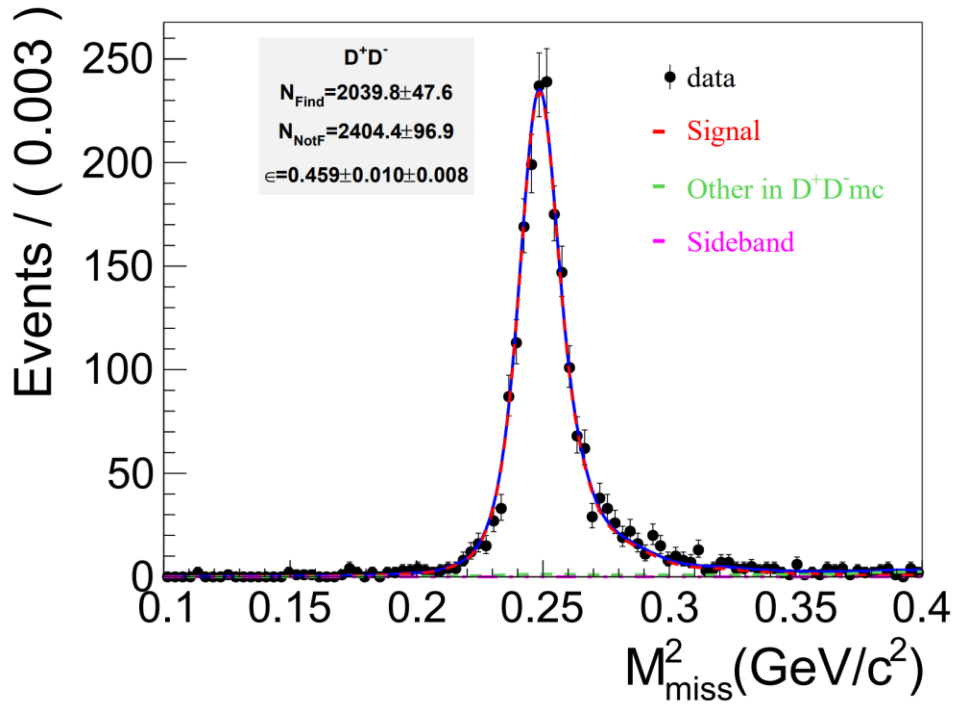
Not Find K^0_S



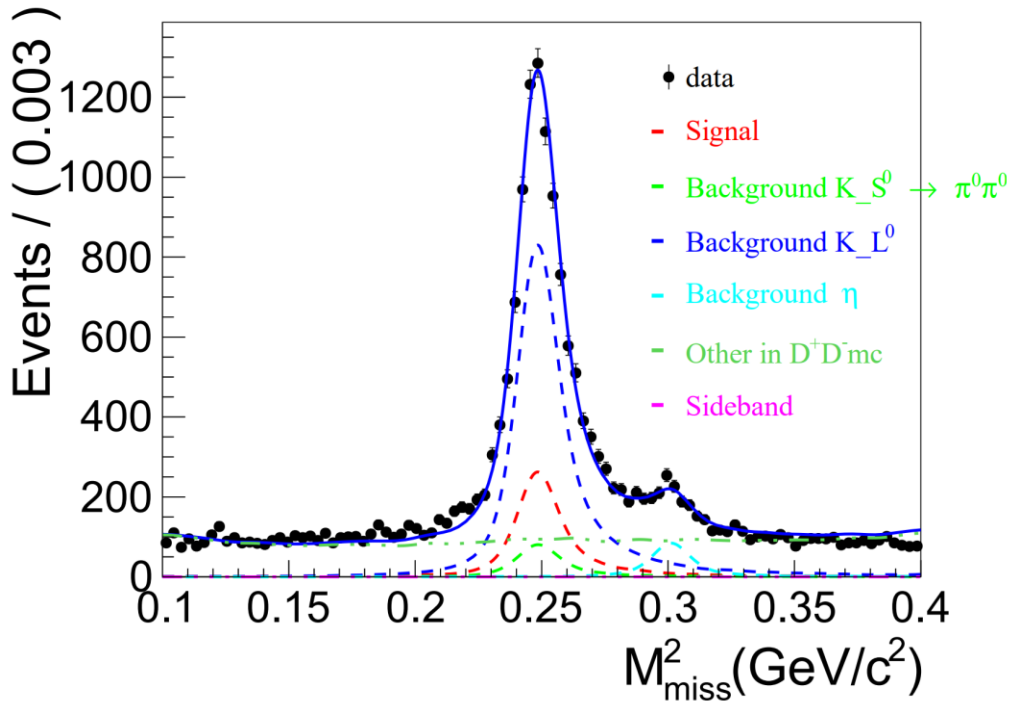
round15

D^+D^- M^2_{miss}: $0.2 < P_{miss} < 0.4\ GeV/c$

Find K^0_S



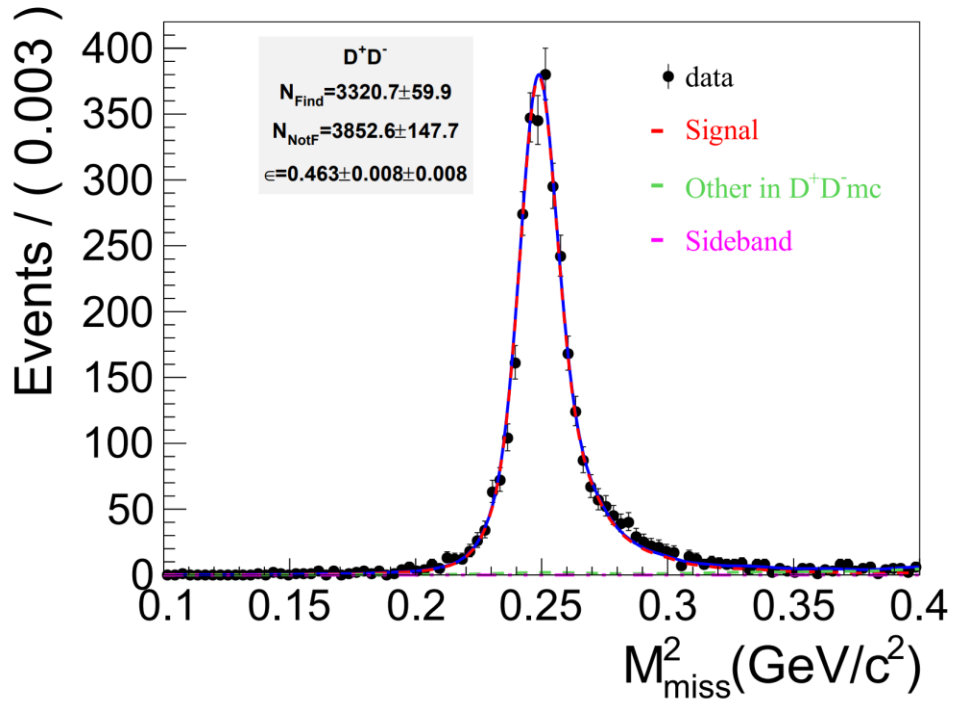
Not Find K^0_S



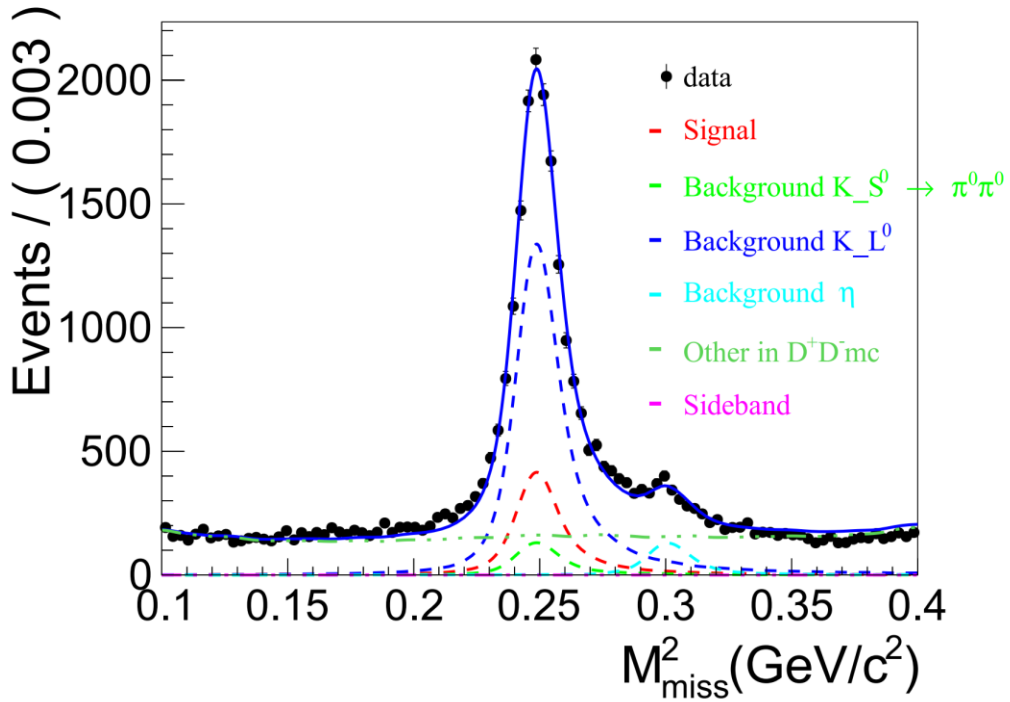
round0304

D^+D^- M^2_{miss}: $0.2 < P_{miss} < 0.4\ GeV/c$

Find K^0_S



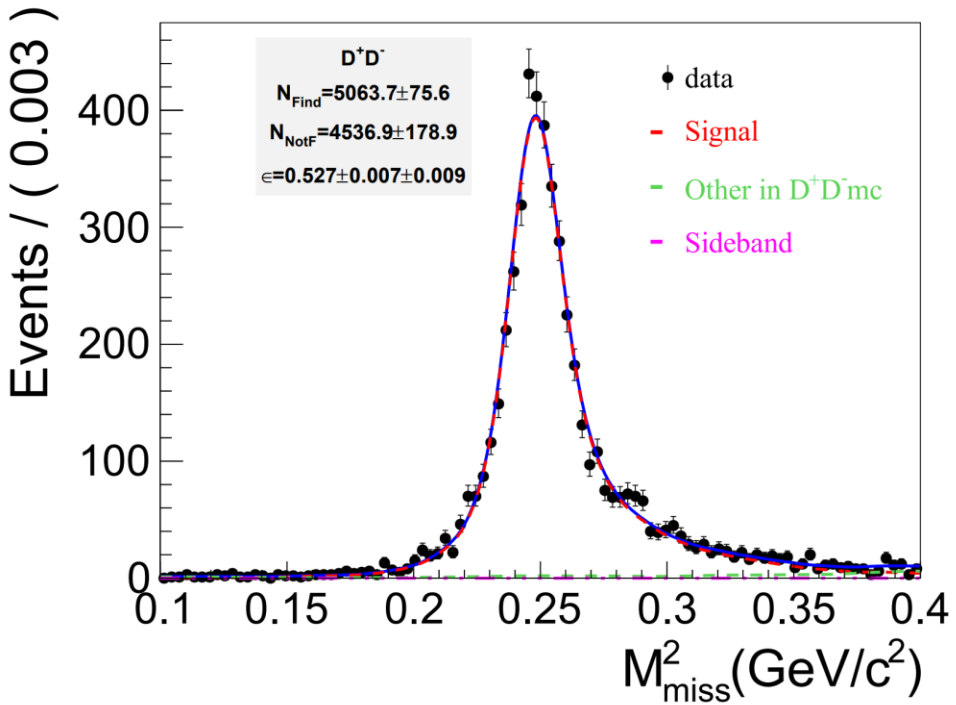
Not Find K^0_S



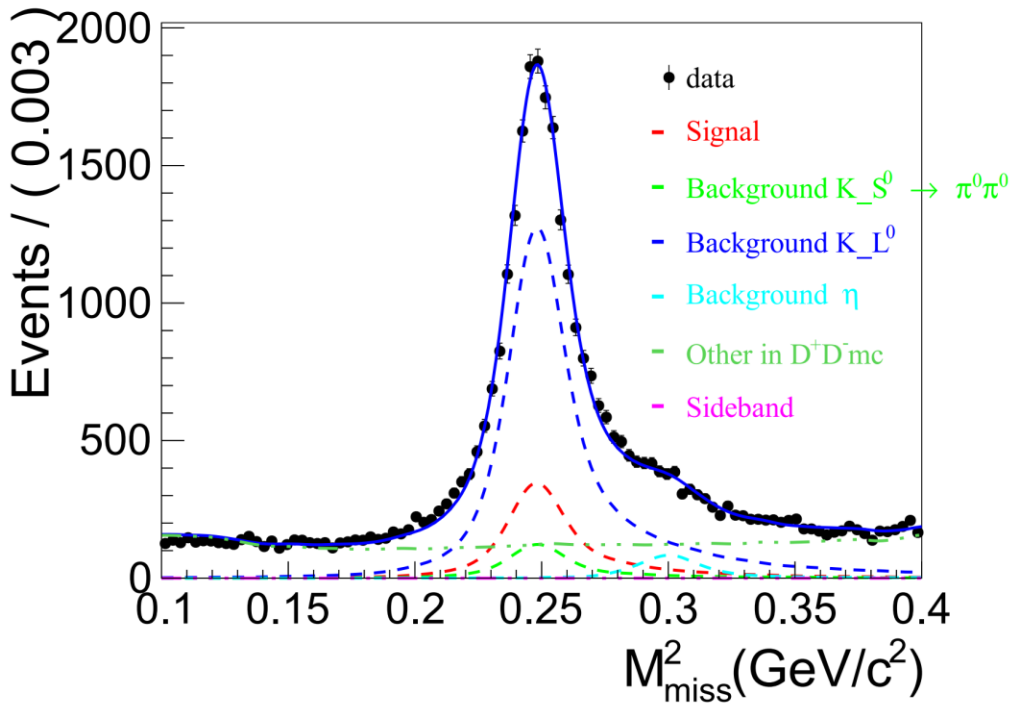
round15

D^+D^- M^2_{miss}: $0.4 < P_{miss} < 0.6\ GeV/c$

Find K^0_S



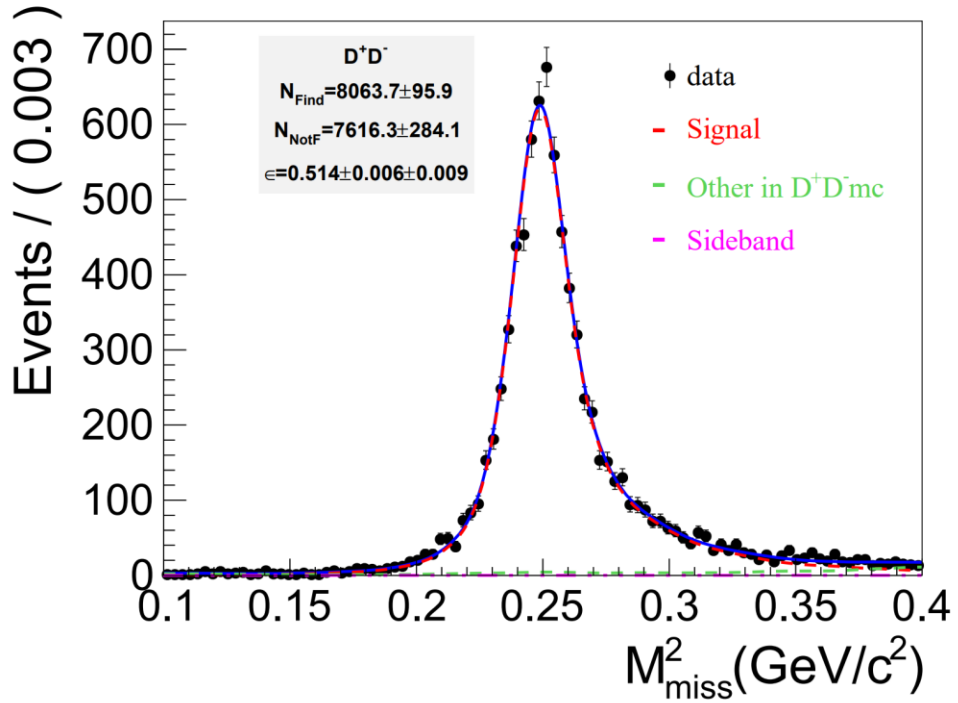
Not Find K^0_S



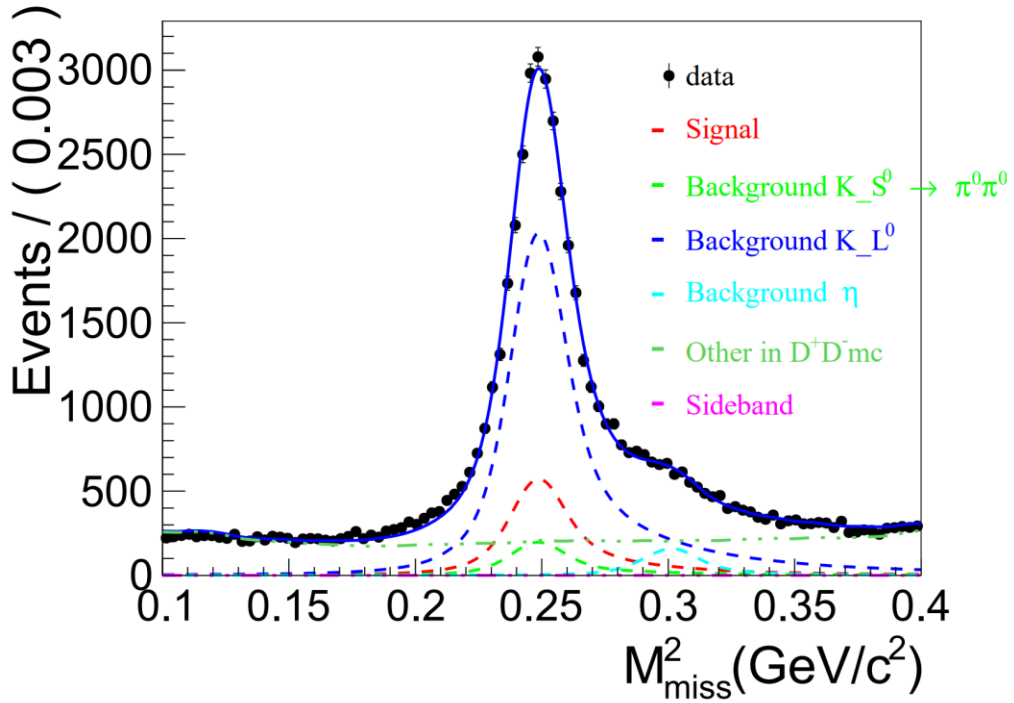
round0304

D^+D^- M^2_{miss}: $0.4 < P_{miss} < 0.6\ GeV/c$

Find K^0_S



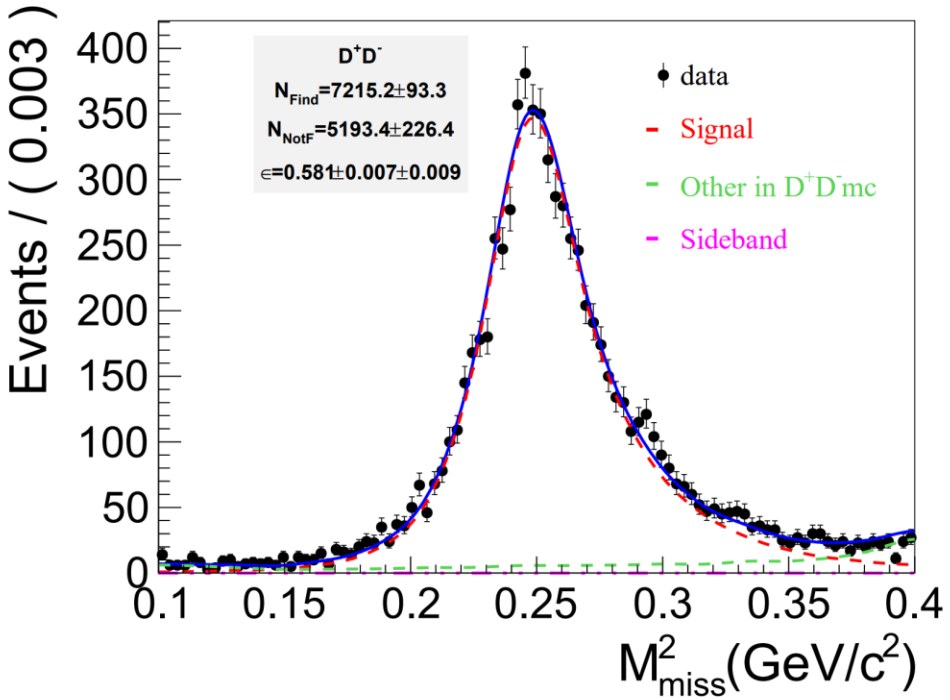
Not Find K^0_S



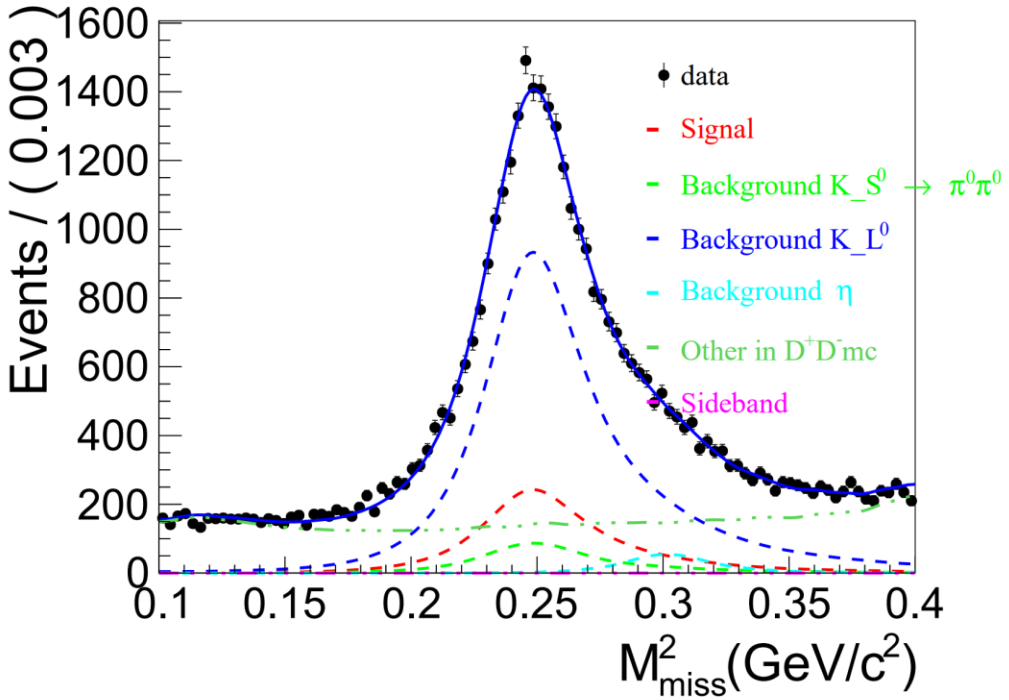
round15

D^+D^- M^2_{miss}: $0.6 < P_{miss} < 0.8\ GeV/c$

Find K^0_S



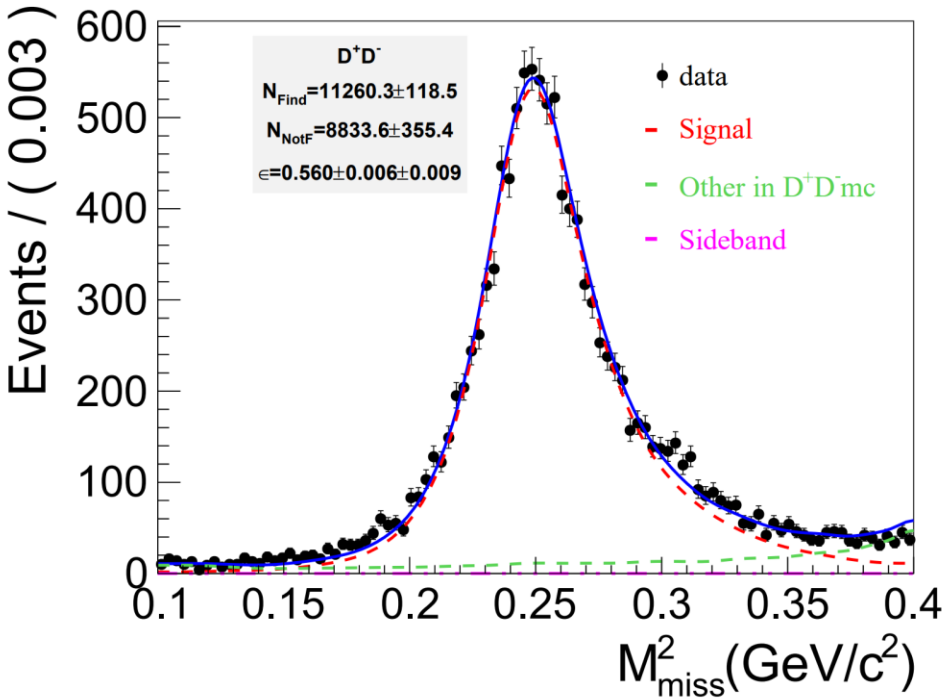
Not Find K^0_S



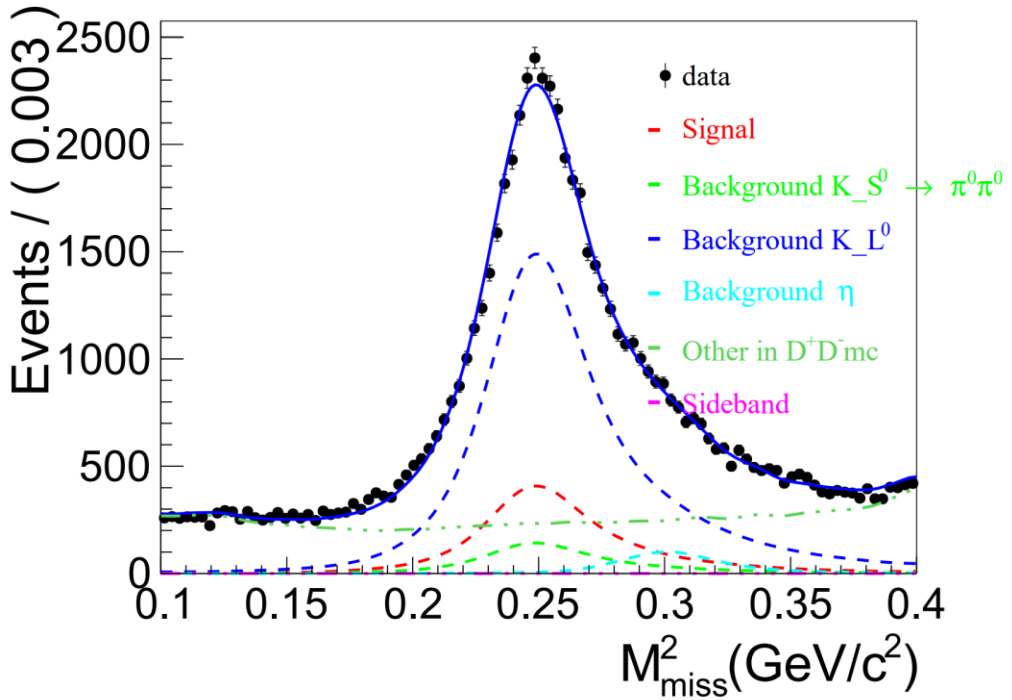
round0304

D^+D^- M^2_{miss}: $0.6 < P_{miss} < 0.8\ GeV/c$

Find K^0_S



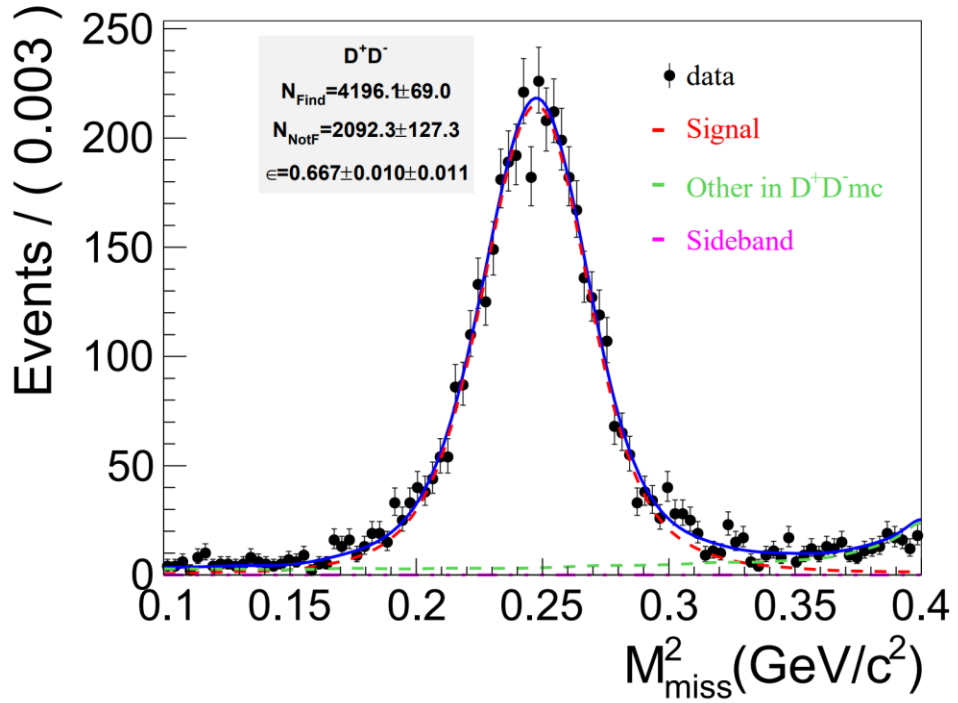
Not Find K^0_S



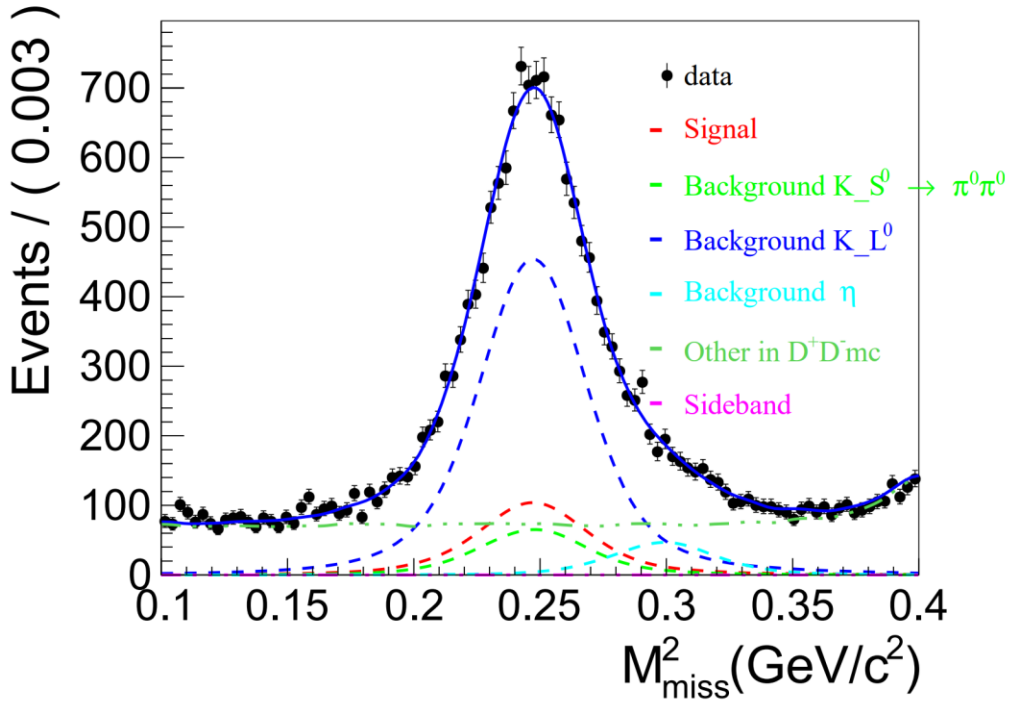
round15

D^+D^- M^2_{miss}: $0.8 < P_{miss} < 1.0\ GeV/c$

Find K^0_S



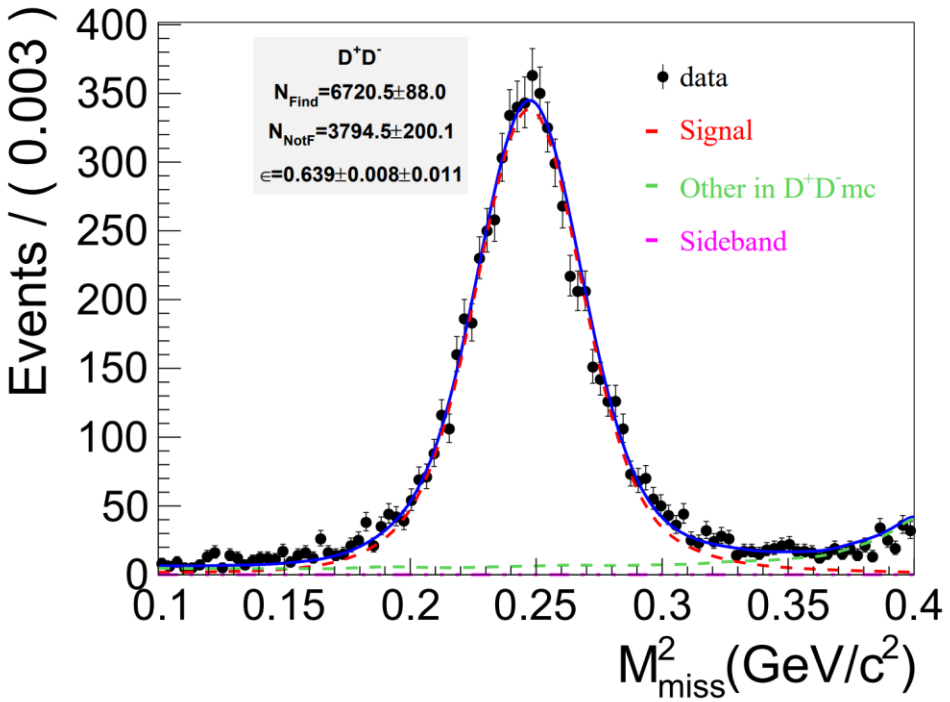
Not Find K^0_S



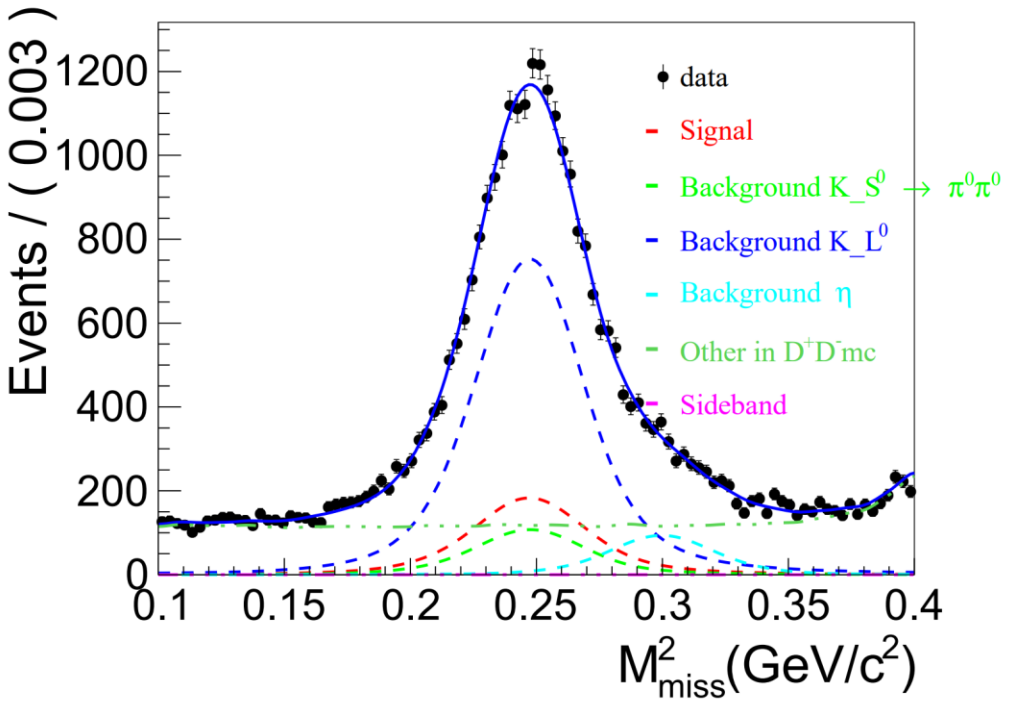
round0304

D^+D^- M^2_{miss}: $0.8 < P_{miss} < 1.0\ GeV/c$

Find K^0_S



Not Find K^0_S



round15

Method 2

Event Selection

- **Missing K_S^0 Candidates :**
  - $P_{sigD} = \sqrt{E_{beam}^2 - M_D^2}; \hat{\vec{P}}_{sigD} = -\hat{\vec{P}}_D;$
  - P_{trk}: track in signal mode except K_S^0 (such as $\pi^{\pm}\pi^0$)
  - $M_{miss} =$

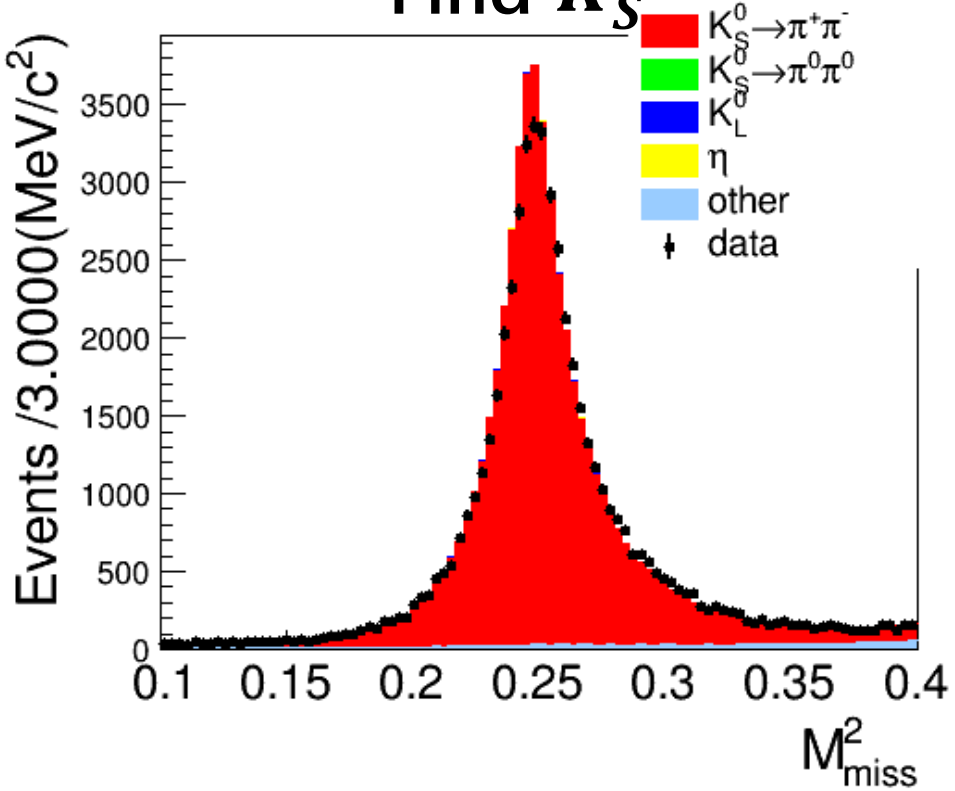
$$\sqrt{\left(E_{beam} - \sum E_{trk}\right)^2 - \left(\vec{P}_{sigD} - \sum \vec{P}_{trk}\right)^2}$$

  - $\Delta M = M_{miss} - M_{K_S^0}$
  - Minimum ΔM is used to select best candidate
- **Vertex Fit Candidates of K_S^0 :**
  - Reconstructed by $\pi^+\pi^-$;
  - $\Delta E_{sig} =$ E_{beam} , M $\sqrt{E_{beam}^2 - \overrightarrow{P}^2_{sigD}}$
  - Minimum ΔE ect best candidate
  - ΔE_{sig} cut: no $.055,0$ V
  - D^0: 1.8 $M_{bcsig} \leq 1.87$ GeV/
    D^+: $1.865 \leq M_{bcsig} \leq 1.875$ GeV/c^2

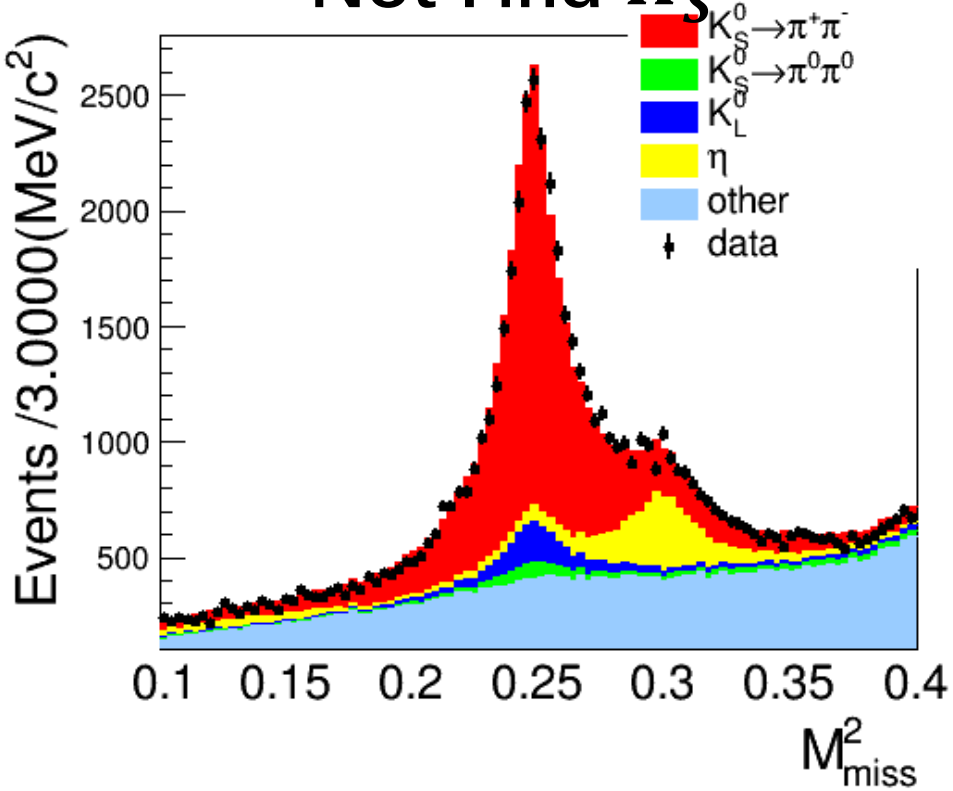
- **$N_{extra\_trk} = 2$**
- **Find K_S^0 :**
  - Vertex fit;
  - Reconstructed by $\pi^+\pi^-$;
  - $\Delta E_{sig} = E_{sigD} - E_{beam}$;
  - Minimum ΔE_{sig} is used to select best candidate;
  - $0.511 > M_{K_s} > 0.487\ M_{K_s}$;
  - $L/err > 2$;
  - $\chi^2_{1st} \& \chi^2_{2rd} < 200$;
- **Not find K_S^0 :**
  - Others;
  - Such as K_L^0 , $K_S^0 \to \pi^0\pi^0$ and η
- **For D^+D^- refine vertex fit**

D^+D^- M^2_{miss}

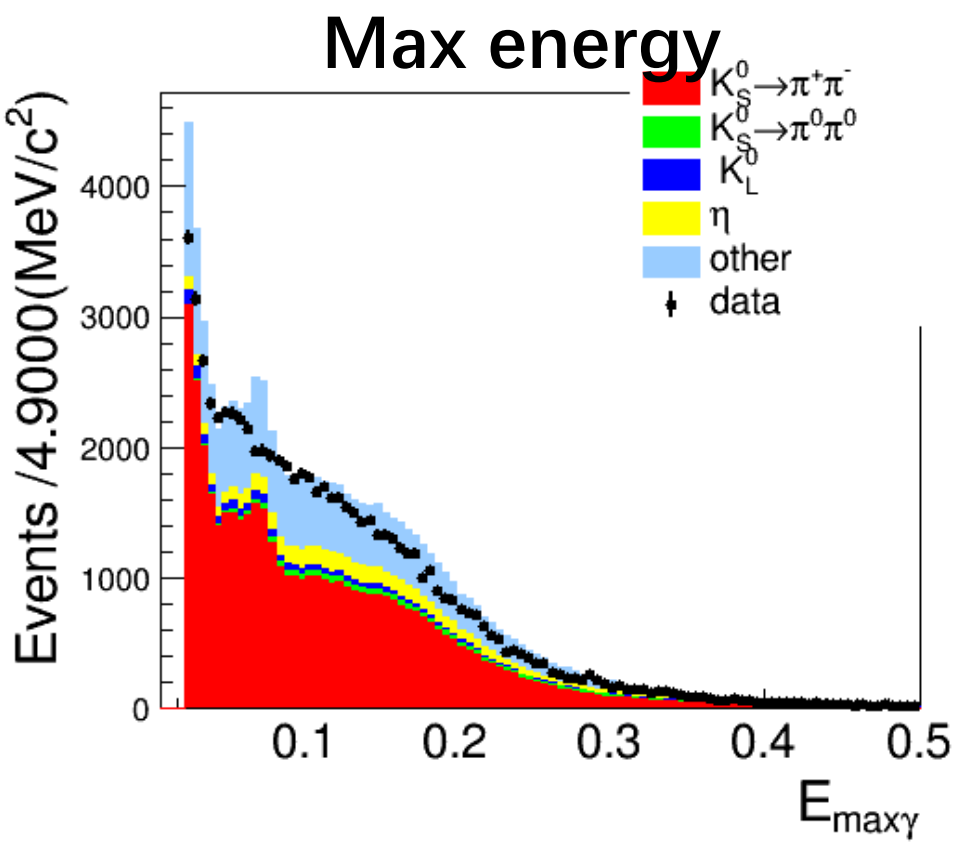
Find K^0_S

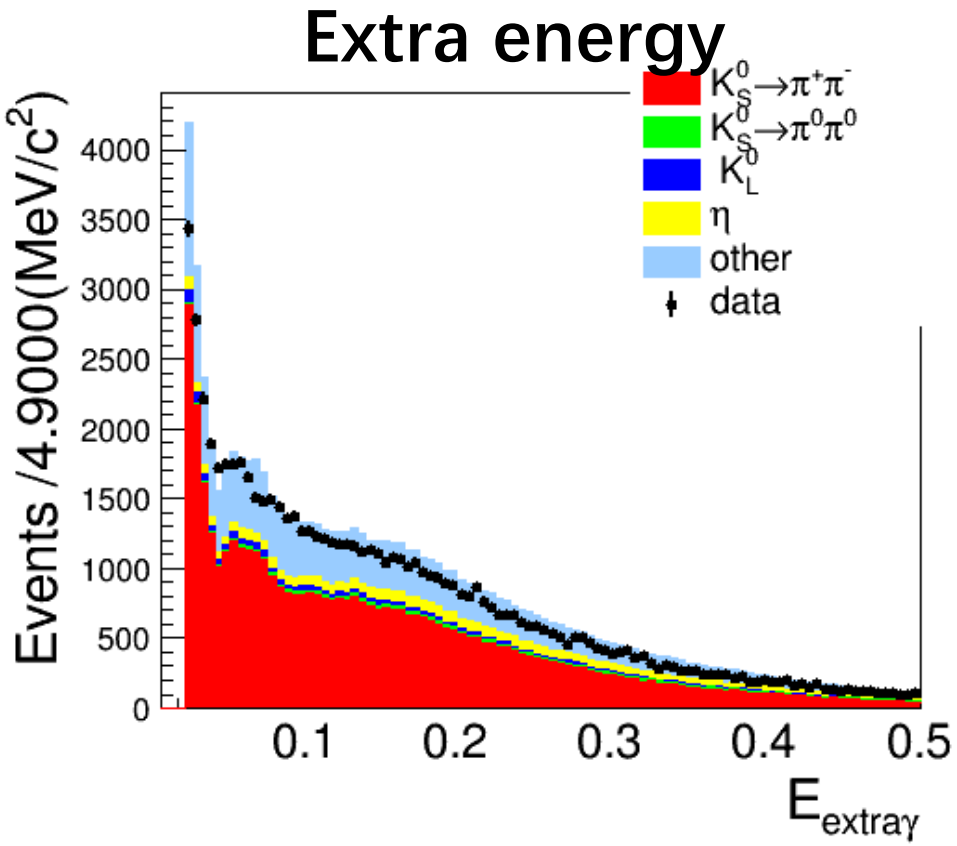


Not Find K^0_S

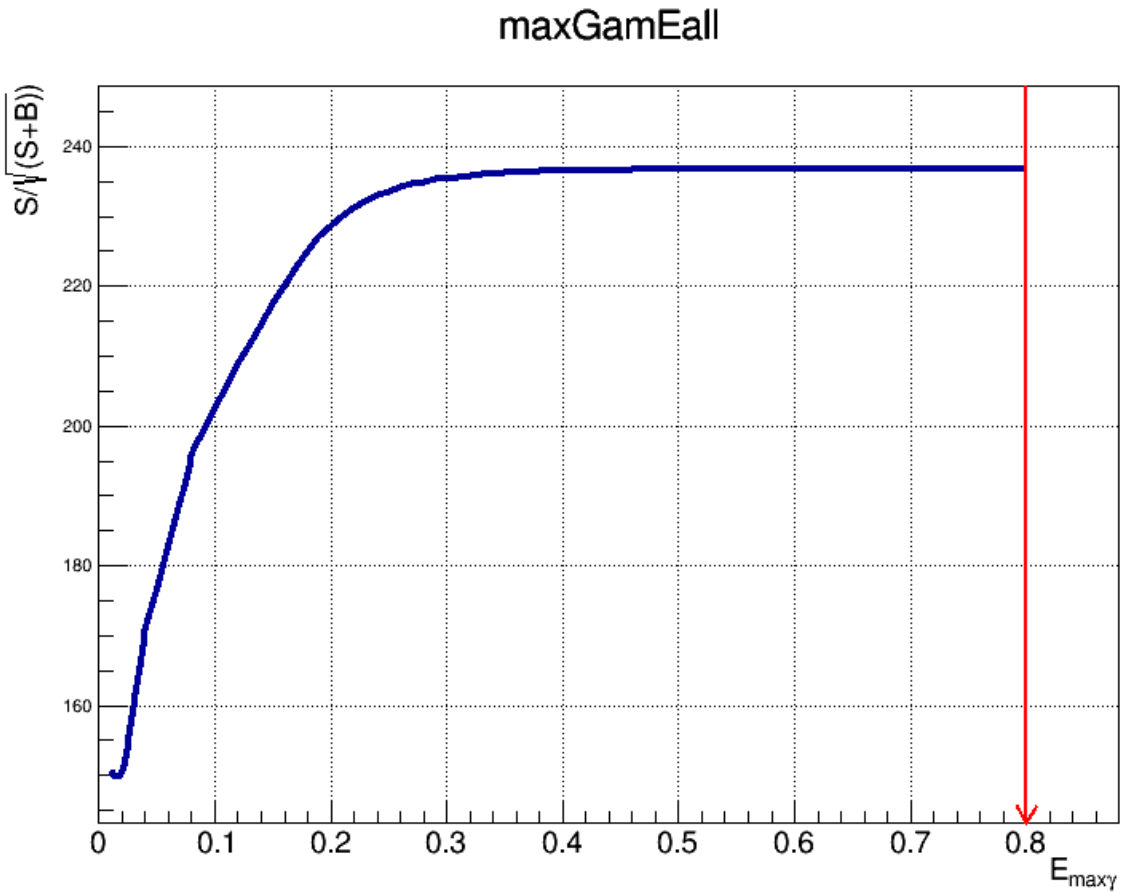


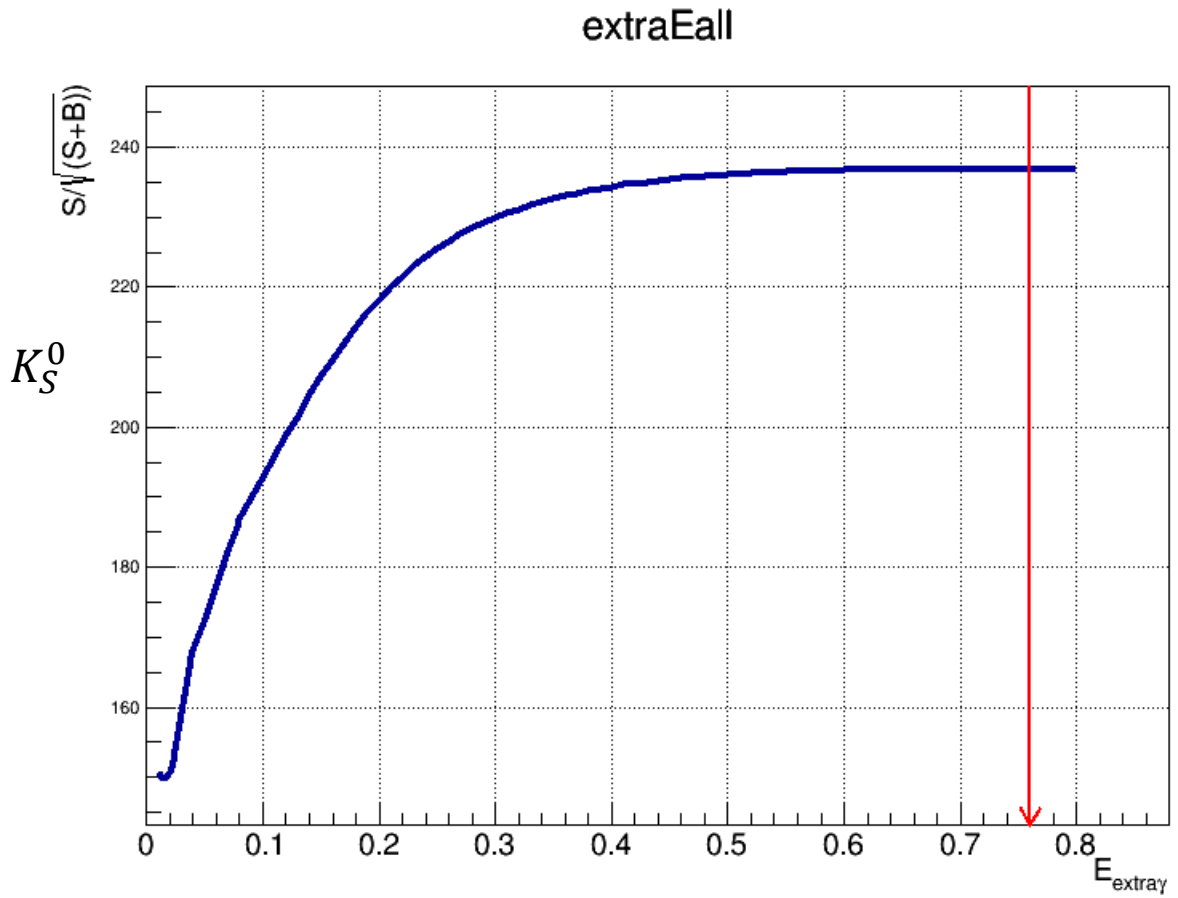
D^+D^- : Three channels





D^+D^- : Three channels



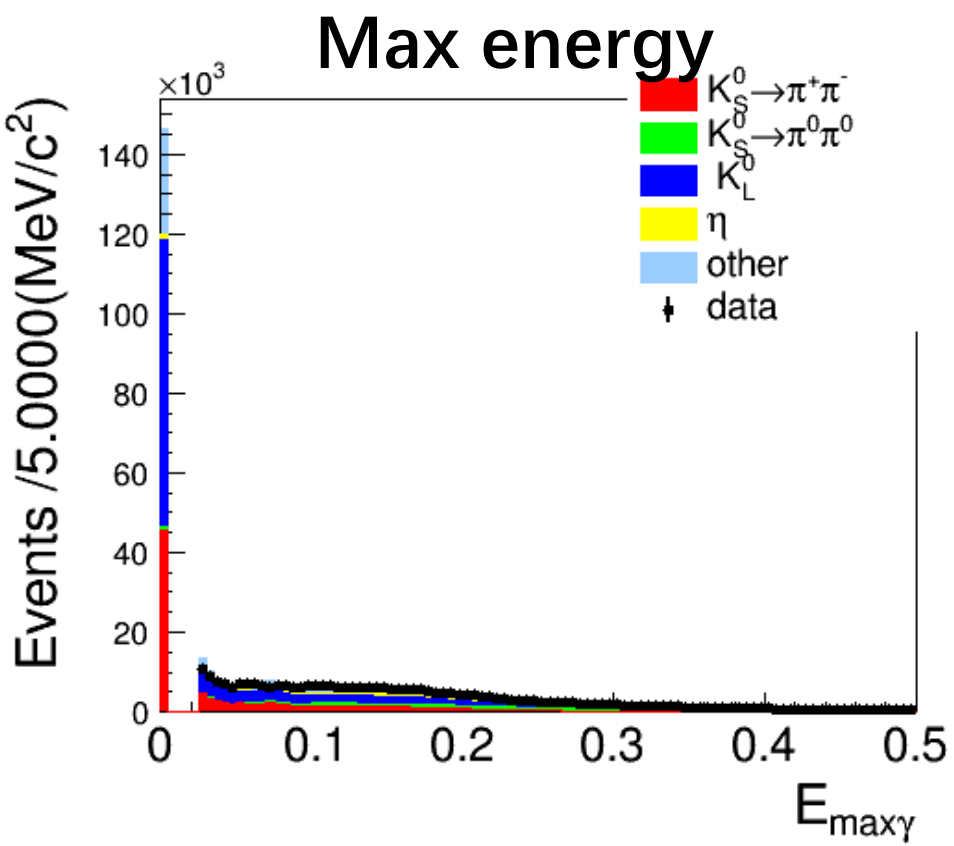


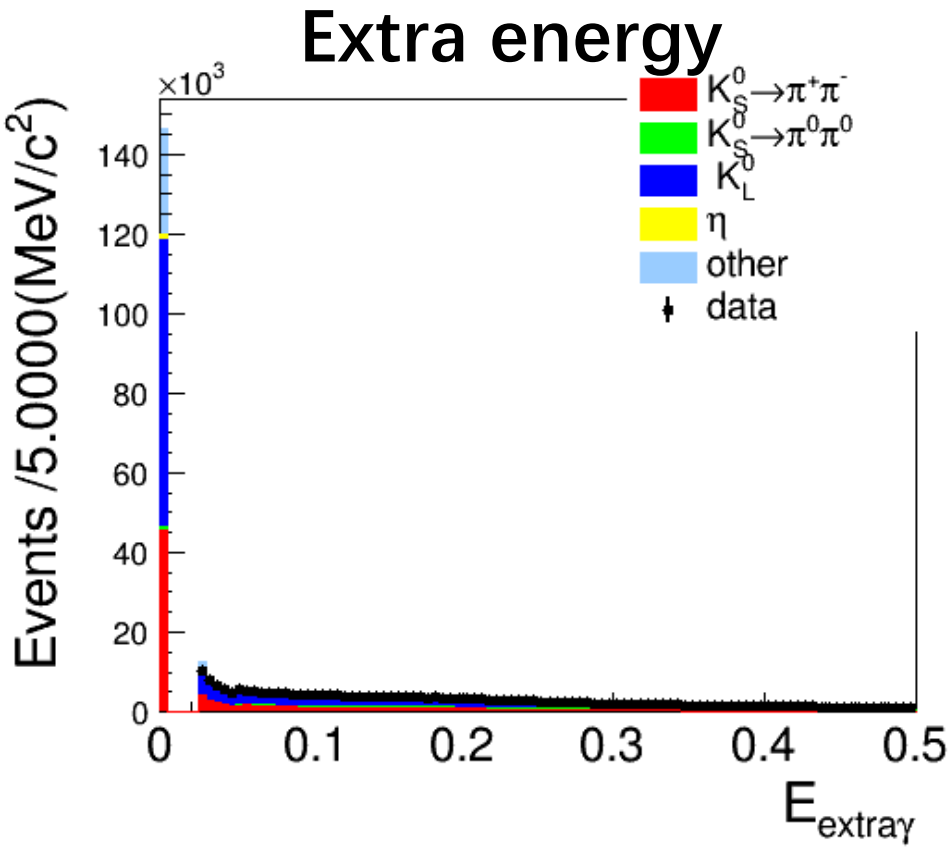
K_S^0

Method 1

Background rejection of K_S^0

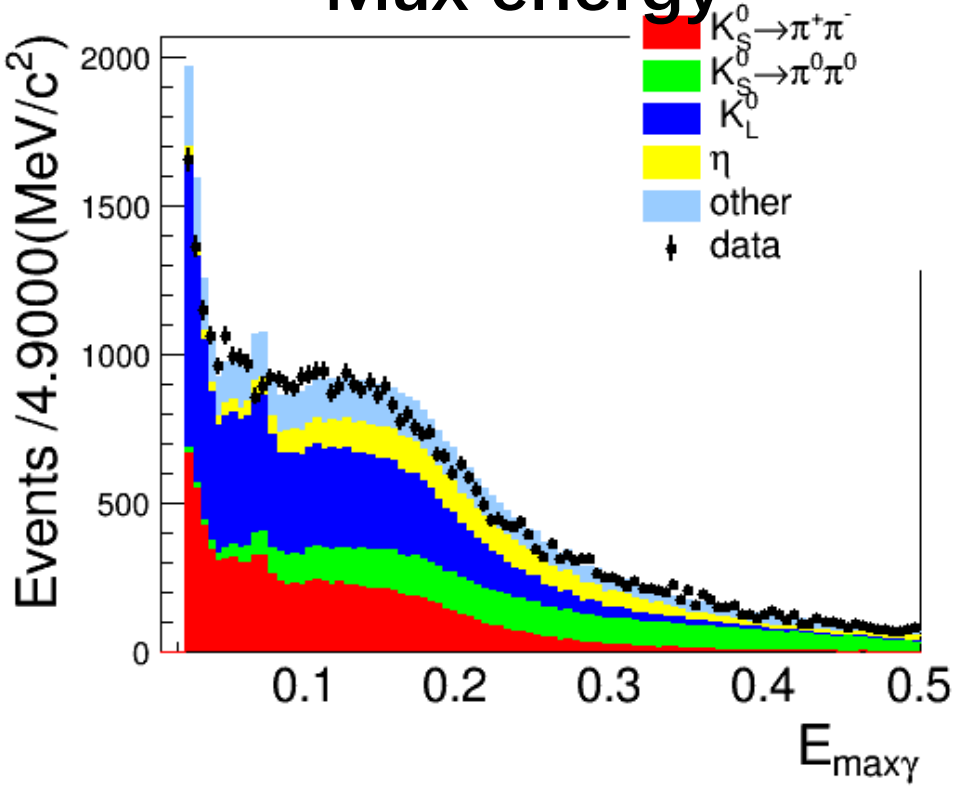
D^+D^- : Three channels



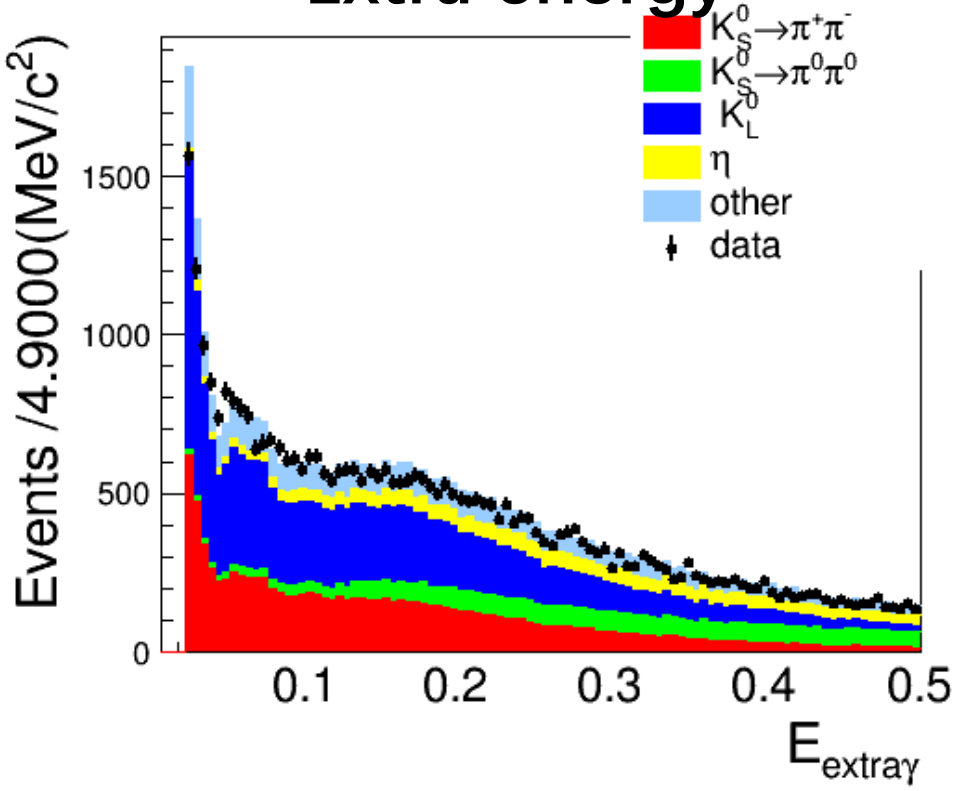


$D^+D^-:D^+\to K_S^0\pi^+ + c.c.$

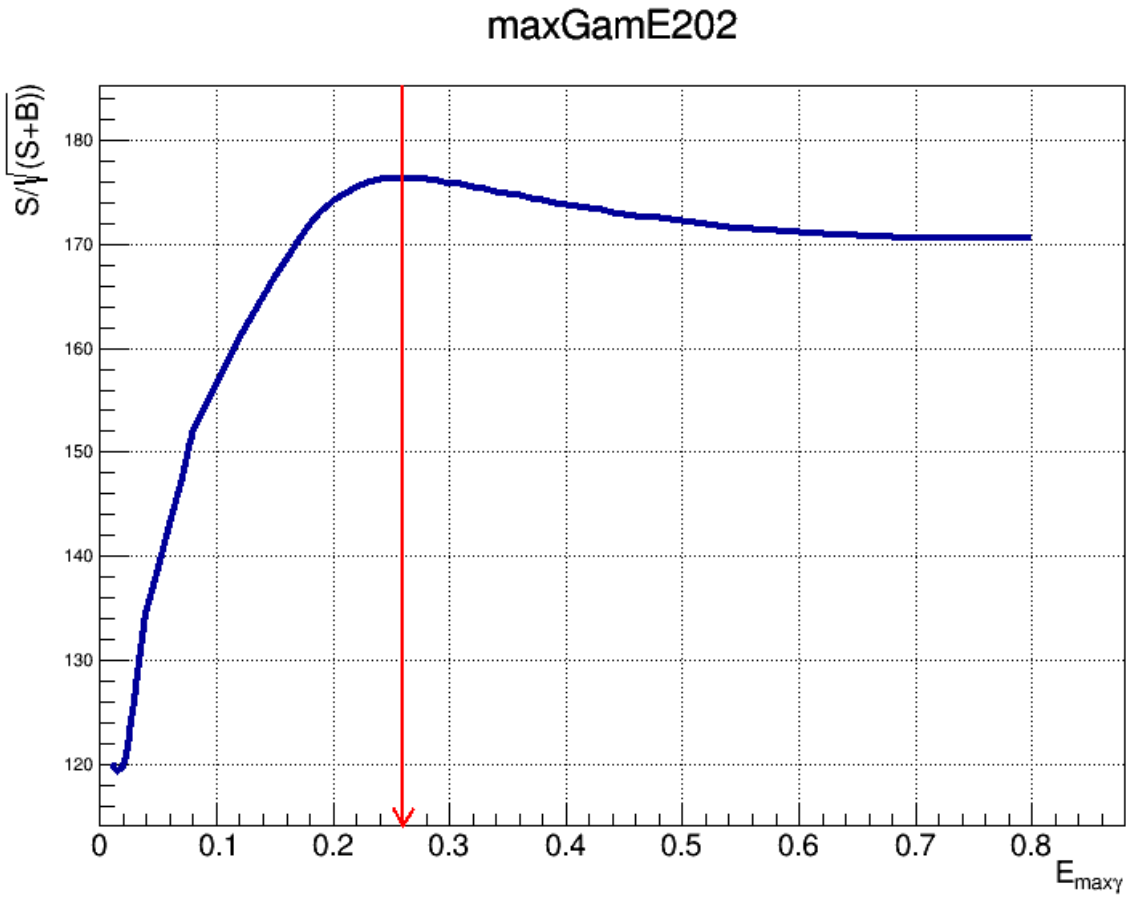
Max energy



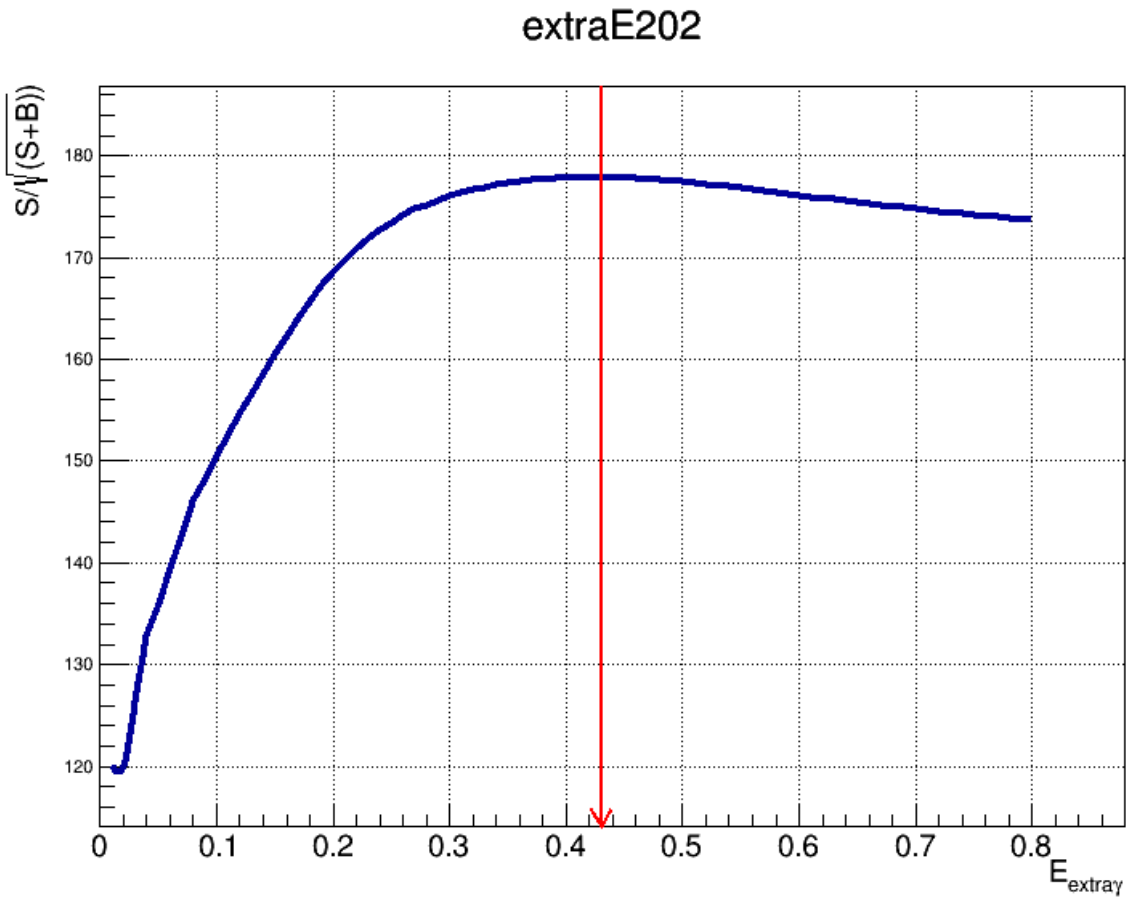
Extra energy



$D^+D^- : D^+ \to K_S^0\pi^+ + c.c.$



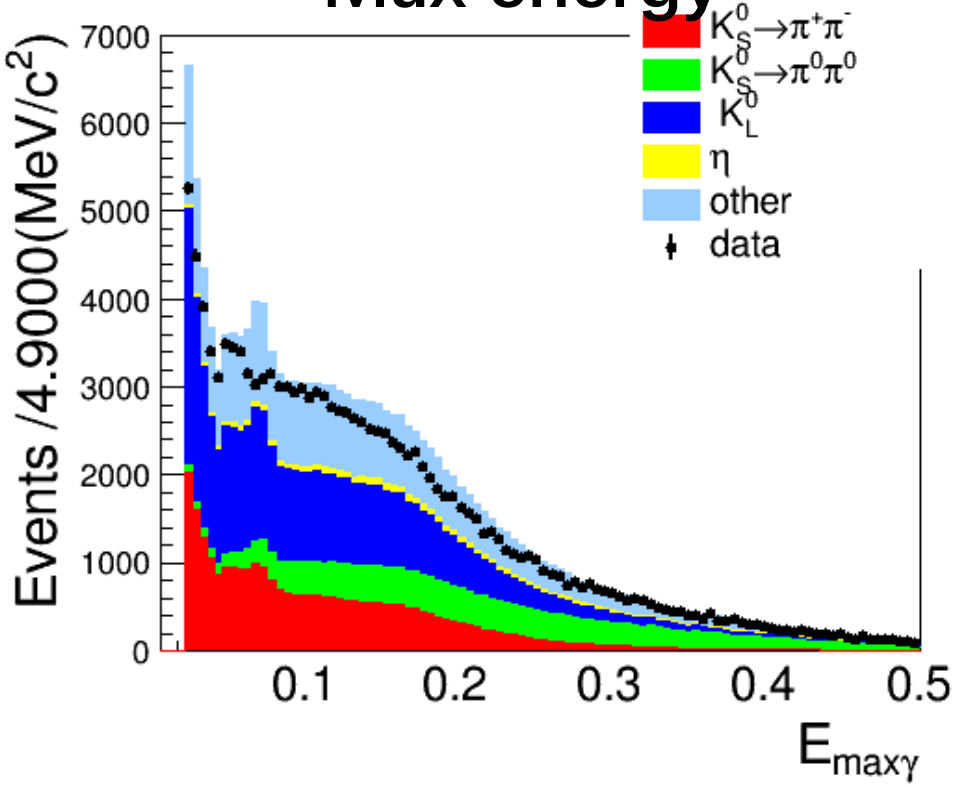
maxGamE cut with max value:0.26
efficiency:0.963 ;rejection:0.311



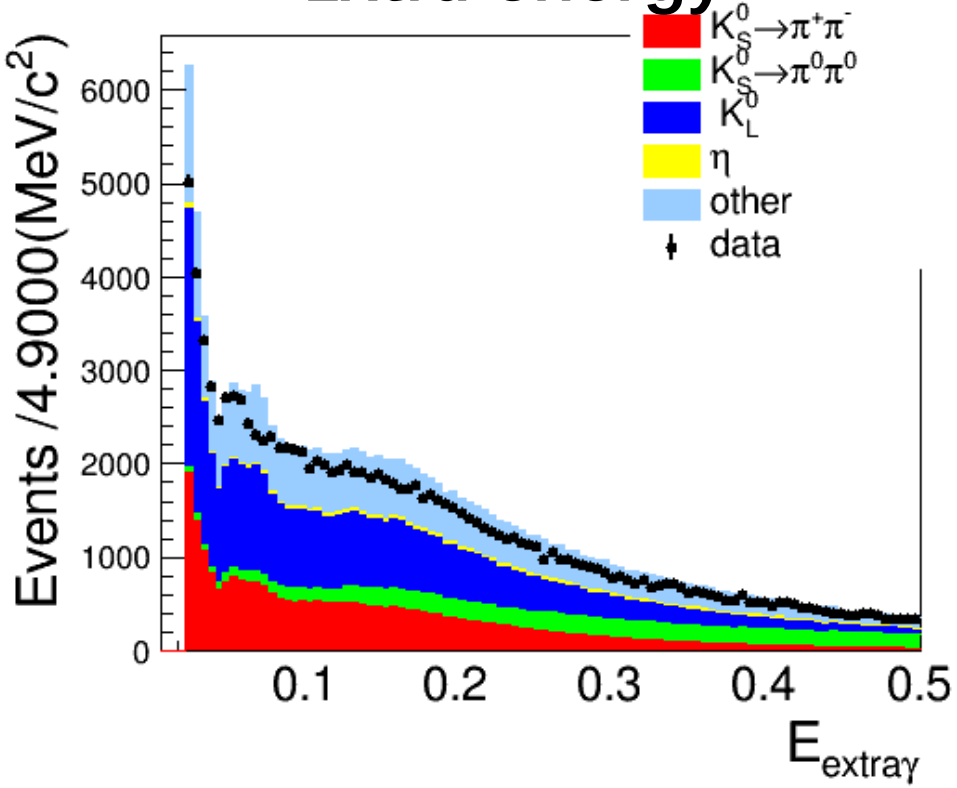
extraE cut with max value:0.43
efficiency:0.967 ;rejection:0.352

$D^+D^- : D^+ \to K_S^0\pi^+\pi^0 + c.c.$

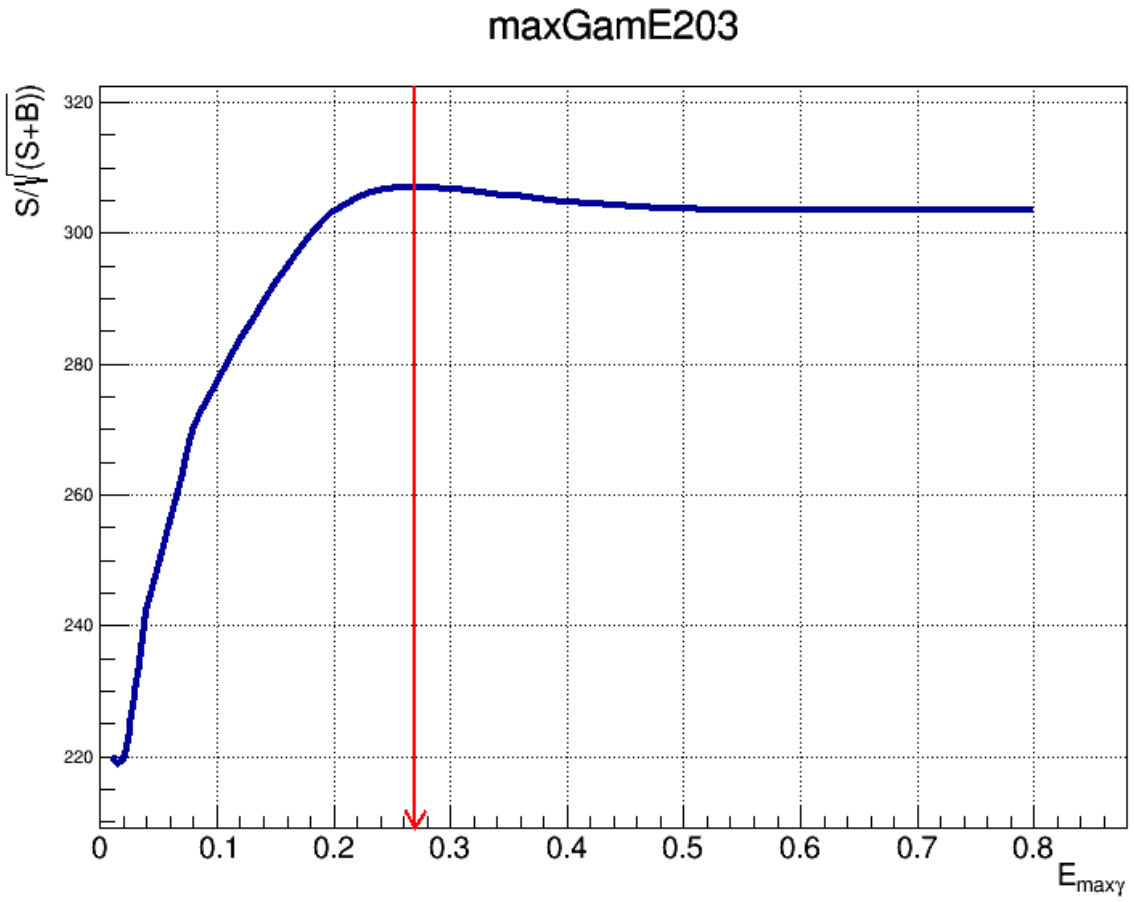
Max energy



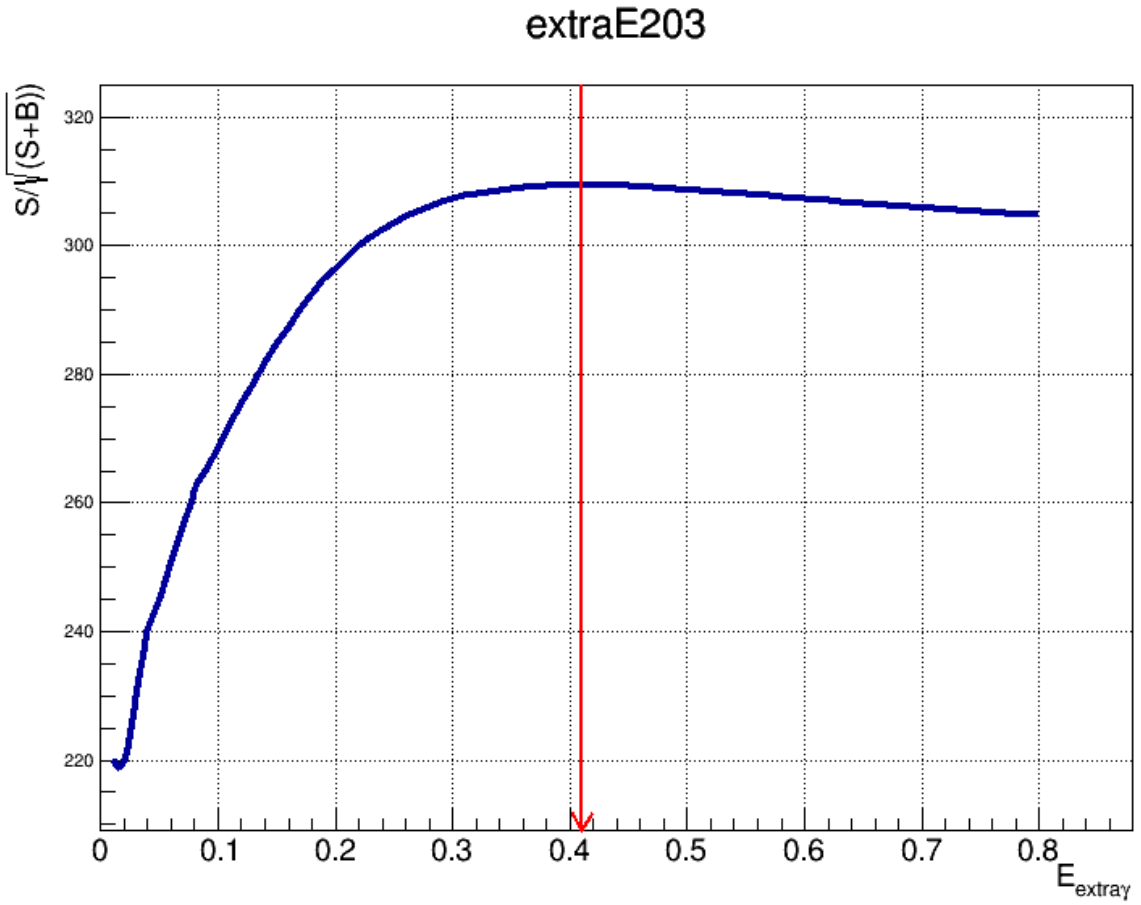
Extra energy



$D^+D^- : D^+ \to K_S^0\pi^+\pi^0 + c.c.$



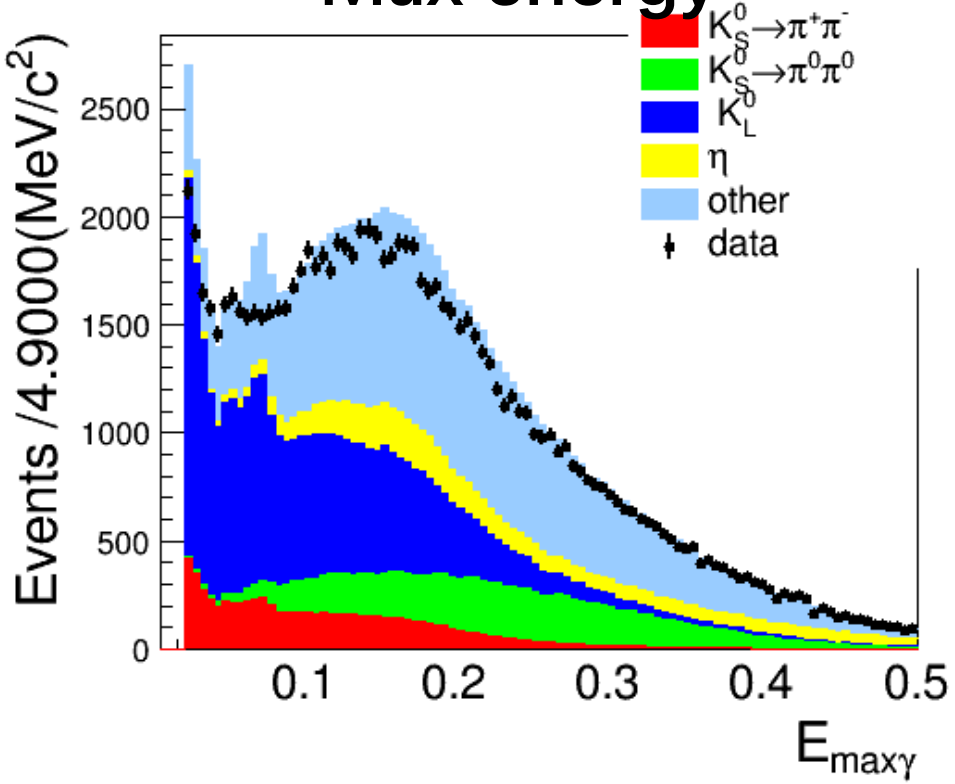
maxGamE cut with max value:0.27
efficiency:0.971 ;rejection:0.162



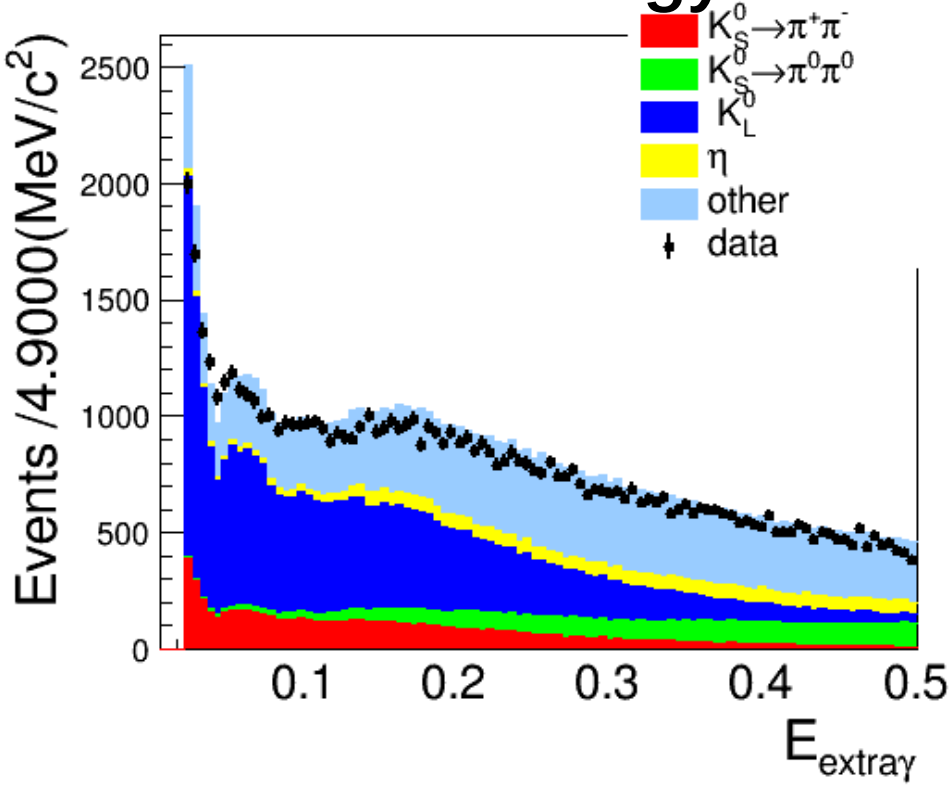
extraE cut with max value:0.41
efficiency:0.972 ;rejection:0.208

$D^+D^- : D^+ \to K_S^0\pi^+\pi^+\pi^- + c.c.$

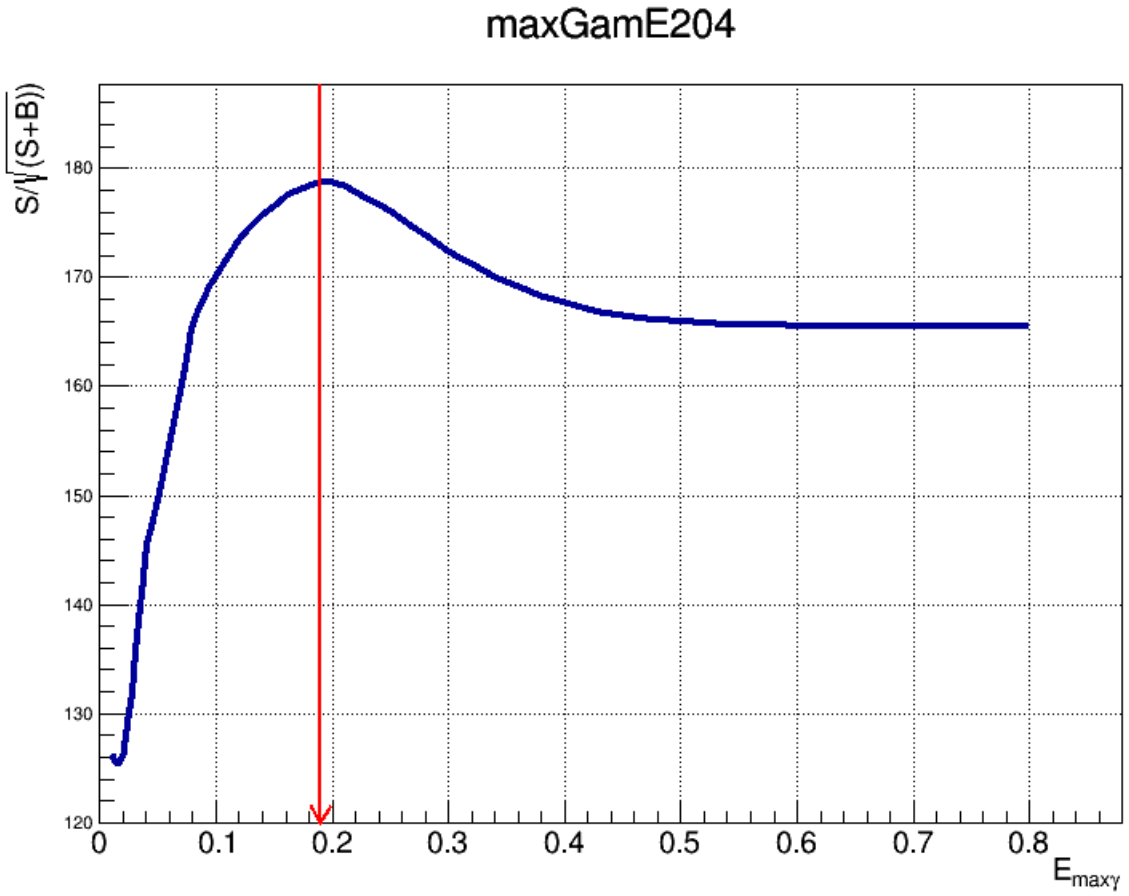
Max energy



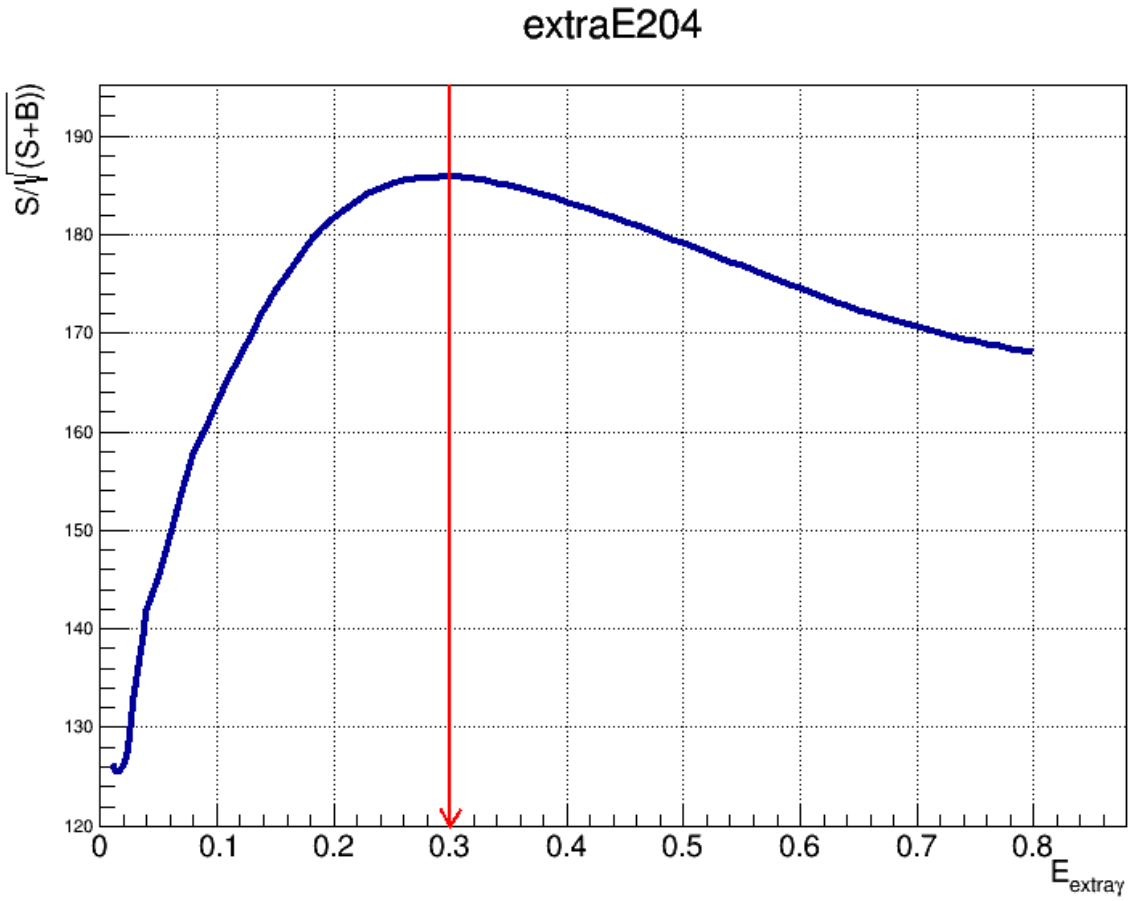
Extra energy



$D^+D^- : D^+ \to K_S^0\pi^+\pi^+\pi^- + c.c.$



maxGamE cut with max value:0.19
efficiency:0.895 ;rejection:0.504

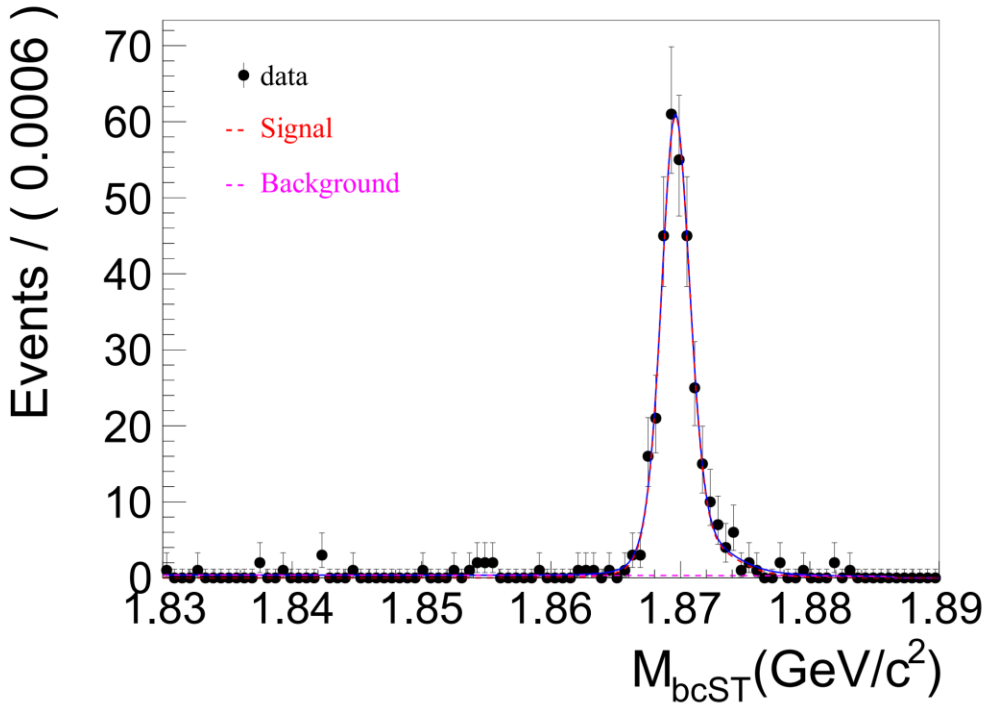


extraE cut with max value:0.3
efficiency:0.903 ;rejection:0.599

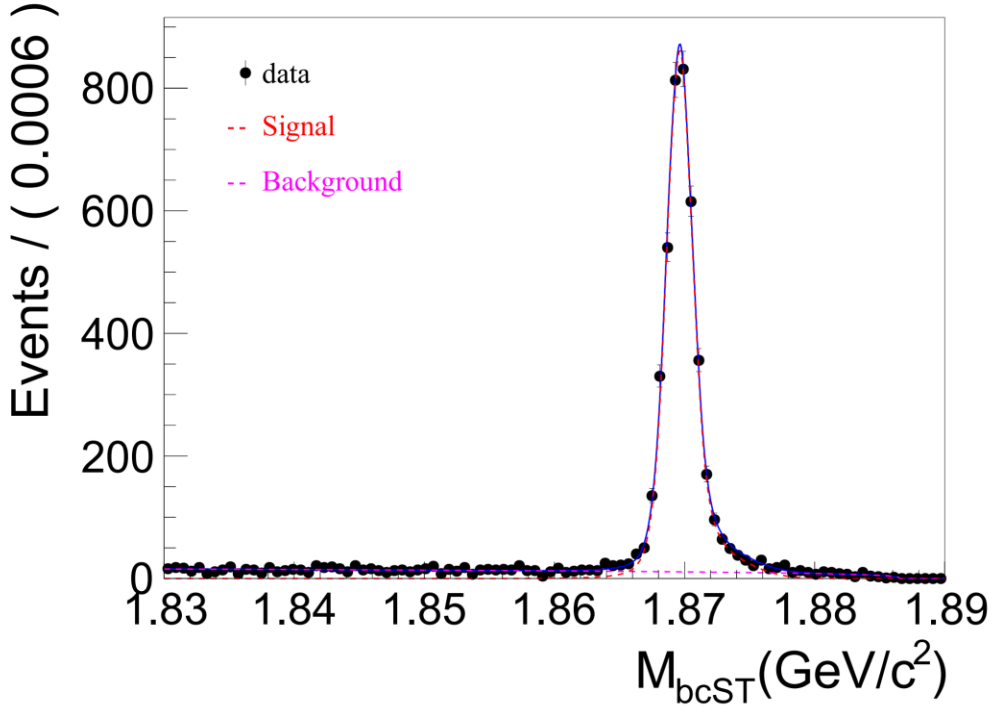
Fit for M_{bc}

D^+D^- M_{bc}: $0 < P_{miss} < 0.2\ GeV/c$

Find K_S^0



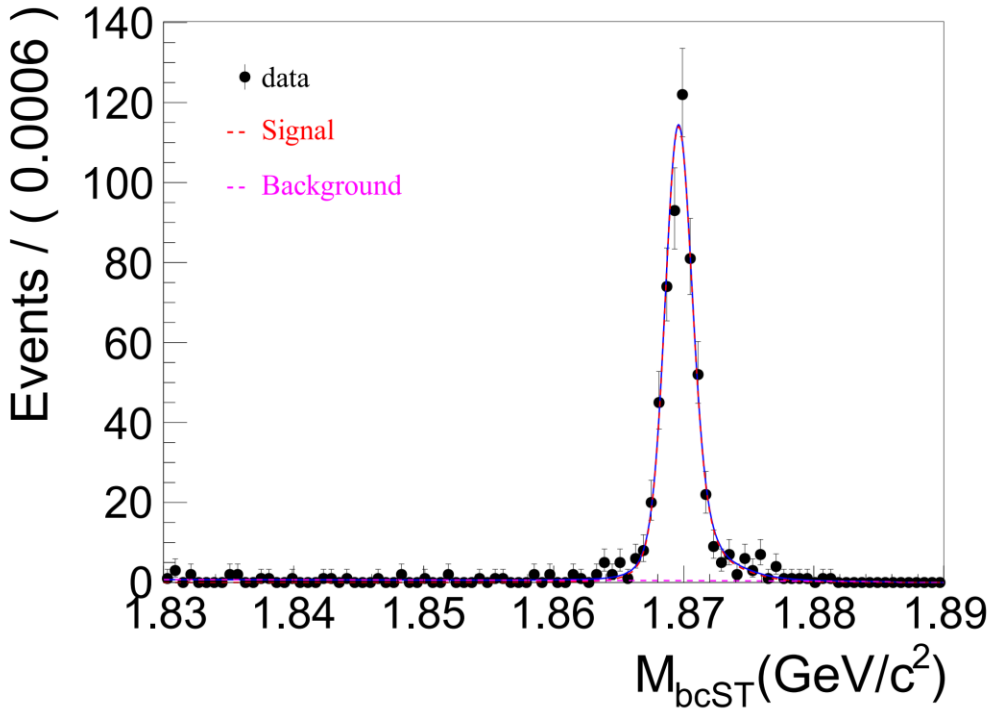
Not Find K_S^0



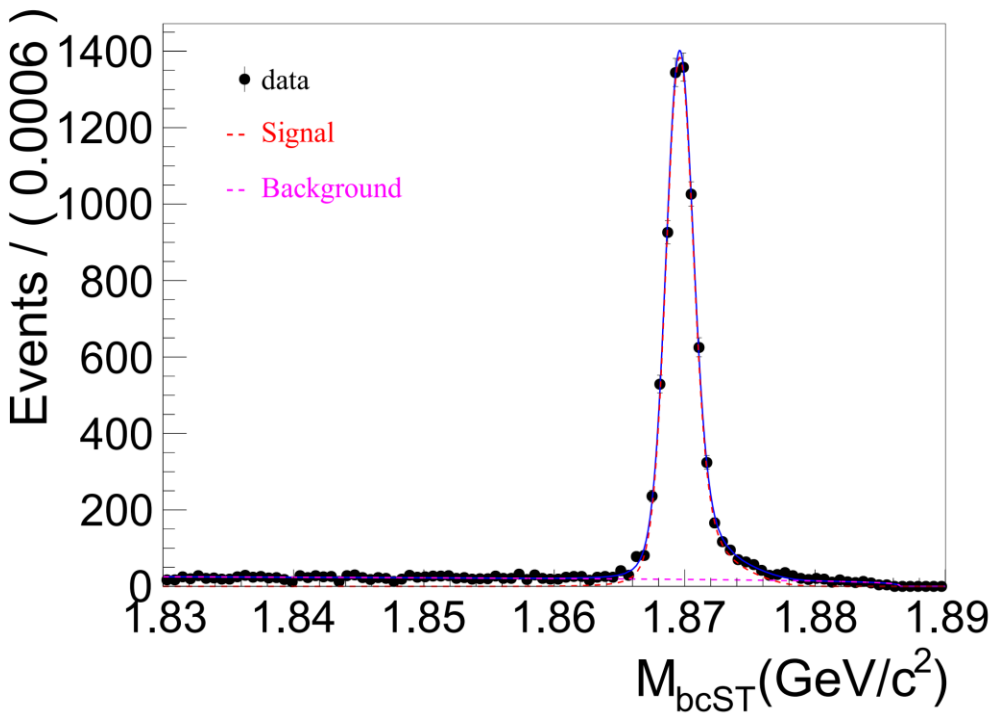
round0304

D^+D^- M_{bc}: $0 < P_{miss} < 0.2\ GeV/c$

Find K_S^0



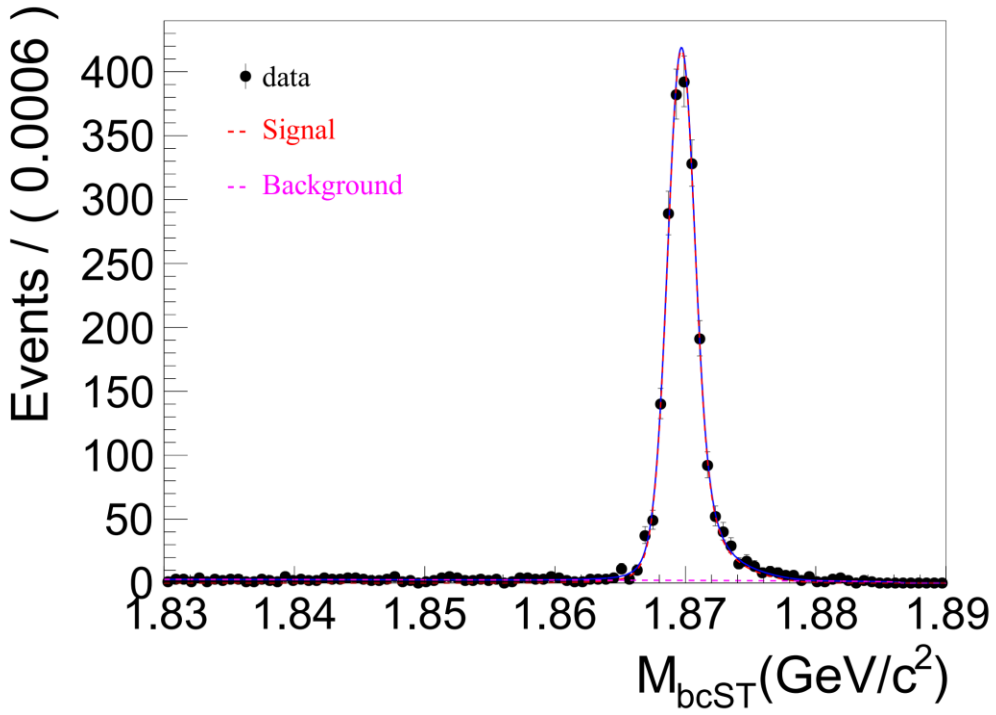
Not Find K_S^0



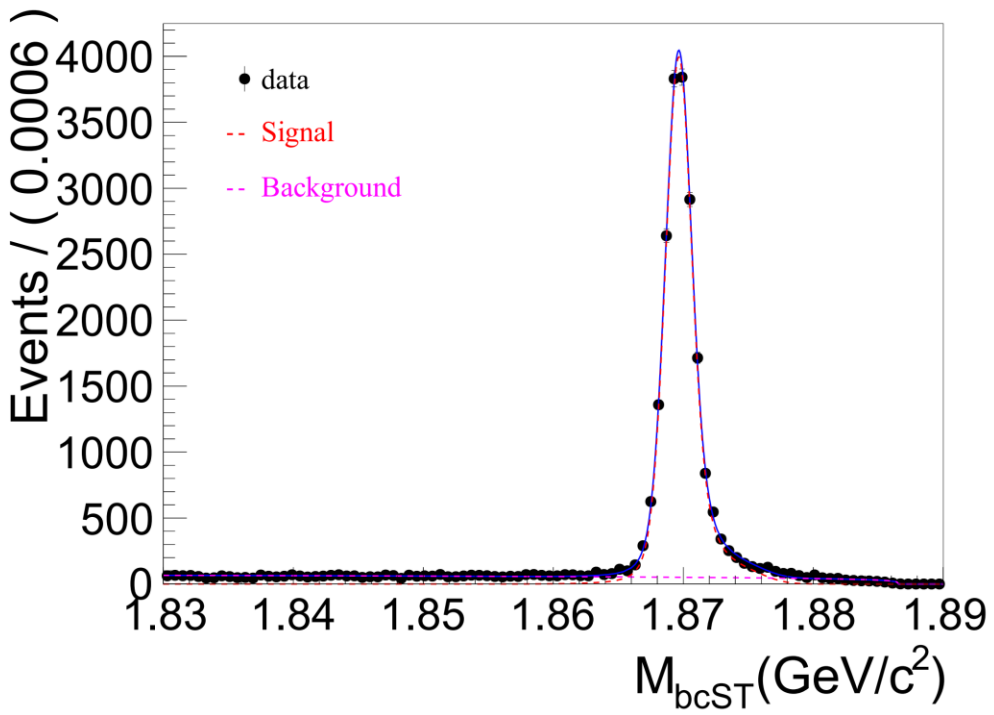
round15

D^+D^- M_{bc}: $0.2 < P_{miss} < 0.4\ GeV/c$

Find K_S^0



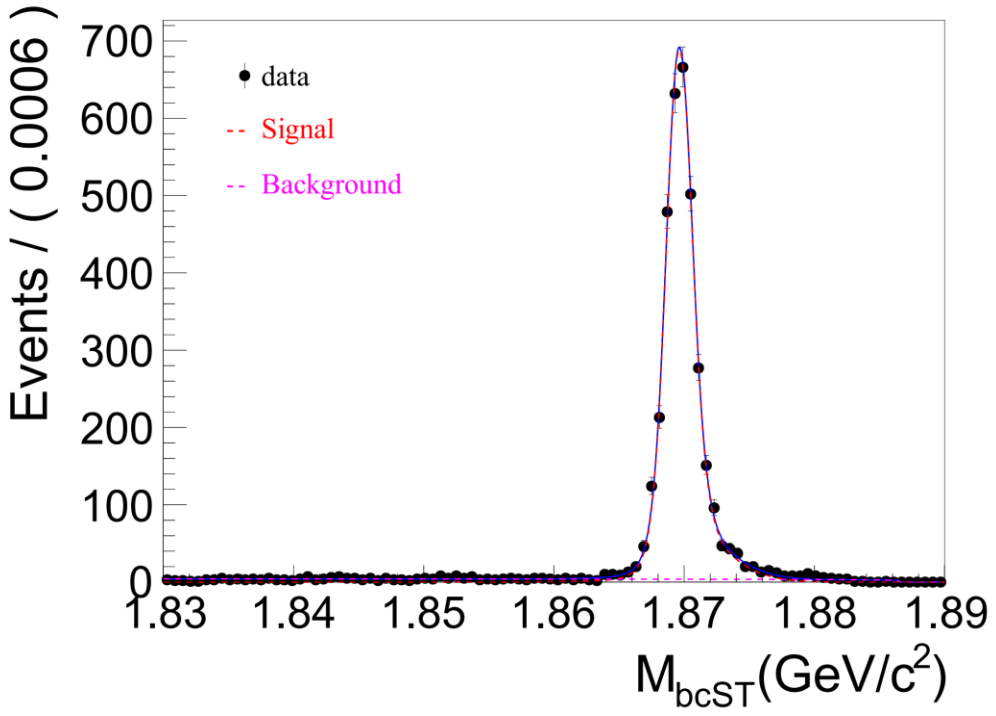
Not Find K_S^0



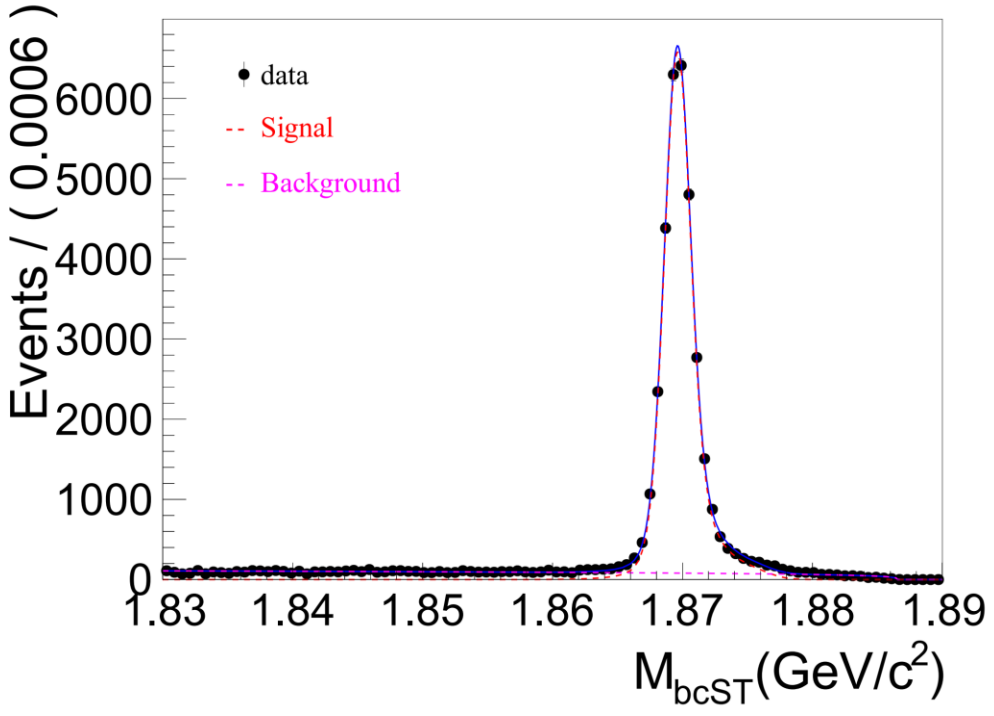
round0304

D^+D^- M_{bc}: $0.2 < P_{miss} < 0.4\ GeV/c$

Find K_S^0



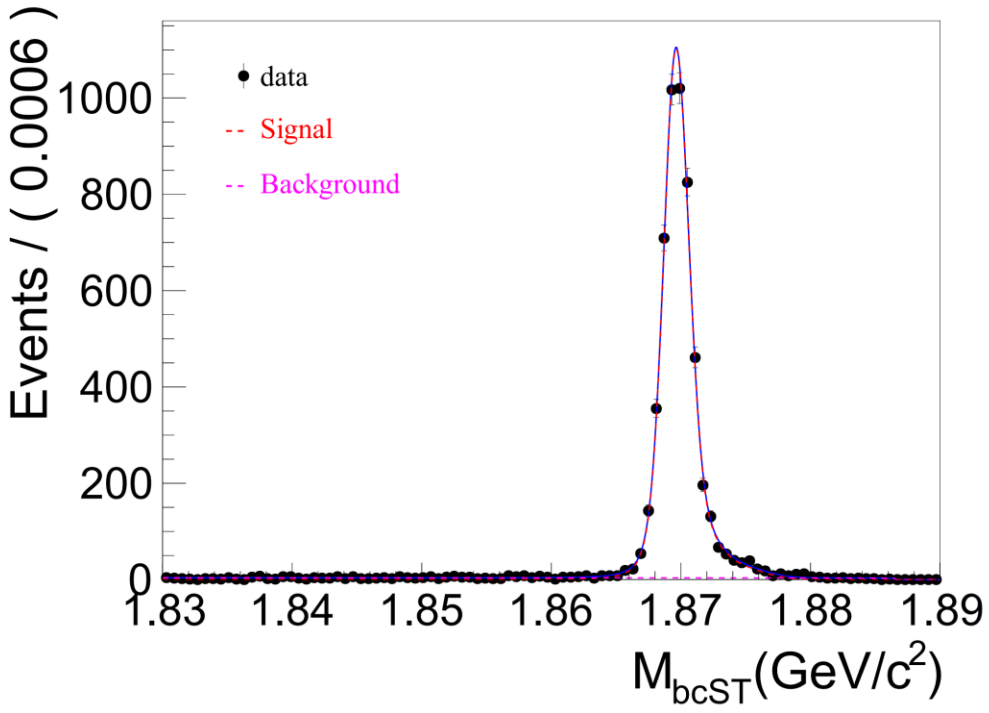
Not Find K_S^0



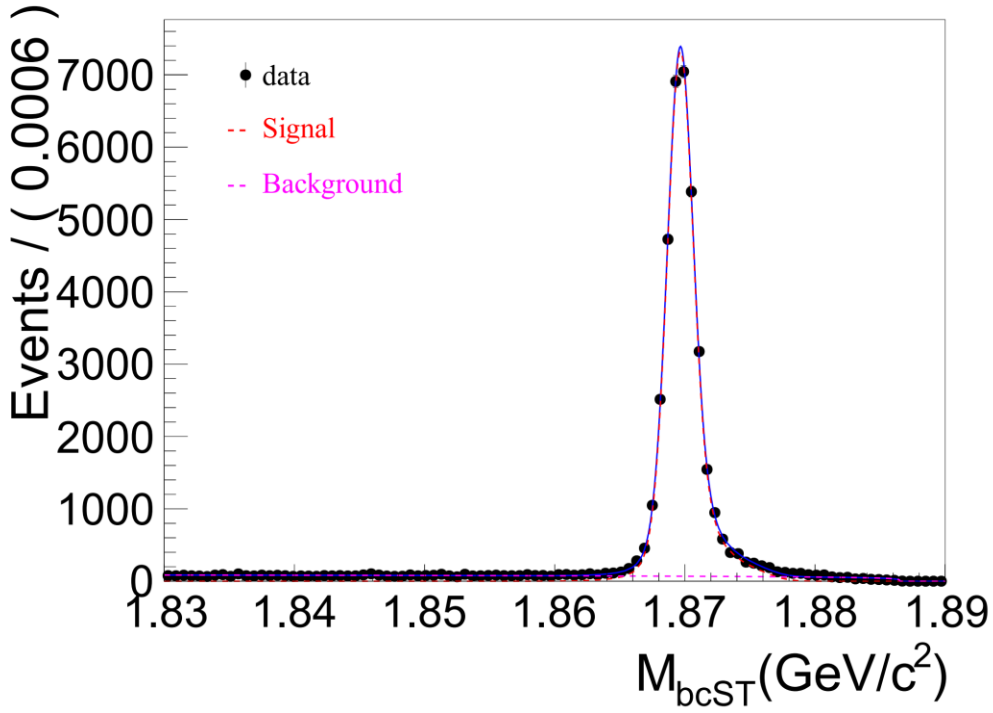
round15

D^+D^- M_{bc}: $0.4 < P_{miss} < 0.6\ GeV/c$

Find K_S^0



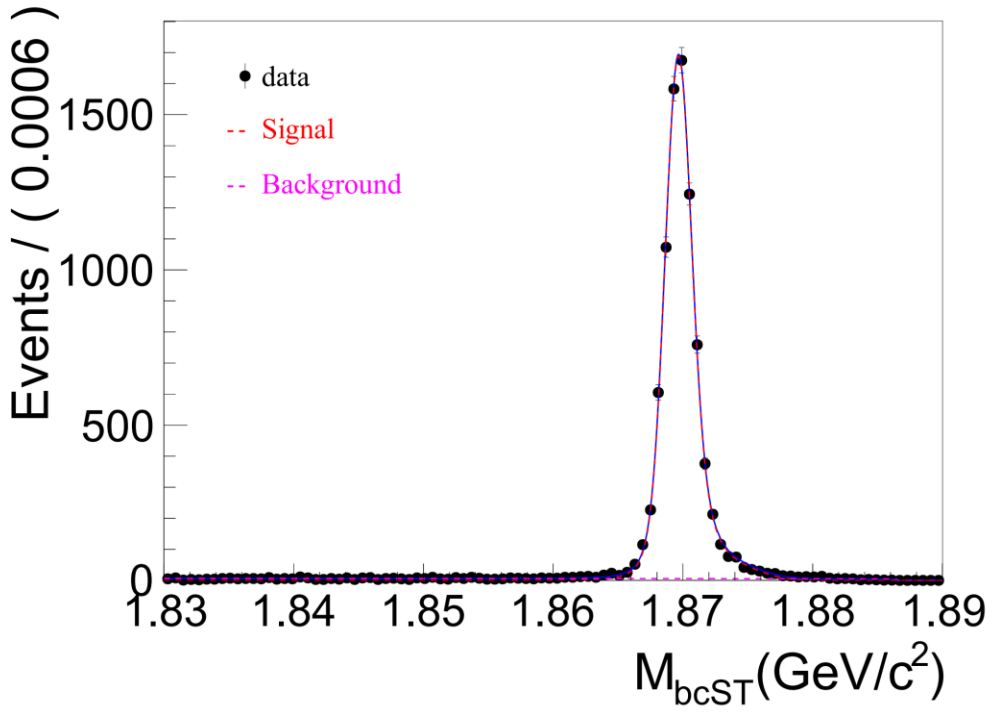
Not Find K_S^0



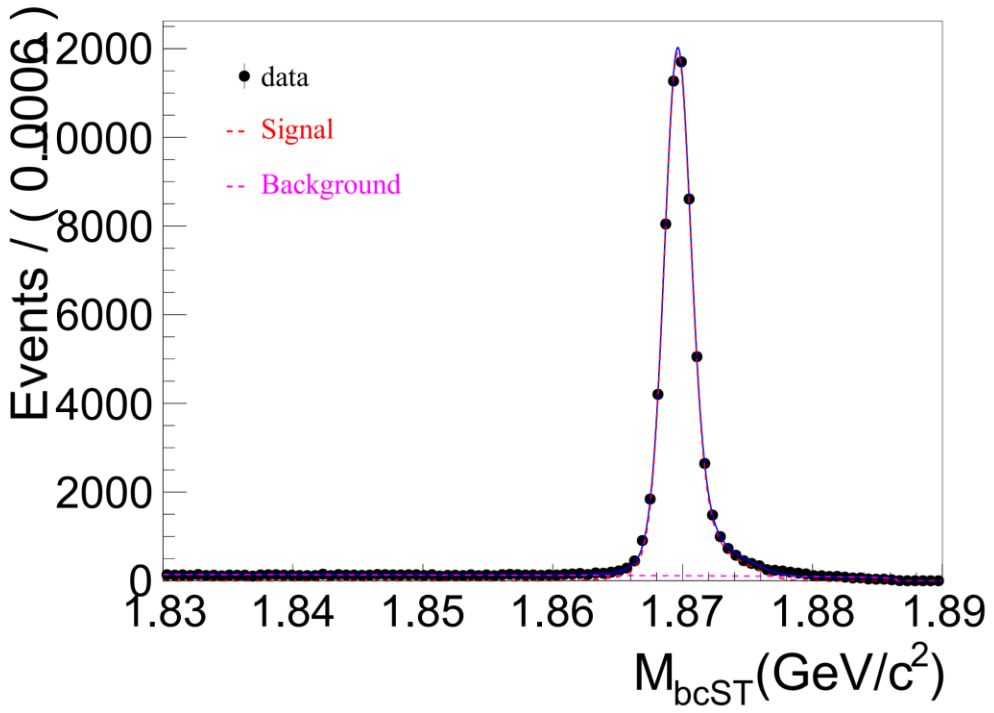
round0304

D^+D^- M_{bc}: $0.4 < P_{miss} < 0.6\ GeV/c$

Find K_S^0



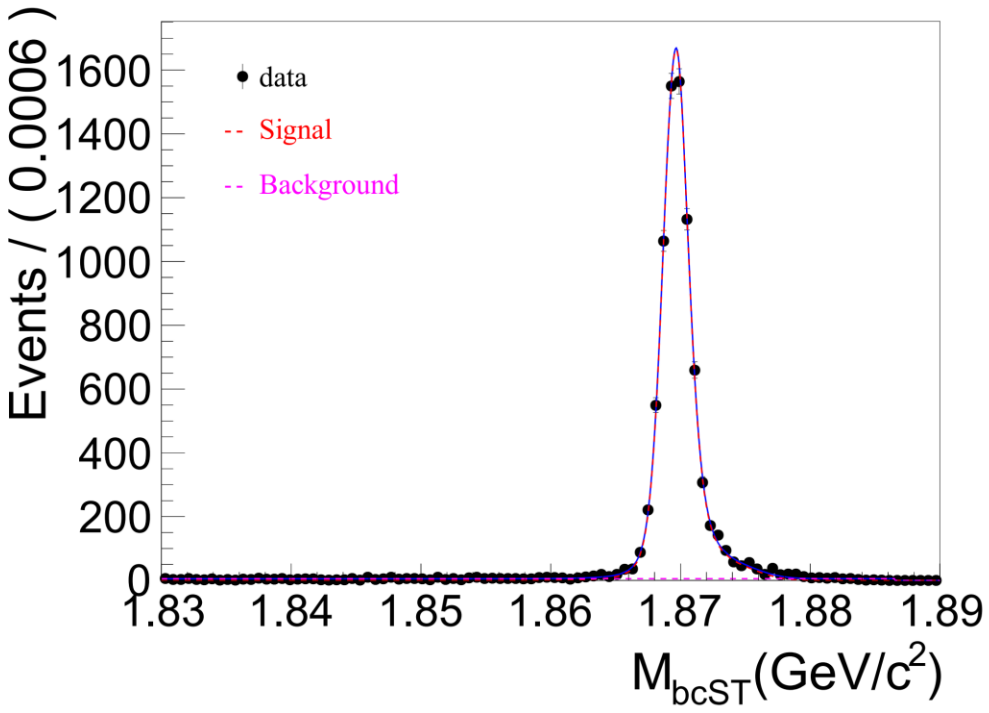
Not Find K_S^0



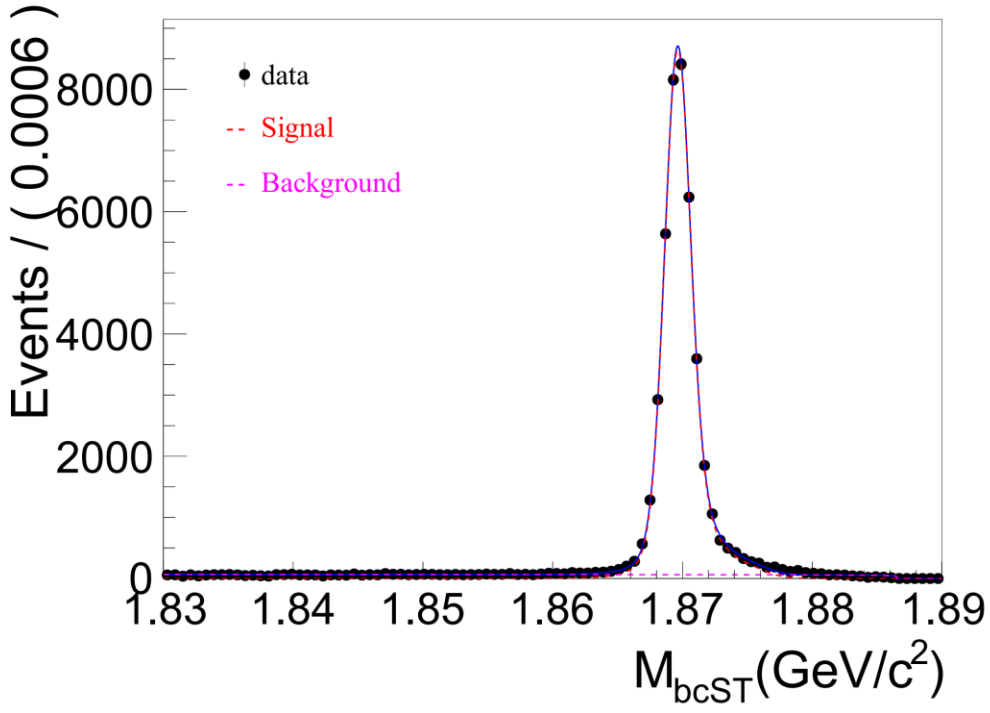
round15

D^+D^- M_{bc}: $0.6 < P_{miss} < 0.8\ GeV/c$

Find K_S^0



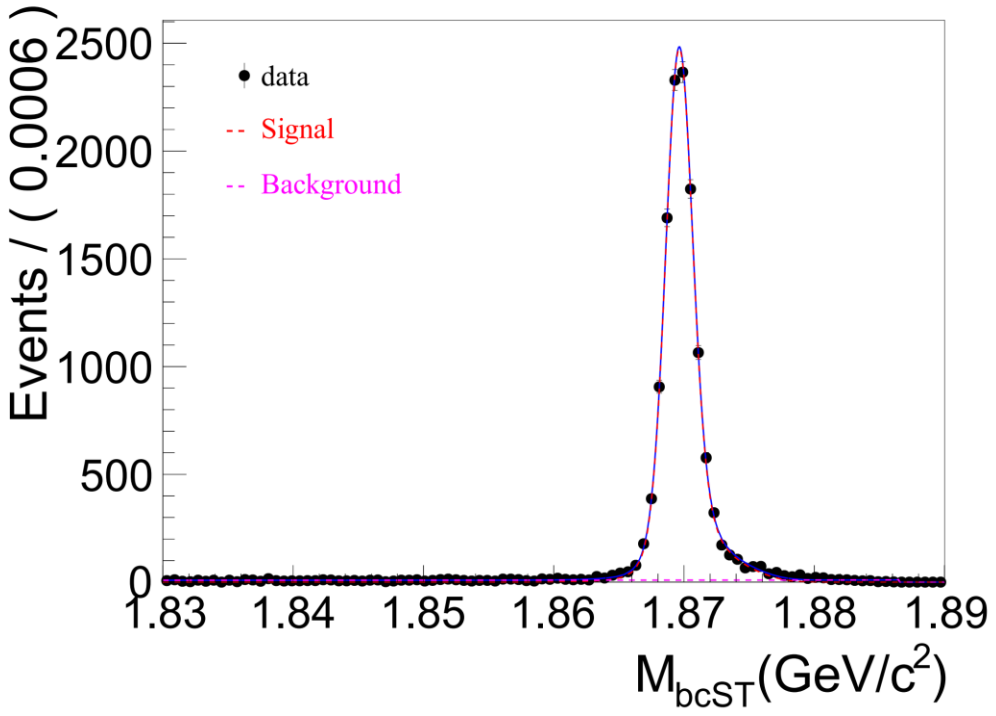
Not Find K_S^0



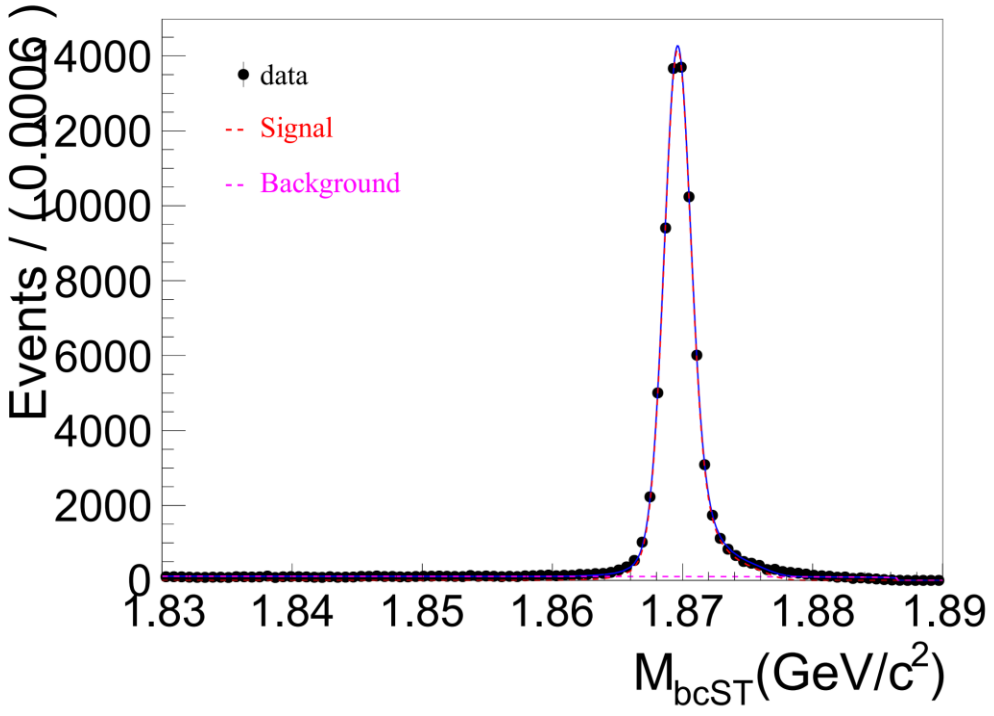
round0304

D^+D^- M_{bc}: $0.6 < P_{miss} < 0.8\ GeV/c$

Find K_S^0



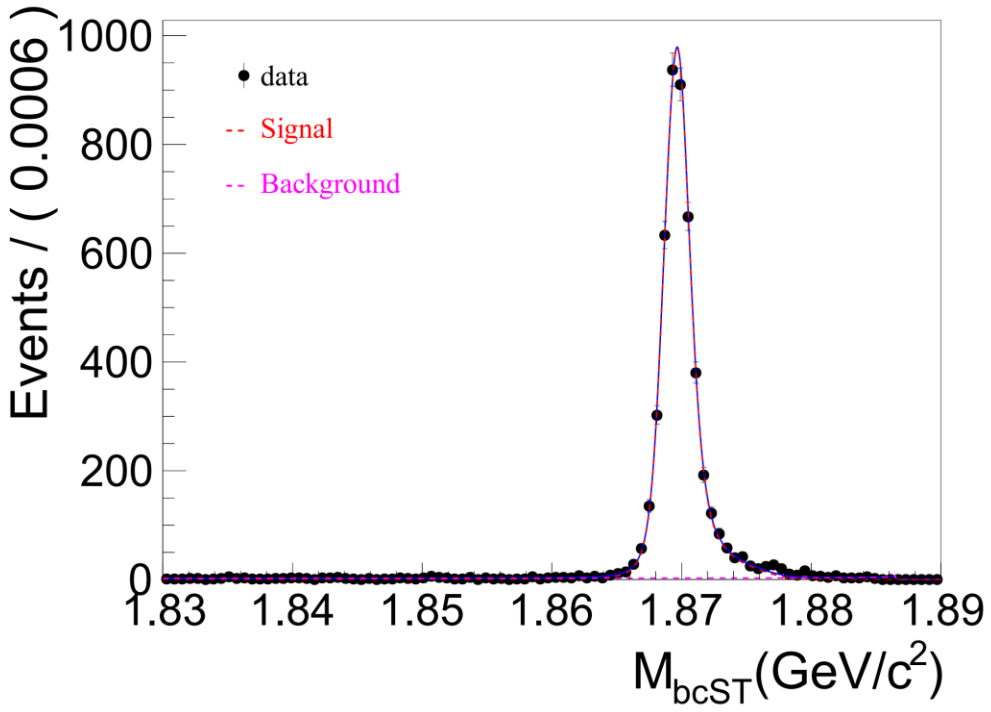
Not Find K_S^0



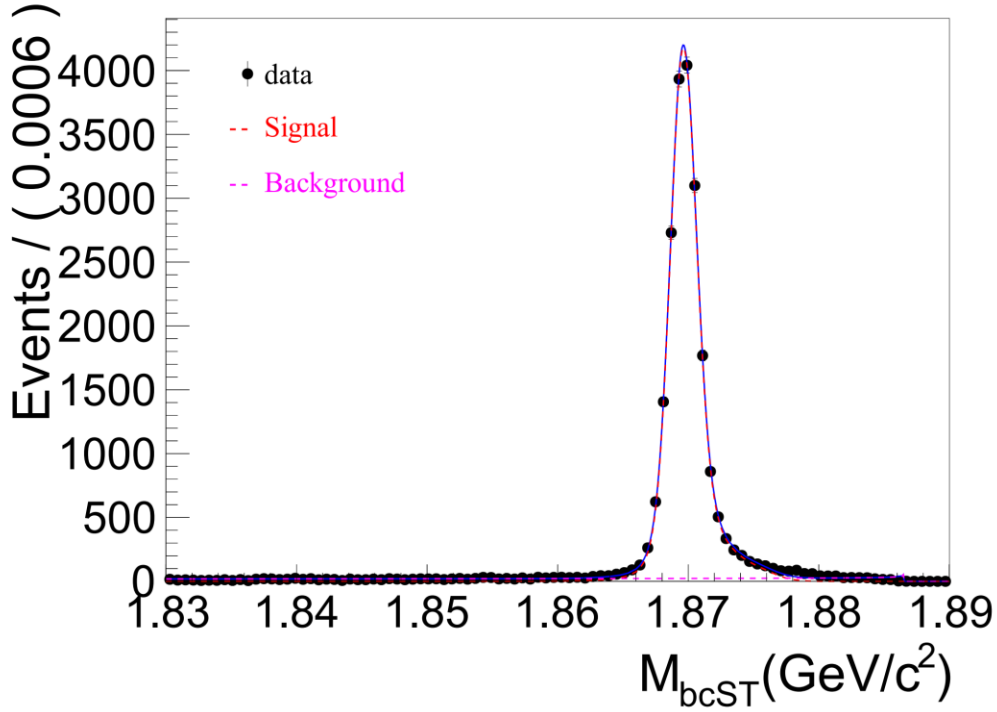
round15

D^+D^- M_{bc}: $0.8 < P_{miss} < 1.0\ GeV/c$

Find K_S^0



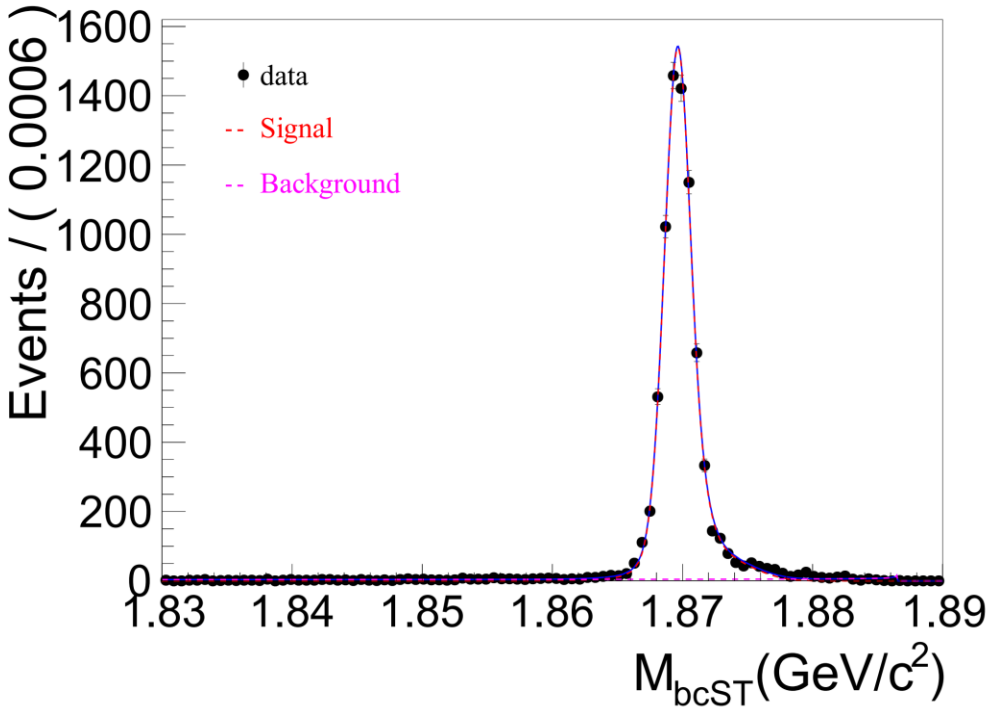
Not Find K_S^0



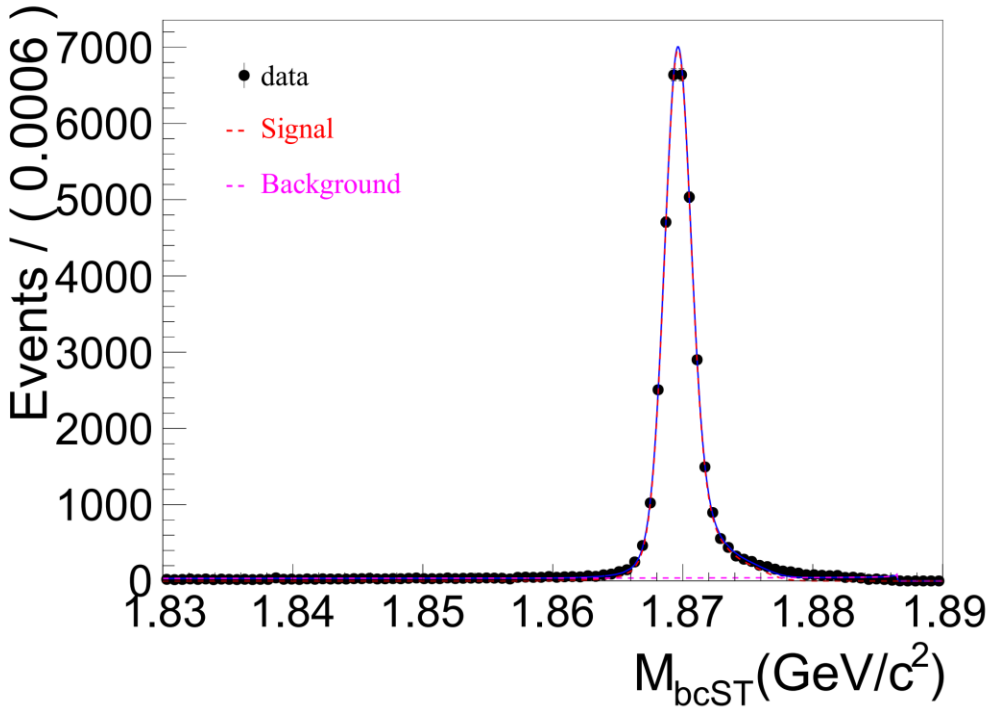
round0304

D^+D^- M_{bc}: $0.8 < P_{miss} < 1.0\ GeV/c$

Find K_S^0



Not Find K_S^0

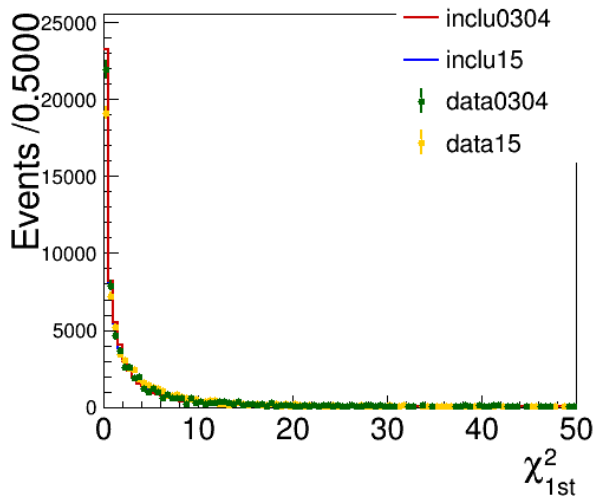


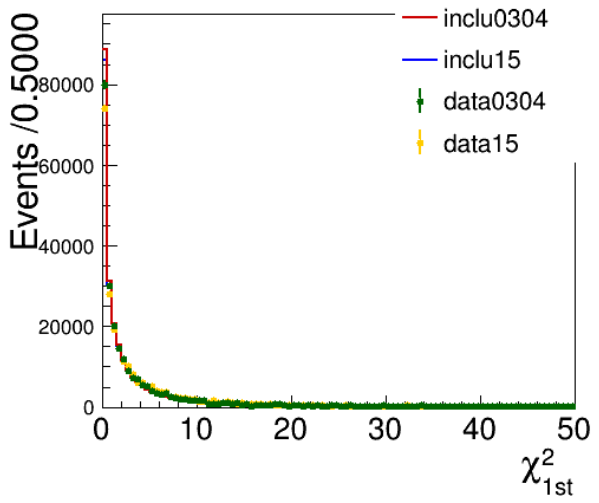
round15

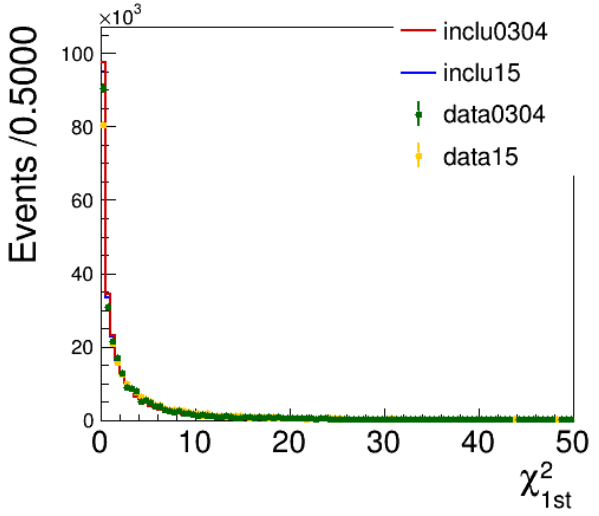
Vertex Fit

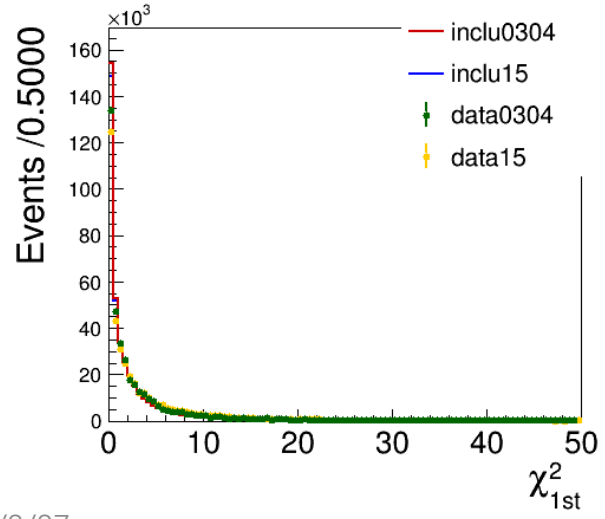
χ^2_{1st}

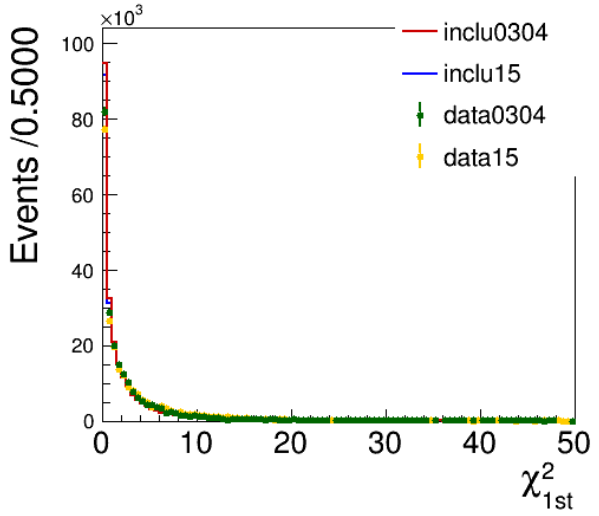
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

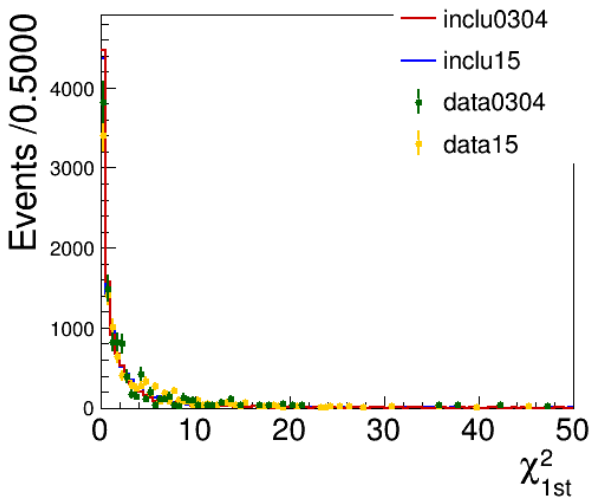








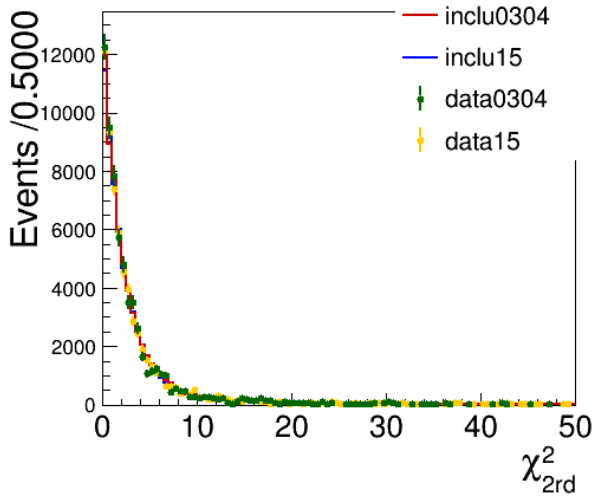


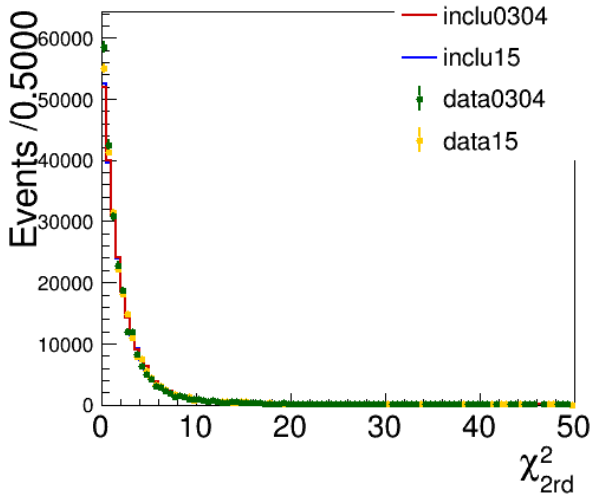


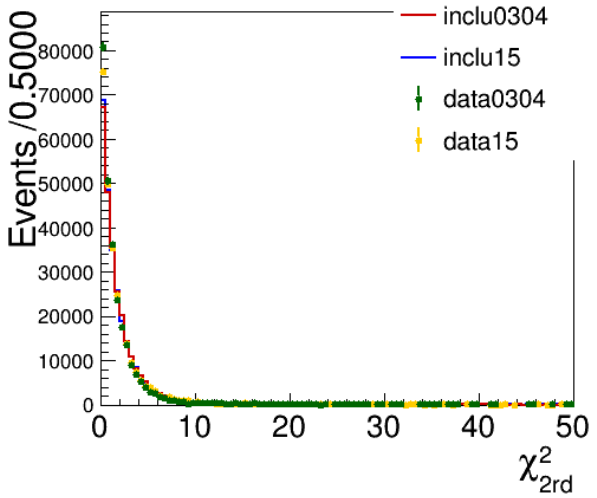
Vertex Fit

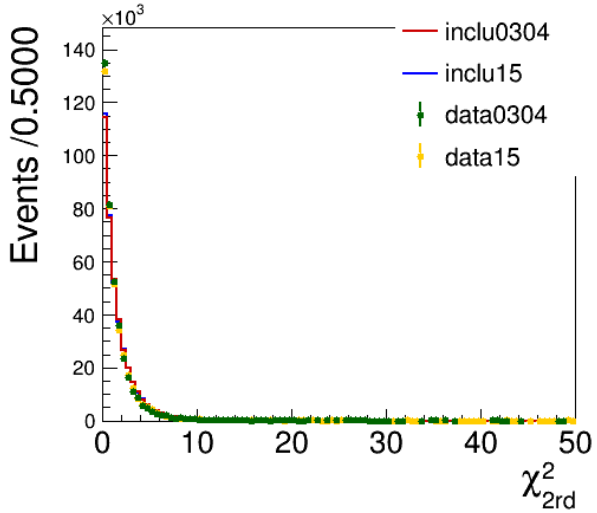
χ^2_{2rd}

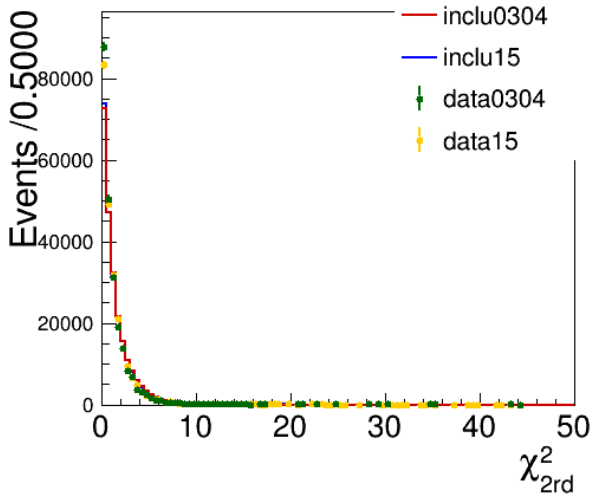
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

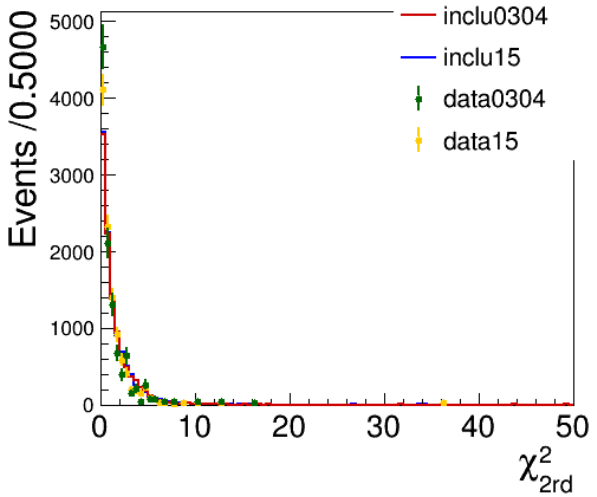








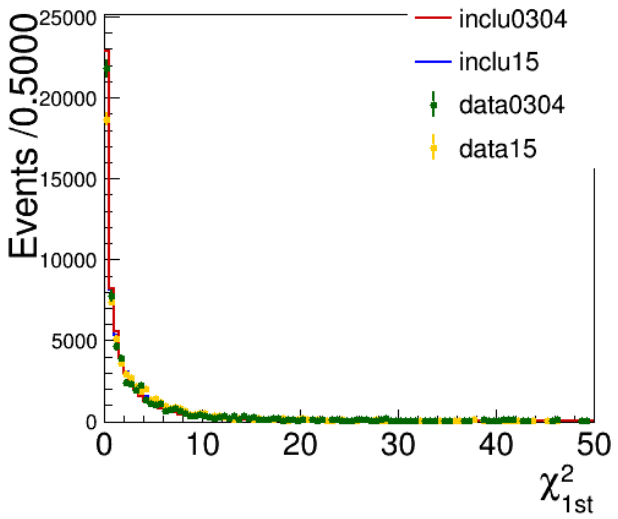


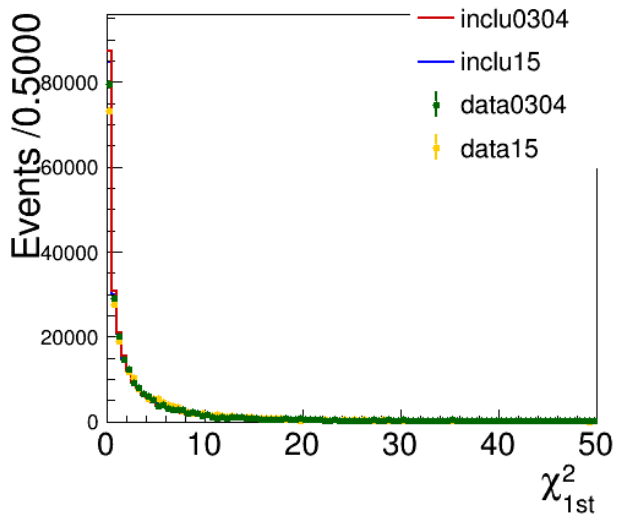


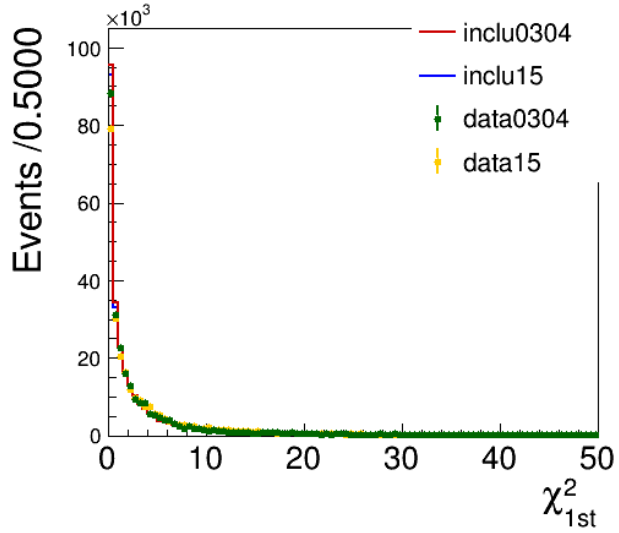
Refine Vertex Fit

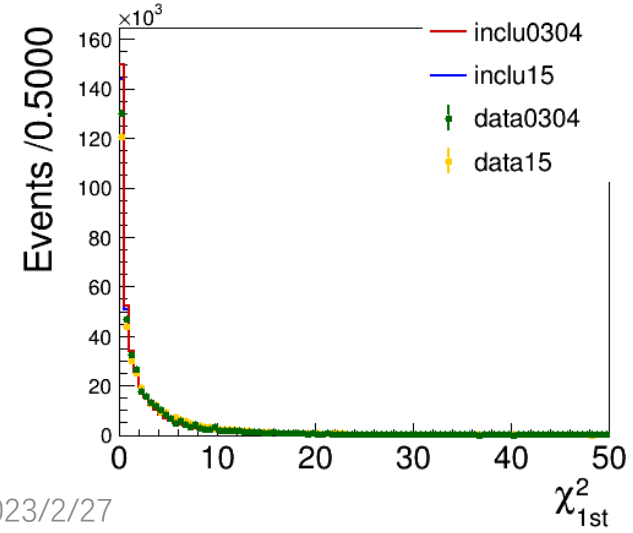
χ^2_{1st}

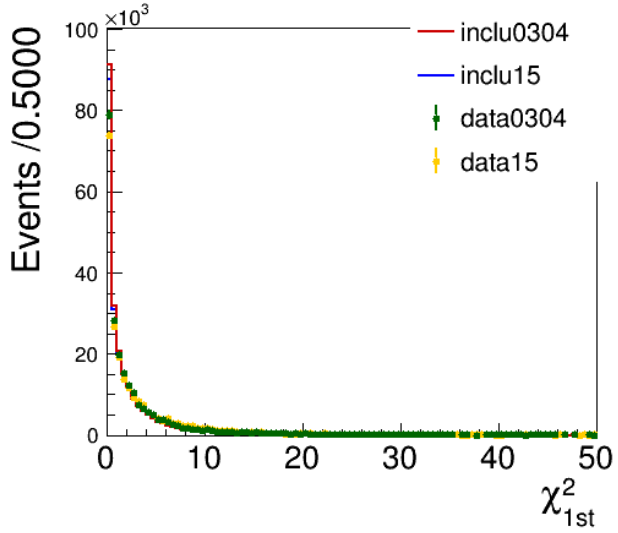
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

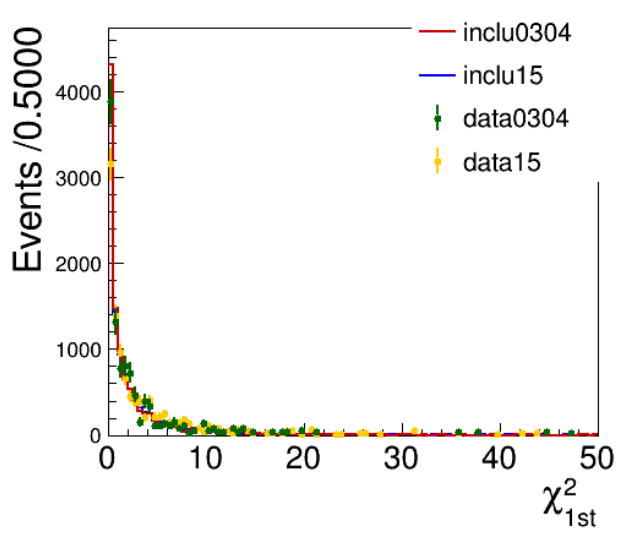








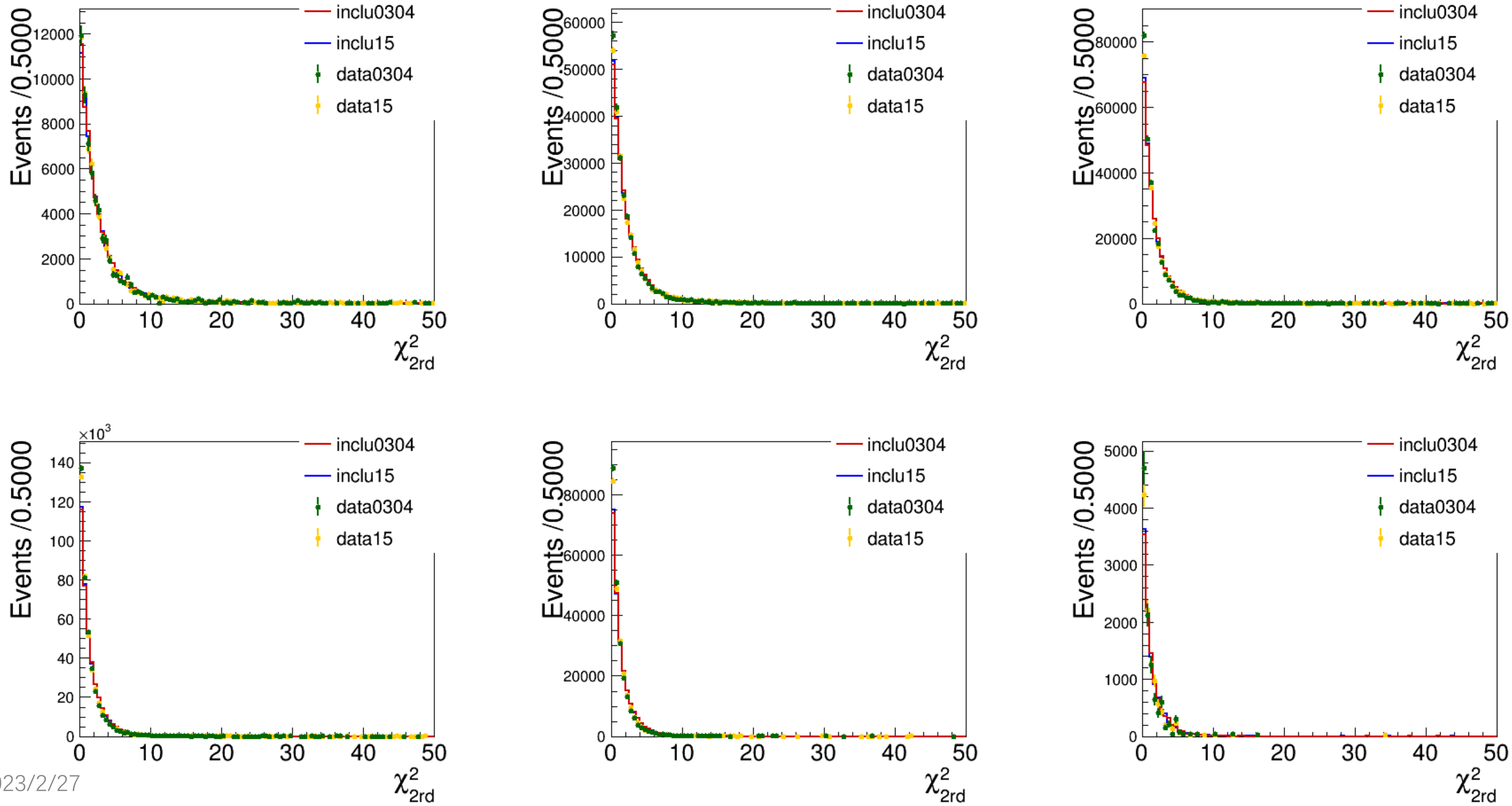




Refine Vertex Fit

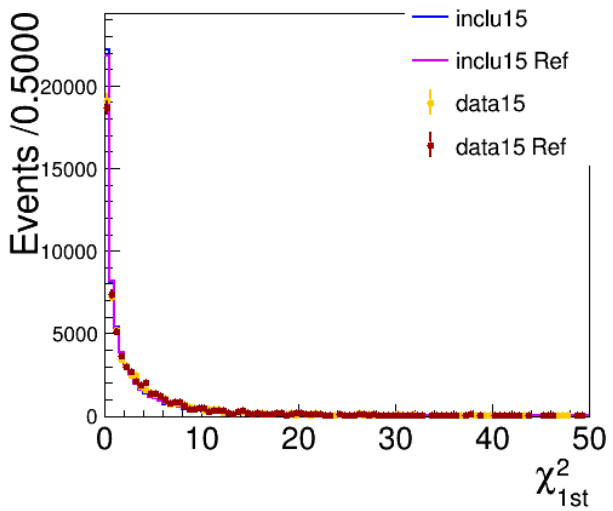
χ^2_{2rd}

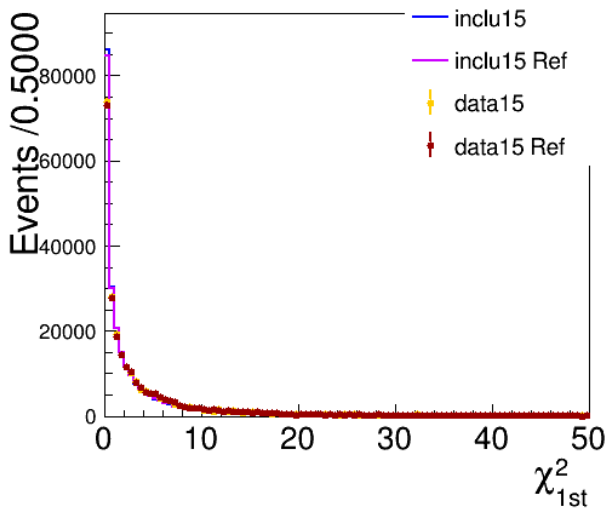
$0.511 > M_{K_s} > 0.487 \; L/err > 2$

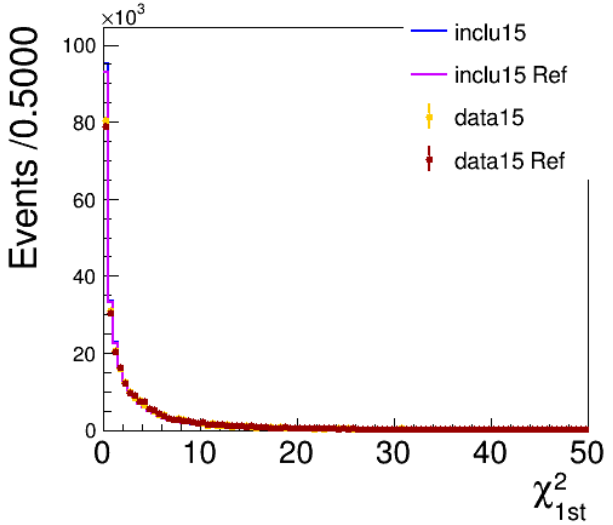


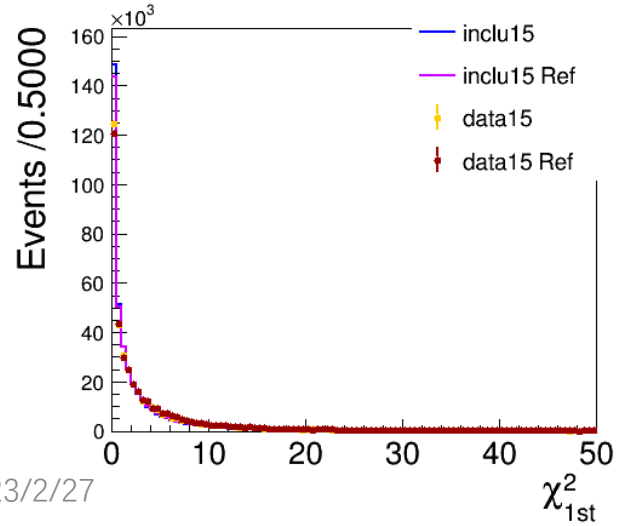
χ^2_{1st}

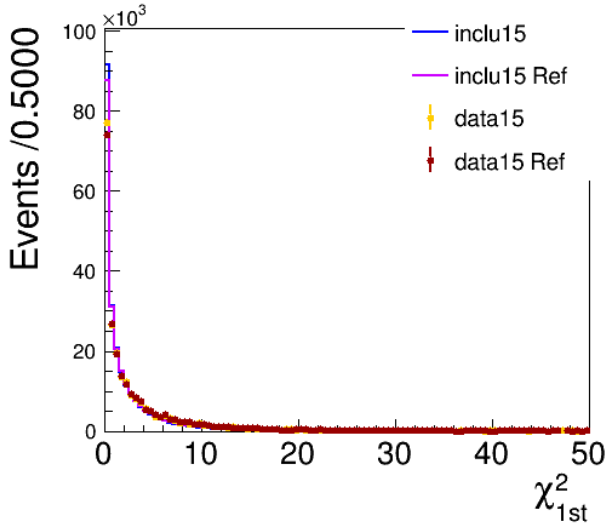
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

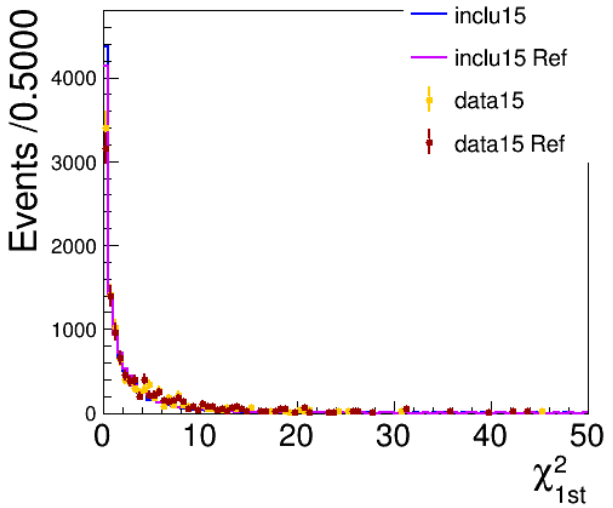






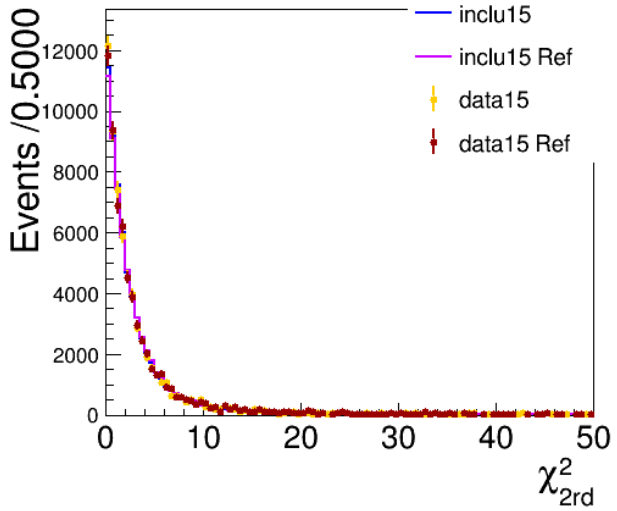


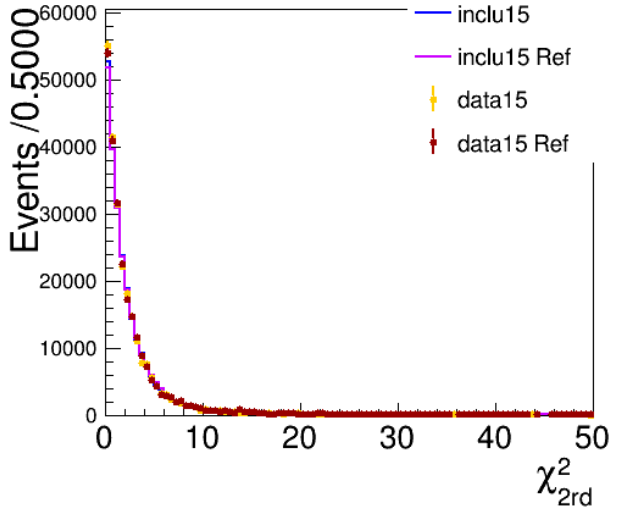


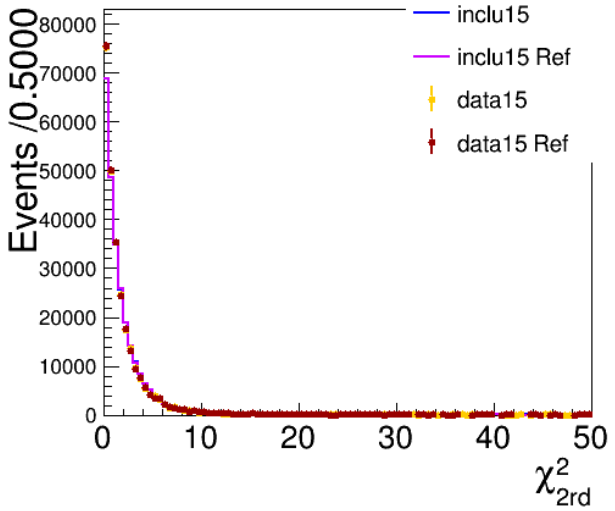


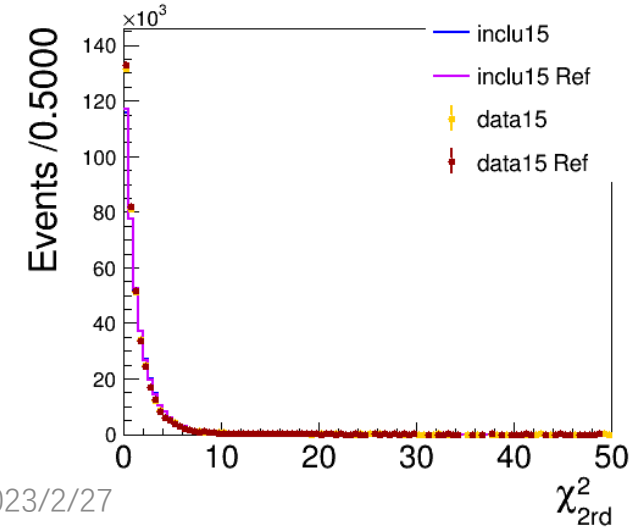
χ^2_{2rd}

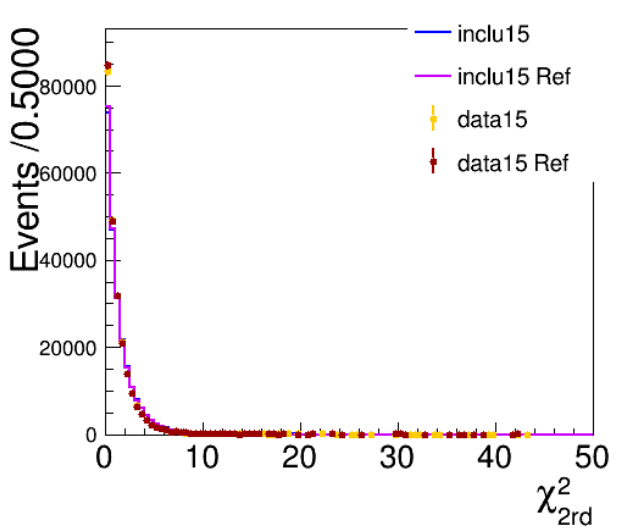
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

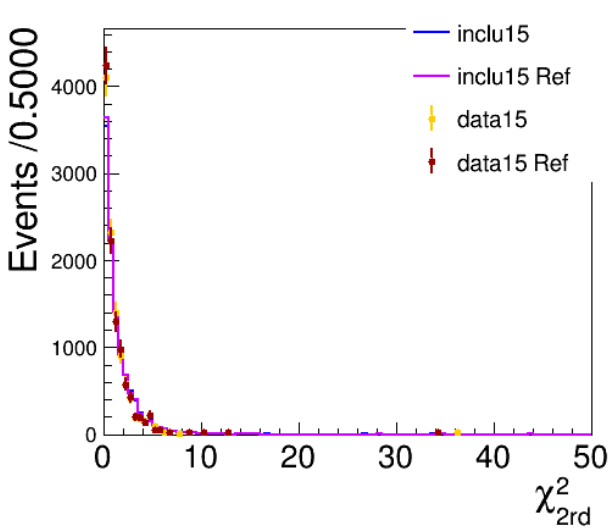






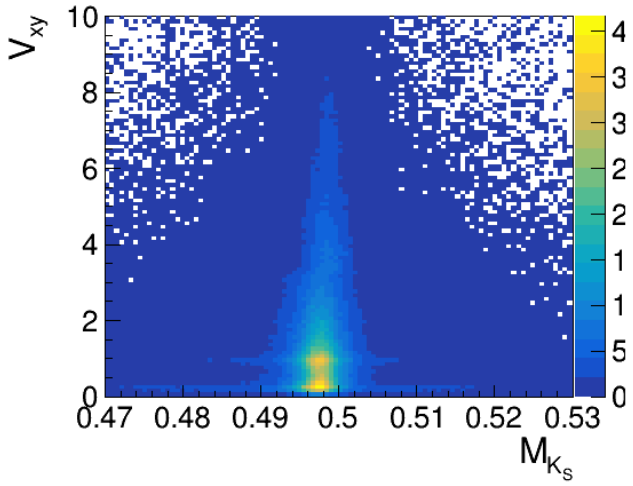




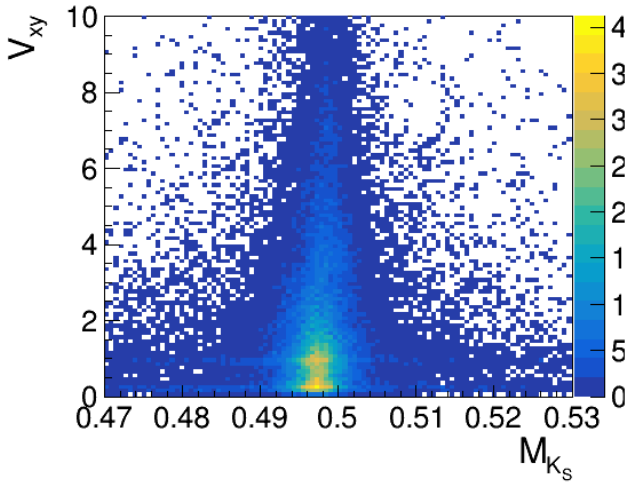


2D distribution between V_{xy} and M_{K_S}

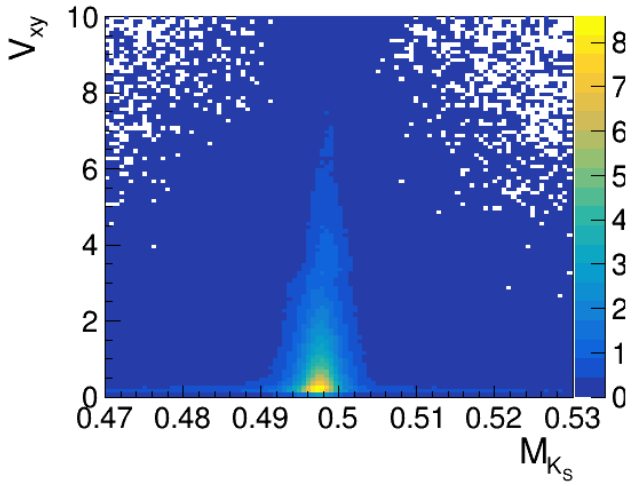
Inclusive mc round0304



Data round0304



Inclusive mc round15



Data round15