Check of Vertex Fit of K_s^0

- Tag mode
- Event selection
- Comparison of Vertex Fit
- Miss K_S^0 mass distribution

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
- **Vertex Fit Candidates of K^0_S :**
  - Reconstructed by $\pi^+\pi^-$;
  - $\Delta E_{sig} = E_{sigD} - E_{beam}$, $M_{bcsig} = \sqrt{E^2_{beam} - \overrightarrow{P}^2_{sigD}}$
  - Minimum ΔE_{sig} is used to select best candidate
  - ΔE_{sig} cut: no π^0: $(-0.025,0.025)$ GeV
    with π^0: $(-0.055,0.040)$ GeV
  - D^0: $1.86 \leq M_{bcsig} \leq 1.87$ GeV/c^2
    D^+: $1.865 \leq M_{bcsig} \leq 1.875$ GeV/c^2

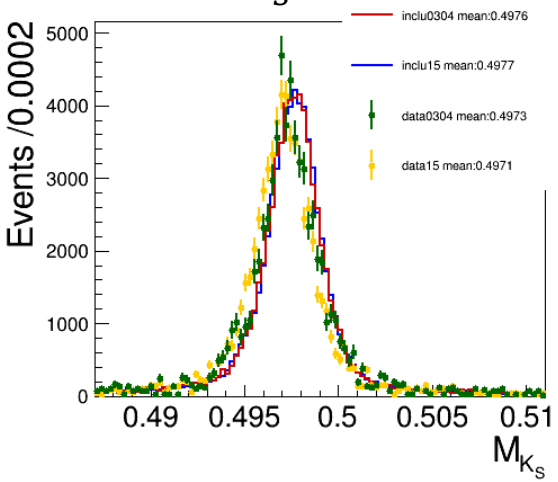
Vertex fit

Vertex Fit

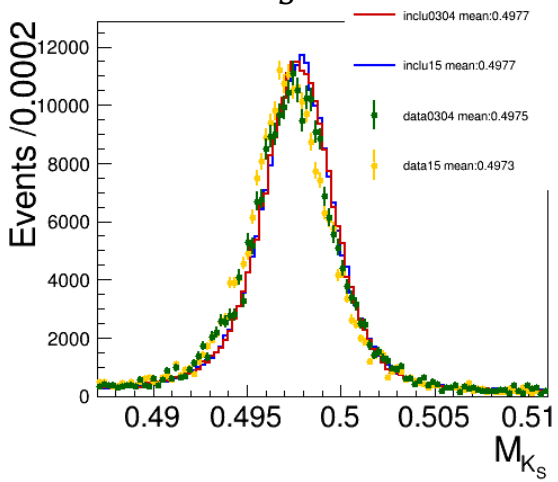
M_{K_S}

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

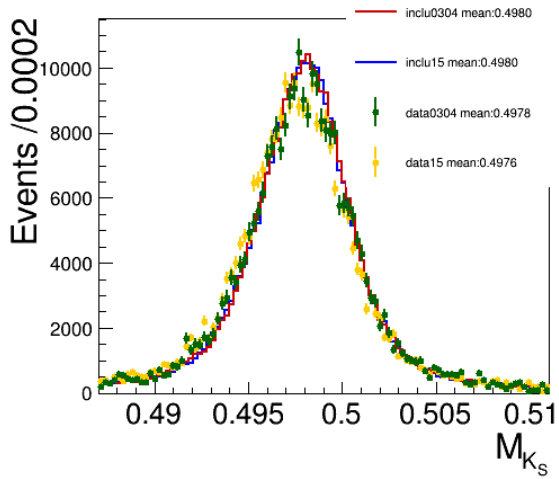
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



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

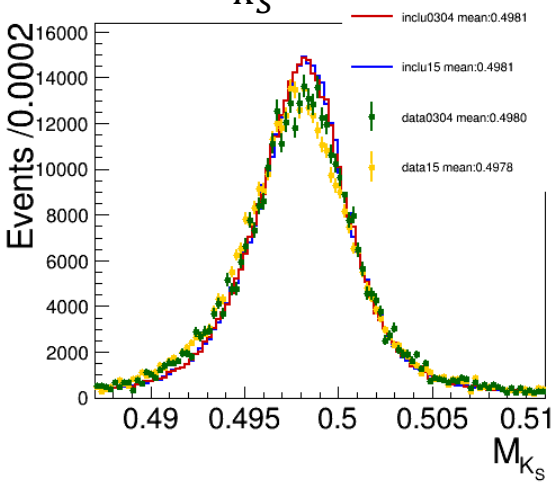


$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$

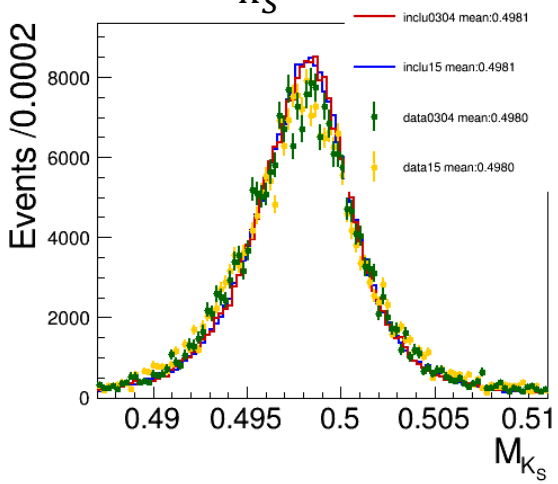


inclu0304
inclu15
data0304
data15

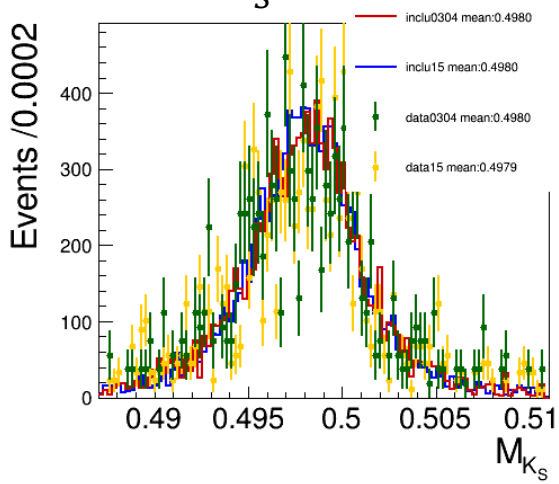
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



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



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

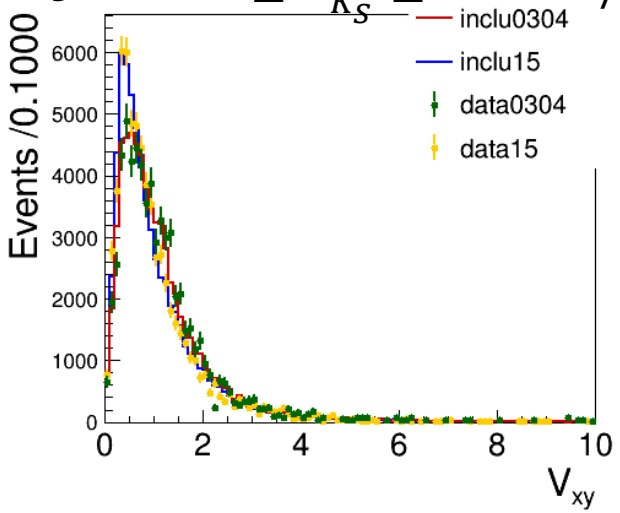


Vertex Fit

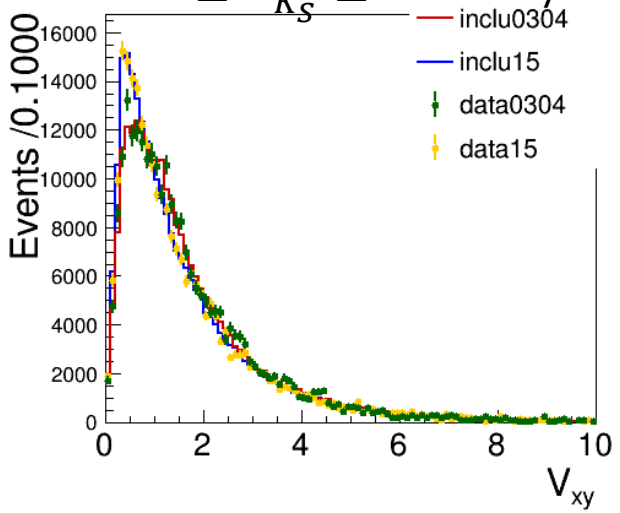
V_{xy}

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

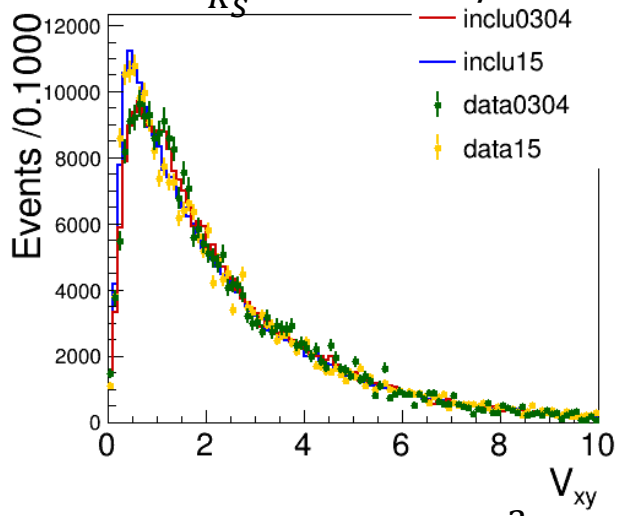
$0.0 \leq P_{K^0_S} \leq 0.2 \; GeV/c^2$



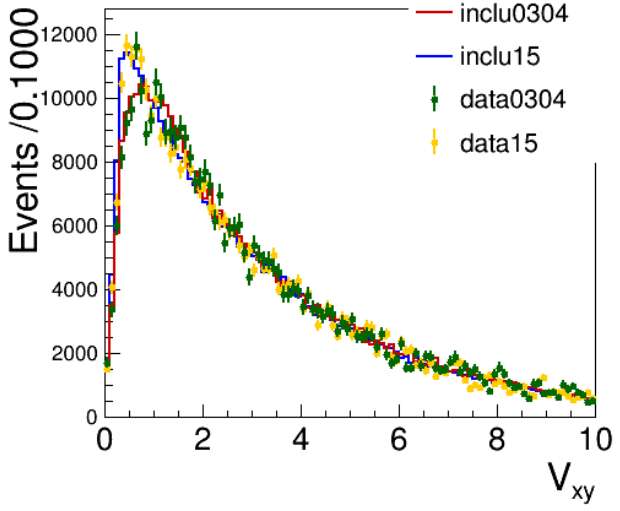
$0.2 \leq P_{K^0_S} \leq 0.4 \; GeV/c^2$



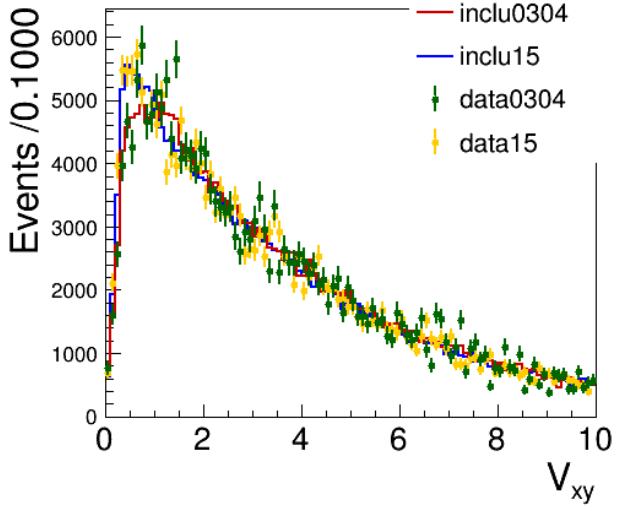
$0.4 \leq P_{K^0_S} \leq 0.6 \; GeV/c^2$



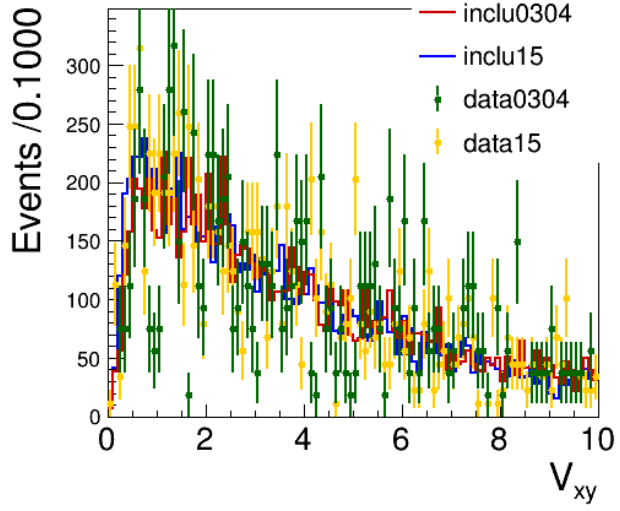
$0.6 \leq P_{K^0_S} \leq 0.8 \; GeV/c^2$



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



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

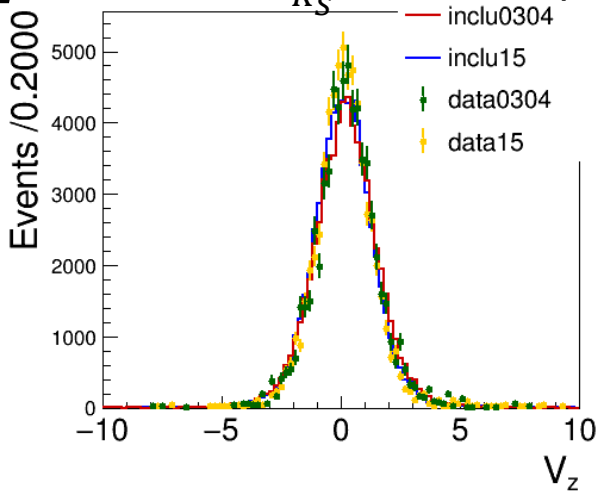


Vertex Fit

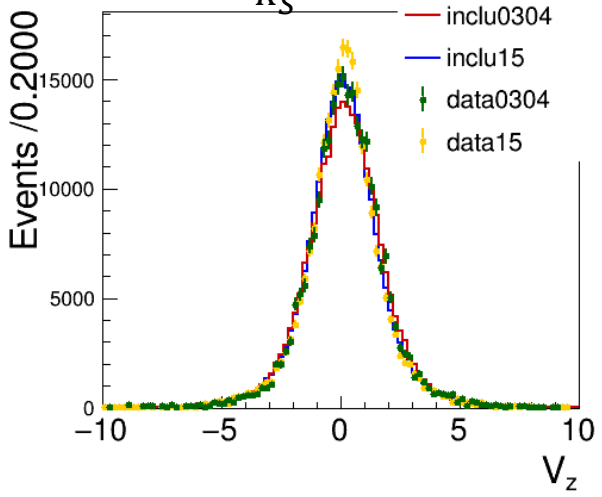
V_z

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

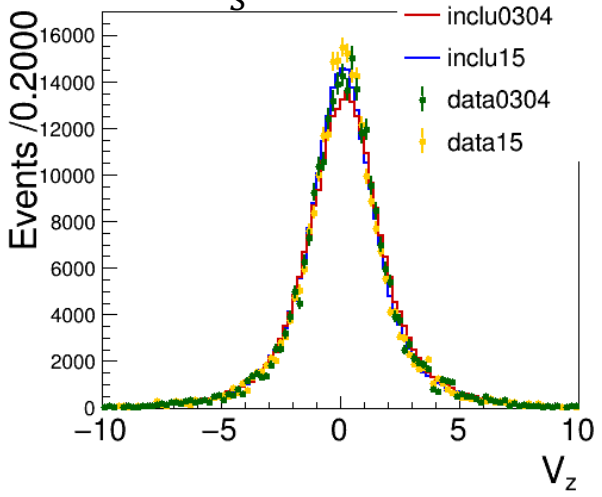
$0.0 \leq P_{K^0_S} \leq 0.2 \; GeV/c^2$



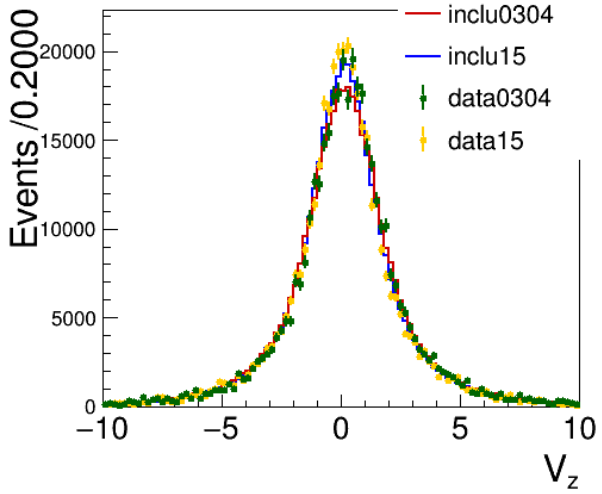
$0.2 \leq P_{K^0_S} \leq 0.4 \; GeV/c^2$



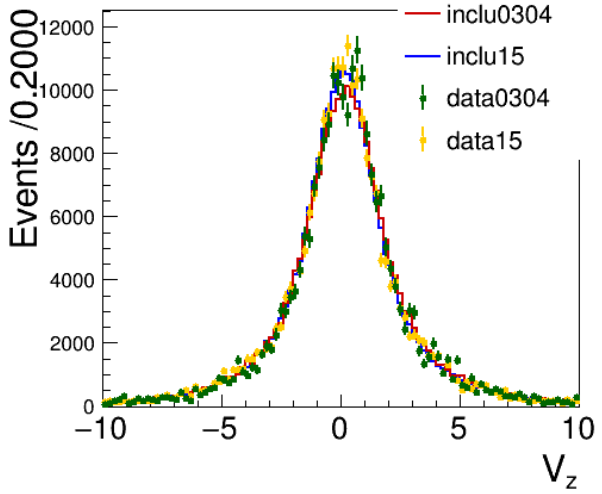
$0.4 \leq P_{K^0_S} \leq 0.6 \; GeV/c^2$



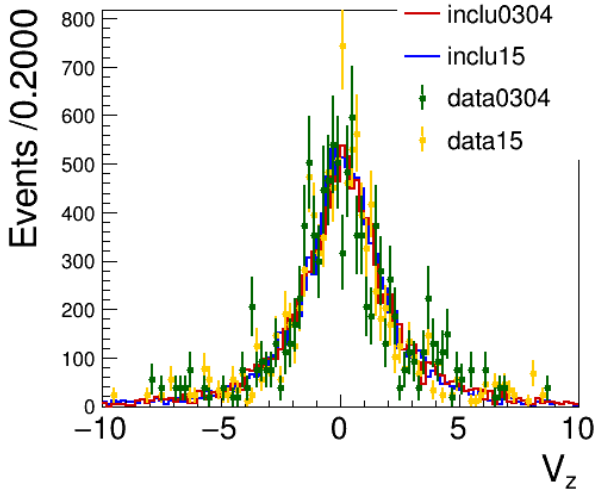
$0.6 \leq P_{K^0_S} \leq 0.8 \; GeV/c^2$



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



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

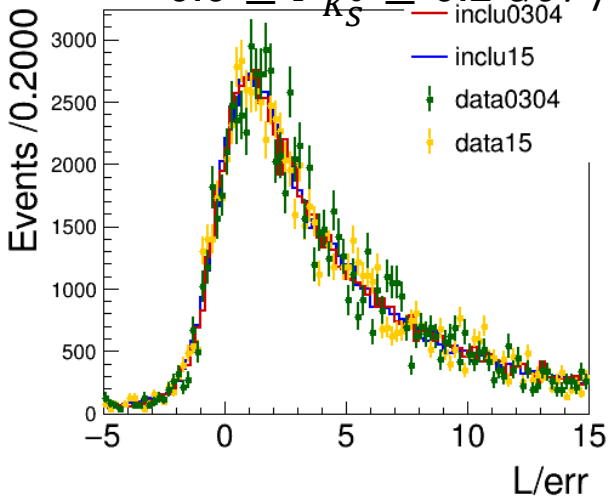


Vertex Fit

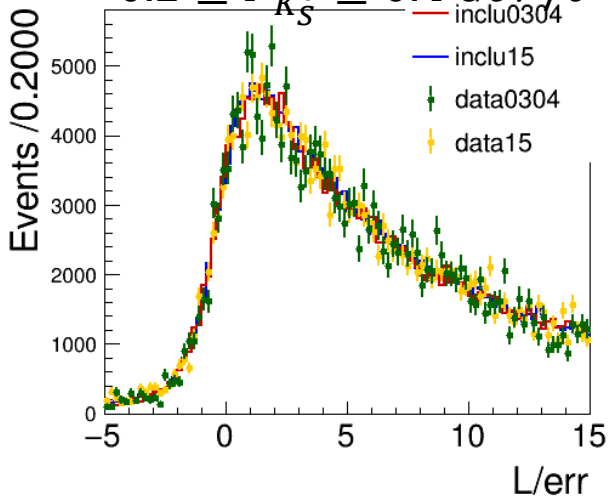
$\chi^2_{1st}\&\chi^2_{2rd} < 200 \;\; 0.511 > M_{K_s} > 0.487$

L/err

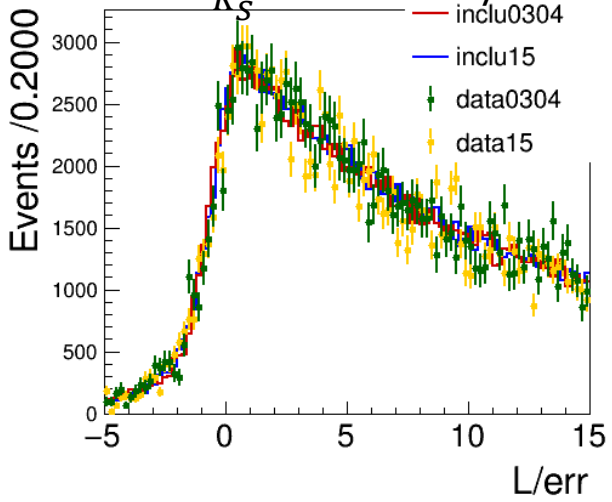
$0.0 \leq P_{K^0_S} \leq 0.2\ GeV/c^2$



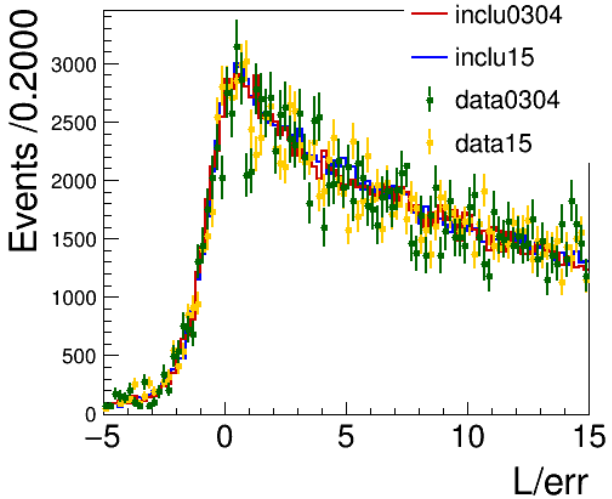
$0.2 \leq P_{K^0_S} \leq 0.4\ GeV/c^2$



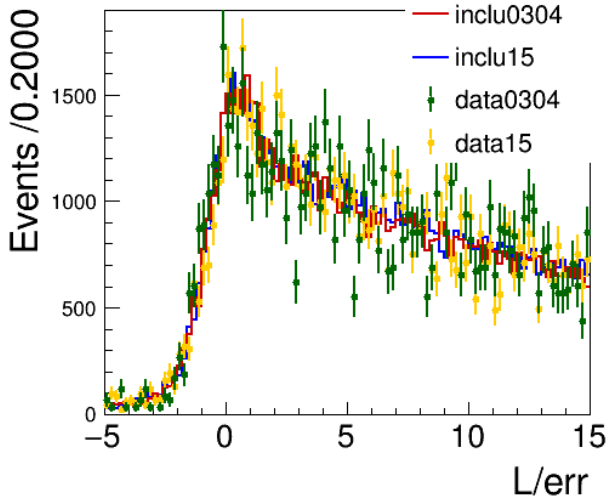
$0.4 \leq P_{K^0_S} \leq 0.6\ GeV/c^2$



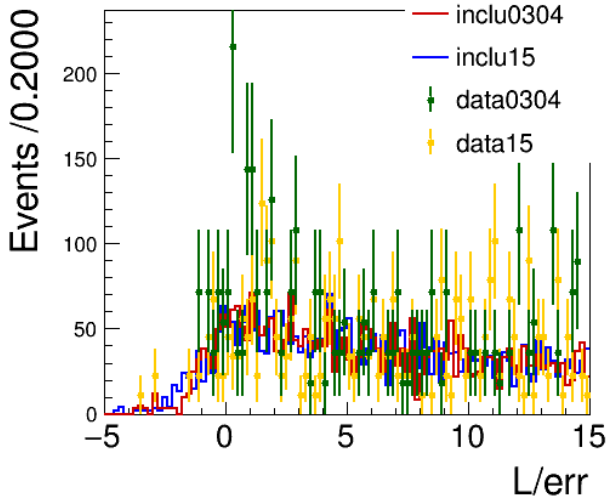
$0.6 \leq P_{K^0_S} \leq 0.8\ GeV/c^2$



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



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

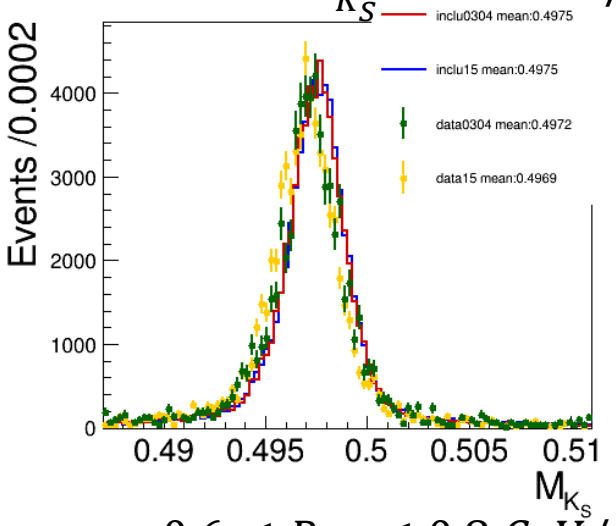


Refine Vertex fit

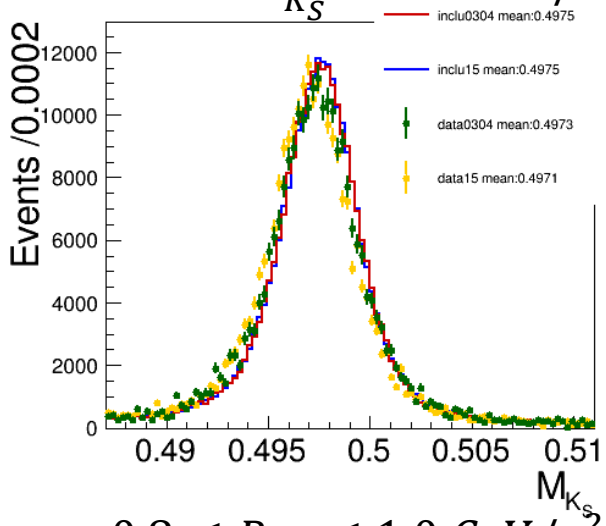
Refine Vertex Fit

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

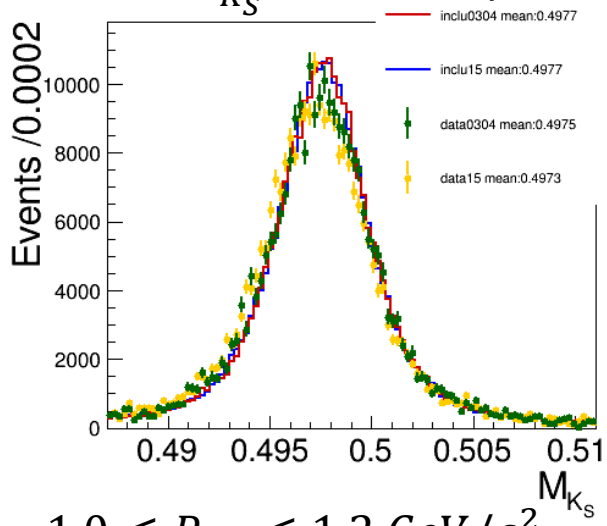
$0.0 \le P_{K_S^0} \le 0.2\ GeV/c^2$



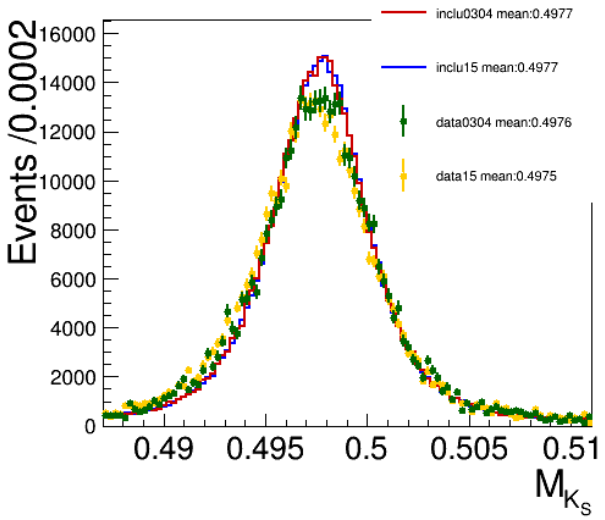
$0.2 \le P_{K_S^0} \le 0.4\ GeV/c^2$



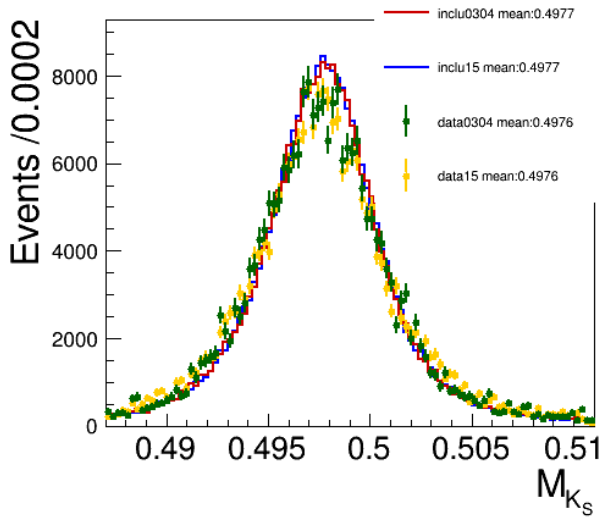
$0.4 \le P_{K_S^0} \le 0.6\ GeV/c^2$



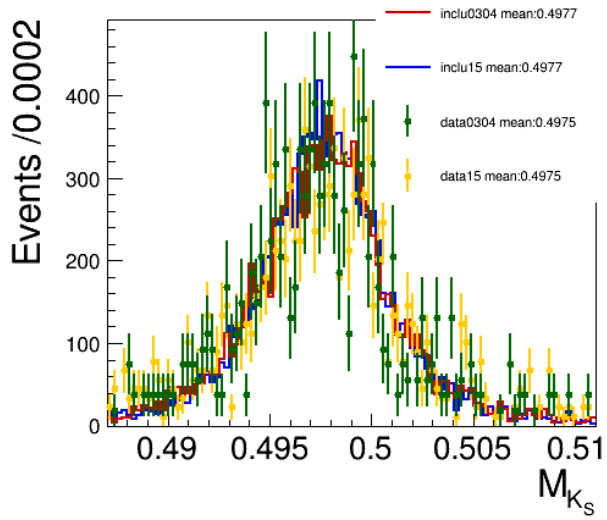
$0.6 \le P_{K_S^0} \le 0.8\ GeV/c^2$



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



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

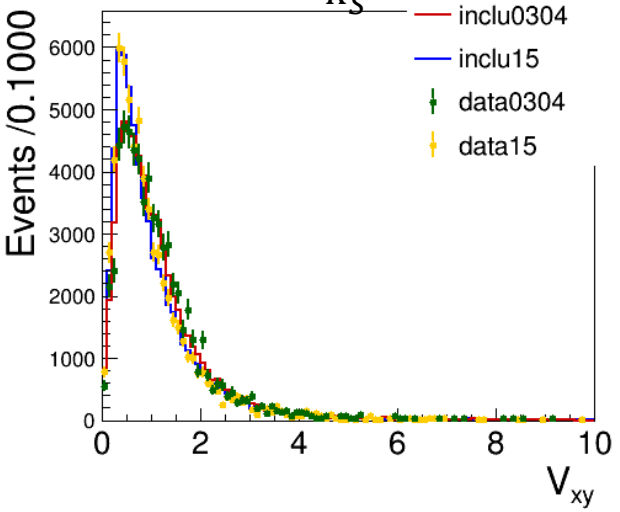


Refine Vertex Fit

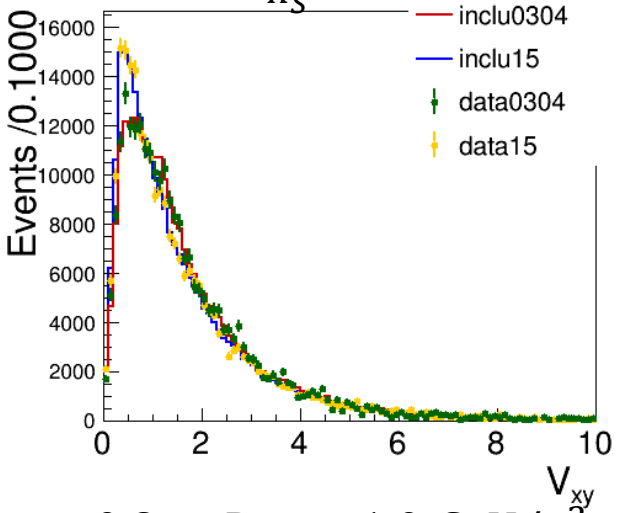
V_{xy}

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

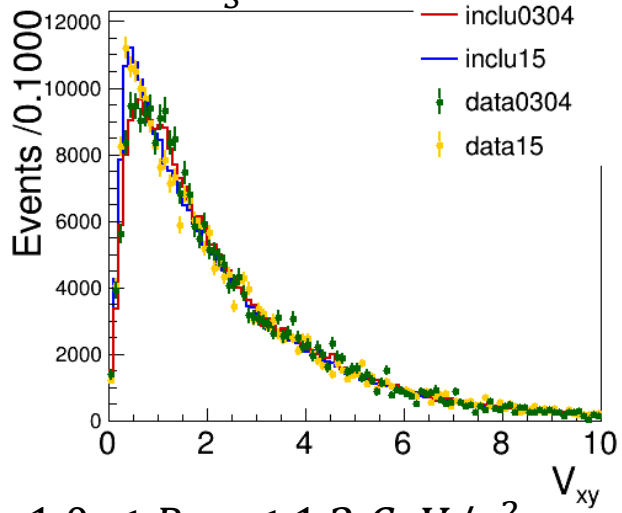
$0.0 \le P_{K^0_S} \le 0.2\ GeV/c^2$



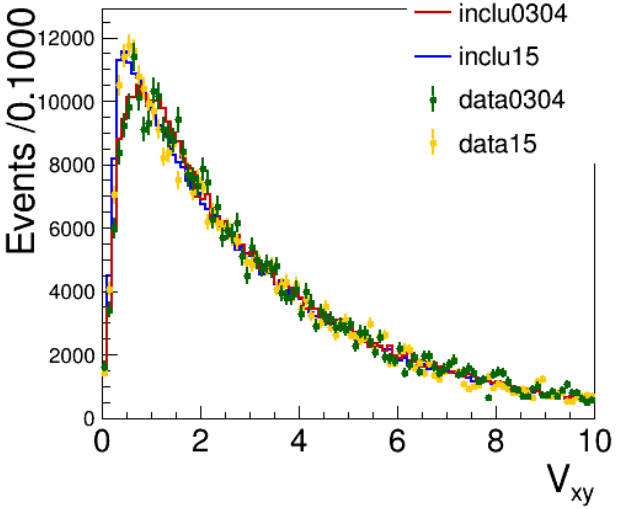
$0.2 \le P_{K^0_S} \le 0.4\ GeV/c^2$



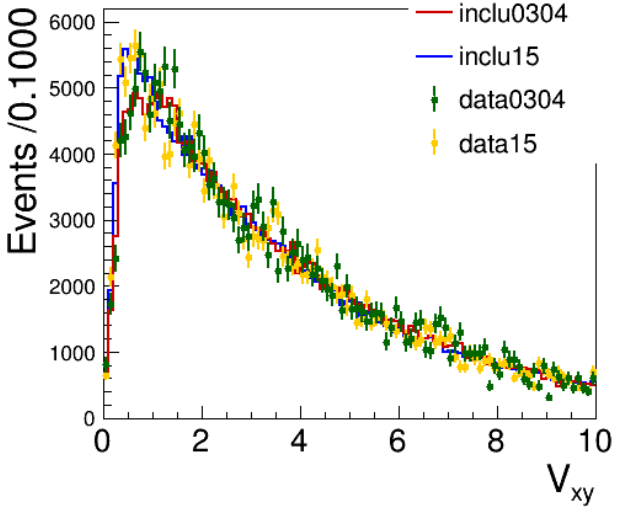
$0.4 \le P_{K^0_S} \le 0.6\ GeV/c^2$



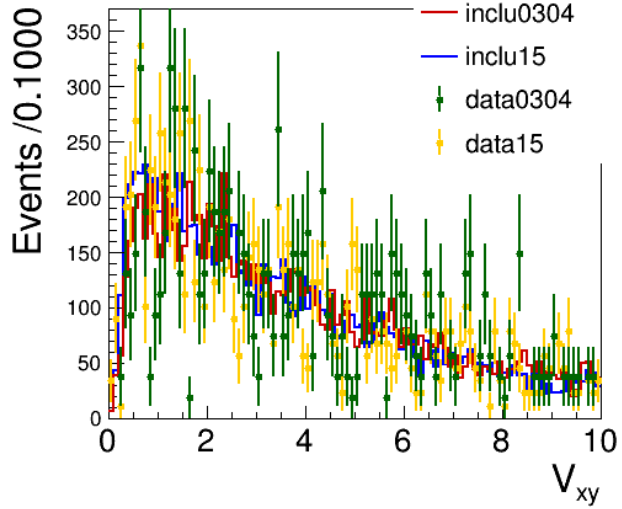
$0.6 \le P_{K^0_S} \le 0.8\ GeV/c^2$



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



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

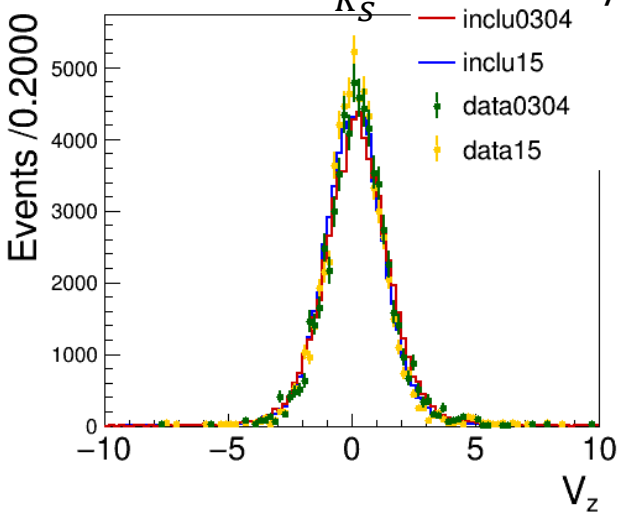


Refine Vertex Fit

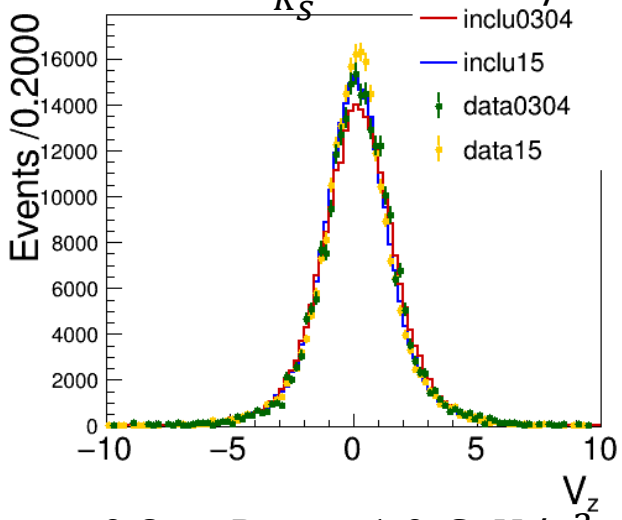
V_z

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

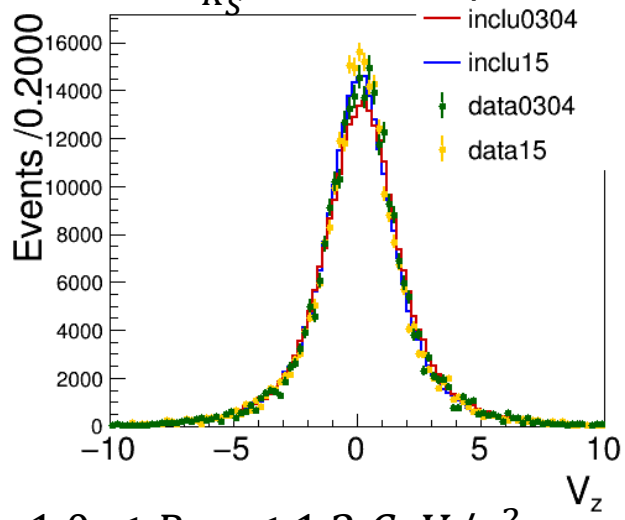
$0.0 \le P_{K^0_S} \le 0.2\ GeV/c^2$



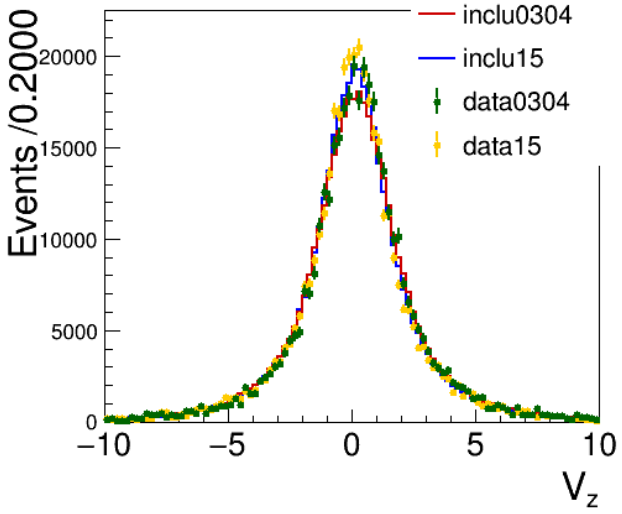
$0.2 \le P_{K^0_S} \le 0.4\ GeV/c^2$



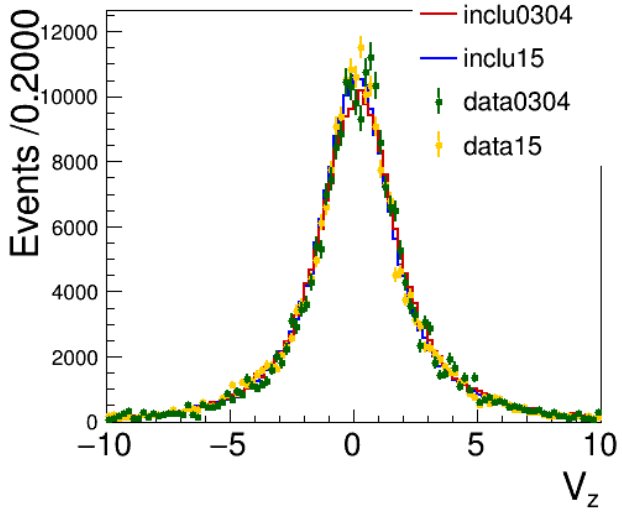
$0.4 \le P_{K^0_S} \le 0.6\ GeV/c^2$



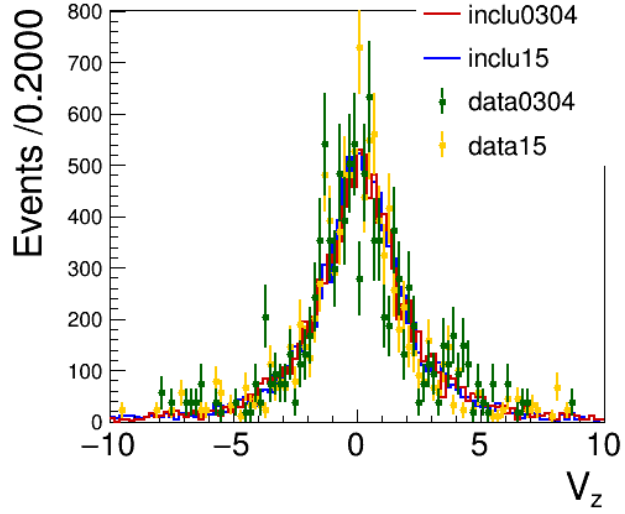
$0.6 \le P_{K^0_S} \le 0.8\ GeV/c^2$



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



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

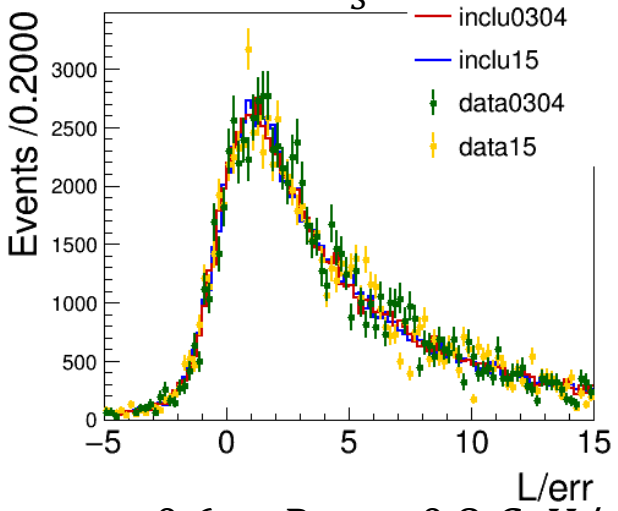


Refine Vertex Fit

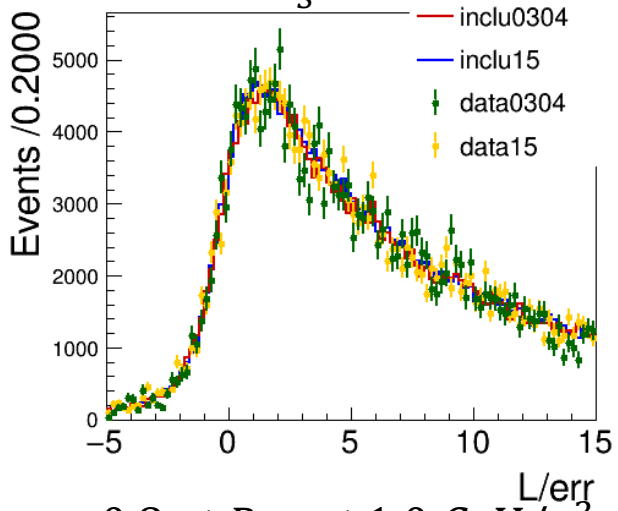
L/err

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

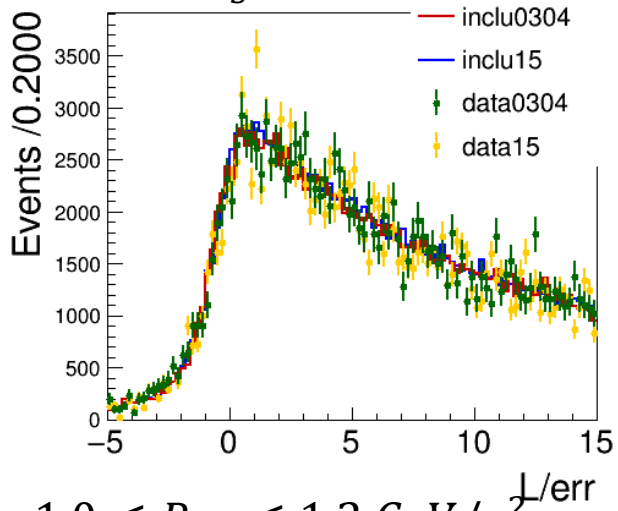
$0.0 \leq P_{K^0_S} \leq 0.2\ GeV/c^2$



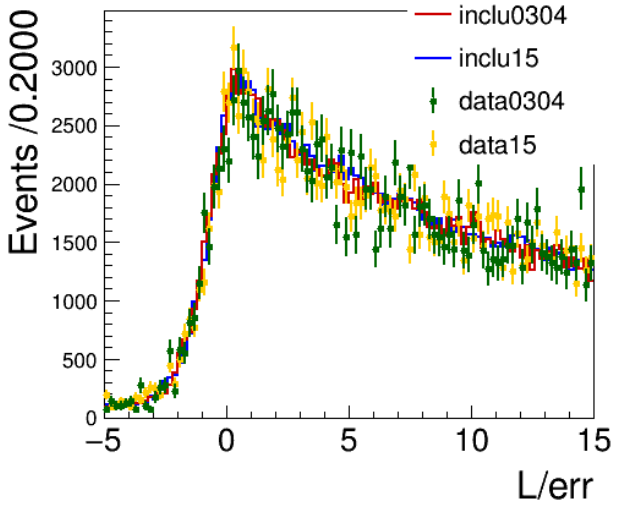
$0.2 \leq P_{K^0_S} \leq 0.4\ GeV/c^2$



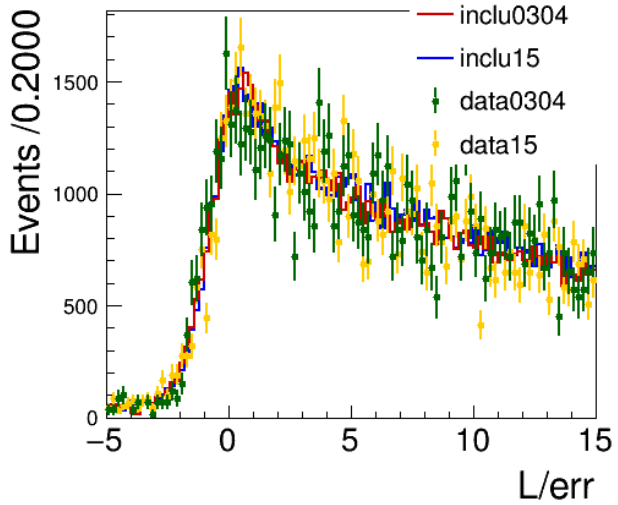
$0.4 \leq P_{K^0_S} \leq 0.6\ GeV/c^2$



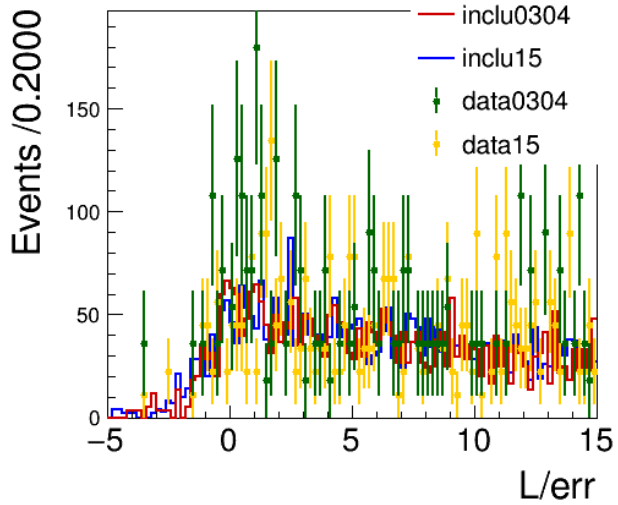
$0.6 \leq P_{K^0_S} \leq 0.8\ GeV/c^2$



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



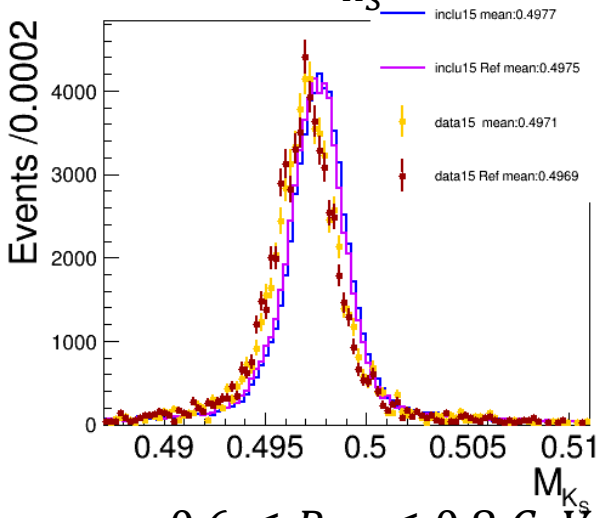
$1.0 \leq P_{K^0_S} \leq 1.2\ GeV/c^2$



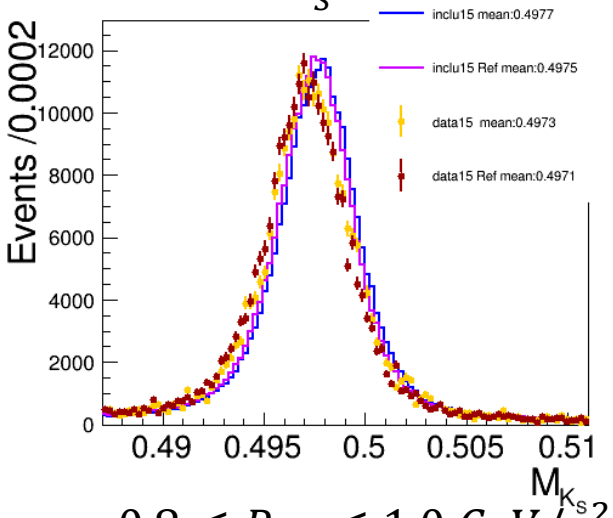
Vertex fit with Refine Vertex fit

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

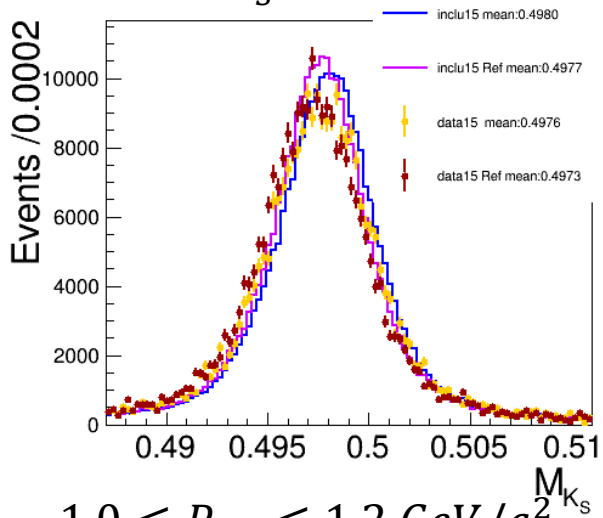
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



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

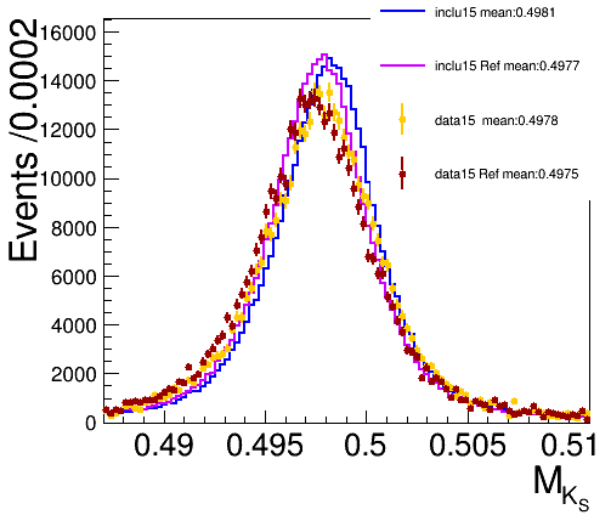


$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$

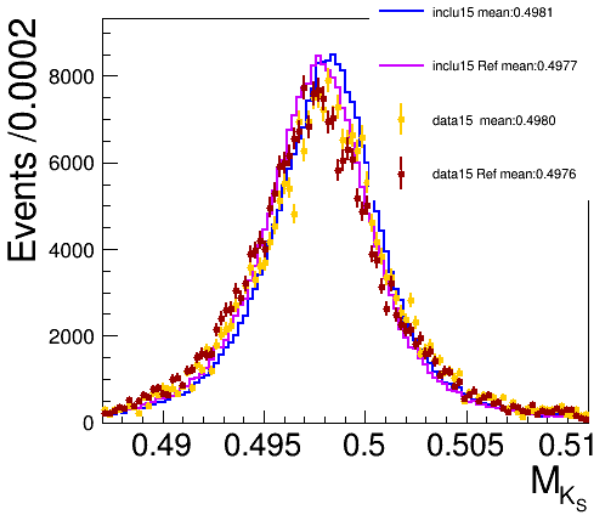


inclu15
inclu15 Ref
data15
data15 Ref

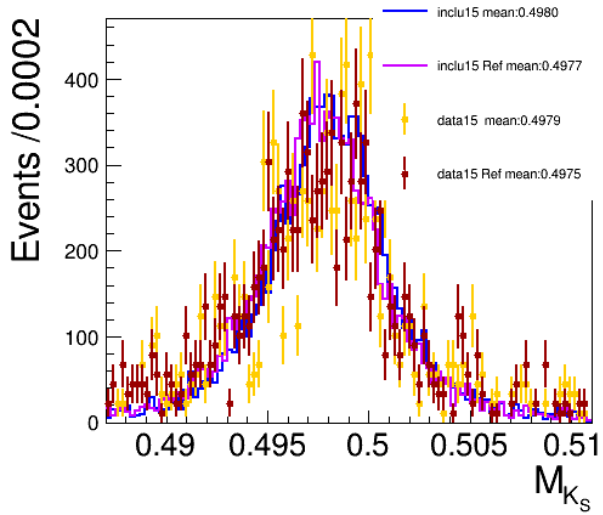
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



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

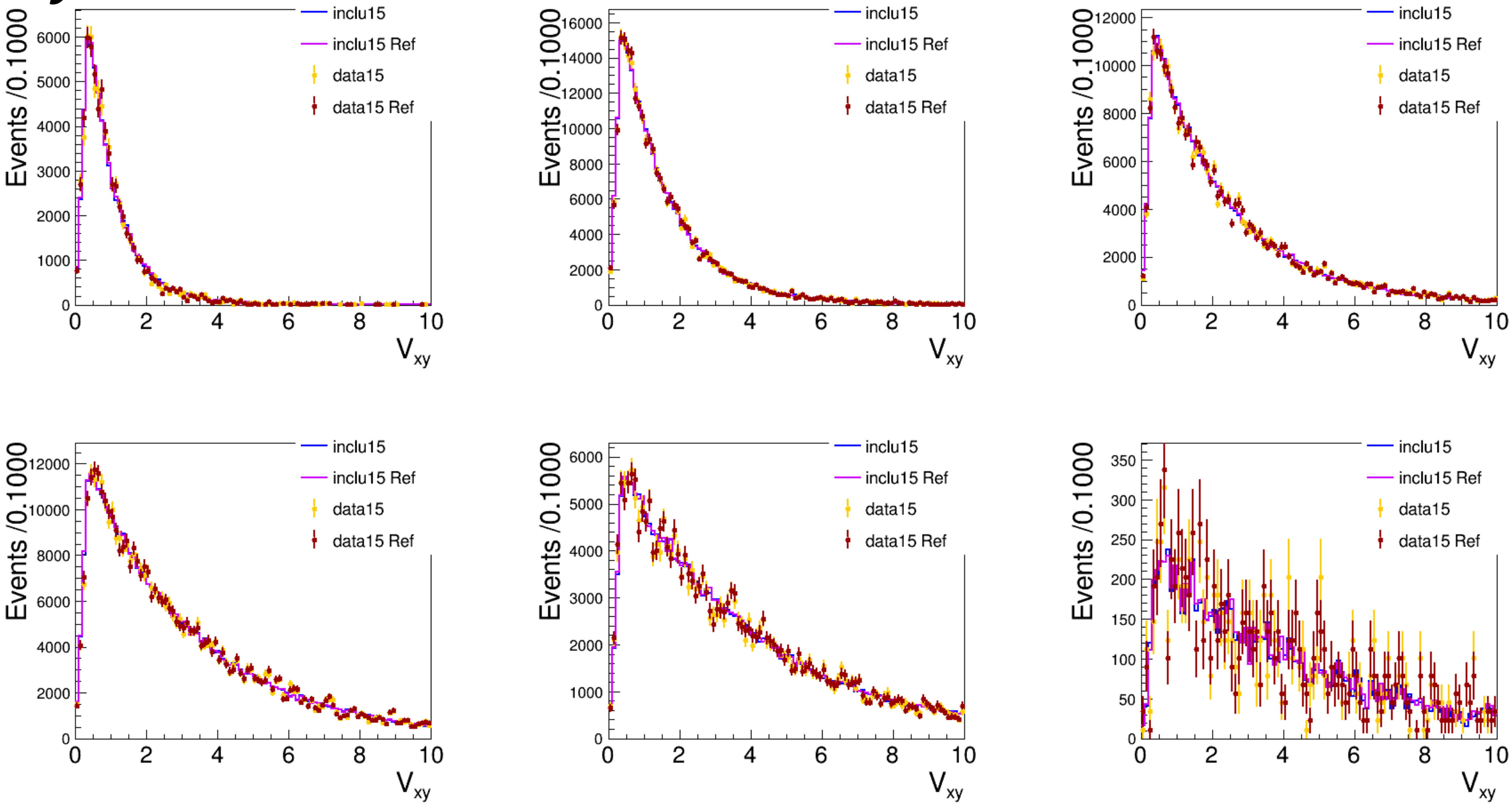


$1.0 \leq P_{K_S^0} \leq 1.2\ GeV/c^2$



V_{xy}

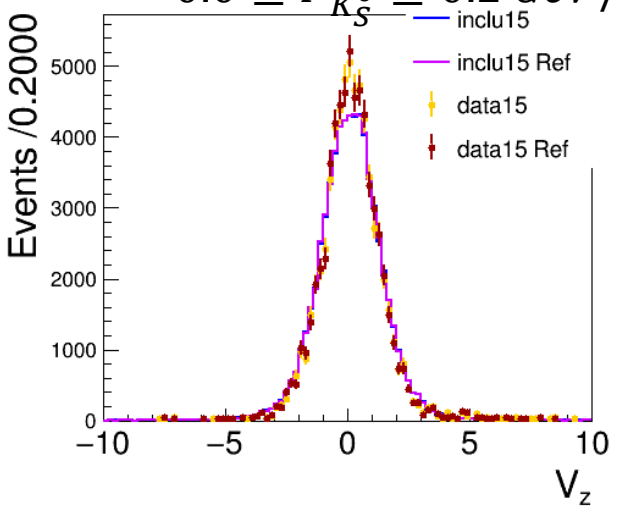
$$\chi^2_{1st}\&\chi^2_{2rd} < 200 \;\; 0.511 > M_{K_s} > 0.487 \; L/err > 2$$



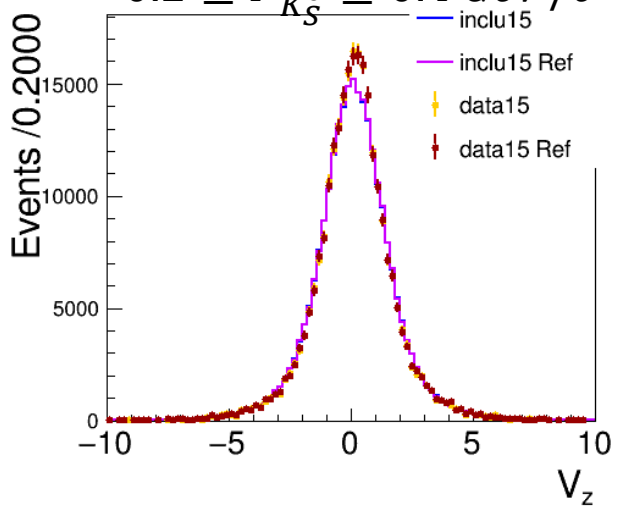
V_z

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

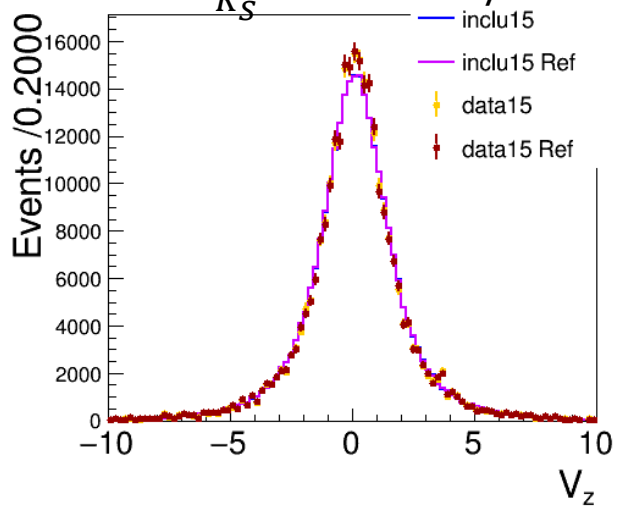
$0.0 \leq P_{K^0_S} \leq 0.2 \; GeV/c^2$



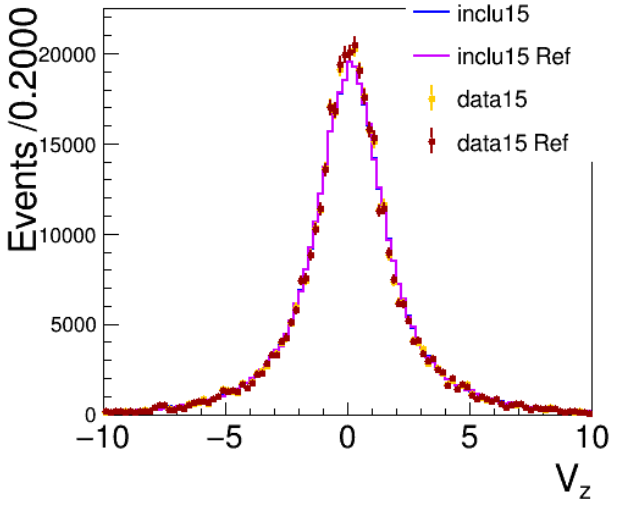
$0.2 \leq P_{K^0_S} \leq 0.4 \; GeV/c^2$



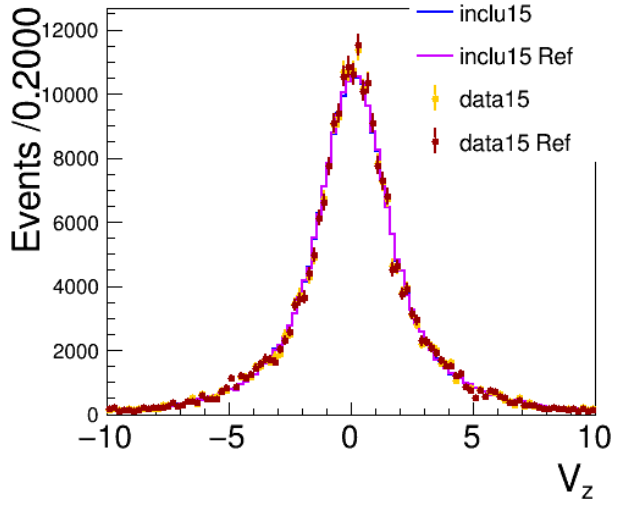
$0.4 \leq P_{K^0_S} \leq 0.6 \; GeV/c^2$



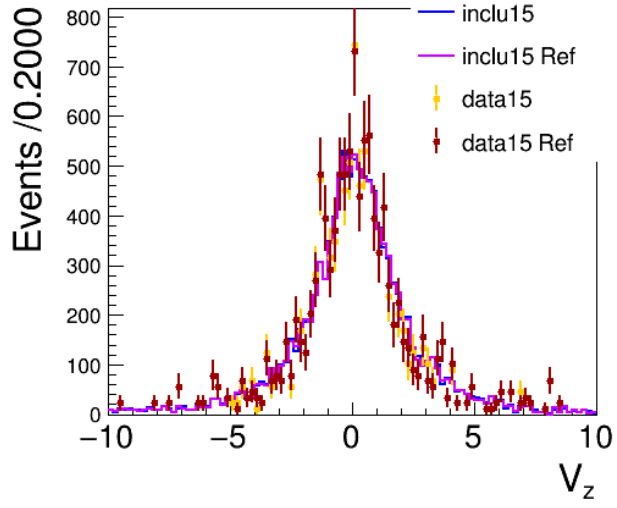
$0.6 \leq P_{K^0_S} \leq 0.8 \; GeV/c^2$



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



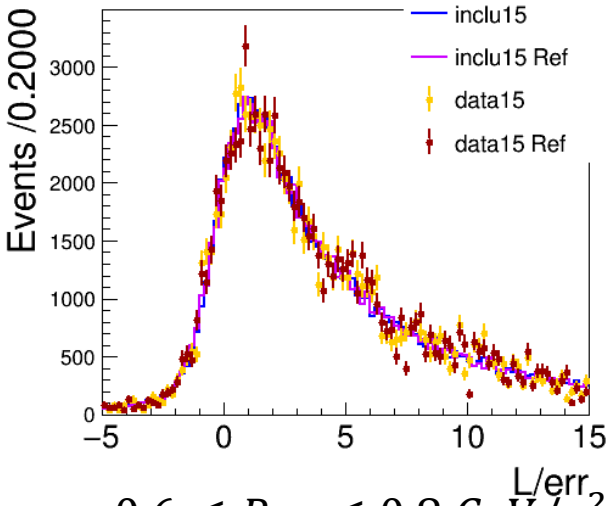
$1.0 \leq P_{K^0_S} \leq 1.2 \; GeV/c^2$



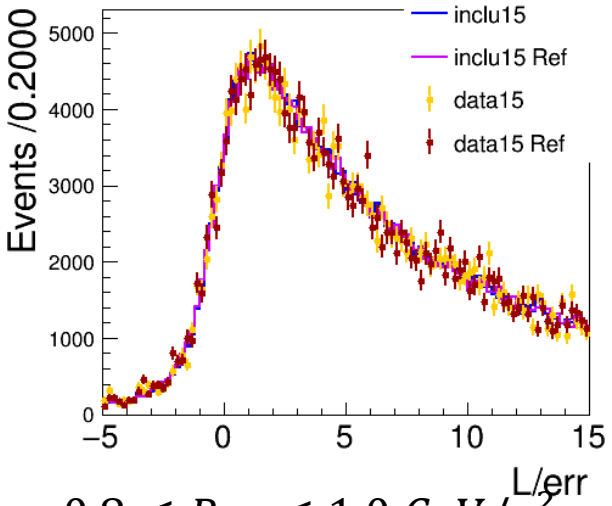
$\chi^2_{1st}\&\chi^2_{2rd} < 200 \;\; 0.511 > M_{K_s} > 0.487$

L/err

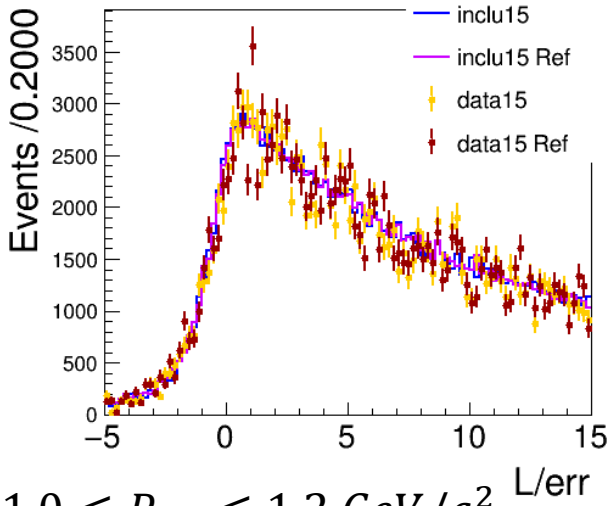
$0.0 \leq P_{K_S^0} \leq 0.2\ GeV/c^2$



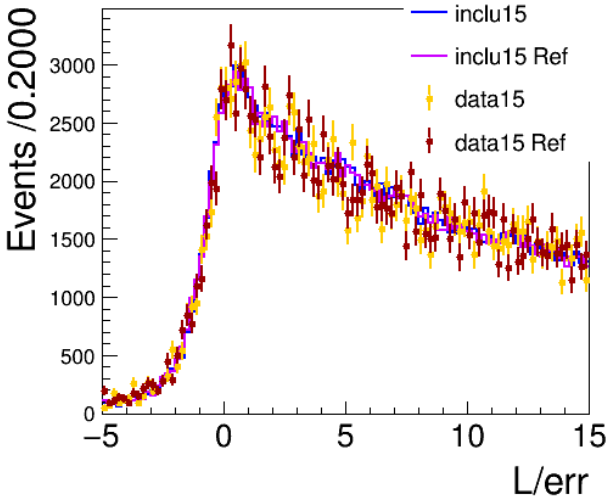
$0.2 \leq P_{K_S^0} \leq 0.4\ GeV/c^2$



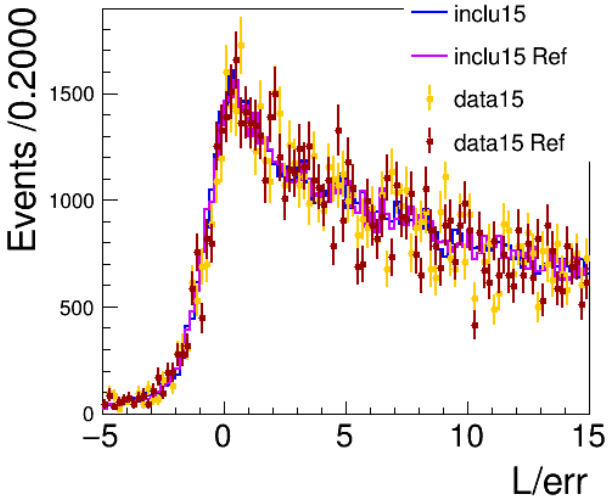
$0.4 \leq P_{K_S^0} \leq 0.6\ GeV/c^2$



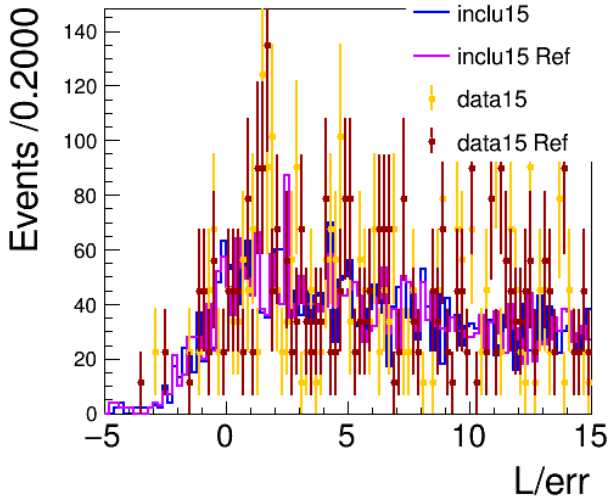
$0.6 \leq P_{K_S^0} \leq 0.8\ GeV/c^2$



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



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



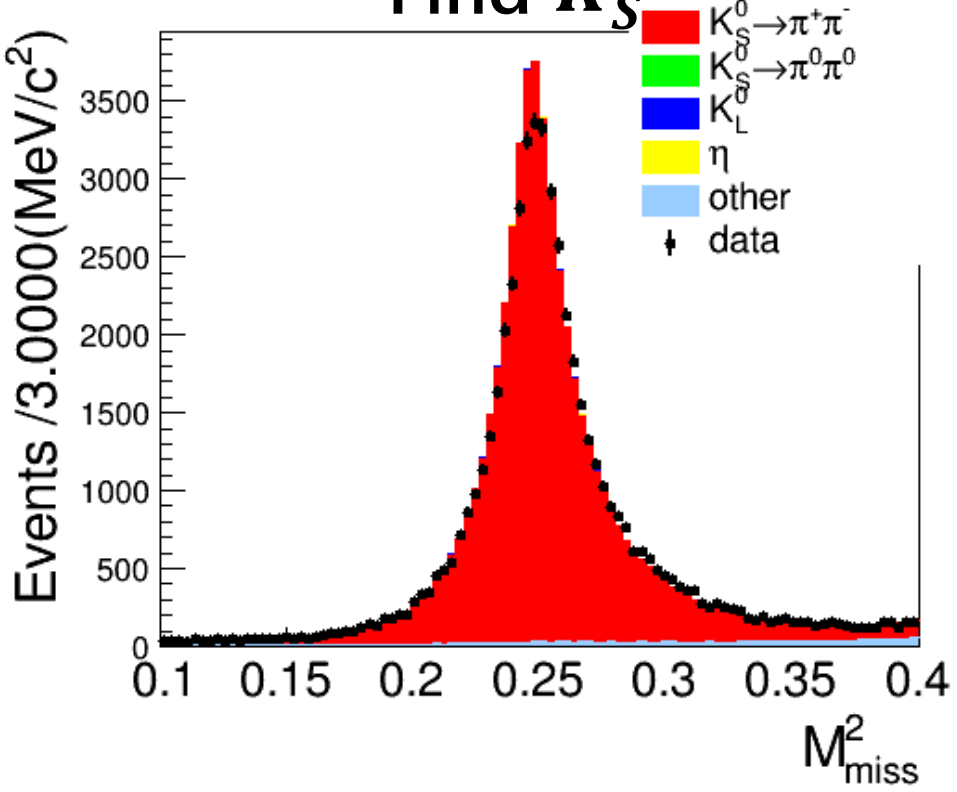
D^+D^- M^2_{miss}

Cut: $N_{extratrk} \leq 2$

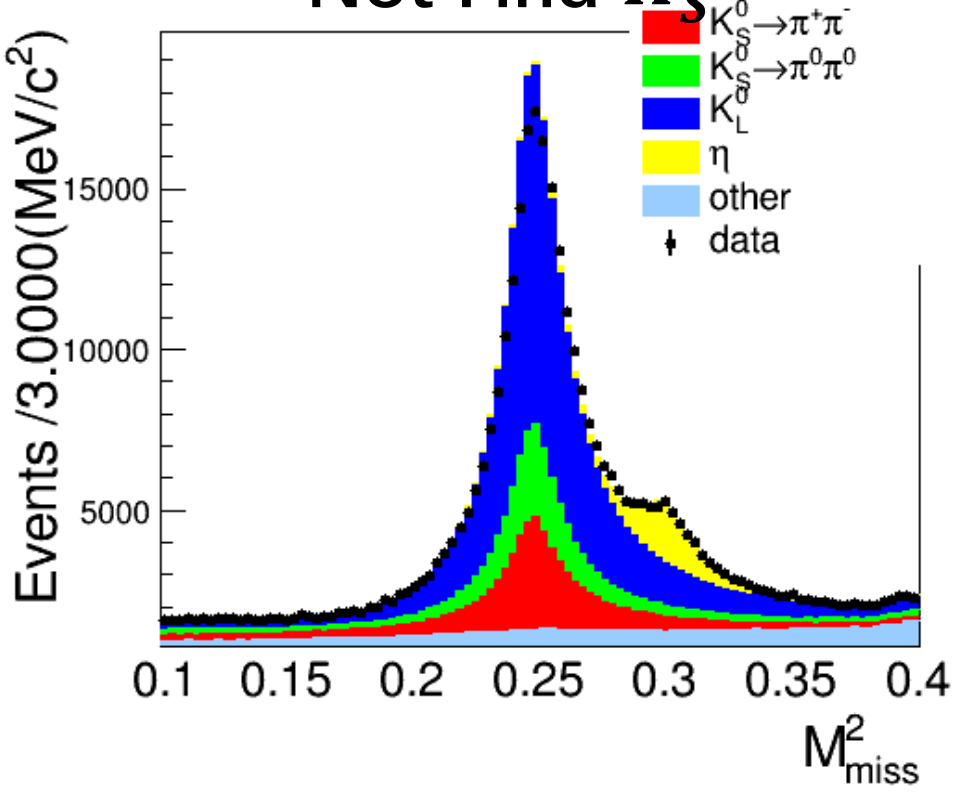
Find K^0_S: $0.511 > M_{K_s} > 0.487$ $L/err > 2$ $\chi^2_{1st}\&\chi^2_{2rd} < 200$

Not Find K^0_S: others

Find K^0_S

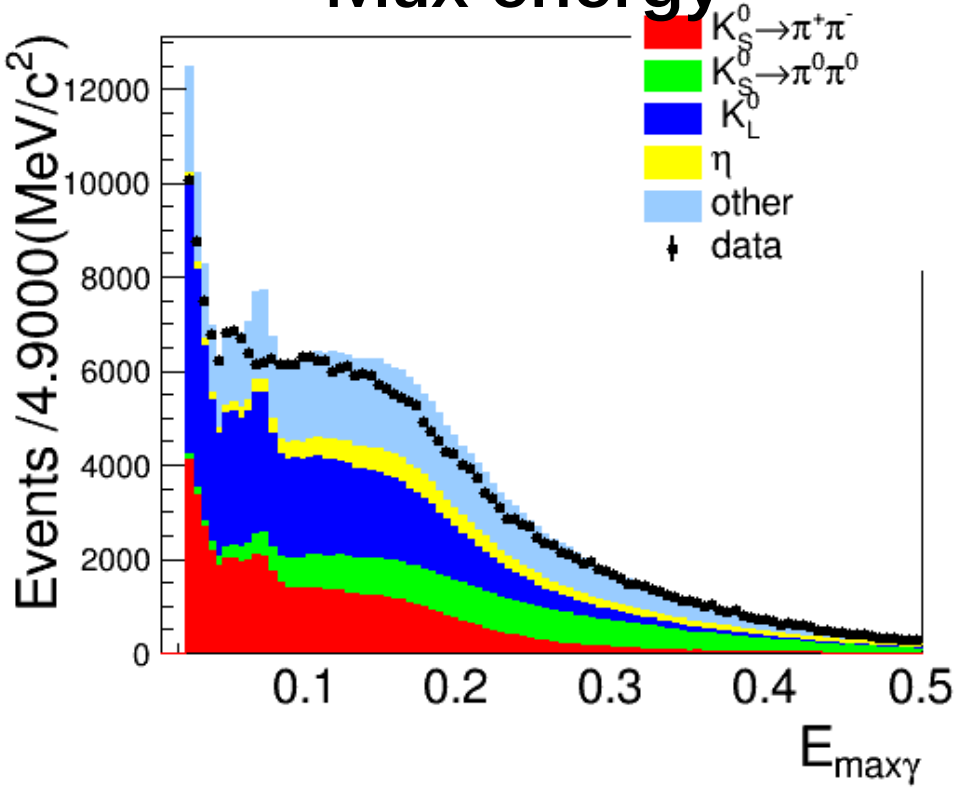


Not Find K^0_S

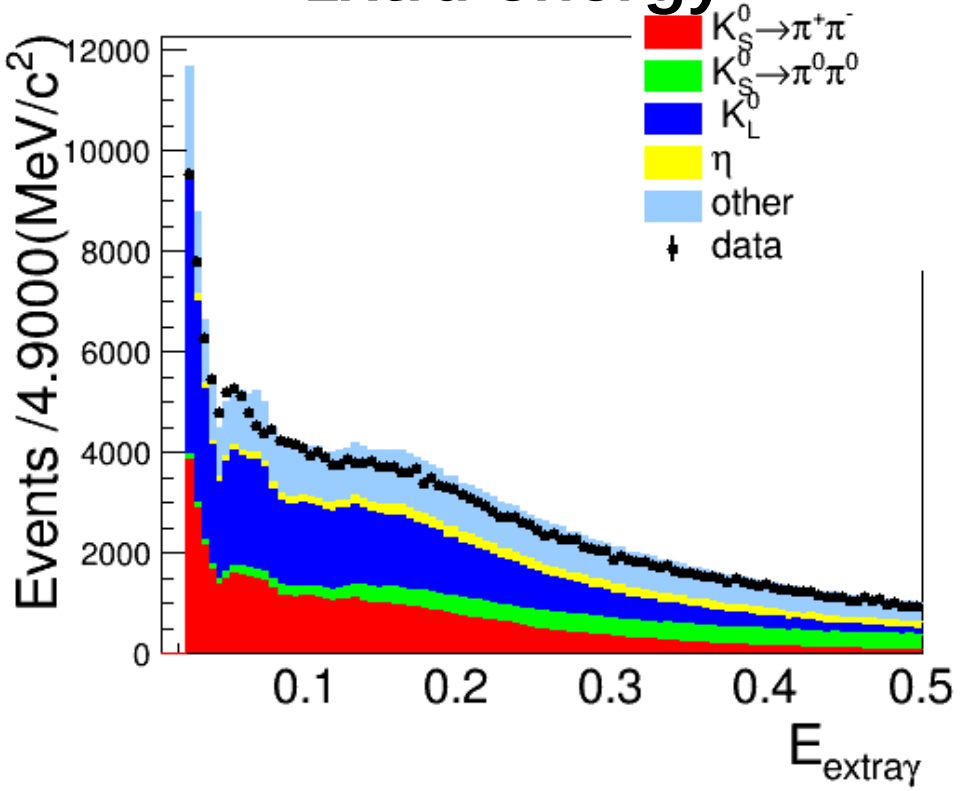


D^+D^- : Three channels

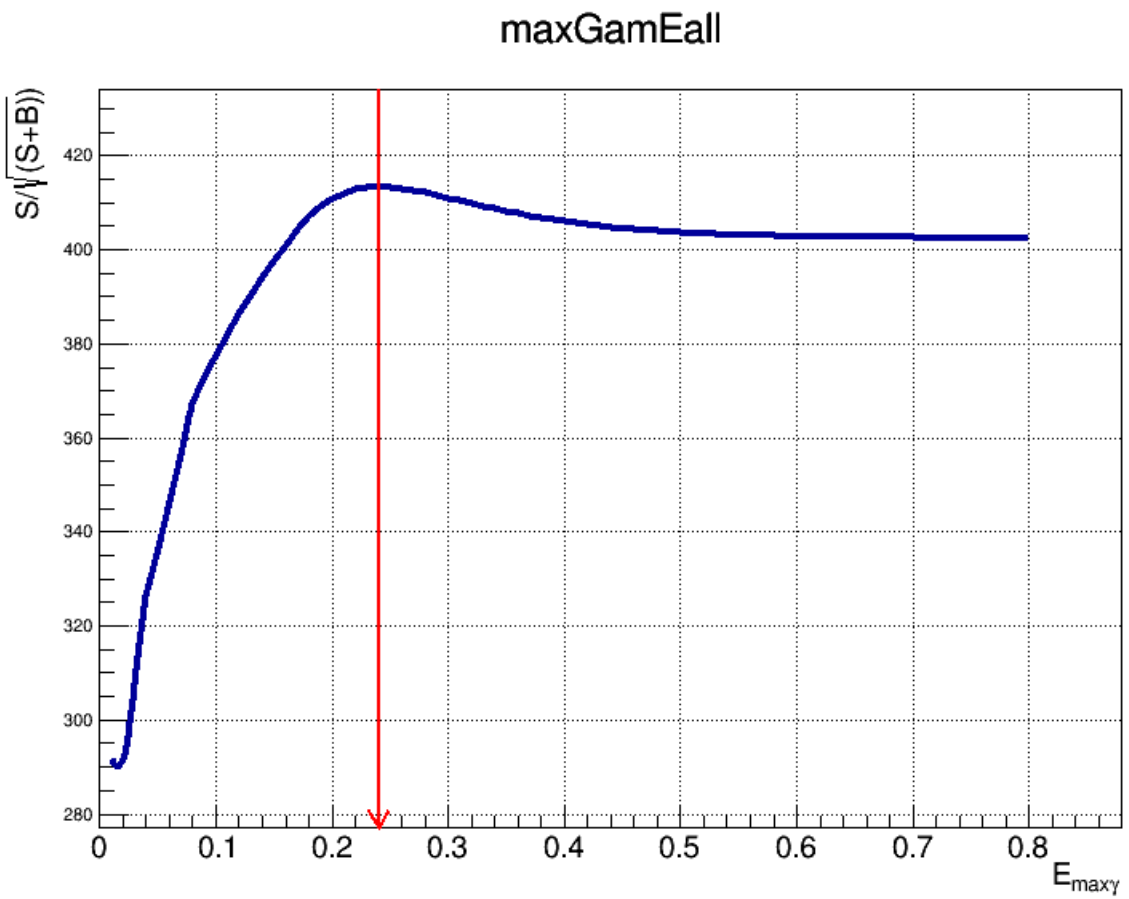
Max energy



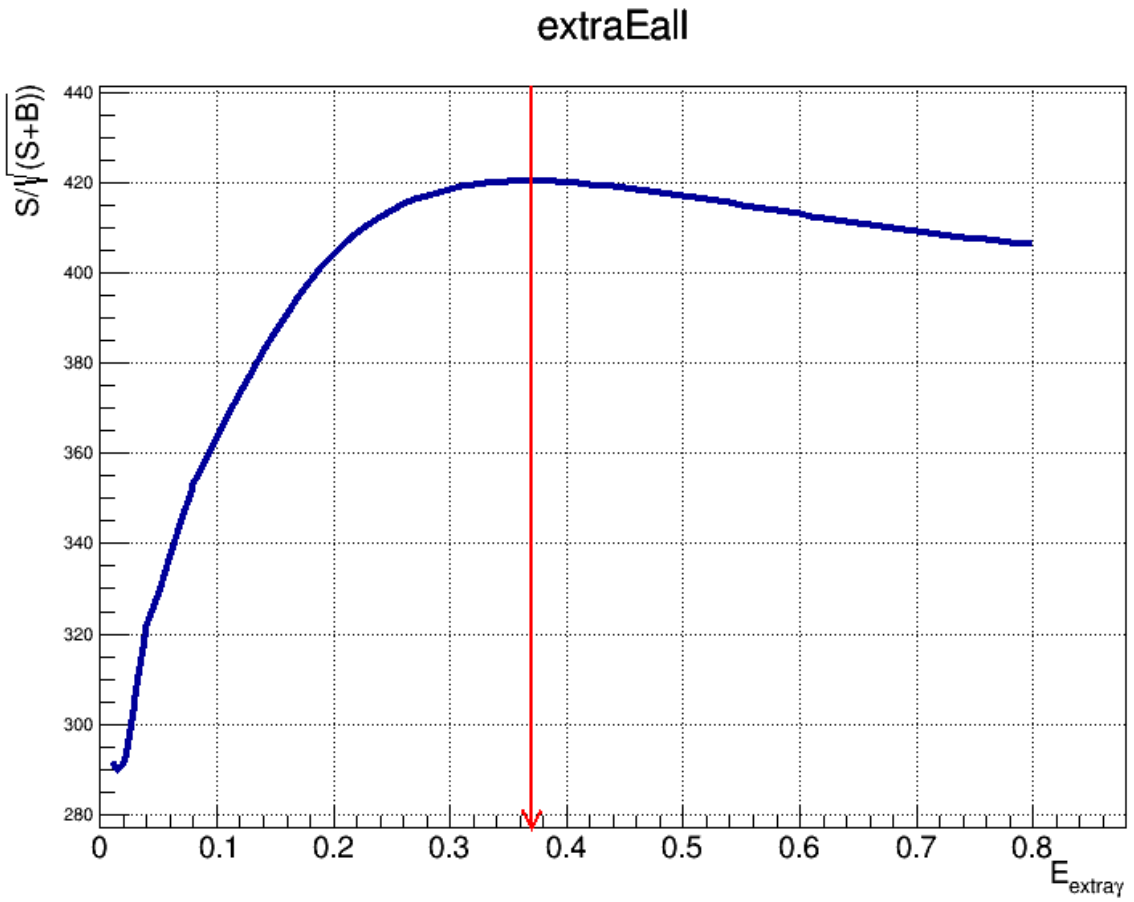
Extra energy



D^+D^- : Three channels



maxGamE cut with max value:0.24
efficiency:0.954 ;rejection:0.272



extraE cut with max value:0.37
efficiency:0.954 ;rejection:0.357

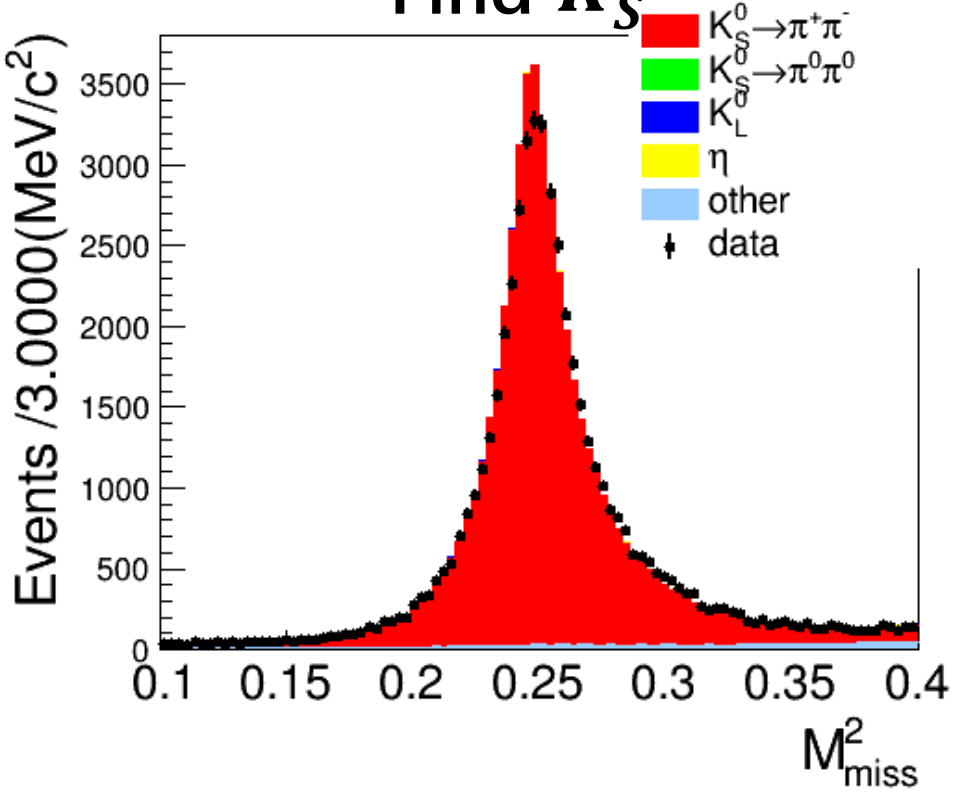
D^+D^- M^2_{miss}

Cut: $E_{extra\gamma} \leq 0.37GeV$

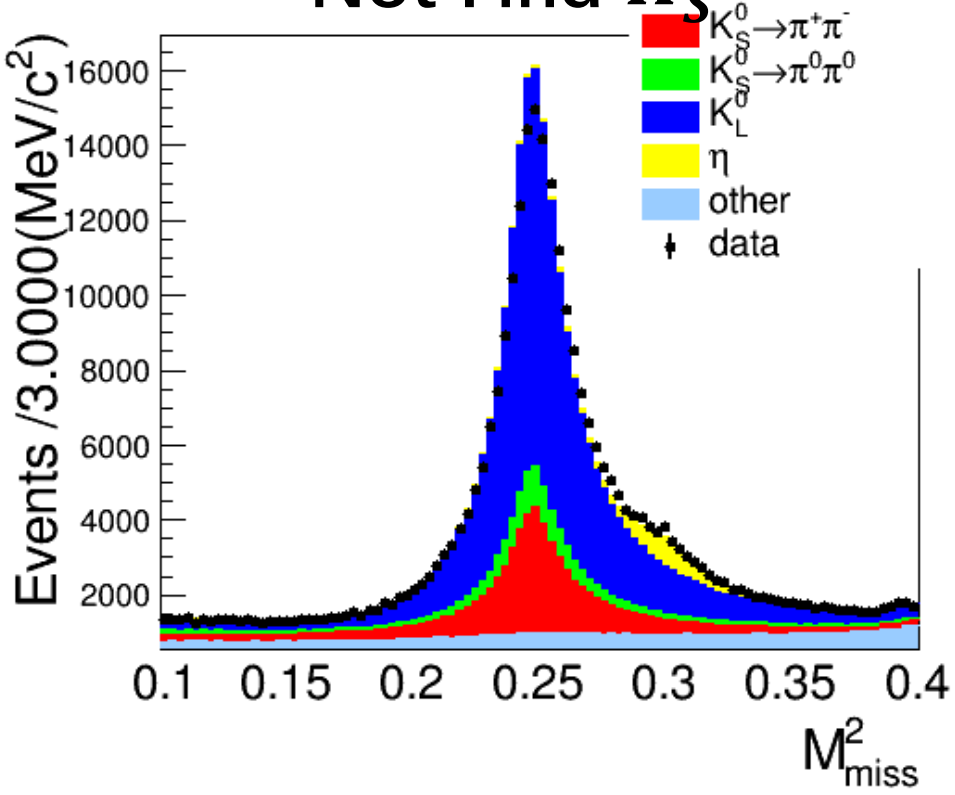
Find K^0_S: $0.511 > M_{K_s} > 0.487$ $L/err > 2$ $\chi^2_{1st}\&\chi^2_{2rd} < 200$

Not Find K^0_S: others

Find K^0_S

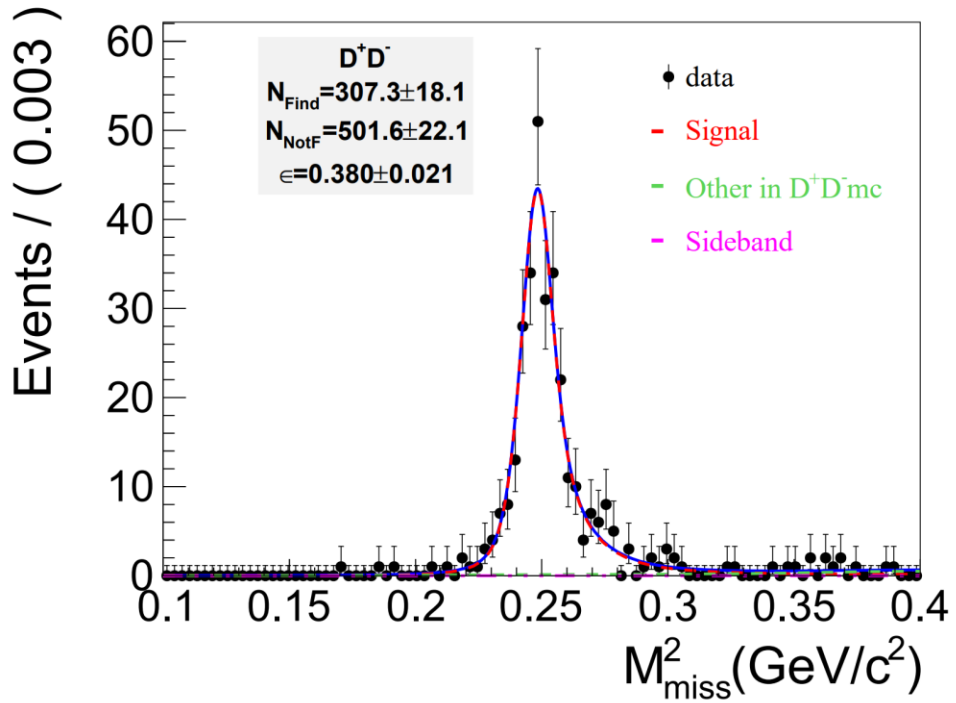


Not Find K^0_S

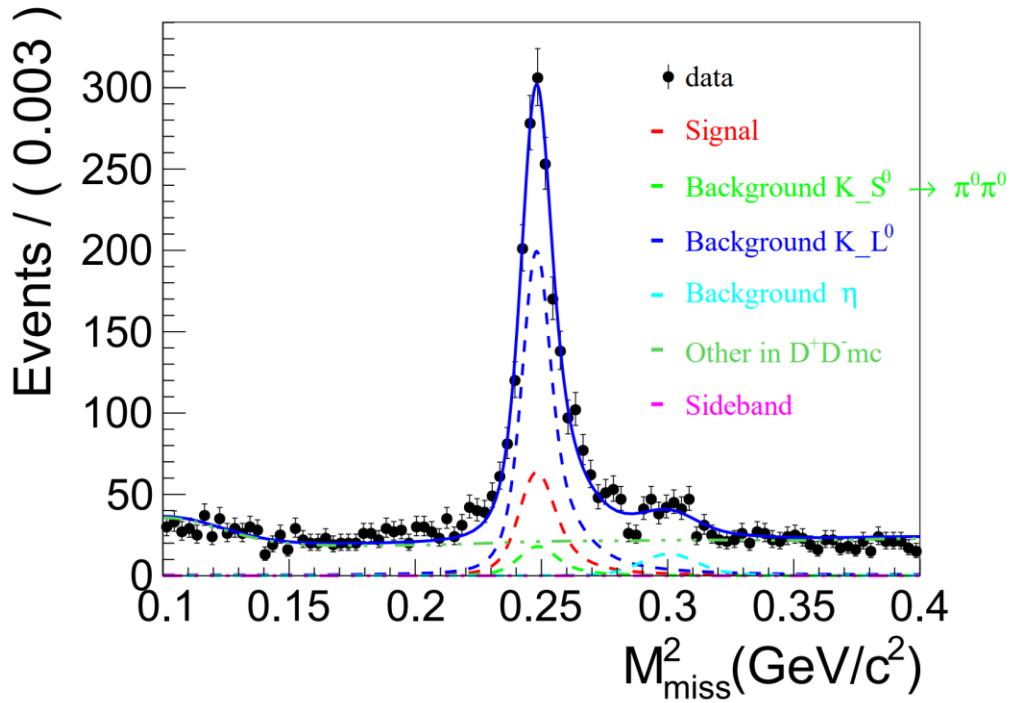


D^+D^- M^2_{miss}: $0 < P_{miss} < 0.2\ GeV/c$

Find K^0_S



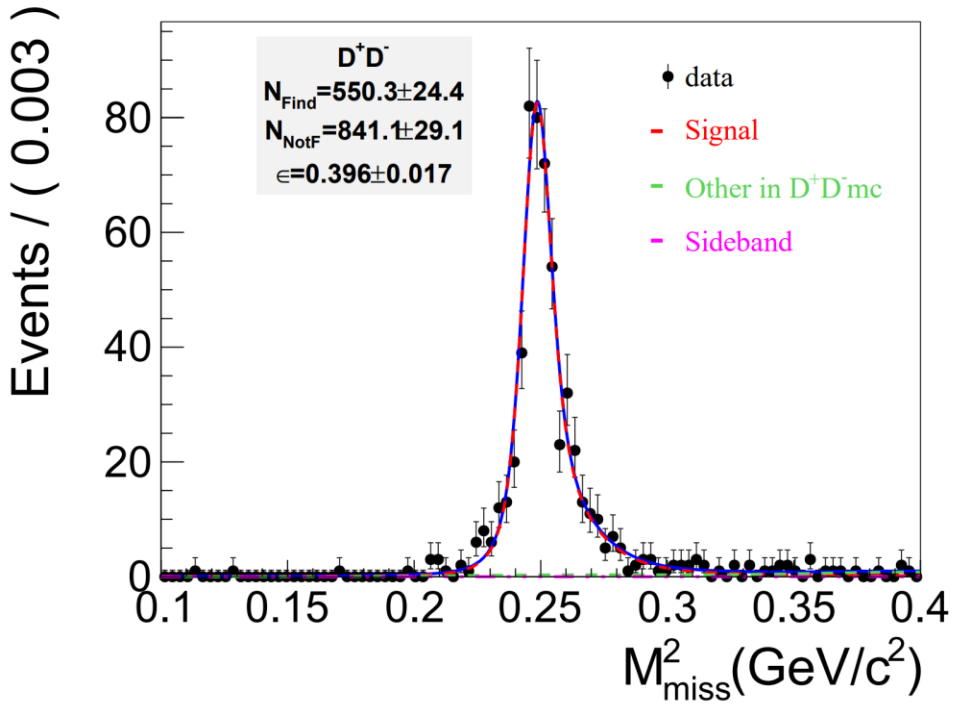
Not Find K^0_S



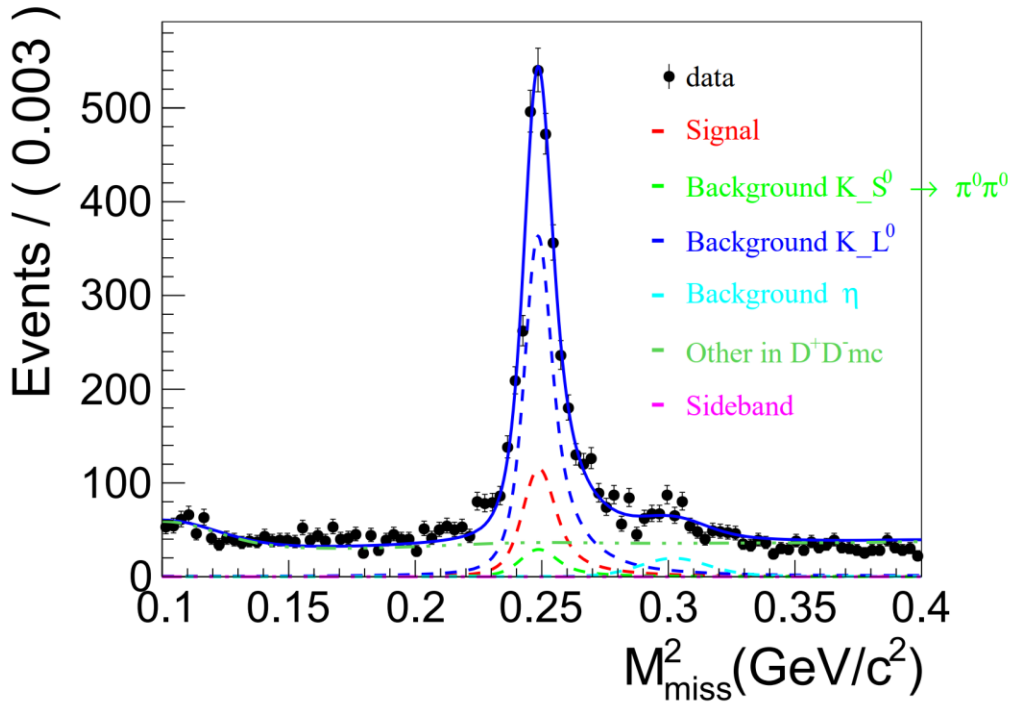
round0304

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

Find K^0_S



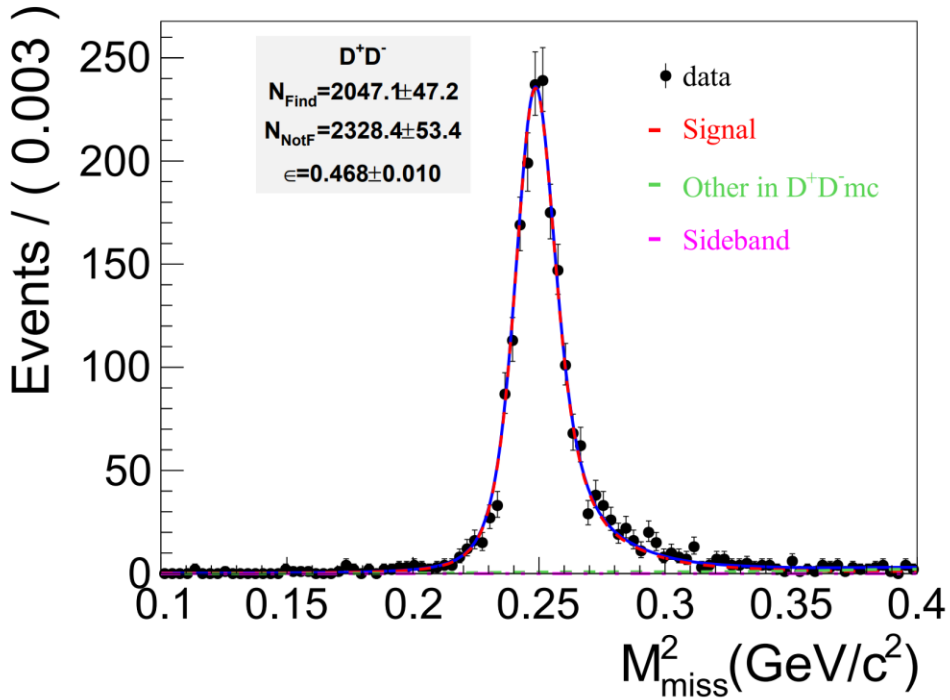
Not Find K^0_S



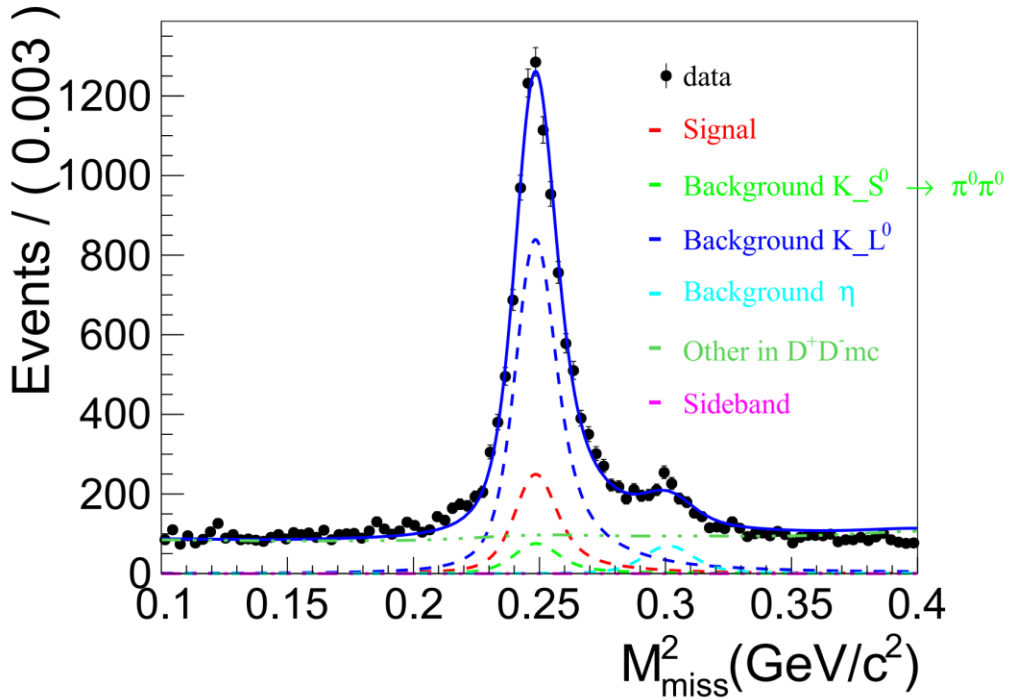
round15

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

Find K^0_S



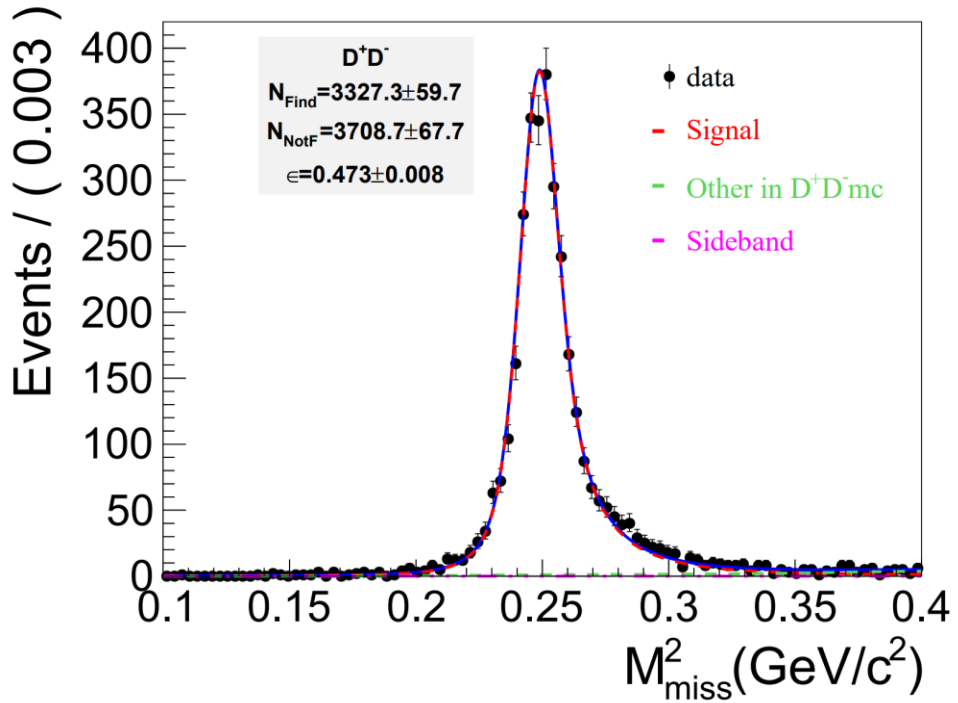
Not Find K^0_S



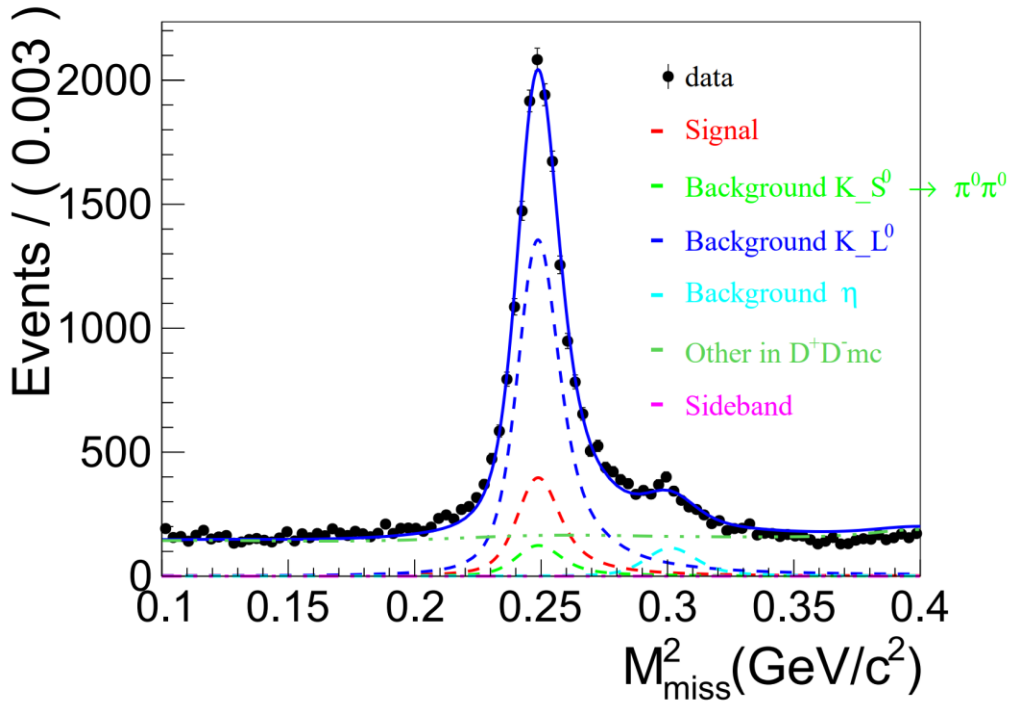
round0304

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

Find K^0_S



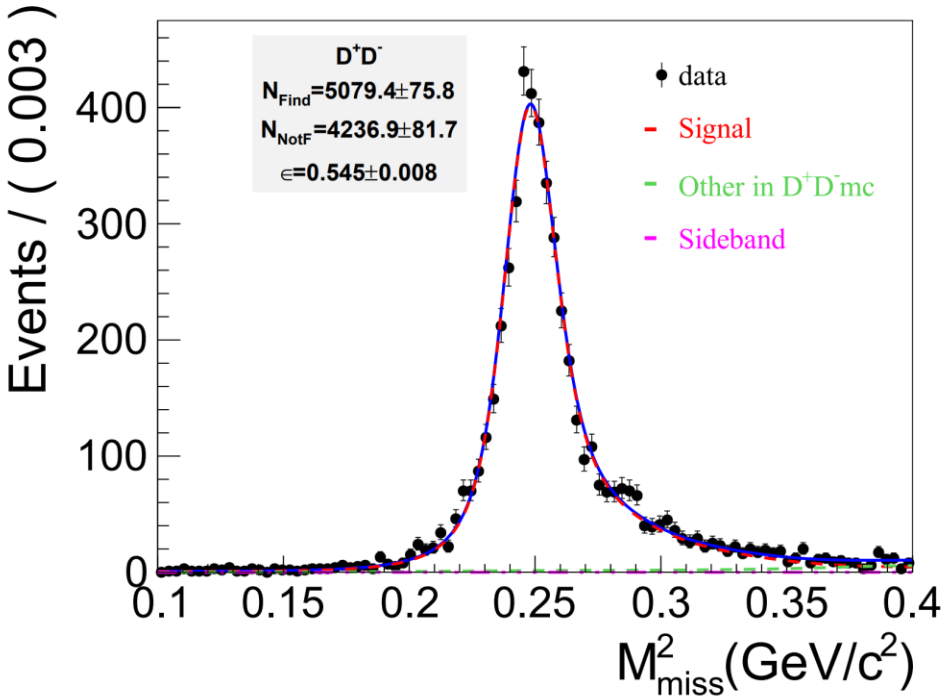
Not Find K^0_S



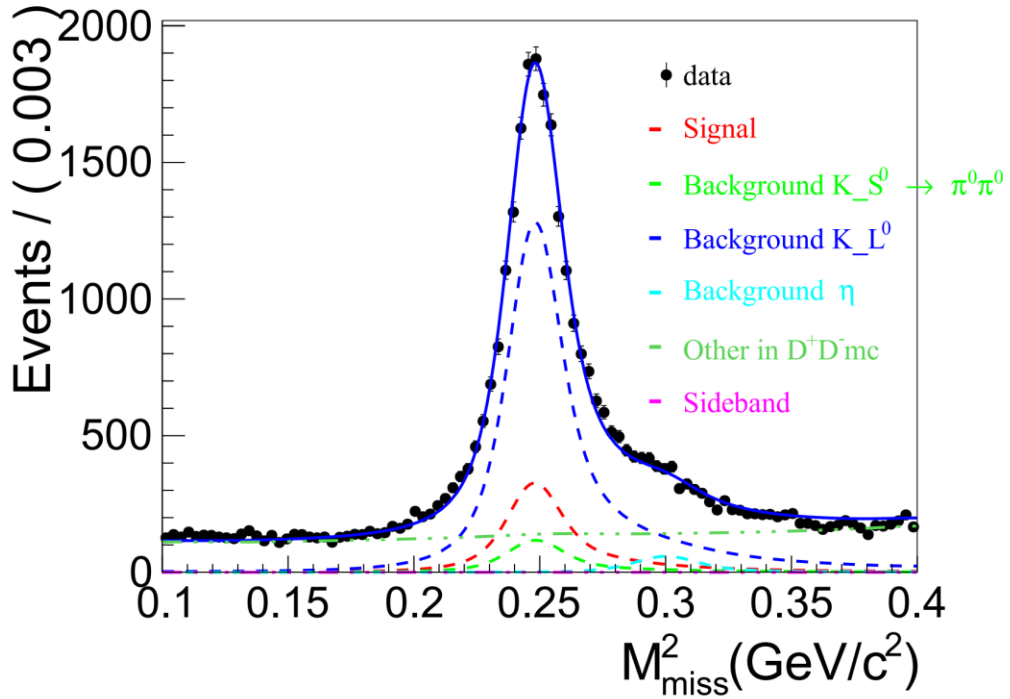
round15

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

Find K^0_S



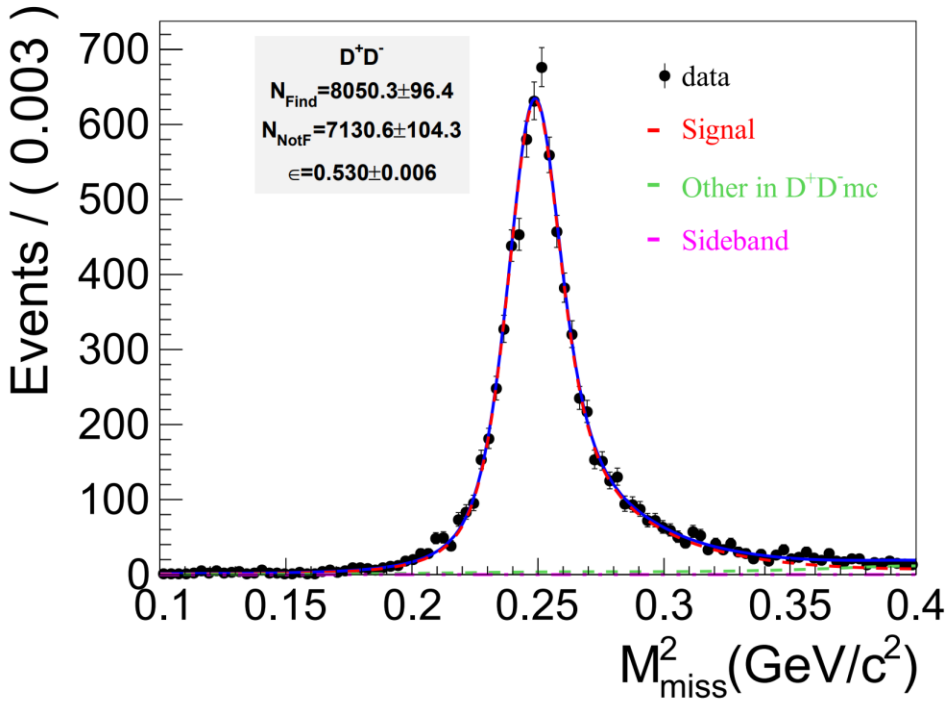
Not Find K^0_S



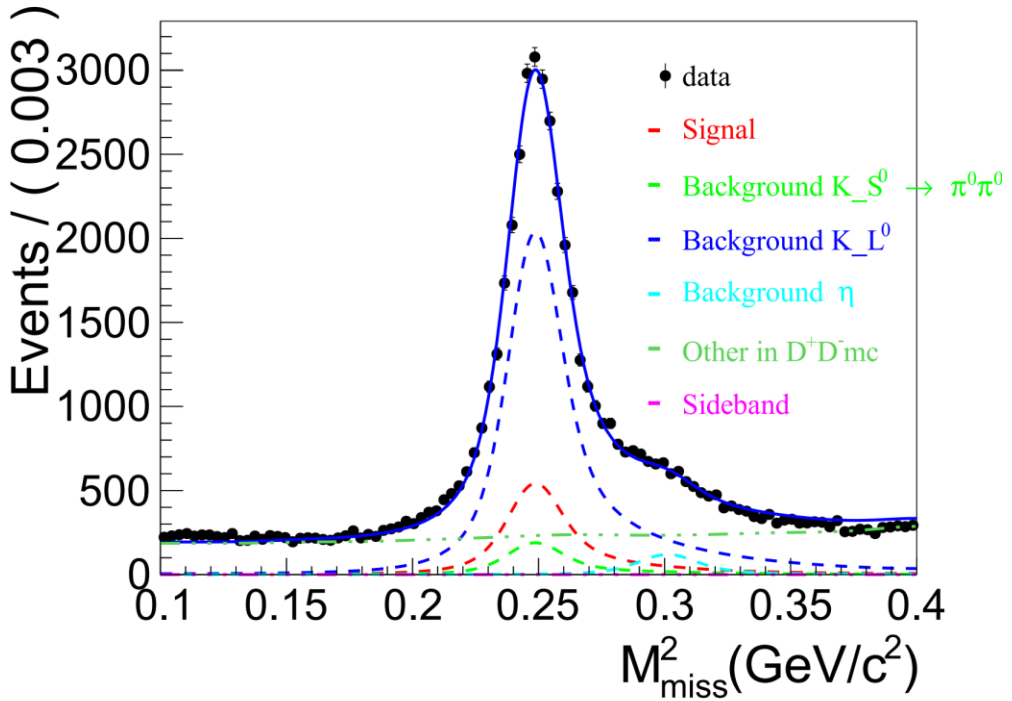
round0304

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

Find K^0_S



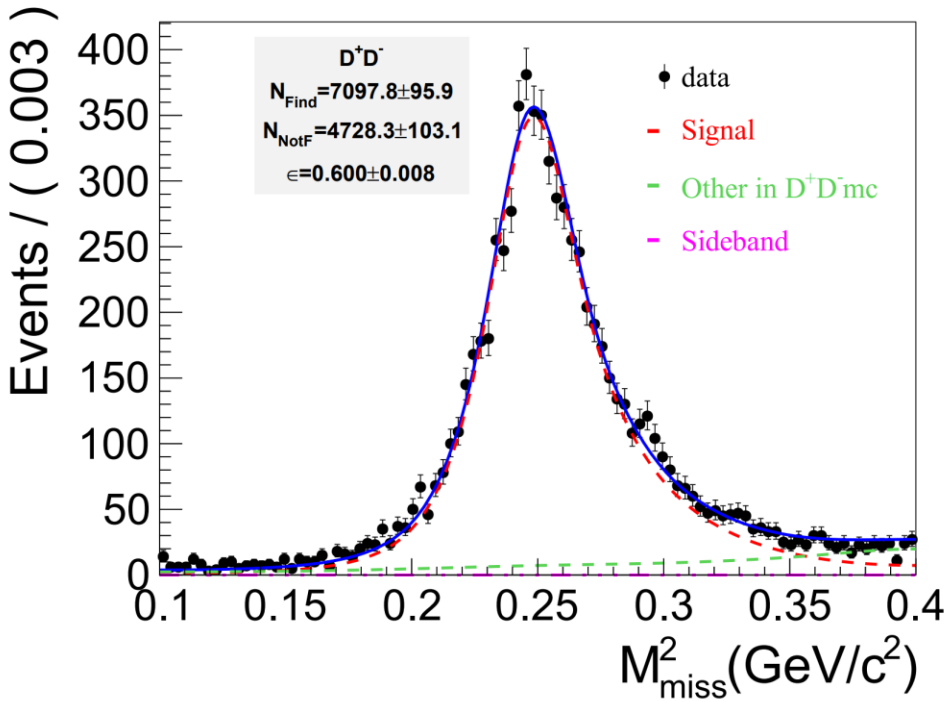
Not Find K^0_S



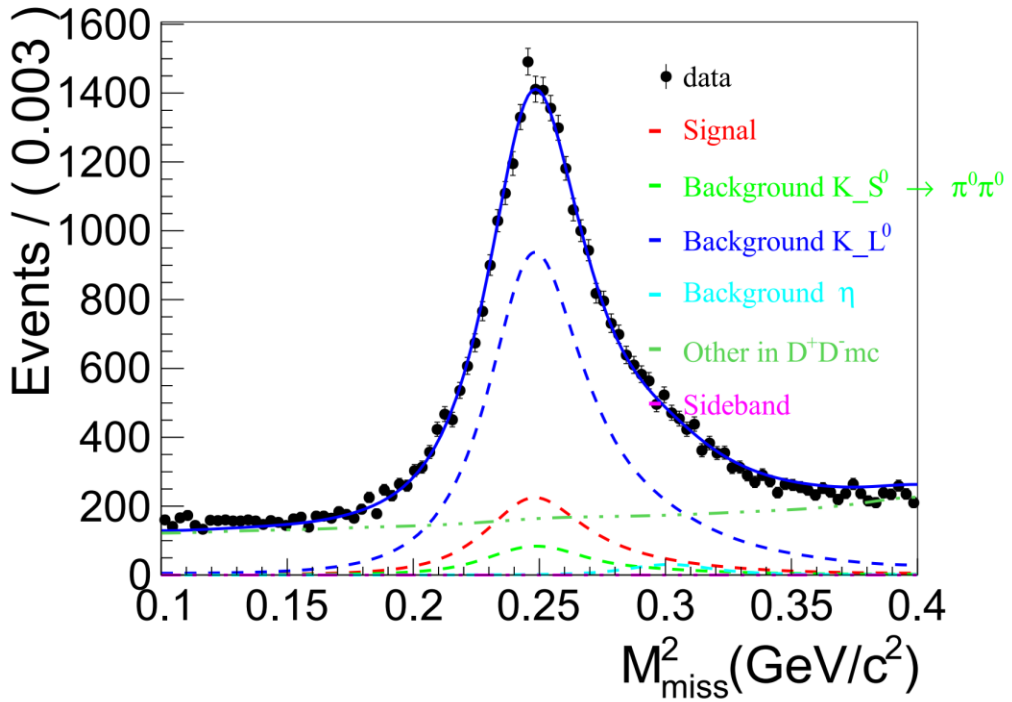
round15

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}: $0.6 < P_{miss} < 0.8\ GeV/c$

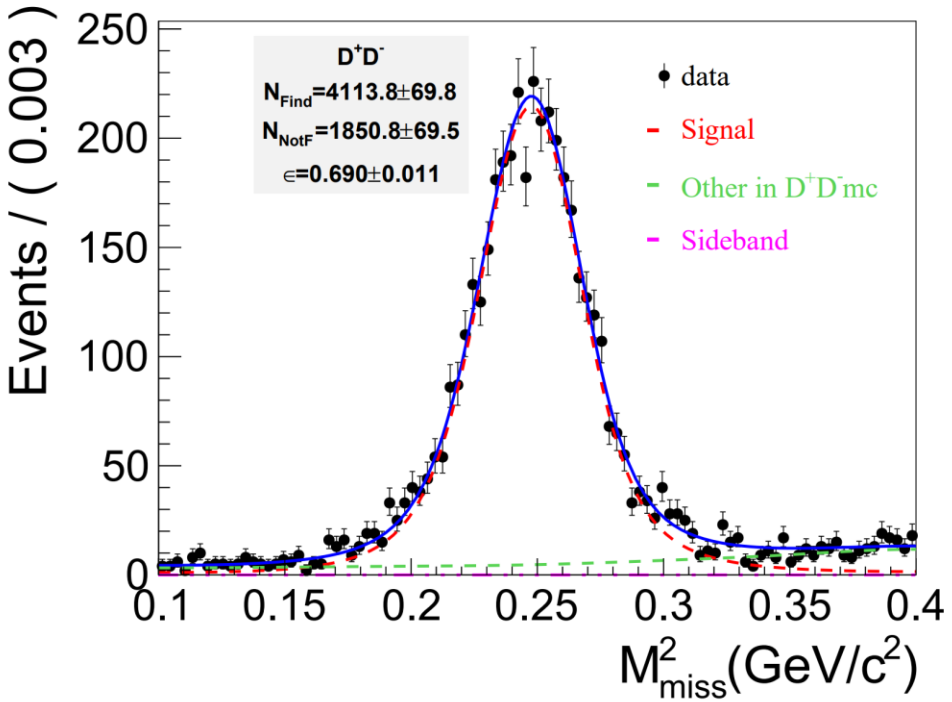
Find K^0_S

Not Find K^0_S

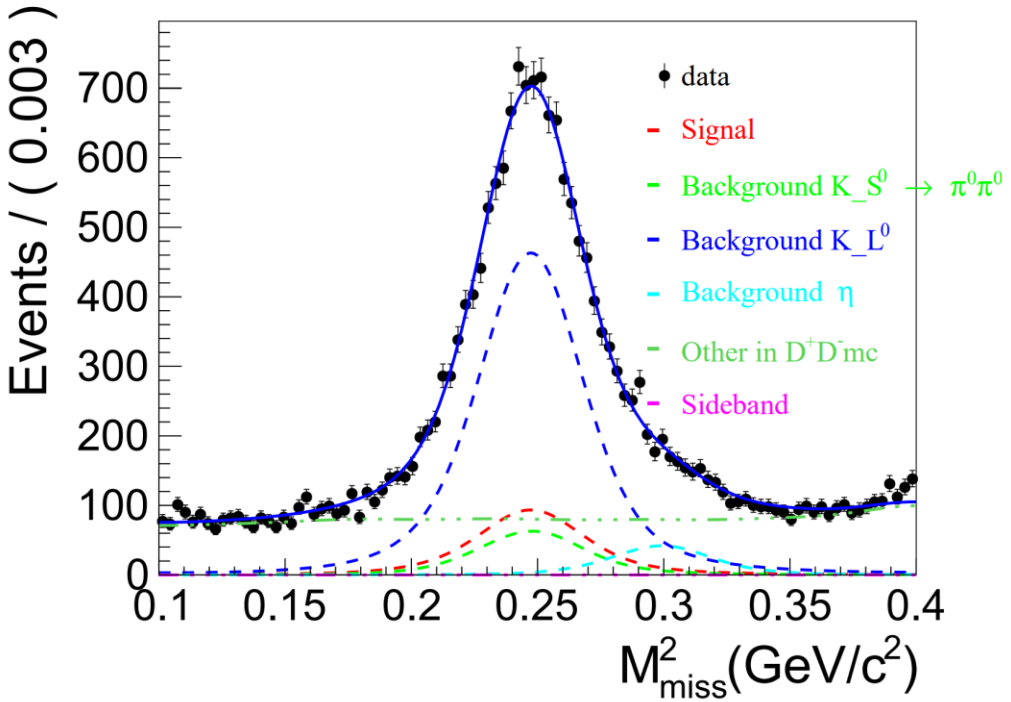
round15

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

Find K^0_S



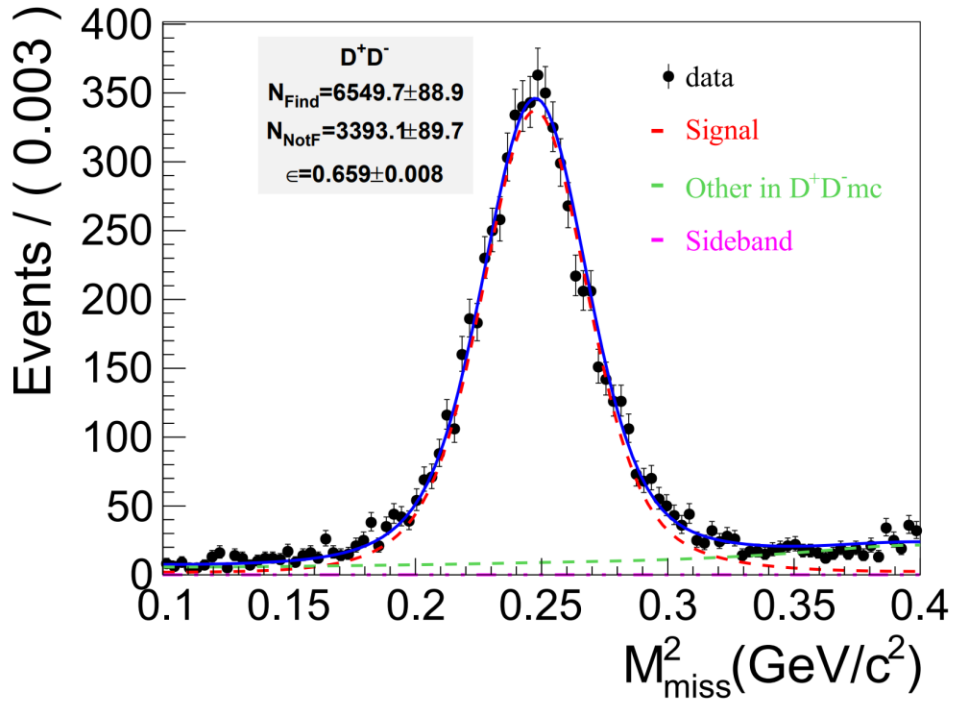
Not Find K^0_S



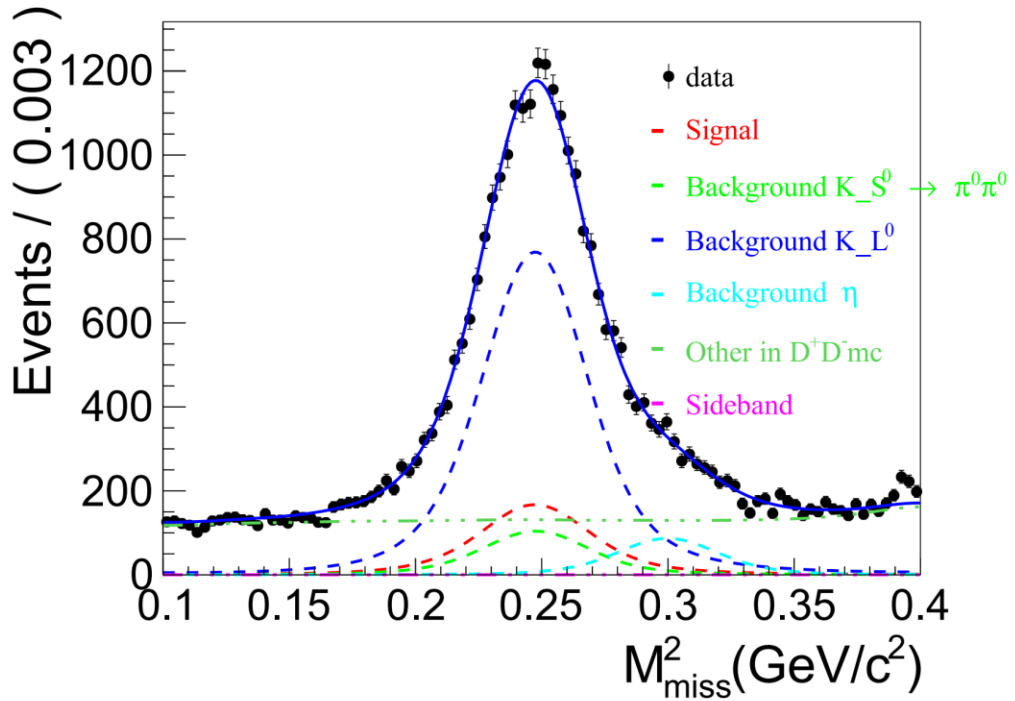
round0304

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

Find K^0_S



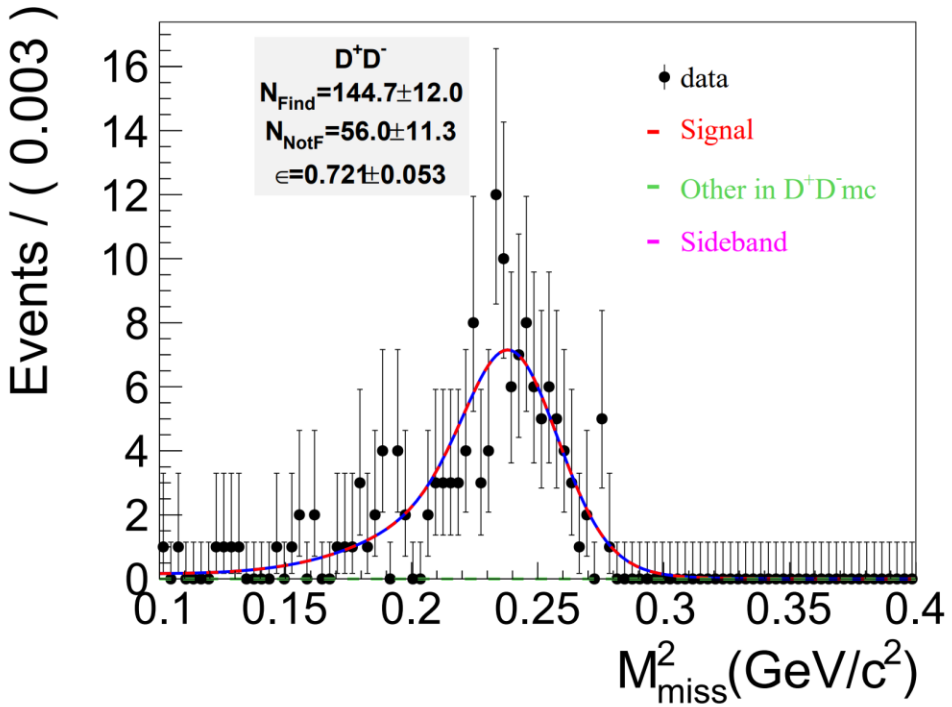
Not Find K^0_S



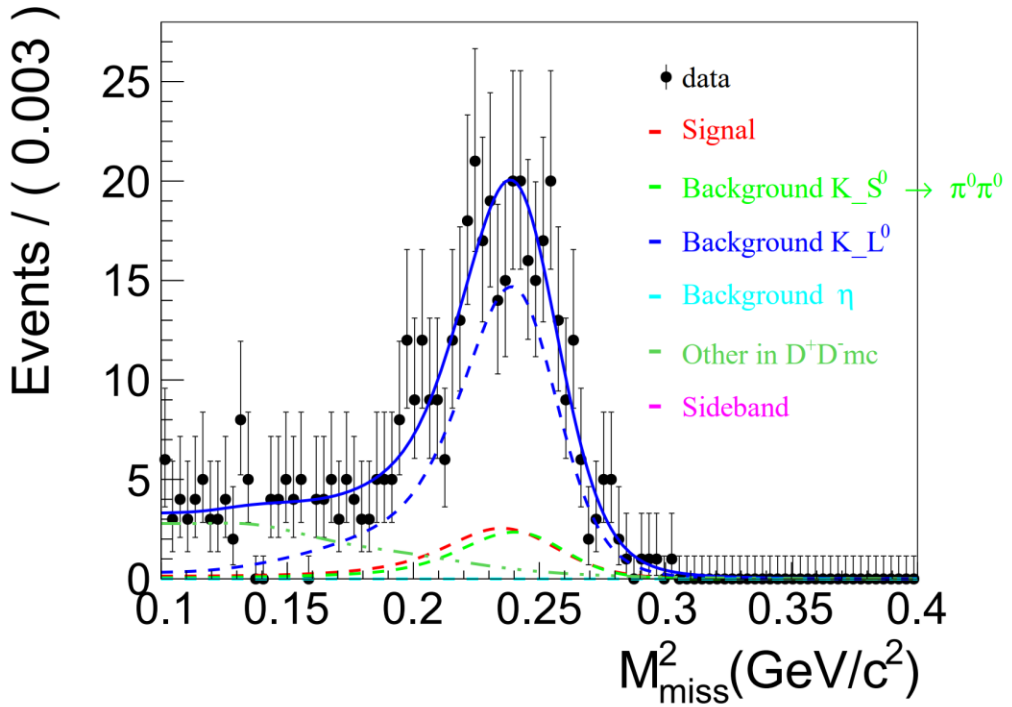
round15

D^+D^- M^2_{miss}: $1.0 < P_{miss} < 1.2\ GeV/c$

Find K^0_S



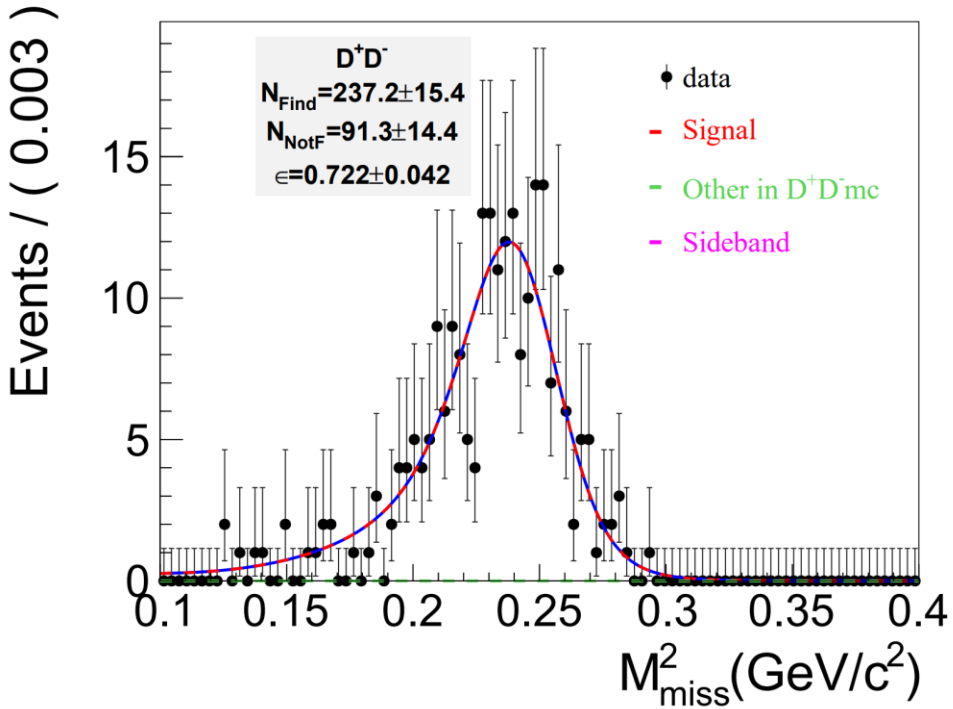
Not Find K^0_S



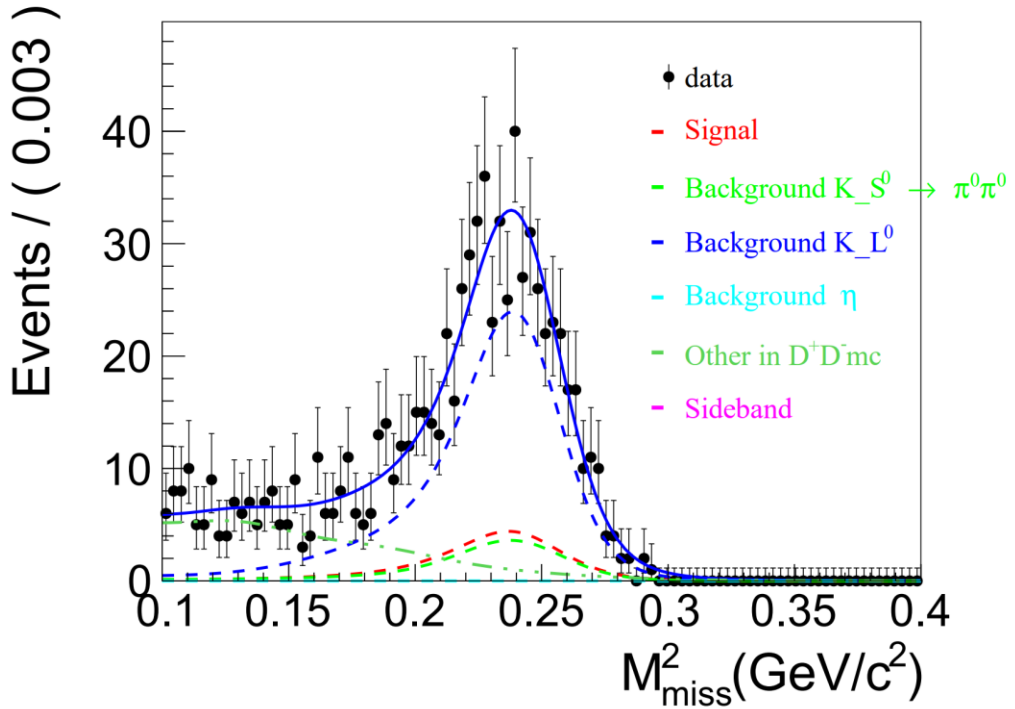
round0304

D^+D^- M^2_{miss}: $1.0 < P_{miss} < 1.2\ GeV/c$

Find K^0_S

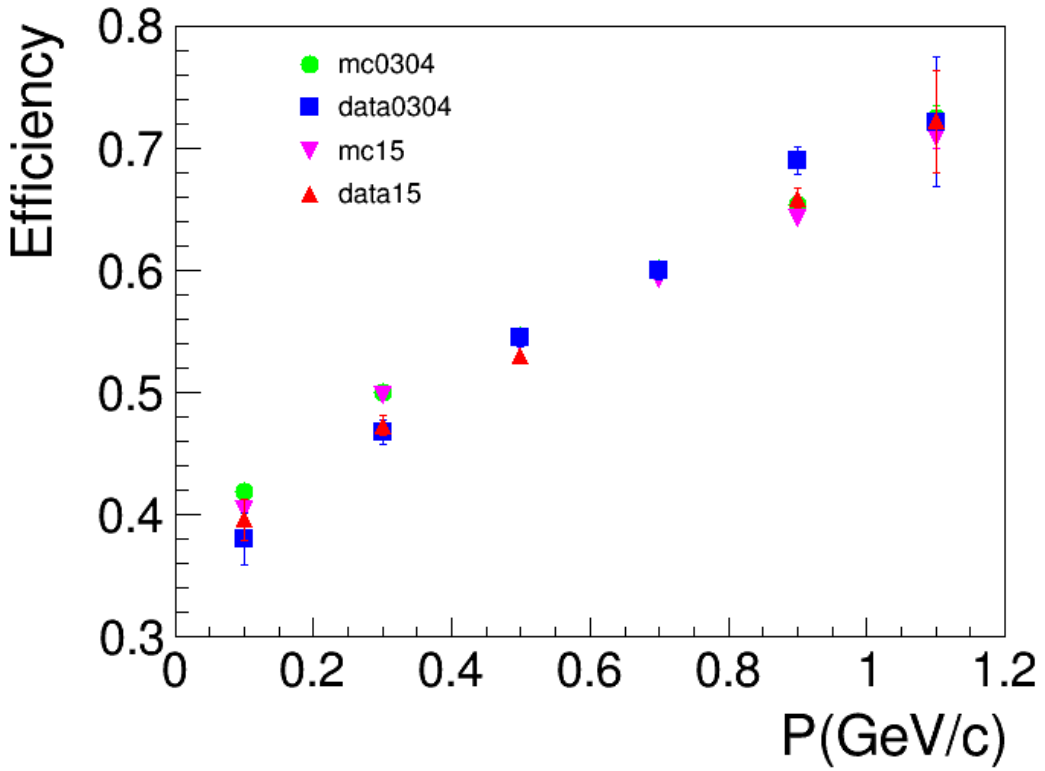


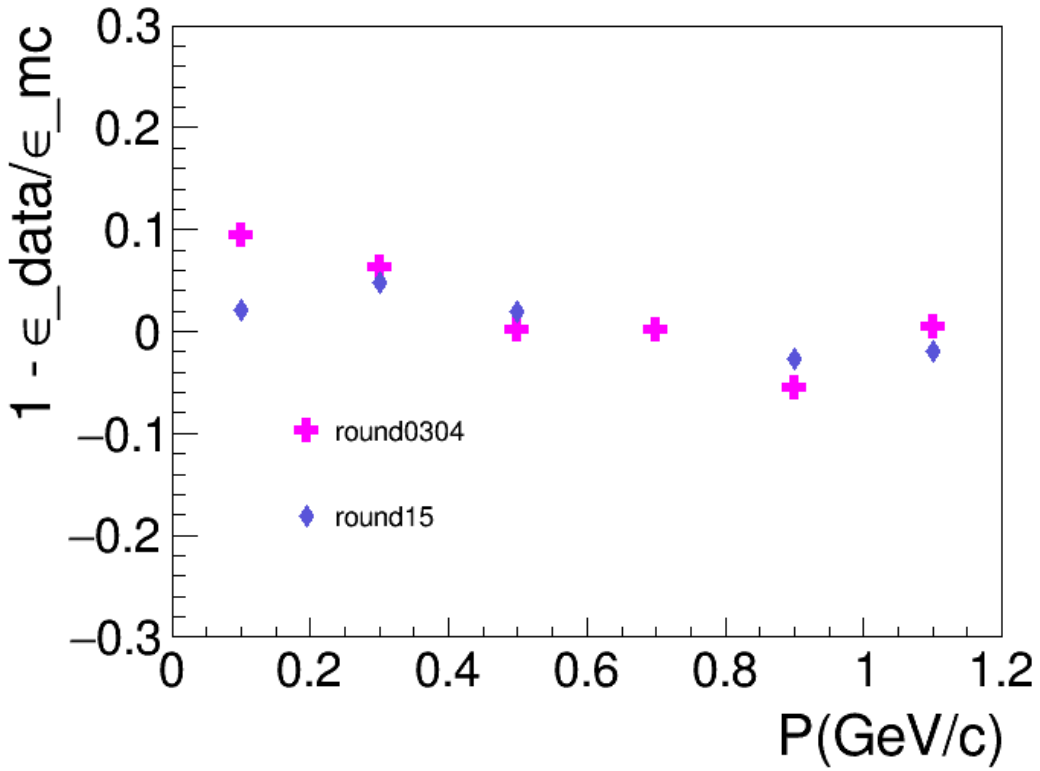
Not Find K^0_S



round15

D^+D^- : K_S^0 efficiency



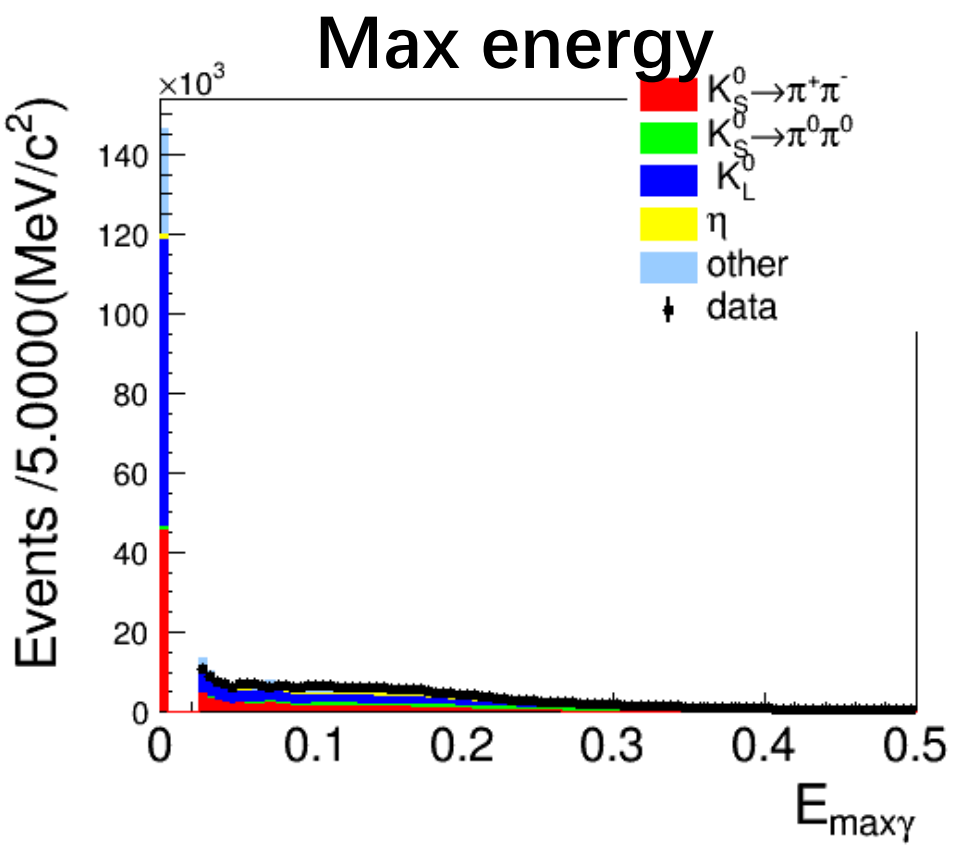


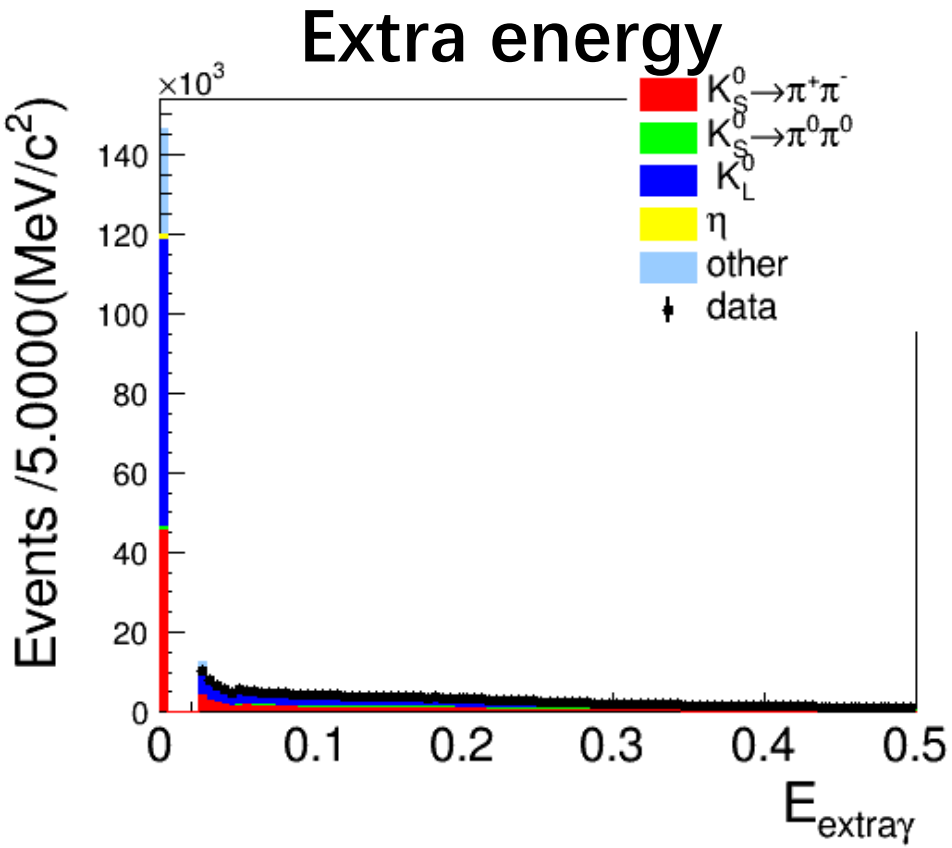
Back up

Data quantity by P_{K_S}

P_{K_S}	(0.0,0.2)	(0.2,0.4)	(0.4,0.6)	(0.6,0.8)	(0.8,1.0)	(1.0,1.2)
Data Round 0304	4089	15453	16604	23058	13971	576
Data Round 15	6685	24763	26517	36749	22150	953
Data Round 0304 (Refine)	4138	15479	16673	13073	13955	574
Data Round 15 (Refine)	6686	24776	26620	36802	22064	954

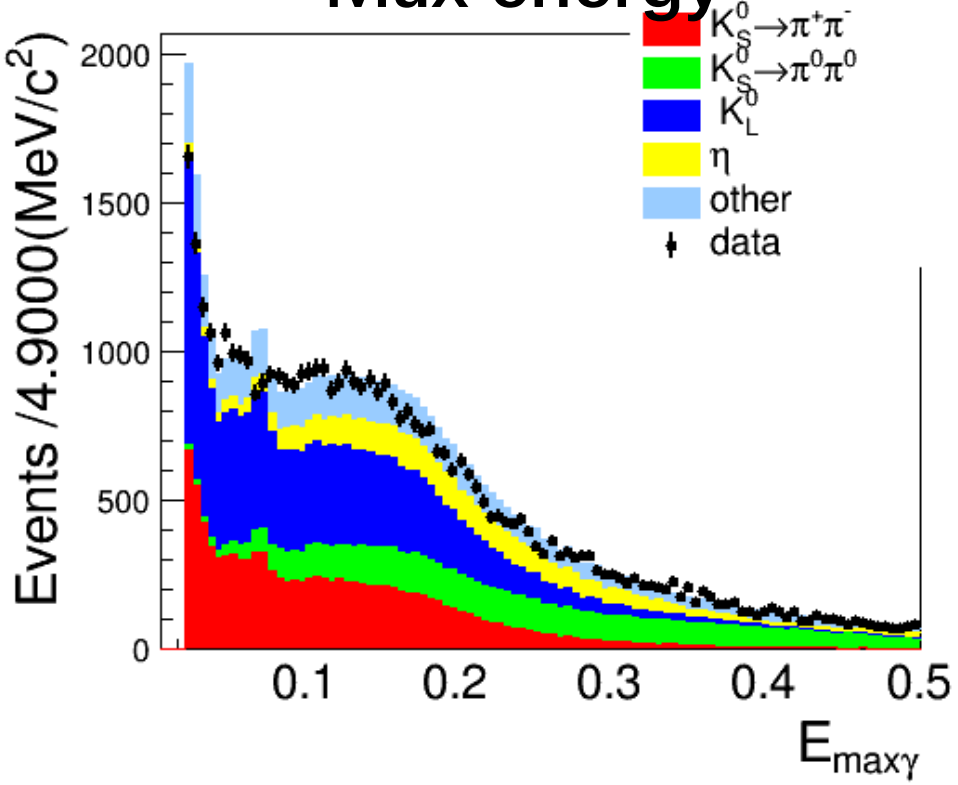
D^+D^- : Three channels



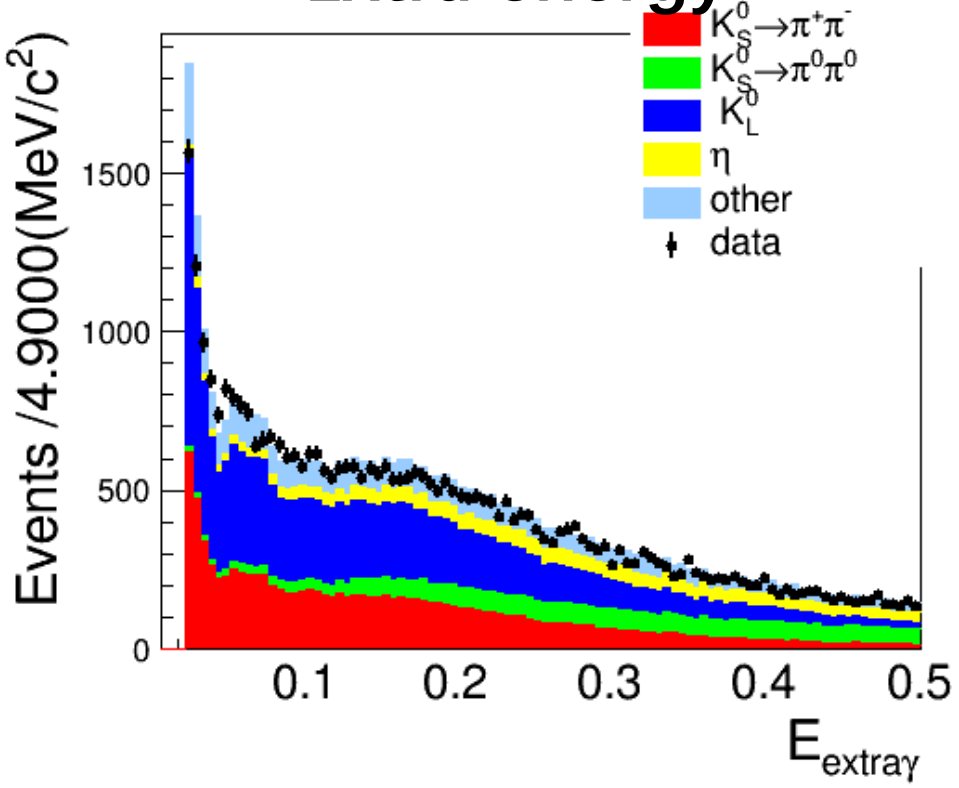


$$D^+D^- : D^+ \to K_S^0\pi^+ + c.c.$$

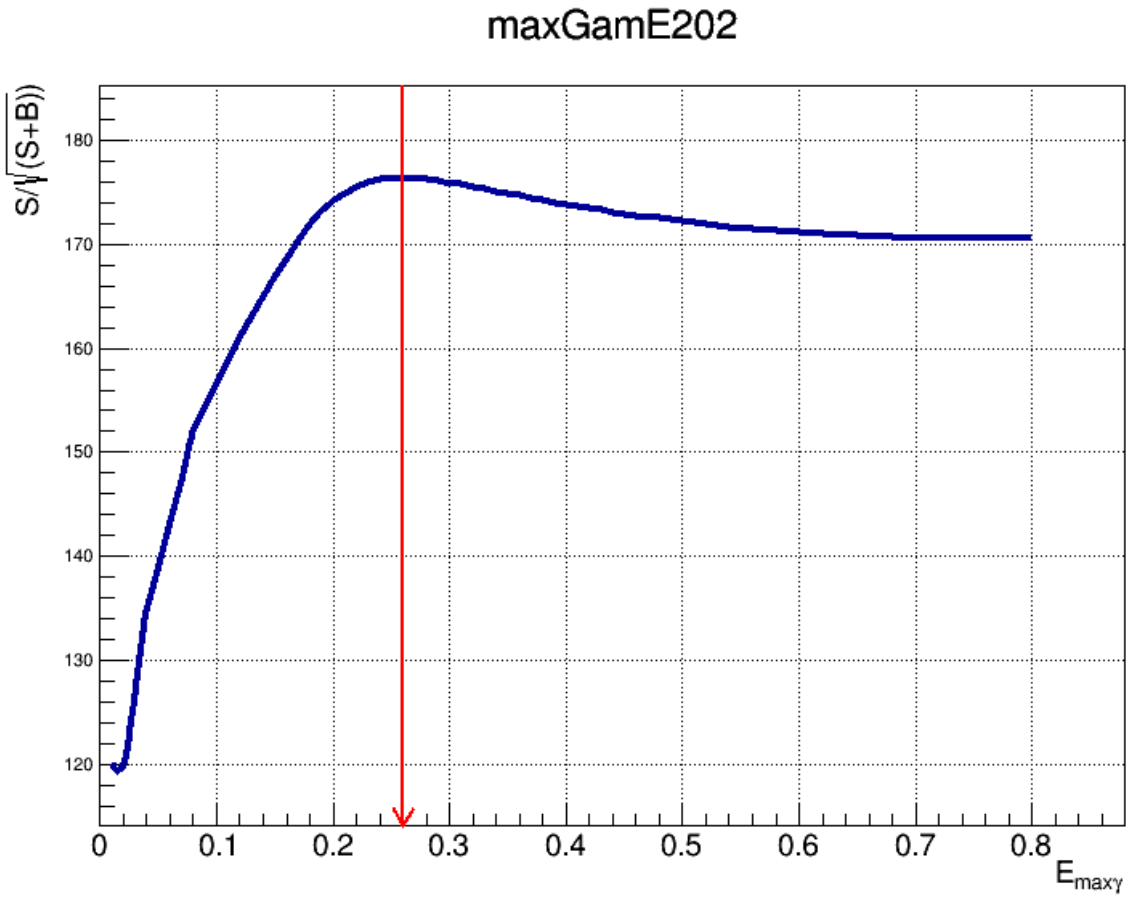
Max energy



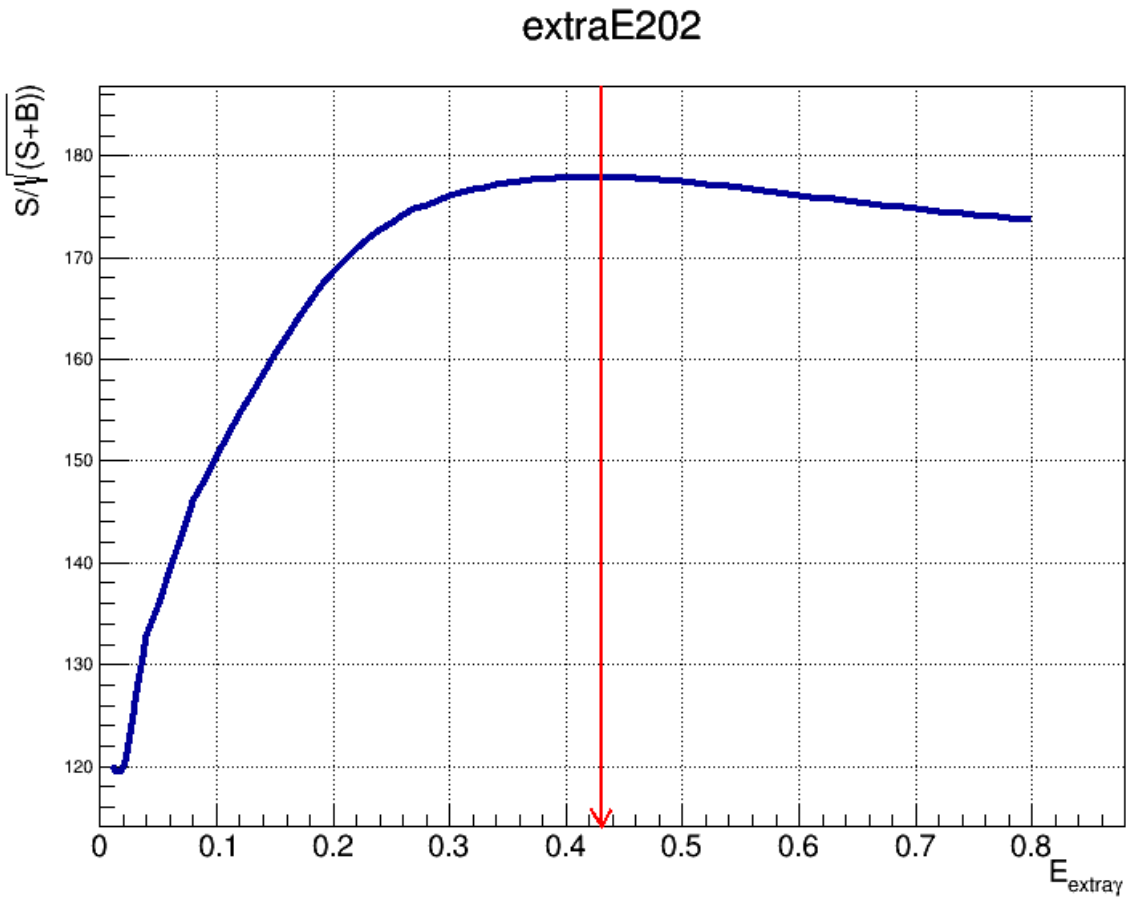
Extra energy



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



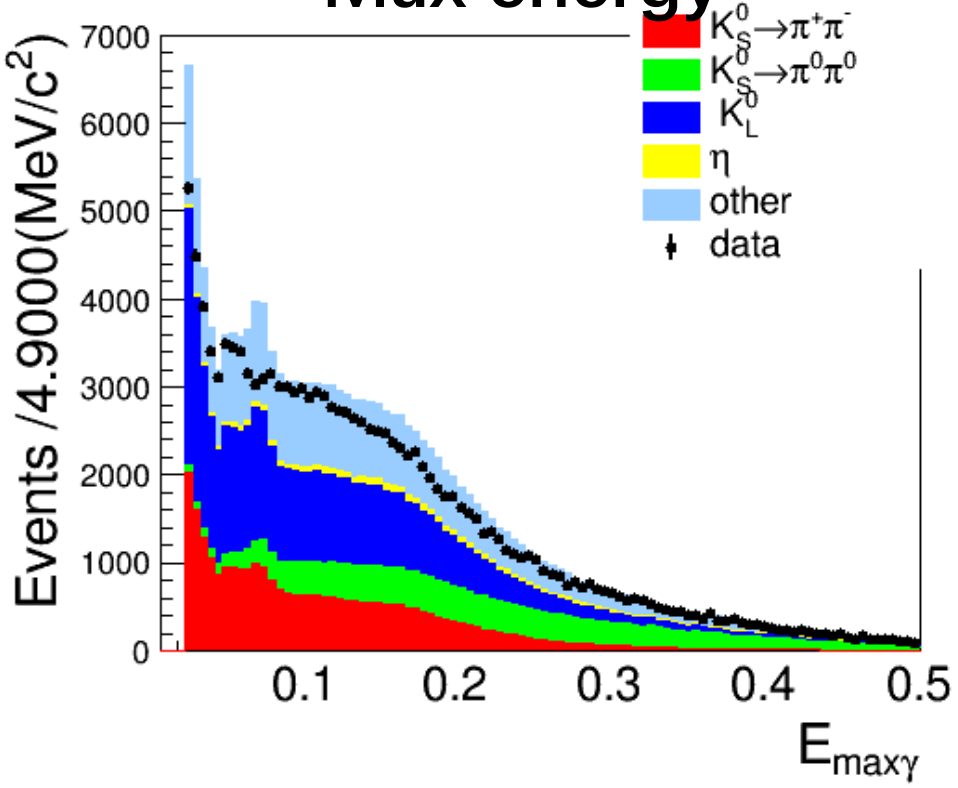
maxGamE cut with max value:0.26
efficiency:0.963 ;rejection:0.311



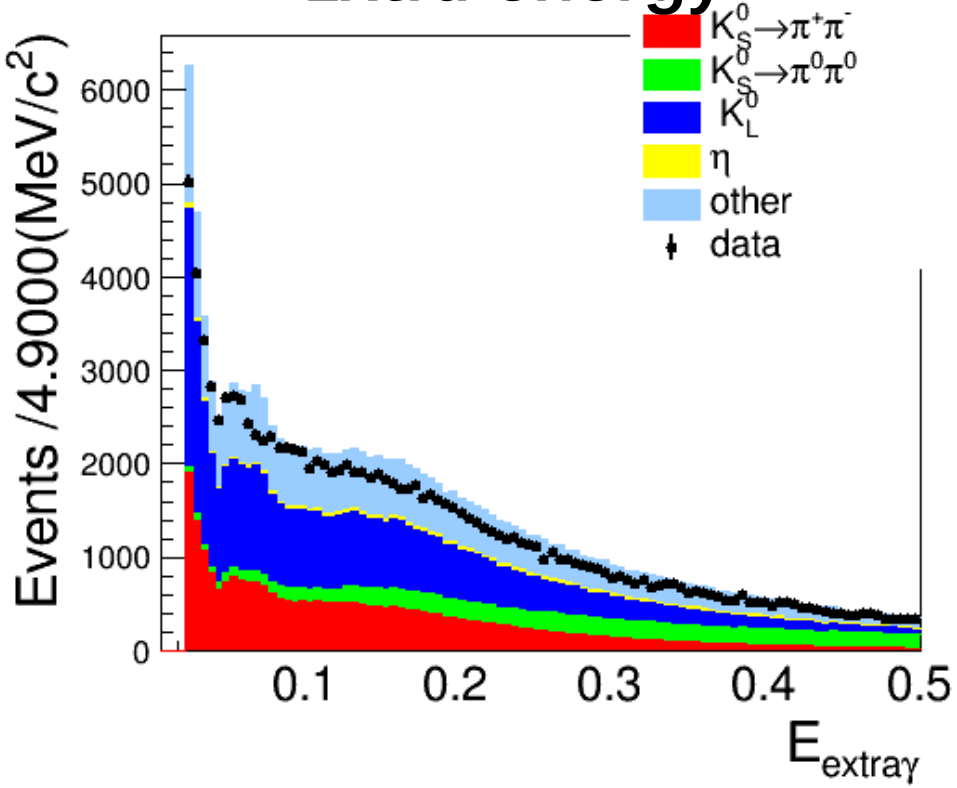
extraE cut with max value:0.43
efficiency:0.967 ;rejection:0.352

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

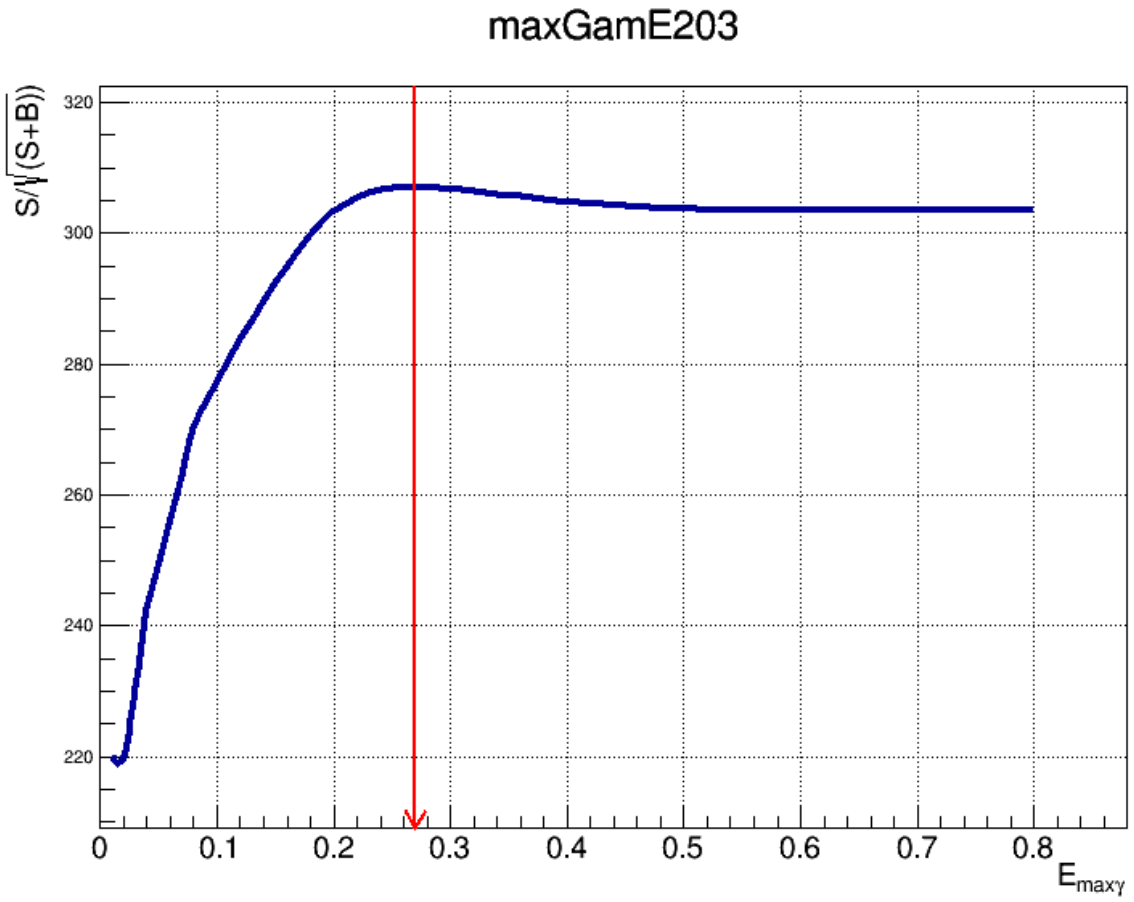
Max energy



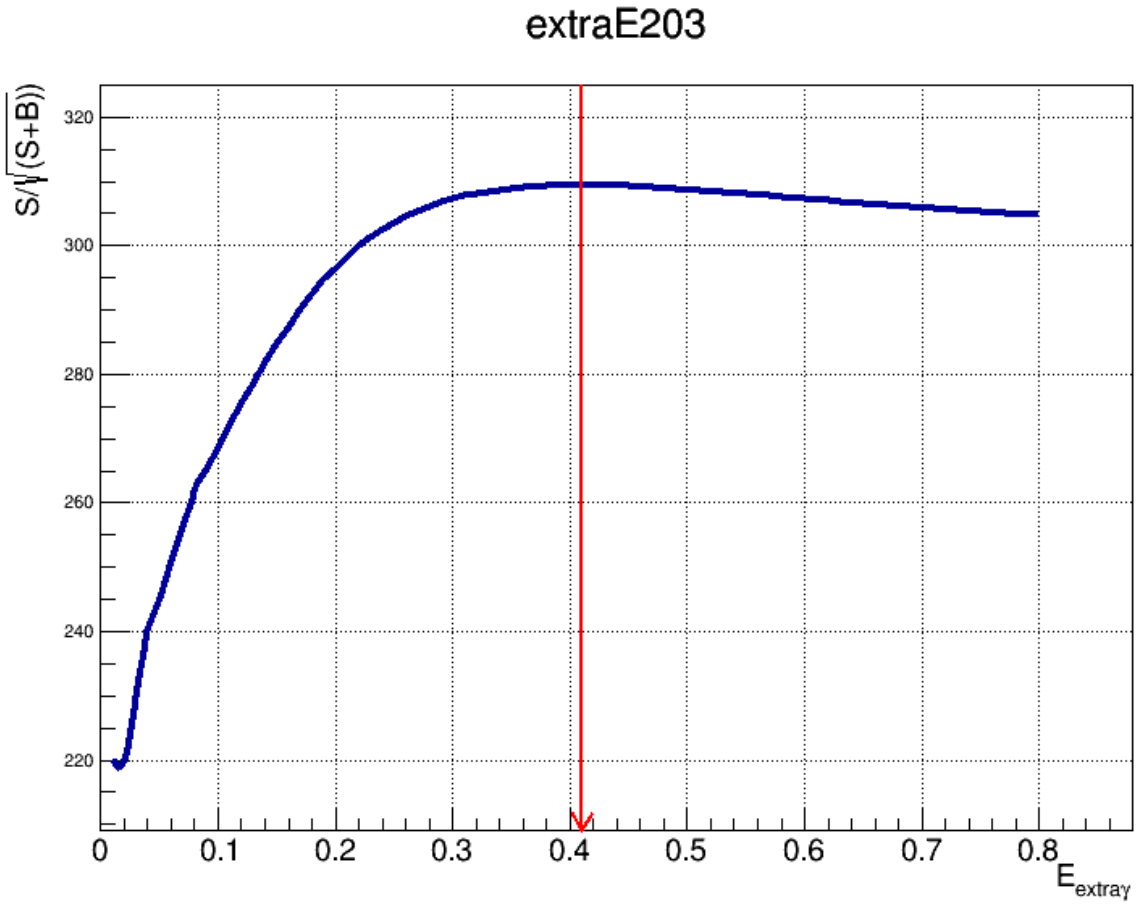
Extra energy



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



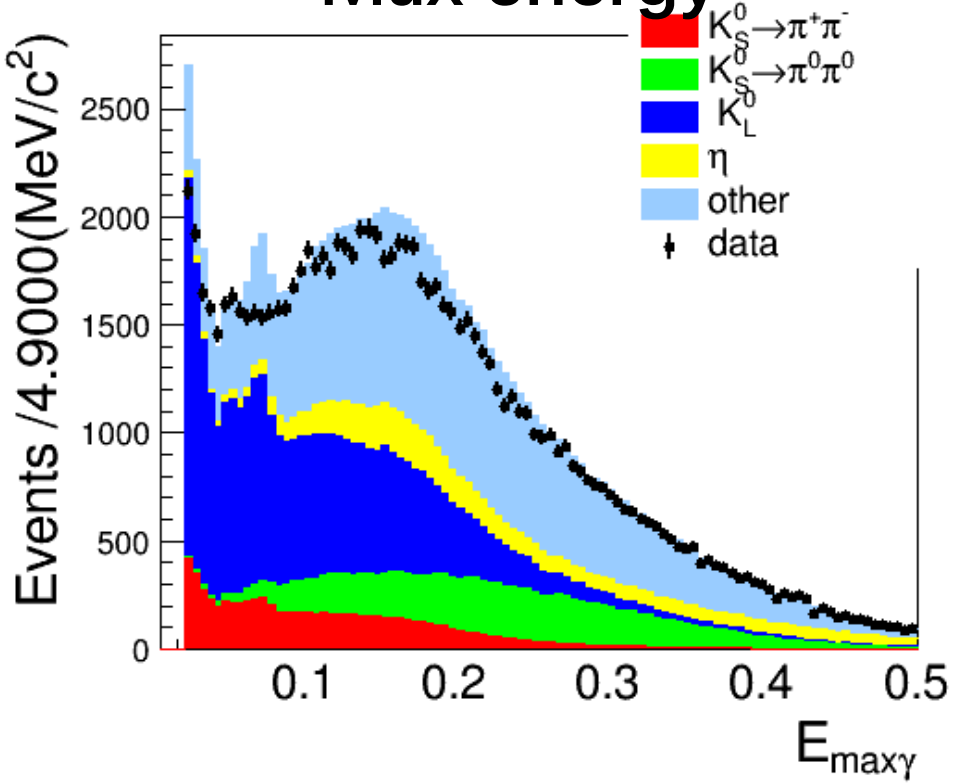
maxGamE cut with max value:0.27
efficiency:0.971 ;rejection:0.162



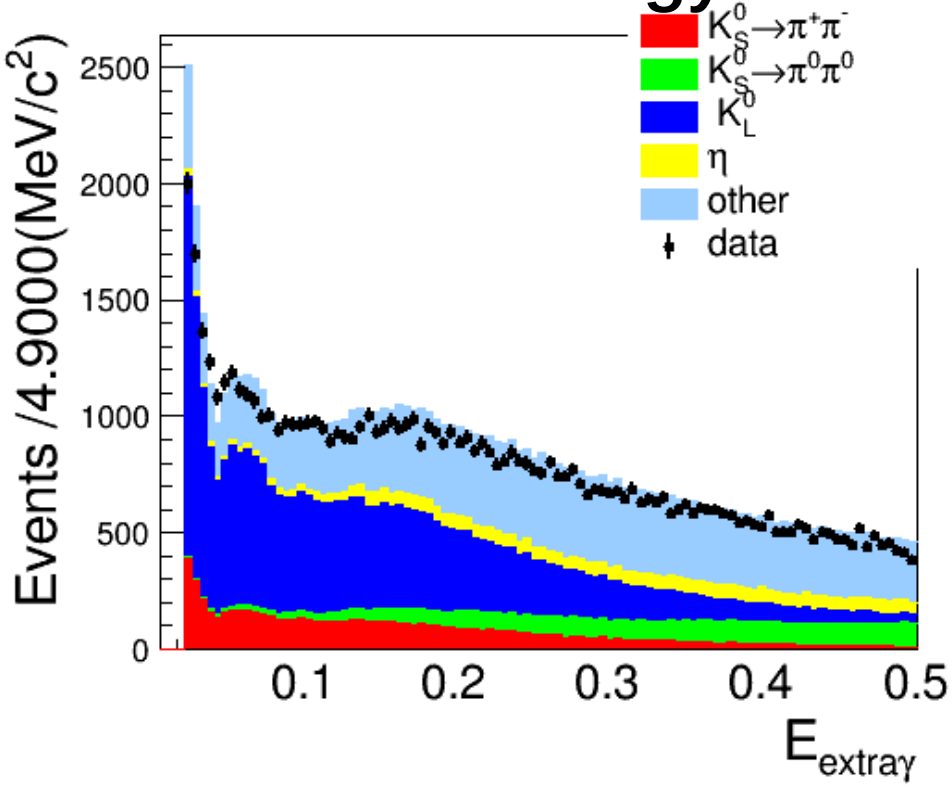
extraE cut with max value:0.41
efficiency:0.972 ;rejection:0.208

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

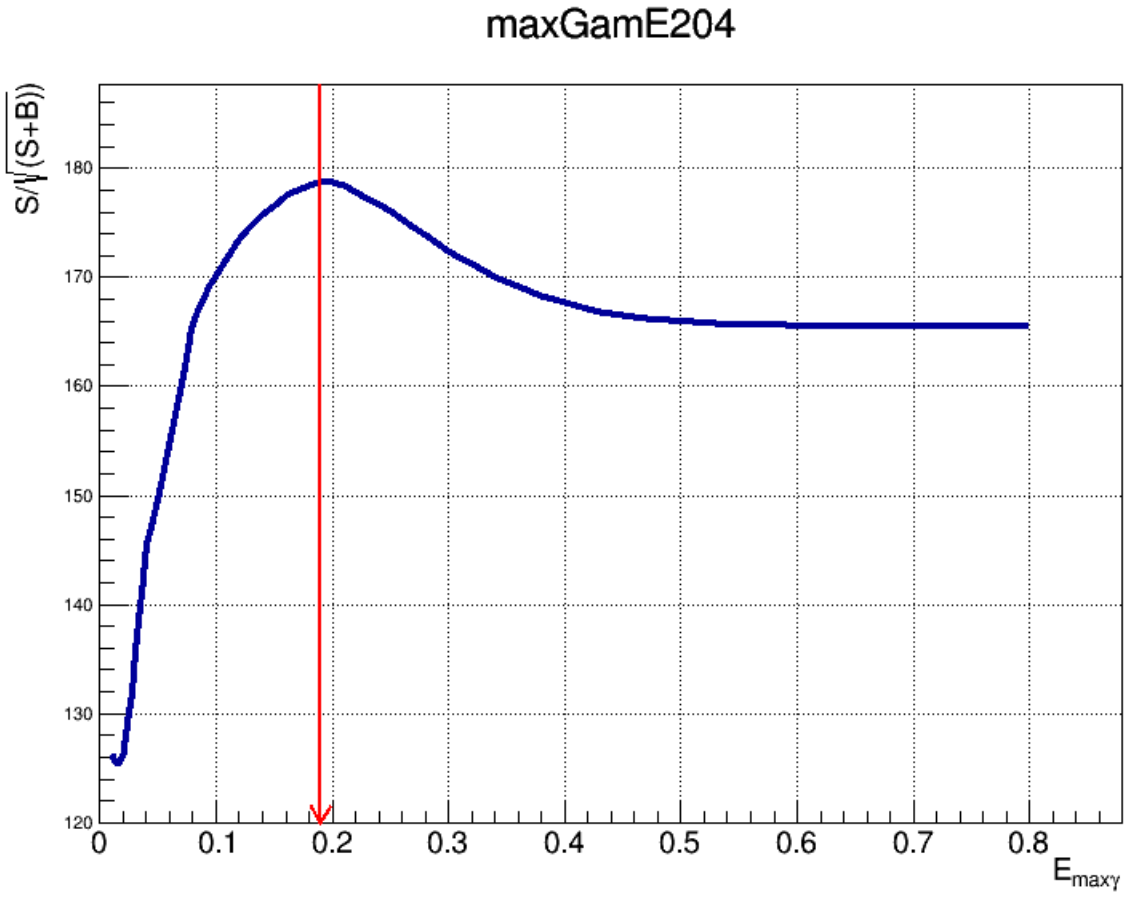
Max energy



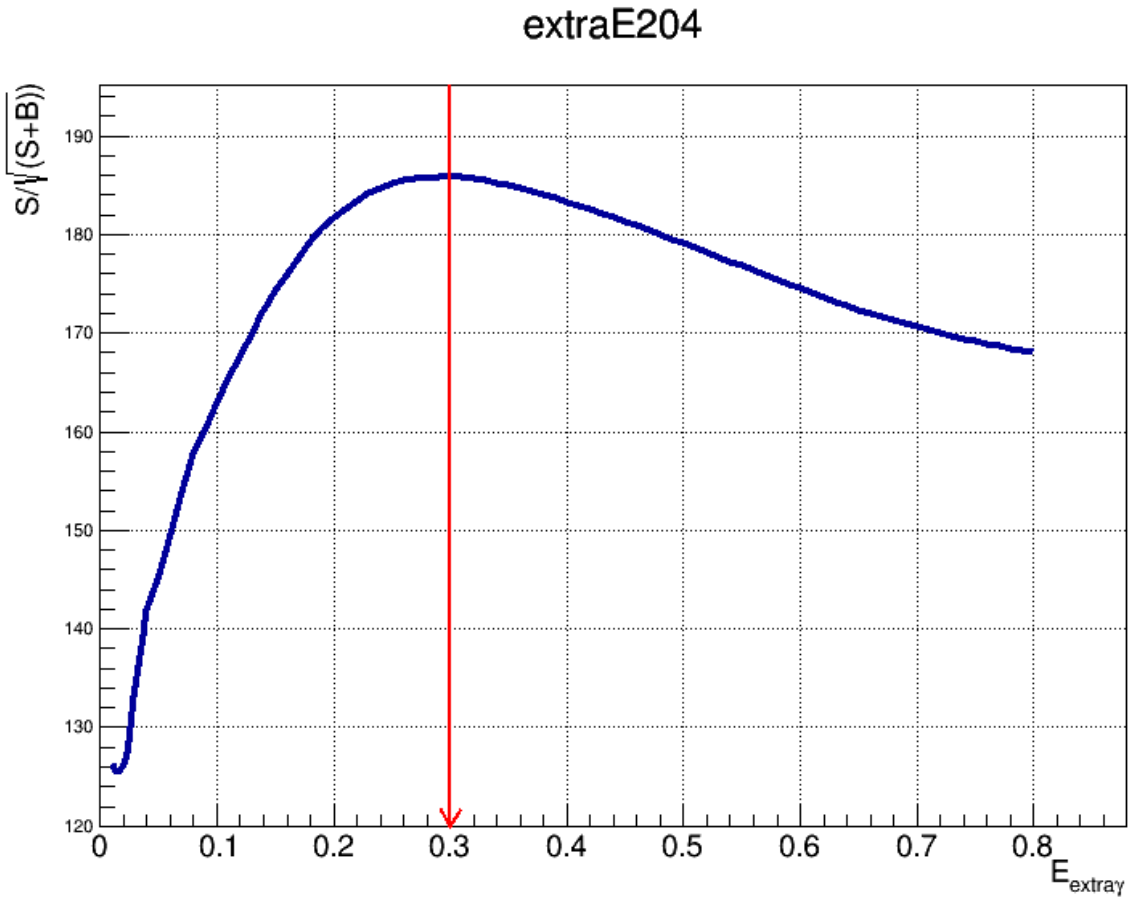
Extra energy



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



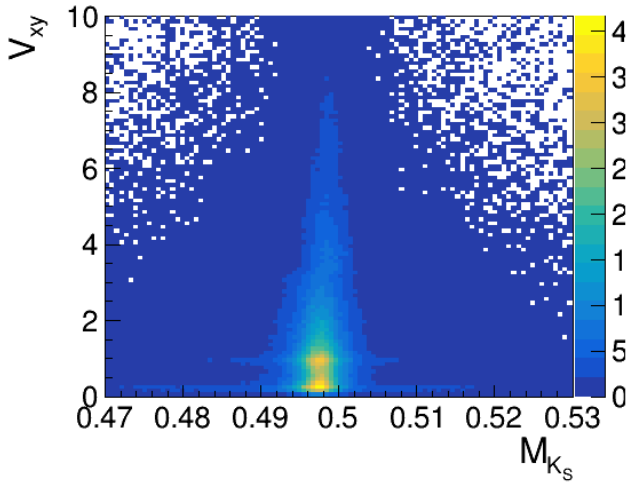
maxGamE cut with max value:0.19
efficiency:0.895 ;rejection:0.504



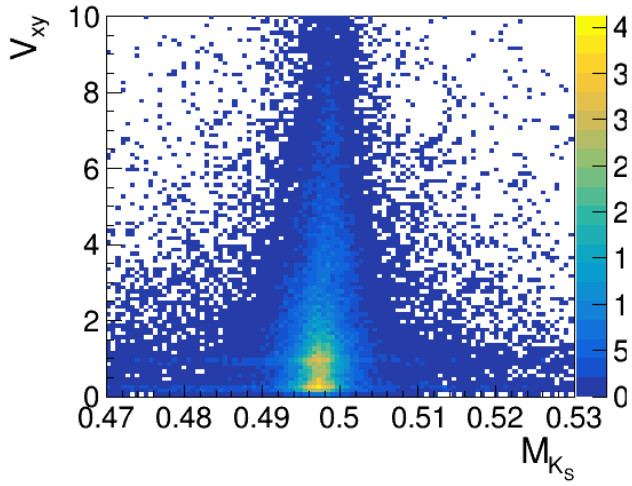
extraE cut with max value:0.3
efficiency:0.903 ;rejection:0.599

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

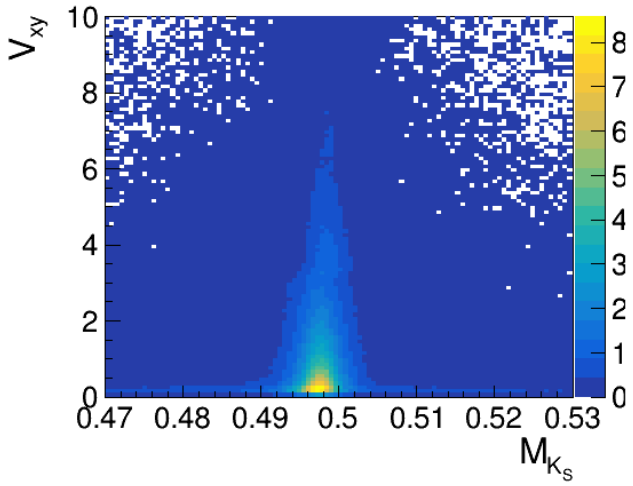
Inclusive mc round0304



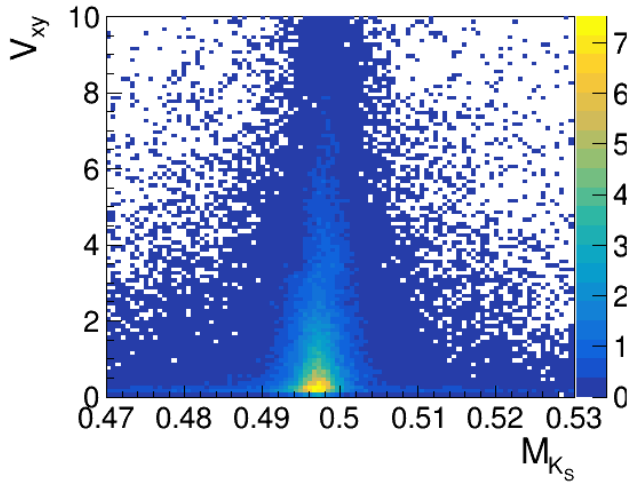
Data round0304



Inclusive mc round15



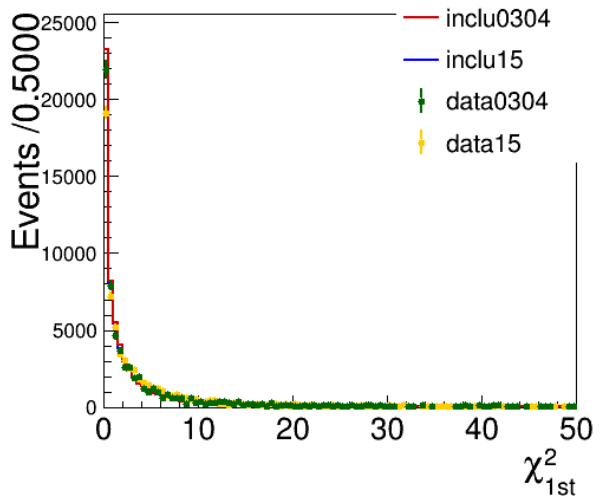
Data round15

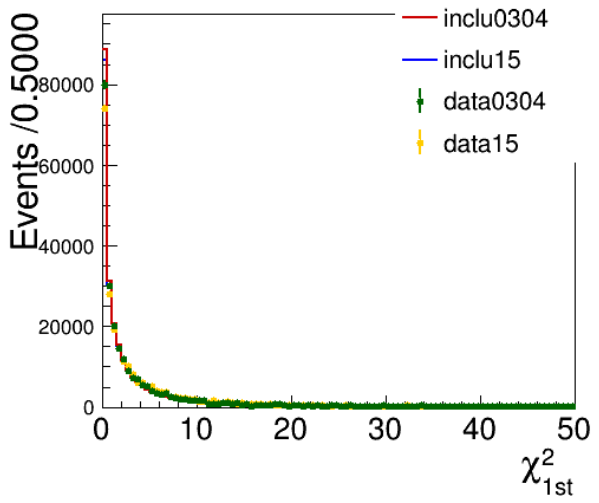


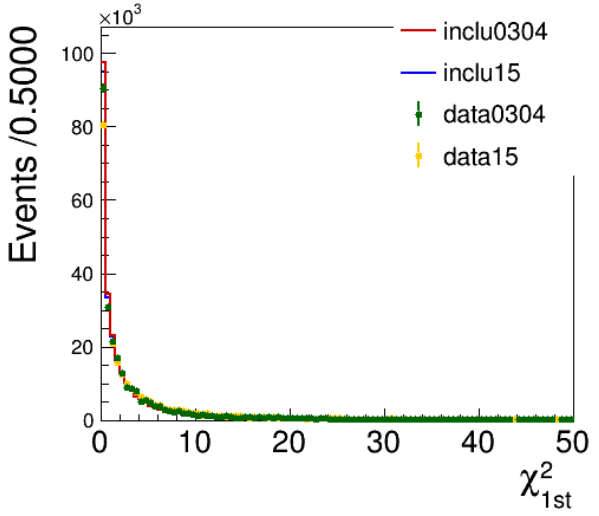
Vertex Fit

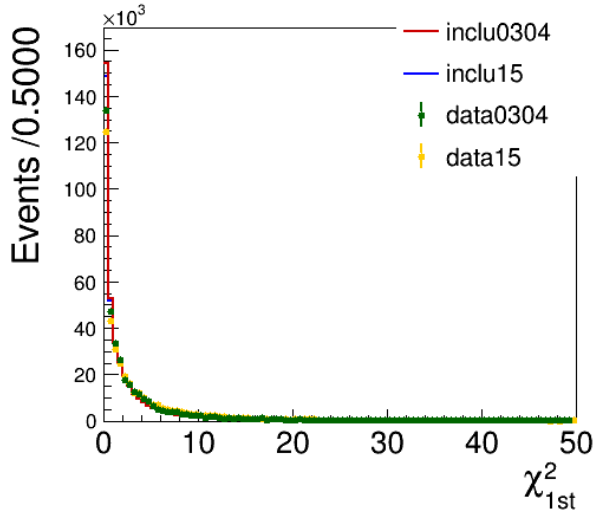
χ^2_{1st}

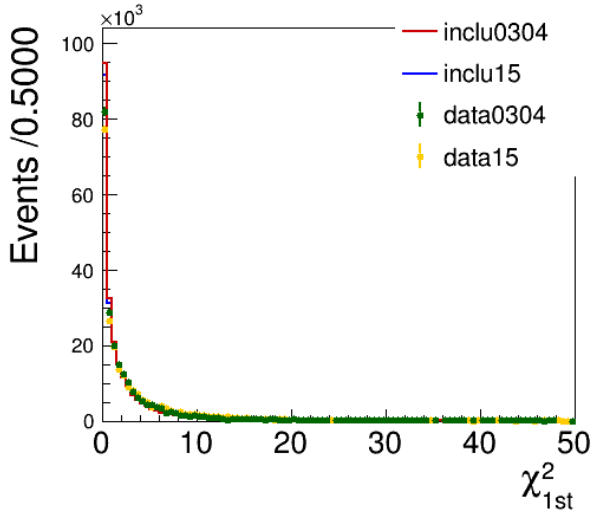
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

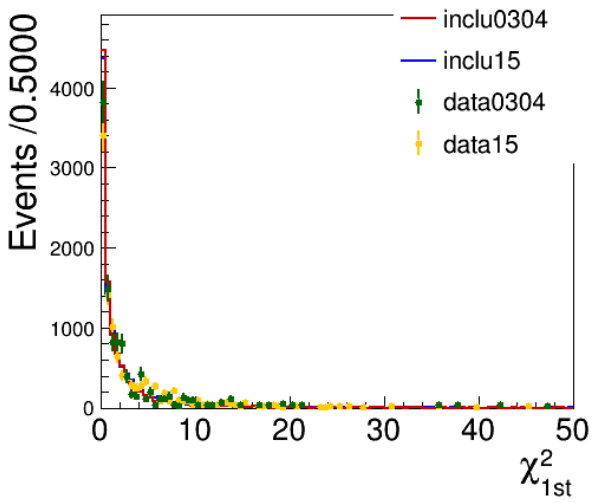








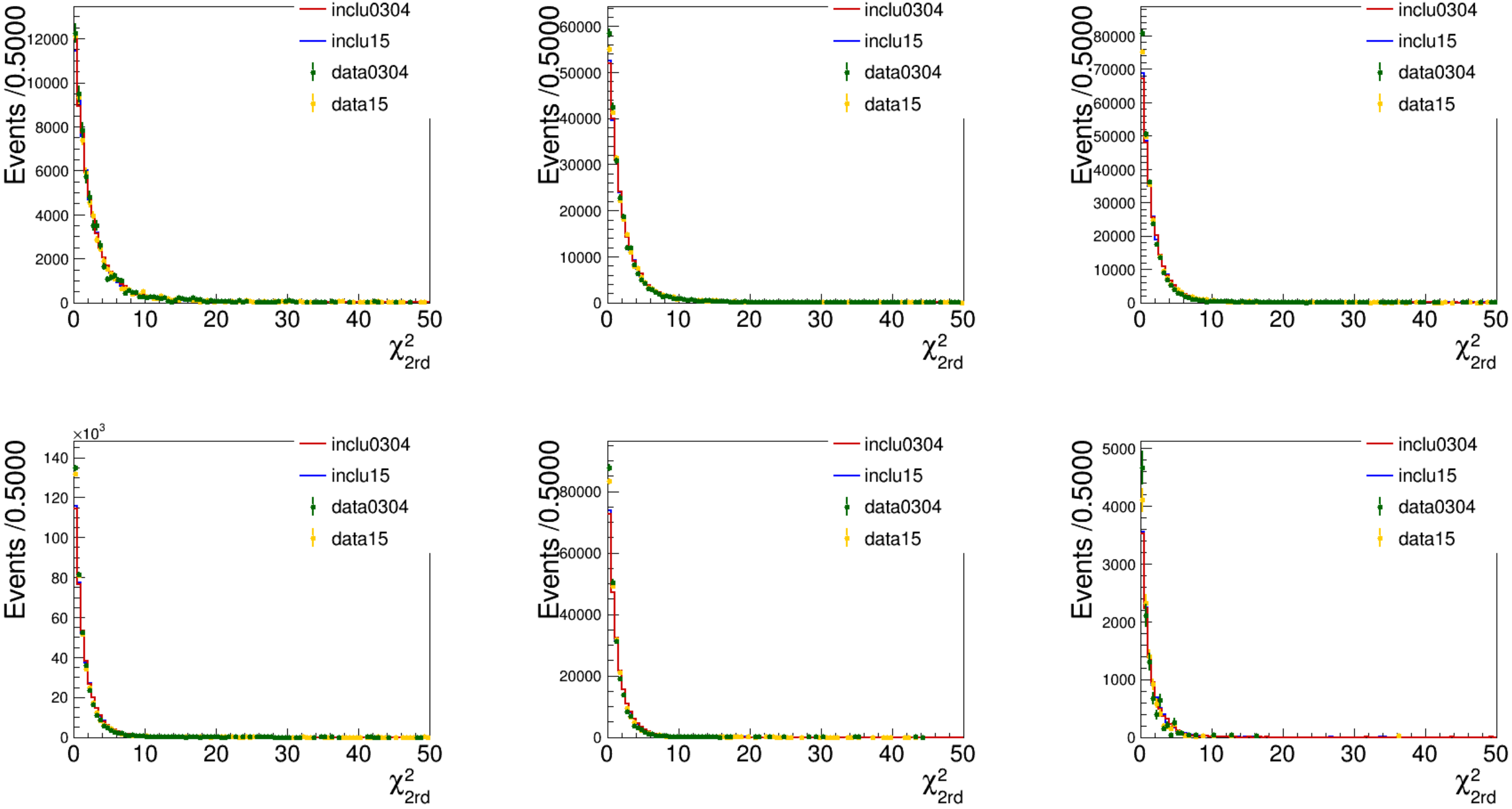




Vertex Fit

χ^2_{2rd}

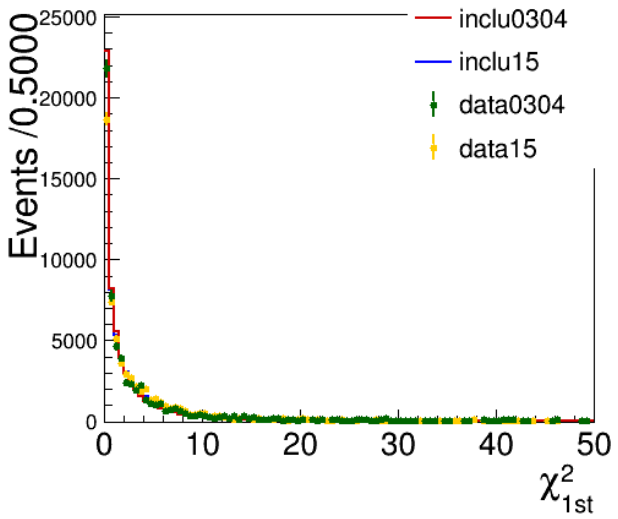
$0.511 > M_{K_S} > 0.487 \; L/err > 2$

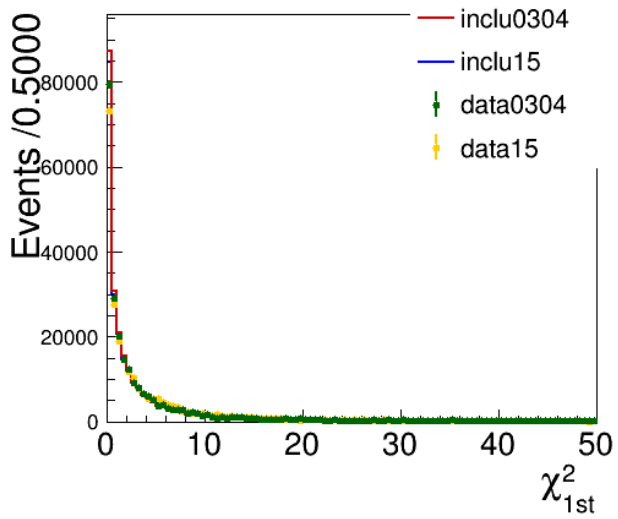


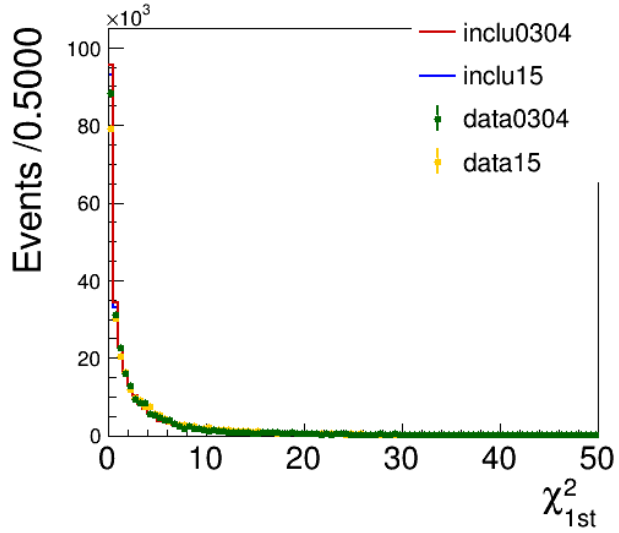
Refine Vertex Fit

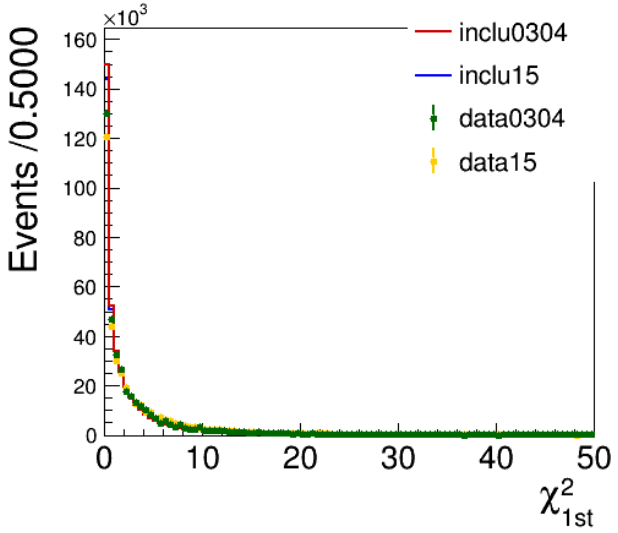
χ^2_{1st}

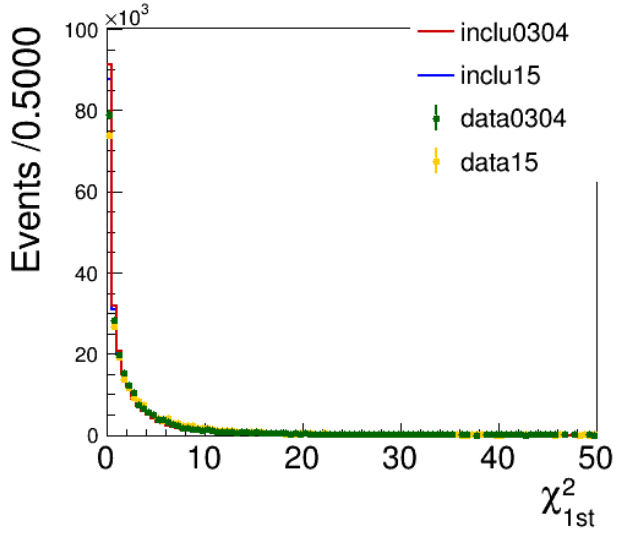
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

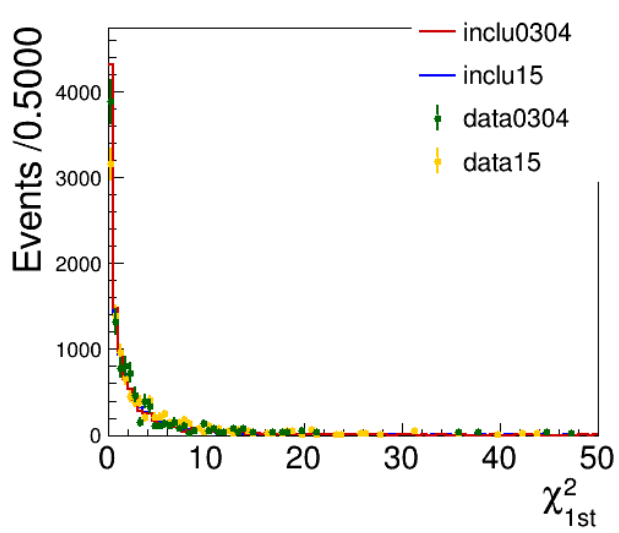








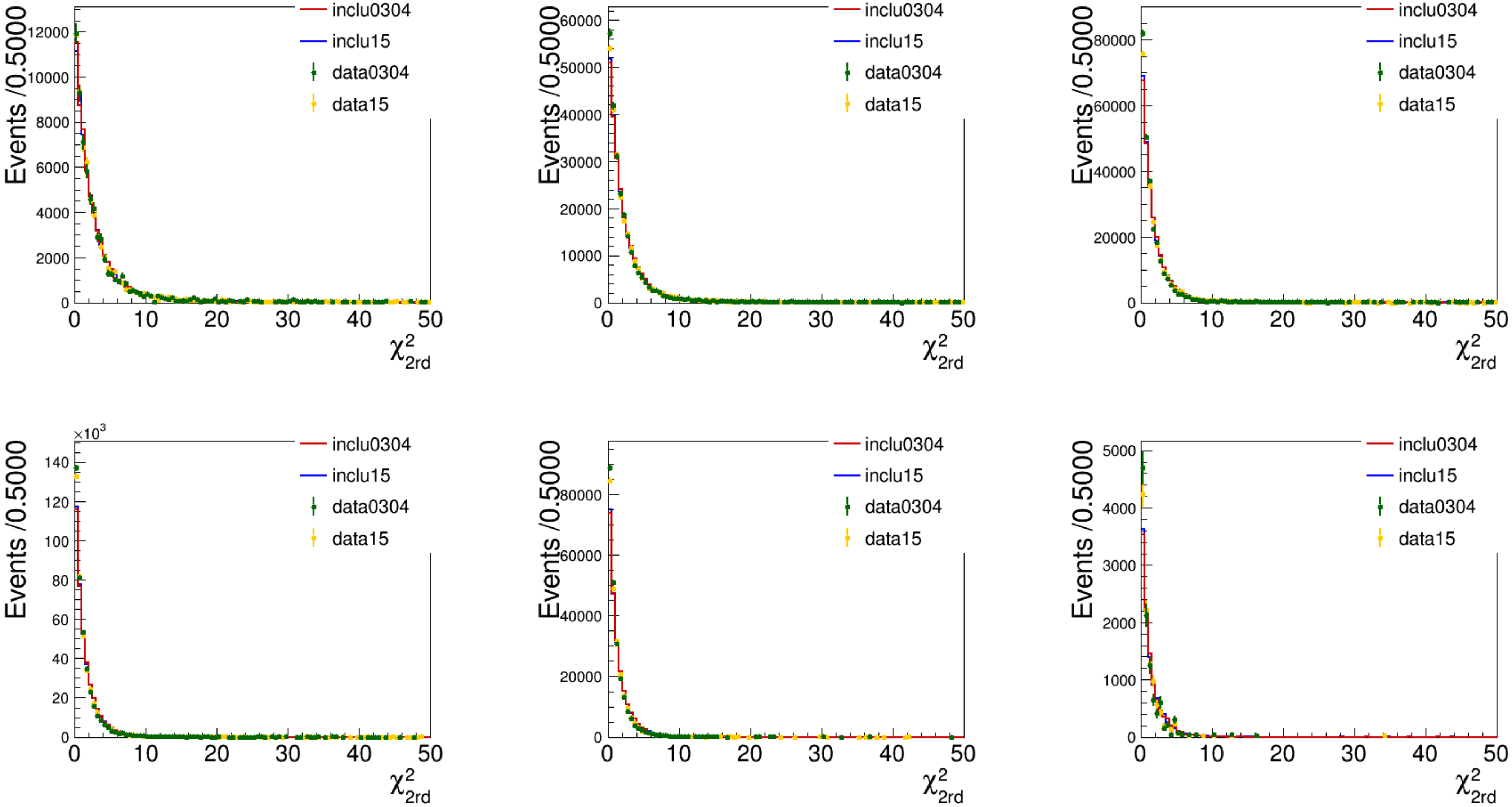




Refine Vertex Fit

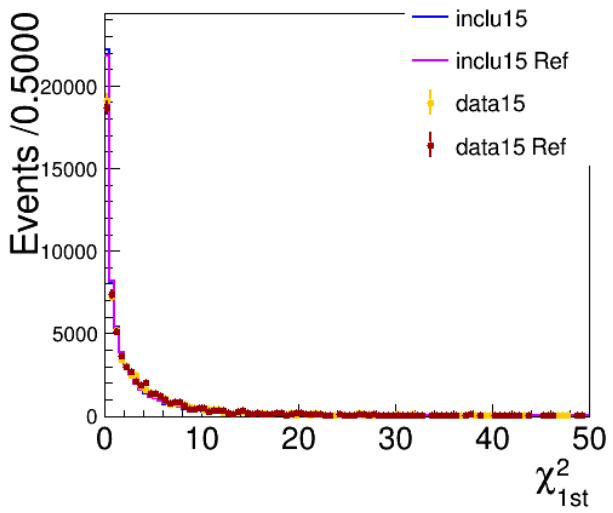
χ^2_{2rd}

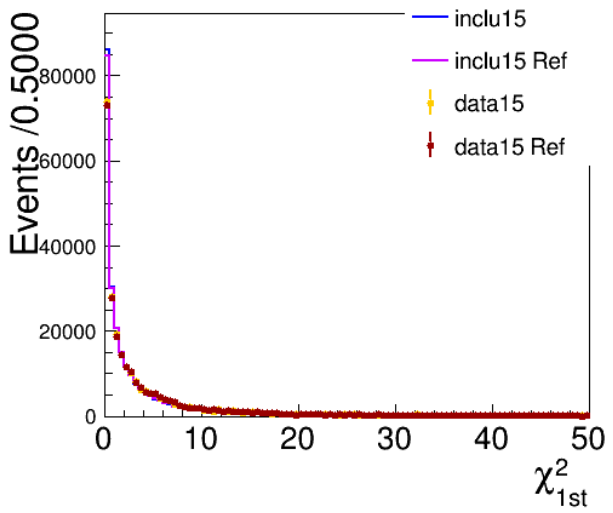
$0.511 > M_{K_s} > 0.487 \; L/err > 2$

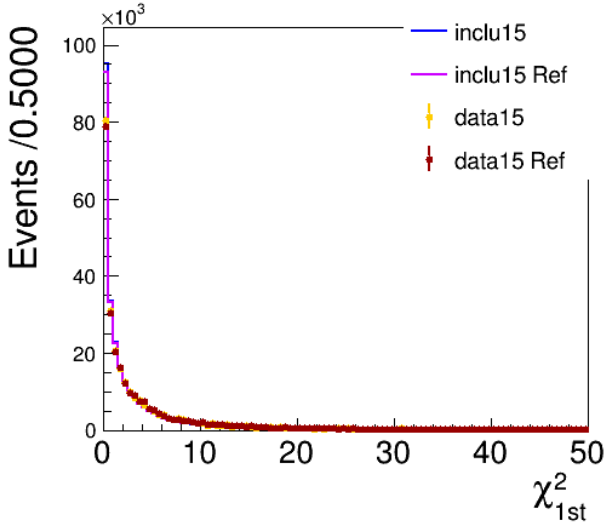


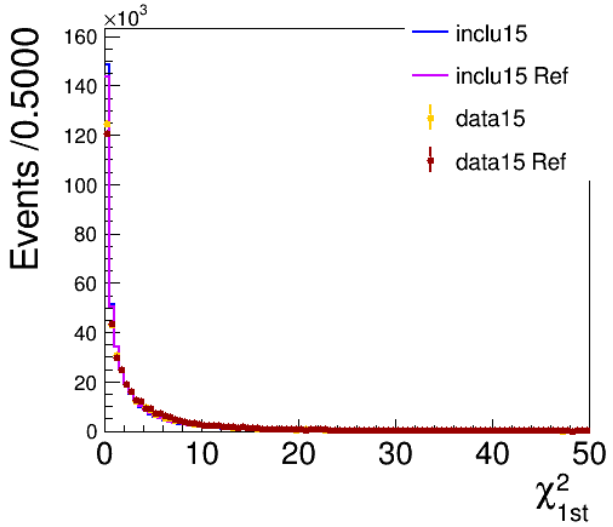
χ^2_{1st}

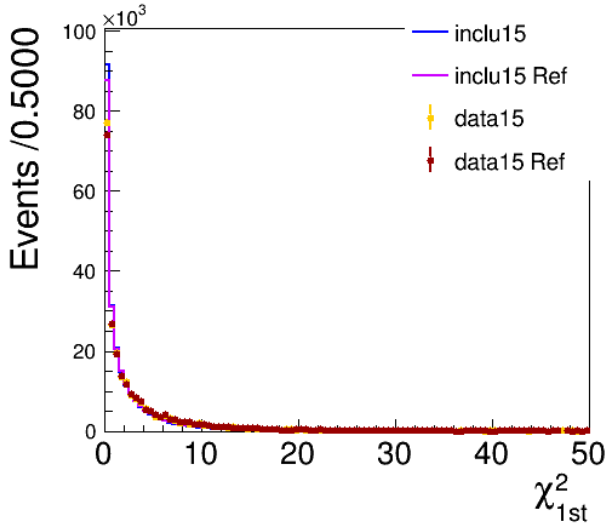
$0.511 > M_{K_s} > 0.487$ $L/err > 2$

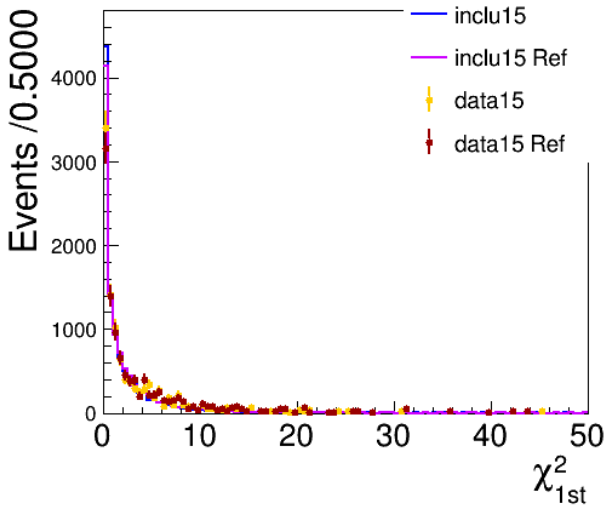












χ^2_{2rd}

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