

Table 2: The results of fitting and branching fractions of χ_{cJ} .

Decay mode	N_{sig}	ϵ (%)	$B (\times 10^{-4})$
$\chi_{c0} \rightarrow p\bar{p}K^+K^-$	785 ± 31	10.1	1.77 ± 0.07
$\chi_{c1} \rightarrow p\bar{p}K^+K^-$	960 ± 33	14.2	1.55 ± 0.05
$\chi_{c2} \rightarrow p\bar{p}K^+K^-$	1251 ± 37	14.8	1.98 ± 0.06

 TABLE I. The branching fractions for $\chi_{cJ} \rightarrow p\bar{p}K^+K^-$, where errors are statistical only.

Quantity	χ_{c0}	χ_{c1}	χ_{c2}
N_{obs}	48.2 ± 7.7	81.5 ± 9.2	131 ± 12
ϵ (%)	3.8 ± 0.1	6.2 ± 0.1	6.8 ± 0.1
$\mathcal{B}(\chi_{cJ} \rightarrow p\bar{p}K^+K^-)$ (10^{-4})	1.24 ± 0.20	1.35 ± 0.15	2.08 ± 0.19

 Table 3: The results of fitting and branching fractions of χ_{cJ} .

Decay mode	N_{sig}	ϵ (%)	$B (\times 10^{-5})$
$\chi_{c0} \rightarrow p\bar{p}\phi$	167 ± 20	11.5	6.72 ± 0.80
$\chi_{c1} \rightarrow p\bar{p}\phi$	39 ± 11	16.2	1.11 ± 0.30
$\chi_{c2} \rightarrow p\bar{p}\phi$	59 ± 12	16.5	1.69 ± 0.35

 TABLE IV. The branching fractions for $\chi_{cJ} \rightarrow p\bar{p}\phi$. The errors are statistical only, and the upper limit is at the 90% C.L.

Quantity	χ_{c0}	χ_{c1}	χ_{c2}
N_{obs}	42.4 ± 8.2	<13.3	24.4 ± 6.8
ϵ (%)	13.9 ± 0.1	17.7 ± 0.1	17.7 ± 0.1
$\mathcal{B}(\phi \rightarrow K^+K^-)$ (%)	48.9	48.9	48.9
$\mathcal{B}(\chi_{cJ} \rightarrow p\bar{p}\phi)$ (10^{-5})	6.12 ± 1.18	<1.58	3.04 ± 0.85

 Table 6: The results of fitting and branching fractions of χ_{cJ} .

Decay mode	N_{sig}	ϵ (%)	$B (\times 10^{-4})$
$\chi_{c0} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$	273 ± 21	16.8	7.33 ± 0.56
$\chi_{c2} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$	131 ± 16	22.7	2.68 ± 0.33

 TABLE III. The branching fractions for $\chi_{cJ} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$. The errors are statistical only, and the upper limit is at the 90% C.L.

Quantity	χ_{c0}	χ_{c1}	χ_{c2}
N_{obs}	28.1 ± 9.8	<6.9	28.9 ± 7.4
ϵ (%)	17.1 ± 0.1	16.3 ± 0.1	12.2 ± 0.1
$\mathcal{B}(\Lambda(1520) \rightarrow pK)$ (%)	22.5	22.5	22.5
$\mathcal{B}(\chi_{cJ} \rightarrow \Lambda(1520)\bar{\Lambda}(1520))$ (10^{-4})	3.18 ± 1.11	<0.86	5.05 ± 1.29

Table 4: The results of fitting and branching fractions of χ_{cJ} .

Decay mode	N_{sig}	ϵ (%)	$B (\times 10^{-4})$
$\chi_{c0} \rightarrow pK^- \bar{\Lambda}(1520)$	210 ± 20	12.4	1.71 ± 0.16
$\chi_{c1} \rightarrow pK^- \bar{\Lambda}(1520)$	268 ± 22	16.8	1.63 ± 0.14
$\chi_{c2} \rightarrow pK^- \bar{\Lambda}(1520)$	290 ± 24	16.8	1.80 ± 0.15

Table 5: The results of fitting and branching fractions of χ_{cJ} .

Decay mode	N_{sig}	ϵ (%)	$B (\times 10^{-4})$
$\chi_{c0} \rightarrow \Lambda(1520) \bar{p}K^+$	228 ± 21	12.6	1.83 ± 0.17
$\chi_{c1} \rightarrow \Lambda(1520) \bar{p}K^+$	207 ± 21	16.9	1.24 ± 0.13
$\chi_{c2} \rightarrow \Lambda(1520) \bar{p}K^+$	291 ± 23	16.9	1.79 ± 0.14

TABLE II. The branching fractions for $\chi_{cJ} \rightarrow \bar{p}K^+ \Lambda(1520) + \text{c.c.}$, where errors are statistical only.

Quantity	χ_{c0}	χ_{c1}	χ_{c2}
N_{obs}	62 ± 12	48 ± 10	79 ± 13
ϵ (%)	9.0 ± 0.1	12.1 ± 0.1	12.4 ± 0.1
$\mathcal{B}(\Lambda(1520) \rightarrow pK^-)$ (%)	22.5	22.5	22.5
$\mathcal{B}(\chi_{cJ} \rightarrow \bar{p}K^+ \Lambda(1520) + \text{c.c.}) (10^{-4})$	3.00 ± 0.58	1.81 ± 0.38	3.06 ± 0.50

conclusion

TABLE VII. Summary of branching fractions for 12 χ_{cJ} decay modes to $p\bar{p}K^+K^-$. The first errors are statistical, and the second ones are systematic. The upper limits are at the 90% C.L. including the systematic errors.

	χ_{c0}	χ_{c1}	χ_{c2}
$\mathcal{B}(\chi_{cJ} \rightarrow p\bar{p}K^+K^-) (10^{-4})$	$1.24 \pm 0.20 \pm 0.18$	$1.35 \pm 0.15 \pm 0.19$	$2.08 \pm 0.19 \pm 0.30$
$\mathcal{B}(\chi_{cJ} \rightarrow \bar{p}K^+ \Lambda(1520) + \text{c.c.}) (10^{-4})$	$3.00 \pm 0.58 \pm 0.50$	$1.81 \pm 0.38 \pm 0.28$	$3.06 \pm 0.50 \pm 0.54$
$\mathcal{B}(\chi_{cJ} \rightarrow \Lambda(1520) \bar{\Lambda}(1520)) (10^{-4})$	$3.18 \pm 1.11 \pm 0.53$	< 1.00	$5.05 \pm 1.29 \pm 0.93$
$\mathcal{B}(\chi_{cJ} \rightarrow p\bar{p}\phi) (10^{-5})$	$6.12 \pm 1.18 \pm 0.86$	< 1.82	$3.04 \pm 0.85 \pm 0.43$

$$\chi_{cJ} \rightarrow p\bar{p}\phi$$

去掉veto of $\Lambda(1520)$ 和 $\bar{\Lambda}(1520)$
后 (此时cut与Gengc一致)

三个衰变道去掉cut后效率整体上浮, 但分支比与自己结果保持一致

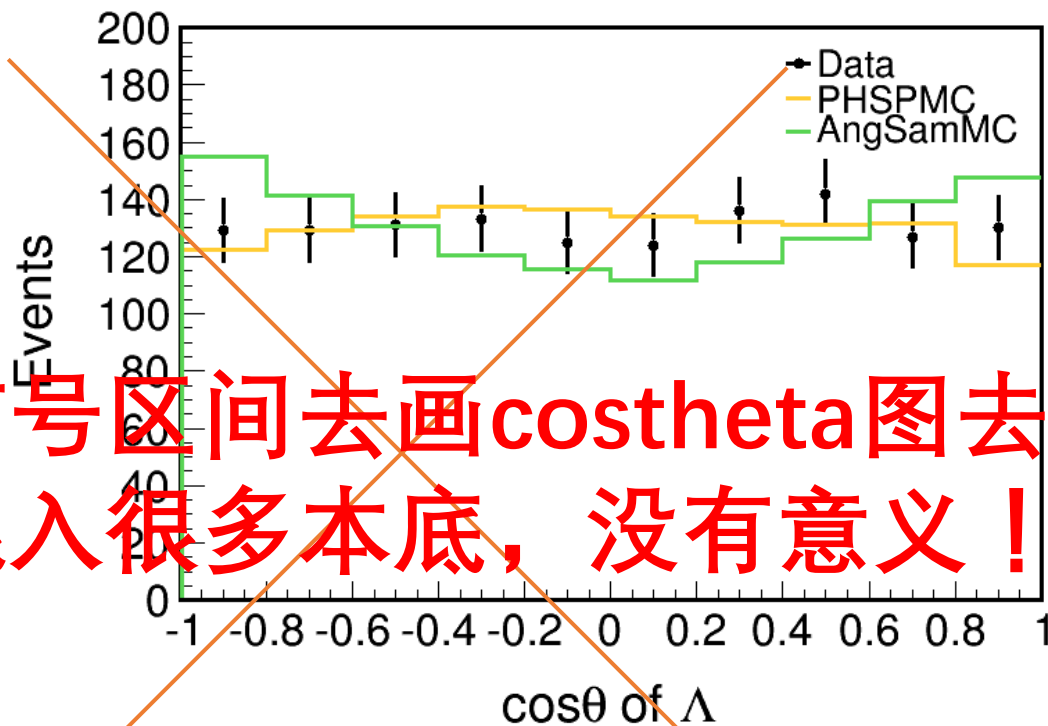
	Nsig	Efficiency	Br
χ_{c0}	With (memo)	167	$(6.72 \pm 0.80) \times 10^{-5}$
	without	230	6.69×10^{-5}
	GengC	42.4	$(6.12 \pm 1.18) \times 10^{-5}$

	Nsig	Efficiency	Br
χ_{c1}	With (memo)		
	without	20.63	
	GengC	<13.3	17.7%

	Nsig	Efficiency	Br
χ_{c2}	With (memo)	59 ± 12	1.69 ± 0.35
	without	72	1.67
	GengC	24.4 ± 6.8	17.7%

$$\chi_{c0} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$$

Boost 后的data、PHSP与AngSam的对比图



没在信号区间去画costheta图去比较，混入很多本底，没有意义！！

PHSP比AngSam更符合data分布

目前只检查了chic0，效率和分支比变化都不大。用不同的拟合方法和产生子给出的结果差别不大。data也检查过，事例数和cut没什么问题。但是分支比就是和文章里的不一致。这个目前搞不清楚。chic2到ppphi也是这样，效率和数据都检查过了，但是分支比和文章相比就是不一致

Nsig		Npsi(2S)	Eff					
249		4.48E+08	15.09%	9.79%	22.50%	22.50%	7.43E-04	sideband信号数, PHSP产生子效率
249		4.48E+08	14.90%	9.79%	22.50%	22.50%	7.52E-04	sideband信号数, AngSam产生子效率 (0912年)
57		1.07E+08	15.52%	9.79%	22.50%	22.50%	6.92E-04	sideband信号数, AngSam产生子效率 (09年)
28.1		1.07E+08	17.10%	9.62%	22.50%	22.50%	3.15E-04	耿聪09年结果
273	21	4.48E+08	16.78%	9.79%	22.50%	22.50%	7.33E-04	fit结果, PHSP产生子效率 (memo上写的)

Gary and Yong,

In the new version, the measurements of $\chi_{cJ} \rightarrow \text{ppbar } k+k-$ has excluded the contribution of intermediates, such as $\text{pk } \lambda(1520)$ and phi ppbar . We think both of two methods, the old one in 2nd version and the new one in 3rd version, are OK.

I need your comments on it --- excluding or including intermediate states? This will determine how I draft the paper. What's your point?

The updating includes:

0) The analysis is based on BOSS6.5.1-p02

1) All of measurements has excluded the intermediate states, such as measurement of $\chi_{cJ} \rightarrow \text{pk } \lambda(1520)$ exclude $\chi_{cJ} \rightarrow \lambda(1520) \lambda(1520)\text{bar}$ and measurements of $\chi_{cJ} \rightarrow \text{ppbar } k+k-$ exclude $\text{pk } \lambda(1520)$ and phi ppbar

2) The comments about cut χ^2 of kinematic fitting on 50 has been added.

3) According to Ronggang's suggestion, values of branching fractions of χ_{cJ} and $\text{phi} \rightarrow \text{KK}$ has been updated to 2010, which come from PDG website.

4) According to Ronggang's suggestions, model "AngSam" is used to produce MC for $\text{psi}(2S) \rightarrow \text{gamma } \chi_{c2}$ instead of model "P2GC2".

5) Model "AngSam3" is adopted to estimate uncertainty of generator for 3-body decay in χ_{cJ} , which generate MC with angular distribution.

6) Uncertainties of mass window of χ_{cJ} , phi and $\lambda(1520)$ are added.

7) 2% is quoted as uncertainty of Tracking efficiency and 4% quoted as uncertainty of total number of $\text{psi}(2S)$, as suggested.

8) Input-Output check and Cross check are added in the Appendix E.

9) Simultaneous fitting is adopted in the measurement of $\chi_{cJ} \rightarrow \lambda(1520) \lambda(1520)\text{bar}$.

Attachment:

http://hmbes3.ihep.ac.cn/HyperNews/get/AUX/2010/09/28/23.04-55110-ree_answer_2_memo_3rd.pdf

Chic2- \rightarrow lamlamb的第一级衰变也用的AngSam，说是因为boss版本的问题！！

$$\chi_{c2} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$$

```
Decay psi(2S)
1.0000 gamma chi_c2 AngSam 1.0 0.0769;
Enddecay

Decay chi_c2
1.0000 Lambda(1520)0 anti-Lambda(1520)0 AngSam 1.0 0.388;
Enddecay

Decay anti-Lambda(1520)0
1.0000 anti-p- K+ PHSP;
Enddecay

Decay Lambda(1520)0
1.0000 p+ K- PHSP;
Enddecay

End
~
~
```

$$\chi_{c0} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$$

```
Decay psi(2S)
1.0000 gamma chi_c0 P2GC0;
Enddecay

Decay chi_c0
1.0000 Lambda(1520)0 anti-Lambda(1520)0 AngSam 1.0 -0.0217;
Enddecay

Decay anti-Lambda(1520)0
1.0000 anti-p- K+ PHSP;
Enddecay

Decay Lambda(1520)0
1.0000 p+ K- PHSP;
Enddecay

End
~
```

$$\chi_{c2} \rightarrow p\bar{p}\phi$$

```
Decay psi(2S)
1.0000 gamma chi_c2 AngSam 1.0 0.0769;
Enddecay

Decay chi_c2
1.0000 p+ anti-p- phi PHSP;
Enddecay

Decay phi
1.0000 K+ K- VSS;
Enddecay
```

$\chi_{c0} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$			
09AngSam/092dfit/Mycut	68	18.13%	7.07×10^{-4}
09AngSam/09sideband/Mycut	57	16.47%	6.53×10^{-4}
0912PHSP/0912sideband/cut与Gengc相同	260	15.38%	7.61×10^{-4}
09AngSam/09sideband/cut与Gengc相同	68	16.8%	7.63×10^{-4}
09PHSP/09sideband/Mycut	57	16.4%	6.55×10^{-4}
09PHSP/09sideband/cut与Gengc相同	68	16.7%	7.68×10^{-4}
0912PHSP/09122dfit/Mycut	273 ± 21	16.8%	7.33 ± 0.56
09PHSP/092dfit/Mycut	68	18.3%	7.00×10^{-4}
Gengc	28.1 ± 9.8	17.1 ± 0.1	$(3.18 \pm 1.11) \times 10^{-4}$

1. 比较09年AngSam和Gengc的结果发现， $\chi_{c0} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$ 是效率相同，但信号事例数09年的AngSam是Gengc的两倍多， $\chi_{c2} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$ 的09年的AngSam是他的两倍多，但信号事例数是Gengc的1.5倍，没到两倍。
2. 年份和产生子没有影响。

效率

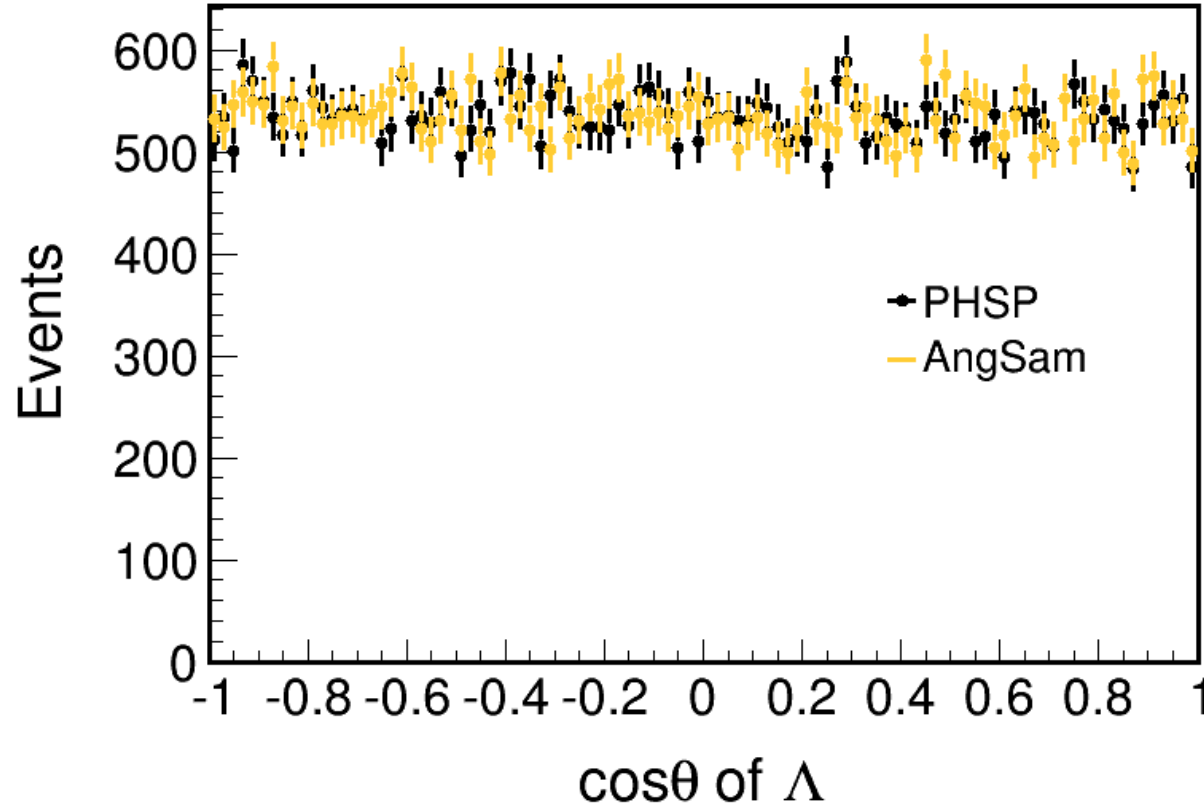
	0912PHSP	09PHSP	09AngSam
Sideband (1.47,1.57)(Mycut)	15.1%	16.41%	16.47%
Sideband(1.47,1.57)(Gengc)	15.38%	16.75%	16.80%
	0912PHSP	09PHSP	09AngSam
Fit range cut(1.47,1.77)(Mycut)	16.78%	18.32	18.13

信号事例数

效率和信号事例数分别用sideband和2dfit方法得到的时候，由于使用的cut条件不同会有差别！

	0912data	09data
Sideband(1.47,1.57)(Mycut)	249	57
Sideband(1.47,1.57)(Gengc)	260	68
	0912data	09data
2dfit	273 ± 21	68

Mctruth角分布对比 (no boost) , PHSP和AngSam保持一致 (chic0)



$$\alpha = -0.02$$

角分布几乎为零，两种产生子的效率没有太大差别。

```
Decay psi(2S)
1.0000 gamma chi_c0 P2GC0;
Enddecay

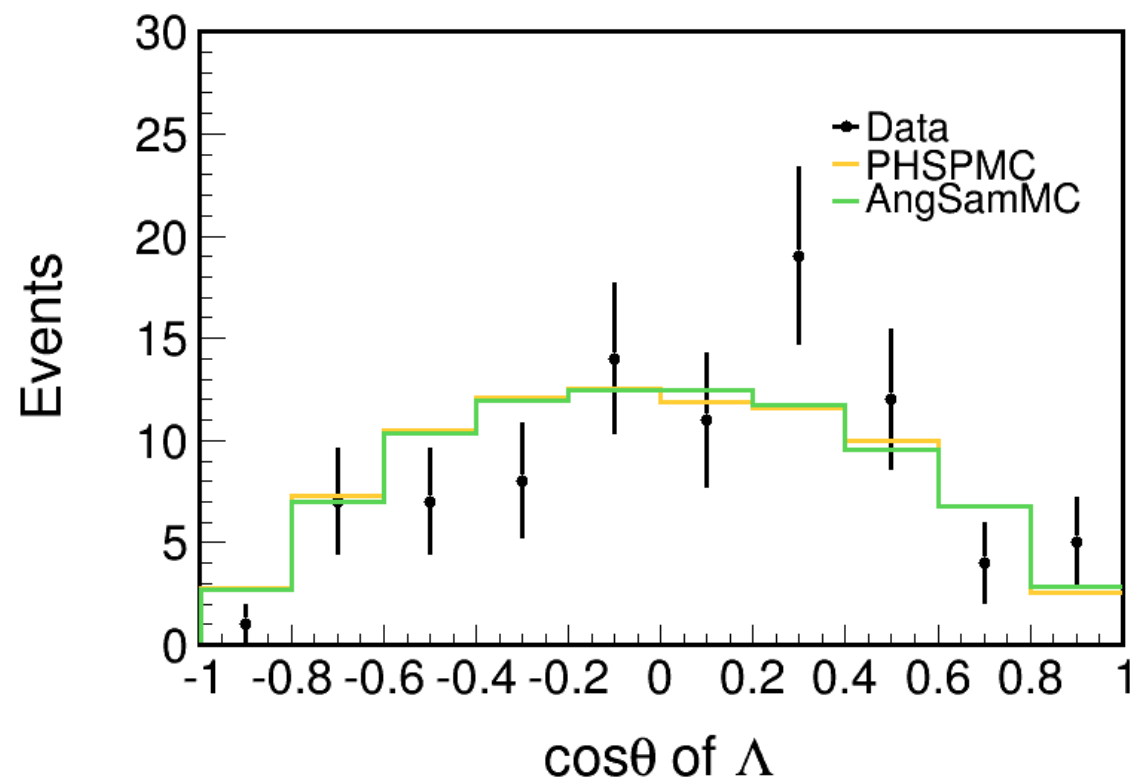
Decay chi_c0
1.0000 Lambda(1520)0 anti-Lambda(1520)0 AngSam 1.0 -0.0217;
Enddecay

Decay anti-Lambda(1520)0
1.0000 anti-p- K+ PHSP;
Enddecay

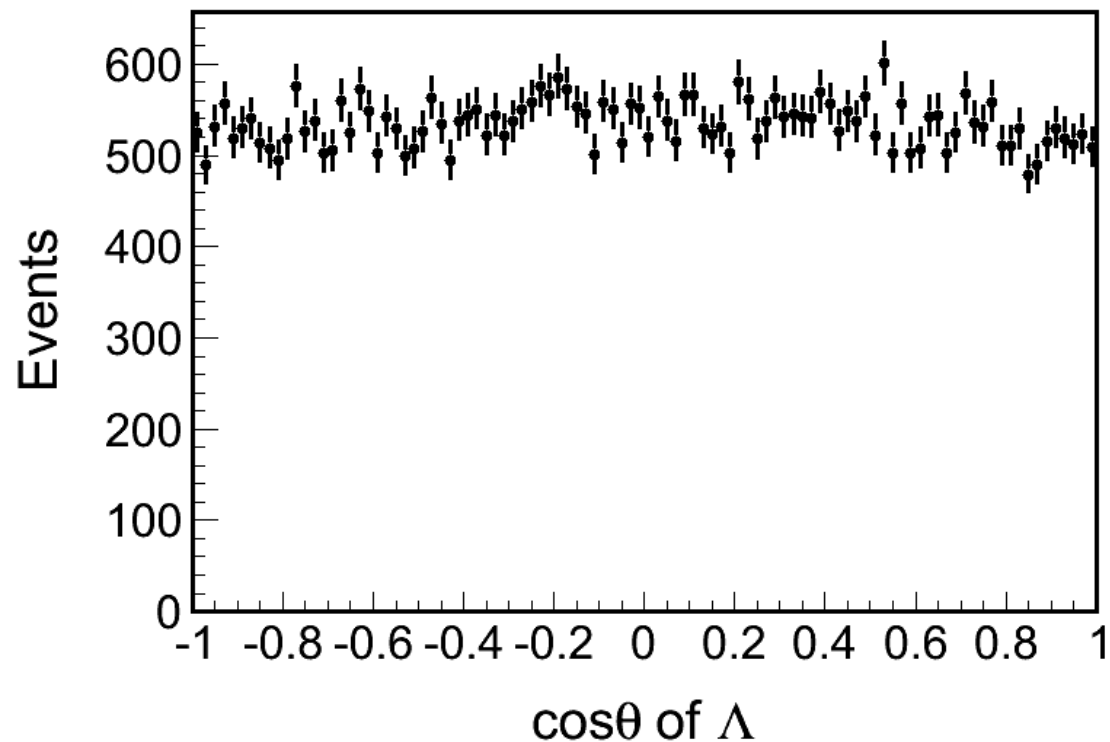
Decay Lambda(1520)0
1.0000 p+ K- PHSP;
Enddecay

End
~
```

限制在 $\Lambda(1520)$ 信号区域内的 $\cos\theta$ [1.47, 1.57]



验证 α 的取值是否影响 $\cos\theta$ of $\Lambda(1520)$ 的曲线弧度



产生 $\alpha = -0.6$ 的signalMC

看起来是平的！存疑？

```
Decay psi(2S)
1.0000  gamma chi_c0                P2GC0;
Enddecay

Decay chi_c0
1.0000  Lambda(1520)0 anti-Lambda(1520)0  AngSam 1.0 -0.6;
Enddecay

Decay anti-Lambda(1520)0
1.0000  anti-p-      K+                PHSP;
Enddecay

Decay Lambda(1520)0
1.0000  p+          K-                PHSP;
Enddecay

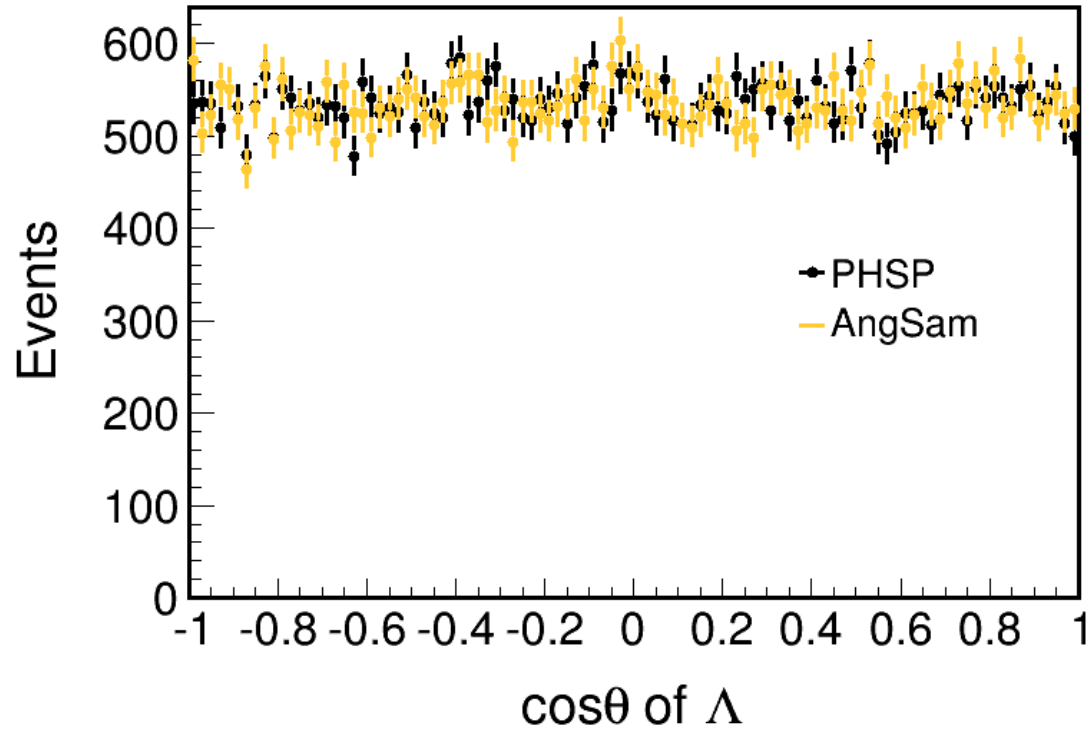
End
```

$\chi_{c2} \rightarrow \Lambda(1520)\bar{\Lambda}(1520)$	Nsig	effi	Br
09AngSam0.388 (2dfit)	44	24.0%	3.55×10^{-4}
09AngSam0.388 (Sideband)	57	21.64%	5.11×10^{-4}
09PHSP(2dfit)	44	23.83%	3.58×10^{-4}
09PHSP(sideband)	57	21.42%	5.16×10^{-4}
PHSP(0912)(2dfitmemo)	131 ± 16	22.7	2.68 ± 0.33
Gengc	28.9 ± 7.4	12.2 ± 0.1	5.05 ± 1.29

	0912PHSP	09PHSP	09AngSam
Sideband (1.47,1.57)(Mycut)		21.42%	21.64%
Sideband(1.47,1.57)(Gengc)			

	0912PHSP	09PHSP	09AngSam
Fit range cut(1.47,1.77)(Mycut)		23.83%	24.0%

Mctruth角分布对比 (no boost), PHSP和AngSam (chic2)



$$\alpha = 0.388$$

```
Decay psi(2S)
1.0000  gamma chi_c2                P2GC2;
Enddecay

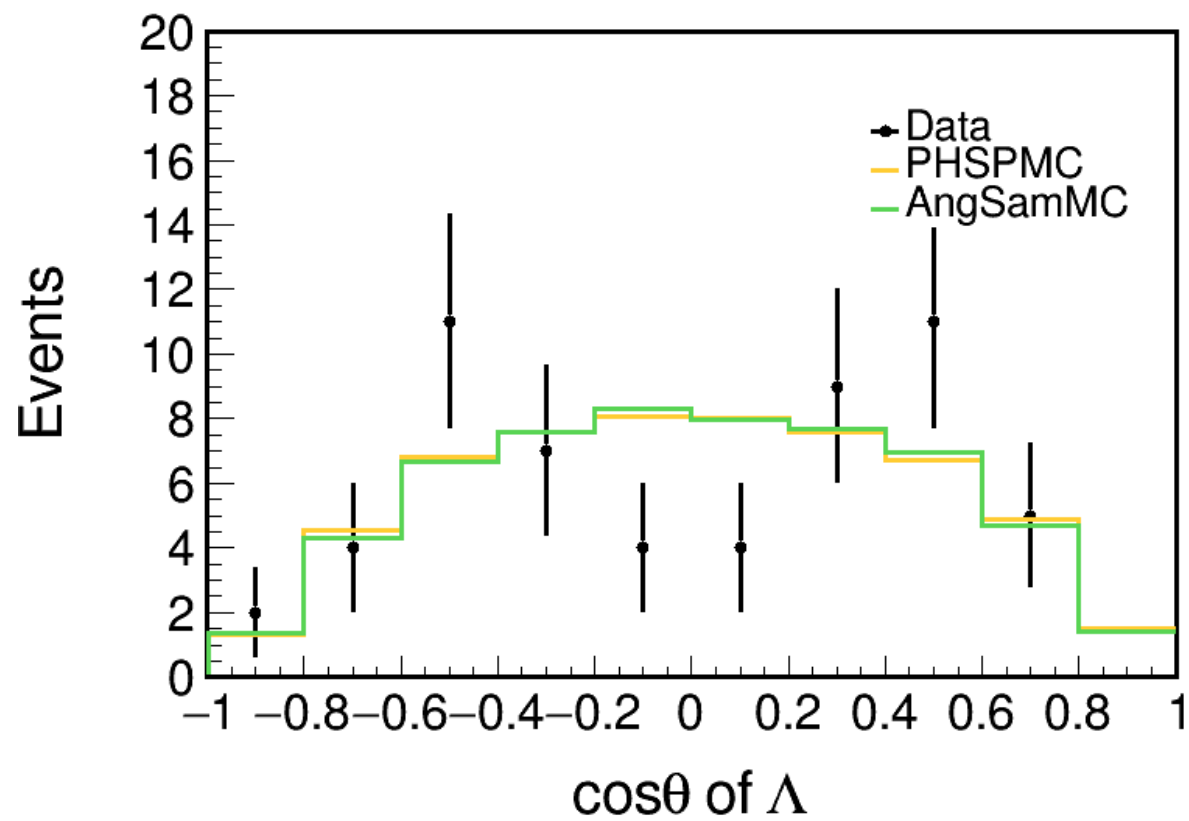
Decay chi_c2
1.0000  Lambda(1520)0 anti-Lambda(1520)0  AngSam 1.0 0.388 ;
Enddecay

Decay anti-Lambda(1520)0
1.0000  anti-p-    K+                PHSP;
Enddecay

Decay Lambda(1520)0
1.0000  p+    K-                PHSP;
Enddecay

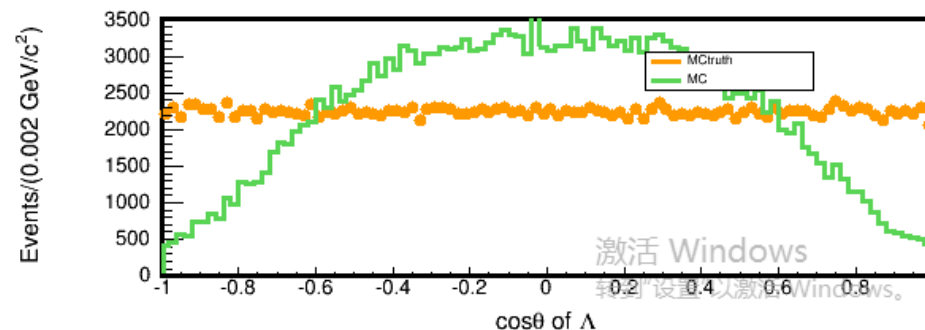
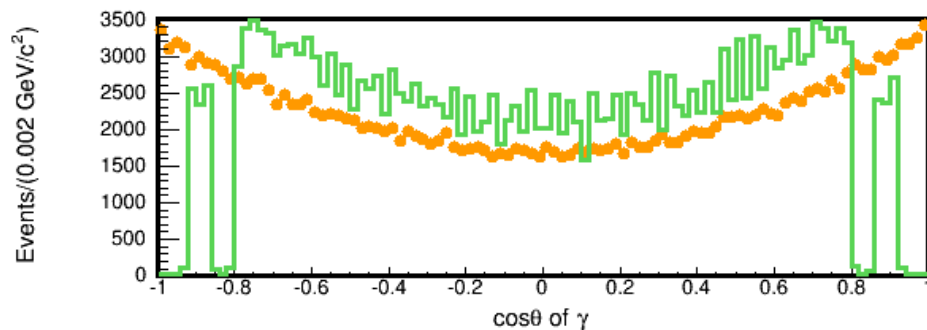
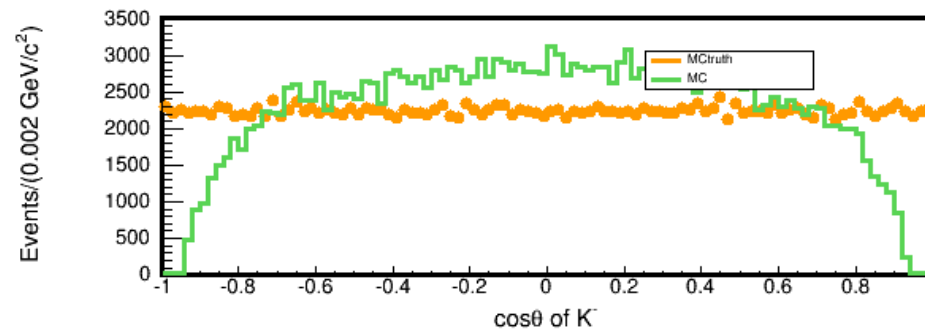
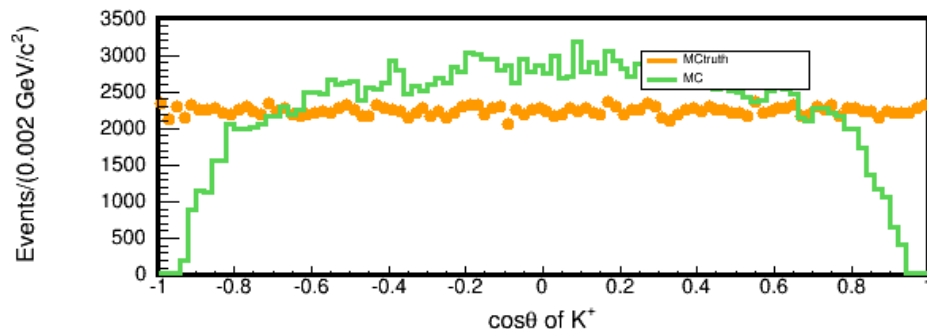
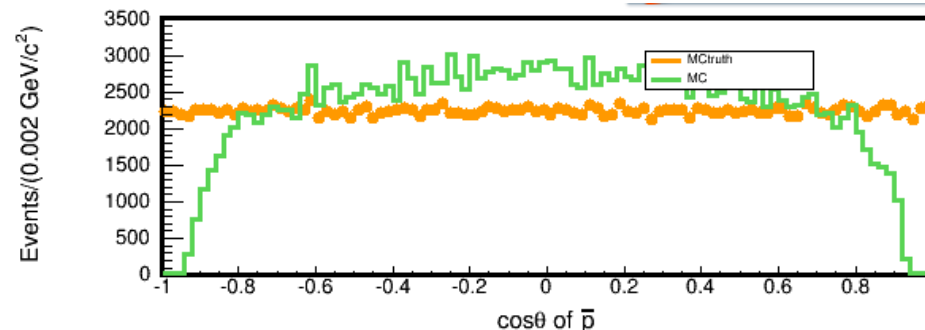
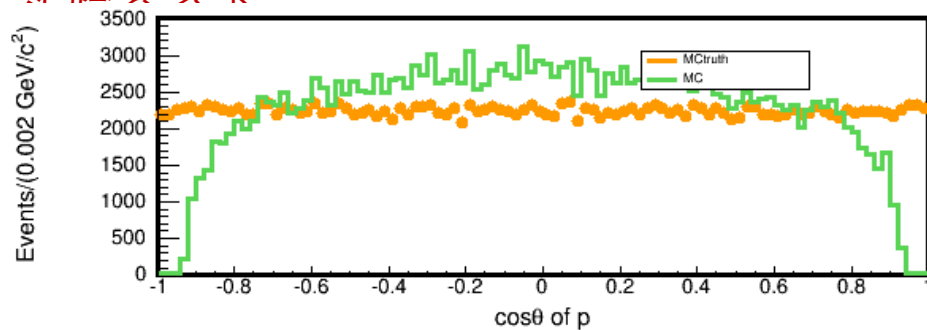
End
~
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```

限制在 $\Lambda(1520)$ 信号区域内的 $\cos\theta$ [1.47, 1.57]



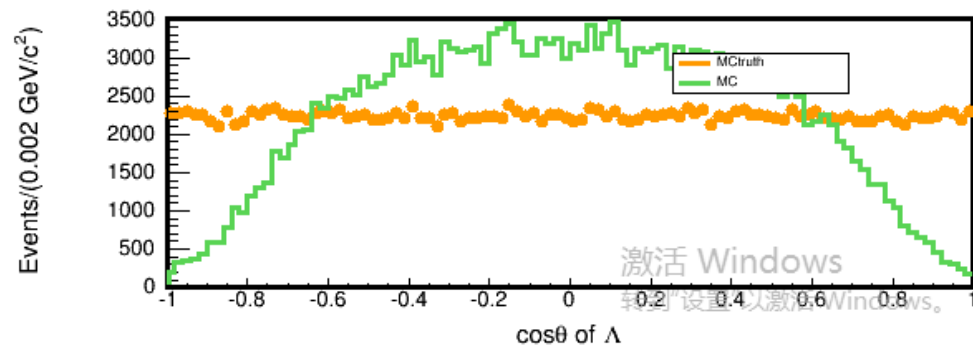
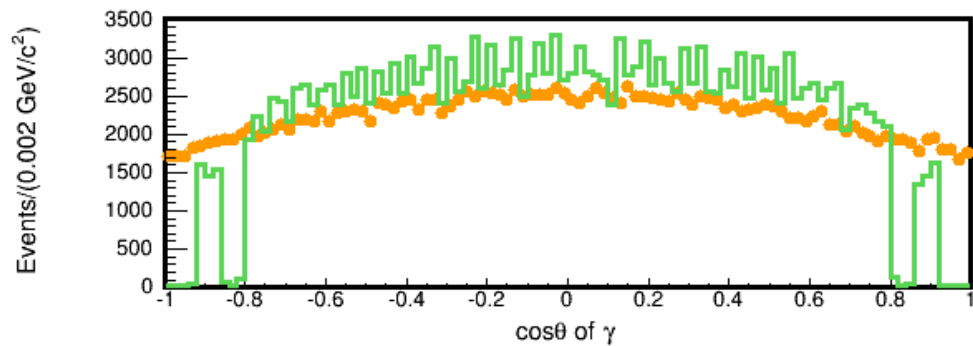
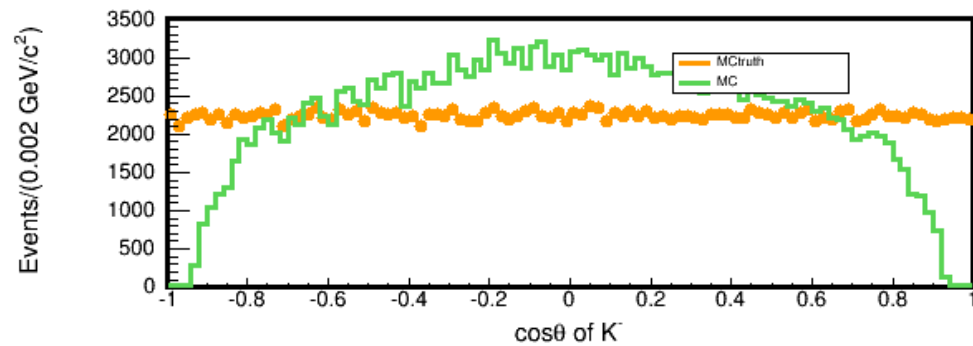
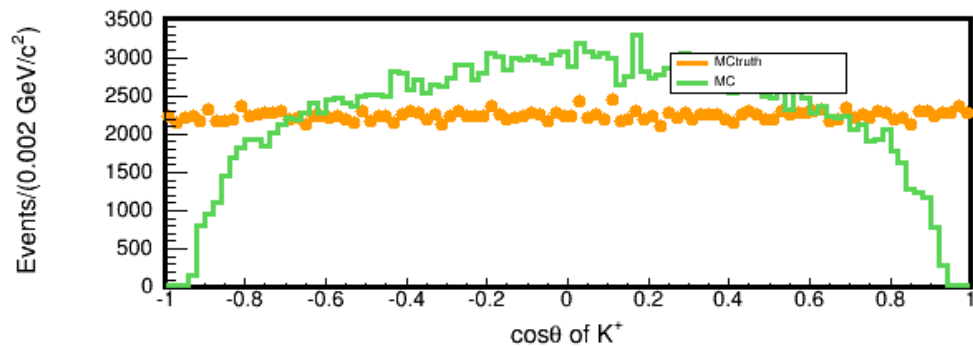
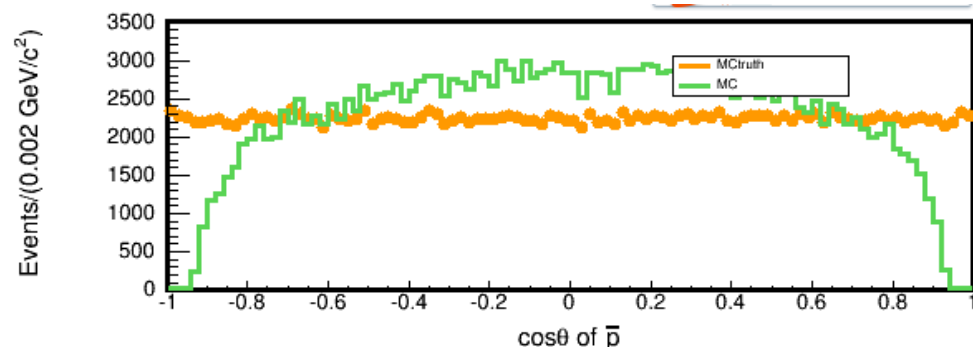
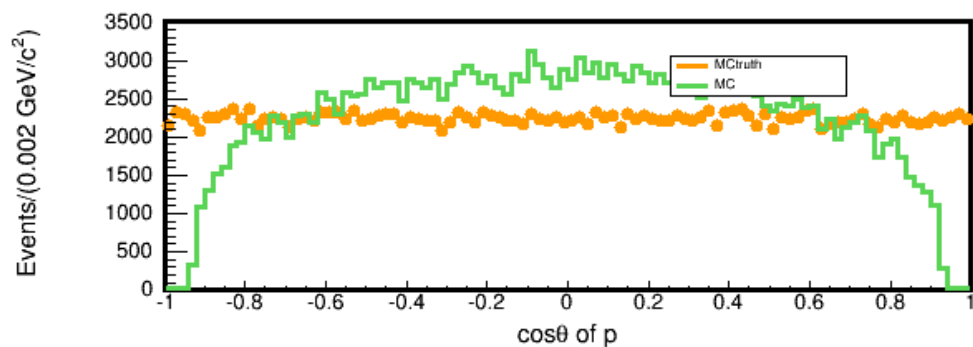
关于 $\cos\theta$ 的Mctruth和MC的对比图 (PHSP)

χ_{c0} no boost 静止系下



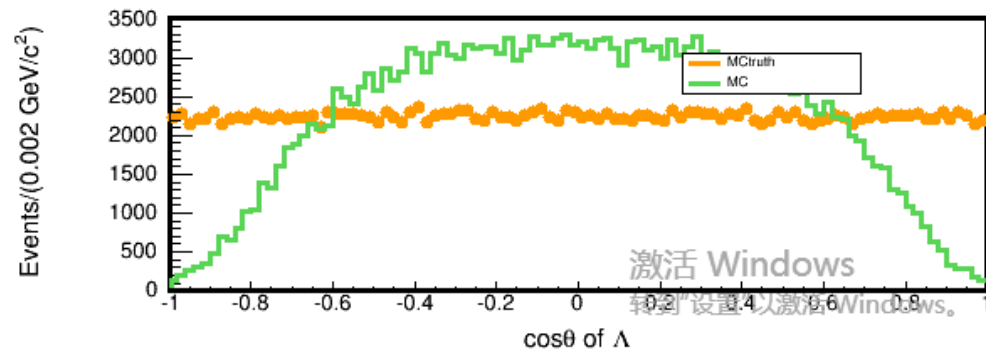
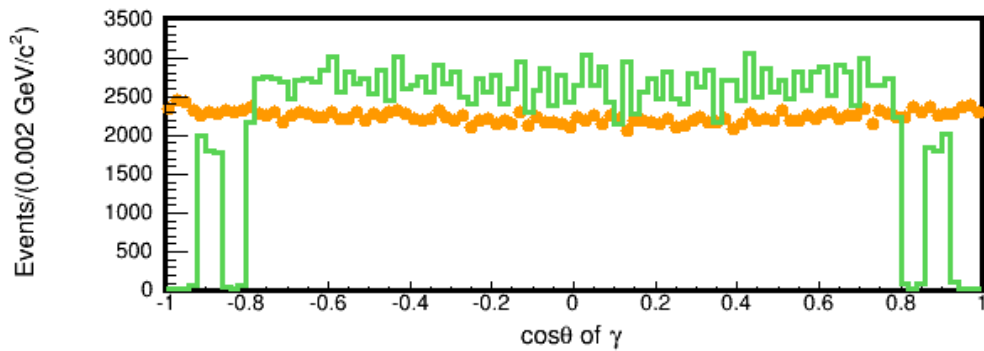
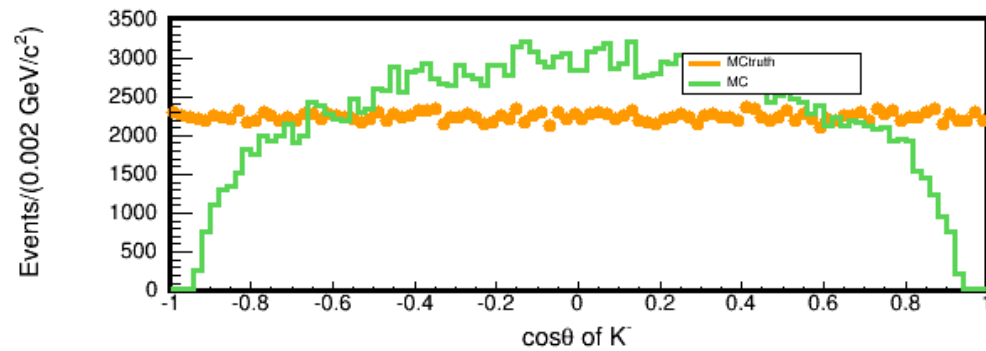
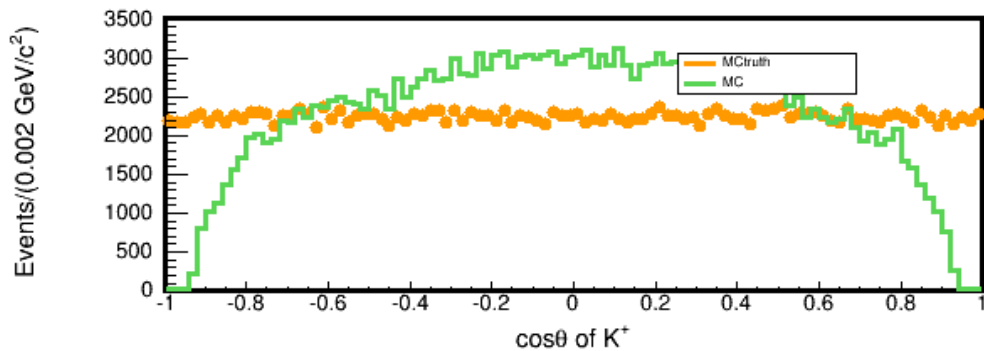
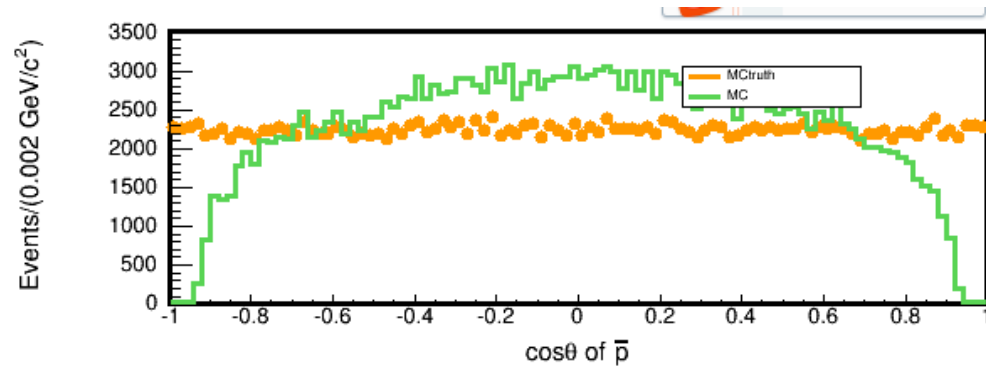
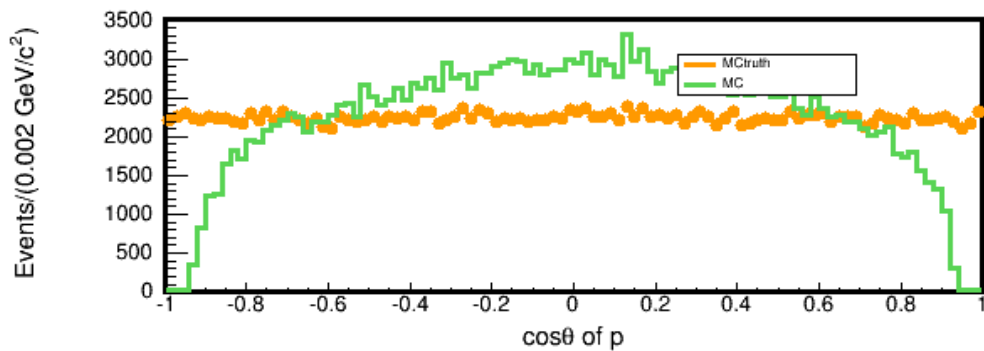
激活 Windows
转到设置以激活 Windows。

χ_{c1} no boost 实验室系下



激活 Windows
转到设置以激活 Windows。

χ_{c2} no boost 实验室系下



激活 Windows
转到设置以激活 Windows。