Study of $\gamma^*\gamma^* \to p\bar{p}$ through un-tag method

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MC Generation

➢ MC Generation

1. cppGamGam Generator helps to obtain the momentum of final particles $e^+e^-p\bar{p}$.
2. Simulation: TrackGen
3. Reweight $M_{p\bar{p}}$ according to the estimated yield.

Decay card

```
noPhotos
Particle vpho 3.773 0.0

Decay vpho
1.000  e-  e+  p+  anti-p-  TrackGen  0;
Enddecay

End
```

Simulation

```
//**************job options for EvtGen***************
#include "$BESEVTGENROOT/share/BesEvtGen.txt"
EvtDecay.userDecayTableName = "gamgamtoppbar.dec";
EvtDecay.FileForTrackGen = {"../../p4sample/ppbar3773-1.dat"};
EvtDecay.ParentParticle = "vpho";
EvtDecay.statDecays = true;
```

MC Generation

- Yield Estimation of $\gamma\gamma \to p\bar{p}$ at 3.773GeV

$$N_{ee\to p\bar{p}} = \int \sigma_{\gamma\gamma\to p\bar{p}}(W_{\gamma\gamma}) * L_{int} * \frac{dL_{\gamma\gamma}(W_{\gamma\gamma}, E_{cms})}{dW_{\gamma\gamma}} dW_{\gamma\gamma}$$

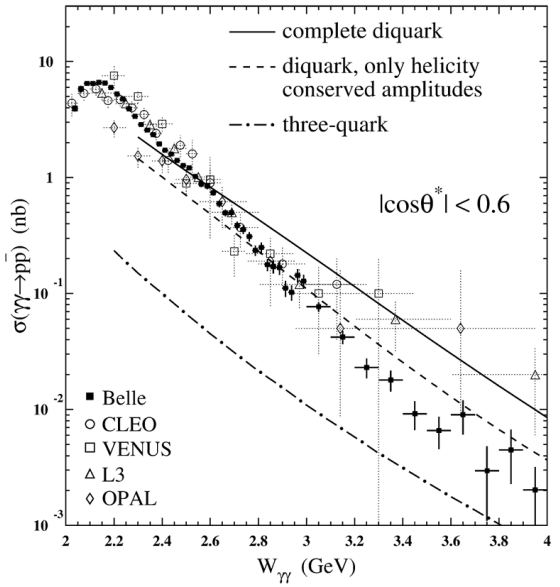


Fig. $\sigma_{\gamma\gamma\to p\bar{p}}(W_{\gamma\gamma})$ Belle Collaboration Physics Letters B 621 (2005) 41–55

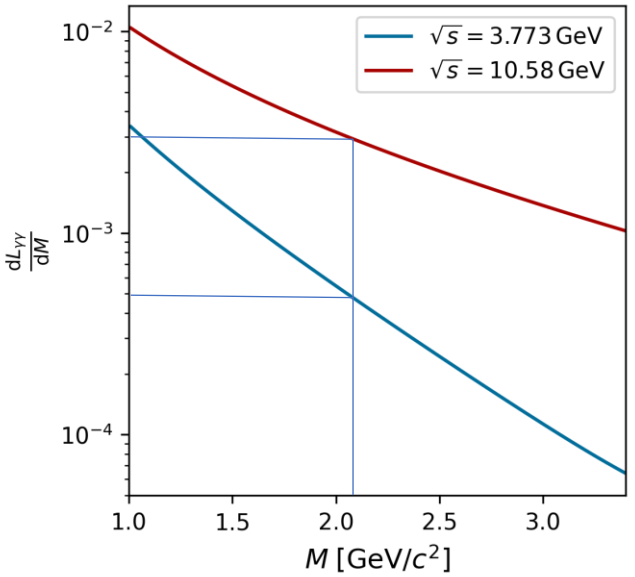
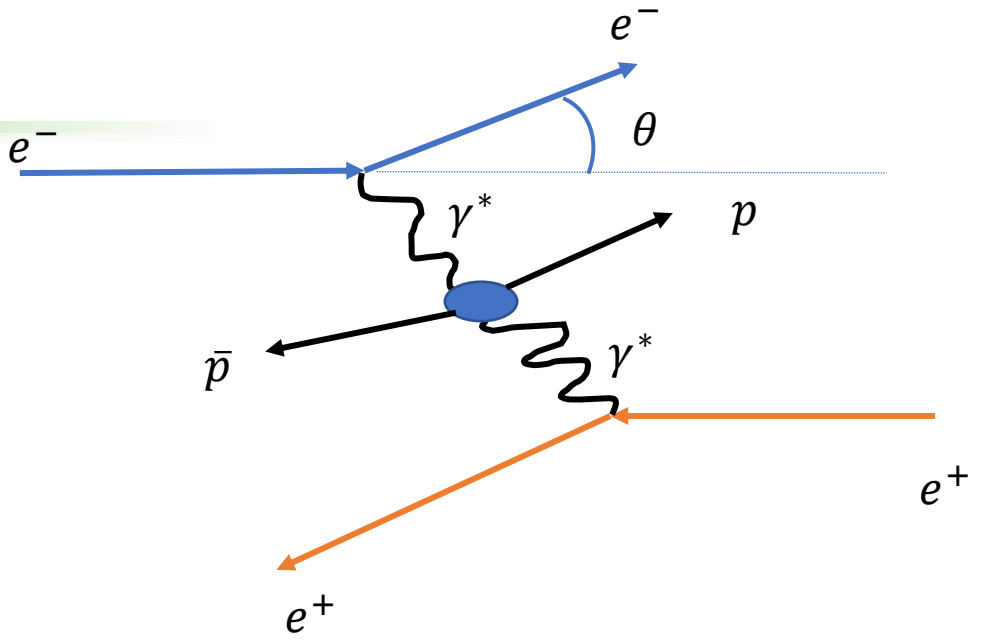


Fig. $\frac{dL_{\gamma\gamma}(W_{\gamma\gamma})}{dW_{\gamma\gamma}}$ calculation.



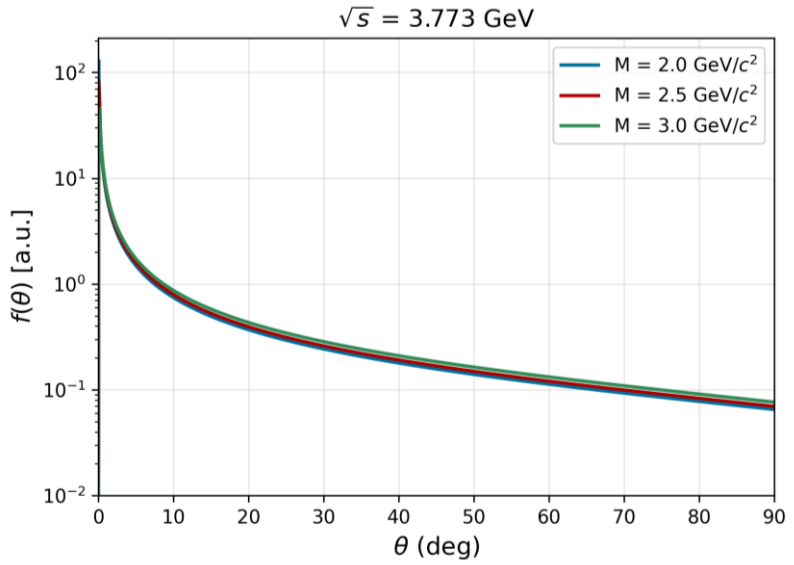


Fig. angular distribution of electron

$P(cos\theta > 0.92)$:
0.84 for 2.0GeV
0.82 for 2.5GeV
0.81 for 3.0GeV

Untag:0.69
Single:0.28
Double:0.03

MC Generation

- Yield Estimation of $\gamma\gamma \to p\bar{p}$ at 3.773GeV

  Angle distribution of $p/\bar{p}$ in $\gamma\gamma \to p\bar{p}$

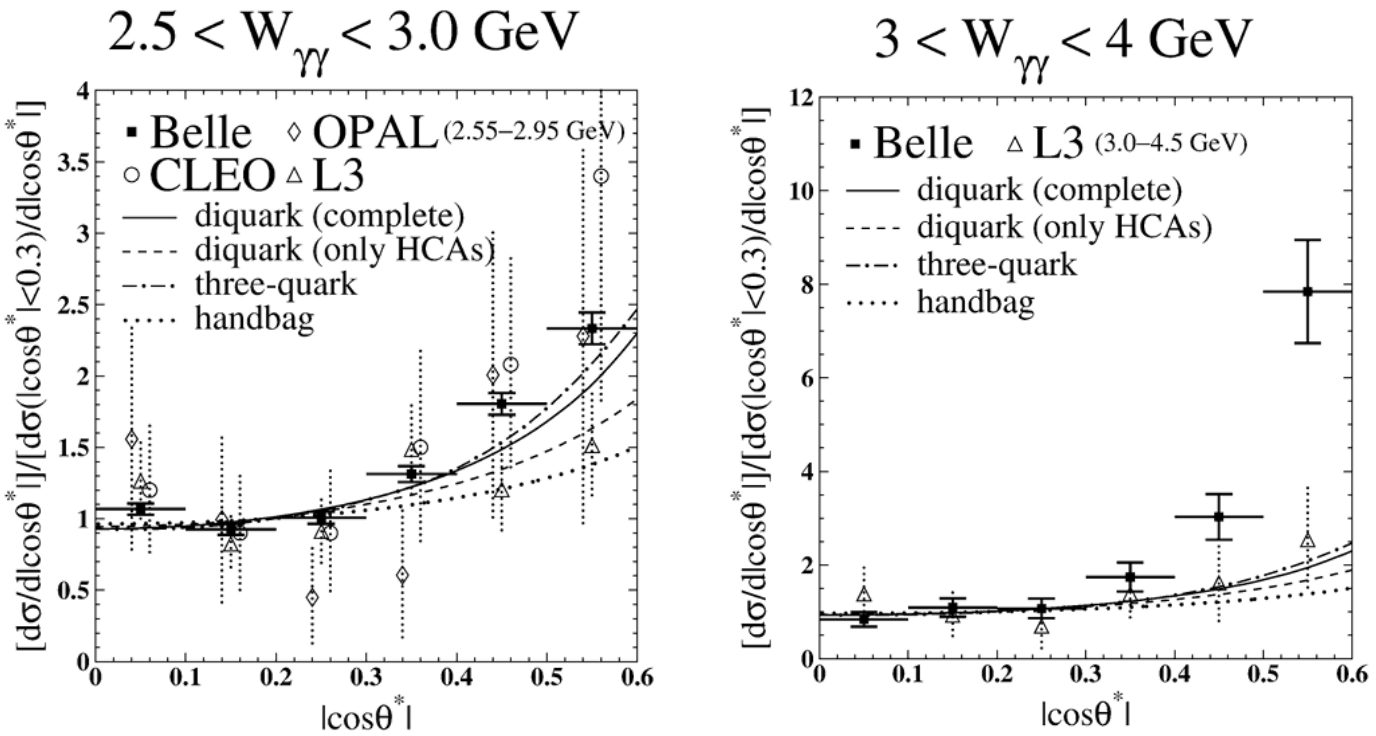


Fig. Differential cross section as a function of $|cos\theta^*|$.

MC Generation

- Yield Estimation of $\gamma\gamma \to p\bar{p}$ at 3.773GeV

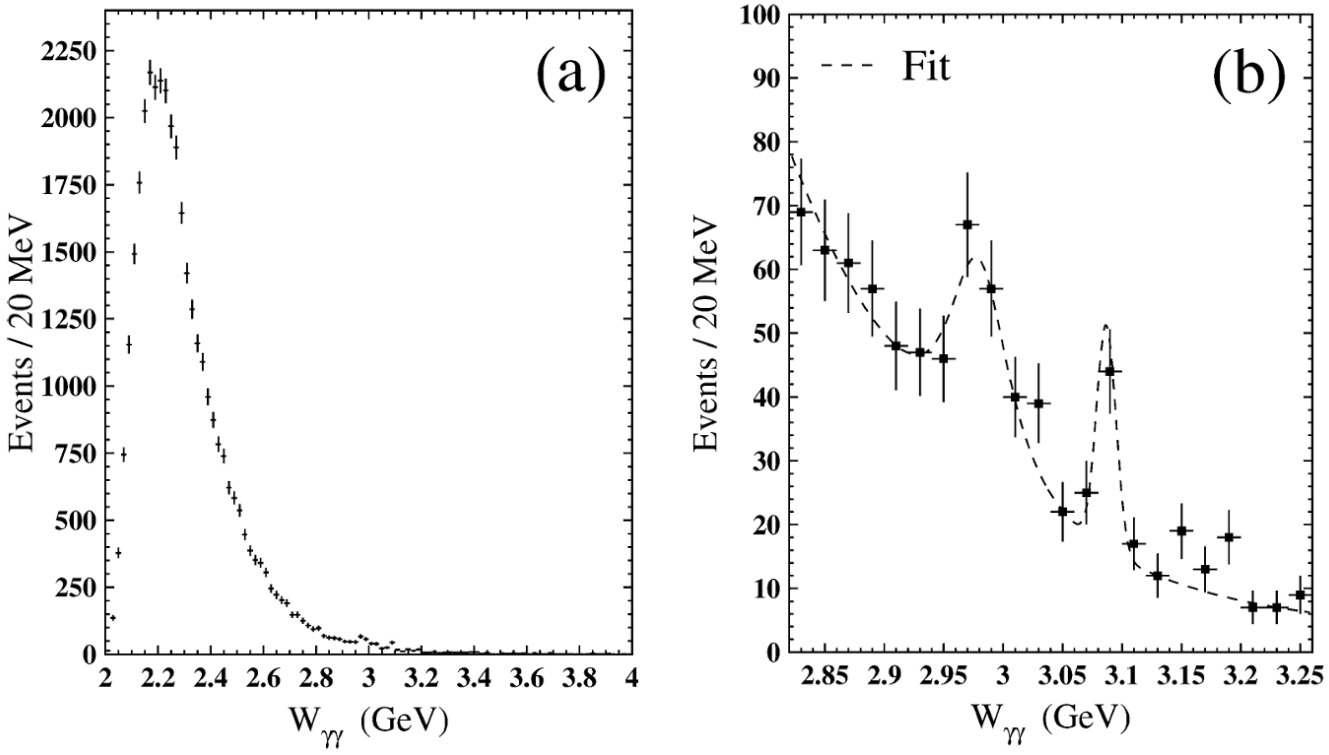


Fig. $W_{\gamma\gamma}$ distribution of events passing all the selection criteria.

Belle 89fb $^{-1}$ at 10.58GeV; $W_{\gamma\gamma} = 2 - 4GeV$, 36094 events

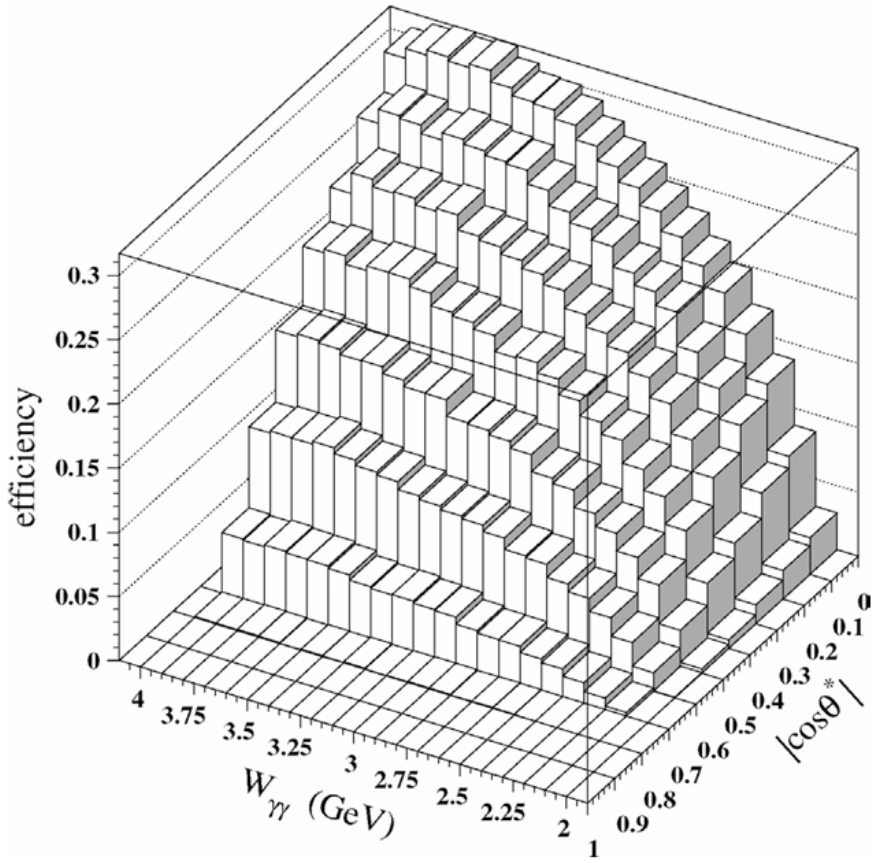


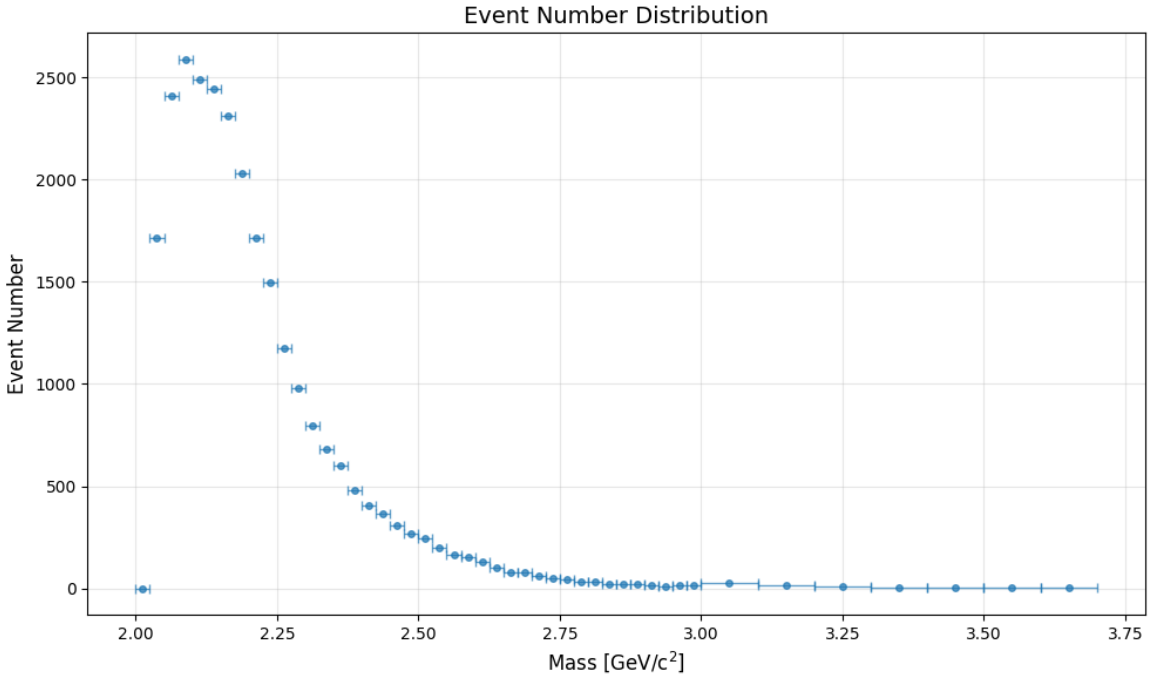
Fig. Overall detection efficiency of $\gamma\gamma \to p\bar{p}$ as a function of $W_{\gamma\gamma}$ and $|cos\theta^*|$

MC Generation

- Yield Estimation of $\gamma\gamma \to p\bar{p}$ at 3.773GeV

$$N_{ee\to p\bar{p}} = \int \sigma_{\gamma\gamma\to p\bar{p}}(W_{\gamma\gamma}) * L_{int} * \frac{dL_{\gamma\gamma}(W_{\gamma\gamma})}{dW_{\gamma\gamma}} dW_{\gamma\gamma}$$

Based on the assumption that $\gamma\gamma \to p\bar{p}$ follows a phase space distribution.



25MeV/Bin 100MeV/Bin

$$\frac{L_{Belle} * \frac{dL}{dW}(Belle) * \epsilon_{Belle}}{L_{BES} * \frac{dL}{dW}(BES) * \epsilon_{BES}} = 4.5*5*0.2=4.5$$

预期:
Untag 10000 events
Stag 1000 events

Single tag

➢ Data and MC samples:

BOSS: 712

Data set: full data sat at 3.773GeV, 20.3fb $^{-1}$

IncMC sample: Hadron Hybrid; 0.25x Bhabha; 15x dimu; 1x $\gamma\gamma \to ee, \mu\mu, \pi\pi, KK, \eta, \eta'$

ExcMC sample: 1.5M $\gamma\gamma \to p\bar{p}$

➢ Event selection:

- Good charged track:

$$|V_{xy}| < 1cm, |V_z| < 10cm, |\cos\theta| < 0.93$$

$$N_{good} = 2, N_{charge} = 0$$

- PID:

p: prob(p)>prob(e, μ, π, K),0.001

e: prob(e)>prob(μ, π, K, p),0.001

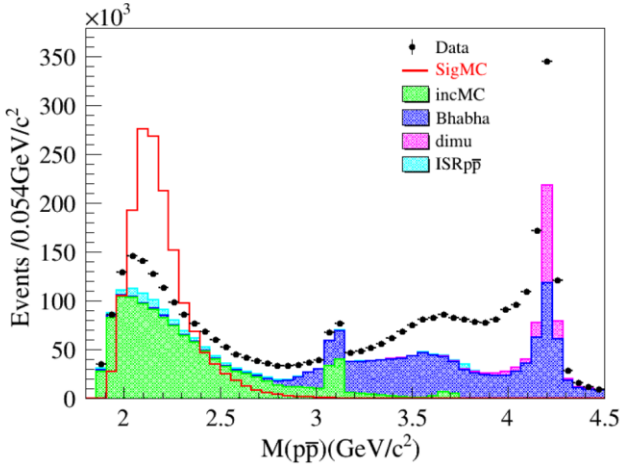
$$N_p = N_{\bar{p}} = 1$$

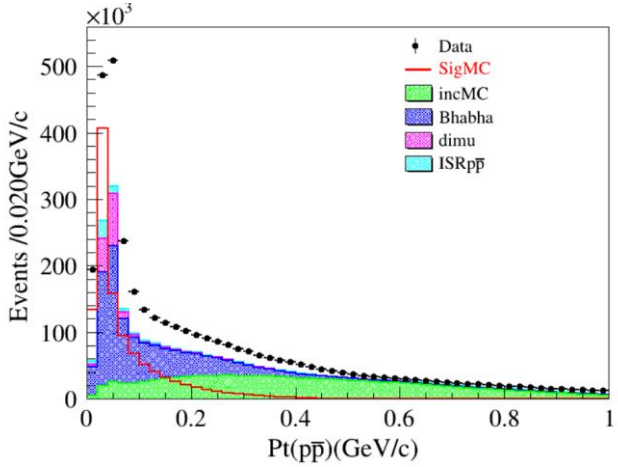
- Vertex Fit:

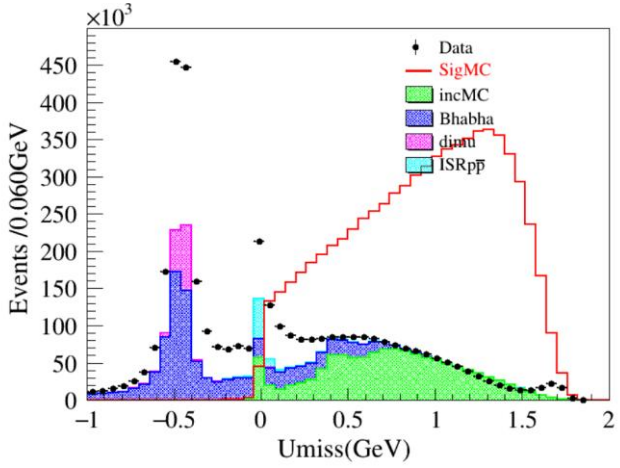
Vertex fit for $p\bar{p}$, success;

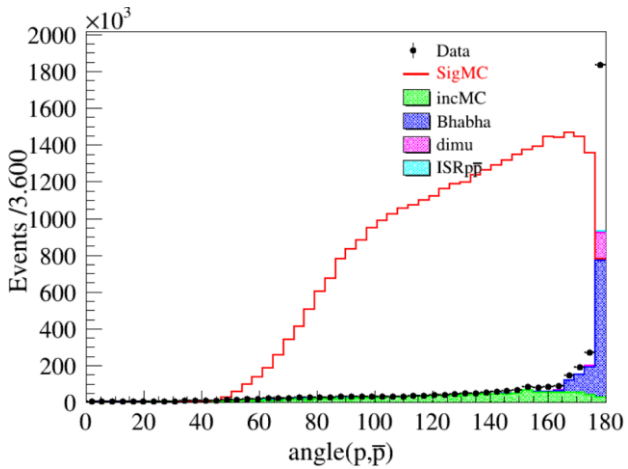
Further Event selection

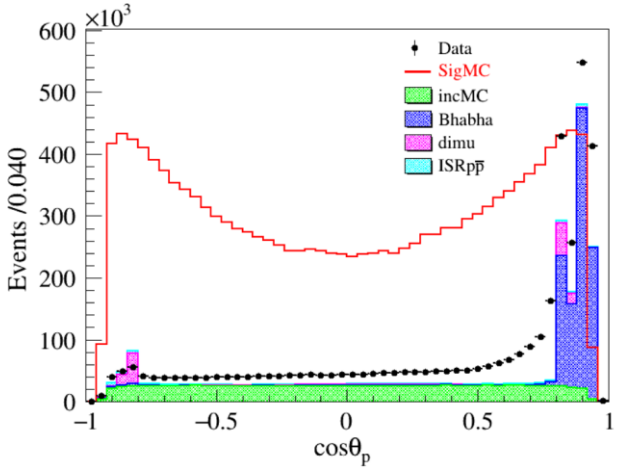
初筛后的质量谱和特征谱:

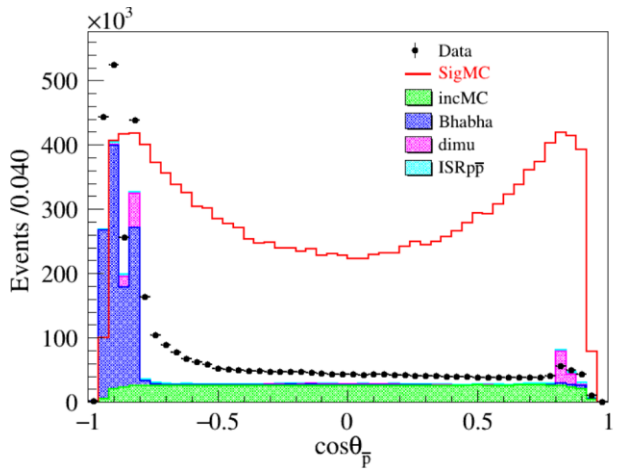


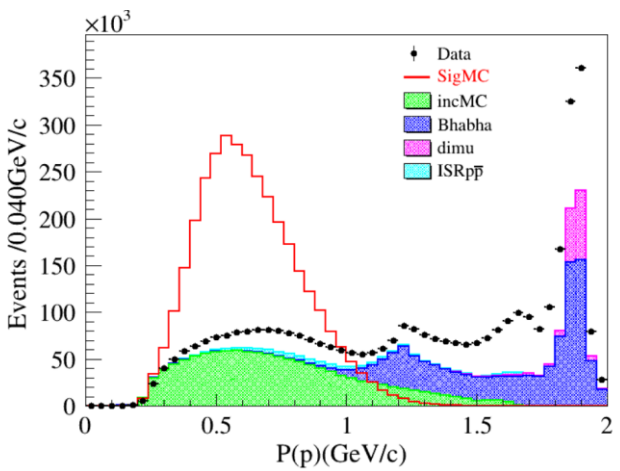


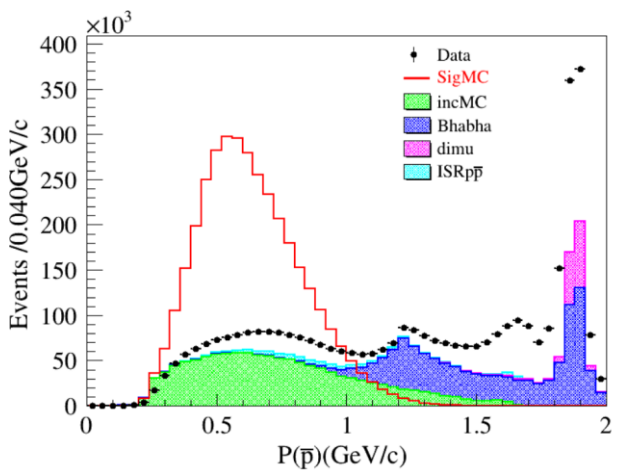








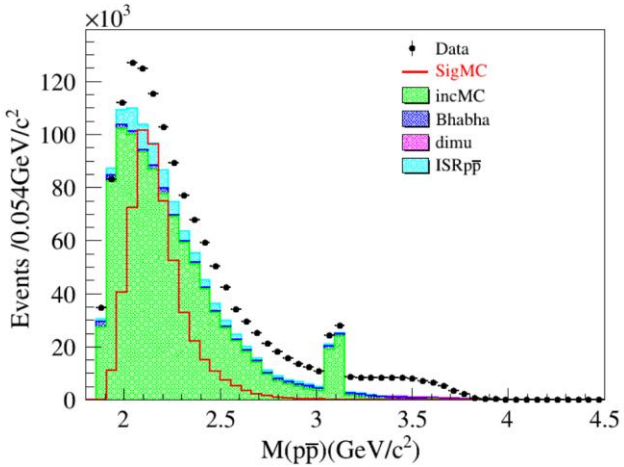


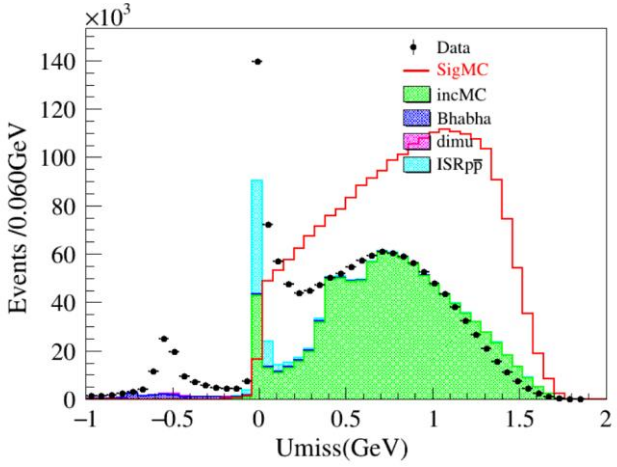


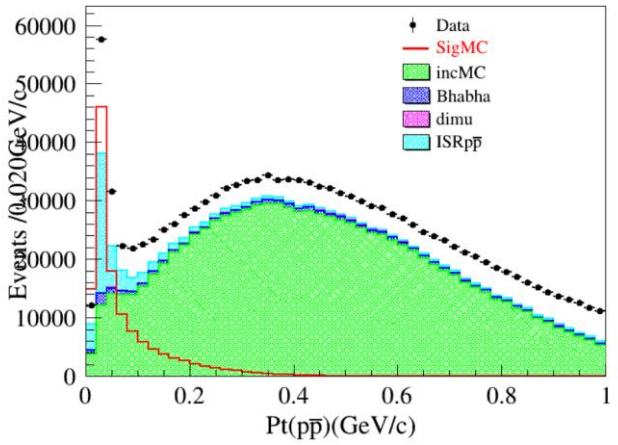
Further Event selection

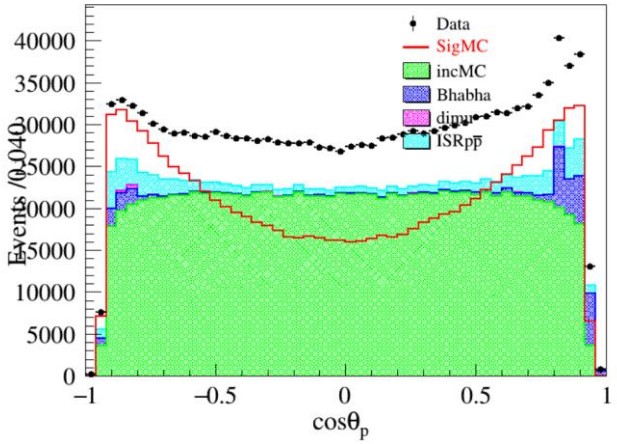
$angle(p, \bar{p}) < 165$

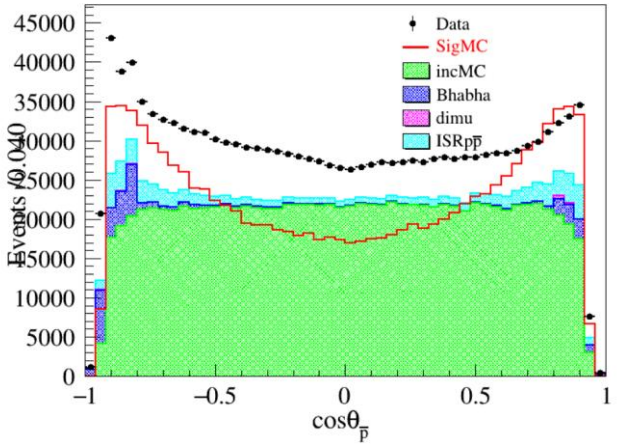
通过ppbar夹角排除Bhabha本底

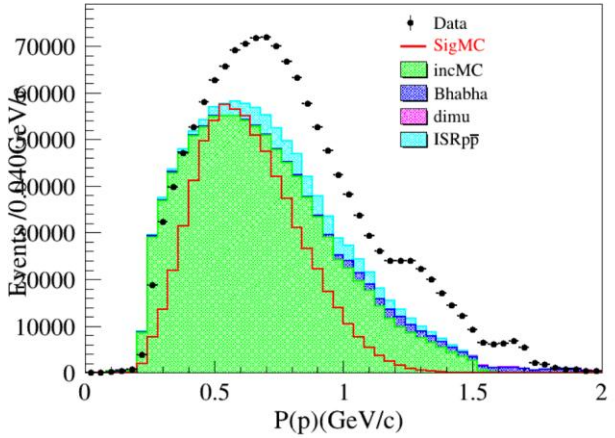


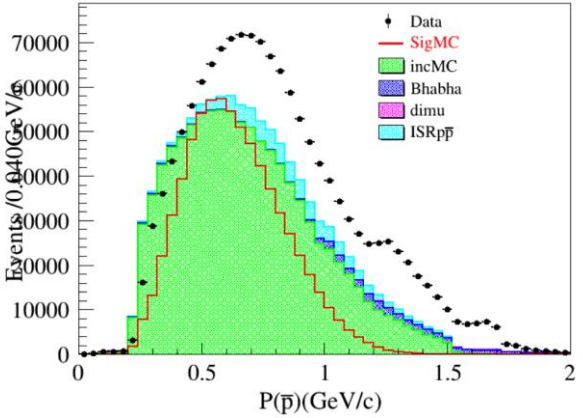








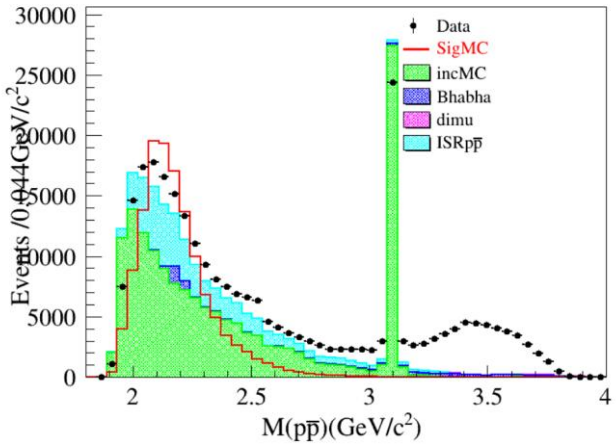


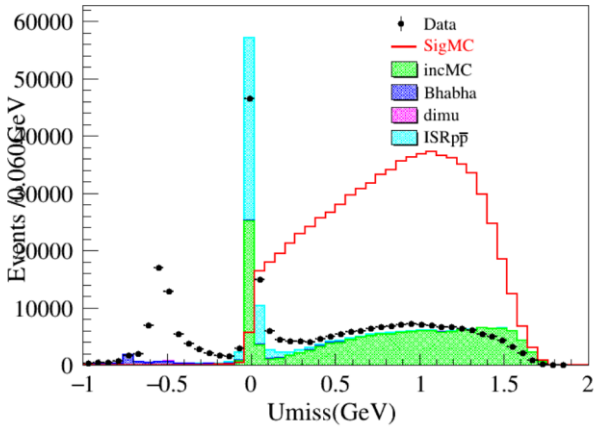


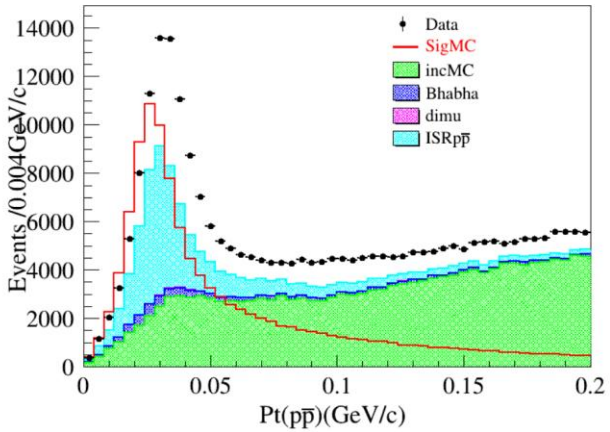
Further Event selection

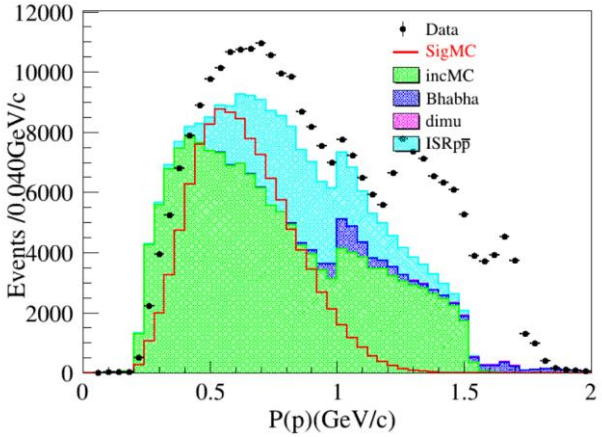
$angle(p,\bar{p}) < 165$
$Pt(p\bar{p}) < 0.2GeV/c$

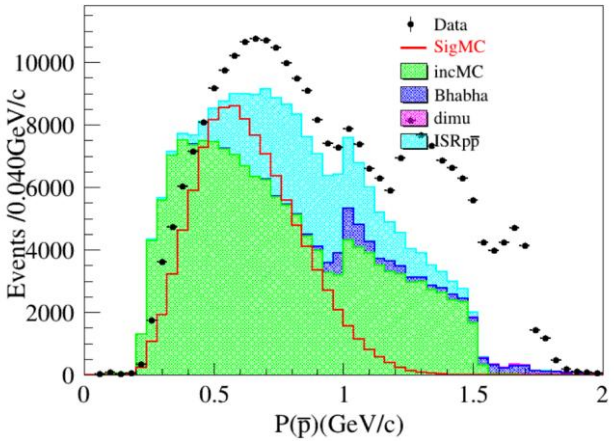
通过ppbar横动量压低本底

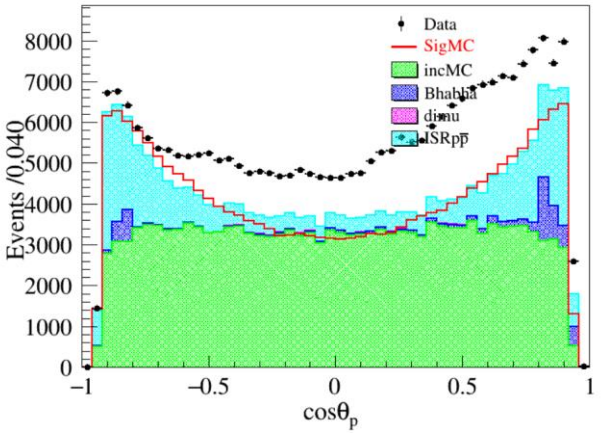


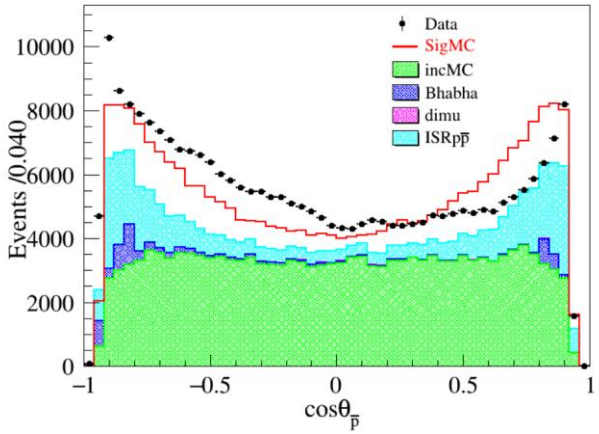








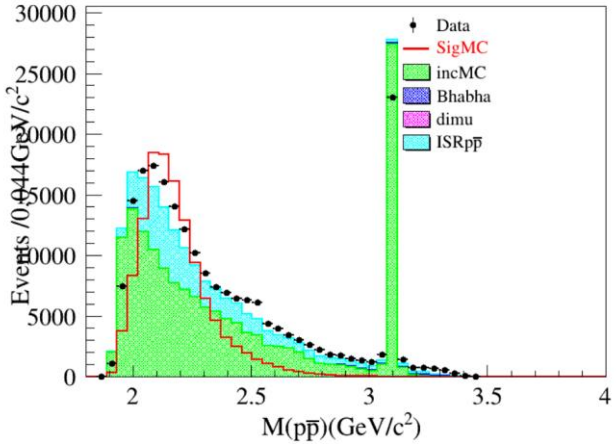


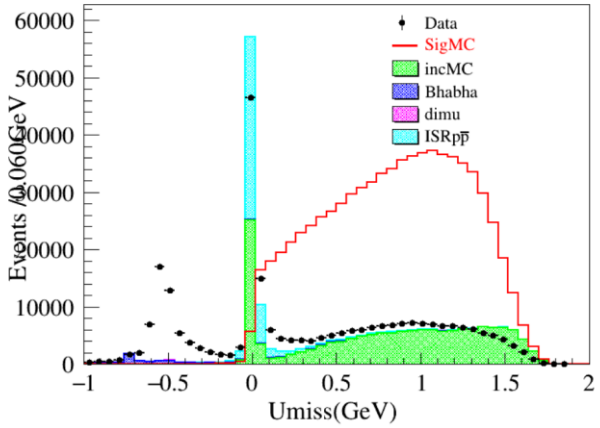


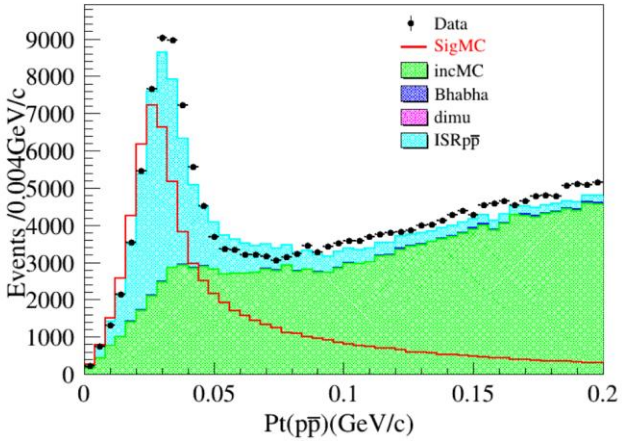
Further Event selection

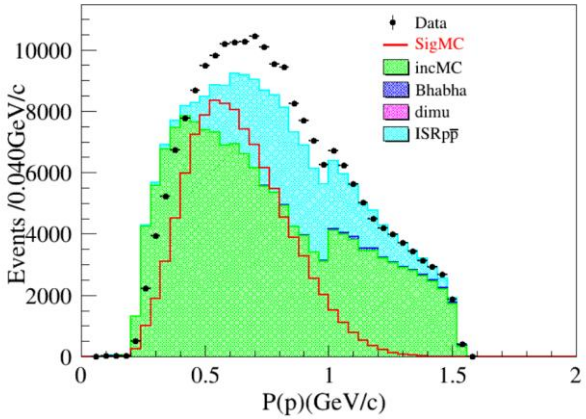
$$angle(p,\bar{p}) < 165$$
$$Pt(p\bar{p}) < 0.2GeV/c$$
$$Umiss > -0.1GeV$$

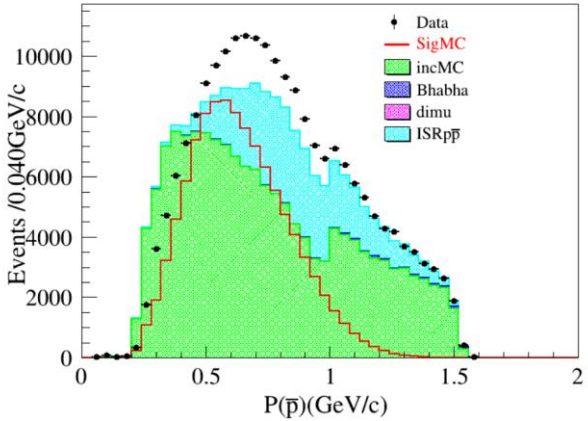
通过Umiss压低误鉴别和辐射ppbar本底

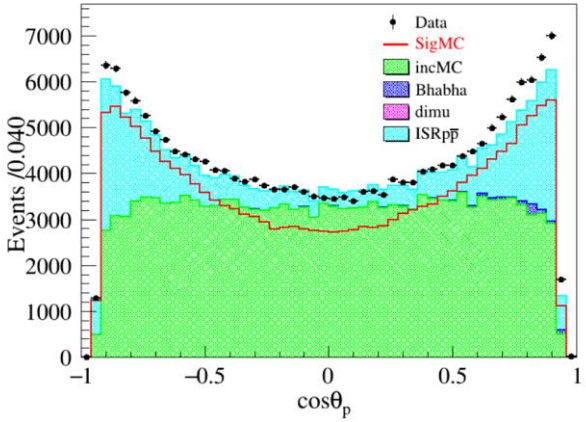


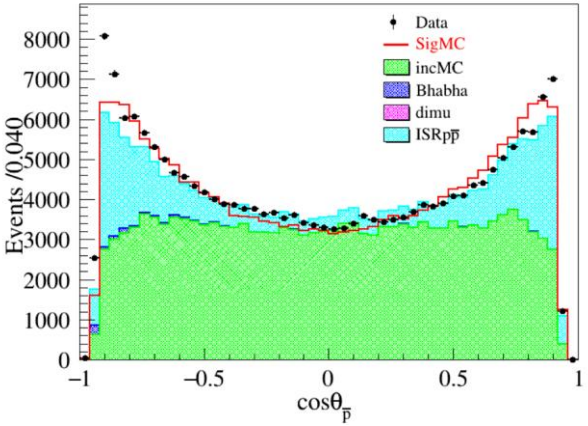












Further Event selection

$$angle(p,\bar{p}) < 165$$
$$Pt(p\bar{p}) < 0.2GeV/c$$
$$Umiss > -0.1GeV$$

rowNo	decay tree	decay final state	iDcyTr	nEtr	nCEtr
1	$x \to p\bar{p}\gamma^F\gamma^F$	$p\bar{p}\gamma^F\gamma^F$	4	28637	28637
2	$x \to J/\psi\gamma, J/\psi \to p\bar{p}$	$p\bar{p}\gamma$	15	27792	56429
3	$x \to p\bar{p}\gamma^F$	$p\bar{p}\gamma^F$	5	19021	75450
4	$x \to p\bar{p}a_0^0\gamma^f, a_0^0 \to \pi^0\eta, \eta \to \gamma\gamma$	$\pi^0 p\bar{p}\gamma\gamma\gamma^f$	158	3265	78715
5	$x \to f_2(1270)p\bar{p}\gamma^f, f_2(1270) \to \pi^0\pi^0$	$\pi^0\pi^0 p\bar{p}\gamma^f$	71	2932	81647
6	$x \to p\bar{p}a_0^0\gamma^f, a_0^0 \to \pi^0\eta, \eta \to \pi^0\pi^0\pi^0$	$\pi^0\pi^0\pi^0\pi^0 p\bar{p}\gamma^f$	13	2708	84355
7	$x \to K^- p\bar{\Lambda}\gamma^f, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+ K^- p\bar{p}\gamma^f$	91	2683	87038
8	$x \to K^+\bar{p}\Lambda\gamma^f, \Lambda \to \pi^- p$	$\pi^- K^+ p\bar{p}\gamma^f$	2	2467	89505
9	$x \to J/\psi\gamma, J/\psi \to \pi^0\Delta^+\bar{\Delta}^-, \Delta^+ \to \pi^0 p, \bar{\Delta}^- \to \pi^0\bar{p}$	$\pi^0\pi^0\pi^0 p\bar{p}\gamma$	28	2079	91584
10	$x \to J/\psi\gamma, J/\psi \to \Lambda\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^- p\bar{p}\gamma$	11	1756	93340
11	$x \to K^+K^- p\bar{p}\gamma^f$	$K^+K^- p\bar{p}\gamma^f$	64	1753	95093
12	$x \to J/\psi\gamma, J/\psi \to \pi^0 p\bar{p}$	$\pi^0 p\bar{p}\gamma$	33	1549	96642
13	$x \to J/\psi\gamma, J/\psi \to \Xi^0\bar{\Xi}^0, \Xi^0 \to \pi^0\Lambda, \bar{\Xi}^0 \to \pi^0\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^0\pi^0\pi^+\pi^- p\bar{p}\gamma$	19	1508	98150
14	$x \to J/\psi\gamma, J/\psi \to \Sigma^0\bar{\Sigma}^0, \Sigma^0 \to \Lambda\gamma, \bar{\Sigma}^0 \to \bar{\Lambda}\gamma, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^- p\bar{p}\gamma\gamma\gamma$	55	1371	99521
15	$x \to \pi^0 p\bar{p}a_0^0\gamma^f, a_0^0 \to \pi^0\eta, \eta \to \gamma\gamma$	$\pi^0\pi^0 p\bar{p}\gamma\gamma\gamma^f$	38	1305	100826
16	$x \to p\bar{p}f_1(1285)\gamma^f, f_1(1285) \to \pi^0 a_0^0, a_0^0 \to \pi^0\eta, \eta \to \gamma\gamma$	$\pi^0\pi^0 p\bar{p}\gamma\gamma\gamma^f$	209	1168	101994
17	$x \to J/\psi\gamma, J/\psi \to \eta p\bar{p}, \eta \to \gamma\gamma$	$p\bar{p}\gamma\gamma\gamma$	86	1156	103150
18	$x \to \pi^0\pi^0 p\bar{p}\gamma^f$	$\pi^0\pi^0 p\bar{p}\gamma^f$	103	1144	104294
19	$x \to f_2(1270)p\bar{p}, f_2(1270) \to \pi^0\pi^0$	$\pi^0\pi^0 p\bar{p}$	57	1097	105391
20	$x \to \pi^0 f_2(1270)p\bar{p}\gamma^f, f_2(1270) \to \pi^0\pi^0$	$\pi^0\pi^0\pi^0 p\bar{p}\gamma^f$	115	1045	106436
.....					
7364	$x \to \pi^0\Sigma^-\bar{\Sigma}^0 a_1^+, \Sigma^- \to \pi^- n, \bar{\Sigma}^0 \to \bar{\Lambda}\gamma, a_1^+ \to \pi^0\rho^+, \bar{\Lambda} \to \pi^+\bar{p}, \rho^+ \to \pi^0\pi^+$	$\pi^0\pi^0\pi^0\pi^+\pi^+\pi^- n\bar{p}\gamma$	7363	1	200553

Further Event selection

$angle(p, \bar{p}) < 165$
$Pt(p\bar{p}) < 0.2GeV/c$
$Umiss > -0.1GeV$

➢ Event selection:

- Good photon:

E_γ>25MeV for barrel & E_γ>50MeV for end-cap;

Emc Time: 0~700ns;

10 degree away from p and 20 degree away from $\bar{p}$;

- π^0 Candidate

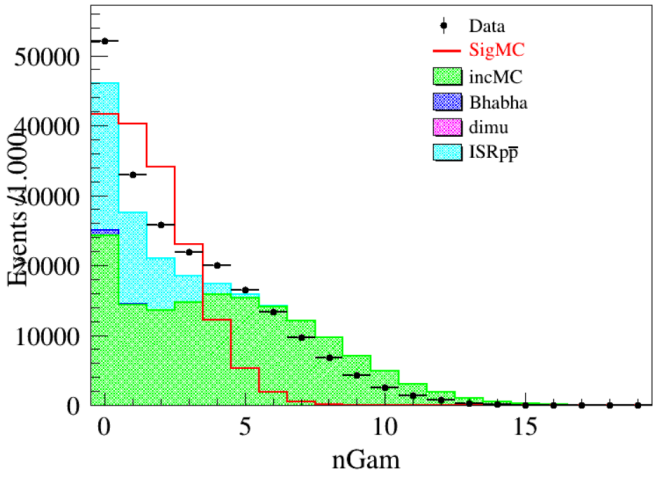
遍历所有的$\gamma\gamma$组合， 计算其不变质量;

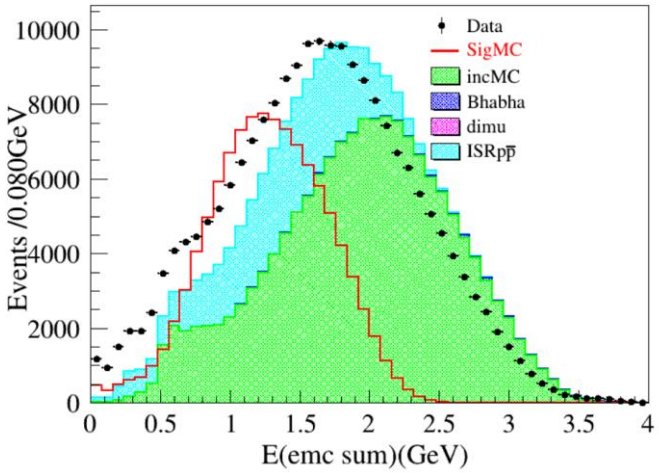
遍历所有的$\gamma\gamma$组合， 进行1C (π^0质量)拟合，记录χ^2;

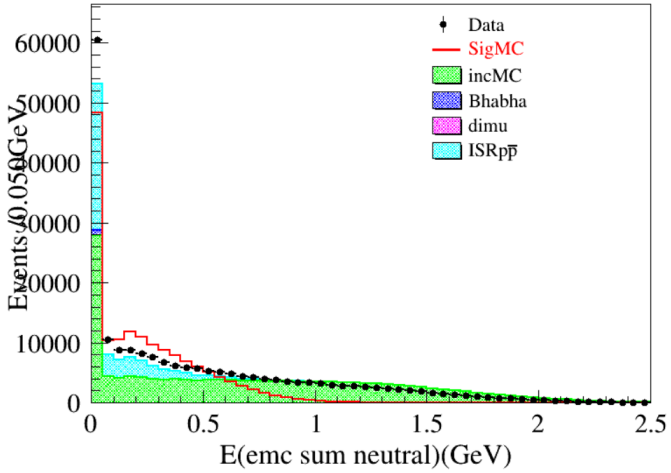
Further Event selection

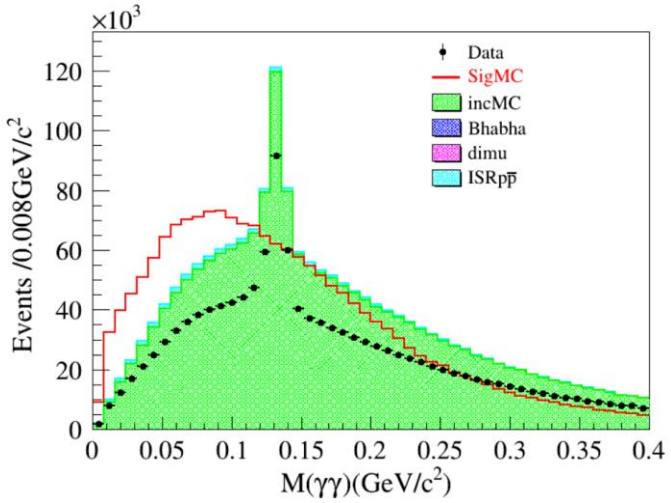
$$angle(p,\bar{p}) < 165$$
$$Pt(p\bar{p}) < 0.2GeV/c$$
$$Umiss > -0.1GeV$$

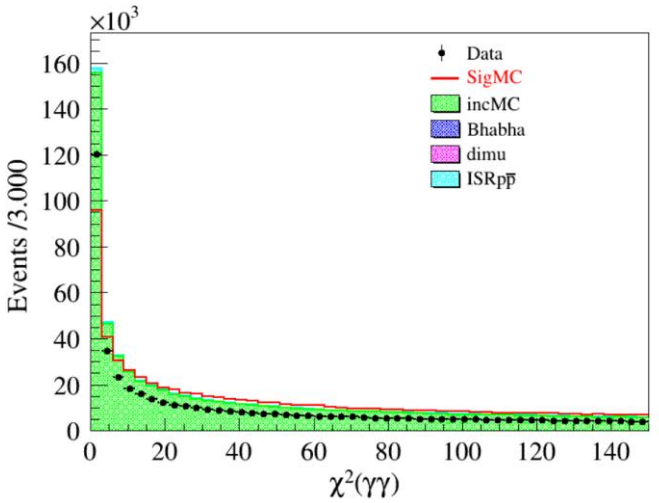
中性径迹信息







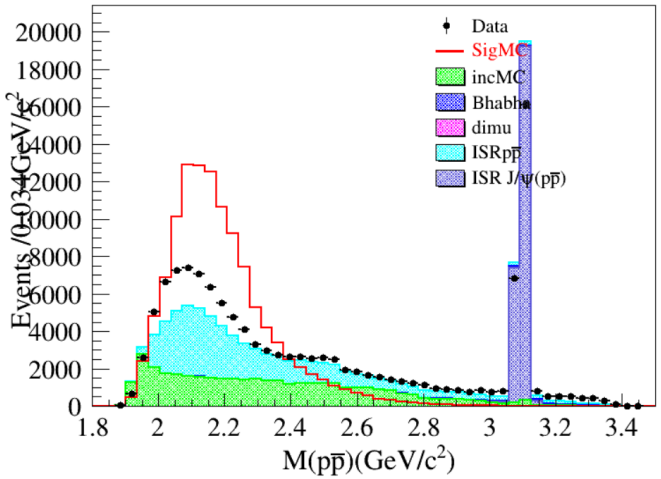


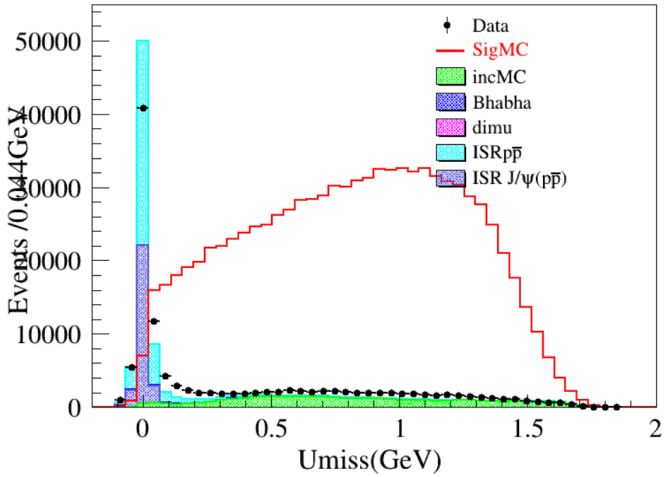


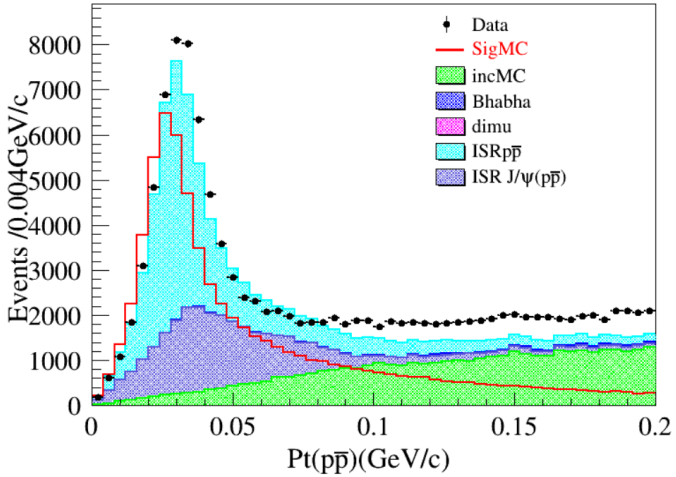
Further Event selection

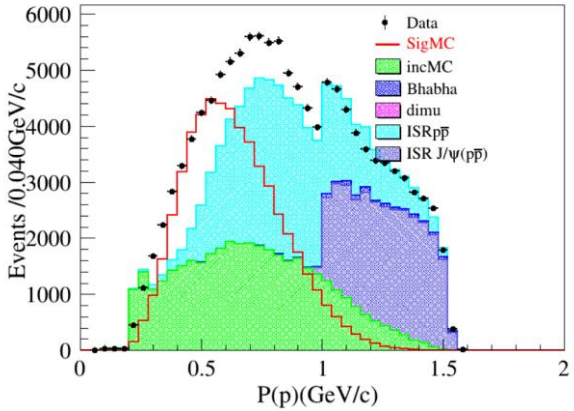
$angle(p,\bar{p}) < 165$
$Pt(p\bar{p}) < 0.2GeV/c$
$Umiss > -0.1GeV$
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$

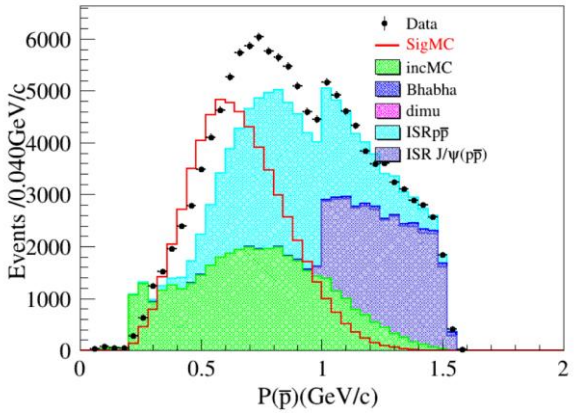
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$: sigMC效率86%, incMC效率33%

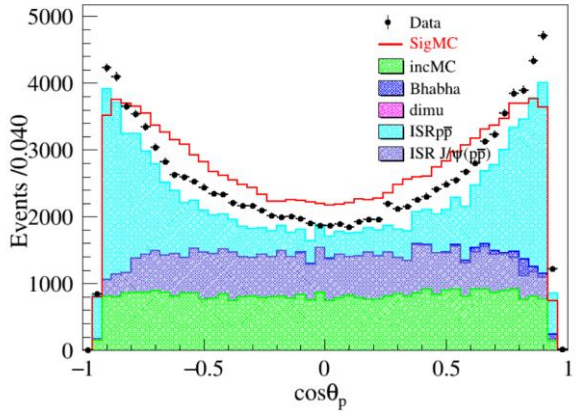


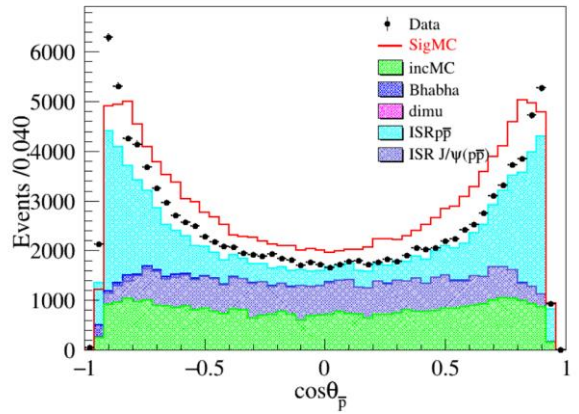








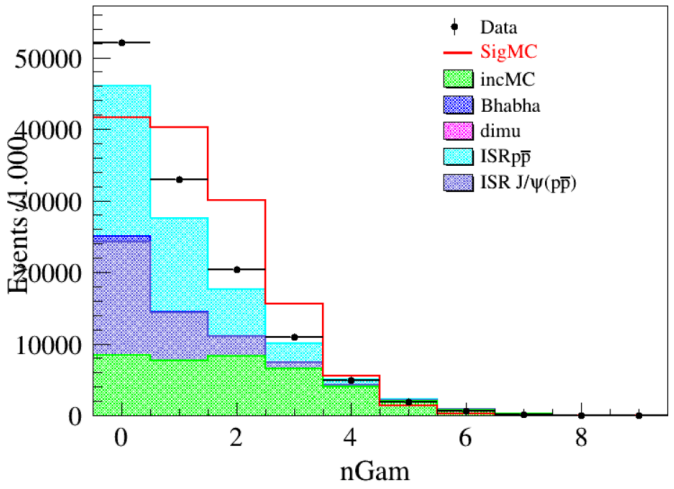


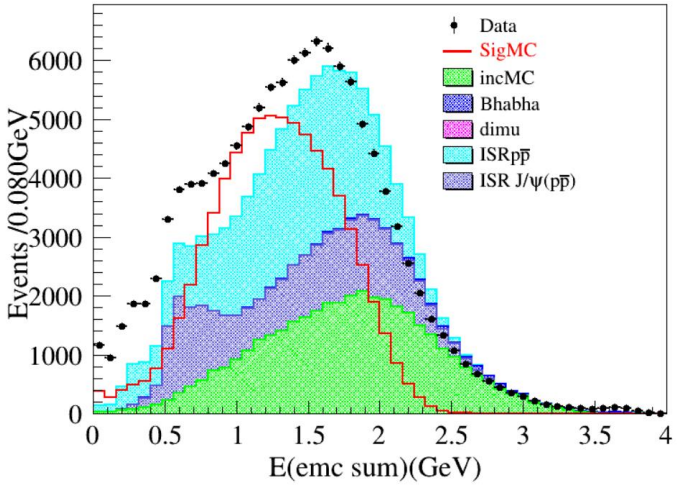


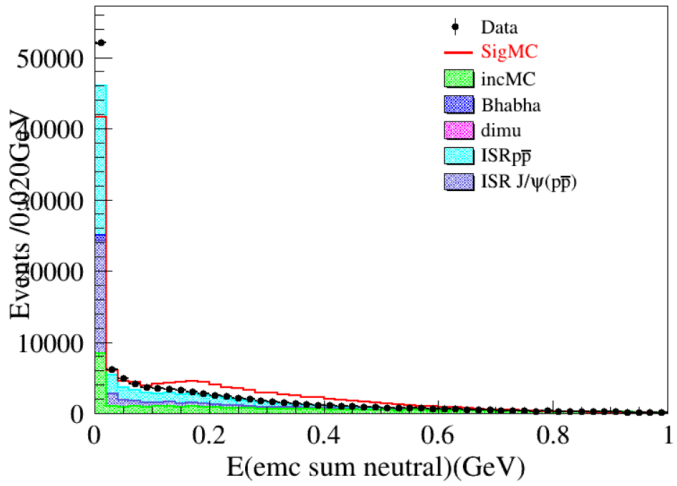
Further Event selection

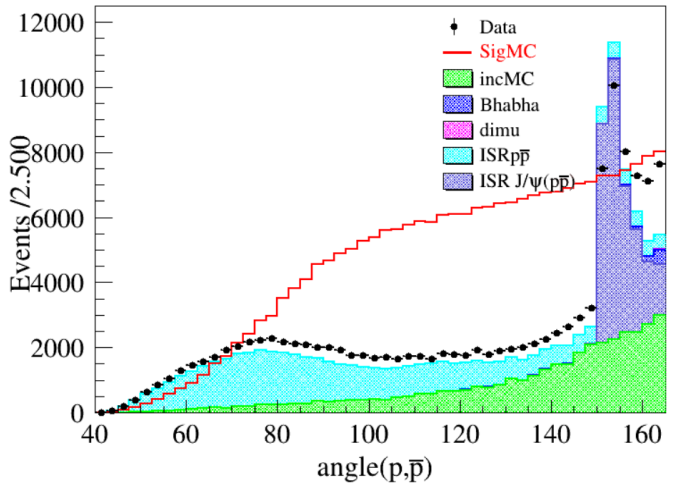
$angle(p,\bar{p}) < 165$
$Pt(p\bar{p}) < 0.2GeV/c$
$Umiss > -0.1GeV$
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$

Veto $0.12 < M(\gamma\gamma) < 0.15GeV$: sigMC效率86%, incMC效率33%









Further Event selection

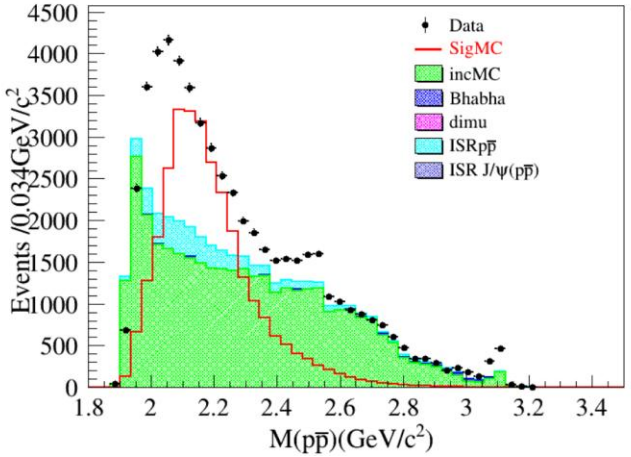
$$angle(p,\bar{p}) < 165$$
$$Pt(p\bar{p}) < 0.2GeV/c$$
$$Umiss > -0.1GeV$$
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$

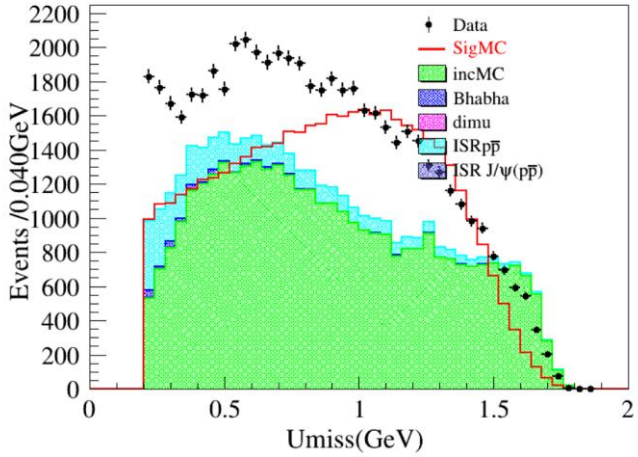
rowNo	decay tree	decay final state	iDcyTr	nEtr	nCEtr
1	$x \to J/\psi\gamma, J/\psi \to p\bar{p}$	$p\bar{p}\gamma$	5	26491	26491
2	$x \to p\bar{p}\gamma^F\gamma^F$	$p\bar{p}\gamma^F\gamma^F$	2	26288	52779
3	$x \to p\bar{p}\gamma^F$	$p\bar{p}\gamma^F$	3	17835	70614
4	$x \to K^-p\bar{\Lambda}\gamma^f, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+K^-p\bar{p}\gamma^f$	56	2101	72715
5	$x \to K^+\bar{p}\Lambda\gamma^f, \Lambda \to \pi^-p$	$\pi^-K^+p\bar{p}\gamma^f$	58	1994	74709
6	$x \to J/\psi\gamma, J/\psi \to \Lambda\bar{\Lambda}, \Lambda \to \pi^-p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^-p\bar{p}\gamma$	4	1613	76322
7	$x \to p\bar{p}a_0^0\gamma^f, a_0^0 \to \pi^0\eta, \eta \to \gamma\gamma$	$\pi^0p\bar{p}\gamma\gamma\gamma^f$	38	1171	77493
8	$x \to K^+K^-p\bar{p}\gamma^f$	$K^+K^-p\bar{p}\gamma^f$	16	998	78491
9	$x \to J/\psi\gamma, J/\psi \to \Sigma^0\bar{\Sigma}^0, \Sigma^0 \to \Lambda\gamma, \bar{\Sigma}^0 \to \bar{\Lambda}\gamma, \Lambda \to \pi^-p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^-p\bar{p}\gamma\gamma\gamma$	14	962	79453
10	$x \to J/\psi\gamma, J/\psi \to \eta p\bar{p}, \eta \to \gamma\gamma$	$p\bar{p}\gamma\gamma\gamma$	32	908	80361
11	$x \to J/\psi\gamma, J/\psi \to \pi^0p\bar{p}$	$\pi^0p\bar{p}\gamma$	9	844	81205
12	$x \to \pi^+\pi^-p\bar{p}\gamma^F$	$\pi^+\pi^-p\bar{p}\gamma^F$	129	760	81965
13	$x \to K^-p\bar{\Lambda}, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+K^-p\bar{p}$	10	726	82691
14	$x \to K^+\bar{p}\Lambda, \Lambda \to \pi^-p$	$\pi^-K^+p\bar{p}$	65	663	83354
15	$x \to J/\psi\gamma, J/\psi \to p\bar{p}\gamma^F$	$p\bar{p}\gamma^F\gamma$	55	553	83907
16	$x \to f_2(1270)p\bar{p}\gamma^f, f_2(1270) \to \pi^0\pi^0$	$\pi^0\pi^0p\bar{p}\gamma^f$	62	505	84412
17	$x \to p\bar{p}a_0^0, a_0^0 \to \pi^0\eta, \eta \to \gamma\gamma$	$\pi^0p\bar{p}\gamma\gamma$	39	410	84822
18	$x \to J/\psi\gamma, J/\psi \to \bar{\Xi}^+\Xi^-, \bar{\Xi}^+ \to \pi^+\bar{\Lambda}, \Xi^- \to \pi^-\Lambda, \bar{\Lambda} \to \pi^+\bar{p}, \Lambda \to \pi^-p$	$\pi^+\pi^+\pi^-\pi^-p\bar{p}\gamma$	40	409	85231
19	$x \to J/\psi\gamma, J/\psi \to \Lambda\bar{\Lambda}\gamma, \Lambda \to \pi^-p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^-p\bar{p}\gamma\gamma$	69	402	85633
.....					
3392	$x \to K_L^0K^+\Delta^0\bar{p}\gamma^f, \Delta^0 \to \pi^0n$	$\pi^0K_L^0K^+n\bar{p}\gamma^f$	3391	1	108878

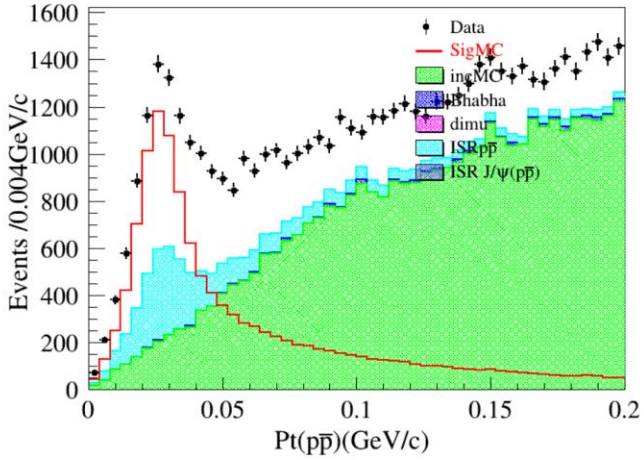
Further Event selection

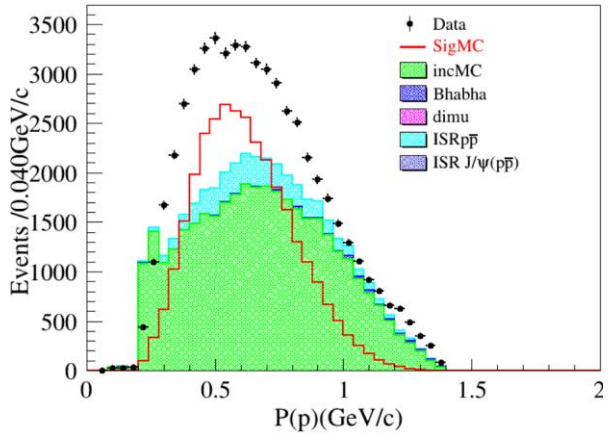
$angle(p,\bar{p}) < 165$
$Pt(p\bar{p}) < 0.2GeV/c$
$Umiss > 0.2GeV$
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$

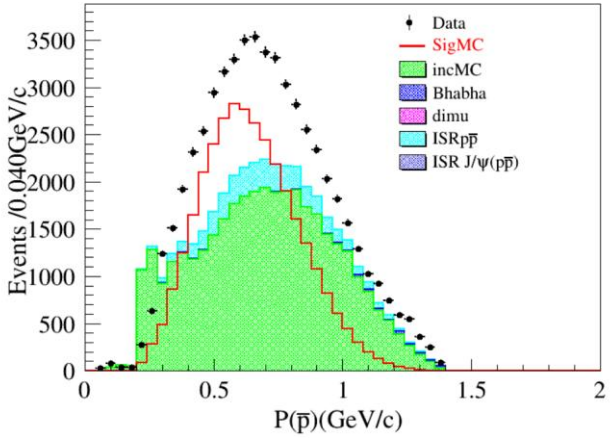
收紧Umiss条件

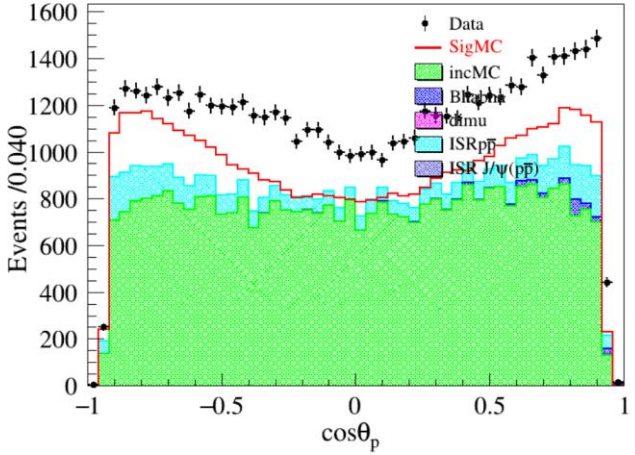


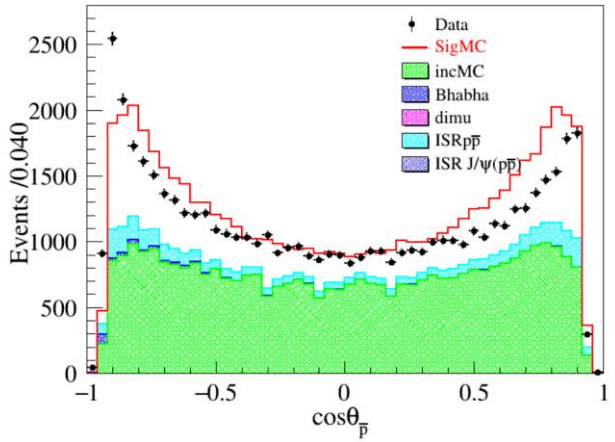








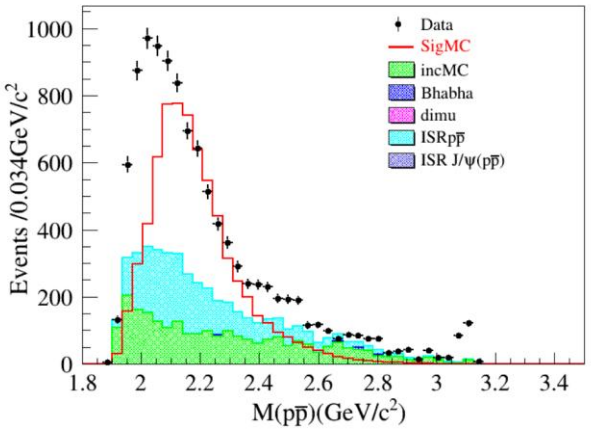


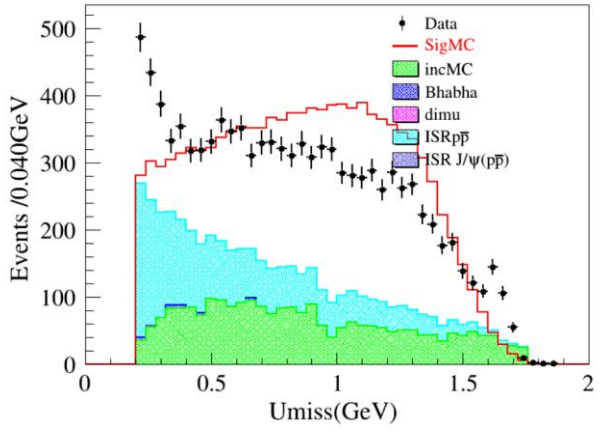


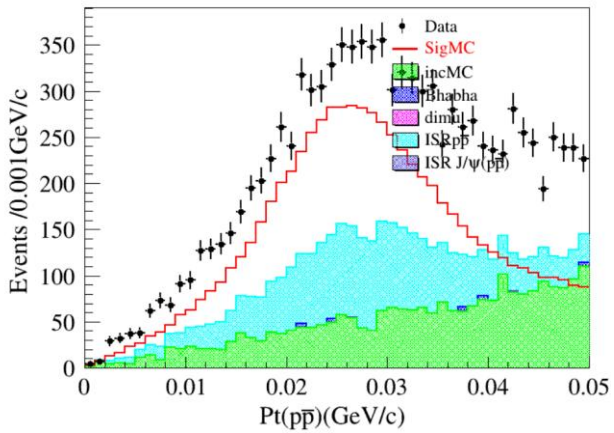
Further Event selection

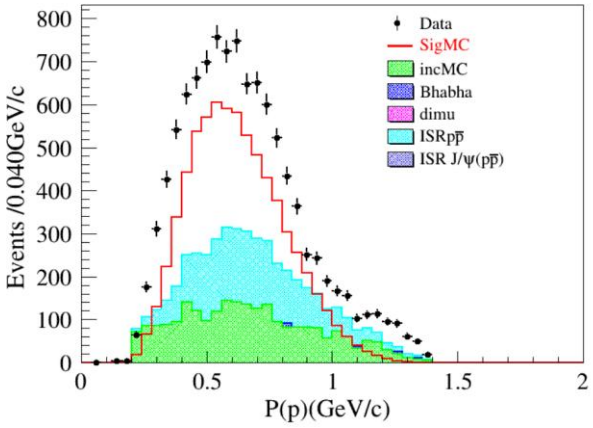
$angle(p,\bar{p}) < 165$
$Pt(p\bar{p}) < 0.2GeV/c$
$Umiss > 0.2GeV$
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$

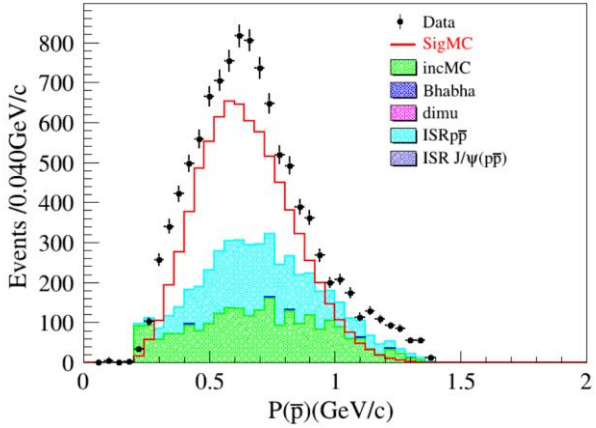
收紧$Pt(p\bar{p})$条件

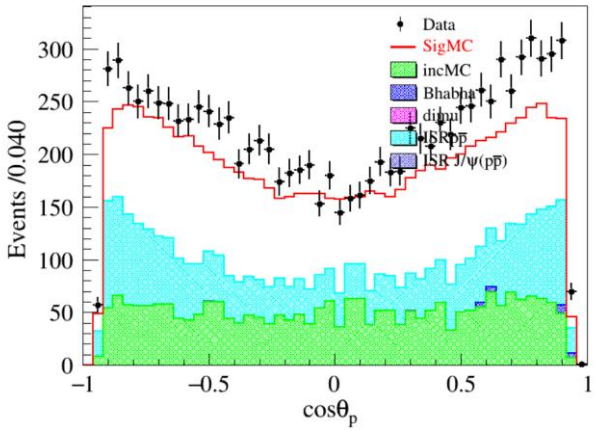


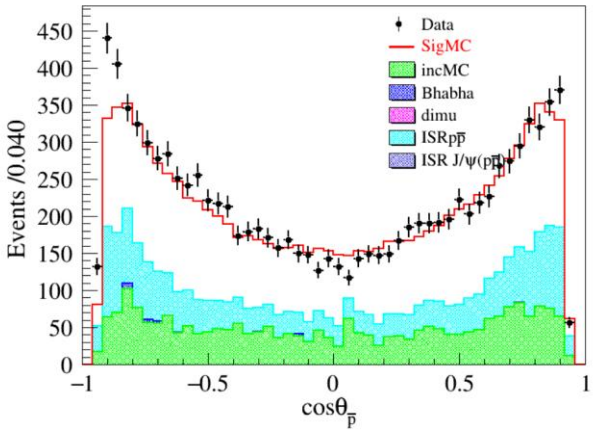












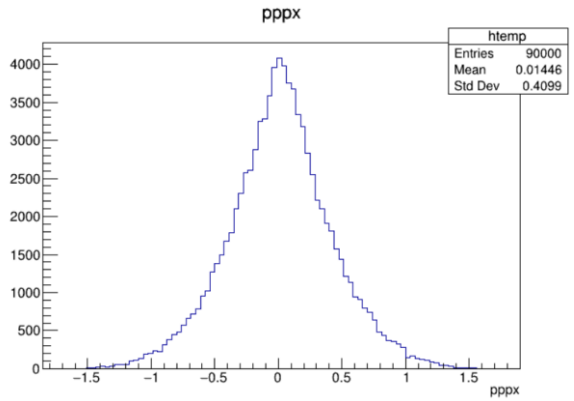
Further Event selection

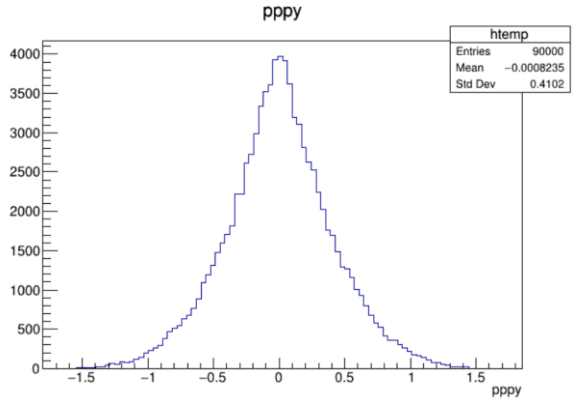
$angle(p,\bar{p}) < 165$
$Pt(p\bar{p}) < 0.05GeV/c$
$Umiss > 0.2GeV$
Veto $0.12 < M(\gamma\gamma) < 0.15GeV$

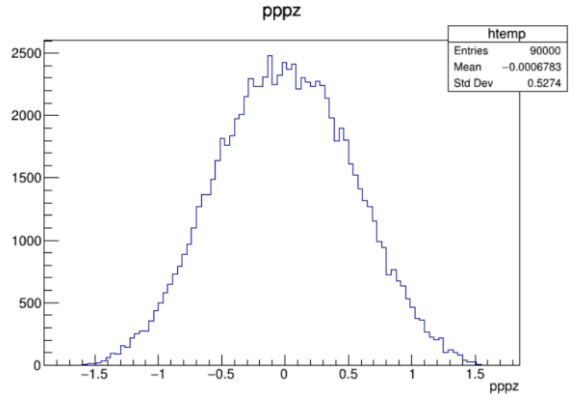
rowNo	decay tree	decay final state	iDcyTr	nEtr	nCEtr
1	$x \to p\bar{p}\gamma^F\gamma^F$	$p\bar{p}\gamma^F\gamma^F$	1	2518	2518
2	$x \to \pi^+\pi^- p\bar{p}\gamma^F$	$\pi^+\pi^- p\bar{p}\gamma^F$	21	183	2701
3	$x \to K^- p\bar{\Lambda}\gamma^f, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+K^- p\bar{p}\gamma^f$	6	137	2838
4	$x \to K^+\bar{p}\Lambda\gamma^f, \Lambda \to \pi^- p$	$\pi^-K^+ p\bar{p}\gamma^f$	9	129	2967
5	$x \to J/\psi\gamma, J/\psi \to \Lambda\bar{\Lambda}, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^- p\bar{p}\gamma$	20	92	3059
6	$x \to p\bar{p}a_0^0\gamma^f, a_0^0 \to \pi^0\eta, \eta \to \gamma\gamma$	$\pi^0 p\bar{p}\gamma\gamma\gamma^f$	34	83	3142
7	$x \to K^+K^- p\bar{p}\gamma^f$	$K^+K^- p\bar{p}\gamma^f$	84	72	3214
8	$x \to J/\psi\gamma, J/\psi \to \Sigma^0\bar{\Sigma}^0, \Sigma^0 \to \Lambda\gamma, \bar{\Sigma}^0 \to \bar{\Lambda}\gamma, \Lambda \to \pi^- p, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+\pi^- p\bar{p}\gamma\gamma\gamma$	2	48	3262
9	$x \to K^- p\bar{\Lambda}, \bar{\Lambda} \to \pi^+\bar{p}$	$\pi^+K^- p\bar{p}$	36	47	3309
10	$x \to p\bar{p}\gamma^F$	$p\bar{p}\gamma^F$	3	46	3355
.....					
612	$x \to \psi'\gamma, \psi' \to \chi_{c1}\gamma, \chi_{c1} \to \pi^0 p\bar{p}$	$\pi^0 p\bar{p}\gamma\gamma$	611	1	4979

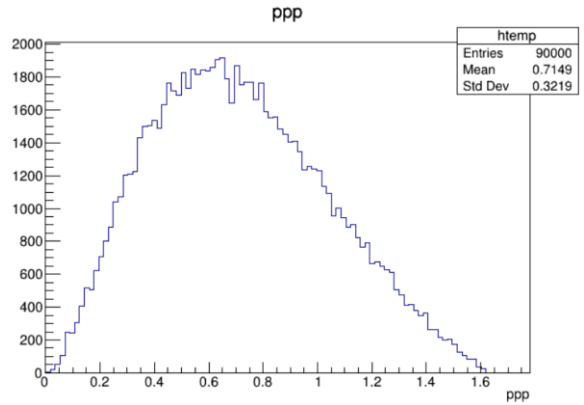
Back Up

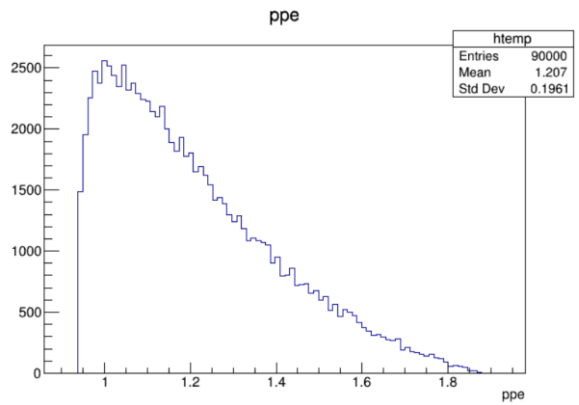
Mctruth information (no selection), Ecms = 3.773GeV, Generator: cpp_gamgam + TrackGen

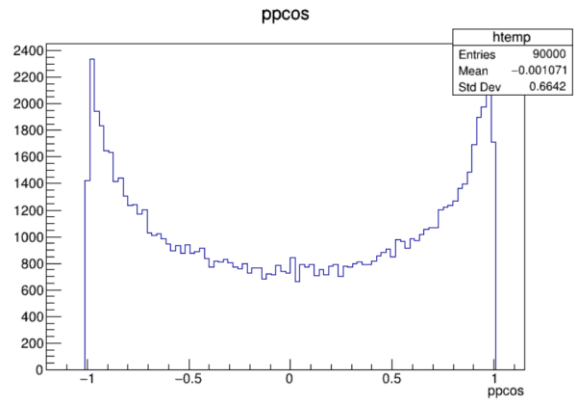




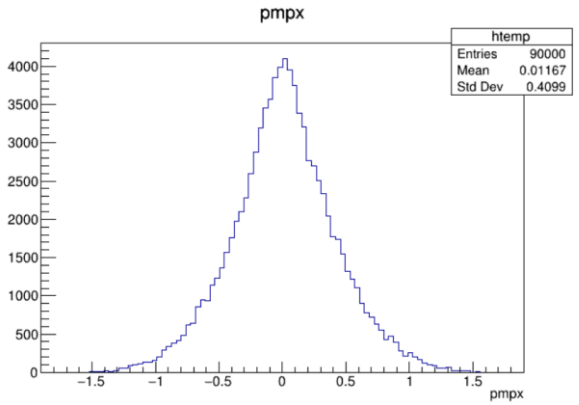


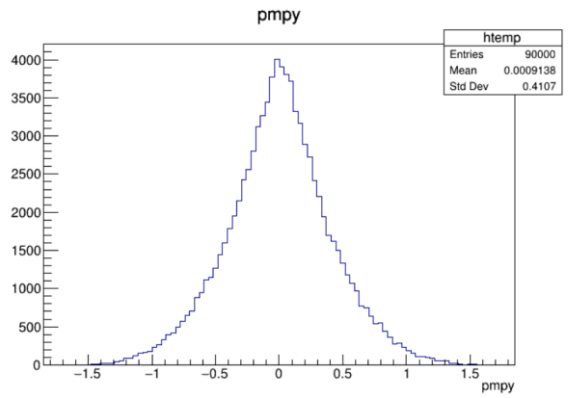


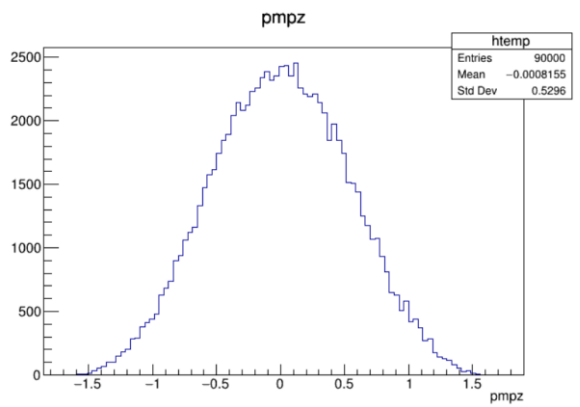


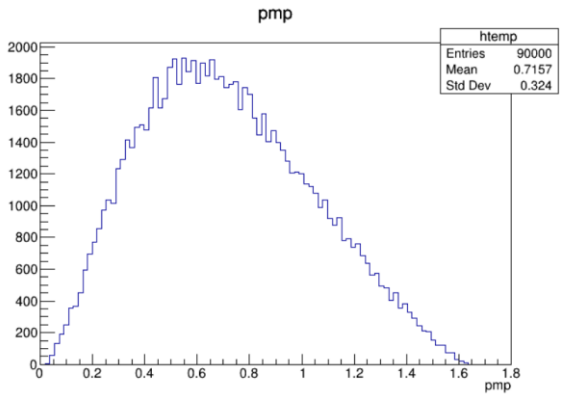


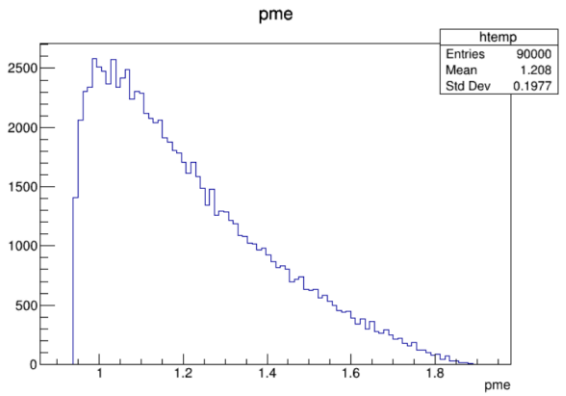
Mctruth information (no selection), Ecms = 3.773GeV, Generator: cpp_gamgam + TrackGen

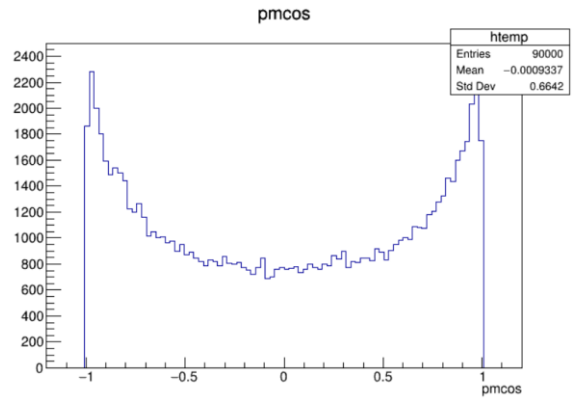




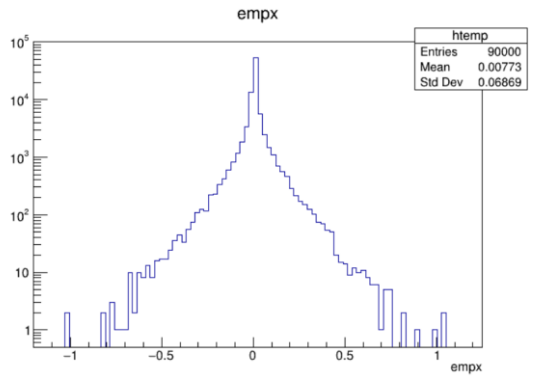


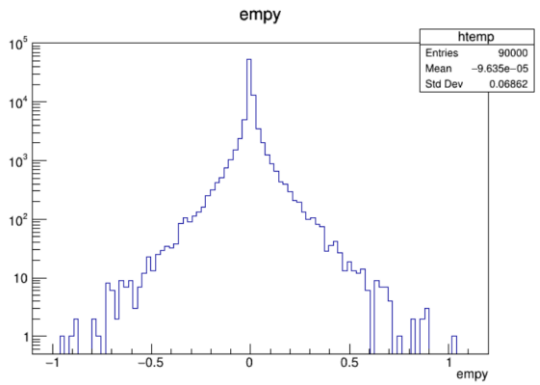


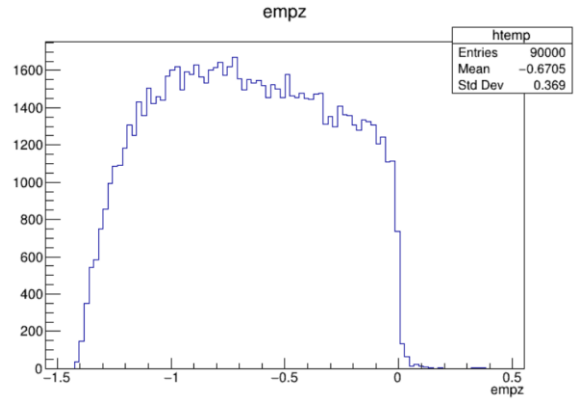


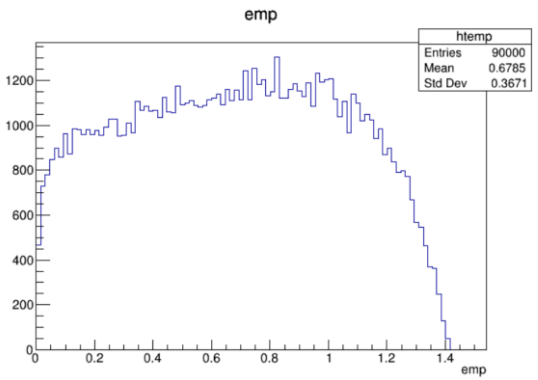


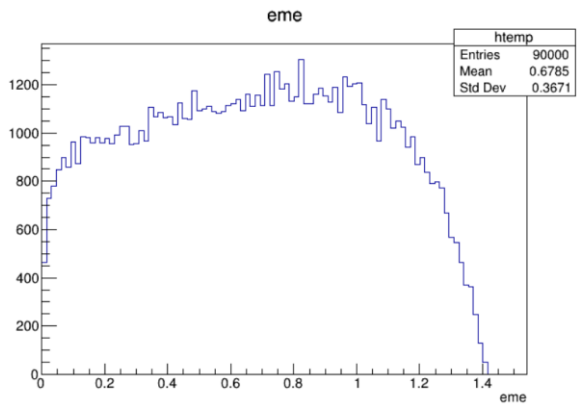
Mctruth information (no selection), Ecms = 3.773GeV, Generator: cpp_gamgam + TrackGen

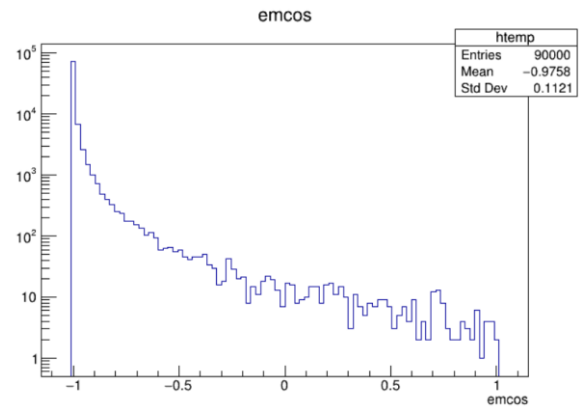




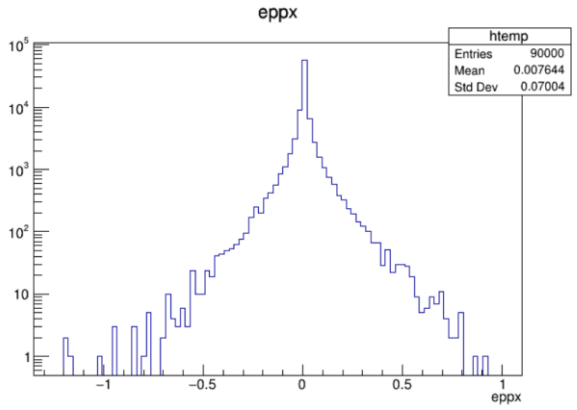


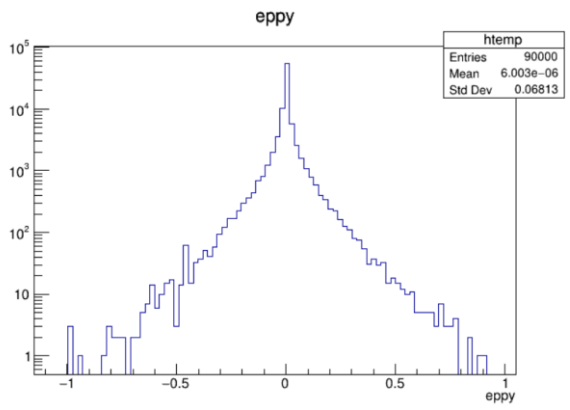


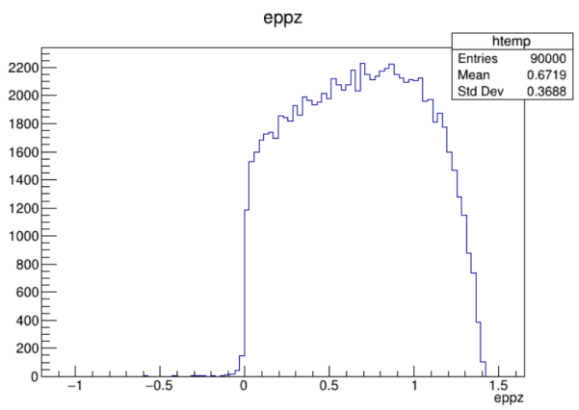


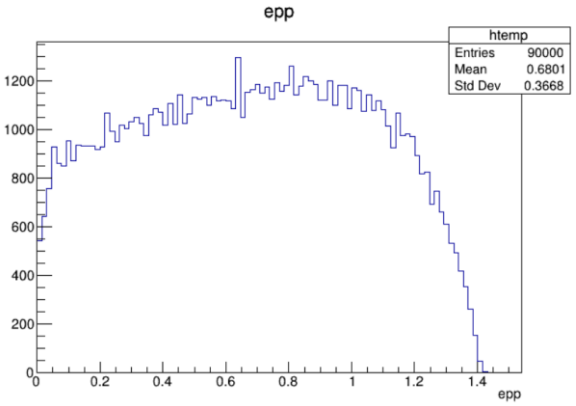


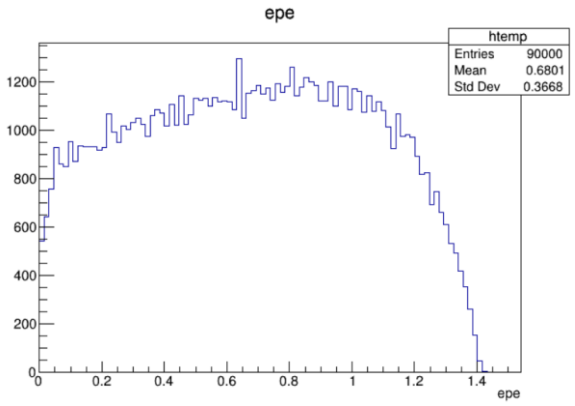
Mctruth information (no selection), Ecms = 3.773GeV, Generator: cpp_gamgam + TrackGen

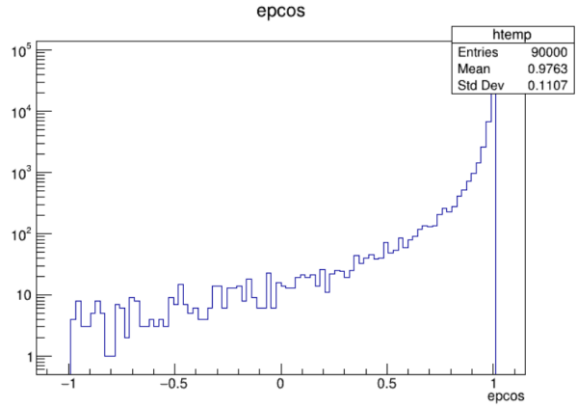


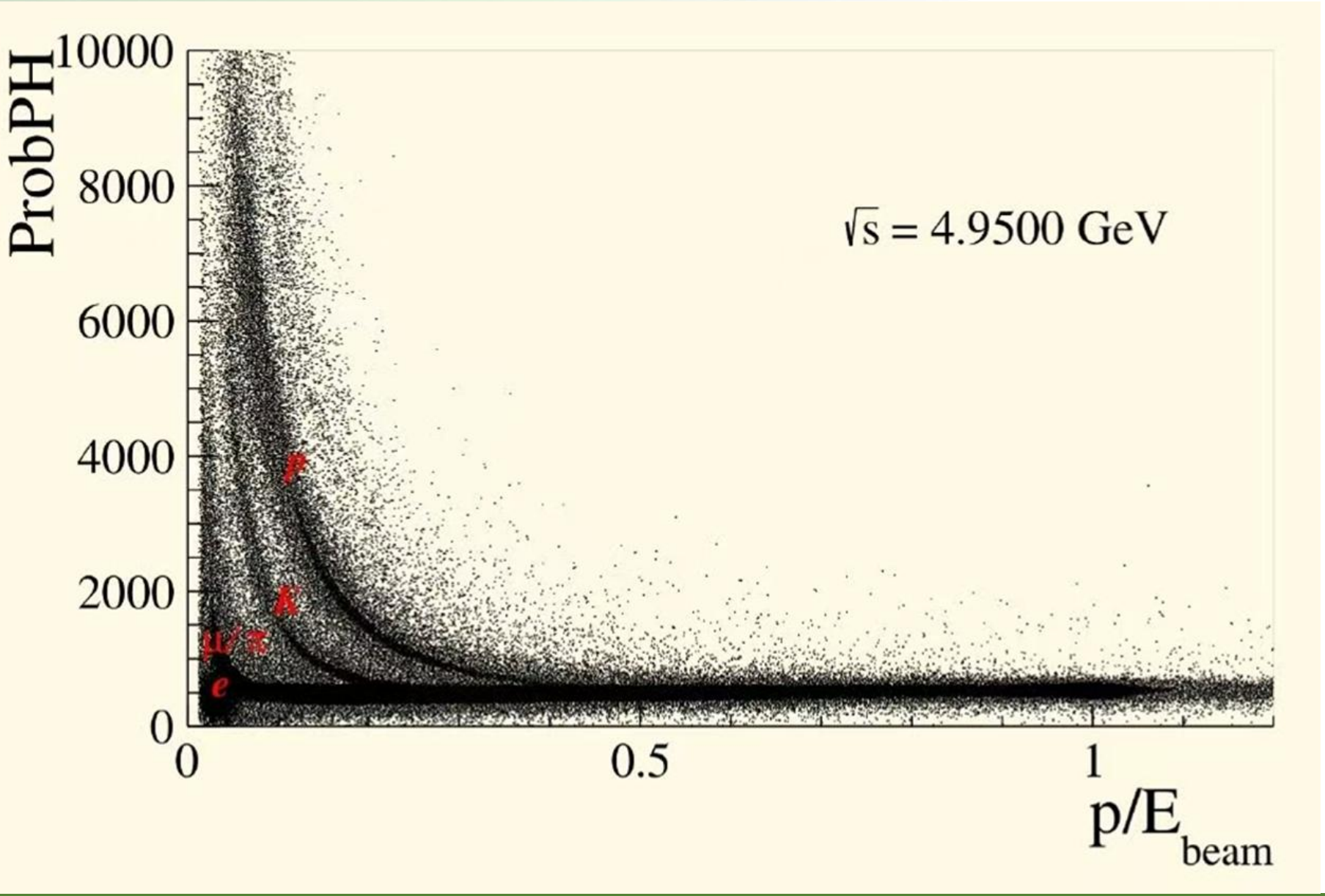






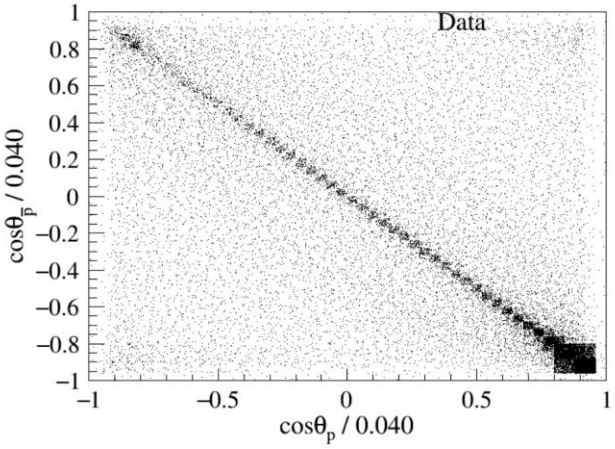


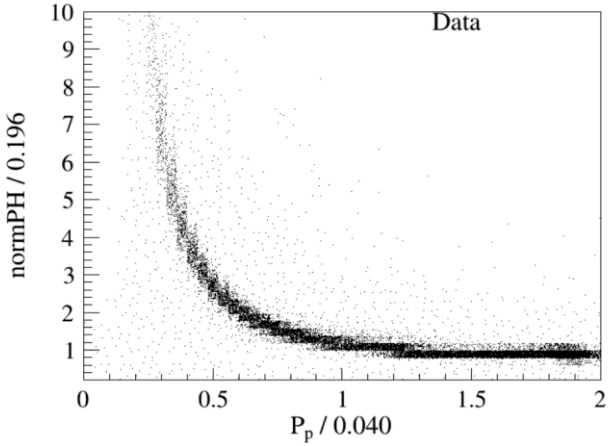


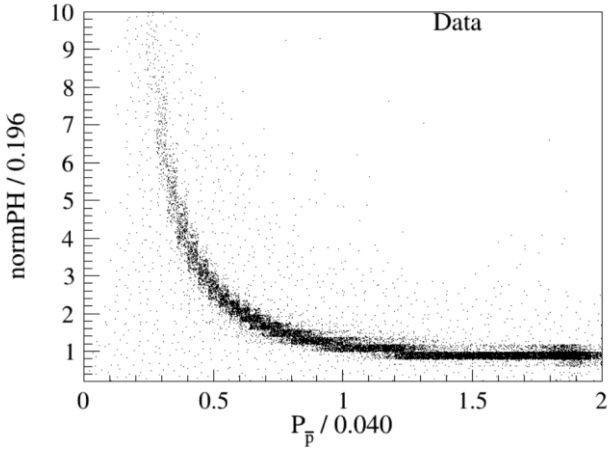

ProbPH
10000
8000
6000
4000
2000
0
0
0.5
1
p/E_beam
√s = 4.9500 GeV
p
K
μ/π
e

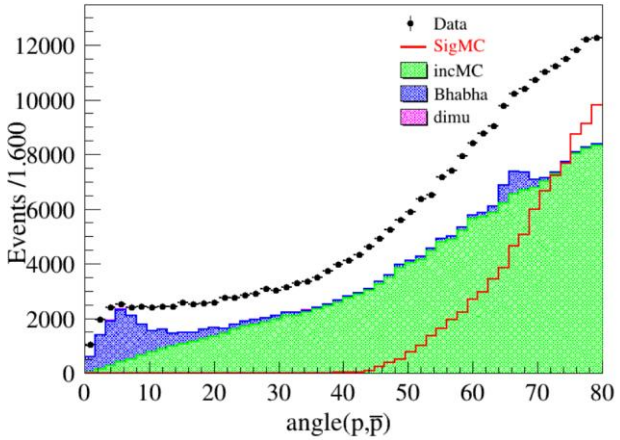
Further Event selection

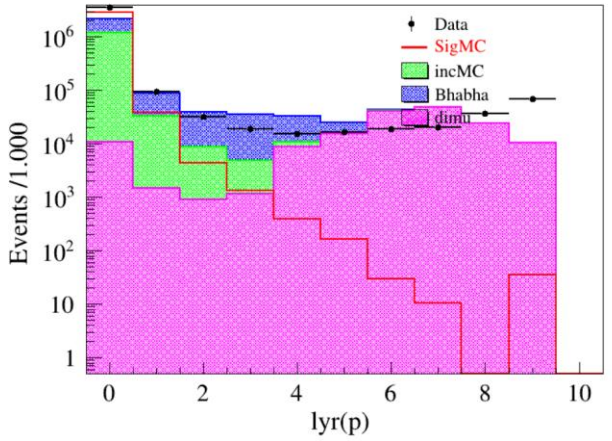
初筛后的质量谱和特征谱:

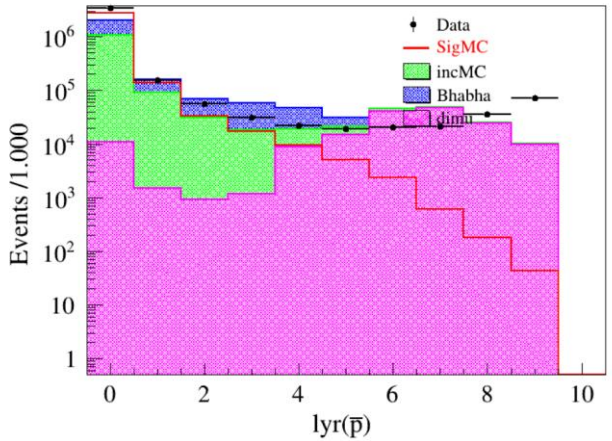


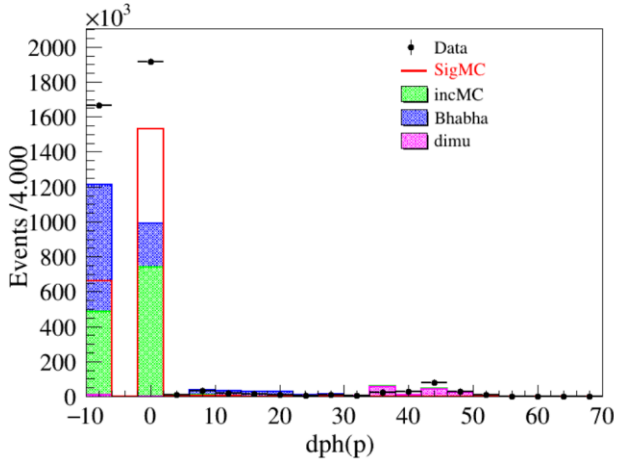


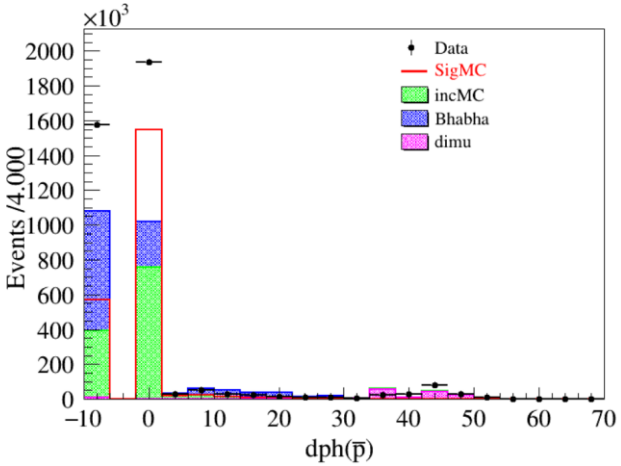


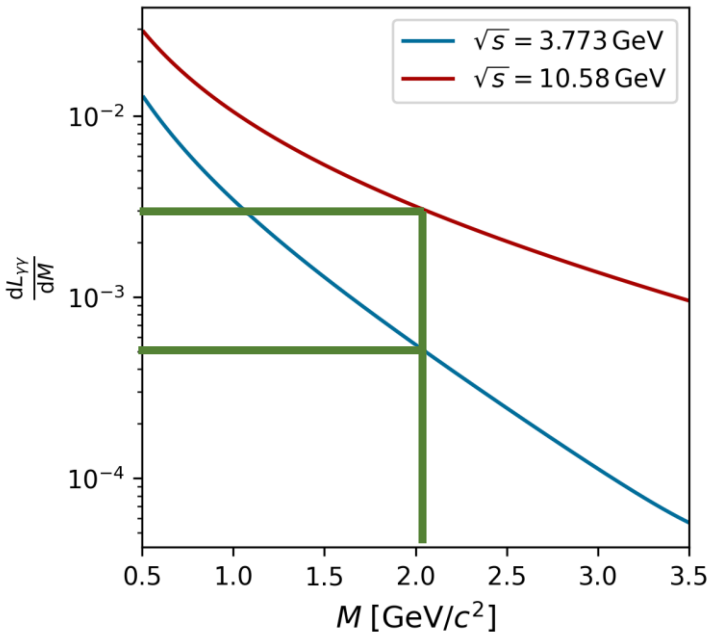


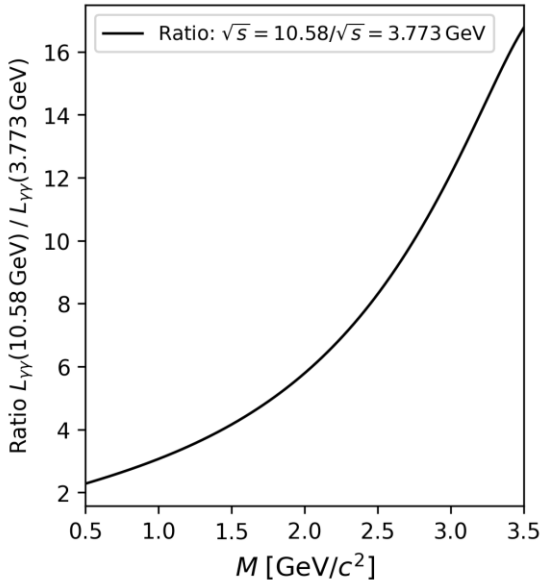


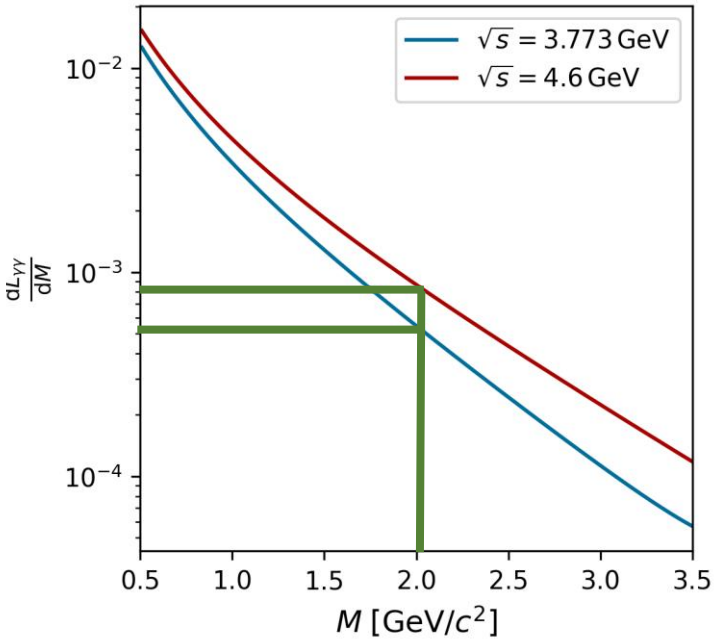


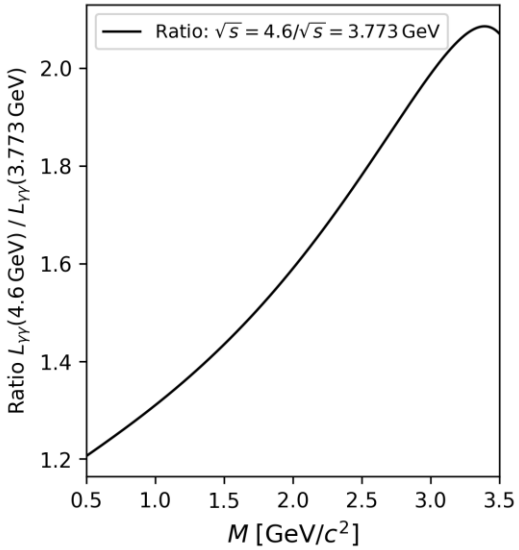




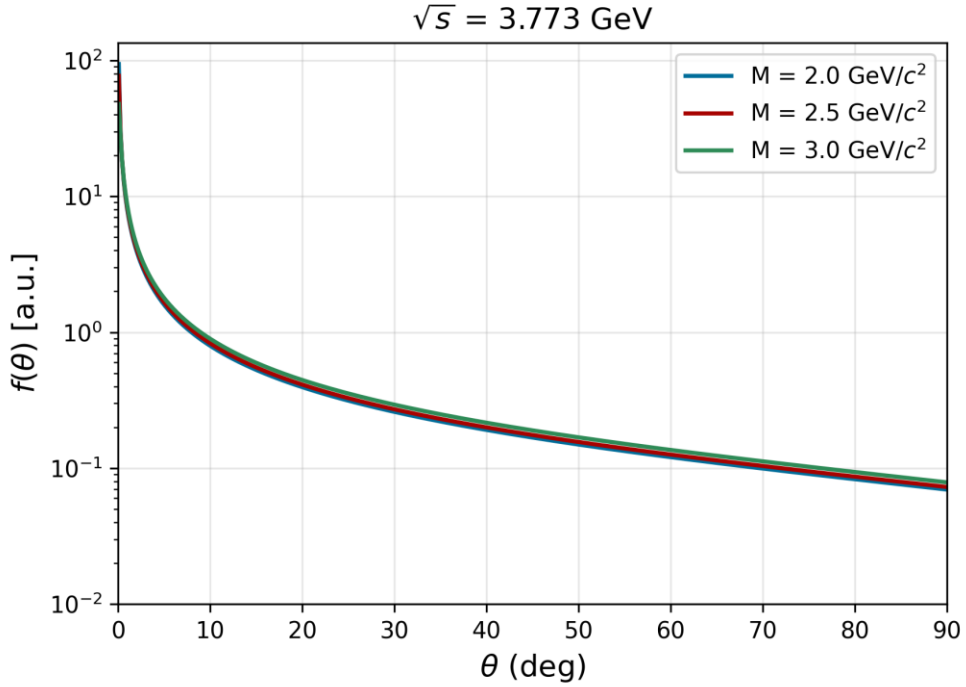

$\sqrt{s} = 3.773\,\mathrm{GeV}$
$\sqrt{s} = 10.58\,\mathrm{GeV}$
$\frac{\mathrm{d}L_{\gamma\gamma}}{\mathrm{d}M}$
$M\,[\mathrm{GeV}/c^2]$

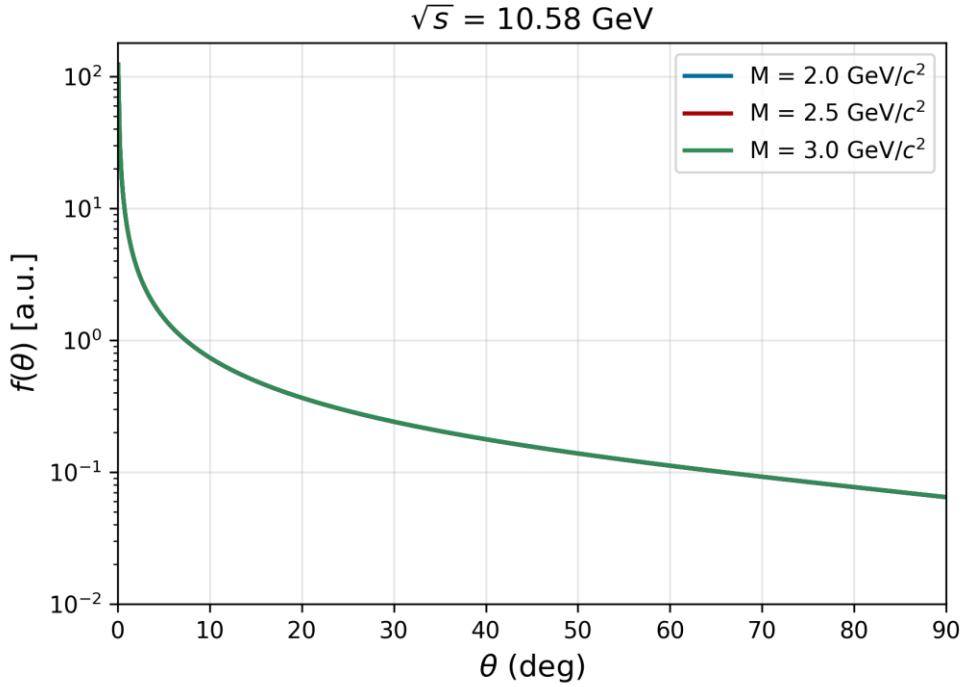

Ratio: $\sqrt{s} = 10.58/\sqrt{s} = 3.773\,\mathrm{GeV}$
Ratio $L_{\gamma\gamma}(10.58\,\mathrm{GeV}) / L_{\gamma\gamma}(3.773\,\mathrm{GeV})$
$M\,[\mathrm{GeV}/c^2]$


$\sqrt{s} = 3.773\,\mathrm{GeV}$
$\sqrt{s} = 4.6\,\mathrm{GeV}$
$\frac{\mathrm{d}L_{\gamma\gamma}}{\mathrm{d}M}$
$M\,[\mathrm{GeV}/c^2]$


Ratio: $\sqrt{s} = 4.6/\sqrt{s} = 3.773\,\mathrm{GeV}$
Ratio $L_{\gamma\gamma}(4.6\,\mathrm{GeV}) / L_{\gamma\gamma}(3.773\,\mathrm{GeV})$
$M\,[\mathrm{GeV}/c^2]$

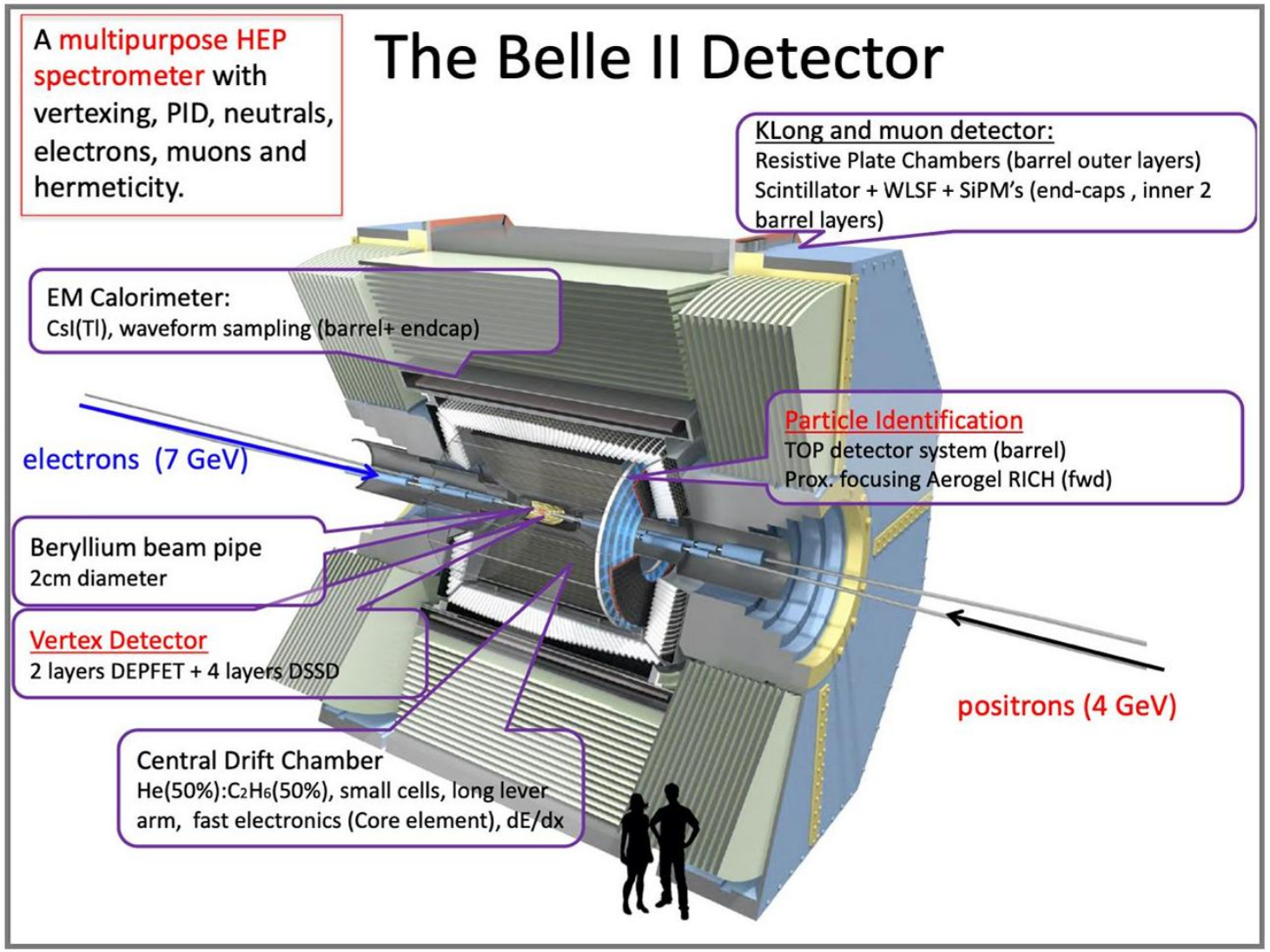
Scattered Electron Angular Distribution in Two-Photon Processes
(Equivalent Photon Approximation, Budnev 1975)





$\boldsymbol{P(cos\theta > 0.92)}$:
0.84 for 2.0GeV
0.82 for 2.5GeV
0.81 for 3.0GeV

$\boldsymbol{P(cos\theta > 0.92)}$:
0.88 for 2.0GeV
0.87 for 2.5GeV
0.87 for 3.0GeV



接收度(角度)：　　BESIII: 23~157

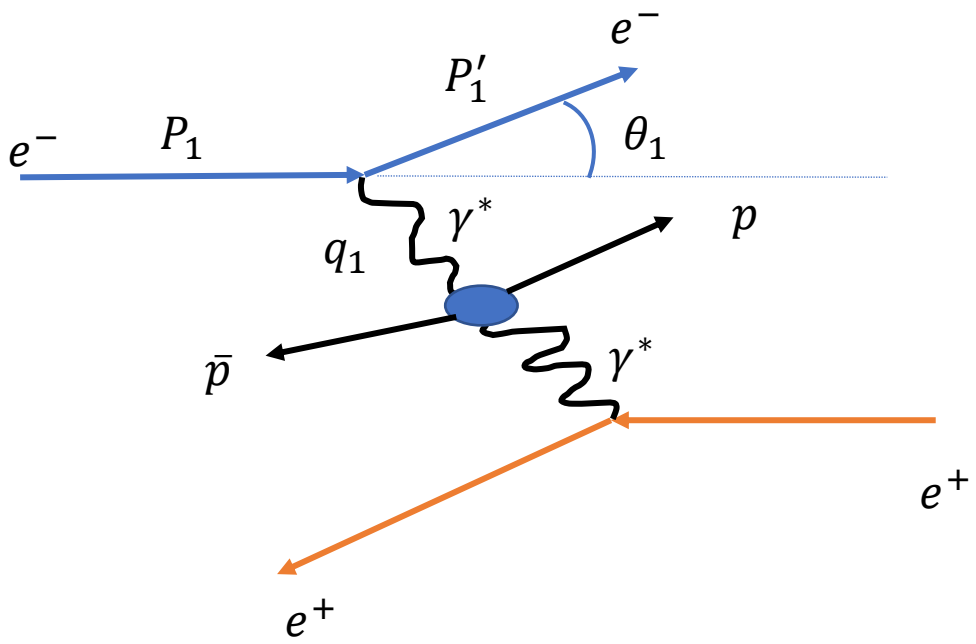
KLM: 18~155
KLM: 24~161

ECL: 12.4~31.4, 32.2~128.7, 130.7~155.1
ECL: 16.4~40.8, 41.8~140.0, 141.7~161.0

ARICH: 14~30
ARICH: 18.5~39.0
TOP: 31~128
TOP: 40~140

CDC: 17~150
CDC: 22~157

BELLE: 22~140 (157)



$$\mathbf{q_1} = (\mathbf{E_1} - \mathbf{E_1'}, \mathbf{P_1} - \mathbf{p_1'}),$$

$$\mathbf{q_1^2} \approx -\mathbf{2P_1P_1'(1-\cos\theta_1)} + \mathbf{m^2}(\mathbf{2} - \frac{\mathbf{P_1'}}{\mathbf{P_1}} - \frac{\mathbf{P_1}}{\mathbf{P_1'}});$$