

CEPC LumiCal group meeting

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BHLUMI

```
#!/bin/bash
#
START=$(date +%s)
Nname=$(uname -n)
#
#23456789.Variable
./evrun.exe << !
FieOut   trial0
CMS Ener  92.3
Th1minRad .0100
Th2maxRad .78539816339744830
NevTot   1000000
!
# Read format is (10x,I20)

END=$(date +%s)
DIFF=$(( $END - $START ))
echo "===== "
echo "= run on $Nname "
echo "= The executable took $DIFF seconds "
echo "=""
echo "===== "
```

Figure. Configuration settings(evrun.run).

th1 = 0.01 rad, th2 = 0.785 rad(45 degree)

```
!-----
npar(1)=  KeyOpt
npar(2)=  KeyRad
CmsEne =  92.3D0  ! 2*Ebeam [GeV], as in Workshop95
c CmsEne = 100.0D0 ! 2*Ebeam [GeV], as in Workshop95
xpar(1)=  CmsEne
th1      = .024d0      ! Detector range ThetaMin [rad]
th2      = .058d0      ! Detector range ThetaMax [rad]
c th1     = .030d0      ! Detector range ThetaMin [rad]
c th2     = .060d0      ! Detector range ThetaMax [rad]

read(5,'(10x,F10.5)') CmsEne
print *,'== Input CMS Energy ',CmsEne
xpar(1)=  CmsEne

read(5,'(10x,F10.5)') th1
print *,'== Input Detector theta low (rad) th1=',th1
read(5,'(10x,F10.5)') th2
print *,'== Input Detector theta high(rad) th2=',th2
*

thmin    = 0.7d0*th1    ! thmin has to be lower than th1
thmax    = 2.0d0*th2    ! thmax has to be higher than th2
IF(KeyWgt .EQ. 2) thmin=th1 ! Because generation below th1 is on!!!
xpar(2)=  CmsEne**2*(1-COS(thmin))/2 ! TransMin [GeV**2]
xpar(3)=  CmsEne**2*(1-COS(thmax))/2 ! TransMax [GeV**2]
xpar(4)=  1D-4          ! Infrared cut on photon energy
CALL bhlumi(-1,xpar,npar)
```

Figure. Configuration settings(evrun.f).

thmin = 0.007 rad, thmax = 1.57 rad(90 degree)

ReneSANCe

```
#####  
# Process id:  
pid : 101  
# 101 - e+e- --> e-e+  
# 102 - e+e- --> ZH  
# 103 - e+e- --> mu-mu+  
# 104 - e+e- --> tau-tau+  
#####  
# ALR:  
alr : 0  
# 0 - sigma, 1 - sigmaRL-sigmaLR, 2 - sigmaRL+sigmaLR,  
# 3 - sigma0L-sigma0R, 4 - sigma0L+sigma0R  
#####  
# Longitudinal polarization of initial particles:  
lamep : 0 # e+ polarization  
lamem : 0 # e- polarization  
#####  
# EW scheme:  
gfscheme : 0  
# 0 - alpha(0)  
# 1 - gfermi  
# 2 - alpha(M_Z)  
#####  
# Cuts:  
#costhcut : 0.9 # cutn on |cos(theta)|  
thetacut : 0.4010704565915762 # cut on theta in degrees (thetacut < theta < 180-thetacut)  
#####  
irun : 0  
iborn : 0  
iqed : 1  
iew : 1  
ilin : 1  
ifgg : 1  
ecm : 92.3 # collision CM energy  
ome: 1e-4 # E_gamma > ome*ecm/2  
#####  
exploreBorn : true  
exploreVirt : true  
exploreHard : true  
#####  
printLHE : true  
printROOT : true
```

th1 = 0.40107 degree(0.007 rad)

Comparison

```

=====
*****
BHLUM4:      WINDOW A
*****
1000000      Accepted total      NEVGEN      A1 =
2924926      Raw prior reject.    IEVENT      A2 =
2560.7689    +- 1.77304070 Xsec M.C. [nb] XSECMC      A3 =
0.00069239  relat. error                  ERELMC      A4 =
1.02565020  +- 0.00069239 weight M.C.   AWT          A5 =
25450      WT<0                      NEVNEG      A6 =
401        WT>WTMAX                 NEVOVE      A7 =
3.00000000  Maximum WT                    WWMX        A8 =
=====

*****
BHLUM4:      WINDOW B
*****
0.26251911  +- 0.00066604 WT1*WT2*T/TP*T/TQ      B1 =
0.99998047  +- 0.00000261 WT3 from KIN04      B2 =
4.08622186  +- 0.00007598 YFS formfac          WT          B4 =
1.02565020  +- 0.00069239 TOTAL                          B5 =
0.00005970  +- 0.00000661 xsec/xtot: WT>WTMAX   WT          B6 =
-0.00000296 +- -0.00000063 xsec/xtot: WT<0      WT          B7 =
=====

*****
WINDOW C
Built-in average control weights.
Should equal one +- statist. err.
*****
1.00026745  +- 0.00047737 <WCTA1>      C1 =
1.00052540  +- 0.00047723 <WCTA2>      C2 =
1.00066599  +- 0.00077756 <WCTA1*WCTA2>    C3 =
1.00008463  +- 0.00028460 <WCTB1>      C4 =
1.00002846  +- 0.00028465 <WCTB2>      C5 =
1.00026142  +- 0.00042541 <WCTB1*WCTB2>  C6 =
=====

```

Figure. Output(evrn.output).

```

MCresult (Born) = 2495087.8325683 +- 5.196125274135 RelErr = 2.0825420277035e-06
MCresult (B+S+V) = 33169.553762616 +- 2.3954872835097 RelErr = 7.2219460673287e-05
MCresult (Hard) = 2527250.5972668 +- 416.98022081254 RelErr = 0.00016499361846566
MCresult (LL11) = 0 +- 0 RelErr = -nan
MCresult (LL22) = 0 +- 0 RelErr = -nan
MCresult (LL12) = 0 +- 0 RelErr = -nan
MCresult (LLF11) = 0 +- 0 RelErr = -nan
MCresult (LLF22) = 0 +- 0 RelErr = -nan
MCresult (LLF12) = 0 +- 0 RelErr = -nan
MCresult (Tot) = 2560420.1510294 +- 416.98710160891 RelErr = 0.0001628588579266
MCresult (Delta) = 0.026184376200434 +- 0.00016713619932245 RelErr = 0.0063830506422254

```

Figure. Output(101.txt).

$$\delta = 1.36 \times 10^{-4}$$

```

|||||
Xsec_BARE1 = 1191.64870524 Nanob.
error = 1.27730590 Nanob.
Xsec_CAL02 = 136.36350689 Nanob.
error = 0.57497863 Nanob.

```

Figure. Output(evrn.output).

Comparison (BHLUMI)

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465348.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1256.853564789840220[nb]
Requiring BARE1, the resulting cross section : 1191.648705240555955[nb]
Requiring all the scattering angles, the resulting cross section : 716.200979007300248[nb]
```

Figure. Statistical results of
BHLUMI (trial0).

```
|||||
Xsec_BARE1 = 1191.64870524 Nanob.
error = 1.27730590 Nanob.
Xsec_CAL02 = 136.36350689 Nanob.
error = 0.57497863 Nanob.
```

Figure. Output(evr.run.output).

BHLUMI

```
#!/bin/bash
#
START=$(date +%s)
Nname=$(uname -n)
#
#23456789.Variable
./evrun.exe << !
FieOut trial0
CMS Ener 92.3
Th1minRad .0100
Th2maxRad .78539816339744830
NevTot 1000000
!
# R
#!/bin/bash
#
END START=$(date +%s)
DIFF Nname=$(uname -n)
#
#23456789.Variable
./evrun.exe << !
FieOut trial1
CMS Ener 92.3
Th1minRad .007
Th2maxRad 1.5707963267948966
NevTot 1000000
!
# Read format is (10x,I20)
END=$(date +%s)
DIFF=$(( $END - $START ))
echo "===== "
echo "= run on $Nname "
echo "= The executable took $DIFF seconds "
echo "= "
echo "===== "
```

Figure. Configuration settings(evrun.run).
th1 = 0.007 rad, th2 = 1.57 rad(90 degree)

```
-----
npar(1)= KeyOpt
npar(2)= KeyRad
CmsEne = 92.3D0 ! 2*Ebeam [GeV], as in Workshop95
CmsEne = 100.0D0 ! 2*Ebeam [GeV], as in Workshop95
xpar(1)= CmsEne
th1 = .024d0 ! Detector range ThetaMin [rad]
th2 = .058d0 ! Detector range ThetaMax [rad]
th1 = .030d0 ! Detector range ThetaMin [rad]
th2 = .060d0 ! Detector range ThetaMax [rad]

read(5,'(10x,F10.5)') CmsEne
print *,'== Input CMS Energy ',CmsEne
xpar(1)= CmsEne

read(5,'(10x,F10.5)') th1
print *,'== Input Detector theta '
read(5,'(10x,F10.5)') th2
print *,'== Input Detector theta '

thmin = 0.7d0*th1 ! thmin has to be lower than th1
thmax = 2.0d0*th2 ! thmax has to be higher than th2
IF(KeyWgt .EQ. 2) thmin=th1 ! Because generation below th1 is on!!!
xpar(2)= CmsEne**2*(1-COS(thmin))/2 ! TransMin [GeV**2]
xpar(3)= CmsEne**2*(1-COS(thmax))/2 ! TransMax [GeV**2]
xpar(4)= 1D-4 ! Infrared cut on photon energy
CALL bhlumi(-1,xpar,npar)
```

```
-----
npar(1)= KeyOpt
npar(2)= KeyRad
CmsEne = 92.3D0 ! 2*Ebeam [GeV], as in Workshop95
CmsEne = 100.0D0 ! 2*Ebeam [GeV], as in Workshop95
xpar(1)= CmsEne
th1 = .024d0 ! Detector range ThetaMin [rad]
th2 = .058d0 ! Detector range ThetaMax [rad]
th1 = .030d0 ! Detector range ThetaMin [rad]
th2 = .060d0 ! Detector range ThetaMax [rad]

read(5,'(10x,F10.5)') CmsEne
print *,'== Input CMS Energy ',CmsEne
xpar(1)= CmsEne

read(5,'(10x,F10.5)') th1
print *,'== Input Detector theta low (rad) th1=',th1
read(5,'(10x,F10.5)') th2
print *,'== Input Detector theta high(rad) th2=',th2

thmin = 1.0d0*th1 ! thmin has to be lower than th1
thmax = 1.0d0*th2 ! thmax has to be higher than th2
IF(KeyWgt .EQ. 2) thmin=th1 ! Because generation below th1 is on!!!
xpar(2)= CmsEne**2*(1-COS(thmin))/2 ! TransMin [GeV**2]
xpar(3)= CmsEne**2*(1-COS(thmax))/2 ! TransMax [GeV**2]
xpar(4)= 1D-4 ! Infrared cut on photon energy
CALL bhlumi(-1,xpar,npar)
```

Figure. Configuration settings(evrun.f).
thmin = 0.007 rad, thmax = 1.57 rad(90 degree)

Comparison (BHLUMI)

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768940576340810
th1 :0.0070000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 948218.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 2552.233897697399698[nb]
Requiring BARE1, the resulting cross section : 2428.167203295416584[nb]
Requiring all the scattering angles, the resulting cross section : 1500.364765359440298[nb]
```

Figure. Statistical results of
BHLUMI (trial1).

```
Xsec_BARE1 = 2428.18512868 Nanob.
error      = 0.56739584 Nanob.
Xsec_CAL02 = 136.36350685 Nanob.
error      = 0.57497863 Nanob.
|||||||||||||||||||||||||||||||||||||||||||||||||||||||||||||
Xcru*Nbare1/Ntot= 2428.18512868 Nanob.
```

Figure. Output(evrun.output).

Comparison (BHLUMI)

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0070000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 948218.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 2552.233898299743942[nb]
Requiring BARE1, the resulting cross section : 2428.167203868480101[nb]
Requiring all the scattering angles, the resulting cross section : 1500.364765713536372[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465348.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1256.853564789840220[nb]
Requiring BARE1, the resulting cross section : 1191.648705240555955[nb]
Requiring all the scattering angles, the resulting cross section : 716.200979007300248[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 491268.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465461.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279750.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1258.023836195959575[nb]
Requiring BARE1, the resulting cross section : 1191.938072130909404[nb]
Requiring all the scattering angles, the resulting cross section : 716.375111295300599[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :0.1000000000000000[Rad]
nevent1_cut1 : 481825.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 460382.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 276299.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1233.842495084390293[nb]
Requiring BARE1, the resulting cross section : 1178.931926678652644[nb]
Requiring all the scattering angles, the resulting cross section : 707.537897679286061[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768940576340810
th1 :0.0070000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 948218.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 2552.233897697399698[nb]
Requiring BARE1, the resulting cross section : 2428.167203295416584[nb]
Requiring all the scattering angles, the resulting cross section : 1500.364765359440298[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768940576340810
th1 :0.0100000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465348.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1256.853564493214435[nb]
Requiring BARE1, the resulting cross section : 1191.648704959319048[nb]
Requiring all the scattering angles, the resulting cross section : 716.200978838272135[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768940576340810
th1 :0.0100000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 491268.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465461.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279750.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1258.023835899057758[nb]
Requiring BARE1, the resulting cross section : 1191.938071849604285[nb]
Requiring all the scattering angles, the resulting cross section : 716.375111126231332[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768940576340810
th1 :0.0100000000000000[Rad]
th2 :0.1000000000000000[Rad]
nevent1_cut1 : 481825.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 460382.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 276299.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1233.842494793195328[nb]
Requiring BARE1, the resulting cross section : 1178.931926400417069[nb]
Requiring all the scattering angles, the resulting cross section : 707.537897512302379[nb]
```

Figure. Statistical results of BHLUMI (trial0).

Figure. Statistical results of BHLUMI (trial1).

Comparison

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0070000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 948218.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 2552.233898299743942[nb]
Requiring BARE1, the resulting cross section : 2428.167203868480101[nb]
Requiring all the scattering angles, the resulting cross section : 1500.364765713536372[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 491268.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465461.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279750.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1258.023836195959575[nb]
Requiring BARE1, the resulting cross section : 1191.938072130909404[nb]
Requiring all the scattering angles, the resulting cross section : 716.375111295300599[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 465348.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1256.853564789840220[nb]
Requiring BARE1, the resulting cross section : 1191.648705240555955[nb]
Requiring all the scattering angles, the resulting cross section : 716.200979007300248[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.768941180699130
th1 :0.0100000000000000[Rad]
th2 :0.1000000000000000[Rad]
nevent1_cut1 : 481825.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 460382.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 276299.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1233.842495084390293[nb]
Requiring BARE1, the resulting cross section : 1178.931926678652644[nb]
Requiring all the scattering angles, the resulting cross section : 707.537897679286061[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.420151029400131
th1 :0.0070000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 999291.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 956471.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 504160.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 2558.604813142320381[nb]
Requiring BARE1, the resulting cross section : 2448.967622275241411[nb]
Requiring all the scattering angles, the resulting cross section : 1290.861423342982562[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.420151029400131
th1 :0.0100000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 512302.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 490166.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 256105.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1311.708364212663810[nb]
Requiring BARE1, the resulting cross section : 1255.030903749476920[nb]
Requiring all the scattering angles, the resulting cross section : 655.736402779384548[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.420151029400131
th1 :0.0100000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 511808.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 489930.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 255887.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1310.443516658055387[nb]
Requiring BARE1, the resulting cross section : 1254.426644593833998[nb]
Requiring all the scattering angles, the resulting cross section : 655.178231186460039[nb]
```

```
CMS :92.29999999999997[GeV]
The total number of events : 1000000.0000000000000000
The total cross section : 2560.420151029400131
th1 :0.0100000000000000[Rad]
th2 :0.1000000000000000[Rad]
nevent1_cut1 : 500382.0000000000000000 (th1 < theta < th2)
nevent1_cut2 : 482112.0000000000000000 (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 249592.0000000000000000 (th1 < theta < th2)
Requiring only the electron scattering angles, the resulting cross section : 1281.188156012393392[nb]
Requiring BARE1, the resulting cross section : 1234.409279853086218[nb]
Requiring all the scattering angles, the resulting cross section : 639.060386335730072[nb]
```

Figure. Statistical results of BHLUMI (trial0).

Figure. Statistical results of ReneSANCe (trial0).

Comparison

	BHLUMI(trial0)				BHLUMI(trial1)			
<i>Events</i>	1e06				1e06			
<i>CMS (GeV)</i>	92.3				92.3			
<i>Infrared cut</i>	1e-04				1e-04			
<i>thmin (Rad)</i>	0.007				0.007			
<i>thmax (Rad)</i>	1.571				1.571			
<i>The total cross section (nb)</i>	2560.769				2560.769			
<i>th1 (Rad)</i>	0.007	0.010	0.010	0.010	0.007	0.010	0.010	0.010
<i>th2 (Rad)</i>	1.571	0.785	1.571	0.100	1.571	0.785	1.571	0.100
<i>cut₁ (nb)</i>	2552.234	1256.854	1258.024	1233.843	2552.234	1256.854	1258.024	1233.843
<i>cut₂ (nb)</i>	2428.167	1191.649	1191.938	1178.932	2428.167	1191.649	1191.938	1178.932
<i>cut₃ (nb)</i>	1500.365	716.201	716.375	707.538	1500.365	716.201	716.375	707.538

Comparison

	BHLUMI(trial0)				ReneSANCe(trial0)				Difference			
<i>Events</i>	1e06				1e06							
<i>CMS (GeV)</i>	92.3				92.3							
<i>Infrared cut</i>	1e-04				1e-04							
<i>thmin (Rad)</i>	0.007				0.007							
<i>thmax (Rad)</i>	1.571				(1.571)							
<i>The total cross section (nb)</i>	2560.769				2560.420				-0.0136%			
<i>th1 (Rad)</i>	0.007	0.010	0.010	0.010	0.007	0.010	0.010	0.010	0.007	0.010	0.010	0.010
<i>th2 (Rad)</i>	1.571	1.571	0.785	0.100	1.571	1.571	0.785	0.100	1.571	1.571	1.571	0.100
<i>cut₁ (nb)</i>	2552.234	1258.024	1256.854	1233.843	2558.605	1311.708	1310.444	1281.188	0.25%	4.27%	4.26%	3.84%
<i>cut₂ (nb)</i>	2428.167	1191.938	1191.649	1178.932	2448.968	1255.031	1254.427	1234.409	0.86%	5.29%	5.27%	4.71%
<i>cut₃ (nb)</i>	1500.365	716.375	716.201	707.538	1290.861	655.736	655.178	639.060	-13.96%	-8.465%	-8.52%	-9.68%

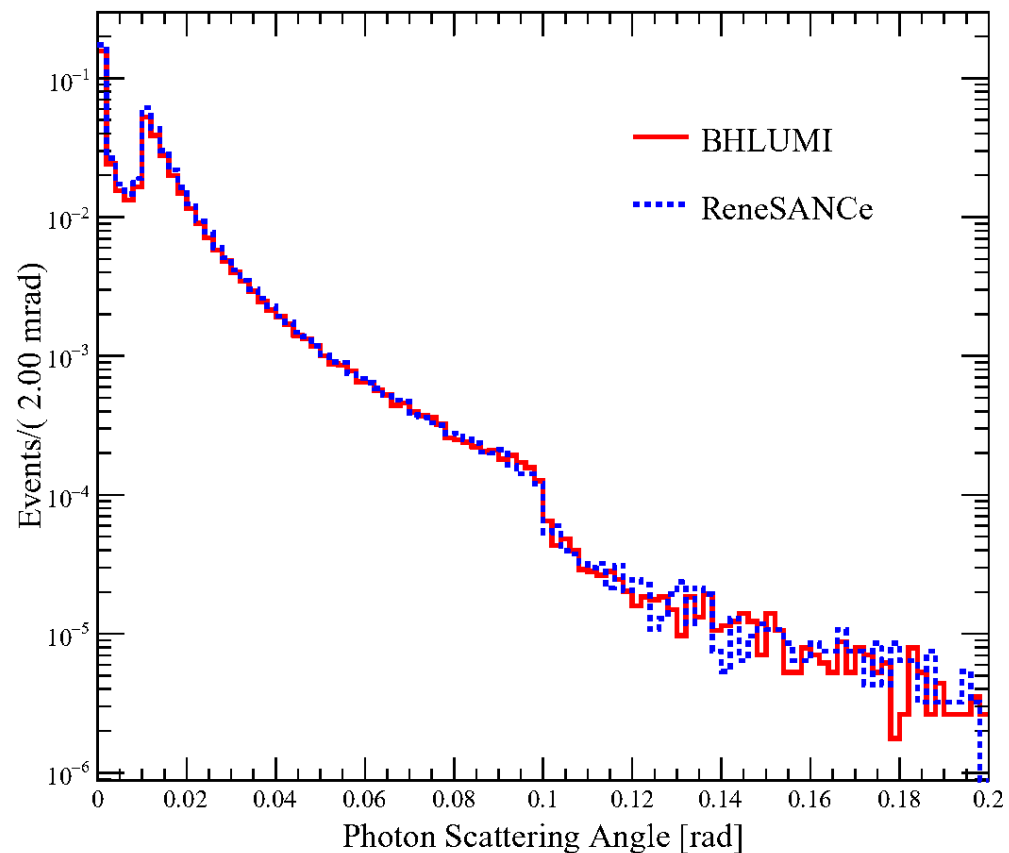
Comparison

	BHLUMI(trial2)				ReneSANCe(trial2)				Difference			
<i>Events</i>	1e06				1e06							
<i>CMS (GeV)</i>	92.3				92.3							
<i>Infrared cut</i>	1e-04				1e-04							
<i>thmin (Rad)</i>	0.025				0.025							
<i>thmax (Rad)</i>	1.571				(1.571)							
<i>The total cross section (nb)</i>	203.253				203.671				-0.206%			
<i>th1 (Rad)</i>	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
<i>th2 (Rad)</i>	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080
<i>cut₁ (nb)</i>	202.388	201.797	184.863	176.465	202.584	201.724	183.122	173.889	0.0968%	-0.0362%	-0.942%	-1.46%
<i>cut₂ (nb)</i>	190.675	190.427	177.904	170.622	194.713	194.102	178.487	169.987	2.11%	1.93%	0.328%	-0.372%
<i>cut₃ (nb)</i>	107.036	106.890	99.351	95.148	109.368	108.877	97.665	92.062	2.18%	1.86%	-1.70%	-3.24%

Comparison

	BHLUMI(trial3)				ReneSANCe(trial3)				Difference			
<i>Events</i>	1e06				1e06							
<i>CMS (GeV)</i>	92.3				92.3							
<i>Infrared cut</i>	1e-04				1e-04							
<i>thmin (Rad)</i>	0.010				0.010							
<i>thmax (Rad)</i>	1.571				(1.571)							
<i>The total cross section (nb)</i>	1259.280				1259.361				-0.00643%			
<i>th1 (Rad)</i>	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
<i>th2 (Rad)</i>	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080
<i>cut₁ (nb)</i>	1254.889	1253.802	1231.169	1221.183	1257.831	1256.441	1228.925	1216.130	0.234%	0.210%	-0.182%	-0.414%
<i>cut₂ (nb)</i>	1190.680	1190.410	1177.849	1170.784	1203.834	1203.078	1184.031	1173.697	1.105%	1.064%	-0.525%	0.249%
<i>cut₃ (nb)</i>	716.413	716.243	707.637	702.840	629.589	628.934	613.512	605.743	-12.11%	-12.19%	-13.30%	-13.81%

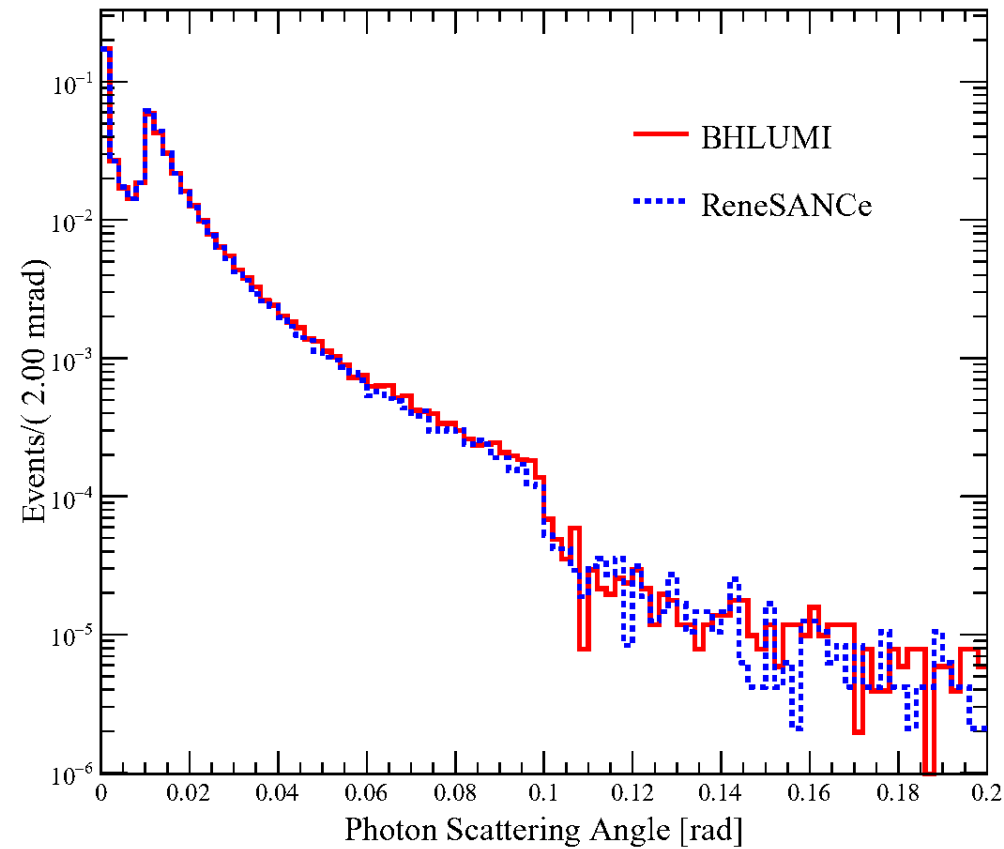
Comparison



BHLUMI : 0.225558

ReneSANCe : 0.248515

Trial3 : th1= 0.01rad, th2= 0.1rad

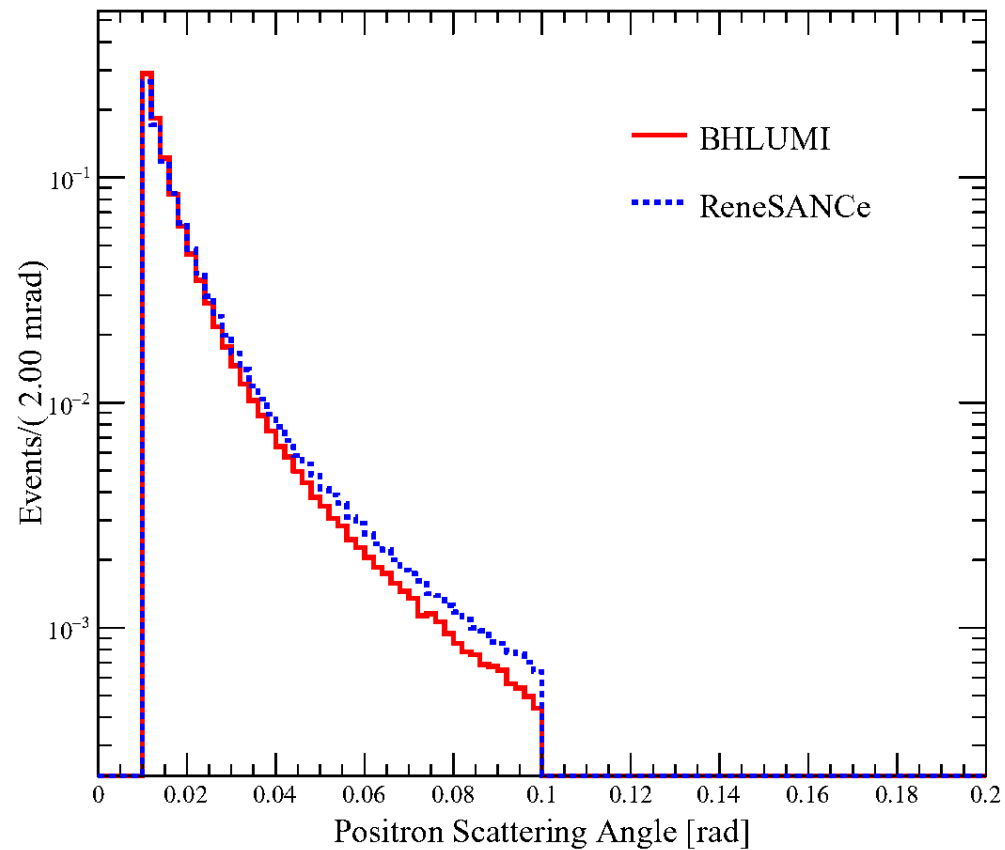


BHLUMI : 0.248637

ReneSANCe : 0.248775

Trial0 : th1= 0.01rad, th2= 0.1rad

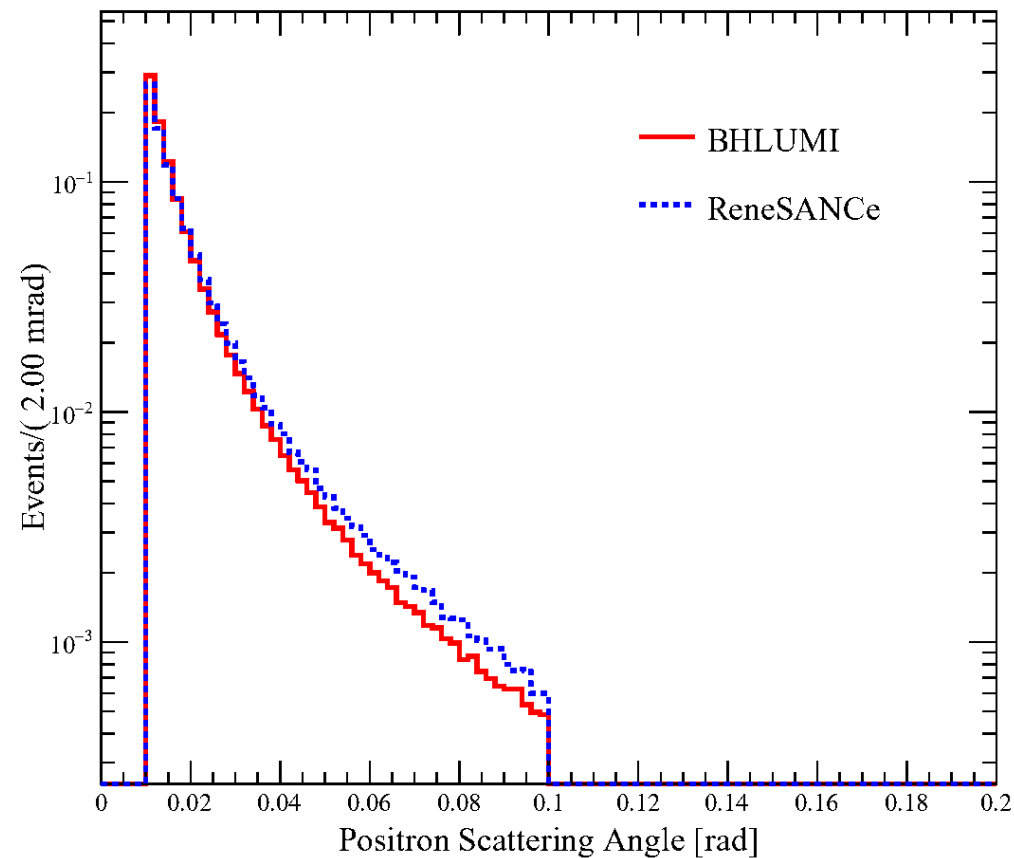
Comparison



BHLUMI : 1

ReneSANCe : 1

Trial3 : th1= 0.01rad, th2= 0.1rad

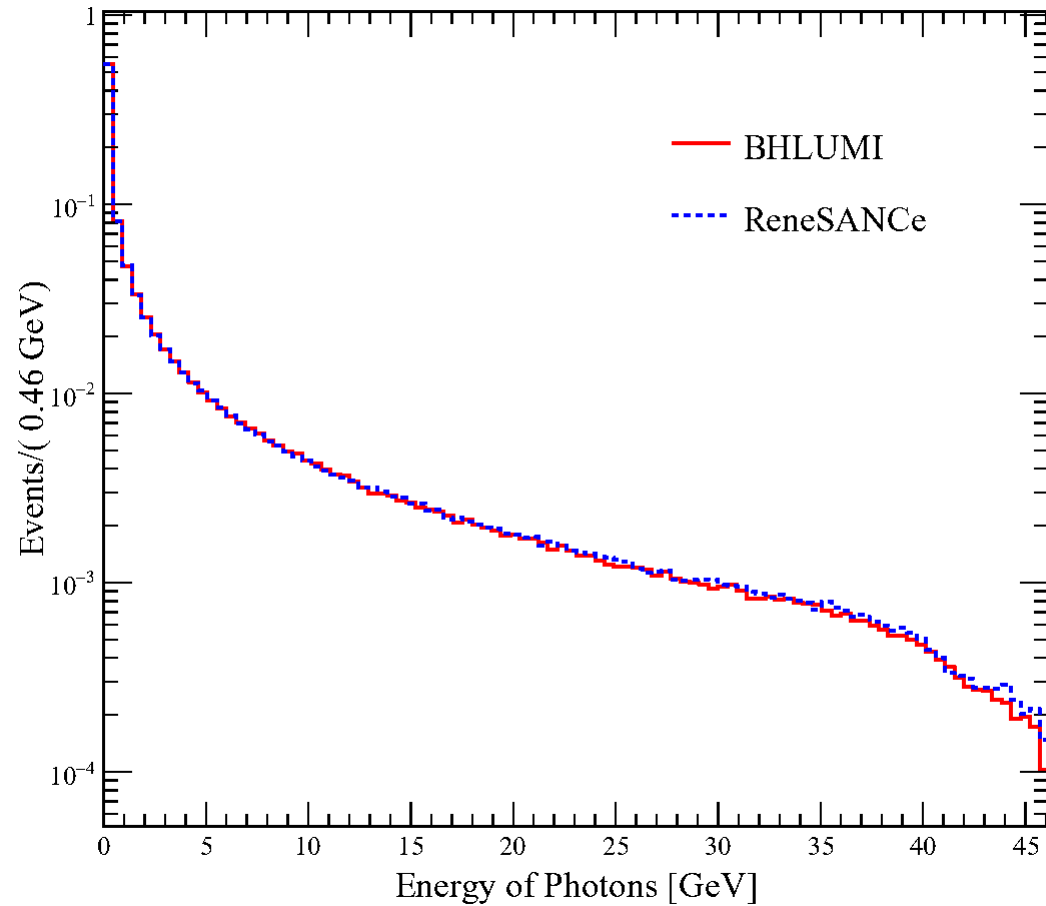


BHLUMI : 1

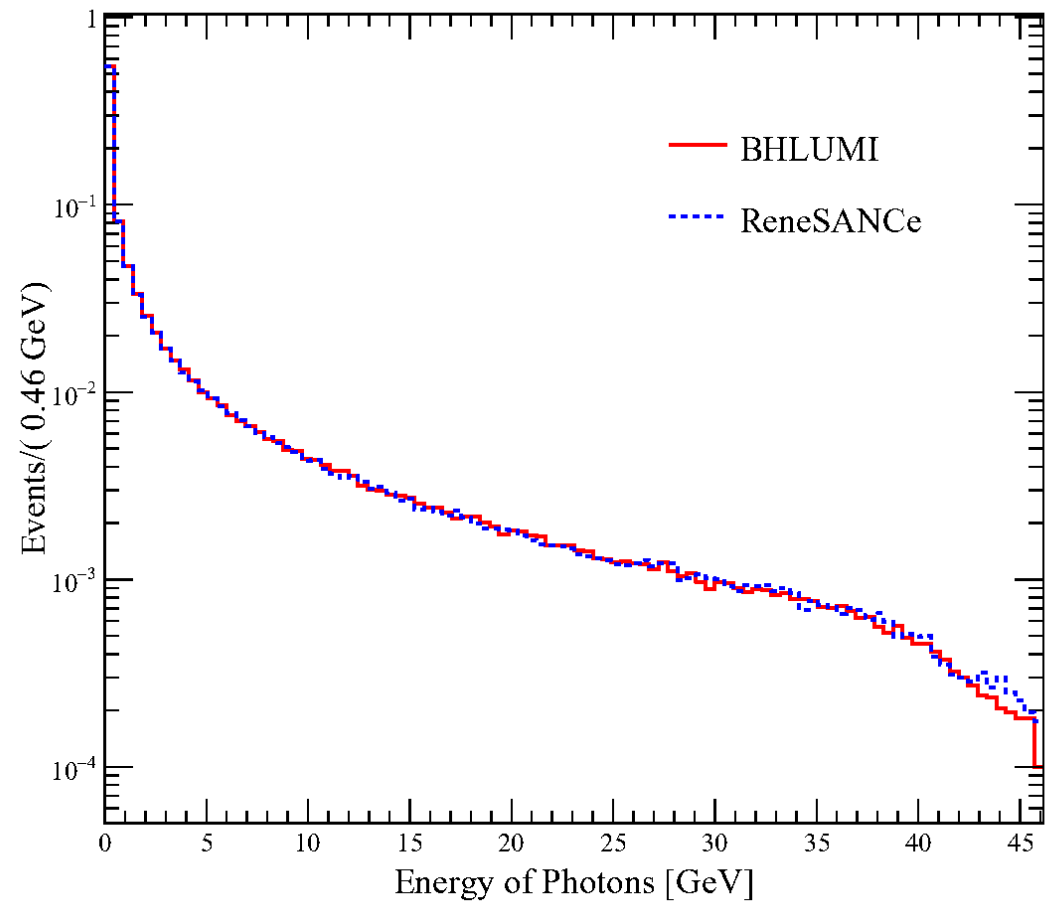
ReneSANCe : 1

Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison

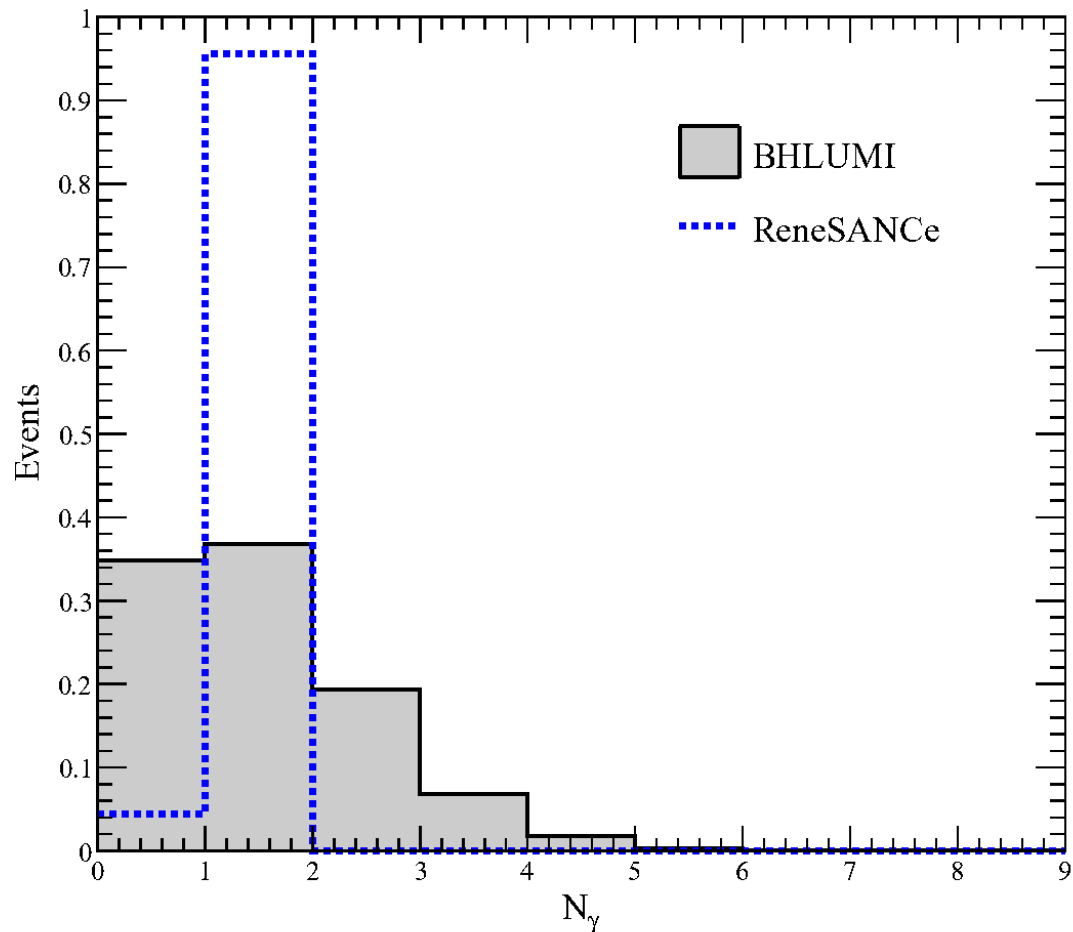


Trial3 : th1= 0.01rad, th2= 0.1rad

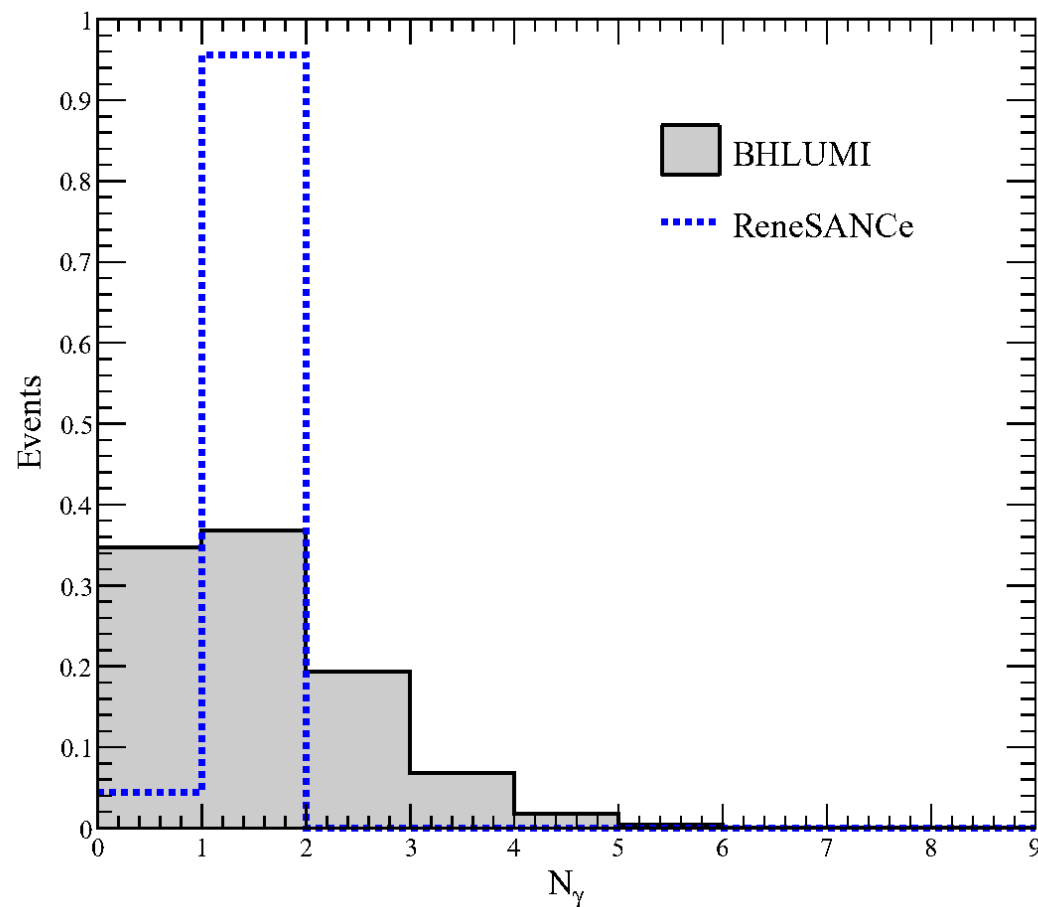


Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison



Trial3 : th1= 0.01rad, th2= 0.1rad



Trial0 : th1= 0.01rad, th2= 0.1rad

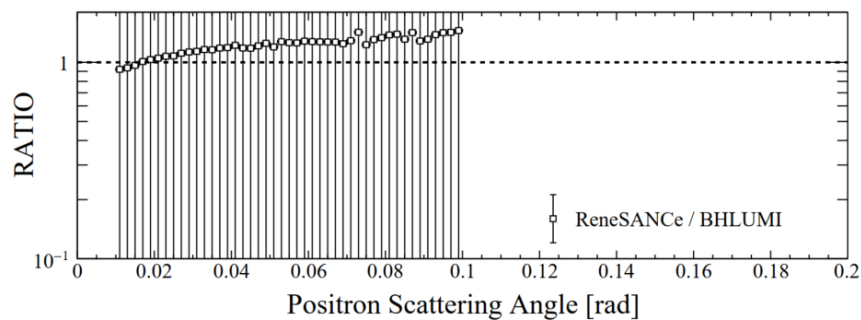
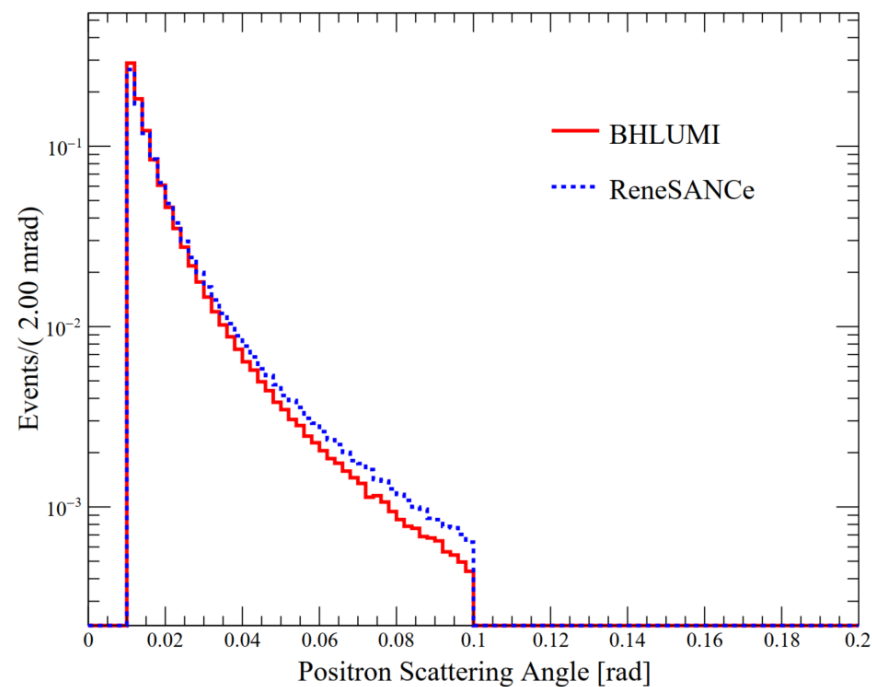
Comparison

	BHLUMI(trial0)	ReneSANCe(trial0)	BHLUMI(trial3)	ReneSANCe(trial3)
0 γ	34.67%	4.4%	34.80%	4.45%
1 γ	36.80%	95.6%	36.84%	95.55%
2 γ	19.40%		19.38%	
3 γ	6.85%		6.77%	
4 γ	1.80%		1.77%	
5 γ	0.38%		0.37%	
6 γ	0.07%		0.06%	
7 γ	9e-05		9e-05	
8 γ	1e-05		2e-05	

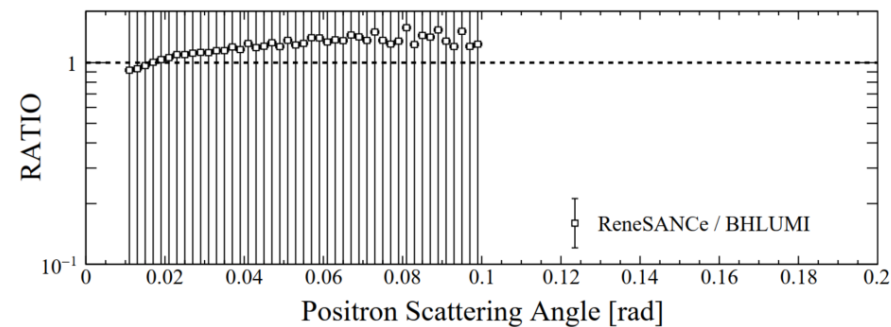
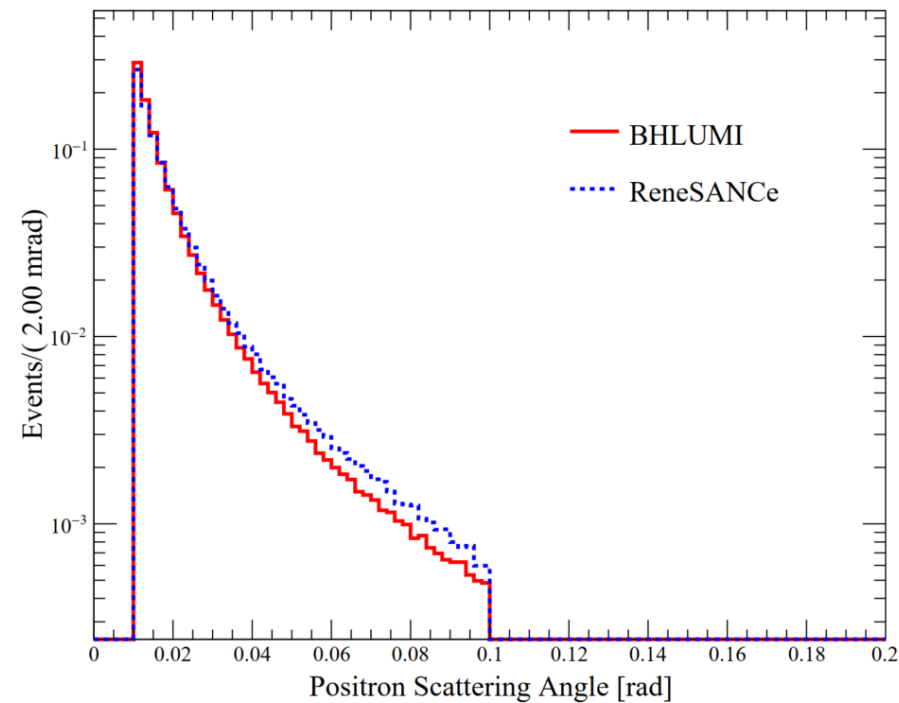
Trial3 : th1= 0.01rad, th2= 0.1rad

Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison

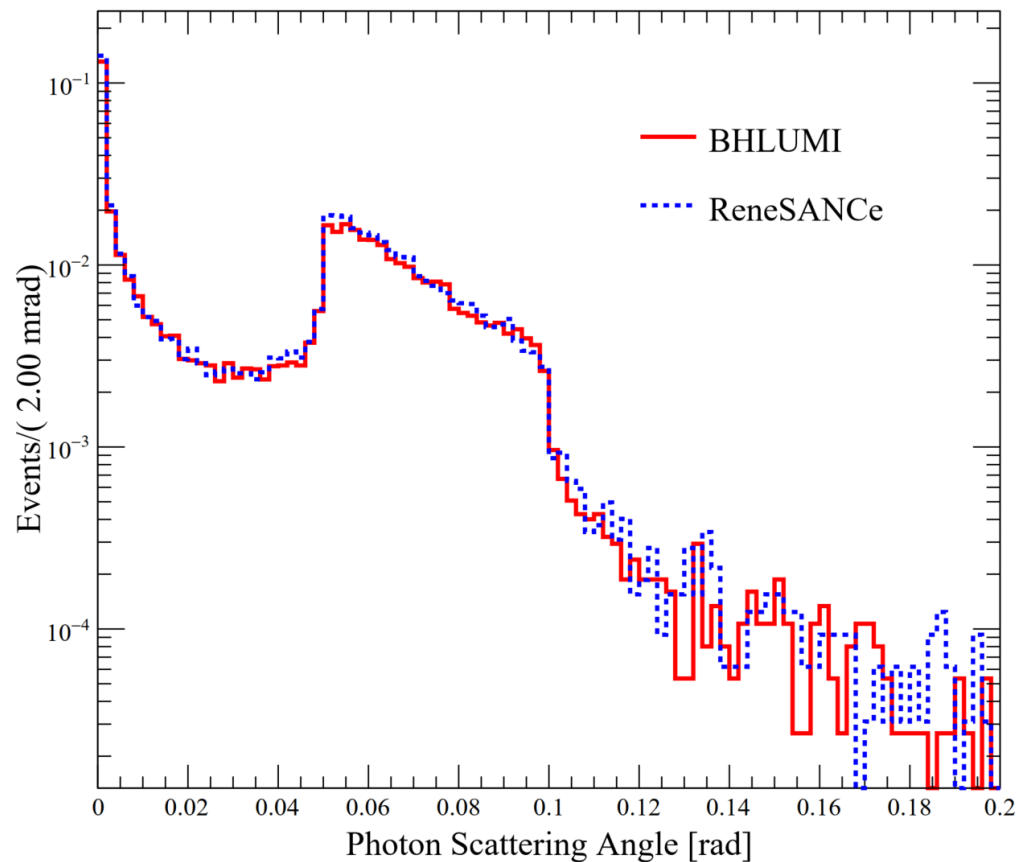


Trial3 : th1= 0.01rad, th2= 0.1rad



Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison

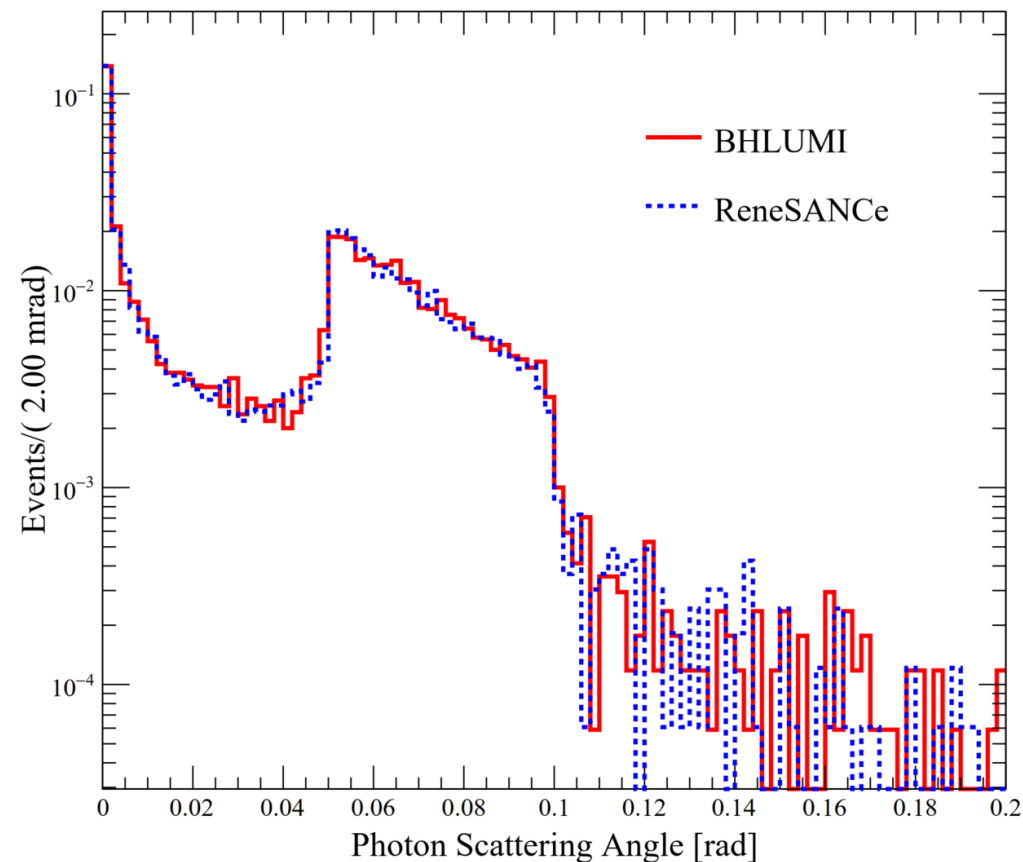


BHLUMI : 0.283882

ReneSANCe : 0.300077

Trial3 : th1= 0.01rad, th2= 0.1rad

Select : (0.05rad, 0.1rad)



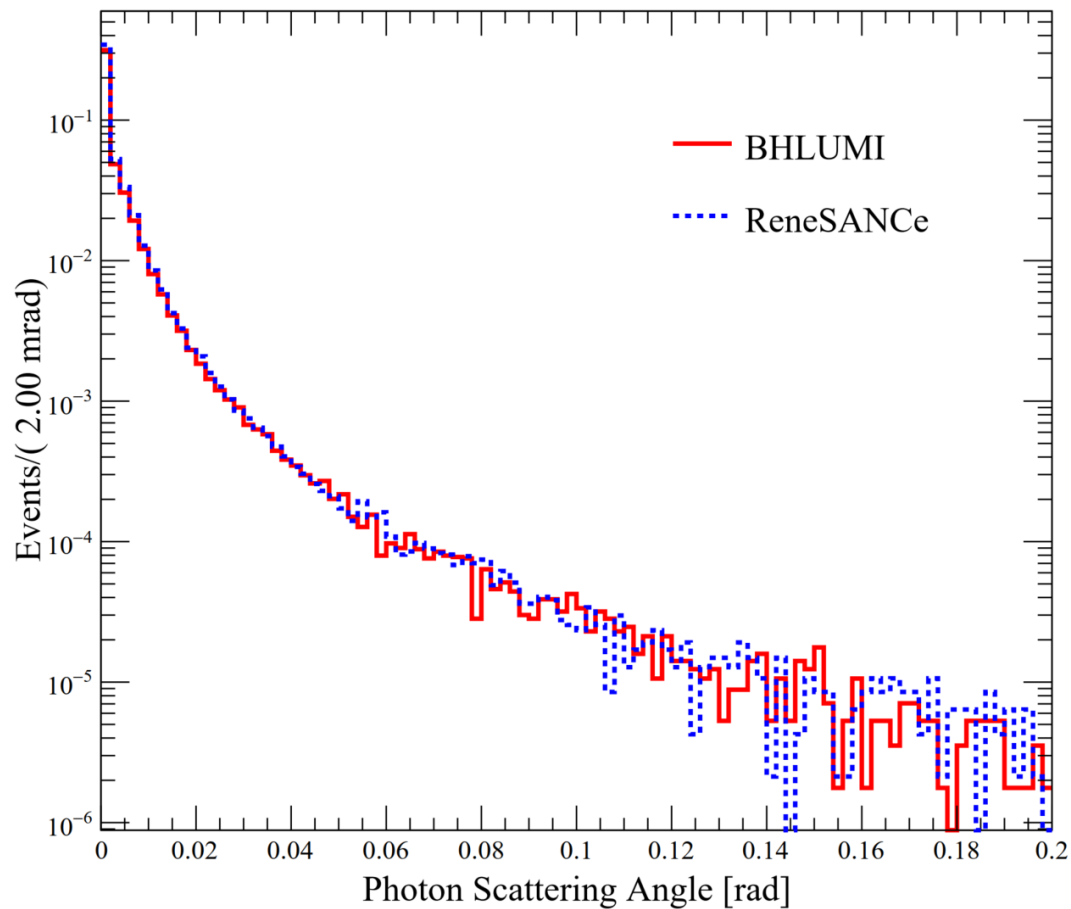
BHLUMI : 0.305267

ReneSANCe : 0.299101

Trial0 : th1= 0.01rad, th2= 0.1rad

Select : (0.05rad, 0.1rad)

Comparison

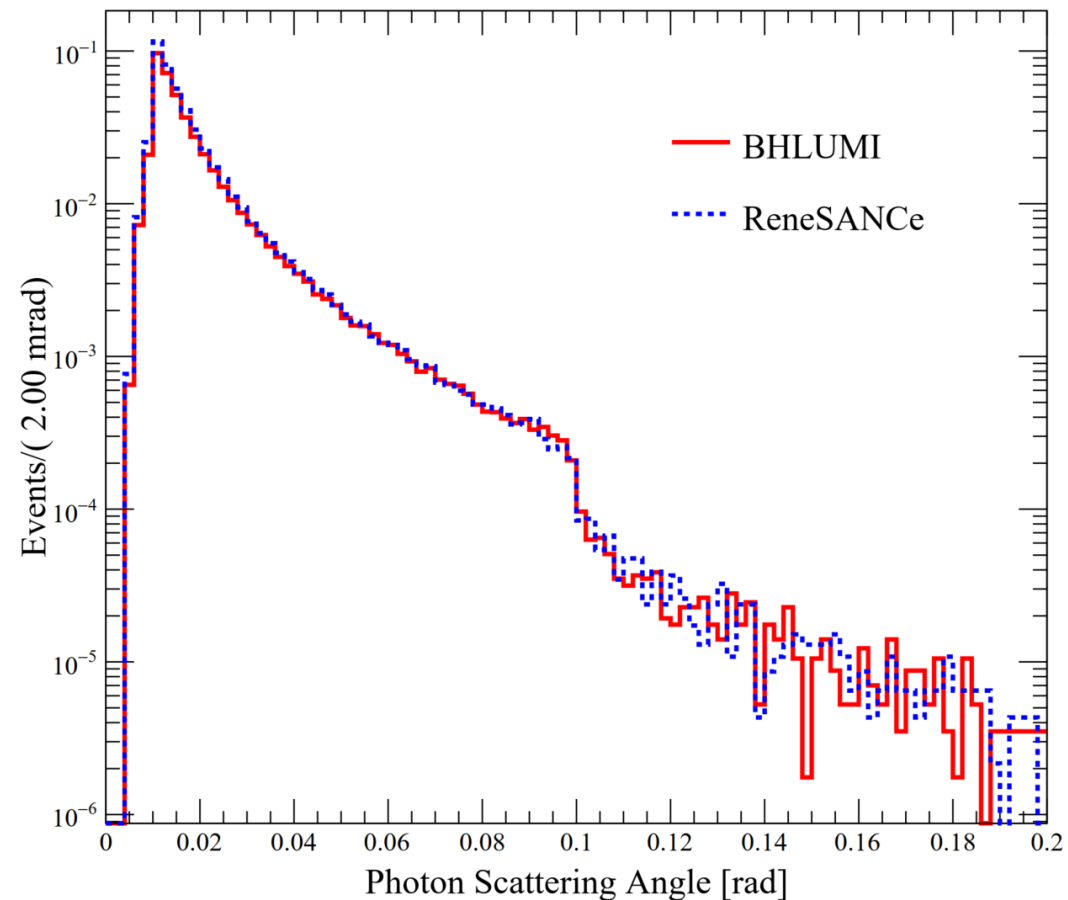


ISR

BHLUMI : 0.0358161

ReneSANCe : 0.0378038

Trial3 : th1= 0.01rad, th2= 0.1rad



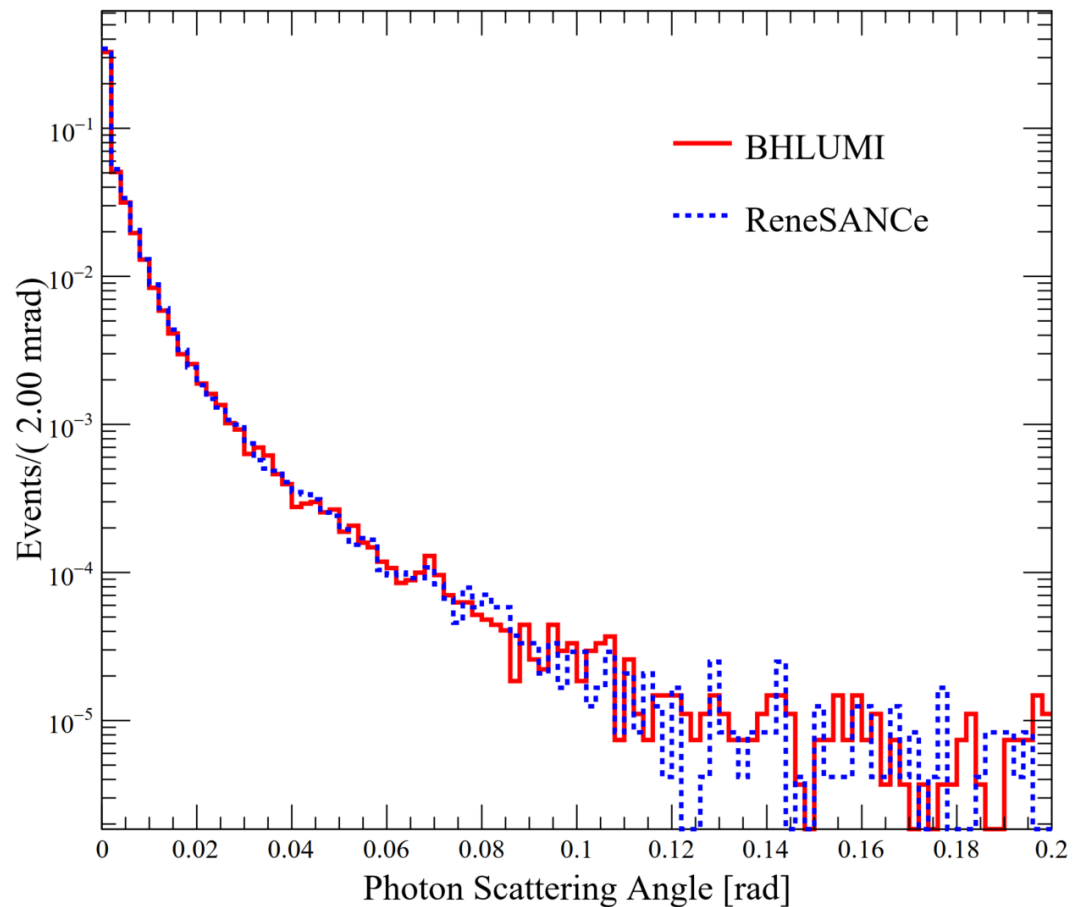
BHLUMI : 0.413858

FSR

ReneSANCe : 0.462642

Trial3 : th1= 0.01rad, th2= 0.1rad

Comparison



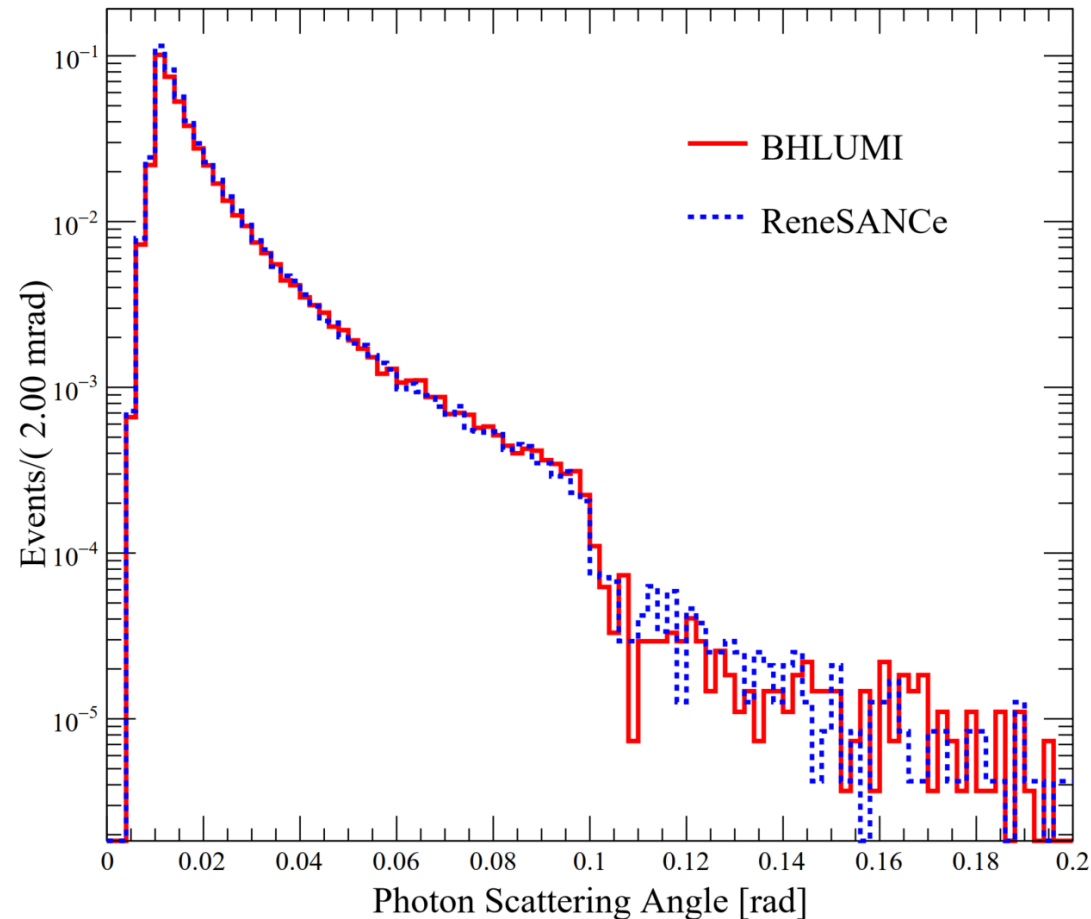
ISR

BHLUMI : 0.0369029

ReneSANCe : 0.0378193

Trial0 : th1= 0.01rad, th2= 0.1rad

2025/4/1



BHLUMI : 0.428604

ReneSANCe : 0.461965

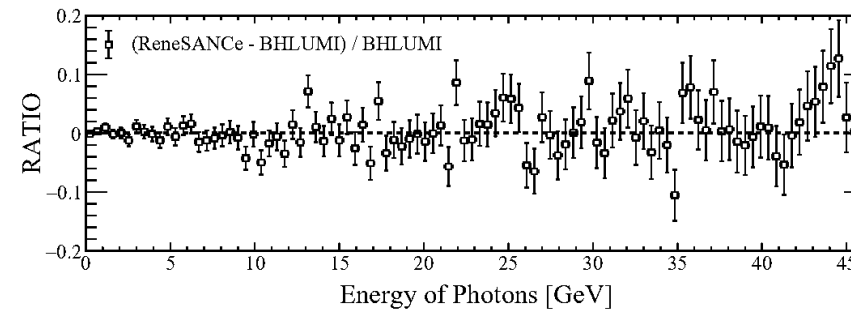
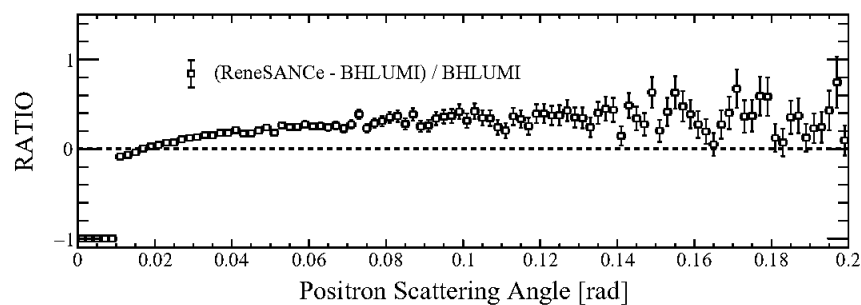
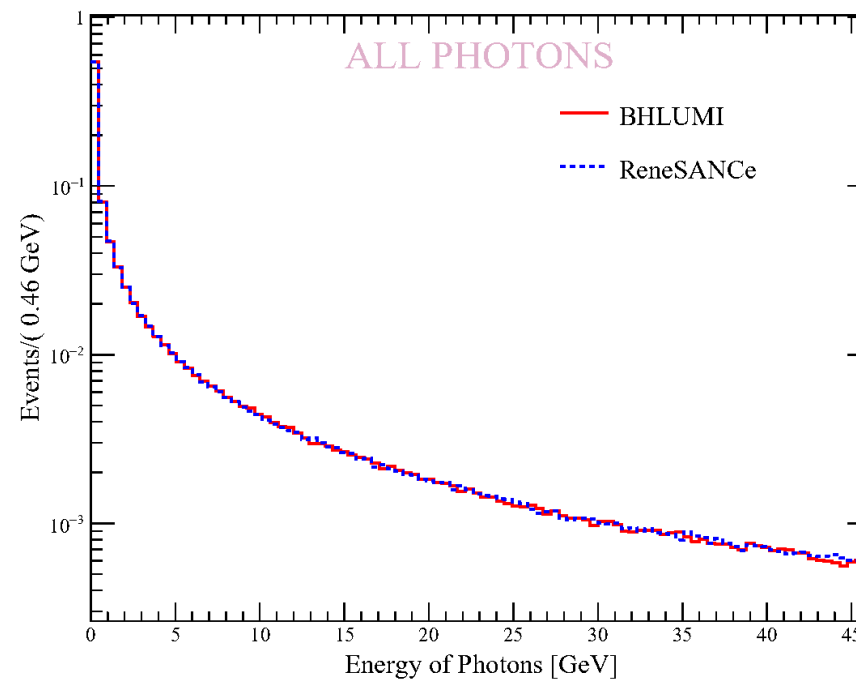
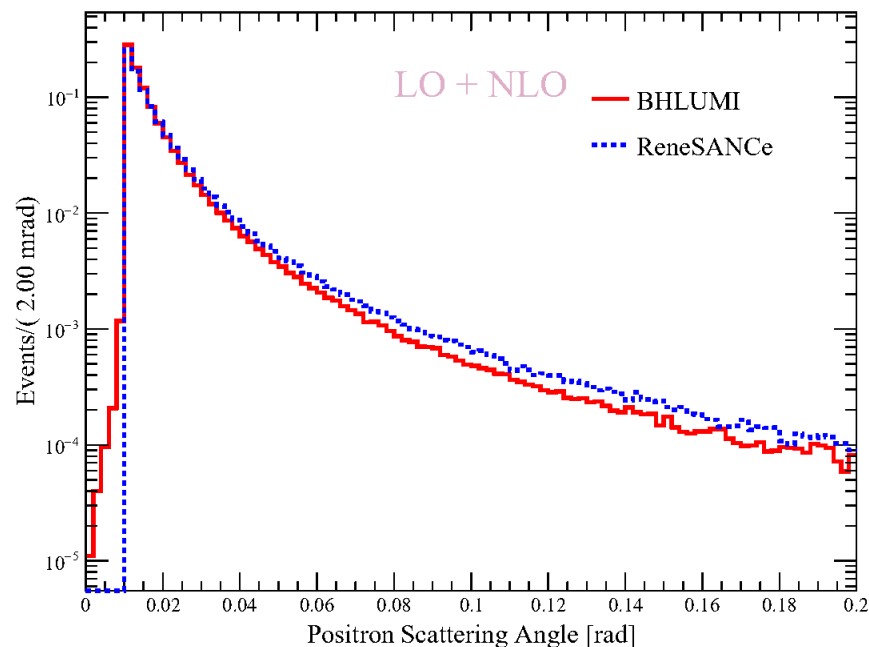
Trial0 : th1= 0.01rad, th2= 0.1rad

FSR

22

Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259\text{ nb}$, $\Delta\sigma = -0.00643\%$

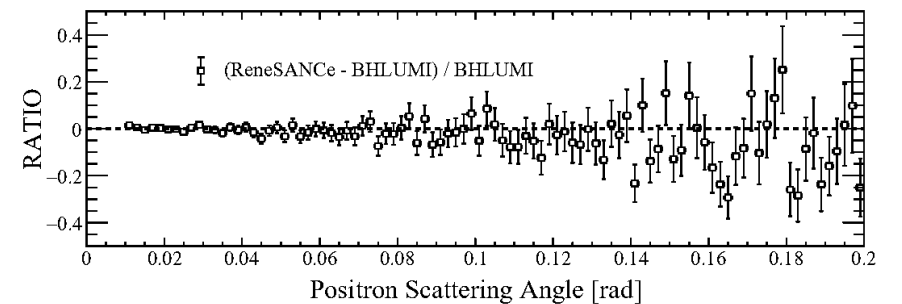
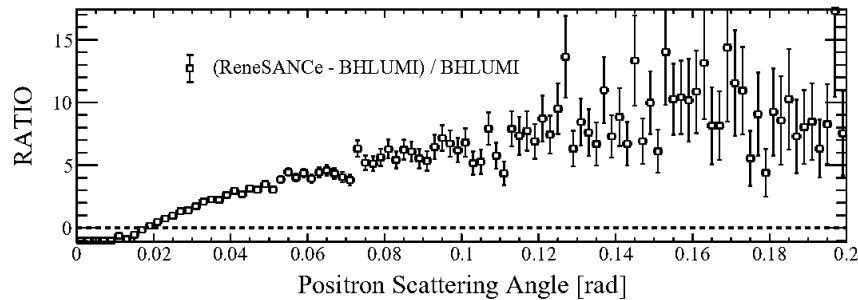
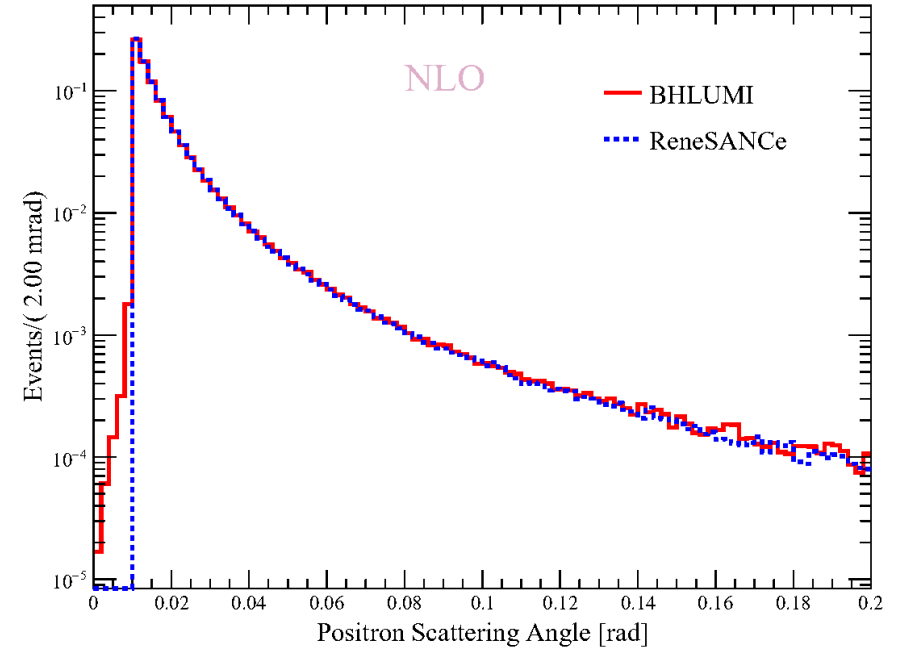
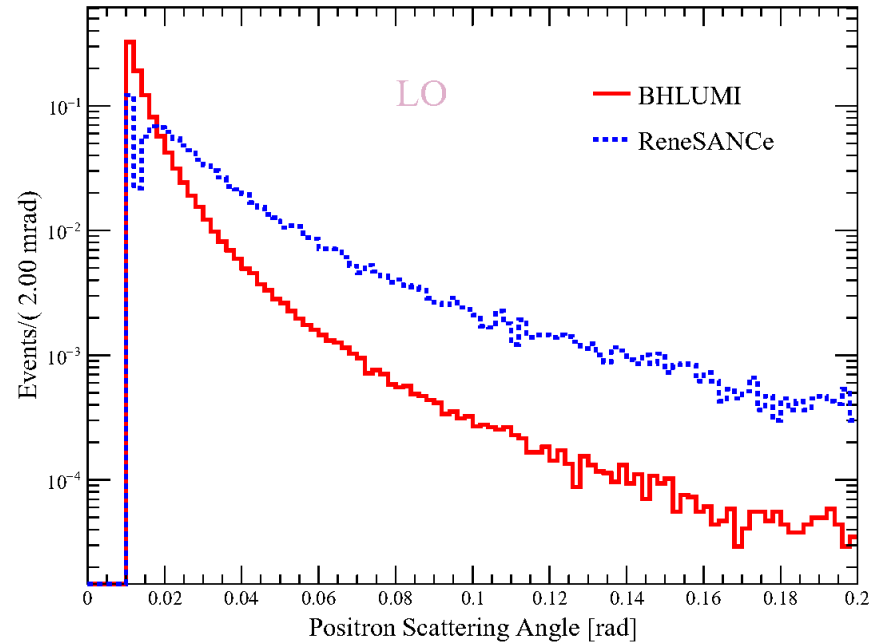


BHLUMI : $1\text{e}+06$
ReneSANCe : $1\text{e}+06$

BHLUMI : $1.06896\text{e}+06$
ReneSANCe : $0.953210\text{e}+06$

Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259 \text{ nb}$, $\Delta\sigma = -0.00643\%$

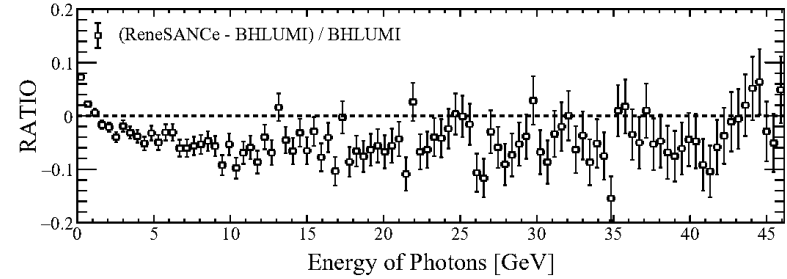
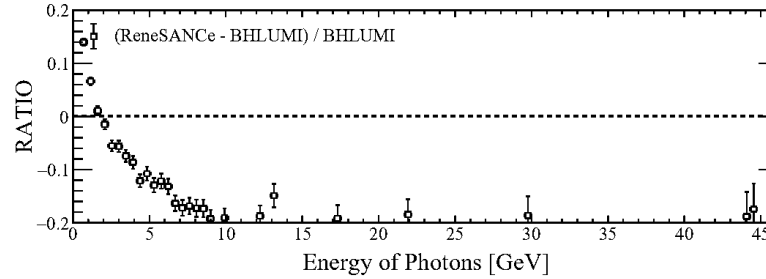
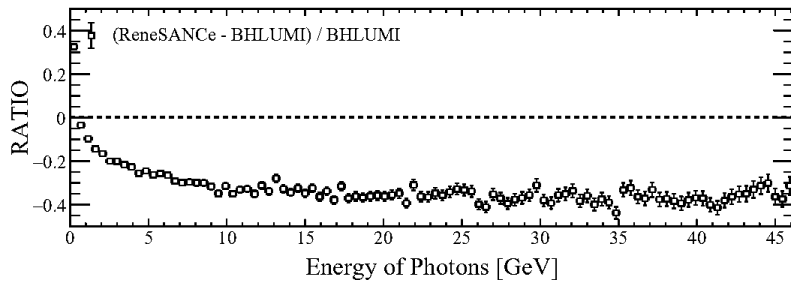
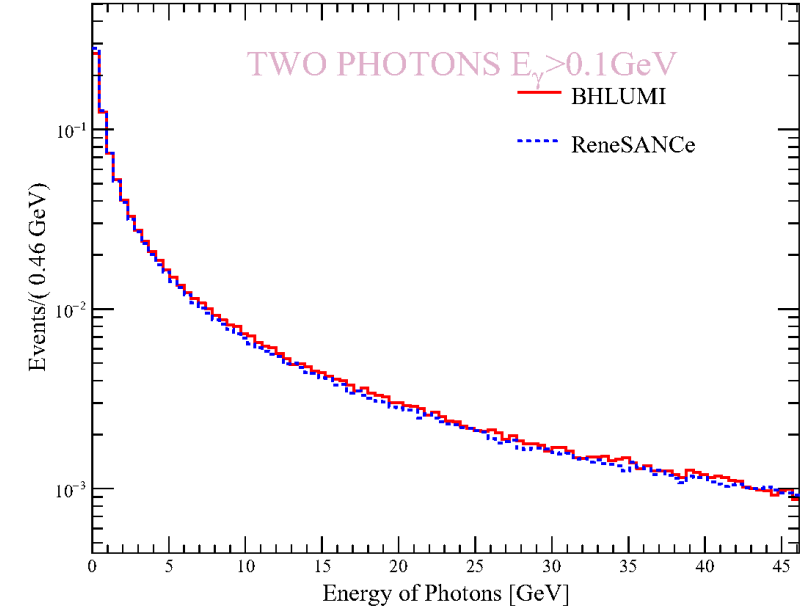
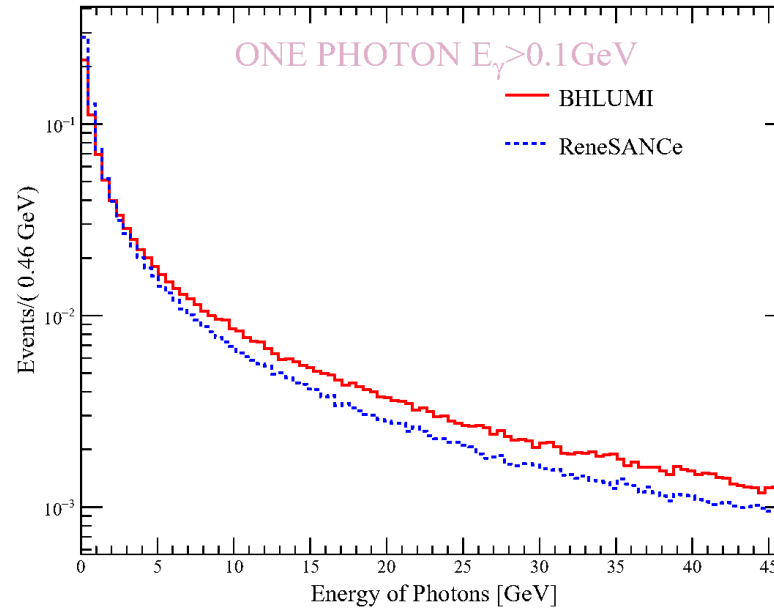
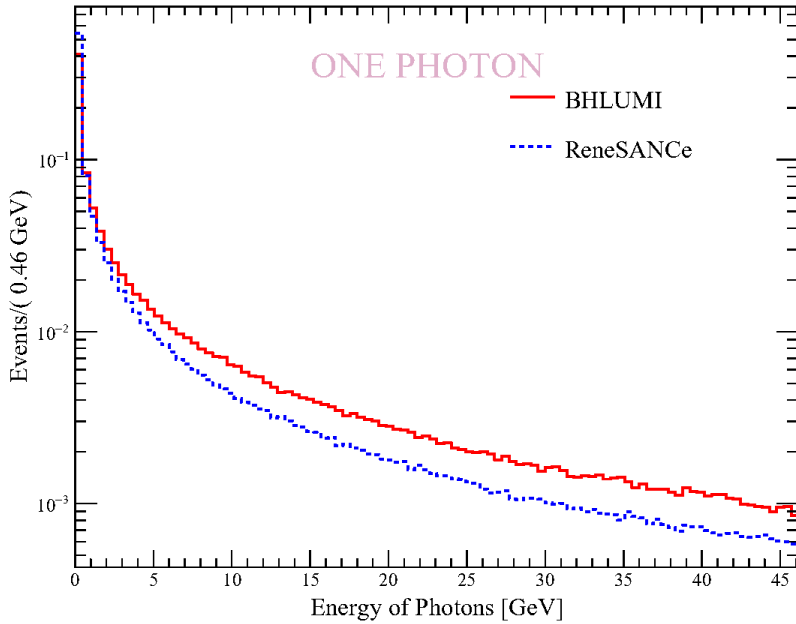


BHLUMI LO : 342529
ReneSANCe LO : 46790

BHLUMI NLO : 657471
ReneSANCe NLO : 953210

Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259 \text{ nb}$, $\Delta\sigma = -0.00643\%$



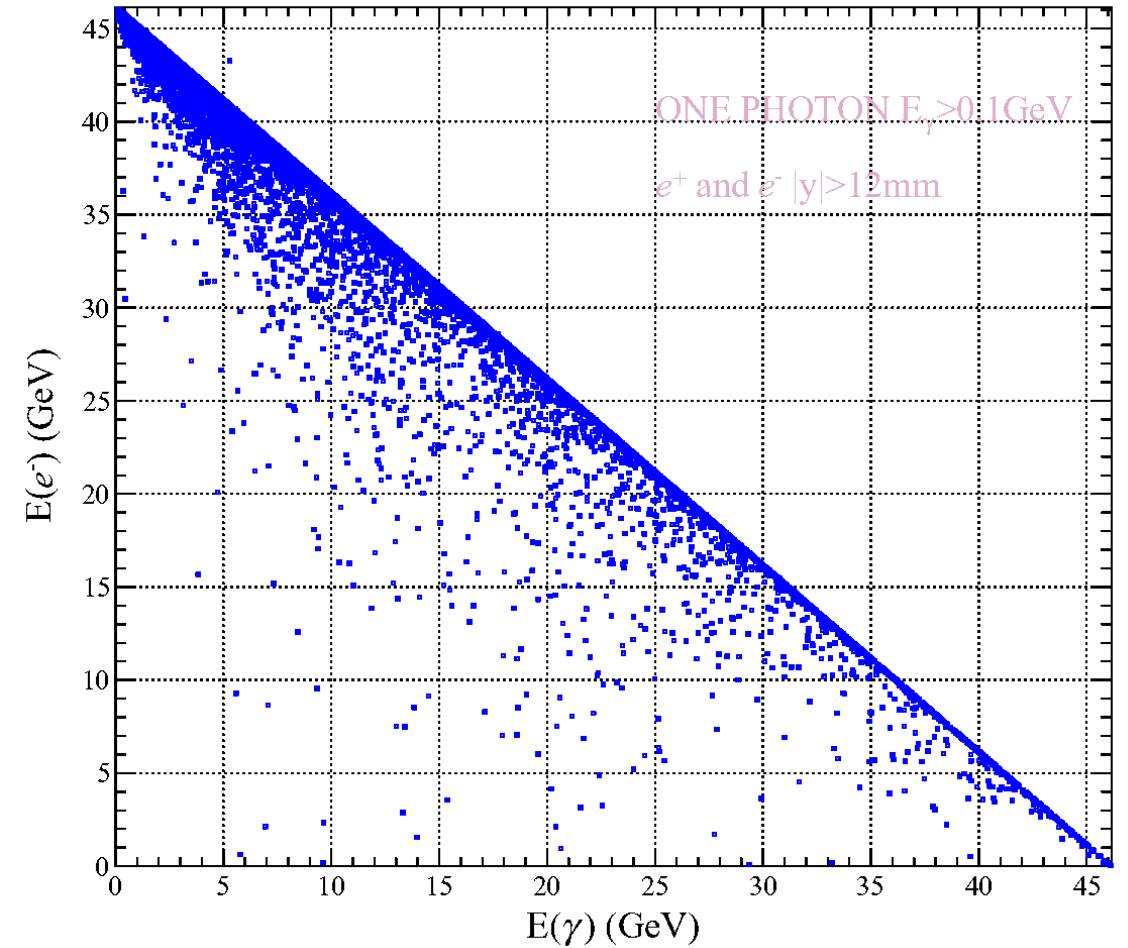
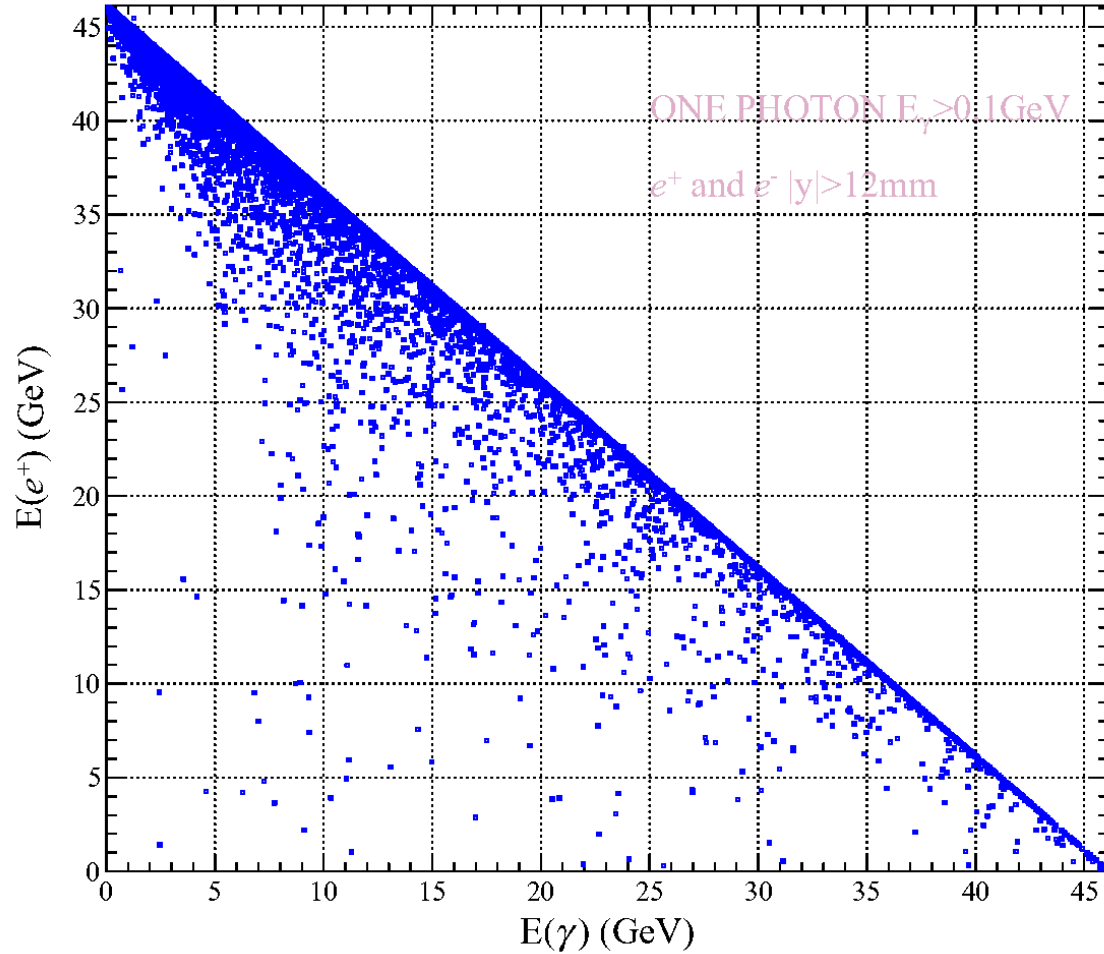
BHLUMI : 657471
ReneSANCe : 953210

BHLUMI : 494729
ReneSANCe : 607355

BHLUMI : 642805
ReneSANCe : 607355²⁵

Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259 \text{ nb}$, $\Delta\sigma = -0.00643\%$



Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259 \text{ nb}$, $\Delta\sigma = -0.00643\%$

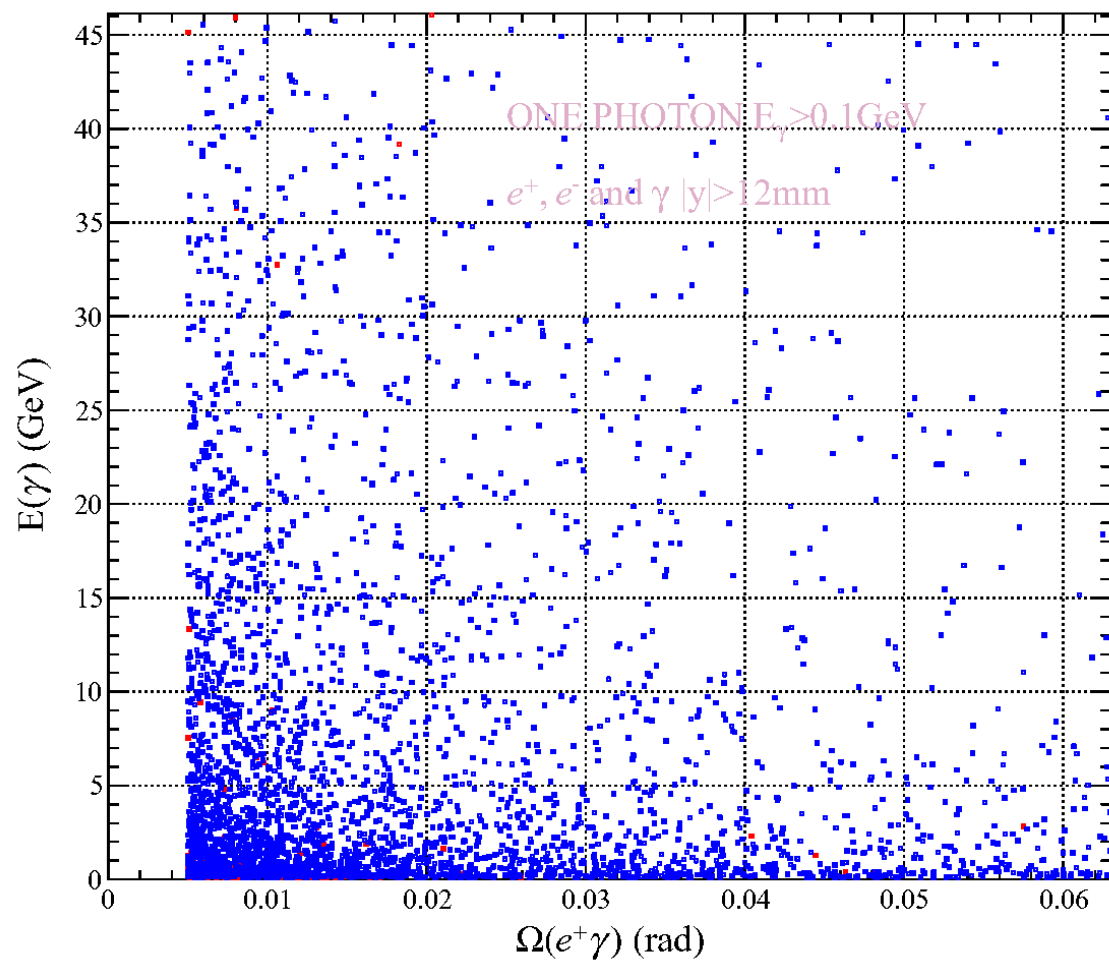
	$ y(e^+), y(e^-) > 12 \text{ mm}$		$ y(e^+), y(e^-) > 12 \text{ mm}$ $E_\gamma > 0.1 \text{ GeV}$			$ y(e^+), y(e^-) , y(\gamma) > 12 \text{ mm}$ $E_\gamma > 0.1 \text{ GeV}$				
BHLUMI	$e^\pm, 0\gamma, n\gamma$	$e^\pm, n\gamma$	$e^\pm, n\gamma$	e^\pm, ISR	e^\pm, FSR	$e^\pm, n\gamma$	e^\pm, ISR	e^\pm, FSR	$\Omega(e, \text{FSR}) > 5\text{mRad}$	$\Omega(p, \text{FSR}) > 5\text{mRad}$
<i>Events</i>	137014	94218	71276	9641	61635	33940	8990	24950	3917	3835
<i>ratio</i>	100.00%	68.77%	52.02%	7.04%	44.98%	24.77%	6.56%	18.21%	2.86%	2.80%
$\sigma(\text{nb})$	172.54	118.65	89.76	12.14	77.62	42.74	11.32	31.42	4.93	4.83
ReneSANCe	$e^\pm, 0\gamma, n\gamma$	$e^\pm, n\gamma$	$e^\pm, n\gamma$	e^\pm, ISR	e^\pm, FSR	$e^\pm, n\gamma$	e^\pm, ISR	e^\pm, FSR	$\Omega(e, \text{FSR}) > 5\text{mRad}$	$\Omega(p, \text{FSR}) > 5\text{mRad}$
<i>Events</i>	161022	143049	89823	34100	55723	42548	32469	10079	4349	4221
<i>ratio</i>	100.00%	88.84%	55.78%	21.18%	34.61%	26.42%	20.16%	6.26%	2.70%	2.62%
$\sigma(\text{nb})$	202.78	180.15	113.12	42.94	70.18	53.58	40.89	12.69	5.48	5.32

	$ y(e^+), y(e^-) > 12 \text{ mm}$		$ y(e^+), y(e^-) > 12 \text{ mm};$ $E_\gamma > 0.1 \text{ GeV}$			$ y(e^+), y(e^-) , y(\gamma) > 12 \text{ mm};$ $E_\gamma > 0.1 \text{ GeV}$			
	$e^\pm, 0\gamma, n\gamma$	$e^\pm, n\gamma$	$e^\pm, n\gamma$	e^\pm, ISR	e^\pm, FSR	$e^\pm, n\gamma$	e^\pm, ISR	e^\pm, FSR	$\Omega(e, \text{FSR}) > 5 \text{ mRad}$
events	1405230	631622	445566	233828	211738	206845	12440	194405	41612
ratio	100%	44.9%	31.7%	16.6%	15.1%	14.7%	0.89%	13.8%	2.96%

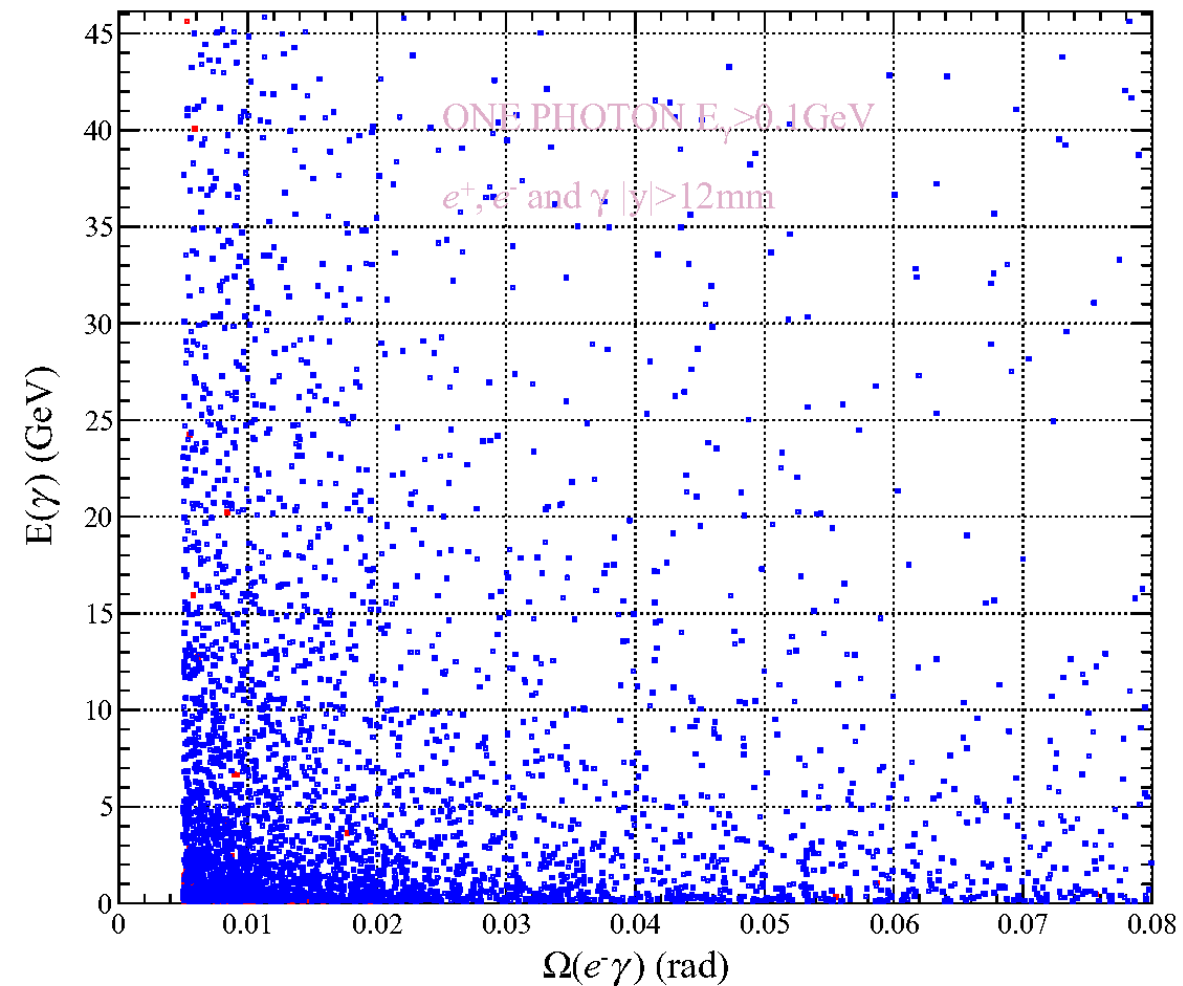
Table 1.2 Bhabha events of BHLUMI generated in (θ_1, θ_2) of (10,80) mRad are boosted to the LumiCal acceptance of $|y| > 12 \text{ mm}$. The events ratio with $E(\gamma) > 0.1 \text{ GeV}$, and the most energetic photon being an ISR or FSE are selected by the smaller opening angle to electrons. The selections are listed for θ to beam centers and y cuts in front of LYSO at $|z| = 647 \text{ mm}$, corresponding to the lowest LAB frame of 18.5 mRad.

Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259\text{ nb}$, $\Delta\sigma = -0.00643\%$



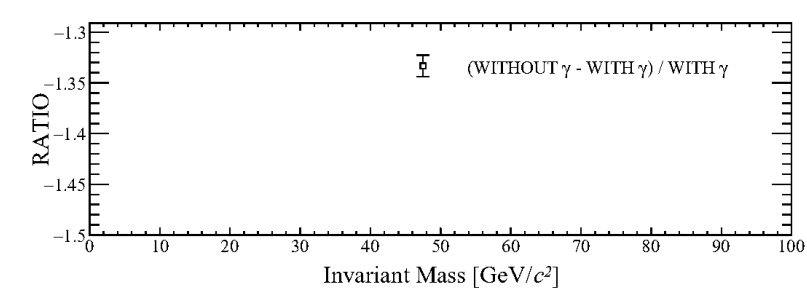
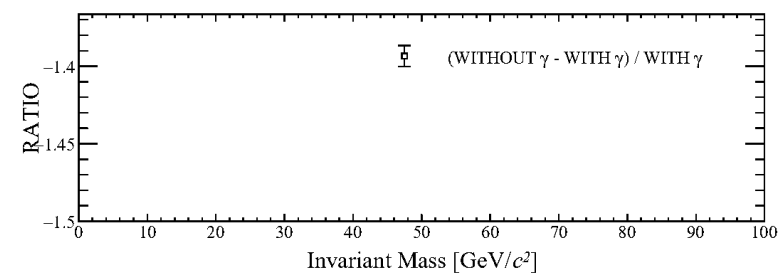
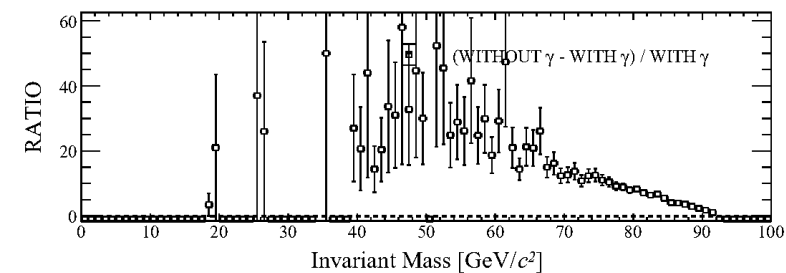
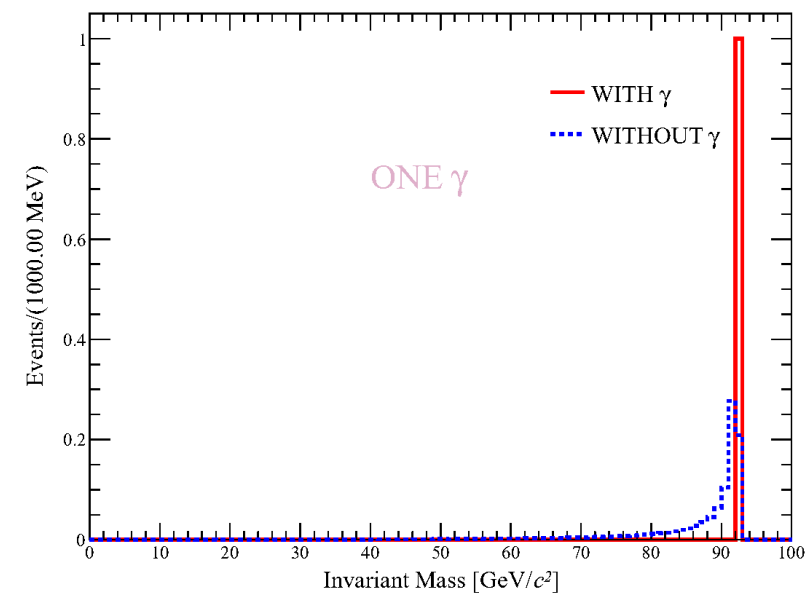
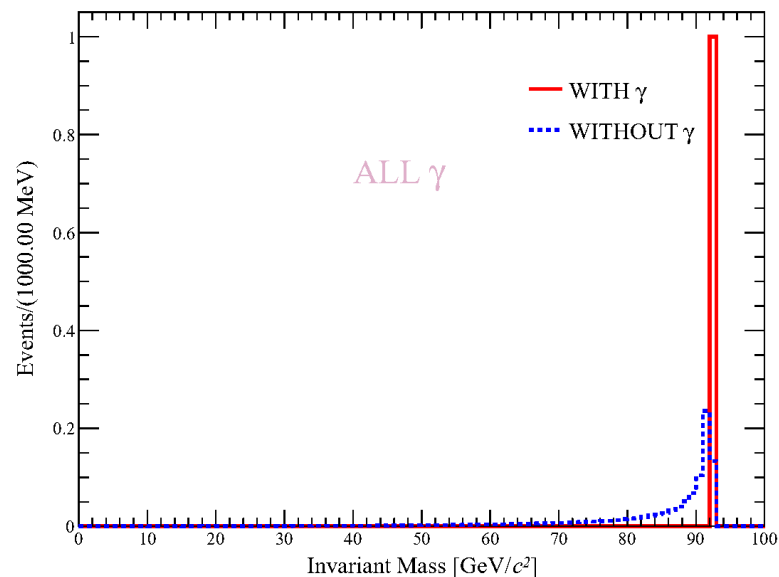
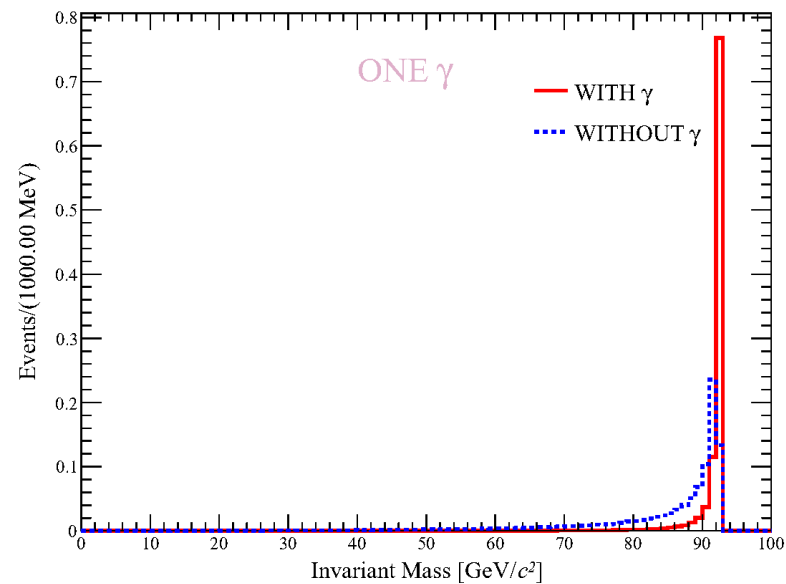
BHLUMI ISR: 248
BHLUMI FSR : 3835



BHLUMI ISR : 244
BHLUMI FSR : 3917

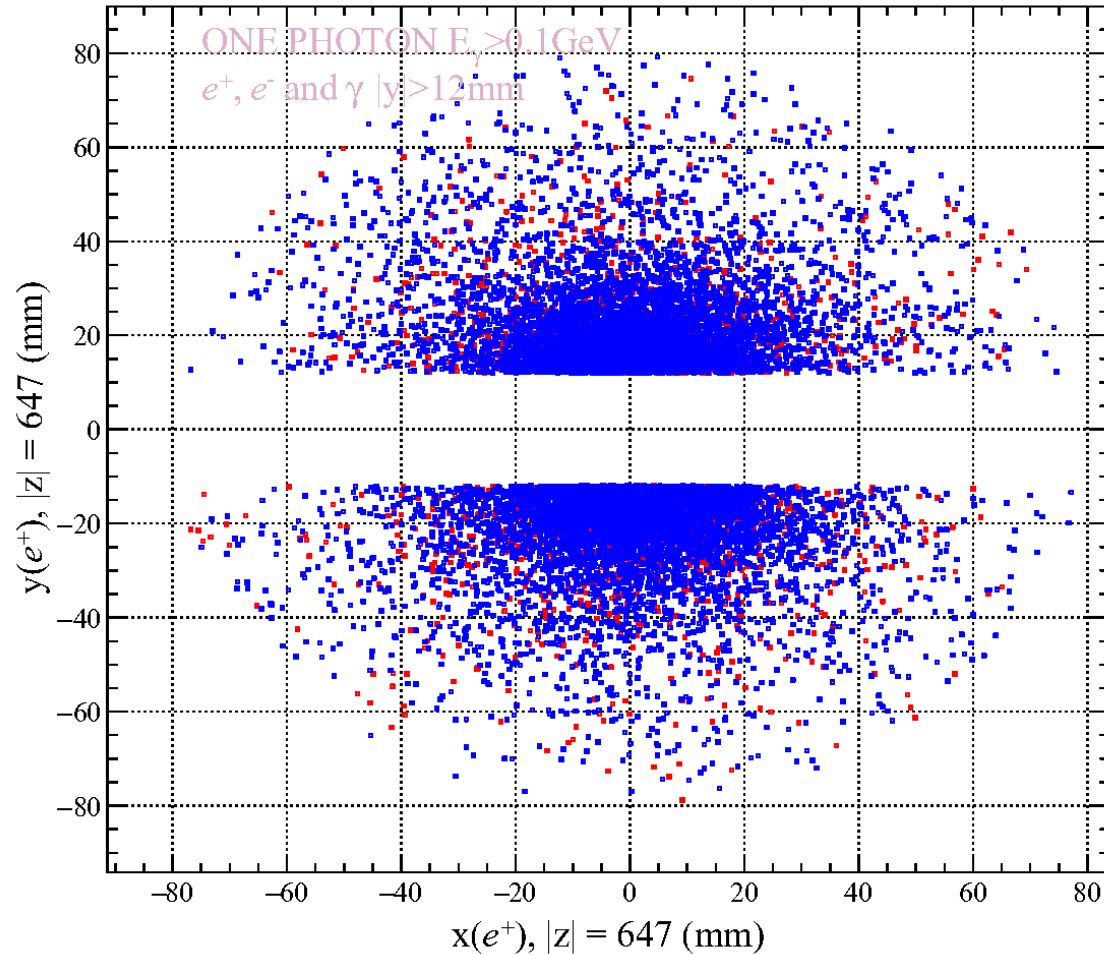
Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259\text{ nb}$, $\Delta\sigma = -0.00643\%$

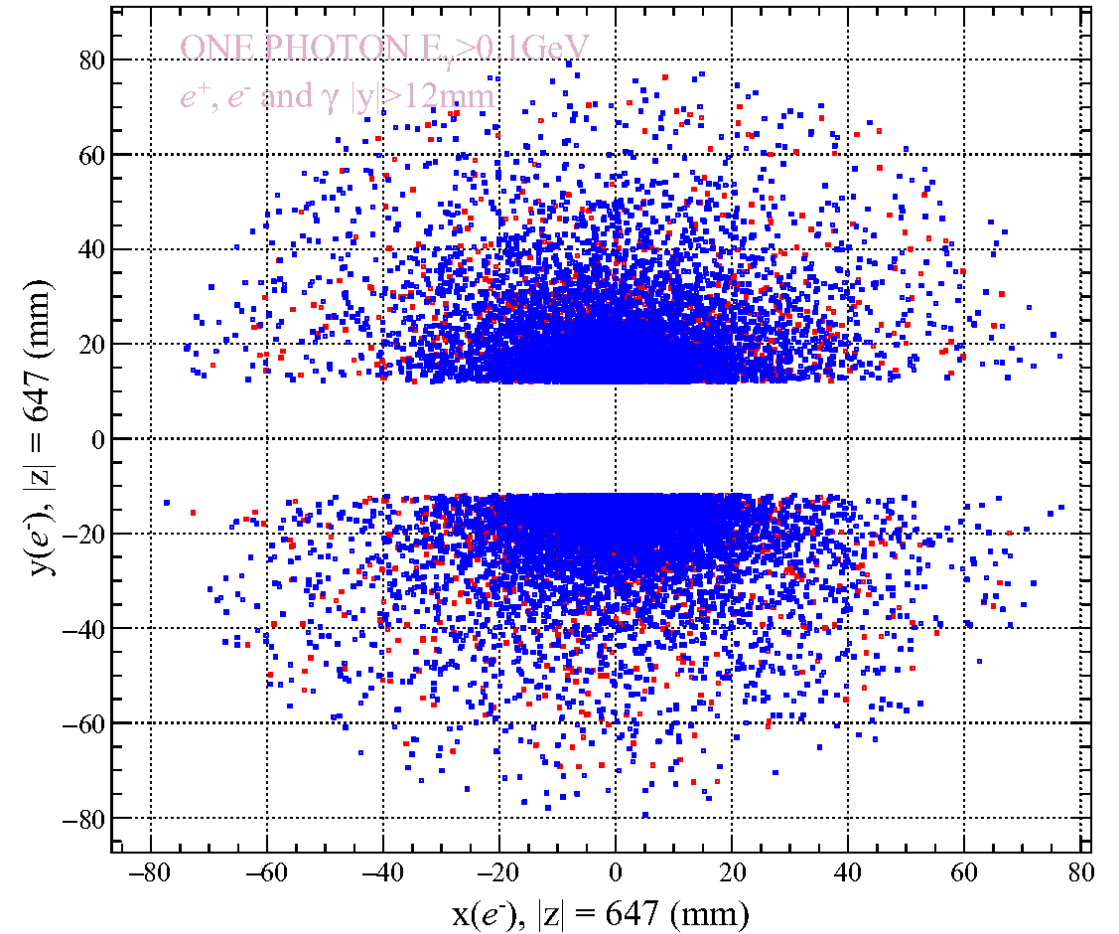


Comparison

Trial3 : $\theta_{\min} = 0.01\text{rad}$, $\theta_{\max} = 1.571$, $\sigma \approx 1259\text{ nb}$, $\Delta\sigma = -0.00643\%$



BHLUMI ISR: 4495
BHLUMI FSR: 12481



BHLUMI ISR : 4495
BHLUMI FSR : 12469