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).

```
!-------------------------------------
      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).

th1 = 0.01 rad, th2 = 0.785 rad(45 degree) **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 - sigma_RL-sigma_LR, 2 - sigma_RL+sigma_LR,
    # 3 - sigma_0L-sigma_0R, 4 - sigma_0L+sigma_0R
#!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
# 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)

Figure. Configuration settings(proc.conf).

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 KINO4                    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(evrun.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_CALO2 =    136.36350689 Nanob.
error      =      0.57497863 Nanob.
```

Figure. Output(evrun.output).

Comparison (BHLUMI)

```
CMS :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465348.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.000000000000000  (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_CALO2 =    136.36350689 Nanob.
error      =      0.57497863 Nanob.
```

Figure. Output(evrun.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=$(date +%s)
DIF Nname=$(uname -n)
ech #
ech #23456789.Variable
ech ./evrun.exe << !
ech FieOut    trial1
ech 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
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
      read(5,'(10x,F10.5)') th2
      print *,'== Input Detector theta
*
      thmin    = 0.7d0*th1    ! thmin ha
      thmax    = 2.0d0*th2    ! thmax ha
      IF(KeyWgt .EQ. 2) thmin=th1  ! Be
      xpar(2)=   CmsEne**2*(1-COS(thmi
      xpar(3)=   CmsEne**2*(1-COS(thma
      xpar(4)=   1D-4         ! Infrare
      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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768940576340810
th1 :0.007000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 948218.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.000000000000000  (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_CALO2 =    136.36350685 Nanob.
error      =      0.57497863 Nanob.
||||||||||||||||||||||||||||||||||||||||||||||||||
Xcru*Nbare1/Ntot=   2428.18512868 Nanob.
```

Figure. Output(evrun.output).

Comparison (BHLUMI)

```
CMS :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.007000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 948218.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465348.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 491268.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465461.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279750.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :0.100000000000000[Rad]
nevent1_cut1 : 481825.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 460382.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 276299.000000000000000  (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]
```

Figure. Statistical results of BHLUMI (trial0).

```
CMS :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768940576340810
th1 :0.007000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 948218.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768940576340810
th1 :0.010000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465348.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768940576340810
th1 :0.010000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 491268.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465461.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279750.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768940576340810
th1 :0.010000000000000[Rad]
th2 :0.100000000000000[Rad]
nevent1_cut1 : 481825.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 460382.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 276299.000000000000000  (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 (trial1).

Comparison

```
CMS :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.007000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 996667.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 948218.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 585904.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 491268.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465461.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279750.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 490811.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 465348.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 279682.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.768941180699130
th1 :0.010000000000000[Rad]
th2 :0.100000000000000[Rad]
nevent1_cut1 : 481825.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 460382.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 276299.000000000000000  (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]
```

Figure. Statistical results of BHLUMI (trial0).

```
CMS :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.420151029400131
th1 :0.007000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 999291.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 956471.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 504160.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.420151029400131
th1 :0.010000000000000[Rad]
th2 :1.570796326794897[Rad]
nevent1_cut1 : 512302.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 490166.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 256105.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.420151029400131
th1 :0.010000000000000[Rad]
th2 :0.785398163397448[Rad]
nevent1_cut1 : 511808.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 489930.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 255887.000000000000000  (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 :92.299999999999997[GeV]
The total number of events : 1000000.000000000000000
The total cross section    : 2560.420151029400131
th1 :0.010000000000000[Rad]
th2 :0.100000000000000[Rad]
nevent1_cut1 : 500382.000000000000000  (th1 < theta < th2)
nevent1_cut2 : 482112.000000000000000  (2(E1*E2 - px1*px2 - py1*py2 - pz1*pz2) > 0.5*CMS*CMS)
nevent1_cut3 : 249592.000000000000000  (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 ReneSANCe (trial0).

Comparison

	BHLUMI(trial0)				BHLUMI(trial1)			
$Events$	1e06				1e06			
$CMS\ (GeV)$	92.3				92.3			
$Infrared\ cut$	1e-04				1e-04			
$thmin\ (Rad)$	0.007				0.007			
$thmax\ (Rad)$	1.571				1.571			
$the\ total\ cross\ section\ (nb)$	2560.769				2560.769			
$th1\ (Rad)$	0.007	0.010	0.010	0.010	0.007	0.010	0.010	0.010
$th2\ (Rad)$	1.571	0.785	1.571	0.100	1.571	0.785	1.571	0.100
$cut_1\ (nb)$	2552.234	1256.854	1258.024	1233.843	2552.234	1256.854	1258.024	1233.843
$cut_2\ (nb)$	2428.167	1191.649	1191.938	1178.932	2428.167	1191.649	1191.938	1178.932
$cut_3\ (nb)$	1500.365	716.201	716.375	707.538	1500.365	716.201	716.375	707.538

Comparison

	BHLUMI(trial0)				ReneSANCe(trial0)				Difference			
$Events$	1e06				1e06							
$CMS\ (GeV)$	92.3				92.3							
$Infrared\ cut$	1e-04				1e-04							
$thmin\ (Rad)$	0.007				0.007							
$thmax\ (Rad)$	1.571				(1.571)							
$The\ total\ cross\ section\ (nb)$	2560.769				2560.420				-0.0136%			
$th1\ (Rad)$	0.007	0.010	0.010	0.010	0.007	0.010	0.010	0.010	0.007	0.010	0.010	0.010
$th2\ (Rad)$	1.571	1.571	0.785	0.100	1.571	1.571	0.785	0.100	1.571	1.571	1.571	0.100
$cut_1\ (nb)$	2552.234	1258.024	1256.854	1233.843	2558.605	1311.708	1310.444	1281.188	0.25%	4.27%	4.26%	3.84%
$cut_2\ (nb)$	2428.167	1191.938	1191.649	1178.932	2448.968	1255.031	1254.427	1234.409	0.86%	5.29%	5.27%	4.71%
$cut_3\ (nb)$	1500.365	716.375	716.201	707.538	1290.861	655.736	655.178	639.060	-13.96%	-8.465%	-8.52%	-9.68%

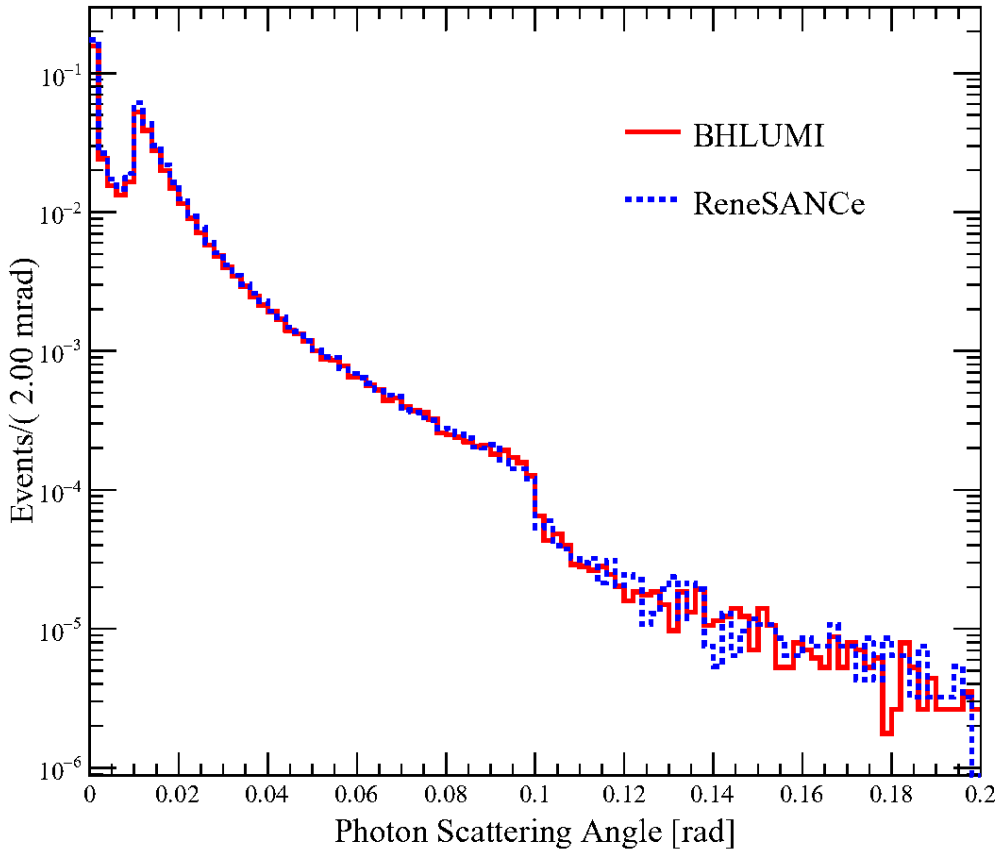
Comparison

	BHLUMI(trial2)				ReneSANCe(trial2)				Difference			
$Events$	1e06				1e06							
$CMS\ (GeV)$	92.3				92.3							
$Infrared\ cut$	1e-04				1e-04							
$thmin\ (Rad)$	0.025				0.025							
$thmax\ (Rad)$	1.571				(1.571)							
$the\ total\ cross\ section\ (nb)$	203.253				203.671				-0.206%			
$th1\ (Rad)$	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
$th2\ (Rad)$	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080
$cut_1\ (nb)$	202.388	201.797	184.863	176.465	202.584	201.724	183.122	173.889	0.0968%	-0.0362%	-0.942%	-1.46%
$cut_2\ (nb)$	190.675	190.427	177.904	170.622	194.713	194.102	178.487	169.987	2.11%	1.93%	0.328%	-0.372%
$cut_3\ (nb)$	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			
$Events$	1e06				1e06							
$CMS\ (GeV)$	92.3				92.3							
$Infrared\ cut$	1e-04				1e-04							
$thmin\ (Rad)$	0.010				0.010							
$thmax\ (Rad)$	1.571				(1.571)							
$the\ total\ cross\ section\ (nb)$	1259.280				1259.361				-0.00643%			
$th1\ (Rad)$	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010
$th2\ (Rad)$	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080	1.571	0.785	0.100	0.080
$cut_1\ (nb)$	1254.889	1253.802	1231.169	1221.183	1257.831	1256.441	1228.925	1216.130	0.234%	0.210%	-0.182%	-0.414%
$cut_2\ (nb)$	1190.680	1190.410	1177.849	1170.784	1203.834	1203.078	1184.031	1173.697	1.105%	1.064%	-0.525%	0.249%
$cut_3\ (nb)$	716.413	716.243	707.637	702.840	629.589	628.934	613.512	605.743	-12.11%	-12.19%	-13.30%	-13.81%

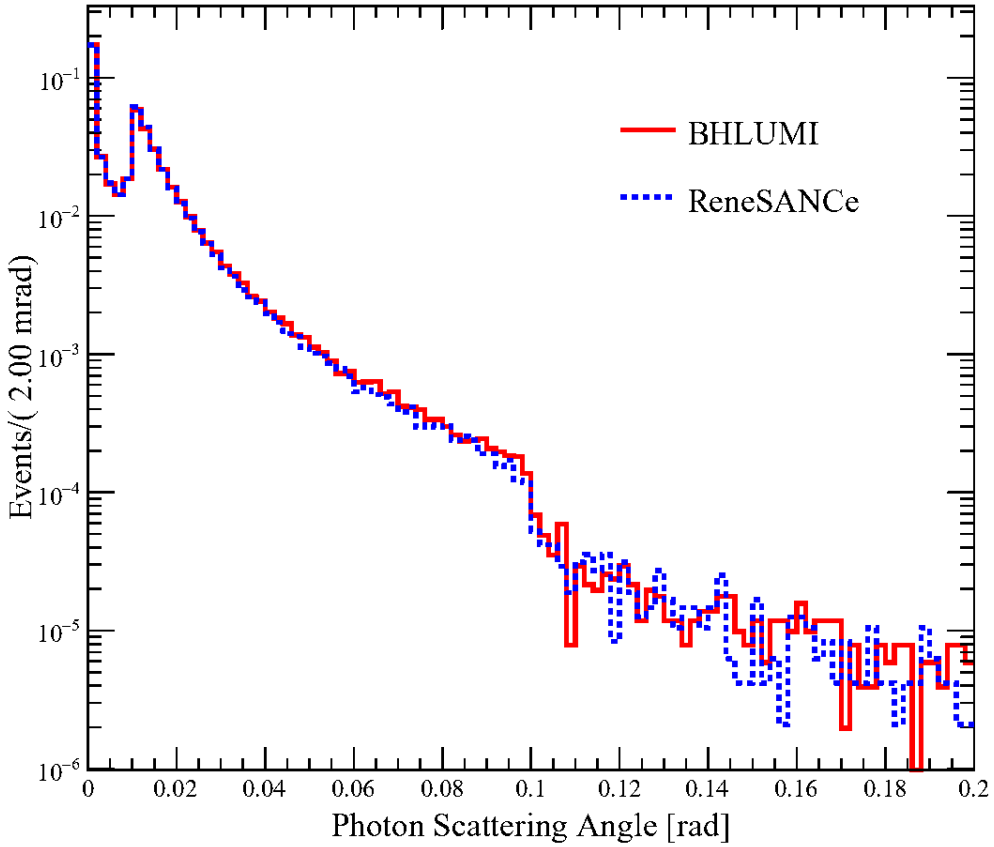
Comparison



BHLUMI : 0.225558

ReneSANCe : 0.248515

Trial3 : th1= 0.01rad, th2= 0.1rad

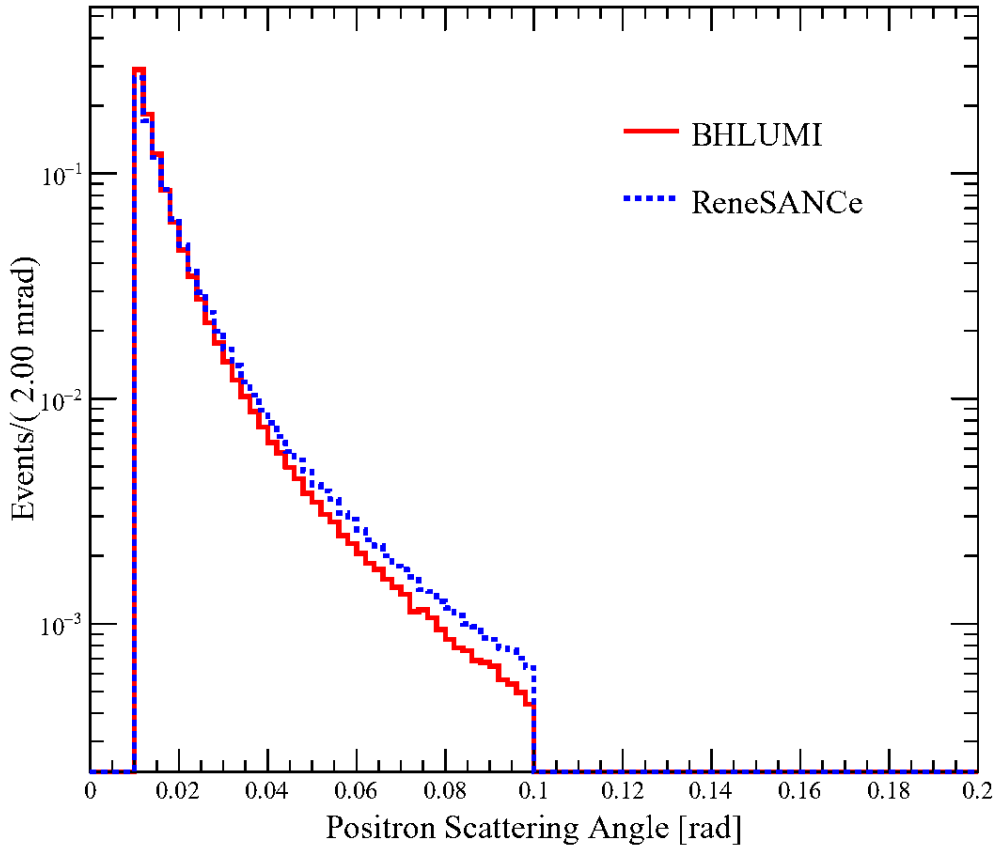


BHLUMI : 0.248637

ReneSANCe : 0.248775

Trial0 : th1= 0.01rad, th2= 0.1rad

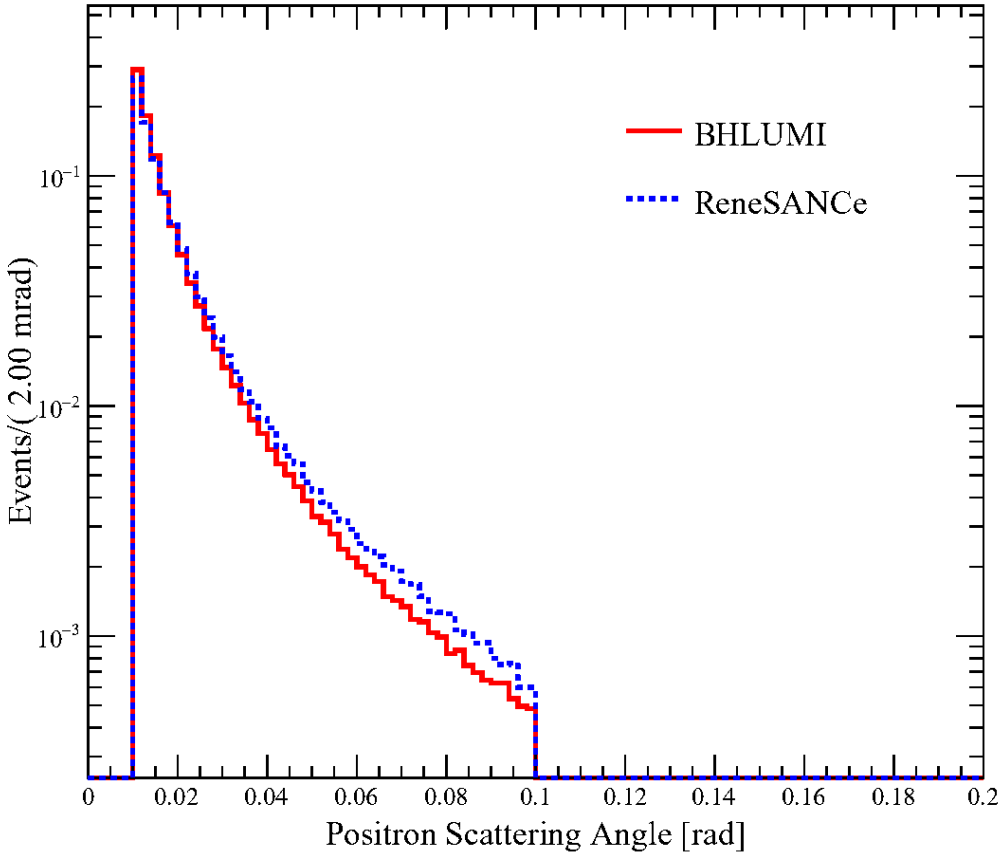
Comparison



BHLUMI : 1

ReneSANCe : 1

Trial3 : th1= 0.01rad, th2= 0.1rad

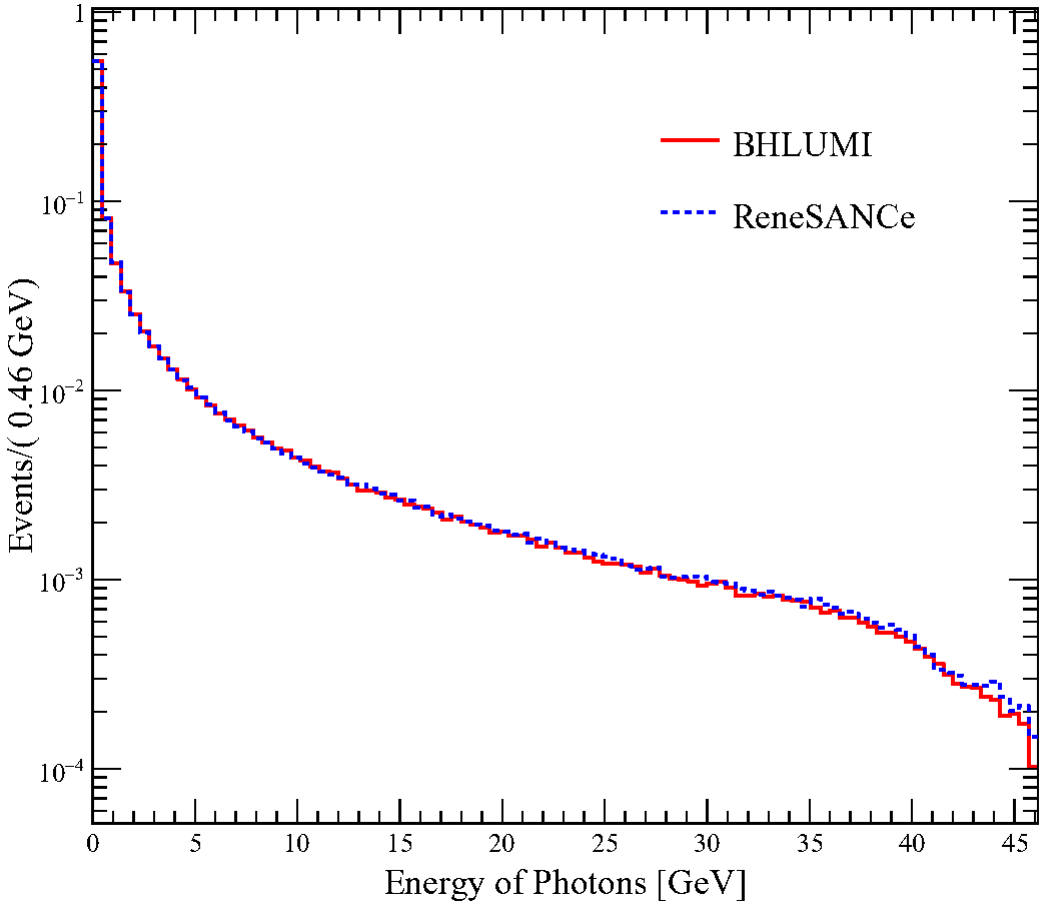


BHLUMI : 1

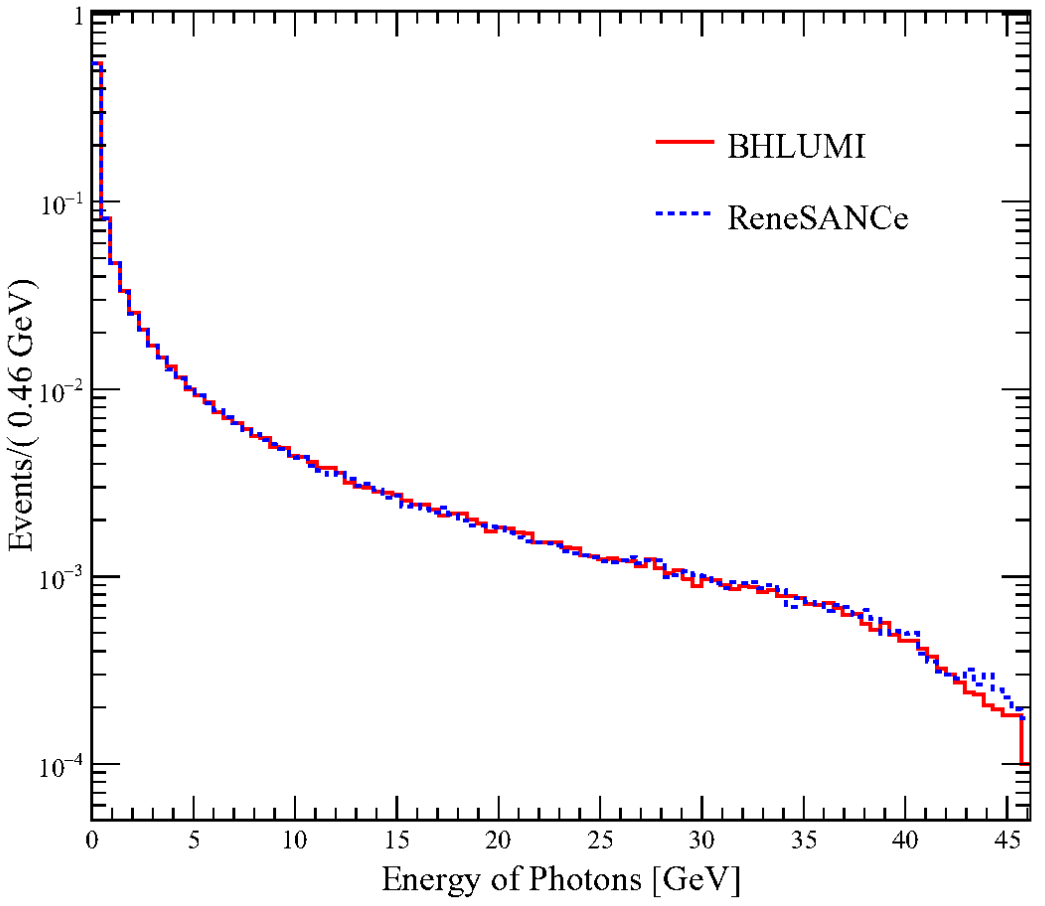
ReneSANCe : 1

Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison

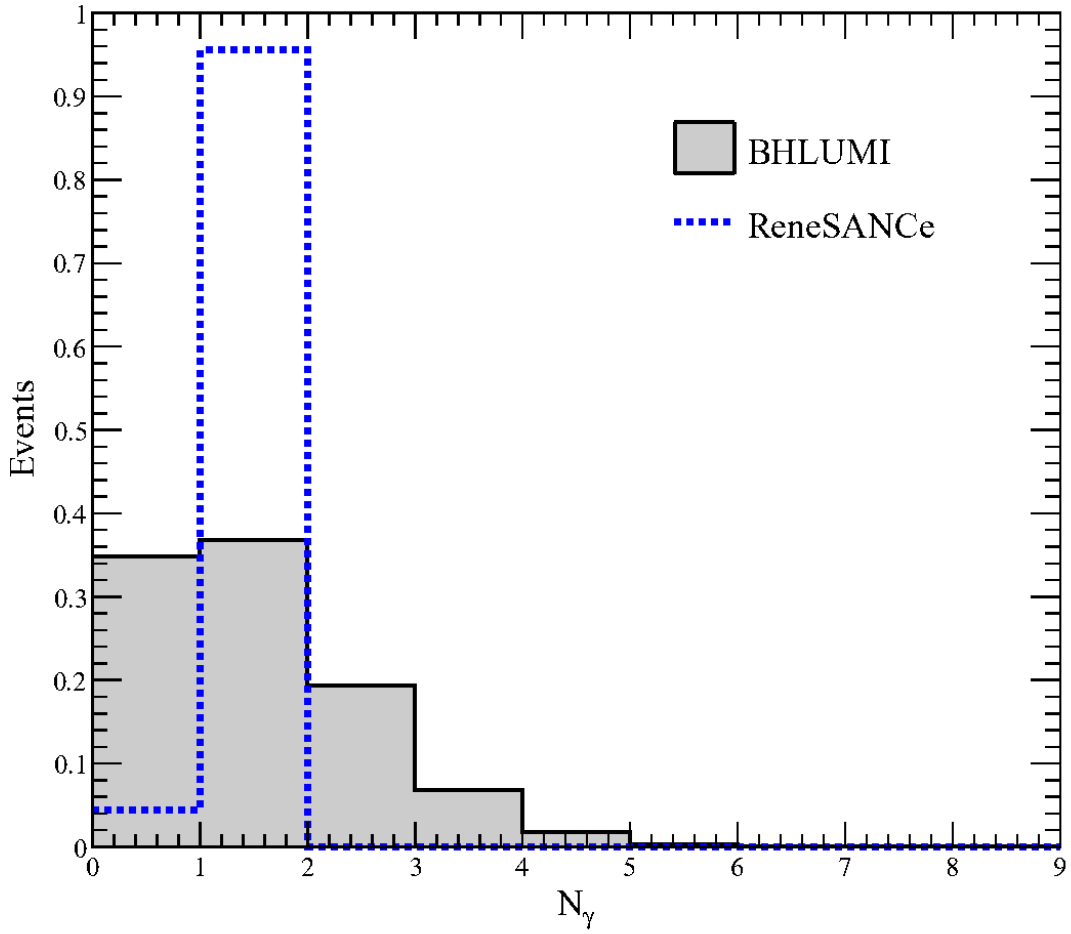


Trial3 : th1= 0.01rad, th2= 0.1rad

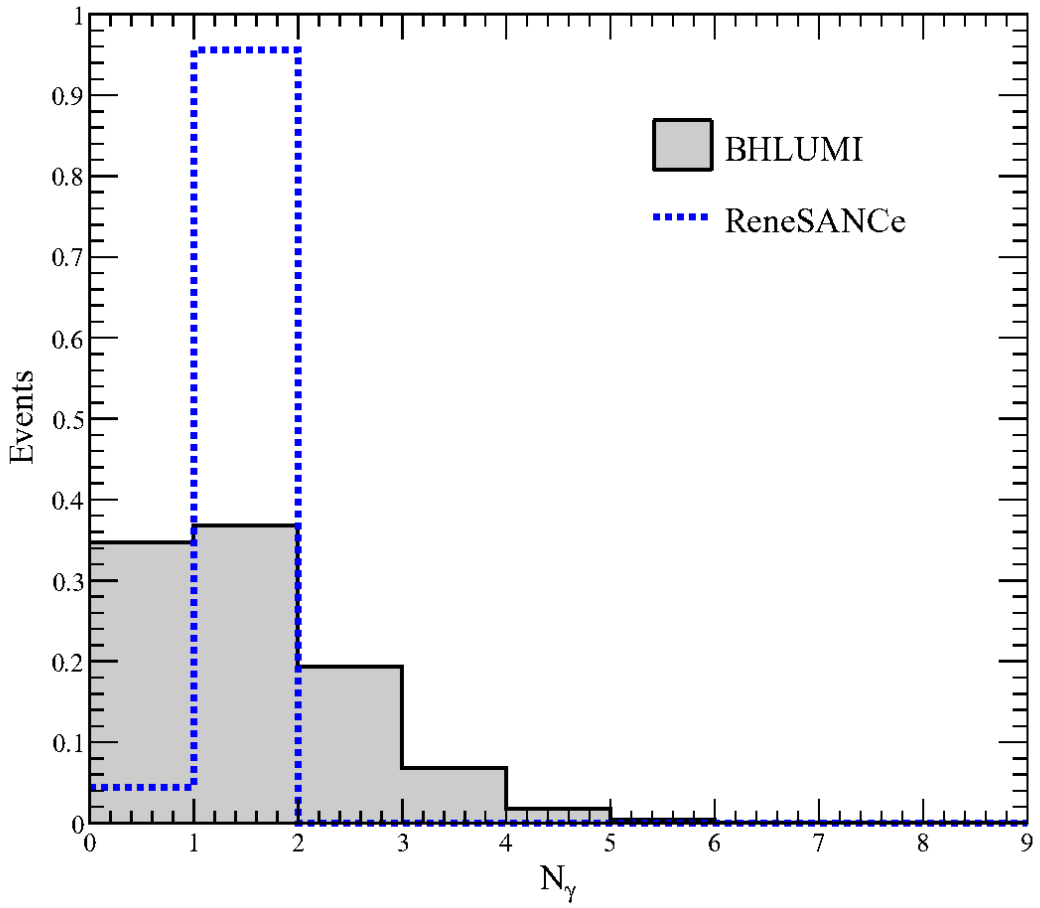


Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison



Trial3 : th1= 0.01rad, th2= 0.1rad



Trial0 : th1= 0.01rad, th2= 0.1rad

Comparison

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

Trial3 : th1= 0.01rad, th2= 0.1rad

Trial0 : th1= 0.01rad, th2= 0.1rad