A prototype of an event generator of inelastic processes in PrimEx

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Main goal:

The incorporation of the cascade model results (Incoherent π^0 photoproduction and π^0 background due to ω decay) into an event generator of inelastic processes

References:

1. T. E. Rodrigues, *Incoherent π^0 photoproduction in the PrimEx kinematics via the MCMC intranuclear cascade model*, PrimEx Note 52, Nov. 2007. Unpublished
2. T. E. Rodrigues et al., Phys. Rev. Lett. 101, 012301, 2008
3. T. E. Rodrigues, *Omega Photoproduction in PrimEx*, PrimEx Note 56, Sep. 2008. Unpublished

Motivation:

The interpretation of the PrimEx data at larger angles (shape/magnitude) demands a state-of-the-art approach to describe the hadronic inelastic background

Physics processes included in the generator ($k = 5.2 \text{ GeV}$):

o $\gamma + A \longrightarrow \pi^0 + X$ (Incoherent π^0 photoproduction <u>with shadowing</u>)

o $\gamma + A \longrightarrow \omega(\longrightarrow \pi^0\gamma) + A$ (Coherent ω photoproduction)

o $\gamma + A \longrightarrow \omega(\longrightarrow \pi^0\gamma) + X$ (Incoherent ω photoproduction)

o $\gamma + A \longrightarrow \omega(\longrightarrow \pi^0\gamma) + N^* + A$ (Incoherent ω photoproduction with isobar)

Parameters for the input file (in.dat):

1000000	Number of events
1	Photoproduction mechanism (1 → NI, 2 → Omega)
1	Target (1→ Carbon, 2 → Lead)
2.25	π^0 polar angle for the double differential xs (0 to 5 degrees)
0.700	π^0 minimum elasticity (X_{MIN})
0.001	Elasticity bin

Output files (running time ~ 10^6 events/min):

❑ dsdteta.dat (differential cross section ($d\sigma/d\theta$) corresponding to the pion elasticity range);

❑ d2sdtetadx.dat (double differential cross section corresponding to the π^0 polar angle);

❑ events.dat (Four vectors of all the π^0's generated at the selected polar angle).

Examples of output files

INCOHERENT PI0 PHOPRODUCTION FROM CARBON WITH SHADOWING
%%%
 PION ELASTICITY (XMIN):   0.700000000000000
%%
        SINGLE DIFFERENTIAL CS (microbars/rad)
%%
       TETA (DEG.)   ds/dteta
 5.000000000000000E-002   2.203610360428239E-002
 0.150000000000000   9.144982995777193E-002
 0.250000000000000   0.179594244374901
 0.350000000000000   0.301674258342626
 0.450000000000000   0.397531309021254
 0.550000000000000   0.506389660826409

 . . .

 4.55000000000000   23.7472070491549
 4.65000000000000   23.4576526477946
 4.75000000000000   23.2461060531936
 4.85000000000000   22.9801302826898
 4.95000000000000   22.5310344912346

(dsdteta.dat)

4

Examples of output files

```
INCOHERENT PI0 PHOPRODUCTION FROM CARBON WITH SHADOWING
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
 PION ELASTICITY (XMIN):              0.700000000000000
 PION POLAR ANGLE (DEG.):             2.25000000000000
 ANGULAR INTERVAL (+/-):              5.000000000000000E-002
 DIFFERENTIAL CS (MICROB/RAD):        8.76992851243230
 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
        DOUBLE DIFFERENTIAL CS (microbars/rad)
 %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
         X                  d^2s/dXdteta           # of pions
   0.699500000000000     0.000000000000000E+000        0
   0.700500000000000     0.000000000000000E+000        0
   0.701500000000000     0.000000000000000E+000        0

 ...
   0.994500000000000      1155.44685144147          131751
   0.995500000000000      1100.62602831025          125500
   0.996500000000000      393.261134354489           44842
   0.997500000000000      265.448196214301           30268
   0.998500000000000      95.0747950032785           10841
   0.999500000000000      81.7971232354560            9327
   1.00050000000000      0.000000000000000E+000         0
   1.00150000000000      0.000000000000000E+000         0
```

(d2sdtetadx.dat)

...

5

Examples of output files

INCOHERENT PI0 PHOPRODUCTION FROM CARBON WITH SHADOWING
%%
 PION ELASTICITY (XMIN):   0.700000000000000
 PHOTON ENERGY = 5.2 GeV
 PION POLAR ANGLE (DEG.):   2.25000000000000
 ANGULAR INTERVAL (+/-):   5.00000000000000E-002
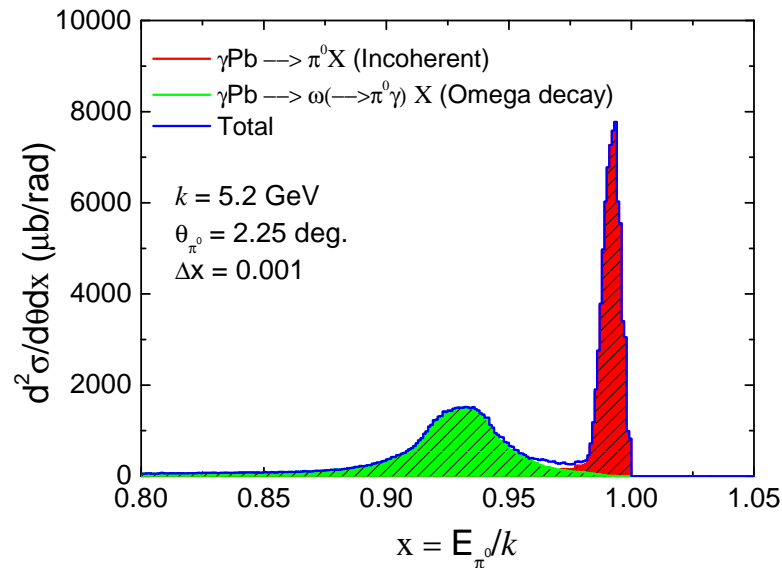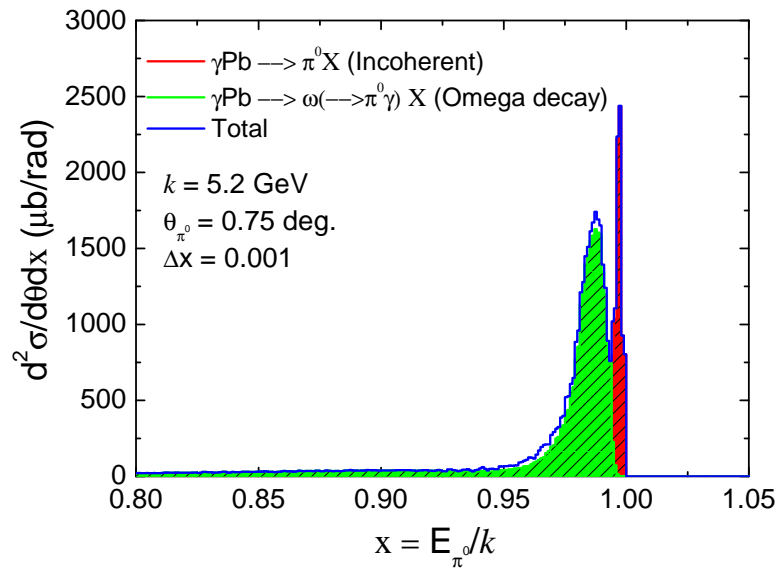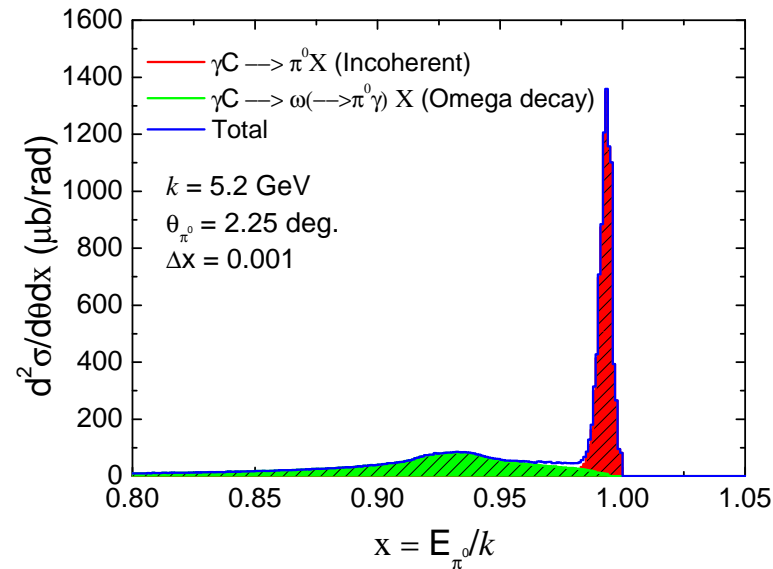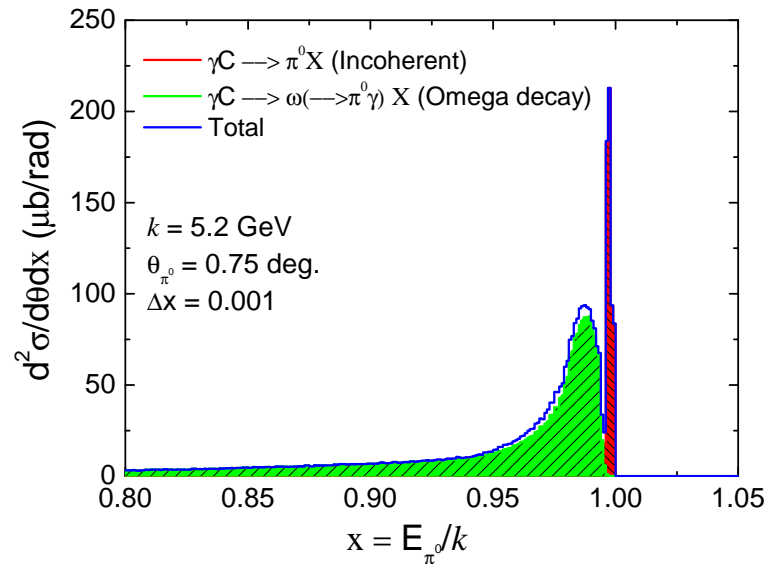%%
 PX (MeV/c)   PY (MeV/c)   PZ (MeV/c)   EPI0 (MeV)
 -106.5288   172.8567   5167.875   5173.624
  147.4687   -139.1509   5160.485   5166.231
 -183.4052   85.65758   5151.986   5157.727
 -143.5497   142.9849   5156.793   5162.537
  6.993357   202.4582   5155.979   5161.722
 -39.53226   199.2659   5170.499   5176.249
  202.0156   -9.676548   5147.535   5153.275
 -33.15068   199.9450   5158.411   5164.155
 -0.2051978   203.2478   5173.004   5178.755
  43.45168   -199.1015   5186.746   5192.502
 -150.7795   134.9909   5150.873   5156.614
 -129.6896   156.3856   5170.883   5176.633
  134.6239   -150.8699   5146.364   5152.103
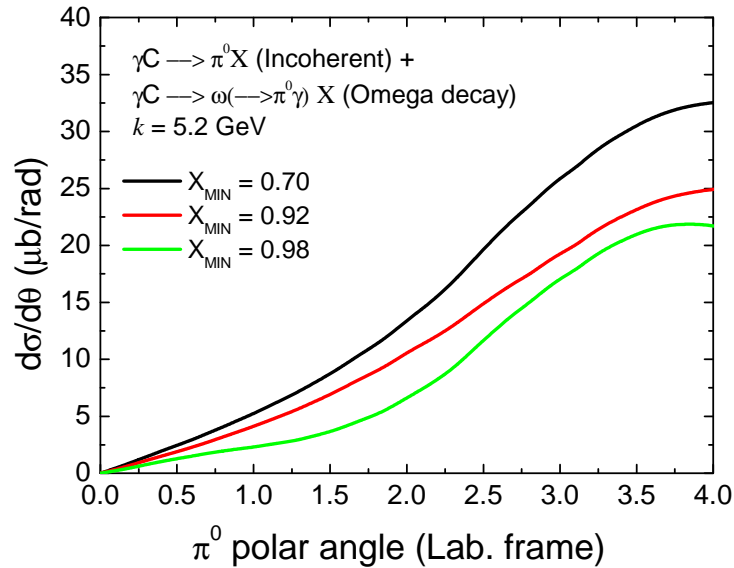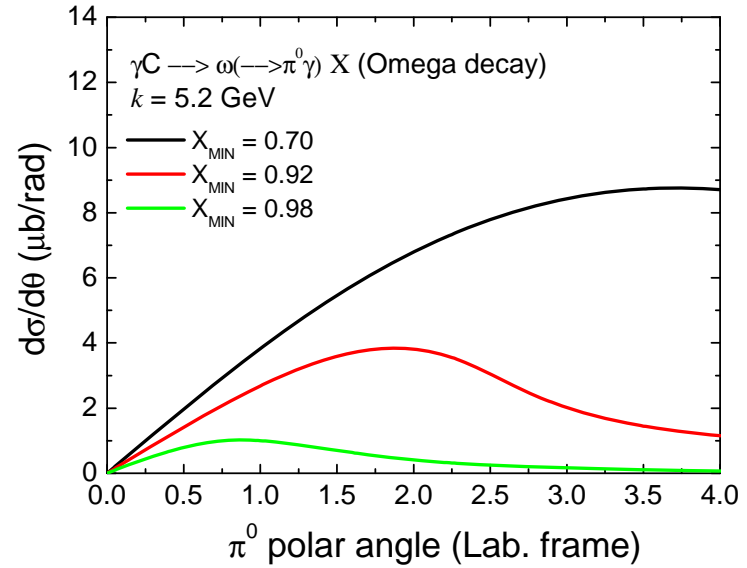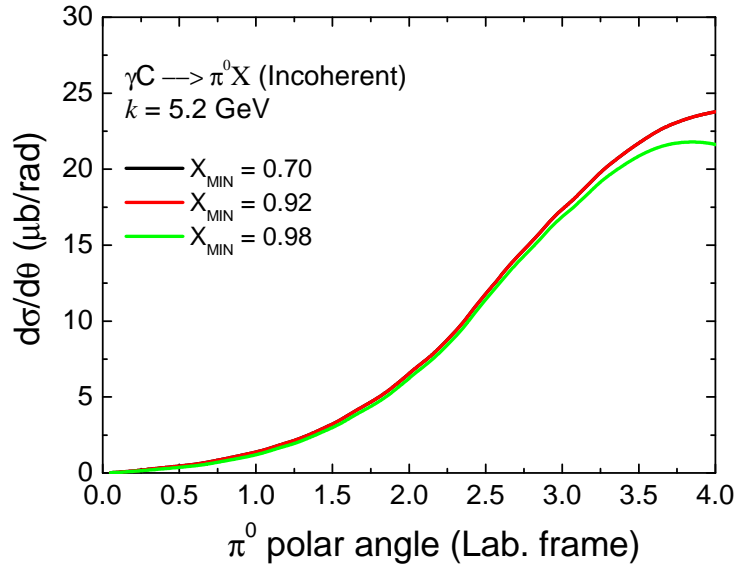 -105.5500   171.3862   5122.944   5128.673

(events.dat)

. . .

6

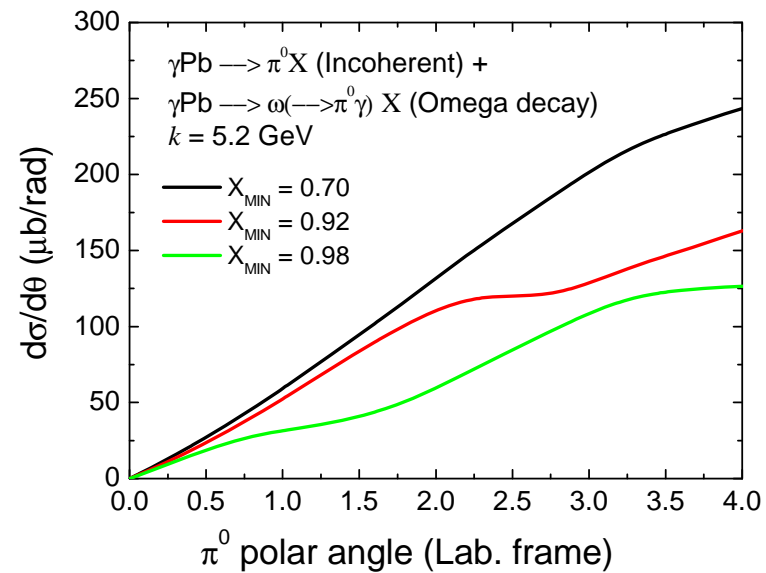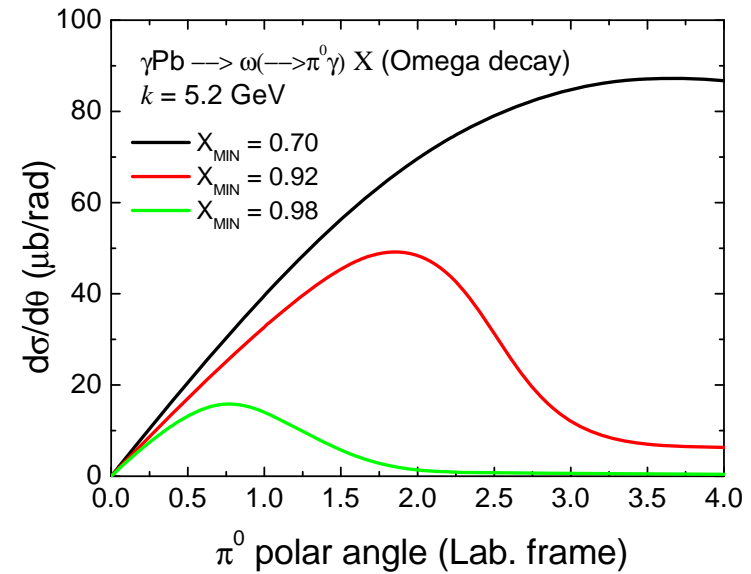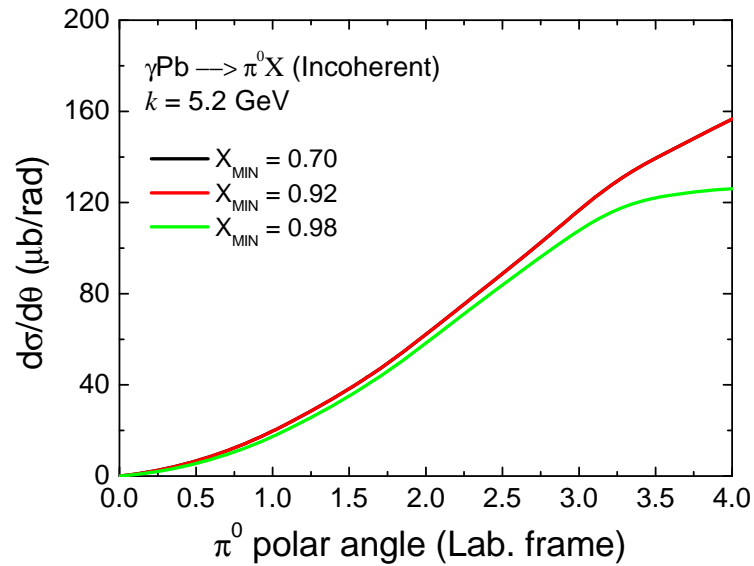# Results: double differential cross section ($\Delta X = 0.001$)

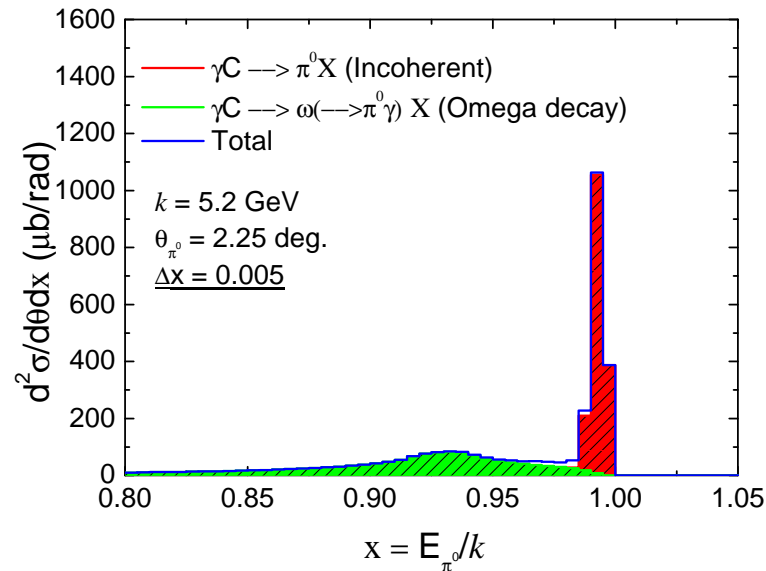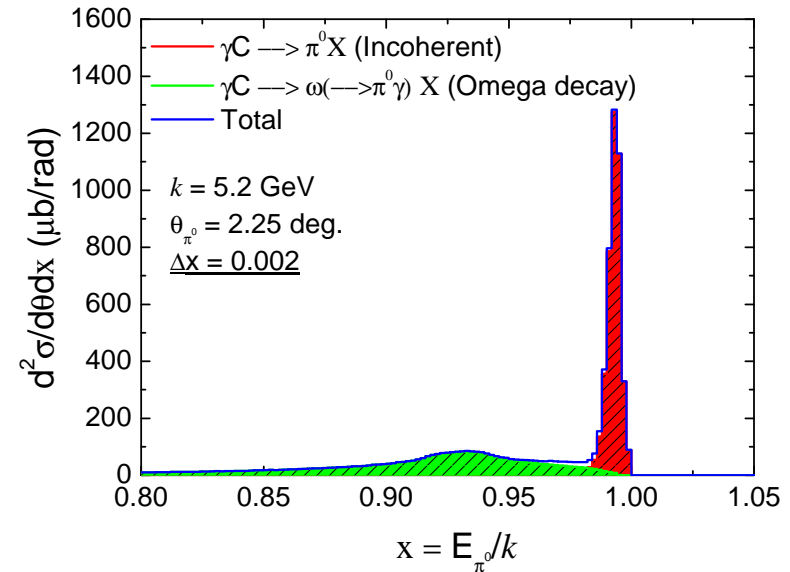# Results: single differential cross section versus X_{MIN} (Carbon)

$\gamma C \longrightarrow \pi^0 X$ (Incoherent)
$k = 5.2$ GeV

$X_{MIN} = 0.70$
$X_{MIN} = 0.92$
$X_{MIN} = 0.98$

π^0 polar angle (Lab. frame)

$\gamma C \longrightarrow \omega(\longrightarrow\pi^0\gamma) X$ (Omega decay)
$k = 5.2$ GeV

$X_{MIN} = 0.70$
$X_{MIN} = 0.92$
$X_{MIN} = 0.98$

π^0 polar angle (Lab. frame)

$\gamma C \longrightarrow \pi^0 X$ (Incoherent) +
$\gamma C \longrightarrow \omega(\longrightarrow\pi^0\gamma) X$ (Omega decay)
$k = 5.2$ GeV

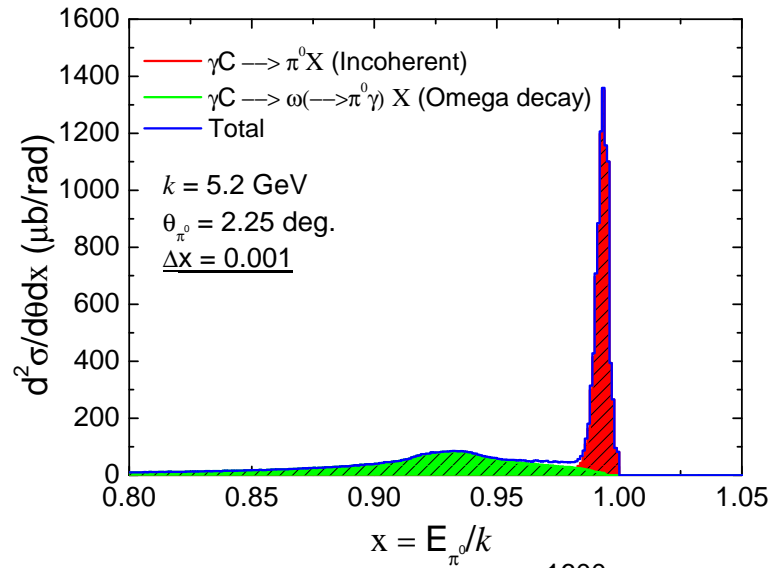$X_{MIN} = 0.70$
$X_{MIN} = 0.92$
$X_{MIN} = 0.98$

π^0 polar angle (Lab. frame)
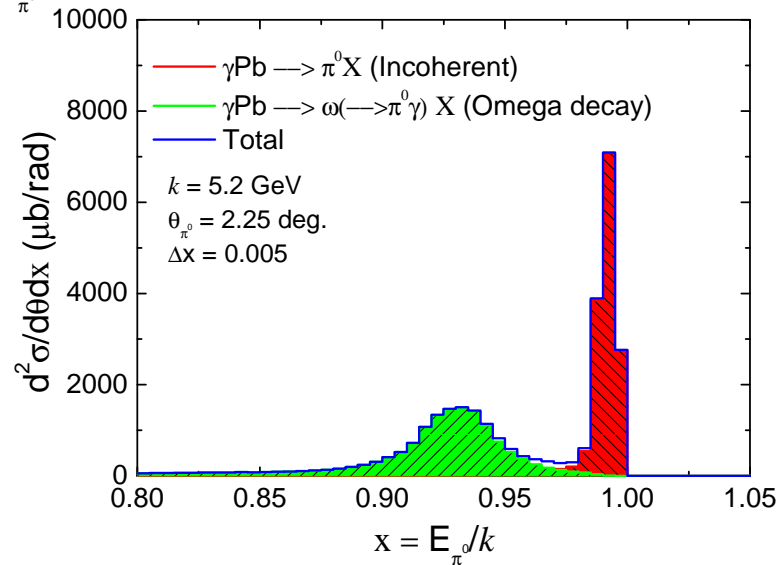
Results: single differential cross section versus X_{MIN} (Lead)

$\gamma Pb \longrightarrow \pi^0 X$ (Incoherent)
$k = 5.2$ GeV

$X_{MIN} = 0.70$
$X_{MIN} = 0.92$
$X_{MIN} = 0.98$

π^0 polar angle (Lab. frame)

$\gamma Pb \longrightarrow \omega(\longrightarrow \pi^0 \gamma) X$ (Omega decay)
$k = 5.2$ GeV

$X_{MIN} = 0.70$
$X_{MIN} = 0.92$
$X_{MIN} = 0.98$

π^0 polar angle (Lab. frame)

$\gamma Pb \longrightarrow \pi^0 X$ (Incoherent) +
$\gamma Pb \longrightarrow \omega(\longrightarrow \pi^0 \gamma) X$ (Omega decay)
$k = 5.2$ GeV

$X_{MIN} = 0.70$
$X_{MIN} = 0.92$
$X_{MIN} = 0.98$

π^0 polar angle (Lab. frame)

Investigating the effect of "energy resolution" (Carbon)

Results: double differential cross section versus ΔX ($\theta_{\pi 0} = 2.25$ deg.)
Investigating the effect of "energy resolution" (Lead)

Running instructions (Windows OS only)

1. Go to http://fep.if.usp.br/~tulio/PrimEx/Event_Generator

2. Modify file in.dat as appropriate

3. Run the Application event generator.exe

4. Output files are: dsdteta.dat, d2sdtetadx.dat and events.dat

5. Contact me if you have any problems or if you need a more specific constraint