Radiation Flux & MDI at CEPC

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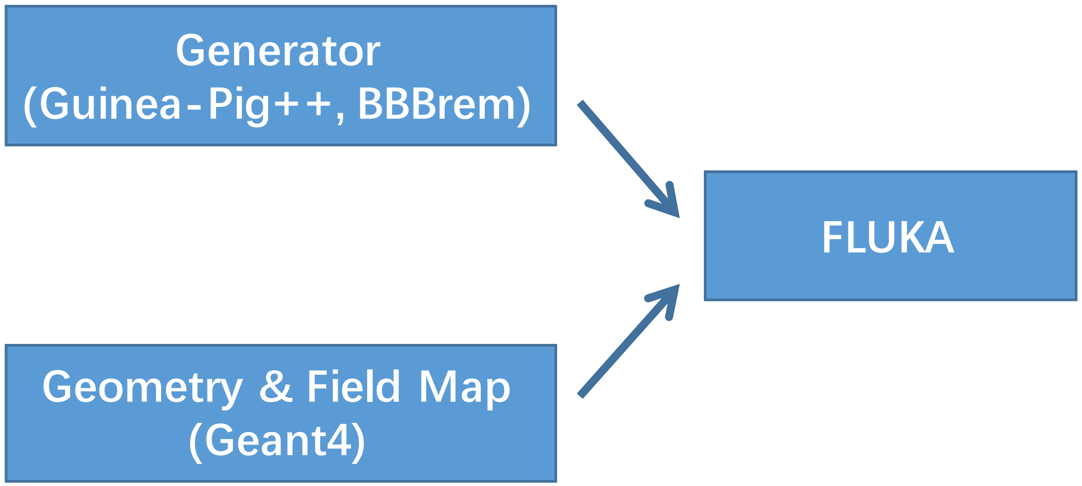
Outline

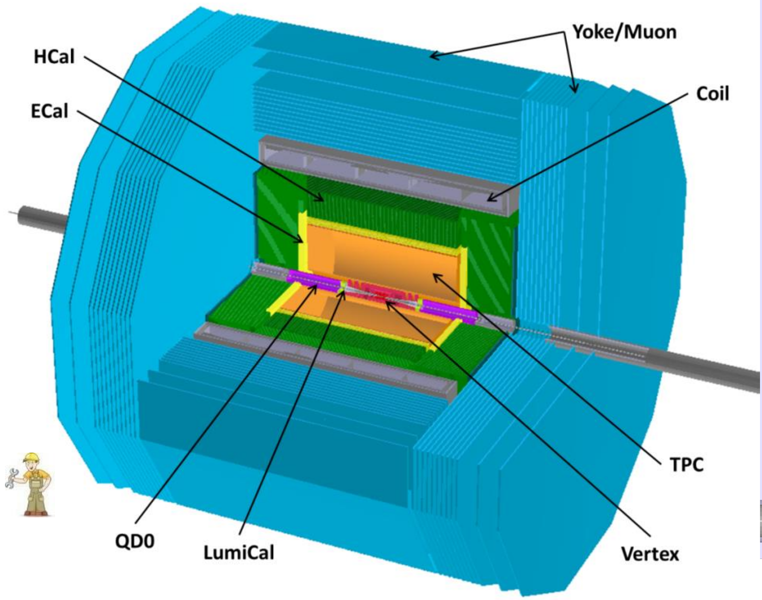
- Geometry Setup
- Source of Backgrounds at CEPC
- Normalization
- Conclusion

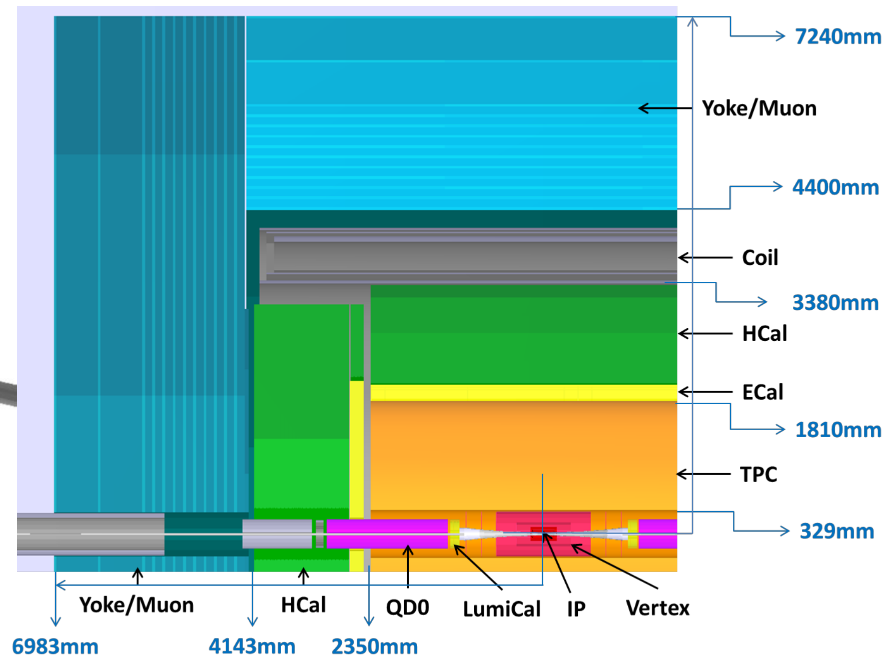
Simulation Framework



Geometry & Field Map Setup is from Mokka model — CEPC_v1

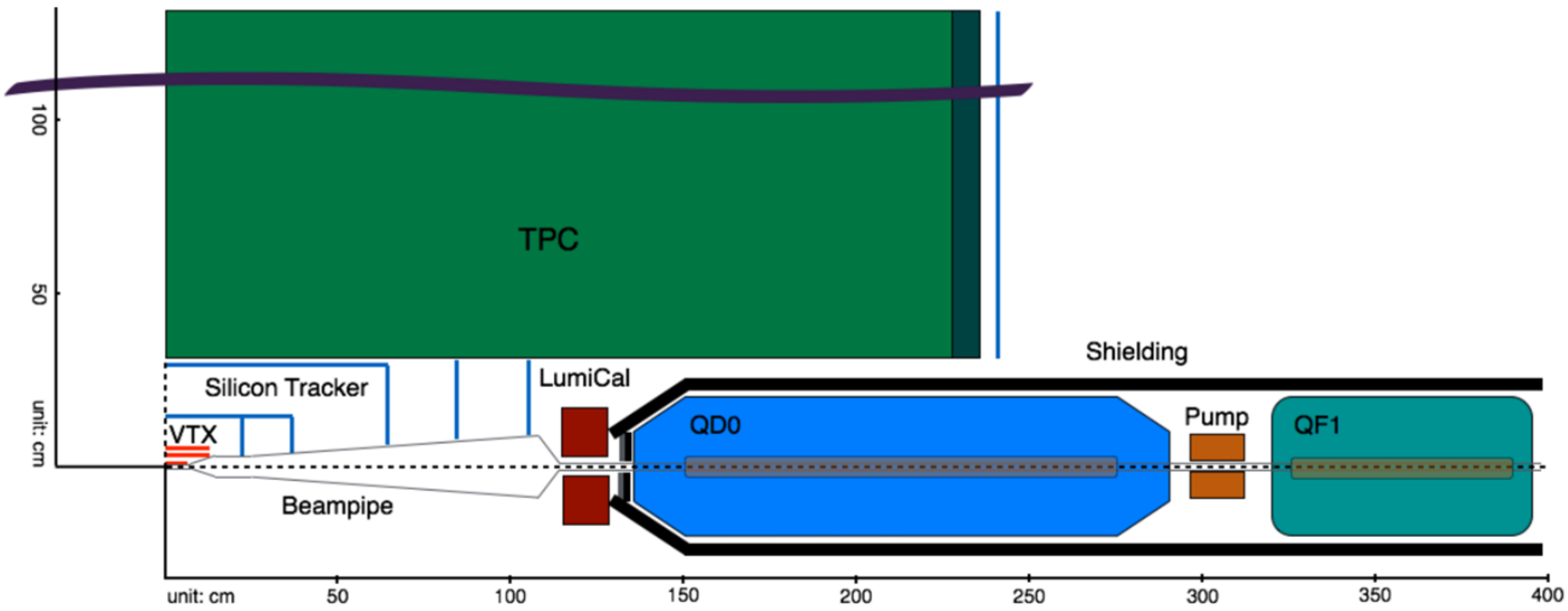
Preliminary Detector Layout





The detector model (CEPC_v1) is inherited from ILD at the beginning of study, and been modified according to the lattice design of CEPC

Preliminary Interaction Region



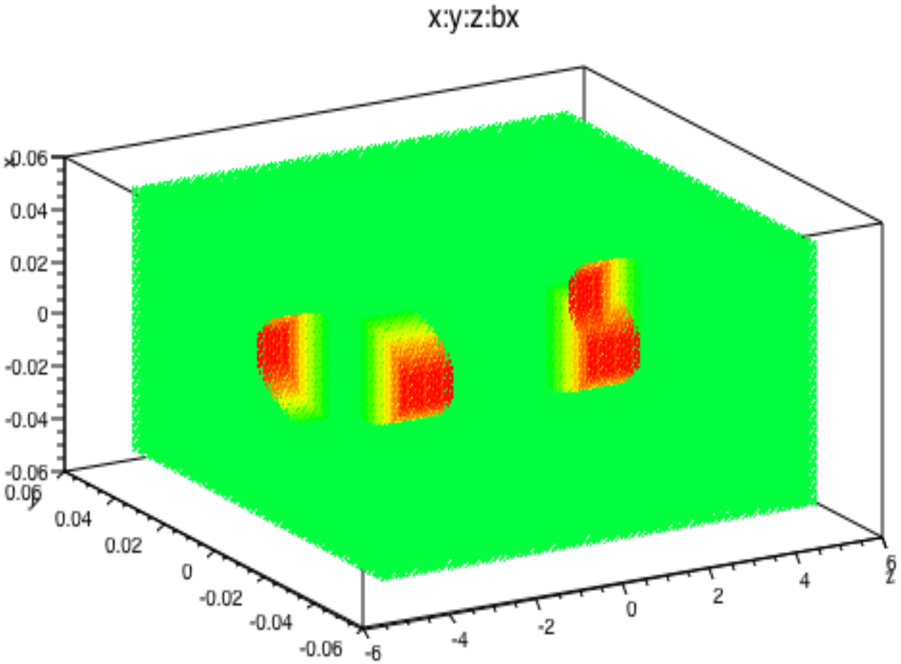
Two beams will collide without crossing angle

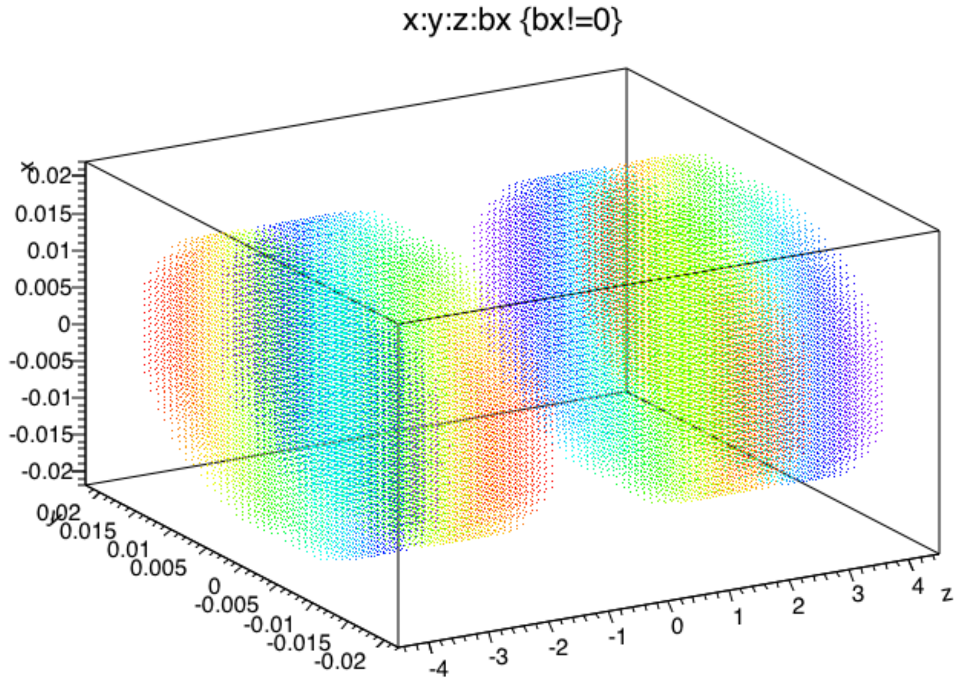
Magnetic Field Setup

- In Quadrupole:
  - B(x,y,z)=(G*y,G*x,0) T
  - In QD0: G=-303.793T/m, 0<R<2cm, 1.5m<Z<2.75m
  - In QF1: G=308.661T/m, 0<R<2cm, 3.25m<Z<3.97m

- Other place:
  - Bz=3.5T, Bx=By=0

CEPC Field Map



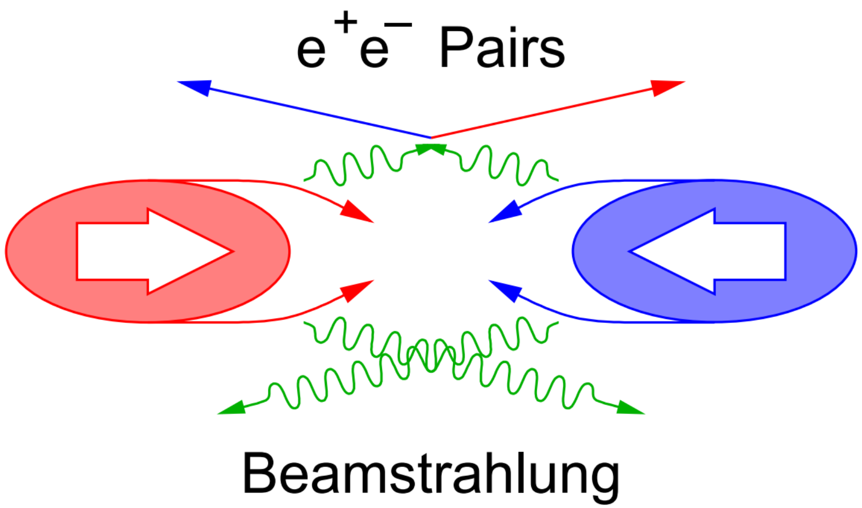


Source of Backgrounds at CEPC

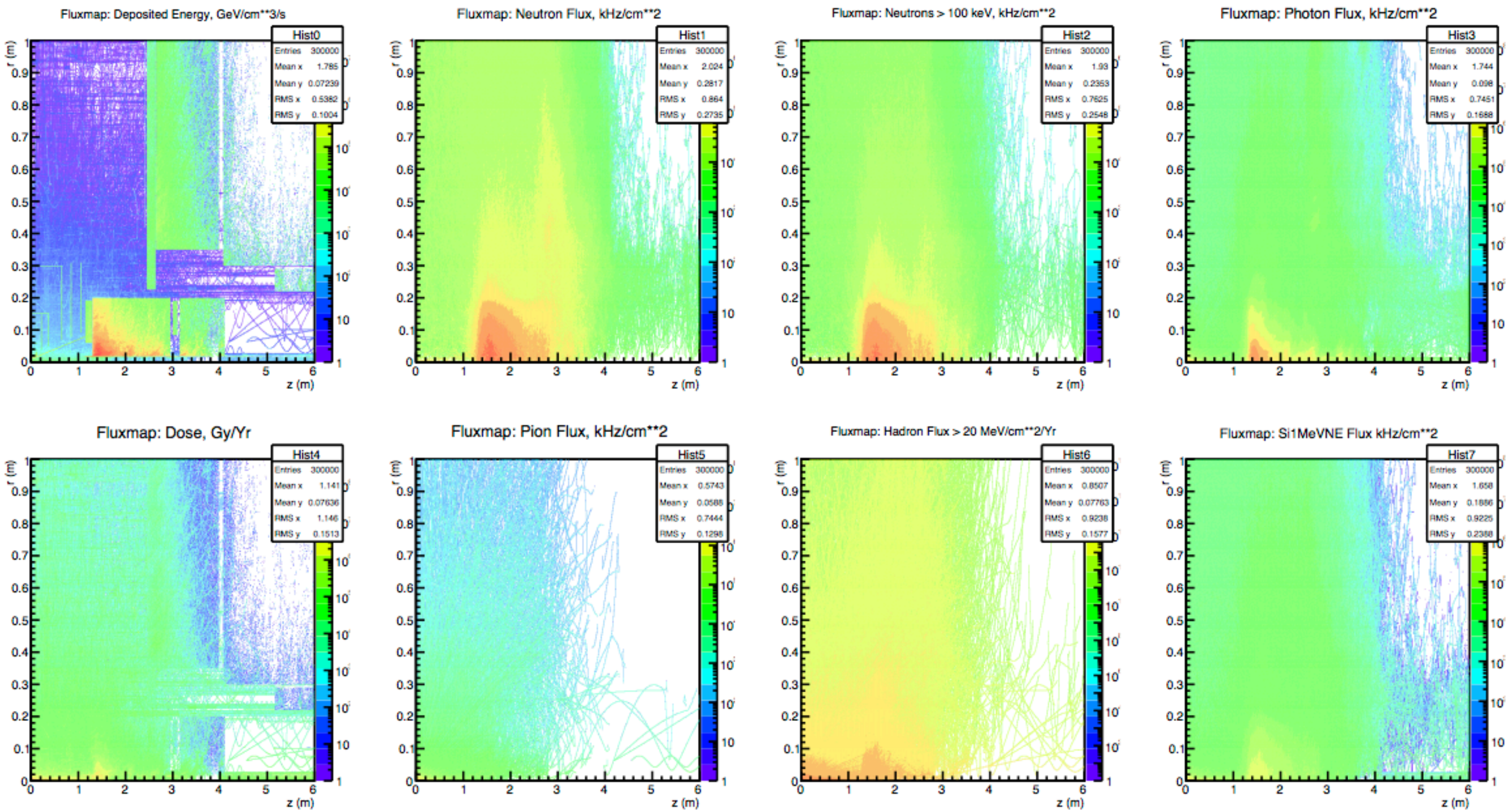
- Beamstrahlung
  - Pair production
  - Hadronic background
- Lost Particles
  - Radiative Bhabha
  - Beamstrahlung
  - Beam-Gas Scattering
  - …
- Synchrotron Radiation
  - Bending Magnets
  - Quadrupoles Magnets

Beamstrahlung

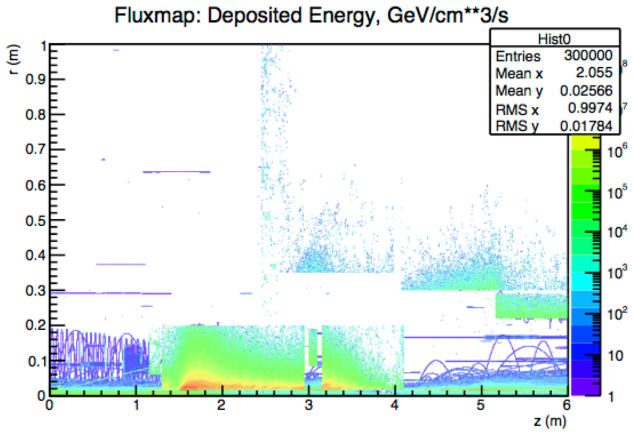
- When two bunches crossing, trajectories of particles in one bunch will be bent by the field of the other bunch and photons will be emitted
- The emitted photons might further interact with each other through pair production and hadronic processes

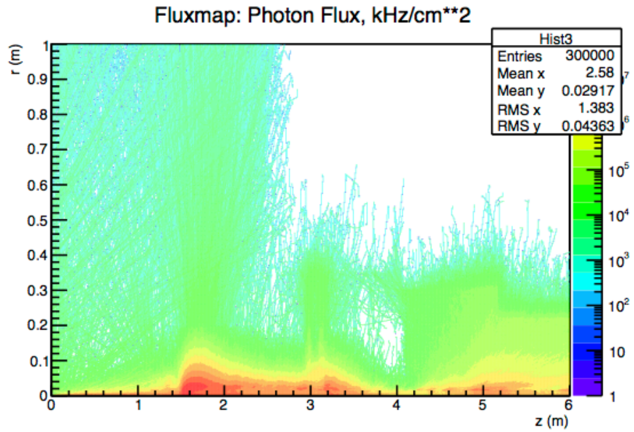


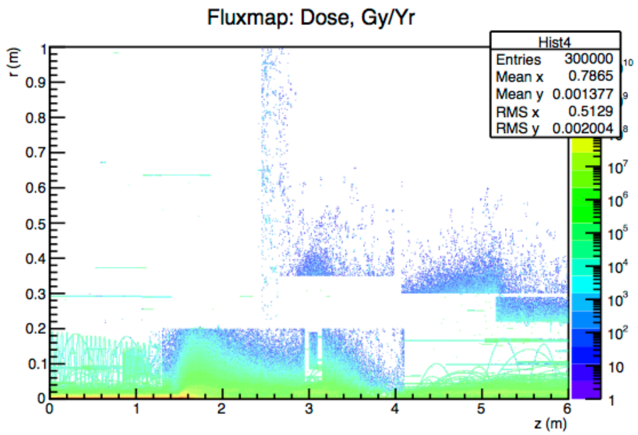
Photon-Hadron Pairs（1 file）

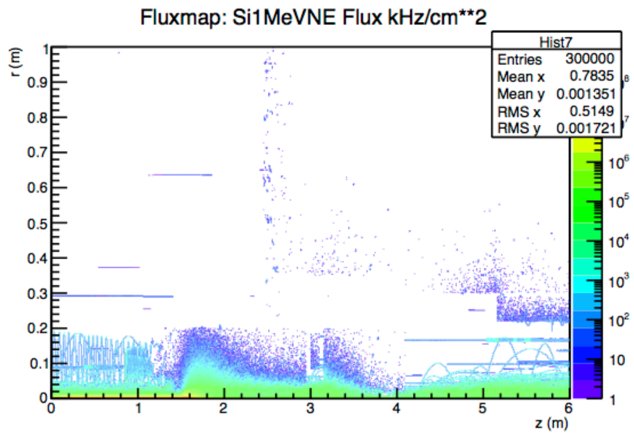


Photon-Electron Pairs（1k files）







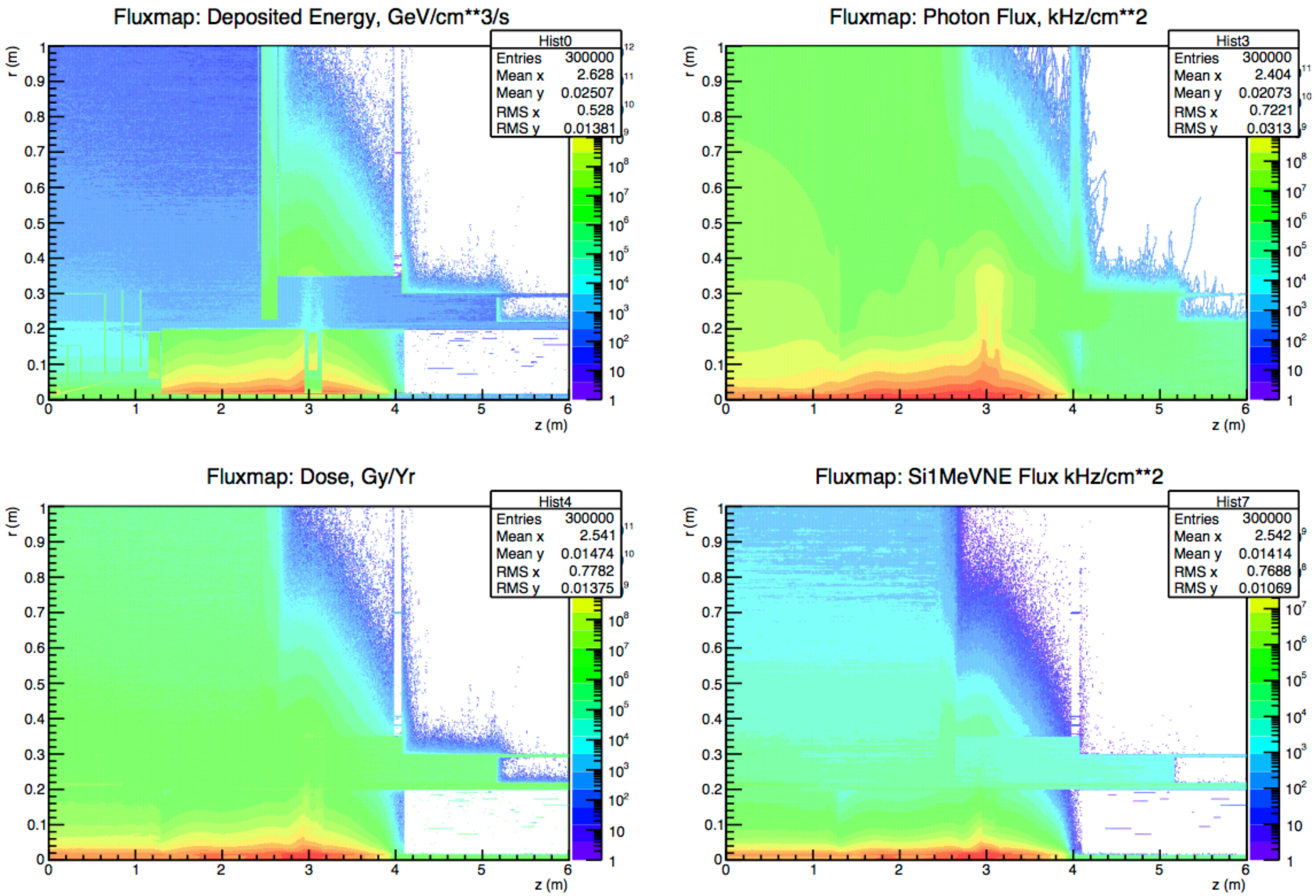


SI1MEVNE means "Silicon 1 MeV-equivalent flux".

It is use for calculations of damage.

Radiative Bhabha

- The process of electron positron scattering coupled with the initial-state radiation is called "radiative bhabha".

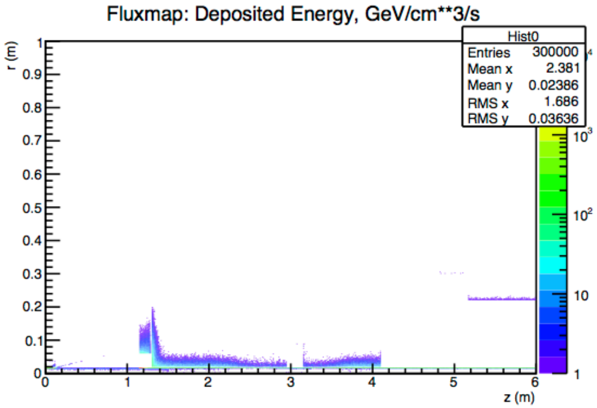


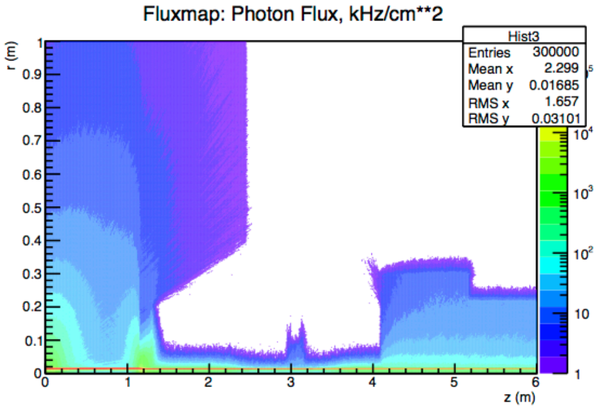
Synchrotron Radiation

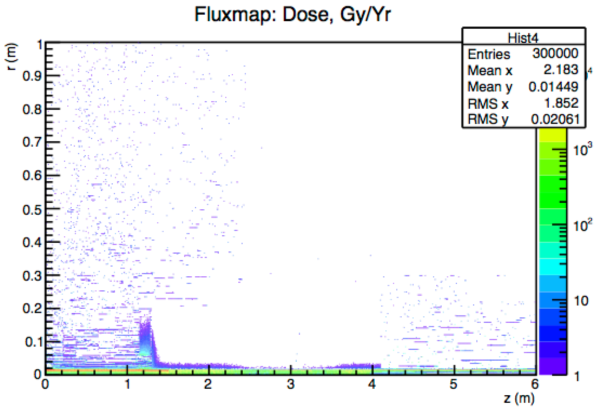
- Electron and positron will emit the synchrotron radiation when their trajectories are bend by Lorentz force in the magnet. In the interaction region, these photons might hit the detector directly. The synchrotron radiation need be paid more attention because the number of photons is very large.

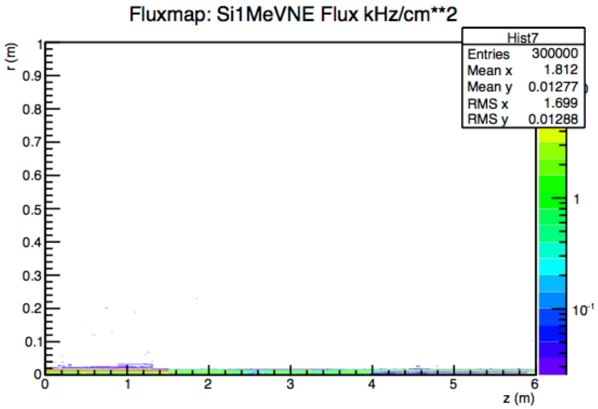
  - **Bending Magnets**
  - Quadrupoles Magnets

SynchrotronRadiation (1 file)
HitPosWide in Z (-12m—8m)

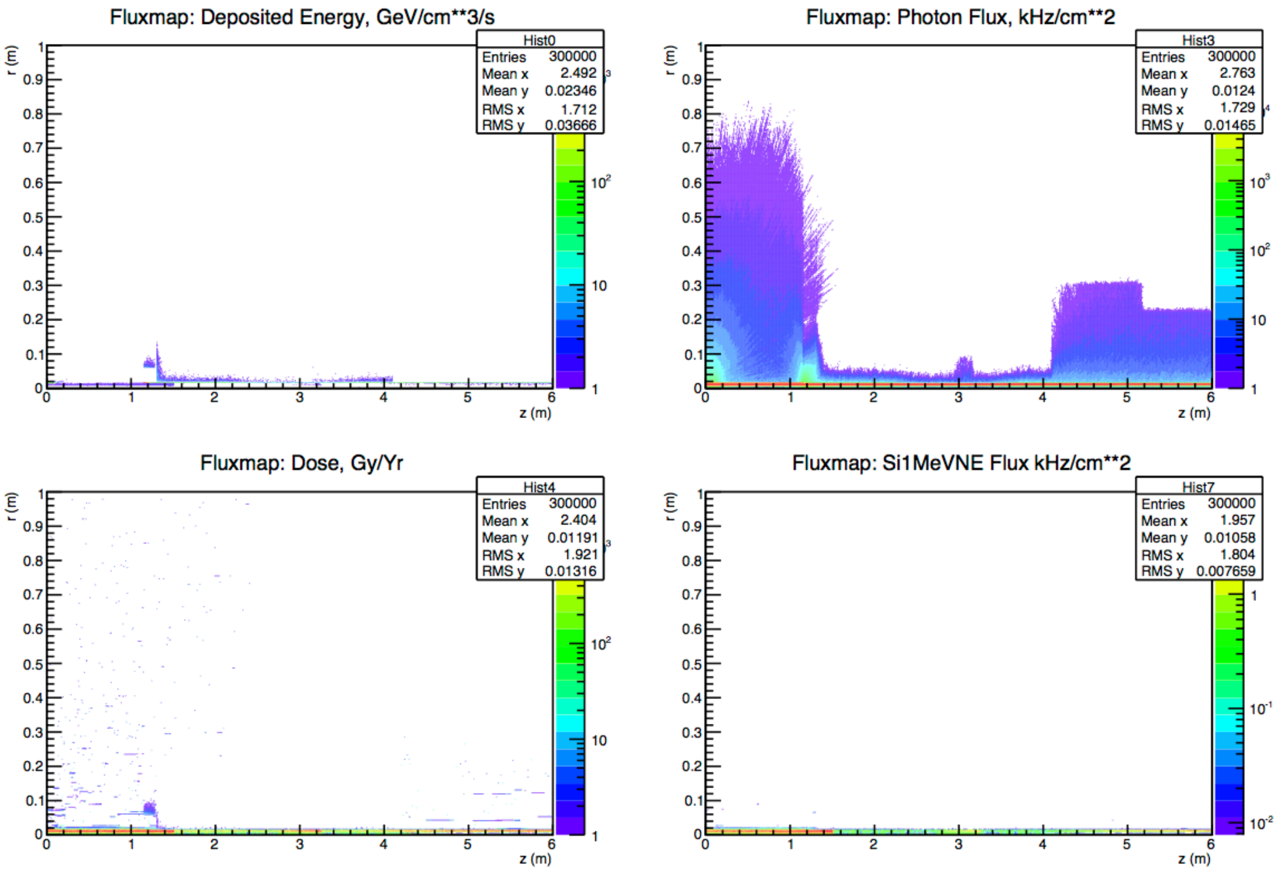








SynchrotronRadiation（1 file）
HitPosWide in Z (-30m—30m)

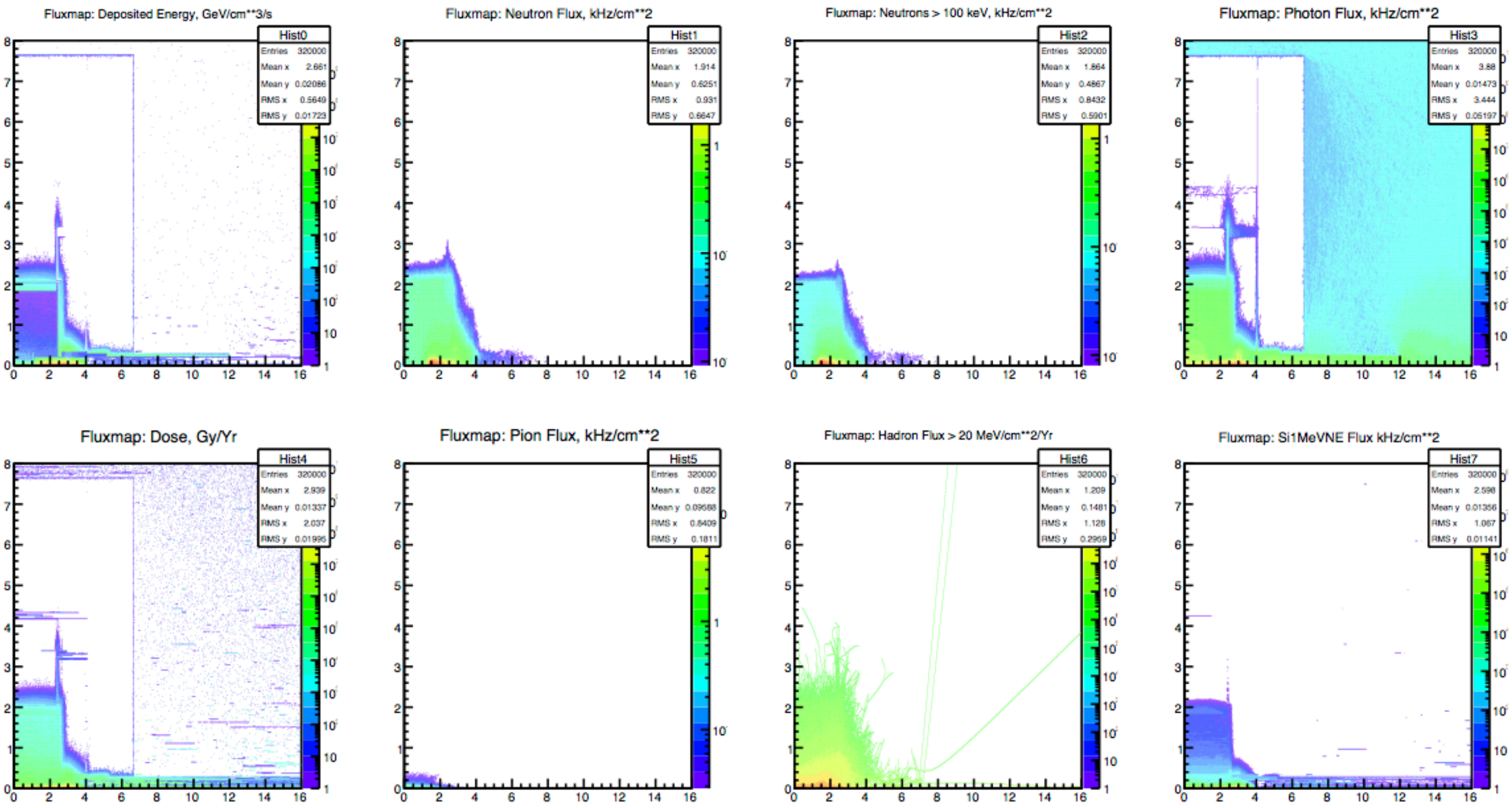


Normalization

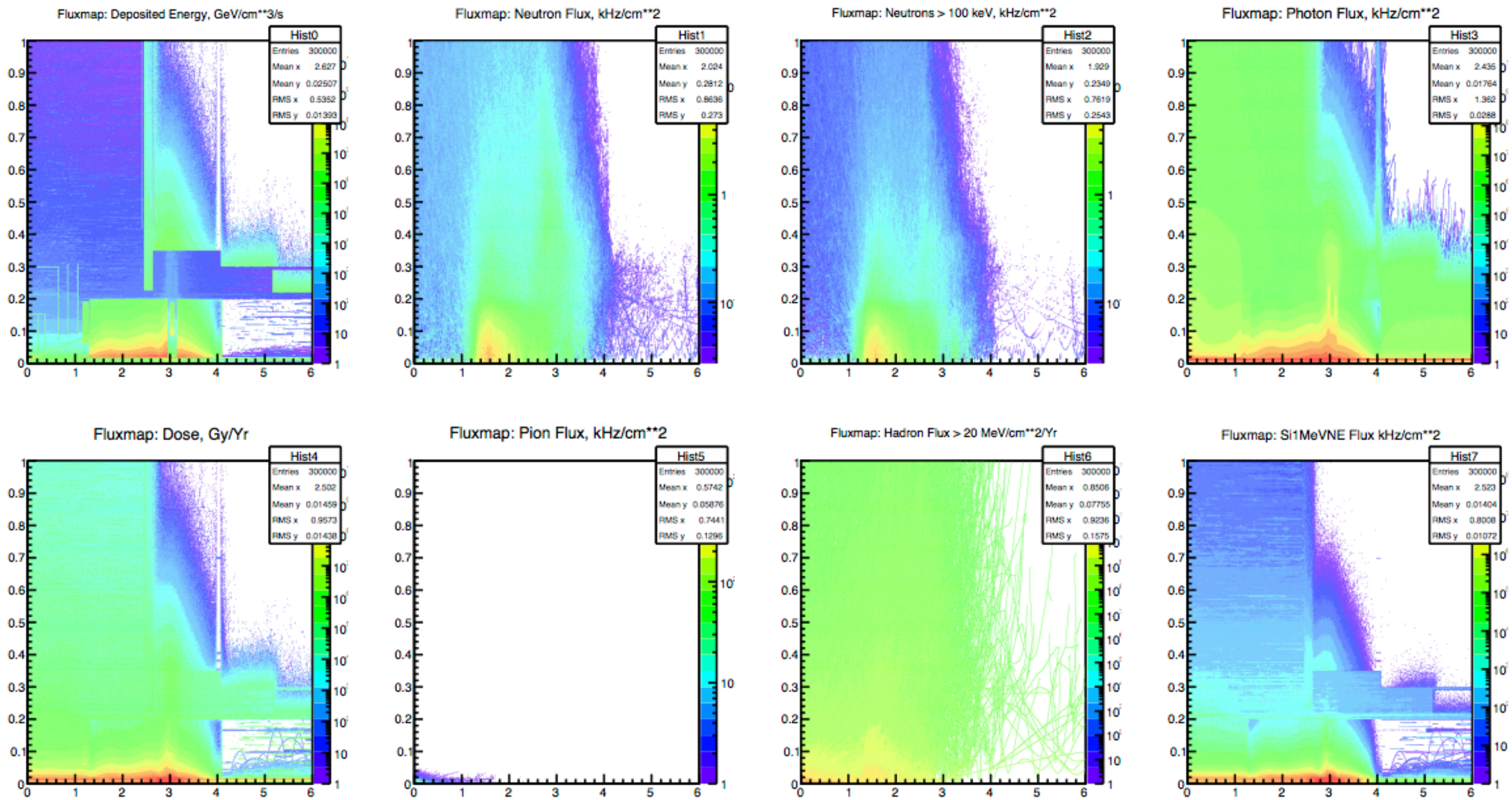
- $H_{BX} = \frac{1}{n_F} F_F F_B F_{IP}$
- $H_S = \frac{f_{BX}}{n_F} F_F F_B F_{IP}$

  - F_B : factor of beam
  - F_{IP}: factor of IP
  - F_F: number of files for one BX
  - n_F: number of sample files
  - f_{BX}: the bunch crossing frequency at one IP

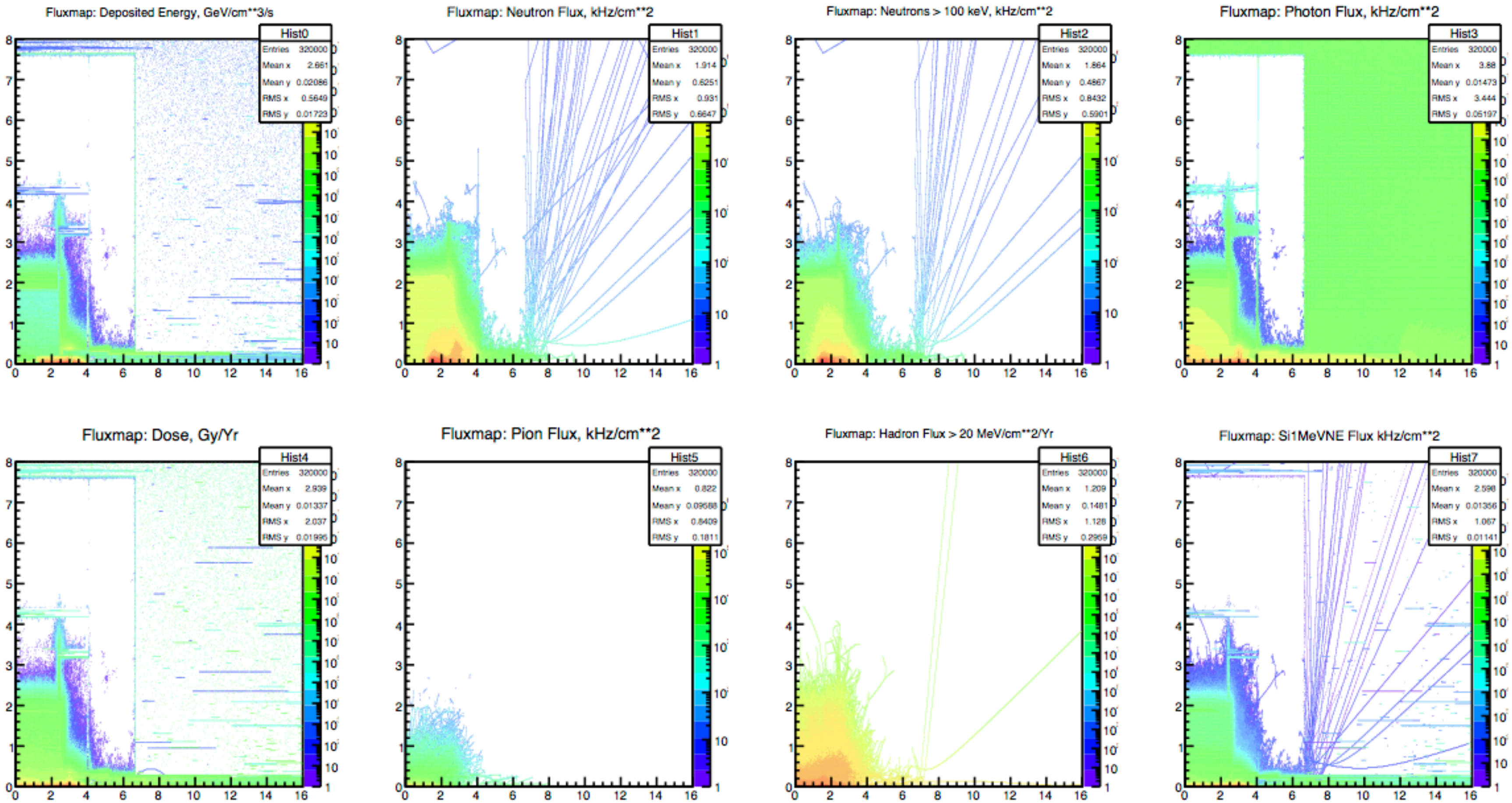
One Bunch Crossing



One Bunch Crossing

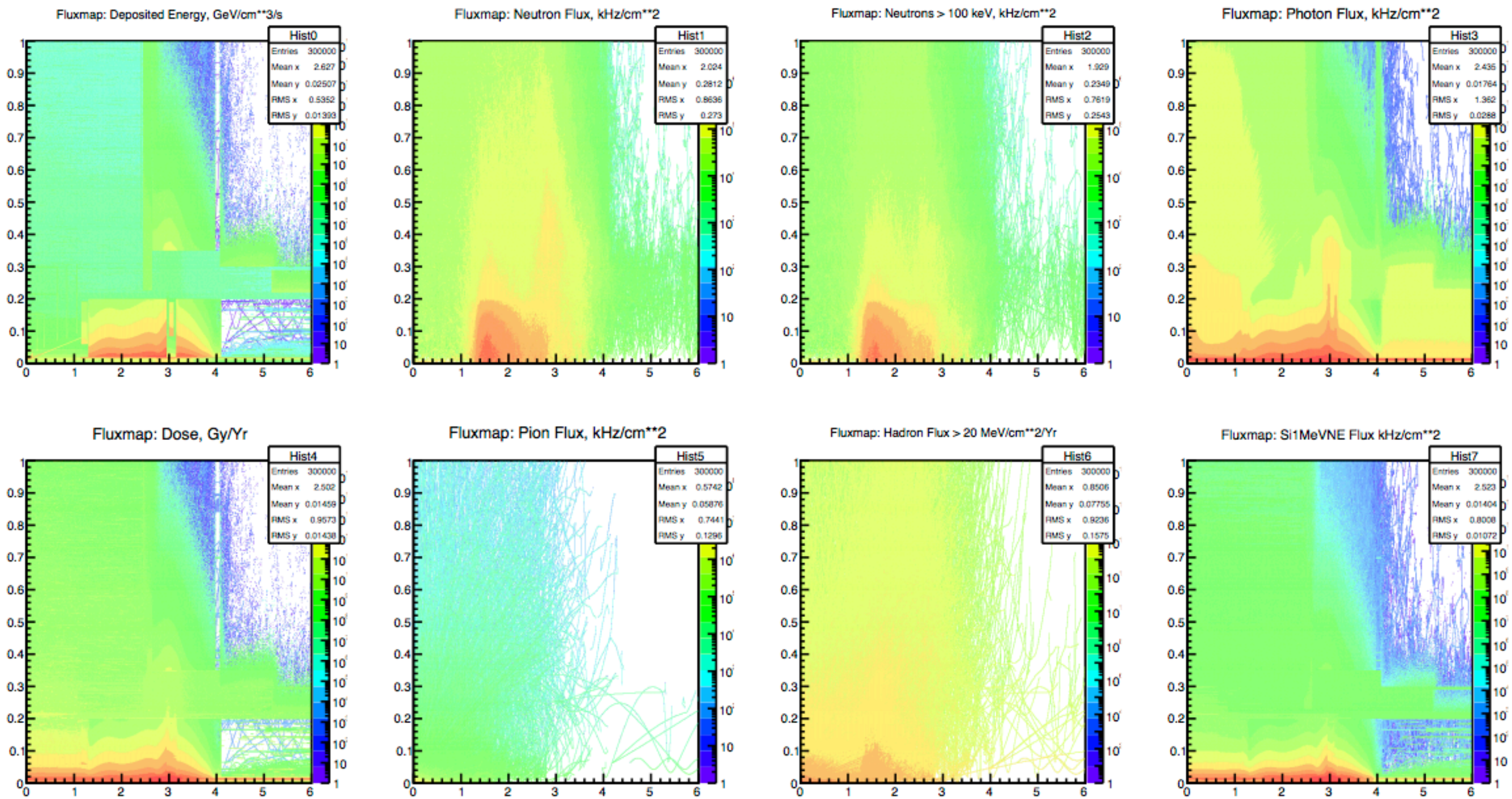


Result



Fluxmap: Deposited Energy, GeV/cm**3/s
Hist0
Entries 320000
Mean x 2.661
Mean y 0.02086
RMS x 0.5649
RMS y 0.01723
Fluxmap: Neutron Flux, kHz/cm**2
Hist1
Entries 320000
Mean x 1.914
Mean y 0.6251
RMS x 0.931
RMS y 0.6647
Fluxmap: Neutrons > 100 keV, kHz/cm**2
Hist2
Entries 320000
Mean x 1.864
Mean y 0.4867
RMS x 0.8432
RMS y 0.5901
Fluxmap: Photon Flux, kHz/cm**2
Hist3
Entries 320000
Mean x 3.88
Mean y 0.01473
RMS x 3.444
RMS y 0.05197
Fluxmap: Dose, Gy/Yr
Hist4
Entries 320000
Mean x 2.939
Mean y 0.01337
RMS x 2.037
RMS y 0.01996
Fluxmap: Pion Flux, kHz/cm**2
Hist5
Entries 320000
Mean x 0.822
Mean y 0.09588
RMS x 0.8409
RMS y 0.1811
Fluxmap: Hadron Flux > 20 MeV/cm**2/Yr
Hist6
Entries 320000
Mean x 1.209
Mean y 0.1481
RMS x 1.128
RMS y 0.2959
Fluxmap: Si1MeVNE Flux kHz/cm**2
Hist7
Entries 320000
Mean x 2.598
Mean y 0.01356
RMS x 1.067
RMS y 0.01141

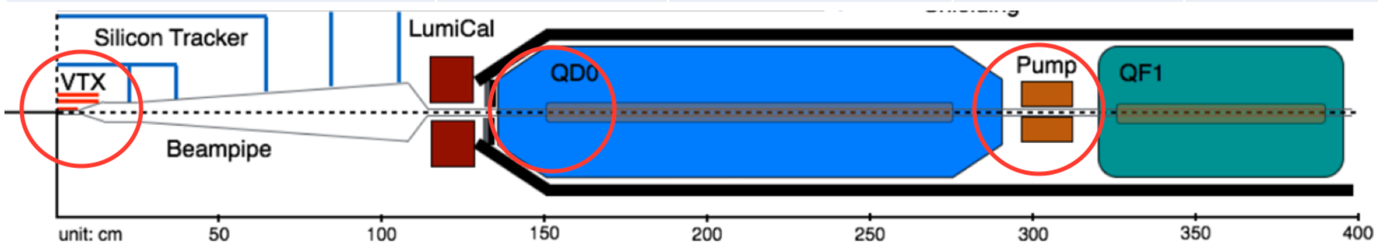
Result (zoom)



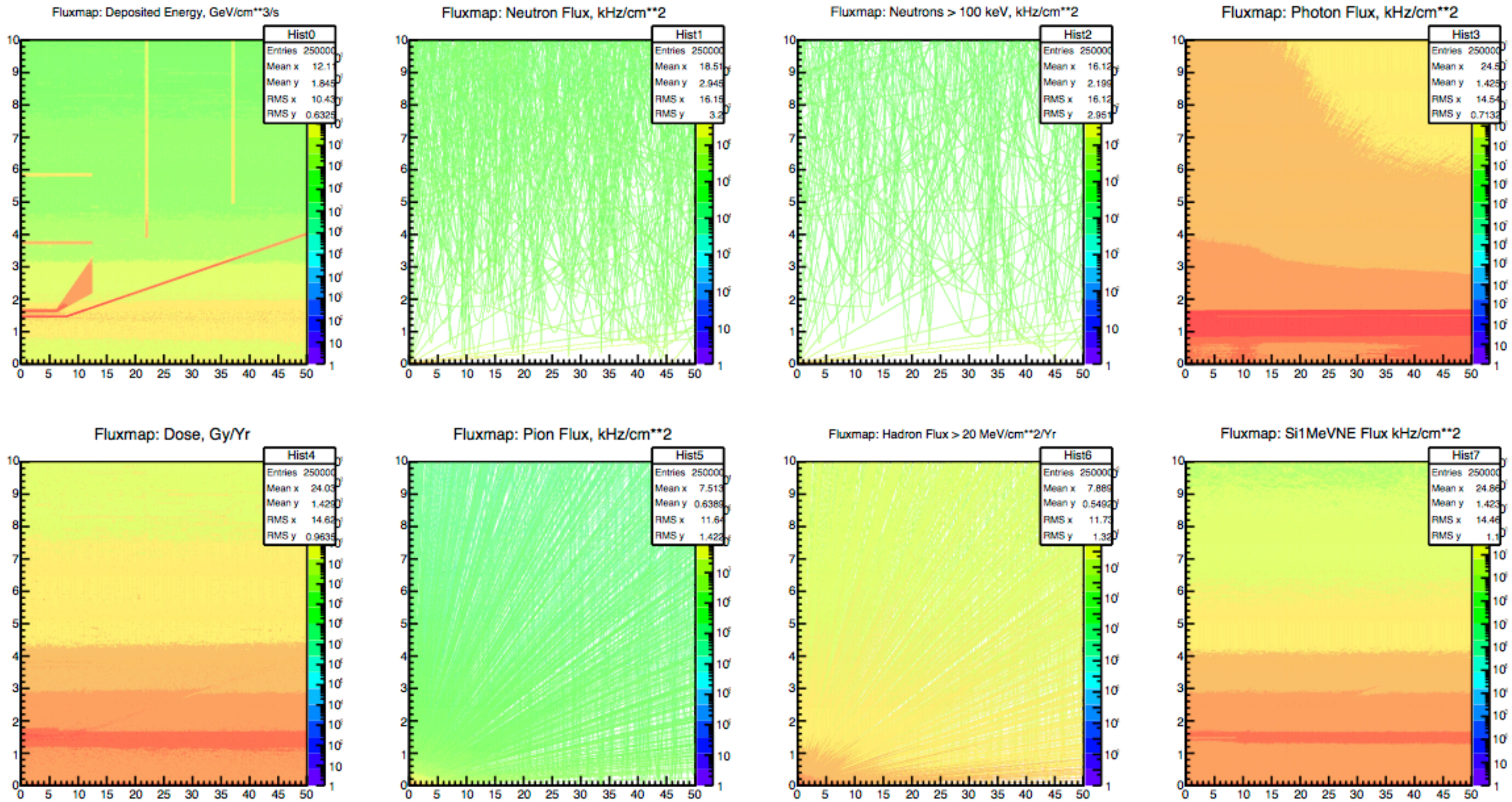
Fluxmap: Deposited Energy, GeV/cm**3/s
Hist0
Entries 300000
Mean x 2.627
Mean y 0.02507
RMS x 0.5352
RMS y 0.01393
Fluxmap: Neutron Flux, kHz/cm**2
Hist1
Entries 300000
Mean x 2.024
Mean y 0.2812
RMS x 0.8636
RMS y 0.273
Fluxmap: Neutrons > 100 keV, kHz/cm**2
Hist2
Entries 300000
Mean x 1.929
Mean y 0.2349
RMS x 0.7619
RMS y 0.2543
Fluxmap: Photon Flux, kHz/cm**2
Hist3
Entries 300000
Mean x 2.435
Mean y 0.01764
RMS x 1.362
RMS y 0.0288
Fluxmap: Dose, Gy/Yr
Hist4
Entries 300000
Mean x 2.502
Mean y 0.01459
RMS x 0.9573
RMS y 0.01438
Fluxmap: Pion Flux, kHz/cm**2
Hist5
Entries 300000
Mean x 0.5742
Mean y 0.05876
RMS x 0.7441
RMS y 0.1296
Fluxmap: Hadron Flux > 20 MeV/cm**2/Yr
Hist6
Entries 300000
Mean x 0.8506
Mean y 0.07755
RMS x 0.9236
RMS y 0.1575
Fluxmap: Si1MeVNE Flux kHz/cm**2
Hist7
Entries 300000
Mean x 2.523
Mean y 0.01404
RMS x 0.8008
RMS y 0.01072

Hot Point

	unit	value	Z(cm)	R(cm)
Deposited Energy	$GeV/cm^3/s$	1.5e+16	296	1.8
Neutron Flux	kHz/cm^2	3.9e+06	149	0.2
Neutrons > 100 keV	kHz/cm^2	3.9e+06	149	0.2
Photon Flux	kHz/cm^2	2.0e+16	290	1.6
Dose	Gy/Yr	6.5e+15	296	1.6
Pion Flux	kHz/cm^2	4.4e+08	1	0.2
Hadron Flux > 20 MeV	kHz/cm^2	5.7e+18	1	0.2
Si1MeVNE Flux	kHz/cm^2	7.9e+13	295	1.6



Result (50cm,10cm)



Conclusion

- Radiation background close to the IP is dominated by particles from pp collisions.
- Beyond beam line, back-splash neutrons become important
- Max Si1MeVNE Flux is about 7.9e+13 kHz/cm^2

Next To Do

- Full physics process
- More geometry detail
- Cross check

THANKS

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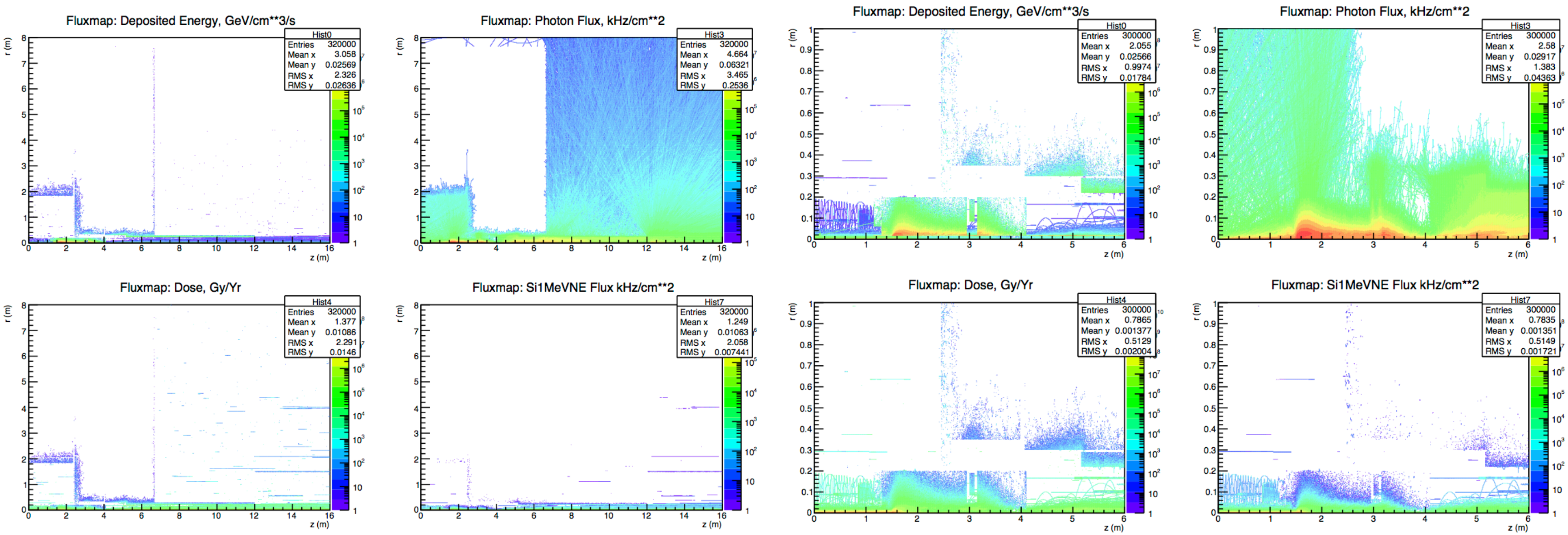
Backup

Bin Size

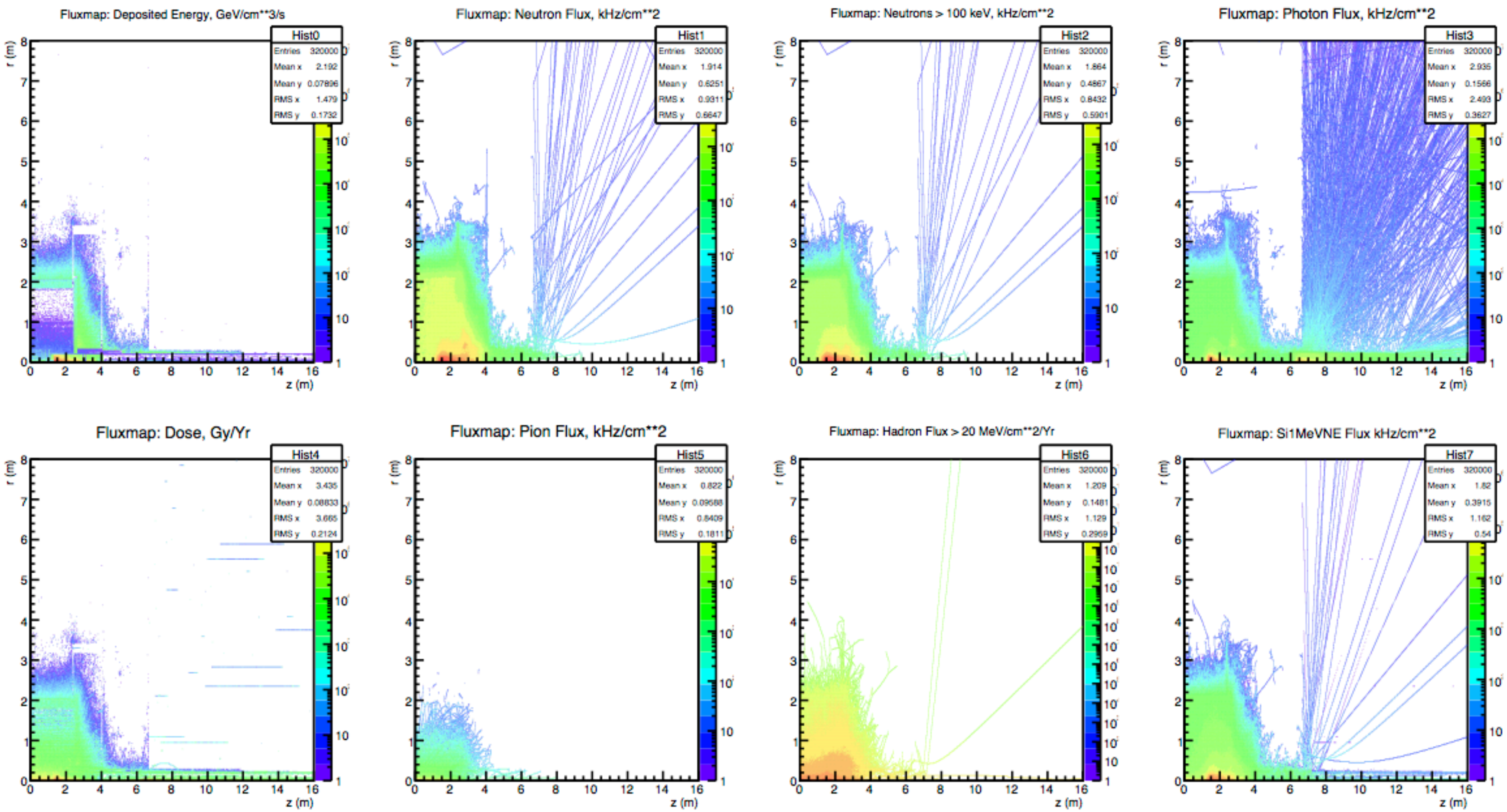
- Full Map
  - 0<R<8m, 400 bins, bin size=2cm
  - 0<Z<16m, 800 bins, bin size=2cm

- Zoom Map
  - 0<R<1m, 500 bins, bin size=0.2cm
  - 0<Z<6m, 600 bins, bin size=1cm

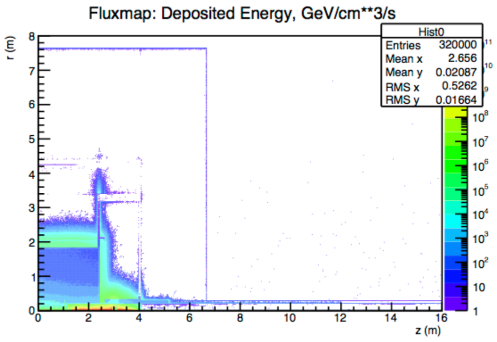
Photon-Electron Pairs（1k files）

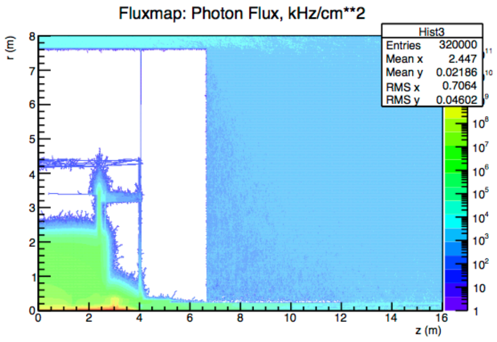


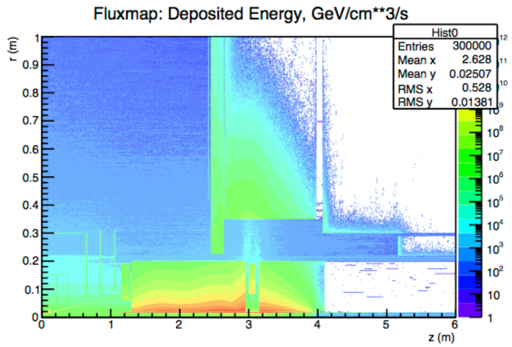
Photon-Hadron Pairs（1 file）

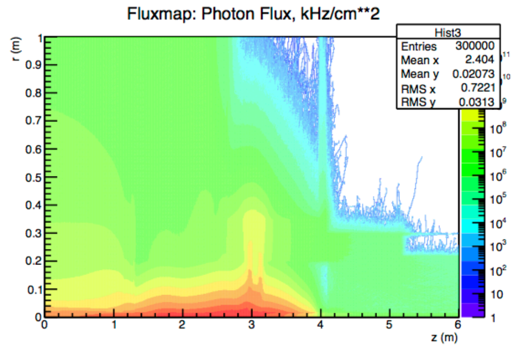


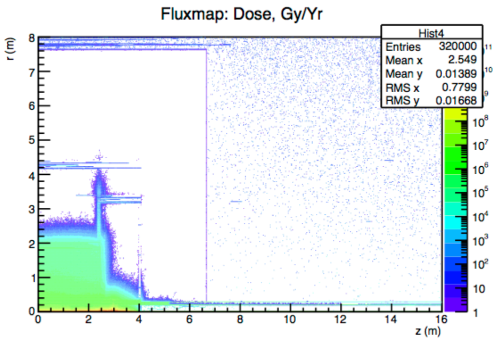
Radiative Bhabha（10 files）

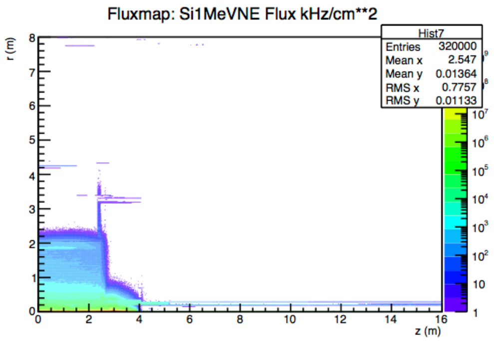


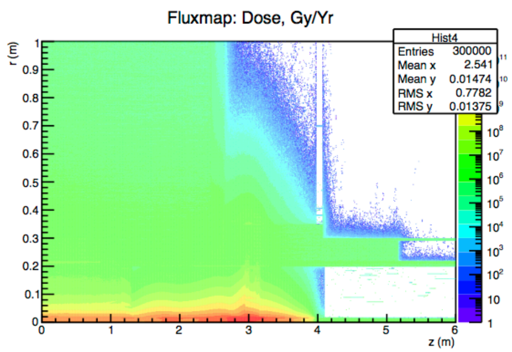


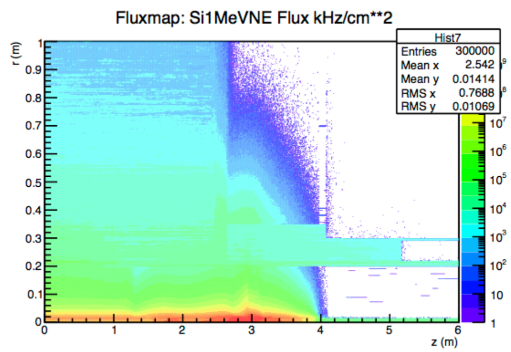




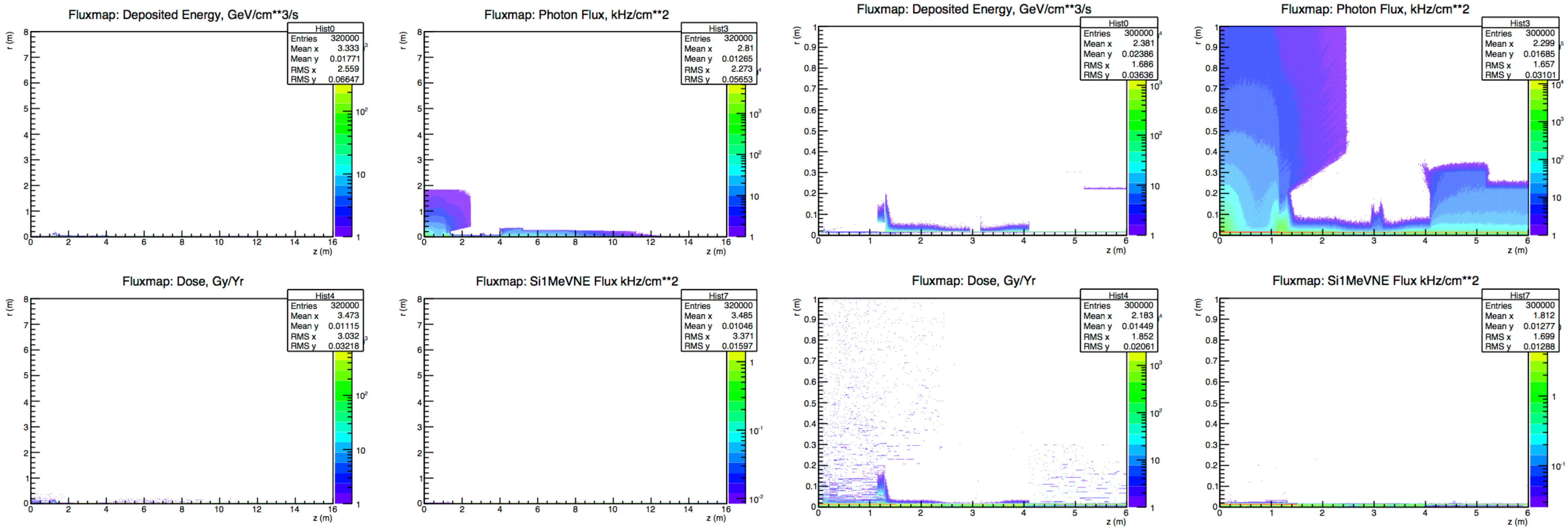




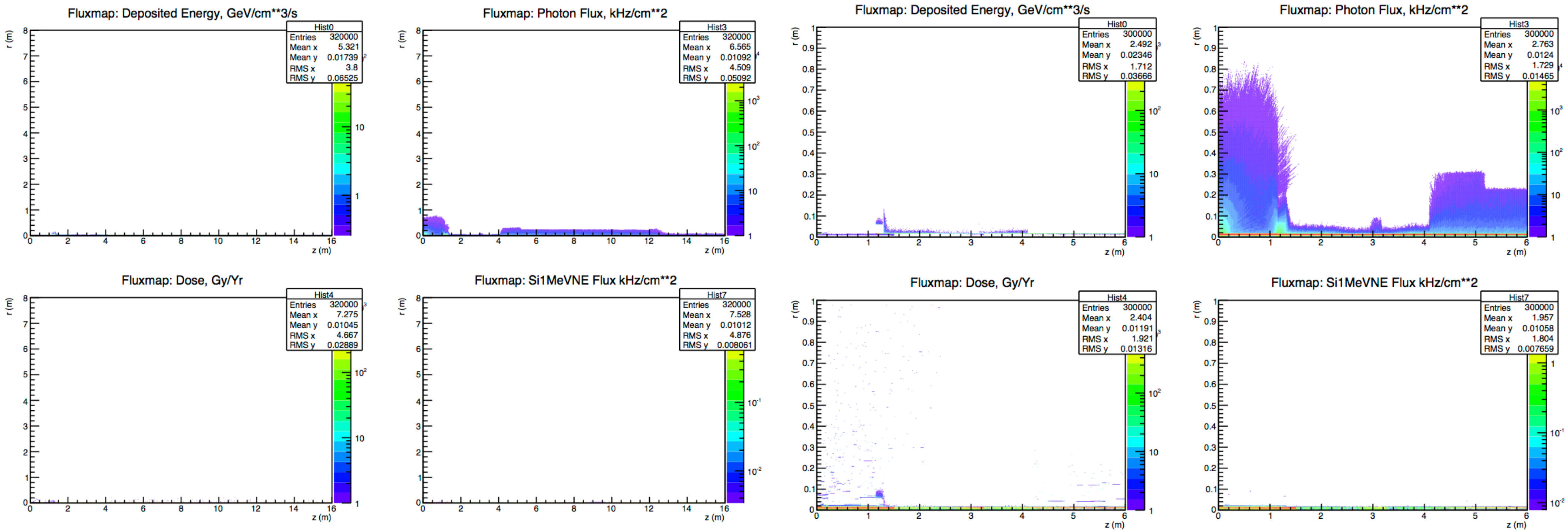


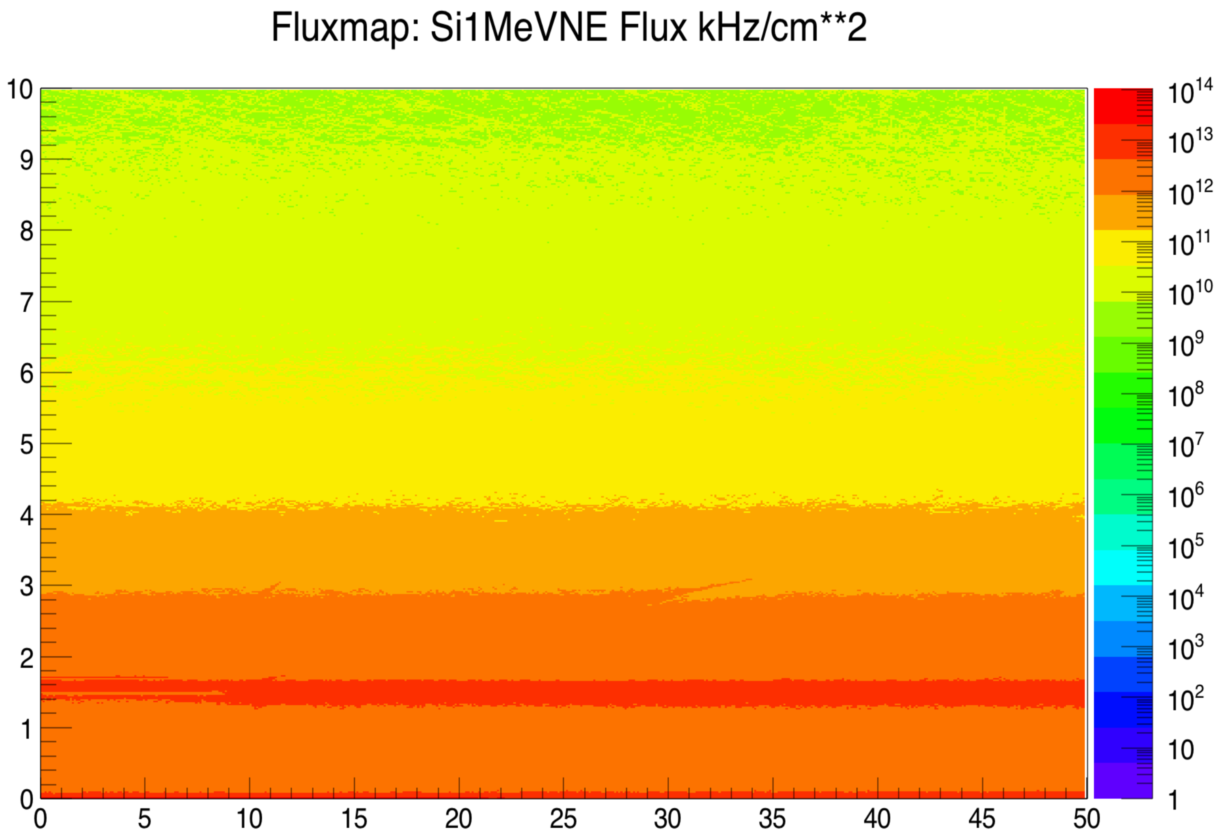


SynchrotronRadiation (1 file)
HitPosWide in Z (-12m—8m)



SynchrotronRadiation （1 file）
HitPosWide in Z (-30m—30m)




Fluxmap: Si1MeVNE Flux kHz/cm**2
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50
1
10
10^{2}
10^{3}
10^{4}
10^{5}
10^{6}
10^{7}
10^{8}
10^{9}
10^{10}
10^{11}
10^{12}
10^{13}
10^{14}