Brookhaven National Laboratory

U.S. DEPARTMENT OF ENERGY

First Look at the Synchrotron Radiation in EicRoot with a TPC (Again)

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Last Update

- Incorrect number of photon per events
- Misery of high momentum secondary electrons

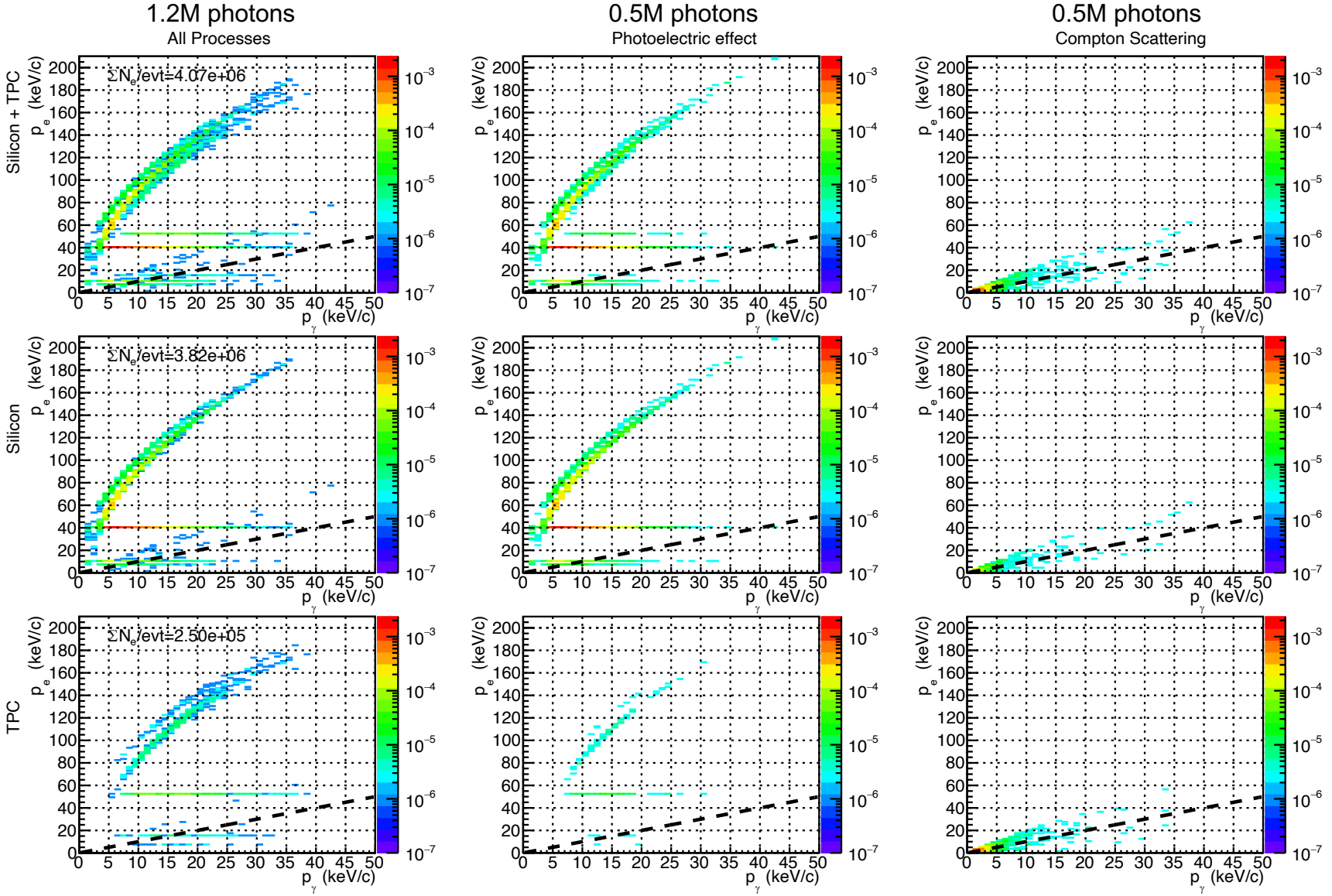
Number of Sychrotron Radiation Photons per ep Event

- One Sychrotron Radiation (SR) Photons root file equivalent to 10^{11} beam electrons
- How many beam electrons passing the ring in each event?
  - For an 18 GeV electron beam, beam current=0.277A → 1.4×10^{18} electron per second
  - ep event rate =83 kHz → event "duration" ~ 12 μs
  - Then, there are $1.4\times10^{18}\times12\times10^{-6} = 16.8\times10^{12}$ electrons per event
- How many SR photon root files equivalent to 1 event? $16.8\times10^{12}/10^{11} = \mathbf{168}$

Physics Processes in GEANT

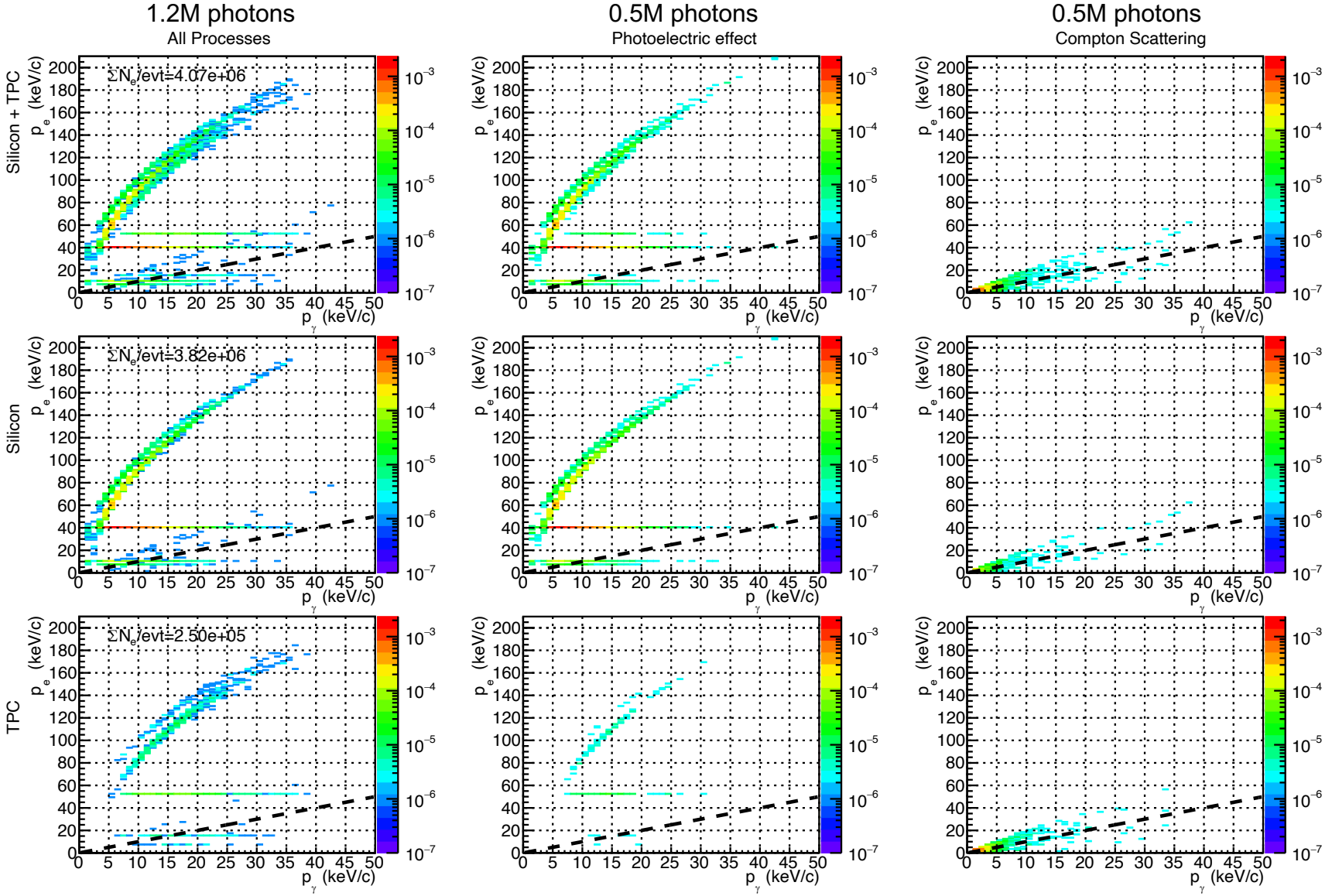
1	Pair production	SR photon energy<e+/e-masses. Don't care.
2	Compton Scattering	Tested.
3	Photoelectron effect	Tested.
4	Positron annihilation with generation of photon	No positron found. Do not care
5	Bremsstrahlung with generation of photon	Tested. No e- generated.
6	Hadronic interaction with generation of secondaries	Don't care
7	Muon-nucleus interaction	Don't care
8	Decay in flight with generation of secondaries	Tested. No e- generated.
9	Continuous energy loss without generation of delta rays	No e- generated. Don't care.
10	Multiple scattering	Tested. No e- generated.

Secondary Electrons Momentum Distributions



- Only two processes generate secondary electrons: Photoelectric effect and Compton Scattering
- 1st column: 1.2M SR photons
- 2nd and 3rd columns: 0.5M SR photons each
- Both physics processes give electron momenta higher than the photon momenta (??)
- 250k e- generated per event in the TPC

Secondary Electrons Momentum Distributions



- Electron momenta higher than the photon momenta in photoelectric effect (??)

  CERN-W5013 (PHYS230):

  $E_e = E_\gamma - E_{shell} + m_e$

- Photoelectric effect generate 4 e- per photon (??)

  $\gamma_{SR} \rightarrow e^- e^- \gamma'$

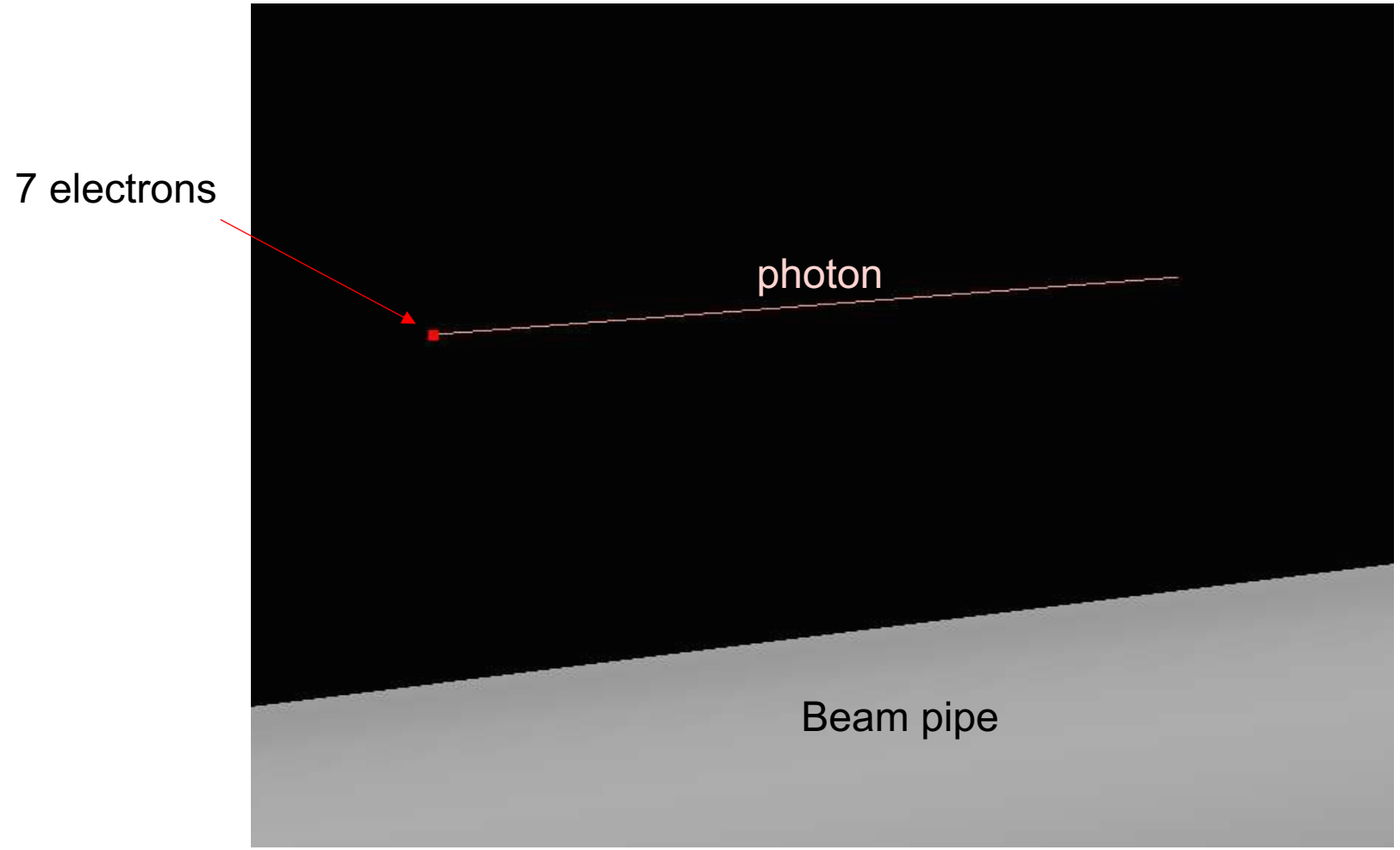
  $\gamma' \rightarrow e^- e^-$

  After the photoelectron emission the atom is left in excited state. The excitation energy equal to the binding energy E_i of the shell in which the interaction took place. ***Subsequently the atom emits a fluorescent photon*** *or Auger or Coster-Kronig electron.*

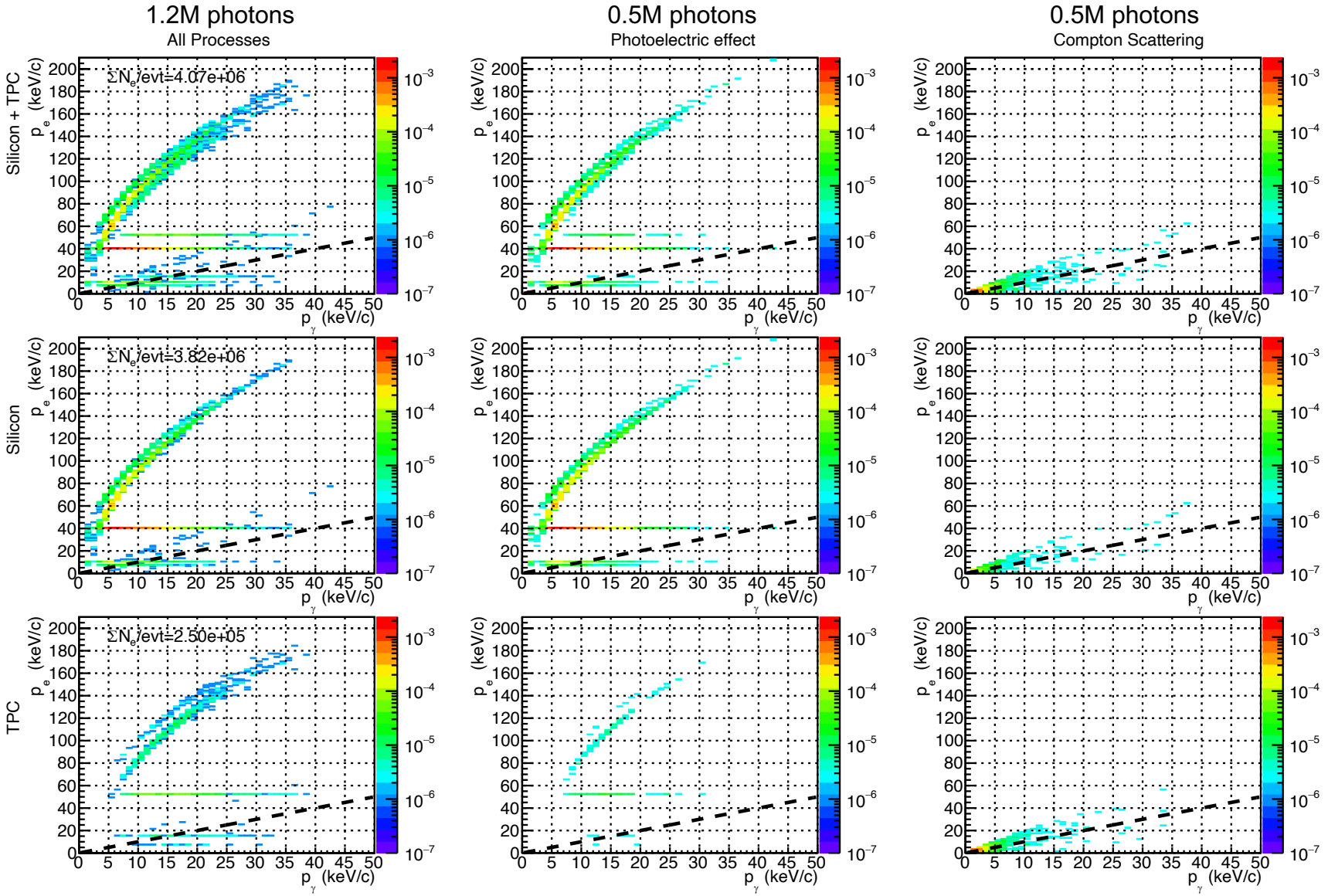
  1st e- : excited?

  2nd e- de-excited?

Event Display (Photoelectric Effects)



Secondary Electrons Momentum Distributions



- Electron momenta higher than the photon momenta in Compton scattering (??)

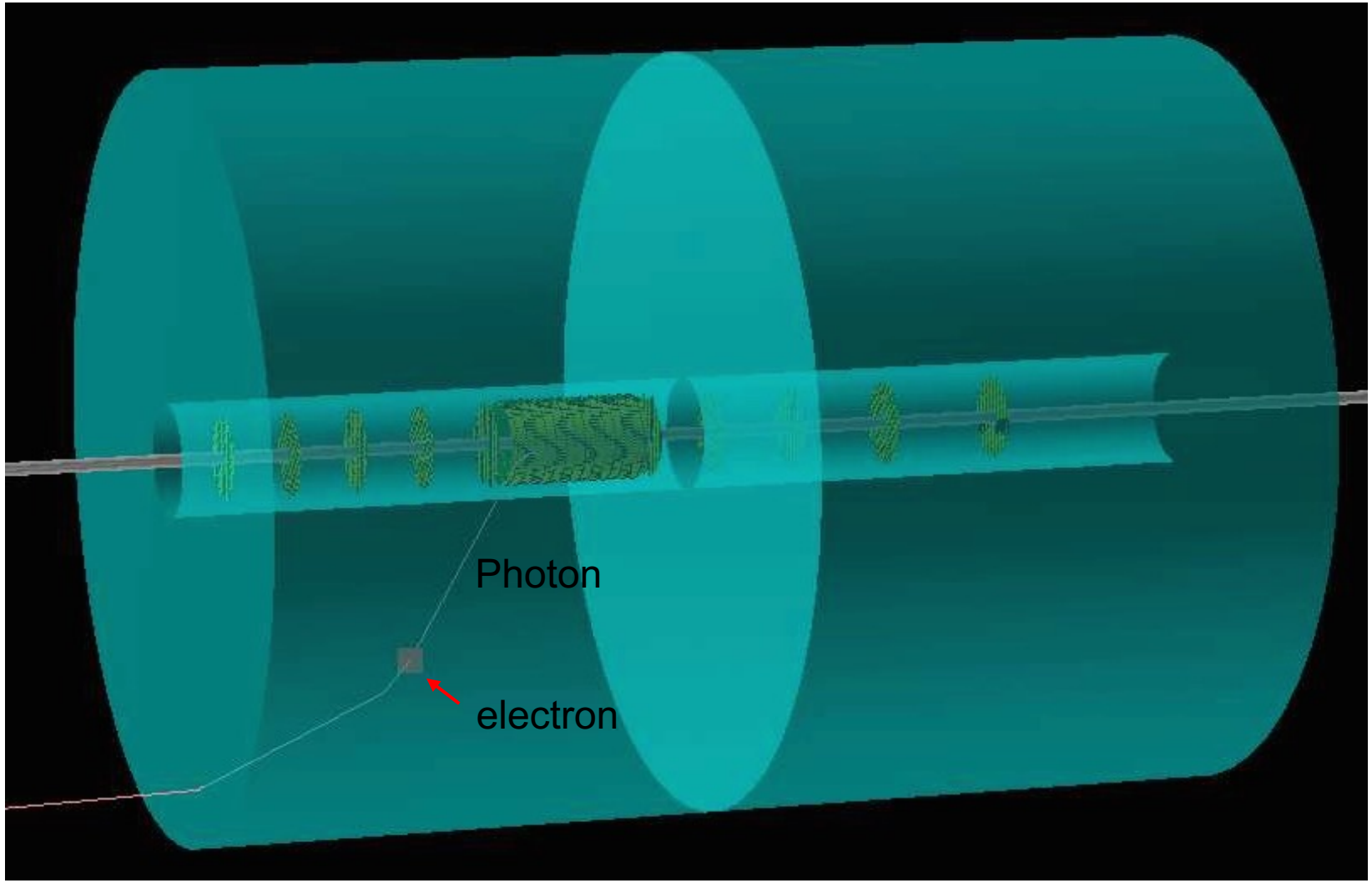
  CERN-W5013 (PHYS220/221):

  $$E_e = E_\gamma \frac{m_e}{m_e + E(1 - cos\theta)}$$

- Compton scattering generate 1 or 2 e- per photon (??)

  The interaction produces one electron

Event Display (Compton Scattering)



Summary

- Corrected the number of SR photons per event
- Beam pipe radius could be too small for these SR photon events
- 250k electrons generated inside the TPC

Print-friendly Section Break

Subtitle