Development of whole-body PET system with 3mm- resolution for 1M$

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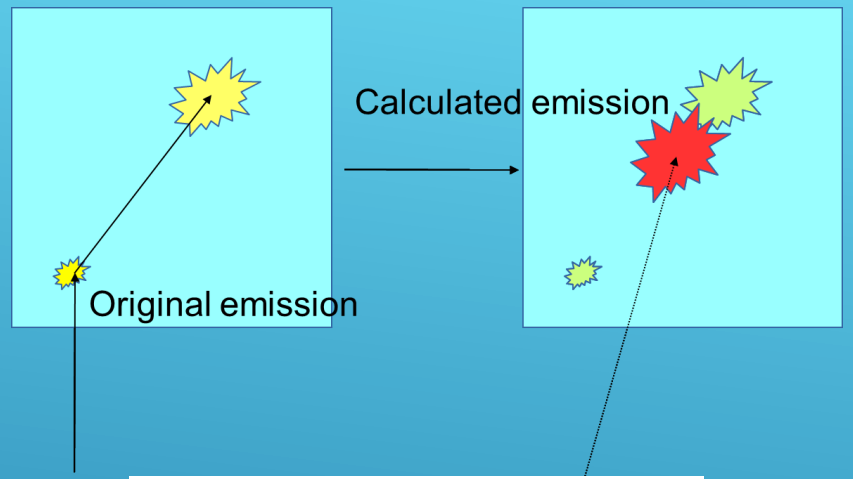
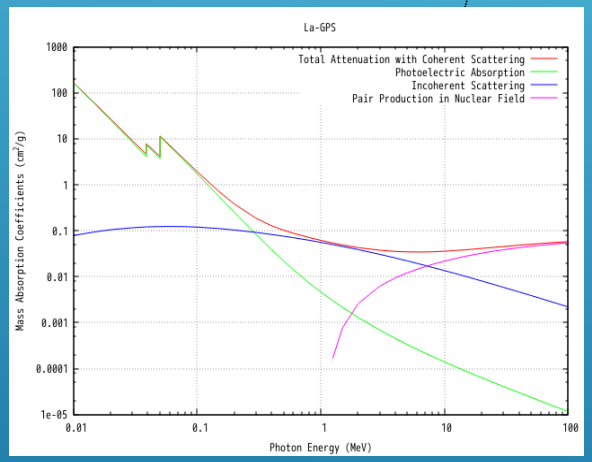
Introduction

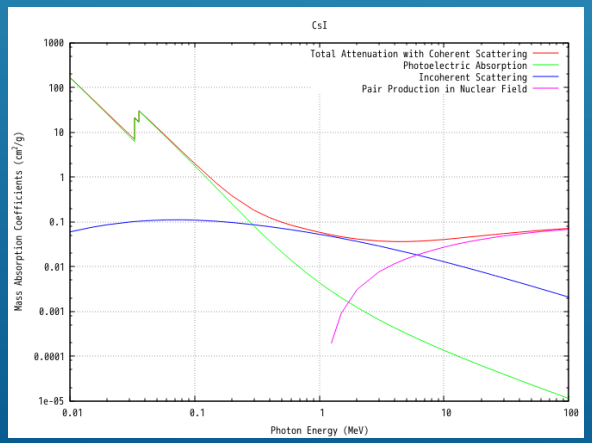
Existing PET systems make
- clear images in demonstration with cold phantom

however…
- unclear images in real diagnosis

What makes PETs' images unclear?







Existing PET

- Centroid of energy deposit method

→ plural emission is misconceived.

- Photon cross section in scintillator

→ Compton scattering occur 4 times as much as photoelectric absorption with 511 keV gamma-ray.

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Compton scattering in scintillator is critical for PET.

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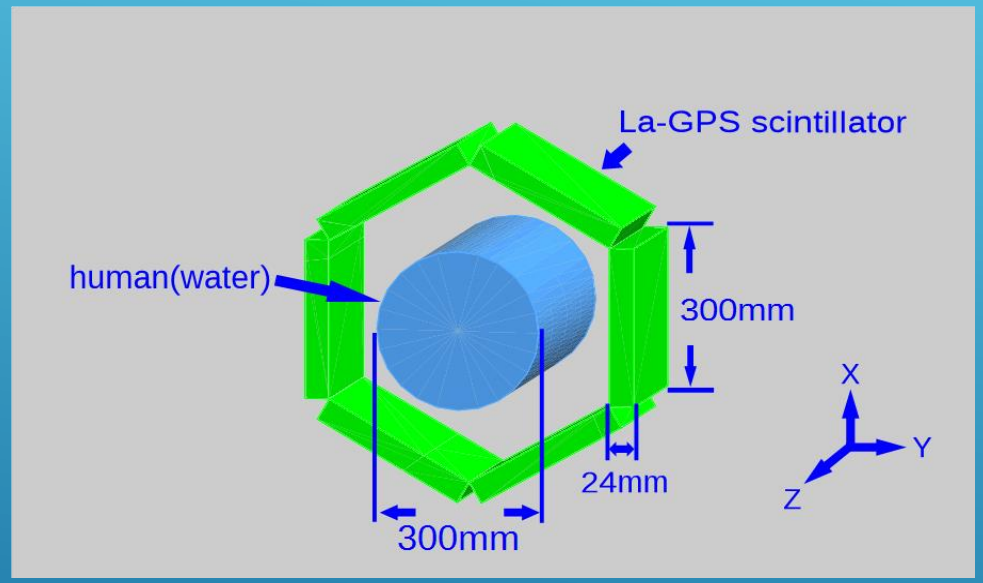
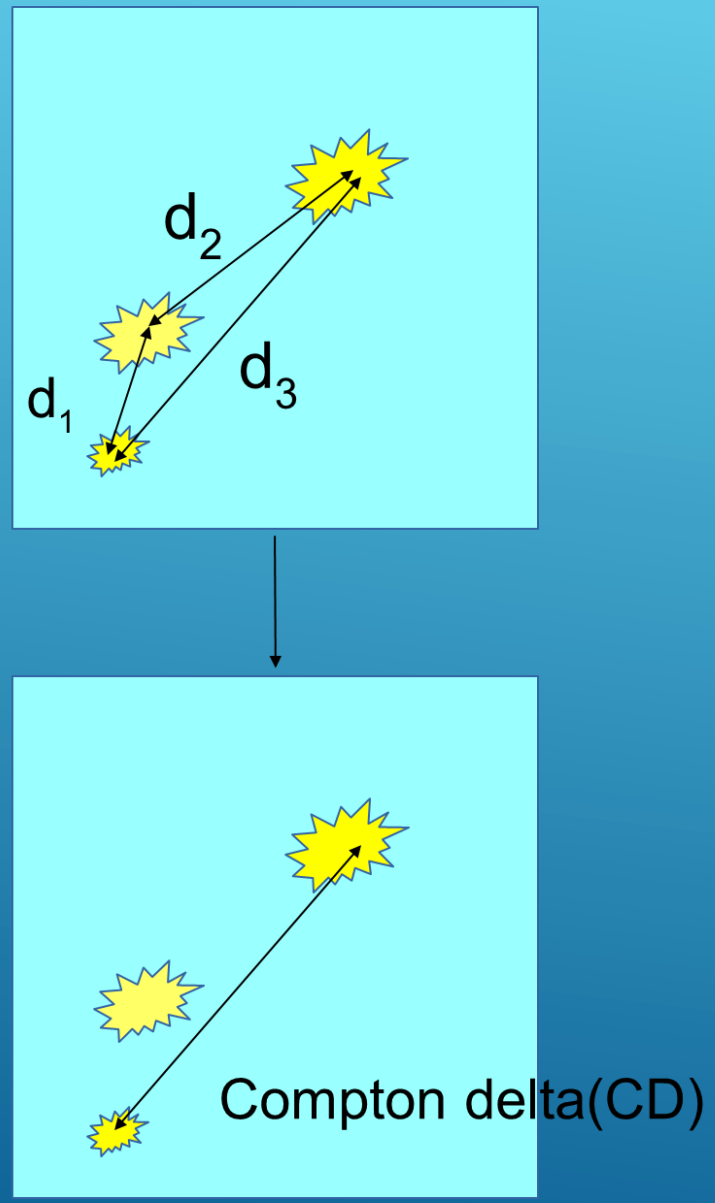
Rejecting them makes PET much better.

GEANT4 simulation



Simulation setting

- Radioactivity concentration
  2 MBq/L in normal tissue (background)
  10 MBq/L in cancer
  →3000 events / mm^3
  in normal tissue
  12000 events / mm^3
  in cancer
- Cancer size 2 by 2 by 2 mm^3
- Energy threshold 420 keV



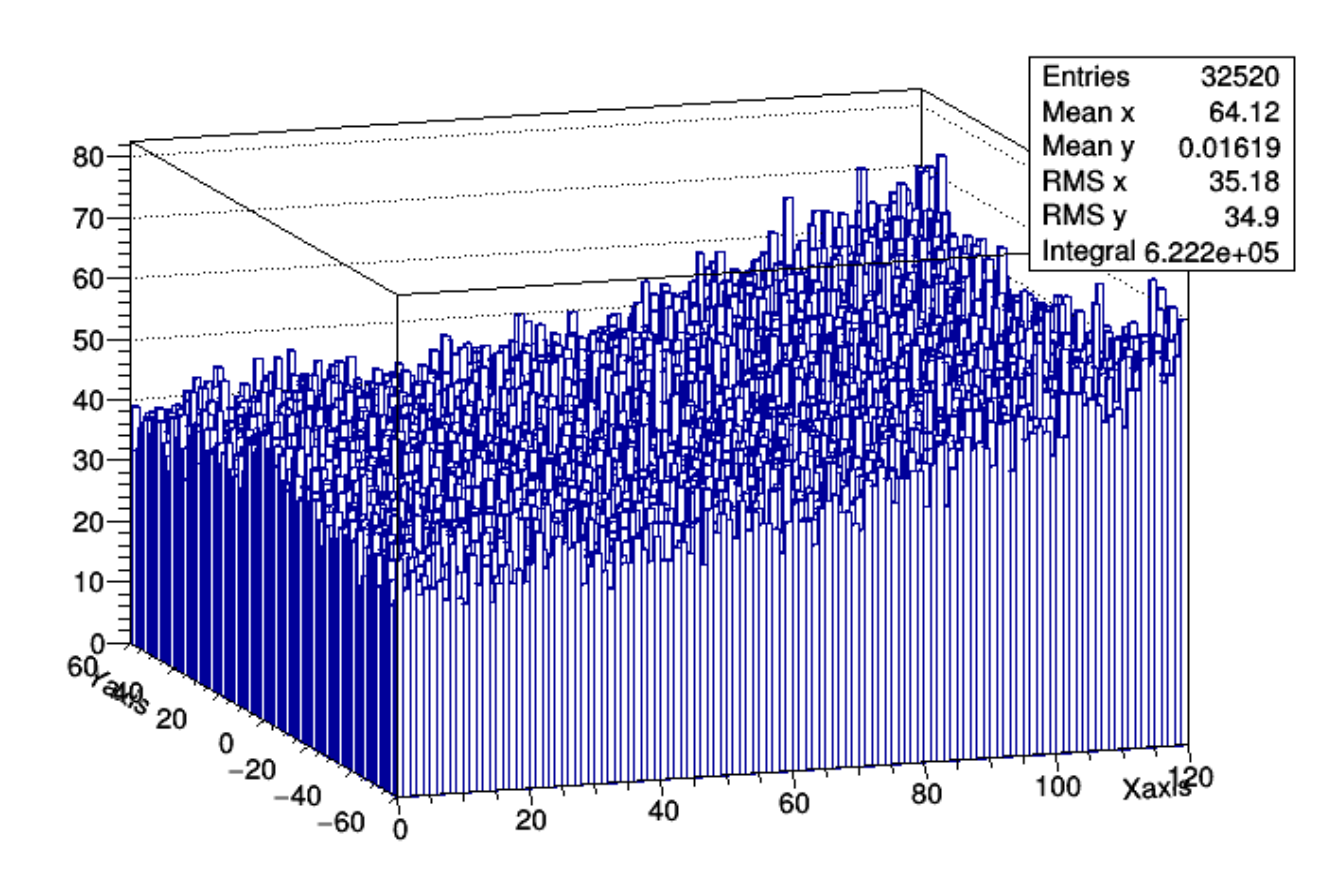
Compton Delta(CD)

a longest distance between any two emission points in a scintillator

(for example, d_3 is Compton Delta in left figure)

Simulation results

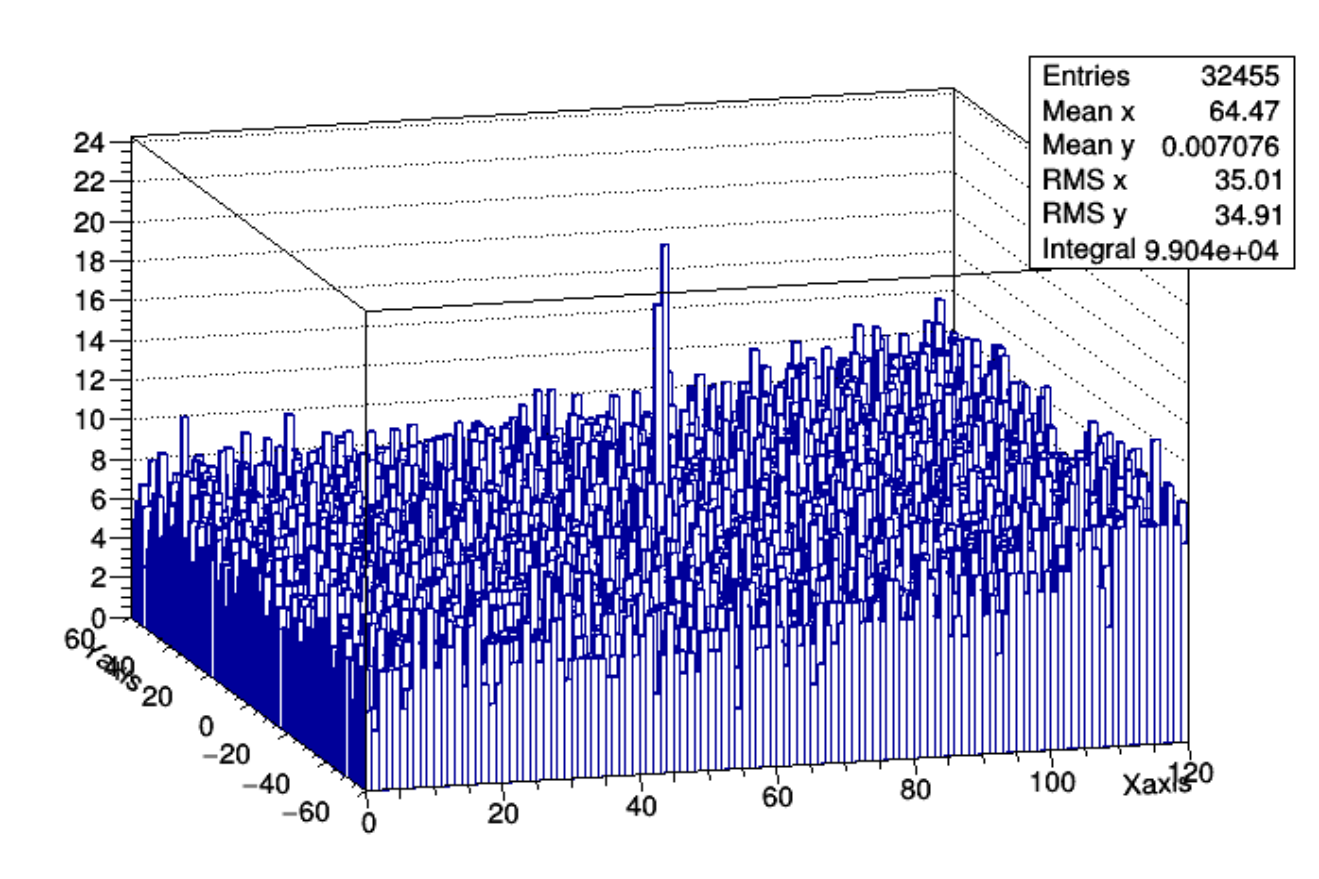
- Traditional system
  (including events whose CD is 10 mm or less)



Background(BG) level: 40
Cancer signal level: 10
statistical error σ of BG: 6.32.
Signal level is less than 3σ.
→Cancer is invisible.

Simulation results

- Scattering rejecting system
  (including events whose CD is 1 mm or less)

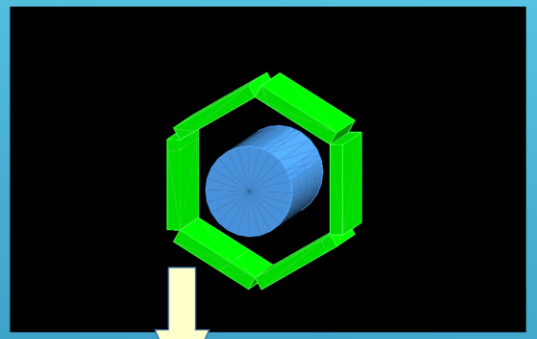


BG level: 7
Cancer signal level: 13
σ of BG: 2.65.
Signal level is more than 3σ.
→Cancer is visible.

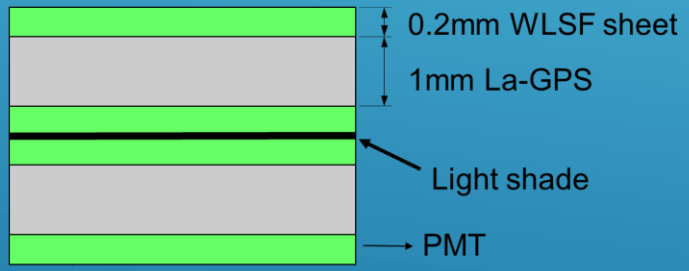
↓

Rejecting scattering makes images clear.

Our new system

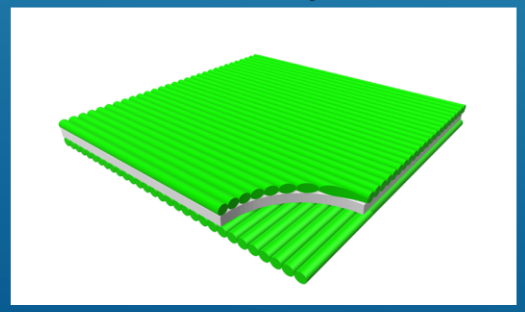


One of detectors



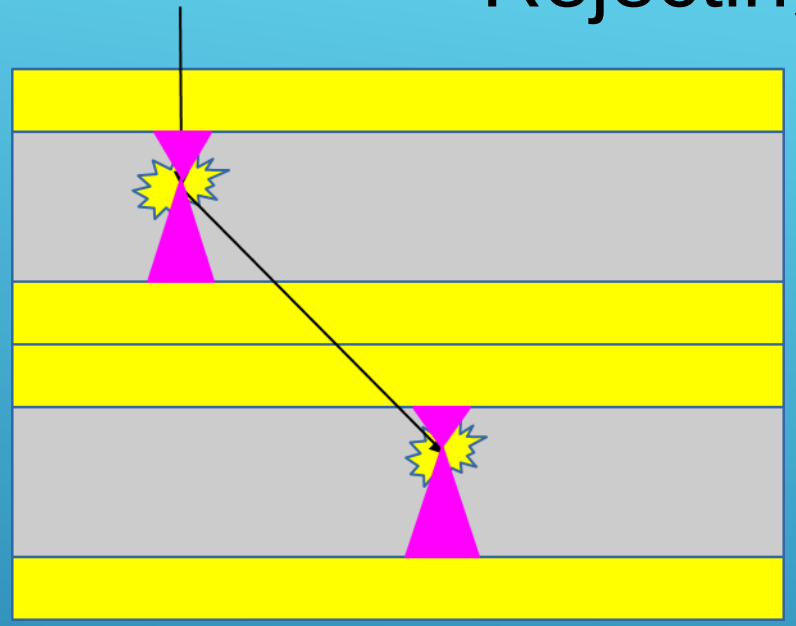
×24

One of layers



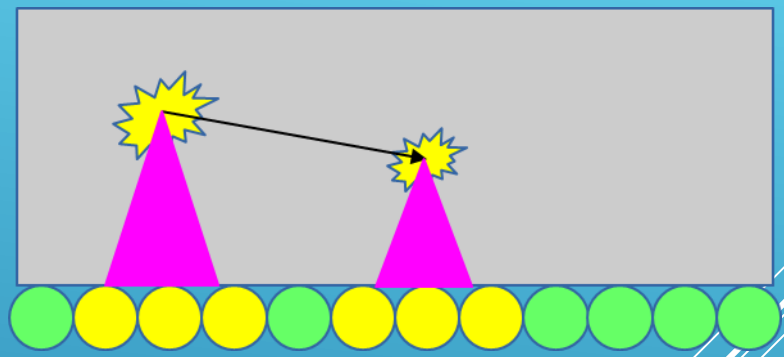
Rejecting method

①



If plural layers output signals, the event regarded as Compton scattering event.

②



If there are too many signals in a layer, the event regarded as Compton scattering event.

In addition, WLSFs & this scintillator are low-cost.

Conclusion

Considering the simulation, rejecting Compton scattering events makes PETs' images more clearly. It can be expected that this system identified 2 mm cancer and total price of PET become 1M$ or less.

Reference

[1]Berger M J; Hubbell J H; Seltzer S M; Chang J; Coursey J S; Sukumar R; Zucker D S;
Olsen K: NIST XCOM: Photon Cross Section Database http://physics.nist.gov/PhysRefData/Xcom/html/xcom1.html (retrived on the 8th of December 2016)

Thank you for listening!!