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CHIBA UNIVERSITY

Proposal of Gamma-ray Computed Tomography(CT)

It's the fluoroscope using gamma rays generated from electron positron pair annihilation with low exposed dose

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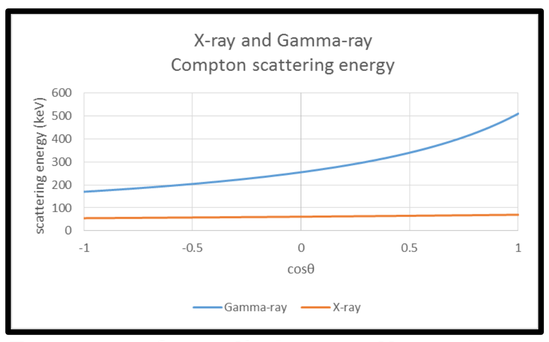
Abstract :We propose Gamma-ray CT which is enable to make 3D figure in body like a X-ray CT make. Its exposed dose is less than 1/10 or 1/100 of that of X-ray CT.

• Introduction

・Amount of exposed dose is about 20mSv by examination of X-ray CT.

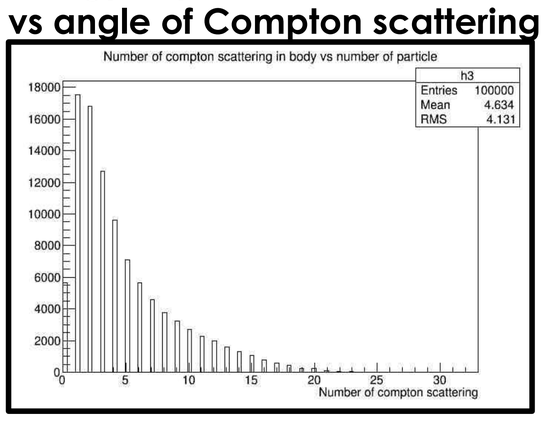
In Japan, If one X-ray CT examine three times a day, it is presumed that about 13,000 people is dead by cancer derived from examination of X-ray CT.



Energy of particle scattered vs angle of Compton scattering

・Two gamma rays which derived from electron positron pair annihilation have constant energy(511keV), and their gamma rays radiate to back to back.

・Angle of Compton scattering is defined by energy of particle.



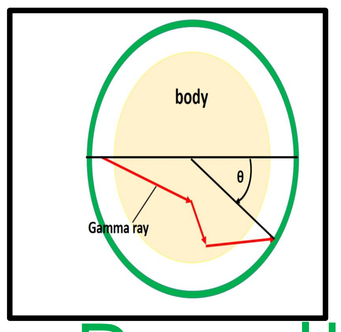
Number of Compton scattering In body vs number of particle

・The percentage of transmission of x-ray radiated to the body is less than 1%.

・That of gamma-ray is 6%. And the scattering angle of one time scattered gamma-ray is identified by its energy.

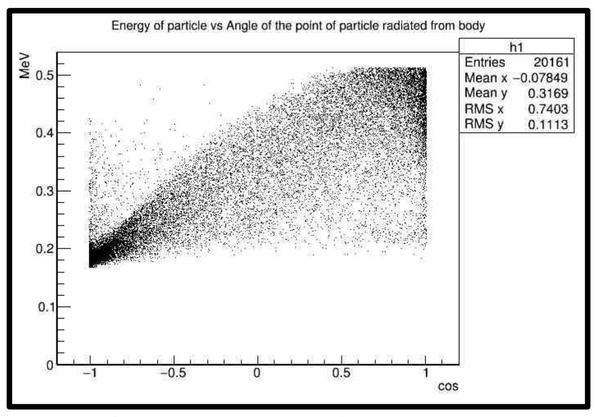
・So number of effective gamma-ray to make 3D figure is 20 times that of X-ray.

• Simulation1 (Geant4)

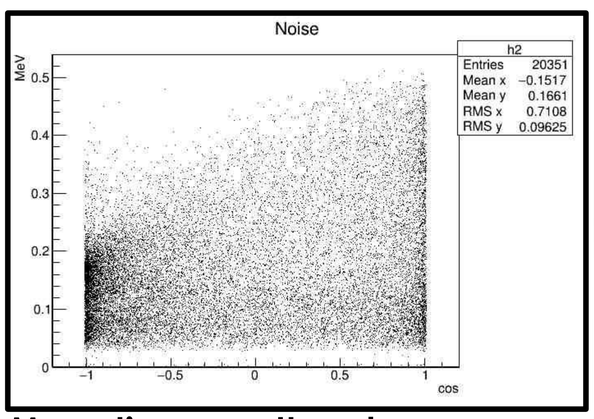


・It is measurement of the angle of particle Radiated from the body and its energy.

Result



One time scattered gamma-ray



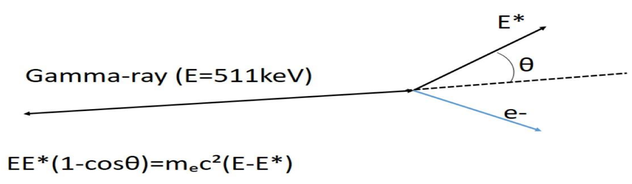
Many times scattered gamma-ray

・One time scattered gamma-rays concentrate in two areas .

・Many times scattered gamma-rays is uniform.

・By removing noises (many times scattered gamma-rays),the total exposure dose become low.

• Method



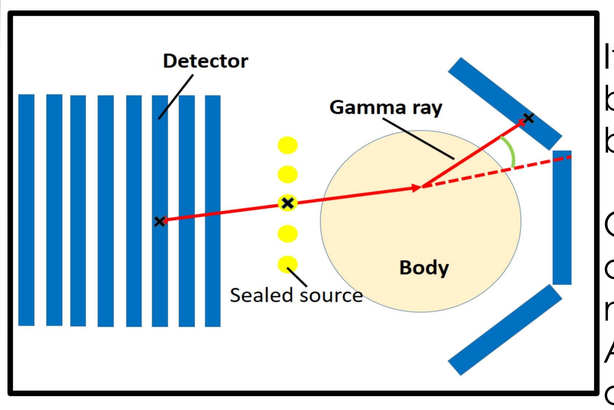
・The angle of scattering is Identified by measuring energy(E*) .

・The point of scattering is identified by the angle and momentum direction of gamma-ray.

• System overview

We propose two methods to make 3D perspective image.

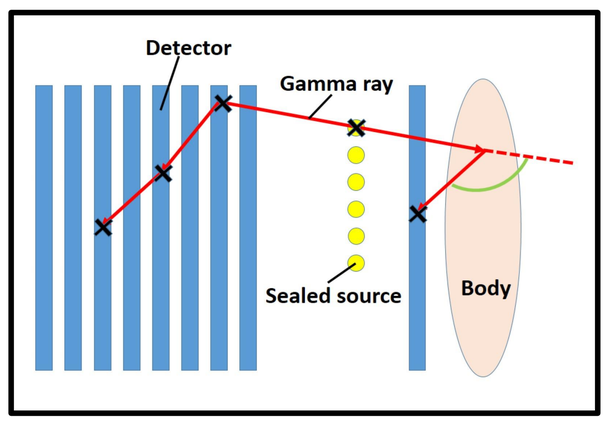
・Transmission type



Its type measures particles permeating the body and particles scattered once in the body.

Only particles radiated at an angle of 20 degrees to 40 degrees from the body is measured.
And particles with energy below 0.4MeV are removed.

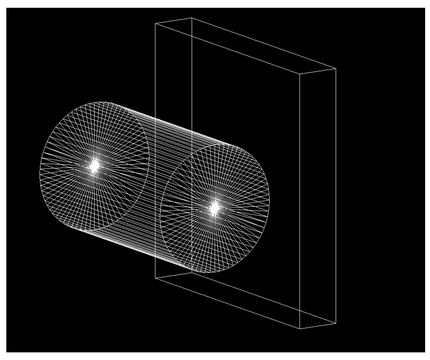
・Reflective type



Its type measures particles reflected on the body.

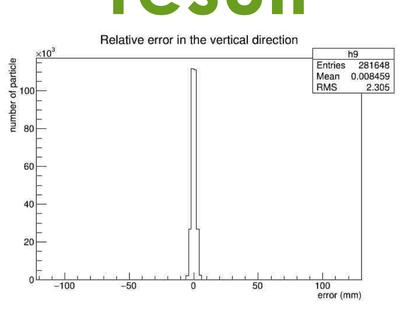
Only particles radiated at an angle above 120 degrees from the body is measured. And particles with energy below 0.15MeV are removed.

• simulation2 (geant4)

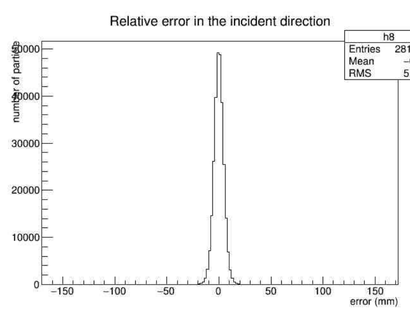


・This simulation is for Transmission type.
・Measuring scattering position.
・Shot 511keV gamma-ray to body and detector (Z direction).
・Detector 's energy resolution is 1.5%.
・Its position resolution is 1mm.

result



・ error (X Y direction) σ = 2.305mm



・ error (Z direction) σ = 5.144mm

• Conclusion

・Relative error of this system is simulated as 2.305 mm in vertical direction and 5.144mm in incident direction.

・We would like to evaluate the error in the future.

• Acknowledgements

・We are grateful to AMED (Japan Agency for Medical Research and Development) for accepting this project.

Contact us freely