a-Si EPID modeling in GATE for Monte Carlo investigation on the dosimetry and optical properties of $Gd_2O_2S:Tb$ and $Lu_2SiO_5:Ce$ scintillators

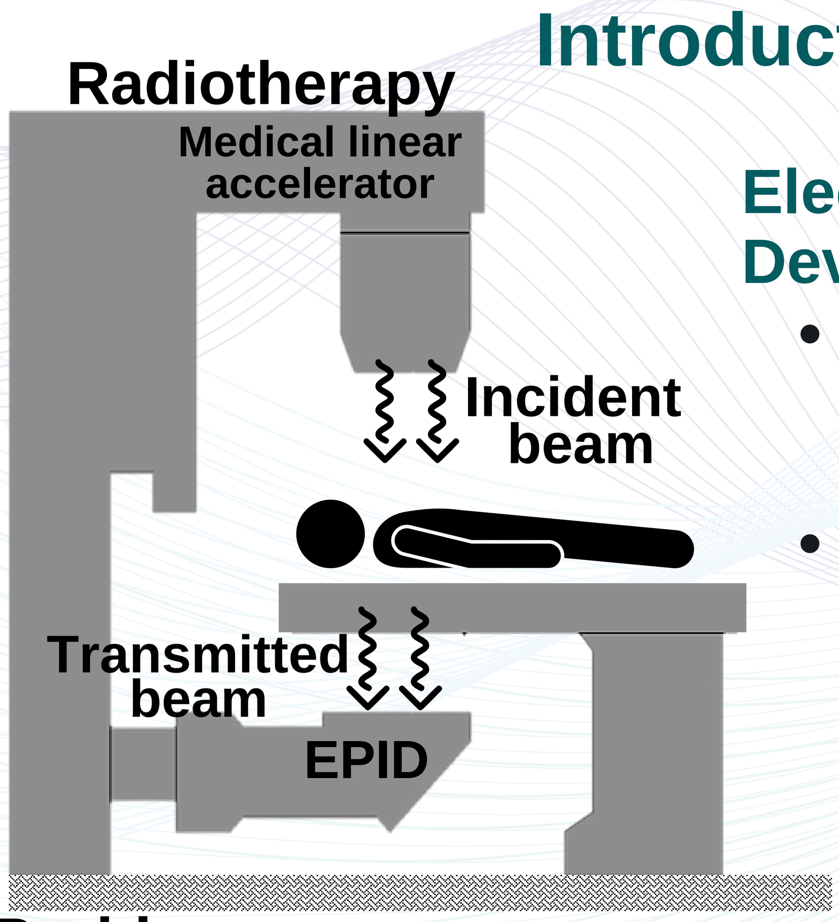
Dainna Recel S. Pamisa* and Catherine Therese J. Quiñones

Department of Physics, Mindanao State University – Iligan Institute of Technology

Mindanao Radiation Physics Center, Premier Research Institute of Science and Mathematics, Mindanao State University – Iligan Institute of Technology

A. Bonifacio Avenue, Tibanga, 9200 Iligan City, Philippines

Introduction



Electonic Portal Imaging Device (EPID)

- Produces patient image during the treatment for set-up verfication
- Has potential for dosimetry applications:
  1. patient dose
  2. portal dose

Problem:

- EPID components are the non-water equivalent hence require a lot of corrections to calculate water-equivalent dose.
- Needs improvement in image quality

EPID Scintillator

terbium-doped gadolinium oxysulfide phosphor

$Gd_2O_2S:Tb$

PET Scintillator

cerium-doped lutetium oxyorthosilicate

$Lu_2SiO_5:Ce$

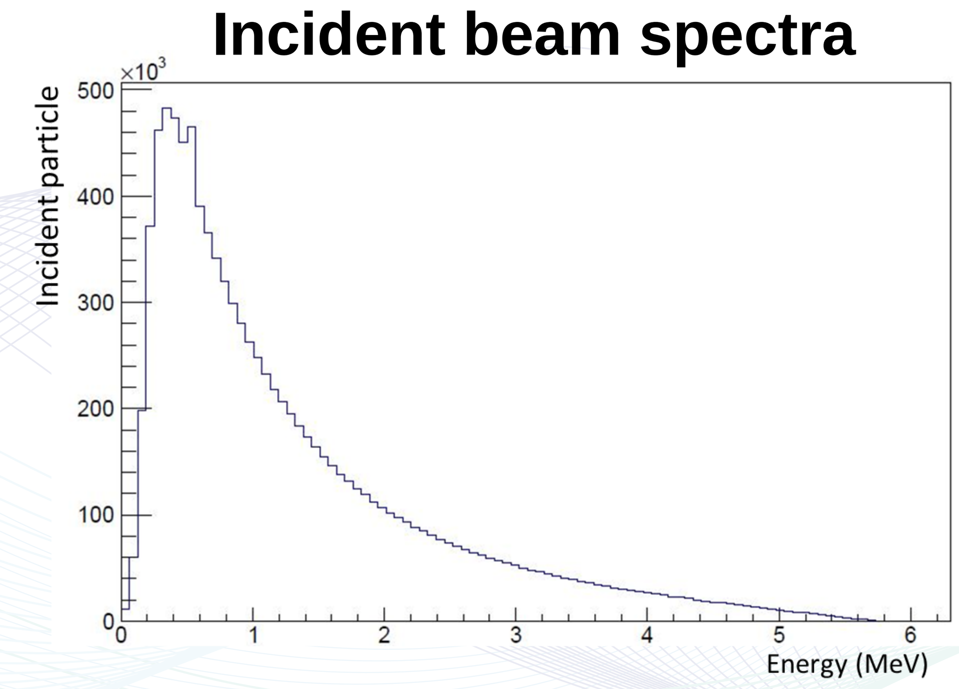
Objective of the study

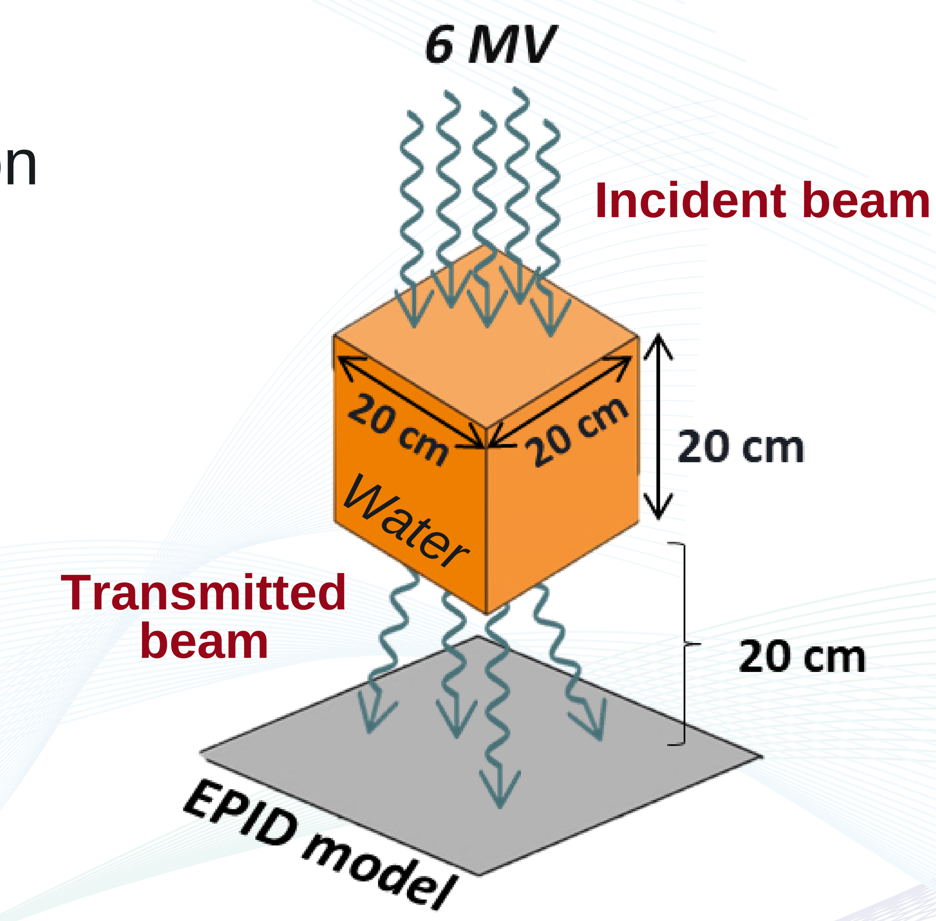
- To implement an EPID model in GATE and use this model to investigate the scattering of the transmitted fluence within the EPID components.
- To compare the dosimetry and optical properties of different scintillating materials.

Materials and methods

Monte Carlo simulations using Geant4 Application for Tomographic Emmission (GATE) version 9.0.

Incident beam spectra





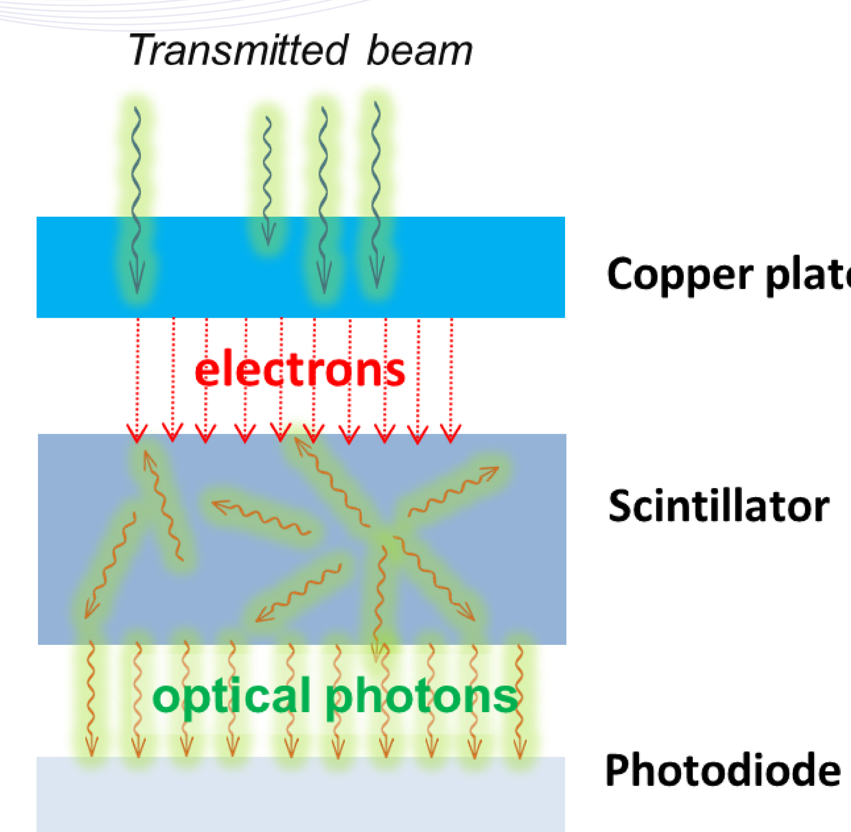
Simulation set-up

Physics list:

- Standards electromagnetic and optical Photon processes

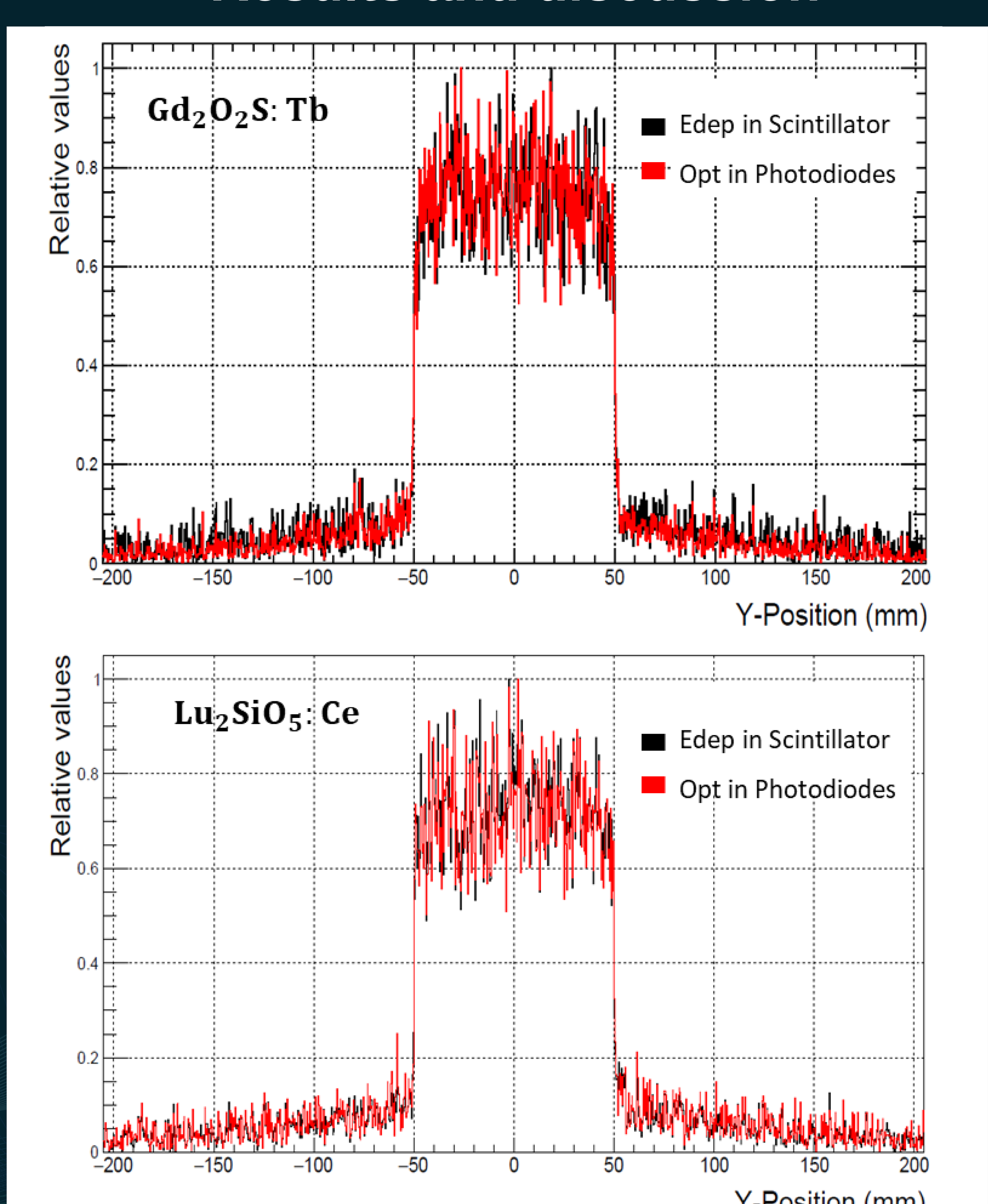
Optical properties and parameters:

EPID component	Properties (parameters)	Value
Scintillator	Refractive index (n_{Phos})	2.4
	Absorption length (l_{Phos})	4.0 cm
	Scattering length (μ_{Phos})	17 μm
	Scintillation yield (SY)	60000/MeV
	Scintillation time decay constant (t)	1 ms
	Emission Spectrum ($\lambda(E)$)	380 nm-620 nm
Photodiode	Refractive index (n_{Phot})	0.46 -5.187
	Absorption length (l_{Phos})	6.29 nm-13300 nm

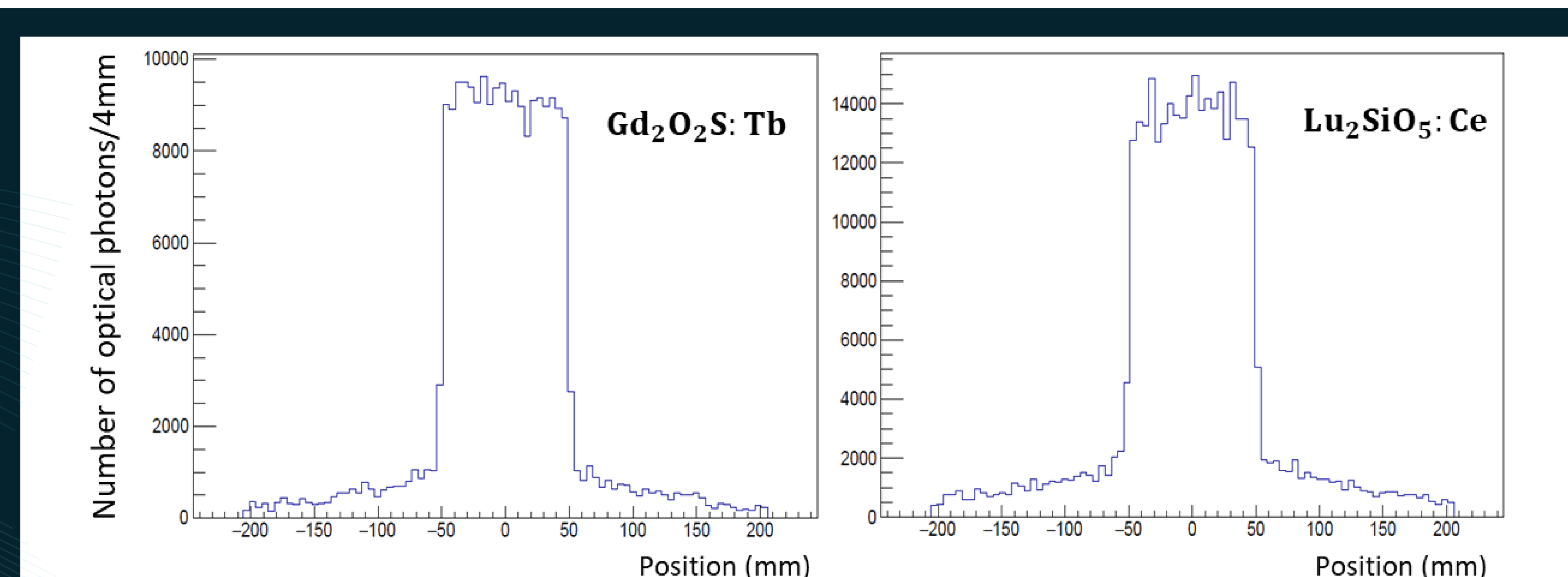


Major layers of the EPID model

Results and discussion



Energy deposited at the scintillator is directly proportional to the number of optical photons detected in the photodiode layer regardless the composition of the scintillating material.



The number of optical photons, however, is significantly higher when using the $Lu_2SiO_5:Ce$ scintillator suggesting a better image signal.

Conclusion

- The higher amount of optical when using $Lu_2SiO_5:Ce$ suggests better image signal compared to the conventional EPID scintillator.
- Measurements at the scintillator and photodiode layers contain significant amount of secondary particles created from other EPID components. The most contribution belongs to the copper plate, which serves as the build-up material.
- The copper plate attenuates low-energy photons and secondary charged particles, interactions of the transmitted fluence to this volume resulted in Compton electrons and electron-positron pairs and, consequently, Bremsstrahlung and annihilation photons.

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*dainna.pamisa@g.msuiit.edu.ph