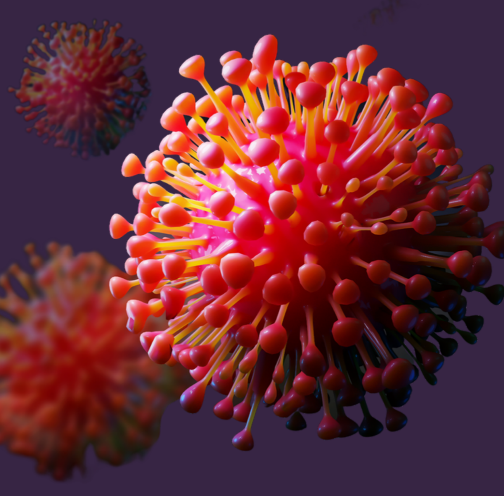

Monte Carlo study on the annihilation photons transmitted from a water phantom irradiated with carbon-12 at varying energies for applications in Positron Emission Tomography (PET)

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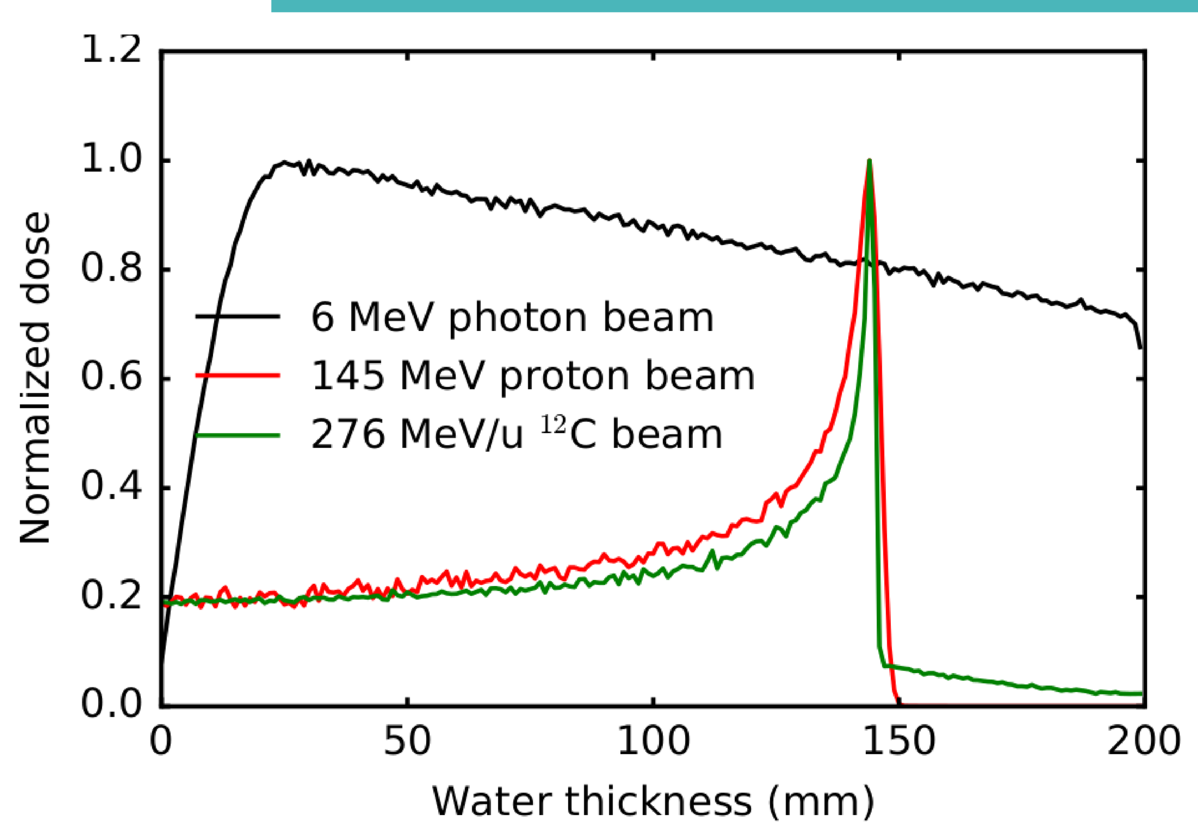
INTRODUCTION

Radiotherapy remains to be an important modality in cancer treatment. It utilizes ionizing radiation through high-speed x-rays, gamma rays, electron beams, proton beams, and other heavy-ion beams such as carbon-12, which works by forming ions and depositing energy in the cells of tissues it traverses. This deposited energy causes breaks in the DNA of cancerous cells, inhibiting their ability to further divide and eventually causing them to die.

The goal of radiotherapy is to maximize the radiation dose delivered to the cancer cells while minimizing the damage done to the healthy cells.

ADVANTAGES OF USING CARBON IONS



- Superior depth-dose profile
- High LET
- High RBE
- Sharper Bragg peak
- Better Dose Conformation

However, errors during and after irradiation could arise, resulting to a shift in the Bragg peak.

OBJECTIVE OF THE STUDY:

To determine if there is correlation between the number of annihilation photons detected by a PET detector and the location of the Bragg peak inside the water phantom.

MATERIALS & METHODS

Monte Carlo simulations using Geant4 Application for Tomographic Emissions (GATE) software

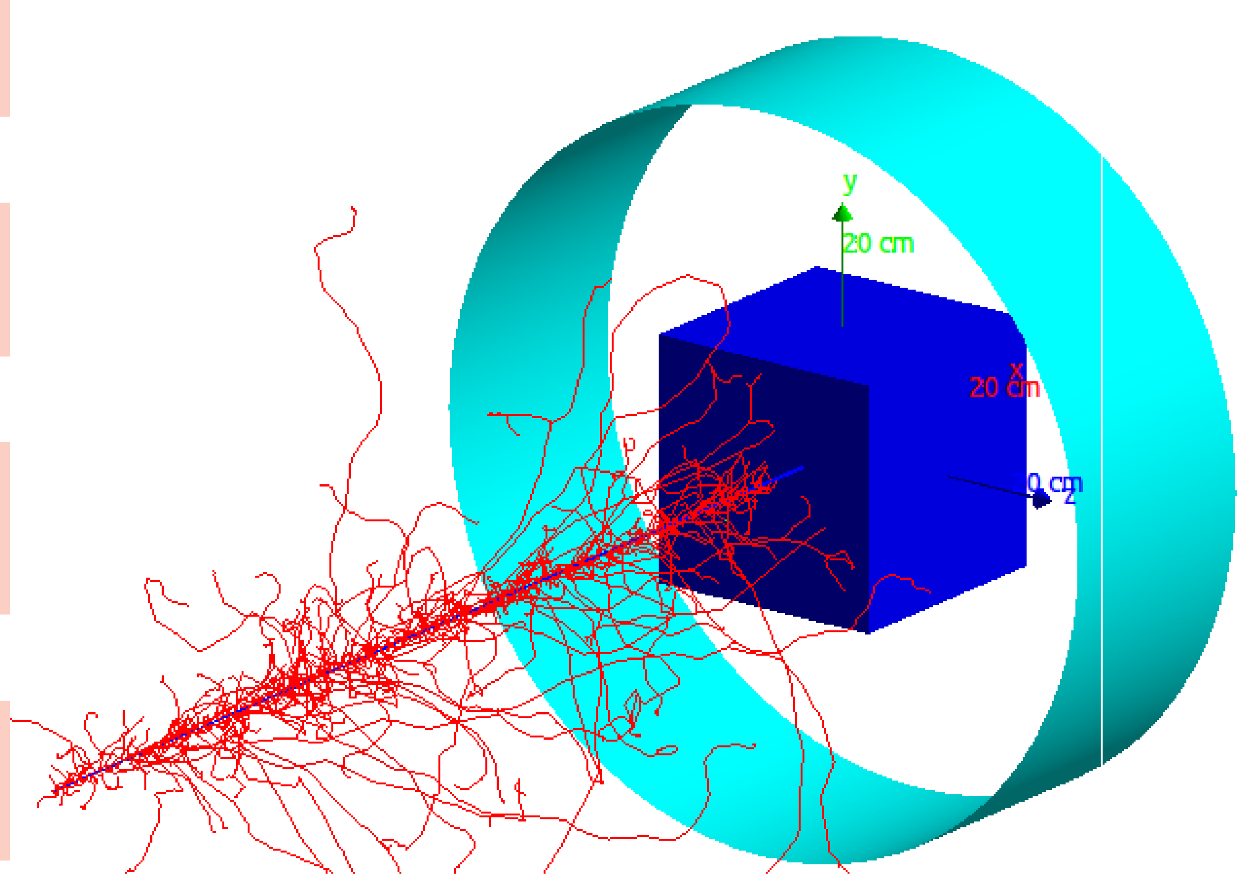
WORLD VOLUME
- air
- 2 m x 2 m x 2 m

PHANTOM
- water
- 20 cm x 20 cm x 20 cm

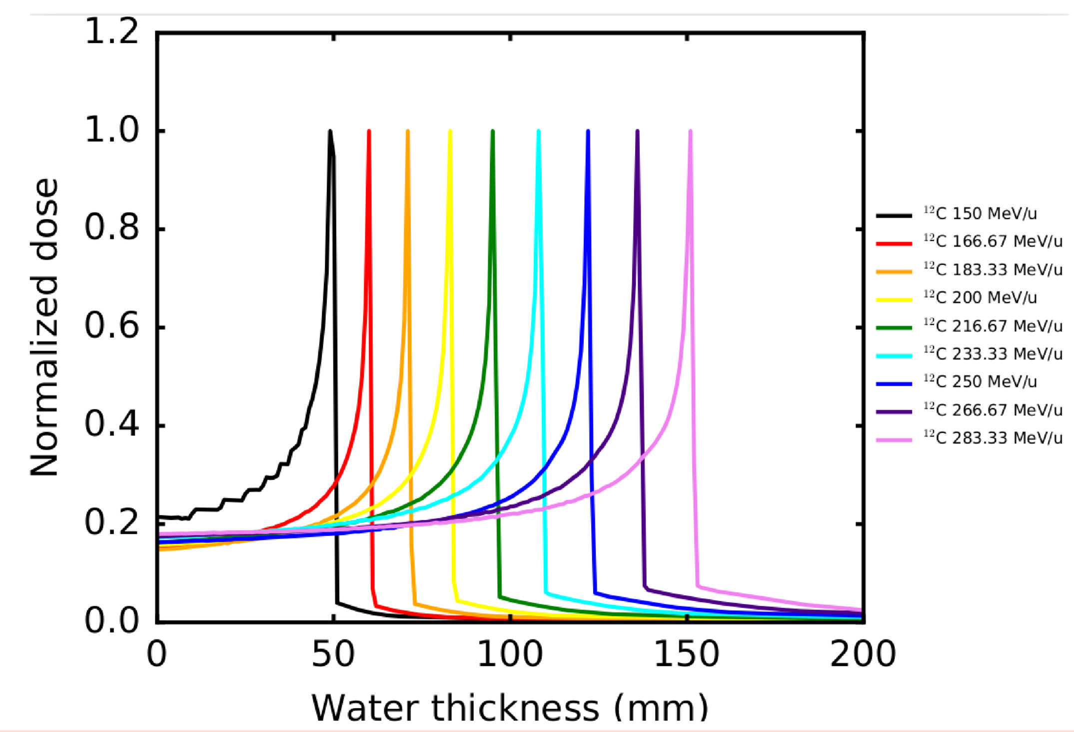
PET DETECTOR
- air
- radius: 30 cm

RADIATION SOURCE
- monoenergetic carbon-12 beam

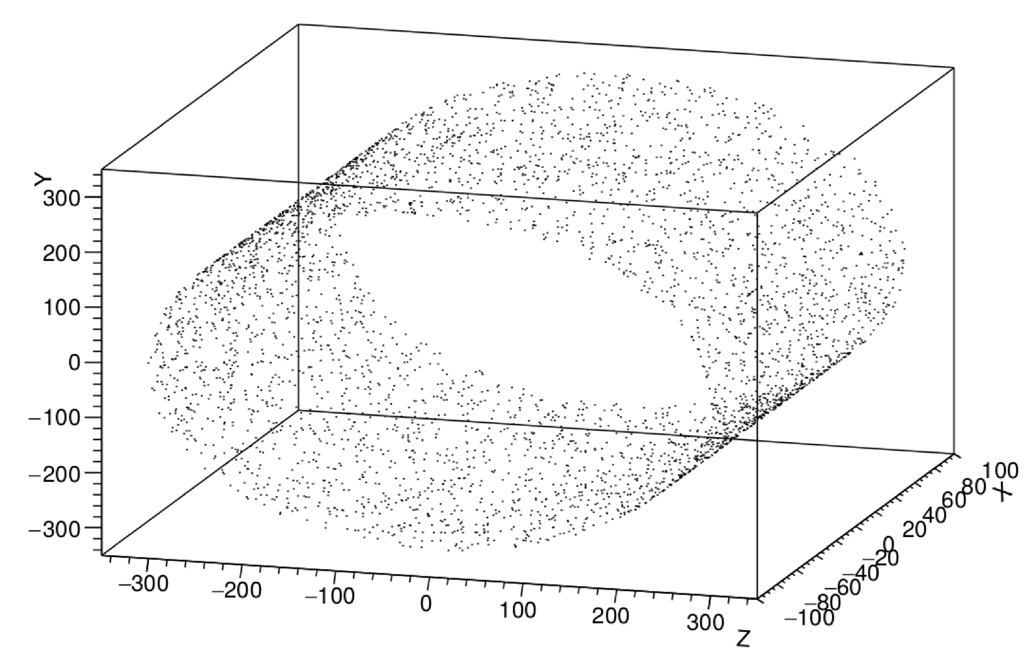
PHYSICS LIST
- QGSP-BIC



RESULTS

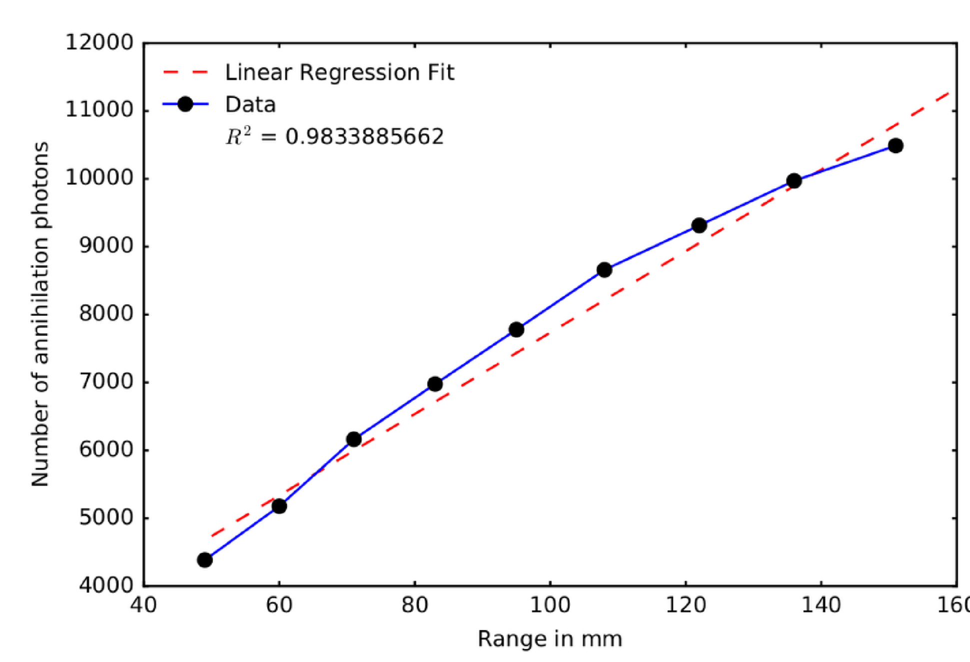


The incident energy of the carbon ion beam is varied uniformly from 150 MeV/u to 283.33 MeV/u. As the incident energy of the beam increases, the Bragg peak is found at a deeper location within the medium.



The distribution of the annihilation photons as detected by the PET detector following a 150 MeV/u carbon ion irradiation of the water phantom.

The numbers of annihilation photons detected were plotted versus the locations of the Bragg peak corresponding to the incident energies of the carbon-12 beam. A linear model of the data is shown, having an R-squared value of almost 1.



CONCLUSION

The number of the annihilation photons detected by a PET detector has a positive and linear correlation with the location of the Bragg peak. This suggests that the number of annihilation photons transmitted following carbon ion radiotherapy is dependent on the location of the Bragg peak.

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