VALIDATION OF THE MONTE CARLO MODEL FOR 6 MV AND 15 MV PHOTON BEAMS OF VARIAN CLINAC IX LINAC

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BACKGROUND

- Over decades, Monte Carlo (MC) method has been acceptable techniques for calculating dose distribution in radiotherapy.
- It is an adequate tool for modeling and simulating radiation transport of particles through several media.
- Important step to using MC for clinical dose validation is modeling the geometry of a linear accelerator head (LINAC)
- Several LINACs are available in the market for clinical use. One of them is the Varian CLINAC IX https://myvarian.com, which is utilized for intensity Modulated radiotherapy, Stereotactic radiotherapy and stereotactic radio-surgery delivery.
- Validating this CLINAC gives us the opportunity to use the accurate model for further dosimetric studies even in a complicated environment where physical measurement is unattainable.

OBJECTIVES

The purpose of this study is to validate the Monte Carlo model of the Varian Clinac IX linear accelerator (Linac).

METHODS AND MATERIALS

- Experimental measurements were performed in a computer controlled PTW-MP3 water phantom and semiflex ionization chamber.
- The central axis percentage depth dose (PDD) and dose profile for 6 MV and 15 MV photon beams were measured using Varian Clinac IX linear accelerator and analyzed using PTW MEPHYSTO software.
- Electron-Gamma-Shower (EGSnrc) MC simulation was done using BEAMnrc and DOSXYZnrc running in Windows.

EGSnrc MC Code has two steps:

- In the first step, the Linac head was modelled using the BEAMnrc package and simulated with 3 x 3 cm^2, 10 x 10 cm^2 and 15 x 15 cm^2 for 6 MV and 15 MV photons beams based on the manufacturer's specification to create a phase space file.

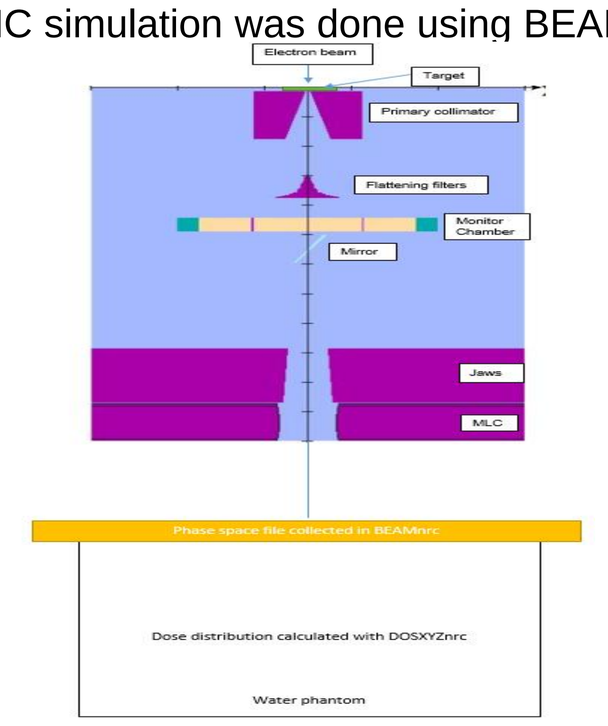

Figure 1: Schematic sketch of the accelerator head, phase space files and water phantom

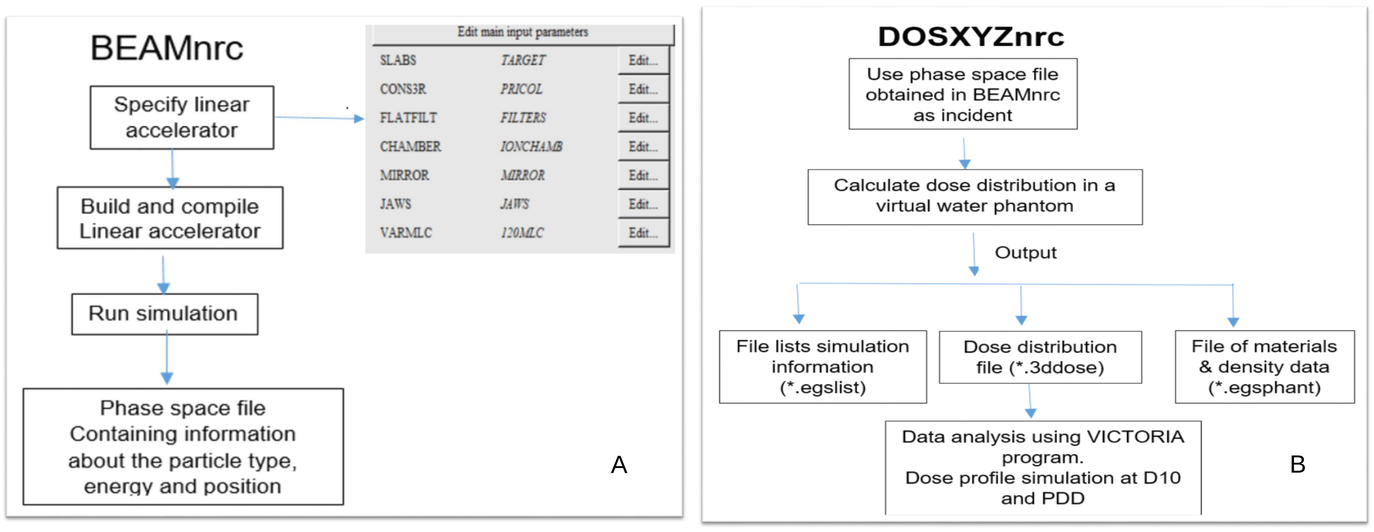

Figure 2: (A) A flow chat of the first step of Simulation using the BEAMnrc. **(B)** A flow chat of the second step of simulation using DOSXYZnrc.

- Second step involves the calculation of the energy deposited within water phantom to get the dose distribution.
- The EGSnrc dose distributions were compared with the experimental measurements using a gamma analyses, employing a 2%/2mm distance-to agreement criterion.

RESULTS

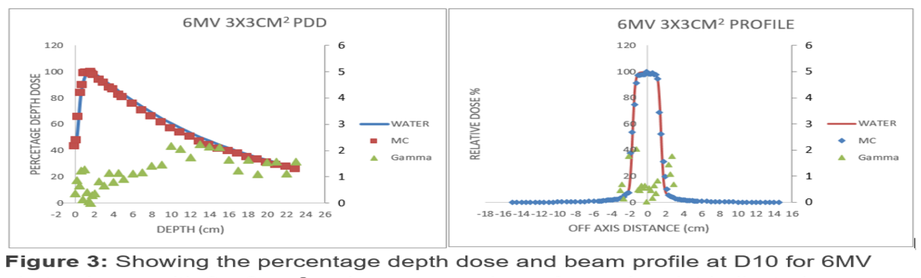

Figure 3: Showing the percentage depth dose and beam profile at D10 for 6MV photon beam with 3 x 3 cm^2 and gamma analyses for each point indicated.

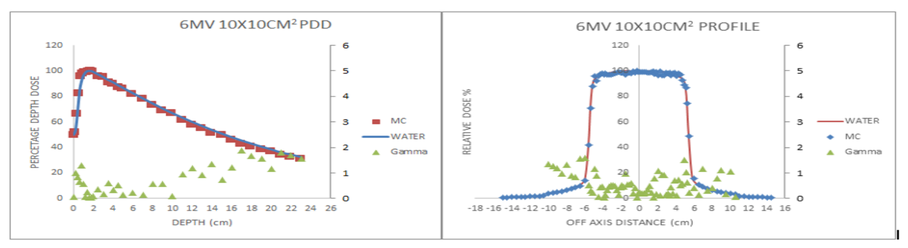

Figure 4: Showing the percentage depth dose and beam profile at D10 for 6MV photon beam with 10 x 10 cm^2 and gamma analyses for each point indicated.

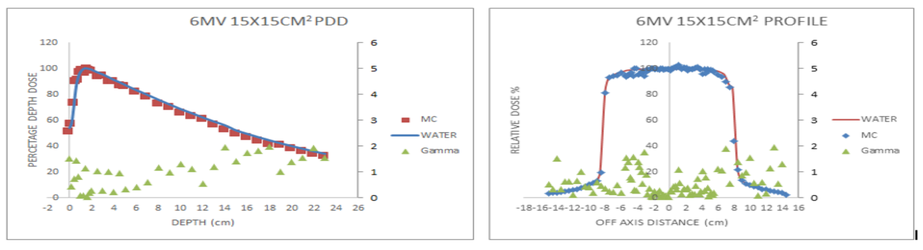

Figure 5: Showing the percentage depth dose and beam profile at D10 for 6MV photon beam with 15 x 15 cm^2 and gamma analyses for each point indicated.

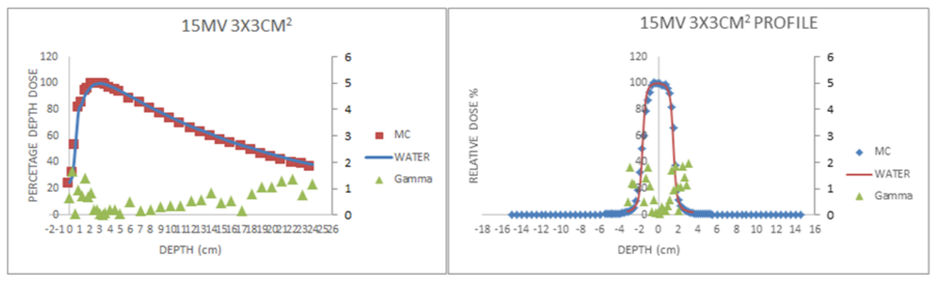

Figure 6: Showing the percentage depth dose and beam profile at D10 for 15MV photon beam with 3 x 3 cm^2 and gamma analyses for each point indicated.

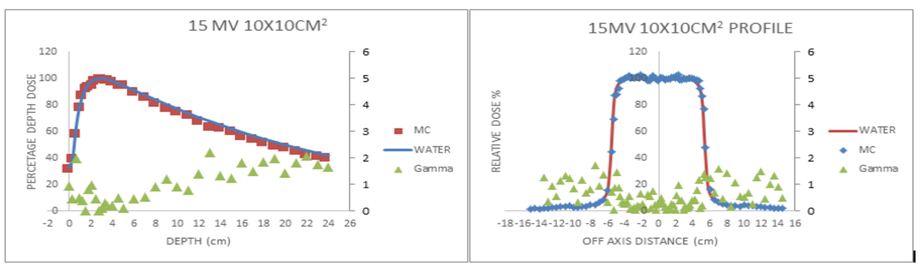

Figure 7: Showing the percentage depth dose and beam profile at D10 for 15 MV photon beam at10 x 10 cm^2 and gamma analyses for each point indicated.

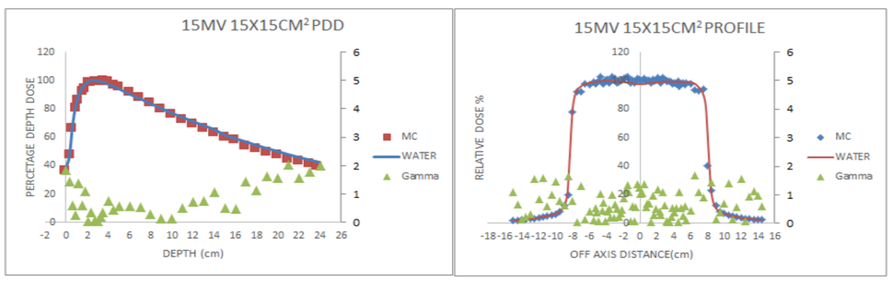

Figure 8: Showing the percentage depth dose and beam profile at D10 for 15MV photon beam with 15 x 15 cm^2 gamma analyses for each point indicated.

DISCUSSION AND CONCLUSION

- The commissioning/experimental data was within the limits set by the manufacturer.
- The associated gamma analysis for each measured and simulated curve is indicated on the graph.
- The maximum different between the EGSnrc calculation and experimental measurements PDD is 1.8% located at the depth of 22 cm with 10 x10 cm^2 for 6MV and 1.9 % at a depth of 22 cm with 15 X15 cm^2 for 15 MV photon beam.
- The mean gamma analysis for profiles was found to be 1% and 1.1% for 15 MV and 6 MV photon beam respectively. The PDDs mean gamma was found to be <1,1 % for both 6MV and 15 MV.
- The EGSnrc Monte Carlo calculated dose distribution agreed well with experimental measurements within 2 % with 3 x 3 cm^2, 10 x 10 cm^2 and 15 x 15cm^2 for 6 MV and 15 MV photons beams for both PDD and profiles.
- This model shows the potential to be used for further dosimetric studies

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