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EASTERN TIME [GMT-4]

Design of An Electron Compensator for Total Skin Electron Therapy with a Single Gantry Pitch Angle

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INTRODUCTION

Classical techniques require two gantry pitch angles to compose a total skin electron therapy (TSET) treatment.[1] Our goal is to reduce the treatment time by using one gantry angle. Monte Carlo (MC) simulations were used to design an electron compensator mounted in the accessory slot of a linac to generate a homogeneous dose distribution.

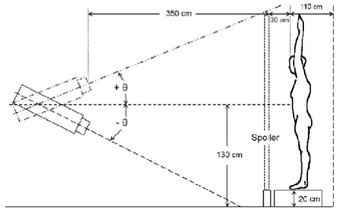


Figure 1. The positions of gantry used to generate a dual field in conventional TSET.

METHODS

- As shown in Figure 2, a previously-validated MC model of an electron accelerator was further validated for extended source-to-surface distances (SSD).[2]
- The gantry angle and the collimating jaws were set to 90° and 40x40 cm², respectively.
- The secondary scattering foil was removed to reduce bremsstrahlung production.
- An electron compensator was modeled in the accessory slot, and was composed of several layers of aluminum foils with different dimensions.
- A water phantom was modeled at 300 cm SSD to mimic a patient treatment. Profiles were measured at 0.5 cm depth.
- The treatment head was simulated with 9 MeV electrons and profiles and depth dose curves were calculated in water.
- Thicknesses of aluminum foils and step sizes were modified to achieve an optimal dose distribution.

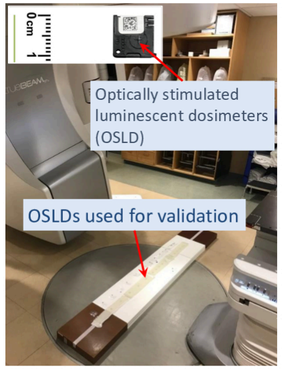


Figure 2. The validation of the MC model for extended SSDs. The setup for profile measurement (without the aluminum compensator) at 224 cm SSD using OSLDs. The gantry is pitched to 15° angle.

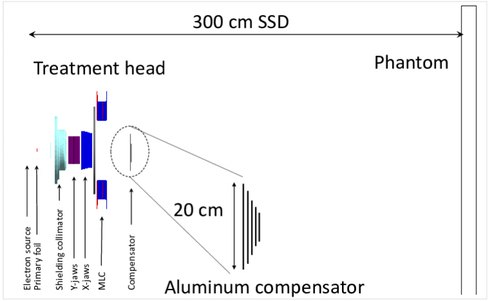


Figure 3. The MC model used in this study. The treatment head without the secondary scattering foil, aluminum compensator, and the phantom at 300 cm SSD are illustrated. The electron compensator is made of several layers of aluminum foils of different dimensions. The gantry is pitched to 90° angle.

RESULTS

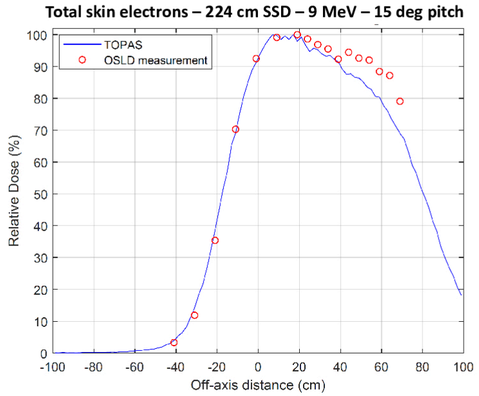
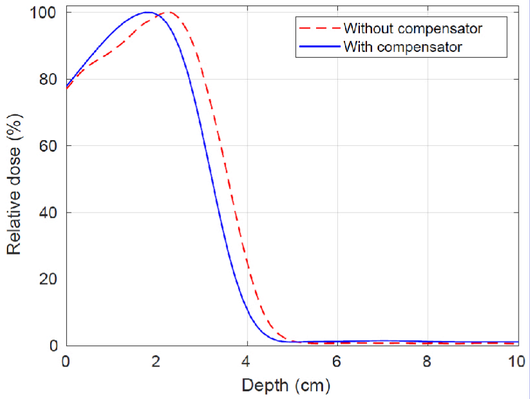


Figure 4. The comparison between the MC calculations and the OSLD measurements (without the aluminum compensator), where most of the calculations are within 3% of the measurement.

Figure 5. The depth dose curves along the central axis for two cases, with and without the aluminum compensator. With the compensator, the depth dose curve shifted ~0.5cm towards the surface. The bremsstrahlung background was on the order of ~1.2%. The removal of the secondary scattering foil reduced the bremsstrahlung background by ~0.2%.



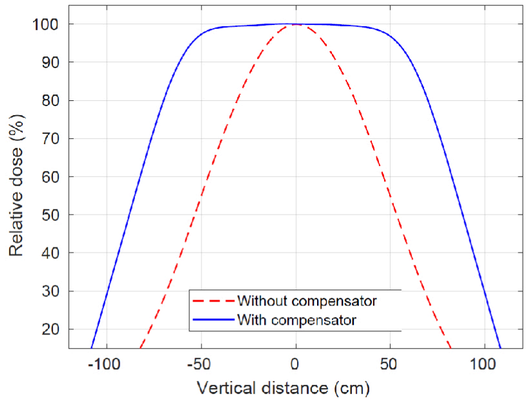


Figure 6. Profiles along the vertical axis for two cases, with and without the aluminum compensator. Using the aluminum compensator resulted in a homogeneous dose distribution across the lateral profile, with a maximum 10% dose variation along 120 cm vertical direction.

CONCLUSIONS

Monte Carlo simulations were used to study and design a compensator that could be placed in the accessory slot to obtain a homogeneous dose distribution for TSET. The preliminary results with the aluminum compensator revealed an ideal dose distribution and a method to reduce the treatment time. The design of the aluminum compensator needs to be optimized for other electron energies and also to increase the required uniform field length to cover the entire patient surface.

REFERENCES

1 **Karzmark CJ, Loevinger R, Steele RE, Weissbluth M.** A technique for large-field, superficial electron therapy. *Radiology. 1960 Apr;74(4):633-44.*

2 **Kaluarachchi MM, Saleh ZH, Schwer ML, Klein EE.** Validation of a Monte Carlo model for multi leaf collimator based electron delivery. *Medical Physics. 2020 Apr 23.*

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