Evaluation of Electron Monte Carlo for Rectangular Shaped Cutouts

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Introduction

The purpose was to evaluate the accuracy of cutout factors determined by Varian Electron Monte Carlo (eMC) and Radformations ClearCalc (CC) when compared to measured values for a wider variety of cutout shapes, electron energies and treatment geometries.

The previous research found that eMC calculated cutout factors had overall good agreement with measured values. However, this work was limited to a select number of cutouts, electron energies and treatment geometries.

This study performed a wider variety of rectangular cutout shapes, electron energies and treatment geometries, in order to further examine the agreement between calculated and measured cutout factors.

Methods and Materials

The cutout factors measured were compared to the values determined by eMC and CC.

A total of 825 cutout factors from 55 different electron blocks were evaluated. eMC (Eclipse V15.6) and CC calculations (V1.7.6) as well as physical measurements at Varian Trilogy was performed with various rectangular shaped cutouts according to the combination of

- energies (6MeV, 9MeV, 12MeV, 16MeV, 20MeV)
- SSDs (100cm. 105cm, 110cm)
- and cone sizes (A6, A10, A15, A20, A25)

Two ion chambers were used for measurements. The Farmer chamber and micro chamber had collecting volumes of 0.6cm3 and 0.015 cm3, respectively. The micro chamber was employed for small fields to overcome the limitation of the detector size of the Farmer chamber (***Figure 1****.(a) and (b)).* To avoid partial volume effects, the chamber was placed parallel to the longitudinal side of the field (***Figure 1****.(c)).*

The ion chambers were placed in solid water and additional solid water was added so that the chamber was at a depth of 1.2 cm for 6 MeV and 2.5 cm for 9-20 MeV.

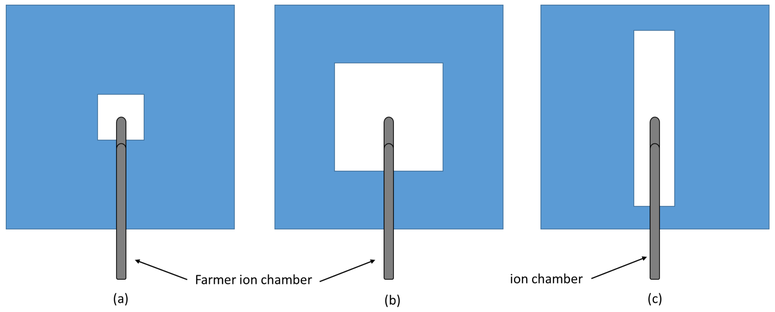

Figure 1. *Comparison of the Farmer chamber for small fields and large fields and placement of ion chamber for rectangular shapes. (a) and (b) show the Farmer chamber cannot fit for small fields; (c) The ion chamber was placed parallel with the longitudinal side.*

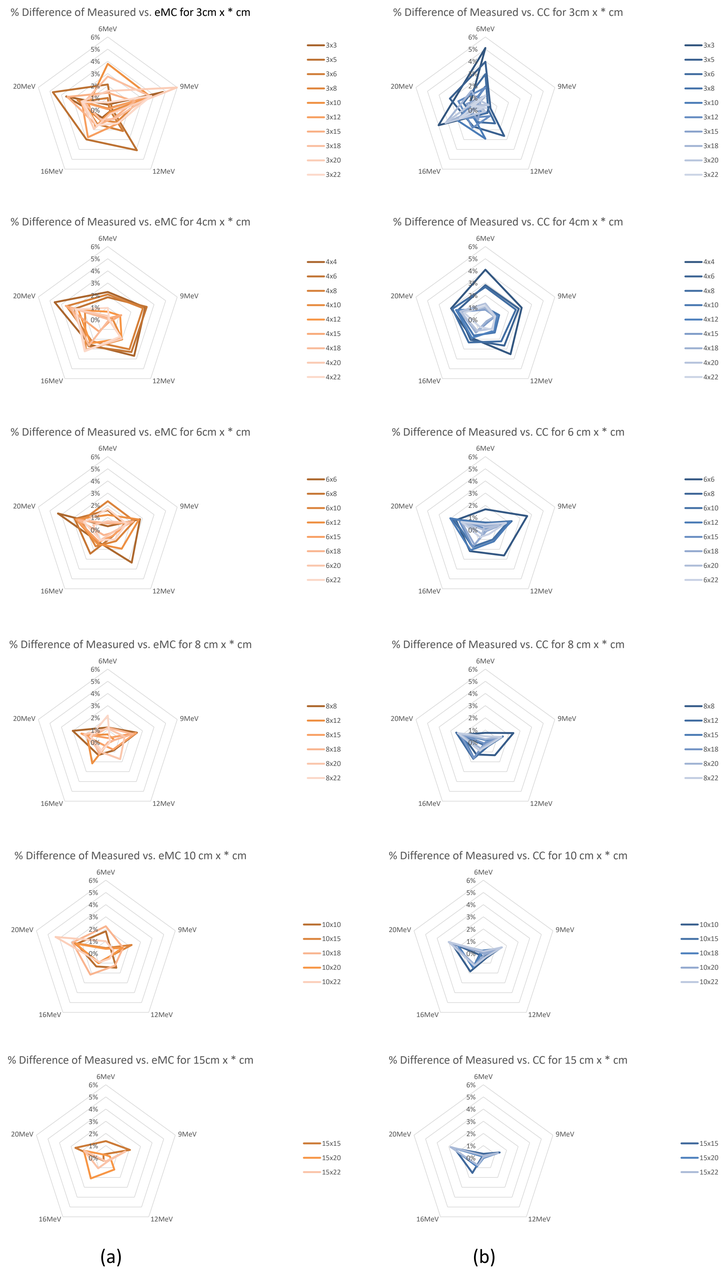

Figure 2. *% differences between Measurement and eMC cutout factors (a) and % differences between Measurement and CC (b) by fields sizes and energies at 100cm SSD. The side of the field size was smaller, the larger difference was observed.*

Results

1. Measurement vs. eMC & Measurement vs. CC

The cutout factors measured were compared with the ones calculated by eMC and CC respectively (***Figure 2***). The differences were within 5% above 4x4 field sizes regardless of energies or SSDs, and most of them were within 3%.

- **The greater discrepancies** were observed at the smaller side of field size less than 4 cm.
- **5 out of 825 cutout factors** had more than 5% discrepancies.
  - Measured vs. eMC 3x20 at 9MeV, 100 SSD
  - Measured vs. CC 3x3 at 6MeV, 100SSD
  - Measured vs. eMC 3x3 at 9MeV, 105 SSD
  - Measured vs. CC 3x3 at 6MeV, 105 SSD
  - Measured vs. eMC 3x3 at 9MeV, 110 SSD

2. Cutout factors by SSD (100, 105, 110)

The % differences between the measured cutout factors and the cutout factors calculated by eMC and CC for a specific SSD were within 3.5% regardless of the SSD or electron energy.

When the cutout factors measured or calculated at a specific SSD were compared to other SSDs, larger discrepancies were observed for smaller field sizes and for lower electron energies.

- **As field size and electron energy** were increased, the discrepancy in cutout factors measured or calculated at one SSD versus the other were reduced.

Conclusions

When the smallest dimension was greater than 4cm, the measurements have a good agreement with eMC and CC.

This study supports the clinical practice of using eMC to calculate the cutout factors for the field size which has a smaller dimension greater than 4cm. The cutout factor should be calculated at the treatment SSD.

The application of eMC will increase efficiency as saving the planning time and manpower.

Limitation

The measurement was performed at the same depth for 9MeV and above, in order to overcome the research time limitation. If the depths were taken at each Dmax, the discrepancies by energies could be more reduced.