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RADIATION DOSIMETRIC CHARACTERISTICS OF SMALL FIELD RADIO SURGICAL CONES

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ABSTRACT

Elekata Snergy Medical Linear accelerator is modelled using EGSnrc Monte Carlo code. The model is validated with measured data. The primary electron beam parameters, the beam size and energy are tuned to match with the measured data, dose profile of $40\times40cm^2$ field and percentage depth dose of $10\times10cm^2$ field are matched during the tuning. Validation of modelled data with measurement is done using gamma analysis, point dose and field size comparisons. For the small adiation fields relative output factors are also compared. Gamma analysis showed a good agreement between the Monte Carlo and measured data. More than 95% of gamma pass rate obtained for $40\times40cm^2$ to $2\times2cm^2$ field size with gamma criteria of 1%, 1mm and more than 98 % with gamma criteria 2%, 2mm for dose profiles. Percentage depth dose compared with gamma pass rate of more than 99% with 1mm 1% criteria. Field size comparison is also in good agreement with measurement, maximum deviation observed is 1.08%. Stereotactic cone field also pass this analysis with more than 98% for dose profiles and 99% for percentage depth dose. Small field output factor shows the deviation 4.3%, 3.4, and 1.9 % for filed sizes 5mm, 3.4mm, 1.9mm respectively.

Keywords: EGSnrc ,Monte Carlo code, Gamma pass rate, Stereotactic cone field, Stereotactic radiosurgery , hypo fractionated

INTRODUCTION

Small radiation fields are widely used in radiotherapy to treat small sized timers especially in brain , lung and liver. These treatments are hypo fractionated treatments called stereo tactic radio therapy (SRT), stereotactic radiosurgery (SRS) , stereotactic body radiotherapy (SBRT)[1-3]. Some of the clinical conditions like Trigeminal neuralgia patients will be treated with very high of 75-80Gy in a single fraction which is close to the critical structures like Brainstem [4]. Therefore, more accurate dosimetry systems required for small radiation field. Unfortunately, small field dosimetry associated with high uncertainty due to the partial source occlusion, size of the detector compared to field size and non-water equivalence of the detector. Therefore, it is recommended to do the Mote Carlo (MC) calculation of dosimetry characteristics of the small fields. It is also recommended to derive the correction factors for relative output factors which is detector specific and field size specific [5-6]. Purpose of this study is to study the dosimetry characteristics of radio surgical cone collimators of Electa Linear Accelerator using the MC technique and derive correction factors some for the clinical small field detectors.

MATERIALS AND METHODS

Elekata Snergy Medical Linear accelerator is modelled using EGSnrc Monte Carlo code. BEAMnrc is used for Linac modelling and DOSEXYZnrc is used for dose calculation in water phantom. Detectors are modelled with DOSRZnrc and EGSchamber code.[7-12] Linac model is done as two parts. The first part is started from the primary electron source followed by targe primary collimator, flattening filter, monitor chamber and mirror. First part scored ap phase space file at 27.21 cm from the target. The second part is started from multi leaf collimator (MLC) secondary collimator, SRS cone and finally scored a phase space file at 100 cm from the target. The second phase space file is used for validation and correction factor calculations. The model is validated with measured data. The primary electron beam parameters, the beam size and energy are tuned to match with the measured data, dose profile of $40\times40cm^2$ field and percentage depth dose of $10\times10cm^2$ field are matched during the tuning. Validation of modelled data with measurement is done using gamma analysis, point dose and field size comparisons[13-15]. For the small fields relative output factors are also compared. Measurements are done in PTW water tank.

RESULTS AND DISCUSSION

Gamma analysis showed a good agreement between the Monte Carlo and measured data. Figure 1 and 2 shows the validation curves of 10X10 cm field both the PDD and Dose profiles are in good agreement. More than 95% of gamma pass rate obtained with gamma criteria of 1%, 1mm. Percentage depth dose compared with gamma pass rate of more than 99% with

1mm 1% criteria. Table 1 shows the PDD at 10 cm comparison for SRS cones. All are in good agreement with MC calculation , maximum observed variation is 1.5%. Table 2 shows the correction factors derived for all four small field detectors, these correction factors shows ionization chamber under responded and diode detectors overresponded in small radiation fields[16-17]. This response variation is due to the density variation of detectors actine volume with respect water [18-21]. Silicon based diode detectors active volume density is higher than that of water. Ionization chamber active volume density is less than that of water. Figure 3 shows the ROFS measured with three different small field detectors and MC calculated ROFs. It shows the clear difference of response. After applying the MC calculated correction factors all are merged with the MC calculated ROFs shows in Figure 4.

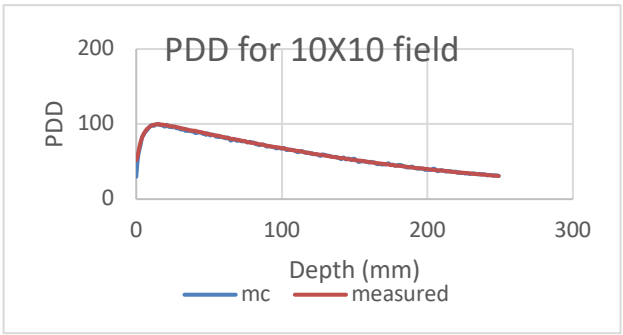

Figure1.PDD of 10x10cm Field

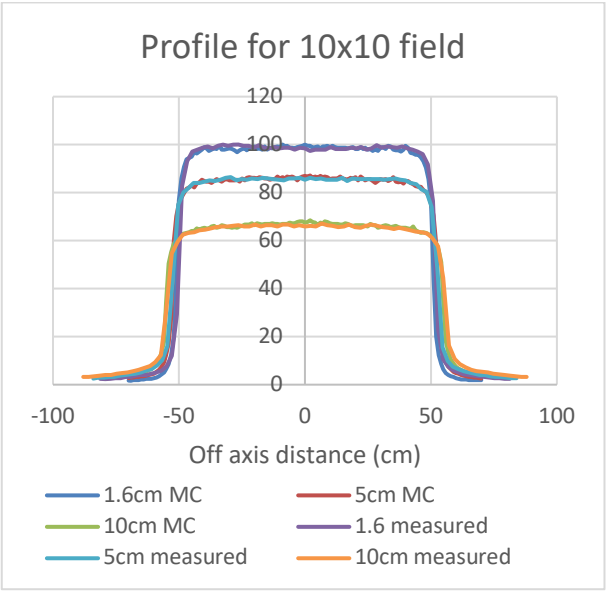

Figure2. Profile at 1.5cm, 5 cm, 10cm

Table1. PDD at 10 cm for SRS cone

PDD at 10 cm			
Cone diameter(mm)	mc	measured	% Variation
5	58.06	58.00	0.1
7.5	59.47	58.60	1.5
10	58.85	58.73	0.2
12.5	59.80	59.06	1.3
15	60.16	59.94	0.4

Table2. Correction factors for small field detectors

Cone Diameter (mm)	**Sun Nuclear EDGE Diode**	**PTW T60017 Diode**	**CC01 Ion Chamber**
5	0.939 ± 0.007	0.962 ± 0.006	1.117 ± 0.008
7.5	0.952 ± 0.007	0.972 ± 0.007	1.055 ± 0.009

10	0.974	±	0.976	±	1.040	±
	0.008		0.007		0.008	
12.5	0.969	±	0.989	±	1.028	±
	0.008		0.009		0.009	
15	0.971	±	0.998	±	1.016	±
	0.008		0.009		0.009	

CONCLUSION

Mont Carlo model of the Elekta Linac along with SRS cone is done by comparing the PDD and dose profile. ROFs shows variations up to 11.7 % for ionization chamber and 6.1% for diode detectors. Correction factors are derived for all three detectors using mote Carlo calculation.

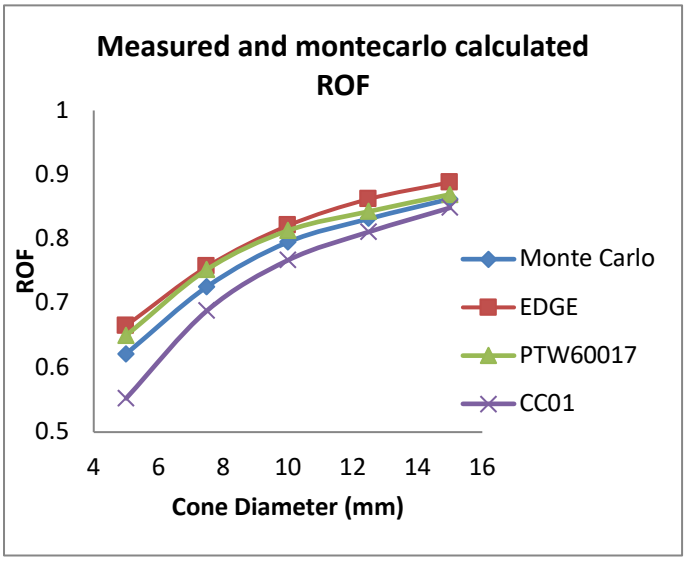

Figure 3. ROF Measured with four different small field detectors

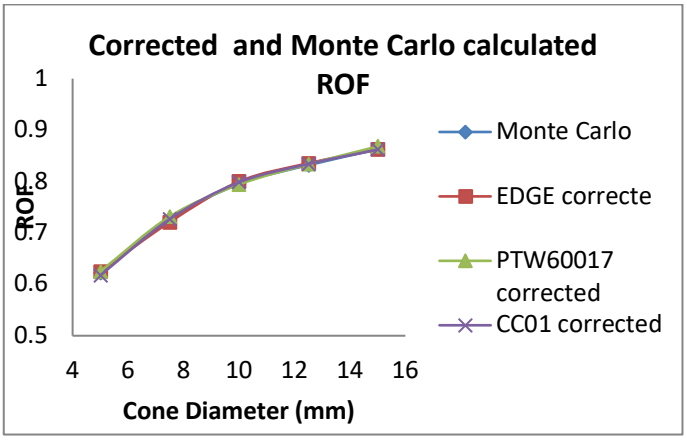

Figure 4. Measured ROF corrected with Correction factors.

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