1D GAMMA ANALYSISONTHEEFFECTOF MEANELECTRONENERGY, FWHM AND XY JAWSTHICKNESSFORSMALL FIELDS

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Introduction: Monte Carlo method is the current gold standard for accurately predicting the dose distribution in any medium for radiotherapy. With the increase in the number of cancer patients that is treated with stereotactic radiosurgery and stereotactic body radiation therapy, there is an accompanying emphasis for small field dosimetric simulations. Most Monte Carlo studies estimate the initial electron beam parameters such as the mean electron energy and the radial intensity (Full Width at Half Maximum, FWHM) by trial and error methods, and concluded that the determination of these parameters must be done independently for small fields[1].However, this approach can be tedious and time-consuming. The current study propose an alternate approach in the determination of these parameters using 1D gamma analysis on the depth dose and lateral profile, for small field sizes such as 2 × 2cm^2, 1 × 1cm^2 and 0.5 × 0.5cm^2.

Methods: EGSnrc-based BEAMnrc code was used to generate the phase space files for a 6 MV photon beam from aVarian ClinaciX linear accelerator. EGSnrc-based DOSXYZnrc code was used to calculate the dose in water. Measured data was obtained using Sun Nuclear EDGE Detector and crosschecked against PTW Diode SRS (PTW-60018) measurements in a Sun Nuclear 3D water scanner. In order to obtain the optimal initial mean electron energy and FWHM, 1D gamma analysis was conducted by imposing the passing criteria from $\gamma_{2.0\%/2.0mm}$ to $\gamma_{0.3\%/0.3mm}$. The parameter with the highest percentage of gamma passes with the most stringent passing criteria will be deemed optimal. The gamma index for the out-of-field (OOF) dose region was also investigated by varying the thickness of the XY jaws of the linear accelerator. Measurement and comparison of the lateral beam profile were performed at depth=1.5cm.

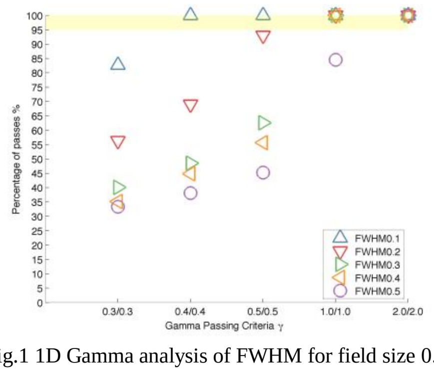

Fig.1 1D Gamma analysis of FWHM for field size 0.5 × 0.5cm^2

Results: Gamma analysis with a stringent passing criteria of$\gamma_{0.3\%/0.3mm}$ shows that unique sets of parameters are required for optimal and accurate simulation for small fields (Fig.1) [2]. Furthermore, as field sizes decreases, higher initial electron beam energy and smaller FWHM are required to match measured data (Table 1). Doses in the OOF region increases with thinner XY jaws.

Table 1:Optimal parameters for small fields based on 1D gamma analysis

Field Size	Mean Electron Energy/(MeV)	FWHM (cm)	Decrease in XY Jaws Thickness / Δt (cm)
0.5 × 0.5cm^2	6.2	0.1	0
1 × 1cm^2	6.1	0.1	0
2 × 2cm^2	6.1	0.2	1.0

Discussion: Results show that independent determination of small field optimal parameters using 1D gamma analysis is potentially more effective and accurate than using direct dose difference test in trial and error methods[3]. Optimal parameters can be clearly distinguished using increasingly stringent passing criteria. By simulating thinner XY jaws, doses in the OOF region can be increased to match measured data due to higher beam transmission [4].

Conclusion: In general, unique sets of parameters are required for an accurate Monte Carlo simulation for small field sizes. The trial and error method to determine the optimal initial electron parameters can be avoided by using the 1D gamma analysis procedure presented in this study.

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