SU-FF-T-100

Characterization of the Elekta Stereotactic Body Frame (SBF) for Use in SBRT Planning

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Purpose: To measure the attenuation of the Elekta Stereotactic Body Frame (SBF) for use in stereotactic body radiotherapy (SBRT) and compare the values to those predicted by the Eclipse treatment planning system (TPS). Depending on the angles of delivery, treatment beams transverse varying thicknesses and densities of the frame. This leads to differential attenuation depending on beam angles. **Method and Materials:** The frame was first tested by measuring attenuation of a 6MV beam delivered over various gantry angles. An ion chamber was positioned in the center of the frame at isocenter. The dose was measured for various gantry angles, which were compared to the anterior beam (gantry 0°). In order to test the ability of Eclipse TPS to properly account for the frame, a solid homogeneous phantom was placed in the frame and then imaged with a CT scanner. Two plans were generated; one with the frame included in the external "Body" contour and one without. The plans were adjusted to deliver the same MUs. The phantom was then treated and the dose was measured at the isocenter. The measured doses were then compared to the two calculated plans. **Results:** The attenuation of the frame was found to be a function of the beam entry point and ranged from 4 to 9%. When the frame and phantom were contoured in Eclipse, the calculated MUs for each field agreed to within 2% of the measured dose. **Conclusion**: The Elekta SBF attenuates the radiation beam and must be accounted for in planning. This can be accomplished in the Eclipse TPS by including the frame in the "Body" contouring. If the frame is not taken into account, it will result in an underdose of approximately 5% for each lateral and posterior field, ranging from 4 to 9%.

SU-FF-T-101

Characterizing Output for a Static TomoTherapy Field

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Purpose: To determine in-air and in-phantom output factors for a static TomoTherapy beam. **Method and Materials:** Measurements and computer simulations of in-air output ratios (S_c) and in-phantom output factors (S_{cp}) have been made for a static TomoTherapy beam. In-air measurements were made at a depth of 10 cm in a commercial mini-phantom for field widths ranging from 1.8 cm to 40 cm, for 2.5-cm and 5.0-cm jaw selections. Measurements were made at source-chamber distances (SCDs) of 85 cm and 105 cm. In-phantom measurements were made at a depth of 10 cm in a full size virtual water phantom for the same field sizes and at an SCD of 85 cm. Data were normalized to the values for the largest available field size (40 x 5 cm^2). Both in-air and in-phantom measurements were compared with simulations made on the TomoTherapy planning system using simulated CT datasets of the full size and mini-phantoms. **Results:** In general, measured and simulated data agreed within 2% for the output factors determined in this work. Measured and simulated S_{cp}s varied steeply (~ 15%) for the field sizes investigated. In contrast, S_cs showed little changes with field size or SCD, although the measured data demonstrated a slightly greater variation with field size than the simulated results. Results were consistent between data taken for different jaw selections, with the best agreement observed for the determined phantom scatter factors, S_p. **Conclusion:** The lack of a flattening filter in the TomoTherapy beam explains the small variation of S_c with field size and SCD. Thus, S_{cp} is due primarily to phantom scatter, which should not vary greatly between TomoTherapy machines. The determination of output factors may be used in the verification of treatment planning doses, both for helical and static deliveries.

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SU-FF-T-102

Clinical Beam Tuning of Low-Energy Electron Beams: Matching Varian and Siemens Linear Accelerators

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Purpose: Tuning nominal energies on linear accelerators is useful for matching machines of different vendors and for altering energies to match clinical needs. In this study we investigated matching a Varian 2100EX 4MeV electron beam to a Siemens Primus 5MeV electron beam. **Method and Materials:** The 4MeV beam of a Varian 2100EX linear accelerator was tuned via a significant shunt-voltage adjustment to match the 5MeV beam of a Siemens Primus linear accelerator. The percent depth-depth dose (PDD) curves and off-axis profiles for multiple field sizes were compared to validate the beam matching. Data was collected with a CC04 cylindrical chamber in water and with a parallel-plate ion chamber in plastic water® (Computer Imaging Reference Systems, Inc., Norfolk, VA). **Results:** The PDD from the parallel-plate and cylindrical ion chambers agreed within 1.1% and 2.5% for the 3x3cm^2 and 10x10cm^2 fields respectively. There was also good agreement in the PDD of the tuned 4MeV (referred to as 4MeV* post-tuning) and 5MeV beams. The depth of D_{max} was identical. Differences in the practical range were only 1mm. The PDD had the best agreement for the 3x3cm^2 field (≤1.5% to depth of D_{90}), followed by the 10x10cm^2 field (≤2.0% to depth of D_{90}) and the 25x25cm^2 field (≤2.5% to depth of D_{90}). Larger disagreements occurred in the dose falloff region beyond D_{90}, typically 2-7%. The off-axis profiles for the 4MeV* and 5MeV beams showed good agreement for the 10x10cm^2 field (≤2%). However, there was a substantial loss in flatness for the 25x25cm^2 field (5.5% for 4MeV*, 2.4% for 5MeV). We believe these differences are caused by the original 4MeV Varian scattering foil, which was not changed to reflect the greater energy of the 4MeV* beam. **Conclusion:** The Varian 4MeV and Siemens 5MeV beams were successfully matched, allowing oncologists to utilize these machines interchangeably.

SU-FF-T-103

Clinical Electron Beam Characteristics Investigations Using the Monte Carlo Method for Absorbed Dose Determination

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Purpose: This work proposes a methodology to build electron beam models capable to accurately represent clinical beams using a simple assumption that it can be represented by a linear combination of monoenergetic beams. Simulations with beam aperture were also performed in order to study the influence of the beam direction on Percentage Depth Dose, PDD. **Method and Materials:** The representation of a clinical electron beam is made assigning weighting factors to each monoenergetic component. For this purpose, depth dose curves were obtained from the Monte Carlo simulations of a set of monoenergetic beams of various energies from 1 to 21 MeV. We defined a parameter so-called as LDED, the Limit Distance for Energy Deposition, which assesses the distance from where the energy deposition drops to less than 1 % of the maximum value. The weighting factors are then estimated focusing on the behavior of each of these parameters as a function of beam energy. **Results**: The PDD close to the phantom surface up to d_{max} (depth of maximum dose) is not affected by the variation of beam aperture, μ, but from this point on its influence becomes very strong. The values of μ adopted were 0.997 and 0.995 for 9 and 15 MeV, respectively. Comparisons between calculated and measured PDD show discrepancies less than 1.3% and 2.8% respectively for 9 and 15 MeV in the build-up region. Twenty million electron histories were simulated to achieve maximum standard deviations of 0.6% and 0.7%. **Conclusion:** This work demonstrates that a simple beam model based on a linear combination of monoenergetic beams and trial and error method can be used to represent clinical electron beams. PDD can be achieved using homogeneous intensity spectra but this it is not adequate for the beam profile, requiring heterogeneous intensity spectrum to reproduce measured data.