

Monte Carlo Commissioning for CyberKnife Multileaf Collimator and Proposed Acceptance Criteria

Tatsiana A. Reynolds¹, Mustafa A. Ozer²

1. Radiation Oncology, MN Oncology, Saint Paul, USA 2. Radiation Oncology, MN Oncology, St Paul, USA

✉ **Corresponding author:** Tatsiana A. Reynolds, tatsiana.reynolds@usoncology.com

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Abstract

Objectives: This work aims to present Monte Carlo (MC) commissioning experience for CyberKnife (CK) Multileaf collimator (MLC). Currently there are no published data for the acceptance criteria for the MC dose calculation algorithm with MLC. Clinically measured tissue-phantom ratios (TPRs), off-center ratios (OCRs) and output factors (OFs) were compared to calculated beam commissioning data and the acceptance criteria for this algorithm were recommended. **Methods:** All measurements were carried out with M6 CK Unit using the photon diode (PTW TN60018) positioned in the computer-controlled 3D Sun Nuclear Scanner. Central axis (CA) TPRs were measured for 11 field sizes (FSs) (7.6x7.7 mm² to 115.0x100.1 mm²) at depth ranging from 0 to 300 mm. The OCRs at particular depths: 15, 50, 100, 200 and 300 mm, were calculated as the ratio of the absorbed doses at a given off-axis points relative to the dose at CA. Measurements of OCR were carried out for 11 FSs by conducting orthogonal scans across the field at a variety of depths. The OFs were defined as the ratio of absorbed dose of a particular FS relative to the dose at a FS=100x100 mm². All measurements were made at a source-detector distance (SDD) of 800 mm. All calculations were utilized in the Accuray Precision (Version 1.1.1.1) treatment planning system with optimum source full width half maximum of the Gaussian distribution of 1 mm and 6.7 MeV energy. Default MLC transmission settings (Center: 0.3%, End: 1.0 %, End Edge: 20%, Side Edge: 32.0%) were used for all calculations. The final calculations were performed with computation uncertainty of 0.3% for TPRs, and OCRs, and 0.2% for OFs. **Results:** The measured OFs and TPRs were found to be in excellent agreement with calculated beam data. 0% difference was shown for OFs for all FSs. For TPRs, maximum percent difference between the calculated and measured TPRs was 1% for depths larger than 15 mm, and 2% in the buildup region across all FSs. To evaluate the percent difference between the measured and calculated OCRs, the beam was divided into 3 regions, within the beam (within the central 80% of the field), penumbra (dose falls off from 80% to 20%) and tail (lower than 20% of the dose). The difference between the calculated and measured OCRs were 3% within the beam, and 20%/1 mm within the penumbra. The largest observed disagreement (up to 100%) between MC calculation and measurement was observed in the tail region due to the high atomic number of the detector sensitive volume in combination with the large decrease in photon and electron energies outside of the larger beams at larger depths. The magnitude of these differences increased with increasing FS and depth. **Conclusion(s):** This work provides the first data for the commissioning of MC with CK MLC. The acceptance criteria for the commissioning are provided.

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Abstract

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