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# Accuracy of Electron Monte Carlo Dose Calculations

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## INTRODUCTION

Monte Carlo simulations represent potentially the most accurate method to for patient dose calculations in radiotherapy. The development of faster computational systems and the advancements of faster Monte Carlo simulation algorithms offer a unique opportunity for the use of Monte Carlo calculations in the clinical environment of radiation oncology. The purpose of the present work is to investigate the accuracy of the electron Monte Carlo dose calculations for irregular surfaces and comparison with traditional electron cut-out measurements.

## AIM

The novelty of the study is in the way it addresses a very common clinical situation:

Electron dose calculations in irregular surfaces. The use of the Monte Carlo dose engine calculations is becoming the standard in modern radiation therapy. As the dose engines become more accurate and precise our methods of validation must become as well with them. Our approach is to validate the accuracy of Electron Monte Carlo dose calculations with in-vivo dosimetry measurements via diode or OSL readings.

## METHOD

Independent dose verification was performed for several cases for which the dose agreement was more than 7% with electron Monte Carlo dose calculations. Electron cut-out measurements pre-treatment in a cubic phantom and in-vivo dosimetry measurements via diode or OSL measurements during the first fraction were performed in those scenarios. Monte Carlo dose calculations were compared against these measurements.

## RESULTS

*Comparisons among Electron Monte Carlo dose calculations with traditional electron cutout, second check methods, and finally with in-vivo dose measurements were carried in the present work. Electron Cut-Out measurements agrees with second check calculation with an average percent dose difference of 1.5%. When comparing Electron Monte Carlo dose calculated against Second Check calculation an average percent dose difference of 10.4% was obtained. And comparison between Monte Carlo dose and Electron Cut-Out physical measurement a percent dose difference of 9.8% was observed.*

*And finally, Electron Monte Carlo Dose calculations were compared with diode measurements and OSLs in vivo measurements on the first fraction with an agreement observed between the in-vivo measurements and the electron Monet Carlo dose calculations with an average dose percent difference of 3.1 %.*

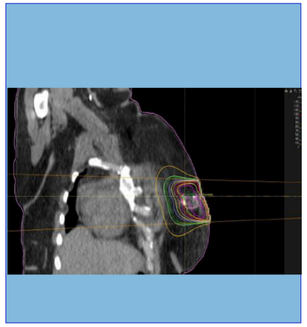

*Figure 1. Breast field with Electron Monte Carlo dose calculation.*

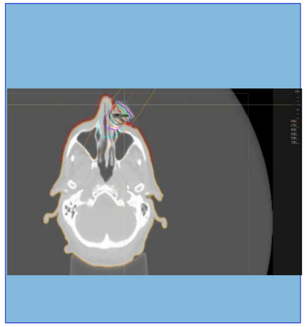

*Figure 2. Nose field with Electron Monte Carlo dose calculation.*

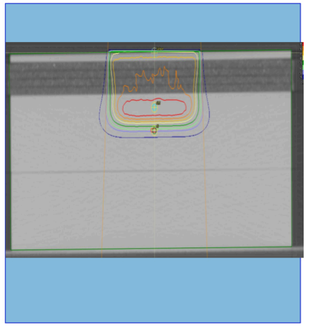

*Figure 3. Common electron cutout phantom used for verification (cubic geometry).*

## CONCLUSIONS

This work indicates the potential for significant time reduction in the electron dose verification for Medical Physicist when using an Electron Monte Carlo dose engine. Our results shows that there is a better estimation of the dose via electron Monte Carlo calculations than with the traditional cut-out measurements.

The use of Electron Monte Carlo dose engines in routine clinical situations can lead a better estimation of the dose in irregular surfaces and in the presence of inhomogeneous media in radiation therapy. In the present clinical flow using electron cut out measurement it can lead to both underestimation and overestimation of the true monitor units needed to deliver the RX dose due to the lack of information about the surface and the media present since it is only based on a rectangular water phantom measurement or similar geometries.

## REFERENCES

Sotirios Stathakis, Carlos Esquivel, Luis Vazquez Quino, Pamela Myers, Oscar Calvo, Panayiotis Mavroidis, Alonso N. Gutiérrez, Niko Papanikolaou, Accuracy of the Small Field Dosimetry Using the Acuros XB Dose Calculation Algorithm within and beyond Heterogeneous Media for 6 MV Photon Beams, International Journal of Medical Physics, Clinical Engineering and Radiation Oncology, 10.4236/ijmpcero.2012.13011, 01, 03, (78-87), (2012).

Luis Vazquez Quino, Claudia Hernandez, Nikos Papanikolaou, A Monte Carlo model for independent dose verification in IMRT and VMAT for the Varian Novalis TX with high definition MLC, International Journal of Cancer Therapy and Oncology, 10.14319/ijcto.33.12, 3, 3, (3312), (2015).

Luis Alberto Vazquez-Quino, Brian Massingill, Chengyu Shi, Alonso Gutierrez, Carlos Esquivel, Tony Eng, Nikos Papanikolaou, Sotirios Stathakis, Monte Carlo modeling of a Novalis TX Varian 6 MV with HD-120 multileaf collimator, Journal of Applied Clinical Medical Physics, 10.1120/jacmp.v13i5.3960, 13, 5, (300-313), (2012).

Jabbari K. (2011). Review of fast monte carlo codes for dose calculation in radiation therapy treatment planning. Journal of medical signals and sensors, 1(1), 73–86.

Ito A. In: In Monte Carlo Transport of Electrons and Photons. Nelson W. R, Jenkins T. M, Rindi A, Nahum A. E, Rogers D. W. O, editors. New York: Plenum Press; 1988. pp. 573–98.

Andreo P. Monte Carlo techniques in medical radiation physics. Phys Med Biol. 1991;36:861–920.

Chetty I, Curran B, Cygler J, DeMarco J, Faddegon B, Liu H, et al. Guidance report on clinical implementation of the Monte Carlo method in external beam radiation therapy treatment planning: Report of the AAPM Task Group No. 105. Med Phys. 2007;34:4818–53.

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