An MCNP-based model for the evaluation of the photoneutron dose in high energy medical electron accelerators

Eleutheria Carinou,[1,4] Ion Evangelos Stamatelatos,[2] Vassiliki Kamenopoulou,[1] Paraskevi Georgolopoulou,[3] Panayotis Sandilos[4]

1. *Greek Atomic Energy Commission, Aghia Paraskevi, 153 10 Attiki (Greece)*
2. *Institute of Nuclear Technology and Radiation Protection, NCSR «Demokritos», Aghia Parasaskevi, 153 10 Attiki (Greece)*
3. *Department of Medical Physics, Saint Savvas Hospital, 171 Alexandras Ave., 115 22 Athens (Greece)*
4. *Department of Radiology, Areteion Hospital, University of Athens, 76 Vas. Sofias Ave., 115 28 Athens (Greece)*

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Abstract

The development of a computational model for the treatment head of a medical electron accelerator (Elekta/Philips SL-18) by the Monte Carlo code MCNP-4C2 is discussed. The model includes the major components of the accelerator head and a PMMA phantom representing the patient body. Calculations were performed for a 14 MeV electron beam impinging on the accelerator target and a 10 cm × 10 cm beam area at the isocentre. The model was used in order to predict the neutron ambient dose equivalent at the isocentre level and moreover the neutron absorbed dose distribution within the phantom. Calculations were validated against experimental measurements performed by gold foil activation detectors. The results of this study indicated that the equivalent dose at tissues or organs adjacent to the treatment field due to photoneutrons could be up to 10% of the total peripheral dose, for the specific accelerator characteristics examined. Therefore, photoneutrons should be taken into account when accurate dose calculations are required to sensitive tissues that are adjacent to the therapeutic X-ray beam. The method described can be extended to other accelerators and collimation configurations as well, upon specification of treatment head component dimensions, composition and nominal accelerating potential.

KEYWORDS: MCNP, photoneutron dose, high-energy accelerators, radiotherapy

Preparation and use of standards for a comparison exercise among users of ^{131}I capsules in South Africa

Winifred M. van Wyngaardt, Bruce R. S. Simpson

Radioactivity Standards Laboratory, CSIR-NML, 15 Lower Hope Road, Rosebank, Cape Town, 7700 (South Africa)

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Abstract

^{131}I is widely used as a diagnostic radiopharmaceutical and for radiotherapy in the treatment of thyroid cancer and hyperthyroidism. Radionuclide/Dose calibrators are used to measure activities for administering to patients. To check the accuracy of calibrators operated by South African nuclear medicine facilities, comparison exercises were conducted among users of ^{131}I capsules.

An ^{131}I solution was standardized by liquid scintillation counting using the absolute $4\pi\beta$-γ coincidence extrapolation technique. The standardization was transferred to the NML ionization chamber for the geometry of 3.6 ml of solution in a 5 ml glass ampoule. Using this calibration, an ionization chamber calibration factor was determined for ^{131}I capsules.

Two comparison exercises were conducted, one year apart. For each one, four ^{131}I capsules were calibrated using the previously determined calibration factor. These capsule standards were sent to different provinces in South Africa where they were measured by all participating facilities. The results indicated that more than 90% of the participants showed deviations from the certified value of less than 10%.

KEYWORDS: ^{131}I, Absolute standardization, Radionuclide or dose calibrator, Comparison.

Biological dose optimization using ramp-like dose gradients in ion irradiation fields

Michael Krämer,[1] Oliver Jäkel[2]

1. *Gesellschaft für Schwerionenforschung (GSI)/Biophysik, Planck-Str. 1, D 64291 Darmstadt (Germany)*
2. *Deutsches Krebsforschungszentrum, Abt. Medizinische Physik in der Strahlentherapie INF 280, D 69120 Heidelberg (Germany)*

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Abstract

We describe a method to improve treatment planning for carbon ion radiotherapy using biologically optimized inhomogeneous dose prescriptions of opposing fields. The biological optimization of single fields is performed in such a way that a linear rise or fall-off of the dose is produced over the target volume. The superposition of these inhomogeneous fields yields a homogeneous dose distribution with improved tissue sparing for concave target volumes. The variation of the relative biological effectiveness (RBE) is fully taken into account. Schematic as well as real patient plans show significant improvements in the dose-volume histograms for ramp-like dose gradients across the target volume in beam's eye-view direction. The method is applicable to ions other than carbon as well.

KEYWORDS: Carbon Ion Radiotherapy, Biological Dose Optimization, Dose Gradients, Inhomogeneous Ion Fields, Ion Radiotherapy Treatment Planning.

A comparison of two image fusion techniques in CT-on-Rails localization of radiation delivery*

Albert Y. C. Fung,[1,] James R. Wong,[2] Chee-Wai Cheng,[3] S. Lisa Grimm,[4] Minoru Uematsu[5]

1. *Department of Radiation Oncology, Nebraska Medical Center, Omaha (NE, USA), 69198*
2. *Department of Radiation Oncology, Morristown Memorial Hospital, Morristown (NJ, USA), 07962*
3. *Department of Radiation Oncology, Arizona Oncology Associates, Tucson (AZ, USA), 85712*
4. *Department of Radiology, Oncology, Albert Einstein Medical Center, Philadelphia (PA, USA), 19141*
5. *Department of Radiology, National Defense Medical College, 3-2 Namiki Tokorozawa, Saitama 359 (Japan)*

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Abstract

A computed tomography (CT) scanner on Rails has been installed in a linear accelerator room at Morristown Memorial Hospital since 2000. The CT-on-Rails has been used for the localization of patient position during radiation delivery for prostate, lung and liver cancer patients. The image management system, the Siemens Syngo system, is the primary software employed in the registration of the planning CT and the treatment CT images. This study compares the two image fusion methods available in the system: Landmark Registration and Visual Alignment. Shifts in 6 CT scans with Rando phantom were deduced from Landmark Registration (automatic algorithm) and from Visual Alignment (manual registration), and compared with the shifts directly measured on the phantom. For Visual Alignment, the isocenter shifts deduced from the fused images generally agreed well with the directly measured shifts on the Rando phantom, with average absolute error of 0.9 mm in anterior-posterior (AP) direction, 1.0 mm in right-left (RL) direction, and 2.0 mm in superior-inferior (SI) direction. The image fusion algorithm was confirmed to be accurate. Some scans with Landmark Registration gave erroneous AP shifts when the anterior radio-opaque marker (BB) registration was off in the AP direction. Visual Alignment was more robust than Landmark Registration in these clinical situations.

KEYWORDS: Fusion localization computed tomography.

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