

PHYSICA MEDICA

<http://www.physicamedica.com>

Indexed/Abstracted in:

ISI (*Biophysics & Biochemistry Citation Index*[®], *Science Citation Index-Expanded*[®],
Journal Citation Reports Science[®], *Research Alert*[®])

Index Medicus and MEDLINE

Excerpta Medica (EMBASE),

INSPEC (*Current Papers in Physics and Physics Abstracts*)

QUEST (a data base dedicated to Health and Medical Physics Journal).

VOL. XX, N. 2, 2004, April-June

Original Papers

Tillman Riess, Theobald Fuchs, Willi Kalender

A new method to identify and to correct circular artifacts in X-ray CT images 43

Sunil Dutt Sharma, Cinzia Mordacchini, Raffaele Novario, Leopoldo Conte, Bhuwan Chandra Bhatt

Comparative Dosimetric Analysis of Varian MLC Only and Jaw Collimator Shaped Fields 57

F. Cusanno, F. Garibaldi, S. Colilli, M. Gricia, F. Giuliani, M. Lucentini, F. Santavenere, G. M. Urciuoli,

E. Cisbani, R. Pani, R. Pellegrini, M. N. Cinti, R. Scafè

Preliminary Evaluation of Compact Detectors for Hand-Held Gamma Cameras 65

Technical Note

Laura De Nardo, Valentina Cesari, Nicole Iborra, Valeria Conte, Paolo Colautti, Joël Herault, Giorgio Tornielli,
Pierre Chauvel

Microdosimetric Assessment of Nice Therapeutic Proton Beam Biological Quality 71

Obituary

Edward J. Hoffman Ph.D. 79

A new method to identify and to correct circular artifacts in X-ray CT images

Tillman Riess, Theobald Fuchs, Willi Kalender

Institute of Medical Physics, University of Erlangen-Nuremberg, Erlangen (Germany)

Manuscript received: July 4, 2003; revised: March 20, 2004

Accepted for publication: May 10, 2004

Abstract

Deviations in the performance of solitary detector channels may introduce circular shaped artifacts in CT images. Therefore, methods to correct for circular artifacts in CT images are needed. Typical state-of-the-art correction methods in today's CT systems have to be applied globally to a reconstructed image (*i.e.*, to the entire image) as they make no attempts to identify image regions actually affected with artifacts. This, however, means that parts of the image may be modified unnecessarily sometimes resulting in unwanted subtle modifications of anatomical structures in the images.

We therefore developed a new approach to be used as an alternative to global correction methods: In a first step an algorithm identifies artifact-affected regions. In a second step, a state-of-the-art correction method can be applied to those regions only. Circular artifacts are identified by applying an optimized edge-detector followed by edge localization, noise discrimination and classification of edges as circular artifacts or anatomical structures. The identification is accomplished semi-automatically: the user controls the sensitivity of the method by selecting one threshold parameter only. The new method was quantitatively analysed by simulating a known number of realistic artifacts at known positions in CT image datasets and subsequently identifying them: On average, 95% and more of the artifacts could be eliminated at the expense of modifying 35% to 40% of the image compared to eliminating all artifacts at the expense of modifying 100% of the image with a state-of-the-art correction without a prior identification step.

KEYWORDS: Computed tomography (CT), multi slice CT detector, Detector channel deviations, Circular image artifacts.

Original Paper

Comparative Dosimetric Analysis of Varian MLC Only and Jaw Collimator Shaped Fields

Sunil Dutt Sharma^{1,3}, Cinzia Mordacchini², Raffaele Novario², Leopoldo Conte¹, Bhuwan Chandra Bhatt³

¹ Dipartimento di Scienze Cliniche e Biologiche, Università dell'Insubria, 21100 Varese (Italy)

² Servizio di Fisica Sanitaria, Ospedale di Circolo, Viale Borri 57, 21100 Varese (Italy)

³ Radiological Physics and Advisory Division, Bhabha Atomic Research Centre, CT&CRS Building, Anushaktinagar, Mumbai, 400094 (India)

Manuscript received: January 29, 2004; revised: March 30, 2004

Accepted for publication: May 13, 2004

Abstract

Multileaf collimators (MLC) are now commonly used to shape treatment fields for conformal radiotherapy. In some of the clinical applications, a large area of extended leaves is uncovered. Such fields can be assumed to be MLC only defined fields. Percentage surface dose (PSD), build up region, percentage depth dose (PDD), penumbra width ($P_{80/20}$), central axis absorbed dose (CAAD) and total scatter factor (S_{cp}) for radiation fields defined by jaw collimators (JC) only, JC and MLC together (JC + MLC), and MLC only were measured to quantify the differences in these parameters due to definition of fields by different combinations of JC/MLC. Measurements were carried out on a Varian Clinac 2100C medical linear accelerator and a Varian 80 leaf MLC with 6 (quality index, $QI = TPR_{20,10} = 0.66$) and 18 MV ($QI = 0.78$) photon beams. Radiation transmitted through JC alone, JC + MLC and MLC alone were also determined. PSD and dose in build up region for MLC only fields are higher than JC/JC + MLC fields. Differences in PSD of MLC only and JC/JC + MLC fields depend on beam energy and field size. These three types of fields have the same PDD while MLC penumbra ($P_{80/20}$) is about 1 mm larger than JC penumbra. CAAD of MLC only field is also higher than JC/JC + MLC field and the difference in CAAD of these fields depend on field size, beam energy and distance of jaw collimators from MLC field boundary. S_{cp} of MLC only field for field sizes greater than 10×10 cm² are comparatively smaller than JC field. Radiation transmitted through MLC alone at 18 MV is 2.66%, which is about 6 times higher than transmission through either of the jaw collimators ($\leq 0.44\%$).

KEYWORDS: Multileaf Collimator, Jaw Collimator, Conformal Radiotherapy, Dosimetry.

Preliminary Evaluation of Compact Detectors for Hand-Held Gamma Cameras

F. Cusanno¹, F. Garibaldi¹, S. Colilli¹, M. Gricia¹, F. Giuliani¹, M. Lucentini¹, F. Santavenere¹, G. M. Urciuoli¹, E. Cisbani¹, R. Pani², R. Pellegrini², M. N. Cinti³, R. Scafè⁴

1. *Laboratory of Physics, ISS, Rome (Italy)*
2. *Department of Experimental Medicine, University of Rome «La Sapienza» (Italy)*
3. *Biophysics PhD School, University of Rome «La Sapienza» (Italy)*
4. *ENEA-TEC, c. r. Casaccia, Rome (Italy)*

Manuscript received: February 28, 2003; revised: July 28, 2003, January 22 and May 27, 2004

Accepted for publication May 31, 2004

Abstract

Hamamatsu Photonics has recently developed a new generation of compact Position Sensitive PhotoMultiplier Tubes (PSPMT) based on metal channel dynode charge multiplication technology. The R5900 family now has a range of compact tubes that differ in the structure of the anode. The models considered in this paper, the C8 and M16, also differ in the photocathode active area. The C8 has a crossed plate anode configuration consisting of 4X + 4Y strips and an active area of 22 × 22 mm² while the M16 has a 4 × 4 anode array with a smaller active area of 18 × 18 mm². In this paper we report our evaluation of the C8 and the M16 tubes for clinical imaging applications such as a hand-held gamma probe, multi-PSPMT camera and for tomographic rings. To this aim, measurements of pulse height uniformity, inter-channel gain variation and anode cross talk were performed using a light source coupled to a 1 mm diameter optical fiber. Finally, the PSPMTs were optically coupled to three CsI(Tl) scintillating arrays with pixel size ranging between 1.5 × 1.5 mm² and 4.2 × 4.2 mm² to compare the imaging properties.

KEYWORDS: Gamma camera, PSPMT, Scintillation crystal.

Microdosimetric Assessment of Nice Therapeutic Proton Beam Biological Quality

Laura De Nardo^{1,2}, Valentina Cesari³, Nicole Iborra⁴, Valeria Conte³, Paolo Colautti³, Joël Héroult⁴, Giorgio Torielli^{1,2}, Pierre Chauvel⁴

1. *University of Padova, Physics Department, Via Marzolo 8, I 35131 Padova (Italy)*
2. *INFN - Sezione di Padova, Via Marzolo 8, I 35131 Padova (Italy)*
3. *INFN - Laboratori Nazionali di Legnaro, Viale dell'Università 2, I 35020 Legnaro (Italy)*
4. *Centre Antoine-Lacassagne Biomedical Cyclotron, 227 Avenue de la Lanterne, F 06200 Nice (France)*

Manuscript received: September 1, 2003; revised: February 10, 2004

Accepted for publication: May 10, 2004.

Abstract

A cylindrical slim TEPC (Tissue-Equivalent Proportional Counter) of 0.9 mm sensitive volume and 2.7 mm of total encumbrance has been constructed. With such a mini counter we have measured the physical quality of the therapeutic proton beam of the Centre Antoine-Lacassagne of Nice (France). Microdosimetric Relative Biological Effectiveness values (RBE_{μ}) have been calculated by using different weighting functions for early effects in mouse intestinal crypt cells. RBE_{μ} , calculated by using the weighting function for 8 Gy, fits very well in-vitro radiobiological data (human melanoma surviving at 8 Gy and human tongue cell carcinoma surviving at 2 Gy) all along the Spread-Out Bragg peak (SOBP). The SOBP lateral penumbra physical quality has been as well measured. At the SOBP end, the biological effective dose is shifted of about 0.5 mm with respect to the absorbed dose, both longitudinally and laterally.

KEYWORDS: TEPC, Microdosimetry, Proton therapy, Proton RBE.