

# Validation of a Simple Analytical Model for In-air Output Factor Calculation for SL-15 Philips-Elekta Linear Accelerator

Maha A. Ali,<sup>1</sup> Ismail Emam<sup>2</sup>

1. Biophysics Dept., Faculty of Science, Cairo University, Cairo (Egypt)

2. Salam Oncology Center, Ministry of Health and Population, Cairo (Egypt)

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## Abstract

A simple analytical approach to model extrafocal radiation (EFR) and monitor chamber backscatter (MBS) – and consequently collimator scatter factor – is investigated. The model has been applied to 6 and 10 MV photon beams produced by a Philips-Elekta SL-15 medical linear accelerator. Both EFR and MBS are determined simultaneously using conventional measured data at the isocenter and the calculated in-air output factors ( $S_c$ ) were in good agreement with the measured values. When the square field size changes from  $4 \times 4$  to  $40 \times 40$  cm<sup>2</sup>, the total intensities of EFR were 17.6% and 13%, while the MBS contributions to  $S_c$  were 0.1% and 0.2% for 6 and 10 MV, respectively. The model was also used to calculate  $S_c$  for symmetric or asymmetric rectangular jaws-defined fields with an accuracy of less than 0.2% at extended or shortened source detector distances. Moreover, the model was verified for both very small field sizes ( $2 \times 2$  cm<sup>2</sup> down to  $0.6 \times 0.6$  cm<sup>2</sup>) and for field sizes defined by micro multi-leaf collimator to check its applicability for stereotactic radiotherapy dose calculations. A simple programme is designed to facilitate the calculation process of  $S_c$  for a medical linear accelerator at different situations either for commissioning or verification of the model at different energies.

KEYWORDS: Medical linear accelerator, Extrafocal radiation, Monitor chamber backscatter, In-air-output factor.

# Theoretical and Experimental Investigation of the Relationship among SAR, Tissues and Radio Frequencies in MRI

Chunsheng Wang, Gary X. Shen, Jin Yuan, Peng Qu, Bing Wu

Department of Electrical and Electronic Engineering, The University of Hong Kong Pokfulam Road (Hong Kong)

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## Abstract

The specific absorption rates (SAR) of three tissues (muscle, brain, bone) are investigated both theoretically and experimentally for MRI at the first time. Finite difference time domain (FDTD) analysis is used to simulate the average SAR of three tissues at three magnetic field strengths (0.5 T, 1.5 T, 3 T). Simulations show that the SAR of muscle, brain and bone increase 7.49 folds, 10.87 folds and 12.92 folds respectively when the magnetic field strength increases from 0.5 T to 3 T. Experiments are carried out to measure SARs of different phantoms which simulate the three human tissues at 1.5 T and 3 T. The experiment results agree with the simulation data very well and within only 11% difference.

KEYWORDS: SAR, FDTD, RF safety.

# Quality assurance of Siemen's Virtual Wedge™ by using film dosimetry

Panagiotis Sandilos,<sup>1,2</sup> Theodoros Paschalis,<sup>1</sup> Pantelis Karaiskos,<sup>2</sup>  
Konstantinos Dardoufas,<sup>1</sup> Lambros Vlachos<sup>1</sup>

1. Department of Radiology, Medical School, University of Athens, Aretaieion Hospital, Athens (Greece)

2. Medical Physics Department, Hygeia Hospital, Athens (Greece)

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## Abstract

A film dosimetry method is proposed for measuring the non-uniform dose distribution generated by Virtual Wedges of a 6 MV Siemens Primus accelerator. This method was chosen due to the dose integration capabilities and the improved spatial resolution that films offer, giving the opportunity of measuring dose distribution in a single beam irradiation. Dose profiles were obtained and analyzed using a 16-bit Vidar film scanner and OmniPro-Accept software. Results were compared with corresponding ones measured with an array ionization chamber for both virtual and conventional wedges. A good agreement was found between the two methods for all the examined wedge angles. This study shows that film dosimetry can be incorporated in a monthly quality assurance program for virtual wedges in order to reduce the required effort.

KEYWORDS: Virtual Wedge, Film dosimetry, Quality assurance.

# The Self-Diffusion Behavior of Polyethylene Glycol in Cartilage as Studied by Pulsed-Field Gradient NMR

Esam E. T. E. A. Mohamed,<sup>1</sup> Stefan Gröger,<sup>2</sup> Jürgen Schiller,<sup>1</sup> Frank Stallmach,<sup>2</sup>  
Jörg Kärger,<sup>2</sup> Klaus Arnold<sup>1</sup>

1. Institute of Medical Physics and Biophysics, Medical Faculty University of Leipzig, Härtelstr. 16/18, D 04107 Leipzig (Germany)

2. Institute of Experimental Physics I, Department of Physics and Earth Sciences, University of Leipzig, Linnéstrasse 5, D 04103 Leipzig (Germany)

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## Abstract

The self-diffusion behavior of the polyethylene glycol (PEG) polymer in bovine nasal cartilage was studied by pulsed-field gradient (PFG) nuclear magnetic resonance (NMR). PFG NMR allows the determination of the mean square displacement of molecules in a given diffusion time (in the range of a few milliseconds up to seconds), monitors distances in micrometer scales and has the advantage of being non-invasive. Moreover the application of PFG NMR does not require concentration gradients.

In a previous study, PFG NMR was used to investigate the self-diffusion behavior of the PEG polymer in cartilage at very high concentrations. In this study, much lower PEG concentrations were used in order to detect the effects of the structural composition of the cartilage tissue more efficiently.

It will be shown that at very low (<10 wt.-%) PEG concentrations, the effect of restricted polymer diffusion in cartilage is negligible. The self-diffusion coefficients (SDC) are primarily influenced by the water content and the molecular weight (MW) of the applied PEG. The problems encountered with PFG NMR diffusion studies using high field gradients as well as *in vivo* aspects of this study are discussed.

KEYWORDS: PFG NMR Polyethylene glycol, Self-diffusion, Restricted diffusion, Cartilage.

## Depth dose characteristics of electron beams at extended SSDs

Basri Günhan, Songül Karaçam, Ayşe Koca, Bayram Demir, Dervis Emre, Nil Akin

*Istanbul University, Cerrahpasa Medical Faculty Department of Radiation Oncology, TR 34303 Cerrahpasa Istanbul (Turkey)*

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### *Abstract*

The purpose of this study is to investigate the behaviour of the percent depth dose curves (%DD) and surface doses of electron beams at extended Source-to Surface Distances (SSDs). A GE Saturne 42 linear accelerator was used in this study, which produces dual photon energies of 6 and 15 MV as well as eight electron energies ranging between 4.5 and 21 MeV. The % Depth Dose curves were generated with water scanning equipment at 6, 9, and 15 MeV for  $4 \times 4 \text{ cm}^2$  and  $20 \times 20 \text{ cm}^2$  field sizes at SSDs of 100 cm, 108 cm, and 115 cm. According to the measurements from surface to the depth of dose maximum the surface dose increased for all of the electron energies studied at extended SSDs for small field sizes. On the other hand for larger field sizes the surface doses decreased at extended SSDs. It was also observed that the increase in the surface dose diminished as the field size approached to  $10 \times 10 \text{ cm}^2$  then the surface dose started decreasing at extended SSDs as the field sizes increased. Extended SSDs have no observable effect on the tail portion of the depth dose curves.

KEYWORDS: Electron beams, Extended SSD, Surface dose, Isodose distribution.

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KEYWORDS: Electron beams, Extended SSD, Surface dose, Isodose distribution.

# Nitrates and Angina: an insight into arterial and venular involvement in blood flow regulation

Romano Zannoli, Luciano Potena, Angelo Branzi

*Institute of Cardiology, University of Bologna, Bologna (Italy)*

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## *Abstract*

This study tested the hypothesis that venular resistance increases during ischaemia and that a prevalent nitrates-induced venodilatation is the crucial mechanism underlying their ability to relieve ischaemia. Using the model of postreactive hyperaemia we used mercury-in-rubber strain gauges to measure forearm blood flow (FBF) and forearm circumference (FC) before and after 5 mg sublingual isosorbide-dinitrate in twelve healthy volunteers. The FC change during reactive hyperaemia was evaluated according to a hydraulic model which assumes that arteriolar resistance (AR) controls the blood inflow and that venular resistance (VR) controls the blood outflow of the vascular capillary reservoir. In this setting FC represents the reservoir volume and any change in this parameter represents the instantaneous difference between input and output flows.

In the absence of nitrates and five minutes of arterial closure, the hyperaemic FC curve shows a rapid increase followed by a slow recovery demonstrating a rapid inflow followed by a delayed outflow of the reservoir. This behaviour may be explained by assuming an initial very low arterial resistance and high venular resistance, followed by a slow reequilibrium of the two.

Repeating the experiment after nitrates intake, the hyperaemic FC curve shows a reduced dimension and a faster recovery to the baseline. Compared with the previous condition, this finding may be explained by assuming a reduced initial venular resistance, which facilitates the blood outflow and hence muscle perfusion. Our findings are coherent with an ischaemia-induced arteriolar dilatation which facilitates filling, and a simultaneous venular constriction which opposes emptying (*arteriovenous ischaemic mismatch*): the action of the nitrates seems to restore the mismatch by acting on the venous side.

KEYWORDS: Reactive hyperaemia, Venous flow, Ischaemia, Nitrates.

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