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Volume 5, No. 1 July 2018 p-ISSN: 2147-7736, e-ISSN:2148-3981



Ankara University
Institute of Nuclear Sciences



Journal of Nuclear Sciences

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Abstracts of Graduate Student
Conference on Nuclear Sciences

11-13 May 2018

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Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000027

Volume Change in Organ At Risks and Its Effect on Cumulative Dose for Head and Neck Image Guided Radiotherapy – Deformable Image Registration

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Received 12.03.2018; received in revised form 26.07.2018; accepted 27.07.2018

ABSTRACT

The purpose of this study is to evaluate the volume change of critical structures and its effect on cumulative dose by employing tighter CTV-to-PTV margins for target level II/III through a GPU-based (Geometric Processing Unit) deformable image registration. Ten H&N cases treated with simultaneous integrated boost (SIB) on a tomotherapy were retrospectively analysed (Accuracy Inc., CA). Each patient had one planning CT and daily kVCT images during the radiation treatment course. The standard – margin plan was generated by giving 3-mm margin to CTV1-3 and compared with the 0-mm margin plan for CTV2-3. However, 3 mm margin of PTV1 was saved to provide tumor coverage.

The volume of right parotid gland was decreased significantly for patients who lost more weight during the treatment course. The mean volume reduction was 11.7 % with the range of 29.3- 1.3 % and 13.5 % with the range of 25.9- 5.7 % in right and left parotid glands respectively. The difference in the delivered dose regarding standard margin plan and 0- mm margin plan was ≈ 10 % for the cord, ≈ 8 % and ≈ 19 % for the left and right parotid gland respectively.

IGRT is one of the most effective tools to correct set-up error and allow the planner to reduce margin. In addition, GPU-based 3D image framework was crucial for dose accumulation and evaluation of critical structures and targets. In this study, it was proved that acceptable cumulative dose for region of interest is consummated when connected with weekly kCVT guidance by using tighter CTV-to-PTV margins for level II and III targets for head and neck cases. On the other hand, change in volume did not affect the cumulative dose of critical structures when tighter CTV-to-PTV margin was employed.

Keywords: Deformable Image Registration, Head and Neck, IGRT, Tomotherapy

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 1

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000028

How Scintillation Crystal Type Affects the Energy Spectrum?

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Received 19.03.2018; received in revised form 26.07.2018; accepted 26.07.2018

ABSTRACT

Scintillation detector is one of the most often used particle detection device in radiation detection and measurements. It is basically composed of a scintillator and a photomultiplier tube (PMT). The most important parameter which affects the energy spectrum is its decay time. In the present work, two different types of plastic scintillators which have different decay times were used. Gamma energy spectra of ^{137}Cs radioactive source were achieved using the spectrometers consisted of different types of plastic scintillation detectors. The effect of the scintillator type to the energy spectrum was investigated. To reveal this effect, the spectra which were obtained with various plastic scintillators were compared to each other. It was concluded that the scintillator type is efficient on determining the optimum energy spectrum.

Keywords: Energy spectrum, Plastic scintillator, Decay time.

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000029

Comparison of Surface Dose in Conventional and Digital Mammography and Forming the Statistical Mars Model for the Patients Who Had Mammography Examination in Compliance with the Mammography Examination Protocol

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Received 24.03.2018; received in revised form 26.07.2018; accepted 27.07.2018

ABSTRACT

Digital mammography equipment in the 230 and 180 conventional mammography equipment were shooting from the upper breast and the inner surface of the patient. Conventional mammography shooting in 50 patients were measured from four different points outside the breast and bottom surfaces in addition to them. This method for TLD 100 dosimetric measurements were made using a dosimeter. A total of 460 patients compared the results obtained by conventional mammography, digital mammography in shooting with the dose received from the upper breast and the inner surface was determined to be higher in this study. As well as breast density values detected during breast ultrasound study of the patient's breast size, used during the measurement kVp and mAs values are also included in the study. This study attempted to establish Mars statistical model using all data obtained.

Keywords: Conventional mammography, Digital mammography, Surface dose, TLD-100 dosimetry

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 3

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000030

Investigation of the Effect of the Temporary Tissue Expander Used for Breast Reconstruction on Dose Distribution of Chest Wall Radiation

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Received 25.03.2018; received in revised form 26.07.2018; accepted 29.07.2018

ABSTRACT

The rate of breast reconstruction after mastectomy is increasing in women with breast cancer. At the breast reconstruction, silicone implants or temporary tissue expanders (TTEs) are placed instead of breast tissue taken during mastectomy. It is unclear how TTEs which contain metallic structures and filled with saline, affect dose distribution during RT. For this reason, so that optimum RT planning can be performed, the effect of metallic port in the Mentor TTE of dose distribution has been examined in our study.

MOSFET, NanoDot OSLD and EBT3 film dosimetric methods were used in the measurements. As a result of single frontal irradiation with metallic port made of samarium cobalt magnet and stainless steel, removed from the TTE, the maximum dose reduction rate at the bottom of the metallic port is 29.65% with NanoDot OSLD. The maximum dose increase rate over the metallic port is 6.25% with NanoDot OSLD. At the results obtained with measurements of 6 MV photon energy on rando phantom using TTE and silicone implant; for 3DCRT and IMRT treatment techniques, dose increase of less than 5% was observed on the over, right and left side of the metallic port with all dosimetric methods and the planning data. Under the metallic port, the rate of dose changes determined below 4% for these two treatment techniques. While using 9 MeV and 12 MeV electron energy, each dosimetric method and the data obtained from the treatment plans are evaluated in measurements dose increments of 12.63% with 9 MeV electrons and 10.66% with 12 MeV electrons were observed on the over, right and left side of the metallic port.

While examining the measurements, due to scattering caused by metallic port while there were doses increasing over the metallic port, there were doses decreasing under the metallic port. But according to the changes in dose at the doses prescribed by international dosimetric protocols ($\pm 5\%$) at our study the change in dose observed with 3DCRT and IMRT techniques at 6 MV photon energy appears to be not large enough to affect tumor treatment provided that the metallic port is introduced into TPS. At the 9 MeV and 12 MeV incision scar electron boost treatments, the metallic port significantly increased the skin dose even though it was introduced to TPS.

Keywords: Temporary tissue expander, Metallic port, Nanodot OSLD, MOSFET, EBT3 film

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 4

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000031

Development of Attitude Scale for Nuclear Energy and Environmental Impacts: Stability and Reliability Study

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Received 26.03.2018 ; received in revised form 26.07.2018; accepted 26.07.2018

ABSTRACT

This study, an attitude scale on the environmental effects of nuclear energy was developed. University students have been tried to determine their views on nuclear energy and environmental effects.

The developed scale is a 5 point likert type attitude scale. Factor analysis was performed on the scale after the development phase of the scale and an adaptation model study was carried out on the scale items and dimensions. The scale was formed as a 37-item draft scale and 366 students were applied. In addition, students' relations with each other in terms of various variables have been examined.

Within the scope of attitude scale reliability and reliability studies for nuclear energy and environmental effects, Cronbach Alpha reliability coefficient before analysis for general reliability was calculated as 0.534. When this value is small, a substance is removed from the scale (item 6) and the Cronbach Alpha reliability coefficient is calculated again. After analysis, it is calculated as 0,600. The results were evaluated at 95% confidence level.

Keywords: Environmental Education, Nuclear Energy, Environmental Impact, Scale Development

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 5

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000032

Making Safety Analysis of PWR Pressure Vessel with Favor Code

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Received 26.03.2018; received in revised form 26.07.2018 ; accepted 26.07.2018

ABSTRACT

Reactor Pressure Vessels are the most important structures in view of keeping the integrity for nuclear power plants. Fracture Analysis of Vessels Oak Ridge (FAVOR) is a code which is used in USA for PWRs and BWRs to make probabilistic analysis to calculate both Pressure Vessel Crack Initiation Frequency and Pressure Vessel Failure Frequency, using thermal hydraulic data, material properties, flaw properties of pressure vessels for some kind of accidents and start up-close down situations. The analysis is concentrated on the belt line of the pressure vessels; this region is the most vulnerable region of the vessels because of the fast neutron fluence, and so material embrittlement increases and fracture toughness decreases in this region. In this study the flaw data files which were supplied have been changed by decreasing the density of flaws which have different sizes and the Crack Initiation Frequency and Failure Frequency of reactor vessels have been searched. Consequently it has been seen that these frequencies have lower values.

Keywords: PWR, Pressure Vessel, FAVOR Code

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Journal of Nuclear Sciences, Vol. 5., No.1, Jan 2018, 6

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000033

Assessment of the Effect of Breathing Movements on the Skin Dose by Comparison of TLD Measurements and Plan Data in Breast Cancer Radiotherapy

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Received 26.03.2018; received in revised form 26.07.2018; accepted 10.08.2018

ABSTRACT

Breast cancer is the most common type of cancer in women. One out of every four women suffers from breast cancer in the world. It is important for receiving adequate skin dose in breast cancer radiotherapy. The detailed information of dose in various depths of skin has a critical importance to determine new treatment techniques. If the skin dose homogeneity is not achieved, the risk of recurrence of disease is increased. Therefore, the homogeneity of dose distribution should be provided on the surface as it is in other parts of the breast.

The aim of this study is to investigate the effect of respiratory movement and using the bolus on skin dose in breast cancer patients treated with helical tomotherapy. TLDs were placed on both the surface of the Alderson RANDO phantom's breast in eight points and on the projections of each points which is about 5 mm deep. A mechanism was used, which can be adjusted to the different frequency and amplitude values to simulate for measurements. The measurements were performed statically and dynamically (frequency=0.3 Hz, amplitude=5mm). Each measurement was repeated with and without bolus. The mean dose values were measured by using TLDs and bolus during respiratory at the surface and at 5 mm depth. The measured TLDs and calculated doses of TPS were compared, investigating the change of skin dose. The data were evaluated using the SPSS 20.0 statistical analysis program. According to the results, it is concluded that the respiratory movement is not a significant effect on the skin dose and it is not necessary to use the bolus. Besides, when TPS and TLD results were compared to each other; it is seen that, the estimation of skin dose of, TPS calculations was higher than TLDs measurements. This is clinically accepted. The results are in good agreement with literature values.

Keywords: Breast Cancer, Radiotherapy, Skin Dose, Respiratory Motion, Thermoluminescence Dosimeter (TLD)

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 7

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000034

Determination of Total Gamma and Peak Efficiency of NaI (TI) Detector

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Received 26.03.2018; received in revised form 26.07.2018; accepted 09.08.2018

ABSTRACT

NaI(Tl) detectors have high detection efficiency. NaI(Tl) is good at detecting low-level radiation sources. In this study, the total gamma and peak efficiency results of NaI (TI) detector for both point and disk sources were investigated. Total efficiency peak obtained by Geant4-based Gate Simulation program consisted with the literature and the data obtained using the hybrid Monte Carlo method. Full energy peak and total efficiency were also compared with the experimental result.

Keywords: Gamma, Detector Efficiency, Hybrid Monte Carlo Simulation, Geant4, Gate Simulation

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Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000035

Modelling of Hottest Channels of VVER-1000 and VVER-1200 Nuclear Reactors by Using COBRA-TF and ZEBRA Thermal Hydraulic Codes

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Received 26.03.2018; received in revised form 26.07.2018; accepted 06.08.2018

ABSTRACT

The Coolant Boiling in Rod Arrays-Two Fluid (COBRA-TF) code is known as a best estimate code, used to perform thermal-hydraulic analyses for a light water reactor vessel. On the other hand, ZEBRA computer code is used to perform closed channel analysis, basically for educational purposes. In this study, the hottest channels of two Russian type nuclear reactors, namely VVER-1000 and VVER-1200, are modelled as one single channel by using COBRA-TF and ZEBRA thermal hydraulic codes. Both outputs of these two codes and operating conditions of hot channels of these different type reactors are compared. Clad outside temperatures, clad inside temperatures, fuel centreline temperatures, pressure drops, qualities and critical heat fluxes are main operating parameters that are compared. Besides, look-up table that is used to calculate critical heat flux for triangular nuclear fuel assembly pitch and outputs of COBRA-TF and ZEBRA codes are also compared. Some of the correction factors which are used on the look-up table results, if/when necessary are included for the calculations as well.

Keywords: COBRA-TF, VVER-1000, VVER-1200, Critical heat flux

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 9

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000036

Application of SPECT / BT Simulations on Dynamic Resources by the Gate Software Oncological Imaging

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Received 27.03.2018; received in revised form 26.07.2018; accepted 26.07.2018

ABSTRACT

Computerized tomography is a method of radiological diagnosis that allows us to arrive at a cross-sectional view of a region of the body under examination using X-rays. SPECT is a high-level 3D imaging of scintigraphy taken for the treatment of conditions such as radioactive materials, thyroid diseases, cancers, tumors, inflammatory diseases, etc. The fact that SPECT and CT are in one system gives spatial and pathological correlation of abnormal metabolic activity. This ensures that images are recorded together at the most efficient level and images are obtained from both systems with a single review.

In this study, SPECT / CT simulations were performed for cylindrical voxel phantoms with near-real content using the GATE (PET & SPECT simulator library) created by the GEANT4 simulation software developed by the European Center for Nuclear Research (CERN). In the installations created in the virtual environment, activity differences, displacement and curtain effects of the tissues were investigated. Analyses were made with the ROOT software to obtain sinograms and dose curves. When the obtained data were analysed statistically, the results of these types of SPECT / CT imaging were found to be significant differences and the results were revealed.

Keywords: SPECT / CT, Voxel, GEANT4, GATE, ROOT

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 10

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000037

Physics and Engineering Aspects of High Power Electron Beam Dump for TARLA

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Received 27.03.2018; received in revised form 26.07.2018; accepted 05.08.2018

ABSTRACT

Beam dumps are commonly used in particle accelerators, to absorb safely, stop and neutralize the high energetic particle beams without any harm to their organic and inorganic surroundings including the beam line itself. Thermal, nuclear and mechanical properties of the system are important for their operability and functionality. Depending on the energy and parameters of particles hitting the beam dump, the beam will transfer heat to the system, and may create radioactive material in beam dump. On the other hand, due to their complex structure, the components used to form beam dumps must be mechanically manufacturable, interchangeable and redundant.

In this work, the design aspects of high power electron beam dump for the TARLA (Turkish Accelerator and Radiation Laboratory in Ankara) Facility -under construction at the Institute of Accelerator Technologies of Ankara University- were discussed. Several beam dump options were taken into account by focusing on nuclear interactions and radioactive properties of the dump. Various core materials such as aluminium, copper, carbon or alloys were compared by using FLUKA and Geant4 simulation tools. Shielding materials and geometries such as lead, concrete have been also taken into account.

Keywords: Beam Dump, Nuclear Activation and Shielding, Fluka, Geant4

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 11

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000038

Economical Investigation of Nuclear Desalination in Akkuyu Nuclear Power Plant

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Received 27.03.2018; received in revised form 26.07.2018; accepted 13.08.2018

ABSTRACT

Increasing population and developing technology both cause environmental pollution, which along with wrong agricultural irrigation and global warming are threatening fresh water resources. Because of this, fresh water production by using desalination facilities is getting popular nowadays. Thermal cycle electricity facilities such as nuclear, coal, oil and gas plants can produce fresh water with electricity by using desalination. Currently, working on this type of facilities is getting important. Nuclear desalination systems can provide cheap and sustainable energy with fresh water to various countries. In this work economical investigation was performed for nuclear desalination facilities that work with VVER 1200 nuclear reactor, which is the first Turkey nuclear power plant now under construction in Mersin, Akkuyu. To achieve this working, Desalination Economic Evaluation Program (DEEP) which was developed by International Atomic Energy Agency (IAEA) was used. DEEP software makes economic analysis of desalination systems with working thermal cycle electricity plants such as nuclear, coal, oil and gas plants. VVER 1200 data were obtained from IAEA data base and environmental data for Mersin Akkuyu were used for analysis. Then analysis for variable desalination technologies with variable production rates to evaluate ideal results were performed. Results of economic analysis for Mersin, Akkuyu nuclear desalination plant working with VVER 1200 reactor, ideal desalination technology and production rate were investigated. With these results electricity demand and price with fresh water demand and price in Turkey to understand desalination plant is suitable for Turkey were determined.

Keywords: Akkuyu Nuclear Power Plant, desalination, DEEP

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 12
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ISSN: 2148-7736

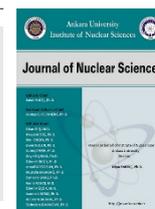


Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000039

Quality Control and Performance Tests in Magnetic Resonance Imaging with the Direction of the Medical Physicist

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Received 27.03.2018; received in revised form 26.07.2018; accepted 26.07.2018

ABSTRACT

The aim of the Magnetic Resonance Imaging (MRG) device is to provide the performance, image quality and patient safety. It was also compared with the quality control and performance tests conducted by the medical physicist in the American College of Radiology (ACR) guide. Quality control and performance tests were conducted with an authorized service engineer of the Philips medical device company on April 12, 2016. A 1.5 Tesla Philips Achieva/Intera MRI device and the phantoms compatible with this device were used at the Radiology Clinic of the OMÜ Faculty of Medicine. The resultant quality control and performance tests result in phantom images; by evaluating these images, no problem and image artefacts were observed in the MRI device concerned.

Keywords: Magnetic Resonance Imaging, Quality Control

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 13

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000040

Radiation Dose from Megavoltage Cone Beam Computed Tomography for IGRT

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Received 09.04.2018; received in revised form 26.07.2018; accepted 13.08.2018

ABSTRACT

In this study, we try to figure out the organ dose of CBCT for head&neck and pelvis's critical organs with three different CBCT protocols. We also compare the image quality of these protocols and try to find the optimum one for dose and image quality. In this study, organ doses were measured for three different megavoltage CBCT protocols on the Siemens Artiste linear accelerator treatment machine. Organ doses were measured by distributing thermoluminescent dosimeters (TLDs) throughout critical organs of an anthropomorphic (RANDO) phantom. The selected organs include rectum, bladder, femoral heads and small intestine for pelvis imaging and spinal cord, brainstem, thyroid and parotid glands for head and neck imaging. The TLDs placed RANDO phantom was irradiated by using three different imaging protocol and the doses were compared. We have also performed image quality tests for each protocol. We have seen that 15 MU protocol has no difference with 8 MU protocols in the means of image quality and the dose of critical organs is much higher than the others as expected. When we compare 8 MU and 8 MU half ring protocols in the mean values of organ doses, we have seen that the doses of organs changes according to the geometrical placements of organs. Accordingly, while the doses of organs, such as rectum, spinal cord and brainstem, nearby the posterior decreases with the use of 8 MU half protocol, the doses of organs located anterior, such as intestine, thyroid and bladder, increases. It is observed that both the contrast resolution and the spatial resolution of the 8 MU half protocol is better than the 8 MU protocol. After obtaining all this information about MV CBCT protocols, we figure out that the choice of CBCT protocol should be done after treatment planning by considering of the doses and location of the critical organs.

Keywords: CBCT, IGRT

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000041

Estimation of the Trapping Parameters of $\text{Li}_2\text{B}_4\text{O}_7:\text{Ag}$, Gd Phosphor using FGC, ID and CGCD Methods

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Received 11.04.2018; received in revised form 26.07.2018; accepted 27.07.2018

ABSTRACT

Lithium tetraborate ($\text{Li}_2\text{B}_4\text{O}_7$) phosphor is a well-known candidate for thermoluminescence dosimetry (TLD), mostly because of its near tissue equivalence. In this study, $\text{Li}_2\text{B}_4\text{O}_7:\text{Ag,Gd}$ phosphor was synthesized using Solution Combustion Synthesis (SCS) method; its kinetic parameters such as trap depth (E_a), frequency factor (s) and order of kinetics (b) were evaluated. The TL glow curve of the phosphor consists of three glow peaks at ~ 80 , 160 and 260 °C with a heating rate of 1 °C/s after 10 Gy beta dose exposure. The activation energies for 160°C TL peak obtained using Fractional Glow Curve (FGC), Isothermal Decay (ID) and Computerized Glow Curve Deconvolution (CGCD) methods were calculated to be 0.86, 0.85 and 0.94 eV, respectively. The frequency factor for the same TL peak was determined as $3.20 \times 10^{14} \text{ s}^{-1}$ and $3.62 \times 10^9 \text{ s}^{-1}$ using FGC and CGCD methods, respectively. It can be concluded that the activation energies obtained by different methods are in agreements with each other.

Keywords: $\text{Li}_2\text{B}_4\text{O}_7$, Fraction Glow Curve Method, Isothermal Decay Method, Computerized Glow Curve Deconvolution Method

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 15

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ISSN: 2148-7736



Hosted by Ankara University

Journal of Nuclear Sciences

p-ISSN: 2147-7736, e-ISSN:2148-3981

Journal homepage: <http://jns.ankara.edu.tr/>



DOI: 10.1501/nuclear_0000000042

Examination of Breast Doses from Digital Mammography and Digital Breast Tomosynthesis from Monitor

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Received 19.04.2018; received in revised form 26.07.2018; accepted 09.08.2018

ABSTRACT

Glandular tissue in the women's breast is a radiosensitive tissue. For this reason, both of the radiological based breast imaging techniques, two dimensional mammography or three dimensional tomosynthesis, are the sources of the risk of radiation-induced carcinogenesis. Since average glandular dose cannot be measurable directly, its evaluation was performed by multiplication of incident air kerma and factors which were obtained by Monte Carlo simulation. In this study, doses from both digital mammography and digital breast tomosynthesis are examined for different imaging procedures and patients, all data taken from one device from the hospital.

Keywords: Tomosynthesis, Mammography, Glandular Tissue, Dose

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Journal of Nuclear Sciences, Vol. 5, No.1, Jan 2018, 16

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ISSN: 2148-7736