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Evaluation of uptake values of FDG: body surface area correction is preferable to body weight correction

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Abstract

Positron emission tomography (PET) using â€˜8F-fluoro deoxy-glucose (FDG) has been successfully employed to image glucose utilization in various tumours (1-15) PET FDG imaging has been used clinically to grade the degree of malignancy of tumours, differentiating recurrent tumour from scar or radiation necrosis, predicting patient survival and tumour staging. It has been reported that the degree of FDG uptake in tumours correlates well with its degree of malignancy. Standardized uptake values (SUVs) are commonly used to assess the uptake of 18F-fluorodeoxyglucose (FDG) in various tumours. Normalization of FDG uptake for patient body weight (SUVbw) has been reported tooverestimate FDG uptake in heavy patients, as their fraction of body fat (with low FDG uptake) is frequently increased. The goal of this study was to see if "normalization of FDG uptake for body surface area" (SUVbsa) is independent of patient body size and more reliable than SUVbw. FDG-PET images were obtained on 40 cancer patients (body weight range: 34-110 kg). For the liver, SUVbw [(mCi/g of tissue)/(mCi injected/patient body weight in g)] and SUVbsa [(mCi/g of tissue)/(mCiinjected/patient BSA in m2)] were calculated. Because most observers are used to using the SUVbw, the two values were compared by making the mean SUVbsa equal to the SUVbw. SUVbsa was 0.79 –5.8 and SUVbw was 3.11 – 28.36, respectively. The SUVbsa had a lower standard deviation than the SUVbw. In large patients, SUVbw overestimates FDG uptake. SUVbsa appears to be preferable to SUVbw because it is less affected by body size.

Influence of gamma irradiation on the electrical properties of $CuPbI_3$ perovskite thin films

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Abstract

The $CuPbI_3$ perovskite thin films, were successfully deposited on room temperature silicon and 200o annealed silicon substrates using spin coating technique were studied as a function of gamma ray doses in order to investigate the radiation detection and dosimetric ability of this material. The deposited samples were irradiated by gamma radiation with 60Co source at room temperature with different dose in the range of 0–100 kGy. Then, the pristine and gamma exposed samples were analyzed by current-voltage (I-V) characterization. In addition, the current-voltage (I–V) characteristics of the pristine and low gamma exposed samples using 137Cs source were studied in order to investigate the effect of gamma dose during different period of time and the responses of the sample as semiconductor live detector. There was an increase in the value of the forward current with increasing gamma dose. The ideality factor of the samples is greater than unity, whereas barrier height and saturation current for the samples changed with radiation because of density of defect induced by gamma and charge carrier trapping on interface layer. The results were in a good agreement with the semiconductor live detector experiment result. This study concludes that incident gamma rays have a significant impact on the $CuPbI_3$ perovskite thin film's electrical properties. The clear resulting impacts of different gamma doses on the characteristics of this material deposited on different substrates may open the channel for further investigations on the ability of this material to be a gamma radiation sensing material.

Development of new gamma rays detection system using CsI and PbI_2 materials as sensing layers of the Microelectromechanical sensors

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Abstract

Recently, development of new gamma rays detection system based on cost effectiveness, high detection properties has spurred a great interest for scientist in the industrial and medical fields. The aim of this research is to combine the well-established scintillating material such as, cesium iodide (CsI) and high atomic number lead Iodide (PbI_2) together with the Microelectromechanical systems (MEMS) sensors, which have been a significant component in the development of smart sensing systems during the last several years due to their high accuracy, sensitivity, and selectivity. The cesium iodide (CsI) and lead Iodide (PbI_2) thin films are used as sensing layers on the silicon micro-electromechanical system. These layers were deposited on the silicon using a thermal evaporation technique to ensure a uniform distribution of the sensing layer. Before, during, and after gamma irradiation with a 137Cs source, the prepared samples were fully characterized using X-ray diffraction (XRD) and current-voltage (I-V) characteristics. The resulting data revealed a promising correlation between the incident gamma rays and changes in the MEMS system's resonance frequency. The full analysis of this study, the static and dynamic response characterization of nanomechanical sensors coated by perovskite, which confirms the proposed setup's potential use as radiation sensing, will be presented.

Radiation hazard assessments of natural radioactivity in clay-based cosmetic Products

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Abstract

Natural sources such as clays, plant extracts, and raw materials containing naturally occurring radioactive material (NORM) have been used as ingredients for medicinal and cosmetic purposes since ancient times. Nowadays, a variety of commercially available cosmetics products used clay mineral as the main formulation, in which contain NORMs that pose unknown radiation risks to the consumer. In this study, 11 samples of clay-based cosmetic products were used to conduct dose assessments on members of the public for various usage scenarios in order to evaluate the external exposure dose. Gamma-ray spectroscopy was utilized to determine the activity concentrations of 238U, 232Th, and 40K in the sample. Meanwhile, doses to skin and other organs from these cosmetic products were modelled using Geant4 Monte Carlo simulations and the MIRD5 mathematical phantom, incorporating Dose Conversion Factors (DCFs). The results revealed that the activity concentration is lower than the reference provided by international regulation. Furthermore, the effective doses in the skin estimated in this study are significantly lower than the International Commission on Radiological Protection (ICRP) reference limit of 50 mSv per year for members of the general public. As a result, it is safe to conclude that the dose from these products poses no radiological risk to the user. The addition of NORMs in cosmetic products, on the other hand, should be done with caution because higher concentrations can raise the dose.

Fabrication of Gamma-Ray Scintillator Detector Using Organic Conjugated Materials

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Abstract

Organic Scintillation Counting (OSC) has been a widespread method for detecting and characterizing radioactivity due to its better time resolution, excellent n-γ discrimination capabilities. We report flexible and efficient composite organic scintillator based on light-emitting conjugated oligomer that harvest the excitation from the surrounding aromatic solvent then emit light intensely. The characteristics of the designed organic scintillator detector have been studied using 137Cs gamma source. Multiple studies were performed to evaluate characteristics of the fabricated liquid scintillator such as emission wavelength, absorption, light output. The results showed that conjugated materials have an effective role in the development of nuclear radiation detection.

Proposing Diagnostic Reference level for CT Pelvis and abdomen Examinations Taif City

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Abstract

CT scan is one of the medical imaging methods that irradiate patients with significant amounts of radiation. These amount of radiation doses must be well estimated if the imaging area is located in part containing radiation-sensitive organs such as the pelvic/abdomen region. The objectives of the current study were to assess radiation dose during abdomen/pelvis CT imaging and estimate the effective dose as well as to propose diagnostic reference level (DRL). Methodology: 200 adult patients irradiated in two major governmental hospital in Taif city, Saudi Arabia, patients' demographic data from was collected such as weight, height and age. Scanner specifications and scan parameters for each pelvis examination were recorded in special data collection sheet. Volume CT dose index (CTDIvol and dose length product (DLP) were utilized to estimate the radiation dose and effective dose. Microsoft Excel was used to analyse the data. There was variation in scanning parameters among two hospitals under study and this result in variation in effective dose between two hospitals. The average DLP, CTDIvol and effective dose were 368.5, 390.7 mGy-cm,10.2,10.8 mGy and 7, 7.4 mSv for hospital one and two respectively. Conclusion: Based on the third quartile of DLP and CTDIw, the recommended DRL for both hospitals was 405 mGy-cm and 21.75 mGy, respectively. The findings revealed a reduced effective dose value when compared with previous studies.

RP-006-VO

Measurement of annual whole-body occupational radiation exposure in medical and industrial fields in Saudi Arabia

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Abstract

Monitoring of Radiation workers' (RWs) occupational doses resulting from working in different applications is essential to comply with the recommended dose limits (20 mSv) and establish a reference level for the annual occupational dose. In this study, the TLD dose records of 58,162 RWs in the medical and industrial fields were collected and analyzed to assess their annual occupational dose - in terms of mean annual effective dose (MAED). The RWs in the medical field included workers in diagnostic radiology (DR), nuclear medicine(NM), radiotherapy (RT), dentistry, catheterization laboratory (Cath Lab.), operation room (OR), and medical internship students (MIS). The RWs in the industrial field included road industry workers who use nuclear moisture density gauges (RI), workers in the phosphate mining industry (PMI), and workers in cyclotron facilities (CF). The MAED ± SD was 0.88 ± 0.56 mSv for DR, 1.22 ± 1.08 mSv for NM, 0.73 ± 0.47 mSv for RT, for 0.78 ± 0.47 mSv dental workers, 0.95 ± 0.61 mSv for Cath Lab., 0.59 ± 0.44 mSv for OR, 0.55 ± 0.34 mSv for MIS, 0.80 ± 0.46 mSv for RI, 0.66 ± 0.45 mSv for PMI and 1.60 ± 1.46 mSv for CF. A one-way ANOVA was carried out to determine significant differences in the MAED between workers in various fields. The results showed significant differences in the MAED between workers ($F[9,58094] = 186.477$, $p = 0.000$). The highest MAEDs in the medical and industrial fields were for NM workers and CF workers, respectively. However, the MAEDs for RWs in both fields, medical and industrial, were below the annual dose limits.

Assessment of Occupational Radiation Exposure to Medical Workers Involved in Interventional Endourology

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Abstract

In recent years, fluoroscopically-guided interventions have become an essential part of endourology practices. Medical staff conducting fluoroscopically-guided interventions procedures are mainly exposed to scatter radiation. This study aims to estimate the annual effective doses for medical workers involved in interventional endourology procedures for five continuous years (2015-2019). A total of 258 workers were monitored from five major medical centres around Saudi Arabia. The effective doses were estimated using thermoluminescent dosimeter (TLD). The TLDs used in this study estimates the whole-body dose equivalent at a depth of 10 mm and referenced as Hp(10). Harshaw 6600 Plus reader was utilized with a sensitivity ranging from 10 □Gy to 1 Gy. The analysis of the TLD data showed that the mean annual effective dose for workers averaged over the study period was 0.70 mSv, ranged from 0.12□3.18 mSv. The mean annual collective effective dose was 180.81 man-mSv. The results revealed that the annual mean effective doses for workers involved in fluoroscopically-guided interventions procedures in Saudi Arabia were way below the recommended dose limit of 20 mSv. However, to comprehensively assess the occupational exposure, further studies should be performed to estimate the annual equivalent dose of the eye.

Radiation Dose Assessment for Nuclear Medicine Workers in Riyadh Region, Saudi Arabia

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Abstract

Nuclear medicine (NM) is an essential medical department concerned with diagnostic and therapeutic procedures where medical radiation workers are exposed to higher radiation exposure than workers in other medical departments. This research aims to analyze the radiation exposure of radiological technologists (RTs) and nurses in NM departments from 2017 to 2021. Data was collected from four major medical centers in the Riyadh region of Saudi Arabia. As recommended by the International Commission of Radiological Protection (ICRP), the whole-body annual dose limit is set at 20 mSv averaged over five consecutive years. The personal dose equivalent Hp(10) of 73 RTs and 46 nurses were estimated using thermoluminescent dosimeters (TLD). The TLDs used in this study were made of Lithium Fluoride (LiF:Mg,Ti) materials (TLD-100). The TLDs were read using a Harshaw 6600 reader along with Win-REMS software. For calibration, the built-in 90Sr/90Y irradiator was utilized. During the study period, the annual mean effective dose averaged over the study period for RTs and nurses was 0.92 mSv (0.01-5.52 mSv) and 1.07 mSv (0.07-3.26 mSv) respectively. The result of this study revealed that no single worker received a dose exceeding the annual dose limit. This indicates a safe working conditions in terms of radiation protection in the NM departments in the Riyadh region of Saudi Arabia.

Skin Dosimetry in Medical Applications Based on Operational Dosimetric Quantities Hp (0.07): A Saudi National Study

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Abstract

The most recent investigations of the data on the atomic bomb survivors shows excess relative risk for the incidence of non-melanocytic skin cancer. On the basis of this data, the International Commission on Radiological Protection (ICRP) proposed a dose limit for skin for the occupationally exposed workers. Limitation of the skin organ dose can still be considered adequate protection against stochastic effects on the skin and which conclusions might or can be drawn with regard to protection against radiation exposure at the workplace. Therefore, this study aims to estimate the annual equivalent doses to skin for medical workers in diagnostic radiology, interventional radiology, nuclear medicine, radiotherapy, dentistry, and operation rooms. In this study, thermoluminescent dosimeter (TLD-100) was used to obtain dose records of 41,180 medical workers for five consequative years (2015-2019). The TLDs used in this study estimates the skin dose equivalent at a depth of 0.07 mm and referenced as Hp (0.07). The annual occupational doses received by skin averaged over the study period for diagnostic radiology, interventional radiology, nuclear medicine, radiotherapy, dentistry, and operation rooms were found to be 0.85±0.63 mSv, 0.88±0.58 mSv, 1.64±0.88 mSv, 0.84±0.97 mSv, 0.81±0.54 mSv, and 0.70±0.44 mSv, respectively. A one-way ANOVA was carried out to determine significant differences in the annual occupational doses received by skin averaged over the study period between workers in different departments. The results showed significant differences in the dose between workers ($F [5,41174] = 63.69$, $p = 0.000$). During the study period, the annual occupational doses received by skin for for all workers were below the annual dose limit of 500 mSv.

The role of Dual energy x-ray absorptiometry scan and bone turnover biomarkers in the clinical assessment of changes in bone density in Rheumatoid Arthritis patients

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Abstract

Rheumatoid Arthritis (RA) manifest periarticular bone loss due to erosions, generalised bone loss and are at a higher risk of fractures. The beneficial clinical response to biologic anti-inflammatory agents as measured by disease activity score 28 (DAS28) my not corresponds with parallel improvement in bone density/erosion and turnover in RA patients. To assess the impact of treatment with biologic anti-inflammatory agents on bone density/erosion and turnover in RA patients, bone mineral density (BMD) and bone turnover biomarkers was investigated. 62 RA patients, included 49 females and 13 males. The mean age of patients was 69±12 years (40-79 years), were subjected to measurements of BMD by using DEXA scan and the plasma levels of bone turnover biomarkers CTX and osteocalcin were measured by enzyme-linked immunosorbent assay (ELISA). BMD of the lumbar spine and hip increased in responder patients after treatment by 0.0396g/cm^2 (3.96%, p<0.001 vs. before treatment) and 0.001g/cm^2 (0.11%, p<0.001 vs. before treatment), respectively. Interestingly, clinically non-responder patients, according to their DAS28, showed an improvement in BMD of the lumbar spine with mean of 0.03g/cm^2 (3.03%, p<0.001 vs. before treatment) and minor reductions in BMD values at the hip with a mean of -0.008g/cm^2 (-0.78%, p<0.001 vs. before treatment. The level of CTX decreased in responder patients after 3 months of treatment compared with before treatment, 164±125pg/ml to 131±129 pg/ml. Interestingly, the level of osteocalcin increased significantly after 3 months of treatment in non-responder patients compared with before treatment, from 11.6 ±8.1ng/ml to 14.9±8.1ng/ml (p=0.01).Treatment with biologic anti-inflammatory agents arrests generalised bone loss at lumbar spine and hip of patients with RA. Interestingly, the beneficial effects of treatment on BMD did not completely parallel improvements in the disease activity of RA patients. The beneficial effects of treatment were also consistent with changes in plasma levels of biomarkers of bone turnover such as C-terminal.telopeptide of type I collagen (sCTX) and osteocalcin.

RP-011-PP

Holy Cross-Moon Shaped Dual Band Absorber for C-Band Application

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Abstract

A dual band electromagnetic perfect metamaterial absorber (PMA) is presented in this article. This novel design comprises a moon shape and a holy cross shape metal bars which are surrounded by a circle and an octagonal close ring resonator (OCRR). A flame retardant dielectric FR4 of thickness 1.6 mm is used as substrate. Popularly used simulator CST microwave studio is applied to simulate the proposed unit cell within the frequency range 1 to 6 GHz. The numerical simulation shows two resonance peaks at 4.11 GHz and 4.99 GHz with excellent absorption rate. The projected PMA exhibits maximum absorption 99.86 % (4.11 GHz) and 99.22% (4.99 GHz) in TE mode for normal incidence angle. The structure of the unit cell was optimized through some recognized parametric studies like design optimization, resonators widths, gaps among resonators etc. The extracted numerical results are tested and authenticated by some validation processes as equivalent circuit modeling, high-frequency structure simulator (HFSS) and array orientations which revealed an unimportant disparity. The offered perfect metamaterial absorber is fit for satellite communication, stealth-coating technology, defense and security uses.

Thermoluminescence Dosimetry using Coloured Marble Beads Irradiated at Radiotherapy Energies

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Abstract

For many decades thermoluminescent dosimeters have proven themselves highly effective for radiation medical dosimetry. Nonetheless as a result of a number of recent developments in medical applications, both in sources and delivery techniques, considerable impetus exists for the development of ever-more accurate dosimeters. Notable has been several contemporary studies concerning the performance of various types of silica-media. Doped and undoped glass beads and optical fibres have demonstrated abilities to detect medical radiations over the dose range sub-mGy to several Gy. Herein, we investigate the dosimetric capability of novel marble beads of different sizes and colour, irradiations being performed at King Khalid Hospital, Hail City, Saudi Arabia. Prior focus on diagnostic applications, including computed tomography, chest x-rays, and use of portable x-ray machines have revealed excellent dose response at low energies for all colours. We now focus on radiation therapy dosimetry, examining the performance of these same marble beads at high energies.

The Efficacy of Thick Gas Electron Multiplier Detector in Measuring 14C for Dating Purpose

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Abstract

Measuring carbon-14 (14C) activity in a material of biological origin provides the age of that material, also indicates the radioactive contamination due to radiocarbon in existing organisms, plants, etc. Several techniques comprising direct and indirect methods are used in dating employing 14C. This study introduced a new method for calculating the 14C activity using Thick Gas Electron Multiplier (THGEM) detector in Self Quenching Streamer (SQS) mode. In this method, by placing the 14C contaminated sample in front of the THGEM detector, the correlation between the 14C activity and the number of SQS light in THGEM holes is obtained via both the Monte Carlo simulation and measurement. The obtained results show that the THGEM detector is suitable to determine the 14C activity in existing organisms and plants. The proposed THGEM detector removes the necessity of expensive electronic amplifiers in conventional 14C detectors. It is expected that the THGEM can be efficiently used in 14C dating and determine the radioactive contamination caused by radiocarbon in plants and the environment.

RP-014-VO

Personalized Dosimetry in Lu177 Radionuclide Therapy

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Abstract

Peptide receptor radionuclide therapy (PRRNT) is a targeted radiation therapy involving the administration of a peptide labelled with radioisotope to target with high affinity and specificity receptors overexpressed on tumours. PRRNT using the somatostatin receptor agonists like 177Lu-Dotatate have been successfully used for the past 15 years to target metastatic or inoperable neuroendocrine tumours. The therapy is performed using 177Lu ((Gamma of 113 keV (6.4%), 208 keV (11%), and beta radiation of 497 keV)) with reasonable half-life (6.64 days). In Kuwait, this study is conducted to evaluate the organ doses during different cycles of theranostic applications. There is a growing body of evidence that show correlations between absorbed dose and tumor response as well as normal-tissue toxicity. This indicate that treatments should be based on personalized dosimetry, aiming to deliver therapeutically effective absorbed doses to tumors, while keeping doses to organs at risk below the threshold levels for deterministic adverse effects. The objective of this study is to assess the patients' effective and organ dose during theranostic applications in Kuwait. A total of 25 patients were undergone theranostic procedures with 177Lu Dotatate in Kuwait Cancer control center. Medium energy collimator was used to acquire images in specific interval time 1-2 hr (before emptying bladder), 6, 24, 48, 72 hr. Organ and total patients doses were calculated using Organ Level Internal Dose Assessment (OLINDA) Software. The mean effective dose (mSv/MBq) for the left and right kidneys, liver and urinary bladder were 0.61 and 0.60, 0.08 and 0.36, respectively. The overall effective dose (mSv) ranged from 0.55 to 7.7. Lu-177 acquired scans provided diagnosable information's. The doses are higher compared to other reported studies. Variation is attributed to the departmental protocol and administered activity. Optimisation of the SPECT/CT imaging protocol is recommended to assure that patients received a minimal effective dose.

Monte Carlo Modelling of in-field and out-of-field dosimtery from 6 MV Elekta Linear accerletor, validation and challenges

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Abstract

In order to be able to establish a framework for the estimation of the dose and the risk due to radiotherapy treatment, the first and most essential step is the precise modelling of the linear accelerator head. These studies are important in order to find ways to reduce the risk. The modelling of linear accelerator presents in the literature focus mainly on in-field dosimetry. Modelling of out-of-field dosimetry with Monte Carlo is challenging because more number of histories are required and more details need to be included in the head model. In this study, a 6 Elekta linear accelerator were modelled and validated against measurements by comparing the output factors, percentage depth dose and lateral profiles. The validated model results compared with measurements for out of field doses up to 60 cm off-axis. The resultant lateral profiles obtained with these models were compared with the out-of-field measurements. Initially the validated model showed discrepancies between measurements and modelled doses at out of field region from 10 to 60 cm off-axis. Even though these models are valid for in-field dosimetry, it was found that there were discrepancies between the calculated and the measured profiles at out-of-field region. Hence, two main adjustments were made in the dimensions and materials of the head components of the LINAC model in order to acquire the best possible agreement with the measured values. Also small head components such as ion chamber, mirror and Mylar sheet are included in the model. The results after modifications showed good agreement between the model and measurements up to 40 cm of field, however from 40-60 cm there still discrepancies. This is due the fact the background radiation
and room scatter was not included in the model.

Cumulative radiation exposure and cancer risk estimation in stroke patients undergoing repeat or multiple CT

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Abstract

In recent years, the issue of cumulative effective dosage received through recurrent computed tomography examinations has been a global concern. Many patients receive a 100 mSv or higher cumulative effective dose, according to statistics. Stroke is the second biggest cause of death worldwide, with around 5.5 million deaths each year. Patients with stroke are subject to multiple and recurrent brain CT scans during their treatment period. The objective of this study was to analyse cumulative effective dose and cancer risk associated with recurrent computed tomography (CT) head scan during the stroke. Data was collected using a validated survey including scanner information, patient height and weight, protocol, and dose indices (CTDI and DLP). Retrospective systematic search at the picture archiving and communicating system (PACS) database for all the patients who underwent at least twice head scans while admitted to the hospital because of stroke. Effective and organ doses calculated by VirtualDose software based on ICRP 103. A total of 70 patients' data extracted conducted a range of two to five scans. The patients were admitted to the hospital for 3 weeks to 3 months. The standard protocol for all patients and the scanning range was 23.9-28.9 cm, with a mean of 28.7±1.7. The mean CTDIvol and DLP values per sequence were 51±1.8 and 632.4±34.8, respectively. The highest organ dose is recorded at the brain and the lowest at the breast. The (mean ± SD), (minimum-maximum) were 56.2±16, 30-75.1 and 3.5±0.9, 2-5 for the brain and breast, respectively. Focusing on referring physician awareness and encouraging request justification and dose optimization for patients subject to frequent radiation exams is crucial. In addition, the cumulative effective dose should be part of training programs for referrers, radiologists and radiographers.

RP-017-PP

Production of Radioisotopes

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Nuclear Medicine Specialist Consultant

Abstract

The Main methods of radionuclide production are: fission, cyclotron and generator. Fission in a nuclear reactor where neutrons are used to bombard fission nuclides such as uranium-235 (235U) by splitting of the large nucleus into smaller fission fragments along with the release of gamma radiation and high energy neutrons. The neutrons as particles are used to bombard stable nuclides to form other radionuclides. Cyclotrons are used to accelerate charged particles such as protons (p) to high velocities to penetrate the targeted atom and interact with the nucleus. Generators produce the most commonly used radionuclide in nuclear medicine, technetium-99m (99mTc). The radionuclide generator sees the decay of a long half-life parent radionuclide to a short half-life daughter radionuclide. The daughter is the radionuclide used in nuclear medicine. An understanding of radionuclide production will assist in the understanding of both diagnostic and therapeutic radioisotopes which suitable for nuclear medicine procedures.

Calibration of some Radiological Scanning Devices used in the Education, Industrial and Medical Sectors in the Kingdom of Saudi Arabia

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Abstract

Different types of radiological scanning devices were identified, and then twenty radiological scanning devices were selected, with the aim of making a statistical work to reach some types of devices used in the industrial, research and medical sectors, and to find the best companies whose devices have a low error rate, and to indicate the quality of the devices used in them, Then suggestions and recommendations. The mechanism of work was initially to identify the radiological scanning devices and to indicate the most important differences between them, and then to know the best reading of the devices, which is in the range (0.80-1.20). Radiation and the necessary procedures before starting the calibration process, and then identifying the calibration and its importance, then calibrating for some of the radiological scanning devices, and then working the statistics on the twenty devices, by classifying them according to the type of device and the target sector (industrial-medical-research) and the error rate and average percentage The error is in each device separately, and then another statistic was made in the form of a table that was classified according to the name of the device, the target company, the error rate in the device, and in the end, calculating the average error rate for the devices in each company separately, and then the table was represented in the form of graphs representing the names of the companies In each sector (medical-research-industrial), the type of device used and the average error rate in it, In the end the average error rate in each field was reached separately and the best sector was known (the average error rate is few) and also the best companies (the average error rate in their devices is few) and the quality of the devices used and the knowledge of the factors affecting the reading of the devices and then suggestions and recommendations Based on the previous results, and in the end, we reached the conclusion of our research, which talked about (calibration of some radiological scanning devices used in the education, industry and medicine sectors in the Kingdom of Saudi Arabia).

Radiological impact assessment and emergency planning zones for accident scenarios in a proposed pressurized water reactor in Saudi Arabia

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Abstract

To license constructing a new nuclear power plant (NPP), it is required to perform a radiological impact assessment that considers potential accidents and emergency planning zones which are based on the estimation of radioactive releases following such accidents. This involves investigating the potential effects on the neighboring population and surrounding environment. This paper assumes that a pressurized water reactor (PWR) to be constructed in the Eastern Coast of Saudi Arabia. This work will consider several accident scenarios, such as: uunmitigated long term station blackout; unmitigated short term station blackout; unmitigated short term station blackout with thermally-induced steam generator tube rupture; unmitigated interfacing system loss of coolant accident with containment bypass; and loss of coolant accident (LOCA) followed by core meltdown, assuming filtration occurs in the containment vessel's annulus and NPP building's ventilation systems. The HotSpot Health Physics Code provides a first-order approximation of the radiation effects associated with the atmospheric release of radioactive materials. HotSpot tool will be utilized to estimate the ground deposition in (kBq/m2) of certain released radionuclides such as 137Cs and 131I. The total effective dose equivalent (TEDE) in (Sv) and cancer risk (probability) will also be estimated for public around the NPP's nominated site. It is expected that the results of the radionuclides dispersion profile are controlled by the weather parameters such as wind speed and direction that varies from season to season. It is anticipated that ingestion pathway will represent the higher contributor to the TEDE. Based on the estimated doses caused by the radionuclide releases following a certain accident scenario, the emergency planning zones will be determined. This study will establish an appropriate emergency plan that ensures the mitigation of radiological impact from nuclear accidents, including preparedness based on the prediction of atmospheric dispersion of radionuclides release during the accident using Gaussian dispersion model.

Impact of high peak kilo-voltage technique on radiation dose for neonates Undergoing chest radiography: experimental phantom study

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Abstract

Purpose: Prematurity and low birth weight are the most prevalent reasons for admission to the neonatal intensive care unit (NICU). Most of admitted patients suffer from respiratory problems and chest radiography remains the most often utilized radiological modality in NICUs. Neonates are more radiosensitive and are at higher risk of cancer than adults. They have a longer life expectancy, which increases the risk of cancer. Therefore, it is essential to protect neonates from radiation hazards. This study assessed the high peak kilo-voltage technique's effectiveness in reducing radiation dose to radiosensitive tissues (eye lens, thymus and gonads) during AP chest X-ray for neonates. Materials and methods: The study employed radiation dose measurement for neonates undergoing chest x-ray while using standard technique and high KVP. The experiment done using an anthropomorphic phantom to perform an AP chest x-ray. A Piranha dosimeter was used to measure the absorbed radiation dose at the level of the eye lens, thymus, breast and gonads. A regression formula was utilized to determine the exposure. Mean values and standard deviation of radiation dose were calculated for eye lens, thymus, breast and gonads. The paired two sample t-test was used to compare the recorded doses. Results: Use of high peak kilo-voltage technique showed reduced radiation dose to tissues and organs. Nevertheless, there was no significant difference in radiation dose between the high peak kilo-voltage technique and standard technique. Conclusion: The use of high peak kilovoltage technique can play a significant role in reducing radiation dose. Efforts should be made to reduce radiation dose to neonates. Future studies to estimate cancer risk are recommended.

RP-021-VO

Enviromental radiotoxical evaluation of soil samples of selected locations in Ondo city, Nigeria

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Abstract

Earth's environment contains abundant natural radio activities. These radioactive materials are long-lived like: 238U, 232Th and 40K. Excessive presence and exposure of these elements to human and/or animal could be hazardous. This work seeked to identify different radionuclide elements present within the soil sample of the selected locations, as well as, determine the levels of abundance of these radionuclides and compare with the global acceptable safety radiation levels. Hence, activity concentration of these elements in soil samples collected from selected locations in Ondo City were investigated using Gamma Ray Spectrometer. Mean concentration values of 238U and 232Th were found to be higher than the International Radioactivity level reported by UNSCEAR (2000) of 35BqKg-1and 30BqKg-1respectivelly, while that of 40K was found to be lower than the reported value by UNSCEAR (2000) of 400BqKg-1the radium equivalent dose was found to be 198.86BqKg-1 as against 370BqKg-1reported by Tahir et al. (2005) while Annual Effective Dose was found to be 0.18(mSvy-1) as against the average value of 70mSvy-1. Therefore, remediation methods were offered to reduce impacts of the radionuclide on human and animal while further investigations into exposure level is suggested.

RP-022-VO

Diagnostic Reference Levels for the Common Adult CT Procedures in South Region of Saudi Arabia

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Abstract

Computed Tomography (CT) examinations have been reported as one of the highest sources of radiation exposure in the medical field compared to other modalities such as conventional radiography. Multiple studies in the literature reported that patient dose from a single CT scan could be as high as 30 mSv and many patients may perform recurrent scans in a short period of time, with a substantial rise in the cancer risk. This study aimed to establishment local diagnostic reference levels (DRLs) for the most common computed tomography (CT) examinations in the Southern region of Saudi Arabia (Jazan region). A total number of 474 patients were included in this survey. CT dose index (CTDIvol), dose length product (DLP), slice thickness, total slices' number, and scan length were recorded. This study includes the brain, chest, abdomen, abdomen-pelvis (AP), chest-abdomen-pelvis (CAP), and pelvis procedures. The patients dose in terms of CTDIvol and DLP for adult patients were 49.32 mGy and 834.82 mGy.cm for the brain procedures, 10.37 mGy and 350.95 mGy.cm for the chest procedures, 14.15mGy and 697.17 mGy.cm for the abdomen procedures, 20.38 mGy and 579.7mGy.cm for AP procedures, 11.98 mGy and 866.79 mGy.cm for CAP procedures, 23.4798 mGy and 734.74mGy.cm for pelvis procedures. The current study indicates the need for dose optimization by establishing proper imaging protocols based on international guidelines. The variation in patients' doses is attributed to variation in the imaging protocols, scan length and number of phases performed per procedure.

A case scenario of radiation surface burst nuclear attack with a yield of 1 megaton produced from a thermonuclear bomb

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Abstract

The threat of nuclear attack will remain imminent in an ever-advancing society. Saudi Arabia is not immune to this threat. The level of emergency preparedness to respond to the threat of nuclear weapons remains wanting. This study aimed to study the impact of a nuclear attack on Riyadh, Saudi Arabia, using a hypothetical scenario. In this scenario, a nuclear attack with a yield of 1 megaton (MT) surface burst produced from a thermonuclear bomb has hypothetically occurred in Riyadh. The effects of the detonation were calculated for the fireball, air blast, thermal radiation, initial nuclear radiation, radioactive fallout, and electromagnetic pulse (EMP). A description of the damaged areas and districts was demonstrated. The fireball would reach about 1800-m across within about 10-seconds with height of about 7.25-km and appear to an observer 80-km from Riyadh. The air blast-affected areas subjected to a range of overpressures (200-psi, 20-psi, 5-psi, and 1.5-psi) were 2 km2, 15 km2, 65 km2, 293 km2. For thermal radiation, the maximum affected area at which first, second, and third degrees burns is possible for those in the open were 1170 km2, 588- km2, and 375-km2, respectively. The effects of EMP that cause damage to electrical equipment were estimated to extend to about 13-km from ground zero. The initial radiation emitted from the detonation would be absorbed entirely within the severe blast and thermal area where a 100-percent fatality is expected. The approximate area affected by the fallout would cover 34,000 km2. Several estimated dose rate fallout contours were evaluated. In conclusion, the most destructive forces were air blast and radiation. Although this hypothetical nuclear attack targeted Riyadh, the fallout would affect large areas outside Riyadh. Therefore, the response focus should be shifted from the air blast affected areas to fallout-affected areas for high yield nuclear attacks.

Radiation response of marble-glass media in diagnostic radiation Applications

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Abstract

Thermoluminescent dosimeters (TLD) have proven themselves particularly effective in radiation assessments, TLDs offering several advantages over other dosimetric forms, including typically being of small size and in certain phosphor-based cases soft tissue equivalent. Glass-based TLDs offer features that promise to extend the utility of TLD, including offering a relatively large dynamic range over which sensitivity to differing levels of radiation exposure is provided, also a water impervious nature. Several studies have demonstrated the potential of doped as well as undoped silica-glass fibres as effective dosimeters in diagnostic and radiotherapy applications. In present study, in seeking a low-cost alternative to fibres we investigate commercially available marble-glass over a range of colour and size, comparing their response over a range of radiation doses. Several characteristics have been investigated including dose response, energy response, and fading, showing good linearity and excellent response. While as expected, the dose sensitivity of marble glass is less than that of much more expensive doped Photonic Crystal Fibres (PCFs), Germanium Flat Fibres (Ge-FF) and co-doped Germanium Boron Flat Fibres (GeB-FF), they nevertheless continue to provide sufficient sensitivity for radiotherapy applications.

RP-025-PO

Influence of annealing temperature and heating rate on the thermoluminescence properties of Lithium Alumina Borate glass doped with Dy^{3+}

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Abstract

The present study investigates the effect of annealing temperature, duration, and heating rate on the thermoluminescence (TL) properties of lithium alumina borate glass with present of ion dysprosium, Dy. The formulation of glass is based on $23Li_2O$ - $7.5Al_2O_3$ - (69.5-x) B_2O_3: x Dy_2O_3 glasses, with x = 0, 0.2, 0.4, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5, and were prepared using melt-quenching technique. We validate the amorphous of the samples by using the X-ray diffraction (XRD) test. All samples were exposed to 60Co source-gamma rays, with the dose rate of 0.003771 Gy/min. The irradiation was standardized at 2 Gy with field size and standard source-surface distance (SSD) of 10 x 10 cm^2 and 2 meters, respectively. The TL properties of the prepared samples were examined using TL reader (Harshaw 3500, USA). Notably, the optimal TL response and highest TL intensity (3.75 x 105 nCg-1) was found in LAB glass with 0.8 mol % of Dy. The greatest peak temperature of the glow curve for all glass samples was seen within range of 150-250 °C. It was determined the annealing process employed 300 °C for 40 minutes at a heating rate of 10 °C s-1 help to optimize the time-temperature profile (TTP) of the samples.

RP-026-VO

Evaluation of lungs doses due to alpha radiation exposure from radon and thoron in the dwellings of northern India for the assessment of health risk

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Abstract

The study has been carried out to know the radiation levels in the region and associated risks and the calculation of lungs doses for the assessment of health risk. Previously, there is no such study has been done in the region. Therefore, it is a baseline study for further similar studies. The cumulating sampling method, which is based on the dosimetric technique fitted with solid state nuclear track detectors (SSNTDs) have been used for the assessment of radon (222Rn) and thoron (220Rn) to calculate lungs doses in the dwellings of Aunchha and Mainpuri cities of Northern India. The detectors are commercially available i.e., LR-115, which has high sensitivity, accuracy, and stability. In both cities, the concentrations of 222Rn and 220Rn vary 5.8 to 86.6 Bq.m-3 & 5.3 to 129.1 Bq.m-3 and 5.8 to 81.5 Bq.m-3 & 22.6 to 96.4 Bq.m-3, respectively. The annual effective doses (AED) vary from 0.2 to 1.4 mSv.y-1 and 0.4 to 1.3 mSv.y-1. The doses rates to lungs from 222Rn and 220Rn exposure at various sites in study area is vary from 0.23 to 3.46 nGyh-1 and 0.23 to 3.26 nGyh-1. There is a very good correlation (R2 = 0.84) in the 222Rn levels of the respective places. The doses to DT-B/ DP+PL (nSv) region of the lungs are within the safe range. The impact of lungs doses DRL and DTL is small from 220Rn with respect to 222Rn, and their values are smaller than the reference level of 10 mSv. Therefore, it may conclude that this area has no risk from 222Rn, and 220Rn exposure indoors.

RP-027-PO

Literature Review: The assessment of radiation occupational exposure from the interventional fluoroscopic procedures

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Abstract

Fluoroscopy interventional procedures offer the minimal invasive image-guided. Fluoroscopy interventional procedures offer advantages over surgery for the diagnosis and treatment of disease. Fluoroscopy interventional procedures are often complex. Hence, high radiation doses were delivered to medical staff and patients. Radiation protection regulations require routine monitoring of radiation doses received by all staff. The International Commission on Radiological Protection has established the standards for radiation protection including the dosage limits. In this respect, the effectiveness of different dosimeters and different shielding of a great concern. This systematic review was conducted to highlight an overview of the health effects of occupational. Radiation exposure from interventional fluoroscopy procedures on medical radiation workers. This systematic review presents relevant to different dosimeters are used to determine the occupational dose to medical staff. Furthermore, a summary was provided regarding to the most sensitive organs at the risk of high exposure to X-ray that are used in intervention fluoroscopy department in many hospitals today. A summary also provided to highlight the effectiveness of different shielding tools that are used to reduce the occupational dose, consequently the deterministic and stochastic effects to medical workers. Additionally, overview was provided on the importance of simulation and highlight its outcome in interventional fluoroscopy department. Interventional fluoroscopy procedures, which can considerably benefit patients, and can also harm both patients and all medical workers who work in fluoroscopy department including; interventional radiologist, nurse and technician due to the high exposure to X-ray radiation. Thus, the protection of radiation provides radiation protection of medical staff in the field is essential. Importantly, doses to the eyes are of particular concern since the lens of the eye is sensitive to radiation. It was noted in many previous studies that researchers did not address the dose levels received by workers under interventional radiology, specifically in the eye and neck area, which is considered one of the most sensitive areas to radiation and must be monitored and ensured that the dose is at the minimum level. Although many studies provided a great concern in procedures that has taken place in interventional fluoroscopy department. There are a clear need for standardization and optimization to facilitate the comparison among different centres.

RP-028-PP

Temperature stability of PRESAGE® dosimeters for end-to-end radiotherapy dosimetry audit

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Abstract

Over the past few years, there has been much interest in developing a dosimeter that can accurately measure dose distributions in three-dimensional (3D) for the end-to-end radiotherapy dose audit. PRESAGE® is a potential 3D radiochromic dosimetry material that has the potential to be used in conjunction with an anthropomorphic phantom for a remote audit. The study aims to investigate the vital aspects of the optical dose-response of PRESAGE® in such settings, which are dose linearity, dose rate dependency, reproducibility, and stability in absorption dose due to temperature effects during transportation of the dosimetry material to radiotherapy centres. PRESAGE® dosimeter samples in 10 mm x 10 mm x 45 mm cuvettes were grouped into two, one stored at room temperature of 27 ºC (RT group) and the other stored at the low temperature of 2oC to 5oC (LT group). To investigate the effect of the temperature on the PRESAGE®. In addition, the LT group was also used to study the reusability and the fading response of the PRESAGE®. The dosimeters were irradiated with a 6 MV photon beam at 600 cGy/min for a 1-10 Gy dose range. Results indicated that PRESAGE® has a linear optical response to radiation dose with an R2 value better than 0.988, has no dependency on dose rate, good reproducibility (<2%), and can be stable for two days post-irradiation. The dose linearity result is consistent with the results obtained from UV-Vis's spectrometry. The absorbed dose decreased gradually and returned to its original state 90 days post- irradiation for the LT group. However, the rate was much faster at two days for the RT group of PRESAGE® In conclusion, studies presented here indicate PRESAGE® to be a promising, versatile, and practical new 3D dosimetry material with applicability for end-to-end radiotherapy dose audit.

RP-030-VO

Shielding and Moderator Materials investigation for DT Neutron Generator Source

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Abstract

Many institutes and laboratories are using the deuterium-tritium (DT) neutron generators because it's wide features, characteristics, applications and its training capabilities using neutrons and associated techniques. Targeted applications of DT include neutron radiography, neutron activation analysis and production of radiotracers for training purposes. The main issue of using such neutron generator is the local shielding to protect the occupational and people in and around the neutron facility, also obtaining a thermal neutron at the test point using an optimal moderator material is essential. This work presents a computational investigation of the candidate's materials as a shielding and moderator for DT neutron source using Monte Carlo N-Particle code (MCNP). A simple model of spherical shielding / moderator is done including the point source in the centre, the source intensity for the generator is considered to be 3E+08 n/s and the neutron energy is 14 MeV. NCRP-21 fluence-to-dose conversion coefficient is used to determine dose rates at a distance 200 cm from the point source in all study cases. The thermal neutrons spectral are calculated for all candidate materials to obtain the optimal moderator. Also, neutron and gamma dose are calculated to evaluate the optimal shielding taking into account the material weight and cost. The results show that the Beryllium and high-density polyethylene are gave a high thermal neutron at the test point while the layers of 10 cm lead, 20 cm iron and 30 cm borated polyethylene provides a lower dose value.

ZnO:Cu as a high dosage thermoluminescence dosimeter

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Abstract

Zinc oxide (ZnO) is a material with hexagonal close packed structure whose thermoluminesce (TL) has been studied in recent years by the Molecular Engineering of Materials Group of the University of Sonora. In this work, we show that ZnO:Cu exhibits features suitable to be considered candidate as a TL dosimeter. ZnO was synthesized by a controlled precipitation chemical method in a chemical bath using zinc chloride ($ZnCl_2$), thiourea [$CS(NH_2)_2$] and sodium hydroxide (NaOH) in stoichiometric amounts. ZnO cooper doping was carried out by mixing ZnO and copper chloride dihydrate ($CuCl_2 \cdot 2H_2O$) in an agate mortar and milling in a planetary ball mill. Pellet shape samples were fabricated from the powder and subsequently were thermally treated at 900 °C for 24 hours. ZnO:Cu presents a single glow peak at 120 °C after 64 Gy exposure. The ZnO glow curve shows glow peaks with an intensity one order of magnitude higher than ZnO:Cu, which shows that the dopant produces a decrease of the TL sensitivity. Scanning Electron Microscopy images showed particles with size < 2 μm in diameter for ZnO and ZnO:Cu, and the Energy Dispersive Spectroscopy showed that the chemical composition agrees with that theoretically expected. Photoluminescence measurements showed quenching due to Cu doping. The TL studies of ZnO:Cu showed a good stability of the TL response in repeated irradiation - TL readouts cycles and a linear dependence of the integrated TL upon irradiation dose (with a Pearson´s r = 0.995) in the range from 64 to 4096 Gy. The results here presented show that ZnO:Cu is an interesting phosphor material for dosimetric applications.

Radiation dose and frequency of examinations in Nuclear Medicine

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Abstract

Medical exposure is the major contributor of manmade radiation to the population (UNSCEAR, 2010). Knowing the population dose has been supported in raising awareness of dose levels (NCRP, 2009, 2019) and UK (Wall et al., 2011). The objectives of this survey were to assess the frequency of different nuclear medicine procedures and to estimate the: average activities administered by nuclear medicine procedures, mean effective dose in each procedure, annual collective effective dose and the annual dose per caput effective dose to Sudan population from nuclear medicine. Five nuclear medicine departments representing the whole existing NM department in Sudan at the time of study (2015) were included in this survey. The administered activity was collected for at least 20 patients in each exam. The effective dose for each exam was calculated using the relevant conversion coefficients published by International Commission on Radiation Protection (ICRP 53, 1988; ICRP 80, 1988; ICRP106, 2008). The collective dose was obtained by multiplying the average effective dose for each exam by the number of procedures performed annually. The effective dose per caput was estimated by dividing the collective procedure dose by the population of Sudan for the same year. Thyroid scan is the most frequently performed procedure (50%), followed by bone scan (34%) and renal scan (14%).The estimated total annual collective and total annual per caput effective dose were 16.3 man Sv and 0.001 mSv, respectively. The major contribution to the collective dose was from bone scan procedures (58%). The total annual frequency of nuclear medicine therapeutic treatments procedures was 0.272 per 1000 population. The results of this survey will contribute in assessing the population dose and in following trends from medical imaging at a national level.

Measurement of Radon concentration and the annual effective dose within different age group in ground water samples of Hafr Al Batin city, Saudi Arabia

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Abstract

Radon and its short-lived decay products play an important role to human exposures from natural source of radiation. Many studies revealed that the incident of lung cancer, colon cancer and stomach cancer are cause from the radon-contaminated water. In the present study, radon concentration from different groundwater samples from different location of Hafr Al Batin city, Saudi Arabia has been investigated using electronic portable radon detector. The total effective annual dose of exposure by inhaled and imbibed water was estimated for different age group from radon concentration. The radon concentration and estimated effective dose were analyzed according to the standard safety guidelines in details. The results of this study will support to the authority and regulators who are responsible for controlling and strategizing to ensure the public safety against radon exposure.

Low Dose Hyper-radiosensitivity In Normal Human Cells

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Abstract

Cells usually have different sensitivity to ionising radiation depending on their phase during the cell cycle, particularly at low-LET radiation. The most sensitive phases in the cell cycle are the M- and G2 phases, where S and G1 are the resistant phases. Low doses of radiation can induce various delayed and non-targeted effects, including bystanders (BE) and hyper-radiosensitivity (HRS), in vitro and in vivo. The region of HRS is thought to be formed by an excessive induction of DNA DSBs, which consequently led to a hyper-activation of the DNA repair mechanisms. Such phenomena result in a modification to the Linear Quadratic (LQ) model to include the out-of-fit dose points. At low doses below 1 Gy of radiation, most mammalian cells have shown HRS, which is frequently followed by an Increased radio-resistance (IRR) phenomenon. To confirm the observations of the HRS and IRR effects and identify their start- and endpoints at low-doses of X-ray irradiations, the AG1522 normal human fibroblasts cells were irradiated with a range of low-doses between 0.05 and 1 Gy. The HRS is pronounced at the dose of 0.2 Gy of X-ray irradiation, followed by the IRR phenomenon as the dose increases up to 0.6 Gy. In the context of radiation protection, these results need to be considered during radiotherapy treatment. The presence of the HRS in the survival curves of normal AG1522 cells after X-irradiation maximises the possible advantage of using such low doses to improve clinical outcomes. These data provide further insight into the radiobiological parameters, highlighting the need to refine existing radiobiological parameters to incorporate such effects and modulate dose distributions.

Modeling of MTR reactor using Open-MC code

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Abstract

Material Testing Reactor (MTR) have been used widely for material testing utilizing neutron bombardment. Currently, 47 MTR still in operation around the globe. Furthermore, Missouri S&T research reactor (MSTR) has been in operation since 1961 for research and education purposes. In addition, MSTR has a maximum thermal energy output of 200 KWh. In this paper, MSTR was modelled using Monte Carlo based code (Open-MC) to evaluate the core parameters. The core parameters included keff and neutron flux profiles. The code model included fuel elements, control rods' fuel element and water inside the core. The obtained parameters were compared with MCNP results. The comparison showed keff relative error was less than 1% with the MCNP output. In addition, the neutron axial profile of the Open-MC simulation showed good agreement with the MCNP neutron profile. In conclusion, the Open-MC code is an open access Monte-Carlo transport simulation code with several features. MSTR Open-MC model was verified with MCNP code and showed excellent agreements.

Determination of Exclusion Zones for Emergency Accident Scenarios of Proposed Nuclear Power Plant in KSA

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Abstract

National plans are being implemented in the KSA to enable domestic green energy plus the other existing national energy resources, especially with the increase of population consumption. As during the last 10 years, the population of the KSA is increasing with growth rate of 21%, which is expected in 2030 to be 38.5 million with a growth rate of 10%. As a result, the demand on the electricity and water will increase. This made the Government to think of alternative solutions to support the growth such as the nuclear power plants (NPPs), as announce by the official royal statement in 2009. Hence, the KSA has proposed 16 NPPs to be built with 17 GWe power generation, to address an increasing demand for domestic electrical energy. The siting of locations where these NPPs will be built must be based on several factors and criteria to ensure that the selected sites are the most suitable with respect to safety, environmental impact, and the economics of power generation and use. The normal operation of the NPP will result in the release of small amounts of radioactivity to the environment, and large releases are assumed for hypothetical accident scenarios, and the radiological consequences of these releases must be assessed. According to the IAEA, the estimation of the concentration of radioactive material released during normal operation and accident conditions is one of the primary elements in the site selection of new NPPs. In this paper, an NPP is assumed to be constructed in the eastern coast of the KSA and the exclusion zones for emergency accident scenarios will be determined. This determination will be based on a radiological health impact assessment for the surrounding people and environment. This includes an estimation of the total effective dose equivalent received by public around the nominated site.

Modeling and Simulation of VERA Core Physics Benchmark Using OpenMC code

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Abstract

Nuclear energy is a resilient source of clean energy representing the second-largest source of low-carbon electricity today. The heat in nuclear power plant is produced as a result of the neutron-nucleus fission reaction occurring within the nuclear fuel. Thus, detailed neutronics analysis studying the neutron paths through matter located inside the nuclear reactor core is exceedingly needed for safety and economic considerations. Due to the development of technologies of high-performance computing, neutronics computer codes are became more effective and sufficient to perform a neutronics calculation of the reactor core. In this work, a commercial pressurized water reactors (PWR) represented by VERA Core Physics Benchmark are modelled and simulated using high fidelity simulation of OpenMC code. Two cases problems have been performed. Case 1 is fuel rod design with UO_2 material and coated within cladding material (Zircaloy-4). The second Case is 17x17 fuel rod/guide tube assembly designed for 2D Hot Zero Power (HZP) Beginning of Cycle (BOC). The calculation for this problem has been performed using Open MC code with ENDF/B-VII.1 cross sections libraries. The criticality keff value was found to be 1.186520± 0.001510 while the reference result was 1.187038 ± 0.000054. The results show that percentage error is about 0.04%. For the Case 2, a value of 1.180183 ± 0.001386 criticality keff was obtained while the reference result was 1.182175 ± 0.000017. The results show 0.17% relative error due change of fuel and moderator temperature as well as the various change of number of particles and generation. Furthermore, list of cases is planned to be investigated in this work with respect to criticality and fuel pin power. Further, examination the development of code capabilities of reactor physics methods would be implemented. Finally, emphasize the performance and accuracy of the OpenMC code within well-established industrial codes are intended to be thoroughly studied.

Status of Medical physics in the Middle East Countries

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Abstract

Middle East Federation of Organizations of Medical Physics (MEFOMP) was established in 2009 with 12 participating countries: Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, Syria, United Arab Emirates and Yemen). The aim of this organization is to raise awareness about medical physics profession in the Middle East region and to highlight some regional collaborations to fined regional solutions. A simple questionnaire was used to collect the information about the status of medical physics in MEFOMP countries, focusing on radiotherapy, nuclear medicine and diagnostic radiology equipment available in each country, the number of available MPs (MP). The number of MPs in the Middle East has been constantly increasing, however, there is a continuous demand for more qualified MPs. Medical Physics is recognized as a health profession in 75% of these countries. The total number of MPs is about 1180, divided into 560 (47.5%) males and 620 (52.5%) females. As shown, the overall number of female MPs in the region is ~16% higher than male. The highest number of MPs exists in Saudi Arabia (about 720). The number of MPs per million population is stretched between 0.5 in Yemen to over 23 in Bahrain. On average, the MEFOMP countries have about 8 MPs per million population. This seems a relatively acceptable number, as the average number in the world is about 2.7; 15–20 per million population in the developed countries and 1–5 per million population in developing countries.The average number of MPs per million in MEFOMP countries is about 8 MPs per million. In MEFOMP countries, the average number of Teletherapy, CT and Nuclear Medicine units are 1, 13.4 and 2.8 units per million population, respectively. Medical Physics educational programs offering MSc degrees are available only in five countries in the region.

RP-040-VO

Important Aspects on the Chemistry and Characteristics of the Ge-68/Ga-68 Generator Systems KFSHRC Experience

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Abstract

Ga-68 has played a remarkable role in clinical research worldwide, particularly in routine clinical studies for oncological applications with Positron Emission Tomography (PET) over the last 20 years. The physical half-life of gallium-68 is 67.71 minutes, and it makes it compatible with the pharmacokinetic characteristics. There are two requirements for using gallium complexes as radiopharmaceuticals: they should be resistant to hydrolysis (the formation of complexes with OH-) and they should be more stable than the Ga(III)– transferrin complex, and thus, the labeled gallium complex must be stable in the presence of transferrin—a plasma protein. The large formation constant of Ga(III)– transferrin (log K = 20.3) and the high plasma concentration of this protein (0.25 g/100 ml) favor the thermodynamic exchange of Ga(III) complexes with transferrin in vivo, and thus, the majority of radioactive gallium complexes used as radiopharmaceuticals have high thermodynamic and kinetic stabilities. Thus, the Ga-68 chemical ion forms play an important factor in the radiolabeling process. Our experience the latter problem will be discussed. There is a sufficient difference in chemical properties between Ge^{4+} and Ga^{3+}, which allows for the employment of several methods of separation. In addition, Ga^{3+} has well- established coordination chemistry and thus it is possible to develop robust agents with high resistance to in vivo $68Ga^{3+}$ trans-chelation. The immediate complex resulting from a reaction between Ga^{3+} and a ligand forms a semi-stable complex but a more stable complex may be obtained through trans-chelation at higher pH values.

RP-041-PP

Effective and Organ Dose during SPECT/CT examinations

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Abstract

Parathyroid glands are 1 to 12 small endocrine glands, with 85% of the individuals having four glands, and have a vital role by production and secretion of parathyroid hormone. Single-photon emission computed tomography combined with computed tomography (SPECT/CT) radionuclide scintigraphy is the gold for parathyroid gland disorders with 98% sensitivity. However, the patients received a high radiation dose to sensitive organs, leading to radiation-induced cancer risks. Therefore, measurement and optimization of patient doses are crucial. This study aims to evaluate patients' radiation dose during parathyroid SPECT/CT procedure and extrapolate the cancer risks for sensitive organs. Radiation dose were assessed for 42 patient (28 (66.7%) female and 14 (33.3%) males) underwent SPECT/CT procedure. The patients' organs and the effective dose were calculated using the 99mTc-MIBI administered activity (AA, MBq) and the dose from the external CT procedure. All procedures were carried out using two-hybrid systems (GE and Siemens SPECT/CT) installed at King Saud Medical City, Riyadh, Saudi Arabia. The mean and standard deviation (SD and range of patient age (y), weight (kg) and AA (MBq), and dose length product (DLP, mGy.cm) were 48.6±15 (19-85), 72±12 (50-100), 844±93 (666-925), and 216±67 (69-335) respectively. Patient effective dose range from 1.4 to 3.6 mSv per procedure. For all patients, a constant tube voltage of 120 kVp was employed. Patients undergoing parathyroid SPECT/CT scanning procedures receive high radiation doses to the sensitive organs. Optimization of imaging protocol is recommended to avoid unnecessary radiogenic risks.

RP-042-VP

Detection Efficiency of CR-39 Nuclear Detector- Etched with SWP

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Abstract

When utilizing solid-state nuclear track detectors to register the charged particles such as protons, alpha, and other heavy ions, the etching parameters are critical. The CR-39 detector is one of the most sensitive detectors for alpha particle detection; however, it has the disadvantages of a long etching time. The goal of this study was to evaluate an alternate etchant made up of 10 ml 6.25 N NaOH and 0.5, 1, 1.5, 2, 2.5 mL of 2-Propanol (2-C3H7OH) (SWP). CR-39 detector was bombarded with alpha particles with energy 2.613 MeV. The etching characteristics such as the diameter of the tracks (D), etching efficiency (η), bulk etching rate (VB), track etching rate (VT), and the sensitivity (V) were calculated and compared. It has been found that adding an organic alcohol (2-propanol) to the etchant solution externally improves etching performance and reduces the time it takes for latent tracks to appear. Results of the irradiation of CR-39 detector with alpha particles along with studding the etching characteristics of track detector has been addressed and through discussed.

RP-043-PO

FTIR and Rheology study of selected Alginic acid samples: Effect of Radiation

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Abstract

FTIR spectroscopy is especial technique for characterizing the alginate samples to indentify the M/G ratio and quantitative determination of mannuronic and guluronic acid. The second-derivative mode which is characteristics of alginates fraction enriched in polymannuronic acid presented two bands at ~820 and 946 cm^{-1} while the polyguluronic acid enriched fraction showed only one peak 814 cm^{-1}. The H120L is homopolyguluronic enriched sample (820 cm^{-1} in fingerprint region) with small amount of mannuronic acid in this enriched fraction. The LFR-5/60 is heteropolyguluronic acid enriched sample in presence of small amount of guluronic acid (814 cm^{-1} peak) i.e. comparatively high G to M in this fraction but %G is lower than that of H120L samples. The additional information of chemical distribution of M &G content is clearly obtained. The region of C=O stretching vibration is occurred at 1080-1400 cm^{-1}, OH bending is obtained in between 1030cm 1 (1026 cm^{-1} & 1028 cm^{-1}) and local symmetry observed at 1400 cm^{-1}– 1700 cm^{-1}; the weak signal and skeletal region is attributed at >2800 cm^{-1} & <700 cm^{-1} respectively. The gelling properties of the samples are M/G <1 and is able to make hard and rigid gel. The rheological parameter G` and G`` were observed higher with the constant frequency mode. The mechanical properties of rheology showed a solid-like nature gels with increasing the frequency and G` and G``were increased a certain time of relaxation.

Reduction of radiation dose and scanning time in lymphoma patients with 18F-FDG PET/CT for first follow-up post chemotherapy by limited scanning

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Abstract

To reduce the patient's radiation exposure and scan time by assessing the reliability of 18F-2- fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography (FDGPET/CT) scan that is confined to the original sites of lymphoma in first follow-up post chemotherapy. 200 lymphoma patients selected and their FDG PET/CT scans reviewed and the sites of disease in pre-chemotherapy and the 1st follow up chemotherapy scans were recorded. The possible saved time from PET part of the scan and a reduction in radiation dose from CT part were calculated when we used PET-CT scan limited to the original sites of lymphoma in 1st follow up chemotherapy scan. 45% of first post chemotherapy scans showed no significant residual FDG-uptake indicating complete metabolic response. Significant residual FDG-uptake at known disease sites was seen in 55 % of first post-chemotherapy PET-CT scans indicating residual disease. There is no detected significant FDG uptake in any new site in the first Post chemotherapy PET-CT indicating no further unexpected sites of lymphoma. The scan time was reduced by 5.3 ± 1.47 minutes and radiation dose reduced by 4.2 ± 1.2 mSv without missing any significant findings when first Follow up chemo PET/CT scan limited to the sites of known disease was performed. It is possible to reduce radiation dose and scanning time in lymphoma patients with whole body 18F FDG PET/CT scan in assessment of early response to chemo in curable lymphoma and it may be sufficient to limit scan to the sites of known disease without missing any significant findings resulting in reduction of the total radiation dose and save time.

Imaging characteristics of several PET radionuclides using Nano PET/CT System

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Abstract

Positron emission tomography (PET) as a quantitative imaging modality is widely utilized in a variety of clinical applications. Flourine-18, Iodine-124, and Gallium-68 are positron emitting radionuclides with beneficial chemical properties for the quantitative imaging. Assess the performance of the PET component of the Nano PET/CT system for radionuclides F-18, Ga-68, and I-124, using the National Electrical Manufacturers Association (NEMA) NU-4 2008 standard was the objective of this study. A plastic plate was utilized to measure spatial resolution. The point source was positioned in air and scanned at the center of axial field of view (CFOV) and two different radial distances from the CFOV. The results of ordered subset expectation maximization reconstruction algorithm in two dimensions (2D OSEM) and three dimensions (3D Tera-Tomo) were compared. The NEMA NU 4 small animal image quality phantom was filled with (3.4, 3.1, and 8.3 MBq) of total activity of F-18, Ga-68, and I-124 respectively to determine the NEMA NU 4 image quality parameters. For the point source measurements, the lowest full width at half maximum (FWHM) values were 1.05, 1.15. 1.54 mm at Center of Field of View (CFOV) for F-18, Ga-68, and I-124 respectively, in the radial direction, using 3D Tera-Tomo algorithm. For image quality phantom study, the % STD and Spill over ratios are measured. The examined scanner exhibited improved performance for F-18 followed by Ga-68. The larger positron ranges of Ga-68 and I-124 and single gamma ray emission cause a lower resolution. When the 3D Tera-Tomo algorithm was used the FWHM and full width at tenth maximum (FWTM) values were greatly improved. The image quality parameters are only slightly affected by the abundance of single γ photons. Only the % STD is unaffected by the positron range. The scatter correction technique is beneficial for the SOR. The spatial resolution of the isotope used affects the RC values.

Thermoluminescence kinetic parameters of proton-irradiated germanium doped silica optical fibres

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Abstract

Glow curve is a key element in thermoluminescence (TL) studies as it provides on-the-ground understanding on the trapping mechanism inside the crystal lattice and hence stability of the material. In the present work, the glow curve structure of in-house fabricated germanium doped (Ge-doped) silica optical fibres (SiO_2:Ge) has been investigated following irradiation by 150-MeV proton beams through use of a synchrotron accelerator. For radiation dose in the range from 1 up to 10 Gy, the Ge-doped optical fibres provide linear TL response, with a coefficient of determination in excess of 98%. The maximum TL glow peak manifests at a temperature within the readout range from 230 to 350 °C. In terms of glow curve shape, the formation remains unchanged throughout the investigated dose range. A plot of TMax against TStop reveals a continuous line of slope, indicating the existence of a quasi-continuous distribution of peaks and trapping centres. Deconvolution shows the glow curves of the optical fibres to be formed of five overlapping peaks, with figures of merit of better than 2% for a dose range from 2 to 10 Gy. Through use of Glow Fit deconvolution software, the TL kinetic parameters (activation energy, frequency factor, peak integral) of the fitted glow peaks were obtained. The data suggesting that the TL glow peaks of the proton-irradiated Ge-doped optical fibres obey second-order kinetics.

Establishment Institutional Diagnostic Reference Levels for Nuclear Medicine at King Fahd Hospital of the University in Al Khobar

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Abstract

Nuclear Medicine (NM) has long played a valuable diagnostic imaging tool for assessing various diseases. While the benefits outweigh the negatives, the dose given to patients should be as low as possible to reduce the level of risk that might be associated. Diagnostic reference levels (DRLs) are a strategy for promoting dose optimization during NM procedures. This study aims to establish new institutional DRLs (IDRLs) for NM practices in King Fahd Hospital of the University (KFHU). A retrospective and prospective study method were used to gather the data from the participating unit. Data for 341 adult patients were analysed statistically by SPSS without weight-based selection criteria to overcome of shortage in the available data. IDRLs for NM practices have been defined as the median value of administered activities (AA) MBq (the 50th percentile) because there are usually not enough data to use the third quartile (the 75th percentile). IDRLs were 37 MBq for lymphoscintigraphy scan, 148 MBq for lung perfusion scan, 185 MBq MAG3renal scan, 189.5 MBq for thyroid scan, 198 for DMSA renal scan, 788 MBq for bone scan, 814 MBq for parathyroid scan, 1398.5 MBq for myocardial perfusion (1 day protocol) scan and 1796.5 MBq for myocardial perfusion (2 days protocol) scan. These values were within the range of the hospital protocol in all procedures. The obtained values were compared with other recent NDRLs from Australia, England and several European countries because there were no local or national DRL values available in Saudi Arabia. IDRLs for the University Hospital were comparable or slightly different than those recent NDRLs. These variations could be because of the diversity of examination protocols, NM scanners, and medical staff skills. The authors recommend establishing national DRLs (NDRLs) to encourage optimization among Saudi NM healthcare facilities based on this study.

Development of borosilicate glass media for neutron sensing

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Abstract

Acknowledging that pure and applied neutron physics give rise to large areas of endeavour (from the astrophysical through to medical and security scanning applications), the research question herein is strictly confined to whether borosilicate glass with its order of 4% boron content can detect the presence of neutrons in a neutron rich environment, albeit in the presence of a much larger fluence of photons. Present interests focus on clinical accelerators operating at 15 MV, giving rise to an estimated x-ray to neutron ratio of 105. The work herein is intended to offer a proof of capability rather than seeking full calibration exposition. The latter would need to deal with a range of complexities, including the specialized use of Bonner spheres for neutron moderation and access to a secondary standards dosimetry lab (SSDL) set up for neutron work. The further restriction is that the work seeks only to investigate detection of neutron contamination at the level of the patient treatment couch. Present work looks at a linac operated in the photon mode, neutron production in the electron mode being lower than in the photon mode by at least two orders of magnitude (Ipe, 2007). Photoneutron generation, the principal mode of production at the energies of interest, is understood to be an endothermic reaction, driven at and above a photoneutron threshold. Making use of linacs operating in the photon delivery mode, the various estimates of the lowest bound for detection of photoneutrons would appear to be 6 MV, the range 7 to 10 MV being more commonly quoted, the particular threshold depending on the materials involved. 2H(γ,n)1H and 9Be(γ,n)8Be are two photoneutron reactions with particularly low threshold energies at 2.226 and 1.666 MeV respectively. These two nuclides have the lowest neutron separation energy among all nuclides. Thus said, deuterium and beryllium do not form components of microscope coverslip glass, certainly not being deliberately applied in formulation of the glass.

Establishment of institutional diagnostic reference levels for digital mammography at King Fahad university hospital in Al-Khobar

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Abstract

This work aims to establish institutional diagnostic reference levels (IDRLs) for digital breast tomosynthesis examinations with a comparison with the corresponding dose values and to investigate the possible correlation between selected exposure parameters and the breast dose. This study included two hundred and twenty-five female participants aged 38-64 years. The participants information (age, height, weight, BMI), and radiographic exposure parameters (tube voltage, tube load, projection view, compressed breast thickness (CBT), compression force, entrance surface dose (ESD), and average glandular dose (AGD)) were recorded. The seventy-fifth and ninety-fifth percentiles were used to set DRLs a cross mean mammogram AGDs and ESDs of all encaged data in Cranio- Caudal (CC) and Medio-Lateral Oblique (MLO) views and at CBT 65±5 mm. For the whole study CBT range, the mean AGD and ESD were 1.51 and 5.71 mGy for CC view and 2.01 and 8.29 mGy for MLO view, respectively. For CBT within 65±5 mm, the mean AGD and ESD were 2.04 and 8.43 mGy for CC view and 2.21 and 9.2 mGy for MLO view, respectively. The 75th percentile of mean AGD and ESD were found to be 2.21 and 2.53 mGy, as well as 9.17 and 10.47 mGy for CC and MLO views, respectively. While the 95th percentile of mean AGD and ESD were 3.72 and 3.2 mGy and 15.84 and 13.28 mGy for CC and MLO views, respectively. The estimated IDRLs were higher than the corresponding values although, they were within the European guidelines limiting values. Also, there was a significant impact of tube load, tube voltage, age, BMI, and CBT on the dose values with a very weak effect of compression force. Lastly, this study is considered the first step to establish a national DRLs for mammography in Saudi Arabia.

The potential use of silica-based commercial float glass for protection of gamma-radiation considering thicknesses

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Abstract

Not only the symbol of luxury but also glass has been used as a structural material in multi-storied buildings in Bangladesh as well all over the world. To evaluate the aptness of glass material against ionizing radiation considering thicknesses is imperative. At present, one of the leading float glasses named Nasir glass is widely used for the mentioned purposes. Locally available in Bangladeshi market six different thicknesses (0.25cm, 0.32 cm, 0.5 cm, 0.59 cm, 0.79 cm and 1 cm) of Nasir float glass is studied herein on gamma-ray shielding purposes. In this regard, key shielding parameters such as linear attenuation coefficients, mass attenuation coefficients, half value layer, radiation protection efficiency and effective atomic number of glass samples have been studied here at energies of 59keV, 661keV, 1173keV and 1332keV for ionizing radiation shielding possessions. The incident and transmitted photon intensity have been measured using a well shielded HPGe □-ray spectrometer associated with necessary electronics. Those measured data have been used to calculate the shielding parameters mentioned above. The values of linear attenuation coefficients of the considered glass samples follow this inclination G-1 > G-2> G-3 > G-4> G-5>G-6. In view of radiation shielding fitness, half value layer of the considered glass samples has made known more apposite comparing with concrete and marble. It has perceived that considered glass samples are (13.6) good aspirants of TLD-200 (Zeff =16.3). Considering HVL it has been found that glass sample G-1(2.5 mm thickness) can reduce 7 % and glass sample G-6 (10 mm thickness) can reduce 20 % of its incident radiation. Moreover, it has seen that sample G-6 has given almost 2.5 times higher radiation protection efficiency value than the sample G-1 herein.

RP-051-VO

Suggested two layers container for shielding the high activity gamma-ray sources

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Abstract

Due to the advantages of using gamma-ray radiation sources in various fields, the average equivalent dose received due to the exposure for these sources increases. The wrong handling or direct exposure to these sources give raises the equivalent dose for the receiver. Thus, a container made up of two layers (metal and glass layers) was suggested to reduce the equivalent dose from the gamma-ray radioactive sources to an acceptable level. In the present work, the Monte Carlo simulation method was utilized to evaluate the equivalent dose at the surface of the container and at 100 cm from the outer container's surface. For example, the simulation study illustrated that the equivalent dose received at 100 cm from an unprotected 137Cs source with an activity of 3.7E+10 Bq is 1542.39 µSv/h. This equivalent dose from an unprotected source is reduced to 1152.06 µSv/h using the first layer of the container which has a 0.5 cm thickness from a binary alloy made of Pb and Zn. Then enhancing the container wall thickness with 5 cm of glass Pb/Bi-based borate glass, the equivalent dose dropped to 219.89 µSv/h. Also, in the present study, the role of Bi_2O_3 in enhancing the ability of the container wall in reducing the equivalent dose was studied.

Radiation risk assessments – why, when and how?

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Abstract

Risk assessment is vital in a radiation laboratory because it raises the awareness of people (classified and unclassified workers) about the hazards in the lab and the methods for working safely in the lab. Therefore, this dissertation aims to assess the risk in the Radiation Laboratory in the Central Teaching Laboratory (CTL) at the University of Liverpool based on a case study taken from the PHYS810 module.

Validation of digital method for patient-specific verification of VMAT treatment using 2D ionisation detector array

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Abstract

Delivery of complex beam parameters during VMAT treatment including the dynamic multi-leaf collimators (MLC) requires the treatment to be validated before delivered to the patient. The use of 2D detector array has become a standard method but requires calibration and is prone to error if not performed properly. This study aims to evaluate the use of digital linac log data for VMAT treatment verification. The treatment from an Elekta Synergy (Elekta ltd., Crawley, UK) was validated against an Octavius 1500 (PTW, Freiburg, Germany) 2D ionisation chamber array. A VMAT treatment plan was delivered from the linac and all the dynamic treatment parameters including monitor unit (MU), MLC position, collimator position, collimator angle, beam angle and time were recorded during treatment delivery. The digital linac log data was extracted from the linac control computer. The data extracted were used to generate the beam fluence using algorithms written in MATLAB (MathWorks, Natick, MA). The gamma pass rate of the fluence delivered was compared to the 2D ion chamber array that was obtained silmultaneously during the log data measurements. The results demonstrated that the digital log data can track MLC leaves with an accuracy of 1.0 mm at speeds ranging from 3.04 to 3.40 cm/s. Evaluation of the fluence generated for the VMAT delivery using digital log data was shown to agree well with planned dose distribution measured in the 2D detector array, with an average gamma pass rate of 92% at 3%/3 mm. Log data obtained higher gamma pass rate of 97.5% compared to 2D array of 91.5%. The digital linac log data provides the basis for an essential high-resolution real-time verification tool that may be used for routine VMAT verification.

RP-054-VO

Assessment of Paediatrics Brain Computed Tomography Dose for Establishment of local Diagnostic Reference level at Central Hospital in the Kingdom of Bahrain

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Abstract

Because of the increased sensitivity of pediatrics to ionizing radiation and the radiation dose received during Computed Tomography (CT) examinations compared to other x-ray imaging techniques, it is necessary to monitor the pediatrics' CT doses to investigate and establish remedies for reducing the possibility of errors or negligence that may lead to radiation doses unnecessary received by patients. This study aimed to estimate pediatric doses during brain CT procedures as a basis and part of the optimization process for pediatric computed tomography procedures. The study was conducted retrospectively on a Siemens Somatom Definition AS CT machine. The study was carried out at the Salmaniya Medical Complex (SMC) radiology department in Bahrain. Pediatric patient data related to radiation doses, including CTDIvol, DLP, and exposure parameters, were collected from the hospital system for three age groups (3months to <1, 1-5y, 6-12y). In addition to clinical indications for each patient and demographic data. The data were analyzed by using Microsoft Excel version 2016 as well as the Statistics Package for Social Sciences (SPSS) program version 26 to calculate the Mean, first quartile (Q1), median, third quartile (Q3), and Standard Deviation "SD" of dose values for each age group. One hundred forty-four patients were divided into three groups according to their age (3months to <1, 1-5y, 6-15y), with an average of 48 patients for each group. The mean and range for brain pediatric DLP (mGy.cm) were 380(360- 390) ,500 (490-508) ,640 (635-660), and the CTDIvol (mGy) were 27 (29–35), 38 (42–45), and 48(50-520 respectively. The radiation doses are within the published diagnostic reference levels (DRL). Still, continuous efforts are required to optimize the imaging protocol based on clinical indication, patient size, and staff training for better dose reduction outcomes and the basis of DRL establishment.

RP-055-VP

Impact of Compact and Novel 1-Bit Coding based Metamaterial Design on Microwave Absorption Applications

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Abstract

The coding metamaterial act as the technological advanced development that have been investigate widely in many application fields. This type of metamaterial typically possesses unique properties compared to the conventional metamaterials. The 1-bit coding metamaterial composed of two types of unit cells, with 0 and π phase responses, which known as '0' and '1' elements, respectively. By coding '0' and '1' elements with controlled sequences, the electromagnetic waves can be manipulated and realize different functionalities. Therefore, it has high possibilities to applied for the microwave absorption application to optimise the outcomes by adopting simple coding sequence construction method. This research work focused on developing compact metamaterial design structure based on the 1-bit coding concept to maximise the absorption ability. All the simulation analysis will be performed by utilising well known Computer Simulation Technology software. Firstly, the unit cells of coding metamaterial design will be analysed the phase response properties to identify the materials with 0 and 180° response. Once, the '0' and '1' elements selected, the proposed design will be used to perform several parametric studies such as, various coding sequences and analyses of diverse lattice values on absorption applications. The bistatic scattering patterns and monostatic Radar Cross Section of the proposed coding metamaterial based on the number of lattices will be analysed as well. Initially, copper material with thickness of 0.035mm is adopted to construct the metamaterial design on the Rogers RO3006 substrate material and ground plane covered by gold. The preliminary studies revealed that, the compact coding metamaterial structure with lowest lattices of 6 exhibit almost 0.3 absorption values. However, this result can be optimised by slightly increase the number of lattices with compact unit cell designs. In a nutshell, the miniaturisation concept can be possible and relatively produce optimised absorption values by utilising smaller unit cell designs.

Experimental investigation on the radiation attenuation characteristics of BaO-SrO-TeO_2- MoO_3 glass system

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Abstract

In this work, new tellurite glasses combinations of attenuating oxides (barium, strontium, and molybdenum) were prepared. The photon attenuation characteristics for the four glasses were reported using experimental method (transmission method) using two emitting sources (137Cs and 166Ho). The experimental mass attenuation factor was compared the theoretical data generated from Phy-X computer program. The comparison showed a satisfactory agreement between both approaches, and the relative difference is less than 3% at 0.184 MeV. Besides, the tenth value layer for the prepared glasses was investigated between 0.184 and 0.81 MeV. We studied the influence of adding MoO_3 on the expense of TeO_2 on the radiation protection efficiency and the transmission factor. The half value layer for the free-MoO_3 glass is varied between 0.361 and 1.97 cm, while it is varied for the glass with 20 mol% of MoO_3 between 0.360 and 1.84 cm. The mean free path for the free-MoO_3 glass is 0.52 cm at 0.184 MeV, 1.09 cm at 0.28 MeV and 2.89 cm at 0.81 MeV. The transmission factor is found to highly depends on the energy of the photons, where it is increased from 46% to 87% for the free-MoO_3 glass when the energy is changed from 0.184 to 0.81 MeV. For the glass with high MoO_3 content, the TF increases from 46% to 86%.

Preparation, radiation shielding and mechanical characterization of $PbO-TeO_2-MgO-Na_2O-B_2O_3$ glasses

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Abstract

Borate glasses composed of $PbO-TeO_2-MgO-Na_2O-B_2O_3$ were successfully prepared by melt-quenching technique. The radiation shielding and mechanical properties of this glass system were thoroughly investigated. The density of the glasses increases from 3.283 to 3.923 g/cm^3 as the PbO content increases from 20 to 35 mol%. The mechanical properties are evaluated using the Makishima and Mackenzie model. The density and chemical composition of the samples are found to affect the mechanical properties. Furthermore, produced glasses' radiation shielding properties were evaluated by calculating the basic attenuation factors such as the mass/linear attenuation coefficients, half/tenth value layers, radiation shielding efficiency and lead equivalent thickness. These parameters were calculated for photon energies in the range of 15 keV-15 MeV using Phy- X software. We discussed the impact of PbO and B_2O_3 on the attenuation parameters of these glasses, and we found that these oxides affected the attenuation ability of the samples, especially at low energies. The mass attenuation coefficient for the prepared glasses has high values at 88 keV. The results for the different parameters demonstrated that the glass containing 35 mol % PbO has the best photon attenuation ability among other glasses. While, the sample with highest B_2O_3 content possesses the highest half value layer. The radiation shielding parameters for prepared glass system were compared with other traditional radiation shielding materials.

Assessment of CBCT Image Quality and Dose for Commonly Used Pre-sets in External Beam Radiotherapy

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Abstract

Image-guided radiation therapy (IGRT) adds an additional imaging radiation dose to existing levels of therapeutic radiation. The extra dose received by organs from multiple cone beam computed tomography (CBCT) scans can be reduced by either, reducing the imaged volume, imaging at low ms, mA, or by limiting the frequency of imaging procedure. In this study, an effort has been made to assess CBCT dose and image quality for standard pre-sets defined for different organs namely, the chest, pelvis, brain, head and neck, and abdomen. The second goal was to investigate whether the dose could be reduced while still achieving high image quality. Image quality was evaluated on the CatPhan Model 503 (Phantom Lab, NY), while organ kV- CBCT doses were evaluated using an Unfors device (Fluke Biomedical) to provide representative measurements for clinical settings. Nominal CBCT projections with reduced exposure times were reconstructed in 3D using the Unfiltered and Filtered-back Projection algorithms. The experimental analysis suggests that adequate image quality could be obtained while decreasing the number of radiographic projections. Reducing the number of the radiographic projections will reduce the scan time and therefore the imaging dose. The proposed method provides an opportunity to reduce the organ doses comparatively lower than the standard CT doses for head and body protocols.

Subwavelength Based Double Negative Metamaterial Resonator for Material Characterisation Using Electromagnetic Wave Spectrum

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Abstract

The strong localization of the electric and magnetic field in the metamaterial based structure attracts a new era of radiation fields in the microwave range. In this research work, we represent double split ring metamaterial with a high effective medium ratio is layered on the dielectric substrate to enhance the sensitivity for the material characterization. Tailoring metallic design and periodical arrangement of split ring resonator in subwavelength range introduce field enhancement and strong localization of electromagnetic field. The design methodology is carried out through the optimization technique with different geometric configurations to increase the compactness of the design. CST microwave studio is utilized for the extraction of scattering computational value within the defined boundary condition. The effective parameters from the reflection and transmission coefficient are taken into account to observe the radiation characteristics for the interaction with the applied electromagnetic spectrum. The matter-wave interaction within the operating microwave frequency range for the proposed metamaterial is measured by the installment of the vector network analyzer. The numerical data for the different dielectric constant with the variation in thickness is used to observe the scattering characteristics of materials for the parametric analysis.

RP-060-VP

Evaluation of Radiation Exposure for Patients undergoing Computed Tomography perfusion Procedure for Acute Ischemic Stroke

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Abstract

Computed tomography perfusion (CTP) is contrast-enhanced dynamic imaging of the brain utilized to assess the blood flow volume and transmit time to the brain's parenchyma. Stroke is the second leading cause of death, 11% of death worldwide, and a significant cause of disability worldwide. Previous studies reported a high radiation dose per procedure with an eye lens equivalent dose (mGy) ranging from 81.0 mGy to 348.0 mGy. This study's objective is to evaluate the radiation dose to patients during CTP procedures and estimate organ doses for the patients. Materials and methods. Three hundred twenty patients with ischemic stroke underwent CTP were examined at King Fahad Medical City (KFMC). The imaging protocol consists of plain CT, CT angiography (CTA), CTP, Angiography. The volume CT Dose Index (CTDIvol, mGy) and dose length product (DLP, mGy.cm) were registered from the PACS system. The effective dose calculation (E, mSv) was extrapolated using computer software. For the CTP procedure, the mean and range of DLP (mGy.cm) for the complete procedure, CT brain, CTA, CTA digital subtraction angiography (DSA), and CTP were 1045 (105-3072), 843 (277-1530), 470.5 (210-1356), 238.8 (105-439), 2712 (2012-3072) examinations, respectively. The mean and range of the effective dose (mSv) and CTDIvol (mGy) were 13.2 (10.6-17.1) 80.5 (6.11 to 256), in that order. The patients' doses showed wide variation due to the selection of multiple phases of acquisition and exposure factors. The dose is higher than most previous studies. Radiation dose optimization is recommended by establishing diagnostic reference level (DRL), proper CT machine setting, and increasing operators' awareness regarding radiation risks.

RP-061-PP

Multiphasic Contrast Computed Tomography Procedure: Effective dose Assessment and Establishment of a Local Diagnostic Reference Level

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Abstract

Exposure to ionizing radiation may induce cancer risk to the patients proportional to the radiation absorbed dose and the organ sensitivity. Therefore, protection of radiation exposure is essential to minimize the radiation cancer risk and prevent the deterministic effects. The International Atomic Energy Agency encourages member countries to establish national diagnostic reference levels (DRLs) to reduce unjustified radiation exposure. This study establishes a local DRL for computed tomography (CT) abdomen procedures. In total, 1444 CT abdomen procedures were carried out during nine months. CT abdomen procedures were carried out at King Faisal Specialist Hospital and research center using six CT machines from different vendors. The mean and range of patients' weight (kg) are 50 (42-120). The recommended DRLs values in DLP (mGy.cm) and CTDIvol (mGy) were 900 and 15 per CT abdomen procedure, respectively. 3% (41 cases) were higher than the national DRL for CT abdomen. The proposed DRL values are slightly higher than the European and the American College of Radiologists (ACR) DRL values in DLP. The purpose of DRL in terms of CTDIvol (mGy) is comparable with the international guidelines. Thus reducing the scan length, is recommended ensuring that patients receive a minimal possible radiation dose while maintaining the image quality.

Positron Emission Tomography with Iodine 124 for Hypoxia imaging

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Abstract

Cancer is a leading health challenge worldwide, with a limited success rate if accompanied by a late diagnosis. Hypoxic solid tumors have a poor prognosis and curability in radiation therapy treatment of cancer tissues. Therefore, assessment of oxygen levels in solid tumors is necessary to improve the percentage of successful treatment. Iodine -124 can detect solid tumor anoxia based on the 3γ annihilation during positron emission tomography (PET). This work aims to assess iodine 124 (124I) in the revealing of hypoxia in biological models. The hypoxia (oxygenation level) in specific biological samples with different oxygen concentrations were used in this study. The peak-to-peak and the peak-to-valley methods were compared in the measurement of the relative 3γ to 2γ yield. A system was configured to detect the yield of the 3γ yield using High Purity Germanium (HPGe) Radiation Detectors installed at King Faisal Specialist Hospital and Research Center (KFSH&RC). Γ-ray spectra for each source were recorded with these detectors under identical operating conditions. The ratios of the relative yield of 3γ/2γ positron annihilation were calculated using the peak-to-valley method as the ratio of the counts summed over the FWTM of the full-energy photopeak. The sensitivity of this technique in differentiating the biological samples is encouraging. This work showed that Iodine 124 could be used as a noninvasive imaging technique for hypoxia in biological samples.

Establishment of Diagnostic Reference Level for Cardiac Interventional Procedures

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Abstract

Medical exposure for ionizing radiation during interventional examinations has harmful effects on exposed patients such as cancer effect or tissue reactions in certain thresholds. Cardiac catheterisations procedures are frequently perform at cardiac catheter laboratories for wide range of clinical indications. This research intended to evaluate the patient's radiation dose during percutaneous coronary interventions (PCI)) cardiac catheterization procedures. In total, 100 procedures were carried out in four hospitals in Khartoum, Sudan. Calibrated Kerma area product meters were used to quantify the patient doses. Effective dose was extrapolated using the national radiological protection board (NRPB)software program. The mean KAP (Gy.cm^2) per PCI procedure were 8.02±0.75 (6.86-9.74), 5.91±0.52 (5.02-6.99), 7.64±0.63 (6.24-8.51), and 12.94±3.96 (9.51-22.71) for Hospitals A, B, C and D, respectively. The overall effective doses ranged from 4.2 to 20 mSv per procedure. Patients' effective is compared to the recent published studies. Diagnostic Reference level (DRL) was proposed based on the third quartile value for PCI procedure.

Estimation the effective dose and cancer risk for patients underwent high resolution chest CT examination for screening COVID-19

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Abstract

High Resolution Computed tomography (HRCT) is widely used to diagnose coronavirus disease (COVID-19) with 92% sensitivity and 83% specificity. Since its emergence in late 2019, the coronavirus disease of 2019 (COVID-19) has infected more than confirmed cases and at least 365 million and 5.6 million deaths worldwide. Chest CT is frequently requested to diagnose and monitor disease progression, complications, and treatment response. However, CT is associated with radiogenic risks. Therefore, it is crucial to assess patients' benefits versus risks to accurate justify the procedure. The purpose of this study was to estimate the radiation dose and cancer risk for patients who underwent high-resolution chest CT examination for screening COVID-19. A total of 52 patients, 33 (63%) male and 19 (37%) female having an age of 56 ± 15 ranging from 20– 95 years, have been studied. All patients underwent CT chest at Radiology Department in Al-Mualim Medical City, Khartoum, Sudan. The radiation dose parameters were presented in terms of volume CT dose index (CTDIvol (mGy) and dose length product (DLP, mGy.cm). The mean CTDIvol ± SD and (range) was 9.5 ± 3.51(5.1 – 19.4) mGy. The mean Dose Length Product (DLP) ± SD and (range) was 350.21±132.66 (179.3 – 734.1) mGy.cm. The patient's effective dose (mSv) for HRCT was estimated to be 5.95 mSv with three cancer risks per every ten thousand procedures. In this study, the radiation dose is within the range of HRCT procedures. However, precise justification criteria are required to ensure the benefit outweighs the projected risk. Interpatient variation attributed to the variation in patients weight, and the applied imaging protocol.

Development and validation of Pressurized Water Reactor (PWR) core by using OpenMC code

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Abstract

The study aims to analyse and compare of cladding material of fuel rod of PWR for Iron-Chromium-Aluminum (FeCrAl) against standard Zircaloy for the improvement of reactor core economics and safety margins. The accident at the Fukushima nuclear power plant due to the accelerated oxidation rate of zirconium at high temperatures potentially experienced during severe accidents, which led to the build-up of hydrogen gas and eventual explosions. One of candidate materials that has the ability to significantly reduce oxidation rate in high temperature is iron-chromium-aluminum (FeCrAl) alloys. The main parameters of interest in this study are effective neutron multiplication factor (Keff), flux distribution and fission rate for fuel pin, fuel assembly. A Monte Carlo N-particle (OpenMC) model has been used to calculate the neutron spectrum in the PWR fuel assembly. The BREAVRS benchmark model applied was for modeling and analysis of fuel assembly of PWR. The results obtained were well consistent, met expectations. The effective neutron multiplication factor of FeCrAl fuel assembly was 0.89880 +/- 0.00201 (Combined k-effective), leakage fraction is 0.00003 +/- 0.00001 and flux distribution had symmetric shape. The effective neutron multiplication factor of zircaloy fuel assembly was 1.00595 +/- 0.00225 (Combined k-effective) and leakage fraction is 0.00002 +/- 0.00001. In future work, the analysis of cladding material will be performed for full reactor core for more investigation.

Measurement of Pediatric Patients Exposure in Pediatric Imaging Procedures

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Abstract

Because of their rapidly dividing tissues, children and pediatricians are more radiosensitive to ionizing radiation and radiogenic hazards than adults. Because younger patients have a longer life expectancy, they are more prone than adults to develop radiogenic cancer. Furthermore, during treatment, children frequently repeated diagnostic procedures, resulting in increased radiation doses. This study investigates pediatric exposure to computed tomography (CT) abdomen and calculates the procedure's radiogenic risk. A total of 86 subjects were subjected to a CT-enhanced abdominal examination. The age (years) of the patients' mean, standard deviation, and range are all 135.0 (2.0-17). The mean and range of the DLP (mGy.cm) and CTDIvol (mGy) per CT abdominal operation were 1740.0 (158-8440.0) (mGy.cm) and 10 (2.1-46.1) (mGy), correspondingly. The effective dose per procedure has a mean and a range of 34. (3.14-176.8). One cancer incidence per 250 CT enhanced abdominal operations is the average radiogenic risk per procedure. The average and range of total irradiation per procedure are 4 (2-8) times. In comparison to other CT scans, the results of this study revealed that the child risk is high. To avoid unwanted radiation dangers, patients' dose optimization and proper creation of a diagnostic reference level (DRL) are required.

PET Scan and Producing Radioactive Materials: the Molecular Imaging Center Expereience

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Abstract

F-18 Fluorodeoxyglucose (FDG) is one of the most important radioactive substances that used in medicine field. The short half-life of FDG, just under two hours, makes it real challenging to produce and use FDG within short time. In western region of Saudi Arabia, the demands of produce such materials increase where they are necessary means to diagnose the cancerous tumors. Molecular Imaging Center (I-ONE) at King Abdulaziz University in Jeddah is the only one that produces radioactive materials in the Western Region. I-ONE is established by Wadi Jeddah Company and operated by ITEL company, one of the leading companies in the field of providing the expertise and the knowledge of radioisotopes production. The radioactive materials are manufactured through a particle accelerator (Cyclotrons) in accordance with the international standers by using high technology. By locating facilities that produce radioactive materials, I-ONE is able to efficiently provide these materials to hospitals, clinics and research facilities in the western region. The center has well-established facilities and has comprehensive fleet and logistic capabilities to cover all Jeddah needs. They are well experienced in the department of nuclear medicine, where they have their own positron emission tomography with computed tomography (PET/CT). Using of PET/CT enhance affordable healthcare in Saudi Arabia and meet the growing need of early detection of cancer. The PET/CT scan uses X-ray together with a radioactive tracer to produce a detailed three-dimensional picture of internal anatomy and function. I-ONE is considered as one of the Saudi Arabia's leading in providing efficient nuclear service in medicine fields with high quality and advanced technology.

Design and development of transparent glasses for radiation shielding applications

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Abstract

In this work, we present the fabrication of free lead glasses for radiation shielding applications by applying the melt-quenching method. The impact of Bi_2O_3 on the physical, mechanical and radiation shielding properties of these glasses was investigated. The density of the glasses enhances from 3.833 to 4.283 g/cm3 due to the change of the Bi_2O_3 content. The Makishima and Mackenzie (MM) were used to calculate the Young's modulus (E), bulk modulus (B), shear modulus (G), longitudinal modulus (L), Poisson's ratio (□), fractal bond connectivity (d), and hardness (H) have also been studied. These parameters have been studies as a function of the mol% of Bi_2O_3 present in the samples. We evaluated the photon shielding competence of the prepared glasses and the calculations were carried out using Phy-X/PSD software between 0.015 and 15 MeV photon energies. From our results, it is demonstrated that the value of the effective atomic number in the low energy range was obviously enhanced with the growth of Bi_2O_3 contents. The mass attenuation coefficient and the effective atomic number results have similar trends, which enhance by adding Bi_2O_3 contents, and reduce with increasing the energy of the photons. The results indicated that the borate glasses with high concentration of Bi_2O_3 had higher radiation shielding properties than some commercial glasses. So, these prepared glasses may utilize in some applications such as radiation shielding.

Borosilicate Glass for Radiation Dosimetry Applications

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Abstract

In this paper, we review the borosilicate glass fabricated as doped and undoped for the application in radiation dosimetry. The undoped borosilicate glasses reported were either fabricated or commercially available. The reported materials used as modifier in the borosilicate glass and their dosimetric performance are subsequently reviewed. The dosimetry techniques reviewed include thermoluminescence (TL), optically stimulated luminescence (OSL) and radioluminescence (RL). The subsequent focus of this review is on the fundamental dosimetric characteristic of the doped and undoped borosilicate glasses including the dose responses and energy dependency. In this article, the thermoluminescence properties observed in the TL glow curve for both doped and undoped borosilicate glasses were reviewed and discussed. The applications of the borosilicate glass in various field of radiation dosimetry are reviewed. At the end of this review, the limitation and potential radiation dosimetry applications of the reported borosilicate glasses are briefly discussed.

The effectiveness of lead apron for thyroid protection in chest X-ray

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Abstract

Chest X-ray is the most technique done in X-ray division particularly with coronavirus. X-rays are important for quality patient care, air travel safety, and counterterrorism techniques. Thyroid gland considered as one of the most radiation sensitive organs of the body specially in infants and children. Therefore, it is important to protect them when having a chest radiograph. The point of radiation protection is to dependably forestall the deterministic impacts of radiation and to reduce the danger of stochastic impacts in all feasible level. Lead apron is powerful when it is worn appropriately, coordinated with the suitable radiation energy and is utilized in a safe and routinely examined environment. There is a doubt about using lead apron in chest X-ray because it may has some benefits and risks. Usage of lead apron is a routine practice in order to decrease likely tube leakage and room scatter. However, the disadvantage is that the leakage from these sources is not measurable in current chest X-ray rooms; hence the apron has insignificant worth. In addition, usage of lead apron in chest X-ray may produces an artifact in the radiograph. In this research benefits and risks of using apron was investigated for the protection of thyroid glands in chest X-ray. This is done by using different dosimeters embedded in an adult male ATOM dosimetric Phantom and irradiated with a portable X-ray machine with and without thyroid shielding. Consistent results were drawn showing that radiation to thyroid gland is less using lead shield.

Photoneutrons and gamma capture dose rates at the maze entrance of Varian TrueBeam and Versa HD linear accelerators

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Abstract

We performed measurements of neutrons and gamma capture dose rates at the maze entrance of Varian TrueBeam linear accelerator. Measurements are performed at Linac energy 15 MV, 10 MV, and 10 MV Flattened filter free (FFF) using calibrated neutron and gamma survey meters. Measurements at a source-to-detector distance of 100 cm from the isocenter using a 10x10 cm^2 X-ray therapeutic beam using a 30x30x15 cm^3 solid water phantom that will produce similar scatter produced by the patient in the radiotherapy treatment room. With Linac operating at its maximum energy, photo neutron doses distributions at several points and point sizes from the is center [1,2]. Neutron dose equivalent ranged. We studied variations of neutron dose equivalent with field size and distance from the isocenter. The measured neutron dose equivalent at the maze entrance ($m.Svh^{-1}$) was at the isocenter was 26.2, 14.7, and 11.3 for 15 MV, 10 MV, and 10 MV FFF, respectively. Neutron dose equivalent at the maze entrance (μSvh-1) were 36.3, 12.3, 10.3 for 15 MV, 10 MV, and 10 MV FFF, respectively. Gamma Capture dose equivalent at the maze entrance ($\mu Sv\ h^{-1}$) was: 28.2, 5.1, and 3.3 for 15 MV, 10 MV, and 10 MV FFF, respectively. Neutron dose rates vary slightly with distance and field size at the patient treatment plane, indicating that radiotherapy patients are exposed to radiation close to neutron dose equivalent rates at the isocenter. The study revealed a vital radiation protection consideration because of neutron contamination in external beam therapy.

Evaluation of patient and occupational radiation risk dose during general radiology procedure

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Abstract

Medical personnel working with ionizing radiation are exposed to significant radiation doses. Previously published studies reported increased incidence of cancer effects and cataracts among cardiologists due to ionizing radiation exposure. Therefore, an assessment of occupational exposure is recommended. This study aims to evaluate patient and occupational exposure during diagnostic, ambient doses and estimate the radiation risk. A total of 20 patients with General Radiology procedures. 46 staff (38 technologists, 8 Radiologists) were evaluated. Occupational and ambient doses were measured using calibrated optical stimulating-luminescent dosimeters (OSL) (Al_2O_3:C). These badges were read using an automatic OSL reader. The mean and standard deviation (SD) of the kVp, mAs, and Dose Area Product are 113.1±16.2, 7.5±11.65, and 869.6, respectively. The mean and range of effective dose (mSv) for Technologist was (0.6±0.36) (0-2.11). The mean and range of effective dose (mSv) for Radiologists were (0.48±0.19) (0.17-0.74). The occupational exposure in this study showed that radiology technologists and Radiologists are exposed to a low dose according to the current workload. The staff does is lower than the most previous literature.

Evaluation of patient and occupational radiation risk dose during general radiology procedure

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Abstract

A significant number of medical specialties use Cath-lab procedures. Radiation protection (RP) for patients and staff is one of the main issues in Cath-lab. UNSCEAR, ICRP, and IAEA have devoted significant time to improving radiation safety in IR over the last years. Several combined factors: prolonged localized fluoroscopy, multiple radiographic exposures, and repeated procedures can cause acute radiation injury to the skin. The values of the dose-area product (DAP) and effective dose for Cath-lab are typically larger than those used in standard diagnostic x-ray examinations. This study aims to evaluate patient and occupational exposure during diagnostic ambient doses and estimate the radiation risk. A total of 32 patients with the Cath-lab procedure. Ten occupational (2 technologists, two medical doctors, and six nurses) are evaluated. Occupational and ambient doses were measured using calibrated optical stimulating-luminescent dosimeters (OSL) (Al_2O_3:C). These badges were read using an automatic OSL reader. The mean and standard deviation (SD) of the Air Kerma and Dose Area Product are 371.1±132.1 and 26052.94, respectively. The mean and range of effective dose (mSv) for Technologist was (0.68±0.014) (0.12-0.13). The mean and range of effective dose (mSv) for Medical doctors were (1.11±0.21) (0.96-1.26). The mean and range of effective dose (mSv) for Nurse were (0.84±0.11) (0.68-1.16). The annual effective dose for cardiac catheterization personnel is the defined dose limit. The Interventional radiology personnel was well protected due to strict adherence to radiological protection guidelines and low workload.

RP-074-PP

Assessment of occupational exposure from SPECT/CT and PET/CT with various radiopharmaceuticals

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Abstract

Hybrid imaging (SPECT/CT and PET/CT) is a valuable diagnostic modality for detecting primary and metastatic malignancy. The first trade PET/CT scanner was performed in early 2001. Over 2,000 PET/CT scanners are working worldwide. Patients and staff may receive significant doses during the procedure. Therefore, radiation protection and safety assessment must ensure that the practice complies with the international guidelines. This study aims to evaluate occupational exposure during diagnostic, ambient doses and estimate the radiation risk. Twenty occupational (5 physicists, ten technologists, two medical doctors, and three nurses) are evaluated. Occupational and ambient doses were measured using calibrated optical stimulating-luminescent dosimeters (OSL) (Al_2O_3:C). These badges were read using an automatic OSL reader. The mean and range of effective dose (mSv) for physicists were (0.72±0.14) (0.49-0.83). The mean and range of effective dose (mSv) for Technologist was (1.4±0.96) (0-3.27). The mean and range of effective dose (mSv) for Medical doctors were 0.45 (0.15-0.74). The mean and range of effective dose (mSv) for Nurse were (1.38±0.25) (1.21-1.66). Constant tube voltage (kVp), 120)) was used for all patients. Staff received significant doses during PET/CT procedures during the administration of dose to the patient, patent preparation, and imaging protocol. Staff is exposed to high-energy gamma rays while CT dose composes 60% of patient's doses. Therefore, optimization of CT acquisition parameter is vital to reduce the dose to its minimal value. Occupational exposure within the recommended annual dose limit.

RP-075-PP

Radiation Dose and Cancer Risk in Children Undergoing a Pediatric Computed Tomography Facial Bones Procedure

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Abstract

Even though computed tomography (CT) scans offer many medical advantages, their increased usage since the 1980s has prompted concerns about cancer risks, particularly after young patients' exposure. CT scans generally deliver 5.0-50.0 mGy of ionizing radiation to each scanned organ. Due to the enormous number of exposures, estimation of patients' doses and their related risk is recommended. This study aims to assess the radiation risk to children during diagnostic procedures. A one-year radiation risk dosage was assessed for 25 pediatric patients. The patient's exposure was calculated using a Computed Tomography instrument (Siemens Somatom Sensation 128 (128-MDCT)). The volume CT dose index (CTDIvol) and DLP were among the measures. The CTDI value is a crucial CT radiation exposure measure. For one year, the mean and range of CTDI and DLP were 17.7 (4.36-45.77) and 391 (93.73-1077.15), respectively. The characteristics related to the radiation dosage were retrieved from the scan protocol generated by the CT system by the participating physicians after each examination. As a result, optimizing CT collection parameters is critical for lowering the dosage to its lowest level. The dosages given to the patients were somewhat more remarkable than in earlier studies.

Establishment of Local Diagnostic Reference Level (LDRL) for Routine Computed Tomography (CT) Brain Examination in Radiology Department, HPUPM

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Abstract

The aim of this study was to establish the local diagnostic reference level (LDRL) for routine adult plain computed tomography (CT) brain examination in Radiology Department at Teaching Hospital Universiti Putra Malaysia (HPUPM). The LDRL were obtained retrospectively in term of third quartile of measured DLP as dosimetric quantity value, later was compared with Malaysian National Diagnostic Reference Level (NDRL). A total of 317 adult plain CT brain examinations were collected. The NDRL for the DLP value of CT brain examination was 1050 mGy.cm. Current finding shows, only six examinations were exceeded the NDRL whereas another 311 examinations were below the NDRL value. The DLP values were ranged from 3.3 mGy.cm to maximum 1518 mGy.cm. The six examination end up with higher DLPs due to the auto-dose scanning mode was used automatically by the machine in order to accommodate larger patient sizes. However, the percentage of DLP value that exceed the NDRL for yearly basis was only 1.89% which less than 10% of standard limit stated by Ministry of Health. In conclusion, the LDRL obtained for CT brain was 762.6 mGy.cm. For higher dose cases that exceeded the NDRL, further evaluation is critical to ensure the dose optimisation for patients and to reduce the occurrence of excessive radiation exposure in future. Of important is that such efforts can be done via good coordination between medical physicists, radiologists and radiographers.

Analysis and Modeling of Thermal Hydraulic Performance for Nuclear Reactor Safety System Using Computational Fluid Dynamics

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Abstract

The future of nuclear energy technology lies in gen IV reactors, which include the high temperature gas cooled reactors design. In order to make sure that this technology is safe, many fundamental and applied research were done in various fields including the Neutronic calculations, material engineering, and Thermal-Hydraulics analysis. Thermal-hydraulic analysis can be done by either observing the performance of key coolant parameters experimentally, or by using computational fluid dynamics (CFD). This study aims to present an investigative study of currently present CFD data and compare it against referenced benchmark experimental data, by using the commercial CFD code ANSYS fluent. This study will include a model for a single jet, two parallel jets and the upper plenum of a 1/16th, scaled down version of the reference Generation IV MHTGR. The models will undergo a grid independence study to determine the minimum appropriate grid size and the data used are for normal operation and accident scenarios and for the laminar and turbulence model.

RP-078-PO

Low dose gamma radiation detection using polymer-functionalized micromechanical sensors

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Abstract

Herein, we aimed to ultrasensitive detection of low-dose gamma radiation using a polymer as sensing layers onto silicon micro-electromechanical systems (MEMS). In this study, two types of polymeric films were deposited on both Si wafers and micro-cantilevers, polyacrylic acid (PAA) and polystyrene (PS). All the samples were irradiated using a 137Cs gamma-ray source with different time exposure. The optical and mechanical properties, reflectivity (R) and surface roughness (RMS) sq, of silicon wafers coated polymeric thin films are studied before and after its gamma irradiation using ultraviolet-visible spectrophotometry (UV-Vis) and atomic force microscopy (AFM). The resonance frequency shift (RFS) of silicon micro- cantilevers coated polymeric thin films are studied during gamma irradiation using a Picomeasure system (PM3). Our results show that the resonance frequency shift of the polystyrene polymer-coated microcantilever was 286.7 Hz after 8 hours of irradiation. The same behaviors for the R and (RMS) sq of the PS thin film were linear as a function of the gamma dose. On the contrary, there was no noticeable change in RFS, R, and (RMS) sq of the PAA thin film. To verify this, we exposed a PS substrate to the same gamma dose and examined its optical properties by spectroscopic ellipsometry (SE) before and after each dose. As in the AFM results, SE results show that the surface roughness increased linearly as a function of the gamma dose. SE experiments demonstrate that this resulting linear effect is due to PS polymer thin films only. Based on our results, the interaction between gamma radiation and the PS polymer revealed that the MEMS coated with PS produced a linear response that could be used to develop radiation sensors for low gamma doses. Although many techniques exist for detecting nuclear radiation, our proposed sensor is characterized by its ultrasensitivity and accuracy of measurements.

RP-080-PO

Estimation of Annual Skin and Effective doses during Interventional Radiology Procedures

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Abstract

Interventional radiologists, assistants, and nursing personnel were exposed to a considerable portion of radiation scattered from the patient with heterogeneous energy. According to recent studies, the frequency of cataract among interventionists is on the rise. Despite the fact that employee safety is a top priority, there are few research on the subject. As a result, assessing employee exposure as well as radiation safety strategies and measures is critical. The goal of this study is to assess staff radiation exposure in radiology over a one-year period, with dosage defined in terms of Hp(10) and Hp(0.07) to determine the likelihood of cancer risk. Hp (10) (deep dose) and Hp (0.07) (skin dose) were used to calculate dose equivalent values. For one year, the measurements were made using calibrated thermoluminescent dosimeters, type LiF: Mg, Ti (TLD-100). The corresponding mean annual dose and range for Hp (10), Hp (0.07) were 4.7 ± 8 (2 – 14.5), 6±5 (1.2 –12.0). The annual dose is below the yearly dose limit. Continuous monitoring is recommended to provide an accurate evaluation of the work environment to ensure that all dose values are kept below annual dose limits.

Radiation & emission phenomena in plasma systems & their applications

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Abstract

In physical plasma materials processing systems, a low electron temperature and high electron density gaseous plasma is often used. Light emission, gas species ionization and radiation phenomenon with their associated parameters are all important factors to consider when setting up an optimal plasma system (a plasma source & its diagnostics) to carry out industrial materials processing. In this paper, a summary of the use of physical radiation to produce processing plasma is presented. In addition, interesting radiation phenomena in a plasma system especially those associated with waves production, propagation & interaction in a plasma are presented. Recent applications in which emission, ionization & radiation phenomena in plasmas were used to produce added value materials are introduced. These materials include for example base metals nanopowders that are difficult to produce in ultra-pure forms otherwise.

RP-082-PO

Assessment of Patient Radiation Dose during Skull X-ray Examinations in King Khalid Hospital in Majmaah

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Abstract

This study aims to measure entrance surface doses during routine skull x-ray examinations of adult patients in diagnostic radiology department in King Khalid Hospital in Majmaah. The patient entrance surface air kerma (ESAK) and the effective dose (ED) with 75th percentile were calculated based on the X-ray tube output and the exposure parameters, as well as utilization of suitable conversion coefficients, respectively. To calculate the effective dose (ED) and the patient entrance surface air kerma, the output and exposure characteristics of the X-ray tube, as well as relevant conversion coefficients, were considered (ESAK). Additionally, the 75th percentile distributions for the ESAK and KAP distributions were computed. Wide range of the entrance skin doses were noticed, which might be due to the difference in the exposure factors which applied for each examination. The study found that the measured ESAK and KAP were within the recommended and acceptable dosage limits. The mean ESAK and KAP values along with 75th percentiles for AP and Lateral skull projection were 1.01 (0.0034) mGy, 0.69 (0.098) mGy, 0.32 (0.009) Gy.cm^2, 0.27 (0.052) Gy.cm^2, respectively. The findings were significantly lower than national reference levels, the most often reported European DRL values, and other previously reported dosage values. The best radiation protection can be achieved by optimizing the radiation dose with preserving the image quality.

Structural Properties and Dielectric Behaviour of Ion beam Irradiated Flexible Polymer Nanocomposites Films

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Abstract

The present work aimed to studying the induced surface modification on flexible polymeric nanocomposite films using low energy argon beam for enhancing the dielectric performance of polymeric films. The composite films are irradiated with different ion beam fluence, using broad beam ion source. The synergistic effects of inorganic nanofiller and ion irradiation on the structural and dielectric properties of the films will be investigated. The films were characterized using X-ray Diffraction (XRD), Fourier transform infrared (FTIR) spectroscopy and scanning electron microscopy (SEM). The XRD was confirmed the successful fabrication of the polymeric composite films, while FTIR peaks are indicating inorganic nanoparticles attached to the polymer chains. The SEM images were indicated a homogenous loading and dispersion of inorganic nanofiller into the polymeric film. The electrical conductivity, dielectric permittivity, electric modulus, complex impedance, and the energy density efficiency of the ppristine and irradiated films have measured in the frequency range of 100 Hz to 5 MHz. These results open the road for utilizing the irradiated flexible composite films for wide range of application such as batteries, super-capacitor, sensors and energy storage applications.

RP-085-VO