2010

OMPI Seminar Archive

Justin Sutherland, Brenda Clark

Date: Thursday, January 21, 2010
National Research Council Canada, 1200 Montreal Road | 3:30 p.m.

Monte Carlo calculated absorbed-dose energy dependence of EBT and EBT2 film.
Justin Sutherland, Carleton University

Abstract: Using EGSnrc user codes we calculated the absorbed-dose energy dependence of GAFCHROMIC EBT and EBT2 film irradiated in photon beams. The absorbed-dose energy dependence was found to be constant in the mega-voltage range but non-uniformities were found in the low energy range. Differences with experimental results in literature for EBT in the kilo-voltage range suggest the possibility of an intrinsic energy dependence.

Management of Error in Radiation Treatment through Incident Learning
Brenda Clark, The Ottawa Hospital Cancer Centre

Abstract: This presentation will describe the implementation of an incident learning system in our radiation treatment program and the analysis of more than 1,000 incidents, most of which had little or no clinical impact. This presentation will answer the obvious question “why report, investigate, determine basic cause and identify learning follow-up on so many incidents with little or no impact on patient treatment?” The answers to this question, and there are many, include reference to the inevitability of human error in systems involving human intervention, the best way to prevent mosquitoes spoiling your summer and, more seriously perhaps, the impact of the Incident Learning System in enhancing the culture of safety at the individual health care professional level and at the multidisciplinary team level by addressing quality improvement initiatives collaboratively with transparent accountability.

Richard B. Richardson

Date: Thursday, February 25, 2010
The University of Ottawa Heart Institute. (40 Ruskin Street), room H2368 3:30 p.m.

Ionizing radiation and aging: rejuvenating an old idea

Richard B. Richardson
Radiation Protection Research and Instrumentation Branch, Atomic Energy of Canada Limited, Chalk River Laboratories

Abstract: This talk reviews the contemporary evidence that radiation can accelerate aging, degenerative health effects and mortality. Around the 1960s, the idea that ionizing radiation caused premature aging was dismissed as the radiation-induced health effects appeared to be virtually confined to neoplasms. More recently, radiation has become associated with a much wider spectrum of age-related diseases, including cardiovascular disease; although some diseases of old age, such as diabetes, are notably absent as a radiation risk. On the basis of recent research, is there a stronger case today to be made linking radiation and aging? Comparison is made between the now-known biological mechanisms of aging and those of radiation, including oxidative stress, chromosomal damage, apoptosis, stem cell exhaustion and inflammation. The association between radiation effects and the free-radical theory of aging as the causative hypothesis seems to be more compelling than that between radiation and the nutrient-sensing TOR pathway. Premature aging has been assessed by biomarkers in calorie restriction studies; yet, biomarkers such as telomere erosion and p16INK4a are ambiguous for radiation-induced aging. Some animal studies suggest low dose radiation may even demonstrate hormesis health benefits. Regardless, there is virtually no support for a life span extending hypothesis for A-bomb survivors and other exposed subjects.
The article is posted on the open access, Aging web:
http://www.impactaging.com/papers/v1/n11/pdf/100081.pdf

Chad Hunter, Laurel Sinclair

Date: Thursday, March 25, 2010
Carleton University, HP5115. 3:30pm.

New Effective Dose Estimates for Rubidium-82 Based on Dynamic PET/CT Imaging in humans.
Chad Hunter (Carleton University & Heart Institute)

Abstract:
Objectives: Published radiation dose estimates for Rubidium-82 vary widely, and no comprehensive study in man has yet been conducted. With the increasing use of Rb-82 PET for myocardial perfusion imaging, improved dosimetry information is needed for accurate risk assessment. The purpose of this study was to measure Rb-82 internal organ and effctive doses with PET/CT in humans. Methods: We recruited 26 cardiac patients and 4 normal subjects with no cardiac history. Dynamic 3D PET scans were acquired (GE Discovery RX/VCT) over 10 minutes following IV injection of 10 MBq/kg Rb-82. Images were reconstructed using FORE-OSEM and 8 mm Hann filter. Cardiac scans of the chest were acquired at rest for all 30 subjects, plus one additional scan of the Head, Neck, Abdomen,Pelvis, or Thighs. Mean Rb-82 residence times were determined in 22 source organs using volumes-of-interest (VOI) drawn on the fused PET/CT images. For large organs a small VOI was used to avoidpartial volume losses. For small organs the average activity above 80% threshold was multiplied by the volume at 40% of the peak value within the organ VOI. Target organ doses and the effective dose estimate were calculated using OLINDA/EXM 1.0 according to ICRP 60, and recalculated according to ICRP 103. Results: A total of 283 organs were measured across the 60 scans, with at least 4 samples obtained in each source organ. The average 'adult' effective dose for Rubidium-82 was found to be 0.00074 mSv/MBq using ICRP 60. Using ICRP 103, the male and female effective doses were 0.00074 and 0.00092 mSv/MBq respectively. The highest dose organs were the lungs, kidneys and stomach wall. Conclusion: These dose estimates for Rubidium-82 are the first to be measured directly with PET/CT in humans, and are 4 to 4.5 times lower than previous ICRP 60 values based on a theoretical blood flow model. The new values derived from human studies suggest a typical effective dose of 0.6 mSv per scan with 3D PET. Research Support: DRAXimage, Ontario Research Fund.

Long Range Detection of Radioactive Threat Material
Laurel Sinclair (Natural Resources Canada)

Abstract:
In both security investigations and incident remediation work, there is a need to precisely define the locations of man-made radioactivity in the environment. Deploying simple gamma and neutron detectors from an airborne platform has proven a valuable method to delineate dispersed radioactivity. However, in some scenarios, a land-based detection system is required. The presence of partial shielding in these cases, and the restriction of the survey platform to roads, necessitates the use of instruments capable of directionality or imaging. To address this need, we are working with a commercial partner on a synthetic aperture gamma array detector. We are also designing and building a rugged and transportable Compton gamma imager. The latest results from these development efforts will be presented.

Elsayed Ali, Tong Xu

Date: Thursday, April 22, 2010
Health Canada (775 Brookfield Road, Ottawa), room 205B . 3:30pm

Unfolding linac photon beam spectra from transmission measurements
Elsayed Ali (Carleton University)

Abstract:
In clinical photon beams, the energy distribution (spectrum) of the photons coming out of the treatment head is the ultimate beam quality specifier, from which many dosimetric quantities can be derived. Because direct spectroscopic measurements (including Compton spectrometry) are not suitable for a typical clinical environment or for typical therapeutic dose rates, a variety of indirect methods to measure megavoltage bremsstrahlung spectra have been investigated in the past. One indirect method, which uses transmission measurements, stood out for its simplicity and cost effectiveness. In this method, various thicknesses of an attenuating material are introduced in the beam path, and the measured ion chamber signals are used to unfold the spectrum. Despite the large volume of experimental and computational work on this method, a definitive work on the subject is still lacking. This is partly because of the inherent ill-conditioned nature of the problem, but largely because previous investigations have collectively a) not fully exploited basic radiation physics principles, b) ignored or grossly approximated various dosimetric aspects of the problem, c) limited the investigations to specific situations or beam energies, d) suffered from weak validation and benchmarking and, e) not carried out the measurements and uncertainty budgets so as to unearth all hidden type-B uncertainties. In this talk, I'll present a series of computational and experimental solutions to address the limitations to unfolding linac photon beam spectra from transmission measurements.

Dynamic dual-energy chest radiography: a potential tool for lung tissue motion monitoring and function study
Tong Xu (Carleton University)

Abstract:
Dual-energy x-ray imaging allows the separation of image signal of soft tissue from bone structures. By removing the anatomic rib background, statistic dual-energy chest x-ray image has the potential of better diagnosis of lung nodules as compared with conventional chest x-ray. With the development of digital flat panel detectors (FPD), Dual-energy x-ray imaging has now become more feasible. The FPD has also enabled another technique: Dynamic chest x-ray imaging, which takes a "movie" of the lung" during a breathing cycle. It may be used to evaluate the lung function for the diagnosis of lung diseases such as emphysema and chronic obstructive pulmonary diseases. In this study, we combined the above techniques and implemented dynamic dual energy chest radiography system. Animal studies were performed to evaluate the feasibility of this technique in lung functional imaging and tumour motion assessment.

Munira Fardous Nahin, Paul Johns

Date: Thursday, May 20, 2010
Time: 3:30pm, refreshment start at 3:15pm. (BBQ at 5pm)
Location: Building M-36, NRC Montreal Rd Campus, Kelvin Room.

(Please check in at the front desk)

Special events: Don't forget to register with Malcolm McEwen **(Malcolm.McEwen@nrc-cnrc.gc.ca)** for the BBQ after the seminar.

(Click here for direction)

(Click here for NRC campus map)

Reproducibility of Tl-201 for cardiac micro SPECT imaging with a rat model
Munira Fardous Nahin (Carleton University and Ottawa Heart Institute)

Abstract:
Gated myocardial perfusion single-photon emission computed tomography (SPECT) is a non-invasive and valuable tool for in vivo measurements of cardiac function. In vivo measurements are used to study heart disease in small animals and thereby develop new therapies and new radio-tracers. The left ventricular end diastolic volume (EDV), end systolic volume (ESV), ejection fraction (EF) and perfusion homogeneity (PH) are important measures of heart function which can be determined using SPECT. Longitudinal imaging of a single animal increases the statistical power of studies and reduces unnecessary sacrifice improving our ability to study disease development and evaluate interventions. Understanding measurement variability is essential for evaluating the significance of observed changes. The purpose of our study was to determine the inter- and intra-subject reproducibility of the left ventricular volumes, ejection fraction and perfusion homogeneity with Tl-201 myocardial perfusion SPECT in a rat model.

Coherently-Scattered X Rays as a Source of Radiological Contrast
Paul Johns(Carleton University)

Abstract:

In diagnostic radiology, up to 90% of the x-ray quanta approaching the image receptor have been coherently or incoherently scattered. Although it is usually treated as a nuisance to be suppressed, scattered radiation also carries information about the patient. Coherent scatter, which is the basis of x-ray diffraction, can be particularly useful. The underlying physics and basic approaches to scatter imaging will be reviewed. Our research progress on modelling the imaging potential of scattered photons, on projection imaging with scatter, and on measuring the basic cross sections, will be reported.

Patrick Assouad, Gabriel Sawakuchi

Date: Thursday, September 30, 2010
Time: 3:30pm, refreshment start at 3:15pm.
Location: Carleton University, Herzberg building room H4351

(Click here for directions)

Special events: Soccer game and Beer after the seminars

Mid-Infrared Fiber Evanescent Wave Spectroscopy for In-Vivo Diagnostic of Malignant Tissue
Patrick Assouad (Carleton University)

Abstract:
Fingerprint molecular spectral signatures have traditionally been obtained from tissue through Fourier Transform Infrared (FTIR) spectroscopy requiring biopsies and appropriate sample preparation. Previous work has identified spectral biomarkers for malignant mutations in several types of cancers. Here, the feasibility of acquiring comparable spectral tissue readings in-vivo is investigated through mid-infrared Fiber Evanescent Wave spectroscopy (FEWS). In this approach, a silver halide fiber is used to guide the radiation to a sensing probe placed in contact with the tissue, eliminating the need for sample collection and preparation. Results of a preliminary analysis are presented comparing both techniques using samples of healthy and malignant cervical tissue. A discussion of inherent complications arising from an in-vivo environment is also given.

LET determination using the optically stimulated luminescence of Al2O3:C
Gabriel Sawakuchi (Carleton University)

Abstract:
Knowledge of biological radiation dose, which in turns depends on the linear energy transfer (LET), is important for hadron therapy of cancer patients. Currently, no technique exists for measuring the LET in hadron therapy clinical dosimetry on a daily basis; the only quantity reported is the absorbed dose. Development of a technique for measuring LET is an important step because without knowledge of the radiation's LET, it is difficult to determine the biological dose (that is, the LET characterizes the dose that causes a biological effect). Hadron therapy beams, including proton and carbon ion beams, have a higher LET and thus produce a greater biological effect than x-ray or electron beams. Therefore, the relative biological effectiveness (RBE) of hadron therapy beams with respect to cobalt-60 gamma rays can differ from unity and the physical absorbed dose (D) can significantly differ from the biological dose (E = D × RBE). The objective of this talk is to show that the optically stimulated luminescence of Al2O3:C detectors can be used to measure LET of therapeutic proton beams.

Ernesto Mainegra, Rebecca Thornhill

Date: Thursday, October 21, 2010
Time: 3:30pm, refreshment start at 3:15pm.
Location: Health Canada (Brookfield rd.), room RPB 205B, please check-in at the front desk. Parking across the street.

(Click here for directions)

Free Air Chamber attenuation corrections for low-energy x-ray beams
Ernesto Mainegra (NRC/Carleton U)

Abstract:
Free Air Chambers (FAC) are used as the primary standard for the calibration of radiation detectors for x-ray beams at the Ionization Radiation Standards (IRS) group at the NRC. The ability to estimate FAC attenuation correction factors for low energy x-ray beams using EGSnrc is demonstrated. Monte Carlo (MC) calculated attenuation correction factors are compared to experimentally determined values. Two sets of beam qualities are used in the study; a mammography set of x-ray beams with tube potentials from 23 kVp up to 50 kVp filtered with 0.064 mm of Mo, and a softer, Al filtered (0.245 mm Al), set of x-ray beams with tube
potentials ranging from 10 kVp up to 80 kVp. An inconsistency in the experimental “evacuated tube” technique for the determination of the attenuation correction is found to be of the order of 0.2% for the softer Al filtered beams and less than 0.1% for the mammography beams.
Discrepancies between the MC calculated and the experimental values of the attenuation correction for the Al filtered beams can be explained by increasing the contribution from L-shell characteristic x-rays suggesting a need to rescale the L-shell electron impact ionization (EII) cross sections.

Magnetic Resonance tools for the Evaluation of Cardiovascular Disease & Metabolic Disorders
Rebecca Thornhill (The Ottawa Hospital)

Abstract:
Cardiovascular disease currently accounts for 30% of all deaths in Canada. Together, ischemic heart disease and acute ischemic stroke result in almost 70 000 deaths in Canada each year, as well as substantial long-term disability.

Magnetic resonance imaging (MRI) is a highly versatile tool, offering a potential ‘one-stop-shop’ for the evaluation of cardiovascular disease. After providing some brief background and MRI terminology, I will discuss how MRI can be used to assess myocardial viability following a heart attack, including evidence gleaned from canine and patient studies of ischemic heart disease.

Secondly, I will provide an example of how MRI can be used for risk stratification in emergency stroke imaging and its potential to predict serious bleeding complications in acute ischemic stroke.

Finally, I will briefly propose how MRI can be used to measure subtle changes in heart function in patients with metabolic disorders such as diabetes. Heart failure is the most common cause of death among diabetics who have suffered a heart attack. In addition to providing clinicians with a sensitive marker of incipient heart failure, MRI strain analysis may offer a non-invasive strategy for delineating incremental benefits from emerging therapies.

Tyler Dumouchel, Eric Vandervoort

Date: Thursday, November 18, 2010
Location: Ottawa Hospital General Campus, main building 2nd floor Auditorium

(Click here for directions)

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Jared Strydhorst, Dmitry Klokov

Date: Thursday, December 16, 2010
Location: University of Ottawa Heart Inistitute. room H-2403

(Click here for map)

Modeling photon attenuation in the reconstruction of small animal pinhole SPECT images
Jared Strydhorst (Carleton University & U.O. Heart Institute)

Molecular imaging of small animals is a valuable tool for research of diseases and development of new drugs and therapies. However, the effects being investigated are often very small and achieving sufficient quantitative accuracy to detect them is a challenge. In particular, photon attenuation can result in significant differences between the true tracer concentration and the measured tracer concentration and limit the reproducibility of measurements between animals. In this work, we investigate modelling the photon attenuation as part of the OSEM reconstruction algorithm. Five rats were injected with Tc-99m tetrofosmin and scanned in a nanoSPECT/CT scanner in both CT and SPECT mode. The CT data was used to create an attenuation map which was incorporated into the reconstruction. For the five rats studied, the absolute measured tracer concentration in the uncorrected reconstructions was 30±2% less than in the attenuation corrected images. In the heart, three of the seventeen segments exhibited significant differences in relative perfusion when corrected and uncorrected images were compared, and several adjoining segments exhibited changes that were nearly significant. No significant changes were observed in the overall uniformity of the cardiac perfusion as a result of attenuation correction.

Radiobiological studies at Chalk River Laboratories: radioadaptive response and DNA repair
Dmitry Klokov, Chalk River Laboratories, Atomic Energy Canada Limited

Chalk River Laboratories (CRL) of Atomic Energy Canada Limited (AECL) is involved in R&D activities that are related to nuclear industry, including research in the field of radiological protection and radiation biology. Radiological Protection Research and Instrumentation (RPRI) branch consists of three sections: Instrumentation, Biodosimetry and Radiation Biology. The Biodosimetry group conducts both service and research activities related to evaluation of a radiation dose received in a potential nuclear accident or terrorist attack and modeling radionuclide routes in an organism. Research activities within the Biodosimetry section are focused around developing novel and improved methods for biological dosimetry. The Radiation Biology section represents a fundamental wing of the branch and involved in basic studies of mechanisms of biological effects of low dose ionizing radiation of different properties (gamma-, alpha-, beta-) that are related to radiological protection. Low dose of ionizing radiation are known to induce radioadaptive response – increased radioresistance to high radiation dose. In our studies we use mouse models, as well as cultured mammalian cells in vitro to investigate mechanisms of radioadaptive responses. End-points include life span, tumour frequency, cytogenetic damage, DNA damage and repair. Our recent results indicate that reapir of DNA double strand breaks (the most deleterious type of DNA lesions that may trigger carcinogenesis) is not involved in systemic radioadaptive responses (increase of life span and decrease of tumour frequency in low-dose irradiated mice). Future studies will examine biological effects of chronic low dose rate exposure to gamma- vs. beta-radiation (Tritium) in mice in vivo at levels of gene expression, epigenetic changes, DNA damage signalling, cytogenetic damage and sife span. Transgenerational effects will be studied as well. RPRI branch is interested in linkages with academic institutions to invite potential students to conduct masters, PhD, or post-doc studies at CRL in the fields of biodosimetry, radiological protection and radiation biology using its state-of-the-art animal research facility, as well as cell and molecular biology, biochemistry, microscopy facilities.