2013

OMPI Seminar Archive

Conor McFadden, Carl Ross and OMPI social event

Date: Thursday, January 17, 2013
Time: 3:30 - 5:00 pm – January 17, 2013
Location: West Foustanellas Auditorium (H-2366) – 2nd floor – The University of Ottawa Heart Institute, 40 Ruskin Street.

In the event that the rideau canal is open for skating, the seminar will be followed by an evening skate from Dow's lake to the Royal Oak at Pretoria bridge for drinks (map). Otherwise, there will be a social gathering at Pub Italia on Preston st (map).

"Performing radiation measurements at the sub-micrometer scale"
Conor McFadden – Carleton University

Abstract: Currently, there is no technique capable of measuring radiation quantities directly with sub-micrometer spatial resolution. Moreover, quantities describing events of energy deposition by ionizing radiation are not well defined on the sub-micrometer scale. Sub-micrometer resolution radiation measurements are important to understand the effects of ionizing radiation in cells and the effectiveness of different types of radiation in causing biological damage. The purpose of this work is to develop a technique capable of: a) measuring energy deposition events with sub-micrometer spatial resolution; and b) co-localizing these events with images of cell nuclei. A custom confocal laser scanning microscope (CLSM) was developed at Carleton which is capable of resolving ionization events in the volume of an Al2O3:C,Mg fluorescent nuclear track detector (FNTD). The spatial resolution of the FNTD technique is at the sub-micrometer scale, which is sufficient for performing radiation measurements at the level of the cell nucleus. This talk will outline the development of the CLSM, as well as our current efforts towards characterization of FNTDs for measuring radiation quantities in clinical radiation beams.

"Making Medical Isotopes – Present Status and Future Prospects"
Carl Ross – National Research Council Canada

Abstract: The isotope crisis of 2009 drew attention to the fact that the global supply of Tc-99m was reliant upon a few aging research reactors. The crisis prompted a review of supply options and a wide range of possibilities have been suggested. Only a few of these are technologically and economically practical and major efforts are underway to have workable solutions by the time NRU stops making medical isotopes in 2016. There are two options being explored to establish a domestic supply for Canada. One approach uses proton cyclotrons to produce Tc-99m directly while the second uses electron linacs to produce Mo-99 which decays to Tc-99m. Technology, economics and politics will all impact on how nuclear pharmacies deliver Tc-99m after 2016. I will review the pros and cons of various approaches and discuss why the electron linac option is the most promising.

Amir Pourmoghaddas and Balazs Nyiri

Date: Thursday, February 28, 2013
Time: 3:30 - 5:00 pm - February 28, 2013
Location: Carleton University - Herzberg Building - Room HP4351

"Quantitative imaging for a dedicated cardiac SPECT camera"
Amir Pourmoghaddas - Carleton University

Abstract: Blood flow imaging of the heart is a very useful tool in the diagnosis of heart disease. The best way for measuring blood flow is by using a positron emission tomography (PET) camera. PET can measure absolute blood flow, that is, exactly how much blood flow is present rather than just a relative measure of whether some parts of the heart have more or less than others. Absolute measurements more accurately diagnose extensive multivessel coronary artery disease. Another popular way to picture blood flow is with single photon emission computed tomography (SPECT). SPECT is a less expensive technology and there are many more of SPECT cameras available than PET cameras, but SPECT has traditionally measured only relative blood flow. A recent revolution in SPECT camera design has greatly improved image quality and opened the door to measuring absolute blood flow. However, in order to increase the accuracy of the camera to allow for quantitative measurements, factors such as attenuation and scatter need to be taken into account. This presentation will describe some of the research done in order to evaluate the performance of scatter and attenuation correction techniques on a dedicated cardiac SPECT camera. Quantitative accuracy may also vary depending on the number of iterations when using iterative reconstruction algorithms. Consistency of activity measurement as a function of MLEM iterations will also be discussed.

"Three self-referencing methods for the measurement of beam spot position"
Balazs Nyiri - The Ottawa Hospital Regional Cancer

Abstract: High-energy electrons, striking a bremsstrahlung target in the treatment head of a linear accelerator, produce the photons used in cancer therapy. The position and distribution of the electrons (beam spot) on the target is controlled by the Linac's beam steering circuitry and influences many clinically relevant treatment and imaging properties. Three quantitative methods of measuring electron beam spot position with respect to the collimator axis of rotation are discussed.

Bryan Muir and Trevor Stocki

Date: Thursday, March 21, 2013
Time: 3:30 - 5:00 pm - March 21, 2013
Location: Conference room A&B, Room C2362, 2nd floor, Cancer Centre South, General Campus, 501 Smyth Road

"Measurements and Monte Carlo simulations for reference dosimetry of electron beams"

Bryan Muir – Carleton University

Abstract: Clinical medical physicists follow protocols, such as the AAPM's TG-51, to calibrate high-energy radiation therapy sources. A working group of the AAPM is currently engaged in updating the TG-51 protocol for high-energy reference dosimetry. This work investigates current recommendations for electron beam reference dosimetry using measurements and Monte Carlo simulations of ion chamber response. Depth-ionization measurements with parallel-plate and cylindrical ion chamber types are performed at NRC in clinical electron beams with energies ranging from 4 to 18 MeV. Variable results are observed in terms of the short- and long-term stability of ratios of chamber readings to reference ion chambers. Monte Carlo simulations of the absorbed dose to the gas in an ion chamber and the absorbed dose to water are performed as a function of depth using the EGSnrc egs_chamber user-code. A variety of realistic clinical accelerator models as well as less realistic electron beam sources are used to study the dependence of dosimetric data on the incident source model. Using these simulations, beam quality conversion factors and gradient effects are investigated for several different cylindrical and parallel-plate chamber types.

"Environmental Transfer Modelling to Determine Radiation Dose to Humans"

Trevor Stocki – Health Canada

Abstract: In January 2009, the IAEA EMRAS II (Environmental Modelling for Radiation Safety II) program was launched. The goal of the program is to develop, compare and test models for the assessment of radiological impacts to the public and the environment due to radionuclides being released or already existing in the environment; help countries build and harmonize their capabilities; and to model the movement of radionuclides in the environment. Within EMRAS II, nine working groups are active; this presentation will focus on the activities of Working Group 1: Reference Methodologies for Controlling Discharges of Routine Releases. Within this working group environmental transfer and dose assessment models are tested under different scenarios by participating countries and the results are compared. This process allows each participating country to identify characteristics of their models in order to refine their methods of estimating the impact of radionuclide releases into the environment. The goal of this working group is to identify reference methodologies for the assessment of exposures to the public due to routine discharges of radionuclides to the terrestrial and aquatic environments. In the framework of this working group, several different models are being applied to estimate the transfer of radionuclides in the environment for various scenarios. In the first phase of the project, the group has been working on a scenario where a nuclear power reactor with a coastal location routinely (continuously) discharges 60Co, 85Kr, 131I, and 137Cs to the atmosphere and 60Co, 137Cs, and 90Sr to the marine environment. In this scenario many of the parameters and characteristics of the representative group were given to the modellers and cannot be altered by the users. Various models have been used by the different participants in this inter-comparison (PC-CREAM, CROM, IMPACT, CLRP POSEIDON, and others). The first scenario is to enable a comparison of the radionuclide transport and dose modelling. These scenarios will facilitate the development of reference methodologies for controlled discharges. A review of the Canadian standard on how to perform these calculations will also be reviewed during this presentation.

Chad Hunter and Ran Klein

Date: Thursday, April 18, 2013
Time: 3:30 - 5:00 pm - April 18, 2013
Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road

1. "Patient body motion affects myocardial blood flow quantification with rubidium-82 PET imaging"
Chad Hunter – Carleton University

Abstract: Patient motion >0.7 cm occurs in >24% of rubidium-82 (Rb-82) dynamic PET scans, and is known to cause attenuation correction (AC) artifacts, but the effects on myocardial blood flow (MBF) quantification are less clear. This study aimed to quantify inaccuracies in MBF, induced by patient body motion. Simulations were performed using patient-derived activity distribution and time-activity curves (TAC) of Rb-82 PET, and a digital NCAT phantom. A simulation without motion was used as a reference standard. Translational motion in three dimensions (±1 and ±2 cm) was simulated (n=12), consisting of an instantaneous shift in the body location at a shift-time (30, 60, 120, 240 s). Noise-free images were reconstructed using filtered back-projection. Dynamic images were reconstructed with and without AC artifacts. Blood flow quantification was performed using the 1-tissue-compartment model, including blood spillover and partial-volume corrections as implemented in the FlowQuant (UOHI) software program. Errors were greatest for shifts at 120s, CTAC misalignment artifacts alone accounted for 5 to 13% error in MBF measurements. CTAC artifacts occurring after the shift-time resulted in 30% greater MBF error compared to those before the shift point. Dynamic body motion alone with regional partial-volume recovery correction (RC) resulted in MBF errors as high as 230%, indicating that inconsistency in the dynamic TAC data is the dominant source of MBF inaccuracy. Regional partial-volume recovery correction (RC) resulted in 80% increase in variability and 20% increase in the maximum MBF error compared to a global-average RC, indicating that regional partial-volume correction methods are also sensitive to body motion. Patient body motion of 1 to 2 cm can result in >200% error in MBF due to inconsistent myocardial TAC data, suggesting that post-reconstruction image-based motion correction may correct for the majority of body motion-induced bias in MBF measurements.

2. "Myocardial blood flow quantification - 82Rb PET is the just the beginning"
Ran Klein – University of Ottawa Heart Institute

Abstract: Our work on quantification of myocardial blood flow using rubidium-82 (82Rb) positron emission tomography (PET) is poised to provide precise clinical information for effective patient management, while substantially reducing the cost of these exams, and radiation exposure. The lessons we learnt and the technology we developed is now being translated to new imaging modalities and applications. This talk will introduce our cutting edge 82Rb PET technology and will highlight ongoing research which exploits this technology.

Dal Granville, Richard Richardson and OMPI BBQ social

Date: Thursday, May 16, 2013
Time: 3:30 - 5:00 pm - May 16, 2013
Location: NRC – 1200 Montreal Road, North Campus

We will be finishing off this season's seminar series with a BBQ at the NRC. To help in organizing this, we would like to have an idea of how many people are planning to come to the seminar and stay for the food afterwards. **Please reply by May 13 to guarantee your share - Claudiu.Cojocaru@nrc-cnrc.gc.ca.** We will make every effort to accommodate special dietary needs (e.g. vegetarians) but only if we know in advance.

Presentations:

1. "Measurement of average LET of proton therapy beams using optically stimulated luminescence detectors"

Dal Granville – Carleton University

Abstract: The biological response of tissue irradiated with heavy charged particle beams depends on both the absorbed dose in the tissue and the linear energy transfer (LET) of the beam. While absorbed dose is routinely measured using a variety of detectors, there is no device available for the routine measurement and verification of LET. This work aims to further develop the optically stimulated luminescence (OSL) technique, which is already well established for absorbed dose measurements, to allow for routine measurements of LET in heavy charged particle beams, specifically proton beams. This presentation will focus on the LET dependence of Al2O3:C OSL detectors, and a proof-of-concept experiment that demonstrates the feasibility of using these detectors for LET measurements of radiotherapy proton beams.

2. "Are Alpha- and Beta-Emitting Bone-Seeking Radionuclides Effective Treatments against Leukemia Stem Cells and Bone Metastases?"

Richard Richardson – Atomic Energy of Canada Limited (AECL)

Abstract: Studies are in progress with clinicians/scientists at Ottawa Hospital that are examining the fundamental effects of ionizing radiation on marrow stem cells, the source of common forms of leukemia and bone cancer. I will also describe the results of a Monte Carlo simulation with scientists at Purdue University, USA, which initially indicated that the radiation dosimetry of bone metastases with bone-seeking radium-223 was effective and non-toxic, but not so when later allowance was made for the diffusion of radon-119.

Nelson Miksys, Richard Wassenaar and OMPI social event

Date: Thursday, September 26, 2013
Time: 3:30 - 5 pm
Location: Room HP4351, Herzberg Building, Carleton University
Nelson Miksys and Richard Wassenaar

Presentations:

1. "Patient-specific Monte Carlo dosimetry for permanent implant brachytherapy"
Nelson Miksys – Carleton University

Abstract: Dose distributions for permanent implant brachytherapy can be more accurately calculated with Monte Carlo (MC) simulations than with the widely-used TG-43 water-based approach because tissue heterogenieties and inter-seed attenuation effects are considered. However, challenges remain in the application of MC in brachytherapy, e.g., the mitigation of streaking artifacts (due to brachytherapy sources) in CT images and the ambiguous assignment of tissues and densities when deriving patient-specific MC phantoms from CT images. This work addresses these challenges, presents results on patient-specific artifact-corrected CT- based MC dosimetry for prostate and breast brachytherapy, and paves the way for clinical application of patient-specific MC dosimetry.

2."Device Design and Security of Radioactive Sealed Sources"
Richard Wassenaar – Best Theratronics

Abstract: Radioactive sealed sources are common worldwide, filling a wide variety of roles, including medical usage. Due to the activity of these sources, the potential for harm to the general public is high, should the sources fall into the wrong hands and be used maliciously. Due this potential threat, there has been increased attention, at the international level, related to the security of such sources. In fact, the CNSC has recently issued new regulatory document pertaining to the security of Category 1 and 2 (high risk) sealed sources. Within this framework, manufacturers plan an important role in ensure devices are designed to meet security requirements. Best Theratronics has been actively working with various regulatory and government organizations to redesign their radiation devices with the goal of greater security in mind. In this talk, the results of that work, including the challenges faced by manufacturers and end-users, will be discussed.

The talks are followed by a social gathering at McLauren's Pub: 301 Elgin Street Ottawa, ON K2P 2N9 (map)

Time: 6-11 pm.

Matt Rodrigues and Dan La Russa

Date: Thursday, October 24, 2013
Time: 3:30 pm
Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road

1. "An automated high-throughput method of the cytokinesis block micronucleus (CBMN) assay for dose estimation in radiation biodosimetry"
Matthew Rodrigues - Carleton University

Abstract: The cytokinesis-block micronucleus (CBMN) assay is employed in biological dosimetry as a method for determining the dose of radiation to an exposed individual from the frequency of micronuclei (MN) in binucleated lymphocyte cells. The assay is typically performed using manual microscopy but it would be advantageous to automate the method to allow for increased throughput. With the development of new technologies such as the ImageStreamX, an imaging flow cytometer, it is now possible to adapt the CBMN assay to an automated imaging cytometry method. The ImageStreamX has adequate sensitivity to quantify radiation doses to within ~0.5 Gy while adding the increased throughput of traditional flow cytometry. The protocol and analysis which adapts the CBMN assay for use on the ImageStreamX will be presented as well as recent results which indicate that binucleated cells (BNCs) and MN can be identified, imaged and enumerated automatically using the ImageStreamX, allowing for dose estimation.

2. "Quality and safety initiatives in radiation therapy at the Ottawa Hospital Cancer Centre"
Daniel La Russa - The Ottawa Hospital Cancer Centre

Abstract: This presentation will review some of the recent updates to the quality management of the Radiation Medicine Program at The Ottawa Hospital Cancer Centre (TOHCC). Emphasis will be put on the use of Failure Mode and Effect Analysis (FMEA) and the use of Statistical Process Control (SPC) in the context of a modern radiation therapy treatment process. Examples of the use of these techniques at TOHCC will be presented along with a overview of some device-centric quality control tests of our IMRT/VMAT treatment processes. A project underway to develop free, open source software for quality control of radiation therapy treatment plans will also be described.

Frank Marshall and Tong Xu

Date: Thursday, November 21, 2013
Time: 3:30 pm
Location: Conference room A&B, Room C2362, 2nd floor, Cancer Centre South , The Ottawa Hospital (General Campus)

1. "Reconstruction of a Distributed Radioactive Source with a Directional Spectrometer"

Frank Marshall - Carleton University

Abstract: The Emergency Response Group at Natural Resources Canada is responsible for developing innovative techniques of reconstruction for localizing and mapping radioactive sources. In one area of research, the group is has been in joint collaboration with Defense Research and Development Canada (DRDC) to determine novel techniques for mapping radioactive distributed sources (RDDs). Over the past two years, Medicine Hat in Suffield, Alberta has provided the testing grounds for several experiments, in which lanthanum-140 sources were detonated. In these experiments, a directional spectrometer was used to record the spatial variation of the source intensity. It consists of four, tightly-packed, NaI detectors. It was mounted on a truck and driven around the source distribution. From this survey, the limited data of points along the truck path leave much information to be extracted regarding the true source distribution. This talk will review some of the methods that are employed to approximate the local intensity in the vicinity of the trucks path. In particular, there will be a review of the method used to determine a factor that converts the measured signal into an intensity measurement for the case of the detector overlying an infinite disc source. This method makes use of a curve of counts versus disc radius, which is called the detector footprint. Results of EGSnrc simulations will be presented for this calculation, as will results of detector parameter simulations.

2. "A GPU implementation of EGSnrc"

Tong Xu - Carleton University

Abstract: As an effort to enable accurate and fast Monte Carlo simulation for potential clinical use, the physics core of the well accepted Monte Carlo simulation package, EGSnrc, was implemented on the parallel computing platform based on GPU, Graphics Process Units. With hundreds of processors integrated in one cost effective board, GPU has recently shown great potential on high performance computing, including Monte Carlo simulations. An introduction to the concept of GPU computing will be given. The simulation structure of EGSnrc was changed to achieve better performance on GPU. Through the simulation of PDDs and dose profiles, the newly developed GPU based system was benchmarked and validated against the original EGSnrc.

Martin Martinov, Peter Raaphorst

Date: Thursday, December 19, 2013
Time: 3:30 pm
Location: Foustanellas Auditorium (room H-2367), second floor, The University of Ottawa Heart Institute. 40 Ruskin st, Ottawa, On K1Y 4W7

1. "Recent developments with BrachyDose"
Martin Martinov - Carleton University

Abstract: This presentation will review the work done for and with BrachyDose in CLRP recently. It will look over a Graphical User Interface (GUI) made for the upcoming distribution of BrachyDose. The GUI has the same functionality as most of the other EGSnrc user-code GUIs wih some additional features. It will give an overview of a graphical reimplimentation of StatDose with additional functionality as well. Then it will cover an analysis of several different eye plaque models used in ocular melanoma treatments, building on the work done creating an eye model in CLRP this previous year.

2. "The Physics and Quality Control of Clinical Bone Mineral Density Programs"
Peter Raaphorst - Carleton University

Abstract: A serious problem in the aging process is the loss of bone minerals resulting in osteoporosis. This causes the bones to become weak a brittle and susceptible to fracture and breaking. Spinal and hip fractures can lead to severe debilitation and to death in the elderly. The rate of bone mineral loss varies between genders and amongst individuals. Early detection of bone mineral loss can lead to intervention and the delay of osteoporosis. Differential x-ray absorptiometry (DXA) can be used to detect bone mineral loss. This is a quantitative x-ray procedure that requires a high level of precision. In order to achieve this precision a quality control process has been developed to allow detection of bone mineral loss in the spine and the hip with precision as low as 0.5%. The physics and quality control of DXA will be described and examples of serious errors that were incurred when a QC program is not followed will be presented.