2014

OMPI Seminar Archive

Elizabeth Orton, Sangeeta Murugkar and winter special event

Date: Thursday, January 23, 2014
Time: 3:30 - 5 pm
Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road
Elizabeth Orton and Sangeeta Murugkar

Presentations:

1. "Automated detection of extra-cardiac interference in Rubidium-82 PET myocardial perfusion imaging"
Elizabeth Orton - Carleton University

Abstract: In nuclear cardiology, myocardial perfusion imaging, MPI, is used to reflect the heart muscle's regional blood supply and it is widely applied for diagnosis and risk stratification of coronary artery disease. MPI studies produced with PET and the radio-labeled cardiac perfusion tracer rubidium-82 chloride, Rb-82, frequently show tracer uptake not only in the myocardium but also in the stomach wall and spleen. When the proximity of these structures to the myocardium is combined with local cardiac and respiratory motion and the spatial resolution of the imaging modality, the result can be an unknown amount of extra-cardiac signal contributing to the area of the image designated as myocardium. An estimated 10% of Rb-82 PET MPI studies suffer from extra-cardiac interference that impacts clinical image interpretation. An algorithm for quickly and consistently detecting extra-cardiac interference in Rb-82 PET MPI will be presented, along with validation of the algorithm against 100 expert-read studies, and finally, algorithm-based prevalence results from 2560 Rb-82 PET MPI studies from the 2011 - 2012 University of Ottawa Heart Institute database.

2. "Optical Molecular Imaging in Biomedicine"
Sangeeta Murugkar - Carleton University

Abstract: Optical molecular imaging (OMI) couples optical imaging with different methods of enhancing chemical contrast at the molecular level. It promises to revolutionize the field of medicine due to its comparatively lower cost, high sensitivity and resolution combined with minimal toxicity. The development and applications of a label-free OMI technique based on coherent anti-Stokes Raman scattering (CARS) will be discussed in this talk. I will describe the design and implementation of the first fiber-optic miniaturized multimodal CARS microscope for the in vivo study of spinal cord disorders in small animals. I will share my vision of label-free OMI based on this technology for early disease detection in the clinic.

The talks are followed by an evening skate on the Rideau canal, ending with a social gathering at the Royal Oak at pretoria bridge (map). Please RSVP to Elizabeth Orton (Eorton [at] ottawaheart [dot] ca) if you'll be joining us for skating and/or meeting us at the pub.

Simin Razavi, Jason Belec and winter special event

Date: Thursday, February 27, 2014
Time: 3:30-5pm
Location: Carleton University - Herzberg Building - Room HP4351

1. "Distortion and efficiency studies of Positron emission tracking system (Pe-track)"
Simin Razavi - Carleton University

Abstract: Following the steps for the development of positron emission based 3D tracking (PeTrack), the co-registration of PeTrack with an x-ray C-arm imaging system showed an uncounted systematic error. Identification of the source of systematic error is essential in order to correct it. One of the possible sources of error could be the spatial distortion of tracking. Several simulations have been done using a Monte Carlo Software (Gate) to investigate the detection efficiency and the spatial distortion. We tracked the raster scanning of a positron source in different detector planes within the field of view. The results show that the distortion at the edge of the planes is increasing when the distance of the planes get farther from the iso-centre of the modules. Meanwhile an experiment has been done tracking a positron source in the real time, using an X-Y plotter to provide the scanning motion. The results from simulation and experiment were compared.

2. "Modeling continuous motion in radiation therapy using Monte Carlo techniques: from breathing interplay effect to tomotherapy leaf latency"
Jason Belec - The Ottawa Hospital Cancer Centre

Abstract: Recent advances in external photon beam radiation therapy techniques include increase in the number of degrees of freedom and continuous change of several machine parameters during treatment delivery (field shape, dose rate, tumor tracking, etc.). In this talk, we will give three clinical examples where the use of Monte Carlo techniques was useful to model continuous motion and overcome limitation of commercial clinical systems. The examples are: 1) total marrow irradiation treated with helical tomotherapy, 2) Head and neck treatments treated with helical tomotherapy and 3) stereotactic ablative lung treatments treated with volumetric modulated arc therapy.

The talks are followed by an evening skate on the Rideau canal, ending with a social gathering at GuadalaHarry's at Dow's Pavillion (map). Please RSVP to Elizabeth Orton (Eorton [at] ottawaheart [dot] ca) if you'll be joining us for skating and/or meeting us at the pub.

Hong Shen, Gerd Melkus

Date: Thursday, March 20, 2014
Time: 3:30 - 5:00 pm
Location: West Foustanellas Auditorium (H-2366) - 2-nd floor - The University of Ottawa Heart Institute, 40 Ruskin Street

1. "The NRC Wide-Angle Free-Air Chamber"
Hong Shen - Carleton University/NRC

Abstract: NRC is setting up a national primary standard to calibrate radioactive seeds for low dose-rate brachytherapy. A commercial wide-angle free air chamber (WAFAC), based on the design pioneered by NIST, was introduced recently for measurement of air kerma strength of the seeds. In order to test the performance of the chamber, it was set up in a low-energy X-ray beam (effective energy of 31 keV) where the air kerma rate has been established using the existing NRC air kerma standard. Excellent agreement of the air kerma rate obtained with the WAFAC using the same aperture opening as the primary standard free-air chamber (FAC) validates the proper functioning of this new instrument. Measurements were also carried out for a range of WAFAC apertures, including the 80 mm aperture used for seed measurements. The results show the importance of including air scatter corrections for large aperture openings. Preliminary measurements with 125I seeds give results that are consistent with the stated seed activity. Work is ongoing to establish the correction factors and uncertainty estimates.

2. "Development and application of biochemical MRI methods for Musculoskeletal Research"
Gerd Melkus - The Ottawa Hospital

Abstract: Osteoarthritis and lower back pain are two major diseases which are linked to the degeneration of cartilage and adjacent tissues such as subchondral bone. Non-invasive imaging techniques can help understand articular cartilage and cartilage repair tissue. Recent developments in the field of Magnetic Resonance Imaging (MRI) can be used to characterize these tissues not only morphologically, but also biochemically. In this presentation, the concepts of quantitative MRI methods (gagCEST, T1rho and Diffusion Tensor Imaging) will be discussed. Moreover, pre-clinical and clinical applications will be shown where biochemical MRI can be used to visualize non-invasively the composition of cartilage and adjacent tissues.

Paul Prior and Lindsay Beaton

Date: Thursday, April 17, 2014
Time: 3:30-5pm
Location: Conference room A&B, Room C2363, 2nd floor, Cancer Centre South, The Ottawa Hospital - General Campus, 501 Smyth Road

1. "An iterative triple energy window approach for cross talk correction in dual isotope Tc99m & In111 small animal SPECT"
Paul Prior - Carleton University

Abstract: Dual isotope SPECT allows simultaneous measurement of two different tracers in vivo. With In111 (emission energies of 171keV and 245keV) and Tc99m (140keV), quantification of Tc99m is degraded by cross talk from the In111 photons that scatter and are detected at an energy corresponding to Tc99m. The Triple Energy Window (TEW) uses counts recorded in two narrow windows surrounding the Tc99m primary window to estimate scatter. Iterative TEW corrects for the bias introduced into the TEW estimate resulting from un-scattered counts detected in the scatter windows. The contamination in the scatter windows is iteratively estimated and subtracted as a fraction of the scatter-corrected primary window counts. The iterative TEW approach was validated with a small-animal SPECT/CT camera using a 2.5mL plastic container holding thoroughly mixed Tc99m/In111 activity fractions of 0.15, 0.28, 0.52, 0.99, 2.47 and 6.90. Dose calibrator measurements were the gold standard. Uncorrected for scatter, the Tc99m activity was over-estimated by as much as 80%. Unmodified TEW underestimated the Tc99m activity by 13%. With iterative TEW corrections applied in projection space, the Tc99m activity was estimated within 5% of truth across all activity fractions above 0.15. This is an improvement over the non-iterative TEW, which could not sufficiently correct for scatter in the 0.15 and 0.28 phantoms.

2. "Astronaut Biodosimetry"
Lindsay Beaton - Health Canada

Abstract: Radiation induces damage to DNA which can be measured using cytogenetic endpoints to determine the level of exposure of an individual based on biological markers. This method is termed biodosimetry and is essential for triage in the case of a large scale radiological/nuclear emergency. Cytogenetic endpoints are also routinely used in other research projects, such as the identification of individual radiation sensitivity biomarkers, as well as the cytogenetic analysis of blood samples from astronauts. The biodosimetry of these astronaut samples provides an in vivo measurement of the biological damage from space radiation. This talk will focus on the biodosimetry methods used by Health Canada with a focus on the analysis of Canadian and European astronaut lymphocytes prior to- and post-flight, and will include some of our recent results.

Victor Malkov, Randle Taylor, IRS tour and annual OMPI BBQ

Date: Thursday, May 22, 2014
Time: 3:30 - 5:00 pm
Location: NRC - 1200 Montreal Road, North Campus, Building M-36 - Kelvin Room (please check in at the front desk)

1. "Implementing charged particle transport in electric and magnetic fields in EGSnrc"
Victor Malkov - Carleton University

Abstract: The development of coupled MRI-radiotherapy technologies for IGRT necessitates the ability to perform Monte-Carlo calculations which take magnetic fields into account. This allows for better understanding of dose perturbations induced by these fields, including in-phantom effects and the electron return effect, apparent at air-phantom interfaces. An algorithm that takes advantage of the EGSnrc charged particle transport to improve efficiency has been implemented, and a boundary crossing method is proposed to deal with general geometries when using the EM field package. Preliminary calculations, including simple slab geometries and ion chambers with constant magnetic fields, are performed to verify functionality and applicability of the code. These calculations show that even under low field conditions the change in exit surface dose is not negligible, and warrants further study.

2. "Filling the gaps in commercial clinical software"
Randle Taylor - The Ottawa Hospital Cancer Centre

Abstract: At The Ottawa Hospital Cancer Centre (TOHCC) the Medical Physics group is currently using and actively developing a number of in house software applications for clinical use. Our in-house software touches on a wide range of clinical areas including our machine quality control program, treatment planning quality control, staff management, incident learning and radiation safety. Bespoke software allows our clinic to fill the gaps in commercial software offerings and create tools that fit well withing our existing clinical workflows and best practices. However, the development of custom software is not without risk and often raises concerns about software quality and ongoing support & maintenance. In this talk I'll present some of the software we've developed and discuss some of the ways we've mitigated the inherent risks of in-house software.

3. Tour and BBQ:

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 19 to guarantee your share : Bryan.Muir [at] nrc-cnrc.gc.ca. We will make every effort to accommodate special dietary needs (e.g. vegetarians) but only if we know in advance.

For interested students there will be a tour of the Ionizing Radiation Standards Group facilities starting at 2:00pm. Please register with Bryan at: Bryan.Muir [at] nrc-cnrc.gc.ca.

Khalid Gameil, Emily Heath and OMPI social

Date: Thursday, September 25, 2014
Time: 3:30-5 pm
Location: Carleton University - Herzberg Building - Room HP4351

1. "Data acquisition for NRC's Ionization Chambers for Radionuclide Standards"
Khalid Gameil - Carleton University/NRC

Abstract: The Radionuclide Lab, at the National Research Council (NRC), uses ionization chambers (IC) to measure the activity of predominantly gamma-emitting isotopes. This study presents data acquired by the combinations of the two ionization chambers (Vinten or TPA) with their respected electrometers (Keithley 6517A or 6517B). This study allows for confirmation on historical data acquired with these chambers as well as give insight to the accuracy of the current process of measuring an isotope's activity. A new data acquisition (DAQ) application was created, called IC_DAQ, to communicate with the electrometers and analyze the data to output the activity in Mega-Becquerels (MBq). In addition, new methods for activity determination were incorporated into the DAQ. The DAQ was validated for multiple isotopes with known activities. Graphs of activities for each combination of isotope, ionization chamber, and electrometer were made to investigate any differences. Dose calibrators are IC's found in every Nuclear Pharmacy and Nuclear Medicine department in every hospital in Canada. The NRC can use its IC and DAQ system to calibrate and check these dose calibrators as a service. This service has been offered in the past and is currently being relaunched. A trial of this process was done at the NRC's Radionuclide Lab.

2. "Modeling and compensating for effects of respiratory motion in lung radiotherapy"
Emily Heath - Carleton University

Abstract: Tumour motion due to respiration poses a challenge to radiation therapy that, if unaccounted for, can lead to a suboptimal treatment. A varisssety of planning and delivery methods have been proposed to compensate for respiratory motion during radiation therapy. One approach that is currently under development is 4D radiotherapy, where individual patient respiratory motion parameters are incorporated into the plan optimization. These "4D" plans have been shown to be more conformal than conventional planning approaches, however, the added complexity of the approach means that these plans are highly sensitive to uncertainties in the patient motion model. This talk will discuss some methods to quantify these motion uncertainties and minimize their impact on the delivered dose.

The talks are followed by a social gathering at Georgetown Pub: 1179A Bank Street (map)
from 5:30pm onward. Hope to see you there.

Leila Lukhumaidze and Miller MacPherson

Date: Thursday, October 23, 2014
Time: 3:30-5 pm
Location: Room RPB 205 (boardroom), Health Canada, 775 Brookfield Road
Leila Lukhumaidze and Miller MacPherson

1. "Electron Impact Ionization in EGSnrc"

Leila Lukhumaidze - Carleton University

Abstract: Monte Carlo simulations play an important role in diagnostic medical imaging, as it is relatively easy to calculate some quantities that are difficult to measure experimentally, such as x-ray doses to the breast and x-ray scatter. The x-ray spectra need to be validated. Usually the validation of Monte Carlo calculation codes is performed by doing a simulation which reproduces an actual experiment and comparing the results to the experimental data. We calculate 5-25 keV x-ray spectra emitted from different target materials using the general-purpose EGSnrc BEAM code with two different Electron Impact Ionization cross sections, one developed by Ivan Kawrakow and another developed by Salvat and referred as Penelope cross section. They are compared to the existing experimental data and a preference for the Penelope cross section is found.

2. "The global need for radiation therapy"

Miller MacPherson - The Ottawa Hospital Cancer Centre

Abstract: In the developing world, cancer now kills more people than HIV, malaria, and tuberculosis combined. By 2035, 70% of all cancers will occur in low and middle income countries (LMICs). Strong efforts are underway on prevention and screening to mitigate this trend, but investments in treatment infrastructure are also needed as not all cancers can be prevented. It has been established that more than half of all cancer patients should have radiation therapy at some point during the course of their care. Unfortunately, the burden of cancer is rising fastest in jurisdictions that have little or no access to radiation therapy. This talk will describe the global cancer landscape, recent efforts to address the gap at local levels, and focus on a Canadian-led initiative to elevate the need for radiation therapy to the global health policy arena.

Marc Chamberland and Paul Johns

Date: Thursday, November 20, 2014
Time: 3:30 - 5:00 pm
Location: Hospital Auditorium, 2nd floor, General Campus (escalator from main lobby to 2nd floor, follow signage)

Presentations:

1. "List-mode motion tracking and correction for positron emission tomography imaging using low-activity fiducial markers"
Marc Chamberland - Carleton University

Abstract: Positron emission tomography (PET) imaging suffers from artifacts caused by patient body motion. We propose a method of tracking three-dimensional (3D) patient body motion during dynamic PET imaging by placing low-activity positron-emitting markers on a patient and using a tracking algorithm to extract the 3D motion information from the raw list-mode PET data. This information can then be used to perform motion correction on the raw list-mode data. Monte Carlo techniques were used to simulate a 92.5-kBq Na-22 marker moving sinusoidally in 3D. The simulated events were combined with list-mode data from patients undergoing cardiac PET imaging in order to test the algorithm. In experimental studies, three external Na-22 markers were placed on a dynamic torso phantom with an initial activity of approximately 680 MBq of Rb-82 in its cardiac insert. We tracked the motion of those markers while simulating breathing motion and patient drift with the phantom. Results show that the tracking can achieve submillimetre precision and accuracy. In addition, the motion information was used to correct the raw list-mode data. Reconstructed images showed no perceivable translational motion compared to the original non-motion-corrected images. We conclude that this technique can potentially replace the need for additional and expensive respiratory-motion/triggering systems used for respiratory-gated or motion-free PET image reconstruction.

2. "X-ray scatter imaging: Cross sections, collimation, and signal extraction"
Paul Johns - Carleton University

Abstract: In diagnostic radiology, scattered photons comprise up to 90% of the radiation downstream of the patient and can provide useful information above and beyond that provided by the transmitted primary x rays. Our development work on x-ray scatter imaging will be described. First, since coherent scatter cross sections are too complicated to calculate, we have measured them for some normal tissues and phantom materials using an energy-dispersive system. Second, step-and-shoot scatter imaging using multiple pencil beams has been demonstrated using 33.2 keV x rays at the Canadian Light Source synchrotron. Collimation design options range from scanning a single pencil beam in tandem with a pixelated scatter detector over the patient, which is prohibitively slow but which captures all scatter information unambiguously, to multibeam geometries which speed acquisition but are reliant on pattern untangling algorithms since the diffraction ring patterns overlap. These innovations in radiography are applicable both in medicine and in industrial nondestructive testing, security imaging, and other areas.

Sarah Cuddy and Elsayed Ali

Date: Thursday, December 18, 2014
Time: 3:30-5 pm
Location: Multimedia room H2373 - 2nd floor - The University of Ottawa Heart Institute, 40 Ruskin Street

1. "Characterizing the effect of position dependent Poission-like noise in multi-pinhole cardiac SPECT"
Sarah Cuddy-Walsh - Carleton University
Abstract: A dedicated-cardiac single photon emission computed tomography (SPECT) camera using multiple pinholes with solid-state cadmium zinc telluride (CZT) detectors provides 2 × better energy resolution, > 4 × increase in camera sensitivity (allowing lower dose or shorter imaging time), and ~2.4 × better spatial resolution than traditional parallel-hole camera designs. The limited angle sampling of the fixed position design in the new camera however leads to a number of unique artifacts with unknown impact on image quality. Our work investigates the extent of these artifacts and how they might impact patient outcomes clinically. Two artifact effects will be discussed. First, the effect of variable pinhole sensitivity across the field of view (FOV) is shown to lead to a position dependent uncertainty in the reconstructed relative radiotracer uptake. Second, we will discuss the effect of having projection views from a limited number of angles on the reconstructed image resolution. Specifically we will look at the change in the resolution at different positions inside the FOV and with different object orientations. Conclusions from evaluating both effects may be used to aid in the interpretation of reconstructed images clinically and to make recommendations for future camera designs.

2. "Rotational artifacts in on-board cone-beam computed tomography"
Elsayed Ali - The Ottawa Hospital Cancer Centre
Abstract: Modern clinical linear accelerators are equipped with on-board x-ray imaging systems. These imaging systems are mainly used to acquire cone-beam computed tomography (CBCT) scans of the patient on the treatment table. The CBCT images help in reproducing the same patient position that was used to create the treatment plan. CBCT images can also, in principle, be used for dose calculations in adaptive planning. While an on-board imaging system is a valuable tool on the linac, it can introduce its own systematic errors in the radiation therapy process. This talk is about a systematic error in the Elekta on-board CBCT imaging systems in the form of a rotational artifact.