2012

OMPI Seminar Archive

Stéphanie Chiasson, Dave Rogers

Date: Thursday, January 19, 2012
Conference room A&B, Room C2362, 2nd floor, Cancer Centre South , The Ottawa Hospital (General)

(Click here for the directions)

Crosstalk corrections using a triple energy window (TEW) method in dual-isotope cardiac SPECT imaging on a dedicated CdZnTe camera
Stéphanie Chiasson – Carleton University

Single Photon Emission Computed Tomography (SPECT) is widely used in the field of cardiac imaging to diagnose and manage heart disease. Implementation of dual-isotope imaging in myocardial perfusion studies has many advantages, including improved image alignment and greatly reduced test duration. Dedicated cardiac cameras based on solid-state (CZT) detectors have recently been introduced into the clinic, with improved energy resolution and greater sensitivity. However, an obstacle to simultaneous imaging is the presence of crosstalk between different isotopes. The purpose of our investigations is to assess the accuracy of using a modified Triple-Energy-Window (TEW) cross-talk correction method for Tl-201/Tc-99m-tetrofosmin dual-isotope imaging with a CZT-based dedicated cardiac SPECT camera. We are studying the correction accuracy using single-isotope clinical studies acquired on the camera at the University of Ottawa Heart Institute and will be testing the method on synthetic dual-isotope studies. This talk will focus on the motivation and methodology being employed in the study and will present some of our preliminary results. Successful implementation of simultaneous dual-isotope SPECT imaging would reduce the test duration from more than 4 hours to 30-45min and greatly improve the patient experience for this common diagnostic procedure.

The value of (W/e)air and its importance to ion chamber dosimetry
Dave Rogers – Carleton University

In an air-filled ionization chamber, the quantity (W/e)air (J/C) relates the quantity of interest, viz the energy deposited by electrons in the air, to a quantity that can be measured, i.e. the charge released. Ion chambers work well because (W/e)air appears to be constant, independent of energy in photon and electron beams. The world's primary standards of air kerma need the value of (W/e)air which was thought to be known at the 0.18% level. With the development in 2008 of Monte Carlo techniques which could accurately account for the perturbing effect of an ion chamber's cavity on the dose in a medium, it became possible to re-analyze the most important papers for determining W/e and it was found that the value in Co-60 beams needs to be changed by 0.8%. Thus the world's primary standards of air kerma in a Co-60 beam need to change by 0.8% which is substantial considering the currently assigned uncertainty of 0.17%. In a separate comparison of values of kQ values measured at NRC to the Monte Carlo calculated values for 37 different ion chambers used in reference dosimetry of accelerator beams, the extremely close agreement implies that a limit on the possible variation of (W/e)air between Co-60 and 25 MV bremsstrahlung beams is less than 0.36% at the 95 % confidence limit. The conclusion is that Monte Carlo calculations are an essential complement to careful measurements in the pursuit of accurate ion chamber dosimetry.

Shoaib Khan, Rob deKemp

Date: Thursday, February 16, 2012
Time: 3:30pm - 5:00 pm (special event after the seminars)
Location: Carleton University - Herzberg Building - Room HP4351

Source Localization using Directional Gamma Ray Spectrometer
Shoaib Khan – Carleton University

The lost or orphan radioactive sources have recently created a concern for different governmental bodies and institutions ranging from the scientific community to the security agencies. That is why it is becoming very important these days to develop robust techniques to find and localize such sources. A well known technique for approximating the distance to the source performs fitting of the measured counts profile along the road to the known model for count rate as a function of source strength, detection efficiency and the location of the source. In our present work we have experimented a complementary technique using a directional gamma survey spectrometer. The instrument consists of four NaI(Tl) detectors oriented vertically in such a way that the crystals on one side shield the crystals on the other side of this vertical arrangement as could be seen in the work that follows. The relative counts in each crystal as a function of trucks position can be used to calculate the azimuthal angle to the source by forming direction vectors. The survey then returns a field of these direction vectors which maybe fit for their point of intersection to determine the horizontal geographic coordinates of the source position. Multiple truck borne surveys were conducted using this instrument on the days Aug 24 and Aug 25 of 2011 driving past Na-22 and Cs-137 sources with this directional spectrometer instrument being inside the truck at different speeds. The surveys were repeated with the source placed at different distances from the road that truck drove through back and forth. Here we are presenting the results of these measurements. We have shown the calculated azimuthal direction vectors as a function of position along the road and then the result of fitting these vectors to obtain the best uncertainty on the extracted source position.

Rubidium-82 PET alternative to Tc-99m SPECT for Myocardial perfusion imaging
Rob deKemp – University of Ottawa Heart Institute

Cardiovascular (CV) disease is the leading cause of death in Canada. Fifty percent of all Tc-99m used in nuclear medicine is for the diagnosis of coronary artery disease (CAD) with SPECT myocardial perfusion imaging (MPI). The reduced supply of Tc-99m requires other tracers to be investigated. Tl-201 SPECT is available but generally accepted to be inferior to Tc-99m. Rubidium (Rb-82), a nonreactor produced tracer, is believed to have superior accuracy compared to Tc-99m and Tl-201 SPECT, with 5-20 times lower radiation dose. In the U.S. Rb-82 generators have been FDA-approved since 1989 and are used increasingly for CAD diagnosis, but are still considered investigational in Canada.
Objectives: To demonstrate that Rb-82 PET MPI is i) an accurate, cost-effective alternative to Tc-99m; ii) superior to Tl-201; iii) can be implemented in multiple Canadian centres for the diagnosis and management of CAD. Short term clinical outcomes of Rb-82 will be evaluated and compared to Tc-99m and Tl-201 SPECT MPI across Canadian imaging centres.
Methods: Rubidium-ARMI is an innovative multidisciplinary, multi-centre imaging research initiative that builds on existing collaborative networks and Canadian industry partnership (DRAXIMAGE). Rubidium PET will be implemented, standardized and validated in 4 overlapping phases over 2 years, at up to 10 Canadian Centres.
Impact: According to the CIHR funding criteria, this project is expected to “lead to clinical trial applications and clinical validation studies which compare novel radiolabeled probes with those in current practice”, and to “bring a new radiopharmaceutical to the clinic” within a short time frame. Increased use of Rb-82 PET MPI has the potential to reduce the demand for Tc-99m by 10-40%, effectively increasing the available supply for other procedures, and improving the standard of care for many Canadians at risk of heart disease.

Rachel Timmins, Gregory Cron

Date: Thursday, March 22, 2012
Time: 3:30pm - 5:00 pm
Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road

Cross-talk correction in dual isotope 111-In / 99m-Tc small animal SPECT imaging
Rachel Timmins – Carleton University

Abstract: Dual-isotope imaging via energy discrimination is a major strength of SPECT imaging but image quality is degraded by cross-talk interference. Cross-talk correction techniques have been developed for clinical SPECT however application to small-animal imaging is not ideal. The reduced subject size & variability in small-animal imaging may allow simpler cross-talk correction methods to provide adequate quantification accuracy. The objective of this study is to evaluate the accuracy of three simple cross-talk correction methods, triple energy window subtraction (TEW) applied in both projection and image space, and convolution subtraction, for use in small-animal 111In/99mTc imaging. We compared the three methods on a simple three syringe phantom to determine the best method and then tested this method across a range of activity concentrations. We then tested the method in-vivo on images of six rats, again over a range of activity concentrations. TEW applied in projection space gave the best reduction of In-111 cross-talk. The concentration of Tc-99m was recovered to within 4+/-1% or less of the true value over the range of concentrations evaluated

Vascular input functions measured using MRI phase
Gregory Cron – Ottawa Health Research Institute

Abstract: Quantitative dynamic contrast-enhanced magnetic resonance imaging can be useful for predicting tumor aggressiveness. An important component of this technique is the concentration-vs-time of contrast agent in the blood, a.k.a. the vascular input function (VIF). The VIF can be very difficult to measure and continues to be a subject of intense research in the MRI community. This talk will describe a relatively new method for measuring the VIF which involves acquisition of the MR phase signal.

Marc Chamberland, Lesley Buckley

Date: Thursday, April 19, 2012
Time: 3:30pm - 5:00 pm
Location: Centre Foustanellas Auditorium - 2nd floor - The University of Ottawa Heart Institute, 40 Ruskin Street

Performance evaluation of real-time motion tracking using positron emission fiducial markers
Marc Chamberland – Carleton University

Abstract: Tumor motion due to patient breathing is a factor that limits the accuracy of dose distribution in radiotherapy. I present an experimental evaluation of the performance of PeTrack, a technique that can track internal fiducial markers in real-time for tumor tracking. PeTrack uses position sensitive detectors to record annihilation coincidence gamma rays from fiducial positron emission markers implanted in or around the tumor. It uses an expectation-maximization clustering algorithm to track the position of the markers. A normalized least mean square adaptive filter was used to predict the position of the markers 100 and 200 ms in the future. I evaluated the performance of the tracking and of the prediction by using a dynamic anthropomorphic thorax phantom to generate three-dimensional 3D motion of three fiducial markers. The algorithm was run with four different data sets. In the first run, the motion of the markers was based on a sinusoidal model of respiratory motion. Three additional runs were done with motion based on patient breathing data. In the case of the sinusoidal model, the average 3D root mean square error for all markers was 0.44 mm. For the three runs based on patient breathing data, the precision of the 3D localization was 0.49 mm. At a latency of 100 ms, the average 3D prediction error was 1.3±0.6 mm for the sinusoidal model and for the three patient breathing runs. At a latency of 200 ms, the average 3D prediction errors were 1.7±0.8 mm for the sinusoidal model and 1.4±0.7 mm for the breathing runs.

Evaluating new techniques to improve adaptive radiotherapy
Lesley Buckley – The Ottawa Hospital Cancer Centre

Abstract: Treatment planning techniques, combined with improved imaging, allow for the creation and delivery of increasingly complex radiotherapy treatments. One of the limitations of a conventional, forward thinking process is that these precise plans are based almost entirely on the patient anatomy at the time of treatment simulation and do not take into account changes that occur once treatment has begun. The increased use of high quality daily image guidance provides additional information regarding the changes to the tumour volume and the surrounding normal tissues throughout the course of treatment. A challenge of radiation therapy is in determining how best to use this information to adapt the treatment to reflect these changes. This talk will discuss the impact of new technology on the clinical implementation of adaptive radiotherapy. Specifically, the potential of 4-D cone beam CT imaging to assess tumour motion will be described. Also, the use of commercially available image registration software and its role in adaptive planning will be discussed.

Elizabeth Orton, Raphael Galea

Date: Thursday, May 17, 2012
Time: 3:30 - 5:00 pm – Thursday – May 17, 2012
Location: NRC – 1200 Montreal Road, North Campus, Building M-36 – Kelvin Room (please check in at the front desk)

Presentations:

1. "Interference of abdominal activity in 82-Rb PET myocardial perfusion imaging"
Elizabeth Orton – Carleton University

Abstract: Positron emission tomography (PET) is considered the gold standard for myocardial perfusion imaging (MPI), defined as generating functional images showing where the blood is flowing into the myocardium by following the distribution of tracers injected into the blood stream. However, even gold standards are not without problems and one such problem encountered in PET MPI, using the two most common perfusion radiotracers (82-Rb and 13-N NH3), is interference due to high levels of tracer uptake in organs close to the heart. Bateman et al. (2006) report that liver and bowel uptake affected interpretation of 10% of Rb-82 PET MPI studies. A review of Rb-82 PET MPI records at UOHI shows that, after mitigation efforts, extra-cardiac interference due to elevated stomach wall uptake is observed at a similar frequency in 'static' images (counter intuitively, 'static' meaning images averaged over both cardiac and respiratory motion). 'Static' images can also be broken down into a cardiac gated series, routinely used to assess heart wall motion and ejection fraction. Observations of cardiac gated images suggest stomach motion over the cardiac cycle is at the sub-voxel level; while the heart contracts away from the stomach, potentially providing a frame where stomach wall to heart separation is sufficient to reliably isolate the stomach activity distribution. Assuming negligible stomach motion between cardiac gates would then allow subtraction of the stomach activity, as defined in the reliable frame, from all others, removing stomach interference in the cardiac gated data. Summation over all cardiac frames would provide a corrected 'static' image. The aim of my research is a reliable method to subtract interfering extra-cardiac signal from 82-Rb PET MPI. This will require stomach wall segmentation, noise reduction and motion assessment. A simplified analytic simulation has been developed to use as a known-truth assessment tool. The simulation matches realistic human anatomy, cardiac and respiratory motion, relative organ activity and image noise. The relationship between stomach wall segmentation and noise reduction will be demonstrated through presentation of initial approaches and results. I will conclude with an outline of future methods for investigation.

2. "Reduce, reuse and recycle: A green solution to Canada's medical isotope shortage"
Raphael Galea – National Research Council of Canada

Abstract: Due to the unforeseen maintenance issues at the National Research Universal (NRU) reactor at Chalk River and coincidental shutdowns of other international reactors, a global shortage of medical isotopes (in particular technetium-99m, Tc99m) occurred in 2009. The operation of these research reactors is expensive, their age creates concerns about their continued maintenance and the process results in a large amount of long-lived nuclear waste, whose storage cost has been subsidized by governments. While the NRU has since revived its operations, it is scheduled to cease isotope production in 2016. The Canadian government created the Non-reactor based medical Isotope Supply Program (NISP) to promote research into an alternative methods for producing medical isotopes. The NRC was a member of a collaboration looking into the use of electron linear accelerators (LINAC) to produce molybdenum-99 (Mo99), the parent isotope of Tc99m. This talk will outline NRC's involvement in every step of this process, from the production, chemical processing, recycling and preliminary animal studies to demonstrate the equivalence of LINAC-Tc99m with the existing supply. This process stems from reusing an old idea, reduces the nuclear waste to virtually zero and recycles material to create a green solution to Canada's medical isotope shortage.

Sarah Cuddy, Patrick Saull and OMPI social

Date: Thursday, September 27, 2012
The first OMPI seminar of the 2012-2013 academic year will be held at Carleton University:
Time: 3:30 - 5:00 pm - Thursday - September 27, 2012

Location: Carleton University - Herzberg Building - Room HP4351 (map)

The seminar will be followed by a social event at MacLaren's Pub located at 301 Elgin st (map)

Presentations:

High Resolution Detectors for Positron Emission Mammography

Sarah Cuddy - Carleton University

Abstract: Dedicated-breast molecular imaging systems such as positron emission mammography (PEM) have potential to improve the sensitivity of cancer in women with radio-dense breasts and to reduce the false-positive rate of breast screening when used as a diagnostic adjunct. To ensure high signal-to-noise ratio and to minimize the patient dose, scintillation detectors in a PEM system must have high annihilation photon detection efficiency. This efficiency can be increased by accepting annihilation photons from wider incident angles and by using depth-of-interaction (DOI) measurement within a scintillation crystal to minimize parallax blurring. We have developed a dual-ended readout block (DERB) detector that uses asymmetry of signals from photodetectors on either end of a scintillation array to measure DOI and uses Anger Logic with light sharing to identify interacting crystal elements while minimizing the number of photodetectors required. Our design was evaluated using DETECT2000 Monte-Carlo simulation and by characterizing a prototype DERB detector. This presentation will discuss the advantages of the design and the effects of various boundary conditions on the performance of the detector.

A Compton Gamma Imager for Safety and Security

Patrick Saull - National Research Council Canada

Abstract: A Compton camera is a device that images a gamma-ray field through reconstruction of the positions and energies of incoming photons which undergo both scatter and absorption in its active volume. In 2007, our small collaboration of researchers from McGill, NRCan, and NRC was awarded $1.4 million in federal R&D funds from CRTI to develop a rugged, person-portable Compton imager for safety and security purposes. The design goal was to be able to localize a 10 mCi Cs-137 source at a distance of 40 meters to a few degrees angular resolution, in under a minute. To keep costs low, we have opted for an all-scintillator, layered design. This talk will focus on one of two approaches we are pursuing: a pixel-based detector, comprising two scatter layers of CsI(Tl) cubes read out with thin silicon photomultipliers (SiPMs), and an absorber layer of conventional NaI(Tl)/PMT units stacked into an array. The final prototype saw "first light" this past August. I will summarize its development, from conception, through early prototypes, to final design, discussing in detail the Compton method, the data acquisition, and the reconstruction algorithm.

Islam El Gamal, David Wilkins

Date: Thursday, October 18, 2012
Time: 3:30 - 5:00 pm – October 18, 2012

Location: West Foustanellas Auditorium (H-2366) – 2nd floor – The University of Ottawa Heart Institute, 40 Ruskin Street (map)

Presentations:

1. "Feasibility study of the determination of absorbed dose to water using a Fricke based system"

Islam El Gamal – Carleton University

Abstract: By measuring the dose to water directly a metrology standard, independent of air kerma, can be developed to make the basis of HDR brachytherapy dosimetry consistent with current dosimetry methods for external radiation beams. The Fricke dosimeter system, a liquid chemical dosimeter, provides a means of measuring the absorbed dose rate to water directly by measuring the radiation-induced change in optical absorption of the Fricke solution. In an attempt to measure the absorbed dose to water directly for a 192Ir HDR brachytherapy source a ring shaped Fricke holder was constructed from PMMA. Benchmark measurements conducted in a 60Co beam yielded a standard uncertainty in the absorption reading of 0.16 %, comparable with previous results in the literature. Measurements of the standard uncertainty of the control (un-irradiated) solution using the holder yielded 0.13 %, indicating good process control and minimal contamination from the holder itself. Irradiations with a 17 GBq source, in a water phantom, gave a standard uncertainty of approximately 0.29 %, indicating that the target uncertainty of less than 1% for the measurement of absorbed dose to water using a Fricke-based primary standard is achievable. This would be comparable with water calorimeter standards currently being developed.

2. "Radiation Safety Then and Now"

David Wilkins – The Ottawa Hospital Cancer Centre

Abstract: The practice of radiation safety in cancer centers has evolved considerably over the years, from a technical discipline to an organizational approach incorporating elements of quality management with a focus on patient safety. This talk will discuss that evolution and its impact on staff doses, and will describe some recent changes to regulations which have affected the approach to radiation safety in cancer centers.

Brandon Zanette, Rowan Thomson

Date: Thursday, November 15, 2012
Time: 3:30 - 5:00 pm – November 15, 2012
Location: Conference room A&B, Room C2362, 2nd floor, Cancer Centre South, The Ottawa Hospital General Campus

Presentations:

1. "Validation of the Bookend Method in Dynamic Contrast Enhanced MRI"

Brandon Zanette – Carleton University

Abstract: Dynamic Contrast Enhanced (DCE) MRI is a method used to obtain quantitative, biologically relevant information in a tissue of interest. DCE-MRI involves the use of a contrast agent injection which is tracked in time via a rapid T1-weighted imaging sequence. The contrast agent will cause a signal increase, which is proportional to its concentration in the tissue. One important use of DCE-MRI is the diagnosis and grading of cancer. There is often a distinct difference in parameter values measured with DCE-MRI between tumours and healthy tissue. The technique currently used for DCE measurements is susceptible to experimental error caused by spatial variation of the flip angle. The goals of this project are to gain a better understanding of this effect and to develop techniques to mitigate these errors, thereby improving concentration estimation.

2. "Monte Carlo simulations on the cellular scale"

Rowan Thomson – Carleton University

Abstract: Monte Carlo simulations are widely applied in radiotherapy for computing dose in macroscopic volumes of interest; however, there is increasing interest in applications at microscopic length scales. This presentation will describe some recent research related to Monte Carlo simulations on cellular length scales. The first part of the presentation will focus on cellular dosimetry for kilovoltage radiation and several cancerous and normal soft tissues. This research investigates how alternative macroscopic dose descriptors track absorbed dose to biologically relevant cellular targets. In the second part I will discuss research aimed at understanding the limitations of widely-used `classical' Monte Carlo simulations of low energy electron transport, and new work towards developing modelling techniques consistent with quantum theory.

Marielle Lesperance, Costel Flueraru

Date: Thursday, December 20, 2012
Time: 3:30 - 5:00 pm – December 20, 2012
Location: Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road (map)

Presentations:

1.“Model-based dose calculations for ocular brachytherapy”

Marielle Lesperance – Carleton University

Abstract: Ocular plaque brachytherapy has been shown to be as effective as complete removal of the eye for treatment of uveal melanoma. Despite this, local control is not always achieved and radiation damage to healthy eye structures may occur. In order to properly link treatment outcome with dose delivered, it is necessary to obtain accurate dose distributions. As current treatment planning assumes the patient is water-equivalent, eye geometry and composition are not taken into account. To assess dose sensitivity to these factors, we have created a full eye model with realistic dimensions and composition. This presentation will discuss the effects on dose of ocular media composition for three different radionuclide sources: I-125, Pd-103 and Cs-131. It will also include comparison between the current method of reporting dose to points of interest and dose to volumes of interest.

2.“Optical imaging modalities for medical application - Optical Tomography”

Costel Flueraru – National Research Council Canada

Abstract: Medical imaging modalities play a significant role in improving the diagnosis, the clinical management of disease and the understanding of disease pathogenesis. In the first part of this presentation I will review the optical imaging modalities and their relation with the conventional medical imaging techniques. The second part will focus on new developments of optical coherence tomography and its applications in cardiovascular imaging and tissue characterization.