2011

OMPI Seminar Archive

Lindsay Beaton, Malcolm McEwen

Date: Thursday, December 16, 2010
Time: 3:30pm
Location: Carleton University, Herzberg Building, HP4351

Biomarkers of Radiation Sensitivity in Human Lymphocytes
Lindsay Beaton (Carleton Univ.& Health Canada)

Radiotherapy is a treatment modality often used for different types of cancer. The goal of treatment is to deliver a toxic dose of radiation to the tumour while sparing the healthy tissue. Sometimes a patient does not have a normal response to radiation; they might be more radiosensitive than normal, in which case a normal dose would result in increased side effects, or they could be radioresistant, in which case a normal dose could result in poor tumour control. The development of a predictive assay for radiation response would allow patients who are sensitive to radiation to be identified and considered for a reduced dose or even an alternative therapy to radiation. Conversely, those resistant to radiation could be prescribed a higher dose, resulting in improved tumour control.
The primary goal of this project is to examine the in vitro γH2AX response in lymphocytes and lymphocyte subsets from patients who have shown a radiosensitive response to radiation to determine whether the more radiation responsive subsets will provide more specific markers for radiosensitivity. Concurrently, cytogenetic endpoints will also be examined in these patients to provide additional information about the mechanisms of radiosensitivity.

OMPI - a year in review

Malcolm McEwen (Director, Ottawa Medical Physics Institute)

The Ottawa medical physics community has one of the most diverse spectra of research and service activities in Canada, and at the heart is the Ottawa Medical Physics Institute (OMPI). Founded in 1989, OMPI provides a forum for presentations and discussion, a networking opportunity for researchers, and a co-ordinating structure for supporting the graduate medical physics program at Carleton University.

This presentation will provide some background on OMPI but the main aim is to celebrate the activities of the organization during the 2009-2010 academic year.

Jason Belec, Glenn Wells

Date: Thursday, February 24, 2011
Time: 3:30pm
Location: Carleton University, Herzberg Building, HP4351

Monte Carlo calculation of photon beam treatment dose distributions delivered using Tomotherapy and VMAT

Jason Belec - The Ottawa Hospital Cancer Centre

The commercial release of volumetric modulated arc therapy techniques using a conventional linear accelerator and the growing number of helical tomotherapy users have triggered renewed interest in dose verification methods, and also in tools for exploring the impact of machine tolerance and patient motion on dose distributions without the need to approximate time-varying parameters such as gantry position, MLC leaf motion, or patient motion. To this end we have developed a Monte Carlo-based calculation method capable of simulating a wide variety of treatment techniques without the need to resort to discretization approximations. The ability to perform complete position-probability-sampled Monte Carlo dose calculations was implemented in the BEAMnrc/DOSXZYnrc user codes of EGSnrc. The method includes full accelerator head simulations of our tomotherapy and Elekta linacs, and a realistic representation of continuous motion via the sampling of a time variable. The functionality of this algorithm was tested via comparisons with both measurements and treatment planning dose distributions for four types of treatment techniques: 3D conformal, step-shoot intensity modulated radiation therapy, helical tomotherapy, and volumetric modulated arc therapy.

Dedicated Cardiac SPECT: Changing How We Look at the Heart

Glenn Wells - The University of Ottawa Heart Institute

Cardiac disease remains one of the leading causes of death in Canada and costs Canadians an estimated 22 billion dollars a year. Nuclear medicine imaging with single-photon emission computed tomography (SPECT) plays a key role in the management of heart disease – at the University of Ottawa Heart Institute, we perform more than 6000 cardiac studies every year. Recent developments in SPECT camera technology has the potential to drastically alter both how we do cardiac imaging and also what information we can obtain. The new dedicated cardiac systems provide a significant increase in sensitivity over standard cameras. The greater sensitivity allows a four-fold reduction in scan times or a similar reduction in the amount of injected activity used in our tests. Based on pixelated cadmium-zinc-telluride solid state detectors, the new designs also provide improved energy resolution and reduced deadtime. Finally, unlike traditional systems, the new SPECT cameras do not rotate. These features offer the potential to improve our ability to perform dual-isotope cardiac perfusion studies and open the door to allowing absolute measures of blood flow in the heart with SPECT. I will discuss the new camera technology and highlight some of the work being done at the University of Ottawa Heart Institute to validate its current performance and to investigate the future capabilities of the new design.

Bryan Muir, Nicolas Ploquin

Date: Thursday, March 24, 2011
Time: 3:30pm
Location: NRC – 1200 Montreal Road, North Campus, Building M-36 – Kelvin Room (please check in at the front desk)

(Click here for directions)

(Click here for NRC campus map)

Characterization of plane-parallel ion chambers for reference dosimetry of MV photon beams

Bryan Muir - Carleton University

Calibration of high-energy radiotherapy sources requires that clinical medical physicists follow reference dosimetry protocols (e.g., TG-51 or TRS-398). In the past, reference dosimetry protocols did not allow the use of plane-parallel ionization chambers for calibration of high-energy photon beams because sufficient data were not available. This work aims to determine beam quality conversion factors, kQ, for several plane-parallel ionization chambers to potentially enable the use of these chambers for reference dosimetry of megavoltage photon beams. Eleven different types of plane-parallel chamber were obtained from the major ion chamber manufacturers. Measurements of the absorbed dose to water calibration coefficient were made at the National Research Council of Canada (NRC) for the 60Co irradiator and the Elekta Precise 6, 10 and 25 MV photon beams to obtain kQ. Monte Carlo simulations of these ionization chambers were performed with the egs_chamber user-code for EGSnrc to calculate kQ factors. For characterization of these chambers over the range of clinically relevant energies, measurements of the time required for chamber stabilization, leakage currents, ion recombination and polarity behavior, as well as chamber-to-chamber variations were investigated. In this talk, I will discuss the results of Monte Carlo simulations and measurements performed to date and how they compare.

Locoregional left breast cancer irradiation: From TomoTherapy to VMAT

Nicolas Ploquin - The Ottawa Hospital Cancer Centre

Treating left sided locoregional breast cancer has always been a challenge because of the contiguous nodal and breast volumes which have a radically different shape and depth over an extended region of the body. The proximity of critical organs at risks such as the heart and the lung, especially for patients who have undergone a mastectomy, makes the treatment even more challenging. A multitude of techniques is available in radiation therapy to treat this volume. In addition to 3D Conformal Radiation Therapy with a linac, the Ottawa Hospital Cancer Centre has been using TomoTherapy technology since 2005 to treat left sided locoregional breast cancer with Intensity Modulated Radiation Therapy (IMRT). We have recently commissioned a new technique on our Elekta Synergy linac called Volumetric Modulated Intensity Modulated Radiation Therapy (VMAT). This technique delivers rotational IMRT on a regular linac, decreasing the treatment time required for a similar quality dose distribution relative to other IMRT techniques. We have investigated the feasibility of adapting our technique developed on TomoTherapy for treating left sided locoregional breast cancer to VMAT on our Elekta Synergy linac. I will briefly review the various rotational IMRT techniques available, then I will present the main components in the commissioning of VMAT technique and finally I will discuss the challenge of treating left sided locoregional breast cancer with IMRT using TomoTherapy or VMAT techniques.

Elizabeth Henderson , Michel Lalonde

Date: Thursday, May 19, 2011
Time: 3:30pm
Location: The Ottawa Hospital General Campus

Note that there is a cyberknife tour before the seminar. Right before 3:30pm, the tour group should meet in front of the fireplace in the new General Campus cancer center building (Radiation Therapy North).

Location #1 (3:30pm tour): new General Campus cancer center building

If you did not registered for Cyberknife tour, please go directly to the auditorium at 4pm for the semianrs.

Location #2 (4pm seminar): Hospital Auditorium, 2nd floor, (Take escalator from main lobby to 2nd floor, Auditorium is behind module G, follow signage)

(Click here for direction)

(Click here for floor map)

Cyberknife in Ottawa

Elizabeth Henderson - The Ottawa Hospital Cancer Centre

The Ottawa Hospital Cancer Center installed a CyberKnife system, used for high precision, small volume radiation therapy treatments, in August 2010. The CyberKnife system consists of a 6MV LINAC mounted on an industrial robot arm. Image guidance is accomplished using a pair of orthogonal ceiling-mounted X-ray sources and corresponding detectors in the floor. With this combination of features, the CyberKnife system is able to track moving targets, significantly decreasing the volume of normal tissue that receives a high dose of radiation. In this talk, I will discuss the commissioning and quality assurance of the CyberKnife system, and the Ottawa Hospital experience in using the CyberKnife to treat brain, spine, liver and lung tumours.

Development of SPECT RNA methodologies for quantifying cardiac wall motion

Michel Lalonde – Carleton University

SPECT radionuclide angiography (RNA) can be used to quantify cardiac wall motion. It has been investigated with phase analysis for its potential at predicting cardiac resynchronization therapy response (CRT), producing modest results. However, the quantitative analysis of wall-motion curves, which is currently qualitative in nature, may hold potential for other applications as well. The development of new SPECT RNA methodologies, in particular, cluster analysis, will help provide increased accuracy and reproducibility for the quantification of cardiac wall motion. This could lead to better prediction of CRT response. In this presentation, I will present an overview of cardiac dyssynchrony and CRT; the results from a second methodology investigated (amplitude analysis) and introduce cluster analysis, and the various steps needed to properly implement it.

Elsayed Ali, Ruth Wilkins

Date: Thursday, June 23, 2011
Time: 3:30pm (BBQ starts at 5pm, see the note below *)
Location: NRC – 1200 Montreal Road, North Campus, Building M-36 – Kelvin Room (please check in at the front desk)

(Click here for direction)
(Click here for NRC campus map)

Unfolding linac photon spectra from simple depth-dose measurements

Elsayed Ali – Carleton University

The current approach to linac photon beam commissioning is to tune the beam model to match measured beam data. It has been shown in the literature that while this `self-tuning' approach is suitable for many application, it does not guarantee that the beam model is accurate for non-standard conditions - e.g., for dose calculations around tissue heterogeneities. A reliable method to determine the true spectra would lead to a more robust commissioning process and allow for stricter testing of the dose calculation engines in treatment planning systems. In this study, the prospects are explored for a method to unfold spectra of clinical photon beams from simple depth-dose measurements. The method is validated on an NRC research linac whose spectra are independently known. In this talk I will present a description of the method and some validation results.

New approaches to high through-put biological dosimetry

Ruth Wilkins – Health Canada

In the event of a large scale radiological/nuclear emergency, biological dosimetry is essential for providing timely assessments of radiation exposure for the general population and to identify first responders who must be restricted from further exposure. The dicentric chromosome assay (DCA) is currently the accepted biodosimetry method for radiation dose assessment, however in a mass casualty scenario this assay is not well suited for providing timely dose estimates due to its time- and expertise-intensive nature. Canada is striving to increase triage-quality biological dosimetry throughput by: 1) increasing the number of trained personnel capable of conducting the DCA and, 2) evaluating alternative approaches to DCA scoring and 3) developing novel, high throughput methods for biological dosimetry. These strategies for increasing throughput for biological dosimetry will be presented.

* 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 RSVP to **Claudiu Cojocaru** by June 20 to guarantee your share. We will make every effort to accommodate special dietary needs (e.g. vegetarians) but only if we know in advance.

Azeez Omotayo, Ian Cameron

Date: Thursday, September 29, 2011
Time: 3:30pm
Location: Carleton University - Herzberg Building - Room HP4351

(Click here for the map)

Characterization of sensitivity changes of nanoDot OSLDs exposed to 6 MV x-ray beams

Azeez Omotayo – Carleton University

The optically stimulated luminescence (OSL) technique is prominently used in dating, environmental and personnel dosimetries. In personnel dosimetry, the most common OSL dosimeter (OSLD) is aluminum oxide doped with carbon (Al2O3:C). Recently, Al2O3:C OSLDs have been applied in medical physics for audit dosimetry programs and quality control protocols in radiotherapy departments. This work presents an investigation of relevant parameters for accurate use and re-use of commercial Al2O3:C OSLDs. The OSLDs were irradiated at The Ottawa Hospital Cancer Center to 6 MV x-ray beams. Numerical simulations were also performed to explain and provide a better insight on the experimental observations.

Evaluation of Diffusion and Diffusion-like Motion in Human Subjects Using MRI

Ian Cameron – The Ottawa Hospital

Magnetic Resonance Imaging (MRI) can be made sensitive to motions on several length scales. In this talk, I will explain how MRI can be used to detect water molecule displacement caused by diffusion. Furthermore, since the motion of blood in many capillary networks can be treated as a diffusion-like process, tissue blood flow in vascular tissues can be measured using the same diffusion-weighted technique. Results showing the anisotropic nature of water diffusion in the white matter of the brain and tissue blood flow maps for the liver and placenta of healthy human subjects will be presented. All of these measurements are performed completely non-invasively and without the use of contrast agents. Another method for measuring tissue blood flow with MRI, called Dynamic Contrast Enhanced MRI, will also be discussed (if time permits).

Karl Landheer, Bog Jarosz

Date: Thursday, October 20, 2011
Time: 3:30pm
Conference room A&B, Room C2362, 2nd floor, Cancer Centre South

(Click here for the map)

Coherent Scatter Ring Integration Imaging

Karl Landheer – Carleton University

Traditional projection X-ray imaging utilizes only the information from the primary photons. Low-angle coherent scatter images can be made simultaneous to the primary images and provide additional information. To speed up acquisition time for coherent scatter projection imaging, we are developing disentangling algorithms for the overlapping scatter patterns generated by multi pencil-beam geometries. We configured a system at the Canadian Light Source synchrotron which utilizes a 33.17 keV monoenergetic pencil beam from a Laue monochromater. The pencil beam then travels through the sample and is absorbed by a tungsten bar. A digital flat panel detector records the scatter patterns from the beams. The sample is scanned through the beams using an automated step-and-shoot setup. The pixel value of the coherent scatter image is generated by integrating the radial profile (scatter intensity versus scattering angle) over an angular range. The angular range integrated over can be adjusted after the data have been acquired to achieve maximum contrast between any two materials of interest. We developed an MLEM-based iterative method to disentangle the scatter patterns. We are also investigating a least-squares method and using simulated data to compare the accuracy of both methods.

Computations of Temperature Patterns in Interstitial Thermal Therapy

Bog Jarosz – Carleton University

In the presentation, several issues pertaining to computations of temperature patterns in cancer thermal therapy will be addressed. Fundamental equations used in the computations will be presented with an analytical solution used in computations of heating pattern for simple geometry. Usefulness of this approach will be evaluated and novel methods will be demonstrated. Use of these methods will be illustrated for the case of brain glioma thermal therapy.

Benjamin Spencer, Janos Szanto

Date: Thursday, November 17, 2011
Time: 3:30pm - 5:00 pm
Room RPB 205B (boardroom), Health Canada, 775 Brookfield Road

(Click here for the map)

Distortion correction, geometric calibration, and volume reconstruction for an isocentric c-arm x-ray system

Benjamin Spencer – Carleton University

In order to facilitate cone-beam CT using a mobile x-ray C-Arm, accurate geometric calibration must be carried out. Such calibration requires a precise correction of x-ray image intensifier (II) distortion. Regional distortion correction was performed for the x-ray II using a planar grid phantom. The distortion correction reduced the RMS error of known locations (or points) spanning the II field of view from 1.71 pixels to 0.63 pixels. For each projection, a six-ball calibration phantom was then used to determine the behavior of 9-geometric calibration parameters. These parameters were subsequently used to achieve 3D volume reconstruction. Without the correction of II distortion the geometric calibration parameters showed the addition of incorrect structured behavior while the reconstructed image was observed to have minor visual differences than the reconstruction with distortion correction incorporated.

CyberKnife: one year later

Janos Szanto – The Ottawa Hospital Cancer Centre

Ottawa has maintained a stereotactic radiotherapy treatment program for 20 years, during which time the technology has evolved steadily. Today, the Ottawa Hospital delivers stereotactic radiotherapy using a piece of “cutting edge” technology called the CyberKnife. I will present a brief history of Ottawa’s stereotactic radiotherapy program, and review the CyberKnife’s unusual dosimetry, its image guidance system and clinical applications. My talk will focus on physics developments done within our CyberKnife program during its first year of operation: improved dosimetry, fiducial based image registration, commissioning of Monte Carlo dose calculation in the CyberKnife treatment planning system, and development of a patient specific quality assurance technique.

Matthew Efseaff, Rolf Clackdoyle

Date: Thursday, December 15, 2011
Time: 3:30pm - 5:00 pm

East Foustanellas Auditorium - 2nd floor, H2368 - The University of Ottawa Heart Institute, 40 Ruskin Street

Repeatability of short term quantitative resting myocardial blood flow measurements using rubidium-82 PET imaging

Matthew Efseaff – Carleton University

Rubidium-82 PET imaging is seeing an increased workload as a myocardial health indicator due to its portability. However, few studies have been published regarding repeatability. We have a highly automated analysis program that we used to investigate myocardial blood flow (MBF) repeatability. We measured the repeatability of resting MBF in a population of coronary artery disease patients (n = 27) and healthy normal volunteers (n = 9). Repeatability was assessed with correlation and Bland-Altman repeatability coefficients. Factors affecting MBF included male/female differences, patients vs. normal volunteers, and partial volume spillover correction ($p \leq 0.001$). We found that the current clinical method was not the best and that there is a clinical benefit (regarding repeatability) in using iterative reconstruction, shorter scan length, and a spillover correction.

Reduced Radiation Dose using Software Techniques?

Rolf Clackdoyle – Université St. Etienne, France

In X-ray CT, radiation dose issues are becoming increasingly significant as technological advances provide more extensive body coverage in shorter scan times. The challenge is to provide equivalent-quality images using reduced x-ray exposures. One of the 'obvious' approaches is to apply recent developments in image reconstruction methods that in principle can provide accurate region of interest (ROI) imaging but without the standard mathematical requirement that the entire slice be irradiated from all directions. In this talk the principles behind one of the ROI methods will be explained, and examples will be shown to illustrate exactly which x-rays are no longer needed. The issue of quantifying radiation dose benefits will be discussed.