2016

OMPI Seminar Archive

OMPI Seminar: Mehan Haidari and Rolf Clackdoyle

Date: Thursday, January 21, 2016
Time: 3:30-5:00 pm - Thursday 21 January 2016. Refreshments start at 3:15 pm.
Location: Room RPB 205 (boardroom), Health Canada, 775 Brookfield Road.

Program:

1. Retrospective dosimetric Monte Carlo study for permanent implant prostate brachytherapy at the Ottawa Hospital Cancer Centre

By Mehan Haidari, Carleton University.

Abstract: Current clinical dose calculation methods for low dose-rate (LDR) prostate brachytherapy are performed following the protocols defined by the AAPM Task Group report no. 43 (TG43) formalism. Under the TG-43 formalism, absorbed dose is calculated in a homogeneous water phantom, ignoring the effects of tissue heterogeneities. Additionally, dose contributions from each radionuclide are considered independently, ignoring interseed attenuation and scattering effects. Using Monte Carlo (MC) techniques, these limitations inherent to TG-43 are overcome. This talk will investigate the MC technique used to calculate dose distributions for a cohort of patients that received LDR prostate brachytherapy at the Ottawa Hospital Cancer Center. Furthermore, some work done in linking patient outcomes with these more accurate dose calculation models will be discussed.

2. Data consistency conditions and their relevance to medical imaging

By Rolf Clackdoyle, Hubert Curien Laboratory in France, and Physics Deartment at Carleton University

Abstract: X-ray Computed Tomography (CT), Positron Emission Tomography (PET), and Single Photon Emission Computed Tomography (SPECT) scanners gather “projections” at different orientations around the patient, and these projections are assembled by the reconstruction algorithm to form a three-dimensional image of the corresponding physical parameter (electron density, positron-emitting isotope, gamma-emitting isotope respectively).

These projections gather largely independent information, which is why so many of them are measured. However, there is a small amount of redundancy (or overlap of information) between projections. This redundancy can be described precisely using mathematical equations referred to as data consistency conditions (DCC). The DCC can be used to remove undesired systematic effects (such as patient motion, to name one of many examples) from the measurements before image reconstruction. Very recently there has been progress in identifying DCC for fanbeam and conebeam imaging geometries which are particularly suitable for CT. One such example of new fanbeam DCC will be presented with a toy problem to illustrate the approach and efficacy in removing systematic effects, even in the presence of (zero-mean) noisy data.

OMPI Seminar: Nelson Miksys and Ian Cameron and Social Event

Date: Thursday, February 25, 2016
Time: 3:30-5:00 pm. Refreshments start at 3:15 pm.

Location: Herzberg Building Room 4351, Carleton University.

Program:

1. Patient-specific Monte Carlo dose calculations for Pd-103 permanent implant breast brachytherapy

By Nelson Miksys, Carleton University.

Abstract: This talk will summarize a recent investigation of patient-specific Monte Carlo dose calculations for patients who received Pd-103 permanent implant breast brachytherapy at The Ottawa Hospital Cancer Centre. One purpose of this work is to compare retrospectively calculated dose distributions between the clinical AAPM TG-43 water-based approach and the Monte Carlo method which models patient-specific anatomy. DVH-metrics evaluated in the PTV and the skin can differ by up to 27% and 48% respectively between TG-43 and Monte Carlo, which may help inform a future reassessment of prescription dose and OAR dose limits. A second purpose of this investigation is to explore the sensitivity on Monte Carlo dose calculations from the necessary modelling choices required to derive virtual patient-specific models. The observed sensitivities motivate the development of clear consensus modelling guidelines to build upon the limited recommendations provided in AAPM TG-186. Towards this goal, we present modelling choice suggestions based on our experiences with patient-specific Monte Carlo dose calculations of breast brachytherapy.

2. Using MRI to assess microvascular blood flow

By Ian Cameron, The Ottawa Hospital, and Physics Deartment at Carleton University

Abstract: Detailed knowledge of microvascular flow can be very useful for the assessment of certain pathologies. We have been working with a radiologist at The Ottawa Hospital for the past several years to develop better ways of measuring microvascular parameters for gliomas using MRI. There are several MRI techniques that are sensitive to microvascular flow. The more established methods track contrast agent as it flows through the tissue; other approaches do not require the injection of a contrast agent. In the first part of my talk I will briefly introduce these different methods, giving relative merits and shortcomings of each. The focus of the talk will then shift to a discussion of Diffusion Weight Imaging and how it could potentially be used to obtain information about slow blood flow in tissues. While it is known that these measurements are sensitive to slow flow, it is not known how the parameters obtained with this approach relate to the parameters from the other MRI approaches. The goal of the research project is to investigate this relationship.

3. Social event announcement from Liz:

Calling all Ottawa physicists (and friends!),

Although the weather is still making the availability of canal skating a prediction with large associated uncertainty, Id like to invite you all to come out for a Winter OMPI Social following the next seminar. Should the canal be open, athletic enthusiasts are invited to join me for a skate from Carleton down to Pretoria, followed by drinks and food at the Royal Oak at Pretoria.

For those of us who are not interested in freezing their toes off, I will make the reservation at the Royal Oak early enough that you can proceed straight there from the seminar. Please feel free to bring friends,

significant others, they typically do an excellent job of balancing the physics-over-beer conversation with all the other things the rest of the world is interested in.

When? Thurs Feb 25th, 5:45pm onwards
Where? Royal Oak Pretoria, (website gives address as Canal 221 Echo Drive)
What to do? Please RSVP to me eortontoh.on.ca so I can estimate the reservation size

I have an extra pair of size 8 mens (~ size 9 womens) hockey skates in case anyone needs to borrow them.

Looking forward to seeing you!

OMPI Seminar: Hamid Moradi and Richard Richardson

Date: Thursday, March 24, 2016
Time: 3:30-5:00 pm - Thursday 24 March 2016. Refreshments start at 3:15 pm.
Location: The Ottawa Hospital Auditorium, 2nd floor, main hospital, 501 Smyth Road

Program:

Webcast link: http://webcast.otn.ca/mywebcast?id=53907227

Presentations:

1. Characterization of radioresistance in human ovarian cancer cells

By Hamid Moradi, Carleton University

Abstract: “The development of a radiosensitivity predictive assay is an attractive goal in radiation Oncology. Since there is a high degree of inter-patient variability in the inherent sensitivity or resistance to therapy, it is crucial to have the ability to identify molecular markers that correlate with sensitivity or resistance to radiation treatment. We have applied Raman micro-spectroscopy (RMS) in vitro to discriminate between the ovarian carcinoma cell lines A2780s (parental wild type) and A2780cp (cisplatin cross radio-resistant variant). These two cell lines represent a good model of tumor tissues of similar origin but with different intrinsic chemo- and radio-sensitivities. Moreover, their radiobiological behavior has been extensively studied and their survival curves under different irradiation schemes are known. The Raman spectra collected from individual cells undergo initial preprocessing (background subtraction, normalization and noise reduction) to yield true Raman spectra representative of the cells. The mean of these spectra are analyzed with Principal Component Analysis (PCA) followed by Linear Discriminant Analysis (LDA) to yield a strong separation between the cell lines. The objective of this ongoing work is to characterize the spectral differences between the two cell types in order to determine the underlying biochemical basis for this separation. The multivariate classification model constructed using such Raman spectra of ovarian cancer cells could potentially be utilized for early prediction of tumor response.”

2. Talk on 2016 paper by Richard Richardson and Mary-Ellen Harper, University of Ottawa: “Mitochondrial stress controls the radiosensitivity of the oxygen effect: Implications for radiotherapy”

By Richard Richardson, Canadian Nuclear Laboratories, Chalk River

Abstract: It has been more than 60 years since the discovery of the oxygen effect that empirically demonstrates the direct association

between cell radiosensitivity and oxygen tension, important parameters in radiotherapy. Yet the mechanisms underlying this principal tenet of radiobiology are poorly understood. Better understanding of the oxygen effect may explain difficulty in eliminating hypoxic tumor cells, a major cause of regrowth after therapy. Our analysis utilizes the Howard-Flanders and Alper formula, which describes the relationship of radiosensitivity with oxygen tension. Here, we assign and qualitatively assess the relative contributions of two important mechanisms. The first mechanism involves the emission of reactive oxygen species from the mitochondrial electron transport chain, which increases with oxygen tension. The second mechanism is related to an energy and repair deficit, which increases with hypoxia. Following a radiation exposure, the uncoupling of the oxidative phosphorylation system (proton leak) in mitochondria lowers the emission of reactive oxygen species which has implications for fractionated radiotherapy, particularly of hypoxic tumors. Our analysis shows that, in oxygenated tumor and normal cells, mitochondria, rather than the nucleus, are the primary loci of radiotherapy effects, especially for low linear energy transfer radiation. Therefore, the oxygen effect can be explained by radiation-induced effects in mitochondria that generate reactive oxygen species, which in turn indirectly target nuclear DNA.

OMPI: Martin Martinov and Claudiu Cojocaru

Date: Thursday, April 21, 2016
Time: 3:30-5:00 pm. Refreshments start at 3:15 pm.
Location: Centre Foustanellas Auditorium, Second Floor, The University of Ottawa Heart Institute, 40 Ruskin Street.

Webcast possibility is being explored. Will update in the next announcement.]

Student speaker

Title: Applications of EGSnrc Monte Carlo simulations on subcellular length scales
Speaker: Martin Martinov, PhD student at Carleton University
Supervisor: Professor Rowan Thomson

Abstract: Increasingly, studies are using Monte Carlo (MC) simulations to investigate the effects of radiation on cellular and subcellular length scales. These studies aim to improve our understanding of microdosimetry and biological effects for existing treatments, as well as to contribute to the development of novel treatment techniques such as the use of gold nanoparticles as radiosensitizers. Due to the challenges and uncertainties of traditional MC simulations at subcellular scales, there is considerable variation in the use of simulation parameters, MC codes and modelling approaches. This work investigates MC simulations on subcellular length scales in a variety of contexts, working towards the development of a more robust, comprehensive, and efficient framework for microscopic simulations."

Member speaker

Title: Water calorimetry as a primary standard for absorbed dose to water
Speaker: Claudiu Cojocaru, PhD, National Research Council Canada

Abstract: In order to investigate the stability of a water calorimetry system as a primary standard for absorbed dose to water, measurements were performed in Co-60 and high energy linac photon beams over a span of several years. Over this period, four sealed and three unsealed water vessels saturated with various gases were used to measure absorbed dose to water. These experiments showed that the water calorimeter system is stable for both the sealed and unsealed water vessels.

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OMPI Seminar and BBQ: Nick Majtenyi and Boguslaw Jarosz

Date: Thursday, May 19, 2016
Time: 3:30-5:00 pm - Thursday 19 May 2016. Refreshments start at 3:15 pm.
Location: NRC - 1200 Montreal Road, Building M-36 - Kelvin Room (please check in at the front desk).

Program:

1) Comparing input function measurements in DCE-MRI using phase and MOLLI
Nick Majtenyi, PhD student at Carleton University
Supervisor: Professor Ian Cameron

Abstract: Dynamic contrast-enhanced (DCE)-MRI is a quantitative imaging technique to obtain tissue hemodynamic information (e.g. tumours). Despite widespread clinical application of DCE-MRI, the technique suffers from a lack of standardization and accuracy, especially with respect to the concentration-versus-time of gadolinium (Gd) contrast agent in feeding arteries (the input function, IF). MR phase has a linear quantitative relationship with Gd concentration ([Gd]), making it ideal for measuring the first-pass of the IF, but is not considered accurate in the steady-state washout. Modified Look-Locker Inversion Recovery (MOLLI) is a fast and accurate method to measure T1 and has been validated to quantify typical [Gd] ranges experienced in the washout of the IF. This work compares two different methods to compute the IF used for DCE-MRI: (1) conventional phase-versus-time and (2) phase-versus-time combined with pre- and post-DCE MOLLI T1 measurements.

2) Ultrasound thermal therapy of cancer: Models and phantom measurements for brain
Boguslaw Jarosz, Emeritus Professor, Carleton University

Abstract: This talk presents issues regarding ultrasound thermal therapy of cancer. A design of an interstitial waveguide applicator will be presented and its physical characterization in a water phantom will be described. Results of measurements imply that for use in thermal therapy an array of applicators must be considered and such an array will be considered for treatment of brain tumours. First, FEA computations of blood flow effects on temperature pattern will be shown. This will be followed by details of a design of blood vessels incorporating phantom with its physical characterization. Heating patterns in the phantom will conclude the presentation.

3) End of season BBQ

Please don’t forget to RSVP Bryan (Bryan.Muir(at)nrc-cnrc.gc.ca) if you will be attending the BBQ after the seminar (along with any dietary restrictions). Deadline for RSVP is May 16th.

OMPI Seminar and Social: Victor Malkov and Greg Cron

Date: Thursday, September 22, 2016
Time: 3:30 - 5:00 pm. Refreshments start at 3:15 pm.
Location: Herzberg Building Room 4351, Carleton University.

Presentations:

1. "Magnetic fields in EGSnrc - validation and applications"

By Victor Malkov, PhD student at Carleton University, Supervisor: David W. O. Rogers

Abstract:
Development of synergistic MRI-radiation therapy machines requires magnetic field capable Monte Carlo codes. We have implemented an efficient and accurate code to perform charged particle transport in magnetic fields in EGSnrc. Verification with the Fano cavity theorem demonstrates excellent agreement between our calculations and theory while also highlighting sensitivities in the magnetic field Fano cavity
testing procedure. The code is used to evaluate the effects of the magnetic field on ion chamber response and lung dose near heterogeneous structures.

2. "The University of Ottawa seven Tesla small animal MRI: cerebral and renal perfusion"

By Greg Cron, PhD, Imaging physicist at The Ottawa Hospital

Abstract:
Dynamic contrast-enhanced (DCE) magnetic resonance imaging (MRI) involves rapid, repeated MRI imaging during intravenous infusion of a contrast agent. These data are combined to make a "movie" of contrast agent delivery to tissues of interest. The movie can be analyzed to obtain blood flow characteristics of the tissue, which can help diagnose pathologies. Development of DCE-MRI protocols is non-trivial, however, especially for small animals. This talk will discuss the first two successful implementations of DCE-MRI on UofO's 7T animal MRI scanner. The first research project looked at how eating a junk food diet affects stroke recovery in rats. The second ongoing project is investigating the effect of aspirin on hypertensive mice and rats.

Social event:
Coordinated by the OMPI graduate student representative, Martin Martinov

This year's first OMPI social will be held at McLaren's on Elgin. A night of drinks and billiards to kick off

OMPI Seminar and tour of NRC facilities: Alexandra Bourgouin and Bryan Muir

Date: Thursday, October 20, 2016
Time: 3:30 - 5:00 pm. Refreshments start at 3:15 pm.
Location: NRC - 1200 Montreal Road, Building M-36 - Kelvin Room (please check in at the front desk).

TOUR: There will be a tour of NRC facilities right after the seminars, starting around 5 pm. NRC staff would like to know the number of people interested in the tour in order to organize the logistics. If you're interested please email **Dr. Malcolm McEwen (Malcolm.McEwen@nrc-cnrc.gc.ca)**.

Presentations:

1) "Ion chamber dose measurements - problems with the temperature-pressure correction factor"
By Alexandra Bourgouin, PhD student, Carleton University and NRC
Supervisor: Malcolm McEwen

Abstract:
Purpose: To investigate the behavior of ionization chambers over a wide pressure range. Methods: Three cylindrical and two parallel-plate designs of ion chamber were investigated. The ion chambers were placed in vessel where the pressure was varied from atmospheric (101 kPa) down to 5 kPa. Measurements were made using Co-60 and high-energy electron beams. The pressure was measured to better than 0.1% and multiple data sets were obtained for each chamber at both polarities to investigate pressure cycling and dependency on the sign of the charge collected.

Results: For all types of chamber, the ionization current, corrected using the standard PTP, showed a similar behaviour. Deviations from the standard theory were generally small for Co-60 but very significant for electron beams, up to 20 % below P = 10 kPa. The effect was found to be always larger when collecting negative charge, suggesting a dependence on free-electron collection. The most likely source of such electrons is low-energy electrons emitted from the electrodes. This signal would be independent of air pressure within the chamber cavity. The data was analyzed to extract this signal and it was found to be a non-negligible component of the ionization current at atmospheric pressure. In the case of the parallel plate chambers, the effect was approximately 0.25 %. For the cylindrical chambers the effect was larger - up to 1.2 % - and dependent on the chamber type, which would be consistent with electron emission from different wall materials. For the electron beams, the correction factor was dependent on the electron energy and approximately double that observed in Co-60.

Conclusion: Measurements have indicated significant deviations of the standard pressure correction that are consistent with electron emission from chamber electrodes. This has implications for both primary standard and reference ion chamber-based dosimetry.

2) "Progress toward updating the TG-51 protocol for electron beam reference dosimetry"
By Bryan Muir, PhD
National Research Council Canada

Abstract:
The addendum to the TG-51 protocol for photon dosimetry was published in 2014 and included refinements to the original protocol. The revision for electron beam dosimetry will require more extensive changes. In this talk, I will discuss progress toward updating the protocol for electron beam dosimetry including: (i) updated Monte Carlo calculations of electron beam quality conversion factors, (ii) gradient corrections and optimal shifts for accurate electron beam dosimetry, (iii) the use of cylindrical chambers in electron beams, and (iv) electron beam primary standard water calorimetry to obtain measured beam quality conversion factors at the National Research Council.

Special event: Dr. Peter Raaphorst COMP Gold Medal Celebration and Spencer Manwell

Date: Thursday, November 17, 2016
Location: The Ottawa Hospital - 501 Smyth Road, Royal Room (very close to the entrance of the cafeteria).
Time: The student talk will be from 3:30 to 4:00 pm as per usual. The event for Dr. Raaphorst will start at 4:00 pm.

This month we are replacing the member speaker with a special event to celebrate Dr. Peter Raaphorst's COMP Gold Medal Award. The afternoon is catered with light refreshments starting at 3:15.

Program:

1) "Toward patient motion compensation in PET imaging studies using PeTrack"

By Spencer Manwell, PhD student, Carleton University

Supervisors: Tong Xu, Rob deKemp, Ran Klein

Abstract: The presence of patient motion can introduce PET image artifacts, such as overestimation of the size of tissues of interest and underestimation of tracer uptake. Artifacts such as these can adversely impact a clinician's ability to diagnose or stage disease. Various approaches exist that seek to address these problems by compensating or correcting the motion of the patient during an imaging procedure. One approach, PeTrack (positron emission tracking), will be the focus of this talk. A review of the PeTrack algorithm, recent evaluations of its performance and prospective investigations into its uses will be discussed.

2) Dr. Peter Raaphorst celebration:

The event starts at 4:00 pm. The first 30 mins are short reflections on Dr. Raaphortst's career and accomplishments, including remarks from Dr. Raaphorst himself. The rest of the afternoon is not structured so that people get a chance to mingle and talk with Peter.

OMPI Seminar: Chris Dydula and Dave Rogers and tour of Health Canada, Radiation Protection facilites

Date: Thursday, December 15, 2016
Times: 2:00 - 3:00 - Tour of Health Canada facilites, 3:30 - 5:00 pm - Refreshments start at 3:15 pm.
Location: Room RPB 205 (boardroom), Health Canada, 775 Brookfield Road, Ottawa. Please check in at the front desk.

The tour of Health Canada facilities requires sign up. Please RSVP Lindsay Beaton (lindsay.beaton@hc-sc.gc.ca).

Presentations:

1) "Prototyping an x-ray scatter projection imaging system at the Canadian Light Source"
By Chris Dydula, PhD student, Carleton University
Supervisor: Dr. Paul Johns

Abstract: A major challenge in traditional x-ray projection imaging, which utilizes only information from primary photons, is obtaining adequate soft-tissue contrast. We are developing a high soft-tissue contrast x-ray projection imaging technique at the Canadian Light Source synchrotron based on the detection of low-angle scattered photons. In order to acquire scatter images in reasonable times, we have configured a system with multiplexed 3 mm2 rectangular pencil beams at 33.2 keV and with samples moving continuously at 1 cm/s during the scan. A consequence of faster acquisition is an increase in the complexity of the scatter data, requiring additional corrections when reconstructing images.

2) "Using Monte Carlo to improve reference dosimetry for low dose rate brachytherapy"
By Dave W. O. Rogers, PhD, Carleton University

Abstract: TLD dosimetry with LiF has been widely used to establish dosimetry parameters for use in brachytherapy, most notably dose rate constants. However almost all of the literature is based on calibrations and factors from the 1980s and/or ignores the fact that the signal per unit dose to the LiF varies substantially with photon energy and/or ignores the fact that the dose to LiF per unit dose to water depends on the details of the seed and shape of the detector. This talk is about using Monte Carlo techniques to overcome these problems and to provide a reanalysis of measured dose rate constants for 24 different seeds. This improves the agreement between the calculated and measured values to within about 1% on average as opposed to the previous disagreement of 5% on average.