2015

OMPI Seminar Archive

Raanan Marants and Laurel Sinclair

Date: Thursday, January 29, 2015
Time: 3:30 - 5:00 pm
Location: Room RPB 205 (boardroom), Health Canada, 775 Brookfield Road

Presentations:

1. "Dose and Position Quality Assurance using the RADPOS System for 4D Radiotherapy with CyberKnife"
Raanan Marants - Carleton University

Abstract: Radiotherapy treatment becomes more difficult in cases where patient motion, such as breathing, causes movement of the treatment target or organs-at-risk. The CyberKnife radiosurgery system offers an excellent solution in the form of real-time tumor motion tracking through its Synchrony respiratory motion tracking system. Such a complex dose delivery system needs independent performance verification to assure safe patient treatments, which can potentially be accomplished with the RADPOS 4D dosimetry system. RADPOS consists of a microMOSFET dosimeter combined with an electromagnetic positioning sensor, enabling it to perform real-time dose and position measurements simultaneously. RADPOS is used as an independent QA tool to verify the CyberKnife system's motion tracking and delivered dose. RADPOS motion measurements are compared with internal metal fiducials and external LED optical markers log files. Dose measurements are compared with GAFCHROMIC film and treatment planning calculations

2. "Surface contamination concentration measurements from aerial radiometric survey"
Laurel Sinclair - Natural Resources Canada

Abstract: Natural Resources Canada has responsibility for emergency response mobile radiometric mapping in the event of a radiological or nuclear incident, whether accidental or malicious in nature. We fly aerial gamma-ray surveys, and extrapolate to isotope-specific concentrations on the surface of the ground, using an assumption that the radiation is infinite in extent and uniform. This approach can accurately determine the total amount of radioactivity, and specify the locations of high and low concentration. However, it suffers from the problem that it produces a result which is averaged over a large area. This is an issue which is particularly acute for emergency response where a highly localized hot spot could be misrepresented as a broad deposit which is relatively weak. We have developed a method to deconvolve the aerial radiometric map for spatial smearing. In this way we can recover some of the sharpness of the features on the ground, and get a more accurate measure of the strength of localized hot spots. In this talk, recent measurements of surface concentrations will be presented, using both synthetic and real-world data.

Dal Granville and Dal Granville

Date: Thursday, February 26, 2015
Time: 3:30 - 5:00 pm
Location: Carleton University - Herzberg Building - Room HP4351

Presentations:

1. “LET measurements in therapeutic proton beams”
Dal Granville - Carleton University
Abstract: The biological response resulting from proton radiotherapy depends on both the absorbed dose in the irradiated tissue and the linear energy transfer (LET) of the beam. While absorbed dose is readily measured using a variety of detectors, there is no device available for the routine measurement and verification of LET. This work aims to further develop the optically stimulated luminescence (OSL) technique to allow for routine measurements of LET in therapeutic proton beams. This presentation will focus on the LET dependence of OSL detectors, and detail the progress made in using them to verify LET in proton therapy treatment plans.

2. “Investigating the anomalous response of the NE2575 ionization chamber, and ideal chamber shapes”
Frédéric Tessier - National Research Council Canada
Abstract: In 1993, upon acquiring a Cs-137 irradiator, physicists in Ionizing Radiation Standards at the NRC noticed that measurements with a large volume 600cc ionization chamber model NE2575 showed an unexpected deviation from the inverse square law, with a discrepancy of up to 4% at 8 meters from the source. Although this anomaly was confirmed experimentally and was well documented, a definitive explanation remained elusive. Twenty years later, we revisit this problem using EGSnrc Monte Carlo simulations to discern the contribution of each chamber component to the anomaly. We show that the observed deviation arises mostly from long photon attenuation paths inside the chamber cylindrical side wall. We propose an empirical correction to address the issue in practice, but also uncover an optimal chamber angle at which the expected behaviour is recovered. Finally, we expand the question and consider the ideal shape of an ionization chamber to minimize deviations from the inverse square law.

Eric Christiansen and Dmitry Klokov

Date: Thursday, March 26, 2015
Time: 3:30 - 5:00 pm
Location: Hospital Auditorium, 2nd floor, General Campus (escalator from main lobby to 2nd floor, follow signage)

Presentations:

1. "Clinical field ionization chamber correction factors for the CyberKnife radiosurgery system"
Eric Christiansen - McGill University

Abstract: A proposed dosimetry formalism for small and non-standard fields involves the determination of ionization chamber correction factors to convert the dose measured in a clinical plan to the dose associated with either a static machine-specific reference (MSR) field, and/or a plan-class specific reference (PCSR) composite field being as close as possible to a class of clinical plans of interest. The aim of this work is to determine detector correction factors for a number of representative Cyberknife treatments, for two microchambers and a commercial plastic scintillator. First, a linac head model was created in BEAMnrc by matching percentage depth dose curves and output factors measured using an A16 microchamber with Monte Carlo calculations performed in egs_chamber to explicitly model detector response. Using this model, intermediate correction factors related to the non-water components of each detector were calculated for the microchambers and the plastic scintillator in fourteen different composite fields inside a solid water phantom. Seven of these fields used a 5 mm diameter collimator; the remaining fields employed a 7.5 mm collimator but were otherwise identical to the first seven. It was determined that large and variable CFs are required for microchambers in small composite fields primarily due to density and volume effects. Corrections are reduced but not eliminated for a plastic scintillator in the same fields.

2. "Effects of low dose gamma-radiation on cellular aging"
Dmitry Klokov - Canadian Nuclear Laboratories

Abstract: The use of ionizing radiation for diagnostic imaging in medicine has increased tremendously over the past three decades, mostly due to rise of the computed tomography technology. Debates continue whether such increased exposures to low doses of ionizing radiation (LDR) may lead to detrimental health effects, such as cancer, later in life. Cellular aging or senescence, a state of irreversible cell cycle arrest, is a means by which damaged cells are prevented from becoming precancerous cells. However, it has recently been linked to cancer due to proinflammatory signalling elicited by senescent cells which promotes cancer growth. We, therefore, sought to examine whether LDR can affect cellular aging/senescence, which in turn may affect cancer risk. Primary cultures of normal human diploid fibroblasts were exposed to 10, 100 mGy or left untreated at a young age and were maintained under normal growth conditions for 70 days in which 100% of cells normally reach the state of senescence. Different end-points were measured in the course of aging the cell cultures related to: a) senescence markers; b) gene expression; c) cell proliferation; d) microRNA expression. Our results showed that accumulation of senescent cells with time was delayed in LDR-exposed cultures. This was accompanied by an increased rate of proliferation and changes in the expression of genes involved in various cellular pathways, such as DNA repair, cell cycle, DNA damage signaling and epigenetic gene expression regulation. Profiling of 1008 most abundantly expressed microRNA genes revealed a significant number of changes in LDR-exposed vs. control cells. Our results suggest that LDR is capable of suppressing the rate of cellular aging in vitro and that the mechanisms of such effect include gene expression changes mediated by epigenetic microRNA pathways. It is important to validate these results using in vivo mouse models and such studies are currently underway at Canadian Nuclear Laboratories. Extended to the in vivo conditions, these data may be used for evaluating potential health risks in patients exposed to LDR in the medical setting, as well as to nuclear industry professionals or public exposed to LDR as a result of nuclear accidents.

Patty Oliver and Eric Vandervoort

Date: Thursday, April 23, 2015
Time: 3:30 - 5:00 pm
Location: West Foustanellas Auditorium (H-2366) – 2-nd floor – The University of Ottawa Heart Institute, 40 Ruskin Street

Presentations:

1. "A study of macroscopic and microscopic dose descriptors for kilovoltage cellular dosimetry using Monte Carlo simulations and cavity theory"
Patty Oliver – Carleton University

Abstract: Monte Carlo (MC) simulations and cavity theory are used to investigate cellular dosimetry for kilovoltage photon sources. Multicellular models of normal and cancerous tissues are developed using data from a literature review; MC simulations are employed to compute doses to cellular targets for a variety of cell morphologies as well as doses to bulk tissues and water. Simulation geometries involve cell clusters, single cells, and single nuclear cavities embedded in various healthy and cancerous bulk tissue phantoms. Cell and nucleus radii range from 5 to 10 microns and 2 to 9 microns, respectively. Variations in cell dose with simulation geometry are most pronounced for lower energy sources: the nuclear dose in a multicell model differs from the dose to a cavity of nuclear medium in an otherwise homogeneous bulk tissue phantom by more than 7% at 20 keV. Bulk tissue and water cavity doses differ from cellular doses by up to 16% so that neither water nor bulk tissue is an appropriate surrogate for subcellular targets in radiation dosimetry. MC results are compared to cavity theory predictions; large and small cavity theories qualitatively predict nuclear doses for energies below and above 50 keV, respectively. Various intermediate cavity theory methods are reviewed. The influence of microscopic inhomogeneities in the surrounding environment on the nuclear dose and the importance of the nucleus as a target for radiation-induced cell death emphasizes the potential importance of cellular dosimetry for understanding radiation effects.

2. "Sources of uncertainty in composite field delivery for the Cyberknife radiosurgery system"
Eric Vandervoort – The Ottawa Hospital Cancer Centre

Abstract: In recent years, stereotactic ablative radiosurgery (SABR) has moved from using rigid frames fixed to a patient's skull to the use of non-invasive frameless techniques requiring in-room image guidance. The Cyberknife, consisting of a compact linear accelerator mounted to an industrial robotic arm, is one such SABR system which has been in use at the Ottawa hospital since 2010. This system delivers highly conformal radiation dose by employing many (typically > 100) small aperture (5 to 60 mm in diameter) radiation fields from many different non-coplanar directions. The central axes of these beams may share a common point of intersection (isocentric) and provide highly-conformal spherically-shaped radiation dose distributions similar to those delivered using arc therapy with cones on a conventional LINAC. The vast bulk of Cyberknife treatments, however, treat arbitrary shaped tumours using hundreds of non-isocentric beams with their central axes directed at points on the exterior surface of a target. The Cyberknife robotic radiosurgery system also employs a complex motion prediction algorithm to compensate for respiratory motion in extracranial treatments. Measurement and simulated results for single detectors and film in a phantom geometry for these isocentric and non-isocentric composite fields will be discussed. The initial calibration of the robot treatment positions, static field commissioning, and the tests employed to monitor and maintain delivery accuracy will be described with a focus on the differences between the Cyberknife and conventional gantry mounted LINAC systems, along with sources of error and opportunities for further investigation.

OMPI Seminar and annual BBQ: Nima Sherafati and Rebecca Thornhill

Date: Thursday, May 28, 2015
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)

Presentations:

1. "Kilo-Voltage X-ray Tube Correction Factors for In-water Measurement"

Nima Sherafati – Carleton University

Abstract: For x-ray tube potentials larger than 100 kV, the AAPM TG-61 protocol for 40-300 kV x-ray beam dosimetry in radiotherapy recommends an in-water measurement which is based on ionization chambers calibrated in air in terms of air kerma. We studied the variation of the overall correction factor (PQch) and its components (known as corrections for the change in the chamber response due to the change in the spectrum distribution in phantom compared to that used for the calibration in air (kQ), displacement of water by the ionization chamber (Pdis) and displacement of water by the stem (Pstem)) as well as the correction for a waterproofing sleeve (Psheath) with depth and field size for 6 different beam qualities in the orthovoltage x-ray range (100 kV < tube potential < 300 kV).

2. "Searching for hidden patterns in cancer and cardiovascular images"

Rebecca Thornhill – The Ottawa Hospital

Abstract: Conventionally, radiologists produce diagnoses on the basis of a combination of their training, experience, and individual judgment. Radiologists perceive image patterns and associate or infer a diagnosis consistent with those patterns. However, there will be an inevitable degree of variability in image interpretation as long as it relies primarily on human visual perception. Pattern analysis can provide a quantitative vocabulary for the otherwise subjective characteristics of lesions. Tools for automated pattern recognition can provide objective information to support clinical decision-making and may serve to reduce variability. To date we have applied quantitative shape and texture pattern analysis to a number of cancer and cardiovascular imaging applications. Several of these will be discussed, with particular focus on how pattern analysis can supplement conventional radiologic interpretation. Finally, these applications will also provide opportunities to discuss some of the pitfalls and challenges presented by these techniques.

* 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 contact Bryan.Muir@nrc-cnrc.gc.ca by May 25 to guarantee your share.
We will make every effort to accommodate special dietary needs (e.g. vegetarians) but only if we know in advance.

OMPI and Social Event: Jaswinder Taank and Malcolm McEwen

Date: Thursday, September 17, 2015
Time: 3:30-5:00 pm - Refreshments start at 3:15 pm.
Location: Carleton University, Herzberg Building, Room HP4351

Presentations:

1. "Examining the influence of humidity on Farmer chamber performance"

By Jaswinder Taank - McMaster University and National Research Council Canada

Abstract: The average energy required to produce an ion pair in an ion chamber (W) is mostly dependent on the gas, the temperature/pressure of the gas, and the type/energy of the radiation. The humidity of the gas also plays a role, albeit a much smaller one. Its influence appears to be flat for typical room humidities and therefore, it often gets ignored in most scientific labs. However, its influence is much more pronounced near relative humidities of 0 and 100% . ICRU 31, the most comprehensive document on the topic, reports an influence of up to ± 0.3%, but it relies on old data generated from the 60s and 70s. Obtaining a more accurate understanding of this behaviour is important for standards labs in particular, because we require uncertainties of about the same order. In this project, we explore the influence of humidity on various farmer chambers using a weak Sr-90 beta source. We also show our most recent measurements from a Co-60 gamma source.

2. World-Wide Radiation Metrology: The BIPM, the CIPM MRA, SIM and NRC

By Malcolm McEwen - National Research Council Canada

Abstract: Since the Metre Convention was signed in 1875 there has been steady progress to ensure the consistency of measurements from one country to another. The Bureau International des Poids et Mesures (BIPM) co-ordinates comparison exercises that demonstrate the equivalency of measurement standards from one national laboratory to another with the aim of simplifying international commerce and eliminating cross-border regulatory barriers.
This presentation will describe how the international realization of the SI is managed under the Mutual Recognition Arrangement of the CIPM and show how NRC, as Canada's National Measurement Institute, plays a major role in world-wide radiation metrology. In addition to the explanation of the many acronyms in this field, the presentation will present the results of recent international comparisons of Canadian measurement standards.

Social event details

For the first OMPI social event of the season, we are going to head over to Maclarens (301 Elgin Street) to play some pool. It is a short drive from Carleton University, and we will try to arrange rides for those who need it. If you are interested in participating or making suggestions regarding OMPI socials in the future, please fill out this short form (http://goo.gl/forms/LfwOFuVHlH). Your RSVP via the form would be greatly appreciated.

OMPI Seminar: Chad Hunter, Dmitry Klokov and Yi Wang

Date: Thursday, October 22, 2015
Time: 3:30-5:00 pm - Thursday 22 October 2015. Refreshments start at 3:15 pm.
Location: Room RPB 205 (boardroom), Health Canada, 775 Brookfield Road Carleton University.

Presentations:

1. Motion correction in Positron Emission Tomography (PET) imaging

By Chad Hunter, Carleton University and The University of Ottawa Heart Institute.

Abstract: Patient motion is a common problem during dynamic PET scans for quantification of myocardial blood flow (MBF). Computer simulation studies indicate that errors in MBF can approach 500 % for scans with severe patient motion. Motion correction algorithms should be effective in identifying mid- and late-time-frame motion, and motion in the left/right direction, since these cases produce the largest errors in MBF, particularly for high resolution PET imaging. A post reconstruction image-based method, and a pre reconstruction projection-based method for detecting and correcting patient motion was developed and evaluated.

2. Rejuvenating effect of low dose gamma-radiation on blood immunological parameters: Evidence for mice vs. human

By Dmitry Klokov and Yi Wang, Canadian Nuclear Laboratories.

Abstract: Our previous results indicated that low dose gamma-radiation may delay the onset of cellular senescence/aging in an in vitro model of normal human fibroblasts. We extended this result into an in vivo mouse study wherein we examined various immunological and DNA damage and repair parameters in C57Bl6/J mice. We compared responses to 10 mGy of gamma-radiation in 2-months old (young) with those in 26-months old (aged) mice. We found that responses in aged mice were in general more pronounced. An aged related shift in levels of blood cytokines (16 cytokines screened) was observed in non-exposed mouse groups. Strikingly, 2 weeks after 10 mGy dose, levels of 6 cytokines in aged mice were reversed back to the levels observed in young non-irradiated control mice. This rejuvenating effect of low dose gamma-radiation on immunological blood cytokine levels required further verification using functional immunological assays in mice, as well as in human patients undergoing low dose diagnostic irradiations.

OMPI Seminar: Amir Pourmoghaddas and Ruth Wilkins

Date: Thursday, November 19, 2015
Time: 3:30-5:00 pm. Refreshments start at 3:15 pm.
Location: The Ottawa Hospital Auditorium, second floor, General Campus

Webstream has been arranged for this month's presentation. If you want to watch it from your computer, the webcast link is: http://webcast.otn.ca/mywebcast?id=49875450

Presentations:

1. Analytically-based photon scatter modeling for a dedicated cardiac SPECT camera

By Amir Pourmoghaddas, Carleton University and The University of Ottawa Heart Institute.

Abstract: Photon scatter is one of the main effects contributing to the degradation of image quality and to quantitative inaccuracy in Cardiac SPECT imaging. One possible way to calculate photon scatter is to model the photon propagation from emission until the photon is lost or detected by the camera, such as in Monte Carlo approaches. Monte Carlo calculations have the advantage of being capable of producing extremely accurate and precise results, but have a large computational burden. In this talk, I will present a technique based on the analytic photon distribution (APD) method for calculating the photon distribution in SPECT projections, as measured with our dedicated pinhole cardiac SPECT camera. This technique uses an estimate of the source distribution and a map of the attenuating medium and is capable of producing scatter calculations in times that have the potential for integration in the clinic. Validation of the technique using phantom experiments will also be presented.

2. The Canadian Biodosimetry Network

By Ruth Wilkins, Health Canada

Abstract: Health Canada is the lead of the Canadian Biodosimetry Network which provides biologically based dose assessments for potentially exposed individuals during a large scale event involving radiological or nuclear material. During such an event, biodosimetry 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. Health Canada has been working to increase triage-quality biological dosimetry throughput by networking both within Canada and internationally. For such networks to function, it is essential to perform proficiency testing to ensure each laboratorys ability to produce high quality dose assessments.

A series of these inter-comparisons will be described. In addition, much effort has been devoted to developing novel, high throughput methods for biological dosimetry. An overview of recent progress in these methods will be presented.

OMPI Seminar: Sara Kashi and Glenn Wells

Date: Thursday, December 10, 2015
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.

Presentations:

1. 4D Monte Carlo simulations for verification of delivered dose to a moving anatomy

By Sara Kashi, The Ottawa Hospital Cancer Centre and Carleton University

Abstract: One of the main concerns during radiotherapy treatment of lung cancer is the impact of respiratory motion on the dose delivered to the target. Different approaches have been used to estimate the dose delivered to a patient while accounting for such motions. In this talk, I will present a 4D Monte Carlo simulation method that uses measurements of a patient's respiratory motion pattern to calculate the dose delivered to a continuously moving anatomy during static or VMAT beam deliveries. A Monte Carlo model of the Elekta Agility linac has been used for dose calculations with this method. Validation of this method using measurements on a respiratory motion phantom will be presented as well.

2. The pros and cons of pinhole SPECT

By Glenn Wells, The University of Ottawa Heart Institute

Abstract: Single-photon emission computed tomography (SPECT) is an imaging modality that is commonly used in the management of cardiac disease. Standard SPECT cameras use parallel-hole collimators, but recently cardiac SPECT cameras with pinhole collimators (and multiple detectors) have been introduced into the clinic. Compared to standard cameras, the multi-pinhole design offers advantages in both sensitivity and resolution which allows decreased acquisition times and reduced patient radiation exposure. The multi-pinhole camera design can also be stationary (i.e. non-rotating) which greatly increases temporal resolution and opens the door to dynamic SPECT imaging. However, a complication of the pinhole collimators is that they produce variable resolution, magnification, and sensitivity across the field of view (FOV) of the camera. The greater complexity of the imaging geometry places a higher demand on the accuracy of the system model used for image reconstruction and methods do not presently exist to measure the camera configuration and
ensure image quality. In this presentation, I will discuss some of the pros and cons of using pinhole collimator cameras for cardiac SPECT and some of the work we have been doing to investigate and characterize these cameras.