

Ottawa Medical Physics Institute (OMPI)

*A Carleton University Research Centre
based in the Department of Physics,
Carleton University, Ottawa, Canada*

www.physics.carleton.ca/ompi

Annual Report # 20
2007 July 1 – 2008 June 30

Submitted by Malcolm McEwen, PhD, OMPI Director.

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Introduction

Medical physicists are applied scientists who use the tools of physics to improve health care. Although physicists can be found involved in almost all aspects of health care medical physics as a practice usually refers to three areas - cancer therapy, medical biophysics, and imaging. Over the years medical physicists have developed such revolutionary technologies as photon and electron cancer treatment machines, and CT, PET, and MR imagers. It is difficult to imagine modern medicine without these technologies and it is indisputable that medical physics has brought large improvements to patient care.

The Ottawa Medical Physics Institute (OMPI), founded in 1989, is based in the Department of Physics of Carleton University in Canada's capital city, Ottawa. It is a network of approximately 30 medical physicists in the Ottawa region who are active in research, teaching and graduate student education. The Ottawa medical physics community has one of the most diverse spectra of research and service activities in Canada. Our members are located at The Ottawa Hospital and Cancer Centre, the University of Ottawa Heart Institute, Health Canada, the National Research Council of Canada (NRC), Atomic Energy of Canada Limited (AECL) Chalk River Laboratories, and Nucletron Canada, as well as at Carleton University. One of the prime activities of OMPI members is to coordinate and deliver the MSc and PhD programs in medical physics within the Physics Department at Carleton University. This Annual Report summarizes our activities during the 2007-2008 academic year.

Membership

Table 1 summarizes our membership, which at year's end numbers 31, and Table 2 lists the Executive of the organisation. Our members' activities span the field of medical physics, including cancer therapy physics (15 members), imaging (7), and radiobiology and health physics (7). Complete profiles are given on the website. Another two new members were welcomed into OMPI this year:

Lesley Buckley – is a medical physicist at The Ottawa Hospital Cancer Centre and recently completed her CCPM professional certification. Lesley is another graduate of the Carleton University medical physics program. Although her thesis topic was that of Monte Carlo calculations she has recently been working on the more practical matter of dose verification using OSL (optically stimulated luminescence) dosimeters.

Balasz Nyiri – is also a medical physicist at The

Ottawa Hospital Cancer Centre. Balasz was involved in the Carleton Practicum during the 2006/07 academic year, leading a session on IMRT, and has been concerned with treatment planning checking for new radiotherapy modalities such as Tomotherapy.

There were other comings and goings. **Ken Shortt** returned to the National Research Council from the International Atomic Energy Agency, where he had been Head of the Section for Dosimetry and Medical Radiation Physics. **Miller MacPherson** left The Ottawa Hospital Cancer Centre to become the Head of Physics at the Credit Valley Cancer Centre in Mississauga. Miller has been instrumental in moving the Cancer Centre to a filmless, paperless system and he will be difficult to replace. **Clive Greenstock** formally of AECL has retired from the medical physics field and left OMPI this year. We wish Clive the very best in his retirement.

Graduate Program

This academic year, Paul Johns gave our foundation course, *Medical Radiation Physics*, in the fall term to an enrollment of 5 new graduate students (plus 2 Special and 2 Audit students). In the winter term, *Physics of Medical Imaging* was taught to a class of 4 by Tong Xu (coordinator), Ian Cameron, Rob deKemp, and Richard Wassenaar. Fifteen students took the *Radiation Protection* course taught by David Wilkins and Pat Saull. Thank you to all those who taught in our program, especially those from outside Carleton who made the time available to benefit our students.

Table 3 lists the graduate students in the program, and Table 4 the graduate theses (four M.Sc. plus one Ph.D.) completed in 2007-2008. In September 2007, Elsayed Ali, Amanda Cherpak and Tyler Dumouchel all defended their theses and have moved into our PhD program. In April 2008 Andrew McDonald completed his MSc 2008 and Kenji Myint completed his PhD in March 2008, having taken up a radiation oncology residency at Northwestern University in Chicago. Congratulations to all of our graduates!

Seminars

The monthly OMPI seminars (Table 5) continue to be well attended: thank you to all speakers and attendees. Once again we followed the annual tradition of a fall soccer game after the season's first seminar and a BBQ after the final seminar. The BBQ was saved from the May showers but it was a pretty close run thing! Thanks again to all the event organizers.

Table 6 lists the 2007-2008 medical physics

component of the regular weekly seminar series of the Carleton University Department of Physics.

OMPI News and Events

External teaching activities

In October 2007 Carleton University and NRC jointly presented the 13th BEAMnrc course, which was attended by 24 students from around the world. BEAMnrc is the foremost Monte Carlo code for simulating the linear accelerators used in radiation therapy and continues to attract new users. In November 2007, Joanna Cygler and David Rogers were formally appointed as the co-directors of the 2009 AAPM Summer School on Clinical Dosimetry. It will be held in Colorado Springs, CO, June 20 - 25 2009. Two other members of OMPI will be faculty members, Iwan Kawrakow and Malcolm McEwen as well as two former OMPI members, Jan Seuntjens and Charlie Ma. AAPM Summer Schools typically attract several hundred attendees and the accompanying textbook should provide a reference on the topic for many years to come. Also in November 2007, OMPI members Iwan Kawrakow and David Rogers presented lectures at the Workshop on Nuclear Data for Science and Technology: Medical Applications held at the Abdus Salam International Centre for Theoretical Physics in Trieste Italy (event sponsored by the IAEA).

People

Rowan Thomson, a Post-Doctoral Fellow working in the Carleton Laboratory for Radiotherapy Physics, was selected by Chatelaine Magazine as one of Canada's "80 women to watch" in their 80th anniversary issue of May 2008. In June **Paul Johns** completed his 3-year term as chair of the department of physics at Carleton University. During his time as chair Paul was instrumental in obtaining recognition of OMPI as a Carleton University Research Centre.

National and International Activities

During the past academic year many OMPI members served on various national and international committees. A small selection is listed here:

AAPM Working Group on Updates to the TG-51 dosimetry protocol – **Malcolm McEwen** (Chair), **David Rogers**

ICRU report committee on "Key data for measurement standards in the dosimetry of ionizing radiation" – **Carl Ross**

Editorial Advisory Board, Physics in Medicine and Biology – **Carl Ross**, **Ken Shortt**, **David Rogers**

Vice President, CCPM (Canadian College of Physicists in Medicine) – **David Wilkins**

International Commission on Radiological Protection (ICRP) Task Group DOAL (Dose Calculation) – **Richard Richardson**

Consultant to International Atomic Energy Agency on in-vivo dosimetry – **Joanna Cygler**

Joint CAP-COMP selection committee for the Peter Kirkby Memorial Medal – **Paul Johns**

CAMPEP (Commission on Accreditation of Medical Physics Educational Programs) Graduate Education Program Review Committee

– **Brenda Clark**

Publications

The AAPM's TG-105 report on "Issues associated with clinical implementation of Monte Carlo-based photon and electron external beam treatment planning" was published in December 2007 (*Medical Physics* **34**, 4818-4853). Seven of the authors are present or past members of OMPI - **Joanna Cygler**, **Bruce Faddegon**, **Iwan Kawrakow**, **Charlie Ma**, **David Rogers**, **Jan Seuntjens** and **Daryoush Sheikh-Bagheri**.

One of the papers based on **Elsayed Ali's** Master's thesis was selected by Physics in Medicine and Biology as their weekly "Featured Article". These are "high-quality articles chosen by our editors and referees for their novelty, high level of interest and potential impact on future research." The paper is entitled "Benchmarking EGSnrc in the kilovoltage energy range against experimental measurements of charged particle backscatter coefficients", *PMB* **53**(2008)1527-1543.

Trevor Stocki of the Radiation Protection Bureau at Heath Canada was part of the international team that showed that the most probable origin of radionuclides measured in Yellowknife was from the announced North Korean nuclear test of October 2006. The team's article was published in *Geophysical Research Letters* in November 2007.

Grants

Glenn Wells received grant funding from the Heart and Stroke Foundation (\$158,375 total over 2 years starting July 2008) for a project entitled "Increasing certainty in micro-SPECT/CT". This project will examine means of improving the accuracy and reproducibility of small-animal SPECT/CT imaging.

Joanna Cygler has received a \$207,000 grant from HTX to develop a 4D dosimetry system (RADPOS) in collaboration with Best Medical Canada. This system is designed to combine dosimetric and positional information to better measure and guide dose delivery to moving tumours (e.g. in the lungs).

Rob deKemp is participating in a multi-centre Institute for Cardiovascular Therapeutics (ICT) program funded by the Ontario Research Fund

(ORF). This project totals \$14.5M over 5 years and includes \$1.5M for molecular imaging in Ottawa.

Ruth Wilkins is the Principal Investigator on the CRTI-funded project, “Rapid Identification of Radiologically-exposed Individuals for Medical Casualty Management”. The Radiobiology Division of Health Canada is partnering with DRDC-Ottawa, AECL Chalk River and McMaster University in this \$2M project.

Equipment

The Heart Institute has added significantly to their imaging capabilities this year. A new small-animal SPECT/CT camera (acquired through a collaboration with MDS Nordion) provides the Institute the ability to image with SPECT and CT any animal from a 20 g mouse through 250 g rats and up to several kg rabbits. The facility will be used for development and evaluation of novel radiotracers and also for basic imaging research. In July 2007 the Institute was only the second institute in the world to receive a GEHC Discovery RX PET/VCT scanner and later in the year received a Siemens INVEON microPET scanner for pre-clinical imaging.

In the last two years there has been a significant upgrade to the computing power available to OMPI members for carrying out Monte Carlo calculations. Such calculations offer the most accurate way to simulate the interaction of ionizing radiation with materials but to do them in a reasonable time requires the right hardware. In 2006 the nest – a CFI/OIT funded cluster of computers – became fully operational for EGSnrc/BEAMnrc calculations in the Carleton Laboratory for Radiotherapy Physics. This Linux cluster has 48 computers with a total of 196 3GHz 64-bit Woodcrest cores. Under an arrangement with TOHRCC, an additional 32 cores have been purchased to expand the cluster and to allow students and staff at the hospital access to this computing facility. In early 2008 another computing cluster was installed at the Institute for National Measurement Standards, consisting of 33 8-core processors. This represents an almost tenfold increase in processor capacity for the Ionizing Radiation Standards Group. These installations will allow OMPI members involved in Monte Carlo simulations to develop more complex models for simulating accelerators, detectors and calculating dose deposition in patients.

OMPI Executive

I would like to thank the following for serving on the Executive in 2007-2008: David Rogers (Academic Officer), Rob De Kemp (Past-Director), and Ruth Wilkins (Secretary). I'd like to thank Miller MacPherson for his efforts over the last two years and his calmness in dodging the slings and arrows of

outrageous misfortune that are part and parcel of the seminar organizer's life. Facing down an audience devoid of coffee and doughnuts was impressive! With Miller's departure to Mississauga, Tong Xu of Carleton University stepped in and completed a successful season of seminars. I'd like to officially welcome him to the position and wish him well for the 2008/09 season. Thanks, finally, to Elsayed Ali for representing the students, and to our observers, Brenda Clark (TOHRCC) and Richard Wassenaar (The Ottawa Hospital).

7. OMPI Website

www.physics.carleton.ca/ompi

The OMPI Secretary maintains a website with detailed information as follows:

- Members
 - profile of research activities, publications, and funding of each member
 - directory of Phone, Fax, and Email contact information
- Students
 - current MSc and PhD student project areas and supervisors
 - past graduates and their current positions
- Seminars
 - abstracts and dates of current and past monthly OMPI seminars
- News
 - current OMPI events
- Annual Reports
 - current and past Annual Reports
- Exec & Rules
 - current OMPI Executive, and rules of operation of the organization
- Societies
 - relevant scientific and professional societies and local contact names
- Ottawa Links
 - links to host institutions and other relevant organizations
- Courses
 - graduate courses and requirements for students in medical physics
- Information
 - info for prospective graduate students
- Contact Info
 - email addresses to contact OMPI

Table 1. OMPI Members, 2007-2008.For details see www.physics.carleton.ca/ompi and select Membership Profile.

	Member	Institution and Unit	Specialization within Medical Physics
1	Lesley Buckley	Department of Medical Physics The Ottawa Hospital Cancer Centre	Radiotherapy
2	Ian Cameron	Diagnostic Imaging, The Ottawa Hospital	MRI
3	Brenda Clark	Department of Medical Physics, TOHCC	Radiotherapy
4	Joanna Cygler	Department of Medical Physics, TOHCC	Radiotherapy
5	Rob deKemp	Cardiac P.E.T. Centre, University of Ottawa Heart Institute	PET
6	Madhu Dixit [§]	Department of Physics, Carleton University	Detectors for ionizing radiation
7	Elagu Elagupillai	Pharma Research Canada Inc.	Radiation protection
8	Lee Gerig	Department of Medical Physics, TOHCC	Radiotherapy
9	Elizabeth Henderson	Department of Medical Physics, TOHCC	Radiotherapy
10	Bog Jarosz	Department of Physics, Carleton University	Ultrasound thermal therapy
11	Paul Johns	Department of Physics, Carleton University	X-ray imaging
12	Iwan Kawrakow	Ionizing Radiation Standards Institute for National Measurement Standards, NRC	Radiotherapy & radiation dosimetry
13	Miller MacPherson	Department of Medical Physics, TOHCC	Radiotherapy
14	Malcolm McEwen	Ionizing Radiation Standards, INMS, NRC	Radiation dosimetry
15	Cheng Ng	Ottawa Hospital Research Institute	Radiobiology and hyperthermia
16	Balazs Nyiri	Department of Medical Physics, TOHCC	Radiotherapy
17	G. Peter Raaphorst	Retired from The Ottawa Hospital Cancer Centre; Consultant	Radiobiology and hyperthermia
18	Richard Richardson	Radiation Biology & Health Physics Chalk River Laboratories, AECL	Radiation physics and radiation protection
19	Dave Rogers	Department of Physics, Carleton University	Radiotherapy & radiation dosimetry
20	Carl Ross	Ionizing Radiation Standards, INMS, NRC	Radiation dosimetry
21	Ken Shortt	Ionizing Radiation Standards, INMS, NRC Currently on leave to IAEA, Vienna.	Radiation dosimetry
22	Trevor Stocki	Radiation Protection Bureau, Health Canada	Health Physics
23	Jason (Jiansheng) Sun	Therapy Systems, Nucletron Canada	Radiation treatment planning
24	Janos Szanto	Department of Medical Physics, TOHCC	Radiotherapy
25	Tony Waker	School of Energy Systems & Nuclear Science University of the Ontario Inst. of Technology	Radiation physics and radiation protection
26	Julia Wallace	Department of Physics, Carleton University	MRI
27	Richard Wassenaar	Division of Nuclear Medicine, The Ottawa Hospital	Nuclear medicine imaging
28	Glenn Wells	University of Ottawa Heart Institute	Nuclear cardiology
29	David Wilkins	Department of Medical Physics, TOHCC	Radiotherapy
30	Ruth Wilkins	Consumer and Clinical Radiation Protection Bureau, Health Canada	Radiobiology
31	Tong Xu	Department of Physics, Carleton University	Motion tracking using PET

[§]Associate Member

Table 2. OMPI Executive, 2007-2008.

Position	Member
Director [§]	Malcolm McEwen
Past-Director [§]	Rob deKemp
Academic Officer [§]	Dave Rogers
Secretary [§]	Ruth Wilkins
Student Representative [†]	Elsayed Ali
Seminar Organizer	Miller MacPherson, Tong Xu
Observer – TOHRCC	Brenda Clark
Observer – The Ottawa Hospital	Richard Wassenaar
Observer – Carleton Physics	Paul Johns

[§]position elected by the members

[†]position elected by the medical physics graduate students

Table 3. Graduate Students in Medical Physics, 2007-2008.

For details see www.physics.carleton.ca/ompi. A list of Past Graduates is also available.

	Student	Degree	Supervisor	Project Area
1	Elsayed Ali	Ph.D.	Dave Rogers	Linac spectral measurements
2	Patrick Assouad	M.Sc.	John Armitage	IR transmission in silver halide fibre
3	Lindsay Beaton	M.Sc.	Ruth Wilkins	Novel biological dosimeters
4	Jason Belec	Ph.D.	Brenda Clark	Elekta radiotherapy
5	Marc Chamberland	M.Sc.	Tong Xu	PeTrack
6	Amanda Cherpak	Ph.D.	Joanna Cygler	Radiation dosimetry applications of MOSFETs
7	Daljit Dhaliwal	M.Sc.	Cheng Ng	Biophysics
8	Tyler Dumouchel	Ph.D.	Rob deKemp	Small-animal PET
9	Claire Footitt	Ph.D.	Ian Cameron	Bolus-tracking MR perfusion imaging
10	Maria Lourdes Garcia-Fernández	Ph.D.	Peter Raaphorst & David Wilkins	Radiobiological model development and verification
11	Elena Gil	M.Sc.	Joanna Cygler	
12	Brian King	Ph.D.	Paul Johns	X-ray scatter imaging: measurement of cross sections
13	Michel Lalonde	M.Sc.	Richard Wassenaar	Nuclear medicine
14	Marc Lamoureux	M.Sc.	Rob deKemp	PET
15	Dan La Russa	Ph.D.	Dave Rogers	Accuracy of Spencer-Attix cavity theory
16	Ernesto Mainegra-Hing	Ph.D.	Iwan Kawrakow	MC corrections for x-ray standards
17	José Martínez-Ortega	Ph.D.	Bog Jarosz	Ultrasound interstitial thermal therapy for brain tumours
18	Andrew McDonald	M.Sc. [¶]	Carl Ross	Linac benchmarking of Monte Carlo simulation models
19	Tara Murphy	M.Sc.	Joanna Cygler	Experimental verification of radiotherapy

20	Kenji Myint	Ph.D. [†]	Lee Gerig	Therapy planning effect on TCP, NTCP for lung lesions
21	Elena Olariu	Ph.D.	Ian Cameron	MR tractography of white matter
22	Amir Pourmoghadas	M.Sc.	Glenn Wells	PET
23	Jennifer Renaud	M.Sc.	Rob deKemp	PET
24	Mojgan Soleimani	M.Sc.	Tong Xu	Motion tracking using PeTrack
25	Jared Strydhorst	M.Sc.	Brenda Clark	Tomotherapy
26	Sorina Truica	Ph.D.	Ian Cameron	Non-contrast methods in perfusion MRI
27	Lilie Wang	Ph.D.	Dave Rogers	Radiation dosimetry correction factors via Monte Carlo

[†] Final degree completed between 2007 July 1 and 2008 June 30; see Table 4

Table 4. Theses Completed, 2007-2008.

Student	Degree	Supervisor	Thesis Title and Date of Defence
Elsayed Ali	M.Sc.*	Rogers	Making the EGSnrc/BEAMnrc system more efficient, accurate and realistic in simulating kilovoltage x-ray systems, Sept 7, 2007
Amanda Cherpak	M.Sc.	Cygler	MOSFET Detectors in Quality Assurance of Tomotherapy Treatments, Sept 4, 2007
Tyler Dumouchel	M.Sc.	deKemp	Evaluation and Correction for Scatter and Attenuation on the LabPET4 Positron Emission Tomography System, Sept 11, 2007
Andrew McDonald	M.Sc.	Ross/McEwen	Experimental Investigation of Megavoltage Electron Beam Scattering, April 16, 2008
Kenji Myint	Ph.D.	Gerig	Dose Errors in the Treatment Planning Process of Cancer Radiotherapy, March 4, 2008

* with Distinction

Table 5. OMPI Seminars, 2007-2008.

For details see www.physics.carleton.ca/ompi and select Seminars.

Date/ Location	Speakers and Titles
Sept 20, 2007 Carleton	Tyler Dumouchel: Performance Evaluation and Correction for Scatter and Attenuation on the LabPET4 Positron Emission Tomography System Andrew McDonald: Electron Scattering in the Megavoltage Range
Oct 18, 2007 Health Canada	Marc Lamoureux: Quantitative PET perfusion imaging in rat myocardium Ian Cameron: Dealing with Rician bias in Quantitative MRI
Dec 13, 2007 Civic Hospital	Jared Strydhorst: Tomotherapy treatment of Breast Cancer: a 4DCT study of immobilization with thermoplastic shells Dave Wilkins : Ottawa's New Temporary Radiotherapy Bunker
Jan 17, 2008 NRC, INMS	Tara Murphy: CMS Xio - an improved algorithm for laryngeal dose calculations? Lesley Buckley: Evaluation of a commercial OSL system for radiation dosimetry
Feb 28, 2008 Carleton	Elsayed Ali: Quantifying the effect of off-focal (extra-focal) radiation on the output of x-ray systems Rob DeKemp: Quantitative Blood Flow Imaging in the Heart with Rb-82 PET

April 17, 2008 Heart Institute	Jennifer Renaud: Myocardial Blood Flow and Coronary Flow Reserve with Rb-82 PET Imaging Balazs Nyiri: Independent Monitor Unit Calculation for a Class of Helical Tomotherapy Treatment
May 22, 2008 NRC	Michel Lalonde: Phase Analysis of SPECT Imaging Daljit Dhalwal: A study on the effects of Tp53 status on the response of human colorectal xenografts to chronomodulated treatments Lilie Wang: The replacement correction factors for ion chamber radiation dosimetry in mega-voltage beams

Table 6. Carleton University Department of Physics Seminars in Medical Physics, 2007-2008.

Listed are departmental seminars on medical physics topics. See www.physics.carleton.ca/seminars for a complete list.

Date	Speaker, Institution, and Title
July 25, 2007	Paul M. Meaney, Thayer School of Engineering, Dartmouth College: Microwave Imaging: Breast Cancer Detection and Thermal Imaging in Conjunction with Focussed Ultrasound Therapy
Sept 28, 2007	M. K. Sundaresan, Carleton University: Generation of High Frequency Acoustic Waves by Magnetic Nanoparticles in an AC Magnetic Field -- Application to Hyperthermia
Oct 16, 2007	H.C. Lee, National Central University Chungli Taiwan ROC: Physics and Evolution of Genomic Sequences
Oct 23, 2007	Fabrice Retiere TRIUMF, UBC Liquid Xenon detector for medical and physics applications
Nov 29, 2007	George Ding, Vanderbilt University: Accurate patient dosimetry of kilovoltage cone-beam CT in radiation therapy
Dec 6, 2007 OCIP Fall Graduate Student Seminar	Lilie Wang, Carleton University: Monte Carlo Calculation of the Replacement Correction Factor in Ion Chamber Radiation Dosimetry Tara Murphy, Carleton University: Evaluation of Treatment Planning Systems with GAFCHROMIC Film for Head and Neck Carcinoma Jared Strydhorst, Carleton University: Treating Breast Cancer with TomoTherapy: Physics Considerations
Dec 12, 2007 OCIP Christmas Symposium	Glenn Wells, Ottawa Heart Institute: X-ray computed tomography (CT) in nuclear medicine: clarifying "uNclear" imaging Rejean Munger, Ottawa Eye Institute: Light: a practical tool for non-invasive health assessment
Feb 14, 2008 OCIP Spring Graduate Student Seminar (I)	Daljit Dhaliwal, Carleton University: A Study on the Effects of Tp53 Status on the Response of Human Colorectal Xenografts to Chronomodulated Treatments
Feb 29, 2008 CAP Lecture	Eldon Emberly, Simon Fraser University: How Cells Measure Space and Time
Mar 4, 2008	Frank Verhaegen, Medical Physics Unit, McGill University Monte Carlo modeling in image-guided radiotherapy
Mar 27, 2008 OCIP Spring Graduate Student Seminar (II)	Jennifer Renaud, Carleton University: Myocardial Blood Flow and Coronary Flow Reserve with Rb-82 PET Imaging Marc Lamoureux, Carleton University: Quantification of Myocardial Blood Flow in Rat Myocardium with N-13-ammonia and the Inveon microPET System
April 29, 2008 OCIP Spring Graduate Student Seminar (III)	Michel Lalonde, Carleton University: Can Phase Analysis of SPECT Blood Pool Imaging Diagnose Mechanical Dyssynchrony? Lindsay Beaton, Carleton University: Design of a Simple Alpha Radiation Exposure System for Irradiation of Adherent Cell Lines
Jun 6, 2008	Alan E Nahum, Physics Department, Clatterbridge Centre for Oncology, Liverpool Improving Radiotherapy Outcome through modelling Tumour (local) Control Probability (TCP)