

Ottawa Medical Physics Institute (OMPI)

*An Organized Research Unit of the Department of Physics,
Carleton University, Ottawa, Canada*

www.physics.carleton.ca/ompi

Annual Report # 17
1 July 2004 – 30 June 2005

Submitted by Robert deKemp, PhD, PEng, PPhys, OMPI Director.

Introduction

Medical physicists are applied scientists who use the tools of physics to improve health care - in cancer therapy, in the related area of medical biophysics, and in medical imaging. Medical physicists have developed revolutionary technologies such as photon and electron cancer treatment machines, and CT, PET, and MR imagers. It is difficult to imagine modern medicine without these technologies: medical physics has brought large improvements to patient care.

The Ottawa Medical Physics Institute (OMPI), founded in 1989, is an organized research unit of the Department of Physics of Carleton University in Canada's national capital, 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 Regional 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 2004-2005 academic year, and is also available on the OMPI website (www.physics.carleton.ca/ompi).

In 2004-2005 OMPI members had over \$2M in research funding as principal investigators from the Natural Sciences & Engineering Research Council (NSERC), the National Cancer Institute of

Canada (NCIC), the Canadian Institutes of Health Research (CIHR), the Heart & Stroke Foundation, the Canadian Breast Cancer Research Initiative, the Canada Foundation for Innovation (CFI), the federal Chemical, Biological, Radiological and Nuclear (CBRN) Research Technology Initiative (CRTI), and others. Furthermore, OMPI scientists participated in research consortia such as the Imaging Network Ontario (funded by the Ontario Research and Development Challenge Fund (ORDCF) and private industry partners). These research funds are administered through Carleton University, the University of Ottawa, and the individual institutions of our members.

Membership

Table 1 summarizes our membership, which currently numbers 27, and Table 2 lists the Executive. Details of the members and their research profiles are maintained on the website. The members are active in all disciplines of medical physics, including cancer therapy physics (13 members), imaging (7), and radiobiology and health physics (7).

Graduate Program

This academic year four graduate half-courses in medical physics were offered. In the fall, Medical Radiation Physics was taught by Paul Johns (10 students, including graduate and Special students including staff from the Regional Cancer Centre). In the winter term, Physics of Medical Imaging was given by Paul Johns, Ian Cameron, Barry McKee and Rob deKemp to 3 students. David Rogers taught Radiotherapy Physics to 6 students including 2 staff members from the Regional Cancer Centre. Peter Raaphorst taught Radiobiology to 10 students including 2 Cancer Centre staff. Our thanks especially to our off-campus members for making their time available to our students.

Table 3 lists the graduate students in the program, and Table 4 the graduate theses (three M.Sc. plus two Ph.D.) which were completed in 2004-2005. The academic year commenced with defenses by two students in the mri field. Juan Parra Robles defended his PhD at the start of September, and continued on to a postdoctoral position with Giles Santyr at the Robarts Institute in London Ontario. Blaine Chronik of the University of Western Ontario was the External Examiner for his thesis. Later that month Steven White defended his MSc, and continued to PhD studies (not in medical physics) at Queen's. At the start of 2005, Mohammad Nisar completed his M.Sc. He continued for some time working in Paul Johns' lab but has now left Ottawa in search of permanent employment. In June, Richard Wassenaar defended his PhD and later in the summer commenced as Nuclear Medicine Physicist at The Ottawa Hospital. Roger Lecomte (U. Sherbrooke) served as External Examiner. Finally, at the end of June, Nishard Abdeen completed his M.Sc. in the area of mri. Dr. Abdeen has given up his General Practice and is now a radiology resident at The Ottawa Hospital. We trust that his medical physics preparation will be put to good use in this program and that he will become a physics-savvy radiologist!

Seminars

The monthly OMPI seminars (Table 5) continue to be well attended. E-mail announcements (ascii text) are sent to all those on our seminar list. A formatted announcement with abstracts, suitable for printing, is available on the website (www.physics.carleton.ca/ompi). Thank you to all speakers and attendees. We followed the annual tradition of a fall soccer game and a winter broomball game after the seminar. Thank you to all event organizers - the events were a success and we intend to continue this tradition in future years.

Table 6 lists the 2004-2005 medical physics component of the regular weekly seminar series of the Carleton University Department of Physics. Several other Ottawa institutions also host invited speakers in medical physics such as the NRC Ionizing Radiation Standards group, The Ottawa

Hospital Oncology Grand Rounds and The Ottawa Hospital City-wide Nuclear Medicine Rounds.

OMPI Website (www.physics.carleton.ca/ompi)

The OMPI Secretary maintains a website with detailed information on the activities of our organization. The current information on this site has been used to produce this Annual Report.

- 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 – web links to host institutions and other relevant organizations
- Courses – graduate courses and requirements for students in medical physics
- Information – for prospective graduate students
- Contact Info – email addresses to contact OMPI

OMPI News and Events

The Ottawa Medical Physics Institute was launched in the fall of 1989 as the Medical Physics Organized Research Unit (MPORU). To mark OMPI's 15th anniversary and to honour its principal founder, Bob Clarke, a symposium was held 5 Nov 2004. The speakers included Peter Raaphorst, Dave Rogers, Bob Clarke, Ian Cameron, and Charlie Ma (Philadelphia). At the close of the symposium, Jean-Guy Godin (Dean of Science) launched the official fundraising campaign for the Robert L. Clarke Graduate Scholarship in Medical Physics. The goal is to build an endowment from which the annual proceeds will fund one promising M.Sc. or Ph.D. student in medical physics each year at Carleton Physics.

Following the OMPI seminars 26 May 2005, a plaque and gifts were presented to Peter Raaphorst on the occasion of his imminent retirement from the position of Head of Medical Physics at the Ottawa Regional Cancer Centre, a position he has held since 1985. Peter was fundamental in the birth of OMPI (MPORU), and served as the founding Director until the end of 1993.

OMPI Executive

I would like to thank the following for serving on the Executive in 2004-2005: Paul Johns (Academic Officer), Ian Cameron (Past-Director), and Ruth Wilkins (Secretary) for keeping excellent minutes and maintaining the OMPI website. Thanks to Esmael (Essi) Ghasroddashti for representing the students, and to David Wilkins and Dave Rogers for representing their groups by attending as Observers. A special thank you to Malcolm McEwen from the NRC who has done a splendid job organizing the monthly student and member seminars this year.

Conclusion

In closing, thank you to all OMPI members and graduate students for your support this past year. Our graduates are in high demand and that will continue in the future. We work in one of the most interesting and rewarding applications of science in our society. Keep up the great work!

Table 1. OMPI Members, 2004-2005.For details see www.physics.carleton.ca/ompi and select Membership Profile.

For a summary listing of contact information, select Directories.

	Member	Institution and Unit	Specialization within Medical Physics
1	Ian Cameron	Diagnostic Imaging The Ottawa Hospital	MRI
2	Robert Clarke	Department of Physics Carleton University (Professor Emeritus)	Ultrasound tissue ablation
3	Joanna Cygler	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy and radiobiology
4	Robert deKemp	Cardiac P.E.T. Centre University of Ottawa Heart Institute	PET
5	Madhu Dixit [§]	Department of Physics Carleton University	Detectors for ionizing radiation
6	Elagu Elaguppillai	Pharma Research Canada Inc.	Radiation protection
7	Lee Gerig	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
8	Clive Greenstock	Safety & Radiological Protection, Chalk River Laboratories, AECL	Radiation biophysics
9	Bog Jarosz	Department of Physics Carleton University	Ultrasound thermal therapy
10	Paul Johns	Department of Physics Carleton University	X-ray imaging
11	Iwan Kawrakow	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiotherapy and radiation dosimetry
12	Gabriel Lam	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
13	Miller MacPherson	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
14	Malcolm McEwen	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiation dosimetry
15	Barry McKee	Diagnostic Imaging The Ottawa Hospital	Nuclear medicine imaging
16	Cheng Ng	Department of Medical Physics Ottawa Hospital Research Institute	Radiobiology and hyperthermia
17	G. Peter Raaphorst	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	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 and radiation dosimetry

20	Giles Santyr	Department of Physics Carleton University Currently on leave to Robarts Institute.	MRI
21	Ken Shortt	Ionizing Radiation Standards Inst. National Measurement Standards, NRC Currently on leave to IAEA, Vienna.	Radiation dosimetry
22	Jason (Jiansheng) Sun	Therapy Systems, Nucletron Canada	Radiation treatment planning
23	Janos Szanto	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
24	Tony Waker	Radiation Biology & Health Physics Chalk River Laboratories, AECL	Radiation physics and radiation protection
25	Julia Wallace	Carleton Magnetic Resonance Facility Department of Physics, Carleton University	MRI
26	David Wilkins	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
27	Ruth Wilkins	Consumer and Clinical Radiation Protection Bureau, Health Canada	Radiobiology

[§]Associate Member

Table 2. OMPI Executive, 2004-2005.

Position	Member
Director [§]	Robert deKemp
Past-Director [§]	Ian Cameron
Academic Officer [§]	Paul Johns
Secretary [§]	Ruth Wilkins
Student Representative [†]	Esmaeel Ghasroddashti (to April 2005) Brian King (April 2005 onwards)
Seminar Organizer	Malcolm McEwen
Observer TOHRCC	David Wilkins

[§]position elected by the members

[†]position elected by the medical physics graduate students

Table 3. Graduate Students in Medical Physics, 2004-2005.For details see www.physics.carleton.ca/ompi and select Students. A list of Past Graduates is also available.

	Student	Degree	Supervisor	Project Area
1	Nishard Abdeen	M.Sc.* ✓	Giles Santyr	Lung gas exchange kinetics via hyperpolarized Xe MRI
2	Andrei Andrievski	M.Sc.	Ruth Wilkins	Novel biological dosimeters
3	Lesley Buckley	Ph.D.	Dave Rogers	Calculation of ion chamber correction factors
4	Cliff Dugal	M.Sc.	David Wilkins	Radiation protection and facility design
5	Claire Foottit	M.Sc.	Ian Cameron	Bolus-tracking MR perfusion imaging
6	Zhanrong (Jeff) Gao	Ph.D.	Lee Gerig	Geometric uncertainties in prostate radiotherapy
7	Lourdes Garcia-Fernández	M.Sc.	G. Peter Raaphorst & David Wilkins	Radiobiological model development and verification
8	Esmaeel Ghasroddashti	Ph.D.	Lee Gerig	Gated radiation therapy
9	Mihai Gherase	Ph.D.	Giles Santyr	Contrast agents for hyperpolarized Xe MRI
10	Brian King	Ph.D.	Paul Johns	X-ray scatter imaging: measurement of cross sections
11	Dan La Russa	M.Sc.	Dave Rogers	Accuracy of Spencer-Attix cavity theory
12	José Martínez-Ortega	Ph.D.	Bog Jarosz	Ultrasound interstitial thermal therapy for brain tumours
13	Kenji Myint	Ph.D.	Lee Gerig	Therapy planning effect on TCP, NTCP for lung lesions
14	Marzieh Nezamzadeh	Ph.D.	Ian Cameron	MR diffusion imaging
15	Mohammad Nisar	M.Sc. ✓	Paul Johns	Collimation for x-ray scatter imaging
16	Ken Nkongchu	Ph.D.	Giles Santyr	Gel radiation dosimetry with MRI
17	Elena Olariu	Ph.D.	Ian Cameron	MR tractography of white matter
18	Juan Parra-Robles	Ph.D. ✓	Giles Santyr	Low-field MRI system using hyperpolarized Xe
19	Zdenko Segó	M.Sc.	Dave Rogers	Models for characterization of radiotherapy beams
20	Randle Taylor	M.Sc.	Dave Rogers	Monte Carlo brachytherapy treatment planning
21	Elena Tonkopi	M.Sc.	Iwan Kawrakow	Computational study of beam quality effects on ion chamber response
22	Sorina Truica	Ph.D.	Ian Cameron	Non-contrast methods in perfusion MRI
23	Richard Wassenaar	Ph.D. ✓	Robert deKemp	Partial volume corrections in cardiac PET
24	Steven White	M.Sc. ✓	Giles Santyr	Absolute lung volume via hyperpolarized Xe MRI

* Part-time

✓ Degree completed between 1 July 2004 and 30 June 2005; see Table 4

Table 4. Theses Completed, 2004-2005.

Student	Degree	Supervisor	Thesis Title and Date of Defence
Juan Parra Robles	Ph.D.	Giles Santyr	<i>Magnetic Resonance Imaging of Lungs at Ultra-Low Magnetic Field Strength using Hyperpolarized ^{129}Xe Gas</i> 2 September 2004
Steven White	M.Sc.	Giles Santyr	<i>Volume Estimation from Three-Dimensional Hyperpolarized ^{129}Xe Magnetic Resonance Images</i> 20 September 2004 (passed with Distinction)
Mohammad Nisar	M.Sc.	Paul Johns	<i>Coherent Scatter X-Ray Imaging of Plastic and Water Phantoms</i> 4 January 2005
Richard Wassenaar	Ph.D.	Rob deKemp	<i>Extravascular Density Imaging for Regional Partial Volume Correction of ^{18}FFDG Cardiac PET Images</i> 3 June 2005
Nishard Abdeen	M.Sc.	Giles Santyr	<i>Measurement of Xenon Diffusing Capacity by Hyperpolarized ^{129}Xe MRI and Dynamic Spectroscopy in Rats with <i>Stachybotrys chartarum</i> Spore-Induced Pneumonitis</i> 30 June 2005

Table 5. OMPI Seminars, 2004-2005.

Seminars are held 3:30 - 5:00 p.m. on the second or third Thursday of the month. The first speaker is a graduate student, and the second speaker is an OMPI member. For details see www.physics.carleton.ca/ompi and select Seminars.

Date and Location	Speakers and Titles
30 September 2004 Carleton University	Richard Wassenaar, <i>Clinical Evaluation of CT versus ^{68}Ge Attenuation Correction in Cardiac PET Imaging</i> Clive Greenstock, <i>Fluorescence Lifetime Studies of DNA Damage in Human Lymphocytes</i>
21 October 2004 The Ottawa Hospital Regional Cancer Centre – General Campus	Kenji Myint, <i>Examining Dose Calculations in the Presence of Tissue Inhomogeneities in a Clinical Treatment Planning System</i> Rob deKemp, <i>Micro-PET Molecular Imaging for Cancer and Cardiovascular Research</i>
9 December 2004 The Ottawa Hospital – Civic Campus	Cliff Dugal, <i>Application of Monte Carlo to Linac Bunker Shielding</i> Richard B. Richardson, <i>The Influence of Age-Dependent Oxygen Levels in Coronary Arteries on Radon and Low-LET Radiation Dose and Induced Cardiovascular Disease</i>
27 January 2005 Health Canada, Radiation Protection Bureau	Elena Tonkopi, <i>Influence of Ion-Chamber Response on Dose/Kerma Measurements in Megavoltage Photon Beams</i> Dave Rogers, <i>Improving the Efficiency of EGSnrc Monte Carlo Calculations</i>
17 February 2005 Carleton University	Elena Olariu, <i>Magnetic Resonance Diffusion Tractography</i> Iwan Kawrakow, <i>How Accurately can we Measure/Calculate the Dose Deposited by External Photon Beams ?</i>
17 March 2005 The Ottawa Hospital – General Campus	Zhanrong Gao, <i>Decoupling the Geometric Uncertainties in Prostate Cancer Treatment with External Beam Radiotherapy (EBRT)</i> Gabriel Lam, <i>Introduction to the Wonderful World of Quantitative Radiobiology</i>

21 April 2005 Ottawa Heart Institute	Lourdes Garcia-Fernández, <i>Fitting the Linear-Quadratic Model to Detailed Data Set for Different Dose Ranges</i> Barry McKee, <i>PET/CT for Oncology at The Ottawa Hospital</i>
26 May 2005 National Research Council – INMS	Zdenko Segó, <i>Multiple-Source Models for the Beams from an Elekta SL25 Clinical Accelerator</i> T. Palani Selvam, <i>Monte Carlo Modelling of the Response of NRC's $^{90}\text{Sr}/^{90}\text{Y}$ Primary β Standard</i> Paul Johns, <i>Scattered Radiation as a Diagnostic X-Ray Technique</i>

Table 6. Department of Physics Seminars in Medical Physics, 2004-2005.

Seminars by invited speakers are usually held 3:30 - 5:00 p.m. on a Monday. Also shown here are the medical physics graduate student speakers in the Fall and Spring OCIP Student Seminars. For a complete list of current and past seminars, see www.physics.carleton.ca/seminars.

Date	Speaker, Institution, and Title
27 September 2004	Jan Seuntjens, Medical Physics Unit, McGill University <i>Advanced Clinical Dosimetry Techniques in Radiation Therapy</i>
15 November 2004	Marco Carlone, The Ottawa Hospital Regional Cancer Centre <i>Challenges for Biologically Based Treatment Planning</i>
3 December 2004	Paul J. Reckwerdt, Tomotherapy Incorporated, Madison, Wisconsin <i>Image Guided Intensity Modulated Radiotherapy: Painting with Photons</i>
6 December 2004	Ervin Podgorsak, Medical Physics Unit, McGill University <i>Crisis in Health Care Financing in North America: A Medical Physicist's Perspective</i>
7 December 2004 OCIP Fall Graduate Student Seminars	Lesley Buckley, Carleton University <i>EGSnrc Investigation of Correction Factors for Radiation Dosimetry</i> Nishard Abdeen, Carleton University <i>Demonstration of Prolongation of Alveolar Gas Transfer Times by Hyperpolarized ^{129}Xe Spectroscopy in Rats with <i>stachybotrys chartarum</i> Spore Induced Pneumonitis</i>
15 December 2004 OCIP Christmas Symp.	Ruth Wilkins, Consumer & Clinical Radiation Protection Bureau, Health Canada <i>Biological Dosimetry for Radiological Emergency Response</i>
1 April 2005	Jerry J. Battista, London Regional Cancer Centre and Dept. of Medical Biophysics, University of Western Ontario, London, Ontario <i>Introductory Medical Physics: What's a Nice Physicist like You Doing in a Hospital ?</i>
18 and 24 May 2005 OCIP Spring Graduate Student Seminars	Cliff Dugal, Carleton University <i>Application of Monte Carlo to Linac Bunker Shielding</i> Elena Tonkopi, Carleton University <i>Influence of Ion Chamber Response on In-Air Profile and Scatter Factor Measurements in Megavoltage Photon Beams</i> Lourdes Garcia-Fernández, Carleton University <i>Fitting the Linear Quadratic Model to Detail Data Set for Different Dose Ranges</i> Zdenko Segó, Carleton University <i>Multiple-Source Models for the Beams from an Elekta SL25 Clinical Accelerator</i> Zhanrong Gao, Carleton University <i>A Study of Prostate Delineation by Using a Gold Standard from the Visible Human Project</i> Marzieh Nezamzadeh, Carleton University <i>MR Diffusion Study in Human Brain Tissue in vivo</i>