

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 # 16
1 July 2003 – 30 June 2004

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 Atomic Energy of Canada Limited (AECL) Chalk River Laboratories, Health Canada, the National Research Council of Canada (NRC), the University of Ottawa Heart Institute, the Ottawa Hospital and Regional Cancer Centre, 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 2003-2004 academic year, and is also available on the OMPI web site (www.physics.carleton.ca/ompi).

Funding and Publications

In 2003-2004 OMPI members had over \$2.1 M in research funding as principal investigators from the Natural Sciences and 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 U.S. National Institutes of Health (NIH), 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), with total budgets of approximately \$60M. These research funds are administered through Carleton University, the University of Ottawa, and the individual institutions of our members.

In the calendar year 2003, OMPI members published over 40 peer-reviewed scientific papers, proceedings, and technical reports on their research here in the national capital region.

Membership

Table 1 summarizes our membership, which currently numbers 28. George Daskalov has left the ORCC to work in the U.S., and Pavel Dvorak will retire from Health Canada in July 2004. Table 2 lists the current OMPI Executive. A list of members and their research profiles is maintained on the web site. The members are active in all disciplines of medical physics, including cancer therapy physics (13), imaging (7), and radiobiology and health physics (9).

Graduate Program

This academic year three 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), and also a special directed studies in medical radiation physics was given to a student as required by that student's comprehensive exam committee. In the winter term, the newest on-campus faculty member, Dave Rogers, taught Medical Radiotherapy Physics (13 students). Demand for this course had been building since its last offering in the winter of 2000. With Dave now establishing his research group in radiotherapy physics on the Carleton campus, the student demand for radiotherapy physics teaching should be met. Also in the winter term, the Medical Physics Practicum was coordinated by Giles Santyr (3 students). In this project-based course, modules are currently offered to the students by Peter Raaphorst, Cheng Ng, Barry McKee, Rob deKemp, Ian Cameron, Lee Gerig, Gabriel Lam, and Joanna Cygler. We thank all our instructors, but especially those from other institutions, who made their time available.

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 2003-2004. First, two M.Sc. defenses were held at the end of the fall term: Dana Mullins defended her M.Sc. in December 2003 and Ziaul Hasan very early in January 2004. Dana is now on contract to Defence Research & Development Canada (DRDC) in Ottawa. Marco Carlone defended his Ph.D. near the end of February; Doug Boreham (McMaster) was the external examiner for the thesis. Marco proceeded to a Physics Resident position at the cancer clinic. At 3.5 years, Marco's time to for a PhD (starting from an M.Sc. from another university) is one of the quickest that we have seen. Gosia Niedbala defended her Ph.D. at the end of April; L. John Schreiner (Kingston Regional Cancer Centre/Queen's) was the external examiner. Gosia has also moved into a Physics Resident position. Gosia had been with us for Q-Year, MSc, and PhD; in that period in addition to her research projects she took all our courses plus others, served as the student rep to OMPI Exec, and furthermore her time with us included birth of their first child (congratulations!). The final defence of the year was the M.Sc. of Andrew Wind in June. Congratulations on the awarding of distinction on his defence - and also on the birth of their

son. Seems to be a trend! Andrew is now at Defence Headquarters in downtown Ottawa.

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 web site (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 2003-2004 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 Web Site (www.physics.carleton.ca/ompi)

Since its inception in 1989 through to 2000, the OMPI produced an annual Newsletter, in part to serve as an annual report to the Dean of Graduate Studies on our activities. The information in these newsletters contained OMPI member profiles, research interests, and publications, as well as current graduate student projects, OMPI seminars, and general information about the graduate program in Medical Physics. Commencing in 2001, this detailed information has been maintained on the web site, and is summarized in the Annual Report each academic year.

The web site is maintained by the OMPI Secretary. 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 Awards

In 2003-2004 OMPI saw one of its founding members, Dave Rogers, move from the Head of the Ionizing Radiation Standards Group at the NRC to accept a Canada Research Chair (Tier 1) position in Therapy Physics at the Physics Department of Carleton University.

OMPI Executive

I would like to thank the following for serving on the Executive in 2003-2004: Paul Johns (Academic Officer), Ian Cameron (Past-Director), and Ruth Wilkins (Secretary) for keeping excellent minutes and maintaining the OMPI web site. Thanks to Esmaeel (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, 2003-2004.

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 Ottawa Regional Cancer Centre	Radiotherapy and radiobiology
4	George Daskalov	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
5	Robert 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	Pavel Dvorak	Consumer and Clinical Radiation Protection Bureau, Health Canada	Radiation protection
8	Elagu Elagupillai	Pharma Research Canada Inc.	Radiation protection
9	Lee Gerig	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
10	Clive Greenstock	Safety & Radiological Protection, Chalk River Laboratories, AECL	Radiation biophysics
11	Bog Jarosz	Department of Physics Carleton University	Ultrasound thermal therapy
12	Paul Johns	Department of Physics Carleton University	X-ray imaging
13	Iwan Kawrakow	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiotherapy and radiation dosimetry
14	Gabriel Lam	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
15	Miller MacPherson	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
16	Malcolm McEwen	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiation dosimetry

17	Barry McKee	Diagnostic Imaging The Ottawa Hospital	Nuclear medicine imaging
18	Cheng Ng	Department of Medical Physics Ottawa Regional Cancer Centre	Radiobiology and hyperthermia
19	Peter Raaphorst	Department of Medical Physics Ottawa Regional Cancer Centre	Radiobiology and hyperthermia
20	Richard Richardson	Radiation Biology & Health Physics Chalk River Laboratories, AECL	Radiation physics and radiation protection
21	Dave Rogers	Ionizing Radiation Standards Inst. National Measurement Standards, NRC & Department of Physics, Carleton University	Radiotherapy and radiation dosimetry
22	Giles Santyr	Department of Physics Carleton University	MRI
23	Ken Shortt	Ionizing Radiation Standards Inst. National Measurement Standards, NRC Currently on leave to IAEA, Vienna.	Radiation dosimetry
24	Jason (Jiansheng) Sun	Therapy Systems, Nucletron Canada	Radiation treatment planning
25	Janos Szanto	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
26	Tony Waker	Radiation Biology & Health Physics Chalk River Laboratories, AECL	Radiation physics and radiation protection
27	Julia Wallace	Carleton Magnetic Resonance Facility Department of Physics, Carleton University	MRI
28	David Wilkins	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
29	Ruth Wilkins	Consumer and Clinical Radiation Protection Bureau, Health Canada	Radiobiology

[§]Associate Member

Table 2. OMPI Executive, 2003-2004.

Position	Member
Director [§]	Robert deKemp
Past-Director [§]	Ian Cameron
Academic Officer [§]	Paul Johns
Secretary [§]	Ruth Wilkins
Student Representative [†]	Esmaeel Ghasroddashti
Seminar Organizer	Malcolm McEwen
Observer ORCC	David Wilkins

[§]position elected by the members

[†]position elected by the medical physics graduate students

Table 3. Graduate Students in Medical Physics, 2003-2004.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	Lesley Buckley	Ph.D.	Dave Rogers	Calculation of ion chamber correction factors
3	Marco Carlone	Ph.D. ✓	Peter Raaphorst	Theoretical basis of survival curves, α/β ratio
4	Cliff Dugal	M.Sc.	David Wilkins	Radiation protection and facility design
5	Zhanrong (Jeff) Gao	Ph.D.	Lee Gerig	Geometric uncertainties in prostate radiotherapy
6	Lourdes Garcia-Fernández	M.Sc.	Peter Raaphorst & David Wilkins	Radiobiological model development and verification
7	Esmael Ghasroddashti	Ph.D.	Lee Gerig	Gated radiation therapy
8	Mihai Gherase	Ph.D.	Giles Santyr	Contrast agents for hyperpolarized Xe MRI
9	Ziaul Hasan	M.Sc. ✓	Paul Johns	Diffraction data for x-ray scatter imaging
10	Carey Larsson	Ph.D.	Robert deKemp	Rubidium-82 perfusion with 3-dimensional PET
11	José Martínez-Ortega	Ph.D.	Bog Jarosz	Ultrasound interstitial thermal therapy for brain tumours
12	Dana Mullins	M.Sc. ✓	Cheng Ng	Effect of circadian rhythm on radiation therapy
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	Gosia Niedbala	Ph.D. ✓	Peter Raaphorst	Biophysics of radiation damage and repair
16	Mohammad Nisar	M.Sc.	Paul Johns	Collimation for x-ray scatter imaging
17	Ken Nkongchu	Ph.D.	Giles Santyr	Gel radiation dosimetry with MRI
18	Elena Olariu	Ph.D.	Ian Cameron	MR tractography of white matter
19	Juan Parra-Robles	Ph.D.	Giles Santyr	Low-field MRI system using hyperpolarized Xe
20	Zdenko Segó	M.Sc.	Dave Rogers	Models for characterization of radiotherapy beams
21	Elena Tonkopi	M.Sc.	Dave Rogers	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
25	Andrew Wind	M.Sc. ✓	Barry McKee	Pinhole SPECT imaging

* Part-time

✓ Degree completed between 1 July 2003 and 30 June 2004; see Table 4

Table 4. Theses Completed, 2003-2004.

Student	Degree	Supervisor	Thesis Title and Date of Defence
Dana Mullins	M.Sc.	Cheng Ng	<i>Chronomodulation of Topotecan and X-Radiation Therapy</i> 12 December 2003
M. Ziaul Hasan	M.Sc.	Paul Johns	<i>Measurement of X-Ray Scattering Form Factors over a Wide Momentum Transfer Range</i> 8 January 2004
Marco Carlone	Ph.D.	Peter Raaphorst & David Wilkins	<i>Determining the α/β Ratio for Prostate Cancer using Clinically Measured Dose Response Data</i> 27 February 2004
Malgorzata (Gosia) Niedbala	Ph.D.	Peter Raaphorst	<i>Evaluation of Radiation Response to Different Dose Rates, with/without Mild Hyperthermia, in Human Breast Carcinoma Cell Lines of Different Radiosensitivities</i> 29 April 2004
Andrew Wind	M.Sc.	Barry McKee	<i>Pinhole SPECT with Iterative Reconstruction and the Median Root Prior</i> 7 June 2004 (passed with Distinction)

Table 5. OMPI Seminars, 2003-2004.

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
18 September 2003 Carleton University	Zhanrong Gao, <i>Investigating the Uncertainty in Prostate Delineation using Data from the Visible Human Project (VHP)</i> Tony Waker, <i>Applied Microdosimetry</i>
23 October 2003 The Ottawa Hospital – Civic Campus	Ken Nkongchu, <i>Fast 3D Imaging for the Purpose of T1 Parameter Estimation</i> Boguslaw Jarosz, <i>Interstitial Thermal Therapy: Hopes, Issues, Concerns</i>
20 November 2003 Ottawa Regional Cancer Centre, General Campus	Mohammad Nisar, <i>Imaging with Coherent X-Ray Scatter Radiation</i> Jiansheng Sun, <i>Accurately Determining Equivalent Square for an Irregular Photon Beam – a New Approach to Solve a Classical Problem</i>
11 December 2003 National Research Council – INMS	Lesley Buckley, <i>Correlated Sampling Monte Carlo Calculations using EGSnrc</i> Peter Raaphorst, <i>Radiobiology in Radiation Therapy Planning and Treatment</i>
22 January 2004 Health Canada, Radiation Protection Bureau	Gosia Niedbala, <i>Evaluation of Radiation Response to Different Dose Rates in Human Cancer Cell Lines Relevant to Cancer Therapy</i> Giles Santyr, <i>Development of H-Xe Contrast Agents for Magnetic Resonance Imaging</i>
12 February 2004 Carleton University	Steven White, <i>Monte Carlo and Phantom Studies to Ascertain the Feasibility of Measuring Absolute Ventilated Gas Space Volumes using Hyperpolarized Xenon MRI</i> Ruth Wilkins, <i>Biological Dosimetry and Markers of Exposure</i>
18 March 2004 Ottawa Heart Institute	Marco Carlone, <i>Parameter Correlation for a Heterogeneous Tumour Control Model</i> Ian Cameron, <i>The Brain and How it “Works”</i>

22 April 2004 The Ottawa Hospital – Riverside Campus	Nishard Abdeen, <i>Dynamic ^{129}Xe NMR Spectroscopy of Rat Lungs in Stachybotrys Chartarum Induced Pneumonitis</i> Paul Johns, <i>Dual-Energy X-Ray Imaging</i>
6 May 2004 National Research Council – INMS	Andrew Wind, <i>The Clinical Potential of Pinhole SPECT with the Median Root Prior Filter</i> Matthias Fippel, Universität Tübingen, <i>Monte Carlo Treatment Planning for IMRT and Proton Therapy</i>

Table 6. Department of Physics Seminars in Medical Physics, 2003-2004.

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
29 September 2003	Paul Johns, Carleton University, Department of Physics <i>Scattered X Rays as a Diagnostic Tool</i>
3 November 2003	John Schreiner, Kingston Regional Cancer Centre and Queen's University <i>Gel Dosimetry – Historical Perspectives and Current State</i>
3 December 2003 OCIP Fall Graduate Student Seminars	Richard Wassenaar, Carleton University <i>Extravascular Density Imaging for Partial Volume Correction of PET Images</i> Juan Parra-Robles, Carleton University <i>Low-Field Magnetic Resonance Imaging using Hyperpolarized Xenon</i> Andrew Wind, Carleton University <i>Pinhole SPECT with OSEM-MRP</i>
19 December 2003 OCIP Christmas Symp.	Julia Wallace, Carleton University <i>Magnetic Resonance Imaging of Hyperpolarized Xenon</i>
5 January 2004	David Jaffray, Princess Margaret Hospital, Toronto <i>Development of an On-line Imaging and Planning System for Image-Guided Radiation Therapy</i>
19 January 2004	Louis-André Hamel, Université de Montréal <i>CZT Detector Development for Gamma-Ray Spectroscopy and Imaging</i>
3 May 2004 OCIP Spring Graduate Student Seminars	Steven White, Carleton University <i>Absolute Gas Space Volumetry using Hyperpolarized Xenon MRI</i> Mohammad Nisar, Carleton University <i>Coherent Scatter X-Ray Imaging of Plastic/Water Phantoms</i>
10 May 2004	Iwan Kawrakow, Ionizing Radiation Standards, Inst. National Measurement Stds., NRC <i>Monte Carlo (MC) Techniques for Radiation Treatment Planning</i>