

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 # 18
1 July 2005 – 30 June 2006

Submitted by Malcolm McEwen, PhD, 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 2005-2006 academic year, and is also available on the OMPI website (www.physics.carleton.ca/ompi).

Members of OMPI have been awarded research funding by 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. OMPI scientists also participate in research consortia such as Imaging Network Ontario.

Membership

Table 1 summarizes our membership, which at year's end numbers 28, and Table 2 lists the Executive. In the fall we said goodbye to Barry McKee (OMPI Secretary, 1996-1998) and to Gabe Lam. Both have retired to Vancouver. And sadly, Robert L. ("Bob") Clarke passed away in December. But three new members were welcomed into OMPI this year:

Brenda Clark – is the new Head of Medical Physics at The Ottawa Hospital Regional Cancer Centre. Brenda moved from Vancouver to Ottawa in the fall of 2005 to take up this position. Brenda is well-known in medical physics circles as the former President of CCPM and the current President of CAMPEP.

Elizabeth Henderson – is a TOHRCC clinical physicist who completed the residency program here in Ottawa. Her research interests are in functional CT cancer imaging.

Richard Wassenaar – is a recent graduate of our program (June 2005) who is now a clinical nuclear medicine physicist at The Ottawa Hospital.

Furthermore, we welcomed Carl Ross of the NRC back to OMPI, after a few years' absence. Many of us remember Carl as a very active Secretary of OMPI in the early 1990's.

Our members' activities span medical physics, including cancer therapy physics (14 members), imaging (6), and radiobiology and health physics (7). Complete profiles are given on the website.

Graduate Program

This academic year our foundation graduate half-course, Medical Radiation Physics, was given in the fall term by Paul Johns to an enrollment of 5 graduate students. In both the preceding and the following year several additional courses were given. Generally, the foundation course, Medical Radiation Physics, is given each year while the more specialized courses in imaging, cancer therapy, and radiobiology are given as demand warrants, usually every two to three years.

Table 3 lists the graduate students in the program, and Table 4 the graduate theses (three M.Sc. plus three Ph.D.) completed in 2005-2006. In August, Elena Tonkopi completed her M.Sc. and is now a physics resident at MD Anderson Hospital in Houston. Lesley Buckley completed her PhD and is now a therapy physics resident at TOHRCC. Charlie Ma (Fox Chase Cancer Center, Philadelphia) was the External Examiner for her thesis. Lourdes Garcia-Fernández completed her M.Sc. and has proceeded to a PhD in a similar area, with supervision continuing to be jointly provided by Peter Raaphorst and David Wilkins. Then in April, Zdenko Sego completed his M.Sc. He is now a computer systems analyst in Detroit. After completing his Ph.D., Mihai Gherase has moved to Mt. Allison University in New Brunswick for a postdoc with David Fleming in trace metal assessment using x-ray fluorescence. Thomas Eykyn of the Royal Marsden was External Examiner. Zhanrong Gao completed his Ph.D. in June (External Examiner: Andrew Kerr, Kingston Regional Cancer Centre / Queen's University) and has commenced a residency in New Jersey where his wife Mei Li and their two children are. 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 have begun a new tradition of a BBQ after the final seminar. Thank you to all event organizers: the events were a great success and we will continue with them in future years.

Table 6 lists the 2005-2006 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 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 – 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

Congratulations to Peter Raaphorst for receiving the Lifetime Achievement Award of the Ottawa Life Sciences Council at its annual Awards Dinner on 26 Sept 2005. In part, the award recognized his pivotal role in networking medical physics across the region including a major part in the founding of OMPI and serving as its Director for the first 5 years.

The death of R L Clarke on 22 Dec 2005 was a great shock to many of us in OMPI who had known him over the years. He was Distinguished Research Professor at Carleton, the principal architect of OMPI and an enthusiastic regular at seminars. He will be sorely missed. A memorial event to celebrate the life of Dr Clarke was held at the University on 14 January 2006. The fundraising campaign for the Robert L. Clarke Graduate Scholarship in Medical Physics continues.

OMPI Executive

I would like to thank the following for serving on the Executive in 2005-2006: Paul Johns and David Rogers (Academic Officers), Ian Cameron (Past-Director), and Ruth Wilkins (Secretary) for keeping excellent minutes and maintaining the OMPI website. Thanks to Brian King for representing the students, and to David Wilkins for representing TOHRCC as an Observer. A special thank you to Rob deKemp from the Ottawa Heart Institute, who stepped down this year from the position of Director after several years of excellent service.

Conclusion

In closing, thank you to all OMPI members and graduate students for your support this past year. OMPI continues to be the premiere forum for medical physicists in Ottawa and the growing membership bodes well for the future. Our graduates continue to be in high demand and the OMPI Executive is working to further enhance both the quality and reputation of the Carleton medical physics graduate program. We work in a fascinating area of science where the impact of our research is felt throughout the whole of society. Keep up the great work!

Table 1. OMPI Members, 2005-2006.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	Brenda Clark	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
3	Robert Clarke	Department of Physics Carleton University (Professor Emeritus)	Ultrasound tissue ablation
4	Joanna Cygler	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy and radiobiology
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	Elagu Elaguppillai	Pharma Research Canada Inc.	Radiation protection
8	Lee Gerig	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
9	Clive Greenstock	Safety & Radiological Protection, Chalk River Laboratories, AECL	Radiation biophysics
10	Elizabeth Henderson	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
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 The Ottawa Hospital Regional Cancer Centre	Radiotherapy
15	Miller MacPherson	Department of Medical Physics The Ottawa Hospital 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 Hospital Research Institute	Radiobiology and hyperthermia
19	G. Peter Raaphorst	Department of Medical Physics The Ottawa Hospital 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	Department of Physics, Carleton University	Radiotherapy and radiation dosimetry
22	Carl Ross	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiation dosimetry
23	Giles Santyr	Department of Physics Carleton University Currently on leave to Robarts Institute.	MRI
24	Ken Shortt	Ionizing Radiation Standards Inst. National Measurement Standards, NRC Currently on leave to IAEA, Vienna.	Radiation dosimetry
25	Jason (Jiansheng) Sun	Therapy Systems, Nucletron Canada	Radiation treatment planning
26	Janos Szanto	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
27	Tony Waker	Radiation Biology & Health Physics Chalk River Laboratories, AECL	Radiation physics and radiation protection
28	Julia Wallace	Carleton Magnetic Resonance Facility Department of Physics, Carleton University	MRI
29	Richard Wassenaar	Division of Nuclear Medicine The Ottawa Hospital	Nuclear medicine imaging
30	David Wilkins	Department of Medical Physics The Ottawa Hospital Regional Cancer Centre	Radiotherapy
31	Ruth Wilkins	Consumer and Clinical Radiation Protection Bureau, Health Canada	Radiobiology

[§]Associate Member

Table 2. OMPI Executive, 2005-2006.

Position	Member
Director [§]	Malcolm McEwen (January 1, 2006 onwards)
Past-Director [§]	Rob deKemp
Academic Officer [§]	Paul Johns (to December 31, 2005) Dave Rogers (January 1, 2006 onwards)
Secretary [§]	Ruth Wilkins
Student Representative [†]	Brian King
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, 2005-2006.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	Elsayed Ali	M.Sc.	Dave Rogers	Monte Carlo modelling of x-ray tubes
2	Andrei Andrievski	M.Sc.	Ruth Wilkins	Novel biological dosimeters
3	Lesley Buckley	Ph.D. ✓	Dave Rogers	Calculation of ion chamber correction factors
4	Amanda Cherpak	M.Sc.	Joanna Cygler	radiation dosimetry applications of MOSFETs
5	Cliff Dugal	M.Sc.	David Wilkins	Radiation protection and facility design
6	Tyler Dumouchel	M.Sc.	Rob deKemp	Small-animal PET
7	Claire Foottit	Ph.D. §	Ian Cameron	Bolus-tracking MR perfusion imaging
8	Zhanrong (Jeff) Gao	Ph.D. ✓	Lee Gerig	Geometric uncertainties in prostate radiotherapy
9	Lourdes Garcia-Fernández	M.Sc. ✓ Ph.D.	G. Peter Raaphorst & David Wilkins	Survival curve modelling versus experiment Radiobiological model development and verification
10	Esmaeel Ghasroddashti	Ph.D.	Lee Gerig	Gated radiation therapy
11	Mihai Gherase	Ph.D. ✓	Giles Santyr	Contrast agents for hyperpolarized Xe MRI
12	Brian King	Ph.D.	Paul Johns	X-ray scatter imaging: measurement of cross sections
13	Dan La Russa	Ph.D. §	Dave Rogers	Fundamentals of ion chamber dosimetry
14	José Martinez-Ortega	Ph.D.	Bog Jarosz	Ultrasound interstitial thermal therapy for brain tumours
15	Andrew McDonald	M.Sc.	Carl Ross	Linac benchmarking of Monte Carlo simulation models
16	Kenji Myint	Ph.D.	Lee Gerig	Therapy planning effect on TCP, NTCP for lung lesions
17	Marzieh Nezamzadeh	Ph.D.	Ian Cameron	MR diffusion imaging
18	Ken Nkongchu	Ph.D.	Giles Santyr	Gel radiation dosimetry with MRI
19	Elena Olariu	Ph.D.	Ian Cameron	MR tractography of white matter
20	Zdenko Segó	M.Sc. ✓	Dave Rogers	Models for characterization of radiotherapy beams
21	Randle Taylor	M.Sc.	Dave Rogers	Monte Carlo brachytherapy treatment planning
22	Elena Tonkopi	M.Sc. ✓	Iwan Kawrakow	Computational study of beam quality effects on ion chamber response
23	Sorina Truica	Ph.D.	Ian Cameron	Non-contrast methods in perfusion MRI
24	Lilie Wang	Ph.D.	Dave Rogers	Radiation dosimetry correction factors via Monte Carlo

§ Fast-tracked from M.Sc. program, Sept 2005.

✓ Degree completed between 1 July 2005 and 30 June 2006; see Table 4

Table 4. Theses Completed, 2005-2006.

Student	Degree	Supervisor	Thesis Title and Date of Defence
Elena Tonkopi	M.Sc.	Iwan Kawrakow	<i>Monte Carlo Investigation of the Influence of Ion Chamber Response on In-Air Measurements in Megavoltage Photon Beams</i> 19 August 2005

Lesley Buckley	Ph.D.	David Rogers	<i>An EGSnrc Investigation of Correction Factors for Ion Chamber Dosimetry</i> 31 August 2005
Lourdes Maria Garcia-Fernández	M.Sc.	G. Peter Raaphorst & David Wilkins	<i>Fitting the Linear-Quadratic Model to Detailed Data Sets for Different Dose Ranges</i> 9 September 2005
Zdenko Sego	M.Sc.	David Rogers	<i>Multiple Source Models for the Beams from an Elekta SL25 Clinical Accelerator</i> 24 April 2006
Mihai Gherase	Ph.D.	Giles Santyr	<i>Characterization of Hyperpolarized ^{129}Xe Dissolved in Perfluorooctyl Bromide Emulsions as a Novel Magnetic Resonance Contrast Agent</i> 31 May 2006
Zhanrong Gao	Ph.D.	Lee Gerig	<i>Investigating Geometric Uncertainties in Prostate Cancer Radiotherapy</i> 19 June 2006

Table 5. OMPI Seminars, 2005-2006.

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
22 September 2005 Carleton University	José Martinez, <i>BUT – Brain Ultrasound Thermotherapy: A Progress Report</i> Malcolm McEwen, <i>Water Equivalent Materials for Reference Dosimetry</i>
20 October 2005 Ottawa Heart Institute	Esmaeel Ghasroddashti, <i>Skin Markers as Surrogates for Tumour Motion in Gated Radiation Therapy</i> Elizabeth Henderson, <i>Functional CT of Cancer</i>
1 December 2005 National Research Council – INMS	Marzieh Nezamzadeh, <i>MR Diffusion Study of Human Brain Tissue in vivo</i> Brenda Clark, <i>Focal Irradiation of Small Brain Tumours – One Physicist's Perspective</i>
8 December 2005 The Ottawa Hospital Regional Cancer Centre – General Campus	Dan LaRussa, <i>An EGSnrc Investigation of the Temperature-Pressure Correction Factor for Kilovoltage X Ray</i> Carl Ross, <i>Absorbed Dose Calorimetry: Techniques and Applications</i>
19 January 2006 The Ottawa Hospital – Civic Campus	Claire Foottit, <i>Dynamic Contrast Enhanced MRI</i> Cheng Ng, <i>Role of a Novel Gene, APM2, in Tumour Cellular Resistance to Cisplatin</i>
16 February 2006 Carleton University	Randle Taylor, <i>Modelling the Xoft AXXENT X-Ray Source: An Electronic Source for Brachytherapy</i> David Wilkins, <i>The Challenge of Defining the Target for Radiation Therapy</i>
23 March 2006 Health Canada, Radiation Protection Bureau	Sorina Truica, <i>In-Vivo Perfusion Fraction Measurements in Human Placenta using IVIM Echo Planar MRI</i> Miller MacPherson, <i>Implementation of Image-Guided Intensity Modulated Radiation Therapy</i>
27 April 2006 The Ottawa Hospital – General Campus	Brian King, <i>Measuring Coherent Scattering Form Factors using Polychromatic X-Ray Sources and Imaging Detectors</i> Richard Wassenaar, <i>Phase Analysis of Radionuclide Cardiac Imaging</i>

25 May 2006 National Research Council – INMS	Andrei Andrievski, <i>Characterizing the H2AX Response of Human Lymphocytes to Ionizing Radiation</i> Lee Gerig, <i>Systematic and Random Errors in TOHRCC Prostate EBRT Process</i>
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Table 6. Department of Physics Seminars in Medical Physics, 2005-2006.

Seminars by invited speakers are usually held 3:30 - 5:00 p.m. on a Tuesday. 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
20 September 2005	Rob deKemp, University of Ottawa Heart Institute <i>Small Animal Positron Emission Tomography for Research in Heart Disease</i>
24 October 2005	Greg Cron, Lab. of Biomedical Magnetic Resonance, Catholic Univ. of Louvain, Brussels <i>Measuring Changes in the Tumour Micro-environment in-vivo In Order to Improve Cancer Treatment Strategies</i>
1 November 2005	Malcolm McEwen, Ionizing Radiation Standards, Inst. National Measurement Stds., NRC <i>The Challenge of Electron Dosimetry in the 80-130 keV Energy Range</i>
23 November 2005	Tong Xu, Dept. Radiological Sciences, U. California at Irvine <i>Real-time Tumour Tracking using Implanted Positron Emission Markers: Concept and Simulation Study</i>
7 December 2005 OCIP Fall Graduate Student Seminars	Ken Nkongchu, Carleton University <i>Gel Dosimetry by 3D Magnetic Resonance Imaging</i> José Martinez-Ortega, Carleton University <i>Brain Ultrasound Thermotherapy: Biophysics, Technology, and Instrumentation</i>
9 December 2005	Juan Parra-Robles, Imaging Research Laboratories, Robarts Research Inst., London Ont. <i>Magnetic Resonance Imaging of the Lungs using Hyperpolarized Noble Gases</i>
10 January 2006	Brenda Clark, The Ottawa Hospital Regional Cancer Centre <i>The Impact on the Physicist's Workload of Increased Resolution in External Beam Radiation Therapy</i>
1 February 2006	Roger Zemp, Optical Imaging Laboratory, Dept. Biomedical Eng., Texas A & M Univ. <i>Biomedical Imaging with Light and Ultrasound: Imaging of Gene Expression, Blood Oxygenation, and Beyond</i>
7 March 2006	Walter Huda, Dept. Radiology, SUNY Upstate Medical University, Syracuse NY <i>Proposal for a Paradigm Shift in CT Dosimetry</i>
22 March 2006	Bruce Faddegon, Dept. Radiation Oncology, U. California at San Francisco <i>The A-B-C's of Monte Carlo in Radiotherapy: Applications and Benchmarks</i>
10 and 17 May 2006 OCIP Spring Graduate Student Seminars	Esmaeel Ghasroddashti, Carleton University <i>The Challenge Presented by Tumour Motion during External Beam Radiation Therapy</i> Mihai Gherase, Carleton University <i>Characterization of Hyperpolarized Xe-129 Dissolved in PFOB Emulsions as a Novel Magnetic Resonance Agent for Cancer Detection</i> Andrei Andrievski, Carleton University <i>Characterizing H2AX Response of Human Lymphocytes to Ionizing Radiation</i> Randy Taylor, Carleton University <i>Monte Carlo Calculations for Brachytherapy</i>