

# Ottawa Medical Physics Institute ( OMPI )

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

Annual Report # 13  
1 July 2000 - 30 June 2001

Full details: [www.physics.carleton.ca/ompi](http://www.physics.carleton.ca/ompi)

*Submitted by Paul C. Johns, PhD FCCPM, OMPI Director 1996-2001.*

## **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 very active network of nearly 30 medical physicists in the Ottawa region. The Ottawa medical physics community has one of the most diverse spectra of research and service activities in Canada. Our members are located at AECL Chalk River, Health Canada, NRC, the Ottawa Heart Institute, the Ottawa Hospital, the Ottawa Regional Cancer Centre, and MDS Nordion, 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 2000-2001 academic year.

## **Funding and Publications**

In 2000-2001 OMPI members had over \$1.4M directly available in research funds 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), and others. Furthermore, OMPI scientists participated in research consortia, funded by the Canada Foundation for Innovation

(CFI) and the Ontario Research and Development Challenge Fund (ORDCF), with a total budget of over \$7M. These funds were administered through Carleton University, the University of Ottawa, and the individual institutions of our members.

In the calendar year 2000, OMPI members published in excess of 57 scientific papers, proceedings, and technical reports on their research here in the national capital region.

### **Membership**

Table 1 summarizes our membership, which now numbers 28. Table 2 lists the Executive. In 2000-2001 the OMPI welcomed one new member:

**Ruth Wilkins** - is a Research Scientist in the Radiation Protection Bureau of Health Canada. Dr. Wilkins completed her PhD studies at Carleton in 1996 in the area of medical biophysics under the supervision of Peter Raaphorst. At Health Canada she has been involved in using the single cell gel electrophoresis “comet” assay and flow cytometry assays for examining the effects of low levels of radiation on human cells.

### **Graduate Program**

This year four graduate half-courses in medical physics were offered: (1) Medical Radiation Physics, taught by Paul Johns; (2) Radiobiology, by Peter Raaphorst; (3) Physics of Medical Imaging, by Giles Santyr (course coordinator), Rob deKemp, Barry McKee, and Paul Johns; and (4) the Medical Physics Practicum, which was coordinated by Bog Jarosz, with modules supervised by Ian Cameron, Joanna Cygler, Lee Gerig, Gabriel Lam, Barry McKee, and Peter Raaphorst. Special thanks to the off-campus instructors for finding the time to teach in our program. Your experience and effort are what make our program a success.

Table 3 lists the graduate students in the program, and Table 4 the graduate theses (5 M.Sc. and 1 Ph.D.) which were completed in 2000-2001. In August 2000 Daron Owen, Debbie Smith, and Mei Li defended their M.Sc., and Robert Leclair his Ph.D. Mei is employed at Mosaid. Daron and Debbie are working as clinical physicists at the cancer facility in Gatineau, and in fact had commenced a few months prior to completion of their degrees. Robert had been on staff in Physics at Laurentian University for about a year prior to defending his degree and he has now obtained NSERC funding for his own research there. There is a lot of demand for our students and they are not delaying commencing their new careers! Mark McDonald completed his M.Sc. in January 2001 and is now an employee in the mri research lab at the Sunnybrook and Women’s College Health Sciences Centre in Toronto. In May 2001 Kenji Myint completed his MSc. He is continuing on for a PhD in our program.

One other student completed this year. In 1995, Greg Cron had moved with Giles Santyr from U. Wisconsin (Madison) to Carleton. While not registered at Carleton, Greg became part of the student body here and participated in OMPI seminars and events. We were pleased to see him complete his Wisconsin Ph.D. this year. At present, Greg is continuing as a post-doc with Giles Santyr.

### **Seminars**

The monthly OMPI seminars (Table 5) continue to be well attended. Thank you to all speakers and attendees. We followed last year's pattern of having a fall soccer game and a winter broomball game, and then added a windup barbecue and volleyball game at the NRC in May. Thank you to all event organizers - the events were a success and we intend to repeat them in future years.

Commencing in September 2001, there will not be a mailing of paper OMPI seminar announcements. An e-mail announcement (ascii text) will be sent to all who are on our seminar list. A formatted announcement with abstracts, suitable for printing, will be available on the web site.

Several Ottawa institutions host invited speakers in medical physics. Table 6 lists the 2000-2001 medical physics seminars which were given in the regular weekly series of the Carleton University

Department of Physics. In Table 7 we also list the presentations of some of the invited speakers hosted by other institutions over the year. The NRC Ionizing Radiation Standards group also runs an informal series of seminars by staff and visitors throughout the year.

### **Newsletter / Web Site / Annual Report**

Since its inception in 1989, OMPI has produced an annual Newsletter, in part to serve as an annual report to the Dean of Graduate Studies on our activities. With the web now becoming a standard information source it was decided that the June 2000 Newsletter (number 12 in the series, 38 pages) would be the last of that format. From now on, we will produce a much slimmer Annual Report which summarizes the activities of the year. Most of the detailed information previously reported in the yearly Newsletter will be archived on the OMPI web site, which is kept up to date throughout the year, and is readily accessible.

The OMPI web site ([www.physics.carleton.ca/ompi](http://www.physics.carleton.ca/ompi)) was completely redesigned over the past year by Marc Gibbons, a co-op student from École secondaire publique De La Salle. Most of the archival information is stored in a database. Maintenance of the database should be much less labour-intensive than the task faced by those who served as OMPI Secretary to produce the past Newsletters. The website information is organized in a manner similar to the past Newsletters:

- Membership Profile - research activities, publications, funding of each member
- Seminars - announcement for the current OMPI seminar, and archive of past seminars
- Courses - graduate courses in medical physics, and course requirements for our students
- Students - lists project area and supervisor for current M.Sc. and Ph.D. students, and lists past graduates and their current positions
- News & Activities - current OMPI events
- Information for Prospective Graduate Students
- Directories - contact information for members and students, in summary form
- Societies - list of relevant scientific and professional societies and names of one or more local contacts
- Ottawa Links - web links to host institutions and other relevant organizations.

### **Other**

The OMPI is pleased to support the recommendation of the OWGIR (Ottawa Work Group for Imaging Research) that the Ottawa Hospital Research Institute initiate a focus in imaging research.

### **OMPI Executive**

I thank the following for serving on the Executive 2000-2001: Giles Santyr (Academic Officer), Pavel Dvorak (Secretary), and Ian Cameron (Past-Director). Thanks go to David Wilkins for his able organization of the seminars, to Kenji Myint for representing the students, and to Cheng Ng and Ken Shortt for representing their groups by attending as Observers.

As of July 1 there will be several changes on the Executive. I look forward to working with Rob deKemp as Director and Ruth Wilkins as Secretary. I will serve as Academic Officer for the next six months. Ian Cameron continues as Past Director, and David Wilkins as Seminar Organizer.

### **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 we foresee that situation continuing. We work in one of the most interesting and relevant applications of science in our society - enjoy and be creative !

**Table 1. OMPI Members, 2000-2001.**

For details see [www.physics.carleton.ca/ompi](http://www.physics.carleton.ca/ompi) and choose Membership Profile. For a summary listing of contact information, choose Directories.

	Member	Institution and Unit	Specialization within Medical Physics
1	Ian Cameron	Diagnostic Imaging 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	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiotherapy
5	Rob deKemp	Ottawa Heart Institute	PET for cardiac imaging
6	Madhu Dixit <sup>§</sup>	Department of Physics Carleton University	Detectors for ionizing radiation
7	Pavel Dvorak	Radiation Protection Bureau Health Canada	Radiation protection
8	V. Elagupillai	Retired/Consultant	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
14	Gabriel Lam	Department of Medical Physics Ottawa Regional Cancer Centre	Radiotherapy
15	Barry McKee	Diagnostic Imaging Ottawa Hospital	Nuclear medicine imaging
16	Cheng Ng	Department of Medical Physics Ottawa Regional Cancer Centre	Radiobiology and hyperthermia
17	Peter Raaphorst	Department of Medical Physics Ottawa 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	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiotherapy and radiation dosimetry
20	Giles Santyr	Department of Physics Carleton University	MRI

21	Ken Shortt	Ionizing Radiation Standards Inst. National Measurement Standards, NRC	Radiation dosimetry
22	Jason (Jiansheng) Sun	Therapy Systems, MDS Nordion	Radiation treatment planning
23	Janos Szanto	Department of Medical Physics Ottawa 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 Ottawa Regional Cancer Centre	Radiotherapy
27	Ruth Wilkins	Radiation Protection Bureau Health Canada	Radiobiology
28	Brad Wouters	Department of Medical Physics Ottawa Regional Cancer Centre	Radiobiology

<sup>§</sup>Associate Member

**Table 2. OMPI Executive, 2000-2001.**

Position	Physicist
Director <sup>§</sup>	Paul Johns
Past-Director <sup>§</sup>	Ian Cameron
Academic Officer <sup>§</sup>	Giles Santyr
Secretary <sup>§</sup>	Pavel Dvorak
Student Representative <sup>†</sup>	Kenji Myint
Seminar Organizer	David Wilkins
Observer	Cheng Ng
Observer	Ken Shortt

<sup>§</sup>position elected by the members

<sup>†</sup>position elected by the medical physics graduate students

**Table 3. Graduate Students in the Carleton University Physics program in Medical Physics, 2000-2001.**

For details see [www.physics.carleton.ca/ompi](http://www.physics.carleton.ca/ompi) and choose Students. A list of Past Graduates is also available there.

	Student	Degree Program	Supervisor	Project Area
1	Marco Carlone	Ph.D.	Peter Raaphorst	Biophysics
2	Greg Cron <sup>§</sup>	Ph.D. ✓	Giles Santyr	Quantitative dynamic MRI of the breast
3	Carey Feagan	M.Sc.	Cheng Ng	Role of p21 in thermal radiosensitization
4	Zhanrong Gao	M.Sc.	Lee Gerig	Mathematical tumour growth model for radiotherapy

5	Salomeh Jelveh	M.Sc.	Bog Jarosz	Ultrasonic interstitial thermal therapy for brain tumours
6	Nina Kalach	M.Sc.	Dave Rogers	Radiotherapy beam quality specifiers
7	Robert Leclair	Ph.D. ✓	Paul Johns	X-ray imaging using scattered radiation
8	Mei Li	M.Sc. ✓	Paul Johns & Madhu Dixit	Gas electron multiplier detectors for x-ray imaging
9	Mark McDonald	M.Sc. ✓	Giles Santyr	Low-field MRI of hyperpolarized xenon
10	Kenji Myint	M.Sc. ✓	Peter Raaphorst	Cisplatin radiosensitization in radiotherapy
11	Marzieh Nezamzadeh	M.Sc.	Ian Cameron	MRI diffusion imaging
12	Malgorzata Niedbala	Ph.D.	Peter Raaphorst	Biophysics of radiation damage and repair
13	Ken Nkongchu	M.Sc.	Giles Santyr & Ken Shortt	Radiation dosimetry using Fricke PVA hydrogel and MRI readout
14	Elena Olariu	M.Sc.	Ian Cameron	MRI diffusion imaging
15	Daron Owen	M.Sc. ✓	Cheng Ng	Effects of low dose radiation with camptothecin
16	Juan Parra Robles	Ph.D.	Giles Santyr	Low-field MRI system using hyperpolarized xenon
17	Razvan Simionescu	Ph.D.	Giles Santyr	MRI
18	Debbie Smith	M.Sc. ✓	Peter Raaphorst	Pulsed dose rate brachytherapy
19	Richard Wassenaar	M.Sc.	Rob deKemp	Partial volume corrections in cardiac PET
20	Matthew Wismayer	M.Sc.	Paul Johns	Diffraction data for x-ray scatter imaging

✓ Degree completed between 1 July 2000 - 30 June 2001; see Table 4

§Registered at U. Wisconsin at Madison

**Table 4. Theses Completed, 2000-2001.**

Student	Degree	Supervisor	Thesis Title and Date of Defence
Mei Li	M.Sc.	Paul Johns and Madhu Dixit	<i>The Gas Electron Multiplier (GEM): A New Detector for Scanned Projection Radiography</i> 17 August 2000
Daron Owen	M.Sc.	Cheng Ng	<i>A Study of the Interaction between Camptothecin and Low Dose Rate Irradiation during Concomitant Application to Human Melanoma Cells</i> 18 August 2000
Debbie Smith	M.Sc.	Peter Raaphorst	<i>The Radiobiological Equivalence of Low Dose Rate Irradiation and Pulsed Dose Rate Irradiation, as it relates to Brachytherapy, using the U-87MG Glioblastoma Cell Line</i> 23 August 2000
Robert Leclair	Ph.D.	Paul Johns	<i>X-Ray Scatter Imaging in Medicine: Model and Experimental Validation</i> 29 August 2000
Mark McDonald	M.Sc.	Giles Santyr	<i>Hyperpolarized <sup>129</sup>Xe Nuclear Magnetic Resonance at 1.89 T and 85 G: A Signal-to-Noise Ratio Comparison</i> 12 January 2001

David Macrillo	B.Sc. - 75.499 project	Janos Szanto	<i>Computational Approximation Methods of Calculating Head Scatter Factor for Use in Clinical Radiotherapy</i> 1 May 2001
Kenji Myint	M.Sc.	Peter Raaphorst	<i>Examining the Role of the Non-Homologous End-Joining Repair Pathway in Cisplatin Radiosensitization and Sub-Lethal Damage Repair</i> 15 May 2001

**Table 5. OMPI Seminars, 2000-2001.**

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.

Date and Location	Speakers and Titles
21 September 2000 Carleton University	Richard Wassenaar, <i>Partial Volume Correction in Myocardial PET</i> Bog Jarosz, <i>Interstitial Ultrasound Applicators for Thermal Therapy: Planning for Success</i>
19 October 2000 ORCC, General Div.	Matthew Wismayer, <i>Determination of Coherent Scatter Form Factors by Utilizing 6.93 keV X-Ray Diffraction</i> Jason Sun, <i>Monitor Unit Setting, Computer vs. Hand Calculations</i>
9 November 2000 IRS NRC	Greg Cron, <i>Measurement of Perfusion Characteristics of Rat Tumours and Human Breast Lesions Using Quantitative Dynamic Contrast-Enhanced Magnetic Resonance Imaging</i> Ruth Wilkins, <i>Biological Dosimetry of Ionizing Radiation in Humans</i>
14 December 2000 Ottawa Hospital, Civic Campus	Nina Kalach, <i>What Constitutes a Clinical Radiotherapy Beam ?</i> Ken Shortt, <i>The Issue of Accuracy in Reference Dosimetry</i>
18 January 2001 RPB, Health Canada	Ken Nkongchu, <i>Quantitative Dosimetry using MRI of PVA Gels</i> Joanna Cygler, <i>Old Brachytherapy – Recent Revival</i>
15 February 2001 Carleton University	Salomeh Jelveh, <i>Ultrasonic Interstitial Heating in Dynamic Conditions</i> Ian Cameron, <i>Diffusion in MR Imaging</i>
15 March 2001 Ottawa Heart Institute	Gosia Niedbala, <i>Evaluation of Radiation Response to Different Dose Rates in a Range of Human Cancer Cell Lines Relevant to Cancer Therapy</i> Paul Johns, <i>Scattered Radiation: A New Way of Making X-Ray Images</i>
19 April 2001 ORCC, General Div.	Zhanrong Gao, <i>A 3D Tumour Growth Model for Radiotherapy Process Simulation System</i> Iwan Kawrakow, <i>Smoothing Monte Carlo Calculated Dose Distributions for RTP</i>
17 May 2001 IRS NRC	Juan Parra Robles, <i>Feasibility of MR Imaging at 8.5 mT Using Hyperpolarized <sup>129</sup>Xe</i> Gabriel Lam, <i>The Pursuit of the Illusive ‘Equivalent Dose’</i>

**Table 6. Carleton University Department of Physics Seminars in Medical Physics, 2000-2001.**

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](http://www.physics.carleton.ca/seminars).

Date	Speaker, Institution, and Title
18 September 2000	George Daskalov, Ionizing Radiation Standards, National Research Council, <i>Discrete Ordinates Photon Transport Calculations for Brachytherapy Treatment Planning Applications</i>
16 October 2000	Gabriel Lam, Ottawa Regional Cancer Centre, <i>The Biophysical Study of Radiation Tolerance Doses of Normal Tissue in Cancer Radiotherapy</i>

13 November 2000	Robert Kearney, Dept. of Biomedical Engineering, McGill University, <i>Methods for the Identification of Nonlinear Biomedical Systems and their Application to Human Ankle Stiffness</i>
15 November 2000	Alan Astbury, TRIUMF, <i>Cancer and Cosmic Rays</i>
24 November 2000	Annie Hsu, Queen's University, <i>Magnetic Barkhausen Noise from Magnetized Pipeline Steel</i>
11 December 2000 OCIP Fall Graduate Student Seminars	Carey Feagan, <i>The Role of p21 in Thermal Radiosensitization</i> Nina Kalach, <i>What Constitutes a Clinical Radiotherapy Photon Beam ?</i> Zhanrong Gao, <i>A Two-Dimensional Tumour Growth Model for Radiation Therapy Process Analysis</i>
18 December 2000 OCIP Christmas Symp.	Lee Gerig, Ottawa Regional Cancer Centre, <i>A Model for the Process of Radiation Therapy</i>
15 January 2001	Judith Herzfeld, Brandeis University, <i>Entropically Driven Order: From Liquid Crystals to Cell Biology</i>
2 April 2001	Xiaoyi Bao, University of Ottawa, <i>Gamma-Induced Attenuation in Normal Single Mode and Multimode, Ge-doped and P-doped Optical Fibres: A Fibre-Optic Dosimeter for Low Dose Levels</i>
17 May 2001 OCIP Spring Graduate Student Seminars	Salomeh Jelveh, <i>Ultrasonic Interstitial Heating in Dynamic Conditions</i> Ken Nkongchu, <i>Quantitative Dosimetry using MRI of PVA Hydrogels</i> Matthew Wismayer, <i>Measurement of Coherent Form Factors for Amorphous Biological Materials</i>
29 May 2001	Brian Rutt, Robarts Institute and University of Western Ontario, <i>Developments in Diffusion and Vascular MRI at the Robarts Research Institute</i>

**Table 7. Partial Listing of Other Seminars of Interest to the OMPI, 2000-2001.**

In addition to the seminars listed in the preceding tables, there are a variety of other seminars in the Ottawa area in the field of medical physics. The following is a partial compilation.

Date	Speaker, Institution, Title, followed by Venue and Host Institution
14 November 2000	Robert Kearney, Dept. of Biomedical Engineering, McGill University, <i>Understanding Stretch Reflex Function through Modeling and Identification</i> , IEEE EMBS Chapter Meeting, Herzberg Laboratories, Carleton University
27 February 2001	Mamoon Haque, Royal Prince Albert Hospital, Sydney Australia, <i>Brachytherapy: Experiences at RPAH and Perspectives</i> , General Division, Ottawa Regional Cancer Centre
25 June 2001	Jean-Philippe Pignol, Toronto-Sunnybrook Regional Cancer Centre, <i>Monte Carlo Simulation: A Tool at the Edge of Radiotherapy, Radiobiology and Medical Physics</i> , General Division, Ottawa Regional Cancer Centre