

Ottawa Medical Physics Institute (OMPI)

(the Medical Physics Organised Research Unit, Dept. of Physics, Carleton University)

Newsletter #10, June 1998

Editor: Barry McKee

(Also on: <http://www.physics.carleton.ca/research/OMPI/>)

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The Ottawa Medical Physics Institute, an Organized Research Unit of Carleton University

The Ottawa Medical Physics Institute of Carleton University has 28 members involved with research and/or teaching in the Ottawa area. To provide a report on activities in the past year, this newsletter (pages 4-21) includes a membership profile including affiliation, current research, funding, and recent publications. The Medical Physics graduate students at Carleton are an important component of the Ottawa Medical Physics Institute. A student section in this newsletter (pages 29-32) lists their research topics and supervisors. The Executive meets about once a month and consists of a Director (Paul Johns), Past-Director (Ian Cameron), Secretary (Barry McKee), Academic Officer (Giles Santyr), and a graduate student representative (Daryoush Sheikh-Bagheri). Other members (Pavel Dvorak, Cheng Ng, and Ken Shortt) attend Executive meetings as observers. Pavel Dvorak has also coordinated the seminars.

A Note from the Director

This is the 10th annual Newsletter of the Medical Physics Organized Research Unit (MPORU). At this important milestone we can look back at the development of medical physics in Ottawa since the ORU was formed in 1989. Based on true collaboration between medical physicists at several institutions in the Ottawa region, we have built an excellent program of MSc and PhD studies, promoted interaction through our monthly seminar series, and encouraged the development of medical physics services in our institutions. Since 1989 there has been significant growth of the medical physics groups in the Ottawa Regional Cancer Centre, hospital imaging departments, and Carleton University Physics.

In the last few years it has become apparent that the name "MPORU" was somewhat confusing to outsiders and that we needed a new, more recognizable label. After a long debate and after discussions with Carleton University administration, the name "Ottawa Medical Physics Institute (OMPI)" was proposed to the MPORU membership this spring and approved by a strong majority. This name was subsequently officially accepted by the board of the Carleton University Faculty of Graduate Studies and Research. Administratively, we continue to be an organized research unit, but now have a more recognizable, less confusing, title primarily for external consumption. It should help us with recruitment to our graduate program, and with recognition in the Ottawa area amongst industry and other health care professionals. The fact that we are based in the Physics Department of Carleton University can be made clear by using the name in the manner "Ottawa Medical Physics Institute, Dept. of Physics, Carleton University, Ottawa Canada".

This academic year we welcomed four new members to the OMPI. In order of joining, they are:

- Jiansheng Sun is a Senior Medical Physicist in the Computer Products Department of Theratronics. Many of us first got to know him when he was an Assistant Research Officer at NRC Ionizing Radiation Standards in the early 1990's and took some of our medical physics courses as a Special Student. As a scientist at Theratronics, Sun is our first member from the industrial sector.
- Iwan Kawrakow is a Visiting Fellow at the NRC IRS group working in the area of photon and electron transport using Monte Carlo. His doctoral training was in theoretical physics at Leipzig. He entered medical physics in 1994 via a post-doc at Leipzig.
- Gabriel Lam is a medical physicist at the Civic site of the Ottawa Regional Cancer Centre (ORCC). For over 20 years he worked in Vancouver in radiobiology and radiation physics, mostly to do with therapy using pions and other particles. He thus brings much experience with innovative treatments to Ottawa. He is clinically certified via Fellowship in the CCPM.

- Madhu Dixit is a Research Scientist in the Centre for Research in Particle Physics (CRPP) at Carleton University. His background is in experimental particle physics. For the past several years Madhu has had an interest in applying technology developed for particle physics to radiological problems. In particular, he has involved several of us in a collaboration to apply gas microstrip detectors to x-ray imaging. Madhu Dixit has been accepted as an Associate Member of OMPI.

Turning now to the graduate program, this year two courses were given in the fall term: Medical Radiation Physics, which I taught, and Radiobiology, given by Peter Raaphorst. In the winter term there was one course: Physics of Medical Imaging, given by Giles Santyr plus Barry McKee and myself. Special thanks to Peter Raaphorst and Barry McKee for finding the time amidst their other demands to teach in the university program.

Five graduate student theses were completed in 1997-98. Larry Gates defended his PhD in August 1997 and is now a post-doc in MRI in Halifax. Mazen Soubra completed his PhD a few weeks later. Mazen had been a part-time student for several years, doing his PhD in addition to being a clinical physicist at the ORCC. This is a very demanding route and it was very satisfying to see Mazen finish. He is currently a clinical physicist with the BC Cancer Agency in Vancouver. In early September, David Gobbi completed his MSc, and moved on to PhD studies at U Western Ontario. There was then a lull in thesis activity until April 1998, when Kevin Lenton completed his PhD. Kevin is currently a post-doc in biophysics at Sherbrooke. The following week Sheri Boyden completed her MSc, and is now exploring various options for the next step in her career.

The International Centre for Low Dose Radiation Research, established this year at the University of Ottawa, culminates a dream by OMPI member V. Elaguppillai and colleague P. Duport. Both left the AECB this year to run the Centre. Its challenge is to resolve the controversy surrounding the effects – deleterious or perhaps even beneficial – of low doses of ionizing radiation. An article appears on page 33 of this Newsletter.

A development of interest to medical physicists in imaging this year has been the formation of the Ottawa Workgroup for Imaging Research. This is an attempt to network various types of medical imaging researchers in the city, involving not only physicists but other scientific disciplines. There is a brief article describing this group on page 34 in the Newsletter.

One of the less pleasant trends of the 1990's is restructuring, and this academic year members of the OMPI in several institutions had this challenge. These included the merger of the Ottawa Civic and Ottawa General Hospitals into the Ottawa Hospital, a process which is still at an early stage, and academic and administrative changes in the Faculty of Science at Carleton University. With respect to the academic changes, in the Carleton Dept. of Physics, the graduate program in subatomic physics and in medical physics is considered a strength, but the undergraduate program has been suffering from declining enrollment and had to be redesigned at short notice this year. Those of us at the university had to put significant time into this and to some extent OMPI business suffered because of the time spent. We thank you for your understanding. When all was said and done, Carleton is launching this coming fall both an Applied Physics (B.Sc.) and an Engineering Physics (B.Eng.) program. Many of the students in these programs will be on a co-op pattern which in the context of the strong advanced technology sector in Ottawa has a lot of potential.

The only change to the OMPI Executive during 1997-98 was that Daryoush Sheikh-Bagheri replaced Miller MacPherson as the graduate student representative.

Thank you to all OMPI members and graduate students for your support – and especially seminar attendance – during 1997-98. Please continue to support our collaboration and keep it strong.

Paul Johns, Director of the OMPI

OMPI Membership Profile including Recent Research

In order that the Newsletter may serve as an annual report to the Dean of Graduate Studies and Research of Carleton University, this section describes briefly the research activities, recent publications, and sources of research funding of the OMPI members. The editor has imposed a standard format.

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Recent Research: Magnetic Resonance Imaging (MRI) is used to study water diffusion in human tissue. In order to better understand, at a basic level, the effects of water diffusion in MRI, the range over which the water molecules diffuse in a given time is measured for a variety of tissues and experimental conditions in human volunteers (completely non-invasively). These results are then interpreted using a combination of analytical models and simulations based on Monte Carlo algorithms. We have also designed and built special gradient coils which allow us to study this process over a much larger range of values than would otherwise be possible.

A second research area that we are involved with is known as functional MRI (fMRI). In fMRI the volunteer is asked to perform a specific task (e.g. finger tapping) and the part of the brain that is used to perform this task is detected. This research is applied to following the recovery of patients who have suffered a recent stroke.

Another research interest is in Hyperpolarized Noble Gas (HNG) MRI. With HNG MRI a special procedure is used to polarize noble gas molecules such that when inhaled by a patient they will produce a signal that can be used to generate an MRI image. This is a very new approach to MRI but it has a lot of potential.

Funding: Co-investigator on NSERC grant to support HNG MRI research. \$200k/yr

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Recent Research: Studying the use of highly focussed beams of ultrasound for the reduction or removal of benign and malignant lesions. The process of tissue destruction, consisting of energy deposition, diffusion and tissue response is being studied experimentally, theoretically and by computer modelling. Appropriate lens design and the dosimetry of high intensity ultrasound are also being investigated. Ultrasound tissue lesioning needs accurate temperature measurement as a function of space and time. The most promising technique uses quantitative results from MRI. Work has been started on measuring the point spread function and time dependence of an MRI temperature measuring system.

Publications:

- R.L. Clarke and G.R. ter Haar, "Temperature rise recorded during lesion formation by high-intensity focused ultrasound", *Ultrasound in Med. & Biol.* 23, 299-306, 1997.
- I.H. Rivens, R.L. Clarke, and G.R. ter Haar, "Design of focused ultrasound surgery transducers", *accepted Trans. IEEE - UFG*, 1996.
- R.L. Clarke, "Modification of intensity distributions from large aperture ultrasound sources", *Ultrasound in Med. & Biol.* 21 (3), 353-363, 1995.

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Recent Research: In the area of clinical electron beam dosimetry the verification process of the new electron beam algorithm implemented in Theraplan Plus is in progress. This algorithm attempts to use a similar approach to dose calculation as has been successfully used for photon beams. One of the explicitly required parameters to describe an electron beam is a Peak Scatter Factor, PSF. Rigorous tests are being performed to evaluate the performance of this algorithm. A special set of carefully machined phantoms with inhomogeneities of various densities imbedded in them is used to carry out the verification tests. Measurements and calculations of Electron Peak Scatter Factors as a function of field size and beam energy are in progress. In parallel to this project, an effort of clinical implementation of electron beam calibration at a new reference depth is carried on. Collaboration with the NRC scientists within the OMEGA project is continued. Clinical implementations of new dosimetry devices (MOSFETS and gafchromic films) are carried on in collaboration with the Canadian industry and scientists from the NRC.

Studies of biological equivalence of high dose rate (HDR) and pulse dose rate (PDR) brachytherapy treatments have been started in collaboration with other scientists from ORCC. Irradiations of human glioma cells and normal human fibroblasts will be carried on under several different fractionation regimes. Amount of biological damage to cells will be measured using asymmetric field inversion gel electrophoresis and other modern techniques.

Publications:

- G.X.Ding, J.E. Cygler, "Measurement of electron beam peak scatter factors", *Med.Phys.* **25**, 251-253, 1998.
- J. Cygler, G.X.Ding, W.Kendal, P.Cross, "Fetal Dose for a Patient Undergoing Mantle Field Irradiation for Hodgkin's Disease", *Med. Dosimetry*, **22**,135-137, 1997.
- J. Cygler, X.A.Li, G.X.Ding, E.Lawrence, "Practical Approach to Electron Beam Dosimetry at Extended SSD", *Phys. Med. Biol.***42**, 1505-1514, 1997.
- D.Wilkins, X.A.Li, J. Cygler, L.Gerig, " The Effect of Dose Rate Dependence of p-type Silicon Detectors on Linac Relative Dosimetry", *Med. Phys.***24**, 879-881, 1997.
- G.X.Ding, D.W.O. Rogers, J. Cygler, "Electron Fluence Correction Factors for Conversion of Dose in Plastic to Dose in Water", *Med. Phys.* **24**, 161-176, 1997.
- N.V. Klassen, L. van der Zwan, J. Cygler, "Gafchromic MD-55 investigated as a precision dosimeter", *Med. Phys.* **24**, 1924-1934, 1997.

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Recent Research: Development of three-dimensional attenuation and scatter corrections for positron emission tomography, and automated 3D cardiac image analysis and interpretation. Current efforts are focused on kinetic modelling of ^{82}Rb blood flow and ^{18}F FDG metabolism measurements. New control algorithms will be developed for the ^{82}Rb isotope delivery system, to allow precise control of infusion dose rates as well as total injected dose and volume.

Funding: MRC grant \$55,000/year. Evaluating new treatments for heart disease using dynamic PET.

Publications:

- C.C. Watson, D. Newport, M.E. Casey, R.A. deKemp, R.S. Beanlands, "Evaluation of Simulation-Based Scatter Correction for 3-D PET Cardiac Imaging", *IEEE Trans.Nucl.Sci.*, **44**: 90-97, 1997.
- R.S.B. Beanlands, R.A. deKemp, A. Scheffel, C. Nahmias, E.S. Garnett, G. Coates, E.Fallen, "Can N-13-ammonia kinetic modeling define myocardial viability independent of F-18 fluorodeoxyglucose?", *J. Am Coll. Cardiol.*, **29**(3): 537-543, 1997.
- R.A. deKemp and R.S. Beanlands. "Postinjection Attenuation Correction using Singles Transmission on a Positron Tomograph without Interplane Septa", *IEEE Nuclear Science Symposium and Medical Imaging Conference 1997*.
- R.A. deKemp and C. Nahmias, "Automated Determination of the Myocardial Long Axis in Cardiac Positron Emission Tomography", *Physiol. Meas.*, **17**: 95-108, 1996.
- R.S.B. Beanlands, T.D. Ruddy, E. Harmsen, R.A. deKemp, J. Veinot, N.G. Hartman, "Myocardial kinetics of technetium-99m teboroxime in the presence of postischemic injury, necrosis and low flow reperfusion", *J. Am. Coll. Cardiol.*, **28**: 487-494, 1996.
- R.A. deKemp, W.F. Jones, C. Nahmias, R.S. Beanlands, "PET Quantitation and Reconstruction: Design and Performance of 3D Single Photon Transmission Measurement on a Positron Tomograph with Continuously Rotating Detectors". In: *Serie Computational Imaging and Vision*, P.Grangeat, J.L.Amans (eds), Kluwer Academic Publishers, 1996.

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Recent Research:

- Experimental elementary particle physics, weak interactions, development of new detectors and instrumentation for particle physics and applied physics. Present interests are: OPAL experiment at CERN and the development of gas microstrip detectors for digital x-ray imaging for medical and industrial applications and for radiation dosimetry.

Publications:

- D.G. Gobbi, J.C. Armitage, M.S. Dixit, J. Dubeau, P.C. Johns, D. Karlen and F.G. Oakham, "Photon counting radiography with gas microstrip detectors", *Proc. 43rd Ann. Meet. Can. Org. Med. Phys.*, 31-33, 1997, Abs: *Med Phys.* **24**, 1997.
- M.S. Dixit, J.C. Armitage, J. Dubeau, D.G. Gobbi, P.C.Johns, D. Karlen, and F.G. Oakham, "Development of gas microstrip detectors for digital x-ray imaging and radiation dosimetry", to be published in *IEEE Trans. in Instrumentation and Measurements*, IMTC97, special issue, (1998).
- R. Sudharsanan, N.H. Karam, A.C. Greenwald, M. Dixit, J. Dubeau, and E.W. Sommerville, "Deposition and characterization of CdZnTe thin films for gas microstrip detectors", *IEEE Trans. Nucl. Sci.*, **3**, 665 (1997).

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Recent Research: Studies of patient doses from x-ray procedures, computer simulations of x-ray procedures, development of testing and measuring techniques, both in medical and non-medical x-ray applications. Facilities: Three phase and single phase radiographic/fluoroscopic, mammographic, dental and industrial x-ray machines, assorted phantoms, measuring equipment and automatic film processor.

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Recent Research: Quantification of the risk to health (cancer, genetic and teratogenic effects) and environmental effects of exposure to low dose and low dose-rate of low and high LET ionising radiation, reduction of uncertainties in risk estimates, design and improvement of radiation practices at work places (hospital, research, power reactor, uranium mine, mill and refinery, radioactive waste disposal facilities) are the areas of main research interest.

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Recent Research: Radiation Therapy is a complex and expensive health care modality. The outcome of the radiation therapy process can be assessed in terms of tumour control, patient survival, normal tissue complication and patient quality of life. In our present research program we are modelling the entire radiation therapy process as a series of independent processes. Each of the processes is represented by a modulation function which degrades the quality of the outcome from some theoretical maximum. Our work is focused on developing a complete model which includes radiation biology, diagnosis and tumour localization, treatment planning, and treatment delivery. The nature of the modulation terms for each step, particularly treatment delivery, is being examined in detail.

Publications:

- Akyurekli D.U., Gerig L.H., Raaphorst G.P., "Changes in Muscle Blood Flow Distribution During Hyperthermia", *International Journal of Hyperthermia*, Accepted, 1997.

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Recent Research:

- Studying radiation-induced conformational changes to the human genome in living cells using time-resolved and immunofluorescence spectroscopies.
- Using electron spin resonance (ESR) bio-dosimetry of human samples or tissue-equivalent surrogate samples.
- Developing an automated multiwell cell survival assay using a redox dye as a vital stain for quantitative studies of biological response modification and the radioprotective action of antioxidants.
- Measuring radiation damage to the lymphocyte immunosurveillance system.
- Fluorescent monoclonal antibody binding to specific cell surface receptors is used to monitor an early-warning response to radiation, cancer-proneness, cell signalling and adaptation mechanisms.
- An immunoassay technique (ELISA) has been set up to measure antioxidant enzyme levels in cells, and to explore their role in inducible and constitutive radiation protection mechanisms.
- Applying health physics and radiation protection to risk assessment.

Funding:

- AECL R&D/overhead support, \$100k
- AECB contract for organically bound tritium dosimetry, \$20k
- Faulding (Canada) contract for using catalase in cancer therapy, \$20k

Publications:

- A. Trivedi, T. Duong and C.L. Greenstock, "Distribution, biokinetics and dosimetry of tritiated organics", *Radioprotection* **32**, Suppl. C-1, 365-370, 1997.
- C.L. Greenstock, "Review of potential biomarkers of radiation exposure", *Proc. AFFRI Workshop on Triage of Irradiated Personnel*, DOE Publ., Bethesda MD, 1997 (in press).
- C.L. Greenstock, "Investigation of an I-125 contamination incident in the NRU reactor, AECL Unplanned Event Report", UER-NRU-96-04, 1997.
- Y. Xu, C.L. Greenstock, A. Trivedi and R.E.J. Mitchel, "Occupational levels of radiation exposure induce surface expression of interleukin-2 receptors in stimulated human peripheral blood lymphocytes", *Radiat. Environ. Biophys.* **35**, 89-93, 1996.
- Y. Xu, B. Conway, J.S.G. Montaner, M.V. O'Shaughnessy and C.L. Greenstock, "Effect of low dose gamma radiation on HIV replication in human peripheral blood mononuclear cells", *Photochem. Photobiol.* **64**, 238-241, 1996.
- K.J. Lenton and C.L. Greenstock, "Free radical scavenging and antioxidant kinetics using a fluorescent protein target", *Cahiers de Radiobiologie*, **4**, 9-12, 1996.
- A. Trivedi, R.E.J. Mitchel, Y. Xu and C.L. Greenstock, "Interleukin-2 receptor as biomarkers for occupational levels of radiation exposure and cancer risk prediction". In: *Proceedings of the International Cancer Congress*, New Delhi, India (Rao, R.S., et al, eds.), Monduzzi Editore, Italy, pp. 2719-2724, 1996.
- A. Trivedi and C.L. Greenstock, "Trends in biodosimetry". In: *Biological Concepts in Radiotherapy* (Singh, B.B., Bhattacharjee, D., eds.), Narosa Publ., New Delhi, India, pp. 62-71, 1996.
- C.A. Chuaqui, A. Petkau, C.L. Greenstock and C.P. Brown, "Identification and monitoring of non-radiological carcinogens", Atomic Energy Control Board (AECB) Report; INFO-0594, Ottawa ON 1-81, 1996.

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Recent Research: Ultrasound thermal therapy of deeply localized tumours. Research involves a wide range of animal and phantom investigation of heating with an array of two to six ultrasonic interstitial waveguide applicators for thermal therapy. Interaction of sonic waves with tissues and mode conversion in tissues have been studied. Finite Element Analysis computations of the above processes have been used to evaluate effectiveness of the arrays for heating. The research includes also laser generated ultrasound for heating.

Funding: NSERC grant \$18k /y.

Publications:

- B.J. Jarosz, D. Kaytar "Ultrasonic Waveguide Applicator Arrays for Interstitial Heating: A Model Study", *IEEE Trans. Ultrason. Ferroelectrics Freq. Contr.*, (in press, 1998).
- B.J. Jarosz "Feasibility of Interstitial Thermo-therapy with Ultrasound Waveguide Applicator Arrays", *SPIE Proceedings*, vol. **3249**, 20-30, 1998.
- B.J. Jarosz "Feasibility of Ultrasound Thermal Therapy with Waveguide Interstitial Applicator Array", *Proceedings, COMP/CCPM 43rd Annual Scientific Meeting*, 10-12 July, Charlottetown, PEI, 185-187, 1997.
- B.J. Jarosz, D. Kaytar "Ultrasonic Heating with Waveguide Interstitial Applicator Array", *Proceedings IEEE IMTC/97*, 97CH36022, 1346-1349, 1997.

- B.J. Jarosz "Feasibility of Ultrasound Hyperthermia with Waveguide Interstitial Applicator", *IEEE Transactions on Biomedical Engineering*, **43**, 1106-1115, 1996.

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Recent Research:

- Investigating means of obtaining diagnostic information using coherent and incoherent scatter. Although coherent scatter has a small cross section compared with Compton scattering, it is a forward directed process, so that coherently-scattered photons have a high probability of reaching the image receptor. Further-more, the differential coherent cross section varies with scattering angle and photon energy in a material-specific manner, even for amorphous materials; this is the diffraction signature of the material. This dependence on Z and chemical structure suggests that it can be used to obtain chemical information about tissues. We are in the pro-cess of a detailed investigation of scatter imaging to determine its sensitivity, i.e. the radiation dose to the patient required to detect the presence of a volume of tissue of specified dimensions against a background of other tissue.
- Member of collaboration at Carleton investigating the use of gas microstrip detectors for medical x-ray imaging. By operating in photon counting mode, the energy of each photon event can be measured, providing input for applications such as dual-energy radiography.
- Studying iterative reconstruction techniques to reduce artefacts in computed tomography (CT) by accounting for the polyenergetic nature of the x-ray beam as well as scattered x rays.

Funding:

- NSERC Operating Grant \$14k /y
- Carleton University GR-5 Funding (Installation of Donated X-Ray Angiography Equipment) \$5k

Publications:

- R.J. Leclair and P.C. Johns, "A Semi-Analytic Model to Investigate the Potential Applications of X-Ray Scatter Imaging", *Medical Physics* **25**, 1008-1020 (1998).
- R.J. Leclair and P.C. Johns, "A Semi-Analytic Model to Investigate the Potential Applications of X-Ray Scatter Imaging", *Proceedings of 43rd Annual Meeting of the Canadian Organization of Medical Physicists*, 114-116 (1997). [Abstract: *Medical Physics* **24**, 1203 (1997)].
- D.G. Gobbi, J.C. Armitage, M.S. Dixit, J. Dubeau, P.C. Johns, D. Karlen, and F.G. Oakham, "Photon-Counting Radiography with Xenon Gas Microstrip Detectors", *Proceedings of 43rd Annual Meeting of the Canadian Organization of Medical Physicists*, 31-33 (1997). [Abstract: *Medical Physics* **24**, 1197 (1997)].
- M.S. Dixit, J.C. Armitage, J. Dubeau, D.G. Gobbi, P.C. Johns, D. Karlen, F.G. Oakham and A.J. Waker, "Development of Gas Microstrip Detectors for Digital X-Ray Imaging and Radiation Dosimetry", *Proceedings of the IEEE Instrumentation and Measurement Technology Conference*, Ottawa, May 1997 (IEEE #97CH36022) pp.1357-1360, 1997.
- P.C. Johns, J.C. Armitage, D.C. Bouius, M.S. Dixit, J. Dubeau, D.G. Gobbi, D. Karlen, and F.G. Oakham, "Development of Gas Microstrip Detectors for Digital X-Ray Imaging", *Proceedings of 42nd Ann Meeting of the Canadian Organization of Medical Physicists*, 255-256, 1996.[Abstract: *Medical Physics* **23**, 809,1996].
- R.J. Leclair and P.C. Johns, "An Investigation of the Use of Scattered Photons in X-Ray Imaging", *Proceedings of 42nd Annual Meeting of the Canadian Organization of Medical Physicists*, 80-81, 1996. [Abstract: *Medical Physics*, **23**, 798-799, 1996].

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Recent Research:

- Electron transport theory,
- Monte Carlo techniques,
- Theoretical dosimetry

Publications:

- I.Kawrakow and A.F.Bielajew, "Single and multiple scattering of electrons", *Nuc Inst. & Meth B* **134**, 325-336 (1998).
- I.Kawrakow and A.F.Bielajew, "On the Condensed History technique", *Nuc Inst. & Meth B* (in press, 1998).
- I.Kawrakow, "Improved modelling of multiple scattering in the VMC model", *Med. Phys.* **24**, 505-517 (1997).
- M.Fippel, I.Kawrakow and K.Friedrich, "Electron beam dose calculations with VMC and the verification data set of the NCI working group", *Phys. Med. Biol.*, **42**, 501-519 (1997).
- I.Kawrakow, "Electron transport: lateral and longitudinal correlation algorithm", *Nuc Inst. & Meth B* **114**, 307-32 (1996).
- I.Kawrakow, "Electron transport: multiple and plural scattering", *Nuc Inst. & Meth B*, **108**, 23-34 (1996).
- I.Kawrakow, M.Fippel and K.Friedrich, "3D Electron Dose Calculation using a Voxel based Monte Carlo Algorithm", *Med. Phys.* **23**, 445-457 (1996).
- I.Kawrakow, "State-of-the-art Monte Carlo techniques for Radiation Treatment Planning", Invited talk, *World Congress on Med. Phys. and Biomed. Engineering*, Nice, France, 1997.
- I.Kawrakow, "Analysis of the Condensed History technique", Invited talk, *International Conference on Monte Carlo Methods*, Monte Carlo, 1997.
- I.Kawrakow and A.F.Bielajew, "New multiple scattering theory and transport algorithm for electron Monte Carlo simulations", *Proceedings of XII ICCR*, Salt Lake City 155 (1997).

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Recent Research: Involved in the work to establish absorbed dose standards based on water calorimetry. This is being done for 20 MV photons and Co-60 beams. The temperature rise in the water, caused by the absorbed dose, has a component which is due to chemical changes in the aqueous absorber. This component is simulated by computer and the simulations are tested by measuring the hydrogen peroxide in the irradiated aqueous systems. Recently, a method was developed for using GafChromic MD-55 (a thin film dosimeter) as a transfer dosimeter with an uncertainty of less than 1%. An effect of polarized light on GafChromic MD-55 was discovered and explained.

Publications:

- N. V. Klassen and C. K. Ross. "Water calorimetry: the heat defect", *J. Res. Natl. Inst. Stand. Technol.*, **102**: 63-74, 1997.
- C. K. Ross and N. V. Klassen, "Water calorimetry for radiation dosimetry", *Phys. Med. Biol.*, **41**: 1-29, 1996.
- N. V. Klassen. "Ice near 0 C: radiolysis and absorbed dose calorimetry", *Radiat. Phys. Chem.*, **48**: 281-87, 1996.

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Recent Research:

- Radiotherapy using charged particle beams including negative pi-mesons and protons. Development of dosimetry and beam delivery techniques for particle beams.
- Theoretical radiobiology of combined effects of mixtures of radiations of different qualities. Investigation of the general concept of effective dose in radiobiology and in radiotherapy.
- Theoretical studies of interaction of toxic agents. Development of general interpretation and definition of synergism and antagonism for mixtures of toxic agents with different mechanisms of action.

Publications:

- K. Nemoto, T. Pickles, A. Minchinton and G. Lam, "The Relative Biological effectiveness of the Modulated Proton Beam at TRIUMF", *Radiation Medicine*, **16**, pp.43-46 (1998).

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Recent Research: Developing a high-resolution pinhole SPECT camera that will achieve a resolution of about 4 mm over a limited field of view. Various image reconstruction methods are being explored. Pinhole tomography should be useful for clinical imaging of the thyroid, and for research applications in radiopharmaceutical development.

- Modelling and measuring the scatter background in SPECT systems to develop and test improved correction methods.

Publications:

- T.A. Hewitt, B.T.A. McKee, and M.J. Chamberlain, "Pinhole SPECT: Towards Clinical Thyroid Tomography", *Proceedings of the 1998 Canadian Organization of Medical Physicists Conference*, London, Ont., 243-245, 1998.
- T.A. Hewitt, B.T.A. McKee, and M.J. Chamberlain, "Towards clinical pinhole SPECT: Some imaging characteristics", *Proceedings of the 1997 Canadian Organization of Medical Physicists Conference*, Charlottetown, July, 49-51, 1997.
- B.T.A. McKee, M.J. Chamberlain and T.A. Hewitt, "A New Direction in Nuclear Medicine Imaging: Pinhole Tomography", *Proceedings of the IEEE Instrumentation and Measurement Technology Conference*, Ottawa, May 1997 (IEEE #97CH36022) pp.1350-1353, 1997.
- M.J. Chamberlain, K.Y. Gulenchyn, R.B. Jammal and B.T.A. McKee, "Nuclear medicine goes filmless: Experience with a miniPACS", *Proceedings of SCAR96, Conference on Computer Applications in Radiology*, Denver, June 1996, 483-484, 1996.

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Recent Research: The ability of drugs to potentiate the response of human cancer cells to X-radiation and hyperthermia is being investigated. The aim of these experiments is to determine if the inhibition of cellular repair of X-radiation damage or the interaction of the drugs with hyperthermia can lead to selective killing of human tumour relative to normal cells. A selective killing of tumour over normal cells is necessary to treat tumours successfully in the clinic. In particular, two types of drugs, DNA topoisomerase poisons and cisplatin, are being emphasized. Both of these drugs are already in active use clinically; the DNA topoisomerase poisons, in particular, are also being investigated as an adjunct to radiotherapy of cancer. Recent work has also focussed on the role of the tumour suppressor, p53, in the modulation of killing by the topoisomerase poisons.

Funding: Supported as a Career Scientist with the OCTRF;

- NCIC (Principal Investigator) interaction between X-radiation and topoisomerase poisons, \$99k/year;
- ORCC Foundation (Principal Investigator) mechanisms of resistance in human pancreatic tumour cells, \$10k;
- NCIC (Co-investigator) interaction of cisplatin with X-radiation and hyperthermia, \$128k/year;
- NCIC grant (Co-investigator) cellular radiosensitivity, \$70k.

Publications:

- Raaphorst, G.P., Mao, J.P., Yang, D.P. and Ng, C.E. "Comparison of hyperthermia radiosensitization and DNA polymerase inactivation in human normal and melanoma cell lines of different radiosensitivities", *Rad. Oncol. Invest.*, **5**: 1-7 1997.
- Wilkins, D.E., Ng, C.E. and Raaphorst, G.P. "Cell cycle perturbations in cisplatin sensitive and resistant human ovarian carcinoma cells following treatment with cisplatin and low dose rate irradiation". *Cancer Chemother. Pharmacol.*, **40**: 159-166, 1997.
- Wallace J.W., Raaphorst, G.P., Somorjai, R.L., Ng, C.E., Fung, M.K.F., Senterman, M. and Smith, I.C.P. "Classification of 1H Magnetic Resonance spectra from untreated and recurrent ovarian cancer using linear discriminant analysis". *Mag. Res. in Medicine*, **38**: 569-576, 1977.
- Ng, C.E., Bussey, A.M. and Raaphorst, G.P. "Reduction of etoposide induced cell killing by hyperthermia can occur without changes in etoposide transport or topoisomerase II activity". *Int. J. Hyperthermia*, **12**: 551-567, 1996.
- Wilkins, D.E., Ng, C.E. and Raaphorst, G.P. "Cisplatin and low dose rate irradiation in cisplatin resistant and sensitive human glioma cells". *Int. J. Rad. Oncol. Biol. Phys.*, **36**: 105-112, 1996.
- Shahine, B.H., Ng, C.E. and Raaphorst, G.P. "Modelling of continuous low dose rate and accelerated fractionated high dose rate irradiation treatments in a human glioma cell line". *Int. J. Rad. Biol.*, **70**: 555-562, 1996.
- Ng, C.E., Bussey, A.M. and Raaphorst, G.P. "Sequence of treatment is important in the modification of camptothecin induced cell killing by hyperthermia". *Int. J. Hyperthermia*, **12**: 663-678, 1996.
- Raaphorst, G.P., Yang, H., Wilkins, D.E. and Ng, C.E. "Cisplatin, hyperthermia and radiation treatment in human cisplatin sensitive and resistant glioma cell lines". *Int. J. Hyperthermia*, **12**: 801-812, 1996.

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Recent Research: Presently there are three main areas of research as follows:

- The study of radiosensitization of human cancer cell to radiation using hyperthermia and drugs. This project includes the study of the response of a wide range of human tumour cells (glioma, ovarian carcinoma, breast cancer, melanoma *etc*) to radiation at different dose rates and the effect of hyperthermia (heating from 40 to 45 deg) on radiosensitization. In addition the effect of chemotherapy agents in combination with hyperthermia and radiation is also being evaluated. In these studies we are also assessing the mechanisms of radiation resistance and the capacity of cells to repair radiation damage. The experimental results are being modelled in

order to develop comprehensive models that can be used to predict radiotherapy outcome. These studies also include design of special radiation apparatus to deliver specific dose rates and require the development of a good understanding of radiation dosimetry.

- Prediction of radiation response. In this study we are evaluating the response of human normal and tumour cells in culture to irradiation. The normal and tumour cells are obtained from patients before undergoing radiation therapy and are assessed for the radiation response and then compared to the response of the patient undergoing radiotherapy. To date we have found a correlation between the *in-vitro* and the patient tissue response. Further studies are ongoing to model these responses and to determine whether the results can be used as a predictor of radiation sensitivity and for customized dose prescription in order to optimize radiotherapy.

- Induction of radiation resistance with low doses of radiation. Our preliminary studies have shown that low dose and low dose rate irradiation can induce radiation resistance in human cells. This can have a major impact on radiation therapy where in some cases radiation is given either in fractions or at low dose rate. In addition such resistance can also have an impact on working in low level radiation fields such as those found in some industries or in outer space. We are currently characterizing this induced resistance in human cells and will develop strategies for its optimization. In addition we are also looking at other means to induce or possibly prevent induction of radiation resistance. These results are being put into models to help predict the radiotherapy response.

Funding:

- NCIC Grant for the study of cellular radiation resistance and methods of sensitization \$101k/y for 3 years.
- NCIC grant for the study of combined treatment of radiation cisplatin and hyperthermia. \$106k/y for 3 years.
- Department of Defence funding for the study of induced radiation resistance. \$23k/y.

Publications:

- G.P. Raaphorst, J. Miao and C.E. Ng. "Interactions of mild hyperthermia, cisplatin and split dose irradiation in human ovarian carcinoma cells". *Cancer Chemotherapy and Pharmacology*. In press 1998.
- D.E. Wilkins, C.E. Ng and G.P. Raaphorst. "Cell cycle perturbations in cisplatin sensitive and resistant human ovarian carcinomal cells following treatment with cisplatin and low dose rate irradiation". *Cancer Chemotherapy and Pharmacology*, **40**: 159-166, 1997.
- G. Alsbeih and G.P. Raaphorst. "Radiosensitive human cells at the crossroads: high split-dose recovery and diminished inducible response". *Int. J. Radiat. Biol.*, **72**, No. 2, 135-137, 1997.
- G.P. Raaphorst, J. Miao and C.E. Ng. "Cisplatin and mild hyperthermia in radiosensitization to low dose rate irradiation in human ovarian carcinoma cells". *Anti Cancer Res.* **17**, 3469-3472, 1997.
- G.P. Raaphorst, J.P. Mao, D.P. Yang and C.E. Ng. "Comparison of thermotolerance development in three human cell lines". *Endocurietherapy/Hyperthermia Oncology*, **12**, 231-240, 1997.
- B.H. Shahine, C.E. Ng and G.P. Raaphorst. "Modelling of continuous low dose rate and accelerated fractionated high dose rate irradiation treatments in a human glioma cell line". *Radiation Research*. In press 1997.
- G.P. Raaphorst, J.P. Mao and C.E. Ng. "A comparison of hyperthermia inhibition of sublethal radiation damage recovery in four human cell lines with different radiosensitivity". *Int. J. of Oncology*. In press 1997.
- G.P. Raaphorst, J.P. Mao, D.P. Yang and C.E. Ng. "Comparison of hyperthermia radiosensitization and DNA polymerase inactivation in human normal and melanoma cell lines of different radiosensitivities". *International Journal of Radiation Oncology*. In press 1997.
- G.P. Raaphorst, J.P. Mao and C.E. Ng. "Thermotolerance effects in thermoradiosensitization in human glioma cells". *Int. J. Hypertherm.* In press 1997.
- J.A. Dolling, D.R. Boreham, D.L. Brown, G.P. Raaphorst and R.E.J. Mitchell. "Rearrangement of human cell homologous chromosome domains in response to ionizing radiation". *Radiat. Res.* In press 1997.
- G. Alsbeih, S. Malone, G.P. Raaphorst. "Intrinsic radiosensitivity as a predictive assay in radiotherapy: rationale for a multifraction approach". *Cahiers de Radiobiologie*. In press 1997.
- G.P. Raaphorst, P. Chabot, S. Doja, D. Wilkins, D. Stewart and C.E. Ng. "Effect of hyperthermia on cisplatin sensitivity in human glioma and ovarian carcinoma cell lines resistant and sensitive to cisplatin treatment". *Int. J. Hypertherm.* **129**, 211-222, 1996.

- G.P. Raaphorst, S. Doja, L. Davies, D. Stewart and C.E. Ng. "Comparison of cisplatin-hyperthermia sensitization in human ovarian carcinoma and glioma cell lines sensitive and resistant to cisplatin treatment". *Cancer Chemother. Pharmacol.* **37**, 574-580, 1996.
- G.P. Raaphorst, J.P. Mao, D.P. Yang and C.E. Ng. "Thermal radiosensitization by protracted low temperature hyperthermia in human glioma cells". *J. Therm. Biol.*, **21**, 239-244, 1996.
- D.E. Wilkins, C.E. Ng and G.P. Raaphorst, "Cisplatin and low dose rate irradiation in cisplatin resistant and sensitive human glioma cells". *Int. J. Radiat. Oncol.*, **36**, 105-111, 1996.
- G.P. Raaphorst, G. Wang, D. Stewart and C.E. Ng. "Concomitant Low Dose Rate Irradiation and Cisplatin Treatment in Ovarian Carcinoma Cell Lines Sensitive and Resistant to Cisplatin Treatment". *International Journal of Radiation Biology*, **69**: 623-631, 1996.
- C.E. Ng, A.M. Bussey and G.P. Raaphorst. "Reduction of etoposide induced cell killing by hyperthermia can occur without changes in etoposide transport or topoisomerase II activity". *Int. J. Hyperthermia*, **12**: 551-567, 1996.
- C.E. Ng, A.M. Bussey and G.P. Raaphorst. "Sequence of treatment is important in the modification of camptothecin induced cell killing by hyperthermia". *Intl. J. Hyperthermia* **12** : 663-678, 1996.
- F.H. Shirazi, J.M. Molepo, D.J. Stewart, C.E. Ng, G.P. Raaphorst and R. Goel. "Cytotoxicity, accumulation and efflux of cisplatin and its metabolites in human ovarian carcinoma cells". *Toxicology and Applied Pharmacology*, **140**, 211-218, 1996.
- G.P. Raaphorst, H. Yang, D.E. Wilkins and C.E. Ng. "Cisplatin, hyperthermia and radiation treatment in human cisplatin-sensitive and resistant glioma cell lines". *Int. J. Hyperthermia*, **12**: 801-812, 1996.
- R.C. Brown, G.P. Raaphorst, C.E. Danjoux and P. Drouin. "Multi-organ fatal chronic complications following radiation treatment for cancer of the cervix, results of fibroblast assay". *Gynecologic Oncology*, **61**: 116-121, 1996.
- D.J. Stewart, G.P. Raaphorst, J. Yau and A.R. Beaubien. "Active vs. passive resistance, dose-response relationships, high dose chemotherapy, and resistance modulation: a hypothesis". *Investigational New Drugs*, **14**, 115-130, 1996.
- E.I. Azzam, S.M. de Toledo, G.P. Raaphorst and R.E.J. Mitchell. "Low dose ionizing radiation decreases the frequency of neoplastic transformation to a level below the spontaneous rate in C3H-10T1/2 cells". *Radiat. Res.* **146**, 369-373, 1996.

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Recent Research:

- Developing, with Dave Dunford, an internal dosimetry Microsoft WINDOWS-based code, called GENMOD that calculates the radiation dose to the lung and other organs.
- Investigating the subcellular dosimetry for tritium-contaminated intakes in collaboration with research workers at Carleton University and AECL.
- Internal dosimetry of tritium and carbon-14 in diet.
- Leader of the Human Dosimetry project group, of the International Energy Agency's "Cooperative Program on Environmental, Safety and Economic Aspects of Fusion Power".

Research Funding: Dosimetry of organically bound tritium derived from diet. AECB, Canada (1996-Present).

Publications:

- A. Trivedi, D. Galeriu, R.B. Richardson and E.S. Lamothe, "Dose Contribution from Metabolised Organically Bound Tritium after Tritiated Water Intakes in Humans", *Bull Radiat. Prot.* 19 (3&4): 1-3, 1996.

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Recent Research:

- Monte Carlo techniques are used to calculate correction factors required for primary radiation standards. Recent examples are the calculation of wall correction factors for ionization chambers used for air kerma standards, and the calculation of the wall effect for Fricke dosimeter vials. These correction factors have a significant impact on several national standards.
- Developing more accurate and easily used clinical dosimetry protocols. In this regard, the effect of beam size and beam quality on ionization chamber calibration factors is being calculated. Also, work is underway on a formalism which will use absorbed dose, rather than exposure, calibration factors.
- Measuring fundamental data using the NRC linear accelerator. A recent project has accurately measured the bremsstrahlung yield from thick targets as a function of energy and angle and compared the results to Monte Carlo calculations. Another project is underway to measure electron stopping powers which play a fundamental role in radiation dosimetry but have never been measured with an accuracy of better than 5 %.
- Working on the OMEGA project. This is a collaboration with Rock Mackie's group at the University of Wisconsin to develop a Monte Carlo based code to calculate the dose in a patient undergoing electron beam radiotherapy. We are developing a general purpose code to model radiation beams from clinical accelerators.

Funding:

- NSERC - graduate student support of \$10k/year
- NIH - \$130k/year (to Ottawa) for three years for the OMEGA project

Publications:

- D.W.O. Rogers, "A new approach to electron beam reference dosimetry", *Med. Phys.*, **25**, 310-320, 1998.
- G.G. Zhang, D.W.O. Rogers, J.E. Cygler, and T.R. Mackie, "Effects of changes in stopping-power ratios with field size on electron beam ROFs", (in press) *Med. Phys.*, 1998 .
- G.M. Daskalov, R.S. Baker, R.C. Little, D.W.O. Rogers, and J.F. Williamson, "Multigroup discrete ordinates photon transport calculations of water kerma for brachytherapy applications", in *Proceedings of the 1998 ANS/RP&S Topical Conference*, April, 1998, Nashville, TN (1998).
- G.X. Ding, D.W.O. Rogers, J.E. Cygler, and T.R. Mackie, "Electron fluence correction factors used in conversion of dose measured in plastic to dose in water", *Med. Phys.* **24**, 161-176, 1997.
- C.M. Ma, B.A. Faddegon, D.W.O. Rogers, and T.R. Mackie, Accurate characterization of Monte Carlo calculated electron beams for radiotherapy, *Med. Phys.*, **24**, 401-416, 1997.
- D.W.O. Rogers, A.F. Bielajew, N.V. Klassen, C.K. Ross, J.P. Seuntjens, K.R. Shortt, and L. Van der Zwan, "NRC Activities and Publications, 1995-97": Report to CCEMRI(I) Meeting, BIPM, CCEMRI(1)97-29, 1997.
- M. Holmes, T. R. Mackie, D.W.O. Rogers, and G.X. Ding, "Comparison of clinical electron dose distributions between a commercial radiation treatment planning system and EGS4 Monte Carlo", In *Proceedings of the XII'th Conference on the Use of Computers in Radiotherapy* (Medical Physics Publishing) 54-56, 1997.
- A. Booth and D.W.O. Rogers. "PROT: A General Purpose Utility for Calculating Quantities related to Dosimetry Protocols". *Technical Report PIRS-529*, NRC Canada, Ottawa, K1A 0R6, 1996.
- D.T. Burns, G.X. Ding, and D.W.O. Rogers. "R₅₀ as a beam quality specifier for selecting stopping-power ratios and reference depths for electron dosimetry". *Med. Phys.*, **23**: 383-388, 1996.
- G.X. Ding, D.W.O. Rogers and T.R. Mackie. "Mean energy, energy-range relationship and depth-scaling factors for clinical electron beams". *Med. Phys.*, **23**: 361-376, 1996.

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Recent Research: The amount of ionizing radiation absorbed by a material generally is specified by the quantity absorbed dose. For purposes of radiation therapy, it is the absorbed dose to tissue which is of most interest. As a first step in determining the dose to tissue, the dose to water is established in some well-defined geometry. Field instruments used to determine the dose to water must be calibrated in terms of some reference standard, and one of the objectives of our group is to develop and maintain standards and calibration services for the absorbed dose to water. Our standard for the absorbed dose to water is based on water calorimetry, in which the energy deposited by the radiation field is determined by measuring the temperature rise in irradiated water. Our intention is to have a single standard which can be used for all photon beams from ^{60}Co gamma-rays to 30 MV x-rays.

A quantity of considerable importance to radiation physics and medical physics is the electron stopping power. Stopping power data in use today are based mainly on calculations. In order to test the calculated values, we are measuring electron stopping powers in the energy range from 5 to 40 MeV for various materials. The technique uses a large NaI detector to measure the electron spectrum after the electron beam has passed through an absorber of known thickness. By comparing the measured spectrum to that calculated using Monte Carlo techniques we can extract the stopping power. Measurements have been completed for a wide range of elemental materials and a few composite materials of dosimetric interest. The standard uncertainty on the measured stopping power is about 0.5% and, in general, the calculated stopping powers agree well with the measured values. In the case of graphite, the measurements show that the crystalline density, not the bulk density, should be used when calculating the stopping power.

Publications:

- K. R. Shortt, C. K. Ross and I. Janovsky, "The Response of LiF TLDs to ^{137}Cs and ^{60}Co gamma Rays", *Radiat. Prot. Dosim.* **69**, 257-266, 1997.
- N. V. Klassen and C. K. Ross, "Water Calorimetry: The Heat Defect", *J. Res. Natl. Inst. Stand. Technol.* **102**, 63-74, 1997.
- Y. Nogami and C.K. Ross. "Scattering from a nonsymmetric potential in one-dimension as a coupled channel problem". *Am. J. Phys.* **64**, 923-928, 1996.
- C.K. Ross and N.V. Klassen. "Water calorimetry for radiation dosimetry", *Phys. Med. Biol.*, **41**,1-29, 1996.
- C.K. Ross and M.S. MacPherson. "Comments on 'A new method to determine ratios of electron stopping powers to an improved accuracy'," *Phys. Med. Biol.*, **41**, 785-788, 1996.

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Recent Research: The knowledge of the photon spectrum from medical linear accelerators improves the quality and accuracy of the radiation dosimetry. The spectral shape strongly influences the dose distribution in the patient especially in the presence of heterogeneities, correction factors required for beam calibration, and unit head design. Additionally, the spectrum shape plays a role in dose calculations involving beam modifying devices.

Direct measurement of a photon spectrum is not possible in a clinical environment. As a result,

approximate methods for estimating these spectra must be considered. In our work, an integral equation formulation for unfolding x-ray spectra from transmission data is being studied. The integral equation to be solved is a Fredholm type of the first kind which is, in general, extremely difficult to solve. Our approach is to transform this to a Fredholm type of the second kind, which is handled much more readily using standard numerical methods such as collocation or Galerkin methods. This approach promises to be challenging and has direct application to other areas of medical physics including the inverse-planning problem.

Publications:

- X.A. Li, D. Salhani, C. Ma, "Characteristics of Orthovoltage X-ray Therapy Beams at extended SSD for applicators with end plates", *Phys. Med. Biol.*, 42, 357-370, 1997.

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Recent Research: The general goal of our research is to develop new Magnetic Resonance (MR) imaging methods for improved patient care. Our primary clinical focus is breast cancer. Current research activities in our laboratory include: the use of spin locking and magnetization transfer contrast for improving detection of lesions in radiodense breasts, characterization of breast lesions (benign vs. malignant) using rapid imaging of gadolinium-based contrast agents, image display and development of an MR-based breast biopsy system. Clinical studies to evaluate the usefulness of these techniques are in progress. Other areas of interest include: in vivo measurement of kidney glomerular filtration rate (in collaboration with the University of Wisconsin), basic physics of MR image contrast, development of MR phantom materials and imaging of hyperpolarized gases (i.e. ^{129}Xe and ^3He) for biomedical applications and non-biological material testing.

Funding:

- NIH FIRST Award from NCI: "Spin locking for magnetic resonance imaging of breast cancer", \$100k/yr.
- NRC/NSERC Research Partnership Grant: "Hyperpolarized Noble Gas (HNG) Technology", \$200k/yr.
- Carleton University, GR-5: Magnetic Resonance Imaging of Cerebral Blood Flow in Rats, 97/98, \$3.5K.

Publications:

- Niendorf E.R., T.M. Grist, F.T. Lee Jr., P.C. Brazy and G.E. Santyr, "Rapid *in vivo* Measurement of Single Kidney Extraction Fraction and Glomerular Filtration Rate with MR Imaging", *Radiology* **206**, 791-798 (1998).
- Bishop J.E., G.E. Santyr, F. Kelcz and D.B. Plewes, "Limitations of the Keyhole Technique for Quantitative Dynamic MRI", *J. Magn. Reson. Imag.* **7**, 716 (1997).
- Niendorf E.R., T.M. Grist, R. Frayne, P.C. Brazy and G.E. Santyr, "Rapid Measurement of Gd-DTPA Extraction Fraction in a Dialysis System using Echo-Planar Imaging", *Med. Physics*, **24**, 1907-1913 (1997).
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- Sevigny P., G. Santyr, J. Wallace, S. Breeze, S. Lang, J. Xu, I. Moudrakovski, B. Simard and J. Ripmeester, "MRI of Hyperpolarized Xenon", *Int. Isotope Society 6th Canadian Chapter Meeting, Ottawa 1998* (abstract).

- Sevigny P., G. Santyr, J. Wallace, S. Breeze, S. Lang, J. Xu, I. Moudrakovski, B. Simard and J. Ripmeester, "MRI of Hyperpolarized Xenon", *Canadian Organization of Medical Physicists*, London, 1998 (abstract).
- Wallace J.C., W.K. Myint, R.L. Clarke, G.E. Santyr, "Mapping of Temperature Gradients in Liver using MRI and Thermocouple Temperature Measurements", *Can. Org. of Medical Physicists*, London, 1998 (abstract).
- Cron G.O., G. Santyr, F. Kelcz, "Multislice Adiabatic Saturation Recovery T1 Measurement for quantitative Dynamic Contrast-enhanced Breast MRI", *Can. Organization of Medical Physicists*, London, 1998 (abstract).
- Cron G.O., G.E. Santyr, F. Kelcz, "Dynamic Contrast-Enhanced Imaging of the Breast with Magnetic Resonance", *-IEEE Instrumentation and Measurement Technology Conference*, Ottawa 1997 (abstract).
- Cron G.O., G.E. Santyr, F. Kelcz, "Correction of Errors due to Slice Profile Imperfections in Quantitative Dynamic Contrast-Enhanced Breast MRI", *Intl. Society of Mag. Res. in Medicine*, Vancouver 1997 (abstract).
- Wilson G.J., G.E. Santyr, M.E. Anderson, P.M. DeLuca, T1 "Relaxation Times of Xe-129 in Tissue Homogenates", *Intl. Society of Magnetic Resonance in Medicine*, Vancouver 1997 (abstract).
- Wilson G.J., G.E. Santyr, M.E. Anderson, P.M. DeLuca, "T1 Relaxation Times of Xe-129 in Tissue Homogenates". Workshop on *Perspectives of MR Imaging using Polarized Gases*, Les Houches, France 1996.
- Cron G.O., G.E. Santyr, F. Kelcz, "Dynamic Contrast-Enhanced Imaging of the Breast with Magnetic Resonance", *Ottawa Life Sciences National Conference*, Ottawa 1996 (abstract).

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Recent Research: In an NIH funded project we are measuring absorbed dose beam quality dependence correction factors (k_Q) of commonly used cylindrical ionization chambers in high energy photon beams. Using the newly available high precision Monte Carlo electron transport algorithms developed by I. Kawrakow and A. Bielajew, special attention is given to problems in our current understanding of wall correction factors (P_{wall}) for photon dosimetry.

Our second project, to which currently great effort is being devoted, deals with the commissioning of the sealed water calorimeter in high energy photon beams. If successful, the Canadian absorbed dose standard will be based on this system.

Using the recently developed new electron transport algorithms we are studying correction factors to use a cavity ionization chamber as air kerma standard for HDR ^{192}Ir brachytherapy sources.

In the framework of the American Association of Medical Physicists' RTC Task Group No 61, we are working on a new dosimetry guide for kV X-rays for clinical physicists and radiobiologists.

Publications:

- J.P. Seuntjens, C.K. Ross, N.V. Klassen, and K.R. Shortt, "A status report on the NRC sealed water calorimeter," *Technical Report PIRS-584*, NRC Canada, Ottawa, K1A-0R6, 1997.
- J.P. Seuntjens, L. Van der Zwan, and C.M. Ma, "Type dependent Correction factors for Cylindrical chambers for In-phantom dosimetry in Medium Energy X-ray Beams," *kV X-Ray Workshop*, Stanford University, 1997.
- C.M. Ma, X.A. Li, and J.P. Seuntjens, "Consistency study on kV dosimetry," *Report at the kV X-Ray Workshop*, Stanford University, 1997.
- H. Palmans, J. Seuntjens, F. Verhaegen, J-M Denis, S. Vynckier and H. Thierens, "Water Calorimetry and Ionisation Chamber Dosimetry in a 85 MeV Clinical Proton Beam," *Med. Phys.* **23**, 643- 650, 1996.
- J. Seuntjens and F. Verhaegen, "Dependence of overall correction factor of a cylindrical ionization chamber on field size and depth in medium energy X-ray beams," *Med. Phys.* **23** 1789 - 1796, 1996.
- C.M. Ma and J.P. Seuntjens, "Correction factors for water-proofing sleeves in kilovoltage x-ray beams," *Med. Phys.* (submitted), 1996.

Ken Shortt

Ionizing Radiation Standards, Institute for National Measurement Standards
 National Research Council of Canada
 Ottawa, Canada K1A 0R6
 993-2715 (voice) 952-9865 (fax) kshortt@irs.phy.nrc.ca (e-mail)

Recent Research: The National Research Council is preparing to declare a new standard of absorbed dose to water based on measurements using water calorimetry. The energy dependence of G, the yield of ferric ions produced by irradiating Fricke chemical dosimetry solution, is being studied. The relative value of the absorbed dose calibration factor for a variety of commercially produced transfer ionization chambers, called k_Q , is also under investigation at several linac energies. Radiation detector development with industrial collaborators is continuing as are experiments in radiation protection using TLDs.

Publications:

- K.R. Shortt, C.K. Ross and I. Janovsky. "The response of LiF TLDs to Cs-137 and Co-60 gamma rays". *Rad. Prot. Dosim.* 69, 257-266, 1997.
- C.J. Peters, N.G. Tarr, K.R. Shortt, I. Thomson and G.F. McKay. "A floating gate MOSFET gamma detector". *Can. J. Phys.* 74(suppl.), 685-688, 1996.

Jason (Jiansheng) Sun

Computer Products, Theratronics, 413 March Road, P.O. Box 13140,
 Kanata, Ontario K2K 2B7.
 591-2100x2256 (voice) 592-6559 (fax) sun.j@theratronics.com (e-mail)

Recent Research:

- 3-D external beam, brachytherapy and stereotactic radiosurgery dose calculation algorithms
- Radiation treatment planning optimization methods
- Dynamic radiotherapy techniques and their implementation in 3-D radiation treatment planning systems

Publications:

- J. Sun, U. Orhun and J.R. Cunningham, "Improvement of Dose Calculation Accuracy Under Small Block for High-energy Photon Beam by Using an Effective Block Transmission Factor", *Proceedings of COMP Annual Conference*, London, Ontario, 52-54, 1998.
- J. Sun, C. Plume-Angers, U. Orhun and J.R. Cunningham, "A Semi-orthogonal Brachytherapy Source Reconstruction Algorithm Implemented in Theraplan Plus Treatment Planning System", *Proceedings of COMP Annual Conference* (1997), Charlottetown, PEI, 179-181, 1997.
- J. Sun and Y. Zhu, "Study of Dosimetric Penumbra Due to Multileaf Collimation on a Medical Linear Accelerator", *International Journal of Radiation Oncology, Biology, Physics* **32**, 1409 (1995).

Janos Szanto

Ottawa Regional Cancer Centre, Department of Medical Physics
 501 Smyth Rd
 Ottawa, Ont, K1Y 8L6
 737-7700 x 6741 (voice) 247-3507 (fax) jszanto@cancercare.on.ca (e-mail)

Recent Research:

Design and Dosimetry of a Fractionated Stereotactic Radiotherapy System.

At the Ottawa Regional Cancer Centre we have developed a unique system for the delivery of fractionated stereotactic radiotherapy. Patients are immobilized in a very accurate, stable, reproducible, non-invasive,

relocatable stereotactic frame which is based on a custom made Cobalt-Chrome bite-block that locks into the undercuts of the teeth. The patient motion is measured by our optically based patient position monitoring system and found to be within ± 1 mm.

The dosimetry of small, high energy X-ray beams has been investigated both experimentally and by Monte-Carlo calculations. Some difficulty arises from the lack of lateral electronic equilibrium and the detectors' relatively large sizes.

Publications:

- Szanto, J., Gerig, L.H., Malone S., Girard, A., Ragnitz, H.W., El-Hakim S., "A System for Fractionated Stereotactic Radiotherapy", *Radiotherapy and Oncology*, **40** (Suppl. 1): S186, 1996.

Akhilesh Trivedi (Associate Member)

Radiation Biology and Health Physics Branch, Atomic Energy of Canada Limited
Chalk River, Ontario, K0J 1J0
(613) 584 3311 x 4764 (voice) (613) 584 1689 (fax) trivedia@aecl.ca (e-mail)

Recent Research:

- Radiobiology and dosimetry of tritium and ^{14}C -related compounds encountered in a CANDU reactor operation.
- Development of advanced bioassay techniques (e.g., ICP-MS, TIMS, HPLC, FTA, ^3He -MS) for monitoring ultra low-levels of radionuclides in biological samples.
- Development of physiologically based metabolic models for dose assessment
- Biomarkers for the dosimetry
- Radiobiology of low-dose low dose-rate exposures and risk prediction
- Cellular and molecular biological effects of exposure to environmental factors
- Risk of tumorigenesis and carcinogenesis in living systems
- Membrane biogenesis and bioenergetics

Funding:

- CANDU Owners group (COG) contract for advanced bioassay development program, \$70 k;
- Atomic Energy Control Board (AECB) contract for OBT-in-diet dosimetry, \$65 k;
- AECL R&D support for tritium and carbon-14 dosimetry, \$110 k.

Publications:

- W. J. Workman, A. Trivedi and R. J. Cornett, "Tritium concentrations in indoor air of the home of an occupationally exposed worker." *Health Physics* (in press, 1998).
- F. Cucinotta, J.W. Wilson, R.E.J. Mitchel and A. Trivedi, "Multistage carcinogenesis models and cosmic-ray exposures." *Adv. Space Res.* (in press, 1998).
- A. Trivedi, T. Duong and C.L. Greenstock, "Distribution, biokinetics and dosimetry of tritiated organics." *Radioprotection* **32**, 365-370, 1997.
- A. Trivedi, D. Galeriu and R.B. Richardson, "Dose contribution from metabolised organically bound tritium after acute tritiated water intakes in human." *Health Physics* **73** 1-8, 1997.
- A. Trivedi, D.P. Morrison and N.E. Gentner, "Relative biological effectiveness of organically bound tritium." *Health Phys.* **73**, 397-398, 1997.
- T. Duong and A. Trivedi, "Evaluation of storage conditions for tritiated thymidine as reference organically bound tritium in urine." *Radioanaly. Nucl. Chem. J. Radioanaly. Nucl. Chem.* **226**, 229-231, 1997.
- A. Trivedi, R. J. Cornett, D. Galeriu, W. Workman and R.M. Brown, "Daily tritium intakes by people living near a heavy water reactor research facility: Dosimetric significance. AECL 11648/COG96-333, Chalk River, Ontario, Canada, 1997.

- Yindong, Xu, C.L. Greenstock, A. Trivedi and R.E.J. Mitchel, "Occupational levels of radiation exposure induce interleukin-2 receptor expression in stimulated human peripheral blood lymphocyte." *Radiat. Environ. Biophys.* **35**, 89-93, 1996.
- A. Trivedi, D. Galeriu, R.B. Richardson and E.S. Lamothe, "Dose contribution from organically bound tritium after tritiated water intakes." *Bull. Radiat. Prot.* **19** 1-3, 1996.

Tony Waker

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 Chalk River, Ontario, K0J 1J0
 613 584-8811 x 3610/3611 (voice) 613 584-1713 (fax) wakera@aecl.ca (e-mail)

Recent Research:

The application of microdosimetric methods and counters in radiation protection mixed field dosimetry and monitoring with particular emphasis on the radiation environment within CANDU power plants. The development of low pressure tissue equivalent proportional counters with enhanced sensitivity and collaborative work on the dosimetric properties of Gas Microstrip Detectors developed at Carleton University and the Centre for Research in Particle Physics at Carleton. The development of experimental methods based on laser desorption and time-of-flight mass spectrometry for the study of radiation damage to DNA as part of a program of microdosimetry at the molecular level for the study fundamental aspects of radiation quality.

Publications:

- A. Pejovic-Milic, F.E. McNeill, W.V. Prestwich, A.J. Waker and D.R. Chettle, "Development Of An Accelerator Based Determination Of Aluminium Burden In Peripheral Bone By Neutron Activation Analysis", *Appl. Radiat. Isot.* **49**, 717-719, 1998.
- V. Moiseenko, A.J. Waker and W.V. Prestwich, "Modelling Early Physical And Chemical Events For DNA Damage Induced By Photons And Tritium Beta Particles", *AECL-11850*, COG-97-374-I, 1998.
- V. Moiseenko, A.J. Waker and W.V. Prestwich, "Energy Deposition Patterns For Tritium And Different Energy Photons - A Comparison Study", *Health Phys.* **71**, p388, 1997.
- J.C. Nunes, W.G. Cross and A.J. Waker, "Feasibility Of Creating CANDU-Like Neutron Fields In An Existing Irradiation Facility" *Radiat. Prot. Dosim.* **72**, 11-20, 1997.
- M.A. Huels, J. Khoury, B. Gueraud, B. Boudaiffa, P.C. Dougal, D. Hunting, L. Sanche and A.J. Waker, "A Novel Apparatus For Low Energy Electron (0-5000 eV) Irradiation Of Lyophilized DNA In An Ultra-Clean UHV Environment", *Microdosimetry - An interdisciplinary approach*. (Ed. Goodhead, O'Neil and Menzel) The Royal Society of Chemistry, p89-92, 1997.
- M.A. Huels, J. Khoury, B. Gueraud, B. Boudaiffa, P.C. Dougal, D. Hunting, L. Sanche and A.J. Waker, "Experimental Microdosimetry With Microstrip Gas Counters" *Microdosimetry - An interdisciplinary approach*. (Ed. Goodhead, O'Neil and Menzel) The Royal Society of Chemistry, p383-386, 1997.
- C. R. Hirning and A.J. Waker, "Needs And Performance Requirements For Neutron Monitoring In The Nuclear Power Industry", *Radiat. Prot. Dosim.* **70**, 67-72, 1997.
- A.J. Waker, K. Szornel and J. Nunes, "TEPC Performance In The CANDU Workplace", *Radiat. Prot. Dosim.* **70**, 197-202, 1997.
- J. C.Nunes, A. J. Waker and A. Arneja, "Neutron Spectrometry and Dosimetry In Specific Locations at Two CANDU Power Plants", *Radiat. Prot. Dosim.* **63**, 87-104, 1996.
- J.C. Nunes, A.J. Waker and M. Lieskovský, "Neutron Fields Inside Containment of a CANDU-600 HWR Power Plant", *Health Phys.* **71**, 235-247, 1996.

Curricula Vitae of New Members

Madhu Dixit (Associate Member)

EDUCATION

1971 Ph.D., Physics, University of Chicago
1963 M.Sc., Physics, University of Delhi
1961 B.Sc., Vikram University

PROFESSIONAL EXPERIENCE

1990 - present Research Scientist & Adjunct Professor, CRPP and Dept. of Physics, Carleton University.
1986 - 90 Senior Research Officer, National Research Council of Canada
1979 - 85 Associate Research Officer, National Research Council of Canada.
1976 - 79 Senior Research Fellow, University of Victoria
1973 - 75 Research Associate, Carleton University
1971 - 73 Associate Research Physicist, University of California, Los Angeles

RESEARCH AND DEVELOPMENT INTERESTS

- Experimental elementary particle physics, weak interactions, development of new detectors and instrumentation for particle physics and applied physics. Present interests are: OPAL experiment at CERN and the development of gas microstrip detectors for digital x-ray imaging for medical and industrial applications and for radiation dosimetry.

PROFESSIONAL AFFILIATIONS

IEEE Instrumentation and Measurements Technical Committee on Imaging Systems
Member of the American Physical Society
Member of the Canadian Association of Physicists

SAMPLE PUBLICATIONS

- D.G. Gobbi, J.C. Armitage, M.S. Dixit, J. Dubeau, P.C. Johns, D. Karlen and F.G. Oakham, "Photon counting radiography with gas microstrip detectors", *Proc. 43rd Ann. Meet. Can. Org. Med. Phys.*, 31-33, 1997, [Abs: *Med Phys.* **24**, 1997].
- M.S. Dixit, J.C. Armitage, J. Dubeau, D.G. Gobbi, P.C. Johns, D. Karlen, and F.G. Oakham, "Development of gas microstrip detectors for digital x-ray imaging and radiation dosimetry", to be published in *IEEE Trans. in Instrumentation and Measurements*, IMTC97, special issue, 1998.
- R. Sudharsanan, N.H. Karam, A.C. Greenwald, M. Dixit, J. Dubeau, and E.W. Sommerville, "Deposition and characterization of CdZnTe thin films for gas microstrip detectors", *IEEE Trans. Nucl. Sci.*, **3**, 665 (1997).
- J. Dubeau, J.C. Armitage, M.S. Dixit, *et al.*, "High Rate and Aging Properties of Microstrip Gas Counters on Plastic Substrates", *Nucl. Instrum. and Methods*, **A367**, 177, 1995.
- G.C. Stuart, J.C. Armitage, M.S. Dixit, J. Dubeau, G.G. Oakham, and S.C. Taylor, "Drift velocity measurements using MSGCs in a test beam", *Nucl. Instrum. and Methods*, **A357**, 605 (1995).
- S.C. Taylor, J.C. Armitage, D. Batchelor, M.S. Dixit, *et al.*, "Operation of plastic MSGCs at high rates", *IEEE Trans. on Nucl. Sci.*, **42**, 432, 1995.

Iwan Kawrakow

EDUCATION

- 1994 Ph.D., Physics, University of Leipzig
 1990 Diploma in Physics, University of Leipzig

PROFESSIONAL EXPERIENCE

- 1998 - present Research Assistant at the IRS-Group/NRC
 1996 - 1998 Postdoctoral fellow at the IRS-Group/NRC
 1994 - 1996 Research Associate at the Clinic for Radiation Therapy and Oncology, University of Leipzig

HONOURS

- Helax Award for the best contribution on the Roentgen Congress in Wuerzburg/Germany 1995
- University of Leipzig Award for the best Masters Thesis in 1990

CURRENT RESEARCH INTERESTS

Electron transport theory, Monte Carlo techniques, theoretical dosimetry

SAMPLE PUBLICATIONS

- I.Kawrakow and A.F.Bielajew, "Single and multiple scattering of electrons", *Nuc Inst. & Meth B* **134**, 325-336 (1998).
- I.Kawrakow and A.F.Bielajew, "On the Condensed History technique", *Nuc Inst. & Meth B* (in press, 1998).
- I.Kawrakow, "Improved modelling of multiple scattering in the VMC model", *Med. Phys.* **24**, 505-517 (1997).
- M.Fippel, I.Kawrakow and K.Friedrich, "Electron beam dose calculations with VMC and the verification data set of the NCI working group", *Phys. Med. Biol.*, **42**, 501-519 (1997).
- I.Kawrakow, "Electron transport: lateral and longitudinal correlation algorithm", *Nuc Inst. & Meth B* **114**, 307-32 (1996).
- I.Kawrakow, "Electron transport: multiple and plural scattering", *Nuc Inst. & Meth B*, **108**, 23-34 (1996).
- I.Kawrakow, M.Fippel and K.Friedrich, "3D Electron Dose Calculation using a Voxel based Monte Carlo Algorithm", *Med. Phys.* **23**, 445-457 (1996).
- I.Kawrakow, "State-of-the-art Monte Carlo techniques for Radiation Treatment Planning", Invited talk, *World Congress on Med. Phys. and Biomed. Engineering*, Nice, France, 1997.
- I.Kawrakow and A.F.Bielajew, "New multiple scattering theory and transport algorithm for electron Monte Carlo simulations", *Proceedings of XII ICCR*, Salt Lake City 155, (1997).
- A.F.Bielajew and I.Kawrakow, "The EGS4/PRESTA-II electron transport algorithm: Tests of step-size stability", *Proceedings of XII ICCR*, Salt Lake City, 153, (1997).

Gabriel Lam

EDUCATION

- 1974 Ph.D., Medical Biophysics, University of Toronto.
 1971 M.Sc., Physics, University of Western Ontario.
 1970 B.Sc., University of Hong Kong.

PROFESSIONAL EXPERIENCE

- 1997 - present Medical Physicist, Ottawa Regional Cancer Centre
 1998 - present Assistant Professor, Department of Radiology, University of Ottawa
 1976 - 1996 Medical Physicist, British Columbia Cancer Agency
 1974 - 1976 MRC Research Fellow, British Columbia Cancer Agency
 1979 - 1997 Honorary Assistant Professor, Department of Pathology, University of British Columbia

PROFESSIONAL CERTIFICATION

MCCPM, (1997), Peer Review A, OCTRF (1997), FCCPM, (1997)

RESEARCH INTERESTS

- Radiotherapy using charged particle beams including negative pi-mesons and protons. Development of dosimetry and beam delivery techniques for particle beams.
- Theoretical radiobiology of combined effects of mixtures of radiations of different qualities Investigation of the general concept of effective dose in radiobiology and in radiotherapy.
- Theoretical studies of interaction of toxic agents. Development of general interpretation and definition of synergism and antagonism for mixtures of toxic agents with different mechanisms of action.

RECENT PUBLICATION

- K. Nemoto, T. Pickeles, A. Minchinton and G. Lam, "The Relative Biological effectiveness of the Modulated Proton Beam at TRIUMF", *Radiation Medicine*, **16**, pp.43-46 (1998).

Jason (Jiansheng) Sun

EDUCATION

1991 - 1992 Special Graduate Studies, Carleton University
1987 - 1991 Ph.D. Solid State Physics, Concordia University
1982 - 1984 M.Sc. Solid State Physics, Nanjing University
1978 - 1982 B.Sc. Physics, Nanjing University

PROFESSIONAL EXPERIENCE

1997 - present Senior Medical Physicist, Theratronics, Kanata, Ontario
1994 - 1996 Medical Physicist, Computer Products, Theratronics
1993 - 1994 P.D.F, Clinical Physics, Ontario Cancer Institute/Princess Margaret Hospital, Toronto
1991 - 1992 Assistant Research Officer, IRS, National Research Council of Canada, Ottawa
1987 - 1991 Teaching & Research Assistant, Physics Department, Concordia University
1984 - 1986 Teacher & Researcher, Centre of Materials Analysis, Nanjing University

RESEARCH INTERESTS

- 3-D external beam, brachytherapy and stereotactic radiosurgery dose calculation algorithms
- Radiation treatment planning optimization methods
- Dynamic radiotherapy techniques and their implementation in 3-D radiation treatment planning systems

SAMPLE PUBLICATIONS

- J. Sun, U. Orhun and J.R. Cunningham, "Improvement of Dose Calculation Accuracy Under Small Block for High-energy Photon Beam by Using an Effective Block Transmission Factor", *Proceedings of COMP Annual Conference*, London, Ontario, 52-54, 1998.
- J. Sun, C. Plume-Angers, U. Orhun and J.R. Cunningham, "A Semi-orthogonal Brachytherapy Source Reconstruction Algorithm Implemented in Theraplan Plus Treatment Planning System", *Proceedings of COMP Annual Conference*, Charlottetown, PEI, 179-181, 1998.
- J. Sun and Y. Zhu, "Study of Dosimetric Penumbra Due to Multileaf Collimation on a Medical Linear Accelerator", *International Journal of Radiation Oncology, Biology, Physics* **32**, 1409 (1995).
- J. Sun, Y. Zhu and J. Van Dyk, "Calculation and Measurement of Photon Dose Inhomogeneity Correction Factors", *Medical Physics* **21**, 924 (1994) (abstract).
- J. Sun and Y. Zhu, "Dosimetric Study of Asymmetric Photon Beams Due to Multileaf Collimation", *Medical Physics* **21**, 1358 (1994) (abstract).

Seminars

OMPI Seminars

One of the main vehicles of the OMPI for developing and maintaining contact is through a seminar series in which all the members and the graduate students in medical physics are required to make a presentation. Seminars are scheduled monthly, and for the last several years have been held at 3:30 p.m. on Thursdays. The seminar location is rotated among the major centres involved in medical physics. Seminar information is posted on the web at <http://www.physics.carleton.ca/research/OMPI>.

Following is a list of OMPI seminars held in 1997-98. The second speaker listed is a graduate student (except Dec. 11).

September 18, 1997 at Carleton University

Jiansheng Sun	Theratronics	<i>Selected physics issues in a 3-D radiation treatment planning system</i>
Tanya Hewitt	Carleton	<i>Single photon emission CT using a pinhole collimator</i>

October 16, 1997 at the Ottawa Civic Hospital

Paul Johns	Carleton	<i>Putting scattered x rays to work</i>
Greg Cron	Carleton	<i>Correction of errors due to pulse sequence and hardware imperfections in quantitative dynamic Gd-enhanced breast MRI</i>

November 20, 1997 at the Ottawa General Hospital

Clive Greenstock	AECL	<i>Recent developments in biophysical dosimetry</i>
Miller MacPherson	Carleton	<i>Measured electron stopping powers from 5 to 30 MeV</i>

December 11, 1997 at NRC

Gordon Symonds	Health Canada	<i>National survey of Canadian mammographic facilities</i>
Ian Cameron	OGH	<i>Water diffusion in MR imaging</i>

January 15, 1998 at the Ottawa Life Sciences Technology Park

Iwan Kawrakow	NRC	<i>Strategies for improving calculation speed of Monte Carlo simulation for radiation therapy</i>
Narine Kizilian	Carleton	<i>Detection of apoptosis using single cell gel electrophoresis assay</i>

February 19, 1998 at the Ottawa Regional Cancer Centre, General Div.

Jan Seuntjens	NRC	<i>Sealed water calorimetry and dissemination of absorbed dose to water through k_Q factors</i>
Geoff Zhang	Carleton	<i>Corrections for relative output factor measurement using an ion chamber</i>

March 19, 1998 at Carleton University

Gabriel Lam	ORCC	<i>The combined effects of mixtures of radiation - a theoretical radiobiological study of the interaction of radiation damages</i>
Daron Owen	Carleton	<i>Camptothecin as a radiosensitizer for LDR irradiation</i>

April 16, 1998 at the Ottawa Regional Cancer Centre, Civic Div.

Madhu Dixit	Carleton/CRPP	<i>Digital radiography with photon counting gaseous detectors</i>
Debbie Smith	Carleton	<i>Radiobiology and pulsed dose rate brachytherapy</i>

Carleton University Physics Department Seminars

Carleton University Physics Department runs a regular seminar series on Monday afternoons (with overflow to other days of the week) at 3:30 p.m. in the Herzberg Building. Information on upcoming seminars is posted on the web. (<http://www.physics.carleton.ca/seminars>). The following seminars of interest to medical physics were held in 1997-98:

September 15 - Dr. Walter Huda, Syracuse: *Computed Radiography: Present and Future.*

September 22 - Dr. R. Morrison, Carleton: *What to do with Nuclear Weapons Material?*

October 20 - Dr. Gary Slater, U of O: *Genetics, Physics, and the Human Genome Project.*

October 27 - Dr. Richard Richardson, AECL: *Fusion, Tritium and the Dosimetry of Tritiated Particulates.*

November 3 - Dr. Madhu Dixit, CRPP: *Digital Radiography using the Gas Microstrip Detector.*

November 24 - Dr. Peter Munro, Univ. of Western Ont: *Technologies for Identifying Geometric Errors in Radiation Therapy.*

December 18 - OCIP Christmas Symposium - Dr Paul Johns, Carleton: *Medical Imaging with Scattered X Rays.*

January 5 - Dr. Don Wiles, Carleton (Chemistry): *Canada's Approach to High-Level Nuclear Waste Disposal.*

Feb. 16 - Dr. Terry Thompson, UWO: *NMR Spectroscopy: No Medical Relevance or New Medical Revolution?*

March 9 - Dr. John Schreiner, Kingston Regional Cancer Centre and Queen's U: *Gel Dosimeters for Volumetric Radiation Dosimetry.*

April 27 - Dr. Howard Michaels, UofT: *Medical Physics Considerations for Stereotactic Radiosurgery and Radiotherapy.*

May 13 - Dr. Pablo J. Prado, Univ. of New Brunswick: *Magnetic Resonance Imaging of Gases: Sensitivity and Resolution Considerations for Time-Efficient Methods.*

OCIP Graduate Student Seminars

November 26 - Fall Seminars

- Daryoush Sheikh-Bagheri, Carleton: *Monte Carlo Simulation of Photon Beams from Medical Linear Accelerators: Improving the Efficiency and Benchmarking the Code.*

- Sheri Boyden, Carleton: *Evidence of Induced Resistance from Survival Curves.*

May 7 - Spring Seminars, I

- Tanya Hewitt, Carleton: *Pinhole SPECT and the Thyroid Organ: A New Look.*

- Robert Leclair, Carleton: *A Systematic Approach to Quantify the Information Content of X-Ray Scatter Images versus Primary Photon Images.*

May 11 - Spring Seminars, II

- Gosia Niedbala, Carleton: *Comparison of Pulse Simulated Low Dose Rate to Low Dose Rate Irradiation with/without Hyperthermia.*

Other Seminars of Interest to the OMPI

In addition to the seminars listed in the above sections, there are a variety of other seminars in the Ottawa area which are of interest to the OMPI. The ones which have been brought to our attention are noted below:

July 16, 1997 at ORCC - Dr Gabriel Lam, Univ. of BC: *The Use of Heavy Charged Particles in Radiotherapy*

July 21, 1997 at the Heart Institute - Dr Terry Oakes, Univ. of BC: *Quantitative Aspects of 3D PET*

July 23, 1997 at NRC - Dr Chunli Yang, Cologne: *One Example of Applications of Nuclear Gamma Resonance Spectroscopy*

July 23, 1997 at ORCC - Dr Patrick Rapley, Northwest Ontario Regional Cancer Centre: *Surface Dose Measurements with TLD Powder Extrapolation*

August 14 1997, at NRC - Dr Allister Ferguson, U. of Strathclyde: *All Solid State Light Sources for Biomedical Imaging.*

October 9 1997, OCIP Seminar at U of O - Dr Sadao Hattori, Japan: *Is Low Dose Radiation Harmful? What are the Radiobiological Evidences?*

December 17, 1997, IEEE EMBS Ottawa Chapter at Carleton Univ. - Carrie Charette: *Is there a Future for a Biomedical Professional at Nortel?*

May 12, 1998, U of O Radiology Research Day:

- Dr. Ian Cameron, Ottawa Hospital: *Diffusion Weighted MR Imaging*

- Tanya Hewitt, Carleton: *A Possible New Way of Viewing the Thyroid: Pinhole SPECT.*

June 30, 1998, Ottawa Work Group for Imaging Research at the U. of O. Neuroscience Research Inst. - Dr Ian Cameron and Dr Matthew Hogan: *Cerebral Perfusion Imaged by MRI Following Bolus Injection of Contrast.*

Medical Physics Graduate Courses

The Carleton medical physics program has three specializations: imaging, therapy and biophysics. Shown below is the menu of courses for each. Required course numbers are printed in **underlined bold font**; the others are recommended.

Depending on the thesis weighting, the Ph.D typically requires four half-courses in addition to the thesis. The normal MSc course requirement is 5 half-courses in addition to the thesis, effective fall 1998. PhD students who lack any of the relevant courses (or their equivalents) required for the MSc must complete them in their PhD. MSc students may be permitted to take up to two fourth-year half-courses and credit them towards the degree. PhD students can credit only graduate courses.

When a student has covered material in a prior program, such as an MSc in medical physics elsewhere, then the equivalent courses at Carleton are of course not required. The courses to be taken by a given student will be decided on in consultation with the student and the supervisor.

Listed for each course is the course number, the campus where taught and the course name. Carleton courses are numbered with the prefix "75" indicating Physics, followed by a 400-series number if fourth year, or either a 500- or 600- series number for graduate courses.

Specialization in Imaging

<u>Fall Term</u>	<u>75.523</u>	Carleton	Medical Radiation Physics
	<u>75.423</u>	Carleton	Physical Applications of Fourier Analysis ¹
	75.527	Carleton	Radiobiology
	75.529	Carleton	Medical Physics Practicum
<u>Winter Term</u>	<u>75.524</u>	Carleton	Physics of Medical Imaging
	75.526	Carleton	Medical Radiotherapy Physics
	75.528	Carleton	Radiation Protection
<u>Fall & Winter</u> (both terms)	ANA 7301	Ottawa HSC ²	Anatomy
	PHS 5210	Ottawa HSC ²	Physiology
<u>Fall or Winter</u>	<u>75.5xx/6xx</u>	Carleton or Ottawa	Half-course outside of medical physics ³

Specialization in Therapy

<u>Fall Term</u>	<u>75.523</u>	Carleton	Medical Radiation Physics
	75.527	Carleton	Radiobiology
	75.529	Carleton	Medical Physics Practicum
<u>Winter Term</u>	75.524	Carleton	Physics of Medical Imaging
	<u>75.526</u>	Carleton	Medical Radiotherapy Physics
	75.528	Carleton	Radiation Protection
<u>Fall & Winter</u> (both terms)	ANA 7301	Ottawa HSC ²	Anatomy
	PHS 5210	Ottawa HSC ²	Physiology
<u>Fall or Winter</u>	<u>75.5xx/6xx</u>	Carleton or Ottawa	Half-course outside of medical physics ³

Specialization in Biophysics

<u>Fall Term</u>	<u>75.523</u>	Carleton	Medical Radiation Physics
	<u>75.527</u>	Carleton	Radiobiology ⁴
	75.529	Carleton	Medical Physics Practicum
<u>Winter Term</u>	75.524	Carleton	Physics of Medical Imaging
	75.526	Carleton	Medical Radiotherapy Physics
	75.528	Carleton	Radiation Protection
<u>Fall & Winter</u> (both terms)	<u>ANA 7301</u>	Ottawa HSC ²	Anatomy ⁴
	<u>PHS 5210</u>	Ottawa HSC ²	Physiology ⁴
<u>Fall or Winter</u>	<u>75.5xx/6xx</u>	Carleton or Ottawa	Half-course outside of medical physics ³

¹ Prerequisite to 75.524; additional to degree if PhD

² HSC = Health Sciences Centre, Smyth Road

³ Subject to approval. Permission may be given for 75.4xx if MSc

⁴ In the Biophysics specialization, one of Radiobiology, Anatomy or Physiology must be taken.

Course Descriptions

75.523 – Medical Radiation Physics (½ course, Fall) Basic interaction of electromagnetic radiation with matter. Sources: x ray, accelerators, nuclear. Charged particle interaction mechanisms, stopping powers, kerma, dose. Introduction to dosimetry. Units, measurements, dosimetry devices.

Reference: H.E. Johns and J.R. Cunningham, *The Physics of Radiology*, 4th ed., 1983.

Lecturer: P.C. Johns

75.524 – Physics of Medical Imaging (½ course, Winter) Outline of the principles of transmission x-ray imaging, computerized tomography, nuclear medicine, magnetic resonance imaging, and ultrasound. Physical descriptors of image quality, including contrast, resolution, signal-to-noise ratio, and modulation transfer function are covered and an introduction is given to image processing.

Prerequisites: 75.523 or equivalent and 75.423 or equivalent.

Reference: S. Webb, editor, *The Physics of Medical Imaging*, 1988.

Lecturers: G. E. Santyr and P.C. Johns.

75.526 – Medical Radiotherapy Physics (½ course, Winter) Terminology and related physics concepts. Bragg-Gray, Spencer-Attix cavity theories, Fano's Theorem. Dosimetry protocols, dose distribution calculations. Radiotherapy devices, hyperthermia.

Prerequisite: 75.523 or equivalent.

References: F.H. Attix, *Introduction to Radiological Physics and Radiation Dosimetry*, 1986.

H.E. Johns and J.R. Cunningham, *The Physics of Radiology*, 4th ed., 1983.

Lecturers: J. Cygler, J. Seuntjens, K.R. Shortt, I. Kawrakow, and L.H. Gerig.

75.527 – Radiobiology (½ course, Fall) Introduction to basic physics and chemistry of radiation interactions, free radicals, oxidation and reduction, G values. Subcellular and cellular effects: killing, repair, sensitization, protection. Measurement methods. Survival curve models. Tissue effects, genetic and carcinogenic effects, mutations, hazards. Cancer therapy. Radiation protection considerations.

Prerequisite: 75.523 or equivalent must have been taken, or be taken concurrently.

Reference: E.J. Hall, *Radiobiology for the Radiologist*, 4th ed., 1994.

Lecturer: G.P. Raaphorst

75.528 – Radiation Protection (½ course, Winter) Biophysics of radiation hazards, dosimetry and instrumentation. Monitoring of sources, planning of facilities, waste management, radiation safety, public protection. Regulatory agencies.

Prerequisite: 75.523 or equivalent.

Reference: Herman Cember, *Introduction to Health Physics*, 3rd ed., 1996.

Lecturer: V. Elagupillai

75.529 – Medical Physics Practicum (½ course, Fall) Hands-on experience with current clinical medical imaging and cancer therapy equipment, and dosimetry and biophysics instrumentation. Experimental projects on medical imaging, radiotherapy, dosimetry, and biophysics, conducted at local clinics and NRC laboratories.

Prerequisites: 75.523 or equivalent. Also, as appropriate to the majority of projects undertaken, one of 75.524, 75.526, or 75.527 or other biophysics course, or permission of the Department.

Coordinator: B. J. Jarosz

ANA 7301 – Anatomy for Medical Physics Graduate Students (½ course, extends through Fall and Winter) A basic course in anatomy for medical physics students utilizing the systemic approach to emphasize practical and clinical aspects of the gross structure of the human body. The course consists of lectures, laboratory demonstrations with dissected materials and a series of audio-visual presentations involving imaging techniques.

PHS 5210 – Mammalian Physiology (full course, extends through Fall and Winter) A comprehensive study of mammalian physiology with an emphasis on regulating mechanisms. The course includes the biophysical basis of excitable tissues and the physiology of the central nervous system, blood and cardiovascular system, respiratory system, endocrine system, G.I. tract and renal physiology. It is assumed that students have a basic knowledge of chemistry, physics and biology.

75.423 – Physical Applications of Fourier Analysis (½ course, Fall) Laplace transform and its application to electrical circuits. Fourier transform, convolution. Sampling theorem. Applications to imaging: descriptors of spatial resolution, filtering. Correlation, noise power. Discrete Fourier transform, FFT. Filtering of noisy signals. Image reconstruction in computed tomography and magnetic resonance. Integral transforms and their application to boundary-value problems.

Prerequisite: Physics 75.387; or permission.

Reference: R.N. Bracewell, *The Fourier Transform and its Applications*, Revised 2nd ed., 1986.

Lecturer: P.C. Johns

75.502 – Computational Physics (½ course, extends through Fall and Winter) Computational methods used in physics research. Introduction to the UNIX operating system. Numerical methods for problems in linear algebra, interpolation, integration, root finding, minimization, and differential equations. Monte Carlo methods for simulation of random processes. Statistical methods for parameter estimation and hypothesis tests. Chaotic dynamics.

Prerequisite: An ability to program in FORTRAN, C, or C++ and permission of the Department.

Lecturer: D. Karlen

Half-course outside of medical physics A half-course in an area of physics outside of medical physics is required. Appropriate possibilities include nuclear, theoretical, quantum, particle, and solid-state physics. Selection is subject to the approval of the Academic Officer.

Giles Santyr, Academic Officer, OMPI

Students

Medical Physics Programme Graduate Students

Note: "Starting date" is the date first taking courses or commenced lab work, not registration date.

Ph.D. Students

*Cron,
Greg
Physics Department, Carleton University
1125 Colonel By Drive, Ottawa K1S 5B6
520-2600x1073 (voice) 520-4061 (fax) gcron@physics.carleton.ca (e-mail)
Starting date: 9/95, Supervisor: Santyr, Specialization: Imaging
Thesis topic: Quantitative dynamic MRI of the breast

Gates,
Larry
MRI Unit, Department of Radiology, Ottawa Hospital - General Site
501 Smyth Road, Ottawa K1H 8L6
Starting date: 9/91, Defence date: 8/97, Supervisor: Cameron, Specialization: Imaging
Thesis topic: MRI measurement of water diffusion

Leclair,
Robert
Physics Department, Carleton University
1125 Colonel By Drive, Ottawa K1S 5B6
520-2600x1854 (voice) 520-4061 (fax) robert@physics.carleton.ca (e-mail)
Starting date: 9/94, Supervisor: Johns, Specialization: Imaging
Thesis topic: X-ray imaging using scattered radiation

*Registered at University of Wisconsin at Madison

Lenton,
Kevin Radiation Biology and Health Physics Branch, AECL Research
 Chalk River Laboratories. Chalk River, Ontario K0J 1J0
 Starting date: 9/92, Defence date: 4/98, Supervisor: Greenstock, Specialization: Biophysics
 Thesis topic: Studies of radiosensitivity at the cellular level

MacPherson,
Miller Ionizing Radiation Standards, Institute for National Measurement Standards
 National Research Council of Canada, Ottawa K1A 0R6
 993-2197 (voice) 952-9865 (fax) mmacpher@irs.phy.nrc.ca (e-mail)
 Starting date: 2/93, Supervisor: Ross, Specialization: Therapy
 Thesis topic: Measurement of electron stopping powers

Sheikh-Bagheri,
Daryoush Ionizing Radiation Standards, Institute for National Measurement Standards
 National Research Council of Canada, Ottawa K1A 0R6
 993-2197 (voice) 952-9865 (fax) dbagheri@irs.phy.nrc.ca (e-mail)
 Starting date: 9/93, Supervisor: Rogers, Specialization: Therapy
 Thesis topic: OMEGA (online Monte Carlo radiotherapy planning)

Soubra,
Mazen Ottawa Regional Cancer Centre, Department of Medical Physics,
 501 Smyth Road, Ottawa K1H 8L6.
 Starting date: 9/88, Defence date: 8/97, Supervisor: Gerig, Specialization: Therapy
 (part-time) Thesis topic: Asymmetric linac fields for radiotherapy

Zhang,
Geoffery Ionizing Radiation Standards, Institute for National Measurement Standards
 National Research Council of Canada, Ottawa K1A 0R6
 993-2197 (voice) 952-9865 (fax) gzhang@irs.phy.nrc.ca (e-mail)
 Starting date: 10/93, Supervisor: Rogers, Specialization: Therapy
 Thesis topic: OMEGA (online Monte Carlo radiotherapy planning)

M.Sc. Students

Boyden,
Sheri Ottawa Regional Cancer Centre, Department of Medical Physics
 501 Smyth Road, Ottawa, K1H 8L6
 Starting date: 9/95, Defence date: 5/98, Supervisor: Raaphorst, Specialization: Biophysics
 Thesis topic: Biophysics of radiation damage and repair

Gauthier,
Yvan MRI Unit, Department of Radiology, Ottawa Hospital, General Site
 501 Smyth Road, Ottawa K1H 8L6.
 737-8476 (voice) 737-8611 (fax) ygauthie@physics.carleton.ca (e-mail)
 Starting date: 1/98, Supervisor: Cameron, Specialization: Imaging
 Thesis topic: MRI measurement of water diffusion.

Gobbi,
David Physics Department, Carleton University
 1125 Colonel By Drive, Ottawa K1S 5B6
 Starting date: 9/95, Defence date: 9/97, Supervisor: Johns/Dixit, Specialization: Imaging
 Thesis topic: Gas microstrip detector

Hewitt,
Tanya Division of Nuclear Medicine, Ottawa Hospital - Civic Site
 1053 Carling Ave, Ottawa K1Y 4K7
 798-5555x3352 (voice) 761-4041 (fax) thewitt@physics.carleton.ca (e-mail)
 Starting date: 9/96, Supervisor: McKee, Specialization: Imaging
 Thesis topic: Pinhole SPECT

- Kizilian,
Narine
Radiation Protection Bureau, Health Canada
Radiobiology Section, 775 Brookfield Road, Ottawa, K1A 1C1.
954-9584 (voice) 941-1734 (fax) Narine_Kizilian@hc-sc.gc.ca (e-mail)
Starting date: 9/97, Supervisor: Raaphorst, Specialization: Biophysics
Thesis topic: Radiosensitivity by measuring Apoptosis using the Comet assay
- Li,
Jun
Ottawa Regional Cancer Centre, Department of Medical Physics
501 Smyth Road, Ottawa, K1H 8L6
737-7700x6942 (voice) 247-3507 (fax) jli@physics.carleton.ca (e-mail)
Starting date: 9/96, Supervisor: Ng, Specialization: Biophysics
Thesis topic: Biophysics of radiation damage and repair
- Niedbala,
Malgorzata
Ottawa Regional Cancer Centre, Department of Medical Physics
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737-7700x6942 (voice) 247-3507 (fax) niedbala@physics.carleton.ca (e-mail)
Starting date: 9/96, Supervisor: Raaphorst, Specialization: Biophysics
Thesis topic: Biophysics of radiation damage and repair
- Owen,
Daron
Ottawa Regional Cancer Centre, Department of Medical Physics
501 Smyth Road, Ottawa, K1H 8L6
737-7700x6942 (voice) 247-3507 (fax) down@physics.carleton.ca (e-mail)
Starting date: 9/97, Supervisor: Ng, Specialization: Biophysics
Thesis topic: Effects of low dose rate radiation with chemotherapeutic drug.
- Sevigny,
Pascale
Physics Department, Carleton University
1125 Colonel By Drive, Ottawa K1S 5B6
520-2600x1855 (voice) 520-4061 (fax) psevigny@physics.carleton.ca (e-mail)
Starting date: 9/97, Supervisor: Santyr, Specialization: Imaging
Thesis topic: MR imaging using hyperpolarized xenon
- Smith,
Debbie
Ottawa Regional Cancer Centre, Department of Medical Physics
501 Smyth Road, Ottawa, K1H 8L6
737-7700x6942 (voice) 247-3507 (fax) dsmith@physics.carleton.ca (e-mail)
Starting date: 9/97, Supervisor: Raaphorst, Specialization: Biophysics
Thesis topic: Pulsed Dose Rate Brachytherapy

Graduate Student Theses Completed in '97-98

- | <u>Student</u> | <u>Degree</u> | <u>Thesis Title</u> |
|----------------|---------------|--|
| Boyden, Sheri | M.Sc. | <i>"Investigation of Adaptive Response in Human Tumour and Normal Cell Lines with Varying Radiosensitivity"</i>
Thesis Supervisor: Peter Raaphorst.
Examination Date: May 4, 1998. |
| Gates, Larry | Ph.D. | <i>"A Study of Water Mobility in Human Tissue In Vivo: Apparent Diffusion Coefficients in Brain and Leg Muscle"</i>
Thesis Supervisor: Ian Cameron.
Examination Date: August 11, 1997. |
| Gobbi, David | M.Sc. | <i>"A High-Pressure Gas Microstrip Detector for Digital Radiography"</i>
Thesis Supervisors: Paul Johns, Madhu Dixit.
Examination Date: September 9, 1997. |

Lenton, Kevin	Ph.D.	<i>"Hydroxyl Radical Scavengers and Antioxidants in Radiation Protection"</i> Thesis Supervisor: Clive Greenstock. Examination Date: April 28, 1998.
Soubra, Mazen	Ph.D.	<i>"Linac Head Scatter Factor for Asymmetric Radiation Field"</i> Thesis Supervisor: Lee Gerig. Examination Date: August 28, 1997.

Undergraduate Honours Physics Project Completed in '97-98

<u>Student</u>	<u>Course</u>	<u>Project Title</u>
Myint, Kenji	75.499	<i>"MRI Thermometry"</i> Supervisor: Giles Santyr.

Visiting Student in '97-98

<u>Student</u>	<u>Home University</u>	<u>Project Title</u>
Buffet, Corinne	Université Joseph Fourier Grenoble, France	<i>"Quantitative Diffraction Measurements of Biological Tissues for Medical Applications"</i> Supervisor: Paul Johns.

Past Student Graduates

Below are listed the current positions held by graduates from the Carleton Physics program in Medical Physics.

BSS Rao	MSc	1970	
Holo Devnani	MSc	1971	
Alan Mortimer	MSc	1974	Scientist, Canadian Space Agency
Donald Richardson	MSc	1975	
Mike White	MSc	1977	Ontario Hydro
Michael Ebifegha	MSc	1980	
Kulvir Kapoor	PhD	1981	Ontario Hydro
Hripsime Shahbazian	MSc	1984	
Bruce Faddegon	PhD	1990	Radiotherapy physicist, Toronto-Sunnybrook Regional Cancer Centre
Elias Zakhour	MSc	1991	Was Physics assistant, Ottawa Regional Cancer Centre. Present position unknown.
Reza Dokht	MSc	1991	sessional instructor in medical physics, Tehran
Julia Older	MSc	1991	(BSc, 1989) Physics assistant, Ottawa Regional Cancer Centre
Andrew Weber	MSc	1991	(BSc, 1988) telecommunications industry
David Wilkins	PhD	1993	Radiotherapy physicist, Ottawa Regional Cancer Centre
Ted Lawrence	MSc	1993	Radiotherapy physicist, Sydney, N.S.
Dennis Heller	PhD	1993	Faculty of Medicine, Univ. of Cincinnati
George Ding	PhD	1995	Radiotherapy physicist, Vancouver
Doru Kaytar	MSc	1995	software industry
Dennis Akyürekli	PhD	1995	(MSc, 1988, BSc, 1985) Radiotherapy physicist, Kingston Regional Cancer Centre
Bilal Shahine	MSc	1995	PhD student at Univ. British Columbia
Ria Corsten	MSc	1995	Radiotherapy physicist, St. John's, Nfld.
Julia Wallace	PhD	1996	Post-doc with Prof. Giles Santyr (CMRF)
Patrick Rapley	PhD	1996	Radiotherapy physicist, Kelowna, B.C.
Cathy MacGillivray	MSc	1996	Trainee in clinical medical physics, Winnipeg

Ruth Brown	PhD	1996	Post-doc, Health Canada
Larry Gates	PhD	1997	Post-doc in clinical mri, Halifax
David Gobbi	MSc	1997	PhD student at Univ. Western Ontario
Mazen Soubra	PhD	1997	Radiotherapy physicist, Vancouver
Kevin Lenton	PhD	1998	Post-doc at Univ. Sherbrooke
Sheri Boyden	MSc	1998	

Scientific Societies of Relevance to Medical Physics

The following scientific societies are of interest to students and scientists in medical physics. For further information contact the individuals listed:

AAPM	American Association of Physicists in Medicine	Paul Johns, Dave Rogers
CAP	Canadian Association of Physicists	Bob Clarke, Paul Johns, Dave Rogers
COMP	Canadian Organization of Medical Physicists	Paul Johns, Lee Gerig, Ken Shortt
CRPA	Canadian Radiation Protection Association	Clive Greenstock, Dave Rogers
EMBS	Engineering in Medicine and Biology Society of the IEEE	Bog Jarosz
HPS	Health Physics Society	Dave Rogers
IRPS	International Radiation Physics Society	Paul Johns
RRS	Radiation Research Society	Peter Raaphorst
ISMRM	International Society for Magnetic Resonance in Medicine	Ian Cameron, Giles Santyr

Kudos

- A Carleton M.Sc. student, David Gobbi, won a prize at the Canadian Organization of Medical Physicists (COMP) annual conference in Charlottetown, July 97, for his poster, *Photon-counting radiography with xenon gas microstrip detectors*.
- Also in July 1997, OMPI member Dave Rogers, Ionizing Radiation Standards, Institute for National Measurement Standards, National Research Council, was elected a Fellow of the AAPM.
- At the 1998 COMP conference in London, it was announced that the paper *Accurate characterization of Monte Carlo calculated electron beams for radiotherapy* by C.M. Ma, B.A. Faddegon, D.W.O. Rogers, and T.R. Mackie, (Med. Phys., **24**, 401-416, 1997) was a runner up for the Sylvia Fedoruk Prize for the best Canadian paper in medical physics in 1997.

OMPI Members Participate in CRPA '98

The Annual Conference of the Canadian Radiation Protection Association (CRPA'98) which was held in Ottawa, May 24 - 28, 1998, attracted over 150 attendees from across Canada and the USA, and 20 exhibitors including the AECB, and the Health Canada (HC) National Dosimetry Service. The organizing committee coordinated by Cait Maloney (AECB) and the programme committee chaired by Gary Kramer (HC), assisted by Clive Greenstock (AECL), arranged plenary and parallel technical sessions on transportation of radioactive waste, reactor safety, environmental monitoring, contamination control, laboratory procedures, hospital safety, risk management, workplace training, waste management and new safety regulations.

Several sessions focussed on topics particularly pertinent to OMPI. Two sessions on health effects chaired by Clive Greenstock and Richard Osborne, featured COG funded R&D carried out at AECL and included a student presentation by OMPI student Kevin Lenton. The sessions, organized by Clive Greenstock, were in recognition of the career contributions, in the fields of health physics, radiation biology, environmental monitoring and operational radiation protection, of Richard Osborne following his recent retirement from AECL. A session on operational health physics included a presentation by a new OMPI member Akhilesh Trivedi (AECL). Another session of interest to OMPI members was on medical Physics and was chaired by Michael Chamberlain (Ottawa Civic Hospital).

A post conference tour of Chalk River Labs, AECL was organized on Friday May 19 for a group of attendees to visit the Radiation Protection Branch, Waste Management Areas, the Moderator Test Facility, the Universal Hot Cells and NRU.

International Centre for Low Dose Radiation Research

The official announcement on December 15, 1997 of the establishment of the International Centre for Low Dose Radiation Research at the University of Ottawa culminated much effort on the part of its Associate Director, OMPI member, Dr. Elagu V. Elagupillai. The Centre is the first institution dedicated to understanding the effects of low doses of ionising radiation, and will be guided by a 10 member Scientific Advisory Board, drawn from experts from France, Japan, Netherlands, UK, USA and Canada. Its mandate is to promote research, education and training on the understanding of the effects on human health of low doses and low dose-rates of ionising radiation. Initially, all available human, animal and cell culture data on the effects of low doses of ionising radiation will be brought together at the Centre for analysis by an interdisciplinary team of scientists, guided by the Scientific Board. The findings of the coordinated research undertaken by this institution are expected to have major implications on the interpretation of the radiological risk of exposure to ionising radiation, on the quality and reliability of information given to the public and concerned institutions, and possibly on radiation protection practices.

The Centre has already received financial support from within and outside Canada. Notable funding agencies include the US Department of Energy, US Nuclear Regulatory Commission, Electricité de France, the Central Research Institute of the Electric Power Industries (Japan), MDS Nordion (Canada), CANDU Owners Group (COG), and the Canadian Nuclear Society.

A number of graduate research projects are envisaged. Several departments and faculties within the University of Ottawa and Carleton University are expected to collaborate with the Centre. Already one graduate student is pursuing his M.Sc. thesis through the Centre. The Centre will facilitate research opportunities for visiting international scientists to work on projects within its domain.

As its first major contribution, the Centre organized a symposium held June 8, 1998, at the University of Ottawa: *International Symposium on Health Effects of Low Doses of Ionising Radiation: Research Directions into the New Millennium*. It was attended by nearly 190 delegates, most of them key people in nuclear science, radiation protection, radiobiology, medicine, environmental studies and regulatory agencies from Canada and USA. All wanted to hear first hand about the very controversial aspects of the low dose effects and the Linear No Threshold (LNT) model controversy, that are increasingly being debated in scientific journals and conferences. The excellent presentations covered a wide range of conflicting views about the meaning of the large amount of data acquired over the past century. The presentations were followed by a panel discussion, which identified a number of research topics aimed at resolving the many issues concerning low dose effects. All in all, the symposium was a success; the proceedings are expected to be published by the end of August 1998. For more information, contact Elagu V. Elagupillai at elagu@aix1.uottawa.ca.

Ottawa Work Group for Imaging Research

The Ottawa Work Group for Imaging Research was formed in March of this year with the sponsorship of the Ottawa Hospital Research Institute. It is the purpose of this group is to act as a forum for the exchange of information and practical discussions between investigators with research interests in biomedical imaging. The workgroup will promote scientific communication between researchers within the universities and research institutes in Ottawa. It is hoped that this will also facilitate collaboration and development of interdisciplinary research projects within the scientific community. Although still in its formative stage the group has members from Carleton University, the University of Ottawa and the Ottawa Hospital. Several members of the group are also members of OMPI.

The Work Group plans to hold regular meetings throughout the coming year. At each meeting there will be a scientific presentation given by a member focusing on his or her own research efforts. The meetings will also provide a forum for members to discuss technical issues and problems of interest to the group. The initial

scientific presentation was given this June by Drs. Ian Cameron and Matthew Hogan and was entitled "Cerebral perfusion imaged by MRI following bolus injection of contrast".

The workgroup is continuing to look for new members with interests in both imaging methods and biomedical science. Further information may be obtained from Dr. Matthew Hogan at the Neuroscience Research Institute, University of Ottawa (e-mail: mhogan@uottawa.ca).

OMPI E-mail Bursters

E-mail sent to the following addresses is broadcast to all users on the respective lists by the e-mail burster at Carleton. Note the change from mporu to ompi.

E-mail address

ompi_members@physics.carleton.ca

ompi_students@physics.carleton.ca

ompi_seminars@physics.carleton.ca

ompi_exec@physics.carleton.ca

Target recipients

Members of OMPI

Students in the Carleton Physics medical physics graduate program

All who receive OMPI seminar announcements

Members of the OMPI Executive

Member and Student Directory

<u>Members</u>	<u>telephone</u>	<u>fax</u>	<u>e-mail address</u>
Cameron, Ian	737-8635	737-8611	ICameron@ogh.on.ca
Clarke, Robert	520-2600x1866	520-4061	clarke@physics.carleton.ca
Cygler, Joanna	737-7700x6267	725-6320	Joanna_Cygler@cancercare.on.ca
deKemp, Robert	761-4275	761-4690	rdekemp@heartinst.on.ca
Dixit, Madhu ¹	520-2600x7535	520-7546	msd@physics.carleton.ca
Dvorak, Pavel	954-0319	941-1734	Pavel_Dvorak@hc-sc.gc.ca
Elagupillai, V	562-5800x1041	562-5873	elagu@aix1.uottawa.ca
Gerig, Lee	737-7700x6736	247-3507	gerig@physics.carleton.ca
Greenstock, Clive	(613) 584-3311x6053	(613)584-4108	greenstockc@aecl.ca
Jarosz, Boguslaw	520-2600x4318	520-4061	jarosz@physics.carleton.ca
Johns, Paul	520-2600x4317	520-4061	johns@physics.carleton.ca
Kawrakow, Iwan	993-2197	952-9865	iwan@irs.phy.nrc.ca
Klassen, Norman	993-9352	952-9865	nklassen@irs.phy.nrc.ca
Lam, Gabriel	737-7700x6388	725-6320	Gabriel_Lam@cancercare.on.ca
McKee, Barry	798-5555x7491	761-4041	bmckee@civich.ottawa.on.ca
Ng, Cheng	737-7700x6940	247-3507	Cheng_Ng@cancercare.on.ca
Raaphorst, Peter	737-7700x6727	247-3507	graaphorst@cancercare.on.ca
Richardson, Richard	(613) 584-3311x4577	(613)584-1713	richardr@aecl.ca
Rogers, Dave	993-2715	952-9865	dave@irs.phy.nrc.ca
Ross, Carl	993-9352	952-9865	carl.ross@nrc.ca
Salhani, Douglas	737-7700x6227	725-6320	dsalhani@cancercare.on.ca
Santyr, Giles	520-2600x8996	520-4061	santyr@physics.carleton.ca
Seuntjens, Jan	993-2715	952-9865	jseuntje@irs.phy.nrc.ca
Shortt, Ken	993-2715	952-9865	kshortt@irs.phy.nrc.ca
Sun, Jason	591-2100x2256	592-6559	sun.j@theratronics.com
Szanto, Janos	737-7700x6741	247-3507	jszanto@cancercare.on.ca
Trivedi, Akhilesh ¹	(613) 584-3311x4764	(613)584-6189	trivedia@aecl.ca
Waker, Tony	(613) 584-8811x3610	(613)584-1713	wakera@aecl.ca
ALL MEMBERS			ompi_members@physics.carleton.ca
OMPI EXECUTIVE			ompi_exec@physics.carleton.ca
SEMINAR NOTICES			ompi_seminars@physics.carleton.ca

<u>Students</u>	<u>telephone</u>	<u>fax</u>	<u>e-mail address</u>
Cron, Greg ²	520-2600x1917	520-4061	gcron@physics.carleton.ca
Gauthier, Yvan	737-8476	737-8611	ygauthie@physics.carleton.ca
Hewitt, Tanya	798-5555x3352	761-4041	thewitt@physics.carleton.ca
Kizilian, Narine	954-9584	941-1734	Narine_Kizilian@hc-sc.gc.ca
Leclair, Robert	520-2600x1854	520-4061	robert@physics.carleton.ca
Li, Jun	737-7700x6942	247-3507	jli@physics.carleton.ca
MacPherson, Miller	993-2197	952-9865	mmacpher@irs.phy.nrc.ca
Myint, Kenji	737-7700x6942	247-3507	kmyint@physics.carleton.ca
Niedbala, Malgorzata	737-7700x6942	247-3507	niedbala@physics.carleton.ca
Owen, Daron	737-7700x6942	247-3507	dowen@physics.carleton.ca
Sevigny, Pascale	520-2600x1855	520-4061	psevigny@physics.carleton.ca
Sheikh-Bagheri, Daryoush	993-2197	952-9865	dbagheri@irs.phy.nrc.ca
Smith, Debbie	737-7700x6942	247-3507	dsmith@physics.carleton.ca
Zhang, Geoffery	993-2197	952-9865	gzhang@irs.phy.nrc.ca
ALL STUDENTS			ompi_students@physics.carleton.ca

¹ Associate Member

² Registered at University of Wisconsin at Madison