MPORU NEWSLETTER

Medical Physics Organized Research Unit
Physics Department, Carleton University

Editor: Carl Ross

Number 4, June 1992

Contents

1. A Note from the Director

Many activities were achieved within the Medical Physics Organized Research Unit in the third year of its operation. Even though the economic situation was somewhat more difficult, the many members of the MPORU maintained stable funding levels in their research projects to support research and graduate student programs. In addition, many members were active in the main objectives of the MPROU, which are: teaching, graduate student supervision, research and scientific presentation. Indeed this high level of activity made it an exciting year resulting in many research publications, new exciting findings in research and further support of graduate students in these research programs.

In 1993, the Canadian Organization of Medical Physicists and the Canadian College of Physicists in Medicine will be holding their annual national meeting, jointly with the Canadian Medical and Biological Engineering Society, in Ottawa. Many members of the MPORU are involved in organizing this meeting on the Carleton University campus. We look forward to hosting a large number of medical physicists in Ottawa and having an exciting scientific program.

The MPORU is committed to providing excellence in graduate student teaching and training in medical physics and providing opportunity for scientific communication and presentation. In this regard, we have had a successful year of graduate student courses as well as a seminar program in which both members and graduate students were able to present their work to the medical physics community. A wide variety of research topics were presented. In addition, guest speakers in various aspects of medical physics were also hosted through the seminar program of the Carleton University Physics Department.

Throughout the year a great deal was achieved and some of these are high-lighted below:

1. A new course, Radiation Protection, was added to the academic program. In addition, the course outline for the Medical Physics Practicum was established.

2. Several new research grants were obtained.

3. Three graduate students successfully completed their thesis program and graduated.

4. Two new members joined the MPORU.

5. There was a large enrolment in the graduate medical physics courses.

These and many other accomplishments, which are outlined in the Newsletter, indicate that the MPORU is moving rapidly forward. The accomplishments within the program are continuing even though we are in a more difficult economic phase within Canada.

The MPORU finds its strength in the multidisciplinary collaborative efforts amongst its members and the various institutions. This effectively allows us to do more with less and is our strength, which we will continue to develop further in the future. In the next year we are looking forward to maintaining our membership strength and our graduate student numbers and in fact, continuing work on the Medical Physics Practicum. In addition, there are several vacant medical physics positions in the medical institutions within Ottawa. When these are filled, these will add further strength to the MPORU and its academic activities.

I wish to thank all the members of the MPORU who made their energies and efforts

available to the success of this program and wish to emphasize that the fruits of this program (a new generation of medical physicists) are extremely important for the future of the medical physics programs in health care, universities and industry in Canada. I look forward to the challenges ahead and do not doubt that the MPORU will continue to prosper and grow.

Peter Raaphorst
Director, MPORU

2. MPORU Executive and Advisory Board

The Executive of the MPORU consists of a Director (Peter Raaphorst), Secretary (Carl Ross); Academic Officer (Paul Johns) and a graduate student representative (Julia Wallace). Members are elected for two year terms. The Executive meets about once a month and has observers from other groups (John Saunders, Gary Kramer and Bog Jarosz). The MPORU seminars were organized by Bog Jarosz.

Members of the Advisory Board are listed below:

Dr. L. Copley
Dean of Science
Carleton University
Colonel By Drive
Ottawa, Ont. K1S 5B6

Dr. W.K. Evans
CEO Ottawa Regional Cancer Center
and VP, OCTRF
190 Melrose Avenue
Ottawa, Ont. K1Y 4K7

Dr. B. Hird, Director OCIP
Physics Department, Faculty of Science
University of Ottawa
34 George Glinski Street
Ottawa, Ont. K1N 6N5

Dr. E.G. Letourneau, Director
Bureau of Radiation and Medical Devices
Health and Welfare
775 Brookfield Road
Ottawa, Ont. K1A 1C1

Dr. G. Peter Raaphorst, Head
Medical Physics Department
Ottawa Regional Cancer Centre
190 Melrose Avenue
Ottawa, Ont. K1Y 4K7

Dr. J.F. Seeley
Dean of Medicine
University of Ottawa
Health Sciences Building
451 Smyth Road
Ottawa, Ont. K1H 8M5

Dr. Ian Smith, Director-General
Division of Biological Sciences
National Research Council
Building M-54
Montreal Road
Ottawa, Ont. K1A 0R6

3. Seminars

3.1 MPORU Seminars

One of the main vehicles of the MPORU for developing and maintaining contacts is through a seminar series in which all the members and the graduate students in medical physics are required to make a presentation.

Seminars take place at 3:30 p.m. on Fridays. Coffee, juice and delicacies are available in the seminar room prior to the meeting.

The following is a list of MPORU seminars held in 1991-92. The first speaker listed for each day is a graduate student.

Date	Speaker	Title
September 20	Ted Lawrence (Carleton University)	Production of Monoenergetic X Rays
	John Saunders (National Research Council)	*In Vivo* MRS from Different Sections of the Heart
October 18	Dennis Heller (Carleton University)	Low Dose-Rate Irradiation *in Vitro* Combined with Continuous Low Temperature Hyperthermia
	Bruce Faddegon (National Research Council)	Applications of Monte Carlo Simulations to Problems in Radiotherapy Treatment Planning
November 15	George Ding (Carleton University)	A New Technique for Portal Image Registration
	V. Elaguppillai (Atomic Energy Control Board)	Dose-Effect Relationship for Lung Cancer due to Exposure to Radon and its Daughters
December 13	Ruth Brown (Carleton University)	Response of Chinese Hamster Spheroids to Multifraction Irradiation
	Lee Gerig (Ottawa Regional Cancer Centre)	Patient Translation Technique for Total Body Irradiation - Design and Dosimetry
January 17	Andrew Weber (Carleton University)	Comparison of Four Methods of Measuring Blood Flow
	Janos Szanto (Ottawa Regional Cancer Centre)	Small Beam Radiotherapy - Design and Dosimetry

February 14	Julia Older (Carleton University)	The Point Spread Function of Computed Tomography
	Ian Cameron (Ottawa General Hospital)	Diffusion Weighted Magnetic Resonance Imaging
March 13	Mazen Soubra (Carleton University and Ottawa Regional Cancer Centre)	Relative Output Factors for Asymmetric Radiotherapy X Ray Fields
	Doug Salhani (Ottawa Regional Cancer Centre)	Design and Radiation Protection of a Radiation Treatment Facility: A Practical Approach
April 10	Dave Wilkins (Carleton University)	MRI of Radiation Injury in the Rat Brain
	Paul Johns (Carleton University)	The Radiation Hazard to Operators and Patients from PTCA

3.2 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 room 252 of the Herzberg Building. The following seminars of interest to medical physics were held in 1991-92:

September 9	Paul Johns, Department of Physics, Carleton University - "Towards Quantitative X-Ray Imaging for Medicine".
October 10	F. Stuart Foster, Sunnybrook Health Science Centre, University of Toronto - "Ultrasound Backscatter Microscopy: Medical and Biological Applications".
November 25	Carl Ross, Ionizing Radiation Standards, NRC - "The Measurement of Absorbed Dose".
December 9	Terry M. Peters, Montreal Neurological Institute, McGill University - "3-D Imaging in Neurology and Neurosurgery".
December 18	D.W.O. Rogers, Ionizing Radiation Standards, NRC - OCIP Christmas Symposium: "Monte Carlo Calculations of Electron Transport: From High Energy Physics to Cancer Treatment".
January 13	Cheng Ng, Ottawa Regional Cancer Centre - "Magnetic Resonance Spectroscopy of Cancer Cells".
February 10	T. Rock Mackie, University of Wisconsin - "From Dosimeter Dosimetry to Simulator Simulation".

March 23 Thomas P. Ryan, Dartmouth Medical School and Thater School of Engineering, Dartmouth College - "Therapeutic Ultrasound for Treatment of Cancer: Computation, Experimental Verification, *In-Vivo* and Clinical Results".

March 30 Aaron Fenster, Robarts Research Institute, University of Western Ontario - "3-Dimensional Vascular Imaging Research Using Ultrasound and CT".

Fall Graduate Student Seminar Afternoon, November 19, 1991

Dennis Akyurekli - "The Effects of Hyperthermia on Renal Blood Flow".

Winter Graduate Student Seminar Afternoon, May 5, 1992

Ted Lawrence - "Production of Monoenergetic X Rays Using a Secondary Fluorescence Target".

4. Membership Directory of the MPORU

Name	Telephone (Fax)	e-mail	Address
Alex Bielajew	993-2715 (952-9865)	BLIF at NRCVM01	Ionizing Radiation Standards Institute for National Measurement Standards National Research Council Ottawa K1A 0R6
Stephen Bly	954-0308 (954-2486)		Acoustics Unit, Room 66 Health Protection Building Health and Welfare Canada Tunney's Pasture Ottawa K1A 0L2
Ian Cameron	737-8635 (737-8470)		MRI Unit Department of Radiology Ottawa General Hospital 501 Smyth Road Ottawa K1H 8L6
Robert Clarke	788-4377 (788-4061)		Physics Department Carleton University Colonel By Drive Ottawa K1S 5B6

Joanna Cygler	725-6267 (725-6320)		Ottawa Regional Cancer Centre Department of Medical Physics Civic Division 190 Melrose Avenue Ottawa K1Y 4K7
Pavel Dvorak	954-0319 (952-7767)		X-Ray Section, Room 257A Health Protection Building Health and Welfare Canada Tunney's Pasture Ottawa K1A 0L2
V. Elaguppillai	995-3041 (943-8954)		Radiation Protection Division Atomic Energy Control Board P.O. Box 1046, Station B Ottawa K1P 5S9
Bruce Faddegon	993-2715 (952-9865)		Ionizing Radiation Standards Institute for National Measurement Standards National Research Council Ottawa K1A 0R6
Lee Gerig	737-6736 (737-6745)		Ottawa Regional Cancer Centre General Division 501 Smyth Road Ottawa K1H 8L6
Clive Greenstock	584-3311 Ext. 6053 (584-4024)	05011 at AECLRC	Radiation Biology Branch A.E.C.L. Research Chalk River, Ontario K0J 1J0
Boguslaw Jarosz	788-2600 Ext. 4318 (788-4061)	BOG@ PHYSICS. CARLETON.CA	Physics Department, Room 350A Carleton University Colonel By Drive Ottawa K1S 5B6
Paul Johns	788-2600 Ext. 4317 (788-4061)	JOHNS@ PHYSICS. CARLETON.CA	Physics Department, Room 420 Carleton University Colonel By Drive Ottawa K1S 5B6
Norman Klassen	993-2715 (952-9865)	KLASSEN at NRCVM01	Ionizing Radiation Standards Institute for National Measurement Standards National Research Council Ottawa K1A 0R6

Gary Kramer	954-6668 (957-1089)		Bureau of Radiation and Medical Devices Health and Welfare Canada 775 Brookfield Road Ottawa K1A 1C1
Alan Mortimer	990-0801		Space Science Division Canadian Space Agency 100 Sussex Drive Ottawa K1A 0R6
Cheng Ng	725-6310 (725-6320)		Ottawa Regional Cancer Centre Civic Division 190 Melrose Avenue Ottawa K1Y 4K7
Peter Raaphorst	725-6228 (725-6320)		Ottawa Regional Cancer Centre Civic Division 190 Melrose Avenue Ottawa K1Y 4K7
Dave Rogers	993-2715 (952-9865)	IRS @ NRCVM01	Ionizing Radiation Standards Institute for National Measurement Standards National Research Council Ottawa K1A 0R6
Carl Ross	993-9352 (952-9865)		Ionizing Radiation Standards Institute for National Measurement Standards National Research Council Ottawa K1A 0R6
Douglas Salhani	737-6716 (737-6745)		Ottawa Regional Cancer Centre General Division 501 Smyth Road Ottawa K1H 8L6
John Saunders	993-8582 (954-7368)		Institute for Biological Sciences Building M-40 National Research Council Ottawa K1A 0R6
Janos Szanto	737-6743 (737-6745)		Ottawa Regional Cancer Centre General Division 501 Smyth Road Ottawa K1H 8L6

Ken Shortt	993-2715 (952-9865)	IRS @ NRCVM01	Ionizing Radiation Standards Institute for National Measurement Standards National Research Council Ottawa K1A 0R6
Ian Smith	990-0884 (952-0583)		Institute for Biological Sciences Room B161A - M-54 National Research Council Ottawa K1A 0R6

5. Medical Physics Graduate Courses

The Carleton medical physics program has 3 specializations: imaging, therapy, and biophysics. Shown below is a menu of courses for each. Required courses are marked →; the others are recommended.

Depending on the thesis weighting, the MSc typically requires 6 half-courses in addition to the thesis; the PhD requires 4. 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 2 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

Fall Term	→	75.523 (Carleton)	Medical Radiation Physics
	→	75.427 (Carleton)	Modern Optics (prerequisite to 75.524; additional to degree if PhD)
		75.527 (Carleton)	Radiobiology
Winter Term	→	75.524 (Carleton)	Physics of Medical Imaging
		75.526 (Carleton)	Medical Radiotherapy Physics
		75.528 (Carleton)	Radiation Protection
Fall & Winter (both terms)		ANA 7301 (Ottawa HSC)	Anatomy
		PHS 5210 (Ottawa HSC)	Physiology
Fall or Winter (one term)	→	75.5xx/6xx (Carleton or Ottawa)	Appropriate physics half-course outside of medical physics (permission may be given for 75.4xx if MSc)
		75.591/691 (Carleton or Ottawa)	Directed Studies

SPECIALIZATION IN THERAPY

Fall Term	→	75.523 (Carleton)	Medical Radiation Physics
		75.527 (Carleton)	Radiobiology

Winter Term		75.524 (Carleton)	Physics of Medical Imaging
	→	75.526 (Carleton)	Medical Radiotherapy Physics
		75.528 (Carleton)	Radiation Protection
Fall & Winter (both terms)		ANA 7301 (Ottawa HSC)	Anatomy
		PHS 5210 (Ottawa HSC)	Physiology
Fall or Winter (one term)	→	75.5xx/6xx (Carleton or Ottawa)	Appropriate physics half-course outside of medical physics (permission may be given for 75.4xx if MSc)
		75.591/691) (Carleton or Ottawa)	Directed Studies

SPECIALIZATION IN BIOPHYSICS

Fall Term	→	75.523 (Carleton)	Medical Radiation Physics
	*→	75.527 (Carleton)	Radiobiology
Winter Term		75.524 (Carleton)	Physics of Medical Imaging
		75.526 (Carleton)	Medical Radiotherapy Physics
		75.528 (Carleton)	Radiation Protection
Fall & Winter	*→	ANA 7301 (Ottawa HSC)	Anatomy
(both terms)	*→	PHS 5210 (Ottawa HSC)	Physiology
Fall or Winter (one term)	→	75.5xx/6xx (Carleton or Ottawa)	Appropriate physics half-course outside of medical physics (permission may be given for 75.4xx if MSc)
		75.591/691 (Carleton or Ottawa)	Directed Studies

* = in the Biophysics specialization, *one* of Radiobiology, Anatomy, or Physiology must be taken.

Course Descriptions

75.523 - Medical Radiation Physics (1/2 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 & J.R. Cunningham, *The Physics of Radiology*, 4th ed., 1983.
Lecturer: P.C. Johns.

75.524 - Physics of Medical Imaging (1/2 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 75.427 or equivalent.
Reference: H.H. Barrett & W. Swindell, *Radiological Imaging*, 1981.
Lecturers: P.C. Johns, I.G. Cameron

75.526 - Medical Radiotherapy Physics (1/2 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 & J.R. Cunningham, *The Physics of Radiology*, 4th ed., 1983.
Lecturers: J. Cygler, D.W.O. Rogers, K.R. Shortt, L.H. Gerig

75.527 - Radiobiology (1/2 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 must be taken concurrently.
Reference: E.J. Hall, *Radiobiology for the Radiologist*, 3rd ed., 1988.
Lecturer: G.P. Raaphorst

75.528 - Radiation Protection (1/2 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.
Lecturer: V. Elaguppillai

ANA 7301 - Anatomy for Medical Physics Graduate Students (1/2 course, extends through Fall + 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 + 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.

75.427 - Modern Optics (1/2 course, Fall) - Diffraction theory, coherence, Fourier optics, spatial filtering; holography and its applications; laser theory: stimulated emission, cavity optics, modes; gain and bandwidth; design and characteristics of atomic and molecular gas lasers.
[This is a Fourth-Year half-course which covers material prerequisite to the Physics of

Medical Imaging graduate course].
Reference: J.W. Goodman, *Introduction to Fourier Optics*, 1968.
Lecturer: M.K. Sundaresan
Appropriate physics 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, solid state, and computational physics.

75.591/691 - Directed Studies - Detailed study of a medical physics topic may be offered as Directed Studies. This provides a means of covering topics other than those described above, and in the last 3 years has been a vehicle for introducing new graduate courses. Note that the intent of the course requirements is to impart a solid grounding in medical physics overall, with detailed subjects in the student's own research area being learned as part of the MSc or PhD project. Therefore, depending on the other courses taken and the thesis project, a Directed Studies course in the area of the student's own research may be deemed to be an additional course beyond those required towards the degree if otherwise the student would be left with too narrow a focus.

Paul Johns
Academic Officer, MPORU

6. Students

6.1 Graduate Students Enrolled in the Medical Physics Program

Student	Date Started*	Supervisor	Specialization	Thesis Topic
PhD Students				
Wilkins, David	Sept 1986	Raaphorst	Biophysics/ Imaging	MRI and MRS of brain tumours
Heller, Dennis	Sept 1988	Raaphorst	Biophysics	Radiobiology of low doserate irradiation
Soubra, Mazen	Sept 1988 (P.T.**)	Gerig	Therapy	Asymmetric linac fields for radiotherapy
Akyurekli, Dennis	Jan 1989 (following completion of MSc with R. Clarke)	Gerig	Therapy/ Biophysics	Physiology of blood flow during hyperthermia
Rapley, Patrick	Sept 1989	Saunders	Imaging	MR coil design, pulse sequences for ovarian cancer
Wallace, Julia	Sept 1989	Raaphorst	Biophysics/ Imaging	Biophysics of tumour cellular & tissue response via MRS

Ding, George	Sept 1991 (Transferred from U Manitoba)	Rogers	Therapy	OMEGA (online Monte Carlo radiotherapy planning)
Brown, Ruth	Sept 1991	Raaphorst	Biophysics	Biophysics of radiation damage and repair
Gates, Larry	Sept 1991	Cameron	Imaging	MRI measurement of water diffusion
Wei, Jiansu	Sept 1991	Rogers	Therapy	OMEGA (online Monte Carlo radiotherapy planning)
Older, Julia	Dec 1991 (following completion of MSc with P. Johns)	Salhani	Therapy	Dynamic radiotherapy planning optimization algorithm
Weber, Andrew	Dec 1991 (following completion of MSc with L. Gerig)	Rogers	Therapy	Measurement of electron stopping powers

MSc Students

Lawrence, Ted	Sept 1990	Johns	Imaging	Fluorescence x ray production for diagnostic radiology

* - date first started taking courses, not the official date of first registration into degree
** - P.T. = Part Time

6.2 Theses and Projects Completed in 1991/92

GRADUATE STUDENT THESES

Reza Dokht	MSc	Thesis Title:	Focusing Ultrasound with Zone Lenses
		Supervisor:	Robert Clarke / Bog Jarosz
		Thesis Examination:	24 May 1991
Julia K. Older	MSc	Thesis Title:	Beam Hardening Correction for Standard Computed Tomography Using Dual-Material Decomposition
		Supervisor:	Paul Johns
		Thesis Examination:	16 December 1991
Andrew J. Weber	MSc	Thesis Title:	Comparison of Four Methods of Blood Flow Measurement
		Supervisor:	Lee Gerig
		Thesis Examination:	17 December 1991

HONOURS FOURTH-YEAR UNDERGRADUATE PHYSICS PROJECTS

Tak Wong	75.499	Project Title:	Effects of Inhomogeneity on Focussing Effectiveness of Ultrasound Beams
		Supervisor:	Bog Jarosz

7. Scientific Societies of Relevance to Medical Physics

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

COMP - Canadian Organization of Medical Physicists: Paul Johns, Ken Shortt.

CAP - Canadian Association of Physicists: Dave Rogers, Bob Clarke, Paul Johns.

SMRI - Society for Magnetic Resonance Imaging: John Saunders.

CRPA - Canadian Radiation Protection Association: Gary Kramer, Dave Rogers.

AAPM - American Association of Physicists in Medicine: Dave Rogers, Paul Johns.

HPS - Health Physics Society (US): Dave Rogers.

RRS - Radiation Research Society: Peter Raaphorst.

8. Announcement of COMP '93

Members of MPORU will have an opportunity to attend the 1993 annual meeting of the Canadian Organization of Medical Physicists which will meet with the Canadian Medical and Biological Engineering Society. The meeting will be held May 12-15, 1993 at Carleton University. Approximately 400 delegates and several equipment manufacturers are expected. A one day symposium of invited speakers on the subject "Lasers in Medicine" will be followed by two and a half days of proffered papers on a wide variety of topics concerned with science and engineering issues in health care.

The conference will be followed by a two day Measurement Seminar organized by the Ionizing Radiation Standards group of the NRC dealing with the primary standards for radiation measurement in Canada.

Further information: Ken Shortt - office 613-993-2725 - fax 613-952-9865.

9. Recent Research by MPORU Members

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 funding of the MPORU members. The editor has attempted to reduce all the contributions to a standard format.

Alex Bielajew

Research: Improving Monte Carlo methods in the therapeutic range (10 keV-50 MeV) by modelling the physics more accurately. Most emphasis is on the EGS (electron gamma shower) Monte Carlo code. Using analytic and Monte Carlo methods to improve the foundations of theoretical dosimetry. Developing fast dose-scoring algorithms for electron beam treatment planning (the OMEGA project).

Publications:

A.F. Bielajew and D.W.O. Rogers (1991) I*mplications of new correction factors on primary air kerma standards in ^{60}Co beams* (in press) Phys. Med. Biol.

S. Walker, A.F. Bielajew and M.E. Hale (1991) *Installation of EGS4 Monte Carlo Code on an 80386-based microcomputer* (in press) Medical Physics.

A.F. Bielajew and D.W.O. Rogers (1991) *A standard timing benchmark for EGS4 Monte Carlo Calculations* (in press) Medical Physics.

D.W.O. Rogers and A.F. Bielajew, *Monte Carlo techniques of electron and photon transport for radiation dosimetry* in "The Dosimetry of Ionizing Radiation"; Vol. III, eds. K.R. Kase, B.E. Bjarngard and F.H. Attix, Published by Academic Press, 1990 427-539.

Rogers, D.W.O. and Bielajew, A.F. 1990 *Wall attenuation and scatter corrections for ion chambers: measurements versus calculations*, Phys. Med. Biol. 35 1065-1078.

A.F. Bielajew 1990 *On the technique of extrapolation to obtain wall correction factors for ion chambers irradiated by photon beams*, Med. Phys. 17 583-587.

A.F. Bielajew, 1990 *Correction factors for thick-walled ionisation chambers in point-source photon beams*, Phys. Med. Biol. 35 501-516.

A.F. Bielajew, 1990 *An analytic theory of the point-source non-uniformity correction factor for thick-walled ionisation chambers in photon beams*, Phys. Med. Biol. 35 517-538.

Funding: Supported as a member of NRC staff.

Ian Cameron

Research: Using Magnetic Resonance Imaging (MRI) to measure blood perfusion, water diffusion and for *in vivo* magnetic resonance spectrometry (MRS). The perfusion measurements have concentrated on placental blood perfusion as a monitor of intrauterine growth retardation. The work may also lead to techniques for measuring organ perfusion and slow blood flow in arteriovenous malformations. The work with diffusion is aimed at obtaining a better understanding of diffusion weighted imaging as well as the diffusion of water *in vivo* at a basic level.

The MRS studies give hydrogen and phosphorus spectra in volumes as small as 2x2x2 cm^3. These spectra give information on the pH, energy metabolism and chemical composition of the tissues being studied. Fluorine spectra have also been obtained and will be used to study fluoriented chemotherapy drugs. A study on the use of ^{31}P MRS for the detection of malignant hyperthermia susceptibility has recently been completed.

Publications:

I.G. Cameron and J.A. Ripmeester 1991 *^{19}F Spin-Lattice Relaxation in the Clathrate Hydrates of SF_6 and SeF_6*, accepted J. Chem. Phys.

L.J. Schreiner, I.G. Cameron, L. Miljkovic, M.M. Pintar, N. Funduk and D.W. Kydon 1991 *Proton NMR Spin Grouping and Exchange in Dentin*, Biophys. J., 59 629-639.

W.T. Sobol, I.G. Cameron and M.M. Pintar 1991 *A Zeeman Level Crossing Study of the Symmetry of the Potential Hindering the Torsion Oscillator CH_3*, Chem. Phys. 151 337-341.

W.T. Sobol, I.G. Cameron and M.M. Pintar 1990, *Rotating Frame NMR Relaxation in the Dipolar Spin Glass $RB_{1-x}(NH_4)_xH_2AsO_4$*, J. Magn. Reson. 88 501-510.

I.G. Cameron, P. Handa and T.H.W. Baker 1990, *Compressive Strength and Creep Behaviour of Hydrate Consolidated Sand*, Can. Geotech. J. 27 255-258.

Funding: NSERC operating grant, $15,000/year.

Robert Clarke

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.

Bruce Faddegon

Research: Working with Alex Bielajew and Dave Rogers on an international collaboration: "The OMEGA Project". This project will realize a long sought goal of applying the Monte Carlo techniques embodied in EGS4 to treatment planning for electron beams in radiation therapy.

Publications:

B.A. Faddegon and D.W.O. Rogers (1992) *Comparisons of Thick-target Bremsstrahlung Calculated with EGS and ITS* (in preparation).

D.W.O. Rogers and B.A. Faddegon (1991) *Re-evaluation of total stopping power of 5.3 MeV electrons in polystyrene*, in press Phys. Med. Biol.

B.A. Faddegon, C.K. Ross and D.W.O. Rogers, *Measurement of Collision Stopping Powers of Graphite, Aluminium and Copper for 10 and 20 MeV electrons*, submitted to Phys. Med. Biol., December 1991.

B.A. Faddegon, C.K. Ross and D.W.O. Rogers 1991 *Angular Distributions of Bremsstrahlung from 15 MeV Electrons Incident on Thick Targets of Be, Al and Pb*, Medical Physics 18 727-739.

B.A. Faddegon, C.K. Ross and D.W.O. Rogers 1990 *Forward-Directed Bremsstrahlung of 10-30 MeV Electrons Incident on Thick Targets of Al and Pb*, Med. Phys. 17(5) 773.

B.A. Faddegon (1990) *Pile-up Corrections in Pulsed-Beam Spectroscopy*, Nucl. Instr. Meth. B51, 431.

B.A. Faddegon, Len Van der Zwan, D.W.O. Rogers and C.K. Ross 1991 *Precision Response-Function Estimation, Energy Calibration, and Unfolding of Spectra Measured With a Large NaI Detector*, Nucl. Instr. Meth. A301 138.

Funding: Supported as a member of NRC staff.

Clive Greenstock

Research: Studying conformational changes in the cellular genome as a result of exposure to stress, such as ionizing radiation, chemical carcinogens and chemotherapeutic agents. A fluorescent probe, ethidium bromide, which intercalates into the DNA, is used to measure the changes. The technique of time-resolved fluorescence spectroscopy can be used for radiosensitivity- and cancer-screening, as well as studying repair-deficient, radiosensitive mammalian cells.

Using electron spin resonance (ESR) spectrometry to study paramagnetic species trapped in irradiated sugars and bio-organic substances. The ESR signals are dose dependent and can be used for dosimetric purposes to quantitate emergency exposures, monitor radioactive contamination and measure accumulated absorbed dose.

Measuring changes or abnormalities in cell membranes using the cell's immuno-surveillance system. Fluorescent monoclonal antibodies which bind to specific cell surface receptor antigens are used to detect radiation damage to human blood lymphocytes. A loss of immunofluorescent binding due to an absorbed dose as low as 0.01 Gy can be observed, which is indicative of a subtle alteration in the cell surface and a sensitive response by the immunosurveillance system.

The biochemical response of cells to ionizing radiation is the ultimate determinant of radiosensitivity. An enzyme-linked-immuno-sorbent-assay (ELISA) technique has been set up to measure cellular levels of antioxidant enzymes, in order to establish their importance in inducible and constitutive radiation protection mechanisms.

Publications:

C.L. Greenstock, N.E. Gentner, K. Gale, B. Smith, D. Adams and J.-A. Walker 1991 *An Investigation of Beryllium Cytotoxicity in Normal and Repair-deficient Cells*, Canadian Fusion Fuels Technology Program (CFFTP) Report No. Co 591, pp 38.

C.L. Greenstock and R.P. Whitehouse 1992 *Radiation chemical studies of sensitization by 5-bromouridine-5'-monophosphate*, Radiat. Environ. Biophys. 31, 1-9.

A. Trivedi and C.L. Greenstock 1992 *Use of sugars and hair samples for ESR emergency dosimetry*, Appl. Radiat. Isot. in press.

C.L. Greenstock and N.E. Gentner 1990 *A Review of Potential Health Hazards Associated with Occupational Exposure to Beryllium*, Canadian Fusion Fuels Technology Program (CFFTP) Report No. Co 330, pp 26.

D.P. Heller and C.L. Greenstock 1990 *Fluorescence Lifetime Analysis: A Detailed Review and Optimization of Instrument Operations and Data Analysis*, Atomic Energy of Canada Limited (AECL), Report No. AECL-10127, pp 52.

Funding:	Canadian Fusion Fuels Technology Program	25K
	Candu Owners Group	150K
	Atomic Energy Control Board	25K

Boguslaw J. Jarosz

Research: Therapeutic application of ultrasound in hyperthermia of deeply localized tumours. Current research concentrates on improvements to already developed interstitial hyperthermia applicator. A non-invasive hyperthermia system currently studied would enable simultaneous ultrasonic imaging of the treated volume. Another project of substantial potential involves the development of a multi-applicator interstitial hyperthermia system for therapy of brain tumours. The latter involves research of laser generated ultrasound.

Publications:
B.J. Jarosz 1991, *Temperature distribution in interstitial ultrasonic hyperthermia*, Proc. 13th Ann. Int. Conf. IEEE Eng. Med. Biol. Soc., 13 178.
B.J. Jarosz and R.L. Clarke 1991, *Interstitial Ultrasonic Hyperthermia Applicator,* to be published.
B.J. Jarosz 1991, *Ultrasonic surface modes generated by laser pulses on duraluminium,* Ultrasonics, 29, 53.
B.J. Jarosz 1990, *Rate of heating in tissue in vitro by interstitial ultrasound*, Proc. 12th Ann. Int. Conf. IEEE Eng. Med. Biol. Soc., Vol. 12, 274.

Funding: Supported as a member of Carleton University staff.

Paul Johns
Research: Studying iterative reconstruction techniques to reduce artifacts in computed tomography (CT) by accounting for the polyenergetic nature of the x-ray beam as well as scattered x rays.

Analyzing the effect of system noise and scattered radiation in dual energy x-ray imaging. The results are being applied to mammography.

Analyzing the radiation dose received during the diagnosis and follow up phases of patients receiving percutaneous transluminal coronary angioplasty. Fifteen hundred patients treated at the Ottawa Heart Institute are involved in the retrospective analysis.

Studying the possibility of using CT for planning screw placement and use of bone cement during spinal surgery. CT was used to measure equivalent K_2HPO_4 concentration in bone, and a supralinear relationship was found between the tensile strength of the screw/bone interface and the K_2HPO_4 concentration.

Investigating the factors controlling the spectral purity and intensity of monoenergetic x rays produced via secondary fluorescence.

Publications:
S.G. Gilbert, P.C. Johns, D.C. Chow and R.C. Black, *Relation of Vertebral Bone Screw Axial Pullout Strength to Quantitative CT Trabecular Bone Mineral Content*, submitted to the Journal of Spinal Disorders.
P.L. Pattee, P.C. Johns and R.J. Chambers 1992 *The Radiation Risk to Patients from Percutaneous Transluminal Coronary Angioplasty* , submitted to Radiology.
P.C. Johns, P.L. Pattee and R.J. Chambers 1991 *Radiation Risk to Patients from Percutaneous Transluminal Coronary Angioplasty* , Radiology 181(P) 234-235 [Abstract].
P.C. Johns, P.L. Pattee and R.J. Chambers 1991 *Radiation Doses in the Diagnosis and PTCA Treatment of Coronary Atherosclerosis*, Medical Physics 18 1073 [Abstract].

Funding: NSERC Operating Grant $20,000.

Norman Klassen
Research: Involved with work to establish absorbed dose standards based on water calorimetry. One initiative is to extend the work done at 20 MV to ^{60}Co. The other is to examine the radiation chemistry of water in order to resolve anomalies between the experimentally determined H_2O_2 yields, the yields predicted by computer simulation and the temperature rise measured in irradiated water.

Participating in a study of radiation-induced cell death by apoptosis in rat thymocytes. Particular emphasis is placed on initial radiation damage. End points used are cell shrinkage, staining, electron microscopy and gel electrophoresis. Participating in a comparison of the OER of mammalian cell lines at "normal" and "ultra-high" dose rates.

Publications:
N.V. Klassen and C.K. Ross 1991 *Absorbed Dose Calorimetry using Various Aqueous solutions*, Radiat. Phys. Chem., **38**, 95-104.

Funding: Supported as a member of NRC staff.

Gary H. Kramer
Research: Improvement of *In-Vivo* measurements and calibrations made by whole body or organ counting systems. This work has two main avenues of applied research. The effects of source geometry on the calibration factors of a given counting system. For example, the calibration of the lung counting system has been recently extended to discover the effects of the distribution of uranium in the lung. The other major area of research is in phantom development. Currently the Human Monitoring Laboratory (HML), which is the Canadian National Calibration Reference Centre for *In-Vivo* Monitoring, is modifying the Torso phantom to better represent women in the work force.

In support of the two major areas outlined above the HML often has to perform tissue equivalency measurements and resin formulations to better approximate human tissue. An example of this was the redesign of the Canadian thyroid phantom.

Publications:
G.H. Kramer, et al 1992 *Rapid Monitoring of Large Groups of Internally Contaminated People*. IAEA Technical Report, in press.
G.H. Kramer and C.E. Webber 1992 *Evaluation of The Lawrence Livermore National Laboratory (LLNL) Torso Phantom by Bone Densitometry and X-ray* International Journal of Applied Radiation Measurements, in press.
G.H. Kramer and K.G.W. Inn 1991 *A Summary of the Proceedings of the Workshop on Standard Phantoms for In-Vivo Radioactivity Measurement*, Health Physics 61(6) 893-894.
G.H. Kramer, L. Noel and L.C. Burns 1991 *The BRMD BOMAB Family* Health Physics 61(6) 895-902.
L. Noel and G.H. Kramer 1991 *Status Report 1989/90: The Results and New Directions of the Human Monitoring Laboratory's Intercomparison Program* Health Physics 60 738.

Funding: Supported as a member of the Department of National Health and Welfare staff.

Alan Mortimer
Research: Studying the way the environment in the immediate vicinity of the cell surface affects what happens to the cell. Ultrasound is known to increase the transport of messenger ions across the cell membrane. Also, the space environment decreases the immune response of cells in suspension. This may be due to reduced convection, leading to reduced surface interaction. Work is underway to study cell surface binding and transport across membranes in simulated micro gravity. Studies are also planned to determine how ultrasound changes the properties of cell membranes thereby affecting wound healing.

Publications:
A.J. Mortimer and M. Dyson *The Effect of Ultrasound on the Transport of Calcium in 3T3 Fibroblasts in Vitro*, J. Ultrasound in Med.
A.J. Mortimer *The Method for the Measurement of Calcium Transport in Micro gravity using Sounding Rocket.*

Funding: Supported as a member of NRC staff.

Cheng E. Ng

Research: Magnetic Resonance Spectroscopy (MRS) techniques are being investigated for distinguishing drug-resistant from drug-sensitive human ovarian tumour cells perfused *in vitro*. MRS techniques are also being investigated for monitoring and/or predicting effects of treatment with x-rays, drugs or hyperthermia on the same cells. The goal of these studies is to establish if MRS can play a role in the diagnosis and/or prognosis of cancer.

The effects of drugs which inhibit the ability of human skin cancer cells to repair x-radiation and hyperthermic damage in culture are also being investigated. The aim of these studies is to establish if inhibition of cellular repair can lead to more effective killing of tumour cells.

Publications:

C.E. Ng, K.A. McGovern, J.P. Wehrle and J.D. Glickson 1992 *^{31}P NMR spectroscopic study of the effect of gamma-irradiation on RIF-1 tumour cells perfused in vitro*, Mag. Res. in Medicine (in press).

K.A. McGovern, J.S. Schoniger, J.P. Wehrle, C.E. Ng and J.D. Glickson 1990 *Gel-entrapped perfluorocarbon: A method for monitoring oxygen concentrations in cell perfusion systems* submitted for publication.

C.E. Ng, K.A. McGovern, J.P. Wehrle and J.D. Glickson 1990 *^{13}C and ^{31}P NMR study of the metabolism of EMT6 spheroids*. Proc. of 9th Meeting of the Society of Magnetic Research in Medicine 852.

G.P. Raaphorst, M. Thakar and C.E. Ng 1992 *Thermal radiosensitization in two pairs of CHO wild-type and radiation-sensitive mutants, submitted for publication.*

Funding: Supported as a Career Scientist with the Ontario Cancer Foundation; Co-investigator on NCIC grant for the study of cellular radiosensitivity, three years, ~$53,000/year.

Peter Raaphorst, Lee Gerig, Joanna Cygler, Janos Szanto and Douglas Salhani

Research: Studying hyperthermia with a view to using it alone or in combination with other modalities for the treatment of cancer. Twenty patients have been treated with a combination of microwave hyperthermia and radiotherapy and the results indicate that hyperthermia can induce improved response over radiation alone. Various methods are being used to study the role of blood flow in the removal of heat during clinical hyperthermia. A probe is being developed which will incorporate both a hyperthermia applicator and a brachytherapy source. Thermocouple arrays used for measuring temperature distributions induced by hyperthermia are being evaluated. Thermometry data are being used to calculate the thermal dose delivered to tissue, and to analyze how blood flow changes in response to hyperthermia.

In vitro studies of the role of repair in the radiation resistance of various human tumour cell lines are underway. Hyperthermia is used to cause radiosensitivity and to inhibit repair. Low dose rate measurements are underway, and they show large increases in survival as the dose rate is lowered. The effects of hyperthermia at low dose rates will also be evaluated. The response of human glioma cells to very high dose rates is being studied.

Magnetic resonance spectroscopy is being used to study ^{31}P in rat glioma cells both in vitro and in vivo. Results show that the stress of cancer therapeutic agents causes changes in the high energy phosphorous metabolites within cells. The effects of

hyperthermia, radiation and chemical agents will be studied.

A solid state (MOSFET) detector is being evaluated as a clinical dosimeter. Various aspects of external beam radiotherapy are being studied. This includes the evaluation of methods for calculating the dose for irregularly shaped fields; the development and implementation of asymmetric arc therapy; the development of a radiosurgery program; the development of a patient position monitor; the evaluation of therapy using asymmetric collimator jaws; the development of dynamic wedges; and the development of algorithms for fitting treatment unit data.

Publications

E.I. Azzam, J.A. Vadasz and G.P. Raaphorst 1991, *Thermal sensitivity and radiosensitization in V79 cells exposed to 2-Adenine or 6-thioguanine.* Rad. Res 125 223-226.

T.J. Bichay, M.M. Feeley and G.P. Raaphorst 1991, *A comparison of heat sensitivity, radiosensitivity and PLDR in four human malignant melanoma cell lines*, accepted Melanoma Research.

V.F. Da Silva, M. Feeley and G.P. Raaphorst 1991, *Hyperthermic potentiation of BCNU toxicity in BCNU-resistant human glioma cells*, J. Neuro-Oncol 11 37.

C.E. Danjoux, E. Zakhour, G.P. Raaphorst, L.H. Gerig and S. Grimes 1991, *Thermalradiotherapy for local, superficial, recurrent cancer.* Canadian J. Oncol. 2 57-61.

L.L. Gerig, J. Szanto and G.P. Raaphorst 1991, *The Clinical Use of Thermocouple Thermometry*, Front Med. Biol. Eng. (in press).

L.H. Gerig, J. Szanto and G.P. Raaphorst 1991, *On The Spatial Resolution of Clinical Thermometers*, Med. Phys. J. (in press).

L.H. Gerig, C.E. Danjoux, G.P. Raaphorst and J. Szanto 1991, *Clinical Thermometry*, Med. Phys. Bio. Eng. (in press).

D. Ko, G.P. Raaphorst, M.M. Feeley, C.E. Danjoux, J. Maroun and W.K. Evans 1991, *The in vitro effects of lonidamine combined with cisplatin in human small cell lung cancer lines*, Anti Cancer Res. 11 235.

G.P. Raaphorst 1991, *Recovery of sublethal radiation damage and its inhibition by hyperthermia in normal and transformed mouse cells*, Int. J. Radiat. Oncol. (in press).

G.P. Raaphorst 1991, *Comparison of radiation damage recovery and its inhibition for cell survival and oncogenic transformation in C3H 10T1/2 cells*, Biochemical Pharmacology 9 71-78.

G.P. Raaphorst and E.I. Azzam 1991, *Comparison of recovery, inhibition and fixation of damage after heating and radiation*, J. Thermal Biol. (in press).

G.P. Raaphorst and E.I. Azzam 1991, *Response of transformed and normal mouse cell lines to anti melanin compounds, hyperthermia and radiation*, Pigment Cell Res. (in press).

G.P. Raaphorst, M.M. Feeley, C.E. Danjoux, V. Da Silva and L.H. Gerig 1991, *Hyperthermia enhancement of radiation response and inhibition of recovery from radiation damage in human glioma cells*, Int. J. Hyperthermia 7 629.

G.P. Raaphorst, M.M. Feeley, L. Martin, C.E. Danjoux, J. Maroun, A.J. de Sanctis and D. Ko 1991, *The enhancement of sensitivity of hyperthermia by lonidamine in human cancer cells, Int. J. Hyperthermia* 7 763.

G.P. Raaphorst, D. Ko, M.M. Feeley, C.E. Danjoux, J. Maroun and W.K. Evans 1990, *The effect of lonidamine alone and in combination with cisplatin on in vitro growth and viability of lung squamous cell carcinoma cell lines*, Anti Cancer Res. 11 41.

J.G. Szekely, G.P. Raaphorst, A.U. Lobreau, S. Delaney, E.I. Azzam 1991, *The effect of colcemid on the heat survival of mitotic V79 Chinese hamster cells*, Microscopy (in press).

J. Van Dyk, R. Barnett, J. Cygler and P. Shragge 1991, *Commissioning and Quality Assurance of Treatment Planning Computers*, OCI/OCTRF Report.

Funding: NCIC grant for the study of cellular radiosensitivity, three years - $64,000/year.
NCIC grant for the study of hyperthermia on perfusion in animals, one year - $40,000/year.
NIH Grant, Study of hyperthermic and low dose rate irradiation, three years - $128,000/year.
Industrial funding, one year - $30,000.
ORCC capital and operating fund.
$16,000/year, MRC graduate fellowship
$16,000/year, NSERC graduate fellowship

Dave Rogers

Research: Using Monte Carlo techniques 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.

Publications:

D.W.O. Rogers and A.F. Bielajew 1990 *Monte Carlo techniques of electron and photon transport for radiation dosimetry* in 'The Dosimetry of Ionizing Radiation', Vol III, eds. K.R. Kase, B.E. Bjarngard and F.H. Attix, Academic Press 427-539.

J. Cygler, D.W.O. Rogers, M. Soubra and J. Szanto 1990, *Effect of gold backing on the dose rate around Iodine-125 seed*, Med. Phys. 17 172.

B.A. Faddegon, C.K. Ross and D.W.O. Rogers 1990 *Forward-Directed Bremsstrahlung of 10-30 MeV Electrons Incident on Thick Targets of Al and Pb*, Med. Phys. 17(5) 773.

B.A. Faddegon, Len Van der Zwan, D.W.O. Rogers and C.K. Ross 1991 *Precision Response-Function Estimation, Energy Calibration, and Unfolding of Spectra Measured With a Large NaI Detector,* Nucl. Instr. Meth. A301 138.

Rogers, D.W.O. and Bielajew, A.F. 1990 *Wall attenuation and scatter corrections for ion chambers: measurements versus calculations*, Phys. Med. Biol. 35 1065-1078.

H. Hirayama, W.R. Nelson and D.W.O. Rogers (1990) *How to Use EGS4 (in Japanese)*, KEK (Japanese National Laboratory for High Energy Physics) Internal Report 89-15, Tokyo.

D.W.O. Rogers 1990, *Monte Carlo Calculation of the Response of Parallel-Plate Chambers in ^{60}Co beams*, NRC Report PIRS-0259.

Funding NRC - ongoing operations and capital funds
NSERC - graduate student support of $12.5 k/year
NIH - $100k/year (to Ottawa) for three years for the OMEGA project.

Carl Ross
Research: Involved with the project to use water calorimetry to establish absorbed dose standards for high energy photon beams. A comparison of our preliminary 20 MV standard with the PTB (Germany) has been completed. The standards agree to better than 1%, although a number of corrections are still under investigation. Have also participated in the work to measure high energy bremsstrahlung spectra using a large NaI detector.

Publications:
N.V. Klassen and C.K. Ross 1991 *Absorbed Dose Calorimetry using Various Aqueous solutions*, Radiat. Phys. Chem. 38(1)95.
B.A. Faddegon, C.K. Ross and D.W.O. Rogers 1991 *Angular Distributions of Bremsstrahlung from 15 MeV Electrons Incident on Thick Targets of Be, Al and Pb*, Med. Phys. 18(4) 727.
B.A. Faddegon, C.K. Ross and D.W.O. Rogers 1990 *Forward-Directed Bremsstrahlung of 10-30 MeV Electrons Incident on Thick Targets of Al and Pb*, Med. Phys. 17(5) 773.
B.A. Faddegon, Len Van der Zwan, D.W.O. Rogers and C.K. Ross 1991 *Precision Response-Function Estimation, Energy Calibration, and Unfolding of Spectra Measured With a Large NaI Detector*, Nucl. Instr. Meth. A301 138.

Funding: Supported as a member of NRC staff.

Ken Shortt
Research: Involved with the establishment of a primary standard of absorbed dose to water for high energy x-rays. The approach is to use a water-filled calorimeter whose heat defect can be calculated or measured to calibrate a Fricke chemical dosimeter solution. The calibrated solution is placed in small glass vials to determine the dose at a point. The Canadian dose standard has been compared to those of other countries using transfer ionization chambers. A number of perturbations, such as those caused by vial walls and water proofing sleeves are under investigation.

Funding: Supported as a member of NRC staff.

10. CVs of New MPORU Members

This year we welcome V. Elaguppillai (AECB) and Cheng Ng (ORCC) as new members of the MPORU. Highlights from Cheng Ng's CVs is given below. (V. Elaguppillai's was not available for this year's Newsletter.) The CVs of established members may be found in previous Newsletters.

Cheng E. Ng

Mailing Address: Department of Medical Physics
Ottawa Regional Cancer Centre
190 Melrose Avenue
Ottawa, Ont. K1Y 4K7

Telephone Numbers: (613) 725-6310 - FAX (613) 725-6320

Current Position: Career Scientist, OCF
Assistant Professor, Radiology, University of Ottawa

Previous Positions:

NMR-Radiobiologist, Johns Hopkins U. School of Medicine, Baltimore, MD
Senior Lecturer, School of Physics, U. of Science, Malaysia
Visiting Scientist, U. of Rochester Cancer Center, Rochester, N.Y.

Education: PhD, Biophysics, U. of Western Ontario
MSc, Biophysics, U. of Western Ontario
BSc Hons., Physics, U. of Science, Malaysia

Sample Publications:

- C.E. Ng, K.A. McGovern, J.P. Wehrle and J.D. Glickson 1992 ^{31}P NMR spectroscopic study of the effect of gamma-irradiation on RIF-1 tumour cells perfused in vitro, Mag. Res. in Medicine (in press).
- K.A. McGovern, J.S. Schoniger, J.P. Wehrle, C.E. Ng and J.D. Glickson 1990 Gel-entrapped perfluorocarbon: A method for monitoring oxygen concentrations in cell perfusion systems. Proc. 9th Meeting of the Society of Magnetic Res. in Medicine 853. Submitted for publication.
- C.E. Ng, K.A. McGovern, J.P. Wehrle and J.D. Glickson 1990 ^{13}C and ^{31}P NMR study of the metabolism of EMT6 spheroids. Proc. of 9th Meeting of the Society of Magnetic Research in Medicine 852.
- G.P. Raaphorst, M. Thakar and C.E. Ng 1992 Thermal radiosensitization in two pairs of CHO wild-type and radiation-sensitive mutants. Abstracts of 39th Meeting of Radiation Research Society, UT 68. Submitted for publication.
- C.E. Ng, M. Bagota, A.M. Bussey and G.P. Raaphorst 1992, Modification of the repair of radiation damage by inhibitors of DNA topoisomerases in human tumour cell lines. Abstracts of 39th Meeting of Radiation Research Society, UT 37. Submitted for publication.
- C.E. Ng, P.C. Keng and R.M. Sutherland 1987, Characterization of radiation sensitivity of human squamous carcinoma A431 cells. Brit. J. Cancer 56 301-307.

11. Kudos

In 1991 MPORU members Lee Gerig and Peter Raaphorst passed both the written and oral exams of the Canadian College of Physicists in Medicine (CCPM), and are now Fellows of the College.

Two papers shared the Farrington Daniels Award for the best paper in radiation dosimetry published in the journal Medical Physics during the previous year. One was by Woo, Cunningham and Jezioranski, and the other was by MPORU members Bruce Faddegon, David Rogers and Carl Ross. Their paper was entitled "Forward-Directed Bremsstrahlung of 10- to 30- MeV Electrons on Thick Targets of Al and Pb" (Med. Phys. 17, 773, 1990).

Alex Bielajew won the 1991 Sylvia Fedourk prize for the best paper published in 1990 by a Canadian in any journal devoted to medical physics. His paper was entitled "On the Technique of Extrapolation to Obtain Wall Correction Factors for Ion Chambers Irradiated by Photon Beams", and was published in the journal Medical Physics (Med. Phys. 17, 583, 1990).