History of International Workshop on Mini-Micro- and Nano-Dosimetry (MMND) and Innovation Technologies in Radiation Oncology (ITRO)

Anatoly B. Rosenfeld[1], Marco Zaider[2], Josh Yamada[2], Michael J.Zelefsky[2]
[1]Centre for Medical Radiation Physics, University of Wollongong, Wollongong NSW 2522, Australia
[2]Memorial Sloan Kettering Cancer Centre, NY, USA

Email: anatoly@uow.edu.au

Abstract. The biannual MMND (former MMD) - IPCT workshops was founded in collaboration between the Centre for Medical Radiation Physics, University of Wollongong and the Memorial Sloan Kettering Cancer Center (MSKCC) in 2001 and has become an important international multidisciplinary forum for the discussion of advanced quality assurance (QA) dosimetry technology for radiation therapy and space science, as well as advanced technologies for clinical cancer treatment.

1. Historical overview

Microdosimetry is the systematic study and quantification of the *spatial* and *temporal* distribution of absorbed energy in irradiated matter. It deals with *stochastic* energy deposition. Microdosimetry is important for characterization of mixed radiation fields for prediction of its biological effect in humans and failure in electronic devices [1].

The idea of the creation of an international forum for discussion on the development of new techniques in microdosimetry and its applications was originated by Prof Anatoly Rosenfeld PhD, of the Centre for Medical Radiation Physics (CMRP) of the University of Wollongong, Australia and Prof Marco Zaider PhD, of the Memorial Sloan Kettering Cancer Centre (MSKCC), USA due to a strong move in the development of a new generation of solid state microdosimetry instruments for space/aviation, radiation protection and radiation therapy. The forum originated at CMRP in 1995 and further boosted by a National Health and Medical Research Council (NHMRC) Project Grant - *Development of Silicon Detectors for Microdosimetry* in 1996. An outcome of this project was the first Silicon on Insulator (SOI) microdosimeter which has demonstrated advancement for microdosimetry in hadron therapy [2].

To address this direction of fundamental and translational research CMRP in partnership with MSKCC founded the Mini-Micro-Dosimetry (MMD) International Workshop. The first inaugural MMD was held from the 16-20th December, 2001 in the Medina Grand Hotel, Sydney, Australia. MMD 2001 highlighted the strong interest in the development and applications of semiconductor radiation detectors, not only for microdosimetry, but also for semiconductor mini-detectors for quality assurance (QA) in radiation therapy. Since 2001 the MMD Workshop has become an important biennial international multidisciplinary forum for the discussion of advanced QA dosimetry technology for radiation therapy including microdosimetry for hadron therapy and space science.

The second MMD workshop was held in conjunction with the World Congress on Medical Physics and Biomedical Engineering from the 24-29th of August, 2003 at the Sydney International Convention Centre. The MMD 2003 workshop included interesting discussions led by invited international speakers on ion radiobiology by Dr Mauro Belli PhD of the Instituto Superiore di Santia, Rome; on the cancer risk of space radiation by Prof John Dicello PhD of Johns Hopkins University; on microdosimetry by Prof Roberto Cherubini PhD of INFN; challenges in radiobiology and dosimetry in synchrotron Microbeam Radiation Therapy (MRT) by Dr Alberto Bravin PhD and Dr Elke Braeuer Krisch of ESRF; on proton therapy by Prof Reinhard Schulte MD of LLUMC; on fast neutron therapy by Dr Mark Yudelev PhD of Karmanos Cancer Institute. All demonstrated the importance of solid state microdosimetry in radiation therapy and space.

In 2005 CMRP and MSKCC decided to extend their collaboration in prostate cancer treatment research by founding the International Workshop on Prostate Cancer Treatment (IPCT) with Prof Anatoly Rosenfeld PhD (CMRP) and Prof Michael Zelefsky MD and Prof Marco Zaider PhD (MSKCC) as Foundation Chairs. This first workshop was held in Sydney in collaboration with St Vincent's Hospital and was co-chaired by Prof Phillip Striker MD of St Vincent's Private Hospital.

Since 2005 both the MMD and IPCT workshops have been run together and known as the MMD-IPCT International Workshops. MMD-IPCT 2005 was held from 5-8 December, 2005 at the University of Wollongong, and became a large multidisciplinary forum which brought together radiation detection scientists, medical physicists, radiobiologists and radiation oncologists to cover many aspects of dosimetry and microdosimetry detectors for QA in radiation therapy and space and advancements in prostate cancer treatment with external X-ray and proton beams and brachytherapy. The invited speakers Dr Josh Yamada MD (MSKCC), Prof Carl Rossi MD (LLUMC), Dr Katja Langen PhD (MD Anderson Cancer Center, Orlando) led fascinating discussions on the comparison of radiation oncology modalities for prostate cancer treatment. Since this workshop, Dr Josh Yamada became Convener of IPCT workshops. Many international dosimetry experts joined MMD-IPCT 2005 including Prof Pavel Olko PhD of the Krakow Institute for Nuclear Physics, Dr Alex Romanyukha of the US Naval Dosimetry Center and Dr Henry Tang of IBM among many others.

MMND-ITRO 2008 was held at the University of Wollongong. The feature of MMD 2008 Workshop was a special session on *Microdosimetry for Space Applications* supported by the National Space Biomedical Research Institute (NSBRI), USA in recognition of the developed microdosimrtry instrument, MIDN for astronaut's personal dosimetry based on the CMRP SOI microdosimetry detector in collaboration with US Naval Academy (USNA), NASA and MSKCC which was supported by a joint NSBRI grant. Invited speakers were Prof John Dicello PhD and Prof Vince Pisacane PhD (USNA).

In 2008 a new topic was introduced at MMD - experiments in nanodosimetry and associated Monte Carlo radiation transport simulations. Invited speakers on nanodosimetry simulations were Dr Sébastien Incerti PhD of CENBG, Bordeaux, and Dr Elisabetta Gargioni PhD of University Medical Center, Hamburg; Dr Henry Tang PhD of IBM; and on experimental nanodosimetry, Prof Reinhard Schulte MD of LLUMC. Due to strong interest in nanodosimetry, along with microdosimetry, it was decided to rename the MMD workshop to Mini-Micro-Nano Dosimetry (MMND). The IPCT 2008 workshop was co-chaired by Dr Josh Yamada MD of MSKCC and it became a forum where invited speakers, Dr James Morris and Prof Carl Rossi MD of LLUMC contributed to interesting discussions on the comparison of prostate cancer treatment with proton therapy versus permanent seed implant brachytherapy and HDR brachytherapy.

In 2010 the MMND-IPCT Workshop was held in conjunction with the Solid State Dosimetry (SSD 16) conference from the 19-24th of September, 2010 at the Sofitel Wentworth Hotel in Sydney. Special guest was US NASA astronaut Dr Leroy Chao PhD who presented a talk on importance of monitoring of the radiation environment during human space missions and the role of microdosimetry for personal radiation protection of astronauts.

MMND-IPCT 2012 was held at the University of Wollongong and had a strong emphasis on nanodosimetry and its relation to microdosimetry and the role of nanoparticles in dose enhancement in

radiation therapy as presented by invited speaker Prof Claude Lesech of Institute des Sciences Moléculaires d'Orsay. Invited speakers, Prof Larry Pinsky PhD of the University of Houston, and Prof Stanislav Pospisil PhD of the Institute of Experimental and Applied Physics, Prague, led discussions on MEDIPIX detectors with their application for space dosimetry on a board of ISS, and neutron and fragments detection in heavy ion therapy. A joint session with IEEE NPSS on innovative scintillating detectors and applications for advanced SPECT and PET-MRI imaging was presented by invited speakers Prof Katia Parodi PhD of LMU, Munich, Dr Paul Lecoq PhD of CERN, Prof Tom Lewellen PhD of University of Washington and Prof Benjamin Tsui of Johns Hopkins University. Alumni of CMRP made a strong contribution to MMND-IPCT 2012 including Dr Benjamin Clasie PhD of F Burr Proton Therapy Centre, MGH, Dr Andrew Wroe PhD of LLUMC in proton therapy technology and Dr Peter Bradley PhD of Zarlink Semiconductor, USA in wireless implantable sensors technology with possible applications for in vivo radiation dosimetry.

At ITRO 2012 we re-introduced again, since the inauguration IPCT 2005, the case studies in prostate cancer treatments led by Dr Josh Yamada MD with important contribution from invited speakers on proton therapy by Prof Carl Rossi MD and on C-12 ion therapy by Dr Hiroshi Tsuji MD of NIRS followed by discussion on the comparison of clinical outcomes of patient treated by protons and C-12 ions versus IMRT and brachytherapy.

The MMND-IPCT 2014 was held from 20-25 October in Port Douglas Sheraton Mirage Hotel and was a great success due to the very interesting scientific and social programs and an outstanding international faculty (http://mmnd-ipct.com). A special session was devoted to the outcome of the ARDENT project (http://ardent.web.cern.ch/) on the development of innovative detectors for QA dosimetry, solid state microdosimetry in radiation therapy and space. The workshops were attended by more than 150 medical physicists, radiation oncologists, radiation detector experts, radiobiologists and radiation space scientists from 15 countries.

Each biennial MMND IPCT workshop was a giant step in the demonstration of innovative technologies that led to progress in solid state microdosimetry, as recently reviewed [3], and its growing applications in proton and heavy ion radiation therapy and space radiation dosimetry. The workshops demonstrated the importance in collaboration and synergy of radiation detectors and dosimetry experts, radiobiologists, medical physicists and physicians to address challenges in contemporary radiation therapy and new avenues. Confirmation of that was demonstrated in the recent outstanding MMND–ITRO 2016 workshop (http://mmnditro2016.com/).

2. References

[1] Rossi H H and Zaider M 1996 Microdosimetry and its applications, Springer
[2] Bradley P D, Rosenfeld A B and Zaider M 2001 Solid State Microdosimetry. *Nucl. Instrum. Methods Phys. Res. B.* **184** 135-57
[3] Rosenfeld A B 2016 Novel detectors for silicon based microdosimetry, their concepts and applications, *Nucl. Instr. Meth. Phys. Res.* A **809** 156-70

3. Memories

Figure 1. MMD-IPCT 2003: John Dicello, Anatoly Rozenfeld (front right) with group of invited speakers including Roberto Cherubini in centre of first row. First row: Michael Lerch, Mark Yudelev, Alesandro Campa, Alberto Bravin. Second row: Elke Braeuer-Krisch, Stephanie Corde, Roberto Cirio (and others).

Figure 2. Michael Zelefsky and Anatoly Rozenfeld (left). Online technology transfer in LDR Brachytherapy by Dr. Zelefsky, MD at St. Vincent's Private Hospital during inaugural IPCT 2005.

Figure 3. MMND –IPCT 2005

Figure 4. MMND-IPCT 2008

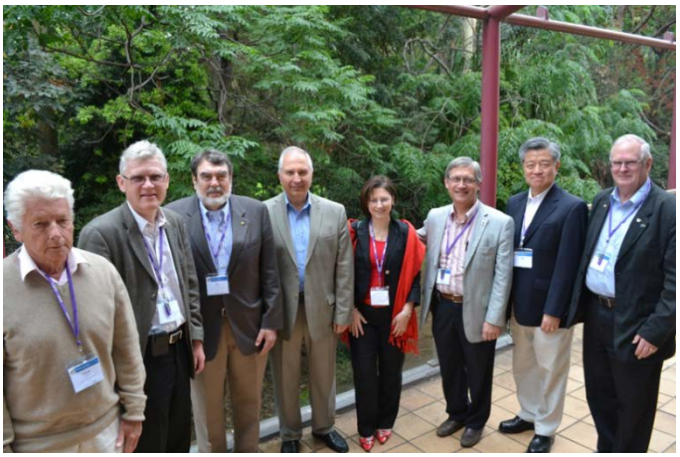

Figure 5. MMND-IPCT 2012, University of Wollongong. From the left to the right: Claude Lesech, Reinhard Schulte, Larry Pinsky, Anatoly Rozenfeld, Katia Parodi, Paul Lecoq, Benjamin Tsui and Tom Lewellen.

Figure 6. MMND-IPCT 2014, Port Douglas, Sheraton Mirage. In a centre Mack Roach, Josh Yamada, Anatoly Rozenfeld.