**18th Annual Meeting**
***Council on Ionizing Radiation Measurements and Standards***

# "RADIATION MEASUREMENTS AND STANDARDS FOR INCIDENT RESPONSE"

**October 19 – 21, 2009**

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THE COUNCIL ON IONIZING RADIATION MEASUREMENTS AND STANDARDS GRATEFULLY THAKS ITS DISTINGUISHED SPONSORS

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## MEETING FOCUS

The 18th Annual Meeting of the Council on Ionizing Radiation Measurements and Standards will focus on radiation measurements and standards for incident response, including the use of radiation itself as a tool in emergencies. For the past eighteen years, CIRMS has played an important role in serving as a public forum for discussion of radiation measurements and standards issues for industry, academia and government. The technical program this year will consist of oral and poster presentations and three parallel workshops that address measurement and standards needs for the following topics:

- Medical Applications [diagnostic and therapeutic radiology, nuclear medicine]
- Radiation Protection [radiochemistry, waste analysis, personnel dosimetry, electronic dosimeters, bioassay and internal dosimetry environmental dosimetry],
- Industrial Applications and Materials Effects [dosimetry for radiation processing, radiobiology, safety at radiation facilities, food irradiation]

As issues in homeland security, and for first responders, can be found in each field – medicine, protection, and industry – these will be addressed in each workshop as appropriate.

## EXECUTIVE SUMMARY

The Council on Ionizing Radiation Measurements and Standards (CIRMS) is an independent, non-profit council that draws together experts involved in all aspects of ionizing radiation to discuss, review and assess developments and needs in this field. Drawing upon expertise from government and national laboratories, agencies and departments, from the academic community and from industry, CIRMS has issued four triennial reports on "Needs in Ionizing Radiation Measurements and Standards." Such needs are delineated in Measurement Program Descriptions (MPDs) that indicate the objective, state background information, define needed action items and resource requirements in terms of personnel and facilities.

Each of the subcommittees of the CIRMS Science and Technology Committee has prepared a series of MPDs pertinent to their area of expertise. These were arrived at through dialog at CIRMS meetings and workshops.

CIRMS Medical Subcommittee, which deals with diagnostic and therapeutic uses of ionizing radiation, has found need in four specific areas:

- Radioactivity Standards and Techniques for Nuclear Medicine
- Dose Mapping Systems for 3D Conformal Radiation Therapy and Intensity Modulated Radiation Therapy
- Absorbed Dose Standards for Brachytherapy Sources
- Liquid Based and Micro-Brachytherapy Sources

These reflect current developments in medicine that have come to rely more heavily on the use of radioactive species for diagnostic purposes and treatment. Brachytherapy, for example, is becoming more widely used as an option to treat prostate cancer. Prior to any such internal or to external treatment of cancer, patient dose mapping is needed so that the physician can best treat the targeted or intended area.

The CIRMS Public and Environmental Radiation Protection Subcommittee (PERP), which dealt with radioactivity found in the environment and its possible public health effects, and Occupational Radiation Protection Subcommittee (ORP), which dealt with worker protection in radioactive environments, have been merged into a joint Radiation Protection Subcommittee (RP). Many activities espoused by PERP were evolving into areas of interest for ORP as well. A new subcommittee devoted to the interests in Homeland Security was formed. Its interests are combined with those in Radiation Protection. Nine Measurement Program Descriptions are defined in these areas:

- Traceability to NIST for Reference, Monitoring and Service Laboratories
- Sorption of Radioactive Elements in Contaminated Soils and Sediments and Urban Structural and Other Materials
- Atom-Counting Measurement Techniques for Environmental and Radiobioassay Monitoring
- Intercomparison Transfer Standards for Neutron Source Calibrations
- Improvements for *In–vivo* and *In-vitro* Radiobioassay Metrology
- Improved Radiation Measurement Infrastructure for Occupational Radiation Protection
- Extension of Calibration Accreditation Criteria to Low Dose Radiations
- Implementation of Support for Personnel Dosimetry Proficiency Testing per ANSI N13.11
- Emergency Radiological Response

These reflect continuing needs to improve upon ways to measure radioactivity, especially in soils, structures and other materials that have been contaminated by hosting activities related to nuclear weapons development. Accurate measurements that will be traceable to national reference standards must be sustained and an understanding of how such radioactivity decays over time is a continuing area of inquiry. Issues of calibration, proficiency testing and the maintenance of a network to monitor dose exposure in occupational settings are covered. The need for a national network capable of responding in the event of terrorist activities involving radiological materials is also addressed.

The CIRMS Industrial Applications and Materials Effects subcommittee (IAME) covers a diverse area generally not related directly to human radiation exposure. In this context, IAME has found need for measurement programs in five areas:

- Radiation Hardness Testing and Mixed-Field Radiation Effects
- Neutron Dosimetry for Reactor Pressure Vessel Surveillance
- Medical Device Sterilization
- Food Irradiation
- Low-Voltage Electron Beam Dosimetry

Terrestrial measurements of the effects (hardening) of types of radiation found in space on electronic materials are essential to satellite operations and communications systems. As nuclear power plants age, radiation effects on their pressure vessels must continue to be monitored. The growing use of irradiation to sterilize medical devices and the emergence of food irradiation demand heightened attention to dosimetry measurements and their traceability to national reference sources.

In an era of constrained government resources, the above point to areas warranting program attention as determined by a consensus of experts from industry, academia and government laboratories and agencies. Adequate resources should be allocated so that the objectives outlined in each area can be accomplished.

## PLENARY AGENDA

Monday, October 19

8:30 am Continental breakfast

9:15 am **CIRMS' Welcome**
*Kim Morehouse, President-Elect, CIRMS*

9:30 am **Welcome to NIST**
*Patrick Gallagher, Deputy Director, NIST*

**ANALYSIS OF PAST INCIDENTS**

9:45 am **The History and Background of the Radiation Effects Research Foundation**
*Daniela Stricklin, Program Officer, Nuclear and Radiation Studies Board, The National Academies*

10:10 am **Physical Methods for Biodosimetry After Radiologic and Nuclear Events**
*Marc Desrosiers, National Institute of Standards and Technology*

**WHAT REALLY HAPPENS IN RADIATION EXPOSURE**

10:35 am **BARDA Development and Funding Advances: From BAA to Mass Casualty Biodosimetry**
*Ronald Manning, Biomedical Advanced Research and Development Authority*

11:00 am Break/Sponsor Poster Session

11:25 am **Assessment of Tissue Dose in Radiological Incidents: Availability of Applicable Dose Coefficients**
*Keith Eckerman, Oak Ridge National Laboratory*

11:50 am **Patient-specific Dosimetry in Nuclear Medicine**
*Michael Stabin, Vanderbilt University*

12:15 pm General Discussion

12:45 pm Lunch

1:45 pm **Breakout sessions**

3:30 pm Break

3:45 pm **Breakout sessions** (continued)

5:20 pm Adjourn

Tuesday, October 20

8:30 am Continental breakfast

8:55 am **Welcome Back**

**STRATEGIES FOR DEALING WITH A RADIOLOGICAL INCIDENT**

9:00 am **Radiological Emergency Planning and Response**
*Eva Lee, Georgia Institute of Technology*

9:25 am **American Contributions to International Standards**
*Morgan Cox, Certified Health Physicist*

9:50 am **Developing Standards for Radiation Transport Simulations**
*Laurie Waters, Los Alamos National Laboratory*

10:15 am **Shielding & Shipping Issues Related to Co-60 High Activity Sources**
*Robert Ricks, MDS Nordion*

10:40 am Break and Poster Session

11:05 am **Challenges To Meet Nuclear Energy Resurgence Resource Requirements**
*Ralph Andersen, Nuclear Energy Institute*

11:30 am **Student Travel Grant Awards Presentations**

CIRMS Student Travel Grant – sponsored by Thermo Fisher Scientific
**Bestowing Shape Memory on Polyacrylates Using Ionizing Radiation**
*Walter Voit, Georgia Institute of Technology*

The Marshall R. Cleland / IBA Industrial Student Travel Grant
**Radiation Crosslinking of UHMWPE in the Presence of Nitroxide Antioxidants**
*Marina K. Chumakov, University of Maryland*

CIRMS Student Travel Grant – sponsored by NIST Ionizing Radiation Division
**Commissioning an Anthropomorphic Pelvis Phantom for Evaluation of Proton Therapy Treatment Procedures**
*Ryan Grant, University of Texas M.D. Anderson Cancer Center*

CIRMS Student Travel Grant – sponsored by NIST Ionizing Radiation Division
**Polymer Gel R2 Response as a Function of Photon Energy for Moderately Filtered X-ray Spectra in the Range of 30-250 kVp Relative to $^{60}$Co**
*Jessica R. Snow, University of Wisconsin*

12:20 pm General Discussion

**PLENARY AGENDA, CONTINUED**

Tuesday, October 20

12:45 pm Lunch

1:45 pm **Breakout sessions**

3:30 pm Break

3:45 pm **Breakout sessions** (continued)

5:20pm Adjourn

6:15 pm Bus from Hilton Hotel to dinner

6:30 pm Dinner at Smokey Glen Farm, Gaithersburg, MD.

Wednesday, October 21

8:30 am Continental breakfast

8:55 am **Welcome Back**

9:00 am **Overview of the Methods for After-the-fact Radiation Dosimetry**
*Harold Swartz, Dartmouth Medical School*

9:25 am **Responding to a Murder that Became a Public Health Event: The Po-210 Poisoning in London**
*Robert C. Whitcomb, Jr., Centers for Disease Control and Prevention*

9:50 am **NIST Boulder Incident Response**
*Timothy Mengers, National Institute of Standards and Technology*

10:15 am **Randall S. Caswell Award for Distinguished Achievements in the Field of Ionizing Radiation Measurements and Standards** presented to:

***Marshall R. Cleland, IBA Industrial, Incorporated***

10:45 Break

11:15 Break-out session reports, introduction of new officers, discussion of CIRMS finances and goals.

12:00 Adjourn and lunch

## IAME - INDUSTRIAL APPLICATIONS AND MATERIALS EFFECTS SUBCOMMITTEE

Breakout Sessions

Monday, Oct. 19

2:00 pm chair: Kim Morehouse

**Regulatory Update – Food Irradiation**
*Lane Highbarger, U.S. Food & Drug Administration*

**Irradiation of Packaging Materials in Contact With Food**
*Vanee Komolprasert, U.S. Food & Drug Administration*

**In-line Sterilization of Planar and Three-dimensional Surfaces for Pharmaceutical and Food Packaging Applications Using Low Energy Electron Beams**
*Anne Testoni, Advanced Electron Beams*

3:30 pm Break

3:45 pm chair: Chip Starns

**Irradiation to Enhance Microbial Safety of Fresh and Fresh-cut Fruit and Vegetables**
*Brendan Niemira, U.S. Department of Agriculture*

**Challenges and Opportunities for Commercial Applications of Food Irradiation: An Industry Perspective**
*Jeffrey Barach and Shannon Cole, Grocery Manufacturers Association*

**Round Table Discussion on Food Irradiation**

5:15 pm Adjourn

## IAME - INDUSTRIAL APPLICATIONS AND MATERIALS EFFECTS SUBCOMMITTEE

Breakout Sessions, continued

Tuesday, Oct. 20

2:00 pm chair: Kim Morehouse

**Radiation Curing of Composites for Vehicle Components and Vehicle Manufacture**
*Marshall R. Cleland, IBA Industrial, Inc.*

**Retrospective on the Use of EB/X-ray for Decontaminating Mail from Biohazards Such as Anthrax**
*Tony Berejka, Ionicorp*

3:30 pm Break

3:45 pm chair: Tony Berejka

**FDA Regulatory Perspective for Standards, Radiation Processing, Dosimetry and Applications for Medical Devices**
*Patrick Weixel, U.S. Food & Drug Administration*

**Industrial Electron Beam Processing – Overview of the Document**
*Marshall R. Cleland, IBA Industrial, Inc. and Tony Berejka, Ionicorp*

**Discussion of CIRMS Needs Report**

5:15 pm Adjourn

## MEDICAL APPLICATIONS SUBCOMMITTEE

Breakout Sessions

Monday, October 19

| | |
|---|---|
| 1:45 pm – 2:15 pm | **Patient-specific Dosimetry for Diagnostic and Therapeutic Uses of Unsealed Radionuclides**<br>*Michael Stabin, Vanderbilt University* |
| 2:15 pm – 2:45 pm | **Biodosimetry Techniques at BARDA**<br>*Marcy Grace, Department of Health and Human Services* |
| 2:45 pm – 3:15 pm | **Incident Response Planning**<br>*Jodi Strzelczyk, University of Colorado Denver* |
| 3:15 pm – 3:30 pm | **Questions and Discussion** |
| 3:30 pm | Break |
| 3:45 pm – 4:15 pm | **An Anthropomorphic Phantom for Proton Dose Verification**<br>*Ryan Grant, Radiological Physics Center* |
| 4:15 pm – 4:45 pm | **Independent Audits of Radiation Therapy Centers and Prevention of Errors**<br>*Geoffrey Ibbott, Radiological Physics Center* |
| 4:45 pm – 5:15 pm | **Errors and Accidents in Radiation Therapy**<br>*Stephen Davis, University of Wisconsin–Madison* |

Tuesday, October 20

| | |
|---|---|
| 1:45 pm – 2:30 pm | **Discussion of Needs Report** |

## RADIATION PROTECTION SUBCOMMITTEE

Breakout Sessions

Monday, Oct. 19

1:45 pm **Calibration of Radiation Protection Dosimeters in High-energy Photon Fields (4-7 MeV)**
*Jens Brunzendorf, Physikalisch-Technische Bundesanstalt*

**Rapid Radioanalytical Screening Methods for Consequence Management**
*Jerome LaRosa, National Institute of Standards and Technology*

**Developing Radioanalytical Metrology Infrastructure for Population Monitoring – Can We Be Pepared for a Radiological Emergency?**
*Svetlana Nour, National Institute of Standards and Technology*

3:30 pm Break

3:45 pm **Radionuclide and Nuclear Material Certified Reference Material Blueprint for Consequence Management, IND Post-det Nuclear Forensics and Safeguards**
*Kenneth G. W. Inn, National Institute of Standards and Technology*

**Nuclear Forensics SRM Program – Status Report**
*Kenneth G. W. Inn, National Institute of Standards and Technology*

**Open Discussion on Presentations**

5:20 pm Adjourn

Tuesday, Oct. 20

1:45 pm **Current MPDs – Keep / Expand / Close**

3:30 pm Break

3:45 pm **New MPDs, Champions**

5:20 pm Adjourn

*CIRMS Student Travel Grant – sponsored by Thermo Fisher Scientific*

## BESTOWING SHAPE MEMORY ON POLYACRYLATES USING IONIZING RADIATION

**Walter Voit**, Amy Varallo, Taylor Ware, and Ken Gall
Georgia Institute of Technology
Atlanta, Georgia

Shape-memory polymers (SMPs) are active smart materials with tunable stiffness changes at specific, tailored temperatures. Thermoplastic SMPs lose "memory" properties near melt temperatures and have large residual strains, while network (thermoset) SMPs fully recover, limiting device disfiguration. However the use of thermoset SMPs has been limited in mass-manufacture and commodity applications because low-cost plastics processing techniques like injection molding and blow molding are not possible with network polymers. In this study thermoplastic SMP precursor resins are crosslinked with electron beam (e-beam) radiation at dosages ranging from 5 to 300 kilogray (kGy) and thermomechanically characterized. The resulting crosslinked polymers show fully recoverable strains over a shape-memory cycle, glass transition temperatures (Tg) between 28 and 60 °C and rubbery moduli (ER) between 0.5 and 13 MPa. Specifically, this study assesses a model poly(methyl acrylate-co-isobornyl acrylate) (MA-co-IBoA) polymer system blended separately with both triallyl isocyanurate (TAIC®) and trimethylolpropane triacrylate (TMPTA) in varying concentrations and irradiated. The most challenging aspect of this work was to devise a system that showed true independent control of Tg and ER and could be post-crosslinked with ionizing radiation. In materials crosslinked during polymerization, this can be accomplished by copolymerizing various linear monomers with different side groups to alter chain mobility and thus Tg of the copolymer on the macro scale. Often this is accomplished by copolymerizing acrylates with methacrylates. However after polymerization, a backbone ternary carbon is created in methacrylates, leading to increased steric hindrance, that impedes molecular motion and thus raises the Tg. So although methacrylates are often used to raise the Tg in SMP systems, their effect in radiation crosslinked systems is undesirable. This backbone ternary carbon is a prime target for degradation, which drives the scission (degradation) to crosslinking ratio as determined by Charlesby-Pinner analysis over 1 and leads to poor mechanical properties. Thus a fundamental challenge exists to raise the Tg while avoiding molecular structures that typically move Tg upward such as backbone ternary carbons. Several linear builders were considered for copolymerization with MA: isobornyl acrylate (IBoA), 4-tert-Butylcyclohexyl acrylate (TbCHA), n-isopropyl acrylamide (NiPAAm), 4-Acryloylmorpholine (AMO) and 2-carboxyethyl acrylate oligomers (CXEA). Isobornyl acrylate was selected due to the large increase in Tg exhibited by MA-IBoA copolymers . The results of this study are intended to enable future advanced applications where radiation induced post-crosslinking bestows the ability to accurately and independently position Tg and the ability to tune recoverable force in SMPs.

*The Marshall R. Cleland / IBA Industrial Student Travel Grant*

## RADIATION CROSSLINKING OF UHMWPE IN THE PRESENCE OF NITROXIDE ANTIOXIDANTS

**[1]Marina K. Chumakov**, [1]Alicia Zack, [2]Joseph Silverman, [2]Mohamad Al-Sheikhly
[1]Fischell Department of Bioengineering [2]Department of Materials Science & Engineering
University of Maryland, College Park, MD

Ultra-high molecular weight polyethylene (UHMWPE) is the standard articulating lining material used in total joint arthroplasty. While radiation-induced oxidation results in premature aging and wear of the material, alkyl radicals bimolecularly cross-link the polymer chains, especially at high dose rates. The use of an antioxidant maintains fatigue strength in addition to reduced oxidation and wear rates. Nitroxides are stable organic compounds that have a strong paramagnetic signal and are very efficient in preventing lipid peroxidation, providing radioprotection in biological tissues[1] and scavenging carbon-centered free radicals[2] *in vivo*. These antioxidants also interact with free radicals in UHMWPE through the electron transfer mechanism[3,4]. Yet this carbon-centered radical scavenging can reduce radiation cross-linking. In addition to the demonstration of radical scavenging in UHMWPE, this work aims to relate the effect of nitroxide concentration on the cross-linking and properties of UHMWPE.

The nitroxides used were 2,2,6,6–tetramethylpiperidine–1–oxyl (TEMPO), and 4-hydroxy-TEMPO (TEMPOL). Cylindrical pellets of 1 mm diameter and 1:1 height-to-width aspect ratio and 1/8 inch diameter plugs were machined from UHMWPE cylindrical disks (Biomet, Inc., Warsaw, IN.). Samples were irradiated to varying total absorbed doses, using a 7 MeV pulsed LINAC at the University of Maryland Radiation Facilities. Samples were annealed or infiltrated with nitroxide at 80°C in glass vials. Free radical analysis was performed on a Bruker ESP300 Electron Paramagnetic Resonance (EPR) Spectrometer. In an adaptation of ASTM Standard F2214, the cross-linked samples were swelled until equilibrium in decahydronaphthalene in a Mettler Toledo TMA/SDTA841e Thermomechanical Analyzer (TMA). The swell ratio, cross-link density and molecular weight between cross-links were calculated according to the standard. There is an approximately 40 – 50% reduction in cross-link density of the irradiated and TEMPO-doped samples, versus those irradiated and annealed, as shown in Figure 1.

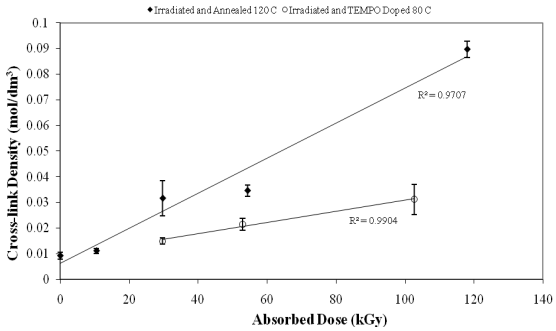


***Figure 1:*** *The Effect of TEMPO Antioxidant on the Cross-link Density of UHMWPE*

It is evident, but not surprising, that the presence of the nitroxide does not completely prevent cross-linking, when added before or after irradiation. It is possible to elucidate the time scale of polymer cross-linking by comparing the cross-link density between the annealed and irradiated and doped samples. Cross-links that would form on this slower scale are scavenged by the nitroxide. EPR spectra corresponding to each processing step will be provided demonstrating the degree of carbon-centered radical scavenging.

## References:

**1.** B. P. Soule. The chemistry and biology of nitroxide compounds. Free Rad. Biology & Medicine 42, 1632 (2007). **2.** A. L. J. Beckwith, V. W. Bowry and K. U. Ingold, Kinetics of nitroxide radical trapping. 1. Solvent effect. Journal of the American Chemical Society 114, 4983 (1992).
**3.** M. K. Chumakov, J. Silverman, and M. Al-Sheikhly. "On the novel use of nitroxides and a-tocopherol as radiolytically-produced free radical scavengers in UHMWPE." 3rd UHMWPE International Meeting, Madrid, Spain, September 14-15, 2007. **4.** M. K. Chumakov, J. Silverman, and M. Al-Sheikhly. "The Novel Scavenging of Free Radicals in UHMWPE with TEMPO, a Nitroxide Antioxidant." Poster 453; 55th Annual Meeting of the Orthopaedic Research Society. Las Vegas, NV, February 22 – 25, 2009.

*CIRMS Student Travel Grant – sponsored by the Ionizing Radiation Division of NIST*

# COMMISSIONING AN ANTHROPOMORPHIC PELVIS PHANTOM FOR THE EVALUATION OF PROTON THERAPY TREATMENT PROCEDURES

**Ryan Grant**
University of Texas M. D. Anderson Cancer Center
Houston, Texas

**Purpose**: To design and implement an anthropomorphic pelvis phantom to audit proton therapy treatment procedures.

**Method and Materials**: A pelvis phantom already in use for independent audits of photon IMRT treatments was retrofitted for use with protons. The relative stopping power of each material used to construct the phantom was measured. Hounsfield Units were determined for each material with a clinical CT scanner. The tissue equivalence of the materials was determined by comparing with the CT calibration curve used clinically for human tissues. A CT simulation of the phantom was then performed and a proton treatment plan was devised. TLD and radiochromic film were inserted in the phantom and the treatment plan was delivered three separate times. The measurements from the TLD and film were compared to calculations made with the treatment planning system. Profile plots through the coronal and sagittal planes were compared to confirm agreement between the treatment plan and delivery.

**Results**: The measured relative stopping powers differed by as much as 10% from values used by the planning system. The comparison between the plan and the TLD showed a difference in dose of less than 2%. The film showed on average a 1 mm shift in the anterior-posterior profile and a 2 mm shift in the superior-inferior profile. The delivered high-dose region shown by the right-left film profile showed a 2 mm compared to the plan profile.

**Conclusions**: Results show the phantom will be able to confirm agreement between measured and calculated dose within 5%/3mm. Stopping power differences between tissue and phantom materials might introduce errors but do not impede passing the set criteria.

**Conflict of Interest:** Work supported by PHS CA010953 and CA081647, awarded by NCI, DHHS, and funds from the RTOG.

*CIRMS Student Travel Grant – sponsored by the Ionizing Radiation Division of NIST*

# POLYMER GEL R2 RESPONSE AS A FUNCTION OF PHOTON ENERGY FOR MODERATELY FILTERED X-RAY SPECTRA IN THE RANGE OF 30-250 KVP RELATIVE TO $^{60}$CO

**Jessica R. Snow**, Larry A. DeWerd[1]
University of Wisconsin
[1]Medical Radiation Research Center
Madison, Wisconsin

Polymer gel dosimetry offers a wide range of potential applications in the three-dimensional verification of complex dose distributions. Gel dosimeters can provide tissue equivalence; high spatial resolution; and lack of energy dependence over a large clinically relevant energy range. However, little is known about the gel's ability to verify dose using low energy photon beams, which could be a limiting factor to the wider use of these dosimeters.

A less toxic alternative to acrylamide-based gel dosimeters was developed called NIPAM which exhibits a similar dose-response with a higher saturation dose. NIPAM gel dosimeters substitute acrylamide with a less toxic monomer known as N-Isopropylacrylamide.

Due to these advantageous dosimetric characteristics a protocol was developed for implementation of this dosimeter within the University of Wisconsin Medical Radiation Research Center. The gel was manufactured in a fume hood under normal atmospheric conditions. R2 measurements were made with a GE Sigma 3 T MRI system, using a multi-echo spin-echo pulse sequence. R2 homogeneity in non-irradiated NIPAM gel phantoms was analyzed for sequence optimization. $^{60}$Co calibration curves were created for doses ranging from 0-50 Gy. The R2 values were in good agreement with previously published data.

Initial low energy measurements were performed with NIPAM gel dosimeters using moderately filtered x-ray spectra in the range of 30-250 kVp relative to $^{60}$Co. A series of gel vials were irradiated to known air kerma values. Monte Carlo (MC) simulations were performed using the MCNP5 code to determine the absorbed dose to gel per unit air kerma as a function of photon energy. Measurements for x-ray beam irradiations were compared with MC calculated results. A significant energy dependence was discovered for energies in the range of 30-250 kVp relative to $^{60}$Co.

Dose rate measurements were performed over the range of dose rates covered in the x-ray beam irradiations, 7.8-13.5 cGy min$^{-1}$. Dose rate did not significantly affect the response of the polymer gels irradiated to 2-10 Gy. The results at a dose rate of 7.8cGy min$^{-1}$ were similar to the data at 13.5 cGy min$^{-1}$.

## *CIRMS 2009/2010 OFFICERS AND SUBCOMMITTEE CHAIRS*

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|---|---|
| President: | Kim Morehouse, US FDA |
| 1st Vice-President: | Chip Starns, ScanTech Sciences |
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| Secretary: | Sander Perle, Mirion Technologies |
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| Immediate Past President: | Nolan Hertel, Georgia Institute of Technology |
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| Homeland Security: | Michael P. Unterweger, NIST |
| Industrial Applications & Materials Effects: | Roberto Uribe, Kent State University<br>John Logar, Sterigenics |
| Medical Applications: | Larry A. DeWerd, University of Wisconsin<br>Geoffrey S. Ibbott, M.D. Anderson Cancer Center |
| Radiation Protection: | Kenneth G.W. Inn, NIST<br>Carl V. Gogolak, US DHS / DOE, retired |

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## *PAST PRESIDENTS OF CIRMS:*

1993 - Marshall R. Cleland, IBA Industrial, Inc.
1994 - Peter Almond, Univ. of Louisville
1995 - R. Thomas Bell, U.S. Dept. of Energy
1996 - Anthony J. Berejka, Ionicorp
1997 - Larry A. DeWerd, Univ. of Wisconsin
1998 - Robert M. Loesch, U.S. Dept. of Energy
1999 - Thomas W. Slowey, K&S Associates
2000 - X. George Xu, RPI
2001 - Joseph C. McDonald, PNNL
2002 - Arthur H. Heiss, Bruker BioSpin Corp.
2003 - Geoffrey S. Ibbott, UT M.D. Anderson
2004 - James A. Deye, Nat'l Cancer Institute
2005 - R. Craig Yoder, Landauer, Inc.
2006 - Mohamad Al-Sheikhly, Univ. of MD
2007 - Shawna Eisele, Los Alamos Nat'l Lab.
2008 – Manny Subramanian, Best Medical
2009 – Nolan Hertel, GA Tech

## ***CIRMS Award for Distinguished Achievement in the Field of Ionizing Radiation Measurements and Standards***

2000 **Randall S. Caswell,** National Institute of Standards and Technology (retired)

## ***Randall S. Caswell Award for Distinguished Achievement in the Field of Ionizing Radiation Measurements and Standards***

2002 **H. Thompson Heaton, II**: Center for Devices and Radiological Health, US FDA (retired)

2004 **Anthony J. Berejka,** Ionicorp +

2006 **Kenneth L. Swinth**, Swinth Associates

2007 **Bert M. Coursey**, U.S. Department of Homeland Security

2008 **Larry A. DeWerd**, University of Wisconsin

2009 **Marshall R. Cleland**, IBA Industrial, Incorporated

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## ***Student Travel Grant Recipients***

| | | |
|---|---|---|
| 2009 | Marina K. Chumakov | University of Maryland |
| | Ryan Grant | University of Texas M.D. Anderson Cancer Center |
| | Jessica R. Snow | University of Wisconsin |
| | Walter Voit | Georgia Institute of Technology |
| 2008 | Regina M. Kennedy | University of Wisconsin |
| | Matthew Mille | Rensselaer Polytechnic Institute |
| 2007 | Jianwei Gu | Rensselaer Polytechnic Institute |
| | Arman Sarfehnia | McGill University |
| | Sarah Scarboro | Georgia Institute of Technology |
| | Zachary Whetstone | University of Michigan |
| 2006 | Kimberly Burns | Georgia Institute of Technology |
| | Maisha Murry | University of Cincinnati |
| | Karl Benjamin Richter | University of Minnesota |
| | Reed Selwyn | University of Wisconsin |
| 2005 | Eric Burgett | Georgia Institute of Technology |
| | Mark Furler | Rensselaer Polytechnic Institute |
| | Andrew Jensen | University of Wisconsin |
| 2004 | Jennifer R. Clark | University of Kentucky |
| | Stephen D. Davis | University of Wisconsin |
| | Carlos Roldan | University of Massachusetts – Lowell |

## ***Student Travel Grant Recipients, continued***

| | | |
|---|---|---|
| 2003 | Sheridan L. Griffin | University of Wisconsin |
| | Malcolm P. Heard | University of Texas M.D. Anderson Cancer Center |
| | Shannon Miller-Helfinstine | Kent State University |
| | Baodong Wang | Rensselaer Polytechnic Institute |
| 2002 | Wes Culberson | University of Wisconsin |
| | Ramazan Kizil | Penn State University |
| | Dickerson Moreno | University of Missouri |
| | Michael Shannon | Georgia Institute of Technology |
| 2001 | Matt Buchholz | Oregon State University |
| | Michael Czayka | Kent State University |
| | Bridgette Reniers | Universite' Catholique de Louvain |
| | Kurt Stump | University of Wisconsin |
| 2000 | Lesley Buckley | University of Wisconsin |
| | Peter Caracappa | Rensselaer Polytechnic Institute |
| | Scott Larsen | State University of New York |
| 1999 | Ahmet Bozkurt | Rensselaer Polytechnic Institute |
| | Ariel Drogin | University of Kentucky |
| | Kurt Marlow | Idaho State University |
| | Oleg Povetko | Oregon State University |
| | Jennifer Smilowitz | University of Wisconsin |

## CIRMS Meetings and Workshops

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| October 2008 | Annual Meeting Focus: "Radiation Measurements and Standards at the Molecular Level"<br>Panel Discussion: Radiation Source Use and Replacement<br>Break-out session workshops:<br>Industrial Applications and Materials Effects<br>Medical Applications<br>Radiation Protection / Homeland Security |
| October 2007 | Annual Meeting Focus: "Measurements and Standards for Radiation Based Imaging"<br>Break-out session workshops:<br>Industrial Applications and Materials Effects<br>Medical Applications: " Imaging for Radiation Therapy Planning and Delivery"<br>Radiation Protection / Homeland Security |
| October 2006 | Annual Meeting Focus: "Implications of Uncertainty in Radiation Measurements and Applications"<br>Break-out session workshops:<br>Industrial Applications and Materials Effects<br>Medical Applications: "Imaging for Radiation Therapy Planning and Delivery"<br>Radiation Protection / Homeland Security |
| October 2005 | Annual Meeting Focus: "The Impact of New Technologies on Radiation Measurements and Standards"<br>Break-out session workshops:<br>Industrial Applications and Materials Effects<br>Radiation Protection<br>Medical Applications: "Unconventional Measurements and Standards" |
| October 2004 | Department of Homeland Security and CIRMS workshop on the development of REALnet - Radiological Emergency Analytical Laboratory Network |
| October 2004 | Annual Meeting Focus: "Biological Dosimetry Measurements and Standards"<br>Break-out session workshops:<br>Medical Applications<br>Homeland Security<br>Industrial Applications and Materials Effects<br>Radiation Protection |

## CIRMS Meetings and WORKSHOPS, CONT'D

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| October 2003 | Annual Meeting Focus: "Radiation/Radioactivity Measurements and Standards in Industry"<br>Break-out session workshops:<br>Medical Applications<br><br>Homeland Security<br>Industrial Applications and Materials Effects<br>Radiation Protection |
| April 2003 | Advances in High Dose Dosimetry |
| October 2002 | Annual Meeting Focus: "Traceablilty for Radiation Measurements and Standards"<br>Break-out session workshops:<br>Traceability and Standards in High-Dose Applications<br>Traceability and Standards for Homeland Security<br>Traceability and Standards in the Medical Physics Community |
| September 2002 | Electron Beam Treatment of Biohazards |
| February 2002 | Ultra-Sensitive Uranium Isotopic Composition Intercomparison Planning Meeting |
| October 2001 | Annual Meeting Focus: "Radiation Standards for Health and Safety"<br>Break-out session workshops:<br>Specifications for Standard *In-Vivo* Radiobioassay Phantoms<br>Food Irradiation Technology Advancements and Perspectives<br>Measurements and Standards for Intravascular Brachytherapy Sources |
| October 2000 | Annual Meeting Focus: "Advanced Radiation Measurements for the 21st Century"<br>Break-out session workshops:<br>Dosimetry for Radiation Hardness Testing: Sources, Detectors, and Computational Methods<br>Measurements and Standards Infrastructure for Brachytherapy Sources<br>Laboratory Accreditation Program for Personnel Dosimetry: Review of the Status of Implementation of New Standards<br>Drum Assay Intercomparison Program |
| May 2000 | Estimating Uncertainties for Radiochemical Analyses |
| April 2000 | Computational Radiation Dosimetry: New Applications and Needs for Standards and Data |
| April 2000 | Radiation Measurements in Support of Nuclear Material and International Security |

## CIRMS Meetings and WORKSHOPS, CONT'D

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| May 1999 | R-level Measurements and Standards for Public and Environmental Radiation Protection |
| April 1999 | Measurements and Standards for Prostate Therapy Seeds |
| April 1999 | Standards, Intercomparisons and Performance Evaluations for Low-level and Environmental Radionuclide Mass Spectrometry and Atom Counting |
| September 1998 | Radiation Dosimetry Protection |
| April 1998 | Measurements and Standard for Intravascular Brachytherapy |
| March 1998 | NIST Radiochemistry Intercomparison Program |
| October 1997 | High Dose E-Beams |
| October 1997 | Electronic Personnel Dosimetry |
| March 1997 | Iodine -125 Brachytherapy |
| February 1997 | NIST Radiochemistry Intercomparison Program |
| September 1996 | Standards and Measurements for Therapeutic Radionuclides for Use in Bone Palliation |
| July 1996 | Mid-year workshops |
| July 1996 | Mutual Accreditations |
| June 1996 | Radiation Sterilization Medical Devices |
| April 1996 | Mutual Accreditations |
| April 1996 | Absolute Dose |
| September 1995 | MQA Gamma Processing |
| March 1995 | New NVLAP Criteria |
| March 1995 | Radionuclide Speciation |
| June 1994 | Ocean Studies SRM |

*Please join us next year for:*

**CIRMS 19th Annual Meeting**

**October 18 – 20, 2010**

**Gaithersburg, Maryland**

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**Visit www.cirms.org for**

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**► CIRMS Report on Needs in Ionizing Radiation Measurement and Standards**

**► membership application**

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**contact us: CIRMS@CIRMS.org**

## *CIRMS - Council on Ionizing Radiation Measurements and Standards*

P.O. Box 1238 Duluth, GA 30096 www.cirms.org 770-622-0026

**MEMBERSHIP APPLICATION**

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   3rd Representative: _____

   Phone: _____ Fax: _____ E-mail: _____

3. Areas of interest:

| | Rep. 1 | Rep. 2 | Rep. 3 |
|---|---|---|---|
| Homeland Security (HS) | _____ | _____ | _____ |
| Industrial Applications & Materials Effects (IAME) | _____ | _____ | _____ |
| Medical Applications (MED) | _____ | _____ | _____ |
| Radiation Protection (RP) | _____ | _____ | _____ |

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