University of Wisconsin
MEDICAL SCHOOL

Department of Medical Physics

November 12, 2007

Cecilia A. Hunter
Director Finance and Administration
AAPM Headquarters
One Physics Ellipse
College Park, MD 20740-3846

Dear Cecilia,

Enclosed are my expenses for the trip to the CIRMS meeting as AAPM liaison. Geoffrey Ibbott is the medical subcommittee co-chair and also a representative to CIRMS for the AAPM. As liaison and co-chairs we are responsible for arranging the Medical breakout session at the CIRMS meeting. This is generally a meeting with international flavor, so in addition to the AAPM interests, the meeting covers what is occurring around the world. The program and breakout sessions are attached with our summary of the meeting. Would you please pass this along to President Martel and others that may be interested. Geoff and I will submit a similar document to the AAPM newsletter in the future.

My expenses are enclosed; Geoff Ibbott will send his in under separate cover. Please make check payable to myself and mail it to the address above. If there are any questions, please contact me.

Sincerely,

Larry A. DeWerd

Larry A. DeWerd, Ph.D., FAAPM
Professor and Director
(Liaison to CIRMS)

1530 Medical Sciences Center
608/262-2170

1300 University Avenue

Madison, WI 53706-1532
FAX 608/262-2413

Report to, PhD, President, Mary K. Martel
and the AAPM
Regarding the Council on Ionizing Radiation Measurements and Standards (CIRMS)
By
Larry A. DeWerd, Ph.D., FAAPM
AAPM liaison to CIRMS
And
Geoffrey S. Ibbott, Ph.D., FAAPM

The Council on Ionizing Radiation Measurements and Standards (CIRMS) is organized for educational and scientific purposes to analyze the current and future needs of ionizing radiation measurements and standards. CIRMS has a broad-based membership from industry, state, federal government and academia. The main objectives of CIRMS are the advancement and dissemination of the physical measurements and standards needed for applications of ionizing radiations. For more information, see: www.cirms.org.

The CIRMS annual meeting this year on October 22-24, 2007 had as its theme "Measurements and Standards for Radiation Based Imaging." The plenary sessions included presentations on imaging in various applications and measurement technologies. The program is attached.

Breakout sessions were on Monday and Tuesday for each of the subcommittees, which include Medical Applications, Radiation Protection/Homeland Security, and Industrial Applications and Materials Effects. The meeting ended with student presentations, two of which were related to medical concerns. These talks included radiation doses from image guiding modalities and water calorimetry for ^{192}Ir HDR applications.

The Medical Applications Subcommittee heard 8 presentations on the topics of Imaging in Brachytherapy, External beam imaging and small field imaging in Radiation therapy during its breakout sessions. There were also some miscellaneous presentations, e.g. a bibliographic database on electron/photon transport.

CIRMS produces a NEEDS report on a 3 year basis. The NEEDS report delineates the areas for measurements and standards needed in the community. The present NEEDS report includes the following:

1. A.2.3 - Radioactivity Standards and Techniques for Nuclear Medicine
2. A.3.3 - Dose Mapping Systems for 3D Conformal Radiation Therapy and Intensity Modulated Radiation Therapy
3. A.7.2 - Absorbed Dose Standards for Brachytherapy Sources
4. A.8.0 - Liquid-Based and Micro-Brachytherapy Sources

For the Medical portion there were a number of suggestions given for these needs in the Medical community. From the discussions that ensued in the Medical Subcommittee, the following title descriptions may be developed:

1. Imaging models from the web to calculate doses in organs. This would also involve 3D dose mapping dosimetry

2. Development of a HDR ^{192}Ir standard. This was a request from the AAPM Brachytherapy Subcommittee and conveyed to CIRMS.
3. Neutron Dosimetry standards
4. Proton Dosimetry standards
5. Electronic brachytherapy standards
6. Liquid based and microbrachytherapy standards
7. Absorbed dose to water for x-ray energies
8. Calibration standards for small fields (IMRT – cyberknife – gamma knife)
9. Development of a water calorimeter

We have enjoyed representing the AAPM at the CIRMS meetings.

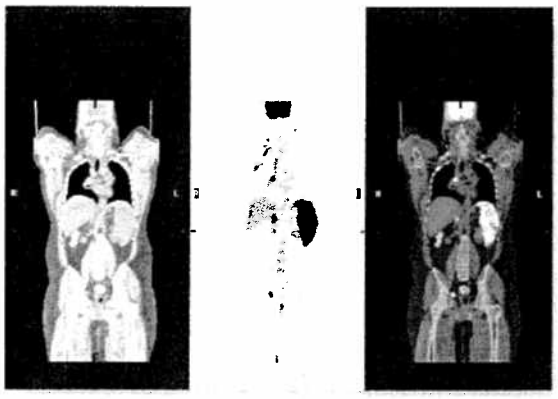
Respectfully submitted by
Larry DeWerd
Geoffrey Ibbott

16th Annual Meeting

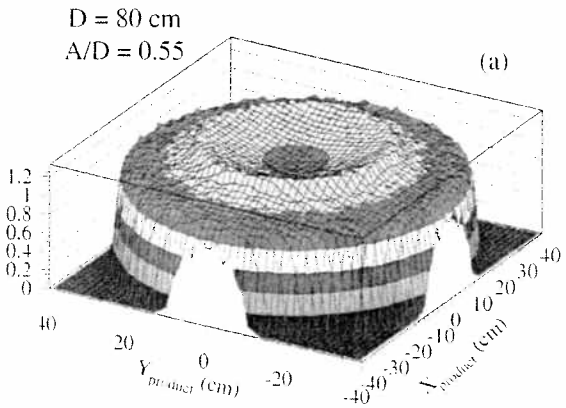
Council on Ionizing Radiation Measurements and Standards

CIRMS 2007

Measurements and Standards for Radiation-Based Imaging



October 22-24, 2007



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16th Annual Meeting
Council on Ionizing Radiation Measurements and Standards

"MEASUREMENTS AND STANDARDS FOR RADIATION BASED IMAGING"

October 22 – 24, 2007

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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 now issues its fourth triennial report 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 has been 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.

MEETING FOCUS

The 16th Annual Meeting of the Council on Ionizing Radiation Measurements and Standards will focus on measurements and standards for radiation-based imaging used in industry, academia and government. For the past sixteen years, CIRMS has played an important role in serving as a public forum for discussion of radiation measurements and standards issues. 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]

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.

Poster Sessions
Two blocks of time will be allocated to poster viewing and discussion. One session will focus on the activities of CIRMS' sponsoring organizations and one session will feature proffered posters on a variety of topics including the research activities of the winners of the Student Travel Grants.

As is traditional with CIRMS meetings, afternoon periods will be devoted to parallel breakout sessions in medical applications, radiological protection (including homeland security) and industrial applications/materials effects.

BREAKOUT SESSIONS

MEDICAL APPLICATIONS

Tuesday October 23rd	Topics/Speakers
2:00 pm – 3:30 pm	Session III: Small field *Imaging in Radiation Therapy* (Chair: Larry DeWerd – Geoffrey Ibbott)
2:00 pm – 2:30 pm	Jim Galvin IGRT accuracy
2:30 pm – 3:00 pm	Jaclyn Homnick, Optically Stimulated Luminescence for Radiation Therapy
3:00 pm – 3:30 pm	T. Feroli, M. Litz, G. Merkel and NR Pereira; End Point Energy Measurement Technique for MeV X-Rays
3:30 pm - 3:45 pm	Break
3:45 pm – 5:15 pm	Discussion of NEEDS Report

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The CIRMS Student Travel Grant, Sponsored by NIST Ionizing Radiation Division

RADIATION DOSES FROM IMAGE-GUIDING MODALITIES USED FOR RADIATION TREATMENT

Mr. Jianwei Gu, Rensselaer Polytechnic Institute

OBJECTIVE

The emerging Image-guided Radiation Treatment (IGRT) procedure requires a means to provide information about the patient setup and organ motions during the radiation delivery. To this end, a number of modalities have become available in recent years including kV cone-beam CT (kV-CBCT), MV-CBCT, CT-on-rails, Cyberknife and tomotherapy MV-CT. Varian, for example, has a commercial in-room KV-CBCT system that is mounted on the accelerator gantry with a rotating arm to generate volumetric data. Such data are hoped to allow the medical physicists to adjust a treatment plan according to the changing patient anatomy prior, during and after the delivery of each fraction. Although these image-guiding procedures offer an opportunity to further improve the tumor controls, the large volumes of health tissue that are irradiated have created a radiation safety concern. The AAPM TG 104 (2007) has recommended that further research to be performed to understand the dosimetry and potential impact of the imaging doses to the patients. Recently, Miften et al (2007) has proposed an IMRT procedure that takes into account of such daily imaging doses from an MV-CBCT in their planning and delivery. This paper describes our preliminary research on modeling the X-ray sources of the kV- and MV-CBCT systems and the applications of these models for calculating patient organ doses under various IGRT procedures.

METHODS and RESULTS

A typical CBCT scanning procedure is simulated using known parameters such as X-ray spectrum, filtration, beam angle, collimation aperture, etc. These models are combined with a whole-body virtual patient, the VIP-Man computational phantom, in the Monte Carlo code, MCNPX to simulate the imaging procedures and to calculate the organ absorbed doses. Various tallies in the MCNPX are used to specify and verify the geometries of the radiation source, collimators and phantoms. A total of 675 projections during the whole 364° gantry rotation were considered for the KV-CBCT and a similar approach was used to model the MV-CBCT procedures. The results show that, depending on the treatment site, the organ doses and the effective dose can be in the range of ~ Gy which is clearly significant in terms of the possibility of causing second cancers in the patients. It is clear that this research can lead to tools very useful to the medical physics community in IGRT dose evaluation and control. One potential aspect is to find ways to maximize the image quality of these systems while minimizing the doses to the patients.

References

AAPM (2007). The Role of In-Room kV X-Ray Imaging for Patient Setup and Target Localization (draft). American Association of Physicists in Medicine, TG 104

Moyed Miften, et al. (2007)."IMRT planning and delivery incorporating daily dose from mega-voltage cone-beam computed tomography imaging." Med. Phys. 34(10): 3760-3767

The CIRMS Student Travel Grant, Sponsored by NIST Ionizing Radiation Division

WATER CALORIMETRY-BASED ABSORBED DOSE TO WATER STANDARD FOR ^{192}IR HDR BRACHYTHERAPY: NUMERICAL AND EXPERIMENTAL FEASIBILITY STUDY

Arman Sarfehnia, McGill University

Purpose: The feasibility of developing a new standard for absorbed dose to water based on water calorimetry for high dose rate iridium-192 (^{192}Ir) brachytherapy sources was studied.

Method and Materials: The heat conduction pattern generated in water by the Nucleotron microSelectron-HDR ^{192}Ir brachytherapy source was simulated using Comsol Multiphjysics™ software. Source self-heating due to self-attenuation of photons and electrons inside the source was calculated. The heat-loss correction K_c was calculated as the ratio of the temperature rise under ideal conditions to temperature rise under realistic conditions. Experimental measurements were made with a parallel-plate vessel of 79mm diameter and 1.2mm thick front and rear glass windows.

Results: The feasibility of a water calorimeter-based absorbed dose standard is determined by a balance between the requirements to obtain sufficient signal to perform a reproducible measurement, the effects of heat loss on the measured signal, and the positioning uncertainties. Due to self-absorption, the source equilibrium temperature was found to be above the ambient temperature by a constant amount that depends only on setup conditions and source activity. For the ^{192}Ir source inside its nylon-12 catheter inserted into water, the steady state source excess temperature per unit source activity was found to be 0.5671 K/Ci. Numerically, the conduction correction factors K_c were found to be independent of source activity and were calculated for several exposure times and at various measurement points away from the ^{192}Ir source inside the calorimeter. A total exposure time between 100 s and 240 s at a distance that receives a minimum of 1 Gy of dose was calculated to minimize the value of K_c to below 0.1%. Based on extrapolation to the mid-run of the best-fit curves to the predrift and postdrift, we experimentally determined the dose to water to be 0.93±0.08 cGy/s at 26.76 mm away from the source and 1.02±0.06 cGy/s at 24.69mm. Based on TG43, these values were calculated to be 0.901 cGy/s and 1.045 cGy/s respectively. The large standard deviation on the experimental data are based only on three experimental calorimetric runs.

Conclusions: We have shown, numerically and experimentally, that water calorimetry for ^{192}Ir HDR brachytherapy is feasible. Total uncertainties of significantly better that 5% on the dose is achievable with only slight modifications of current water calorimetry techniques and instruments. This work forms the basis of a future absolute dose to water standard for ^{192}Ir HDR brachytherapy.

The Thermo Fisher Scientific Student Travel Grant

USE OF A THYROID PROBE FOR ASSAYING INTERNAL CONTAMINATION FOLLOWING A RADIOACTIVE DISPERSAL DEVICE (RDD)

Sarah Scarboro, Georgia Institute of Technology

Research Funded by the Radiation Studies Branch of the Centers for Disease Control and Prevention

In today's society, emergency preparedness has become an unfortunate requirement for major cities. The preparations made will play a crucial factor in the timely response of emergency medical personnel to extensive numbers of injured people. In the event of the use of a Radioactive Dispersal Device (RDD) in a highly populated area, internal contamination due to inhalation is a primary concern. Of major importance is developing a method for quickly and efficiently separating individuals who have received significant internal dose and those who have not. The device of choice to accomplish this is a whole-body counter, often found at nuclear power plants, but not readily available in major cities. Thus, instruments that were not originally intended for assaying internal contamination are being examined for their usefulness in this situation. One of these instruments is a thyroid probe, generally found in most hospitals.

The typical use of a thyroid probe is in conjunction with nuclear medicine procedures, as well as tracking the thyroid uptake of certain radioisotopes in patients and hospital staff. In order to assay internal contamination, the probe[1] will instead be placed on the chest wall to measure activity from the lungs. A phantom comprised of slabs of lucite (PMMA) and virtual water was used to simulate the chest wall thickness. The collimated detector of the probe was used with this phantom to collect data on the detectable activity for chest wall thicknesses ranging from 0mm to 108 mm. Experimental data was completed for six gamma-emitting isotopes (Cesium-137, Cobolt-60, Americium-241, Barium-133, Manganese-54, and Sodium-22) that could potentially be used in an RDD.

In addition to the slab phantom, an MCNP model of the thyroid probe was built to verify the experimental measurements. This model was also used in conjunction with 6 MIRD (Medical Internal Radiation Dose) phantoms, also modeled in MCNP, and was placed at 4 locations on the body. These locations were centered over the right lung, slightly inferior to the right shoulder blade on the back, over the neck, and on the anterior surface of the thigh. Biokinetic modeling of the movement of the isotope through the body with time was performed to estimate the expected activity in various organs as a function of time.

The results of this project show that the thyroid probe is a good candidate for use in assaying internal contamination. A two-page reference sheet will be developed for hospital staff to use in the event of such an emergency. This reference will include the protocol for using the thyroid probe as well as thresholds for determining if the individual requires further medical attention.

[1]The thyroid probe used in this project was the Capintec, Inc. Captus 3000 Thyroid Uptake System

The Marshall R. Cleland – Radiation Dynamics, Inc. Student Travel Grant

INVESTIGATION OF VARIOUS SHIELDING METHODS FOR AN ISOTROPIC 14.1 MEV NEUTRON SOURCE

Zachary D. Whetstone, Adrienne L. Lehnert, Kimberlee J. Kearfott, University of Michigan

This research was conducted in order to determine the proper shielding for a portable isotropic 14.1 MeV neutron source. To define the restricted emission angle and to protect nearby personnel when standoff distances are limited, shielding materials were added around the source. Using Monte Carlo N-Particle Transport Code, Version 5, several shielding geometries were tested. Materials investigated were polyethylene, polyethylene enriched with ^{10}B, steel, and lead. Various simulations were run testing the individual materials as well as combining them. It was found that at 1.5 m from the source, the most effective shielding is a combination of several layers of borated polyethylene and steel. Without any shielding, the dose is 2.15×10^{-15} Sv per source particle. With a shielding consisting of multiple layers of steel totaling 35 cm thick and several layers of polyethylene totaling 15 cm thick, the dose drops to 1.57×10^{-17} Sv per emitted neutron at 180° opposite the shield opening. When the entire 35 cm thickness of steel surrounded the source and was covered by 15 cm thick of polyethylene the total dose was 1.97×10^{-17} Sv per neutron. However, when the 15 cm of polyethylene was placed directly around the source and the 35 cm thick of steel surrounded it, the dose was 5.96×10^{-17} Sv per neutron. The alternated steel and polyethylene shielding had a mass of 7300 kg. By reducing the shielding thickness by 10 cm, the mass decreased to 5300 kg while the dose increased to 4.91×10^{-17} Sv per source particle. To reduce the mass even further, 50 cm of polyethylene was used, which had a mass of 1200 kg, but only reduced the dose to 8.89×10^{-17} Sv per neutron. Adding lead shielding around the steel and polyethylene decreased the dose to 9.06×10^{-18} Sv per neutron, but added a mass of 3900 kg. Substituting boron enriched polyethylene in to the layered shielding dropped the dose to 1.30×10^{-17} Sv per source neutron.

CIRMS Workshops

October 2006	Annual Meeting Focus: "Implications of Uncertainty in Radiation Measurements and Applications" Break-out session workshops: Industrial Applications and Materials Effects Medical Applications: "Imaging for Radiation Therapy Planning and Delivery" Radiation Protection / Homeland Security
October 2005	Annual Meeting Focus: "The Impact of New Technologies on Radiation Measurements and Standards" Break-out session workshops: Industrial Applications and Materials Effects Radiation Protection 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" Break-out session workshops: Medical Applications Homeland Security Industrial Applications and Materials Effects Radiation Protection
October 2003	Annual Meeting Focus: "Radiation/Radioactivity Measurements and Standards in Industry" Break-out session workshops: Medical Applications Homeland Security Industrial Applications and Materials Effects Radiation Protection
April 2003	Advances in High Dose Dosimetry
October 2002	Annual Meeting Focus: "Traceablilty for Radiation Measurements and Standards" Break-out session workshops: Traceability and Standards in High-Dose Applications Traceability and Standards for Homeland Security 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

CIRMS WORKSHOPS

October 2001	Annual Meeting Focus: "Radiation Standards for Health and Safety" Break-out session workshops: Specifications for Standard *In-Vivo* Radiobioassay Phantoms Food Irradiation Technology Advancements and Perspectives Measurements and Standards for Intravascular Brachytherapy Sources
October 2000	Annual Meeting Focus: "Advanced Radiation Measurements for the 21st Century" Break-out session workshops: Dosimetry for Radiation Hardness Testing: Sources, Detectors, and Computational Methods Measurements and Standards Infrastructure for Brachytherapy Sources Laboratory Accreditation Program for Personnel Dosimetry: Review of the Status of Implementation of New Standards 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
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

CIRMS WORKSHOPS

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

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CIRMS 17th ANNUAL MEETING

October, 2008

Gaithersburg, MD

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