


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

2002	H. Thompson Heaton II	Center for Devices and Radiological Health, US FDA
2004	Anthony J. Berejka	Ionicorp
2006	Kenneth L. Swin	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
2010	Geoffrey Ibbott	MD Anderson Cancer Center
2011	Kenneth Inn	NIST
2012	Joseph C. McDonald	Pacific Northwest National Laboratory, retired
2013	Stephen M. Seltzer	NIST
2015	X. George Xu	Rensselaer Polytechnic Institute




FIRST MEETING: JUNE 17, 1991


1991	Organizing Committee held 2 meetings On June 17 proposed a slate of officers
1992	Ballots mailed to participants in Organizational Meeting. Officers elected February 10
1992	Officers and Organizing Committee meeting March 31. CIRMS turned over to officers
1992	Invitations to join sent in April 10 organizations, corporations, and individuals
1992	Inaugural Meeting scheduled for October 22-23



CIRMS Council on Ionizing Radiation Measurements and Standards




Medical Applications



Radiation Protection



Industrial Applications



Homeland Security

4th Report on Needs in Ionizing Radiation Measurements and Standards
December 2004

January 21, 2004

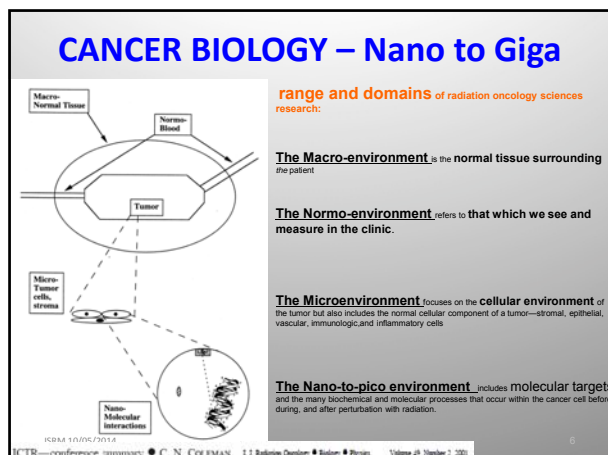
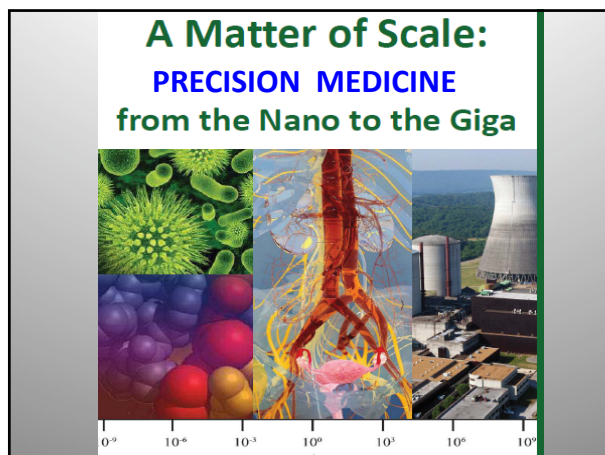
Dr. James Deye
National Cancer Institute
6130 Executive Blvd., MSC 7440
Rockville, MD 20892-7440

Dear Dr. Deye:

I would like to congratulate you on yet another successful annual meeting of the Council on Ionizing Radiation Measurements and Standards (CIRMS), held recently here at the National Institute of Standards and Technology. The focus of this latest meeting, "Radiation Radioactivity Measurements and Standards in Industry," clearly aligns with NIST's mission to "work with industry to develop and apply technology, measurements and standards." It is great to have so many representatives from the more



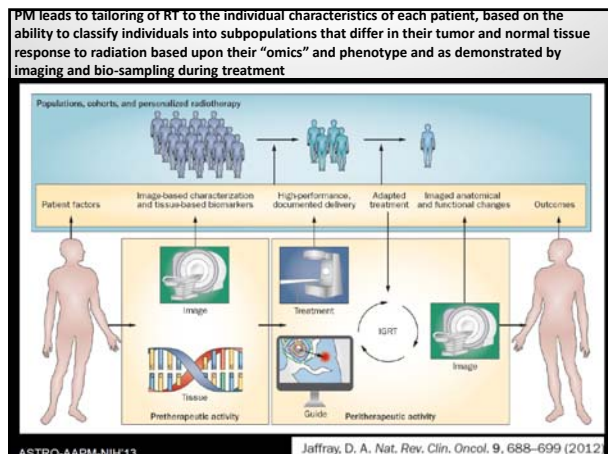
Arden L. Benoit, Jr.
Director



PRECISION MEDICINE


- refers to the tailoring of medical treatment to the **individual characteristics of each patient**. It is based on the ability to classify individuals into subpopulations that differ in their susceptibility to a particular disease, in the biology and/or prognosis of those diseases they may develop, or in their response to a specific treatment

	<u>MEDICAL PRACTICE</u>	<u>OUTCOME</u>	<u>SCIENCE</u>
Population		population Average no- / partial-/ complete-response	histo-path/ anatomy epidemiology/ statistics
Personalized		Prognostic likely course based upon pre-Tx "omics"	above + molecular biology
Precision		Predictive / Quantitative patient specific outcome / adaptive Tx	above + physics and chemistry of disease process



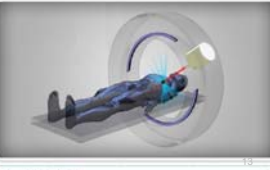
“biology based” RADIOTHERAPY

NOTE:
PRECISE DELIVERY of radiation
Is NOT sufficient for
PRECISION MEDICINE



Hypothesis: Patterning radiation dose according to imaged functional or molecular distributions will increase the TR

Emission Guided Radiation Therapy



Physical Measurement Laboratory

NIST Home > PML > Radiation Physics Division > Radioactivity Group > Radiopharmaceutical Standardization Laboratory

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Radiopharmaceutical Standardization Laboratory

Description:
Radioactivity measurements for diagnostic and therapeutic nuclear medicine in the United States are based on measurements at NIST. Activity measurements for the gamma-ray-emitting radionuclides are made using 4π liquid scintillation spectrometry and 4πv ionization chamber. The calibration process also includes identification of radionuclidic impurities by germanium spectrometry. Recent development work has focused on therapeutic nuclides for nuclear medicine, radioimmunotherapy, and bone palliation. Future work will focus on intravascular brachytherapy and diagnostic imaging.

Specifications / Capabilities:
The radiopharmaceutical standardization laboratory provides calibration services for radionuclides and is available for technical users who must make measurements consistent with national standards or who require higher accuracy calibrations than are available with commercial standards. NIST also undertakes basic research to develop new methods of standardizing radionuclides for diagnostic and therapeutic applications. These studies include measurements of decay-scheme parameters, such as half lives and gamma-ray emission probabilities, and identification of radionuclidic impurities.

Access Information:
The customer has no direct use of the facility. NIST staff can provide calibration services for any previously standardized radionuclide. As part of the same program, research associates of the Nuclear Energy Institute produce standards that are certified by NIST as Standard Reference Materials for distribution to the radiopharmaceutical user communities.

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RADIATION SCIENCE AND MEDICINE
RELATED SESSIONS

AACR.org

MEET THE EXPERT SESSION
Radiation and Immunotherapy: From Preclinical Models to Cancer Patients
Tuesday, April 21, 2015, 7:00 a.m. - 8:00 a.m.
Room 108, Pennsylvania Convention Center
CHI-Chicago
Saba C. Formenti, New York University, New York, NY

POSTER SESSIONS
Special Populations, Supportive Care, and Survivorship Research / Radiation Oncology
Tuesday, April 21, 2015, 8:00 a.m. - 12:00 noon
Section 23

Targeting Cell Death and DNA Repair
Tuesday, April 21, 2015, 8:00 a.m. - 12:00 noon
Section 32

Radiation Biology 1: DNA Damage and Repair, Molecular Modulators of Radiation Response, and Resistance
Tuesday, April 21, 2015, 8:00 a.m. - 12:00 noon
Section 18

Radiation Biology 2: Modifiers and Signal Transduction, Sensitivity, Resistance, and Therapy

QUALITY ??

A recent review of the literature by Stone et al¹ found **significant concerns with preclinical data concerning the efficacy of 10 drug-radiation combinations presented in 125 publications prior to 2015**. While the preponderance of concerns were related to the biological aspects of these studies, it was also noted that necessary **radiation parameters were either “not reported (or were unclear)” to an extent that compromised the reproducibility of the experiment**. This was true for both the in vitro and in vivo studies.

Stone H, Bernhard EJ, Coleman CN, et al. Systematic Review: Preclinical Data on Efficacy of 10 Drug-Radiation Combinations: Evaluations, Concerns and Recommendations. *Translational oncology*, 2015; in press.

**Reproducibility
Validation
Efficacy**

NIH mulls rules for validating key results

Raise standards for preclinical cancer research

C. Glenn Begley and Lee M. Ellis propose how methods, publications and incentives must change if patients are to benefit.

Efforts over the past decade to characterize the genetic alterations in human cancers have led to a better understanding of molecular drivers of this complex set of diseases. Although we in the cancer field hoped that this would lead to more effective drugs, historically, our ability to translate cancer research to clinical success has been remarkably low¹. Sadly, clinical trials in oncology have the highest failure rate compared with other therapeutic areas. Given the high unmet need in oncology, it is understandable that barriers to clinical development may be lower than for other disease areas, and a larger number of drugs with suboptimal preclinical validation will enter oncology trials. However, this low success rate is not sustainable or acceptable, and investigators must reexamine their approach to translating discovery research into greater clinical success and impact.

Many factors are responsible for the high failure rate, notwithstanding the inherently difficult nature of this disease. Certainly, the limitations of preclinical tools such as inadequate cancer-cell line and mouse models² make it difficult for even

Small animal radiotherapy research platforms

- F. Verhaegan et al, PMB 56 (2011) pp 55-83

System	Photon energy range (keV)	Field range at treatment site	Fixed fields/size	Max dose rate (Gy min ⁻¹)	Image resolution at treatment site (µm)	Targeting accuracy (µm)	Refs
SARBP (Johns Hopkins University)	5-225	0.5 mm ² –10 × 10 cm ²	F/A	4	130	200	Wong et al 2009, Tryggestad et al 2009, Manifar et al 2009
X-RAD (Princess Margaret Hospital)	5-225	1 mm ² –10 × 10 cm ²	F/A	4	200	200	Clarkson et al 2010
Washington University (^{60}Co)	380	5–15 mm ²	F	2.9	N/A	100–180	Stojadinovic et al 2006, 2007, Kiehl et al 2008
Stanford University	70–120	0.1–6 cm ²	F/A	2	49	100	Graves et al 2007, Rodriguez et al 2009, Zhou et al 2010
University of Texas Southwestern	5–320	1–20 mm ²	F/A	>10	113	65	Song et al 2010, Polakis et al 2011

F: Mean photon energy of x-ray source



DOSE IS NOT JUST A NUMBER !

Volume 118 (2013) <http://dx.doi.org/10.6028/jres.118.021>
Journal of Research of the National Institute of Standards and Technology

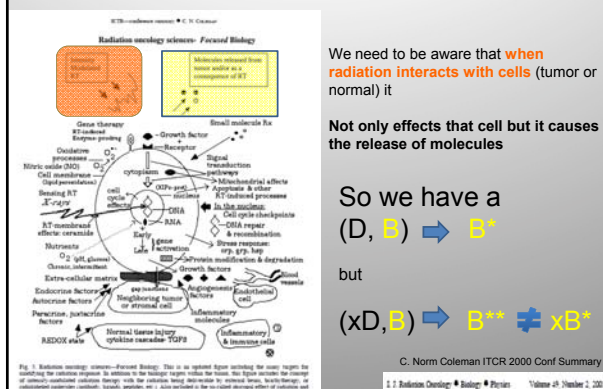
The Importance of Dosimetry Standardization in Radiobiology

Marc Desrosiers¹, Larry DeWerd², James Deye³, Patricia Lindsay⁴, Mark K. Murphy⁵, Michael Mitch¹, Francesca Macchiaroni⁶, Strahinja Stojadinovic⁷, and Helen Stone²

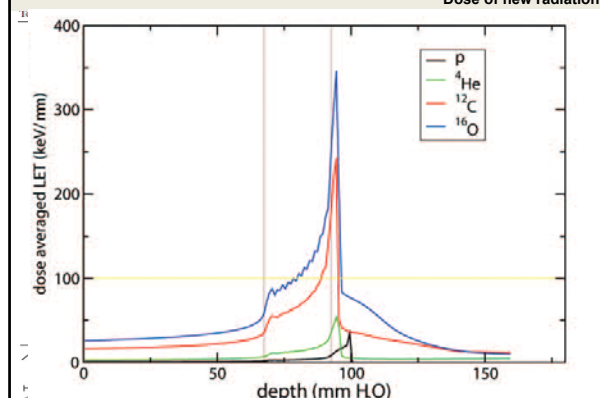
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- 7 University of Texas Southwestern Medical Center Dallas, Texas

<http://www.nist.gov/pml/div682/grp02/dosimetry-standardization-for-radiobiology.cfm>

RT is “FOCUSED BIOLOGY”



But **dose is only a SURROGATE** for biological effect and lot of the underlying biology is unknown, so RT defines the **Relative Biological Effect: (RBE) = Dose of ref radiation / Dose of new radiation**



Future development of biologically relevant dosimetry

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Given the complexity of the initiation and occurrence of biological processes on various time and length scales, and given that neither microdosimetry nor nanodosimetry on their own can fully describe the biological effects as a function of the distribution of energy deposition or ionization, a multiscale approach is needed to lay the foundation for the aforementioned new physical quantities relating track structure to relative biological effectiveness in proton and ion beam therapy.

OPENMED Beam specification parameters (2016)

A proposal to transform an existing heavy ion accelerator at CERN, LEIR, into a non-clinical, biomedical research facility.

3.1.9 Requirements for dosimetry and fluence monitoring

Dose measurements must be possible at low and high dose rates, as well as for low and high LET particles.

- Basic dosimetry: ionization chambers and other techniques, solid state, calorimetry and chemical systems, **as required in a medical clinic**. This needs to be the **same standard as required by** Swiss/French **national reference laboratories for absorbed doses**.

Physical Measurement Laboratory

NEST Home • NPL • Radiation Physics Division • Dosimetry Group • Electron and Proton Absorbed-Dose-to-Water Primary Standards

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Electron and Proton Absorbed-Dose-to-Water Primary Standards

Synopsis:

Work on absorbed-dose standards for particle beams is in progress, with preliminary results obtained for both high-energy electrons (at the NIST Clinic 2100C) and double-scattered protons (at the Proton Therapy Center, NC Davidson County, in Houston TX), and the Hargett University Proton Therapy Institute, in Hampton VA).

Description:

The NIST water calorimeter, originally designed and tested in photon beams (Co-60 and subsequently in 6 MV and 18 MV x-rays from the NIST Clinic 2100C), is being put to use in particle beams as well. In 2011, measurements conducted at the NIST Clinic 2100C with high-energy electron beams under standard reference conditions (12 MeV, 16 MeV and 20 MeV) in a water phantom were carried out along with similar sets of measurements obtained in 6 MV photons. (The latter were done as a consistency check on the calorimeter, since comparisons could be made with a double-out profile obtained from a Farmer chamber that had been calibrated both in Co-60 and Clinac 6 MV beams.) These were followed by measurements with a parallel-plate chamber that had been calibrated previously in Co-60. While calorimeter results were between 0.5 % of the depth-dose curve at each depth, they were <1 % higher than the chamber results at all depths. The discrepancy is believed to be a consequence of an error in the value of k_{elec} , the so-called photon-electron conversion factor adopted by ICRU-51. Additional measurements and Monte Carlo simulations are expected to resolve the issue. The calorimeter has also been used in a vertical, double-scattered proton beam at the Hargett University Proton Therapy Institute (HUPTI), in what was the first such field size measurement. The first set of measurements, done in December 2012, were conducted with the NIST calorimeter and four ionization chambers – two each at NIST and HUPTI, all four of which had been used in a 2011 proton intercomparison tested by the Proton Therapy Center (PTC), at the MD Anderson Cancer Center. Results from the calorimeter, averaged over 22 exposures, showed agreement with experimental uncertainties for all four phantoms, using the IAEA TRS-398 CoA for converting charge to proton dose. NIST looks forward to future visits both to HUPTI and to the PTC, in order to provide calorimetry results to support the results of the chamber intercomparisons.




Photograph by Ronald Tash

End User:
ongoing

Lead Organization(s):
NPL

Staff:
Dosimetry Group
Ronald Tash

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Targeting Tumors with Particle Beams

Today, the National Cancer Institute (NCI), part of the National Institutes of Health, and the Department of Energy (DOE) are each announcing the selection of several new research awards to advance particle beam therapies for the treatment of cancer. Particle beam approaches use directed protons or heavier ions, such as carbon ions – to target and kill cancerous tissue. Because the delivered particles interact strongly with tissue at a certain distance within the body that depends on the energy of the beam, the damage to surrounding healthy tissue can be minimized, offering an important potential alternative or supplement to more conventional radiotherapy (using x-rays or gamma rays), chemotherapy, and surgery. At present, there are 14 proton therapy centers in the United States, there are only a few carbon ion therapy facilities worldwide, but none are in the United States. The NCI awards announced today support planning for the establishment of a Center for Particle Beam Radiation Therapy as a national research resource, and the DOE awards address development of improved hardware that could make the task, increase the measurability, and considerably reduce the steep costs of particle beam therapy research.

The Planning Grant awards for the national research centers that could be made by NCI. The planned center would serve as a research award to an **interdisciplinary research center to develop innovative cancer therapy particle beam projects**. Ultimately, the proposed center is expected to perform critically relevant research using ion beams. The planning grants include pilot projects that will enable a research agenda in particle beam delivery projects, dosimetry, radiation biology, and/or translational pre-clinical studies. The centers encourage other researchers to collaborate with the awardees in advancing the capabilities for particle beam therapies.

The DOE awards are being made under the Accelerator Sharing Program. The machinery needed to produce and control particle beams, such as **synchrotrons, cyclotrons, and related beam delivery systems, is expensive and complex**. This machinery, however, can be used in a variety of fields, ranging from high-energy physics to materials science to medical treatment. The DOE program has the responsibility for long-term, fundamental research and development of this machinery. The new awards that support researchers in the generation of the accelerated particles and in the powerful magnets that direct the charged particles are designed to make these key components smaller, lighter, more versatile, and potentially less expensive.

Radiation Biodosimetry Medical Countermeasure Devices

Guidance for Industry and Food and Drug Administration Staff

Precision Medicine for Triage

Document issued on April 18, 2016.

The draft of this document was issued on December 30, 2014.

1. Accuracy in relation to the dose delivered

In order to demonstrate analytical accuracy, if the device output is radiation dose, then the device's measurement of the biological response to radiation will probably be compared to the physical calculated dose delivered. Therefore, the accuracy of the delivered dose is crucial, and the protocol for designing proper telemetry should be included in all study protocols. As discussed above, we expect that because the biodosimetry output will be confounded by the biological response to radiation, there will be between-individual variations which may complicate the correlation of the output to the radiation dose delivered.

Precision Medicine (RT) > Radiation Standards

Physical dose for EBRT
(continuation – dosimeters, small fields)

Physical dose for pre-clinical and triage
(continuation – SOPs, counter measures (neutrons))

Physical dose for particle beams
(further development – measurements and basic reference data)

Activity Standards
(further development – clinical isotopes, QI/radiomics)

PRECISION MEDICINE IN RADIATION ONCOLOGY:
Personalizing Radiation Treatment

Co-sponsored by NCI, ASTRO and AAPM

June 16-17, 2016

NIH Campus, Bethesda, Maryland

Message from the Director, NIH: Selection of Eric Dishman as Director of the Precision Medicine Initiative Cohort Program

4/12/2016

MUSEUM

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY



X RAYS

Radio Activity

Historical Standards

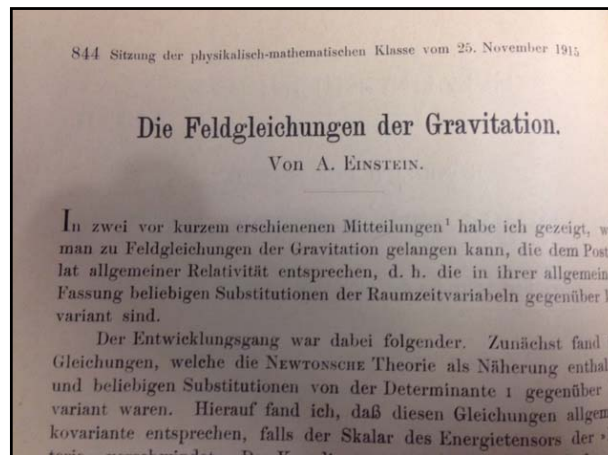
Working Standards

Measures of Gravity

NIST and The Nobel

---much more

Research in radium began at the National Bureau of Standards (NBS) in December, 1913 when a phial containing 20.28 milligrams of pure radium arrived from abroad. It was a certified equivalent to the International Radium Standard at Severs, France, and a cover communication described its comparison with another quantity of radium salts prepared at Vienna and accepted as a second standard. NBS served hospitals and physicians by analyzing their radium salts against the International standard. Ernest Dornery was the principal NBS researcher on radium as he made intercomparisons of sealed radium standards and started an investigation of the gamma-ray method of radium measurement. (From: [Advances in Physics](#) by Raymond C. Cochran, p. 146-147)



Thanks for this award and honor



And thanks to my wife [Joan](#) for her enduring support