Fifty-Eighth
Annual Meeting Program

Opportunities in Radiation Science:

From Low Dose to Climate Change

March 28–29, 2022

NCRP Mission:

To support radiation protection by providing independent scientific analysis, information and recommendations that represent the consensus of leading scientists.

@NCRP2022

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Introduction

Opportunities in Radiation Science: From Low Dose to Climate Change

Fifty-Eighth Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP)

Every year we face new challenges and opportunities in the fields of radiation science and radiation protection. This year is no exception. Today we live in a world challenged by a global pandemic and an ever-nearing climate crisis; where clean power is valued but nuclear waste has no home; where a trip to Mars is within our grasp; where medical advancements allow us to treat patients more effectively; and where research techniques open doors to understanding how low-dose radiation exposures affect cells and therefore lives.

This year's NCRP meeting brings together experts from across the world to talk about the status of and to engage with you, our NCRP members and partners, on identifying opportunities for advancing radiation science on all of these current topics. Along with our outstanding keynote speakers (see Featured Speakers below), the planning committee worked with the NCRP Program Area Committees (PACs) to create a program that includes the following topic areas:

- Applying COVID-19 Lessons to Radiological Emergency Response
- Identifying National Defense Needs
- Optimizing Next Generation Medical Treatment
- Reducing Climate Change through Nuclear Power
- Addressing Waste Management
- Integrating Knowledge Across Disciplines
- Supporting Space Travel
- Understanding Low Dose Health Effects

This year's virtual meeting will be more interactive than previous annual meetings. Not only will you get to ask questions of the panel members, but the experts will ask for audience input on their pressing questions (see Interactive Technology below). We are taking advantage of the collective knowledge of all attendees to pave the next steps in radiation science in the United States.

Established in April 2019, the John D. Boice, Jr., Young Investigator Award, is given this year to Sara Dumit from Los Alamos National Laboratory. This Award is given to recognize an early career professional engaged in some aspect of science pertaining to radiation protection and measurements.

NCRP gratefully acknowledges recordings provided by:

- the Joint Armed Forces Honor Guard from the Military District of Washington D.C. who will open our Annual Meeting; and
- Kimberly Jordan of the U.S. Nuclear Regulatory Commission who will sing our National Anthem.

Featured Speakers

The Eighteenth Annual Warren K. Sinclair Keynote Lecture will be delivered by Dr. Joe W. Gray, Professor and Gordon Moore Endowed Chair at Oregon Health and Science University, and Chair of the National Academy of Sciences' committee on Developing a Long-Term Strategy for Low-Dose Radiation Research in the United States. Dr. Gray will provide an overview of the steps undertaken by the Committee to identify needs and develop a low-dose research strategy.

The Forty-Fifth Lauriston S. Taylor Lecture will be delivered by Dr. Gayle E. Woloschak, Professor at Northwestern University and Fellow of the American Society for Radiation Oncology. Dr. Woloschak is a vice-president of NCRP's PAC 1 on Basic Criteria, Epidemiology, Radiobiology, and Risk. She is an expert in low dose and low dose rate responses, having served in various national and international committees on radiation protection.

The Fifth Thomas S. Tenforde Lecture will be delivered by Dr. Jill A. Lipoti, NCRP Distinguished Emeritus Member and who, before retirement, directed the activities of the Radiation Protection Programs for New Jersey, with responsibility for the x ray, radioactive materials, nuclear emergency response, environmental monitoring, radon, and nonionizing programs, involving regulation and licensure of professionals. Dr. Lipoti will discuss ways to apply our collective radiation protection knowledge to the challenges of our time.

Interactive Technology

Throughout the meeting, participants will be using Slido.com to ask questions and participate in polls. This tool will allow virtual attendees to interact with each other and the presenters on the same platform.

Access Slido:

- Join at slido.com
- Code #NCRP

How to participate:

- Enter your questions
- Up-vote the questions you most want answered
- Participate in polls

Need help? Email jess.wieder@gmail.com

Monday, March 28, 2022

Opening Session

9:30 am **Presentation of the Colors**
Joint Armed Forces Honor Guard from the Military District of Washington, DC

Singing of the National Anthem
Kimberly Jordan
U.S. Nuclear Regulatory Commission

9:35 am **NCRP Welcome**
Kathryn D. Held
President, NCRP

9:50 am **Introduction**
Evagelia C. Laiakis
Jessica S. Wieder
Program Co-Chairs

Eighteenth Annual Warren K. Sinclair Keynote Address

10:00 am **Introduction of the Speaker**
Kathryn D. Held

Developing a Long-Term Strategy for Low-Dose Radiation Research in the United States
Joe W. Gray
Oregon Health & Science University

Applying COVID-19 Lessons to Radiological Emergency Response

Sara D. DeCair, *Session Chair*

10:20 am **An American in Asia: Takeaways from the Asian COVID-19 Response**
Andrew J. Cordiner
Federal Bureau of Investigation Hazardous Materials Response

10:35 am **Vaccine Hesitancy and the Social Side to Protective Actions**
Monica Schoch-Spana
Johns Hopkins Center for Health Security

10:50 am **Applying Lessons from the COVID-19 Pandemic Response to Radiological/Nuclear Preparedness, Response and Recovery**
Orly Amir
U.S. Department of Homeland Security

11:05 am **Interactive Q&A**

11:20 am **Break**

Identifying National Defense Needs

Jeffrey J. Whicker, *Session Chair*

11:35 am **National Needs in Emergency Response and Homeland Security**
Julian G. Hill
U.S. Department of Homeland Security

12:00 pm **National Need for U.S. Department of Defense's Multiple-Parameter Radiological Biodosimetry/ Dosimetry Diagnostics Network**
Ricardo A. Reyes
Defense Health Agency

12:20 pm **Interactive Q&A**

12:35 pm **Lunch**

Optimizing Next Generation Medical Treatment

Pat B. Zanzonico, *Session Chair*

1:30 pm **The "Promise" of Targeted Radiopharmaceutical Therapy**
Lisa Bodei
Memorial Sloan Kettering

1:45 pm **Treatment Optimization in Radiopharmaceutical Therapy**
George Sgouros
Johns Hopkins Hospital

2:00 pm **Optimizing Next Generation Medical Treatment: Identified Opportunities in Medical School Education**
Neha Vapiwala
University of Pennsylvania

2:15 pm **Interactive Q&A**

Integrating Knowledge Across Disciplines

Manuela Buonanno, *Session Chair*

2:30 pm **"Y" and the Change in Practice of Routine Gonadal Shielding During Radiography**
Donald P. Frush
Duke University Medical Center

2:40 pm **Sometimes a Statement Just Isn't Enough: The Importance of Considering Your Audience and Their Needs**
Angela Shogren
U.S. Environmental Protection Agency

2:50 pm **Interactive Q&A**

3:00 pm **Preclinical Studies with Proton FLASH Radiotherapy for Gastrointestinal and Sarcoma Tumors in Rodents and Canines**
Constantinos Koumenis
University of Pennsylvania

3:10 pm **FLASH: High Therapeutic Potential While Sparing Normal Tissue Complications at Ultra-High Dose Rates: Dosimetry Aspects**
Magdalena Bazalova-Carter
University of Victoria, Canada

3:20 pm **Interactive Q&A**

3:30 pm **Break**

Forty-Fifth Lauriston S. Taylor Lecture on Radiation Protection & Measurements

3:45 pm **Introduction of the Lecturer**
Kathryn D. Held

Long-Term Radiation Animal Studies: A Story Continues
Gayle Woloschak

Tuesday, March 29, 2022

Understanding Individual Responses to Ionizing Radiation

Nobuyuki Hamada, *Session Chair*

9:30 am **Potential Modifiers of Radiation-related Risk of Circulatory Diseases: Implications for Individual Differences in Radiation Response**
Preetha Rajaraman
U.S. Health and Human Services

9:50 am **Interactive Q&A**

Supporting Space Travel

Jeffrey J. Whicker, *Session Chair*

10:00 am **Space Exploration: Evolving Recommendations for Radiation Protection Standards and Research**
S. Robin Elgart
National Aeronautics and Space Administration

10:20 am **Interactive Q&A**

Opportunities in Radiation Science: From Low Dose to Climate Change

Fifth Thomas S. Tenforde Topical Lecture

10:30 am **Introduction of the Lecturer**
Jessica S. Wieder

Opportunities in Radiation Science: Applying Our Collective Knowledge to the Challenges of Our Time
Jill A. Lipoti

11:00 am **Break**

Addressing Waste Management

Brian A. Powell, *Session Chair*

11:15 am **DOE Cleanup Efforts with Alaskan Native, Native American, Minority and Low-income Peoples and Communities**
Joanna Burger
Rutgers University

11:30 am **In-Service Condition of Radon Barriers over Uranium Mill Tailings Disposal Facilities in the United States**
Craig Benson
University of Virginia

11:45 am **ARPA-E ONWARDS Program: Addressing the Backend of Advanced Reactors Fuel Cycles**
Robert Ledoux
U.S. Department of Energy

12:00 pm **Interactive Q&A**

12:15 pm **Lunch**

Reducing Climate Change through Nuclear Power

Willie O. Harris, *Session Chair*

1:00 pm **Nuclear Energy - Today and Tomorrow**
Hilary Lane
Nuclear Energy Institute

1:15 pm **NextGen RP: Applying Remote and Automated Technologies to Enhance and Optimize Nuclear Power Plant Radiation Protection Operations**
Karen S. Kim-Stevens
Electric Power Research Institute

1:30 pm **Small Modular Reactor/Advanced Nuclear Reactor Health Physics Challenges**
Bryan S. Pell
Duke Energy

1:45 pm **Interactive Q&A**

Interactive: Opportunities in Radiation Science

2:00 pm Evagelia C. Laiakis
Jessica S. Wieder
Program Co-Chairs

Conclusions

2:30 pm **NCRP Vision for the Future and Program Area Committee Activities**
Kathryn D. Held
President, NCRP

3:00 pm **Adjourn Scientific Meeting**

3:15 pm **NCRP Annual Business Meeting**

4:30 pm **Adjourn**

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Eighteenth Annual Warren K. Sinclair Keynote Address

10:00 am

Introduction of the Speaker
Kathryn D. Held

Developing a Long-Term Strategy for Low-Dose Radiation Research in the United States
Joe W. Gray
Oregon Health & Science University

The U.S. Department of Energy's Low Dose Radiation Research Program funded experimental research on cellular and molecular responses to low-dose radiation from 1999 to its termination in 2016. Congress recently re-enacted the program and requested that the National Academies of Sciences, Engineering, and Medicine (the National Academies) develop a long-term strategic and prioritized research agenda to guide the research. In response to the Congressional request (Public Law 116-260), the National Academies formed a committee of experts to help define the health and safety issues that need to be guided by an improved understanding of low-dose and low dose-rate radiation health effects and to recommend a long-term strategic and prioritized research agenda to address scientific

research goals. Such an agenda is necessary to address the complex issues of low-dose radiation research and to maintain a pool of educated and trained professionals and appropriate research infrastructure. The Academies committee will also address coordination between federal agencies and other national and international low dose radiation research projects and programs.

Applying COVID-19 Lessons to Radiological Emergency Response

Sara D. DeCair, *Session Chair*

10:20 am

An American in Asia: Takeaways from the Asian COVID-19 Response

Andrew J. Cordiner
Federal Bureau of Investigation Hazardous Materials Response

From a background in hazmat preparedness and response, potential lessons applicable to radiological/nuclear emergency response will be explored through a unique lens: That of an American living and working in Singapore during the pandemic. Comparing and contrasting the evolving situation in the United States with that in Asia could bring additional perspectives to identifying improvements to our U.S. system of preparedness, practice for and response to a radiological/nuclear disaster. When rapidly evolving conditions lead to rapidly changing scientific information being presented by governments globally, messages are bound to become confused and conflated. Undoubtedly, the public will have new perspectives on taking actions based on government recommendations and mandates based on their individual experiences during this pandemic. Also a low-probability, high-consequence event, a radiological/nuclear disaster will stretch the capabilities of state, local, territorial and tribal governments, as well as capture the attention of the entire world, as we saw in 2011 during the Fukushima Dai-ichi Nuclear Power station releases. Putting identified key lessons from the COVID-19 response into practice for radiological/nuclear preparedness will take time, and work is already underway.

10:35 am

Vaccine Hesitancy and the Social Side to Protective Actions

Monica Schoch-Spana
Johns Hopkins Center for Health Security

Despite the power to save lives during the COVID-19 pandemic, getting vaccinated, wearing masks, and physically distancing oneself have been unevenly practiced by individuals and social groups in the United States; moreover, these protective measures have at times triggered interpersonal tensions, public controversy, and

community protests. Drawing from the case of COVID-19 vaccination, this talk will address the importance of better understanding of, planning for, and real-time adaptation to the social and behavioral realities associated with protective actions during a public health emergency. Among the topics and learnings to be addressed are:

- the uptake of a protective measure like vaccine happens at the speed of public trust;
- the development of a successful medical countermeasure requires both biological science and social science (*e.g.*, what factors will likely affect access and acceptance, what messages about risks and benefits will be meaningful to which groups); and
- rapid social science and ongoing community engagement provide critical feedback to improve an emergency response just-in-time.

10:50 am

Applying Lessons from the COVID-19 Pandemic Response to Radiological/Nuclear Preparedness, Response and Recovery

Orly Amir
U.S. Department of Homeland Security

An incident which constrains specialized resources on a local, state and national scale; officials communicating with members of the public about the risks of an invisible hazard; and the public taking protective actions to save their lives and to ease the burden on an overwhelmed emergency response system — these are just a few of the parallels that can be drawn between the COVID-19 pandemic and a large-scale radiological or nuclear (R/N) incident. From 2020 to 2021, researchers working on behalf of the U.S. Department of Homeland Security's (DHS) Science and Technology (S&T) and its Radiological/Nuclear Response and Recovery project extracted lessons from emergency response plans, policies, literature, and other resources of the COVID-19 pandemic and aligned them with known gaps and challenges for an R/N emergency response. This presentation will explore a few of the opportunities identified for improved R/N emergency preparedness, including expanded research, development, test and evaluation, refined planning and exercises, and updated guidance for public and responder protection.

11:05 am **Interactive Q&A**

11:20 am **Break**

Identifying National Defense Needs

Jeffrey Whicker, *Session Chair*

11:35 am

National Needs in Emergency Response and Homeland Security

Julian G. Hill
U.S. Department of Homeland Security

This talk will focus on the future of radiological and nuclear detection for Homeland Security applications. Technology and capabilities have progressed substantially in the past 20 y since 9/11 in terms of reliability of hardware, improved algorithms, and reductions in nuisance alarms. Further progress is needed on a number of fronts. Future detection systems need to fully realize the promise of emerging detector materials to improve resolution, reduce costs, and increase capabilities. Data analytics, live data streaming, fusion of disparate data sources, and machine learning algorithms will be paramount considerations to improve detection decision outcomes moving forward. Dual capability to perform both homeland security detection and emergency response health and safety missions will be valuable modalities of new systems. And finally, more frequent, candid and detailed technical interactions between the industry science communities and Federal government senior leaders and program managers will be a vital element for a mutual understanding of both the state of the possible and operational mission imperatives.

12:00 pm

National Need for U.S. Department of Defense's Multiple-Parameter Radiological Biodosimetry/Dosimetry Diagnostics Network

Ricardo A. Reyes
Defense Health Agency

The United States needs a comprehensive national biodosimetry/dosimetry program to address the requirements for assessing radiation dose/injury in response to radiological/nuclear accidents/incidents. In order to meet its field-mission requirements, the U.S. Department of Defense (DOD) would intentionally send its members into a potentially radiologically-contaminated or high-radiation exposure area. Therefore, it would be appropriate that DOD be among the leads of a national biodosimetry/dosimetry network. The vision for this network includes coordination with other agencies, such as the U.S. Department of Energy, U.S. Department of Health and Human Services, U.S. Food and Drug Administration, national laboratory networks, national laboratories, and private industry. DOD will leverage existing limited internationally-validated capability, and integrate the right administrative and coordinating infrastructure to develop the necessary capacity for sustaining the network. The leading capabilities at the Armed Forces Radiobiology Research Institute and the Naval Dosimetry Center will be part of the network. This network will use a nested flow of biological samples from established laboratories in the military healthcare system and other organizations. A proposed course of action is that the Defense Health Agency will provide the necessary oversight, support and

coordination. The network will use signs and symptoms, standard clinical tests, and advanced biodosimetry diagnostic tests, in a multi-parameter approach. Examples of the advanced capabilities considered for dose estimation are cytogenetic biodosimetry, electron paramagnetic resonance dosimetry, whole-body counting, and assays from radiation-induced molecular biomarkers. Other modalities may be part of the network as the DOD develops capability and capacity for supporting radiological/nuclear mass-casualty events.

12:20 pm **Interactive Q&A**

12:35 pm **Lunch**

Optimizing Next Generation Medical Treatment

Pat B. Zanzonico, *Session Chair*

1:30 pm

The "Promise" of Targeted Radiopharmaceutical Therapy
Lisa Bodei
Memorial Sloan Kettering

This lecture will illustrate the current scenario and future perspectives of targeted radiopharmaceutical therapy (TRPT).

TRPT is becoming very popular due to its favorable safety and efficacy profile. The ability to deliver systemically a targeted radiation to selectively treat cancer while following its destiny with imaging and calculating the tolerated amounts through dosimetry is called "theranostics" and is the characteristic that prompted the development of diverse and effective radiopharmaceuticals over the past 40 y.

Since the first application of radioiodine in thyroid cancer in the 1940s, the demonstration of efficacy and tolerability of radiolabeled octreotides in neuroendocrine tumors, which culminated in a successful Phase III study, and the more recent also successful phase III results of ^{177}Lu-PSMA in prostate cancer, opened the scene to the application of the theranostic concept to many types of cancer.

This is made possible by the current availability and development of new cancer targets, such as receptors, antibodies, or extracellular molecules.

Radionuclide therapy development is a multidisciplinary effort which requires the contribution of radiochemists, oncologists, pharmacologists, medical physicists, and nuclear medicine physicians specialized in therapy delivery. The therapeutics experimented so far have obtained high levels of recognition and commercial interest.

In the future, the growing discoveries of specific tumor-associated targets, including those directed to the so-called "big killers," as well as the increased availability of alpha emitting radionuclides, is leading to numerous clinical investigations in the arena of available cancer therapies, and hopefully to a growing number of approved radiopharmaceuticals.

1:45 pm

Treatment Optimization in Radiopharmaceutical Therapy

George Sgouros
Johns Hopkins Hospital

Radiopharmaceutical therapy (RPT) is defined by the delivery of radioactive atoms to tumor-associated targets. Tumors are thereby irradiated by intravenous administration of the radiolabeled targeting agent. In this regard, RPT is related to chemotherapy and targeted therapy. Targeted cells are killed *via* radiation-induced damage. In this regard, RPT is consistent with radiation-induced cytotoxicity. Radiopharmaceutical therapy, therefore, shares features of both conventional systemic therapies and external beam radiotherapy. Since almost all the radionuclides used in RPT also emit photons, the distribution of the therapeutic may be imaged. The ability to calculate tumor and normal tissue absorbed dose from such images enables dosimetry-driven optimization of clinical trials, and potentially individual patient treatment planning. To date, RPT implementation has largely been administered without the benefits of imaging and dosimetry, capabilities intrinsic to this modality, but unfamiliar to medical oncology practitioners. This puts RPT at a disadvantage since those features that distinguish it and can make it better than other oncologic systemic therapies are not used.

2:00 pm

Optimizing Next Generation Medical Treatment: Identified Opportunities in Medical School Education

Neha Vapiwala
University of Pennsylvania

The field of targeted radionuclide therapies is experiencing an exponential growth curve. With U.S. Food and Drug Administration approval expected imminently, radionuclide therapies for prostate cancer will join the long-standing arsenal of radionuclide therapies for thyroid cancer (I^{131}), neuroendocrine tumors (Lu^{177}-Lutathera), neuroblastoma (I^{131}-MIBG), and other, relatively low-incidence cancers. These agents have generally been administered by physicians with formal nuclear medicine training, many of whom may not be clinically active. The introduction of radionuclide therapies for a “big” indication such as prostate cancer, with more anticipated in the future for similar highly prevalent cancers, brings to fore a growing controversy as to which specialists are most qualified to administer and oversee such therapies: nuclear medicine physicians, radiation oncologists, medical oncologists, or a newly imagined hybrid specialist? Regardless of what the preferred answer may be, the critical element to this question is what level and type of training is optimal and should be required before any physician can be deemed qualified for radionuclide therapy delivery. The complexity of the requisite training will in turn be impacted by and dependent upon whether such therapies are administered based on patient-specific radiation dosimetry (more akin to radiation therapy delivery) or generally standardized administration, like chemotherapy, with the latter not surprisingly being preferred by the pharmaceutical companies marketing these therapies as well as medical oncologists. This session will help to first

provide an overview and examples of targeted radionuclide therapies, followed by a review of the technology with advantages and disadvantages of a dosimetric approach to such therapies. My talk will focus on the issues of developing and ideally establishing consensus on the training standards and experience requisite for radionuclide therapy delivery. These educational considerations will ultimately impact the availability and effectiveness of these therapies for the patients whom they were designed to benefit.

2:15 pm **Interactive Q&A**

Integrating Knowledge Across Disciplines

Manuela Buonanno, *Session Chair*

2:30 pm

"Y" and the Change in Practice of Routine Gonadal Shielding During Radiography
Donald P. Frush
Duke University Medical Center

This "Y" follows three other "whys." Why change the practice of routine gonadal shielding (GS), why is this challenging, and why does much of this responsibility fall to subsets of imaging professionals?

Why change?

1. advances in technology since the 1950s have reduced radiography patient doses up to 95 %;
2. contrary to our understanding in the 1950s, current evidence strongly suggests potential human heritable effects from radiography are exceedingly remote;
3. the current ICRP gonadal weighting factor has decreased by 60 %;
4. GS, even when placed according to guidelines, may not fully cover the gonads, especially ovaries;
5. shielding may increase the dose to gonads and surrounding abdominal organs when used with automatic exposure control;
6. shielding in the exposure field may obscure anatomy necessary for full diagnostic potential; and
7. when reused, GS may be a hygiene issue.

Why is this change difficult despite available recommendations – based on this current scientific evidence – such as NCRP Statement No. 13? Long-standing practices and expectations are confronted, regulations/guidance vary (including among imaging specialties) and may be slow to change, diverse populations need to accept (requiring different communication strategies), and the scope of GS recommendations can lack clarity. These complexities are why subsets of imaging experts have greater relevance and responsibility for resultant GS practice change: the final "Y" then is the symbolic joining of arms to base representing the ensuing unified advancement of safe and effective use of medical radiation for our patients and those caring for them.

2:40 pm

Sometimes a Statement Just Isn't Enough: The Importance of Considering Your Audience and Their Needs

Angela Shogren
U.S. Environmental Protection Agency

When NCRP Scientific Committee 4-11 began crafting a statement to recommend ending the use of routine gonadal shielding, it was clear that the committee needed to address questions and concerns around implementation and communicating these changes to patients. As the statement began to take shape, the committee considered the merit of a separate, but complementary, implementation guide for practitioners.

After drafting implementation guidance for health care practitioners and administrators, the committee realized there was another key audience concern that needed to be addressed, namely, patients and carers who have come to expect gonadal shielding during radiological procedures. NCRP can best serve this audience by providing a patient-centered pamphlet that clearly communicates the reason for the change in gonadal shielding practices and addresses concerns about patient safety.

In the case of Statement No. 13, *NCRP Recommendations for Ending Routine Gonadal Shielding During Abdominal and Pelvic Radiography* (2021), a compendium of resources was developed to ensure that we were able to reach each identified target audience. These resources have been so well received that they have been translated into multiple languages by other organizations.

2:50 pm

Interactive Q&A

3:00 pm

Preclinical Studies with Proton FLASH Radiotherapy for Gastrointestinal and Sarcoma Tumors in Rodents and Canines

Constantinos Koumenis
University of Pennsylvania

Radiation therapy (RT) is used with curative intent for most solid tumors including sarcomas and pancreatic cancer. Despite significant improvements in conformal RT delivery, many patients still develop RT-induced toxicities which limit its efficacy. Ultra-high dose rate radiation (FLASH-RT) refers to RT delivered at much higher dose rates compared to standard (or conventional) RT and has shown great promise in preclinical models in reducing damage of normal tissues while maintaining tumor control.

We developed and tested the first system to accurately deliver FLASH Proton RT (F-PRT) using double-scattered protons and published the first report of F-PRT-mediated normal tissue radioprotection. Compared to standard proton therapy (S-PRT; <1 Gy s^{-1}), F-PRT (60 to 110 Gy s^{-1}) significantly decreased overall mortality from late epithelial gastrointestinal fibrosis in mouse models following whole abdomen or focal intestinal RT, whereas pancreatic tumor growth inhibition was essentially indistinguishable between the two modalities.

Similarly, we found that F-PRT spared skin toxicities and lymphedema severity compared to S-PRT with no difference in efficacy of control of mouse sarcoma xenografts. F-PRT spared a larger portion of the proliferative/progenitor compartments of the intestine and the skin while RNA-seq and scRNAseq analyses demonstrated a cytoprotective/wound healing interferon response in the immune compartment. Finally, we have completed a Phase I feasibility clinical trial of F-PRT versus S-PRT in 26 canine sarcoma patients and found that F-PRT ameliorated induction of the profibrogenic cytokine TGF-β. We will also briefly discuss potential clinical use of F-PRT with emphasis on hurdles facing this modality for full clinical implementation.

3:10 pm

FLASH: High Therapeutic Potential While Sparing Normal Tissue Complications at Ultra-High Dose Rates: Dosimetry Aspects
Magdalena Bazalova-Carter
University of Victoria, Canada

FLASH radiotherapy delivered at ultrahigh dose-rates (UHDR) has shown promise in reducing normal tissue toxicity while maintaining tumor control, and it is thought to have the potential to revolutionize cancer treatment. In this talk, the available systems capable of electron, proton and photon UHDR delivery will be first briefly described, then challenges and possible solutions of UHDR dosimetry will be discussed. The talk will focus on ionization chambers, radiochromic films, and luminescent dosimeters, and their characteristics in terms of temporal and spatial response will be summarized and recent developments in UHDR dosimetry described. Dosimetry considerations for clinical translation of FLASH radiotherapy will also be briefly discussed.

3:20 pm **Interactive Q&A**

3:30 pm **Break**

Forty-Fifth Lauriston S. Taylor Lecture on Radiation Protection and Measurements

3:45 pm **Introduction of the Lecturer**
Kathryn D. Held

Long-Term Radiation Animal Studies: A Story Continues
Gayle Woloschak

The U.S. Department of Energy embarked on the study of long-term effects of radiation beginning from around 1940 until 1995 by examining life-shortening effects of ionizing radiation on burros, pigs, rats, mice, dogs, primates and other species. Of these many studies, data are available for most while tissues remain only from

some rats, dogs and mice. A total of over 120,000 animals were studied (and probably the number is much larger!). The experiments were done in a systematic way with tissues studied and archived, detailed pathologies and diseases recorded, and much of the information provided in database format. Many of the logistics of the experiments, data on each individual animal for a variety of endpoints, and available tissues from the animal can be found at the janus.northwestern.edu/wololab website. Experiments were done to evaluate effects of radiation quality, dose and dose-rate, effects of *in utero* exposures, external beam and internal emitters, and many more. This talk will discuss use of those studies in the past, present and future.

Tuesday, March 29, 2022

Understanding Individual Responses to Ionizing Radiation

Nobuyuki Hamada, *Session Chair*

9:30 am

Potential Modifiers of Radiation-related Risk of Circulatory Diseases: Implications for Individual Differences in Radiation Response

Preetha Rajaraman
U.S. Health and Human Services

The current system of radiological protection aims to minimize harmful health effects of ionizing radiation based on estimates of risk to an “average” person. While the use of an age- and sex-averaged approach is pragmatic, growing evidence indicates substantial individual variation in radiosensitivity due to various genetic, epigenetic and environmental factors. Understanding the factors governing individual susceptibility to radiation, along with the magnitude of these effects, could inform approaches to radiation protection in occupational, medical and public settings. The International Commission on Radiological Protection is currently reviewing evidence for modifiers of radiation-induced cancer, circulatory, ocular and neurological diseases. While there is substantial evidence for modifiers of radiation-related risk for cancer endpoints, the evidence is less clear for other outcomes. This presentation will focus specifically on potential modifiers of radiation-related risk for circulatory diseases in various exposure settings (medical, occupational, environmental), identifying gaps in the current literature, and discussing potential implications for radiation protection.

9:50 am **Interactive Q&A**

Supporting Space Travel

Jeffrey J. Whicker, *Session Chair*

10:00 am

Space Exploration: Evolving Recommendations for Radiation Protection Standards and Research
S. Robin Elgart
National Aeronautics and Space Administration

Understanding the health risks for exploration missions has been a challenge throughout human history. While the missions we current engage in may be different from what our ancestors experienced while crossing the Bering Strait Land Bridge or setting out across the South Pacific in canoes, the challenge remains. We don't really know what will happen until we get there and experience it for ourselves. Fortunately, throughout the space age we have been able to collect information regarding environmental conditions astronauts will experience. This information has been vital to support the characterization of the potential health risks of the environmental hazards and development of effective mitigation strategies to protect crew health.

Since the beginning of the space program, space radiation exposure has been monitored and limited due to the known health effects of radiation experienced on Earth. As the understanding of terrestrial radiation exposure evolved so have the protection standards for space radiation exposure. However, National Aeronautics and Space Administration (NASA) has some unique challenges for characterizing and mitigating health risks due to the distinctiveness of the space radiation environment. This presentation will provide a glance back at how radiation protection standards have evolved through the space age as well as a glance forward to how the Space Radiation Element for NASA's Human Research Program plans to execute a robust research strategy to characterize and mitigate the radiation health risks that may impact our astronaut crews.

10:20 am **Interactive Q&A**

Fifth Thomas S. Tenforde Topical Lecture

10:30 am **Introduction of the Lecturer**
Jessica S. Wieder

Opportunities in Radiation Science: Applying Our Collective Knowledge to the Challenges of Our Time
Jill A. Lipoti

The value of applying the collective knowledge of NCRP members to emerging challenges is that the scientific society can remain relevant and sustainable. Many

challenges are emerging concurrently. The COVID pandemic, climate change, biodiversity loss, and the national reckoning with racial and social inequity have produced a fractured and contentious society. Misinformation has overspread factual information. Trusted information sources have been dismissed as their value system has been judged to overshadow their messages. Solutions are available, but they require unified and universal action, which means political will. Identifying options requires an interdisciplinary team — to consider unintended consequences, to figure out a way to mitigate those issues, and to consider the agency of the public to accept the solution. All of us will need to communicate factually and empathetically to understand our audiences and provide messaging that address their concerns.

The pandemic taught us to adapt quickly. We have isolated ourselves, had personal conversations by talking to our laptop, seen doctors over telemedicine, changed policies in a week that would have taken years to change otherwise, and focused like a laser on obtaining toilet paper. Our language grew new words. To address climate change at the same time as social justice in an atmosphere of distrust with economic constraints will require similar concerted and accelerated action.

This is not to suggest that radiation is the ultimate answer to every one of our large scale challenges, but that when a solution is identified that includes a radiation component, it should not be rejected due to public opposition. The NCRP skill set is the ability to read data and turn it into knowledge, the ability to listen to affected communities and empower them to be part of the shaping their future, the scientific ability to consider multiple variables and solve for the optimum solution, and the ability to communicate truth to power. NCRP has operated at the intersection of science, policy and communication since its inception in 1929 and its interdisciplinary processes are needed now more than ever.

11:00 am **Break**

Addressing Waste Management

Brian A. Powell, *Session Chair*

11:15 am

DOE Cleanup Efforts Involving Native American Tribes
Joanna Burger
Rutgers University

U.S. Department of Energy (DOE)-Environmental Management is tasked with cleaning up legacy wastes, while protecting human health and the environment before, during and after remediation. This responsibility includes several challenges:

- recognizing and involving Native Americans and Alaskan Natives as Sovereign Nations;
- recognizing the Treaty Rights of Native Americans and Alaskan Natives;
- involving minority and low-income community members and interest groups;
- involving these groups in decisions during all phases of remediation;
- protecting the environment, ecological and eco-cultural resources, and the

cultural aspects, as well as the historical sites and resources; and
- balancing these competing claims equitably.

The placement of DOE sites near a water source (major rivers) increases the importance of these different claims, especially for environmental and social justice communities. We briefly describe several cases where DOE involvement and collaboration with these diverse communities was essential to successful cleanup decisions and implementation, including at Hanford Site, Savannah River Site, Amchitka Island, and Brookhaven National Laboratory. While Hanford and Savannah River sites have ongoing cleanup missions, cleanup at Amchitka Island has been completed and long-term periodic monitoring is ongoing. These sites all have riverine or marine ecosystems that are important to the cultures of neighboring and regional communities, as well as containing important ecological resources. Similarly, they all involved a range of parties, including DOE, U.S. Environmental Protection Agency, state agencies, and local communities, as well as U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, and Tribal members at some of them. Consortium for Risk Evaluation with Stakeholder Participation (CRESP) participated in multiple ways as an independent academic-based organization, with the CRESP role tailored to site-specific needs and challenges. The essential aspects included respect for, and inclusion of, community involvement and communication throughout, with special recognition and adherence to the Sovereign Nation status of tribes. Combining tribal and other community science and knowledge improved the overall scientific basis for remediation decisions and resolution of differences.

11:30 am

In-Service Condition of Radon Barriers over Uranium Mill Tailings Disposal Facilities in the United States

Craig H. Benson
University of Virginia

Final covers at four uranium mill tailings disposal facilities in service for approximately two decades were evaluated to provide insight into the evolution of earthen final covers at radioactive waste disposal facilities over time. Analog profiles having similar characteristics as the cover at each site were studied to provide insight into the very long-term condition. At each site, multiple test pits were excavated to expose the radon barrier layer. Radon flux measurements were made on the surface of the barrier using different size chambers, and large intact block samples were collected from the radon barrier for hydraulic conductivity assessment. Radon flux measurements were also made on the underlying tailings so that the radon diffusion coefficient could be determined. Morphological studies were conducted to characterize the structure in the radon barriers, which was quantified using a soil morphological development score (SMDS). Findings from the study demonstrate that extensive structure develops in radon barriers, leading to more permeable conditions than anticipated during design (»1 x 10^{-9} m s^{-1}). In some cases, radon diffusion coefficients are higher than anticipated during design. In-service hydraulic conductivities and diffusion coefficients are strongly related to the degree of structural development in the radon barrier, as indicated by the SMDS. Despite these changes in the radon barrier, radon fluxes at each site met the requirements stipulated in Uranium Mill Tailings Radiation and Control Act of 1978, even after decades of service (<0.74 Bq m^{-2} s^{-1}).

11:45 am

ARPA-E ONWARDS Program: Addressing the Backend of Advanced Reactors Fuel Cycles
Robert Ledoux
U.S. Department of Energy

The goal of ARPA-E's ONWARDS Program is to develop technologies that address significant challenges to closing the backend of advanced reactor (AR) nuclear fuel cycles. Specifically, ONWARDS seeks to develop and demonstrate sustainable technologies that will significantly improve the *disposal impact* of used nuclear fuel and other waste streams stemming from the implementation of AR fuel cycles by developing innovative and cost-effective approaches in reprocessing, material accountancy, and waste forms. ONWARDS metrics include an order-of-magnitude reduction in AR waste volume generation or repository footprint compared to light-water nuclear reactors, better than 1 % fissile-mass accountancy in reprocessing streams, and development of high-performance AR waste forms for a variety of potential deep-geological repositories and disposal concepts. The fuel cycles under consideration are Tri-structural isotropic, metal and molten salt. The potential intersections these innovations may have in addressing existing used nuclear fuel disposal impact from light water reactors will also be discussed.

12:00 pm **Interactive Q&A**

12:15 pm **Lunch**

Reducing Climate Change through Nuclear Power

Willie O. Harris, *Session Chair*

1:00 pm

Nuclear Energy - Today and Tomorrow
Hilary Lane
Nuclear Energy Institute

The nuclear industry is at an exciting, yet pivotal turning point, the likes of which has not been recognized in over 40 y. The Nuclear Energy Institute is the trade association for the commercial nuclear industry and represents over 300 member companies, both domestically and globally. This presentation will provide a high-level overview of the state of the industry, to include successes and accomplishments within the current fleet of 93 reactors, and the state-of-play for the upcoming wave of advanced reactors, the first of which will be built and operational in this decade. Policymakers now agree: nuclear is the answer to achieve reliable, resilient deep-decarbonization. Bi-partisan legislation at the state and federal levels highlights this support for existing and new nuclear, now and into 2022 and beyond.

1:15 pm

NextGen RP: Applying Remote and Automated Technologies to Enhance and Optimize Nuclear Power Plant Radiation Protection Operations

Karen S. Kim-Stevens
Electric Power Research Institute

Currently, most radiation measurement and characterization activities that occur at nuclear power plants are conducted manually and on a routine basis regardless of whether conditions warrant the evaluation. Advances in sensor, indoor positioning systems, and data transmission science and technology have enabled remote and automated operations in many industries. There have been advances in radiation remote monitoring technology for non-nuclear power plant purposes and for environmental monitoring following the Fukushima accident. The combination of remote, automated data transmission/operations technology and advanced radiation monitoring technologies could be applied for: plant area radiation monitoring, worker radiation monitoring, effluent monitoring, environmental monitoring. A large fraction of the radiation safety functions at a nuclear power plant could be streamlined with the implementation of more advanced, remote monitoring technologies, application of advanced data analytics and modeling/trending, and utilization of the radiological information to better inform workers, work processes, and reporting needs. Leveraging advanced technologies to risk-inform and automate radiation protection tasks during operation and emergency situations will lead to cost savings and improvements in radiation protection and plant operations and enhance the health and safety of the workers, members of the public, and the environment.

Technological solutions may exist to address pieces of this strategy. However, a platform for integrating the radiological information from multiple devices and advanced data analytics with plant processes and systems is currently not available. Electric Power Research Institute is conducting research to identify, develop, demonstrate, and provide information about technologies and strategies that support efficient and safe risk-informed, condition based, and data driven operations.

1:30 pm

Small Modular Reactor/Advanced Nuclear Reactor Health Physics Challenges

Bryan S. Pell
Duke Energy

The goal of providing carbon-free electricity to consumers is daunting. Current renewable energy such as wind and solar power is often unreliable due to weather patterns. Solar power requires energy storage solutions as consumer power loads are highest during the early morning and evening. Fossil fuel baseload power must be replaced as electric power needs are expected to increase in the future. While commercial nuclear reactors have a track record second to none, having produced carbon-free electricity 24/7 for decades, they are expensive and risky to build. Small modular reactors (SMRs) and advanced nuclear reactors (ANRs) have been proposed as ways to bypass financial and safety barriers that have plagued the investment in building more conventional nuclear reactors. These modular

reactors allow for less onsite construction, increased containment efficiency, and enhanced safety due to passive nuclear safety features.

In this presentation, current SMR/ANR testing, development and legislation is discussed to understand timelines and barriers that need to be overcome before SMRs/ANRs can be used as a carbon free alternative to base power generation.

Additionally, like conventional boiling water and pressurized water reactors, SMRs and ANRs present their own set of challenges for health physics personnel. Areas such as emergency planning, used fuel disposal and storage, radioactive waste, radiological concerns, and operational risks are examined in order to help health physics personnel understand how they might participate and advocate the use of SMRs/ANRs as a carbon free alternative to base power generation.

1:45 pm **Interactive Q&A**

Interactive: Opportunities in Radiation Science

2:00 pm

Evagelia C. Laiakis
Jessica S. Wieder
Program Co-Chairs


Conclusions

2:30 pm

NCRP Vision for the Future and Program Area Committee Activities
Kathryn D. Held
President, NCRP

3:00 pm **Adjourn Scientific Meeting**

3:15 pm **NCRP Annual Business Meeting**

4:30 pm **Adjourn**

Program Committee

Co-Chairs

Evagelia C. Laiakis
Georgetown University

Jessica S. Wieder
U.S. Environmental Protection Agency

Members

Sara D. DeCair
U.S. Environmental Protection Agency

Nobuyuki Hamada
CRIEPI Radiation Safety Research Center

Willie O. Harris
CN Associates

Brian A. Powell
Clemson University

Angela Shogren
U.S. Environmental Protection Agency

Jeffrey J. Whicker
Los Alamos National Laboratory (retired)

Pat B. Zanzonico
Memorial Sloan Kettering Cancer Center

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@NCRP2022

2023 Annual Meeting

Integration of Physics, Biology and Epidemiology in Radiation Risk Assessment

March 27–28, 2023
Bethesda, Maryland

Annual Warren K. Sinclair Keynote Address

Dr. Joe W. Gray has been selected to give the 18th Warren K. Sinclair Keynote Address at the 2022 Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP). The Address, entitled “Developing a Long-Term Strategy for Low-Dose Radiation Research in the United States,” will be a featured presentation at the 58th NCRP Annual Meeting to be held virtually March 28-29, 2022. The Address will be given at 10:00 a.m. on March 28, 2022. The keynote speaker series honors Dr. Warren K. Sinclair, NCRP's second President (1977 to 1991).

Dr. Joe W. Gray, a physicist and an engineer by training, holds positions as Professor and Gordon Moore Endowed Chair, Biomedical Engineering Department; Director, Oregon Health and Science University Center for Spatial Systems Biomedicine; and Associate Director for Biophysical Oncology, Knight Cancer Institute at the Oregon Health and Science University. He is also Emeritus Professor, University of California, San Francisco; and Senior Scientist, Lawrence Berkeley National Laboratory.

Dr. Gray's work is described in over 500 publications and 80 U.S. patents. He is a Fellow of the American Association for the Advancement of Science and the American Institute for Medical and Biological Engineering; an elected member of the Institute of Medicine of the National Academy of Sciences; a member of the National Institutes of Health; a Fellow of the American Association of Cancer Research Academy; and Executive Councilor of the Board of Councilors for the Radiation Effects Research Foundation, Hiroshima, Japan.

Lauriston S. Taylor Lecture

Dr. Gayle E. Woloschak has been selected to give the 45th Lauriston S. Taylor Lecture at the 2022 Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP). The lecture, entitled “Long-Term Radiation Animal Studies: A Story Continues,” will be the featured presentation at the 58th Annual Meeting to be held virtually on March 28-29, 2022. The Lecture will be given at 3:45 p.m. on March 28, 2022. The lecture series honors the late Dr. Lauriston S. Taylor, NCRP Founding President (1929 to 1977) and President Emeritus (1977 to 2004).

Dr. Woloschak received her BS in Biological Sciences, from Youngstown State University and a PhD in Medical Sciences from the University of Toledo (Medical College of Ohio). She did her postdoctoral training at the Mayo Clinic.

Currently, she is Professor of Radiation Oncology and Radiology at Northwestern University Feinberg School of Medicine in Chicago and Associate Dean of the Graduate School. She and her group have been involved in studies of molecular consequences of radiation exposure, late tissue effects associated with radiation, and the use of radiation-inducible nanomaterials for cancer imaging and therapy. Dr. Woloschak also teaches radiation biology to radiation oncology and radiology residents, cardiology trainees, and graduate students and manages the Advanced Grant Writing Workshop for the Radiological Society of North America (RSNA). She has served on review panels for various federal agencies including the National Institutes of Health, the National Aeronautics and Space Administration, the U.S. Department of Energy, RSNA, the U.S. Army Medical Research and Material Command, and others. She is currently Editor-in-Chief for the International Journal of Radiation Biology, Section Editor for PLOS One, and serves on a variety of editorial boards.

Dr. Woloschak was elected to the Council in 2003 and served on the NCRP Board of Directors from 2014 to 2020. She is Chair of NCRP Program Area Committee 1, Basic Criteria, Epidemiology, Radiobiology, and Risk; was a consultant to Scientific Committee (SC) 89-3; a member of Council Committees 1 and 2 and SCs 1-16, 1-23, and 6-12; and has served on organizational committees for several NCRP meetings. She also served as President of the Radiation Research Society and is a member of the U.S. delegation to the United Nations Scientific Committee on the Effects of Atomic Radiation.

Thomas S. Tenforde Topical Lecture

Dr. Jill A. Lipoti has been selected to give the 5th Thomas S. Tenforde Topical Lecture at the 2022 Annual Meeting of the National Council on Radiation Protection and Measurements (NCRP). The Address, entitled “Opportunities in Radiation Science: Applying Our Collective Knowledge to the Challenges of Our Time” will be a featured presentation at the 58th NCRP Annual Meeting to be held virtually on March 28-29, 2022. The Lecture will be given at 10:30 a.m. on March 29, 2022. The topical lecture series honors Dr. Thomas S. Tenforde, NCRP's fourth President (2002 to 2012).

Dr. Lipoti moved to Whidbey Island, Washington in 2018 after retiring as an Assistant Teaching Professor at the Department of Human Ecology at Rutgers University. She conceived and taught “Introduction to Sustainability” and the “Practicum in Sustainability” from 2014 to 2018 as part of the Minor in Sustainability.

Dr. Lipoti retired from the New Jersey Department of Environmental Protection in 2013. She was the Director of the Division of Water Monitoring and Standards, with responsibility for fresh water and marine water monitoring efforts. One of her responsibilities was to oversee the AmeriCorps Watershed Ambassador program - to inspire the next generation of water pollution control professionals. These experiences led to her current position as a member of the Island County Marine Water Resources Committee and as Commissioner of the Scatchet Head Water District.

Prior to Dr. Lipoti's involvement in water resources, she was Director of the Division of Environmental Safety and Health with responsibility for directing the state's radiation protection programs, quality assurance, release prevention, pollution prevention and right to know programs. She participated in nuclear emergency response planning and led an effort to improve planning for recovery from a nuclear accident. Dr. Lipoti also led team effort to redirect the x-ray inspection program from a measurement based program to a quality assurance program, focusing on radiation dose and image quality. Dr. Lipoti served as Chairman of the Conference of Radiation Control Program Directors, a national organization.

Dr. Lipoti was first elected to the Council in 2001 and now serves as a Distinguished Emeritus member. She served on the NCRP Board of Directors from 2002 to 2007 and the Budget and Finance Committee from 2002 to 2008. Dr. Lipoti is a member of Program Area Committee (PAC) 5. She also served on PAC 7 and Scientific Committees 5-1 and 6-2; on the Advisory Panel on Public Policy; and in various capacities for annual meetings, including the program committee and session chair.

Dr. Lipoti has provided advice to the International Atomic Energy Agency regarding radiation safety and security, traveling to Ethiopia and Uganda to consult with their radiation control program personnel. She has chaired the Radiation Advisory Committee of EPA's Science Advisory Board and served on the Food and Drug Administration's Technical Electronic Product Radiation Safety Standards Committee for two terms. She has MS and PhD degrees in environmental science from Rutgers, The State University of New Jersey.

John D. Boice, Jr., Young Investigator Award

Established in April 2019 by a generous donation by President Emeritus / Director of Science, John D. Boice, Jr., the Young Investigator Award is given to recognize an early career professional engaged in some aspect of science pertaining to radiation protection and measurements. Dr. Sara Dumit has been selected as the second recipient of the award which includes a travel grant to attend the annual meeting of NCRP where she will be recognized for her accomplishments.

Dr. Dumit is a Health Physicist at Los Alamos National Laboratory (LANL) and a Lindau Nobel Laureate Meeting Alumna (2021). She earned her PhD in pharmaceutical sciences from Washington State University, with doctoral research work conducted at the U.S. Transuranium and Uranium Registries. Her postdoctoral research work was completed at LANL's Internal Dosimetry Group - Radiation Protection Division.

Her research in internal dosimetry focuses on the strategically important field of actinide biokinetics, especially where these biokinetics are affected by chelation treatment. Her areas of expertise include biokinetic model development, chelation modeling (plutonium-DTPA), and medical countermeasures after actinide intakes.

She serves as a member of the NCRP Scientific Committee 6-13: Methods and Models for Estimating Organ Doses from Intakes of Radium. She is also a member of the European Radiation Dosimetry Group (EURADOS) Working Group 7 on Internal Dosimetry, including being a member of both task groups, Biokinetic Modeling of DTPA Therapy and Internal Dosimetry in Case of Emergency. She is a member of the Public Information Committee of the Health Physics Society (HPS), and a consultant for the ANSI N13.64, Medical Management of Radiologically Contaminated Wounds. She also serves as a guest lecturer on Internal Dosimetry at Northern New Mexico College and as an ad hoc reviewer for the Health Physics Journal.

Dr. Dumit has contributed numerous publications to the radiation protection literature and presented her research numerous times (nationally and internationally), including as invited speaker at HPS and EURADOS meetings.

Biographies

Orly Amir (Speaker): Division Director at the National Urban Security Technology Laboratory (NUSTL), a government-owned and government-operated laboratory of the U.S. Department of Homeland Security's Science and Technology Directorate (DHS S&T). Ms. Amir manages NUSTL's Radiological/Nuclear Response and Recovery Research and Development portfolio, which has led to the development of new tools and knowledge product solutions that support federal, state, local, tribal and territorial first responders, emergency managers, incident commanders and decision-makers during radiological or nuclear emergencies. Prior to joining S&T in 2014, Ms. Amir worked for the New York-New Jersey-Connecticut-Pennsylvania Regional Catastrophic Planning Team where she managed the development of an emergency management training program and evacuation and nuclear response planning tools. She also worked on Capitol Hill as a legislative staff member for a Member of Congress, focusing on energy, transportation and environmental policy issues. Ms. Amir has a bachelor of arts in political science from Union College and a master of urban planning from New York University's Robert F. Wagner Graduate School of Public Service.

Magdalena Bazalova-Carter (Speaker): An Associate Professor and Tier 2 Canada Research Chair in Medical Physics in the Department of Physics and Astronomy at the University of Victoria in British Columbia, Canada. She received her PhD degree at McGill University and postdoctoral training at Stanford University. Her current research interests include Monte Carlo simulations and experiments of x-ray fluorescence and photon-counting computed tomography imaging, small animal radiotherapy and FLASH and spatially-fractionated radiotherapy. She is a member of the American Association of Physicists in Medicine (AAPM) Task Group 359 on FLASH (ultra-high dose rate) radiation dosimetry and a Deputy Editor of *Medical Physics*. She is also the recipient of the 2018 John S. Laughlin Young Scientist Award awarded by the AAPM.

Craig H. Benson (Speaker): Dean of Engineering Emeritus at the University of Virginia and Wisconsin Distinguished Professor Emeritus at the University of Wisconsin-Madison. He is an international authority on landfills and waste containment systems. His expertise includes municipal solid waste, hazardous waste, coal combustion residuals, mining and mineral processing wastes, low-level radioactive waste, mixed radioactive waste, uranium mill tailings, and bauxite residuals. He has worked extensively on liner and cover systems for waste containment for more than three decades. Dr. Benson is a Professional Engineer and member of the National Academy of Engineering.

Lisa Bodei (Speaker): Attending and Director of Targeted Radionuclide Therapy in the Molecular Imaging and Therapy Service at Memorial Sloan Kettering Cancer Center. She graduated from the Medical University of Pisa, earned her Doctor of Medicine degree in 1995 and remained at Pisa University as a Resident in Nuclear Medicine at the School of Specialization until 1999. In 2009, she was awarded a PhD (magna cum laude) from the Department of Nuclear Medicine and Molecular Imaging, University of Groningen, The Netherlands, for her work in peptide receptor radionuclide therapy using somatostatin analogues. Her main research interests are in theranostics, particularly peptide receptor radionuclide therapy with somatostatin, bombesin, and prostate-specific membrane antigen analogues for diagnosis and therapy, and translational research applied to radiopeptide therapy of neuroendocrine tumors.

Dr. Bodei has authored 180 articles in international peer-reviewed journals and published eight invited book chapters. She currently serves as the associate editor of the *Journal of Nuclear Medicine*, section editor for *Molecular Imaging and Therapy of Clinical Imaging*, and on the editorial boards of several scientific journals including the *Journal of Nuclear Medicine* and the *European Journal of Nuclear Medicine and Molecular Imaging*. Dr. Bodei has given numerous lectures at national meetings in Europe and international meetings in the United States and Europe. She has served on many committees both as a participant and at an executive level.

Biographies

Manuela Buonanno (Session Chair): Received her BSc in physics from the University of Naples "Federico II" in Italy and her PhD in biophysics from Rutgers University, New Jersey. She is currently an Associate Research Scientist at the Center for Radiological Research at Columbia University, New York.

Her early publications dealt with the expression of nontargeted effects induced by ionizing radiation. Her in vitro studies aimed at investigating the role of radiation quality [linear energy transfer (LET)] and dose in the propagation of stressful effects in the progeny of bystander cells. She extended those studies in vivo using small animal models exposed to microbeam irradiation. Her current studies aim at exploiting the biophysical properties of ionizing radiation (LET, dose, dose rate) to devise more effective radiotherapy treatments. Her research interests include characterization of the response of cells, three-dimensional tissue models, and mouse models to therapeutically relevant doses of radiation delivered at dose rates spanning several orders of magnitude (FLASH). Another main research interest focuses on determining the efficacy and safety of far-UVC radiation for prevention of surgical site infections, and for room decontamination of airborne pathogens including coronaviruses.

Dr. Buonanno is current chair of the Education and Website Committee of the Radiation Research Society, and vice chair of the Radiation Education task force of NCRP Program Area Committee 7.

Joanna Burger (Speaker): Distinguished Professor of Biology at Rutgers University in New Jersey, where she conducts research on ecological and human health risks, stressors, and management. She is especially interested in the intersection of public health and ecosystem health, within a context of environmental and social justice. Her early work in this area involved working with minority communities around contaminated sites, including U.S. Department of Energy (DOE) sites, on the risks of mercury from fish consumption. She co-edited a series of papers for *Risk Analysis* on environmental and social justice. She is on the Management Board of the Consortium for Risk Evaluation with Stakeholder Participation (CRESP), a multi-university consortium aimed at providing DOE with advice, research, and stakeholder engagement to aid in DOE-Environmental Management decision making. She has collaborated extensively with Native American and Alaskan Native peoples, as well as low-income and minority groups. She served on several national and international committees including for the National Academy of Sciences, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration, Scientific Committee on Problems of the Environment (Switzerland), and BBVA Awards (Spain). She is a Fellow of the International Union for Pure and Applied Chemistry, American Association for the Advancement of Science, and International Ornithologist's Union. She received the Distinguished Lifetime Achievement Award from the Society of Risk Analysis, a distinguished Career Award from the Proteomass Society, and is Certified *via* Eminence by the American Academy of Environmental Engineers and Scientists. She has published over 600 papers in refereed journals and over 25 books.

Andrew J. Cordiner (Speaker): Supervisory Special Agent (SSA) Andrew J. Cordiner, Jr. entered on duty with the Federal Bureau of Investigation (FBI) in May 2003, and is the current Regional Attaché handling all Weapons of Mass Destruction (WMD) matters in Asia. He also works counterproliferation, cyber, counterterrorism, financial, and criminal matters in Singapore.

SSA Cordiner started his FBI career in Washington, DC, on the AMERITHRAX Task Force, investigating the anthrax attacks of 2001, which resulted in the largest WMD investigation in U.S. history. Subsequently, he joined the D.C. Joint Terrorism Task Force to lead the WMD and HazMat programs. In this capacity, he led the Interagency Crisis Management Team for the 2009 Presidential Inauguration, for which he received the FBI Director's Award for Distinguished Service to the Law Enforcement Community.

In 2012, ALAT Cordiner was promoted to a field supervisor in the FBI's New York Office, and led the Cyber Criminal Squad in investigating all aspects of cybercrime, including business email compromise, malware, ransomware, network intrusion, and cyber enabled fraud. SSA Cordiner subsequently returned to Washington, DC to lead the Cyberterrorism ISIS Sympathizer Program, responsible for investigations into cyber hackers sympathetic to, and engaging in global cyber jihad operations in support of ISIS.

In 2016, ALAT Cordiner oversaw all WMD investigations globally for the FBI, as the Chief of the WMD Investigative Unit. This included the FBI's largest Dark Web undercover operation against actors trafficking explosives and other WMD materials worldwide. In this role, he was an FBI representative to the White House National Security Council for counter-WMD efforts.

Prior to working for the FBI, Mr. Cordiner worked for Lehman Brothers. He was also a New York Firefighter/Emergency Medical Technician, working for various first responder/fire agencies in New York.

Sara D. DeCair (Program Committee, Session Chair): has been with the U.S. Environmental Protection Agency (EPA) Office of Radiation and Indoor Air since 2003. She has focused on radiological emergency preparedness and spent over a decade negotiating the finalization of the 2017 EPA *Protective Action Guides (PAG) Manual*. Assisting with adoption of the updated PAG Manual has continued to be a collaborative effort with the Federal Radiological Monitoring and Assessment Center, Advisory Team for Environment, Food and Health and the Federal Emergency Management Agency, and the U.S. Nuclear Regulatory Commission. Currently, Ms. DeCair is Associate Center Director for the EPA's radiological protection program's Center for Science and Technology, a small group of radiation experts who provide federal guidance reports and lead an in-house health physics continuing education program for the Agency.

She previously worked for 7 y with the State of Michigan's Department of Environmental Quality. Three of those years were spent in nuclear power plant emergency response and planning where she went from participating in to becoming a trainer for everything from state field team leader, dose assessor, decontamination team leader, various Emergency Operations Center positions, and eventually scenario development and exercise design.

The 3 y prior, Ms. DeCair worked as a State of Michigan inspector of radioactive materials registrants and radiation incident responder. Incident responses ranged from scrap yard portal monitor alarms to oil and gas pipe yard naturally occurring radioactive material (NORM) discoveries to medical waste from Ohio or Canada. Source identification, isolation, storage, and even disposal were among the responsibilities of the incident responder. She also led the instrument calibration efforts for materials program instruments, completed several oil and gas NORM site cleanups, and facilitated the proper disposal of numerous orphan radioactive sources in the state.

Ms. DeCair is a longtime national Health Physics Society (HPS) member and has served 4 y on the Board of the Baltimore-Washington Chapter of HPS.

S. Robin Elgart (Speaker): Received her BS in Microbiology from the University of California at Santa Barbara and her PhD in Biomedical Physics from the University of California at Los Angeles in the laboratory of Dr. Keisuke Iwamoto. Her dissertation focused on characterizing the DNA damage response following low-dose radiological exams in patient samples. Dr. Elgart has over 15 y of diverse research experience across multiple life-science disciplines including microbiology, medical physics, and radiation biology. Before joining the Human Research Program [National Aeronautics and Space Administration (NASA)] as the Space Radiation Element Scientist in April 2020, Dr. Elgart served as a subject matter expert specializing in space radiation health risks for the NASA Space Radiation Analysis Group as well as a Space Environment Officer for Mission Control Center - Houston. As the Space Radiation Element Scientist, Dr. Elgart's primary objective is to develop and execute a robust applied research strategy to meet the agency's goal to safely put the first woman on the Moon and the first humans on Mars.

Donald P. Frush (Speaker): The John Strohbehn Professor of Radiology at Duke University Medical Center. He earned his undergraduate degree from the University of California, Davis, medical degree from Duke University Medical Center, was a pediatric resident at University of California, San Francisco, completed a radiology residency at Duke Medical Center and a fellowship in pediatric radiology at Children's Hospital in Cincinnati. He is certified by the American Board of Radiology with additional certification in Pediatric Radiology. Dr. Frush's research interests are predominantly involved with pediatric body computed tomography (CT), including technology assessment, techniques for pediatric CT examinations, assessment of image quality, CT radiation dosimetry and radiation protection, and risk communication in

medical imaging. Other areas of investigation include CT applications in children and patient safety in radiology. He is the current chair of the Image Gently Alliance. Other leadership roles have included the Society for Pediatric Radiology, NCRP, American Board of Radiology, Radiological Society of North America, and the American College of Radiology. International organizational affiliations have included the International Atomic Energy Agency, World Health Organization, and International Society of Radiology.

Nobuyuki Hamada (Program Committee): He received a BSc in radiological sciences from Ibaraki Prefectural University of Health Sciences, and became a registered radiological technologist in 1999. He earned his MSc and PhD in pharmaceutical sciences from Nagasaki University in 2001 and 2004, respectively. He was a visiting PhD student at the U.K. Gray Cancer Institute for six months in 2003. He was a postdoctoral fellow at the National Institute of Radiological Sciences and in Tohoku University Institute of Development, Aging and Cancer, and a Center of Excellence Associate Professor in Gunma University Graduate School of Medicine. He is currently Senior Research Scientist at Central Research Institute of Electric Power Industry Radiation Safety Research Center, and Visiting Professor at Hiroshima University Research Institute for Radiation Biology and Medicine.

For NCRP, he is a PAC 1 member and was a Consultant to Scientific Committee 1-23 that produced NCRP Commentary No. 26. For the International Commission on Radiological Protection (ICRP), he is a member of Task Groups 111 and 119 and a Mentor, and was a member of Task Group 102 that produced ICRP Publication 152, Associate Editor for Publications 126 through 132, and Assistant Scientific Secretary. For Organisation for Economic Co-operation and Development/Nuclear Energy Agency (NEA)/Committee on Radiological Protection and Public Health, he is a member of High Level Group on Low Dose Research/Radiation and Chemical Adverse Outcome Pathways (AOP) Topical Group, and was a member of Expert Group on Radiological Protection Science that produced NEA No. 7265 report. He also serves on Consultation Committee for AOP Development for Space Flight Health Outcomes, Associate Editor for *Radiation Research*, *International Journal of Radiation Biology*, and *Frontiers in Oncology*, and Editorial Board Member for eight journals such as *Mutation Research/Reviews in Mutation Research* and *PLOS ONE*. He was also a member of the International Radiation Protection Association Task Group Phase 3 “The implementation of the eye lens dose limit,” and Chair of Scientific Advisory Board for the European CONCERT LDLensRad.

He has been involved in various radiation effect studies since 1998, his current focus being placed on tissue reactions (e.g., circulatory and ocular disease). He has published >130 papers in peer-reviewed international journals and has received >20 awards.

Willie O. Harris (Program Committee, Session Chair): Senior Director, Radiation Protection for CN Associates. In his current role, he serves as a consultant in radiation protection focusing on Nuclear Power Plant Operations, Decommissioning of nuclear and non-nuclear facilities, and serving as an radiation safety officer for several broad scope licenses. Prior to work for CN Associates, he was the Director, Radiation Protection for Exelon Nuclear. In this role he was responsible for the governance and oversight of the radiation protection programs for the largest operator of nuclear power plants in the United States. He has over 40 y experience in radiation protection, which has included 30 y of program management and supervisory experience. He is a Certified Health Physicist, a registered radiation protection technologist and held a senior reactor operator certification.

Kathryn D. Held (NCRP President, Speaker): President of the NCRP in January 2019. She held the position of Executive Director and Chief Science Officer from 2016 to 2018. She was first elected to the Council in 2006 and served on the NCRP Board of Directors from 2008 to 2014. She was Vice President from 2011 to 2016 of Program Area Committee 1 on Basic Criteria, Epidemiology, Radiobiology, and Risk. She also served as Chair of the Program Committee for the 2011 Annual Meeting on “Scientific and Policy Challenges of Particle Radiations in Medical Therapy and Space Missions.” Dr. Held was a member of Scientific Committee (SC) 1-22 on Radiation Protection for Astronauts in Short-Term Missions and Phase I of SC 1-24 on Radiation Exposures in Space and the Potential of Central Nervous System Effects and an advisor to several NCRP committees.

Biographies

Dr. Held is an Associate Radiation Biologist in the Department of Radiation Oncology, Massachusetts General Hospital (MGH) and Associate Professor of Radiation Oncology (Radiation Biology) at Harvard Medical School (HMS). At MGH, Dr. Held leads a team that is involved in research on molecular mechanisms for the induction of bystander effects by high energy particles in cells and tissues, characterization of charged particle beam induced DNA damage responses and cell killing, and mechanisms for regulation of DNA damage response by cell-cell communication. Dr. Held also teaches radiation biology to radiation oncology medical and physics residents and graduate students at MGH/HMS and the Massachusetts Institute of Technology.

Dr. Held earned her PhD in biology from the University of Texas, Austin. She has served on review panels for numerous federal agencies including the National Institutes of Health, the National Aeronautics and Space Administration (NASA), and the U.S. Army Medical Research and Material Command programs and other organizations such as the Radiological Society of North America. She is on the Editorial Boards of Radiation Research and the International Journal of Radiation Biology, and has served on committees for the National Academy of Science/National Research Council, NASA, and the American Society of Radiation Oncology. She is a past President of the Radiation Research Society.

Julian G. Hill (Speaker): Has been at the forefront of developing and deploying nuclear detection systems for Homeland Security applications for the past 20 y and was one of the founding senior leaders of the Countering of Weapons of Mass Destruction/Domestic Nuclear Detection Offices (CWMD/DNDO). He currently leads the development, acquisition, deployment and sustainment of chemical, biological, radiological and nuclear detection technology for the U.S. Department of Homeland Security (DHS). He previously led the Strategic Planning and Systems Engineering and Evaluation entities within CWMD/DNDO. As such, he founded DNDO as the premier Nuclear Detection Test and Evaluation entity within the U.S. government.

Prior to joining DHS, Mr. Hill was a senior program manager with the Pacific Northwest National Laboratory where he managed the engineering development and deployment of the first generation of radiation portal monitors deployed to the U.S. border. He also developed the technical basis and negotiated with the Russian Federation for $1B+ program to shut down the three remaining Russian Federation plutonium production reactors by replacing the energy with coal-fired heat and electrical power plants. He was also responsible for the characterization of the Hanford Site Tank Wastes.

Mr. Hill earned a BS in Chemical Engineering from the University of Buffalo in 1987 and is an alumnus of the Federal Executive Institute and the Harvard Kennedy School of Government.

Karen S. Kim-Stevens (Speaker): Principal Project Manager at the Electric Power Research Institute (EPRI).

Ms. Kim-Stevens manages the research conducted by Radiation Safety team within the Nuclear Sector. These projects are related to nuclear power plant occupational and public radiation protection, low and intermediate level waste management, effluent management, low-dose health effects, and radiological groundwater and environmental protection. Over her years at EPRI Ms. Kim-Stevens has also managed various research projects related to nuclear power plant decommissioning and water chemistry.

Ms. Kim-Stevens holds a BS in Nuclear Engineering and Chemical Engineering from the University of California, Berkeley (2006) and a Masters of Radiation Health Physics degree from Oregon State University (2013). Ms. Kim-Stevens received her health physicist certification from the American Board of Health Physics in 2016. Ms. Kim-Stevens joined EPRI in 2005.

Biographies

Constantinos Koumenis (Speaker): Born in Nicosia, Cyprus, he received his BS degree in Pharmacy (with honors) from the Aristotle University of Thessaloniki, and his PhD degree in Biochemistry from the University of Houston, Texas in 1994. He completed a postdoctoral fellowship in Radiation and Tumor Biology at Stanford University. He was appointed as Assistant Professor at Wake Forest University in 1999 and then moved to the University of Pennsylvania (UPenn) in Philadelphia, as Associate Professor. He is currently the Richard Chamberlain Endowed Professor and Vice-Chair for Research, in the Department of Radiation Oncology at UPenn's Perelman School of Medicine. He is also Associate Director for Translational Research at the Abramson Comprehensive Cancer Center at UPenn. His scientific research interests include the development of novel mouse models for radiation toxicity and the testing of new radiation technologies and modalities such as FLASH radiotherapy. His group is also engaged in the study of the role of the tumor microenvironment on tumor progression, metastasis and resistance to therapy.

Evagelia C. Laiakis (Program Committee Co-Chair, Speaker): Associate Professor in the Department of Oncology at the Lombardi Comprehensive Cancer Center and the Department of Biochemistry and Molecular and Cellular Biology at Georgetown University. She received her PhD degree in Human Genetics from the University of Maryland at Baltimore, studying radiation induced genomic instability and the contribution of proinflammatory processes. She subsequently completed her postdoctoral fellowship at Georgetown University, in the field of radiation biodosimetry through metabolomics and lipidomics. Dr. Laiakis was elected to NCRP in 2019 and has been serving as a member of PAC 1 since 2016. She was a member of the Organizing Committee for the 2021 NCRP Annual Meeting and is the current Co-Chair of the 2022 NCRP Annual meeting.

She is an Associate Editor for the *International Journal of Radiation Biology* and *Radiation Research* and the 2019 recipient of the Jack Fowler Award from the Radiation Research Society. Dr. Laiakis' laboratory aims to expand the field of radiation metabolomics and lipidomics through mass spectrometry with untargeted and targeted approaches and design a high-throughput easily deployable assay for biodosimetry purposes. Her research focus includes understanding metabolic responses to scenarios involving a wide range of doses (low dose to acute radiation syndrome associated doses), dose rates, normal tissue responses, and radiation quality effects, utilizing biofluids and tissues from rodents to humans. Her work has also expanded to space radiation effects, in combination with stressors such as microgravity, with emphasis on immune and muscle related changes.

Hilary Lane (Speaker): Joined the Nuclear Energy Institute (NEI) in 2017 and has over 12 y of experience in defense and commercial nuclear.

Prior to joining NEI, Ms. Lane worked at the U.S. Nuclear Regulatory Commission and the National Nuclear Security Administration in Washington, D.C., in both the Office of Defense Nuclear Nonproliferation and Office of Defense Programs. During that time, Ms. Lane served on assignment to the British Embassy in Washington, and to Lawrence Livermore National Laboratory in Livermore, California.

Ms. Lane graduated with honors from the University of Maryland with a BS in Materials Science and Engineering. She also holds an Associate's Certificate in Project Management from George Washington University.

Robert Ledoux (Speaker): Serves as a Program Director at the Advanced Research Projects Agency-Energy (ARPA-E). His areas of interest include the intersection of nuclear physics and nonproliferation, energy production, and transportation.

Prior to joining ARPA-E, Dr. Ledoux served as the Founder, President, and CEO of Passport Systems, a technology company in nonintrusive cargo inspection. At Passport Systems, Dr. Ledoux co-invented powerful new technologies with the U.S. Department of Homeland Security Domestic Nuclear Detection Office to aid in the nonintrusive inspection of cargo and co-authored over 20 U.S. and international patents. Prior to founding Passport Systems, he served as Vice President of Pyramid Technical Consultants, developing

hardware and software for the control of magnetic scanning systems and accelerator control used in semiconductor manufacturing equipment. Previously as an Associate Professor of Physics at the Massachusetts Institute of Technology, he studied high-energy nuclear interactions in search of new phases of hadronic matter.

Bryan S. Pell (Speaker): The Corporate Lead Scientist for the Radiation Protection Station Sciences Division of Duke Energy's Nuclear Fleet. He has worked for Duke Energy for 8 y and in Radiation Protection for 29 y. He provides oversight and support to the Radiation Protection departments at six nuclear sites.

Mr. Pell has extensive Radiation Protection experience having worked at commercial nuclear power plants, U.S. Department of Energy/U.S. Department of Defense/ Formerly Utilized Sites Remedial Action Program sites, research laboratories, and waste acceptance facilities throughout the United States. His positions have steadily progressed in responsibility and oversight over his career.

Mr. Pell holds a BS degree in Nuclear Engineering from Excelsior College. He passed the National Registry of Radiation Protection Technologists exam in May 1998 and is currently on the Board of Directors for the Power Reactor and Instrumentation sections of the Health Physics Society.

Master Sergeant Pell is also a retired veteran, serving in the U.S. Army Reserve for 22 y. He was involved in the Drill Sergeant School program for most of his military career before serving in Baghdad, Iraq, during Operation Enduring Freedom as the landlord of the Victory Base Complex from 2009 to 2010.

Brian A. Powell (Program Committee, Session Chair): The Jerry E. and Harriet Calvert Dempsey Associate Professor of Waste Management in the Department of Environmental Engineering and Earth Sciences at Clemson University. Dr. Powell's research focuses on understanding and prediction of the physical, chemical and biological processes which govern the mobility of radionuclides in natural and engineered systems. He has a BS in Chemistry from the University of Montevallo, and an MS and PhD in Environmental Engineering and Science from Clemson University. Prior to joining the faculty at Clemson University, Dr. Powell held postdoctoral appointments at the Lawrence Livermore National Laboratory and the Lawrence Berkeley National Laboratory. Dr. Powell has conducted sponsored research in a wide range of projects dealing with topics of sorption and environmental transport of actinides, nuclear forensics, development of radiation detection and radiation detection laboratory courses, iodine, radium, strontium geochemistry in wetland and subsurface sediments, radionuclide geochemistry of saltstone and solid waste performance assessments at the Savannah River Site, measurement of thermodynamic parameters supporting advanced fuel cycle chemistry, and related topics. The knowledge gained from this work can be used to evaluate risk posed by subsurface contamination of radionuclides, to design remediation strategies for contaminated sites, and to facilitate the use of safe disposal practices.

Along with serving on the NCRP PAC 5 committee, Dr. Powell is also a member of the Radiation Safety Committee of the U.S. Environmental Protection Agency Scientific Advisory Board and a member/lecturer for the U.S. Department of Energy National Analytical Management Program, Education and Training Subcommittee. Additionally, Dr. Powell is the winner of the 2014 South Carolina Governor's Young Researcher Award for Excellence in Scientific Research and the 2011 Clemson University Sigma Xi Young Investigator of the Year.

Preetha Rajaraman (Speaker): Serves as a key advisor to the U.S. Secretary of Health and Human Services (HHS) on matters involving health and biomedical research in South Asia. She is responsible for in-country representation, monitoring and coordination of the policy, programs and interests of all HHS agencies over a broad portfolio spanning health policy, noncommunicable and communicable diseases, health safety and security, and research and innovation. Dr. Rajaraman has over 20 y of experience in health research and policy, with a particular focus on genetic susceptibility to ionizing radiation and other environmental carcinogens. She has served as an expert advisory member for various international bodies including the International Commission on Radiological Protection, the World Health Organization, and the

Lancet Oncology. Dr. Rajaraman holds a PhD in Epidemiology (Johns Hopkins), an MSc in Environmental Health (University of Washington), and a BA in Biology (Reed College, Phi Beta Kappa).

Ricardo A. Reyes (Speaker): Has over 30 y of experience in the field of Nuclear Engineering and Medical Health Physics. He has 25 peer-reviewed published articles, a book chapter, three technical guides, and multiple abstracts. COL Reyes' expertise is in Radiation Dosimetry and most of his published work is in Biodosimetry. The North Atlantic Treaty Organization, the International Atomic Energy Agency, and the World Health Organization internationally recognize his research in electron paramagnetic resonance.

Colonel Reyes commissioned as a U.S. Army Nuclear Medical Science Officer in 1999. His duty stations include a variety of assignments in the U.S. and abroad. He is a Subject Matter Expert in Chemical-Biological-Radiological-Nuclear (CBRN) Defense and a medical CBRN planner, having held multiple military assignments in this field. His deployments include the Republic of Georgia, Kuwait, and Iraq. COL Reyes is the Defense Health Agency (DHA) Radiation Safety Director, DHA U.S. Nuclear Regulatory Commission license Radiation Safety Officer, and the Radiological Health Consultant to the U.S. Army Surgeon General.

Ricardo Reyes holds a Bachelors in Nuclear Engineering (1988) and Masters in Nuclear Engineering Sciences (1996) from University of Florida. In 2008, he completed his PhD in Environmental Health Sciences with emphasis in Medical Health Physics at the Uniformed Services University F. Edward Hébert School of Medicine. In 2021, COL Reyes graduated with honors from the U.S. Army War College in Carlisle, Pennsylvania with a Masters of Strategic Studies.

Monica Schoch-Spana (Speaker): A medical anthropologist, is Senior Scholar with the Johns Hopkins Center for Health Security and Senior Scientist with the Department of Environmental Health and Engineering at the Johns Hopkins University Bloomberg School of Public Health. For over 20 y, she has conducted research on public health emergency management, focusing on community resilience, behaviorally realistic emergency plans, public engagement in disaster planning, post-epidemic recovery, and crisis and emergency risk communication. She has also worked diligently to translate scholarly research into actionable recommendations for policymakers and practitioners, including most recently as co-Principal Investigator for *CommuniVax* - a national ethnographic research coalition whose expert advisory group and six local teams are partnering with communities of color to tackle COVID-19 vaccine access and acceptance issues and to put equity at the center of the pandemic recovery process. National advisory roles include the Homeland Security Subcommittee of the Board of Scientific Counselors for the U.S. Environmental Protection Agency and the Resilient America Roundtable of the National Academies of Sciences, Engineering and Medicine, which she formerly co-chaired. From 2003 to 2017, Dr. Schoch-Spana worked at the University of Pittsburgh Medical Center, Center for Health Security; prior to that, at the Johns Hopkins University Center for Civilian Biodefense Strategies, starting in 1998. She received her PhD in cultural anthropology from Johns Hopkins University.

George Sgouros (Speaker): Professor and Director of the Radiological Physics Division in the Department of Radiology at Johns Hopkins University, School of Medicine. The focus of his research is on modeling and dosimetry of internally administered radionuclides with a particular emphasis on patient-specific dosimetry, alpha-particle dosimetry, and mathematical modeling of radionuclide therapy. Dr. Sgouros is author on more than 200 peer-reviewed articles, as well as several book chapters and review articles. He is the recipient of the Society of Nuclear Medicine and Molecular Imaging (SNMMI) Saul Hertz Award for outstanding achievements and contributions in radionuclide therapy. He is a member of the Medical Internal Radionuclide Dose Committee of the SNMMI, which he chaired from 2008 to 2019. He is also a member of the International Commission on Radiation Units and Measurements Report Committee on "Bioeffect Modeling and Equieffective Dose Concepts in Radiation Therapy" and chair of Report Committee 31 on "Treatment Planning for Radiopharmaceutical Therapy." Dr. Sgouros served on the Scientific Committee of the International Atomic Energy Agency/World Health Organization Network of Secondary Standards Dosimetry

Laboratories (2014 to 2018); and is a Consociate member of NCRP. Dr. Sgouros is a former chair (2015 to 2017) of the National Institutes of Health (NIH) study section on Radiation Therapeutics and Biology. He was also

a member of the Ad hoc Working Group on Radiation Oncology, NIH, National Cancer Institute, Clinical Trials and Translational Research Advisory Committee (2019 to 2021). Dr. Sgouros is also founder and principal of Rapid, a start-up that provides dosimetry and imaging services and products in support of radiopharmaceutical therapy.

Angela Shogren (Speaker): Deputy Director of the Office of Web Communication at the U.S. Environmental Protection Agency (EPA). Prior to her time in the Office of Web Communication, Ms. Shogren spent the beginning of her career in the Radiation Protection Division of the EPA supporting communication, outreach and education around radiation protection topics. Ms. Shogren received a master's degree in Strategic Public Relations from George Washington University and has been working in risk communication since 2009. Ms. Shogren has been instrumental in the creation of EPA radiation education curriculum tools for science educators (www.epa.gov/radtown), assists in radiological emergency response communication efforts, and has represented EPA as a radiation risk communication expert in a working group led by the World Health Organization.

Neha Vapiwala (Speaker): Professor and Vice Chair of Education in the Department of Radiation Oncology at University of Pennsylvania (Penn). Her clinical and research interests focus on the management of patients with genitourinary (GU) cancers and biological and technological improvements in radiation therapy delivery. She currently serves as the Principal Investigator of several therapeutic trials for prostate cancer patients, including a recently activated national phase III randomized clinical trial through the ECOG-ACRIN cooperative group. Dr. Vapiwala is a member of numerous national and international scientific committees dedicated to GU cancer research and education, including the American Society of Clinical Oncology and American Society of Radiation Oncology (ASTRO) Scientific Program Committees and the National Cancer Institute's Prostate Cancer Task Force. She serves on ASTRO's Board of Directors and the editorial boards of *JAMA Oncology* and *Journal of Clinical Oncology*. In addition, Dr. Vapiwala is a recognized leader in undergraduate and graduate medical education. She served as Assistant Dean of Student Affairs until 2019 when she was appointed Dean of Admissions at Penn's Perelman School of Medicine. Dr. Vapiwala has served on the Association of Directors of Radiation Oncology Programs' Executive Committee, and presently sits on the American Board of Radiology's oral certification exam committee. She is also the current Chair of the Accreditation Council for Graduate Medical Education's Radiation Oncology Residency Review Committee.

Dr. Vapiwala completed her undergraduate training in 3 y at Johns Hopkins University with a double major in Biology and Hispanic Studies before spending a year as a high school science and math teacher. She then matriculated at Penn's medical school, after which she completed her internship at Albert Einstein Medical Center before returning to Penn for her post-graduate residency training.

Biographies

Jeffrey J. Whicker (Program Committee, Session Chair): Worked at Los Alamos National Laboratory as a health physicist and scientist for over 30 y. He received an MS in Health Physics and a PhD in Environmental and Radiological Health Science from Colorado State University and is certified by the American Board of Health Physics. Dr. Whicker is an elected Board Member of NCRP, served as a Board Member of the Health Physics Society, consulted for the International Atomic Energy Agency since 2018 on environmental sampling and remediation decisions, and was on the Editorial Board for the journal Radiation Protection Dosimetry for 8 y. He has been the recipient of numerous achievement awards including the U.S. Department of Energy Secretary's Honor Award (2020). He is an author or co-author of hundreds of scientific publications, invited talks, book chapters, and presentations mostly on indoor and outdoor radiological air quality and measurements that span issues ranging from worker protection, homeland security, radiological dose and risk assessment for the public and the environment, and environmental quality. His research in outdoor air quality focused on aerosol transport through wind-driven suspension of contaminated soil and the effects of ecosystem disturbance on environmental transport rates. This research has broad implications for both public and ecosystem health.

Jessica S. Wieder (Program Committee Co-Chair, Speaker): The Director of the Center for Radiation Information and Outreach at the U.S. Environmental Protection Agency (EPA). As a communicator, she is passionate about using the right words to convey risk in a manner that is understandable and actionable. Ms. Wieder served as EPA's senior radiation public information officer during the 2011 Fukushima Daiichi nuclear accident response and was part of the contingency planning team for the 2020 and 2011 U.S. Mars Rover launches. In 2013, she was awarded EPA's Exemplary Customer Service Award for her leadership in enabling all levels of government to provide quick, effective communications to the American people in response to large-scale radiological emergencies. Ms. Wieder is on the NCRP Board of Directors. In 2019 - in her role with NCRP - Ms. Wieder became a TED educator on how to survive nuclear fallout.

Pat B. Zanzonico (Program Committee, Session Chair): Received a BS in Physics from Cooper Union in 1977 and a PhD in Biophysics from the Cornell University Graduate School of Medical Sciences in 1982. He served on the faculty of the Department of Radiology (Nuclear Medicine) of the New York Hospital-Cornell Medical Center and is currently a Member and Attending Physicist at Memorial Sloan Kettering Cancer Center, Co-Head of the Center's Small-Animal Imaging Laboratories, and Chairman of its Committee on Radiation. He also serves on the Special Contributing Faculty of the Gerstner Sloan-Kettering Graduate School and is an Adjunct Professor of Applied Physics and Mathematics at Columbia University. Dr. Zanzonico is Associate Editor of the British Journal of Radiology and the European Journal of Nuclear Medicine and a member of the Editorial Boards of the Journal of Nuclear Medicine and Medical Physics. He is also a member of the Medical Internal Radionuclide Dosimetry Committee of the Society of Nuclear Medicine and Molecular Imaging and Vice-Chairman of the U.S. Nuclear Regulatory Commission's Advisory Committee on Medical Uses of Isotopes, and a past Consultant to the International Atomic Energy Agency. Dr. Zanzonico has over 120 peer-reviewed publications and over 75 invited presentations. He is actively involved in biomedical research on radionuclide-based methods for detecting and localizing tumor hypoxia, immune effector-cell trafficking, patient-specific dosimetry for radionuclide therapies, and small-animal and molecular imaging.

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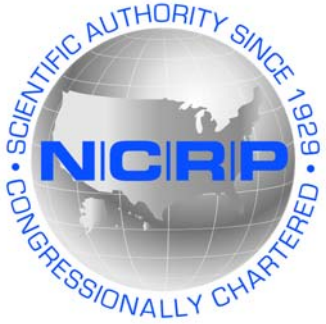

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