

PRESENTED BY  iia

 IMRP2024
Costa Rica

Irradiation Technologies

Available, Sustainable
& Growing

Nordion and Sterigenics are proud to have been Regional Sponsors of **IMRP 2024**.

Thank you to the **International Irradiation Association** for once again hosting a successful, engaging event to bring together the irradiation community and promote sustainability within our industry.

At Sotera Health, our business units, Nordion, Sterigenics and Nelson Labs are driven by our mission of **Safeguarding Global Health®**. We know that our purpose is greater than our products and services. That's why responsibility is integral to everything we do: it's the foundation of what we stand for and what we strive to achieve.

Across our global network, we approach environmental sustainability with the same passion, dedication and commitment as the mission-critical services we provide. This has made us respected leaders in our industry, a position we work to earn every day.

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A photograph of a modern, multi-story atrium with a curved glass roof and white columns. The space is bright and open, with a large green circular overlay in the center containing the word "Introduction". The atrium has a polished floor reflecting the light, and there are some tables and chairs visible in the lower left. The glass walls offer a view of lush greenery outside.

Introduction

A REVIEW OF IMRP 2024

The 21st International Meeting on Radiation Processing IMRP 2024, organized by the International Irradiation Association (iia), was held at the Costa Rica Convention Center, San José, Costa Rica on November 4-8, 2024. Participants originated from 24 countries with the largest attendance being from the United States, Belgium, Canada, China, France, UK, Brazil, Costa Rica, and Germany.

This document can only capture some of the meeting's content. We hope that readers will find it to be a valuable summary of the meeting and a reflection of the state of radiation processing in 2024.

The iia thanks all contributors to this document including the session Chairs and Moderators that provided a summary of their sessions and panel discussions for this publication. Some of the summaries supplied may have been modified slightly for clarity and impartiality.

Organizing Committee:

- Paul Wynne (iia), iia Chairman & Director General
- Arthur Dumba (iia), iia General Manager, Chair of Organizing Committee
- Aaron DeMent (Sterigenics), Deputy Chair

Program Committee:

- Brian McEvoy, STERIS, Ireland (Chair)
- Rob Edgecock, iia, UK (Deputy Chair)
- Samuel Dorey, Sartorius, France
- Vu Lekate, Abbott, USA
- Ariadne Rivadeneira, IBA, Bolivia
- Gustavo Varca, E-Beam Services, USA
- James Vesper, Valsource, USA
- Richard Wiens, Nordion, Canada
- Allen Yang, CIRC, China

The program planning for IMRP 2024 underwent a paradigm change. All previous editions had the program committee construct the invited speaker program first and then complement this with abstract presentations. For IMRP 2024, the program committee,

under Brian McEvoy's exemplary leadership, defined the global objectives for the program and launched the Call for Abstracts one year prior to the conference. A record number of abstracts submissions, over 170, were received. This allowed the program committee to construct a program that was of great interest to the audience.

Another new component for IMRP 2024 was the integration of 'Tech Theatres'. Three of these theatres, named 'Radiation Field', 'Dosimetry Square' and 'Equipment Alley', were located in the exhibit hall. This enabled attendees to listen to technical talks about 'The How of Radiation Processing' while networking with exhibitors and other participants.

The provision of networking opportunities, fostering a sense of community among professionals, and facilitating knowledge sharing and collaboration, were all part of the value of IMRP 2024.

Overview of the IMRP 2024 program

Monday, Nov 4			Tuesday, Nov 5	
	The Business of Radiation Processing		Application Plenaries	
Room	Sessions: Guanacaste Exhibits/Breaks: Foyer		Guanacaste 1-2	Guanacaste 3
08:00 – 09:30	Arrival & Welcome Coffee	08:00 – 09:00	Arrival & Exhibition	
09:30 – 11:00	PL1 – Opening & Welcome	09:00 – 10:00	Tech Theatres & Exhibition	
11:00 – 11:30	Coffee Break	10:00 – 17:00	Radiation Sterilization Forum	Phyto-sanitary Irradiation Forum
11:30 – 12:30	PL2 – High Level Updates on Important Industry Segments*		<i>Sponsored by GEX</i>	<i>Sponsored by Gamma-Service Recycling</i>
12:30 – 14:00	Lunch and Networking		Coffee Break 11:20 – 11:40	Coffee Break 11:00 – 11:30
14:00 – 15:00	PL3 – High Level Updates on the Various Radiation Processing Technologies*		Lunch 12:40 – 14:00	Lunch 12:30 – 14:00
15:00 – 16:00	PL4 – Sustainability and Science*		Coffee Break 15:20 – 15:45	Coffee Break 15:00 – 15:30
16:00 – 16:15	PL5 – Asia Regional Update*		Tech Theatres & Exhibition	
16:15 – 19:00	Welcome Reception & Exhibition Opening <i>Sponsored by Steris</i>	17:00 – 18:00		

Wednesday, Nov 6			Thursday, Nov 7	Friday, Nov 8
	Sustainability, Science and Innovation		Education, Leadership Development and Regulation	Technical Tours
Room	Sessions: Guanacaste Exhibits/Breaks: Central		Sessions: Guanacaste Exhibits/Breaks: Central	
08:00 – 09:00	Arrival & Exhibition	08:00 – 09:00	Arrival & Exhibition	Sterigenics and STERIS
09:00 – 10:00	Tech Theatres & Exhibition	09:00 – 10:00	Tech Theatres & Exhibition	
10:00 – 11:00	PL6 – Sustainability Keynote & Round Table <i>Sponsored by Wuxi El Pont</i>	10:00 – 11:00	PL8 – Education and Leadership Development	
11:00 – 11:30	Coffee Break	11:00 – 11:30	Coffee Break	
11:30 – 12:45	PL7 – Sustainability Presentations	11:30 – 12:30	PL9 – Regulatory (HC/Pharm/Phyto)	
12:45 – 14:00	Lunch & Networking <i>Sponsored by GEX</i>	12:30 – 14:00	Lunch and Networking	
14:00 – 15:00	Tech Theatres & Exhibition	14:00 – 15:15	PL10 – Round Table, Awards and Closing	
15:00 – 15:45	Posters Group A (odd #)	15:30 – 16:30	iia General Assembly	
15:45 – 16:30	Posters Group B (even #)			
16:30 – 17:30	Best Poster Spotlight & Audience Voting of Best Abstracts <i>Poster session sponsored by GIPA</i>	19:00 – 23:00	Gala Dinner – <i>Marriott Hacienda Sponsored by IBA</i>	

THEME

The theme for IMRP 2024 was:

‘Irradiation Technologies – Available, Sustainable and Growing’.

Available	All irradiation technologies (gamma, electron beam and X-ray) remain available and are evolving to meet changing needs and demand for radiation processing. IMRP 2024 highlighted the ongoing availability of irradiation to meet the growing needs of healthcare, food safety, high-tech materials, and environmental protection.
Sustainable	Sustainability remains a critical focus as we continue to advance radiation processing practices. IMRP 2024 highlighted the importance and adoption of sustainable operating practices by the irradiation industry and its role in supporting the United Nations Sustainable Development Goals.
Growing	The demand for irradiation technologies continues to grow, driving investment and innovation. IMRP 2024 provided insights into future opportunities for growth and innovation in radiation processing, addressing both scientific advancements and business aspects within the industry.

SUSTAINABILITY

Many IMRP 2024 participants recognize the significant role that radiation processing plays in promoting safety, health, economic growth, and environmental protection across the globe. As we look to the future, we must become more aware of the environmental impact of our operations.

The iia was proud to announce its goal of achieving the Blue Flag Sustainability Certification for IMRP 2024, awarded by the Costa Rican organization ‘Bandera Azul Ecológica Eventos Especiales’ (Blue Flag Program - Special Events). This certification represents iia’s commitment to reducing the environmental impact of the conference while promoting sustainability in all aspects of event planning and execution. This is the first time in the history of the conference that the event was certified sustainable, in line with the theme.

ABOUT COSTA RICA

Costa Rica was chosen as the host country of IMRP 2024 due to its well-established and growing medical device manufacturing and export sectors, which, notably, include radiation processing. Additionally, Costa Rica's exceptional sustainability credentials played a key role in the selection process.

ABOUT THE IIA AND IMRP

The International Meeting on Radiation Processing, IMRP, is recognised as the leading international event for those involved in the applications, science and technology of radiation processing. It is where the business and science of irradiation come together to discuss recent advances, current trends and the issues and opportunities that impact the commercial use of ionizing radiation.

IMRP is organized every 2-3 years on a different continent, with the first meeting held in Puerto Rico in 1976. IMRP 2024 marked the 21st edition of the International Meeting on Radiation Processing,

The host of IMRP is the International Irradiation Association (iia). The role of iia is to 'Communicate, Educate, and Advocate' and IMRP provides an excellent platform for these activities through networking, sharing, and learning. The event brings together the key figures and companies in radiation processing, creating the best opportunities for networking and advancing the business, science, technology, and applications of irradiation.





The Program

MONDAY 4TH NOVEMBER 2024

The Business of Radiation Processing

PL1 - Plenary Session

Opening & Welcome

The opening of IMRP 2024 was preceded by a short film that highlighted the journey of IMRP from Puerto Rico in 1976 to Costa Rica in 2024. The film highlighted the theme of the meeting and how the application of irradiation provides solutions to a wide range of industries. The role and network of the iia was illustrated and thanks was given to the Regional Sponsors.

Opening Remarks – Chair of the Organizing Committee of IMRP 2024

Presenter: Arthur Dumba, International Irradiation Association, Selzach, Switzerland

Arthur Dumba, General Manager of the International Irradiation Association (iia), welcomed participants to IMRP 2024 and expressed his enthusiasm at reconnecting with professionals from across the radiation processing community. IMRP, hosted by the iia since 1976, is a key event fostering communication, education, and advocacy within the industry. The theme this year, 'Irradiation Technologies - Available, Sustainable and Growing', underscores the increasing demand for irradiation technologies, the importance of innovation, and the need to prioritize environmental responsibility in all facets of the sector.

Sustainability is a core focus of IMRP 2024, reflecting the industry's growing awareness of its environmental impact beyond just the technologies used. The event itself earned Costa Rica's Blue Flag Certification for supporting local sustainability initiatives. The program includes nearly 200 abstracts and features plenary sessions, technical theatres, posters, and exhibitions all centered around the main hall to promote engagement. Thanks were extended to major sponsors, including Nordion, Sterigenics, IBA, and STERIS, and to the IAEA for supporting student attendance. Attendees are encouraged to use the IMRP 2024 WebApp for schedules and information, and to participate in the Welcome Reception that marks the official opening of the exhibition.

Opening Remarks – iia Chairman

Presenter: Paul Wynne, International Irradiation Association, Ludlow, United Kingdom

Paul Wynne, Chairman of iia, commented on the 21st edition of the International Meeting on Radiation Processing (IMRP) which marked 48 years since the first event was held in Puerto Rico in 1976. Our industry has evolved considerably since its inception. 1950 to 1980

can be described as the 'Age of the Pioneers', from 1980 until 2010 as the 'Age of the Corporations'. The current period can best be described as the 'Age of the Environment', hence environmental issues are reflected in IMRP 2024 with a focus on sustainability. Today, all irradiation technologies (gamma, electron beam and X-ray) remain available, viable, and investable, with the irradiation industry contributing significantly to global socio-economic development.

When considering environmental issues, we should be aware that there is a growing body of rules, guidance and legislation that places specific reporting requirements on companies, both large and small. The idea of Corporate Social Responsibility reporting has been in place for many years, but Environmental and Climate related reporting requirements are relatively new. Just as with ISO 11137 environmental reporting requirements are complex and increasingly the subject of detailed guidance and debate.

In the U.S. we have the Green House Gas Protocol (GHG) and the Task Force on Climate Related Financial Disclosures (TCFD). These ideas are increasingly reflected in rules being formulated by the Securities and Exchange Commission (SEC). California has gone further with the latest CARB requirements (California Air Resources Board) being signed off as recently as 27 Sept 2024. In response to these Rules, Price Waterhouse Coopers (intl accountancy firm) commented that the "California climate disclosure laws will have a global impact" it has been suggested that these rules could affect 10,000 companies. In Europe, there has been further work on European Sustainability Reporting Standards (ESRS) and in late Sept the final version of the Australian Sustainability Reporting Standards (ASRS) were approved. Similar developments are taking place throughout the world.

The IMRP has evolved significantly over the years, with the International Irradiation Association (iia) now organizing the event. Today the iia serves as a hub for the irradiation community, collaborating with regional associations and leading initiatives, such as the Society for Sterility Assurance Professionals (SfSAP) and the Phytosanitary Irradiation Platform (PsIP). IMRP continues to highlight the importance of leadership, networking and collaboration, recognizing the contributions of both experienced professionals and emerging leaders. IMRP 2024 offers a valuable opportunity to share knowledge, foster innovation, and strengthen our community.

IMRP Regional Sponsor Welcome – Nordion

Presenter: Riaz Bandali, Nordion, Ottawa, Canada / Mike Rutz, Sterigenics, Oak Brook, US

This presentation serves as an opening and welcome to the IMRP 2024 event in Costa Rica, highlighting Nordion's presence as a regional sponsor and featuring several of its leaders and their presentations. It acknowledges the changing global landscape, marked by geopolitical conflict, the lasting effects of the pandemic, and the rise of artificial intelligence, leading to increased complexity and uncertainty.

The presentation also positions nuclear energy as a sustainable solution to current challenges, emphasizing its emissions-free nature, potential for refurbishment and new construction, long-term investment value, and production of medical isotopes. Nordion emphasizes that "The Future is Now" and focuses on the importance of sustainable energy sources, growth through investment and innovation, and the current availability of solutions, while noting that the time for cobalt-60 allocation is ending.

Opening Remarks – Chair of the Program Committee of IMRP 2024

Presenter: Brian McEvoy, STERIS, Tullamore, Ireland

Brian McEvoy, Chair of the IMRP 2024 Program Committee, welcomed all the participants to the meeting and to Costa Rica. The theme of IMRP 2024 is 'Irradiation Technologies - Available, Sustainable and Growing' and Brian highlighted how appropriate and relevant Costa Rica is to this theme due to the country's impressive sustainability credentials and its adoption of radiation processing. Radiation processing plays a vital role in contributing towards the UN Sustainable Development Goals through the provision of healthcare and food products. IMRP 2024 will highlight some of these contributions and the work of our industry in the adoption of sustainable business practices.

Brian talked about the challenges in developing a program that meets the needs of multiple technologies and the many important applications used by so many industries. The IMRP 2024 conference program was entirely shaped by the abstracts received to ensure that the needs of industry were best met. A record number of over 170 abstracts were received, highlighting the importance of IMRP and the enthusiasm of industry and the scientific community to contribute.

The presentation element of the program is based on plenary presentations, tech theatres and posters.

The plenary presentation sessions talk about the 'business' of radiation processing, where technology and application overviews and updates are provided, and insights into what is happening around the world are shared.

The three dedicated 'tech theatres' are a new addition for IMRP 2024, located in the exhibit hall and called 'Radiation Field', 'Dosimetry Square', and 'Conveyor Alley'. Here, presentations would be provided about the 'how' and 'what' of radiation processing and it is where exhibitors and presenters will have the opportunity to showcase their diverse innovations and product offerings. The tech theatres contribute to making the exhibition hall an exciting and dynamic space for networking, making new connections, catching up with industry colleagues and learning from the presenters and exhibitors.

The poster session is the forum for presenting the science and research in radiation processing. With in excess of thirty posters, we at IMRP 2024 are proud to showcase such

an array of diverse research and thoughts regarding the future paths of development. A new and exciting poster final involving a selected group of posters (selected by judging committee) would be presented on tech theatre stages for audience live voting.

Another program innovation for IMRP 2024 is the introduction of Early Career Professional Awards. These awards recognised the achievements of emerging young talent and future leaders in the irradiation industry.

Brian thanked the members of the IMRP 2024 Program and Organising Committees, the International Irradiation Association, those who contributed to the content of the program and all those individuals and organisations that have worked to bring our industry together in Costa Rica. Brian finished by stating he looked forward to an exciting and innovative meeting and having the opportunity to reconnect with so many members of our community.

PL2 - Plenary Session

High Level Updates On Important Industry Segments

Session Introduction

Richard Wiens, Nordion, Kanata, Canada

Session Introduction

Samuel Dorey, Sartorius, Aubagne, France

Medical Devices

Presenter: Emily Craven, Boston Scientific, Ottawa, Canada

This presentation by Emily Craven discusses the changes and trends in the medical device sterilization industry over the past 5 years and provides insights into the future. It highlights how factors like COVID-19 have strengthened regulations, spurred interest in novel gas technologies, and driven the construction of more machine-source radiation facilities. The presentation also shares results from an informal survey of sterilization service providers, medical device manufacturers, and consultants, revealing trends such as increased investment in electron beam and x-ray capacity, a focus on new product development in machine source technologies, and efforts to strengthen supply chain resiliency.

Looking ahead, the presentation suggests several key areas of evolution for the medical device industry in the next 5 years. These include a push to "sterilize less" by re-evaluating sterility assurance level (SAL) requirements, designing for sterilization to enhance supply chain agility, leveraging artificial intelligence for process monitoring and prediction, and

increasing sustainability through greater adoption of machine-source technologies. The overarching theme emphasizes adaptation and innovation in response to evolving challenges and the growing importance of sustainability within the medical device sterilization sector.

Bioprocessing

Presenter: Samuel Dorey, Sartorius, Aubagne, France

The presentation provides an in-depth look at the bioprocessing market, particularly focusing on biopharmaceuticals. Dr. Samuel Dorey, Principal Scientist in Materials & Irradiations, outlines the vision and mission of supporting biopharmaceutical manufacturing to improve health for more people. Biopharmaceuticals, derived from living cells, offer advantages over chemical drugs, such as targeting only diseased cells and having fewer side effects. The global pharma market is projected to reach approximately €2 trillion by 2028, with biologics increasing their market share from 30% to 40%. The manufacturing of biopharmaceuticals is complex, requiring end-to-end sterile solutions, including virus clearance, filtration, chromatography, and cryo-preservation.

The presentation also highlights the growing adoption of Single-Use Systems (SUS) in bioprocessing due to their flexibility and better ecological footprint compared to traditional stainless-steel systems. These systems consume less water and energy, contributing to sustainability goals. The biopharmaceutical industry is aiming for ambitious targets, including achieving net-zero emissions by 2045 and enhancing resource circularity. The focus on innovative life science tools and sustainable practices is crucial for advancing healthcare and making therapies more accessible and affordable.

Phytosanitary

Presenter: Murray Lynch, Steritech Pty Ltd, Dandenong South, Australia

The presentation provides a detailed overview of phytosanitary irradiation, highlighting its significance in global trade and the Australian experience. Murray Lynch, the retired CEO of Steritech, outlines the journey of implementing phytosanitary irradiation in Australia, emphasizing the persistent efforts over 20 years despite initial skepticism. Key milestones include the first international shipment in 2005, achieving full food standards in 2021, and the establishment of digital labeling in 2023. Today, Australia operates two facilities year-round, treating over 80 crops and serving all major retail networks and six export markets.

The presentation also addresses the challenges faced in horticultural trade, such as perishability, evolving biosecurity needs, climate change, and the loss of production chemistry. It underscores the importance of building the right facilities in optimal locations to ensure speed to market and quality maintenance. Looking ahead, the focus is on

sustainability, technology selection, and maintaining a cold chain for fresh produce. The upcoming IMRP24 Phytosanitary Session will cover global insights, regulations, producers' perspectives, and technology advancements, encouraging community engagement and collaboration.

PL3 - Plenary Session

High Level Updates On The Various Radiation Processing Technologies

Gamma

Presenter: Richard Wiens, Nordion, Kanata, Canada

The presentation provides a high-level update on the gamma radiation processing industry. It highlights the continued relevance and growth of gamma technology, noting that 30% of single-use medical devices globally, and 40% in the U.S., are sterilized using gamma radiation. The industry has approximately 300 gamma facilities worldwide and has experienced growth rates of 2-3% prior to 2018, 5-6% from 2018 to 2022, and an expected attenuated growth in 2023/2024 due to inventory adjustments.

The presentation emphasizes the importance of the energy source for gamma radiation, highlighting nuclear power's role in providing emissions-free, baseload energy that supports climate goals. It also discusses the global supply chain for Cobalt-60, the isotope used in gamma irradiation, and the challenges and initiatives in transportation and logistics, including increased governmental awareness and carrier sustainability efforts. The overall message is that gamma radiation remains an effective, well-understood, and sustainable technology for sterilization and other applications.

X-ray/E-beam

Presenters: Jeremy Brison, IBA sa, Louvain-la-Neuve, Belgium

Thomas Servais, IBA sa, Louvain-la-Neuve, Belgium

The presentation by Thomas Servais and Jeremy Brison from IBA Industrial focuses on the advancements and market trends in high-power E-Beam and X-Ray technologies. They highlight the rapid growth of X-Ray solutions since 2019, driven by their scalability, with a target of 150MCi equivalent by 2030. The presentation also emphasizes the increasing use of high-energy E-Beam for radioisotope manufacturing and the significant rise in X-Ray installations globally. Key innovations include the development of Solid State Power technology, which offers high efficiency, modularity, and futureproofing, and the integration of digital solutions for enhanced equipment effectiveness and remote monitoring.

Additionally, the presentation discusses the expansion of irradiation applications for phytosanitary purposes, aiming to reduce chemical use and improve product freshness. Environmental applications of E-Beam technology are also explored, particularly in the remediation of complex molecules in water and soil. The presenters stress the importance of sustainability, with efforts to reduce the carbon footprint through eco-design, renewable energy, and process efficiency. The overall message is one of continuous innovation and growth in the E-Beam and X-Ray sectors, with a strong focus on sustainability and digital integration.

PL4 - Plenary Session

Sustainability and Science

Sustainability Approach

Presenter: Christoph Herkens, IONISOS, Limonest, France

The presentation focuses on the company's comprehensive approach to sustainability in its sterilization and crosslinking services. Ionisos operates across five countries with 12 sites and 300 employees, serving key client segments such as medical devices, pharma and biotech, and packaging. The presentation defines sustainability as managing resources to meet present needs without compromising future generations, emphasizing the importance of balancing environmental health, economic viability, and social equity. It highlights the growing necessity for businesses to adopt sustainable practices due to societal, political, and environmental pressures, referencing frameworks like the United Nations Sustainable Development Goals and various sustainability reporting standards.

Ionisos' sustainability strategy encompasses four main areas: people, partnership, planet, and governance. The company aims to create a safe and satisfying workplace, ensure reliable partnerships, reduce its carbon footprint, and maintain strong governance practices. The presentation details the steps taken to measure and reduce greenhouse gas emissions, including transitioning to green electricity and improving energy efficiency. It also discusses the challenges and ambitions in further reducing emissions across different technologies, such as gamma, electron beam, and ethylene oxide sterilization. The journey towards sustainability is described as complex and requiring continuous improvement, leadership, and cross-functional collaboration.

Applications of E-beam

Presenter: Suresh Pillai, Texas A&M University, College Station, United States

The presentation focuses on the current state and future potential of electron beam (eBeam) and X-ray technologies for various applications. It begins with a historical overview,

noting the discovery of X-rays and radioactivity, and highlights the commercial availability of these technologies in different energy ranges (low, medium, and high). The presentation emphasizes the versatility and penetration capabilities of these technologies, which are measured in Grays (Gy) or Kilograys (kGy).

Prof. Pillai discusses the rapid advancements in eBeam and X-ray technologies and their applications in areas such as PFAS destruction, crop mutation, and pathogen control. He stresses the need for more decision-makers in industry and government to understand these technologies, advocating for their inclusion in educational curricula. The presentation also calls for democratizing the technology by making it more affordable and versatile, addressing societal needs like plastic waste management and water reclamation. Prof. Pillai concludes with a positive outlook on the future of these technologies and offers tips for addressing skepticism, emphasizing the organic nature of electrons and their safety.

Polymer Modification

Presenter: Xavier Coqueret Université de Reims Champagne-Ardenne, Reims, France

The presentation discusses advancements in radiation processing of polymer materials, emphasizing the balance between performance enhancement and sustainability. It outlines established applications such as cross-linked plastics for cables and heat-shrinkable packaging, alongside emerging areas like renewable carbon composites and additive manufacturing. The focus is on continuous improvement in processing techniques, environmental impact, and product performance, particularly in the context of low-energy electron beam (EB) technology.

Additionally, the presentation highlights key topics for the upcoming IMRP 2024, including post-irradiation aging, sterilization effects on polymers, and the potential of machine learning in producing radiation-grafted materials. It also addresses the importance of recycling, environmental remediation, and the development of new materials such as nanomaterials and hydrogels for medical applications. Overall, the document underscores the need for innovation in radiation processing to meet sustainability goals while advancing polymer technology.

Environmental Applications

Presenter: Bumsoo Han, International Atomic Energy Agency (IAEA), Wien, Austria

The presentation highlights the IAEA's active role in leveraging radiation technology to address various environmental challenges, including pollution control, waste management, and resource recycling. It emphasizes ongoing and completed Coordinated Research Projects (CRPs) focused on wastewater treatment, flue gas purification, sludge hygienization, and plastic recycling. The IAEA promotes the use of electron beam (EB) technology, including transportable and mobile EB machines, to facilitate on-site demonstration and

implementation of radiation-based solutions for environmental applications. These initiatives aim to provide cost-effective, safe, and efficient methods to mitigate pollution and improve environmental quality across member states.

Additionally, the presentation underscores the importance of international collaboration and knowledge sharing through conferences, workshops, and research activities. It notes the development of guidelines for environmental applications of ionizing radiation, with publications forthcoming in 2025. The IAEA also plans to strengthen its support by supplying specialized radiation equipment, such as self-shielded EB machines and higher-energy accelerators, to meet diverse needs. Overall, the presentation underscores the integrated efforts of the IAEA to promote sustainable environmental management using innovative radiation technologies, fostering global cooperation in the transition towards more environmentally friendly industrial practices.

PL5 - Plenary Session

Asia Regional Update

Asia Regional Update

Presenter: *Yan Ren, China Isotope Radiation Corporation, Irradiation Business Division, Beijing, P.R. China*

The presentation provides a comprehensive overview of the development and current state of the nuclear technology industry in China, emphasizing its rapid growth driven by technological innovation, favorable policies, and market demands. It highlights China's existing infrastructure, including research reactors and facilities dedicated to producing medical isotopes, with an expected annual growth in demand for medical isotopes ranging from 5% to 30%. The sector encompasses applications in medical diagnostics, radiopharmaceuticals, nuclear medical equipment, and safety/security industries, contributing significantly to China's economy with a total output value of around 70 billion USD and an annual growth rate of 15-20%. The industry is positioned within the global context, where over 150 countries develop nuclear technologies, making it a vital component of national economies and international markets.

The presentation also discusses future challenges and opportunities in the radiation processing sector. It underscores the importance of environmental protection policies, the development of green and simplified irradiation equipment, and the encouragement of nuclear technology applications through government planning. Technological innovations are driving product upgrades, specialization, and intelligentization of irradiation devices. With increasing applications in sterilization, material modification, breeding, and security, coupled with rising demand and supply constraints for industrial sources, the market for

irradiation devices is expected to grow robustly. Overall, China's nuclear industry is poised for substantial expansion, contributing to both domestic needs and global technological progress in nuclear applications.

TUESDAY 5TH NOVEMBER 2024

Concurrent Forum – Radiation Sterilization

Radiation Sterilization: Part 1

Moderator: *Vu Lekate of Abbott, Temecula, United States*

The opening of IMRP 2024 was preceded by a short film that highlighted the journey of IMRP from Puerto Rico in 1976 to Costa Rica in 2024. The film highlighted the theme of the meeting and how the application of irradiation provides solutions to a wide range of industries. The role and network of the iia was illustrated and thanks was given to the Regional Sponsors.

The Standard Distribution of Resistances (SDR) - History & Future

Presenters: *Chris M Hardman, United States, Department Scientist, Bioburden/Radiation, Nelson Labs*

Martell Winters, United States, Director of Science, Nelson Lab

Population C, also called the Standard Distribution of Resistances, has been the microbiological benchmark for radiation sterilization since the early 1980s. The development of the SDR should be understood by industry and it provides insights into how the SDR, and associated dosing tables, can be used when investigating sterilization dose establishment or dose audit failures and aberrant bioburden data. Also, analysis of the SDR reveals a potential Achilles heel which is currently being discussed in the industry and is prompting additional guidance that is being included in the new revision of ISO 11137-1.

New Guidance On Bioburden Characterization For Radiation-Sterilized Products In 11137-1

Presenters: *Chris M Hardman, United States, Department Scientist, Bioburden/Radiation, Nelson Labs*

Martell Winters, United States, Director of Science, Nelson Lab

The presentation discusses the Standard Distribution of Resistances (SDR) and enhanced guidance for dose establishment in radiation sterilization. It explores the influence of SDR components on sterility test outcomes and the potential impact of increased bioburden on

test failures. The presentation also questions the validity of Population C within the SDR and whether resistant microorganisms pose an infection risk.

Furthermore, the presentation highlights concerns arising from computer simulations that deviate from the SDR, leading to pass/fail scenarios. Despite these concerns, it emphasizes that there is no evidence suggesting that terminally radiation-sterilized products are unsafe for use. The discussion concludes by advocating for improved bioburden characterization, additional verification dose experiments, and a shift towards bioburden stability best practices in the context of ISO 11137-1 reviews.

Filling Data, Education And Tool Gaps That Impede The Expansion Of X-Ray And Electron Beam For Sterilization – Progress Of Team Nablo, An International Collaboration.

Presenter: Leo S Fifield, United States, Chief Scientist, Advanced Materials and Manufacturing, Pacific Northwest National Laboratory

Market forces are increasingly pushing manufacturers of polymer-based medical devices and biopharmaceutical production components to consider alternatives to cobalt-60 gamma-rays and ethylene oxide for sterilization. This diversification naturally includes the technically mature but underutilized options of X-ray and electron beam (E-beam). Published studies indicate there are data and education gaps that impede such diversification. To fill the data, education, and tool gaps that challenge transition to these machine alternatives, an international group of collaborators, Team Nablo, was formed in 2018 by the Office of Radiological Security within the United States National Nuclear Security Administration. It currently has over a dozen active member organizations from the radiation processing industry.

The presentation summarized Team Nablo progress involving ongoing and anticipated projects, including 1) Measurement and comparison of the differences in radiation effects between gamma-ray, X-ray, and E-beam irradiated products; 2) Measurements showing the relative effects of low-energy E-beam energies ($\sim 1\text{-}5\text{ MeV}$) to those of 10 MeV E-beam; and 3) Identifying and filling needs in E-beam and low-energy dosimetry technologies and in-line process control tools.

The team has generated gamma-ray, X-ray, and E-beam effects comparison data for over a dozen medical devices and constituent polymer samples involving more than 30 polymer types. These results are publicly available via journal publications and the new Tony Faucette Polymer Effects Library. The outcomes show that an international collaborative team such as Team Nablo, with funding support, can provide significant and tangible contributions to the radiation processing industry.

Low(er) Energy Radiation Solutions – Accelerating Acceptance

Presenters: *Michael Fletcher, United States, President, Ebeam Consulting LLC*

*John R Logar, United States, Sr. Director, Sterility Assurance, MQSA,
Johnson & Johnson*

The healthcare industry continues to transform at a rapid pace, and the need for streamlined in-house solutions are being evaluated as viable alternatives to traditional contract sterilization solutions. Two such alternatives are low energy e-beam (0.3-5 MeV) and low energy X-ray (~300 keV). Typically, implementation and acceptance of alternative sterilization solutions can take a long time and be put under additional scrutiny, creating long implementation-timelines, necessitating large amounts of testing and data collection, and resulting in uncertainty in the requirements for regulatory approval. This presentation will present the current opportunities, innovations, and irradiation solutions available for these equipment categories. In addition, this presentation will report the highlights and outcomes from an Industry Scientific Exchange being conducted in March 2024, that is focused on scale-up and acceptance of several alternative sterilization modalities. An output of this Exchange will be the creation of strategic roadmaps detailing the submission requirements for products to be sterilized by low(er) energy radiation solutions.

Radiation Sterilization: Part 2

Combined effects (dose, dose rate, irradiation atmosphere and irradiation temperature) on polymer modification during radiation sterilization treatment – An EPR study.

Presenter: *Nicolas Ludwig, France, Project Manager, Irradiation/Dosimetry, Aerial*

Team Nablo, an international collaborative team, was formed in 2018 to reduce barriers to the expansion of X-rays and e-beams for radiation processing applications including product sterilization. Several studies have been initiated on the comparison of irradiation technologies (gamma, X-ray, and e-beam) on over 30 polymers.

The impact of radiation on polymers can generally refer to dose rate effects, but dose rate cannot be considered individually. Temperature increase, especially at high dose and high dose rate, proves that dose, dose rate and temperature are intrinsically linked. Moreover, dose rate effects can be due to oxygen exhaustion mechanisms which cannot occur in an inert atmosphere. Thus, the goal of this study is to evaluate the combined effects on several polymers. Knowing that free radicals are the seeds of every modification occurring during irradiation of polymers, EPR spectroscopy was performed for the post-irradiation analyses to monitor radical nature and concentration. A focus will be given on the understanding of the combination of these effects on radical evolution.

Irradiations have been conducted on the Aerial feerix® plant at 7 MV X-rays and 10 MeV e-beam at 42 irradiation conditions. Single layer LDPE, PP, POE, CIIR, and PVC samples, as well as multi-layer films (S71 and S80), were provided by manufacturers. A design of experiment was constructed with dose (15 to 85 kGy), dose rates (0.003 kGy/s to 12 kGy/s), irradiation temperatures (-5°C to 60°C) and irradiation atmosphere (0 to 100% of oxygen). This approach was chosen to permit multi-factorial analysis.

Combinations of factors have been analyzed and are discussed. Dose rate alone generally exhibits only a limited effect on radical generation.

Radical detection and electron-spin resonance (ESR) monitoring in polymer materials irradiated with gamma, X-rays and e-beam.

Presenter: Blanche Krieguer, France, PhD Student, Protisvalor Méditerranée

Among the various techniques for sterilizing medical devices and biopharmaceuticals, gamma irradiation remains the most widely used. Alternative radiation sterilization methods are being implemented: high energy electron beam and X-rays.

Understanding that free radicals initiate all changes in polymers during irradiation, ESR was utilized after irradiation to track the characteristics and levels of these radicals. Some of these radicals exhibit a longer lifetime, which can be detected using ESR from days to weeks after irradiation. Monitoring the quantity and identifying the types of radio induced radicals helps to assess the impact of radiation sources on materials and evaluate suitability and processing capability of irradiation technologies.

This study involves a comparative analysis of polymers (i.e. PP, PE, PA, POM, and fluoropolymer) materials that have been exposed to gamma rays, X-rays, and electron beams at different absorbed doses.

The different groups of polymers studied generated characteristic radicals regardless of the irradiation technology used. Among the 31 materials studied, a similar ESR signal and no significant difference in radical concentration were observed between gamma, X-rays, and electron beam irradiation for each group of polymers. The equivalence of the ESR signals, kinetics, and radical concentration for the different classes of polymers studied indicate that a similar radiation-matter interaction can be demonstrated.

Considerations For Transferring Product From Gas To Radiation

Presenter: Thor S Rollins, United States, VP of Medical Devices, Nelson Labs

The presentation evaluated the biocompatibility assessments required, as it pertains to the transition from gas to radiation sterilization methods for medical products. As industries increasingly explore alternative sterilization techniques, understanding the nuanced

implications on biocompatibility becomes imperative. The presentation will address key considerations, challenges, and strategies involved in ensuring the safety and efficacy of medical devices during this transformative shift. What materials are most impacted and why and can biocompatibility get better or worse with the change. Join us as we navigate the intricate landscape of biocompatibility to facilitate a seamless and successful transition in sterilization processes.

Radiation Sterilization: Part 3

Implementing X-Ray As An Alternative And Additional Sterilization Method For Polymeric Materials Used In Pharmaceutical And Biopharmaceutical Manufacturing

Presenter: Weibing Ding, United States, Director, GSK

One of the lessons learned from the COVID-19 pandemic was to ensure business continuity by securing supply chain proactively. To mitigate the potential supply constraint of gamma source, X-ray is being established as an alternative and additional sterilization method for polymeric single use systems (SUS) and components in pharmaceutical and biopharmaceutical manufacturing processes.

ASTM E30512 indicates that end users are responsible for qualifying incoming SUS and components.

This talk will present the approaches for implementation of X-ray sterilized SUS. Since the medicines industry is highly regulated to ensure product quality and patient safety, prudent and specific considerations need to be taken for new drug introduction and existing commercial products when applying a new sterilization technology.

The risk-based approaches, combined with scientific study results on effects of X-ray on polymeric materials and regulatory compliance considerations, enabled the implementation of X-ray sterilization as a meaningful way to mitigate the potential supply constraint from gamma source.

Streamlining The Design Of Irradiation Solutions With Pre-Engineering

Presenter: Sébastien Masson, Belgium, Solution Offering Engineer, IBA sa

The escalating global demand for sterilization/ionization capabilities, catalyzed by the pressure on Gamma and EtO and the industry electrification, has led to a surge in demand for irradiation centers utilizing electron accelerators. The market, once used 2 to 5 integrated systems annually, now seeks over 20 yearly.

As the technology matures, buyer profiles and requirements are evolving. While past emphasis was on beam power, current demands focus on process integration, flexibility, automation, and logistic flows. Despite the appealing business model, the perceived complexity of these solutions and technology transition can deter potential adopters. Addressing these concerns during due diligence is crucial.

The primary objective of this support is to concentrate on the industrial vision and the final value for the customer. The paper outlines how analytical estimations, Monte Carlo modeling, and product testing rapidly converge to an ideal modality, with DURs and annual throughput provided. Multiple options for modality transfer and product testing in real conditions are offered. This allows a preliminary choice and the establishment of a ROI model.

The integration steps with the conveyor, dosimetry, safety, and Process Control System are detailed iteratively with building and shielding optimization. Discussions on automation, storage, ERP interface, and efficiency are held in parallel. Once validated, a set of summary documents are provided. Finally additional services to expedite the go-to-market strategy are presented.

Recent examples in E-beam and X-Ray solutions demonstrate that pre-engineering significantly mitigates project risks, enhances prospects' understanding, and reduces time to market.

Mevox's Compact Self-Shielded E-Beam System: Answering The Industry's Demand For In-House Sterilization

Presenter: Shane Stutchbury, Canada, Product Manager, STERIS

For medical device manufacturers, it can be extremely challenging to integrate the sterilization step required for their products into existing factories and manufacturing processes. As a result, the vast majority of products requiring irradiation are contracted to off-site services, and for good reason. Product volume, geometry, density, composition, not to mention radiation licensing and the sheer scale of constructing and operating an irradiation facility, can all be disqualifying factors.

This presentation will put forward a Canadian case study in which several self-shielded irradiators were designed and constructed for a specific product. Highlighted will be the reasons this product and customer was suitable for this system, and examples of incompatible product will be shown for comparison.

For certain manufacturers with suitable products and volumes, bringing an irradiator in-house can be a game changer. Mevox's self-shielded e-beam system has a compact footprint that allows it to be retrofitted into the corner of an existing factory floor. An in-situ sterilization step shrinks the supply chain, allows for e-beam energy optimization, and

provides total control of the manufacturing process. In addition to the real-world example, this presentation will define the range of products and volumes that are optimal candidates for the Mevex compact system.

Gamma/E-Beam/X-Ray Economic Analysis In China Scenario

Presenter: Wei Peng, P.R. China, Chairman, Beijing LituoXinda Technology Co., Ltd (LTXD)

Irradiation sterilization as a green and safe sterilization method is widely used in the treatment of food, medical products, herbals and agricultural products worldwide. The main technologies for irradiation sterilization are gamma, electron beam and X-ray.

Based on the characteristics of the irradiation technology mentioned above and the current actual investment and operation situation in China, this paper focuses on economic analysis on investment of irradiation plant with different technologies under the same market conditions (medical product with density of 0.2g/cm³ and 25kGy).

The linear accelerator (10MeV/20kW) has the best economic efficiency when the annual processing volume is below 40000 to 50000 cubic meters in China. When the annual processing volume is greater than 40000 to 50000 cubic meters, the economy of Rhodotron electron accelerator (10MeV/100kw) is the best-rays (7MeV, X-ray conversion efficiency of 12%) are already more economical than gamma rays when the annual processing volume is greater than 40000 to 50000 cubic meters, but there is still regulatory barriers to 7MeV X-rays, which urgently need to be promoted. The economy of X-ray (5MeV, X-ray conversion efficiency of 8%) still needs to be further improved, but due to the ability to configure and alternate with electron beams of 5 or 10MeV at the same time, the economy can be greatly improved, and it is also an optional combination method to replace cobalt sources especially the continue increasing of the price of Co-60.

Radiation Sterilization: Part 4

Sustainable Packaging Considerations For Radiation Processing

Presenter: Wendy Mach, United States, Sr. Director, Technical Services, Leadership team, Canyon Labs

Packaging and sustainability illustrate that no single packaging type; plastic, glass, metal, or paper, is a leader across every attribute of packaging. There are both positive and negative features that vary in terms of sustainability, application, and region of use. As packaging sustainability pressure continues to grow in the medical device industry, understanding how sterilization can contribute to the initiative is important. This presentation will discuss the advantages of radiation processing and the contributions to sustainability including reducing

or replacing unnecessary packaging, evaluating compatibility with other diverse materials and high-level considerations when making changes to your sterilization process.

Effectiveness Of A Conversion Program

Presenter: *Christophe Deneux, France, Sr Director Global Sterility Assurance, Becton Dickinson*

Regulatory challenges and environmental activism in the US and EU continue to threaten the viability of EtO sterilization and will impact the supply base. The supply of Co60 is constrained going forward as commercial powerplants undergo refurbishment and decommissioning, and geopolitical pressures mount in eastern Europe. Overall, the supply base is at or near full capacity. Without alternatives, continuity of supply remains at risk and growth may be constrained.

Due to this uncertain environment, many companies initiated a conversion program to E-Beam, X-Ray or other technologies (VHP, NO2, ClO2...). How effective is their conversion program?

A presentation on a holistic view of a conversion program: Where to start? How to prioritize? What are the challenges? How to get adherence from the company and all functions? How to communicate within the MedTech Industry? Do we have the tools to simplify and expedite studies? Can we convert all products?

The Application Of Monte Carlo Simulations To Electron Beam Sterilization Processes: A Case Of Study On Industrial Dosimetry

Presenters: *Adrian Arias-Blanco, Spain, International researcher, Mechanical Engineering Department, University Carlos III de Madrid*

Eric D Crawley, United States, Senior Sterilization Engineer, Abbott Assurance of Sterility Task Force, Abbott

Dosimetry is a requirement as a part of the development and validation of the sterilization radiation process. The quality of results is limited mainly by the dosimeters. This is especially concerning in industrial applications where measurement must be carried out in products with non-homogenous geometries. Monte Carlo simulations present a good complementary tool to dosimetry measurements as it can provide additional information. There are few studies in which Monte Carlo methods are applied to dosimetry industrial electron beam applications. This study aims to overcome the lack of available data using Monte Carlo methods in industrial dosimetry applications.

Two different software programs based on different source codes have been used for this study. One based on PENELOPE and the other based on GEANT4. The evaluation of this software consists of two parts. The first part is an error analysis, where several input

parameters for the modelling of an electron beam process have been evaluated, discerning into the most critical ones. In the second part, considering the conclusions from the first part, Monte Carlo modeling has been applied to an industrial case of study. A commercial product in two different configurations has been simulated in Monte Carlo, comparing the differences between numerical and experimental results.

Good agreement between experimental and numerical results has been obtained with simple geometries during the error analysis, nevertheless, in the second part of study there has been an increase in the error applying the same considerations/simplifications as in the first part.

Concurrent Forum – Phytosanitary Irradiation

Phytosanitary 1 - Global Insights: Unveiling the World of Phytosanitary Irradiation

Ariadne Daniela Vargas Rivadeneira, Bolivia, Product Manager, IBA sa opened the session by introducing the presenters and discussing the session objectives.

On the second day of IMRP 2024 in Costa Rica, the Phytosanitary Irradiation Forum took place - an afternoon dedicated to presenting and discussing key topics related to the use of irradiation for phytosanitary treatment of fresh produce. The aim was to continue supporting irradiation as a widely accepted phytosanitary method around the world.

Phytosanitary irradiation involves the application of ionizing radiation to eliminate or sterilize quarantine pests in fruits and vegetables, without compromising product quality. It is a safe, effective, and environmentally friendly alternative to chemical fumigation or cold treatments and is particularly valuable for tropical and perishable commodities.

This technology is endorsed by international organizations such as the International Plant Protection Convention (IPPC), the International Atomic Energy Agency (IAEA), Codex Alimentarius, and FAO, and has been formally adopted in trade protocols by several countries, including the United States, Mexico, Australia, New Zealand, and others.

The main stakeholders involved in its development and adoption include national plant protection organizations (NPPOs), regulatory authorities, irradiation service providers, exporters, fresh producers, retailers, and scientific institutions. As global trade expands and sustainability becomes a growing concern, phytosanitary irradiation is gaining traction as a versatile and scalable solution.

The forum was structured into four sessions, beginning with a global overview of the status of phytosanitary irradiation. It then shifted focus to the regulatory frameworks relevant to this sector. Later, the forum featured remote participation from fresh produce exporters who

shared their experiences applying irradiation as a tool to access international markets. The day concluded with a review of available technologies that enable the practical implementation of this method.

Summary of PsIP Workshop

Presenter: Paul Wynne, United Kingdom, Chairman, International Irradiation Association

The presentation provided an overview of the Phyto-sanitary Irradiation (PsIP) workshop, focusing on the use of low-dose irradiation for fresh produce phytosanitary purposes. The presentation highlighted key aspects such as the drivers of phytosanitary irradiation (trade and biosecurity), its genesis, progress to date, and the purpose of the workshop.

The workshop involved 35 participants from 13 countries, addressing diverse topics like market access, biosecurity, sustainability, compliance, and operational challenges. The key outcomes included the recognition of a lack of common understanding among stakeholders, regional regulatory differences, and the importance of focusing on three pillars: facilities, trade protocols, and food standards.

The actions proposed included stakeholder mapping, ongoing webinars, regional events, evolving strategies, and documentation of best practices. The workshop aimed to expand community engagement and knowledge sharing.

Overview Of Project AM19002, A Two-Year Australian Initiative

Presenter: Benjamin Reilly, Australia, Fresh Produce Business Manager, Steritech

Ben Reilly (Steritech) presented an overview of Project AM19002, a two-year Australian initiative designed to build capacity in irradiation across multiple sectors. The project involved collaboration with 12 organizations across five countries and addressed core barriers such as regulatory gaps, trade protocols, and infrastructure limitations. Outcomes included new export protocols, domestic standard development, digital labelling efforts, and a coordinated national strategy to align industry, regulators, and stakeholders.

Cereals, Grains And Legumes Irradiation For Türkiye: Past, Present And Future Opportunities

Presenter: Dr Nurcan Cetinkaya, Turkey, Food Irradiation Consultant, Head Office Gamma-Pak Sterilization Industry and Trade Inc.

The presentation outlines the critical role of phytosanitary irradiation in safeguarding Turkey's significant grain and legume production against increasing insect infestations exacerbated by climate change. As a major grain exporter, Turkey faces heightened risks from pests due to warmer climates, which threaten crop yields and food security. Traditional pest control methods are becoming less effective, necessitating innovative solutions.

Low-dose e-beam and X-ray irradiation emerge as promising technologies, offering efficient pest disinfestation for both bulk cereals and packaged legume seeds without compromising product quality or safety. Historical efforts, including Turkey's first commercial grain irradiation facility in 1967, provide a foundation, while global examples from Ukraine, China, and Russia demonstrate successful modern implementations of electron accelerator-based irradiation systems.

The presentation also highlights comprehensive production data for cereals and dry legumes in Turkey, emphasizing the economic and strategic importance of protecting these crops. It discusses parameters for irradiation facilities and the practical considerations for adopting irradiation technologies in storage and processing environments. Concluding, it identifies the high potential for expanding irradiation applications in Turkey, recommending e-beam systems for bulk grains and X-ray systems for packaged seeds as the most cost-effective strategies. Overall, the report advocates for phytosanitary irradiation as a sustainable, scientifically sound response to evolving agricultural challenges posed by climate change and global trade demands.

Phytosanitary 2 - Clearing the Path: Navigating the Regulations of Phytosanitary Irradiation

Phytosanitary Irradiation: Clearing the Path: Navigating the Regulations of Phytosanitary Irradiation

Presenter: Dr Laura Jeffers, United States, Senior Risk Manager, USDA

The presentation covers the development, current state, and future challenges of the USDA APHIS PPQ Phytosanitary Irradiation Programs. These programs are designed to manage pest risks in agricultural imports and exports through irradiation treatments. Key Highlights of the presentation:

The Early Years - Origins: The program evolved alongside U.S. commercial agricultural production and the use of methyl bromide pesticide. **Paradigm Shift:** The focus shifted from mortality to other endpoints like sterilization, reduced fitness, and inability to emerge or fly.

The Present - Current Practices: The program includes preclearance and offshore irradiation, upon-arrival irradiation in the U.S., domestic quarantine irradiation, and irradiation for U.S. exports. **Regulatory Process:** Establishing phytosanitary irradiation involves multiple steps, including market access, facility certification, and importer compliance. **Growth:** The program has grown significantly, from 195 metric tons in 2007 to 53,000 metric tons in 2023.

Top Countries: Major contributors include Mexico, Vietnam, and India. **Top Commodities:** Key commodities include mangoes, guavas, and sweet oranges.

Challenges - Regulatory Hurdles: FDA regulation of irradiation as a food additive. Capacity Building: Maximizing the capacity of upon-arrival irradiation programs. Education: Raising awareness among manufacturers and regulators about phytosanitary irradiation and perishable logistics.

Resources - Guides and Registries: Various resources are available for stakeholders, including import guides, treatment information, and the APHIS Stakeholder Registry.

The presentation highlights the importance of phytosanitary irradiation in ensuring the safe import and export of agricultural products, while also addressing the challenges and resources available to stakeholders.

Progress On Establishing An X-Ray Sanitary And Phytosanitary Research And Development Program For Horticulture In New Zealand

Presenter: Lisa Jamieson, Food Innovation, The New Zealand Institute of Plant and Food Research, Auckland, New Zealand

The presentation provided an update on establishing an X-ray sanitary and phytosanitary (SPS) research and development facility for the horticulture sector in New Zealand. It highlights the challenges faced in importing the country's first phytosanitary source, including logistics, licensing, and training. The presentation notes that New Zealand has been importing irradiated fresh produce since 2004, primarily from Australia, and discusses the potential for X-ray irradiation to address SPS issues for exports, especially in light of New Zealand's stringent anti-nuclear stance and the need for effective pest control measures.

The presentation also covered the regulatory framework for food irradiation in New Zealand, which is governed by Food Standards Australia New Zealand (FSANZ). It outlines the steps taken to ensure compliance with the Radiation Safety Act (2016) and the modifications needed for the irradiation equipment. The potential benefits of X-ray irradiation for various export sectors, including horticulture, dairy, and seafood, are discussed, along with the importance of thorough performance testing and regulatory approval. The presentation concludes with a summary of the next steps, including shipping, commissioning, and testing of the irradiation facility.

Guidelines For The Harmonization Of Regulations In Latin America And The Caribbean For The Commercialization Of Irradiation Technology Based On International Standards For Phytosanitary Measures

Presenter: Emilia Bustos Griffin, United States, Technical Assistance, Research & Development, J.B. Trini Associates

The presentation discussed the harmonization of regulations in Latin America and the Caribbean (LAC) for the commercialization of irradiation technology based on International Standards for Phytosanitary Measures (ISPMs). It highlighted the importance of agriculture to the economies of LAC countries and the need for effective phytosanitary treatments for tropical and subtropical fruits and vegetables. Despite the potential benefits, irradiation technology is underutilized in the region, with only a few countries having established regulatory frameworks and facilities for food treatment. The presentation emphasizes the need for harmonization of regulations, increased awareness, and investment in phytosanitary irradiation (PI) to enhance trade and overcome quarantine restrictions.

The presentation outlined the regulatory challenges and opportunities for PI in the LAC region, including the involvement of multiple agencies and international organizations. It discusses the unique benefits of PI, such as its ability to provide effective pest control without requiring pest mortality, and the need for guidelines to assist with regulatory designs. The presentation concludes by highlighting the steps needed to establish and expand PI programs, including policy development, market evaluation, and research on efficacy and product viability. It underscores the importance of close coordination with government authorities and the potential of PI as a beneficial risk management tool to enhance imports and exports in the region.

Phytosanitary 3 - Harvesting Innovation: The Producer's Take on Phytosanitary Irradiation for Fresh Produce

Introduction: Harvesting Innovation

Presenter: Arved G Deecke, Mexico, Founder / Member of the Board, BENEION

The Phytosanitary Irradiation Forum focused on the innovative use of phytosanitary irradiation for fresh produce. Moderated by Arved Deecke, the session highlighted perspectives from producers and experts across different regions.

Sponsored by Gamma-Service Recycling, the forum underscored the importance of phytosanitary irradiation as a tool for innovation in the fresh produce industry. By enabling producers to meet stringent international phytosanitary requirements, this technology opens up new market opportunities while ensuring the safety and quality of exported goods. The session brought together diverse viewpoints, demonstrating how phytosanitary

irradiation is transforming agricultural practices globally and fostering economic growth for producers.

Phytosanitary Irradiation In Costa Rica: Estimated Volumes For Phytosanitary Irradiation

Presenter: Diógenes Rodríguez, Servicio Fitosanitario del Estado, Costa Rica

As a local authority, he presented an overview of the country's current legal framework for irradiation and identified a wide variety of exportable fruits that could benefit from this technology. He highlighted Costa Rica's strong export infrastructure, with the United States and European Union as its main markets, and proposed Limón as the most suitable location for a future irradiation facility. He emphasized that phytosanitary irradiation offers a safe, year-round, and sustainable alternative to traditional treatments for the country's diverse agricultural output.

COCANMEX: First To Market: Growing a prosperous business out of the market access opportunity that phytosanitary irradiation provides to Mexican growers and exporters of fresh produce.

Presenter: Roger Gay, Cocanmex, na, Mexico

The presentation provides an overview of the producer's perspective on phytosanitary irradiation for fresh produce, focusing on Mexican fruits, particularly mangoes. The session highlights the importance of phytosanitary irradiation in ensuring the quality and safety of fresh produce. The presentation covers various facilities in Mexico, including locations in Tapachula, Michoacan, and Nayarit, as well as international locations in Toronto, Portland, and Vancouver. The document emphasizes the diverse range of mango varieties treated, such as Nam Dok Mai, Kent, Cherry Mango, Palmer, and Osteen, and the use of hot water treatment methods.

The market analysis reveals that 45% of total sales come from fruits, 30% from frozen products, and 25% from flowers. The irradiation capacity is noted to be 45,000 tons. The session underscores the role of phytosanitary irradiation in meeting the demands of international markets and maintaining high standards for produce quality. By leveraging advanced treatment methods and a robust network of facilities, producers can ensure that their products meet stringent safety and quality requirements, thereby enhancing their market competitiveness.

Wandin Valley Farms: An Australian Cherry Producer Perspective

Presenter: Tim Jones, Wandin Valley Farms, Wandin North, Australia

Tim Jones, an Australian cherry grower from Wandin Valley Farms, discusses the global context of cherry production, noting the seasonal differences between the Northern and Southern Hemispheres and highlighting Chile's significant role in the Southern Hemisphere market. He explains that Wandin Valley Farms is a family-owned business with orchards in Victoria and Tasmania, supplying cherries to both domestic and export markets. A key challenge for exporting is meeting biosecurity requirements, which traditionally involves cold treatment or fumigation. However, fumigation with methyl bromide poses issues due to the need to heat the fruit, which negatively impacts its quality, making irradiation a more appealing alternative.

Tim argues strongly for the benefits of irradiation over methyl bromide fumigation, emphasizing its effectiveness in maintaining food freshness through cold chain management, its lack of residual effects, and its environmental advantages. While acknowledging potential consumer perception challenges and the higher cost of establishing irradiation facilities, he cites successful examples of irradiation use in exporting to Vietnam, Indonesia, and Thailand, as well as for domestic supply to Tasmania and Western Australia. He concludes by stressing the importance of irradiation for managing pests and diseases, ensuring biosecurity, and facilitating trade, particularly given the increasing pressures from warming temperatures.

Phytosanitary 4 - Tech Challenges and Breakthroughs: Advancing Phytosanitary Irradiation Solutions

Introduction: Tech Challenges And Breakthroughs

Presenter: Paul Wynne, International Irradiation Association, Ludlow, United Kingdom

The presentation outlines a session on phytosanitary irradiation, focusing on technological challenges and breakthroughs.

The session aims to address advancements in phytosanitary irradiation, highlighting both the challenges and innovative solutions in the field. The presentations cover a range of topics, from high-capacity systems and versatile applications to the practical implementation and success of X-ray technology for produce. This forum provides a platform for industry leaders to share their experiences and discuss the future of phytosanitary irradiation, emphasizing the importance of technological innovation and collaboration in overcoming current challenges and advancing the field.

Mevex High-Capacity And Short Treatment Cycle Time Food Irradiation System

Presenter: Shane Stutchbury, STERIS, Ottawa, Canada

The presentation discusses a high-capacity linac X-ray system designed for phytosanitary irradiation of food. The system features dual modality, allowing it to switch between E-beam and X-ray outputs using a retractable X-ray converter. This flexibility enables efficient processing of various products, such as using X-ray for mangos and E-beam for herbs and spices. The system can switch modes in less than a minute, enhancing operational efficiency. E-beam mode offers higher throughput and lower operating costs, making it suitable for certain products, while X-ray mode is essential for products requiring deeper penetration and uniform treatment.

The presentation also addresses challenges like bottlenecks during phytosanitary doses, especially when processing large pallets. Increasing power alone does not always increase throughput due to conveyor limitations. To overcome this, the implementation of dual opposing beamlines is suggested to increase throughput without raising processing speeds. The key takeaway is that both E-beam and X-ray modalities are powerful when optimized for specific products, and the operational flexibility of using the same equipment for both modes can lead to significant improvements in efficiency and cost savings. The treatment of food using these technologies is growing worldwide, highlighting the importance of innovation and optimization in this field.

Versatile Solutions For Phytosanitary Irradiation And Multi-Purpose Applications

Presenter: Ariadne Vargas Rivadeneira, IBA sa, La Paz, Bolivia

The presentation explores versatile solutions for phytosanitary irradiation and multipurpose applications. It highlights the continuous growth of the phytosanitary irradiation market, which had a capacity to treat around 50,000 tons per year up to 2019. The presentation emphasizes the need for facilities to handle both low-dose phytosanitary products and high-dose products, ensuring reliability and flexibility. Key technological considerations include the integration of cold chain logistics, minimal downtime, and full pallet treatment. E-beam and X-ray technologies are discussed for their cost efficiency and performance, with high-speed conveyors enabling fast treatment times.

The IBA phytosanitary irradiation solution focuses on high-speed conveyors and redundancy systems to ensure reliability, with treatment times as fast as 1.5 minutes per pallet. The use of 7 MeV X-ray technology is highlighted for its efficiency and throughput improvements, although regulatory restrictions may limit its use in some regions. The presentation underscores the importance of overcoming barriers and continuing to innovate in phytosanitary irradiation technology to meet market demands. The goal is to provide

flexible, reliable, and efficient solutions that can adapt to the varying needs of the market and ensure the scalability and competitiveness of phytosanitary irradiation as a business.

Success Of X-Ray For Produce – Establishing, Operating And Installing Second Machine

Presenter: Benjamin Reilly, Steritech, Mickleham, Australia

Ben Reilly (Steritech) shared the success story of Steritech's X-ray platform in Australia, highlighting its role in enabling domestic and international trade. He discussed the challenges of maintaining uptime, the business case for adding a second beam, and the importance of stakeholder alignment. He also emphasized the long-term value of generic protocols and digital labeling to facilitate broader adoption.

Benebion: Adding An X-Ray Treatment Modality To Our Phytosanitary Treatment Facility

Presenter: Arved Deecke, BENEbION, Zapopan, Mexico

The presentation discusses BENEbION's initiative to add an X-Ray treatment modality to its phytosanitary treatment facility in Mexico. Founded in 2011, BENEbION has grown to serve diverse markets, including food products, frozen goods, medical devices, and pet products. The company aims to address the challenges of seasonality, climatic events, and market imbalances that affect the demand for phytosanitary irradiation. With the current gamma plant reaching capacity, BENEbION projects a need for a threefold increase in capacity by 2040, which the cobalt market cannot meet. Therefore, X-Ray technology is proposed as a more efficient solution to manage demand fluctuations and enhance capacity.

The implementation of X-Ray technology involves the IBA Rhodotron TT1000 BeWide solution, which offers high-speed material handling and semi-automated warehousing. This technology is expected to improve the efficiency of phytosanitary irradiation, allowing for faster processing times and better management of seasonal and climatic demand spikes. The collaboration between BENEbION and IBA aims to push the boundaries of large-scale industrial X-Ray machines, ensuring the facility can handle high product density ranges and maintain high processing speeds. This strategic move is designed to optimize production logistics and support the continued growth of the phytosanitary segment.

Panel Discussion - All Presenters

Summary

The message was clear: technology is no longer the barrier. Both IBA and Mevex have developed robust, flexible, and efficient systems. Real-world users like Steritech and

Benebion have proven that phytosanitary irradiation can be scaled successfully. The focus must now shift toward addressing other remaining barriers—regulatory updates, cost structure clarity, and shared standards—through collective action as a global community.

The Phytosanitary Irradiation Forum at IMRP 2024 was not just a showcase of progress — it was a clear signal that the industry is ready. Science is sound. The technology is proven. The experiences are real. What remains is the collective will to harmonize, scale, and support the implementation of this powerful tool globally.

Across all four sessions, one message resonated: phytosanitary irradiation is no longer a future technology — it is a present solution. From regulators to growers, from engineers to exporters, the ecosystem is aligning. Technological limitations have been overcome, and now the main challenges lie in outdated regulatory frameworks, fragmented standards, and the need for informed engagement with authorities and markets.

This forum demonstrated the strength of collaboration — across continents, sectors, and disciplines. If we are to fully realize the potential of phytosanitary irradiation, we must continue working together to fill the remaining gaps: in awareness, in regulation, and in market integration. The path forward is not about proving that irradiation works — it is about making it work everywhere. Together.

WEDNESDAY 6TH NOVEMBER 2024

Sustainability, Science and Innovation

PL6 - Plenary Session

Sustainability Keynote & Round Table

Introduction

Presenter: *Brian McEvoy, Ireland, Chief Technology Officer, Applied Sterilization Technologies, STERIS*

At IMRP 2022 in Bangkok, a question was posed by a delegate (Christoph Herkens, Ionisos) regarding the topic of Sustainability and its importance and relevance to our radiation processing industry. Consequently, the theme for IMRP 2024 was Sustainability – Available, Sustainable and Growing. During the plenary presentations on Day 1 of IMRP 2024, where the key topics for the business of radiation processing were discussed, Christoph Herkens presented on the importance of Sustainability and how his company is seeking to measure and address.

From this inciteful opening, a dedicated session was scheduled in the Wednesday plenary sessions of IMRP 2024. The goal of the session was to open with a 'big picture' perspective of the topic of sustainability. For this, the audience enjoyed a keynote address from Dr. Amit Limaye, Director of the Sustainable Medical Technology Institute at Becton Dickinson. From this high-level overview from the perspective of a medical device manufacturer, the session then included five presentations from the perspectives of radiation equipment, source suppliers and end users of irradiation technologies.

The aim of the session was to bring the central theme of IMRP 2024 to light with tangible examples of what companies are measuring, actioning and focusing on to drive sustainability within their organizations and our radiation processing industry as a whole. The hope and expectation was that delegates may be able to take back some learnings and insights that they may be able to apply to their own organizations.

Keynote Presentation: Sustainability In The Medical Device Industry – Implications For Product Design And Sterilization

Presenter: Amit Limaye, United States, Director, Sustainable Medical Technology Institute, Becton Dickinson & Company (BD)

The presentation showcased what Sustainability means to Becton Dickinson & Company. BD is a company of some \$19.4bn revenue reported in FY23 making some 34+bn devices annually with a team of 70k+ associates, who recently celebrated 125 years in business. Dr. Limaye heads up the Sustainable Medical Technology Institute at BD and he described how BD is addressing sustainability; focusing on measurements, targets, and actions. SMTI was formed in April 2022 to focus on 'product impacts'.

BD's 2030+ commitments to sustainability, which include focus on: climate change, product impact; responsible supply chain; healthy workplace and communities; and transparency were explained. BD are taking an end-to-end view on Greenhouse Gas emissions and have identified Scope 3 as the main contributor to BD's emissions. Dr. Limaye's group within SMTI are focused on reducing the environmental impact of BD products and helping BD's customers sustainability needs by addressing materials of concern; evaluating sustainable sterilization technologies; adopting design for sustainability strategies and circular economy solutions. The presentation then provided further explanation and case studies on the topic of sustainable design practices which included life cycle assessment; sterilization method selection and the stakeholder collaborations that are required to drive success. On the topic of sterilization, Dr. Limaye shared considerations for evaluation of sterilization modality which include technology maturity and ability to scale-up; Operational complexity and cost effectiveness; material compatibility and packaging configuration; product performance and biocompatibility; and regulatory pathway.

Cobalt-60 Supply Chain Sustainability

Presenter: *Corby Nicholson, Canada, Director, Operations, Nordion*

Mr. Nicholson's presentation started with a video insight into Nordion and how it produces Cobalt-60 isotope for irradiation. The presentation started with some insights into the environmental advantages that gamma irradiation has over accelerator-based technologies, namely lower electrical consumption and consequently lower greenhouse gas production. Furthermore, it was highlighted that some 99% of cobalt returned from the field is recycled.

The presentation explained the manufacturing process, supply chain and safety and environmental focus associated with cobalt manufacture and use. With an annual demand of only ~600kg of Cobalt-59, Cobalt-60 production is a by-product of clean nuclear energy production. On the topic of transportation of Cobalt-60, Mr. Nicholson highlighted that the use of sea transport, sailing 10% slower results in 30% reduction in emissions. In closing, the presentation summarized that Cobalt-60 supply involves a supply chain that is highly regulated and controlled with a low environmental impact and a long lifecycle enhanced by significant recycling of returned material.

Sustainability For Irradiated Product Used In Biopharma And The New Challenges

Presenter: *Lucie Delaunay, France, Manager of Materials and Irradiations, Product Development, Sartorius Stedim FMT SAS*

Industries face significant sustainability challenges, particularly in decarbonizing product lifecycles. Healthcare constitutes some 4-5% of global Greenhouse Gas Emissions with half emanating from the supply chain. Sartorius has a 2045 target of net-zero. Ms. Delaunay highlighted the importance of Lifecycle assessments to determine 'cradle to gate' and 'cradle to grave' environmental and sustainability impacts, with a particular focus on how the sterilization of single-use products using gamma and X-ray irradiation affects the carbon footprint.

The environmental impact and long-term viability of irradiation processes need to consider activities such as supplier reduction efforts and localization of irradiation sites to minimize supply chain emissions. Examination of product decarbonization and circularity strategies will involve activities such as migration to alternative feedstock; production waste elimination and circular options post-use. Ms. Delaunay presented some product case studies highlighting the recycling and circularity challenges for irradiated products, while highlighting the benefits of 100% closed loop and 100% return rate approach. It was demonstrated how two-times irradiation of recycled polymers can alter properties, an example of which may be discoloration: However, with product functionality maintained, strategies may be developed to address concerns and further enable circular economy implementation.

PL7 - Plenary Session

Sustainability Presentations

Moderator: Brian McEvoy, STERIS & Program Chair IMRP 2024

Coupling Sustainability Assessments With Business Continuity Strategies For Implementation Of Multiple Sterilization Technologies

Presenter: James Hathcock, Cytiva, Needham, United States

The presentation focuses on the importance of coupling sustainability assessments with business continuity strategies for the implementation of multiple sterilization technologies in the medical device industry. It highlights that having various sterilization options like moist heat, EtO, and different types of ionizing irradiation (Gamma, X-ray, E-beam) supports business continuity. The presentation also delves into the sustainability impact of these technologies, particularly comparing Gamma and X-ray irradiation in terms of energy requirements and Global Warming Potential (GWP) in different regions like the US and Switzerland.

The presentation includes specific case studies, such as Cytiva's assessment of the carbon footprint associated with the conversion from Gamma to X-ray irradiation. It emphasizes the negligible footprint of Cobalt-60, the traditional source for Gamma irradiation, and contrasts it with the higher electricity consumption and associated CO₂ emissions of X-ray technology due to photon conversion efficiency. The slides also touch upon data-driven reporting for sustainability, covering Scope 1, 2, and 3 emissions related to water, waste, and CO₂e, and underscore the strategic advantage of having alternative sterilization technology qualifications for business continuity and growth.

Maximizing Waste Valorization: Identifying Electron Accelerator Technologies For The Future And Supply Chain Needs

Presenter: Jennifer Elster, Pacific Northwest National Laboratory (PNNL), Richland, United States

The presentation discusses maximizing waste valorization by identifying electron accelerator technologies for future supply chain needs. It highlights the advantages of electron beam (eBeam) processing, such as the absence of radioactive sources, enhanced safety, flexibility in irradiation, and its potential as a disruptive technology for sludge treatment due to its efficiency in eliminating pathogens, breaking down organic compounds, and improving de-waterability. The presentation suggests that wastewater treatment plants should be

considered resource recovery facilities, producing valuable products like water, nutrients, and energy.

The presentation also addresses the adoption of new modalities for wastewater, soil, and sludge treatment, driven by the increasing limitations of Co-60 availability and the decreasing costs of eBeam technology. It points out the supply chain challenges, including the lack of customized accelerator technologies, the limited number of global vendors, long installation times, and the need for industry-wide standardization. The research indicates that eBeam treatment of sewage sludge can enhance methane generation during anaerobic digestion and cause beneficial physiochemical changes in sewage sludges, such as significant viscosity reduction.

Making X-Ray Carbon Neutral: Challenges & Way Forward

Presenter: Anthony Lemmens, IBA sa, Louvain-La-Neuve, Belgium

The presentation discusses the challenges and ways forward in making X-ray technology carbon neutral. It addresses the significant energy consumption of X-ray irradiation facilities, noting that a typical facility operating 24/7 can use around 10,000 MWh per year. The presentation emphasizes the importance of transitioning to renewable energy sources to mitigate the carbon footprint.

Lemmens outlines a strategy involving optimization, decarbonization, and recovery to achieve sustainable X-ray irradiation. Optimization focuses on improving energy efficiency, throughput, and uptime, while decarbonization involves using renewable energy sources like solar panels. The recovery aspect explores opportunities to utilize excess energy for on-site use or local heating networks. The presentation also highlights IBA's commitment to sustainability through global initiatives and B Corp certification.

PL7.5 - Plenary Session

Blue Flag Accreditation Ceremony

Moderator: *Arthur Dumba, Switzerland, General Manager, International Irradiation Association*

The Costa Rica Blue Flag Program Certification signifies that IMRP 2024 has been officially recognized for its commitment to environmental sustainability and responsible event management. This certification was awarded by Costa Rica's Bandera Azul Ecológica program under the 'Special Events'.

The Blue Flag certification is an international eco-label that acknowledges events and locations meeting stringent environmental criteria. For IMRP 2024, this included:

- **Eco-Friendly Venue:** Utilization of a certified sustainable venue with LEED standards, efficient water conservation systems, and comprehensive waste management initiatives.
- **Sustainable Materials:** Provision of eco-friendly conference materials, including bags, notepads, and pens made from certified sustainable materials, and the use of recyclable signage.
- **Catering and Waste Reduction:** Commitment to locally sourced ingredients, careful planning to prevent food waste, and the elimination of single-use plastics.
- **Energy Efficiency:** Implementation of energy-efficient lighting systems and low-power appliances, with practices to power down equipment when not in use.
- **Waste Management:** Establishment of dedicated recycling stations and the use of biodegradable cleaning products.
- **Carbon Offsetting Initiatives:** Engagement in environmental compensation activities, such as tree planting and shoreline clean-up efforts.

These measures reflect IMRP 2024's dedication to minimizing its environmental impact and promoting sustainability in all aspects of event planning and execution.

Achieving the Blue Flag certification underscores IMRP 2024's role as a leader in integrating sustainable practices within the radiation processing industry. This accomplishment not only enhances the event's reputation but also sets a benchmark for future conferences and events in the sector, encouraging the adoption of environmentally responsible practices across the industry.

THURSDAY 7TH NOVEMBER 2024

Education, Leadership, Development and Regulation

PL8 - Plenary Session

Education and Leadership Development

Moderator: Arthur Dumba, Switzerland, Organizing Committee Chair, Session Lead

The Education, Leadership and Development Plenary Session at the IMRP 2024 conference, in Costa Rica, focused on leadership development and training for the next generation of radiation processing professionals. The session featured insights from industry leaders, including a presentation on innovative online training programs designed to equip emerging professionals with the necessary skills for radiation processing.

This session also explored broader educational strategies to address skill gaps and support career growth within the field.

International Irradiation Association Leadership Program - Benefits For Companies, Students, And Industry Professionals

Presenters: Adrian Arias-Blanco, University Carlos III de Madrid, Leganes, Spain

Emily Glowski, PHD Student · UT Southwestern Medical Center, USA

Having participated in the 2023/2024 Leadership program, Adrian and Emily presented on The International Irradiation Association (iia) Leadership Program and how it is designed to support the growth and development of the irradiation industry by fostering leadership skills among professionals, students, and companies involved in irradiation technologies. The presentation showed:

Talent Development: How companies can benefit from the Leadership Program by nurturing their emerging leaders, which helps create a more skilled and knowledgeable workforce. This strengthens the company's internal capacity for innovation and leadership.

Enhanced Industry Visibility: Companies that actively support or sponsor the program can enhance their visibility within the global irradiation community. It positions them as leaders in supporting the development of industry professionals.

Evolution: How the leadership program is evolving to provide mentors for the participants, create areas of focus for upcoming professionals in the radiation industry and give job opportunities for those that participate in the program.

What The Definition Of The Term, “Expert” Means For Sterility Assurance Professionals

Presenter: James L Vesper, United States, Director, Learning Solutions, ValSource / SfSAP

As Chair of the Learning and Training Evaluation Workstream, in the Society for Sterility Assurance Professionals, James provided industry guidance on:

- Provided examples of health authority requirements for demonstrating competency and expertise of responsible persons in sterility assurance
- Creating an ecosystem for developing sterility assurance professionals which includes Healthcare product manufacturers, contract sterilizers, Education delivery organizations, individuals and Health Authorities/regulators.
- Presented the ways that expertise can be acquired, and the journey from novice/newcomer to expert using the Society for Sterility Assurance (SfSAP) frameworks.

The presentation summarizes:

- Those working in areas of sterility assurance need technical knowledge and skills relevant to their roles and responsibilities.
- Having competent personnel offers substantial benefits to regulatory authorities, manufacturing/contract organizations, and individuals
- Having competent sterility assurance professionals provides public confidence in the food, drugs, medical devices and other products we consume
- SfSAP has worked with international industry experts to develop the Learning Frameworks
- Learning Frameworks identify the resource documents, knowledge, skills, and experiences that professionals need as they progress
- Learning Frameworks can be used by individuals, manufacturers and contract organizations, educators, and health authorities

The presentation showed how SfSAP learning frameworks can be used by individuals and organizations, and health authorities as a pathway to develop expertise in those involved in assuring the sterility of pharmaceuticals, medical devices, and single-use systems

AAMI Standards to Training Pipeline

Presenter: Amanda Benedict, United States, VP, Sterilization, AAMI

This presentation outlines AAMI’s comprehensive approach to radiation sterilization standards and training development. It highlights AAMI’s dual role in managing national (AAMI ST-WG02) and international (ISO/TC 198/WG 2) sterilization standards, with over 200 U.S. and international experts contributing to consensus standards such as the ISO 11137 series. The program emphasizes the development, adoption, and application of voluntary

consensus standards that serve as the foundation for educational frameworks like the AAMI CISS and SfSAP Learning Frameworks, enhancing standards adoption and practical application in the medical device industry.

AAMI's training programs have evolved into primarily virtual offerings since 2020, allowing for flexible, demand-driven course delivery with expert-led instruction. The courses, which include public training, expert insights, and eLearning, feature real-life examples and hands-on exercises tailored to various radiation sterilization topics. Looking ahead to 2025, all industrial sterilization training courses will be revised to incorporate current and future-focused issues such as sustainability, supply chain, capacity, and capability. This approach ensures that training remains relevant and responsive to industry challenges while promoting comprehensive education and leadership development in sterilization practices.

On-Line Training Courses For The Next Generation Of Radiation Processing Professionals

Presenter: Florent F Kuntz, France, Strategic Development Manager, Aerial

The Irradiation Panel has the delivery of educational content supporting career development as a key objective. We need to ensure that the next generation of professionals have access to training resources designed to equip them with the knowledge and skills to succeed. Hands-on and in-person training is the ideal but is expensive and may not be accessible to all.

The presentation outlines the goals and structure of an online training program developed by the Irradiation Panel's Education and Training Working Group. This initiative aims to enhance the skills of radiation processing professionals by providing accessible, comprehensive training modules. Targeted towards both newcomers and individuals seeking to deepen their expertise, the program will cover critical topics related to irradiation technology, such as sterilization methods, regulatory considerations, and dosimetry. The content will be curated by industry experts and undergo peer review, ensuring accuracy and relevance. The modules are expected to be available by the second quarter of 2025, allowing widespread access for panel members and non-members alike.

In addition to the comprehensive content, the training program will feature interactive elements, including knowledge tests and Q&A sessions with working group members. Feedback from a member survey indicated strong interest in online courses, revealing a community readiness to engage with this educational offering. The Irradiation Panel's commitment to developing guidance documents addressing industry challenges reinforces the importance of ongoing education and the creation of professional competency in the field of radiation processing. With this initiative, the Panel aims to cultivate a new generation of qualified professionals well-versed in the underlying principles and practical applications of irradiation technology.

The initial module is planned to be released by Q2 of 2025 and will be available to both Panel members and non-members.

On-Line Training Courses For The Next Generation Of Radiation Processing Professionals

Presenter: Deepak Patil, United States, Vice President, Sterilization Science and Technology, STERIS

The presentation highlights ASTM Committee E61, which focuses on developing and maintaining standardized practices, methods, and guides for ionizing radiation processing and dosimetry. This includes applications in medical products, pharmaceuticals, foods, polymers, and other consumer goods. The committee is composed of 160 members from 18 countries with 35% outside the US, and has developed 37 approved standards. They meet twice a year—once in person and once virtually—to discuss standards and advancements. The committee aims to foster the use of these standards through meetings, workshops, and symposia, ensuring consistency and safety in radiation processing worldwide.

In addition to standards development, ASTM Committee E61 places a strong emphasis on education and leadership development within the field. This is exemplified by their Radiation Processing hands-on workshops held approximately every 2-3 years. These in-person, four-day workshops are designed around the SfSAP framework and E61 structure and are led by industry subject matter experts. They combine plenary sessions with practical hands-on training featuring real company examples. The most recent workshop was in February 2024 in San Diego, with future workshops planned. This training effort helps professionals stay current on best practices and strengthens the industry's overall competence and safety culture.

PL9 - Plenary Session

Regulatory (Healthcare/Pharmaceutical/Phytosanitary)

Moderator: James Vesper, Society for Sterility Assurance / ValSource, Inc., USA

The goal of this regulatory session was to discuss issues dealing with irradiation that are important for regulatory compliance and product quality. Three speakers presented; the presentations were followed by a brief panel discussion.

A Survey Of The Regulatory Landscape

Presenter: Kimberly Patton, Performance Review Institute, Georgetown, United States

In her role, Ms. Patton reviews and performs audits of all types of irradiation modalities, which has given her a broad view of issues, gaps, and trends. She also gathers insights from the Regulatory Working Group of The Society for Sterility Assurance (SfSAP) that she heads. In terms of gaps and deficiencies, she has observed resource gaps that include a lack of competent personnel in operational, technical, and quality roles; issues in dosimetry handling that could be reduced by error-proofing; testing timelines issues that can be exacerbated when outside contract microbiology labs are involved; the lack of training when it is called for and the inappropriate assignment of training when the cause of the problem is mis-attributed to “human error”; and the underutilization of problem-solving tools like fishbone analysis, Five Whys, and fault trees. Trends that she has been seeing recently include the transferring of one type of radiation technology such as gamma to either E-beam or X-ray. Another trend is the lack of qualified human resources due to lack of availability in certain locals, and a high rate of turnover. The lack of qualified personnel conducting audits is also being seen and confirmed by both sterilization facilities and medical device companies. SfSAP has been developing learning frameworks to identify competencies for those working in the field of irradiation. This effort is meant to help reduce deficiencies seen in the industry and to develop a workforce with the knowledge and skills needed.

Assessing The Most Appropriate Radiation Source For Healthcare Products

Presenter: Alan Montgomery, Johnson & Johnson, Durham, United States

Assessing the Most Appropriate Radiation Source for Healthcare Products was presented by Alan Montgomery from Johnson & Johnson. In 2020, the radiation landscape was being shaped by a decrease in the cobalt supply, an increased demand for radiation sterilization, supply chain disruptions, and an unknown X-ray sterilization capacity. All of these issues put significant pressure on the broad capacity of radiation sterilization. While some of these sources of pressure have since been resolved to some degree (e.g., cobalt supply, supply chain disruptions), J&J’s intent was to look at an approach to validate X-ray as a viable, sustainable sterilization option for some product types. To do this, risk assessments were performed on how the process conditions could vary between gamma and X-ray. Temperature, dose-rate, energy, and dose distribution data were collected and compared; products chosen to be validated were those that could have the largest positive impact on supply chain. For future products, J&J, during product development is simultaneously pursuing dual-path, gamma/X-ray sterilization with data that can be submitted together in regulatory filings. The benefit of such an approach is to have flexibility, supply chain efficiency, and, when possible, reduce capacity issues through lowering minimum doses.

Regulatory Approaches, Challenges, And Successes With Risk Evaluation, Qualification And Acceptance Of X-Ray Sterilization As An Equivalent Alternative To Gamma

Presenter: James Hathcock, Cytiva, Needham, United States

There has been a significant increase in the use of single-use systems (SUS) by the biopharmaceutical industry. As part of a company's selection and qualification process, they rely on data from the component manufacturers whose components are assembled by integrators and then sterilized. To secure the needed irradiation capacity to meet biopharma requirements, there has been an industry-aligned effort to have interchangeability between gamma (which has been predominantly used) and X-ray. A number of different reports and peer-reviewed papers have been published with the intent to "verify" and not "revalidate" demonstrating that there are no meaningful adverse effects related to X-ray as compared to gamma. The basis for this approach is based on the underlying physics; comparative data that considers, among other things, materials, physical properties, biologic efficacy, and chemical factors; and a risk-based evaluation. Between 2021 and 2024, industry representatives have presented their findings and have had discussions with regulatory bodies in the U.S., Europe, and Japan. The feedback from these authorities has been generally positive as they see the need for such flexibility and have made suggestions to help move the effort ahead. Key challenges that are seen include that implementation of this is expected to hit quickly across diverse portfolios of products, there are some regulatory filings that specifically mention gamma that will need to be amended, and the reaction of other health authorities who have not been initially consulted is not known.

Panel Discussion

Panelists: Kimberly Patton, Performance Review Institute, Georgetown, United States

Alan Montgomery, Johnson & Johnson, Durham, United States

James Hathcock, Cytiva, Needham, United States

The presenters were asked to comment on several questions including:

Alan, your presentation focused solely on gamma and x-ray irradiators, is electron beam also part of the strategy for ensuring sustainability?

Alan Montgomery: My presentation focused solely on gamma and x-ray because they are both photon-based radiation sources and generally products that are well suited for one can transfer fairly easily to the other. For products with higher densities or dose uniformity requirements of less than 2.0 that are currently validated in gamma will likely have difficulty

validating an e-beam process to deliver these doses. Products that are currently validated in ebeam were also not impacted by the cobalt supply challenges in recent years and as a result were not pushed to look for alternative radiation sources. One watch out if going from ebeam to either gamma or x-ray is that some of the product testing requirements mentioned in TIR104 could be increased due to the fact that studies done in ebeam are generally at lower temperatures with a shorter exposure to ozone than would be expected in a photon-based irradiator.

James Hathcock: From a bioprocess perspective, ebeam does offer some key benefits, and will be something our industry further evaluated in the future. However, given the current challenge to quickly qualify an equivalent alternative, the dose uniformity and penetration of X-ray makes it the easiest path forward currently.

Are you seeing any examples of regulatory agencies “harmonizing” or becoming more “un-harmonized?” Can you give an example or two?

James Hathcock: From the bioprocess discussions on X-ray, we did have EMA invitees in the FDA discussions, and FDA attendees on the EMA discussion. Hence there is good engagement in listening about the issues, though I think we are far from a cohesive ICH-style guidance for this.

Kim Patton: There are harmonization efforts going on globally and have been for some time. One such group is ICH: The International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH). ICH's mission is to achieve greater harmonisation worldwide to ensure that safe, effective and high quality medicines are developed, registered and maintained in the most resource efficient manner whilst meeting high standards.

3 agencies participating:

- Europe (EU/EMA, European Federation of Pharmaceutical Industries and Associations)
- Japan (Ministry of Health Labor and Welfare, Japanese Pharmaceutical Manufacturers Association)
- US (FDA, PhRMA – Pharma Research and Manufacturers of America)

Benefits touted are fewer duplicate tests, reports, and submissions. Data for review is more consistent. Quicker access to safe and effective new drugs and lower costs

FDA has released its new rule – most recent well- known effort.

On January 31, 2024, the FDA issued a final rule amending the device current good manufacturing practice (CGMP) requirements of the Quality System (QS) Regulation under 21 CFR 820 to align more closely with the international consensus standard for Quality Management Systems for medical devices used by many other regulatory authorities around the world. This action continues the FDA's efforts to align its regulatory framework with that

used by other regulatory authorities to promote consistency in the regulation of devices and provide timelier introduction of safe, effective, high-quality devices for patients.

An amendment to the Australian legislation was registered on 18 October, with effect from 19 October, allowing ARTG applications for Class III medical devices to be supported by US FDA 510k clearances. Such ARTG applications must also be supported by an MDSAP QMS certificate.

CLOSING PLENARY SESSION

The closing session of IMRP 2024 brought the event to a thoughtful conclusion, reflecting on the key themes of sustainability, innovation, and collaboration within the radiation processing industry. The session celebrated the progress made over the past few days, highlighting the importance of the environmental, commercial, and technical sustainability of irradiation technologies. Participants were reminded of the industry's growing commitment to addressing environmental challenges, and the keynote speaker's insights into sustainability left a lasting impression on the audience.

A key feature of the closing session was the roundtable discussion, which provided a platform for open dialogue among industry leaders, experts, and attendees. The conversation focused on the future of radiation processing, emphasizing the need for continued collaboration to meet the evolving demands of the market. Topics covered included advancing environmental regulations, sustainability practices, and how the industry can support emerging technologies. The roundtable reinforced the idea that collective efforts and knowledge-sharing are essential to driving the industry forward and addressing global challenges.

As the session concluded, participants were encouraged to remain engaged with the iia and the broader irradiation community, emphasizing the importance of building relationships and sharing expertise to advance the field. The closing remarks also highlighted upcoming initiatives and the anticipation of future IMRP events, leaving attendees with a sense of optimism and purpose as they returned to their professional endeavors.

Awards



IMRP LAUREATE AWARDS

IMRP Laureates are awarded to individuals who have had a significant impact on the commercial or scientific application of irradiation and to those who have contributed to the development of the irradiation industry. Laureate awards were introduced at the second International Meeting on Radiation Processing held in Miami in 1978. Usually there are two Award winners, a Business Laureate and Scientific Laureate. Over the past 44 years, 41 Laureates have been awarded.



The recipient of the IMRP 2024 Scientific Laureate Award was **Alain Strasser**.

Alain Strasser has been general manager of Aerial, a private R&D organization (36 people) that makes the link between researchers and industrial needs, for almost 30 years. Listening to industrial needs has been our leitmotif for the 38 years of Aerial's existence.

Alain is a pioneer in high energy X ray and electron beam conversion (his PhD work in 1991). His mentor was Marsh Cleland...and he has done many X ray trials for IBA in the last 20 years.

He is the 'father' of our Feerix facility, a great idea we had almost 10 years ago, which has become a very important platform for the future of our industry. Feerix is dedicated to performing tests and trials mainly for the medical device industry at a time where many stakeholders are interested in looking into alternative technology to radioactive sources. Feerix is also an excellent venue for both theoretical and practical training courses for E beam and X ray technologies, which is the key for maintaining competences and the further growth of our industry.

Alain achieved Aerial's position as an IAEA Centre of Excellence in 2016. Activities through the agency are also fully in line with our DNA...!

He contributed heavily to the organization of IMRP 19 in Strasbourg, and one year later in 2020, during the pandemic, Alain proposed to IBA that a food irradiation symposium be created, IFIS. The third IFIS meeting will be held in China by the end of this year. Indeed, Alain is a great promoter of food irradiation, especially phytosanitary application and spices decontamination. He keeps communicating with the European Union on that matter, trying to convince our European deputies to update the regulations.



The recipient of the IMRP 2024 Business Laureate Award was **Murray Lynch**.

Murray retired in September of 2024 after more than 43 years of employment with Steritech. From an entry level warehouse role, Murray rose through the ranks finishing his career as CEO, a role he has held for 14 years. As CEO, Murray has displayed outstanding vision,

innovation and leadership for both Steritech's business and the wider radiation industry. Murray has led a team that has expanded to over 140 staff, successfully achieving what many considered impossible, including several world-first advancements in the application of phytosanitary irradiation.

Murray has navigated the financial, technical and operational challenges of being a first mover in phytosanitary irradiation in Australia. He has long championed phytosanitary irradiation in Australia and around the world, even when he was faced with strong resistance from almost all stakeholders. At times this included questions from within Steritech on the viability of the phytosanitary business. While Murray could never have predicted the challenges that lay ahead, he had a clear vision which he remained steadfast and focused on, breaking insurmountable challenges into smaller achievable steps of progress that were each celebrated by a steadily growing number of supporters. While investing in his vision, he continued to lead a profitable and growing core business.

During this 20-plus-year phytosanitary journey, Murray identified government and industry stakeholders, working with them to develop effective food standards, guide research, contribute to papers and support the development of trade protocols. He recognised the importance of Steritech not only being an expert in irradiation but also an expert in biosecurity and fresh produce trade. In particular, he has demonstrated patience and persistence in emphasising the importance of maintaining quality across all aspects of the product, including cold chain infrastructure, rather than focusing solely on the treatment process.

In 2020 Murray opened Australia's second purpose-built fresh produce treatment facility. In doing so he realised the application of new X-ray source technology for phytosanitary irradiation, which became the world's first commercially operational, purpose-built fresh produce EBX facility.

Murray's ability with people and talent development has been critical to building, operating and maintaining this facility. It was only three months after opening when the global COVID pandemic struck. Murray's leadership and relationships as well as the team he had assembled proved critical to the unfathomable task of maintaining and operating this complex new equipment, while also maintaining strong growth in the volume of fresh produce treatments, outperforming rest-of-market trade during this time.

Steritech now operates two purpose-built phytosanitary facilities that treat fresh produce 52 weeks a year. The business services over 80 different fresh produce crops for three domestic states and six export markets. The treatment is used by every supermarket retail chain in Australia and has been critical to maintaining trade under emergency biosecurity circumstances.

Murray has led a team that not only pioneered the first treatment of an international shipment of fresh produce but also built the most diverse phytosanitary irradiation business globally, ranking as the second largest by volume after Benebion in Mexico.



IMRP Laureate Award recipients at IMRP 2024: Alain Strasser (left) and Murray Lynch (right)

IMRP EARLY CAREER PROFESSIONAL AWARDS

At IMRP 2024, the Early Career Professional (ECP) Award was introduced to celebrate the achievements of emerging leaders in the irradiation industry. This award spotlights the contributions of Early Career Professionals and highlights their potential as future leaders in the field.

The recipients of the inaugural IMRP 2024 ECP Awards are:

- *Nicolas Ludwig Aerial, France*
- *Spencer Mickum Steris, USA*
- *Abbas Nasreddine Aerial, France*
- *Gustavo Varca E-Beam Services, USA*
- *Ariadhne Vargas Rivadeneira IBA, Bolivia*



Early Career Professionals Award recipients left to right:
Ariadne Vargas Rivadeneira, Abbas Nasreddine, Nicolas Ludwig, Spencer Mickum, Gustavo Varca.

POSTER AWARDS

The committee decided to award three poster award winners in the categories of Best Industry, Best Scientific, and Best Overall Poster. The poster committee shortlisted 5 authors in each category. These 15 authors presented a 5-minute pitch during the Poster and Networking Reception. Then, for the first time ever, the audience got to vote for their favorite poster.

Each winner received an award of USD500 by wire transfer. Printed certificates were given to the winners immediately after the voting period.

Best Industry Poster - Damien Preels

How to accurately calibrate the scanning and pseudo-parallel magnets in an X-ray center?

Damien PRIEELS¹, Donovan Marechal¹, Frédéric Dessy¹, Abbas Nasreddine², Florent Kuntz².

¹Industrial, IBA, Louvain-la-Neuve, Belgium; ²Aerial CRT, Illkirch, France

In a typical X-ray center, the end of the beam line is equipped with an X-ray horn in which the electron beam is scanned on an X-ray converter to produce the X-ray field. The scan horn may also include a pseudo-parallel magnet to adjust the divergence of the electron beam to offer a focusing or defocusing effect.

The calibration of those magnets is typically performed by measuring the X-ray profile along the scan direction. Methods are proposed in ISO/ASTM 51649 for electron beam width determination, but users have developed their own method for X-ray scan width assessment. In these methods, no distinction is made between the beam width and scan width while those are two distinct quantities. While such approximation was acceptable until now, it should be revisited due to the context evolution. In particular, the emphasis put on Monte Carlo simulations, to predict dose in product and to 'calibrate' X-ray sites, forces manufacturers to calibrate the magnets to the physical scan width. Failure to do so may generate confusion and hurdles when comparing measurements with simulations. Also, the trend towards parametric release might benefit from a closer look at this variable which has a direct impact on the dose.

Measuring accurately the scan width in X-ray is more difficult than it may appear. Difficulties come from the non-accessibility to the electron beam, possible misalignment of the detector with the beam, contamination of the X-ray field by electrons, non-uniformity of the beam etc.

This paper will present a method for determination of the physical scan width, its calibration as well as the pseudo-parallel magnets setting to minimize the different sources of inaccuracy. Experimental work was performed on the 7 MV X ray beam line of the Feerix® facility of Aerial.

Best Scientific Poster - Suresh Pillai

It's not all about the dose - The case of eBeam - Mediated PFAS destruction.

Bo Wang¹, John Lassalle¹, Purshotam Juriasingani², David Staack¹, Suresh Pillai¹.
¹National Center for Electron Beam Research, Texas A&M University, College Station, TX, United States; ²TetraTech, Inc, Austin, TX, United States

We had previously established that high eBeam doses were necessary for meaningful PFAS degradation in environmental matrices. Upon exposure to 2000 kGy, the PFOS

concentrations in composted biosolid samples decreased from 59.3 ng/g in untreated samples to 2.01 ng/g in eBeam treated samples, showcasing a 94% total PFOS degradation. In non-composted biosolid samples, PFOS concentration decreased from 20.5 ng/g to 0.98 ng/g (93.6% reduction), and PFOA concentration in residual solids fell below analytical detection limits. In such high dose treatments, sample temperatures as high as 400°C can be encountered. Was PFAS destruction only due to the eBeam dose or temperature or both? Therefore, we devised experiments to investigate the impact of temperature increase during a 2000 kGy treatment on PFAS degradation. We focused on incremental low eBeam doses (25 kGy) applied to PFAS-impacted biosolid samples and non-composted biosolid samples until reaching a total of 2000 kGy. The results were striking. A distinct difference emerged in the results obtained when the biosolid samples were directly exposed to 2000 kGy compared to sludge samples exposed to 2000 kGy incrementally (without concurrent temperature effects). In the composted biosolid samples, the reduction of PFOS was 14% at 500 kGy, 25% at 1000 kGy, and 47% at 2000 kGy, in contrast to the 97% reduction observed when the same biosolid samples were directly exposed to 2000 kGy. Thus, approximately 50% of the observed PFOS reduction at high eBeam doses can be attributed to temperature effects, while the remaining 50% can be attributed to the involvement of ionization chemistry and a synergy between ionization chemistry and temperature.

Best Overall Poster - Nicolas Ludwig

Upon PMMA degradation by radiation technology for recycling application.

Nicolas Ludwig¹, Florent Kuntz¹, Marina Pecora², Damien Favier², Christian Gauthier², Jacques Lalevée³, Quentin Raffy⁴. ¹Aerial CRT, Illkirch, France; ²Institut Charles Sadron CNRS, Strasbourg, France; ³Institut de Science des Matériaux de Mulhouse CNRS, Mulhouse, France; ⁴Institut Pluridisciplinaire Hubert Curien CNRS, Strasbourg, France

Nowadays, the management of plastic waste represents a major challenge. If recycling is already in place in some sectors, it struggles to gain widespread interest. In the case of PMMA, the use of thermochemical treatment has proven its effectiveness in the depolymerization [1], however, it requires much energy which can limit its industrialization [2]. As PMMA is well known to be degraded by radiation treatment through chain scissions mechanisms [3], in this work, PMMA was irradiated in order to optimize these effects and to initiate the depolymerization. The possibility of degrading crosslinked PMMA, which reprocessability is limited, has been explored additionally.

Three grades of PMMA have been used: casted ($M_w=3,000,000$ g.mol⁻¹); extruded ($M_w=70,000$ g.mol⁻¹); casted and crosslinked ($M_w=3,000,000$ g.mol⁻¹). Irradiations were conducted on the Aerial feerix[®] plant with 7 MV X-rays and 10 MeV electron beam, as well as on IPHC's cyclotron Cyrécé with 24 MeV proton beam. Irradiation temperature has also been taken into consideration. Mechanical measurements, HPLC-SEC, DSC and gel fraction

analysis were performed to evaluate post irradiation modifications in chemical structure and properties.

PMMA has shown a degradation in chain size and in properties in every irradiation condition which is consistent with occurring chain scissions. Looking at chain size, it appears that irradiation tends to standardize the polymer molecular mass after exposure, even with different initial chain lengths. Crosslinked PMMA could be degraded by irradiation from 100 % gel fraction down to 0 % at high absorbed dose.

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IMRP 2024 was enhanced considerably by the organizations that sponsored the meeting. The success and long-term viability of IMRP is made possible by the support of sponsors.

The iia particularly thanks Regional Sponsors STERIGENICS and NORDION who made the largest financial contribution to the meeting.

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The iia also thanks the International Atomic Energy Agency (IAEA) for their financial contribution that enabled several students to attend IMRP 2024.





Pre- Conference Workshop



PsIP

phytosanitary
irradiation platform

Pre-Conference Workshop

SUNDAY 3RD NOVEMBER 2024

Unlocking the Potential of Phytosanitary Irradiation

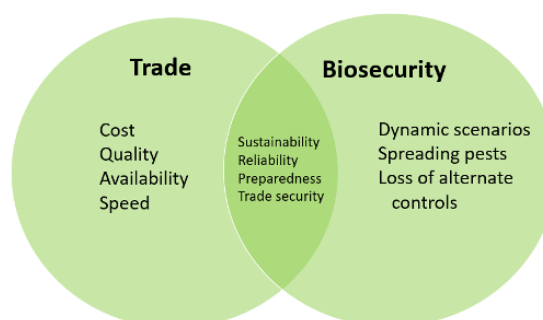
The 'Unlocking the Potential of Phytosanitary Irradiation' workshop, held on Sunday 3 November 2024, brought together 35 participants from 13 countries to explore and identify the necessary steps to support and promote the phytosanitary irradiation industry. The PsIP would like to thank all presenters and participants for contributing to this energetic and productive workshop.

The workshop began with three opening presentations from industry experts, then moved towards interactive discussion with participants. The meeting highlighted the difference between 'phytosanitary irradiation' that treats fresh products for biosecurity purposes, 'food irradiation' for food safety and security purposes and 'sterile insect techniques' used to mitigate damage caused during the in-field growth stage. With its complex stakeholder landscape, phytosanitary irradiation addresses biosecurity needs while facilitating international trade.

Trade & Biosecurity: The dual drivers of phytosanitary irradiation

Discussions highlighted the dual drivers of phytosanitary irradiation: trade and biosecurity. Trade opportunities are enhanced once biosecurity risks are addressed. Trade opportunities are further enhanced as irradiation can contribute to cost efficiency, product quality, availability, and speed. Biosecurity is of importance where there is a risk that invasive pests could cross regional, national or international borders resulting in the spreading of pests that could result in long-term damage to ecosystems. Techniques to address biosecurity are limited, with diminishing alternatives while maintaining controls that offer reliable solutions. Irradiation provides an effective solution whilst also addressing sustainability, preparedness, and trade security.

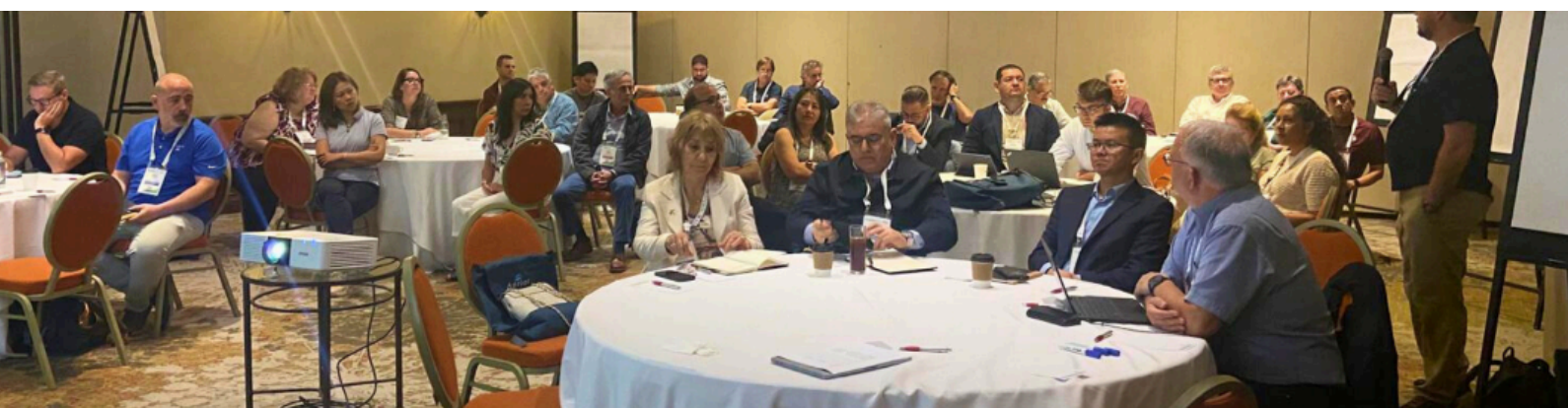
The workshop explored the wide array of challenges in implementing this technology, including regulatory compliance, facility design, market access, and consumer acceptance, underscoring the multidisciplinary effort required to succeed.



The Three Pillars: A framework for addressing all challenges.

To focus efforts and address the complex challenges that come with implementation the workshop organized discussions around three pillars: **'Facilities'**, **food 'Standards'**, and **trade 'Protocols'**. These three pillars served as a framework for addressing technical, regulatory, and market-related challenges.

The workshop outcomes revealed a lack of common understanding and varying regional regulations. There was a consensus that the three pillars were a valuable tool which helped assimilate the plethora of matters that need to be addressed in order to unlock the potential of phytosanitary irradiation.



Outcomes and future actions for PsIP

The workshop considered the work of the IAEA/FAO, the focus of IFIS (International Food Irradiation Symposium) and PsIP. It was agreed that, where appropriate, the work of these three initiatives should be aligned.

- The workshop helped the PsIP to identify the following future actions:
- Evolve to create a wider community of engaged participants
- Include new individuals to help support the PsIP Steering Committee
- Undertake initiatives to address matters of common interest such as
 - stakeholder mapping
 - hosting more regional events
 - evolving strategies
 - documenting best practices to guide and expand the adoption of phytosanitary irradiation



Technical
Tours

TECHNICAL TOURS

IMRP technical tours are always popular as an opportunity to visit a facility and learn more about their technologies and operations. For the final day of IMRP 2024, Sterigenics EO Facility Tour and STERIS Applied Sterilization Technologies E-beam and EO Facility Tour made their facilities available. Both tours were quickly fully booked by 73 participants.

Sterigenics EO Facility

The Sterigenics EO Facility in Costa Rica is located in Zona Franca ProPark contiguo a Dos Pinos, Alajuela.

The technical tour was of the site that offers a 3 Pallet Sterilizer, 6 Pallet Sterilizer and 15 Pallet Sterilizer. The site also offers EOSTat® Rapid Processing, Process Validation and Parametric Release.

More Information at: <https://sterigenics.com/location/alajuela-costa-rica/>

STERIS Applied Sterilization Technologies E-beam & EO Facility

The STERIS Applied Sterilization Technologies E-beam and EO Facility in Costa Rica is located in Alajuela.

The technical tour was of the site that offers 2 EO Lines that have a capacity of 6 standard pallets or 8 Euro pallets, 3 EO lines that have a capacity of 14 standard pallets or 16 Euro pallets and 2 10MeV, 15kW horizontal delivery Electron Beams.

More Information at: <https://www.steris-ast.com/site/alajuela-costa-rica/>

Quina Nida

Appendices

APPENDIX 1: List of Oral Presentations

This appendix and the following ones list the presentation titles and the authors. Links to the oral presentation are given where sharing of the presentation has been authorized.

Plenary Sessions

Plenary 2 - High level updates on important industry segments

Moderator: Richard Wiens

PL2.2

Medical devices

Emily Craven

PL2.3

Bioprocessing

Samuel Dorey

PL2.4

Phytosanitary

Murray Lynch

Plenary 3 - High level updates on the various radiation processing technologies

Moderator: Richard Wiens

PL3.1

Session Introduction

Richard Wiens

PL3.2

Gamma

Richard Wiens

PL3.3

X-ray/E-beam

Thomas Servais

Plenary 4 - Sustainability and science

Moderator: Richard Wiens

PL4.1

Sustainability approach

Christoph Herkens

PL4.2

Applications of E-beam

Suresh Pillai

PL4.3

Polymer modification

Xavier Coqueret

PL4.4

Environmental applications

Bumsoo Han

Plenary 5 - Asia Regional Update

Moderator: Richard Wiens

PL5

Asia Regional Update

Shen Lixin

Plenary 6 - Sustainability Key Note & Round Table

Moderator: Brain McEvoy

PL6.1

Keynote Lecture: Introduction to sustainability

Amit Limaye

PL6.2

Cobalt-60 supply chain sustainability

Corby Nicholson

PL6.3

Sustainability for irradiated product used in biopharma and the new challenges

Lucie Delaunay

Plenary 7 - Sustainability Presentations

Moderator: Brain McEvoy

PL7.1

Coupling Sustainability Assessments with Business Continuity Strategies for Implementation of Multiple Sterilization Technologies

James Hathcock

PL7.2

Maximizing waste valorization: Identifying electron accelerator technologies for the future and supply chain needs

Jennifer Elster

PL7.3

Making X-Ray carbon neutral: challenges & way forward

Anthony Lemmens

PL7.4

Roundtable

Amit Limaye

PL7.5

Blue Flag accreditation ceremony

Plenary 8 - Education and Leadership Development (SfSAP; iia Leadership Program, AAMI)

Moderator: Arthur Dumba

PL8.1

International Irradiation Association Leadership Program. Benefits for companies, students, and industry professionals

Adrian Arias-Blanco

PL8.1

International Irradiation Association Leadership Program. Benefits for companies, students, and industry professionals

Emily Glowski

PL8.2

What is an expert in sterility assurance? How can I become one?

James Vesper

PL8.3

On-line training courses for the next generation of radiation processing professionals

Florent Kuntz

PL8.4

On-line training courses for the next generation of radiation processing professionals

Amanda Benedict

PL8.5

On-line training courses for the next generation of radiation processing professionals

Deepak Patil

Plenary 9 - Regulatory (HC/Pharm/Phyto)

Moderator: James Vesper

PL9.1

Keynote: A survey of the regulatory landscape

Kimberly Patton

PL9.2

Assessing the Most Appropriate Radiation Source for Healthcare Products

Alan Montgomery

PL9.3

Regulatory Approaches, Challenges, and Successes with Risk Evaluation, Qualification and Acceptance of X-ray Sterilization as an Equivalent Alternative to Gamma

James Hathcock

Phytosanitary Irradiation Sessions

Phyto1 - Phytosanitary Irradiation: Global Insights: Unveiling the World of Phytosanitary Irradiation

Moderator: Ariadne Vargas Rivadeneira

Phyto1.1

Introduction: Global Insights

Ariadne Vargas Rivadeneira

Phyto1.2

PsIP workshop summary - Key learnings for the journey

Paul Wynne

Phyto1.3

Summary of AM19002

Benjamin Reilly

Phyto1.4

Cereals, Grains and Legumes Irradiation for Türkiye: Past, Present and Future Opportunities

Nurcan Centinkaya

Phyto2 - Phytosanitary Irradiation: Clearing the Path: Navigating the Regulations of Phytosanitary Irradiation

Moderator: Benjamin Reilly

Phyto2.1

Introduction: Clearing the Path

Benjamin Reilly

Phyto2.2

USDA programs

Laura Jeffers

Phyto2.3

Progress on establishing an X-ray sanitary and phytosanitary research and development program for horticulture in New Zealand

Lisa Jamieson

Phyto2.4

Guidelines for the harmonization of regulations in Latin America and the Caribbean for the commercialization of irradiation technology based on International Standards for Phytosanitary Measures

Emilia Bustos Griffin

Phyto3 -Phytosanitary Irradiation: Harvesting Innovation: The Producer's Take on Phytosanitary Irradiation for Fresh Produce

Moderator: Arved Deecke

Phyto3.1

Introduction: Harvesting Innovation

Arved Deecke

Phyto3.2

Phytosanitary Irradiation in Costa Rica: Estimated volumes for phytosanitary irradiation

Diogenes Rodriguez

Phyto3.3

COCANMEX: First to market: Growing a prosperous business out of the market access opportunity that phytosanitary irradiation provides to Mexican growers and exporters of fresh produce

Roger Gay

Phyto3.4

EMEX: Mangoes irradiation: How irradiation complements water treatment

Tim Jones

Phyto4 - Phytosanitary Irradiation: Tech Challenges and Breakthroughs: Advancing Phytosanitary Irradiation Solutions

Moderator: Paul Wynne

Phyto4.1

Introduction: Tech Challenges and Breakthroughs

Paul Wynne

Phyto4.2

Me vex high-capacity and short treatment cycle time food irradiation system

Shane Stutchbury

Phyto4.3

Versatile solutions for phytosanitary irradiation and multi- purpose applications

Ariadnne Vargas Rivadeneira

Phyto4.4

Success of X-Ray for produce – establishing, operating and installing second machine

Benjamin Reilly

Phyto4.5

BENEBION: Adding an X-Ray treatment modality to our phytosanitary treatment facility

Arved Deecke

Radiation Sterilization Sessions

RadSter1 - Radiation Sterilization: Part 1

Moderator: Vu Lekate

RadSter1.1

Opening

Vu Lekate

RadSter1.2

The Standard Distribution of Resistances (SDR) - History and Future

Martell Winters

RadSter1.3A

Filling data, education and tool gaps that impede the expansion of x-ray and electron beam for sterilization – progress of Team Nablo, an international collaboration

Leo Fifield

RadSter1.3B

Low(er) Energy Radiation Solutions – Accelerating Acceptance

John Logar

Low(er) Energy Radiation Solutions – Accelerating Acceptance

Michael Fletcher

RadSter2 - Radiation Sterilization: Part 2

Moderator: Vu Lekate

RadSter2.1

Combined effects (dose, dose rate, irradiation atmosphere and irradiation temperature) on polymer modification during radiation sterilization treatment – An EPR study

Nicolas Ludwig

RadSter2.2

Radical detection and electron-spin resonance (ESR) monitoring in polymer materials irradiated with gamma, X-rays and e-beam

Blanche Krieguer

RadSter2.3

Considerations for transferring product from gas to radiation

Thor Rollins

RadSter3 - Radiation Sterilization

Moderator: Vu Lekate

RadSter3.1

Implementing X-ray as an alternative and additional sterilization method for polymeric materials used in pharmaceutical and biopharmaceutical manufacturing

Weibing Ding

RadSter3.2

Streamlining the design of irradiation solutions with pre- engineering

Sébastien Masson

RadSter3.3

Mevex's compact self-shielded E-beam system: answering the industry's demand for in-house sterilization

Shane Stutchbury

RadSter3.4

Gamma/E-beam/X-ray economical analysis in China scenario

Wei Peng

RadSter4 - Radiation Sterilization (Continued)

Moderator: Vu Lekate

RadSter4.1

Sustainable packaging considerations for radiation processing

Wendy Mach

RadSter4.2

Effectiveness of a conversion program

Christophe Deneux

RadSter4.3

The application of Monte Carlo simulations to electron beam sterilization processes: a case of study on industrial dosimetry

Eric Crawley

The application of Monte Carlo simulations to electron beam sterilization processes: a case of study on industrial dosimetry

Adrian Arias-Blanco

RadSter4.4

Q&A

Tech Theatre Presentations

TT-Rad1 - Radiation Field

Moderator: Simon Forknall

TT-Rad1.1

Influence of irradiation on the antioxidant capacity of green coffee

Daili Barreira

TT-Rad1.2

Electron beam technology isn't a one-trick pony—it's revolutionizing sustainable waste recycling with its emerging applications

Suresh Pillai

TT-Rad1.3

Innovative Solutions for Complex Challenges: How Reveam Applies Advanced Accelerators to Transform Food Safety and Quality

Chip Starns

TT-Rad1.4

Experimental and simulation studies of POPs degradation by e-beam application to PFAs

Stephane Lucas

TT-Dos1 - Dosimetry Square

Moderator: Aaron Neighbour & Brian McEvoy

TT-Dos1.1

Calibration, intercomparison and simulations: Key factors in dosimetry for better phytosanitary treatment

Bimo Saputro

TT-Dos1.2

Comparison of Kerma water and absorbed dose to water for high energy X-ray irradiation – A Monte Carlo simulation approach for absorbed dose estimation

Abbas Nasreddine

TT-Dos1.3

Virtualization of System Parameters for Dose Distribution Optimization

Spencer Mickum

TT-Dos1.4

Applications of Mathematical Modelling at gamma irradiator sites

Chris Howard

TTEquip1 - Equipment Alley

Moderator: Gustavo Varca

TT-Equip1.1

Electron linear accelerators for industrial applications

Sergey Kutsaev

TT-Equip1.2

Electrical grid resiliency measures for electron beam and X-ray facilities

Jennifer Elster

TT-Equip1.3

A case study of addressing supply chain bottlenecks by building an internal sterilization solution

Thomas Bunch

TT-Equip1.4

Roadmap to an Electron Beam or X-ray Center for Industrial Applications

Jodi Lieberman

TT-Rad2 - Radiation Field

Moderator: Mark McCorkell

TT-Rad2.1

Growing cobalt-60 supply for a sustainable futures

Michael Aube

TT-Rad2.2

Securing gamma sources on a budget: multi-use technologies

Michal Kuca

TT-Rad2.3

Small Scale, Big Opportunity

Junwei Zhao

TT-Dos2 - Dosimetry Square

Moderator: Michael Pageau

TT-Dos2.1

Irradiation Sterilization of Medical Devices – A guidance document on Release Based on Irradiation Parameters (RBIP).

Mark Bailey

TT-Dos2.2

Process Control - Low energy e-beam sterilization at Tetra Pak Filling machines

Arne Miller

TT-Dos2.3

Steris E&T Dose Monitor Real-time dose delivery: Rethinking critical processing parameters in machine monitoring

Shane Stutchbury

TT-Dos2.4

Trend Towards Machine-Based Release in X-ray Sterilization

Damien Prieels

TTEquip2 - Equipment Alley

Moderator: Samuel Dorey

TT-Equip2.1

A new generation of X-Ray solutions with automatic beam tuning & continuous OQ

Jeremy Brison

TT-Equip2.2

The rise of Solid-State power - a game changer in the accelerator world

Arnaud Pierard

TT-Equip2.3

Progress in developing a superconducting accelerator for efficient X-ray production

Jayakar Thangaraj

TT-Equip2.4

The Future of X-ray Irradiation: Addressing Supply Chain Risks and Opportunities

Desmond Harmon

TT-Rad3 - Radiation Field

Moderator: Kyrstan Polaski

TT-Rad3.1

Integrated Approach for Bulk Pharmaceutical Sterilization

Bryce Telford & Zabrina Tumaitis-Namba

TT-Rad3.2

Dose Establishment - Are we asking the right question?

John Logar

TT-Rad3.3

Sulfamethoxazole degradation in aqueous solution under electron beam irradiation

Yongxia Sun

TT-Dos3 - Dosimetry Square

Moderator: Alain Strasser

TT-Dos3.1

Challenges of Perspex lab calibrations verses in-situ calibration

Scarlett Kynance

Considerations when using alanine tape tab dosimeters on frozen product during irradiation

Scarlett Kynance

TT-Dos3.2

Increasing the predictability of E-beam processing: practical cases & evidences

Arnaud Pierard

TT-Dos3.3

Monte Carlo simulation of product qualification in gamma irradiators

Ines Duarte

TT-Dos3.4

An Irradiation platform to educate, promote and disseminate the benefits of using electron accelerators

Florent Kuntz

TTEquip3 - Equipment Alley

Moderator: Ariadne Vargas Rivadeneira

TT-Equip3.1

E-Beam and X-Ray – More than meets the eye

Joern Meissner

TT-Equip3.2

Optimization of Bremsstrahlung X-ray converters for radiation processing

Thomas Kroc

TT-Equip3.3

Variable Scan in X-Ray: Make X-Ray even simpler and more accessible

Jeremy Brisson & Ariadne Vargas Rivadeneira

TT-Rad4 - Radiation Field

Moderator: Simon Forknall

TT-Rad4.1

A Multidimensional Approach to Safety and Efficacy in Radiopharmaceuticals

Alan Montgomery

TT-Rad4.2

Radiation Treatment strategies for Conservation of Tunisian Cultural Heritage: Utilization for safeguarding noble textile in women's ceremonial attire.

Arbi Mejri

TT-Rad4.3

How do cross-linkers and stabilizers compete in irradiated thermoplastics of relevance for the cable industry?

Xavier Coqueret

TT-Rad4.4

Summary of CGN Dasheng's innovation in Electron Accelerator technology and industrial applications

YanJun Liu

TT-Dos4 - Dosimetry Square

Moderator: Florent Kuntz

TT-Dos4.1

Virtual dose mapping as a tool to minimize dose uniformity ratios (DUR) and maximize throughput

Tobias Funk

TT-Dos4.2

RisøScan 2.0

Jacob Hjørringgaard

TT-Dos4.3

Implementing dynamic geometries, temporal particle tracking and simulation synchronization for full 4-D Monte Carlo simulations in EGSnrc

Malcolm McEwen

TTEquip4 - Equipment Alley

Moderator: Vu Lekate

TT-Equip4.1

Steris E&T compact self-shielded E-beam system: answering the industry's demand for in-house sterilization

Shane Stutchbury

TT-Equip4.2

A new generation of cybersafe Process Control Systems for operator-less industrial operations

Dominique Vincent

TT-Equip4.3

Scattering Plates - Experimental results vs Monte Carlo

Arnaud Pierard

TT-Rad5 - Radiation Field

Moderator: Mark McCorkell

TT-Rad5.1

Radiation Security – Cobalt 60 transport and use in industrial irradiators in North America

Greg Fulford

TT-Rad5.2

Secure In-Place Storage (SIPS): Safe and secure interim storage options for disused radioactive sealed sources to strengthen end-of-life management.

Rahul Muralidharan

TT-Rad5.3

Lifetime management - recycling old Cs-137 radiation sources: development of an environmentally friendly technology to reduce radioactive waste

Gabor Kaszas

TT-Rad5.4

BVN - Improving the method for process release

John Logar

TT-Dos5 - Dosimetry Square

Moderator: Gustavo Varca

TT-Dos5.1

Practical application of mathematical modelling to optimize Operational Qualification activities

Michel Herve

TT-Dos5.2

Virtual Dose Mapping of a Gamma Irradiation Facility to Study Sensitivity of Dose Uniformity to Operational Parameter Variations

Tobias Funk

TT-Dos5.3

What is a homogeneous product in X-ray processing?

Ines Duarte

TT-Dos5.4

PUFFIn – A user friendly fast interface for calculating and visualizing the dose distribution in irradiated products

Randolph Schwarz

TTEquip5 - Equipment Alley

Moderator: Richard Wiens

TT-Equip5.1

Ensuring Food Security and Food Safety by Examining the Feasibility of Implementing eBeam/X-ray Technologies

Oscar Acuna

TT-Equip5.2

Towards new service and operational models with guaranteed uptime: Dream or reality?

Valentin Archontidis & Emmanuelle Wagnies

TT-Equip5.3

A Case Study on Designing and Implementing a Sustainable Integrated Cybersecurity and Physical Protection System to Protect Radiological Sources and Operational Systems at a Gamma Irradiation Facility

Lorenazo Pedrazzini

TT-Equip5.4

Reveam's Revolutionary High-Throughput Electron Beam Food Processing Facility

Jeff Pelletier

APPENDIX 2: Sponsors and Exhibitors

ITEMS SPONSORED	COMPANY
<i>PREMIUM DELEGATE SERVICES</i>	
DELEGATE BAGS	Aerial
CONFERENCE WEB APP	CGN
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<i>DELEGATE SERVICES</i>	
POCKET GUIDE	GAMMA RECYCLING
REGISTRATION DESK	WUXI
LUNCH BREAK (SOLD PER DAY)	GEX
<i>SOCIAL/NETWORKING</i>	
WELCOME RECEPTION & EXHIBITION OPENINGS	STERIS
GALA DINNER (<i>THURSDAY EVENING</i>)	IBA
EXHIBITION & POSTER NETWORKING SESSION (<i>WEDNESDAY PM</i>)	GIPA
BEST POSTER AWARDS	POND
SUSTAINABILITY	WUXI
<i>TECH THEATRES</i>	
TECH THEATRE "RADIATION FIELD"	STERIS
TECH THEATRE "DOSIMETRY SQUARE" (<i>TUESDAY</i>)	AERIAL
TECH THEATRE "DOSIMETRY SQUARE" (<i>WEDNESDAY</i>)	GEX
TECH THEATRE "EQUIPMENT ALLEY"	SANDIA
<i>TECH THEATRES RECORDINGS</i>	
RECORDINGS - RADIATION FIELD	STERIS
RECORDINGS - DOSIMETRY SQUARE	CGN
RECORDINGS - EQUIPMENT ALLEY	STERIS
<i>PLENARY PRESENTATIONS</i>	
FORUM	GEX
FOOD AND PHYTOSANITARY FORUM (<i>TUESDAY</i>)	GAMMA RECYCLING
REGULATION AND SUSTAINABILITY PLENARY (<i>WEDNESDAY, AM ONLY</i>)	WUXI

List of Exhibitor

EXHIBITOR	LOCATION
<i>Aerial – Technology Resource Centre</i> http://www.aerial-crt.com/en	19-20
<i>AMT - Applied Manufacturing Technologies</i> https://appliedmfg.com/	11
<i>CGN Dasheng Electron Accelerator Technology Co., Ltd.</i> http://www.cgndasheng.com/	6-7
<i>China Isotope Radiation Corporation</i> http://www.circ.com.cn/	9
<i>Etigam</i> http://www.etigam.nl/	10
<i>Gamma-Service Recycling GmbH</i> http://www.gamma-recycling.de/	24
<i>GEX Corporation</i> http://www.gexcorp.com/	25
<i>Hopewell Designs, Inc</i> http://www.hopewelldesigns.com/	23
<i>IBA Industrial</i> http://www.iba-industrial.com/	18-21
<i>International Irradiation Association (iia)</i> https://iiaglobal.com/	27
<i>IZOTOP – Institute of Isotopes Co. Ltd. / Canadvise International</i> http://www.izotop.hu/	13
<i>Office of Radiological Security</i> https://www.energy.gov/nnsa/office-radiological-security-ors	15

EXHIBITOR

LOCATION

Pond & Company<https://www.pondco.com/>

8

RayXpert<https://www.trad.fr/>

22

RI Research Instruments<https://research-instruments.de/en/>

11

Sterigenics / Nordion<https://sterigenics.com/> / <https://www.nordion.com/>

1

STERIS<https://www.steris-ast.com/>

14-17

ThreeRays (Beijing) Technology Co., Ltd<https://www.3raystech.com/>

16

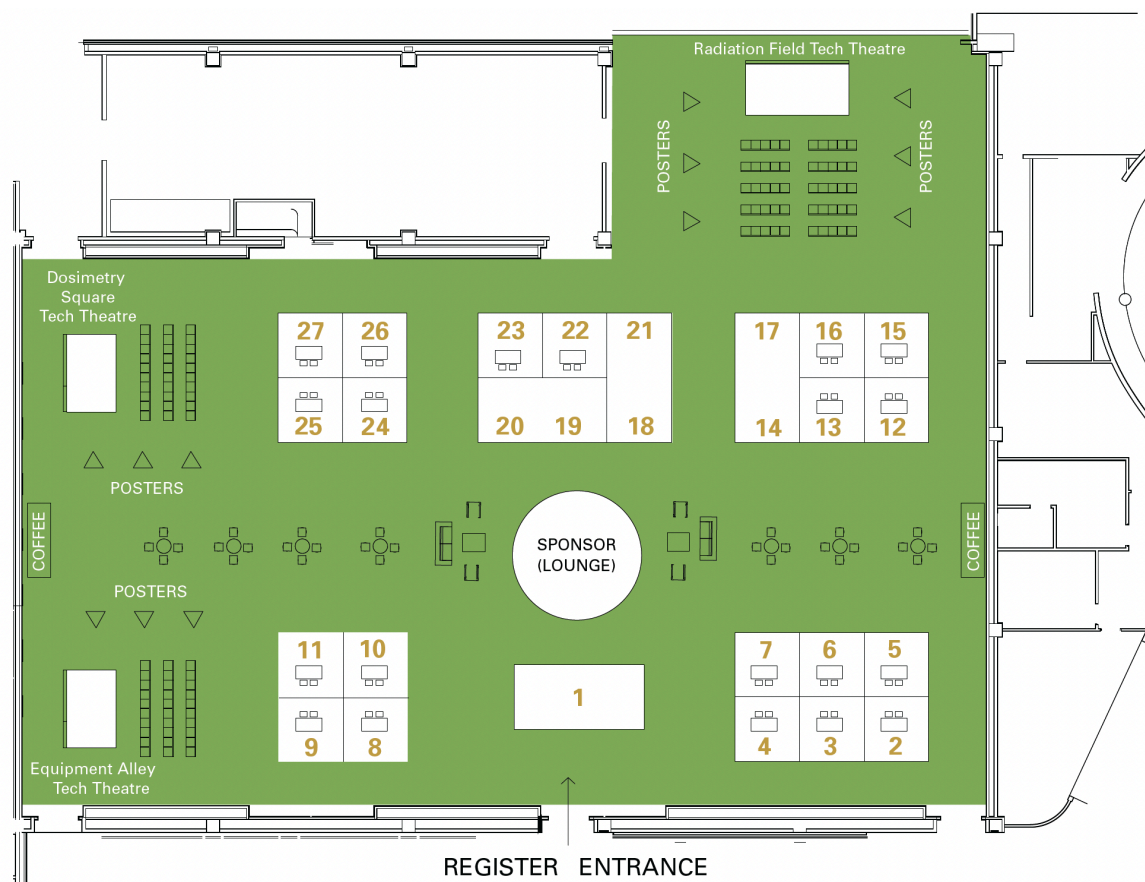
True Indicating, LLC<https://www.trueindicating.com/>

4

Wuxi El Pont Radiation Technology Co., Ltd.<http://www.elpont.net/en>

26

Floor Plan



Exhibitor Listing

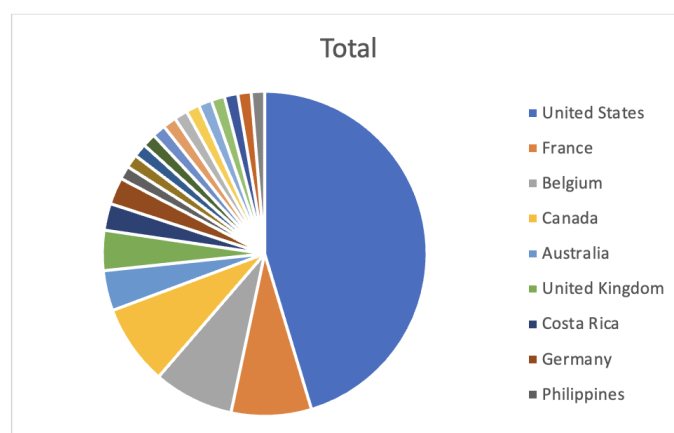
Aérial	19-20	Lituoxinda	16
Applied Manufacturing Technologies	11	Nordion	1
Canadvise International s.a.	13	Office of Radiological Security	15
CGN Dasheng Electron Accelerator Technology Co., Ltd.	6-7	Pond	8
Etigam	10	Research Instruments	3
Gamma-Service Recycling	24	Sterigenics	1
GEX Corporation	25	STERIS	14-17
Hopewell Designs, Inc.	23	TRAD	22
IBA	18-21	True Indicating	4
International Irradiation Association	27	Wuxi El Pont	26
IZOTOP- Institute of Isotopes Co. Ltd.	13		

APPENDIX 3: Conference Feedback and Evaluation

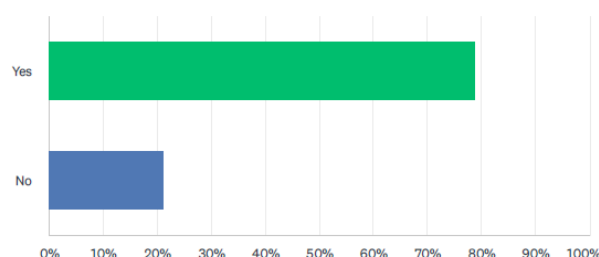
A survey was performed to collect feedback from IMRP 2024 delegates. The survey aims to help iia understand the level of satisfaction with the various elements of the meeting program and organization, and to gather ideas that may be implemented at a future IMRP. The results of the IMRP 2024 survey are as follows:

Q1. Please enter your country of origin:

Country	Count of Country
United States	34
France	6
Belgium	6
Canada	6
Australia	3
United Kingdom	3
Costa Rica	2
Germany	2
Philippines	1
Brasil	1
Switzerland	1
URUGUAY	1
Mexico	1
Bolivia	1
Poland	1
Indonesia	1
China	1
Ireland	1
Brazil	1
Italy	1
India	1
Grand Total	75

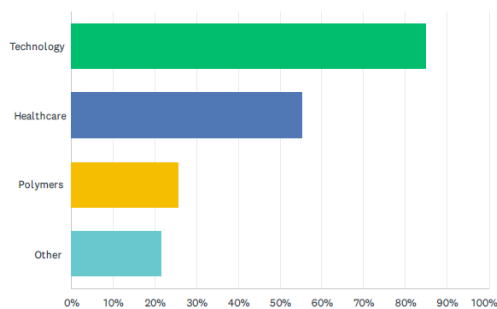


Q2: Is your organization a member of iia?



ANSWER CHOICES	RESPONSES	
Yes	78.95%	60
No	21.05%	16
TOTAL		76

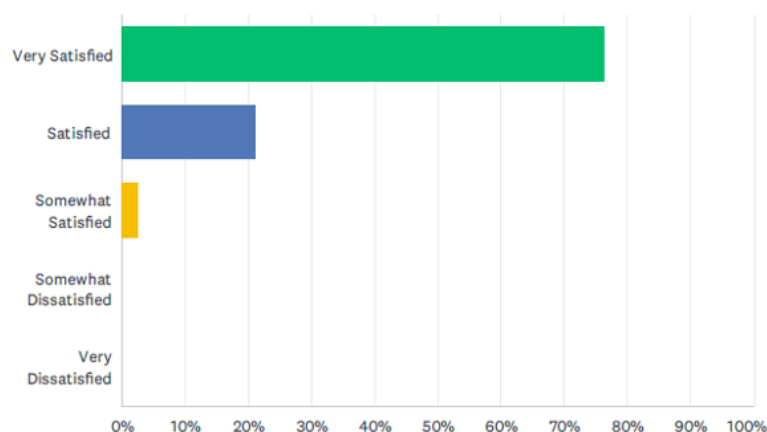
Q3: What are your main interests?



ANSWER CHOICES	RESPONSES	
Technology	85.14%	63
Healthcare	55.41%	41
Polymers	25.68%	19
Other	21.62%	16
Total Respondents: 74		

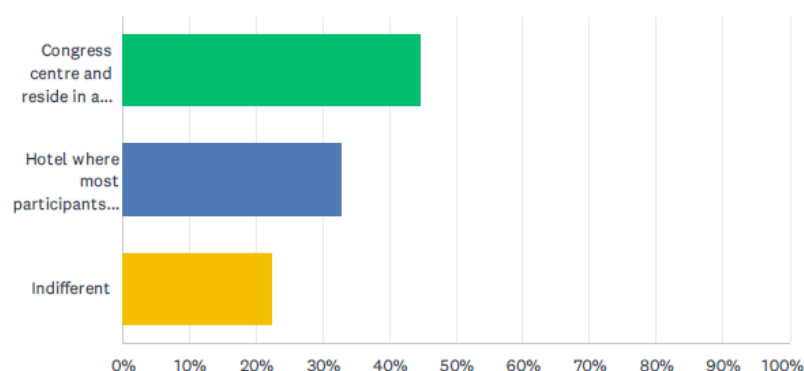
Other Main Interest	Count
Dosimetry	7
Phytopsanitary	2
Source manufacturing	1
How modeling meet sterilization needs	1
Food irradiation	1
Applications	1
Cobalt 60	1
Dosimetry and modeling	1
All technologies ans all applications to radiation	1
Dosimetry, process control	1
Fresh Produce Phytopsanitary	1
Ebeam and x-Ray applications	1
networking	1
Phyto irradiation	1
Process optimization	1
Environment	1
Simulation	1
Environmental	1
Sterility Assurance	1
Food	1
food and phytopsanitary	1
Grand Total	28

Q4. How satisfied overall are you with the IMRP 2024 Conference?



ANSWER CHOICES	RESPONSES	
Very Satisfied	76.32%	58
Satisfied	21.05%	16
Somewhat Satisfied	2.63%	2
Somewhat Dissatisfied	0.00%	0
Very Dissatisfied	0.00%	0
TOTAL		76

Q5: Which kind of IMRP venue do you prefer?



ANSWER CHOICES	RESPONSES	
Congress centre and reside in a different place (like this IMRP)	44.74%	34
Hotel where most participants stay	32.89%	25
Indifferent	22.37%	17
TOTAL		76

Q6: Please rate your satisfaction with the IMRP program:

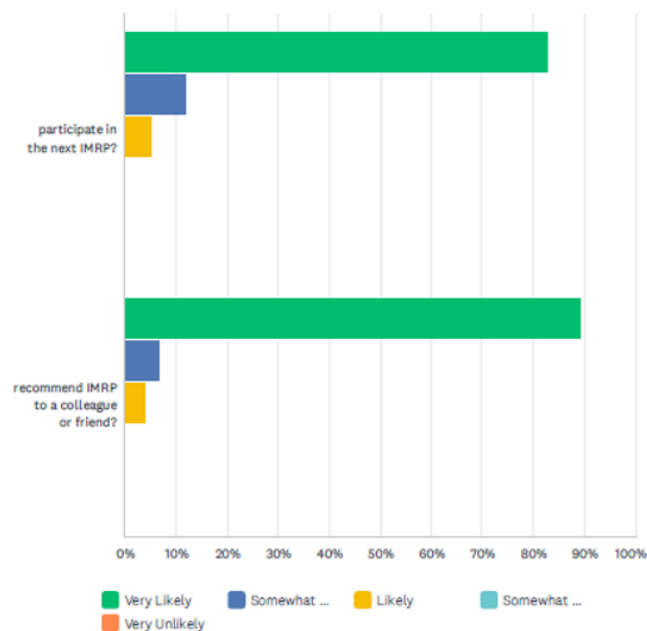
	VERY SATISFIED	SATISFIED	SOMEWHAT SATISFIED	SOMEWHAT DISSATISFIED	VERY DISSATISFIED	NOT APPLICABLE	TOTAL
Program Balance (Plenary vs Forums vs Tech Theatres)	50.00% 38	39.47% 30	9.21% 7	0.00% 0	0.00% 0	1.32% 1	76
Monday Plenary Day	57.33% 43	28.00% 21	6.67% 5	2.67% 2	0.00% 0	5.33% 4	75
Tuesday Radiation Sterilization Forum	58.90% 43	30.14% 22	5.48% 4	0.00% 0	1.37% 1	4.11% 3	73
Tuesday Phytosanitary Irradiation Forum	31.51% 23	20.55% 15	2.74% 2	0.00% 0	0.00% 0	45.21% 33	73
Wednesday Sustainability Plenary	41.10% 30	35.62% 26	15.07% 11	0.00% 0	0.00% 0	8.22% 6	73
Thursday Plenary Day	46.67% 35	32.00% 24	14.67% 11	1.33% 1	0.00% 0	5.33% 4	75
Quantity of Sessions	50.00% 37	41.89% 31	4.05% 3	1.35% 1	0.00% 0	2.70% 2	74
Tech Theatres	45.33% 34	29.33% 22	12.00% 9	9.33% 7	2.67% 2	1.33% 1	75
Wednesday Afternoon Poster Session	48.00% 36	38.67% 29	8.00% 6	2.67% 2	0.00% 0	2.67% 2	75
Exhibition	56.00% 42	36.00% 27	4.00% 3	1.33% 1	1.33% 1	1.33% 1	75
Networking Opportunities	82.67% 62	14.67% 11	2.67% 2	0.00% 0	0.00% 0	0.00% 0	75

Q7. What topics or initiatives would you recommend to be considered for future conferences?

Many topics and initiatives to be considered for future conferences were received from 40 people. This is a summary of the responses received. Please contact the iia if you wish to review all the comments in detail.

1. Many thoughts were shared on program content for a future meeting including: materials compatibility, polymer modification and crosslinking; virtual dose mapping, Monte Carlo simulation vs measured dose results and modelling; artificial intelligence and big data; more pharma/biopharma; more business overview sessions; low energy e-beam and X-ray; parametric release, dosimetry and dose mapping requirements; transfer of irradiation modality; environmental applications, plastic waste and recycling of polymers; net zero for irradiation and long term environmental sustainability; regulation, standards, ISO11137 and ISO audits; routine process optimization; phytosanitary treatment and food irradiation; modernization of legacy equipment; irradiator repair and maintenance; education and training; failures in industrial sterilization etc.
2. Several thoughts were shared of the program arrangements including: make the program more interactive; include brainstorming sessions to identify industry gaps; have fewer talks, be more selective; share a wider range of perspectives with more balanced participation, encourage diversity.
3. Several thoughts were shared on organization of future meetings including: include more dedicated networking opportunities; more tech theatres; more plenary sessions; greater outreach to local community and educational institutes; improve the award voting system to avoid corporate bias; greater assistance in ensuring delivery of exhibitor goods; more food choice and coffee all day; shorter commute from main hotel to venue; photos of every speaker etc.

Q8. How likely are you to participate in the next IMRP:



	VERY LIKELY	SOMEWHAT LIKELY	LIKELY	SOMEWHAT UNLIKELY	VERY UNLIKELY	TOTAL RESPONDENTS
participate in the next IMRP?	82.67% 62	12.00% 9	5.33% 4	0.00% 0	0.00% 0	75
recommend IMRP to a colleague or friend?	89.19% 66	6.76% 5	4.05% 3	0.00% 0	0.00% 0	74

Q9. Please rate your satisfaction with conference logistics:

	VERY SATISFIED	SATISFIED	SOMEWHAT SATISFIED	SOMEWHAT DISSATISFIED	VERY DISSATISFIED	N/A	TOTAL	WEIGHTED AVERAGE
Meeting Space at CCCR	75.68% 56	20.27% 15	2.70% 2	0.00% 0	0.00% 0	1.35% 1	74	1.32
Shuttle Service	33.33% 25	34.67% 26	12.00% 9	1.33% 1	2.67% 2	16.00% 12	75	2.53
Catering - Coffee Breaks	53.95% 41	34.21% 26	7.89% 6	0.00% 0	3.95% 3	0.00% 0	76	1.66
Catering - Lunch Breaks	56.58% 43	30.26% 23	7.89% 6	3.95% 3	1.32% 1	0.00% 0	76	1.63
Welcome Reception	68.92% 51	27.03% 20	1.35% 1	0.00% 0	0.00% 0	2.70% 2	74	1.43
Gala Dinner	50.00% 35	7.14% 5	0.00% 0	0.00% 0	0.00% 0	42.86% 30	70	3.21
Registration Process	72.73% 56	25.97% 20	1.30% 1	0.00% 0	0.00% 0	0.00% 0	77	1.29
Web App imp.guide	49.35% 38	37.66% 29	6.49% 5	1.30% 1	0.00% 0	5.19% 4	77	1.81

Q10. General comments:

General comments were received from 24 people. This is a summary of the key points. Please contact the iia if you wish to review all the comments in detail.

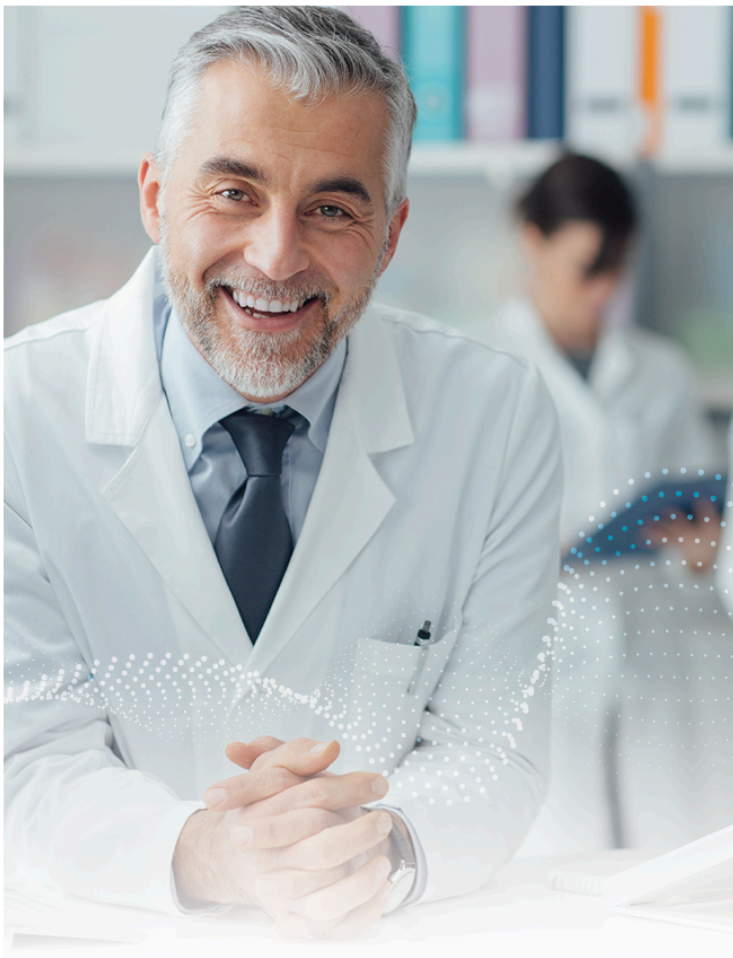
1. Four people commented positively about the Tech Theatres in the exhibition hall. They observed that better sound management, such as temporary curtains or the use of headphones, is necessary to make the presentations easier to hear clearly.
2. Two people commented on the profile of speakers: the balance of plenary speakers was too biased towards older male speakers; too many old guys on the podium.
3. Two people commented on the WebApp: the WebApp was a little difficult to navigate on a cell phone for finding/keeping track of sessions; the web guide was great however it required portrait mode.
4. Three people commented on the regularity of the shuttle buses, shuttle bus capacity and the import of heavy traffic.
5. Five people commented on food and beverages: there was excessive amounts of food; coffee or other refreshments could have been available more continuously; food was not good etc.
6. There were eight generally positive comments: my first IMRP, left a very good impression on how the industry is and what it can be; very satisfied, looking forward to the next IMRP; very happy with the breadth and depth of topics; great networking, exciting future; fantastic venue and program etc.
7. Other comments included: if science drives this field forward, then more emphasis should be on science; QR codes to eliminate business cards were not functional; the private parties on Tuesday and Wednesday set up an awkward situation for those not invited, I recommend having a no-host social gathering on these days to provide a reasonable alternative for those not invited.

APPENDIX 4: Recipients of IMRP Laureate Awards

LAUREATES	IMRP#	YEAR
Charles Artandi, Paul Cooke	2	1978
William Baird, Arthur Charlesby	3	1980
Toshikazu Higashino	4	1982
John Masefield, Vivian Stannett	5	1984
Ken Morganstern, Joe Silverman	6	1987
Frank Fraser, Frank Ley, Sam Nablo	7	1989
Marshall Cleland, Joseph Farkas	8	1992
Jan Leemhorst, William McLaughlin, Pierre Vidal	9	1994
Sueo Machi, Arne Miller	10	1997
Masaaki Takehisa, Alan Tallentire	11	1999
Joyce Hansen, Robert Morrissey	12	2001
Yves Jongen, George West	13	2003
John Corley, Theo Sadat, James Whitby	14	2006
Dieter Ehlermann, Rocco Basson	15	2008
Olgun Güven, John Kowalski, Wang Chuanzhen	16	2011
Andrzej Chmielewski, Paul Minbiole	17	2013
Mohamad Al-Sheikhly, Zhang Xianghua	18	2016
Yves Henon, Maria Helena Sampa	19	2019
Byron Lambert, Paul Wynne	20	2022
Alain Strasser, Murray Lynch	21	2024

APPENDIX 5: IMRP Conference Locations & Dates

IMRP#	YEAR	LOCATION
1	1976	Dorado, Puerto Rico
2	1978	Miami, USA
3	1980	Tokyo, Japan
4	1982	Dubrovnik, Yugoslavia
5	1984	San Diego, USA
6	1987	Ottawa, Canada
7	1989	Noordwijkerhout, Netherlands
8	1992	Beijing, China
9	1994	Istanbul, Turkey
10	1997	Anaheim, USA
11	1999	Melbourne, Australia
12	2001	Avignon, France
13	2003	Chicago, USA
14	2006	Kuala Lumpur, Malaysia
15	2008	London, UK
16	2011	Montreal, Canada
17	2013	Shanghai, China
18	2016	Vancouver, Canada
19	2019	Strasbourg, France
20	2022	Bangkok, Thailand
21	2024	San José, Costa Rica



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Our members are leaders in the irradiation industry who recognise the importance of cooperation, education and communication and who wish to engage with decision makers throughout the world.

WHO SHOULD JOIN?

Membership of iia is diverse and open to all organisations that are involved in the business or science of radiation processing.

- Users of irradiation
- Suppliers of contract irradiation service
- Suppliers of irradiation equipment
- Suppliers of irradiation related products and services
- Irradiation consultancies
- Research Institutes and Universities
- Government department and regulators

The iia membership categories allow for SMEs to large multinational organisations, consumers, suppliers, academia, research bodies and government agencies. The membership categories and fees are mainly determined by the size of the member organisation. This structure endeavours to share the cost of operating the organisation in a fair and equitable way whilst encouraging a diverse membership base both geographically and in terms of the type and size of organisations that participate. The iia is a not-for-profit organization.

For details about iia membership and to access the online membership application form, please visit iiaglobal.com/join-iia

If you have any questions or would like further information about iia membership, please contact info@iiaglobal.com

We look forward to hearing from you and welcoming your organisation as a member of iia.

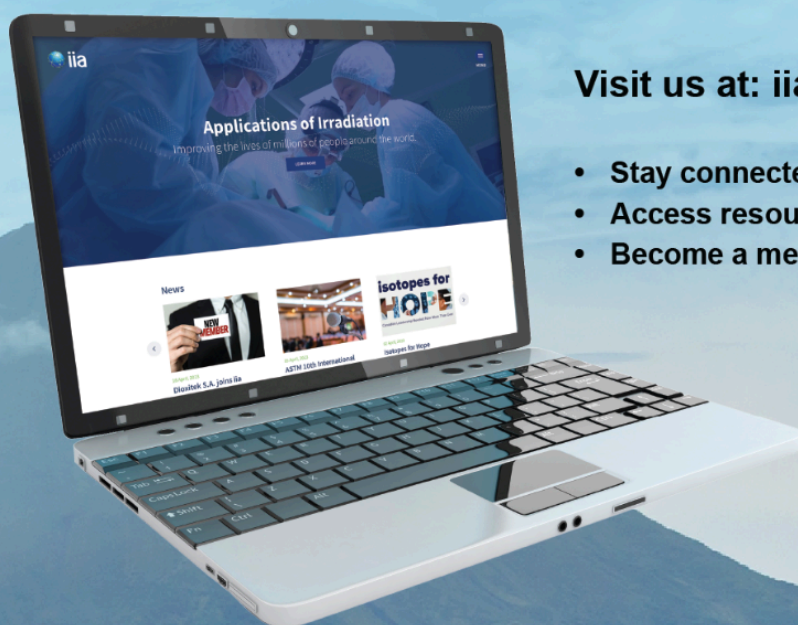


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INNOVATION DOESN'T STOP AT IMRP2024



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