

# Competences for medical applications of nuclear science

*Workshop report with conclusions and recommendations*

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## Abstract

Following on the dynamic built by the initiative on medical applications of nuclear science launched by former Commissioner Mariya Gabriel at the beginning of 2023, the Joint Research Centre (JRC) gathered relevant stakeholders for a workshop on 24<sup>th</sup> October 2023 at the JRC site in Petten to discuss “Competencies for Medical Applications of Nuclear Science”. This followed the first workshop, organised on 27 April 2023 at JRC Ispra on the translation of radiotheranostics cancer research into clinical practice in Europe.

The objective of this second workshop was to address the nuclear competences and skills required to sustain medical applications of nuclear science throughout their life cycle. The promotion of dialogue and collaboration among stakeholders, as well as synergies between initiatives at EU level and across Member States were discussed. The need to perform National nuclear workforce assessment for human resources supply and to promote interdisciplinary education & training schemes building skills in the nuclear medical area have been identified.

With a participation of around 80 stakeholders from the academia, the industry, researchers, health professionals with different expertise in clinical practice, as well as EU Member States representatives, this workshop discussed the current challenges impacting the availability of appropriate competences to enable the medical applications of nuclear science. It aimed to identify the gaps in the demand and offer of skilled workforce and to define critical areas where action is needed.

Some of the key takeaways were the risk of losing competences and expertise with an impact for accessibility of treatments to European patients; a clear demand for well trained, qualified workforce to handle nuclear medical applications with the advent of new radionuclides and treatments; a requirement for multidisciplinary skills; a big disparity in training initiatives amongst EU Member States and the challenge to attract and retain young talents in this field.

The main recommendations made by the stakeholders were the following:

1. The need for coordination at European level for information related to nuclear education and training for health professionals.
2. The European Commission can host discussions for a community of training institutions to discuss and exchange on training audiences, gaps and needs, interoperability and accreditation.
3. Possible creation of an EU network of training institutions across EU Member States.
4. Education providers and existing education platforms need to join forces and collaborate to expand their learning content to cover the needs.
5. Regulators of pharmaceutical and nuclear fields should be encouraged to meet and discuss the interface between their mandates
6. Endorsement of European-level accreditation or a recommended, gold standard model of education and training in radiation protection by the professional societies EANM, EFOMP, EFRS, ESR, ESTRO.

All presentations as well as the results of the online survey are collected in the public link

<https://circabc.europa.eu/ui/group/0e8b2985-afd8-485c-8db1-e1cba61eccd3/library/d5003579-2c5a-4965-a8dc-45c54caf90a4>

## Acknowledgements

The workshop was organised by the Euratom Coordination Unit of the JRC, in collaboration with the European Nuclear Education Network (ENEN), with the assistance of other colleagues from the JRC and from DG RTD, along with the support of several European stakeholders from the research community and medical associations

The authors thank the speakers and panellist for their valuable contributions during the workshop, which led to stimulating exchanges and allowed to identify concrete follow-up recommendations. The authors also appreciated the relevant comments and feedback on this report.

### List of speakers and moderators:

- Mr Mark Arntzenius	Process engineer, NRG
- Mr Leon Cizelj	Head of Reactor engineering division at Josef Stefan Institute
- Mr Christophe Deroose	Professor at KU Leuven and chair of the Erasmus + funded project “RLT Academy”
- Ms Marieke van Dok	Director for Medical Isotopes, Dutch Ministry of Health, Welfare and Sport
- Ms Ulla Engelmann	Director for Nuclear Safety and Security at the Joint Research Centre (JRC)
- Ms Margarida Goulart	Head of Unit, Euratom coordination unit, Joint Research Centre (JRC)
- Mr Brian Guldbaek Eriksen	Project officer at the Euratom coordination unit, Joint Research Centre (JRC)
- Mr Jean-Christophe Gariel	Deputy Director General of the Institute for radiation protection and nuclear safety (IRSN) and European partnership PIANOFORTE coordinator
- Ms Odile Jaume	CEO of the International Centre for Precision Oncology (ICPO)
- Mr Michel Koole	Scientific Liaison Officer at the European Association of Nuclear Medicine (EANM)
- Ms Anouk Lafortune	Policy officer, DG EAC
- Mr Hermen van der Lugt	Director for Compliance, Risk and Organisation for NRG PALLAS
- Ms Renata Madru	Medical physicist at Skane University Hospital in Lund and Member of EFOMP project committee
- Mr Bernard Magenmann	Deputy Director General of the Joint Research Centre (JRC)
- Mr Philippe Montarnal	Nuclear attaché at the Permanent Representation of France to the European Union
- Prof. Graciano Paulo	Professor of medical imaging and radiotherapy at the Polytechnic University of Coimbra and Euramed rocc-n-roll project Work Package 7 leader,
- Mr Gabriel Pavel	Executive Director of the European Nuclear Education Network (ENEN)
- Ms Csilla Pesznyak	President of the European Nuclear Education Network (ENEN)
- Joaquin Sanchez	Director for Scientific and Technical coordination at CIEMAT
- Ms Antonella di Trapani	Senior Analyst for Education, Outreach and Knowledge Management, Head of the NEST, OECD-Nuclear Energy Agency (NEA)

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- Guillaume Lauwers, Euratom Coordination, Joint Research Centre



# 1 Introduction

The JRC workshop on “Competences for Medical Applications of Nuclear Science” was the second in a series of three stakeholders’ consultations on the topic of medical applications of nuclear technologies. It gathered stakeholders from the academia, research, professional associations, industry, as well as health professionals and representatives from EU Member States and the European Commission to discuss the competences and skills necessary to the medical applications of nuclear science, throughout the arrays of activities involved. The workshops were launched by Commissioner Mariya Gabriel at the Third European High Level Nuclear Roundtable on Medical Applications of 13 February 2023 and focused on enabling the translation of innovation on nuclear medical applications into practice, from the research and production side, all the way to the end users, patients and healthcare facilities. Medical applications of nuclear science hold the promise of innovative treatments and personalised care for patients battling cancer and other severe diseases. Nevertheless, their potential can be hindered by various challenges including stability of supply, lack of available specialised workforce and several other technical, logistical, regulatory and political roadblocks preventing the translation of medical advances into clinical practices that can be accessible to all European patients. The workshops aim to obtain a clear overview of the situation in Europe, to identify current and foreseen issues and to come up with concrete recommendations and follow-up actions. This particular workshop explored the need to develop multidisciplinary skills, preserve and attract new talents and provide the necessary trainings to the staff handling the nuclear technologies used in the medical field.

## Summary of interventions during the welcoming section of the workshop

The Deputy Director General of the JRC, Bernard Magenhann welcomed the participants and highlighted the strong societal expectations carried by the medical applications of nuclear technologies, particularly in the fight against cancer with the advent of new promising treatments. However, as pointed out by the president of ENEN, Csilla Pesznyak, the competencies necessary to the safe and quality-assured production, distribution and use of the medical applications of nuclear science are multidisciplinary and crosscut over different areas such as research & innovation, nuclear engineering, radioactive waste management, transport of radioactive materials, radiation protection, medical physics, and radiobiology. Therefore very specific education and training is required for the staff to acquire the appropriate skills to handle medical radioisotopes applications using ionizing radiation. This necessitates providing base knowledge across the disciplines involved with nuclear technologies in the health sector. However, as underlined by Joaquin Pedro Sanchez Sanz, representative of the Spanish presidency of the EU Council, careful attention also has to be paid to hybrid careers and the issue of attracting workers, particularly from the young generation, into the nuclear sector and, even more so, in the area of nuclear medical applications. As emphasised by Marieke van Dok, Director at the Dutch Ministry of Health, this is all the more important since exponential growth of new radiopharmaceuticals should be expected in the coming years and decades. This will present challenges not only for the research and scientific spheres, but also the healthcare sector. This translates into particular issues to be tackled like the security of supply of medical radioisotopes but also, just as importantly, the need for available qualified staff to deal with nuclear medical applications and radionuclides. The efforts undertaken by the European Commission, notably through the SAMIRA action plan, have been positively underlined and Ms van Dok stated that the Netherlands were strongly committed to this issue by investing in the new nuclear research reactor (PALLAS), specifically focused on the production of medical radionuclides. As estimates predict a growing number of patients will rely on those nuclear medical technologies in the near future. There is therefore urgency to focus on ensuring that the needs for nuclear skills and competences applied to the health sector are effectively met for the ultimate benefit of all patients.

## 2 Summary of the presentations

### 2.1 Topical session 1 – Overview of the state of play of nuclear competences in the EU

Developing and maintaining nuclear competences in Europe is a strategic imperative if the EU wants to keep its independence of action in key nuclear activities while preserving its ability to innovate. More particularly, in the area of nuclear medical applications, the EU holds a leading role in the supply of medical radionuclides to the global market, as well as in the area of R&D. Ensuring the access to nuclear medicine treatments, especially in light of new radionuclide therapies and guaranteeing the safe and secure use of all nuclear-related activities in the medical sector is paramount. This will require the availability of sufficiently well-trained and qualified staff, across various disciplines.

However, the ageing workforce and a dropping number of young graduates in nuclear science and engineering compromise the ability to renew or even strengthen the current workforce. This raises concerns that the EU is at risk of losing essential competencies in the nuclear sector at large, with a clear impact for the medical field using nuclear technologies.

This issue has been raised by several EU Member States, including by some with limited nuclear capabilities, as evidenced by a non-paper sent to the European Commission by a group of 15 EU Member States in April 2023. The paper specifically referred to the need to boost the dynamic of skill development in the nuclear sector. It is worth noting that some EU Member States have implemented national initiatives to attract workforce in the nuclear sector.

Efforts have also been undertaken at European level through various actions led by the European Commission and supported by EU Member States. These include activities of the European Human Resources Observatory for the Nuclear sector (EHRO-N), specific projects funded by the Euratom programme and coordinated by ENEN and the organization of a European High-Level Round Table on medical applications in February 2023 by former Commissioner Mariya Gabriel for Innovation, Research, Culture, Education, and Youth, from which derives this workshop on competences. Other initiatives led by international partners, also strive to address this challenge, such as the Nuclear Education, Skills, and Technology Framework (NEST) of the OECD's Nuclear Energy Agency (NEA). This multinational framework aims to create the next generation of nuclear talents through the transfer of practical experience and knowledge. It includes a number of projects such as MANTRAS, which covers medical applications of nuclear science and provides hands-on training and skills in the areas of radioisotope production, nuclear and radiation techniques, as well as radiation protection and safety applied to medical applications. Enhanced cooperation between stakeholders would enable them to be more aware and benefit from such initiatives.

It was argued during this session that when deploying their efforts, the EU and its Member States should adopt a multidisciplinary approach to ensure the quality and safety of nuclear medicine imaging and therapy procedures. Indeed, nuclear medical applications involve a variety of medical professions and skills: medical physicists and technologists for calibration and quality control of the systems for imaging procedures, radiopharmacists dealing with the chemistry aspects of radiopharmaceutical used in diagnosis and therapy, medical doctors responsible for the diagnosis and treatment of patients, as well as radiographers responsible for performing the imaging procedure, and nurses. The focus should thus be on a broad level of training to ensure in-depth acquisition of knowledge across disciplines. Due to a strong heterogeneity among the trainings provided in the EU Member States, harmonization of such programs and basic minimum training requirements should be set for nuclear medicine professionals, as well as all professional disciplines directly or indirectly involved in patient care. Moreover, continuous learning is a necessity to integrate innovation in nuclear imaging and radionuclide therapies and could be tackled by platforms such as the European School of Multimodality Imaging & Therapy (ESMIT), put in place by the European Association of Nuclear Medicine (EANM).

Another issue discussed is the attraction of young talents into the sector, as early as possible in their curriculum, notably by encouraging mobility for young professionals and students. Mobility schemes are considered an efficient way for students to acquire hands-on expertise and to gain work experience with different organizations, stakeholders and environments. This goes hand in hand with adequate and targeted communication towards the youth and cooperation at the European level in order to attract the necessary talents in the field of nuclear medical applications.



## 2.2 Topical session 2 – Competences needed for the safe and efficient use of medical applications of nuclear technologies

The second session of the workshop focused more in depth on the multidisciplinary competences and specialised skills required across the range of activities using ionising radiation and nuclear technologies for medical purposes. A particular challenge in the coming years will be ensuring the security of the supply chain for medical radioisotopes. Research nuclear reactors play a crucial role in the production chain and, in a context of ageing infrastructures, are dependent on a cooperative European and international network of actors. Therefore, in September 2023, the Dutch government decided to give full funding for the construction of a new research reactor – PALLAS, which will be dedicated to the production of medical radioisotopes. New infrastructures like PALLAS will require developing competences encompassing two essential perspectives, pertaining both to the nuclear and the pharmaceutical sectors. Indeed, it will necessitate sufficiently qualified workforce to operate the nuclear reactor, driven by safety and security imperatives, as well as nuclear medical specialists focused on securing treatments for hospitals and driven by patient care and product quality.

The increasingly important role played by ionizing radiation and nuclear technologies in the medical sector require to develop skills and mindset specific to both the nuclear and the pharmaceutical sectors. However, this presents a particular challenge when both differ in their approach to the regulatory framework, the quality standards, the speed of innovation and even career paths. Recommendations were made to develop a vision on competence development in nuclear medicine that integrates the two perspectives, and also to elaborate national plans aimed at strengthening the nuclear education and the (nuclear-) pharmaceutical education systems.

It is also essential to provide adequate training to medical physicists and medical physics experts who contribute to maintaining and improving the quality, safety and efficient clinical use of medical applications of nuclear technologies. The EU regulatory framework has laid down basic safety standards through the Directive 2013/59/Euratom to protect health workers and the general public against exposure to ionizing radiations. The directive notably require the establishment of appropriate curricula in the EU Member States, along with corresponding diplomas or certificates. Ensuring continuous training after qualification has been obtained, including on new techniques and radiation protection requirements is also explicitly stated. However, a 2023 survey carried out among European medical physical experts shows that the years of specialization training including on radiation protection differ considerably between EU Member States, calling for greater harmonization. However, education and training should not be limited to nuclear medicine physicians and medical physicists and rather integrate a multidisciplinary approach addressed at the broad range of professionals involved in the diagnosis and therapeutic use of radiopharmaceuticals (radiographers, nurses, chemists, physicians, etc.). A radiation protection and dosimetry focus across the medical physicists radiographers and nursing training would also be useful.

Multidisciplinary competences are also relevant to better harness the potential of new technologies, like artificial intelligence (AI), which can be useful for applications such as analysing radiotherapy images or helping manage the supply chain for radiopharmaceuticals. How best to integrate these new technologies into the healthcare sector and to provide the appropriate education and training to experts remains to be defined.

There are already education and training initiatives that offer a comprehensive, multidisciplinary curriculum for radioligand therapy, such as the ICPO ACADEMY FOR THERANOSTICS, which was launched in 2023 as an online e-learning platform. This and other platforms, targeting health professionals in the broad sense (physicians, chemists, physicists, technologists, nurses), should address the very specific need for more standardized and certified professional education at international and European level to ensure the successful spread of radiopharmaceutical use in therapy.

The growing use of nuclear technologies in healthcare brings additional challenges with the possible exposure of patients and healthcare staff to ionizing radiation and calls for adapted skills and competences. Globally, there is growing concern about the loss of competences in the field of radiation protection research and operation, and about the variable training requirements in the different EU Member States. Nevertheless, a pre-requisite to better healthcare delivery is the research on the medical applications of ionizing radiation, their implementation and consistent use throughout Europe, including aspects of radiation protection. At EU level, the Euratom Work Programme 2021-2022 has called for the creation of PIANOFORTE, a European partnership for radiation protection research, which notably aims to develop competences in radiological protection via a specific work package dedicated to education and training. A particular challenge is to attract young talent in this field characterised by an ageing workforce.

### 3 Panel discussion – Challenges to ensuring and developing the necessary competences for the medical applications of nuclear science

Following the contributions in session 1 and 2 and based on the interventions of the different panellists and the ensuing discussion, a number of key points can be highlighted to better understand and overcome the challenges to acquiring and developing the necessary competences fit for the medical applications of nuclear science.

1. There is an urgent need to promote education and training and to build skill for the medical use of radionuclides
2. In order to attract young talents to the sector, actions should be focused on enhancing career attractiveness and development
3. A proper stock taking of past and existing actions and recommendations at European and national levels would be useful
4. Education and training programmes should include a particular focus on radiation protection and dosimetry, which should be more systematically factored in as an essential component of medical applications using ionizing radiation.
5. New technologies such as AI should be addressed and assessed for their potential use and benefits.

In order to establish and enable the equal access of all eligible European patients to medical technologies based on radionuclides, as well as ensuring the safe use of other medical applications of nuclear science, the acquisition of specific skills and trained expertise is required across various professional areas. Training the experts through dedicated and appropriate education and training programmes appears as a priority, which faces a number of inherent challenges. Throughout the discussion, different issues have been raised such as harmonizing education and training at EU level; in the face of great heterogeneity, the contents seem poorly integrated in existing curricula within EU Member States, which makes some topics possibly inaccessible to students and young professionals.

Another point of focus in the discussion was the question of enhancing career attractiveness and development to both attract and retain talents needed for the medical applications of nuclear science. A particular challenge here is to appeal to the younger generation by promoting career prospects in the nuclear medical field but also reviewing the communication addressed at them to better understand their motivation.

It has also been pointed out that radiation protection and related aspects remain somewhat a blind spot for medical professionals handling nuclear technologies who lack appropriate training and understanding of the importance of this field, leading to a shortage of competences. This also needs to be addressed at research level.

Through this workshop, an overview of the situation was given but a proper stock taking of the current workforce, the future demand and supply to identify the gaps in human resources is needed at national level. This nuclear workforce assessment needs to specifically address the competences needs for medical applications of nuclear science.

New technologies with promising potential for the field such as AI can also be another point of attention as they will require further assessment both for their considered specific application to nuclear medicine and more wide-spread uptake in healthcare.

#### 3.1 Past and current recommendations and actions

The promotion of education and training frameworks should go hand in hand with an assessment of human resources and competences needs for medical applications for nuclear science, which should be included in the National Nuclear Workforce Assessment carried out by EU Member States and addressing both demand and supply.

Concerns over an ageing workforce in the nuclear sector first rose in the 2000's and led to the adoption of Council Conclusions on nuclear skills in 2008<sup>1</sup>, which “*encouraged the Member States and the European Commission to establish a review of professional qualifications and skills in the nuclear field for the European Union*”. This political impulse steered the European Commission into launching the European Human Resources Observatory for the Nuclear sector (EHRO-N) in 2010 as a tool for developing methodologies and best practices to allow conducting national nuclear workforce assessments. EHRO-N also performs review of the demand and supply of human resources in the EU nuclear sector, based on national reports, to identify gaps in the education and training frameworks.

A further political momentum was given in 2019 by another set of Council Conclusions on non-power nuclear and radiological technologies and applications<sup>2</sup>, which stated Member States were responsible for maintaining and developing expertise, skills and resources relevant to their needs and recommended they carry out a mapping exercise of those resources, cooperating with EHRO-N, to address future needs.

Several initiatives have produced recommendations on medical radionuclides actions. The discussion has illustrated the existence of a variety of initiatives stemming from those recommendations and supported by previous and current EU programmes (Euratom, Horizon 2020 and Horizon Europe, Erasmus+ and Marie Skłodowska Curie Actions). However, more action is needed at EU level to support harmonization and streamlining of those initiatives.

### 3.2 Promoting targeted, harmonized and integrated education and training for nuclear medical applications

The discussion led to the acknowledgement of a need to strengthen education and training schemes specifically addressed to all relevant professionals handling radionuclides and other nuclear technologies in the medical field. In view of the increasing role played by nuclear medicine in both diagnosis and therapy, it is essential to provide appropriate educational and training tools across the disciplines of professionals involved with radioactivity and patient care, including technologists and nurses.

There is a need to identify and draw an inventory of the existing initiatives and solutions in terms of education and training, as well as the opportunities for synergies between them that could be implemented at EU level and across Member States. Existing initiatives have been presented like the Radioligand Therapy (RLT) Academy, funded via the Erasmus+ programme, which focuses on nuclear medicine professionals. It aims to map the need of the educational landscape on Radioligand Therapies and to develop a training curricula via a virtual Academy consisting both of interactive online courses and physical trainings in health centres. Another initiative is the online e-learning platform ICPO ACADEMY FOR THERANOSTICS, which provides clinicians, researchers, physicists and radiochemists as well as nurses and technologists with comprehensive, multidisciplinary and certified training in theranostics in precision oncology. The curriculum was developed under the leadership of its president, Prof. Richard P. Baum, a world-leading pioneer in nuclear medicine and radiomolecular precision oncology.

These examples attest to the need to coordinate European-level online training programmes, as well as standardized and certified education targeting all the relevant professional groups to increase the accessibility to new radiopharmaceutical based treatments. Overall, the expansion of training programmes with a blend of online and onsite practical learning is necessary at EU level.

There is a clear need to promote more dialogue and cooperation between all the relevant stakeholders from the industry, public authorities, the academia, training centres and the research sphere, at all levels to be able to launch concrete skills initiatives.

### 3.3 Career development and attracting talents to the field

A strong challenge faced by the field of medical applications of nuclear science is the necessity to attract, develop and retain the necessary talents, especially young professionals, to prepare the next generation of the workforce and ensure the availability of the necessary competences

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<sup>1</sup> [https://www.consilium.europa.eu/uedocs/cms\\_Data/docs/pressdata/en/intm/104389.pdf](https://www.consilium.europa.eu/uedocs/cms_Data/docs/pressdata/en/intm/104389.pdf)

<sup>2</sup> Council Conclusions on “Non-power nuclear and radiological technologies and applications”, 9437/19

This issue of attractiveness implies a need to support more initiatives at university level to enhance communication addressed at students and help make them aware of the varied professional opportunities in the area of nuclear medical applications. It was also pointed out that connecting the academia and the recruiting needs of the industry can prove difficult and would require better communication to express this demand and help future young professional articulate their career options. Similarly, connecting universities and professional actors in the industry, for instance via mobility schemes for students, could help inform their choice. The objective is to make sure that all engaged stakeholders work in a coordinated manner by promoting nuclear career opportunities in the medical field to increase the overall attractiveness of the sector.

Appropriate tools for continuous learning and trainings would also enable career developments and allow for the uptake of innovative treatments in medical procedures, which requires specific and interdisciplinary competences.

One particular challenge highlighted is the issue of attracting young talents in the field of radiation protection research.

### 3.4 Focus on radiation protection and dosimetry

Stakeholders repeatedly emphasized radiation protection, as a field of research and an essential competence for the safe and efficient use of nuclear medical applications, which requires targeted education and training for the current and future clinical workforce across all different professions involved in the application of ionizing radiation. There is currently a lack of health professionals with sufficient expertise and competences in radiation protection, mostly due to an absence of appropriate and mandatory focus on this issue in the education and training programmes, including vocational learning but also due to low research activity in the radiation protection medical area.

The EURAMED rocc-n-roll project<sup>3</sup> notably tries to address this issue by including a work stream on education and training in medical application of ionizing radiation and related radiation protection. The objective is to organise, disseminate and implement a concept for education and training in medical radiation protection among health professionals. Another goal is to provide a methodology for integrating more systematically education and training in radiation protection in all research projects to enable researchers to gain a sound knowledge base and build capacity and sustainability in the field.

There is indeed a need to also focus on the current, and future medical radiation protection researchers, outside the clinical departments and including pre-clinical research. The PIANOFORTE partnership funded under the Euratom programme, notably aims to address this with open calls as a way to attract and retain new talents in this field. The discussion really stressed the importance of well-trained future generations of radiation protection experts with sufficient knowledge, skills, and competences, to cover the future needs.

However, there are no common regulatory requirements across EU Member States concerning the content, the duration and the certification of education and training in medical physics and radiation protection. Given the number of patients which undergo medical imaging and radiotherapy treatments every year in Europe, a consensus among Member States on harmonised standards for education and training and certification in radiation protection should be sought.

The need to build knowledge, skills, and competences in radiation protection, directly relates to a benefit-risk communication with the patients and the public when envisioning medical procedures. Therefore a radiation protection and dosimetry focus should be required across health professionals, especially for medical physics and radiographers.

### 3.5 Benefit assessment of new technologies like AI

To ensure the safety and a sustainable chain of radiopharmaceutical supply for patient care it would be an advantage to use AI based management systems.

Further assessment to educate and better understand the best practice of implementing AI together with the new nuclear technologies within healthcare is nevertheless required.

Another challenge is to ensure a Europe-wide uptake of the newest technologies and approaches.

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<sup>3</sup> <https://roccnroll.euramed.eu/>

## 4 Conclusions and recommendations

Based on the discussion, the following recommendations were made by the stakeholders:

1. The need for coordination at European level for information related to nuclear education and training for health professionals.
2. The European Commission can host discussions for a community of training institutions to discuss and exchange on training audiences, gaps and needs, interoperability and accreditation.
3. Possible creation of an EU network of training institutions across EU Member States.
4. Education providers and existing education platforms need to join forces and collaborate to expand their learning content to cover the needs.
5. Regulators of pharmaceutical and nuclear fields should be encouraged to meet and discuss the interface between their mandates
6. Endorsement of European-level accreditation or a recommended, gold standard model of education and training in radiation protection by the professional societies EANM, EFOMP, EFRS, ESR, ESTRO.

## References

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Goulart M., Holzwarth U., *Translating radiotheranostic cancer research into clinical practice in Europe*, Workshop report and conclusions, Publications Office of the European Union, Luxembourg, 2023, doi:10.2760/92392, JRC134480

## List of abbreviations and definitions

CIEMAT	Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas
DG EAC	Directorate General for Education, Youth, Sport and Culture
DG RTD	Directorate General for Research and Innovation
EANM	European Association of Nuclear Medicine
EFOMP	European Federation of Organisations for Medical Physics
EFRS	European Federation of Radiographer Societies
EHRO-N	European Human Resources Observatory for the Nuclear sector
ENEN	European Nuclear Education Network
ESMIT	European School of Multimodality Imaging & Therapy
ESR	European Society of Radiology
ESTRO	European Society for Radiotherapy and Oncology
EU	European Union
EURAMED rocc-n-roll	Euratom funded project in the field of medical applications of ionising radiation and related radiation protection
ICPO	International Centres for Precision Oncology Foundation
IRSN	Institut de Radioprotection et de sûreté nucléaire
JRC	Joint Research Centre
NRG	Nuclear Research and Consultancy Group
OECD-NEA	Organisation for Economic Cooperation and Development – Nuclear Energy Agency
PALLAS	New medical isotopes research reactor to be built in The Netherlands
PIANOFORTE	Euratom funded partnership for research in radiation protection and ionising radiation.
RLT Academy	Radioligand Therapy Academy

## Annexes

### Annex 1. Agenda

- 08:30-09:30    Arrival at the Joint Research Centre // Registration
- 09:30-09:50    Welcome and Introduction  
Mr Bernard Magenhann, Deputy Director General, JRC  
Ms Csilla Pesznyak, President of ENEN  
Mr Joaquin Pedro Sanchez Sanz, Director scientific and technical coordination, CIEMAT  
Ms Marieke van Dok, Director Medical Isotopes, Dutch Ministry of Health, Welfare and Sport
- 09:50-11:10    Topical session 1 – Overview of the state of play for nuclear competences in the EU  
*Moderator: Ulla Engelmann (Director, Directorate Nuclear safety and security, JRC)*
- 09:50-10:10    Mr Philippe Montarnal, nuclear attaché at the Permanent Representation of France to the EU
- 10:10-10:30    Mr Leon Cizelj, Division Head Scientific Councilor at Jozef Stefan Institute and Professor at the University of Ljubljana
- 10:30-10:50    Ms Antonella di Trapani, Senior Analyst for Education, Outreach and Knowledge Management and Head of the NEST and Global Forum Secretariats, OECD-NEA
- 10:50-11:10    Mr Michel Koole, Scientific Liaison Officer at EANM
- 11:10-11:40    Coffee break & Group photo
- 11:40-13:00    Topical session 2 – Competences needed for the safe and efficient use of medical applications of nuclear technologies  
*Moderator: Gabriel Pavel (Executive Director, ENEN)*
- 11:40-12:00    Mr Hermen van der Lugt, CRO of NRG/Pallas
- 12:00-12:20    Ms Renata Madru, Member of EFOMP projects committee
- 12:20-12:40    Ms Odile Jaume, CEO of ICPO
- 12:40-13:00    Mr Jean-Christophe Gariel, Deputy Director General at IRSN, in charge of Health and Environment
- 13:00-15:00    Buffet lunch
- 14:00-15:00    *(Tour of the HFR spare reactor vessel will be organised for participants on site)*
- 15:00-16:15    Panel Discussion – Challenges to ensuring and developing the necessary competences for the medical applications of nuclear science



*Moderator: Margarida Goulart (Head of Unit, Euratom Coordination, JRC)*

Panellists

- 15:00-15:25      Short presentations from panellists on their main recommendations in the topic  
Mr Brian Guldbaek Eriksen, Coordinator of EHRO-N, JRC  
Mr Graciano Paulo, Professor at the Polytechnic University of Coimbra and Work  
Package Leader in EURAMED Rocc-N-Roll project  
Mr Christophe Deroose, Professor at KU Leuven  
Mr Mark Arntzenius, Process engineer at NRG  
Ms Anouk Lafortune, DG EAC
- 15:25 -16:15      Q&A and discussion of the recommendations
- 16:15-16:35      Wrap-up & Conclusions  
Mr Bernard Magenmann, Deputy Director General, JRC  
Ms Csilla Pesznyak, President of ENEN

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