Draft proposal for a European Partnership under Horizon Europe

Partnership for Radiation Protection Research

January 2021

About this draft

This draft was prepared by a group of delegates of European radiation protection institutes and MEENAS, the umbrella structure of the European radiation protection platforms (MELODI, EURADOS, EURAMED, NERIS, ALLIANCE, SHARE). It has therefore been prepared and shared with a vast majority of the European organisations (including academia) practically involved in radiation protection and radiation protection research that represent all aspects to be covered by the activities described in this document.

In this Partnership, it is proposed to conduct research and innovation activities on the basis of a system of competitive open calls. The overall premise for this Partnership is that the rules of participation in open calls, as developed within the H2020 CONCERT EJP will also apply. Specifically, it is assumed that the open calls will be managed by an independent entity so that POMs who form the governance of the Partnership may participate in submitted projects. The governance can be modified should this rule no longer apply.

Content

1 General information

1.1 Draft title of the European Partnership

Working title: Partnership for Radiation Protection Research

1.2 Lead entity (main contact)

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1.4 Summary (max 500 characters)

The Partnership for Radiation Protection Research is intended, through a competitive open call system, to consolidate and strengthen the EU's research and innovation capacity for improving radiation protection of the population, workers and the environment. We aim to further enhance the science-based best level of protection in relation with the safe use of ionising radiation for both power and non-power applications with a special emphasis on diagnostic and curative use of radiation in medicine and in answer to societal needs.

2 Context, objectives, expected impacts

2.1 Context and problem definition

Radiation protection based on state-of-the-art scientific evidence is an important requirement for modern, industrialized countries with great importance for medicine, the safety of the nuclear energy cycle, including waste management and a range of other uses of ionising radiation and radionuclides beneficial to the European population. Moreover, natural ionising radiation is ubiquitous on earth and in space. Therefore, exposures to naturally occurring radioactive material either from industries handling such materials or from natural terrestrial sources such as radon are also to be considered. Next to this, radiation workers, patients, occupational groups exposed to radiation (air crew, space crew) and the public are rightly concerned that their health and the environment are not compromised unduly by the various uses (or indeed the consequences of radiological incidents or accidents) of ionising radiation and radioactive materials.

2.1.1. Global and sectorial policy context

Political agendas around the world are committed to address **the United Nations 2030 Agenda for Sustainable Development Goals**[1] (SDGs). As many industrial activities, nuclear energy and - more generally - activities making use of ionising radiation and radioactive materials entail risks to health and ecosystems. Therefore, a robust, equitable, socially as well as economically acceptable and science-based system of protection of both people and the environment is essential and supports the implementation of many SDGs.

Within this global context, this Partnership largely focuses on research activities, innovation and related measures regarding infrastructure and knowledge management and is intended to meet these goals, requirements and the societal concerns.

Development of non-power applications of ionising radiation is an asset for Europe

In parallel to the development of nuclear energy, non-power applications of ionising radiation have become key tools for exploring matter or improving health (Figure 1) as was reminded by the recent **SAMIRA Council Conclusions**[2] on non-power nuclear and radiological technologies and applications calling the Commission to "*support research on topics related to non-power applications of nuclear and radiological technologies*" and by a recent report published by EC DG ENER[3]. Over the years, health has become the most important non-power application area routinely using ionising radiation in imaging and therapeutic applications, complementing the two other imaging modalities, Magnetic Resonance and Ultrasound. Therapeutic applications using ionising radiation are developing and paving the way for personalized and targeted therapies. Ionising radiation has also spread to many industrial domains, ranging from sterilization and disinfection to security-control systems, from non-destructive testing to environmental applications. Nanotechnologies, nanoelectronics, photonics, advanced materials, biotechnologies and advanced manufacturing use ionising radiation tools. The European Union hosts a substantial infrastructure of facilities dedicated to fundamental or applied research, a broad network of advanced universities and research centres, as well as world-class industrial and innovative SMEs (Small and medium-sized enterprises), competing at the global level. This dynamic environment makes European Union a world leader in the development and use of ionising radiation technologies for the benefit of society.

It has been estimated that the ionising radiation applications of accelerators alone underpin nearly half a trillion dollars' worth of global commerce a year[4]. The world-market value of ionising radiation equipment can be evaluated at more than EUR 35 billions per year, with health applications being the most important non-power sector. This global equipment market is attractive, with a high 3-6% annual growth rate and bright export prospects. The equipment market is also competitive, driven by constant innovation, which requires substantial investments. Ionising radiation applications create high added-value jobs in the Health, Industry and Research fields for a highly-educated and well-trained work force.

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[1] See https://sustainabledevelopment.un.org/ for the definition of the 17 SDGs. The most concerned SDGs by this Partnership are: SDG3 on Good health and well-being, SDG4 on Quality education, SDG5 on Gender equality, SDG6 on clean water and sanitation, SDG7 on affordable and clean energy, SDG8 on Decent work and economic growth, SDG9 on Industry, innovation and infrastructure, SDG12 on Responsible consumption and production, SDG13 on Climate action, SDG14 on Life below water, SDG15 on Life and land, SDG17 on Partnerships for the goals.

[2] https://www.consilium.europa.eu/en/press/press-releases/2019/06/06/the-council-underlines-role-of-non-power-nuclear-technologies/

[3] https://ec.europa.eu/energy/studies/european-study-medical-industrial-and-research-applications-nuclear-and-radiation-technology_en?redir=1

[4] https://ec.europa.eu/energy/studies/european-study-medical-industrial-and-research-applications-nuclear-and-radiation-technology_en?redir=1

In the EU-27 member states plus the UK over 1,000,000 professionals are dose-monitored[5]. The health sector accounts for over 700,000 of such workers and the industrial sector (excluding nuclear energy) for 90,000 employees. In addition, the major European Health equipment companies employ over 60,000 individuals in Europe, a large number of whom work in the ionising radiation tools business, without accounting for the jobs induced along the supply chain. In addition, tens of thousands of jobs in smaller equipment-manufacturing companies, health institutions, laboratories, and industry & research centres depend indirectly upon these technologies.

Such an asset should be fostered so as to continue to improve the quality of life for European citizens, while simultaneously generating employment and economic growth. However, this can only be achieved responsibly with the best safety standards in relation to the protection of humans and of the environment. A major objective of this Partnership will therefore be to contribute to this goal through targeted research activities.

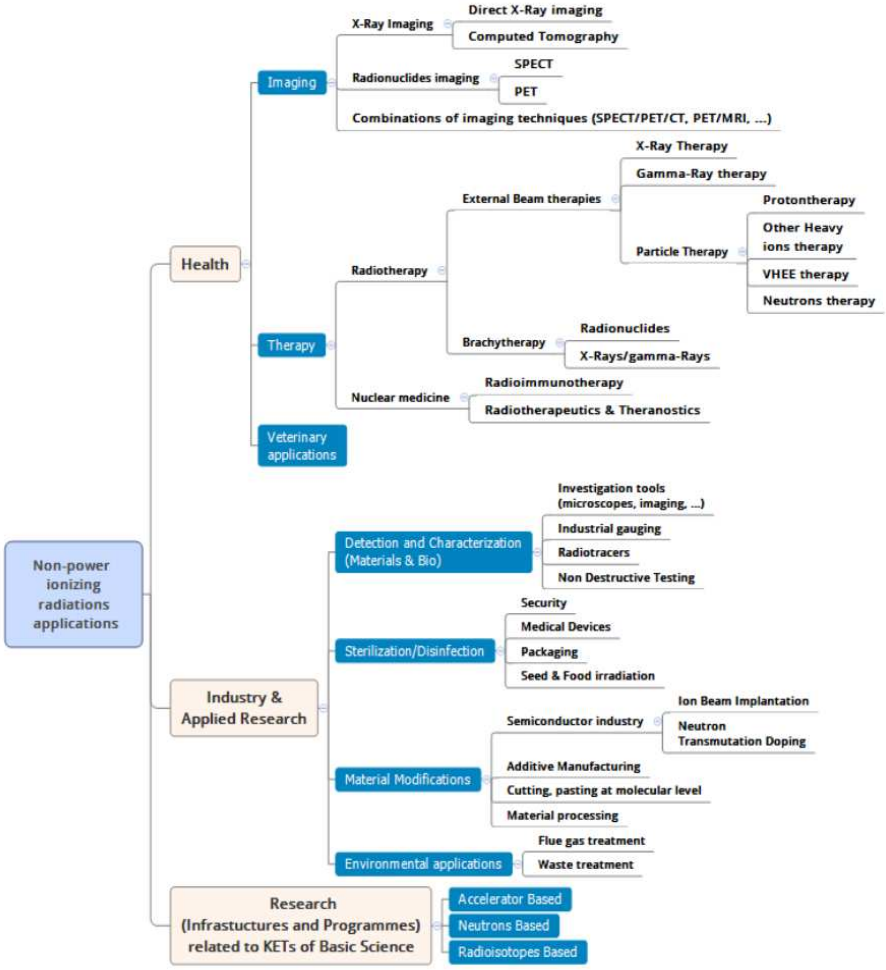

Figure 1: Global snapshot of non-power applications of ionising radiation (from "European Study on Medical, Industrial and Research Applications of Nuclear and Radiation Technology", Contract ENER/17/NUCL/SI2.755660, 2018).

[5] https://esorex-platform.org/

Innovation related to application of ionising radiation and corresponding radiation protection is a key advantage for Europe

In the context of a partnership it is important to stress that the research driven by the partnership should enhance basic knowledge and enable the development of new ideas, designs, services and products improving radiation protection rules and guidelines for better life and health. To foster innovation - defined as the development of new products, designs or ideas - is essential for European economy and can be seen, from the global perspective, as a key advantage for Europe and its society. The competitiveness of European economy can be only guaranteed by ensuring a smooth knowledge and technology transfer between research and industry. To this end, the partnership must focus on basic and applied research and simultaneously seek opportunities for the transfer of results to the industry for the benefit of health and standard of living.

The Partnership referring to radiation protection is ideally suited to contribute to the innovation in Europe because radiation protection research is reflected in a broad spectrum of European activities and initiatives. For example, Europe has very advanced institutes and companies focusing on developing radiation dosimeters and dosimetry systems, providing a high potential for innovations in this field. Similarly, Europe benefits from numerous companies developing and selling medical equipment, some of which are world-leading. Development of medical radiation technologies is not possible without cutting edge know-how in the fields of dosimetry and radiation biology, so a close link between industry and academia is necessary. Furthermore, there is a high social demand for better protection of humans and the environment from hazards generated by modern technologies which include radiation. Consequently, research results in the fields of radiation biology and radiation ecology can be successfully transferred into ideas and concepts for new products. In order to ensure equally high security standards on European level, timely information and involvement of national and European authorities is essential to allow uniform regulations.

The potential for knowledge transfer between research and industry could already be demonstrated in some European research programmes of the past. Examples are new dosimetric approaches like those based on the PODIUM[6] project of CONCERT, like new detector designs for nuclear medicine based on the MADEIRA[7] project or like the dedicated breast CT developed in a corresponding EC project. Currently, open questions related to radon and NORM exposure of humans and the environment are addressed in the EU funded RadoNorm[8] project, which will provide solutions for radiation risk reduction for individuals and the public. Although these examples demonstrate the transfer potential, there is space for improvement due to continuous development of diagnostic and therapeutic procedures. The Partnership will thus implement an ambitious research and innovation plan including a dedicated strategy to achieve the goals of such plans for projects to be performed within its framework as described in sections 2.2 and 3.1. Here, a close collaboration will be built up with the recently funded projects Rocc-n-roll[9], SINFONIA[10] and RadoNorm. The innovation plans will identify the potential industrial partners, the necessary developments and suitable evaluation methods and dedicated IP strategies.

The Partnership will provide a framework for innovation in the area of radiation protection and thus contribute to the economic wellbeing but also an improved health protection of the European population.

[6] https://podium-concerth2020.eu

[7] https://cordis.europa.eu/project/id/212100/reporting/it

[8] https://cordis.europa.eu/project/id/900009/fr

[9] https://cordis.europa.eu/project/id/899995

[10] https://cordis.europa.eu/project/id/945196

The rapid development of applications making use of ionising radiation is beneficial for the improvement of medical diagnosis and treatments. This will allow new diagnostic and therapeutic approaches for combating cancer, but also quality and safety need to remain a high priority

As mentioned above, medicine has become the most important non-power application routinely using ionising radiation in diagnostic and therapeutic applications. The three main medical specialties using ionising radiation-based tools are radiology, radiotherapy and nuclear medicine.

Imaging is of primary importance for making correct diagnoses and providing treatments. Medical imaging relies largely on ionising radiation, the use of which is constantly growing in European Union and outside. Current numbers for the EU-27 and the UK are[11]:

- 500 million radiographs per year (one per citizen per year on average);
- 45 million CT-scans (CT "Computed tomography") procedures per year;
- About 10 million nuclear-medicine imaging procedures (SPECT "Single photon emission computed tomography" and PET/CT "Positron Emission Tomography with computed tomography") are performed per year.

Ionising-radiation technologies are also widely used for cancer therapy. Cancer is a major health problem in the European Union with about 2.8 M new cases per year and 1.7 M deaths per year (without non-melanoma skin cancer)[12]. The EU has been actively working to reduce the incidence and improve the therapy of cancer for decades, and its work has paid off. The first '**Europe against Cancer Plan'**[13], dating back to the late 1980s, resulted in important EU legislation on tobacco and occupational health. Since then, EU Member States have taken a number of actions and have committed, in line with the United Nations Sustainable Development Goals, to reduce premature mortality from chronic diseases, including cancer, by one third by 2030. They have also committed to meeting the **WHO targets on non-communicable diseases**[14] by reducing mortality from cancer by 25%.

Against this backdrop, the new Commission presidency committed in the Political Guidelines to "a European plan to fight cancer, to support Member States and stakeholders in improving cancer control and care […] to reduce the suffering caused by this disease" and for Europe to take the lead in the fight against cancer. The **Europe's Beating Cancer Plan**[15] - currently under preparation -- will focus on all key stages of the disease: prevention; early diagnosis; treatment and care, and the quality of life of patients and former patients.

Experts[16] estimate that about 50% of all cancer patients would benefit from radiotherapy during the course of their disease and currently 1.6 million radiation therapy treatments[17] are performed every year. Among patients suffering from cancer, surgery and radiotherapy, alone or combined with other modalities (chemotherapy, combined treatment...) are the major contributors to cure cancer. The last

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[11] "European Study on Medical, Industrial and Research Applications of Nuclear and Radiation Technology", Contract ENER/17/NUCL/SI2.755660, 2018

[12] http://gco.iarc.fr/today/online-analysis-pie?mode=cancer&mode_population=continents&population=990&sex=0&cancer=29&type=1&statistic=0&prevalence=0&color_palette=default

[13] https://cordis.europa.eu/article/id/38-europe-against-cancer-action-plan/fr

[14] https://www.who.int/nmh/ncd-tools/definition-targets/en/

[15] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12154-Europe-s-Beating-Cancer-Plan

[16] Radiotherapy equipment and departments in European countries: Final results from the ESTRO-HERO survey. Radiotherapy and Oncology 112 (2014)

[17] Rosenblatt E, et al. Radiotherapy capacity in European countries: an analysis of the Directory of Radiotherapy Centres (DIRAC) database. Lancet Oncol. 2013 Feb; 14(2):e79-86

decade showed an impressive opening for combining radiotherapy not only with other conventional therapies (surgery and chemotherapy) but also with novel anti-cancer treatment modalities such as gene- and immune therapy or nanomedicine, which pave the way for personalized anti-cancer therapies. In order for these novel combination strategies to become part of the everyday treatment routine, substantial advances are needed in understanding the interactions between radiation and the above mentioned treatment modalities, especially regarding potential toxic effects on normal tissues. This outlines the major need for a strong interaction between industrial and academic partners to develop safe and effective combined strategies. Increasing the efficiency of radiotherapy must be obtained while decreasing radiotherapy side effects on normal tissues. Here, nuclear medicine promises advanced cancer treatments, paving the way for a real "personalized medicine". Such personalized cancer treatments could increase therapy success rates, avoid useless treatment trials and lead to potential savings for the health systems. In addition, new molecular imaging approaches are necessary for better diagnosis, for improved stratification of patients and better predicting personalized therapy approaches for combating cancer. Individualization of radiology procedures is however not limited to radiation therapy but is at least in the same way relevant in radiation based diagnostics.

Globally, about 20 per cent of the radiation doses received by the general public stem from "artificial", "man-made" sources, of which almost all comes from health applications. In Europe, CT, plain radiography, fluoroscopy, interventional radiology and nuclear medicine procedures currently contribute respectively around 57%, 17%, 12%, 9%, 5% to the total population dose for diagnosis purposes. In radiology, the number of exams increases on average by around 6% every year in the recent years and, being an essential tool in cancer management, radiotherapy treatment is estimated to increase by 16% by 2025 on average across Europe[18]. While diagnostic and medical application of ionising radiation has been continuously improved to fight cancer, radiation protection aspects must not be neglected in this process.

Echoing the **WHO/IAEA 2012 Bonn Call for Action**[19], European medical professional organisations, equipment manufacturers and competent authorities have responded appropriately. Authorities have developed and implemented landmark regulations, namely the EC Basic Safety Standards (Directive 2013/59). CT equipment manufacturers, in collaboration with HERCA (Heads of the European Radiological Protection Competent Authorities)[20] have developed and provided multiple dose-reduction features in CT systems for many years, and these developments continue today. Professional medical organisations are developing and harmonizing the "3A" (awareness, appropriateness, audit) approach, making extensive use of advanced IT and Big Data techniques[21]. However, with further optimizing and harmonizing of procedures as well as with a meaningful personalization the risk related to diagnostic and therapeutic procedures can still be largely reduced and the outcome improved. The existing and further potential improvements also influence the radiotherapy sector, with equipment delivering X or γ-rays, electrons, neutrons or ions more accurately to tumours and combining imaging and therapy techniques for personalized treatment planning.

All stakeholders (National Authorities, Scientific and Professional Societies, Equipment Manufacturers, Practitioners…) recognize the issue of dose-exposure optimization for ionising radiation imaging applications. Important advances were achieved over the two last decades, but efforts still remain to achieve further dose reduction and procedure harmonization. Another important way of protection is towards a better justification of examinations and medical procedures. Training about the health risks

[18] Borras JM, et al. How many new cancer patients in Europe will require radiotherapy by 2025? An ESTRO-HERO analysis. Radiother Oncol. 2016 Apr; 119(1):5-11
[19] https://www.iaea.org/resources/rpop/resources/bonn-call-for-action-platform
[20] https://www.herca.org/highlight_item.asp?p=13&itemID=17
[21] http://www.eurosafeimaging.org/about/call-for-action

associated with low dose exposures is a key orientation, as well as the use of non-irradiating diagnostic methods, such as Magnetic Resonance and Ultrasound imaging.

From a general point of view, radiology, radiotherapy and nuclear medicine are developing proactively through equipment improvements and many national and European initiatives (for instance the "**IC PerMed Secretariat**"[22] which is aimed at establishing Europe as a global leader in personalized medicine research). Nuclear medicine offers considerable potential in this respect. The theranostics approach, where imaging and therapy are closely linked in a customized manner to increase the success rate of treatments and avoid unnecessary ones, may lead to cost savings for health systems. The growth potential of theranostics is attested by the fact that, over the past few years, large pharmaceutical corporations have been investing heavily in this area or closely monitoring the work of smaller radiopharmaceutical-development companies, leading some market analysts to predict a sustained double-digit growth of this market over the 20 coming years. Similarly, innovation in radiotherapy meets multiple challenges from technical, biological, clinical and societal points of view. Scientific, technological and biological advances over the last decades have resulted in major improvements in the implementation, indications, and therapeutic index of radiotherapy. Based on technical innovations such as conformal radiotherapy, intensity modulation, stereotaxic body radiotherapy, hadron therapy and Magnetic Resonance Imaging embedded system and improved biological knowledge, these progresses will lead to improved cost effectiveness. Finally, the innovative technology trends propelling radiology forward will continue and even accelerate. For acceptance of the innovative new methods into practice, Artificial Intelligence have demonstrated remarkable progress in the field and provide new perspectives on how the domain could be advanced. New technological developments like spectral imaging, dark field or phase contrast imaging and molecular imaging approaches already do offer new information helpful for a more precise therapeutic approach - or will be developed to do so.

There is need for further research to benefit from the potential to increase the safe use of radiation in medicine and this is one of the aims of this Partnership. This will be beneficial for the improvement of diagnosis and treatments, for the radiation protection of patients and workers but also for contributing to the European objective of emerging as a global leader in the use of ionising radiation in medicine through innovation. Patients will benefit from the improved safety of medical radiation applications and improved knowledge on potential radiation side effects will contribute to higher degree of confidence in the process of shared decision making regarding the choice of optimal medical interventions.

An important point is that a wide range of skilled personnel (researchers, engineers and technicians, radiographers, radiologists, medical physicists, dosimetry specialists, nurses, etc.) are needed to implement non-power ionising radiation applications. The medium-term threat of a skilled-personnel shortage is shared by European Institutions, as well as by Health, Industry and Research stakeholders, all echoing the same finding in the nuclear-energy field. This potential cross-disciplinary shortage of skills jeopardizes the sustainability and safe development of such applications. This education and training challenge will be addressed as a specific objective of this Partnership.

The protection of human health and the environment against the dangers of ionising radiation is at the heart of Global and European strategies

There is growing concern among European citizens about human and environmental health and obviously this Partnership on Radiation Protection intends to provide answers to these concerns as it is done for other stressors (like chemical risks). Since exposure to radiation and radionuclides has a potential impact on human and environmental health in line with other existing and known stressors,

[22] https://www.icpermed.eu/en/icpermed-secretariat.php

this Partnership emphasizes that radiation protection should not be considered in an isolated context, but with a global view (considering all stressors as in the "exposome" concept). Within that global context, development goals, acts, guidelines have been developed.

In the **Global Environment Outlook 6**[23], the UN calls for immediate action to address pressing environmental issues and to achieve the SDGs. In particular, the UN notices that "*ecosystem boundaries often do not correspond to geopolitical boundaries, so many environmental problems, especially those related to pollution, are often transboundary in nature, such as air pollution, freshwater contamination (surface and groundwater), marine pollution, wastewater, leakages of pollutants, dumping of hazardous and nuclear wastes and species loss. Because many of these transboundary problems are interrelated, there are extensive opportunities to take advantage of co-benefits from policy solutions, but these require greater cooperation and coordination across political boundaries*".

The **Council conclusions**[24] **for the 8th Environmental Action Programme** (EAP) "Turning the trends together" recall that the Union is committed to a high level of protection of the environment and human health and to the improvement of the quality of the environment. It again urges the Commission to present without any further delay a Union strategy for a non-toxic environment in close collaboration with the Member States and the Union Institutions, in line with the 7th EAP.

In the field of environmental health which establishes a direct link between human health and ecosystem health, **the European Environment and Health Process**[25], led by WHO Europe, aims to bring together the environment and health sectors, and promote joint solutions, in particular to address the environment-related health goals and targets of the 2030 Sustainable Development Agenda. In the **Ostrava Declaration of 2017**[26], ministers and representatives of countries in the WHO European Region set out an intersectoral and inclusive approach towards improving environmental health. The main outcome of the Conference was the key commitment for all Member States to attain visible, measurable and equitable progress in environment and health in the WHO European Region by enhancing national implementation and action, both domestically and internationally, which is paramount for effective advancement on health and environment.

The field of environmental health research has also undergone important structuration over the last few years, driven in part by 1) the unifying vision of the exposome which aims to consider all environmental exposures from conception to death in order to decipher the causes of chronic diseases and 2) the One Health concept which aims to promote a more integrated, systemic and unified approach of human, and ecosystemic health, with the underlying goal of defining prevention measures which protect both humans and ecosystems. Both concepts push toward a holistic vision and multisectorial ways to conduct integrated research and manage threats, which is essential in a world of competing risks. A major translation of this new structuration is the current development **of the Health Environment Research Agenda for Europe (HERA)**[27]. As part of the developing agenda[28], environmental and occupational

[23] United Nations Environment Programme (2019) Global Environment Outlook 6 https://www.unenvironment.org/resources/global-environment-outlook-6

[24] https://www.consilium.europa.eu/en/press/press-releases/2019/10/04/8th-environmental-action-programme-council-adopts-conclusions/

[25] https://www.euro.who.int/en/health-topics/environment-and-health/pages/european-environment-and-health-process-ehp

[26] https://www.euro.who.int/en/media-centre/events/events/2017/06/sixth-ministerial-conference-on-environment-and-health/documentation/declaration-of-the-sixth-ministerial-conference-on-environment-and-health

[27] https://www.heraresearcheu.eu/

[28] EU Research agenda for the Environment, Climate & Health 2020-2030. Interim document – February 2020, updated on May 5 2020 https://static1.squarespace.com/static/5d6d2b4f677cfc00014c7b53/t/5ec5b03e2706f13e3f5bf6e3/1590014029073/Research+Agenda+preliminary+20052020+Covid+update_RG5+update.pdf

exposures to low doses of ionising radiation, including from (but not limited to) radon and medical exposures have been clearly identified.

As announced in the political guidelines for 2019-2024 and in continuation of all the initiatives mentioned above, the **Green Deal Communication**[29] was issued in December 2019. The Green Deal is an integral part of the Commission's strategy to implement the United Nation's 2030 Agenda and the Sustainable Development Goals and to take into account the extreme concern of citizens about the effects of climate change and of environmental deterioration on both human and ecosystem health. "*It resets the Commission's commitment to tackling climate and environmental-related challenges that is this generation's defining task*". This European Green Deal aims to protect, conserve and enhance the EU's natural capital, and protect the health and well-being of citizens from environment-related risks and impacts. Further, the Green Deal announced the Biodiversity Strategy for 2030[30], which Communication has recently been published.

The present Partnership is fully in line with these International and European global strategies and agenda with the aim of improving the protection of human health and the environment within the context of the various sources and uses of ionising radiation and in answer to societal concerns and needs.

Environmental impact issues are a key point in the debate on the implementation of a sustainable economy

In December 2019, in parallel with the **Green Deal Communication**, a political agreement[31] between the European Parliament and the Council on the creation of the world's first-ever "green list" classification system for sustainable economic activities, or taxonomy, has been endorsed. The Taxonomy Regulation provides for a general framework that will allow for the progressive development of an EU-wide classification system for environmentally sustainable economic activities.

The agreement neither explicitly excluded nor included nuclear energy in the list of eligible environmentally sustainable economic activities. The importance of "climate-neutral energy" for the transition has been explicitly recognized, while the principle of assessing "the feasibility of all existing technologies" has been introduced into an article dealing with transition activities. The decision to include or exclude nuclear energy has therefore been left to the detailed rules based on a **Technical Expert Group** (TEG) input, subject to "do no significant harm criteria" (DNSH), in particular with regards to the disposal of waste, as well as specific references to life-cycle considerations. On March 2020, the TEG delivered its final report[32] and concluded: "*Given these limitations, it was not possible for TEG, nor its members, to conclude that the nuclear energy value chain does not cause significant harm to other environmental objectives on the time scales in question. The TEG has therefore not recommended the inclusion of nuclear energy in the Taxonomy at this stage. Further, the TEG recommends that more extensive technical work is undertaken on the DNSH aspects of nuclear energy in future and by a group with in-depth technical expertise on nuclear life cycle technologies and the existing and potential environmental impacts across all objectives*".

This Partnership, through the innovative research activities it will develop in the field of the impact assessment of ionising radiation on both humans and the ecosystems, intends to provide bias free useful scientific elements as inputs helping as a part of the extensive technical work called for by the TEG. This will be of particular importance on the issue of potential environmental or health impacts related

[29] https://ec.europa.eu/info/publications/communication-european-green-deal_fr
[30] https://ec.europa.eu/environment/nature/biodiversity/strategy/index_en.htm
[31] https://data.consilium.europa.eu/doc/document/ST-14970-2019-ADD-1/en/pdf
[32] https://ec.europa.eu/info/files/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en

to the use of nuclear energy. The Partnership outcome may also be relevant for other sources of energy as well where workers may be exposed to NORMs such as for geothermic energy production.

Research and innovation is key for improving radiation protection science-based regulation and standards and meeting stakeholders´ expectations

Radiation protection research has an impact on (1) the scientific knowledge on effects of exposure of living organisms (including humans) to radioactive substances and ionising radiation in various situations and effects on health, on (2) principles of radiation protection that are based not only on science but also on values and experience, on (3) international standards, and in the end on (4) radiation protection practices (Figure 2). At the international level, the key organisations responsible for these four pillars of radiation protection and major end-users of research are primarily the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), International Commission on Radiological Protection (ICRP), Organisation for Economic Co-operation and Development/ Nuclear Energy Agency (OECD/NEA), International Atomic Energy Agency (IAEA), World Health Organisation (WHO), International Labour Organisation (ILO), European Commission (EC), Head of the European Radiological Protection Competent Authorities (HERCA), International Commission on Radiation Units and measurements (ICRU) and the International Electrotechnical Commission (IEC).

Exploitation of Research & Innovation (R&I) may take place *via* various routes and therefore it is necessary first to discuss within the scientific community and with stakeholder groups what the potential ways of exploitation are in the scientific context (advancement of science and technology), in the knowledge-based radiation protection recommendations and standards, and in the more applied level providing new methods, models, products and services that support radiation protection practices in industry, hospitals or any units of medical services and research centers. International and European standards and guidelines will be implemented at the national level, where science-based standards can provide a reliable and societally acceptable basis for protective actions and help formulating guides, recommendations and regulations.

Radiation protection standards in Europe and elsewhere are highly dependent, first of all, on scientific knowledge that is reviewed in cycles by national committees, European committees (*e.g.*, the EURATOM Article 31 Groups of experts), and by UNSCEAR and, secondly, on the recommendations made by the ICRP that seeks to take account for the scientific developments (Figure 2). The acquisition of new scientific knowledge through research is therefore a crucial element in improving radiation protection standards for the public, the environment, radiation workers, and persons in the medical field (patients and staff). During the last century of radiation protection, there has been an evolution of the system of protection, mainly driven by new knowledge on radiation effects but also by changes in the society, both in terms of societal values and technological development. Although current radiation protection standards are generally judged to be acceptably robust, there remains considerable scientific uncertainty particularly with regard to human health risks at low doses and/or low dose rates, and to the ecosystem health now recognized as strongly interconnected with human health.

The system of radiation protection is based not only on science but also on values and experience. Lessons learned from several events showed that radiological protection considerations alone are not sufficient to make recommendations or to take decisions but also societal and economic factors have to be taken into account. The values are addressed by the ethical and societal principles for protection of the various categories among workers, public, environment and patients with the three principles of protection being: justification, optimization and limitation. The communication of risks, risk assessment and management of protective strategies both with the public and among stakeholders is important. Both actual risks and perceived risks need to be addressed and put in context with the many beneficial uses of radiation in modern society. For example, are medical imaging procedures always justified? Radiation risks linked with nuclear power production along with *e.g.* low greenhouse gas emissions and other externalities need to be considered and compared with those from other sources of energies over their entire life cycles. In addition to science, also values underlying derivation and application of the safety

standards need to be transparent. The safety standards should support policy makers and enable people to make their own informed choices. Sometimes protective actions may lead to health risks, like it was the case with evacuation of elderly people and hospitalized patients after the Fukushima accident. Good decisions call for societal and ethical considerations in addition to radiation risk assessment. The principal of "doing more good than harm" proposed by the ICRP has to be considered in the implementation of protective actions as well as in the development of new techniques.

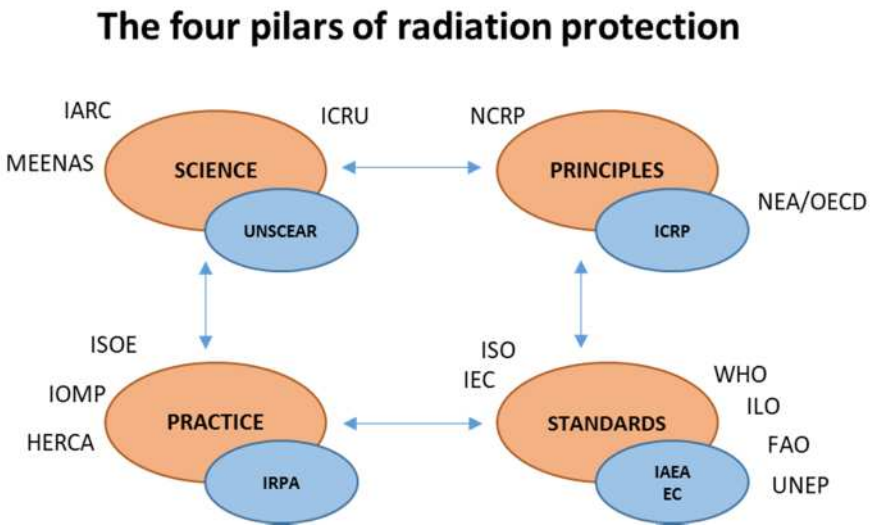


Figure 2. A simplified scheme of the four pillars of radiation protection, the major end-users of research and their interactions. Abbreviations: UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation), ICRP (International Commission on Radiological Protection), EC (European Commission), IAEA (International Atomic Energy Agency), IRPA (International Radiation Protection Association), IARC (International Agency for Research on Cancer), MEENAS (MELODI, EURADOS, EURAMED, NERIS, ALLIANCE, SHARE), ICRU (International Commission on Radiation Units & Measurements), NCRP (National Council on Radiation Protection & Measurements), NEA/OECD (Nuclear Energy Agency/The Organisation for Economic Co-operation and Development), WHO (World Health Organisation), ILO (International Labour Organisation), FAO (Food and Agriculture Organisation), UNEP (United Nations Environment Program), ISO (International Organisation for Standardization), IEC (International Electrotechnical Commission), ISOE (Information System for Occupational Exposure), IOMP (International Organisation for Medical Physics), HERCA (Heads of the European Radiological protection Competent Authorities). (Adapted from Lazo, 2016[33]).

While the international recommendations of the ICRP and the Basic Safety Standards (BSS) by IAEA and EURATOM are mainly based on knowledge of radiation risks, ethical and societal values and past experience, research is also serving the information needs of regulators and authorities in Member States responsible of transposition of the standards in the national legislation and associated recommendations and practices as well as the needs of those engaged in radiation practices (*e.g.* industry, medicine, any risk assessors) and other stakeholders (*e.g.* patient associations, association for nature conservation, professional associations and many other interest groups). Science helps developing recommendations and standards that form the basis for the European BSS. These standards need to be implemented in a harmonized manner in the European Member States. This calls for R&I actions that range from basic to applied research and technological development. While helping in the implementation of the EURATOM BSS requirements, continuous research is also needed for testing the adequacy of the requirements and to propose ways how requirements or their implementation could be improved. Within this context, radiological protection is an essential component of the EURATOM program. It enables technology development, good professional practice and effective regulatory supervision through the EURATOM BSS Directive and links scientific experts across Europe and beyond on a cost efficient basis.

[33] Lazo, 2016. Evolution of the radiation protection system and its implementation. Health Physics 110(2):147–150

Within this context, a major challenge of this Partnership will consist in consolidating regulations and improving practices by capturing low-doses research advances with the final objective of a better protection of human health and the environment. The partnership will ensure that scientific expertise and technical resources basis which is indispensable to effectively implement EURATOM BSS remain available across Member States, at the highest level of excellence.

Emergency preparedness needs continuous sustained cross-border European efforts

The Fukushima-Daiichi nuclear power plant accident reminded us that the combination of multiple low probability events can lead to actual real-world disaster. While all the SDGs are relevant for building a sustainable and resilient world, a number of them have targets directly or indirectly related to disaster risk reduction. Implementing the Sustainable Development Goals also contributes to achieving the goal of the **United Nations Sendai Framework for disaster risk reduction**[34] 2015-2030. This Framework outlines four priorities: (1) Understanding disaster risk; (2) Strengthening governance to manage disaster risk; (3) Investing in disaster risk reduction for resilience and; (4) Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction. The Framework was adopted at the **Third UN World Conference on Disaster Risk Reduction** in Sendai, Japan, on March 18, 2015 where the EU played a key role in the negotiations. The European Commission adopted the Communication **Post 2015 Hyogo Framework for Action: Managing risks to achieve resilience**[35], followed by EU Member States **Council Conclusions**[36] outlining the EU position. In June 2016, the European Commission published an action plan that aims to guide the implementation of the Sendai Framework in EU policies. The plan covers a five-year period and provides for a more systematic disaster-risk-informed approach in EU policy making. Through society-wide engagement, it proposes concrete activities on risk knowledge, risk investments, disaster preparedness, and resilience.

Although much has been done since the Fukushima accident to improve preparedness in case of a nuclear or radiological accident, much more has to be achieved in this field in relation to new threats or new installations and devices using ionising radiation. **The challenge to be tackled by this Partnership will be to contribute to improve the anticipation and resilience in case of radiological or nuclear event on technical and social levels.**

Easy access to research infrastructures and Education and Training (E&T) activities are key elements for maintaining and further developing the internationally renowned European excellence in radiation protection research

The European excellence in the field of radiation protection research is internationally recognized. One of the reasons is that Europe was able, during these last decades and thanks to national and European efforts, to maintain and develop specific infrastructures that are of prime importance for research activities. These infrastructures include so-called large infrastructures such as exposure facilities for animal and plant experiments (both laboratory and field facilities) but also epidemiological cohorts, clinical cohorts, biobanks, databases and analytical platforms (including e-infrastructures). The inventory of European infrastructures and future needs performed during the H2020 CONCERT EJP has revealed that most infrastructures required for tackling current radiation protection challenges are already available within Member States and Associated Countries. The current challenge, that will be tackled in this Partnership, is to facilitate their access by maintaining their visibility, to assure their

[34] https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030
[35] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0216&from=EN
[36] https://www.consilium.europa.eu/uedocs/cms_data/docs/pressdata/en/jha/143119.pdf

sustainability beyond national short-term constraints and, last but not least, to support cross-border exchange visits of students and researchers for their optimal use.

In parallel to the ease of access to infrastructures, another major challenge lies in the field of human resources. Besides the fact that new skills and knowledge are needed to tackle scientific challenges (bioinformatics, data science…) the demographics of the radiation protection research community is changing, both due to population aging and changing pressures in the work environment. Pioneering researchers are now retiring whereas the subject is no longer as fashionable as it was during the infancy of nuclear power; students are struggling to find secure career appointments against competition from other fields. This is observed in all fields of radiation protection research and it exists a medium-term threat of a skilled-personnel shortage. This potential cross-disciplinary shortage of skills jeopardizes all the efforts that have been made this last decade to integrate the radiation protection research community and finally the recognized excellence of Europe in this field. Within this context, Education and Training activities will play a central role in this Partnership.

2.1.2. Links with previous Research & Innovation (R&I) Partnerships, identification of scientific challenges and R&I needs

During the last decade, there has been a strong move towards the integration of European research in radiation protection. Concerned about the fragmentation of research and the decline of research resources, the High Level Expert Group[37] (HLEG) proposed the Multidisciplinary European Low Dose Initiative for the integration of low dose risk research in Europe, leading to the establishment of the MELODI association in 2010. The purpose of MELODI was to set up and maintain a Strategic Research Agenda (SRA) for low dose risk research, promote education and training and to coordinate the use of resources, including research infrastructures. Encouraged by the success of MELODI, other R&D platforms integrating European research actors in radioecology (ALLIANCE[38] established following a diagnostic made by the FUTURAE project), nuclear and radiological emergency response and recovery (NERIS[39]), and medical use of radiation (EURAMED[40]) were established with similar aims in their respective fields. EURADOS[41] that was founded already in the 1980´s as an expert organisation of the European dosimetry community also prepared a SRA in its respective field. Soon it was realized that there are synergies between the platforms, creating a need for coordination and joint programming. Such needs were addressed by the OPERRA[42] project and the COMET[43] project in FP7 (2013-2017) and the CONCERT[44] European Joint Programme (EJP) for Radiation Protection Research in H2020 (2015-2020). More recently, the newly established SHARE[45] platform has further consolidated the expertise in social sciences and humanities and has prepared a SRA for the integration of social sciences in radiation protection research. A key principle of the SRAs is that they are regularly updated and open for comments and amendments by anyone interested. In order to improve the coordination of the radiation protection activities, the European Radiation Protection platforms (MELODI, EURADOS, EURAMED, NERIS, ALLIANCE, SHARE) are now structured under the MEENAS umbrella structure. This structure, formalized by the signing of a Memorandum of Understanding by the six platforms, aims to:

[37] http://www.melodi-online.eu/about_m.html
[38] http://www.er-alliance.eu/
[39] https://www.eu-neris.net/
[40] https://www.euramed.eu/
[41] https://eurados.sckcen.be/
[42] http://www.melodi-online.eu/operra.html
[43] https://radioecology-exchange.org/content/comet-project-archive
[44] https://www.concert-h2020.eu/
[45] https://www.ssh-share.eu/

- promote the integration and the efficiency of European R&D in radiation protection to better protect humans (public, patients and workers) and environment;
- advance scientific excellence;
- maintain and develop European research capacity;
- encourage scientific education and training and foster key research infrastructures in the field of radiation protection;
- foster international collaboration and collaboration with organisations and networks in a non-exclusive manner by open interaction with the wider research community and stakeholders.

The research platforms have established mechanisms to prioritize research in the field of radiation protection and developed roadmaps for radiation protection research. Up to now, their use of the roadmaps has been limited to two open calls implemented during the CONCERT EJP. In December 2019, both on the basis of the individual SRAs elaborated by the platforms and on the outputs of the different radiation protection research projects conducted under the 7th and the 8th Framework Programme, the CONCERT EJP delivered a Joint Roadmap[46] for radiation protection research elaborated by a working group including representatives of the six radiation protection platforms and specific CONCERT Programme Owners and Programme Managers (POMs). This Joint Roadmap reflects the broad spectrum of societal and scientific issues requiring consideration by the radiological protection research community. It is intended to provide a solid basis to define priority areas and strategic objectives for mutual cooperation and a vision and role for a European radiation protection research programme to 2030 and beyond. It may serve as a starting point for joint discussion and cooperation across the multitude of involved disciplines, a reference for evaluation of progress and finally a basis for promoting a European vision on radiation protection research.

The Joint Roadmap presents a view of the joint research challenges in the context of existing and potential exposure scenarios (Table 1), relevant from societal and radiation protection point of view. The term “Joint” refers to the fact that the joint research challenges cover many disciplines, requiring collaboration of research communities of the different platforms needed to tackle the challenges.

[46] https://www.concert-h2020.eu/en/Publications

RP in various exposure scenarios		Anthropogenic	Anthropogenic	Anthropogenic	Natural
ICRP classification	Contexts ⇨ Exposure Scenarios ⇩	Medical therapy and diagnosis	Nuclear applications and applications of IR other than medical	Use of natural resources (NORM, TENORM)	Natural background radiation
Planned	1. Medical / Patients	Patients undergoing diagnostics or RT			
Planned	2. Industrial applications / public & environment		Discharges from nuclear sites during normal operation	Discharges from industry dealing with NORM	
Planned	3. Workers	Personnel in health care & production of radiopharmaceuticals	Personnel in nuclear installations & use of industrial IR sources	Personnel in NORM generating industries	Aviation personnel & astronauts
Existing	4. Nuclear or industry using NORM/ public & environment		Legacy from nuclear fuel cycle or other nuclear installations	NORM legacy sites	
Existing	5. Natural background / public & environment				Elevated natural background
Emergency	6. Nuclear or radiol. accident / public, workers, environment	Accident/incident with medical sources, radiopharmaceuticals	Accidents in nuclear installations	Accidental releases from NORM industry	

Table 1: Exposure groups related to different exposure situations categorized according to the ICRP classification (planned, existing or emergency exposure situations). The columns represent the different exposure sources (anthropogenic/natural) and contexts (medical, nuclear industry, NORM-TENORM and natural). Within the different exposure situations, various groups of exposure scenarios are identified. NORM-TENORM: Naturally Occurring Radioactive Materials - Technologically Enhanced Naturally Occurring Radioactive Materials (TENORM) (from D3.7 Second joint roadmap for radiation protection, 2020[47]).

Eight Joint Research Challenges were identified and are summarised in Table 2 (A – H), together with the platforms needed to tackle them. Within these research challenges, the Joint Roadmap highlighted 20 "game changers" (or bottlenecks) defined as research issues that, when successfully resolved, have the potential to impact substantially and strengthen the system and/or practice of radiation protection for people (public, workers, patients) and the environment through 1) significantly improving the evidence based, 2) developing principles and recommendations, 3) developing standards based on the recommendations and 4) improving practice. These challenges and associated "game changers" form the basis for appropriate multidisciplinary projects, addressed in a new partnership for radiation protection.

[47] https://www.concert-h2020.eu/en/Publications

Joint Research Challenges	Scenarios
A. Understanding and quantifying the health effects of radiation exposure	1-6
B. Improving the concepts of dose quantities	1-6
C. Understanding radiation-related effects on non-human biota and ecosystems	1-2, 4-6
D. Optimising medical use of radiation	1, 3
E. Improving radiation protection of workers	3, 6
F. Integrated approach to environmental exposure and risk assessment from ionising radiation	2, 4-6
G. Optimise emergency and recovery preparedness and response	6
H. Radiation protection in society	1-6

Table 2: Overview of joint research challenges derived from exposure scenario groups (from D3.7 Second joint roadmap for radiation protection, 2020[48]). See table 1 for a description of the scenarios.

It is important to consider that the Joint Roadmap is a living document that will need to be updated on a regular basis, considering on the one hand advances and developments that affect the research needs and on the other hand the apparition of new scientific challenges, results or societal concern. With this in mind, special attention will be paid to the outputs of several on-going important H2020 European projects as their results may provide elements potentially modifying the priority setting of the Joint Roadmap. These projects are the following:

1) H2020 MEDIRAD[49] research and innovation action (2017-2022) which aims to enhance the scientific bases and clinical practice of radiation protection in the medical field and thereby addresses the need to better understand and evaluate the health effects of low-dose ionising radiation exposure from diagnostic and therapeutic imaging and from off-target effects in radiotherapy.

2) H2020 HARMONIC research and innovation action (2019-2024) which aims at better understanding the long-term health effects of medical exposure to ionising radiation in children, specifically those undergoing radiotherapy for cancer or X-ray guided imaging for cardiac interventions.

3) H2020 EURAMED Rocc-n-roll coordination and support action. This 3-year project (2020-2022) is dedicated to the development of a SRA based on the existing EURAMED SRA, integrating the healthcare and digitization challenges, and a corresponding roadmap defining priorities focusing on transferability into clinical practice to allow a coordinated research and innovation approach towards medical application of ionising radiation and the corresponding radiation protection research for better diagnosis, therapy, and monitoring with less radiation-induced detriment, thus improving patient care.

4) H2020 RadoNorm research and innovation action (2020-2025). This research project will target all relevant steps of radiation risk management for radon and NORM exposure situations. It aims to reduce scientific, technical and societal uncertainties by (i) initiating and performing research and technical developments, (ii) integrating education and training in all research and

[48] https://www.concert-h2020.eu/en/Publications
[49] http://www.medirad-project.eu/#top

development activities, (iii) and disseminating the project achievements through targeted actions to the public, stakeholders and regulators.
5) H2020 SINFONIA research and innovation action (2020-2024). The main objective of the project is to develop novel methodologies and tools that will provide a comprehensive risk appraisal for detrimental effects of radiation exposure on patients, workers, carers and comforters, the public and the environment during the management of patients suspected or diagnosed with lymphoma and brain tumours and treated by radiotherapy.

European radiation protection research efforts have made great progress over the last decades and paved the way for an integrated approach, bringing together the fields of radiation biology, radiation epidemiology, dosimetry and medical radiation protection, low-dose risk research, emergency preparedness and response, radioecology, as well as the input from social sciences and humanities research in the implementation of radiation protection. This is impressively reflected by the Memorandum of Understanding signed by all six platforms. This broad spectrum is well recognized worldwide. This partnership will use the experience gathered up to now in terms of scientific results and of organizing the complex interaction between different key players in Europe and beyond, in order to pursue multidisciplinary research based on a structured planning process.

It will take decades to address all research challenges identified in the CONCERT Joint Roadmap. As EURATOM programmes are limited in time and budget (typically five years), it is necessary to define priorities for the next 5 years. Therefore, this partnership proposes to address research priorities from the Joint Roadmap that support the priority EU policies and are aligned with Horizon Europe pillars (excellent science, global challenges and European industrial competitiveness, innovative Europe) while taking into account the fact that some research challenges require a longer term effort.

Within this context, **high priority should be dedicated to medical applications** considering that 1) medical exposures are, by far, the largest artificial source of exposure of the European population and 2) the fight against cancer is a top priority of the mandate of the present European Commission. In order to ensure an appropriate continuity in the research goals and methodologies, in line with the contents of the CONCERT Joint Roadmap, two other priorities have been identified to further understand and reduce uncertainties associated with health risk estimates for exposure at low doses and low dose-rates in order to consolidate regulations and improve practices and to further enhance a science-based European methodology for emergency management and long-term recovery.

Therefore, the priorities that will be addressed in the Partnership are as follows:

1) **To improve the prevention, detection and safe treatment of cancer** in contribution to "Europe's beating cancer plan" that aims at "improving the prevention, detection, treatment and management of cancer in the EU while reducing health inequalities between and within Member States" and of the Horizon Europe "Cancer" Mission[50]. The Partnership, through its research activities will provide inputs to at least two recommendations by the recent "Report of the mission board for cancer"[51] namely: "advance and implement personalised medicine approaches for all patients in Europe" and "develop an EU-wide research programme on early diagnostics and minimally invasive treatments". Bridges with Partnerships "ERA for health", "Personalized medicine", "Artificial intelligence, data and robotics" and "Metrology", and their associated social and ethical dimensions would also be beneficial. R&I needs and opportunities in radiation protection associated with this overarching challenge consist of:

[50] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/12154-Europe-s-Beating-Cancer-Plan
[51] https://op.europa.eu/en/publication-detail/-/publication/b389aad3-fd56-11ea-b44f-01aa75ed71a1/

a. the harmonisation of the practices throughout Europe especially with respect to the protection of human health from the harmful effects of ionising radiation and with respect to the potential benefit of the use of ionising radiation for the individual patient;
b. The optimisation of protocols to improve the protection of patients using AI techniques;
c. The development of innovative diagnostic and therapeutic techniques using ionising radiation;
d. A better understanding of the magnitude and individual variability of risks related to ionising radiation and patient understanding therein; including a characterisation of radiosensitivity and radiosusceptibility;
e. Performing research to pave the way to personalized medicine, including factors of gender and age as part of individual radiation sensitivity, susceptibility and degenerative fragility;
f. Robust consideration of patient concerns, trust and limitations to personalisation;
g. Investigating technology acceptability and uptake.

2) **To consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances** in support of the EU Green Deal objectives, specifically to ensure the sustainable transition "while also protecting citizens' health from environmental degradation and pollution, and addressing air and water quality". This ambition is shared again with the "Health" cluster with which a later connection could be beneficial. The major R&I needs for radiation protection for this challenge are:
    a. A better understanding and quantification of low-dose effects on health and ecosystems through mechanistic approaches as well as new instruments and tools for the radiological monitoring of the environment;
    b. A better understanding of basic mechanisms by determining individual reactions to radiation and by quantifying radiation damage from the physical interaction of ionising radiation;
    c. Facilitating uptake of research results by decision makers and regulators, to improve protection of workers, public and the environment by science based policy recommendations.

3) **To improve the anticipation and resilience in case of radiological or nuclear event and the management of legacy sites** in support of the Action plan on the Sendai Framework for disaster risk reduction. This challenge will be a contribution to the EU objective of creating "*a resilient and more stable Europe that protects*" and research performed during the Partnership will be closely connected to the Horizon Europe "Civil security for society" cluster that is aimed at an "improved disaster risk management and societal resilience" through better understanding of natural and man-made disasters and by the development of novel concepts and technologies to counter these risks. It will also be closely connected to activities developed in the "food, natural resources, agriculture, and environment, biodiversity" cluster one of the objectives of which is "*reducing environmental degradation and pollution*". Links with the Partnership on Metrology will be established. R&I needs in radiation protection associated with this challenge are:
    a. Development of robust prediction models of radiological contamination in the environment for an integrated dose and risk assessment;
    b. Optimisation of emergency and recovery preparedness and response using Artificial Intelligence and Big Data;
    c. Improvement of stakeholder's involvement strategies; including the communication of results of radiological protection to non-specialist audiences such as policy decision-makers and the general public;
    d. Optimisation of processes and relevant values such as reasonableness and tolerability.

2.2 Common vision, objectives and expected impacts

2.2.1 Vision

The purpose of the Partnership is to consolidate an EU-wide research and innovation community in the field of radiation protection to support EU and national authorities and to further develop process with new data, knowledge, innovative methods and skills to address current knowledge gaps, societal concerns and emerging issues. An integrated approach to radiation protection research, exploiting synergies between the various areas of expertise including cancer diagnosis and treatments, also outside the radiation protection remit, is required to fully realize maximum benefits and outcomes. This Partnership, largely based on the integration effort accomplished by the radiation protection research community this last decade and supported within H2020 and before by the EC/EURATOM research programme framework, will lead to a better coordination of and thus more efficient research efforts, in particular those regarding the risks associated with medical, industrial or environmental exposure, and on emergency management in relation to accidents involving radiation. The vision that supports this Partnership is to provide a pan-European scientific and technological basis for a robust system of protection and more consolidated science-based policy recommendations to decision makers in all these different fields and – at the same time - to innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches always considering radiation safety. In the long term, these efforts will translate into additional or improved practical measures through innovation and improved scientific insights in view of a better outcome of patients suffering from cancer and the effective protection of people (public, workers and patients) and the environment.

This Partnership builds on:

- the successful reorganisation, integration and consolidation effort of the European radiation protection research landscape performed by the European research community during the last decade;
- the experience acquired when implementing several FP7 projects (DoReMi, OPERRA and COMET) and, more recently, the H2020 CONCERT EJP for the integration of radiation protection research and on-going H2020 research programmes (EURAMED Rocc-n-roll, MEDIRAD, HARMONIC, RadoNorm, SINFONIA);
- the existence of a recently published Joint Roadmap for radiation protection research that was established as a deliverable of the H2020 CONCERT EJP by a working group including representatives of the six radiation protection platforms and specific CONCERT Programme Owners and Programme Managers;
- the capacity and quality of many national radiation protection programmes and efforts by different Member States, including national funding and research schemes.

This Partnership will have an impact on radiation protection of humans and the environment in many ways. By consolidating our scientific knowledge, the results of the research activities will support the implementation of the European Basic Safety Standards, to help cope with the new requirements and harmonize the practices throughout Europe. The Partnership addresses both human protection and protection of the environment. The holistic approach covers both, risk assessment and risk management, as well as development of measurements techniques, tools, methods and best practices to cope with the issues related to radiation exposure, thus making a major impact on society. Research is needed for risk prediction in specific situations and for foresight, to anticipate potential exposures. New knowledge will contribute to evidence-based recommendations at international level and informed risk communication.

Research on risk management will improve risk prevention, the resilience of societies for emergencies, help to set up action plans and work on the mitigation and remediation. Guidelines, recommendations and regulations are needed, along with good practices and reliable methods for field and laboratory work. A graded approach in risk management is needed and research will help in putting exposures and risks in perspective. Technological development comes up with new standards, technological innovations and improved capabilities. Finally, young, well trained experts in the radiation protection

research field are needed to supply the society with well-grounded expertise, leading to improved social capital in the EU. Critical infrastructures need to be supported and access to these infrastructures should be possible for the whole radiation protection community.

The Partnership will develop alonside the research innovation plans. The innovation plans will identify the potential industrial partners, the necessary developments and suitable evaluation methods and include a SWOT analysis.

The research foreseen and the derived recommendations will enable consolidated, harmonized and robust decision making in the field of radiation protection throughout Europe and beyond.

Additionally, it aims to homogenize and combine national efforts by all Members States to guarantee the highest radiation protection level of its citizen and at the same time provide other services that are enabled by radiation, especially in the field of medicine. In that sense, a large part of the Partnership will be dedicated to support the "Europe's beating cancer plan" that is currently under preparation. Indeed, it is of the utmost importance for the system of radiological protection to optimise the medical application of ionising radiation and to harmonise the practices throughout Europe especially with respect to the protection of human health from the harmful effects of ionising radiation and with respect to the potential benefit of the use of ionising radiation for the individual patient. This is especially true for the diagnosis and treatment of cancer. The ultimate goal is to optimise the use of ionising radiation for the diagnosis and treatment for each patient on an individualized approach based on individual risk and sensitivity in a standardized way throughout Europe. New methodologies or optimised approaches can reduce the radiation exposure to each patient while maintaining or even improving clinical outcome and help to allow similar conditions for patients within Europe and require new or even potentially additional protection measures.

Through this Partnership, EURATOM will strengthen radiation protection communities from academia to private industry throughout Europe and will multiply the successes that have been made in the last decade through the improved homogenization and integration of the different fields of radiation protection. Radiation protection research aims to even better serve communities across all Member States, and only a strong stakeholder and user-based focus of the co-funded research will enable scientific innovations to translate rapidly into improvements of quality of life and health for European citizens.

2.2.2 General, specific and operational objectives

The general objective of this Partnership is to improve health, people's lives and the quality of the environment by contributing to the fight against cancer and improving protection against effects from low doses of radiation (including radiological consequences of nuclear accidents or radiological events) by organizing radiation protection research through competitive open calls.

The wider policy context, *i.e.* at the international level, in which this Partnership is developed, has been described in Section 2.1.1. To establish the objective of the Partnership, the focus has been on the most recent policy documents and the new requirements they define at the European level. The objectives therefore respond to the research and innovation needs identified in the following policy documents:

- European Directive 2013/59/EURATOM laying down Basic Safety Standards (BSS) for protection against the dangers arising from exposure to ionising radiation;
- Orientations towards the first Strategic Plan for Horizon Europe (2019);
- "Europe beating's cancer action plan" under preparation;
- European Green Deal (in particular "Preserving and restoring ecosystems", "A zero pollution ambition for a toxic free environment");

- SAMIRA Council Conclusions[52] on non-power nuclear and radiological technologies and applications;
- European action plan on the Sendai Framework for disaster risk reduction;
- Technical annex to the TEG final report on the EU taxonomy (9 March 2020);
- Communication: A European strategy for data[53].

The General Objective will be reached through the achievement of six specific objectives (four topical specific objectives and two non-topical specific -transverse- objectives) that are presented below. The four topical specific objectives are aimed at tackling the three priorities defined in section 2.1.2. Operational objectives and indicators are provided for the grouping of the four topical objectives and for each of the non-topical specific objectives.

Topical specific objectives

Specific objective 1: To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches allowing better patient outcome and safety

Medical use of ionising radiation is the largest source of exposure on average for the population in developed countries as in Europe. There is a large difference in radiation exposure due to medical applications between different European countries and there is also a difference in the medical use itself. Therefore, it is of great importance for the system of radiological protection to optimise the medical application of ionising radiation and to harmonise the practices throughout Europe especially with respect to the protection of human health from the harmful effects of ionising radiation and with respect to the potential benefit of the use of ionising radiation for the individual patient. This is especially true for the diagnosis and treatment of cancer. The ultimate goal is to optimise the use of ionising radiation for the diagnosis and treatment for each patient on an individualized approach in a standardized way throughout Europe.

New methodologies or optimised approaches can reduce the radiation exposure to each patient while maintaining or even improving clinical outcome and help to allow similar conditions for patients within Europe and require new or even potentially additional protection measures. This is especially important for treatment of infants and toddlers as they have a long life span ahead of them. The transfer of the new or optimized approaches into clinical routine is necessary to really optimize the medical use of radiation. This has to be done in a standardized way throughout Europe allowing all European patients benefitting from the new or optimized methods and procedures in the same way. This is especially true for example for new technological developments such as AI based methods. In this context it is of utmost importance to guarantee a safe use of such methods and to avoid radiation exposure without a secure diagnosis or treatment. Although, the medical use of ionising radiation should follow the same standards throughout Europe, these guidelines still have to take into account the individual benefit for each single patient. To widen this approach to all medical applications of ionising radiation would be a big step for optimized medical care and optimized radiation protection.

[52] https://www.consilium.europa.eu/en/press/press-releases/2019/06/06/the-council-underlines-role-of-non-power-nuclear-technologies/
[53] https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1582551099377&uri=CELEX:52020DC0066

<u>Specific objective 2:</u> To improve scientific understanding of individual radiation response and risk

Individual variation in radiation-related risk for cancer and other non-cancer chronic diseases is a key area to address for radiation protection and medical treatment. Differences in the magnitude of radiation-induced effects between individuals, or groups, may relate to sex, age at exposure, state of health, genetic and epigenetic make-up, lifestyle, and attained age. Such differences, if significant, raise profound ethical and policy questions as to whether some individuals or groups are inadequately or over-protected by the present system and regulations. It is also an increasing factor to be considered in medical radiation protection. During therapy, healthy body regions outside the irradiated field will still receive low radiation doses, probably leading to long-term consequences of radiation therapy, due to better long-term survival of the patients. Similar concerns exist with repeated medical diagnostic investigations using ionising radiation, especially in young children and infants, due to the longer life span ahead of them, but also in adult patients due to the generally expected higher life expectancy. These exposures need to be quantified and optimised.

At present, there is insufficient information about the mechanisms behind and size of the differences in response between individuals and their consequential influence on risk estimates either after high therapeutic doses or at low doses and dose-rates. In order to address policy questions and regulation, it is necessary to obtain better scientific insight in the origin and extent of the variations in sensitivity in the population, in the sizes of the variations, characteristics affecting the variation and in the proportions of the population that are affected and the socio-economic variables at play. Importantly, reliable and robust biomarkers predictive of individual risk need to be identified and characterized through basic mechanistic research before application in epidemiological or medical studies. These developments form the key scientific foundation for the health target of SO1: individualized therapy for all EU citizens.

<u>Specific objective 3:</u> To consolidate regulations and improve practices in the domain of low dose exposures of humans and the environment by further understanding and reducing uncertainties associated with health risk estimates

The central aim of the radiological protection system is to protect humans and the environment from possible harmful effects of ionising radiation. Risks to human health and to health of the environment are a prime consideration in all occupational and public exposure settings. The Partnership aims to achieve a comprehensive quantitative and mechanistic understanding of radiogenic health and environmental effects, with special focus on low doses because of prevailing uncertainties about the levels of risk. The current regulations of human radiological protection are based on the assumption that any level of exposure can cause an effect, and that the dose-effect relationship is best represented by the linear non-threshold (LNT) model assuming a straight line from zero dose upwards. Due to insufficient statistical power, epidemiological studies on humans are not able to provide data to resolve the uncertainties at low doses. Hence, the LNT approach is based on the precautionary principle which is prudent but not satisfactory. What is needed to reduce the uncertainties regarding low dose effects are mechanistic studies on biological, physical and environmental effects of radiation. Open questions that need to be resolved include 1) the pathways of radiation induced cancer and non-cancer diseases which will allow defining key molecular events in the adverse outcome pathway (AOP) approach; 2) the impact of dose rate on biological effects which will allow validating the currently adopted dose and dose rate effectiveness factor (DDREF) of 2; 3) the particle track structure and resulting biological effectiveness of different radiation qualities that are the basis for defining radiation weighing factors. At the ecosystem level, system approaches to study whole ecosystems and define AOPs are needed and it is particularly important to lift existing controversies regarding the effects on wildlife reported in the Chernobyl and Fukushima exclusion zones. Workers can also be exposed to low doses of radiation, and it is important to be able to monitor workers reliably and accurately in real time and to provide input for the optimal application of the protection principle. Equally important are studies of societal perspectives on radiation risks and effective communications between science and society to enable compliance with regulations and practices leading to improved protection. It must be stressed that the International

Commission on Radiological Protection (ICRP) has recently started working on revising its radiation protection recommendations which form the basis of the European radiation protection directive. Hence, new mechanistic insights into radiation effects that can improve the system of radiological protection and their effective dissemination are urgently needed.

Specific objective 4: To be better prepared to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites

In nuclear or radiological emergency management including accidental exposures, medical follow-up and long-term recovery as well as in legacy site management the radiological impact and risk assessment is of prime importance and demands the improvement, development and customisation of several new methodologies and advanced tools. As a basis for more robust radiological impact assessment there is a need to further improve the understanding and associated modelling of radionuclide dispersion and transfer processes. The evolution of knowledge and technology will advance risk assessment and risk management tools and methodologies which can be efficiently implemented in order to improve preparedness in case of radiological or nuclear event and management of legacy sites. Artificial Intelligence (AI) and big data technologies provide new capabilities in all domains from monitoring to decision support tools and more broadly to the decision-making processes. They allow processing large volumes of – potentially heterogeneous – information and accumulated knowledge, either in real-time or via machine learning algorithms. Exploiting Artificial Intelligence (AI) and big data technologies, new methods for radiological impact assessment and new-generation Decision Support Systems (DSS) providing guidance for improved response and recovery strategies, can be developed. The appropriate inclusion of societal and ethical dimensions in DDS are also paramount.

To cope with novel threats and accident scenarios arising from new and future nuclear and radiological technologies further development of risk assessment and risk management approaches and improvement of socio-technological capabilities is required. As an essential part of impact and risk assessment in post-emergency situations and legacy management, a robust prediction of radiological contamination in the environment, for an integrated dose and risk assessment will be pursued. Research in effective communication and stakeholder involvement strategies is key for success as it contributes to trust and confidence building helping to improve resilience of potentially affected communities and better manage (post) emergency and recovery phases as well as legacy sites.

The operational objectives for the 4 specific objectives presented above are as follows:

Operational objective N° 1: Develop and implement annual research and innovation work programmes (AWPs) on the basis of the 3-(or 5) year common strategies associated with the 4 topical specific objectives.

Provisional indicators
The strategic indicators will have to be developed and specified during the development of the 3 (or 5) year common strategies and annual work programmes but example includes:

- Percentage of the activities set out in the 3 (or 5)-year common strategy that are covered by AWPs (annually, increasing).

Operational objective N° 2: Define the themes of the open calls with transparent and inclusive criteria and a dedicated prioritization process to address the research challenges associated with the 4 topical specific objectives.

Provisional indicators:

- Timely organisation of consultations with Consortium members and other stakeholders (minimum 1 month reserved for providing input).

- Number of inputs from stakeholder groups to each round of prioritization (periodically, increasing in total number of inputs, as well as diversity of stakeholder groups providing inputs).
- Timely submission of 'scoping' documents setting out the priority R&I activities identified in the consultation.

Operational objective N° 3: Launch several open calls to address the priority research topics and with a particular aim of embarking with a variety of LTP and TP.

Provisional indicators:
- Number of open calls launched (target: minimum two).
- Number of LTP and TP responding to the open calls (no target, increasing).

Operational objective N° 4: Unify AI activities across topical fields to create a focal point between AI research and radiation protection and to further develop these topics in the different application areas of radiation protection with a focus on security and robustness.

Provisional indicators:
- Number of Meetings between the radiation protection (RP) community and the Artificial Intelligence (AI) / machine learning community (target: minimum two).
- Number of AI-focussed projects in open calls.

Operational objective N° 5: Update the JRM and associated priorities based on the updated radiation protection platforms' SRAs, the evolving societal needs and the results of already funded projects.

Provisional indicator:
- Publication of the updated JRM and associated priorities.

Other indicators related to the monitoring of scientific advances will have to be developed and specified during the development of the common strategies and AWPs and in close link with the themes of the open calls that will be retained at the end of the prioritization process.

Non-topical specific objectives

Specific objective 5: To maintain a sustainable expertise capability on radiation protection issues across the EU by fostering the availability, the use, the sharing and the optimization of existing state-of-the-art infrastructures at European level and beyond, and conducting education and training activities.

Excellent radiation protection research is based on three pillars: 1) Maintenance and easy access to relevant research infrastructure, 2) Building and maintenance of knowledge by education and training of young scientists, promotion of young talents in radiation science and lifelong learning and 3) Set up of a FAIR[54] data culture enabling open science and enhance effective exchange of data and information between different researchers, stakeholders and policy domains. These requirements play a key role in radiation protection research and are basic for the implementation of the research activities.

The inventory of European infrastructures and future needs performed during the H2020 CONCERT EJP has revealed that most infrastructures required for implementing the Joint Roadmap are already available within Member States, Associated Countries or beyond. The next step, which is the purpose

[54] **FAIR** : **F**indable, **A**ccessible, **I**nteroperable, **R**eusable

of this specific objective, will be to make better use of research infrastructures existing across Member States. In line with the "European strategy for data"[55], specific efforts will be dedicated to high-quality sample/data acquisition and sample/data storage with the aims to share and re-use of archived materials. A strategic work plan for maintenance, updating, mutual use and new needs of suitable infrastructures is necessary to tackle emerging challenges (for instance study on new radiopharmaceuticals).

Building and maintaining knowledge turns out to be a great challenge and places big demands on the skills and resources of the research community due to 1) new technologies including bioinformatics, powerful computing, data science, including handling of large data sets 2) changing pressures in the work environment and aging population and 3) maintenance and access to research infrastructure on national and global level.

Next to education and training of trainers and young researchers entering the field of radiation protection research, there is a need for lifelong learning programmes to enable researchers to enter emerging research fields within the course of their research careers.

Finally, a FAIR data culture enabling open science and enhance effective exchange of data and information between different stakeholders and policy domains is mandatory in order to use the generated data and new knowledge optimally and for the benefit of all.

Following operational objectives and associated provisional indicators are put forward:

Operational objective N° 6: Create a FAIR data culture, with regard to findability, accessibility, interoperability, and reusability of the generated data and thus enabling open science and enhance effective exchange of data and information between different stakeholders and policy domains.

Provisional indicators:

- Number of collaborations with external data platforms for the storage of data from the Partnership (periodically, target all data of Partnership).
- Easy and free access to data generated from public financed projects.

Operational objective N° 7: Ensure long-term sustainability of excellent European infrastructure for radiation research, easy access for researchers and students to infrastructure and data.

Provisional indicators:

- Total number of infrastructure facilities, accessed during the partnership (annually, increasing).
- Total number of researchers using radiation protection research infrastructures in Europe during the partnership (annually, increasing).
- Number of harmonisation processes (including quality standards, practices and protocols in relation with the use of infrastructures and also intercomparisons between methods, laboratories and infrastructures) (annually, increasing).
- Total number of FAIR data sets, provided for information and shared with the community to enable open science (annually, increasing).

Operational objective N° 8: Set up and foster Education and Training activities in all the relevant fields of activity of the Partnership and implement a long-term strategy for sustainable effective and efficient education and training in radiation protection and related disciplines.

Provisional indicator:

[55] https://ec.europa.eu/digital-single-market/en/policies/building-european-data-eco

- Number of actions envisaged during the next 10 years that are elaborated in the strategy document and the work plan.
- Number of scientific courses, training activities.
- Number of participants attending Education and Training activities (annual, no target, increasing).
- Scores from evaluation questionnaires with participants and E&T activities.
- Number of mobility grants.
- Number of BSc, MSC, PhDs and Early Career Scientists participating during project phase.
- Scores from evaluation questionnaires with participants and E&T activities.

<u>Specific objective 6:</u> To involve all the relevant stakeholders at the different stages of the implementation of research projects and assure efficient dissemination, knowledge management and uptake of results

The system of radiation protection is based not only on science but also on values and experience. The values are addressed by the ethical and societal principles for protection of the various categories among workers, public, environment and patients with the three principles of protection being: justification, optimization and limitation. The communication of the approach, risks, risk assessment and management of protective strategies both with the public and among stakeholders is of crucial importance. Both calculated risks and perceived risks need to be addressed and contextualised with the many beneficial uses and limitations of radiation in modern society. In addition to transparency in science, the values underlying derivation and application of the safety standards need to be transparent, inclusive and to take into account ethical considerations. The safety standards should support policy makers and enable people to make their own informed choices. Furthermore, citizens should continue to be involved by supporting open and participatory approaches to research and innovation in the field of radiation protection. Good decisions call for consideration of societal issues and of citizen involvement in the options and assessment of risks associated with radiation exposure.

While the international recommendations of the ICRP and the BSS of the IAEA and EURATOM are mainly based on knowledge of radiation risks, ethical and societal values and past experience, research is also serving the information needs of regulators and authorities in Member States responsible for transposition of the standards in the national legislation and associated recommendations and practices as well as the needs of those engaged in ionising radiation practices (*e.g.* industry, medicine, any risk assessors) and other stakeholders (*e.g.* patient associations, association for nature conservation, scientific and professional associations and many other interest groups including international organisations). This Partnership is intended to respond, as much as possible, to the expectations of these different categories of stakeholders, all interested by a safer use of ionising radiation for both energy and non-energy applications. In other words, the objective is that research and innovation activities conducted within the scope of the present Partnership are better aligned with the values, the needs and expectations of society in order that scientific research can inform decision making more effectively and be responsive to, and acceptable by, societal and stakeholders' need.

Beyond the participation of stakeholders to the prioritization exercise or the sharing of results, the ambition of this specific objective is to promote the co-conception (through their implication during the preparation of the calls) and co-implementation (through their active involvement during the course of certain projects) of research activities with stakeholders. This stakeholder engagement will result in enhanced education and high numbers of informed citizens.

Through open calls mechanisms, new knowledge will be acquired all along the Partnership duration. The communication and dissemination of these results is a key success factor in achieving the goals of the Partnership. The research projects funded along with the LTPs and TPs engaged will be asked to actively contribute to result dissemination. Open access of data and data sharing along with results dissemination to relevant stakeholders including the public and the patients will be strongly encouraged as it will contribute to a rapid translation of research results into radiation protection practice in Europe.

A devoted strategy will be developed to ensure that main outputs and impacts of the Partnership are known, widely disseminated and easily accessible. In particular, dialogue and collaboration with the international research community will be essential for mutual support and for the identification of needs and opportunities for harmonization actions and development of tools that support the collaboration. Connecting this Partnership with the international community will foster the dissemination of results and will promote the importance of data and knowledge sharing among international networks. Europe has long been a strong component of R&I effort in the field of radiation protection and has therefore been influential in UN bodies, at ICRP level and in various international organisations. As a continuation, during the full course of this Partnership, a specific effort will be dedicated to communicate and dialogue with the relevant international organisations, namely IAEA, UNSCEAR, WHO, ICRP, and OECD/NEA.

This strategy will make use of innovative, interactive approaches in communication and take into account the specific needs of the different categories of stakeholders. Links will be established and maintained with the ongoing research projects (funded under H2020 programme) in order to avoid overlaps, to build on experience and to jointly promote results.

Knowledge management is a key point to ensure an optimal uptake of the results by the concerned parties. Specific efforts will be devoted to manage new scientific knowledge acquired and to facilitate their immediate access to the different stakeholders. This knowledge management effort will include results from ongoing H2020 projects in the field of radioprotection. Also, specific meetings or events will be organized in order to present results and encourage their uptake by the various stakeholders.

Following operational objectives and associated provisional indicators are identified:

Operational objective N° 9: Foster European leadership at the international level for research and innovation in radiation protection research by establishing links with other international organisations.

Provisional indicators:

- Number of relevant international organisations identified and contacted (every two years, no target).
- Number of representatives of other international organisations in the Stakeholder and Advisory Board (no target).

Operational objective N° 10: Foster public engagement in R&I.

Provisional indicator:

- Number of public engagement events and opportunities (*e.g.* innovative social media engagement, citizen science and crowd-sourcing, debate).

Operational objective N° 11: Effectively and transparently communicate and disseminate knowledge produced by the Partnership, ensuring stakeholders accessibility to results and foster the regulatory uptake of knowledge produced under the Partnership.

Provisional indicators:

- Number of scientific communications (including publications and bibliometric analysis; oral/poster presentations) (annually, increasing) and public engagement activities.
- Number of other communications (including reports in non-scientific media; published policy briefs) (annually, increasing).
- Number of Partnership events (annually, target 1 main event per year).
- Number of followers of the Partnership (website views and/or social media followers).
- Number of references to the Partnership related results in policy documents (periodically, no target, increasing).

- Number of regulatory and policy gaps addressed by the Partnership (annually starting Y1, increasing, no target).
- Number of policy briefs.

2.2.3 Expected impacts, exit strategy and intervention logic

Expected impacts and benefits for Europe

Through its research and innovation activities, the Partnership for radiation protection research will address major EU policy priorities and will support several actions within the Horizon Europe R&I Missions and Pillars.

The major expected impacts and benefits of the Partnership are as follows:

- Improving quality of life and health of European patients through the development of new and optimised diagnostic and therapeutic approaches;
- Contributing to the well-being of European citizens by contributing to a better protection of health (public, workers, patients) and of the biodiversity against the effects of ionising radiation;
- Improving the anticipation and the resilience of Europe in case of radiological/nuclear event;
- Preserving the health and the environment by a better management of radiological legacy sites across Europe;
- Promoting excellence in science, creating high-quality knowledge and widening participation through an Project call system open to the whole radiation research community;
- Generating innovation-based growth through the development of new techniques in both the medical and radiation protection field;
- Delivering on citizens' and better addressing societal challenges by inclusion of SHS approaches in the definition, conduct and dissemination of knew knowledge;
- Strengthening human capital by fostering education and training actions in the field of radiation protection and associated science;
- Fostering transnational and international collaboration, exchange and network, especially by easing the share of radiation protection related research infrastructures at the European and international levels.

Exit strategy

This Partnership will build on the one hand the successful and efficient structuring of the radiation protection research community achieved through both the H2020 CONCERT EJP (and on-going H2020 projects such as MEDIRAD, HARMONIC, RadoNorm, EURAMED Rocc-n roll and SINFONIA) and the creation of the MEENAS umbrella structure with the six platforms. Currently, one may consider that the vast majority of the organisations (national institutes, academia and other research entities) involved in radiation protection research are members of one or several more platforms. During the last decade, many scientific and technical activities have been performed by the different platforms independently or in association. On the other hand, this Partnership builds on the existing radiation protection research funding schemes in the different member states, which all have slightly different needs from the radiation protection research community, based on different types or levels of radiation exposure in their societies.

As an exit-strategy, this Partnership, based on principles of transparency, inclusiveness and mutual learning among disciplines and through the implementation of several challenges identified in the CONCERT Joint Roadmap and associated activities, will reinforce the already well-advanced integration process. At the same time, through the cooperation within this Partnership, national funding programs will align around the research activities and will enable more efficient advances towards the overall goals of enhanced sustainability and health.

Although aware of the well-identified difficulties associated with the existence of programmes dependent on two treaties, the effective possibility that bridges the cleft are established between this Partnership and other Partnerships dependent on other sectors would be a cost-effective and considerable progress, to the benefit of the scientific community, stakeholders (including decision-makers) and, at the end, European society. The social, economic and associated scientific challenges that Europe faces require breaking down the borders between sectors and having a global approach, particularly in the field of medicine (and particularly in the field of cancer fighting) and the protection of human health and the environment. As an exit strategy, the ambition of this Partnership is, in close connection and with the help of Commission services, to initiate long-term, real and effective collaborations with one or several other Horizon Europe Partnerships or Clusters.

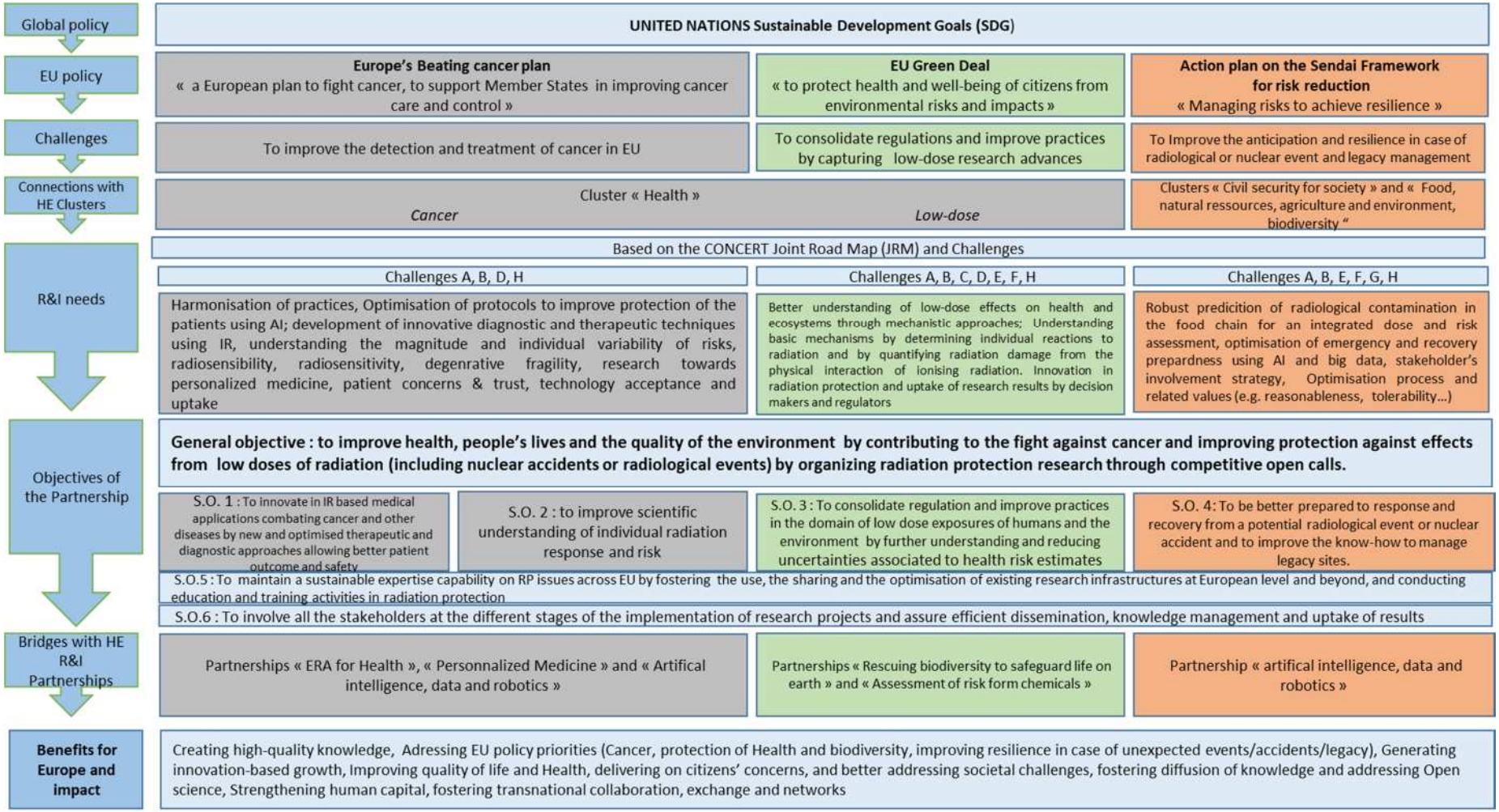
Within the next years, Europe will have to make crucial societal, economic, industrial and health domain-related choices. For instance, the work of comparing options for future societal and industrial choices should be conducted in close collaboration with other fields of research outside of the historical radiation protection community, including the chemical toxicology, climate, and energy expert, social scientists and economist communities. This will be necessary to produce sound comparisons integrating all these aspects, in order to propose the best solutions to help mitigate the climate and biodiversity crises in line with the objectives of the Green Deal.

The exit-strategy of this Partnership and how it will evolve will depend on its own achievements and developments but also on the achievements and developments under other projects, programmes and Partnerships developed by the European Commission under Horizon Europe. By the (intermediary) end of this Partnership in 2028 important developments will have been made, societal context will have changed and many new demands and opportunities will arise.

Intervention logic

Figure 3 shows the intervention logic leading from global and EU policy to the objectives and expected impacts and benefits for Europe of the Partnership for radiation protection research.

Figure 3: Intervention logic of the Partnership for Radiation Protection Research



2.3 Necessity for a European Partnership on radiation protection research

The general objective of Horizon Europe is to "*deliver scientific, technological, economic, and societal impact from the Union's investment in research and innovation so as to strengthen the scientific and technological bases of the Union and foster its competitiveness in all Member States*". Horizon Europe will thereby deliver on the Union strategic priorities and contributes to the accomplishment of EU objectives and policies, contribute to tackling global challenges, including Sustainable Development Goals, and to strengthen the European research Area. Any Partnership belonging to the Programme shall thus maximize Union added value, promote directionality and deliver additionality by focusing on objectives and activities that cannot be effectively achieved by Member States acting alone, but in cooperation.

Directionality: EU action in the area of radiation protection is based on different Articles of the EURATOM Treaty, and, as mentioned in Section 2.1, stems, directly or indirectly, from the EU's commitment to the United Nations 2030 Agenda for Sustainable Development Goals, Conventions (for instance OSPAR Conventions) and Calls for Actions (*e.g.* Sendai Framework, IAEA/WHO Bonn Call for Action,…). Both national- and EU- level actions aiming at same goals are indispensable to provide a pan-European scientific and technological basis for a robust system of radiation protection of people and the environment and more consolidated science-based policy recommendations to decision makers in this area. While helping in the establishment and the implementation of the EURATOM requirements (namely and currently, the Council Directive 2013/59/EURATOM) in the Member States, continuous research is also needed for testing the adequacy of the requirements and to propose ways how requirements or their implementation could be improved. Also, research will be beneficial for the improvement of cancer diagnosis and treatments, for the radiation protection of patients and workers but also for contributing to the European objective of emerging as a global leader in the field of the use of ionising radiation in medicine, and more globally non-energy applications of IR, through innovation. This requires efficient cooperation between the EU and its Member States, especially in the field of radiological protection research. Such cooperation implies a transnational, integrated and interdisciplinary approach that will be facilitated by the existence of the radiation protection platforms that are efficient transnational integration tools. Through this Partnership, the efforts of EU and Member States (and Associated Countries) will go in the same direction, towards agreed objectives.

Additionality, complementarity and synergy: Neither a single State, nor the EU on its own has the capacity to address the prioritized research challenges in the field of radiation protection of people and the environment at the current state. A bundling of resources is needed, something that can only be achieved via a European co-fund partnership. About ten years ago, the major concern in the field of radiation protection research was the fragmentation of research activities and the decline of research resources at the European level. Since then, a remarkable reorganisation of the European radiation protection research landscape has taken place. Platforms in different fields were established, SRAs were developed together with roadmaps. While the individual platforms have brought together European scientists and consolidated their strategies, there has been in parallel an increased collaboration between the radiation protection platforms within the integrative work packages of the CONCERT EJP to develop priorities and, as a final product, a joint roadmap. To perform this work, the platforms succeeded to gather most research groups active in their fields of research in a successful attempt to combat fragmentation of research and to pool a critical mass. More than 200 organisations are members of the six thematic platforms and more than 90 entities were involved in CONCERT. They have joined their forces to create and update the strategic agendas. It should be noticed that about one third of the 200 organisations are universities and that, in total, these organisations represent 25 over 27 plus the UK Member States. This Partnership will continue building on this remarkable integration effort, enlarging it to include the additional complementary expertise required to cover the whole remit of radiation protection and ensure the ability of the Partnership to tap into all available national expertise and stakeholders in the field of European radiation protection research. On top of this continued

coordination, this partnership will bring forward essential resources for prioritized topics in radiation protection, that would otherwise not be addressed and might lead to a loss of capacity and expertise in the EU.

Long-term perspectives and commitment: The EURATOM dynamics in the field of radiological protection research during the past decade demonstrate the increasing capability of the scientific community to use the development of thematic platforms as well as the use of European funding instruments, including with national co-funding mechanisms (*i.e.* EJP CONCERT) for the required interdisciplinary work. Within this context, the European Partnership will provide the necessary longer term perspective for sustainability in radiation protection research. A multi-annual programme is required for an optimized implementation of the research activities envisaged in the Partnership that tackles many challenges. These challenges are highly multidisciplinary and require a supra national coordination and collaboration in order to improve efficiency and to avoid duplication. A co-funded Partnership established for several years appears as the best tool to ensure an efficient coordination and optimized planning of research activities through a long-term call planning system to turn the challenges into reality. This long-term vision is also necessary to introduce some flexibility as the Joint Roadmap (and associated challenges) should be considered as a living document regularly up-dated by the platforms (through the up-date of their respective SRAs), as new challenges may arise (for instance, the development of new radiopharmaceuticals or radiotherapy techniques or new nuclear reactor technology such as small modular reactor) and may need specific research actions.

2.4 Partner composition and target group

Composition of the group preparing the Partnership: the group involved in the preparation of this Partnership is referred to as the extended MEENAS group. It is composed of delegates of large European radiation protection institutes (including feedback from national Programme Owners and Programme Managers) and the European Radiation Protection Platforms (MELODI, EURADOS, EURAMED, NERIS, ALLIANCE, SHARE), now combined under the MEENAS umbrella structure and representatives of several radiation protection institutions that shared the information with and included feedback from national Programme Owners and Programme Managers. The participation of the delegates of the Platforms is a key point as they act as a relay between the extended MEENAS group and the whole radiation protection research community as more than 200 organisations from more than 25 European countries are members in the six platforms. The present draft Partnership has therefore been prepared and shared with the vast majority of the European organisations (including academia) practically involved in radiation protection research that represent extensive skills in all aspects to be covered by the activities. Moreover, several partners have participated in and coordinated various EU projects on topics related to radiation protection issues in the different domains including non-nuclear energy applications or medical applications.

Grant signatories: the initial grant signatories are currently envisioned to be, depending on technical boundaries of the grant agreement:

- the national programme owners/funding agencies and the programme managers in radiation protection designated by each Member State;
- the national programme owners/funding agencies and the programme managers designated by interested Associated Countries;
- the radiation protection platforms.

Current plan is to have signatories from all Member States and avoiding excess of grant signatories (ideally 1 or 2) per Member State.

According to the results of the different open calls, additional partners shall associate with the consortium as Linked Third Parties (LTP) or Third Parties (TP).

Role of national radiation protection agencies: given the nature of a co-funded European Partnership, the national program owners and managers nominated by the participating states are the partners of the

initial agreement. They play a crucial role to align national radiation protection interests with the joint European research roadmap and contribute the required "other than Union" funding.

Role of Radiation Protection Research Platforms: as mentioned previously, the platforms succeeded to gather, most active organisations in their fields of research in the attempt of the community to combat fragmentation and to pool a critical mass. Nowadays, it is more than 200 organisations (representing 25 Member States) that are gathered through the platform activities and this number is still increasing. Platforms played a key role in the elaboration of the Joint Roadmap as they all provided an SRA that was elaborated in a collaborative way. They will continue to be key actors in this Partnership as it will seek the engagement of a number of expert communities that are represented in the Platforms due to the broad scope of the challenges and the diversity of fields of expertise needed. As specified above, the recent initiative of the six platforms of creating an umbrella structure called MEENAS should be highlighted as it demonstrates again the willingness inclination of the community to work in an integrated and multi-disciplinary manner.

Necessity to establish links with non-European radiation protection research initiatives/networks: the concern expressed by the HLEG in 2010 about the fragmentation of European research and the decline of research resources in the field of radiation protection research was not specific to Europe. Similar concerns arose recently in Asia and in North-America, especially in the low-dose research domain. To overcome this fragmentation, Japan launched the Planning and Acting Network for Low Dose Research (PLANET). PLANET is a network to promote low dose radiation research, which aims to identify priorities of research needs and propose support system for cooperation and collaborative researches in Japan. PLANET also intends to establish an all-Japan network among regulators, academia, research institutes and stakeholders. In parallel in the United States, the Electric Power Research Institute (EPRI) initiated the International Dose Effect Alliance (IDEA) with the objective of providing a mechanism for organisations around the world to discuss low dose radiation research programs, priorities, and approaches.
Finally, as an overarching initiative taken by the OECD/NEA/CRPPH, the High-Level Group for Low-Dose Research (HLG-LDR) global networking proposes to build a global network that facilitates collaboration among ongoing and planned low dose ionising radiation research programmes and encourages the collective sharing of information and resources. One of the goals is to enhance collaboration with the OECD, operating under the Extended Advisory Group for Molecular Screening and Toxicogenomics (EAGMST – which has been developing the Adverse Outcome Pathway (AOP) approach to organize published evidence on mechanisms of toxicity, spanning multiple levels of biological organisation in the chemical and ecological fields). The HLG-LDR is currently developing tools and methodologies to support these objectives with 2 major initiatives:

- the elaboration of international database of research projects in the field of low dose;
- the exploration of areas where the HLG-LDR and chemical AOP communities could potentially collaborate with the support of both NEA and OECD AOP programme.

Given the importance of the OECD/NEA initiative, a permanent Dialogue between this Partnership members and the HLG-LDR will be established in order to leverage the European influence in the low-dose research area.

In the field of dosimetry, the Asian Radiation Dosimetry Group (ARADOS) initiative, which is a voluntary network launched by Korea, China and Japan 2015, has the objective of establishing a platform for promoting the research and development among Asian countries in the field of ionising radiation.

In the field of emergency response and recovery, several international organisations have established networks to favour the exchange and harmonization of preparedness among the countries. NEA has set up a standing working party on nuclear emergency matters with a focus on the organisation of the INEX exercises covering the different phases of the emergency and recovery. WHO has established the collaboration network REMPAN, a communication platform to share the information and to advocate for the radiation-emergency related activities of the network member institutions. The IAEA helps

maintaining and strengthening effective emergency preparedness and response capabilities on a national and international level, through the development of safety standards, guidelines and technical tools and training to assists Member States in building the capacity for emergency response. Collaborations with the European research platforms have already been set up and will be further developed within this Partnership.

This Partnership will establish links and, if appropriate, collaborative and/or appropriate coordination actions with these different networks, thus further promoting scientific debate and optimisation of resources.

3 Planned implementation

3.1 Activities

The six specific objectives of section 2.2.2 will be reflected in the proposed activities (organised according 5 Work Packages – WPs), with a focus on creating impact. The maximization of impact will be ensured through a specific work package on dissemination (WP5).

A lot of work for harmonization of radiation protection research in Europe and for establishing interdisciplinary links was done during the H2020 CONCERT EJP. The results of this preparatory work should now be used to ensure that all Radiation protection stakeholders are properly involved in establishing the research priorities, and that they all will benefit from the results of this Partnership. The focus should therefore be on the research and innovation efforts, and the scientific and technological advancement that will form the bases of all improvements in radiation protection. This scientific and technological work will be based upon the needs identified by the radiation protection platforms and described in the joint roadmap, as well as input from the radiation protection stakeholders and the national programmes. This focus on the much needed scientific and technological developments will also be reflected in the budget. The major part of this budget should be used for the open calls.

A simple structuring of activities is proposed, with a limited number of work packages and associated tasks (Figure 4). The deliverables will be clear and concise to optimize their dissemination and uptake by the stakeholders and data will be open to the research community. The number of deliverables should be optimal for their purpose, allowing adequate monitoring of the project. The project management will be executed in one dedicated work package, WP0.

The main tasks will be listed below, to be further elaborated and developed.

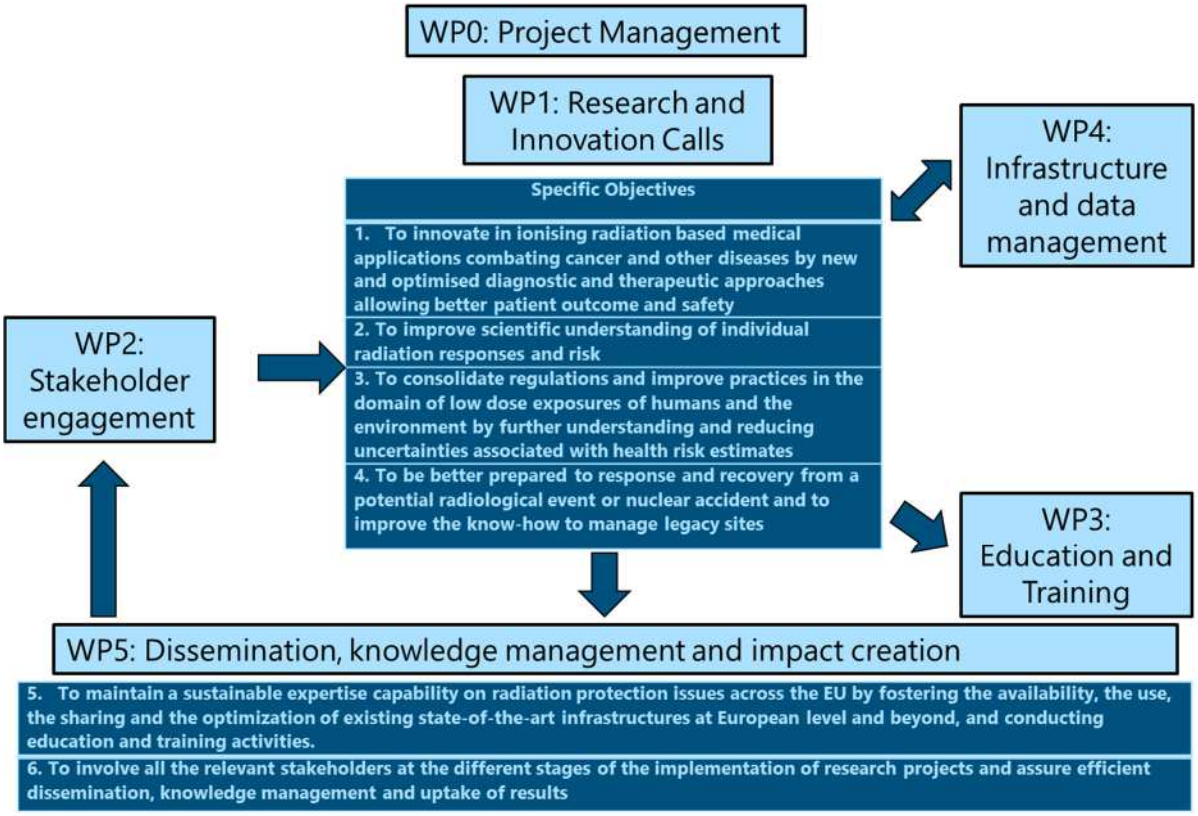


Figure 4. Links between the different Work Packages proposed in the Partnership

WP1. Research and Innovation Calls

This work package will be the basis of the whole project, by organizing several open R&I calls. Universities and research institutes, POM's, industry and other organisations from all over Europe will have the opportunity to join in the research consortia and submit proposals. The goal is to integrate national and European research programmes. The R&I projects should contribute to the overall objectives of the Partnership and thus improve the radiation protection in Europe and beyond.

The major task of WP1 is therefore, to develop research priorities based on the specific objectives defined in 2.2.2. These priorities will form the bases of the text for the Open Calls. As there will be several Open Calls, the priority setting should be repeated before each call, taking into account new developments and results from the previous calls. The call priorities should also be aligned with the priorities from participating Member States and further input from radiation protection stakeholders, including broader publics. A multidisciplinary and transnational approach is needed in this exercise.

The Partnership will set up the call priorities in close connection with stakeholders, but the open calls will be issued by an independent call secretariat. They will collect all competing proposals and organize the review process with an international peer-review panel outside and independently of the consortium. Specific attention will be paid to the composition of the peer-review panel through inclusion of experts from adjacent and relevant fields in order to ensure the bridging with other R&I sectors. The proposals should address the call topics, and will be scored in alignment to the scoring system and criteria in the European Commission's Work programme and according to criteria such as scientific excellence, alignment with the priority goals of the EURATOM programme objective, impact, quality and efficiency of the implementation, and attention to social and ethical aspects. The final decision on funding will be made by the Management Board of the Partnership that is committed to follow the ranking lists established by the peer-review panel.

Another task of the Partnership is to perform a periodic update of the Joint Roadmap, considering on the one hand advances and developments that affect the research needs and on the other hand the apparition of new scientific challenges, results or societal concern. The basis for the update will be informed by the Strategic Research Agenda's from the Radiation Protection Platforms (which are also periodically revised), the interaction with stakeholders, and results from research projects. Special attention will be paid to the outputs of several on-going important H2020 European projects (MEDIRAD, HARMONIC, EURAMED Rocc-n-roll, RadoNorm, SINFONIA) as their results may provide elements potentially modifying the priority setting of the Joint Roadmap and Partnership agenda.

This work package will comprise the following activities:

- develop and implement annual research and innovation work programmes on the basis of the 3- (or 5) year common strategies in turn based on the JRM and the specific objectives;
- priority setting for the open R&I calls, and setting up and issuing the call text;
- organisation of several open R&I calls, based on the priorities. This includes determining the call conditions and criteria, launching the call through the independent call secretariat, evaluation of the proposal through the independent call secretariat, and awarding the winning proposals;
- each winning proposal will be added in the Partnership as a separate WP;
- follow-up and interact with the winning R&I projects, resulting from the open calls;
- update the joint roadmap after 5 years with input from the SRA's from the radiation protection platforms, and through interaction with the stakeholders and the radiation protection platforms, and with input from the scientific results.

WP2. Stakeholder engagement

It has become increasingly important for scientific research projects and programmes to engage with societal stakeholders, including wider publics. Such engagement helps to ensure that societal concerns are identified and considered when formulating research calls and helps building trust among institutions, citizens and other stakeholders, as well as ownership of research outcomes.

A stakeholder engagement plan will be elaborated that sets out the approach to involve the various stakeholders, including citizens, in various ways and forms, from idea generation, to establishing priorities for research calls, and co-development of research and innovation products. Any form of engagement entails assumptions about what is at stake, who should or could participate, and what the outcome of the engagement process should be. For this reason, the stakeholder engagement plan will be set out in consultation with stakeholders in the spirit of inclusion, openness, accountability, and responsibility. This strategy will build on the experience and lessons learned from the stakeholder involvement approach in CONCERT and the CONCERT funded projects. Participatory activities will range from information, collation and dissemination, through to consultation, dialogue, partnering, and citizen science projects.

A Stakeholder and Advisory Board will be established, drawing on a wide range of actors (institutional and non-institutional) with a tangible or intangible (yet to be shaped or discerned) interest in radiation exposure situations and the related radiological protection issues. These actors may be affecting radiation protection decisions, be affected by the formulation and resolution of a problem or challenge, or represent an affected party (humans or the environment). During the H2020 CONCERT project, a wide stakeholder mapping exercise has been carried out to identify the radiation protection stakeholders; this will be revised and amended within this WP, notably with attention to creating synergies with other EC programmes (*e.g.* Health and Environment, Security, etc.), and including stakeholders already identified by the radiation protection platforms. The Stakeholder and Advisory Board will include representatives of national authorities (including civil protection), European (EC) and international

actors (*e.g*. ICRP, IAEA, OECD-NEA, WHO, UNSCEAR, IRPA, ILO,…), radiation protection practitioners (*e.g.* medical professional associations medical practitioners, nuclear workers), regulators, industry (*e.g.* nuclear energy site owners, NORM industry, site remediation companies), academia (researchers, universities, research organisations), Civil Society Organisations (*e.g.* medical patients' organisations) and NGO's, citizens (*e.g*. representatives of communities living in areas characterized by existing exposure situations). Representatives of the research platforms will also participate in this group. This list is neither exhaustive nor limitative at this stage.

This Stakeholder and Advisory Board will be engaged throughout the whole process of the Partnership. The Partnership should provide a forum to discuss stakeholder's concerns, interests, needs and priorities, as well as the strategic and technical aspects to ensure the progress of radiation protection research. The Stakeholder and Advisory Board will be involved for the identification and development of research priorities. They will also be involved in the dissemination of the results and recommendations from the Partnership.

The Partnership will establish mechanisms to enable for participation (*e.g.* resourcing) and for transparent and effective communication with all relevant stakeholders and opportunities for meaningful engagement. It will promote open knowledge and communication to citizens and policymakers and will capitalize on the expertise of stakeholders to enhance the uptake of results and translate research on and knowledge into policy in an effective way.

A range of activities will be implemented to reinforce the capacity of R&I actors regarding the engagement of stakeholders in their research activities, including engagement of policy stakeholders, of citizens and of businesses. This is fundamental since the R&I individuals and teams are the first entities that need to engage stakeholders, whereas the European Partnership *per se* will help capacity building for engagement with European and international stakeholders. This will require the production of guidance documents as needed and the organisation of dialogues, workshops and training sessions gathering academia and targeted stakeholders.

Whereas EURATOM is the core funding programme of nuclear and radiological related research, the radiation protection research activities have a broader societal perspective and many topics are related to scientific domains within (nuclear safety, waste and disposal, decommissioning) but also outside the EURATOM programme. As many Partnerships are currently being formed within the Horizon Europe programme, bridges with them could be advantageously established, for instance in the health, the environment or the security domains. The links are to be established so that we get their input on the R&I program, for clear collaboration, networking and interaction.

There is also a clear necessity to establish links with non-European radiation protection research initiatives/networks. Fragmentation of radiation protection research is a risk in the whole world. International organisations like ICRP and UNSCEAR are at the bases of collecting all research information for radiation protection. OECD/NEA, WHO and IAEA have already established networks and dedicated expert groups to address different research challenges involving a large number of countries. So this Partnership will establish links and collaborative actions with these different organisations. The research priorities and roadmap should be compared to other similar initiatives outside of Europe.

This work package will comprise the following activities:

- elaborate a stakeholder engagement plan and set up the Stakeholder and Advisory Board;
- prepare, design, implement, feed-back, follow up, and evaluate all the stakeholder engagement activities;

- maintain 2-way communication with the Stakeholder and Advisory Board throughout the whole Partnership, including on the priority setting of the R&I calls, involvement in the R&I projects, and to enhance uptake of results and recommendations;
- establish links with other EC Partnerships, like metrology, nuclear safety, waste management, health, environment, security…;
- establish links with the international radiation protection community and the radiation protection communities outside of Europe to create synergies and establish key elements of a global strategy for radiation protection.

WP3. Education and Training

Over the last ten years, through the Network of Excellence DoReMi, PREPARE project and the CONCERT EJP, the EC has funded an annual programme of short courses giving students a free hands-on introduction to and training in RP research topics and techniques. It has also provided travel grants to enable students and early career researchers to present their work at conferences, attend courses, or go for exchange visits to laboratories. These activities were very successful and should be continued to ensure sustainability of EU's skill base and global expertise.

To guarantee a sustainable approach and to facilitate integration with the activities in the other WPs, it is proposed to create a coordinating "Radiation Protection School - RPS" where competence building and knowledge transfer actions such as development and delivery of courses, and mobility actions for students and junior professionals are managed, in interaction with the scientific WPs. In addition, the "RPS" will set up guidelines to stimulate integration of PhD and Master thesis projects in the scientific WPs. It will also set up a work plan for attracting and retaining students and scientists into the project research fields. A dedicated part of the Partnership website will serve as information exchange with the other WPs and consortium (and external) partners. It is foreseen that this RPS works in an efficient and effective manner, assuring maximal support for sustainable learning activities. This RPS can be set-up to complement and possibly cooperate with integrate already existing initiatives, like the International Radiological Protection School (IRPS) from NEA and other more topical schools.

This work package will comprise the following activities:

- setting up a long-term strategy for promoting and implementing effective, efficient and sustainable education and training actions under the umbrella of a "radiation protection school", in interaction with the R&I programme and taking maximal advantage of successful experiences from previous projects in radiation protection (and other European education and training initiatives);
- developing guidelines to assure effective integration of education and training activities across the different project WPs;
- setting up and implementing a methodology to provide support for mobility of students and junior researchers to European E&T by offering grants for participation to education and training actions such as courses, workshops and internships;
- promoting, developing and organizing targeted education and training courses, workshops and seminars within the R&I Programme. Attention should also go to training of the end-users and decision-makers from the research results;
- developing a work plan for attracting and retaining students and junior scientists into the Radiation Protection research fields by promoting the specialized knowledge, skills and attitudes needed to maintain the full competence of the radiation protection research.

WP4. Infrastructures and data management

To conduct competitive and cutting-edge research, European scientists should have access to the most advanced, unique, and large-scale resources, instruments and expertise in Europe. Infrastructures

include so-called large infrastructures such as exposure facilities including those for animal and plant experiments (both laboratory and field facilities), epidemiological cohorts, sample banks, databases and analytical platforms, models and software tools and e-infrastructures.

The inventory of European infrastructures and future needs performed during the H2020 CONCERT EJP has revealed that many infrastructures necessary for implementing the Joint Roadmap are already available within Member States, Associated Countries or beyond. The next step, which is the purpose of this specific activity, will be to ensure optimized use of the research infrastructures existing across Member States. The current challenge is to facilitate their access by increasing their visibility, to assure their sustainability beyond national short-term constraints and, last but not least, to support cross-border exchange visits researchers for their optimal use. In parallel, further harmonization of quality standards, practices and protocols in relation with the use of infrastructures including the implementation of inter-comparisons. In line with the "European strategy for data", specific efforts will be dedicated to high-quality sample/data acquisition and sample/data storage with the aims to share and re-use of archived materials. A strategic work plan for maintenance, updating, mutual use and new needs of suitable infrastructures necessary to tackle emerging challenges will be produced. Moreover, the sustainability of rare but necessary facilities will be given priority. There is also a need for improvements in some of these critical infrastructures. Furthermore, an effort will be made to harmonize practices and protocols amongst multiple facilities. Last but not least, funding strategies will be developed.

Data management is linked to infrastructures, as also databases and data repositories are considered as infrastructure. In the Partnership, attention will focus on setting up a data management plan. Adherence to the data management plan will be a requirement in the Consortium Agreement. The data management plan will identify likely datasets generated, storage requirements, probable reuse scenarios and access restrictions, including ethical requirements. Effective data management will also be a requirement of any projects funded.

This work package will comprise the following activities:

- providing support for cross–national access to infrastructure for projects that contribute to the realisation of the joint roadmap;
- elaborate a strategic work plan for maintenance, updating, mutual use and new needs of suitable infrastructures necessary to tackle emerging challenges, including, the sustainability of rare but necessary facilities;
- further harmonization of quality standards, practices and protocols in relation with the use of infrastructures including the implementation of inter-comparisons when appropriate;
- setting up a data management plan.

WP5. Dissemination, knowledge management and impact creation

The translation of the science and innovation in this Partnership into impact (*i.e.* benefits beyond academia) is an essential part of the overall work programme. Communication, dissemination of information, translation of innovation and exploitation of results are the key success factors in achieving the goals of the Partnership. The overall aim of this WP is to maximize the impact of the project by establishing the external communication tools and the dissemination of the aims and results throughout the entire course of the project to the relevant stakeholders, including the wider public. Each target group needs specific, targeted communication strategies and materials. The uptake of innovation results by industry is also very important, so establishing links with industry and SME's will be done from the beginning of the project. They can also be partner in R&I projects.

The Basic Safety Standards are very important for the protection of the public, the workers and the environment. This Partnership will amongst others support the implementation of the revised European Basic Safety Standards by giving best possible advice based on evidence from research. For this, the scientific results need to be translated into practical recommendations for improved regulations. Further,

results will be discussed in workshops bringing together the research platforms, program owners and managers, national authorities and regulators. In particular, a.o. HERCA and EURATOM Article 31 group of experts will be included in the discussion on the links between the results of the Partnership and the Basic Safety Standards.

We will maintain a flow of open information (using a website, working papers and social media) about the Partnership's work plans, protocols, data, results and other outcomes. The science-society interfacing activities under this WP will result in improved uptake of science-based knowledge and innovation by practitioners and market. This should also help to encourage the uptake of new scientific knowledge in the radiation protection legislation and accelerate the pace of innovation.
This work package will comprise the following activities:

- Set up a knowledge management plan so that the created knowledge can be shared, used and managed by the Partnership;
- set-up a Communication Plan that will define the main communication/engagement objectives, identify the key target audiences, and define the appropriate tools and channels according to the target audience. The impact strategy will also consider intellectual property and identify any opportunities for commercialisation of the outputs. Links should be established with the stakeholder engagement actions. A scientific publications policy will be drafted and shared with all project investigators for approval. Open Access publishing will be obligatory, unless there will be reasonable decision for protection of Intellectual Property. Open Access to research data will be applied in the Partnership. All this should allow transfer of knowledge and results and effectively use the results of the Partnership;
- develop external dissemination material, project logo, a project website, etc. which be a key tool for disseminating the project's aim, relevance and progress to a wide public. Create a hub for social media to facilitate dissemination and communication of the project results;
- promote outreach activities to key stakeholders, making use of existing platforms like the European Radiation Protection Week (ERPW);
- develop science-based recommendations on radiological protection, with the goal to ensure an efficient uptake of the results into policy, like the development of updated Basic Safety Standards;
- approaches for management and monitoring of effectiveness of communication, dissemination and exploitation activities will be adopted to assure continuous feedback and improvement or adjustment.

3.2 Resources

For European co-funds, the European Commission foresees funding rates of 30 up to 70 %. On proposal submission, co-fund partners will have to declare how the national co-funding or in-kind funding is secured to complement up to 100 %. National POMs will play a key role in securing this.
The present Partnership will allocate the biggest share of its budget to research and innovation activities linked with the R&I defined priorities. R&I activities will be mainly accomplished *via* open calls, with a global national co-fund minimum threshold of 30%. The exact percentage will depend on the total budget, the granting system of the EC and on how the final Partnership will distribute the budget over the different activities and the applied refunding rule. In the CONCERT EJP, 60% of the total budget was allocated to R&I activities and the aim of the present Partnership is to exceed it. Also, for the projects answering the call, research partners will have to declare how the national co-funding is secured. Feasibility of the national co-funding for a proposal will be one of the evaluation criteria in the decision-making process regarding the funding of proposals.

The Partnership will additionally allocate funds for integrative activities that include for instance access to research infrastructure, for general E&T activities and for specific tasks which can be tackled within

the consortium, such as updating the Joint Roadmap. E&T activities will include funding of courses (at a proposed co-funding level 30%) and travel grants for early career researchers (refunded at 100%). Integration activities will be co-funded by Partnership members.

Management of the consortium, administration of calls and funded projects, evaluation of proposals and projects will get a refund of 100% and will not take more than 10% of the total costs. Resources will also be reserved for communication and dissemination activities as well as engagement in activities related to policy uptake of results.

Different co-funding sources by country will be envisaged. Partner countries should explore the possibilities to use other EU funding programmes, beyond Horizon Europe, such as structural funds for the co-funding and the development of their structural or human capacities. The Partnership as such will look at possibilities to use *e.g.* Marie-Sklodowska-Curie funds or the ERASMUS programme to facilitate the training of next generation scientists and risk assessors.

At national level, it is expected that resources will come from different policy domains. In many Member States radiation protection authorities support research *via* open calls and will act as program owners. General research funding bodies may also reserve resources for co-funding. Finally, in some countries, ministries have their own allocated budgets dedicated to research activities – the ambition of the Partnership will be to join forces on these and thereby optimize the use of resources.

3.3 Governance

The Partnership (grant signatories) will be composed of Programme owners and Programme managers and the Radiation Protection platforms.

We foresee that the European Partnership on Radiation Protection will include over 40 full members (grant signatories) that will include the national programme owners/funding agencies and the programme managers designated by each Member State (1 to 2 per member state), the interested Associated Countries, and the 6 radiation protection research platforms.

Designated programme managers and programme owners will be government authorities in radiation protection, funding agencies, radiation protection research institutes and universities. Through the Open Calls, additional organisations (academia, research institutes, consultancy organisations, …) will adhere to the Partnership as Linked Third Party (LTP) or Third Party (TP). In addition, it is worth to remind that more than 200 organisations are involved in the 6 radiation protection research platforms.

A strong and cost-efficient Governance structure is needed for the Partnership to achieve its set general objective as described in Chapter 2.

The governance structure is set up to assure the achievement of the desired project outcomes and to optimize the project management. The successful development of the Partnership programme in Radiation protection and associated organisations (LTPs and TPs) and its ability to achieve set objectives will largely depend on:

- the efficient collaboration between the Partners, and associated organisations (LTPs and TPs);
- the efficient link with relevant EC institutions and other relevant European programmes, also outside EURATOM, such as the Health and Environment programmes;
- the identification and prioritization of the research and innovation needs based on the JRM through further interaction with stakeholders;
- the effective translation of R&I needs in R&I activities *via* Open Calls and the development of the according operational programme;

- the continued interaction with a broad range of stakeholders;
- the dissemination and uptake of the results of the Partnership.

In order to ensure that the Partnership delivers on the planned objectives, processes will need to be installed to allow for strategic priority setting, implementation of Open Calls, organisation of consultations and collection of relevant advice, a transparent and efficient decision making process throughout the duration of the project, a monitoring system for project progress, the proper dissemination and uptake of results and information, the preservation of the acquired knowledge and information base. This is discussed in Sections 2.2.2 and 3.1.

The governance structure (Figure 5) is instrumental in reaching the objectives of the Partnership in Radiation Protection. It is largely built on the experience of the CONCERT-EJP that has proven to provide good governance and decision making by all partners in a cost-efficient way while allowing for advisory processes.

The proposed provisional governance will be further refined in the proposal and in subsequent documents such as the Consortium Agreement.

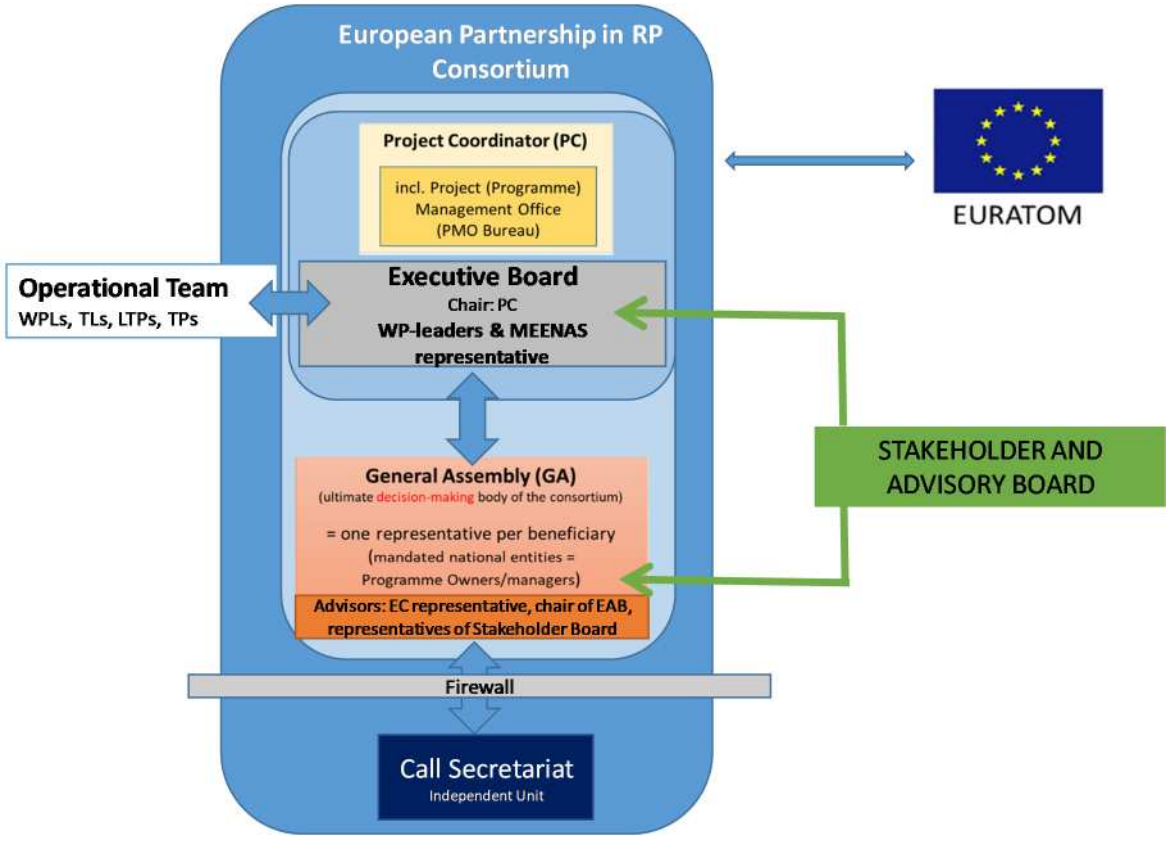


Figure 5: Preliminary Governance structure of the Co-fund Partnership in Radiation Protection.

Project Coordinator (PC):
The project coordinator will be responsible for the global coordination of the project in collaboration with the Project Management Office and the Executive Board. He/She will have the following responsibilities:

- Communication:
  - Formal contact point for the EC for the Partnership and ensuring project related exchange with the Commission;

  - Presidency over General Assembly and Executive Board and general project meetings;
  - Preparing and communicating the yearly project progress reporting to the General Assembly.
- Global management and monitoring in collaboration with the Executive Board:
  - Follow-up and adaptation of the project planning;
  - Organising, steering, checking and assuring the reporting in time towards the EC;
  - Overall monitoring of progress on all work packages and setting in place procedures for ensuring more detailed progress monitoring in consultation with the subgroups;
  - Allocating the budget to the partners and monitoring of the expenses; assistance towards the participants concerning administrative aspects of the project;
  - Coordinating the payments to the partners.
- Final responsible for the reporting:
  - Deliverables, progress reports, yearly management reports;
  - Sending paper documentation to European Commission.

The PC may be assisted by a Scientific Coordinator, who will assist in aligning the project at scientific level; check the scientific consistency, check the deliverables content-wise…

Project Management Office (PMO):
The PMO is a small, working group acting as a secretariat, for administration and coordination of scientific integration activities. The PMO is likely established at the institution which assumes the role of Coordinator and staffed by this institution's personnel. It may also consist of a few staff members delegated by a few Programme Owners and/or Managers (POMs) and operating on behalf of the consortium or the activity may be outsourced yet functioning in close collaboration with the PC.

The PMO will work to support the coordinator also in all the activities that need representation within the European Commission and it will serve as a connecting element between PC and Executive Board. The PMO is in charge of the day-to-day technical coordination of the project, as well as provide administrative support to the parties. Functions of this PMO will include:

- Perform the pursuit of progress work involved with technical-administrative aspects;
- Assistance and coaching at administrative level to the partners;
- All contract amendments to be presented to the European Commission. The PMO will be responsible for implementation of changes (Update and maintaining the Consortium Agreement; prepare and submit requests to amend the Grant Agreement) and contributes all of the necessary documentation;
- All the contracts and contacts with the research projects will run through the PMO; the PMO will assist the POMs with their contracts with the LTPs and TPs;
- Preparation of the project and General Assembly (GA) meetings in collaboration with the coordinator and the ExB.

Executive Board (ExB):
The Executive Board consists of the WP leaders and a representative from MEENAS and is chaired by the Project Coordinator, assisted by the PMO. The role of the Executive Board is fundamental for the project. It ensures the successful management and execution of the project by taking care of the coordination and correct implementation of the scientific project tasks of respective work packages. The ExB reports to and is accountable to the General Assembly. The Executive Board:

- ensures the implementation of the overall Partnership;
- ensures the strategic governance of the Partnership to ensure the strategic decisions are implemented throughout the activities of the Partnership (in interaction with the Stakeholder and Advisory Board;

- translates the JRM in a 3-year common strategy, develop priorities and related activities for the Partnership and develop the basis for Open Calls (in interaction with the Stakeholder and Advisory Board);
- translates the 3-year common strategy in Annual Work Plans (AWP);
- follows up research projects in close contact with the project coordinator;
- monitors the achievements of milestones and deliverables and ensure its overall quality before submission to the EC;
- proposes and manages any changes of the technical work programme of the project;
- in concertation with the PC, manages the budget and the use of resources in line with the agreed AWPs;
- cross-coordinates between work-packages and tasks;
- liaises with the GA for problems encountered during the Partnership;
- ensures a good and transparent communication to the GA and the consortium;
- oversees and ensures the dissemination strategy of the Partnership and uptake of results by the Partnership;
- ensures promotion of team spirit.

The project Executive Board will be the nucleus of the Partnership and main forum for the information exchange between Work Package Leaders, PC, PMO and GA.

General Assembly (GA):
The General Assembly is the ultimate decision-making organ of the Partnership and discusses and decides about the strategy and the major orientations of the Partnership, its priorities and actions to be supported, project performance, budget allocations. It is composed of representatives of the Partnership signatory organisations, *i.e.* POMs and Platforms (1 representative and vote per signatory organisation). The membership will ensure a wide geographical coverage and ensure a good representation of R&I programme owners and funders and managers, and the research community, the latter also through the representation by the radiation protection platforms. The GA acts as global steering and management committee. It should be stressed that the Platforms represented within the GA represent almost the entire radiation protection community, which the Partnership considers as truly valuable.

The GA will be responsible for all decisions of a general nature within the framework of the Grant Contract and the Consortium Agreement. Three major tasks are highlighted,

- the endorsement of the 3-year strategy, the AWPs and the proposal of Open Call programme proposed by the Executive Board;
- any re-definition of the overall work plan, the coordination of the activities and communication between the subgroups, and the overall project progress assessment;
- the endorsement of the detailed budget allocation.

The detailed responsibilities and tasks will be described in the project's Consortium Agreement. The General Assembly is chaired by the Project Coordinator and assisted by the PMO. The Chair of the Stakeholder and Advisory Board will be invited to report to the General Assembly about the activities of, the questions from and the decisions by the Stakeholder and Advisory Board.
The project officer or other representative of DG for Research and Innovation, Directorate J- Energy (EURATOM), Unit J.2 - Fission will be invited to the GA. The Partnership will also invite the EURATOM Scientific and Technical Committee to send a member as an observer to the GA.

Operational team
The Operational team consists of the Work Package Leaders, the Task Leaders and all the staff involved in the operational execution and implementation of the project tasks and the execution of the selected project proposals. The staff is delegated by the Consortium Partners (the Grant Signatories) and by the

LTPs and TPs, the latter joining according to the results of the different Open Calls (to the Open Calls LTPs, TPs and POMs can reply).

The Operational team is the implementation and execution body of the project. WPLs and TLs are heading the operational team. This operational group is not a specific decision-making or advice organ. It is the group who will execute the work of the project.

The Operational team including POMs, LTPs and TPs is presented up in the Governance structure (Figure 5) to make the community of LTPs and TPs is core to the achievements within this co-fund Partnership because they are among the main implementers of the JRM and employed on the basis of their specific expertise and excellence required to tackle selected JRM priorities. .

LTPs and TPs will not be signatory members of the consortium but are associated with it as the LTPs and TPs are associated with specific POMs (through the development of national partnerships) or with the Platforms. Therefore the Operational team is partially inside (the consortium members) and outside (LTPs and TPs) the consortium.

LTPs and TPs are not signing the Grant Agreement and Consortium Agreement, which is only signed by the beneficiaries (*i.e.* POMs). Their legal responsibilities towards the consortium are controlled by the beneficiary to whom they are linked (LTP) or by whom they are funded (TP).

Within this Partnership and following up from the experience from CONCERT, we plan for the projects that emerge from the Open Calls to create special consortium agreements for the selected project consortia. These are supposed to address the special needs of the selected projects and will stand hierarchically below Grant Agreement and Consortium Agreement. This approach will help the integration of the selected project partners among them and the interaction with the Partnership itself.

Work Packages Leaders (WPLs)
Together with the Coordinator and a MEENAS representative, the Work package Leaders (WPLs) form the ExB and are in charge of managing and leading their WP. Also, they are heading the operational group.

The WP leaders together with their Task Leaders are responsible for carrying out all activities and tasks as described in the individual work packages. They draft the contributions to the AWPs. They oversee deadlines, consolidate the specification reports of each WP, they quality control deliverables, and supervise the management of resources and financial management. They interact on a continuous basis with the partners involved in the specific tasks.

WP leaders should have an integrative vision of the work of their WP within the project; ensure that optimal links and interactions are established within their WP and with other WPs and activities. WPLs should monitor and guarantee sub-project performance and promote information exchange and synergistic interaction between sub- projects.

WPLs should ensure dissemination and uptake, together with TLs and other WPLs, of the results of their WP.

Task Leaders (TLs)
Task Leaders are responsible for managing their tasks and contributing to the development of AWPs, implementing the AWPs and contributing to the financial and technical reporting. They will interact closely with the WP leaders. They are responsible for ensuring that the work is conducted in accordance with the appropriate deadlines and resources, and delivered with high scientific quality. They will interact closely with the WP leader and alert the WP leader of any difficulties and propose solutions for these difficulties.

Stakeholder and Advisory Board (SAB)
Horizon Europe encourages the collaborative links in Europe to contribute in reducing the R&I divide. Our Partnership aims to close the gap between R&I and regulatory processes and societal needs by creating a large network of partners and stakeholders. We will also liaise with representatives of health, environment and research at national level, EU and international level to ensure the R&I impact in different policy areas.

This means we will create a strong Stakeholder and Advisory Group (SAB) that will be pivotal in our interaction with the larger stakeholder community. This SAB is very important as we need to demonstrate that the research the Partnership will perform corresponds to needs expressed by the different stakeholders (regulators, international organisations, NGOs, industry, representatives of civil society including patients, DG-ENER, other EC-directorates or programmes, international organisations,…). The SAB will gather a broad range of stakeholders that may be organized around different thematics. The members within the SAB may be the spokes voices for stakeholder communities which they represent and with whom they discuss.

We aim for an active interaction with the stakeholders and expect a dedicated involvement of the SAB members so that the results of our R&I activities, our E&T,… responds to *e.g.* regulatory requirements and needs, citizen's expectations for a safer radiation environment.
Our Partnership will provide a forum to discuss stakeholder's interests, needs and priorities, as well as the strategic and technical aspects to ensure the progress in radiation protection R&I.
The Stakeholder and Advisory Board will be assigned with following provisional tasks:

- consult the GA and ExB in the R&I priorities and prioritization process;
- stipulate requirements of project outcomes to assure their impact and promote their use and uptake by different stakeholder communities;
- provide a final feedback on results evaluation and expectations for future evolution;
- follow-up of research projects;
- be actively involved in participatory activities and organisation of stakeholder events;
- contribute to the dissemination and uptake of project results.

Call Secretariat (CS)
The Call Secretariat (CS) will be a central separate call management office, separated from the rest of the project governance system (firewall) to avoid possible conflict of interest.

The CS will organize the operative steps involved in the open calls. Its members are chosen from organisations not involved in the execution of research within this project. The CS stands in for the administration and organisation of the evaluation process of open competitive calls based on the decisions of the consortium.

Depending on the experience and expected workload, the CS shall be composed of project partners who have the necessary competence, independence and experience to manage open calls. In order to preserve the independence, partners in the CS need to declare in writing, that they, the organisation they belong to, and any third party linked to them in relation to the Consortium will refrain from responding to open R&I calls as prepared in the co-funded Partnership. Another possibility is that the CS is subcontracted to an external organism. It is up to the submitting Partnership consortium to decide which option they take.

The workload and responsibilities of the CS need to be concisely defined and planned in advance, ensuring the reliable and efficient functionality, which applicants expect from public funding organisations. The usual workload will cover:

- prepare the necessary call documents (Call and evaluation document, Call text, Guidelines for Applicants, Proposal Templates;
- provide the required call information & promote the call;
- provide a system for submission of proposals;
- provide a system for evaluation of calls and coordinate the evaluation of proposals;
- provide a system for impartial proposal selection and attribution;
- prepare a system for monitoring the call implementation;
- prepare a system for monitoring the funded Projects.

Open Calls
One of the core pillars and activities in the co-funded Partnership will be the organisation of Open Calls for proposals for research and innovation (R&I) on "Radiation Protection Research in Europe" in support of the 4 specific objectives defined in 2.2.2. Some of the resulting activities will be difficult to co-fund directly by Member States and Associated Countries because of a lack of suitable national support schemes. This requires a high degree of commitment by the Programme Owners in the ability of national cash contributions through suitable Member States and Associated Countries funding schemes.

Ethics and Data Protection Board (EDPB)
The Ethics and Data Protection Board (EDPB) will consist of specialists in ethics, legal matters and data protection from the partner organisations, supporting the ExB in these matters and reviewing all related documents as well as established processes for the management of contractual requirements in these areas. At least one member of the EDPB should be an accredited Data Protection Officer and one member should be a Legal Officer in their institution.

Governance and governing principles
The European Partnership for Radiation Protection Research will run under the following governance and governing principles, adapted from the H2020 EJP EURAD governing principles in their vision document[56]:

Positive Attitude – Contributors will work positively towards achievement of the general and specific objectives of the radiation protection Partnership. All contributions will be valued. Work will be carried out considerately and respectfully by all, maintaining relationships that respect diversity, different roles and respect the knowledge, insight, experience and expertise of others.

Maintenance of Independence – It is possible for different organisations with different roles in their national programme to work together, without prejudice to their own role in the national implementation process. Different parties can have common agreement of what R&I should be done and how, and all can collaborate in the oversight of the proposed strategy and objectives, however, having independence in developing their own views on the interpretation of the research results and data that are generated is essential.

Transparent Governance – A transparent, balanced and efficient mode of governance.

Scientific Excellence – R&I activities shall focus on achieving enhanced radiation protection of man (public, workers, and patients) and environment and increasing our knowledge base and reducing uncertainties in our assessment through excellence in science. Scientific excellence does not only mean excellence in scientific research, but also excellence in connecting science to society, in teaching and mentoring scientists, in science management, and in science advice to policy makers.

[56] https://www.ejp-eurad.eu/sites/default/files/2019-12/EURAD%20Vision.pdf

Added Value – Ensuring that Joint Programming provides real added value (*e.g.* improved financial arrangements, addressing more effectively societal challenges, more robust R&I outputs, etc.). Administration costs should represent a small proportion (including ongoing legal, EC admin., etc.) versus money spent on the technical and scientific scope.

Inclusiveness – Ensuring that the different Member States and different categories of actors and groups of interest are involved in the definition and implementation of the projects under this Partnership.

Equitable Financing – Financial costs (financial/in-kind) should be equitable; participants should contribute what they can afford, or what they consider matches their interest in a project.

Complementary Participation – Participation in Joint Programme is complementary to R&I activities, which will continue to be undertaken nationally or jointly outside of the auspices of the Partnership but these undertakings may be linked to this Partnership.

Tangible Results – The scope is appropriately prioritized and focused on the objective to achieve tangible results within a reasonable timeframe. Translating the societal challenges linked with radiation protection requires the generation of new knowledge, combined with the consolidation, maintenance and transfer of existing knowledge.

3.4. Openness and transparency

3.4.1. Establishment of the Partnership

In the development of this Partnership document, the work was initiated by representatives of the European Radiation Protection Platforms and representatives of several radiation protection institutes, but at different moments there was interaction with all POMs under CONCERT and with the European radiation protection community through the platforms so that this Partnership document also was developed in an open, transparent and inclusive way.

The Partnership for radiation protection is developed based on the experiences obtained during implementation of the CONCERT-European Joint Programme for the Integration of Radiation Protection Research under Horizon 2020. The Partnership will integrate national programme owners and programme managers (POMs) in the EU Members States and the European Radiation Protection Platforms (MELODI, EURADOS, EURAMED, NERIS, ALLIANCE, SHARE). As such, it assembles mandated and wider research representatives of all EU countries or associated countries to Horizon Europe and EU institutions, which are involved in radiation protection research and corresponding risk assessment and/or management. As Partnership we will do an effort to include POMs from all EC-countries (within CONCERT not all EC countries were represented) to join the initial Partnership (replying to the co-fund call). POMs will be requested to engage in developing (formal) national networks in radiation protection to allow easy access of LTPs to the project, to boost national developments next to the EC co-fund project and to facilitate the spreading of project results at national level. We will invite and welcome associated countries or international partners. Through the system of transparent Open calls virtually every relevant organisation involved in a successful call will be linked to the Partnership and join and contribute to the research programme as the Partnership develops. By engaging with various stakeholders (regulators, policy makers, professionals, citizens, industrials, patient groups, international org…) early in the development of the Partnership, various needs will be reflected in the Partnership structure and the Joint Roadmap that will be regularly updated all along the project duration. The approaches for enforcement of interaction with them will be established.

3.4.2. Access to results

Communication, dissemination, exploitation of results and information sharing are key success factors in achieving the goals of the Partnership. This is why we have integrated these requirements into all levels of this proposals – into the specific objectives, but also in the governance structure by identifying WPs that explicitly focus on these tasks. Communication with policymakers, the scientific community, practitioners, patient groups, other stakeholders and the wider public will be two-way, with partners both providing and requesting information. Regular mapping of the stakeholders together with already existing radiation protection networks will allow to reach out to society and show the impact and benefits of the radiation protection Partnership. A dissemination strategy and a plan for access to and exploitation of the results with early ideas of their implementation will assure transfer of knowledge and results with the aim to enable the European society to use and take up the Partnership outcomes. This includes improved and better emergency preparedness, better clinical procedures resulting in better patient care and reduced health care costs as well as improvement of European industry in all fields of radiation protection purposes. The dissemination strategy will make available the know-how, products and technologies to the identified stakeholders, or to any other interested, and will be regularly updated during the Partnership's lifetime. As part of Partnership, the effective research translation mechanisms will be developed to center the radiation protection research outcomes also on societal priorities as much as determined by technical capabilities. Research that aligns social and technical dimensions, and thereby generates robust knowledge, is imperative. This integrated approach requires research and innovation in the following areas:

- new theory on knowledge exchange mechanisms between technical and societal spheres to underpin new practices;
- empirical investigation of effectiveness of, and limitations to, current communicative structures and cultures to identify areas for intervention and action;
- novel forms of citizen engagement, including in the advancement of innovative technological interventions.

The Partnership will promote Open Access of the publications, research data and project developments (*e.g.* models) according to the adopted policy. The intention of the Partnership is, as presented in the objectives, to implement open research policy as much as possible including the broad possibility of contributions from all kinds of research institutions and stakeholders. In case of any restrictions, the reasons for a potential restriction will be reported.
The Partnership for radiation protection deploys a diversity of channels and tools to be used in all actions to maintain a steady dialogue with EU stakeholders and related international activities throughout the lifetime of the Partnership. All information about the Partnership, its dedicated research projects of the open calls and the results will be made available *via* the Partnerships web site. Open access publications will be the norm for scientific publications. Data generated by the Partnership will be FAIR and findable *via* a centralized data library such as STOREdb and made available for risk assessment and research teams for analysis. An ethical and legal framework will be developed to enable the use and re-use of data for different purposes and by different users, while respecting data privacy legislation.
The participation of new partners and actors in the definition of common priorities and their participation in the Partnerships itself or its activities (including eligibility for funding) will be stimulated and supported, including eligibility for funding. More details can be found in the specific objectives in 2.2.2. and the WP descriptions.

3.4.3. Proactive recruitment

The Partnership will support a proactive and continuous recruitment policy to address the development in radiation protection field. There is a significant aging of researchers and other experts in the field, therefore special attention will be given to establish the E&T programme to support the needs of present generation and also to allow for sufficient future generation of researchers. The E&T programme will

be supported by the gap analyses and particular financial schemes to enable dynamic and agile respond to evolution in the radiation protection sector throughout the Partnership lifetime.

3.4.4. Consultations on the Annual Work Plan

The Partnership will have robust consultation procedures in place to establish and manage the development of the SRA/Roadmap with priorities in the field. As described, the established European Radiation Protection Platforms (MELODI, EURADOS, EURAMED, NERIS, ALLIANCE, SHARE) are already continuously developing and upgrading the Joint Roadmap with the joint research challenges in the context of existing and potential exposure scenarios priorities. The approach to the regular renewal of the Joint Roadmap will be based on openness, transparency, inclusiveness of all participants and be based on the governmental structure as presented in Section 3.3. The ultimate decision-making body will be General Assembly who will endorse the 3-year strategy, the Annual Work Plan and the proposals of Open Call programme.