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D 2.2 – Research priorities for the second open call

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Abstract

PIANOFORTE set as a major priority to launch three open calls to fund R&D projects on radiation protection. To select the research topics to be included in the open calls, Task 2.1 is in charge of defining and applying a prioritization process, in close collaboration with PIANOFORTE Programme Owners and Managers (POMs), Stakeholder and Advisor Board (SAB), platforms and external stakeholders, as well as PIANOFORTE WP3 in charge of stakeholder engagement. The first open call was published on the 24th of April 2023 and included 3 topics (See Deliverable 2.1).

Considering the lessons learned in the prioritization process followed to select the research topics for the first PIANOFORTE open call, Task 2.1 defined a revised procedure to select the research topics to be included in the second open call.

Task 2.1 members elaborated a first shortlist of topics considering the topics that were not selected in the first open call, asking the POMs, the SAB and the six European radiation protection research platforms for input on the topics that could be included in the second open call, on the criteria to be applied for the selection of the final topics and on the method for prioritising and scoring the topics with respect to the above criteria.

Several iterations with the European platforms, including a meeting in October 2023 to discuss and agree on the prioritization process to be followed, allowed the selection of a reduced number of topics (8) that were scored by POMs, SAB, platforms and external stakeholders according to the prioritization criteria and scoring methods selected.

Considering the scores provided by POMs, SAB, platforms and external stakeholders, PIANOFORTE Task 2.1 selected four topics for the second open call: A2, D3, E3 and G2. Since the topic A1 (Developing a knowledge base for a better understanding of disease pathogenesis of ionising radiation-induced cancer to improve risk assessment) was underrepresented in the projects funded by the first PIANOFORTE open call (only one project was funded), the PIANOFORTE Executive Board proposed to replace topic A2 with A1, proposal that was approved by the General Assembly in December 2023. Therefore, the four topics selected for the second open call are:

- A1-Developing a knowledge base for a better understanding of disease pathogenesis of ionising radiation-induced cancer to improve risk assessment.
- D3-Implementation of new and optimized radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.
- E3-Development of techniques and methods to go beyond effective dose in case of internal exposure following a nuclear or radiological emergency.
- G2-Ensure readiness and scientific knowledge to support Environmental Impact Assessment and emergency preparedness and response for novel nuclear technologies.

This Deliverable describes in detail the procedure followed to prioritise and select the research topics to be included in the second PIANOFORTE open call.

Table of Contents

1 Objective of this deliverable

One of the main objectives of the PIANOFORTE project is to launch scientific open calls, to which the radiation protection community could respond in a competitive manner. A specific task within WP2 was dedicated to identifying the most pertinent research topics within the area of interest of each of the six radiation protection platforms and to coordinate prioritisation of the research topics based upon consultations with PIANOFORTE POMs, SAB as well as different external stakeholders in a transparent manner. Stakeholders' consultation was shared between WP2 Task 2.1 and WP3 (Stakeholder engagement). A scheme of the stakeholder involvement strategy for the prioritisation of research topics to be used in PIANOFORTE open calls is included in the PIANOFORTE Grant Agreement[1] (*Figure 1*).

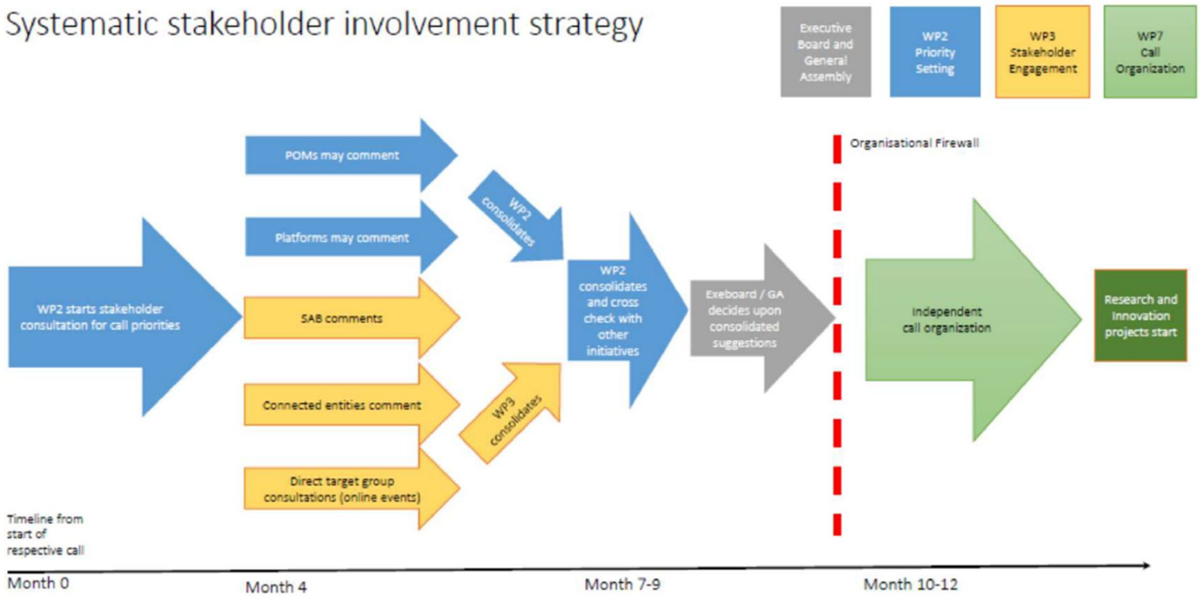


Figure 1: Scheme of the stakeholder involvement strategy for the prioritisation of research topics to be used in PIANOFORTE open calls.

PIANOFORTE published the first open call on 24th of April 2023 (https://pianoforte-partnership.eu/calls/open-call-2023).

Taking into account the lessons learned in the prioritization process of research topics for the first open call (Deliverable 2.1), an updated procedure was proposed by PIANOFORTE Task 2.1 members to be used to prioritise the research topics for the second open call. The procedure is described in detail in this deliverable.

[1] Grant agreement 101061037-PIANOFORTE

2 Procedure to prioritise the research topics for the PIANOFORTE second open call

The procedure to prioritise the research topics for the PIANOFORTE second open call, prepared by Task 2.1 members, was approved by the Executive Board at the end of February 2023 (see Annex 1). Soon after, the steps described in the procedure were initiated and are described below.

2.1. First consultation with POMs and SAB (2023-04-19)

PIANOFORTE assembled the research topics not included in the first open call, integrating the feedback received from platforms, POMs, SAB and external stakeholders on these topics.

In conformity with the principle of Horizon Europe regarding the importance of integrating social sciences and humanities (SSH) in EU-funded projects, a note was inserted at the beginning of the document highlighting the need for considering SSH-related aspects in the projects funded by PIANOFORTE.

In mid-April, PIANOFORTE sent to POMs and SAB the description of the procedure for prioritization of topics (see Annex 1) together with a shortlist of topics proposed for the second open call (see Annex 2). POMs and SAB were asked to give their feedback both in defining the topics for the second open call and in the criteria to be used for the prioritisation of the topics. They also had the possibility to suggest a maximum of 2 new topics, and to merge or reword topics. In addition, two templates prepared by PIANOFORTE to facilitate the suggestion of new topics (see Annex 3) and of criteria for prioritization of the topics (see Annex 4) were also sent to POMs and SAB, kindly asking them to send their feedback by 20 May 2023.

With the feedback received from POMs and SAB on the topics proposed for the second open call, PIANOFORTE produced an updated shortlist of topics that included seven new topics (A5, C3, E2, E3, E4, G2 and G3), the rewording of one topic (C1), and revisions of previous topics in light of comments made by the SAB on four topics (F1, F2, F3 and H1) (see Annex 5).

The suggestions received from POMs and SAB on the criteria to be used to prioritise the topics for the second open call, together with the prioritization criteria used in the first open call, were collected in an Excel file by PIANOFORTE (see Annex 6).

2.2. First consultation with platforms

The updated shortlist of topics and the document with the revised prioritization criteria were distributed to the six European Radiation Protection research platforms (ALLIANCE, EURADOS, EURAMED, MELODI, NERIS and SHARE) asking them for specific input in:

- <u>Topics for the second open call</u>: propose new topics (a maximum of 2) (using template in Annex 3); reformulate topics if needed; comment and/or adopt new topics suggested by POMs and/or

SAB; suggest possible combination among topics within each platform; suggest possible combination of topics among platforms to increase interdisciplinarity.

- Prioritization criteria: suggest new prioritisation criteria (using the template in Annex 4) as well as scoring methods to evaluate topics according to these criteria; suggest revision of the prioritisation criteria used for the first open call.

The Platforms also received the description of the procedure to follow during prioritising topics for the second open call proposed by PIANOFORTE (see Annex 1).

All the documents were distributed to the platforms on June 8, 2023, with the request to send their feedback by July 31, 2023.

All the platforms sent feedback on the topics proposed for the second open call. In summary, the feedback from platforms included:

- Six new topics were proposed (A6 by MELODI; B2 by EURADOS; D4 and E5 by EURAMED; H1 and H2 by SHARE).
- Rephrasing of four topics (E1 by EURADOS; D2 by EURAMED; C1 and C3 by ALLIANCE). EURADOS suggested that topic E2 should be rephrased.
- Merging of topics G2 and G3, and revision of the text of the resulting topic (NERIS).
- Rejection of topic E3 (EURADOS).
- According to the comments received from SAB, ALLIANCE revised theme F (suggesting two topics F1 and F2 instead of three), and SHARE revised topic H1.

The platforms EURAMED, NERIS and SHARE sent feedback on the prioritization criteria (see Annex 7).

PIANOFORTE Task 2.1 reviewed and integrated the comments received from platforms on the topics for the second open call and produced a new version of the document with the list of topics (see Annex 8).

Taking into account the suggestions received from platforms, POMs and the SAB, PIANOFORTE WP2 and WP3 selected the prioritization criteria (see Annex 9) and used them to evaluate the topics (see Annex 10).

Based on the results obtained after evaluating the topics according to the agreed prioritization criteria and weighting based on relevance to PIANOFORTE specific objectives and/or scientific excellence (see Annex 11), PIANOFORTE Task 2.1 shortened the list of the topics proposed by platforms, POMs and SAB to 7 topics. In addition to the selected criteria, the content of the projects funded in PIANOFORTE first open call were also considered, to avoid any redundancy. The seven topics selected for the shortlist (see Annex 12) were:

- A2. Define how the temporal and spatial variations in dose delivery affect the risk of health effects following radiation exposure through the integration of experimental and epidemiological data and including optimised detection and dosimetry.
- A3. Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage.
- B1. To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.
- C2. Determine the effects of ionizing radiation on ecosystem functioning and biodiversity, as well as their potential consequences to human wellbeing (e.g. culture, food consumption, work and recreational activities).
- D3. Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.
- E3. Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency.
- H3. Sustainable practices and risk management strategies in radiological protection.

PIANOFORTE Task 2.1 made a first evaluation of the topics using the criteria selected and the results are shown in Annex 11.

According to the procedure to prioritise the research topics for the second open call described in Annex 1, PIANOFORTE organised a meeting on the 13 of October 2023, during the ERPW2023 in Dublin, to present the shortlist of topics and the prioritisation criteria based on which this shortlist was created and discuss them with the platforms.

In order to facilitate the participation of the platforms, PIANOFORTE Task 2.1 sent them the following relevant documents beforehand to be discussed in the mentioned meeting:

- Shortlist of topics that emerged as outcome of the 6th step of the procedure described in Annex 1 (see Annex 12).
- The prioritisation criteria and the scoring of the subtopics obtained as result of the 5th step of the procedure described in Annex 1 (see Annex 11).
- List the topics and subtopics that emerged as outcome of the 4th step of the procedure described in Annex 1 (See Annex 8).

The same documents were also sent in parallel to the SAB members, asking them for inputs.

During the meeting held in Dublin, in addition to platforms' representatives, members of the PIANOFORTE Executive Board, WP2 and WP3 participated. After reviewing the scores given to the different topics for each of the criteria selected, it was unanimously agreed to add one more topic to the shortlist:

- G2. Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies.

2.3. Second consultation with platforms, POMs, SAB and external stakeholders

A shortlist with eight scientific topics was elaborated after the meeting in Dublin, and distributed to platforms, POMs and SAB (see Annex 13), inviting them to rank the eight topics in the short list in numerical order (1 to 8, with 1 the highest and 8 the lowest priority) using a form prepared for this purpose (see Annex 14).

In parallel, PIANOFORTE WP3 organised a consultation with external stakeholders (by Topical online meetings, TOMs) on the prioritised topics for the second open call. Stakeholders were provided with the same documents as POMs and SAB and were asked for the same type of comments on the topics description and to rank the topics. The details of this consultation are described in Deliverable 3.2.

2.4. Final selection and approval of topics for the second open call.

Taking into account the rankings from the platforms, POMs and SAB, including the feedback from the TOMs (Figure 2) (see details on the ranking obtained in Annex 15), and applying a multi-criteria analysis method, PIANOFORTE selected a reduced number of topics (to a maximum of four) from the shortlist, to be included in the second open call.

To obtain an aggregate ranking, the social multi-criteria tool SOCRATES was used (https://web.jrc.ec.europa.eu/policy-model-inventory/explore/models/model-socrates/). This tool was developed at the European Commission JRC-Ispra with the purpose of policy evaluation, which is typically characterised by the necessity to consider a plurality of dimensions and stakeholders (Munda et al., 2022[2]; Munda 2022[3]). SOCRATES provides three types of analysis: multi-criteria analysis, sensitivity analysis, and equity analysis. The latter analysis considers opinions of different social actors (in our case platforms, POMs and SAB) and illustrates clusters of preferences and then distance between the positions of different social actors.

[2] Munda G., Azzini I., Cerreta M. and Ostlaender N. (2022). SOCRATES Manual. Software Manual for Social Multi-Criteria Evaluation, Version November 2022.

[3] Munda G. (2022) Qualitative reasoning or quantitative aggregation rules for impact assessment of policy options? A multiple criteria framework, Quality & Quantity. International Journal of Methodology, Vol. 56, pp. 3259–3277. https://doi.org/10.1007/s11135-021-01267-8

The four topics selected were:

- A2-Define how the temporal and spatial variations in dose delivery affect the risk of health effects
- D3-Implementation of new and optimised radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.
- E3-Development of techniques and methods to go beyond effective dose in case of internal exposure following a nuclear or radiological emergency.
- G2-Ensure readiness and scientific knowledge to support Environmental Impact Assessment and emergency preparedness and response for novel nuclear technologies.

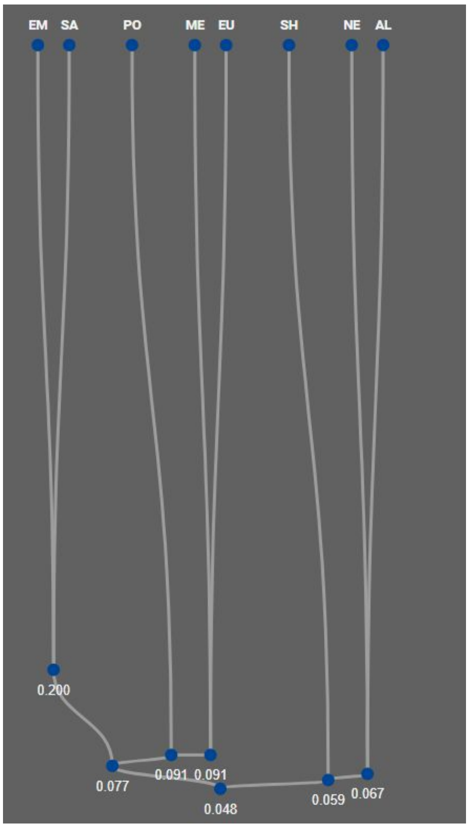
These four topics were approved by the PIANOFORTE Executive Board (ExB) and were presented to the General Assembly (5 of December 2023, Budapest). Considering that the topic A1 (Developing a knowledge base for a better understanding of disease pathogenesis of ionising radiation-induced cancer to improve risk assessment) was underrepresented in the projects funded by the first PIANOFORTE open call (only one project was funded), the ExB proposed to replace topic A2 with A1. This proposal was formally submitted to the General Assembly for a vote and it was approved with 17 votes in favour, 14 against and 2 abstentions.

In order to obtain a joint, aggregated ranking of topics, in a first step, the rankings provided by POM's were aggregated to obtain an overall ranking for POMs. In a second step, the aggregated ranking from POMs was combined with those provided by platforms and the SAB. All of these social actors were assigned, on advice from the Executive Board, an equal weight (Figure 2).

RANKING SOCRATES POMs	SAB	RANKING SOCRATES PLATFORMS	AGGREGATED SOCRATES RANKING: POMs, PLATFORMS, SAB	TOM Ranking (excluding POM participants in TOM meeting)	Topic
2	1	1	1	6	*A2. Define how the temporal and spatial variations in dose delivery affect the risk of health effects*
1	3	4	2	3	*A3. Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage*
6	8	8	8	7	*B1. To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.*
7	7	7	7	1	*C2. Determine the effects of ionizing radiation on ecosystem functioning and biodiversity*
5	2	2	3	4	*D3. Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.*
4	5	6	5	2	*E3. Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency*
3	6	3	4	5	*G2. Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies*
8	4	5	6	8	*H3. Sustainable practices and risk management strategies in radiological protection*

Figure 2. Rankings from the platforms, POMs and SAB, including the feedback from the TOM of the shortlist of topics for the second open call.

Furthermore, the equity analysis, see below, highlighted the divergences in preferences.



Credibility	Coalition	1º	2º	3º	4º	5º	6º	7º	8º
0.200	**EM** [EURAMED], **SA** [SAB]	A2	D3	A3	H3	E3	G2	C2	B1
0.091	**ME** [MELODI], **EU** [EURADOS]	D3	A2	A3	B1	E3	G2	H3	C2
0.091	**PO** [POMs], **ME** [MELODI], **EU** [EURADOS]	A2	A3	D3	E3	B1	G2	C2	H3
0.077	**EM** [EURAMED], **SA** [SAB], **PO** [POMs], **ME** [MELODI], **EU** [EURADOS]	A2	D3	A3	E3	B1	G2	H3	C2
0.067	**NE** [NERIS], **AL** [ALLIANCE]	G2	C2	E3	H3	A2	D3	B1	A3
0.059	**SH** [SHARE], **NE** [NERIS], **AL** [ALLIANCE]	G2	H3	C2	E3	A3	D3	A2	B1
0.048	**EM** [EURAMED], **SA** [SAB], **PO** [POMs], **ME** [MELODI], **EU** [EURADOS], **SH** [SHARE], **NE** [NERIS], **AL** [ALLIANCE]	A2	A3	D3	G2	E3	H3	C2	B1

The largest discrepancy is between the preference for A2, D3, A3, E3 on the one hand (preferred by the group consisting of EURAMED, SAB, EURADOS, MELODI, POMs) and the preference for G2, H3, C2, on the other hand, (preferred by the group consisting of NERIS, ALLIANCE, SHARE).

Based on the final ranking suggested by the equity analysis, and taking into consideration the rationale that no platform should have more than one proposed topic selected, the recommendation was made to select topics A2, D3, G2 and E3, which would also include the top ranked options from the above-mentioned clusters, as well as E3 which received a high priority from TOMs. However, as a result of discussions with arguments presented by MELODI, it was agreed that topic A1, included but not sufficiently addressed in call 1, and which was also judged more important than A2, should replace topic A2 in call 2.

Therefore, the four topics retained for the second open call are as follows:

- A1-Developing a knowledge base for a better understanding of disease pathogenesis of ionising radiation-induced cancer to improve risk assessment.
- D3-Implementation of new and optimized radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of incising radiation.
- E3-Development of techniques and methods to go beyond effective dose in case of internal exposure following a nuclear or radiological emergency.
- G2-Ensure readiness and scientific knowledge to support Environmental Impact Assessment and emergency preparedness and response for novel nuclear technologies.

3 Concluding remarks

Task 2.1 assembled a list of radiation protection research topics that were not selected for the first PIANOFORTE open call. The topics chosen for the first open call were excluded from this list.

The list of topics was distributed to POMs, SAB and platforms for comments. In addition, they also had the possibility of commenting on the prioritization criteria to be used in the second open call.

For the second open call, POMs and SAB also had the possibility to suggest new topics (a maximum of two) as well as suggest criteria to be applied for the prioritization of the topics. The topics proposed by POMs and SAB were reviewed by platforms, which also had the possibility to suggest a maximum of two new topics (per platform), as well as criteria for prioritization. Applying the prioritization criteria agreed, PIANOFORTE ranked the selected topics and reduced them to a short list of 8 topics.

POMs, SAB, platforms and external stakeholders (WP3) scored the 8 topics selected by PIANOFORTE using the criteria agreed. Based on all the scores received, the PIANOFORTE Executive Board proposed to the General Assembly four topics to be included in the second open call:

- A1-Developing a knowledge base for a better understanding of disease pathogenesis of ionising radiation-induced cancer to improve risk assessment.
- D3-Implementation of new and optimized radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of incising radiation.
- E3-Development of techniques and methods to go beyond effective dose in case of internal exposure following a nuclear or radiological emergency.
- G2-Ensure readiness and scientific knowledge to support Environmental Impact Assessment and emergency preparedness and response for novel nuclear technologies.

The prioritisation process for the third open call will start in April-May 2024. A detailed prioritisation workflow will be set together with WP3, which will be applied only after PIANOFORTE Executive Board approval.

4. Annexes

4.1. List of annexes

Annex 1: Description of the procedure, steps to follow to define research topics for PIANOFORTE second open call.

Annex 2: Reformulation of topics FOR PIANOFORTE second open call.

Annex 3: Template for suggestion of new research topics on radiation protection.

Annex 4: Template for suggestion of criteria to be applied to prioritise the research topics for PIANOFORTE second open call.

Annex 5: Topics for PIANOFORTE second open call.

Annex 6: Prioritisation criteria - compiled new suggestions and modifications by POMS and SAB.

Annex 7: Prioritisation criteria - compiled new suggestions and modifications by POMS, SAB and Platforms.

Annex 8: Cumulative list of topics for PIANOFORTE second open call (4th step).

Annex 9: Prioritization criteria of topics for PIANOFORTE second open call.

Annex 10: Scoring of topics for PIANOFORTE second open call.

Annex 11: Scores of topics: summary from 5th step.

Annex 12: Shortlist of topics for PIANOFORTE second open call (6th step).

Annex 13: Shortlist of topics for PIANOFORTE second open call (7th step).

Annex 14: Form for ranking the topics included in the shortlist.

Annex 15: Ranking results for topics shortlisted for PIANOFORTE second open call.

4.2. Annex 1: Description of the procedure, steps to follow to define research topics for PIANOFORTE second open call

Description of the procedure, steps to follow to define research topics for PIANOFORTE Second Open Call

Prepared by Task 2.1 and WP3

Approved by PIANOFORTE Executive Board

- 1st step: reformulate the topics not selected for 1st call, based on the comments received (from POMs, SAB and stakeholders). It was agreed that we will start with all the topics not included in the 1st call, including the individual sensitivity topic. In later steps we can still decide not to take it in the shortlist (action WP2 – outcome: list of topics).
- 2nd step: Prepare 2 templates: one for suggestion of new topics (including why the topic is important: e.g. for PIANOFORTE, for Europe, etc.) and one for suggestion of criteria to be applied to prioritise (including how the criteria should be used: scores) to be sent to POMs, SAB and Platforms. Also a document explaining the whole process should be prepared (action WP2 – outcomes: 2 templates and 1 document)
- 3rd step: ask for new topics to POMs and SAB, for possible merging of topics, and for possible reformulation of topics. Limit the number of new topics that can be proposed (max of 2). We will also ask for suggestions on criteria that could be applied to prioritise the topics. The platforms will also be able to suggest new topics, but this will be done in step 4. This to avoid 2 iterations through the platforms, because they can immediately also comment on the topics suggested by the SAB and POMs. (action WP3 – outcomes: list of topics, list of criteria)
- 4th step: The topics that will result from Steps 1 and 3 will be sent to the platforms for comments. Platforms will be asked to propose new topics (max of 2), to suggest merging of topics, to possibly reformulate topics, or to adopt new topics suggested by POMs and /or SAB. Platforms will also be asked to send criteria to be applied for prioritization of the topics. (action WP2 - outcomes: list of topics, list of criteria)
- 5th step: PIANOFORTE will select criteria for evaluating topics based on the suggestions from POM, SAB and platforms. The selected criteria will be used by PIANOFORTE to evaluate the topics. (action WP2+WP3 – outcome: list of criteria + scoring)
- 6th step: PIANOFORTE will shorten the list of the topics proposed by platforms, POMs and SAB to 6-8 topics based on the criteria suggestions and the feedback from the ranking exercise for call one. Also the content of the projects funded in call 1 will be taken into account, to avoid any redundancy (action WP2+WP3 – outcome: 1st version of shortened list of topics)
- 7th step: PIANOFORTE will present and discuss the shortlist with the platforms and SAB. (action WP2+WP3 – outcome: final shortened list of topics)
- 8th step: the platforms, POMs and SAB will be asked to rank the topics in the short list. The evaluation of these topics performed in Step 5 can be used as background information. The ranking will be asked in numerical order (1, 2, 3,… from highest to lowest priority) (action WP2+WP3 – outcome: rankings of shortened list of topics by POMs, SAB and platforms)
- 9th step: Consultation with stakeholders (TOM) can be done in parallel with step 8, to provide extra input for the final selection of topics. (action WP3 – outcome: feedback from TOMs).

- 10th step: PIANOFORTE will choose a few topics (2-3) from the shortlist, based on the ranking from the platforms, POMs and SAB, including the feedback from the TOM. Multi-criteria analysis can be used for this. (action WP2+3 – outcome: final topics for 2nd Call)
- 11th step: approval by ExB and GA

Timeline:

- Ask approval from ExB on this procedure: end of February
- Step 1 and 2: 15 April 2023
- Step 3: send out by 20 April 2023, answers by 20 May 2023
- Step 4: send out end of May, answers by end of June 2023
- Step 5 and 6: July-August 2023
- Step 7: September 2023
- Step 8: send out end of September, answers by end of October 2023
- Step 9: October 2023
- Step 10: November 2023
- Step 11: December 2023

4.3. Annex 2: Reformulation of topics for PIANOFORTE second open call

Overview of topics and subtopics

General note: *Under Horizon Europe, "the effective integration of social [sciences and humanities] SSH in all clusters, including all Missions and European partnerships, is a principle throughout the programme" (European Commission, 2022[4]). SSH are considered to be "a key constituent of research and innovation" (idem). In accordance with these principles and the PIANOFORTE commitments and objectives, all* ***projects funded by PIANOFORTE are expected to take into account the social, economic, behavioural, institutional, historical and/or cultural dimensions, as appropriate for the topic addressed****.* ***Contributions from one or more SSH disciplines may be required to ensure the social robustness and social impact of the research and innovation chain****.[5]*

A. Understanding and quantifying the health effects of radiation exposure

A1.

Define the risk of ionising radiation-induced non-cancer diseases after low and intermediate doses as defined by UNSCEAR[6]by understanding disease pathogenesis through assessing near-field, out-of-field and non-targeted effects after therapeutic doses and dose-rates and following diagnostic procedures and interventional radiology. The focus should be on developing a knowledge base on the mechanisms of one or more of the following diseases or health conditions: cardiovascular, cerebrovascular, neurocognitive diseases, neurodevelopmental, metabolic and immune disorders. Proposals should apply biologically relevant models and/or molecular epidemiological approaches based on available human cohorts. Related social, psychological and communication studies should be included where appropriate. Studies related to ionising radiation-induced cataracts and establishment of new human cohorts are not within the focus of the current call.

Proposals should address one or several objectives of the topic.

A3.

Developing a knowledge base and analytical tools to understand the major features of variability in the radiation response including radio-sensitivity (tissue reactions), radio-susceptibility (cancers) and radiation-induced aging by focusing on one (or both) of the following subtopics:

- Studies focusing on a better understanding of the mechanisms and link to advancing individualised cancer treatment by investigating the role of genetic factors, epigenetic factors, sex, co-morbidities, environmental and lifestyle factors and the interactions between these depending on dose levels.

[4] European Commission, 2022. Horizon Europe (HORIZON). Programme guide. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

[5] For Guidelines on integration of SSH see PIANOFORTE deliverable 2.6.

[6] Sources, Effects and risks of ionizing radiation. UNSCEAR 2012 Report
Annex A. Attributing health effects to ionizing radiation exposure and inferring risks. Page 23, Table 1. Terminology for bands of radiation dose used in this report
https://www.unscear.org/unscear/en/publications/2012.html

Where relevant proposals should include communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and informed consent.

- Seeking biomarkers of individual risk through cellular/molecular, systems biological approaches, radiomics investigations. Evaluating potential predictive factors and correlating them with health outcomes. Biomarker investigations should include validation of proposed biomarkers in suitable cohorts. In case of studies related to previously identified biomarkers validation and quality control should be included.

Research on both high and low doses is encouraged.

A4.

Define how the temporal and spatial variations in dose delivery affect the risk of health effects following radiation exposure through the integration of experimental and epidemiological data and including optimised detection and dosimetry by focusing on one of the following subtopics:

- Understanding the link between exposure characteristics (radiation quality, dose and dose-rate, acute and chronic exposures) and the cancer and non-cancer effects and implications for improvement/optimisation of innovative radiotherapy (e.g. FLASH therapy, proton/ion therapy).

- Understanding the effects of intraorgan dose distribution through observations in patients exposed to inhomogeneous dose distributions and experiments with organotypic tissue models

- Addressing the difference between risks from internal and external exposures through the integration of new knowledge on the effects of chronic exposures, intra-organ dose distribution and radiation quality considering energy deposition at different scales (from intracellular to organs).

In epidemiological studies evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization should be included.

B. Improving the concepts of dose quantities

B1.

To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.

The dependence of biological effectiveness on radiation quality is commonly believed to be related to the differences in the energy deposition pattern on a microscopic and nanoscopic scale. Identification and quantification of the relevant statistical characteristics of the microscopic spatial pattern of interactions (e.g., spatially correlated occurrence of clusters of energy transfer points) are an essential prerequisite for improvement of present dose concepts and understanding the radiation damage mechanism.

The topic should focus on one or more of the following subtopics:

- Investigating the physical characteristics of energy deposition on microscopic scale with the aim of developing a novel, unified concept of radiation quality as a general physical characteristic of the radiation field that would allow separating the physical and biological components contributing to the eventual biological effects of radiation.

- Developing microdosimetric and nanodosimetric detectors, revising their measurement concepts, and developing a 'gold standard' for track structure simulation codes along with their validation. Establishment of robust uncertainty budgets for micro- and nanodosimetric quantities obtained by measurement or simulation and identification of the major uncertainty sources.

- A comprehensive multi-scale characterization of the physical aspects of radiation energy deposition with quantitative investigation and correlation of track structure with biological effects at molecular and cellular level and their consequences at supra-cellular levels. Radiobiological experiments should be performed with relevant micro- and nanodosimetric metrological methods, thereby facilitating the identification of useful connections for further advancements in radiobiological modelling. The cancer development processes should also be considered in the modelling to obtain an estimation of low dose risk.

C. Understanding radiation-related effects on non-human biota and ecosystems

C1.

Resolving the controversy with regard to the effects on wildlife reported in the Chernobyl and

Fukushima exclusion zones. Many studies have reported no significant effects of radiation on wildlife (e.g. in the Chernobyl and Fukushima exclusion zones), whereas others reported significant radiation effects on different wildlife populations at very low dose rates (even below natural background exposure). The establishment of reliable, consensus-based conclusions on the long-term ecological effects attributable to radiation in those emblematic contaminated territories would have a very significant impact on the robustness and credibility of radiological environmental risk assessment methodologies (e.g., validity of 'no-effect' benchmark dose-rates). Priorities are to characterize the influence of exposures on the populations currently living in contaminated environments, through (1) robust exposure assessments (considering past exposures and including internal exposure, heterogeneity, differing radiation qualities) and considering other stress factors; (2) the identification of the key factors determining the vast reported variation in wildlife populations' sensitivity to radiation; (3) the identification and validation of biomarkers of exposure and effects that are relevant for effects at the population's level.

C2.

Determine the effects of ionizing radiation on ecosystem functioning and biodiversity, as well as their potential consequences to human wellbeing (e.g. culture, food consumption, work and recreational activities).

The demonstration of the increased sensitivity of ecosystem processes to ionizing radiation, in comparison with the reported effects at the population level, would strongly question the robustness of risk assessments that rely only on population-effect data. On the other hand, if it is shown that the functional or structural redundancy (biodiversity) of the ecosystems brings greater robustness against the effects of radiation and potential other threats or anthropogenic degradations (multi-contamination, climatic change…), the conservatism of the current assessments would be supported. Although the subject is very broad, some targeted studies are achievable within a reasonable timeframe: experimental research on the effects of ionizing radiation on functional processes is expected in controlled conditions (e.g. microcosms and mesocosm studies), as well as the reinterpretation (e.g. by ecological modelling) of the reported data on the current state of ecosystems and their temporal evolution in contaminated territories.

Moreover, the consequences of the impact on ecosystem functioning may have many dimensions, not only biophysical, but also economic and socio-cultural. Those societal issues are also to be addressed, with the aim to provide a coherent framework encompassing both the radiation protection of human and ecosystems.

D. Optimising medical use of radiation

D2.

Improving the quality of medical imaging and radiation therapy and optimize the dose received by patient especially but not limited to cancer-treatment. This includes means to i) set up of reliable computational methodologies such artificial intelligence (AI) methods for medical applications including e.g. radiation dose prediction, image quality enhancement and pharmacokinetic modelling, ii) strategies for testing and validation of data and methods used for AI/Machine Learning (ML) applications or modelling and iii) methods to allow generalizability of ML models to allow application independent of hospital equipment.

Social, ethical and legal dimensions of the use of AI and other computational models should when appropriate also be addressed, such as, how the use of AI will impact current practices; what the effect will be on the gaps observed between best practice and guidelines, on the one hand, and current practices, on the other; and what the concerns and expectations of patients and other stakeholders are in the context of these technological developments.

The proposed research should contribute to the harmonization and application of technology and, in the context of informed consent, communication throughout Europe. Patient organizations must be involved.

D3.

Implementing EU-wide epidemiological studies of patients to enhance quality and safety of medical radiation applications and developing a knowledge base and analytical tools to better predict and reduce risk of secondary cancer and non-cancer disease in patients subjected to diagnostic methods using ionizing radiation and in cancer patients treated with radiotherapy.

Well-designed clinical epidemiological studies should conduct long term follow up, and focus on most at risk populations. The results of the clinical epidemiological studies should be used to optimise treatment and imaging protocols and patient follow-up. The studies should consider patient-specific dose modifiers in derivation of dose estimates as appropriate to different settings and can increase capabilities for radiation dose tracking and managing programmes to provide relevant and standardized dose estimates. Only already existing cohorts should be considered, building up new cohorts does not fit in the timeframe and budget of the call.

Epidemiological studies should include an evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization.

The topic should explore collaborative ways to improve the engagement with and communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and consent and improve radiation protection behaviours.

E. Improving radiation protection of workers and public

E1.

Developing a knowledge base and analytical tools to improve radiation protection of workers, and members of the public and thus to contribute to the translation of the BSS into practice by focusing on one or more of the following objectives:

- Improvement of biokinetic models and personalised dosimetry that will lead to the improvement of the assessment of internal exposure;

- Development of real time practical individual dosimetry of workers by harnessing the developments in new connected technologies, with due account to individual behaviour and social group culture;

- Development of a practical neutron personal dosimeter.

F. Developing an integrated approach to environmental exposure and risk assessment from ionising radiation

F1.

Robust modelling of radiological contamination in the human food chain, for an integrated dose and risk assessment of post-emergency situations, with focus on developing reliable and practicable approaches. The topic should take into account future changes in the European agricultural practices and fisheries management (including fish farming), sustainable development considerations and the need to further develop marine and freshwater dispersion and biota transfer models due to the fact that NPPs are often built on the coast and the future tendency of and the tendency of building of SME or nuclear-powered floating vessels.

F2.

Identifying and quantifying the key processes that influence radionuclide behaviour in existing environmental contamination situations with a special focus on:

- the management and clean-up of existing sites, as well as to the licensing (including social licensing) of future discharges and large quantities of NORM residues.

- the management and the licensing (including social licensing) of discharges of liquid NORM residues into marine as well as fresh water ecosystems

- developing the modelling basis for accurate dose assessment and establishment of holistic and sustainable remediation approaches.

F3.

Integrating risk assessment and management and especially focusing on risk integration for radiation and other stressors. Specific emphasis is required on integrated and holistic risk assessments. There is a need for the improvement and/or development of innovative methods to characterise the source terms to delineate the multiple-hazard footprint (e.g., geostatistical interpretation of environmental, radiological, chemical data) of a site in space and time. Innovative modelling approaches are also needed to support decision making and to identify the most significant sources of uncertainty related to the impact on human and environmental health including social considerations.

G. Optimising emergency and recovery preparedness and response

G1.

Improvement of radiological impact assessments, decision support and response and recovery strategies by focusing on one or more of the following aspects:

- the use of AI and big data technologies in radiological impact assessments, in the development / optimisation of measurement strategies, for the calculation (along with other novel methodologies) of uncertainties in model results and for optimization and operationalization of emergency preparedness and response practices; integration of AI and big data technologies in Decision Support Systems for better guidance of the end user in countermeasure strategy definition;

- compilation of the databases that are required by AI technologies, with historic and scenario information - including besides nuclear/radiological accidents, scenarios of new threats, such as war situations;

- improved communication/dialogue with stakeholders due to better information availability, considering data protection regulations (GDPR).

H. Radiation protection in/with society

H1.

Effective translation mechanisms between social and technical dimensions of radiation protection.

The objective of the topic is to investigate how different radiation protection actors perceive the added value of inter- and transdisciplinary collaborations in the field of radiation protection; what their expectations and needs are; what challenges and enablers of collaborations can be found in the different radiation protection fields; and what are the main barriers for the institutional uptake of results from inter- and transdisciplinary collaborations. Projects addressing this topic should contribute to developing systematic approaches to inclusion of societal dimensions within the radiological protection system and methodological innovation enabling inter- and transdisciplinarity in radiation protection research.

4.4. Annex 3: Template for suggestion of new research topics on radiation protection

PIANOFORTE 2nd Open Call: Template for suggestion of new topics

Text of the proposed topic (please give a title and a short description):
Who suggested it?
How does it relate to PIANOFORTE scientific specific objectives?[1] (If it relates to more than one specific objectives, please detail each.)
How does it contribute to major research priorities/orientations formulated by HORIZON EUROPE?[2]
What major gaps within radiation protection research are addressed by the topic?
Is the suggested topic related to more than one discipline of radiation protection? If yes, please indicate how and why this multidisciplinary approach could add to answering the formulated research gap.
Other remarks:

[1] PIANOFORTE Grant Agreement Document, Annex 1, Part B.

[2] As set in the HORIZON Europe priorities – the "missions", see e.g. https://op.europa.eu/en/publication-detail/-/publication/9f832590-8d43-11ec-8c40-01aa75ed71a1

4.5. Annex 4: Template for suggestion of criteria to be applied to prioritise the research topics for PIANOFORTE second open call

PIANOFORTE 2nd Open Call: Template for suggestion of criteria to be applied for prioritization

Guide to complete the template:

In order to make a list of research topics for the PF Second Open Call that reflect the priorities of the radiation research community, the proposed topics should be ranked based on pre-defined prioritization criteria.

We would like to ask the contribution of all parties that have the possibility to suggest research topics (platforms, POMs, SAB, other stakeholders) to suggest criteria for prioritization as well. In this way, prioritization of the topics will be done with the largest possible consensus.

Please suggest prioritization criteria based on which the scoring allows an as objective evaluation of the topics as possible and feasible. Please suggest not more than 3 criteria. Please use the Table below.

As an example, please see in Annex 1 the prioritization criteria and ranking used in Call 1.

Text of the suggested prioritization criterion:
Please explain why this is important
Please suggest scoring and how scoring should be applied

Annex 1:

Prioritization of subtopics for PIANOFORTE Call 1:

Feasibility: (i.e. the subtopic or certain objectives of the subtopic can achieve significant progress within the available timeframe and budget) assuming that projects within Call 1 last max. 3 years and have an estimated total budget of 3000-3500 k€ for large calls and 1000 k€ for small calls:

- **"2" feasible** – feasible in BOTH timeframe and budget.
- **"1" moderately feasible** - feasible to address only partially the subtopic or certain objectives of the subtopic within the available timeframe and budget.

Relevance for PIANOFORTE specific objectives: (to what extent it adheres to PIANOFORTE priorities and objectives)

- **"2" strong relevance** - Strongly endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to min. 2 specific objectives of PIANOFORTE)
- **"1" moderate relevance** – endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to 1 specific objective of PIANOFORTE)

Relevance for other EU initiatives outside EURATOM:

- **"2" relevant** - endorsed and mentioned as a priority research topic by other EU initiatives outside EURATOM (e.g. HORIZON EUROPE, EU4HEALTH, etc.)
- **"1" not relevant** – not mentioned as a priority research topic by other EU initiatives outside EURATOM (e.g. HORIZON EUROPE, EU4HEALTH, etc.)

Societal impact

- **"3" high societal impact:** projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, occupational) / environments leading to significant risk reduction or providing significant support for improved radiation protection policies or practice
- **"2" moderate societal impact:** projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, occupational) / environments leading to some risk reduction or providing support for improved radiation protection policies or practices
- **"1" low societal impact:** projects which cannot be directly linked/translated into radiation protection policies

Scientific impact:

- **"3" high scientific impact:** projects most likely providing new research results (data, methods, software, recommendations, guidelines, etc.) of high scientific excellence likely to lead to scientific publications in highly ranked (Q1 and Q2) journals relevant for the large scientific community not only radiation protection research
- **"2" moderate scientific impact:** projects most likely providing new research results (data, methods, software, recommendations, guidelines, etc.) of scientific excellence publishable in radiation - related journals of high impact and relevant for the large radiation protection community
- **"1" low scientific impact:** projects most likely providing highly specialized research results (data, methods, software, recommendations, guidelines, etc.) in the field of radiation protection relevant only for restricted groups within the radiation protection community and which are publishable in specialized journals focusing on radiation protection research

Redundancy: (to what extent the topic has recently been and/or is currently being addressed by other projects) (recently closed projects = projects closed within the last 3 years)

- **"3" non-redundant** - no redundancies with ongoing or recently closed EURATOM and/or other EC-funded projects (projects closed within the last 3 years)
- **"2" partially redundant** - partially addressed by ongoing or recently closed EURATOM-funded or other EC projects but a large part of the topic still not researched
- **"1" redundant** - it has substantial redundancies with recently closed and/or ongoing EURATOM or EC projects

4.6. Annex 5: Topics for PIANOFORTE second open call

Overview of topics and subtopics

General note: *Under Horizon Europe, "the effective integration of social [sciences and humanities] SSH in all clusters, including all Missions and European partnerships, is a principle throughout the programme" (European Commission, 2022[7]). SSH are considered to be "a key constituent of research and innovation" (idem). In accordance with these principles and the PIANOFORTE commitments and objectives, all* ***projects funded by PIANOFORTE are expected to take into account the social, economic, behavioural, institutional, historical and/or cultural dimensions, as appropriate for the topic addressed. Contributions from one or more SSH disciplines may be required to ensure the social robustness and social impact of the research and innovation chain.***[8]

A. Understanding and quantifying the health effects of radiation exposure

A1.

Define the risk of ionising radiation-induced non-cancer diseases after low and intermediate doses as defined by UNSCEAR[9]by understanding disease pathogenesis through assessing near-field, out-of-field and non-targeted effects after therapeutic doses and dose-rates and following diagnostic procedures and interventional radiology. The focus should be on developing a knowledge base on the mechanisms of one or more of the following diseases or health conditions: cardiovascular, cerebrovascular, neurocognitive diseases, neurodevelopmental, metabolic and immune disorders. Proposals should apply biologically relevant models and/or molecular epidemiological approaches based on available human cohorts. Related social, psychological and communication studies should be included where appropriate. Studies related to ionising radiation-induced cataracts and establishment of new human cohorts are not within the focus of the current call.

Proposals should address one or several objectives of the topic.

A3.

Developing a knowledge base and analytical tools to understand the major features of variability in the radiation response including radio-sensitivity (tissue reactions), radio-susceptibility (cancers) and radiation-induced aging by focusing on one (or both) of the following subtopics:

- Studies focusing on a better understanding of the mechanisms and link to advancing individualised cancer treatment by investigating the role of genetic factors, epigenetic factors, sex, co-morbidities, environmental and lifestyle factors and the interactions between these depending on dose levels. Where relevant proposals should include communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and

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[7] European Commission, 2022. Horizon Europe (HORIZON). Programme guide. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

[8] For Guidelines on integration of SSH see PIANOFORTE deliverable 2.6.

[9] Sources, Effects and risks of ionizing radiation. UNSCEAR 2012 Report
Annex A. Attributing health effects to ionizing radiation exposure and inferring risks. Page 23, Table 1. Terminology for bands of radiation dose used in this report
https://www.unscear.org/unscear/en/publications/2012.html

informed consent.

- Seeking biomarkers of individual risk through cellular/molecular, systems biological approaches, radiomics investigations. Evaluating potential predictive factors and correlating them with health outcomes. Biomarker investigations should include validation of proposed biomarkers in suitable cohorts. In case of studies related to previously identified biomarkers validation and quality control should be included.

Research on both high and low doses is encouraged.

A4.

Define how the temporal and spatial variations in dose delivery affect the risk of health effects following radiation exposure through the integration of experimental and epidemiological data and including optimised detection and dosimetry by focusing on one of the following subtopics:

- Understanding the link between exposure characteristics (radiation quality, dose and dose-rate, acute and chronic exposures) and the cancer and non-cancer effects and implications for improvement/optimisation of innovative radiotherapy (e.g. FLASH therapy, proton/ion therapy).

- Understanding the effects of intraorgan dose distribution through observations in patients exposed to inhomogeneous dose distributions and experiments with organotypic tissue models

- Addressing the difference between risks from internal and external exposures through the integration of new knowledge on the effects of chronic exposures, intra-organ dose distribution and radiation quality considering energy deposition at different scales (from intracellular to organs).

In epidemiological studies evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization should be included.

A5 - New topic suggestion:

Systematic review and meta-analysis of recent scientific and epidemiological data (last 10 years) on low dose effects from diagnostic procedures to identify a consensus on the best model to be used at low doses (LNT or other).

This relates to PIANOFORTE specific objective 3: To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates. It contributes to major research priorities/orientations formulated by HORIZON EUROPE by creating/ contributing to the creation of European Data Strategy. It addresses the following gaps in RPR: Diagnostic procedures are dealing with very low doses procedures; the definition of very low dosed exposure remains unclear and their specific risk is not comprehensively addressed yet in theory and in practice. The potential impact on the future BSS is also concerned. It is a multidisciplinary topic, involving radiobiologists, epidemiologists and regulators.

B. Improving the concepts of dose quantities

B1.

To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.

The dependence of biological effectiveness on radiation quality is commonly believed to be related to the differences in the energy deposition pattern on a microscopic and nanoscopic scale. Identification and quantification of the relevant statistical characteristics of the microscopic spatial pattern of interactions (e.g., spatially correlated occurrence of clusters of energy transfer points) are an essential prerequisite for improvement of present dose concepts and understanding the radiation damage mechanism.

The topic should focus on one or more of the following subtopics:

- Investigating the physical characteristics of energy deposition on microscopic scale with the aim of developing a novel, unified concept of radiation quality as a general physical characteristic of the radiation field that would allow separating the physical and biological components contributing to the eventual biological effects of radiation.

- Developing microdosimetric and nanodosimetric detectors, revising their measurement concepts, and developing a 'gold standard' for track structure simulation codes along with their validation. Establishment of robust uncertainty budgets for micro- and nanodosimetric quantities obtained by measurement or simulation and identification of the major uncertainty sources.

- A comprehensive multi-scale characterization of the physical aspects of radiation energy deposition with quantitative investigation and correlation of track structure with biological effects at molecular and cellular level and their consequences at supra-cellular levels. Radiobiological experiments should be performed with relevant micro- and nanodosimetric metrological methods, thereby facilitating the identification of useful connections for further advancements in radiobiological modelling. The cancer development processes should also be considered in the modelling to obtain an estimation of low dose risk.

C. Understanding radiation-related effects on non-human biota and ecosystems

C1.

Resolving the controversy with regard to the effects on wildlife reported in the Chernobyl and

Fukushima exclusion zones. Many studies have reported no significant effects of radiation on wildlife (e.g. in the Chernobyl and Fukushima exclusion zones), whereas others reported significant radiation effects on different wildlife populations at very low dose rates (even below natural background exposure). The establishment of reliable, consensus-based conclusions on the long-term ecological effects attributable to radiation in those emblematic contaminated territories would have a very significant impact on the robustness and credibility of radiological environmental risk assessment methodologies (e.g., validity of 'no-effect' benchmark dose-rates). Priorities are to characterize the influence of exposures on the populations currently living in contaminated environments, through (1) robust exposure assessments (considering past exposures and including internal exposure, heterogeneity, differing radiation qualities) and considering other stress factors; (2) the identification of the key factors determining the vast reported variation in wildlife populations' sensitivity to radiation; (3) the identification and validation of biomarkers of exposure and effects that are relevant for effects at the population's level.

***Proposed rewording of C1**:*

The reported radiation related effects on wildlife reported in the Chernobyl and Fukushima exclusion zones has varied. Many studies have reported no significant effects of radiation on wildlife in these *areas, whereas other studies have reported significant radiation effects on different wildlife populations at very low dose rates (even below natural background exposure). The establishment of reliable, consensus-based conclusions for the long-term ecological effects attributable to radiation in those emblematic contaminated territories would have a very significant impact on the robustness and credibility of radiological environmental risk assessment methodologies (e.g., validity of 'no-effect' benchmark dose-rates). Priorities are to characterize the influence of exposures on the populations currently living in contaminated environments, through (1) robust exposure assessments (considering past exposures and including internal exposure, heterogeneity, differing radiation qualities) and considering other stress factors; (2) the identification of the key factors determining the vast reported variation in wildlife populations' sensitivity to radiation; (3) the identification and validation of biomarkers of exposure and effects that are relevant for effects at the population's level.*

C2.

Determine the effects of ionizing radiation on ecosystem functioning and biodiversity, as well as their potential consequences to human wellbeing (e.g. culture, food consumption, work and recreational activities).

The demonstration of the increased sensitivity of ecosystem processes to ionizing radiation, in comparison with the reported effects at the population level, would strongly question the robustness of risk assessments that rely only on population-effect data. On the other hand, if it is shown that the functional or structural redundancy (biodiversity) of the ecosystems brings greater robustness against the effects of radiation and potential other threats or anthropogenic degradations (multi-contamination, climatic change…), the conservatism of the current assessments would be supported. Although the subject is very broad, some targeted studies are achievable within a reasonable timeframe: experimental research on the effects of ionizing radiation on functional processes is expected in controlled conditions (e.g. microcosms and mesocosm studies), as well as the reinterpretation (e.g. by ecological modelling) of the reported data on the current state of ecosystems and their temporal evolution in contaminated territories.

Moreover, the consequences of the impact on ecosystem functioning may have many dimensions, not only biophysical, but also economic and socio-cultural. Those societal issues are also to be addressed, with the aim to provide a coherent framework encompassing both the radiation protection of human and ecosystems.

C3 - new topic suggestion:

Title: Radiation protection of marine wildlife in a multi-contaminant context

This project encompasses both field and modelling investigations, aimed to investigate processes governing the transfer of radionuclides in the marine environment and effects on populations of non human biota. Special attention is given to situations where interactions of radionuclides with other contaminants may occur, such as marine NORM, discharges from oil and gas industries to the sea, and contaminated fjords and estuaries. Attention is also directed to using ecological/population modelling. The work should lead to dosimetry impact evaluation and producing advice from a regulatory perspective, such assessing how robust are the benchmarks for risk assessment of non-human biota in a marine multi-contaminant context.

This topic is a direct answer to Topic C (Understanding radiation-related effects on non-human biota and ecosystems), and specifically C2 (determine the effects of ionizing radiation on ecosystem functioning and biodiversity), because it aims at the demonstration of the increased sensitivity of ecosystem processes to ionizing radiation (in the presence of other contaminants), and the comparison with the reported effects at the population level (for biota), addressing the issue of the robustness of risk assessments. It contributes to the priority on restoring our oceans and waters, a major research orientation of horizon Europe, by providing necessary knowledge to assess and therefore aid in restoring/regenerating marine ecosystems, tackling multi-contaminant pollution. Addressed research gaps: The marine radioecology topic has been significantly underfunded at the European level, yet there are knowledge gaps in the understanding of marine processes directly affecting the parameterisation of models used in impact assessment. The gap is most important in situations where the presence of non-radioactive pollutants modifies the biogeochemical behaviour (speciation) of radionuclides, the way they enter the biota and the resulting effects. A key question is how the presence of heavy metals and other pollutants make populations of biota more susceptible to the impact of (otherwise) low levels of radiation, and what are the regulatory implications.

At the technical level, this topic will combine elements of biogeochemistry, dosimetry, transfer and foodweb modelling, impact assessment and regulation. At the higher level, radiological protection is a multi-disciplinary scientific and technical activity involving (a) radioecology, (b) protection of workers, the public and the biota and (c) the development of regulation. The project focusses on radioecology (with focus on the sustainability of ecosystems and biodiversity), the system of protection of non-human biota (with field and modelling of effects on biota populations) and the search for a consistency of approaches between the regulation of radioactive and chemical substances (by, for example, finding empirical and modelling relationships between radionuclides and heavy metals and using radionuclides as tracers for marine processes). It is in fact necessary to consider the tree aspects in order to answer the knowledge gap.

D. Optimising medical use of radiation

D2.

Improving the quality of medical imaging and radiation therapy and optimize the dose received by patient especially but not limited to cancer-treatment. This includes means to i) set up of reliable computational methodologies such artificial intelligence (AI) methods for medical applications including e.g. radiation dose prediction, image quality enhancement and pharmacokinetic modelling, ii) strategies for testing and validation of data and methods used for AI/Machine Learning (ML) applications or modelling and iii) methods to allow generalizability of ML models to allow application independent of hospital equipment.

Social, ethical and legal dimensions of the use of AI and other computational models should when appropriate also be addressed, such as, how the use of AI will impact current practices; what the effect will be on the gaps observed between best practice and guidelines, on the one hand, and current practices, on the other; and what the concerns and expectations of patients and other stakeholders are in the context of these technological developments.

The proposed research should contribute to the harmonization and application of technology and, in the context of informed consent, communication throughout Europe. Patient organizations must be involved.

D3.

Implementing EU-wide epidemiological studies of patients to enhance quality and safety of medical radiation applications and developing a knowledge base and analytical tools to better predict and reduce risk of secondary cancer and non-cancer disease in patients subjected to diagnostic methods using ionizing radiation and in cancer patients treated with radiotherapy.

Well-designed clinical epidemiological studies should conduct long term follow up, and focus on most at risk populations. The results of the clinical epidemiological studies should be used to optimise treatment and imaging protocols and patient follow-up. The studies should consider patient-specific dose modifiers in derivation of dose estimates as appropriate to different settings and can increase capabilities for radiation dose tracking and managing programmes to provide relevant and standardized dose estimates. Only already existing cohorts should be considered, building up new cohorts does not fit in the timeframe and budget of the call.

Epidemiological studies should include an evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization.

The topic should explore collaborative ways to improve the engagement with and communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and consent and improve radiation protection behaviours.

<u>E. Improving radiation protection of workers and public</u>

E1.

Developing a knowledge base and analytical tools to improve radiation protection of workers, and members of the public and thus to contribute to the translation of the BSS into practice by focusing on one or more of the following objectives:

- Improvement of biokinetic models and personalised dosimetry that will lead to the improvement of the assessment of internal exposure;

- Development of real time practical individual dosimetry of workers by harnessing the developments in new connected technologies, with due account to individual behaviour and social group culture;

- Development of a practical neutron personal dosimeter.

E2 – New topic suggestion:

- Development of platforms and mechanisms to educate the public about radiation and exposure risks to reduce unnecessary concerns, stress related ill health outcomes, poor decision making and pressure on responders in the event of an incident or emergency.

Need for research on how best to manage citizen scientists performing dosimetry in emergencies: the available techniques and mobile phone apps have serious flaws, limitations and inaccuracies, yet will inevitably be used and have their results published and distributed rapidly on social media. The community needs to be proactive in establishing ways to anticipate and mitigate this, and develop the means to improve citizen dosimetry. The existence of improved citizen dosimetry may also enhance efforts to establish effective personal dosimetry during radiological emergencies that avoids some of the problems currently associated with retrospective dosimetry.

E3 – New topic suggestion:

- Development of direct and indirect methods to rapidly assess internal radiation exposures for large numbers of people in the event of an incident or emergency.

- The revision of operational dose quantities proposed in ICRU Report 95 will present challenges for dosimetry for external radiation sources. Research is needed for personal, area and environmental dosimetry, and for calibration methods, to scope and cost the changes that will be needed to ensure that operational radiation protection can move seamlessly from old set of quantities to the new.

E4 – New topic suggestion:

Assessment of suitability and limitations of current biokinetic models and development of approaches and procedures for determination of organ dose rates in case of accidental internal exposure.

Description: Biokinetic models for internal dosimetry have been developed for an occupational exposure. Their application for the assessment of high radionuclide intakes in accidents through bioassays may be limited. Harmonized principles and recommendations may be useful also for dose assessment in accidental radionuclide intakes.

Suggested topic extends the existing topic E1 and it fits Pianoforte specific objective 4: To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites.

F. Developing an integrated approach to environmental exposure and risk assessment from ionising radiation

Note: We received the following general comment to Topic F from SAB during preparing topics for Call 1: "The 3 F subtopics are poorly written and explained, and they need to be better defined to know the expectation of the research in these subtopics (The topic and underlying challenges are better explained in Appendix C). Not a lot of thinking has been given to F subtopics. Difficult to see the innovation and originality. Lack of clarity on what it is expected from scientists/research."

Since this is the competence of the respective platform, it might consider to take into account or not this comment.

F1.

Robust modelling of radiological contamination in the human food chain, for an integrated dose and risk assessment of post-emergency situations, with focus on developing reliable and practicable approaches. The topic should take into account future changes in the European agricultural practices and fisheries management (including fish farming), sustainable development considerations and the need to further develop marine and freshwater dispersion and biota transfer models due to the fact that NPPs are often built on the coast and the future tendency of and the tendency of building of SME or nuclear-powered floating vessels.

F2.

Identifying and quantifying the key processes that influence radionuclide behaviour in existing environmental contamination situations with a special focus on:

- the management and clean-up of existing sites, as well as to the licensing (including social licensing) of future discharges and large quantities of NORM residues.

- the management and the licensing (including social licensing) of discharges of liquid NORM residues into marine as well as fresh water ecosystems

- developing the modelling basis for accurate dose assessment and establishment of holistic and sustainable remediation approaches.

F3.

Integrating risk assessment and management and especially focusing on risk integration for radiation and other stressors. Specific emphasis is required on integrated and holistic risk assessments. There is a need for the improvement and/or development of innovative methods to characterise the source terms to delineate the multiple-hazard footprint (e.g., geostatistical interpretation of environmental, radiological, chemical data) of a site in space and time. Innovative modelling approaches are also needed to support decision making and to identify the most significant sources of uncertainty related to the impact on human and environmental health including social considerations.

G. Optimising emergency and recovery preparedness and response

G1.

Improvement of radiological impact assessments, decision support and response and recovery strategies by focusing on one or more of the following aspects:

- the use of AI and big data technologies in radiological impact assessments, in the development / optimisation of measurement strategies, for the calculation (along with other novel methodologies) of uncertainties in model results and for optimization and operationalization of emergency preparedness and response practices; integration of AI and big data technologies in Decision Support Systems for better guidance of the end user in countermeasure strategy definition;

- compilation of the databases that are required by AI technologies, with historic and scenario information - including besides nuclear/radiological accidents, scenarios of new threats, such as war situations;

- improved communication/dialogue with stakeholders due to better information availability, considering data protection regulations (GDPR).

G2 – New topic suggestion:

Identity and gain scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response related to emerging deployment of Small Modular Reactors

Given the diversity in SMR technologies and their various levels of technology readiness, EIA and EPR are areas where more robust science-based demonstration of protection of workers, the public and the environment is needed for the three types of exposure situations (planned, emergency, existing) and the strategy and scale of deployment of such new technologies. The limited existing knowledge and know-how do not allow to implement a holistic impact assessment including the consequences (benefits and disadvantages) of the technologies deployment. For example, the research proposals should provide approaches, data and adapted or new models to support the EIA and EPR issues for the wide spectrum and sizes of SMRs, their potential uses, and the related risks (depending e.g. on source terms, design, co-location with industrial sites and multiple hazards, surrounding environment such as remote mining site).

Two other important issues are to understand/anticipate how public perception about such new technology would evolve and to justify improved strategies for public information, communications and dialogue/debate.

The suggested topic relates to PIANOFORTE specific objectives 3 and 4. It contribute to major research priorities/orientations formulated by HORIZON EUROPE: Adaptation to climate change (overall to provide the necessary information/approach to support science-based demonstration of whether and how far new technologies such as SMRs may contribute to achieve SDGs). Ideally should be developed with (i) SMR nuclear safety specialists; (ii) experts in social sciences and risk communication.

G3 – New topic suggestion:

Ensure readiness to carry out environmental exposure and risk assessments for novel nuclear technologies – The potential deployment of Small Modular Reactors (SMR) and Advanced Modular Reactors (AMR) alongside ongoing development of nuclear fusion facilities will leave capability gaps in current environmental assessment data, methodologies and tools for both planned and emergency exposure situations. This can include different reactor designs leading to contributions from radionuclides that are less well studied; potentially different siting of such facilities eg on rivers/lakes or closer to population centres; and the potential for several facilities in closer proximity to each other than for existing NPPs. The integration of exposure assessments for both human and biota for such technologies should continue to be developed in the context of such novel technologies.

H. Radiation protection in/with society

Note: We received the following comment from SAB at the time of preparation of Call 1: The subtopic is difficult to understand without going back to Appendix C (detailed description of topics). It should be improved using the information included in Appendix C.

H1.

Effective translation mechanisms between social and technical dimensions of radiation protection.

The objective of the topic is to investigate how different radiation protection actors perceive the added value of inter- and transdisciplinary collaborations in the field of radiation protection; what their expectations and needs are; what challenges and enablers of collaborations can be found in the different radiation protection fields; and what are the main barriers for the institutional uptake of results from inter- and transdisciplinary collaborations. Projects addressing this topic should contribute to developing systematic approaches to inclusion of societal dimensions within the radiological protection system and methodological innovation enabling inter- and transdisciplinarity in radiation protection research.

4.7. Annex 6: Prioritisation criteria - compiled new suggestions and modifications by POM and SAB

Criterion	Comment 1	Comment 2	Comment 3	Comment 4	Comment 5
Feasibility: (i.e. the subtopic or certain objectives of the subtopic can achieve significant progress within the available timeframe and budget) assuming that projects within Call 1 last max. 3 years and have an estimated total budget of 3000-3500 k€ for large calls and 1000 k€ for small calls: "2" feasible – feasible in BOTH timeframe and budget. "1" moderately feasible - feasible to address only partially the subtopic or certain objectives of the subtopic within the available timeframe and budget.	**Take out**			**Take out** (better for projects than topics)	**OK**
Relevance for other EU initiatives outside EURATOM: "2" relevant - endorsed and mentioned as a priority research topic by other EU initiatives outside EURATOM (eg. HORIZON EUROPE, EU4HEALTH, etc) "1" not relevant – not mentioned as a priority research topic by other EU initiatives outside EURATOM (eg. HORIZON EUROPE, EU4HEALTH, etc)				**Take out**	**OK**
Relevance for PIANOFORTE specific objectives: (to what extent it adheres to PIANOFORTE priorities and objectives) "2" strong relevance - Strongly endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to min. 2 specific objectives of PIANOFORTE) "1" moderate relevance – endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to 1 specific objective of PIANOFORTE)	**Ok**			**Consider rescoring** on 1-3 scale	**OK**
Societal impact: -"3" high societal impact: projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, occupational) / environments leading to significant risk reduction or providing significant support for improved radiation protection policies or practice -"2" moderate societal impact: projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, occupational) / environments leading to some risk reduction or providing support for improved radiation protection policies or practices -"1" low societal impact: projects which cannot be directly linked/translated into radiation protection policies	**Take out**	**Reformulate:** add „patients" -3 [..] (public, medical, patients, occupational) / environments [..] - 2 [..] (public, medical, patients, occupational) / environments - - 1: as before		**Reformulate as below** or **split in subcriteria** for: numbers affected, individual risk avoided, impact on policy, urgency (e.g. is it urgent now, or potentially in the future?). - "3" [..] ; or **urgent societal issue** - "2" [..] ; or potential exposure - "1" - as before	**OK**

Criterion	Comment 1	Comment 2	Comment 3	Comment 4	Comment 5
Scientific impact: -"3" high scientific impact: projects most likely providing new research results (data, methods, software, recommendations, guidelines, etc.) of high scientific excellence likely to lead to scientific publications in highly ranked (Q1 and Q2) journals relevant for the large scientific community not only radiation protection research -"2" moderate scientific impact: projects most likely providing new research results (data, methods, software, recommendations, guidelines, etc.) of scientific excellence publishable in radiation - related journals of high impact and relevant for the large radiation protection community -"1" low scientific impact: projects most likely providing highly specialized research results (data, methods, software, recommendations, guidelines, etc.) in the field of radiation protection relevant only for restricted groups within the radiation protection community and which are publishable in specialized journals focusing on radiation protection research	Take out			**Reformulate:** - "3" high scientific impact: topics likely to: i) provide new theories or concepts; or ii) novel applications of theories and concepts relevant for the large scientific community not only radiation protection research - "2" moderate scientific impact: topics likely to: i) provide new theories or concepts; or ii) novel applications of theories and concepts relevant for the large radiation protection community - "1" low scientific impact: topics likely to: i) provide new theories or concepts; or ii) novel applications of theories and concepts projects most likely providing highly specialized research results (data, methods, software,	**OK**
Redundancy: (to what extent the topic has recently been and/or is currently being addressed by other projects) (recently closed projects = projects closed within the last 3 years) -"3" non-redundant - no redundancies with ongoing or recently closed EURATOM and/or other EC-funded projects (projects closed within the last 3 years) -"2" partially redundant - partially addressed by ongoing or recently closed EURATOM-funded or other EC projects but a large part of the topic still not researched -"1" redundant - it has substantial redundancies with recently closed and/or ongoing EURATOM or EC projects	**Reword:** change „redundant" with „overlapping'; **Change in scores:** 2 for non-overlapping, 1 for partially overlapping, -1 for overlapping				**OK**
NEW - Interdisciplinarity: Topic of interest to more than 1 RP Platform - "3" topic of interest to 3 or more RP Platforms - "2" topic of interest to 2 RP Platforms - "1" topic of interest to 1 RP Platform	**Proposer**				

NEW Prioritisation according to scientific risk- This is about evaluating the probability that the proposed research will yield significant new results. High risk/high return investigations would be ranked higher than lower risk measurements of existing (albeit important) systems. Scientific risk is important as an evaluation criterion because it is a measure of the potential for a scientific breakthrough. Projects that "play it safe", involving continuation/extension of past projects, are less likely to lead to important scientific benefit. 1 – Using existing approaches to evaluate aspects of a previously investigated system. 2 – Using novel/innovative approaches to evaluate aspects of a previously investigated system. 3 – Using novel approaches to evaluate a new, not previously investigated system. Note that increased risk does not equate to lower feasibility. The criteria 'high scientific risk – high gain' means that scientific risk is welcome, but quite separately, there is a need to convince evaluators that the proposer has the knowledge and skills to get the job				Proposer	

4.8. Annex 7: Prioritisation criteria - compiled new suggestions and modification by POMS, SAB and Platforms

Criterion	EURAMED	SHARE	NERIS
Feasibility: (i.e. the subtopic or certain objectives of the subtopic can achieve significant progress within the available timeframe and budget) assuming that projects within Call 1 last max. 3 years and have an estimated total budget of 3000-3500 k€ for large calls and 1000 k€ for small calls: “2” feasible – feasible in BOTH timeframe and budget. “1” moderately feasible - feasible to address only partially the subtopic or certain objectives of the subtopic within the available timeframe and budget.	**Take out** (better for projects than topics)	**Take out**	**Take out**
Relevance for other EU initiatives outside EURATOM: “2” relevant - endorsed and mentioned as a priority research topic by other EU initiatives outside EURATOM (eg. HORIZON EUROPE, EU4HEALTH, etc) “1” not relevant – not mentioned as a priority research topic by other EU initiatives outside EURATOM (eg. HORIZON EUROPE, EU4HEALTH, etc)		This criterion should get less weight, or projects that show this relevance, might receive an extra point	
Relevance for PIANOFORTE specific objectives: (to what extent it adheres to PIANOFORTE priorities and objectives) “2” strong relevance - Strongly endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to min. 2 specific objectives of PIANOFORTE) “1” moderate relevance – endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to 1 specific objective of PIANOFORTE)	Increase the importance of this criterion as that is what Pianoforte offered in the proposal	This is the most important criterion. We propose to keep it, but to change the scale to (1-3).	

Societal impact: -"3" high societal impact: projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, occupational) / environments leading to significant risk reduction or providing significant support for improved radiation protection policies or practice -"2" moderate societal impact: projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, occupational) / environments leading to some risk reduction or providing support for improved radiation protection policies or practices -"1" low societal impact: projects which cannot be directly linked/translated into radiation protection policies		**OK**	It should be reformulated to include 'urgent societal issue' or interest for level "3"
Scientific impact: -"3" high scientific impact: projects most likely providing new research results (data, methods, software, recommendations, guidelines, etc.) of high scientific excellence likely to lead to scientific publications in highly ranked (Q1 and Q2) journals relevant for the large scientific community not only radiation protection research -"2" moderate scientific impact: projects most likely providing new research results (data, methods, software, recommendations, guidelines, etc.) of scientific excellence publishable in radiation - related journals of high impact and relevant for the large radiation protection community -"1" low scientific impact: projects most likely providing highly specialized research results (data, methods, software, recommendations, guidelines, etc.) in the field of radiation protection relevant only for restricted groups within the radiation protection community and which are publishable in specialized journals focusing on radiation protection research		The criterion stays, but the explanation of the criterion needs to be revised, e.g. all research should be publishable in highly ranked journals	Agrees with comment 4

Redundancy: (to what extent the topic has recently been and/or is currently being addressed by other projects) (recently closed projects = projects closed within the last 3 years) -“3” non-redundant - no redundancies with ongoing or recently closed EURATOM and/or other EC-funded projects (projects closed within the last 3 years) -“2” partially redundant - partially addressed by ongoing or recently closed EURATOM-funded or other EC projects but a large part of the topic still not researched -“1” redundant - it has substantial redundancies with recently closed and/or ongoing EURATOM or EC projects	**Remove** this criterion as this cannot be judged by the call text or the call text needs to be too specific in some cases, this has to be judged in proposal evaluation	**OK**	
NEW - Interdisciplinarity: Topic of interest to more than 1 RP Platform - “3” topic of interest to 3 or more RP Platforms - “2” topic of interest to 2 RP Platforms - “1” topic of interest to 1 RP Platform			Agree with the inclusion of ‘interdisciplinarity’ as a criteria but there is a need to add some further detail to explain the criterion to the same level of detail as other criteria. For example does ‘topic of interest to more than one platform’ mean that the platforms will need to be actively involved in the research or nominate their interest in a topic when prioritising call topics?

NEW Prioritisation according to scientific risk- This is about evaluating the probability that the proposed research will yield significant new results. High risk/high return investigations would be ranked higher than lower risk measurements of existing (albeit important) systems. Scientific risk is important as an evaluation criterion because it is a measure of the potential for a scientific breakthrough. Projects that "play it safe", involving continuation/extension of past projects, are less likely to lead to important scientific benefit. 1 – Using existing approaches to evaluate aspects of a previously investigated system. 2 – Using novel/innovative approaches to evaluate aspects of a previously investigated system. 3 – Using novel approaches to evaluate a new, not previously investigated system. Note that increased risk does not equate to lower feasibility. The criteria 'high scientific risk – high gain' means that scientific risk is welcome, but quite separately, there is a need to convince evaluators that the proposer has the knowledge and skills to get the job done effectively.			**Does not agree** (This criteria is unlikely to be highly scored for areas such as EPR where applied research is more relevant. In such areas, existing knowledge is being advanced to apply to novel aspects of EPR so the criterion is currently formulated would not appear appropriate. It is suggested that the existing criteria of 'scientific impact' with the new proposed wording is more appropriate as it is the outcome of the research that is important.)

Innovation potential refers to the ability of a research topic to contribute to the creation of novel and impactful solutions, advancements, or insights. Innovation potential drives the advancement of knowledge and understanding. Research topics with high innovation potential have the capacity to introduce new ideas, concepts, and methodologies that expand the boundaries of knowledge, also between different disciplines, and lead to breakthroughs. Scoring: - 3: research contributing to new theories, methodologies, or approaches, or those that challenge existing paradigms and generate new insights ; - 2: research topics that make significant incremental advances building on existing knowledge or extending previous work in a meaningful way; - 1: research topics that make some incremental advances building on existing knowledge or extending previous work.		Proposer	
Scores and criteria	All criteria should have the same soring first and then a weighting factor. Doubling of criteria has to be avoided		

Comments on general procedure	A discussion about the criteria within MEENAS together with WP2 and WP3 to allow a common understanding in advance of scoring, this should also include rules for scoring. - No changes of scores after scoring by platforms – there could be requests but not changes			

4.9. Annex 8: Cumulative list of topics and subtopics for PIANOFORTE second open call (step 4)

This list represents the cumulative list of topics including those from the CONCERT JRM which were not included in PIANOFORTE Call 1, new topic suggestions by POMs and SAB, new topic suggestions and revisions by platforms.

Overview of topics and subtopics

General note: *Under Horizon Europe, "the effective integration of social [sciences and humanities] SSH in all clusters, including all Missions and European partnerships, is a principle throughout the programme" (European Commission, 2022[10]). SSH are considered to be "a key constituent of research and innovation" (idem). In accordance with these principles and the PIANOFORTE commitments and objectives, all* ***projects funded by PIANOFORTE are expected to take into account the social, economic, behavioural, institutional, historical and/or cultural dimensions, as appropriate for the topic addressed****.* ***Contributions from one or more SSH disciplines may be required to ensure the social robustness and social impact of the research and innovation chain****.[11]*

A. Understanding and quantifying the health effects of radiation exposure

A1.

Define the risk of ionising radiation-induced non-cancer diseases after low and intermediate doses as defined by UNSCEAR[12] by understanding disease pathogenesis through assessing near-field, out-of-field and non-targeted effects after therapeutic doses and dose-rates and following diagnostic procedures and interventional radiology. The focus should be on developing a knowledge base on the mechanisms of one or more of the following diseases or health conditions: cardiovascular, cerebrovascular, neurocognitive diseases, neurodevelopmental, metabolic and immune disorders. Proposals should apply biologically relevant models and/or molecular epidemiological approaches based on available human cohorts. Related social, psychological and communication studies should be included where appropriate. Studies related to ionising radiation-induced cataracts and establishment of new human cohorts are not within the focus of the current call.

Proposals should address one or several objectives of the topic.

A2.

Define how the temporal and spatial variations in dose delivery affect the risk of health effects following radiation exposure through the integration of experimental and epidemiological data and including optimised detection and dosimetry by focusing on one of the following subtopics:

[10] European Commission, 2022. Horizon Europe (HORIZON). Programme guide. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

[11] For Guidelines on integration of SSH see PIANOFORTE deliverable 2.6.

[12] Sources, Effects and risks of ionizing radiation. UNSCEAR 2012 Report
Annex A. Attributing health effects to ionizing radiation exposure and inferring risks. Page 23, Table 1. Terminology for bands of radiation dose used in this report
https://www.unscear.org/unscear/en/publications/2012.html

- Understanding the link between exposure characteristics (radiation quality, dose and dose-rate, acute and chronic exposures) and the cancer and non-cancer effects and implications for improvement/optimisation of innovative radiotherapy (e.g. FLASH therapy, proton/ion therapy).

- Understanding the effects of intraorgan dose distribution through observations in patients exposed to inhomogeneous dose distributions and experiments with organotypic tissue models

- Addressing the difference between risks from internal and external exposures through the integration of new knowledge on the effects of chronic exposures, intra-organ dose distribution and radiation quality considering energy deposition at different scales (from intracellular to organs).

In epidemiological studies evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization should be included.

A3.

Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage

Scope of the subtopic:

Risks related to exposure to IR depend on the dose, dose rate, type of IR (ie radiation quality), volume of the body exposed and the type of exposed organs and tissues, each exhibiting different radiosensitivities. Dose-effect relationships may depend on the initial health state, history of previous exposure and lifestyle before and after exposure. Studies focusing on the role of specific target cells, such as stem cells / progenitor cells, the role of genetic and epigenetic factors, microenvironmental factors, sex and age at exposure, co-morbidities, environmental and lifestyle factors and the interactions between these depending on dose levels could contribute to a better understanding of the mechanisms responsible for individual response to radiation at the level of tissue reactions, stochastic effects such as cancer and radiation-induced aging and could help in advancing individualised cancer treatment.

Objectives of the subtopic:

The subtopic should investigate mechanisms of individual variations in radiation response as detailed above by focusing on one or several of the following objectives:

- Risks after radiotherapy
  - Internal partial body exposure via targeted radionuclide therapy (TRT) with different radiation qualities. In particular, exposure of the bone marrow, kidneys and liver should be considered, as organs with the highest risk of exposure for adverse effects in this type of medical application
  - External beam therapies and brachytherapies with different dose rates, fractionation schemes or dose-volume histograms, hypo-fractionated radiation therapy, novel particle therapies (proton, hadron, heavy ion therapies). Since these therapies are often combined with chemotherapy or immunotherapy, synergies between the different therapeutic combinations should be explored at the individual patient level from the point of view of the risk for therapy-related side effects (tissue or stochastic effects) and for maximizing treatment efficiency.

- Risks in children and young adults

  A further objective of the subtopic is to investigate the specific risk of children and young adults after multiple diagnostic exposures related to cardiac catheterization or repeated brain CT scans as well as therapeutic applications for lymphomas or orbito-ocular/central nervous system tumors for long-term cardiovascular damage, cognitive impairment or second primary malignancies.

- Biomarkers of individual risk

  Another objective is to seek biomarkers of individual risk through cellular/molecular, and/or systems biological approaches, radiomics investigations, evaluating potential predictive factors and correlating them with health outcomes. In case of studies related to previously identified biomarkers, validation and quality control should be included.

These objectives should be carried out among others by taking use of existing patient datasets and biobanks and by applying relevant preclinical 2D and 3D models, and relevant in vivo models. Where relevant, proposals should include communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and informed consent.

The proposal should focus on one or several of the above objectives.

<u>Impact of the subtopic:</u>

This proposal addresses three of the four PIANOFORTE specific objectives: „Improving patient radiation protection in relation to the use of ionizing radiation in the medical field" and "To improve scientific understanding of the variability in individual radiation response and health risk of exposure" "To support BSS regulations..."

The subtopic also relates to other non-EURATOM initiatives, in the frame of the mission area "Conquering Cancer – improving the lives of more than 3 million people by 2030 through prevention, cure and for those affected by cancer including their families to live longer and better".

This proposed new topic strengthens the link and synergy between radiation protection and medical treatment: towards an improved benefit—risk balance. This topic should be performed by a consortium including both radiation biology experts and medical partners to ensure impact and transferability of this research to the clinic in a swift way.

<u>B. Improving the concepts of dose quantities</u>

B1.

To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.

The dependence of biological effectiveness on radiation quality is commonly believed to be related to the differences in the energy deposition pattern on a microscopic and nanoscopic scale. Identification and quantification of the relevant statistical characteristics of the microscopic spatial pattern of interactions (e.g., spatially correlated occurrence of clusters of energy transfer points) are an essential prerequisite for improvement of present dose concepts and understanding the radiation damage mechanism.

The topic should focus on one or more of the following subtopics:

- Investigating the physical characteristics of energy deposition on microscopic scale with the aim of developing a novel, unified concept of radiation quality as a general physical characteristic of the radiation field that would allow separating the physical and biological components contributing to the eventual biological effects of radiation.

- Developing microdosimetric and nanodosimetric detectors, revising their measurement concepts, and developing a 'gold standard' for track structure simulation codes along with their validation. Establishment of robust uncertainty budgets for micro- and nanodosimetric quantities obtained by measurement or simulation and identification of the major uncertainty sources.

- A comprehensive multi-scale characterization of the physical aspects of radiation energy deposition with quantitative investigation and correlation of track structure with biological effects at molecular and cellular level and their consequences at supra-cellular levels. Radiobiological experiments should be performed with relevant micro- and nanodosimetric metrological methods, thereby facilitating the identification of useful connections for further advancements in radiobiological modelling. The cancer development processes should also be considered in the modelling to obtain an estimation of low dose risk.

B2.

Research to assist the implementation of the new ICRU Report 95 operational dose quantities.

The radical changes to the operational quantities for measurement of external doses in the workplace, either via personal dosimeters or prospective measurements using radiation protection instrumentation, will require the improvement of current technologies or the development of novel detection methods. Parallel developments are required for members of the public, for whom personal dosimeters are not practical and dose levels need to be much lower. In advance of the improved detection methods, a review is required into how and whether calibration laboratories can adapt existing calibration fields to meet the requirements of the new quantities, and develop new calibration fields, to ensure that the new quantities can be used. Further, where the new operational quantities are not suitable for traditional calibration methods, fully quality assured Monte Carlo methods should be developed to ensure calibration is possible.

The expectation of ICRU and ICRP is that the changes will lead to better estimation of detriment to occupationally exposed individuals and for members of the public. Assessment of the changes in risk estimation is needed to evaluate the merits of the proposals. Estimates should be made for a range of exposure scenarios, considering the changes in the quantities and the likely accuracy of the dose estimates using those quantities. Public perception of the changes needs to be assessed because estimates using these quantities are generally the basis for communicating on exposures that they might have received.

The long period of stability in the quantities used to estimate occupational doses has led to stability in epidemiological estimates of detriment. The discontinuity in dose estimation will inevitably impact on epidemiological models, the impact of which is yet to be determined.

<u>It relates to PF objectives:</u>

To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates.

Major gaps within radiation protection research addressed by the topic:

Lack of instrumentation and personal dosimeters able to accurately measure the new operational dose quantities. Also, a lack of suitable calibration fields.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE:

Conquering Cancer.

Topic related to more than one discipline of radiation protection:

The proposal relates to operational radiation protection methods, metrology and epidemiology.

C. Understanding radiation-related effects on non-human biota and ecosystems

C1.

Resolving the controversy with regard to the effects on wildlife reported in the Chernobyl and Fukushima exclusion zones.

The reported radiation related effects on wildlife reported in the Chernobyl and Fukushima exclusion zones has varied. Many studies have reported no significant effects of radiation on wildlife in these areas, whereas other studies have reported significant radiation effects on different wildlife populations at very low dose rates (even below natural background exposure). The establishment of reliable, consensus-based conclusions for the long-term ecological effects attributable to radiation in those emblematic contaminated territories would have a very significant impact on the robustness and credibility of radiological environmental risk assessment methodologies (e.g., validity of 'no-effect' benchmark dose-rates). Priorities are to characterize the influence of exposures on the populations currently living in contaminated environments, through (1) robust exposure assessments (considering past exposures and including internal exposure, heterogeneity, differing radiation qualities) and considering other stress factors; (2) the identification of the key factors determining the vast reported variation in wildlife populations' sensitivity to radiation; (3) the identification and validation of biomarkers of exposure and effects that are relevant for effects at the population's level.

C2.

Determine the effects of ionizing radiation on ecosystem functioning and biodiversity, as well as their potential consequences to human wellbeing (e.g. culture, food consumption, work and recreational activities).

The demonstration of the increased sensitivity of ecosystem processes to ionizing radiation, in comparison with the reported effects at the population level, would strongly question the robustness of risk assessments that rely only on population-effect data. On the other hand, if it is shown that the functional or structural redundancy (biodiversity) of the ecosystems brings greater robustness against the effects of radiation and potential other threats or anthropogenic degradations (multi-contamination, climatic change…), the conservatism of the current assessments would be supported. Although the subject is very broad, some targeted studies are achievable within a reasonable timeframe: experimental research on the effects of ionizing radiation on functional processes is expected in controlled conditions (e.g. microcosms and mesocosm studies), as well as the reinterpretation (e.g. by ecological modelling) of the reported data on the current state of ecosystems and their temporal evolution in contaminated territories.

Moreover, the consequences of the impact on ecosystem functioning may have many dimensions, not only biophysical, but also economic and socio-cultural. Those societal issues are also to be addressed, with the aim to provide a coherent framework encompassing both the radiation protection of human and ecosystems.

C3.

Radiation protection of marine wildlife in a multi-contaminant context

This topic encompasses both field and modelling investigations, aims to investigate processes governing the transfer of radionuclides in the marine environment, their effects on populations of non-human biota and to define the most appropriate post-accidental management actions. Special attention is given to potential accidental releases from coastal nuclear power plants or through rivers, and to situations where interactions of radionuclides with other contaminants may occur, such as marine NORM, discharges from oil and gas industries to the sea, and contaminated fjords and estuaries. Attention is also directed to using ecological/population modelling. The work should lead to dosimetry impact evaluation and producing advice from a regulatory perspective, such as assessing how robust are the benchmarks for risk assessment of non-human biota in a marine multi-contaminant context. It should also lead to the proposition of adapted management actions in order to reduce the risk for the ecosystem and human, and to promote the coastal resilience of contaminated areas.

This topic is a direct answer to Topic C (Understanding radiation-related effects on non-human biota and ecosystems), and specifically C2 (determine the effects of ionizing radiation on ecosystem functioning and biodiversity), because it aims at the demonstration of the increased sensitivity of ecosystem processes to ionizing radiation (in the presence of other contaminants), and the comparison with the reported effects at the population level (for biota), addressing the issue of the robustness of risk assessments.

It contributes to the priority on restoring our oceans and waters, a major research orientation of horizon Europe, by providing necessary knowledge to assess and therefore aid in restoring/regenerating marine ecosystems, tackling multi-contaminant pollution (Restore our Ocean and Waters (europa.eu)). It also contributes to the priorities concerning coastal resilience that will be presented at EurOCEAN in October 2023 by the European Marine Board (Coastal Resilience | European Marine Board).

Addressed research gaps: The marine radioecology topic has been significantly underfunded at the European level, yet there are knowledge gaps in the understanding of marine processes directly affecting the parametrization of models used in impact assessment. One important gap concerns the situations where the presence of non-radioactive pollutants modifies the biogeochemical behavior (speciation) of radionuclides, the way they enter the biota and the resulting effects. A key question in this context is how the presence of trace metals and other pollutants make populations of biota more susceptible to the impact of (otherwise) low levels of radiation, and what are the regulatory implications. Another major gap is our capacity to simulate and predict the transport and deposition of suspended sediment particles bearing radionuclides (in case of release). The Fukushima accident highlighted the role played by the sediment as a secondary source of contamination over the long term, especially affecting benthic species. Sediment deposition and resuspension processes must now be precisely modelled, particularly in highly anthropized coastal areas (aquaculture, tourism, …) to better anticipate the long term economic impacts caused by contamination.

At the technical level, this topic will combine elements of biogeochemistry, dosimetry, transfer and foodweb modelling, impact assessment and regulation.

D. Optimising medical use of radiation

D1.

Improving the quality of medical imaging and radiation therapy especially but not limited to cancer-treatment.

This includes means to i) set up of reliable computational methodologies such artificial intelligence (AI) methods for medical applications including radiation dose prediction and image quality enhancement and e.g. pharmacokinetic modelling beyond the state of the art , ii))strategies for testing and validation of data and methods used for AI/Machine Learning (ML) applications or modelling, c) methods to allow generalizability of ML models to allow application independent of hospital equipment and d) development and implementation of key performance indicators.

Social, ethical and legal dimensions of the use of AI and other computational models should also be addressed, in particular, how the use of AI will impact current practices; what the effect will be on the gaps observed between best practice and guidelines, on the one hand, and current practices, on the other; and what the concerns and expectations of patients and other stakeholders are in the context of these technological developments.

The proposed research should contribute to the harmonization and application of technology and, in the context of informed consent, communication throughout Europe. Patient organizations must be involved.

The developments cannot include those that are developed or implemented within SINFONIA like risk assessment related tools in the context of lymphoma or brain tumour patients. In the same way, developments for image quality assessment in oncological imaging is only suitable if they go beyond the state of the art introduced within the MEDIRAD and the i-Violin projects. Methods developed in the last two mentioned projects are mainly based on methods not using AI or ML based methodology and could be further developed using such methodologies.

How does it relate to PIANOFORTE scientific specific objectives?

1. To improve the prevention, detection and safe treatment of cancer
2. To consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances

Link of D2 to PIANOFORTE specific objectives:

1. To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches improving patient health and safety and supporting transfer of the R&I outcome to practice.

Link of D2 to PIANOFORTE expected outcomes:

5. Implementation and use of big data and artificial intelligence techniques in certain fields of radiation protection (such as medical applications, emergency preparedness); awareness of these techniques among the whole community

13. In the field of medical applications: (a) new knowledge providing elements to decision-making and risk-benefit analysis; (b) transfer of new optimised medical procedures into clinical practices; (c) elements to pave the way to personalised medicine

14. Improvement of the radiation protection of patients and of the general public in normal and accidental situations

Major gaps within radiation protection research addressed by the topic: optimised radiation protection and increased efficiency of diagnostic/therapeutic procedures could lower possible adverse health effects contributing to the improvement of existing / development of new methods for diagnosis and treatment

It contributes to major research priorities/orientations formulated by HORIZON EUROPE:

Scientific research questions included are also addressed in the on-going Horizon research area "Mission on cancer". It is directly linked to both Europe's Beating Cancer Plan (Action 17) of HORIZON Europe and the Strategic Agenda for Medical Ionising Radiation Applications (SAMIRA initiative).

Various elements of Topic D have been addressed by several of the recently closed or currently running EURATOM projects, such as MEDIRAD (ended 2022), SINFONIA (ending 2024), HARMONIC (ending 2024), SECURO (started 2022), therefore potential overlaps had to be considered and redundancy avoided. The recommendations of closed projects have to be taken into consideration (eg. MEDIRAD). The EURATOM project EURAMED rocc-n-roll will also recommend research needs that have to be considered. EURAMED would request to take the strategic research agenda and roadmap developed by EURAMED rocc-n-roll into account.

Importantly, scientific research questions targeted by topic D are addressed not exclusively by EURATOM funded research projects at European level. Other EC research initiatives (the Health programme within Horizon Europe, EU4Health, Samira initiative) or research options funded by European professional organisations (such as European Society of Radiology or European Association for Nuclear Medicine) have launched calls on this topic and further open calls are released.

Currently there are several on-going projects in the area of topic D funded by EC initiatives outside EURATOM (eg. QuADRANT project, i-VIOLIN, Prismap, INTERACT-Europe, SIMPLERAD, CHAIMELON, EUCANIMAGE). It had been evaluated that projects meeting the proposal text for D2 are not repeating work of running projects.

In summary:

- Topic D contributes to the realisation of at least 3 specific objectives of PIANOFORTE and several expected outcomes.
- It is of high relevance, since medical use of ionising radiation is the largest source of exposure and it addresses the concerns of patients exposed to IR.

Topic related to more than one discipline of radiation protection:

The Improving the quality of medical imaging and radiation therapy depends often on dosimetric approaches (EURADOS interests) beside other aspects. Risk assessment (Melodi topics' related) is also important and is a basis for the quality improvement. The validation of the quality is important as part of the patients' acceptance as well as the regulators approaches. In that sense, there are also aspects of SHARE related research.

In summary: The topic is also related:

Topic A (Understanding and quantifying the health effects of radiation exposure)

- Topic B (Improving the concepts of dose quantities)

- Topic E (Improving radiation protection of workers and population)

- Topic H (Radiation protection in/with society)

Other remarks:

To our understanding the priority should be very high, because this topic deals among others with the urgent problem of quality assurance for processing algorithms using machine learning. This is the only way how AI can best be used for reducing radiation to healthy tissue of patients.

Regarding redundancy: The relevance of the topic was recognised by EURATOM and there could have been the danger that various EC initiates and projects could overlap with this important subtopic (MEDIRAD, EUCANIMAGE, i-VIOLIN, SINFONIA, SIMPLERAD, CHAMELEON). The only project of these dealing with AI based methods is SINFONIA, the risk appraisal there is connected to A2 rather than D2. To avoid overlaps the text had been specified and the new project could potentially build on the already existing capacities. Another aspect is that the topic involves substantial technical development as well, in which companies producing medical equipment for diagnosis and therapy using various ionizing radiation techniques can also be included, therefore funding modalities of public-private partnership should also be promoted.

D2.

Implementing EU-wide epidemiological studies of patients to enhance quality and safety of medical radiation applications and developing a knowledge base and analytical tools to better predict and reduce risk of secondary cancer and non-cancer disease in patients subjected to diagnostic methods using ionizing radiation and in cancer patients treated with radiotherapy.

Well-designed clinical epidemiological studies should conduct long term follow up, and focus on most at risk populations. The results of the clinical epidemiological studies should be used to optimise treatment and imaging protocols and patient follow-up. The studies should consider patient-specific dose modifiers in derivation of dose estimates as appropriate to different settings and can increase capabilities for radiation dose tracking and managing programmes to provide relevant and standardized dose estimates. Only already existing cohorts should be considered, building up new cohorts does not fit in the timeframe and budget of the call.

Epidemiological studies should include an evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization. Further, epidemiological studies might contribute to better risk assessment for exposures below 100 mSv.

The topic should explore collaborative ways to improve the engagement with and communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and consent and improve radiation protection behaviours.

D3.

Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.

Adaptive radiation therapy has been developed over the last years. New therapeutic approaches are currently under development like different targeted radionuclide therapies, FLASH therapies or Microbeam therapies are being further developed and these and hadron therapies are being evaluated regarding their clinical potential for certain applications. The implementation is still difficult and not applied uniformly across Europe. Therapies have to be optimised and then evaluated regarding their potential protection for healthy tissues especially for high risk groups like paediatric patients.

All of these therapeutic procedures allow for certain diseases potentially treatments that would be suitable to reduce the radiation exposure of healthy tissues while maintaining the cancer / disease control thus potentially avoiding secondary malignancies. However, for FLASH and microbeam therapy the mechanisms are not completely understood, for hadron therapies clinical studies are missing proving the benefits in terms of radiation protection of patients and long term outcome for a variety of clinical entities. A similar statement is true for targeted radionuclide therapies. For adaptive radiation therapy it has to be investigated how it can be best implemented and what are the clinical prerequisites and the requirements for staff to achieve best possible results in terms of radiation protection of patients. Especially, in the cases of adaptive radiation therapies, targeted radionuclide therapies and hadron therapies, standard application and standard protocols as well as operating procedures need to be defined.

As stated in the CONCERT JRM medical use of ionising radiation is recognised as the largest source of exposure of the population in Europe and therefore of concern for society. It is of great importance to optimise radiological protection in medical applications of ionising radiation and to harmonise the practices throughout Europe with respect to the protection of human health from the harmful effects of ionising radiation and the potential benefit of the use of ionising radiation for individual patients. Topic D includes both basic and translational research and transfer into the clinical practice.

How does it relate to PIANOFORTE scientific specific objectives?

1. To improve the prevention, detection and safe treatment of cancer
2. To consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances

Link of new proposal to PIANOFORTE specific objectives:

1. To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches improving patient health and safety and supporting transfer of the R&I outcome to practice.

Link of new proposal to PIANOFORTE expected outcomes:

13. In the field of medical applications: (a) new knowledge providing elements to decision-making and risk-benefit analysis; (b) transfer of new optimised medical procedures into clinical practices; (c) elements to pave the way to personalised medicine

14. Improvement of the radiation protection of patients and of the general public in normal and accidental situations

Major gaps within radiation protection research addressed by the topic:

Impact: optimised radiation protection and increased efficiency of therapeutic procedures could lower possible adverse health effects contributing to the improvement of existing / development of new methods for treatment.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE:

The subtopic is part of the new SRA of EURAMED made within EURAMED rocc-n-roll

It refers to many of the identified gaps and research needs of EURAMED rocc-n-roll SRA and also to breakthroughs 2, 3 of the corresponding roadmap.

The topic partly addresses some of the MEDIRAD technical recommendations especially those for research and safe implementation.

Topic related to more than one discipline of radiation protection:

The topic is also related to:

- Topic A (Understanding and quantifying the health effects of radiation exposure)

- Topic H (Radiation protection in/with society)

Other remarks:

Regarding redundancy: The relevance of the topic was recognised by EURATOM. Also, optimised radiation therapy is a cornerstone of safe use of ionising radiation to combat cancer, there are only few currently running projects funded for this in the European context. SINFONIA is just trying to assess the risk associated with therapeutic applications rather than useful implementation of new or optimised radiation therapy procedures. Another aspect is that the topic might involve substantial technical development as well, in which companies producing medical equipment for diagnosis and therapy using various ionizing radiation techniques can also be included, therefore funding modalities of public-private partnership should also be promoted.

E. Improving radiation protection of workers and public

E1.

Developing analytical tools and knowledge base to improve practices in low dose exposures of radiation workers

Developing analytical tools and knowledge base to improve practices in low dose exposures of radiation workers, to support the improvement of their radiation protection, and to contribute to the translation of the BSS into practice.

Currently, in many specific workplaces (FLASH installations, laser driven accelerators, industrial pulsed high-power lasers, Small Modular Reactors) it is difficult to properly implement BSS for workers since adequate reliable methods and means of detection are not yet established. Further, in most countries, the legislative framework doesn't exist for these installations. To facilitate the development of adequate technical tools and best practice guides for BSS implementation, the proposed research should focus on one or more of the following objectives:

1) To obtain reliable response to enable better estimation of radiation exposure of radiation workers by:

   a. developing and benchmarking of dosimeters for ultra-short pulsed fields
   b. developing compact, light, easy to read and affordable neutron dosimeter for continuous or pulsed fields

2) To help to establish and foster a radiation protection culture in professional (scientific and industrial) environments that previously haven't had to face radiation generated risks, by developing adequate methodologies and guides.

It relates to PF objectives: To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates.

Major gaps within radiation protection research addressed by the topic: Novel exposure scenarios that require innovation in radiation protection to ensure acceptable protection for exposed individuals.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE: Conquering Cancer.

Topic related to more than one discipline of radiation protection:

The proposal relates to operational radiation protection methods, laser driven and pulsed fields, small modular reactors.

E2.

Development of platforms and mechanisms to educate the public about radiation and exposure risks to reduce unnecessary concerns, stress related ill health outcomes, poor decision making and pressure on responders in the event of an incident or emergency

There is a need for research on how best to manage citizen scientists performing dosimetry in emergencies: the available techniques and mobile phone apps have serious flaws, limitations and inaccuracies, yet will inevitably be used and have their results distributed rapidly on social media. The community needs to be proactive in establishing ways to anticipate and mitigate this and develop the means to improve citizen dosimetry. The existence of improved citizen dosimetry may also enhance efforts to establish effective personal dosimetry during radiological emergencies that avoids some of the problems currently associated with retrospective dosimetry.

The rapid increase in both social media communications and technological advancements in detectors, including mobile phones, available for citizen use, presents a potential way to register massive amounts of data to generate dose maps. These data hold significance not only in emergency situations but also could be used for background urban and rural dose maps. Currently, however, there exists a notable gap in understanding of how citizens will effectively employ these detectors during emergencies and how this potential huge amount of data will be processed for generating radiological maps, which will subsequently help decision-makers.

The research should be focused on one or more of the following objectives:

1) Characterization and quality control of dose detectors used by citizens.
2) Empowering the public through their active engagement in the measurement process.
3) Promoting exercise campaigns that utilize citizen platforms not only for educational purposes but also to improve the knowledge of decision-makers in case of an accident.
4) Data processing for dose estimation. Given that a large amount of data that will be generated by many citizen scientists, with varied detectors, locations and integration times, it is essential, pre-analyse the data before building the dose map, to harmonize the readings from the different detectors.
5) Assimilate the data into national networks controlled by the authorities.

It relates to PF objectives: To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites.

Major gaps within radiation protection research addressed by the topic: Understanding how the public will react to a radiation emergency, especially when they have the ability to contribute to the response as citizen scientists.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE: Conquering Cancer.

Topic related to more than one discipline of radiation protection: The proposal relates to emergency response, dosimetry, and social sciences. Social science input to accident and emergency dosimetry will aid understanding of how the public will react to an emergency when they can make their own measurements.

E3.

Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency

Description: In order to adequately prepare for and respond to a nuclear or radiological emergency, the capability to estimate absorbed dose to tissues within a specified period of time and how much of this dose could potentially be averted, through interventions, is required. Such estimates are needed to plan and implement protective actions, first aid, immediate medical treatment, medical follow-up. Such estimates are also needed for risk communication to any affected persons, medical professionals, decision-makers, and the public.

The key priority, after treatment of life-threatening injuries, is to identify people at risk of developing radiation-induced harmful tissue reactions. For this purpose, current International guidance and safety standards recommend the use of tissue absorbed doses delivered over a short period of time. The ICRP is currently working on the development of the relevant supporting datasets and other information needed to facilitate the expansion of such an approach. Most of the datasets and assessment methods presently available, do not permit the calculation of such doses or other doses of interest, such as averted doses resulting from countermeasures (e.g. thyroid blocking), nor do they allow dose modifying factors to be taken into account. Tools are needed not only for emergency preparedness but also for estimating the relevant doses from individual bioassay measurements in the event of an emergency. The monitoring of children and pregnant women and producing dose assessments for them, using appropriate biokinetic and dosimetric models, should be a specific priority.

Many existing emergency guidelines, based on equivalent or effective doses, provide action levels. Typically, above a given action level, medical follow-up is recommended. What kind of examinations are recommended? At which frequency? Should any combined external/internal exposure and chemical toxicity be taken into account? Similarly, guidelines for first responders are needed, for example, follow-up of casualties who have been contaminated.

In case of a severe radiological event, some people might receive significant doses and other doses of no concern. Whatever their dose level, people should be informed about their individual monitoring results, dose and risk estimates. Communicating results just in terms of doses has been shown to be quite ineffective and communicating the risks might well be a better strategy. To support such an approach, tools should be developed, taking into account the most up to date risk models, particularly those based on absorbed doses. Along with the tools, a communication strategy which would be defined with the aid of public health and social science experts should be agreed. Decision makers would also be better informed if risk rather than doses were used.

Finally, whatever the dose level and type of accident, doses should be assessed as accurately and as quickly as possible and this may potentially need to be done for up to tens of thousands of people. With respect to the accuracy of doses a major issue is the characterization of the physico-chemical properties of the radionuclides involved in an incident, as this can have a significant impact on dose estimates. With regard to the need for fast and numerous dose assessments, alternative bioassay measurements and monitoring techniques should be evaluated (e.g. spot urine, nasal swabs, gamma-camera, portable equipment for monitoring in the field), and recommendations issued to select the most appropriate measurement strategy. Even for some key radionuclides like ^{131}I there are still debates on the most appropriate monitoring strategy, especially for early monitoring.

These challenges should be addressed to provide national authorities and international bodies with validated tools, methods and procedures.

The research should be focused on one or more of the following objectives:

1) Develop techniques, methods and tools enabling rapid assessment of the organ or tissue absorbed doses delivered over a short period of time, taking into account any dose modifying factors which are important for emergency dosimetry (e.g. age, sex, stable iodine intake, health conditions).
3) Develop methods and tools to assess any health risks associated with internal exposures and develop guidelines to communicate the results.
4) Establish guidelines on the medical follow-up after a contamination that does not require urgent action.
5) Develop rapid techniques for individual monitoring and the assessment of the physico-chemical properties of radionuclides.
6) Study the uncertainties and variabilities of dose estimates with respect to different bioassay measurements and prepare a global strategy of combined use of all available information.
7) Test and disseminate the developed techniques, methods and strategies by conducting international intercomparison exercises and establishing a network of experts and laboratories for sharing expertise and technical capabilities in an emergency.

It relates to PF objectives **G** "*Optimising emergency and recovery preparedness and response*" and particularly to **G2**. It also relates to PF objective **E1** "*Improving radiation protection of workers and population*", particularly "*translation of the BSS into practice*". Indirectly, it will also contribute to the objective of *improving scientific understanding of the variability in individual radiation response* as individual response of persons can be taken into account.

Major gaps within radiation protection research addressed by the topic: go beyond effective dose for the assessment of individual risk in case of nuclear emergency

It contributes to major research priorities/orientations formulated by HORIZON EUROPE: Conquering Cancer, as the improved models can also be of use for internal dosimetry in nuclear medicine applications.

Topic related to more than one discipline of radiation protection: The proposal relates to emergency response, dosimetry, epidemiology and social sciences.

E4.

Development of Online Dosimetry

Individual monitoring of workers currently uses active and passive personal dosimeters: these dose assessments are the primary basis for controlling radiation exposures and are the source of the data used to determine detriment versus dose in the lower dose range. Accurate dose assessments are needed to protect workers and to further our understanding of detriment for the doses to which workers and the public are routinely exposed. Both of the dosimetric methods are technically equivalent. They are generally reliable enough for photon personal dosimetry, while for neutron personal dosimetry the measurement and detection accuracy is lower, and the detection threshold higher. For the nuclear sector, medical, accelerators and cosmic ray dosimetry, better methods are needed, especially for neutrons.

Passive dosimeters have legal validity, but results are only known after processing, readout and analysis are performed by the individual monitoring service. Active dosimeters are also legally accepted, and the immediate response is an advantage in case of accidental irradiation. However, the high cost limits the use to specific situations. Development of better active dosimetry systems is needed.

Online dosimetry represents an innovative approach with the potential to replace both passive and active dosimeters and give real-time results. It is based on 3D motion tracking systems reconstructing the irradiation scenario and Monte Carlo simulations for dose assessment. The technique has important potential, making it a game changer in personal dosimetry. In neutron workplaces it might solve the problems associated with the low accuracy of neutron personal dosimeters. In strongly non uniform irradiations (like interventional radiology) it permits assessment of the dose to critical organs like eye lenses. In mixed and non-uniform radiation fields it permits the workers to perform their activities without too many personal dosemeters (e.g. a nuclear power plant worker performing maintenance operations, a surgeon performing an interventional cardiology procedure). The method also permits direct estimates of effective dose to be made, which bypasses the operational dose quantities and the need for personal dosemeters and provides a direct estimate of detriment. This technique, together with the improvement of computational phantoms, could lead to more individual dosimetry, specific to the sex and dimensions of the individual.

It relates to PF objectives: To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates.

Major gaps within radiation protection research addressed by the topic: Poor quality personal dose assessments, lack of real time dose and dose rate information, direct estimation of protection quantities, with consequent improved data for epidemiology at dose levels that most workers and members of the public are exposed to.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE: Conquering Cancer.

Topic related to more than one discipline of radiation protection:

The proposal relates to operational radiation protection methods, Monte Carlo and epidemiology.

F. Developing an integrated approach to assess environmental ionising radiation exposure, to support and improve risk assessment, risk management, mitigation and post remediation evaluations.

F1.

Developing an integrated approach to environmental exposure and risk assessment from ionising radiation (One Health and Exposome frameworks)

The objective of this topic is to develop an integrated approach to environmental exposure and risk assessment from ionizing radiation. Integration may be achieved through the Exposome framework, comprising all environmental exposures across one's lifetime, and the One Health framework, recognizing the interconnection between human, animal, and environmental health, and promoting holistic solutions to global health challenges.

Within the context of radiation protection, an integrated approach should take into account all possible sources of contamination specific to all practices involving radioactivity as well as nuclear accidents and threats due to nuclear-armed conflicts. Various application contexts, including controlled discharges, accidental releases and post-emergency situations and existing situations, should be considered, and the developed approach should be able to cope with several possible contamination and exposure scenarios.

This implies new developments focusing for example on: the integration of all sources of exposure to ionizing radiations over the entire lifespan (normal and accidental releases of radionuclides, natural radioactivity, medical exposure…); the representation of the spatial and temporal dynamics within the environment up to the human food chain; the influence of other stressors such as temperature, water stress, noise etc. or presence of other contaminants. Innovative modelling approaches can also be proposed to support accurate dose, after physical, chemical, and biological characterization of existing sites with radiological contamination. This may include identifying and quantifying the key biogeochemical processes that influence radionuclide behaviour to further improve the understanding and associated modelling of radionuclide dispersion and transfer processes in the environment. Thus, the output could also be used for the establishment of new and efficient remediation strategies.

Overall, changes in external circumstances due to society trends or economy sustainable considerations should be considered, e.g.: changes in agricultural practices, fish or shellfish farming, future development in nuclear industry (e.g. small modular reactors) as well as on-going changes in human living environment including social considerations.

F2.

Development of preliminary risk assessment schemes and technologically enhanced systems for the identification of radiation hotspots, the assessment of the potential for effects and the valorization of wastes.

Within the CONCERT Joint Road Map it is stated that holistic approaches to risk assessment are increasingly justified to ensure sustainable and safe use of radioactive substances and to protect both human and ecosystem health. Also, the integration of scientific, societal and economic considerations is needed, for the development of risk assessment approaches that meet societal and governments expectations, better informed decision-making and improved risk communication among stakeholders and with the overall society. The Environmental Risk Assessment frameworks are comprehensive tools, that use an exposure-based approach, which is difficult to transfer and apply to radioactively contaminated sites and whose limitations were recognized by ICRP, which include: 1) absence of benchmark values/doses for all the radionuclides present at the site; 2) difficulties associated to IR (ionising radiation) dose estimation; 3) absence of adequate models to estimate doses from complex mixtures of radionuclides; 4) the problem of co-occurring contaminants in the calculation of the toxicity pressure. Therefore, for more chronic exposures and for an emergent/emergency situation, decisions are always based only on environmental IR levels assessed through conventional radiation dosimeters measuring only external IR dose. This is a serious limitation, that may account for both the underestimation of overestimation of risks. A retrospective risk assessment would benefit from an extensive evaluation of the radiation distribution with the production of radiation maps with well identified hotspots, performed by high-speed diagnosing systems, able to perform a sensitive and reliable preliminary evaluation of the possibility of induction of exposure effects. Also, the development and validation of holistic and conceptual frameworks, able to integrate data and make a preliminary evaluation of risks, based on weight of evidence, is of utmost importance to deliver a first set of recommendations for risk mitigation and thus to protect both biota and human health, trough extrapolations from a set of bioindicator species and biosensors.

Proposals should focus on:

-The development of preliminary risk assessment frameworks, that are simple to apply for a fast delivery of a first set of recommendations, based on the precautionary principle, that will allow the design of effective risk mitigation strategies to rapidly limit risks to both biota and human health;

-The development of autonomous flight technology equipped with the appropriate sensors and in parallel with Information and Communication Technologies for allowing sites surveillance for radiation hotspots. Developing innovative biosensors to equip these technologies for the assessment of potential exposure effects in several possible contamination scenarios (from activities within the nuclear fuel cycle, to nuclear accidents and threats due to nuclear armed conflicts). By exploring the data that can be gathered with multiple-parameter devices it will be possible to support and improve environmental risk assessment, risk management, mitigation and post remediation evaluations; Risk assessment, based on risk maps and in effects evidence, should thus become a reality in the short term to support decision-making.

- The development of technologies that will associate the identification of radiation hotspots with the identification of the radionuclides present in such hotspots, with value for the industry and production of radionuclides for the clinical purposes (cancer treatment/diagnosis), for the improvement of waste management strategies, towards a strategy of a Zero waste concept and Waste valorization.

G. Optimising emergency and recovery preparedness and response

G1.

Improvement of radiological impact assessments, decision support and response and recovery strategies

The proposal should focus on one or more of the following aspects:

- the use of AI and big data technologies in radiological impact assessments, in the development / optimisation of measurement strategies, for the calculation (along with other novel methodologies) of uncertainties in model results and for optimization and operationalization of emergency preparedness and response practices; integration of AI and big data technologies in Decision Support Systems for better guidance of the end user in countermeasure strategy definition;

- compilation of the databases that are required by AI technologies, with historic and scenario information - including besides nuclear/radiological accidents, scenarios of new threats, such as war situations;

- improved communication/dialogue with stakeholders due to better information availability, considering data protection regulations (GDPR).

G2.

Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies

The emerging and future deployment of Small Modular Reactors (SMR), Advanced Modular Reactors (AMR) and nuclear fusion facilities will leave capability gaps in current environmental assessment data, methodologies and tools for both planned and emergency exposure situations. There is significant diversity in SMR, AMR and fusion technologies which can include differing reactor designs to those used for existing large-scale nuclear facilities. As an example, this may lead to contributions from radionuclides that are less well studied; potentially different siting criteria for such facilities eg on rivers/lakes/floating reactors or closer to population centres; and the potential for several facilities in closer proximity to each other than existing NPPs. The research proposals should aim to prioritise the areas for further development drawing on reviews of technological readiness for example to provide approaches, data and adapted or new models to support EIA and EPR issues for novel nuclear technologies, their potential uses, and the related risks.

EIA and EPR are areas where more robust science-based demonstration of protection of workers, the public and the environment is needed for the three types of exposure situations (planned, emergency, existing) and the strategy and scale of deployment of such new technologies. The limited existing knowledge does not allow for a holistic impact assessment including the consequences (benefits and disadvantages) of the deployment of such technologies. The integration of exposure assessments for both human and biota for such technologies should continue to be developed in the context of such novel technologies.

Two other important issues are to understand/anticipate how public perception about such new technology would evolve and to justify improved strategies for public information, communications and dialogue/debate. There is the potential to also consider the occupational radiation protection aspects of such technologies for example of workers during routine operation, maintenance and transport.

<u>It relates to PF objectives:</u>

Two specific objectives would be supported by this topic

3. To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates.

The work will support several elements of the BSS relating to both emergency preparedness and response regulations as well as those used for planned exposure situations

4. To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites.

The work would improve knowledge to support the preparedness for any radiological events involving novel nuclear technologies.

Major gaps within radiation protection research addressed by the topic:

As noted, there are a range of novel nuclear technologies which may differ in both the reactor design or in their planned use. This research topic has the objective of identifying the key scientific knowledge gaps for the use of such technologies in relation to both EIA and EPR purposes to ensure the impacts of such technologies are understood in advance of wider deployment.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE:

The topic contributes to several of the Missions identified by HORIZON EUROPE as major research priorities, ie

- A Climate Resilient Europe: preparing Europe to climate disruptions and accelerating the transition to a future Europe within safe planetary boundaries
    - o The basis for the novel energy production methods that are the focus of this topic are ones that can be considered low carbon technologies. The research will help inform the safe regulation and use of such technologies.
- Restore our Oceans and Waters: regenerating marine and freshwater ecosystems, eliminating pollution and decarbonising the blue economy
    - o Novel energy production technologies will need to be considered in the context of sustainability of their emissions. This research topic will provide data and tools to help inform understanding of the impacts of such emissions.
- 100 Climate-neutral cities: support, promote and showcase 100 European cities in their systemic transformation to climate neutrality by 2030 and turn these cities into innovation hubs for all cities
    - o Technologies such as Small Modular Reactors may enable cities to transition away from higher carbon-emitting energy production technologies. This research topic informs the regulation and safety requirements that need to be considered.

Topic related to more than one discipline of radiation protection:

Clear links to EPR, radioecology, social sciences and EIA and so relevant to the NERIS, ALLIANCE and SHARE platforms. The topic relates to the operation of novel nuclear technologies during both routine operations and emergency situations and how they will be perceived by society so there is a need to work collaboratively to develop the scientific knowledge needed to fill this gap.

H. Radiation protection in/with society

H1.

Effective translation mechanisms between social and technical dimensions of radiation protection.

Efforts have been made in recent years to highlight the interconnections between the social and technical dimensions of radiation protection, to stimulate collaboration between technical and social sciences and humanities disciplines and the involvement of larger stakeholder groups in research and innovation processes. It has been recognised that better alignment of research and practice in RP with the values, needs and expectations of society requires, among others effective research translation mechanisms between the technical and social dimensions of RP and the identifying barriers and developing of systematic approaches to inclusion of societal dimensions at all levels of the RP system. This requires methodological innovation and new, transformative ways of doing day-to-day research, which involves exchanges between disciplines and with societal actors, to identify and explore commonalities and divergence in views, values and expectations. However, there has been little research on how the different actors perceive the added value of these collaborations in the field of radiation protection, what the institutional uptake is of research outputs resulting from these collaborations, and there are no systematic approaches to the inclusion of societal dimensions within the radiological protection system. Moreover, while stakeholder engagement in research and innovation is increasingly asked for (e.g. in Horizon Europe), there is a need to explore current practices through an ethical lens.

The objective of the topic is thus to investigate how different radiation protection actors perceive the added value of cross disciplinary collaborations in the field of radiation protection; what their expectations and needs are; what challenges and enablers of collaborations can be found in the different radiation protection fields; and what are the main barriers for the institutional uptake of results from inter- and transdisciplinary collaborations.

H2.

Supporting Radiation Protection: Effective Communication and Engagement on Controversial topics in Knowledge-Evolving Societies

This topic encourages innovative research that explores various aspects of risk and health communication in the context of controversial information and uncertainty regarding radiation effects in during knowledge evolving and changing societal environment. It aims at enhancing communication strategies, fostering ethical stakeholder engagement, and promoting citizen-centred and community-centred communication on controversial topics within the field of radiation protection. Research projects should focus on the following key areas:

I) Understanding Perspectives: Investigate the viewpoints, concerns, and information needs of the public and authorities regarding radiation risks. Explore their perceptions of controversial information and uncertainties associated with radiation effects, with a specific emphasis on risk and health communication.

II) AI-assisted and Social Media Communication: Analyse the influence of AI-assisted and social media communication on risk perception and radiation protection behaviours in different exposure situations including emergency scenarios. Explore how social media platforms, aided by artificial intelligence impact the dissemination of information and public response to radiation-related risks.

III) Sustainable Communication: Examine sustainable communication practices that effectively address radiation-related issues, taking into account both the radiological and non-radiological effects of radiological emergencies, particularly on mental health. Draw insights from experiences such as the COVID-19 pandemic to develop communication strategies that promote sustainability in radiation protection contexts.

IV) Ethical Stakeholder Engagement: Investigate ethical aspects of stakeholder engagement in radiation protection. Explore issues such as inadequate compensation, representation, diversity and inclusion, the neglect of stakeholder opinions, and power dynamics in decision-making processes.

Identify who benefits from stakeholder engagement, as well as the added value stakeholders gain from their involvement.

IV) Patient-Centred Communication: Address patient-centred communication, specifically in the context of informed consent, connected to the diagnostic and therapeutic use of ionising radiation. Improve communication practices among healthcare providers, patients, and caregivers, especially when conveying complex information related to radiation effect.

It relates to PF objectives:

The topic is relevant to:

- objective 1: To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches improving patient health and safety and supporting transfer of the R&I outcome to practice, point g): Robust consideration of patient concerns, trust and limitations to personalisation.

- objective 4: To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites", notably point 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. Major gaps within radiation protection research addressed by the topic:

The topic addresses the need for innovative approaches, sound methodologies and actionable outcomes for radiation protection communication related to controversial topics in our knowledge-evolving societies. The topic also addresses an appropriate science and risk communication as well as the lack of trust in science and scientists.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE:

This project is aligned with the Horizon Europe pillars (excellent science, global challenges and European industrial competitiveness, innovative Europe) by focusing on controversial topics related to ionising radiation in today's society, where knowledge is continuously evolving and uncertainties need to be better understood and communicated. This project contributes to the improvement of well-being and resilience of Europe's citizens and as a consequence to a resilient Europe, better prepared to face future crises. The proposed topic follows an trans- and interdisciplinary approach and deals with consequences of digitalisation for communication and engagement.

Topic related to more than one discipline of radiation protection:

Addressing the suggested topic will require involvement of several social sciences and humanities disciplines. It is however relevant to the broad radiation protection community, particularly i.e. medical use of IR, emergency preparedness, radioecology.

H3.

Sustainable practices and risk management strategies in radiological protection

Promoting sustainable radiological risk management practices and strategies in various areas of radiation protection (e.g. reuse of NORM residues, sustainable remediation of contaminated sites, sustainable radiology) is as a key issue on nowadays society. However, the practical application of the concept of sustainability differs.

The research topic aims at providing comprehensive theoretical frameworks for promoting sustainable practices and management strategies within the varied radiation protection fields. Among others, this requires exploring and analysing the diverse understandings and interpretations of sustainability within different radiation protection fields; examining how various stakeholders, including professionals, communities, and policymakers, conceptualize sustainability and its social, economic, and environmental dimensions; investigating the underlying values, cultural influences, and socio-technical boundaries that shape sustainability perspectives and practices in radiation protection. To this end, the interplay between technological advancements, social systems, and sustainability objectives should be examined. Finally, the role of participatory approaches that facilitate dialogue, mutual learning, and co-creation of sustainable solutions requires further attention.

The topic acknowledges the cultural, social, and contextual factors that influence sustainability interpretations and emphasizes the importance of inclusivity, collaboration, and mutual understanding in the pursuit of sustainable development in radiation protection. The findings can inform policy development, decision-making processes, and community engagement initiatives, ultimately fostering sustainability in radiation-related activities across diverse contexts.

<u>It relates to PF objectives:</u>

The topic is relevant for areas of radiation protection, but is particularly connected to PIANOFORTE

- specific Objective 2: To consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances in support of the BSS implementation and 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”.

- specific Objective 4: To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites”. In promoting sustainable practices and sustainable risk management strategies, it provides a theoretical and practical framework ensuring the appropriate “inclusion of [environmental,] societal and ethical dimensions in DSS” (decision support systems). By paying special attention to stimulating dialogue, mutual learning and co-creation the ethical evaluation of stakeholder engagement practices it also contributes to “Research in effective communication and stakeholder involvement strategies”.

<u>Major gaps within radiation protection research addressed by the topic:</u>

Radiation protection options should take into account the wider social, environmental and economic considerations, alongside radiological risk. However, there is currently no overarching theoretical framework to integrate these considerations. While promoting sustainable practices and risk management strategies is in focus in various radiation protection areas and is recognised as a key issue, the understanding and practical application of the concepts differ, and the extent to which the various dimensions are taken into account, particularly the social one, varies. There is a need to develop the theoretical and practical basis underlying these different sustainability perspectives in radiological protection.

<u>It contributes to major research priorities/orientations formulated by HORIZON EUROPE:</u>

The topic aligns with the Horizon Europe vision of supporting the UN Sustainable Development Goals. In particular, the ambition to tackle policy priorities and facilitate the uptake of research in decision-making in implementation of the green transition.

It connects to 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".

Topic related to more than one discipline of radiation protection:

Caring for sustainability inherently requires insights from several disciplines as well as from different societal actors, since it deals with environmental (e.g. environmental degradation, waste), social (e.g. human health and wellbeing) and economic dimensions. Only such an integrated approach can address the research gap in a meaningful and effective way.

4.10. Annex 9: Prioritization criteria of topics for PIANOFORTE second open call

Relevance for PIANOFORTE specific objectives: (to what extent it adheres to PIANOFORTE priorities and objectives)

- **"3" strong relevance** - Strongly endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to min. 3 specific objectives of PIANOFORTE).
- **"2" moderate relevance** – endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to 2 specific objective of PIANOFORTE).
- **"1" weak relevance** - endorsed and specifically mentioned as a priority research topic or overarching objective by PIANOFORTE (it adheres to 1 specific objective of PIANOFORTE).
- **+1** - endorsed and mentioned as a priority research topic by other EU initiatives outside EURATOM (e.g. HORIZON EUROPE, EU4HEALTH, etc.).

Societal impact

- **"3" high societal impact:** projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, patients, occupational) / environments leading to significant risk reduction or providing significant support for improved radiation protection policies or practice
- **"2" moderate societal impact:** projects likely to have positive impact society wide or positive impact on particular population groups (public, medical, patients, occupational) / environments leading to some risk reduction or providing support for improved radiation protection policies or practices
- **"1" low societal impact:** projects which cannot be directly linked/translated into radiation protection policies

Scientific impact:

- **"3" high scientific impact:** topics likely to: i) provide new theories or concepts; or ii) novel applications of theories and concepts relevant for the large scientific community not only radiation protection research
- **"2" moderate scientific impact:** topics likely to: i) provide new theories or concepts; or ii) novel applications of theories and concepts relevant for the large radiation protection community
- **"1" low scientific impact:** topics likely to: i) provide new theories or concepts; or ii) novel applications of theories and concepts projects most likely providing highly specialized research results (data, methods, software, recommendations, guidelines, etc.) in the field of radiation protection relevant only for restricted groups within the radiation protection community and which are publishable in specialized journals focusing on radiation protection research

Redundancy: (to what extent the topic has recently been and/or is currently being addressed by other projects) (recently closed projects = projects closed within the last 3 years)

- **“3” non-redundant** - no redundancies with ongoing or recently closed EURATOM and/or other EC-funded projects (projects closed within the last 3 years)
- **“2” partially redundant** - partially addressed by ongoing or recently closed EURATOM-funded or other EC projects but a large part of the topic still not researched
- **“1” redundant** - it has substantial redundancies with recently closed and/or ongoing EURATOM or EC projects

Innovation potential: refers to the ability of a research topic to contribute to the creation of novel and impactful solutions, advancements, or insights. Innovation potential drives the advancement of knowledge and understanding. Research topics with high innovation potential have the capacity to introduce new ideas, concepts, and methodologies that expand the boundaries of knowledge, also between different disciplines, and lead to breakthroughs.

- **“3” high innovative potential** - research contributing to new theories, methodologies, or approaches, or those that challenge existing paradigms and generate new insights
- **“2” moderate innovative potential** - research topics that make significant incremental advances building on existing knowledge or extending previous work in a meaningful way
- **“1” low innovative potential** - research topics that make some incremental advances building on existing knowledge or extending previous work.

4.11. Annex 10: Scoring of topics for PIANOFORTE second open call

Subtopic	Relevance for PIANOFORTE	Societal impact	Scientific impact	Redundancy	Innovation potential	Total	Extra points duer to Horizon-Europe priorities
A1	3	2	2	2	2	11	
A2 (former A4)	3	2	3	3	2	13	
A3	3	3	3	2	3	14	
B1	2	2	3	3	2	12	
B2	1	3	1	3	1	9	
C1	2	2	2	3	2	11	
C2	3	3	2	3	3	14	
C3	2	2	2	3	3	12	+1: Horizon Europe: water & oceans: H10+H1113 POINTS
D1 (original D2)	1	3	2	1	2	9	+1: Horizon Europe: Cancer mission: 10 POINTS
D2	2	3	2	2	1	10	+1: Horizon Europe: Cancer mission: 11 POINTS
D3 (suggested by EURAMED)	2	3	3	1	3	12	+1: Horizon Europe: Cancer mission: 13 POINTS
E1	1	2	2	3	2	10	
E2	1	2	2	2	1	8	+1: Horizon Europe: Citizens engagement?: 9 POINTS
E4 (will be E3)	3	2	2	3	2	12	Text of this topic needs to be expanded before the ERPW
E5 (will be E4)	1	3	2	3	3	12	
F1	1	3	2	3	2	11	
F2	1	2	2	2	1	8	+1: Horizon Europe: Circular economy: 9 POINTS
G1	1	2	3	3	2	11	
G2	2	3	2	3	1	11	+1: Horizon Europe: water & oceans: 12 POINTS
H1	1	3	2	3	2	11	
H2	2	3	2	2	3	12	
H3	2	2	3	2	2	11	+1: Horizon Europe: circular economy; 12 POINTS

4.12. Annex 11: Scores of topics: summary from step 5

	A1	A2	A3	B1	B2	C1	C2	C3	D1	D2	D3	E1	E2	E3	E4	F1	F2	G1	G2	H1	H2	H3
Relevance for PIANOFORTE specific objectives	**3**	**3**	**3**	**2**	**1**	**2**	**3**	**2**	**1**	**2**	**2**	**1**	**1**	**3**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**2**
Societal impact	2	2	3	2	3	2	3	2	3	3	3	2	2	2	3	3	2	2	3	3	3	2
Scientific impact	**3**	**3**	**3**	**3**	**1**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2**	**2**	**3**
Redundancy	2	3	2	3	3	3	3	3	1	2	1	3	2	3	3	3	2	3	3	3	2	2
Innovation potential	1	2	2	2	1	2	3	2	2	1	3	2	1	2	3	2	1	2	1	2	3	2
			1					1	1	1	1		1				1		1			1
Score ≥ 12	**11**	**13**	**14**	**12**	**9**	**11**	**14**	**12**	**10**	**11**	**13**	**10**	**9**	**12**	**12**	**11**	**9**	**11**	**12**	**11**	**12**	**12**
Shortlist: Weight on high scoring in relevance to PIANOFORTE and/or scientific impact		**	**	*			*				*			*								*

4.13. Annex 12: Shortlist of topics for PIANOFORTE second open call (step 6)

Shortlist of topics and subtopics for PIANOFORTE Call 2

This list represents the shortlist based on prioritisation of the subtopics using the agreed prioritization criteria and weighting based on relevance to PIANOFORTE specific objectives and/or scientific excellence.

Overview of topics and subtopics

General note: *Under Horizon Europe, "the effective integration of social [sciences and humanities] SSH in all clusters, including all Missions and European partnerships, is a principle throughout the programme" (European Commission, 2022[13]). SSH are considered to be "a key constituent of research and innovation" (idem). In accordance with these principles and the PIANOFORTE commitments and objectives, all* ***projects funded by PIANOFORTE are expected to take into account the social, economic, behavioural, institutional, historical and/or cultural dimensions, as appropriate for the topic addressed****.* ***Contributions from one or more SSH disciplines may be required to ensure the social robustness and social impact of the research and innovation chain****.[14]*

A. Understanding and quantifying the health effects of radiation exposure

A2.

Define how the temporal and spatial variations in dose delivery affect the risk of health effects following radiation exposure through the integration of experimental and epidemiological data and including optimised detection and dosimetry by focusing on one of the following subtopics:

- Understanding the link between exposure characteristics (radiation quality, dose and dose-rate, acute and chronic exposures) and the cancer and non-cancer effects and implications for improvement/optimisation of innovative radiotherapy (e.g. FLASH therapy, proton/ion therapy).

- Understanding the effects of intraorgan dose distribution through observations in patients exposed to inhomogeneous dose distributions and experiments with organotypic tissue models

- Addressing the difference between risks from internal and external exposures through the integration of new knowledge on the effects of chronic exposures, intra-organ dose distribution and radiation quality considering energy deposition at different scales (from intracellular to organs).

In epidemiological studies evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization should be included.

[13] European Commission, 2022. Horizon Europe (HORIZON). Programme guide. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

[14] For Guidelines on integration of SSH see PIANOFORTE deliverable 2.6.

A3.

Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage

Scope of the subtopic:

Risks related to exposure to IR depend on the dose, dose rate, type of IR (ie radiation quality), volume of the body exposed and the type of exposed organs and tissues, each exhibiting different radiosensitivities. Dose-effect relationships may depend on the initial health state, history of previous exposure and lifestyle before and after exposure. Studies focusing on the role of specific target cells, such as stem cells / progenitor cells, the role of genetic and epigenetic factors, microenvironmental factors, sex and age at exposure, co-morbidities, environmental and lifestyle factors and the interactions between these depending on dose levels could contribute to a better understanding of the mechanisms responsible for individual response to radiation at the level of tissue reactions, stochastic effects such as cancer and radiation-induced aging and could help in advancing individualised cancer treatment.

Objectives of the subtopic:

The subtopic should investigate mechanisms of individual variations in radiation response as detailed above by focusing on one or several of the following objectives:

- Risks after radiotherapy
    - Internal partial body exposure via targeted radionuclide therapy (TRT) with different radiation qualities. In particular, exposure of the bone marrow, kidneys and liver should be considered, as organs with the highest risk of exposure for adverse effects in this type of medical application
    - External beam therapies and brachytherapies with different dose rates, fractionation schemes or dose-volume histograms, hypo-fractionated radiation therapy, novel particle therapies (proton, hadron, heavy ion therapies). Since these therapies are often combined with chemotherapy or immunotherapy, synergies between the different therapeutic combinations should be explored at the individual patient level from the point of view of the risk for therapy-related side effects (tissue or stochastic effects) and for maximizing treatment efficiency.
- Risks in children and young adults

  A further objective of the subtopic is to investigate the specific risk of children and young adults after multiple diagnostic exposures related to cardiac catheterization or repeated brain CT scans as well as therapeutic applications for lymphomas or orbito-ocular/central nervous system tumors for long-term cardiovascular damage, cognitive impairment or second primary malignancies.
- Biomarkers of individual risk

  Another objective is to seek biomarkers of individual risk through cellular/molecular, and/or systems biological approaches, radiomics investigations, evaluating potential predictive factors and correlating them with health outcomes. In case of studies related to previously identified biomarkers, validation and quality control should be included.

These objectives should be carried out among others by taking use of existing patient datasets and biobanks and by applying relevant preclinical 2D and 3D models, and relevant in vivo models. Where relevant, proposals should include communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and informed consent.

The proposal should focus on one or several of the above objectives.

Impact of the subtopic:

This proposal addresses three of the four PIANOFORTE specific objectives: „Improving patient radiation protection in relation to the use of ionizing radiation in the medical field" and "To improve scientific understanding of the variability in individual radiation response and health risk of exposure" "To support BSS regulations..."

The subtopic also relates to other non-EURATOM initiatives, in the frame of the mission area "Conquering Cancer – improving the lives of more than 3 million people by 2030 through prevention, cure and for those affected by cancer including their families to live longer and better".

This proposed new topic strengthens the link and synergy between radiation protection and medical treatment: towards an improved benefit—risk balance. This topic should be performed by a consortium including both radiation biology experts and medical partners to ensure impact and transferability of this research to the clinic in a swift way.

B. Improving the concepts of dose quantities

B1.

To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.

The dependence of biological effectiveness on radiation quality is commonly believed to be related to the differences in the energy deposition pattern on a microscopic and nanoscopic scale. Identification and quantification of the relevant statistical characteristics of the microscopic spatial pattern of interactions (e.g., spatially correlated occurrence of clusters of energy transfer points) are an essential prerequisite for improvement of present dose concepts and understanding the radiation damage mechanism.

The topic should focus on one or more of the following subtopics:

- Investigating the physical characteristics of energy deposition on microscopic scale with the aim of developing a novel, unified concept of radiation quality as a general physical characteristic of the radiation field that would allow separating the physical and biological components contributing to the eventual biological effects of radiation.

- Developing microdosimetric and nanodosimetric detectors, revising their measurement concepts, and developing a 'gold standard' for track structure simulation codes along with their validation. Establishment of robust uncertainty budgets for micro- and nanodosimetric quantities obtained by measurement or simulation and identification of the major uncertainty sources.

- A comprehensive multi-scale characterization of the physical aspects of radiation energy deposition with quantitative investigation and correlation of track structure with biological effects at molecular and cellular level and their consequences at supra-cellular levels. Radiobiological experiments should be performed with relevant micro- and nanodosimetric metrological methods, thereby facilitating the identification of useful connections for further advancements in radiobiological modelling. The cancer development processes should also be considered in the modelling to obtain an estimation of low dose risk.

C. Understanding radiation-related effects on non-human biota and ecosystems

C2.

Determine the effects of ionizing radiation on ecosystem functioning and biodiversity, as well as their potential consequences to human wellbeing (e.g. culture, food consumption, work and recreational activities).

The demonstration of the increased sensitivity of ecosystem processes to ionizing radiation, in comparison with the reported effects at the population level, would strongly question the robustness of risk assessments that rely only on population-effect data. On the other hand, if it is shown that the functional or structural redundancy (biodiversity) of the ecosystems brings greater robustness against the effects of radiation and potential other threats or anthropogenic degradations (multi-contamination, climatic change…), the conservatism of the current assessments would be supported. Although the subject is very broad, some targeted studies are achievable within a reasonable timeframe: experimental research on the effects of ionizing radiation on functional processes is expected in controlled conditions (e.g. microcosms and mesocosm studies), as well as the reinterpretation (e.g. by ecological modelling) of the reported data on the current state of ecosystems and their temporal evolution in contaminated territories.

Moreover, the consequences of the impact on ecosystem functioning may have many dimensions, not only biophysical, but also economic and socio-cultural. Those societal issues are also to be addressed, with the aim to provide a coherent framework encompassing both the radiation protection of human and ecosystems.

D. Optimising medical use of radiation

D3.

Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.

Adaptive radiation therapy has been developed over the last years. New therapeutic approaches are currently under development like different targeted radionuclide therapies, FLASH therapies or Microbeam therapies are being further developed and these and hadron therapies are being evaluated regarding their clinical potential for certain applications. The implementation is still difficult and not applied uniformly across Europe. Therapies have to be optimised and then evaluated regarding their potential protection for healthy tissues especially for high risk groups like paediatric patients.

All of these therapeutic procedures allow for certain diseases potentially treatments that would be suitable to reduce the radiation exposure of healthy tissues while maintaining the cancer / disease control thus potentially avoiding secondary malignancies. However, for FLASH and microbeam therapy the mechanisms are not completely understood, for hadron therapies clinical studies are missing proving the benefits in terms of radiation protection of patients and long term outcome for a variety of clinical entities. A similar statement is true for targeted radionuclide therapies. For adaptive radiation therapy it has to be investigated how it can be best implemented and what are the clinical prerequisites and the requirements for staff to achieve best possible results in terms of radiation protection of patients. Especially, in the cases of adaptive radiation therapies, targeted radionuclide therapies and hadron therapies, standard application and standard protocols as well as operating procedures need to be defined.

As stated in the CONCERT JRM medical use of ionising radiation is recognised as the largest source of exposure of the population in Europe and therefore of concern for society. It is of great importance to optimise radiological protection in medical applications of ionising radiation and to harmonise the practices throughout Europe with respect to the protection of human health from the harmful effects of ionising radiation and the potential benefit of the use of ionising radiation for individual patients. Topic D includes both basic and translational research and transfer into the clinical practice.

<u>How does it relate to PIANOFORTE scientific specific objectives?</u>

1. To improve the prevention, detection and safe treatment of cancer
2. To consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances

Link of new proposal to PIANOFORTE specific objectives:

1. To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches improving patient health and safety and supporting transfer of the R&I outcome to practice.

Link of new proposal to PIANOFORTE expected outcomes:

13. In the field of medical applications: (a) new knowledge providing elements to decision-making and risk-benefit analysis; (b) transfer of new optimised medical procedures into clinical practices; (c) elements to pave the way to personalised medicine

14. Improvement of the radiation protection of patients and of the general public in normal and accidental situations

<u>Major gaps within radiation protection research addressed by the topic:</u>

Impact: optimised radiation protection and increased efficiency of therapeutic procedures could lower possible adverse health effects contributing to the improvement of existing / development of new methods for treatment.

<u>It contributes to major research priorities/orientations formulated by HORIZON EUROPE:</u>

The subtopic is part of the new SRA of EURAMED made within EURAMED rocc-n-roll

It refers to many of the identified gaps and research needs of EURAMED rocc-n-roll SRA and also to breakthroughs 2, 3 of the corresponding roadmap.

The topic partly addresses some of the MEDIRAD technical recommendations especially those for research and safe implementation.

<u>Topic related to more than one discipline of radiation protection:</u>

The topic is also related to:

- Topic A (Understanding and quantifying the health effects of radiation exposure)

- Topic H (Radiation protection in/with society)

<u>Other remarks:</u>

Regarding redundancy: The relevance of the topic was recognised by EURATOM. Also, optimised radiation therapy is a cornerstone of safe use of ionising radiation to combat cancer, there are only few currently running projects funded for this in the European context. SINFONIA is just trying to assess the risk associated with therapeutic applications rather than useful implementation of new or optimised radiation therapy procedures. Another aspect is that the topic might involve substantial technical development as well, in which companies producing medical equipment for diagnosis and therapy using various ionizing radiation techniques can also be included, therefore funding modalities of public-private partnership should also be promoted.

E. Improving radiation protection of workers and public

E3.

Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency

Description: In order to adequately prepare for and respond to a nuclear or radiological emergency, the capability to estimate absorbed dose to tissues within a specified period of time and how much of this dose could potentially be averted, through interventions, is required. Such estimates are needed to plan and implement protective actions, first aid, immediate medical treatment, medical follow-up. Such estimates are also needed for risk communication to any affected persons, medical professionals, decision-makers, and the public.

The key priority, after treatment of life-threatening injuries, is to identify people at risk of developing radiation-induced harmful tissue reactions. For this purpose, current International guidance and safety standards recommend the use of tissue absorbed doses delivered over a short period of time. The ICRP is currently working on the development of the relevant supporting datasets and other information needed to facilitate the expansion of such an approach. Most of the datasets and assessment methods presently available, do not permit the calculation of such doses or other doses of interest, such as averted doses resulting from countermeasures (e.g. thyroid blocking), nor do they allow dose modifying factors to be taken into account. Tools are needed not only for emergency preparedness but also for estimating the relevant doses from individual bioassay measurements in the event of an emergency. The monitoring of children and pregnant women and producing dose assessments for them, using appropriate biokinetic and dosimetric models, should be a specific priority.

Many existing emergency guidelines, based on equivalent or effective doses, provide action levels. Typically, above a given action level, medical follow-up is recommended. What kind of examinations are recommended? At which frequency? Should any combined external/internal exposure and chemical toxicity be taken into account? Similarly, guidelines for first responders are needed, for example, follow-up of casualties who have been contaminated.

In case of a severe radiological event, some people might receive significant doses and other doses of no concern. Whatever their dose level, people should be informed about their individual monitoring results, dose and risk estimates. Communicating results just in terms of doses has been shown to be quite ineffective and communicating the risks might well be a better strategy. To support such an approach, tools should be developed, taking into account the most up to date risk models, particularly those based on absorbed doses. Along with the tools, a communication strategy which would be defined with the aid of public health and social science experts should be agreed. Decision makers would also be better informed if risk rather than doses were used.

Finally, whatever the dose level and type of accident, doses should be assessed as accurately and as quickly as possible and this may potentially need to be done for up to tens of thousands of people. With respect to the accuracy of doses a major issue is the characterization of the physico-chemical properties of the radionuclides involved in an incident, as this can have a significant impact on dose estimates. With regard to the need for fast and numerous dose assessments, alternative bioassay measurements and monitoring techniques should be evaluated (e.g. spot urine, nasal swabs, gamma-camera, portable equipment for monitoring in the field), and recommendations issued to select the most appropriate measurement strategy. Even for some key radionuclides like ^{131}I there are still debates on the most appropriate monitoring strategy, especially for early monitoring.

These challenges should be addressed to provide national authorities and international bodies with validated tools, methods and procedures.

The research should be focused on one or more of the following objectives:

1) Develop techniques, methods and tools enabling rapid assessment of the organ or tissue absorbed doses delivered over a short period of time, taking into account any dose modifying factors which are important for emergency dosimetry (e.g. age, sex, stable iodine intake, health conditions).
3) Develop methods and tools to assess any health risks associated with internal exposures and develop guidelines to communicate the results.
4) Establish guidelines on the medical follow-up after a contamination that does not require urgent action.
5) Develop rapid techniques for individual monitoring and the assessment of the physico-chemical properties of radionuclides.
6) Study the uncertainties and variabilities of dose estimates with respect to different bioassay measurements and prepare a global strategy of combined use of all available information.
7) Test and disseminate the developed techniques, methods and strategies by conducting international intercomparison exercises and establishing a network of experts and laboratories for sharing expertise and technical capabilities in an emergency.

<u>It relates to PF objectives</u> **G** "*Optimising emergency and recovery preparedness and response*" and particularly to **G2**. It also relates to PF objective **E1** "*Improving radiation protection of workers and population*", particularly "*translation of the BSS into practice*". Indirectly, it will also contribute to the objective of *improving scientific understanding of the variability in individual radiation response* as individual response of persons can be taken into account.

<u>Major gaps within radiation protection research addressed by the topic:</u> go beyond effective dose for the assessment of individual risk in case of nuclear emergency

<u>It contributes to major research priorities/orientations formulated by HORIZON EUROPE:</u> Conquering Cancer, as the improved models can also be of use for internal dosimetry in nuclear medicine applications.

<u>Topic related to more than one discipline of radiation protection:</u> The proposal relates to emergency response, dosimetry, epidemiology and social sciences.

H. Radiation protection in/with society

H3.

Sustainable practices and risk management strategies in radiological protection

Promoting sustainable radiological risk management practices and strategies in various areas of radiation protection (e.g. reuse of NORM residues, sustainable remediation of contaminated sites, sustainable radiology) is as a key issue on nowadays society. However, the practical application of the concept of sustainability differs.

The research topic aims at providing comprehensive theoretical frameworks for promoting sustainable practices and management strategies within the varied radiation protection fields. Among others, this requires exploring and analysing the diverse understandings and interpretations of sustainability within different radiation protection fields; examining how various stakeholders, including professionals, communities, and policymakers, conceptualize sustainability and its social, economic, and environmental dimensions; investigating the underlying values, cultural influences, and socio-technical boundaries that shape sustainability perspectives and practices in radiation protection. To this end, the interplay between technological advancements, social systems, and sustainability objectives should be examined. Finally, the role of participatory approaches that facilitate dialogue, mutual learning, and co-creation of sustainable solutions requires further attention.

The topic acknowledges the cultural, social, and contextual factors that influence sustainability interpretations and emphasizes the importance of inclusivity, collaboration, and mutual understanding in the pursuit of sustainable development in radiation protection. The findings can inform policy development, decision-making processes, and community engagement initiatives, ultimately fostering sustainability in radiation-related activities across diverse contexts.

It relates to PF objectives:

The topic is relevant for areas of radiation protection, but is particularly connected to PIANOFORTE

- specific Objective 2: To consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances in support of the BSS implementation and 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".

- specific Objective 4: To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites". In promoting sustainable practices and sustainable risk management strategies, it provides a theoretical and practical framework ensuring the appropriate "inclusion of [environmental,] societal and ethical dimensions in DSS" (decision support systems). By paying special attention to stimulating dialogue, mutual learning and co-creation the ethical evaluation of stakeholder engagement practices it also contributes to "Research in effective communication and stakeholder involvement strategies".

Major gaps within radiation protection research addressed by the topic:

Radiation protection options should take into account the wider social, environmental and economic considerations, alongside radiological risk. However, there is currently no overarching theoretical framework to integrate these considerations. While promoting sustainable practices and risk management strategies is in focus in various radiation protection areas and is recognised as a key issue, the understanding and practical application of the concepts differ, and the extent to which the various dimensions are taken into account, particularly the social one, varies. There is a need to develop the theoretical and practical basis underlying these different sustainability perspectives in radiological protection.

It contributes to major research priorities/orientations formulated by HORIZON EUROPE:

The topic aligns with the Horizon Europe vision of supporting the UN Sustainable Development Goals. In particular, the ambition to tackle policy priorities and facilitate the uptake of research in decision-making in implementation of the green transition.

It connects to 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".

Topic related to more than one discipline of radiation protection:

Caring for sustainability inherently requires insights from several disciplines as well as from different societal actors, since it deals with environmental (e.g. environmental degradation, waste), social (e.g. human health and wellbeing) and economic dimensions. Only such an integrated approach can address the research gap in a meaningful and effective way.

4.14. Annex 13: Shortlist of topics for PIANOFORTE second open call (step 7)

Shortlist of topics and subtopics for PIANOFORTE Call 2

This list represents the shortlist based on prioritisation of the subtopics using the agreed prioritization criteria and weighting and the outcome of the discussion of the shortlist with the platforms on 13 October 2023.

Overview of topics

General note: *Under Horizon Europe, "the effective integration of social [sciences and humanities] SSH in all clusters, including all Missions and European partnerships, is a principle throughout the programme" (European Commission, 2022[15]). SSH are considered to be "a key constituent of research and innovation" (idem). In accordance with these principles and the PIANOFORTE commitments and objectives, all* ***projects funded by PIANOFORTE are expected to take into account the social, economic, behavioural, institutional, historical and/or cultural dimensions, as appropriate for the topic addressed. Contributions from one or more SSH disciplines may be required to ensure the social robustness and social impact of the research and innovation chain***.[16]

A. Understanding and quantifying the health effects of radiation exposure

A2.

Investigating the effects of temporal and spatial variations in dose delivery on the risk of health effects

Scope of the topic

To characterise the differences in quantitative and mechanistic aspects of response dependent on radiation qualities, energy spectra and dose-rates both singly and as mixed fields was identified as a major research need in the First Joint Roadmap which will improve our understanding on the health effects and risks associated with these different exposure scenarios.

Objectives of the topic:

Define how the temporal and spatial variations in dose delivery affect the risk of health effects following radiation exposure through the integration of experimental and epidemiological data and including optimised detection and dosimetry by focusing on one of the following subtopics:

- Understanding the link between exposure characteristics (radiation quality, dose and dose-rate, acute and chronic exposures) and the cancer and non-cancer effects and implications for improvement/optimisation of innovative radiotherapy (e.g. FLASH therapy, proton/ion therapy).

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[15] European Commission, 2022. Horizon Europe (HORIZON). Programme guide. https://ec.europa.eu/info/funding-tenders/opportunities/docs/2021-2027/horizon/guidance/programme-guide_horizon_en.pdf

[16] For Guidelines on integration of SSH see PIANOFORTE deliverable 2.6.

- Understanding the effects of intraorgan dose distribution through observations in patients exposed to inhomogeneous dose distributions and experiments with organotypic tissue models.

- Addressing the difference between risks from internal and external exposures through the integration of new knowledge on the effects of chronic exposures, intra-organ dose distribution and radiation quality considering energy deposition at different scales (from intracellular to organs).

In epidemiological studies evaluation of the quality of available dosimetric data and identifying weaknesses and future needs for harmonization and standardization should be included.

Impact of the topic:

This topic addresses three of the PIANOFORTE specific objectives, contributing “To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches improving patient health and safety and supporting transfer of the R&I outcome to practise.” “To improve scientific understanding of the variability in individual radiation response and health risk of exposure.” and “To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates.”

The topic is a highly interdisciplinary one, since it requires combined expertise in the field of radiobiology, dosimetry, epidemiology, medical applications, which fall in the competence of the different platforms such as MELODI, EURADOS, EURAMED.

The topic is expected to generate new knowledge relevant for the large scientific community, outside radiation science as well. It harbours high innovation potential.

A3.

Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage

Scope of the topic:

Risks related to exposure to IR depend on the dose, dose rate, type of IR (ie radiation quality), volume of the body exposed and the type of exposed organs and tissues, each exhibiting different radiosensitivities. Dose-effect relationships may depend on the initial health state, history of previous exposure and lifestyle before and after exposure. Studies focusing on the role of specific target cells, such as stem cells / progenitor cells, the role of genetic and epigenetic factors, microenvironmental factors, sex and age at exposure, co-morbidities, environmental and lifestyle factors and the interactions between these depending on dose levels could contribute to a better understanding of the mechanisms responsible for individual response to radiation at the level of tissue reactions, stochastic effects such as cancer and radiation-induced aging and could help in advancing individualised cancer treatment.

Objectives of the topic:

The topic should investigate mechanisms of individual variations in radiation response as detailed above by focusing on one or several of the following objectives:

- Risks after radiotherapy

- Internal partial body exposure via targeted radionuclide therapy (TRT) with different radiation qualities. In particular, exposure of the bone marrow, kidneys and liver should be considered, as organs with the highest risk of exposure for adverse effects in this type of medical application

- External beam therapies and brachytherapies with different dose rates, fractionation schemes or dose-volume histograms, hypo-fractionated radiation therapy, novel particle therapies (proton, hadron, heavy ion therapies). Since these therapies are often combined with chemotherapy or immunotherapy, synergies between the different therapeutic combinations should be explored at the individual patient level from the point of view of the risk for therapy-related side effects (tissue or stochastic effects) and for maximizing treatment efficiency.

- Risks in children and young adults

A further objective of the topic is to investigate the specific risk of children and young adults after multiple diagnostic exposures related to cardiac catheterization or repeated brain CT scans as well as therapeutic applications for lymphomas or orbito-ocular/central nervous system tumors for long-term cardiovascular damage, cognitive impairment or second primary malignancies.

- Biomarkers of individual risk

Another objective is to seek biomarkers of individual risk through cellular/molecular, and/or systems biological approaches, radiomics investigations, evaluating potential predictive factors and correlating them with health outcomes. In case of studies related to previously identified biomarkers, validation and quality control should be included.

These objectives should be carried out among others by taking use of existing patient datasets and biobanks and by applying relevant preclinical 2D and 3D models, and relevant in vivo models. Where relevant, proposals should include communication among patients, caregivers, medical personnel and other stakeholders in order to empower them for informed decision-making and informed consent.

Impact of the topic:

This topic addresses three of the four PIANOFORTE specific objectives: „Improving patient radiation protection in relation to the use of ionizing radiation in the medical field" and "To improve scientific understanding of the variability in individual radiation response and health risk of exposure" "To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates".

The topic also relates to other non-EURATOM initiatives, in the frame of the mission area "Conquering Cancer – improving the lives of more than 3 million people by 2030 through prevention, cure and for those affected by cancer including their families to live longer and better".

The topic strengthens the link and synergy between radiation protection and medical treatment: towards an improved benefit—risk balance. This topic should be performed by a consortium including both radiation biology experts and medical partners to ensure impact and transferability of this research to the clinic in a swift way.

B. Improving the concepts of dose quantities

B1.

To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.

Scope of the topic:

The dependence of biological effectiveness on radiation quality is commonly believed to be related to the differences in the energy deposition pattern on a microscopic and nanoscopic scale. Identification and quantification of the relevant statistical characteristics of the microscopic spatial pattern of interactions (e.g., spatially correlated occurrence of clusters of energy transfer points) are an essential prerequisite for improvement of present dose concepts and understanding the radiation damage mechanism.

Objectives of the topic:

The topic should focus on one or more of the following subtopics:

- Investigating the physical characteristics of energy deposition on microscopic scale with the aim of developing a novel, unified concept of radiation quality as a general physical characteristic of the radiation field that would allow separating the physical and biological components contributing to the eventual biological effects of radiation.

- Developing microdosimetric and nanodosimetric detectors, revising their measurement concepts, and developing a 'gold standard' for track structure simulation codes along with their validation. Establishment of robust uncertainty budgets for micro- and nanodosimetric quantities obtained by measurement or simulation and identification of the major uncertainty sources.

- A comprehensive multi-scale characterization of the physical aspects of radiation energy deposition with quantitative investigation and correlation of track structure with biological effects at molecular and cellular level and their consequences at supra-cellular levels. Radiobiological experiments should be performed with relevant micro- and nanodosimetric metrological methods, thereby facilitating the identification of useful connections for further advancements in radiobiological modelling. The cancer development processes should also be considered in the modelling to obtain an estimation of low dose risk.

Impact of the topic:

This topic addresses two of the PIANOFORTE specific objectives, namely: "To improve scientific understanding of the variability in individual radiation response and health risk of exposure." and "To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates." The topic is expected to generate new knowledge relevant for the large scientific community, outside radiation science as well.

C. Understanding radiation-related effects on non-human biota and ecosystems

C2.

Determine the effects of ionizing radiation on ecosystem functioning and biodiversity

Scope of the topic:

The demonstration of the increased sensitivity of ecosystem processes to ionizing radiation, in comparison with the reported effects at the population level, would strongly question the robustness of risk assessments that rely only on population-effect data. On the other hand, if it is shown that the functional or structural redundancy (biodiversity) of the ecosystems brings greater robustness against the effects of radiation and potential other threats or anthropogenic degradations (multi-contamination, climatic change…), the conservatism of the current assessments would be supported.

Objectives of the topic:

The main objective of the topic is to investigate the effects of ionizing radiation on ecosystem functioning and biodiversity, as well as their potential consequences to human wellbeing (e.g., culture, food consumption, work and recreational activities) by focusing on one or more of the following specific objectives:

- Experimental research on the effects of ionizing radiation on functional processes in controlled conditions (e.g., microcosms and mesocosm studies).

- The reinterpretation (e.g., by ecological modelling) of the reported data on the current state of ecosystems and their temporal evolution in contaminated territories.

- Addressing the economic and socio-cultural dimensions of the impact of ionizing radiation on ecosystem functioning with the aim to provide a coherent framework encompassing both the radiation protection of human and ecosystems.

Impact of the topic:

This topic addresses three of the four PIANOFORTE specific objectives: “To improve scientific understanding of the variability in individual radiation response and health risk of exposure” “To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates” and “To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites.”

The topic adheres to the missions “Soil health and food” and “Healthy oceans, seas, coastal and inland waters” of Horizon Europe. It is closely connected to the Horizon Europe “Food, natural resources, agriculture, and environment, biodiversity” cluster that among its objectives includes “reducing environmental degradation and pollution”.

Therefore, the topic has a large scientific impact, since knowledge generated will be of interest for the broad scientific community. It also has great innovative potential.

D. Optimising medical use of radiation

D3.

Implementation of new and optimised radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.

Scope of the topic:

As stated in the CONCERT JRM medical use of ionising radiation is recognised as the largest source of exposure of the population in Europe and therefore of concern for society. It is of great importance to optimise radiological protection in medical applications of ionising radiation and to harmonise the practices throughout Europe with respect to the protection of human health from the harmful effects of ionising radiation and the potential benefit of the use of ionising radiation for individual patients.

Adaptive radiation therapy has been developed over the last years. New therapeutic approaches are currently under development like different targeted radionuclide therapies; FLASH therapies or microbeam therapies are being further developed and these and hadron therapies are being evaluated regarding their clinical potential for certain applications. The implementation is still difficult and not applied uniformly across Europe. All of these therapeutic procedures allow for certain diseases potentially treatments that would be suitable to reduce the radiation exposure of healthy tissues while maintaining the cancer / disease control thus potentially avoiding secondary malignancies.

Objectives of the topic:

The proposal should focus on one or several of the following objectives taking use of basic and/or translational research and/or transfer into the clinical practice:

- Optimisation and evaluation of the above mentioned novel radiotherapies regarding their potential protection for healthy tissues especially for high risk groups like paediatric patients.

- A better understanding of the mechanisms of FLASH and microbeam therapy.

- Clinical studies proving the benefits in terms of radiation protection of patients and long term outcome for a variety of clinical entities for hadron therapy and targeted radionuclide therapies.

- For adaptive radiation therapy it has to be investigated how it can be best implemented and what are the clinical prerequisites and the requirements for staff to achieve best possible results in terms of radiation protection of patients.

- Definition of standard application and standard protocols as well as operating procedures for adaptive radiation therapies, targeted radionuclide therapies and hadron therapies.

Impact of the topic:

This topic addresses two of the four PIANOFORTE specific objectives: “To innovate in ionising radiation based medical applications combating cancer and other diseases by new and optimised diagnostic and therapeutic approaches improving patient health and safety and supporting transfer of the R&I outcome to practise.” and “To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates”.

The proposal should contribute to improve the prevention, detection and safe treatment of cancer and to consolidate regulations and improve practices in domains using ionising radiation by capturing low-dose research advances. In the field of medical applications the proposal should provide: (a) new knowledge providing elements to decision-making and risk-benefit analysis; (b) transfer of new optimised medical procedures into clinical practices; (c) elements to pave the way to personalised medicine.

The topic is directly linked to Horizon research area "Mission on cancer", Europe's Beating Cancer Plan of HORIZON Europe and the Strategic Agenda for Medical Ionising Radiation Applications (SAMIRA initiative).

It has a large scientific and societal impact being relevant for the broad scientific community.

E. Improving radiation protection of workers and public

E3.

Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency

Scope of the topic:

In order to adequately prepare for and respond to a nuclear or radiological emergency, the capability to estimate absorbed dose to tissues within a specified period of time and how much of this dose could potentially be averted, through interventions, is required.

The key priority, after treatment of life-threatening injuries, is to identify people at risk of developing radiation-induced harmful tissue reactions. Tools are needed not only for emergency preparedness but also for estimating the relevant doses from individual bioassay measurements in the event of an emergency. The monitoring of children and pregnant women and producing dose assessments for them, using appropriate biokinetic and dosimetric models, should be a specific priority.

In case of a severe radiological event, some people might receive significant doses and other doses of no concern. Whatever their dose level, people should be informed about their individual monitoring results, dose and risk estimates. Communicating results just in terms of doses has been shown to be quite ineffective and communicating the risks might well be a better strategy. To support such an approach, tools should be developed, taking into account the most up to date risk models, particularly those based on absorbed doses. Along with the tools, a communication strategy which would be defined with the aid of public health and social science experts should be agreed. Decision makers would also be better informed if risk rather than doses were used.

Finally, whatever the dose level and type of accident, doses should be assessed as accurately and as quickly as possible and this may potentially need to be done for up to tens of thousands of people. With respect to the accuracy of doses a major issue is the characterization of the physico-chemical properties of the radionuclides involved in an incident, as this can have a significant impact on dose estimates. With regard to the need for fast and numerous dose assessments, alternative bioassay measurements and monitoring techniques should be evaluated (e.g. spot urine, nasal swabs, gamma-camera, portable equipment for monitoring in the field), and recommendations issued to select the most appropriate measurement strategy. Even for some key radionuclides like ^{131}I there are still debates on the most appropriate monitoring strategy, especially for early monitoring.

Objectives of the topic:

The research should be focused on one or more of the following objectives:

- Develop techniques, methods and tools enabling rapid assessment of the organ or tissue absorbed doses delivered over a short period of time, taking into account any dose modifying factors which are important for emergency dosimetry (e.g., age, sex, stable iodine intake, health conditions).

- Develop methods and tools to assess any health risks associated with internal exposures and develop guidelines to communicate the results.

- Establish guidelines on the medical follow-up after a contamination that does not require urgent action.

- Develop rapid techniques for individual monitoring and the assessment of the physico-chemical properties of radionuclides.

- Study the uncertainties and variabilities of dose estimates with respect to different bioassay measurements and prepare a global strategy of combined use of all available information.

- Test and disseminate the developed techniques, methods and strategies by conducting international intercomparison exercises and establishing a network of experts and laboratories for sharing expertise and technical capabilities in an emergency.

<u>Impact of the topic:</u>

This topic addresses three of the four PIANOFORTE specific objectives: “To improve scientific understanding of the variability in individual radiation response and health risk of exposure”; “To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates” and “To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites”.

The topic has multidisciplinary dimensions, since it relates to emergency response, dosimetry, epidemiology and social sciences. Moreover, it goes beyond effective dose for the assessment of individual risk in case of nuclear emergency.

G. Optimising emergency and recovery preparedness and response

G2.

Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies

<u>Scope of the topic:</u>

The emerging and future deployment of Small Modular Reactors (SMR), Advanced Modular Reactors (AMR) and nuclear fusion facilities will leave capability gaps in current environmental assessment data, methodologies and tools for both planned and emergency exposure situations. There is significant diversity in SMR, AMR and fusion technologies, which can include differing reactor designs to those used for existing large-scale nuclear facilities. As an example, this may lead to contributions from radionuclides that are less well studied; potentially different siting criteria for such facilities, e.g., on rivers/lakes/floating reactors or closer to population centres; and the potential for several facilities in closer proximity to each other than existing Nuclear Power Plants.

Objectives of the topic:

This research topic has the objective of identifying the key scientific knowledge gaps for the use of novel nuclear technologies in relation to both Environmental Impact Assessment (EIA) and Emergency Preparedness, Response and Recovery (EPR) purposes to ensure the impacts of such technologies are understood in advance of wider deployment. The proposal should focus on one or more of the following objectives:

- To prioritise the areas for further development drawing on reviews of technological readiness for example to provide approaches, data and adapted or new models to support EIA and EPR issues for novel nuclear technologies, considering their potential uses, and the related risks

- To provide, in the areas of EIA and EPR, more robust science-based demonstration of protection of workers, the public and the environment for the three types of exposure situations (planned, emergency, existing) and the strategy and scale of deployment of novel nuclear technologies. The limited existing knowledge does not allow for a holistic impact assessment including the consequences (benefits and disadvantages) of the deployment of such technologies. The integration of exposure assessments for both human and biota for such technologies should continue to be developed in the context of such novel technologies.

- To understand / anticipate how public perception about new nuclear technologies would evolve and to develop improved strategies for public information, communications and dialogue/debate

- To consider the occupational radiation protection aspects of such technologies for example of workers during routine operation, maintenance and transport

Impact of the topic:

This topic addresses two of the four PIANOFORTE specific objectives. Regarding the objective “To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates”, the work will support several elements of the BSS relating to both emergency preparedness and response regulations as well as those used for planned exposure situations. Regarding the objective “To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites”, the work would improve knowledge to support the preparedness for any radiological events involving novel nuclear technologies.

The topic contributes to several of the EU Missions in HORIZON EUROPE, such as “A Climate Resilient Europe: preparing Europe to climate disruptions and accelerating the transition to a future Europe within safe planetary boundaries” — the basis for the novel energy production methods that are the focus of this topic are ones that can be considered low carbon technologies and thus the research will help inform the safe regulation and use of such technologies; “Restore our Oceans and Waters: regenerating marine and freshwater ecosystems, eliminating pollution and decarbonising the blue economy” — novel energy production technologies will need to be considered in the context of sustainability of their emissions and this research topic will provide data and tools to help inform understanding of the impacts of such emissions; “100 Climate-neutral cities” — technologies such as SMR may enable cities to transition away from higher carbon-emitting energy production technologies, so this proposal should inform on the regulation and safety requirements that need to be considered.

H. Radiation protection in/with society

H3.

Sustainable practices and risk management strategies in radiological protection

Scope of the topic:

Radiation protection options should take into account the wider social, environmental and economic considerations, alongside radiological risk. However, there is currently no overarching theoretical framework to integrate these considerations. While promoting sustainable practices and risk management strategies is in focus in various radiation protection areas and is recognised as a key issue, the understanding and practical application of the concepts differ, and the extent to which the various dimensions are taken into account, particularly the social one, varies. There is a need to develop the theoretical and practical basis underlying these different sustainability perspectives in radiological protection.

Promoting sustainable radiological risk management practices and strategies in various areas of radiation protection (e.g., reuse of NORM residues, sustainable remediation of contaminated sites, sustainable radiology) is as a key issue on nowadays society. However, the practical application of the concept of sustainability differs. The research topic aims at providing comprehensive theoretical frameworks for promoting sustainable practices and management strategies within the varied radiation protection fields and explore opportunities and challenges for their practical implementation.

The topic acknowledges the cultural, social, and contextual factors that influence sustainability interpretations and emphasizes the importance of inclusivity, collaboration, and mutual understanding in the pursuit of sustainable development in radiation protection. The findings can inform policy development, decision-making processes, and community engagement initiatives, ultimately fostering sustainability in radiation-related activities across diverse contexts.

Objectives of the topic:

The proposal should focus on one or more of the following objectives:

- To explore and analyse the diverse understandings and interpretations of sustainability within different radiation protection fields.

- To examine how various stakeholders, including professionals, communities, and policymakers, conceptualize sustainability and its social, economic, and environmental dimensions.

- To investigate the underlying values, cultural influences, and socio-technical boundaries that shape sustainability perspectives and practices in radiation protection. To this end, the interplay between technological advancements, social systems, and sustainability objectives should be examined.

- To assess the role of participatory approaches in facilitating dialogue, mutual learning, and co-creation of sustainable solutions.

Impact of the topic:

This topic addresses two of the four PIANOFORTE specific objectives: “To support regulations and implementation of the BSS and improve practices in the domain of low dose exposures of humans and the environment by better understanding and reducing uncertainties in risk estimates” and “To provide the scientific basis to recommendations, procedures and tools for assuring better preparedness to response and recovery from a potential radiological event or nuclear accident and to improve the know-how to manage legacy sites".

By promoting sustainable practices and sustainable risk management strategies, the proposal should provide a theoretical and practical framework ensuring the appropriate "inclusion of [environmental,] societal and ethical dimensions in DSS" (decision support systems). By paying special attention to stimulating dialogue, mutual learning and co-creation the ethical evaluation of stakeholder engagement practices it should also contribute to "Research in effective communication and stakeholder involvement strategies".

By consolidating regulations and improving practices in domains using ionising radiation through the capture of low-dose research advances in support of the BSS implementation and of the EU Green Deal objectives, the proposal should specifically ensure the sustainable transition "while also protecting citizens' health from environmental degradation and pollution and addressing air and water quality".

The topic aligns with the Horizon Europe vision of supporting the UN Sustainable Development Goals. In particular, the ambition to tackle policy priorities and facilitate the uptake of research in decision-making in implementation of the green transition.

The topic connects to 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".

4.15. Annex 14: Form for ranking the topics included in the shortlist

Form for ranking shortlist

PIANOFORTE Second Open Call: Short list of scientific topics to be ranked		
Topic	**Ranking** ***(1 to 8, from highest to lowest priority)***	**Comments**
A2. Define how the temporal and spatial variations in dose delivery affect the risk of health effects		
A3. Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage		
B1. To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.		
C2. Determine the effects of ionizing radiation on ecosystem functioning and biodiversity		
D3. Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.		
E3. Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency		
G2. Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies		
H3. Sustainable practices and risk management strategies in radiological protection		

4.16. Annex 15: Ranking results for topics shortlisted for PIANOFORTE second open call

Platforms' rankings:

Topic	MELODI	EURADOS	NERIS	ALLIANCE	EURAMED	SHARE	Average	SOCRATES
A2. Define how the temporal and spatial variations in dose delivery affect the risk of health effects	**3**	1	5	7	1	6	3.83	1
A3. Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage	**1**	5	6	8	3	3	4.33	4
B1. To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.	**4**	3	8	5	6	8	5.67	8
C2. Determine the effects of ionizing radiation on ecosystem functioning and biodiversity	**7**	8	3	1	7	4	5.00	7
D3. Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.	**2**	2	7	6	2	5	4.00	2
E3. Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency	**5**	4	2	4	5	7	4.50	6
G2. Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies	**6**	6	1	2	8	2	4.17	3
H3. Sustainable practices and risk management strategies in radiological protection	**8**	7	4	3	4	1	4.50	5

There are large discrepancies in the rankings of the different platforms – see also equity analysis below. The overall ranking proposed by SOCRATES corresponds to a large extent to that obtained if we calculated the average score.

POMs' rankings:

Topic	A2.	A3.	B1.	C2.	D3.	E3.	G2.	H3.
Stockholm University	2	1	3	7	6	5	8	4
SCK	8	3	7	1	6	2	4	5
SURO	1	4	5	8	6	2	3	7
NNGYK	3	1	4	5	2	6	8	7
POMs-IT	1	3	4	7	2	5	6	8
UKHSA	3	1	6	7	4	2	5	8
IRSN	5	4	6	3	1	7	2	8
JSI	8	6	7	4	5	1	3	2
NCSRD	3	4	6	7	5	2	1	8
GIG	8	7	4	3	6	5	1	2
CEA	2	1	5	6	3	4	7	8
SMWK	5	2	1	8	3	6	4	7
APA	7	3	8	5	4	2	1	6
EK	1	4	3	8	7	2	5	6
UEF	1	3	7	2	4	6	5	8
DSA	4	2	8	3	6	5	1	7
RIVM	1	6	7	8	5	4	3	2
IST	3	1	2	7	4	5	6	8
BfS	5	1	8	7	4	3	2	6
SVK	3	2	4	5	1	6	8	7
DEMA	6	8	5	4	7	3	1	2
SSM	2	1	3	7	4	6	5	8
HDZR	6	8	5	1	7	3	2	4
Average	3.83	3.30	5.13	5.35	4.43	4.00	3.96	6.00
RANKING SOCRATES	2	1	6	7	5	4	3	8

There are also here large differences. SOCRATES[17] suggests the overall ranking shown in the table above (all POMs received equal weight). In the case of Italy, three POMs provided an identical ranking and they were considered in further analysis as one entity.

[17] https://knowledge4policy.ec.europa.eu/modelling/topic/social-multi-criteria-evaluation-policy-options_en/socrates_en

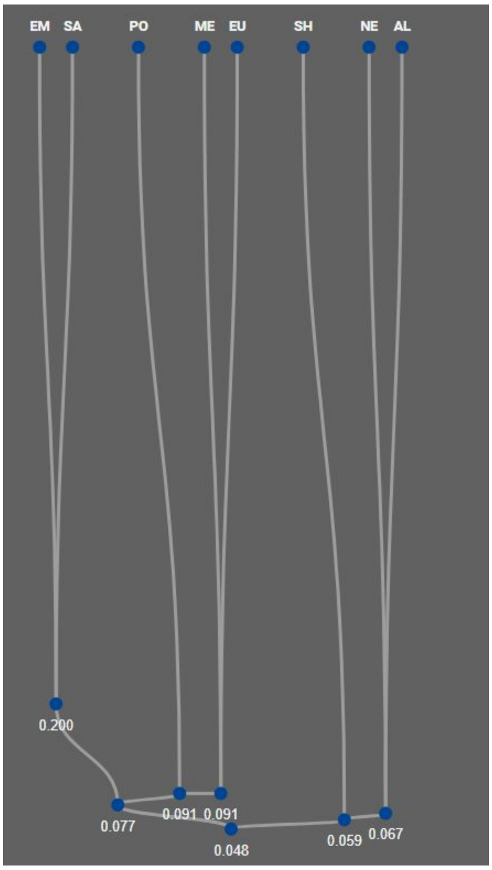
All rankings combined:

RANKING SOCRATES POMs	SAB	RANKING SOCRATES PLATFORMS	ALL AGGREGATED SOCRATES	TOM Ranking (excluding POM participants in TOM meeting)	Topic
2	1	1	1	6	*A2. Define how the temporal and spatial variations in dose delivery affect the risk of health effects*
1	3	4	2	3	*A3. Improved understanding of the adverse effects of ionising radiation in medical applications through tailored radiobiological studies focusing on major features of individual variability in the response to radiation-induced damage*
6	8	8	8	7	*B1. To quantify correlations between microscopic energy deposition and radiation damage, including improved measurement and simulation techniques.*
7	7	7	7	1	*C2. Determine the effects of ionizing radiation on ecosystem functioning and biodiversity*
5	2	2	3	4	*D3. Implementation of new and optimised Radiation therapy approaches for better targeting to protect healthy tissues better against detrimental effects of ionising radiation.*
4	5	6	5	2	*E3. Development of techniques and methods to go beyond effective dose in case of internal exposures following a nuclear or radiological emergency*
3	6	3	4	5	*G2. Ensure readiness and scientific knowledge to support Environmental Impact Assessment and Emergency Preparedness and Response for novel nuclear technologies*
8	4	5	6	8	*H3. Sustainable practices and risk management strategies in radiological protection*

Aggregation with SOCRATES was made considering 8 actors with equal weights: the 6 platforms, the aggregated POM and the SAB. TOM ranking was NOT taken into account in the SOCRATES ranking.

If we take maximum one topic per platform, the choice would be: A2 (or A3), D3, G2, (E3).

Equity analysis



Credibility	Coalition	1º	2º	3º	4º	5º	6º	7º	8º
0.200	EM [EURAMED], SA [SAB]	A2	D3	A3	H3	E3	G2	C2	B1
0.091	ME [MELODI], EU [EURADOS]	D3	A2	A3	B1	E3	G2	H3	C2
0.091	PO [POMs], ME [MELODI], EU [EURADOS]	A2	A3	D3	E3	B1	G2	C2	H3
0.077	EM [EURAMED], SA [SAB], PO [POMs], ME [MELODI], EU [EURADOS]	A2	D3	A3	E3	B1	G2	H3	C2
0.067	NE [NERIS], AL [ALLIANCE]	G2	C2	E3	H3	A2	D3	B1	A3
0.059	SH [SHARE], NE [NERIS], AL [ALLIANCE]	G2	H3	C2	E3	A3	D3	A2	B1
0.048	EM [EURAMED], SA [SAB], PO [POMs], ME [MELODI], EU [EURADOS], SH [SHARE], NE [NERIS], AL [ALLIANCE]	A2	A3	D3	G2	E3	H3	C2	B1

There are 3 clearly distinguishable clusters of preferences.

The largest discrepancy is between the preference for A2, D3, A3, E3 on the one hand (preferred by the group consisting of EURAMED, SAB, EURADOS, MELODI, POMs) and the preference for G2, H3, C2, on the other hand, (preferred by the group consisting of NERIS, ALLIANCE, SHARE).

Overall, selecting A2 (or A3), D3, G2 as recommended by the final ranking (and assuming only one topic per platform selected) seems equitable as it includes top ranked topics from all three clusters of preferences.