



## **Strategic Agenda for Education and Training in support of the Multidisciplinary European Low Dose Initiative (MELODI)**

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## 1. Introduction on the importance of E&T to underpin research

The focus of the MELODI platform is research into the risks from levels of ionising radiation in the region where it is still unclear whether the linear no-threshold model applies, or whether the risks are significantly greater or less than predicted by this model. Significant deviations in either direction would be significant both socially and economically. Less risk if proven scientifically would be of considerable reassurance to the public. More risk would have implications for the justification and optimisation of practices that involve the controlled use of radiation, particularly in the medical area.

MELODI acknowledges that at the relevant level of radiation exposure the incidence of harmful effects can be obscured by the noise in natural occurrence rates, and that to obtain reliable risk estimates requires studies over many years, even decades, employing a wide range of scientific disciplines. This long-term broad-scope process requires management to ensure continuity and cross-fertilisation of all the necessary disciplines. It is precisely this stewardship of the necessary resources of knowledge, skills, and expertise that calls for a strategic programme of education and training specifically designed to ensure a continuing influx of new top-level students into the needed scientific areas.

Since the year 2000, Europe-wide studies have identified a problem with the maintenance of the range of expertise essential to keep up competence and run an effective programme of research into the risks to humans and the environment from low-dose radiation. The findings indicate that specific programmes aiming at knowledge management across generations have to be designed in order to achieve sustainable continuity and development (see for example, the HLEG Report, <http://www.hleg.de/fr.pdf>). These programmes must be responsive to the needs of the research community, and be developed and maintained through a process of continuing interaction with stakeholders.

There are many ways in which E&T can provide support to the research community:

1. Providing entry points for attracting new students into one of the relevant disciplines.
2. Supporting students with career development to help them continue in the area
3. Integration of university teaching departments with institutions engaged in cutting edge research programmes for the benefit of both
4. Providing continuing education for working researchers in order to provide access to new and emerging developments and infrastructures, and to help penetrate the walls of the silos of specialisation
5. To provide a conduit for new research results to a wider scientific and operational radiation protection audience in order to raise the profile of the topic of fundamental radiation risk research.

This document will consider a strategic approach to constructing a programme of E&T support that takes account of each of these elements.

## 2. Definition of the scope of the E&T essential to MELODI

In taking a strategic approach to E&T, it is necessary first to answer some questions, to clarify just exactly what will be within the area of interest. With limited resources the focus must be on what will best serve the needs identified in the previous section.

### 2.1. The topics of interest for E&T

MELODI (Multidisciplinary European Low Dose Initiative) is a European Platform dedicated to low dose ionizing radiation risk research. The aspects of the research as defined in the MELODI Strategic Research Agenda are: basic mechanisms, health risk evaluation, and impact of radiation exposure characteristics. That means the research is aimed at the understanding and quantification of the risks of the range of manifestations of harm, in the various exposure situations. Importantly, it does not include radiation risk prevention or remediation, so it is not “radiation protection” in the full sense. Rather, this research area provides the fundamental risk data from which radiation protection policy and practice is derived. It is very important that this document looks after the interests of the MELODI community and does not get distracted by the interests of all the other platforms and professions associated with radiation protection.

Examples of different topics covered by this SA:

#### Biology

- Molecular and cellular radiation biology
- Cytogenetics
- Molecular radiation epidemiology
- Main principles of radiation genetics and embryology
- Radiosensitivity and possibility for its modification
- Non-targeted radiation effects and epigenetics, their role in low dose radiation risk
- Immunology

#### Physics

- Initial interactions of radiation with biological systems
- Track structure modelling
- Radiation metrology and dosimetry of ionizing radiation

#### Mathematics and statistics

- Radiation epidemiology
- Systems radiation biology
- Bioinformatics

#### Ecology

- Environmental radiobiology and the ecosystem approach

## **2.2. Should MELODI E&T concentrate on entry level or include life-long learning?**

Ideally E&T support should be given to researchers for their whole career path. But which is the critical point that would benefit most from sponsorship and promotion? Given the need to build up the strength of the research community, arguably this point is when students are looking to specialise and decide whether to continue on after a first degree in biology, ecology, physics, mathematics, etc., and if so, which particular area is of interest. This is where the “free taster” can be very valuable. To be free it must be supported through some type of sponsorship, and this should be seen as a strategic priority.

The continuing professional development (CPD) should also be included in the strategic plan, but possibly with focus on management and coordination rather than large-scale sponsorship. To a large extent CPD happens automatically through the process of attending conferences, developing new research proposals, and forming new research partnerships. Any good researcher will be continuously investigating more deeply within his or her area of specialisation. The contribution that a strategic E&T plan can make is to encourage scientists to look into new areas of science or technology. This can be done through the identification of promising topics and the organisation of teaching seminars at conferences etc.

## **2.3. What are the respective roles for E&T in development of expertise of researchers, and knowledge management/dissemination?**

In the context of this document, knowledge management consists of getting the maximum benefit from new knowledge generated and used by the low-dose radiation risk research community. This must be achieved by ensuring that the knowledge generated achieves maximum impact on the relevant bodies (scientific, industry, radiation protection, regulatory, international advisory, etc.) and also by ensuring that key new knowledge becomes a core part of the “corporate knowledge” of the research community. Any funding body now supporting research usually requires that every project dedicates resources to “impact” from the research results, and there is no real need to give added support to this aspect of knowledge management. However, the growth of corporate knowledge tends to happen organically, without any strategic plan. Individual scientists explore their own particular interests, attend conferences, talk to old colleagues over dinner, meet new colleagues who challenge their ideas, and progressively deepen their own knowledge. This may or may not find its way into PhD research topics, new research proposals and collaborations, and teaching syllabi. In a sense there is a healthy aspect to this process, in that it is how science proceeds. And a vigorous branch of science thrives and grows. The problem we face in low-dose research is that, for reasons such as public opinion about radiation, competition from new glamour sciences, and fickle public funding, this branch needs assistance.

So to address the above question, the part of knowledge management that is calling for a strategic plan of E&T is the incorporation of all the key new knowledge into the foundation of the hypotheses, models, and practices of the low-dose community. This is needed at all levels, from MSc, through PhD, post-doctorate, to senior scientists. The role of E&T is therefore to ensure that new knowledge is included in all initiatives. In particular:

1. Short “taster” courses offered by research and academic institutions that carry out cutting edge research;

2. Teaching seminars given at the MSc/PhD level by research project consortium members on new developments directed both to students and to practicing scientists for CPD;
3. Collaboration between research institutes and universities to allow MSc and PhD students to do project and thesis work in the newest research areas;
4. Strategic presentation of promising new scientific topics or technologies in teaching sessions at conferences (non-radiation topics, new infrastructures, measurement methods, computational methods, modelling paradigms, etc.)

#### **2.4. Should MELODI E&T be for “home consumption” or for “export”?**

E&T clearly must be directed towards development of the personnel potentially entering, entering, or already part of the radiation protection research community (the “home market”). But is there a strategic benefit from exporting E&T on the topics dealing with the basics of low-dose radiation risk to scientists from other disciplines or to other professions? The possibilities would include providing courses in the basic sciences (radiobiology, epidemiology, radiation physics, radiochemistry) or new research to medical physicists, radiation oncologists, radiation protection instructors, regulators, etc. The argument for doing this is part altruistic (the recipients would benefit and gain a greater understanding of radiation protection issues) and part that it would raise the profile of the research in terms of relevance and importance among stake-holders. But there are also contrary arguments. The low-dose community is small and has limited resources whereas the possible audiences listed above are huge, and they already have well-organised and well-funded bodies managing both entry qualifications and CPD. An initiative in this direction could divert precious resources away from where the primary need is.

After consideration of the alternatives, the opinion of the WG is that while the main E&T effort and resources must be directed to the home market, the door should not be closed on at least maintaining a dialogue with all users of radiation protection, in order to review at regular intervals the possibility of collaboration. Stake-holder relationship management may be a critical component of obtaining future funding.

### 3. Clarification of the specific needs for education and training activities

As previously noted, E&T in support of low-dose radiation risk research has two main priority areas: attracting/supporting new students and young scientists, and CPD of working scientists. Secondary priorities are exporting the science of low-dose radiation risk to other groups and professions and dissemination of new work through teaching events. This section considers ways of addressing each of these priorities.

#### 3.1. Specific needs for attracting and holding new students and young scientists

There are three stages to this process: catching the initial interest of the student, providing a course of study leading to a degree, and then being able to offer the student a secure career, first as a post-doctorate, then as a working scientist.

Students can be attracted to the area at any stage, and not just as a new graduate. But the starting level is most likely to be at the MSc level, when, after having graduated with a BSc in a more general topic, the student is looking for an area of interest to continue in. Experience with the short courses sponsored by DoReMi and more recently by CONCERT ([http://www.concert-h2020.eu/en/Concert\\_info/Education\\_Training](http://www.concert-h2020.eu/en/Concert_info/Education_Training)) has shown that 2-week courses hosted by one of the research institutions are very successful in giving students a taste of the research area at heavily subsidised cost. An alternative is the summer/winter school (eg. The NASA Space Radiation Summer School, <https://spaceradiation.jsc.nasa.gov/nsrss/> or the SCK•CEN Summer school in radiation biology <http://academy.sckcen.be/en>). We encourage the use of short courses and exchanges to allow young researchers the opportunity to visit and exchange with the leading research laboratories in topics that are not primarily part of their main research area, but which can broaden the scope of their studies, allow linking to other domains, and stimulate "out-of-the-box" thinking the other platform topics.

*Continued support of such initiatives needs to be maintained into the future.*

Having caught the student's interest, it is then necessary to provide a course of study leading to a degree in the relevant discipline. While many academic institutions can in principle offer such a course, it is preferred that the research component of the course be part of an active collaborative research programme so that the student can benefit from being at the forefront of the science and from the networking with other students and researchers. Collaboration amongst universities and between universities and research institutes is covered in Chapter 4 below.

Once the student graduates, ideally there should be openings for further study for a PhD, then a choice of post-doctoral positions, and then tenured employment within the research field. If this is seen as a good possibility, or even a likelihood, for a top student, then it will be an incentive to excel and stay with the field. But whether this will be the case over the next decades will depend more on the fortunes of low-dose research, its perceived relevance, and funding support, than on E&T initiatives. Nevertheless, initiatives for setting up industry/public-funded fellowships or joint positions with collaborating institutions should be explored, and a strategic plan can make the best of whatever the situation is, by making sure that the available possibilities for a career path are

communicated widely to the candidates. In this latter respect, the initiatives taken by the European Radiation Research Association for Young Scientists (EURAYS, <http://www.eurays.eu/>) and Task 7.5 of CONCERT ([http://www.concert-h2020.eu/en/Concert\\_info/Education\\_Training/Task7\\_5](http://www.concert-h2020.eu/en/Concert_info/Education_Training/Task7_5)) should be applauded and supported. They provide opportunities for networking and information sharing both amongst young scientists, and between young scientists and senior academics and researchers. *This networking to enable inclusion of students and young scientists into the research community needs to be given a higher profile at meetings and in universities where students are working for their first specialised degrees.*

### **3.2. Continuing professional development of the scientific community**

As previously discussed, continuing professional development (CPD) is something that a working scientist with any enthusiasm for her/his topic will do anyway, with no need for encouragement. Unlike many professions, where continued registration is contingent on collecting a minimum number of “CPD points” per year, this should not be needed in this case. But the CPD process is organic and local, rather than global. There is a potential to take a more global strategic view, and to seek to influence the growth of the corporate knowledge by making opportunities for targeted learning readily available. There are two aspects to this: the strategic choice of which topics should be promoted, as core areas that should be strengthened, or new disciplines/technologies “outside the square” that could lead to a breakthrough; and the organisation of the teaching events.

Concerning the choice, this a task that this WG should take responsibility for. The present document will be reviewed and updated at regular intervals. Each revision should include a review of any directions that need to be promoted for CPD. The annual workshop organised by MELODI has established the practice of including a session on E&T in the programme. This would be an opportunity for brainstorming and collecting requests for refresher and outreach teaching sessions. Recommendations would then be compiled and put in the next draft of the E&T SA.

There are many opportunities for CPD events. Any conference that covers low-dose radiation risk research should be encouraged to organise at least one teaching session taking account of the recommendations in this SA. In particular, the annual MELODI workshop (in whatever form it takes) should provide either a satellite teaching seminar or early morning teaching sessions. The E&T WG should play a primary role in the selection of topics and organisation of these sessions. Further to sessions associated with conferences and meetings, there is currently the option of proposing CDP seminar/workshops under the annual CONCERT E&T calls ([http://www.concert-h2020.eu/en/Calls/ET\\_Call\\_2016](http://www.concert-h2020.eu/en/Calls/ET_Call_2016)).

### **3.3. Other possible E&T initiatives**

#### **3.3.1 E&T in dissemination**

Dissemination was mentioned in section 2.3 above as an essential part of “value for money” that a funder looks for in a research project. For the main part dissemination is achieved through publications, conference presentations, press releases, etc. However a particularly effective way of ensuring that new research results are taken up by the research community is to present them by means of in-depth teaching seminars or workshops, giving full details on background, methods,

problems, and then questions and answers. The programme should be aimed both at sharing knowledge within the European low-dose research community and also at the wider radiation protection field including radioecology, emergency response, and the medical use of radiation. *It is strongly recommended that this practice be adopted, particularly in collaborative projects that develop new areas or methods that could potentially have wider applications.*

### **3.3.2 E&T provided for other professions**

This was mentioned in section 2.4 above. It was judged to be of possible strategic benefit but not high priority. There certainly is an argument for providing a basic understanding of radiobiology to professionals whose job includes making value judgements about radiation risk (such as radiation protection experts, radiation oncologists, radiologists, medical physicists, medical practitioners, etc.). A good grounding in what is well known, what is poorly known, and what is not known will help in providing perspective when providing advice as an expert, rather than merely repeating the standard guidelines.

However, there are precedents for such E&T contributions. The FP7-funded project EUTEMPE-RX providing teaching modules for radiology medical physics experts (<http://www.eutempe-rx.eu/>) included a module on basic radiobiology. Judging from the feedback the pilot course was well appreciated. This work was requested and funded specifically by the project and was not an ab initio initiative on the part of institution providing the course.

*So while there is a place for such actions, and they may be called for in the future, it is not the recommendation of this SA that they be promoted and resourced from general E&T funds.*

### **3.3.3 E&T online**

The number of online resources is increasing all the time. As well as the conventional website, there are social media for networking, and multi-media online teaching technologies. All of these could be used to promote and convey E&T for the benefit of the low-dose research community.

The basic requirement is a website that provides the hub for E&T relevant to MELODI. At the time of drafting this document such a website does not exist. The ideal placement would be a tab on the home page of <http://www.melodi-online.eu/>. Contents could include:

- Overview of E&T to support the MELODI community, with contact details for more information;
- Advertising of courses, seminars, travel grants, etc.;
- Advertising of calls to host courses, Euratom calls, etc.;
- Links to EURAYS, young scientist networks, etc.;
- For the future, possibly links to enrolment in online courses.

*The setting up and maintenance of such a site would take resources and dedication. However, it is strongly recommended that avenues are explored for ways of doing this, as it would enhance the profile and effectiveness of all of the initiatives promoted in this SA.*

## 4. Strategies for integrating/coordinating E&T resources

It was recognised in the HLEG report (<http://www.hleg.de/fr.pdf>) that international networking amongst academic institutions was essential in order to pool expertise, as was networking with non-academic research institutions. This section considers possible ways to facilitate such networking.

### 4.1 Coordination between academic institutions

There are a number of ways in which academic institutions can share their resources. The simplest technically is for one to employ visiting lecturers from other institutions to contribute to the teaching. This does not have the benefit of the students getting to work with the outside lecturers, but it does broaden the range of topics that can be included.

Another approach is for universities in EU States to develop mutual recognition arrangements, so that a student can easily transfer from one university to another. If courses are constructed in a modular fashion then modules can be shared and cross-credited using the European Credit Transfer and Accumulation System (ECTS). This will make it easier for students to follow a course of study according to their own interest. A wider use of the ECTS to include accredited summer/winter schools and focussed short courses would permit the incorporation of these into degree courses as well.

The ideal example of networking and collaboration is given in the European Masters course in radiobiology that was set up and run by Klaus Trott at UCL, London, from 1992 to 2012. This in effect “cherry-picked” the ideal expert European centres and organised the curriculum such that the students spent time at each. It has not been possible to recreate this course because of the difficulties in reconciling the different academic requirements in different States. However, such multi-national courses are constructed regularly through the Erasmus Mundus programme, so it is important that the possibilities and technical challenges continue to be explored.

*Collaboration amongst universities in the EU States should be encouraged and developed through participation in the MELODI Platform. Possible technical solutions to achieve greater integration between universities from EU States should be further investigated.*

### 4.2 Collaboration among E&T and research institutions

Collaboration between universities and research institutions can be of considerable mutual benefit in many ways. Students provide a ready labour force, particularly when the work contributes to the requirements for an MSc or PhD thesis. Student placements can lead to subsequent post-doctoral positions, and conversely the institution will have the opportunity to select the top students. A university typically covers a much wider range of related disciplines than a single-discipline research institute, opening up the possibility for multi-disciplinary collaborations. At the same time research resources can be used for course modules in the university courses.

EC-funded research generally encourages the cooperation between E&T and research. This has been made explicit in the first call launched by the CONCERT European Joint Programme. In this call applicants are encouraged to present an E&T plan that details how MSc and PhD project work will be

incorporated in the research programme, and how the research methodologies and developments will be disseminated into the E&T community through workshops and seminars.

There is also scope to encourage researchers to collaborate across scientific disciplines as many techniques utilised by the radiation science researcher are used also used in other life science areas and increasing awareness of the field. This may encourage penetration of radiation science in to universities and institutes that otherwise would be resistant.

*Collaboration between academic and research institutions should be promoted by encouraging universities to join in research consortia, and by participating in the MELODI Platform. Research calls should continue to promote the E&T component of RTD programmes.*

#### **4.3 Multi-platform multi-discipline E&T colloquia and fora**

An essential part of the development of networking and collaboration initiatives is to provide meeting sessions organised especially to get the main players together. In the low-dose research area the annual MELODI Education and Training Forum has been providing this function. With the move of the annual MELODI Workshop to a more general Radiation Protection Week, there is a danger that the specific needs of the MELODI community will become submerged in the much larger radiation protection community. While it is an important role of the forum to explore commonalities with the other platforms and RP groups, it should be a role of this E&T Working Group to ensure that there is an annual meeting dedicated to the aims of E&T for the specific support of the MELODI research community.

The purpose of the forum should be twofold: looking inward and looking outward. The first purpose is to provide practical networking between members of the MELODI community; discussion about what is happening in EU member states, what is needed, who can collaborate with whom, and what opportunities there are. The second purpose is to broaden the awareness of what is happening beyond the community: to compare notes with what other platforms are doing in their E&T programmes (ALLIANCE, NERIS, EURADOS, medical groups etc.), to explore the role of E&T for regulators (eg. HERCA), or international radiation protection advisory groups (IAEA, ICRP), or other E&T groups (EUTERP, ENEN).

*The MELODI E&T WG should review the effectiveness of the annual E&T Forum and make recommendations about the subsequent forum when seen to be necessary.*

## **5. Strategies for funding education and training**

Since 2010 E&T initiatives in support of low-dose radiation research have been largely funded through Euratom contracts, first DoReMi (2010 – 2015, [http://www.doremi-noe.net/training\\_and\\_education.html](http://www.doremi-noe.net/training_and_education.html)) then CONCERT (2015 – 2020, [http://www.concert-h2020.eu/en/Concert\\_info/Education\\_Training](http://www.concert-h2020.eu/en/Concert_info/Education_Training)). It is central to EC policy, and Euratom policy in particular, that support for science includes building European excellence, and that elevating the

capability of the research community through strategic E&T plays and essential part. However, in order to provide security to the E&T programme and some assurance of continuity for the decades into the future that are needed for the research effort, the funding base should be widened and diversified. This section considers some ways in which this could be done.

### **5.1 Stakeholder support**

The need for reaching out to and engaging stakeholders with interest or concerns about radiation risks is an issue for the research community as a whole as well as the E&T sector. It is the attitude of stakeholders that translates into national government policy, leading to national funding policies for science and education, and ultimately to EU policy. There is also the possibility that individual stakeholders with responsibility for radiation safety can be persuaded that funding E&T can be an effective way to strengthen our protection from radiation risks.

The radiation exposure scenarios of concern include medical, environmental (radon, naturally-occurring radioactive material (NORM), technologically-enhanced NORM), occupational (nuclear industry, aircrew, radon, NORM, etc.), radiological emergencies, remediation following emergencies, and possible radioactive material security threats. The stakeholders concerned include the nuclear industry, radiopharmaceutical industry, NORM-related industries, security-related stakeholders, Civil Protection, First responders, and the general public.

MELODI should maintain a policy on engaging with stakeholders, and take advantage of each contract to include funded tasks to carry this out, as for example in Workpackage 5 of CONCERT. As well as discussing the concerns for radiation safety, efforts must be made to promote an understanding of the contribution and importance of fundamental research into the risks, so that this aspect of research can be appreciated. In particular the full picture of how the research community functions and thrives needs to include the role of E&T.

*It should be a role of the MELODI E&T Working Group to maintain an overview of the efforts made to develop relationships with stakeholders, and make recommendations on promotion of E&T where appropriate.*

### **5.2 EC funding**

As remarked in the introduction to this section, substantial funding for E&T comes by way of EC umbrella contracts such as DoReMi and CONCERT, or as a component of research and technology development (RTD) projects. E&T is integrated into EC policy and it is likely (although not assured) that this situation will continue at least into the medium term (~10 years). As well as the EC calls directly relevant to MELODI there have been other E&T focused calls. These are typically directed towards training in radiation protection or nuclear technology and engineering (eg. ENETRAP, ANNETTE).

*Considering the importance of this source of revenue, every effort needs to be made to ensure that present and future calls are taken advantage of to support E&T within the MELODI area of interest.*

### **5.3 National funding**

National support of research into radiation protection as a whole is highly variable across the EU, as evidenced by the variation in financial support from Programme Owners participating in the CONCERT European Joint Programme. All States have national budgets for science and education, but there is generally nothing ring-fenced for radiation protection. This funding is made available on a competitive basis, and radiation protection is up against cancer research, global warming, and other topics seen as top priority. A certain amount of the national public funding will make its way to the research institutes and universities, and this undoubtedly already makes a significant contribution in the MELODI area, in providing the co-funding for EC contracts.

Is there a place for a strategy to enlarge the contribution? The answer must be yes, but with moderate expectations. This is the area where stakeholder engagement can play a part, by raising the public, professional, and regulatory perceptions of the importance of radiation risk.

There are other national bodies that can potentially fund or influence the funding for E&T. These include professional bodies that require a regular accumulation of CPD (continuing professional development) points, or regulatory bodies that require education and qualification levels to meet a minimum standard to comply with the law.

There is the potential to take greater advantage of the support of radiation protection in individual States. In practical terms this would be difficult to work with at the European level. It would be more useful for a national group or committee to be formed, which understands the local ways, to lobby and negotiate with individuals in the relevant places. The outcomes can be reported at the annual E&T Forum to give inspiration to others.

*Where there is the potential to use national state funding or professional/regulatory requirements to enhance the likelihood of national support for E&T in the MELODI area, this should be explored at the national level, and the outcomes communicated to MELODI through the E&T Forum.*

### **5.4 Individual funding**

Most countries have scholarships available to students, from a wide range of donors (deceased estates, lottery funds, industry, charities, etc.). They also come with a wide range of conditions (student's country of origin, place of study, topic of study, etc.). It is not out of the question that with sufficient lobbying such a scholarship could favour radiation risk research. Even if not that specific, there are many scholarships offered in the general scientific area that would be available for students. Indeed, this is undoubtedly occurring as part of normal university practice.

This is a potential source of funding that could be given a higher profile. There are websites that provide search tools for available opportunities. Some centralised coordination of the resource, possibly via the website recommended in section 3.3.3 should be considered.

**6. Road map. Recommendations for what should happen and when**

To be prepared for a subsequent draft.