



THE NATIONAL RADIATION PROTECTION R&D PLATFORM (PEPRI)

The National Radiation Protection R&D Platform (PEPRI) is an association, founded in July 2014 by the Spanish Radiation Protection Society (SEPR), whose purpose is to promote R&D&I focused on protection against ionizing and non-ionizing radiations (RP). PEPRI is open to all national entities in any way related to R&D in RP. At present it has 63 members from all the sectors connected to this activity.

INTRODUCTION

According to a survey conducted for the period from 2009 to 2014, R&D in the field of RP is a sector that has had average resources of around €10.5 M/year during this period. The external funding of these resources comes from the European Union Framework Program (23%), the Spanish Nuclear Safety Council (CSN) R&D Plan (16%), the National R&D Plan (9%), endowments from other private, autonomous and local entities (12%) and a high degree of self-financing of the research entities (40%).

This sector has not been explicitly recognized in our country's R&D, although it is true that Spain currently has technological infrastructures and experimental capabilities with considerable activity in RP R&D. Our research groups have a growing presence in European programs. With a varying degree of extent in our country, this R&D covers all the range from basic research (effects of radiation, epidemiology, dosimetry, radioecology, etc.) to the more operational aspects or applied research.

With the idea of identifying this sector and organizing it in the face of the requirements of the new European R&D Plan – HORIZON 2020 – which requires that national programs exist to be able to support specific projects with European financing, on July 3, 2014 the con-

stituent assembly of the National Radiation Protection R&D Platform (PEPRI) was held in the headquarters of the CSN, promoted by the SEPR and the CSN. The founding members of PEPRI were 40 entities from all the involved sectors: Hospitals, R&D institutes and universities, industry and energy, engineering and service firms, equipment manufacturers and marketers, and institutions. It is worth mentioning that in PEPRI there are not only researchers and developers, but also technology users that can promote developments of interest to them. PEPRI currently has 63 members and is governed by a General Assembly of all its members and a Management Council composed of 18 members that represent the different sectors present in PEPRI. The president of PEPRI is currently professor Francisco Fernandez Moreno, Professor Emeritus of the Autonomous University of Barcelona (UAB) and former CSN councilor, and the post of secretary is held by SEPR and on its behalf by Alegría Montoro, researcher of University and Polytechnic Hospital La Fe of Valencia.

Since its creation the Management Council has held 5 meetings: in Barcelona, Seville and the last 3 in Madrid, and on June 25, 2015 a meeting of the General Assembly was held in Valencia, in the framework of the joint Congress of the Spanish Radiation Protection and Medical Physics Societies.

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ALMUDENA REAL GALLEGO

CIEMAT

PIO CARMENA SERVERT

Endesa

Hospitals	R&D Institutes and Universities		Engineering & Service Firms
HC San Carlos IIS La Fe IIS-IP H La Princesa INIBIC-COG HU Gregorio Marañón HU Central Oviedo H Santa Creu i Sant Pau HCU Lozano Blesa Organización Sanitaria Integrada ARABA H. Virgen de La Victoria H. La Paz H. 9 de Octubre	CIEMAT CREAL Inst. Salud Carlos III IRYCIS UP Madrid U Sevilla U País Vasco U Rovira y Virgili UA Barcelona U Barcelona CEDEX UP Cataluña UP Valencia U Zaragoza (LABAC) U Autónoma de Madrid (CBMSO) U Extremadura (LARUEX) U I Baleares (LRA) U Salamanca U Huelva U Cantabria U Burgos	U Valencia GFM UC Madrid Centro Láseres Pulsados Salamanca U Murcia II Biomédicas Alberto Solís CSIC UAM U Granada CSIC "Eduardo Torroja" U de La Laguna U Las Palmas de Gran Canaria U Castilla-La Mancha	GNF Eng. Tecnomat GDES PROINSA SEA Ingeniería CEER SL Geocisa SINCROTÓN Alba GESTISA Centro Nacional de Dosimetría (CND)
Total 12		Total 31	Total 10
Industry & Energy		Equipment Manufacturers & Marketers	Regulators
			Consejo de Seguridad Nuclear (CSN)
UNESA ENRESA ENUSA		ARRAELA TECNASA LASME SL Heglesson SS	Miscellaneous
Total 3		Total 4	Sociedad Española de Protección Radiológica (SEPR) Sociedad Española de Física Médica (SEFM)
			TOTAL PEPRI MEMBERS: 63

Table 1. PEPRI Participants in July 2016.

PEPRI OBJECTIVES

The objectives of PEPRI, approved in its constituent assembly and included in its Charter, are as follows:

- Promote the growth of the RP scientific and technological base.
- Coordinate nationwide RP R&D&I initiatives and foster collaboration between the different players.
- Suggest scientific-technological priorities of the sector to the National R&D Plan.
- Advise, facilitate and support the coordination of Spanish participation in international R&D programs, and especially in the EU's HORIZON 2020.

These objectives are being developed in three specific courses of action:

- Preparation of sector documents and databases to promote RP R&D in Spain. In 2015, a report on Radiation Protection R&D in Spain was issued as a letter of presentation of the sector, and at present the platform is working on the preparation of a RP R&D Strategic Plan and a database of RP training offerings in the medical field in Spain.
- Collaboration with the CIEMAT to coordinate Spanish participation in RP R&D in HORIZON 2020, through the European Joint Program CONCERT (EJP CONCERT). CIEMAT has been appointed national Program Manager (PM) in CONCERT.
- Identification and implementation of collaborative RP R&D projects of

mutual interest to various RP sectors in Spain.

SECTOR DOCUMENTS ON RP R&D IN SPAIN

Report on RP R&D in Spain

Promoted by the PEPRI Management Council, this report summarizes the information provided by the PEPRI members for the 2009-2014 period it has been published in 2015. This report is available on the SEPR website: www.sepr.es.

This report concludes that, in Spain, there is a long tradition of research and development in the field of RP, which has been carried out both by

centers that basically focus on this subject and by groups of researchers from universities and other research centers of a more general nature. At present there are several programs under way that directly or indirectly include RP R&D among their objectives.

The current lines of work of RP research are related to the lines of interest that, at the European level, are reflected in the strategic agendas of the various European RP R&D platforms such as NERIS, MELODI, EURADOS and ALLIANCE. In this report, these lines have been grouped together in ten thematic areas, which are developed in 34 subareas and 117 lines. The distribution of the resources allotted in the 2009-2014 period by thematic area is shown in Figure 1.

The RP R&D players in Spain – researchers and promoters – are shown in Table 2, with the corresponding weight of allotted resources.

By order of allocation of financial resources to RP R&D by the Spanish entities, the main programs are as follows:

- EURATOM R&D Framework Program
- CSN R&D Program
- National R&D Program
- UNESA R&D Program
- ENRESA R&D Program

As for the RP R&D infrastructures, there are several singular facilities, including the CIEMAT which is a Spanish public research body that



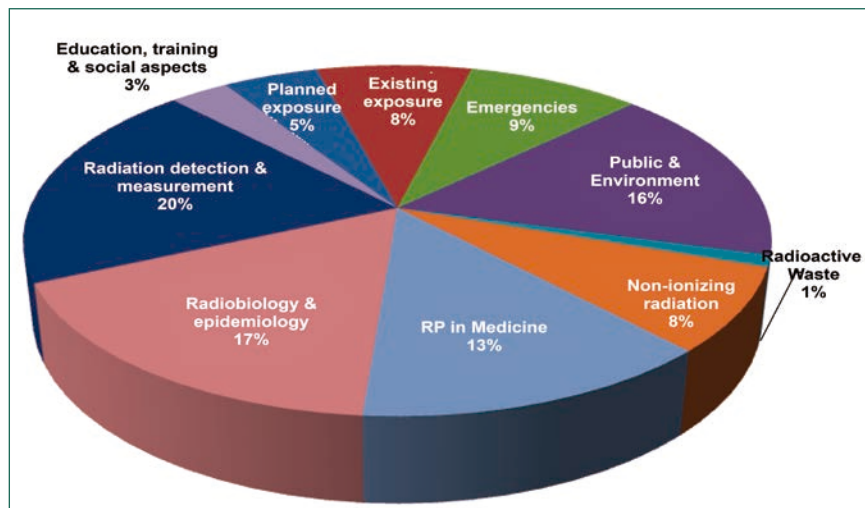


Figure 1. Distribution of the resources allotted in the 2009-2014 period by Thematic Area.

RESEARCHERS			
• CIEMAT	30%	• U. Málaga	2%
• CREAL	14%	• Hospital Gregorio Marañón Madrid	1%
• U. Autónoma Barcelona	6%	• Tecnatom	1%
• U. Complutense Madrid	5%	• Inst. Salud CARLOS III	1%
• U. Cantabria	4%	• Servicio Gallego de Salud	1%
• U. Sevilla-CN Aceleradores	4%	• U. Barcelona	1%
• Sincrotrón ALBA	3%	• Inst. Ramón y Cajal Inv. Sanitaria	1%
• U. Autónoma Madrid	3%	• Grupo Domínguis	1%
• C. Láseres Pulsados	3%	• Hospital 12 de Octubre Madrid	1%
• U. Extremadura (LARUEX)	3%	• U. País Vasco	1%
• U. Politécnica de Madrid	3%	• U. Las Palmas de GC	1%
• U. Politécnica de Cataluña	2%	• U. Islas Baleares	1%
• U. Rovira y Virgili Tarragona	2%	• Rest (15 entities)	5%
PROMOTERS			
• EU Framework Program	23%	• National R&D Plan	9%
• CIEMAT Self-financing	21%	• Other private entities	8%
• Self-financing of rest	20%	• Industry and Energy	3%
• CSN	16%	• Autonomous Communities & Local Admin.	1%

*U: University; C: Center; Admin.: Administration

Table 2. Distribution of the resources allotted in the 2009-2014 period: Researchers and Promoters.

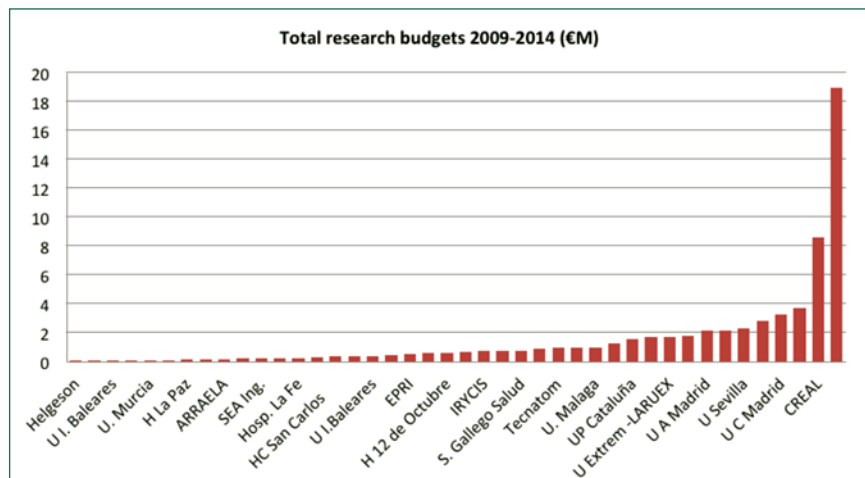


Figure 2. Resources of the different RP research organizations in Spain.

has nine laboratories that cover the thematic areas of environmental and public radiation protection, personal and ambient dosimetry, numeric calculus in dosimetry and radiation metrology. Also included, among others, are the National Accelerator Center of Seville, the ALBA Synchrotron, and the Pulsed Laser Center of Salamanca. In addition, a large number of universities, hospitals and some companies also have installations and calculation methods that enable them to undertake R&D activities. Thus, the calculation capabilities of the sector have also been estimated. Numerous Spanish university groups, and also research centers and engineering firms, have extensive experience in the use of programs for Monte Carlo simulation of radiation transport that are applied to very diverse thematic areas: emergency situations, dosimetry, shielding design, etc. The most widely used programs include: MCNPx, PENELOPE, GEANT 4, etc.

In the reference period, there have been more than 1,100 publications reported by the different researchers, which amounts to an average of more than 190 publications a year. In addition, 5 patents have been identified for designs of shielding materials and other products, e.g. computer programs, courses, etc., resulting from these activities.

PEPRI RP R&D Strategic Plan

On the basis of the aforesaid report, work on an RP R&D Strategic Plan for PEPRI is currently under way. The SWOT (S: Strengths; W: Weaknesses; O: Opportunities; T: Threats) and CAME (C: Correct; A: Adapt; M: Maintain; E: Explore) [English acronym: TOWS] analyses have been completed and four strategic lines have been identified: Institutional actions; R&D promotion; Communication between groups; and Knowledge management. Each of these lines has specific objectives that will be developed in a series of short-, medium- and long-term tasks, and indicators for follow-up thereof will be defined. The final version of the Strategic Plan is expected to be presented in the next meeting of the PEPRI General Assembly, scheduled for November 25, 2016 (Figure 4).

As part of this work, a detailed analysis has also been made of the needs and potential of R&D in the different areas, subareas and lines

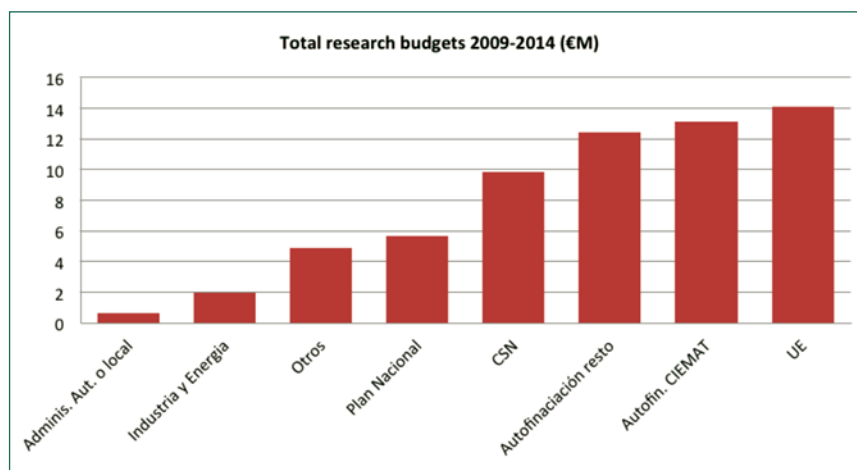


Figure 3. Resources contributed by the different RP R&D promotion plans in Spain.

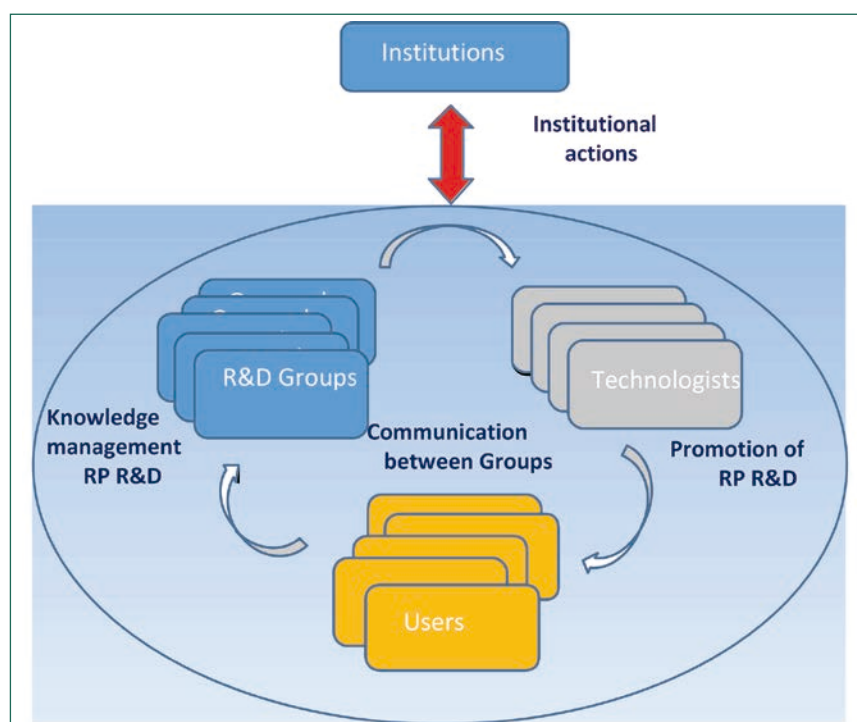


Figure 4. PEPR Strategic Objectives.

in which the RP R&D has been structured. Specifically, the following aspects have been assessed for each line:

- Current level of knowledge.
 - Modeling capability.
 - Existence of experimental data.
 - Existence of industrial or commercial developments.
 - Current level of development in Spain.
 - Maintenance or implementation needs.
 - Consistency with the EU R&D lines.
- The main conclusion is that there is

a need to acquire knowledge, especially in radiobiology and radiological emergency management, where more model development is also needed. Lack of experimental data is identified in radiobiology, but also in dosimetry, radioactive waste and radiological emergency management. Finally, industrial development needs are detected in dosimetry, occupational RP, radioactive waste and radiological emergency management. The conclusions of this analysis will be included in the current Strategic Plan.

Database of the RP Training Capabilities in the Medical Field in Spain

On October 26, 2015, the Spanish Medical Colleges Organization (OMC) and the IAEA signed an agreement in order to establish a framework of cooperation to create capabilities in Latin American and Caribbean countries in the fields of clinical radiology, including: nuclear medicine, diagnostic imaging, radiation oncology, radiobiology and medical physics, as well as in the fields of health-related nutrition and environmental studies. To develop the RP aspects of this agreement, both the IAEA and the OMC requested the CSN, CIEMAT and SEPR, in collaboration with PEPR, to each collaborate within the scope of their respective competencies.

Several specific areas of work have been identified in this line, including collaboration in theoretical-practical training of Latin American professionals in Spain. This can be achieved either with the existing on-site or online courses or, according to the needs, with ad-hoc courses developed by the Spanish entities. PEPR is working to create a catalogue of the national RP training activities and capabilities in medical applications which could serve to offer on-site and online education and training courses to professionals from the Latin American countries. An initial version of this catalogue is expected to be available at the end of 2016.

Other proposed activities are to invite representatives of SEPR to participate in technical seminars organized by the IAEA on these subjects; identify Spanish experts to take part in webinars on RP-related issues in the medical uses of ionizing radiation; collaborate to prepare and distribute educational e-learning material translated to Spanish from English material provided by the IAEA; and collaborate in the development and use of the results of IAEA projects related to the prevention of accidental exposures in radiotherapy (SEVRA-SAFRON) and to radiological safety in interventionist procedures, in particular in relation to system SAFRAD.



Meeting with the OMC and the IAEA in the CSN (January 26, 2016).

SPANISH PARTICIPATION IN HORIZON 2020

In the European context, RP is primarily integrated into the Euratom R&D Program, specifically in topic C: Foster Radiation Protection, which includes action NFRP 7: Integrating radiation research in the EU, with financing amounting to €19.8 M from European funds and national co-financing worth another €8 M.

This action has been implemented through a European Joint Program (EJP) mechanism. An EJP is a co-financing action designed to support coordinated national research and innovation programs. The purpose of

an EJP is to attract and pool a critical mass of national resources focused on Horizon 2020 objectives and challenges. These actions may also include complementary activities of network creation and coordination between the programs of different countries.

The European Commission contemplates four types of participation in an EJP:

- *Program Owner (PO)*, which in general are the national ministries / regional authorities responsible for defining, financing or managing the programs undertaken at the national or regional level.

- *Program Manager (PM)*, which are research centers, financing agencies or other entities – not necessarily public – that implement the national or regional research and innovation programs under the supervision of the PO. The PO may at the same time be a PM (POM). The PMs are designated by mandate of the PO.
- *Linked Third Party (LTP)*, an entity associated with the PO or PM via a structural agreement and to which an EJP task has been assigned.
- *Third Party (TP)*, which is any research group that is part of a proposal approved in the open calls that are launched in the EJP.

Only one proposal – called CONCERT – was submitted for action NFRP 7. CONCERT has been set up by a consortium composed of 32 PM from 22 European countries and Norway and headed by Bundesamt für Strahlenschutz (BfS) of Germany. Also participating in this consortium are the currently existing European RP platforms: ALLIANCE (radioecology), EURADOS (radiation dosimetry), MELODI (Effects and risks of low radiation doses) and NERIS (Radiological emergency and post-emergency preparedness), as well as 20 LTP.

The EJP CONCERT is expected to have two open calls, one in 2016 and another in 2017, to finance RP R&D projects. The topics of these calls will be based on those identified as priorities in the strategic research agendas developed by the above mentioned European RP platforms as well as on the RP R&D national programs of the participating countries. The 2016 call was closed on August 2 and included two topics:

- Improve the models to estimate the risk of radiation-induced effects (cancer and other effects) for low dose levels and rates.
- Diminish the uncertainties in the models to estimate the radiological risk to people and the environment in nuclear emergency situations and existing situations, including NORM, to facilitate decision making.

In Spain (Figure 5), for the Radiation Protection area, the Ministry of Economy and Competitiveness (MINECO) acts as Program Owner (PO), since it is responsible for the

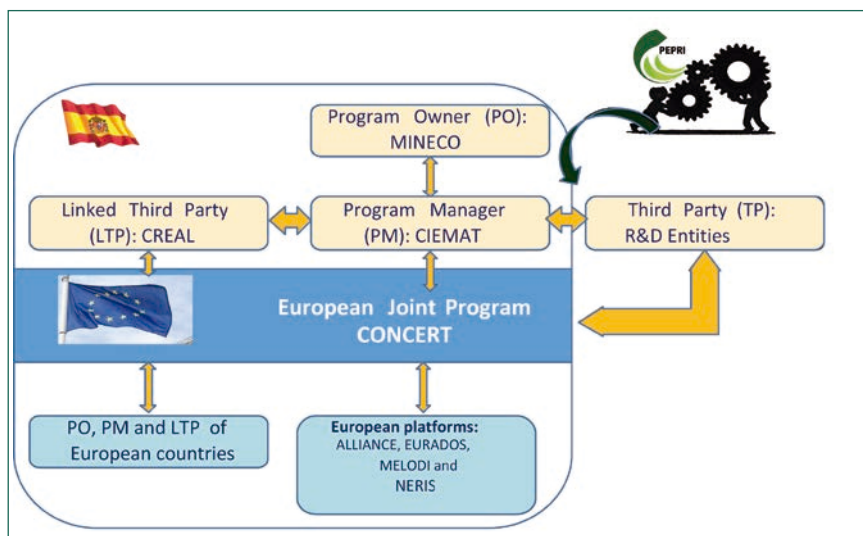


Figure 5. Coordination scheme of Spanish participation in EJP CONCERT.

National R&D Plan. The MINECO has appointed the CIEMAT as Program Manager (PM). Thus CIEMAT participates in the EJP CONCERT as Spanish PM and is a member of its Management Council. In addition, the Center for Research in Environmental Epidemiology (CREAL) participates in the EJP CONCERT as Linked Third Party (LTP) to PM CIEMAT.

The CIEMAT's functions as PM are as follows:

- Obtain the national funding for the Spanish research groups that take part in the CONCERT calls. For this purpose, based on the data regarding Spanish participation in the EU 6th and 7th FPs, the necessary amount has been estimated. Meetings have been held with MINECO and other possible financing entities such as the CSN. MINECO has compromised to create a specific call to finance Spanish entities that participate in proposals that have been accepted by CONCERT.
- Identify the entities with which the CIEMAT has a signed Framework Agreement and which would be eligible to become Spanish LTPs.
- Keep all the stakeholders in this scheme in Spain informed of the opportunities that arise in the different calls. To this end, the CIEMAT held a meeting on November 5, 2014 in its offices in Madrid, where it presented the strategic research agendas of the European platforms, the basis for the topics in the future calls of CON-

CERT. An informative meeting convened by CIEMAT and PEPRI was also held on the same day, to inform about the scheme described above. The novelties of CONCERT are also periodically reported via PEPRI to all its members. An information dossier on this subject, prepared by the CIEMAT, is available on the SEPR website www.sepr.es, in the section corresponding to PEPRI.

In addition to this collaboration with the CIEMAT to disseminate information related to CONCERT, PEPRI has another two specific functions in this context:

- Collaborate in the creation of an RP R&D Plan that supports the concept of "co-financing action", designed to support the coordinated national research and innovation programs which are the basis of CONCERT.
- Serve as a point of contact between researchers and researchers and promoters to form strong national groups that can lead projects submitted to CONCERT, together with other European R&D entities.

PROMOTION OF PEPRI RP R&D PROJECTS

Another of the Platform's most important activities is to put users demanding know-how and technology into contact with developers so that the latter can cover the needs of the former through joint research pro-

jects. The following figure shows the scheme of demand identification, development, integration and application of know-how and technology (Figure 6).

PEPRI is currently working in this line on three specific initiatives.

• Development of a technique for rapid discrimination of radioactive content of biological samples for *in vitro* internal dosimetry.

This proposal is promoted by the National Accelerator Center of the U. Seville, the U. of the Basque Country (researchers), Tecnatom (technologist) and UNESA (users). The CIEMAT is also interested.

The objective is to refine a protocol for preparation and analysis of Pu, U and other long-lived α and β emitters in biological samples for the rapid determination (24 hours) of the existence of certain radioactive isotopes in these biological samples, for application to *in vitro* internal dosimetry. This technique is applicable to emergency situations or potential contaminations of a large number of people which would recommend the use of discriminatory measures to focus on the really affected people.

The planned projects phases are as follows:

- Evaluate the existing capacity in Spain to analyze and quantify the levels of ^{239}Pu in urine by compiling data on the available techniques and their characteristics (response time, precision, etc.), and identify possible nationwide deficiencies for their application to accident situations.
- Based on the above point, identify and develop complementary techniques to the existing ones that could shorten the lab and analysis work time. The purpose of these techniques would be to identify, as quickly as possible, what would be a "positive" reading of ^{239}Pu in urine in conventional radiological monitoring and offer a conclusive result in less than 48 hours as of reception of the urine sample in the lab.
- Organize a network of accredited laboratories that have the ability to do this type of analysis, in order to be able to give a coordinated, rapid, effective response to the competent authorities in the event of an emergency situation that requires performing urine ^{239}Pu de-

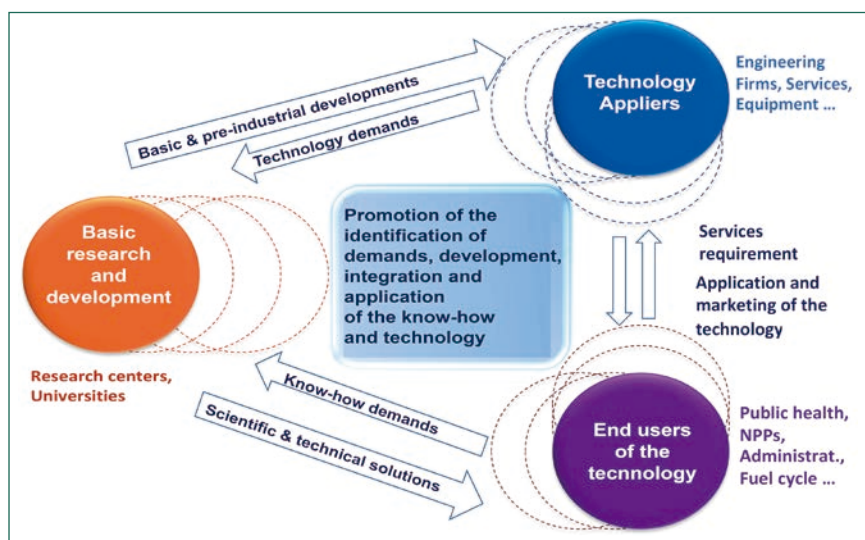


Figure 6. PEPRI project generation scheme.



terminations. The project to be developed aims to optimize the existing resources and knowledge in the country to provide this response.

• **Adaptation of the national capabilities for rapid discrimination of radioiodine incorporation in emergencies**

This proposal is initially promoted by the CIEMAT, the Universities of the Basque Country and the Balearic Islands (researchers), Tecnatom (technologist) and UNESA, University and Polytechnic Hospital La Fe of Valencia, Santa Creu i Sant Pau Hospital and General University Hospital Gregorio Marañón (users). More hospitals are expected to join in a more advanced phase of the project.

After the Chernobyl and Fukushima accidents, it has been seen that the radioisotopes that contribute the most to the committed effective dose equivalent from internal exposure are I-131, Cs-137 and Cs-134. Due to the short decay period of I-131 and the great uptake capacity of the thyroid gland, it is necessary to take immediate activity measurements of I-131 in order to complete an early screening of the people involved based on the quantity of activity deposited in the thyroid gland, and subsequently perform an epidemiological follow-up to try to prevent stochastic and determinist effects associated with the incorporation of this radioisotope.

The objective of the project is to refine a direct discriminatory thyroid measurement technique using conventional equipment duly calibrated on a unified basis. This idea is based on the THYROID exercise of Nordic Nuclear Safety and is applicable to emergency situations or potential contaminations of a large number of people which would recommend the use of discriminatory measures to focus on the really affected people.

The purpose of this project is to qualify the existing national resources to measure I-131 in the thyroids of members of the public in emergency situations, and to establish a rapid measurement protocol in the population affected by a nuclear or radioactive accident with high atmospheric emissions, fundamentally in the form of I-131 gas, that would rapidly permit a highly reliable identification of risk groups in children, adolescents and adults who may have been affected by the accident, in order to perform a

rapid screening in situations in which there is a large number of potentially affected people.

The calibration of equipment with different phantoms representing not only adults but also children and adolescents will improve the accuracy of the thyroid gland I-131 activity measurement in these age groups.

In short, the objectives would be to:

- Identify the available sites and equipment in the nation for thyroid screening measurement.
- Harmonize the equipment calibration process by using the same phantoms and sources of calibration. Develop and apply a general radiation metering equipment calibration plan, as well as medical diagnosis equipment and ambient contamination metering equipment, with several inserted thyroid phantoms with solid radioactive sources of Ba-133 and Cs-137, simulating different ages defined in standard ANSI/HPS N13.35. Thyroid phantom specifications will comply with the requirements of new standard ANSI/HPS N13.44-2014.
- Verify the calibration. Qualification of all the public and private project member organizations throughout Spain that have radioactivity metering equipment to rapidly and accurately make a direct measurement of I-131 activity in an emergency situation.

The project end product would be the establishment of a national network for the fast measurement of

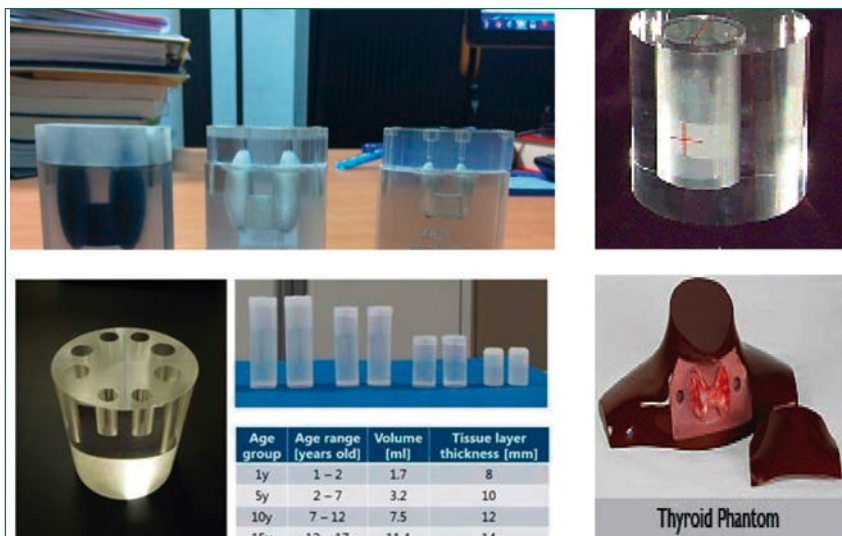
I-131 in thyroids which associates the equipment response to thyroid activity and a projected dose, thus promptly identifying the groups of risk in the affected population.

• **Spanish Network of Excellence of Biological Dosimetry Laboratories (REDB)**

This proposal is promoted by Hospital La Fe, Hospital Gregorio Marañón, Autonomous U. of Barcelona, U. Murcia, U. Seville and Institute of Biomedical Research of La Coruña (INIBIC) and Oncology Center of Galicia (COG).

The creation of the REDB will unite these Spanish laboratories with an experience in biodosimetry and will significantly improve the country's capabilities to estimate the absorbed dose of ionizing radiation. This will result in a tool to help make medical decisions. It will therefore also have a considerable socio-economic impact thanks to the provision of key scientific information regarding the long-term damage caused by radiation and the management of people concerned about their health condition.

Consequently the comprehensive, standardized methods that are included in the network will enable a better response in the event of a large-scale radiological event in Spain in which the operational capacities of a single laboratory could be overwhelmed. The general objective of REDB is therefore to establish a sustainable Spanish network in



Type of sources to be used in the metering equipment calibration project.

biological dosimetry that can provide a coordinated response to a radiological or nuclear accident in Spain.

The specific objectives are as follows:

- Create an operational base that identifies the biological dosimetry techniques used by each member laboratory of the network, as well as the capabilities of each one to receive and process the samples and estimate the dose in the event of a radiological emergency.
- Perform inter-laboratory training and qualification exercises to train their employees in those techniques not used in their work centers, in case there are plans to incorporate them.
- Assure quality standards in accordance with international guidelines and/or standards for dose estimation based on inter-comparison exercises between laboratories.

The project includes the following phases:

Phase 1.- Identification of the biological dosimetry techniques developed by each laboratory, as well as the capabilities to receive and process samples for dose estimation.

Phase 2.- Selection of the biological dosimetry technique(s) to be used for the comparisons.

Phase 3.- Execution of the first inter-comparison exercise, which will consist of the coordinating laboratory sending images (obtained from image banks created by the RENEB and BioDoseNet networks) to the support laboratories for interpretation.

Phase 4.- Execution of the second inter-comparison exercise, which will consist of the coordinating laboratory sending blood samples irradiated at different doses to the support laboratories for simulation of a radiological emergency in which the implicated laboratory cannot process all the blood samples it receives due to the magnitude of the event.

Phase 5.- Analysis of the results of both the first and the second inter-com-

parison. Uniformity and precision in the dose estimation will be assessed.

Phase 6.- Complementary training and qualification exercises, scheduled in parallel with the inter-comparisons and afterwards. The network members will analyze the additional training needs and will help to provide the training.

CONCLUSIONS

With practically only two years of existence, the National Radiation Protection R&D Platform (PEPRI) is intended to occupy an important space in national R&D as a reference body for exchanging information and for coordinating and promoting collaborative R&D projects in the field of RP. However, the degree to which this is achieved depends not only on the management of the platform itself, but also on the active, generous participation of all the national RP R&D entities and its use as a forum to come together and launch joint initiatives to the benefit of this sector and the general public in Spain. ■