



## **A Network to enhance International Cooperation for Research and Training on Nuclear Engineering between Universities and other Higher Education Institutions**

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### ***Abstract***

*The educational capacity of many Institutions of Higher Education in Nuclear Engineering has been sharply decreasing during last decades under the combined effect of a declining interest among students as well as from academic and political authorities. Furthermore, financial restrictions have made it increasingly difficult to maintain and develop facilities, equipment and academic staff needed for practical training of students as well as for basic research in the involved institutions. Industry, research institutes and universities need to work together to co-ordinate more effectively their efforts to encourage the younger generation and to develop and promote a program of collaboration in nuclear education and training. The obvious solution is an increasing cooperation at the international level on the educational efforts. The CHERNE network is a wide-scope open academic initiative to enhance cooperation among its partners, focused on teaching and learning activities. Typical activities organized within the network include workshops, intensive courses and seminars. Student and professor exchanges are very important and are organized in the framework of the ERASMUS and other international programs. In this paper, the CHERNE network, its objectives and the activities developed, or foreseen are presented.*

**Keywords:** *international cooperation, technical universities, nuclear engineering, learning improvement, student exchange, intensive international courses.*

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### ***Resumen***

*La capacidad educativa de muchas instituciones de educación superior en ingeniería nuclear ha disminuido considerablemente durante las últimas décadas bajo el efecto combinado de un interés decreciente entre los estudiantes y*

*las autoridades académicas o políticas. Además, las restricciones financieras han hecho cada vez más difícil mantener y desarrollar instalaciones, equipo y personal académico necesario para la capacitación práctica de los estudiantes, así como para la investigación básica en las instituciones involucradas. La industria, los institutos de investigación y las universidades deben trabajar juntos para coordinar más eficazmente sus esfuerzos para alentar a las generaciones jóvenes y promover un programa de colaboración en educación y capacitación en el campo nuclear. La solución obvia es una creciente cooperación a nivel internacional en los esfuerzos educativos. La red CHERNE es una iniciativa académica abierta de amplio alcance para mejorar la cooperación entre sus socios, centrada en actividades educativas. Las actividades típicas organizadas dentro de la red incluyen talleres, cursos intensivos y seminarios. Los intercambios de estudiantes y profesores son muy importantes y se organizan en el marco ERASMUS y otros programas internacionales. En este trabajo, se presenta la red CHERNE, sus objetivos y las actividades desarrolladas o previstas.*

**Palabras clave:** *cooperación internacional, universidades técnicas, ingeniería nuclear, mejora del aprendizaje, intercambio de estudiantes, cursos intensivos internacionales.*

## **1. Introduction**

The educational capacity of many Institutions of Higher Education in Nuclear Engineering has been sharply decreasing during last decades under the combined effect of a declining interest among students as well as academic and political authorities. Furthermore, financial restrictions have made it increasingly difficult to maintain and develop facilities, equipment and academic staff needed for practical training of students as well as for basic research in the involved institutions. Nevertheless, a significant number of professionals at different levels of education continue to be required for safely operating and managing the nuclear industry and other activities involving the use of radiations.

Each university and country presents a different situation, but many departments that were initially able to propose a large panel of orientations in this field had to reduce their offer and to concentrate it on a few specialities.

Industry, research institutes and universities need to work together to co-ordinate more effectively their efforts to encourage the younger generation and to develop and promote a program of collaboration in nuclear education and training. The obvious solution is an increasing cooperation at the international level on the educational efforts. For this reason, several networks have been developed, some of them focused on specific domains, others concentrated on high level professional training, some strongly structured and others not.

The CHERNE network, created in 2005, is an initiative mainly focussed on teaching and learning activities to develop a wide-scope open academic network to enhance cooperation, competence and equipment sharing between its partners.

Cooperation should enhance the mutual support by learning from each other, by exchanging experiences, and by regular mutual reflections on how to counteract the 'less interest among students' and the 'less interest among the academic and political authorities' and also on how to learn from more successful or from less successful partners.

In this paper, the CHERNE network and its main objectives are presented as well as activities developed since its foundation. Special attention is given to international intensive courses organized for students of member institutions.

## **2. The CHERNE network**

The CHERNE network has its origin on some ERASMUS Intensive Programmes (IP) organised during first years of this century with the participation of ČVUT (České Vysoké Učení Technické v Praze, Czech Republic), DIQN-UPV (Departamento de Ingeniería Química y Nuclear, Universitat Politècnica de València), ISIB (Institut Supérieur Industriel de Bruxelles, Belgique), XIOS (Hogeschool Limburg, Diepenbeek, Belgium) and FH Aachen (Fachhochschule Aachen, Campus Jülich, Germany) (Čechak et al., 2005).

A larger partnership was considered necessary to extend the scope of this collaboration, and it was initiated with the constitution of the CHERNE network in 2005 during a workshop organised in Valencia (Spain) by UPV (Ródenas, J. (Ed.), 2005). The five mentioned institutions plus Alma Mater Studiorum - Università degli Studi di Bologna (Italia) signed a declaration to constitute CHERNE that stands for Cooperation in Higher Education on Radiological and Nuclear Engineering. This declaration contains details concerning organisation, membership and activities of the network.

The partners of CHERNE meet once a year in a workshop to evaluate the activities of the network and discuss any proposal to extend or modify them as well as amendments to the declaration if any. No fee is foreseen for CHERNE membership. CHERNE has a minimal administrative organisation, ensured by the Secretary elected at the annual meeting. Secretary of CHERNE was Prof. José Ródenas (UPV) since 2005 till 2015 when he irrevocably resigned and it was elected Prof. Isabelle Gerardy (ISIB-HE2B) who presently continues being the Secretary. The Secretary manages a Web page through which the activities of the network are communicated. The site was <https://www.upv.es/cherne/> till 2016 when it moved to <http://www.cherne.ntua.gr/>. A Bulletin was also periodically published for partners and a CHERNE platform was created to give public access to activities.

Academic and research institutions, companies or individuals are accepted as members on presentation by two members, including at least one European academic member. Documents for this presentation as well as the list of partners can be found at the official Web site.

The Initial Members were the founders of CHERNE in 2005:

- UPV Dep. Ing. Química y Nuclear, Universitat Politècnica de Valencia (Spain)
- Haute École Paul-Henri SPAAK, ISIB, Institut Supérieur Industriel de Bruxelles (Belgique), presently renamed HE2B (Haute École Bruxelles-Brabant)
- ČVUT, (Czech Technical University in Prague, Czech Republic)
- XIOS, presently Hasselt University, Diepenbeek (Belgium)
- Fachhochschule - Aachen University of Applied Sciences, Jülich (Germany)
- Alma Mater Studiorum - Faculty of Engineering - Università di Bologna (Italia)

Successive Members joined the network:

- UPC, ETSEI de Barcelona, Universitat Politècnica de Catalunya (Espanya)
- Dipartimento di Ingegneria Nucleare, Politecnico di Milano (Italia)
- Dipartimento di Fisica, Università degli Studi di Messina (Italia)
- KSU, Kansas State University (USA)
- Dipartimento di Fisica ed Astronomia, Università di Catania (Italia)
- IST, Instituto Superior Técnico from Universidade Técnica de Lisboa (Portugal)
- Departamento de Física, Universidade de Coimbra (Portugal)
- Dipartimento di Ingegneria Nucleare, Università di Palermo (Italia)
- Cadi Ayyad University, Marrakech (Morocco)
- Universidad de Salamanca (Espanya)
- NTUA, National Technical University of Athens (Greece)
- Aristotle University of Thessaloniki (Greece)
- Belarusian State University, Minsk (Belarus)
- Universidade da Beira Interior (UBI), Covilhã (Portugal)
- Università degli Studi di Milano (Italia)
- Hochschule University of Manheim, Germany

Some of this members were suppressed from the CHERNE network because they didn't participate in any activity or workshop during 5 years.

There are also three individual members:

- Dr. Dieter Hennig, Berlin (Germany)
- Prof. François Tondeur, Brussels (Belgium)
- Prof. Herwig Janssens, Diepenbeek (Belgium)

### **3. CHERNE activities**

The scope of CHERNE is not limited and any activity related to higher education in radiological and/or nuclear engineering can be proposed. CHERNE activities will be organised mostly for students of members, mainly at Master level. They should include at least a one-week/2 ECTS module. It's necessary to include practical training in activities for students,

including when possible access to large facilities. The language used in CHERNE activities is English. They will be organised at no cost, or very low fee, for students coming from other partner institutions. The organising partner will find and propose cheap accommodation for the students coming from abroad. When possible, the organisation of CHERNE activities will be included in ERASMUS exchanges. Therefore, the partners are encouraged to sign bilateral ERASMUS agreements.

### **3.1 Workshops**

An important activity is the Annual Workshop where activities developed in each partner institution are presented including teaching and research. The Workshop is open to non-members who can present their own activities. At the same time, the Annual Council of CHERNE is organised to evaluate the network activities and discuss new proposals. So far, 15 Workshops have been organised: Valencia (Spain) in 2005, where the network was created (Ródenas, J. (Ed.), 2005), Valencia in 2006 (Ródenas, J. (Ed.), 2006), Prague (Czech Republic) in 2007, Favignana (Italy) in 2008 (Mostacci, D. and Ródenas, J. (Eds.), 2008), Jülich (Germany) in 2009, Coimbra (Portugal) in 2010, Brussels (Belgium) in 2011, Athens (Greece) in 2012, Salamanca (Spain) in 2013, Thessaloniki (Greece) in 2014, Minsk (Belarus) in 2015, Cervia (Italy) in 2016, Covilhã (Portugal) in 2017, Macugnaga (Italy), in 2018, Portopalo di Capo Passero, (Italy) in 2019.

### **3.2 Intensive courses**

ERASMUS Intensive Programmes were the most important of intensive courses. **PAN**: Practical Approach to Nuclear techniques, was organised in 2002 and 2003 in Prague, and in 2004 in Mol-Brussels. After the creation of CHERNE, a second IP (**SPERANSA**, Stimulation of Practical Expertise in Radiological and Nuclear SAfety) was organised in 2006 (Mol-Jülich), 2007 (Prague) and 2008 (Mol-Brussels). Posterior IPs supported by the Erasmus programme were: **JUNCSS** (Jülich Nuclear Chemistry Summer School) organised always in Jülich (2008, 2009, 2010); **ICARO** (Intensive Course on Accelerator and Reactor Operation and applications) organised in 2009 (Lisboa ITN), 2010 (Catania-Palermo) and 2011 (Lisboa ITN); **SARA** (Safe Application of RAdiation and radionuclides) organised in 2012 (Mol-Jülich), 2013 (Prague) and 2014 (Mol-Geel- Diepenbeek); **MANTRA** (Medical Applications of Nuclear Techniques and Radiations) organised in 2014, (Bologna). Professors and students of several CHERNE members participated in these IPs.

Other one-week courses were organised in Jülich: **MARC** (Methods and Applications of Radiation Chemistry); and **RADAM** (RAdiation Detection And Measurement). In 2009 and 2010 two intensive courses took place in Brussels and Diepenbeek (Belgium): Radiation protection and nuclear measurement in non-conventional sectors (**RAP-NOCOS**) and XIOS-ISIB Measurements of Environmental Radioactivity (**XI-MER**). Master Seminars at UPV were given by professors of CHERNE partners (PoliMilano, ISIB, FH Aachen and Coimbra).

PRA (Probabilistic Risk Assessment of Nuclear Power Plants at UPV, 24-27 January, 2011. And many others.

### **3.3 Participation at International Conferences**

The organization and interest of CHERNE as well as activities organised and improvements achieved were presented by CHERNE members at different International Conferences. Some of them are: ETRAP 2005, Brussels, Belgium (Čechak et al., 2005); First EUTERP Platform Workshop 2007, Vilnius, Lithuania (Ródenas, J., 2007).; European Nuclear Conference 2007, Brussels, Belgium (Tondeur, F. and Ródenas, J., 2007); NESTet Conference 2008, Budapest, Hungary (Ródenas, J., 2008); IRPA-12 Buenos Aires 2008; ETRAP 2009, Lisboa, Portugal (Ródenas, J., 2009); 1<sup>st</sup> World Engineering Education Flash Week, SEFI Annual Conference, Lisboa 2011.

## **4. Erasmus+ Strategic Partnership**

New Erasmus+ programs, replacing IPs appeared with a different format. They were Strategic Partnership projects. Some members of CHERNE applied for these projects and they got two successive projects approved. “*Blended learning in radiation protection and radioecology (15PS0002)*” for 2015-2017 and “*Train the trainees - Train future trainers in radiation protection and nuclear technology (18PS0002)*” for the period 2018-2020 (Schreurs, S., 2019).

### **4.1 Blended learning in radiation protection and radioecology**

Objectives of development of a blended learning program in radiation protection and radioecology are the continuous education program for people already involved in radiation protection, but also acquisition of specific competences in the nuclear field for those who were not involved in nuclear and radiological techniques during their studies. Another objective is the contribution towards standardization of the knowledge across Europe in radiation protection and safe use of radioactive materials.

E-learning (virtual mobility) and training courses (real mobility) were two ways to fulfil these objectives. E-learning modules are used as a preparation for advanced course modules, for selection of students in the case of practical sessions and finally for the follow-up of the global program. Real mobility give access for students to large experimental devices not present in each country and to be given the opportunity to do an internship in other EU countries.

Training modules organised have been: **Safe industrial applications of radiation and radionuclides** at CTU Prague (2016); **Radiochemistry** at HESpaak, FHAachen (2016); **Probability Risk Assessment** at UPV (2017); **Radioactive waste management** at UHasselt (2017); and **Practical radiation protection in medical field** at Bologna University.

#### **4.2 Train future trainers in radiation protection and nuclear technology**

Starting from the previous developed blended learning environment with E-modules and training schools, new teaching activities are proposed. Before each training school, 2 Moodle modules for self-study and MCQ for self-assessment. Tasks in advance in small mixed groups (3-4 students); Video lectures on SDGs and 3 Google meet sessions. The training school includes team work in the same mixed groups, e-modules to prepare the lab activities and background information, group task presentation, Trainer' presentations about lab experiments and final MCQ.

During 2019 three training schools have been organized: MERADE, Environmental radioactivity in Brussels; RC-MED, Radiochemistry and medical dosimetry in Mannheim; and NIRM, Nuclear Industry and Risk Management in Prague. Next academic year, training schools will be continued in other universities.

### **5. Results**

Positive results and negative ones have been got so far. Among positive ones they are: IPs organised; Courses and Seminars given by professors of one institution in others; Cooperation bilateral and multilateral between institutions for Master and PHD Thesis. These collaborations imply Erasmus bilateral agreements between partner institutions. Exchanges of professors and students can be considered the main fruit of the network. Among negative results, they can be mentioned those courses not organised or without enough attendance, inactive partners, some failure in communication.

The main problem associated with CHERNE activities is financing, the key difficulty. If the courses are to be financially viable, they need to be supported by grants, mostly from the EU programs. If the courses are not financed, it is necessary to look for sponsors. On the other hand, CHERNE activities are based on the enthusiasm of individuals in a number of partner institutions, without whom the network would soon be disbanded. A young generation should continue their work. For some activities, it is difficult to bring together a good enough group of students who will regard the course as a contribution to their education, and not merely as a pleasant sightseeing tour.

### **6. Conclusions**

On the basis of an existing collaboration between some teaching institutions, the creation of the CHERNE network permitted to enhance the educational cooperation among the partners.

The main target of the network has been to develop teaching activities for the benefit of students of the institutions belonging to the network.

The CHERNE network represents a clear added value for students, in particular with the intensification of Erasmus exchanges between partners. Consequently, the exchange of students has been clearly increased, giving them an access to specialized fields not developed in their own institution.

A clear result obtained so far with the CHERNE network, more specifically with the intensive courses developed, is the enhancement of the interest of students and academic authorities on Nuclear Engineering.

The perspective of the CHERNE network is to gradually propose more activities, while admitting new partners who can contribute to the network's life with new activities and more students benefiting of them.

Strategic Partnership projects are giving more opportunities to students of our institutions to participate on training courses through Europe, improving their learning and giving them the possibility of contacts with other institutions.

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