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MEET-CINCH

First Public Report

2017 - 2018



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programme 2014-2018 under grant agreement No 754 972.*



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EXECUTIVE SUMMARY

The MEET-CINCH First Public Report briefly introduces the MEET-CINCH project, a three-year project with 12 partners from 9 countries implementing a modular European education and training concept in nuclear and radiochemistry financed from the Euratom research and training programme. Above all, the Report describes main achievements from the first year of its realization.



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1. MEET-CINCH – AIMS AND OBJECTIVES

In 2010–2016 two “CINCH projects” – CINCH-I: Cooperation in Education in Nuclear Chemistry, and CINCH-II: Cooperation and training in Education in Nuclear Chemistry – were supported within Euratom FP7. The projects aimed at mitigating the special skill-based deficits within nuclear chemistry at master and doctorate levels and the decline of number of staff qualified in this field. The projects were built around the well-proven five-phase (Analysis, Design, Development, Implementation, Evaluation) Systematic Approach for Training (SAT) developed by IAEA; while CINCH-I dealt with the first three phases of the process, CINCH-II concentrated on the implementation. Additionally, evaluation mechanisms were proposed and tested on the pilot courses developed during the projects. The European Network on Nuclear and Radiochemistry Education (NRC) and Training (nrc-network.org) was established in CINCH-II project.

The MEET-CINCH project does not aim at sustainability of CINCH-I and CINCH-II only – its main aims are to proactively bring the results achieved so far to the end-users (such as companies involved in radiochemistry and radioprotection via the CINCH VET – Vocational Education and Training – e-shop), significantly contribute to attracting new talents and increasing the nuclear (chemistry) awareness by developing a **MOOC – Massive Open Online Course**, and investigate the applicability of the modern **Flipped (Inverted) Classroom** concept in the nuclear chemistry teaching and training field.

The main objectives of MEET-CINCH are as follows:

1. To extend the number of Vocational Education and Training courses developed in the previous projects and make them better available to the end-users. To reach this objective:

- the CINCH-II VET Syllabus will be updated to cover all the courses developed and demonstrated under CINCH, CINCH-II and MEET-CINCH projects
- several new courses will be completed and brought up to the pilot level. These courses will make use of combination of all the existing tools – e.g. **RoboLab** exercises, Computers in Science exercises, CINCH Moodle course management system – and will both use and expand the teaching material available from **NucWik**.
- a new platform – **CINCH VET e-shop** – will be launched that will provide easy access to and details of all courses brought at least to a pilot level. This platform is expected



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to be a major contribution to the sustainability of the results achieved in all the above-mentioned projects.

2. To attract new talents to the nuclear field. This will be achieved by increasing the awareness of the relevance of Nuclear and Radiochemistry for society by:

- developing and offering a **MOOC** on NRC's importance. In addition, to increasing the awareness, this is expected to increase the number of students that select a career path which includes an NRC component
- developing a **teaching package aimed for use in high schools for 16-18-year-old pupils**. The package will demonstrate the importance of NRC for society and future work opportunities. This activity is also expected to increase the number of students that select an education that includes an NRC component, small or large
- establishing a **Mobility Fund** that will facilitate participation of students and young researchers from other "chemistry" Euratom joint projects, such as, e.g., GENIORS in lab courses and summer schools provided by MEET-CINCH or other activities.

The modern **Flipped Classroom (or so-called Inverted Classroom) concept** will complement the available tools for teaching and training in the nuclear and radiochemistry field. In conjunction with the **NucWik database of teaching materials**, a set of the **RoboLab remote operated laboratory experiments** and the CINCH Moodle distant learning management platform MEET-CINCH will provide a comprehensive toolkit, available in the **CINCH VET e-shop**. The end user will be able to compile courses tailored to individual needs from this flexible modular base of teaching material.

To achieve the objectives defined above, MEET-CINCH will provide a flexible modular teaching and training NRC toolkit to serve the needs of the **nuclear energy industry and all industries working with radioactive substances**. These include **theradiopharmaceutical chemistry and those using radioactive sources and probes for analytical purposes in all relevant fields including fundamental radiochemistry research, radioecology, Gen IV system development, toxicology, nuclear forensics, industrial application of radiotracers, and many more**.

The Flexible Modular Concept of course design is easily adaptable to virtually any target group. A possible scheme how to use the teaching elements available after finishing the MEET-CINCH project in courses providing different level of knowledge is depicted in Figure 1 below. Selecting elements from a comprehensive toolkit allows a more efficient use of



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teaching material and manpower in comparison to the classical way of setting up courses independently for each level.

The teaching and training toolkit will promote collaboration and exchange of material between teachers; maximizing the use of available resources. The toolkit adopts the flipped classroom concept, using innovative elements such as electronic media or remote teaching and learning investigated in the previous projects, but also classroom elements and classical hands-on training. In order to bundle resources, student mobility will be an integral part of the approach.

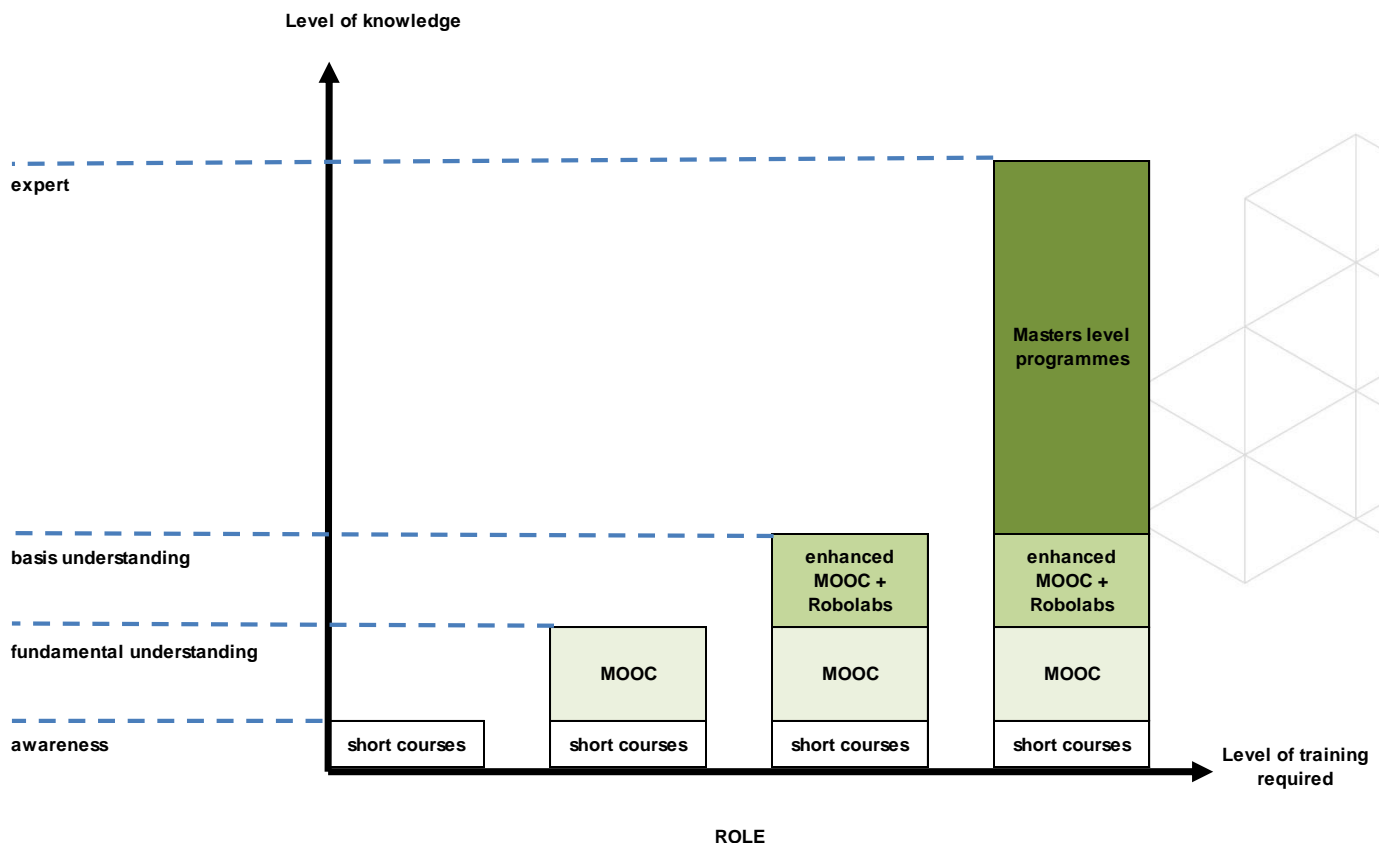


Figure 1: Flexible Modular concept of course design



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2. PARTNERSHIP

The MEET-CINCH consortium involves 12 partners from 9 EU countries including universities, research facilities and partners from industry. Coordinator of MEET-CINCH is Prof. Dr. Clemens Walther from the Institute for Radioecology and Radiation Protection of the Leibniz University Hannover, Germany. All partners involved are listed in the Table 1 below.

| | |
|----|--|
| 1 | Coordinator: Gottfried Wilhelm Leibniz University Hannover (LUH, Germany) |
| 2 | Czech Technical University in Prague (CTU, Czech Republic) |
| 3 | Chalmers University of Technology (CHALMERS, Sweden) |
| 4 | University of Helsinki (UH, Finland) |
| 5 | University of Cyprus (UCY, Cyprus) |
| 6 | Jozef Stefan Institute (JSI, Slovenia) |
| 7 | University of Leeds (UNIVLEEDS, United Kingdom) |
| 8 | National Nuclear Laboratory Ltd. (NNL, United Kingdom) |
| 9 | Politecnico di Milano (POLIMI, Italy) |
| 10 | Evalion Ltd. (EVALION, Czech Republic) |
| 11 | Commissariat a l'energie atomique et aux energies alternatives (CEA, France) |
| 12 | Reseau European pour l'enseignement des Sciences Nucleaires (ENEN, France) |

Table 1: MEET-CINCH partners



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3. ORGANIZATION OF THE WORK

Organisation of the project is built around **three pillars**:

1. **Nuclear Awareness** aiming on general public and secondary school students,
 2. **Sustainability and Evolutionary Developments** aiming at **vocational education** and **training (VET)** of **NRC professionals**,
 3. **Novel Education and Training** aiming both at **university students** and **VET**,
- supported by three cross-cutting activities:
4. **Mobility**,
 5. **Management**,
 6. **Ethics requirements**.

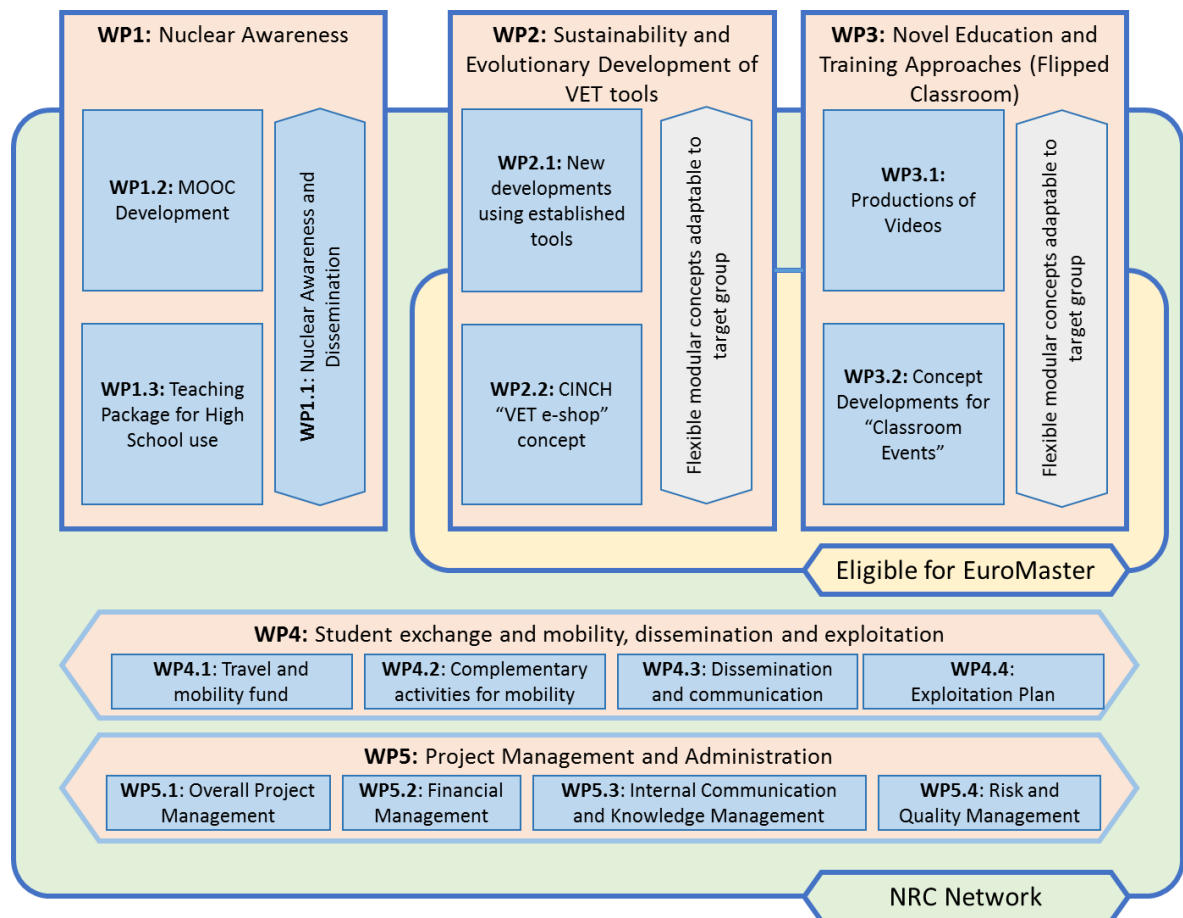


Figure 2: Structure of MEET-CINCH



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4. PILLAR 1: NUCLEAR AWARENESS

This pillar, defined in Work Package 1, aims to enhance people's general awareness of the needed and beneficial use of nuclear and radiochemistry techniques and methods. In particular, it is important to convey this to students to persuade a larger fraction of them to select an education within or including the nuclear and radiochemistry (NRC) field. With this background it is of the utmost importance to develop and perform NRC teaching and training according to the needs of research institutions, industry, hospitals, and other end-users. Requirements and demands were already surveyed in CINCH II. However, MEET-CINCH seeks direct contact with, and input from, the above-mentioned groups in order to consider their special needs. In particular, detailed information on current training needs are collected from the end-users in **nuclear medicine** and a **teaching package for use in high schools** that exemplifies the benefit and opportunities presented by NRC will be produced.

To reach these goals, in the first year of the project, several workshops were organized and oral/poster presentations were given at international conferences and seminars. Within the reporting period, JSI organised institute open days on 24 March 2018 for the open public, where radiochemistry was presented to interested audience. UH actively continued the survey on the education and training needs in the field of radiopharmaceutical chemistry by sending the questionnaire to potential respondents and analysing the received responses.

Concerning the Teaching Package for High School use, NNL has been working with selected colleges to establish dates for the trials in June 2018. The purpose of the trials is to establish which RoboLabs (see pillar 2: Sustainability and Development of VET-Tools) are best suited for the students, as well as which supporting teaching media and materials work the best. Working in collaboration with LUH and UiO, NNL has extensively tested the RoboLabs concerning the attenuation of Gamma-radiation and IonLaB (see p. 12), to ensure they will work within the classroom trials. As expected, there were a number of technical issues relating to the software (web browser plugins). These issues were tackled successfully and NNL was able to run the trials from their own laptops. A backup option has been developed for both labs for the purposes of the trials. NNL also produced worksheets and pre-learning materials to support the classroom trials, and have produced certificates for the students who participated within the trials.



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Dates have been set with 5 of the 6 schools that initially agreed to take part in the trials. The purpose of these trials is to engage with the schools to disseminate the aims of the MEET-CINCH project, to pitch the content of the initial draft, to test a couple of the RoboLabs in the classroom environment and to test the effectiveness and appropriateness of some videos. Piloting of selected activities has been also scheduled by UNIVLEEDS to take place during the Nuclear Summer School for 16-17-year olds held in Leeds 16-18 July 2018.

To convey the importance of nuclear and radiochemistry to many potential students and the public in general, a **MOOC (Massive Open On-line Course)** was chosen as a new and innovative method providing insight into what our field has to offer to society

How to design a MOOC?

The design started from the identification of the educational gaps of the target students: **Bachelor students in chemistry/physics/engineering/scientific areas**. Then, the learning objectives have been re-formulated, in order to be the guidance for choosing the topics of the MOOC. Both **General Learning Goals** and **Didactical Learning Goals** have been re-defined. Then a specific methodological approach, named **Pedagogical framework**, has been chosen. The MEET-CINCH Pedagogical Framework leads teachers in creating their lessons so that students could intuitively get the core concepts, thanks to a simulation or an immersion in a situation, and then could complete their knowledge through systematic content explanations, exercise to apply the gained knowledge, self-assessments, papers and links to examine and learn in depth each topic. This process is shown in the Figure 3.

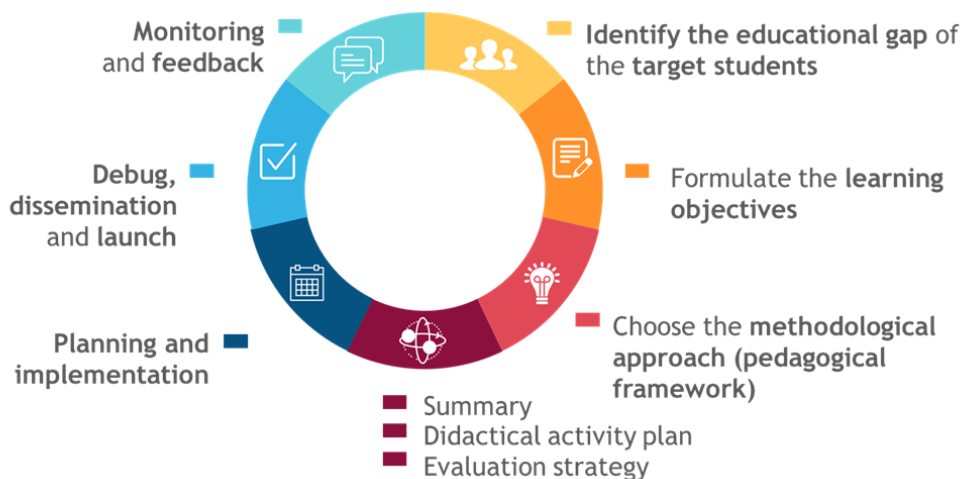


Figure 3: Design-steps for a MOOC



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Subsequently, a tentative **Table of Contents** has been finalized, including the weeks' and modules' definition, and the results have been shared and agreed between the partners. The table of contents includes:

Week 1: Radiochemistry for the environment

- 1.1 Environmental monitoring (NORM - Agriculture - Nuclear accidents)
- 1.2 Environmental remediation
- 1.3 TENORM

Week 2: Radiochemistry for health

- 2.1 Nuclear medicine
- 2.2 Medical sterilization
- 2.3 Food irradiation/ disinfestation

Week 3: Radiochemistry for industry

- 3.1 Tracer technology (Oil and fuel production)
- 3.2 Radiation processing

Week 4: Radiochemistry for nuclear energy

- 4.1 Reprocessing of spent fuel
- 4.2 Confinement
- 4.3 Decommissioning of nuclear/industrial plants
- 4.4 Waste management

Week 5: Radiochemistry for society

- 5.1 Cultural heritage (Dating, conservation)
- 5.2 Nuclear forensics and proliferation
- 5.3 SHE.

The first module titled **“Environmental Monitoring”** of Week 1 labelled **“Radiochemistry for the environment”** has been selected for the **development of the prototype**, to share with the partners at the second MEET-CINCH project meeting in Gothenburg.



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To create the video-prototype, POLIMI lecturers/teachers have prepared a written text of the entirety of module 1. Then, with help of an instructional designer, they identified the main topics and conceived an initial simulation. For each lesson a storyboard has been filled in. The storyboard contains all the information about the lesson and a table with 3 columns for the text, the animation and the keywords. Starting from this storyboard and thank to continuous and intense dialogue among teachers, visual and instructional designers, the prototype video has been recorded, produced and published: <https://youtu.be/jt9xZfsO0FQ>. A screenshot of that prototype video with Prof. Mariani from POLIMI as lecturer is shown in figure 4.

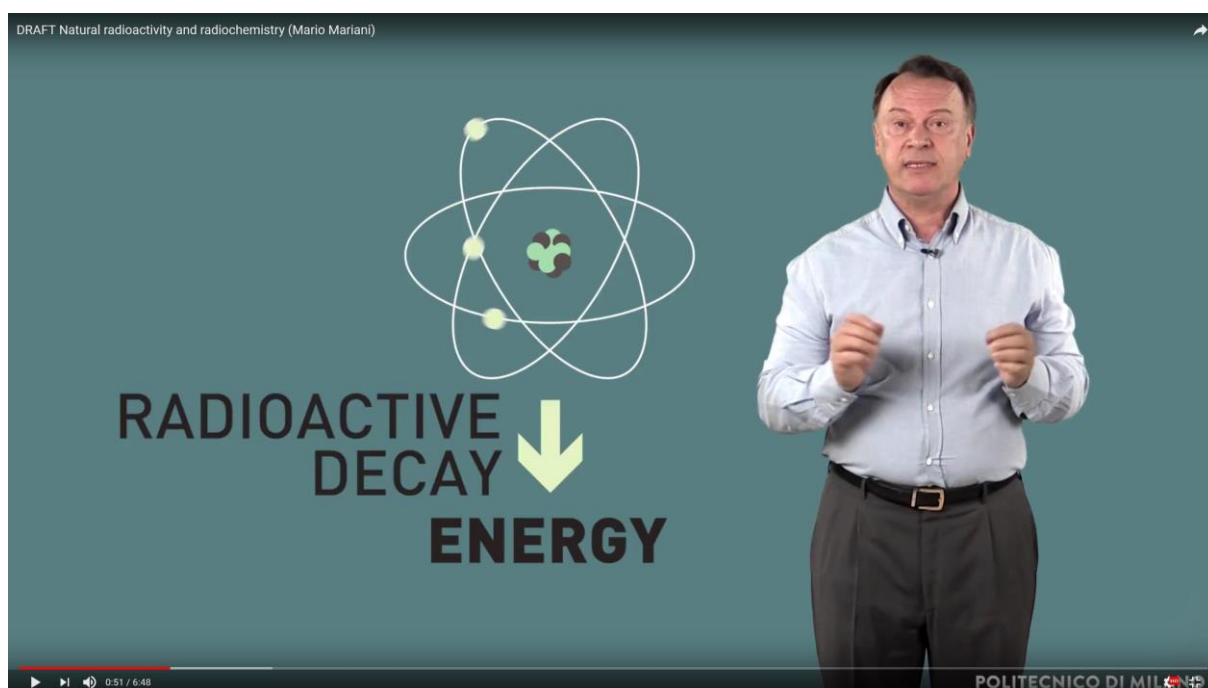


Figure 4: Prof. Dr. Mario Mariani in the MOOC prototype video

The structure of the UNIVLEEDS MOOC – **“Decommissioning of nuclear facilities”** – has been agreed upon. There will be four segments, with an approximate participation time of 45-60 mins each.

At the end of each segment, there will be a short assessment to ensure assimilation of the content, before the next segment is opened for access. UNIVLEEDS has begun to develop their MOOC storyboard in preparation for the video creation.



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5. PILLAR 2: SUSTAINABILITY AND DEVELOPMENT OF VET-TOOLS

Focus of the work on new developments using established tools was the elaboration of course content and materials. Very useful discussions with the involved partners resulted in some adjustments being made to the initial course proposals. For example, JSI and UCY are now collaborating on a combined spectroscopy training. A joint broad spectroscopic theory course proposal has been worked out, and each partner will develop a more specific practical course to support the theory. The course manual for UCY's Alpha-Spectroscopic Analysis of Uranium in Seawater has been produced and lab infrastructure implemented.

The first of the courses to be piloted (Hands on Training in Nuclear Chemistry) is scheduled for delivery by CTU in July 2018. All preparatory work (pre-learning materials on the MOODLE platform and the practical course manuals) has been completed. The course has been announced and is expected to be oversubscribed, as there is interest from both the non-academic and academic user groups. The announcement of HoT is shown in the Figure 5:

| | | |
|---|--|---|
| <p>Target group</p> <p>This dedicated training course aims at delivering the basics of nuclear and radiochemistry to trainees with a chemical background at Masters level (e.g. Chemistry/Chemical Engineering, and/or recent PhD students), who need to extend their skills and knowledge to the field of nuclear and radiochemistry.</p>  <p>Motivation</p> <p>The lack of trained nuclear chemical specialists has been identified in all branches of nuclear industry and also in other areas where skills in NRC are required, such as radiopharmacy, nuclear medicine, radiation protection and radioecology, and many others. Retraining general chemistry graduates is one of the options for mitigating this problem.</p>  | <p>Czech Technical University In Prague</p>  <p>Faculty of Nuclear Sciences and Physical Engineering Department of Nuclear Chemistry Břehová 7, 11519 Prague 1 Czech Republic</p> <p>MEET-CINCH Consortium <i>A Modular European Education and Training Concept In Nuclear and Radio Chemistry</i></p>  <p>http://www.cinch-project.eu</p> <p>MEET-CINCH is a HORIZON 2020 EU Framework Programme project aiming to improve and evolve nuclear chemistry education and training in Europe.</p> <p>The project closely collaborates with the European Network on Nuclear Chemistry Education and Training aiming to shift the education and training in nuclear chemistry to a new level.</p> <p>Contact: malinakova@jfifi.cvut.cz</p> | <p>Funded by the Horizon 2020 Framework Programme of the European Union</p>  <p>meet cinch</p>  <p>HANDS ON TRAINING IN NUCLEAR CHEMISTRY</p>  <p>Prague 2018 June 18-22</p> |
|---|--|---|



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| | | |
|--|---|--|
| Objectives While the course does not substitute full formal training, it provides fundamental theoretical knowledge of principles and concepts in nuclear chemistry necessary for understanding the processes and methods in radiochemistry, and practical hands-on training required for the work with open ionising radiation sources (handling of radioactive materials, application of radionuclides and ionizing radiation, etc.). | Introductory lectures (CINCH Moodle) Fundamentals of nuclear chemistry 1 Structure and properties of atomic nuclei. Classification of radionuclides. Kinetics of radioactive decay. Radioactive equilibria. Binuclear reactions. Yield of nuclear reactions. Fundamentals of nuclear chemistry 2 Natural radioactivity. Radioactive decay chains. Nuclear fission, fission products. Hot atoms chemistry. Szilard-Chalmers system. Radiation chemistry. Actinides and transactinides. Radiation detection and dosimetry Interaction of IR with matter (α , β , γ , neutrons). Detection of ionizing radiation (detector types, principles). Dosimetry of ionizing radiation. | Practical exercises (Jun 18-22, 2018) Handling of radioactive materials - pipetting, work behind shielding and in glove box. Preparation of working solutions with required activity from the stock radionuclide. Contamination survey, decontamination, preparation of wipe smear samples. Radionuclide generator preparation and milking. Radioactive equilibria. Sample activation via neutron irradiation. Decay curve measurement and deconvolution, half-life determination. Gamma-spectrometry – calibration, efficiency, measurement. Liquid-liquid extraction of uranium. Uranium specific activity, estimation of its isotopic abundance. Liquid scintillation counting. |
| Arrangements The course is organised by the MEET-CINCH Consortium and it consists of a theoretical component which will be delivered through distance learning via CINCH Moodle (see and sign up at moodle.cinch-project.eu). The practical hands-on component will take place at laboratories of the Department of Nuclear Chemistry of CTU in Prague. All teaching will be in English. | Prerequisites Radiation protection Distance learning course on CINCH Moodle. Participants have to successfully finish this course before entering the on-site course. https://moodle.cinch-project.eu/ | |
| Location Department on Nuclear Chemistry Břehová 7, 11519 Prague Czech Republic |  | |
| Admission Requirements For application for attendance of the course, please visit the MEET-CINCH web pages at www.cinch-project.eu/events/courses/ , download the application form, and send the filled-in form to Stěpanka Malináková (malinakova@jfifi.cvut.cz). No course fee will be charged to the participants and a small budget exists to support a limited number of participants. Application deadline is May 31, 2018. | | www.cinch-project.eu www.jaderna-chemie.cz www.cvut.cz |
| Travel Information http://www.idos.cz http://www.dpp.cz/en/ http://www.prg.aero/en/ | | |

Figure 5: HoT- course announcement

POLIMI has taken on board comments from the workshop at the first project meeting in November 2017 and has been working to develop their chemical dosimetry course into 2 components; a 1-day e-learning broad theoretical course on chemical dosimetry, and a 2-day more in-depth chemical dosimetry course comprising 1 day of theory and a 1-day practical component.

For the stand-alone e-learning courses that include students' registration, quizzes and evaluations, the student management platform CINCH Moodle was set-up (<http://moodle.cinch-project.eu>). A list of different courses developed in MEET-CINCH can be found in the Table 2.



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| Course | Lead Partner | Delivery Method |
|---|--------------|-------------------------------|
| Chemical Dosimetry | POLIMI | E-learn / Practical |
| Decommissioning of Nuclear Facilities | LEEDS | MOOC |
| Hands on Training in Nuclear Chemistry | CTU | MOODLE / Hands On |
| Radioanalytical Methods | CTU | CLASS / Hands On |
| Separation Methods in Radiochemistry | CTU | MOODLE / Hands On |
| Spectroscopic Analysis for Alpha / Beta-Gamma Materials | JSI (UCY) | Lecture / E-learn |
| - Determination of Po-210 in environmental samples by alpha-particle spectrometry | JSI | Lecture / Practical / E-learn |
| - Determination of Ra-226 and Ra-228 in water samples | JSI | Lecture / Practical / E-learn |
| - Alpha-Spectroscopic Analysis of Uranium in Seawater | UCY | Practical |

Table 2: MEET-CINCH NRC-courses

Remote controlled experiments – the RoboLabs

The Institute for Radioecology and Radiation protection (IRS) of LUH contributes to this project by running and maintaining three fully remote-controlled experiments (also referred to as Remote Controlled Labs, RCL). These remote-controlled experiments were set up in CINCH II and spotlight different aspects of nuclear chemistry. They allow a user to operate complete radiochemical experiments via the internet from anywhere in the world. Although hands-on experiments will always be the first choice for teaching basic radiochemical knowledge and skills, remote controlled experiments are much closer to real work in a laboratory than e.g. computer simulations and can be seen as a true enhancement of modern learning concepts. Different levels of difficulty concerning the analysis of the experiment can be implemented and minor errors (as they might happen during real work in a laboratory also) can be made by operating the system via the internet. That enhances the



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learning effect compared with computer simulations significantly and can, therefore, contribute to the education and training of students in radiochemistry.

The handling of radioactive material in a chemical laboratory is a high cost factor with respect to manpower, lab space and material. It can be observed that the number of universities who are willing to conduct these time-consuming and work-intensive experiments constantly decreases. For these universities remote-controlled experiments may prove an important alternative as a teaching tool with the aim to offer a practical education and training in nuclear chemistry.

The basic concept of the remote-controlled experiments is in general quite simple and shown in the Figure 6.

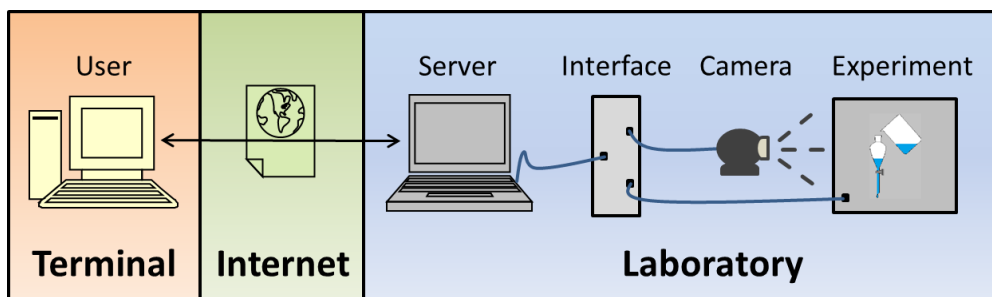


Figure 6: General set-up of remote controlled experiments

A camera is placed in front of each experiment that can be controlled by robotic manipulators. These controls together with the camera-feed are being transferred from a server located in the lab via the internet to a user with the appropriate login-data. The software for the RCLs was developed in LabViewTM – using its native ability for web-based control. In order to control the experiment, the user needs a browser with the respective LabView-plugins installed on his terminal.

Three RoboLabs were built at IRS and are shortly described below:

- **GammaLab** for gamma-spectrometry
- **PAULA** to demonstrate the concept of autodeposition
- **IonLab** to perform a chromatographic separation of Sr90 and Y90.



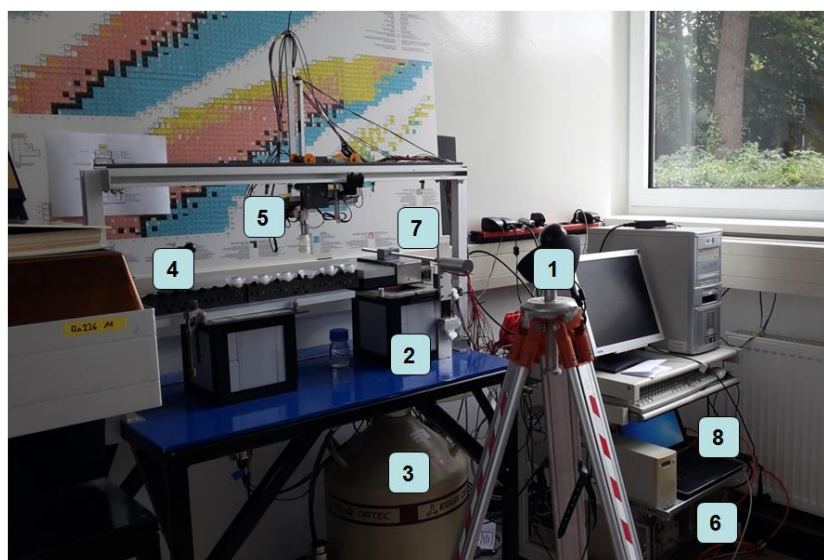
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GammaLab

GammaLab is a remote-controlled gamma spectroscopy system that allows for the identification and quantification of gamma-emitting radionuclides from a pre-selected variety of samples. All samples are placed in tightly closed plastic containers, capped with a metal disk that can be picked up by the magnetic robotic arm.



1. webcam for video-feed
2. germanium detector
3. liquid nitrogen coolant
4. rack with radioactive samples containing different activities
5. remote controlled sample changer
6. data acquisition system
7. lead shielding of the detector
8. computer for data transfer

Figure 7: General set-up of remote-controlled experiments

Figure 7 shows the hardware setup of GammaLab: A gripper-arm (5) picks up a sample selected from a rack (4) holding different radioactive samples. Subsequently, it is placed on top of a high purity germanium detector (2) cooled with liquid nitrogen (3). One motor moves horizontally, from the rack to the germanium detector and back, while the second one is moving vertically, lifting and placing the samples from/in the rack/detector, with the aid of an electromagnet. The top of the lead shielded detector chamber (7) can be opened and closed with the help of an electric motor. The experiment is controlled by a LabView routine running on the server (8). The user can observe the experiment in real time with the help of a camera (1). The Operating Panel is shown in the Figure 8.



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Figure 8: Panel to operate GammaLab

This GammaLab experiment can be used for several teaching goals:

- Demonstration on gamma spectroscopy.
- A list of unattributed samples is provided to the student with the task to identify the samples by analysing the gamma-spectra obtained.
- Understanding when and why the knowledge of statistical evaluation methods such as applying characteristic limits is important and how corresponding calculations have to be performed.

Prior to the start of an experimental run and based on the teaching goals up to six samples are selected from the following assortment available at LUH:

- a depleted U-fuel pellet containing nuclides of the ^{238}U and ^{235}U decay chains
- uranium glass beads
- monazite sand, which contains radionuclides of the ^{232}Th decay chain
- contaminated soil from an IAEA collaborative study (^{226}Ra contamination)
- phosphogypsum from an IAEA collaborative study, with an increased content of natural radionuclides
- two ^{232}U solutions of different filling height
- two pitchblende solutions, with radionuclides of the ^{238}U and ^{235}U decay series



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- a soil sample taken from the gate of the Fukushima Daiichi nuclear reactor after the accident
- an environmental water sample.

Additional samples based on the teaching goals of a given class can easily be made available on demand.

LUH performed extensive testing of the “HPGE gamma spectroscopy of environmental samples” RoboLab exercise, both in-lab and using the remote connection. Issues arising during the testing phase have been largely solved and the system is now running stable. LUH has also supported>NNL on ensuring the readiness of the IonLab experiment to support the High School Training Packages.

PAULA (Programmable AUtodepositionLAB)

With this experiment, the user is able to control via the internet an autodeposition experiment. The teaching goal of the experiment is the demonstration of electrochemical deposition techniques for the measurement of radionuclides. In the Figure 9, the real experiment is presented, side by side with a diagram.

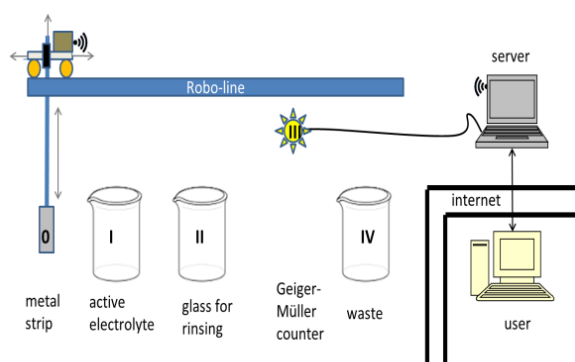


Figure 9: Setup of PAULA

The experiment can be used to teach and demonstrate fundamentals in electrochemistry and the use of deposition techniques for the measurement of radioactivity. As the radioactive technetium deposited on the metal strips can be measured with very high efficiency by the Geiger - Müller counter (which is one important outcome of the



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experiment), the experiment works with very low total activities. In the Figure 10, the front-panel of PAULA is shown.

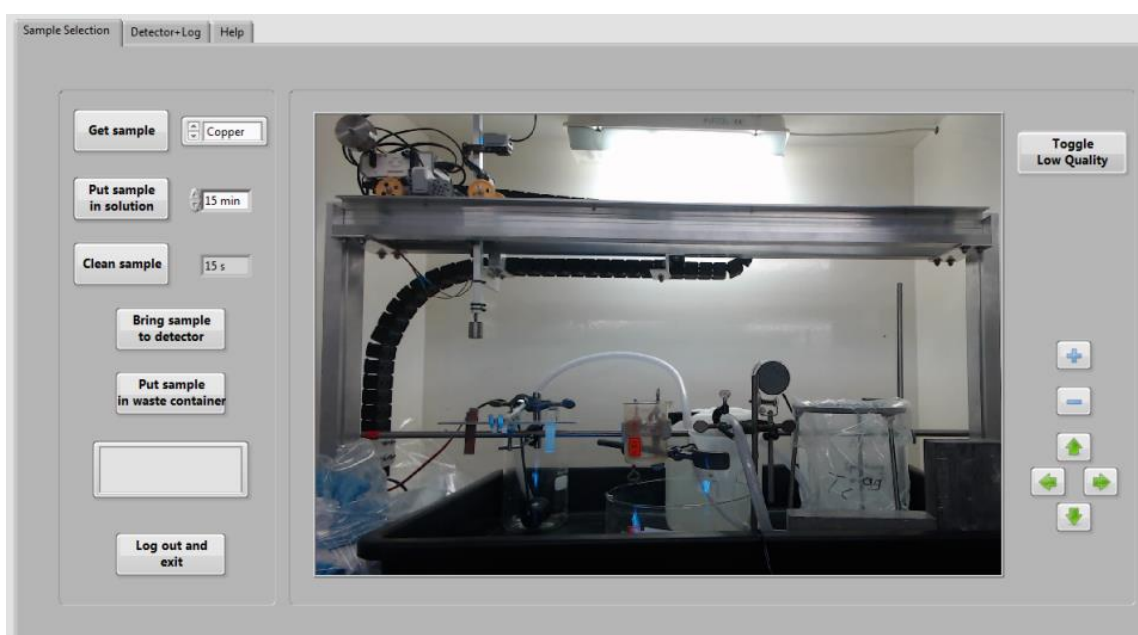


Figure 10: Front-panel to operate PAULA

IONLab

IONLab is a basic remote-controlled ion-chromatography setup. It allows the user to apply a mixture of radionuclides onto a column and then use a selection of solvents for the elution. The separation is followed by a Geiger-detection that yields a simple chromatogram of the activity. In order to enhance out of solution-detection, a small slide takes up the drop-shaped liquid coming from the column and transforms it into a thin-layered laminar flow. The experiment can be used to learn the fundamentals in theoretical, as well as practical chromatography and demonstrates the potential of chromatographical methods for the separation of radionuclides. Now it is set-up to perform a Y-90/Sr-90-separation using Sr-Resin as a solid extraction phase and different nitric acid concentrations for the separate elution. The front-panel of IONLab including the web-cam picture is shown in the Figure 11.



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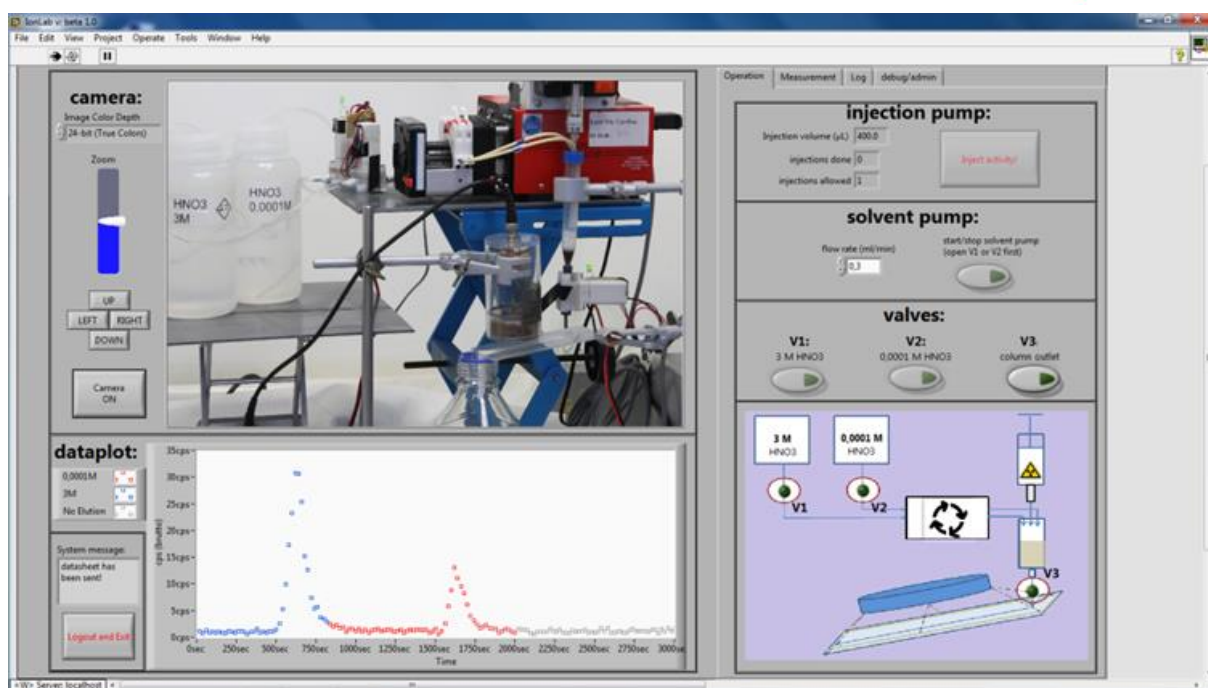


Figure 11: Front-panel to operate IONLab

RoboLabs at the University of Oslo

In addition to that, the University of Oslo supports MEET-CINCH with three additional RoboLabs although they are not an official partner in MEET-CINCH. These RoboLabs deal with:

- Absorption of Gamma-radiation in matter
- Neutron-activation of silver and
- Separation and detection of ^{234m}Pa (under construction).

Especially the RoboLab to demonstrate the absorption of Gamma-radiation in matter is in use for several MEET-CINCH courses. More information can be found on the Nuc-Wik webpage: <http://nucwik.com/about%20us/roboLab/index.html>.

One new RoboLab will be developed by POLIMI. This RoboLab is to be developed to a virtual lab concept, to make it more accessible for wider participation, by simulating the real-life experiment.



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Reaching sustainability: e-VET-shop and Interactive Screen Experiment (ISE)

CINCH VET e-shop

A new platform – CINCH VET e-shop – will be launched that will provide easy access to and details of, including periodicity and pricing, all courses brought at least to a pilot level. This platform is expected to be a **major contribution to the sustainability of the results achieved** in all the above-mentioned CINCH projects.

As part of developing the functional requirements and determining options for design and hosting of an e-learning platform, the e-learning websites have been reviewed to determine what they offer and to develop ideas for the MEET-CINCH platform.

CTU have continued to view/review commercial platforms including EVENTFORM and AMAZON with the advanced options of the recent upgrades to MOODLE.

Interactive Screen Experiment (ISE)

In order to create long-term sustainability, it is important to think beyond the end of the project. The problem quickly becomes apparent that the maintenance costs for the RoboLabs are so high that it is difficult to guarantee the functionality of the experiments. In the first 12 months, therefore, in addition to the measures already mentioned, much discussion and thoughts were given to how a sustainable stabilisation of these experiments could be conceivable. One possible solution could be so-called ISEs.

The Interactive Screen Experiment (“ISE”, in German “IBE”) was developed in 1996 at the Institute for Didactics of Physics and Teacher Education (IFPL) of the TU Berlin. This new digital format, which represents a further development of the real film, enables the user to perform realistic actions with photographically depicted objects in standard multimedia systems. Thus, the ISE combines the advantageous properties of real film with the learning-relevant properties of interactive simulation.

The ISE is a new type of learning object for representing physical experiments. Compared to other media, it has the following properties:

An essential characteristic of the learning object in ISE is the representation by real images as in a real film. Hence, the experimental data and the states of the experiment are based on the mapping of real processes. In contrast, the simulation is always based on a mathematical model. The disadvantages of the real film, which lie in its linearity and the limited interaction



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possibilities (e.g. starting and stopping the film via keys), are not present in an ISE, since any number of parameters can be changed by "direct manipulation" as in simulation. For some examples see: <https://didaktik.physik.fu-berlin.de/projekte/ibe/beispiele/index.html>.

By developing these ISEs, the remote-controlled experiments could be usable in future beyond MEET-CINCH. After a detailed discussion during the 2nd project meeting in Gothenburg in May 2018 it was decided to aim at the development of ISE to "conserve" RoboLabs used in MEET-CINCH. LUH has already contacted the inventors of the ISEs at the FU Berlin to prepare the implementation.

Another advantage of ISEs is the possibility that any number of users could use the experiment simultaneously, which would make it particularly suitable for school classes but also in the flipped classroom (see Pillar 3). The vertical and networking character of MEET-CINCH will be emphasized and supported again.

6. PILLAR 3: NOVEL EDUCATION AND TRAINING APPROACHES (FLIPPED CLASSROOM)

Novel Education and Training approaches aim at implementing the flipped classroom concept, containing two tasks. The traditional classroom concept of a speaker or teacher standing in front of his audience is substituted. Instead, electronic video teaching material is provided which has to be worked through by the students individually. These video lectures go beyond a mere videotaping of a real lecture. They last typically 90 minutes and comprise subsections of 10-15 minutes each, followed by a kind of activation such as, e.g., self-evaluation (for instance multiple choice quizzes). The anonymous video teaching is complemented by the classroom elements forming the personal pillar of the flipped classroom concept and carrying much of its benefits. These events require personal presence of the participant. They can be scheduled alternating with the video lectures, i.e. one 90 minutes' video course followed by a 2h seminar, or several video lectures followed by a block course of one or two days. While the first option serves well for university education, the latter is very attractive for vocational training of employees, minimizing the time out of office. It also fits with the Open University concept in the UK that has been popular in the past with employees to study for degree qualifications later in their career – they tend to meet up at Summer schools for tutorial / practical type sessions.



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This Pillar is divided into two tasks reflecting the flipped classroom structure. In the first task, video courses are designed and produced. The second task comprises conceptual planning and production of templates for the classroom elements that can be very different depending on the end-user. Personal presence is considered a limited resource and optimum use is made by setting up the classrooms in very specific ways. These include tutorial sessions in small groups, workshop like block courses – for instance tailored to the needs of industry or regulators. In the case of university education, the focus is clearly on an optimal teacher to student ratio and teaching on a level as personal as possible in order to have optimum efficiency. Careful design and performance are necessary. The principle of the Flipped Classroom is depicted in the Figure 12.



Figure 12: The principle of the Flipped Classroom

A thorough preparation of the individual is a prerequisite for successful classroom performance. University education can build on the educational level already achieved with respect to autonomy that can be expected (e.g. MSc in addition to Chemistry Education). In Vocational training (industry), however, teachers are often confronted with a high heterogeneity of previous skills and knowledge. Offering tailored classroom events for each subgroup can largely increase quality and efficiency of the training

After MEET-CINCH will be completed, teachers can build their courses from the available material from the e-shop. The classroom events, however, need to be developed and



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conducted very specifically for each group tailored to the needs of the students. For heterogeneous groups different events have to be built which might be offered in parallel. MEET-CINCH cannot provide a classroom event for each thinkable case. However, some generic classroom events will be developed and tested.

In the first year of MEET-CINCH the contents of the three courses, “**Basic Course on Ionizing Radiation**”, “**Basic Course on Analytical Radiochemistry**” and “**Development of Radiotracers**” were prepared and sent for feedback to partners. E.g. the “**Basic Course on Ionizing Radiation**” developed by LUH will contain the following topics:

- **Atom** (Atomic shell, nucleus, α , β , γ decays, Radioactive decay with decay law)
- **Liquid drop model** (Masses, mass defect, binding energy, Weizsäcker’s mass formula, Applications of WMF)
- **Alpha decay** (Introduction, Gamow theory, Spectrometry + detection issues (self-absorption, sample thickness, absorption in the detector...))
- **Beta decay** (Interaction with matter, Spectrum, neutrino, energy balance, Fermi theory of the beta decay, liquid scintillation spectrometry – principle)
- **Gamma decay** (electromagnetic radiation, properties, interaction with matter, Compton effect, Pair production, Photoelectric effect, absorption of gamma radiation, Gamma spectrometry, type of detectors and their principle, Structure of the Ge detector, calibration)
- **Shell model** (Shell model of the atom -> shell model of the nucleus, Different potentials, Yukawa potential, W.S. potential, Spin-orbit interaction, Deformed nuclei, excitation scheme Nilsson model, Magic numbers, Gamma ray transition probabilities)
- **Neutrons** (History, Properties, neutron sources, neutron energies, moderation of neutrons, Neutron spectra, neutron detection (principle), Neutron activation,
- **Nuclear reactions** (General, cross section, energy balance, Fission – time scale, fission product yield, 4 factor formula (neutron life cycle in the reactor), compound nucleus; direct interaction)
- **Dosimetry** (pathways of exposure, 3 cardinal rules of radiation protection (time, distance, shielding), Stochastic & deterministic effects of radiation, ion dose, energy dose, equivalent dose, quality factor, effective dose, dose rate, equivalent dose rate, radiation weighting factors, organ dose, physical and biological half-life, types of dosimeters; chemical dosimeters)



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- **Radiochemistry** (Basics of radiochemistry: chemistry of the massless (M. Curie), Typical methods used in radiochemistry: isotopic tracers, isotope dilution, separation1: (co)precipitation autodeposition / electrodeposition separation 2 ' ; ion exchange / ion selective sorption / ionchromatography, separation 3: liquid extraction, Radiolysis and ROS, Application example: purex process
- **Natural radioactivity** (Primordial, radiogenic and cosmogenic nuclides, natural decay series, natural background radiation in Europe & the world, civilizational radiation exposure).

LUH has started preparing the materials for all the modules of the **“Basic Course on Ionizing Radiation”**. The structure of the video lectures has been worked out in detail, and scenarios for the first seven modules have been developed.

The content and structure of the **“Basic Course on Analytical Radiochemistry”** and **“Development of Radiotracers”** have been worked out in the same detailed way by JSI and UH respectively.


JSI has prepared scenarios for 13 modules and another 22 modules were filmed. 21 videos were finalized and published on [videolectures.net](http://videolectures.net/meet-cinch_courses/) and are accessible on the link http://videolectures.net/meet-cinch_courses/. The Figure 13 shows two screen-shots of these excellent video lectures!



Institut "Jožef Stefan", Ljubljana, Slovenija

Intro to uranium determination in water

Marko Štok, Ljudmila Benedik
Jožef Stefan Institute



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Euratom research and training programme 2014-2018 under grant agreement No 754 972



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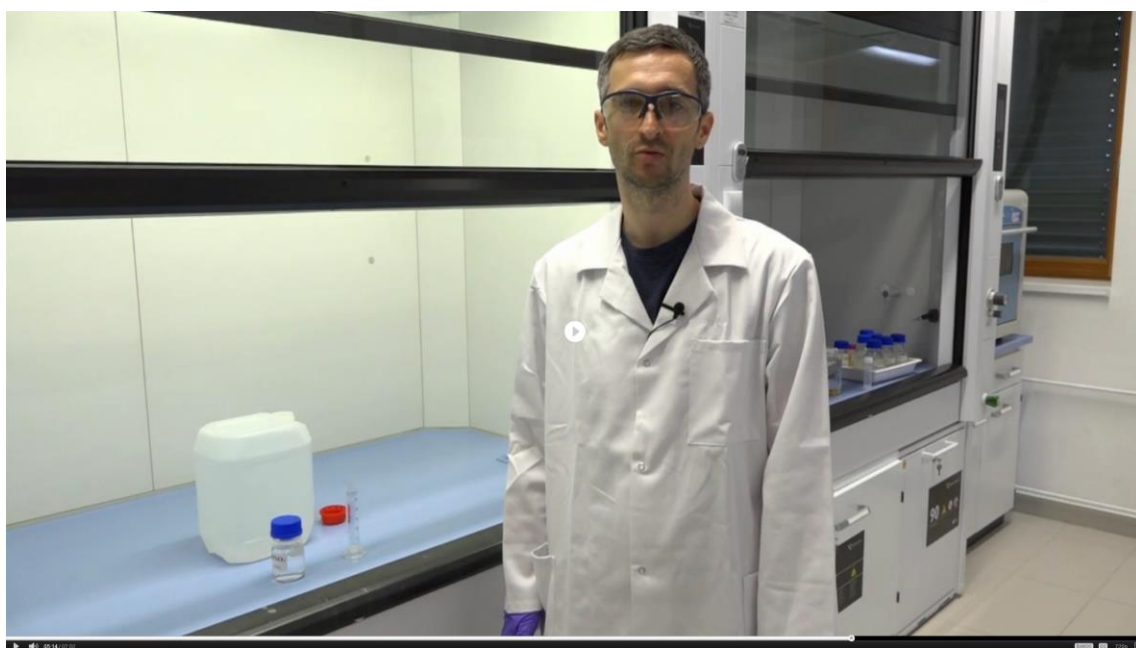


Figure 13: Dr. Marko Strok of JSI presenting a video-lecture about the uranium determination in water

A feedback on the first published videos for the determination of uranium in water was requested from the partners, who responded very positively about the videos. In addition, videos were promoted among existing contacts of the group with all positive comments. Videos were already used in training activities performed by the group member in the South Africa for IAEA.

UH is working on the development of short-course on the topic “**Development of Radiotracers**”. A preliminary idea on the structure and content of the course was developed further and it was also designed for the flipped classroom concept; compiling of lecture materials has also started.

Based on the discussions in the project meeting there seems to be need for implementation of the course as a part of university educational programmes. UH will thus try to fit the short-course as a part of the MSc level course “*Radiopharmaceutical chemistry*”, i.e. swap some of the lectures into the new concept, and collect feedback from the students in early 2020.



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POLIMI has started collecting the material necessary for producing the two 90-minute lessons on **“Chemical Dosimetry for Industrial and Medical Applications”** to be produced for the Flipped Classroom. In the second half of 2018, the structure of the video lectures will be defined and the content of each subunit will be described in more details. A presentation of the collected material and of the lessons’ structure will be produced, in order to share it with the partners at the next meeting before the production of the videos.

Novel education and training approaches should comprise as many stakeholders as possible. For that reason, a tailored training event for members of regulators and administrative bodies should be developed in MEET-CINCH, too. The challenge for the development of such a course lies in particular in the fact that members of regulators and administrative bodies are often accustomed to work in their native language. Inspired by a virtual experiment developed by the German-Swiss Association for Radiation Protection to determine the half-life of Ba-137 (see figure 14), the idea was therefore born to implement this course as a virtual laboratory. As a task, members of regulators and administrative bodies will then examine whether this (virtual) radiochemistry laboratory can be licensed in accordance with their national laws and circumstances. The great advantage of this approach is that, in addition to the use of the mother tongue, national legal regulations can also be easily considered, e.g. by implementing pdf-documents. Additionally, this course could also be conducted using the flipped classroom approach, in which the course participants first walk through the virtual laboratory in a self-learning phase and then discuss and evaluate the results in the presence phase.



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Figure 14: Virtual reality lab to determine the half-life of Ba-137m.

7. STUDENT EXCHANGE AND MOBILITY DISSEMINATION AND EXPLOITATION

In order to make optimum use of capacities and resources on the European level, student mobility will be strongly encouraged. A Travel Fund was established and is operating particularly for participation in practical courses and training sessions. One additional important aim is ensuring that the information about the project and its results is delivered (communicated and disseminated) among the nuclear community and all relevant target groups. This aim is subdivided into four tasks, the first operating the Travel and Mobility Fund, the second directed towards complementary activities for mobility, the third covering the dissemination and communication, and the fourth designing and supervising the exploitation plan.



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The main objective of establishing the Travel and Mobility Fund is to stimulate exchange of knowledge and practical experience among the community (within and outside of MEET-CINCH activities) and future researchers. Students (MSc and PhDs) represent the primary target group, but also teachers and other members of the community will benefit from MEET-CINCH activities and measures in area of education/training and mobility. The primary aim of this action is the integration of students and trainees into Euratom-supported research projects. The main purpose of the fund is to support student mobility, particularly for participation in MEET-CINCH and other Euratom “chemistry” projects practical courses and training sessions.

The Fund’s requests are screened and handled by the Travel Fund Operator and a group of participants within the steering committee of the project. In addition to the Travel Fund, complementary measures for enabling the mobility will be actively sought and exploited.

In the first year of the project, the Travel Fund has been operational and received a total of 7 requests for funding, which all have been granted. However, some participation has been withdrawn (2 students from Cyprus), after the funding confirmation, due to personal issues.

Concerning complementary activities for mobility, the activities have already started at Chalmers, where the first request for an Erasmus student arrived on the 11th of December 2017, for a bachelor thesis in nuclear chemistry. The discussions are on-going and the student is supposed to arrive in January 2019.

Collaboration with CTU on identification of students eligible for the support and distribution of the Travel Fund for the participation in the MEET-CINCH Hands-on Training in Nuclear Chemistry course has been completed successfully.

The general communication and dissemination of information about the project is assured by a set of measures such as e.g.:

- Official project webpage (www.cinch-project.eu)
- Project leaflet, generic presentation and generic poster
- Publications in scientific journals and/or popular magazines, etc.
- Presentations of project results on relevant conferences and meetings
- Two public reports.



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The MEET-CINCH project, as well as the NRC network, have been presented at the 18th Radiochemical Conference (RadChem 2018) in Mariánské Lázně , Czech Republic and at MARC XI in April 2018 by LUH. CTU was also active in the presentation of the MEET-CINCH project at the RadChem 2018 conference. POLIMI contributed to the presentation of the MEET-CINCH project, along with the MOOC prototype video, at the seminar organized by Politecnico di Milano, CIRTEN and SOGIN, titled: “Il deposito nazionale per lo smaltimento dei rifiuti radioattivi in una logica di sviluppo sostenibile. Aspetti progettuali e funzionali” (“The national repository for the disposal of radioactive waste in logic of sustainable development. Design and functional aspects”) in May 2018 and at the 14th Workshop on European Collaboration in Higher Education on Radiological and Nuclear Engineering and Radiation Protection – CHERNE 2018 (29 May - 1 June 2018).

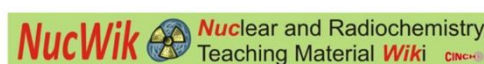
At these conferences, presentations on the projects work were given and flyers for the MEET-CINCH collaboration and the NRC network have been handed out.

Evalon continuously operates and maintains the project webpage. They have also produced templates of certificates of appreciation which will be awarded to third parties which will cooperate on project activities and testing of the results as for example students of high schools participating in the Teaching Package for High School. Thus, the certificates will also serve as a mean of dissemination. Within this period, the issue of the NucWik, the interactive storage place of CINCH-II materials, closing down have been solved (see the Figure 15).



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Welcome to NucWik!

Welcome to the NucWik site for teaching material for Nuclear and Radiochemistry. Everybody is welcome to use material from this site, but it's primarily aimed at teachers teaching at Universities. At NucWik you will find ready made texts, explanations, illustrations, calculation exercises, laboratory exercises, etc. to help you in teaching Nuclear and Radiochemistry (NRC).

NucWik was operated as a wiki until March 2018, but after our host [WikiSpaces.com](#) decided to terminate their service by June 2018 it was decided to run NucWik as a normal web-site for the time being. Even if it is no longer operated as a wiki, we still hope that you will help us to develop even more and better material! We strongly urge you to contribute, the usefulness and quality of NucWik depend on as many people as possible contribute - help yourself and us to enhance the quality of our teaching! Please contact us if you have material to share!

NucWik was created as part of the CINCH EU-project for evaluating and planing nuclear and radiochemistry teaching in Europe. Please refer to the CINCH web-pages at: <http://cinch-project.eu/index.php> for details about this project.






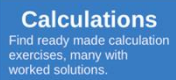

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|  About NucWik NucWik is a site for collecting and distributing teaching material for Nuclear and Radiochemistry. Read more |  Using NucWik Examples and ideas for how you can use material from NucWik in your teaching. Read more |  Latest News NucWik has moved and is no longer a wiki. Read more | |
|  RoboLab Exercises performed in a real laboratory, controlled remotely. Goto Page |  Laboratory Complete (and partial) descriptions of laboratory exercises Goto Page |  Calculations Find ready made calculation exercises, many with worked solutions. Goto Page |  Old NucWik .html files of all content from the old wiki that used to run on wikispaces.com Goto Page |

Figure 15: New set-up of NucWik at <http://nucwik.com/>

The results generated in the MEET-CINCH project will be described as exploitable foregrounds according to principles of IPR protection and reported to the EC as well as to the target groups through the Consortium communication channels. The aim is not only to fulfil the obligatory formal requirements for exploitation planning, but mainly to define sustainability of the results and their further development in the project post-completion phase. The concepts and results developed within the project (e.g. the e-shop concept) are perceived as “products”, that must be able to generate sufficient resources for sustaining and extending the project impacts. The corresponding long-term exploitation strategy will include a plan of post-completion operation, development and funding of all MEET-CINCH results.



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European Network on Nuclear and Radiochemistry
Education and Training: **nrc-network.org**
nucwik.com – CINCH-created site for teaching material for Nuclear and Radiochemistry
nucwik.wikispaces.com – CINCH-created wiki for learning aids in Nuclear Chemistry
moodle.cinch-project.eu – CINCH-created e-learning platform for Nuclear Chemistry

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