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MEET-CINCH

Second Public Report

2018 - 2020

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European Commission | Horizon 2020 European Union funding for Research & Innovation

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EXECUTIVE SUMMARY

The MEET-CINCH Second Public Report briefly introduces the MEET-CINCH project, a three-year project with 13 partners from 10 countries implementing a modular European education and training concept in nuclear and radio chemistry financed from the Euratom research and training programme. Above all, the Report describes main achievements from the first two years 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 (NRC) Education 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 (like 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 On-line 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:

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

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

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, industry working with radioactive substances**, such as **radiopharmaceutical chemistry or 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

teaching material and man power 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 personnel 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.

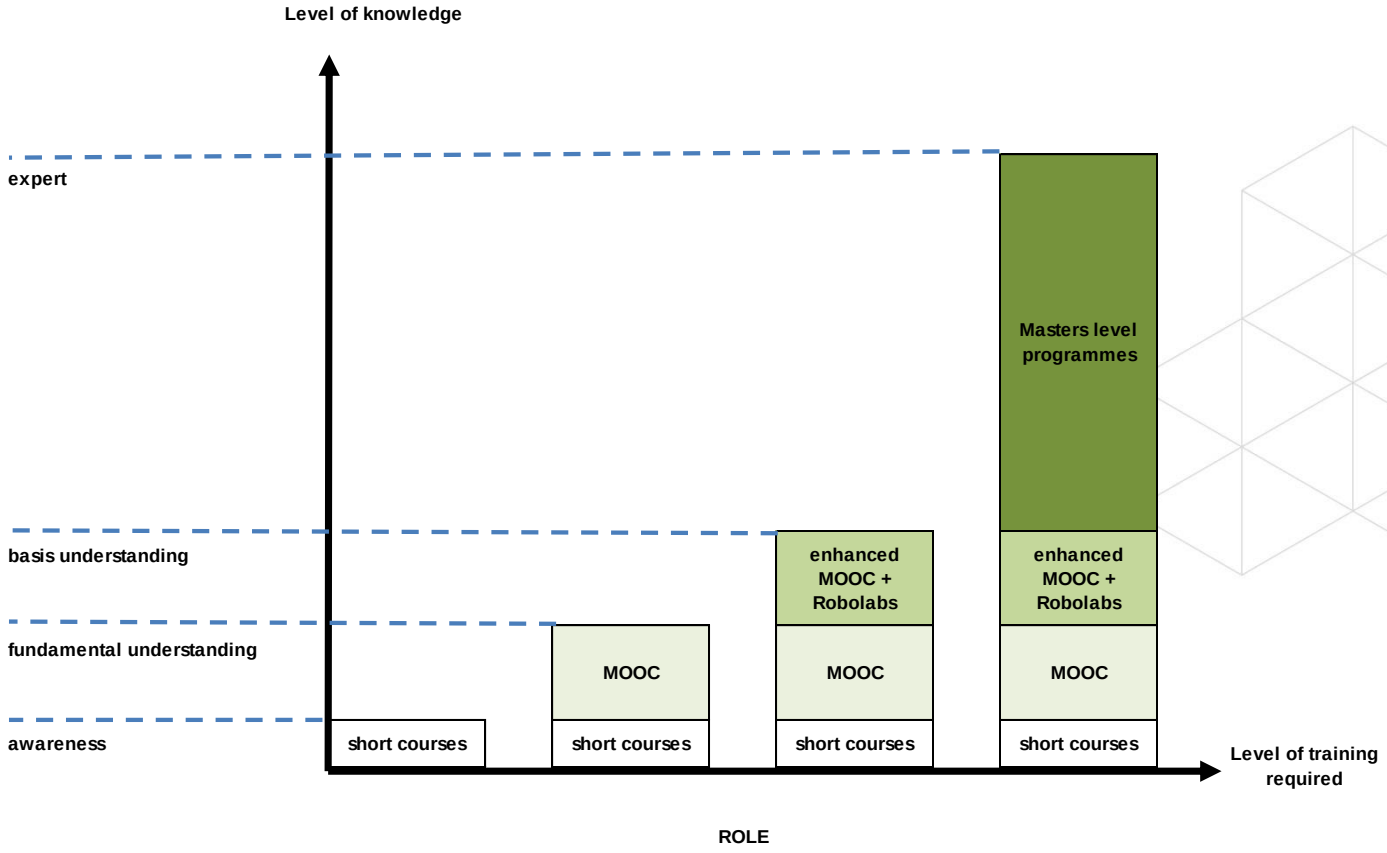


Figure 1. Flexible Modular concept of course design

2. PARTNERSHIP

The MEET-CINCH consortium involves 13 partners from 11 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. For the last year of the project (from 01.07.2019 to 30.06.2020), University of Oslo joined MEET-CINCH.

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	European Nuclear Education Network (ENEN, Belgium)
13	University of Oslo (UiO, Norway)

Table 1: MEET-CINCH partners

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.**

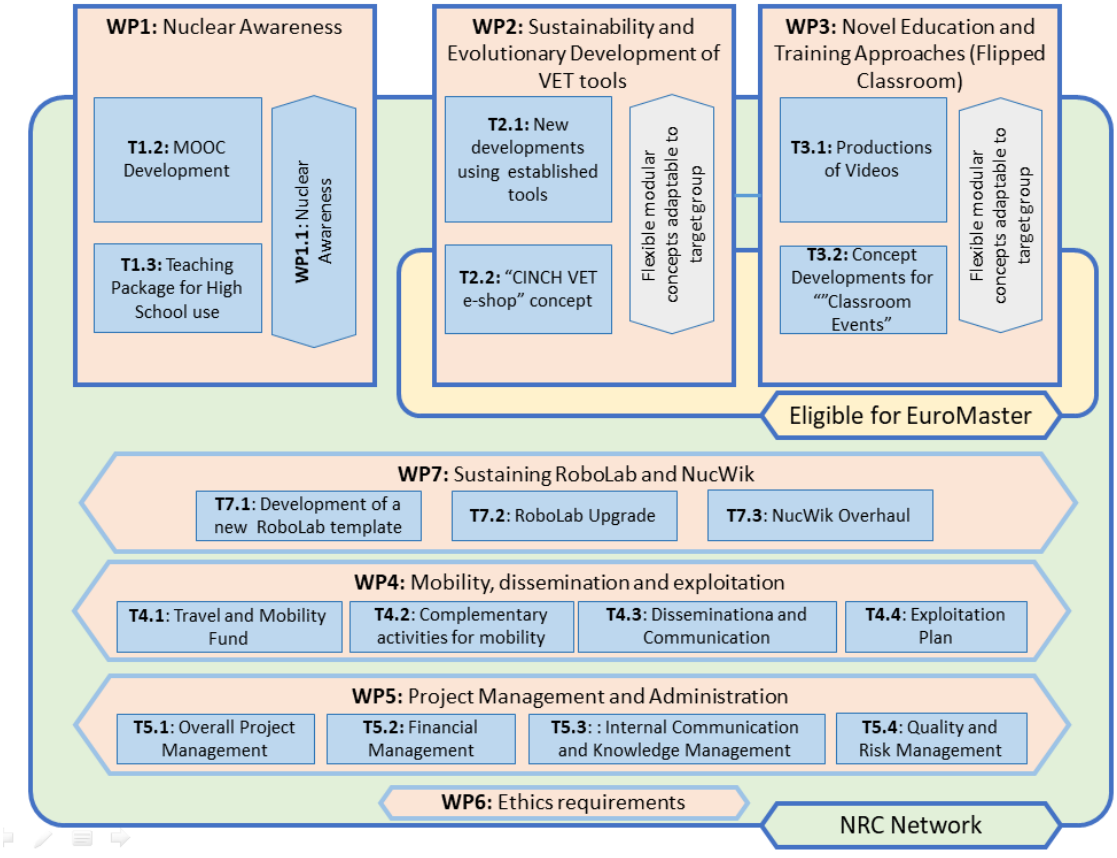


Figure 2: Structure of MEET-CINCH

As University of Oslo (UiO) joined MEET-CINCH for the last 12 months of the project, the 7th WP Sustaining RoboLab and NucWik was introduced. Main task in this WP7 is to support the modernization and maintenance of the Robo-Labs Experiments and NucWik.

4. PILLAR 1: NUCLEAR AWARENESS

This pillar, defined in the Work Package 1, aims to enhance people's general awareness to 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's of 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 several workshops were organized and oral/poster presentations were given at international conferences and seminars by nearly all partners. For example, **JSI** was actively engaged in raising nuclear awareness through presentation of the Radiochemistry and research activities related to general public. **NNL** carried out workshops at schools and colleges to test the teaching package. **UH** activities were addressed to enhance general nuclear awareness and especially awareness of possible options for nuclear and radiopharmaceutical chemistry education among potential new students, academia and industry. **UCY** delivered a presentation on "The Radioactive Elements of The Periodic Table" during the 8th High School Student and Teacher Conference on Natural Sciences (February 22nd to 24th 2019, Paphos-Cyprus). The audience (high school students and teachers) were informed about radionuclides/radioactivity and the MEET-CINCH project in order to attract their interest in issues related to Radioactivity and Nuclear Energy.

Very positive progress has been made in the High School Package (see pillar 2: **Sustainability and Development of VET-Tools**). Following the in-class workshops in June 2018, the IonLab experiment was selected for further development. NNL has developed a storyboard around the IonLab to introduce students to radiochemistry. A "RoboLab workshop" hosted by UiO

was conducted to optimize the use of the RoboLabs and implement necessary technical developments. During this workshop, it was agreed that all RoboLabs require an upgrade to the latest version of TeamViewer (NXG), but that simulated versions of the experiment are more suitable for classroom use. LUH is currently upgrading IonLab to NXG as well as developing a simulated version of the experiment (ISE).

NNL has trained seven colleagues in delivering the IonLab teaching material and organised five further workshops that were conducted very successfully in June 2019 in the United Kingdom:

1. 13th June 2019: West Lakes Academy
2. 17th June 2019: St Benedict's
3. 18th June 2019: Priestley College
4. 19th June 2019: Energy Coast UTC
5. 20th June 2019: St John Rigby.

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 (see first public report). Developing a MOOC is a complex process, starting with the identification of the target group – in our case Bachelor students in chemistry/physics/engineering/scientific areas. Then, the learning objectives including both the general and the didactical learning goals have to be formulated, in order to be the guidance for choosing the topics of the MOOC. Then a specific methodological approach, named Pedagogical framework, have to be chosen before the MOOC itself can be produced after the storyboards have been written and approved by POLIMI. At the end, the MOOC will consist of five blocks, each of which can be attended in one week (see also the First Public Report here):

Week 1: Radiochemistry for the environment
Week 2: Radiochemistry for health
Week 3: Radiochemistry for industry
Week 4: Radiochemistry for nuclear energy
Week 5: Radiochemistry for society .

Compared to the original planning, a few adjustments concerning the table of content had to be made since the development of the MOOC turned out to be more time demanding than

originally planned. Nevertheless, the overall MOOC-project is not at risk and will provide a major impact on nuclear awareness in the target-group of bachelor students. Development of Week 1 e. g. is already completed. To watch two examples of the produced videos that are part of the MOOC, click here:
https://www.youtube.com/watch?v=28DpCjZzl6s&feature=youtu.be

Figure 3: Prof. Dr. Mario Mariani presenting facts in a video belonging to Week 1

or here: https://www.youtube.com/watch?v=yYo_c9Phcf8&feature=youtu.be

Figure 4: Vivien Pottgießer (LUH) explaining why nuclear forensics isn´t just simply forensics (Week 5 of the MOOC)

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

MEET-CINCH Courses

In MEET-CINCH **VET-Tools, course content and material** have been developed continuously focusing on new developments using established tools. A list of different courses developed in MEET-CINCH can be found in table 2.

Course	Lead Partner	Delivery Method
Chemical Dosimetry - Fundamentals	POLIMI	e-learn
Chemical Dosimetry	POLIMI	Classrrom / practical
Dose Calibration in Gamma and X Ray Fields	POLIMI	e-learn / Robolab
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
Plutonium Winter School	CHALMERS	Pilot

Table 2: MEET-CINCH NRC-courses

On July 3 to 5 2019, a Hands-on-training-course dealing with chemical dosimetry was provided by POLIMI (Announcement see figure 5). Additional courses were conducted by JSI and UCY ("HoT RadioChemical Spectroscopic Analysis") on December 9 to 13 2019 - see figure 6), by POLIMI ("HoT Chemical Dosimetry, 2nd Edition") on February 24 to 28 2020 (see figure 7), and by CTU ("HoT RadioAnalytical Methods") on February 3 to 7 2020 (see figure 8).

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).

TARGET GROUP

This training course aims at delivering the basics of chemical dosimetry to trainees with a background in Chemistry and Chemical-Nuclear Engineering with the need to extent their theoretical and practical skills in the chemical dosimetry field.

OBJECTIVES

The course provides fundamental theoretical knowledge of dosimetry and chemical dosimetry for both industrial and medical applications. The experimental hands-on training provides the basic practical skills for preparation, irradiation and analysis of chemical dosimeters and gel dosimeters.

INTEGRATED NUCLEAR LABORATORIES - CoSNEF
DEPARTMENT OF ENERGY
RADIOCHEMISTRY AND RADIATION CHEMISTRY LABORATORIES
B18 building - Via La Masa, 34 Milano – Italy
www.polimi.it

MEET-CINCH Consortium
A Modular European Education and Training Concept in Nuclear and Radio CHemistry

http://www.cinch-project.eu

MEET-CINCH is a HORIZON 2020 EU Framework Program project aiming to improve and evolve nuclear chemistry education and training in Europe.

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.

POLITECNICO MILANO 1863
DEPARTMENT OF ENERGY

HANDS-ON TRAINING ON CHEMICAL DOSIMETRY

Milano
3-5 July 2019

Funded by the Horizon 2020 Framework Programme of the European Union

ORGANIZATION

The course is organized by the MEET-CINCH Consortium and it consists of a theoretical part on fundamentals of Chemical Dosimetry, which will be delivered through distance learning via CINCH Moodle (see and sign up at moodle.cinch-project.eu).
The following practical Hands-on training will take place at the Radiochemistry and Radiation Chemistry laboratories at Politecnico di Milano.
All teaching will be in English.

LOCATION

Politecnico di Milano - Department of Energy Radiochemistry and Radiation Chemistry Laboratories, Building B18 - Via La Masa, 34 Milano

REGISTRATION

For detailed information, please visit the MEET-CINCH web page to download the application form (www.cinch-project.eu/events/courses/).
Send the filled-in form to Elena Macerata (elena.macerata@polimi.it).
No course fee will be charged to the participants and a small budget exists to support a limited number of participants.
Application deadline is 15 May, 2019.

TRAVEL INFORMATIONS

http://www.milanomalpensa-airport.com
http://www.trenord.it/en/timetable/timetable.aspx
https://maps.polimi.it/maps/

e-learning course FUNDAMENTALS ON CHEMICAL DOSIMETRY

- Introduction on Dosimetry: role and need
- Basics of Absorbed dose and Radiation Exposure: example of exposure in real life
- Dosimeters
  - General principles and features required
  - Overview on dosimeters and applications
- Chemical dosimetry
  - General principles
  - Radiolysis in solid and liquid
  - Radiolytic yields and correlation with dose
  - Overview on chemical dosimeters for medical and industrial applications
- Self Assessment/Assessment

The on-line part will be made available to the participants at moodle.cinch-project.eu.
Participants have to successfully finish this course before entering the on-site course.

PRACTICAL SESSION
3-5 July 2019

Hands-on experience of using chemical dosimeters

Laboratory chemical preparation of:
- Fricke standard dosimeter
- Fricke gel dosimeter

Optical 1D and 2D analysis of:
- FAS dosimeter for industrial application
- GafChromic films for medical application
- Fricke standard dosimeters and Fricke gel dosimeters
- Polymer gel dosimeters

Data analysis:
- Calculation of the radiolytic yield and molar extinction coefficient
- Use of ImageJ Open Software for image analysis
- Calibration curve acquisitions
- Evaluation of unknown dose
- Evaluation of the diffusion process of Fricke gel dosimeter
- Evaluation of isodose curves of a clinical treatment plan using GafChromic films

Practical sessions will be introduced by short theoretical presentations.

Technical tour at the National Centre of Oncological Hadrontherapy
https://fondazionecnao.it/it/

Figure 5: HoT- course announcement, July 3 to 5 2019 in Milano

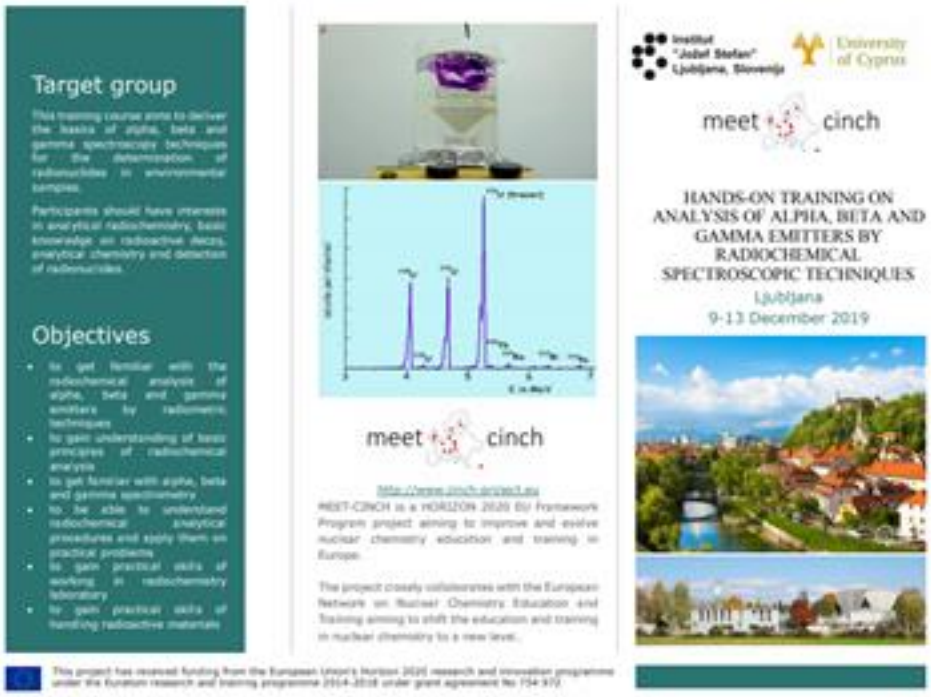


Figure 6: Announcement of HoT RadioChemical Spectroscopic Analysis, December 9 to 13 2019

Figure 7: Announcement of HoT Chemical Dosimetry (2nd Edition), February 24 to 28 2020

Figure 8: Announcement of HoT RadioAnalytical Methods, February 3 to 7 2020

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 have been set up in CINCH II and spotlight on 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 level of difficulties 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 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 and radioactive sources 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 9.

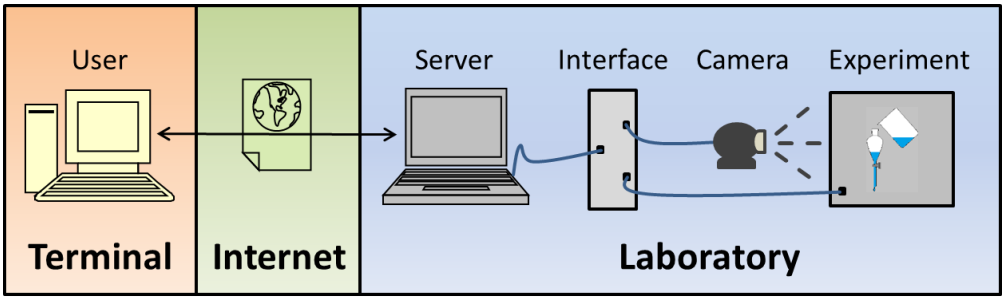


Figure 9: General set-up of remote controlled experiments

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 LabView™ – 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/her terminal.

Thanks to **UiO** who has joined MEET-CINCH for the last year of the project the LabView ™ code used for running the RoboLabs will be updated. This work is divided in two tasks:

1. Develop and test a new "template" for RoboLabs running on the new NXG version of LabView. This will provide a skeleton which can be used for individual RoboLab exercises and should make porting of the existing RoboLabs to the new version easy. And
2. Upgrade the existing RoboLab exercises (at UiO) to the new LabView technology, using the template developed in the step 1.

Three RoboLabs were built at LUH:

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

Additionally three further RoboLabs at UiO are now official part of MEET-CINCH:

- **Absorption of radiation** in matter
- **neutron-activation** of Ag
- **Separation and detection of ^{234m}Pa** (under development).

A detailed description of the three RoboLabs can be found in the First Public Report. Fortunately from 01.06.2019 until the end of the project, UiO has been able to join MEET-CINCH and establish the 7th work-package dealing mainly with updating, improving and maintaining the RoboLabs in general and LabView as essential software in particular.

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

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 mentioned CINCH projects.

NNL and **CTU** collaborated to explore the potential options for design and hosting of an e-learning platform. The concept of the e-shop has shifted to accommodate what is considered to be a sustainable solution with the e-shop becoming a signposting platform to link end-users with nuclear chemistry training providers. The “passport” is to be re-titled to reflect a less authoritative training history portfolio – there were concerns amongst partners that the phrase “passport” was too formal. Instead, it will be a portfolio of training information including courses attended through the e-platform with the option for certificates to be uploaded by the trainee – verification of the training history will be down to the interested party to test and prove in much the same way a prospective employer does when presented with a CV and certificates.

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 leading to the decision to develop so called **Interactive Screen Experiments (ISE)**. By developing these ISEs, the remote-controlled experiments could be usable in future beyond MEET-CINCH. 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. For more details see the First Public Report.

LUH started with support of experts at Freie Universität Berlin to develop the first ISE for the RoboLab "GammaLab". It is planned to develop a similar ISE for IonLab in order to get more independent of the service and maintenance that has to be provided to run the original RoboLabs. Access to the ISE of GammaLab is possible via https://tetfolio.fu-berlin.de/tet/947091 at anytime. In figure 10 a screen shot of the ISE is shown. Compared with the original RoboLab only three measuring times can be chosen but as in reality different mistakes can be made by the end-user to ensure that at least basic practical skills are learned.

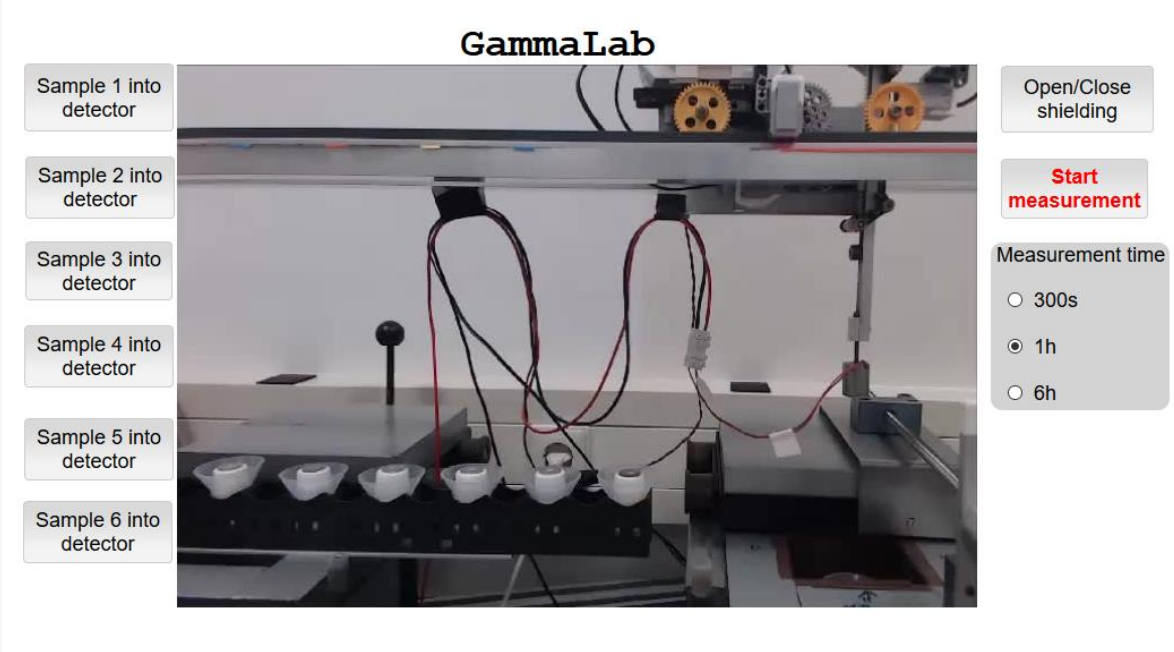


Figure 10: Screenshot of the first developed Interactive Screen Experiment (ISE) for GammaLab

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

As described in the First Public Report, 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.

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

The following Flipped-Classroom events have been developed:

- **"Basic Course on Ionizing Radiation"** by LUH,
- "**Basic Course on Analytical Radiochemistry**" by JSI and
- "**Development of Radiotracers**" by UH.

Additionally POLIMI prepared a **„Short Course on Chemical Dosimetry for industrial and medical applications“**.

Flipped Classroom: Basic Course on Ionizing Radiation

The **basic course on ionizing radiation** was planned and developed as a flipped classroom concept. Classic lecture courses with a teacher standing in front of the students were substituted by videos the students have to watch. Each module, containing 3 to 6 videos, is corroborated by a so-called presence phase or classroom event. These events of 90 minutes each need to be planned and structured carefully, in order to deepen and consolidate the contents of the videos. The aim of the presence phase is NOT to give a mere repetition or summary of the videos. Doing so would demotivate students and keep them from watching the videos the following week. Rather, each presence phase starts with a quiz using an audience response system. Based on the outcome, topics not yet fully understood by the students are explained. This is not necessarily done by the teacher. In general, and as the first approach, group work is performed by having the students explain the topic to each other and try to find the right answer collectively. This approach strengthens the team spirit and leads to a more sustainable knowledge, since the students need to focus on the problem much more intensely than by just listening to the teacher giving the solution right away. Only as an “ultima ratio”, if no one of the students comes up with the right answer, the teacher jumps in. This part of the presence phase lasts between 20 and 40 minutes. In the following ca. 60 minutes, related topics are taught by use of various didactic tools, ranging from personal work (e.g. reading texts) to group work including the full audience. Most of the time, group work of only two to three students was performed, e.g. solving simple exercises applying the knowledge attained in the videos.

LUH has held the “Basic Course on Ionizing Radiation” over a duration of three weeks, between 11.04 and 02.05.2019, with 130 students (from the courses of MSc chemistry and Bachelor students preparing for the teaching degree).

During the preparation phase, the students had to watch videos at home, which had been previously prepared by the LUH team. There were a total of approx. 50 videos, which summed up to about 12.4h of video footage.

Seven presence phases were held in the classroom. For this, the students were divided into 6 exercise groups. During the presence phases, several didactical methods were used with

the purpose to deepen the understanding of the concepts and information given in the videos: audience-response questions, work in groups, jigsaw teaching technique, think-pair-share, conversation in class, mind maps, fact sheets, individual work, worksheets, learning with mistakes and the speed dating method.

Additionally, **during the presence phases one RoboLab and one ISE have been used**.

Before the beginning and after the end of the course, the students have been asked to fill in some questionnaires. This will help to improve the next run of the course that is planned for spring 2020. The flipped classroom concept as a whole and the presence phases in particular were evaluated by written pre- and post tests of all students at the one hand and by personal interviews of volunteers at the other.

In summary, **students appreciate the working atmosphere in the groups**. The quantitative data suggest that female students and student teachers in particular benefit from this. The huge increase in perceived teacher support speaks for the time spent guiding students through the exercises and giving feedback through the assessment phase (see figure 11).

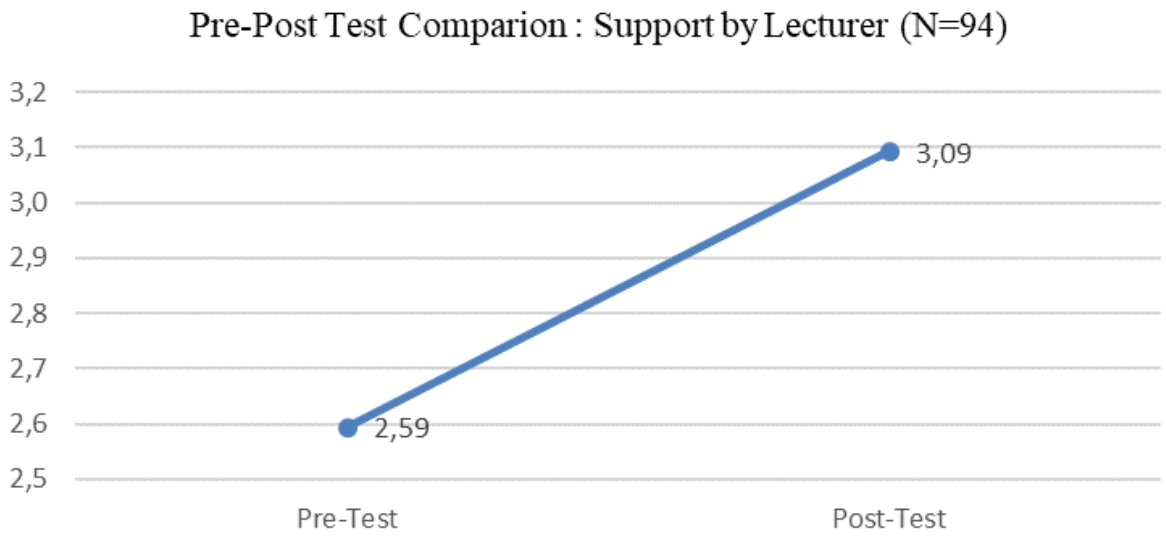


Figure 11: Perceived support by the lecturer in presence-phases.

As a second example of the evaluation results, figure 12 shows a summary of the free text comments in the evaluation survey. In this regard, the audio response system ("clicker") questions are highlighted as an extremely positive and useful method.

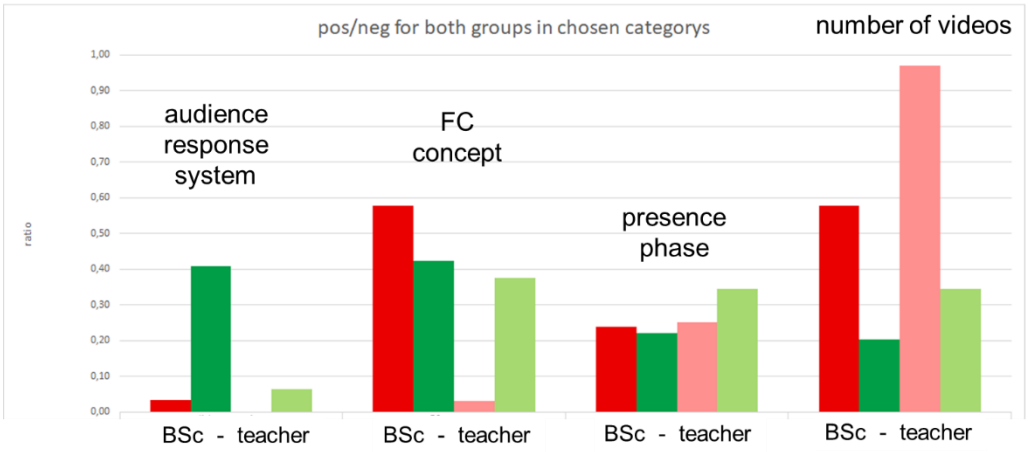


Figure 12: Summary of free text comments in the evaluation survey

As a remarkable result figure 13 shows an enormous increase of the students self-concept concerning physics for female students. Since female students are still underrepresented in this subject this result shows a strong strength of the flipped classroom method compared with traditional lectures.

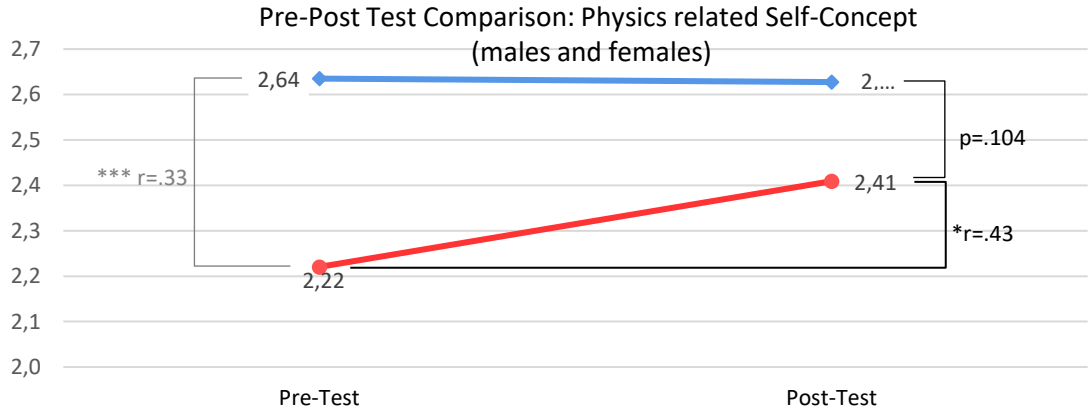
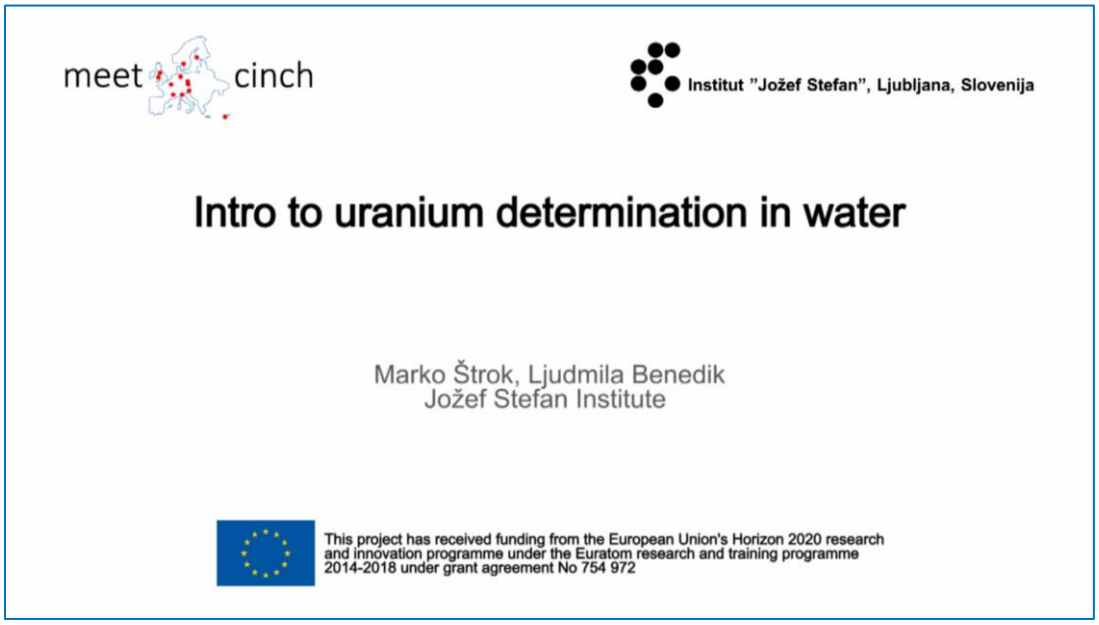


Figure 13: Physics related self-concept of females (red line) and males (blue line) before and after the flipped classroom intervention (scale: 1= lowest, 4= highest).

Student's feedback suggests that in some areas, students would like to see more detailed calculations, but fewer different topics in the presence phases. Therefore, the implementation time will be extended in the next run planned **from April to June 2020** (from 4 weeks to a full semester, spreading the content over a longer period and having only one instead of two presence phases per week). This will void a large part of the negatively noted criticism and thus also have a possible influence on the students' motivation. The interviews suggest that a reduction in methodological diversity (didactic elements) might be appropriate for B.Sc. students. In contrast to this, teacher training students emphasize this diversity in a positive way. The usefulness of a division according to study programs can be justified very well by the qualitative data of the interviews.

Flipped Classroom: Basic Course on Analytical Radiochemistry

JSI has filmed all modules, and after post-production they were published on videolectures.net. The on-line learning module on Moodle for the pilot delivery of the "Determination of Uranium" part of the "Basic course on analytical radiochemistry" was prepared and tested. The course was delivered at Al-Farabi Kazakh National University in Kazakhstan with attendance of one PhD student, three MSc students and seven bachelor students. Feedback has been collected before starting the course, after finishing the e-learning part on Moodle and at the end of the course. The responses were evaluated. The Figure 14 shows two screen-shots of these excellent video lectures!



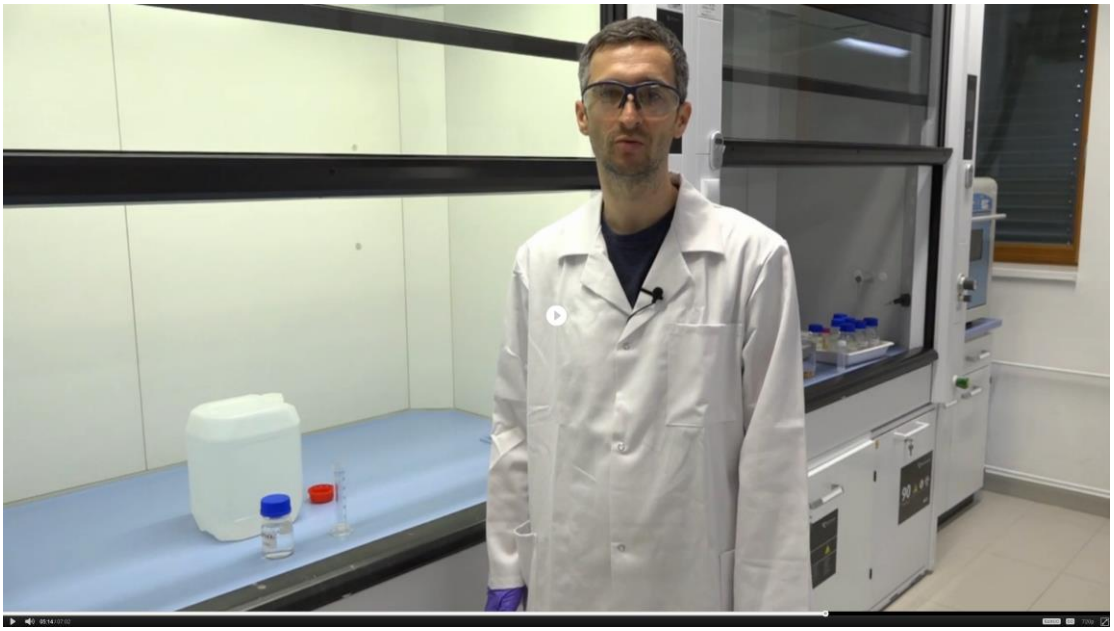


Figure 14: Dr. Marco Strok of JSI presenting a video-lecture about the uranium determination in water

Flipped Classroom: Development of Radiotracers

The course **"Tailored training event for nuclear medicine end-**users" will be based on the masters level radiochemistry course. The recordings have been planned at the Unitube studio of UH and will be edited in house. A total of 5 videos have been planned which includes lectures on "Carbon-11, Nitrogen-13 and Oxygen-15 labelling methods", "F-18 labelling methods", "Radioiodine labelling methods", "Metallic radionuclides and radionuclide generators" and "Quality Control (QC) of radiopharmaceuticals and GMP". The video lectures have a total length of 30 – 45 min each but they are broken down into smaller segments to keep the audience interested.

Flipped Classroom: Chemical Dosimetry

As mentioned above, **POLIMI** developed a hands-on-training concerning "Chemical Dosimetry". This course was also developed in the flipped classroom format. Chemical Dosimetry is to be delivered as flipped classroom to students in their first and second year of the MSc programme. Topics are radiation chemistry and chemical dosimeters, starting from the radiolysis process and extending to the medical applications of gel/film chemical dosimeters. The course is structured as two lessons, each one involving a two hours self-learning phase, followed by 90 minutes in-classroom activities. During the self-learning phase, the students have to use .ppt presentations with oral comments and texts as e-learning material available one week prior to the presence phase. This self-learning phase is then followed by in-classroom activities, developed ad hoc to stimulate discussion of students to each other, with the teacher acting as a moderator. On November and December 2019, this short course has been conducted with 16 students at the first year of MSc in Nuclear Engineering (14) and Biomedical Engineering (2) at Politecnico di Milano by two weekly presence phases of 90 minutes each. The presence phases have been structured as on-line quizzes, teamwork and group discussions on relevant case studies. At the end of the course, a focused questionnaire has been proposed to students and positive feedback has been collected. The flipped classroom teaching package has been prepared in English and it is ready to be provided to teachers that would like to present Chemical Dosimetry to their classrooms.

A Tailored training event for members of regulators and administrative bodies

Education and Training (E&T) of members of authorities in Radiochemistry and Radiation Protection (RP) is one of the main issues to ensure a good practice of RP. MEET-CINCH took

that in account by developing **a tailored training event for members of regulators and administrative bodies**. One difficulty foreseen was that attendees from administrative bodies from different European Countries would not be willing to participate in an English language pilot project. Additionally, national regulations concerning radiation protection differ in various countries and are written in national languages. To overcome that problem an e-learning solution was developed (see First Public Report) at **LUH**. Core of that course was to decide from the perspective of the authority representatives in three different scenarios whether a (virtual reality) radionuclide-lab fulfils all the technical and structural requirements to be licensed according to the German regulations. For each of these three scenarios one correct virtual version of the lab and one virtual lab with minor errors was developed. After calculating the so called “room-category” according to the competent German technical rule (DIN 25425) the member of the regulators had to walk through to room with errors in order to find these errors. Afterwards the lab without errors could be assed to see the difference. As an example in figure 15 the realisation of contact-free water tab compared with a usual water tap is shown.

Figure 15: contact-free water tap compared with usual water tap

Additionally errors based on wrong behaviour of persons in the lab had been implemented, too. As an example you can see in Figure 16 a cup of coffee in the lab – an easy mistake to find.

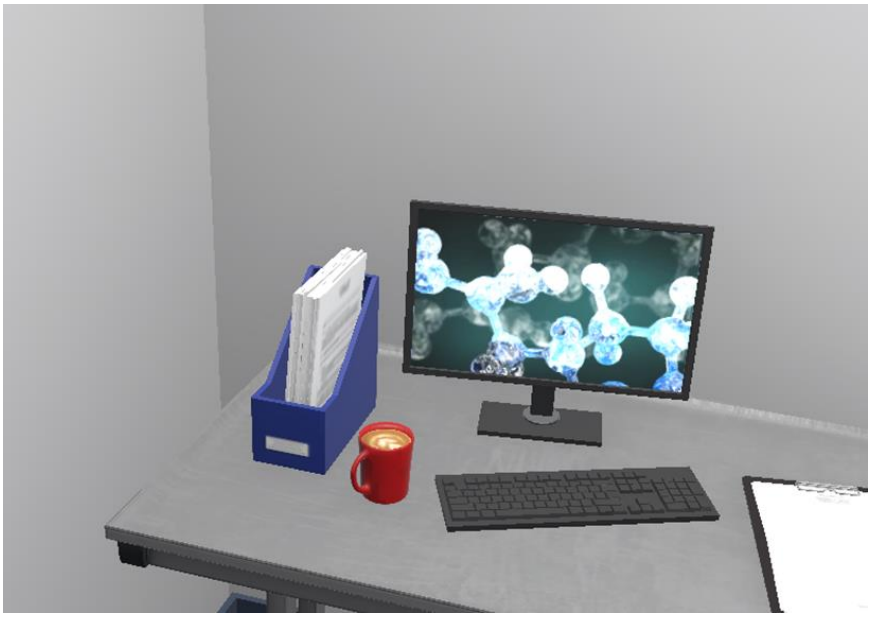


Figure 16: A cup of coffee in the radionuclide lab as an example of obvious error

More sophisiticated was the fact that from time to time a person is entering the lab with a coat that is sometimes closed (right behavior, figure 17) and sometimes not (wrong behaviour, see figure 18).

Figure 17: A staff member is leaving the lab with a closed coat

Figure 18: A staff member is entering the lab with an open coat

The virtual laboratory uses nearly no language; details of objects that cannot be visualized are described with few words which can be exchanged easily in order to enable the use of different languages, too. Necessary information like the set of handled radionuclides, the amount of activity and the way the nuclides are handled are described in separate documents. **Hence, a solution was found to develop a course for members of regulators and authorities that can be adapted to national rules and languages very easily and therefore can be used in different countries.**

A prototype of the course was conducted on 29.08.2019 at LUH. Nearly 120 members of regulators attended the course; approximately half of them entered the virtual lab as part of pre course preparation and completed the course entirely. The virtual lab including all descriptions is still available (see https://www.cinch-project.eu/news/detail/detail/News/tailored-training-for-members-of-regulators-and-administrative-bodies/) and can be used to train member of regulators and competent authorities at any time. The results were evaluated and the feedback given was extremely positive. Concerning the learning outcome, figure 19 shows that the vast majority of participants agreed on the question “Concerning DIN 25425 I learned a lot” and stated that

the duration of the course was reasonable. An overwhelming majority of the participants enjoyed the course and would like to taka a similar course again – a result that shows that using virtual reality for education and training in the field of radiochemistry or radiation protection can have a major impact. Especially the fact that the usage of virtual reality can be very motivating should be used in further programs.

Additionally, the participants stated two further major advantages of this tailored training event:

1. Once the program is installed on the computer, **it can be used at any time**. While access to real radionuclide-labs is often limited to short periods of time and demands greater effort, the virtual lab can be easily visited and studied at any time.
2. It was emphasized that especially **new members of authorities**, who have never entered a radionuclide lab before, **appreciated the virtual lab**. This tailored training event is a perfect possibility to prepare the first visit of a radionuclide lab in order to get familiar to the most important techniques, rules and the necessary equipment.

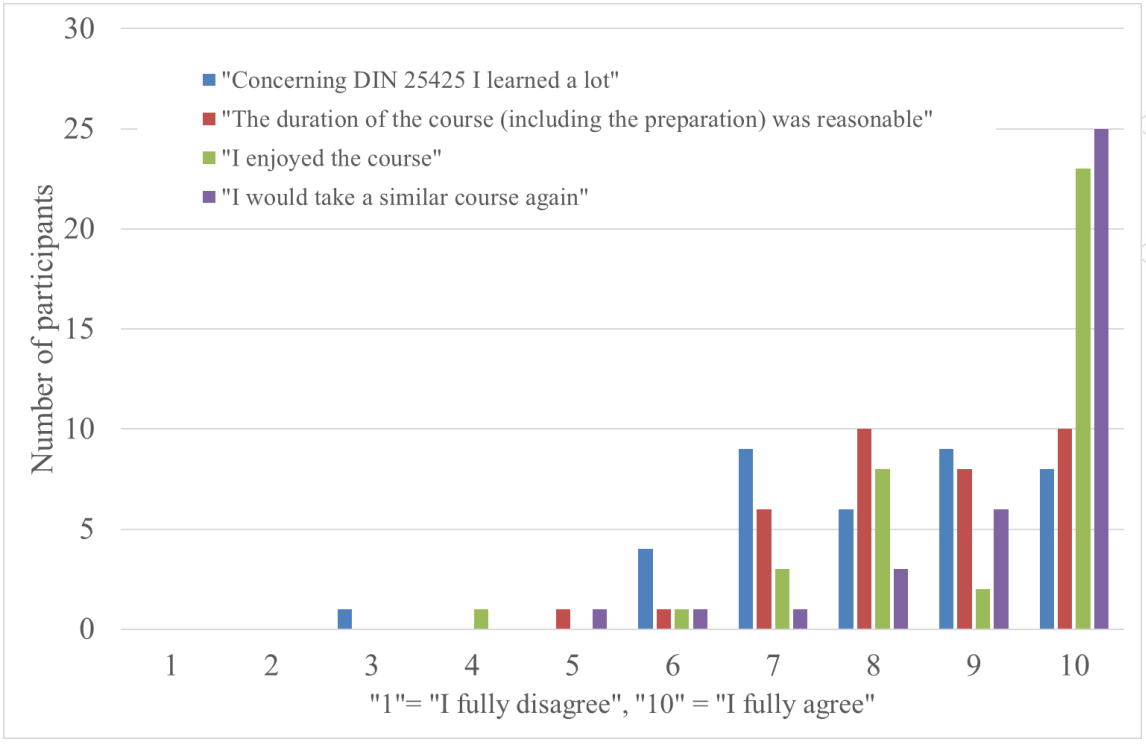


Figure 19: Evaluation of motiviation and learning outcomes

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 enforced. 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. 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 or high-school students and other members of the community will benefit from MEET-CINCH activities and measures in area of education/training and mobility. 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.

In order to bring together internationally renowned experts and young European Bachelors, Masters and PhD students in the field of radiochemistry, physics, biophysics, radiology, radiopharmacy, medicine and life sciences, as well as students who are freshly graduated from school and high-school students with a high interest in applied science, **a MEET-CINCH Spring School will be held on March 2- 6 2020 in Larnaca, Cyprus.** It offers a full education and vocational training, qualifying students and graduates to better understand and address the needs of adequate protection against adverse effects of ionising radiation while making optimum use of its many beneficial aspects. The School will include five days of intensive classes and hands-on training and intends to inform participants on the latest developments in innovative research fields of radiochemistry. European experts will talk about: Radiation protection and dosimetry, radioecology, nuclear forensics, geo- and cosmochronology, nuclear radiochemistry for medical applications, nuclear fuel cycles, radiochemistry for reactor operation and recycling of nuclear waste, decommissioning and application of radiotracers and radioisotopes. The announcement-flyer is shown in figure 20.

Figure 20: Announcement of the Spring School on March 2- 6 2020 in Larnaca, Cyprus

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.

The MEET-CINCH project, as well as the NRC network, have been presented at many different meeting and conferences throughout whole project period. In addition to the presentations mentioned in the First Public Report, MEET-CINCH was during the second period also presented for example:

- Presentation of MEET-CINCH at the joint meeting of the working group for training and the working group for legal questions of the German and Swiss professional association for radiation protection, which took place in Karlsruhe, Germany on 19 and 20.03.2019. by LUH
- Presentation of MEET-CINCH at the 8th EUTERP Workshop “Optimization of training in radiation protection”, on 10-12.04.2019 in Malta by LUH
- Presentation of MEET-CINCH to EC JRC, unit G2 staff, during a meeting that took place on 05.04.2019 by ENEN
- Dissemination of the MEET-CINCH project the Technical Working Group of Nuclear Knowledge Management section of IAEA Vienna. The meeting took place between 27 and 31 May 2019, at IAEA Headquarters in Vienna, Austria by ENEN
- Dissemination of the MEET-CINCH project during the ENEN-Russia forum that took place at Atomexpo 2019 conference in Sochi, Russian Federation. Atomexpo: 13-18.04.2019 by ENEN
- Presentation of MEET-CINCH Radioanalytical and Nuclear Chemistry Conference, which was held in Budapest in May 2019. (NNL)
- Information about the MEET-CINCH project was disseminated among the members of the Society of Radiopharmaceutical Sciences at the International Society of Radiopharmaceutical Sciences conference in China (UH)

- JSI has had presentation of the project and videos on the Jožef Stefan Institute open days in March 2019 as well as it had contribution towards MOOC presentation at RANC 2019
- The Virtual Laboratory, which has been developed by the LUH during the MEET-CINCH project has been presented at the 51. Annual meeting of German-Swiss radiation protection association 2019, 9-12, September 2019 in Würzburg, Germany. (LUH)
- The Virtual Laboratory has been also presented at the German-Swiss radiation protection association's Symposium for new development in radiation protection law and ordinances 18-19. November 2019 in Hamburg, Germany.
- During the EU-Projects „Project JO3.01/13: Provision of assistance related to developing and strengthening the capabilities of the Energy and Minerals Regulatory Commission (EMRC) and related to radioactive waste management in Jordan" the Virtual Laboratory has been used by TÜV NORD for teaching purposes.
- The MEET-CINCH project has been presented at the Migration 2019, which took place in Kyoto, Japan from 15 to 20 September 2019.

Evalion 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. As already mentioned in the first public report the interactive storage place of CINCH-II and MEET-CINCH material is now at https://nucwik.com/ that, of course, is also linked to the main MEET-CINCH homepage (https://www.cinch-project.eu/). Nucwik.com will be overhauled until the end of the project completely. Additionally subpages with links to the different teaching material categories (calculation exercises, laboratory exercises, RoboLab exercises, simulations, etc.) will be created with links to all relevant material.

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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