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Authors:	Roberta Cirillo		
For the Lea	d Beneficiary	Reviewed by Work package Leader	Approved by Coordinator
Roberta Cirillo		Roberta Cirillo	Mojmír Němec
Roberto	a Coult	Roberta Cirillo	NECACH

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Coordinator:	Mojmír Němec
EC Project Officer:	Kateřina Ptáčková
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Coordinator contact:	+420 224 358 331, mojmir.nemec@fjfi.cvut.cz
Administrative contact:	+420 245 008 599, <u>cinch@evalion.cz</u>
Online contacts:	http://www.cinch-project.eu/

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EXECUTIVE SUMMARY

This report presents the A-CINCH project and its outcomes achieved in the first 18 months of the project realization.

A-CINCH is the latest one in the CINCH project series. It is based on a collaboration among 17 partners from 13 countries, funded by the Euratom research and training program.

The project tackles the lack of interest of the young generations towards the fields of nuclear and radiochemistry. It attracts people to the field exploiting the 'learn through play' concept.



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1 INTRODUCTION AND BACKGROUND

A-CINCH stands for "Augmented Cooperation in education and training In Nuclear and radiochemistry". It is the latest from a series of nuclear and radiochemistry dedicated actions collectively referred to as "CINCH series".

The 1st project was CINCH then came CINCH-II and MEET-CINCH.

The CINCH projects have aimed at the **C**oordination of education and training In **N**uclear **CH**emistry and started by receiving support from the EURATOM FP7 and H2020 programs.

CINCH and CINCH-II 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.

MEET-CINCH aimed at involving end-users, bringing the so far achieved 'CINCH results' to them, and at attracting new talents to the radiochemistry field and increasing the nuclear chemistry awareness. On top of that, A-CINCH completes the CINCH learning materials and tools with the most modern methods, revises and complements the so far produced materials and ensures for easy access through the CINCH HUB that is being developed. It also looks more closer at the youngsters. The goal of A-CINCH is to take actions to address the loss of the young generation's interest for nuclear knowledge in general and for nuclear and radiochemistry (NRC) in particular. The project intends to rely on the "learn through play" concept with the aim of attracting high school students to the nuclear and radiochemistry field and provide nuclear and radiochemistry students and teachers with attractive and state-of-the-art teaching tools and sources.



Figure 1: A-CINCH approach to address the young generation's interest



2 A-CINCH SPECIFIC OBJECTIVES

Based on the very encouraging results of the Virtual Reality Laboratory (VR-Lab) during the previous CINCH projects, the innovative concept of the A-CINCH project is "Using VR and Augmented Reality (AR) to enhance NRC teaching".

A-CINCH targeted age group remains wider than only the young generation though, including older students, teachers and even professionals.

Another important objective of the A-CINCH project is the development of the so-called CINCH HUB that will wrap up all previous CINCH results into a single user-friendly and easy-to-navigate interface. It will be completed with newly developed courses and other materials, and it will also implement a highly innovative Virtual Lab based on the involvement of augmented reality and gamification applied on nuclear and radiochemistry education with the overall goal to increase number of students and trainees. The concept of the HUB and the idea behind is presented in Figure 2 below. The CINCH HUB alpha version has been developed and the project partners have been asked to test it and provide for their feedback.

The whole concept focuses on the VR-Lab which together with a special series of tools like:

- Massive Open Online Courses (MOOC);
- Nuclear and Radiochemistry Teaching Material Wiki (NucWik);
- Learning Management System platform (Moodle);
- Robotic Remote-Controlled Experiments (RoboLabs);

combined with a series of innovative methodologies:

- Virtual reality teaching;
- Online teaching;
- Virtual laboratories;
- Hands on Training;
- Flipped classroom;
- Gamification;

produce relevant content for teachers and students that can be used for:

- Summer schools;
- Class materials and teaching;
- Materials for introducing the nuclear radiochemistry to citizens;
- Materials for upgrading knowledge skills and competences of employees.



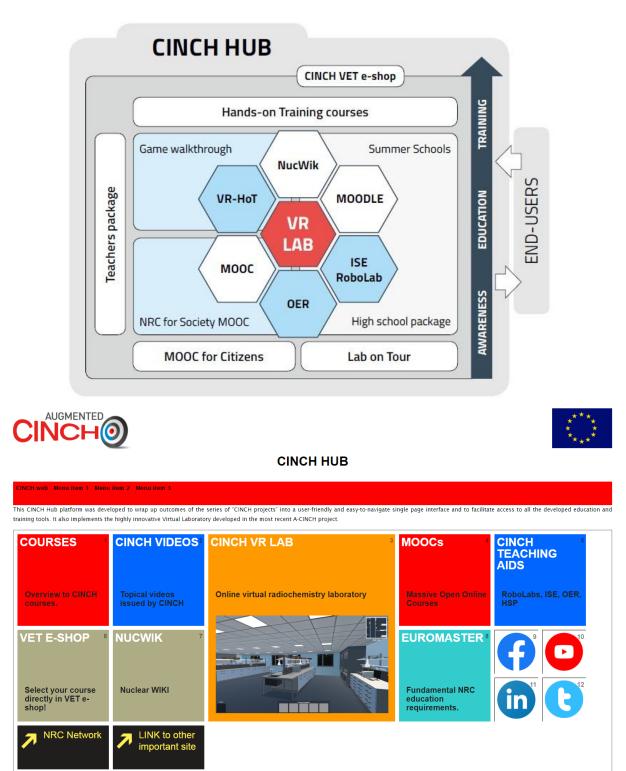


Figure 2: CINCH HUB description and title page of its alpha version. It is supposed to embed all the educational tools produced as project outputs both in A-CINCH and in the previous projects in the CINCH series.



3 PROJECT CONSORTIUM

The A-CINCH consortium consists of 17 partners from 13 countries as summarized in Table 1 below.

Table 1: A-CINCH partners

N°	Participant organization name	Short name	Country
1	Czech Technical University in Prague - COORDINATOR	сти	Czech Republic
2	Gottfried Wilhelm Leibniz University Hannover	LUH	Germany
3	Politecnico di Milano	POLIMI	Italy
4	Institut Jozef Stefan	JSI	Slovenia
5	Chalmers Tekniska Hoegskola Ab	CHALMERS	Sweden
6	Helsingin Yliopisto	UH	Finland
7	University Of Leeds	UNIVLEEDS	United Kingdom
8	Otto-von-Guericke University	OVGU	Germany
9	National Nuclear Laboratory Limited	NNL	United Kingdom
10	Institut Mines-Telecom	IMT	France
11	European Nuclear Education Network	ENEN	Belgium
12	University Of Cyprus	UCY	Cyprus
13	Universitetet I Oslo	UIO	Norway
14	The Secretary of State for Environment, Food and Rural Affairs	CEFAS	United Kingdom
15	Evalion s.r.o	EVALION	Czech Republic
16	M.V. Lomonosov Moscow State University – pending decision ¹	MSU	Russian Federation
17	Instituto Superior Tecnico	IST	Portugal

¹ At the time of this report compilation, the European Commission has taken restrictive measures against the Russian Federation. The collaboration with the Russian partner in A-CINCH is being closely evaluated and a decision about if they shall be excluded from the project or not it still pending.







Figure 3: Location of the A-CINCH partners



4 ORGANISATION OF THE WORK

A-CINCH is composed of 7 work packages (WP) and is built around 3 pillars.

These three pillars update, contain, link and use all of the earlier developed tools and encompass the new ideas behind the A-CINCH objectives.

The unifying goal of these pillars is to develop a platform, the CINCH HUB, where it will be easy to navigate through the CINCH tools and materials, and, at the same time, to use this platform as a gateway to modern education.

Pillar 1: Virtual Reality Laboratory

Entailing

- WP1: Virtual reality NRC laboratory
- WP2: Virtual Reality (VR) Hands on Training (HoT)

Pillar 2: Wrap-ups and developments

Entailing

- WP3: Valorization, wrap-ups and maintenance
- WP4: Developments and revisions

Pillar 3: Nuclear Awareness

Entailing

• WP5: Nuclear chemistry awareness

There are two more WPs which are in charge of developing cross-cutting activities

- WP6: Dissemination & Networking
- WP7: Mobility & Management

Figure 4 shows the structure of the project work.



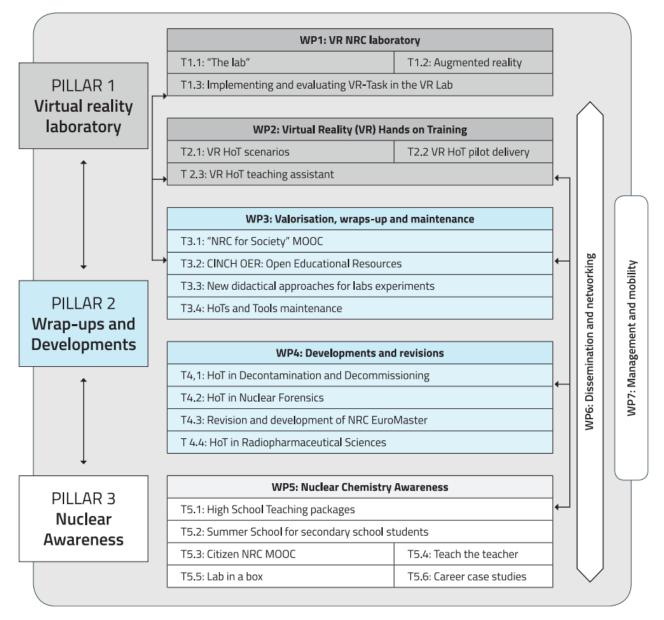


Figure 4: The A-CINCH project structure



5 OUTPUTS PRODUCED

This report is being drafted when the A-CINCH project reaches half-life (18 months) of its implementation.

During this phase, the ground has been settled to build upon previously achieved results and some new outputs have been realised already.

The following paragraphs provide an overview of the so far achieved project outputs.

5.1 Pillar 1: Virtual Reality Laboratory

As previously mentioned, this pillar is driving the work of

- WP1: Virtual reality NRC laboratory
 - Partners: LUH, UH, OVGU, UiO, MSU,
- WP2: Virtual Reality (VR) Hands on Training (HoT)
 - Partners: CTU, POLIMI, JSI, CHALMERS, UH, UiO, IST.

WP1 is dedicated to the development of a 3D environment for NRC laboratories. The outputs will consist in a platform where the Virtual Reality (VR) Hands on Training (HoT) scenarios will be implemented.

The VR-Lab represents an innovative aspect of the A-CINCH project that links different outputs of the project to each other. It will give the user a broad virtual insight into a radiochemical laboratory and the virtual environment will offer various working tasks in a playful way.

The concept of VR-Lab will present several rooms and each one of them will be designed following the requirements and the technical standards for working as a radiochemist. The users will also be able to interact with objects in order to simulate working in a real laboratory.

The goal is to maximize the educative effect by integrating CINCH learning tools, gamifying the teaching process and granting access to teaching material. The VR-Lab utilizes the already existing or updated materials and tools together with the newly developed A-CINCH results and provide them to the target groups in highly innovative and attractive way.

The solution is being developed for desktop devices.

WP1 is closely related and interconnected with WP2. The main objective of WP2 is to develop scenarios and screenplays to be used in VR HoTs. The selected HoTs are as follows:

- HoT 1.1 Determine half-life from the mass of long-lived radionuclide (CTU)
- HoT 1.2 Szilard-Chalmers Reaction (UiO)
- HoT 2.1 Determination of Po-210 and Pb-210 in water samples (JSI)
- HoT 3.1 Superficial decontamination, contamination conditioning and release of radioactive metallic waste (POLIMI)
- HoT 4.1 F18 production from cyclotron, synthesis of F18-FDG and administration to tumor bearing mouse (UH)
- HOT 4.2 Elution of radionuclide generators (UH).

In parallel, a virtual teaching assistant will be introduced in the form of an interactive game walkthrough to the VR HoT users. This virtual assistant is intended to provide help on how to complete some specific tasks and also provide a link to NRC fundamentals and additional resources. This will be accomplished by taking advantage of and reusing already existing resources and teaching materials produced within previous CINCH projects (NucWik, video lectures and other).



The VR HoTs provide for two basic levels: for less and more advanced users in the NRC field. The introduction of VR HoTs will allow to create an educational platform and will provide a learning tool which could be used as "teasers" for both high school students to attract their attention, and for the general public to create awareness. For more advanced students, it is an attractive teaching tool simulating the laboratory environment accessible any time and with low costs.

The gaming experience associated to the VR HoTs will allow to better deliver the content to the young generation. This is intended to be a tool to enhance their learning outcome and possibly light up their interest for the radiochemistry domain.

At this stage, some elements of the virtual laboratory have been developed:

- Quest system,
- Quest journal,
- Navigation assistance,
- Teaching information,
- Radiation simulation, half-life determination and HoT related activities (e.g., measurement of Po-210 and Pb-210 in water),
- Lab equipment.

Save and loading options are issues that will be stressed and sorted out in the next reporting period to prevent the student from repeating the same steps and tasks over and over that could be quite discouraging for the user and bring little of learning outcome.

In the next months a test version will be ready and there is the possibility to test it with the students who will take part in the first Summer School organised under the project, in July 2022 in Leeds.

The main target groups for this product are high school or bachelor students, hence the "gamification-based" approach, and the general public. However, it can be used also by older or more experienced people since it is possible to lower the level of guidance all along the game.

Below, Figure 5 presents a series of screenshots showing some previews of how the VR Lab will look like.



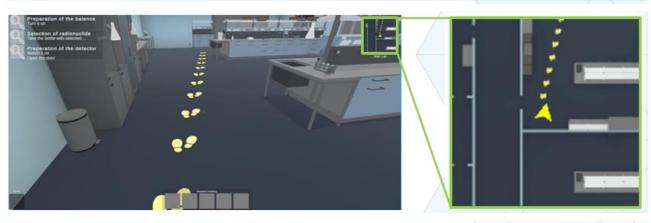


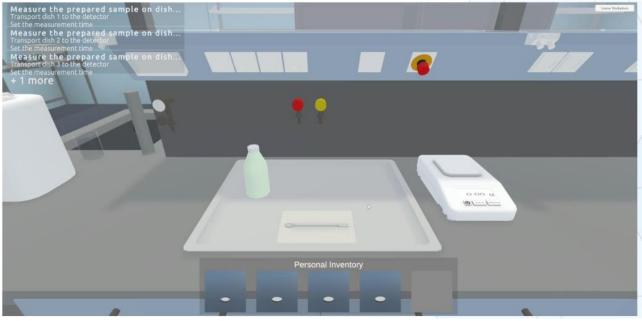
.

Preparation of the balance

Selection of radionuclide Take the bottle with selected chemical and pl...

Preparation of the detector Switch it on Open the door







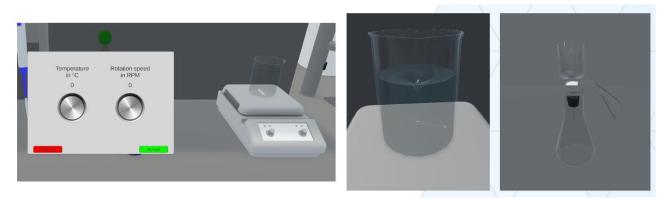


Figure 5: Screenshots from the VR Lab preview

5.2 Pillar 2: Wrap-ups and developments

As previously mentioned, this pillar is driving the work of:

- WP3: Valorisation, wrap-ups and maintenance
 - o Partners: CTU, LUH, POLIMI, JSI, CHALMERS, UH, UCY, UiO, CEFAS, MSU, IST,
- WP4: Developments and revisions
 - CTU, LUH, POLIMI, JSI, IMT, UIO, CEFAS, MSU, IST.

WP3 focuses its effort in valorising the knowledge that has already been developed along the previous projects in the CINCH series. It will improve the MOOC experience among students, promoting new pedagogical approaches among teachers and making new material available as Open Educational Resources (OER) and practices.

Within the series of CINCH projects, many courses and teaching materials have been delivered. To share the materials as wide as possible, ensuring high quality and enable access to different target groups, effort is dedicated to design the way to share the already created knowledge, and to release and share the teaching and learning materials as OER. At the same time, this activity is expected to result in increased awareness of NRC.

CINCH OER will be:

- Free resources published under the Creative Commons Licence,
- Digital, accessible to anyone, anytime via the internet,
- High quality university level educational materials,
- Organized as courses,
- Not requiring any registration,
- Not degree-granting or certificate-granting.

This WP aims as well to ensure access to this material in the future (even after the project ends). The MOOC titled "Nuclear-Radiochemistry for Society" will be delivered in parts, several editions animated by webinars and forum discussions. It will be kept continuously up to date since there will be feedback provided by the users.

Furthermore, selected usage patterns will be designed and toolkits to facilitate the use of the same MOOC in different contexts will be produced.

A model showing how to release and use the available CINCH materials and resources as OER will be also designed. The choice of what material is released via this model will be made on the basis of collected data and gap analysis performed about the future needs of the teachers.

All the produced material is guaranteed to remain available.

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The interaction with teachers by means of dedicated teacher training is also planned. This will be an important opportunity to share experiences in difficulties in teaching and to be aware of different options to engage students by means of new methodological choices and pedagogical approaches.



Essential radiochemistry for society

AUDIENCE

The course is addressed to Bachelor students in scientific areas, who are interested in realising the involvement of Nuclear - and Radio - chemistry in everyday life and understanding the advantages it could introduce.

PREREQUISITE

Scientific background knowledge deriving from high school and higher education, in particular on chemistry, physics and math.

ACTIVITIES During the course participants are involved in webinars by experts and professionals and live discussions.

COURSE SYLLABUS

Week 1 - Radiochemistry for the environment Module 1 — Natural Radioactivity Module 2 — Radioactivity from anthropogenic activities Module 3 — Environmental remediation

- Week 2 Radiochemistry for health Module 1 — Nuclear medicine Module 2 — Sterilization by ionizing radiation Week 3 — Radiochemistry for industry
- Module 1 Tracer technology Module 2 Radiation processing
- Week 4 Radiochemistry for nuclear energy Module 1 — Reprocessing of spent fuel Module 2 — Confinement and Waste Management Module 3 — Decommissioning of nuclear/industrial plants
- Week 5 Radiochemistry for society Module 1 Cultural heritage Module 2 Nuclear forensics and proliferation

Workload 5-6 hours/week

Enroll on the course: https://www.pok.polimi.it





This project has received funding from the Euratom research and training programme 2019–2020 under grant agreement No. 945301 and from the Norwegiar Research Council under grant agreement N* 313053.

Figure 6: MOOC flyer

Two series of webinars have been realised:

- CINCH Talks (five webinars so far): .
 - <u>Safety of future reactors (Gen IV)</u> A story from the past and present
 - Basics of Nuclear Fuel Cycle and generation of Radioactive Waste 0
 - Molecular Imaging and Translational Research: from Molecules to Man 0
 - Tracking immune cells using PET 0
 - Neutron activation analysis. 0
- CINCH Talks for teachers (five webinars).



MOOC SPREADING (activity 3.1.e)

CINCH Talks for Teachers (Ex Teacher Training)

- An Open Toolkit for Gender-Balance Design
 23 September 2021 Paola Corti, POLIMI; Ana Moura Santos, Universidade de Lisboa
- Create high quality videos on your own
 18 November 2021 Valeria Baldoni, POLIMI
- Creating educational content in a gender-conscious perspective 14 December 2021 - Valeria Baudo, POLIMI
- Open Educational Resources
 18 January 2022 Paola Corti, POLIMI
- CINCH OER: creating and releasing OER and transforming CINCH content in open content
 17 March 2022 Paola Corti, POLIMI



Figure 7: Webinar series organised by POLIMI

The MOOC has also been used in different contexts:

- By UH along with flipped classrooms,
- By JSI with PhD students,
- By UiO in their "radioactivity" course.

The feedback so far was always very positive.

The GAP analysis was performed by CHALMERS to select the material to transform into OER. Moreover, new didactical approach is under development (videos by JSI, interactive screen experiments by LUH). Also, one HoT has been organised by POLIMI on <u>Chemical Dosimetry</u>. Grants were distributed to facilitate attendance thanks to the A-CINCH Travel Fund. The second HoT will take place in June, 2022. It will be organised by JSI and UCY and will deal with <u>Radiochemical Spectroscopic Analysis</u>. Grants will be also available to facilitate attendance thanks to the A-CINCH Travel Fund. The last HoT on Working with Plutonium and Actinides is foreseen for September 2022 and will be organized by CHALMERS.

The already existing, maintained and upgraded tools are the RoboLabs at LUH and UiO and NucWik by UiO. At this stage, the MOOC is being updated, the MOOC flyer has been updated and there are 97 enrolled users from 15 countries.



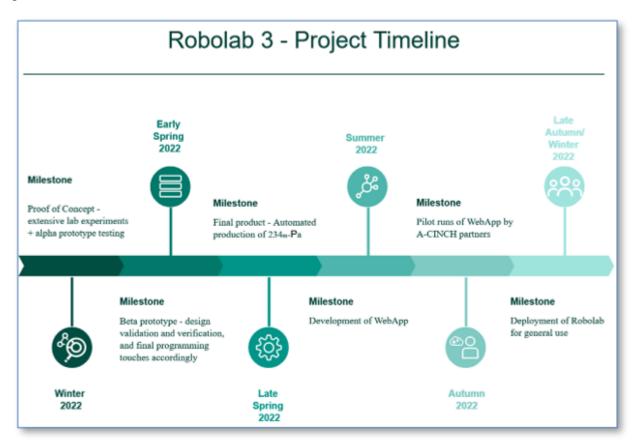


Figure 8: A new RoboLab is in progress

The main goal of WP4 is the development of new HoT courses.

In the previous CINCH projects, several courses were fully developed and tested. Based on the feedback from participants and related end-users, the course template was optimised and is available for additional courses. The planned new HoT courses aim at covering the areas that are now receiving high attention in the European scientific community.

The new foreseen Hands-on Training courses are:

- 1. **HoT on Decontamination and Decommissioning (D&D)**. University curricula in D&D are still rare or just being designed, and the nature of D&D requires practical experience and the ability to apply a wide spectrum of knowledge in a flexible way. A basic HoT is essential to fill this gap.
- 2. **HoT in Nuclear Forensics**. Nuclear forensics is a part of forensic sciences and it covers a broad scope of disciplines (such as chemistry, physics, biology, social sciences, and more). It is used both for evidence analysis and in many other disciplines for the evidence evaluation (e.g., in crime investigations). However, similar to all forensic sciences, crucial attention to sampling, sample treatment, measurement, and evaluation of the measured results is required to maintain the initial information.

HoT in Radiopharmaceutical Sciences (RS). This is a multidisciplinary field that involves chemistry, radiochemistry, pharmaceutical sciences and biology to assure the development of new radiopharmaceuticals and their safety and efficacy in clinical use.

The new HoTs in WP4 are under development, with some parts already realized:

- 1. The structure of the HoT in Decontamination and Decommissioning is available on the Moodle.
- 2. The scenario for the HoT in Forensics is ready and some related videos are under development.
- 3. The schedule for the HoT in Radiopharmaceutical Science is ready.



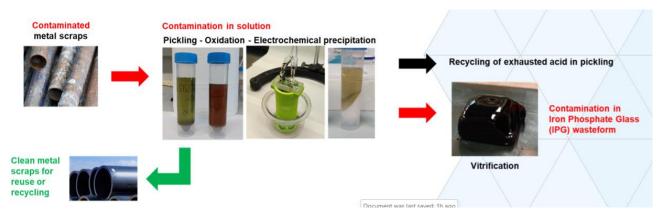


Figure 9: D&D HoT preparation

WP4 will also review and further develop the NRC EuroMaster quality label, developed in CINCH and CINCH-II as a label for universities that meet the NRC Minimum Requirements for teaching nuclear and radiochemistry developed in CINCH-II and approved by the Division of Nuclear and Radiochemistry of the EuChemS (DNRC).

5.3 Pillar 3: Nuclear Awareness

As previously mentioned, this pillar is driving the work of:

- WP5: Nuclear Chemistry Awareness
 - Partners: LUH, POLIMI, CHALMERS, UNIVLEEDS, NNL, UCY, CEFAS, MSU, IST.

WP5 develop a distributable and sustainable toolkit of standalone resources to promote and increase awareness of the NRC field. The overall objective is to make the field attractive to the younger generation and motivate students to pursue a career in nuclear chemistry either in the industry or academia. WP5 targets the pupils, general public as well as high school teachers to make them aware of the importance of NRC for the society. This action also aims to equip parents and teachers with insights to inform their children or students about careers in this field. Although each task is a standalone resource (or tool). The products have been designed so that they can be utilised together to enhance their effectiveness.

The product are:

- teaching package for high school teachers. will self-• Α It be а college contained distributable classroom package intended to inform and enthuse students, ideally prior to further career selection.
- A Summer school for Secondary / High School Students has been developed and will be piloted in the UK in July 2022.
- A MOOC for citizens will be developed adapting the scientific content to a general public level of understanding. It aims to bring innovation to nuclear education at a basic level to inform parents, students and the public of NRC in society, and as a potential career choice.
- A tool called "Teach the Teachers" will be designed to provide teachers with an introduction to the role of NRC in society and the range of careers available as well as to introduce the training resources developed in CINCH to date.
- An outreach toolkit called "Lab-in-a-Box" is being developed. It will allow its users to select activities/materials appropriate to the audience of the festival/fair being targeted.
- A series of case studies will be produced that highlight where and how nuclear/radiochemists have made an impact stressing the benefits of having trained nuclear/radiochemists.



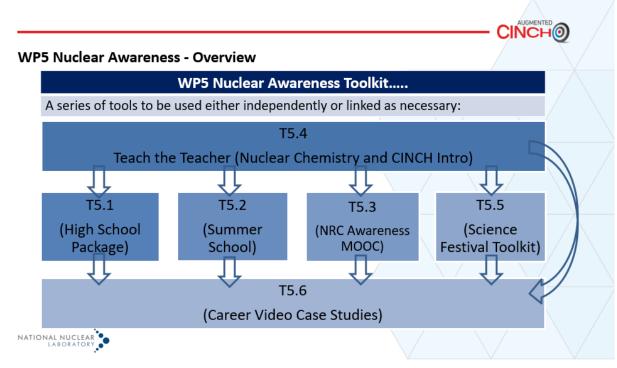


Figure 10: Overview of WP5

At this stage:

- The teaching package is under development: some lessons and videos are ready to be shared.
- The MOOC is being adapted for the general public, testing is foreseen for September 2022.
 - The <u>Summer School in Leeds</u> has been announced and advertised. It will take place in July 2022. The program is ready and several manifestation of interest has been already collected (about 17). The capacity of the Summer School is up to 25 participants.
- A radiation monitoring activity for students has been designed.
- The scenario of the Teach the Teachers package is ready and several schools (7-11 years old students) have been contacted. The scenario will be updated according to their feedback.
- The videos describing the career studies are under preparation. The aim is to provide variety rather than a uniform set of videos and experiences.
- The content of Lab in a box is ready to be presented.

5.4 Cross Cutting Activities

5.4.1 WP6: Dissemination and Networking

WP6 main objective is to provide support in the dissemination and implementation of project results to ensure that the information about the project and its outputs will be delivered among the nuclear community, all relevant target groups and end-users.

At the same time, WP6 should assure the long-term sustainability and exploitation of the CINCH series results. Among other actions, setting up and maintaining the project website is a particular task in WP6.



Promotion of events or participation in networking events at the national and international levels complete the list of tasks.

Till now, the A-CINCH project has been promoted at the following events:

- {by ENEN + CTU, mar 2021} The A-CINCH coordinator was invited to present the A-CINCH project at the ENEN Special Event in March 2021.
- {by ENEN sept 2021} A-CINCH poster exposed at the <u>NENE2021 Conference</u> in Bled and a paper about the project has been submitted for publication in the proceeding.(Hybrid format, about 170 in presence)
- {by ENEN nov 2021} The A-CINCH project was presented at the <u>NESTet 2021 Conference</u>. This event has been organised in a hybrid format in Brussels in mid-November 2021, and gathered about 100 attendees (including representative of the EU Commission – among them, A-CINCH project officer)
- {by ENEN dec 2021} Furthermore, ENEN presented A-CINCH at the World Nuclear Exhibition <u>WNE</u> during the event dedicated to students. (About 60 attendees online + 40 in presence) – Dec 2021.
- {by ENEN + CTU, mar 2022} The A-CINCH coordinator was invited to present the A-CINCH project at the <u>ENEN Special Event</u> in March 2022.
- {by CTU, sept 2021} at the 73rd Annual Congress of the Slovak and Czech Chemical Societies
- {by POLIMI, oct 2021} at the 32nd Miller Conference on Radiation Chemistry, October 9-14 2021, Corsica Island, France
- {by POLIMI, feb 2022} Miller Online Workshop on Radiation Chemistry, 10–12 February 2022

The work of this WP runs horizontally throughout the project duration in order to drive the previous as well as the newly elaborated results towards their exploitation and the long-term sustainability. In parallel to all these activities, WP6 is in charge to deliver the CINCH HUB, the portal that will link together all the CINCH tools from previous and current projects and will serve as a gateway to all CINCH tools and materials.

At this stage, the CINCH HUB is ready in its alpha version and feedback from the consortium is being gathered in order to improve it.

5.4.2 WP7: Management and mobility

WP7 is the second transversal activity of the project. Its objective is to provide an efficient management of the A-CINCH activities including overall project steering.

Furthermore, the A-CINCH Travel Fund is managed and administered in WP7. This will assure the international exchange of knowledge and practical experience among students, teachers for secondary, higher and vocational education, end-users, and lecturers through the mobility scheme.

At this stage, the HoT on Chemical Dosimetry organized by POLIMI has already seen its participants supported in travel, accommodation and subsistence expenses by the Travel Fund. Next action in line will be the HoT on Radiochemical Spectroscopic Analysis organized by JSI and UCY. The Travel Fund handbook is public accessible at <u>this link</u>.



GENERAL CONCLUSIONS

The A-CINCH project is the latest in the series of CINCH projects, all of them revolving around education and training in nuclear and radiochemistry.

A-CINCH started in October 2020 and currently reached half of its duration. The ground has been settled in all the WPs and activities proceeded as planned with minor deviations.

The general concept permeating all A-CINCH output is 'learn through playing' in order to light up the interest of the younger generation for nuclear radiochemistry and make the NRC studies more attractive for current and future students.

Since many educational tools have been produced already in the previous CINCH projects, and more will be developed under A-CINCH, a portal will be delivered during this project: the CINCH HUB (currently existing in alpha version) which provides easy-to-navigate interface to all CINCH materials and tools for all target groups.