# ANSELMUS

## Advanced Nuclear Safety Evaluation of Liquid Metal Using Systems

# NEWSLETTER No.1

**Grant Agreement Number 101061185**
**Start date: 01/09/2022 – Duration: 48 months**

**This project has received funding from the Europen Union's Horizon EURATOM 2021 Research and Training Programme under Grant Agreement No. 101061185**

ANSELMUS SUMMER SCHOOL

# ANSELMUS heavy metal summer school

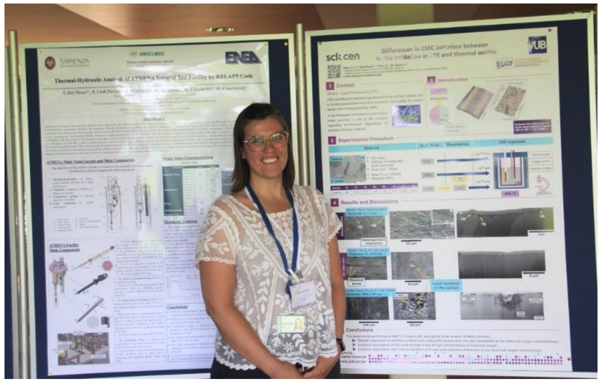
Time flies when you are having fun. It has already been over four months since we had our first fabulous fantastic heavy metal school organized in conjunction with the Graspop metal meeting music festival, the latter being word famous in all of Europe. And it was a successful meeting if I may say so. We had thirty three applications, of whom unfortunately only twenty could be accommodated because quality (of the teaching experience that is) is preferred over quantity. Ultimately, two of the chosen twenty could not make it due to visa problems. Due to the generous support of the EU, both via the ANSELMUS project but also though ENEN+, it was possible to offer financial mobility support to most of the students.

As planned the school dealt with a wide range of topics including rationale & motivation, system designs of the ALFRED reactor and the MYRRHA Accelerator driven system, non-nuclear applications of heavy liquid metals, fuel, materials, thermal hydraulics, coolant chemistry, reactor physics and safety. Each of these topics were covered by one or more lectures. We had the pleasure to have contributions from Michele Frignani from Ansaldo Nucleare, Ferry Roelofs from NRG, and a long list of SCK CEN lectures: Serguei Gavrilov, Borja González Prieto, Graham Kennedy, Antonin Krása, Jun Lim, Julio Pacio, Kris Rosseel, Guy Scheveneels, Valentyn Tsisar, Katrien Van Tichelen and Paul Schuurmans.

I am sure that the EU will be very happy with the quality of lectures and the fact that having in-house people significantly reduces travel costs. Finally, it was also great to have contributions from two guest lecturers: Christian Ekberg from Chalmers University and Thomas Wetzel from KIT.


A second important aspect of the school is letting the students do some work as well. For that we had interactive sessions where small groups of students worked out a component of a (hypothetical) heavy metal cooled system. On this occasion the plan was to build a reactor to power a large plant for crypto current mining. Topical experts were available for consultation and at the end of the exercise, each group presented their results.


In addition, there was a poster session where sixteen of the students presented their current research activities to an audience of colleague students and lecturers. Here the liveliness of the presentations and the discussions that emerged more often than not, forced the well-disciplined and strict time keeper to intervene.

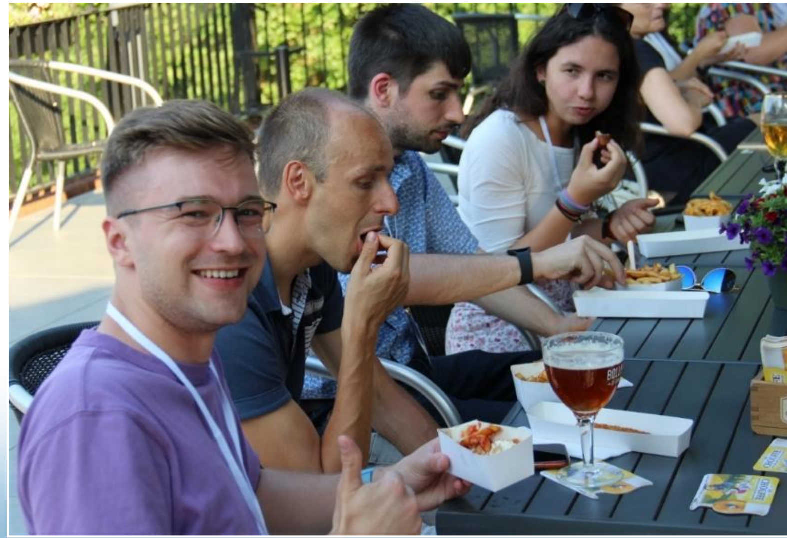


A technical visit to the heavy metal experimental hall at SCK CEN was also organized but unfortunately, because that is inside the nuclear site, there are no pictures taken.

Of course, “all work and no play makes the student a dull person” so there was also some relaxation. The school being organised in Belgium, it is almost self evident that there was a detailed study session of fries and beer which was, for some reason, well received.

Finally, the excellent relationship we had with the Graspop festival allowed us to have a technical visit behind the scenes of the festival where we got access to the main stage and even to the inner sanctuary where all the very famous metal bands reside before (and after) their gig. On top of that, we could even offer every student a free ticket to go to the festival on Friday after the end of the school.

All that is left now is to thank every person that helped realizing the school, not only the lecturers but also the staff of the SCK CEN academy and Margot Degrève from the project office. On to the VKI lecture series in 2025!




**Author: Paul Schuurmans – SCK CEN;**
**Contact: paul.schuurmans@sckcen.be**

# ENEA Installations: the NACIE-UP Facility

NACIE-UP is a rectangular loop which allows to perform experimental campaigns in the field of the thermal-hydraulics, fluid-dynamics, chemistry control, corrosion protection and heat transfer and to obtain correlations essential for the design of nuclear plant cooled by heavy liquid metals.

It basically consists of two vertical pipes (O.D. 2½”), working as riser and downcomer, connected by two horizontal pipes (O.D. 2 ½ ”). The whole height of the facility is about 7,7 m, while the horizontal length is about 2,4 m.

A prototypical grid-spaced fuel pin bundle simulator (FPS), with a maximum power of 235 kW, is installed in the lower part of the riser. A proper heat exchanger is placed in the upper part of the downcomer.

NACIE-UP is made in stainless steel (AISI 304) and can use both lead and the eutectic alloy LBE as working fluid (about 2200 kg, 220 l of capacity). It was designed to work up to 550°C and 10 bar. The difference in height between the center of the heating section and the center of the heat exchanger is around 5 m and it is very important for the intensity of the natural circulation. In the riser, an argon gas injection device ensures a driving force to sustain forced convection in the loop.

*NACIE-UP facility*

ANSELMUS FACILITIES ON FOCUS

The facility includes:

- The Primary side, filled with LBE, with 2½" pipes. It consists of two vertical pipes, working as riser and downcomer, two horizontal pipes and an expansion tank;
- A Fuel Pin Simulator (19-pins) 235 kW maximum power, placed in the bottom of the riser of the primary side;
- A Shell and tube HX placed in the higher part of the downcomer;
- A prototypical thermal flow meter;
- Several bulk thermocouples to monitor the temperature along the flow path in the loop;
- The Secondary side, filled with water at 16 bar, connected to the HX, shell side. It includes a pump, a pre-heater, an air-cooler, by-pass and isolation valves, and a pressurizer with cover gas;
- An ancillary gas system, to ensure a proper cover gas in the expansion tank, and to provide gas-lift enhanced circulation;
- A LBE draining section, with ½" pipes, isolation valves and a storage tank.

The ancillary gas system has the function to ensure the cover gas in S101 and to manage the gas-lift system in the riser for enhanced circulation regime; the maximum flow rate attainable with the gas-lift is around 10 kg/s. In 2023 the pumping system will be upgraded with the installation of an electromagnetic pump with flow rates up to 20 kg/s.

Due to the features of the loop, several experimental tests were carried out in the past years to characterize the transition from forced to natural circulation with heavy liquid metal and the flow blockage.

The isolation 2 ½" ball valve V142, placed downstream the FPS, will protect the FPS during the draining of the facility and can be partially closed to regulate the mass flow rate through the loop.

An expansion tank is located at the end of the riser and is partially filled with Argon as cover gas to control the pressure inside the primary circuit. Two level sensors LD101, LD102, are located respectively 80 and 180 mm above the outlet nozzle of the riser, inside the expansion vessel.

The flow meter FM101 is based on the thermal effect and is accurate for mass flow rates within the range 0.6-10 kg/s. It consists in a 2½" pipe with two RTD at the inlet and outlet, a bulb heater and a static mixer. A special control of the bulb power provides fast response to transients while the travelling time of the fluid is compensated. FM101 has been tested in the last configuration of NACIE-UP and it has an accuracy under 5%.

The secondary side is a 16 bar pressurized water loop, with a circulation pump, a pre-heater, the HX shell side, an air-cooler and a pressurizer.

Several experimental campaigns were conducted in the NACIE-UP facility in the field of thermal-hydraulic of Heavy Liquid Metals.

In 2023, the loop will be converted in pure lead to carry out experiments on deformed bundle configuration for the ANSELMUS project. A new test section with deformed pins will be mounted in the facility substituting the BFPS test section and will be instrumented with about 100 thermocouples and a differential pressure transducer.

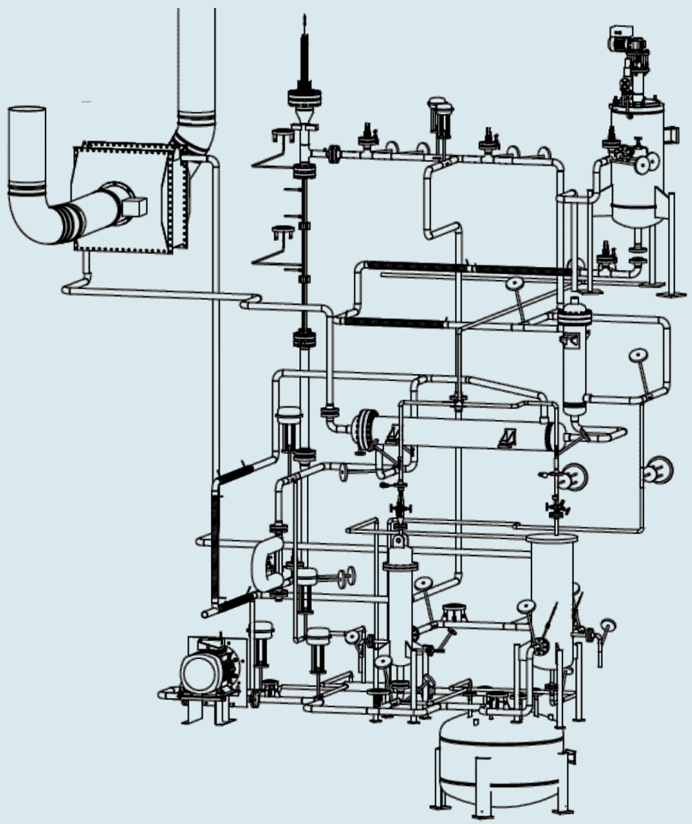
**Authors: Ivan Di Piazza, Mariano Tarantino, D. Martelli – ENEA;**
**Contact: ivan.dipiazza@enea.it**

# SCK CEN Installations: MEXICO Facility

MEXICO (Mass Exchanger in Continuous Operation), an LBE experimental loop designed specifically for coolant chemistry research for MYRRHA, is a remarkable system that offers unique advantages in the field. Unlike most LBE loops, MEXICO was meticulously engineered to possess three distinct temperature zones, achieved by coupling two main heater zones and two economizers. This exceptional flexibility enables researchers to efficiently study coolant chemistry across a wide range of temperatures.

To monitor the evolution of oxygen concentration throughout the loop, MEXICO is equipped with a total of 21 strategically placed oxygen sensors. These sensors are positioned across the various temperature zones, spanning from the highest temperature zone to the lowest. The data collected from these sensors plays a vital role in validating the numerical model of oxygen mass transfer in LBE, enhancing the accuracy and reliability of the research.

In addition to its advanced oxygen monitoring system, MEXICO incorporates two efficient filtration systems including cold trap. These systems effectively separate suspended solid impurities and dissolved impurities from the coolant, ensuring a cleaner and more controlled experimental environment.

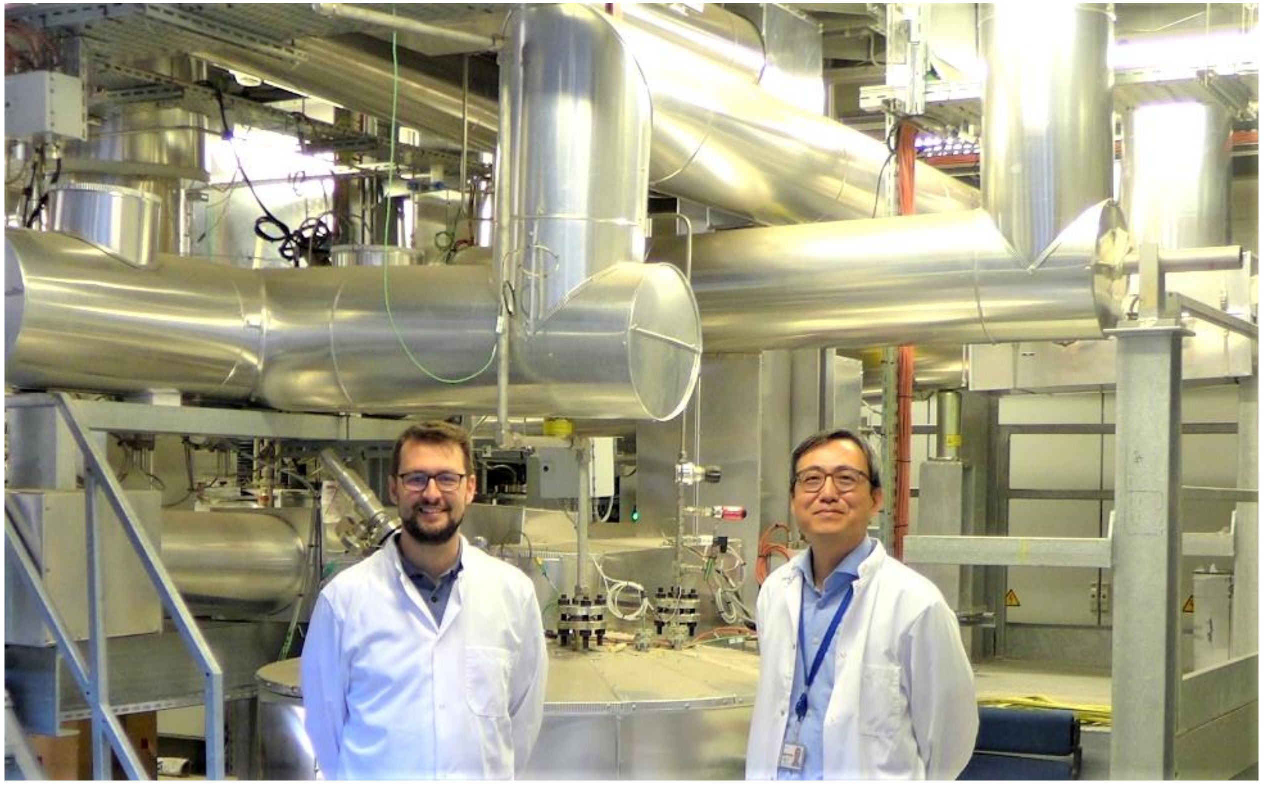


*3D Drawing of MEXICO Loop*

Since its commissioning in early 2014, MEXICO has successfully conducted numerous experimental campaigns, which have yielded valuable insights in various areas. Some of the notable campaigns include the oxygen control system performance test, filter performance test, and integrated heated fuel assembly test. These campaigns have contributed to the continuous improvement and optimization of the system's performance, highlighting its reliability and effectiveness in achieving research objectives.

Looking ahead, the ANSELMUS project aims to develop an innovative oxygen control system. This system will combine a lead-oxide mass exchanger with a cold trap, which will demonstrate cutting-edge advancements in the field. The primary objective of this task is to validate the long-term reliability of the oxygen control system, with a special emphasis on its resistance to chemical poisoning in the lead-oxide mass exchanger. By addressing these critical aspects, ANSELMUS seeks to further enhance the capabilities and functionality of oxygen control system. Dr. Alessandro Marino and Dr. Jun Lim will be the primary contributors to this endeavor.

In summary, MEXICO's unique design, encompassing flexible temperature zones, extensive oxygen monitoring, and efficient filtration systems, positions it as a leading platform for coolant chemistry research. Its successful track record of experimental campaigns and the ongoing advancements through the ANSELMUS project solidify MEXICO's significance in pushing the boundaries of scientific knowledge in the field of LBE coolant chemistry.



*Dr. Alessandro Marino (left) and Dr. Jun Lim (right) in front of MEXICO loop*

**Author: Jun Lim, Alessandro Marino (SCK CEN)**
**Contact: jun.lim@sckcen.be**

# Conceptual Design of Deformed Fuel Pin Bundle Experiment on Alfred Mock-Up

In the framework of the ANSELMUS EU Project, the conceptual design of a new experiment is carried out. For the realization of the experiment, a new test section (DFPS, Deformed Fuel Pin Simulator) will be manufactured and mounted in the NACIE facility and the experiment to assess the effect on the pin deformation on temperature field in the fuel pin bundle of the ALFRED Fuel Assembly in flowing Lead will be carried out.

## DFPS Test Section

A new Deformed Fuel Pin Simulator (DFPS) test section will be designed, manufactured and installed in the NACIE Facility. For the Test Section, the pins used for the BFPS experiment (SESAME project) in the NACIE facility will be dismounted and re-used. The pins have features to simulate conditions close to the one of ALFRED FA.

The heated pins have a diameter of 10 mm, an active length of 600 mm, and a clad thickness of 0.835 mm. A CFD pre- and post-test will be carried out by ENEA and the other partners of the European project ANSELMUS. From preliminary tests, it emerged that is very important to model the interior of the pins to characterize correctly the overheating due to the deformed pins.

The new deformed bundle test section will be manufactured by bending 3 pins and re-arranging the test section with new instrumentation. The main parameters characterizing the test section in comparison with the ALFRED Fuel Assembly (FA) are summarized in Table *1*.

*Table 1 -Main parameters of the Deformed Fuel Pin Simulator*

| Parameter | DFPS | ALFRED FA | |
|---|---|---|---|
| $d_{pin}$[mm] | 10 | 10.5 | Pin Outer diameter |
| p/d | 1.3 | 1.3 | Pitch to diam ratio |
| Power [kW] | 250 | - | Total power |
| Pin power [kW] | 13.1 | - | Pin power |
| Wall heat Flux [MW/m$^2$] | 0.7 | 0.7-1 | Heat flux |
| Npin | 19 | 127 | Number of pins |
| $L_{active}$ [mm] | 600 | 600 | Active region |
| $\delta_{wall}$ [mm] | 2.1 | 2.1 | Distance of the lateral pins from the wall |

Results of the pre-tests showed that with 2 mm max bending at z=300 mm there is more than 70°C of overheating in the surrounding pins at z=500 mm and more than 50°C at z=300 mm. in nominal conditions, therefore the choice is perfectly coherent and the configuration is highly perturbed by the modified geometry. From this pre-test analysis, 2 mm max bending was chosen as reference value for the design of the test section. The two deformed configurations to be tested will be called configuration A and B; the two configurations will be obtained by rotating the deformed pins 2, 13, 16 of an appropriate angle by Swagelok connectors.

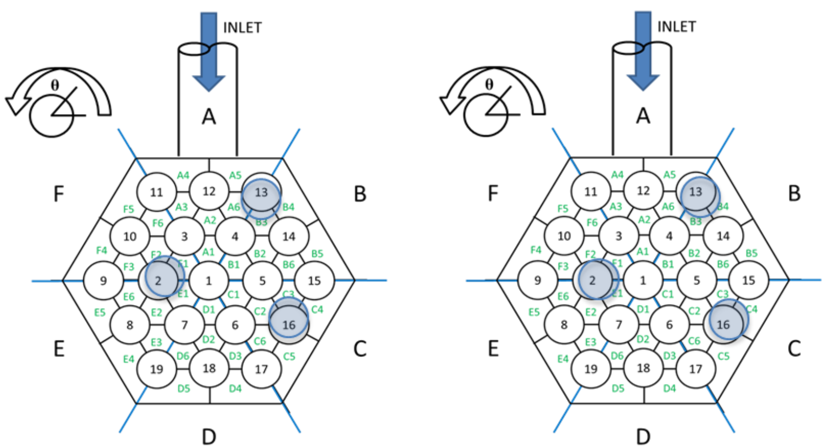



*Figure 1 - Deformed configurations to be tested*

The DFPS test section will be instrumented by bulk and wall thermocouples to allow a complete mapping of the temperature field. The bended pins 2, 13 and 16 will not be instrumented to allow rotation by Swagelok connectors. Two monitoring sections have been selected in the active region: in the middle (plane A, 300 mm from the beginning of the active region) and close to the outlet of the active region at (plane B, z=500 mm). Moreover, a differential pressure transducer will measure the pressure drop across the bundle for code validation.

A notional scheme of the thermocouples in the monitoring sections is shown in Figure 1. A complete test matrix with flow rates up to 20 kg/s representative of the ALFRED pin bundle, will be carried out.

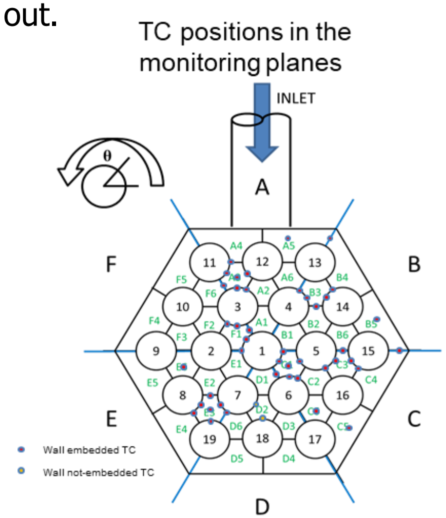



*Figure 1 - Notional scheme of the location of the thermocouples in the generic monitoring section (z=300 mm, 500 mm)*

**Authors: Ivan Di Piazza (ENEA), Daniele Martelli (ENEA), Pietro Cioli Puviani (Politehnica di Torino), Mariano Tarantino (ENEA);**
**Contact: ivan.dipiazza@enea.it**

# Phenomena and Identification Ranking Table

Between the 7th and the 9th of March 2023, the ANSELMUS partners gathered in Petten (The Netherlands) in the JRC-EC premises, to kick-start the Phenomena Identification and Ranking Table (PIRT) exercise.

**WHAT is PIRT?**

- PIRT is a systematic way of eliciting and gathering knowledge from a panel of selected experts on the field of Heavy Liquid Metals (HLM) → subjective decision-making tool.
- PIRT will help to identify and rank phenomena in complex systems → ALFRED and MYRRHA designs.
- It is a mean to identify system and component vulnerabilities and pave the way to further R&D activities.

**WHY do we perform a PIRT?**

- GOAL → Have a robust safety demonstration for ALFRED and MYRRHA designs.

MIND THE GAP

**MAIN OBJECTIVES**

- To gather experts' knowledge and achieve consensus across the EU HLM community about the phenomena having low level of knowledge and high importance for safety demonstration in compliance with EURATOM safety directive requirements.
- To drive decision making processes towards the identification of further needs for the development, verification and validation of numerical tools and methods for nuclear safety analysis of innovative HLM-based systems.
- To structure a systematic and knowledge driven R&D roadmap towards a timely licensing of pilot plants and demonstrators for EU Gen-IV and ADS innovative HLM technologies.

*PIRT Team attending in-person and virtually the PIRT KoM*

ANSELMUS

Mind The Gap!

- **Step 1** – Define the issue
- **Step 2** – Define the specific objectives
- **Step 3** – Obtain Database information
- **Step 4** – Define Hardware and Scenario
- **Step 5** – Establish the Figure of Merit
- **Step 6** – Identify Phenomena
- **Step 7** – Importance Ranking
- **Step 8** – Knowledge Assessment
- **Step 9** – Documentation

A set of 3 in-person meetings were agreed to take place across the whole PIRT procedure and also several virtual progress meetings in between are being arranged to organize and share the tasks of each participant.

**PIRT Kick-off Meeting (March 7-9, 2023)**

- Main objectives
- Methodology
- Panelists selection
- Reference concept designers
- Initiating events selected
- Preliminary feedback

**PIRT Preliminary Scoring (+18M)**

- Systematic discussion about phenomena for selected transients
- Score the State of Knowledge and Importance for FOM
- Identify open points
- Need for sensitivity or numerical evaluations
- Consensus about priorities

**PIRT Finalization (+16M)**

- Additional analyses
- Achieve a final consensus
- Gap scoring – Top-down view driving R&D roadmap

**ANSELMUS**
**Mind The Gap!**

**Status of activities**

- PIRT Methodology was discussed focusing on the Figures-of-Merit, Component partitioning and scoring criteria (JRC)
- The consolidated ALFRED and MYRRHA design versions were introduced (ANSALDO and SCK CEN)
- Preliminary selection of transients for ALFRED and MYRRHA was made
- Existing models and new need for ALFRED and MYRRHA were identified
- Scenario definitions for ALFRED and MYRRHA were chosen
- A panel of 22 experts from 9 organizations was elected (expertise in thermalhydraulics, neutronics, mechanics and chemistry to evaluate the level of knowledge and importance of identified phenomena).
- Dedicated discussion on the Figures-of-Merit (FoM), component partitioning and scoring criteria ➔ This will lead to the GAP identification of phenomena with high importance and low knowledge.

**Gap Identification ➔ Priority R&D effort**

| | **Rank of Importance (impact on FOM)** | | | |
|---|---|---|---|---|
| **Adequacy of knowledge (data)** | High | Medium | Low | Insignificant (N/A) |
| Fully known | | | | |
| Known | **GAP** | | | |
| Partially known | **GAP** | **GAP** | | |
| Very limited knowledge/ Unknown | **GAP** | **GAP** | **GAP** | |

**Authors: Luca Ammirabile, Oriol Parera-Villacampa -JRC;**
**Contact: Oriol.PARERA-VILLACAMPA@ec.europa.eu**

# Social sciences in ANSELMUS

**Since the start of the ANSELMUS project, a team of social and natural scientists from Belgium and Romania has been stimulating researchers involved in the ANSELMUS project to engage with the social impact of innovative heavy metal-cooled nuclear technology.**

***Meet the team*** *(from left to right):*

*Mirela NITOI (RATEN), Robbe GEYSMANS (SCK CEN), Joke KENENS (SCK CEN), Minodora APOSTEL (RATEN), Marin CONSTANTIN (RATEN), Mirela CHIRLESAN (UPIT), Mirela STRATONE (UPIT), Catrinel TURCANU (SCK CEN). Team member absent in this picture: Bogdan Marinescu (UPIT)*

**A number of activities and exercises that bring together different researchers and that create spaces for societal and ethical reflections are planned. Meet the team, learn about sociotechnical integration, get to know the activities, and become involved!**

Work package 5 of the ANSELMUS project harbours a task that aims to study the societal impact of innovative heavy metal-cooled nuclear technology. This task reflects the ambition of the ANSELMUS project to consider societal and ethical considerations in the development of heavy liquid metal technology and to generate socially robust knowledge and innovation. To achieve these goals, a team of social and natural scientists from Belgium (SCK CEN) and Romania (RATEN, UPIT) has joined forces (Figure 1). Over the next months and years, they will run in tandem a set of sociotechnical integration activities, societal dialogues, and surveys. These activities not only set out to create more insight into the societal and ethical aspects that underpin technical projects but also aim to create spaces for mutual learning and interaction between different project collaborators and stakeholders. As such, the team wants to ensure the uptake and practical application of the research findings in the field of nuclear research.

Since the start of the ANSELMUS project, some key steps have already been taken. To kick-start the series of activities related to social and ethical considerations, three social scientists from SCK CEN traveled to Romania in February to meet up with researchers from RATEN and social scientists from the University of Pitesti (UPIT). Through a series of constructive meetings and a tour of the RATEN facilities, they reviewed and adapted different exercises and methodologies that aim to foster sociotechnical integration, i.e., the uptake of societal (and ethical) dimensions in technology and science. To maximize the impact of this first step and to encourage ethical and societal reflections among experts involved in the design and development of heavy liquid-cooled nuclear systems, the team decided on a first series of three activities. These include an online reflection exercise, Socio-Technical Integration Research (STIR), and a workshop.

ANSELMUS

ACTIVITIES TO REMEMBER

In spring, we launched our first activity, an online survey (Figure 1). SCK CEN and RATEN researchers, involved in ANSELMUS project, were invited to fill out five questions. These questions inquired about their views regarding responsible research and innovation (RRI), an approach that stimulates research and innovation to take up and anticipate their potential societal implications. In total, 17 Belgian and 23 Romanian researchers completed the exercise. From the responses, we learned that our respondents regard ethics and social impact as the most important elements of responsible research and innovation. But then again, funding is perceived as the biggest obstacle. We also learned that the respondents are most interested in science education when it comes to responsible research and innovation. Respondents from RATEN also showed interest in open access and ethics. Even if not representative, these results will inform the content of one of our upcoming activities, a workshop. The objective of this exercise was not only to encourage reflection about the way research and innovation are conducted, but also served as an appetizer and recruitment strategy for a second activity, which was initiated in May.

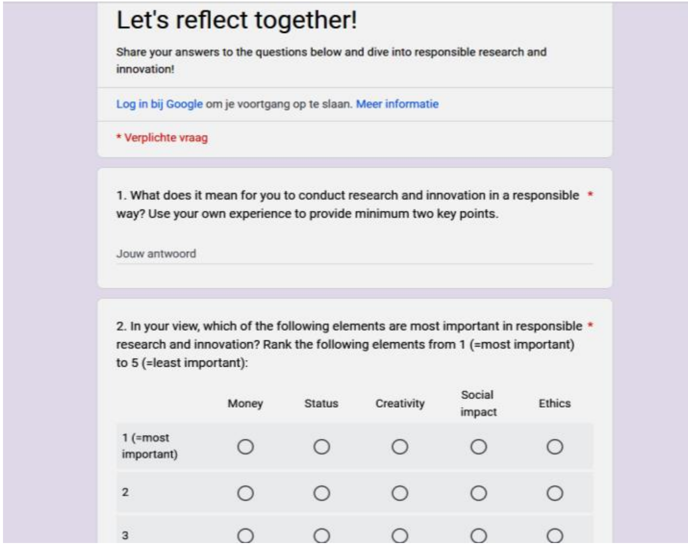



*Figure 1 - Snapshot of our first activity. Want to try it yourself? Click the link to participate: https://forms.gle/ASe8AVQxaqki8kHGA*

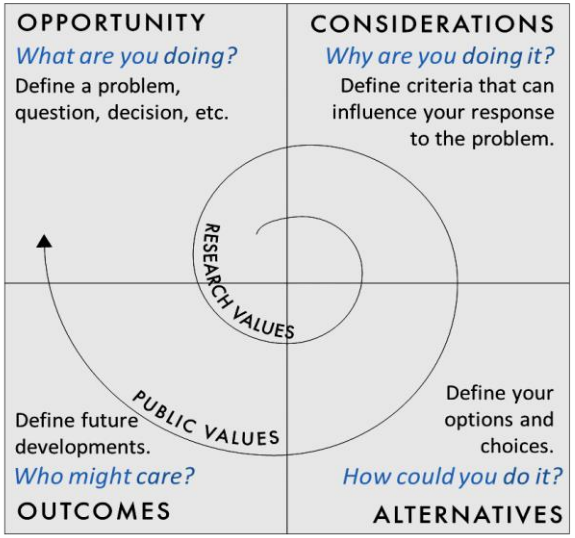



*Figure 2 - Decision protocol used in SocioTechnical Integration Research, source: https://cta-toolbox.nl/tools/STIR/*

Together with 5 SCK CEN researchers and 6 RATEN researchers who volunteered to participate in the first exercise, we embarked on a series of collaborative reflection exercises. By organizing a reflection exercise once per week over six weeks, we bring a social scientist and a technical expert to the same table. The topic of discussion is informed by what the expert is currently working on and/or the decisions (s)he has to make. Following a set of guiding questions (Figure 2), we take the issue or decision to reflect on criteria that influence the decision, potential solutions or options, and the outcome of these possibilities. This exercise is part of a research method called SocioTechnical Integration Research (STIR), which aims to map how researchers and experts make decisions and explore possibilities within the decision-making process. This method also helps to assess capacities for the integration of various aspects, including societal and ethical ones. We believe it has been a positive experience for both the involved social scientists and experts. Interested in trying out the decision protocol yourself? Use the Figure 2 to try and analyze a decision yourself!


**Author: Joke Kenens (SCK CEN);**
**Contact: joke.kenens@sckcen.be**


Later this year, a workshop will be organized at SCK CEN and RATEN, to bring together the research findings from the first and second exercises. It will close off the first series of exercises that focused on creating a stimulating environment for researchers to actively engage in responsible research and innovation. In a second phase of the project, this will feed into an event where we will invite the public to participate and discuss advanced nuclear technologies, as well as into a survey of public views regarding these technologies. So, stay tuned, because there is more to come!

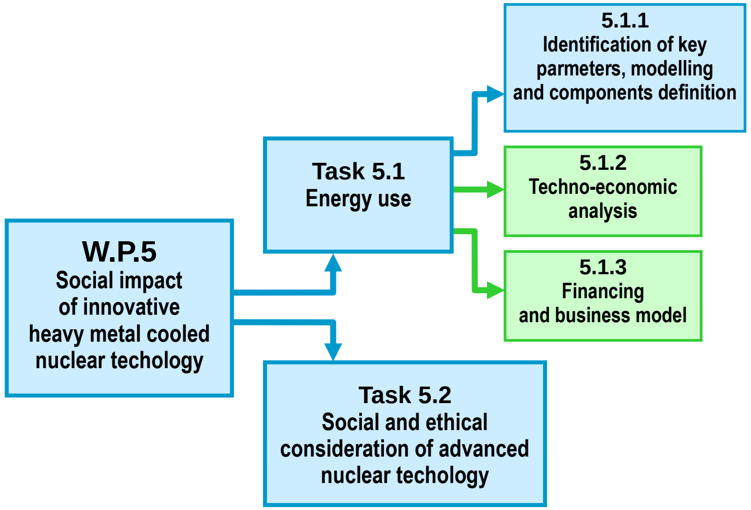
ANSELMUS

ACTIVITIES TO REMEMBER

# LFRs economic and financial analysis: an open problem

The first objective of the activity was to study the state-of-the-art of LFRs economics and finance. To acomplish this, a systematic literature review (SLR) considering both scientific and industrial literature, was performed, considering both lead and lead-bismuth eutectic technologies. The SLR is based on Scopus and on the main nuclear agencies and design organizations websites.

- **Scientific literature.** Out of the 488 documents we took into account, only 12 were actually relevant.
- **Industrial literature.** IAEA, NEA, GIF and design organizations websites were searched. We retrieved 9 additional documents reaching a total of 21.
- **Economic analysis.** Found information only in 18 documents. Both the estimations for the specific capital cost and the levelized cost of electricity greatly vary. The former from 1400 to 16000 $/kWe, the latter from 30 to 350 $/MWh.
- **Financial analysis.** We retrieved only 5 documents, 3 of which only mention the public finances received by the projects. The remaining 2 perform also a yearly revenue estimation.




| | |
|---|---|
| **1 month** | **Submission process of the review** <br> **Definition of needed inputs to compute CAPEX and OPEX for the LFR. Definition of relevant outputs of the techno-economic analysis** |
| **1-3 monthS** | **Involvement of Ansaldo Nucleare to decide which nuclear systems we should focus on** |
| **3-6 monthS** | **Identification of critical parameters and possible risks to perform sensitivity analysis on the systems (such as construction costs and period, financial characteristics, capacity factor etc.)** |
| **Over 6 monthS** | **Addition of non technical aspects to evaluate maturity and potential of designs. Considerations on possible customers and cogeneration options for possible off-take agreements** |

It is clear how important is going to be the involvement of different companies working in the nuclear sector, and in possible cogeneration applications.

From the SLR emerged that a comprehensive economic and financial analysis for the LFR is still missing. Knowledge is fragmented among few documents and/or articles. Most of them fail in giving clear and rightful assumptions for the computations. We found knowledge gaps regarding the economics of the fuel cycle and the licensing process. Moreover, it is not clear how the finances should be divided among debt, equity and self-financing (for SMRs) and how to consider stakeholders involvement.

**Authors: F. Tassone, M. E. Ricotti, S. Lorenzi, G. Locatelli -Politechnica di Milano**
**Contact: federico.tassone@polimi.it**

# Work on “Inspection Strategy”


The activity of ANSELMUS task 4.1 is in close connection with the activity of the European Network for Inspection Qualification (ENIQ). ENIQ is a utility driven network working mainly in the areas of qualification of non-destructive testing (NDT) systems and risk-informed in-service inspection (RI-ISI) for nuclear power plants (NPPs).

During the 2022 fall meeting, ENIQ members had a first discussion on the challenges of in-service inspection (ISI) of LFRs and advanced reactors.

ENIQ is recognised as one of the main contributors to today’s global qualification guidelines for in-service inspection. ENIQ is Technical Area 8 of NUGENIA, which is one of the three pillars of the Sustainable Nuclear Energy Technology Platform (SNETP) with focus on Gen II & III reactors. ENIQ members are coming from mainly European utilities & licensees, inspection qualification bodies, inspection vendors & technology providers and to a limited extent from research institutes and universities plus observers from Japan, Canada and the U.S. ENIQ members are all experts in the field of ISI and NDT of water-cooled reactors (BWR, PWR, CANDU). Since its establishment in 1992 ENIQ has issued over 60 documents, including the “European Methodology for the Qualification of Non-Destructive Testing” and the “European Framework Document for Risk-Informed In-Service Inspection”. SMRs and advanced reactors are relatively new to ENIQ members, but with growing interest of utilities and industrial companies in their countries to deploy such reactors, ENIQ launched discussion on the ISI needs and inspection qualification for such reactors.

In the ENIQ 2022 fall meetings ENIQ members provided a number of comments on ISI of LFRs. Higher operating and shutdown temperatures of LFRs compared to LWRs is seen as the major challenge. Dose rate (fast neutron spectrum) and possibly the grain structure of the vessel (austenitic stainless steel 316L) are seen as additional challenges. Inspection of reactor internals, heat exchangers, in-vessel support structures, virtually everything that is inside the vessel is regarded as challenging. Here the question came up whether the liquid lead can be drained from the vessel when the reactor is in shutdown. The above issues raised by ENIQ members have led to a joint online meeting organized on 27$^{th}$ April 2023 between ANSELMUS T4.1 contributors and LFR designers, in which the reactor designers explained in detail the LFR designs in scope of the projects (MYRRHA and ALFRED). The meeting was extremely helpful and similar presentations will be presented in the ENIQ 2023 fall meetings (17$^{th}$ – 19$^{th}$ October 2023 in Madrid). In the NDE in Nuclear 2023 Conference, organized from 27$^{th}$ – 29$^{th}$ June in Sheffield, the start-up company newcleo will deliver a presentation on ISI of their LFR design.

**Author: Oliver Martin (JRC);**
**Contact: oliver.martin@ec.europa.eu**

ANSELMUS

GET TO KNOW US

# Know who we are

### Few questions to *Federico Tassone,*

*PhD student in Energy and Nuclear Science and Technologies of Politecnico di Milano*

***When did you start your PhD?***

*I applied at the end of 2022 and officially started February 2023.*

***Why did you decide to start a PhD? Did you always considered this research field?***

*After completing my M.Sc. in nuclear engineering here in Politecnico, I felt the research in the nuclear sector, especially for SMRs and Gen IV rectors, was becoming more and more relevant for the decarbonization goals of the EU. Also here in Italy, notoriously against nuclear, the introduction of SMRs starts to be considered in the energy mix. I began the university wanting to specialize in the nuclear sector, therefore I would say I was always interested in all nuclear science and technologies and that I managed to follow the path I was hoping for.*

***This is an important period for the nuclear sector, do you think your work is valuable?***

*Yes! I think what I am doing right now is just a small portion of the large European project which is ANSELMUS. Nonetheless, it is a relevant part of the project still and I like to think my contribution is going to be important.*

***What is like being part of a project like ANSELMUS?***

*I did not fully grasp it before starting. For sure it is interesting and motivating, but at the same time I am not used to this kind of responsibilities (yet).*

***How much of your time is dedicated to the ANSELMUS project?***

*I would say that it depends on the specific period. Some weeks are entirely dedicated to the project, and one such example was the week of the second ANSELMUS technical review meeting last September. On the other hand, I have to dedicate some time also to other PhD activities such as courses and exams. In the end, I would say that 70% of my working time is dedicated to the project, but this number will probably change in the future.*

### Interview with *Jean Muller*, *researcher at von Karman Institute*

***How did you find out about the VKI and what prompted you to come here?***

*I didn't come to the VKI by chance. During my thesis, I was lucky enough to benefit from the assistance of a former student of the VKI, Dr. Laurent Zimmer, who is a researcher at the CNRS and a lecturer at the Ecole Centrale Paris. He steered me towards a post-doctorate at the VKI and put me in touch with Philippe Planquart (CPMO at VKI).*

*My family also played a role in my knowledge of the Institute. My father worked in the field of fluid mechanics, which piqued my interest in the VKI. I had initially applied for the RM (Research Master), but in the end I opted for a Research Master at the University of Grenoble. However, my interest in the VKI has never waned, as it is one of Europe's leading research centres in fluid mechanics. As soon as I arrived, my professional growth was meteoric. I was confronted with fascinating practical cases and research problems. My career began with a bibliographical study and experiments on surface detection using two cameras, an idea that was abandoned in favour of another measurement method. I quickly acquired total autonomy over certain installations.*

***Can you describe your career development at the VKI, in particular when you went from post-doctoral student to research engineer?***

*During my postdoc, my experience was essentially linked to a specific project. However, towards the end of my postdoc and as a research engineer, I assumed scientific responsibility for several projects, collaborating with other researchers, engineers and technicians. This collaboration proved to be constructive, requiring adaptation to each person's character. But it was easy to adapt because all the teams are looking in the same direction. They are all driven by research and a deep-rooted family value where people support each other and stand together to achieve this common goal and continue this project of an independent institute with research and educational aims. This institute is almost unique in Europe in this respect.*

***Could you tell us more about the projects you are currently involved, in particular ANSELMUS and PASCAL?***

*I'm currently involved in the ANSELMUS and PASCAL projects as part of the VKI's thermohydraulics and liquid metals research group. At the time, I was one of the few people carrying out experimental research in the field of nuclear safety within this group, which was mainly made up of specialists in numerical simulation and modelling. So it was only logical that I should put my experimental skills to good use on these projects. Our flagship facilities for this project are AUPINEL for studying reactors in operation, and SHAKESPEARE, which enables us to study the reaction of a reactor in the event of a seismic accident.*

***Were you aware of the MYRRHA and ALFRED projects before you joined the VKI?***

*The MYRRHA and ALFRED projects, were previously unknown to me, as I had no experience of liquid metal reactors. This field was purely theoretical for me, until I discovered that it was possible to implement concrete demonstration and reactor projects (MYRRHA and ALFRED).*

***How did your integration into the VKI and the Brussels community go?***

*The VKI and the Brussels community have been very welcoming. People are generally very friendly, and the Brussels community is exceptionally international and European. This has allowed me to discover different ways of life, which has enriched my experience. However, working in an international environment requires a great part of energy, as you have to find a balance between community involvement and the need for time for yourself, especially in an intellectually demanding job. It's essential to take a step back from time to time to recharge your batteries. Brussels has plenty of parks and green spaces where you can clear your head and find some calm in the urban storm.*

*In conclusion, my experience at the VKI has been one of the most enriching stages of my life. I have grown as a scientist and as an individual, and I have discovered an inclusive and stimulating atmosphere at the Institute and in Brussels. This has led me to re-evaluate my personal and professional priorities, and the Institute's caring but demanding atmosphere has enabled me to make significant progress.*

ANSELMUS
GET TO KNOW US

# ANSELMUS project partners

*Thank you for your attention!*



**FOLLOW US!**

http://www.anselmus.eu