SNETP
Sustainable Nuclear Energy
Technology Platform

Poster Exhibition

25-27 March 2026

2026 SNETP FORUM

Madrid, Spain

Tomorrow’s Reactors

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ESFR-SIMPLE

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Visit our website
www.esfr-simple.eu

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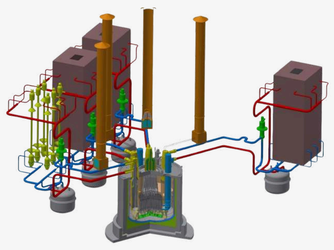
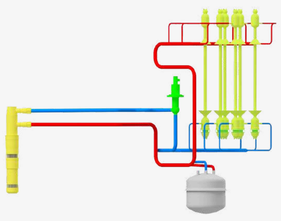
Objectives

- Improving the safety and economics of the European Sodium Fast Reactor (ESFR)
- Relying on innovative technologies
- In line with the ESNII roadmap





SP1: ESFR advances

WP1
ESFR with metallic fuel

WP2
AI for bubble detection

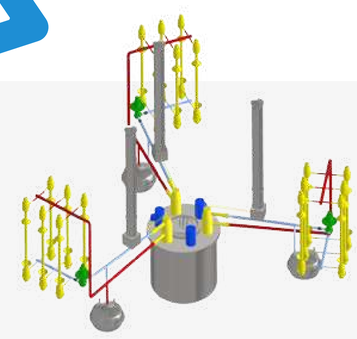
WP1
ESFR secondary system upgrade

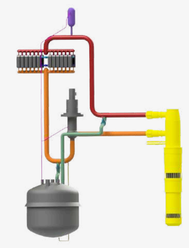
SP2: ESFR-SMR

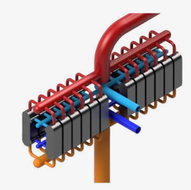
WP3
SMR core and system design

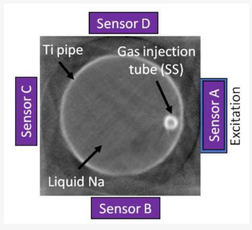
WP5
SMR flexible grid integration

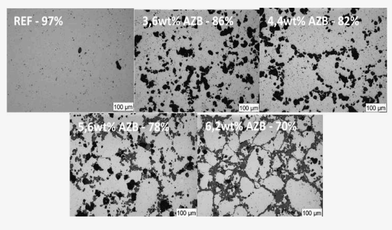
WP4
SMR safety studies









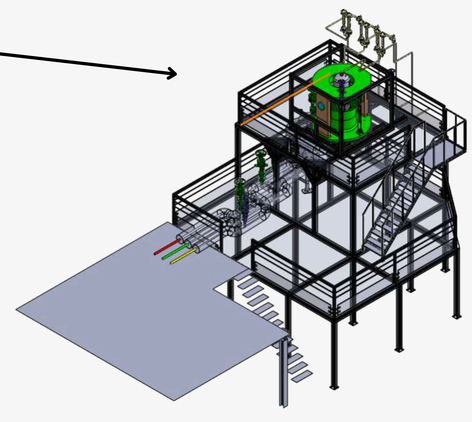


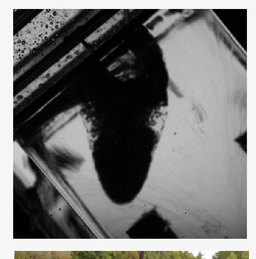
WP7
Instrumentation for bubble detection

WP6
Advanced components for passive safety

WP8
MOX fuel optimization

SP3: Experiments





We're exploring a new project proposal for the upcoming SFR call. For interest or information, please contact Camille Laguerre at camille.laguerre@cea.fr.

ESFR SIMPLE

This project has received funding from the HORIZON-EURATOM-2021-NRT-01 under Grant Agreement No. 101059543.

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MIMOSA

MultI-recycling strategies of LWR SNF focusing on MOlten SAlt technology

More information
@MIMOSA EURATOM

Visit our website
mimosa-euratom.eu

Coordinator contact
mimosa-wp8@eurtd.com

Orano recyling plant at La Hague (France)

Duration: June 2022/26 (4 years)

Context & objectives

Multi-recycling in LWRs is a solution for the closure of the fuel cycle, but it presents limitations related to the degradation of the Pu isotopic composition and the generation of minor actinides (MA), leading to an increase of vitrified high-level waste when compared to multi-recycling with Fast Reactors (FRs).

Improvement in converting Pu isotopes and MA into fission products (FPs) with shorter half-lives can be achieved with the introduction of advanced FR systems, among which the molten salt reactor (MSR) using chloride salt is a promising option. There is no experience with chloride MSRs (Cl MSRs) in operation, but they have been studied and tested on experimental set-ups, showing great improvement in the conversion rate of actinides.

MIMOSA aims to develop an accessible, cost/risk optimised multi-recycling strategy of LWR spent fuels in the EU, based primarily on multi-recycling of Pu (and reprocessed U) in LWRs combined with the Cl MSR, using available infrastructure in the EU such as the reprocessing plant in La Hague, France.

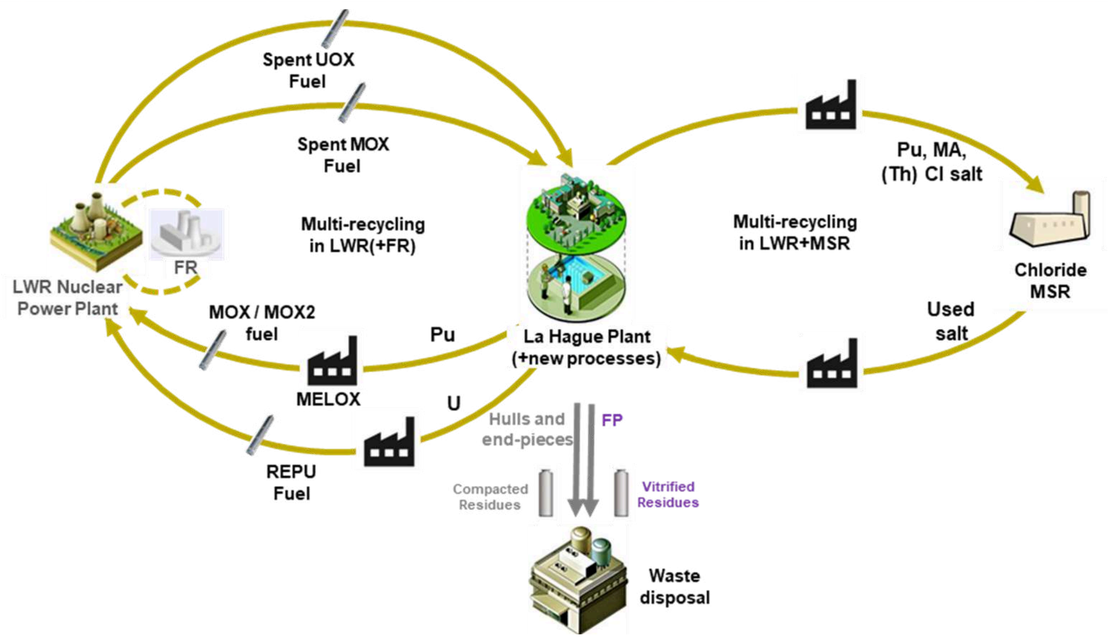
The achievement of the MIMOSA objectives will contribute to the development of materials and technologies useful for not only MSRs but also other high temperature, high corrosion applications such as the chemical industry or energy storage, and pave the way for Cl MSR deployment in Europe.

Work programme

MIMOSA focuses on the demonstration of the technical feasibility and performance of Cl MSRs on Pu and MA conversion and on production of valuable isotopes for other applications:

- Assessment of chloride salt properties to support studies of reactor performance and safety
- Simulations of chloride salt composition evolution in the reactor
- Demonstration of key aspects of technical feasibility of chloride MSRs
- Study of salt recycling and back-end options, particularly in synergy with La Hague plant
- Evaluation of valuable isotopes for other applications, and the way to extract, separate and purify them from MSR

MIMOSA will raise the TRL of several Cl MSR technologies, processes and materials from 1 or 2 to 3 or 4. Results are considered in scenario studies that analyse the role chloride MSRs may play in the EU's future nuclear energy systems to further the sustainable management of SNF from LWRs.



Highlights

- **SNF inventories, energy needs, and nuclear fleet have been assessed for the EU.** Simulation rounds of scenarios were performed, addressing the role of MSRs within EU-27 for light-water reactor spent nuclear fuel multi-recycling purposes.
- **Selected salt mixtures in the NaCl-$MgCl_2$-$PuCl_3$ system have been synthesized** in order to perform characterization and further experimental work. Most of the salt properties measurements have been performed. Preparation of salt mixtures in NaCl-$ThCl_4$-$PuCl_3$ is on-going for similar characterization.
- **Three MSR configurations were selected,** representative of small demo or larger commercial MSR, with different salt compositions, Pu quality, etc. Neutronic depletion simulations were performed to assess the evolution of salt mixtures composition, in particular FPs.
- **A chloride salt irradiation experiment was performed in the LR-0 reactor (Czech Republic),** during which the neutronic properties of a selection of chloride salts were measured**.** Comparison with nuclear data libraries revealed differences in critical parameters, emphasizing the need for experimental validation.
- **A programme for structural materials corrosion tests was set up.** Selected material samples were tested for resistance to corrosion when in contact with chloride salt in variable configurations and exposure durations. Dynamic corrosion tests are now under preparation. A corrosion / irradiation test bench was constructed by the Dutch Institute for Fundamental Research (DIFFER) for combined phenomena investigation.
- **The technical study of used salt treatment in synergy with La Hague plant was performed,** and no major obstacles were identified in a demonstrator reactor ($1m^3$), although significant dilution is necessary. In parallel, the experimental setup design for dissolution tests at the Joint Research Centre has been completed. The pyrochemical salt treatment alternatives have also been studied. Two extraction methods achieved over 99% efficiency. The vitrification experiments using borosilicate glass to stabilize the chlorides salt waste were successfully performed, and vitrification experiments with iron phosphate glass have begun.
- **Valuable isotopes produced in MSRs were assessed and quantified.** Their applications and associated market were described. A thermodynamic database on the platinoids' chloride phases was developed, and experiments validated the metallic state of the platinoids and noble metals. A device to test the ability and efficiency of gas bubbling to extract solid particles in molten salt was constructed and tests have started.

Partners

MIMOSA will present its results during a special session of the EUROMOST Conference (Baden-Baden, 26-29 May 2026)

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MIMOSA

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Objectives

The ENDURANCE projects aims at supporting the safe operation and the technological development of Molten Salt Reactor (MSR) technology in Europe. The objectives of the project are:

- to create an environment for a constructive alignment, connecting the needs of reactor designers and industry with the university and research centre capabilities and the regulator requirements and to maintain the competence inside the Europe
- to enable the MSR safe development and deployment increasing the SRL and the TRL on key enabling phenomena, technologies and methodologies (Critical Technology Elements) and filling R&D gaps
- to identify the future R&D needs required to enable the safe development of MSR in Europe and define the technology roadmap development to preserve research and industry leadership in Europe on MSR technology

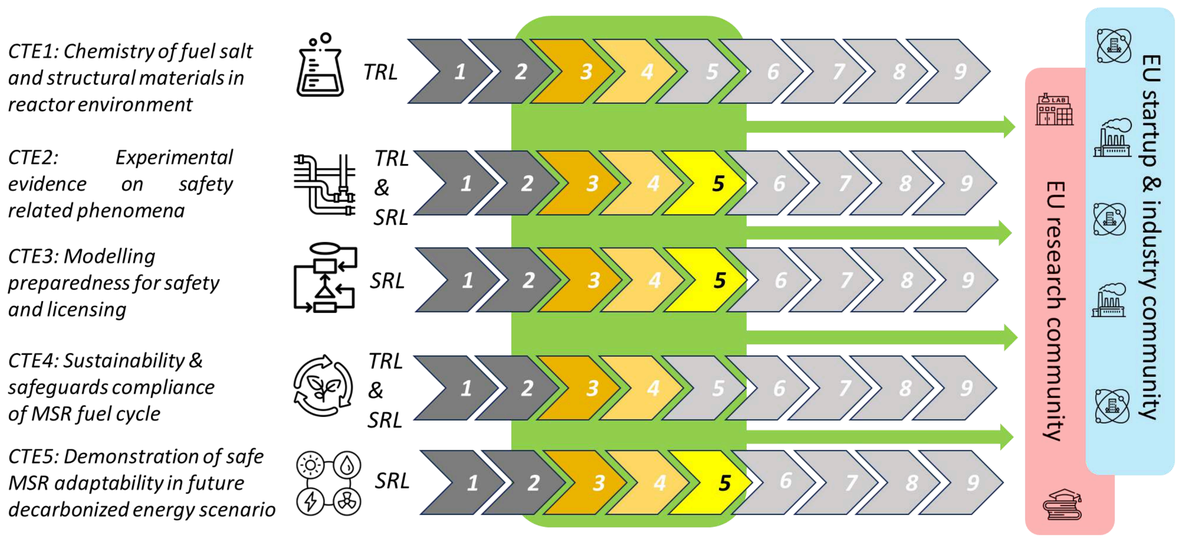
Activities on MSR systems

The main activities currently under development in ENDURANCE are:

- Thermo-physical properties measurements, front-end modelling and simulation, and PIE in reactor environment, aimed at improving the understanding of fuel and materials behaviour under representative conditions,
- Experimental analysis of the transport and deposition of solid fission products, neutronics parameters, and natural circulation, in order to assess radionuclide redistribution mechanisms, and improve the predictability of passive heat removal
- PIRT, TAR and computational methods for supporting safety analysis and licensing, including numerical and experimental benchmarks, to identify key safety phenomena and reduce uncertainties in modelling
- Assessment of MSR fuel cycle sustainability, reprocessing schemes, off-gas systems and process safeguardability, with the objective of evaluating long-term resource efficiency, waste minimisation strategies, proliferation resistance, and compliance with safeguards
- Evaluation of operational flexibility of MSR in poly-generation and relative safety aspects, analysing load-following capabilities and integration with hybrid energy systems,

Critical Technology Elements

The project has identified five critical technology elements as areas in which the effort on R&D and safety assessment is more required to close the gap for demonstrating that MSR technology could be deployed in compliance with the highest safety standards, excelling in waste management and proliferation resistance, thus providing a relevant contribution to the integrated European energy vision.



Partners

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ENDURANCE

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101165896.

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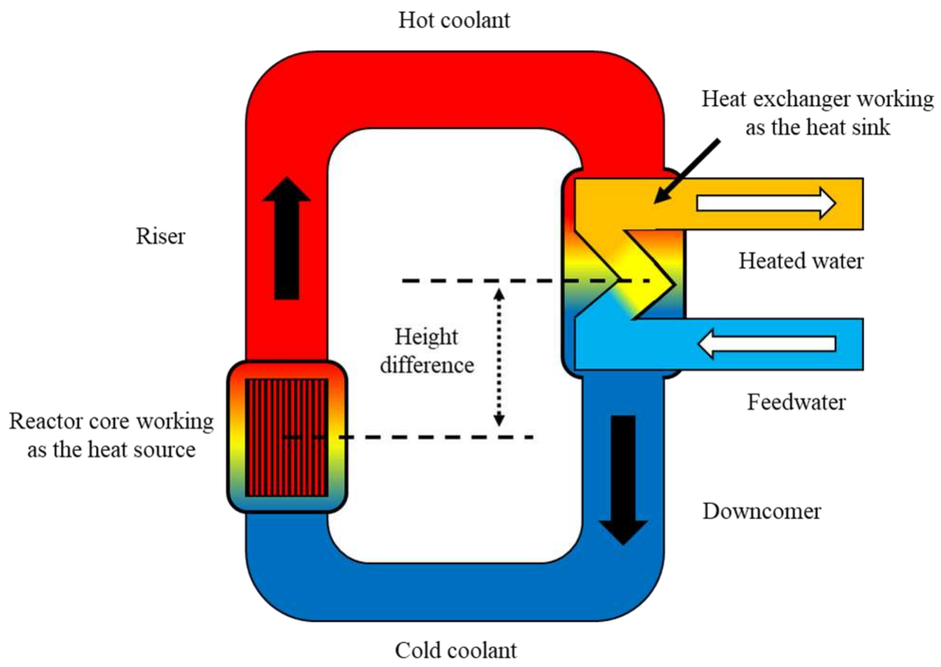
Requirements for low-temperature SMR fuel safety assessment: experimental gaps and research opportunities

Janne Heikinheimo, Brahim Dif, Essi Jäppinen, Jussi-Pekka Ikonen and Rebekka Komu
(VTT Technical Research Centre of Finland Ltd)

Introduction

Low temperature, heat-only small modular reactors (SMRs) introduce an operating regime for fuel that deviates from the thermal-chemical envelope of conventional light-water reactors. Therefore, extension of conventional validation data for fuel is required. Concepts, such as the Finnish LDR-50, introduce following conditions for the fuel:

- Coolant temperature of approximately 150 °C
- Low system pressure
- Boron-free primary circuit chemistry
- Modest linear heat rates



LDR lite design provides a public version of a 50 MWth district heating reactor for benchmark purposes: https://serpent.vtt.fi/kraken/index.php?title=LDR_lite_benchmark

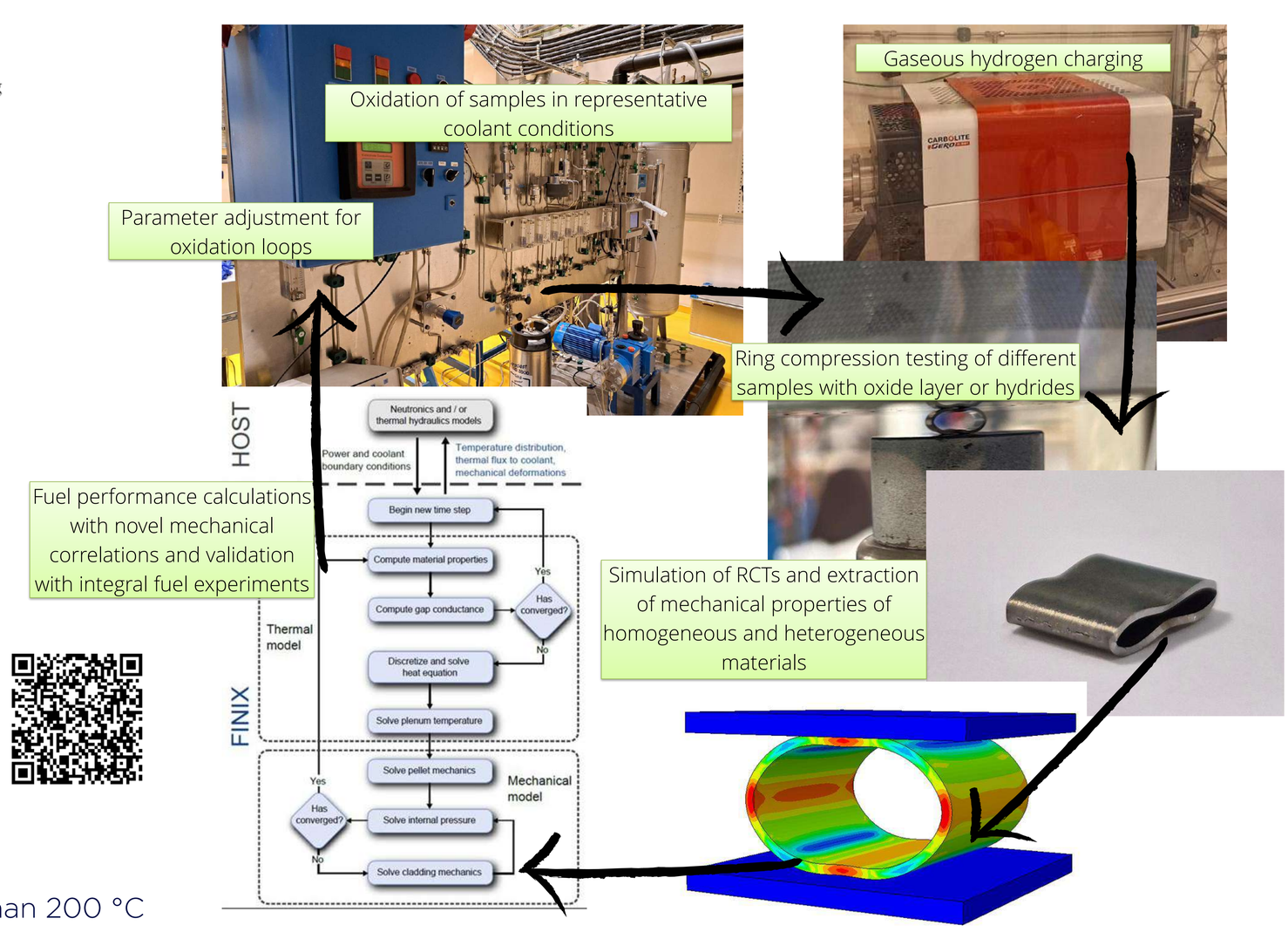
Research opportunities

- Extrapolation of oxidation kinetic expressions to less than 200 °C introduces significant uncertainty in oxide growth rates, hydrogen uptake fractions and long-term cladding embrittlement predictions. Dedicated long-duration autoclave or loop experiments in representative conditions could help to establish reliable low-temperature corrosion kinetics.
- Combined effect of prolonged low-temperature exposure in reactor and moderate hoop stress effects on cladding mechanical behavior remains insufficiently characterized: Microstructural evolution, delayed hydride cracking susceptibility and irradiation-assisted hardening require systematic mechanical testing and advanced characterization.
- Low linear heat behavior of the fuel requires targeted irradiation data. Validation of gap conductance correlations, pellet-clad mechanical interaction models, dimensional stability, and power cycling requires experimental confirmation.

Methods

VTT investigates cladding material properties using separate-effects testing combined with finite element modelling (FEM). The following experimental and analytical techniques are employed:

- Corrosion and oxidation studies of cladding samples in instrumented loops simulating primary circuit conditions
- Hydride formation studies using gaseous hydrogen charging
- Microstructural and compositional characterization using SEM, TDS, TOF-SIMS, and TEM
- Ring compression tests (RCTs) combined with FEM



Conclusions

Coordinated research activities could support the development of an integrated experimental and modelling framework for fuel behavior covering both long-term operation and transient conditions in the low-temperature regime. Key phenomena include cladding oxidation, hydrogen uptake and hydride formation, and cladding mechanical behavior.

From Passive System Performance to Design Extended Conditions: a Structured Research Pathway for Advanced Reactor Licensing

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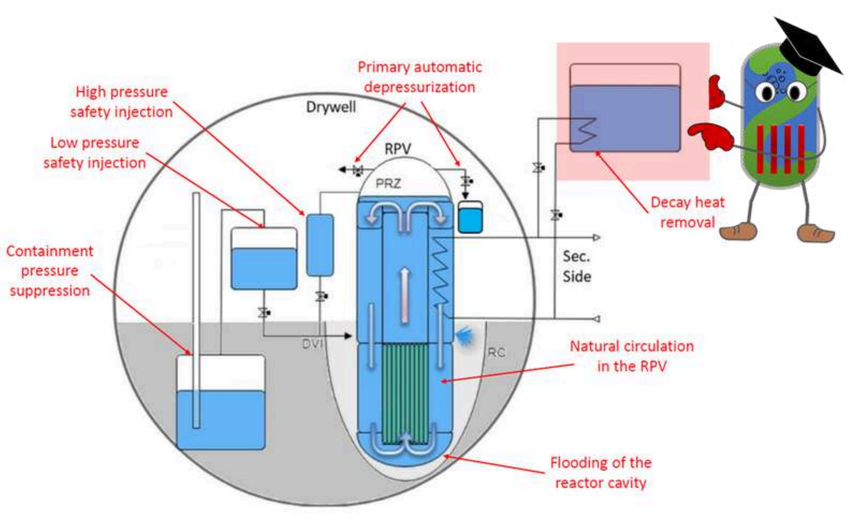
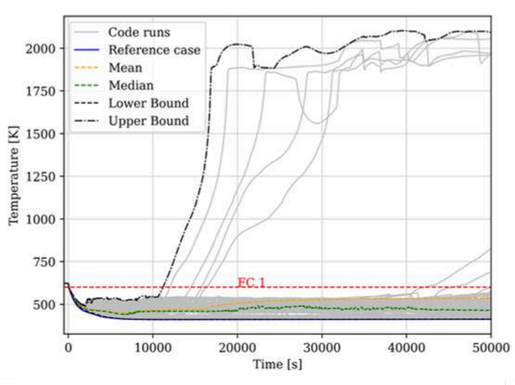
Background

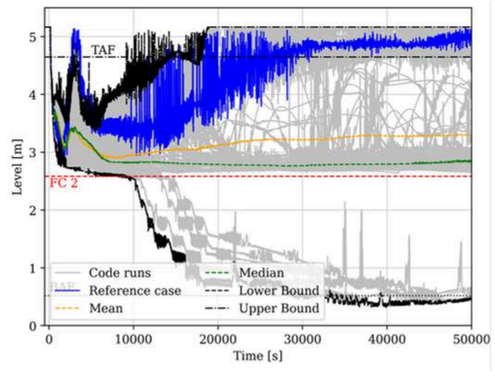
- SMR increasingly rely on Passive Safety Systems (PSS) to perform key safety functions.
- PSS enhance inherent safety, relying on gravity-driven phenomena.
- PSS performance can be sensitive to boundary and environmental conditions, due to the lower driving forces.
- Challenging conditions may affect PSS performance and promote transitions from DBA to DEC A and B.
- Structured framework is needed to link PSS performance with accident progression for SMR licensing.

A first case study

- Challenging conditions such as the presence of non-condensable gases, undetected leaks, excessive heat losses, suboptimal piping layout, limited valve opening area in discharge lines, fouling or plugging in heat exchangers may trigger Thermal-Hydraulic instabilities in PSSs as decay heat removal system.

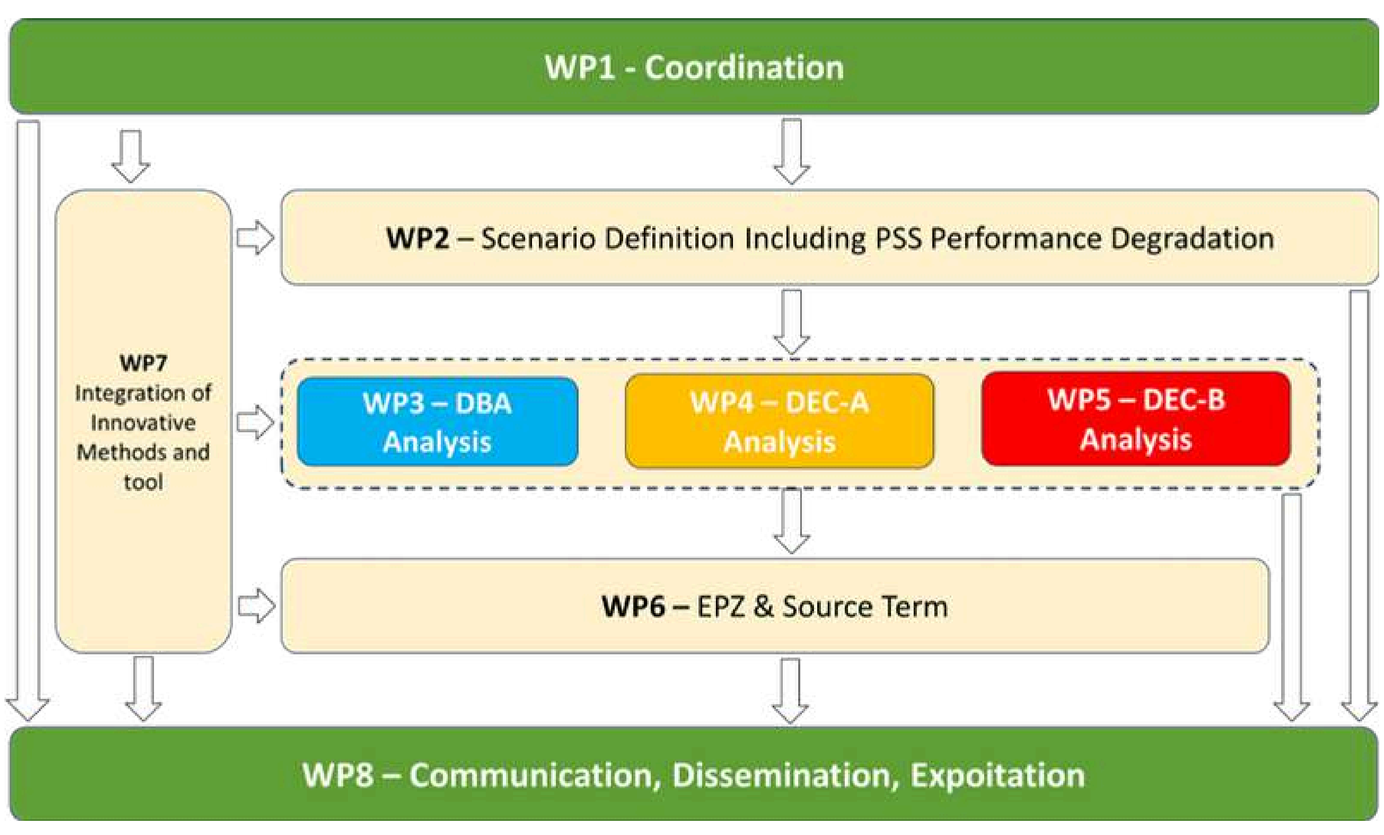






- These conditions can influence PSSs operation and may degrade their performance, potentially promoting a progression from DBA toward DEC.

Structure proposed



Key objectives

- **Move safety demonstration** beyond a binary view of system success vs hardware failure.
- Assess how **partial PSS degradation may drive transitions** from DBA to DEC-A/B.
- **Identify DEC-A and B scenarios** from PSS performance degradation using BE methods.
- **Identify and harmonize safety acceptance criteria** for PSSs performance.
- Apply widely used European **safety analysis code chains**.
- **Develop innovative methods** to support BE analysis of PSSs.
- **Assess code uncerntainties** with dedicated validation activities.
- **Synergies with initiatives** in different Fora as EU, NEA, IAEA.

Expected impacts

- **Improved understanding of PSS performance** under challenging operating conditions.
- Identification of **mechanisms** potentially **leading from DBA to DEC** scenarios in SMRs.
- **Identification of DEC scenarios** triggered by PSS performance degradation using BE methods.
- **Confirmation** of the suitability of **European safety analysis code chains for SMR applications**.
- **Support to effective safety demonstration** and licensing of SMRs.

Target designs

- **Representative** generic LW-SMR designs of potential deployment relevance in Europe.
- **Valorise** the generic databases already developed within previous European projects (e.g. SASPAM-SA, EASI-SMR, etc), including a) Integral configuration PWR & BWR b) Loop configuration PWR c) District heating reactors.

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KIT High-Fidelty Multiphysics Simulation Codes for WC-SMRs

V.H. Sanchez-Espinoza, L. Mercatali, K. Zhang, J. Duran-Gonzales, A. Campos-Munoz, M. Boettcher, G. Huaccho-Zavala (Karlsruhe Institute of Technology (KIT))

Motivation

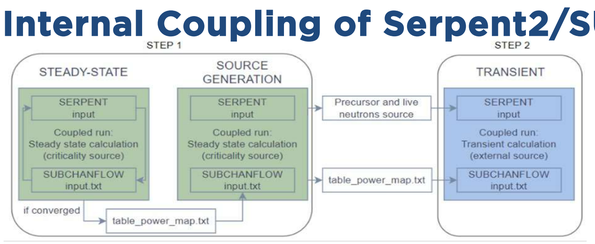
- Deployment of Water-cooled (WC) SMRs in EU and worldwide.
- Challenges for core physics and plant analysis tools due to
  - Compact, heterogeneous, large number of burnable poisons,
  - Multi-dimensional flow and mixed convection inside the integrated Reactor Pressure Vessel (RPV),
  - Boron-free, natural circulation and helical-coiled HX in many designs

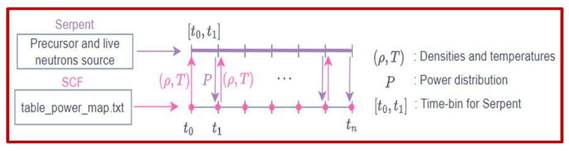
Objectives

- Transition from nodal/channel level to pin/subchannel core analysis based on transport solvers (Deterministic and Monte Carlo).
- Development of multi-scale/-physics safety analysis tools by integrating subchannel codes and CFD-solvers into the best-estimate coupled codes based on 3D nodal diffusion and 1D/3D system TH codes.

High-fidelity Methods and Results

Internal Coupling of Serpent2/SUBCHANFLOW

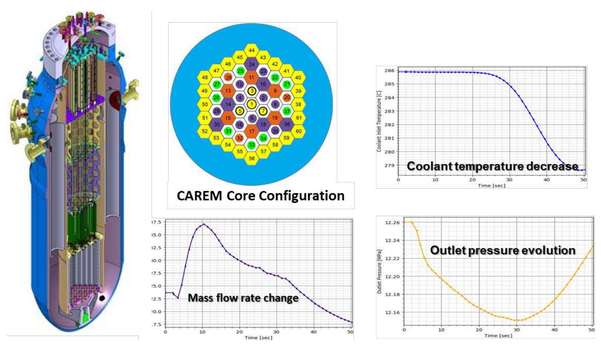




Internal Serpent2/SUBCHANFLOW Coupling

- Two-step approach
  - Steady-state and source gen.
  - Transient simulation
- Transient simulation
  - External source mode
  - Time-binning structure (dt)
  - Population control
  - Constant TH-properties at dt
- Picard iteration scheme
- Exchange of parameters
  - Power: P_{ik}
  - Fuel temperature: T_{ik}^{fuel}
  - Coolant temperature: T_{jk}^{cool}

CAREM Cold Water Injection (CWI) Scenario



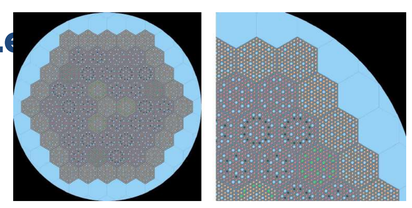
Cold Water Transient Scenario:

- Power: 100 MWth
- Initial event: secondary side failure
- Cold water front entering the core with 25s delay (T-inlet decreases by 8 °C)
- Core mass flow rate increases around 14 kg/s during the first 10s
- Pressure decreases by 0.11 MPa

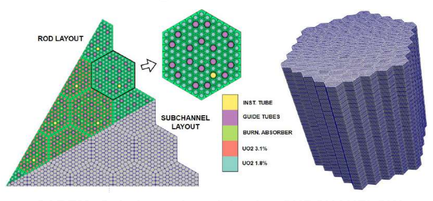
Research question:

- Impact on core local conditions?
- Are safety margins still there?

CAREM Core: Neutronic/Thermal Hydraulic Models (Pin Le

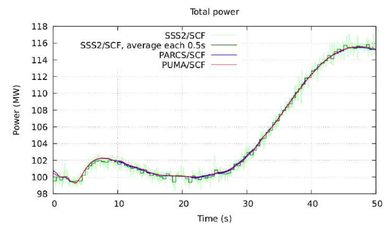


CAREM: Serpent 2 detailed core model



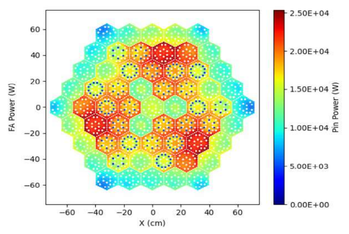
CAREM: Subchannel model using SUBCHANFLOW

Key-safety Parameters: High-fidelity versus nodal/channel

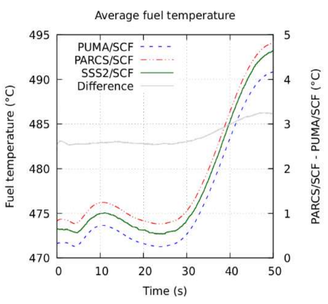


CWI: Power evolution predicted by pin/nodal simulations

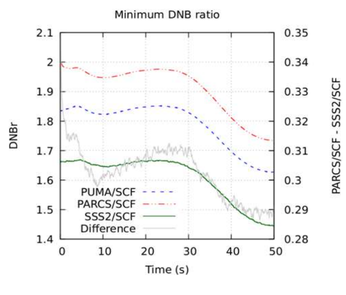
- Total power uncertainty:0.6%
- Pin power uncertainty:4%
- KIT HOREKA HPC:
  - 760 cores (10 nodes)
  - 19 days simulation time



CAREM: 2D Pin Power (axially integrated)



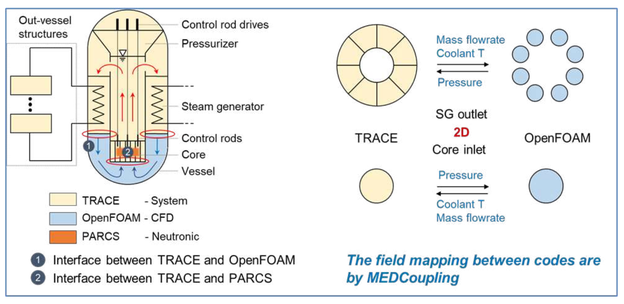
CWI: Fuel Temperature Evolution



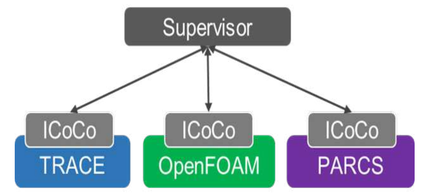
CWI: DNBR predicted by different codes

- First-of-the-kind transient simulation with Monte Carlo
- Close agreement between nodal and MC-solutions
- Higher peaks predicted by MC
  - Tfuel: 35 °C at 0s
  - Tfuel: 45 °C at 50s
  - Void: 38 % (Pin) > 25 % (nodal)

Multi-scale/-physics Best-Estimate Codes



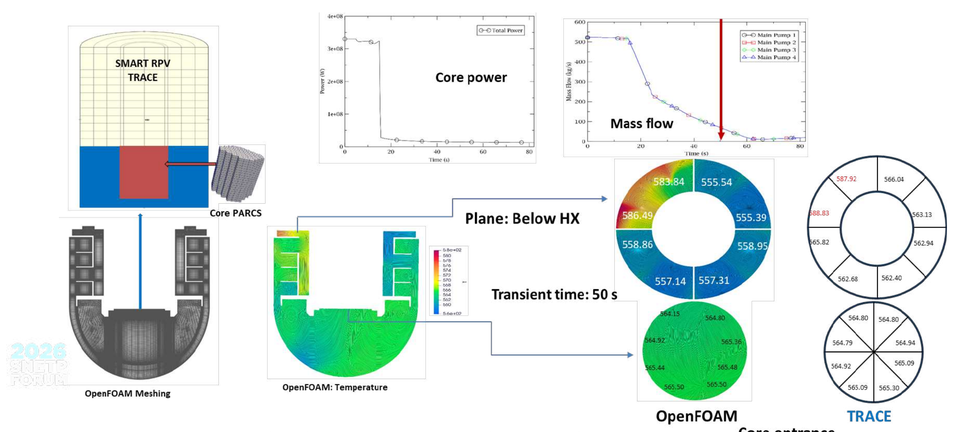
Multiscale-coupling of system TH code with CFD-Codes based on ICoCo



ICoCo-based Coupling of TRACE/PARCS/OpenFOAM

McSAFER

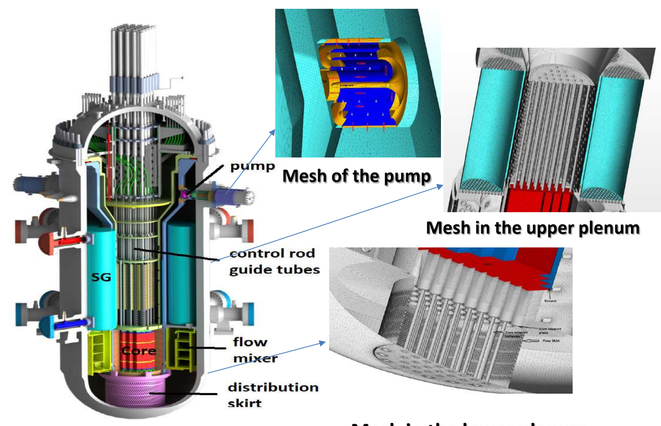
SMART MSLB Analysis with TRACE/PARCS/OpenFOAM



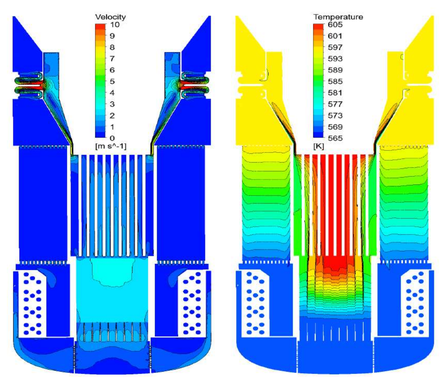
SMART MSLB: Details of coolant temperature distribution in the RPV

- CFD predicts local temperature distribution better than TRACE at
  - Downcomer
  - Lower plenum
  - Core entrance

Detailed CFD-Simulations of WC-SMRs



SMART RPV Internals



SMART: Local velocity and coolant temperature distribution predicted by ANSYS CFX at nominal conditions

- CFD predicts local temperature distribution better than TRACE at
  - Downcomer
  - Lower plenum

Conclusions

- Potentials of high-fidelity core analysis for prediction of local safety parameters demonstrated
  - Explore pin/subchannel and/or pin/porous-media CF coupled with transport solver (deterministic and MC)
- Promising results of multi-scale/-physics coupled best-estimate safety tools including CFD
  - Increase use of subchannel and CFD TH for core analysis in future
- Provide reference solutions for low-order solvers
- Applicability to large LWRs and liquid-metal FRs feasible

This project has received funding from KIT NUSAFE Program and partly from Horizon Europe – Euratom McSAFER Project under grant agreement No 945063.

Karlsruher Institut für Technologie

McSAFER

INTERACTIVE BOARD

Tomorrow's Reactors

Local acceptance

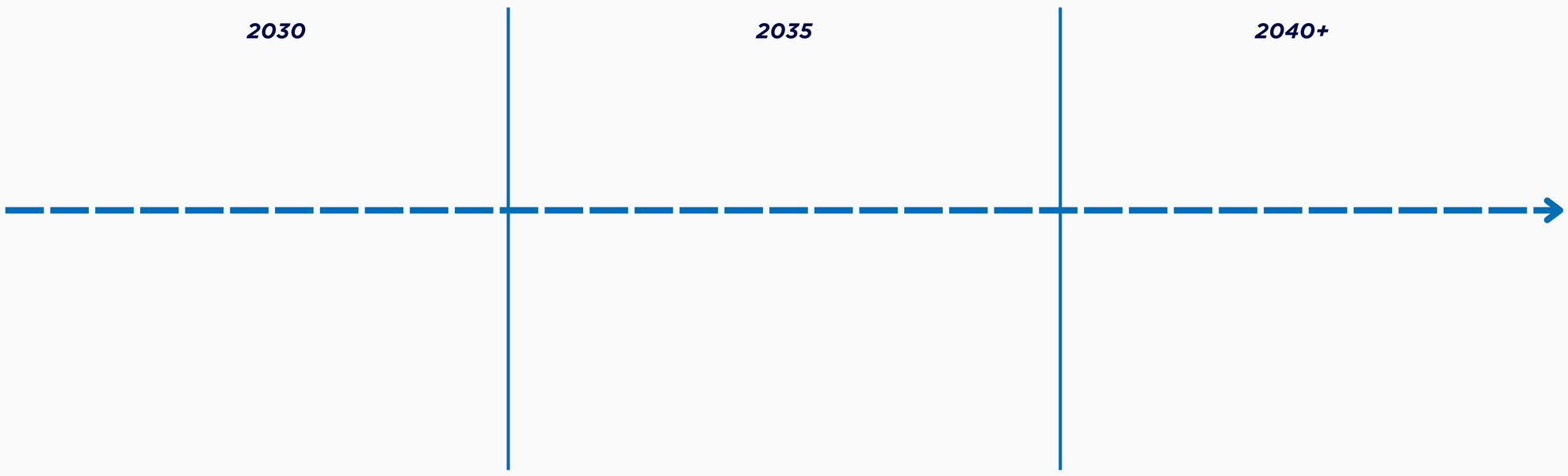
With energy prices soaring, would you advise a large or a small reactor in your area of living to meet local energy demand?

Add a sticker under your answer.

Timeline bar

Which advanced reactor technology and when should/could it be deployable at Scale and what are the conditions for success?

Place one sticker where you stand.



INTERACTIVE BOARD

Tomorrow's Reactors

Usage

If your region had an advanced reactor, what should it be used for first?

Add a sticker under your answer.

Reliable electricity	***District heating***	***Local heat and power***	***Hydrogen production***	***Back-up for renewables***

Condition

Under which condition would you personally support an advanced reactor near you?

Place one sticker where you stand.

Strong local benefits

Very strict and transparent safety

Clear contribution to climate

Local involvement in decisions

I would not support it in any case

Smarter & Safer Today

Labelled by SNETP

Discover our labelled projects

ASSAS

More information
@SNETP

Visit our website
www.snetp.eu

Coordinator contact
bastien.poubeau@asnr.fr

Objectives

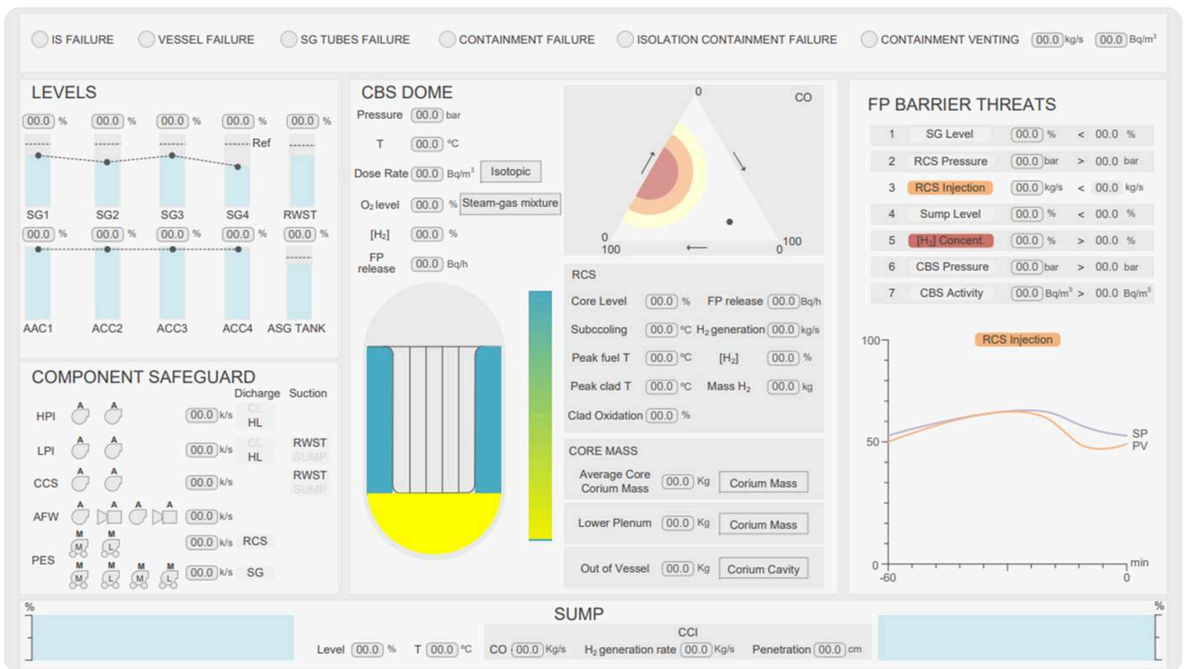
- Develop a basic-principles severe accident simulator:
  - Close to best-estimate accuracy
  - With real-time execution
  - Supporting basic training on severe accident phenomenology
  - Serving as a prototype for future industrial simulators
- Develop fast surrogate models for ASTEC and MELCOR thanks to machine-learning (ML)
  - Assess various hybridization strategies
  - Bring the nuclear and data science communities together
- Publish a machine-learning ready severe accident database
- Accelerate the European reference severe accident code ASTEC with parallel programming

Expected Impact

- Extend industrial simulators with severe accident modelling capacities to support operator training, safety assessment and procedure development
- Advance the use of ML for scientific simulation in nuclear science
  - Demonstrate its added value
  - Train nuclear researchers on ML
- Provide data scientists with a high-quality database
  - Industry-grade multi-physics simulations
  - Generalisation of results to other scientific fields and industrial sectors
- Strengthen Europe's autonomy for severe accident simulation

Highlights

- User-friendly interactive simulator with Main Control Room and Virtual Reality Displays
- 1,500 ASTEC transient calculations saved on the datahub for 100TB of raw data
- > 3-fold increase of ASTEC computational efficiency thanks to efficient programming and input deck simplification
- 5 different ML modelling strategies:
  - Surrogate model of Melcor for a Nordic Boiling Water Reactor
  - ML model of the containment during the ex-vessel phase of a severe accident
  - Data-driven thermal-hydraulic model for specific components
  - Surrogate model for the reactor vessel until its rupture
  - Improved initialisation of the iterative thermal-hydraulics solver of ASTEC
- 2025 Workshop on machine learning for simulation



Partners

BELV · ES GROUP · Gobierno de España, Ministerio de Ciencia e Innovación, Ciemat Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas · ENEA · ENERGORISK · IRSN Institut de Radioprotection et de Sûreté Nucléaire · ivs · Jožef Stefan Institute · KIT Karlsruher Institut für Technologie · KTH Vetenskap och Konst · PHIMECA L'ingénierie responsable · Paul Scherrer Institut PSI · tecnatom · TU Delft

assas

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101059682.

Labelled by SNETP

Discover our labelled projects

GO-VIKING

Gathering expertise On Vibration ImpaKt In Nuclear power Generation

GO-VIKING is a Horizon Europe initiative bringing together some of the best expertise in fluid dynamics, flow-induced vibration (FIV) phenomena, and structural integrity of key Nuclear Power Plant (NPP) components all over the world. It aims at improving the operation and safety of contemporary nuclear power plants and the design evaluation of new reactor concepts.

GO-VIKING

Visit our website
www.go-viking.eu

Coordinator contact
Angel.Papukchiev@grs.de

Co-coordinator contact
zwijsen@nrg.eu

More information
@GO-VIKING

More information
@GOVIKING_EU

Duration: June 2022 – May 2026

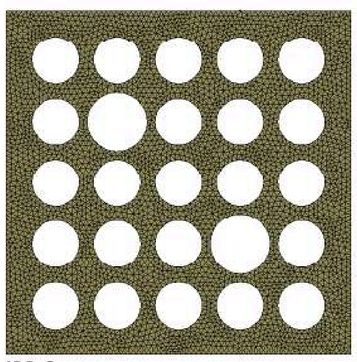
Objectives

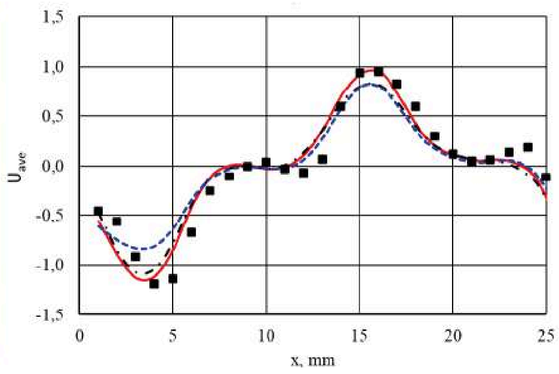
- Generation of **new experimental and high-resolution numerical data, relevant for nuclear fuel assemblies** (FAs) **and steam generators** (SGs)
- Provision of **validated fast-running fluid-structure interaction** (FSI) tools with uncertainty quantification methods
- Training of stakeholders and graduates **in numerical FIV analysis**
- Expanded knowledge on **efficiency, accuracy and reliability of FSI methods**
- Synthesis of **best practices for FIV analyses** and highly increased expertise in FIV phenomena in NPP

Expected Impact

- Shorter NPP outages, increased plant availability and lower staff exposure through less leaking fuel rods and steam generator tubes
- Reduced probability of steam generator tube rupture accidents enhance the reactor safety
- The development and application of accurate and efficient FSI tools and methods improve the understanding of FIV phenomena
- Such programs support vendors in the design, regulators in the safety evaluation, and operators in the deployment of innovative nuclear systems

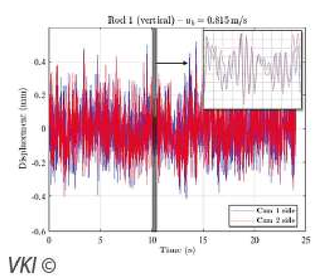
Achievements



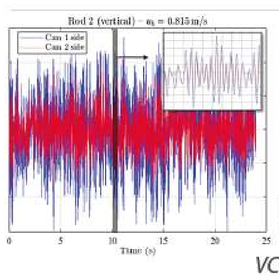


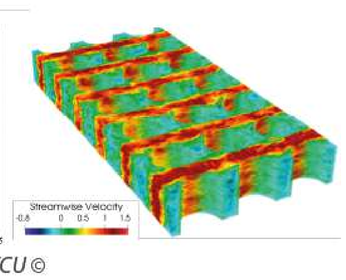
IPP ©

- Cantilever Rod Benchmark finalized and documented
- Large Eddy Simulation applied for the prediction of Turbulence-Induced Vibrations in ALAIN rod bundle
- The predictive potential and the associated challenges of FSI based on LES thoroughly investigated and documented



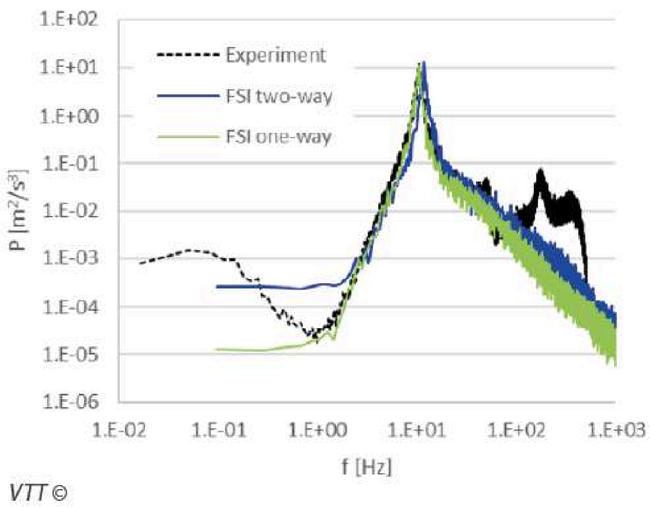
VKI ©



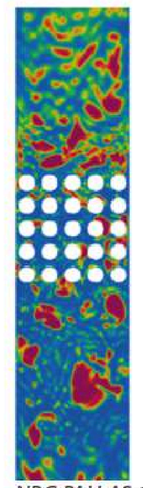


VCU ©

- GOKSTAD experimental campaigns concluded, and provided valuable flow and tube vibration data for different configurations
- High-fidelity GOKSTAD simulations performed
- AMOVI runs with very large tube displacements (fluid-elastic instability) analysed

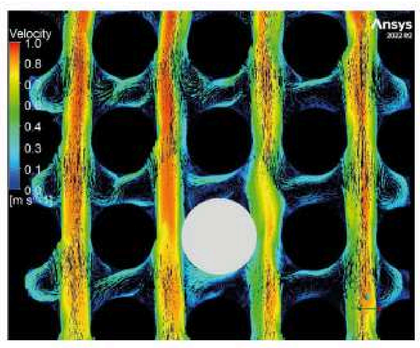


VTT ©

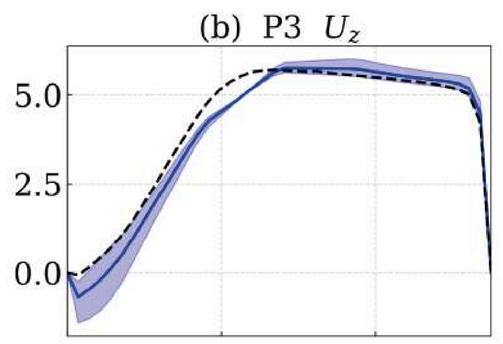


NRG PALLAS ©

- The analyses on the two-phase Cantilever Rod experiment revealed the potential to predict FIV in axial two-phase flow
- TITAN and TREFLE simulations are currently being completed and documented
- These demonstrate agreement among partners' predictions for vibrations in complex two-phase cross-flow conditions



GRS©



TU Delft©

- The validation of some fast-running methods concluded
- Major progress in the generation of synthetic pressure fluctuations demonstrated
- Developed uncertainty quantification and sensitivity approaches successfully validated on real experiments

Partners

*EDF UK R&D

Funded by the European Union

Learn more about GO-VIKING, scan me!

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SASPAM-SA

Safety Analysis of SMR with PAssive Mitigation strategies - Severe Accident

More information
@SASPAM-SA Horizon Euratom Project

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Visit our website
www.saspam-sa.eu

SASPAM-SA

Horizon Euratom project

Funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Commission-Euratom. Neither the European Union nor the granting authority can be held responsible for them.

For PSI
Project funded by

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Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Confederation

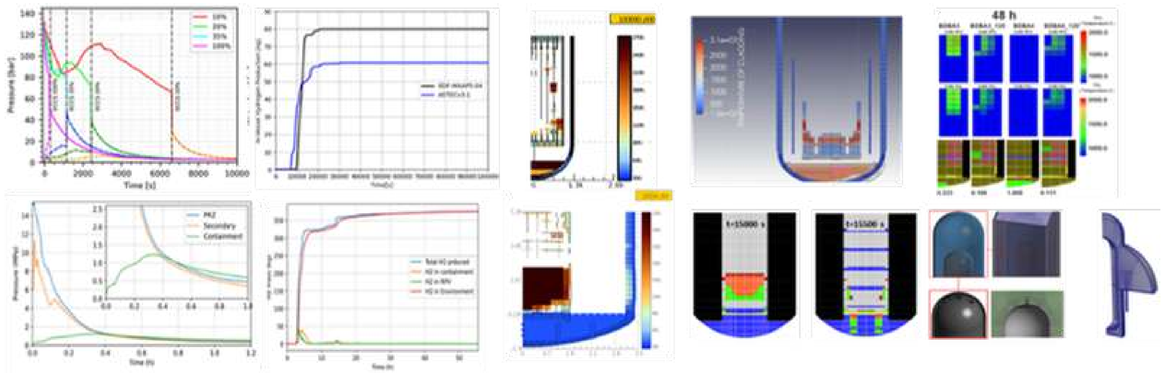
Federal Department of Economic Affairs, Education and Research EAER
State Secretariat for Education, Research and Innovation SERI

About us

- SASPAM-SA project proposal has been funded in HORIZON-EURATOM-2021-NRT- 01-01, “Safety of operating nuclear power plants and research reactors”;
- The project has started on the 1st October 2022 and the planned duration is 48 months; the overall cost is 4276038.85 Euros and the EU Contribution is 2991694.00 Euros.

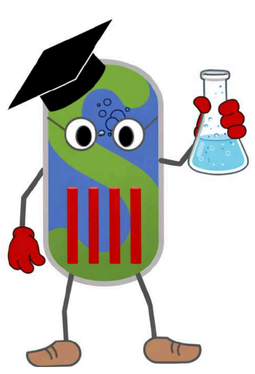
Working Package 2

- **Key Objective**: Analyse DBA and SA scenarios using state-of-the-art integral and CFD codes to assess the main thermal-hydraulic and core degradation phenomena and compare code results.
- **Main Outcomes**: Simulation campaign completed with consistent code-to-code agreement, main Figure-of-Merits trends successfully reproduced.



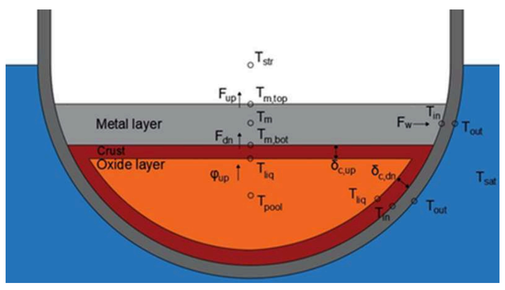
Working Package 3

- **Key Objective**: Assess and extend the applicability of existing experimental data to iPWR and identify needs for new experiments across key phenomena.
- **Main Outcomes**: Experimental datasets collected and compared with iPWR conditions, calculated in WP2, key phenomena and experiments selected and discussed collaboratively.



Working Package 4

- **Key Objective**: Collect input data from WP2 scenarios for stand-alone IVR analyses and develop a 0D model to perform preliminary evaluations.
- **Main Outcomes**: Required IVR input data collected, 0D stand-alone IVR module developed in MATLAB and Python, preparation for detailed IVR calculations and model improvements underway.



Working Package 5

- **Key Objective**: Assess containment behaviour and provide evaluations of size and extension of EPZ for some SA scenarios.
- **Main Outcomes**: Containment and source term simulation under investigation.

Partners

Dissemination

- Project results disseminated by workshops, annual meetings, scientific publications and open training activities for SMR community.
- Collaboration between researchers, regulators and industry, supporting deployment of SMR in Europe.

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SEAKNOT

Strengthening Education and Training activities on Severe Accidents within SNETP/NUGENIA: a major Outcome of the EC-SEAKNOT project

More information
@SEAKNOT-EU Project

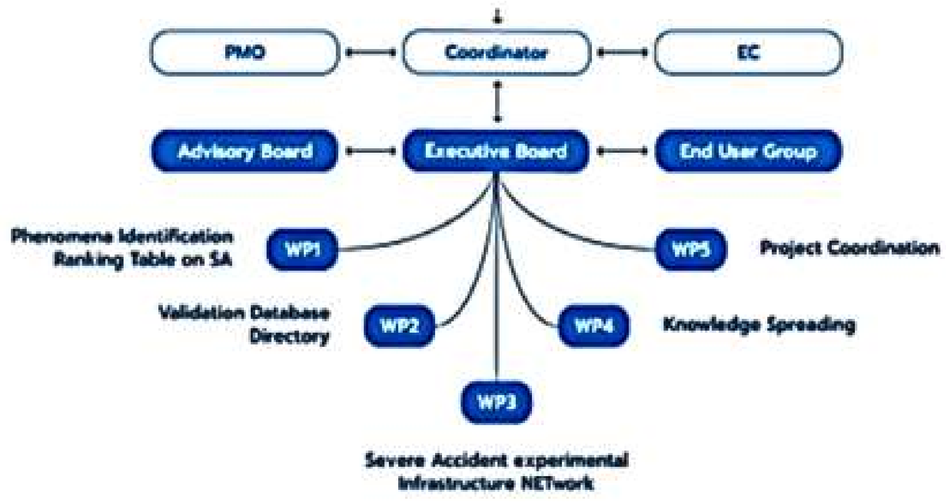
Visit our website
seaknot-project.eu

Coordinator contact
Luis E. Herranz
luisen.herranz@ciemat.es

Introduction

SEvere Accident research and KNOwledge managemenT for LWRs

Seaknot project is devoted to knowledge preservation and dissemination about Severe Accidents in EU.



SAP (Severe Accident Phenomenology) 2023 and 2025 short courses (Madrid and Julich)

- Central to SEAKNOT's success was the design and implementation of two major training events that targeted knowledge transfer on severe accident phenomena and mitigation strategies. In the past years, between 2006 and 2021, nine editions of the Severe Accident Phenomenology (SAP) short course were organized, focusing on sharing knowledge about SA with MSc and PhD students as well as researchers new to this area.

- These courses took place as part of the SARNET network, NUGENIA, and later SNETP/NUGENIA TA2. As part of the current SEAKNOT project, two more editions (SAP 2023 at UPM Madrid with 60 attendees and SAP 2025 at FZJ Julich with 61 participants) have been held, incorporating updated lectures that addressing recent developments in SA research.

SEAKNOT Goals

- Perform a critical analysis of the existing knowledge on severe accidents
- Identify needs for future experimental research required to understand the severe accident progression
- Disseminate and improve the knowledge of young researchers regarding both analytical and experimental investigations

SASCamp 2025 (Severe Accident Summer Camp) (Julich)

- Throughout five days, two experienced instructors, rotating daily, guided small groups of participants as they addressed assignments covering five key SA topics (in-vessel phase, ex-vessel phase, containment phenomena, source term, and uncertainties in source term quantification), sharing their expertise through practical applications of theoretical knowledge in these subject areas.

- SASCamp 2025 received very positive feedback from its 21 participants and 10 instructors, with particular praise for the new training format.

- The interactive, problem-solving format significantly enhanced learners' analytical skills and understanding of complex accident sequences, promoting competency-based learning that is directly applicable to different contexts.

To continue this successful path, the next edition of the European "Severe Accident Phenomenology" SAP short course will be held at KIT, Karlsruhe, Germany in 2027, again in the framework of SNETP NUGENIA TA2.

P. Piluso[a], S. Paci[b], Luis H. Herranz[c]

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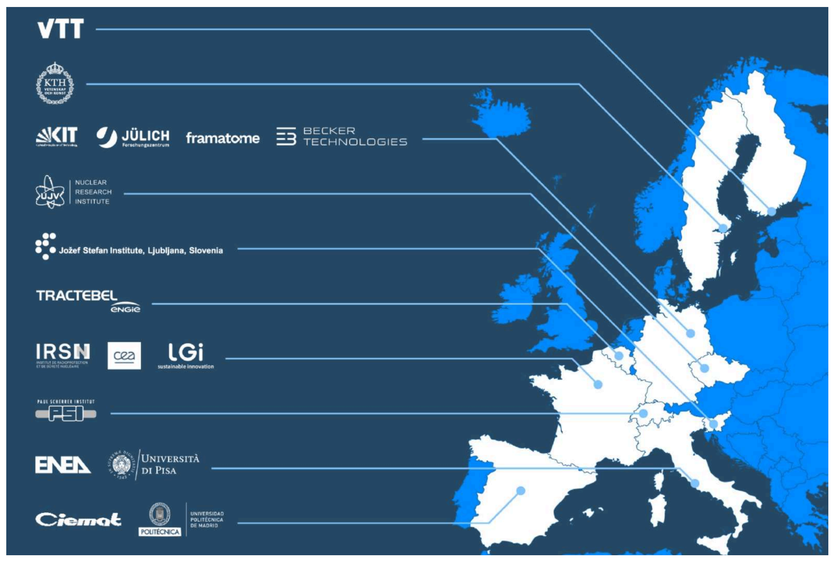
[b] UNIPI, Dipartimento di Ingegneria Civile e Industriale, via Diotisalvi 2, 56122 Pisa, Italy
[c] CIEMAT, Unit of Nuclear Safety Research, Av. Complutense 40, 28040 Madrid, Spain

Partners



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IN SUPREMÆ DIGNITATIS 1343 UNIVERSITÀ DI PISA

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101060327

SEAKNOT

2026 SNETP FORUM

25-27 March | Madrid, Spain

Towards a European simulation platform for accidental scenarios safety calculations and source term estimates for AMR

Isabelle Duhamel (ASNR), Nathalie Girault (ASNR), Paul Van Uffelen (JRC), Jaakko Leppänen (VTT)

Introduction

An active policy is currently being pursued in several European countries and by the European Union to promote the development of Advanced Modular Reactors (AMR) designs. There is therefore a clear need to pool efforts at the European level towards the development of an integrated simulation platform gathering several types of computational tools dedicated to accidental scenarios and source term studies.

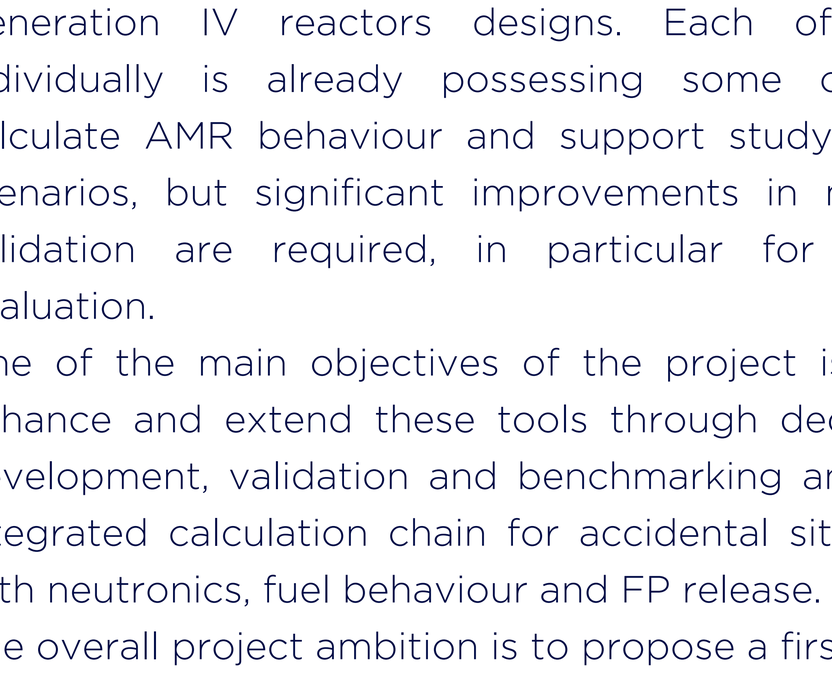
Ambition and Objectives

This proposal is mainly grounded on a few existing simulation tools, extensively developed and validated for LWR applications, and in some cases, partially extended to some Generation IV reactors designs. Each of these tools individually is already possessing some capabilities to calculate AMR behaviour and support studying accidental scenarios, but significant improvements in modelling and validation are required, in particular for source term evaluation.

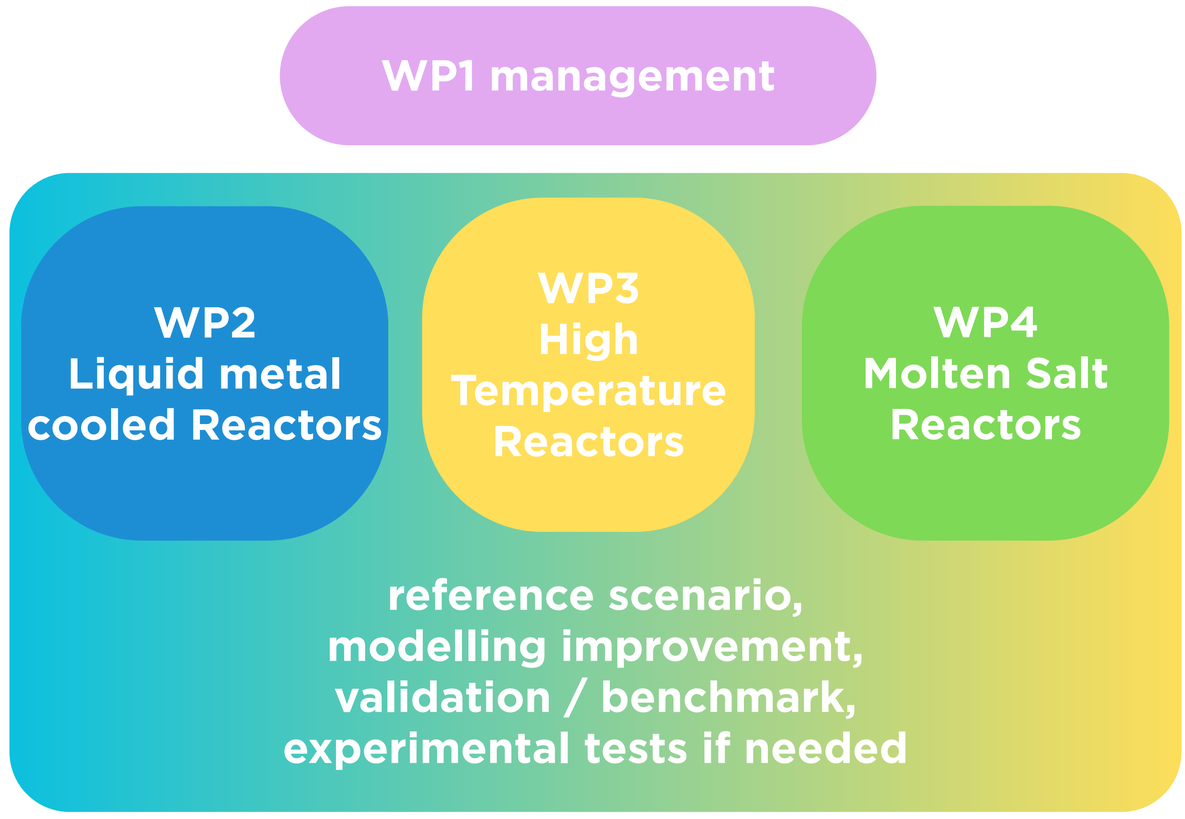
One of the main objectives of the project is therefore to enhance and extend these tools through dedicated model development, validation and benchmarking and develop an integrated calculation chain for accidental situation dealing with neutronics, fuel behaviour and FP release.

The overall project ambition is to propose a first version of an integrated simulation platform and applications in few years.

Integrated simulation platform



Planned structure



This work will benefit from the feedback from start-ups and manufacturers involved in the project advisory board which will help to identify priority modelling needs.

Conclusion

The proposed development of a European simulation platform to assess AMR source terms in accidental scenarios aligns with the European Commission's Strategic Energy Technology Plan and the Strategic Action Plan from European Industrial Alliance on Small Modular Reactors.

The technological maturity of AMR designs and their level of scientific knowledge greatly differ and will thus require model developments of varying importance. The project is therefore designed to rely on robust and versatile codes in order to remain sufficiently flexible to accommodate future extensions, depending on emerging industrial choices and design trends.

The project will allow:

- First Source Term evaluation for some relevant accidental scenarios for different AMRs designs
- Gaps identification and move forward with further design developments

2026 SNETP FORUM

25-27 March | Madrid, Spain

Machine Learning-Based Surrogate Modeling for Rapid Brittle Fracture Analysis of Reactor Pressure Vessel Nozzles

Yaroslav Dubyk (IPP-Centre), Vitalii Antonchenko (IPP-Centre)

Introduction

The structural integrity of Reactor Pressure Vessel (RPV) nozzles under Pressurized Thermal Shock (PTS) conditions is crucial for the safe operation and life extension of nuclear power plants. While FEM simulations provide high accuracy for evaluating Stress Intensity Factors, their substantial computational cost hinders multi-variant sensitivity studies and real-time monitoring. This work proposes a high-fidelity surrogate model based on ML to overcome these limitations, specifically addressing the non-linear thermomechanical behavior at the bimetallic cladding-base metal interface. By leveraging advanced regression algorithms, the study demonstrates a transition from time-consuming numerical simulations to near-instantaneous fracture mechanics assessments.

Objectives

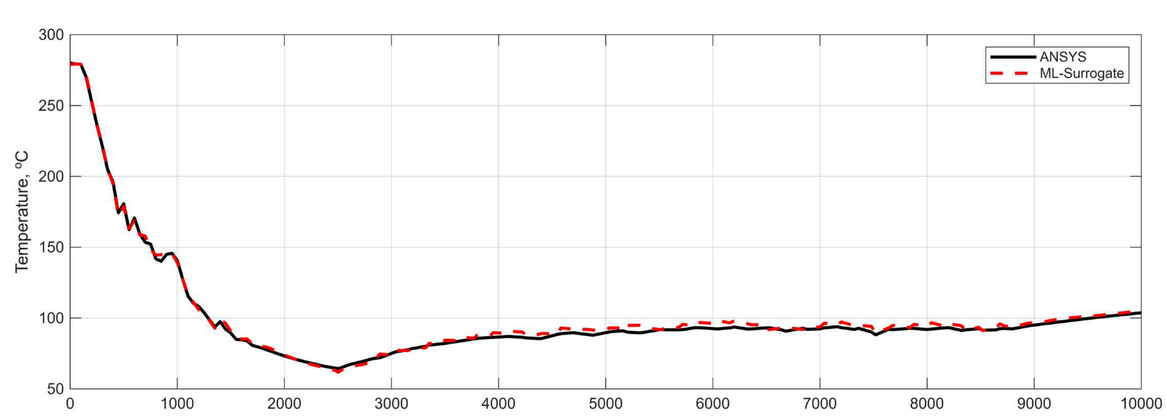
- To develop a hybrid surrogate modeling framework that predicts full-thickness temperature and stress profiles using Artificial Neural Networks (ANN).
- To enhance model robustness by implementing physics-informed feature engineering, including layer-specific thermal gradients and moving averages to account for thermal inertia.
- To validate the accuracy and computational efficiency of the hybrid approach by comparing ML-based results with benchmark FEM data across a wide range of emergency cooling scenarios.

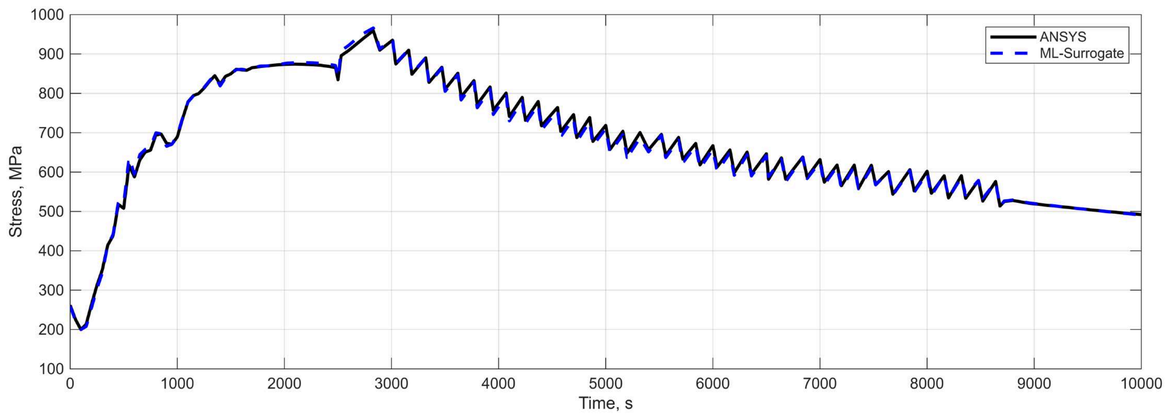
Methodology

- Data Synthesis and Pre-processing: A comprehensive dataset was generated from 60+ ANSYS transient simulations, with 20 scenarios used for training and the remainder for independent batch testing.
- Feature Engineering: Seven key input predictors were selected, including boundary conditions (P, T, HTC) and dynamic features such as cooling rates and specialized thermal gradients calculated separately for the cladding and base metal layers..
- Neural Network Architecture: A multi-output feed-forward ANN was implemented with a 45-25 hidden layer structure and 402 output nodes, utilizing the Levenberg-Marquardt algorithm to simultaneously predict temperature and stress distributions.
- Hybrid SIF Calculation: The SIF were determined by coupling the ML-predicted stress profiles with polynomial fitting and pre-calculated Influence Coefficient (IC) tables.

Results

- Predictive Accuracy: The model demonstrated exceptional performance on unseen test scenarios, achieving a coefficient of determination R^2 of 0.979 for temperature fields and 0.996 for stress profiles.
- Error Metrics: The Root Mean Square Error (RMSE) remained remarkably low, with stress deviations averaging approximately 9.67 Pa, ensuring high confidence in the subsequent fracture mechanics evaluations..
- Computational Efficiency: The hybrid ML-IC approach reduced the total calculation time per transient from several hours of FEM processing to less than 100 milliseconds without compromising engineering precision.
- Bimetallic Handling: The inclusion of layer-specific gradients allowed the model to accurately capture the stress discontinuities at the cladding interface, which is the most critical zone for brittle fracture initiation.





Conclusion

The developed surrogate model provides a robust and computationally efficient alternative to traditional FEM for the brittle fracture analysis of RPV nozzles. By predicting full stress profiles rather than direct SIF values, the model maintains a high degree of physical interpretability and allows for the rapid assessment of varying crack sizes without re-training. The high correlation results (R^2 > 0.99) validate the use of ANN as a reliable tool for nuclear safety applications. Future implementation of this digital twin framework could significantly enhance the capabilities of proactive structural integrity management and real-time decision-making systems in nuclear power plants.

INTERACTIVE BOARD

Smarter while safe Today

Top safety priority

Where should we focus first to make today's plants smarter while safe?

Add a sticker under your answer.

DESIGN	***Operations***	***Human factors***	***Digital tools***

Confidence scale

How confident are you that current nuclear technologies can support Europe's energy transition and competitivity?

Place one sticker where you stand.

LOW

MEDIUM

HIGH

INTERACTIVE BOARD

Smarter while safe Today

Biggest barrier

What is today's biggest barrier to smarter while safe nuclear?

Add a sticker under your answer.

Regulation	***Public acceptance***	***Costs***	***Skills & workforce***

Your word

One word / or sentence that comes to mind when you think of safe nuclear today?

Nuclear for Industry & Society

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Visit our website
www.easi-smr.eu

Coordinator contact
nicolas.sobecki@edf.fr

The Project

Ensuring Assessment of Safety Innovation for SMR (EASI-SMR) is a four-year project project that addresses safety issues associated with **L**ight-**W**ater **S**mall **M**odular **R**eactors **(LW-SMR)** innovations. It endeavors to advance the technologies that will support these innovations for **rapid deployment across Europe and beyond.**
The project research activities support further **design, construction, commissioning and operation of LW-SMR reactors in the safest way**.

Our Objectives

1- Ensure the **highest level of the safety of LW SMRs based on passive systems.**
2- **Assess the safety impact** of LW-SMRs designs' specificities
3- **Address regulatory and societal challenges** towards the deployment of SMRs in Europe.

Our Added Value

The objectives set by the EU in terms of energy transition and industries decarbonation offer huge potential market opportunities, attracting many players who are active in bringing SMRs technologies to reality in Europe.
The EASI SMR project will facilitate this deployment by tackling the various R&D gaps associated with design innovations, as well as by disseminating project research results through education and training activities, thereby ensuring:

- **LW-SMR acceptability**
- **LW-SMR safety**
- **EU energy security**
- **EU decarbonisation**
- **EU nuclear workforce development**

Partners

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101164810.

2026 SNETP FORUM

25-27 March | Madrid, Spain

GEMINI initiative: HTGR for building a low-carbon future for transport and industry

Michel Pasquet (Framatome), Janusz Malesa (NCBJ), Michael Fütterer (JRC), Olivier Tougait (Framatome), Olivier Baudrand (ASNR), Dominique Hittner (HTR)

Introduction

- In H2020, an Euratom funded project, GEMINI +, developed the design of a high temperature helium-cooled reactor for cogeneration of high temperature steam (550°C) and electricity meant at contributing to the decarbonization of industry. Then project GEMINI 4.0 has showed that GEMINI+ design can supply hydrogen, synthetic fuels and chemicals going from cogeneration to poly-generation in a cost effective way.

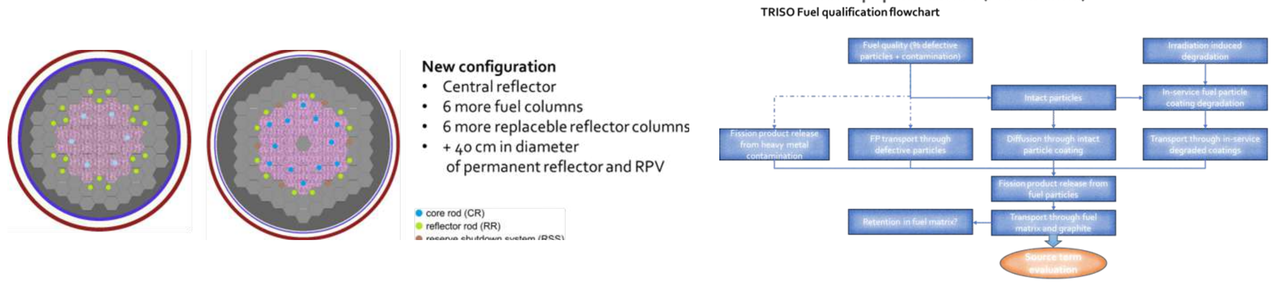
Objectives

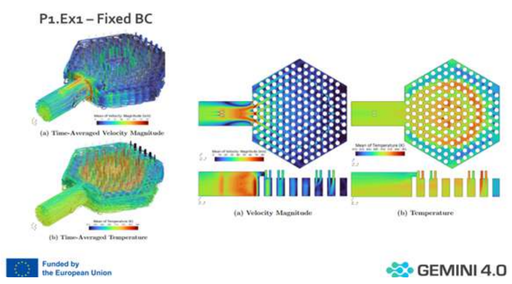
- Consolidate the GEMINI+ system safety demonstration and ensure that its licensing readiness is assessed by regulators and TSOs including the scenario in which it is used in poly-generation mode.
- Develop the capability of the GEMINI+ system to operate in a cost-effective way in poly-generation mode.
- Plan for the development of a consistent fuel cycle for high temperature reactors with respect to fissile resources as well as a safe, and an acceptable back-end.
- Implement an ambitious communication plan aimed towards political and industry stakeholders and the general public, with the goal of removing obstacles to nuclear solutions for the decarbonisation of industry.

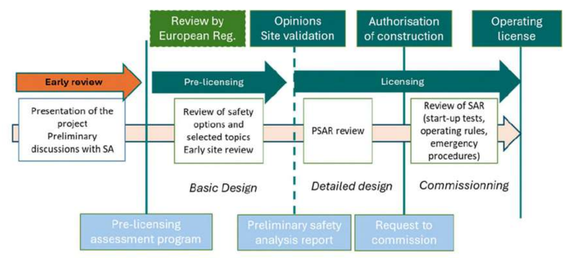
Results

- Optimization of the GEMINI+ Design, Control of the helium gas distribution at the core outlet, definition of instrumentation, monitoring and tests plan, assessment of codes & standards for high temperature for the materials, mechanical components and the graphite
- Definition of the reference TRISO fuel supply chain and the fuel cycle from HALEU supply to back end
- assessment of the licensing readiness of the GEMINI+ design and positive review of the path and conditions from Finland, Poland and France Safety Authorities
- Definition of a pertinent and cost-effective architecture for the decarbonized electricity, heat and hydrogen supply in industry
- Summer school with participation of some industrial companies

Fuel roadmap qualification (Framatome)







Conclusion

The GEMINI initiative has demonstrated the viability of the HTGR to build a low-carbon future for transport and industry. The next step is to consolidate the demonstration of the TRISO fuel reliability in normal and accidental conditions. A corresponding project will be proposed in the next EURATOM call.

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101059603

GEMINI+

GEMINI 4.0

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TANDEM

Small Modular ReacTor for a European sAfe aNd Decarbonised Energy Mix

More information
@SNETP

Visit our website
www.snetp.eu

Coordinator contact
claire.vaglio-gaudard@cea.fr

Objectives

- Development of an integrated vision of the **low-carbon energy mix** on a local/regional scale (a urban area or an industrial area) for heat, electricity and hydrogen.
- Support for the deployment of multi-purpose **Small Modular Reactors (SMRs)** integrated into nuclear **hybrid energy systems** as reliable, resilient, and affordable clean energy options in Europe

Expected Impact

- Development of **tools and methodologies** to assess nuclear hybrid energy systems.
- Implementation on demonstrative study cases to assess **safety, technical performances** (flexibility of energy supply), **techno-economics, environmental impact and citizen engagement.**
- Release of technical recommendations and policy briefs.
- Set-up of an open and long-term **European community** supporting the development and deployment of nuclear hybrid energy systems.
- Creation of close links with other international communities (international organisations, Euratom projects).

Highlights

New MODELICA Library to Build Simulators
Scan the QR code to access the library.

Learn more about TANDEM, scan me!

Highlights

Safety Analysis of Hybridisation Transients

- Development of a coupling between **nuclear safety codes** (ATHLET & CATHARE) and modelica BOP model.
- Simulation of normal operation, AOO and DBA.
- Analyses enabling to show the **hybrisation impact** on safety assessment in the project framework- no major new challenge to overcome.

Techno-economics and Environmental Impact

- Optimisation of an objective function taking into account contraints on environmental impact to size the components of the hybrid energy systems with **Backbone and PERSEE.**
- Analysis of **case studies:** two cases for the district heating and electricty supply (Helsinki Metropolitian Area, Finland and Moravian-Silesian Region in Czech Republic), one for an energy hub (port with virtual data in France).

Partners

TANDEM

Funded by the European Union

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OperaHPC : OPEn HPC theRmomechanical tools for the development of eAtf fuels

B. Michel(CEA), M. Bertolus (CEA) A. Pivano (CEA), R. Largenton(EDF), J. Heikinheimo(VTT), A. Scolaro (PSI), L. Luzzi(POLIMI), R. LoFrano(UNIPI), M. Zilly(FRAMATOME)

Introduction

The licensing of advanced fuel materials and designs for Gen-II/III reactors require extending the qualification of industrial fuel performance codes to meet nuclear safety authorities' requirements, including verification, validation, and uncertainty quantification processes.

The OperaHPC project focuses on developing advanced simulation tools that enable 3D representation of fuel rods. Specifically, it aims to contribute to the qualification of fuel performance codes using advanced simulation tools with physics-based modelling and high-performance computing (HPC) capabilities.

Methodology

The project's activities span from fundamental research, including experimental characterization of fuel creep behaviour coupled with small-scale simulations, to representative engineering fuel safety studies using improved industrial fuel performance codes and HPC 3D simulations. The project also develops open-source codes, such as OFFBEAT and SCIANTIX for the fuel rod scale and MMM at the fuel microstructure scale.

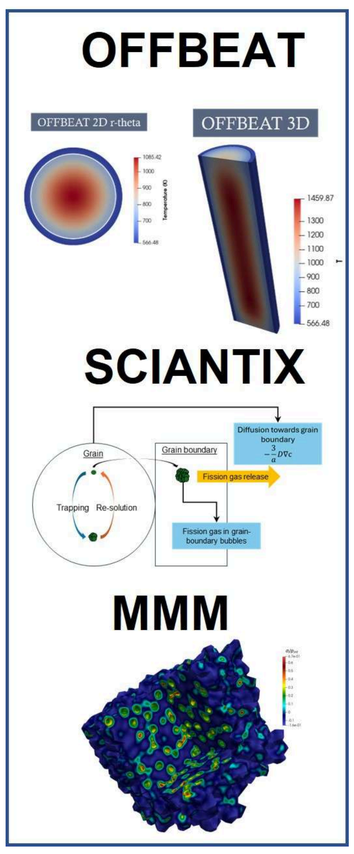
Additionally, machine learning techniques are being developed to enhance the transfer between 3D simulations and industrial models. A key strength of this approach is the capitalization of all developments and results obtained in the project, which are made available through open-source codes for partners and the broader fuel performance codes and materials communities.

Conclusion

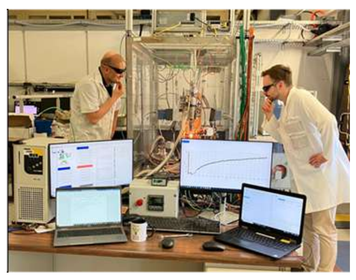
At this stage of the project numerous results are available for education and training on open-source Fuel Performance Codes. Among these, a MOOC dedicated to OFFBEAT and SCIANTIX has been developed, and a one-week training program involving 40 participants took place in January 2026.

Results

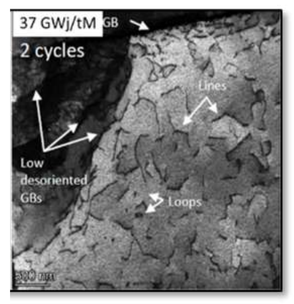
- By the end of the second period, a new creep test device was developed and qualified on inert materials for mechanical loading conditions representative of an incidental operating power transient. In the third period, this testing device will be implemented in a hot cell of the LECA-STAR facilities at CEA to measure the creep behaviour of irradiated fuel.
- The corresponding samples have been fully characterized at the nano-scale to provide all the TEM data needed for developing a physics-based mechanical model. Thanks to these experimental data and atomic/dislocation scale simulations, a crystal plasticity law has been improved to assess the impact of irradiation on fuel creep behaviour. Furthermore, new mechanical laws for Cr-coated eATF cladding have been implemented for the HPC codes developed in the project.
- Reference versions of the OFFBEAT/SCIANTIX and MMM codes are available on open-source repositories for fuel assessment. The validation and new learning database with 3D simulation results are under completion for fuel studies.
- New VVER input data have been computed and prepared for fuel performance evaluation under Design Basis Accident irradiation loading conditions.



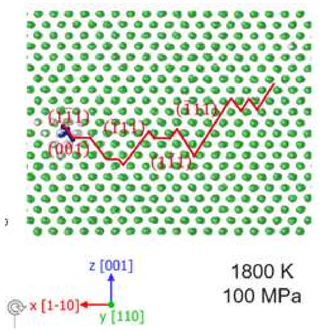
Open source codes of the OperaHPC project



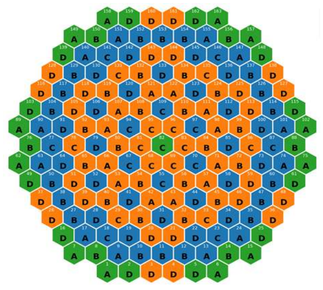
Qualification of the creep test device



Dislocation density measurment in irradiated UO2



Dislocation mobilty in UO2



VVER core study for irradiation loading conditions

School on fuel performance codes : OperaHPC project January 2026

OPERA HPC

www.operahpc.eu

Coordinator: bruno.michel@cea.fr

This project is co-funded by the European Union

INTERACTIVE BOARD

Nuclear for Industry & Society

Quick vote

In which non-electric application would you most like to see nuclear used in your country?

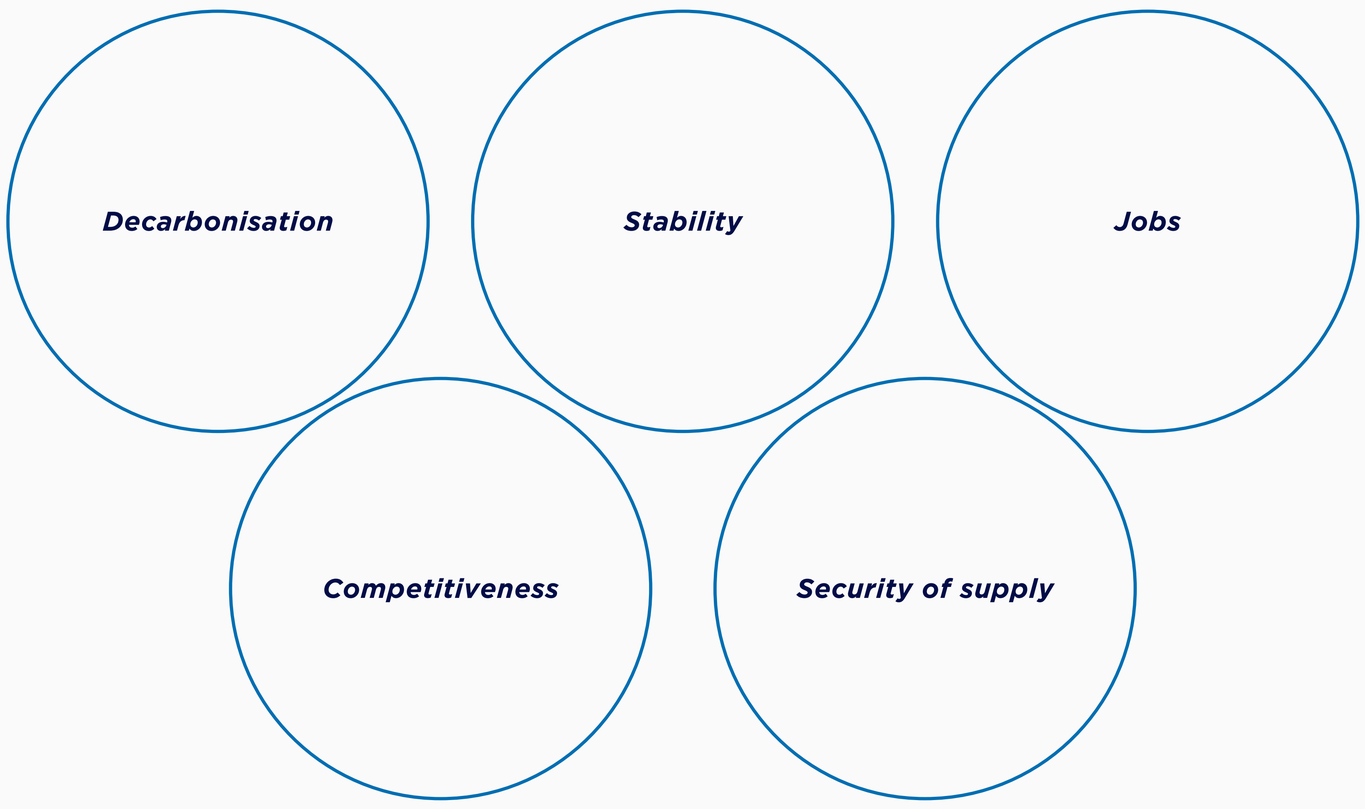
Add a sticker under your answer.

District heating	*Heat for industry*	*Hydrogen production*	*Desalination / clean water*	*Reliable electricity remote areas*

One-word impact

What is the main benefit of using nuclear for industry & society?

Choose one word and add a sticker



INTERACTIVE BOARD

Nuclear for Industry & Society

Benefits

Society benefits MOST from nuclear when...

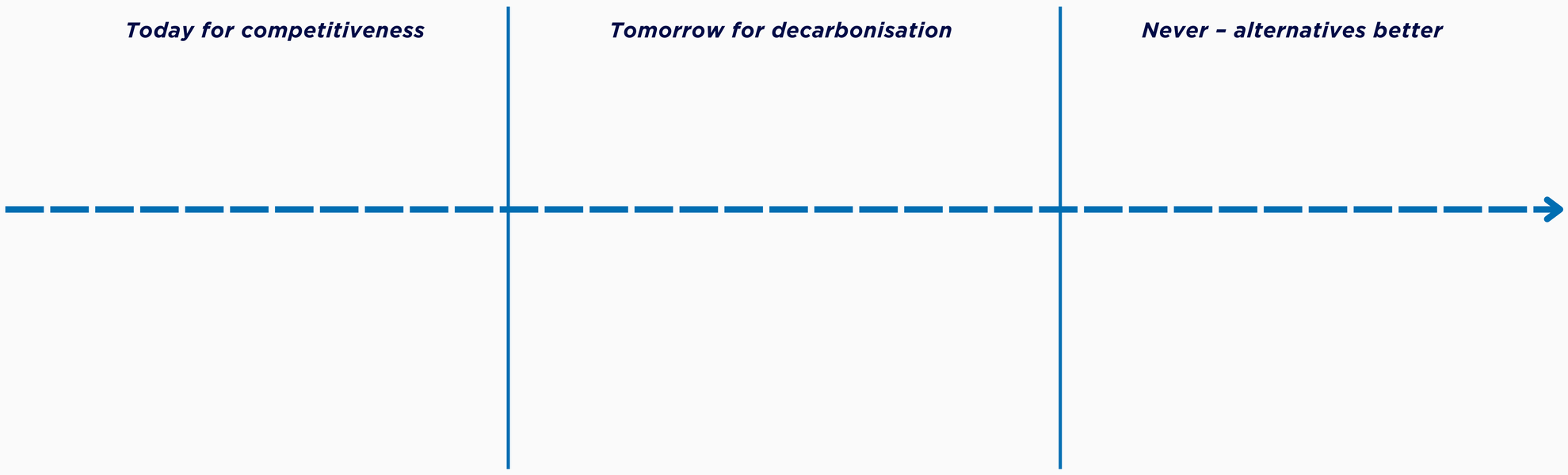
Add a sticker under your answer.

Prices stay stable	*Jobs are created*	*Emissions drop fast*	*Independence grows*

Timeline bar

Industry needs nuclear...

Place one sticker where you stand.



2026 SNETP FORUM
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SNETP
Sustainable Nuclear Energy Technology Platform

Innovating Materials & Components / Waste & Recycling

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Coordinator contact
Yann Perin & Mathieu Hursin
yann.perin@grs.de & mathieu.hursin@psi.ch

Objectives

The EVEREST project is dedicated to improving the safety and efficiency of nuclear reactors through cutting-edge multi-physics modelling. By leveraging advanced computational tools, EVEREST produces more accurate and detailed data, which is essential for validating and refining safety margins in nuclear power plants. One hurdle for a broader adoption of such models is the lack of dedicated experimental data for validation, especially when it comes to their improved spatial resolution. Through the production of high-resolution experimental data at three European research reactors, EVEREST will also attempt to fill this gap.

This research not only **contributes to safer, more efficient energy production but also supports the transition to climate-neutral energy systems**. The project actively involves key stakeholders—such as students, utilities, and regulators—by **providing training**, promoting the adoption of these advanced models, and **ensuring the long-term preservation of nuclear safety knowledge through educational initiatives**.

Expected Impact

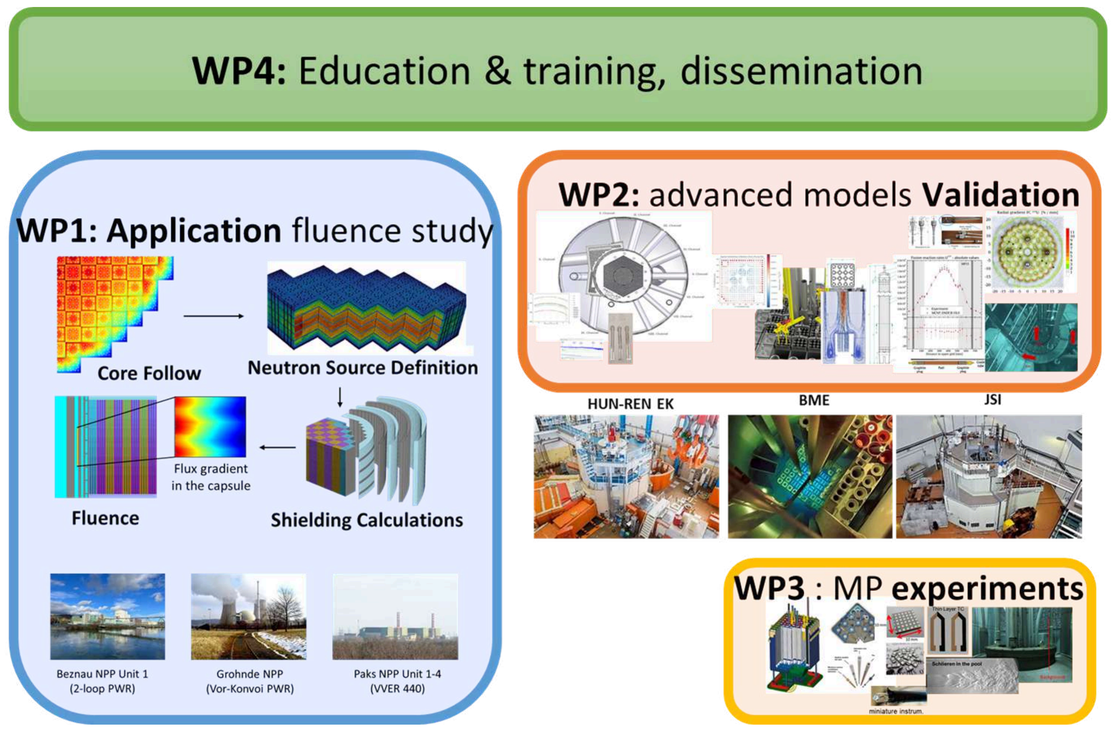
The EVEREST project intends to :

- **quantifying** the impact of using advanced multi-physics models for the modelling of Long Term Operation (LTO) relevant parameters (vessel fluence) in PWR and VVER reactors;
- **demonstrating** the accuracy of their results, especially the improved resolution through the production of dedicated experimental data;
- and **promoting** them to key groups of the nuclear engineering community (students, utilities, regulators).

Highlights

During its first 18 months, the EVEREST project achieved:

- the internal release (delivrable D1.1) of **reactor datasets** for three operating European NPPs (Beznau, Grohnde, Paks), enabling fluence modelling studies;
- the production of **new experimental data** at the BRR reactor (delivrable D2.1);
- the production of **Advanced multi-physics modelling frameworks** for research reactors (BRR, TRIGA, BME) ;
- the development of **innovative high-resolution instrumentation.**



Partners

This project has received funding from the HORIZON-EURATOM-2023-NRT-01 under grant agreement No 101163288.

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INNUMAT

Innovative Structural Materials for Fission and Fusion

More information
@SNETP

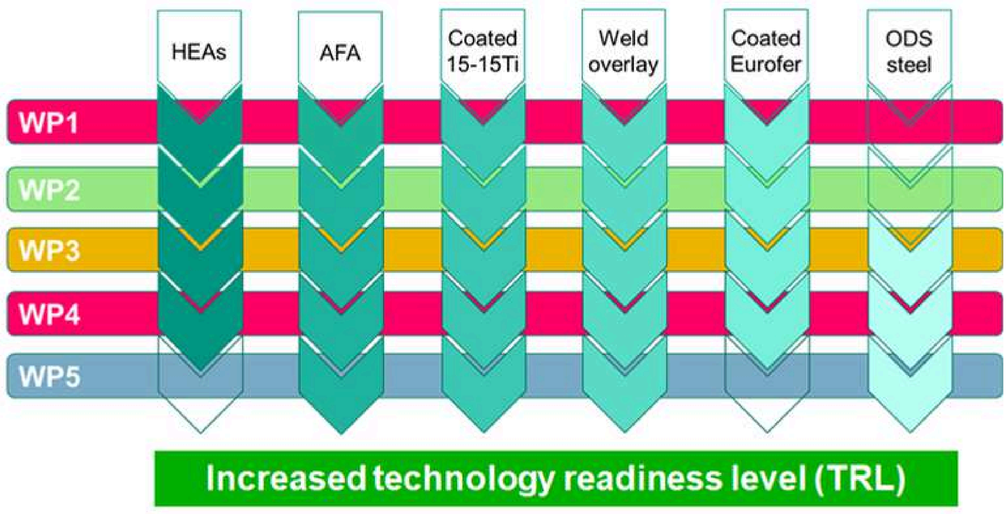
Visit our website
www.innumat.eu

Coordinator contact
jarir.aktaa@kit.edu

Objectives

- Development and qualification of innovative structural materials / material solutions for fission **MSR** & **LFR** (incl. SMRs) and fusion **DEMO**
- Increase of **TRL** of considered materials with respect to:
  - compatibility with coolants
  - HT mechanical behavior and thermal stability
  - radiation tolerance
- **Cross-cutting** aspects: one WP dealing with the synergies in terms of innovative materials between fission and fusion as well as nuclear and non-nuclear energies

WPs and research tracks – matrix structure



Highlights

- New complex concentrated alloys with promising compatibility with coolants, high temperature strength, thermal stability and irradiation tolerance developed based on a genetic algorithm for multi-objective optimization combined with basic experimental assessments
- Investigated high alloyed AFA steels demonstrated excellent compatibility with heavy liquid metals (Pb and LBE) with no signs of corrosion at 600°C after 5000h and even no liquid metal embrittlement (LME) under application relevant loading conditions
- First datasets on high temperature mechanical behavior and thermal stability of REFERENCE materials generated in a comprehensive characterization programme including tensile, creep, fracture mechanics, low cycle fatigue and small punch testing
- Machine learning interatomic potentials developed for various INNUMAT relevant materials and used in molecular dynamics simulations of overlapping collision cascades and, hence, formation of primary defects due to irradiation
- Observation and modelling of radiation-induced elemental clustering/precipitation in complex, multiple element alloys

Partners

innumat

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101061241.

2026 SNETP FORUM

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Nuclear fuel cycle back-end considerations for SMR/AMR deployment: EURAD-2 FORSAFF findings

Alan H. Tkaczyk (University of Tartu), David García (Amphos 21), Jesús S. Martínez (Amphos 21), Francisco Álvarez-Velarde (CIEMAT), Kateryna Fuzik (SSTC NRS), Gabriele Magugliani (Politecnico di Milano), Anne Saturnin (CEA), Virginie Wasselin (ANDRA), Josef Brinek (UJV Řež), Nadja Železnik (EIMV), Sami Naumer (VTT), Timothy Schatz (VTT)

Introduction

Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs) are viewed as promising solutions for low-carbon electricity, driven by enhancements in safety and in manufacturing.

Given the high diversity in SMR/AMR waste stream composition, decay heat profiles, and chemical stability, **EURAD-2 Work Package 4 FORSAFF** explores the alignment of SMR/AMRs characteristics with the development of Waste Management (WM) infrastructure.

Objectives

FORSAFF addresses this strategic gap by evaluating technical, regulatory, and stakeholder-related aspects of SMR/AMR waste management.

This multi-dimensional work focuses on the back-end implications of four main reactor technologies:

- **Light Water Small Modular Reactor (LW-SMR)**
- **Liquid Metal Fast Reactor (LMFR)**
- **High Temperature Gas-cooled Reactor (HTGR)**
- **Molten Salt Reactor (MSR)**

The goal is to promote a holistic approach that avoids a narrow focus on just the front-end or operational phase.

Methodology

The study is structured through cross-disciplinary tasks:

- Inventory profiling for each technology selected for both operational and spent fuel waste, and assessment of pre-disposal and reprocessing options.
- Technical and regulatory mapping to evaluate current WM frameworks for SMR and AMR designs.
- Inclusion of perspectives from Waste Management Organizations (WMOs), Technical Support Organizations (TSOs), Research Entities, and integration with civil society views on safety and transparency.

Results

- LW-SMRs generate waste streams similar to existing large-scale plants, allowing for the transfer of established management practices and regulatory frameworks. However, compact reactor core sizes can result in increased material activation, and additional efforts are essential to demonstrate waste storage safety and regulatory compliance.
- For AMRs, the primary gap in knowledge stems from limited operational experience with associated waste streams. AMRs generate non-standard waste streams such as irradiated graphite (HTGRs), chemically reactive coolants (LMFRs), and molten salts (MSRs). These systems will need updated Waste Acceptance Criteria (WAC) and require novel treatment and/or reprocessing approaches.

The four SMR/AMR technologies considered in EURAD-2 FORSAFF.
(Image source: US Department of Energy, Office of Nuclear Energy, https://x.com/GovNuclear/status/1990587533613310012)

Conclusion

The deployment of SMRs and AMRs relies on the early integration of waste management considerations into their design and operational phases. To build confidence among international stakeholders and civil society, accelerated R&D on non-standard waste and the parallel evolution of regulatory frameworks are essential. To gain public support, it is important that SMR/AMR development includes inclusive, transparent engagement processes and accountability on long-term waste management.

We acknowledge the technical support of Lara Nigro in the preparation of this poster.

The European Partnership on Radioactive Waste Management-2 (EURAD-2) is co-funded by the European Union under Grant Agreement N° 101166718.

2026 SNETP FORUM

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Advancing Harmonization in Decommissioning and Radioactive Waste Management: Outcomes and Impact of the EURATOM HARPERS Project

Réka Szőke (Institute for Energy Technology), Elke Jacops (SCK CEN)

Introduction

European Council Directives and IAEA Safety Standards underpin national frameworks for decommissioning and radioactive waste management. However, their implementation varies widely across EU Member States due to differing national regulations and local practices. These inconsistencies hinder cross-border cooperation and create challenges for regulators, operators, and other stakeholders.

Objectives

The EURATOM HARPERS project (HARmonised PracticEs, Regulations and Standards in waste management and decommissioning) (2022-2025) aimed to establish and clarify the benefits and added value of more aligned and harmonized regulations and standards for nine topics related to cross-border services, circular economy principles and advanced technologies in decommissioning and nuclear waste management.

Methodology

To ensure alignment with stakeholder needs, HARPERS was designed as a two-stage project supported by a strong stakeholder community. The topic development included literature reviews, surveys, workshops, and webinars. with the objective to extract key insights, identify enablers and barriers, and assess opportunities for harmonization.

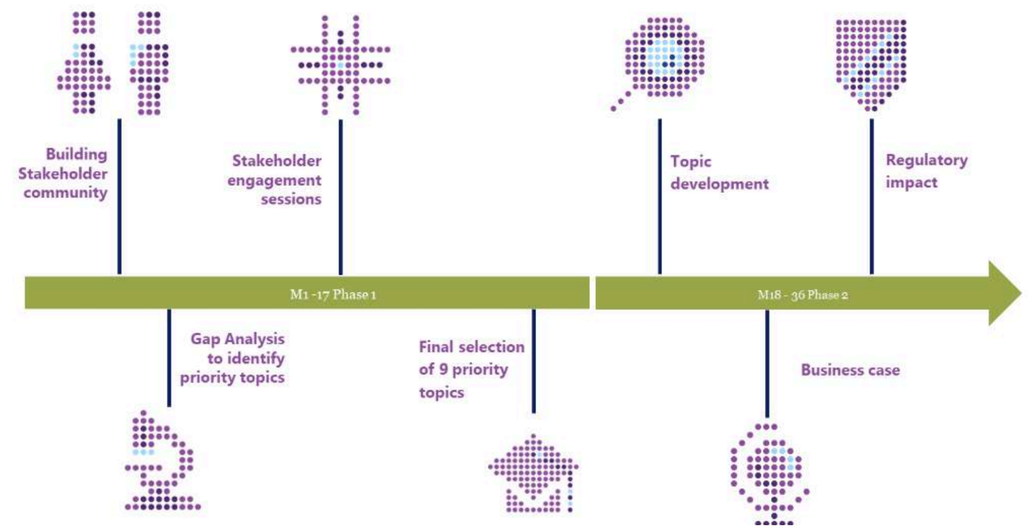

Figure 1: Timeline of the HARPERS project, indicating the 2-phase approach

Results

The project identified priority areas for harmonisation and used a structured method to distinguish regulatory challenges from strategic, technical, and perceived barriers.

Key findings and recommendations are summarised in a series of position papers, supported by business cases demonstrating the technical, environmental, commercial, operational, and sociopolitical benefits of harmonisation.

The analysis shows that although regulatory frameworks generally exist, practical obstacles persist due to differences in national interpretation, planning practices, and technical implementation.

To address these issues, the project proposes six cross-cutting priority actions:

Figure 2: Cross-cutting priority actions

Conclusion

The HARPERS project demonstrates that progress toward harmonised decommissioning and waste management practices is both feasible and beneficial.

- Through broad consultation and technical assessment, the project identified common challenges and developed practical recommendations to address them.
- Harmonisation can streamline regulatory processes, improve safety and predictability, and support efficient cross-border cooperation.

Continued collaboration between regulators, operators, and technical support organisations will be essential to maintain the momentum generated by HARPERS and to ensure coherent long-term strategies for waste management and disposal across Europe.

HARPERS
HARMONISED PRACTICES, REGULATIONS AND STANDARDS IN WASTE MANAGEMENT AND DECOMMISSIONING

Funded by the European Union

This project received funding from the Euratom research and training programme 2021-27 under grant agreement No 101060028. It was co-funded by the Research Council of Norway under the International Calls International Collaborative Project - Project number 345806, and by UKRI Grant 10041121 under the Horizon Europe Guarantee.

2026 SNETP FORUM

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Innovative Glove-Box Cementation System for Small Volume of Alpha-bearing Liquid Waste

Sara Cardellicchio (Sogin), Paola Negrini (Sogin), Lorenzo Terribili (Sogin), Federica Pancotti (Sogin)

Introduction

In the Plutonium Plant (IPU) at the Sogin Casaccia site, approximately 310 L of alpha-contaminated Intermediate Level Liquid Waste are currently stored.

The waste poses specific challenges due to:

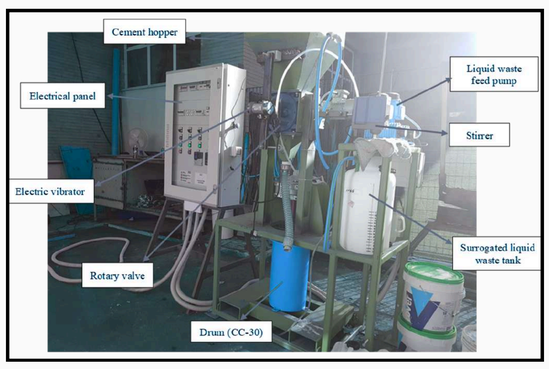
- Liquid form with higher radionuclide mobility,
- Physico-chemical characteristics and high alpha activity, mainly plutonium,
- Very small volume, requiring tailored solutions

Objectives

The aim of the project was to obtain a final waste package, suitable for handling, transport, interim storage and final disposal, according to the highest safety and confinement standards.

Methodology

- Following an evaluation of technical and strategic alternatives, on-site direct cementation was selected as the optimal solution and a dedicated small-volume processing system was engineered to treat and condition the waste.
- Waste characterization identified two primary streams—acidic and alkaline fraction—each requiring specific pre-treatment and conditioning strategies.
- A comprehensive laboratory testing program was performed to define the operating parameters, the cementing materials and to assess the stability and durability of the resulting waste forms.
- A full-scale mock-up test validated both the process and the final waste package
- The design phase focused on the development of a small scale cementing system inside a glove-box, allowing all operations—handling, mixing, pre-treating, cementing and packaging—to be performed under high-integrity containment conditions that ensure operator protection and prevent any dispersion of alpha contamination.
- The design also included a tailored drum with lost paddle to be coupled with the process area through an alpha tight port. This drum was intended to serve simultaneously as the process vessel and the final disposal package.



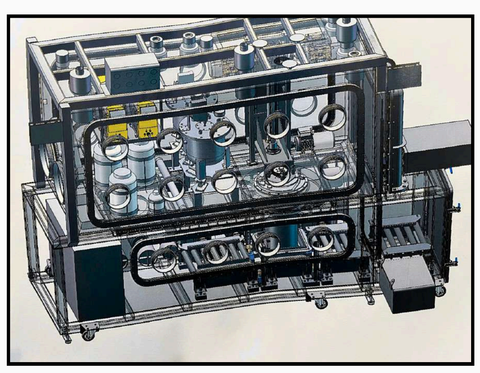


Figure - Left: full-scale mock-up; Right: 3D Glove-Box design

Results

- The system has been realized and it is in the final testing phase.
- It is composed of a process module, an handling module for the drum and a cement loading and dosing module.
- The system operates in a semi-automatic mode, reducing manual intervention and guaranteeing process repeatability.
- In the process module treatment, mixing, dosing, transfer and cementing operations are implemented.
- Specific environmental and process parameters are fully monitored by the control system.
- The system represents a flexible solution, capable of accommodating different waste chemistries, small and variable volumes: it has been implemented to also cement liquids with an organic fraction.

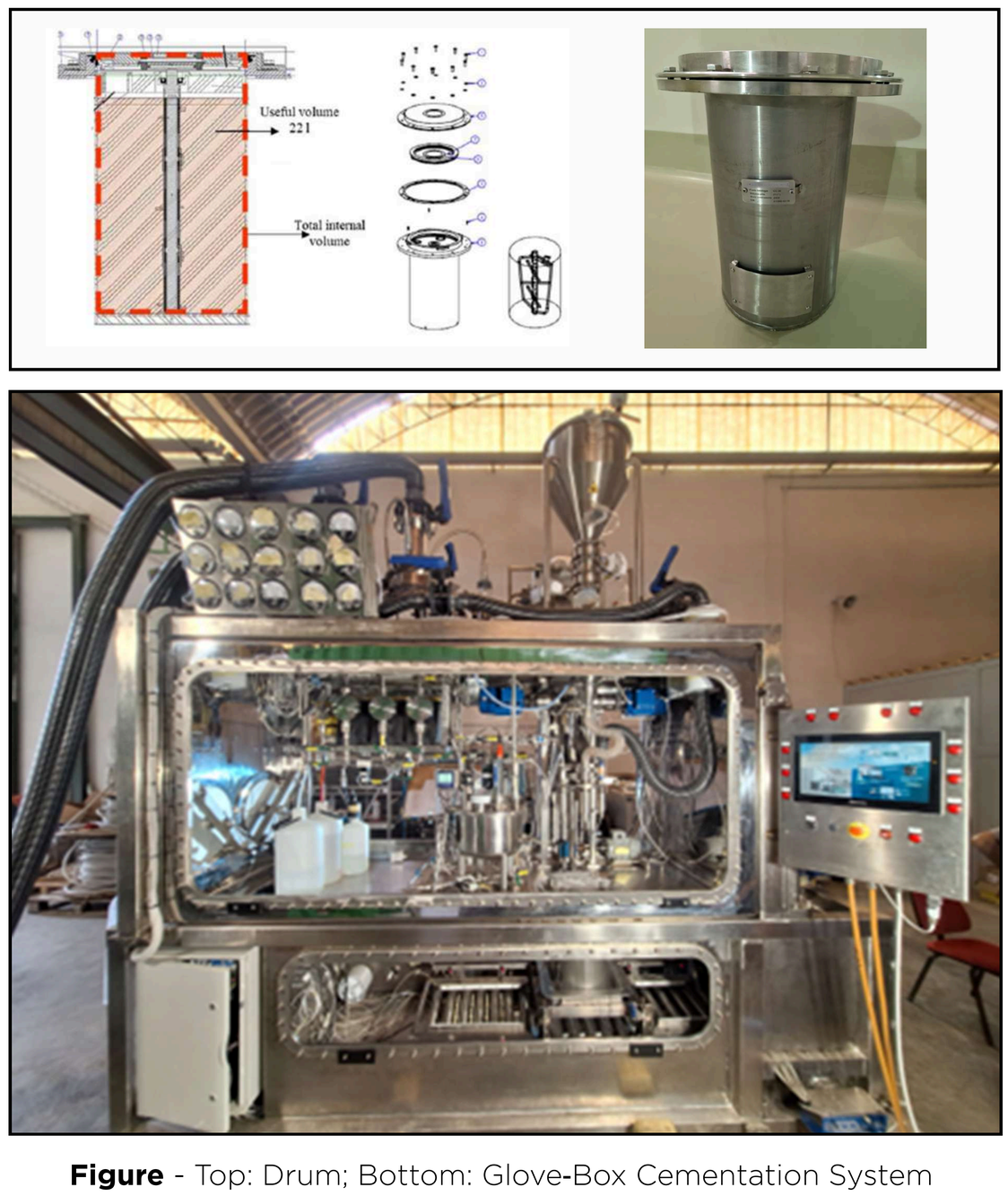


Figure - Top: Drum; Bottom: Glove-Box Cementation System

Conclusion

The glove box cementing system provides a robust, safe, and efficient approach for conditioning limited volumes of alpha-contaminated waste within a highly controlled environment, offering a flexible solution adaptable to specific waste streams and plant constraints and contributing meaningfully to ongoing Italian nuclear decommissioning efforts.

SOGIN | nucleare e ambiente

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25-27 March | Madrid, Spain

PARCOVAL

PAlladium Recovery for CO2 VALorisation

Anthony Ropp, Frédérique Hourcade, Elisabeth Guillaut (Orano Support)

Introduction

Securing access to critical raw materials, including platinum-group metals (PGM), is essential to meet Europe's climate objectives as they are used in the automotive industry to reduce harmful emissions as well as in hydrogen production, storage and fuel cells. Today, the only source of PGM in the European Union is recycling, and the EU remains highly dependent on imports of extracted metals from third countries.

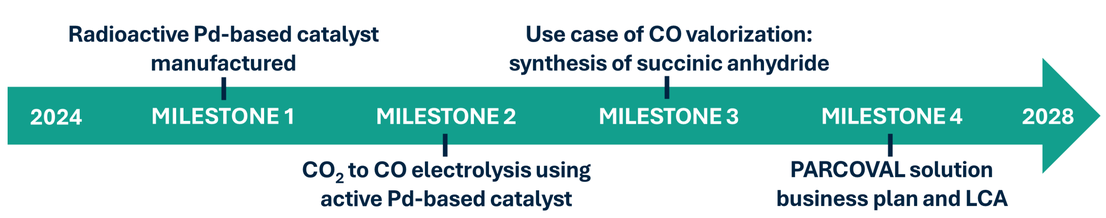
The PARCOVAL project (2024-2028) aims to demonstrate the potential recovery and valorisation of palladium from spent nuclear fuel .

Objectives

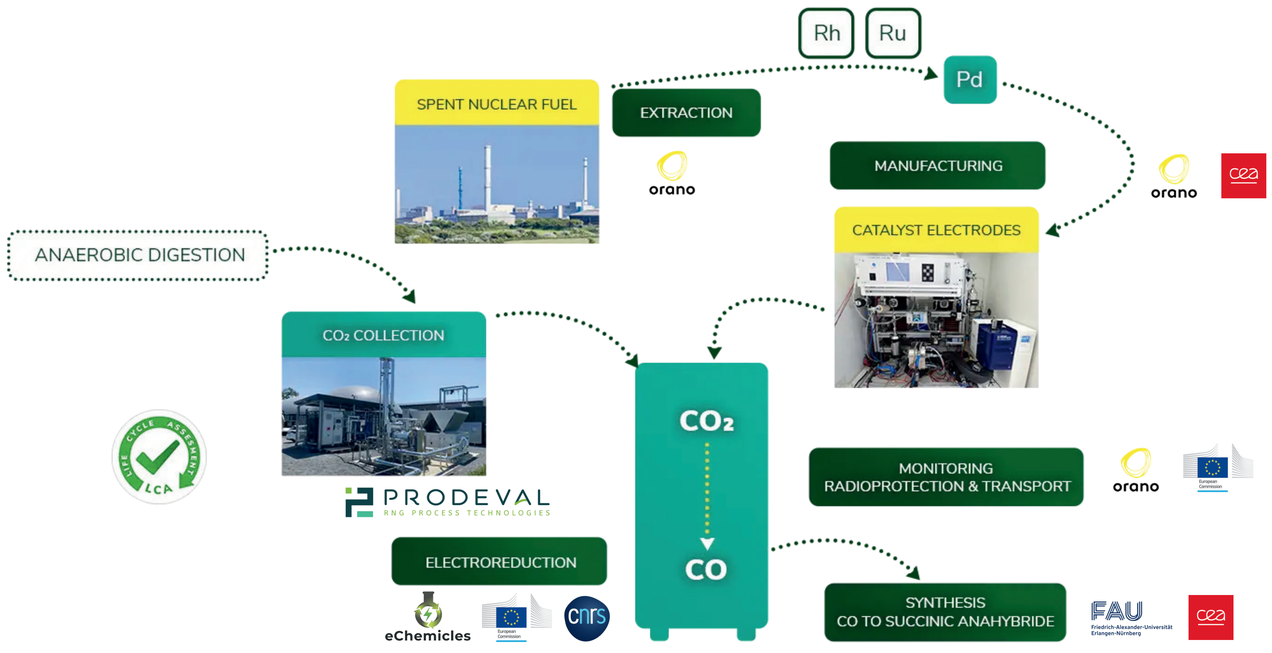
The first objective of the project is to extract radioactive Pd from spent nuclear fuels, which are today vitrified and considered a nuclear waste. Palladium found in SNF as a fission product is made up of stable isotopes except Pd-107 (17 wt. %). Pd-107 is a pure soft beta emitter (0.035 MeV), but fission palladium has to be separated from Ru-106/Rh-106 and Ag-110m which are gamma emitters and therefore more constraining regarding radioprotection measures. A key requirement of PARCOVAL project is to recover Pd pure enough to be handled in glove box in order to minimize operational constraints and to protect operators from radioactivity according to the ALARA principles. This would provide a good balance between handling constraints and the possible beneficial effects of radioactivity on the Pd catalytic performance.

PARCOVAL's second objective consists in demonstrating the valorisation of the recovered Pd as an electrocatalyst for the reduction of biogenic CO2 to CO as a reactive intermediate to a larger class of high-value chemicals. In particular, PARCOVAL will study the production of **succinic anhydride** – a monomer that would allow technological development towards bio-based polymers and thus to green chemistry. PARCOVAL will also conduct a life-cycle analysis (LCA) to compare radioactive Pd to Pd extracted from mining; address safety and security measures for radioactive PGM use; and assess the market potential of its solution.

In this manner, **PARCOVAL seeks to provide concrete and innovative example of how nuclear technologies can deliver tangible benefits beyond the energy sector**, contributing to the competitiveness and decarbonization of other strategic segments of the European economy.



Methodology



PARCOVAL concept. Credit: partners of the PARCOVAL consortium. Orano spent fuel processing plant in La Hague (France), where Pd will be extracted from SNF. Copyright: Orano, Cyril Crespeau. CO2 electrolysis test station at eChemicles. A similar one will be built and transported to the Joint Research Centre to test the radioactive Pd-catalyst. Copyright: eChemicles. PRODEVAL's V'COOL® unit for carbon dioxide liquefaction. Credit : PRODEVAL.

Results

Palladium recovery

A Pd extraction process based on a precipitation protocol using ascorbic acid was successfully developed and validated on non-radioactive solutions with a very good yield. This protocol has been applied to real radioactive Pd effluents (dissolution fines), with approximately 1 g of Pd recovered to date. Successive precipitations enable Pd purification from its main impurities and various options are under study to further purify the recovered Pd.

Demonstration of the CO_2 to CO valorisation process using the Pd-based catalyst

A cathode manufacturing protocol based on electrodeposition of recovered Pd and commercial Ag was optimized by CEA during the project's first year. The radioactive cathodes prepared at Orano's nuclear fuel recycling facility in La Hague (France) will be sent to the Joint Research Centre (JRC) in Karlsruhe (Germany) during 2026 to be tested using a zero-gap electrolyzer developed by the Hungarian SME eChemicles.

Best practice framework for the use of radioactive Pd

Radioprotection studies are conducted to implement best practices for the manipulation and the transport of radioactive samples along the project, based on chemical and radiological characteristics of the radioactive Pd. Furthermore, recycling pathways and radioactive waste management for the radioactive catalyst at its end-of-life were evaluated.

CO_2 sustainable sourcing and environmental impact

A life cycle analysis of the process developed in the project is under study by CEA, starting with the production of biogenic CO_2. This method evaluates environmental impacts at each stage of the process — from resource extraction to final valorisation.

orano cea cnrs eChemicles PARCOVAL

PAlladium Recovery for CO_2 VALorisation

PRODEVAL RNG PROCESS TECHNOLOGIES

FAU Friedrich-Alexander-Universität Erlangen-Nürnberg

European Commission

Co-funded by the European Union

Co-funded by the European Union. Views and opinions expressed are, however, those of the author(s) only and do not necessarily reflect those of the European Union or Euratom. Neither the European Union nor Euratom can be held responsible for them.

INTERACTIVE BOARD

Innovating Materials & Components / Waste & Recycling

R&D priority

What should be the top R&D priority for materials and components to accelerate the deployment of nuclear in the EU?

Add a sticker under your answer.

Lifetime extension	***Extreme condition resistance***	***Easier maintenance***

Waste optimism scale

How optimistic are you about advanced fuel cycles and recycling by 2050?

Place one sticker where you stand.

Not optimistic

Cautiously optimistic

Very optimistic

INTERACTIVE BOARD

Innovating Materials & Components / Waste & Recycling

Most promising approach

Which approach feels most promising for nuclear waste?

Add a sticker under your answer.

Minimisation at source	***Recycling/advanced fuel cycles***	***Other options***

One benefit

One key benefit of better materials or waste management?

Knowledge, Licensing & European Collaboration

Labelled by SNETP

HARMONISE

Towards harmonisation in licensing of future nuclear power technologies in Europe

More information
@SNETP

Visit our website
www.snetp.eu

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Introduction

- The current nuclear regulatory framework originated in the 1960s for licensing early nuclear installations.
- There is a broad agreement with the need to review this regulatory framework, incorporate novel concepts and empower it with adequate capabilities

Methodology

- Development of tools and methodologies to assess HARMONISE is a three-year project that has been developed through six work packages
- The project has seventeen participants including JRC
- Sixteen participants originate from ten EU Member States and one participant originates from Ukraine.
- The work was done by review of international safety standards published by IAEA, review of available safety cases of fusion facilities ITER and DEMO, assessment of potential licensing gaps for Generation IV reactor ALFRED, review of Risk-Informed and Performance-Based approach for application to Nuclear Power Plants, review of the existing Codes and Standards in light of their applicability to Generation IV reactors.

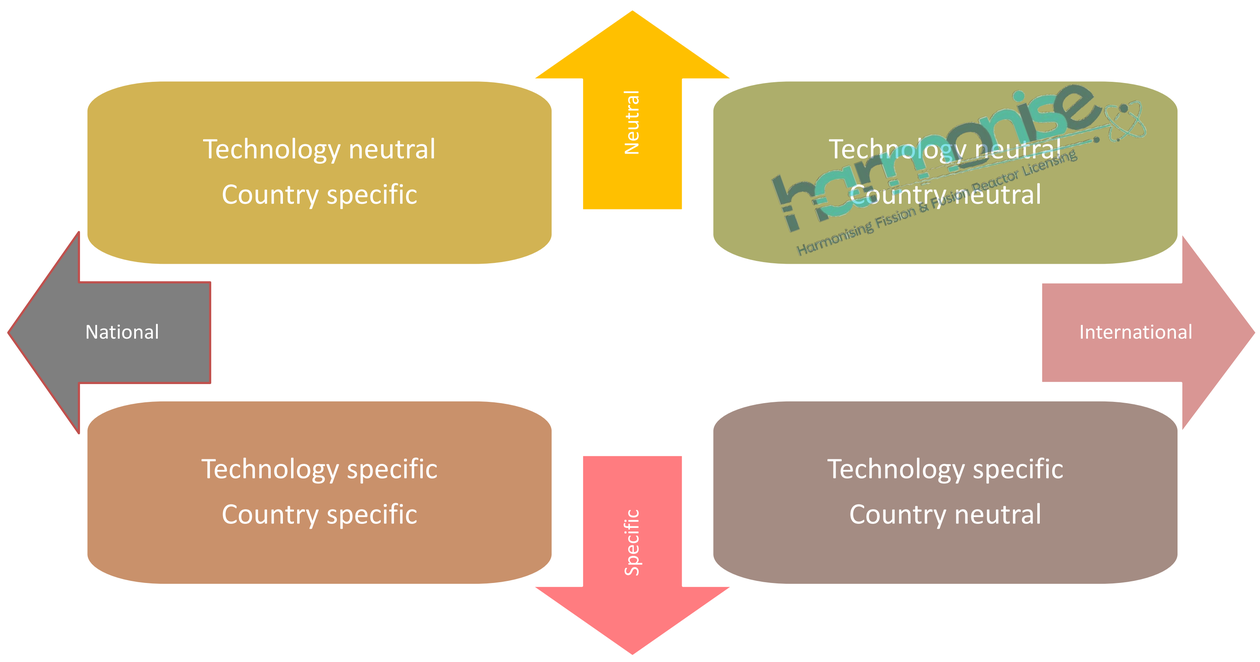
Highlights

- Analysis has showed that substantial portion of the high-level IAEA documents is technology neutral
- There were documents for which amendment proposals were introduced that could be considered as recommendations for additional examination

Learn more about HARMONISE , scan me!

Highlights

- The current safety case documentation of fusion facilities has been reviewed drafting observations and recommendations
- Departure from a prescriptive-based to a performance-based approach is examined from the viewpoint of accordance with the safety objectives of evolutionary and innovative designs and fusion power plants
- A review has been carried out on risk insight usage and performance-based requirement application for licensing advanced nuclear installations
- The needs associated with the technical specificities of advanced reactor technologies and the foundations of the current regulatory frameworks have been analysed
- A study has been performed to identify the innovation impact on the applicability of current safety frameworks to ALFRED and DEMO
- The codes and standards needs for developing innovative nuclear installations have been identified via a survey
- For a number of digital technologies their potential applications in the field have been elucidated



Partners

This project has received funding from the European Commission-Euratom under Grant Agreement No 101061643.

Labelled by SNETP

Discover our labelled projects

SANE Euratom

More information
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www.sane-euratom.eu

Objectives

The SANE project (Safety Assessment of Non-Electric Uses of Nuclear Energy) focuses on exploring how nuclear energy can be used beyond electricity generation. Although non-electric applications have been around for decades, they remain underutilized. The nuclear industry and potential end-users lack a clear understanding of these possibilities.

SANE assesses the safety and technical feasibility of retrofitting existing reactors, designing purpose-built reactors, and developing new reactors at different sites. The project also examines how to communicate the risks of these new applications and adapt emergency preparedness plans for emerging technologies.

Highlights

Nuclear energy is more than just electricity. The SANE project aims to unlock the potential of non-electric applications of nuclear power, providing reliable energy solutions for a wide range of industrial and societal needs such as process industry, district heating, desalination, urban waste water treatment, space applications, agriculture, hydrogen production, e-fuel production, ship propulsion and others.

Expected Impacts

Scientific Impact

SANE develops tools and best practices to address radiation exposure and improve public communication.

Technological Impact

The project helps ensure that nuclear installations meet the highest safety standards and considers socio-economic factors in non-electric applications.

Economic Impact

SANE promotes nuclear innovation and supports the broader adoption of non-electric applications of nuclear energy.

Societal Impact

By contributing to a sustainable future, SANE aligns with the UN's Sustainable Development Goals, such as Climate Action and Clean Water.

Electricity

1 700 TWh/year
Extra low carbon electricity production to be deployed by 2050.

80 GW
European Nuclear capacity to be replaced by 2050 (end of life)

Hydrogen

> 20 Mt H2/year
REPower EU Market Estimate for 2030

1 000 TWh/year
Equivalent additional clean electricity demand

Industrial Heat

~ 1 250 TWhth H2/year
Iron - Steel, Non-metalic minerals and chemicals heat demand in EU26

> 45% market
Heat < 400°C

District Heat

~ 1 250 TWhth H2/year
Current district heat demand in EU26

> 2/3 fossil-fueled
Assets to be retrieved and replaced in the coming two decades

Electricity production with nuclear power

CO_2 avoided: 1.25 Gt

Electricity produced: 2 486.6 TWh

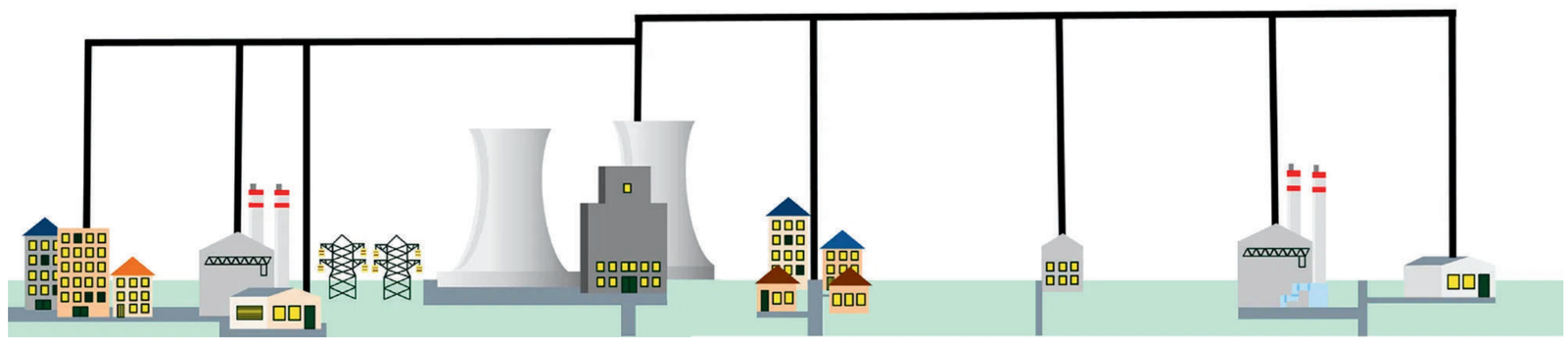
Non-electric application of nuclear power

District heating: 1 418 GWh

Industrial heating: 1 341 GWh

Hydrogen Production

Desalination: 41 GWh



Partners

VTT

ЭНЕРГОРИСК

INERIS
maîtriser le risque pour un développement durable

EAG
EMPRESARIOS AGRUPADOS · GHESA

SSTC NRS
ДЕРЖАВНЕ ПІДПРИЄМСТВО ДЕРЖАВНИЙ НАУКОВО-ТЕХНІЧНИЙ ЦЕНТР З ЯДЕРНОЇ ТА РАДІАЦІЙНОЇ БЕЗПЕКИ

KIT
Karlsruher Institut für Technologie

CVŘ

PSI

cea

NRG PALLAS
Nuclear. For Life.

sckcen

SANE

This project has received funding from Horizon Europe – Euratom programme under grant agreement No. 101163929.

The Associated Partner PSI is funded by the Swiss State Secretariat for Education, Research and Innovation (SERI).

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OFFERR

More information
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Visit our website
www.snetp.eu

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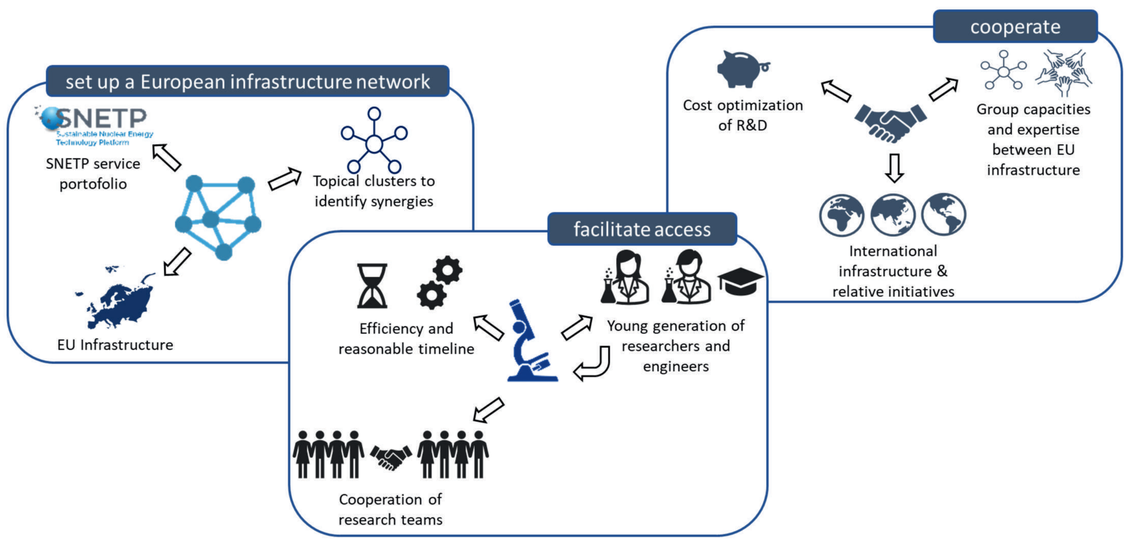
Objectives

- **Support the SNETP Association** in facilitating R&D experts' access to vital nuclear science infrastructures.
- Serve as a **conduit for Euratom program grants to User Facilities** for their services and to successful research teams.
- **€7.2 million budget allocated** for funding new experiments.
- Project duration from September 2022 to August 2026 with a total budget of €9 million.
- Involvement of **17 partners** in the initiative.
- The **OFFERR Catalogue** brings together **230+ facilities in one place**, a landmark resource for the European nuclear community and SNETP.



Expected Impact

By **facilitating transnational access to over 230 facilities**, the project accelerates the development of safer, more efficient energy solutions and innovative non-power applications such as nuclear medicine.

This collaborative ecosystem not only preserves high-level scientific expertise within the EU but also **streamlines the path to commercialising the next generation of carbon-free technologies.**

Highlights

Across **6 successful cut-off dates**, the OFFERR program has funded **50+ projects**, bridging the gap between innovative concepts and tangible results.

These projects, **both fast track (<50 k€) and complex projects (> 50 k€)** demonstrate a robust commitment to safety and modernisation.

Designated **areas include**:

- Light Water Reactor sustainability,
- Advanced fission reactor concepts,
- Waste and decommissioning,
- Nuclear science applications,
- Advanced nuclear fuels,
- Innovation in nuclear instrumentation,
- Radioprotection and nuclear medicine

Partners

OFFERR

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101060008.

Discover our partner project

Skills4Nuclear

More information
@Skills4Nuclear

Visit our website
skills4nuclear.eu

Coordinator contact
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Objectives

The Skills4Nuclear project aims to **address workforce and skill shortages in EU nuclear fission and fusion sectors** by establishing a long-term collaborative framework that integrates industry, research and training bodies.

Its primary goal is to ensure the safe and efficient use of current and future nuclear technologies, including Small Modular Reactors, by **fostering industry-driven workforce development and enhancing capacity-building** in nuclear safety, waste management, decommissioning, radiation protection and medical applications.

Expected Impact

The Skills4Nuclear project is set to **fortify Europe's nuclear sovereignty** by bridging the critical skills gap across the fission and fusion sectors.

Its long-term impact lies in creating a sustainable, inclusive pipeline of talent, **facilitating a "just transition"** for fossil fuel workers and implementing a strategic roadmap that prioritizes diversity.

Ultimately, these efforts safeguard Europe's high standards in safety, waste management, and medical applications, **ensuring a workforce ready to lead the global clean energy transition**.

Highlights

- The creation of a **European Forum for Nuclear Workforce and Skills**, which will monitor workforce needs, identify emerging skills gaps and continuously update training programs.
- The development of a **Nuclear Skills Strategy**, a multi-annual roadmap guiding efforts to attract, retrain, upskill and reskill professionals for the nuclear sector.
- The implementation of **reskilling and upskilling programs** enabling workers from other industries, such as fossil fuels, to transition into nuclear roles.
- The development of a series of **recommendations and tools** aimed at attracting more people to the nuclear sector.

Learn more about S4N

Partners

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101213280.

LLMs4EU

Energy Domain

https://www.llms4eu.eu/

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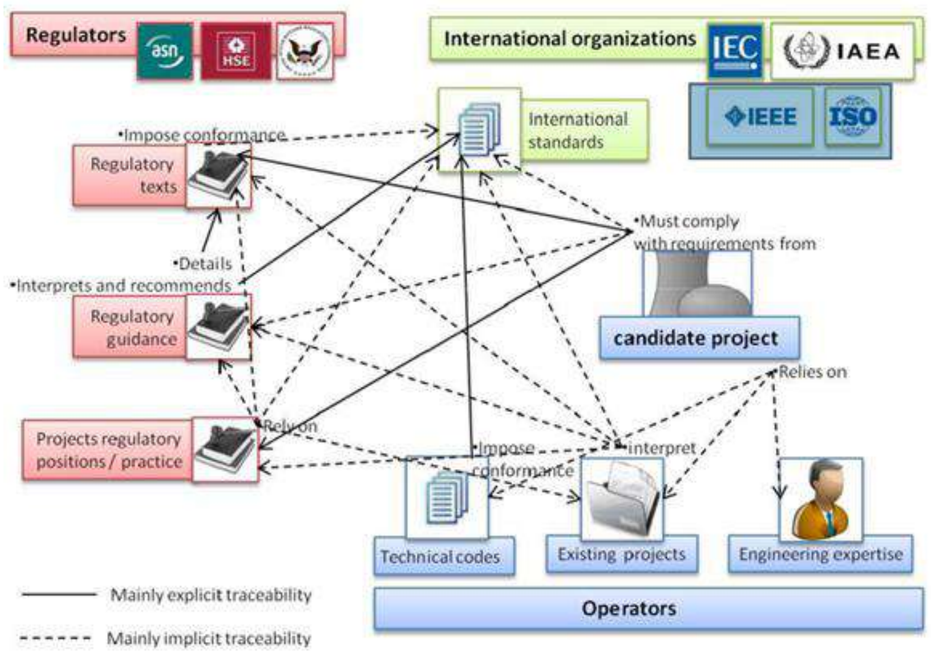
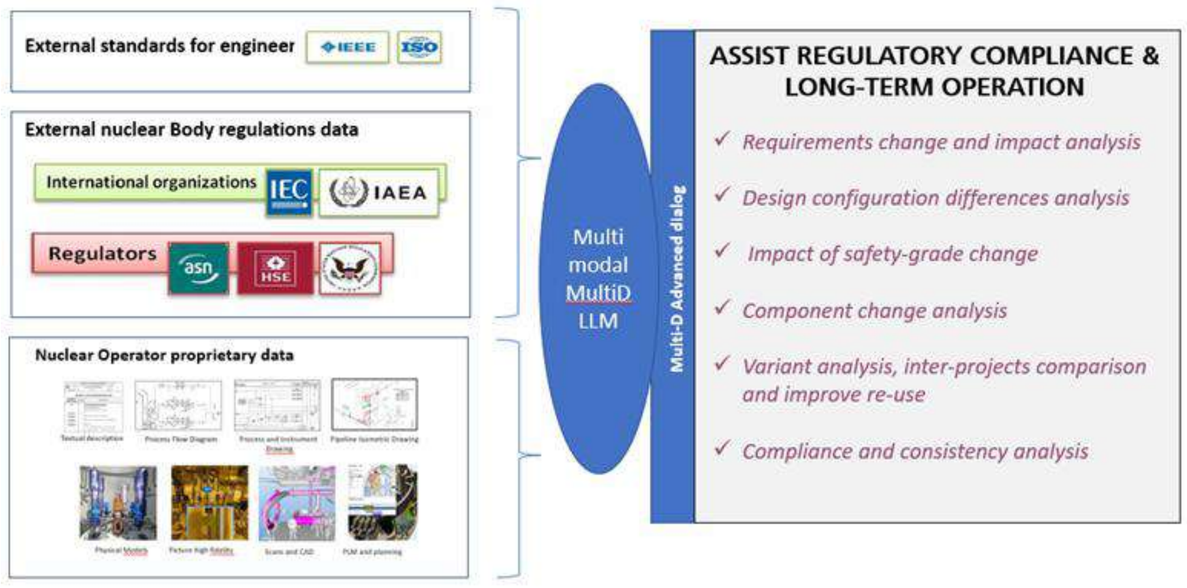
Objectives

- Preserve European linguistic and cultural diversity, and sovereignty
- 5 use-cases, one on Energy being led by EDF
- Main task: fine-tuning an LLM for processing Nuclear Regulatory Requirements
- Coordinated by the Alliance for Language Technologies (ALT-EDIC)
- From March 2025 to March 2028, with 40M€



- LLM's energy use-cases: requirement extraction, requirement elicitation, requirement formalization, and regulatory compliance analysis and comparison
- Examples:
  - Comparison between I&C software safety requirements of two different national regulators
  - Impact on the use of Commercial-Off-The-Shelf (COTS) elements in a new design
  - Compliance analysis between implemented safety requirements and official ones



The FSTP Call

- Data are a keystone
- A FSTP call is planned to help gather data (and labeled data) for the dataset creation, the fine-tuning and the evaluation
- What we need:
  - Nuclear requirements, whatever the format (natural language, EARS, INCOSE), and the level of formalization (semi-structured languages, formal languages – CRML, FRET, Stimulus,…). Models of requirements are also useful.
  - Data from requirement compliance/comparison analysis use-cases
  - Any nuclear regulatory or requirements documentations
  - Any documentations related to nuclear systems
- The FSTP call also includes annotation and labeling activities

Partners

EDF, CEA, Fondazione Bruno Kessler, Assystem, Thales, SNETP Sustainable Nuclear Energy Technology Platform, alt-edic, pleias, Lighton

Co-funded by the European Union

This project is co-funded by the Digital Europe Programme under Grant Agreement 101198470.

LLMs4EU

INTERACTIVE BOARD
Knowledge, Licensing & European Collaboration

Challenge

What is the biggest challenge today?

Add a sticker under your answer.

Licensing new designs	***Harmonising rules***	***Sharing knowledge***

EU cooperation

How important is European cooperation for nuclear innovation?

Not very	***Important***	***Essential***

INTERACTIVE BOARD
Knowledge, Licensing & European Collaboration

Skills gap

Where do we most need skills in the next 10–15 years?

Add a sticker under your answer.

Reactor technology	***Digital & data***	***Safety & regulation***

What if...

If you could change one thing in licensing to support innovation...

Smart Nuclear: AI & Digital Twins

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El-Peacetolero

More information **@SNETP**

Visit our website **www.snetp.eu**

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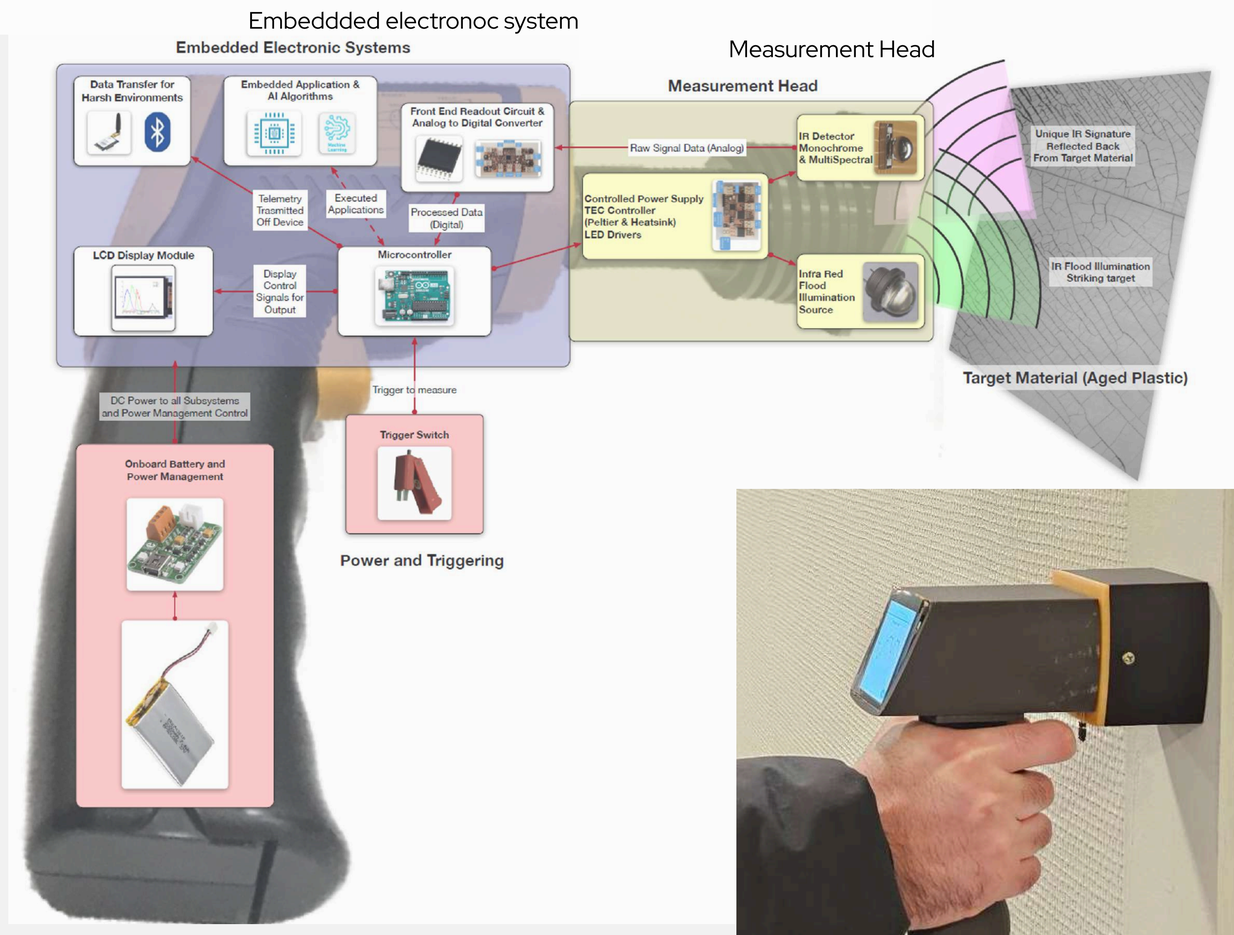
El-Peacetolero - System Block Diagram



El-Peacetolero Final prototype

Context & challeges

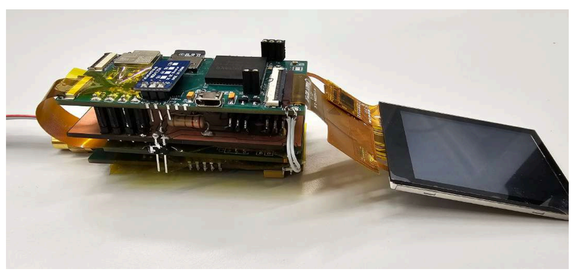
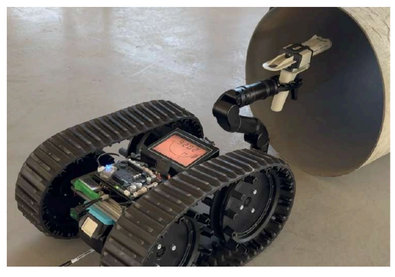
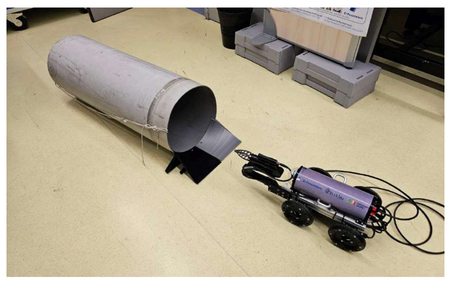
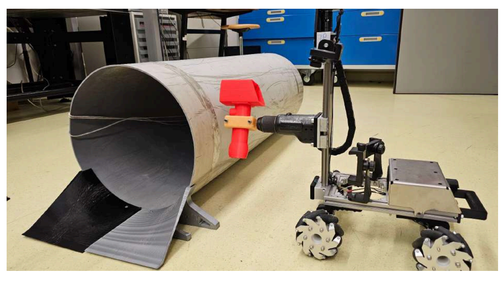
- Polymers play a crucial role in NPP security
  - Pipes, Cables, Paintings, Seals, …
  - Ageing monitoring is therefor fundamental
- Current monitoring methods :
  - Invasive, time consuming, High cost
  - Can't afford early detection of embrittlement
- Non-invasive real-time monitoring is needed

Objectives & methodology

Design a hand-held, embedded optoelectronic system deploying AI for in-situ real-time polymer identification and diagnosis .

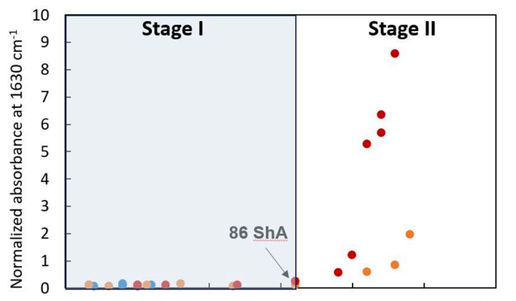
Budget: 3 652 170 €
EU Funding : 2 999 236 €

El-Peacetolero compact prototype on a robot

Key results

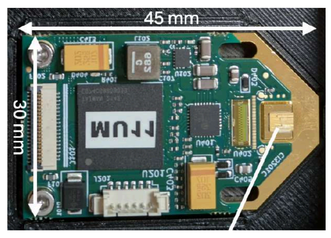
El-Peacetolero Ageing threshold



Stage I: No absorption bands at 1630 cm-1. Shore A hardness increases from 72 to 86 (0 - 21 days at 120°C; 0 - 368 days at 80°C)
Stage II: Rapid growth of absorption bands at 1630 cm-1. Shore A hardness exceeds 86.

- **120°C_28 days: normalized absorbance at 1630 cm-1 = 0.56. Shore A hardness = 89 ShA**
- **80°C_552 days: normalized absorbance at 1630 cm-1 = 0.59. Shore A hardness = 91 ShA.**

Compact multi-lambda QCL IR source



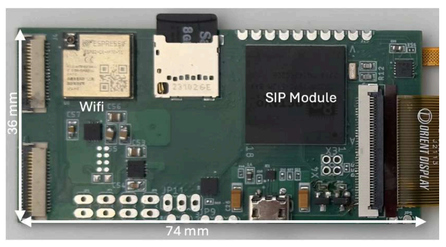
Autonomous device handling multiple laser source
4 QCL Lasers :
- 1730cm-1 ; 1647 cm-1 ; 1086 cm-1 ; 1002 cm-1

Size reduction :
The volume of the device is **divided** by a **factor 50**.

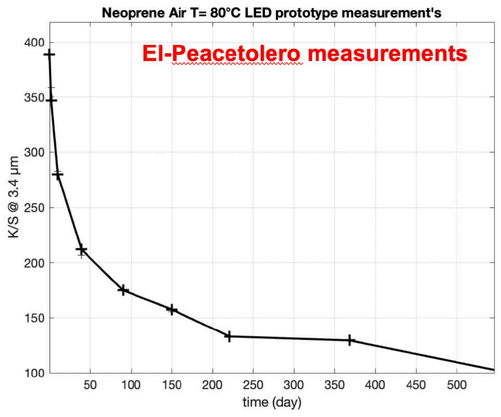
El-Peacetolero Edge computing and Tiny ML platform

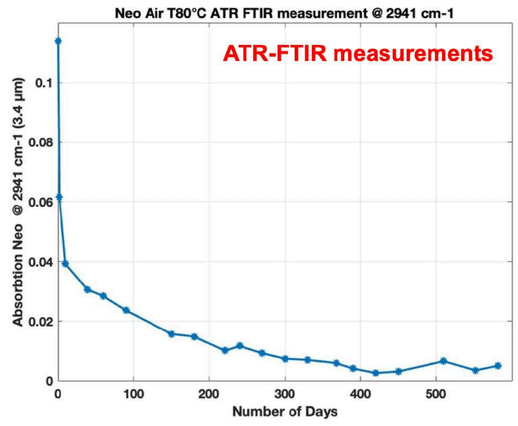
Tiny ML platform design is based on a System In Package module (SIP) :

- Compactness, high performance, low power consumption, …
- Robustness against radiations.
- Can handle and accelerate matrix computing and display.



El-Peacetolero measurements vs ATR-FTIR





Partners

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n° 945320.
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El-Peacetolero

Labelled by SNETP

Discover our labelled projects

FIND

More information
@FIND-EU-PROJECT

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Visit our website
www.find-project.eu

Objectives

Led by ASNR, France's nuclear safety regulator, FIND is a groundbreaking project that brings innovative monitoring technologies to improve nuclear safety.

1. Develop real-time remote monitoring systems for safety-critical defects in aging NPP metallic pipes.
2. Develop instrumentation to support the management of incidents and accidents.
3. Validate innovative NDE technologies' performance in nuclear environments.
4. Foster new technology adoption across the sector.
5. Bridge communication between operators and technology providers to enhance nuclear safety.

Highlights

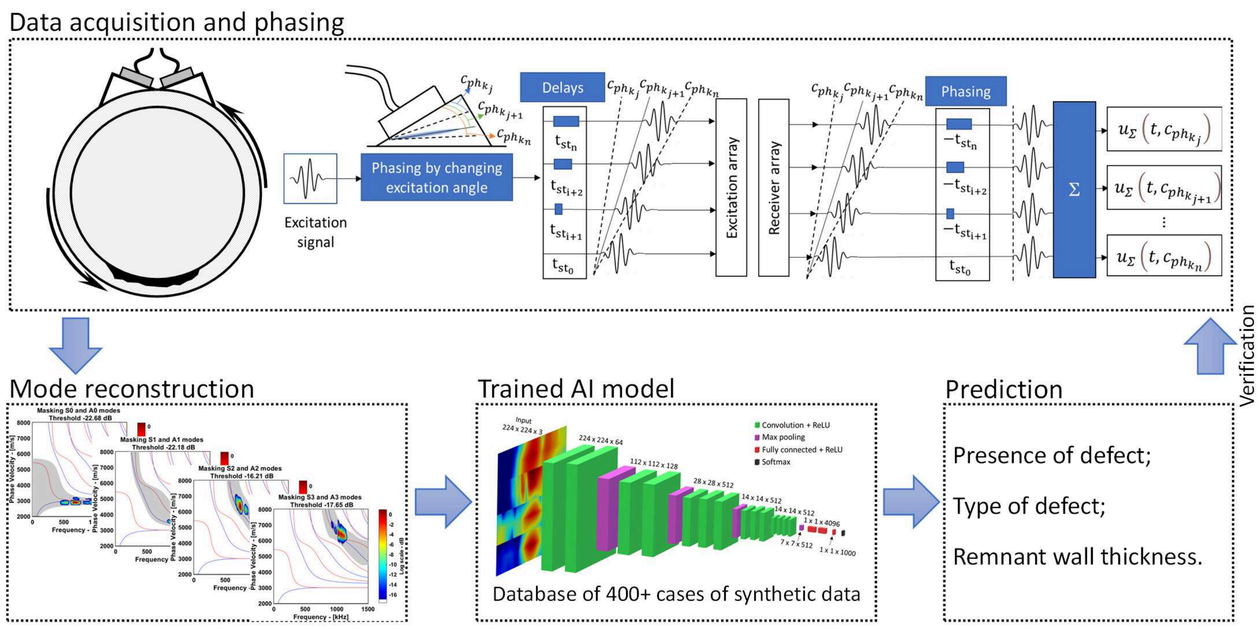
FIND employs advanced monitoring and sensing technologies to detect and manage a wide range of critical defects in nuclear facilities:

- Monitoring deformation, feedwater pipe leakage, stress corrosion cracking, thermal and vibrational fatigue, and flow-accelerated corrosion.
- Adapting ultrasonic technologies such as guided-wave tomography and acoustic emission.
- Developing embedded signal processing for digital twin sensors.
- Tracking water movements during loss-of-coolant accidents using heated thermocouples.
- Measuring fission products during severe accidents with metallic-organic framework sensors.

Expected Impact

FIND's technologies are designed to be cost-effective and minimally intrusive, supporting safer and more efficient long-term operation of nuclear power plants.

- **Technical & safety innovation:** Development of advanced monitoring systems and digital twin technologies to prevent and manage abnormal situations in nuclear power plants.
- **Methodological advancement:** Creation of a roadmap for technology adoption, including recommendations to adapt qualification codes and standards, , as well as human and organisational factors impacting operational acceptability.
- **Industrial impact**: Improved long-term operation of nuclear facilities through better maintenance planning leading to reduced costs and shorter outages, lower worker radiation exposure, and opportunities for technology transfer to other sectors.



General methodology for the inspection of metallic pipes thanks to high-order ultrasonic guided waves

Partners

FIND

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101163659.

Labelled by SNETP

Discover our labelled projects

iWeld

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Coordinator contact
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Objectives

The ambition of iWeld is to transform the practice of ultrasonic inspection of thick welds across several industry sectors: Current ultrasound imaging neglects the heterogeneous microstructure of materials and assumes a homogeneous medium with constant wave velocity. While this assumption is reasonable most of the time, it is not in austenitic stainless steel welds, leading to positioning errors of defects and a reduced signal to noise ratio.

iWeld pursues two different and complementary research avenues to obtain a map of the weld's microstructure, and uses this information in structure informed imaging (SI-TFM).

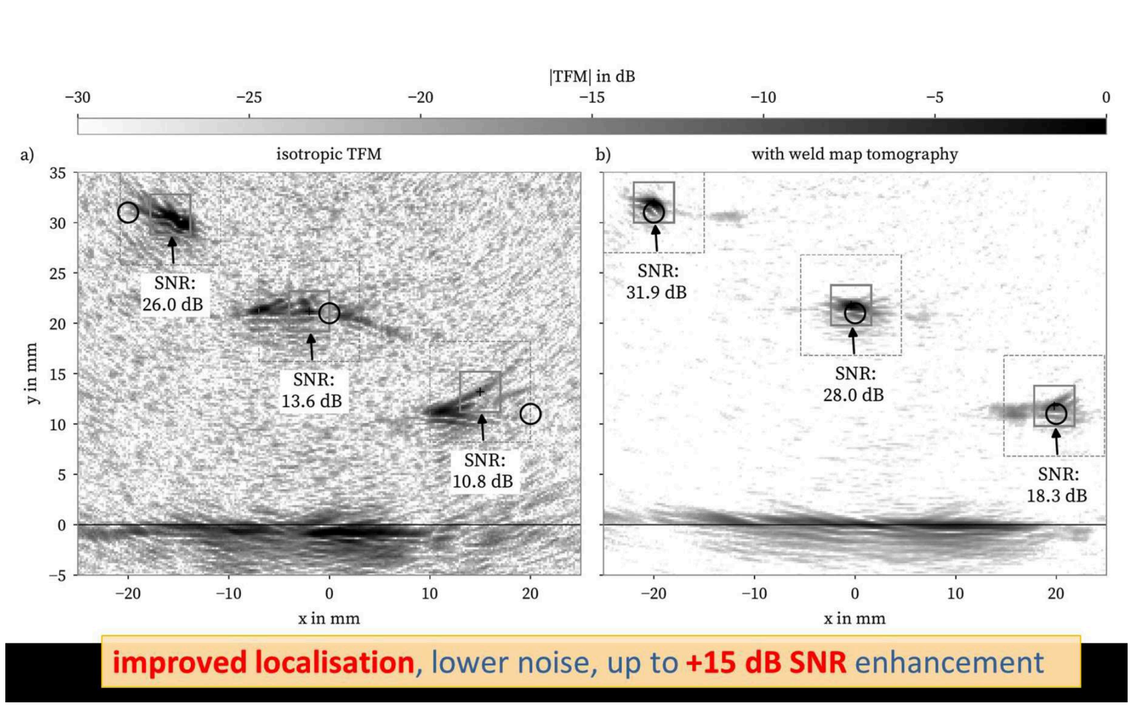
Expected Impact

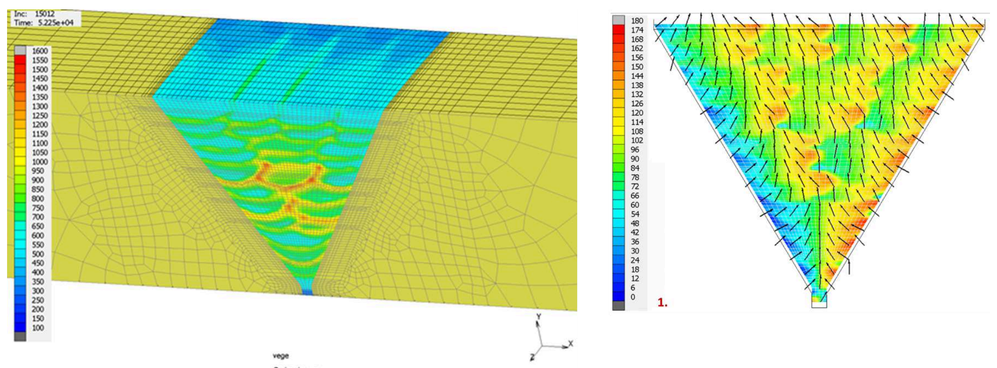
We expect iWeld to raise awareness and compensate for experience gaps in ultrasound inspection of heterogeneous welds for various industries, by improving the understanding of the effect of the microstructure and its associated uncertainty on ultrasonic imaging, and by accounting for the uncertainty of the microstructure in imaging complemented by inversion algorithms.

Working together with an acquisition system manufacturer, iWeld will illustrate the benefits of structure informed imaging on a representative weld, and provide a proof of concept of an actual close to realtime implementation.

Highlights

To date, the potential of solidification simulations has not been exploited by the NDT community well enough. Relatively high complexity and the need for specialized materials science expertise built a barrier for embedding such work in ultrasonic testing. iWeld employs artificial intelligence to provide an interface to complex physical modelling which relies on known and available input parameters but does not require solidification expertise. It is the first time such a tool is developed, tailored (but not limited to) several industrial contexts.





Partners

eDF · University of Southampton · cea · TRANSVALOR · ktu kaunas university of technology 1922 · MPA Stuttgart Materials Testing Institute University of Stuttgart · Imperial College London · EXTENDE CIVA NON DESTRUCTIVE EVALUATION

iWeld intelligent weld inspection

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2026 SNETP FORUM

25-27 March | Madrid, Spain

Advancements of multi-dimensional fuel performance codes by physics-based and machine-learning informed models

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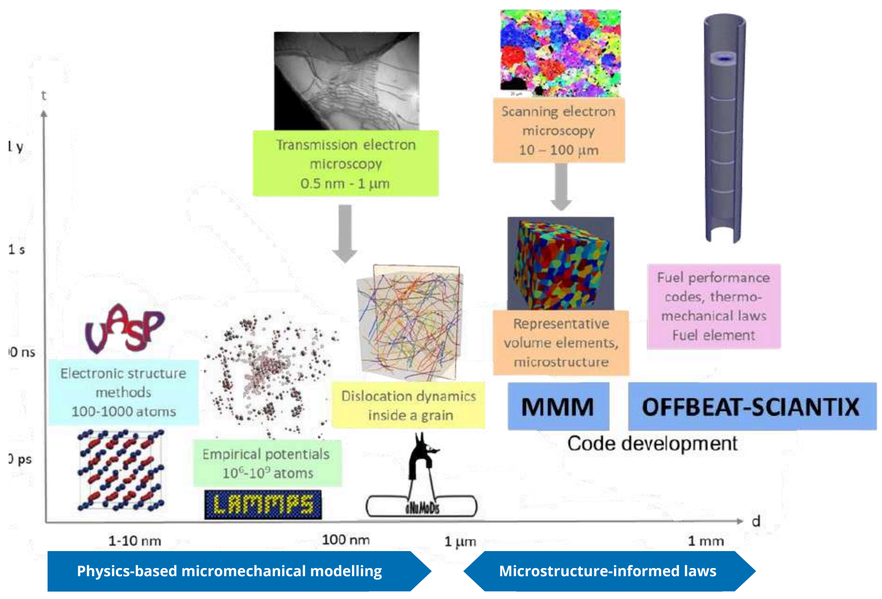
Introduction

Next-generation **enhanced Accident Tolerant Fuel (eATF)** and claddings (Zirconium alloys with innovative outer coatings) require the contribution of **3D high-fidelity** simulations in order to accelerate the qualification of traditional codes. **OperaHPC Project** delivers a complete multi-scale computational chain, from local microstructural scale to the full thermomechanical scale, enhanced by Machine Learning surrogates that make HPC simulations industrially viable.



Strategic objectives

Develop and validate **open-source computational tools** for thermomechanical simulation

- **MMM** (MFEM-MGIS-Mfront) mesoscale (microstructural scale) code
- **OFFBEAT/SCIANTIX** engineering scale simulation code (fuel element)
- Prototype tool, **meshless smoothed particle hydrodynamics (SPH)** method

Develop **improved models** for Fuel Performance Codes (FPCs), towards safety assessments for operating power transients and Design Basis Accidents (DBAs) with standard UO_2 fuel, eATF, and innovative claddings

Methodology

WP3 Input data & boundary conditions (BCs)

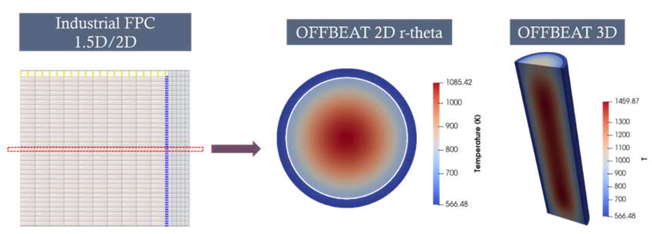
- 3D high-fidelity BCs, based on the BEARVS benchmark, including the computational scheme for LOCA and RIA transient scenarios.
- Reference results and BCs from state-of-the-art codes (TRANSURANUS, FALCON, FAST)
- Data transfer with OFFBEAT: coupling methodologies with Serpent and SCIANTIX

WP4 3D HPC Simulation Tools

- Microstructural scale: meso-scale analysis on heterogeneous representative volume elements with MMM
- Fuel rod scale: thermo-mechanical analysis with OFFBEAT
- Multi-scale meshless methodology with SPH
- Development of physics-based models and coupling methodologies for deployment on HPC infrastructures: CRESCO7/8 (ENEA) and CCRT Topaze (CEA)

WP5 Verification, Validation, Uncertainty Quantification (VVUQ)

- Code-to-code benchmark with OFFBEAT, ALCYONE, BISON (2D, 3D) for PCMI analysis. Verification through Method of Exact (MES) or Manufactured Solution (MMS)
- Experimental validation of OFFBEAT, MMM, SCIANTIX on separate-effect or integral tests (PCMI, LOCA, RIA)
- Uncertainty and sensitivity analysis with OFFBEAT and SCIANTIX

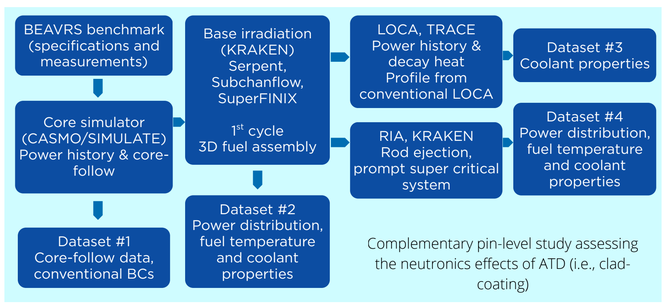


WP6 Development of improved models for industrial FPCs

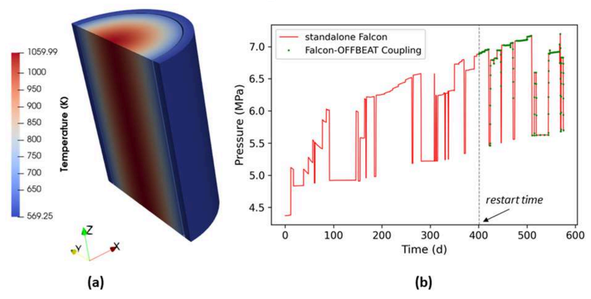
- Generation of a learning database from OFFBEAT and MMM results for PCMI and fuel over-fragmentation
- Develop Machine Learning (ML) and Reduced Order Model (ROM) based fast-running models to for use in industrial FPCs

Results

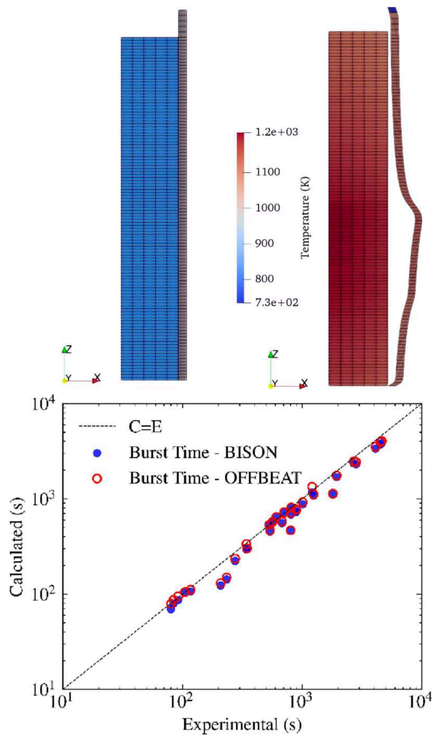
The high-fidelity boundary conditions for LOCA and RIA scenarios have been published in Zenodo as a database (https://doi.org/10.5281/zenodo.14525347).



Mapping from 2D industrial code FALCON to high-fidelity OFFBEAT 3D code, validated against the BEAVRS Benchmark

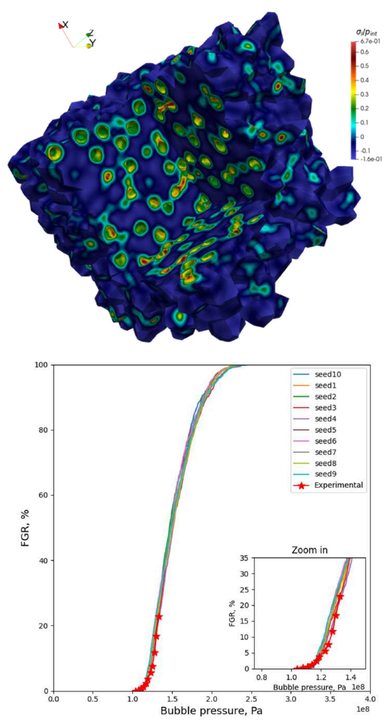


Extension of OFFBEAT mechanical framework to model large strains and integrate high-temperature models for LOCA



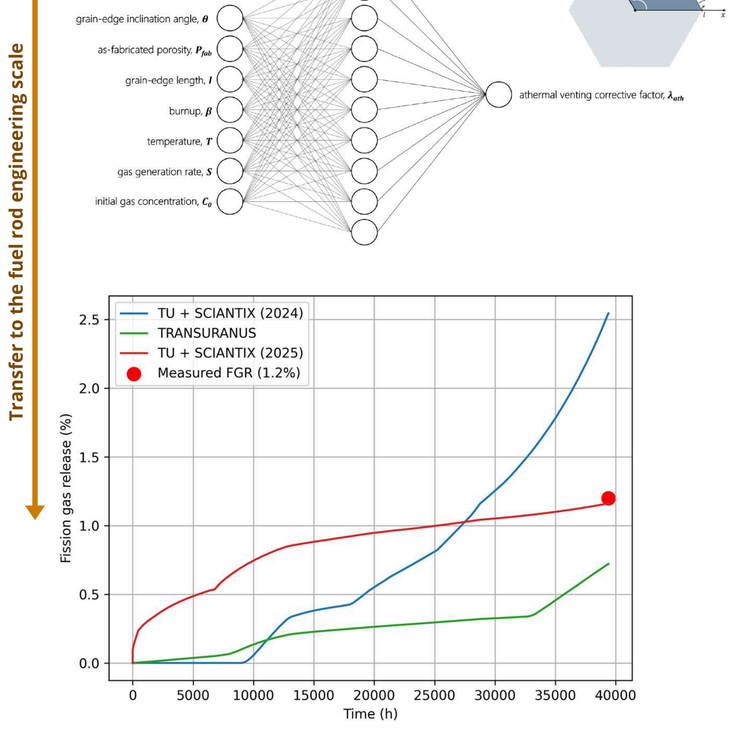
Validation against experimental data

3D simulation of crack initiation by over-pressurized bubbles: Fission gas release as a function of the bubble internal pressure. 1024 cores@Topaze (15')



Validation against experimental data

Athermal fission gas release with ML-surrogate model



Validation against experimental data

Conclusions

OperaHPC Project develops new open-source codes for nuclear fuel performance analysis, enabling **3D HPC simulations** with **physics-based modelling** while meeting industrial usage requirements. The synergy between basic research, **ML-driven surrogates**, and rigorous VVUQ provides a production-ready framework for the **qualification** of advanced reactor technologies.

School on fuel performance codes : OperaHPC project January 2026

This project has received funding from Horizon Europe – Euratom programme under grant agreement No 101061453

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2026 SNETP FORUM

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Data driven support of maintenance activities

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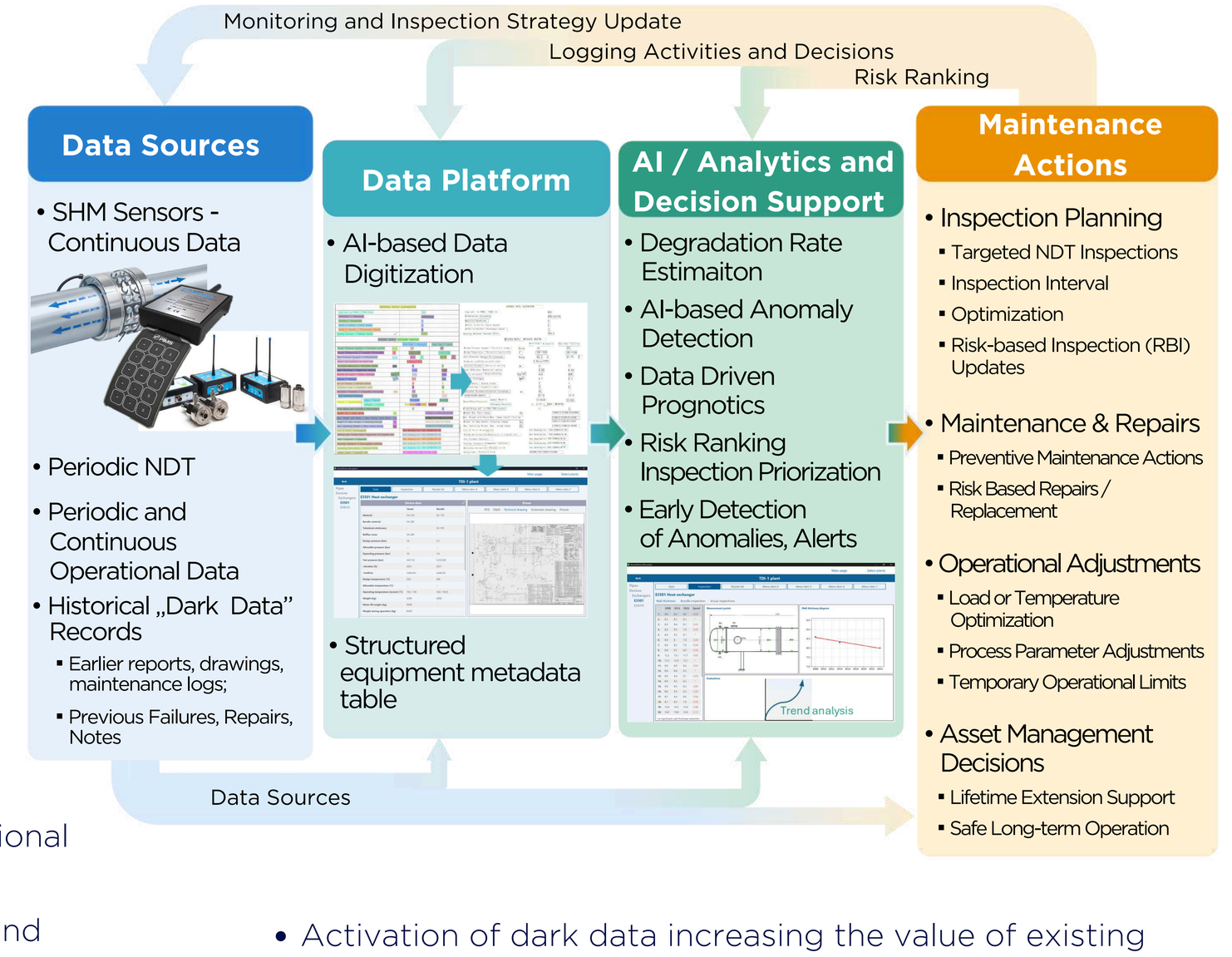
Introduction

Nuclear power plants in lifetime extension programs must demonstrate long-term safe operation. Decades of inspections, NDT results and operational records have created vast datasets, much of which remains fragmented “dark data”. Advances in data engineering and artificial intelligence (AI) now enable data-driven approaches for predictive maintenance and integrity management.



Concept

- Integration of Structural Health Monitoring (SHM), periodic NDT inspections, and operational parameters into a unified digital framework.
- Transformation of historical documentation and inspection results into structured, searchable datasets.
- Creation of a consistent asset-level data model covering the full lifecycle of components.
- Combination of physics-based degradation models and data-driven analytics for trend evaluation and prediction.
- Support for risk-informed and condition-based maintenance strategies.

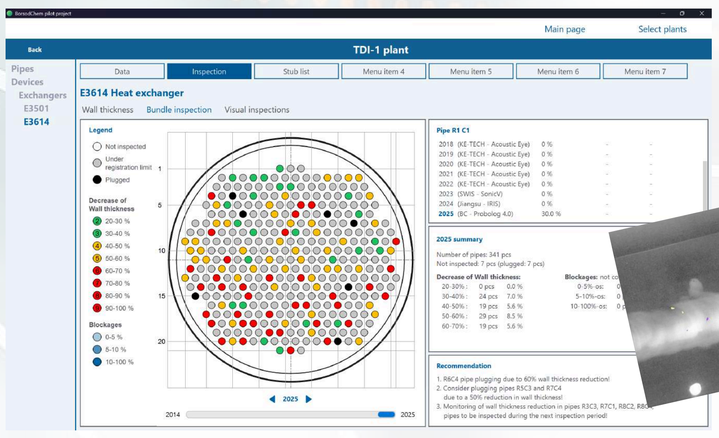
Impact on Maintenance and Integrity Management

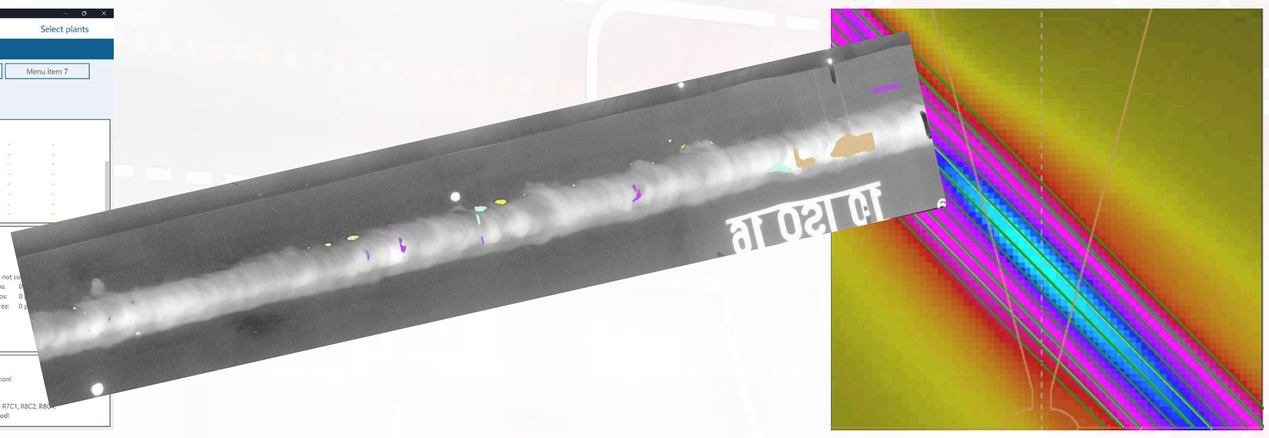
- Improved degradation monitoring through continuous integration of SHM and inspection data.
- More accurate lifetime predictions based on large historical datasets.
- Activation of dark data increasing the value of existing inspection records.
- Reduced engineering effort through automated data processing and analysis.
- Improved transparency and traceability of integrity assessments.
- Lower operational risk through earlier detection of degradation trends.
- Optimized maintenance strategies and more efficient allocation of inspection resources.

Conclusion

In the future, NDT will be a data-driven, modelled, and integrated part of operations — not "just" testing, but meaningful input for strategic decisions.
Our goal is for NDT, as a tool of SHM, to be an integral, data-driven part of the decision support chain.

AEMI
Atomic Energy Engineering Ltd.





2026 SNETP FORUM

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NAGHY

Solutions for ISR predictive maintenance

LAIFA Bilal (Orano), RAMDEWOR Ruben (Orano), LALDJI Aymen (Orano)
MACE Jean-Reynald (Orano)

Introduction

KATCO, a joint venture between Orano and Kazatomprom, operates uranium mining sites in Kazakhstan using ISR technology. Well clogging frequently reduces flow rates and productivity, and restoration has historically relied on manual data analysis, limiting operational efficiency.

Objectives

The primary goal of the **NAGHY** project is to transition from manual monitoring to a predictive and automated maintenance framework. Key objectives include:

- Increasing well productivity and improving the quality of the final product.
- Reducing operational costs through better logistical planning.
- Enhancing decision-making for field teams through data-driven insights.
- Boosting personnel motivation by acquiring new technological skills.

Methodology

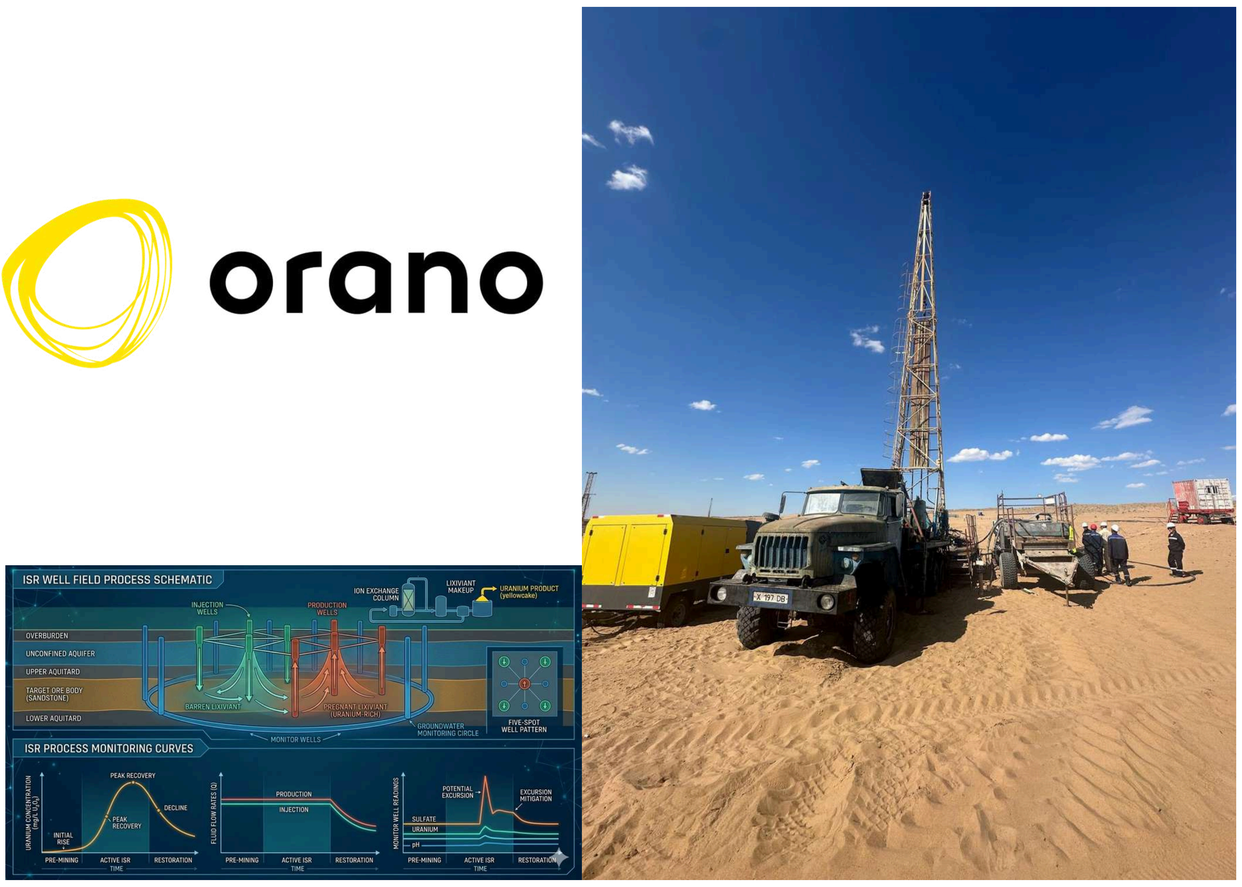
Developed between November 2023 and March 2025 in collaboration with the innovation team, the project utilizes advanced analytical tools :

- Mathematical Modeling: The clogging phenomenon is captured using exponential regression models to forecast the non-linear degradation of well performance.
- Data Integration: Historical production data is extracted from existing databases using Python, SQL, and PI Builder.
- Optimization Tool: The resulting solution, the Operations Optimization Tool, serves as a decision-support platform that predicts well behavior and generates a recommended D+30 treatment plan.

Results

The implementation of this predictive approach has delivered significant operational benefits :

- Earlier Detection: Faster identification of performance degradation caused by clogging.
- Effective Prioritization: Improved scheduling and prioritization of maintenance actions.
- Resource Optimization: Overall optimization of operational resources and improved reliability of ISR operations.



Conclusion

The **NAGHY** project positions KATCO as an innovative leader in the application of artificial intelligence within the mining industry. By integrating data-driven predictive maintenance, the company has created a robust framework that shapes the future of technology while relying on today's analytical capabilities to ensure efficient and reliable uranium extraction.

NAGHY
SOLUTIONS DE MAINTENANCE PRÉDICTIVE ISR | URANIUM

INTERACTIVE BOARD

Smart Nuclear: AI & Digital Twins

AI

Where do you see the most value for AI and digital twins?

Add a sticker under your answer.

Design	***Operation***	***Maintenance***	***Safety***

AI decisions

How comfortable are you with AI-supported decisions in nuclear operations?

Not comfortable	***Mixed***	***Comfortable***

INTERACTIVE BOARD

Smart Nuclear: AI & Digital Twins

Main obstacle

What is the main obstacle to AI and digital twins in nuclear?

Add a sticker under your answer.

Data	***Regulation***	***Trust***	***Skills***

You want to see...

What kind of smart nuclear application would you like to see demonstrated first?