EUROPEAN COLLABORATIVE EFFORTS TO ACHIEVE EFFECTIVE, SAFE, AND COST-CONTROLLED DISMANTLING OF NUCLEAR FACILITIES

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FISA, 01/06/2022

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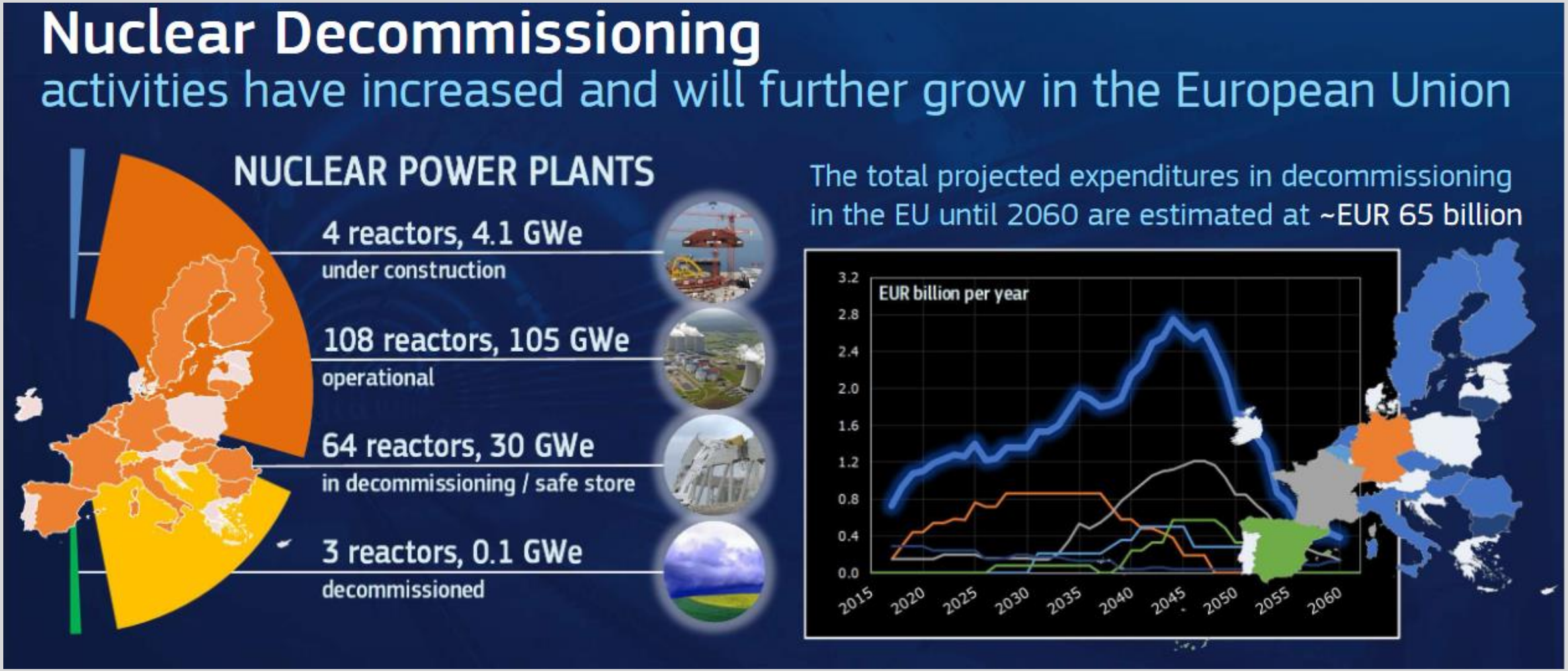
Summary

CONTEXT : DISMANTLING OF NUCLEAR REACTOR IN EUROPE

A BRIEF OVERVIEW OF EUROPEAN COLLABORATIVE PROJECT SUPPORTED BY EURATOM

ZOOM ON SOME ACHIEVMENTS OF THE EURATOM'S PROJECTS AND PERSPECTIVES

Context



Source : European Commission

Stakes in power generation nuclear reactors dismantling

Graphite reactors : Many technical challenges due to huge dimension, thickness of concrete and steel, large amount of graphite to be safely retrieved

Other reactors (PWR, BWR, HWR…) : technical feasibility has been established

In both cases, today's main practices are only partially industrial :

- Operation are mainly carried out manually
- Extensive use of personnal protection measures
- Poorly reproductible nature of the operations
- Poor ratio between time consumed to perform the operations and time used to plane, monitor and control them

Euratom's projects

common goal

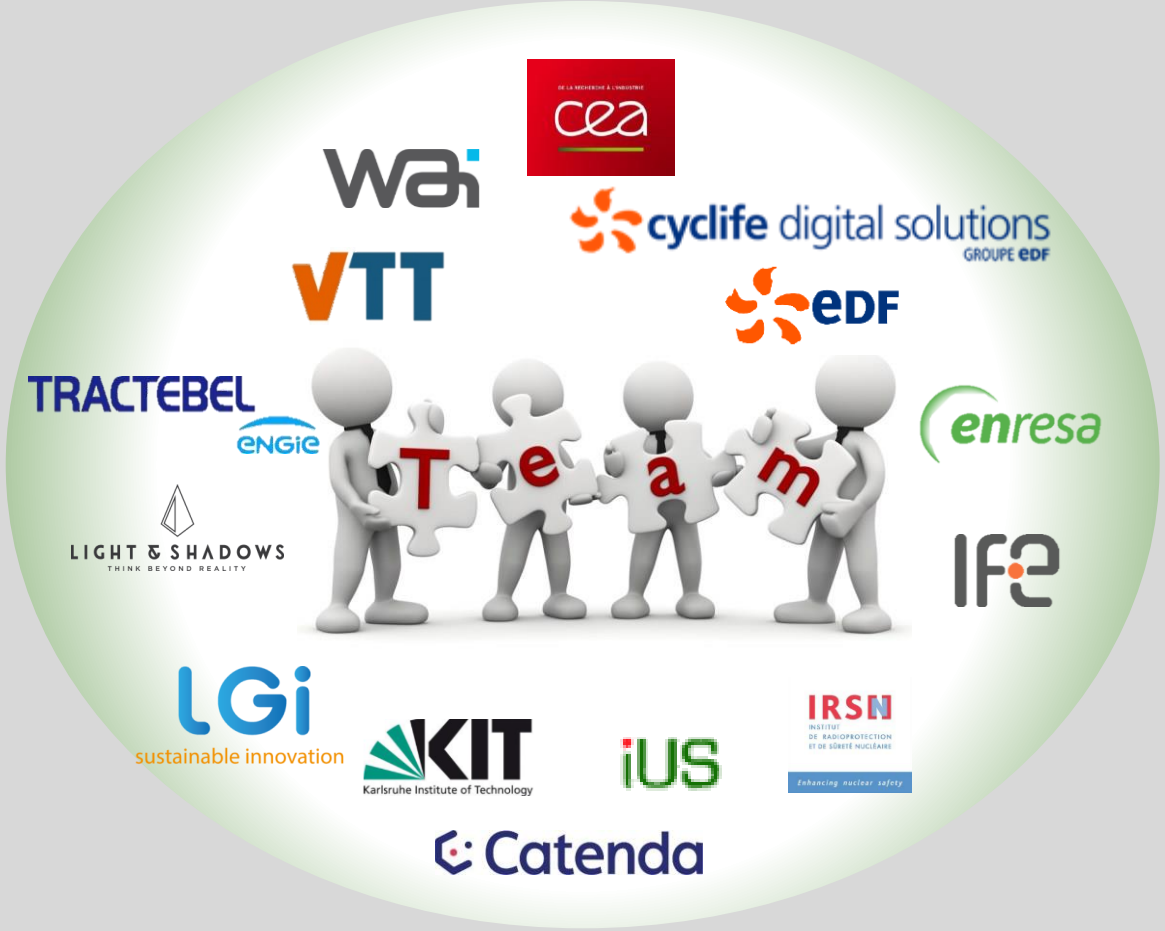
Move forward to an efficient, safe, cost-controlled and industrial way of dismantling using the full potential of the so-called « 4.0 industry » technologies :

- Digital technologies
- Automatised or semi automatised robotics
- LASER cutting
- …

Overview of the projects (1/5)

PLatform based
on **E**merging and **I**nteroperable **A**pplications
for enhanced **D**ecommissioning process**ES**

- **3 years (01/10/2020 - 30/09/2023)**
- **14 partners from 7 countries**
- **Coordinated by CEA**



Overview of the projects (2/5)

Improved **N**uclear **SI**te characterisation for waste minimisation in **D**ecommissioning and Dismantling operations under constrained **E**nvi**R**onment

- **4 years (06/2017 - 11/2021)**
- **18 partners from 10 countries**
- **Coordinated by CETAMA (CEA Energies Division)**

Overview of the projects (3/5)

CLEANDEM

Cyber physica**L** **E**quipment for unm**A**nned **N**uclear **DE**commissioning **M**easurements

- **3 years (03/2021 - 02/2024)**
- **11partners from 4 countries**
- **Coordinated by CEA list**

Overview of the projects (4/5)

Laser **D**ismantling Environmental and **S**afety **A**ssessment

- **4 years (07/2020 - 06/2024)**
- **6 partners from 4 countries**
- **21 external stakeholders (Expert Group, End User Group and Support Group)**
- **Coordinated by ONET Technologies**

Overview of the projects (5/5)

INNO4GRAPH

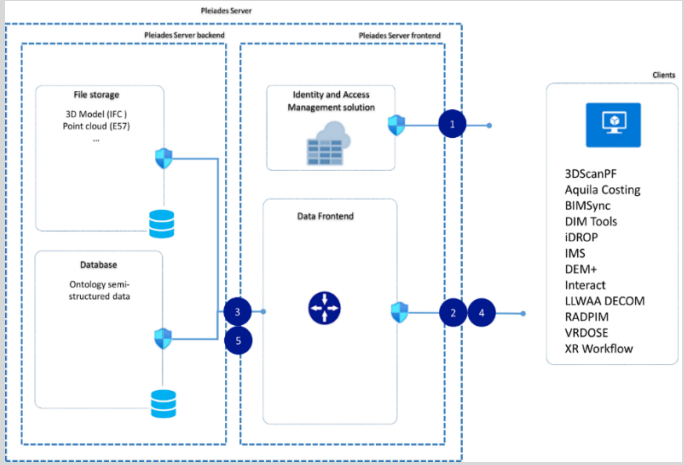
INNOvative tools **FOR** dismantling of **GRAPH**ite moderated nuclear reactors

- **3 years (09/2020 - 08/2023)**
- **13 partners from 5 countries**
- **Coordinated by EDF**

EDF
enresa
GRAPHITECH
cyclife digital solutions GROUPE EDF
cea
SOGIN
LITHUANIAN ENERGY INSTITUTE
CIRTEN Consorzio Interuniversitario per la Ricerca TEcnologica Nucleare Inter-University Consortium for Nuclear Technological Research
Westinghouse
ANSALDO NUCLEARE Ansaldo Energia Group
MANCHESTER 1824 The University of Manchester
tecnatom
ARTTIC a PNO international management services company

Example of achievements

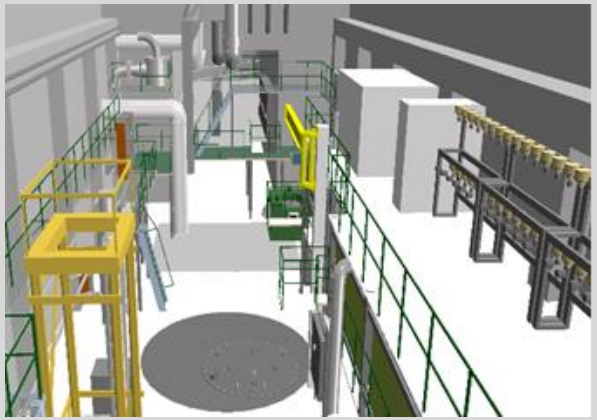
PLEIADES
Smarter Plant Decommissioning

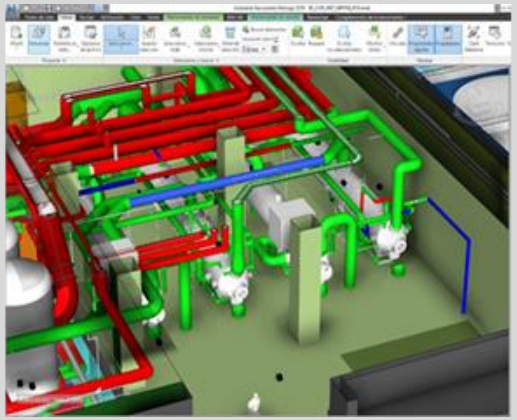


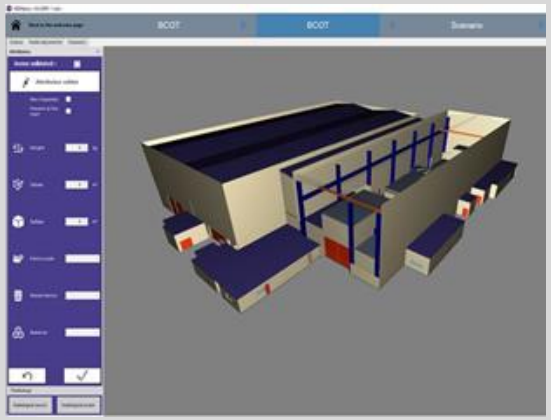
PLEIADES platform, which architecture aims at maximizing the collaboration between its different software modules.

It is based on common ontology (a common language) and a common BIM-like database to make the interaction between the software as efficient as possible

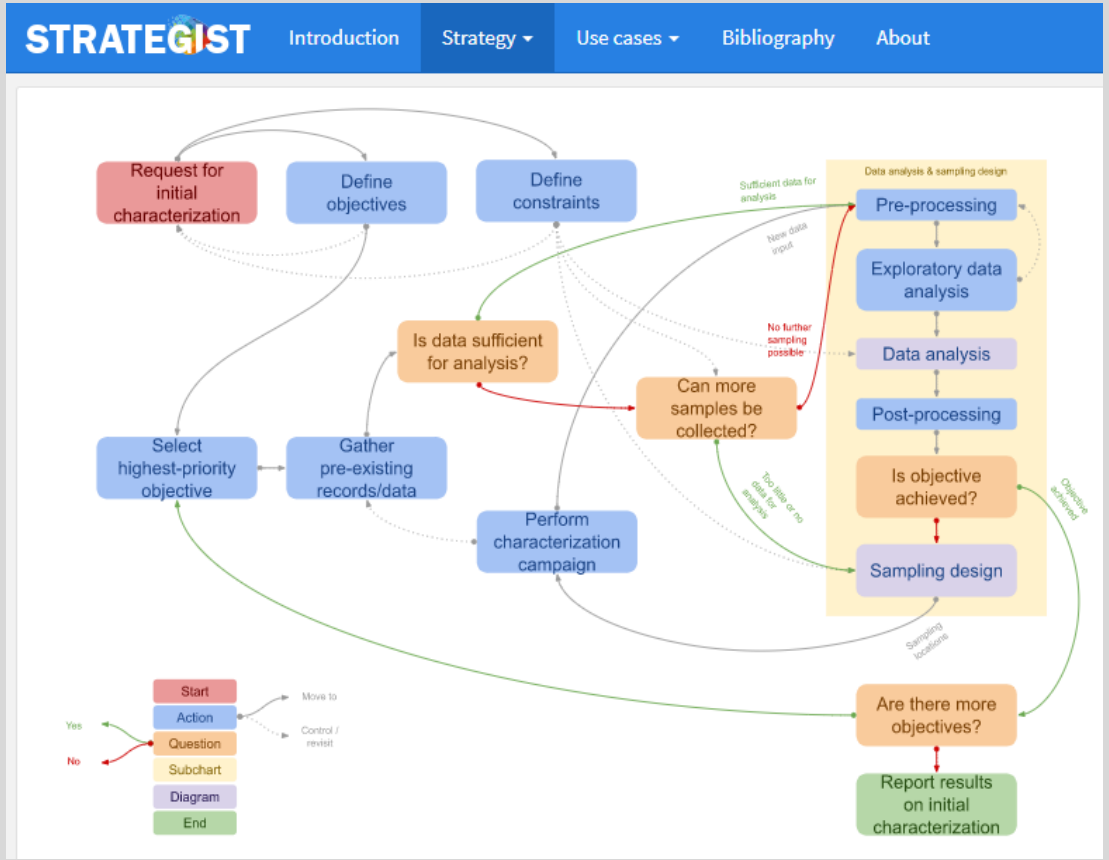
→ 3D models of the three nuclear facilities provided by IFE (left), ENRESA (middle) and EDF (right) as use cases of PLEIADES platform :







Example of achievements



INSIDER developed digital tools to help in characterization phases implementation **:**

- **STRATEGIST (S**ampling **T**oolbox for **R**adiological **A**ssessment **T**o **E**nable **G**eo-statistical and statistical **I**mplementation with a **S**mar**t** **T**actic**):** step-by-step guide to implement the sampling strategy for the characterization of contaminated sites (https://strategist.sckcen.be/)

- **INSPECT (I**n **S**itu **P**robe **S**election **T**ool**) :** decision helping tool for the selection of the suitable detectors for the different D&D phases

Example of achievements

Laser Dismantling Environmental and Safety Assessment

Laser Cutting Development → **Environmental and worker protection** → **Safety Assessment** → **Decommissioning of nuclear facilities**

Milestone completed:
Specifications for the dismantling of reactor components agreed (inputs for the other activities).

ONET TECHNOLOGIES, EQUANS EMPOWERING TRANSITIONS — 100%

Milestone completed:
First campaign achieved (laser beam residual power, aerosols and hydrogen).

Laboratory tests to be continued:
Additionnal tests to be continued until 08/2023

cea, IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE — 60%

Milestone completed:
Qualification activities in the Technology Qualification Plan are defined and scheduled

Qualification activities:
-Appraisal of laser system maturity
-Technology Qualification Plan
-Monitoring qualification activities progress (on-going).

Vysus Group — 70%

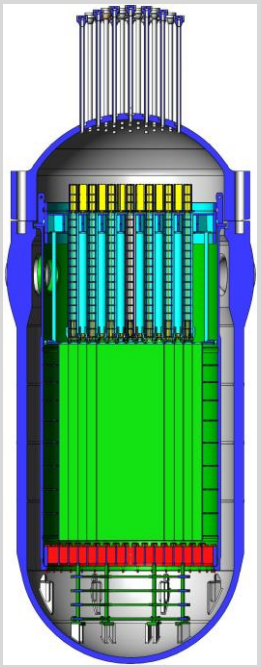
Safety assessment:
-Risk analysis with regards to safety
-Compilation of inputs from previous activities (on-going).

tecnatom, IRSN INSTITUT DE RADIOPROTECTION ET DE SÛRETÉ NUCLÉAIRE — 40%

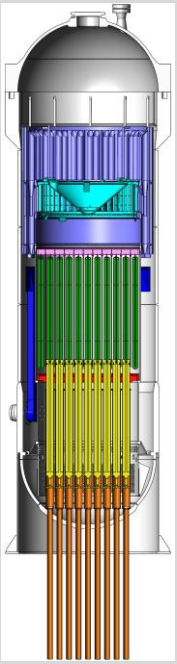
Demonstrators:
-First studies for the definition of the complete laser system for the 2 phases of the demonstrator (on-going)

ONET TECHNOLOGIES, cea, EQUANS EMPOWERING TRANSITIONS — 40%

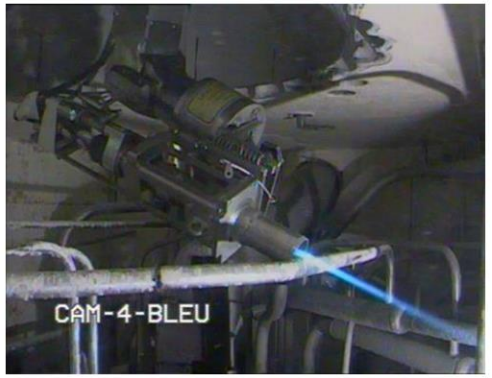
+ End-users



PWR



BWR



Up to **200mm in thickness** in air (14kW laser power)

Three milestones achieved up to now:

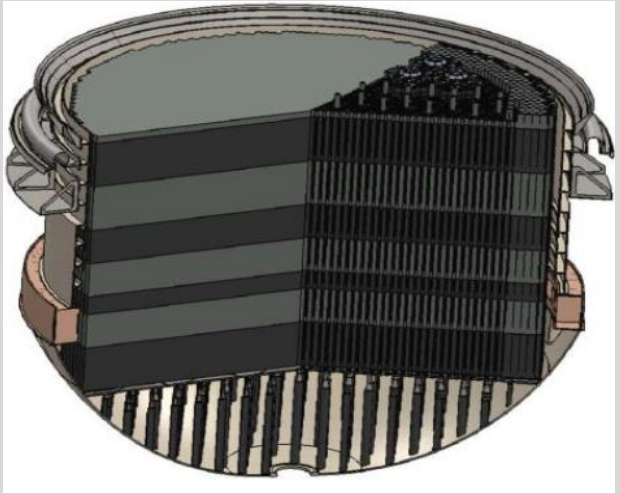
- Specifications for the dismantling of reactor components agreed.
- Qualification activities in the Technology Qualification Plan are completed.
- Technical countermeasures defined at laboratory scale.

Cutting tests (demonstrators) to be started from September 2023

Achievements during and beyond Inno4Graph

Design of a representative and full scale mock-up of the Chinon A2 graphite stack

- To **minimise risks** of the complex and repetitive operations (several thousands bricks for a single stack) of the graphite core retrieval and **increase the probability of success**

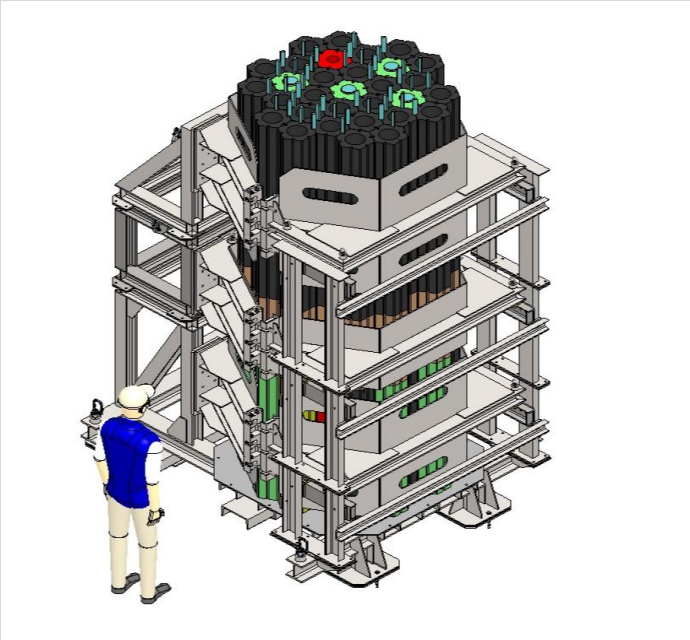


Developments of methodologies and tools

Demonstration to stakeholders

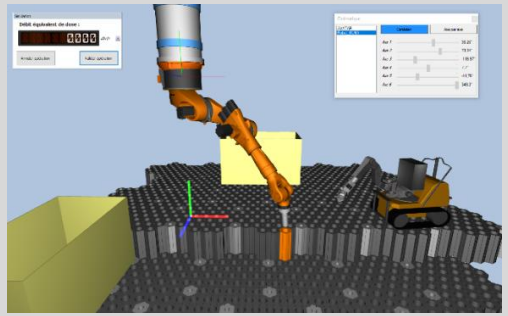
Operator training

Development of alternative methodologies and tools during on-site operations



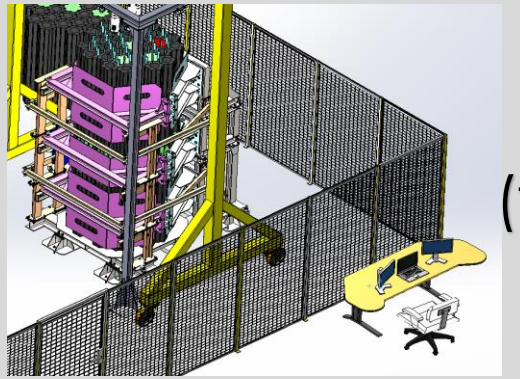
Achievements during and beyond Inno4Graph

- Testing programme is defined according to the **risk analysis associated to the graphite extraction scenario**
- Tests to be performed in the **Industrial Demonstrator** from 2022

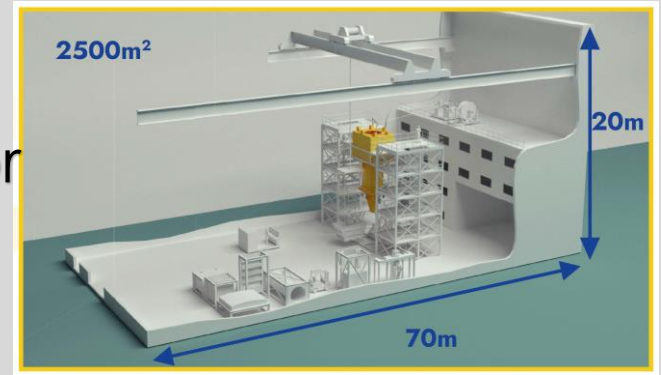


Numerical simulations

Physical tests



Remote control tests
(from Industrial Demonstrator control room)



Conclusions and perspectives

5 projects, **1** common goal : to implement 4.0 Industry technologies in order to :

- Improve the knowledge reliability of the installations
- Minimise dose rates
- Facilitates sharing of informations between the stakeholders of a dismantling project

Beyond the traditional technical locks, **2** other challenges have been tackled :
- Tools and methodologies must be applicable to a maximum of various projects
- Drastic proof of safety and reliability of new technologies are required

As a results of the 5 projects :

- A unique common data and knowledge base
- New tools design or methods natively taking into account the needs of a maximum of dismantling operators. **10** different European countries are involved in the five projects, plus Switzerland, Ukraine, United-Kingdom and Japan through end users groups.
- New test facilities have also been put in place and will allow the joint work undertaken to be continued.

→ All of this paves the way to further collaborative projects and developments, in order to continue to implement safe, reliable and efficient new technologies in European dismantling projects.

For more information : websites

https://www.inno4graph.eu/

https://ldsafe.eu/

https://pleiades-platform.eu/

https://insider-h2020.eu/

http://cleandem-h2020.eu/