The Use of Digital Technologies for Nuclear Decommissioning Activities in the Euratom Projects: PLEIADES, DORADO and XS-ABILITY

Conférence AGeCSO-KCO 2026
Association pour la Gestion des Connaissances dans la Société et les Organisations – Knowledge Communities Observatory
27- 29 avril 2026, Strasbourg (France)

Joseph A. Ridao, Antti Räty, Marie-Bénédicte Jacques, Maugan Michel, Dusan Daniska, Omar Zahra, Abdenour Benkrid, Sascha Gentes

The projects PLEIADES, DORADO, and XS-ABILITY have received funding from the Nuclear Research and Training EURATOM

Content

1. **PLEIADES: PL**atform based on **E**merging and **I**nteroperable **A**pplications for enhanced **D**ecommissioning process**ES**
   - First Steps
   - Achievements
   - Main Outcomes and Further Directions
2. **DORADO: D**igital twins and **O**ntology for **R**obot **A**ssisted **D**ecommissioning **O**perations
   - Main Objectives of DORADO
   - Project Organization
   - Continuation from PLEIADES
   - Technologies to be Implemented and Demonstrated in Real Use Cases
   - Data Management
   - Current Development
3. **XS-ABILITY: Access**ing hard-to-reach areas with **A**dvanced and **B**reakthrough **I**nnovation for re**L**iable **I**n-situ characterization of a facili**TY**
   - Project Overview
   - Objectives, Organization and Current Development
4. Cooperation Between DORADO and XS-ABILITY
   - Common Activities
5. End-Users Group
6. Summary
7. References

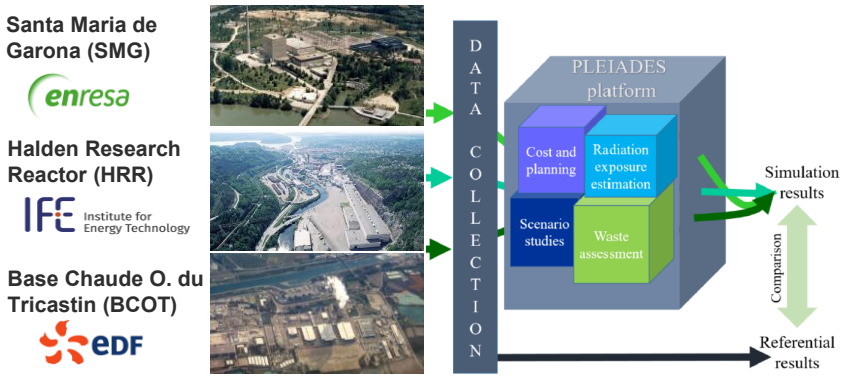
1. PLEIADES

PLEIADES
Smarter Plant Decommissioning

PLatform based on Emerging and Interoperable Applications for enhanced Decommissioning processES

[1] PLEIADES partners

[2]



[3] Implementation of PLEIADES on real use cases (Fig. 2)

- **Call**: H2020 NFRP-2019-09 "Fostering innovation in decommissioning of nuclear facilities"
- **Duration:** 3 years (1/10/2020 - 30/09/2023)
- **Consortium:** 14 partners
  - Countries: FR (6), DE (2), NO (2), ES (1), FI(1), BE (1), SK (1)
  - 4 academic/research organisations, 1 TSO, 4 industrial companies, 5 SMEs
- **Objectives:**
  - Demonstrate a **modular software ecosystem** based on **interconnection of front-line support tools** through a **decommissioning specific ontology** building upon open **BIM (Building Information Modeling)**;
  - Propose an **ontology** for an international standard of decommissioning with **specific terminology/ vocabulary definition** for a **common understanding** and **common knowledge modeling**;
  - Validation of the platform in the **6 user stories** from **3 case studies** in **different European countries**

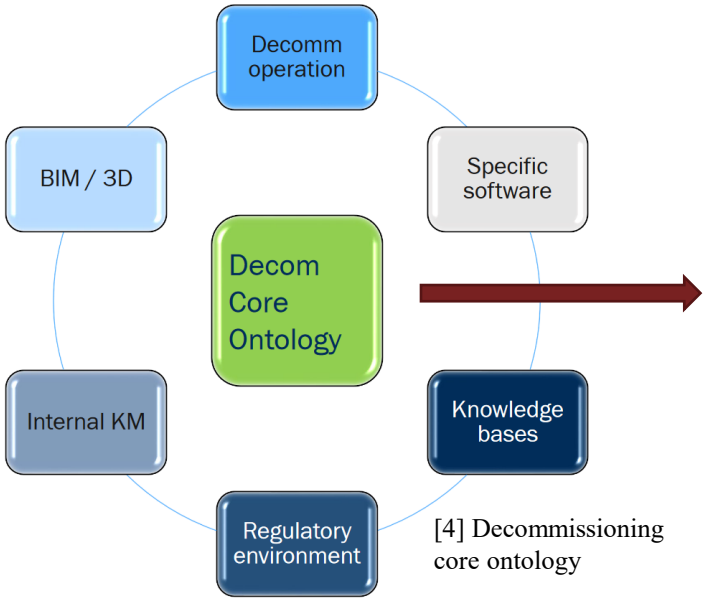
1. PLEIADES

PLEIADES
Smarter Plant Decommissioning

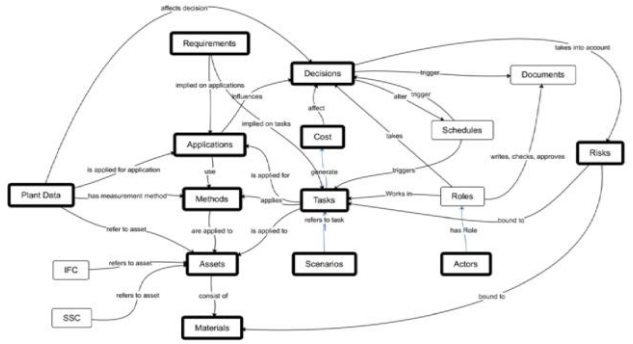
Achievements

[1] PLEIADES partners

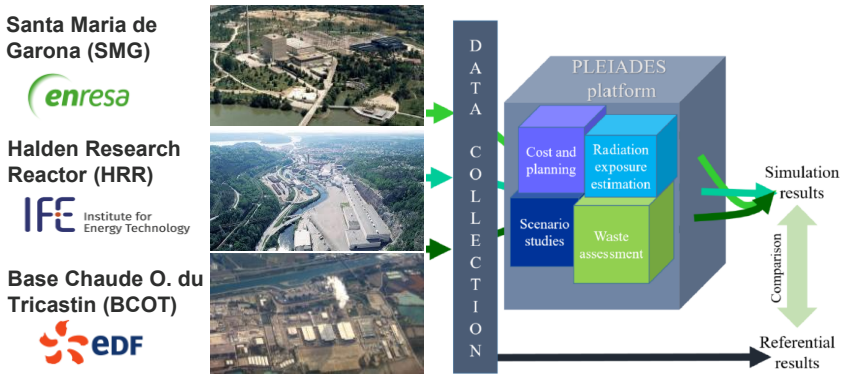
[2]



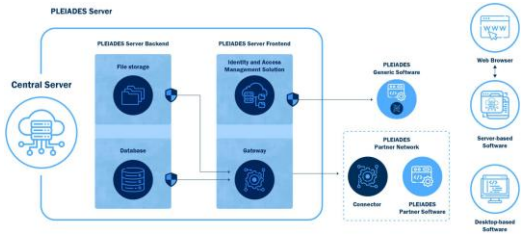
[4] Decommissioning core ontology



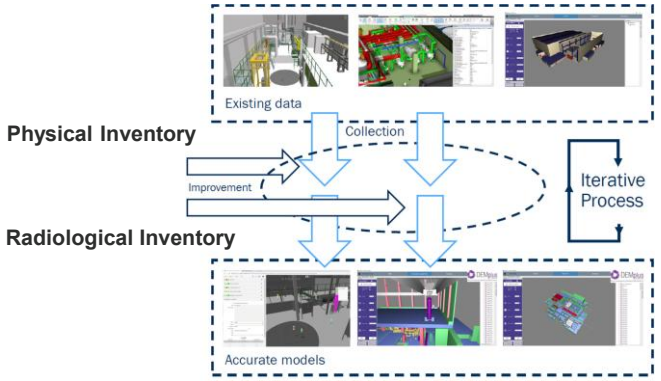
[5] Decommissioning core ontology



[3] Implementation of PLEIADES on real use cases (Fig. 2)



[6] Server architecture in PLEIADES (Fig. 4)



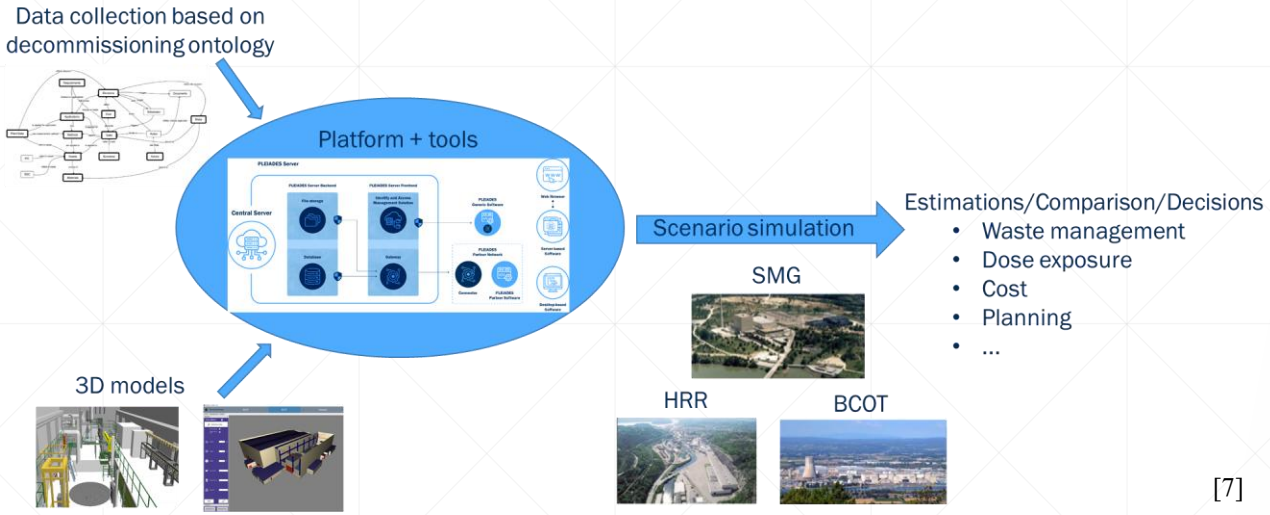
[6] Use cases 3D models and data in PLEIADES (Fig. 3)

1. PLEIADES

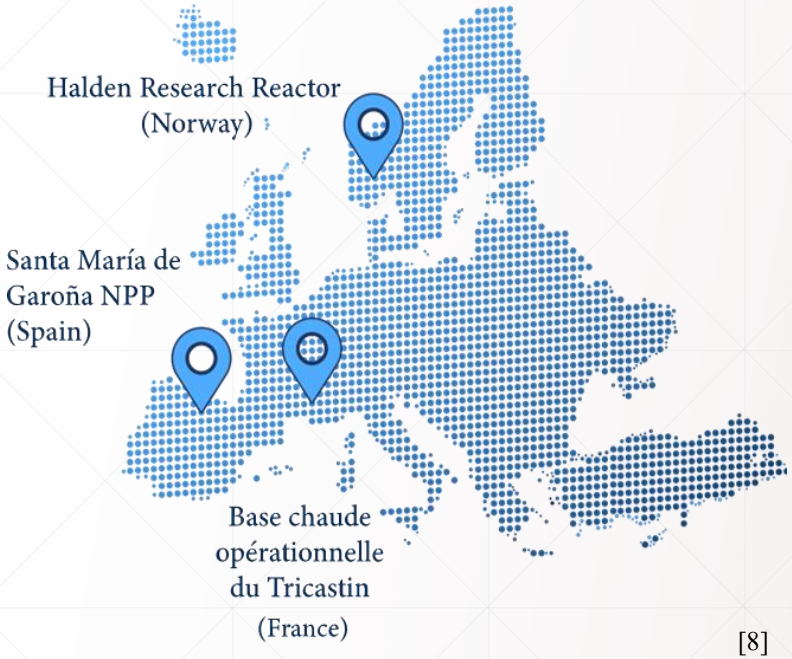
PLEIADES
Smarter Plant Decommissioning

Main Outcomes and Further Directions

- **Main outcomes:**
  - Decommissioning ontology definition;
  - Platform development integrating the ontology API, 3D models, multiple tools;
  - Application on 3 real cases.



[7]



[8]

- **Identified further directions:**
  - Ontology extension & API enhancement;
  - Platform enhancement and generalization with additionnal tools;
  - Promotion & diffusion of the concept.

2. DORADO

Digital twins and Ontology for Robot Assisted Decommissioning Operations

DORADO

Digital twins and Ontology for Robot Assisted Decommissioning Operations

DORADO Partners

VTT, IFE, KIT Karlsruher Institut für Technologie, wai, ASNR, iUS, AMPHOS 21 Scientific and Strategic Environmental Consulting, SPIX INDUSTRY, Université de Strasbourg, sck cen, Catenda, EPRI

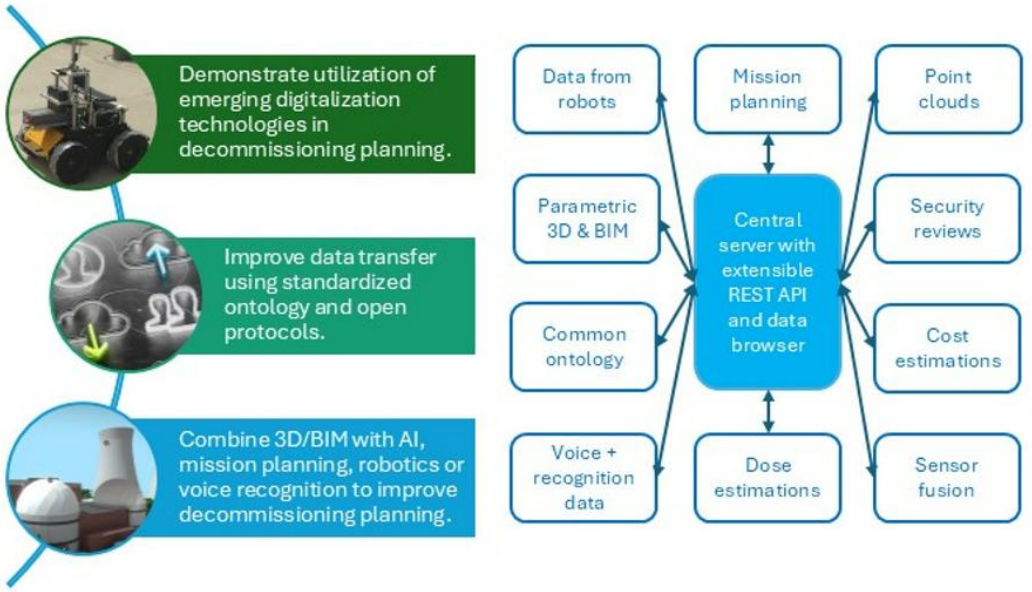
Key facts

36 months
12 partners
8 countries
5 work packages

Technologies

Robotics
Sensor fusion
Data management
Voice recognition
Ontology
BIM / 3D
Artificial intelligence
Dose estimation
Mission planning

Research goals



Work packages in brief

WP1
Prepare and manage project

WP2
Finetune research goals

WP3
Implement technologies

WP4
Demonstrate on real use cases

WP5
Train, exploit & standardize

Final expectations

1) Integrate emerging digital technologies into one coherent platform to support decommissioning planning.
2) Extend decommissioning ontology and data transfer protocols to cover new use cases.
3) Describe extensible API to provide standardized data exchange between tools used in decommissioning planning.

[9] www.dorado-project.eu

[10] Antti Räty & DORADO consortium. Euratom project DORADO. Digidecom2024 conference, November 2024. Halden, Norway

2. DORADO

Main Objectives of DORADO

The problem to solve

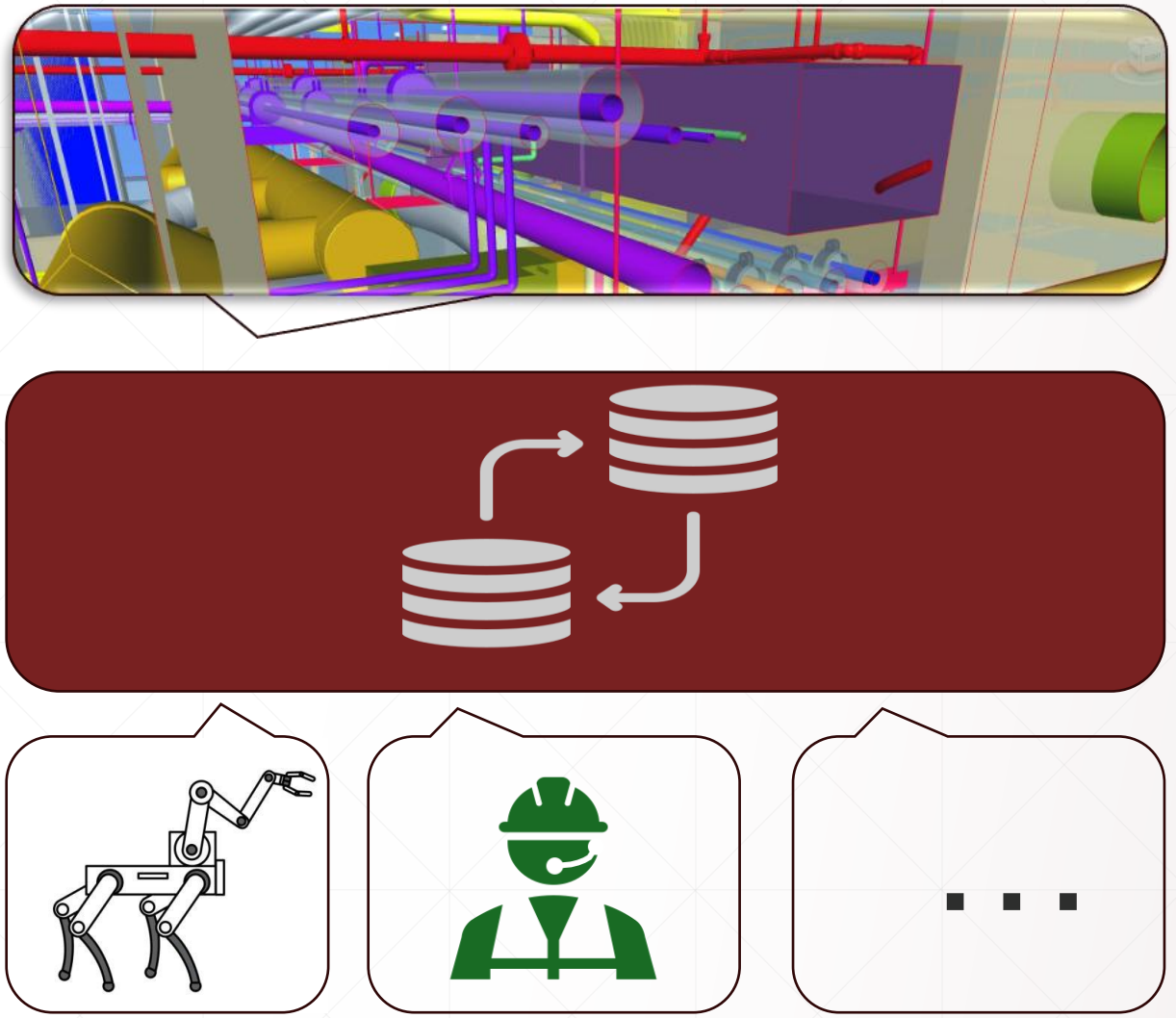
- BIM and Digital Twins are used at all steps of large projects;
- Such data needs to be up-to-date and accessible by many actors;
- Common language and protocols are needed to insure the coherence of the data.

Sample technologies / situations

- Data for *robot planning;*
- *Field operators*' data generation.

The proposal from DORADO

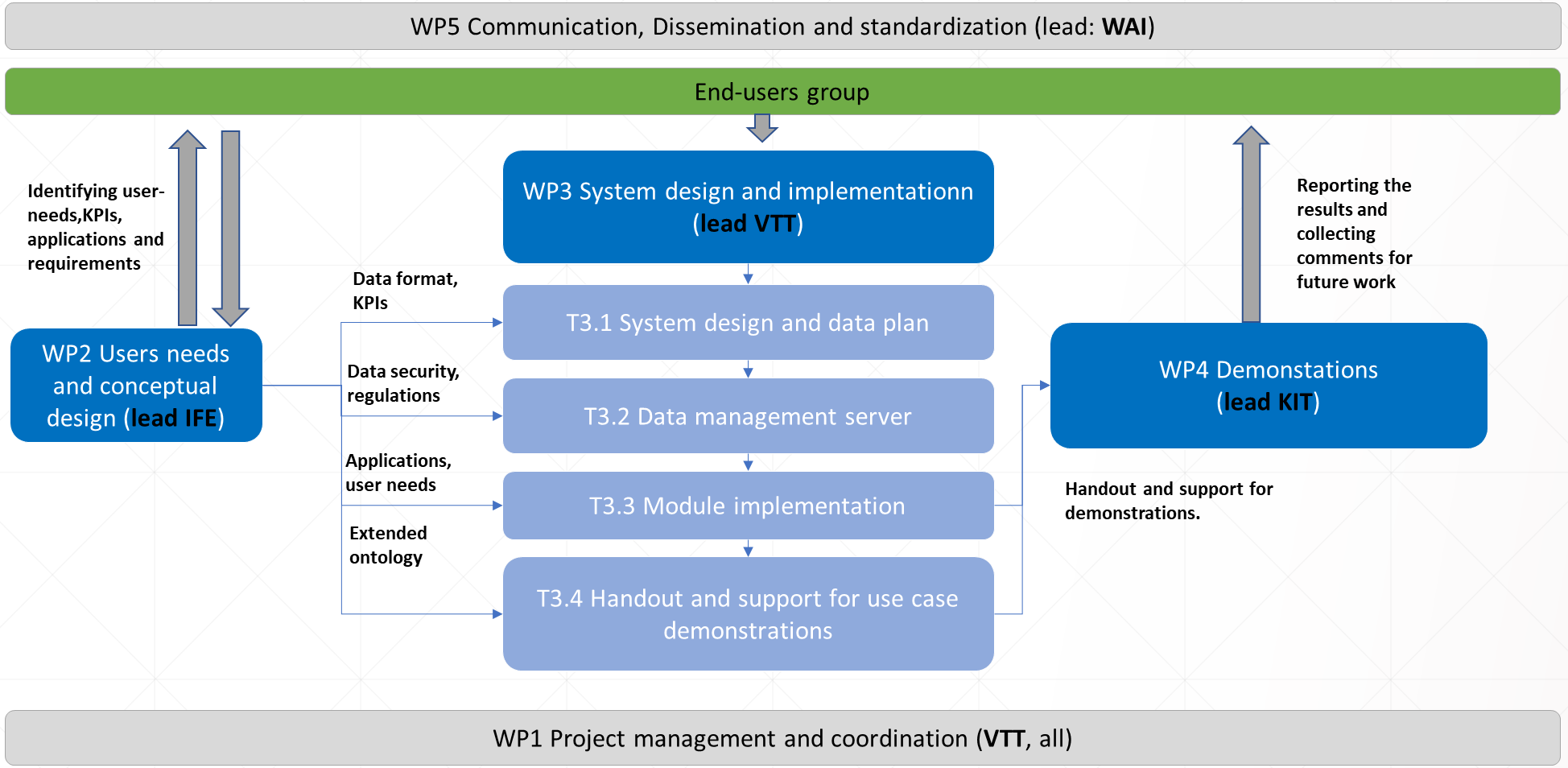
- A platform to share/consume data across a wide variety of actors.



[11] A. Räty, M. Becker, F. Borrmann, J. Ridao & DORADO consortium. Digital technologies in DORADO project. 3rd webinar, April 8, 2025

2. DORADO

Project Organization

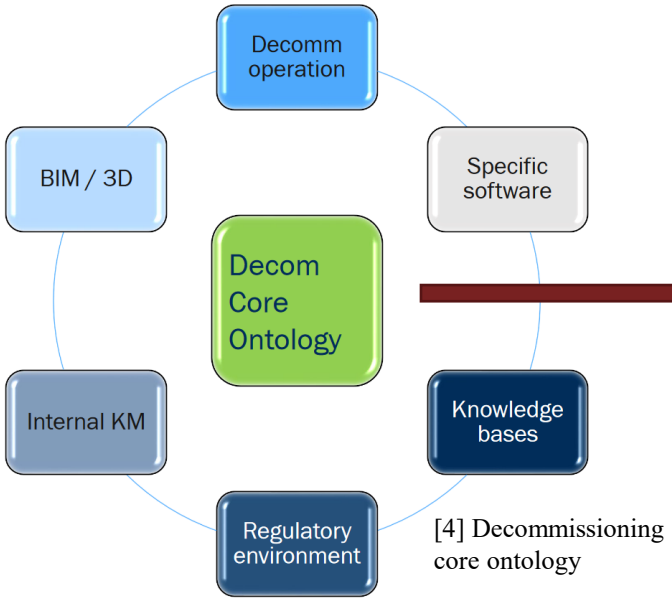


[12] DORADO project flow

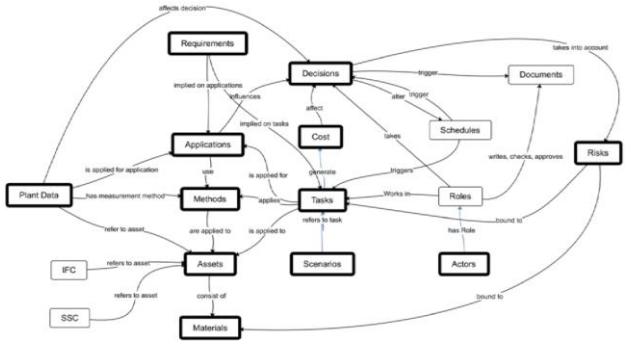
2. DORADO

Continuation from PLEIADES

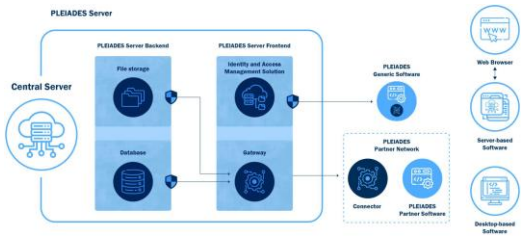
- In PLEIADES, a platform was developed, but software integration just started. Recommended next steps:
  - Extension of the coverage of the supported ontology and supported decommissioning planning activities;
  - Continuation in the development of the ontology and the API (Application Programming Interface)
  - Integration of further technologies such Artificial Intelligence (AI), Robotics and sensor networks;
  - Promotion of the concept for wider use.



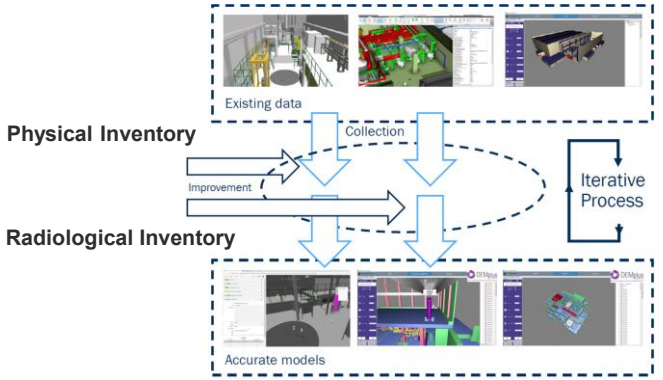
[4] Decommissioning core ontology



[5] Decommissioning core ontology



[6] Server architecture in PLEIADES (Fig. 4)



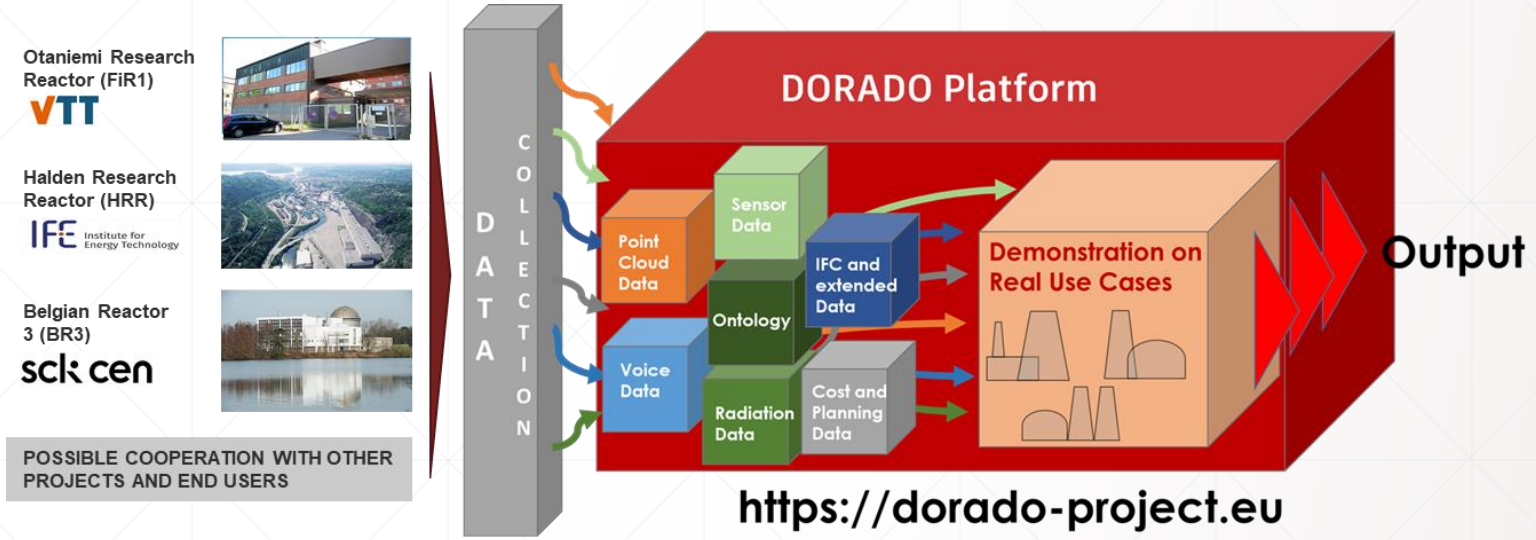
[6] Use cases 3D models and data in PLEIADES (Fig. 3)

2. DORADO

Technologies to be Implemented and Demonstrated in Real Use Cases

- Sensor data fusion with temporal dimension;
- Environment data comparison against BIM (validation of the BIM model);
- Point-cloud and 3D model change detection (similar as previous point., but aimed for regular updating of the model);
- Digital twins based ALARA (As Low as Reasonably Achievable) dose estimation;
- Server-based integration with IFC (Industry Foundation Classes) file format and extended data queries;
- Mission control, robot route optimization;
- Human to System smart voice assistant interface;
- Standardization using a common ontology.

- Connection with AI (Artificial Intelligence), Robotics, and integration of sensor networks.



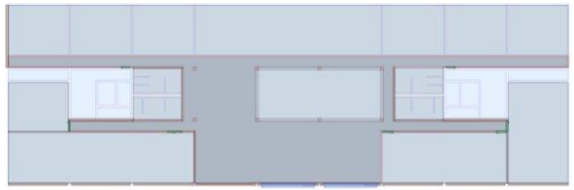
[13] Demonstrations on real use cases

2. DORADO

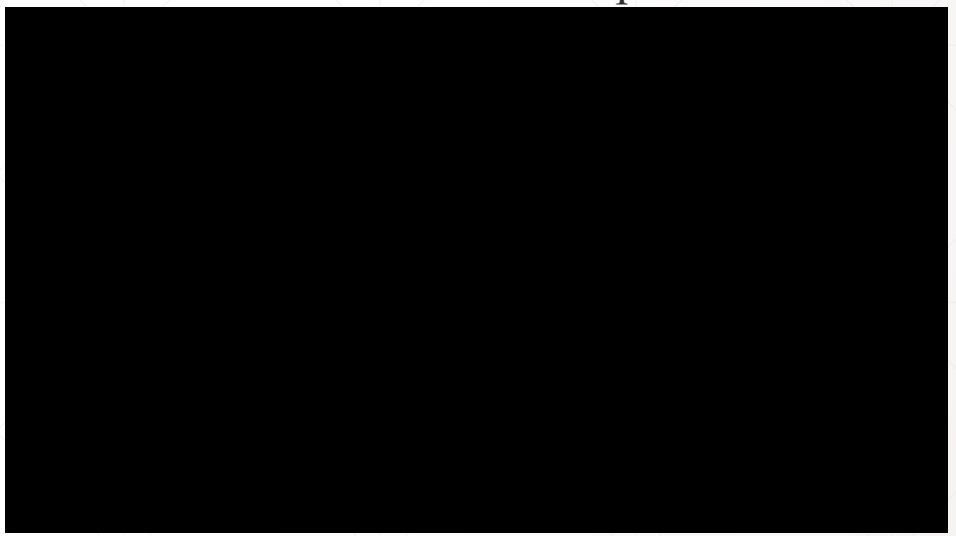
Technologies to be Implemented and Demonstrated in Real Use Cases

Mission points interface

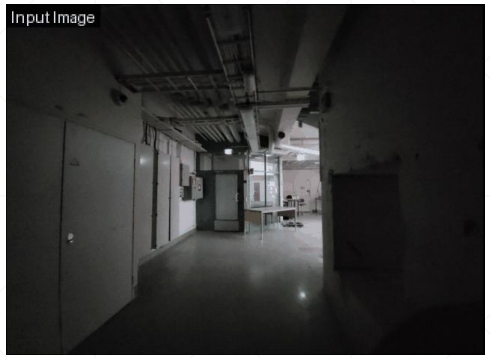
2D floor plans from IFC



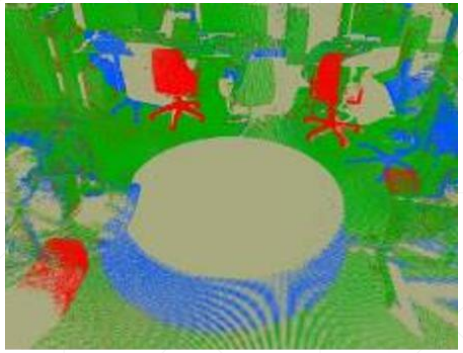
Near real-time radiation interpolation



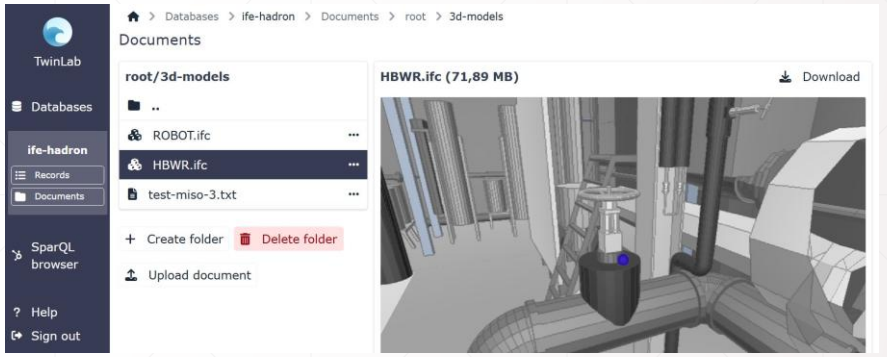
Visual localization



Change detection



Central Server

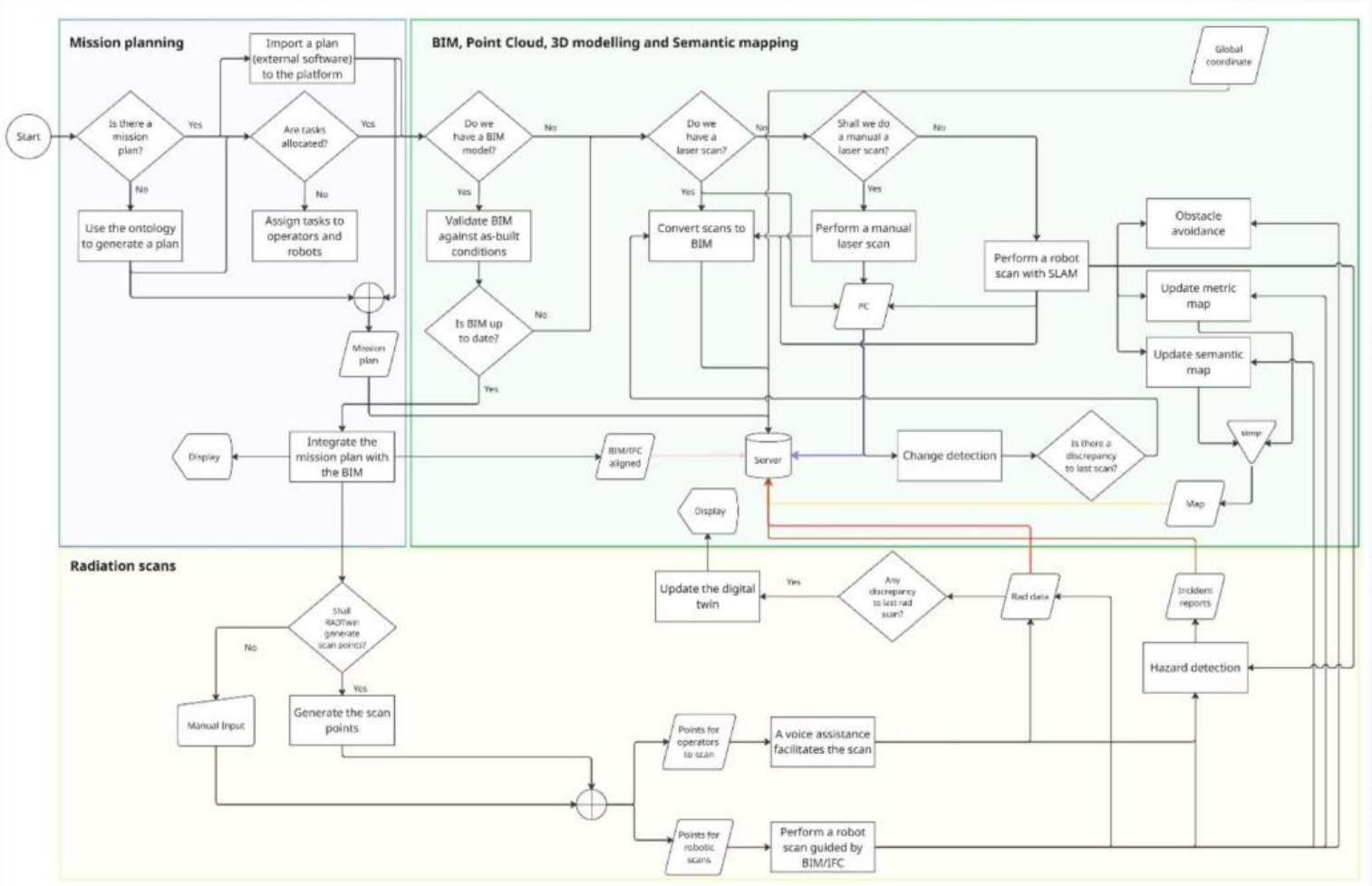


2. DORADO

Data Management

- Creation of a Mission Planning
  - Smaller Tasks assigned to an Agent
    - Humans
    - Robots
- Completion of the Model
  - Remapping of the environment
    - Manually
    - By Robots
- Conversion of point cloud data to 3D models
  - Use of semi-automated methods
  - Comparison with previous point clouds
- Processing and use of AI

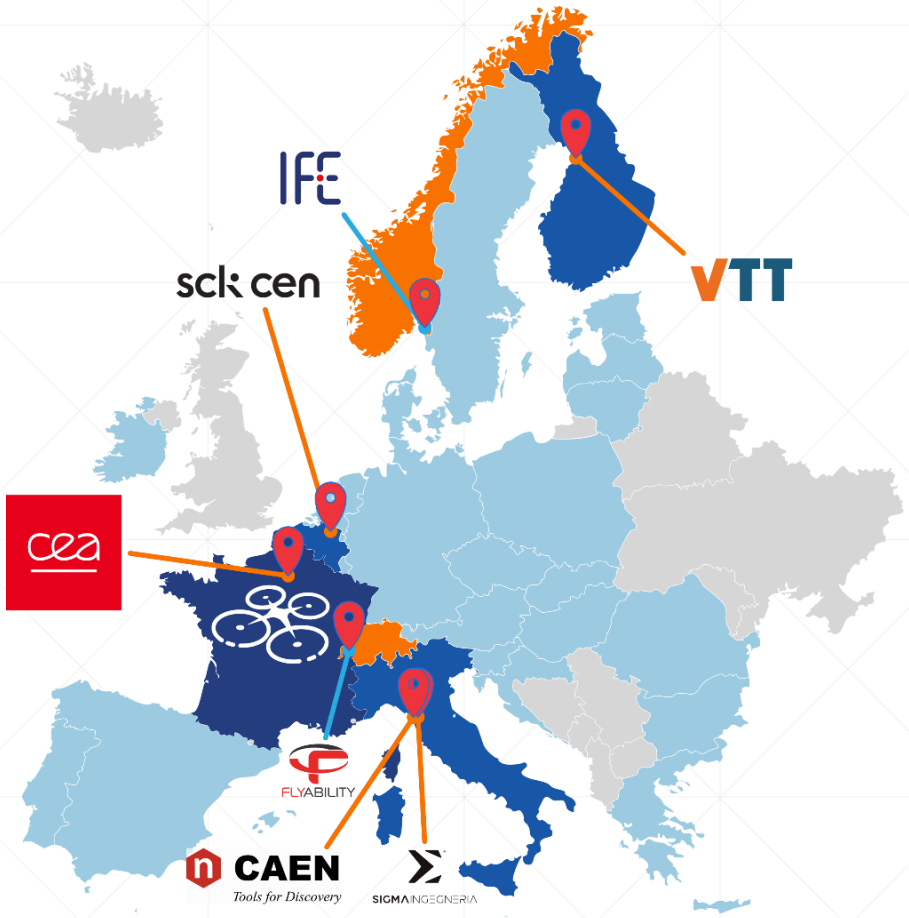
- The process is iterative



[14] A. Räty, P. Honkamaa, J. Ridao, O. Zahra, A. Benkrid, D. Daniska. Applying Digital Twins and Ontology for Robot Assisted Decommissioning Operations - Euratom Project DORADO. WM Symposia 2026 Conference, March 8 - 12, 2026, Phoenix, Arizona, USA

3. XS-ABILITY

Accessing hard-to-reach areas with **A**dvanced and **B**reakthrough **I**nnovation for re**L**iable **I**n-situ characterization of a facili**ty**



3 years

2 M€ (100 % EC)
+Associated Partners' own financing

Target TRL

1 2 3 4 5 6 7 8 9

8 partners from 7 countries

Aim: Bring innovative technologies in decommissioning

Approach & Main goals

- ❑ Reach hard to access locations
- ❑ Measure hard to measure radionuclides
- ❑ Use cases validation in nuclear facilities

Reduce
COST
TIME
DOSE

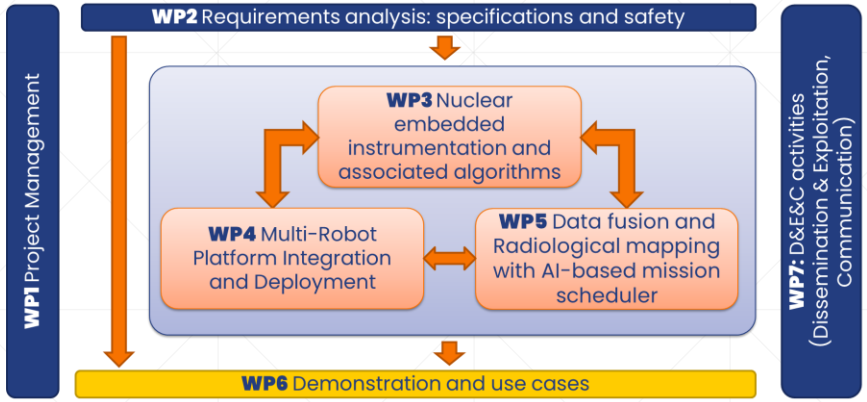
XS-ABILITY has received funding from the European Union's Horizon Europe EURATOM Research & Innovation program under agreement #101166392.

[15] Maugan Michel, on behalf of the XS-ABILITY Consortium. Update on the XS-ABILITY project. IAEA Technical Meeting, Nov 2025, Vienna, Austria.

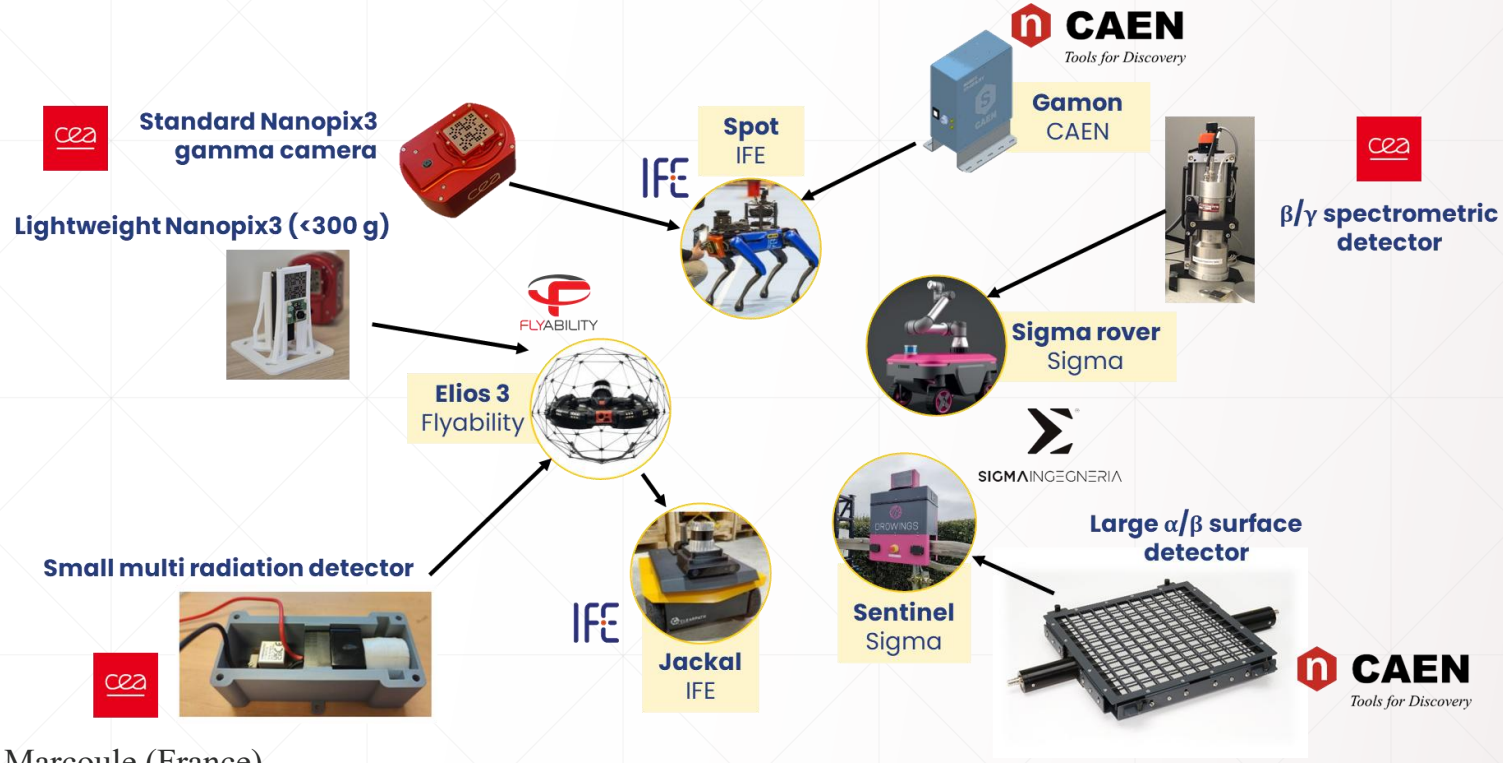
3. XS-ABILITY

Objectives, Organization and Current Development

- **Main Objectives:**
  - Develop specific radiological sensors to be embebbed on wheeled/legged UGV (Unmanned Ground Vehicle), as well as UAV (Unmanned Aerial Vehicle);
  - Selected for their complementary action during D&D operations and the technological capabilities they offer regarding improvements in compactness, robustness of use, and multimodality measurements.
- **Organization:**



- **Current Developments:**
  - Radiation sensors embedded on UxVs;
  - Autonomous Multi-robot systems with embedded sensors
  - AI-based mission scheduler and Task assignment
  - Final demo is planned at Summer 2027 at G2 reactor, CEA Marcoule (France)



[15] Maugan Michel, on behalf of the XS-ABILITY Consortium. Update on the XS-ABILITY project. IAEA Technical Meeting, Nov 2025, Vienna, Austria. [16] https://xs-ability.eu/

4. Cooperation Between DORADO and XS-ABILITY

Common Activities

- Some partners are involved in both projects, DORADO and XS-ABILITY:
  - VTT – Technical Research Centre of Finland;
  - IFE - Institute for Energy Technology of Norway;
  - SCK CEN - Belgian Nuclear Research Centre;
- Common activities between DORADO and XS-ABILITY are being organized;
  - Joint visits to facilities for data collection;
    - This will allow managing the interfaces between:
      - Data Collection
      - Data Management

DATA COLLECTION **DATA MANAGEMENT**

5. End-Users Group

End-users are invited to follow our projects via webinars, newsletters and other publications.

- Technological experts and DORADO tools users
- Business management (how tools connect to business value chain and enable new services)

What will be the value for end-users to participate?

The end-user's value in following the project is built on the opportunity to increase their understanding of each technology, strengthen their own understanding of the benefits of using each technology and hence, gain a better understanding of how the technologies can be utilized in their own business. We aim to focus on following questions:

- **What is the technology and how is it used?**
- **What are the benefits of using the technology? Examples presented.**
- **How can the technology be applied? Examples presented.**
- **How does the technology support nuclear decommissioning and dismantling projects?**

6. Summary

- The PLEIADES Project lasted 3 years, between 2020 and 20203.
  - Despite the **international difficulties** in the beginning of the project (movement restrictions due to the unprecedent health emergency), the PLEIADES consortium successfully completed the project:
    - This would have been unlikely without the **use of digital technologies** to conduct regular virtual project meetings during the first year and a half of the project, after which the team met in person for the first time.
- Following the success of PLEIADES and the potential it generated regarding the use of digital technologies for decommissioning operations, the Euratom Research and Training Programme funded the DORADO project:
  - DORADO continues the previous work by integrating more technologies to the server and extending the ontology;
  - Eight new technologies are handled and will be demonstrated in real environment. Emphasis on utilizing BIM and AI;
  - Holistic approach and data compatibility is the key!;
- The DORADO project and the XS-ABILITY project are collaborating together to develop work that will be very beneficial between different technological areas;

- An End-Users group has been created. It is made up of different stakeholders from the nuclear sector – regulators, technical/scientific support organizations, small or medium enterprises... – committed to the changes and mutations in companies brought about by the industry 4.0;
  - We welcome new members to the end users group!

7. References

[1] M.-B. Jacques (2021). PLEIADES, the Smarter Plant Decommissioning. DEM 2021 –International Conference on Decommissioning Challenges (France, Avignon)

[2] M.-B. Jacques, J.-E. Hulsund, I. Szoke (2022). PLEIADES project overview. DigiDecom 2022- Halden

[3] [6] Marie-Benedicte Jacques, Antti Räty, Joseph A. Ridao Cabrerizo, Dusan Daniska. European Collaborations for Safe and Efficient Dismantling: Digital twins, Ontology and Data Exchange, EPJ Nuclear Sci. Technol. 11, 19 (2025). https://doi.org/10.1051/epjn/2025022

[4] F. Borrmann, F. Becker, V. Hein, I. Szöke, M.-B. Jacques, J.A. Ridao, D. Daniska, F. Patrice. An international approach to nuclear decommissioning ontology, in DEM 2021 – International Conference on Decommissioning Challenges. France, Avignon, 2021 September 13-15 (2021)

[5] I. Szöke, M.-B. Jacques, F. Borrmann. PLEIADES, the Smarter Plant Decommissioning, in DEM 2021 – International Conference on Decommissioning Challenges. France, Avignon, 2021, September 13-15 (2021)

[7] [8] https://pleiades-platform.eu/

[9] [10] [12] Antti Räty & DORADO consortium. Euratom project DORADO. Digidecom2024 conference, November 2024. Halden, Norway

[11] A. Räty, M. Becker, F. Borrmann, J. Ridao & DORADO consortium. Digital technologies in DORADO project. 3rd webinar, April 8, 2025

[13] www.dorado-project.eu/

[14] A. Räty, P. Honkamaa, J. Ridao, O. Zahra, A. Benkrid, D. Daniska. Applying Digital Twins and Ontology for Robot Assisted Decommissioning Operations - Euratom Project DORADO. WM Symposia 2026 Conference, March 8 - 12, 2026, Phoenix, Arizona, USA

[15] Maugan Michel, on behalf of the XS-ABILITY Consortium. Update on the XS-ABILITY project. IAEA Technical Meeting, Nov 2025, Vienna, Austria.

[16] https://xs-ability.eu/

Thank you for your attention!

Any questions?

Follow us!