PLEIADES

Smarter Plant Decommissioning

The use of digital twins for waste estimation in nuclear facilities' dismantling and decommissioning: the PLEIADES project

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Safe[ND] 2023 – Berlin

13-15 September 2023

This project has received funding from the EURATOM Research & Training Programme 2014-2018 under the Grant Agreement n°899990. The content of this document reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.

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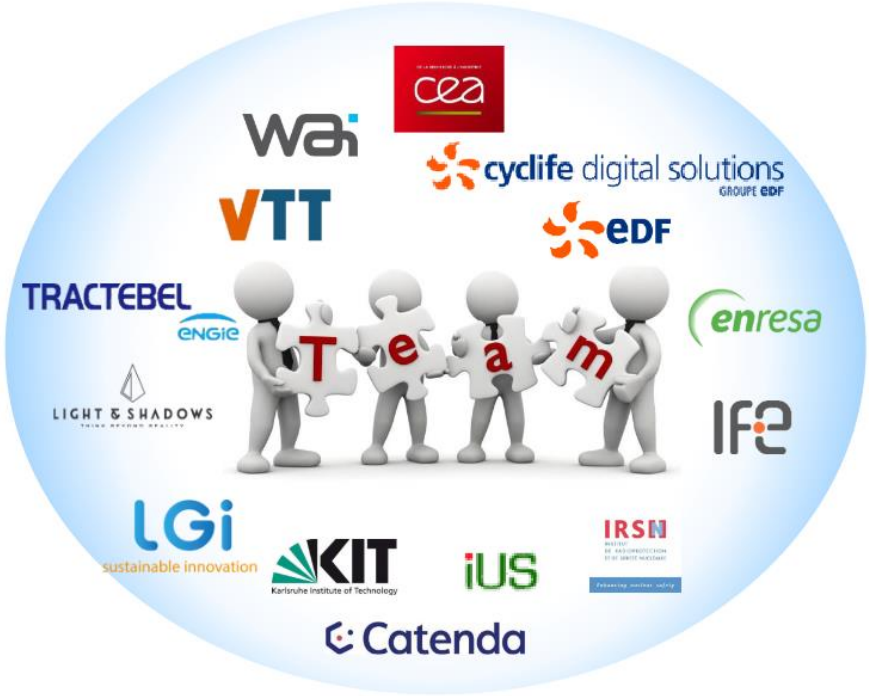
Introduction

- PLatform based on Emerging and Interoperable Applications for enhanced Decommissioning processES
  - Call: H2020 NFRP-2019-09 – « Fostering innovation in decommissioning of nuclear facilities »
  - Duration: 01.10.2020 – 30.11.2023
  - Consortium: 14 partners
    - 7 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



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Digital Tools

- A number of cutting-edge digital tools is collected and implemented

Sources: [2] [11]

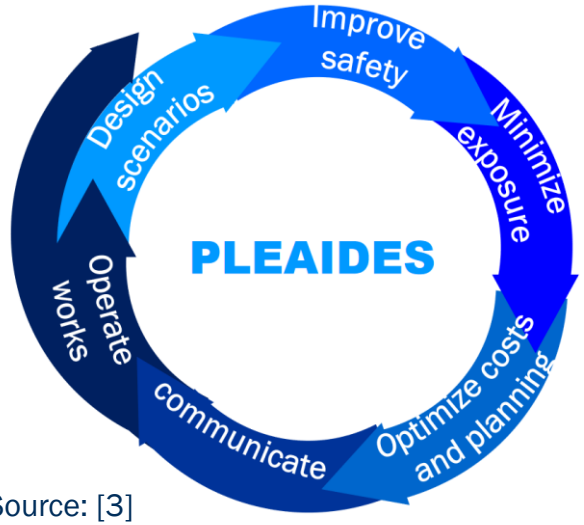
CEA IDROP — VR dismantling simulation with collision & radiological modelling	**Cyclife DS** DEMPLUS — Decision-support tool combined with 3D simulation	**IFE** VRDOSE™ — Detailed job planning tool with a radiological model library
Catenda BIMSYNC — IFC[1] compatible BIM platform used in construction	**WAI** AQUILA COSTING — ISDC[2] compatible client-server based costing tool	**IFE** RADPIM — Radiological characterisation tool (part of VRdose family)
iUS IMS — Semantic wiki based nuclear info system	**KIT** 3DSCANPF — Robotic platform for 3D scans and imaging	**LS** INTERACT — XR[4] platform with physics engine
EDF & CEA DIM TOOL — Dismantling Info Modelling system for storing all facility data	**VTT** ARWORKFLOW ALVAR BIM ACCESS — AR[3] training platform with advanced tracking capabilities	**Tractebel** WASTREAM — Waste Routes and Activity Assessment tool

[1] **IFC**: Industry Foundation Classes; [2] **ISDC**: International Stricture for Decommissioning Costing; [3] **AR**: Augmented Reality; [4] **XR**: Mixed Reality

Data/info acquisition and management → Characterization and Job planning → Decisions, Costing, Waste management → Demonstration and Training

Objectives

- Main objectives are:
  - Creating a new digital methodology to improve nuclear decommissioning;
  - Definition of an ontology and procedures for the digitization of nuclear facilities' dismantling and decommissioning;
  - Facilitate higher standardization required for international application.
- Ultimate goal is to protect workers, the environment and optimise costs.



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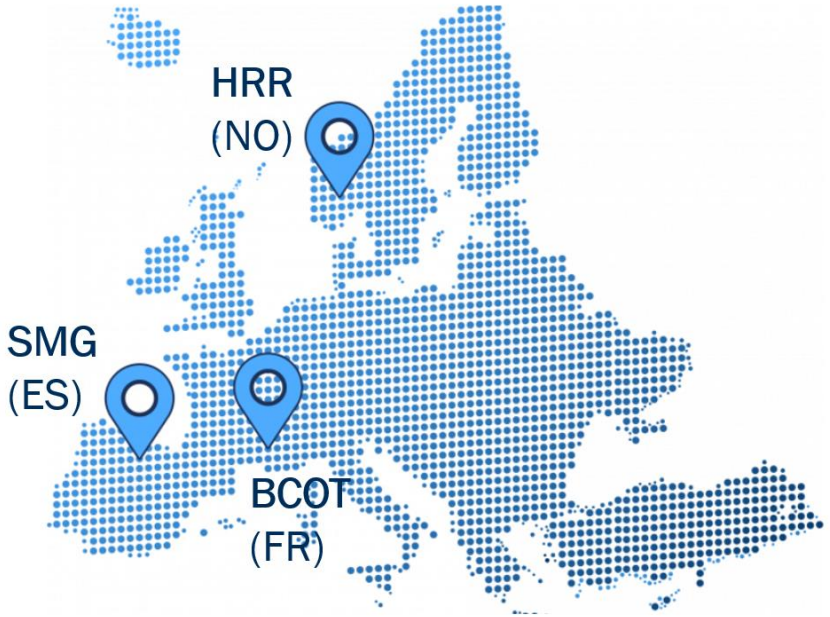
Demonstration on Real Use Cases

- Application on 3 real use cases in Europe
  - Halden nuclear Research Reactor (HRR), Norway;
  - Santa María de Garona (SMG), Spain;
  - Base Chaude Opérationnelle du Tricastin (BCOT), France.



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Santa María de Garona (SMG)

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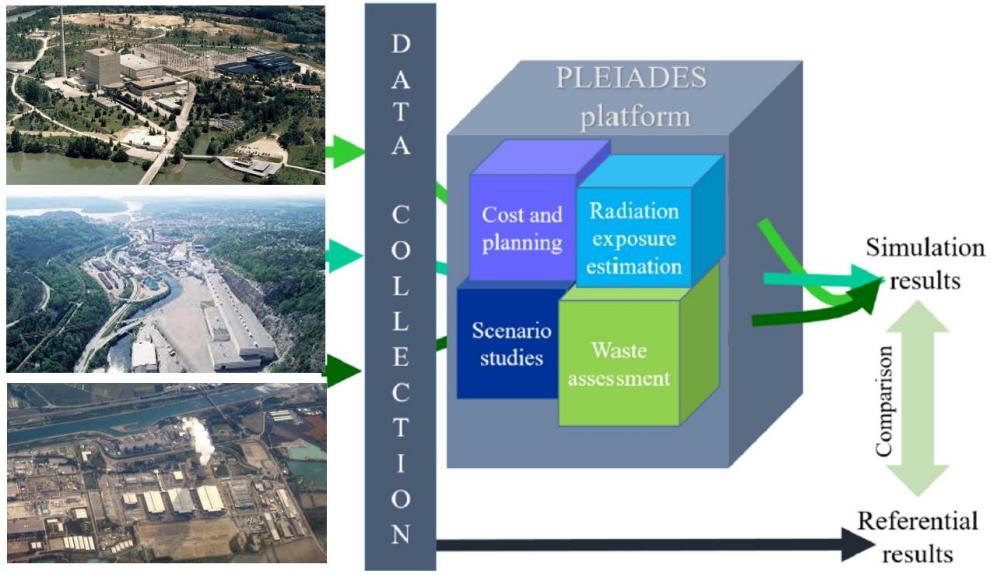
Halden Research Reactor (HRR)

IFE Institute for Energy Technology

Basse Chaude O. du Tricastin (BCOT)

EDF



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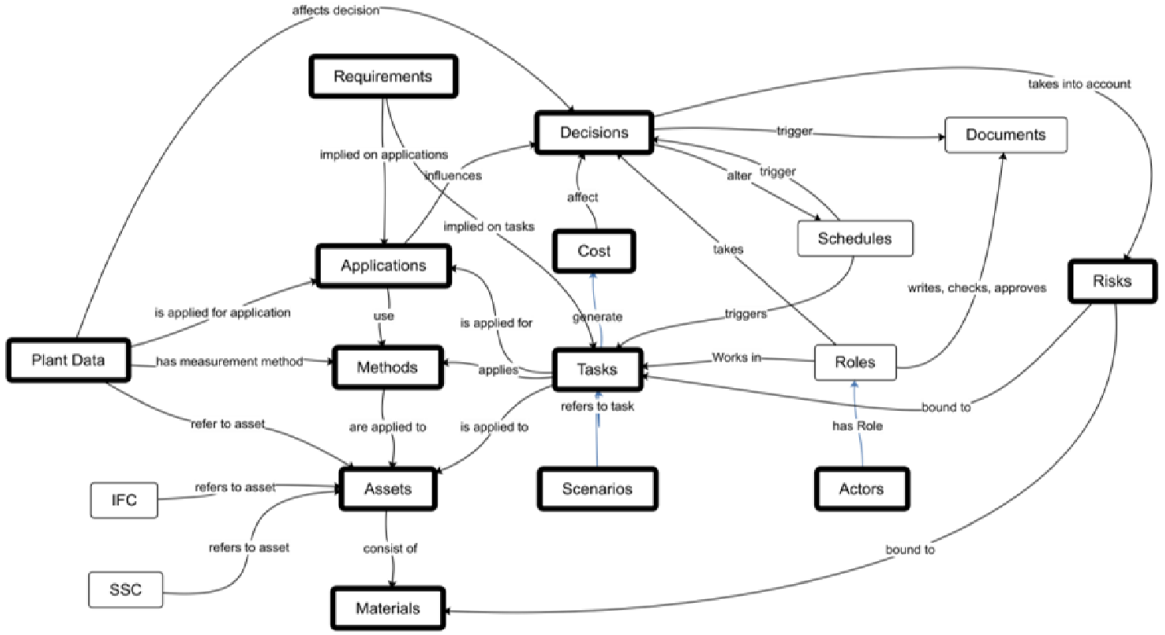
Organization

- 7 Work Packages (WP) in 38 months:
  - **WP1:** Requirement analysis, specification and test design;
  - **WP2:** PLEIADES platform development;
  - **WP3:** Implementation of PLEIADES platform on real use cases;
  - **WP4:** Modelling and results evaluation;
  - **WP5:** Standardisation efforts, exploitation and training;
  - **WP6:** Dissemination, communication & stakeholder engagement;
  - **WP7:** Project coordination and management.

Results: Requirements & Specifications

- Definition of a core nuclear decommissioning ontology



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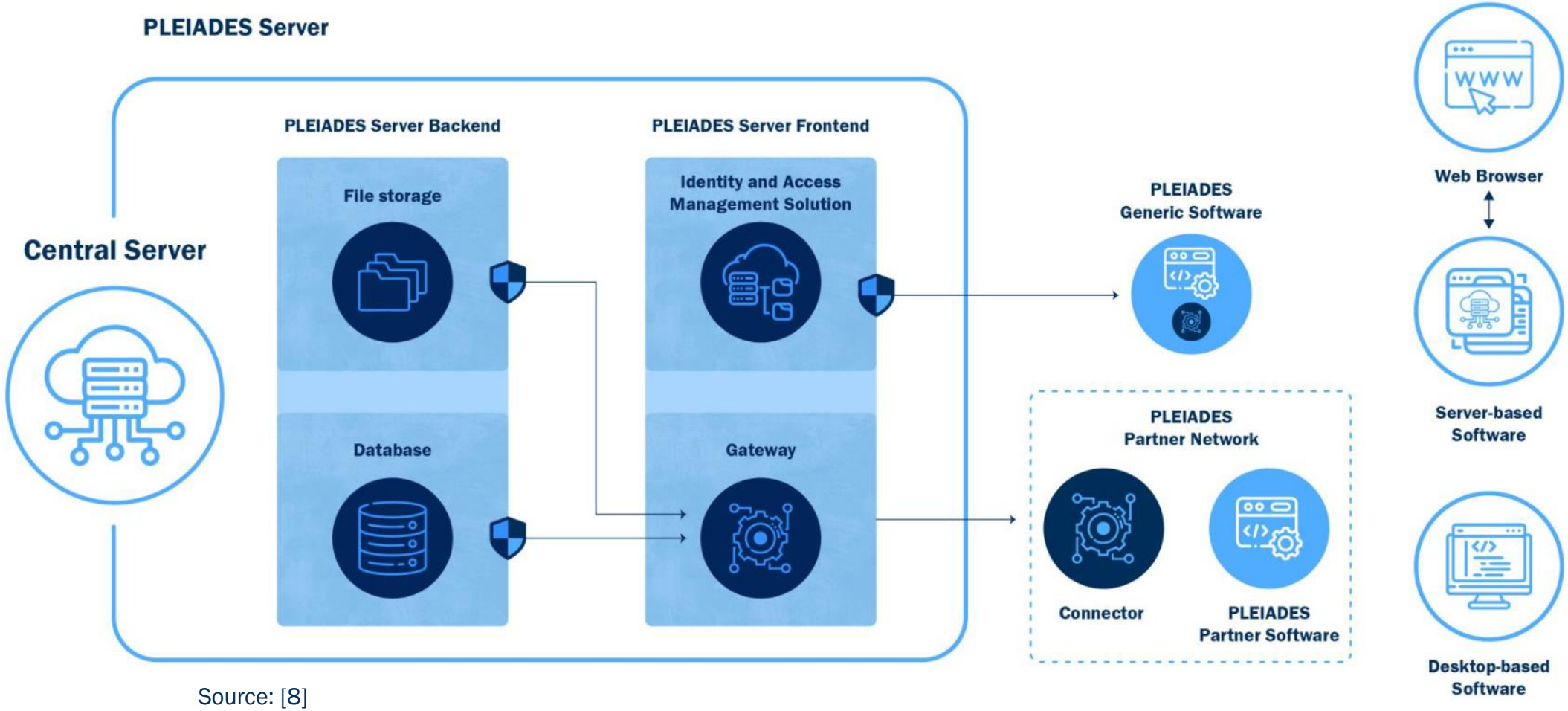
- Definition of 6 user stories (US)
  - **US#1:** Manual vs. remote radiological characterization;
  - **US#2:** 3D supported vs. digitally enhanced dismantling;
  - **US#3:** Manual vs. automated decontamination of building surfaces;
  - **US#4:** Strategic risk management planning;
  - **US#5:** Regulatory/TSO review capabilities;
  - **US#6:** Strategic waste management planning.

Results: PLEIADES Platform Development

- After being specified, developed and tested, the platform is operational



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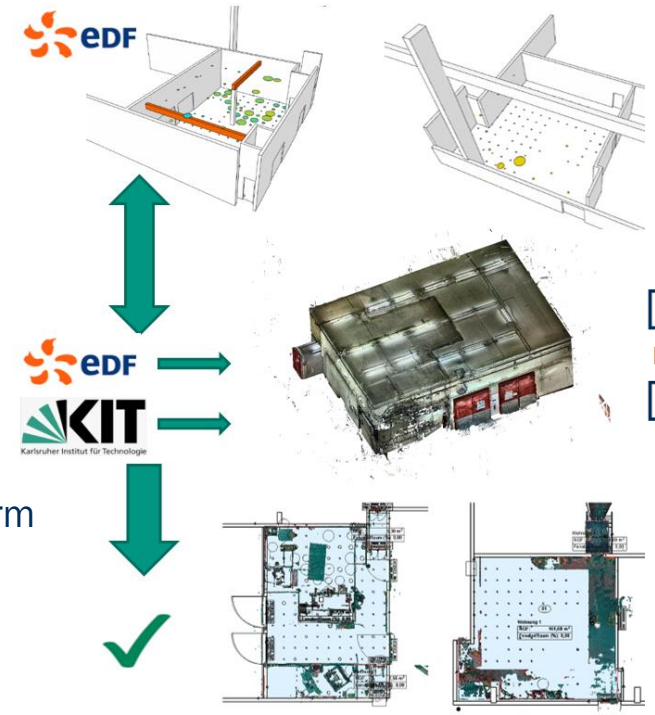
Results: Development of Digital Models

- Implementation on real use cases
  - Input
    - Physical inventory, features;
    - Radiological inventory.
  - Activities
    - Analyze inputs;
    - Identify gaps and problems;
    - Propose and perform activities to complete the models.
  - Output



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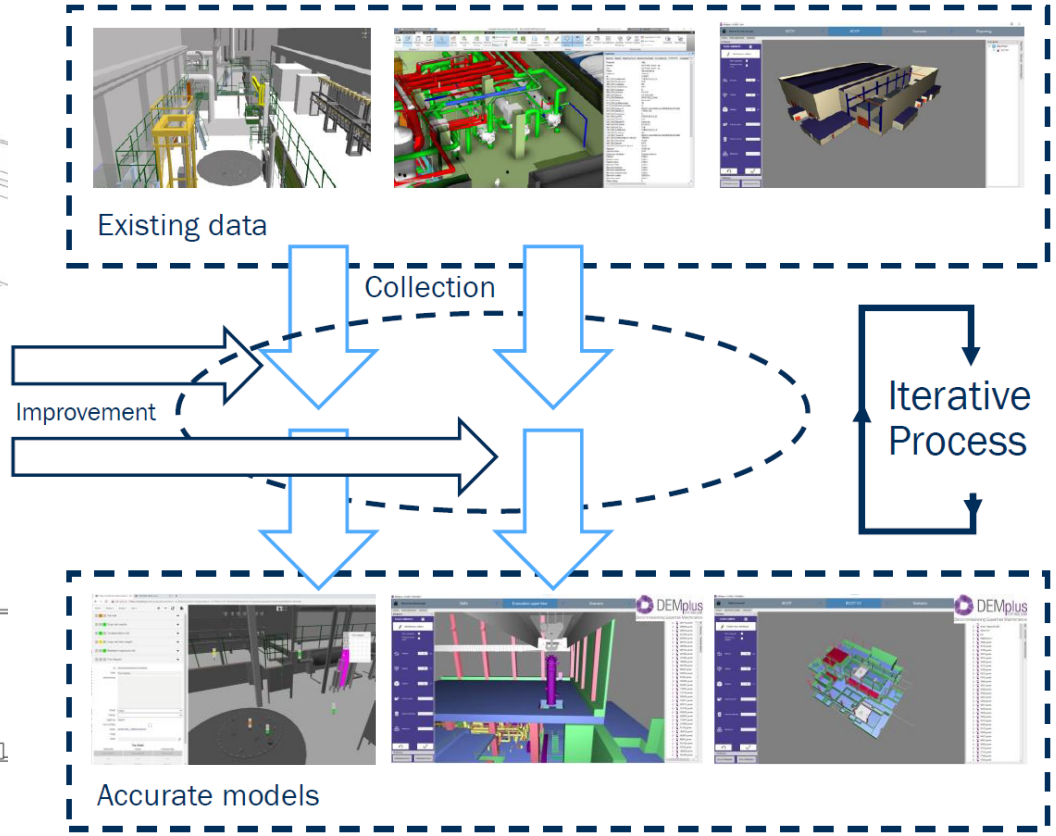

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The Use of Digital Models

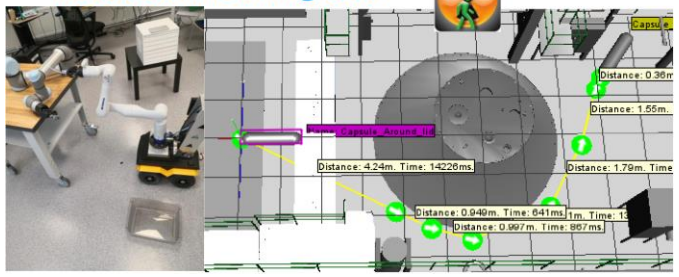
- Some examples of simulations

Halden Research Reactor (HRR)

IFE Institute for Energy Technology

US#1: Manual vs. remote radiological characterization

Robot scenario timing tests



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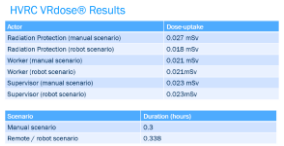
HVRC VRDose®



US#4: Strategic risk management planning

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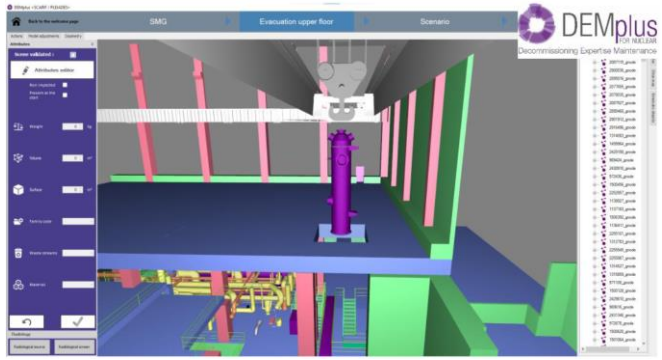
US#2: 3D supported vs. digitally enhanced dismantling

SMG 3D model visualization on DEMplus®



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US#5: Regulatory/TSO review capabilities

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US#3: Manual vs. automated dec. of building surfaces

Test and results from DEMplus® scenario simulations

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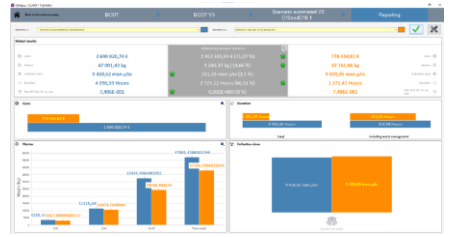

US#6: Strategic waste management planning

- Decommissioning planning activities demonstrated:

Cost estimation, waste estimation, dismantling visualization, risk management, TSO/regulatory reviews

Summary

- Core **nuclear decommissioning ontology** was developed;
- **Open, robust and flexible platform** for digitalization of decommissioning planning implemented;
  - Open = the API interface is publicly available;
  - Robust = large amount of data can be processed (3D models, point clouds, structured data);
  - Flexible = any software, independent from the technology, can connect and benefit from the common data environment.
- Successfully demonstrated on **6 user stories** utilizing various technologies like 3D modelling, VR/XR, computational analysis used at different stages of decommissioning planning.

Further Steps

- Continue in the development of the ontology and the API;
- Extend the coverage of the decommissioning planning activities that can be supported by the PLEIADES platform;
- Utilization of other digitalization technologies like artificial intelligence, robotics or integration with sensor networks.

Source: [14]

Sources

[1] [6] M.-B. Jacques (2021). PLEIADES, the Smarter Plant Decommissioning. DEM 2021 –International Conference on Decommissioning Challenges (France, Avignon)

[2] [4] [5] www.pleiades-platform.eu

[3] [8] [9] M.-B. Jacques, J.-E. Hulsund, I. Szoke (2022). PLEIADES project overview. DigiDecom 2022- Halden.

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

[10] S. Gentes, J. A. Ridao, M.-B. Jacques, B. Clere, Mathieu Pomarel (2023). PLEIADES-Projekt: Verwendung digitaler Modelle | PLEIADES project: the use of digital models. KONTEC 2023 (Germany, Dresden)

[11] [12] [13] I. Szoke, J.-L. Flouttard (2023). PLatform based on Emerging and Interoperable Applications for enhanced Decommissioning processES. International Conference on Nuclear Decommissioning: Adressing the Past and Ensuring the Future. 15-19 May 2023, Vienna, Austria

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