International Conference on

### Nuclear Decommissioning

15 – 19 May 2023, Vienna, Austria

Addressing the Past and Ensuring the Future

### PLEIADES

### <u>PL</u>atform based on <u>Emerging and Interoperable Applications</u> for enhanced <u>Decommissioning processES</u>







Smarter Plant Decommissioning



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### <u>PLatform based on</u> <u>Emerging and Interoperable Applications</u> for enhanced <u>Decommissioning processES</u>

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## Summary

- **1. PLEIADES Concept**
- 2. PLEIADES Project
- **3.** Use Cases and Test Presentation
  - ≻HRR
  - > BCOT
  - ≻ SMG
- 4. Conclusion and Perspectives







### Introduction

<u>PL</u>atform based on <u>Emerging and Interoperable Applications for</u> enhanced <u>D</u>ecommissioning process<u>ES</u>



### 14 36 PARTNERS MONTHS



#### 

### Objective

#### Demonstrate

a **modular** software ecosystem based on interconnection of front-line support tools through a decom specific **ontology** so building upon open **BIM**\*.

### Work Steps

Concept proposed before application

- User needs -> Tech specifications
- User sorties -> SW development
- KPIs -> Testing
- Evaluation and reporting

### **3 Use Cases**





## **User need analysis**



#### **DigiDecom 2021 – DIGITAL**

Online international workshop focusing on digital transformation, robotics and other game changing trends in nuclear decommissioning





News 13 January 2021

PLEIADES is looking for experts to help us with our survey!

The main goal of PLEIADES is to demonstrate a modular decommissioning support ecosystem based on interconnection of tools provided by the partners through a decommissioning specific ontology building upon open BIM (see more information in the slides further down). We kindly ask you to spend some of your valuable time for providing input so that the project outcomes meet the requirements of practitioners.

Take our survey here







## PLEIADES The most advanced tools all together

Data/info acquisition and management

Commission

Characterization and Job planning

Decisions, Costing, Waste management



- 1. 3DScanPF (KIT): Robotic platform for <u>3D scans</u> and imaging
- 2. DIM (EDF): Dismantling Info Modelling system for storing all facility data
- 3. Bimsync (CATENDA): IFC<sup>1</sup> compatible <u>BIM platform</u> used in construction
- 4. iUS IMS (iUS): Semantic wiki based nuclear info system
- 5. RadPIM (IFE): Radiological <u>characterisation</u> tool (part of VRdose family)
- 6. VRdose (IFE): Detailed job planning tool with a radiological model library
- 7. DEMplus (CYCLIFE DS): Decision-support tool combined with 3D simulation
- 8. Aquila costing (WAI): ISDC<sup>2</sup> compatible client-server based <u>costing</u> tool
- 9. iDROP (CEA): VR dismantling simulation with collision & radiological modelling
- 10. WASTREAM (Tractebel): Waste Routes and Activity Assessment tool

11. XRWorkflow (VTT): AR<sup>3</sup> training platform with advanced tracking capabilities
 12. INTERACT (LS): XR<sup>4</sup> platform with physics engine

<sup>1</sup> IFC: Industry Foundation Classes

- <sup>2</sup> ISDC: International Stricture for Decommissioning Costing
- <sup>3</sup> AR: Augmented Reality <sup>4</sup> XR: Mixed Reality





## **PLEIADES: software platform**





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### **PLEIADES Demos**



#### Safet Protecting workers from radiation $\checkmark$ Protecting the environment by $\checkmark$ minimising radioactive waste **PLEAIDES** Optimising costs $\checkmark$

BCOT

 $\checkmark$ 

...

### Scenario simulation

mpror

SMG



Estimations/Comparison/Decisions

- Waste management ۲
- Dose exposure •
- Cost •
- Planning

. . .







### International nuclear decom project ontology







## **Use Cases and Tests**

#### Implementation of PLEIADES on date from real sites

- HRR: Halden Research Reactor (IFE)
- BCOT: Base Chaude Operationnelle du Tricastin (EDF)
- SMG: Santa Maria de Garona (Enresa)

Test PLEIADES though use cases based on different user stories

- User Story #1: Manual vs. remote radiological characterization
- User Story #2: 3D supported vs Digitally enhanced dismantling
- User Story #3: Manual vs. Automated decontamination of building surfaces



## **Use Cases and Tests**

#### Process

- Data integration in the PLEIADES database
  - 3D models, physical and radiological inventories, scenario...
- Tool of the PLEIADES platform tap into this common data repository

### Tools employed for scenario simulation and costing

- VRdose (with RadPIM, BIMsync and RiskBIM) (IFE)
- DEMplus® for nuclear (Cyclife Digital Solutions)
  DEMplus
- iDrop (CEA) 2drop
- AquilaCosting (WAI)





## **Use Cases and Tests: HRR**

#### Halden Research Reactor (HRR)

- HRR: Provide knowledge about performance of nuclear fuel and materials under normal, transient and accident conditions. Part of OECD NEA research program 1958 to 2018.
- A comparison of manual and remote radiological characterization plans for selected components within the Halden Reactor hall.





## **Use Cases and Tests: HRR**

- HVRC VRdose® dose-uptakes for each worker was uploaded to the PLEIADES database from the HVRC VRdose® PLEIADES plugin
- The radiation calculations in VRdose were done by doing kriging interpolation on the measurements set.



#### HVRC VRdose® Results

| Actor                                  | Dose-uptake |
|--|-------------|
| Radiation Protection (manual scenario) | 0.027 mSv   |
| Radiation Protection (robot scenario)  | 0.018 mSv   |
| Worker (manual scenario)               | 0.021 mSv   |
| Worker (robot scenario)                | 0.021mSv    |
| Supervisor (manual scenario)           | 0.023 mSv   |
| Supervisor (robot scenario)            | 0.023mSv    |

| Scenario                | Duration (hours) |  |
|-------------------------|------------------|--|
| Manual scenario         | 0.3              |  |
| Remote / robot scenario | 0.338            |  |



## **Use Cases and Tests: BCOT**

#### Base Chaude Operationnelle du Tricastin (EDF) – BCOT

- Nuclear facility dedicated to nuclear maintenance. Mainly used to maintain, store and decontaminate equipment and tools from contaminated circuits and equipment of EDF nuclear power reactors.
- Made of a 5000 sqm nuclear workshop, split into 22 blockhouses.
- Test of the User Story #3: Manual vs. Automated decontamination of building surfaces
- BCOT 3D model visualization on DEMplus  $\ensuremath{\mathbb{B}}$







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## **Use Cases and Tests: BCOT**

### Base Chaude Operationnelle du Tricastin (EDF) – BCOT

• Test and results from DEMplus® scenario simulations



Use of a robot for remediation and radiological control of the surfaces increases the duration of the project by a 3 factor. Due to the duration increasing, the cost of the project increase by a 3.5 factor.

| Estimation                    | Manual scenario | Gap (initial unit) | Gap (%) | Automated scenario |
|-------------------------------|-----------------|--------------------|---------|--------------------|
| Cost                          | 778.4 k€        | + 1912.4 k€        | + 246 % | 2690.8 k€          |
| Duration                      | 1371 hours      | + 2726 hours       | + 199 % | 4097 hours         |
| Total waste                   | 37.8 tons       | + 9.2 tons         | + 24 %  | 47.0 tons          |
| Primary waste                 | 27.8 tons       | 0                  | 0 %     | 27.8 tons          |
| induced & technological waste | 4.9 tons        | + 7.8 tons         | + 159 % | 12.7 tons          |
| Packages mass                 | 5.1 tons        | + 1.4 tons         | + 27 %  | 6.5 tons           |
| Collective dose               | 9660 µSv        | - 241 µSv          | - 2 %   | 9419 µSv           |
| atmospheric<br>contamination  | 0.75 RCA        | 0                  | 0 %     | 0.75 RCA           |

In conclusion, manual scenario seems to be more suitable considering the initial radiological inventory of the BCOT and the significant increase in time and costs for the automated scenario.





## **Use Cases and Test: SMG**

#### Santa Maria de Garona (Enresa) – SMG

- Boiling Water Reactor (BWR-3) shutted down in 2012 after 41 years of operation and in D&D process since 2017. Today several drawings are compiled, some of them dating back more than 40 years and having suffered considerable updates.
- User Story #2: 3D supported vs Digitally enhanced dismantling
- SMG 3D model visualization on DEMplus®









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# **Conclusion and Perspectives**

- User need analysis showed very high interest and many opportunities
- Standardization of data representation is key for a true international approach
- There is a gap between theoretical ontology and practical integration but solvable
- PLEIADES tests will clarify practical usability/readiness
- PLEIADES in only the beginning! need to continue in strong international collab.

Let's continue discussing about PLEIADES and digitalization in general at:

PLEIADES II ...?



# **DigiDECOM** October 24-26 2023 Finland + Online







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