



# Expected contribution of statistical methods to nuclear decommissioning of CEA facilities

DE LA RECHERCHE À L'INDUSTRIE

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**D&D deployed for CEA nuclear facilities**



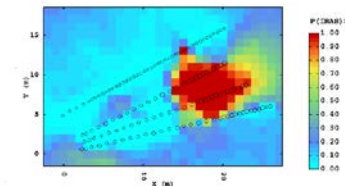
**Analysis in support to D&D**



**R&D applied to D&D**

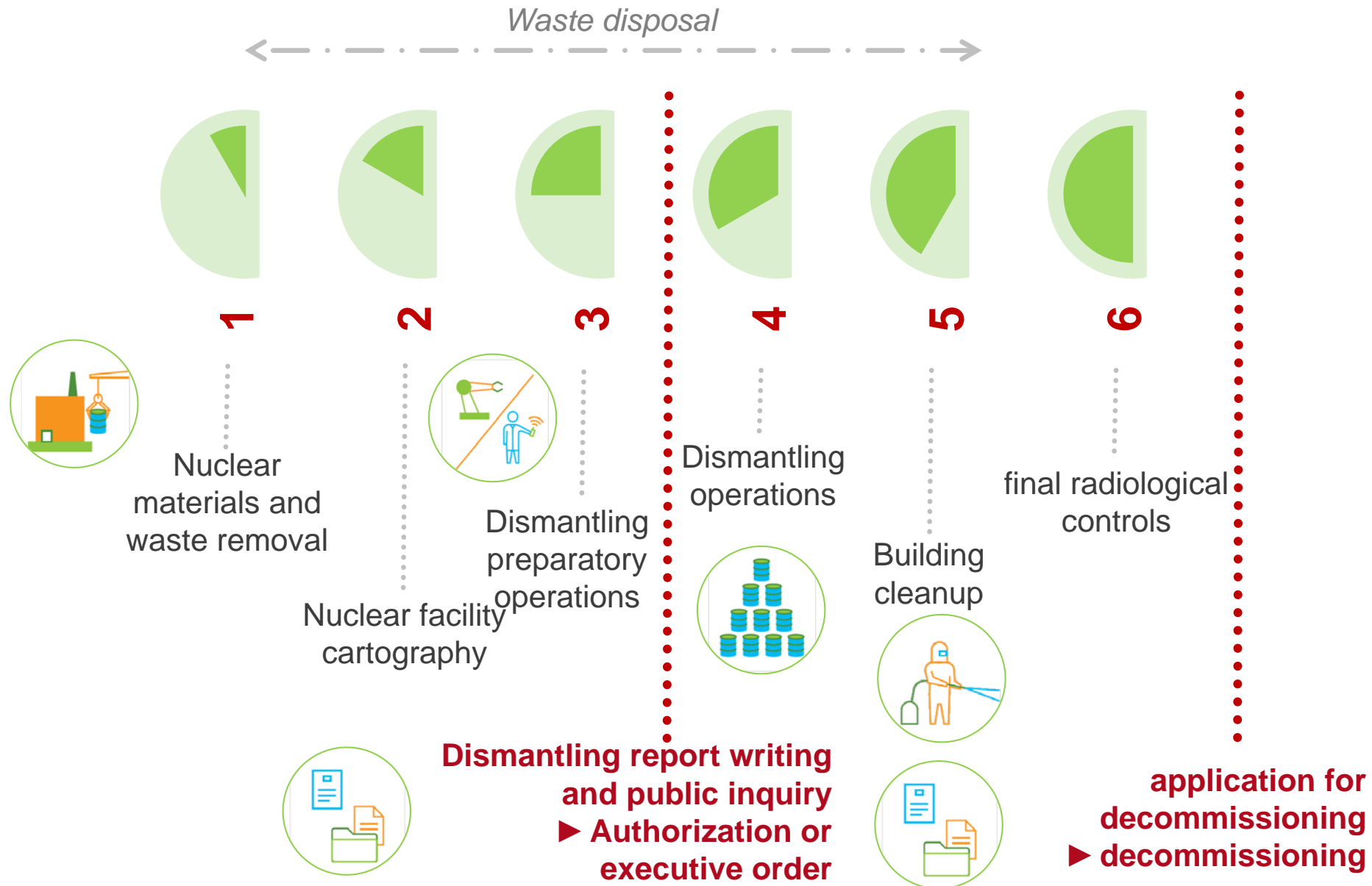


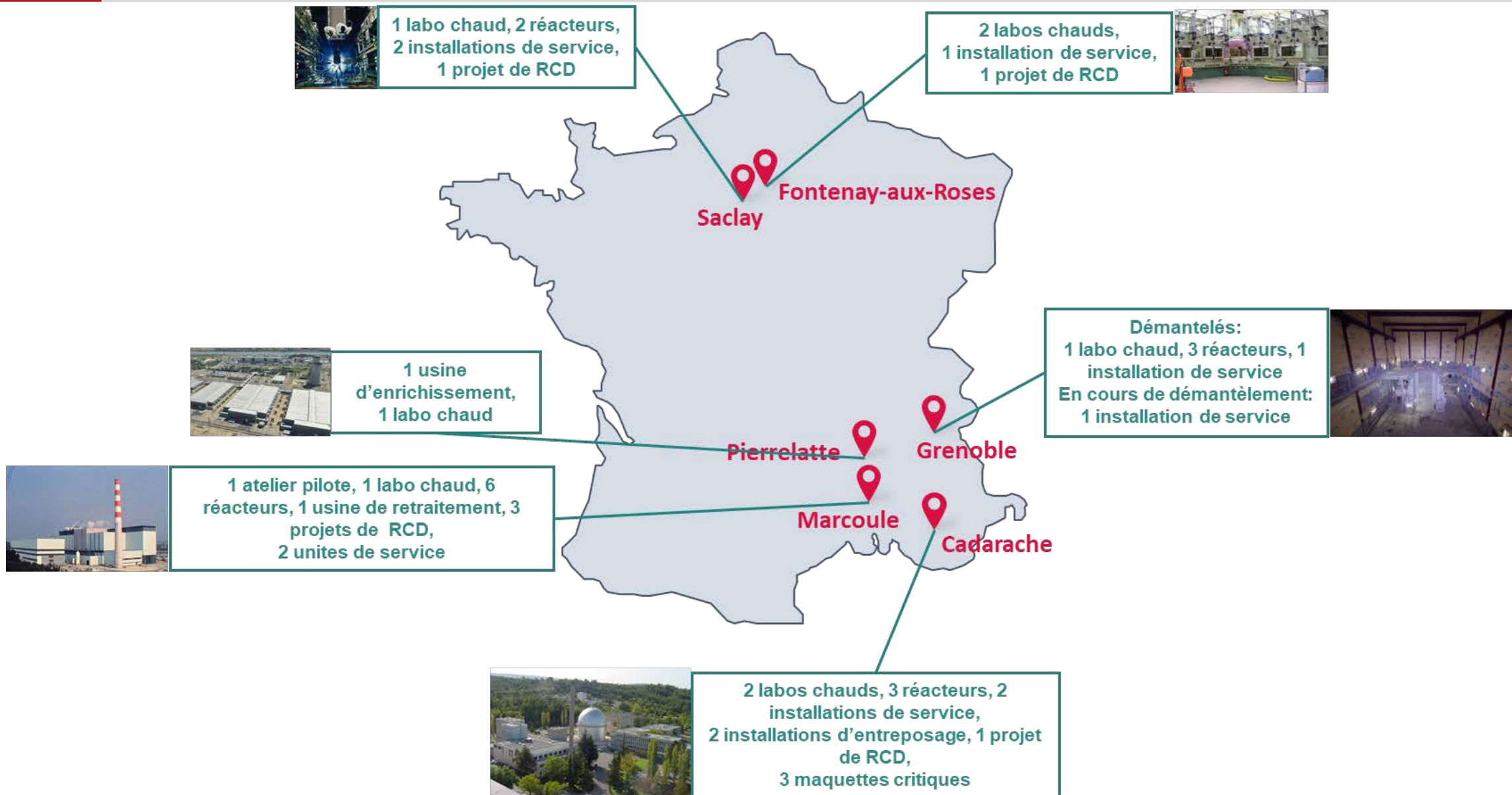
**Expected contribution of statistical methods to D&D**





## D&D deployed for CEA nuclear facilities





► **Large diversity of nuclear facilities**

- Reactors
- Accelerators and irradiators
- Laboratories, and nuclear plant
- Facilities for waste treatment and storage



► **No « series » effect**

► **Various sizes**

- Reactors : Ulysse → Phénix
- Laboratories to plant LAMA → bat 18 FAR  
→ APM → UP1



► **R&D facilities**

- Various liquid and solid wastes



► **Spent nuclear fuel treatment**

- Contamination and irradiation level potentially high

► **Historical nuclear sites**



## ► **PASSAGE Project**

- Dismantling end : **2013**
- **3** nuclear reactors and **1** laboratory decommissioned
- june 2018 : Send of the application for decommissioning for nuclear facilities : **ultimate administrative step** of full Grenoble site decommissioning

## **First complete industrial C&D operation at site scale**



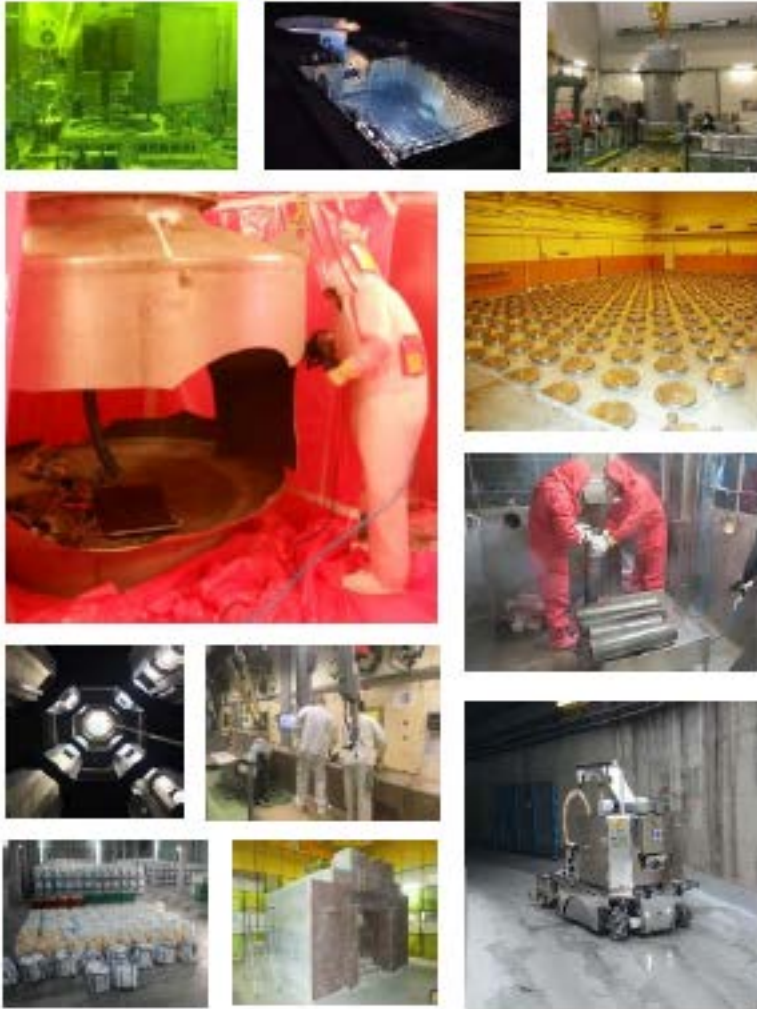
## ► Operational issues

- ✓ Initial state control of old facilities
  - characterization improvement and coupling with virtual reality to contribute of dismantling scenario definition
- ✓ Waste management control
  - sorting, treatment, conditioning, transport, storage
- ✓ need of stabilized specifications for existing storage or for future storage to define both R&D and characterization actions

## ► Transversal safety priorities

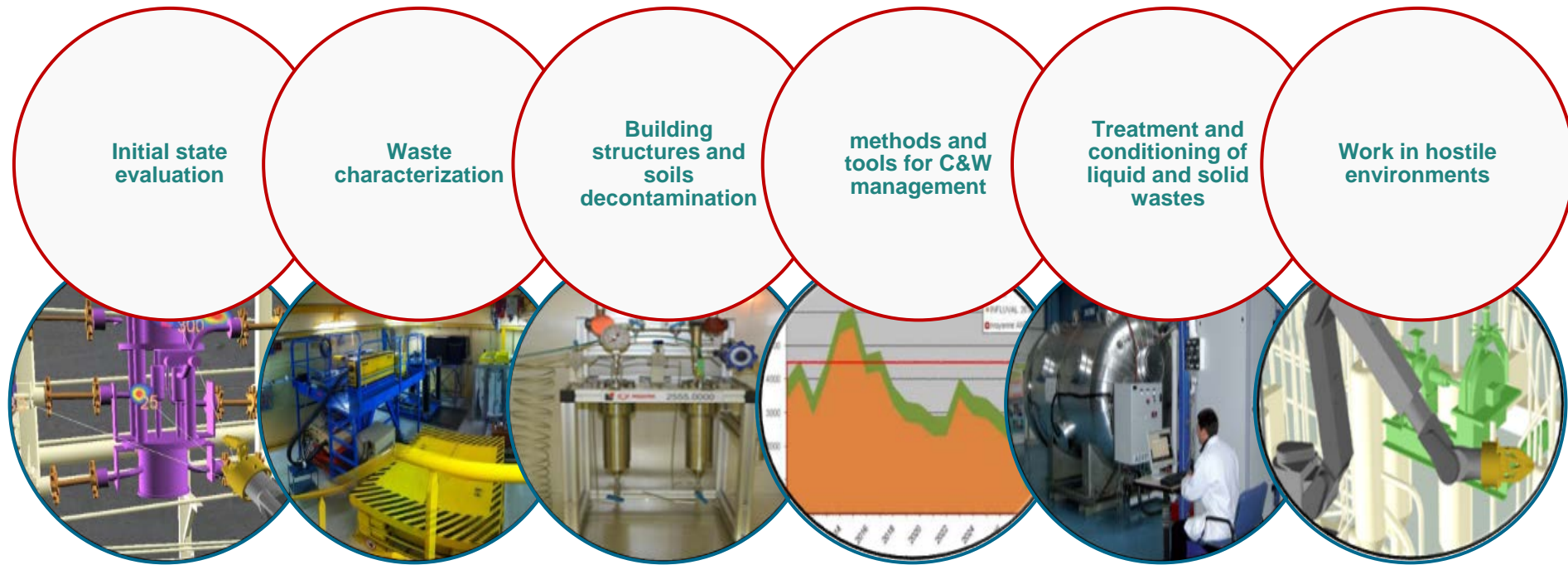
- ✓ Polluted Soils characterization and management
- ✓ Construction of waste treatment and storage facilities associated with recovery operations
- ✓ R&D needed in support for these operations
- ✓ Analysis capacities, particularly radiochemical, sized to support dismantling projects





## R&D applied to D&D

## 6 axes for R&D



► **D&D activities have reached maturity, but technological/methodological developments are needed to improve:**

- ✓ the operational performance of complex projects,
- ✓ dose uptake and to improve work safety & security on nuclear operator
- ✓ waste minimization

### Short-term applied R&D (3-5 years)

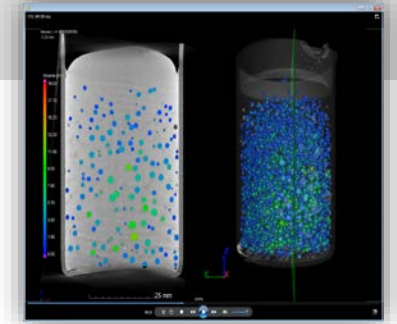
- ▶ Contribute to the realization of the 10 priority D&D projects
- ▶ General & transversal studies required for at least two D&D projects of the CEA (and industrial partners)

### Medium-long term prospective R&D (5-10 years): Technical and economic optimization, with equivalent level of safety

- ▶ Develop and qualify technological processes
- ▶ Evaluate the future treatment/packaging options for unpackaged waste
- ▶ Evaluate the technical feasibility of re-classifying packages/historical waste to the different storage

### Breakthrough R&D (including dedicated theses)

- ▶ Identify new axis of research for topics in the coming years.
- ▶ Attract new recruits on future topics with real technical and scientific issues.
- ▶ Building an active network between researchers and A&D projects



*H<sub>2</sub> bubbles modelling in irradiated bitumen*



*Geopolymer matrix for Mg-clad blocking*



*ROL plasma destruction process*



*« Coccomyxa actinabiotis »  
microalgae accumulating NRs*



## Analysis in support to D&D

## ► Analysis needs include all the C&D project phases whose :

- ✓ Initial knowledge of liquid and solid wastes
- ✓ Process controls
- ✓ Operation monitoring of the of facilities,,
- ✓ Compliance Guaranty to with outlet requirements

## ► Aim

- ✓ Rationalize analysis use of in terms of :
  - Quantity,
  - quality,
  - Rendering times
  - Economic optimum,
- ✓ Contribute to maintaining/developing the CEA team expertise

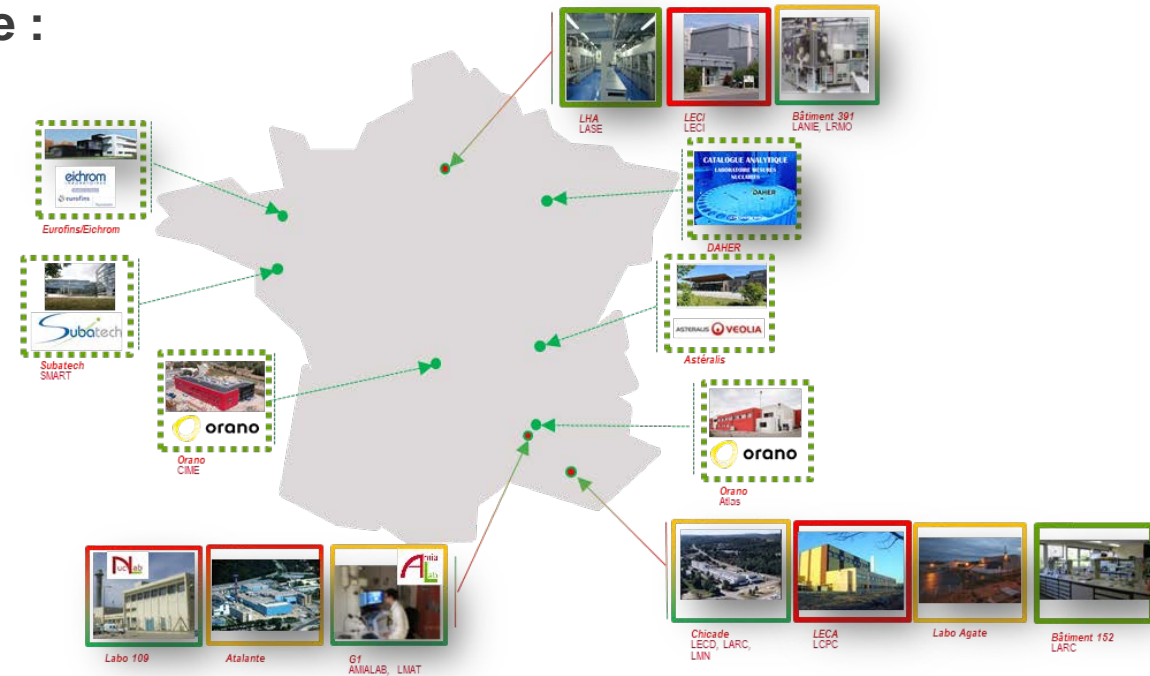
## ► Ensure the interface between projects and analysis laboratories

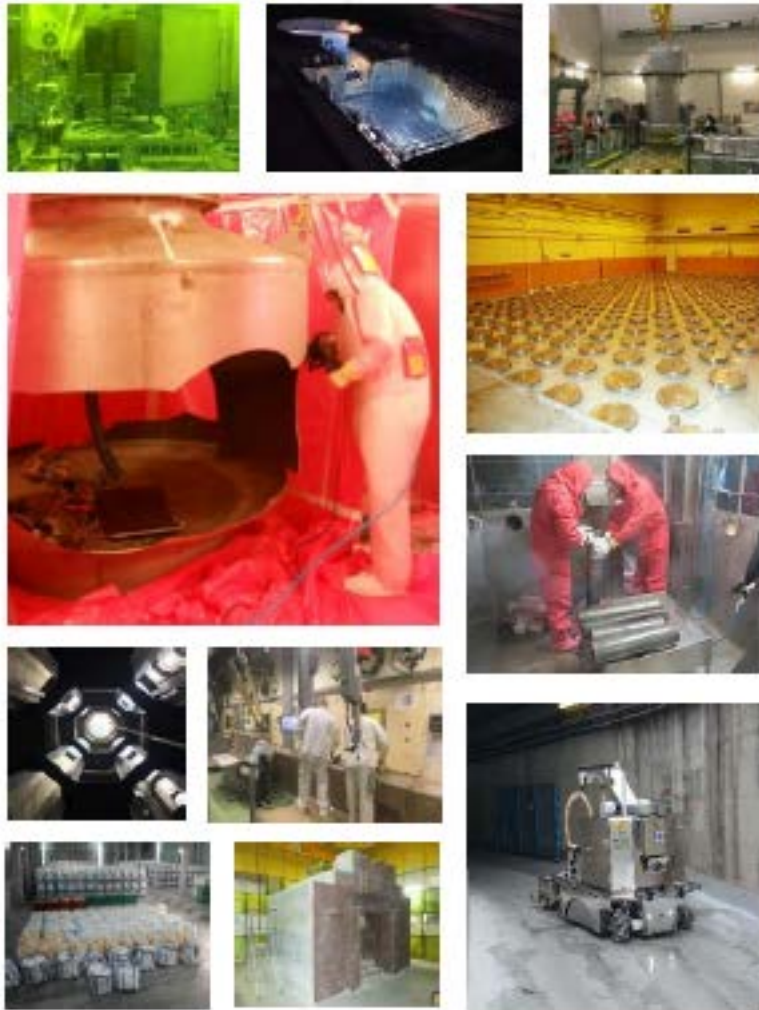
- ✓ Challenging project needs and laboratory offers,
- ✓ Translating needs and offers in understandable language

## ► Anticipate responses to future needs

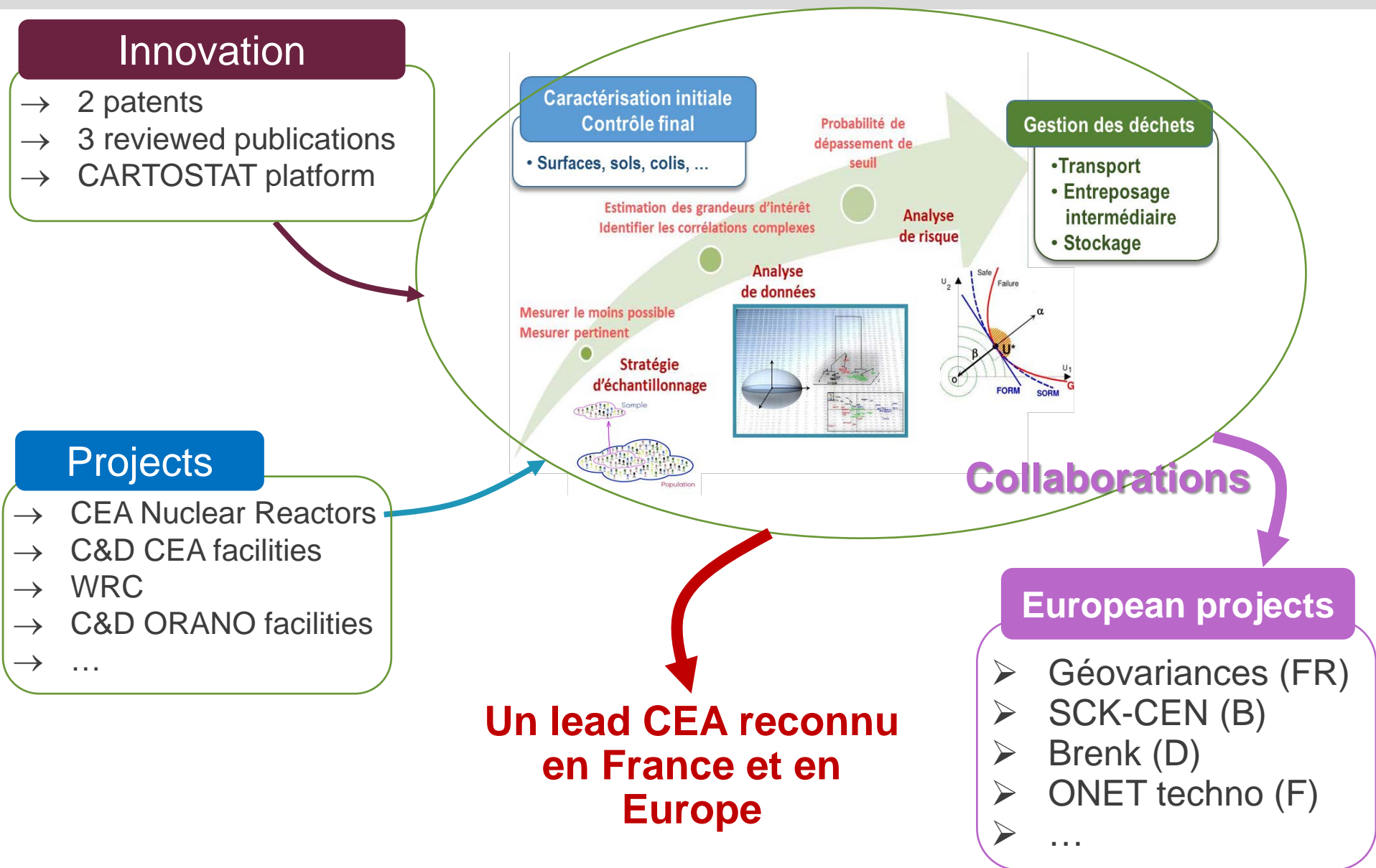
- ✓ Identifying over 5-10 years,
- ✓ Support analytical developments in interaction with R&D for D&D

## ► Laboratory network use





## Expected contribution of statistical methods to D&D



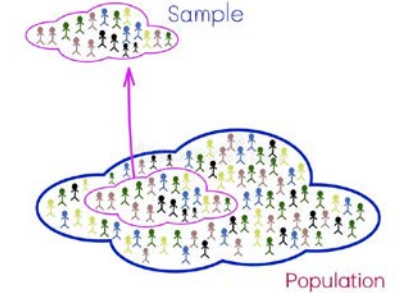
► Initial and final characterization (1/2)

## Characterization

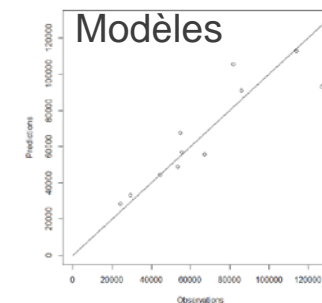
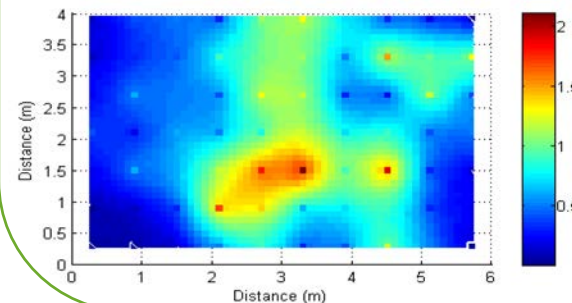
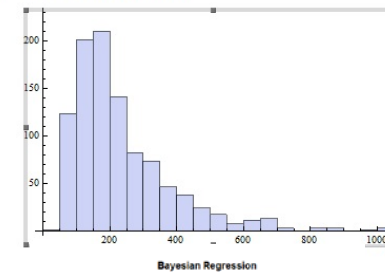
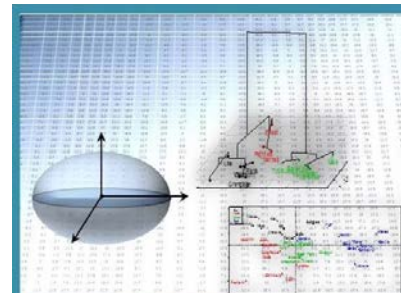


**D&D Constraints**  
(exploitation, financial, ...)

## Statistic for sampling strategy



## Data Statistic analysis Machine learning





## ► Initial and final characterization (2/2)

**Événements**

- Chute, Incendie, Infiltrations - inondations
- Risque H<sub>2</sub>
- Dégradation conteneur  
(carbonatation, fissures, corrosion externe,...)

**Confinement dynamique**

- Ventilation naturelle et/ou forcée
- Filtres, arrêt extraction
- Récupération des eaux, ...

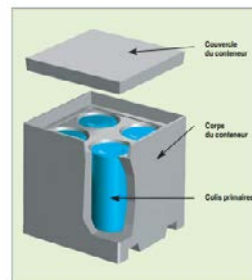
**Confinement statique**

Systèmes passifs + Règles de conception

1<sup>ère</sup> barrière  
Colis (métal,  
ciment, verre,  
...)



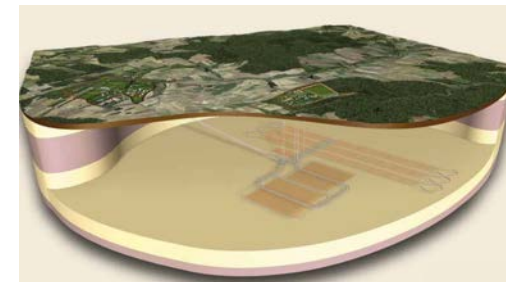
2<sup>ème</sup> barrière  
Conteneur  
béton ou acier



3<sup>ème</sup> barrière  
Alvéole

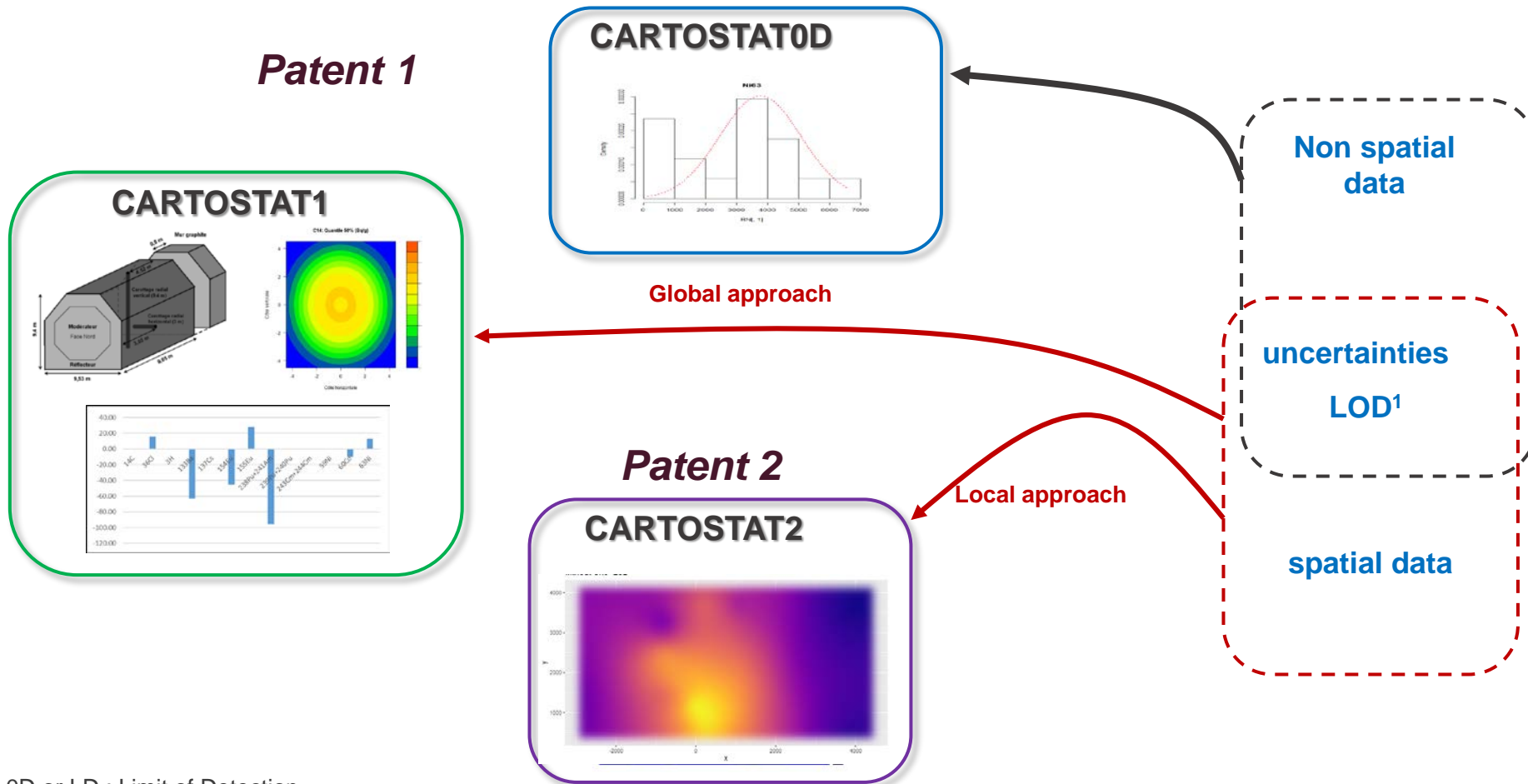


4<sup>ème</sup> barrière  
Matrice  
géologique  
argileuse



► Surface and object CARTOGRAPHY

**CARTOSTAT : Characterization and cARTOgraphy of pollution with STATistical Techniques**



<sup>1</sup> LOD or LD : Limit of Detection

▶ **Non destructive measurements**

- ✓ Radiological cartographies
- ✓ **Background noise versus low radionuclide contamination**

▶ **Sampling**

- ✓ Where,
- ✓ How much,
- ✓ How many,
- ✓ **Sample representativeness ?**

▶ **Analysis**

- ✓ Counting time versus number of measurements,
- ✓ Uncertainty measurement determinations.

▶ **Data treatments**

- ✓ **With few analysis results (sampling in difficult and constraint conditions)**
- ✓ **With dispersion of analysis result (sampling conditions, representativeness)**



**Thank you for your attention**