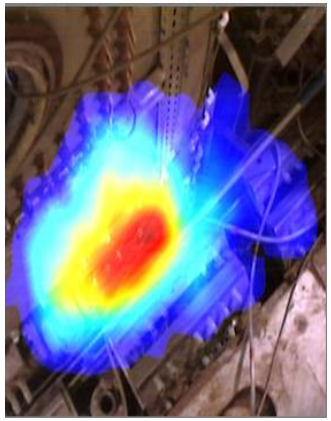
PREDEC 2016

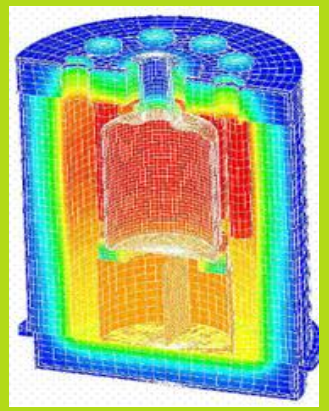
International Symposium on PREparation for DECommissioning

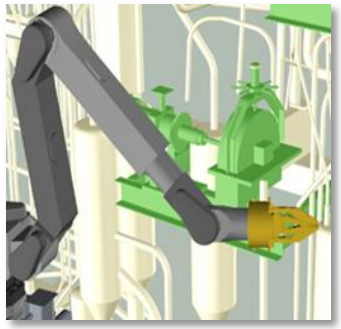


Benefits from R&D for D&D Projects Preparation

FROM RESEARCH TO INDUSTRY

cea den





nuclear expertise from France

Christine GEORGES

17th February 2016

SPECIAL FEATURES OF CEA D&D PROJECTS

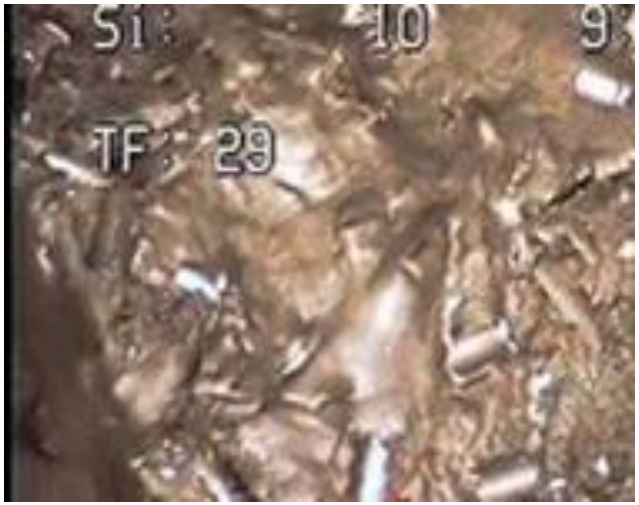
500 M€/year
800 CEA employees and about 2500 employees from supply chain

- **Wide variety of facilities with no series effect**
  - Reactors: pool-type, fast breeder, gas graphite…
  - Accelerators and irradiators,
  - Fuel cycle laboratories, workshops and plants
  - Waste treatment and storage facilities
- **Different facility sizes**
  - Reactors: Ulysse (piloting training) -> Phénix (Industrial)
  - Facilities : FAR or LAMA -> UP1
- **High contaminated areas**
- **Waste diversity**
- **History and traceability of Old nuclear facilities**

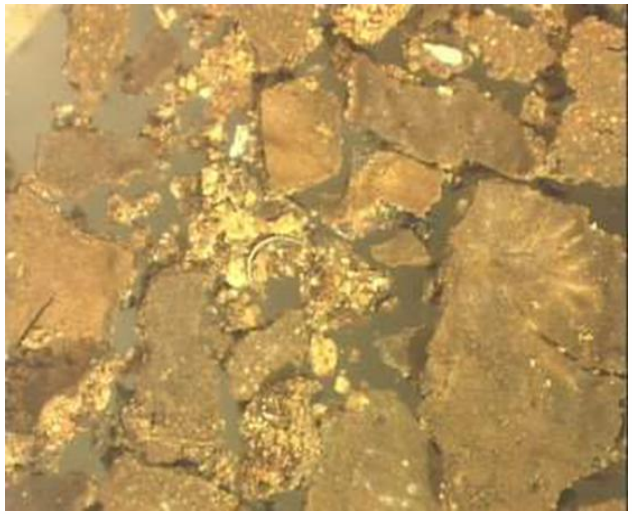
WIDE RANGE AND LARGE AMOUNT OF HLW WASTE

Ex UP1 : 75 types of legacy wastes, located in18 different locations:

- ~ 3150 glass canisters
- ~ 1630 t of HLW Mg clads
- ~ 1300 t of powdery waste
- ~ 1300 drums of alpha-waste
- 60 000 drums of bituminized waste
- Active areas = 140 000 m3
- 26 000t of waste from active areas



- Very different in they chemical and radionuclide composition
- long-lived radionuclides
- Re-disposal required

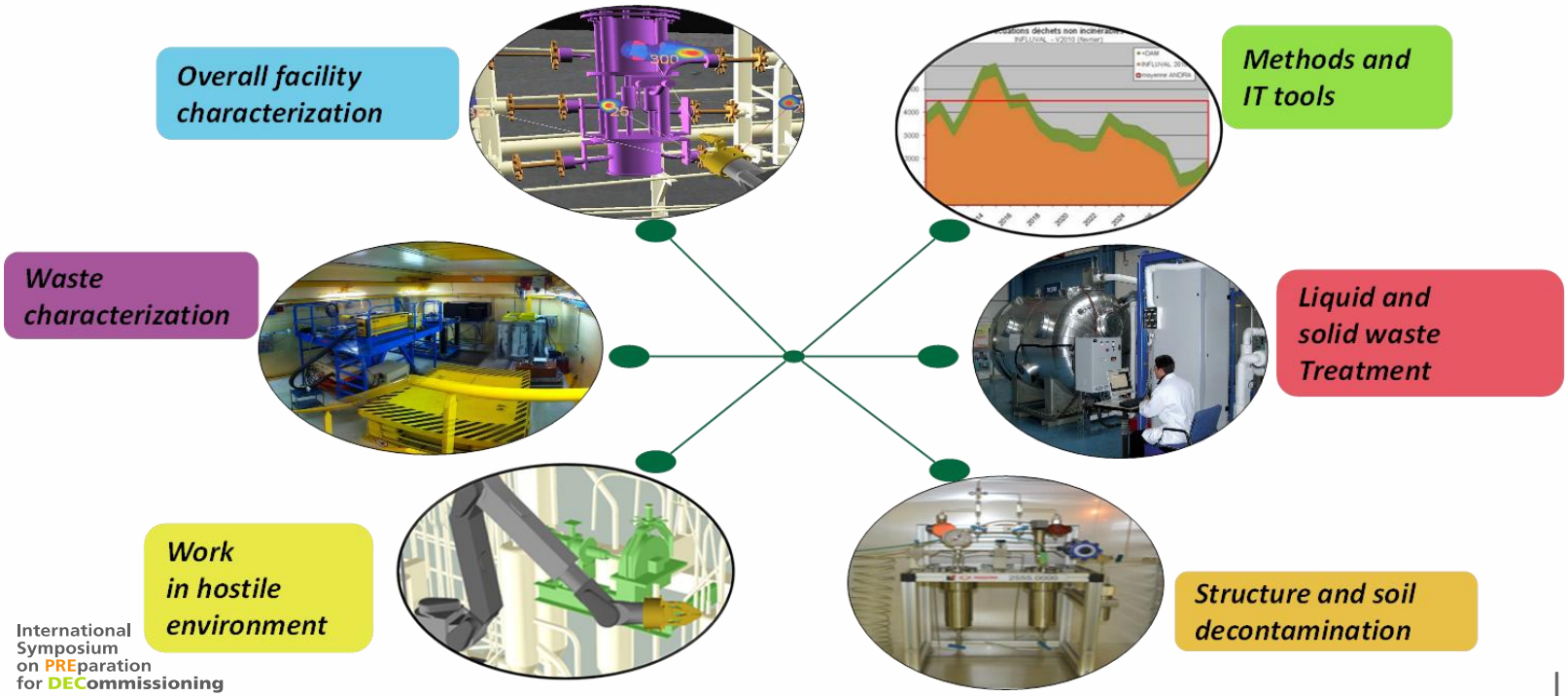


CEA D&D R&D, TECHNOLOGIES AND PROCESSES

R&D Program has two main purposes :

- **Optimizing R&D activities in support of clean-up and dismantling programs**
  - to reduce the cost, the duration of the work, the doses incurred, the amount of waste produced
  - to improve the safety and security of dismantling worksites
- **Developing and promoting R&D and expertise**
  - to share R&D developments
  - to provide expertise
  - to develop industrial partnerships

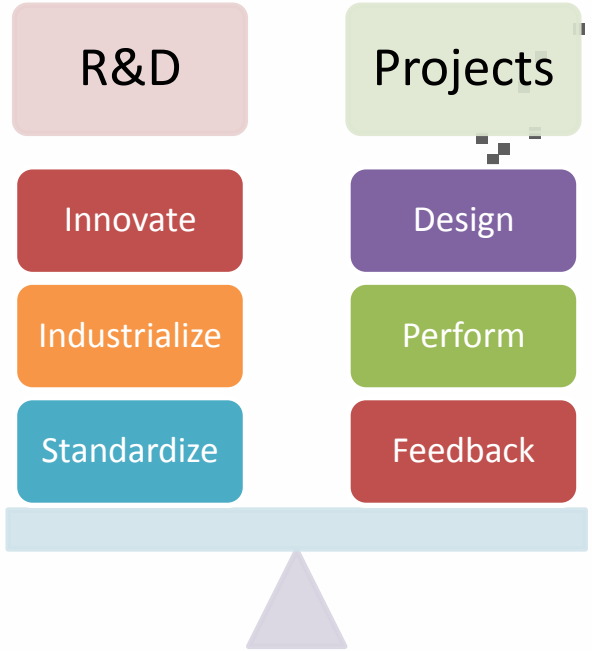
CEA leads R&D actions and develops expertise in 6 main axis

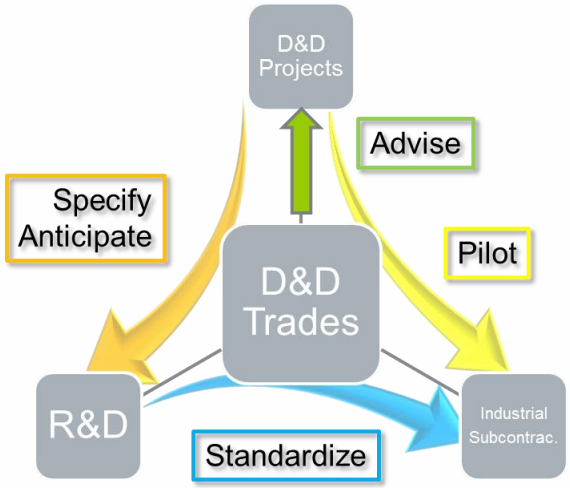


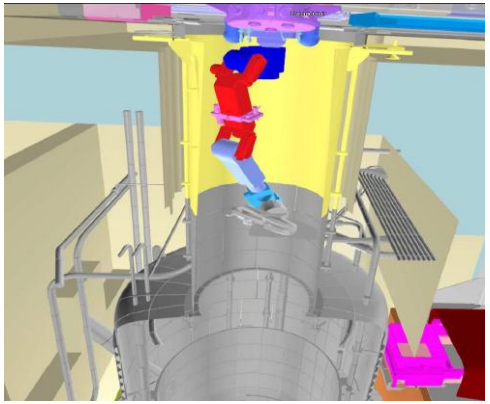
CEA BOTH OPERATOR AND RESEARCH ORGANIZATION

Synergy between R&D, expertise and experience from D&D workshops

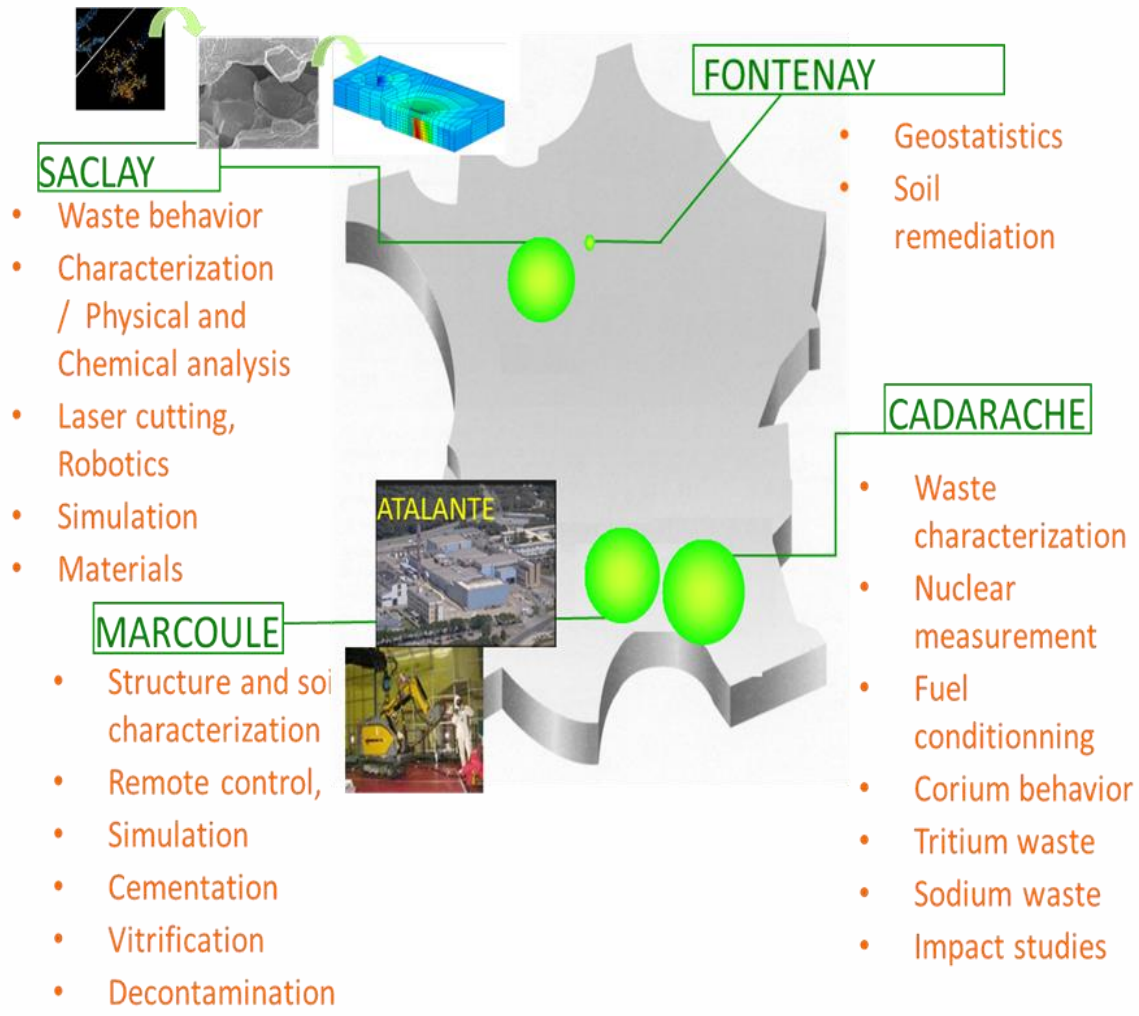
- Orientation of R&D towards industrial needs
- Easy access to pilot workshops in order to give confidence to other users
- Opportunity for sharing with other contracting authorities the development of solutions on same challenges







EXPERTISE AND R&D FOR D&D



- Development of R&D programs,
- Research partnerships,
- Access to pilot job sites,
- Access to laboratories / technological platforms,
- Consulting,
- Technology transfer

IN SITU CHARACTERIZATION

NEEDS for:

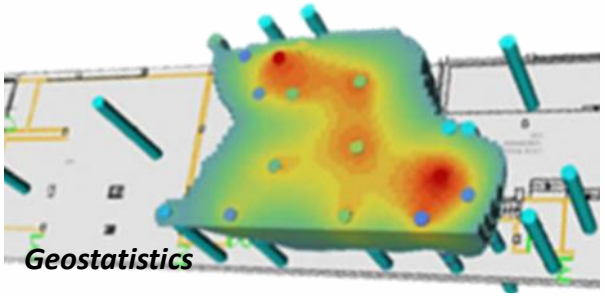
- Better knowledge of radiological and physical states to control hazards management, cost and delay
- Reduction of doses integrated by operators
- Optimization of samplings

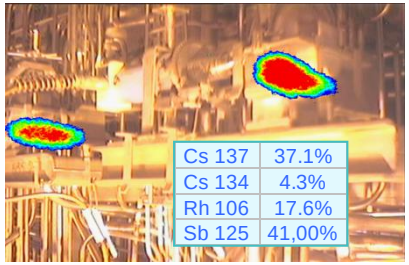
EARNINGS

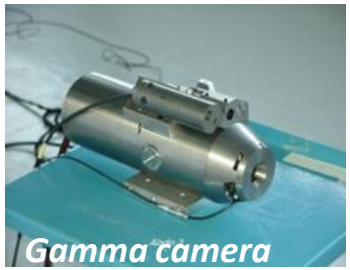
Optimization of D&D scenarios, from the identification of characterization objectives through to the final physical and radiological inventory

IMPROVEMENTS

- to map facilities and soil,
- to localize hot spots,
- to identify radionuclides,
- to estimate radioactivity,


Geostatistics

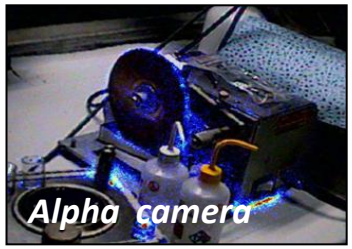



Gamma camera


LIBS technology


Gamma spectrometry for concrete contamination


Autoradiography


Alpha camera

WASTE CHARACTERISATION

NEEDS for:

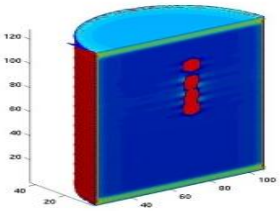
- Better knowledge of radiological and physical states with less uncertainties in the mesurements
- Transportable and multipurpose systems for different kind of waste

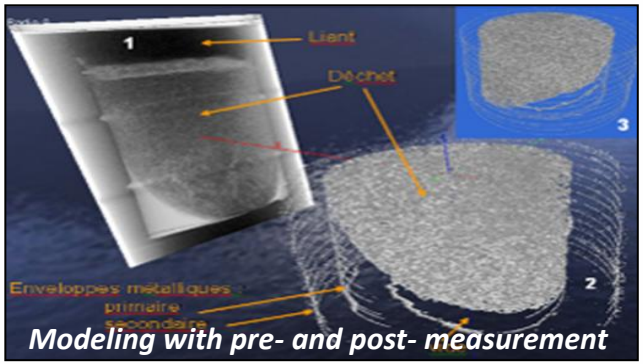
EARNINGS

- Waste minimization
- Good predictive data for st facilities
- Optimization of characterization processes

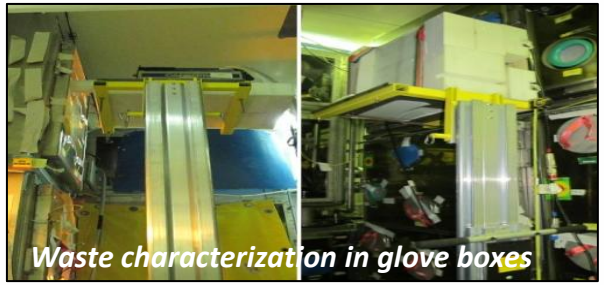
IMPROVEMENTS

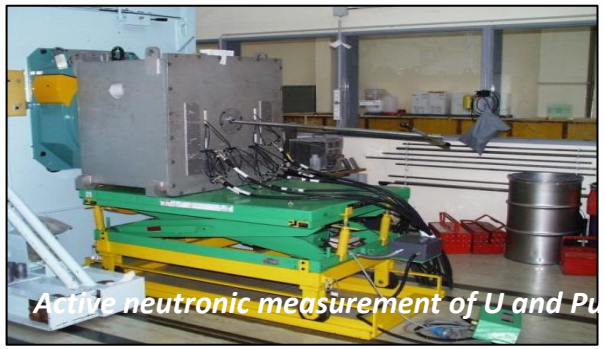
- non destructive analysis:
  - γ et α imaging
  - γ spectrometry
  - Neutronic measurement
- Destructive analysis :
  - beta long live analysis



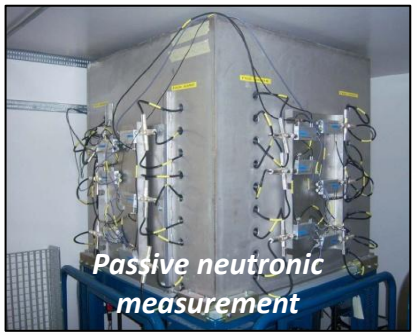


Modeling with pre- and post- measurement


Waste characterization in glove boxes


Active neutronic measurement of U and Pu


assive neutronic measurement o Uranium


Passive neutronic measurement

STRUCTURE AND SOIL DECONTAMINATION

EARNINGS

- Identify and implement decontamination techniques for radioactive solids, structures and soils
- Waste optimisation

IMPROVEMENTS

- Technologies adaptable to many geometrical configurations, and to a wide range of materials and natures of contamination:
  - ✓ aspirable self-drying gels,
  - ✓ laser ablation,
  - ✓ viscous foams or active solutions,
  - ✓ float foams or supercritical fluid,
  - ✓ coating gels, …
- Studies of chemical medium formulations with associated physico-chemical characterizations,

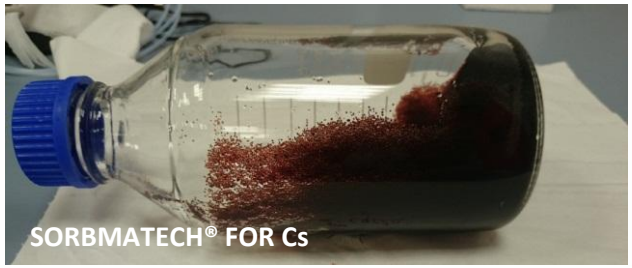
DECONTAMINATION OF LIQUID WASTE

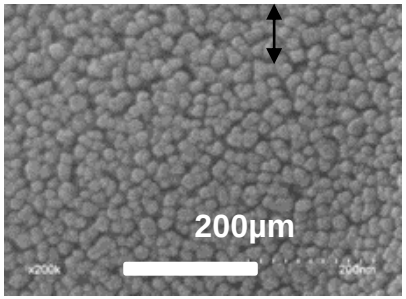
EARNINGS

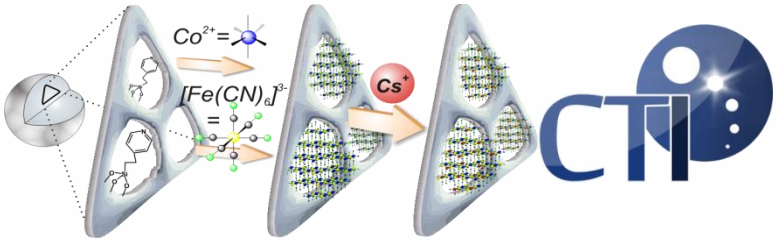
- Increase decontamination efficiency
- Minimization of generated waste
- Compatibility with large flowrates
- Compatibility with existing waste treatment (cementation, vitrification)

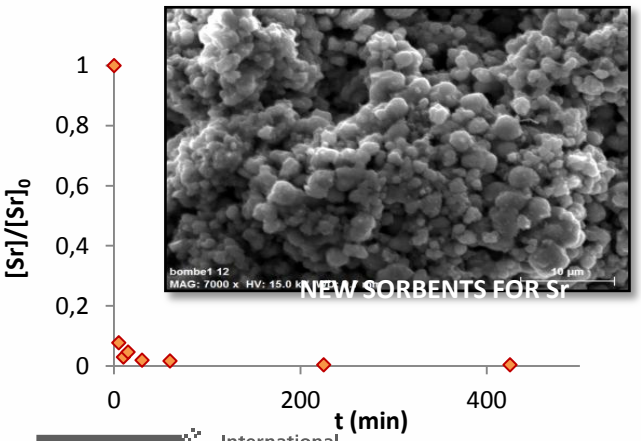
IMPROVEMENTS

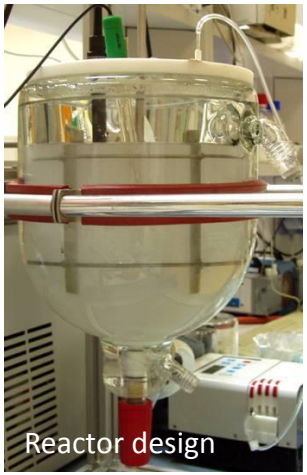
- Innovative decontamination process design
- Innovative Cs and Sr sorbents design
- Sorbent synthesis from laboratory scale up to industrial scale.











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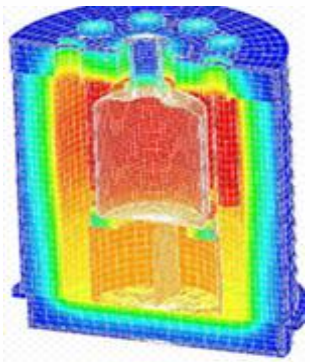
WASTE TREATMENT / CONDITIONNING / LONG TERM BEHAVIOR

EARNINGS

- Develop efficient treatments for complex radioactive wastes (mercurials, sodics, tritiates, Mg from decladding, powders, graphite, sludges, other legacy waste, ..)


In-Can Melting


Hydrothermal oxydation



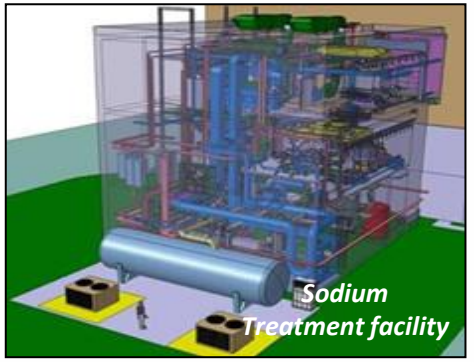

Plasma under water

IMPROVEMENTS

- design and carry out radioactive waste treatment processes from laboratory scale through to industrialization phases.

- Several thermal processes for the treatment of solid or liquid organic radioactive wastes:
  - ✓ incineration,
  - ✓ mineralization of organic liquids by hydrothermal oxidation or by plasma incineration
  - ✓ Vitrification (in-can melting)
  - ✓ Encapsulation with geopolymers (Mg, oils),
  - ✓ Mercury, sodium, tritium waste, treatment, etc.


opolymer matrix


Sodium Treatment facility

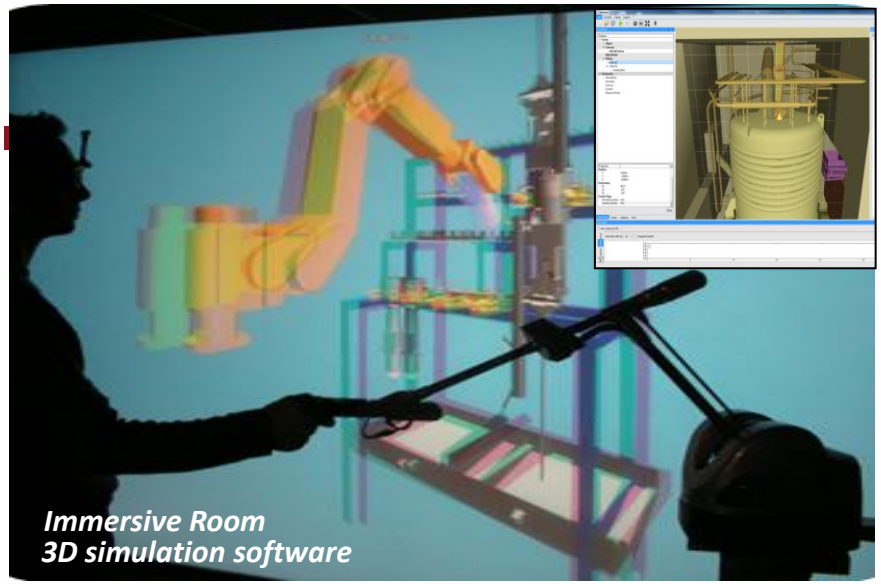
REMOTE TECHNOLOGIES

EARNINGS

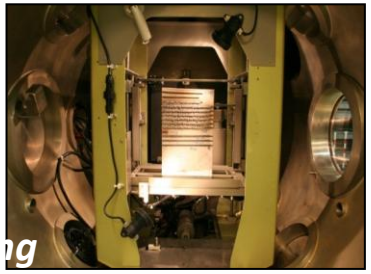
- Validate intervention scenario feasibility
- Reduce the doses integrated by operators
- Minimize cost, delay, waste volume, cuttings
- Compare alternative scenarios
- Qualify remotely-controlled

IMPROVEMENTS

- Design, adaptation of fine-tuning innovative systems for computer-assisted tele-operation actions, as well as carriers: remote handling MAESTRO
- Development of laser cutting processes in air or under water to improve cutting yields while limiting the aerosols and waste generated.
- Development of 3D simulation software and virtual reality: Immersive Room for training


Immersive Room
3D simulation software

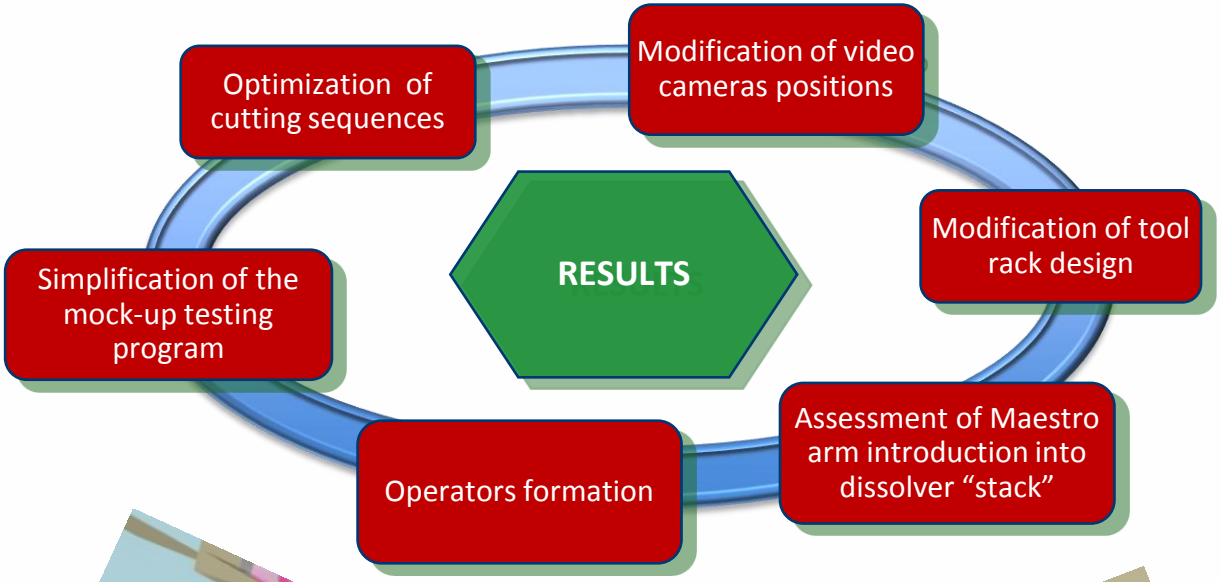

Laser cutting

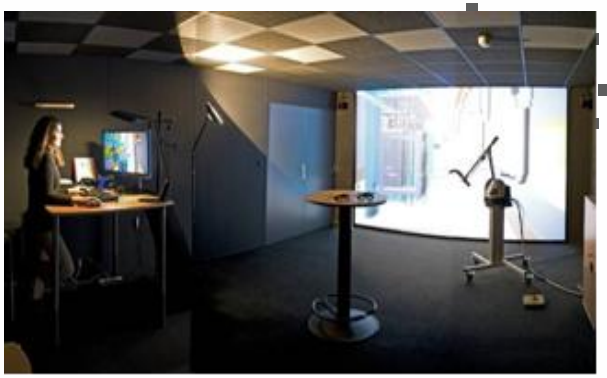


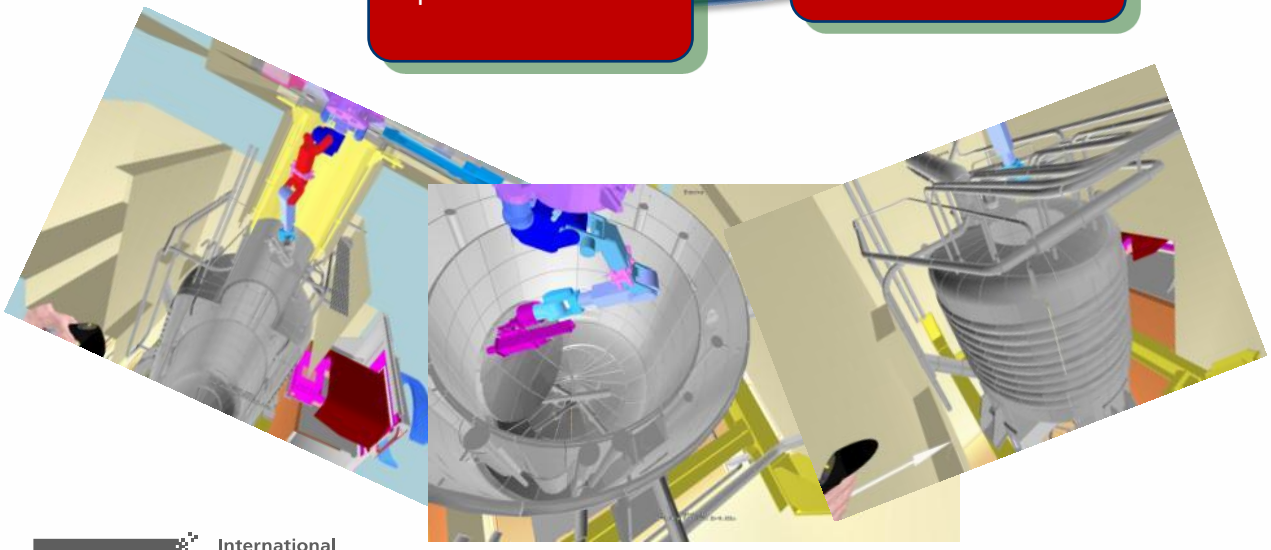

Maestro with laser

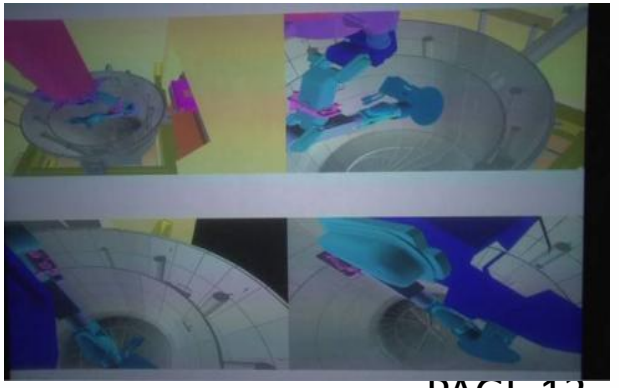

Pilot workshop

REMOTE DISMANTLING OF THE DISSOLVERS
The use of Virtual Reality to secure the project



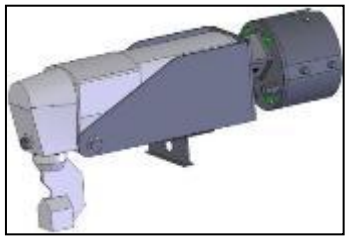


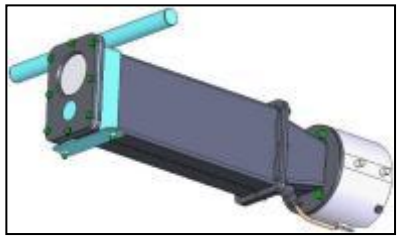


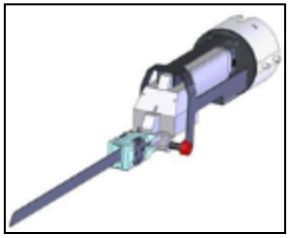


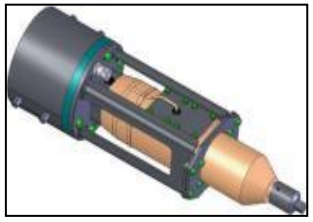
MAESTRO SYSTEM CONCEPT

Several factory tools, have been studied, developed and qualified.

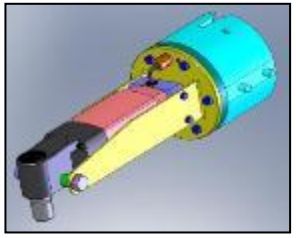

Nibbler

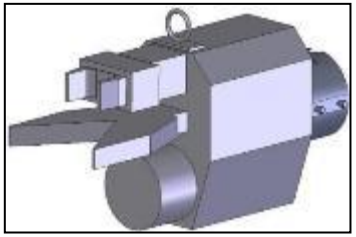

Gamma camera

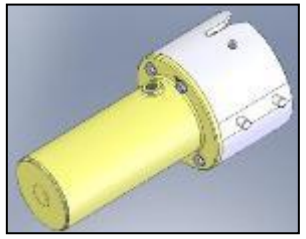

Alternating saw

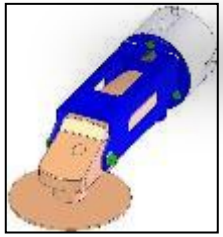

Drill


Laser torch

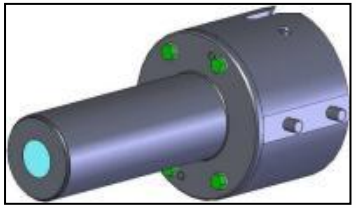

Offset screwdriver


Hydraulic shears

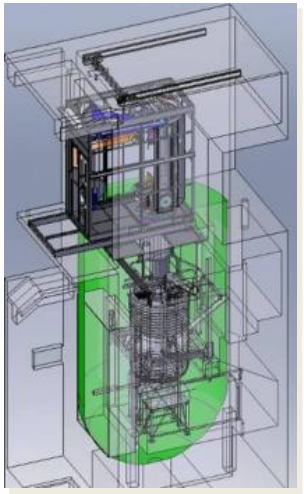

Video camera


Disk grinder


Screwdriver


IF104 radiation probe

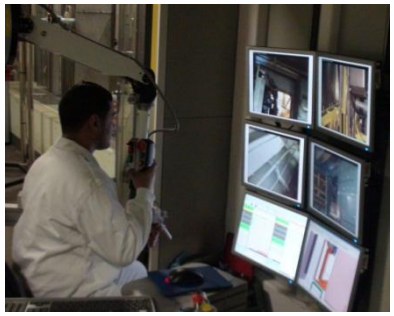
MAESTRO PERSPECTIVES



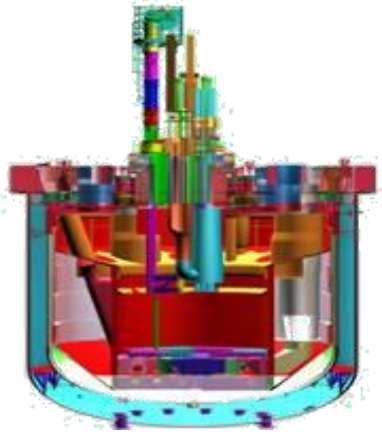
Pétrus – Building 18

Rapsodie

UP1 – Dissolvers MAR 200



APM

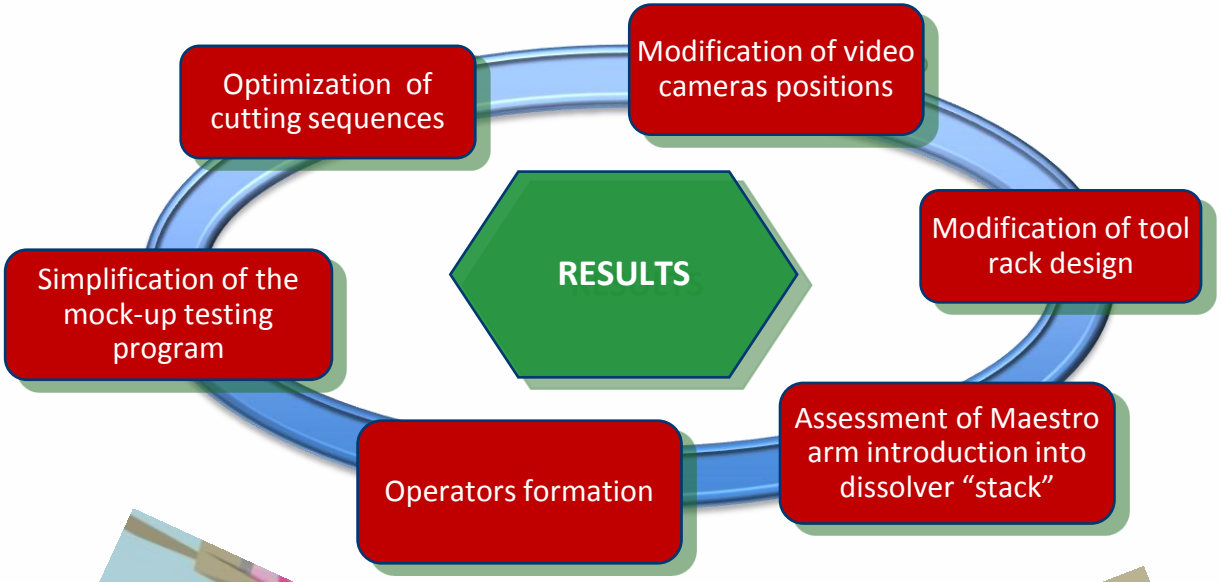


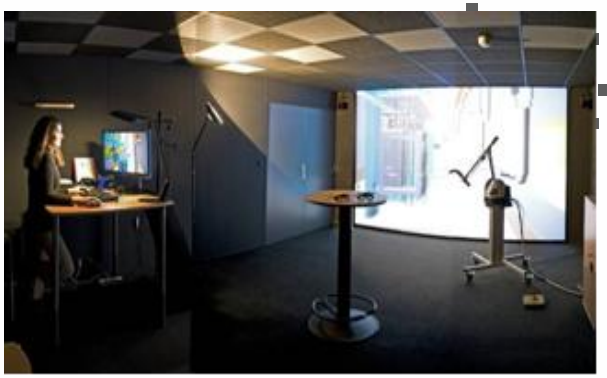
Phénix

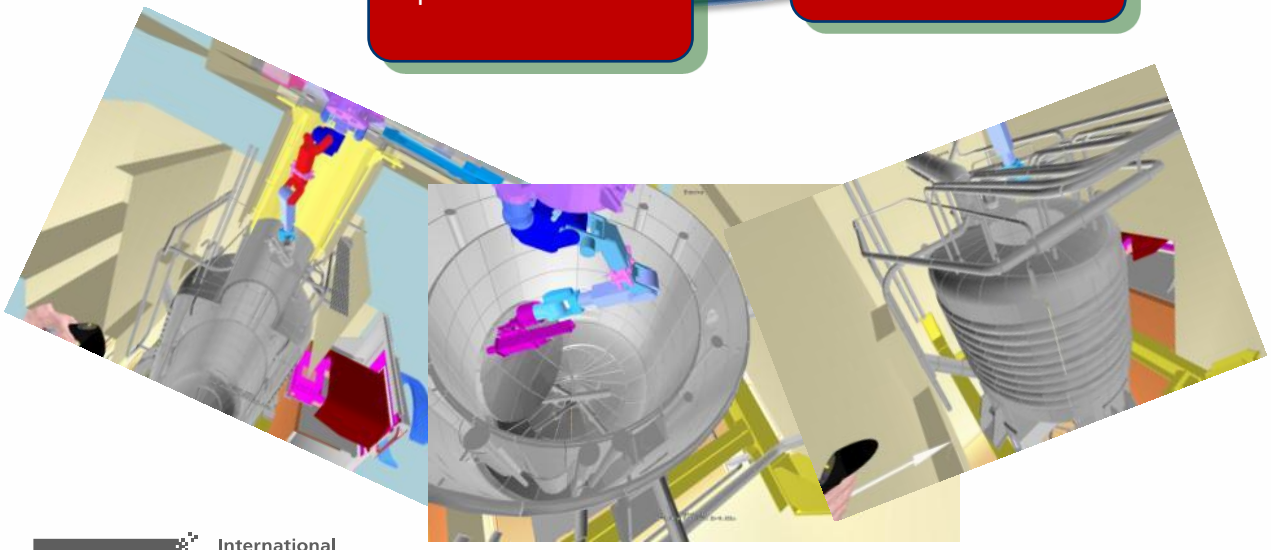
UP1 - AVM

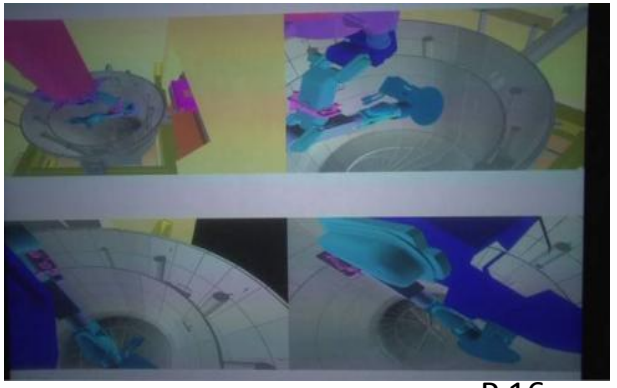
REMOTE DISMANTLING OF THE DISSOLVERS

The use of Virtual Reality to secure the project





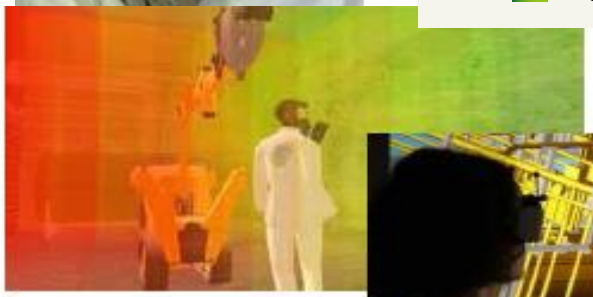




DEFINITION OF SCENARIOS: A COMPLETE MODEL

Characterization

Simulation, virtual reality



Remote technologies, robotics

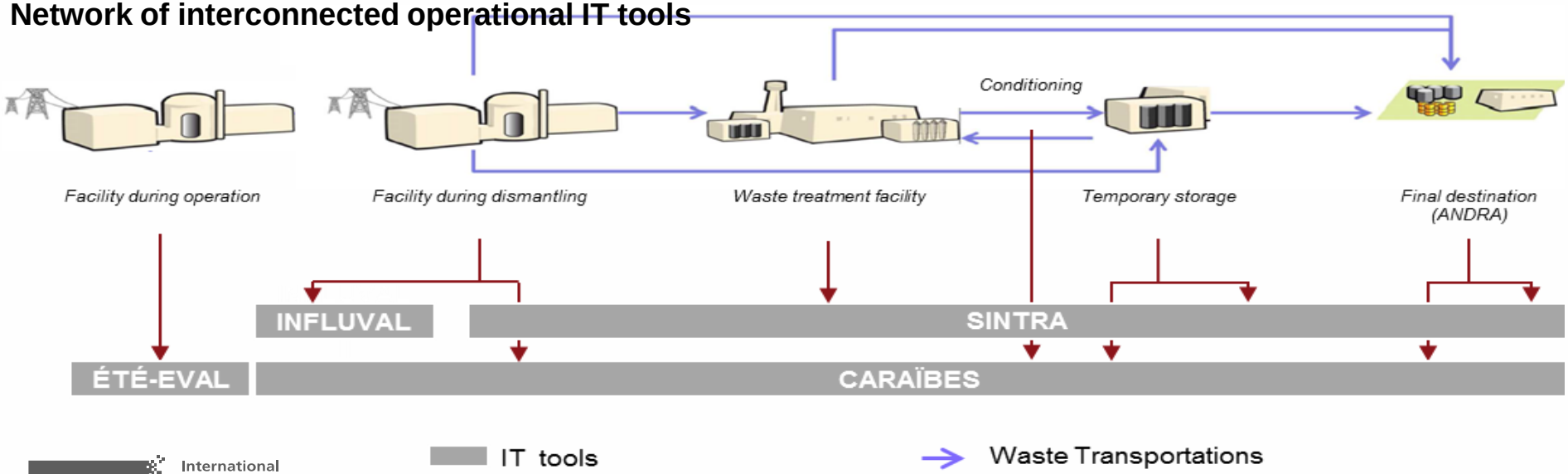
EXPERTISE/ MASTERING DISMANTLING SCENARIOS

- **Tools for estimation of overall costs (ETE –EVAL)**
- **Tools for project management (DEM +, Saphir, etc.)**
- **Tools for transportation management (SINTRA)**
- **Tools for waste management (CARAIB, INFLUVAL)**

Key figures:

- ***3000*** technico-economic costing ratios,
- ***+50*** product headings,
- ***225 000*** packages recorded
- ***+300*** users.

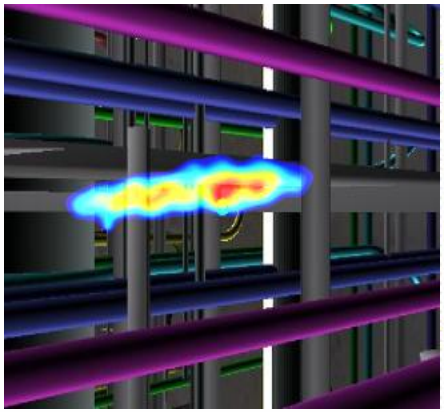
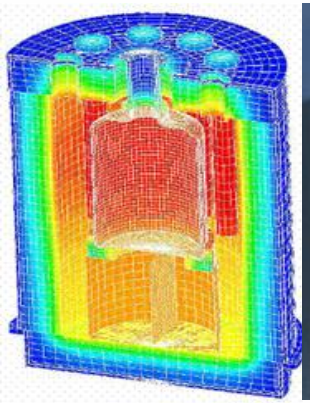
Network of interconnected operational IT tools

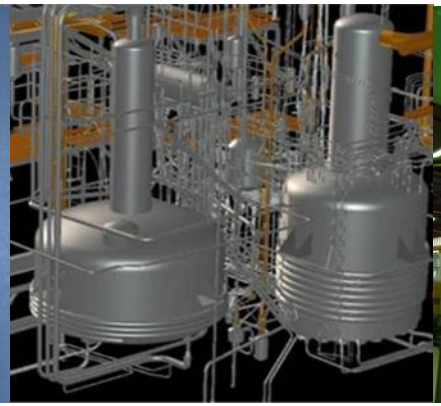
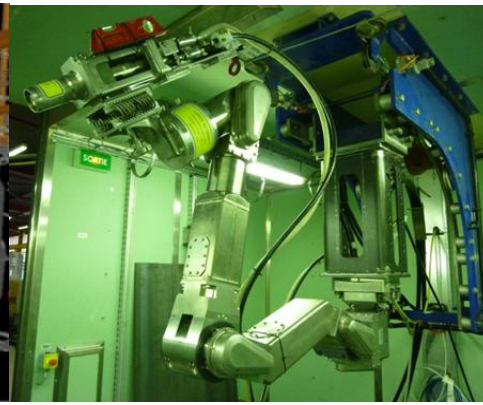


CONCLUSION: MAIN CHALLENGES of D&D

- Preparation
- Strategic vision / priorization
- Integrated organization and Synergy between technical trades, operators, project management teams and R&D teams
- Need for R&D to afford adequate technologies and processes with need to get involved since engineering studies.
- Need for international sharing of R&D and best practices

- Unique position of CEA both Operator and Research Organization
- Numerous facilities under decommissioning, with contamination levels sometimes very high, and a wide diversity from laboratory scale to industrial plants.
- CEA leads R&D actions and develops expertise in the 6 main axis of D&D
- R&D has a special role to help decrease costs, schedules and amounts of waste and to improve the safety of workshops.
- CEA is willing to work in partnership with other contracting authorities and industrialists in order to share R&D developments and to implement results.

Thank you
for your attention