

DE LA RECHERCHE À L'INDUSTRIE



The JHR Hot Cells : General layout and implementation of safety requirements, and experimental means.

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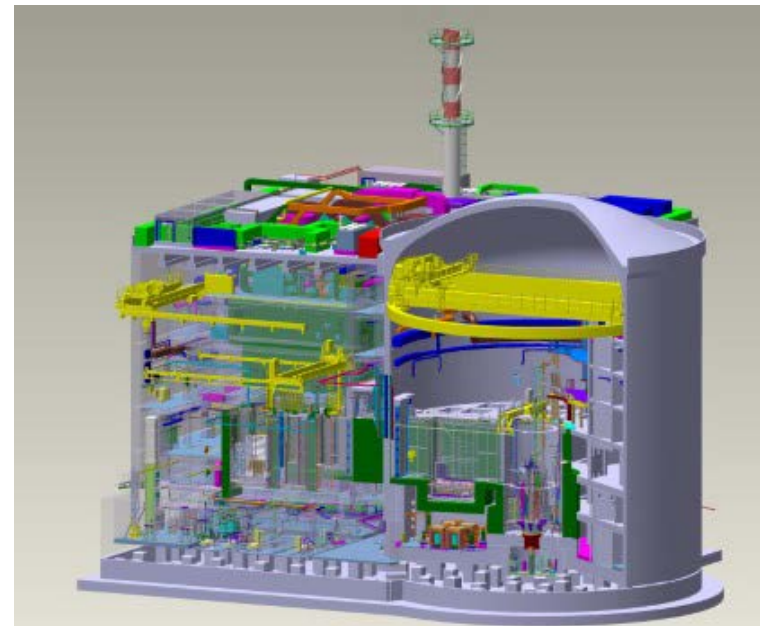
Presentation of the JHR (Jules Horowitz Reactor)

The JHR is the new CEA Material Testing Reactor.

JHR is designed to reproduce on a small scale, real power plant conditions for :

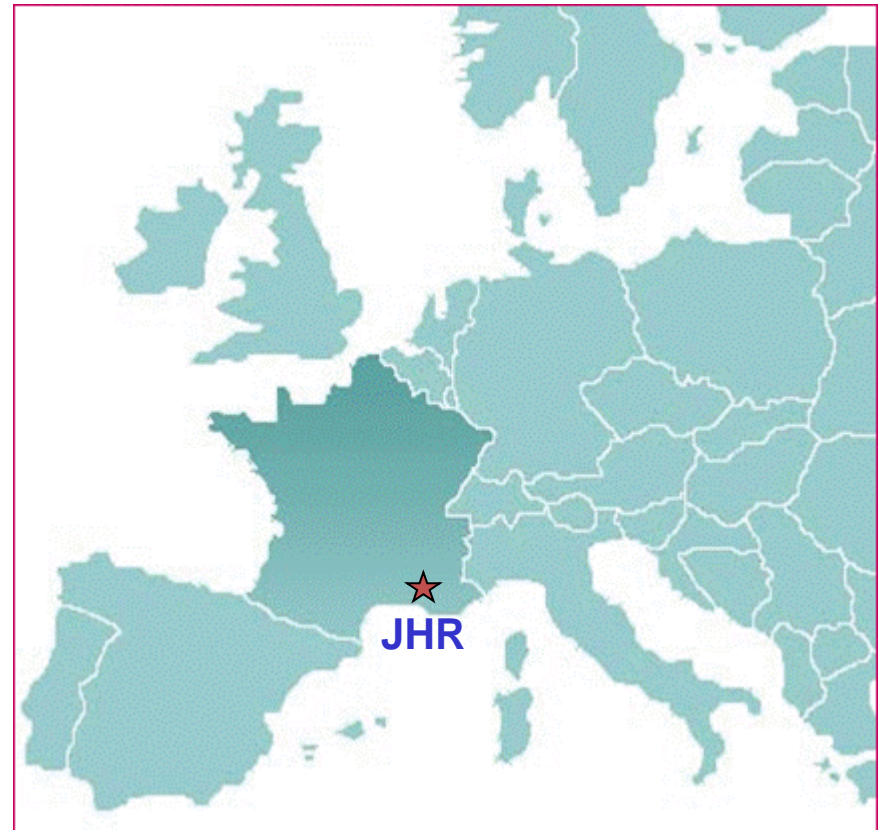
- **Material screening** : comparison of materials tested under representative conditions,
- **Material characterisation** : behaviour of material in wide range of conditions : from normal use to accidental conditions,
- **Fuel element qualification** : test of one / several fuel rods (clad+fuel) under normal and severe conditions (up to clad failure).

JHR will also supply Radio-isotopes for medical application (target : 25 % of the European demand).



General Information

- JHR is financed by a international consortium,
- CEA is the owner and the nuclear operator,
- The construction site is located in the CEA Cadarache Center, south of France,
- The construction is currently running (civil work is almost over),
- The first operating (first criticality) is planned before end of this decade,



Pictures of the Construction Site



Reactor roof
installation
(end of 2013)



Internal view of
the polar crane



General view
(current situation)

The JHR Hot Cells

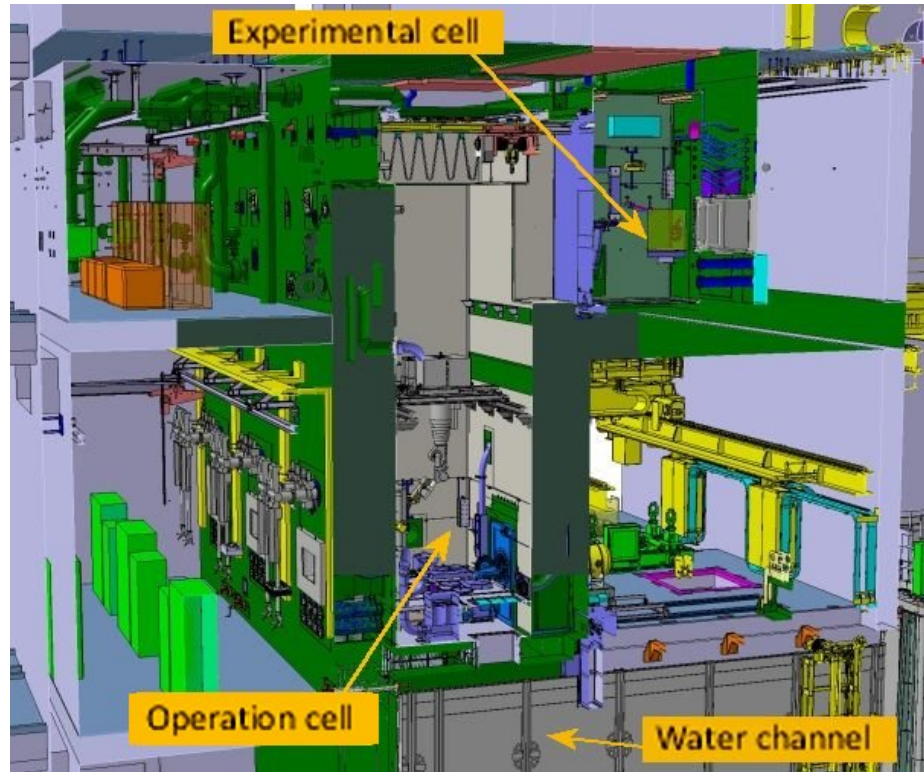
The JHR hot cells are dedicated to manage all irradiated components coming from the reactor :

- the JHR irradiated fuel after pool decay for evacuation and reprocessing,
- the experimental samples of irradiated fuel and/or materials for characterization in the facility or externally,
- the medical radionuclides after irradiation, for evacuation and extraction of radioactive tracers,
- the irradiated structures of the reactor,
- the radiating and / or contaminant waste generated by the reactor.

The hot cells constitute the mandatory path for all irradiated components, coming from the pools to the shielded casks (and then outside of JHR).

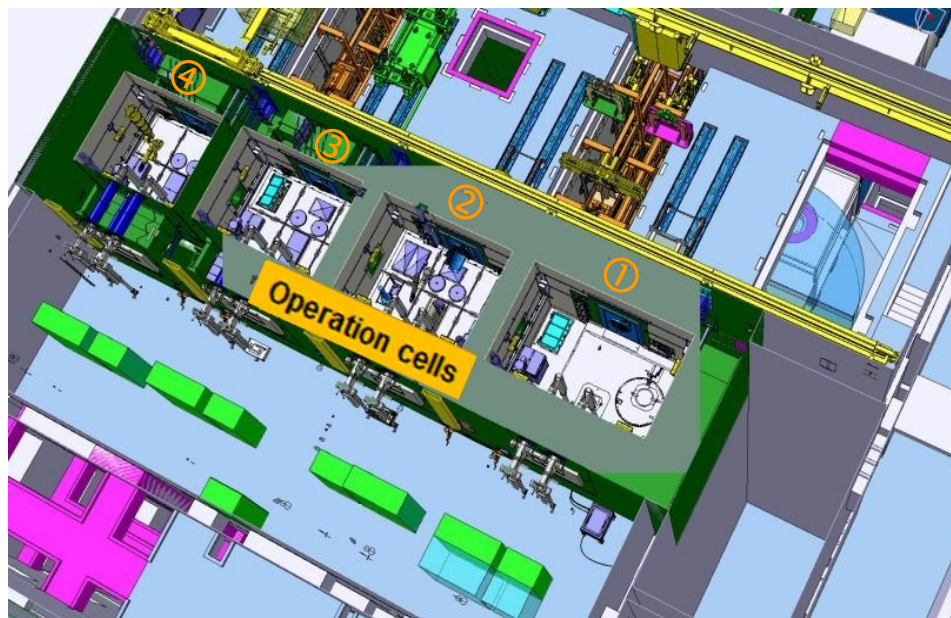
General layout of JHR Hot Cells

- JHR is constituted of **seven hot cells in total**, disposed on two levels,
- First level is composed of **4 operation cells** (surface 10 m², height 13 m),
- Second level, communicating with the first level, is composed of **3 experimental cells** (surface ~10 m², height 4 m),



The four Operation Cells

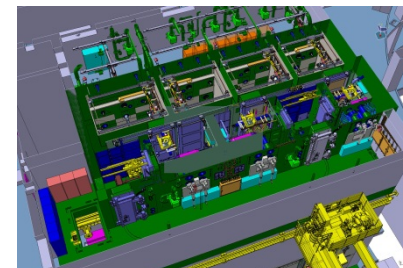
- Two polyvalent cells (②, ③) for fuel and material samples, inertable,
- One cell ① dedicated to the exit of used fuel, medical radionuclides and waste
- One cell ④ dedicated to high contaminated samples (clad failure experience),
- The cells are equipped with usual remote handling means :
 - Lifting crane
 - Light and heavy manipulators
 - Storage wells,
 - Cask connections (horizontal and vertical),
 - Communication trapdoors with water channel for transfers from the pools.



The three Experimental Cells

■ Dual purpose :

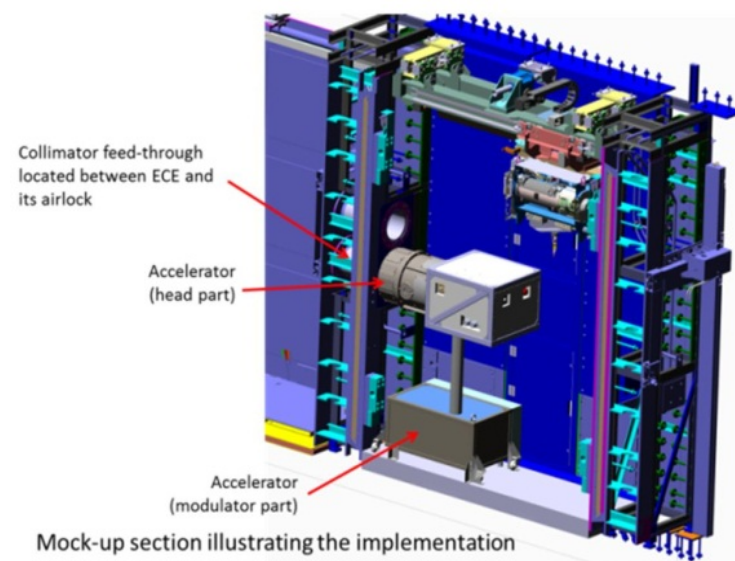
- receiving the experimental samples (fuel/material) to perform characterization in cells,
- Serving as a response to heavy maintenance in large cells (support hatch),
- -> entry of operator is relatively easy : breathable air, motorized shielded doors, ...



■ They are equipped with the same mechanical equipment as operation cells.

■ For experimental needs, the hot cells integrate NDE benches :

- Dimensional measurement of plates/rods (neutron swelling),
- Spectrometry analysis / Xray imaging of fuel samples,



Safety Requirement

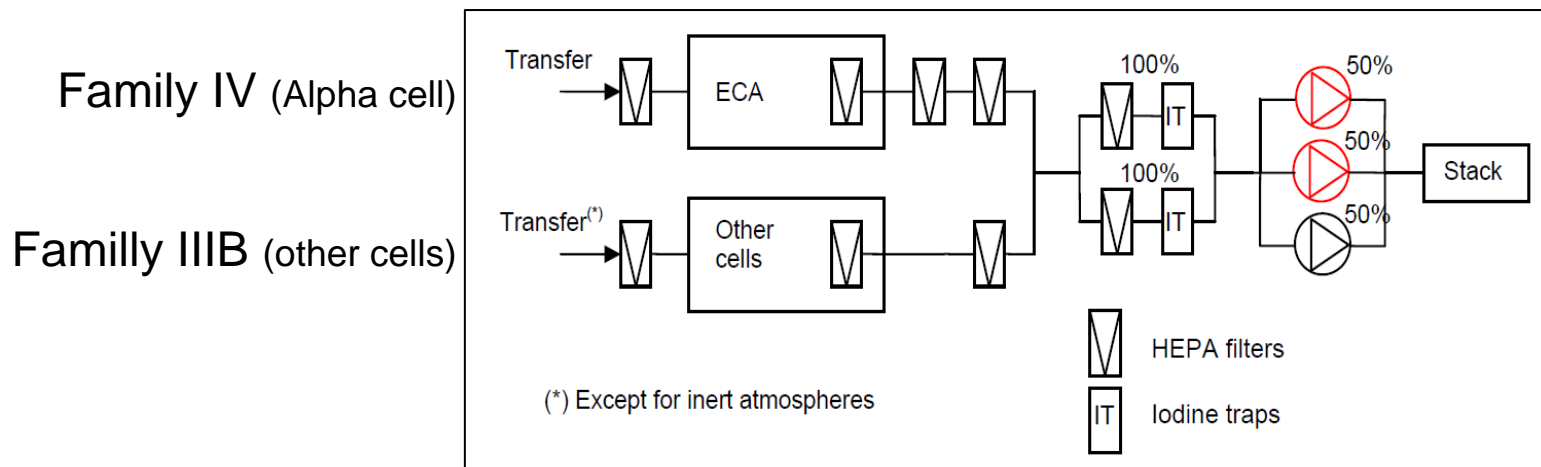
JHR hot cells integrate, from first stages of design, recent safety requirements for following risks :

- dissemination of radioactive dust,
- seismic event,
- radiation hazards,
- load fall,
- Fire.

Dissemination

The prevention of dissemination is based on a high-level static containment, completed with a dynamic containment,

- General tightness of hot cells is set at 10^{-2} V/h
- All hot cells are covered with a stainless steel liner,
- Every crossing has its own leakage rate.



Seismic event

Safety requirements regarding seismic event are :

- preservation of the biological protection,
- preservation of the static and dynamic containments,
- mastery of sub-criticality.

Thus :

- The main structures of hot cells (incl. liner, crossing, ...) is designed to withstand an earthquake without damage,
- Most of inside equipments are anchored to stay in place during an earthquake,
- The ventilation of cells is designed to continue operating during and after an earthquake,
- Regarding sub-criticality, equipment inside the cells using the control mode of geometry must keep their shape during an earthquake.

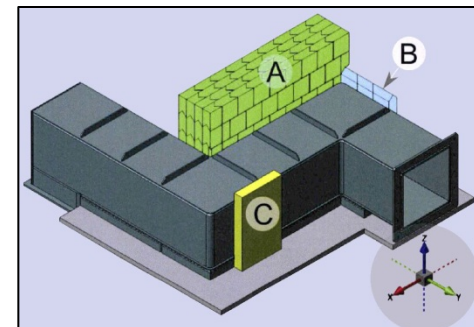
Radiation hazard

The walls of JHR hot cells are dimensioned accordingly :

- gamma radiation: $3,7 \cdot 10^{15}$ Bq of ^{60}Co
- neutron radiation: $2,7 \cdot 10^8$ n/s,
- This source term correspond to four recently irradiated fuel elements of JHR.

Walls of hot cells are made of 1.20 m thick heavy concrete (density 3.5)

- Singularity into the wall are balanced by embedded lead .



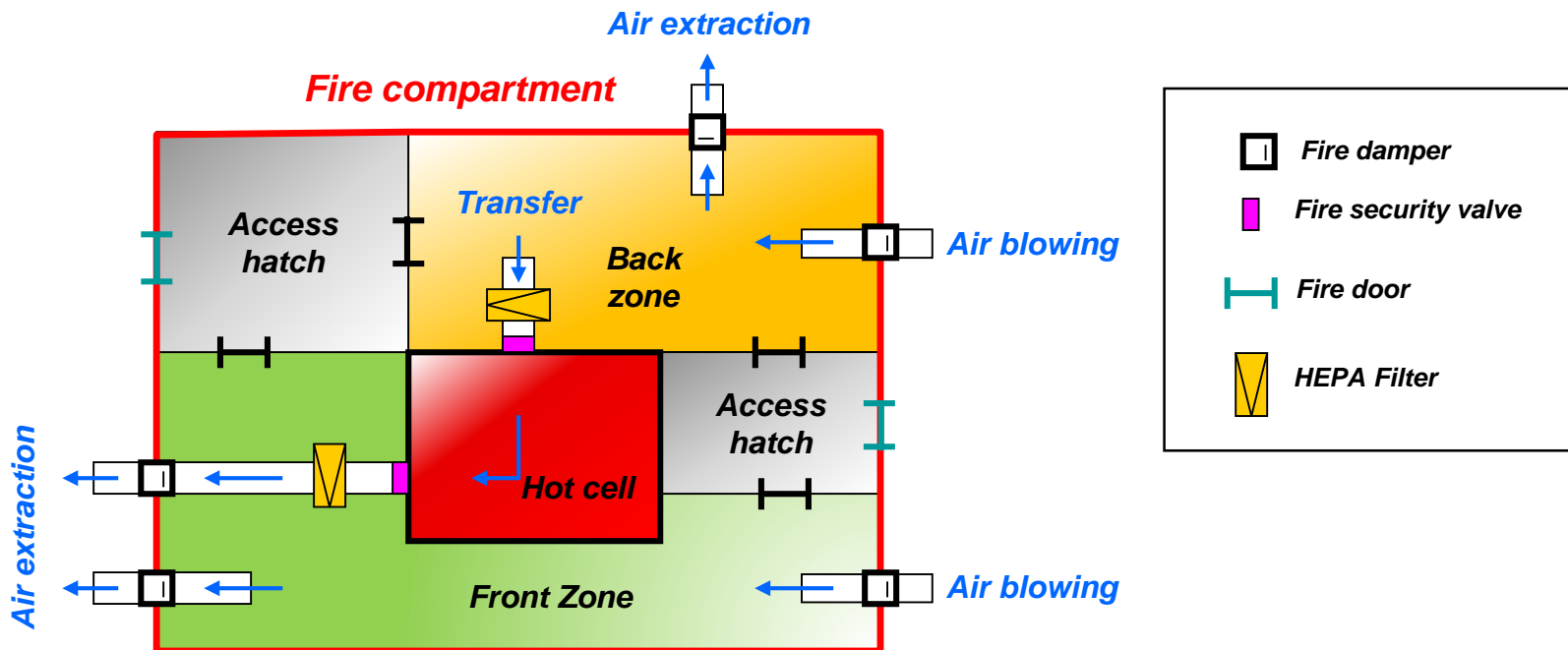
Safety requirements regarding load fall are :

- The reliability of the lifting cranes in the cells is set at 10^{-5} /year (risk of load drop),
- Concrete floor of the hot cells is dimensioned to withstand the fall of the heaviest load (heavy manipulator) : 2,5T from 7 m height.

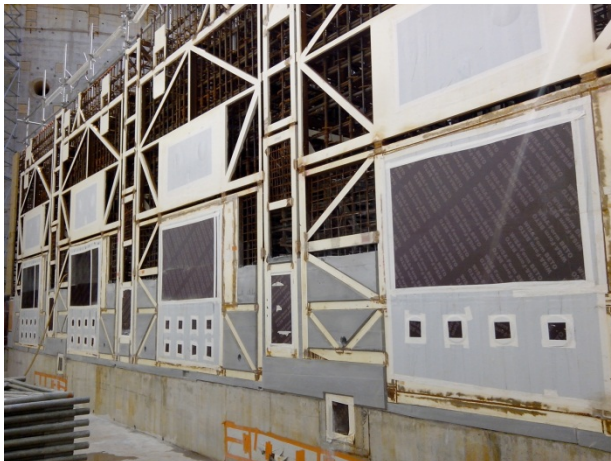
Fire Protection

Fire protection is a major issue for Hot Cells:

- Several equipment of hot cells are not qualified enough for fire resistance : shielded windows, manipulators, ...
- -> the fire compartment boundary is extended to surrounding rooms.



Pictures of the hot cells construction

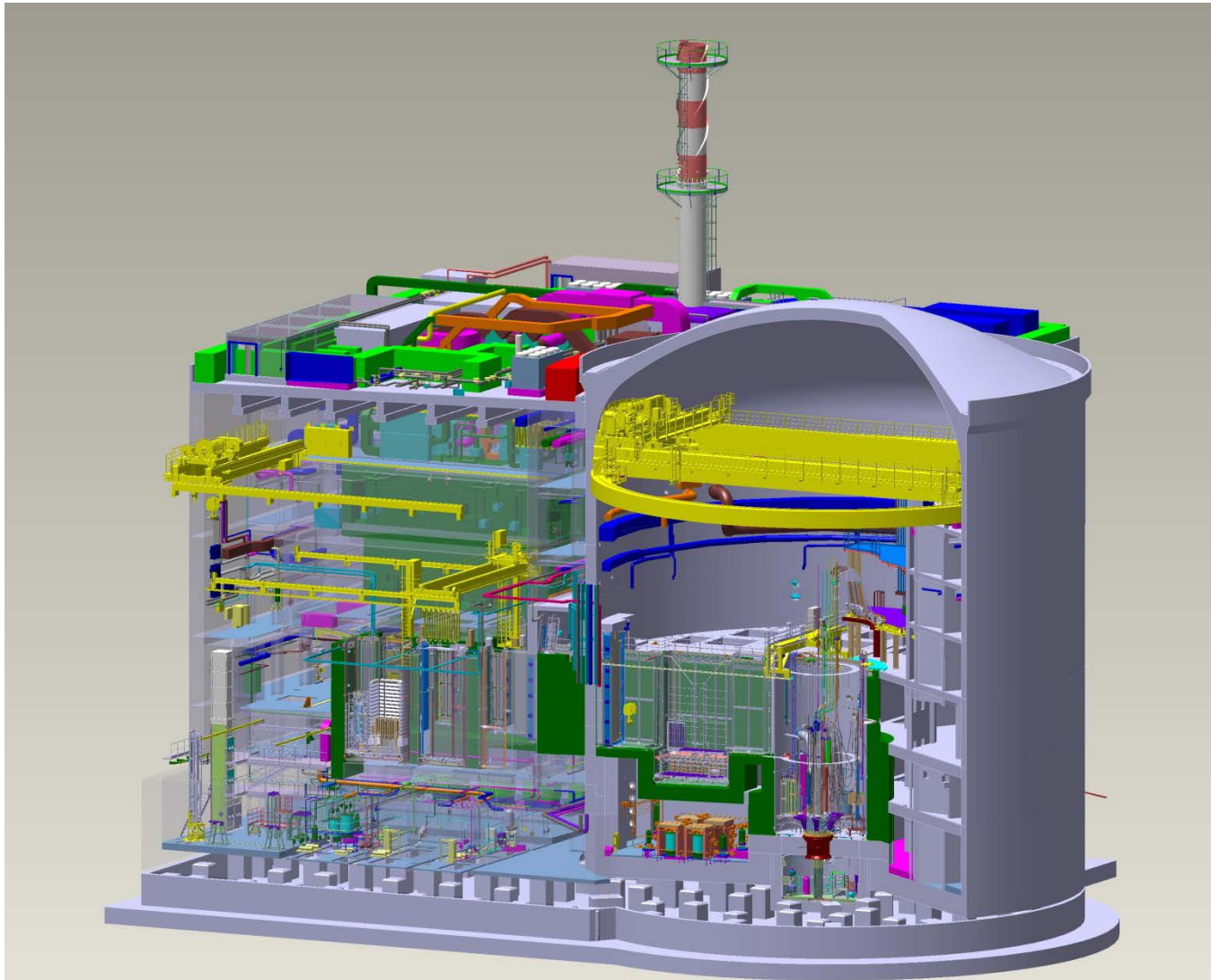


Thank you for your attention

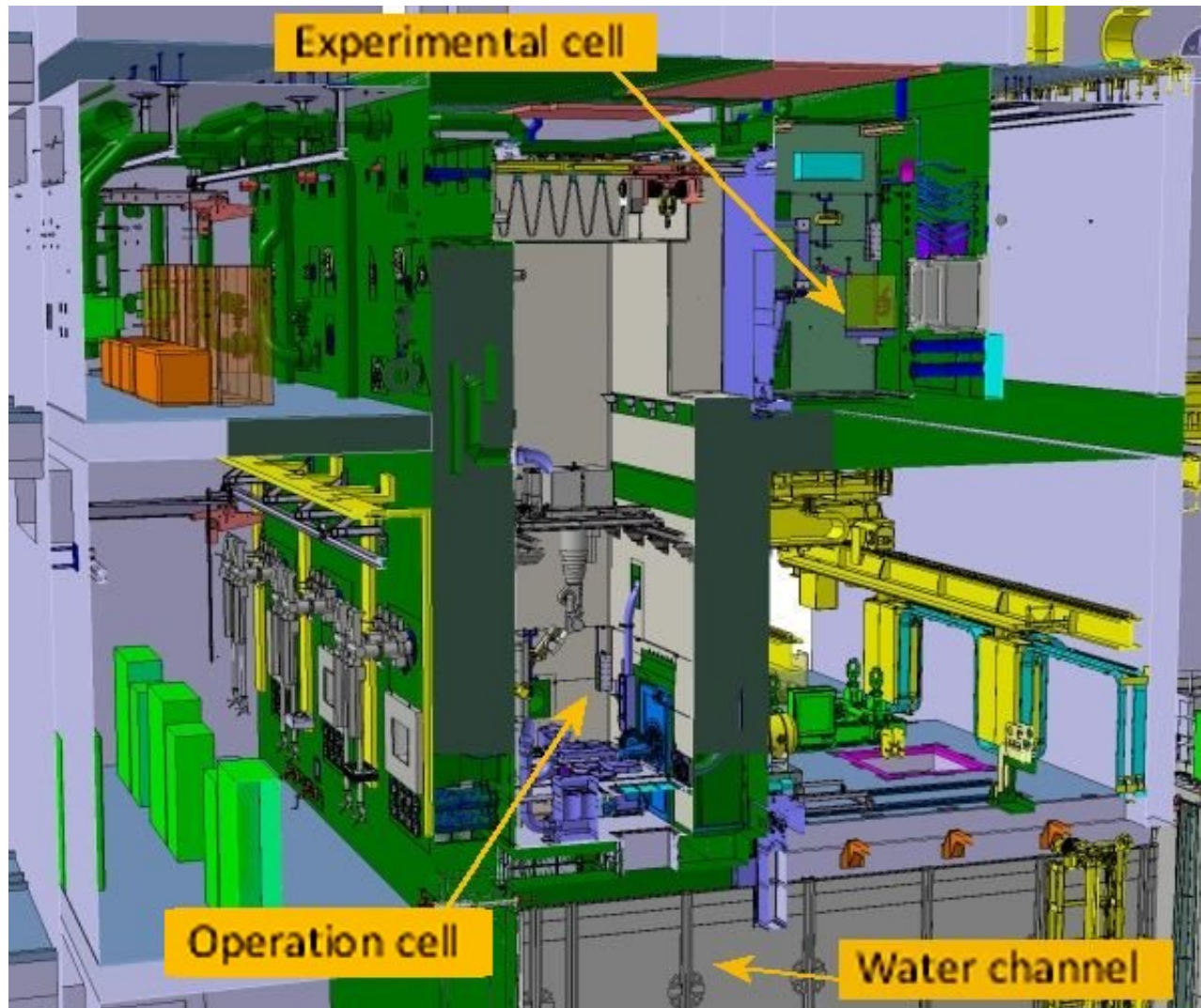


July 2014 : pouring the first step of the reactor roof

The Jules Horowitz Reactor



General layout of JHR Hot Cells



Overview of experimental cells

