



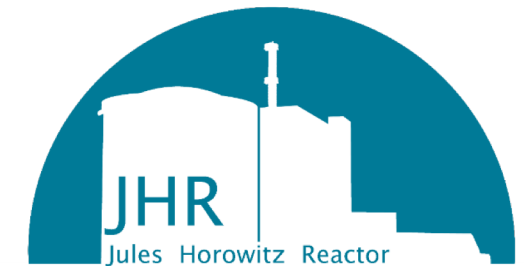
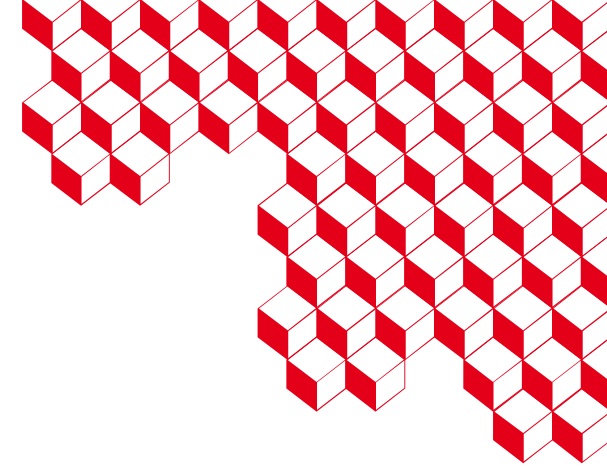
**Jules Horowitz Reactor project: a future Material Test Reactor in support to nuclear industry, regulators and R&D institutes; status as of mid-2023 following major reassessment of the project and setting-up of « pre-JHR » phase before start-up of the reactor.**

*Dr Gilles Bignan & All*

*French Atomic and Alternatives Energies Commission (CEA)*

*JHR project International Affairs Manager*

*[gilles.bignan@cea.fr](mailto:gilles.bignan@cea.fr)*



# French Energy Policy :

## New orientations given by French President in February 2022 with the objective of Net Zero by 2050

① **Energy sobriety:** reduction of energy consumption by 40% in 2050

② **Increase of low carbon energy production**

- **Strong increase in renewables** (PV, in-land and off-shore wind, geothermals)
- **Launch of a new nuclear program targeting 25 GW new capacity by 2050**
  - ✓ **LTO (lifetime extension > 50 years** of existing NPPs subject to safety consideration)
  - ✓ **Launch of « New Buid program » with 6 EPR2** (3x twins as proposed by EDF) and study for **8 more EPR2**
  - ✓ **Innovation program for SMR/AMR with 1 b€ public funding** : support of industrial French SMR program NUWARD and call for new projects for AMR (start-ups), targeting a prototype by 2030
- **New law called « acceleration for building new nuclear facilities » endorsed by the senate and the parliament in May 2023**
- **JHR –once in operation- will become a key research reactor in support to the presnet French fleet (56 NPPs) and the future one**



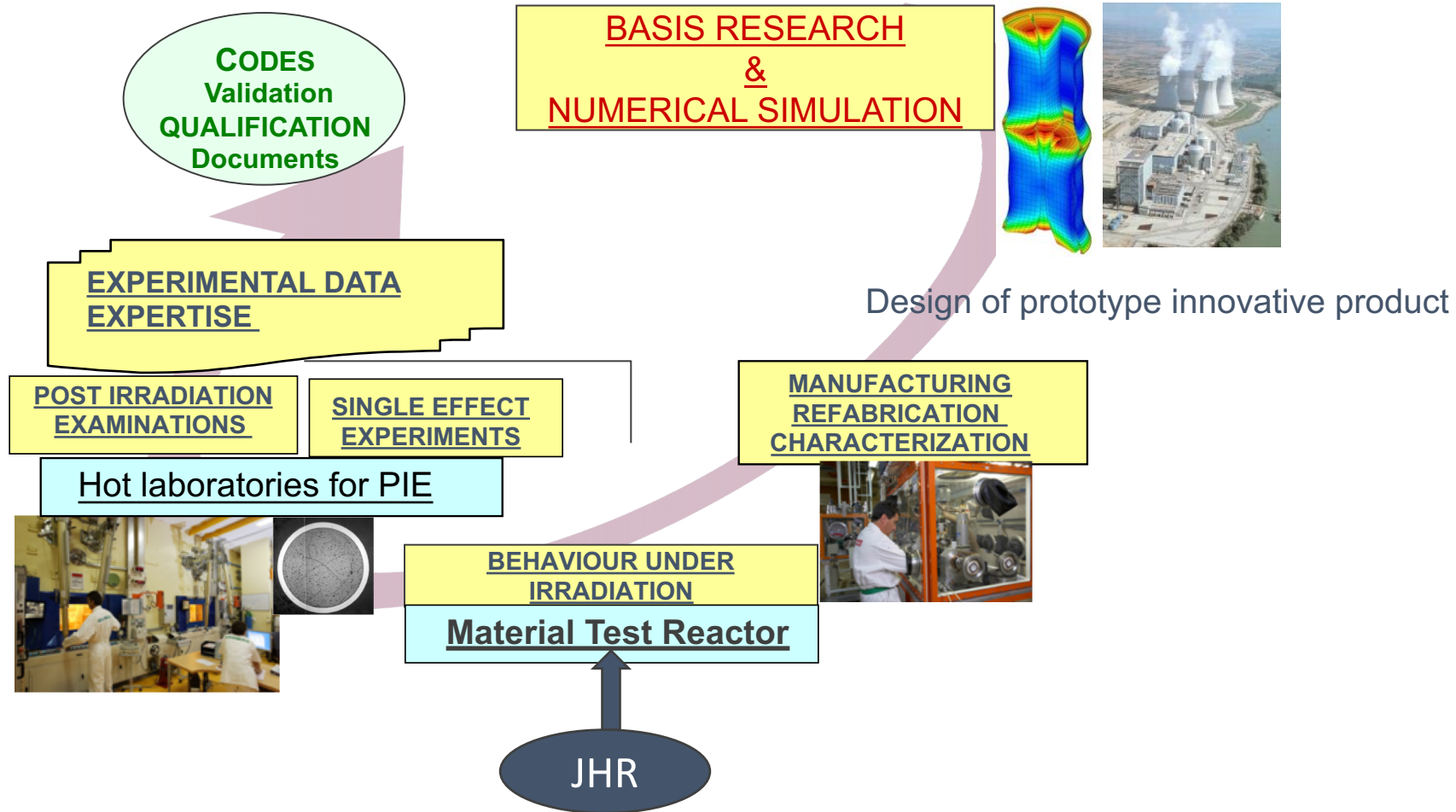
**CEA strongly involved in PV and hydrogen technologies**



**CEA already engaged in R&D program for NPP lifetime assessment up to 40y... to be further continued for 50y+**



**CEA strongly involved in NUWARD and in innovative nuclear energy production systems**



JHR the only MTR Under construction  
in Europe- EC/ESFRI Landmark



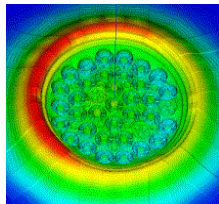
# *JHR Experimental capacity*

# 1. JHR hosting capabilities

**In reflector**  
Up to  $3.5E14$  n/cm<sup>2</sup>.s (th)  
Fixed irradiation positions  
( $\Phi 100$  mm &  $\Phi 200$  mm)  
and 4 displacement systems

LWR fuel experiments  
+  
Material ageing  
(low ageing rate  
Exple : RPV material)

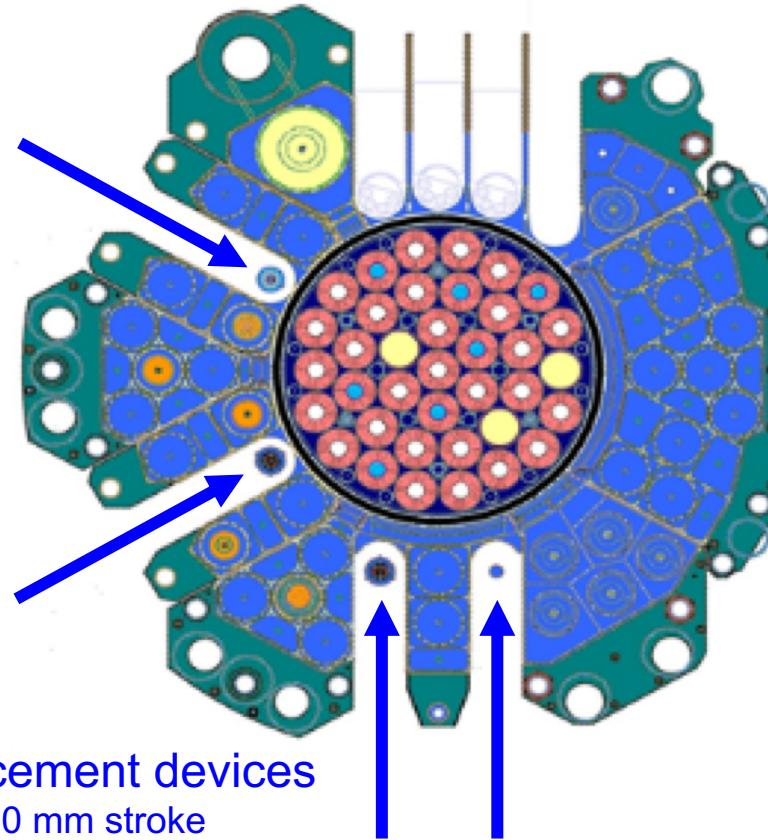
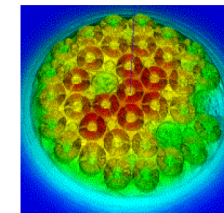
Thermal neutron flux



**In core**  
Up to  $5.5E14$  n/cm<sup>2</sup>.s ( $E > 1$  MeV)  
Up to  $1.E15$  n/cm<sup>2</sup>.s ( $E > 0.1$  MeV)  
7 small locations ( $\Phi \sim 32$  mm)  
3 large locations ( $\Phi \sim 80$  mm)

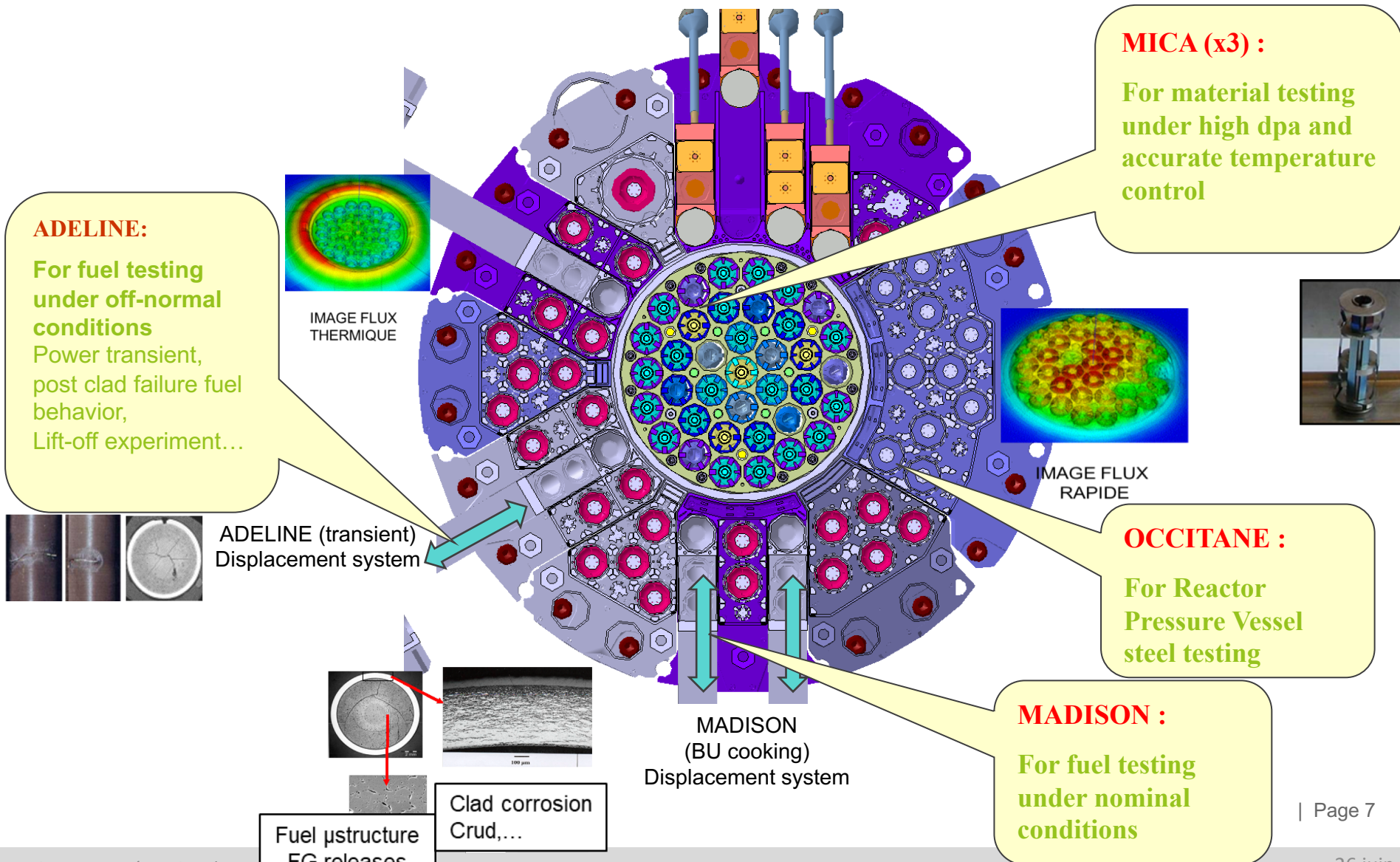
Material ageing  
(high ageing rate)  
+  
Gen IV fuel experiments

Fast neutron flux

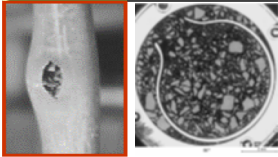


Displacement devices  
450 mm stroke  
 $V_{max} = 6$  mm/s

→ A large range of neutron fluxes and spectra

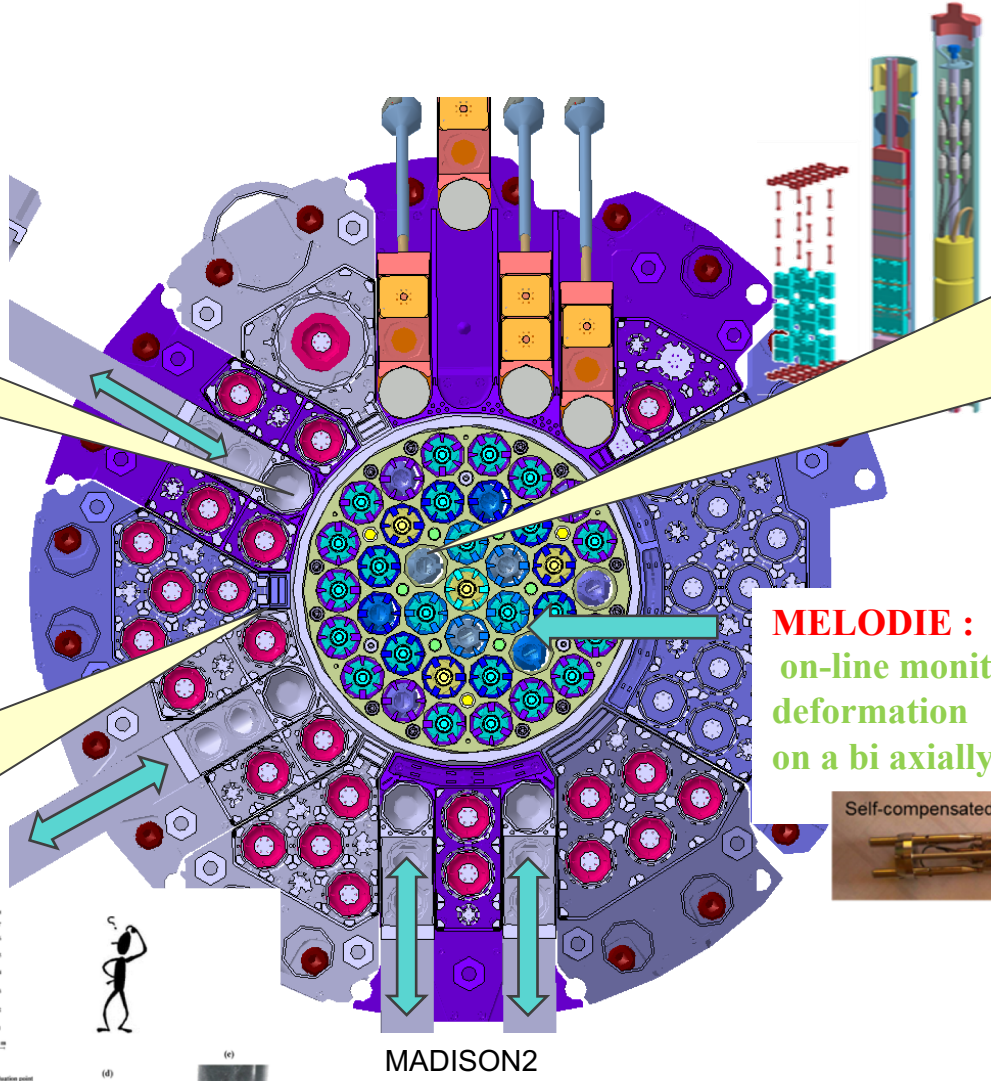
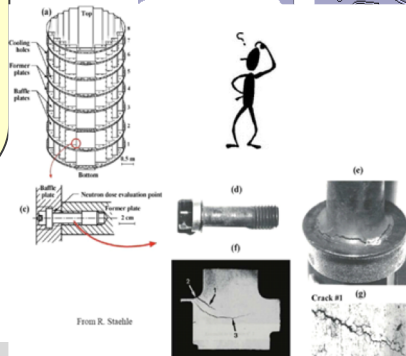


**LORELEI :**  
fuel testing under  
accidental  
conditions (LOCA)



**Advanced MICA (x2)**  
For material testing  
under high dpa and  
accurate temperature  
control (+ mechanical  
loading)

**CLOE :** Corrosion  
loop for “Zr alloy  
Corrosion” and  
“Irradiation  
Assisted Stress  
Corrosion  
Cracking”



**MELODIE :**  
on-line monitoring of bi-axial  
deformation  
on a bi axially-loaded clad sample





# *JHR OPERATING RULES*



JHR consortium gathers organizations which take part financially and get permanent access to JHR experimental capacities  
(1 representative / organization)

## JHR International Consortium : Research centers & Industrial companies



In several cases, the organization (member of the JHR consortium) is itself the representative of a national domestic consortium which gathers organizations among industry, R&D organizations, TSO, or Safety Authority...

CEA is mandated by the Governing Board to enlarge to consortium before start-up of operation



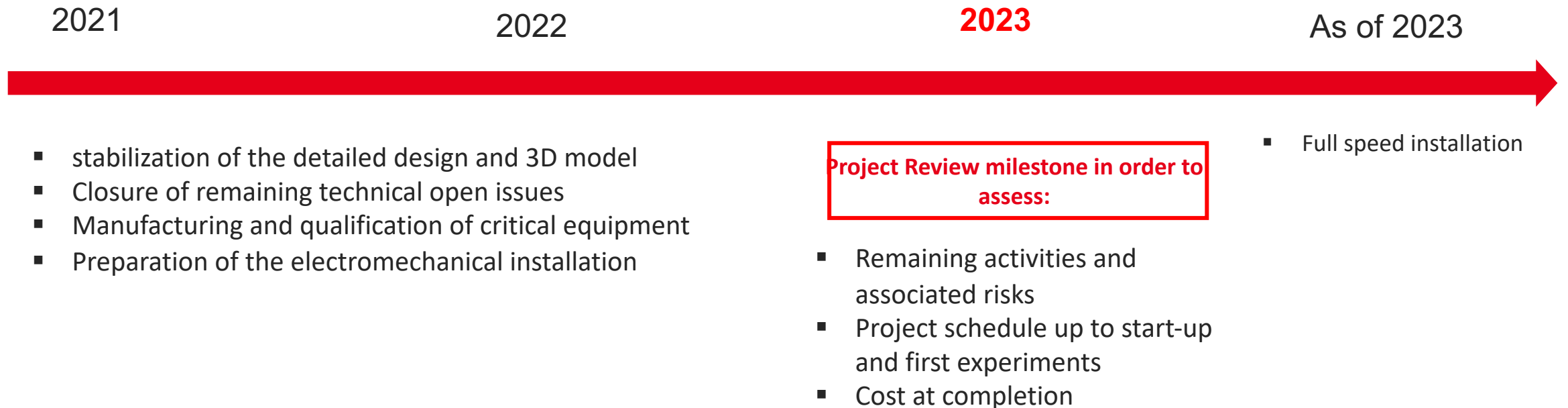
# **New organisation as of March 2020 following 2019 audit from the French Government**



# Overall JHR Roadmap validated by the French authorities



After the Recovery Action Plan implementation (2019-2020), the 2021-2023 roadmap is under implementation



# Major construction highlights during the years 2021-2022-2023

More info see JHR website :  
<https://jhrreactor.com>





# Safety first

## Occupational and nuclear safety are our first priorities

- Occupational Safety : 2 years record without lost-time accident reached in 2022

- End of May 2023: 140 days without any work accident
- Safety policy implemented by every company at site under the coordination of CEA

- High-level safety:**

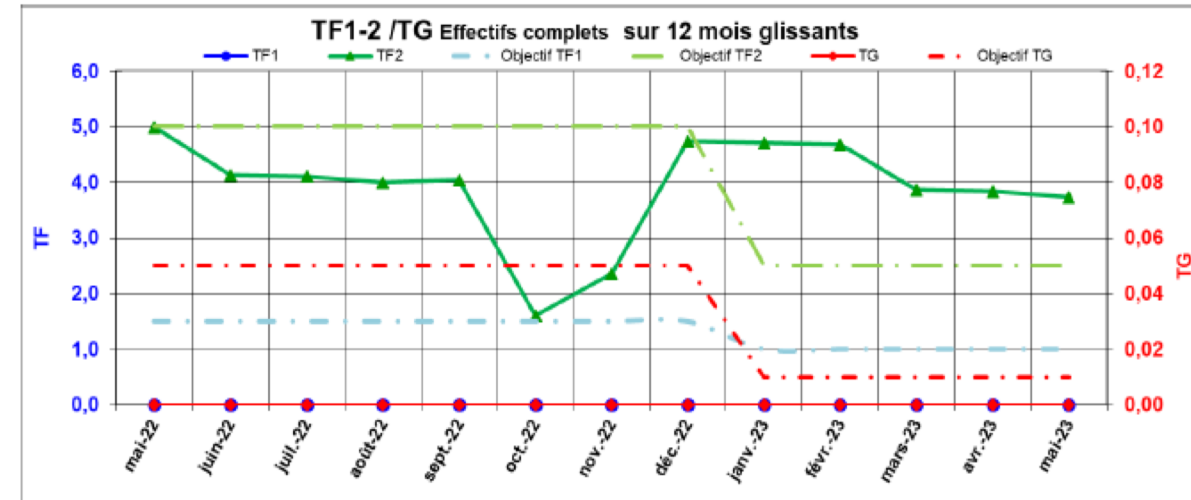
- Safe design following up-to-date regulations and standards (seismic resistance, post Fukushima enhanced safety rules)
- Safety culture training for all team members
- Kick-off of anticipated examination by ASN

**TF1: 0,0**

**TF2: 3,7**

**TG: 0,00**

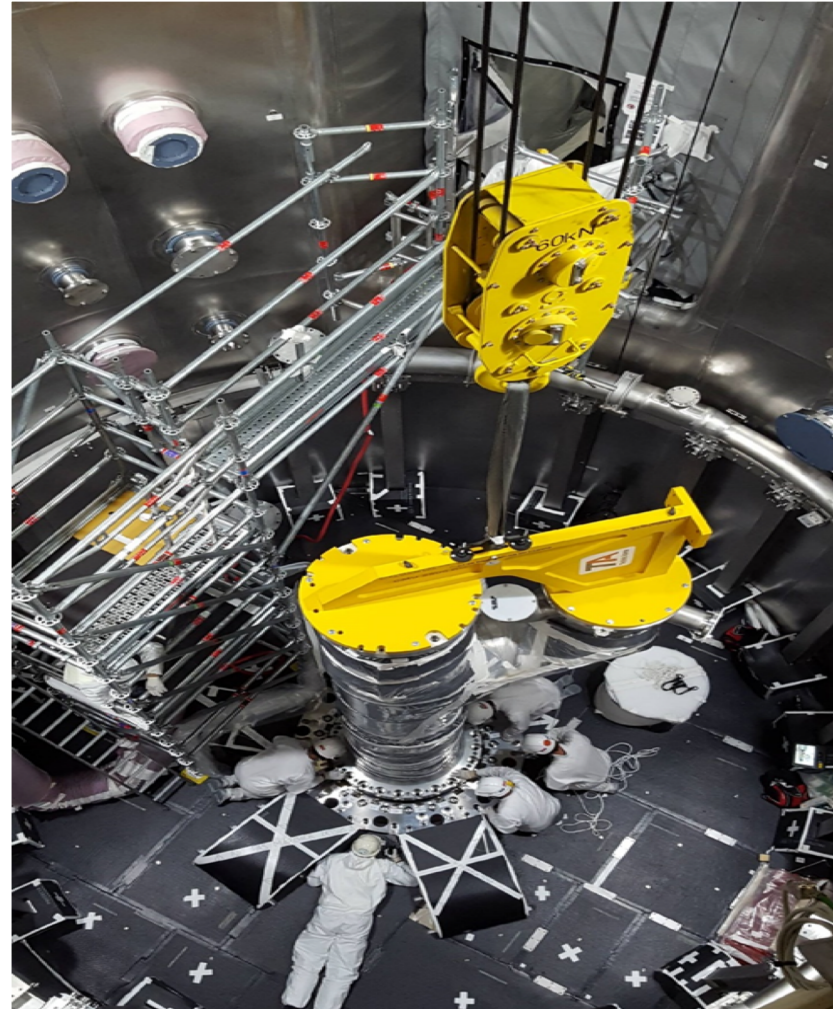
TF1 : nombre d'Accident de Travail Avec Arrêt (ATAA) survenus sur les 12 derniers mois rapporté à 1 million d'heures travaillées.  
TF2 : nombre d'ATAA + d'ATSA (Sans Arrêt) survenus sur les 12 derniers mois rapporté à 1 million d'heures travaillées.  
Effectifs pris en compte dans les indicateurs : productifs et improductifs tous lots ainsi que le personnel projet RJH



# Project progress

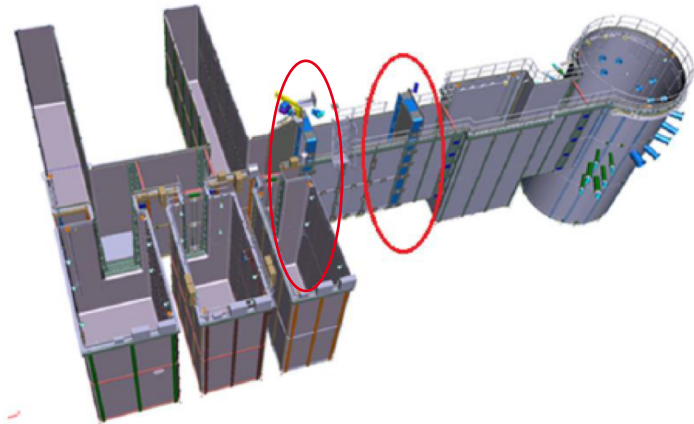


## Core vessel implementation



# Under water gate

## Introduction of the door frame

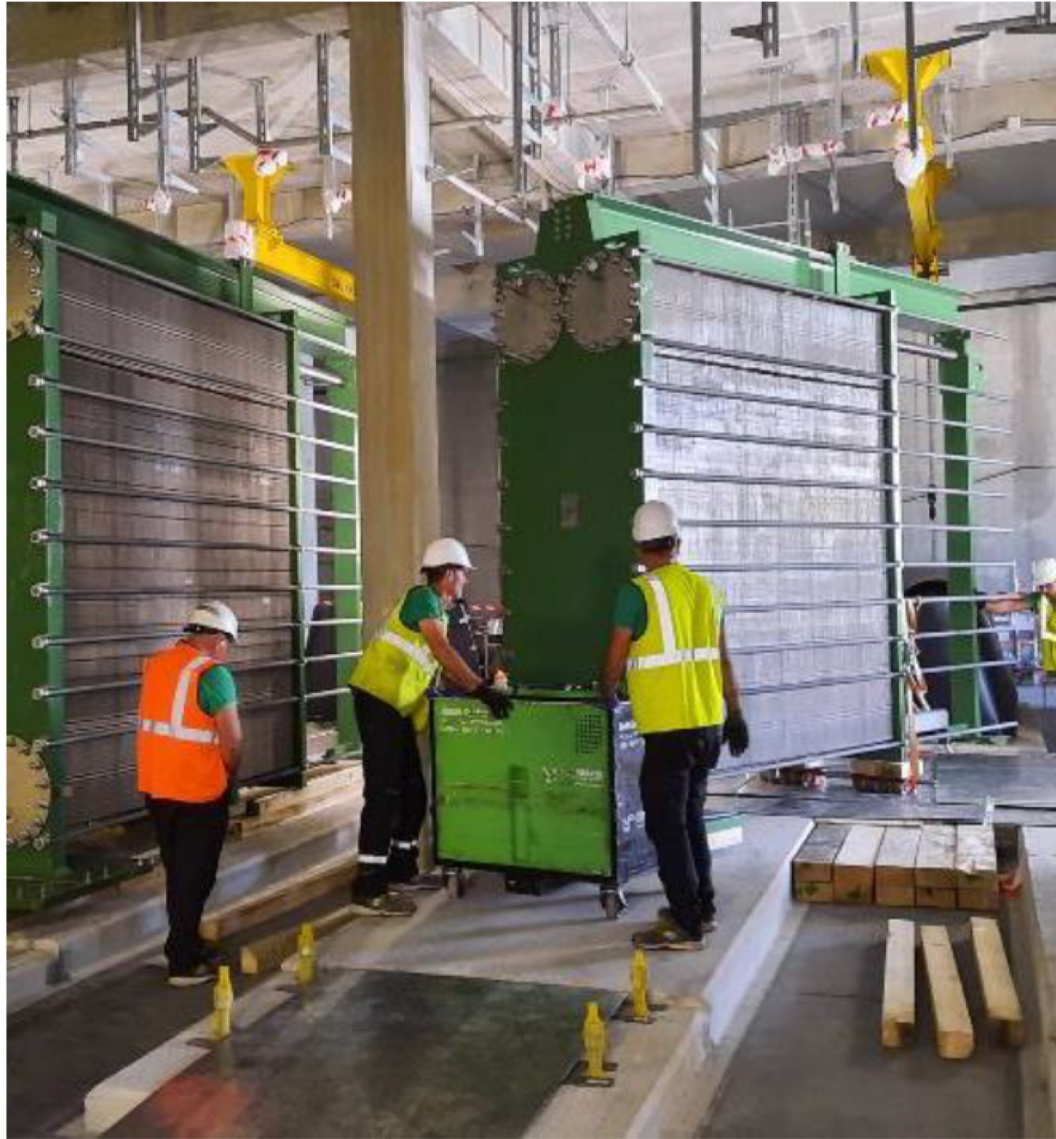


**Reactor building**

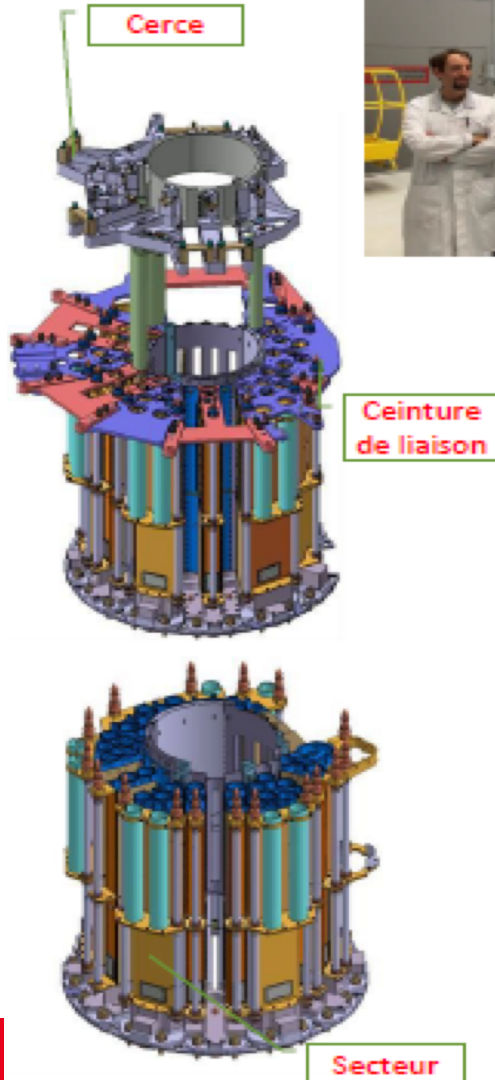
**Auxiliary building**



# Mounting of Secondary/Tertiary Heat Exchangers

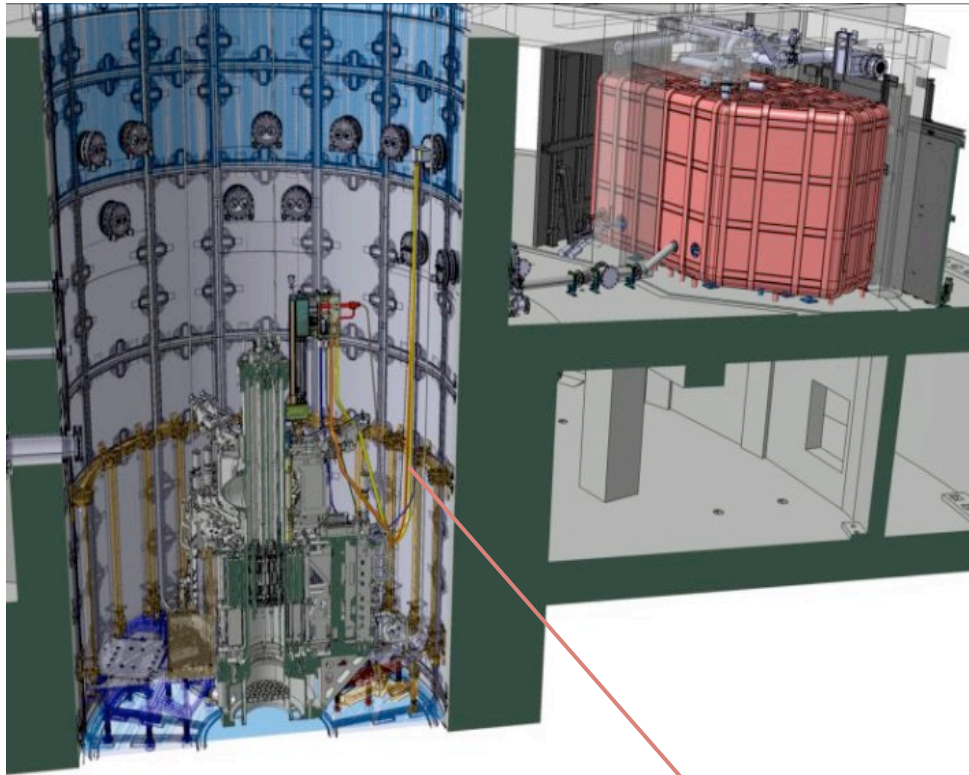


# In Factory operation: Mounting of the reflector

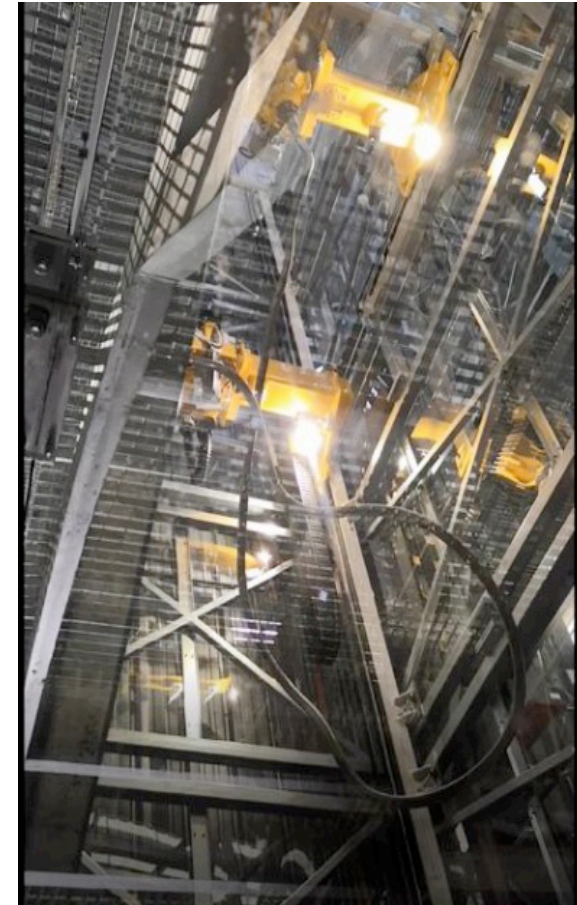


# ADELINE / UNDERWATER PIPES - FATIGUE TESTS

**2500 CYCLES OF FATIGUE TESTS WITOUT LOSS OF TIGHTNESS NOR DEFORMATION**



**Under Water Pipes**

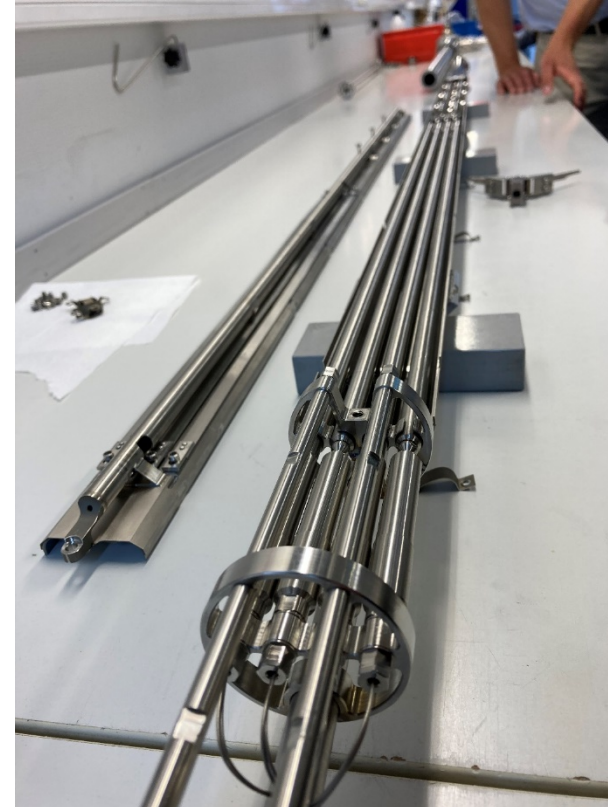
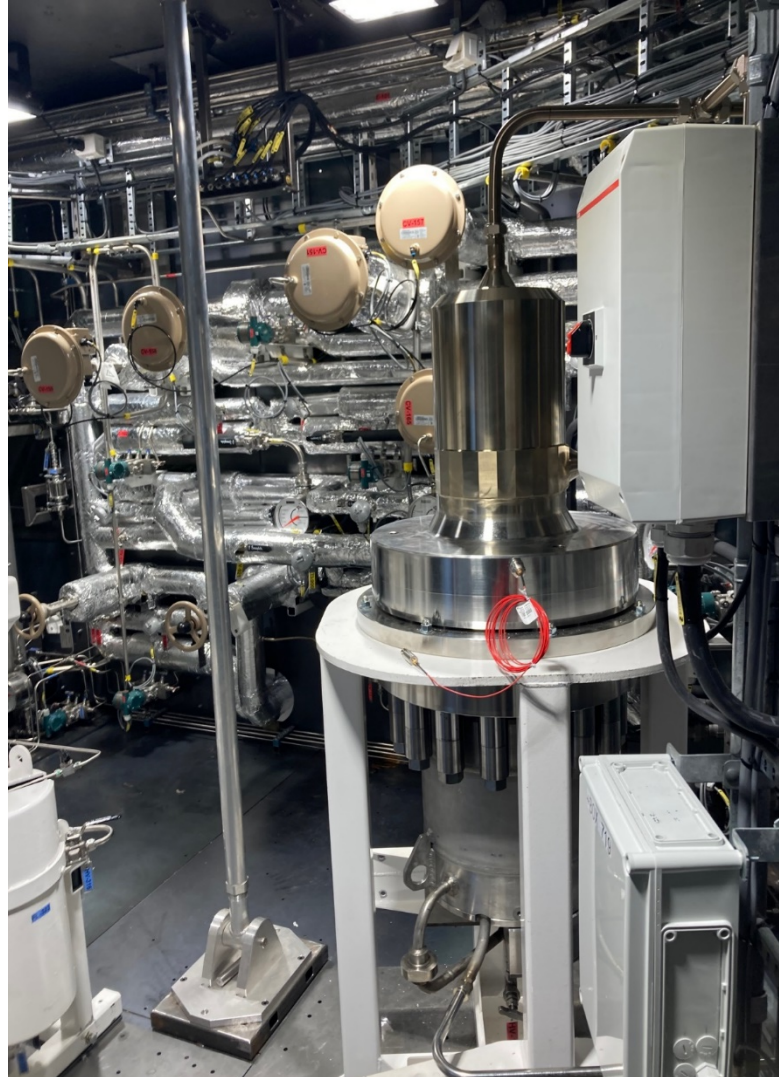


**Test Bench**



# MOCK-UP OF MADISON LOOP AT IFE HALDEN

**Madison Loop**



**Dummy Rig**



# Completion of DLC - Supporting structure of experimental devices



# Preparing JHR international community



- The yearly seminar
- The Seconded Program
- The 3 Working Groups and the preparation of future joint programs
- The ICERR designation by the IAEA



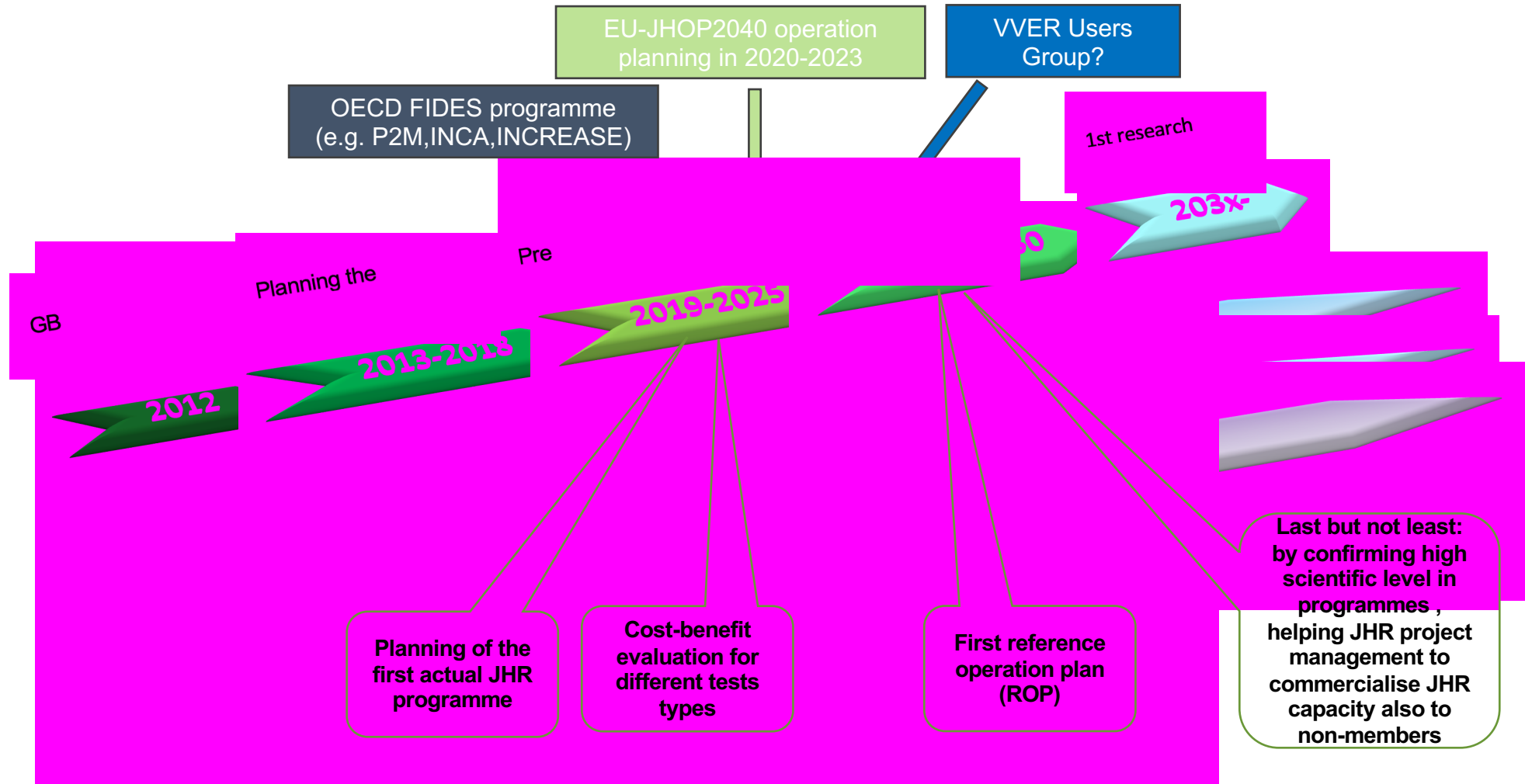
**IAEA**  
International Atomic Energy Agency

**CEA Cadarache Research Centre**  
Commissariat à l'énergie atomique et aux énergies alternatives  
in partnership with IRSN  
Institut de Radioprotection et de Sécurité Nucléaire

**IAEA designated ICERR**  
International Centre based on Research Reactor  
for  
*Hands-on Training and Joint R&D Projects*

Designation period 2020 - 2025



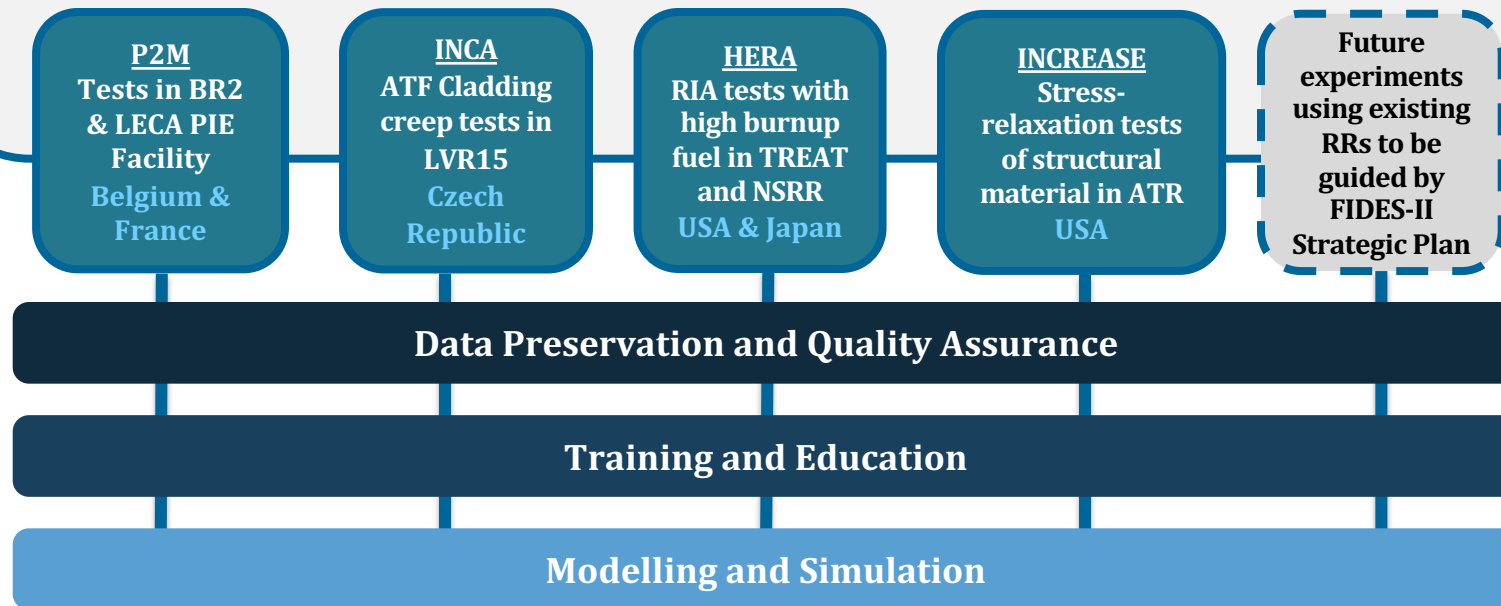


# Framework Design

*Experimental programs complimented by cross-cutting pillars*

## Second Framework for Irradiation Experiments – FIDES-II

- NEA joint undertaking, established pursuant to Article 5 of the NEA Statutes in co-ordination with the Nuclear Science Committee (NSC) and the Committee on the Safety of Nuclear Installations (CSNI)
- A stable, sustainable, reliable platform for fuel and material testing using nuclear research reactors (RRs) in NEA member countries
- Generates experimental results and expertise for shared costs
- **FIDES-II Program of Work includes 4 Joint Experimental Programmes (JEEPs) & 3 cross cutting pillars**

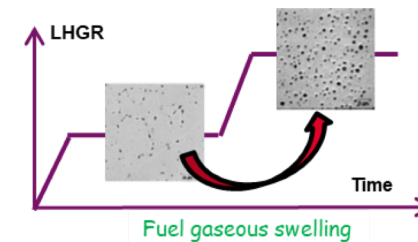
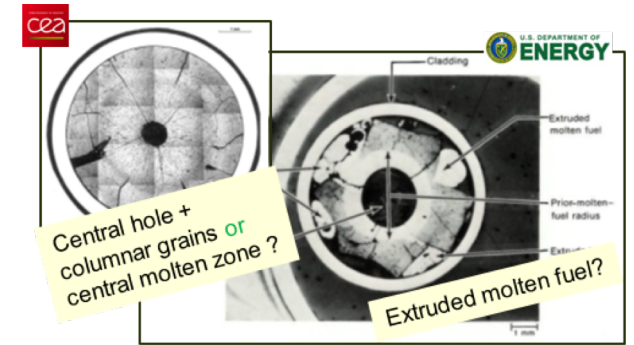


**Governing Board Chair:**  
Raymond Furstenau (NRC, US)  
**Governing Board Vice-Chair:**  
Gilles Bignan (CEA, France)  
**Technical Advisory Group Chair:**  
Olivier Marchand (IRSN, France)  
**Technical Advisory Group Vice-Chair:**  
Daniel Wachs (INL, US)  
**NEA Secretariat:** [Michelle Bales](#)



# 1. Introduction - P2M Objectives

- Limited data are available on power to incipient fuel melting transients
  - Fuel melting during irradiation and residual molten zone after irradiation
  - Mechanisms for central hole & dense zone formation
  - Possible movements of melted fuel
  - Impact of melting on fuel rodlet behavior
- P2M addresses high LHR transients leading to incipient centerline fuel melting without failure
  - Fuel thermal expansion & gaseous swelling
  - Incipient fuel melting & overall impact on fuel behavior
  - Fuel structural & microstructural evolutions
  - Fission gas release
  - Cladding strain
- P2M tests should provide valuable information for the parties involved in the field of nuclear fuel by
  - Providing of reliable data for enhancement of fuel performance code V&V towards partial fuel melting
  - Helping to strengthen actual safety margins with respect to partial fuel melting in various operational conditions
  - Providing of licensing data (usable for new methodologies & fuel products)



Continuation in the JHR ADELINe exp device

