# Jules Horowitz Reactor (JHR) status as of early 2025 following reassessment of the project and setting-up of « pre-JHR » phase before start-up of the reactor

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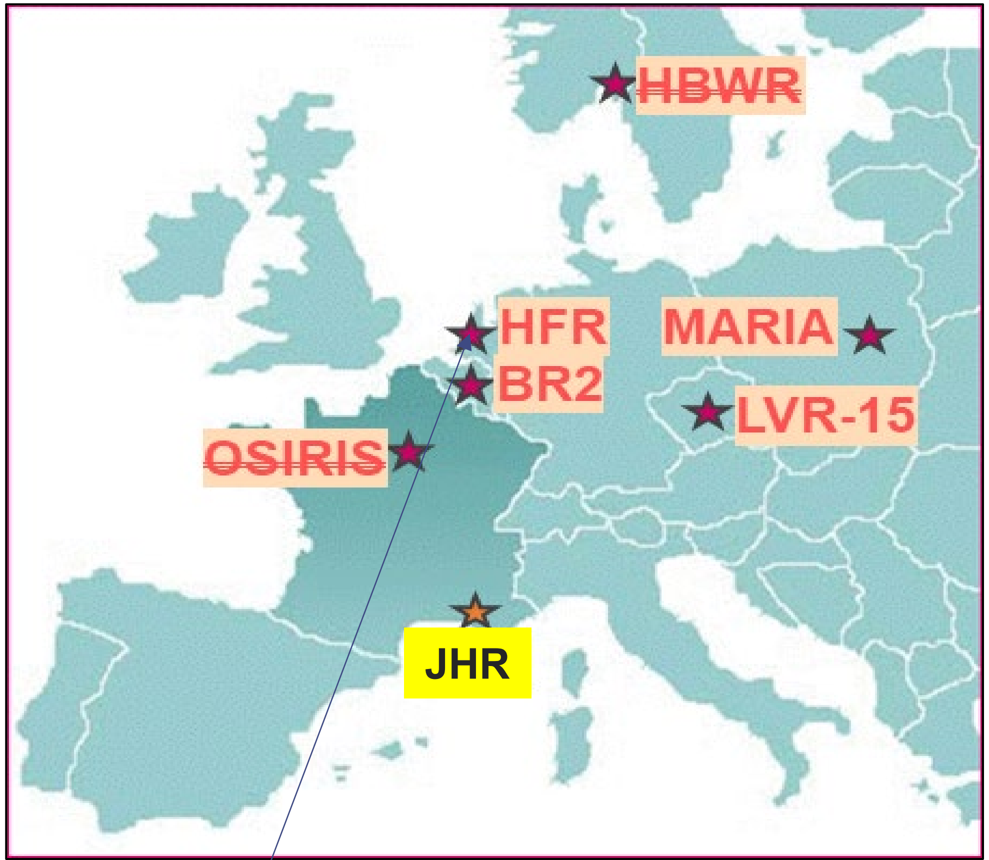
# 1.Why JHR, a new Material and Test Reactor in Europe?

# An old fleet of Material Test Reactors in Europe

| Country | Reactor | Power (MWth) | Age in 2024 (year) |
|---|---|---|---|
| **Czech Republic** | LVR15 | 10 | 68 |
| **Norway** | HBWR | 19 | Shutdown mid 2018 |
| **Netherlands** | HFR | 45 | 64 |
| **Belgium** | BR2 | 100 | 64 |
| **Poland** | MARIA | 30 | 48 |
| **France** | OSIRIS | 70 | Shutdown end 2015 |
| **France** | RJH | 100 | Under construction |




New: PALLAS Project focused on radio-isotopes production

# A research reactor supporting of the nuclear industry

**An intense source of neutrons to accelerate the ageing of fuels and materials**

**1 year testing in JHR** ⟷ **8 to 10 years of operation in a nuclear power plant**

The goal is to study and qualify the effects of irradiation on materials and nuclear fuels

# JHR, in support to radioisotope production chain

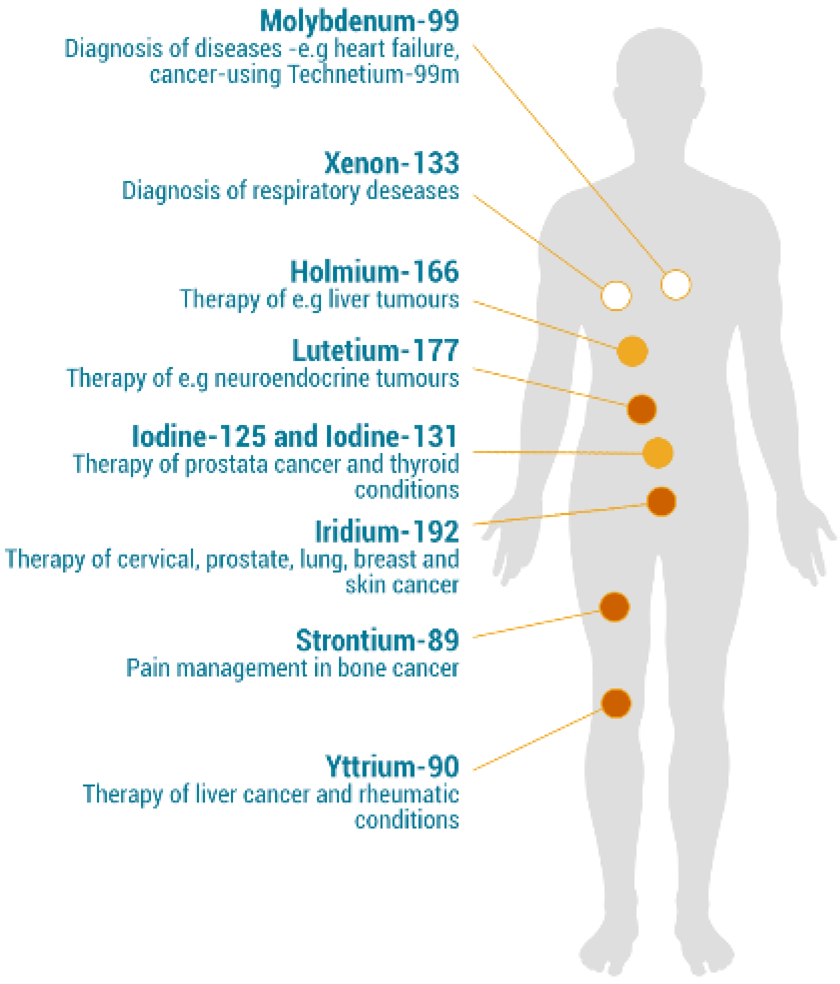
## JHR is committed to irradiate between 25 and 50% of the European annual Molybdenum$^{99}$ targets

**Molybdenum but not only…**

JHR aims to become a leading player in securing the European supply of medical radioisotopes. Due to its high thermal neutron flux, it makes possible to produce a wide range of radioisotopes.

**Thanks to :**

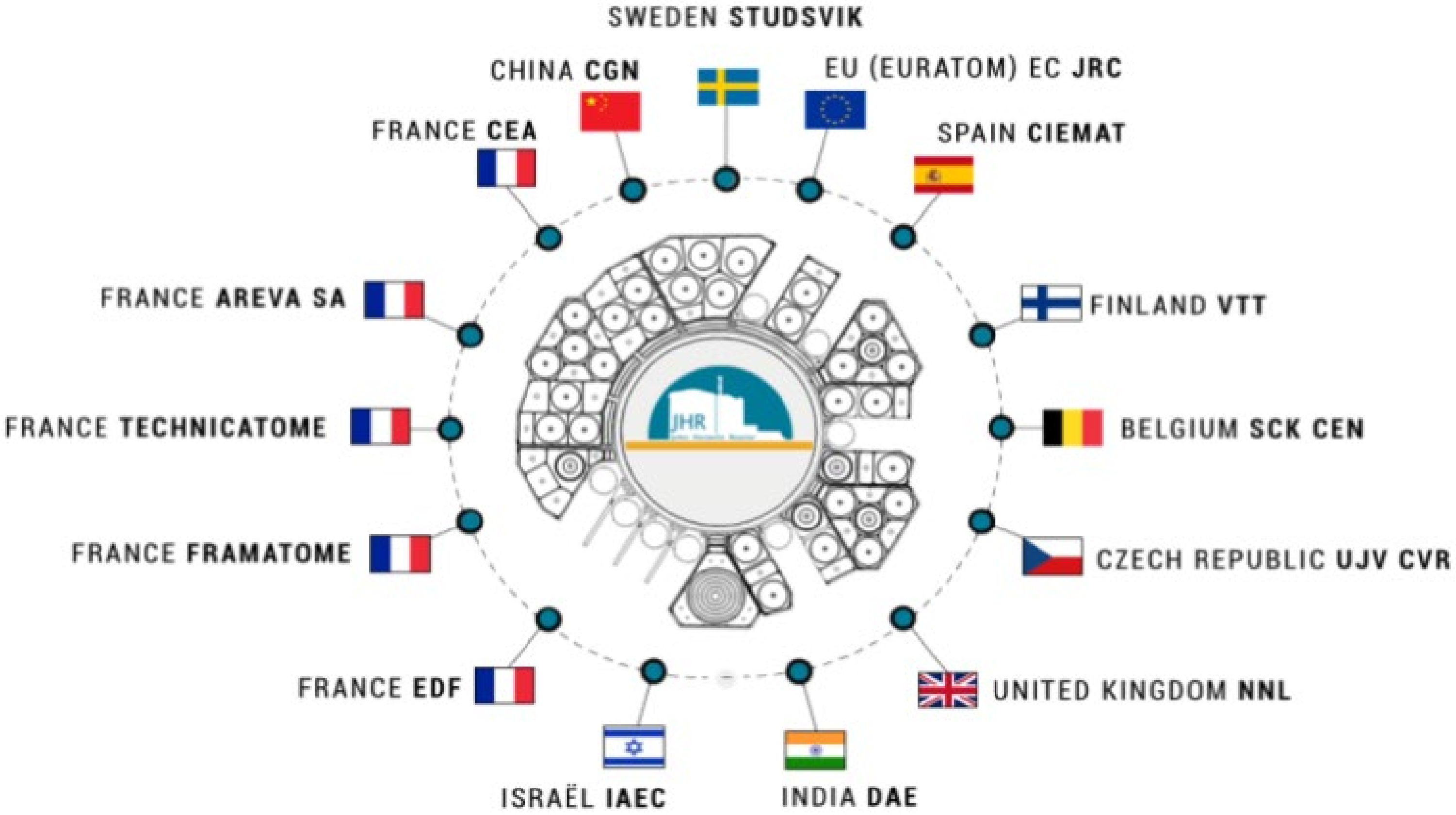
- **Large panel** of irradiation locations in core or in reflector
- Irradiation devices and containers **adapted** to the target specificities
- Flow studies to ensure the arrival and departure of targets during the **allocated time**
- An active role and listening into the radisiotope community to **anticipate and master** the evolution of the needs
- **Equilibrated** business model



# An international User's Facility

## A Consortium of today 15 members for construction and operation

- CEA, owner, nuclear operator, project manager
- Each Consortium member contribute to finance the construction (in-kind or cash) and has in return access rights to the experimental capacity
- Partners are private and public entities
- **CEA is mandated by the JHR Governing Board and the French Government to enlarge this international consortium**

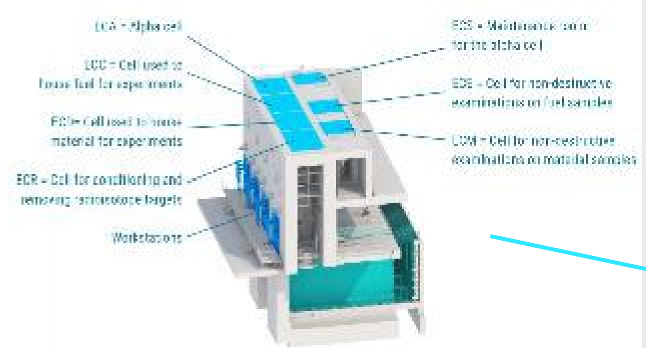


# 2.How does it work?

# Organisation of the nuclear buildings

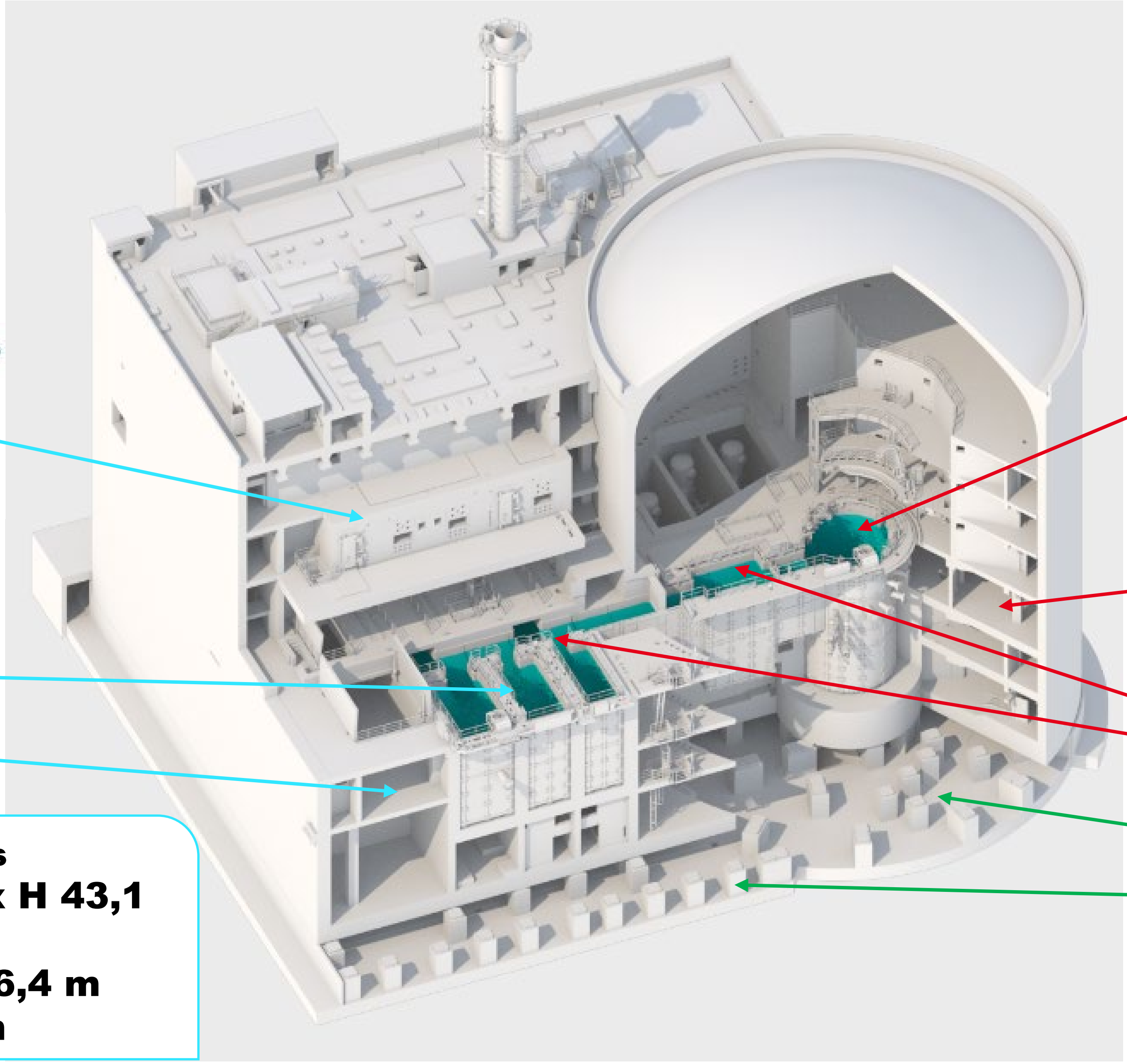
**AUXILIARY BUILDING**

**Hot cells**



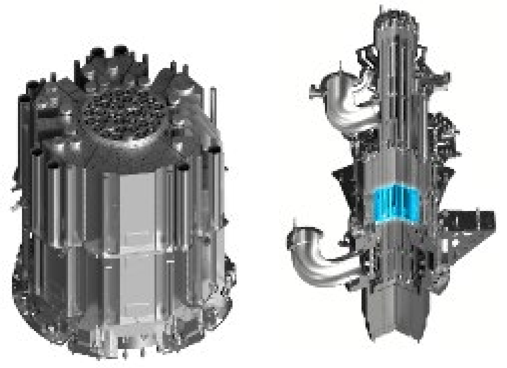

**Storage pools**

**Truck hall**



**REACTOR BUILDING**

**Reactor core**



**Shielded cubicles**

**Water block**
**Continuous renewal**

**Underground**
**Seismic pads**

**Dimensions**
**BUR : Φ 36,6 m x H 43,1 m**
**BUA : 50,3 x 46,4 m**
**H : 34,8 m**

# The core

**OSIRIS reactor view**

Highly instrumented devices

Online fission gas measurements

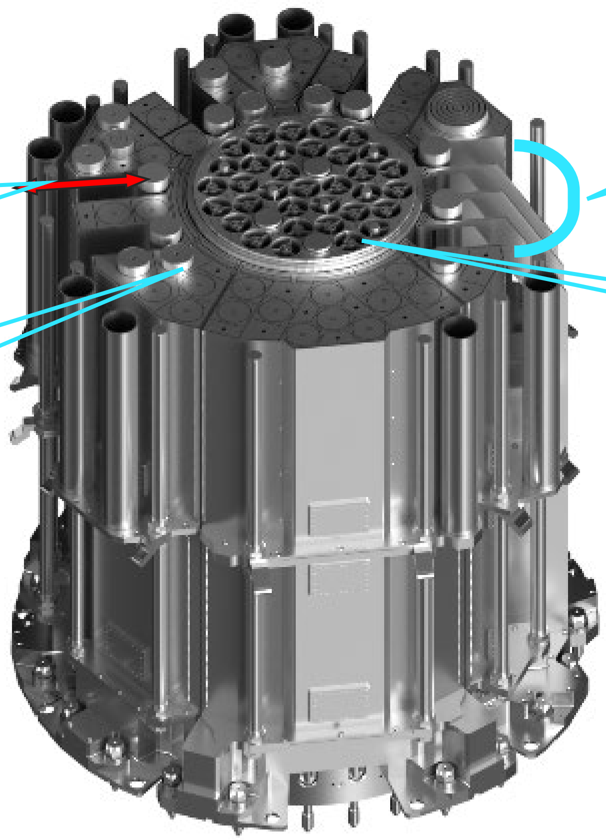
Up to 20 simultaneous experiments

**Displacement system**

**To adjust the neutron flux power needed**

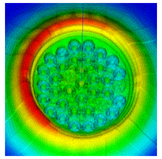
**(power transient)**

**4 molybdenium[99] displacement systems**

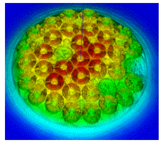


**Material aging program**

**Some of radioisotope devices irradiation location**



**Thermal neutron flux**



**Fast neutron flux**

# 3]  JHR status

# Overall JHR Roadmap

## In the last few years

**Recovery Action Plan** implementation (2019-2020),

Implementation of the 2021-2023 roadmap → **project review in 2023** (remaining activities and associated risks /project schedule up to commissioning and first experiments / cost at completion)

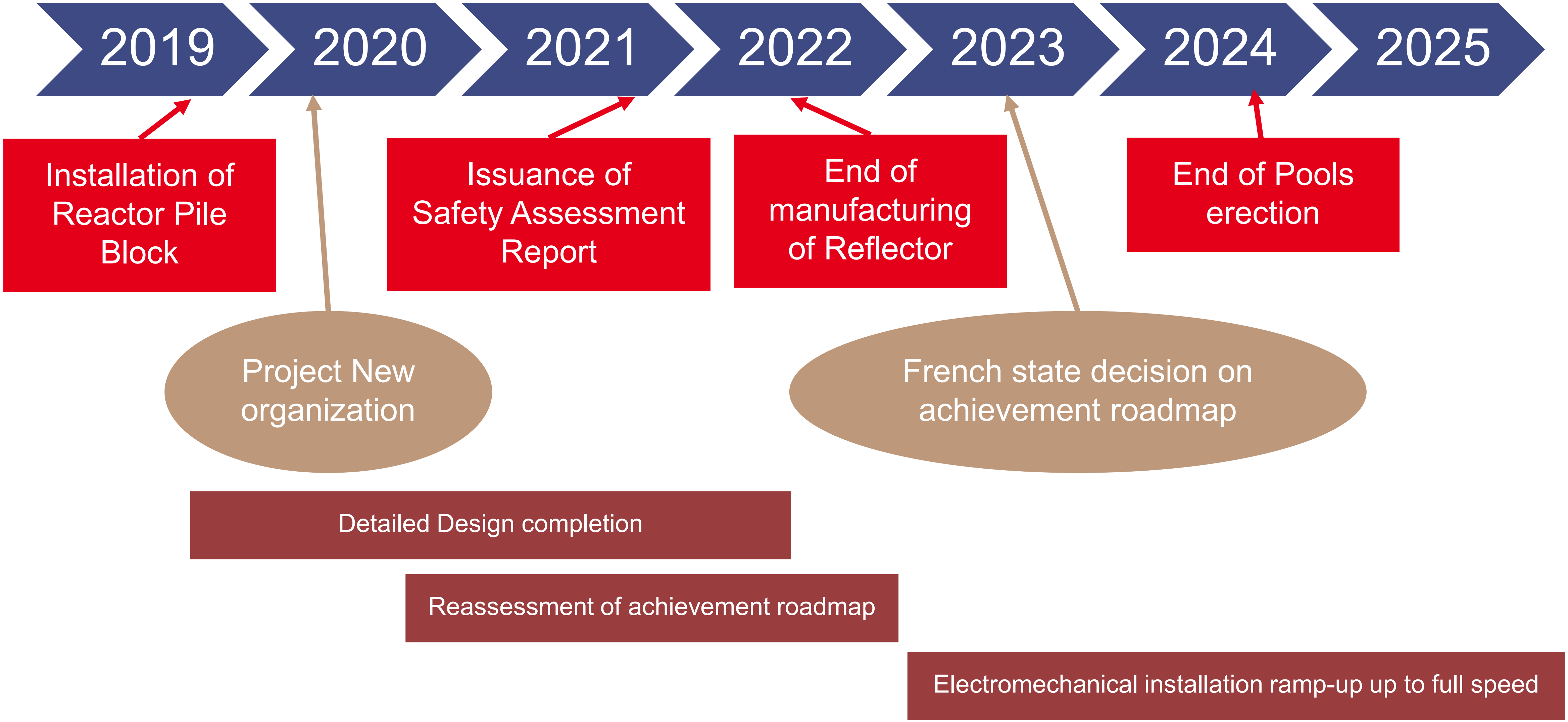
## Nuclear Policy Council of 19 July 2023

- decision made to endorse the roadmap elaborated by CEA to **finalize the installation of the reactor by 2032-2034**
- **key-role of the JHR** for the extension of the existing nuclear fleet and for the deployment of nuclear reactors, both EPR and SMR recognized

## As of mid-2023, full speed installation

- Development of a reference schedule with the 3 main market holders
- Optimization of the schedule based on an action plan based on:
  - Integration of subsequent modifications in parallel with assembly and testing
  - Adjusting project resources to needs
  - Setting up acceleration measures
  - Risk anticipation
- Optimized planning is the common target of all project stakeholders: divergence at the end of 2032
- Aiming for the optimized schedule makes it possible to secure a start between the end of 2032 and the date obtained in the reference schedule (mid 2034)

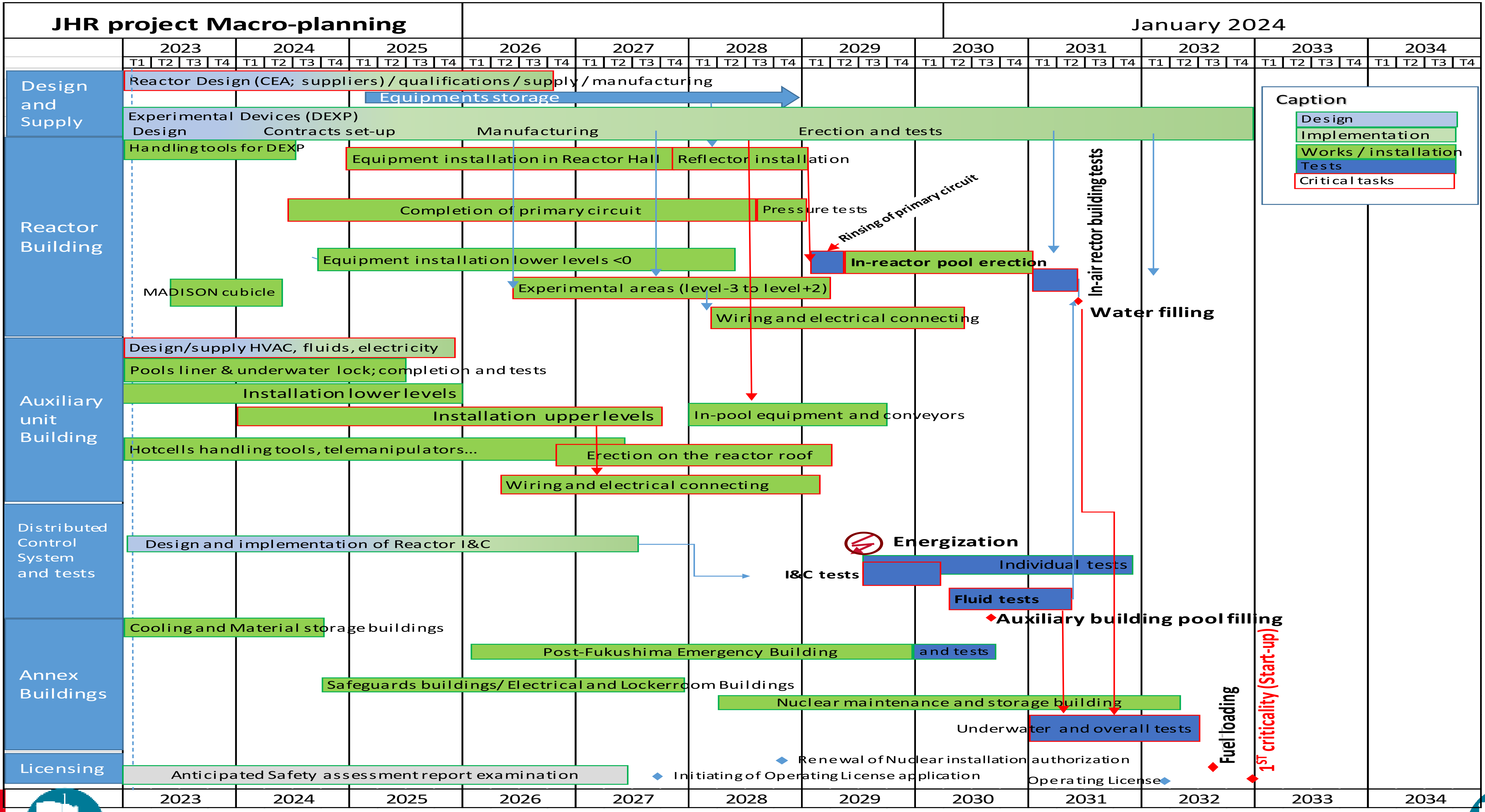
# Major achievements in the previous years



# Major milestones of JHR project in the coming years

- 2025 : End of the detailed preliminary design phase of the 1$^{st}$ fleet of experimental devices
- 2025 : Ramp-up of the electromechanical assembly in the Reactor Building
- 2026 : Start of experimental area assembly
- 2027 : End of assembly in the Auxiliary Nuclear Building
- 2028 : End of assembly of the primary circuit
- 2029 : Commissioning of electrical distribution and start of functional tests
- 2030 : Filling of Auxiliary Nuclear Building pools
- 2031 : Filling of Reactor Building pools
- 2032 : Fuel loading and First Criticality (start-up)

# JHR completion schedule



# Reactor Hall

# Recent Achievements (2024-2025)

**Finalisation of pool liners in the Nuclear Auxiliary Building**

**Polar Crane re-qualification in the Nuclear Reactor Building**

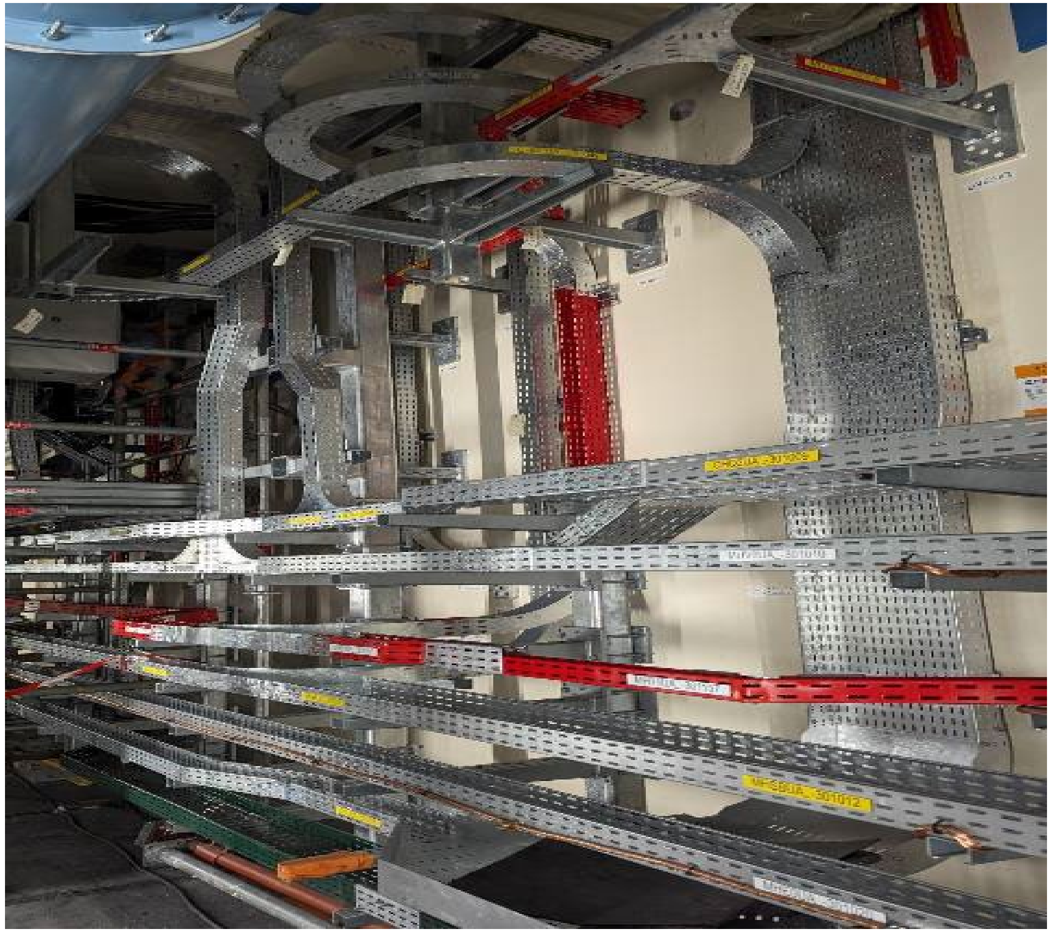
**Test of the UGXR bench in the pool of TOTEM installation**

# Recent Achievements (2024-2025)

**Concrete pouring in Safeguards building**

**Implementation of equipments Level -3**

# Recent Achievements (2024)



**implementation of cable trays for electricity**

# Recent Achievements (2024-2025)


**Installation of supports and pipes in the cooling circuit building**

# 4]  What kind of experiments and devices ?

# JHR hosting capabilities

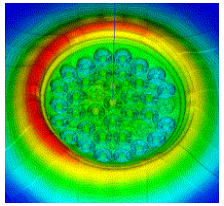
**In reflector**

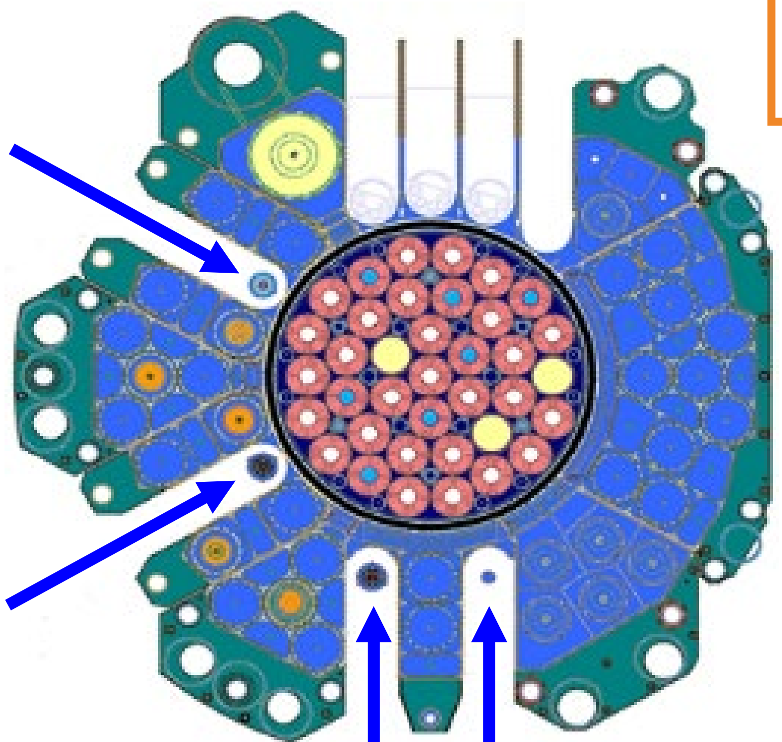
**Up to 3.5E14 n/cm².s (th)**

**Fixed irradiation positions**
**(Φ100 mm & Φ200 mm)**
**and 4 displacement systems**

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

Thermal neutron flux





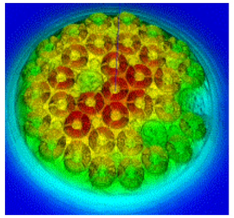
**In core**

**Up to 5.5E14 n/cm².s (E> 1 MeV)**
**Up to 1.E15 n/cm².s (E> 0.1 MeV)**

**7 small locations (Φ ~ 32 mm)**
**3 large locations (Φ ~ 80 mm)**

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

Fast neutron flux



Displacement devices
450 mm stroke
Vmax = 6 mm/s

→A large range of neutron fluxes and spectra

# Enlargment of the first fleet of experimental devices

## Available for the JHR start-up

**ADELINE**

**For LWR fuel testing under off-normal conditions** (Power transients)

To be confirmed January 2026

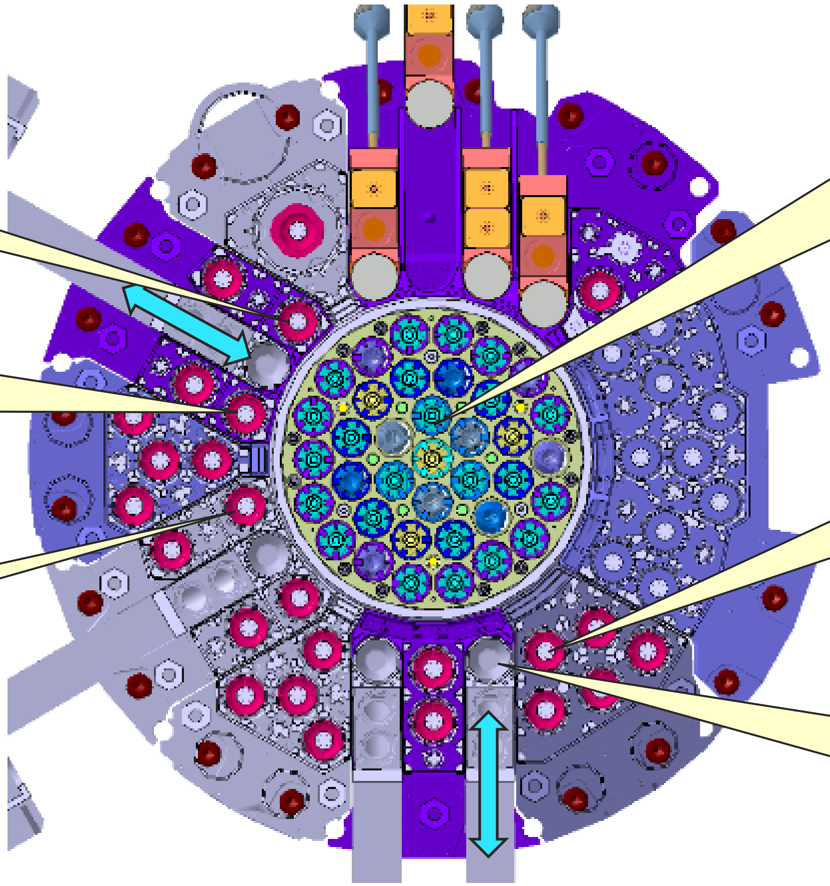
**CLOE**

Corrosion loop for "Zr alloy Corrosion" and "Irradiation Assisted Stress Corrosion Cracking"

NEW

**FUICA**

Fuel capsule for LWR fuel selection and burn-up acquisition



**MICA (x5)**

For material testing under high dpa

Including pressurised samples with constant pressure loading NEW

**OCCITANE**

For Reactor Pressure Vessel steel testing (under low dpa)

**MADISON**

For LWR fuel testing under nominal conditions

# Second/third fleets of experimental devices

## Available few years after fleet 1

**RISHI (IGCAR)**

Loop for Material testing under Na environment

**LORELEI**

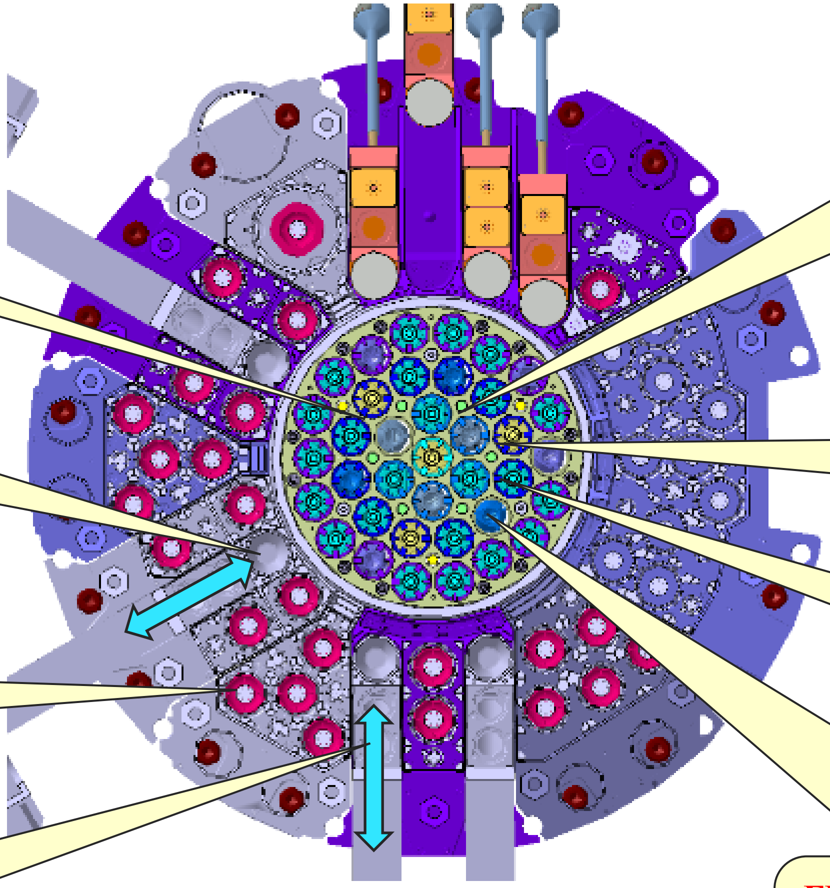
Fuel testing under accidental conditions (LOCA)

**FUSERO A**

Biaxial tests on ceramics (diagnostic windows)

**MADISON 2 (second or third fleet)**

For LWR fuel testing under nominal conditions



**MICA - MELODIE**

Specific sample holder for on-line monitoring of bi-axial deformation on a bi axially-loaded clad sample

**LEBICA (CGN/CNPRI)**

For material testing under Pb-Bi environment

**CALIPSO**

For material testing under high dpa and accurate temperature control

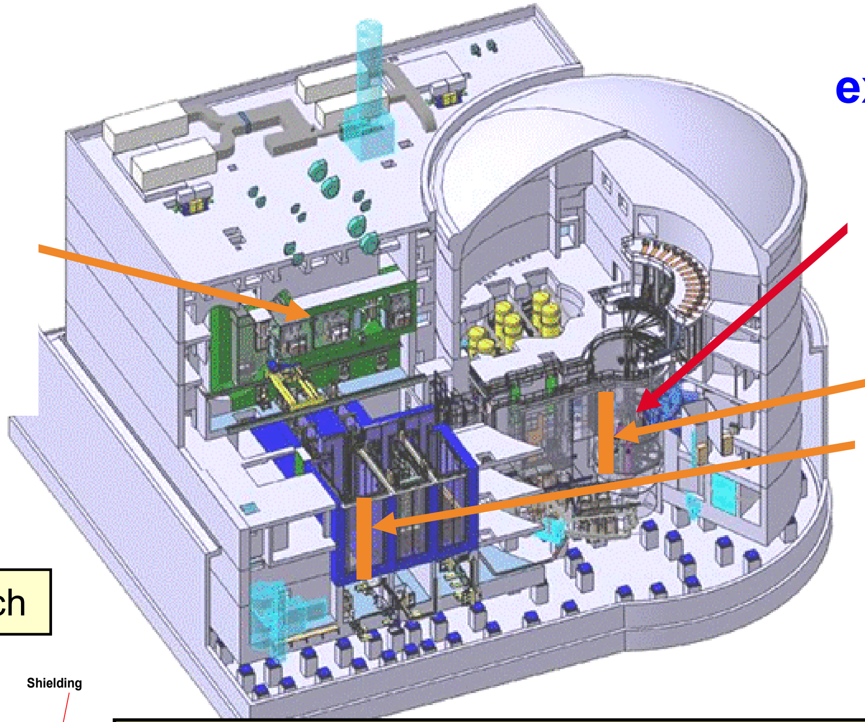
**FUSERO C**

Thermomechanical fatigue on divertor tiles (4 points bending or tension)

# Non Destructive Examination Benches

**Sample examination in hot cells**

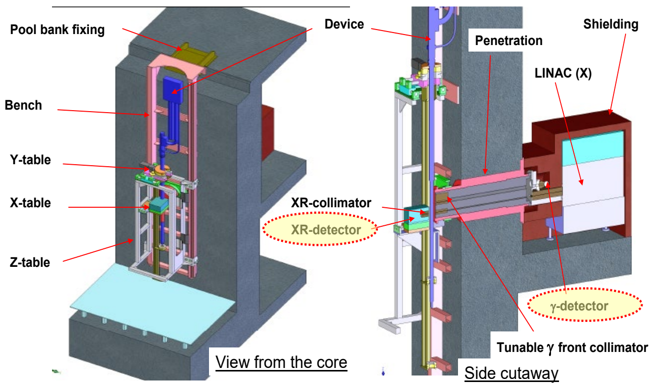
- Gamma and X-Ray tomography systems
- Multipurpose test benches



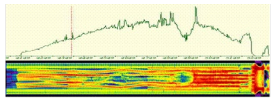
**Test device examination in pools**

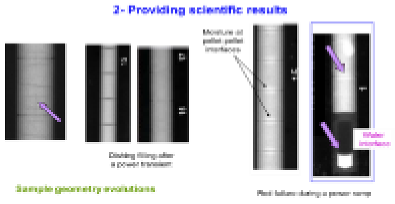
- Neutron imaging system in reactor pool
- Coupled X-ray & γ bench in reactor pool
- Coupled X-ray & γ bench in storage pool

Coupled Gamma &X-ray bench

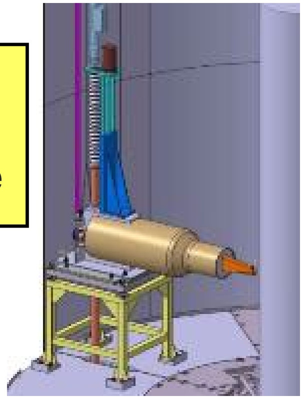



- Initial checks of the experimental loading
- Adjustment of the experimental protocol
- On-site NDE tests after the irradiation phase






Neutron Imaging System



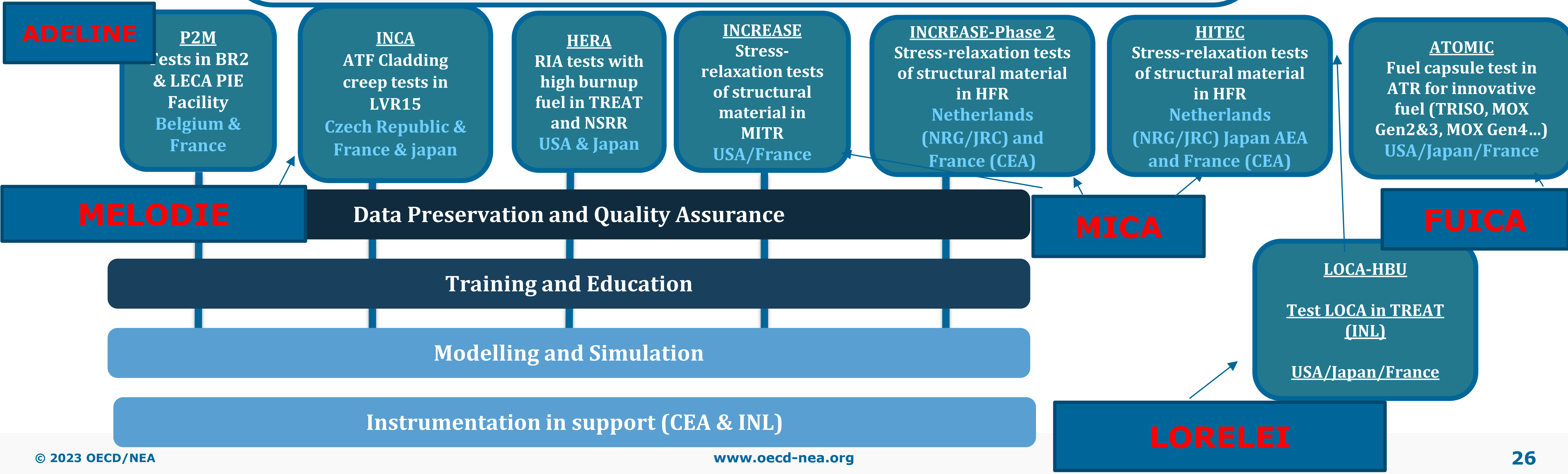
# Preparation of JHR experiments using MTR's in operation through the OECD/NEA/FIDES2 Framework

# Framework Design 2nd Triennal Program of Work

*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 Statues 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 for the first triennial: 4 new JEEPs proposal under evaluation for 2nd and 3rd triennal**



# Thank you for your attention

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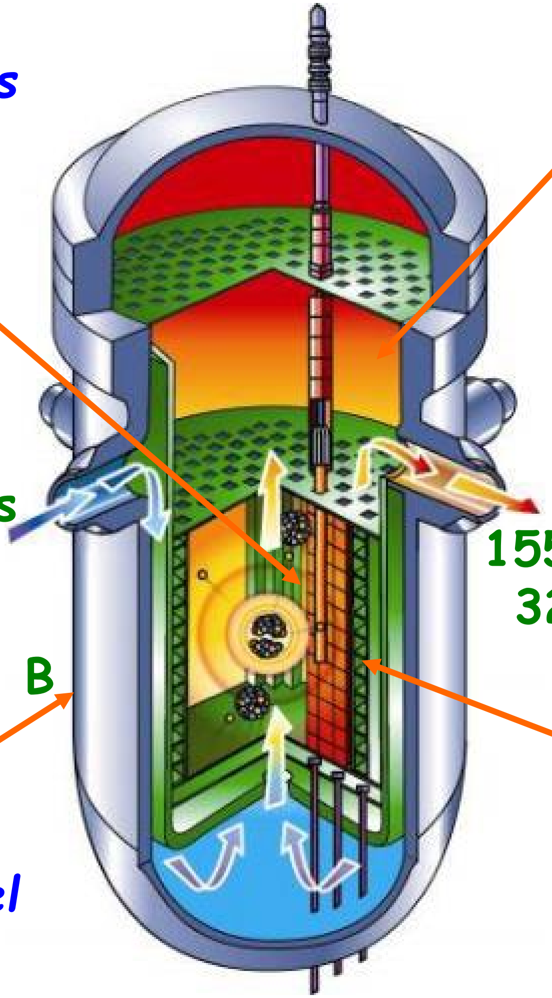
# Appendices

# Material experimental needs and JHR devices



Mica

*Fuel Assemblies*
*Zr alloys*

300 - 400°C
10/15 dpa
5 - 6 years

*Core Internals*
*Nickel alloys*

Occitane

~ 320°C
few 0.1 dpa
40 ➔ 60 years

155 bars
293°C
Water
$H_2$, LiOH, B

155 bars
328°C

*Control rods*
*Austenitic steels*

~ 320°C
~ 10 dpa
few years

Mica

~ 300°C
0.1 dpa
40 ➔ 60 years

Occitane

*Vessel*
*Bainitic steel*
*16MND5*
*A508 Cl 3*

*Core Internals*
*Austenitic steels*

Mica

300 - 380°C
30 - 120 dpa
40 ➔ 60 years

**+ Corrosion aspects → Cloe in LWR conditions**

# Fuel experimental needs and JHR devices

**Selection** / **Characterization** / **Qualification** / **Safety tests**

**or**

**Burn-up acquisition**

**Fuel capsule, Madison ,…**

**Madison with instrumented fuel rod , Adeline**

**Madison (nominal), Adeline (ramp tests)**

**Lorelei (LOCA)**

- Main objectives
  - ✓ Basis irradiation of several innovative products under similar conditions
- Main requirements
  - ✓ High embarking capacity
  - ✓ Few instrumentation
  - ✓ Post irradiation examination

- Main objectives
  - ✓ Measurement of physical properties under neutron flux
  - ✓ Investigation of: Burn-up effect / Fission gas release / Pellet-Clad interaction / Chemical effect / Creep phenomena …
- Main requirements
  - ✓ High instrumentation
  - ✓ Accurate control of environment conditions (steady or transient)
  - ✓ Single effect experiments

- Main objectives
  - ✓ Reproduction of environment conditions of power reactors in normal, incidental or **accidental** situations
  - ✓ Envelope situations targeted
- Main requirements
  - ✓ Good representativity of power reactor (steady and transient states)
  - ✓ Long term or short term irradiations