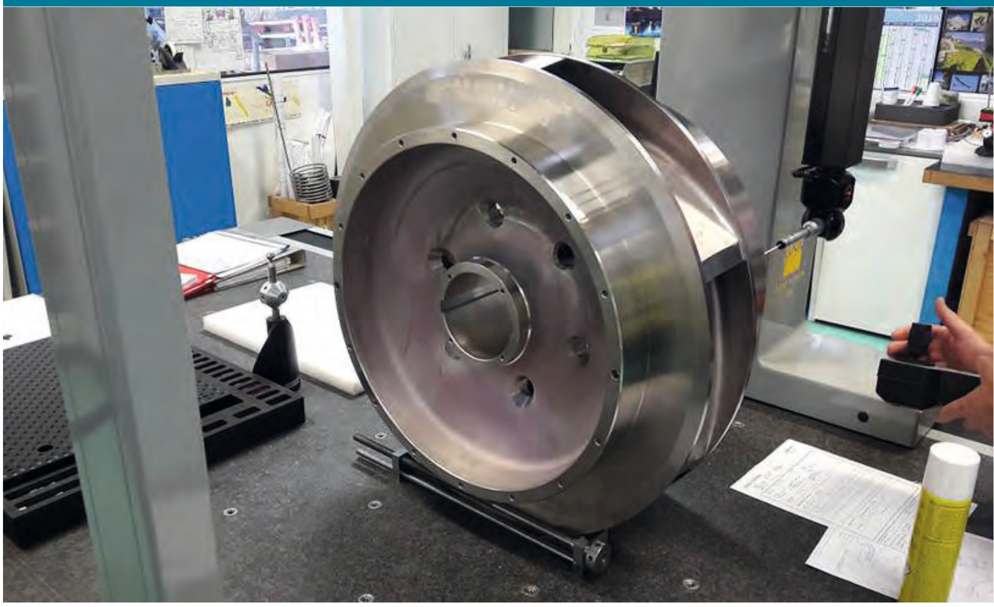
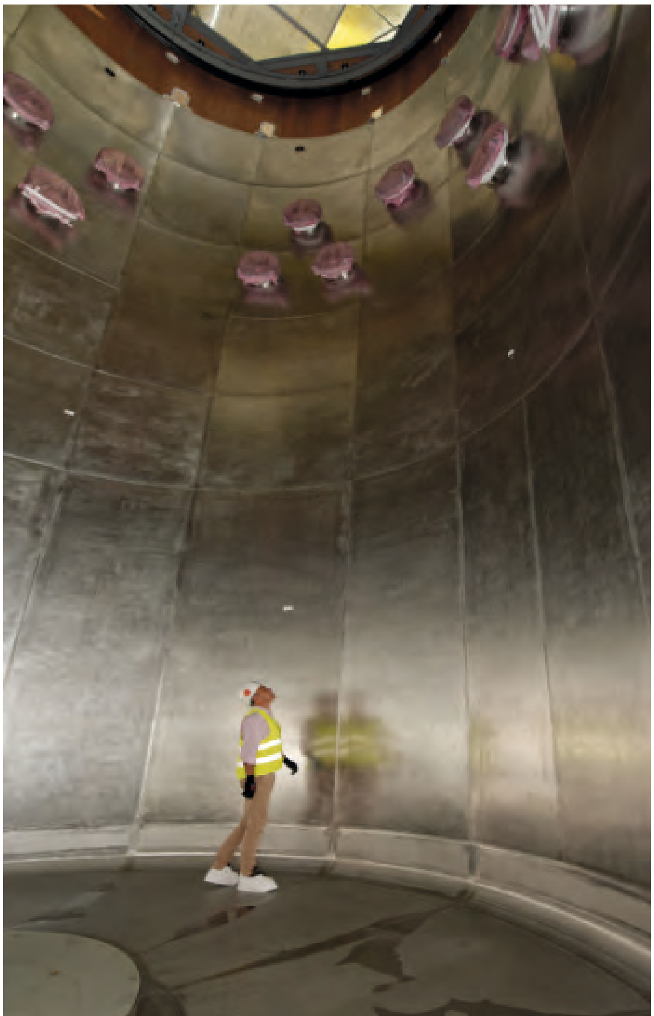
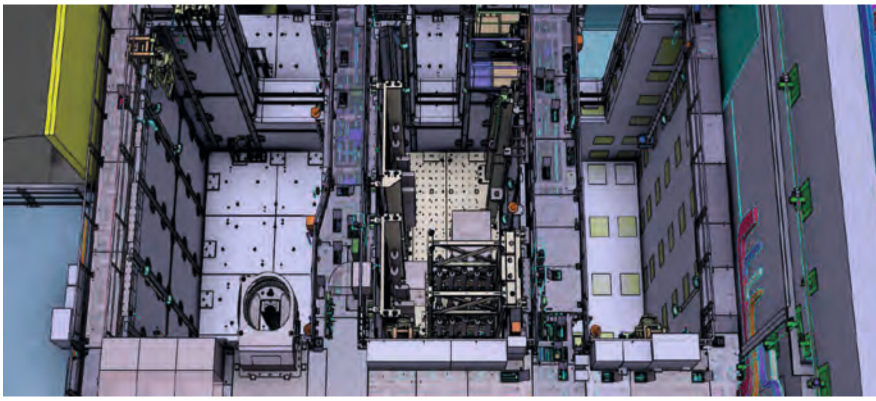
JHR
Jules Horowitz Reactor

# Activities Brochure 2019




# 2019 JHR Status Report


The Jules Horowitz Reactor
*Project*

The present status report cannot be communicated without prior written authorization from the CEA.

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Editor: Gilles Bignan

## FOREWORD

In 2019, as well as in 2020, safety is the utmost priority of the JHR project. With 11 accidents, including 4 loss-time accidents, our frequency rates are roughly at the same level as in 2018 : in 2020 a drop in the figures is expected and the JHR project team will strengthen actions to improve safety, while site activities will increase.

In 2019 the project has entered a new phase with the start of mechanical erection. In September, Technicatome successfully installed the first elements of the reactor-pile block. A few weeks later, it was the turn of the primary heat exchangers, supplied by our Consortium partner CIEMAT and Spanish partners as an in-kind contribution. In hot cells, the metallic liner was completed under the leadership of our Consortium partner NRI/CVR.

There was also good progress for the preparation of experimental loops and devices. I would like to mention the factory acceptance test passed on the HGXR bench by our Consortium member VTT, in the frame of its in-kind contribution.

2019 was marked by the French Prime minister decision to continue with the JHR project provided the implementation by Oct 1st, 2020 of recommendations issued after an audit done in 2018.

An action plan is in place whose main axes are :

- 4 basic behaviours: always give priority to safety; tell facts and speak the truth; commit and get results ; promote team spirit
- Change in the organisation and governance with an integrated team between CEA and Technicatome under the leadership of CEA
- Design freeze and issuance of a shared project schedule
- Focus suppliers on project stakes and schedule
- Anticipation of licensing
- Issuance of the business plan
- Search for additional financial contribution

2020 will therefore be a decisive year for the JHR project with the implementation of this roadmap!

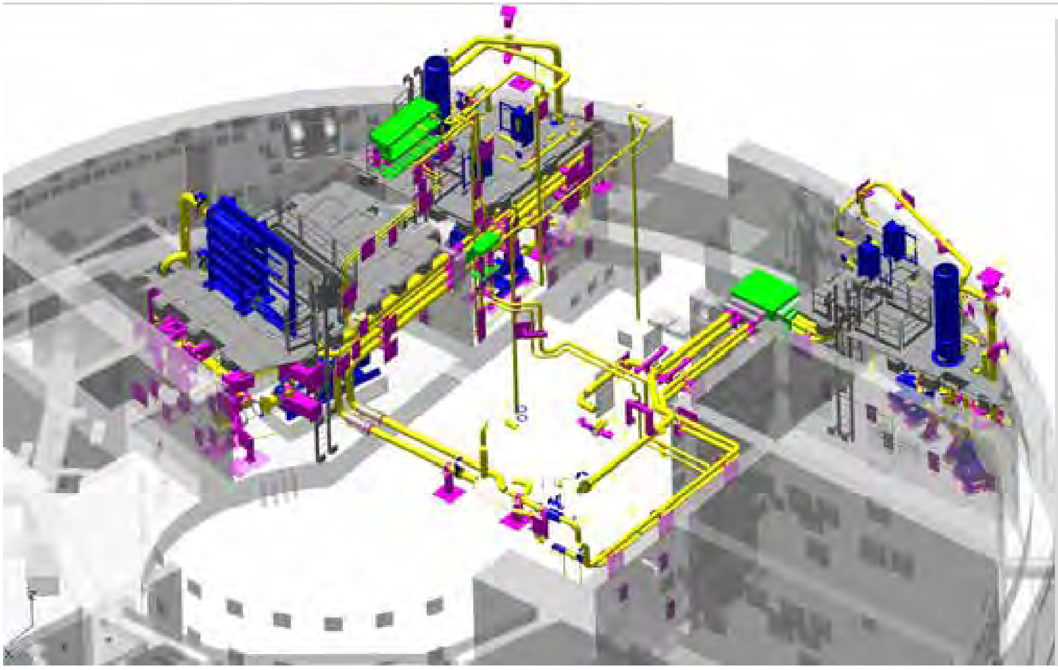
In 1920, Ernest Rutherford predicted the existence of a particle in the nucleus and called it "neutron". A hundred years later, I would like to thank the JHR project team and all contributors and stakeholders for their effort and their support. They keep the JHR project on the good path to produce large flux of neutrons for the nuclear industry and research as well as for medical purposes.

David Emond
JHR project leader

# JHR *facility design and construction status*

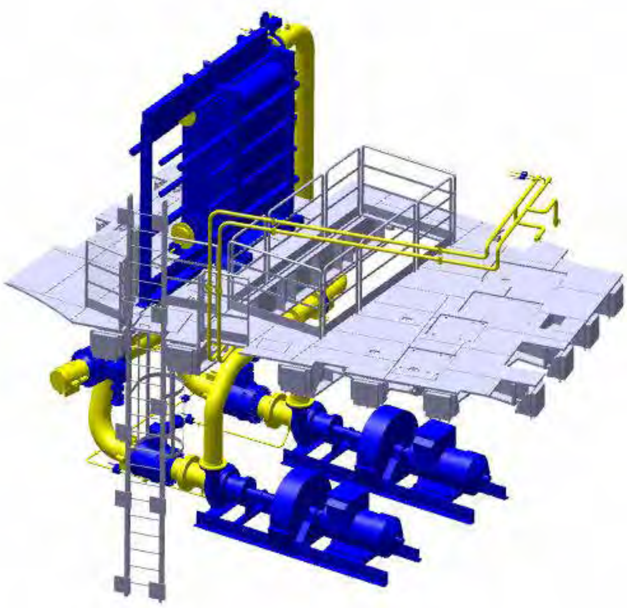
## 1.1 Reactor building pools - Reflectors primary cooling system - Safeguards cooling systems

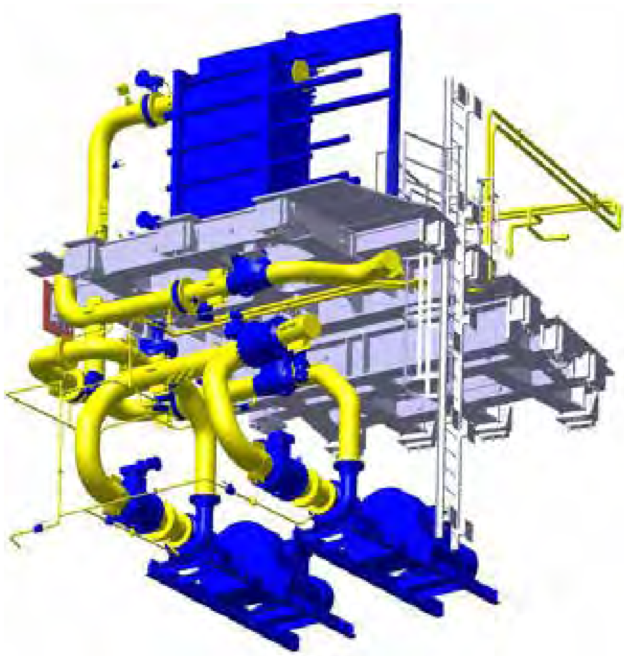
In 2019, those systems are in the end of their detailed design phase, to integrate last configuration modifications and some interfacing adaptations.



*Whole systems' perimeter in reactor building, starting from fixed points of reactor pool interfaces or ESPN N1 component of the primary system and ending to the last exchangers (primary/secondary or secondary/tertiary).*

Reactor Pool and reflectors' primary cooling systems and associated bunker's floor structureswelded.

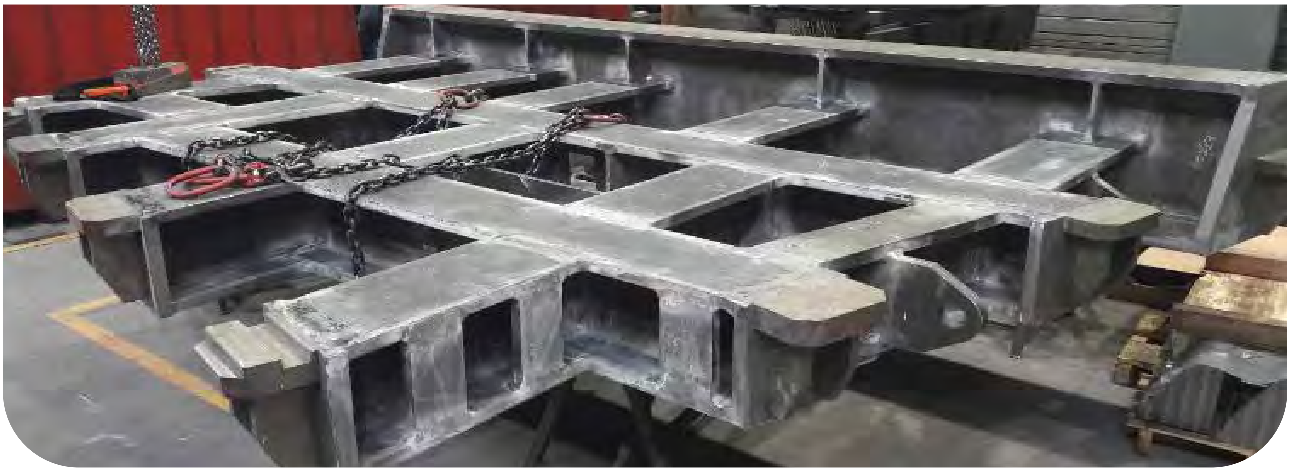




Meanwhile, manufacturing for the bunkers' floors structures is in progress. The photos shows the main structures of the reactor pool primary cooling system cubicle floor, in two mechanically independent parts. The first structure with a boxed design will carry the system's primary exchanger along with pipping. The second one will carry the MOLI's twin exchangers and the two pumps of the interim storage pool cooling system, together with pipping.

*Part. A*

*Part. B*



Material supplies for the pipping manufacturing of the circuits are also in progress.


*Flanges ESPN N2 with engraving identification*

*Forged component for feedthroughs*

*Accessories for welding on pipes*

*Stainless steel pipes tubes ready for pre manufacturing*

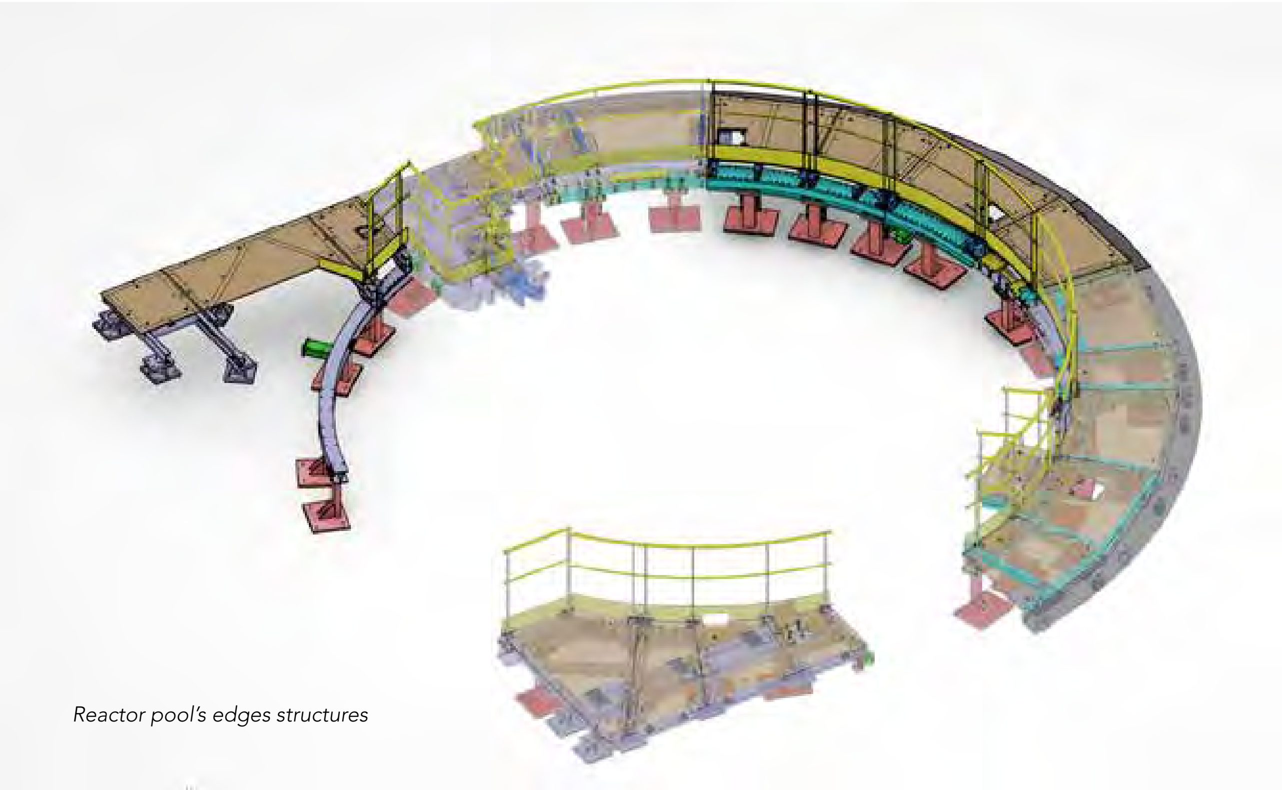
## 1.2 Pool's edges structures

The pool's edges structures are stainless steel designed mainly to:

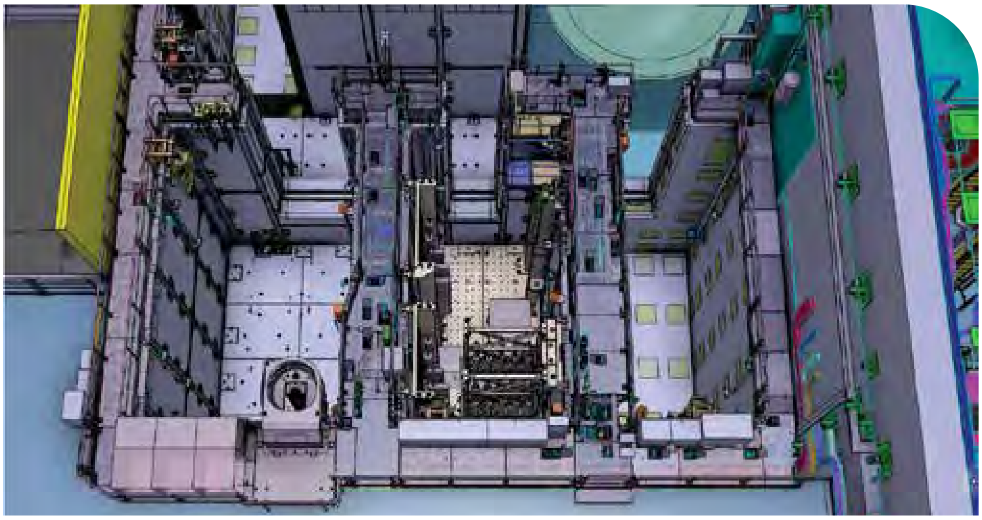
- Carry heavy equipment plunging into the pools like workstation for experimental devices, fuel or experimental devices racks…
- Carry light and medium weight equipment and cable trays
- Carry various piping with dynamic decoupling requirement
- Allow operators access around the pools.

They are composed of mechanically independent sectors, to simplify dynamic coupling management (13 sectors in reactor building and 8 double sectors in nuclear auxiliary building). The main challenges for those structures are to address the decoupling requirements and the complex on site assembly sequence gathering multiple contractors (structures, pipping, electric wires …)

In 2019, those structures are in the end of their detailed design phase and first sectors of reactor building are in manufacturing phase (with some anchorage pre-work also done on site).



*Reactor pool's edges structures*



Nuclear annex building pools with their edge structures

Short anchored stud welding and pickling

Tie down on site pre-work : concrete drilling and tie-plate welding

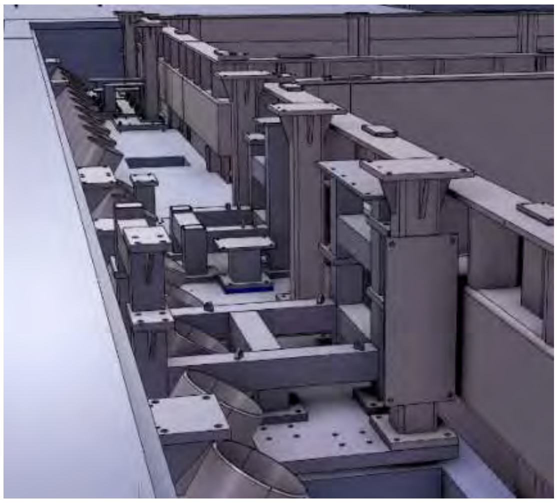
Upper deck welding preparation

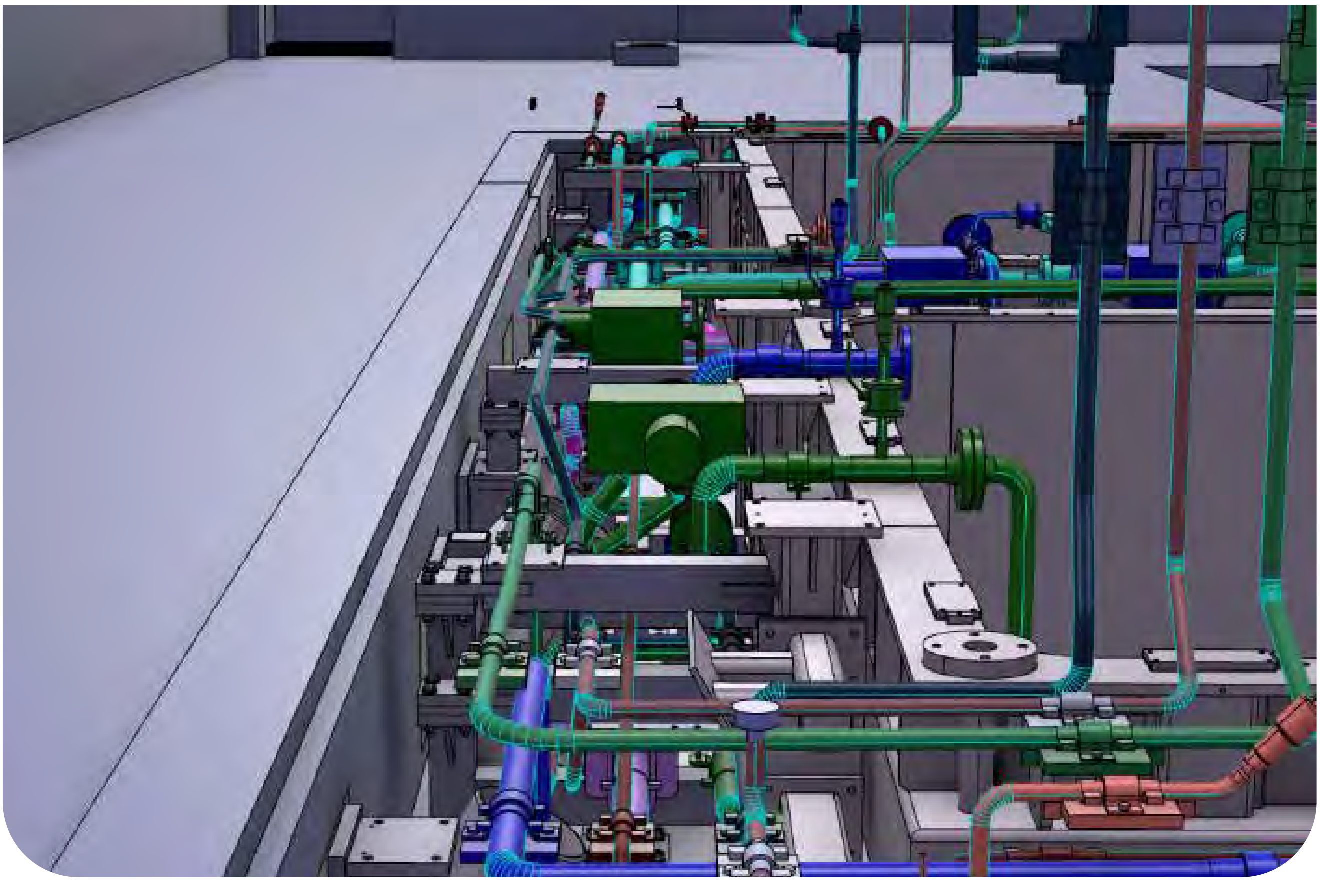

Raw material for reactor pool's edge structures

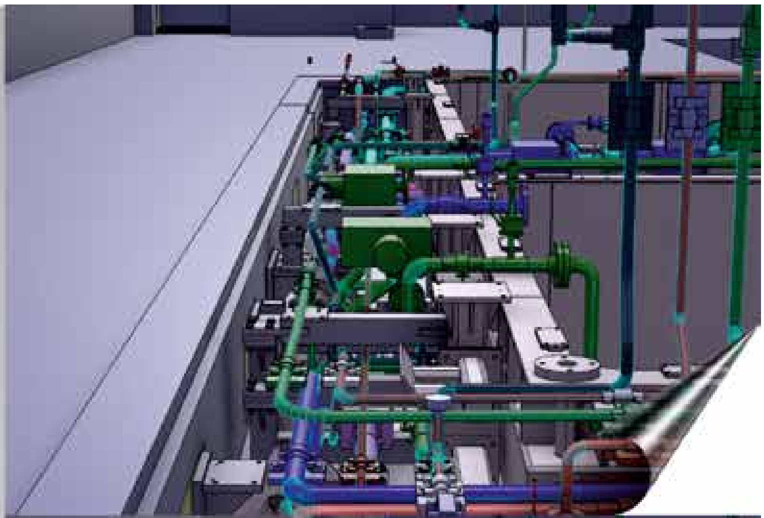
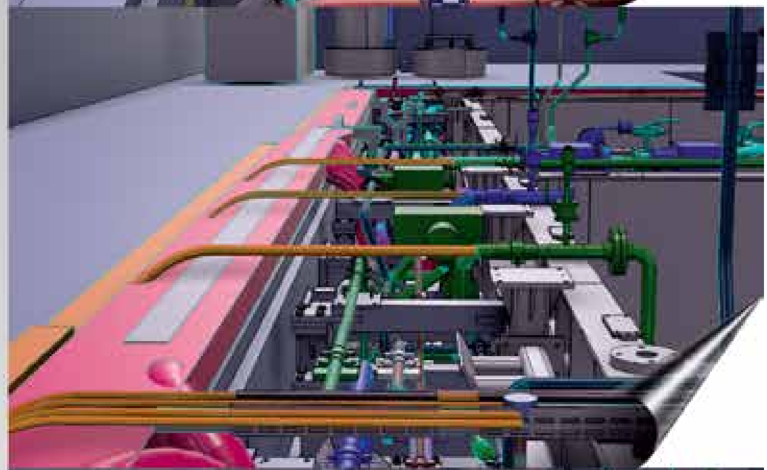
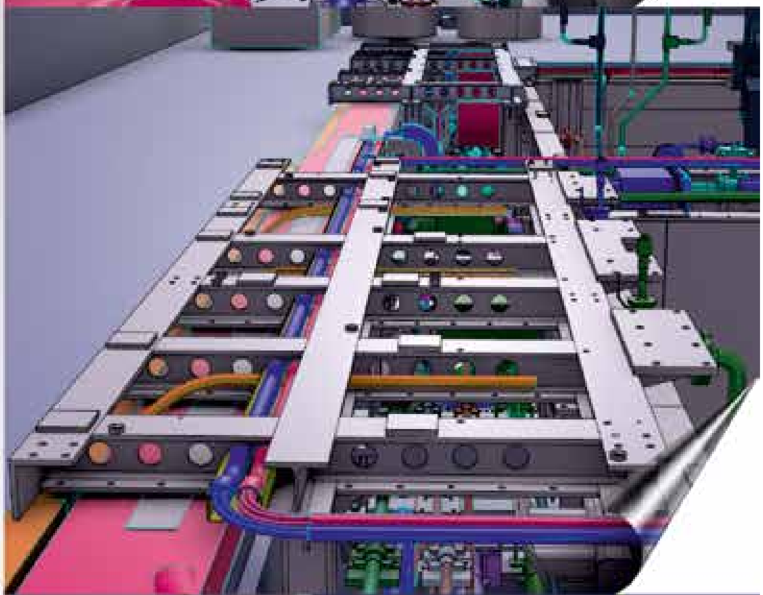
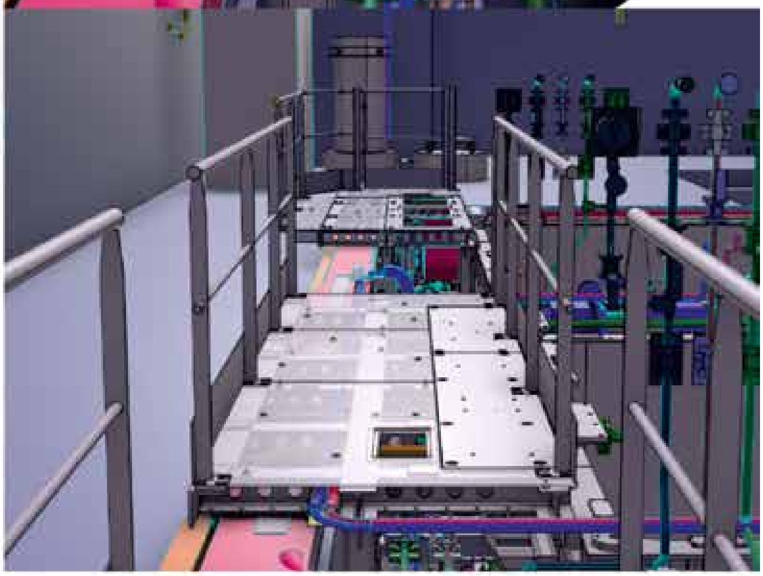
Structures and templates on the assembly test area

Half of the upper deck structure for the first sector, waiting for final machining

*On site assembly simulation for nuclear auxiliary building pool's edge structure with pipping and cable trays*



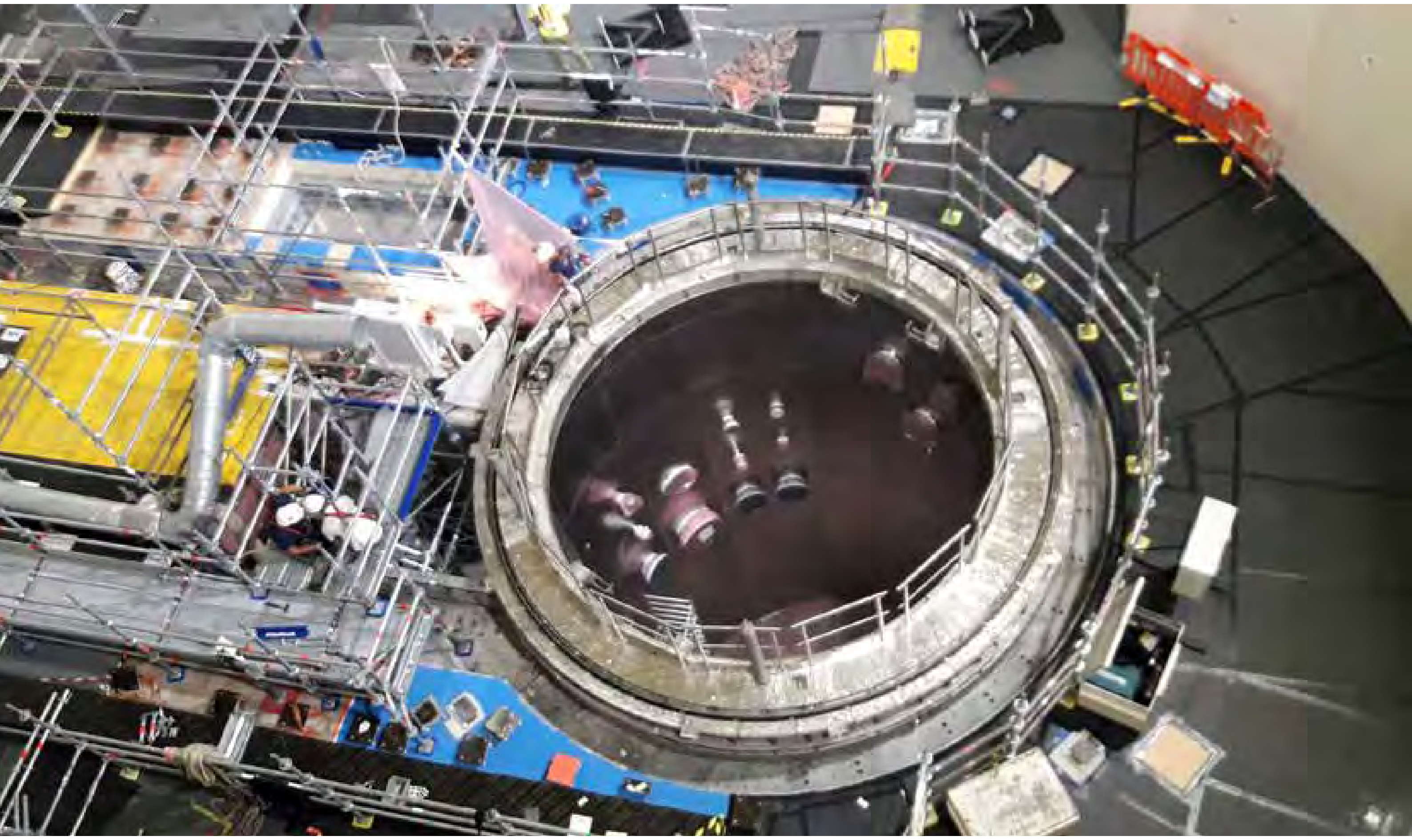


## 1.3 Pools tanking

The main achievement of the year 2019 was the completion of the reactor pool liner leading to the start of integration of components of the reactor pile-block.

This reactor pool equipped with 29 penetrations is one of the most complex realization of the JHR project and this challenge has been achieved thanks to all the efforts of the combined team.



Strict design constraints (thermal loading, material fatigue and elongation, positionning uncertainties on civil work structures…) lead to the development of a new anchoring system (called Diabolo) interfacing with the with the civil work structures.

Thus, since the setting-up of the first diabolo end of 2014, the implementation of this reactor pool liner faced several difficulties due to these extremes requirements. These difficulties lead to redesign and fabrication of the penetrations in compliance with a tough planning. To solve these challenges innovations were performed ( advanced mortar for the cement, new welding techniques…).

The realisation of this circular pool (H=12,3 m ; D=7m) has necessitate :

- 25 000 hours of engineering,
- 5,5 years of on-site work,
- 752 diabolos systems welded associated with 6016 screws,
- 96 welded sheets,
- 410 m of welding for the liner and 50 m of welding for the penetrations.

All the weld have been subject to inspection via two independent techniques

(Radio and Ultrasonic)

# 1.4 IN KIND CVR Hot Cells

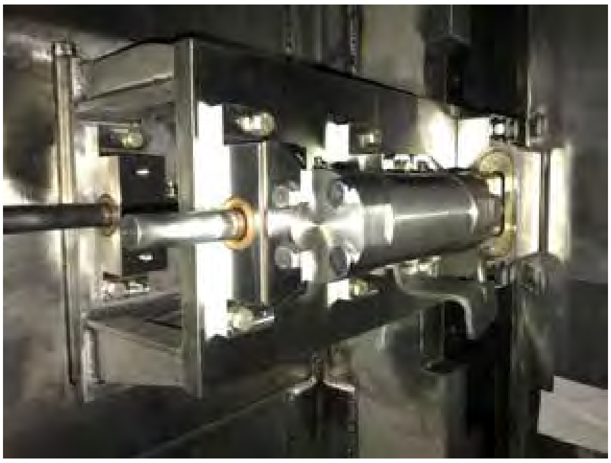
In 2019, CVR and its partners made significant progress on the manufacturing of equipments of the Hot Cells. The stainless steel tanking of the Hot Cells has been completed including passivation allowing the implementation of first components. In the front zone area and in the gallery, the tackles and the monorail have been installed leading to the possibility to bring the windows of the small cells at the +1 level. Biological Shielding doors between cells and the front zone area of the small cells have been equiped with motors and sensors. Moreover, biological doors of the channels have been installed.
In factory, the manufacturing of lifting unit is completed and tests have started.

***2019*** *Waterproofness test of the alpha doors*

***S8 2019*** *Final acceptance of additional shielding of the level +2 floor*

***S3 2019*** *Passivation of hot Cells tanking*

***S15 2019*** *Installation of tracks and tackles*

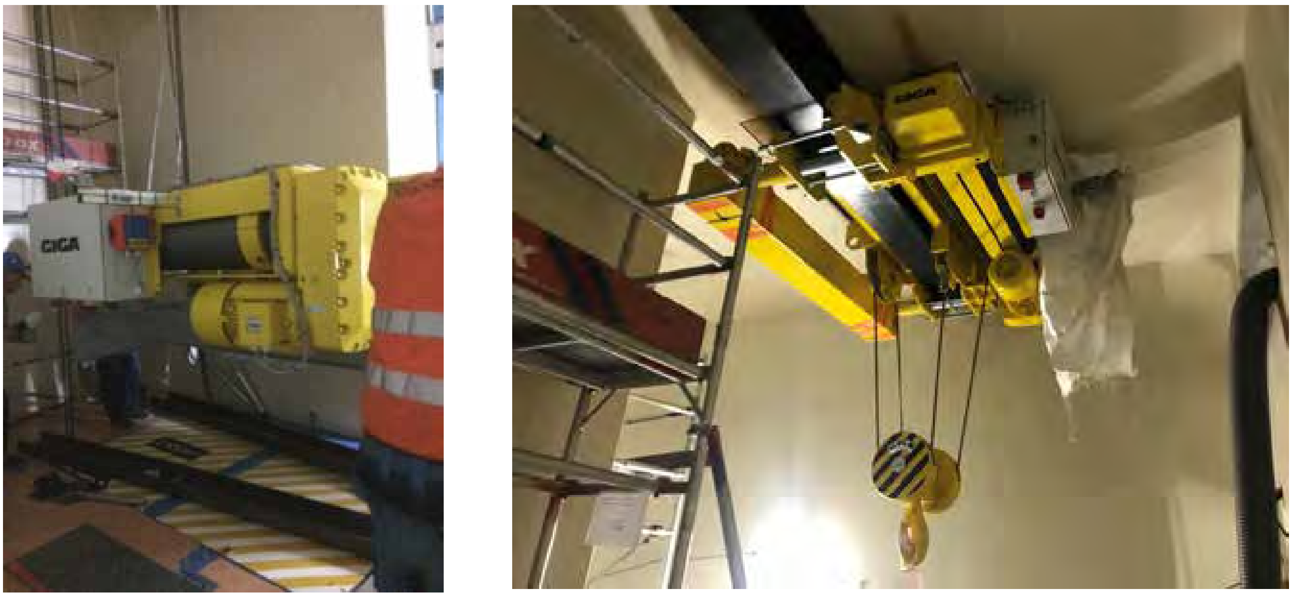


***S18 2019*** *Installation of door locking systems in small cells*

***October 2019*** *components welding within the cells*

*Start of electrical  wiring of a revolving door*

*Implementation of biological shielding doors in the EPM channel*




*Installation of monorail in front area of the small cells*

# 1.5 Reactor Pile-Block components

In 2019, Technicatome and his subcontractors made significant progress in factory and on site regarding the equipments of the reactor pile block.

After the completion of the reactor pool liner in August 2019, in 2nd September 2019 an important milestone has been reached with the start of mounting of the reactor pile-block with the implementation of the bottom penetration unit and the 2 water boxes. These ac-tions required higer level of clean environment (Level 2 of the RCCMRx code) leading to a complete clean of the reactor hall.

In parallel to these on-site mounting, the supply and factory acceptance tests were conti-nuing : pool floor, Berylium blocks, test of core delta pressure lines, false floor within the crypt.

*Water box mounting*

*Final acceptance test of superior internal structure*

*Final acceptance tests of 69 Beryllium blocks*

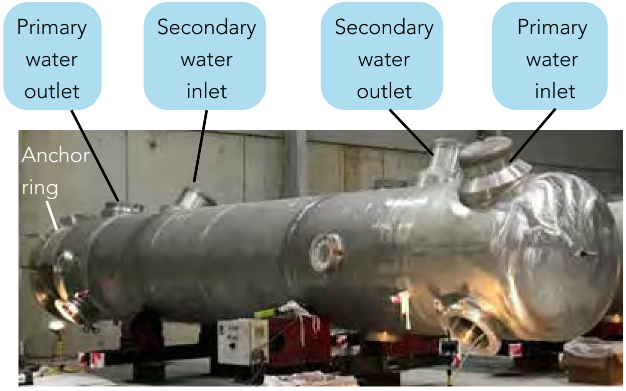
# 2 MECHANICAL COMPONENTS

## 2.1 In-Kind CIEMAT Heat Exchangers

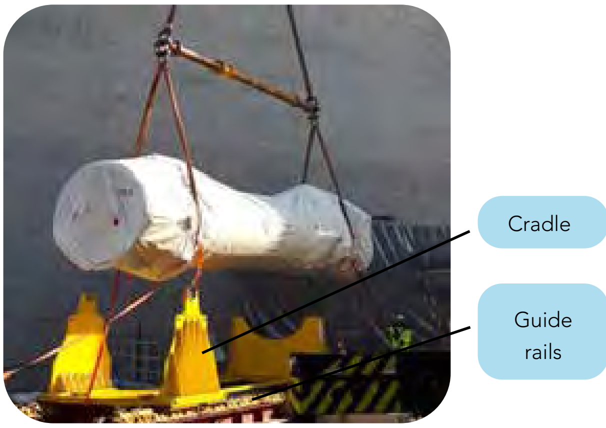
In november 2019, CEA and its prime contractor TECHNICATOME completed an important milestone of the JHR project : the on-site installation of the three heat exchangers of the primary circuit.

These exchangers were supplied as part of the in-kind contribution from the Spanish Consortium represented by the spanish research institute CIEMAT (Centro de Investigaciones Energéticas Medioambientales y Tecnologicas). The design was operated by the spanish company Empresarios Agrupados (EA) and the manufacturing and the on-site installation was operated by the spanish company Equipos Nucleares S.A (ENSA).

Each exchanger is installed in a vertical position in an independent room called primary cubicle. Their function is to allow thermal power evacuation from the primary circuit to the secondary circuit. Each exchanger measures 12 meters high, 1.78 meters in diameter and weighs around 30 tons. Each exchanger obtained its certificate of compliance with the french nuclear pressure equipement regulations.




***Global view of an heat exchanger***

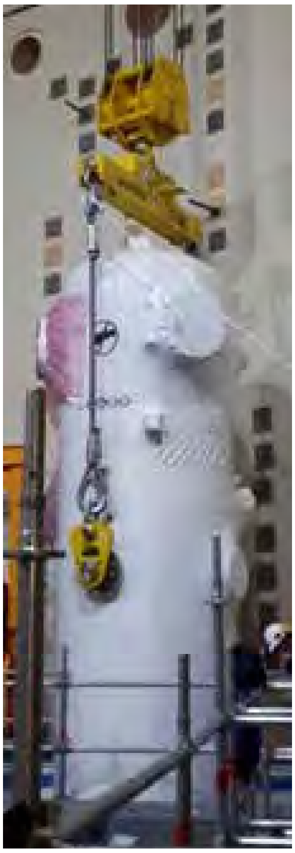



For each exchanger, the sequence of operations for the on-site installation is :

- Unloading on a cradle that is moved horizontally on guide rails inside the JHR by hydraulic cylinders
- Verticalization (moving from the horizontal position to the vertical position) by the polar crane, translation and descent of the exchanger inside its casemate and its anchor rods.

*Verticalisation*

*Translation*



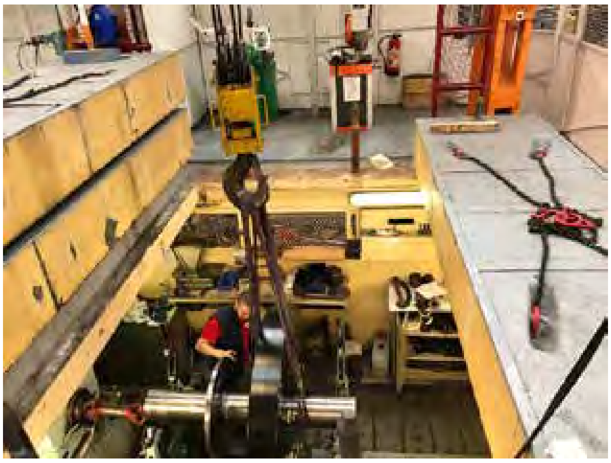
*Descent in the cubicle*

*Exhanger in the cubicle*

## 2.2 Primary Pumps

Pump on the test loop

Tests of maintenance tools



Tests of inertial wheels at 125% of nominal speed

Wheel dimensional control

The company SPX Flow (ex Clyde Union) is the supplier of the 3 JHR Primary pumps.

The contract includes the delivery of the pumps, the associated motors, speed variators and transformers.

The "First of a Kind" pump passed endurance tests giving satisfactory behavior.

The components are beign prepared for a final integration of the pumps in factory.

The tests on the second pump have started (up to now an issue on hydraulic test is under investigation).

Part of the maintenance tools have been tested with the presence of the future JHR operator.

Moreover, inertial wheels have been tested at 125% of the nominal speed to guarantee the absence of any bursting risk.

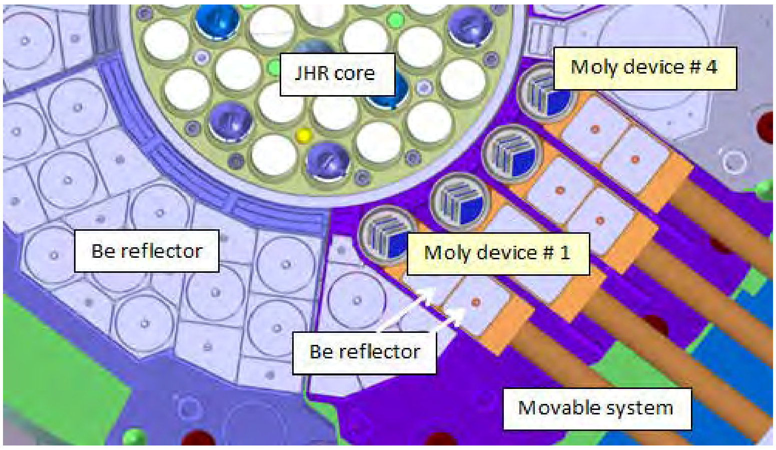
# 3 Moly Project

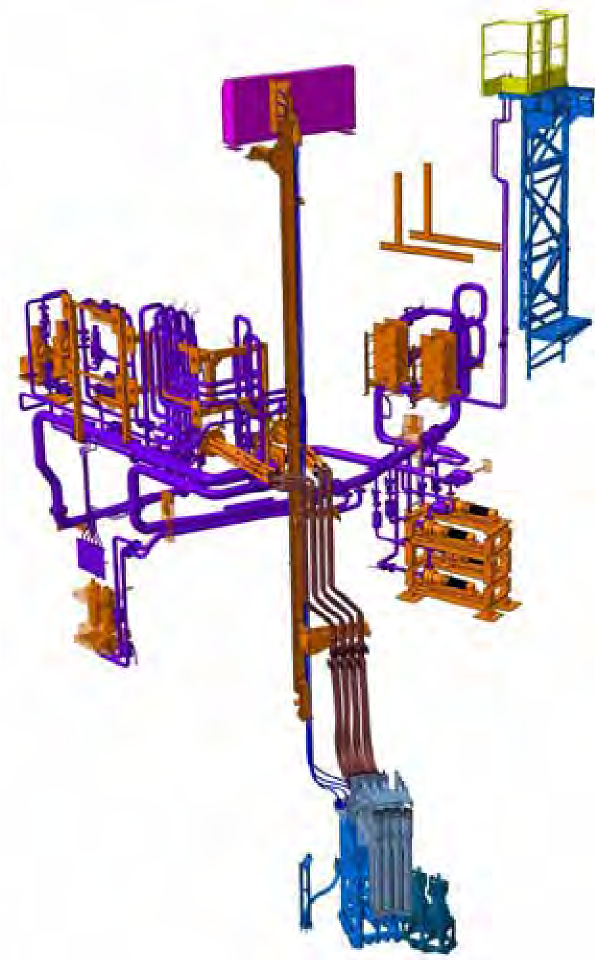
The year 2019 has been marked for MOLY Project by:

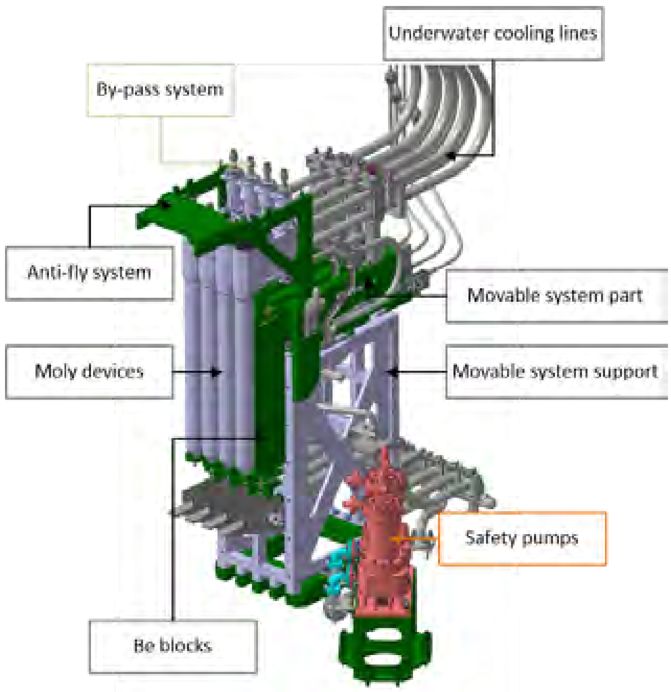
- for in-pile part :
significant improvement of Engineering studies, manufacturing of several components and negociation with potential suppliers ;

- for out-of-pile part(normal cooling circuit of targets and commanc-control) : detailed design studies have been completed and the manufacturing of heat exchangers has been launchedor out of pile part ;

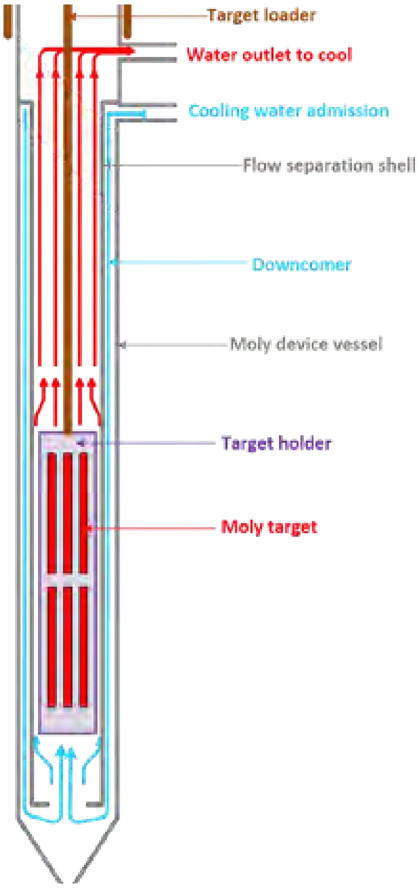
- for equipments of the supply chain : the contracts for the engineering studies and manufacturing of independant equipment from irradiated targets have been put in place.



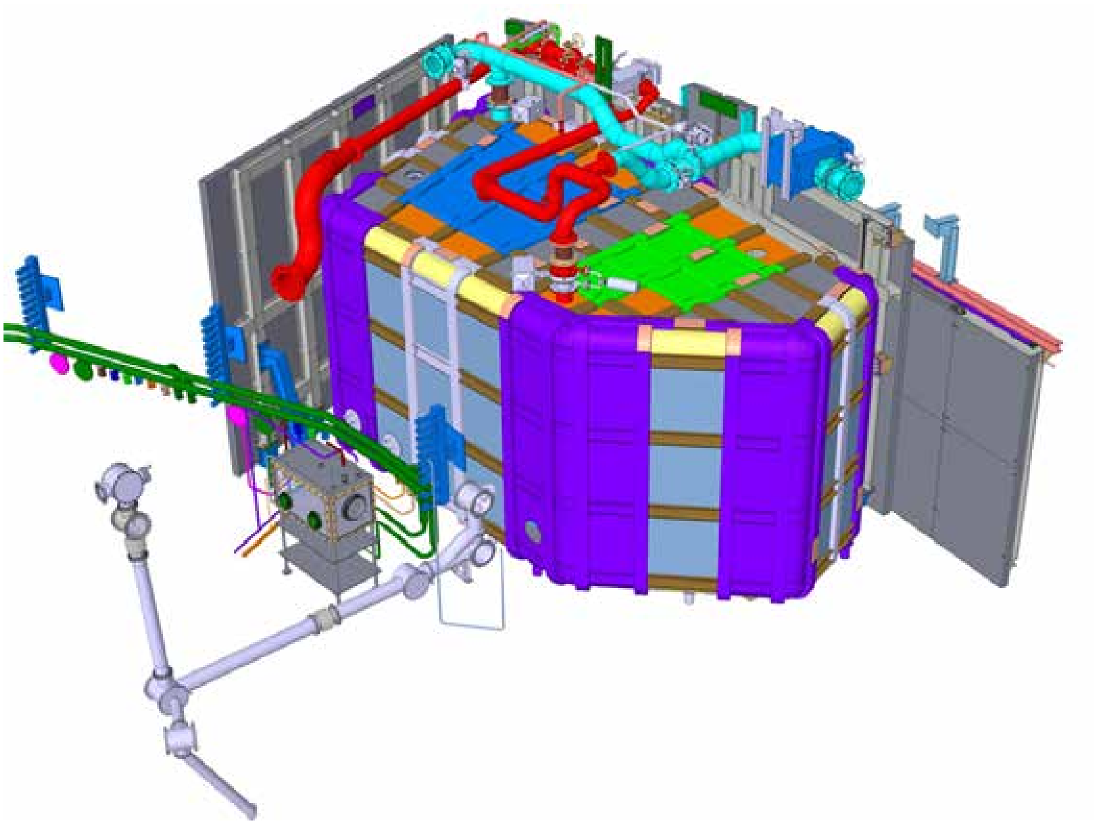



*In-pile part manufacturing : movable system support*




*In-pile part manufacturing : irradiation device*

# *Experimental* devices



# 2 HOSTING SYSTEMS UNDER DEVELOPMENT

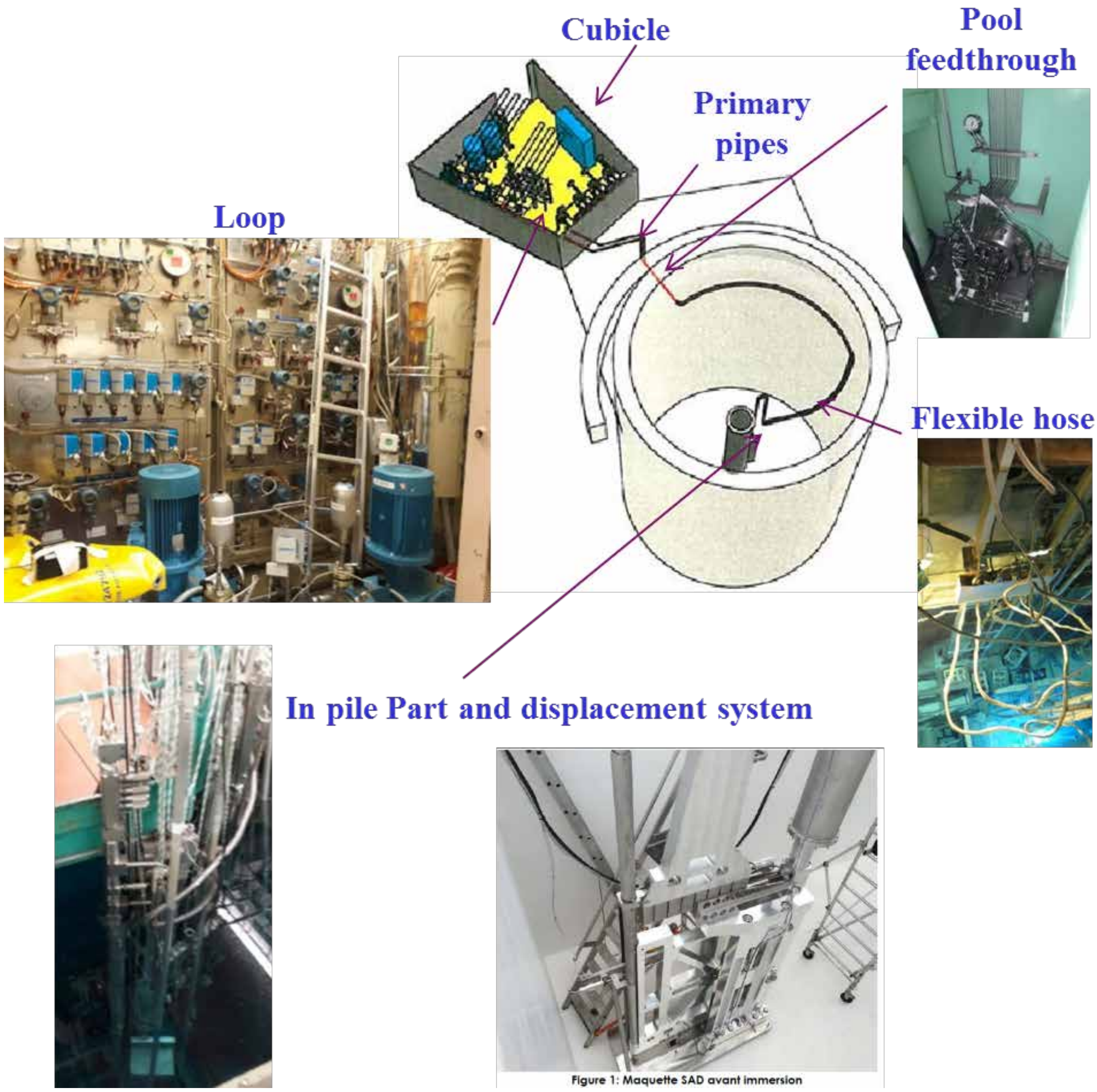
## 1.1 MADISON

<u>**An experiment dedicated to LWR fuel experimental needs:**</u>

The MADISON device will provide the nuclear industry (utilities, research institutes, fuel vendors...) a facility dedicated to the testing of LWR fuel samples under normal operating conditions of power plants:

- An **in-pile part located** on a displacement system, in JHR reflector will provide neutron flux conditions required for any type of experimental programs. Fuel linear power and transient scenarios will be representative of conditions that do not lead to clad failure

- A **water loop** implemented in JHR reactor building will supply the in-pile part with thermal-hydraulics and chemical conditions expected by customers.




CEA plans to have this device available for JHR start-up.

**A device gathering CEA/OSIRIS and IFE/Halden knowledge and best practices:**

CEA is including in the MADISON device the feedback from both **OSIRIS reactor** in France and **Halden reactor** in Norway. For that purpose, CEA has subcontracted to IFE/Halden the detailed design of the first irradiation rig (including instrumentation), the water loop and I&C system.

This experimental device will ensure the continuity of use of most of experimental devices existing in these experimental reactors: OSIRIS experiments performed in GRIFFONOS and ISABELLE4 test devices, Halden experiments performed in IFA's irradiation device with single or multi-rod irradiation rig.

The first MADISON device will allow using most instruments currently used in these two reactors, and specific evolutions of the MADISON irradiation rig would allow using all of them (counter-pressure sensors, diameter gauge...).

## Main achievements in 2019

The cubicle manufacturing is well under way, with the objective of starting the installation in the JHR in 2020.

The function of this heavy structure (about 40 t, stainless steel liner, reinforced by steel beams, able to withstand 1 bar internal overpressure and equipped with biological shielding) is to mitigate consequences in case of a hypothetical accidental breach.

*Machining of biological shielding plates interloccking joints*

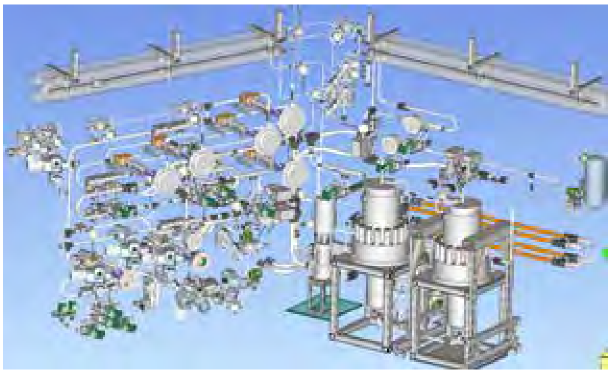
*Steel frame painting*

**IFE Halden** has continued the fabrication of a full-scale mockup loop (fully representative, including I&C), but without actual fuel rods (nuclear power simulated by electric heaters).

The goal is to validate the design (thermal-hydraulic performances, chemistry, control systems and regulations tuning) but also maintenance operations in a mockup cubicle, in inactive conditions, before manufacturing the final loop.

Following the HBWR shutdown and IFE staff downsizing, progress has been slower than expected, however procurement is now complete and loop assembly is underway.

*Assembly of mockup loop in IFE Halden (high pressure part)*



*Mockup loop CAD model*
*(only high pressure circuit shown with main circulation* pumps)

As announced last year, CEA has contracted the procurement of the primary pump for the mockup loop with a manufacturer specialized in canned motor models for the nuclear industry. A standard pump will be designed and manufactured, with an option to purchase safety-classified pumps with an identical design (but manufactured according to the RCC-MRX code) for the final loop if testing at IFE Halden is satisfactory.

Main tasks expected in 2020

The cubicle installation in the JHR facility is scheduled for 2020. The construction is modular (pre-assembled in factory), reducing on-site welding and allowing a relatively quick installation in the facility.

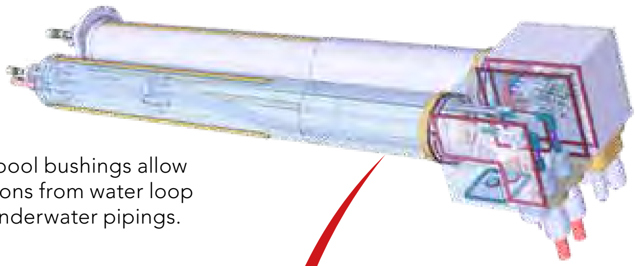
The main circulation pump should be delivered this year, and tested with the other components in the mockup loop at IFE Halden in Norway, beginning with cold and hot steady state tests and later some incidental transients.

The CEA will subcontract manufacturing of the final loop after this testing phase. IFE and CEA will write the main equipment specifications and draft detailed engineering drawings to prepare this phase.

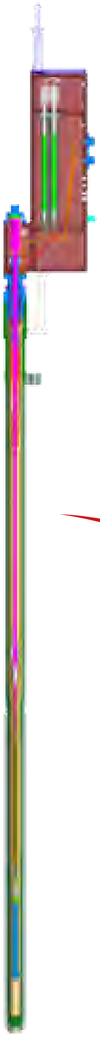
CEA will continue to prepare the safety report, along with the supporting studies (accidental transients analysis with the CATHARE code, radiation protection studies, seismic analysis…).

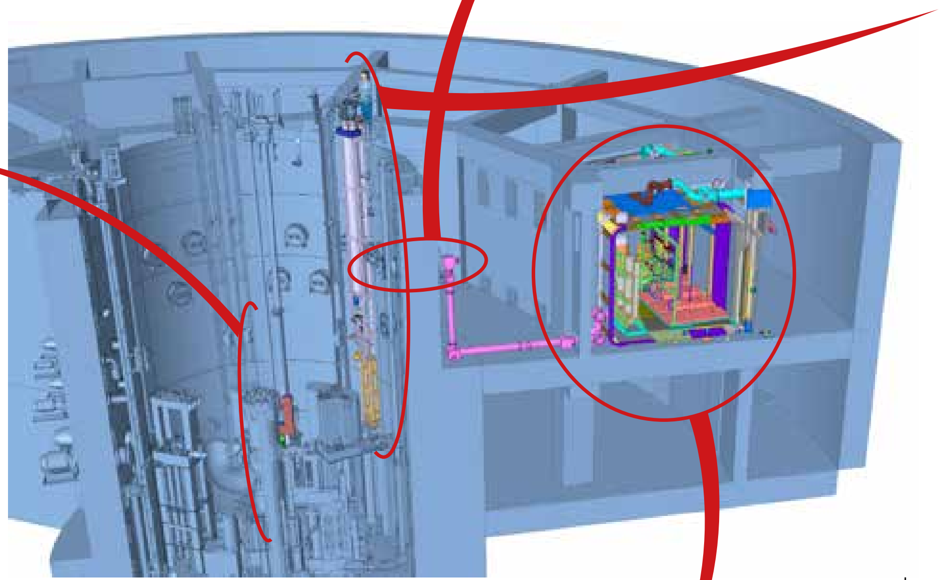
# 1.2 ADELINE

**A one rod loop device for up to limit irradiations of LWR fuel samples.**
**The first version of ADELINE (Advanced Device for Experimenting up to Limits Nuclear fuel Element) experimental loop will be dedicated to power ramp testing.**



The reactor pool bushings allow interconnections from water loop pipings to underwater pipings.

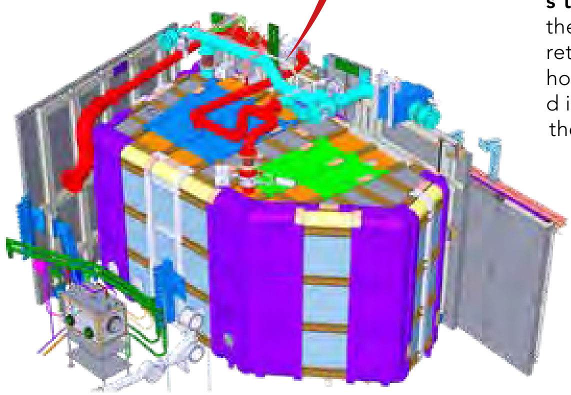




**ADELINE device implementation in JHR facility**

In pile part: **the underwater transfer station** allows the loading and retrieving sample holder without disconnecting the ADELINE device.

In pile part: **irradiation device** located on displacement system in reflector which adjusts the neutron flux conditions required by the experimental programme.

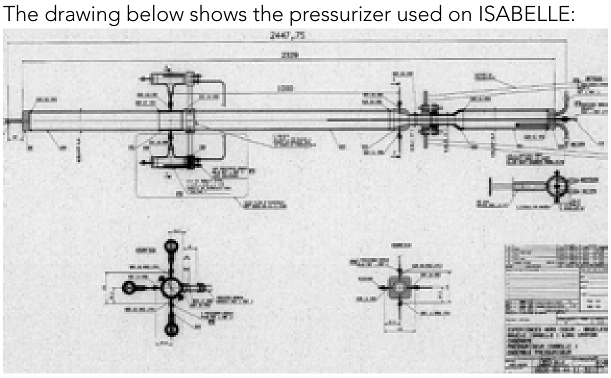


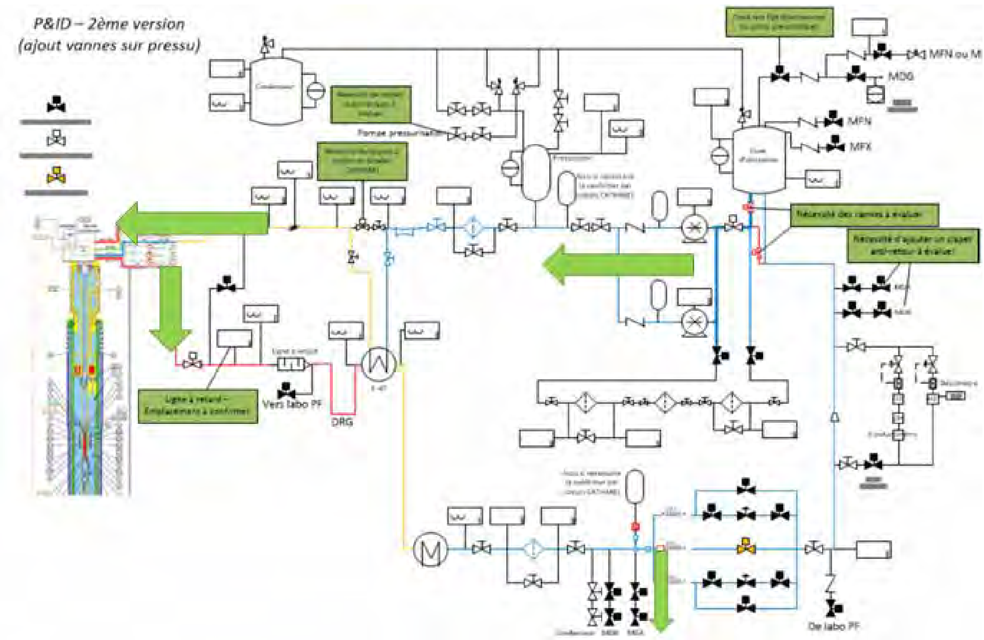
**A water loop**, which components are installed in a blockhouse, located in the JHR reactor building generate the thermo-hydraulic and chemical conditions (PWR or BWR type) required in the irradiation device.

# 1.2.2 Main achievements in 2019

During 2019, the consortium faced major difficulties to supply circulating pumps due to nuclear environment and technical requirements. Qualification has been the most problematic for manufacturers. In addition, the decision to change the loop process has been taken by the CEA. Instead of using pumps to let the cooling water flow thru the loop, a pressurizing skid (the same kind used in the past on the former ISABELLE device, OSIRIS reactor, Saclay) has to be designed.

The drawing below shows the pressurizer used on ISABELLE:






Hence, the loop process has begun to be redesigned until last summer and many changes on the P&ID have already been made.

Meanwhile, studies of the irradiation device have been carried on and the teams started working on the manufactu-
ring
program of the pressure flask
(made out of Zircalloy rods).

# 2.2.3 Main tasks expected in 2019

Preliminary design studies of the loop are expected to be finished mid-year. Hence, the final loop design (pipe and capacities implementation studies,) will have to be conducted.

Moreover, the design of others irradiation components are almost finished.

Finally, some modifications from interfaces reactor or from nuclear safety studies will have to be taking into account by the consortium in order to complete the global final device design by 2020.

# 1.3 MICA

• Towards consulting for manufacturing

It has been decided to first focus on three MICA with test coupons without internal pressure and not subjected to mechanical stress (MICA "without pressure"). These devices will be integrated into the very first cycles of JHR.

But design requirement for « pressurized MICA » are taken into account as most as possible. It concerns for example the number of fluid connectors for pressure control or the place for specific fluid transfers. Specific safety requirement or structural analysis studies concerning "pressurized MICA" will be taken into account for next devices.

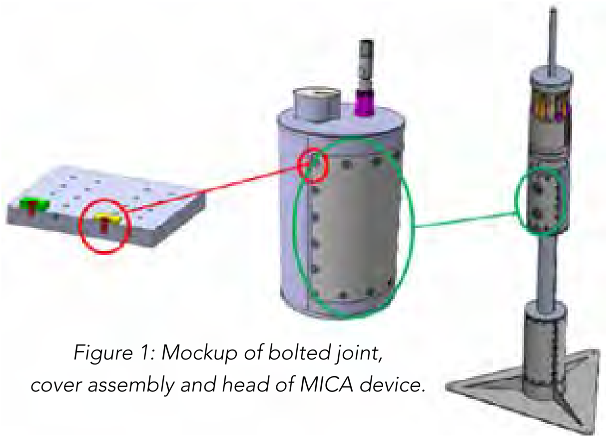


*Figure 1: Mockup of bolted joint, cover assembly and head of MICA device.*

The head of MICA device has been optimized in 2019 (mass reduction, number of cover reduced, shape of cover optimized, design optimized for manufacturing). Before the call for tender process of three MICA, a mock-up of the head of the device (and other elementary subsystems) will be tested in 2020 (mechanical and fluidic connection between sample device and containment device, sealing, manufacturing). (Figure 1).

**• Tight feedthrough**

Manufacturing and test of the first tight feedthrough prototype have been achieved in 2019

**• Manufacturing and delivery of bundles prototypes scale 1 (25 m).**

Both fluidic and electrical connections are concerned by an inherent mechanical weakness. In order to precise the load applied on the test device and its connectors, prototypes of bundles, scale one, have been manufactured. Specific equipment have also been designed and manufactured in 2018 to be able to perform test in 2019 (Figure 3).

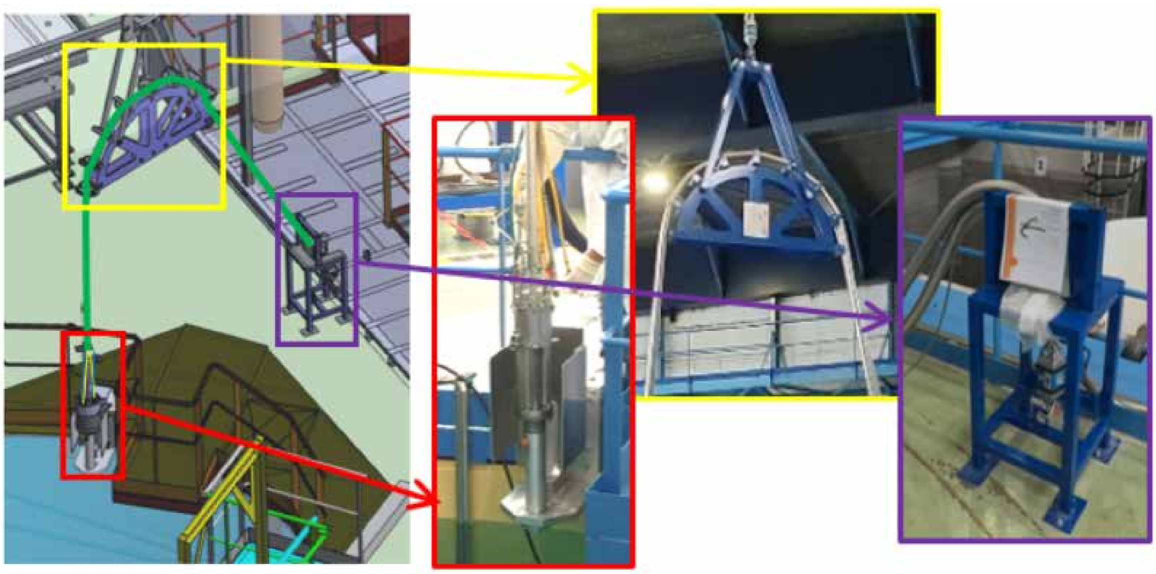


*Figure 3 Head of MICA test device with its extender, and specific equipment for test.*

• **CARDENAK Process.**

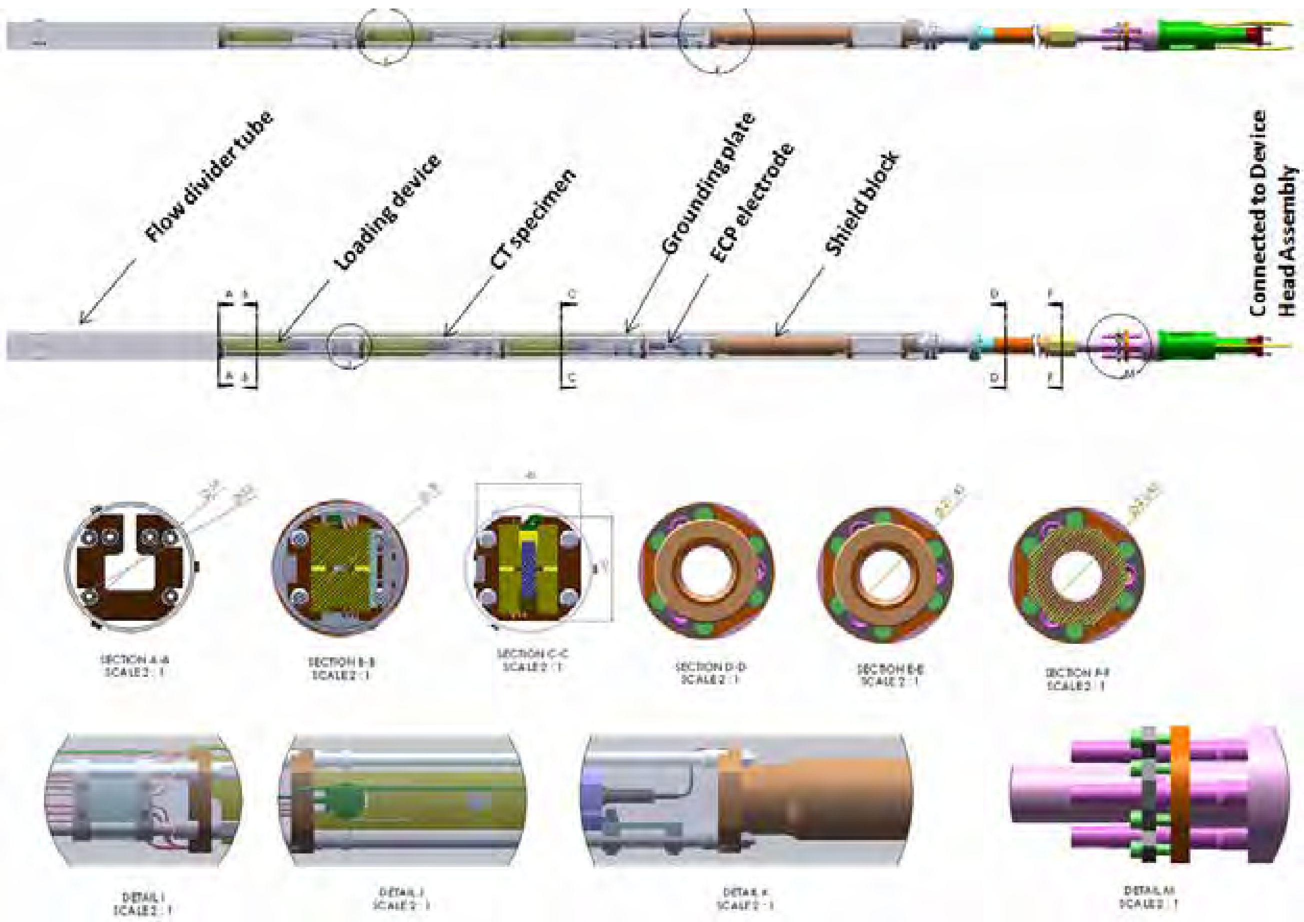
A safe process for the NaK destruction has been developed (the CARDENAK process). The first operation of this process consist to transform the irradiated NaK in a carbo-nate, during a slow and controlled reaction. This first operation will occur in glove-box into the JHR. The second operation consists to dissolve the carbonate into water. The final liquid is also eliminated as a liquid waste.

Technical document required for the call of tender process for the CardenaK process were started in 2019 and will be achieved in 2020.

Corrosion Loop Experiments (CLOE) is designed to study the Irradiation-assisted stress corrosion cracking (IASCC), a local degradation phenomenon induced due to synergistic effect of material irradiation and water chemistry, by performing integral test in one of the irradiation position in JHR. CLOE is an experimental loop consisting of an In-pile part and Out of pile process system, which simulates Light Water Reactor (LWR) operating conditions.

The device allows applying in-situ mechanical load on to the test specimens during the experiment. It facilitates monitoring of sample temperature, crack growth rate, electrochemical potential, water temperature inside the test rig. Measurements of dissolved oxygen, hydrogen, conductivity, water temperature, pressure, etc. are also performed in the out of pile system located in cubicle for scientific analysis. The CLOE experimental loop

represents India's In-kind contribution to the JHR project.




**Test Rig for Crack Propagation**

## Main Achievements in 2019

Preliminary design of CLOE has been accepted by CEA. Towards initiation of detailed design phase, various documents on QA management, CLOE life cycle, product tree structure, RCC-MRx keys for pressure equipments, input & assumption for thermal hydraulics analyses etc were prepared by BARC along with the release of documents on pressure & safety classification, Working situations, Design & manufacturing guidelines for COTS Category-0 component, ambient condition etc by CEA.

The remote access of CATHARE code was provided to BARC which was used for analysing the effect of external conditions on CLOE. Experiments were performed for qualification of Flow amplifiers with multiple nozzle arrangement. As a part of design validation & mock up qualification studies, a prototype process loop is being built in BARC.

Civil work has been completed. Some components (Ion exchangers, Filters, Storage tank, Loop feed pump, Flow meters, Accumulators etc.) including a multistage canned motor pump have been received at site.

*Multistage Caned motor pump*

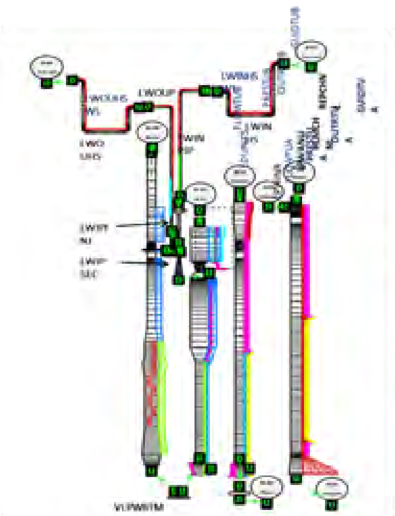
*Feed water pump*

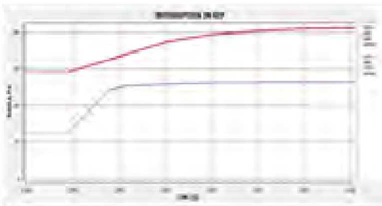
*Make up pump*

*Storage Tank*

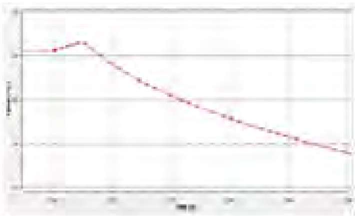
*Filters*

*Ion Exchange vessels*





Instantaneous Stoppage of REP water



LORI: 190 pcm

*CATHARE model of In-pile part*

**Components for Prototype Process Loop for CLOE**

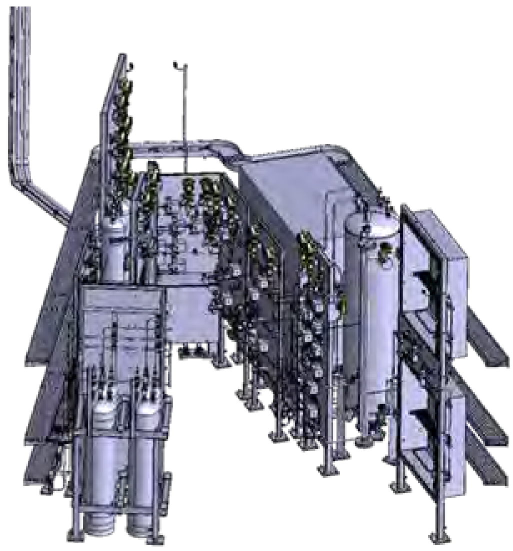
## Lorelei Device

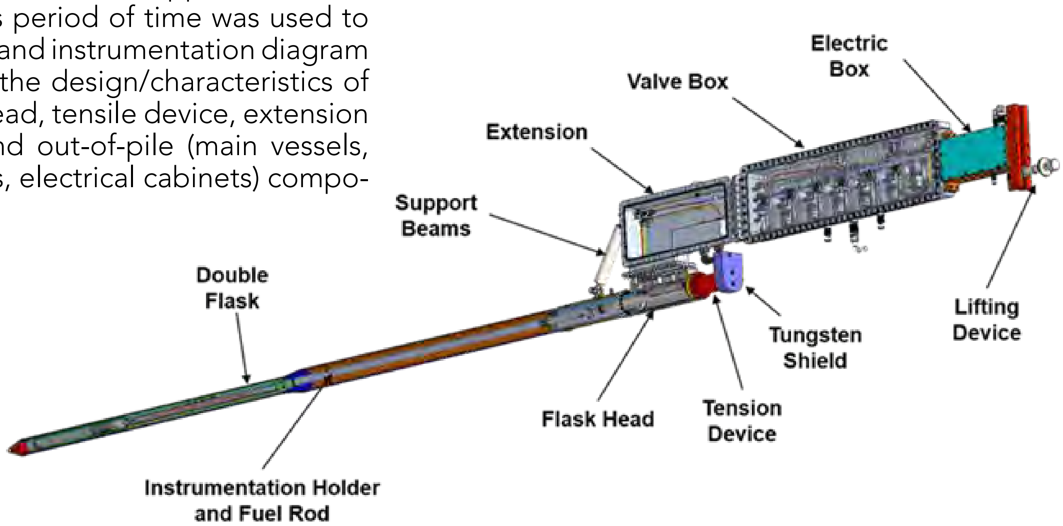
The LORELEI (Light water One Rod Equipment for LOCA Experimental Investigations) testdevice is designed to study the thermomechanical behavior of a fuel rod and fission products (FP) released under loss-of-coolant accident (LOCA) conditions. The device is a single-rod closed loop system placed on a displacement device inside a defined channel in the reflector. This equipment will consist of a pressurized in-pile thermo-siphon able to cool a single fuel sample for fuel re-irradiation before triggering the LOCA sequence. It will be equipped with a gas injection system able to rapidly dry-out the fuel rod and simulate a LOCA transient. An electrical heater in the sample holder will be used to obtain a homogeneous temperature distribution and a neutron screen can be used to flatten the neutron flux profile along the fuel sample. It will be possible to re-inject water in the device to simulate the quenching process at the end of the experiment.

The device will be used to investigate fuel cladding ballooning and burst, as well as cladding corrosion phenomena (oxidation and hydrating), post quench behavior and fission gas releases. For this reason, the device will be connected to the Fission Product laboratory.
The design and manufacturing of LORELEI constitutes the in-kind contribution of the Israel Atomic Energy Commission (IAEC) which joined the consortium at the end of 2011.
The Preliminary Design Review (PDR) was approved in January 2014. The feasibility of the experimental setup to meet the technical and scientific requirements was detailed in this review.

The years 2014, 2015 and 2016 were devoted to the detailed design and the Critical Design Review (CDR) was approved in November 2016. This period of time was used to finalise the piping and instrumentation diagram (P&ID), as well as the design/characteristics of the in-pile (flask head, tensile device, extension and valve box) and out-of-pile (main vessels, valves and sensors, electrical cabinets) components.

The production readiness phase started in 2017 and at the beginning of 2018, Rotem sub-contracted the design of the components in the cubicle to the Baran/Idom companies. Key documents are expected in 2020 such as manufacturing drawings, Final calculation notes, equipment specifications and risk analyses for pressure equipment.





# NON-DESTRUCTIVE EXAMINATION BENCHES

## 1. Introduction

Within the frame of JHR construction, Non Destructive Examination (NDE) systems have been required for:

- Underwater examinations on integral devices (in-pools)
    - o Neutron imaging system (reactor pool),
    - o Gamma and X-Ray scanning systems (UGXR system), one for reactor and one for storage pools.
- In-air examinations on samples (hot cells)
    - o Gamma and X-Ray scanning system (HGXR system)

## 2. VTT Contribution

## 2.1.Status of the UGXR benches

In 2019 the project proceeded from manufacturing to assembly and testing. A specific clean area at the workshop was constructed and the procedures for the factory acceptance tests were finalised. The first bench was assembled and the factory acceptance tests were carried out during the summer and autumn 2019.

The tests were carried out successfully otherwise, but some sensors were found to be faulty. Also, the motors needed for 3D movements in the bench need some tuning and VTT's subcontractor Idom is solving these issues with the motor manufacturer. New sensors will be introduced to the first bench during the reassembly of the bench and they will be verified in the site acceptance tests in Cadarache. The sensors were faulty only for the first bench. The second bench was assembled in late 2019 and the factory acceptance tests for that bench will be done in early 2020. After the factory tests the both benches will be dismantled, cleaned and packed for transportation to France.

The schedule has been refined and currently the delivery of the benches to Cadarache will take place during summer 2020 and the foreseen finalisation of the site acceptance tests is early 2021. After this there will be a training period for the CEA personnel and finalisation of the documentation.

### 2.2. Status of the UGXR out-of-pile part

(collimators and biological shielding)

In parallel with the UGXR benches, the manufacturing of the underwater collimators and biological shielding was performed. Similarly as with the UGXR benches, all components for the col-limators have been manufactured and the assem-bly & testing phase is on-going. Factory acceptance test procédure have been done and there e.g. accuracy, positioning, sealing and maintenance test play a very important role. The testing period for the collimators will be quite compact as the testing will follow that of the HGXR devices (see next). The delivery of the devices to France is foreseen in mid-2020.

*Figure 1. First UGXR bench assembled and ready for the tests at the workshop (left) and UGXR collimators assembled in the test bench (right).*

## 2.3. Hot cell bench and the collimators

For the hot cell gamma measurement and X-ray radiography bench and the collimators (HGXR), the manufacturing was finished in 2019 including also the poured lead components as well as the tungsten collimator parts. The assembly of the devices was done in spring 2019 and the factory acceptance tests were performed in summer and autumn 2019.

The tests were successful and no major modification were needed. VTT's subcontractor Idom has provided the final documentation for the devices and also produced the operation and maintenance manuals, which are under review. The training of the CEA personnel is foreseen to take place at the beginning of 2020 in Spain, after which the devices will be transported to Cadarache and this part of the in kind can be closed.

*Figure 2. HGXR test bench (left), collimators (right) and the I&C cabinets ( behind)*

## 2.4. Hot cell bench and the collimators

For the hot cell gamma measurement and X-ray radiography bench and the collimators (HGXR), the manufacturing was finished in 2019 including also the poured lead components as well as the tungsten collimator parts. The assembly of the devices was done in spring 2019 and the factory acceptance tests were performed in summer and autumn 2019. The tests were successful and no major modification were needed. VTT's subcontractor Idom has provided the final documentation for the devices and also produced the operation and maintenance manuals, which are under review. The training of the CEA personnel is foreseen to take place at the beginning of 2020 in Spain, after which the devices will be transported to Cadarache and this part of the in kind can be closed.

## 3. CEA contribution

The main achievements in 2019 for the NDE benches are:

• Oversight of the equipment manufacturing and assembly, including industrial inspection in the sub-contractor's factory and IDOM's laboratory, including control of manufacturing documentation,

• Follow-up of the commissioning operations of UGXRB and the factory acceptance tests of HGXR,

*a. UGXR collimator parts before assembly*
*b. UGXR second bench parts before assembly*
*c. Assembly operation of the UGXR collimators*
*d. Commissioning operations of the first UGXR bench*
*e. Factory acceptance test of HGXR bench*

**Preparation of the JHR onsite installation of the benches :**

o Management of the interfaces with the facility and other providers,

o Oversight of the design and manufacturing of the supporting structures of the benches (SUB) in the RER and EPI pools.

*Preparing of the welding operations of the supporting structures of the benches*

o Follow-up of the manufacturing of the X ray camera prototype and testing with a linear accelerator in the Chicade facility in Cadarache.

*X ray camera shielding*

*X ray camera electronics*

*X ray camera testing bench*

# JHR *as an international facility*

# 1ST JHR SCHOOL
# 1ST-3RD APRIL 2019

The first JHR school was held early April 2019 and the "students" were able to participate on the 9th JHR seminar right after.
This first edition gathered 13 young scientists/Engineers participants from Consortium Members (CVR, VTT, NNL, IAEC) and the Lectures were given from UNIBO (University of Bologna,SCK.CEN, Technicatome and CEA).
The topics addressed during the school were the following:

- Why irradiation in research reactors?
- Scientific needs for fuel research
- Scientific needs for material research
- Different types of research reactors
- Why a new MTR in Europe – JHR Specifications
- Modeling tools and support to the design of research reactors and its test devices
- French Safety requirements for a new material testing reactor and its experimental capacity
- Design guidelines for the JHR reactor
- Design of modern experimental devices and associated challenges
- Workshop on JHR simulator: practical exercises on different operatio

a) Analysis of experimental data from various MTRs experiments and structuration of an experimental data

b) Fundamental physics: production of strategic isotopes for big research instruments and big physics (say f.i. neutrinos)

c) Fast power transients: what could be done in the JHR?

d) Impact of neutron spectrum on material behavior: what has been done in the past and pertinent analysis of JHR specifities

*First JHR School (April 2019-Cadarache Castle)*

It was proposed and endorsed by the Governing Board to continue this initiative every 2 years and enlarging it outside the consortium (investigating possibility of having an European framework –ENEN- umbrella).

# 9th JHR scientific and technical seminar (3rd – 5th April 2019)

This ninth Scientific and Technical Seminar on the JHR experimental capacity welcomed, as non-consortium members, some representative from the US-NRC, China-CGN and French IRSN.

It was structured as follows:

• The first day was dedicated to technical presentations during which around 100 participants were able to share and discuss progress on the latest developments in the JHR experimental capacities (experimental devices under development, experimental devices under feasibility studies and associated non-destructive equipment to support these developments).

Members and non-members of the JHR Consortium were strongly encouraged to continue sending staff to the JHR team for a secondment period (typically one year) in order to share "JHR Knowledge and Culture" and to strengthen relations between JHR partners.

• The second day was devoted to feedback from the previous WGs meetings and to preparing future joint international projects: focus was placed on the outcomes of the OECD/NEA October 2019 workshop on the experimental capacities to perform in-reactor experiments following Halden permanent shutdown.

Parrallel sessions of the 3 working groups mainly on preparation of international joint programs (P2M and INCA) and on the preparation of the Euratom call for establishing JHR roadmap for the first 15 years of operation – JHOP2040 were held. Such future International Joint R&D Programs gathering the JHR Community would be open to non-members through NEA new framework called FIDES (Framework for IrraDiation ExperimentS)

*JHR Community (9th scientific & technical seminar- April 2019)*

October 2020

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