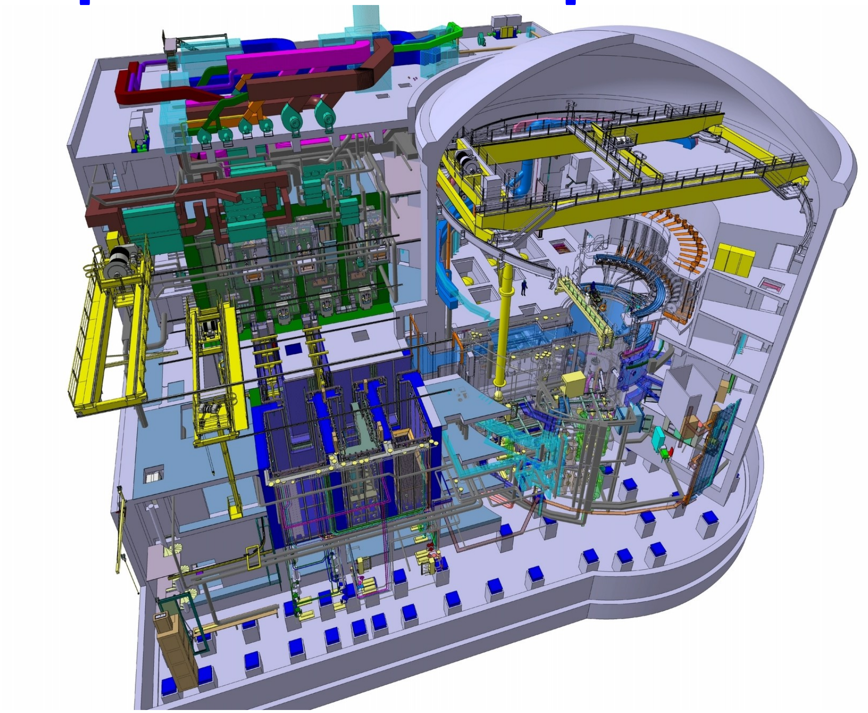
The Jules Horowitz Reactor (JHR) Project

Experimental capabilities



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Outlines

- Introduction
- Irradiation experiments requirements
- JHR capabilities
- Conclusion

Introduction

he Jules Horowitz Reactor (JHR) is a modern experimental capability for studying materials and fuels behaviours under irradiation:

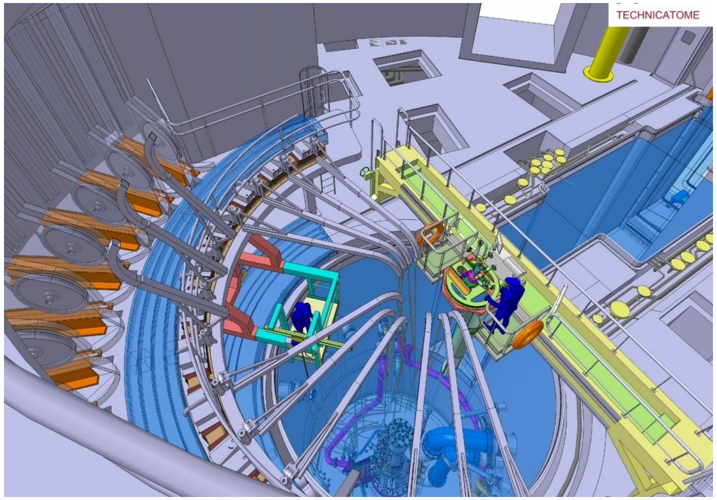
upports to Nuclear Power Plants of generations II and III,

evelopments for future generations of reactors (Gen IV,Fusion),

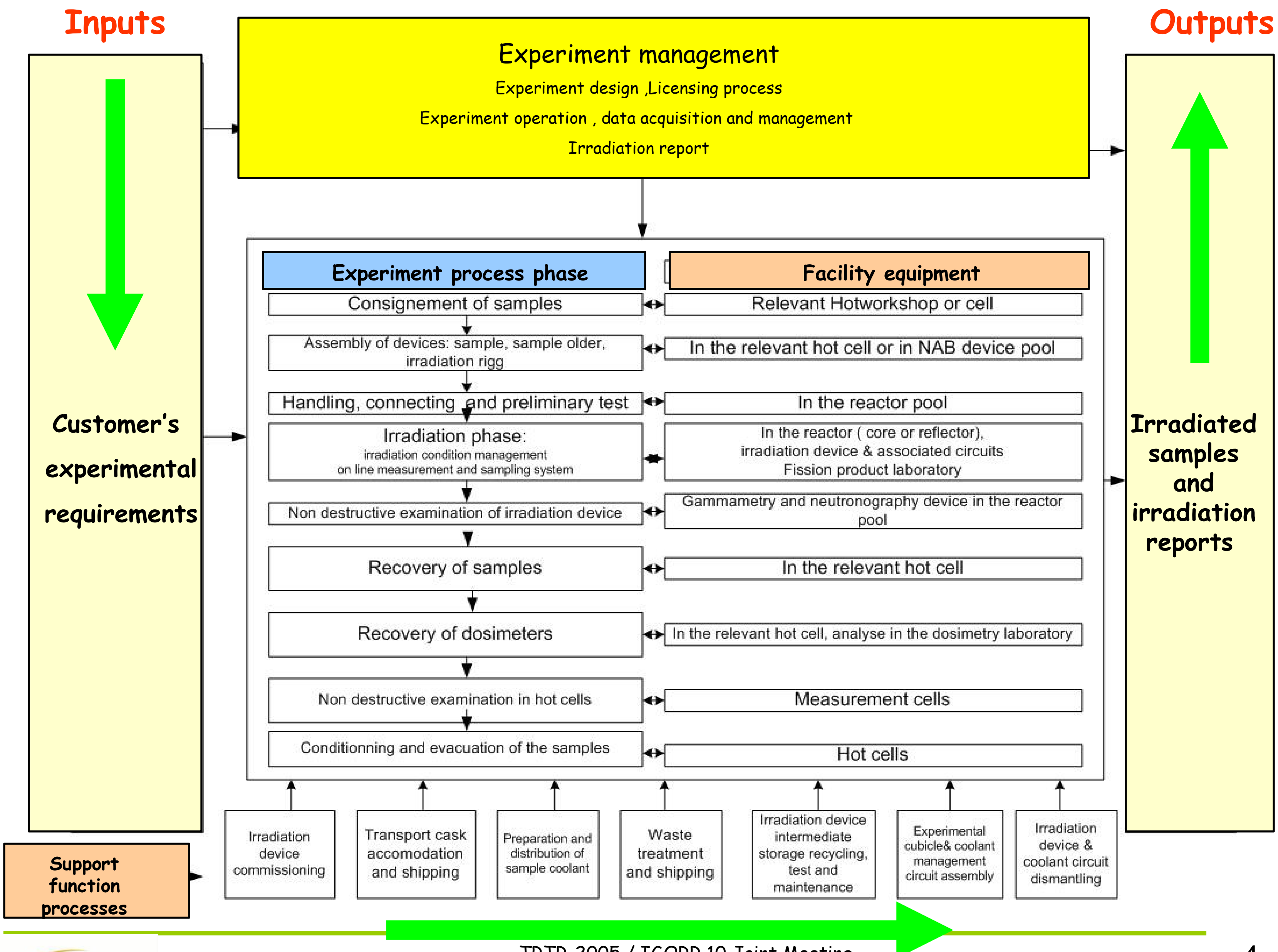
Radio-isotopes production for medical applications.

The conception takes into account :

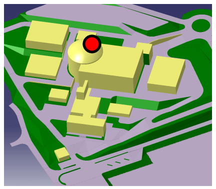
- Fast flux performances in the core able to perform important damages on materials,
- Thermal flux performances in the reflector to reach high power on fuel samples,
- Integration of equipments allowing carrying out complete experimental irradiations operations.



Irradiation experiments requirements



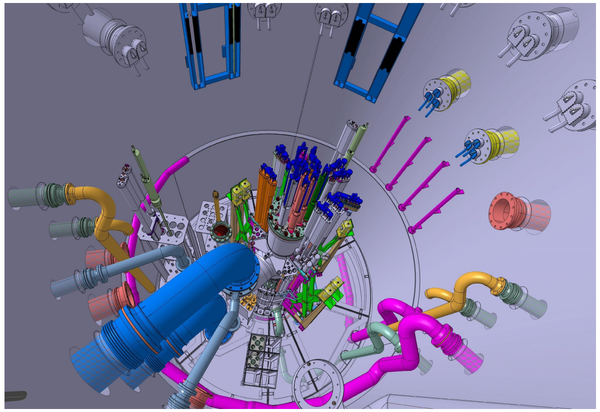
JHR capabilities



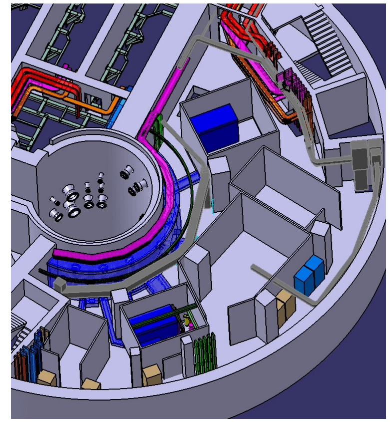
Reactor

Building

A driver core

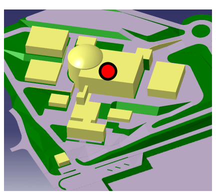


An experimental area:



located around the core,

- ✓ 14 experimental cubicles,
- ✓ I&C rooms surfaces on 2 floors,
- ✓ 11 penetrations penetrations with the reactor pool.

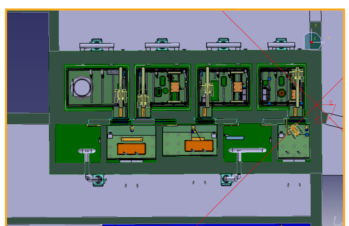


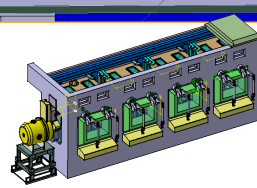
Nuclear

Auxilliary

Building

(NAB)



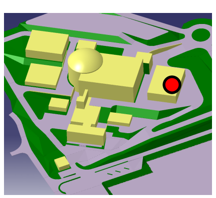


Four hot cells :

- ✓ Pre-and post irradiation operations (conditioning,examinations),
- ✓ Alpha cell for experiments with contamination risks.

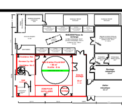
Dosimetry laboratory:

- ✓ Quick access of the fluence integrated by the samples.



Support

Buildings



Differents utilities supports (workshops)

- ✓ Experiments preparation with limital external transports.

Phase 1, Reception and preliminary tests

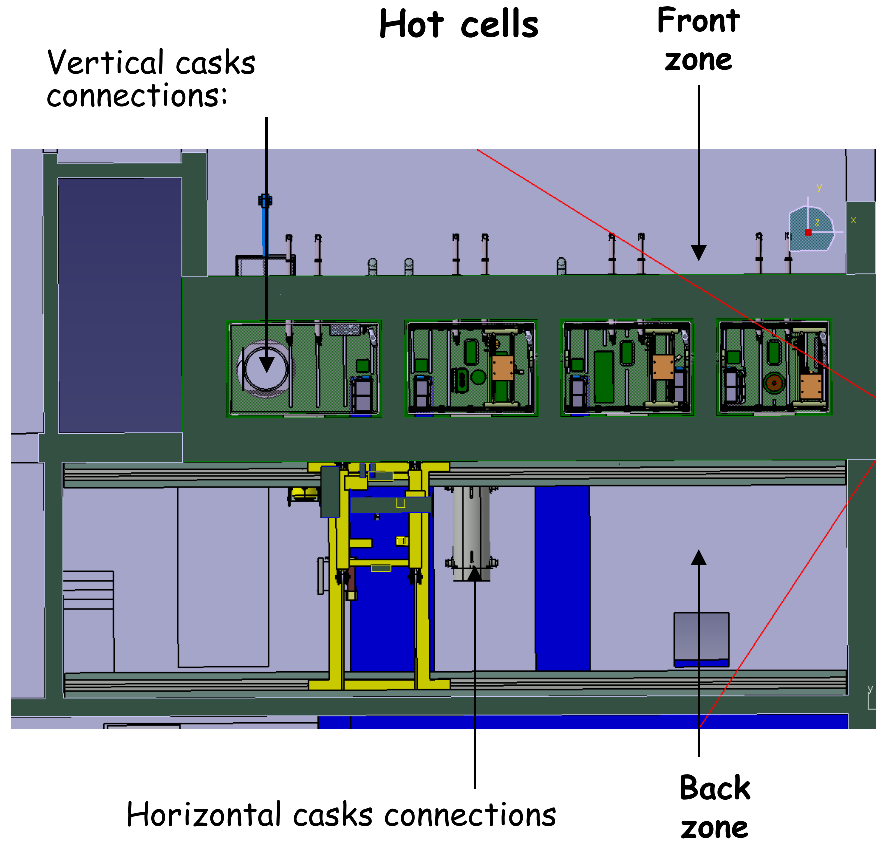
➢ **Irradiated samples (fuels and materials) :**

Back zone of the cells:

- Vertical and horizontal connections,

Storage pool of components:

- Possibility to accept casks for underwater loading.



➢ **Devices :**

Cold workshop:

- Final assembling,
- Controls,
- Test benches.

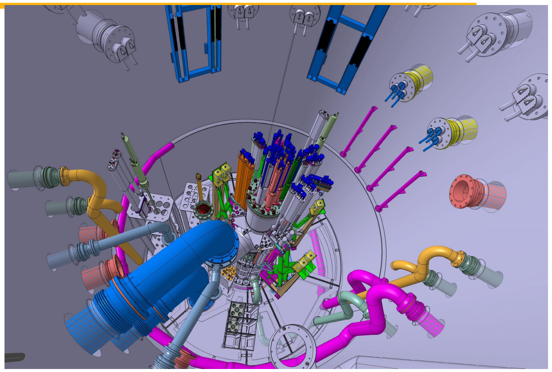
Hot workshop:

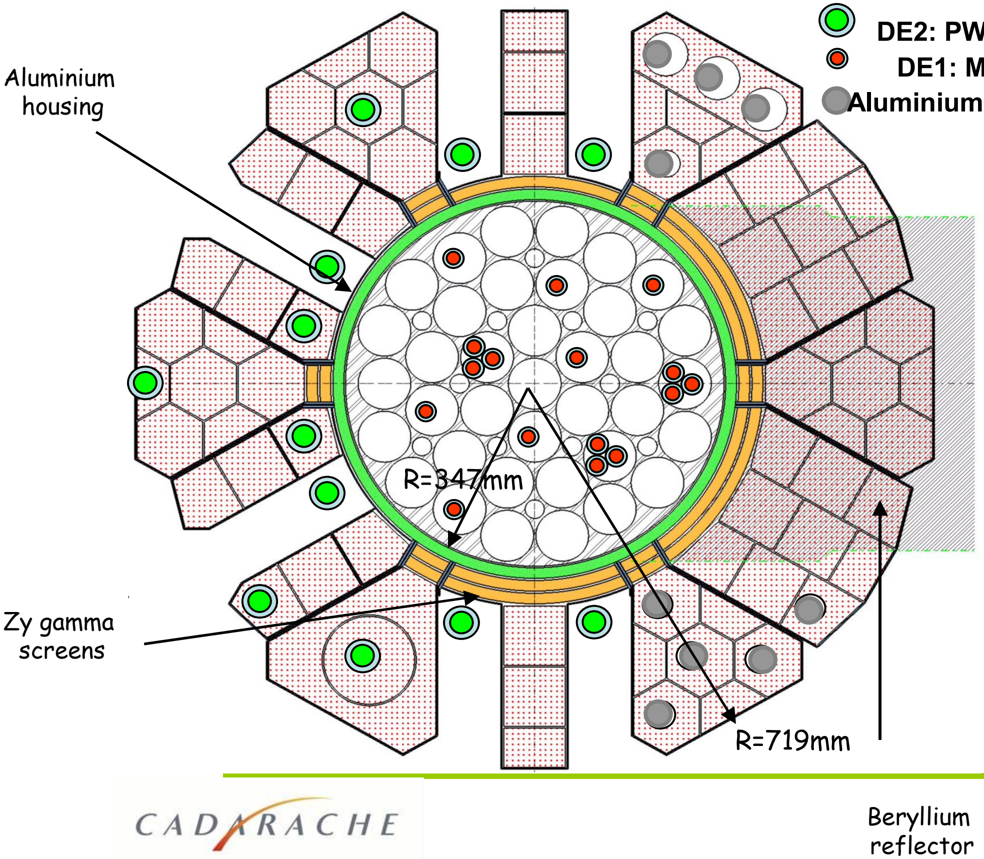
- New fuel loading operations,
- Device transfer in the facility,
- Recovery of irradiated components for re-using.

Phase 2, Irradiation phase (1/3): Driver Core

Main design features:

- Pool reseach reactor operating up to **100MW**$_{th}$.
- Cooling and moderate by forced ciculation of light water in pressurised circuit.
- Surrounded by a modular reflector of beryllium cooled by the pool water.
- Fully compatible with radial power ramps on the fuels samples in the reflector.



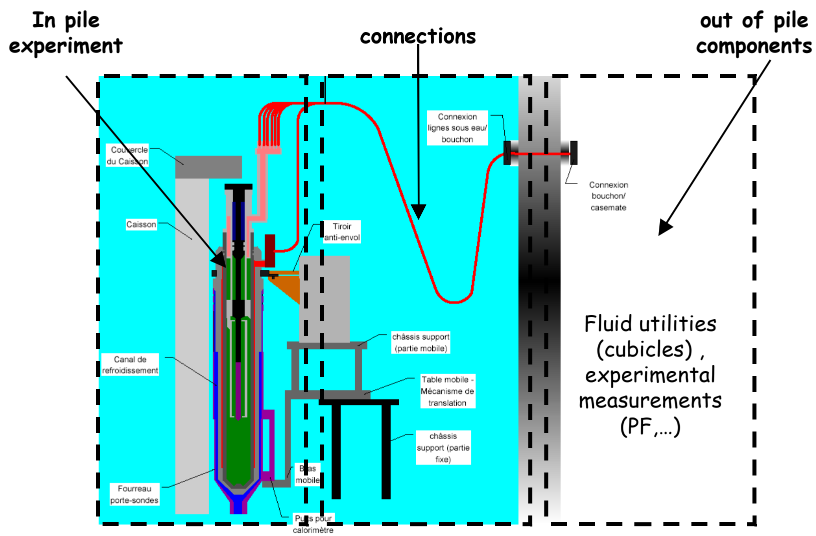


- **Reference core configuration**

High fluxes requirements for high dpa irradiation (up to 16 dpa/y).

- *10 irradiations inside the core*
  - *7 small (32mm)in the center of fuel element*
  - *3 large (50mm) instead of a fuel element*
- *6 in the reflector on displacement systems*
- *6 in the reflector on fixed positions*
- *9 radio isotopes production devices in the reflector*

Phase 2, Irradiation phase (2/3): Irradiation devices



- **Displacement systems**

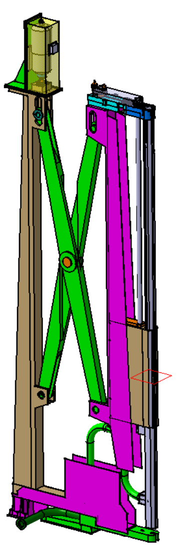
Performances:

- **Maximal linear power : 600 W.cm^{-1}**

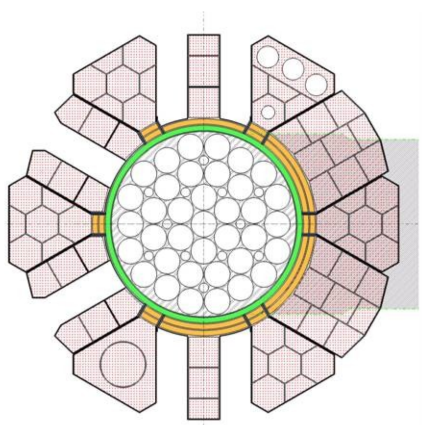
(1% U_5 fuel enrichissement)

- **Power ramps:**

200 to 600 W.cm^{-1}.min^{-1}

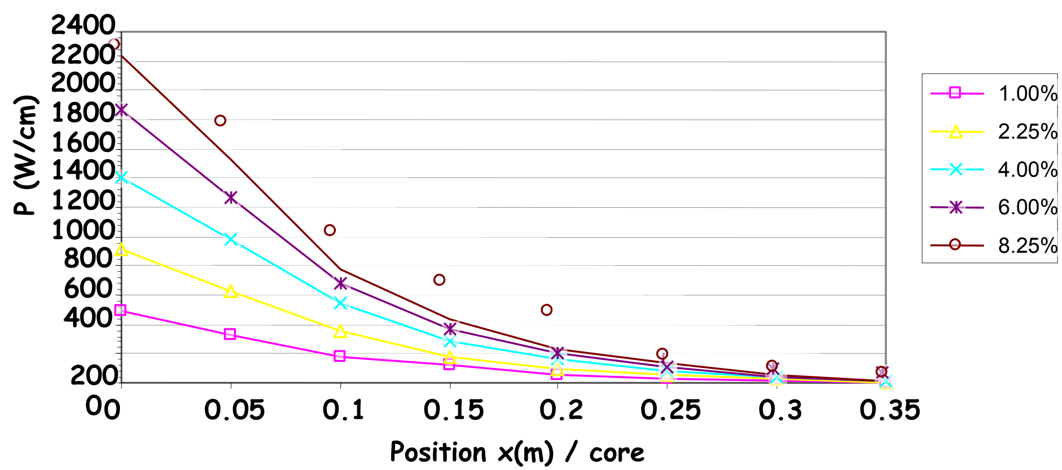


6 systems around the core



Fuel power = F(location)

analytical studies



Phase 2, Irradiation phase (3/3): Experimental area

- *A Fission products laboratory*

✓ **FP activities measurements in water :**

- *Following on line the releases of FP of non tight fuels rods,*

✓ **FP activities measurements in gases : (high levels countings):**

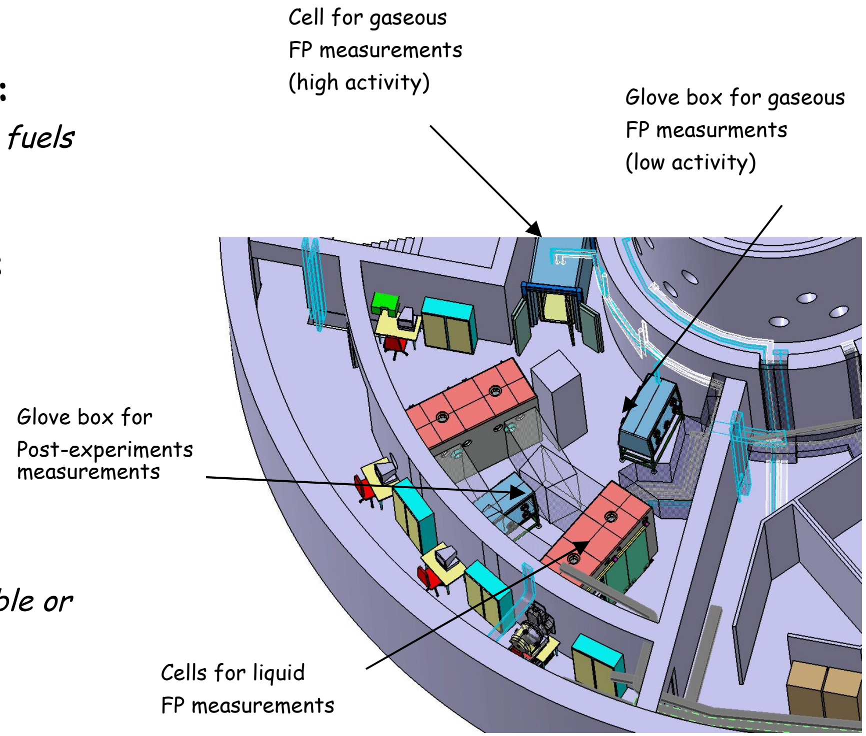
- *On line fission gas releases,*
- *Activity release in case of accidental scenario ,…*

✓ **FP fission gases measurements (low activities) :**

- *Fission gas releases from HTR or GFR during stable or specific transients,*

✓ **Post-experiments measurements :**

- *Activities of liquid and fission samples during a long period (few days to few months),*



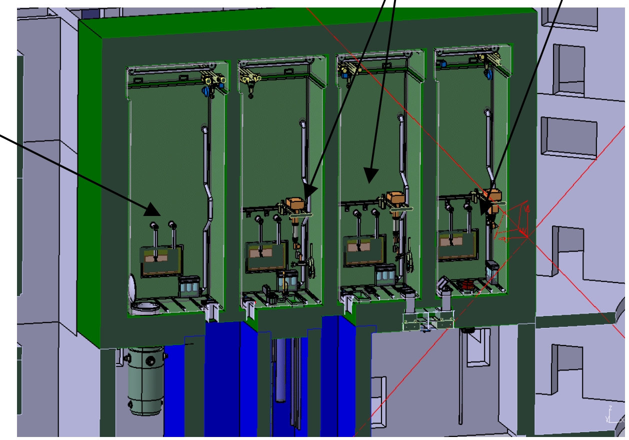
Phase 3, Recovery of the samples

- **Hot cells**
- ✓ One for radio-isotopes recuperation and conditioning.
- ✓ Two polyvalent hot cells for experiments on materials and not damaged fuels,
- ✓ Alpha cell.

Cell for Radio-isotops conditionning

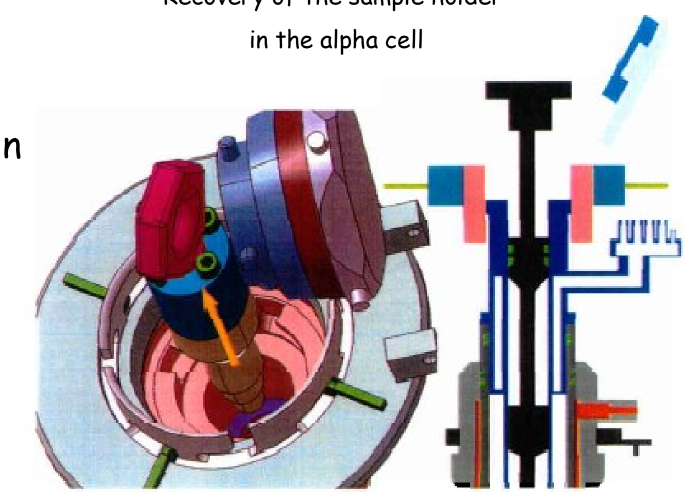
Polyvalent cells for Material and fuels

Alpha cell



- **Alpha cell**
- ✓ Fuel experiment with clad failure in normal conditions (alpha device),
- ✓ Fuel experiment in degradated situation (standard device – non alpha),
- ✓ Devices dismantlement with contamination risks,
- ✓ Re-use of some parts of the alpha device (sample holder, device envelopes).

Recovery of the sample holder in the alpha cell



→ Specific tight-interface at the inlet of the cell,

Decontamination systems inside the cell

Phase 4: Non Destructive Examinations (NDE)

- ✓ Control of the global aspects of the fuel rods or material samples after the transport or after irradiation sequences,
- ✓ Burn-Up & Fission Products inventory determination,
- ✓ Fission gas releases determination in the top of the device (LOCA experience),
- ✓ Verification of REA qualities,…

- **In the hot cells,**

- **In the pools,**

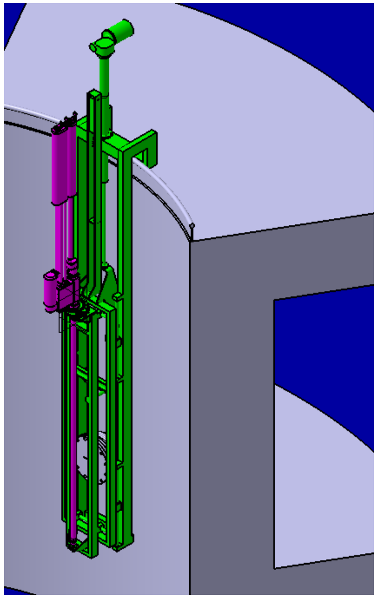
Gamma-scanning
Neutronography,

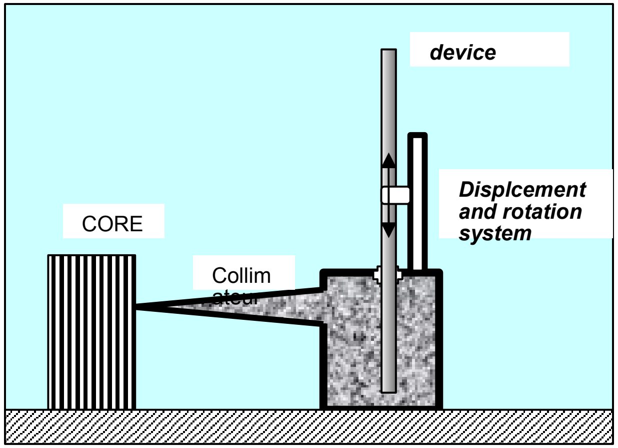
Visual,

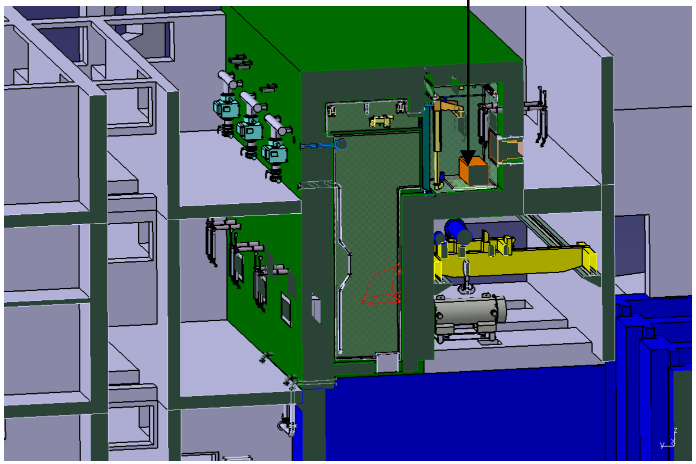
Microscopy,

Eddy curents,…

NDE equipments in the hot cells







Conclusion:

The Jules Horowitz Reactor ,

modern and performant has the capabilities to :

- ✓ **Manage multiple and various experiments,**
- ✓ **Offer global prestations and equipments adapted with the customers needs.**
- ✓ **Equiped with specific alpha cell and on-line fission products laboratory allowing to drive and characterise experiments on non tight samples,**

With a international users-facility vocation,
the JHR will statisfy the irradiations requirements
of the MTR community in the next decades.