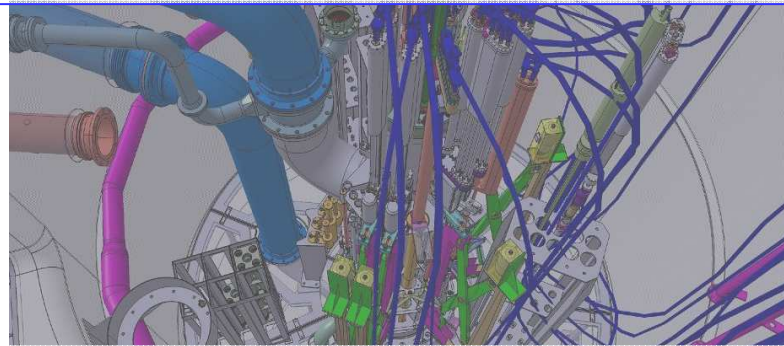
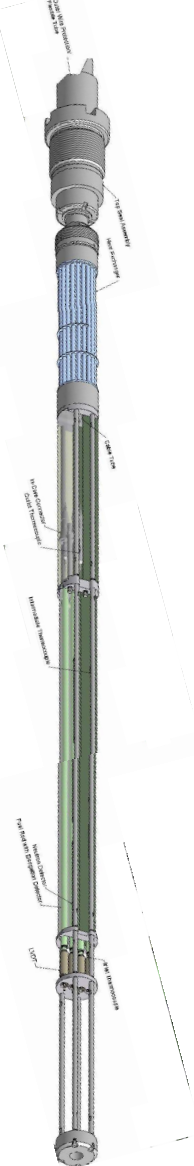




The MADISON experimental hosting system in the future Jules Horowitz Reactor



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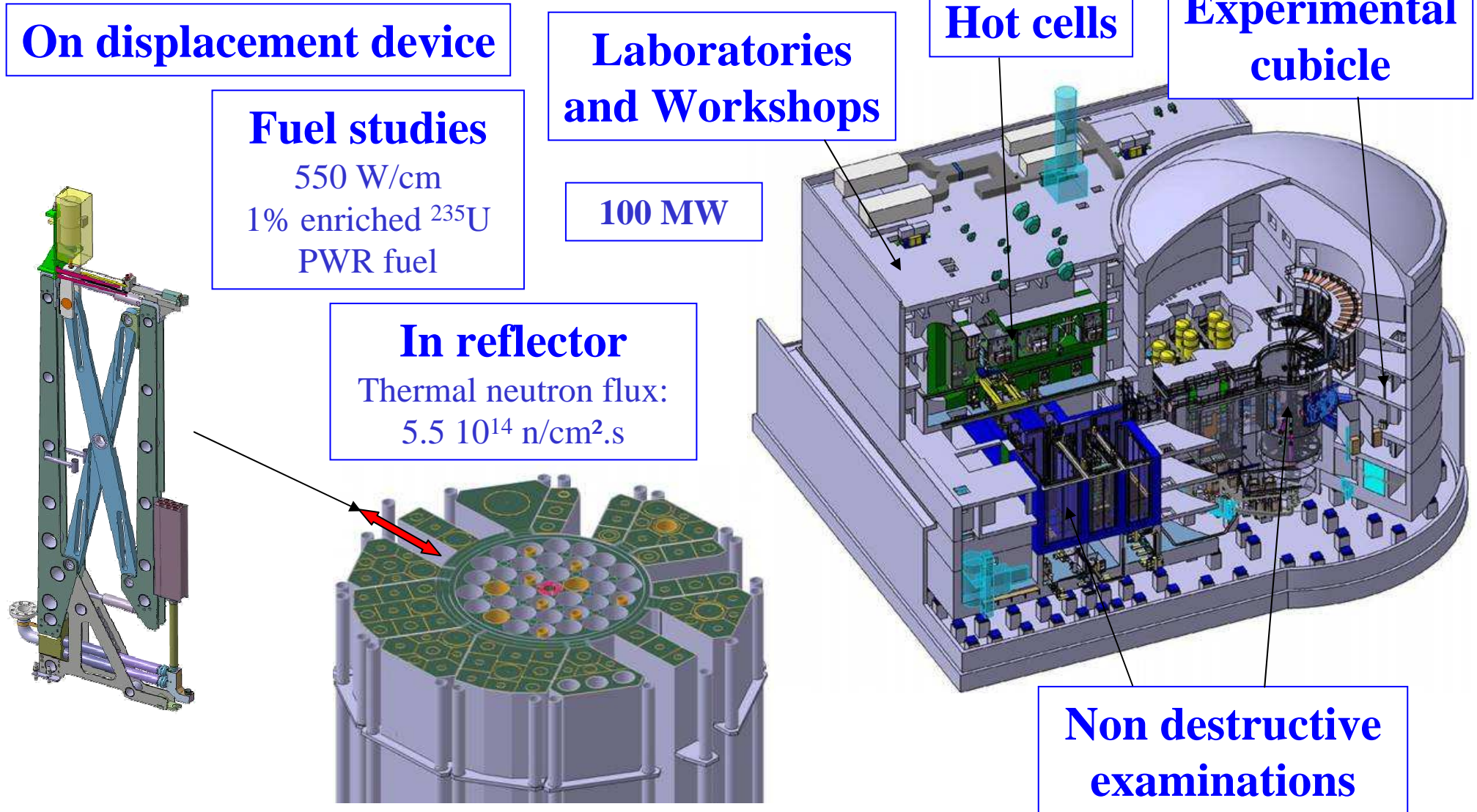


Layout

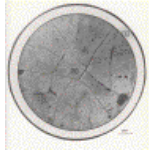


- ↪ **The MADISON device in the JHR experimental capacity**
- ↪ **CEA-IFE Halden collaboration**
- ↪ **Description of the current design**
- ↪ **The irradiation rig**
- ↪ **The loop system**
- ↪ **Instrumentation**

MADISON device in JHR facility



MADISON device among JHR PWR fuel experimental devices



Selection, characterisation and qualification of fuel products

MADISON loop

Standard = 4 rods rig

- Fuel product vs BU/LHGR
- Fuel microstructure selection
- Long term irradiations (creep, corrosion, crack growth...)
- Slow power variations
- Batch conditioning (ramp...)

Multi-rod rig

Homogeneous conditions

Rod failure not expected

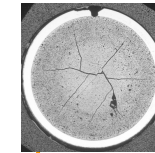
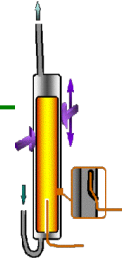
MADISON loop

1 rod rig

- Single effect experiments (FG release,...)
- Fuel microstructure selection
- Properties of fuel material
- Metrology under flux (PCMI...)

Highly instrumented irradiation on single rod

Rod failure not expected



Margins mastery

ADELINE loop

Standard = 1 rod rig

- Incidental situations: power ramps...
- Post-failure behaviour
- Thresholds: T_{melting} , lift-off...

High performance

Management of degraded fuel

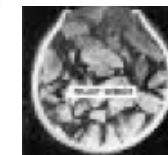
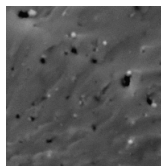


Basis knowledge acquisition

- Fuel microstructure selection
- Properties of fuel material

Data for modeling

Cooking capsule (+ sample geometry)



Safety experiments

- LOCA
- Fast transients
- FCI

Phenomenology

LOCA = LORELEI capsule (1 rod)





energie atomique • énergies alternatives

CEA-IFE Halden collaboration



IFE Institute for Energy Technology

The OECD
Halden Reactor
Project

• Interest of the collaboration

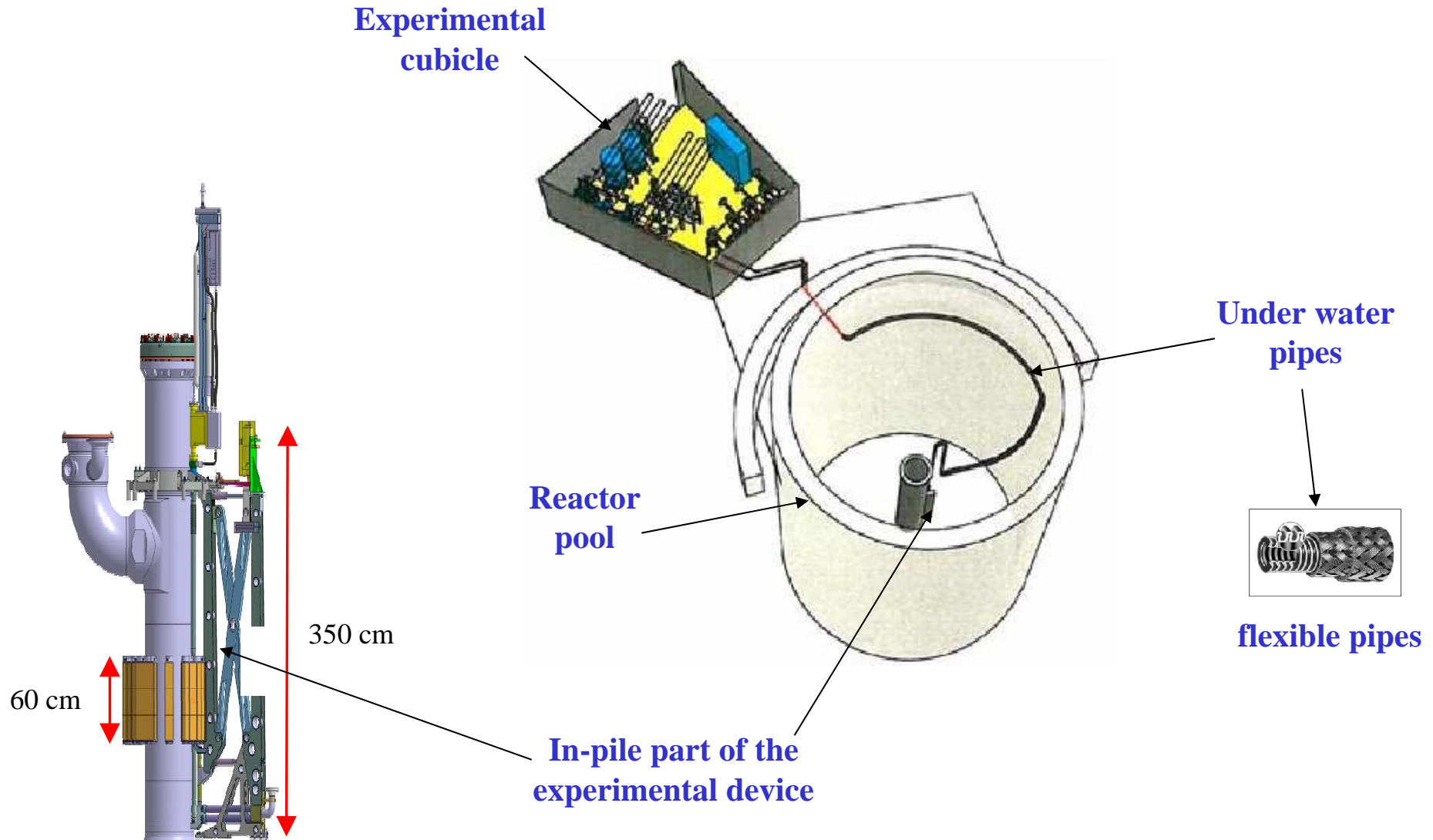
- Take advantage of IFE long experience and include best practices:
 - ✓ Design, manufacturing and operation of experimental loops
 - ✓ Technology of irradiation rig
 - ✓ In core instrumentation
 - ✓ Instrumentation and Control
 - ✓ Chemistry monitoring of experimental loops (BWR tests)

• Main phases of the project

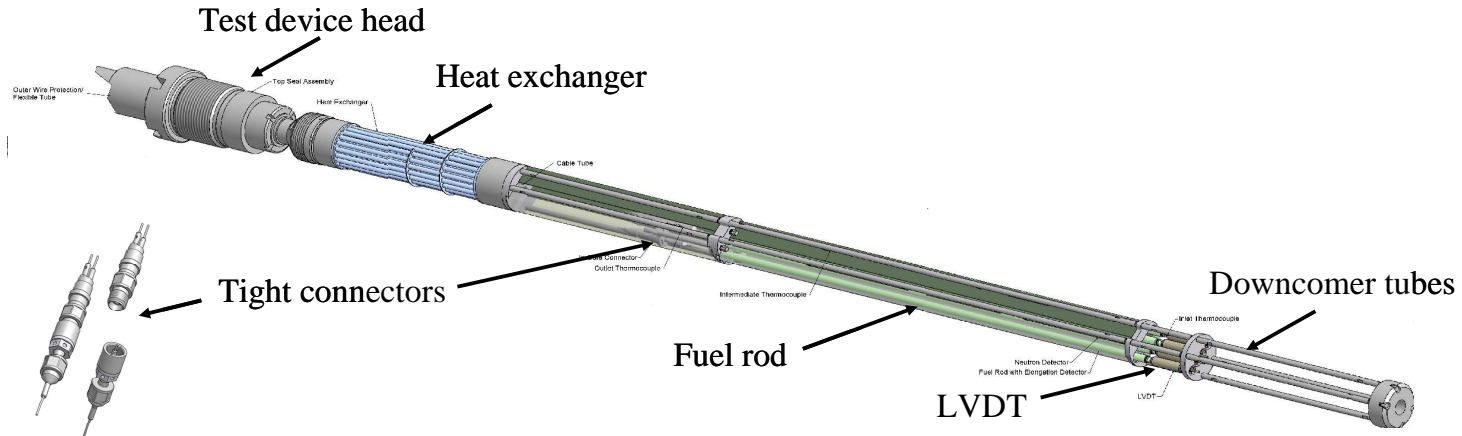
- Feasibility phase:
 - ✓ From June 2008 to March 2010
 - ✓ Ability to adapt IFE device to JHR geometry and safety standards
 - ✓ Feasibility demonstrated
 - ✓ First design of the loop system and irradiation rig
- Detailed design phase:
 - ✓ Targeted between 2011 and 2012
 - ✓ Detail design of all components with detailed manufacturing process
 - ✓ Safety analysis
- Manufacturing phase:
 - ✓ Targeted between 2013 and 2014
 - ✓ Manufacturing of the experimental device
 - ✓ Mounting and delivery to JHR site
- Availability scheduled for the beginning of JHR operation



Description of the current design



The irradiation rig



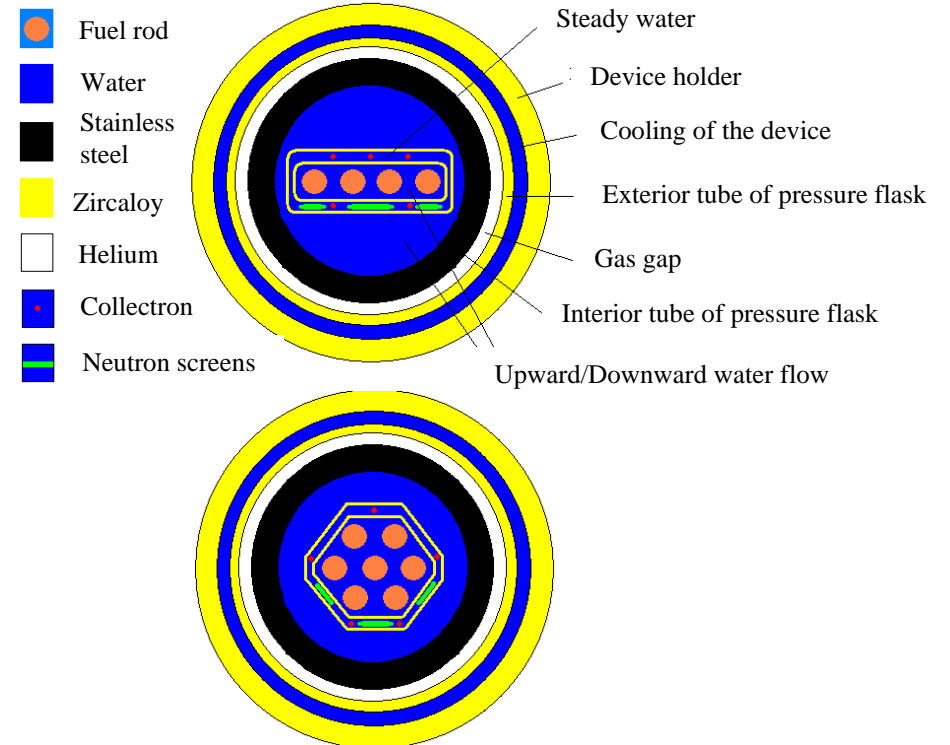
• Standard version

- 4 instrumented samples irradiation rig:

- ✓ Good homogeneity
- ✓ Linear power: 400W/cm max
- ✓ MOX or UO2 fuels
- ✓ Fresh fuel or high burn up

• Versatility

- Large embarking capacity (8 rods max)
- Single rod version highly instrumented



Water loop architecture



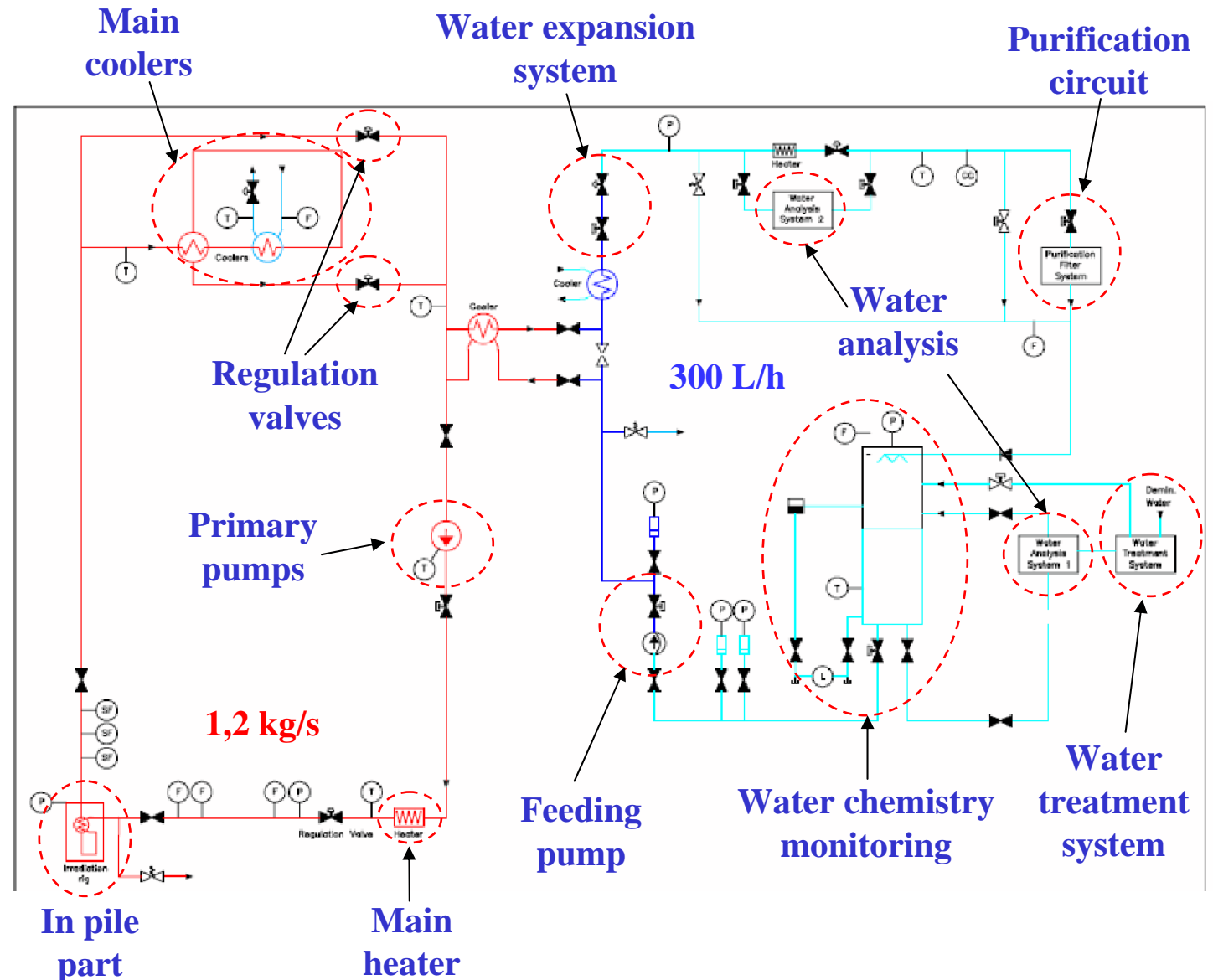
• Thermal-hydraulics

- PWR/BWR conditions

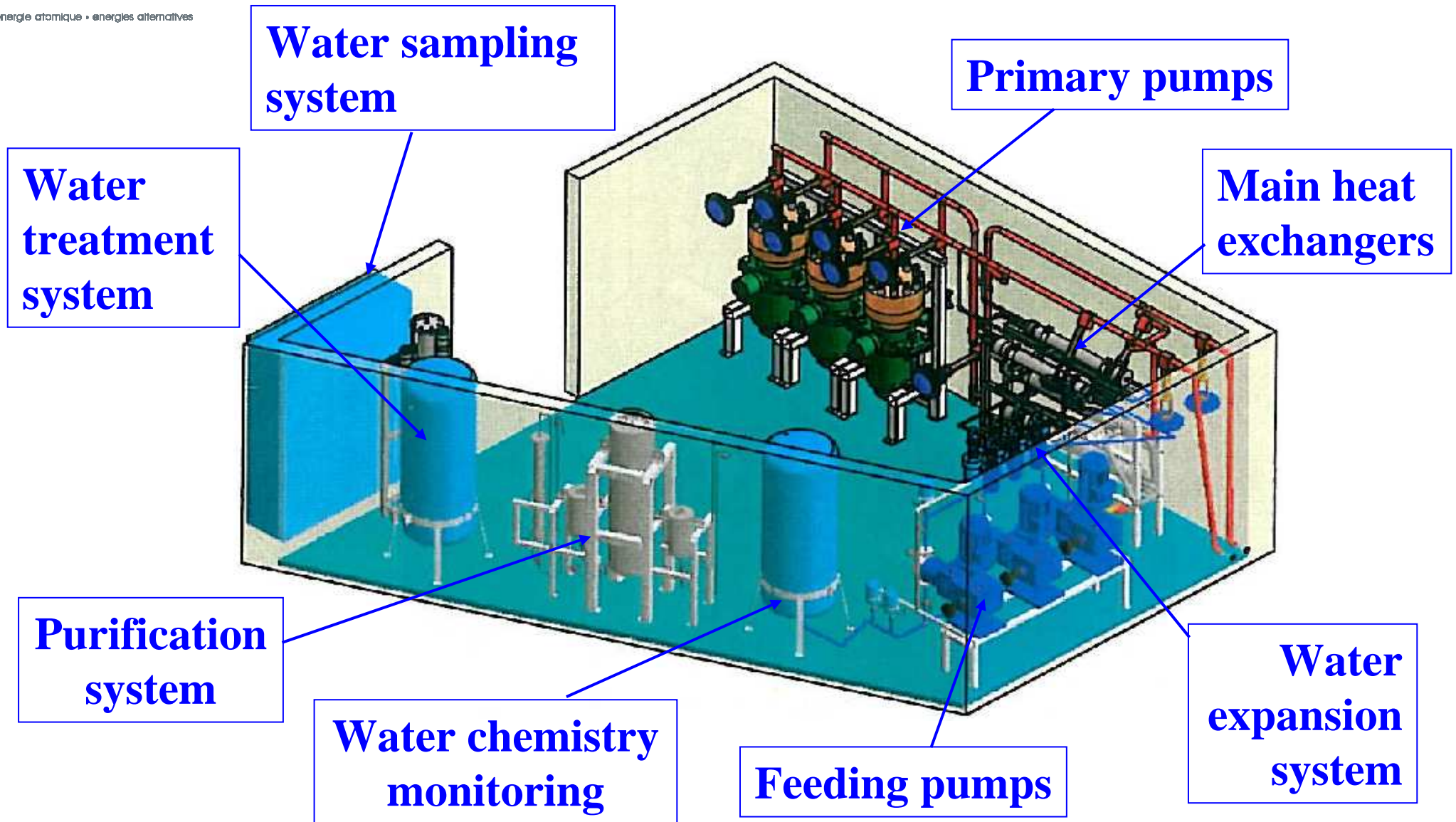
- ✓ Pressure
- ✓ Temperature
- ✓ Velocity
- ✓ Void fraction

• Chemistry

- PWR/BWR chemistry
- Specific chemistry

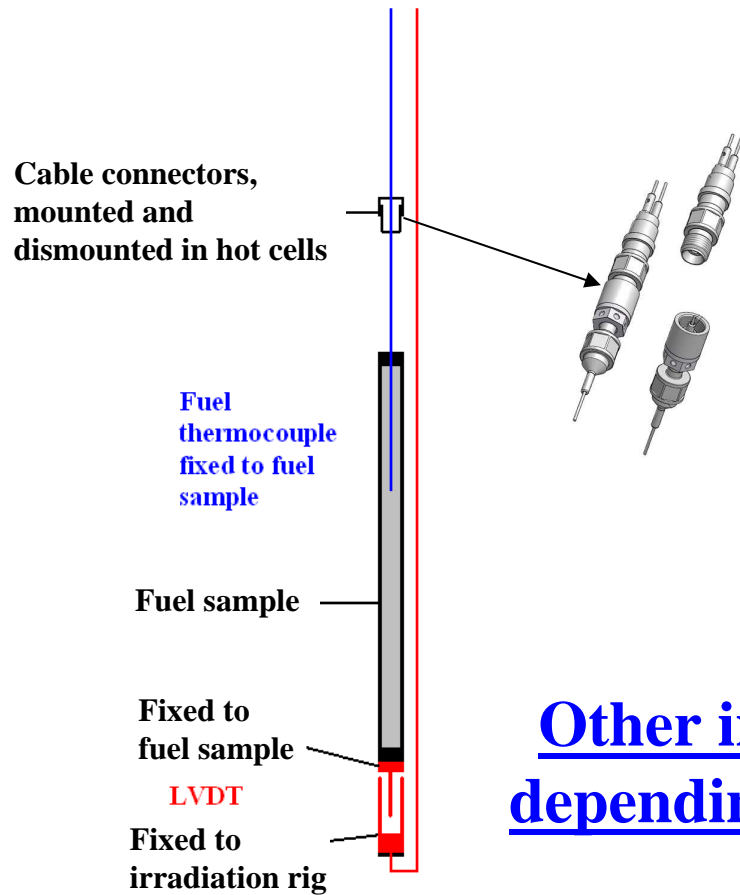


Component integration in Cubicle



• On fuel sample

- Standard instrumentation
- Evolution possible for specific rigs



• In the water loop

- Fixed to irradiation rig
 - ✓ Pressure sensors in the test section
 - ✓ Thermocouples at various elevations
 - ✓ Collectrons
- In the cubicle
 - ✓ Main water flow
 - ✓ Pressure sensors
 - ✓ Chemistry
 - ✓ Water activity

On-line thermal balance in the test section:
A 3% precision is targeted.

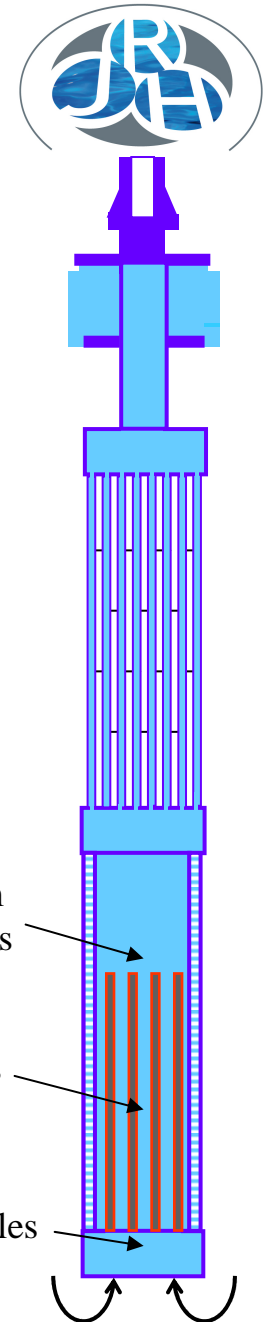
Thermal balance on fuel samples in upward water channel

Other instrumentation possible depending on experimental needs

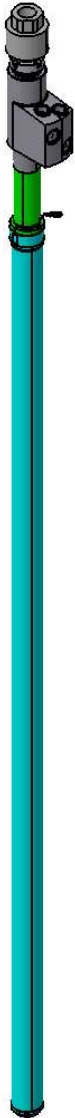
4 downstream thermocouples

8 collectrons

4 upstream thermocouples



Conclusion: MADISON device



- ↪ An Innovative experimental device using the JHR experimental capacity
- ↪ Best practices from CEA and IFE-Halden
 - Robust design
 - I&C
 - Thermal-hydraulics
 - Chemistry
- ↪ A versatile equipment
 - Hosting capacity
 - I&C
 - Thermal-hydraulics
- ↪ Schedule for operation in the beginning of JHR operation to answer experimental needs
- ↪ Industrial partners welcomed to submit their experimental needs

