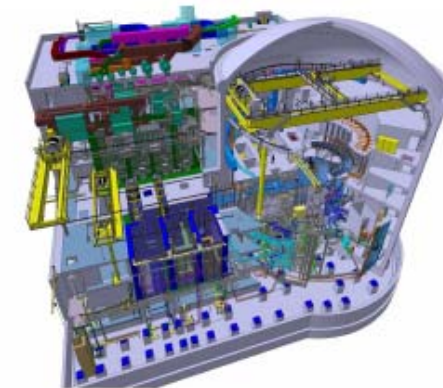
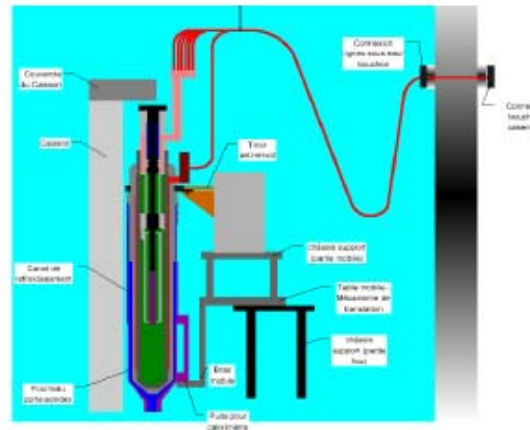




JHR Project

ADELINE loop Performances

Advanced Device for Experimenting up to Limits Irradiated Nuclear fuel Elements



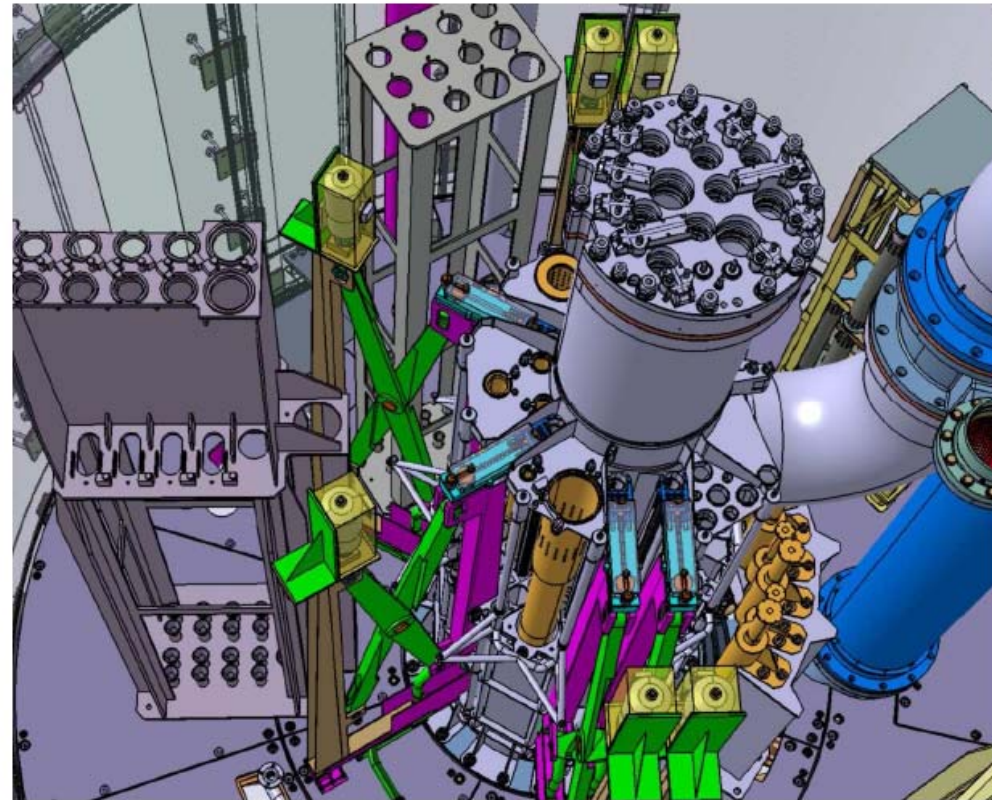
stephane.gaillot@cea.fr

Other contributors:
D.Parrat, C.Garnier, G.Laffont, C.Gonnier (CEA)

JHR Characteristics

designed at 100MW_{th},

- ↪ Compact core geometry (60cm diameter),
- ↪ Reflector in Beryllium,
- ↪ Light water coolant - closed primary circuit (12 bar pressurisation),
 - ✓ High materials damages capabilities: 15 dpa/year (core),
 - ✓ High thermal neutrons flux (reflector): 8 x PWR th. neutrons flux,
- ↪ High experimental platform: possibility to manage 25 irradiation devices (x13 in the core and x12 in the reflector),
- ↪ Experimental and exploitation equipments integrated in the facility (NDE systems,, FP laboratory, hot cells with specific one for failures rods conditioning).



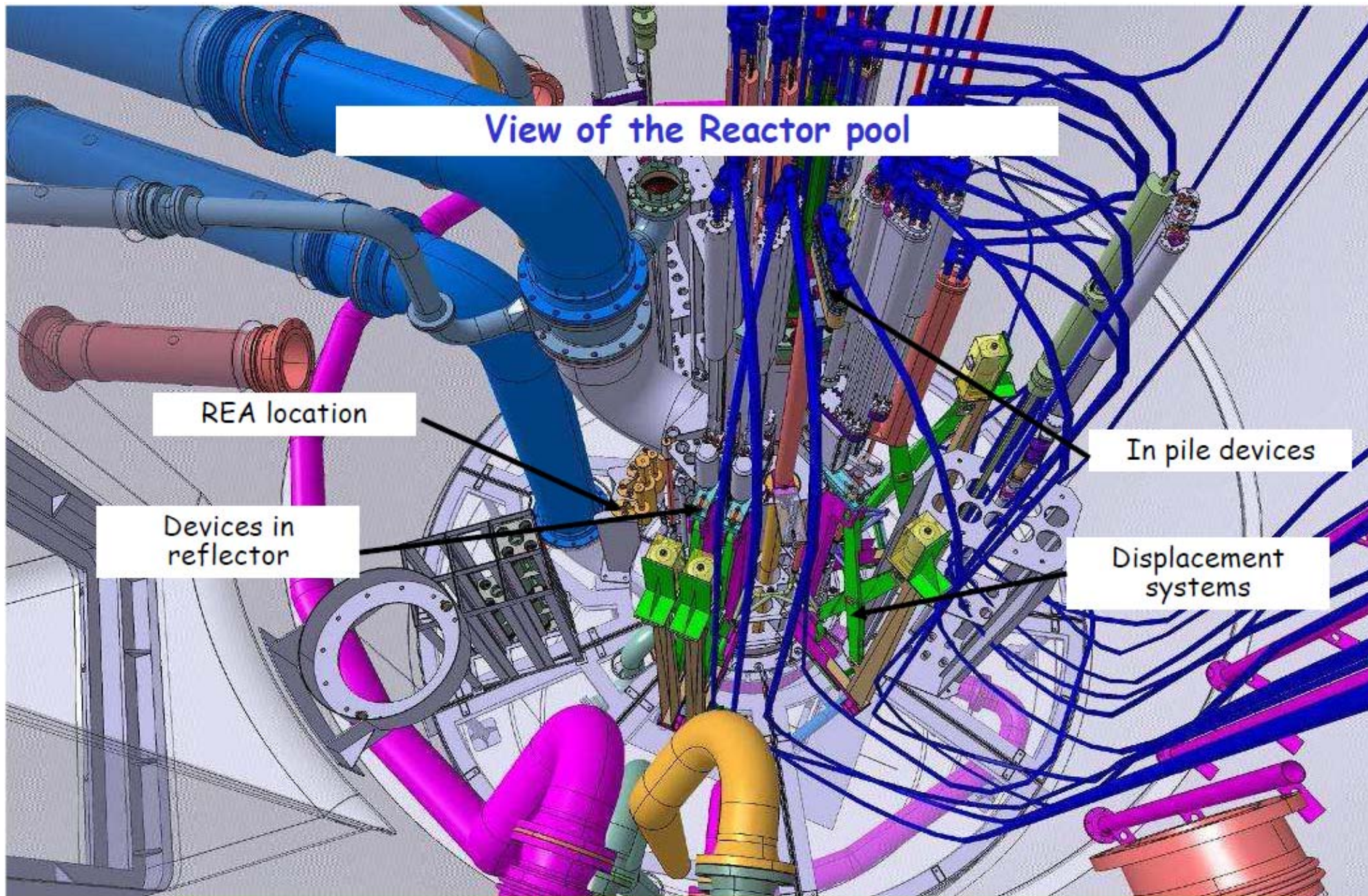


Adeline loop : General objectives

The experimental LWR ADELINe loop will be able to reproduce various experimental irradiation scenarios such as :

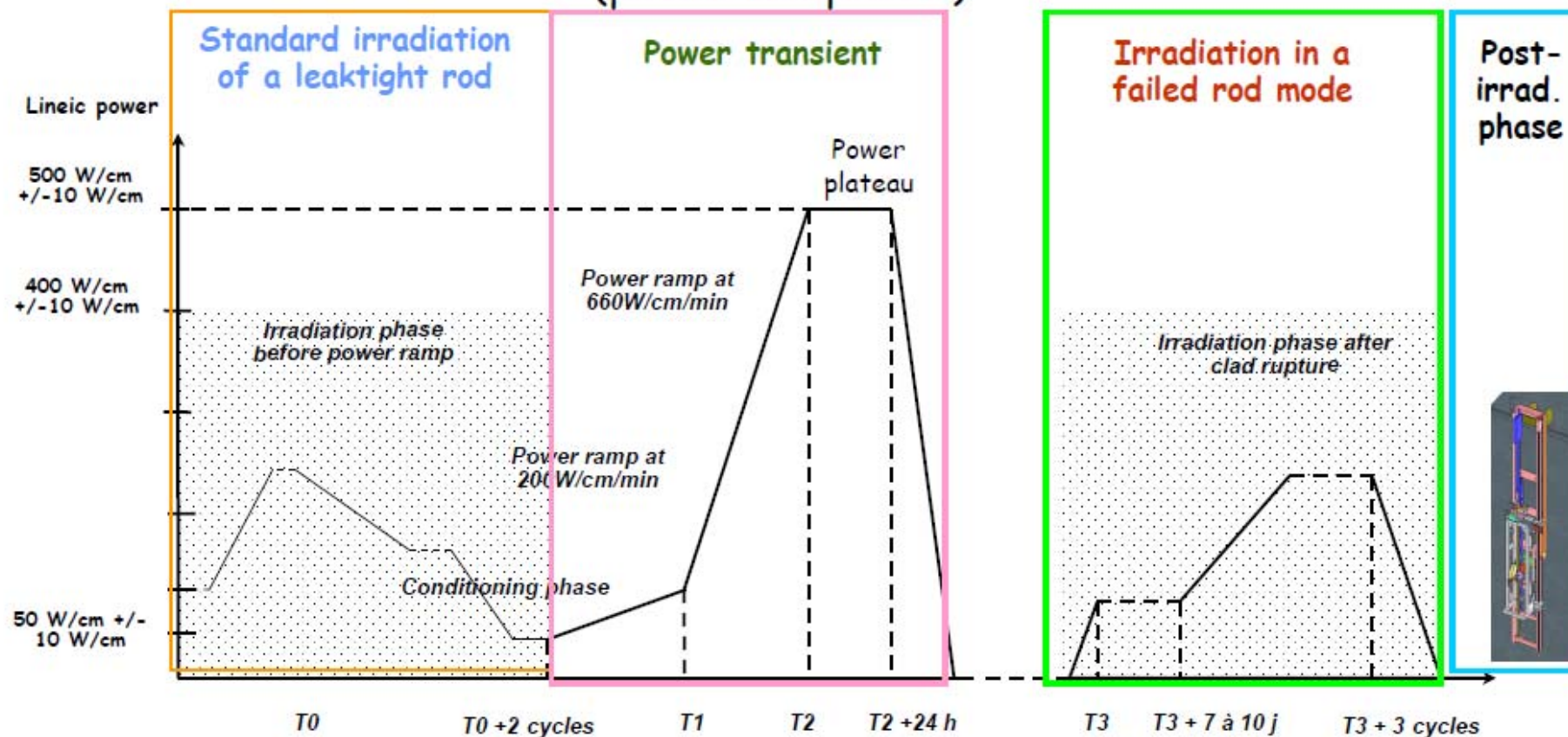
- ✓ **Soliciting or complex linear heat generation rate (LHGR) time histories**
until 500 W.cm^{-1} with a fresh fuel sample,
with an enrichment of 1% ^{235}U .
- ✓ **Power ramp tests**
rate up to $660 \text{ W.cm}^{-1}.\text{min}^{-1}$ minimum.
- ✓ **Permanent irradiation in a failed mode**
with on-line monitoring and purification of the fission products
and actinides released in the coolant,
- ✓ **Fuel centre melting conditions approach,**
- ✓ **Rod internal over-pressurization ("lift-off"),**
- ✓ **Rod internal free volumes gas sweeping.**



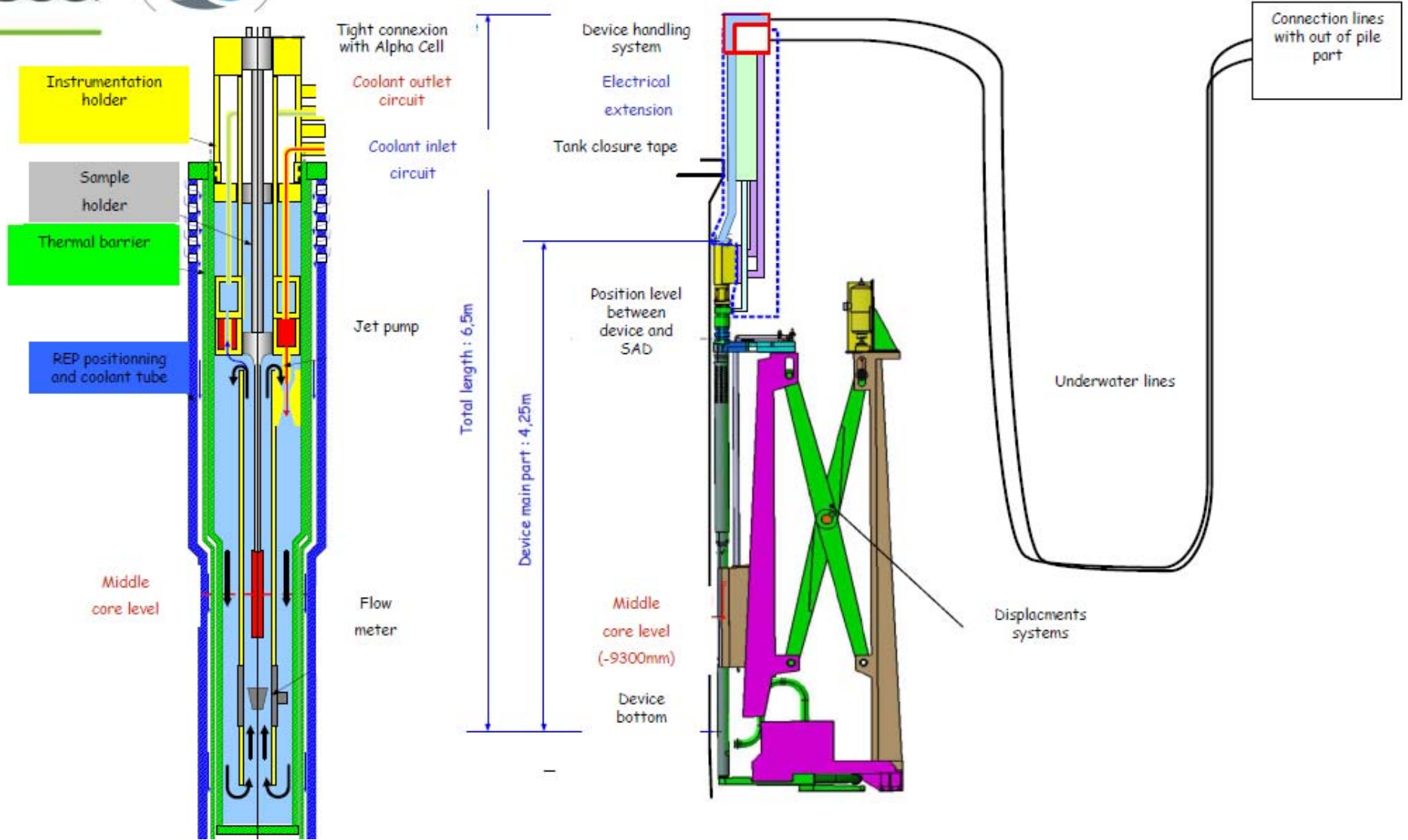




ADELINE loop typical experimental transient (power ramp test)



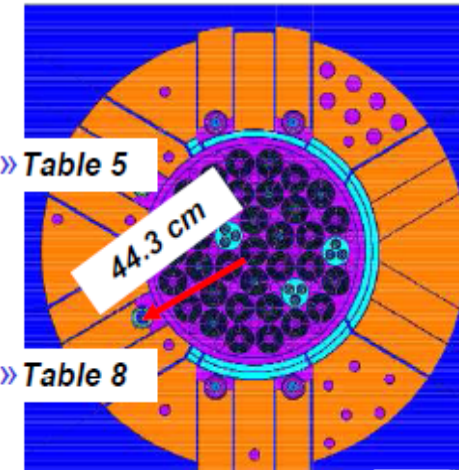
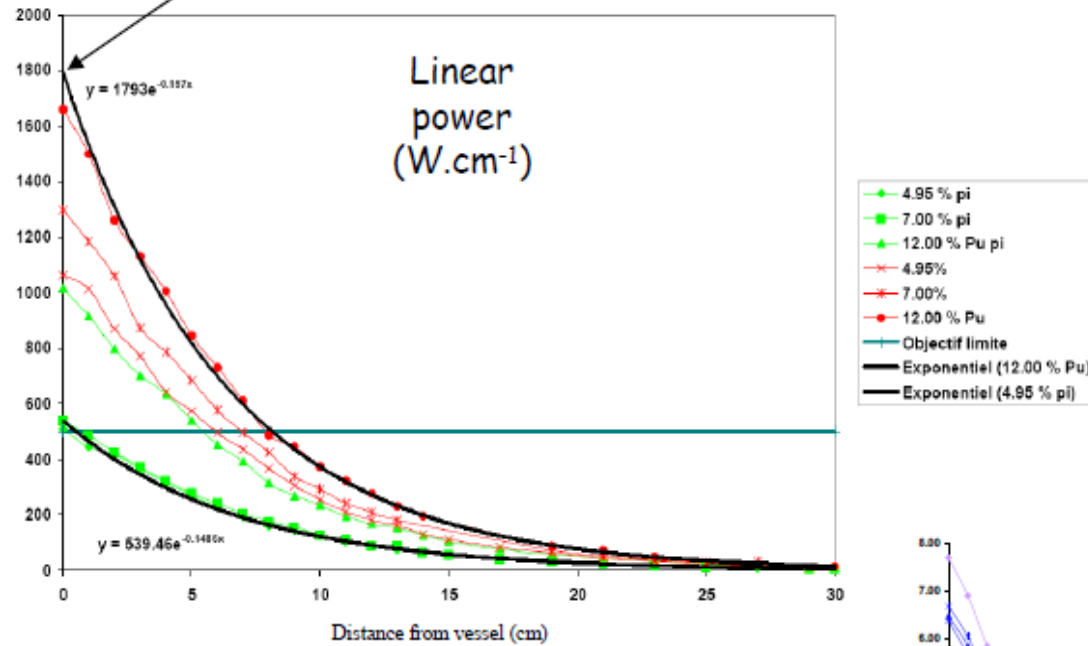
In pile part: General Overview of the device



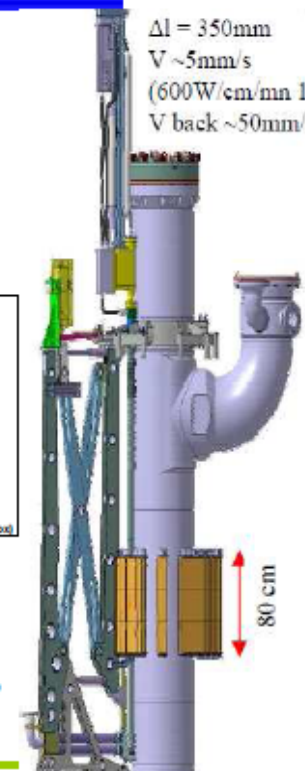
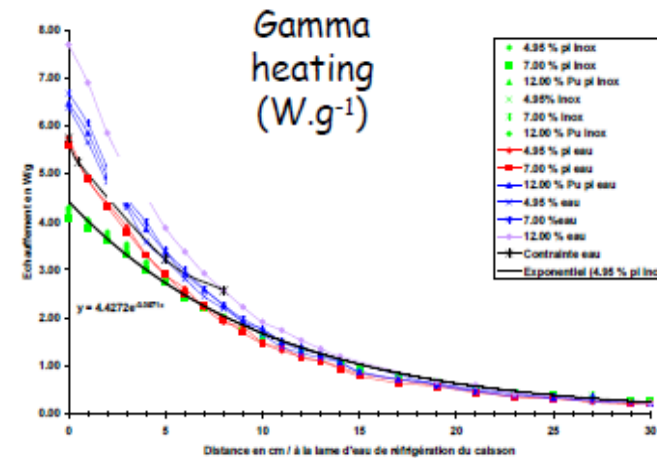
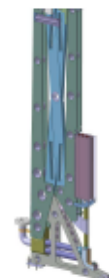
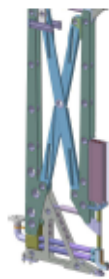


Neutronic performances

1mm displacement
8 to 10 W/cm

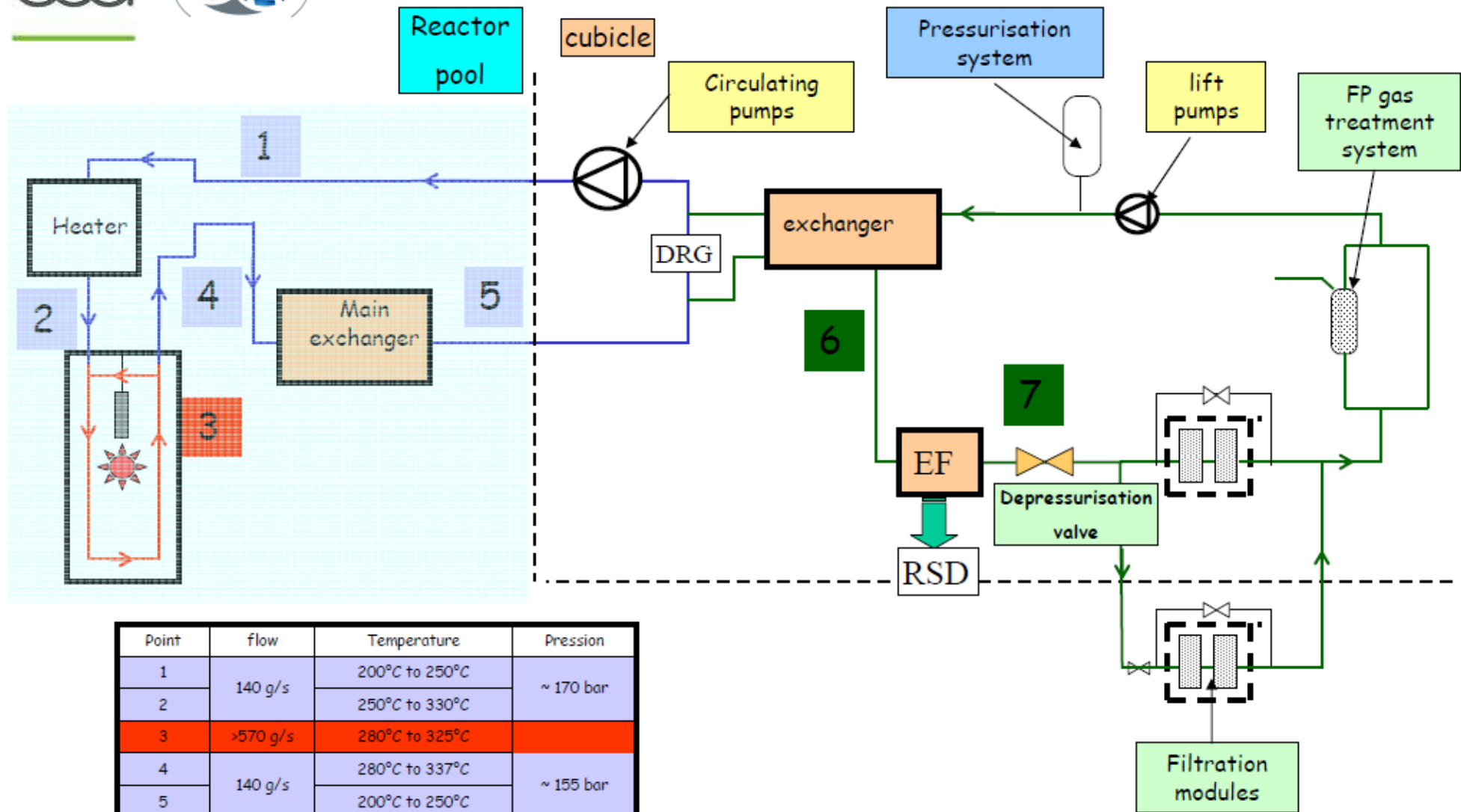


$\Delta l = 350\text{mm}$
 $V \sim 5\text{mm/s}$
(600W/cm/mn 1%U5)
 $V_{\text{back}} \sim 50\text{mm/s}$





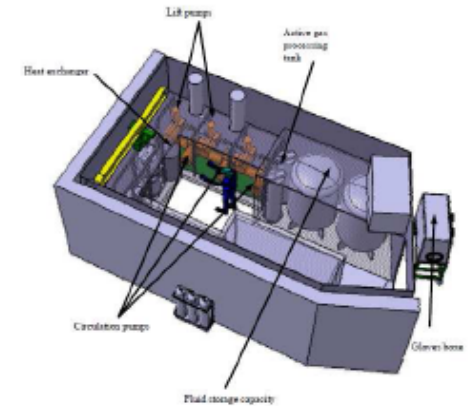
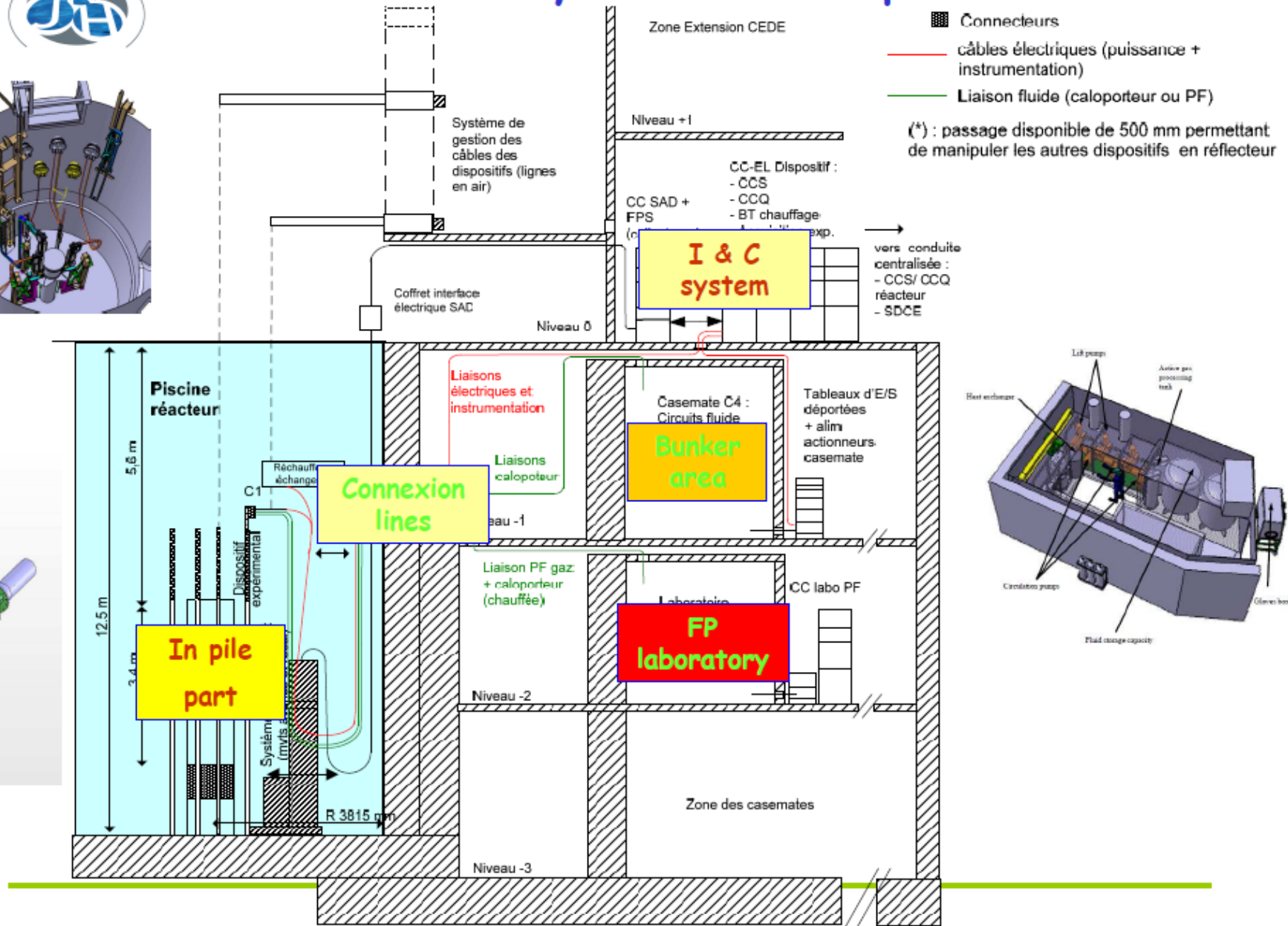
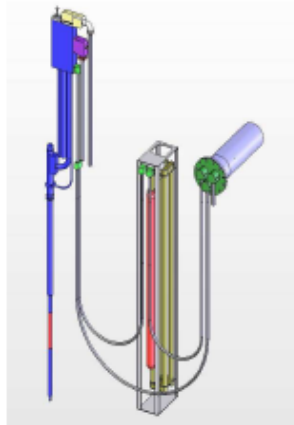
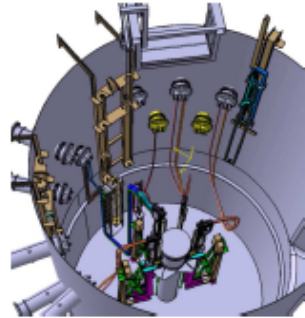
Adeline loop : Thermal hydraulics parameters



Point	flow	Temperature	Pression
1	140 g/s	200°C to 250°C	~ 170 bar
2	140 g/s	250°C to 330°C	
3	>570 g/s	280°C to 325°C	
4	140 g/s	280°C to 337°C	~ 155 bar
5		200°C to 250°C	
6	30 g/s	between 250°C and 50°C	~ 5 bar
7		<50°C	



General layout of the loop

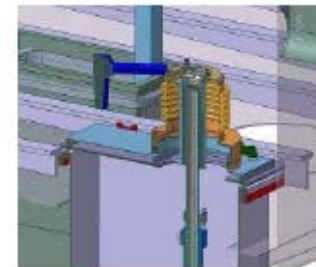
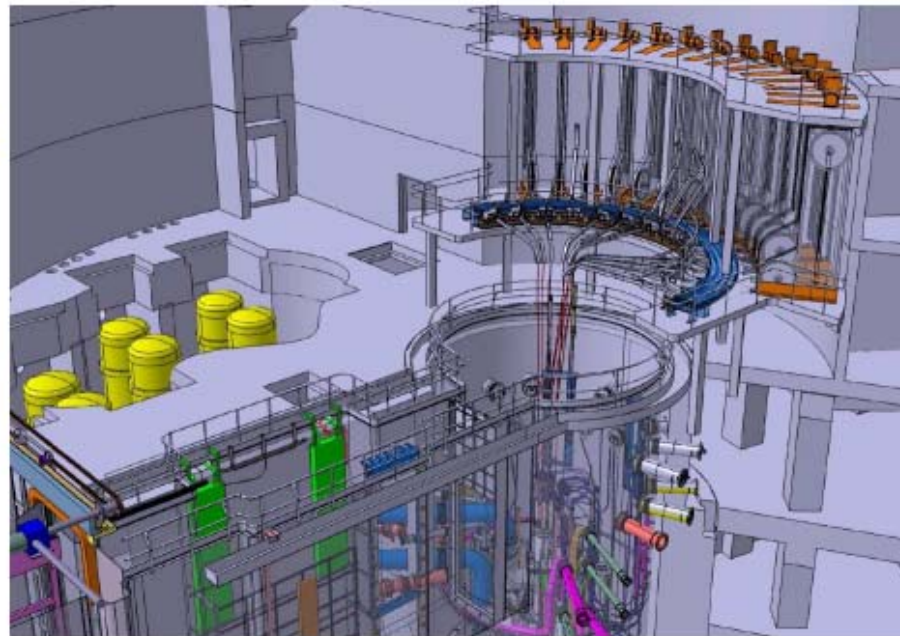
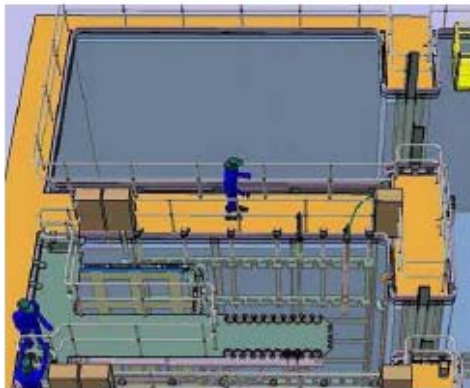




JHR facility Integration

↪ Design phase take into account facility interfaces such as :

- ✓ Pools underwater storage,
- ✓ Displacement systems in reactor pool,
- ✓ Non destructive equipments (gamma and X ray stations, neutron imaging system),
- ✓ Under water transfer to hot cells block and connexion to alpha hot cell,
- ✓ Data exchanges with reactor I&C systems,





Conclusion

- ↪ Disponibility of ADELINÉ fuel irradiation loop (PWR) at the start-up of the JHR facility in 2014.

- ↪ Integrate in the current design studies:
 - ✓ Proposal of a simplified version for irradiation tests with low risk of clad failure,

 - ✓ Proposal of a version for BWR tests,

 - ✓ Proposal innovation concepts concerning materials, manufacturing processes, instrumentation, embedded electronics,...).