The Jules Horowitz Reactor: a new High performances European MTR open to international community

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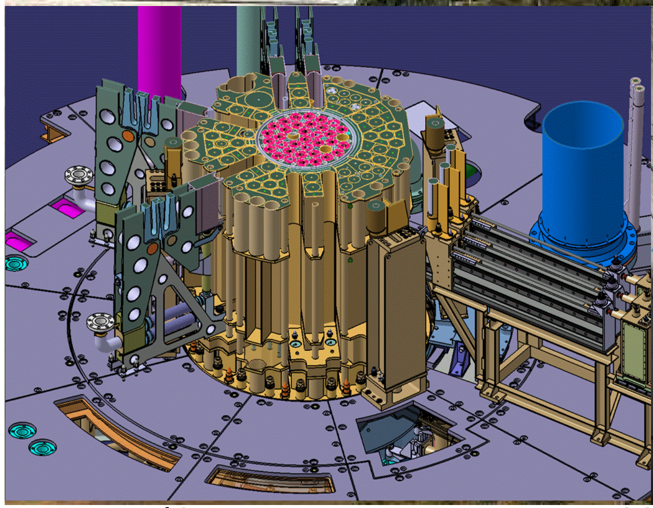
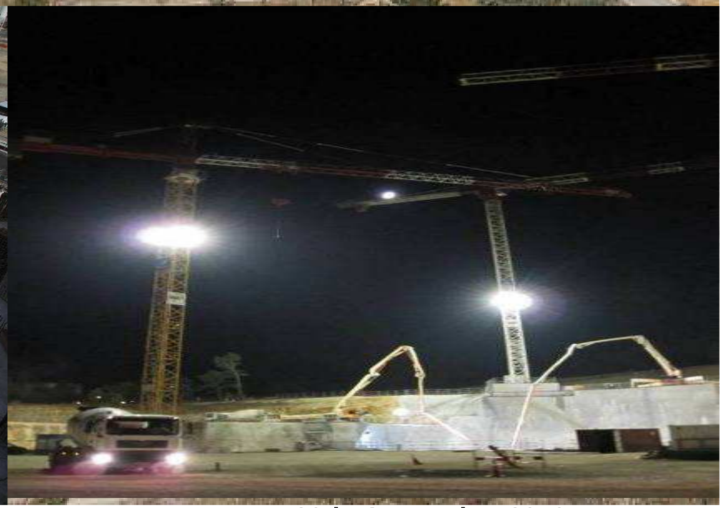
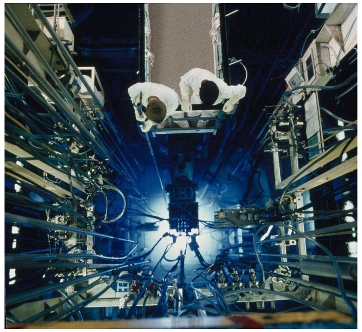


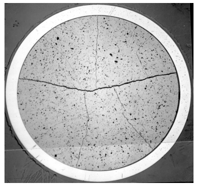


MTR context

- MTRs have provided valuable support to develop nuclear energy and are still necessary to sustain industry and public bodies



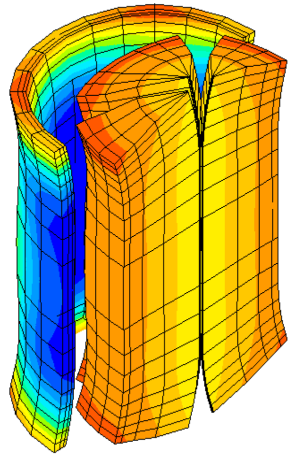
- Existing MTRs providing support to industry are ageing
  - ✓ Ex. Halden (50 y.), OSIRIS (44 y.)…
  - ✓ With increasing risk of shut-down
    - ☞ R2 in Sweden shut-down at 45 y. with a 6 month notice !
  - ✓ With increasing probability of incident after 40 years of operation
    - ☞ NRU (52y.), HFR (48 y.)



- At least one new MTR dedicated to nuclear energy support is necessary (requirement from the ESFRI roadmap)
  - ✓ As an international user-facility (mature industry, large available knowledge)

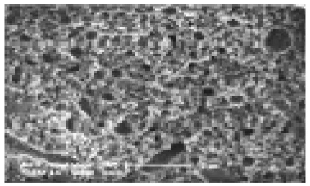
CEA Strategy on MTR: Sustaining Material Testing capacity in France (from OSIRIS to JHR)

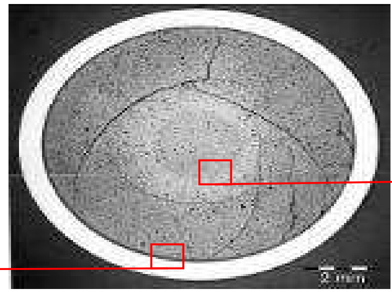
- Material Ageing under irradiation
  - ✓ dpa, …
  - ✓ Corrosion, Radiolyse …



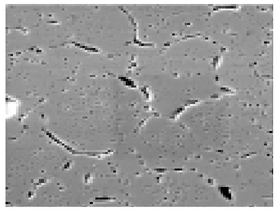
- Fuel Behaviour under irradiation
  (PCI,FGR…)

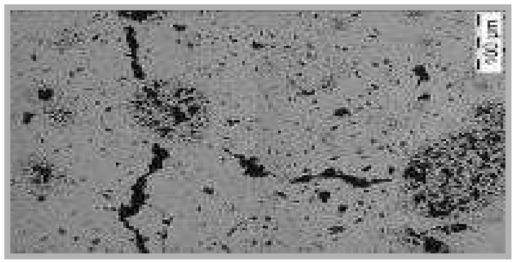
Restructuration
à fort taux
(RIM)

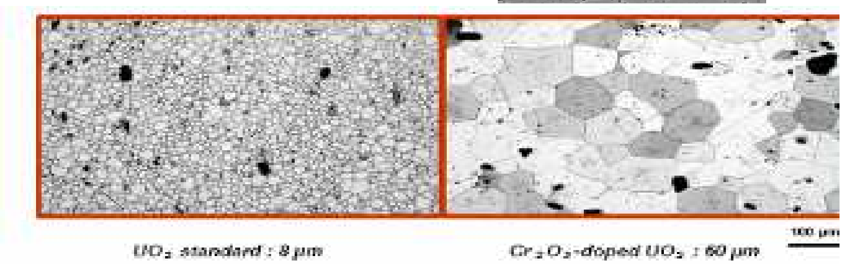




Précipitation
gaz de
fission

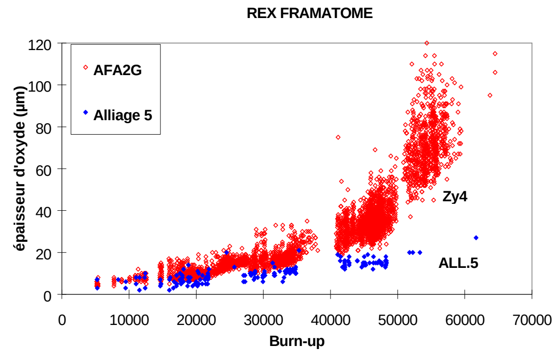






JHR meets key needs for Industry and public bodies

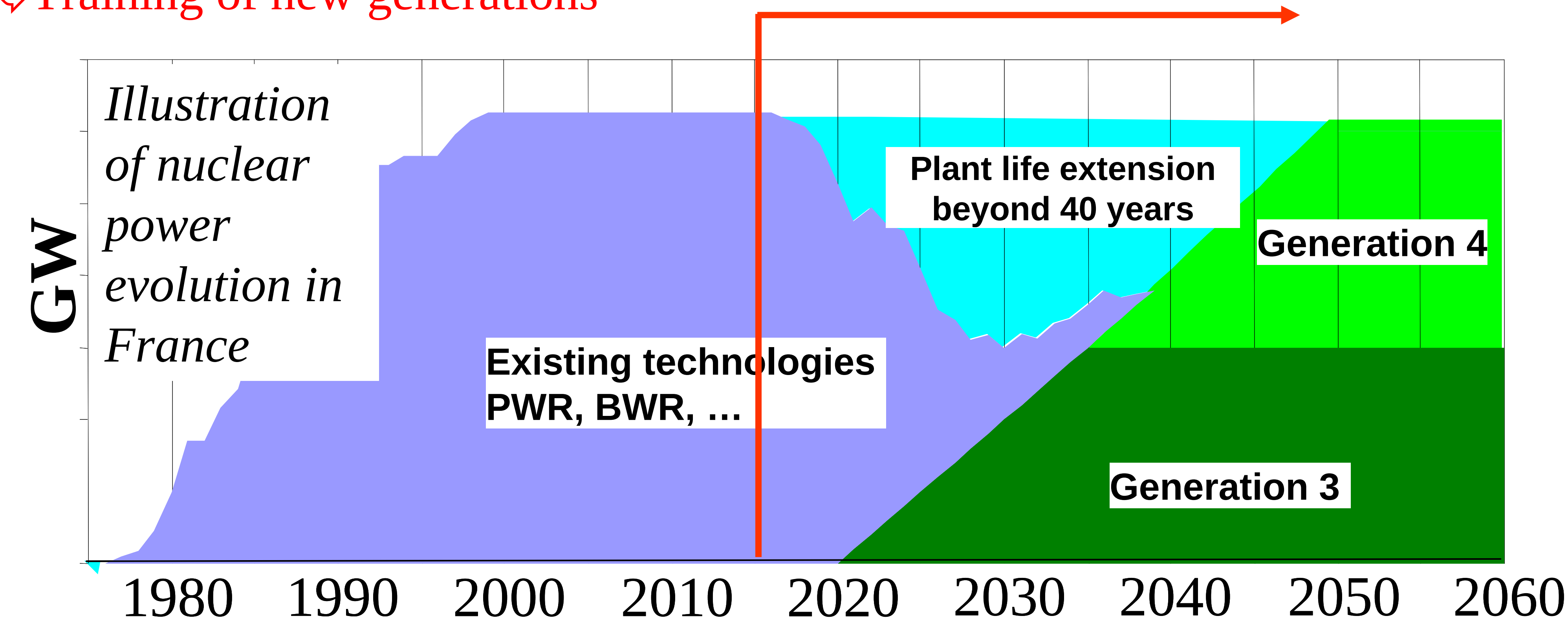
- Plant life time management for a capital intensive technology
  - ✓ Plant operation optimisation
  - ✓ Ageing management
  - ✓ New plant business case
  - ✓ Support to national licensing process



- Fuel evolution and related safety demonstration
  - ✓ Product optimisation by the Vendors
  - ✓ Fuel behaviour validation by Utilities in incidental and accidental situation
  - ✓ Innovations to improve U consumption in Gen 3 and for sustainability in Gen 4
  - ✓ Support to national licensing process
- To support expertise
  - ✓ Training of new generations
  - ✓ Credibility for public acceptance
  - ✓ Assessment of safety requirements evolution and international regulation harmonisation

JHR status:
an MTR optimised to support industrial & public needs

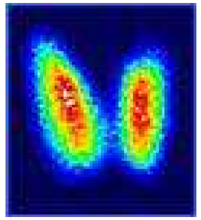
- Safety and Plant life time management (ageing & new plants)
- Fuel behaviour validation in incidental and accidental situation
- Assess innovations and related safety for future NPP: Gen 3 and Gen 4
- Training of new generations



JHR status

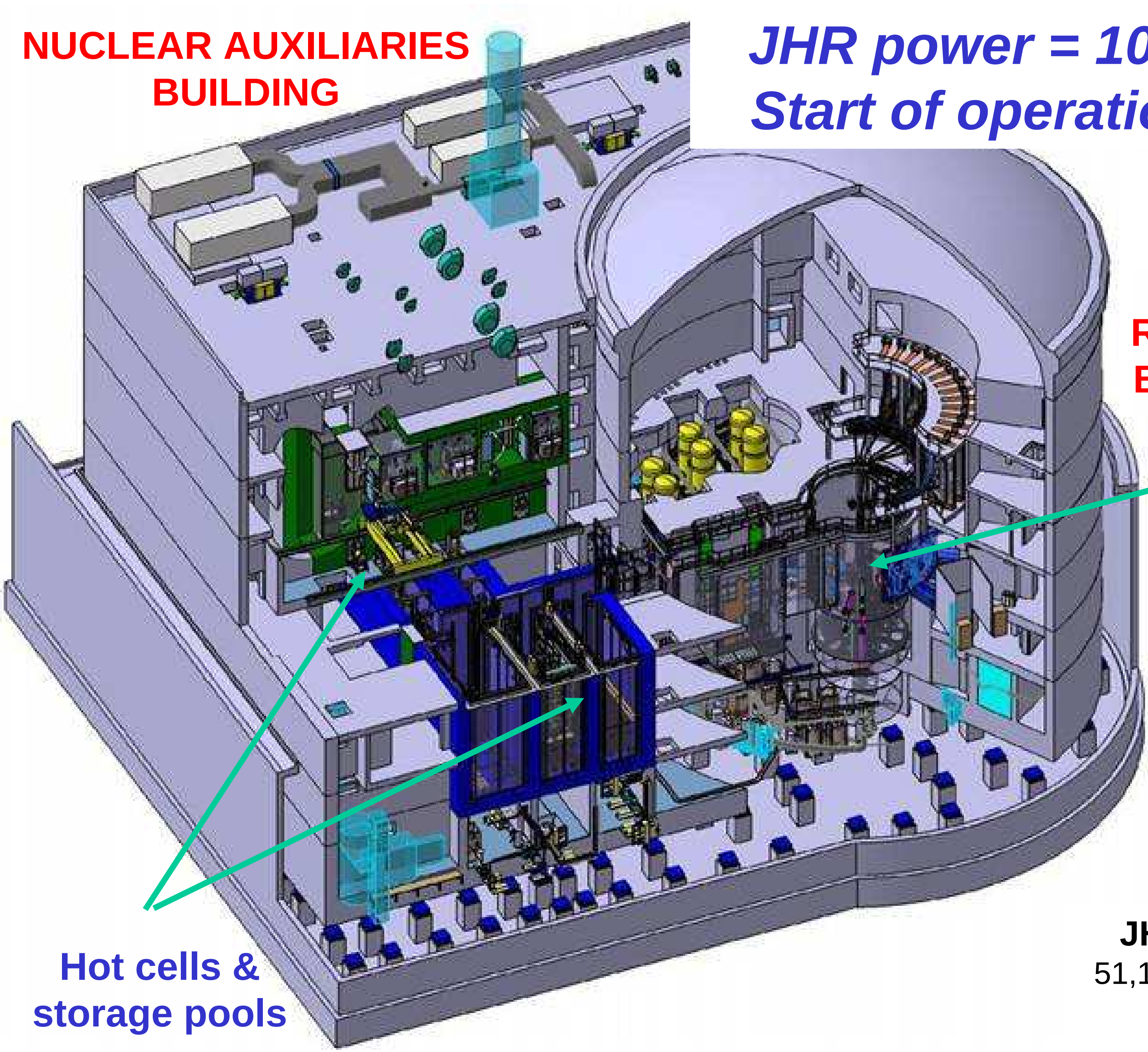
- JHR optimised for fuel and material testing for the benefice of industry and public bodies
- JHR will also provide significant MOLI production for medical purposes

  (see Mr Gaillot presentation , this conference)



- JHR is now under construction
  - ✓ Design completed, Site excavation completed
  - ✓ First concrete : 6/08/09 ; Lower basement completed end September 09
  - ✓ Upper Basement concrete poured beginning of June 2010 (completed fall 2010)
- On going procurement process
  - ✓ Engineering for the realisation phase, civil work, pumps for the primary circuit, …
  - ✓ More than 90% of the project cost engaged fall 2010 (700 M€)
- Licensing process: Preliminary Safety Analysis Report assessment
  - ✓ Start of the process: public consultation 2005, public enquiry 2006
  - ✓ A large effort in the technical assessment (2007, 2008)
  - ✓ Nuclear Installation Decree: 12th October 2009

JHR power = 100MW/70MW
Start of operation mid 2014



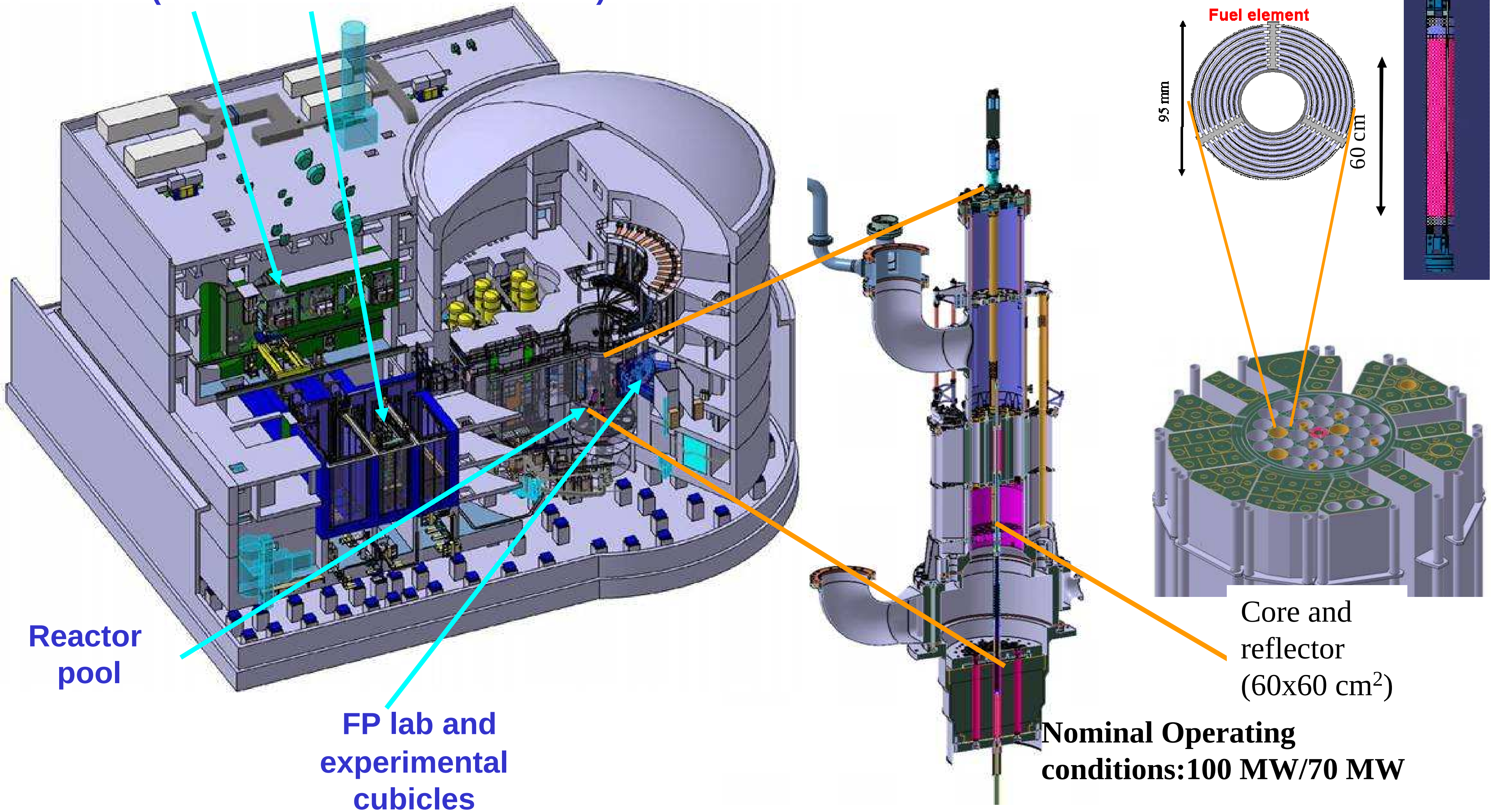
JHR characteristics

51,12m x 46,75m + Φ36.6m

H 34,4m + H44,9 m

JHR General presentation

Hot cells and storage pools
(Non destructive examinations)



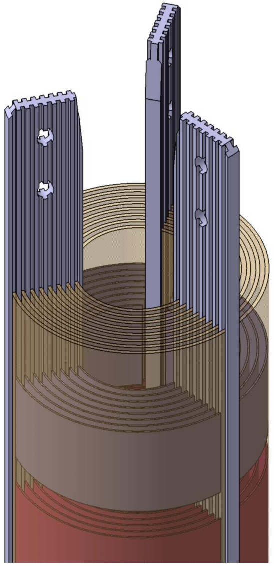
Reactor pool

FP lab and experimental cubicles

Core and reflector ($60x60\ cm^2$)

Nominal Operating conditions:100 MW/70 MW

Fuel elements and in-core experimental location

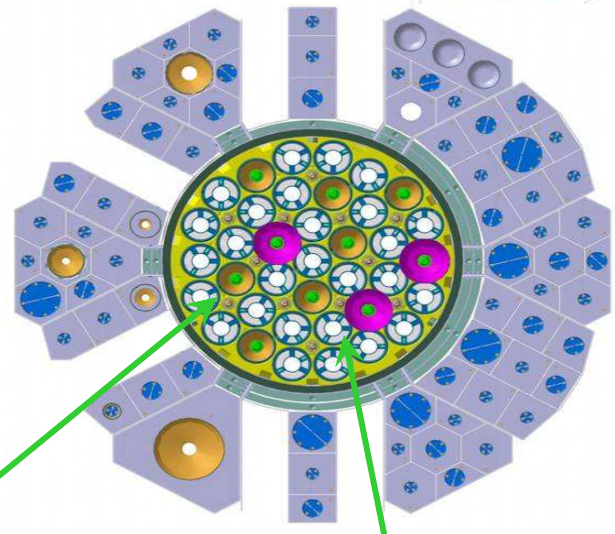


Reference LEU high density Fuel for the JHR Project : UMo 8g/cc (19.75%)

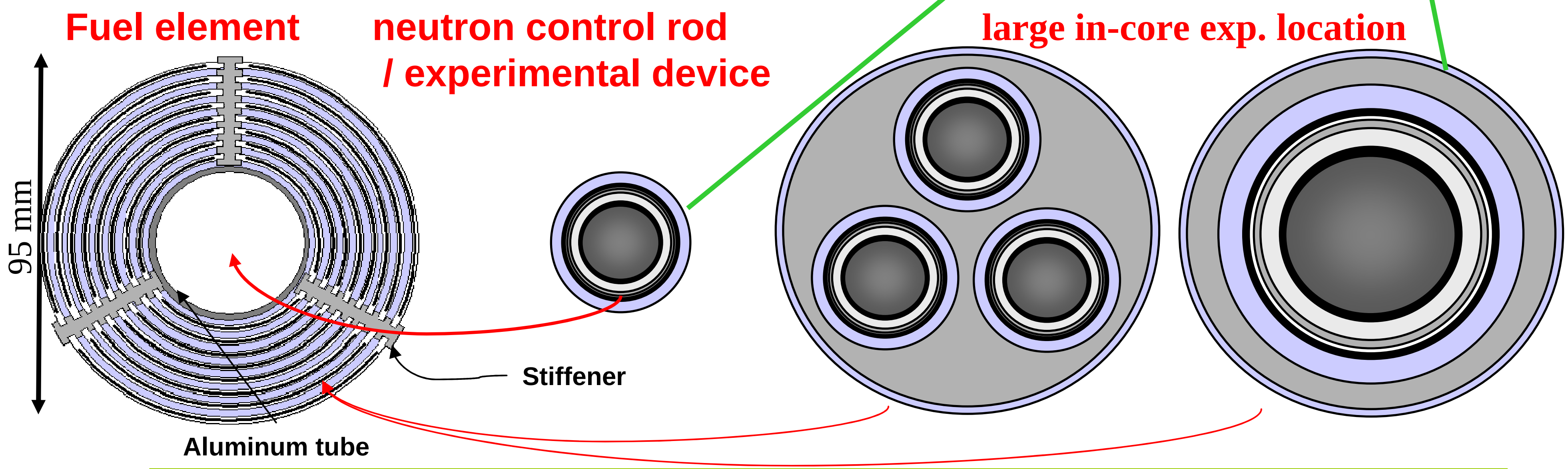
Back-Up:

U3Si2: ≤27% U5, 4,8gU/cm³

Cladding Al FeNi



experimental locations: ∅ 32 or ∅ 80 mm



JHR core characteristic

In core

Up to 5.5 10^{14} n/cm².s > 1MeV

Up to 10^{15} n/cm².s > 0.1MeV

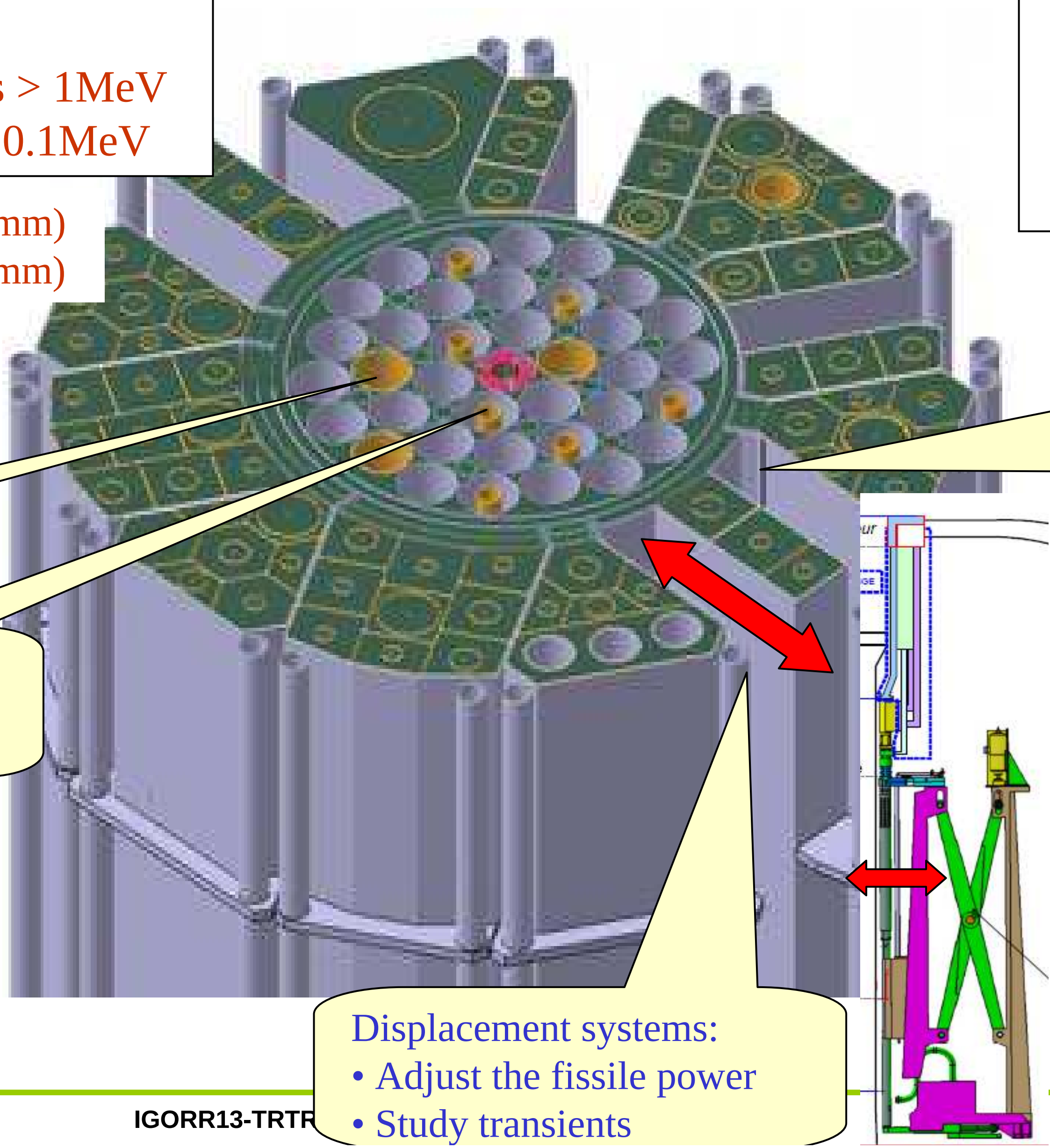
Small locations (Φ~ 32 mm)

Large locations (Φ~ 80 mm)

In reflector

Up to 5.5 10^{14} n/cm².s

Fixed positions and displacement systems

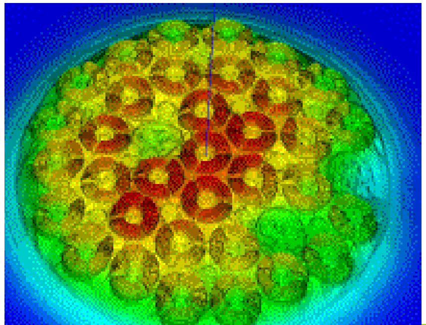


Fuel studies: up to 600 W/cm with a 1% ^{235}U PWR rod

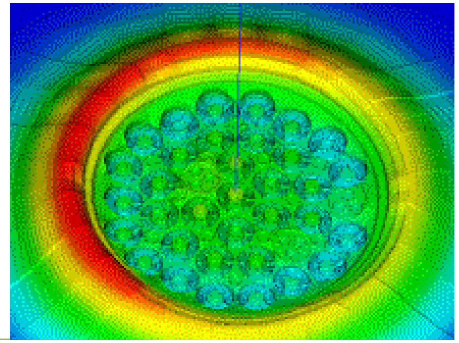
Fuel experiment

Material ageing (up to 16 dpa/y)

Displacement systems:
- Adjust the fissile power
- Study transients



Fast neutron flux



Thermal neutron flux

JHR Consortium, a framework to operate JHR as a User-Facility open to International collaboration

JHR Consortium, economical model for investment & operation

- ✓ CEA, owner & nuclear operator with all liabilities
- ✓ JHR Members owner of Guaranteed Access Right
  - ☞ In proportion of their financial commitment to the construction
  - ☞ With a proportional voting right in the Consortium Board
- ✓ A Member can use totally or partly his access rights
  - ☞ For implementing proprietary programs with full property of results
  - ☞ and/or for participating to the Joint International Programs with other Partners
    - – To address issues of common interest & key for operating NPPs
  - ☞ Operation cost paid only for utilized access rights

JHR present partnership: research centers & Industrial companies

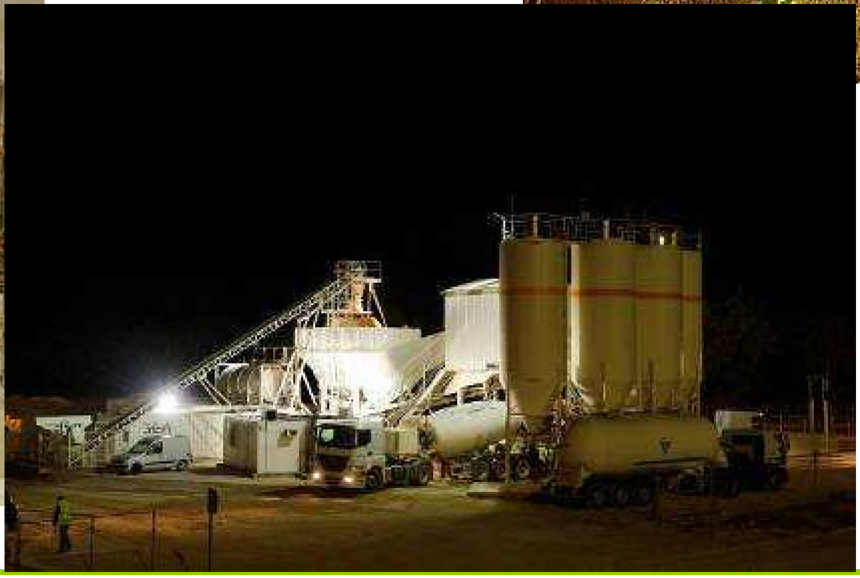
JHR
Civil construction works

Civil works

- Installation of the inferior basement reinforced bars
  - ✓ Around 275 kg of steel bars per concrete cubic meter
  - ✓ Up to 3 layers of bars, 32mm in diameter, per face and per horizontal direction

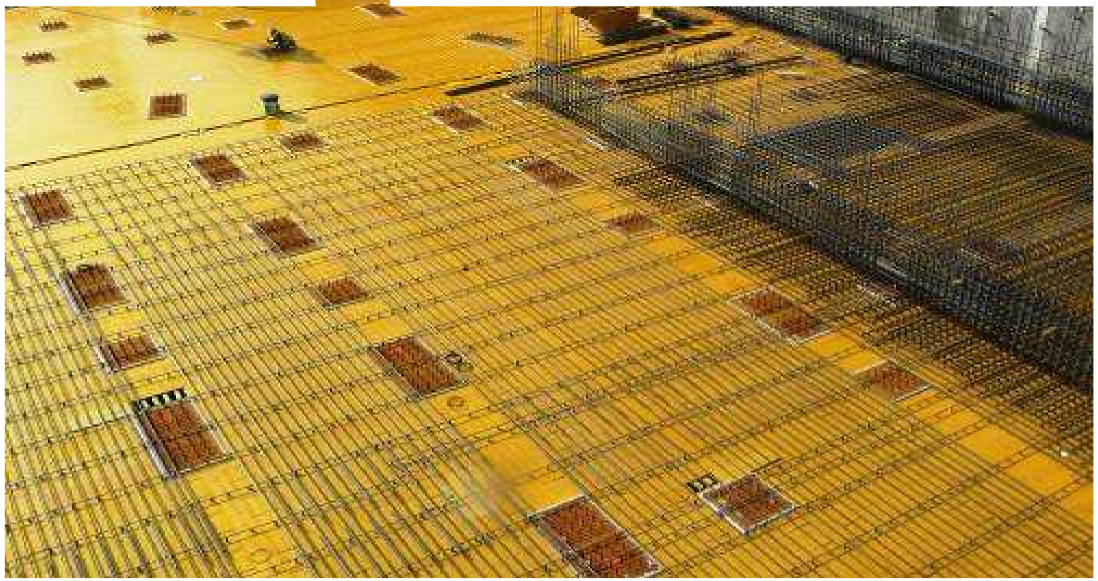
Civil works

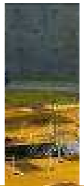
- Pouring of the inferior basement
  - ✓ 4,000 concrete m^3 August 2009
  - ✓ Performed in 5 phases (5 blocks), from 200 m^3 to 1500 m^3
  - ✓ The job was managed by night:
    - ☞ to have acceptable temperatures for the concrete
    - ☞ to avoid the traffic



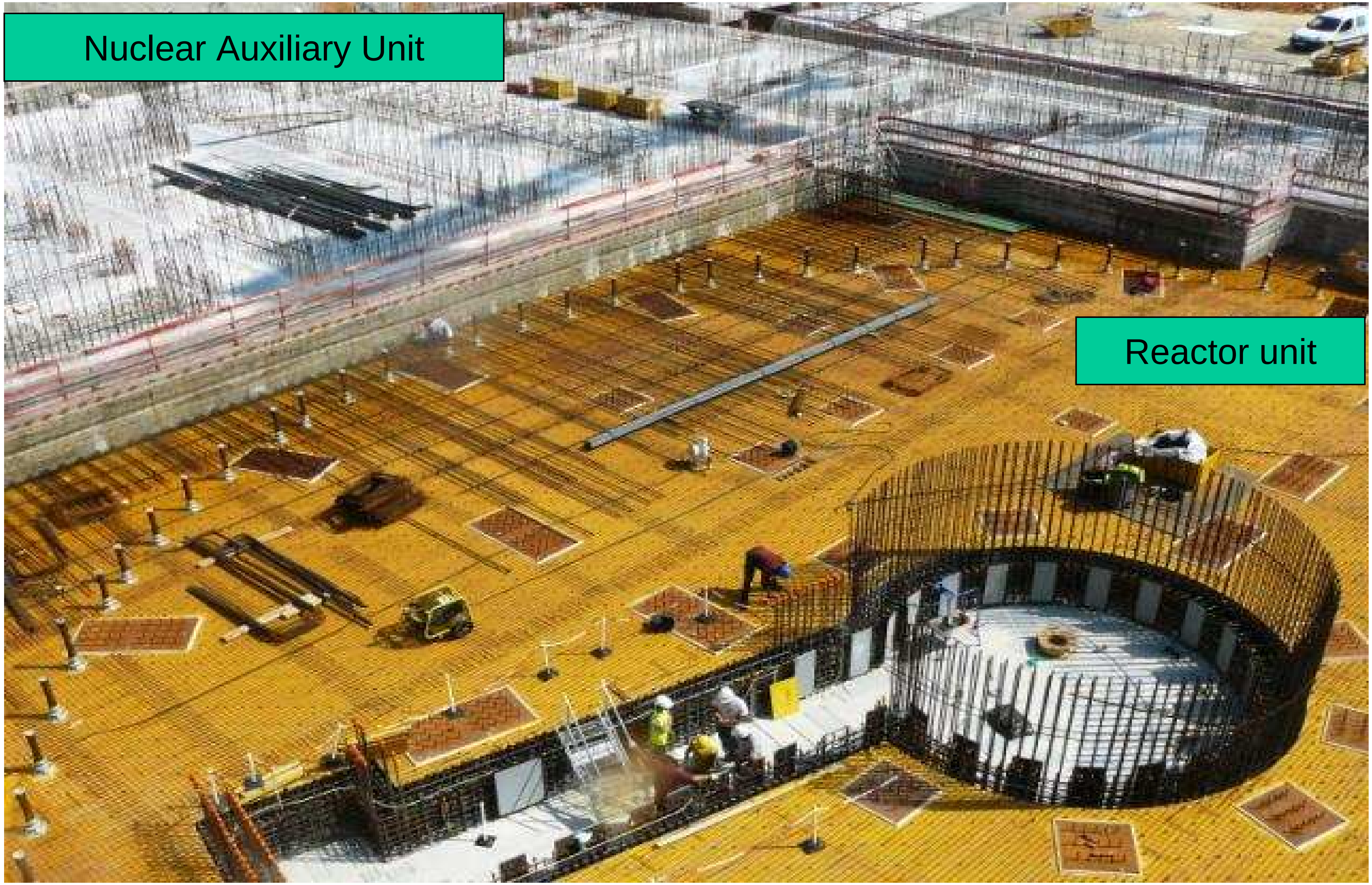
Anti-sismic pads

preparation of upper Basement (June 2010)





View of Nuclear Unit –July 2010

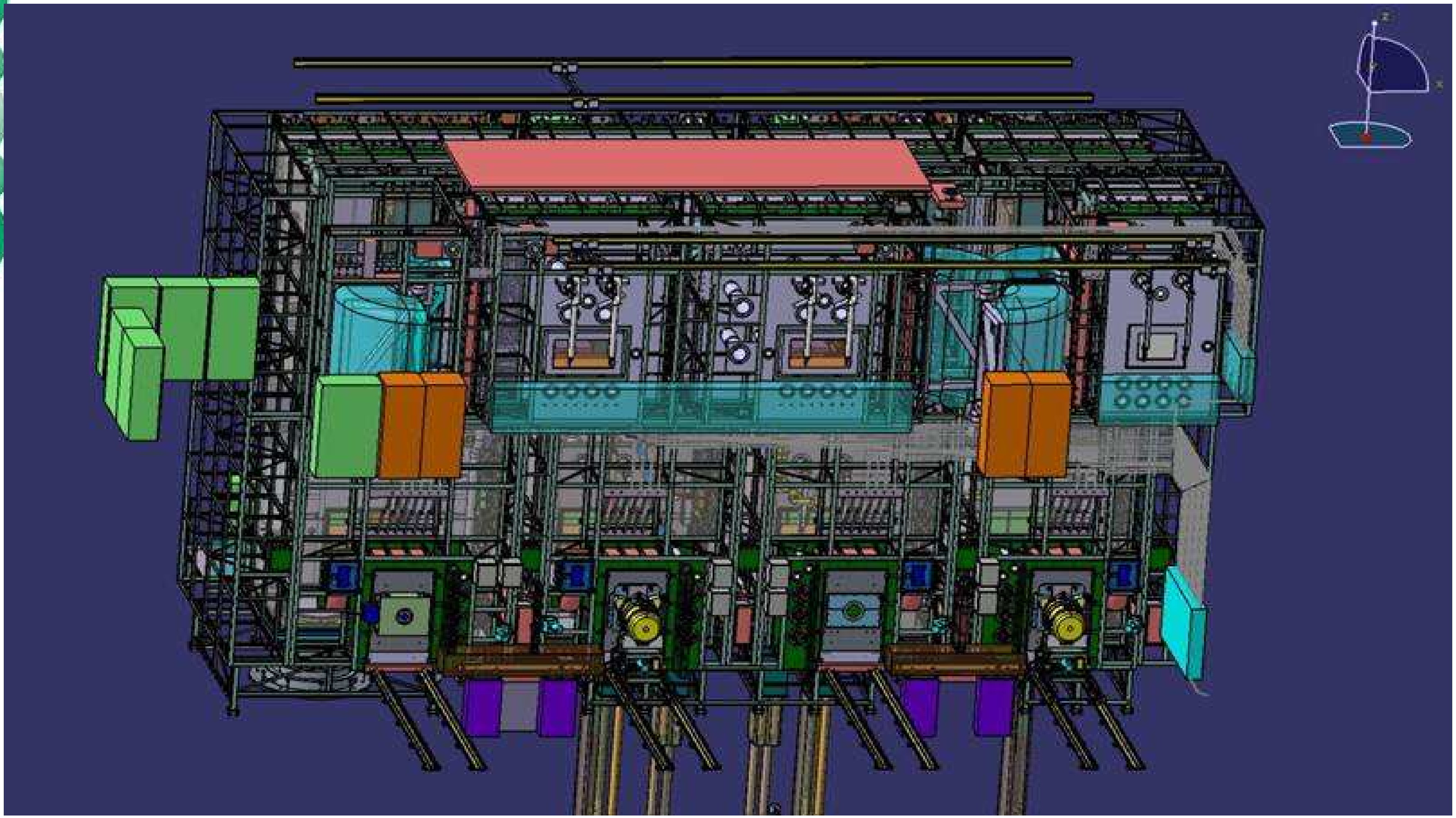


The Hot Cells for the Jules Horowitz Reactor

Ing. Jiří Žďárek CSc.

Research Center Řež Ltd.

Hot Cells



Spanish in-kind contribution to the JHR project

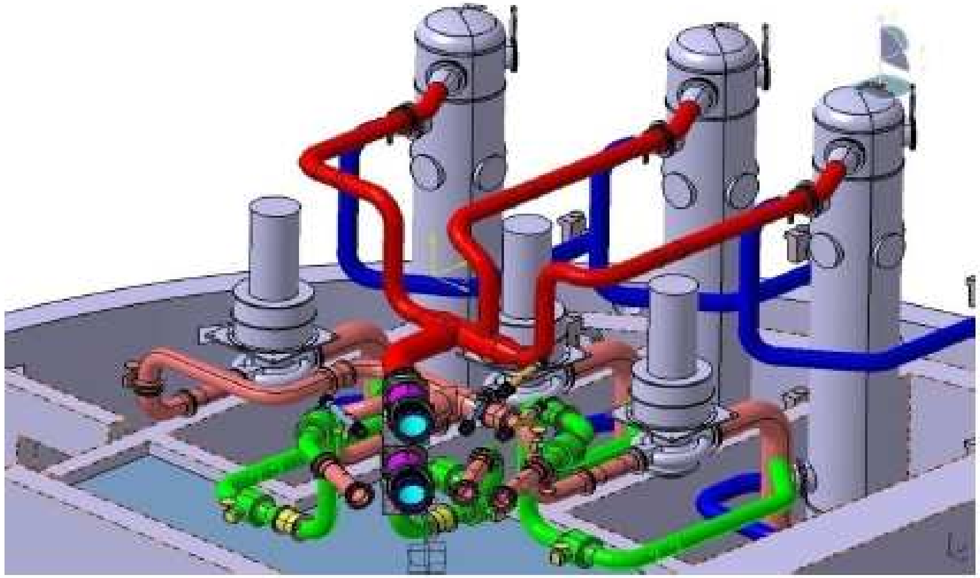
Heat EXchangers + EXperiment SIMUlator (EXSIMU)

E. González

CIEMAT, CSN,EA,ENSA,ENUSA,SOCOIN,TECNATOM

Heat Exchangers CONCEPT

Design, manufacturing and supply of Three (3) Heat Exchangers for Primary Circuit (RPP)



General view of complete RPP

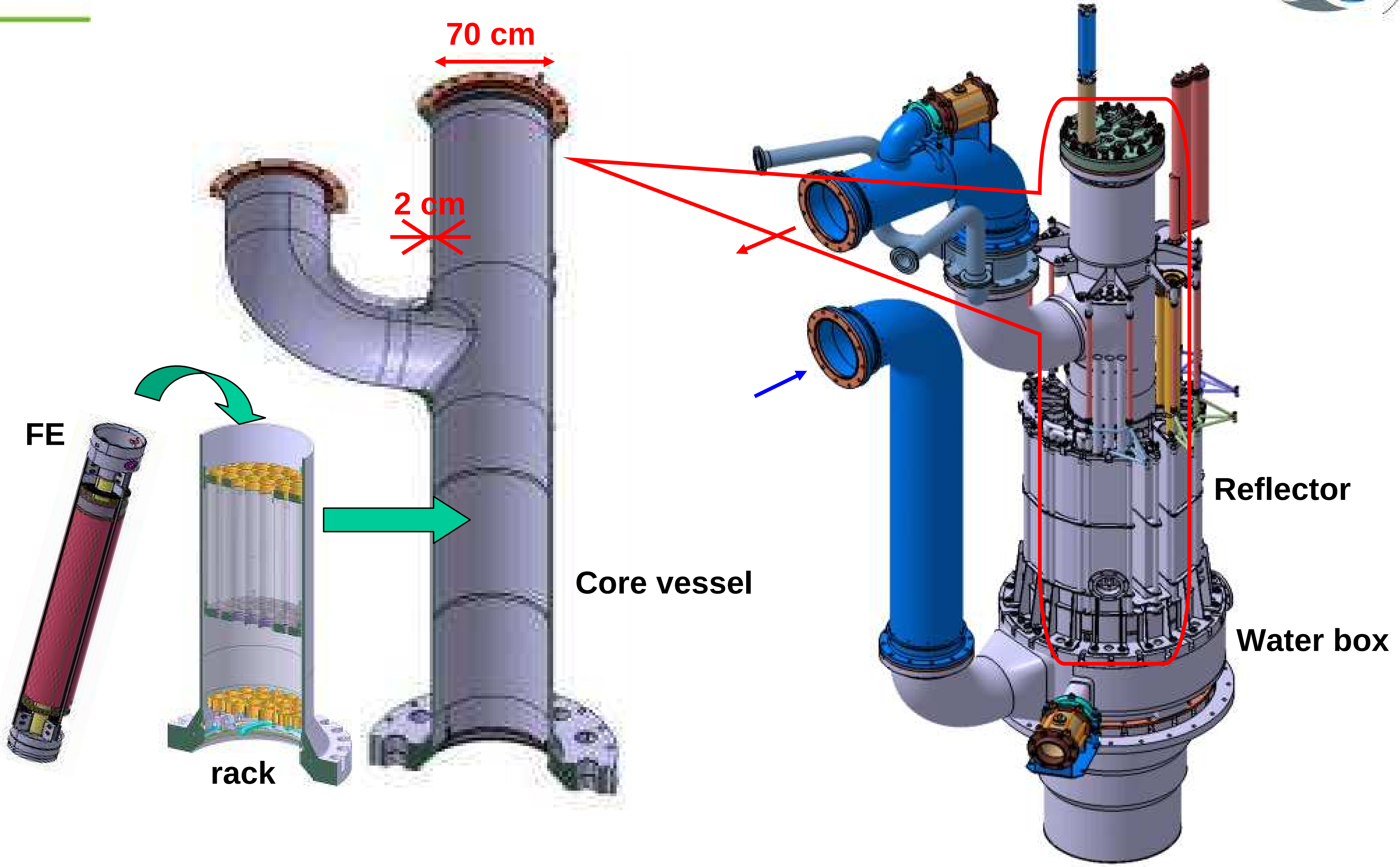
OBJETIVES:

1. To guarantee a thermal power of 110MWt (36,67 MW) under normal conditions of primary and secondary circuit

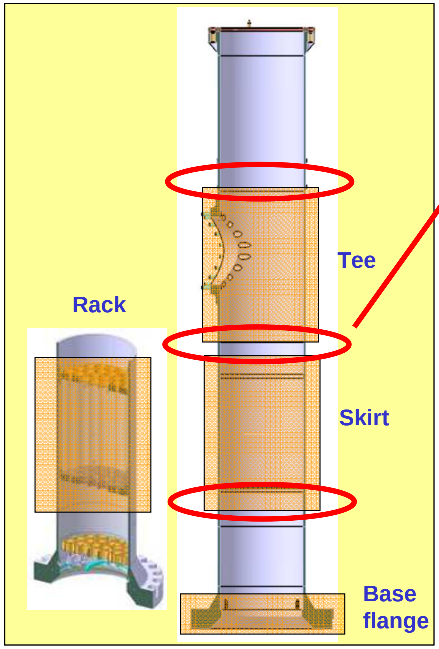
2. To act like secondary barrel of primary fluids

Some Technical highlights

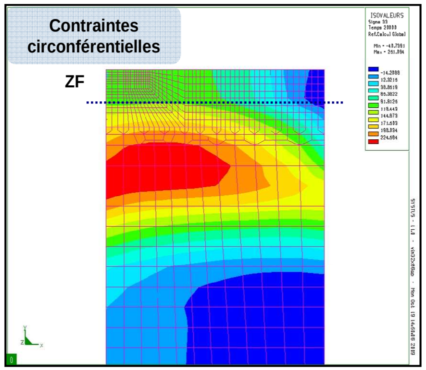
Internal structures qualification process



Qualification program
Main stages and decisions



2009 – 2010 : **Welding process qualification and optimisation** on full size skirts on demonstrator



Circumferential welding strength simulation

End 2009 :

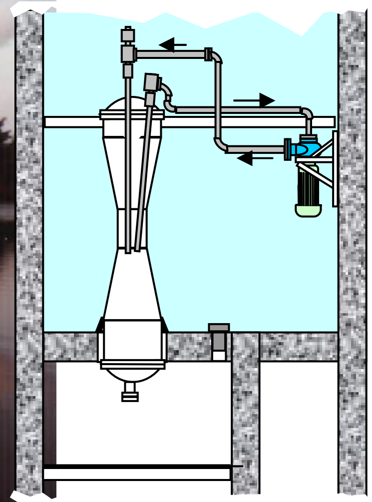
Two welding solutions capables for qualification phase

End 2010 : **Regulatory qualification** (QMOS)

JHR Fuel Qualification

The EVITA program in BR2

(see Mr Koonen presentation this conference)

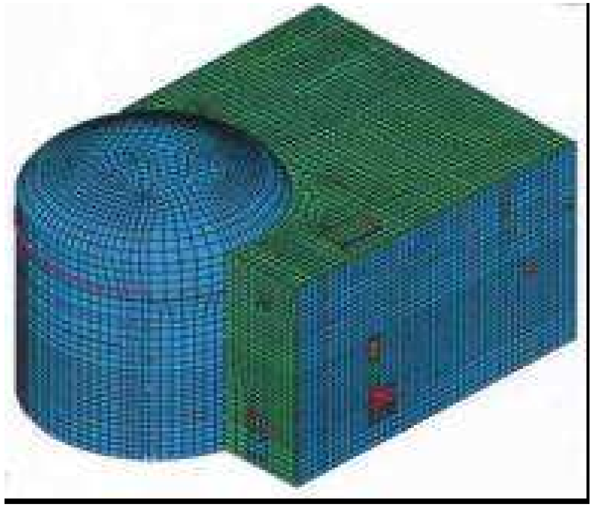


Impact on new Safety regulation on building a new MTR

(see Mr Pascal presentation this conference)

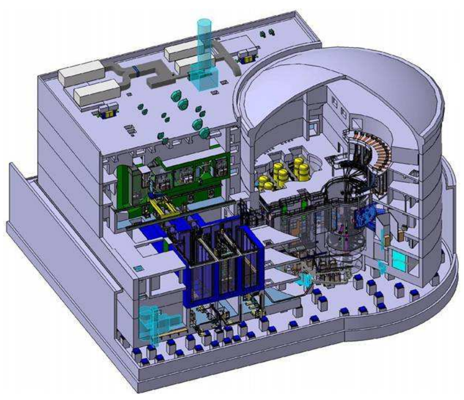
Impact on the JHR facility design

BUILDING



Confinement :

- **Partially pre-stressed containment complying with large margins with leak tightness criteria, in case of Master Severe Accident (BORAX type)**
- **Automatic isolation in case of BORAX type accident**
- **Leak off zone and dynamic confinement with double isolation of penetrations**



Installation on aseismic pads

Columns bear and aseismic pads

Sismic risk :

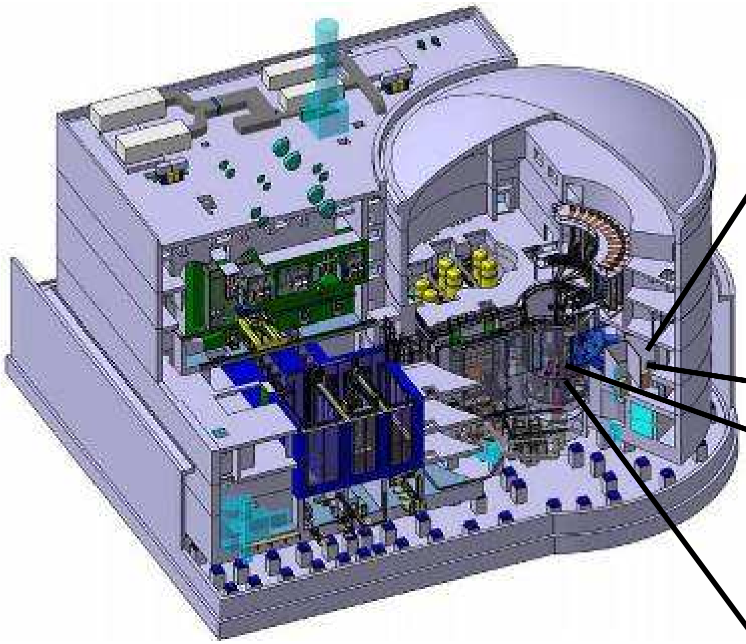
- **~200 aseismic pads and suitable rebars**
- **Distorsion limitations and easier design of the water block**

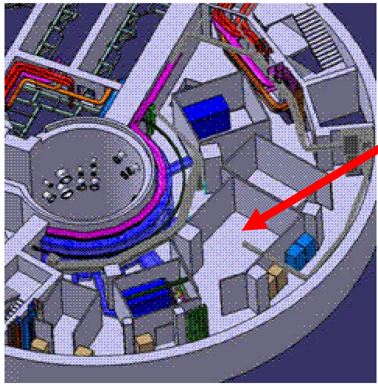
JHR Experimental Capacity

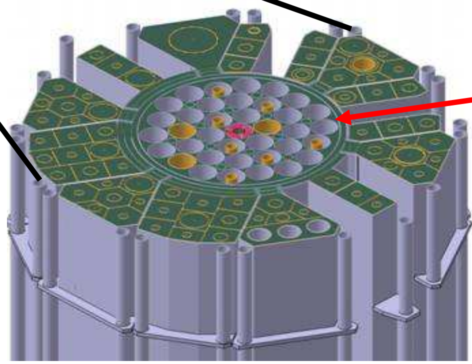
The different levels of experimental capacities

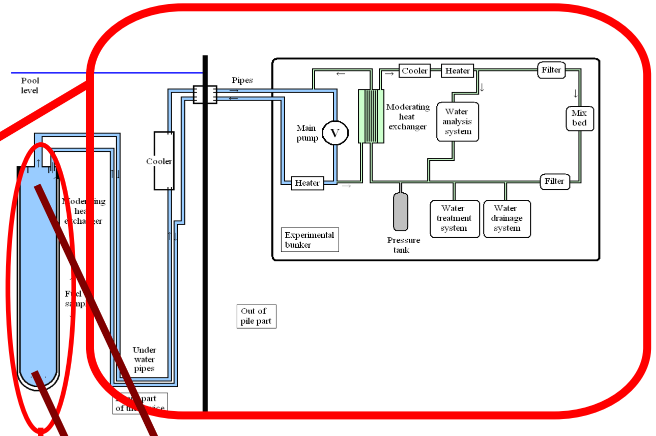
Reactor capacities

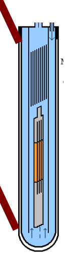
The experimental hosting system capacities
(dedicated to an experimentation family)











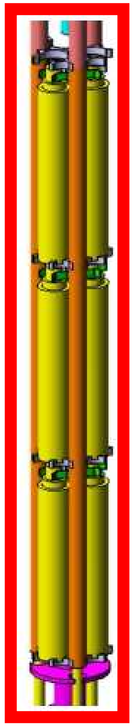
Sample holder
and instrumentation
(dedicated to an experiment)

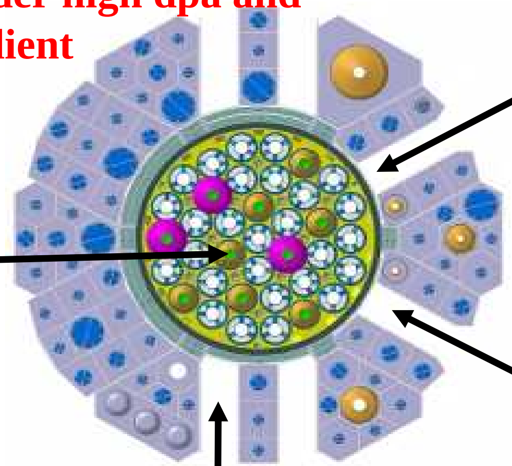
Hosting experimental systems under development

SCIENCE, MODELLING, TECHNOLOGIES TRAINING

CALIPSO & MICA *(See Mr Moulin presentation this conference)*

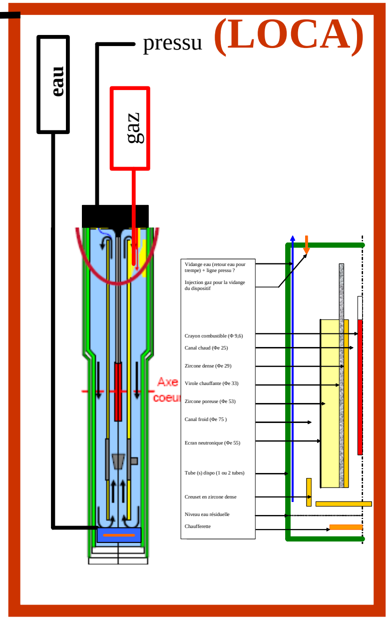
For material testing under high dpa and controlled thermal gradient

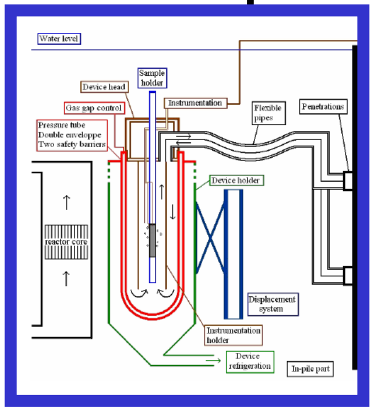


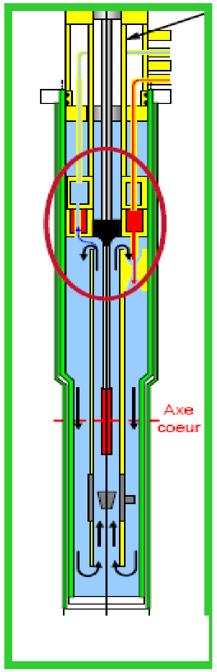


LORELEI

For fuel testing under accidental conditions (LOCA)





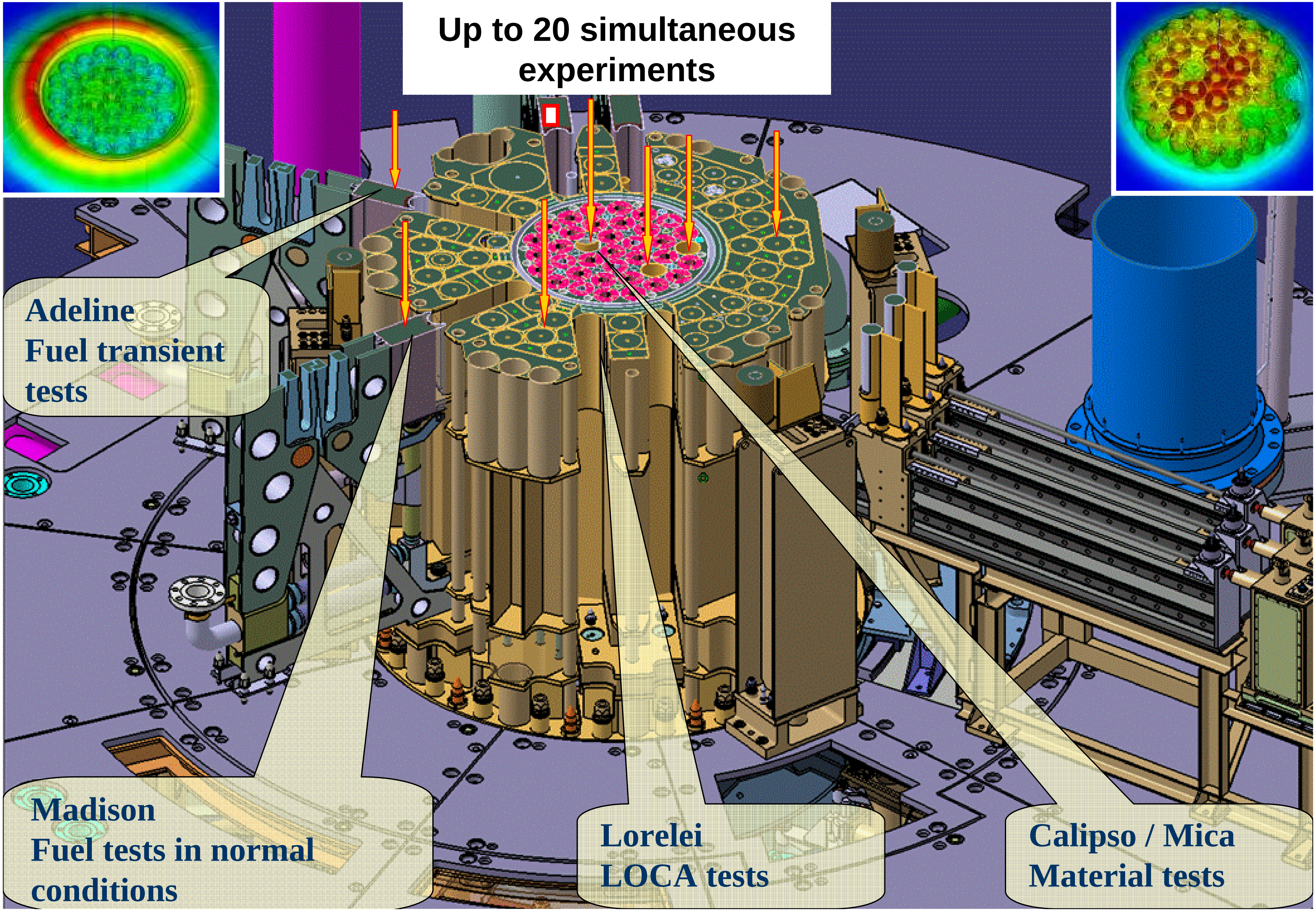


MADISON

For fuel testing under nominal conditions
(see Mr Roux presentation this conference)

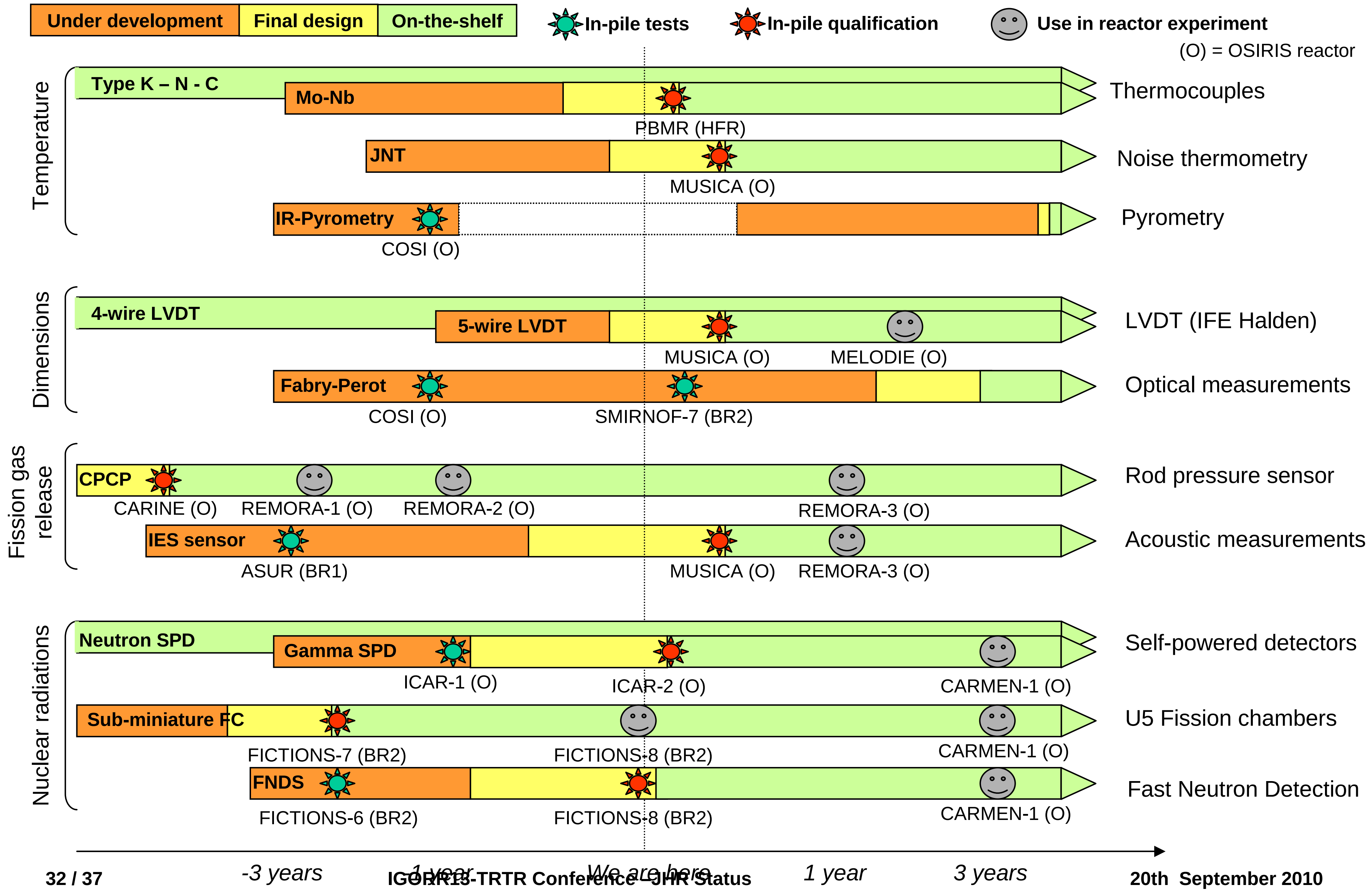
ADELINE

For fuel testing under off-normal conditions and FP online measurements



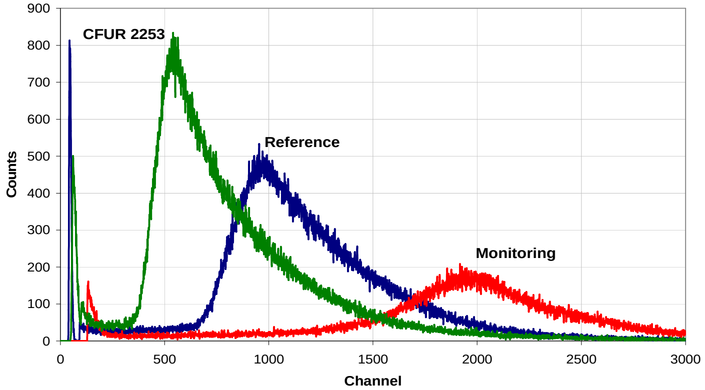
Up to 20 simultaneous experiments
Adeline
Fuel transient tests
Madison
Fuel tests in normal conditions
Lorelei
LOCA tests
Calipso / Mica
Material tests

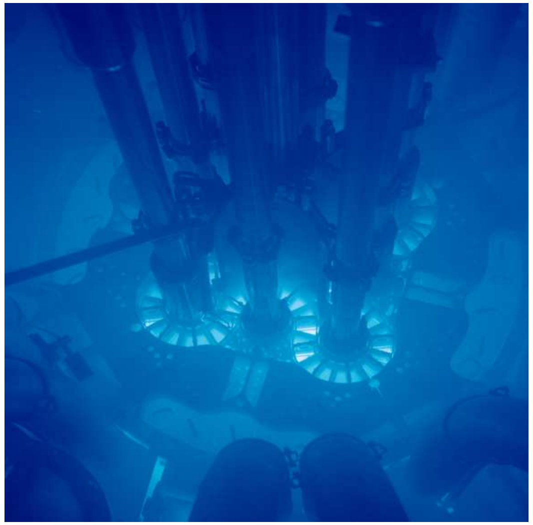
Importance of on-line measurement: the R&D program on instrumentation within an international framework



Example: MOU between INL and CEA for Cooperation in Instrumentation for Research Reactors

Phase 1 : fission chamber measurements in ATR-C (Oct. 2010)



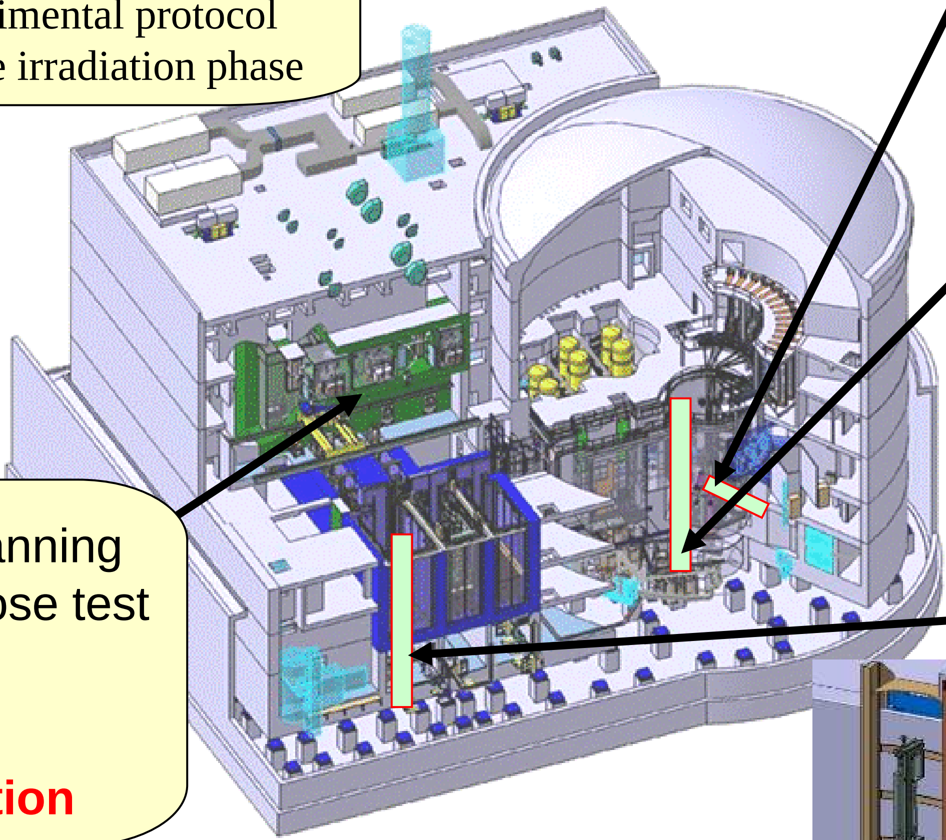


Non Destructive Examination Benches in JHR –VTT collaboration

(see Dr Parrat presentation this conference)

Objectives

Initial checks of the experimental loading
Adjustment of the experimental protocol
Final NDE tests after the irradiation phase



Gamma and XR scanning system & multipurpose test benches
in Hot cells

Sample examination

Neutron imaging stand in reactor pool

Test device examination

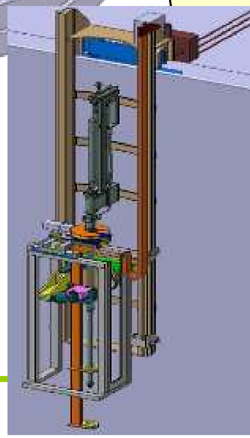
X-ray & γ stands

in reactor pool

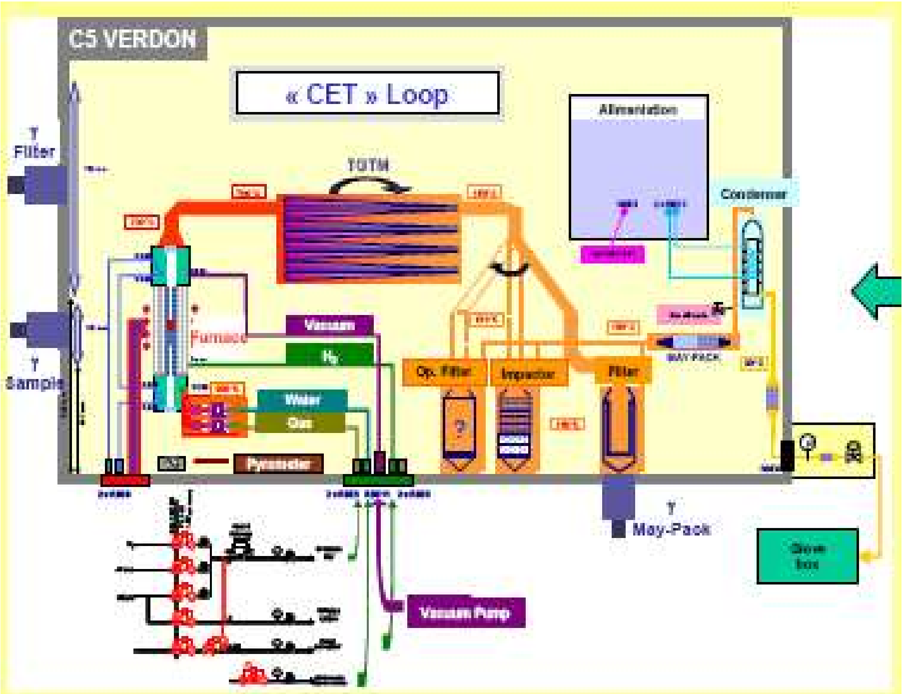
(short lived γ emitters ;

examinations during intercycles)

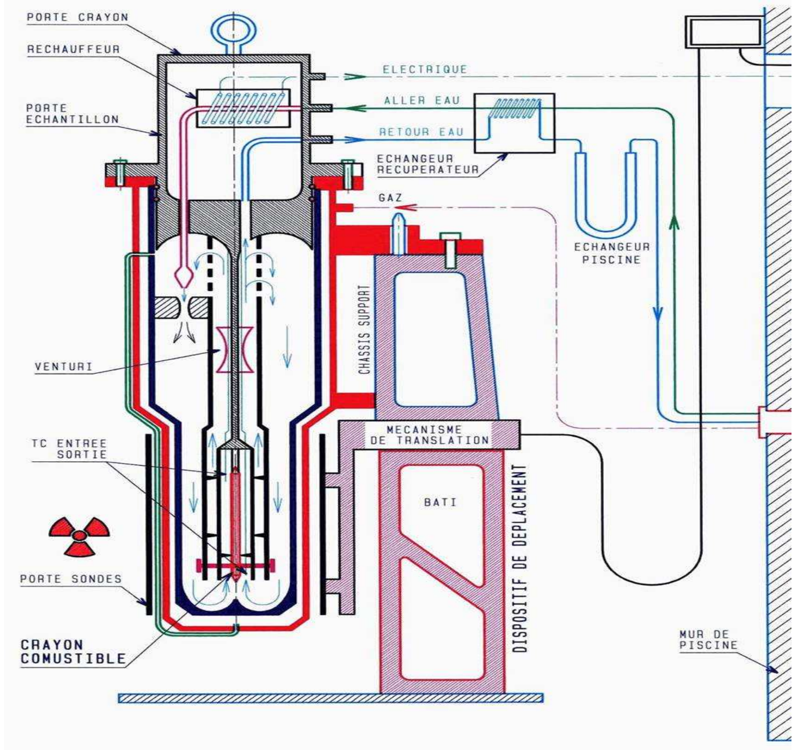
X-ray & γ stands
in storage pool



Building-up the scientific community around JHR: the Jules Horowitz International Programme (JHIP) Approach



CEA Hot-Cell Loop VERDON



CEA Ramps Test device in OSIRIS ISABELLE

Jules Horowitz International Programme (JHIP)

- Strategic Scope
  - ✓ To address fuel and materials issues of common interest that are key for operating plants and future NPP
  - ✓ Centred around an efficient utilization of JHR features
  - ✓ Operates in synergy with technical infrastructure and expertise available in member country laboratories
- Organisation: To implement the JHIP as an OECD/NEA project
- Propose a two phases project:
- Phase 1: R&D programs on CEA existing facilities (OSIRIS, LECI, LECA…) to prepare future JHR experimentations (2012-2015)
- Phase 2: R&D programs on JHR (2016-2019)

Thank you for your attention…

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