



# FISA 2019

9<sup>th</sup> European Commission Conference  
on EURATOM Research and Training  
in Safety of Reactor Systems

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Pitești, Romania



## ***SUPPORTING INFRASTRUCTURES AND RESEARCH REACTORS: STATUS, NEEDS AND INTERNATIONAL COOPERATION, IAEA ICERR (INTERNATIONAL CENTRES BASED ON RESEARCH REACTORS) AND IGORR (INTERNATIONAL GROUP ON RESEARCH REACTORS) FP7 AND H2020 JHR ACCESS RIGHTS***

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CEA - FRANCE

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# Introduction

- The panorama of Research Reactors in the world is evolving:
- Many Research Reactors are old, because built in the sixties.
  - SM3 (Ru, 1961), HFR (NL, 1961), BR2 (B, 1962), ATR (USA, 1967), MIR (Ru, 1967)
- Some have recently been shutdown.
  - Osiris (F, 2015), JMTR (Japan, 2017), Halden (Norway, 2018)
- Only very few under construction.
  - JRTR (Jordan, started 2016), JHR (F), MBIR (Ru), VTR (USA),...
- Some newcomer countries are looking for a RR or a Zero-Power Reactor
  - KSA (30 kW), Senegal, Tunisia, ...

=> **Needs for international collaborations & more coordination.**

# The Jules Horowitz Reactor - Objectives

## 1. R&D in support to nuclear Industry

- Safety and Plant life time management (ageing & new plants)
- Fuel behavior validation in incidental and accidental situation
- Assess innovations and related safety for future NPPs

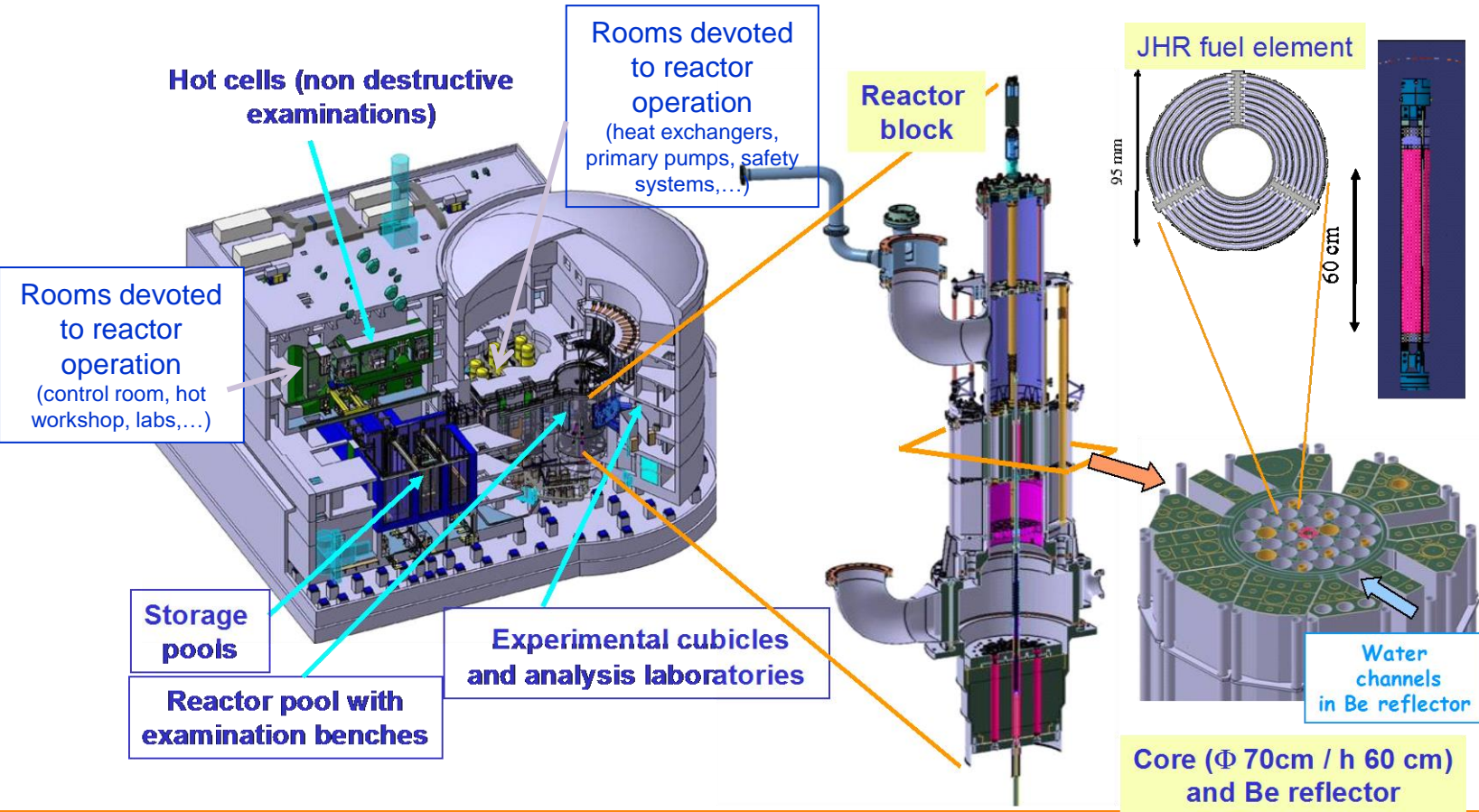
## 2. Radio-isotopes supply for medical application

- $^{99}\text{Mo}$  production : JHR will supply 25% of the European demand (today about 8 millions protocols/year) - Up to 50% upon specific request

## 3. A key tool to support expertise

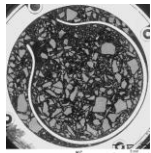
- Training new generations (JHR simulator, secondees program)
- Maintaining a national expertise staff and credibility for public acceptance
- Assessing safety requirements evolution and international regulation harmonization

# The Jules Horowitz Reactor – A 100 MWth pool-type MTR



# The Jules Horowitz Reactor - Main experimental devices - Fuel

## LORELEI fuel testing under accidental conditions (LOCA)

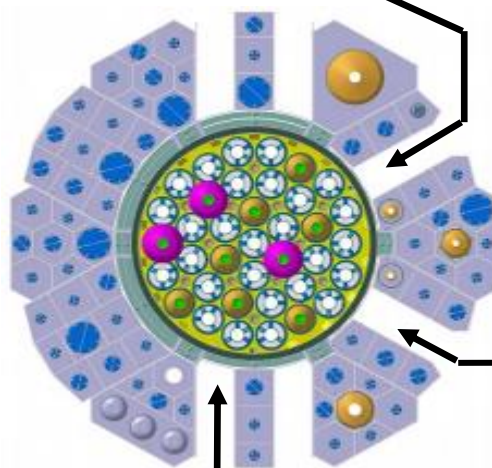
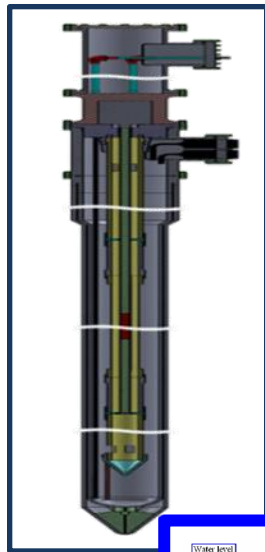


• Source Term (FP releases)

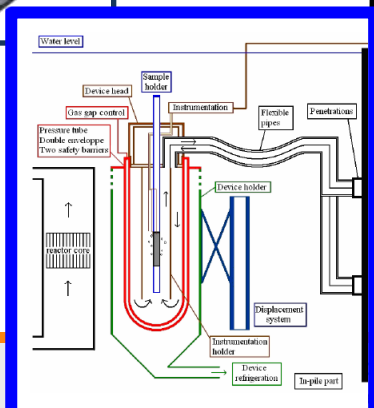
• Rod thermal-mechanical behaviour

- Ballooning and clad burst (fuel relocation)
- Corrosion at high T
- Quenching

IAEC In-Kind



**MADISON** Fuel testing under nominal conditions

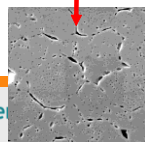
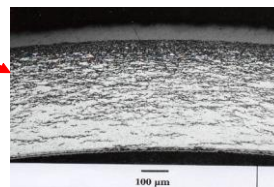
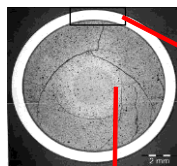
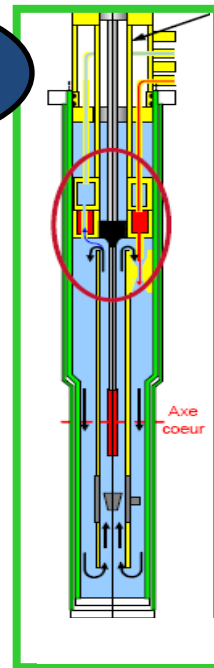


**ADELINÉ**  
For fuel testing under off-normal conditions

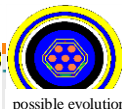


Power transient, post clad failure fuel behavior, Lift-off experiment...

EDF Support



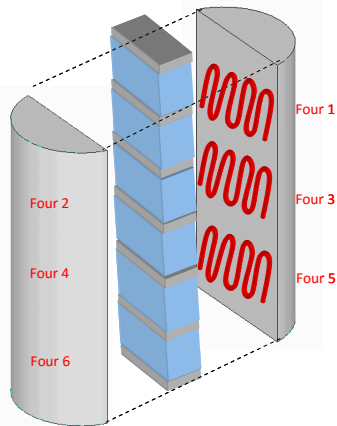
CEA Support





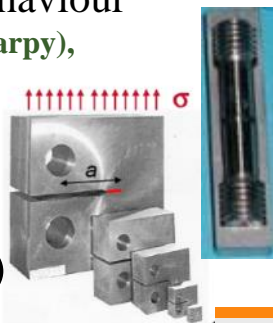
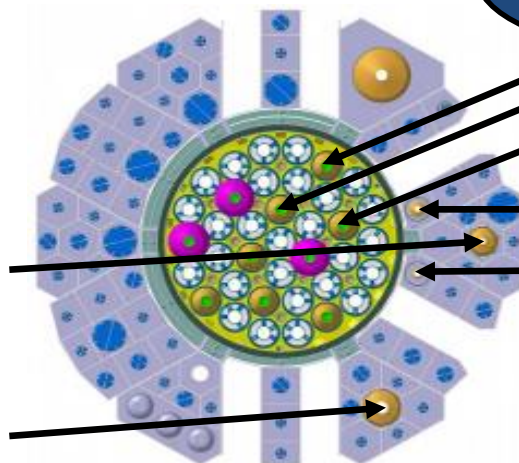
# The Jules Horowitz Reactor - Main experimental devices - Materials

## OCCITANE: Pressure vessel steel testing

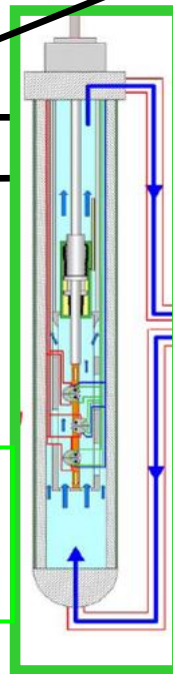


- Irradiated material behaviour
- Tensile tests, resilience test (Charpy), crack propagation tests .....
- Behaviour of Thermal affected zones

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Support



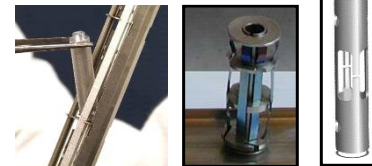
CEA  
Support



CLOE: Corrosion loop for “Zr alloy Corrosion” and “Irradiation Assisted Stress Corrosion Cracking”

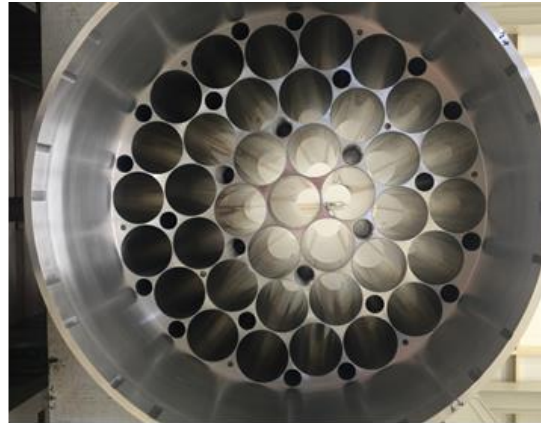
MICA: Material testing under high dpa & accurate temperature control (+ mechanical loading)

Specimen for microstructure evolution, tensile test, for 1 or 2D creep tests, for bending tests (stress-relieving experiments), ...



DAE  
In-Kind

# The Jules Horowitz Reactor – Construction in Progress





# The Jules Horowitz Reactor - Consortium

- JHR consortium gathers organizations (research centres and industrial companies) which take part financially and get permanent access to JHR experimental capacities

framatome



IAEC

Studsvik

AREVA



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DE LA RECHERCHE & L'INDUSTRIE  
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**VTT**

**edf**

**TA**  
TechnicAtome



भाभा परमाणु अनुसंधान केंद्र  
BHABHA ATOMIC RESEARCH CENTRE

NATIONAL NUCLEAR  
LABORATORY

- In some cases, the member of JHR consortium is itself the representative of a national domestic consortium.

# Preparing the experimental programmes

- Several actions to gather a scientific community around JHR and to prepare the first experimental programmes once JHR in operation:
- The Consortium established 3 Working Groups:
  - For fuel irradiations,
  - For material irradiations
  - For technology issues linked to exper. devices.
- A yearly JHR scientific & technical seminar:
- In April 2019, a first JHR school was added.
- Secondments of foreign engineers.
- Other actions are described later.
- This list is not exhaustive.



# European Support to JHR: FP7 and H2020 access rights

## The European Commission has been supportive of JHR access from the beginning:

- Since 2009: several contracts with JRC & DG-RTD, through JHR-Collaborative Project (2009 – 2010) and using FP7 & H2020 frameworks.
- By mid-2018, the **EC has secured 5.15 % of guaranteed access to irradiation capacity.**
- It makes the EC the larger foreign contributor to the JHR.

## Three new actions:

- New H2020 Euratom funding **to increase its access rights up to 6 %** (Euratom call OA6)
- An interest of JRC to develop together an experimental test loop that would fit current and future requirements for material and/or fuel tests in the JHR, to be confirmed within the 2021-2025 Euratom financial allocation,
- A Coordinated Support Action to build a roadmap for the use of Euratom Access Rights for the benefit of EC Member States to access JHR Experimental capacity.

## The CEA is very thankful to the European Commission for its continuing support.

# The ICERR initiative, created by IAEA

## IAEA Objectives

- *Create international scientific networks*
- *Make available CEA (or other ICERR) facilities and experience to affiliates*
- *Lead innovative joint programs with shared results*
- *Enhance utilization of Research Reactors*
- *Host international scientists / engineers (visiting scientists, operators...)*
- *Provide “hands on” nuclear education in the field*

=> CEA (JHR and ancillary facilities) labelled in Sept. 2015.

## Results

- **7 affiliate agreements signed by CEA :** Slovenia (JSI), Morocco (CNESTEN), Tunisia (CNSTN), Indonesia (BATAN), Algeria (COMENA), Jordan (JAEC), United Arab Emirates (FANR)
- **Implementation in progress** (secondments, safety expertise, core computations, measures in research reactors, various exchanges, ...)

# The OECD/NEA initiative: the P2M joint project proposal

- The nuclear community extensively used the Halden reactor for experimental programmes, under OECD/NEA aegis. But it was shutdown last year.
- Networking several infrastructures (MTRs and hot cells) on a same program, is a good approach to maintain skilled teams.
- A “core group” with SCK•CEN, CEA and EDF proposed to OECD/NEA the P2M R&D program, currently the first and most developed proposal.
- It aims at quantifying mechanisms in a LWR fuel rod during a power transient, with a focus on power levels initiating a central melting of the fissile material.
- Task 1 includes 2 tests fall 2020 & fall 2021 in BR2, to obtain a predetermined molten volume fraction at the hottest part of the experimental rod.
- PIE will be performed at LHMA (SCK•CEN) and LECA-STAR (CEA Cadarache).
- Task 1 is expected to be completed by mid-2023.



# IGORR

- IGORR: International Group on Research Reactors.
- Since 3 decades, **a unique forum for exchanges of information between Operators of Research Reactors** sharing experience and expertise then enhancing the general human capacity building.
- The JHR project is regularly presented in detail at IGORR conferences which are gathering the research reactor community worldwide.
- IGORR-18 in Jordan (March 2019).



- ***IGORR-19 to be hosted in Dimitrovgrad, Russia – Sept. 2020.***

# Conclusions

- Research Reactors are key tools for E&T and for “hands-on training”.
- 80 % of the fleet are small RR, mainly used for E&T.
- In a world of ageing research reactors, the future would be limited to a few new facilities open to international programmes, like JHR.
- As JHR construction is progressing, it is of vital importance to start with the best test devices and the most adapted to the customers’ needs.
- CEA designed JHR from the start as an international user’s facility.
- Members of JHR Consortium = many European countries + India + Israel.
- **Thanks to important and continuing support of the European Commission, through FP7 and H2020, the JHR will offer access to European countries particularly for research training.**
- Other international initiatives are also well adapted to these collaborations: i.e. IAEA ICERR label, P2M project of the OECD/NEA and IGORR forum.