SNETP
Sustainable Nuclear Energy Technology Platform

Czech research infrastructure for supporting the implementation of the SNETP strategic research agenda

MAREK MIKLOŠ

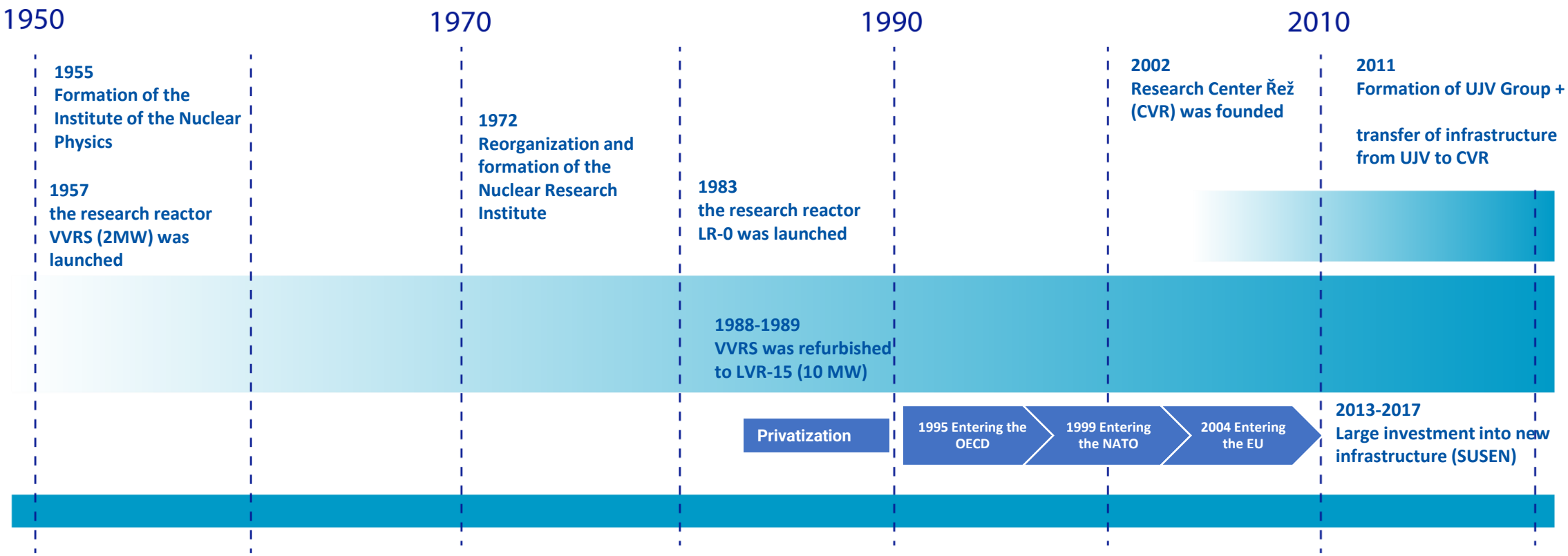
Research centre REZ, ltd. (CVR)

Content

- Research centre Rez (CVR)
- Large Research Infrastructure operated by CVR
- Current R&D topics supporting SNETP Strategic R&I Agenda

Research centre Rez (CVR)

History of CVR



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CVR is a member of UJV Group

Nuclear Research Institute (ÚJV Řež, a. s.) provides a wide range of services such as safety analyses, calculationsof reactor core landfills, design of conventional and nuclear power engineering, production and delivery of radiopharmaceuticals, reactor surveillance programs, disposal of radioactive waste and many others.

The mission of the company Research Centre Řež is research, development, and innovation in the field of energy, especially nuclear energy. The research infrastructure SUSEN (Sustainable Energy), two research reactors and a set of experimental equipment (rigs and loops) form the backbone of the research infrastructure of the company.

Research and Testing Institute Plzeň deals mainly with research, development and sophisticated diagnostics of power plants. It provides a range of services for manufacturing companies in the metallurgical, energy and transport industries as well as for operators of power plants

ŠKODA PRAHA is an EPC contractor of power plants on turnkey basis. Over many years ŠKODA PRAHA has built excellent experience with the construction of power plants that are proven by extensive list of international reference projects.

Research centre Rez

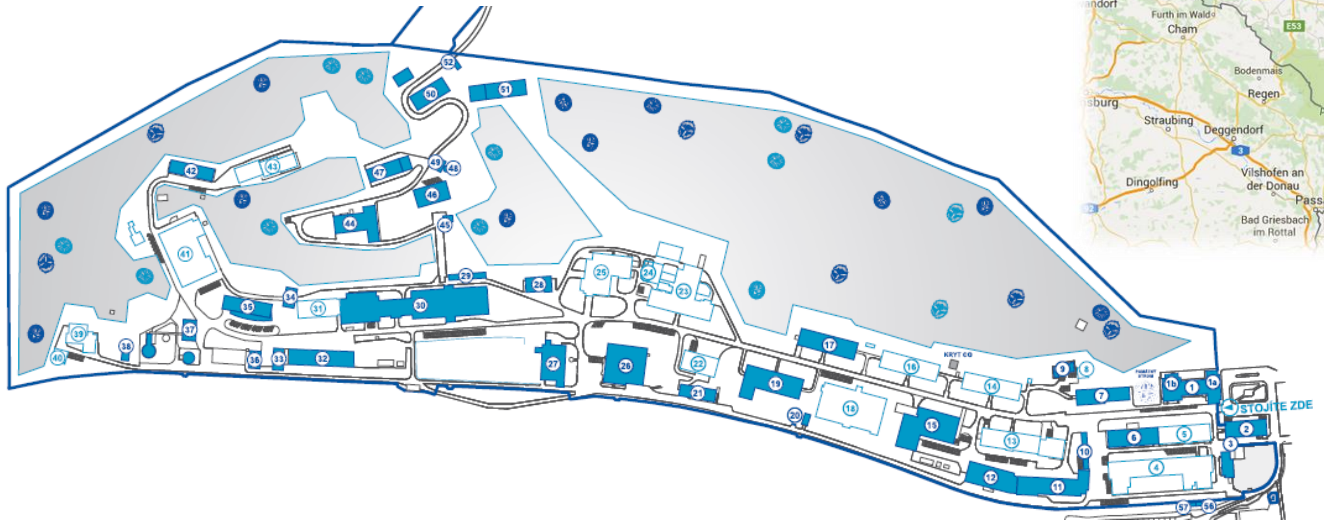
- R&D organization focusing on development of technologies and technical support for power generation industry
- Since 2002/1955
- 370 employees

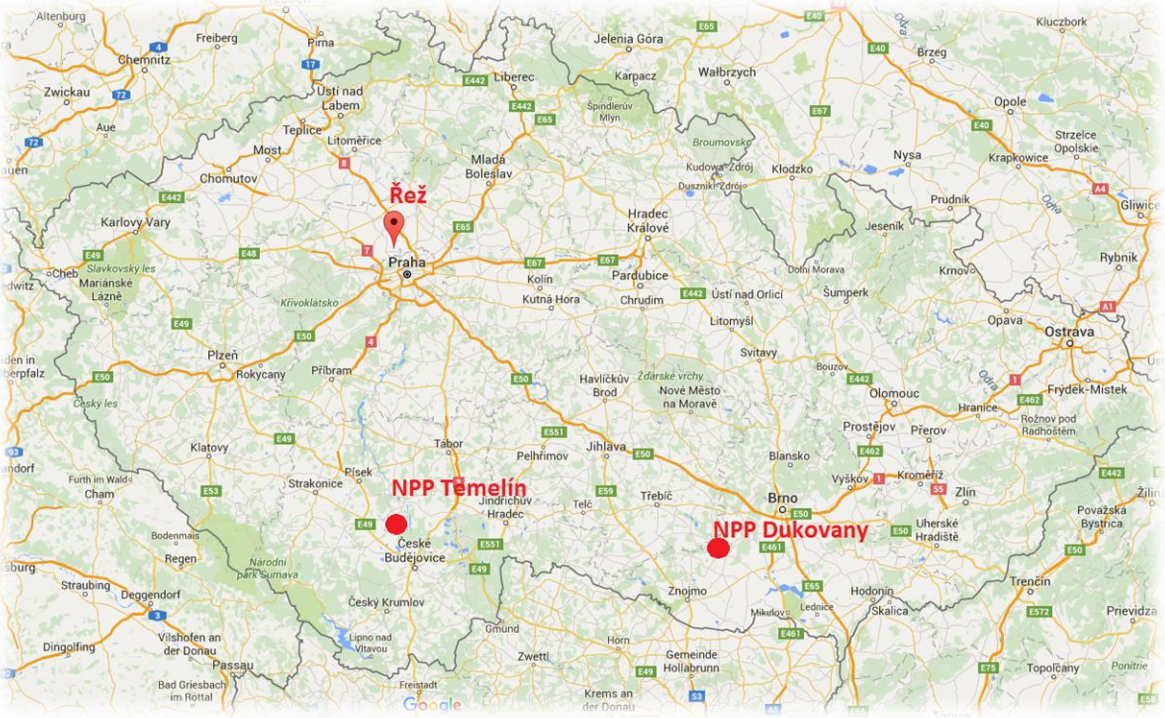
Research centre Rez

Headquarter in Husinec-Rez

- Area 1200 x 270 m

Facilities in Pilsen and Brno





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CVRs main activities

- Support for the operation of current nuclear units
  - Long Term Operation
  - Development, qualification and implementation of new NDT methods and robotic manipulators
  - Evaluation of condition and qualification of components
  - Waste management (spent fuel management, radioactive waste treatment, deep geological repository)

- Research and development in the field of GEN IV and small modular reactors
  - Basic and advanced materials research
  - Microstructural and microchemical analyzes
  - Advanced chemical and analytical methods
  - 2 SMR designs within UJV Group

- Reactor irradiation services
- Design, construction, manufacture
  - Irradiation rigs, testing devices
  - Hot cells (CVR, JHR)
- Hydrogen and fusion technologies
- Modern technologies for energy storage
- Publishing activities in the field of nuclear energy
- Training and education

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CVR international role

Engagement in international projects, associations and consortia is bringing to the company important links to knowledge platforms.

Technology Platform "Sustainable Energy for the Czech Republic"

European Energy Research Alliance

NUclear GENeration II & III Association

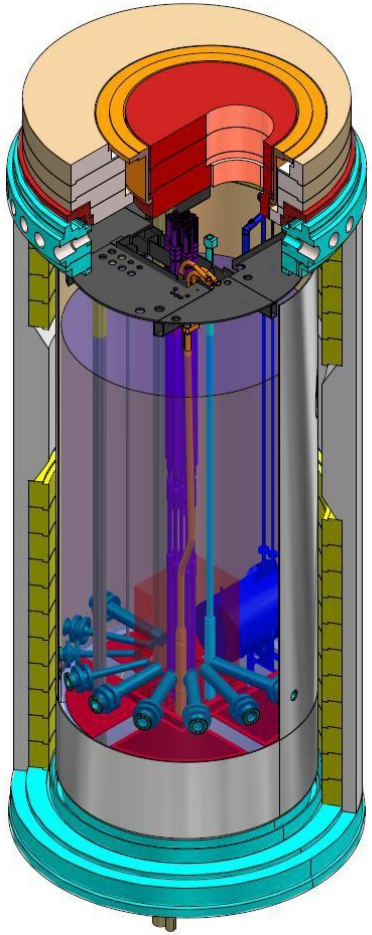
The European Fusion Education Network

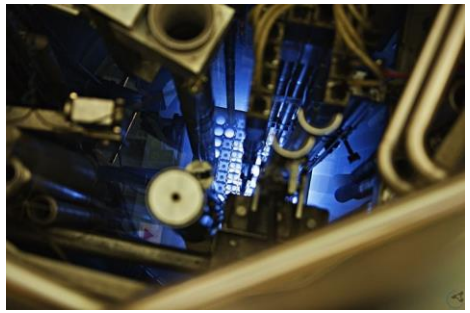
Jules Horowitz Reactor consortium

Large Research Infrastructure

Research reactor LVR-15

Reactor type	**tank**
Pressure	**atmospheric**
Average temperature	**45°C**
Coolant	**demineralized water**
Reflector	**beryllium**
Nominal power	**9.7 (max. 10) MWt**
Thermal flux	**max. 2.5 x 10^{14} n/cm^{2}s**
Fast flux	**max 2.5 x 10^{14} n/cm^{2}s**





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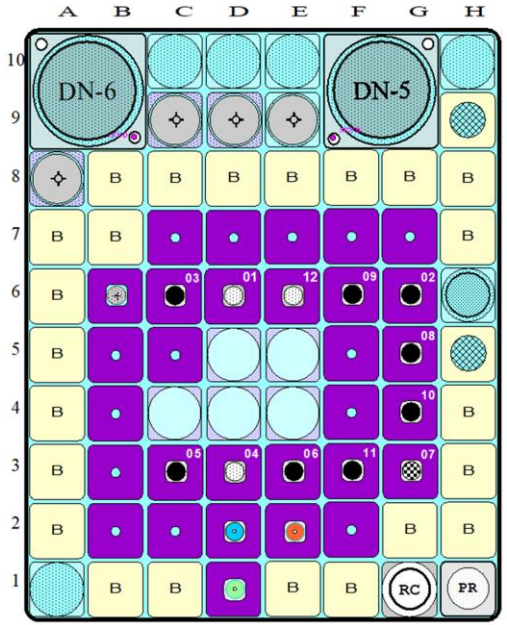
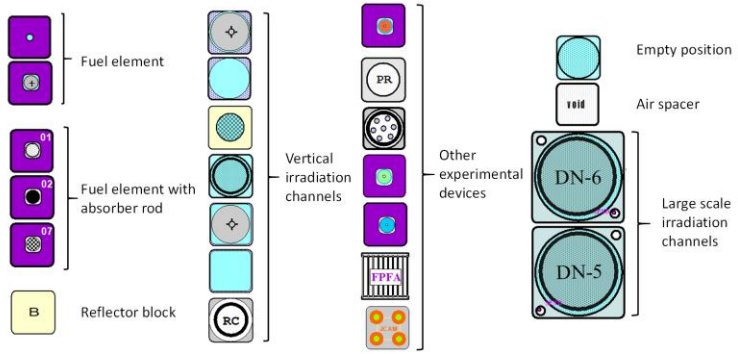
LVR-15 utilization

- Material research, *no fuel irradiation*
  - Irradiation rigs: standardized, special purpose rigs
  - Past experience with in-pile water loops: BWR, PWR
  - Currently in operation out-of-pile loops: SCWL, HTHL (prepared for future in-pile operation)
- Isotope production (medical, industrial)
- Neutron Transmutation Doping
  - Rotating probes for Si ingots
- Neutron beams
- 9 Horizontal channels
  - Basic neutronic studies





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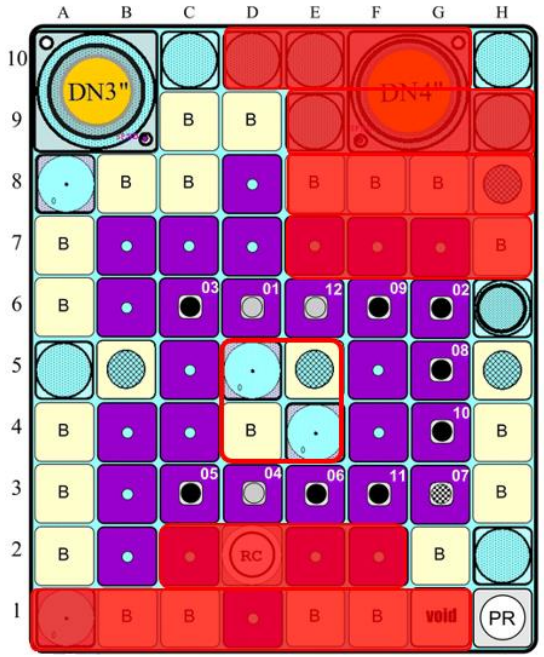
LVR-15 irradiation rigs



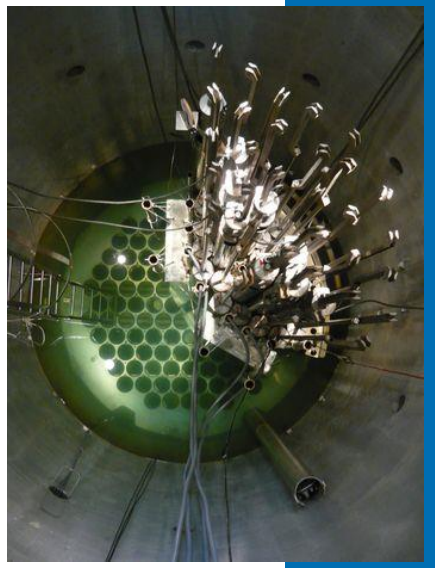
- CHOUCA type rig
  - standardized
  - inert gas, electrical heaters
  - Unique sample holder for each irradiation
- Single purpose rigs
  - not standardized
  - Inert gas, liquid metal
- Gen IV. and fusion applications
  - High dpa rigs (cladding, guide tubes, …)
  - Inert gas, temperature controlled by gas gap and gas mixture
  - Placed in the fuel assembly of LVR-15
- Low fluence rigs (concrete, aggregates)
  - Inert gas, temperature controlled by gas gap and gas mixture
  - Placed at the edge or out-of-core

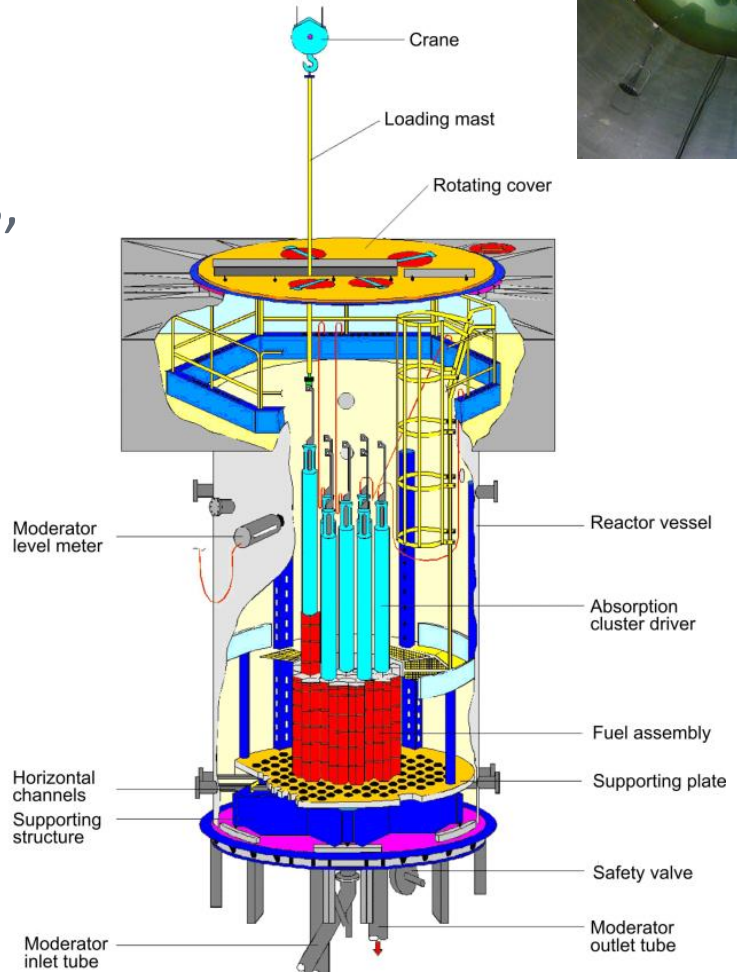
Hot and semi-hot laboratories

- Basic PIE
  - Visual inspections, geometry measurement
  - 3D activity measurement of income specimen
  - Water and helium pycnometry
- Mechanical testing
  - Creep (thermal, combination creep-fatigue)
  - Tensile (Tensile tests, fracture toughness test, low cycle fatigue, combined load), T up to 1,200°C
  - Pulsator (High cycle fatigue), T up to 800°C
  - Autoclave (SSRT), T up to 350°C
- Microstructural analyses
  - HR-STEM equipped with tensile and heating holder up to 1,000°C
  - LOM, MHV, SEM with EDS, WDS a EBSD
  - Nanoindenter with nano scratch tester
  - Secondary Ion Mass Spectroscopy (SIMS) for isotopic analysis
    - *Not in hot cell*

Research reactor LR0

- The light water zero power reactor
- Flexible reactor with flexible core arrangements
- For determination of neutron-physical characteristics of various types of reactor lattices, kinetics experiments
- Reactor chambers and other I&C equipment testing
- Experiments with various insertion zone types
  - Graphite
  - Fluorine salts
- Experimental verification of criticality and subcriticality in relation to zone parameters
- Verification of computation codes





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Experimental loops: out-of-pile

- SCWR loop – water of supercritical parameters
  - 550 °C, 25 MPa
- HTHL loops – high-temperature helium
  - S-Allegro loop: to support development of ALLEGRO or other GFR concepts
  - up to 850 °C, 7 Mpa, 0,5 kg/s
- sCO_2 loop – supercritical carbon dioxide
  - heat transfer through sCO_2
- Metal liquid loops
  - Pb, PbBi, PbLi
- FLiBe loop – LiF-BeF_2 and nickel-based alloy
  - < 760°C
- CSP loop – Concentrated Solar Power

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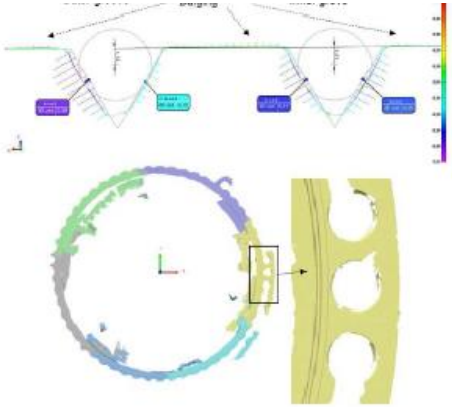
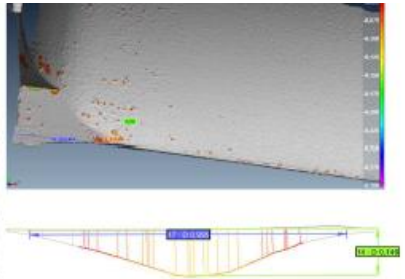
Non-destructive laboratory

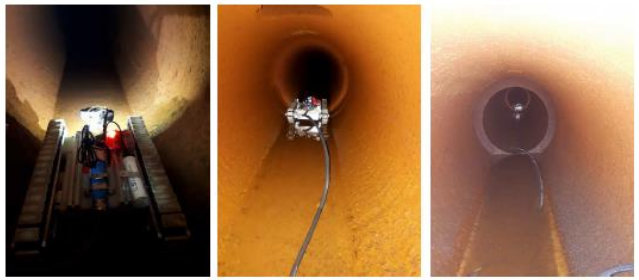
ENIQ
European Network for Inspection & Qualification
NUGENIA Technical Area 8

- Development of new NDT with use of current NDT techniques, their qualifications and applications at power plants (*implementation in LTO programs*)
  - Fabrication of test specimens
- Development of manipulators





- References
  - Measurement of corrosion pits on steam turbine blades
  - Measurement of hydroelectric power plant rotors
  - 3D profilometry of RPV VVER 1000
  - Wet storage of research reactor LVR-15
  - Eddy current testing of turbine blades at Temelín NPP
  - Measurement of creep damage on steam pipelines
  - Visual inspection of buried pipeline



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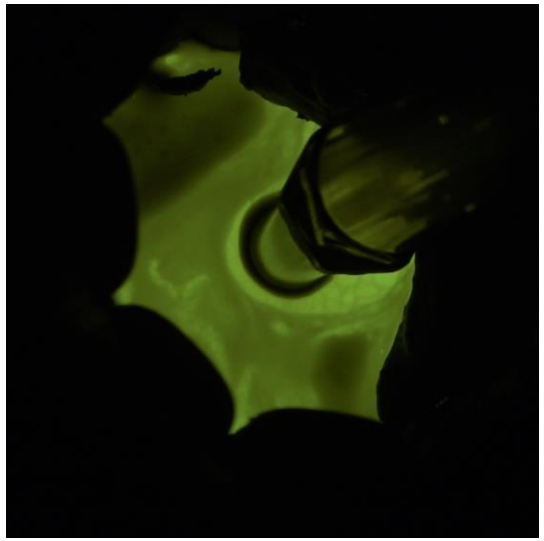
Cold crucible laboratory

- Technology for high-frequency induction heating
- For thermal treatment of materials which are very difficult to treat by standard procedures
- Used for melting different materials, primary to study behavior of corium during severe accidents



- Liquidus/Solidus temperature measurement
- Thermal conductivity
- Viscosity
- MCCI studies
  - Concrete
  - RPV steels

Main R&D topics supporting SNETP Strategy Research and Innovation Agenda

Current R&D in CVR supporting Gen II – Gen III nuclear reactors

- Long Term Operation
  - Structural and System Diagnostics – NDT method, fuel inspections at NPP, manipulators development and application, root cause analyses, water chemistry update
  - Radiation degradation studies of concrete structures
  - MCCI experiments for verification of safety analyses

- Advanced materials
  - Accident Tolerant Fuel studies
    - INCA within FIDES
    - Different type of irradiation for creep and growth studies
    - Fretting wear studies on irradiated specimens under PWR conditions

INCA
In-pile Creep Studies of ATF claddings

FIDES

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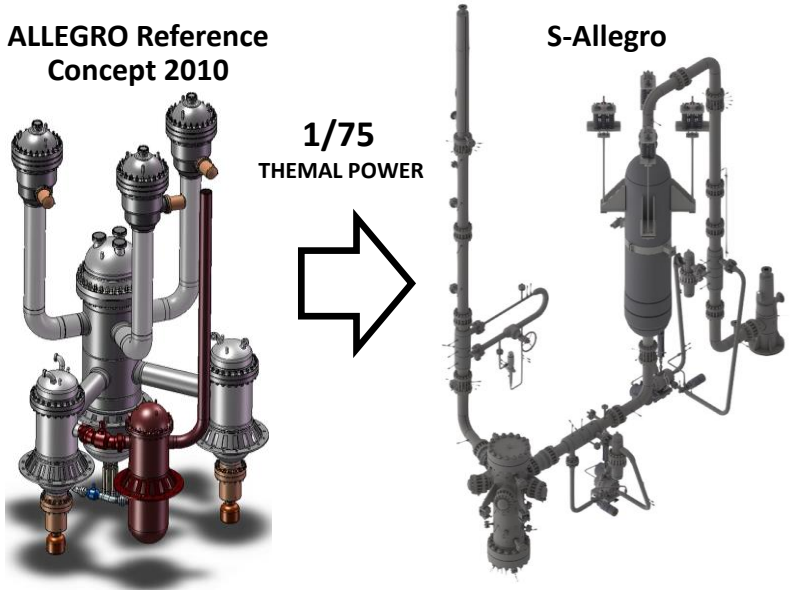
Current R&D in CVR supporting Gen IV nuclear reactors

- Material studies under Pb or Pb-Bi environment
  - Corrosion + material embrittlement studies
  - Mechanical testing under Pb environment
  - Oxygen control + impurities removal
  - Possibility for irradiation in special rig

- Studies under high-temperature-helium environment
  - Support of Allegro and HeFasto (SMR by UJV)
  - In-pile HTHL loop under safety review



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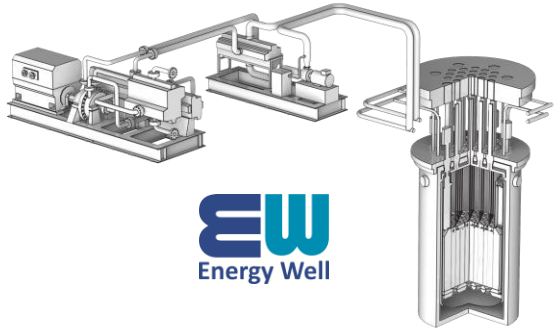
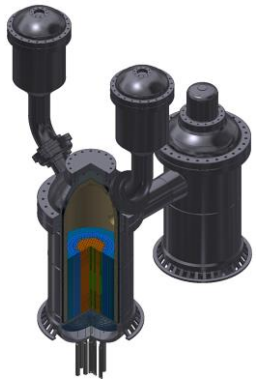
Current R&D towards SMRs

- Material studies under different environment
  - Neutron irradiation, Pb, LiF-BeF_2, HTGR, SCWR
- Energy Well
  - Based on TRISO fuel and cooled by fluoride salt
  - 20 MWt for 7 years
  - For remote areas or areas with poor infrastructure
- HeFasto
  - Based on GFR technology
  - 200 MWt, with output temperature 900°C
  - H_2 production or industrial heat





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