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Experimental Research Reactor LVR-15

Present status and programs

Jan KYSELA, Jakub PRAHL

12th IGORR, Beijing, P.R.China

28th-31st Oct 2009

Research Centre Rez

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Located in the Czech Republic, near Prague

daughter company of NRI Rez, oriented exclusively on R&D

Participates in R&D programs and international projects like JHR and ADRIANA
Will apply for a support from EU structural funds (Sustainable Energy Project)

Main Research Facilities in Rez

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Research Reactor LVR-15

- commissioned in 1957
- twice reconstructed (last in 1989) – exchange of all components
- licensed till 2018 (re-licensing till 2028)

Research Reactor LR-0 (ZERO POWER REACTOR)

- critical assembly for basic research in neutron physics

Both reactors financed from contracts or research projects (no institutional support from government)

Hot and semi-hot laboratories – designed for PIE

Experimental loops – new SCWL and HTHL

Others (R&D facilities for processing or storage RA waste, monitoring of concentrations, production of radiopharmacs for pharmaceutical, etc.)

Zero-power experimental Reactor LR-0

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- **Suitable for measurements of neutron-physical characteristics of nuclear reactors, suitable for physical experiments in a wide range of fuel assemblies number, fuel enrichment, different H_3BO_3 concentration in moderator, varied arrangement of absorbing elements in assemblies.**
- **Fuel: shortened fuel assemblies of VVER-1000 and VVER-440 type with enrichment of (1.6 ÷ 4.4) % 235U**
- **fuel rod: UO2 pellets - 7.53 mm, active length 125 cm; total length 137.5 cm, cladding 9.15 x 0.72 mm (Zr+1% Nb)**
- **Reactor vessel: 3.5 m, height 6.5 m, aluminium**
- **Maximum thermal neutron flux: 10^{13} $n.m^{-2}.s^{-1}$**

Research Reactor LVR-15

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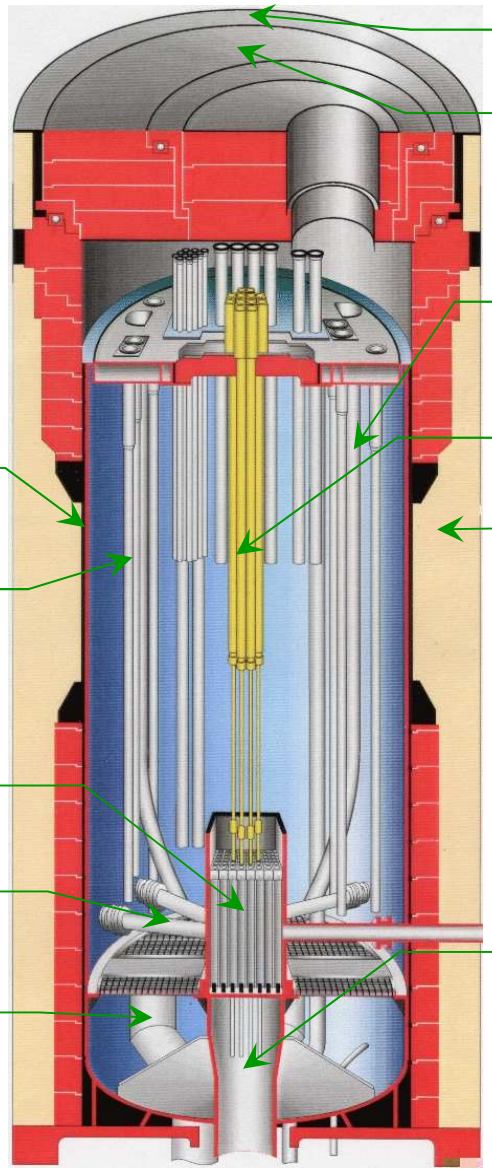
Longitudinal cross section



Research Reactor LVR-15

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Main parameters:

Reactor type: tank
Fuel: IRT-2M Russian provenience NZCHK (36%),
Nominal power: 10 MW_{th}

Thermal flux: 1.5 x 10^{18} n/m^2s
Fast flux: 3.0 x 10^{18} n/m^2s
at the end of beam tube: 1.0 x 10^{13} n/m^2s
irradiation channel in fuel: 1.2 x 10^{18} n/m^2s
irradiation channel in reflector: 9 x 10^{17} n/m^2s

After using new type of fuel (IRT-3M), nominal power up to 15 MW_{th}

Core of Research Reactor LVR-15

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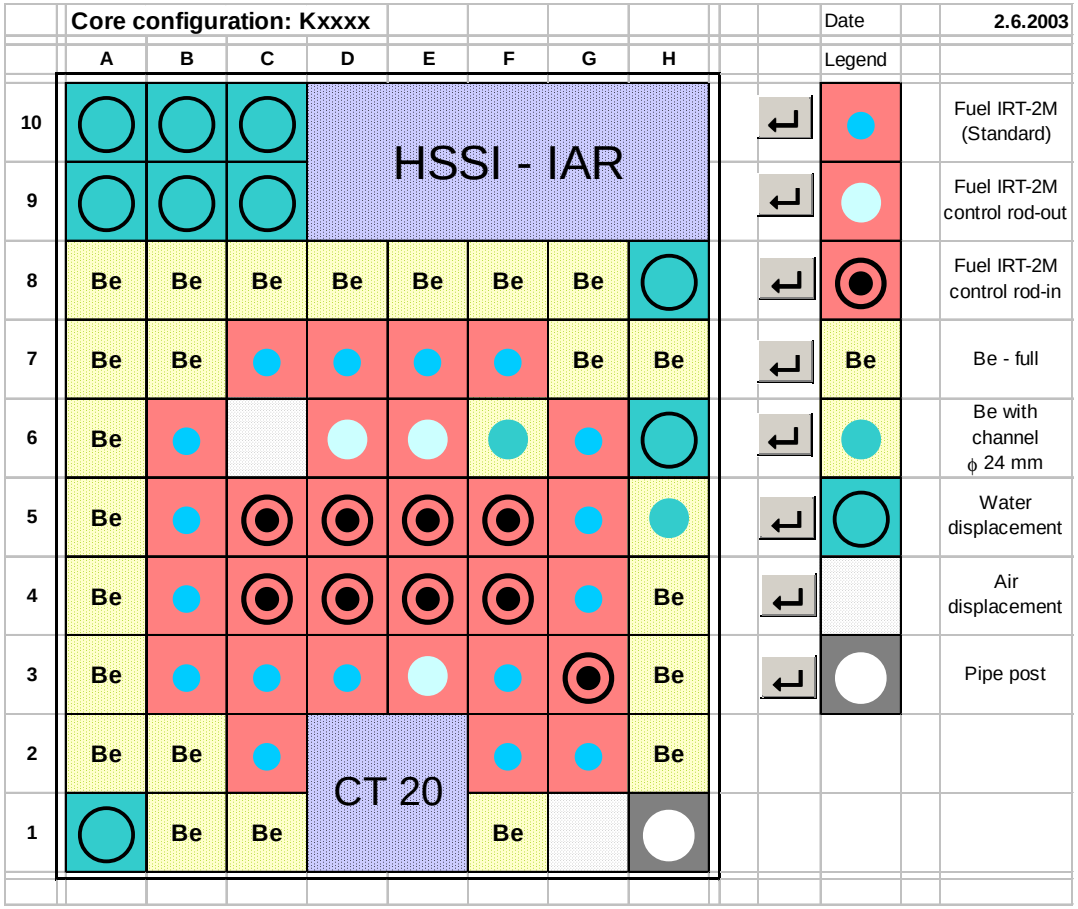

View into the active core of reactor LVR-15, Cherenkov radiation

Fields of use of LVR-15

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Radiation source for:

- **Material testing experiments of the reactor pressure vessel at water loops and at irradiation rigs CHOUCA**
- **Activation analysis with the pneumatic rabbit system**
- **Experiments at beam tubes in the field of nuclear and applied physics**
- **Irradiation for radio-pharmaceutical production**
- **Irradiation of silicon single crystals**
- **Experiments at the thermal column in the field of neutron capture therapy**

Reactor LVR-15 – neutron beams

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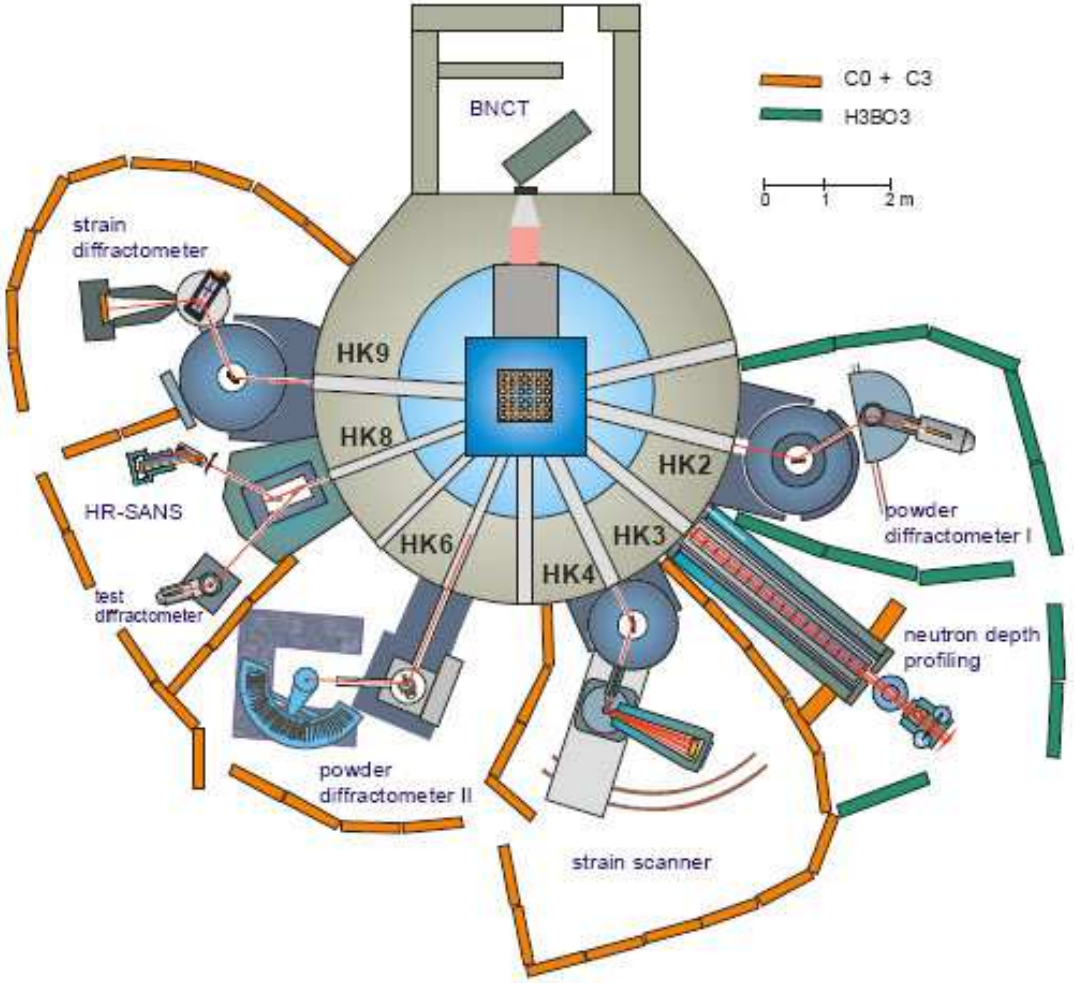
Designed for basic research in material science



IN-PILE testing - Loops and rigs

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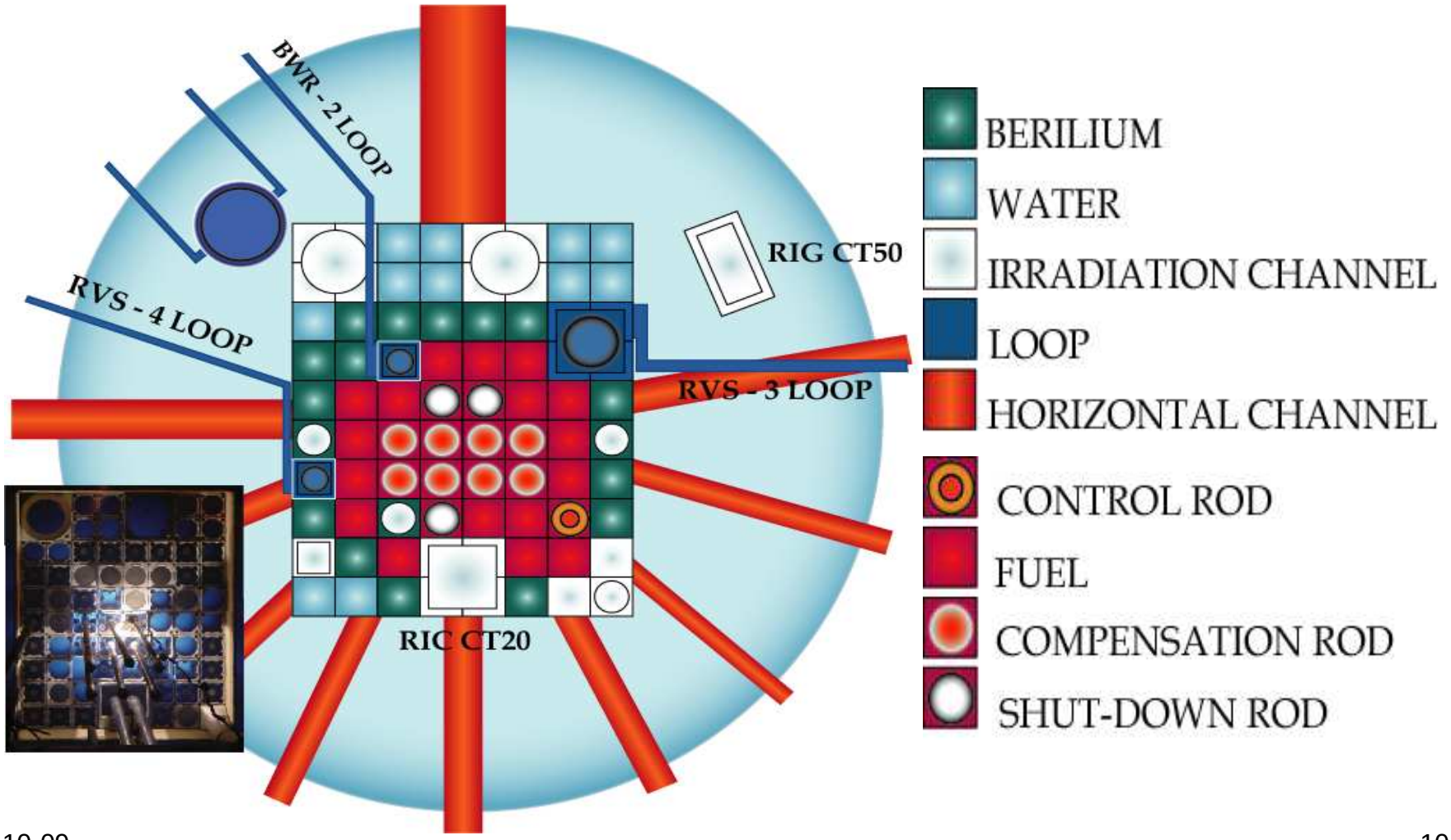
Location of loops and rigs in LVR-15 reactor



IN-PILE testing – Loops for PWR/BWR

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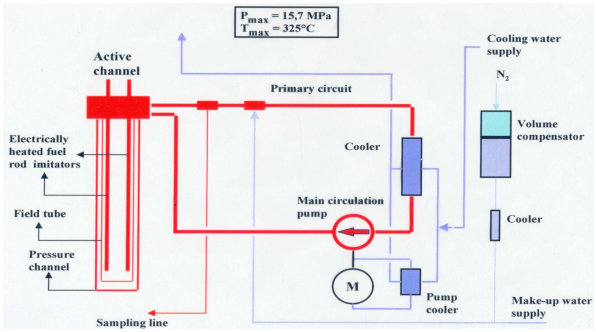
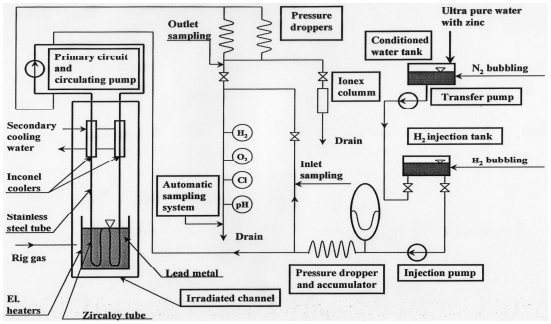
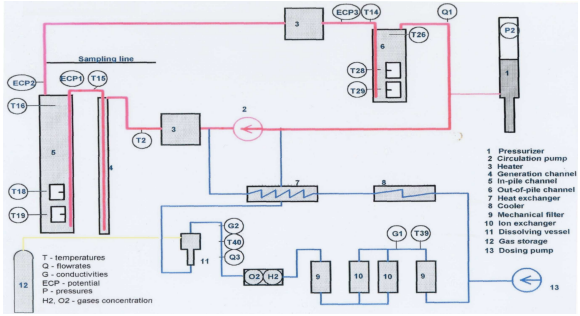
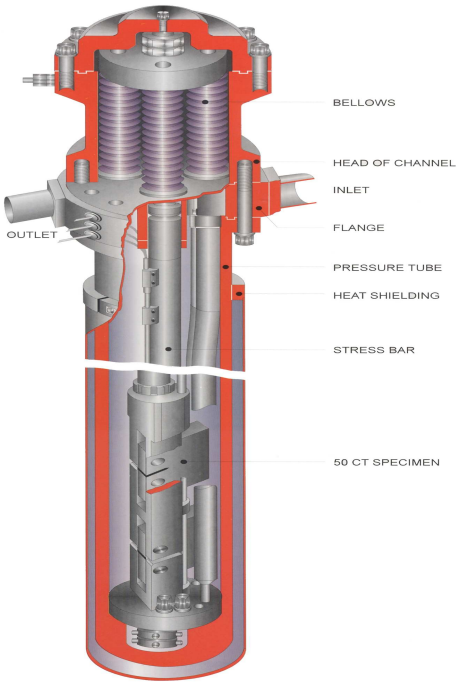






RVS-4 **Zinc injection** **BWR-2**

Loop	Water chemistry	Temperature (^{o} C)	Pressure (MPa)	Flow rate (t/h)
RVS-3	VVER/PWR	345	16,5	3-10
BWR-1	BWR	300	10	2
BWR-2	BWR	300	12	8
ZINC	PWR	320	15,5	0,8-1
RVS-4	VVER	322	15,7	2



IN-PILE testing – mechanical tests

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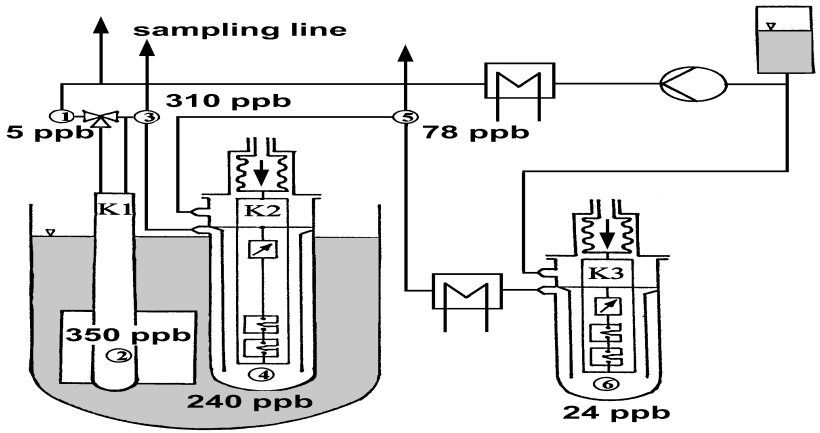
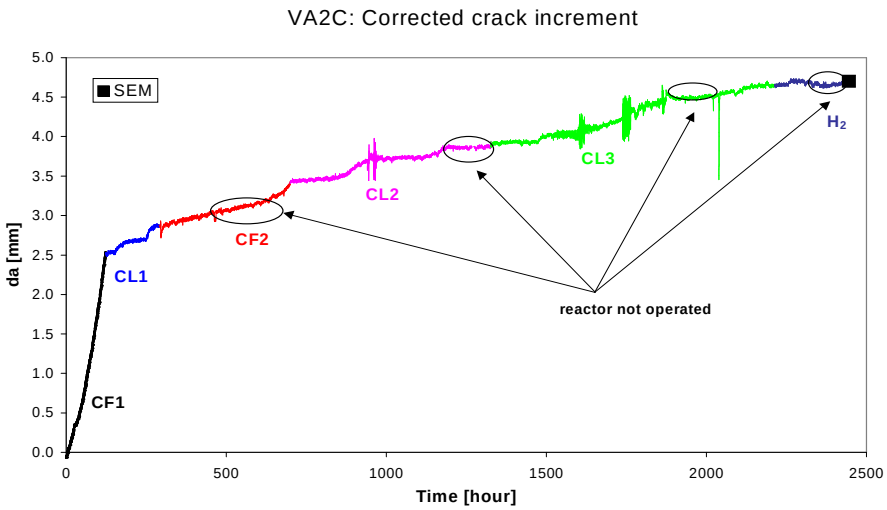
- SCC and IASCC tests have been performed for BWR
- Reactor water loop BWR 2, 8t/h flow rate, 0,4 t/h purification rate
- Constant load or cycling with 1CT/2CT specimens were used
- Potential drop measurements was used for crack growth rate
- In-pile SSRT (Slow Strain Rate Tests) was used for highly irradiated core internals of PWR
- Reactor water loop RVS-3, 8t/h flow rate, with PWR water chemistry conditions was used





IN-PILE testing - Rigs

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CHOUCA, Flat rigs

Research on material properties degradation under radiation:

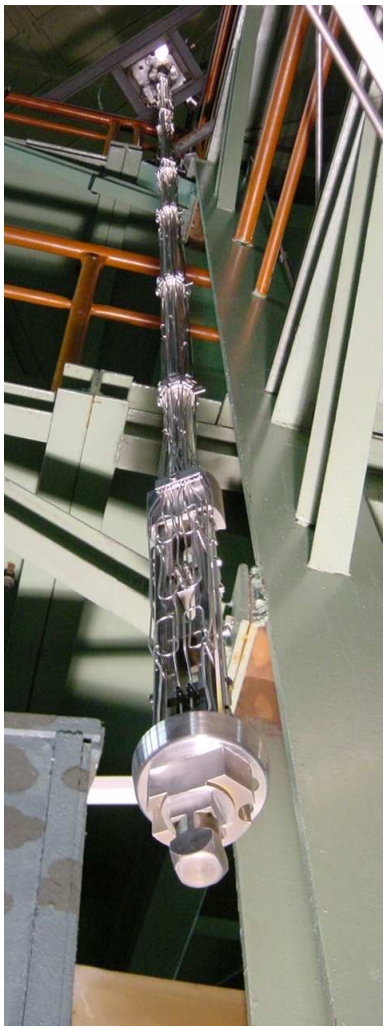
- Charpy V-impact specimens
- tensile specimens of different types up to 12 mm in diameter
- slow strain rate test specimens
- fracture toughness 0.5T CT specimens

6 heating sections, range from 200±10 °C to 350±10 °C in inert gas

Modifications:

· up to 6 1T CT specimens,

· four 2T CT specimens



New loops for R&D for GIII / GIV

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Supercritical water reactor (SCWR) and Very high temperature reactor (VHTR) experimental base for in-pile material and chemistry study (synergy effects of materials,coolant chemistry, radiation and mechanical load)

Located in a new experimental hall (co-financed by EU)

visited by the Czech Prime minister in 2008

SCWL

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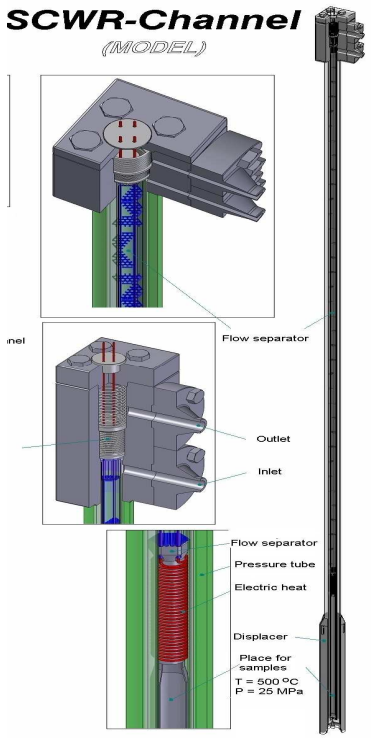
SCWR Reactor Water Loop for Water Chemistry and Radiolysis Study:

Parameters: 600℃, 25 MPa in the active core
390 ℃ in the main pipelines
flowrate 200 kg/h



Objectives (channel type A) :

- to understand the chemistry and chemical properties of supercritical water
- to study in-core radiolysis for in-flux behavior of materials

Objectives (channel type B)

- SCC of alloy steels and austenitic steels
- IASCC of RPV and core internals
- SSRT of pre-irradiated austenitic specimens

SCWL

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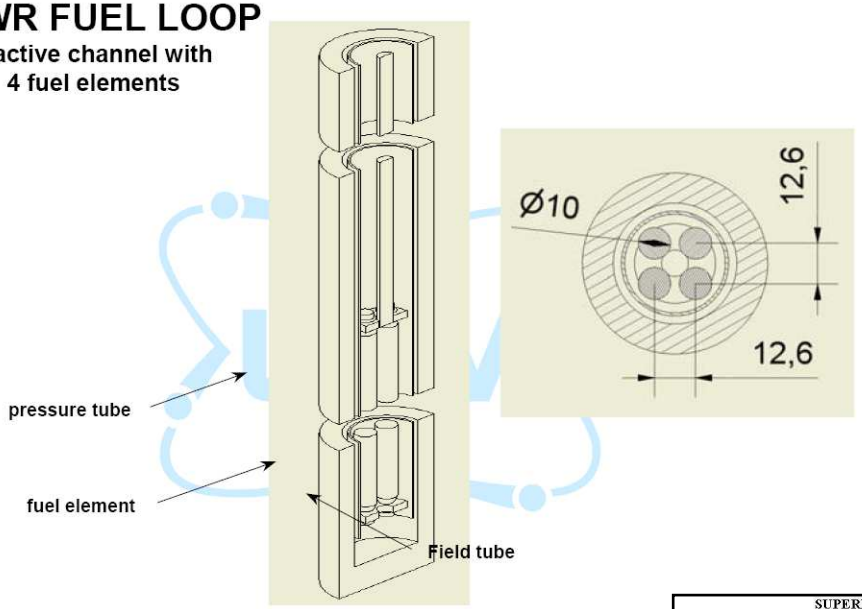
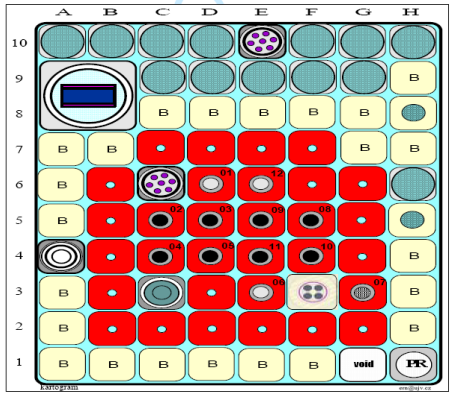
SCWR FUEL LOOP

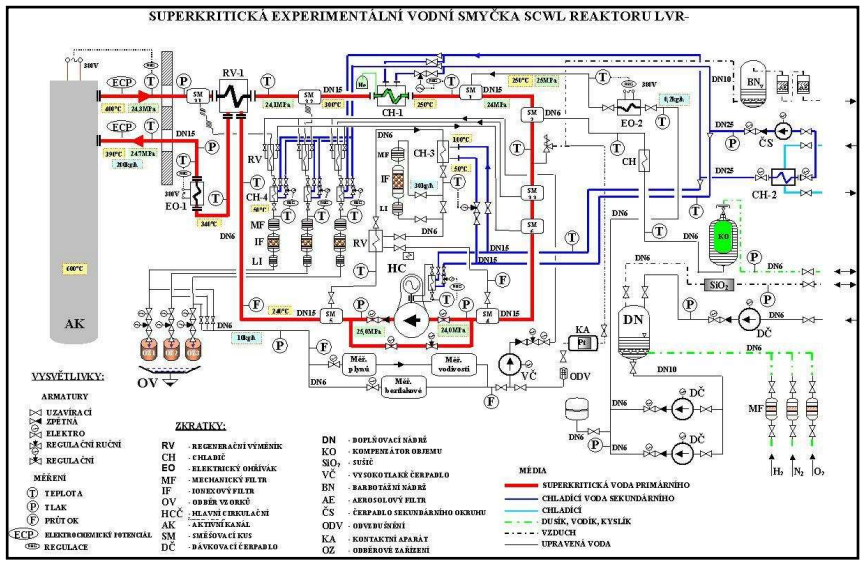
- ✓active channel with 4 fuel elements



LOCATION OF FUEL LOOP

- ✓ configuration with fueled loop (4 fuel pins)





SCWL with its auxiliary circuits

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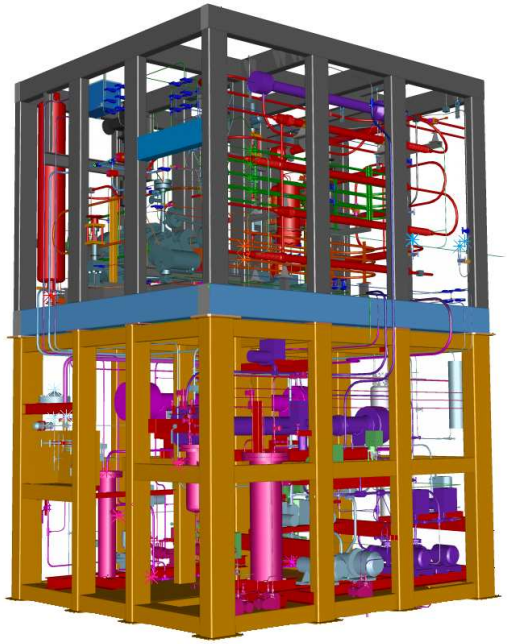

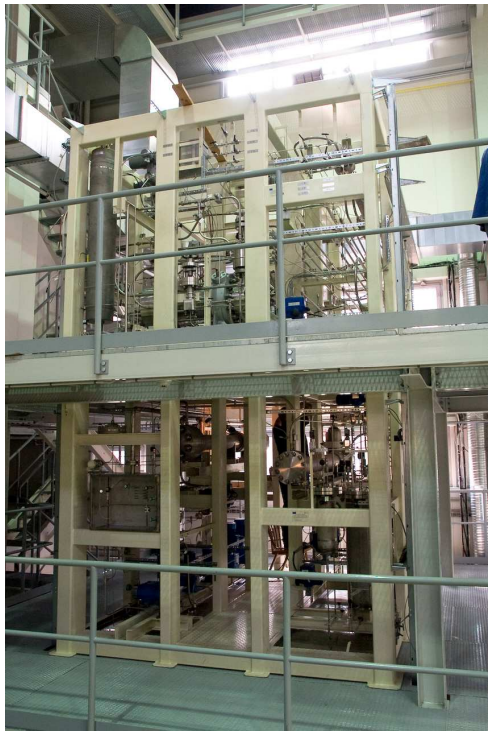

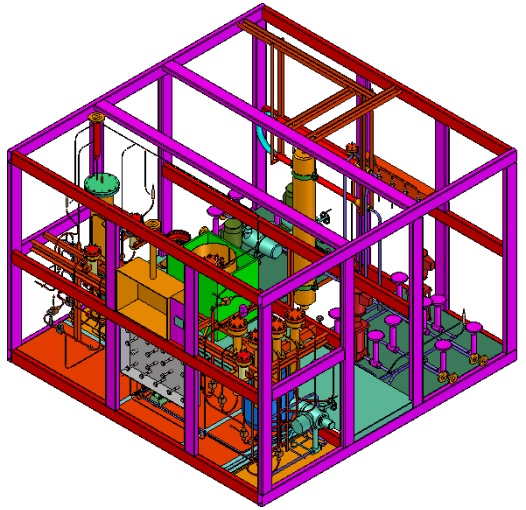

HTHL

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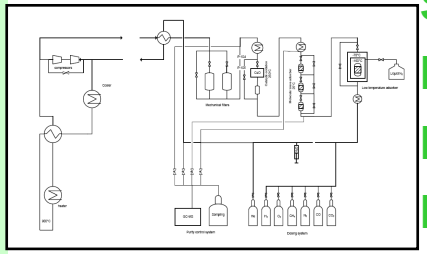
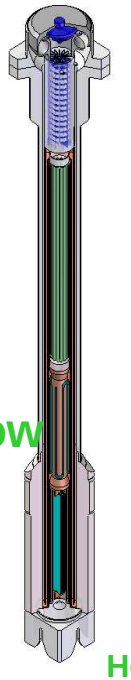
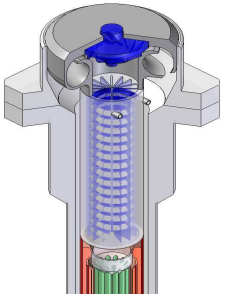
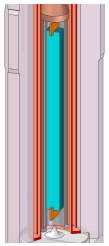
Parameters:

- Pressure up to 7 Mpa
- Temperature up to 900 ℃
- Space for samples: 30 x 570 mm
- Sample size: 4 x 40 mm
- Fast neutron flux: 1 x 10^{14} n/cm^{2}s
- Flow up to 36 kg /hour
- Purification rate (5÷10)% of main flow









He loop in-pile irradiation channel with internal circulator

Testing of reactor component materials

- Reactor graphite materials
- Reactor pressure vessel internals

Effect of He impurities on structural material corrosion

Impurities control and analytical methods for their evaluation

In first stage material irradiation without mechanical load will be performed

In second stage creep tests and fatigue tests are considered

HTHL and its components

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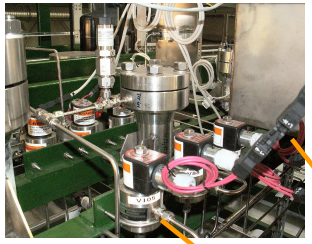
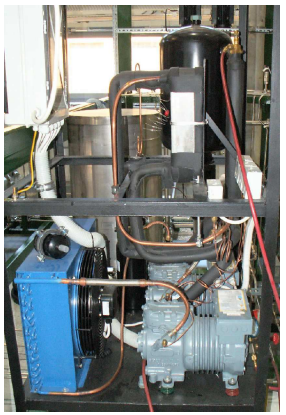


Impurities dosing system

Dimensions of the cage: (3,5 x 3,4 x 2,7) m

Volume and pump compensator

Low temperature adsorber – molecular screen



Low temperature adsorber

Consumption panel

Post-irradiation evaluation

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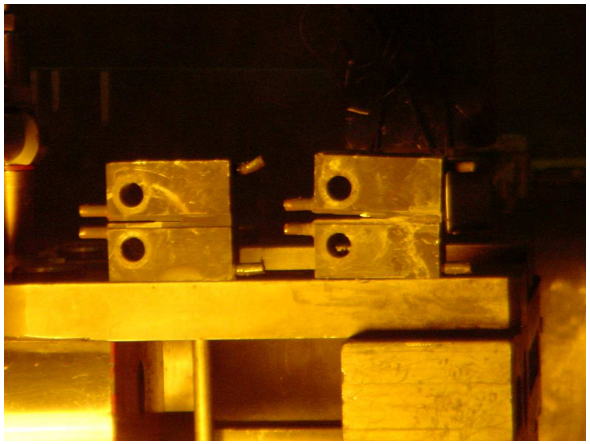
Carried out in 5 hot cells situated in the reactor building (dissmantling)



or in hot/semi-hot cells close to the reactor

special PIE (fracture toughness and tensile tests as well as producing of coupons for SEM and TEM investigation) specimens

static tensile tests, impact instrumented Charpy V-notch type tests on standard and subsize specimens, static fracture toughness tests on standard and subsize specimens, crack growth rate in air, vacuum and BWR/PWR environments, stress corrosion tests in BWR/PWR environments

slow rate stress corrosion tests

Future Plans – „Sustainable Energy“

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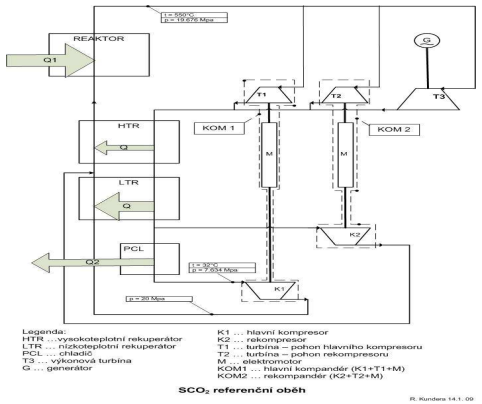
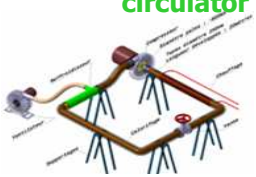
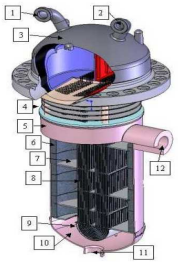
Technological Circuits with Supercritical Water Parameters (SCWR) and Supercritical Carbon Dioxide (SCCO2), Technological Circuits with High-Temperature Helium (VHTR)

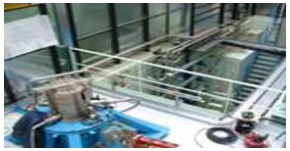


Compressor & circulator



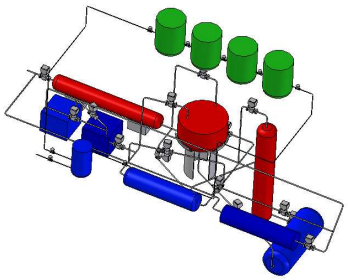
Helium quality management





Thermal-hydraulic & helium components

Technological Circuit With Sodium



And many more…

Total budget about 98M€ (2011-2015)

To be financed from EU Structural funds and the Czech Republic state budget.

Contact and Additional Information

Research Centre Řež Ltd.

http://www.nri.cz/eng/rsd_services.html

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