

# LACOMECO project within the 7<sup>th</sup> EU FWP

## Large Scale Experiments on Core Degradation, Melt Retention and Containment Behaviour

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## Project details

- Four KIT large-scale experimental facilities, **QUENCH, LIVE, DISCO, and HYKA** are offered to external partners from EU within the Transnational Access to Large Research Infrastructures (TALI) Project of the 7<sup>th</sup> EU FWP:
  - 1 experiment in QUENCH
  - 1 experiment in LIVE
  - 1 experiment in DISCO
  - 2 experiments in HYKA
- Investigation of accident scenarios from core degradation to melt formation and relocation in the vessel, melt dispersion to the reactor cavity, and hydrogen related phenomena in severe accidents
- Activities within the LACOMEKO project are strongly coupled to SARNET2

# R&D priorities on severe accident management

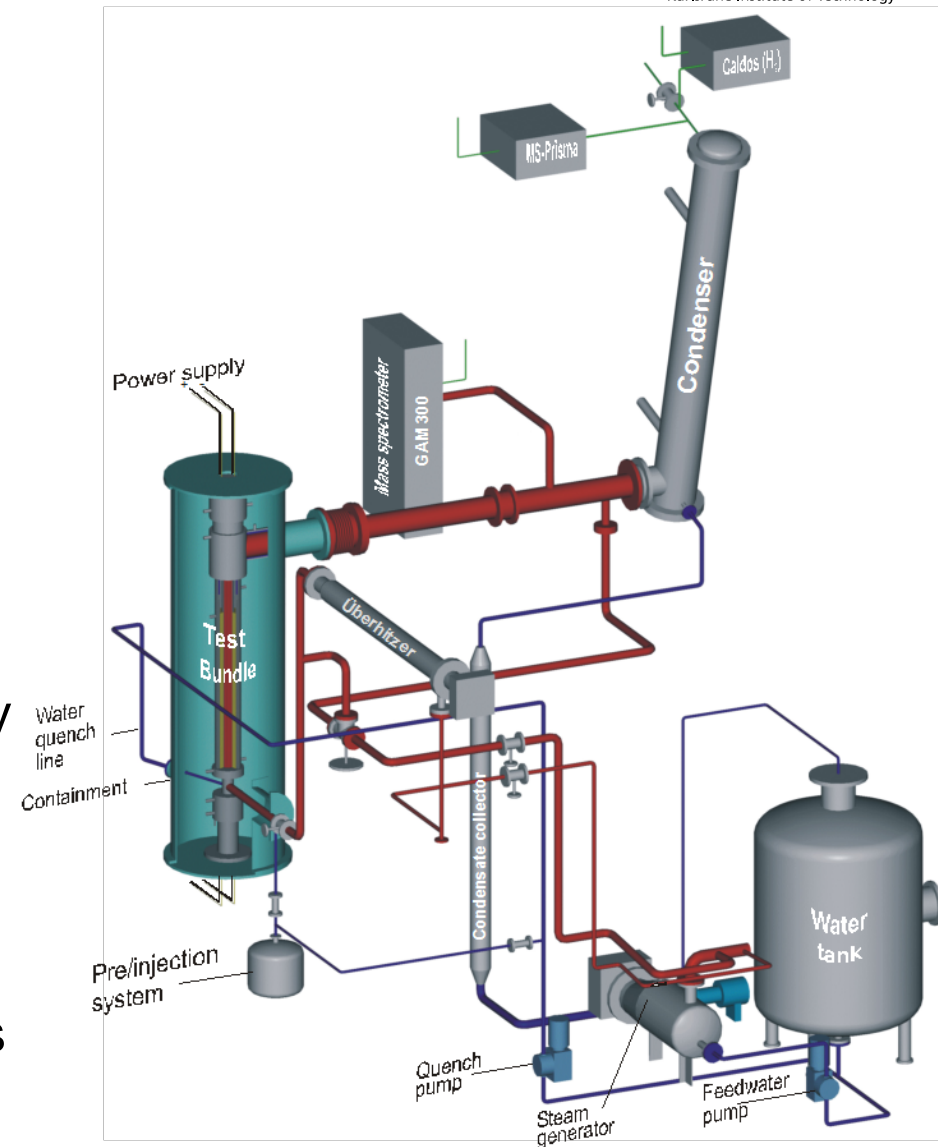
- **High priority** (further research is considered as necessary)
  - **Core coolability during reflood and debris cooling**
  - Ex-vessel melt pool configuration during Molten Corium Concrete Interaction (MCCI), ex-vessel corium coolability by top flooding
  - **Melt relocation into water, ex-vessel Fuel Coolant Interaction (FCI)**
  - **Hydrogen mixing and combustion in containment**
  - Oxidising impact (Ruthenium oxidising conditions/air ingress for High Burn-up and Mixed Oxide fuel elements) on source term
  - Iodine chemistry in Reactor Coolant System (RCS) and in containment

# R&D priorities on severe accident management

- **Medium priority** (these items should be investigated further as already planned in the different research programs):
  - *Hydrogen generation during reflood and melt relocation in vessel*
  - *Corium coolability in lower head*
  - Integrity of Reactor Pressure Vessel (RPV) due to external vessel cooling
  - *Direct containment heating (DCH)*
- **Low priority** (could be closed after the related activities are finished):
  - Corium coolability in core catcher with external cooling
  - *Corium release following vessel rupture*
  - Crack formation and leakages in concrete containment
  - Aerosol behaviour impact on source term (in steam generator tubes (SGT) and containment cracks)
  - Core reflooding impact on source term

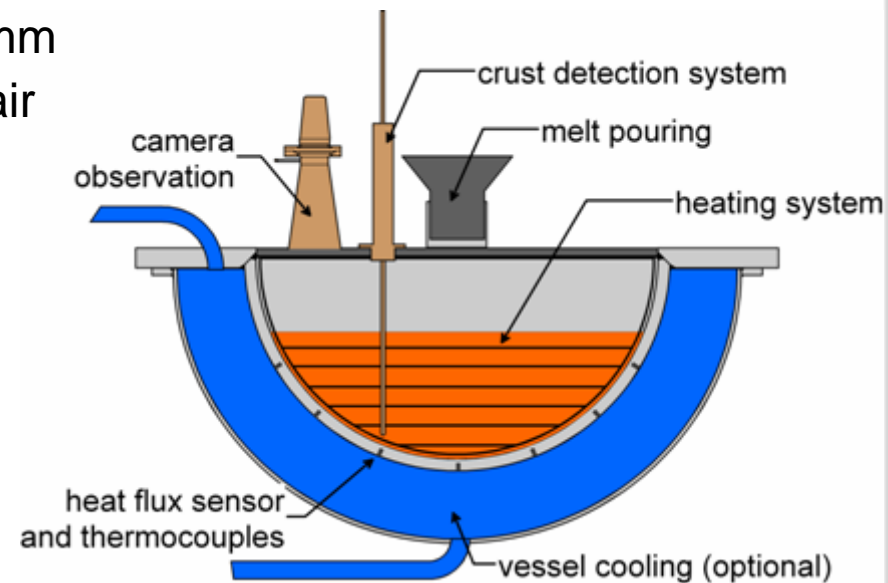
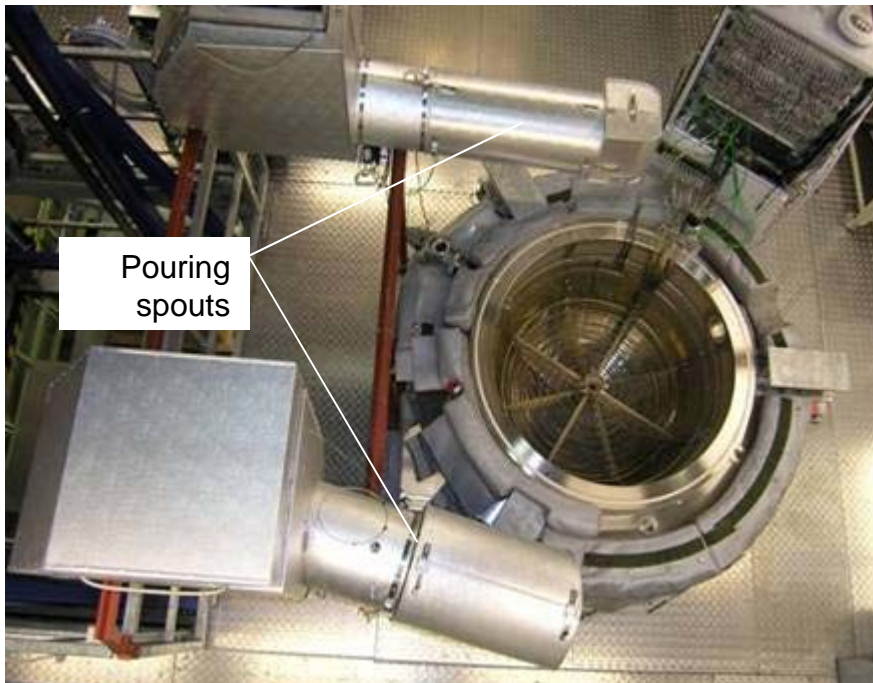
# QUENCH facility

- Bundle with 21-31 fuel rod simulators of ~2,5 m length
- Electrically heated length: ~1 m; max. power ~70 kW
- Fuel simulated by  $ZrO_2$  pellets
- Quenching (from the bottom) with water or saturated steam
- Gas analysis by mass spectrometry ( $H_2$ , steam ...)
- Fully instrumented to measure T, p, flow rates, water level, etc.
- Corner rods removable during tests



# LIVE facility

- 1:5 scaled RPV,  $\varnothing 1$  m, wall thickness  $\sim 30$  mm
- cooling vessel to allow cooling by water or air
- heating furnace of  $\sim 220$  l volume
- volumetric heating system
- maximum temperatures of up to  $1100$  C
- central and non-central melt relocation



## Instrumentation

- thermocouples
- mechanical sensors
- video (optical and IR) cameras
- recording of the power input
- extraction of melt samples

# DISCO facility



## **General Objectives:**

- Upper bound of pressure, at which no relevant dispersal occurs
- Amount of corium dispersed from the cavity
- Location of corium
- Investigation of different cavity geometries
- Pressure build-up during DCH
- Hydrogen source during DCH

## **Main data:**

- |   |                             |
|---|-----------------------------|
| ■ Containment vessel                                | 14.0 m <sup>3</sup> , 1 MPa |
| ■ RPV and RCS vessel                                | 0.08 m <sup>3</sup> , 2 MPa |
| ■ Steam accumulator                                 | 0.08 m <sup>3</sup> , 4 Mpa |
| ■ Simulant melt                                     | alumina-iron melt (2400 K)  |
| ■ Gas   | steam, air, hydrogen        |
| ■ Burst pressure                                    | 0.7 – 2.5 MPa               |
| ■ Variable cavity geometry, different failure modes |                             |

# HYKA facilities for hydrogen research



- Analysis of H<sub>2</sub> distribution and combustion processes in severe PWR accidents and BWR incidents
- Provision of an adequate scientific basis for reliable hydrogen risk reduction in NPPs

## *Parameters of the test vessels*

- A1: 110 m<sup>3</sup>, 100 bar
- A3: 30 m<sup>3</sup>, 60 bar
- A6: 23 m<sup>3</sup>, 40 bar





# Selection of the proposals with participation of

- Members of the LACOMECEO Executive Group
- SARNET2 experts
- SARNET2 Work Package coordinators
  - *objective was to link the activities of the LACOMECEO project to the SARNET2 NoE*
- SARNET2 Sub-Work Package leaders (based on the experiment objectives and research topics proposed)
  - *WP4: ASTEC (ASTEC)*
  - *WP5: Corium and Debris Coolability (COOL)*
  - *WP6: Molten Corium Concrete Interaction (MCCI)*
  - *WP7: Containment (CONT)*
- The LACOMECEO Scientific Officer of DG RTD

# Selected LACOMEKO experiments

## ■ **QUENCH:**

- QUENCH-16: Slow oxidation of fuel rod bundles in air atmosphere (KFKI / AEKI, Budapest, Hungary together with INRNE Sofia, Bulgaria)

## ■ **LIVE:**

- LIVECERAM: Dissolution kinetics of a pure  $\text{KNO}_3$  crust by a  $\text{KNO}_3/\text{NaNO}_3$  melt (CEA, Grenoble, France)

## ■ **DISCO:**

- DISCO-FCI: Ex-vessel fuel coolant interaction experiment in the DISCO facility (IRSN, Fontenay-aux-Roses, France)

## ■ **HYKA:**

- UFPE: Upward flame propagation experiment in air-steam-hydrogen atmosphere (JSI, Ljubljana, Slovenia)
- DETHYD: Detonations in partially confined layers of hydrogen-air mixtures (WUT, Warsaw, Poland)
- HYGRADE: Hydrogen concentration gradients effects understanding and modelling with data from experiments at HYKA (CEA, Saclay, France)

# Acknowledgments

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Thank you for your attention