SCK•CEN

STUDIECENTRUM VOOR KERNENERGIE
CENTRE D'ETUDE DE L'ENERGIE NUCLEAIRE

Intended use of MELCOR for MYRRHA Safety Assessment

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Outline

- Context:
  - SCK•CEN, the Belgian Nuclear Research Centre
  - MYRRHA, Multi-purpose hYbrid Research Reactor for High-tech Applications
- MELCOR intended use for MYRRHA Safety Assessment:
  - Design Basis Accidents
  - Severe Accidents
- Conclusions

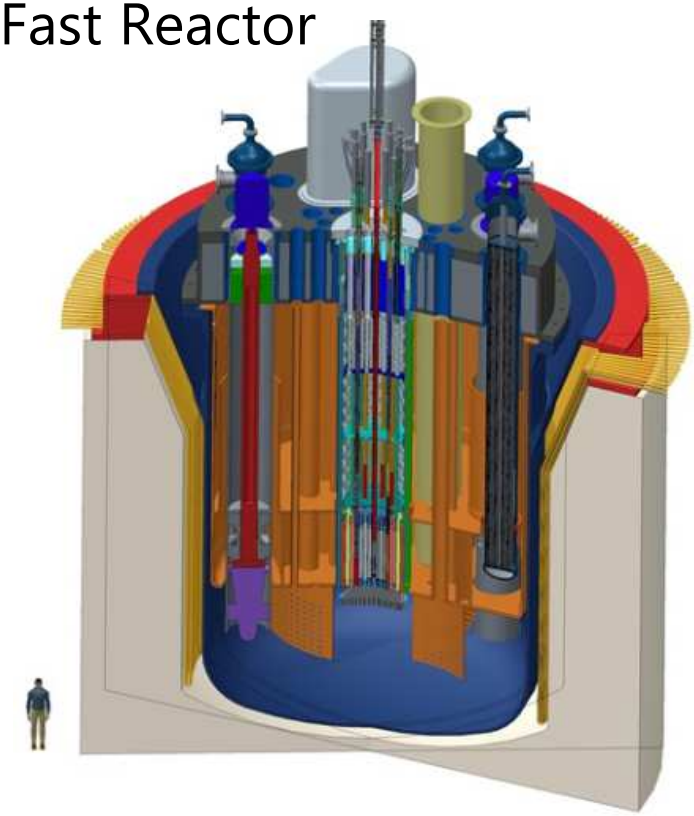
- *The SCK•CEN technical visit at a glance:*
  - *VENUS-F*
  - *HADES*
  - *TCH Hall*

SCK•CEN – Belgian Nuclear Research Centre

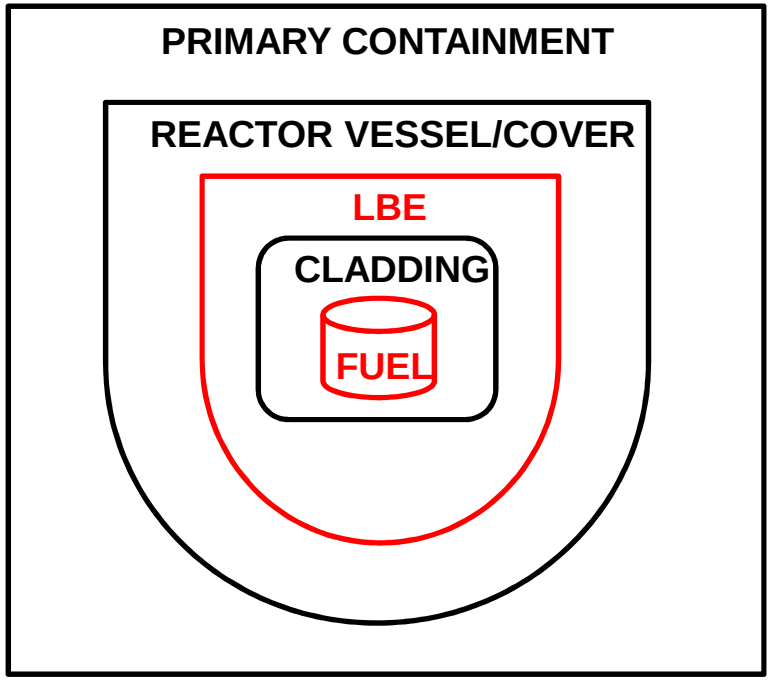
- Foundation of public utility
- One of the largest research centres in Belgium, ≈ 700 employees
- Our statutory mission prioritizes:
  - safety and efficiency of nuclear installations
  - solutions for the disposal of radioactive waste
  - radiation protection
  - sustainable development
  - education and training
- Operates several nuclear facilities:
  - BR2 material testing reactor
  - BR1 research reactor
  - VENUS-F reactor
  - HADES underground research laboratory
  - …

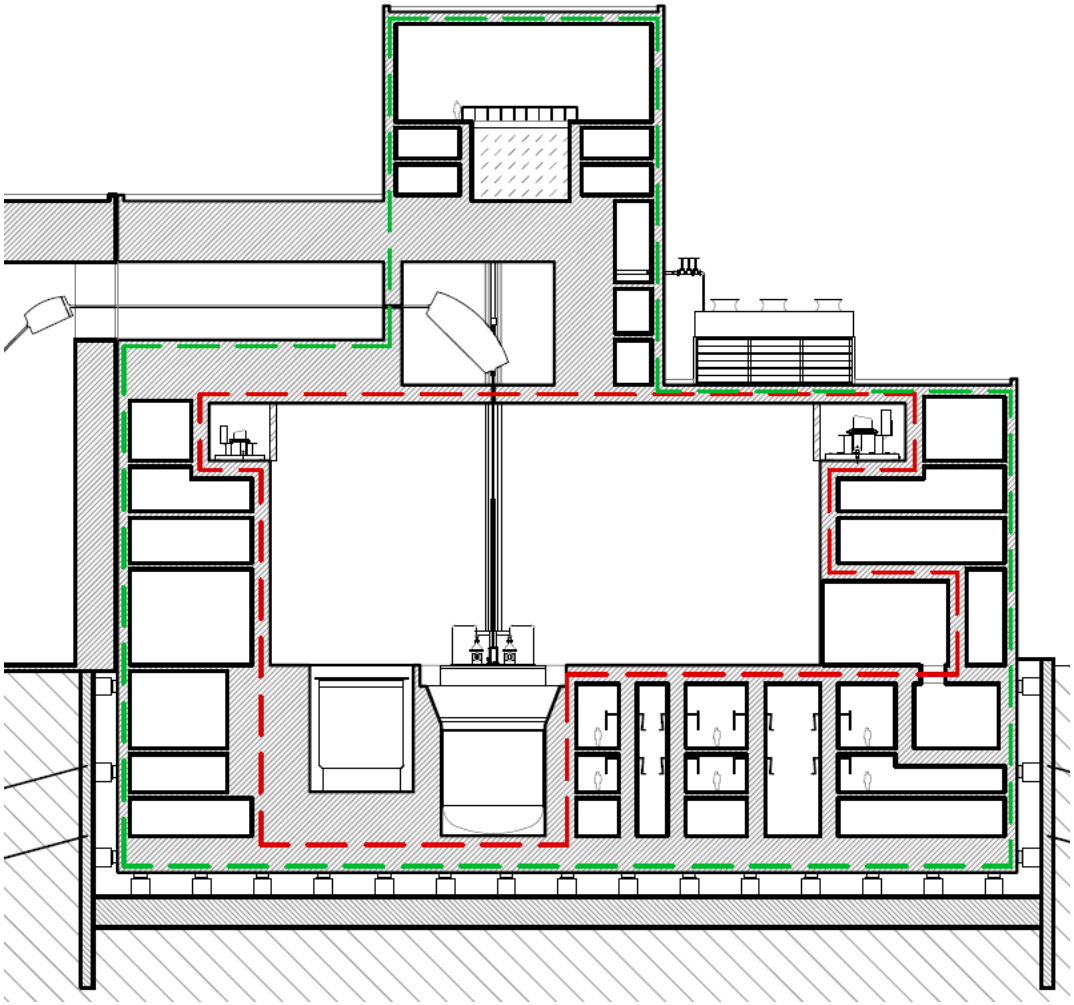
MYRRHA

- Multi-purpose hYbrid Research Reactor for High-tech Applications
- Flexible fast spectrum irradiation facility, both subcritical and critical
- **ADS first demonstration facility at power (50-100 MW)**
- European Technology Pilot Plant for Lead Fast Reactor
- Application catalogue:
  - Material & fuel development for innovative reactor systems
  - radio-isotope production
  - doped silicon production
  - fundamental science applications



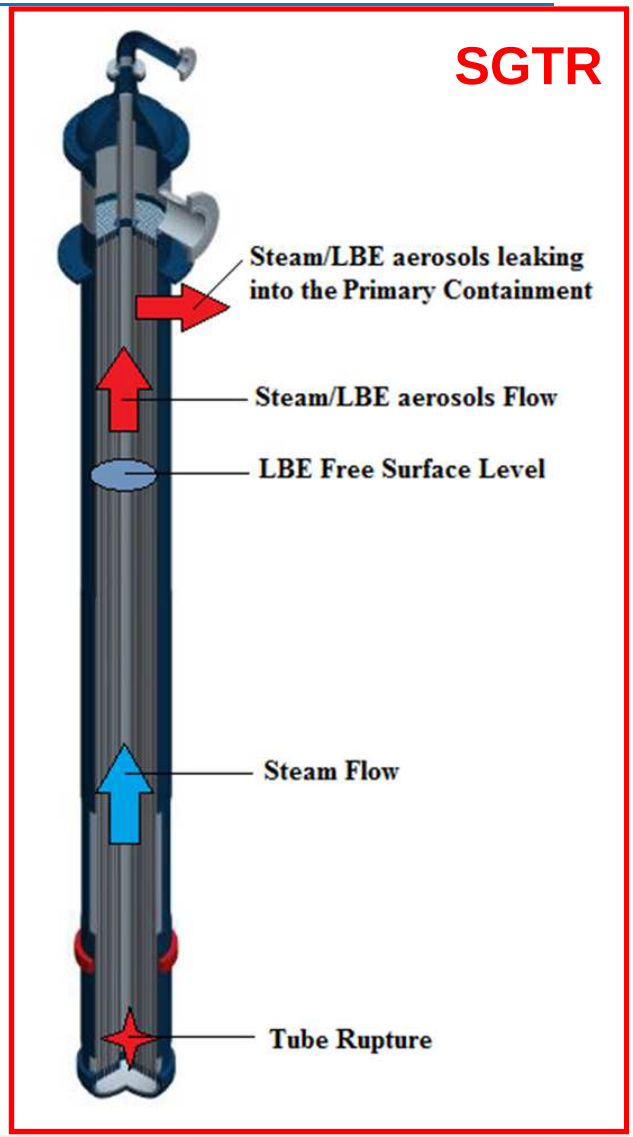
MYRRHA Design: SOURCE TERMS and BARRIERS





MELCOR for MYRRHA Design Basis Accidents

- Passive confinement:
  - **MSLBA**: pressure/temperature in PC
  - **SGTR**: pressure/temperature/source term in PC
    - A comparison with CONTAIN code is foreseen in European project framework
  - I and Cs are retained coolant LBE
    - Passive confinement possible?
  - **Fuel manipulation accident** (ex-vessel): source term PC
  - **(Partial) LOCA scenarios**: source term in PC
- Hazards:
  - Source term behaviour in case of fire

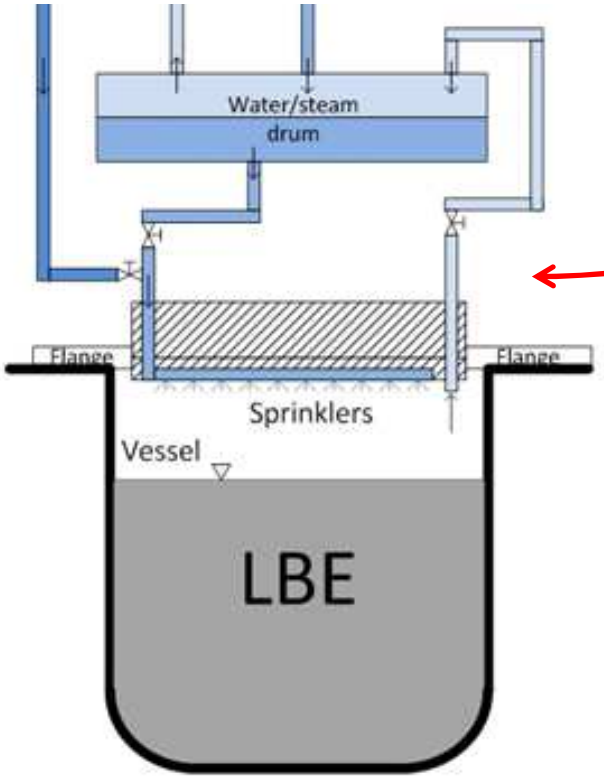


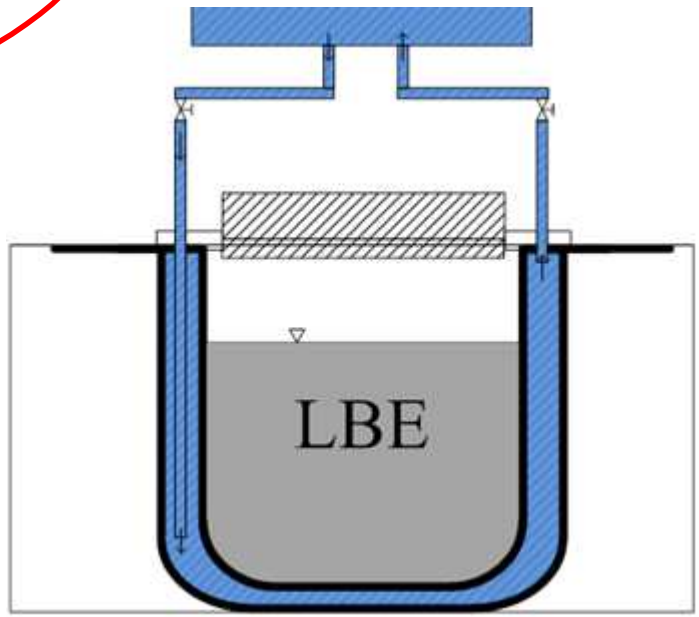
MYRRHA Severe Accidents

- Severe accidents for MYRRHA:
  - Intention is to practically eliminate core melt
    - Typical initiators like LOCA are excluded
  - Hypothetical Master Severe Accident
    - Flow blockage main residual risk
  - Core disintegration phase studied with SIMMER code:
    - Critical issue is fuel compaction (recriticality and core disruption)
  - Fuel relocation in primary system:
    - In vessel retention studies:
      - mechanical integrity of the primary system boundary: cooling of fuel debris/avoid or manage recriticality
      - with dedicated methods (CFD, ….)

MELCOR for MYRRHA Severe Accidents

- MELCOR might be used to determine source term in top cooling system (possible containment bypass leak)
- This will involve polonium modeling



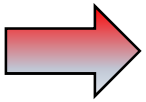


Conclusions (1/2)

- Intended Use of MELCOR – 1st Phase:
  - Containment overpressure evaluation in case of accidental M&E release from the secondary system: MSLBA or SGTR
    - M&E release calculated by RELAP model provided as input to MELCOR
    - Design envelope for PC
    - A code-to-code comparison with CONTAIN calculations is planned
  - Investigations over possible implementation of polonium behaviour
    - Polonium evaporation experiments currently on-going at SCK•CEN and PSI

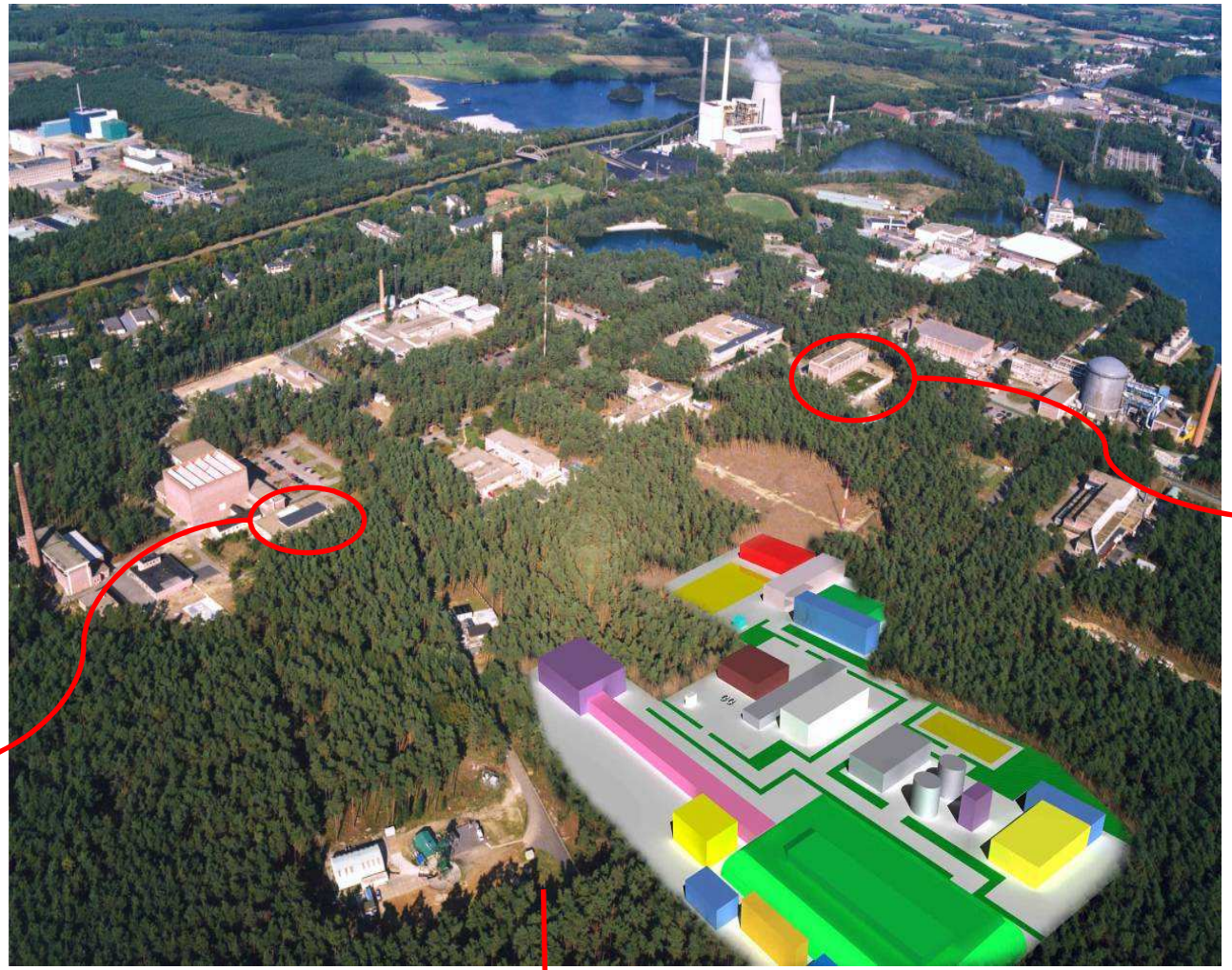
Conclusions (2/2)

- Intended Use of MELCOR – 2nd Phase
  - Detailed assessment of the source term evolution inside the PC for:
    - FA manipulation accidents (ex-vessel)
      - Transport and deposition behaviour of FP aerosols after clad failure.
    - LBE spilling scenarios (e.g. due to leaks in the LBE Conditioning System):
      - LBE activation product source term (evaporation from the LBE spill/condensation on surfaces).
    - SA scenarios:
      - LBE/polonium source term
      - FP source term coming from degraded core relocated at the top of the LBE pool (*to be further investigated*)



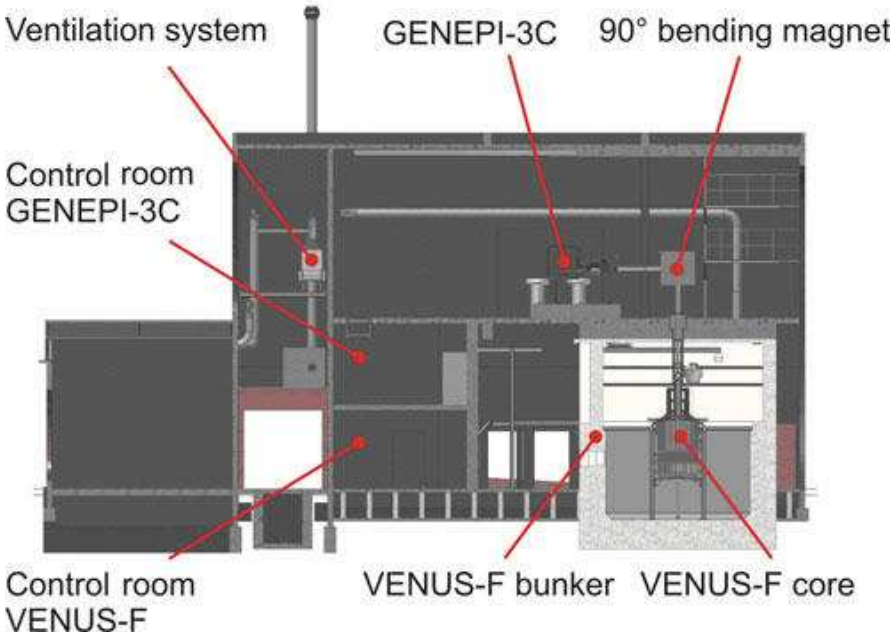
Input for Radiological Consequence Analyses

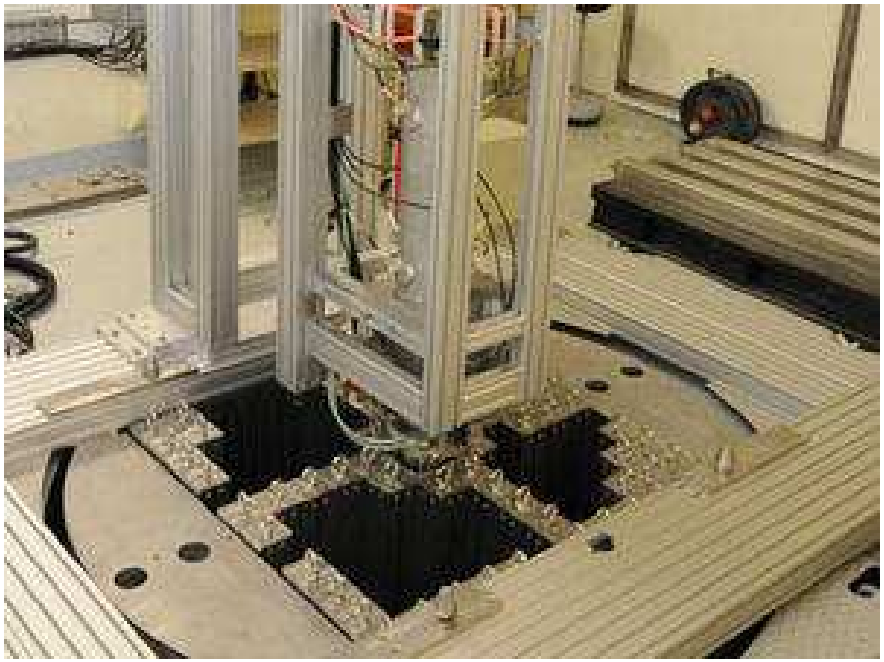
The SCK•CEN technical visit at a glance



VENUS-F

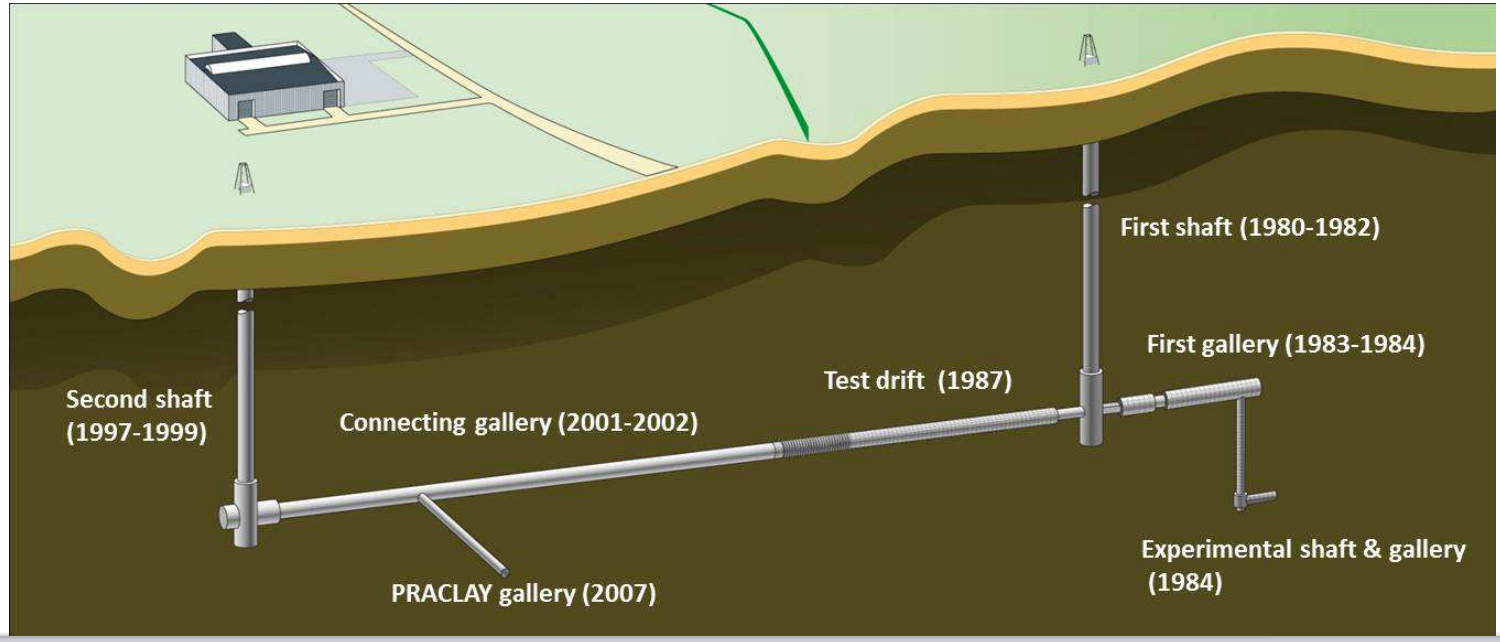
- October 2011: **for the very first time** a lead-based subcritical reactor was coupled with a particle accelerator in continuous mode:
  - online subcriticality monitoring
  - operational procedures in ADS





HADES

- Underground (**225 m**) laboratory for experimental research on geological disposal of high-level and long-lived radioactive waste
- **1980**: start construction of the underground research laboratory HADES to study the Boom clay at great depth
- Initial issue was the construction of infrastructures at a depth of 200 meters in plastic clay layers (lack of experience)



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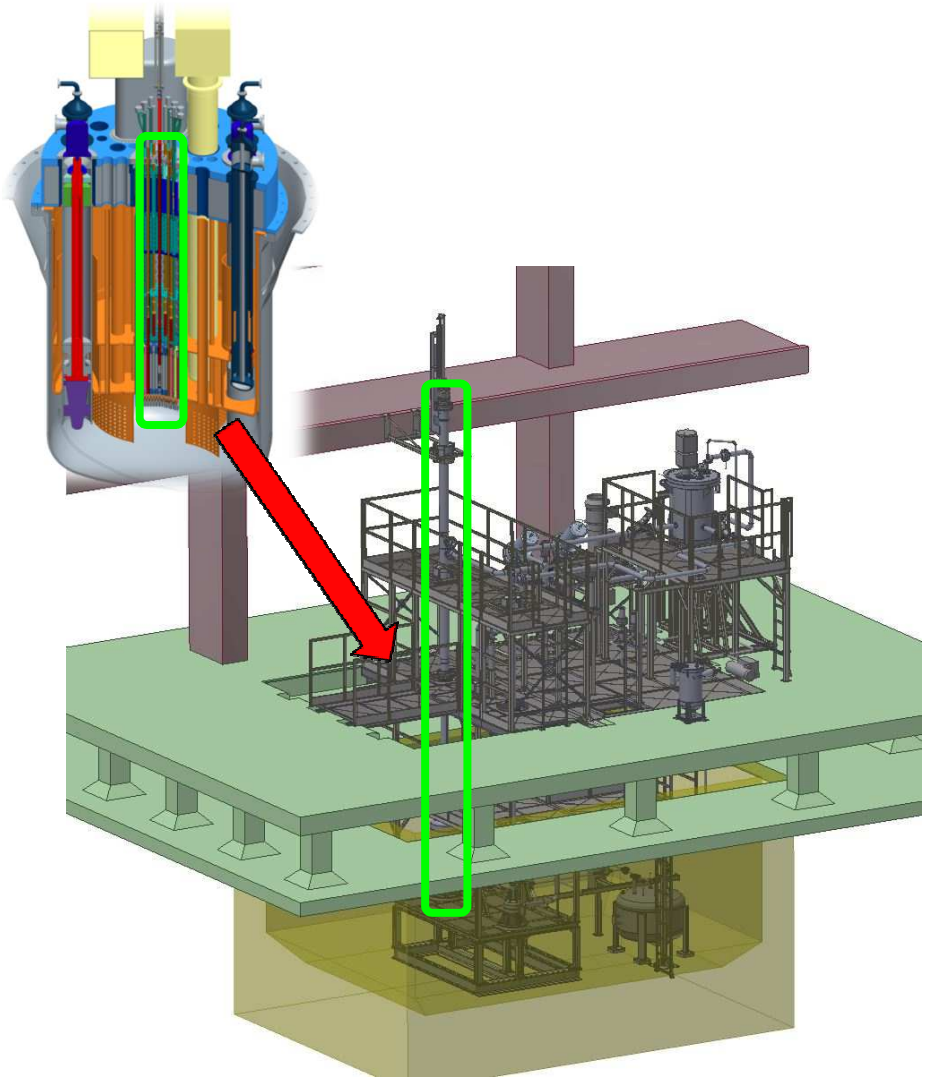
HADES

- Phase 1 (1980-1987)
  - Freezing the clay

- Assessing the safety of a geological repository in poorly indurated clay

TCH Hall - COMPLOT

- TCH Hall hosts several facilities in support of MYRRHA
  - An example: **COMPLOT** = **COM**ponent **LO**op **T**esting
- Characterisation of hydraulic and hydrodynamic behaviour of **full-scale** MYRRHA components in LBE
  - Fuel assembly hydraulics
  - Spallation target hydraulics
  - Control and safety rod hydrodynamics



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