Karlsruhe Institute of Technology

Institute for Neutron Physics and Reactor Technology (INR)
Section for Analysis of Beyond Design Nuclear Events (ADE)

MSR design and safety studies at KIT

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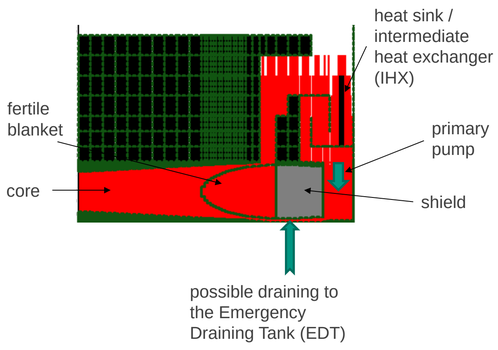
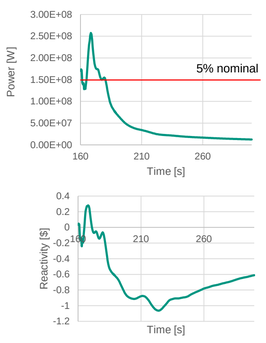
MSFR: fast MSR with fluoride salt

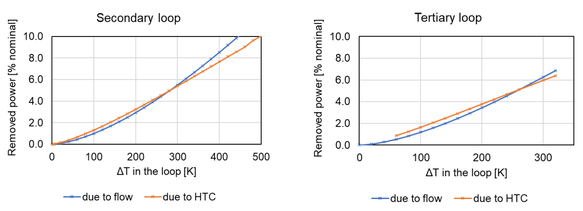
SAMOSAFER and earlier EU projects

- Steady state and ULOF simulations with SIMMER code

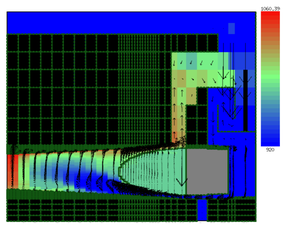




- Decay heat removal

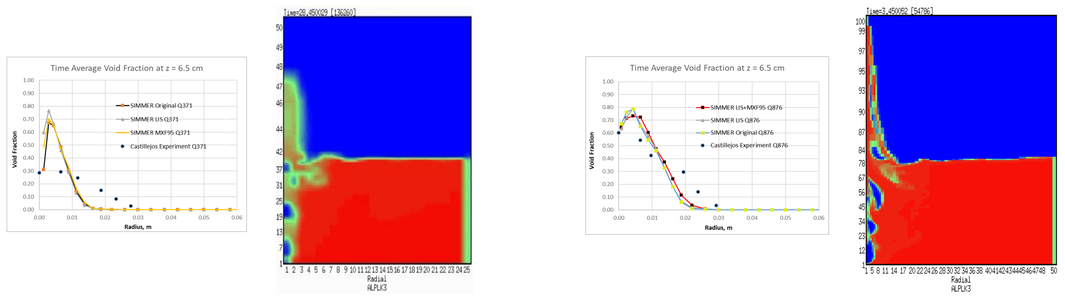


Power removed by natural circulation loops.
Results from analytical tool for DHR calculation

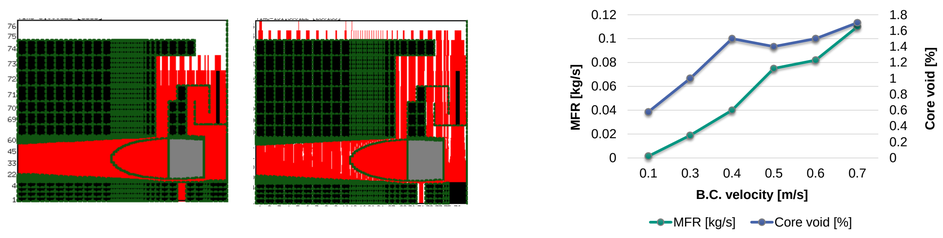


Temperature distribution at ~4.5% nominal power, with natural circulation

- Modeling of gas-injection experiments (gas into water)



- Helium injection to MSFR core

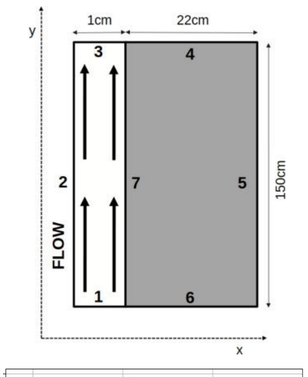


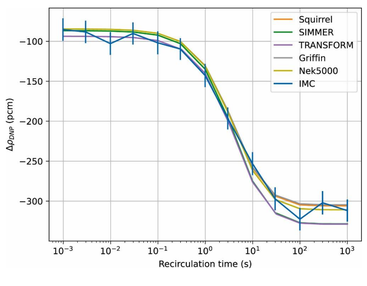
Thermal MSR

Code benchmark with DTU (Denmark) and other partners

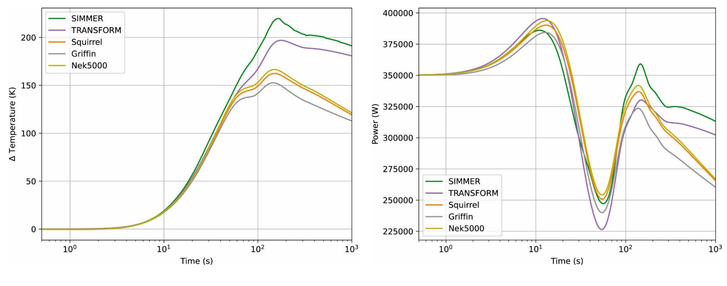
2D slab geometry:

- Channel with flowing molten salt
- Graphite-moderated, fluoride salt





Loss of reactivity due to the fuel flow

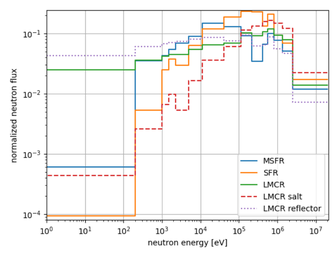


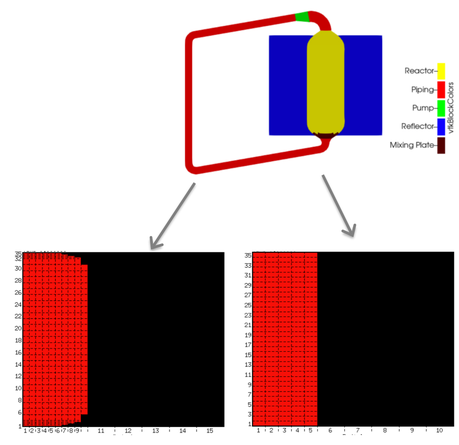
ULOF transient: outlet temperature and power evolution

Chloride-based MSRs

- Development of EOS for chloride salts:
  - 2/3 NaCl + 1/3 UCl_3, 93.2%wt enriched Uranium (LOTUS MCR)
  - 62 NaCl + 31.2 $MgCl_2$ + 6.8 $PuCl_3$ (ARAMIS-P fuel salt)
  - 58 NaCl + 42 $MgCl_2$ (ARAMIS-P coolant salt)
- Development of models and transient anaylsis

LOTUS MCR





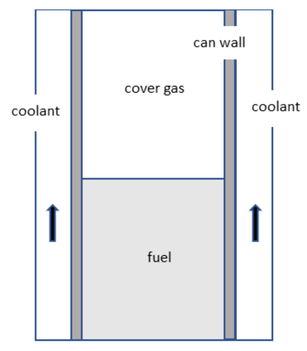
ARAMIS-P

- Code benchmark with ENDURANCE EU project participants
- Fuel cycle studies

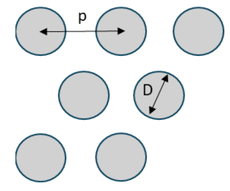
MSR-ST

MSR design with fuel-in-structure elements **(MSR-ST):**

- steel or Ni-alloy cylindrical, few-meter-high structures
- filled with liquid fuel up to their mid-height,
- gas plenum above the fuel



view on the core from the top



p – pitch
D – element diameter

Selected original correlation [1]:

$$\mathrm{Nu} = 0.85 \cdot \mathrm{Ra}_{\mathrm{R}}^{0.19}$$

based on **ANSYS Fluent** simulations was replaced by:

$$\mathrm{Nu} = 0.52 \cdot \mathrm{Ra}_{\mathrm{R}}^{0.19}$$