Karlsruhe Institute of Technology

HELMHOLTZ ASSOCIATION

Institut für Neutronenphysik und Reaktortechnik

Anlagenentwicklung, Systemdynamik und Sicherheit

iNR

LIMTECH Alliance *and HEMCP: Helmholtz Energy Materials Characterization Platform*

# Development of high temperature test facilities for material investigations in hot liquid metal flows

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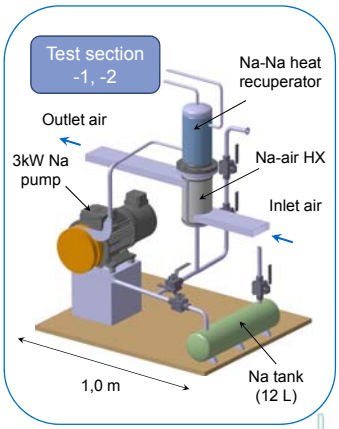
## HEMCP Project
(Helmholtz Material Characterization Platform):

- Increased interest in LMs utilization in energy field (nuclear, solar) at high temperatures requires the development and qualification of appropriate materials. These have to be experimentally investigated and qualified in hot LM (sodium) environment
- Development of high temperature experimental loops for material investigation and qualification and test of direct energy converters
- Temperature: cold side 700 K (stainless steel)
  hot loop: 1000 K (Inconel)
- Mass flow rate: ~300 kg/h

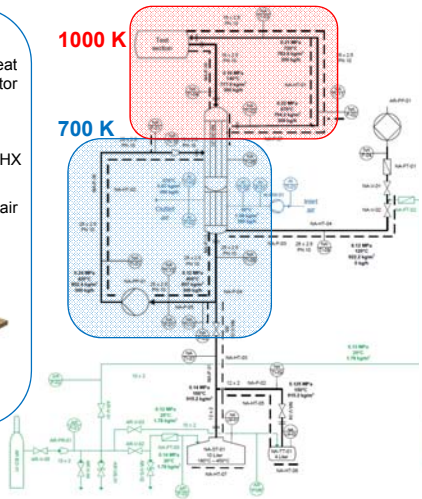
## 1000 K SOLTEC loops – main tasks (SOdium Loop for TEst Materials and Corrosion)

- Thermal/mechanical material creep fatigue evaluation (normal operation/thermal cycles) in flowing hot Na environment – unique
- Materials: AISI 316Ti, 1.4988, 1.4970, advanced PM2000, innovative W-Cu compounds
- Corrosion/errosion tests for innovative materials in sodium environment: austenitic steels with variable chrome content, nickel-based steels, Inconel-based steels and W-Cu laminate pipes
- Long term tests for innovative AMTEC (Alkali-Metal Thermal-to-Energy Converter) designs

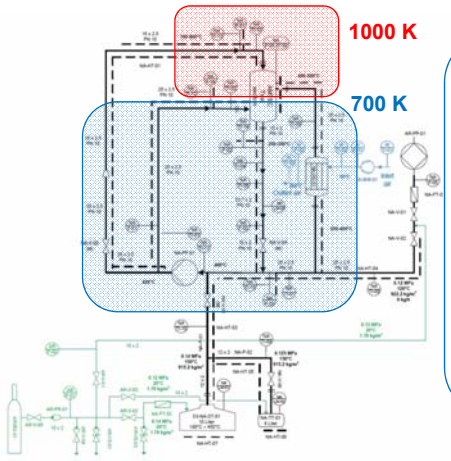
## SOLTEC loops: P&I diagrams



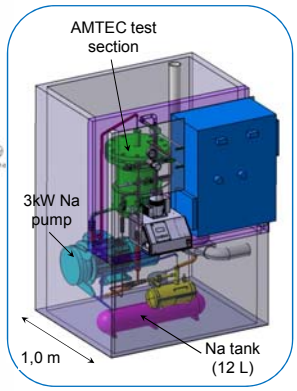

**SOLTEC – 1, – 2**
**3D model**




**SOLTEC – 1, – 2**




**SOLTEC – 3**

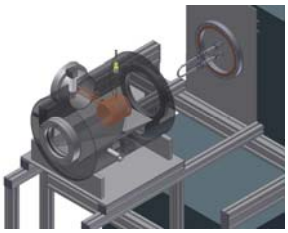



**SOLTEC – 3**
**3D model**

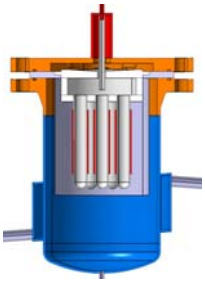
## Test sections and main components

**Test section 1:**
**universal traction facility**

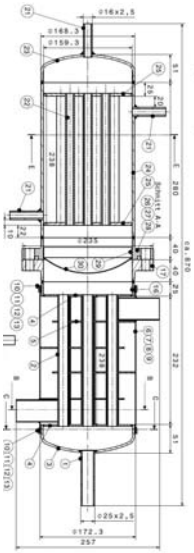
Sample probes:
W-Cu compounds



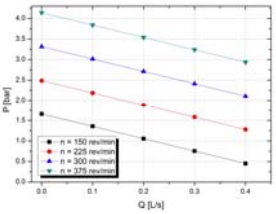
**Test section 2:**
**material test chamber**



**Test section 3:**
**universal casing**



Na-Na-Air
heat exchanger



Pump characteristic line

Permanent
magnet pump

**Loop details:**

- Zwick/Roell Z100 universal traction facility (traction and compressive forces up to 50 kN)
- Maytec vacuum oven (> 1000 °C, vacuum ~ $10^{-5}$ mbar)
- Safe design (based on in-house experience): fast drainage, low Na amount, low system pressure
- Combined Na-Na heat recuperator (high efficiency) and Na-air heat exchanger: compact design
- Heat exchangers: countercurrent flow arrangement

**Present stand:**

- Design finished
- Construction in progress
- Set-into-operation: End 2016

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