Karlsruhe Institute of Technology

HELMHOLTZ ASSOCIATION

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

Institut für Neutronenphysik und Reaktortechnik
Anlagenentwicklung, Systemdynamik und Sicherheit

B4: Phase changes in liquid metals for direct energy conversion

Alkali Metal Thermal to Electric Converter (AMTEC)

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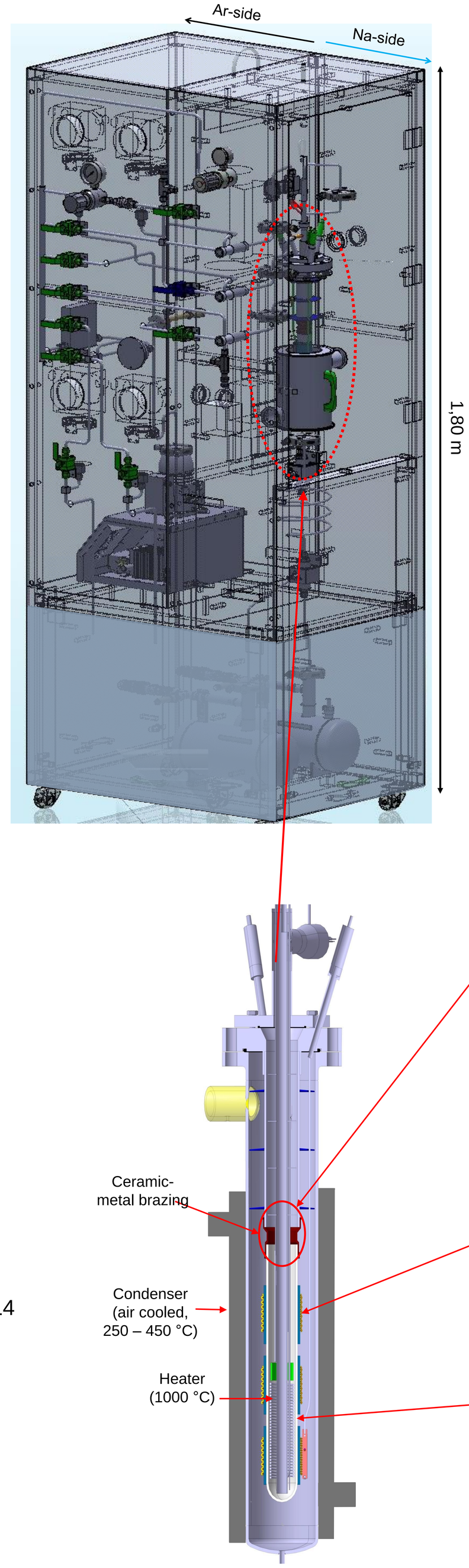
Project status

- Test facility currently in the construction phase (acquisition phase finished; components in fabrication)
- Infrastructure of the AMTEC laboratory available
- Optical laboratory available for ceramic examination
- First attempts for sputtered electrode achieved

AMTEC TEst FAcility (ATEFA)

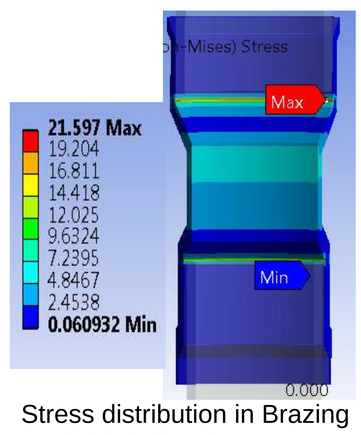
- Compact design
- Control Na-flow and pressure trough Ar (p_{Ar} & $\dot{m}_{Ar}$)
- Na-side separated from Ar-side
- Separable cell and storage tanks
- Safety aspects:
  - Na-side isolated in a metallic containment
  - In case of power loss (PC) manual control possible
  - Highest pressure 1.5 bara
  - Metallic tub for Na collection
  - In case of fire Na containment will be floated with Ar
  - Tanks tested to overpressure

Variable	AMTEC @ INR
V	0.4 – 1.2 V
I	0.5 – 1.5 A/cm²
P	0.5 – 1.5 W/cm²
$\eta_{present}$	~ 20 %
T_{Na}	600 – 1000 °C
p_{Na}	10 Pa – 0.1 MPa

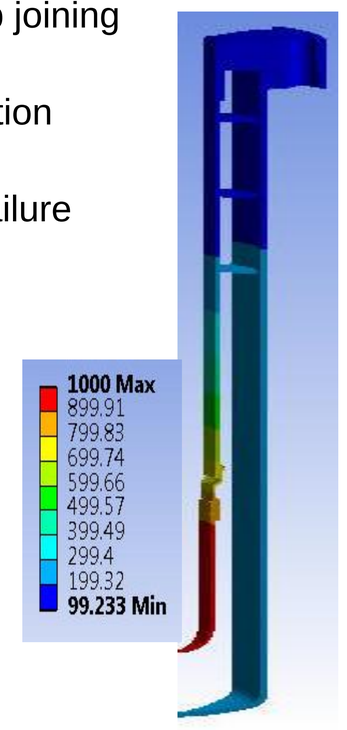


Safety analysis

- Temperature and stress distribution in cell obtained (steady state and transient analysis)
- No failure at working conditions (1.5 bar, 1000 °C) → safe design
- Highest stresses in BASE-Nb joining → possible failure at ≥ 6 bar
- Cooling under forced convection (transient) → no failure
- High ΔT along BASE → no failure



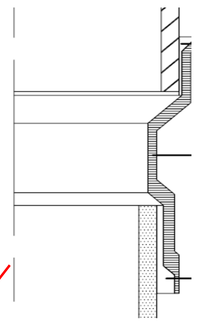
Stress distribution in Brazing [MPa]. Steady state.



Temperature distribution in 1/8 of the cell [°C]. Steady state.

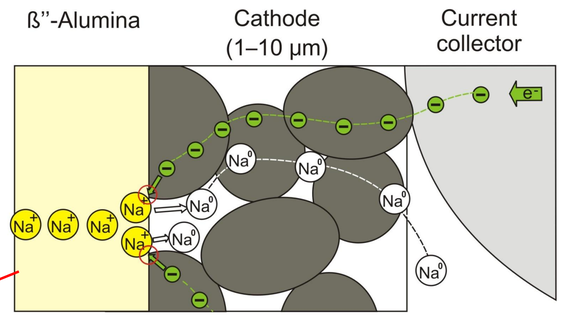
AMTEC test cell

Ceramic to metal joining



- TiNiNb Sealing → tested in the nineties at INR
- New sealing materials (active brazing alloy)

Electrode (Cathode) and current collector



- Magnetron sputtered cathode
- Grid / foam current collector

BASE (ß''-Alumina Solid Electrolyte)

- Surface cleanliness
- Surface microcracks

Surface microcrack (Tennenhouse, 1975)

Main goals 2014

- Set into operation: November 2014
- Ceramic-metal joining
- Sputtered electrode
- Analysis of the ceramic surface
- CO_2 cleaning of the ceramic
- First measurements
- Proposals for design optimization → Improved technology