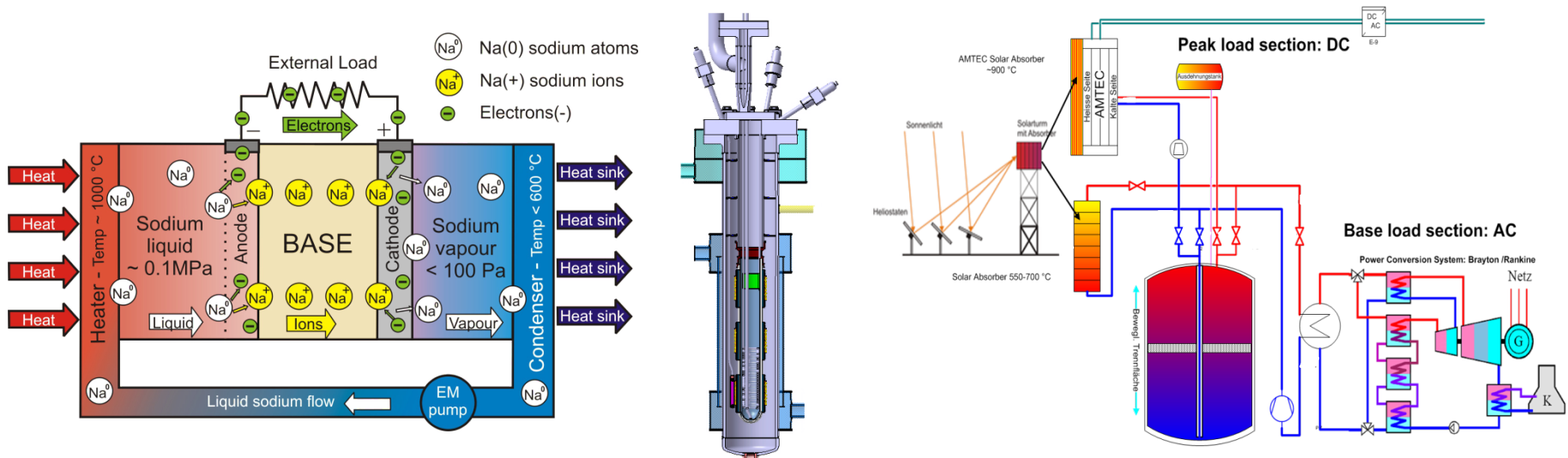


B4: Phase changes in liquid metals for direct energy conversion

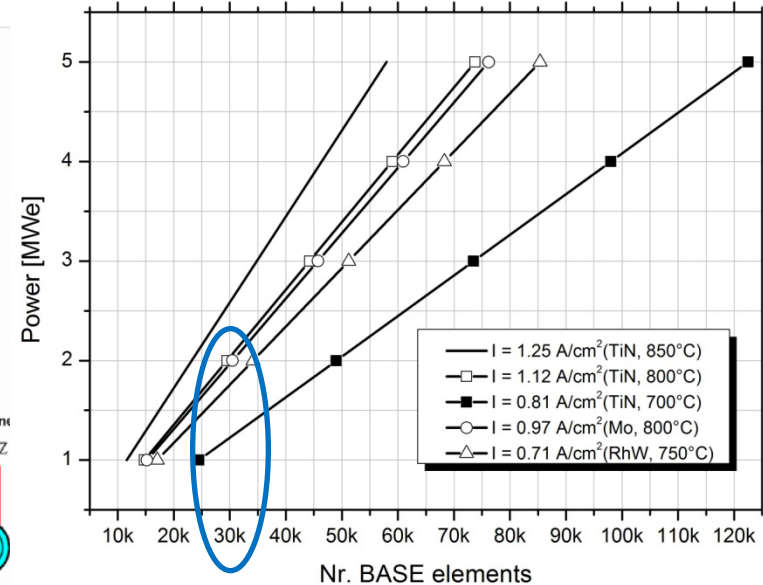
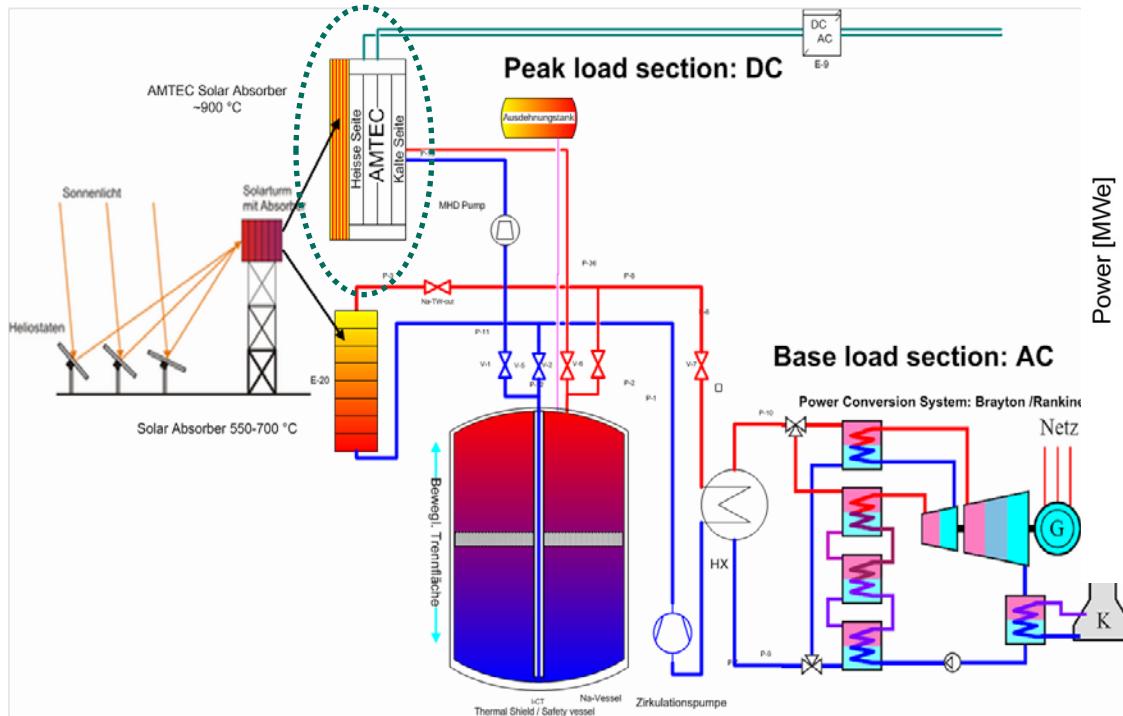
A. Onea, N. Díez de los Ríos Ramos, W. Hering, A. Weisenburger,
M. Lux, J.L. Palacios, R. Stieglitz

LIMTECH Meeting, 10–11.11.2014, Ilmenau

Karlsruhe Institute for Technology (KIT) – Institute for Neutron Physics and Reactor Technology (INR)



Hybrid concept*: AMTEC & CSP



AMTEC cluster

- Electrical output: ~ 2 MWe
- Nr. BASE elements: ~ 30k
- Current density: ~ 1 A/cm²
- Open issue: power loss

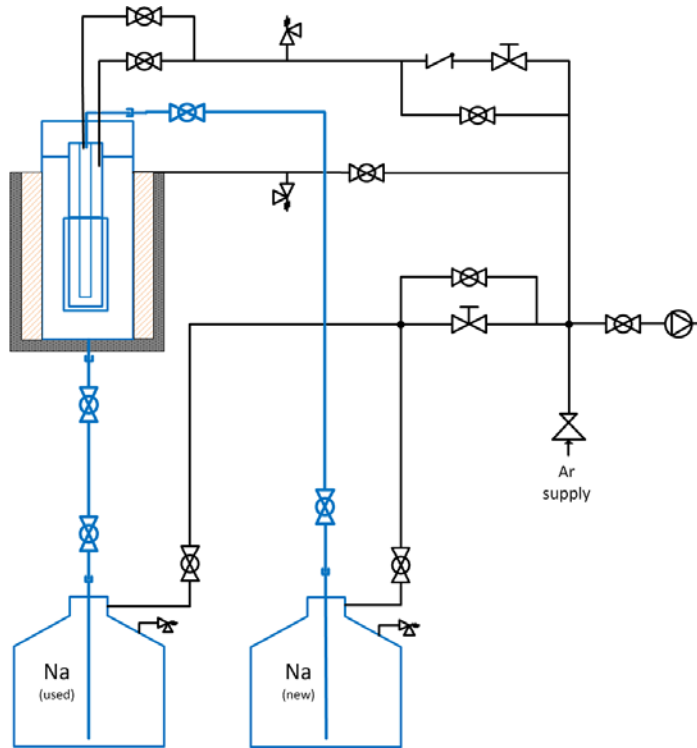
*Hering et al., E2C, Maastricht, 2012

A & CSP:

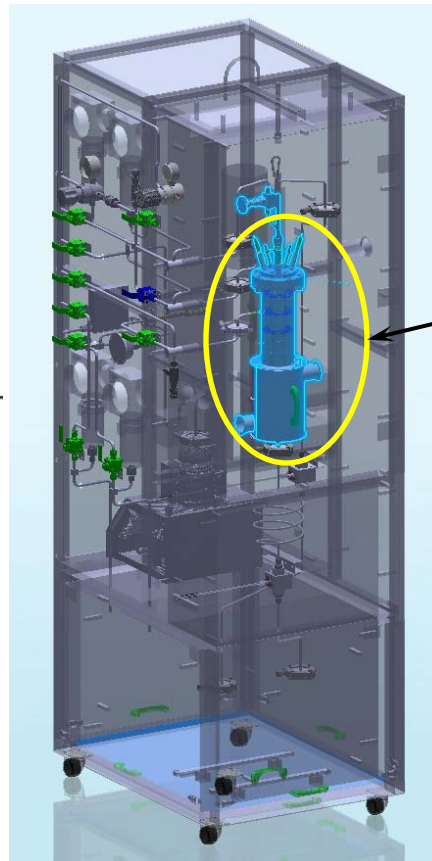
- HTF + storage fluid: Na
- Plant size: ~ 100 MWth
- Loading time: 6 – 8 h
- Storage time: 16 – 18 h
- Storage tank*: 200 – 550 °C
- AMTEC: > 600 °C

ATEFA Facility: Status (1)

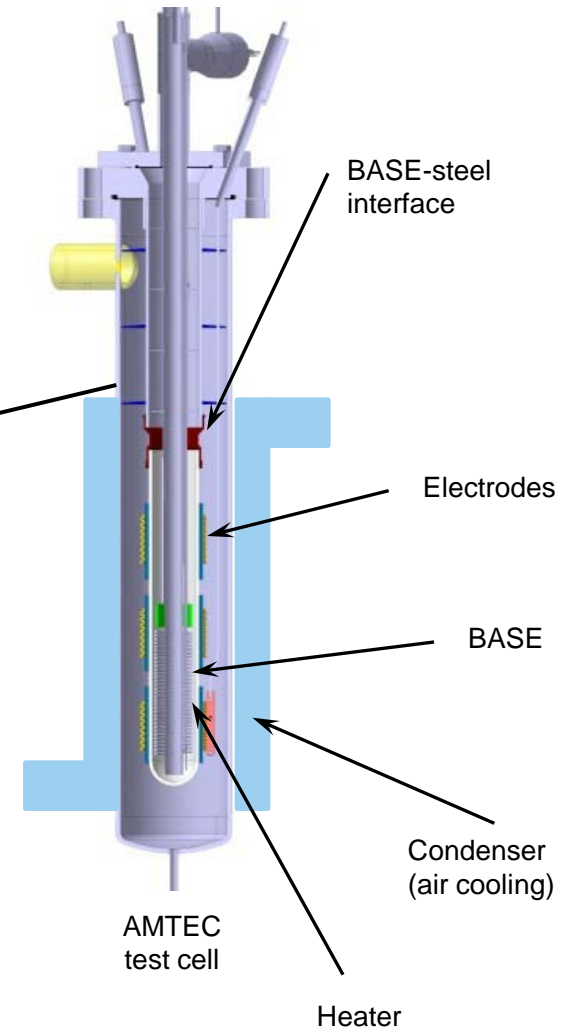
■ Stand: in construction



ATEFA Facility – P&I Diagram



ATEFA facility
CAD model

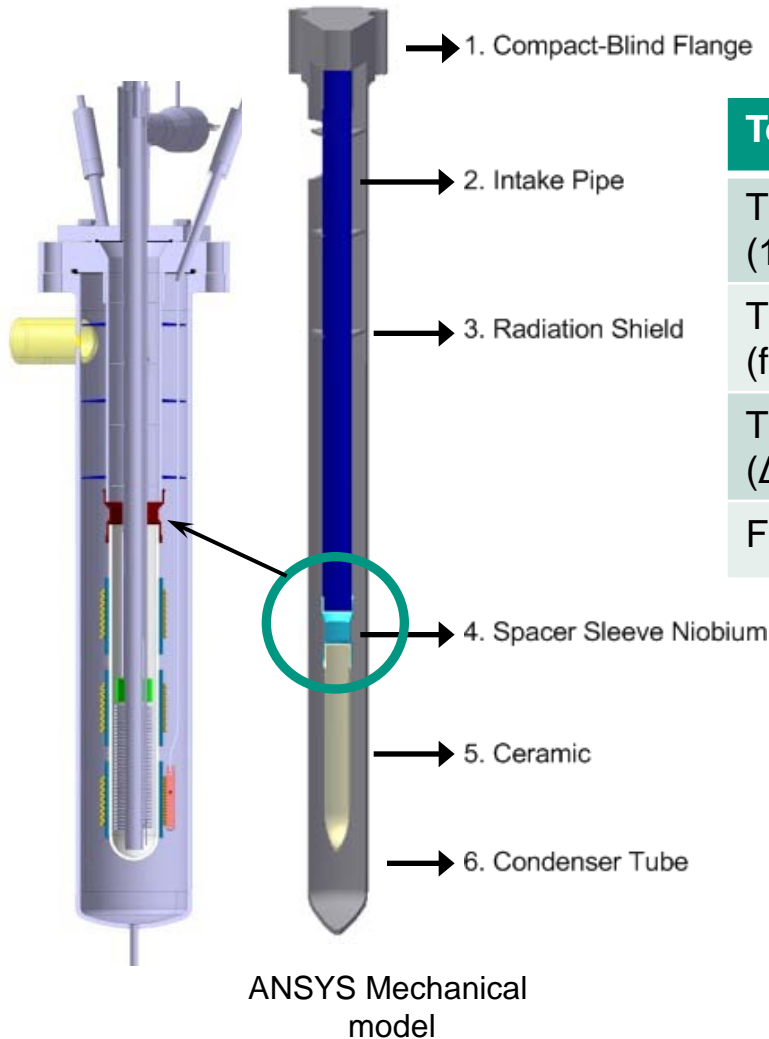


See Poster: Nerea Diez de los Rios Ramos

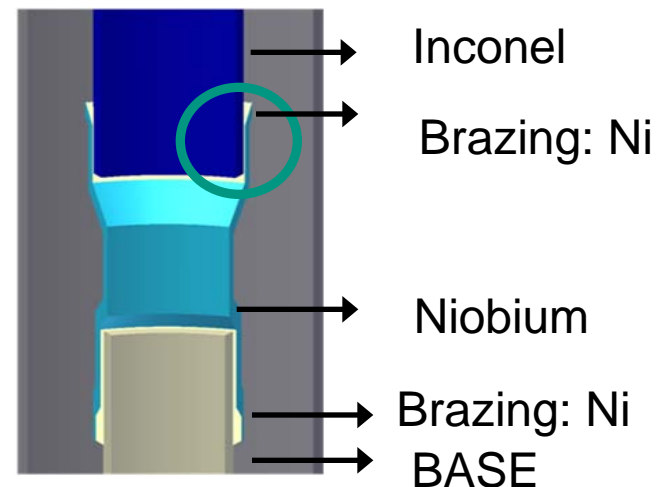
ATEFA Facility: Status (2)

		Stand	Remarks
Components	Na, Ar valves,	✓	
	Vacuum pump	✓	
	Control unit, instrumentation, trace heating	✓	
	Na tank	✓	2nd tank in progress
Test cell	Mo deposition	✓	
	Metal-ceramic brazing	In progress	First tests 11.2014
	Frame	In progress	01.2015
Assembly framework	Frame machining	In progress	
	Assembly frame	02.2015	
AMTEC lab	Ar supply	✓	
	Glove-box operable	✓	
	Melting facility	✓	First tests 11.2014
First tests		03.2015	Exp. campaign 04.15

AMTEC cell – Structural & thermal analysis

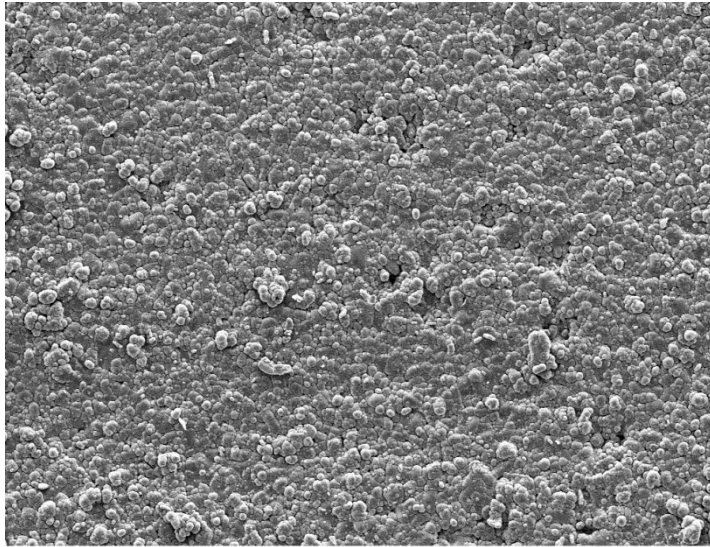


Test case	Analysis	Results
T & S distribution (1000°C, 2 bar)	Steady state	No failure at operating range (safety factor ~3)
T & S distribution (forced convection)	Transient	No failure
T & S distribution ($\Delta T_{BASE} = 300^\circ C$)	Steady state	No failure
Failure pressure	Steady state	~0.7 MPa at upper brazing



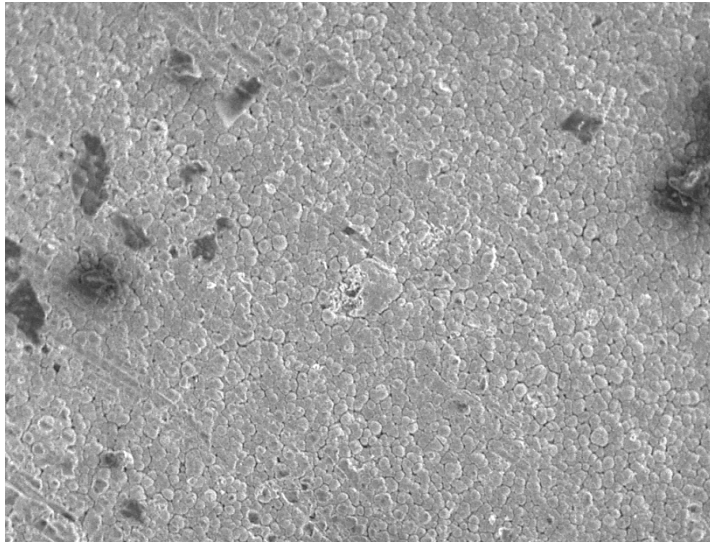
J.L. Palacios

BASE sputtering (Mo)*



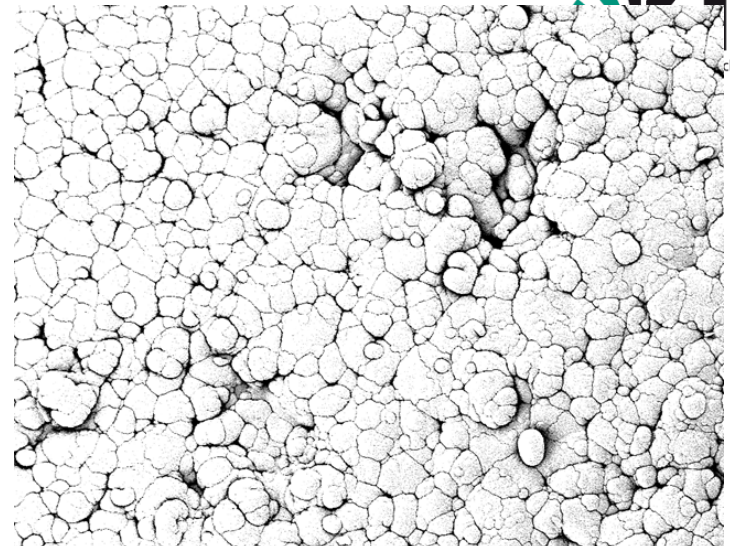
15 keV 200 14.10.2014 Mo-Sputtern 60mA

100 μm



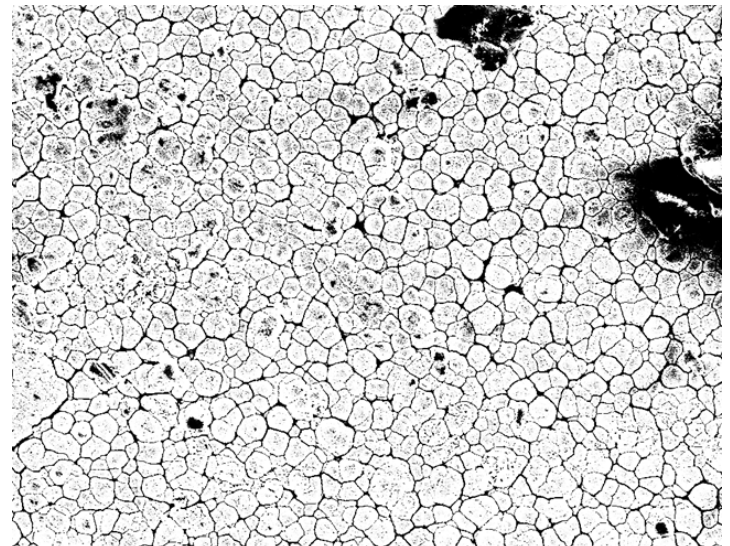
10 keV 300 22.10.2014 Mo-Sputtern 102mA, 24h

80 μm



1 keV 700 14.10.2014 Mo-Sputtern 60mA

40 μm

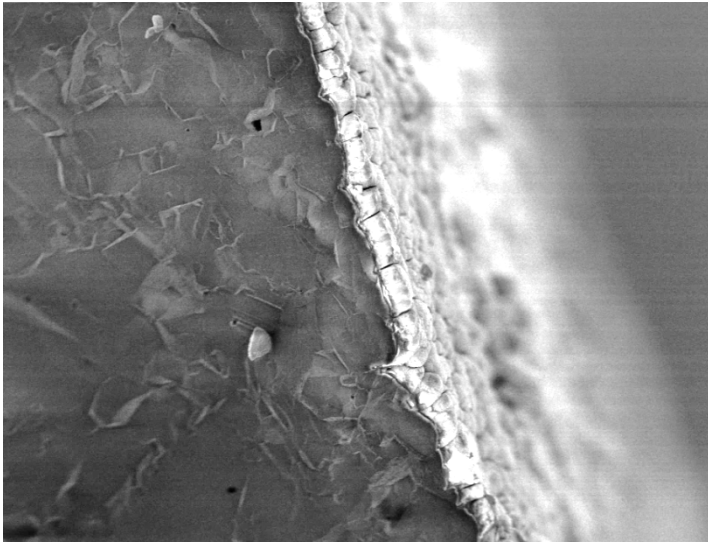


10 keV 700 22.10.2014 Mo-Sputtern 102mA, 24h

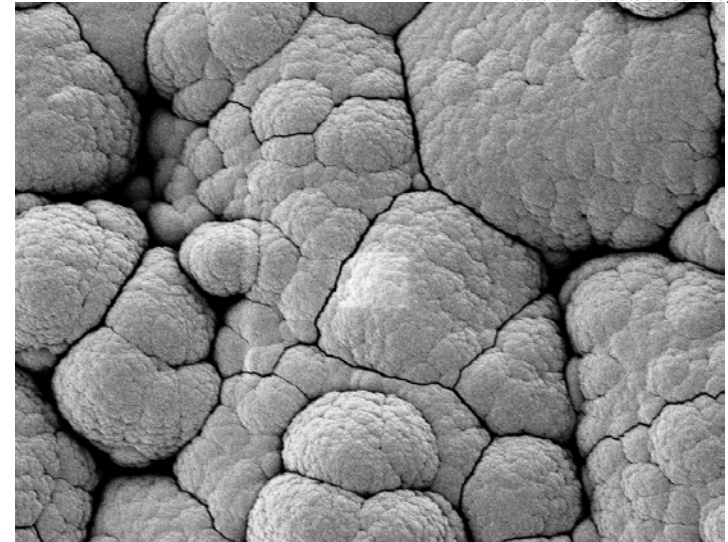
40 μm

*Alfons Weisenburger, KIT - IHM, alfons.weisenburger@kit.edu

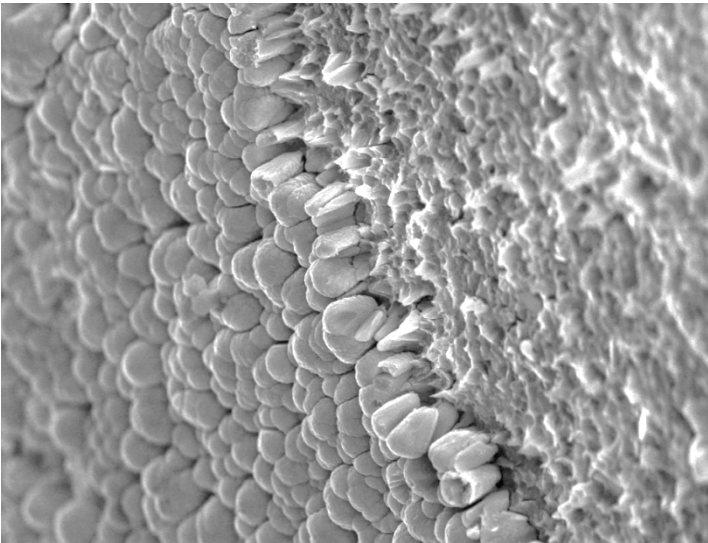
BASE sputtering (Mo)



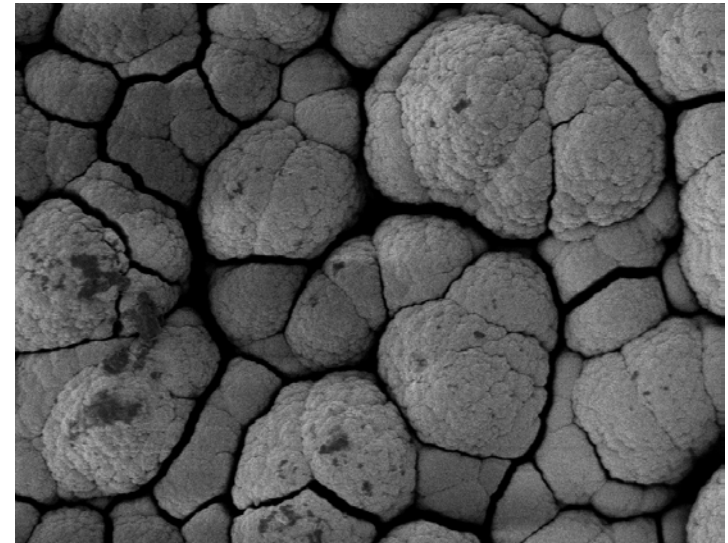
1 keV 700 14.10.2014 Mo-Sputtern 60mA, Querschnitt | 40 μm |



1 keV 5000 14.10.2014 Mo-Sputtern 60mA | 5 μm |



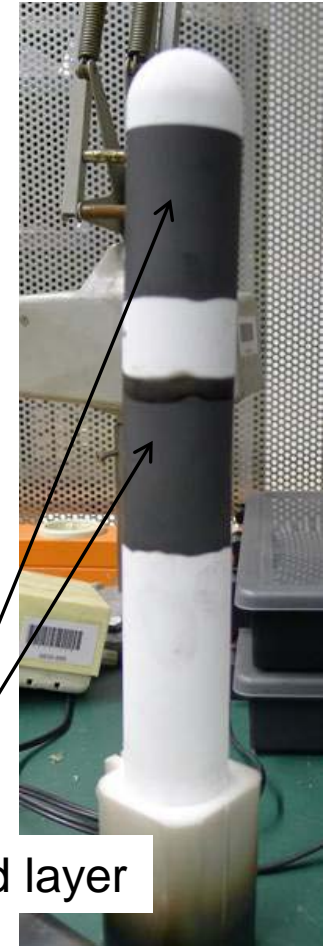
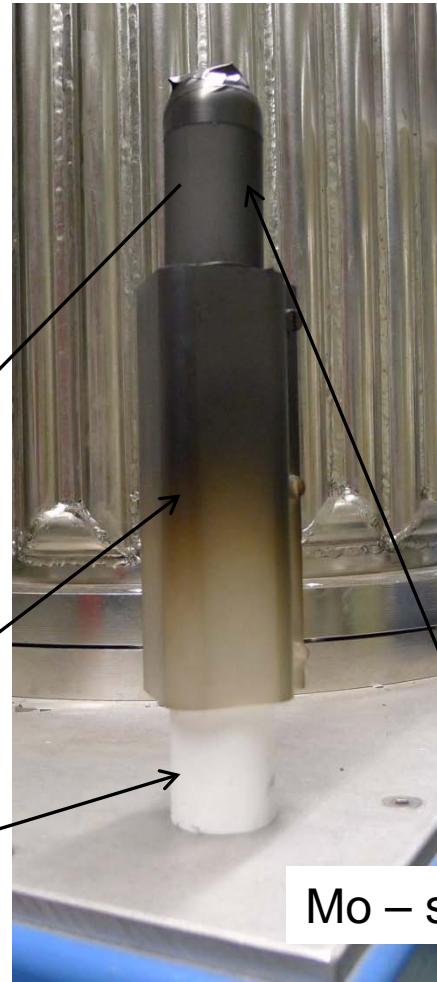
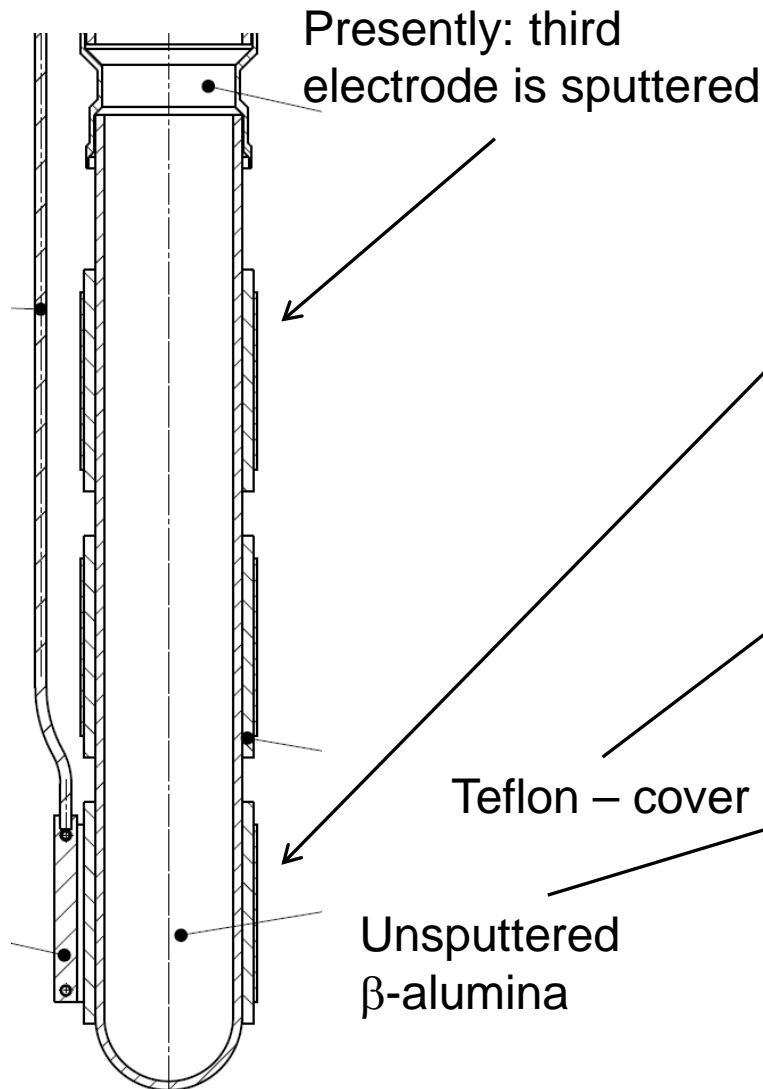
20 keV 1300 21.10.2014 Mo-Sputtern 102mA, 24h | 20 μm |



1 keV 5000 22.10.2014 Mo-Sputtern 102mA, 24h | 5 μm |

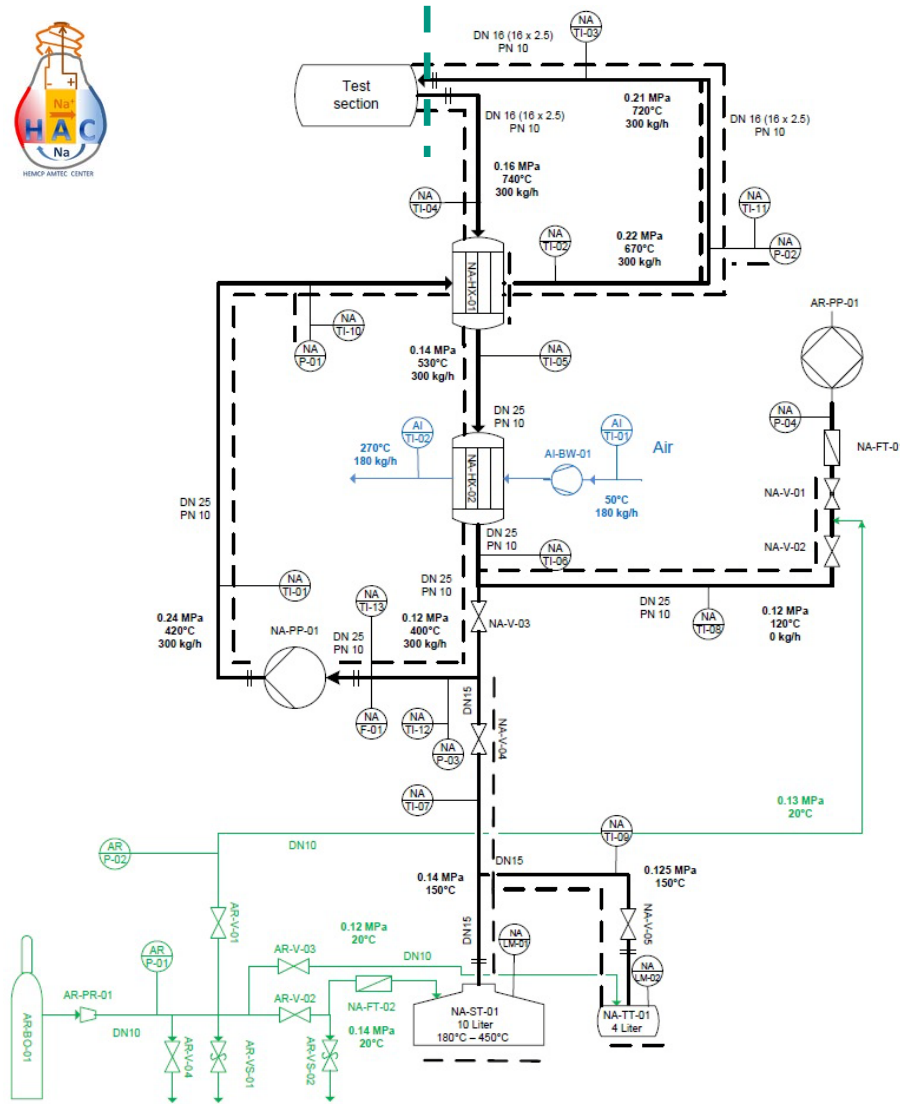
BASE sputtering (Mo)

Magnetron sputtering



Mo - sputtered layer

HAC Facilities: SOLTEC



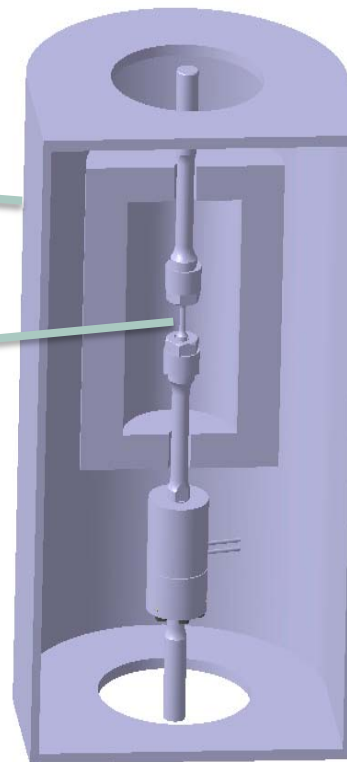
HEMCP infrastructure

- 8- shape loop for long term material and corrosion tests
- High efficient intermediate HX
- Temperatures:
Cold loop: 700 K (SS)
Hot loop: 1000 K (Inconel)
- Mass flow rate: ~300 kg/h
- Design: ready
- Acquisition phase: started
 - Na-pump
 - Universal traction facility
- Construction start: End 2014
- Set into operation: Spring 2015

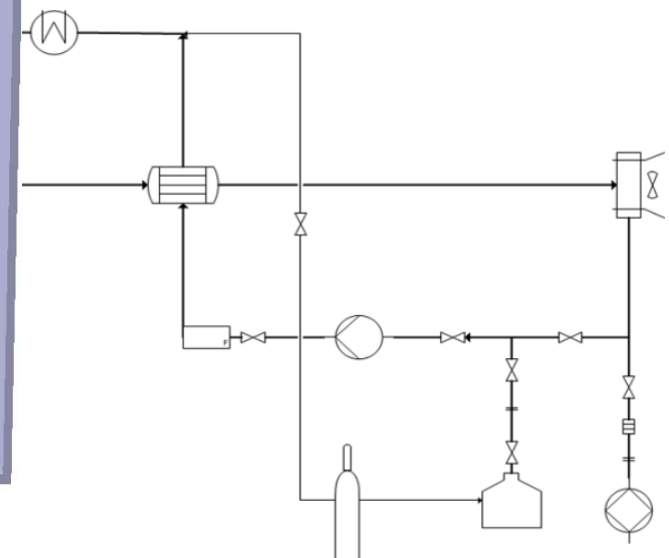
Initial design: Pascal Hinkerohe

Future Material testing

- Creep fatigue / stress corrosion cracking
- W-compounds and metal-ceramic joints
- Up to 1000 K in vacuum furnace
→ **Unique: in situ tests with flowing sodium**



Interface to SOLTEC – loop



Contents

1. AMTEC clusters for A&CSP
2. AMTEC TESt FAcility (ATEFA)
 - a) Status
 - b) Test cell - Structural analysis
 - c) Test cell - Mo deposition, BASE
3. SOdium Loop for TESt Materials and Corrosion (SOLTEC – HAC)

