

Testing of Materials and Coatings at up to 1150 °C and 300 bar for use in Oxy- Combustion Turbine

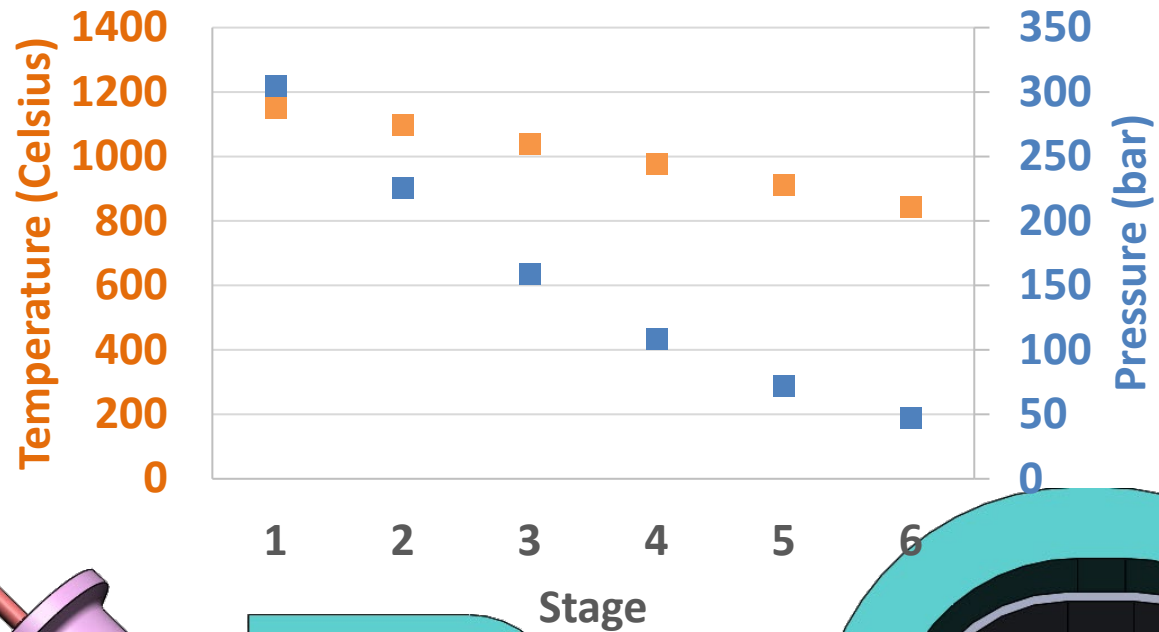
SOUTHWEST RESEARCH INSTITUTE®

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Material solutions and testing for sCO₂ at 1150 °C and 300 bar



MATERIALS ENGINEERING

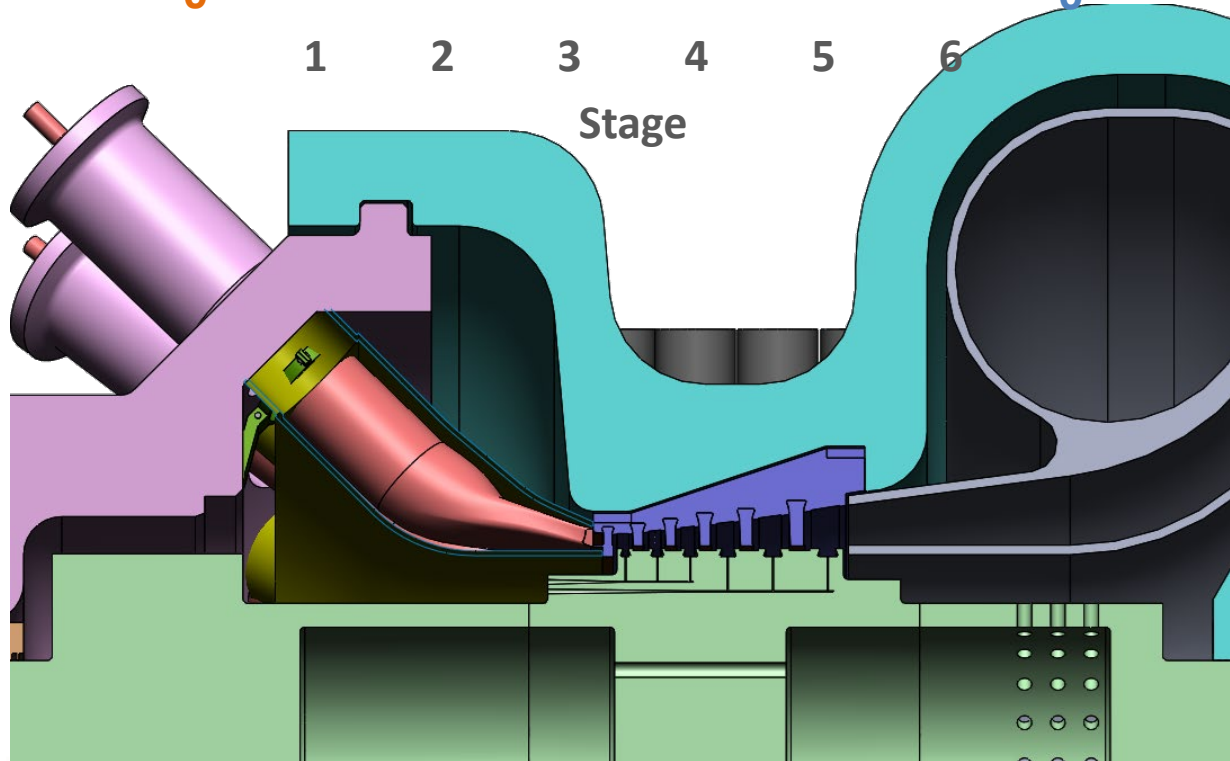
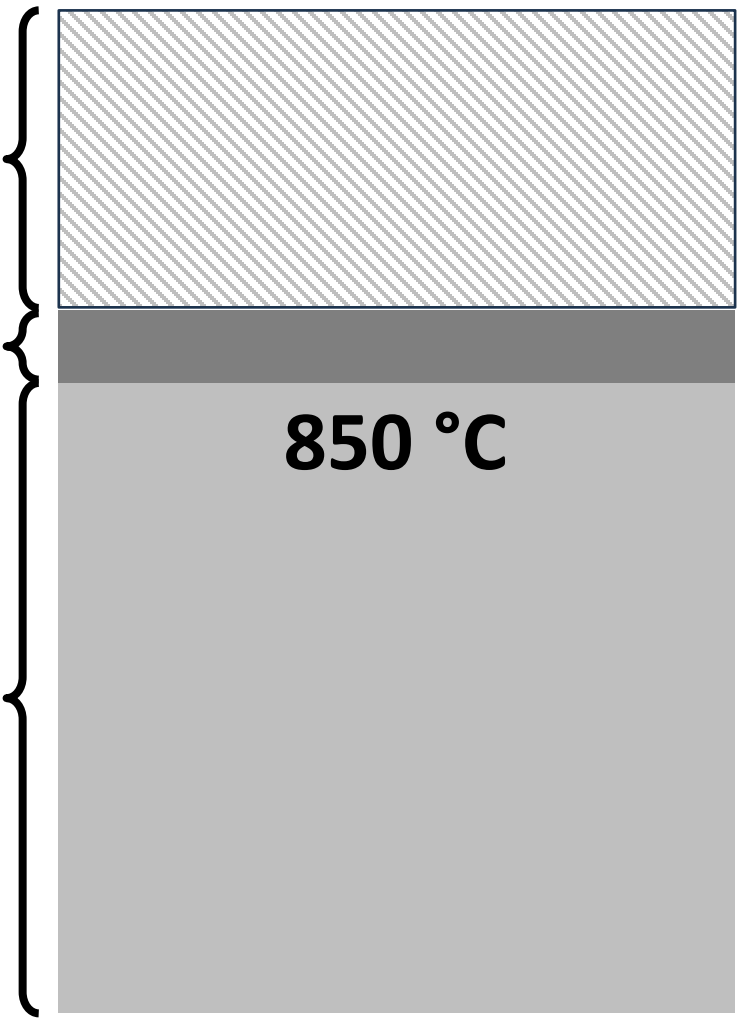


Thermal barrier coating:
Thermal insulation

Bond coat:
Oxidation protection

Substrate:
Mechanical properties

1150 °C

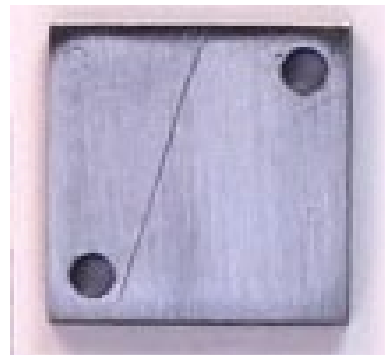


MECHANICAL ENGINEERING

Range of materials investigated



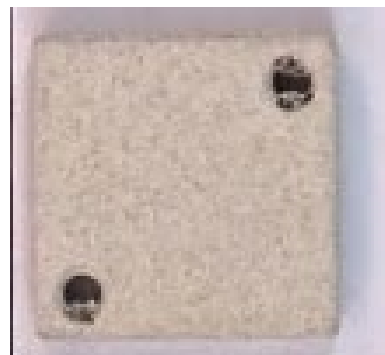
Alloy	UNS	Bare	NiCrAlY	NiCrAlY & TBC	Th. Sp.. & TBC
693	N06693	✓	✓		
740H	N07740	✓	✓	✓	✓
Nimonic 105	N13021	✓	✓		
APMT Kanthal	n/a	✓	✓		
353 MA	S35315	✓	✓		
Sanicro 25	S31035	✓	✓		
718	N07718	✓	✓		
230	N06230	✓	✓		
625	N06625	✓	✓	✓	✓
HR-224	n/a	✓	✓		
HR-120	N08120	✓	✓		
214	N07214	✓	✓		
282	N07208	✓	✓	✓	✓



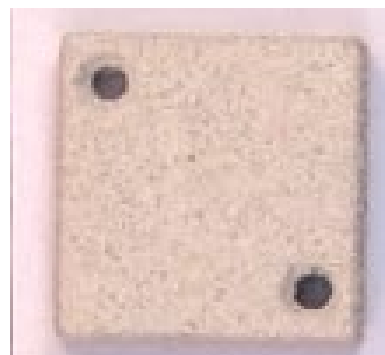
Bare



NiCrAlY bond coat



NiCrAlY bond coat & TBC



Thermal sprayed bond coat & TBC

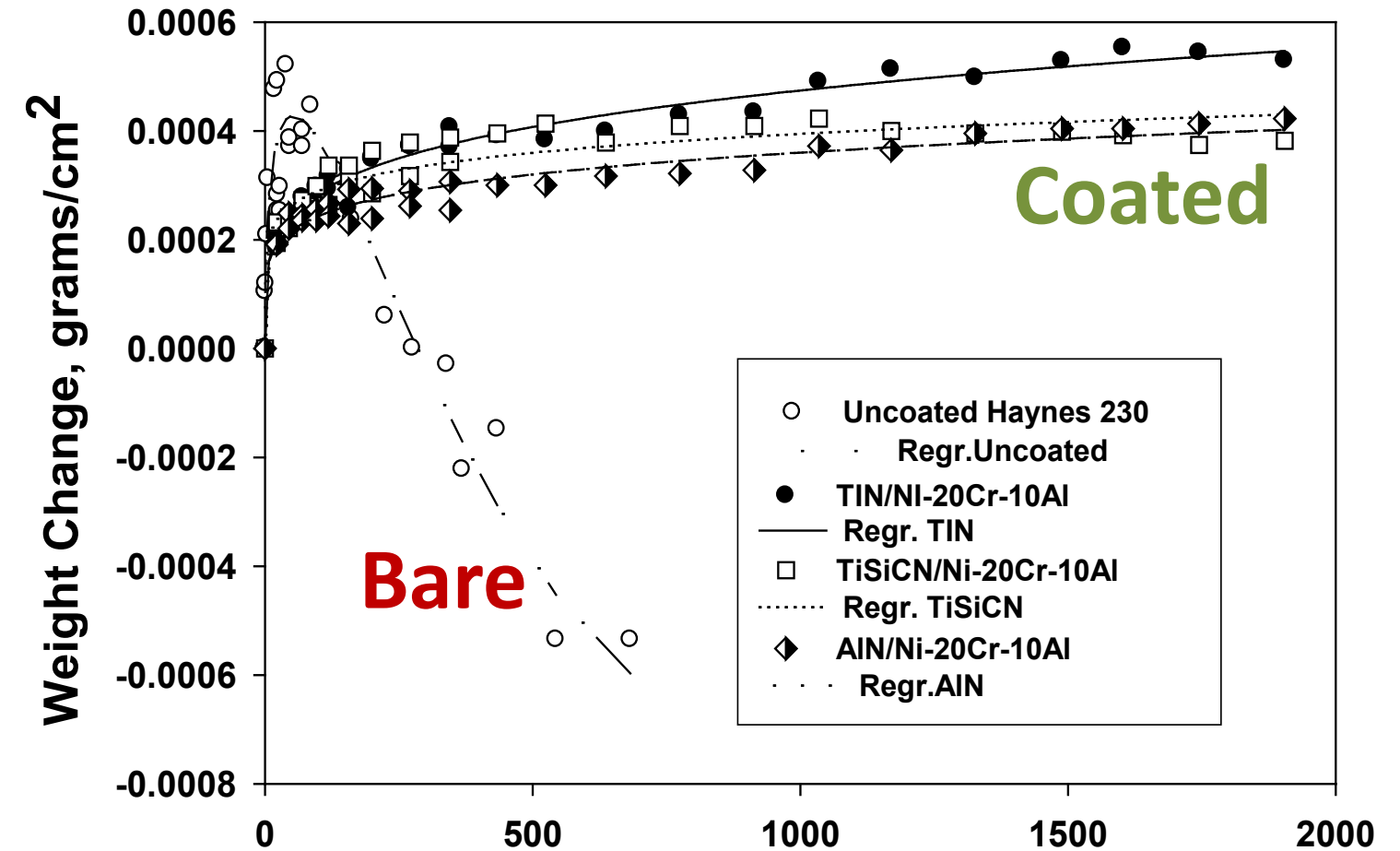
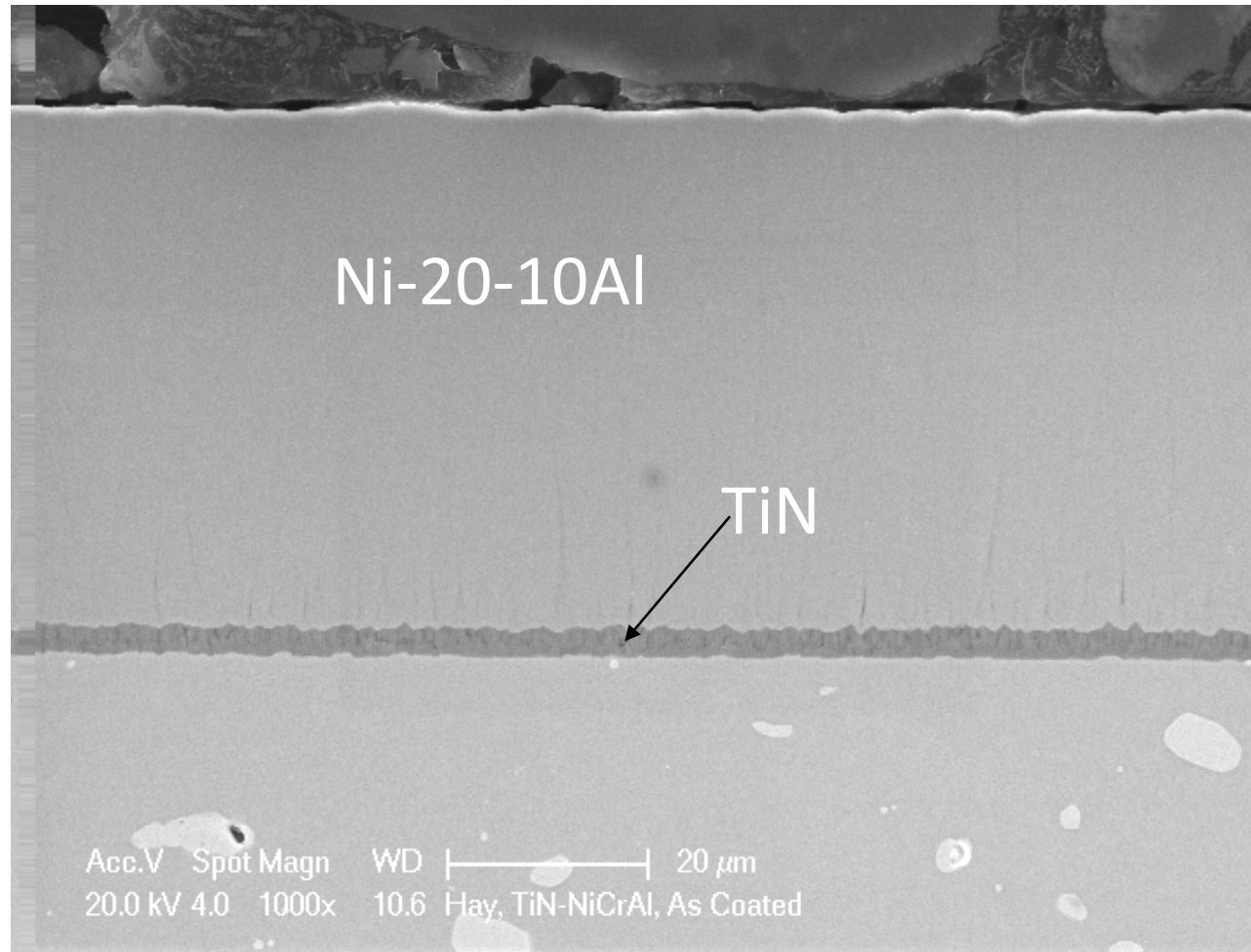
- Chromium oxide nickel alloy
- Aluminum oxide nickel alloy
- Chromium oxide stainless steel



Benefits of NiCrAlY nanocrystalline bond coat



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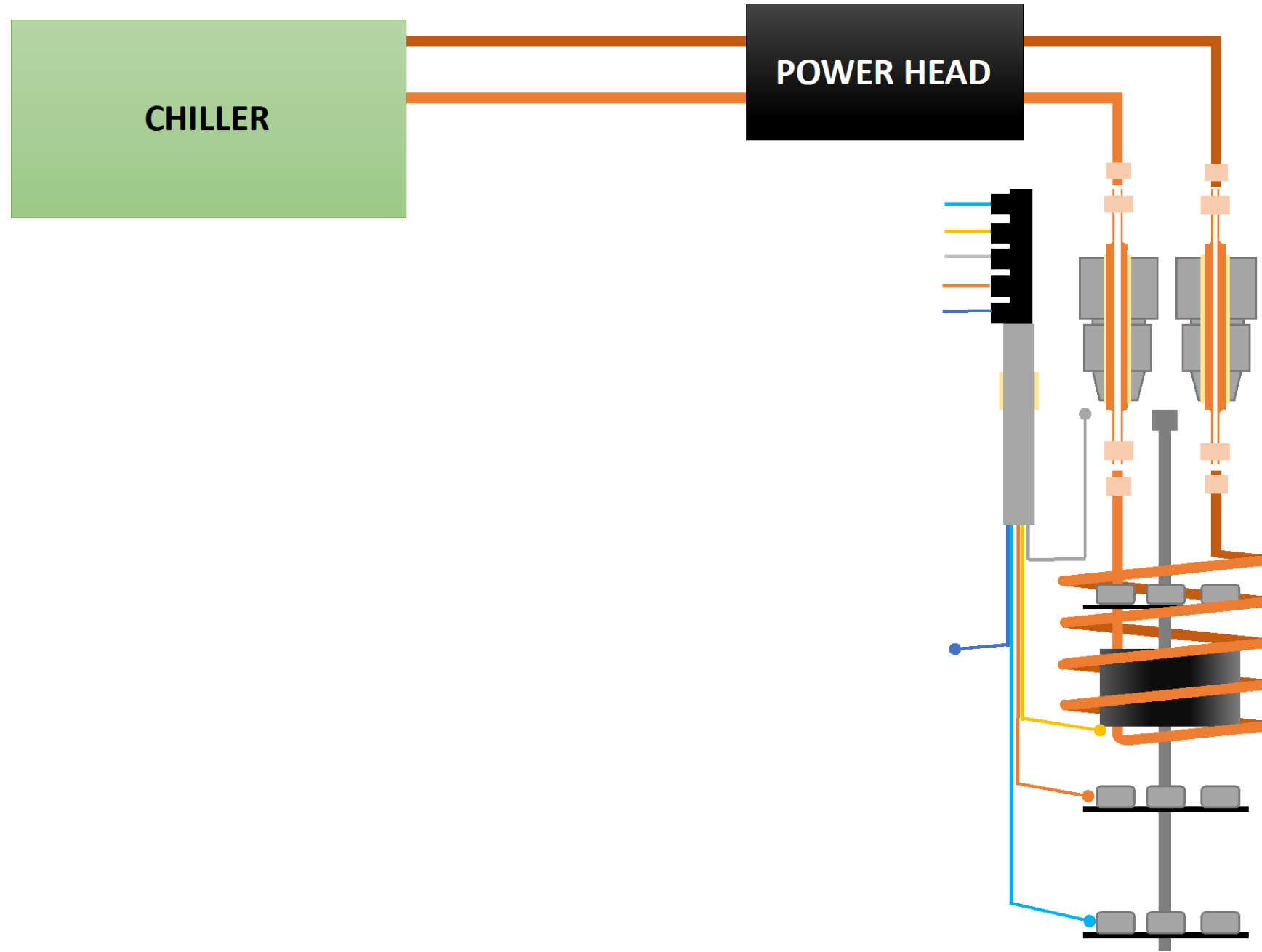


Chemical Composition wt.% :
MCrAl: 11.8Al, 18.7Cr, Bal. Ni

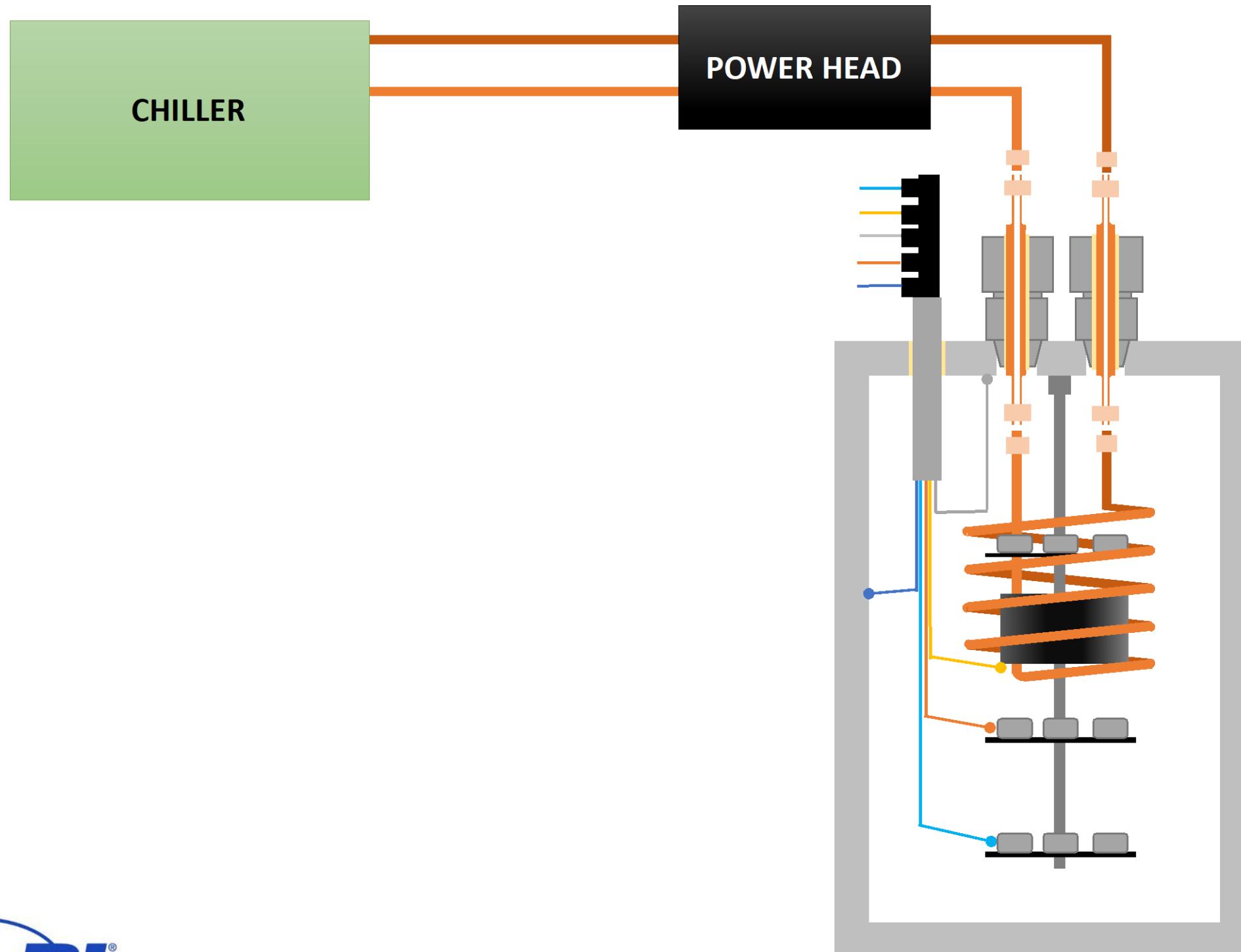


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Induction coil...



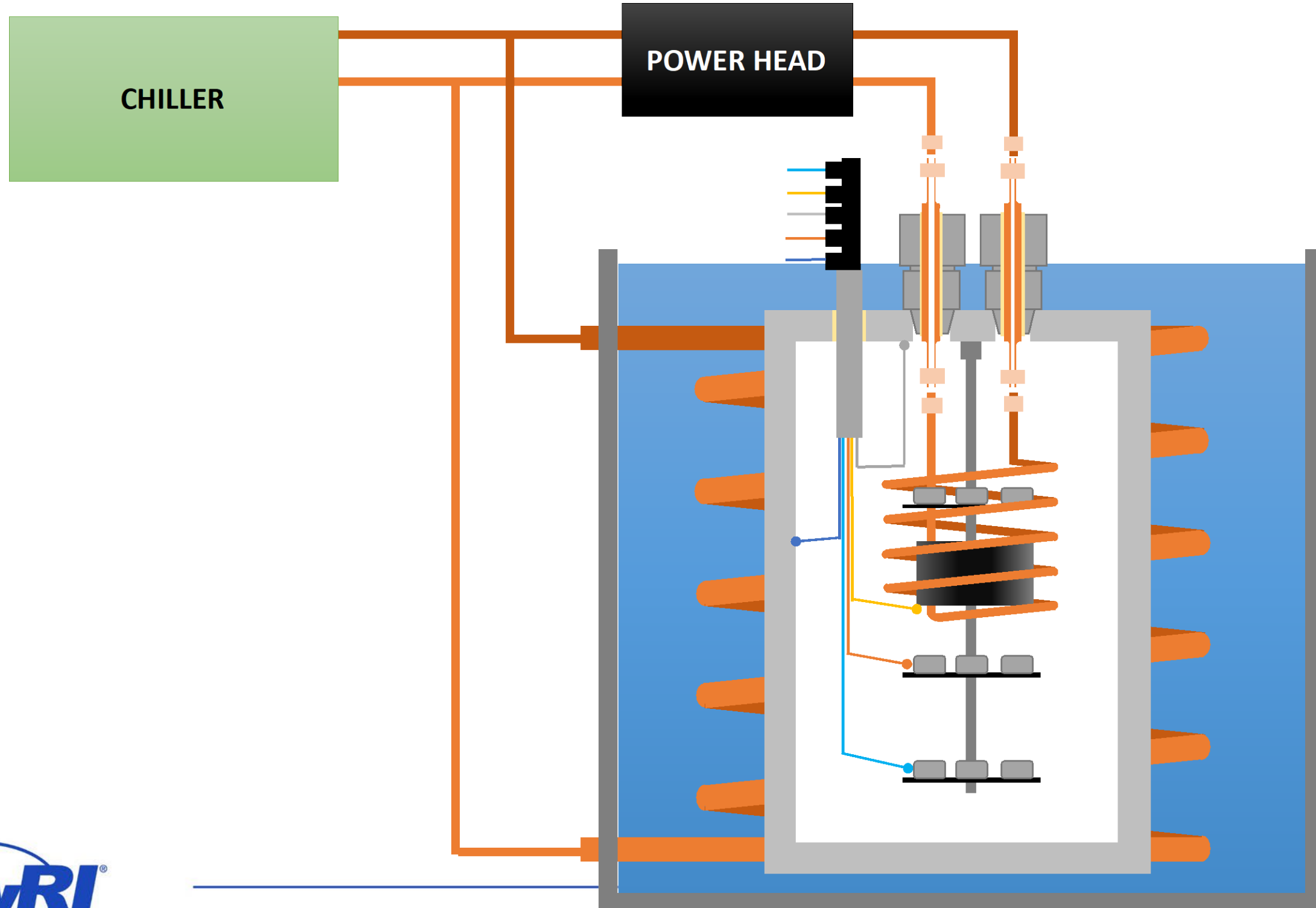
... inside an autoclave ...



... in a cooled bath...



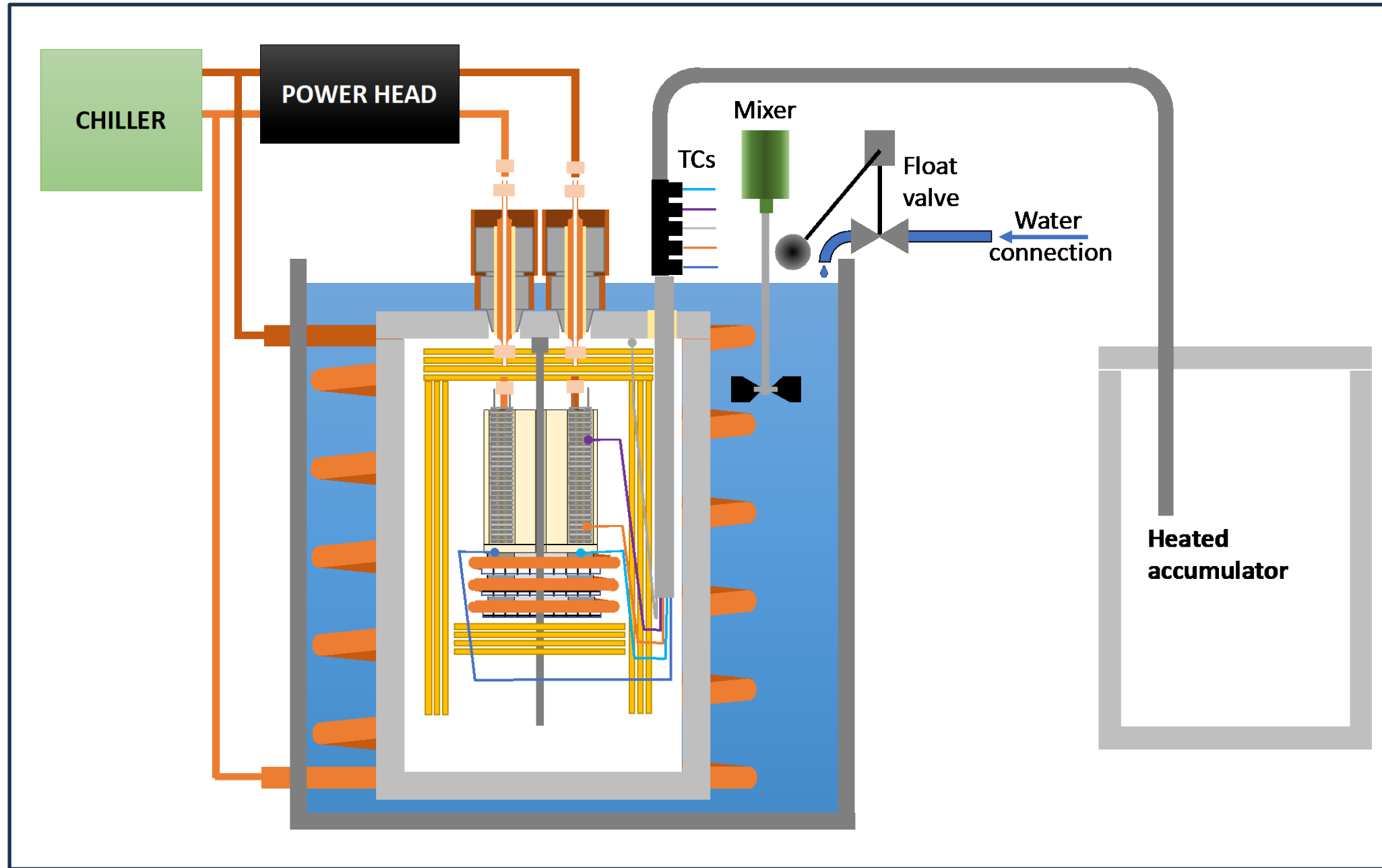
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... and connected to an accumulator.



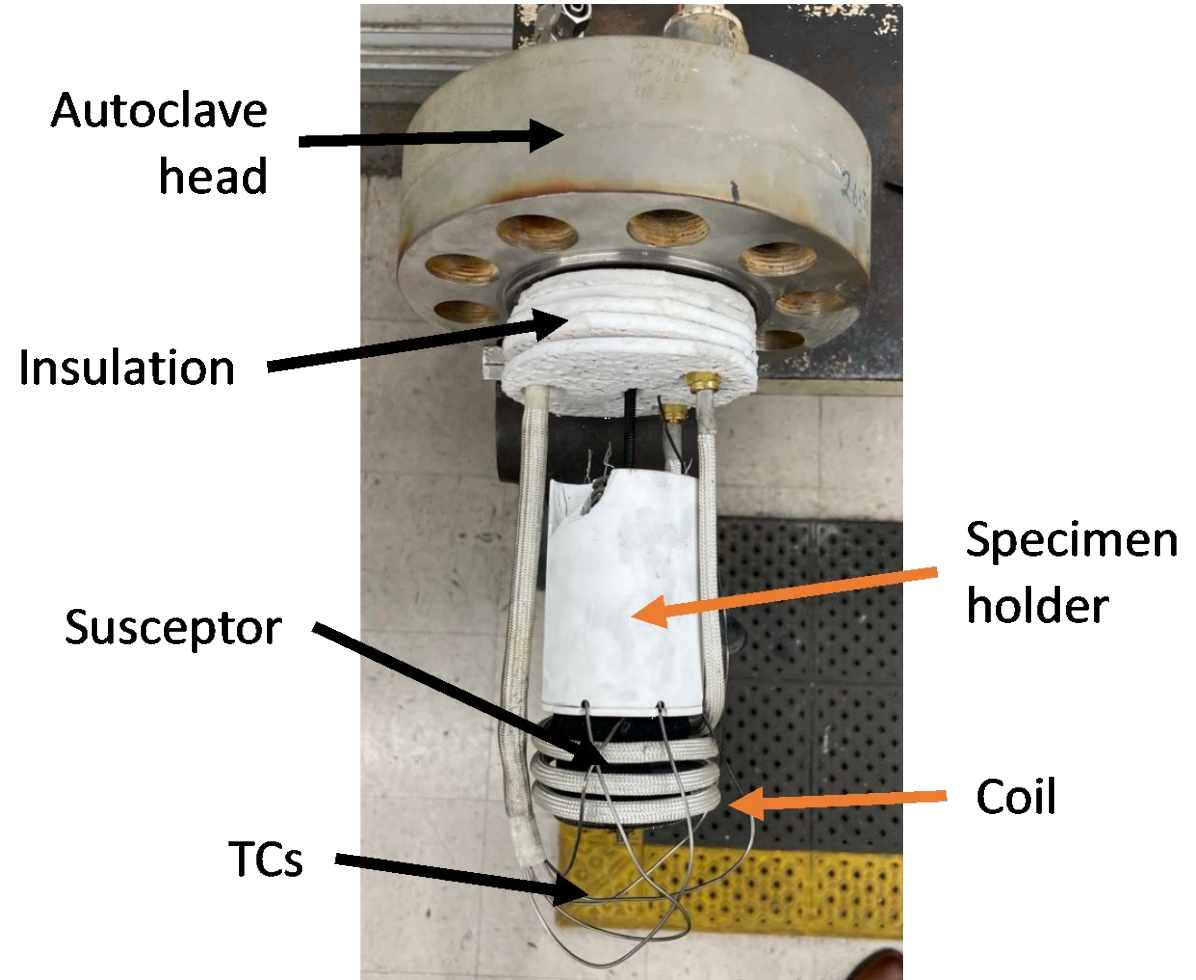
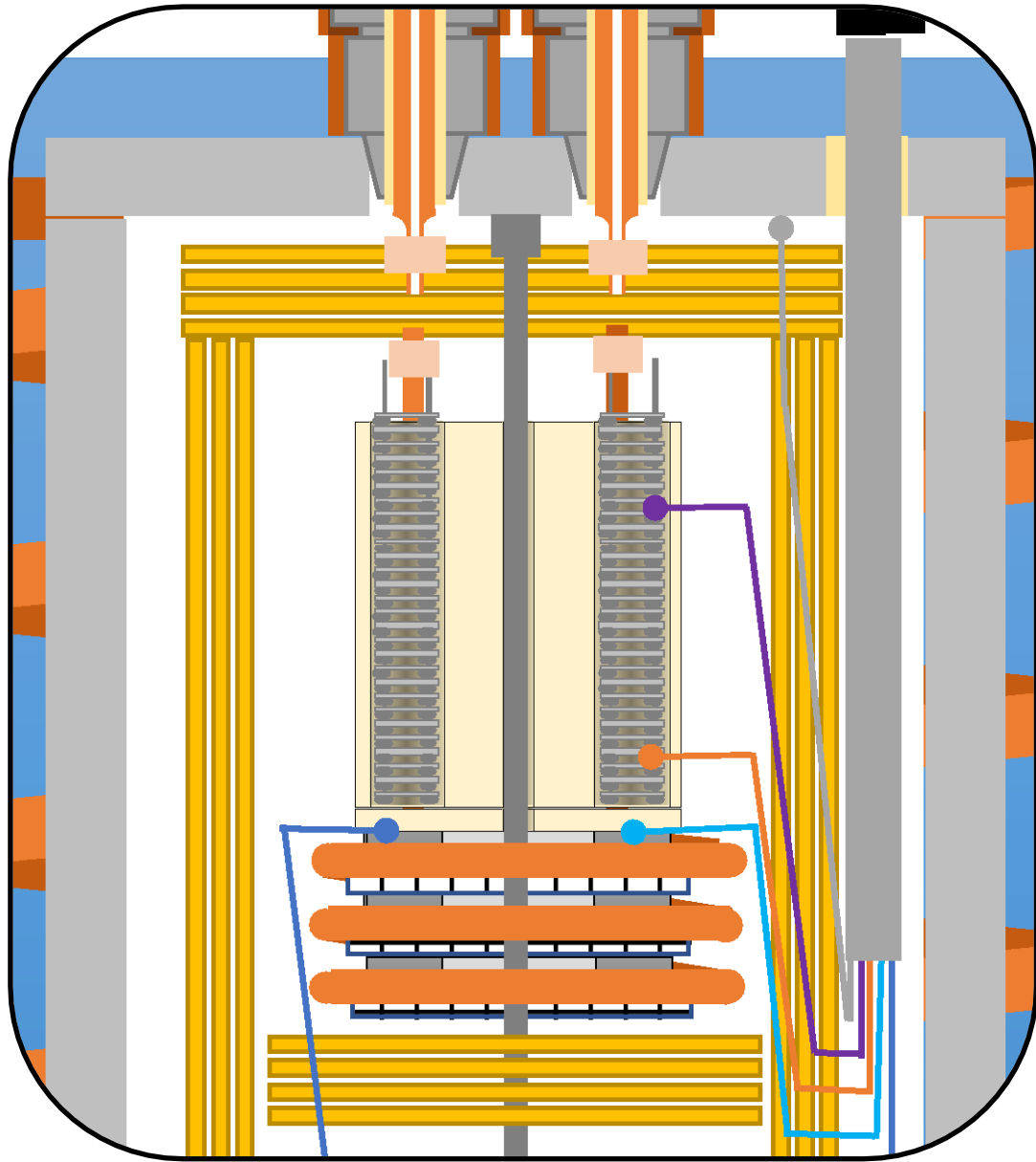
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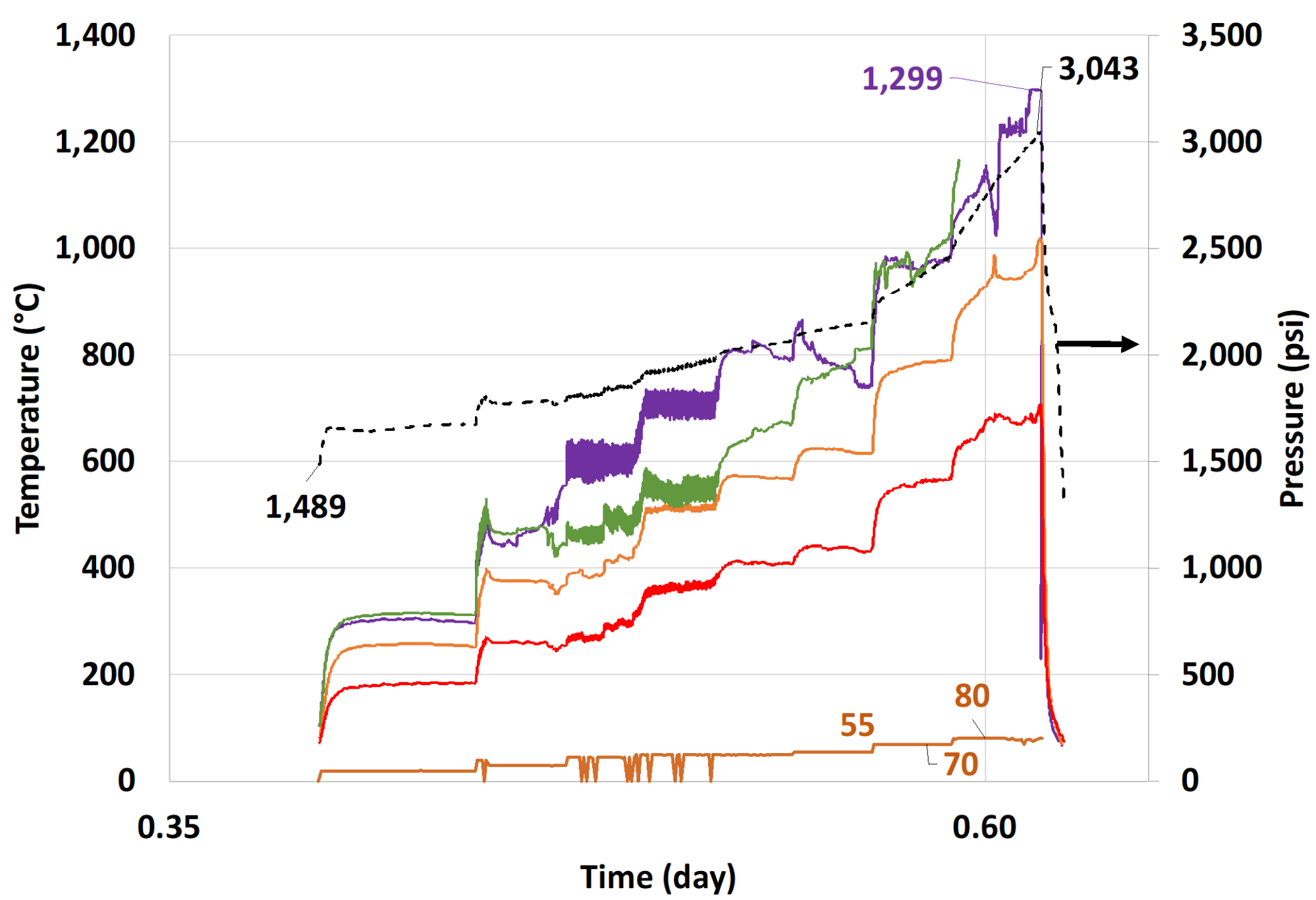


Using a susceptor for heat source

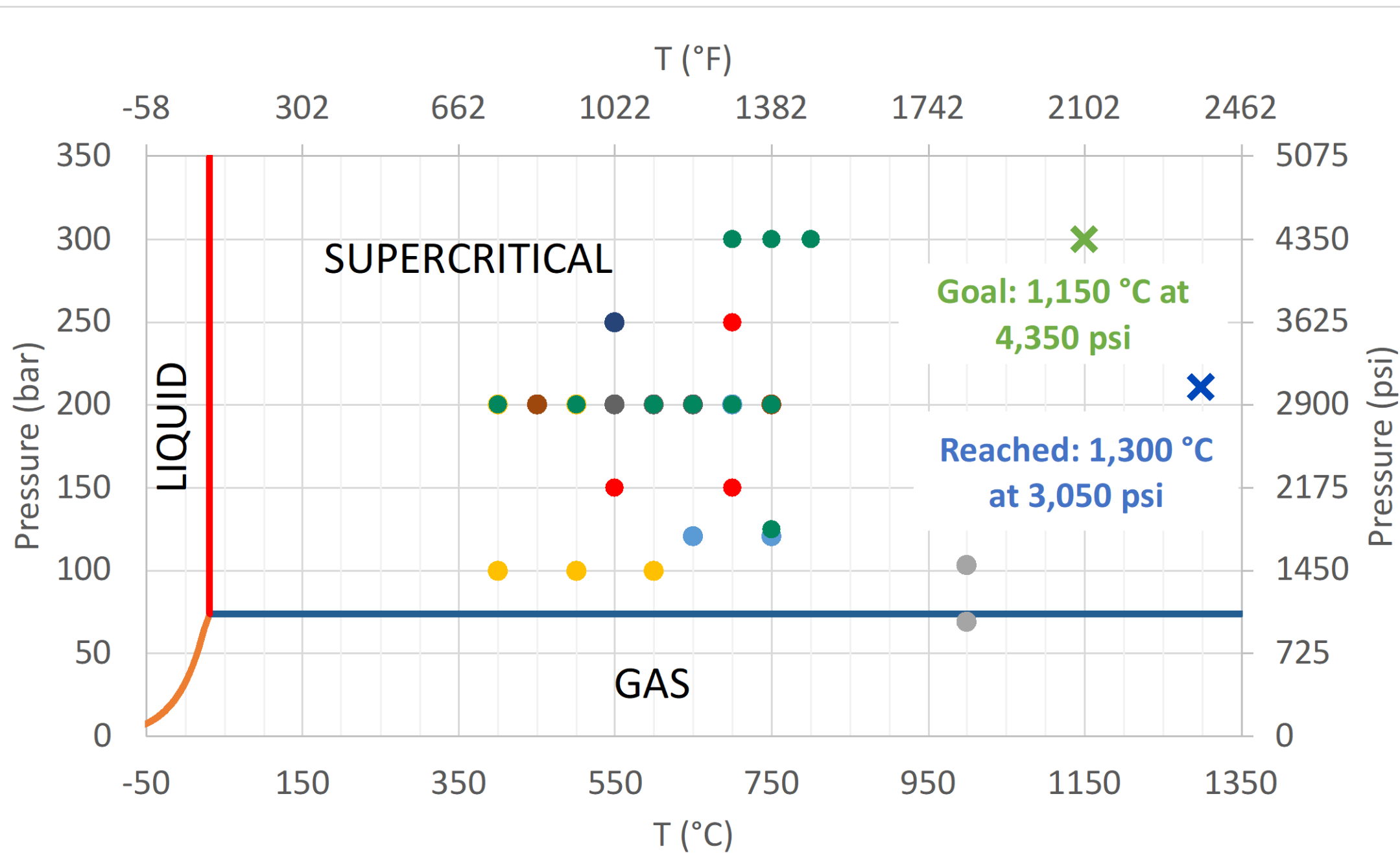


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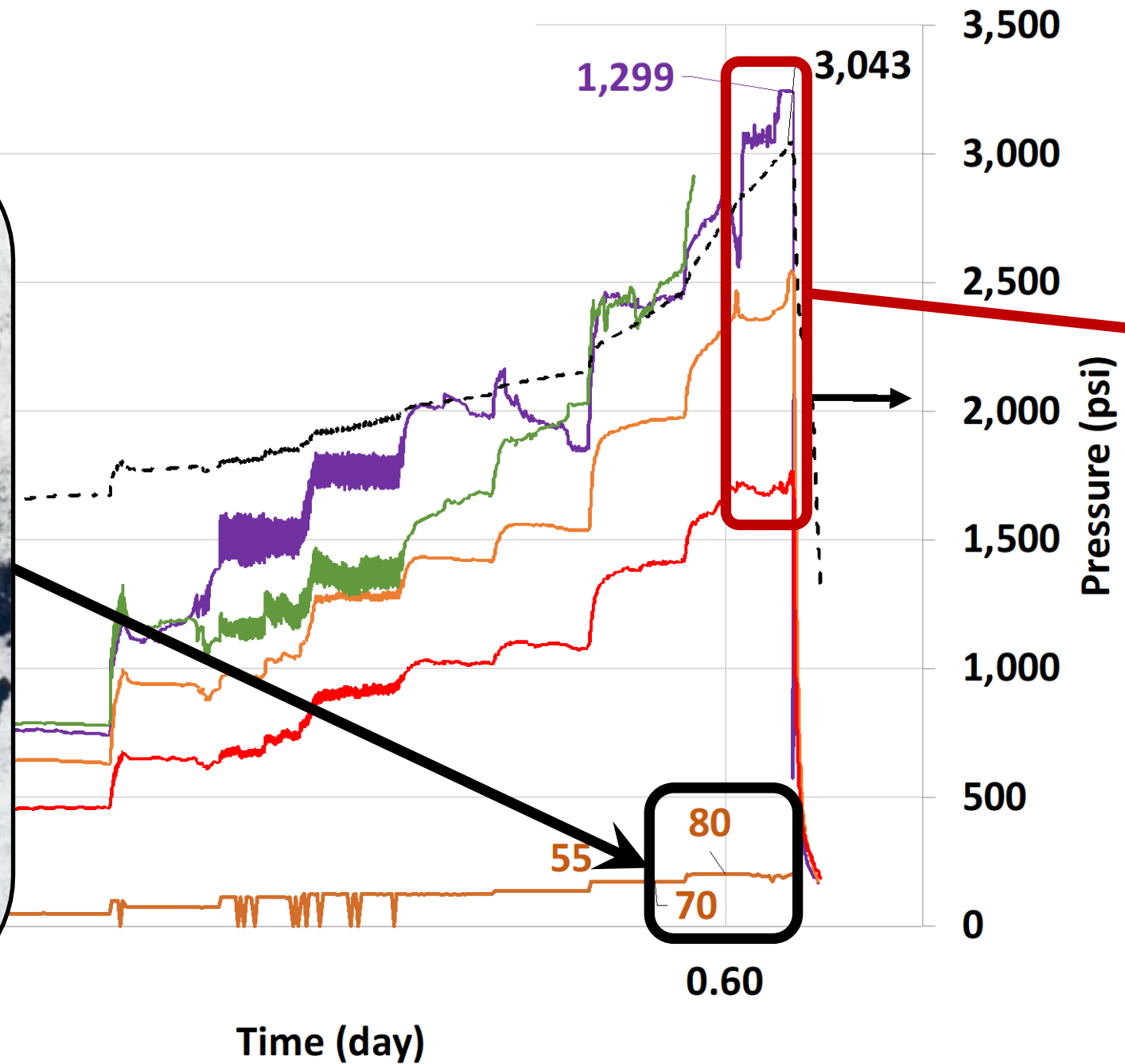


— Susceptor 1 — Top — Susceptor 2 — Mid — Pw1 - - - Pressure



- INL
- JAEA
- MIT
- NRC
- CEA
- Wisconsin
- KAIST
- ORNL
- ✕ SwRI goal
- ✕ SwRI achieved

Issues



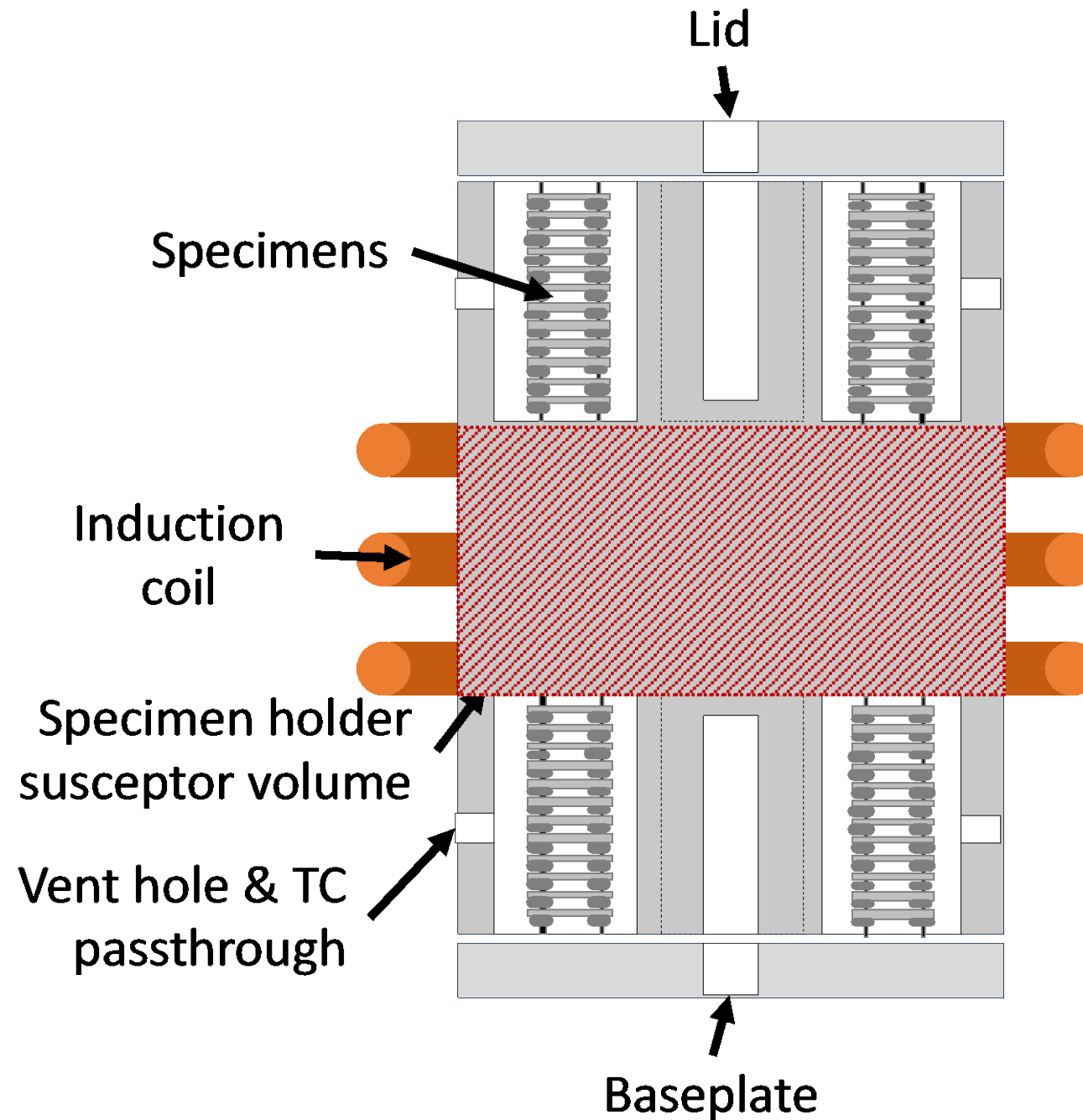
When power > 80%

— Susceptor 1 — Top — Susceptor 2 — Mid — Pw1 - - - Pressure

Homogeneous heating and resilience



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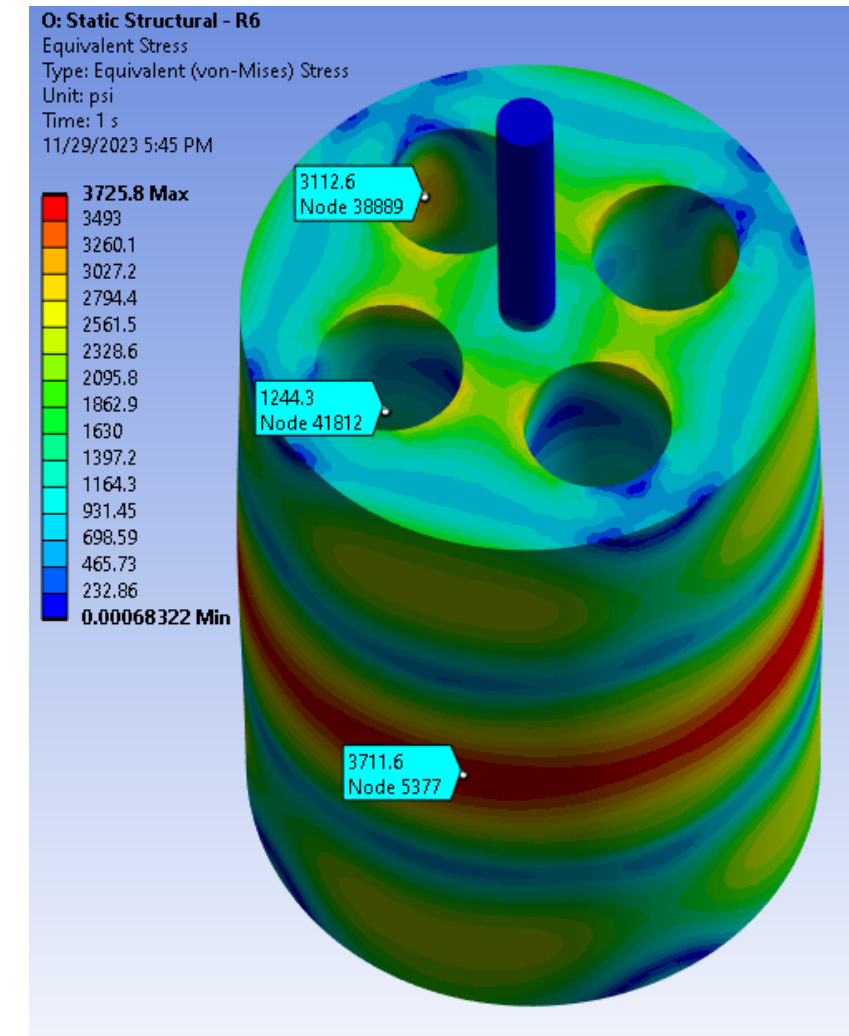
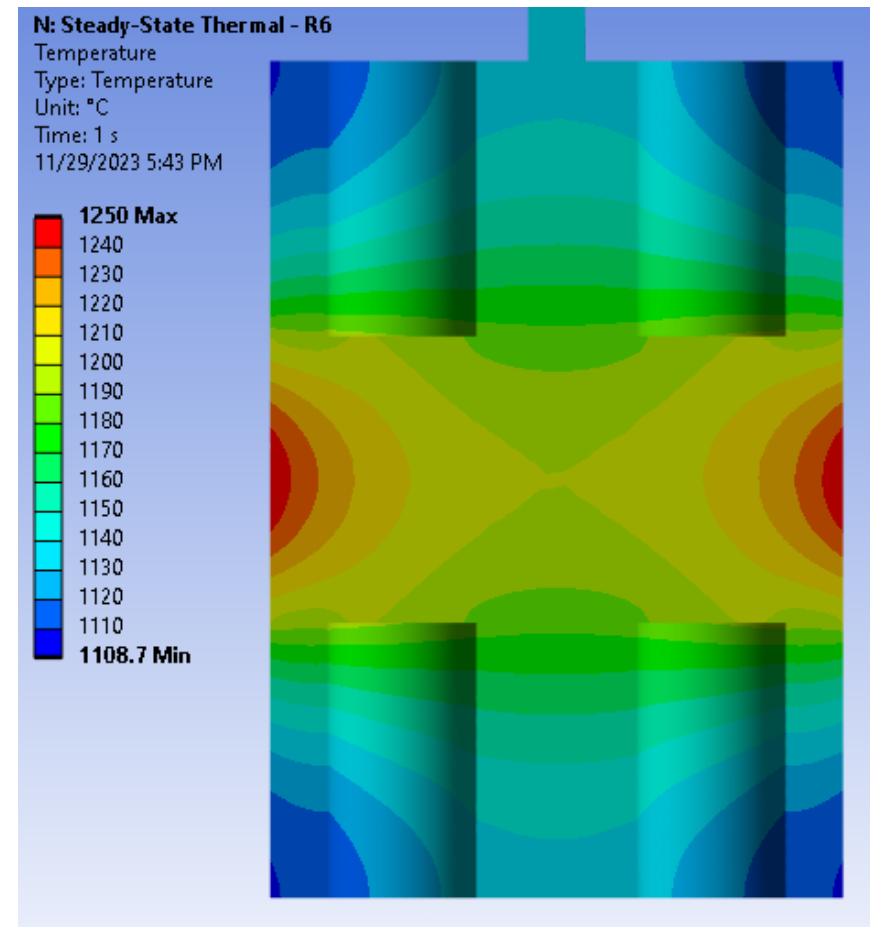
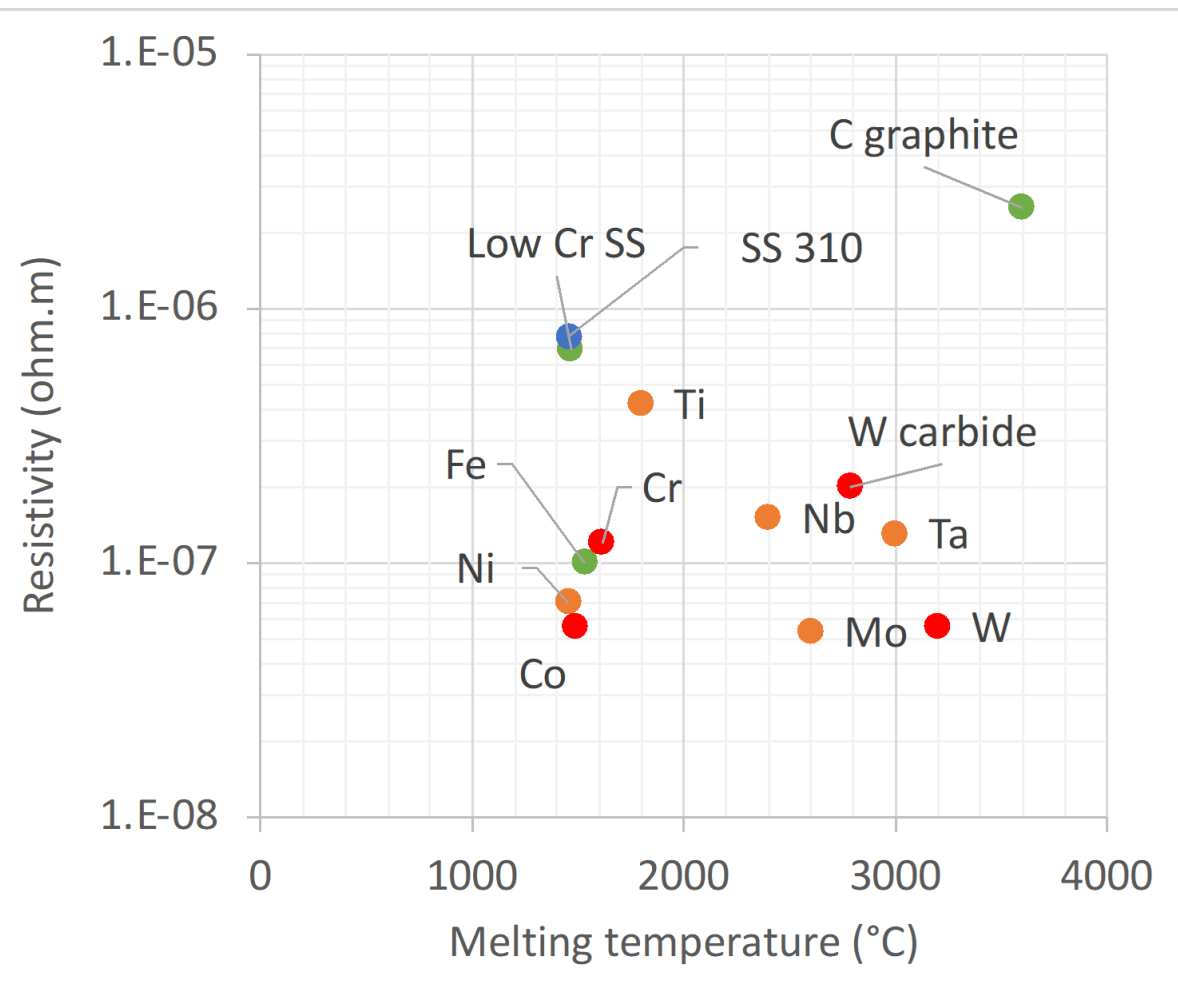


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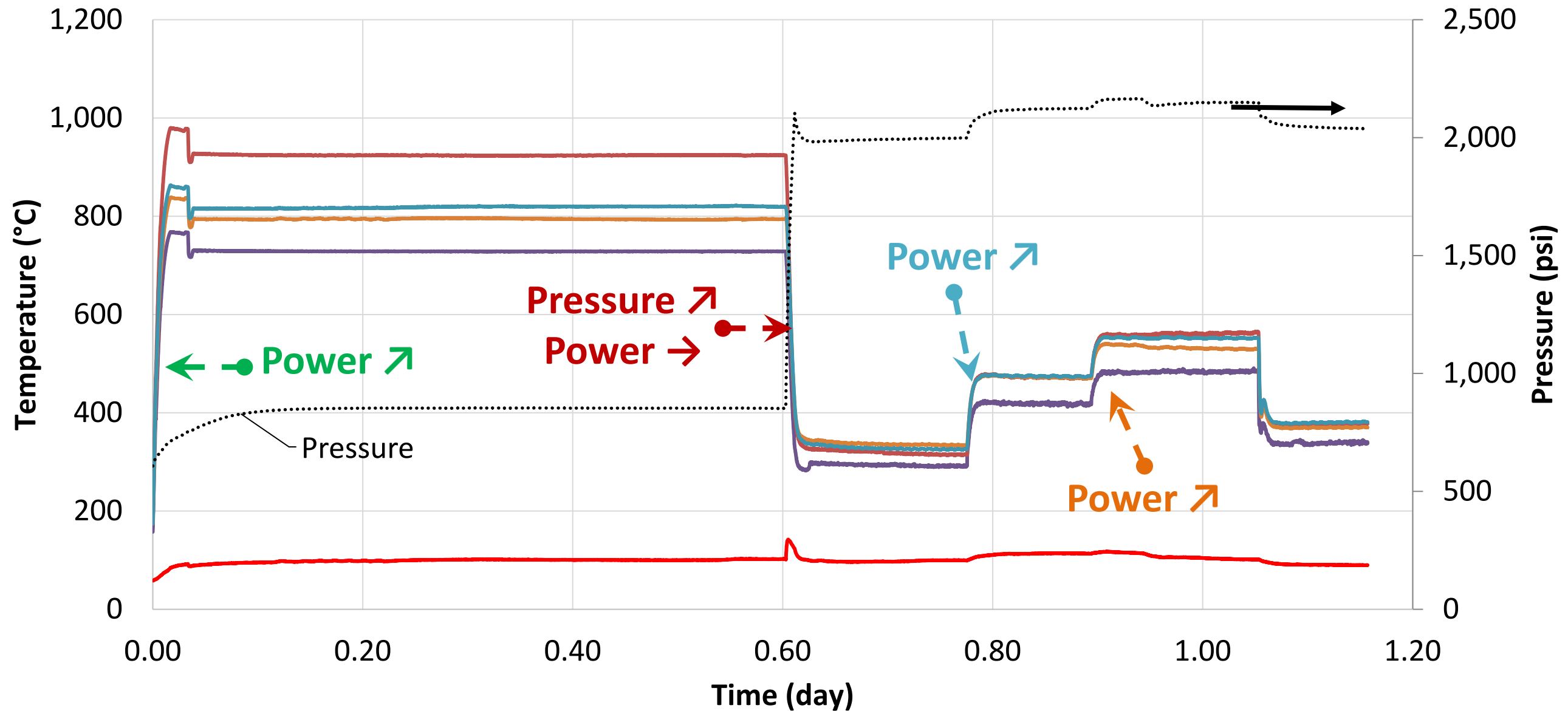
Homogeneous heating and resilience

Stainless steel 310:

- Resistivity
- Magnetic
- Machining
- Cost
- Maximum service temperature: 1150 °C

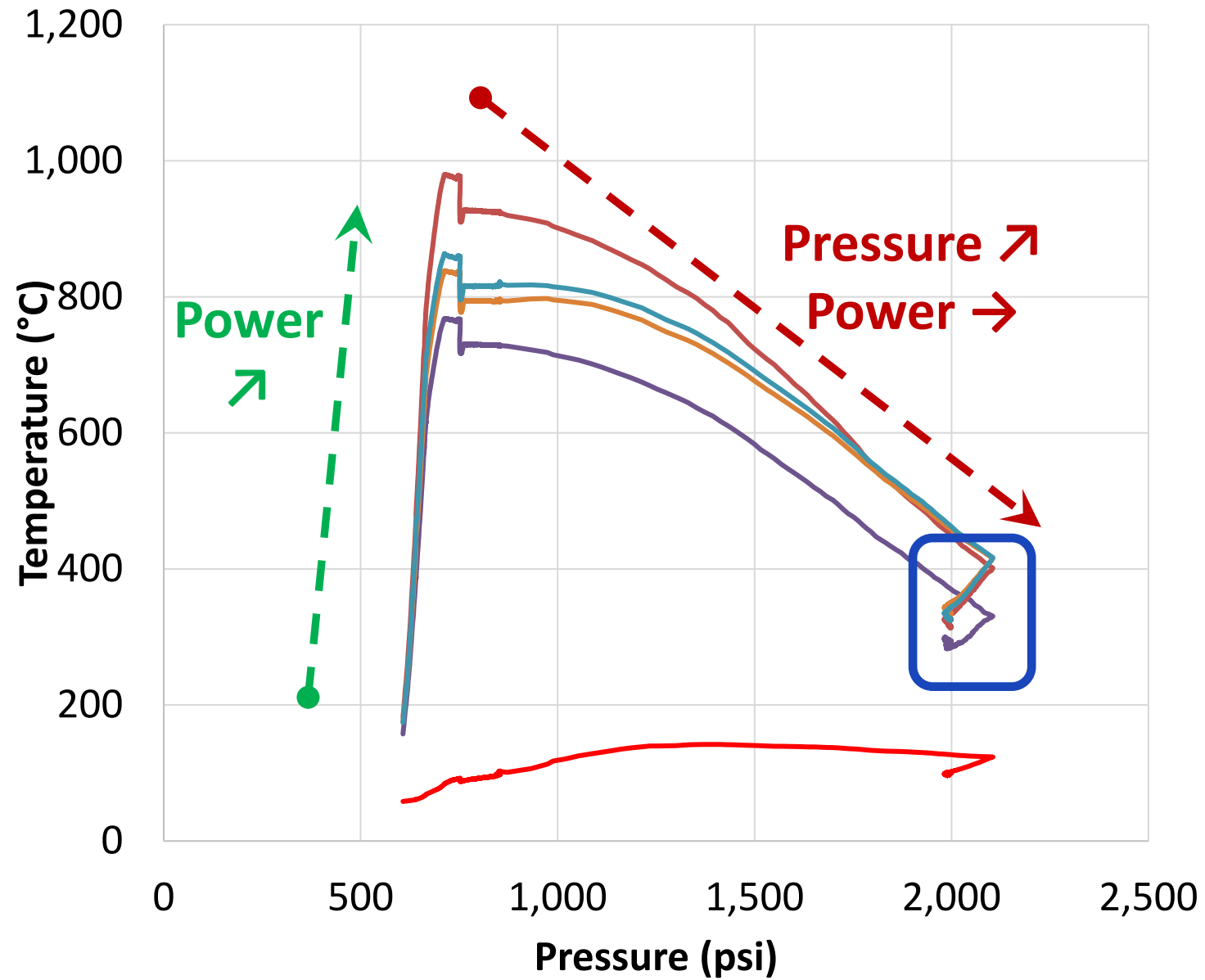


Where are we now?



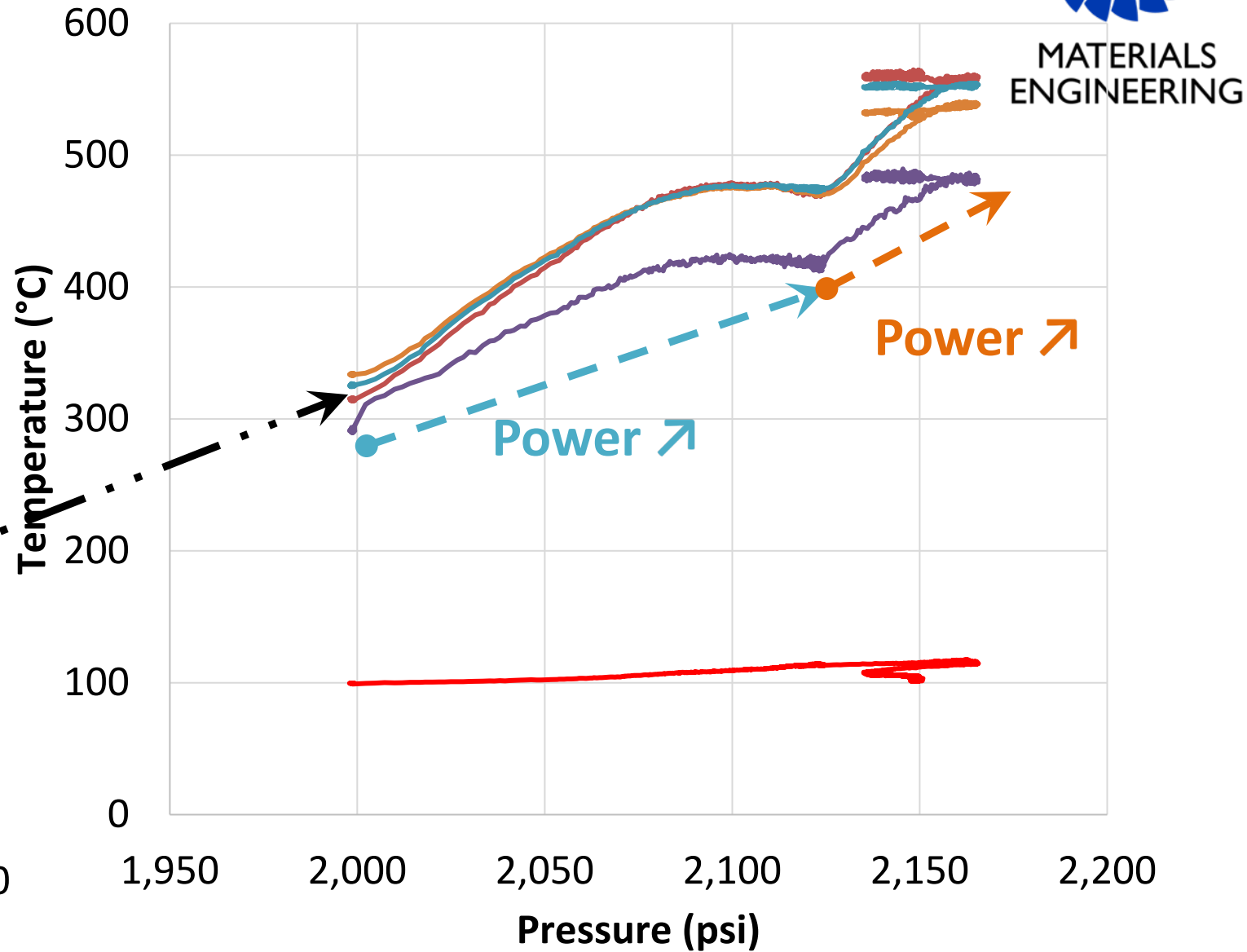
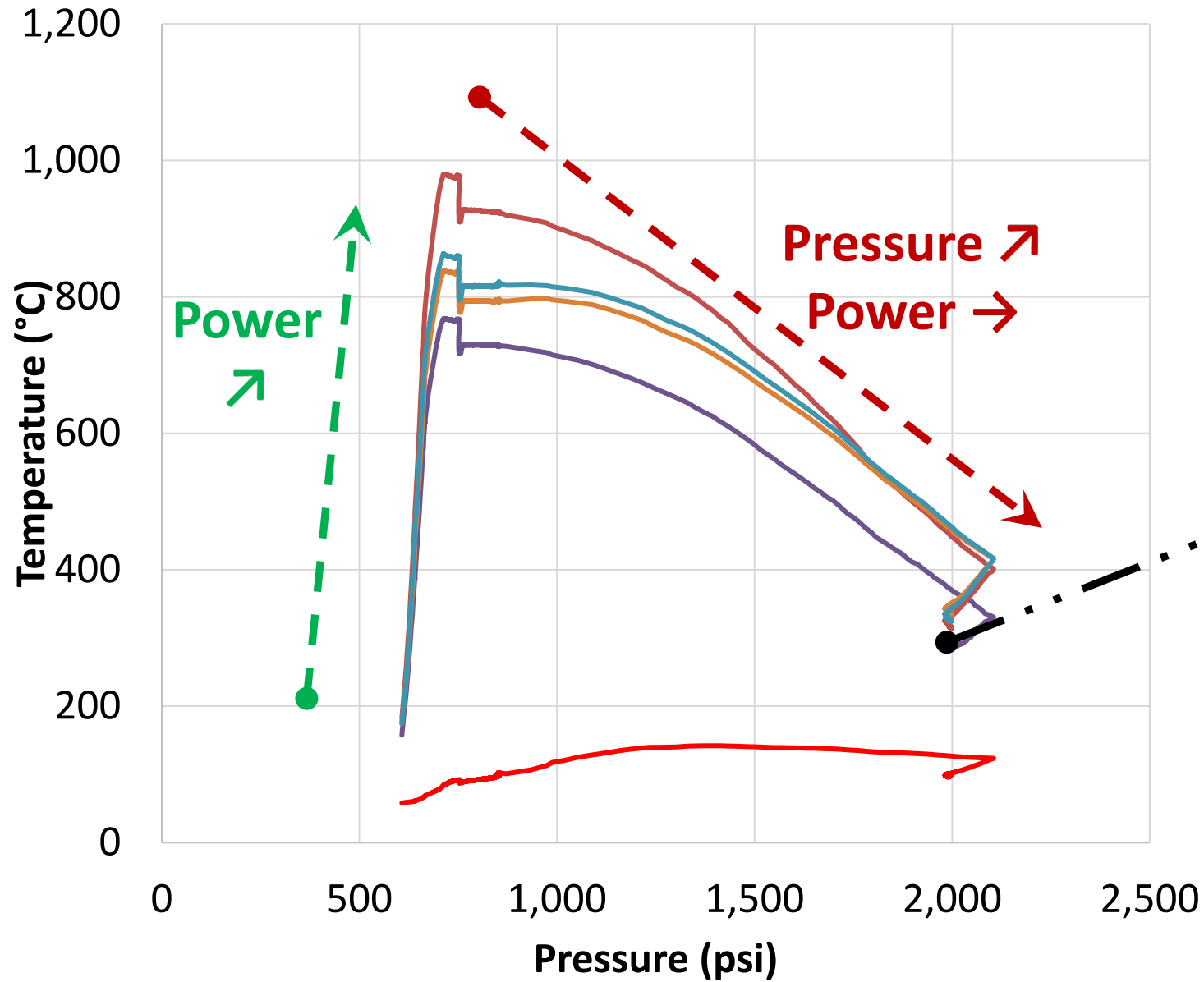
— Top left — Top right — Bot right — Bot left — Bot bulk Pressure

Where are we now?



— Top left — Top right — Bot right — Bot left — Bot bulk

Where are we now?



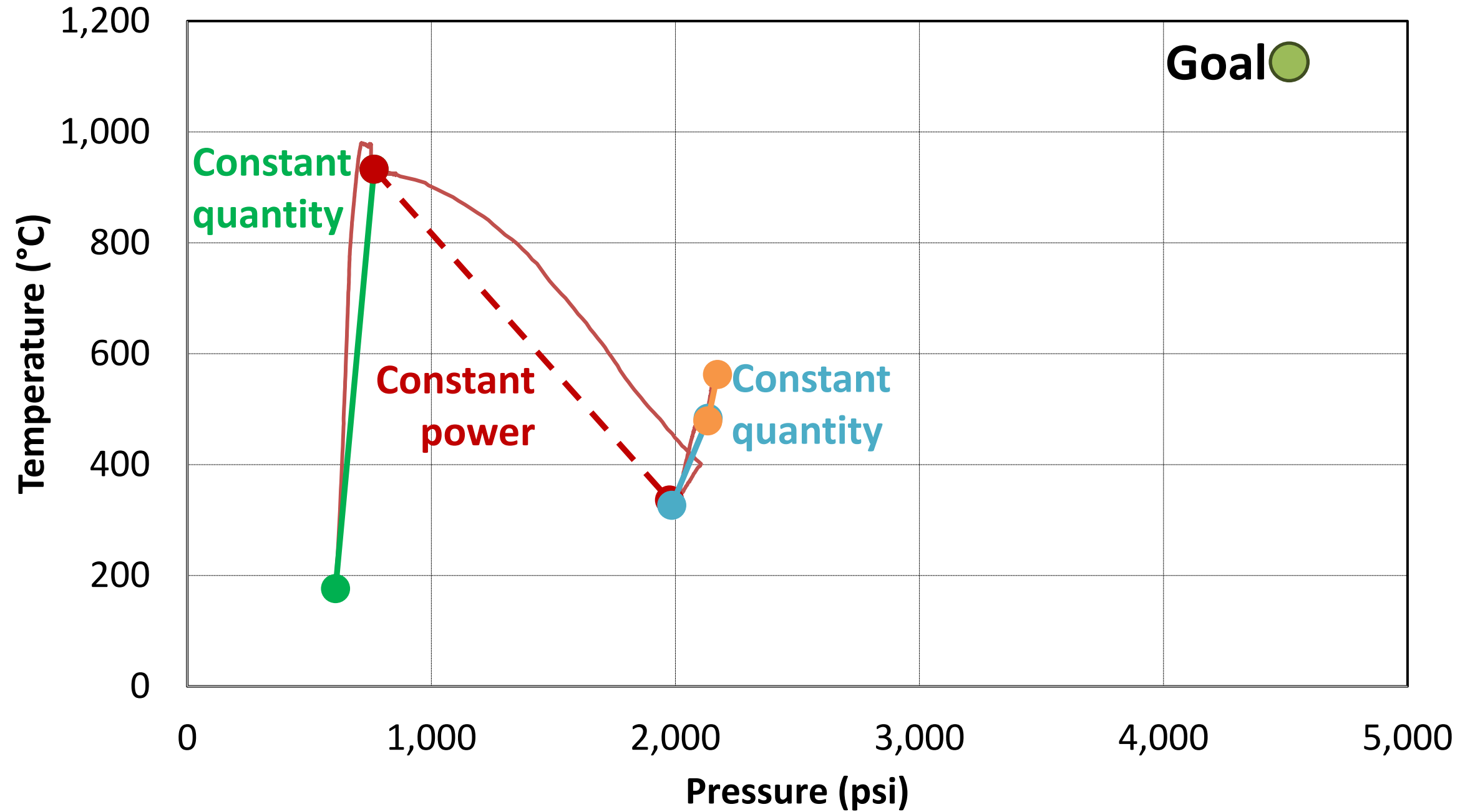
— Top left — Top right — Bot right — Bot left — Bot bulk

— Top left — Top right — Bot right — Bot left — Bot bulk



MECHANICAL ENGINEERING

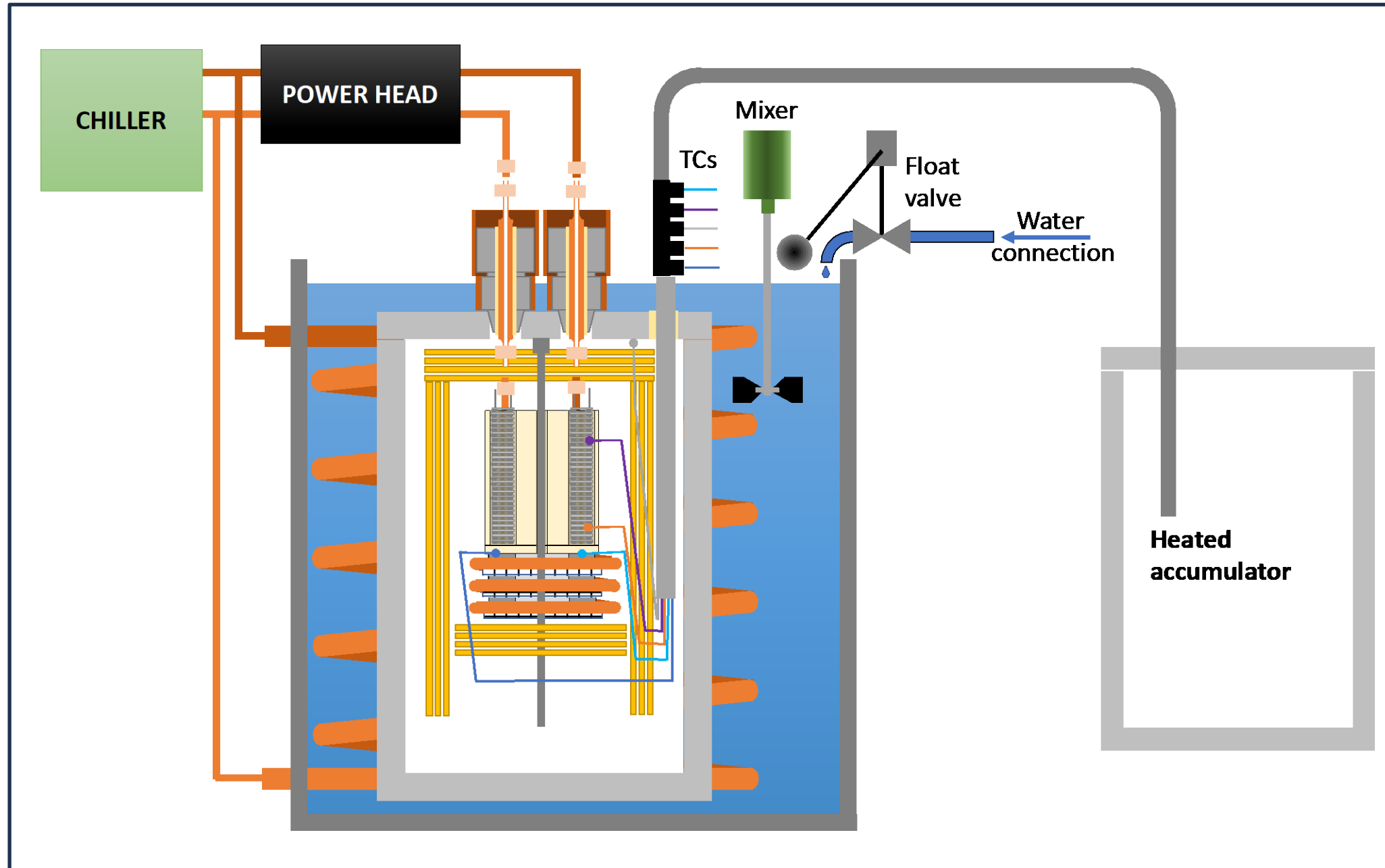
Where are we now?



Unexpected: too much cooling



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Acknowledgements

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