

Towards, Competitive, Reliable, Safe and Sustainable Concentrated Solar Power (CSP) Plants

Midterm meeting REA, 18-19 April 2024

Thermomechanical study of central solar receivers working with high temperature heat transfer fluids (HTFs)

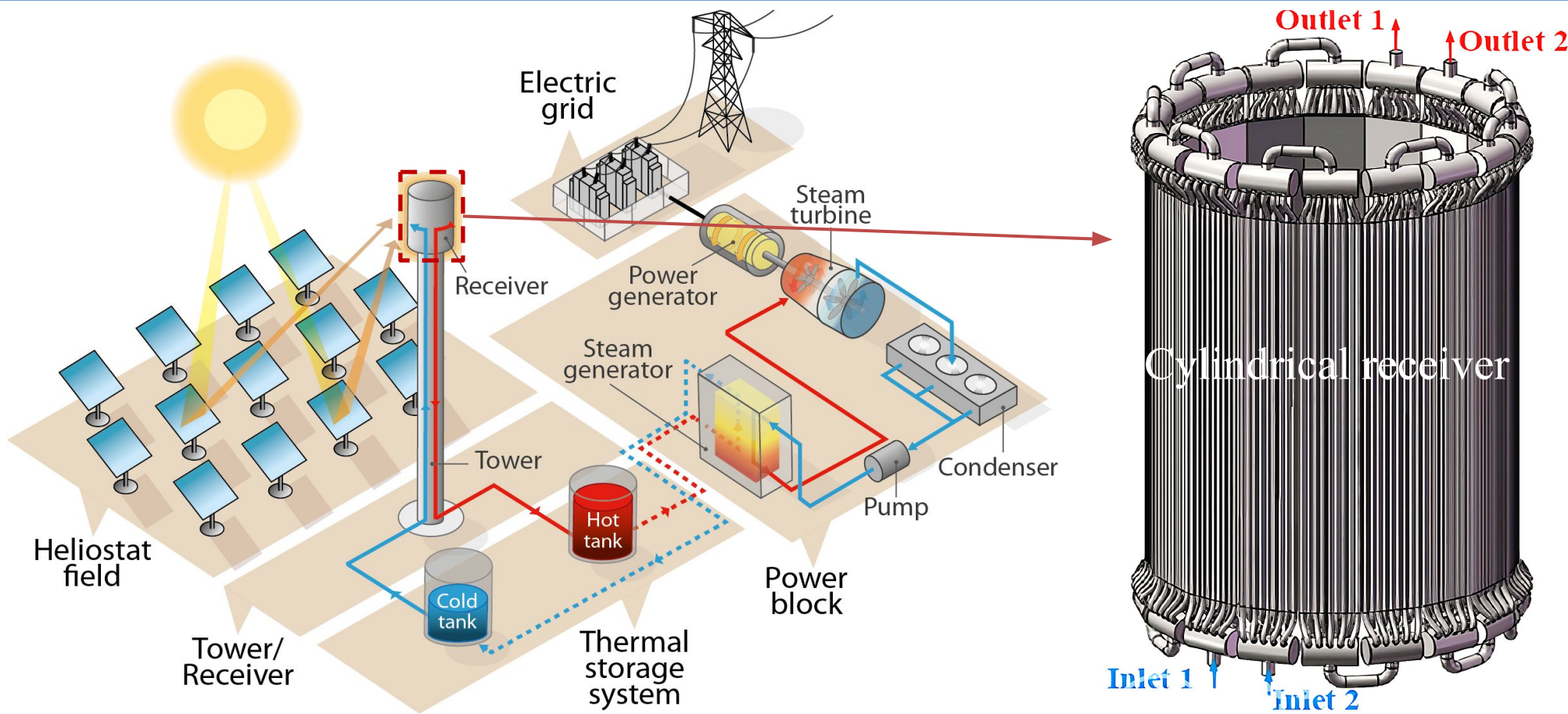
Vahid Safari (DC4)

Supervisors:

Prof. Antonio Acosta-Iborra
Prof. Celia Sobrino

uc3m

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Carlos III
de Madrid



Heat Transfer Fluid: Solar Salt
Working Temperature: $\sim 560^{\circ}\text{C}$

Heat Transfer Fluid

Higher Operating Temperatures ($>560^{\circ}\text{C}$)

Lower Corrosion Rate

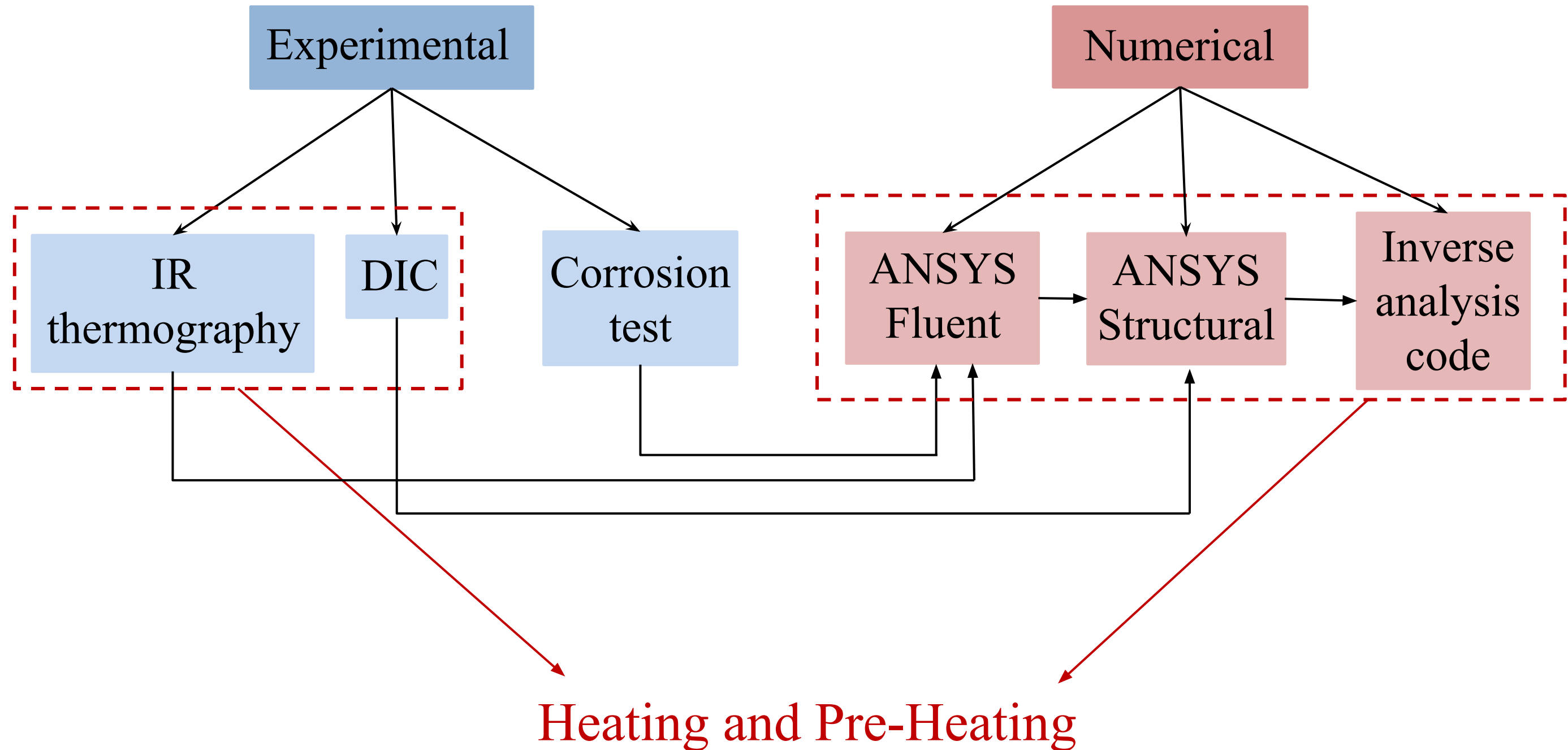
Higher Thermal Conductivity and Heat Storage Capacity

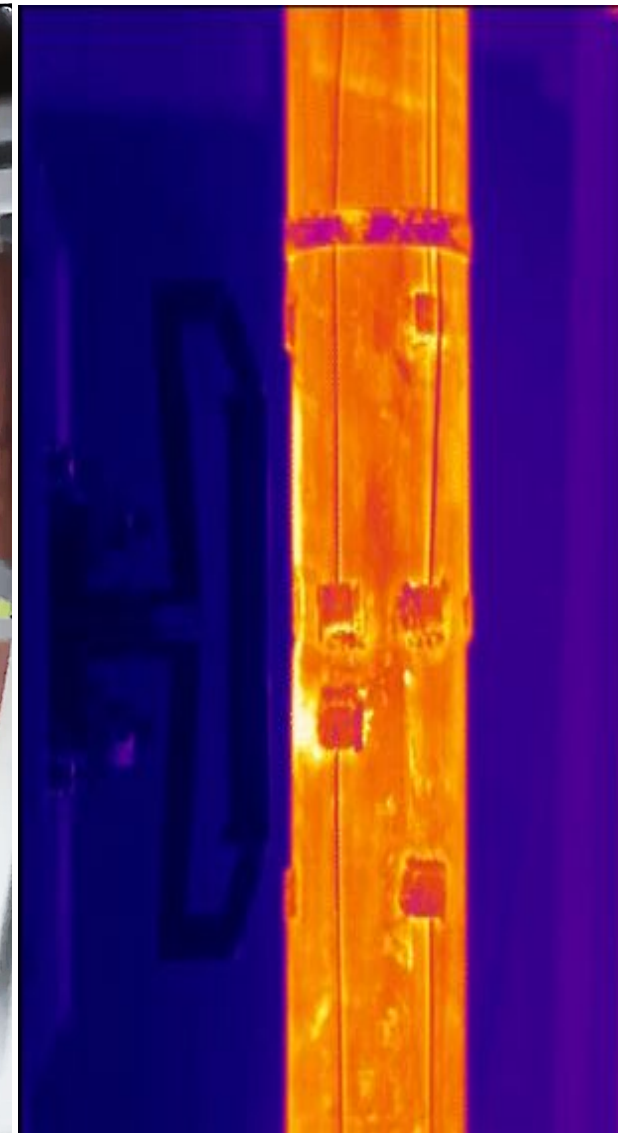
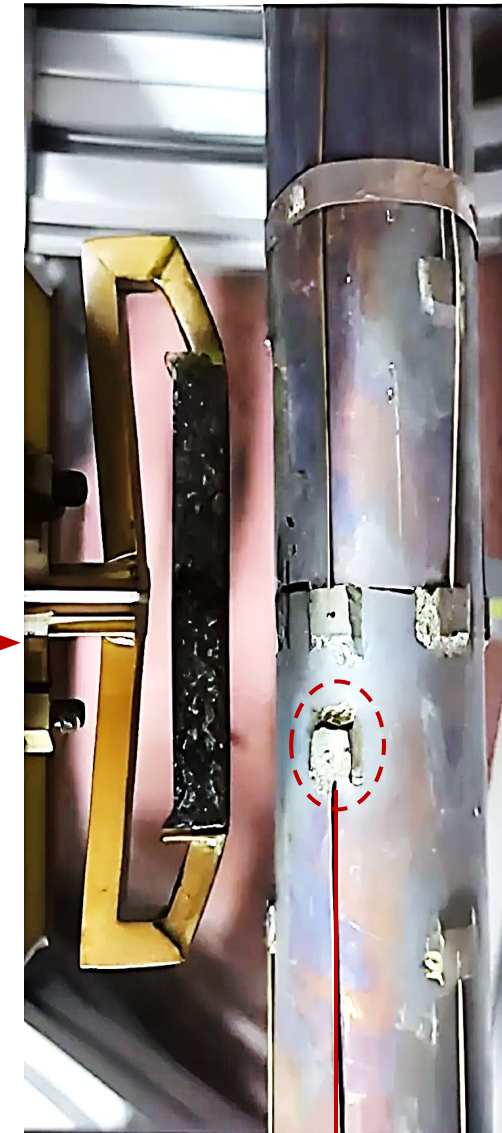
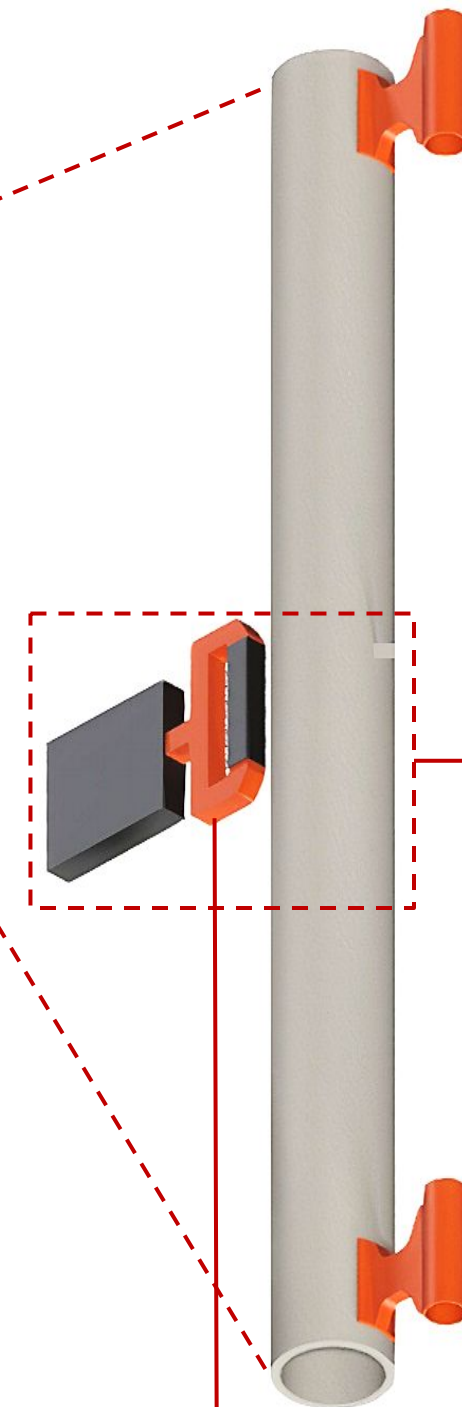
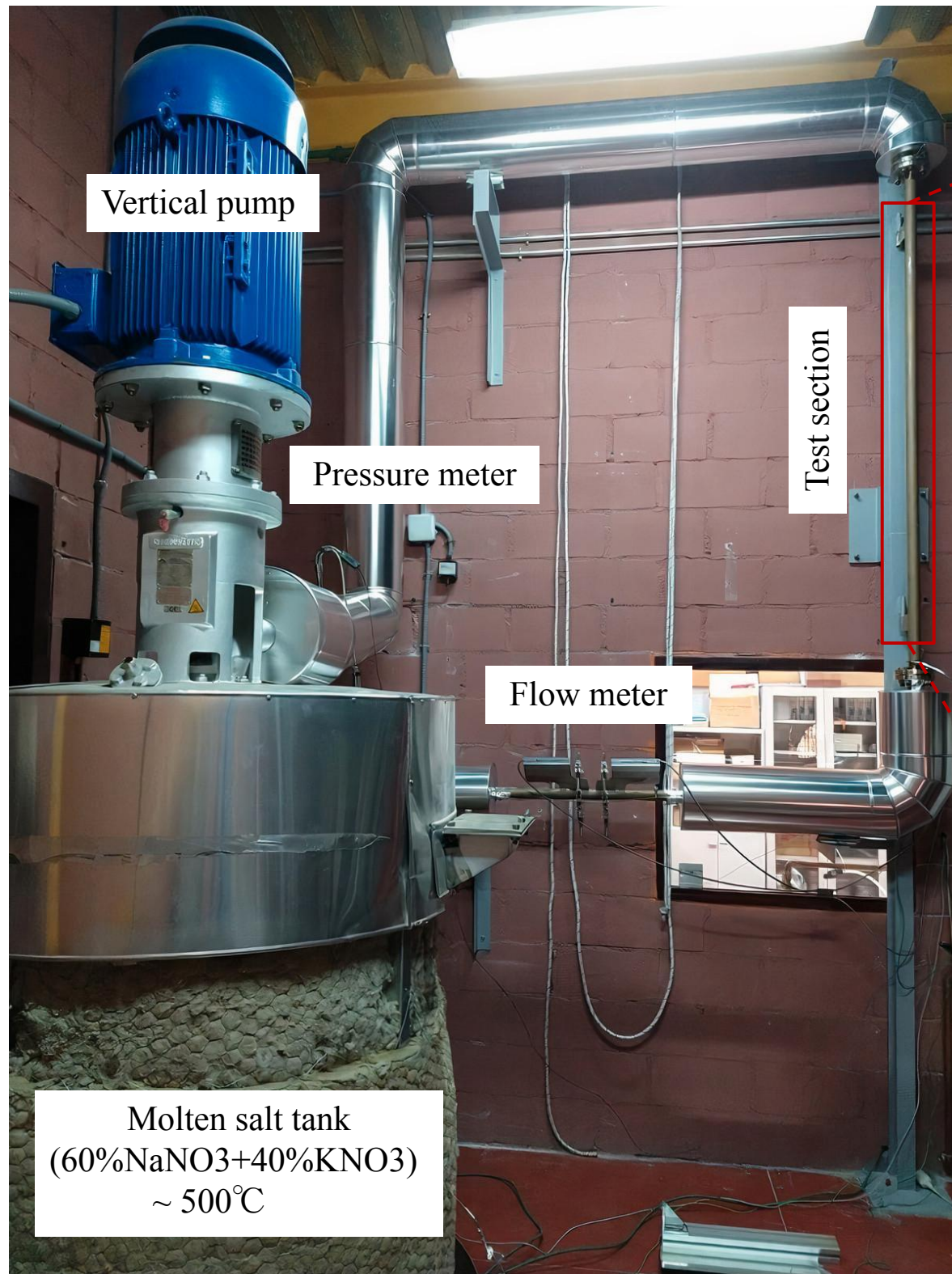
Tube Material

High Operating
Temperatures

Improved Thermal, Creep and Fatigue Resilience

Excellent Corrosion Resistance

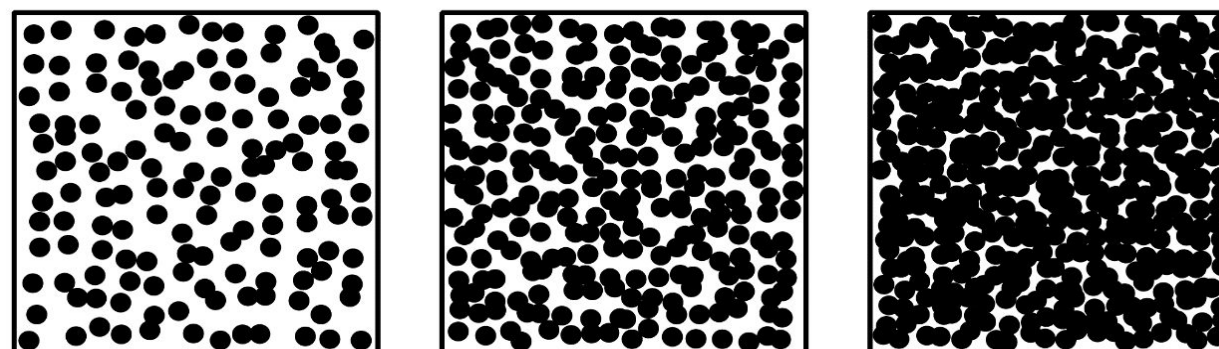
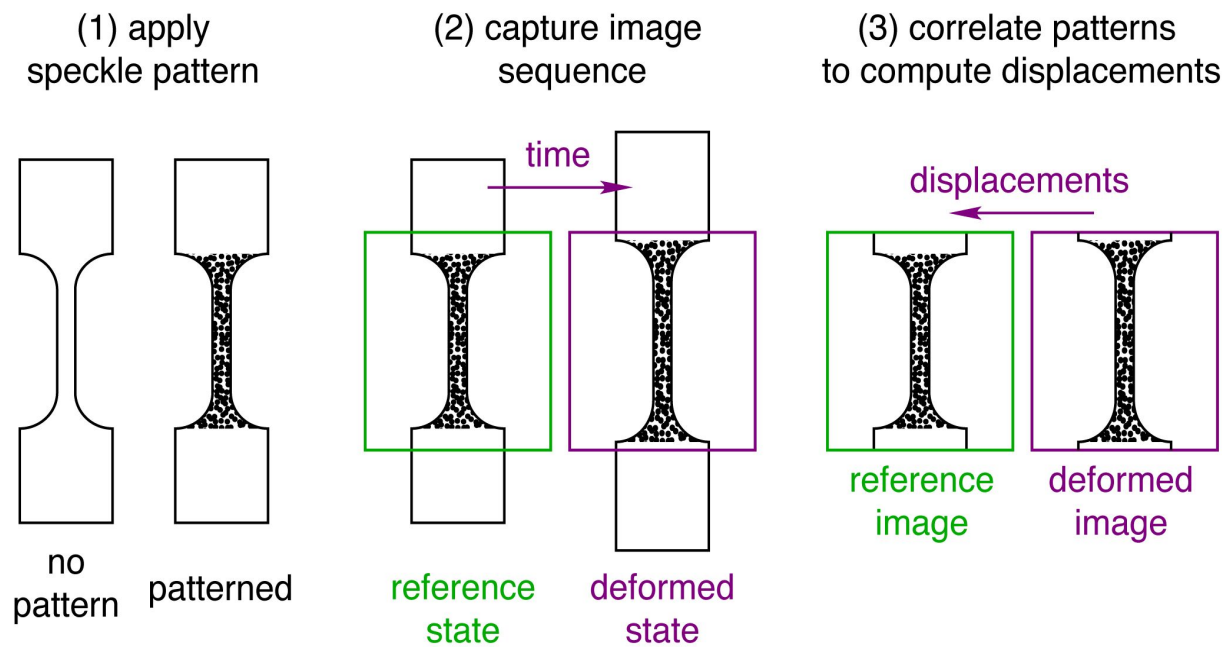




Thermocouple

Solar Simulator

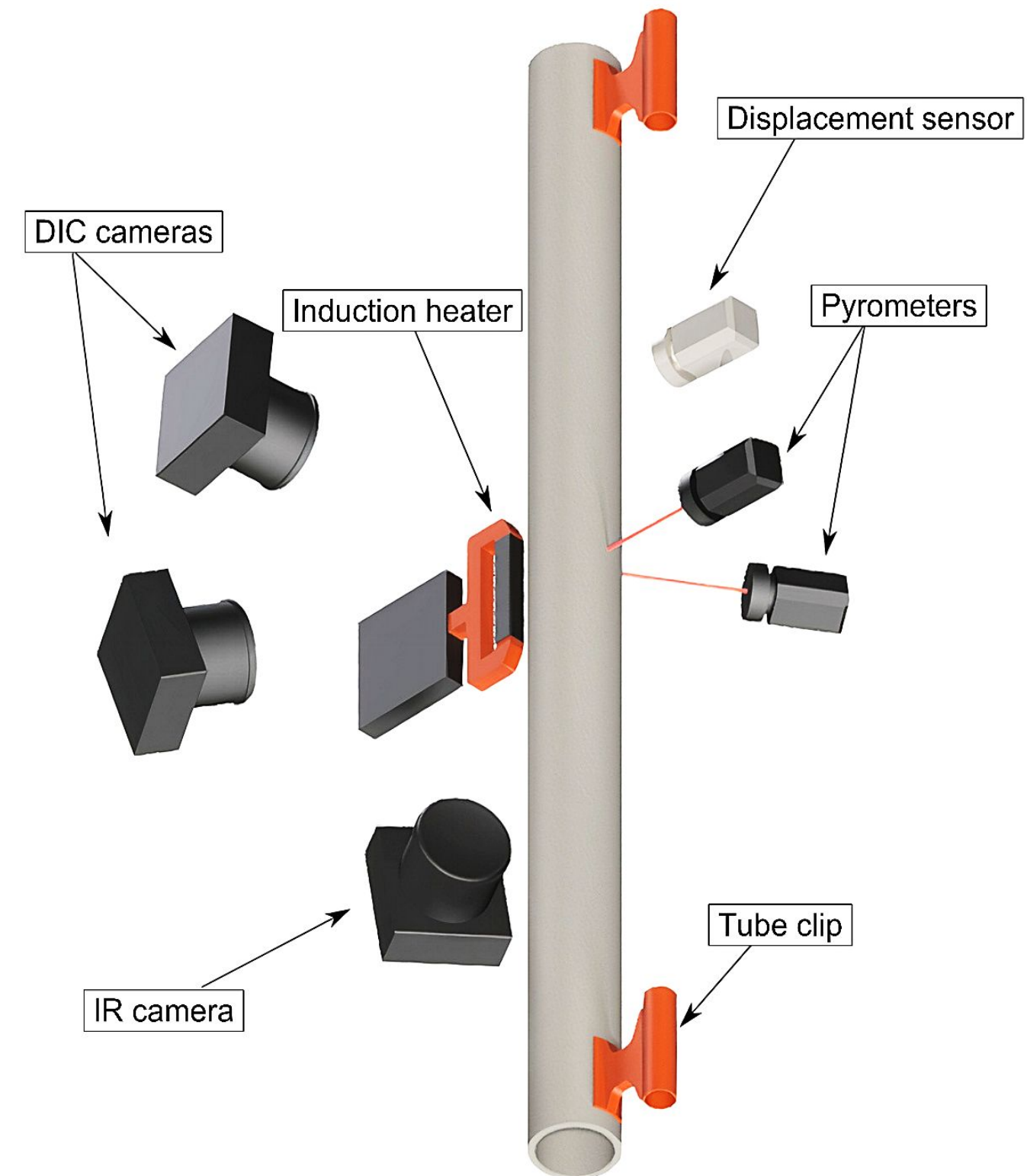
3D Displacement Measurement



too sparse

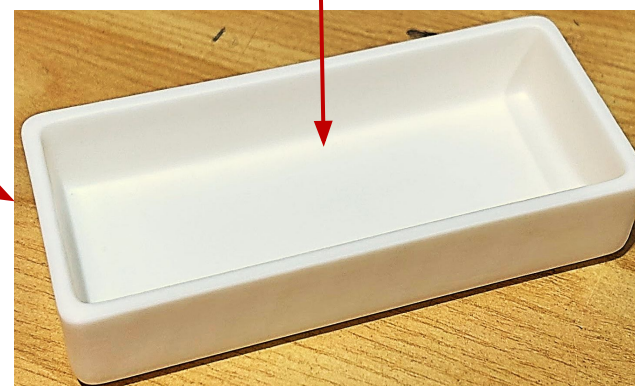
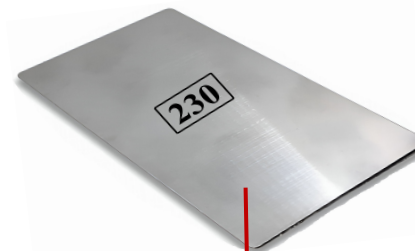
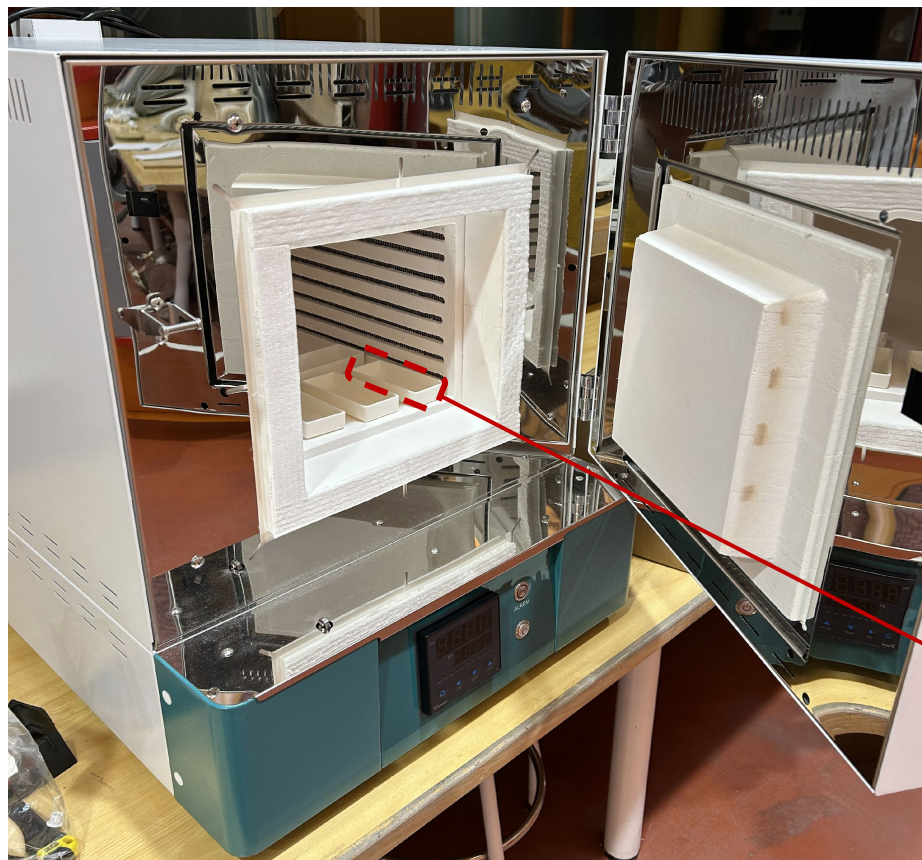
just right

too dense

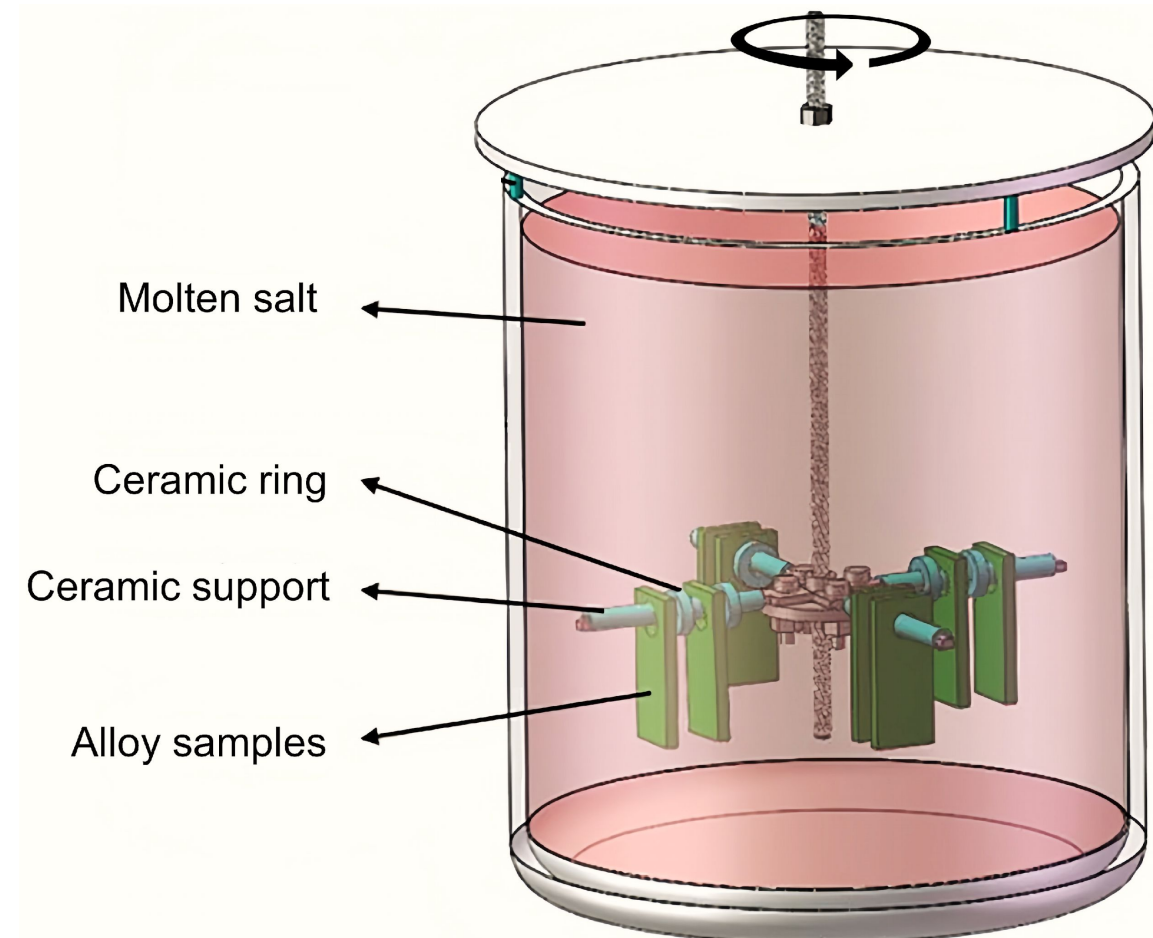


Molten salts (wt%)	Melting point (°C)	Stability limit (°C)	Density (g·cm ⁻³)	Heat capacity (kJ·(kg·K) ⁻¹)
Solar Salt: KNO ₃ /NaNO ₃ (40/60)	240	530–565	~1.8 (400 °C)	~1.5 (400 °C)
HITEC: KNO ₃ /NaNO ₃ /NaNO ₂ (53/7/40)	142	450–540	~1.8 (400 °C)	1.5 (400 °C)
K ₂ CO ₃ /Li ₂ CO ₃ /Na ₂ CO ₃ (32/35/33)	397	> 650	2.0 (700 °C)	1.9 (700 °C)
KF/LiF/NaF (59/29/12)	454	> 700	2.0 (700 °C)	1.9 (700 °C)
KCl/NaCl/ZnCl ₂ (23.9/7.5/68.6)	204	850	~2.0 (600 °C)	0.8 (300–600 °C)
KCl/MgCl ₂ /NaCl (17.8/68.2/14.0)	380	> 800	~1.7 (600 °C)	~1.0 (500–800 °C)

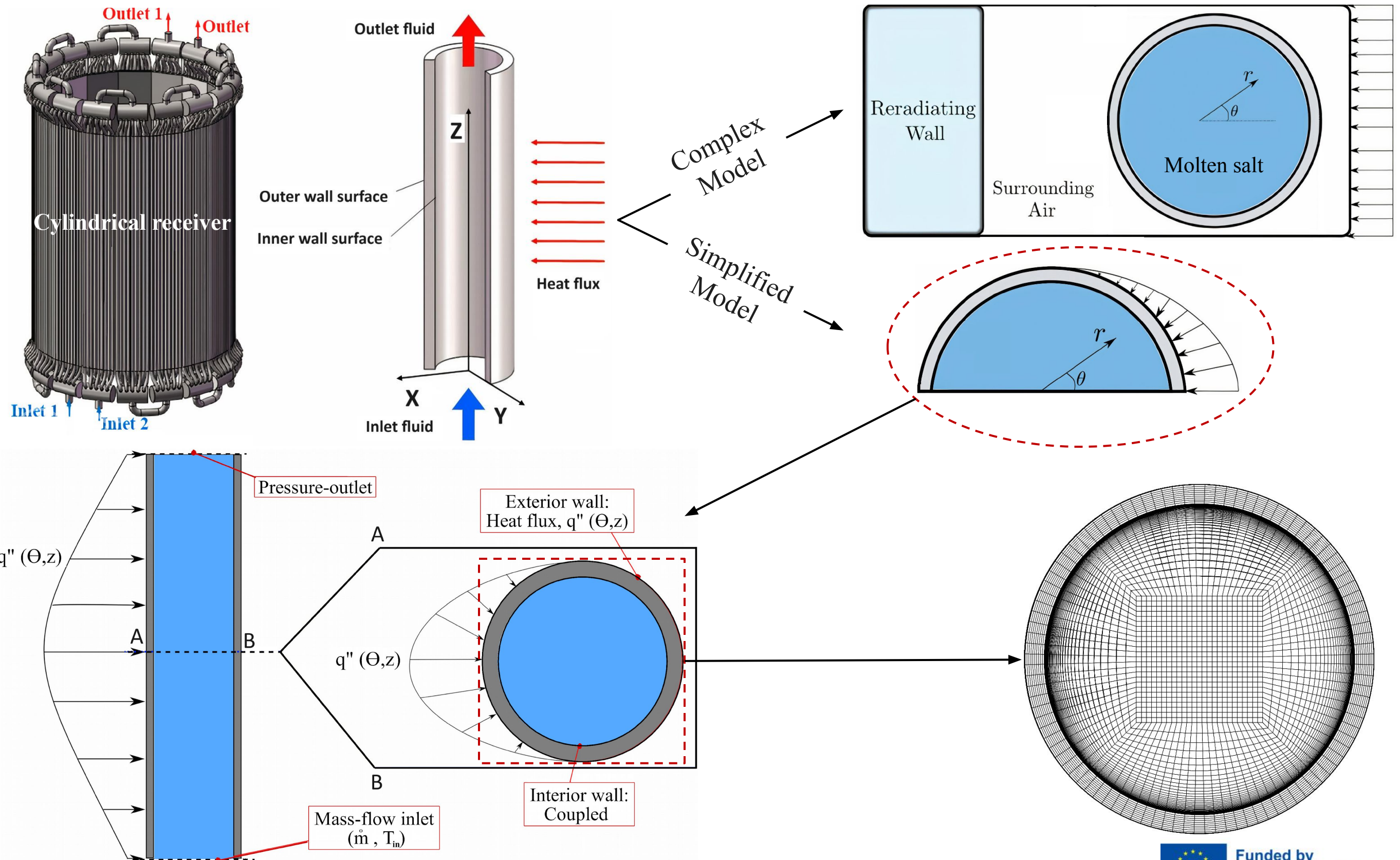
Alloys: 316 - 625 - 617 - 602 - 230

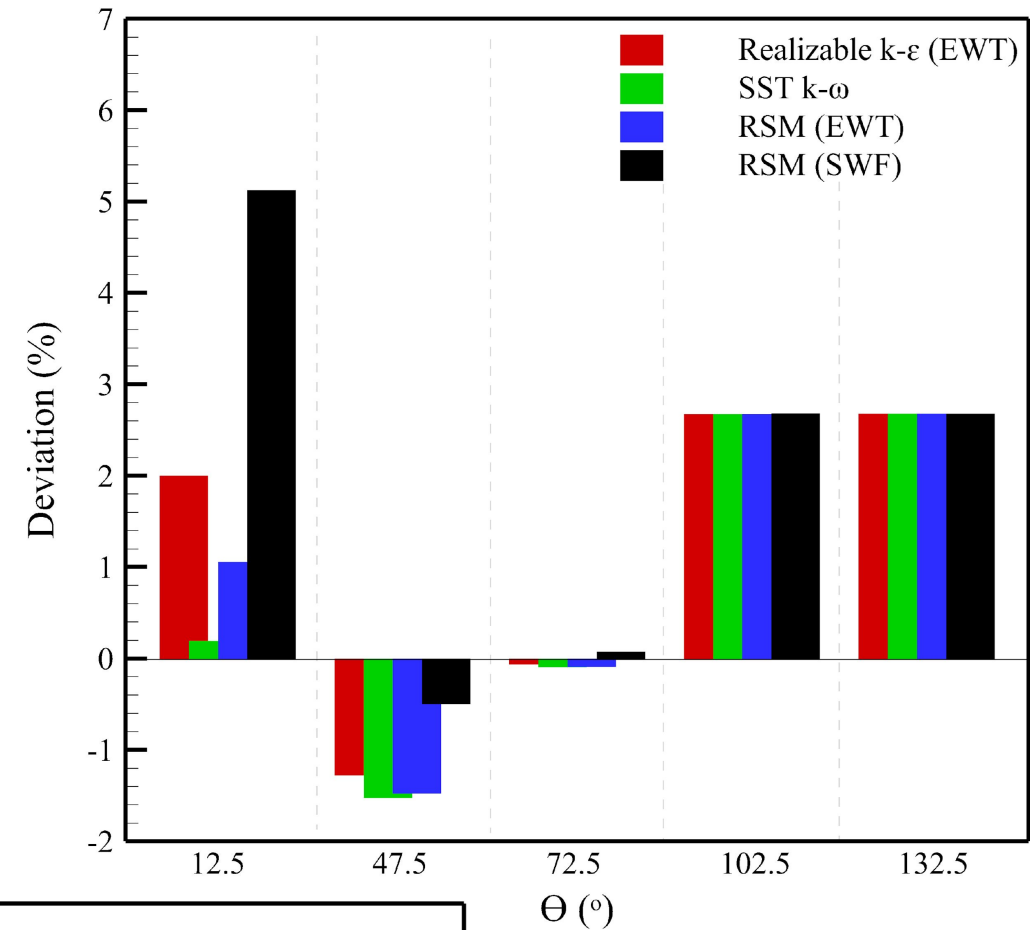
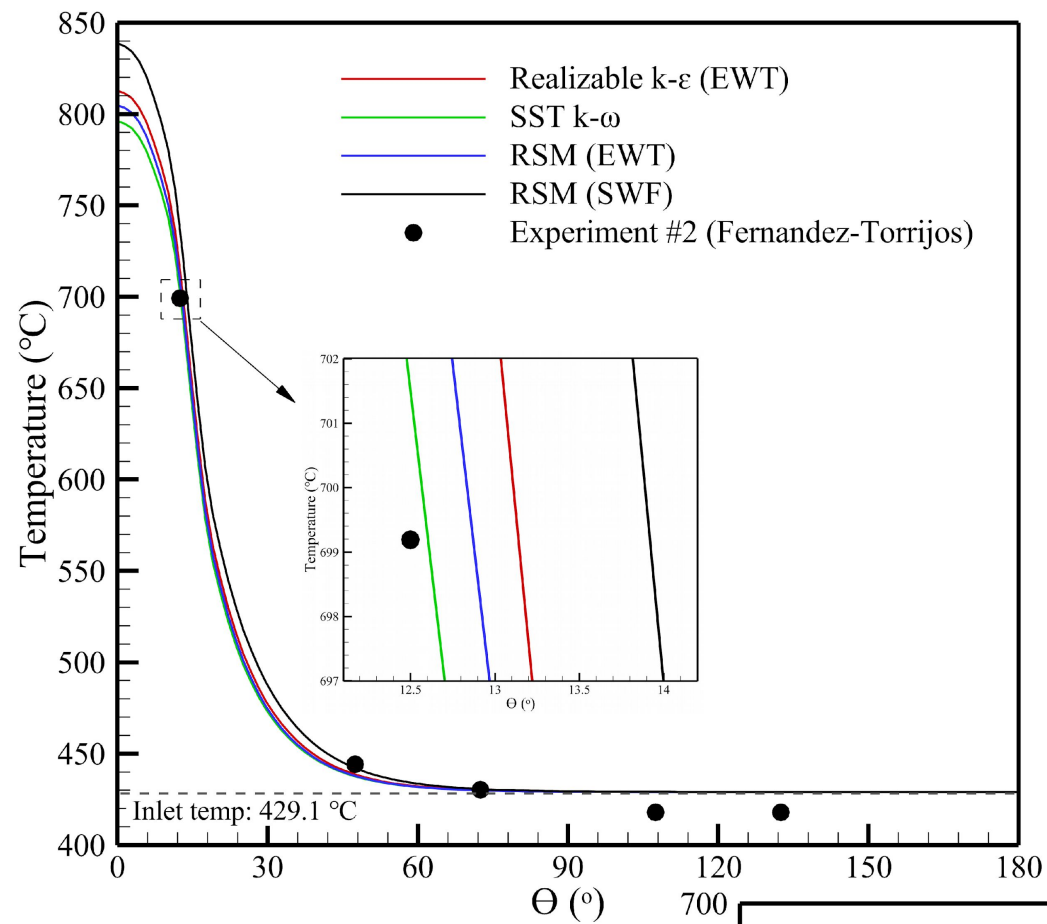


Ding et al. 2021, Engineering

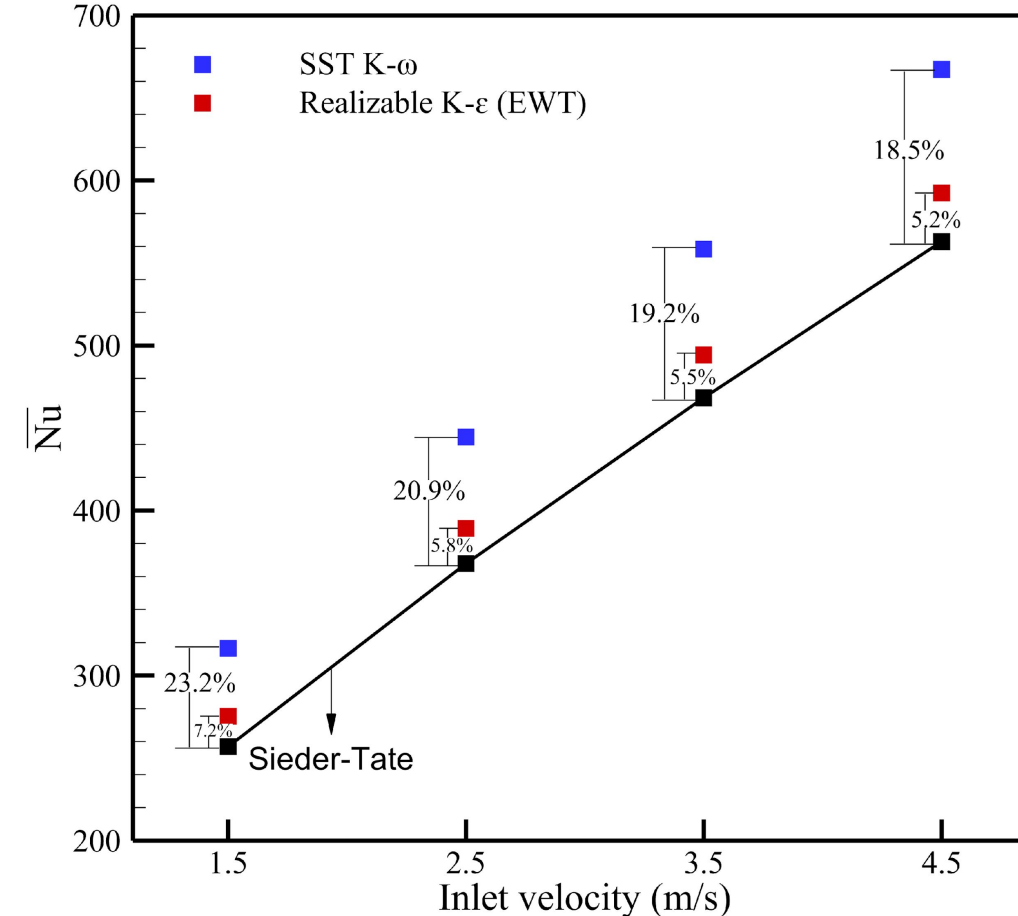


Li et al. 2021, High Temperature Corrosion of Materials



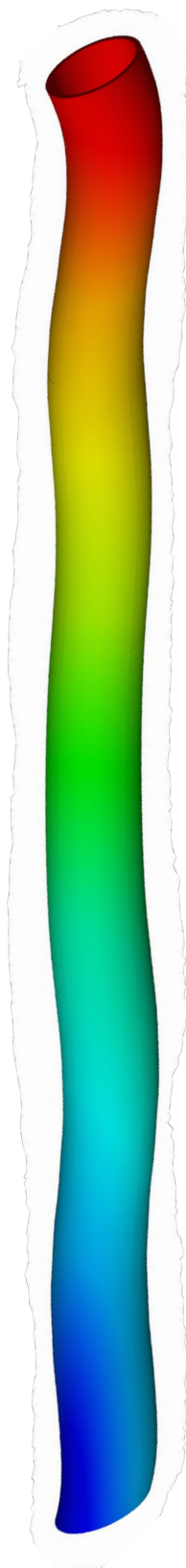
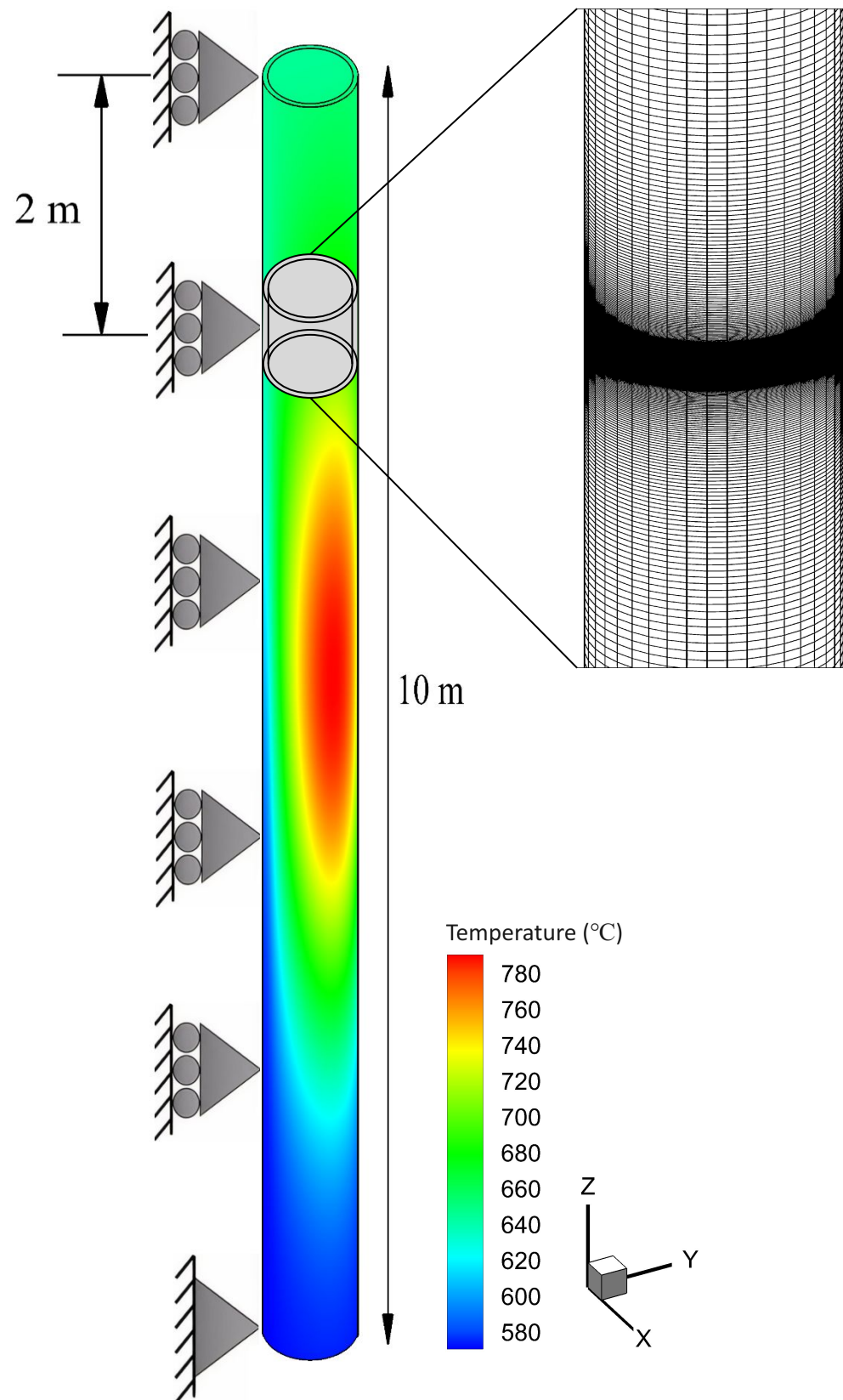


Experimental data from Fernandez-Torrijos et al. 2020, Applied Thermal Engineering

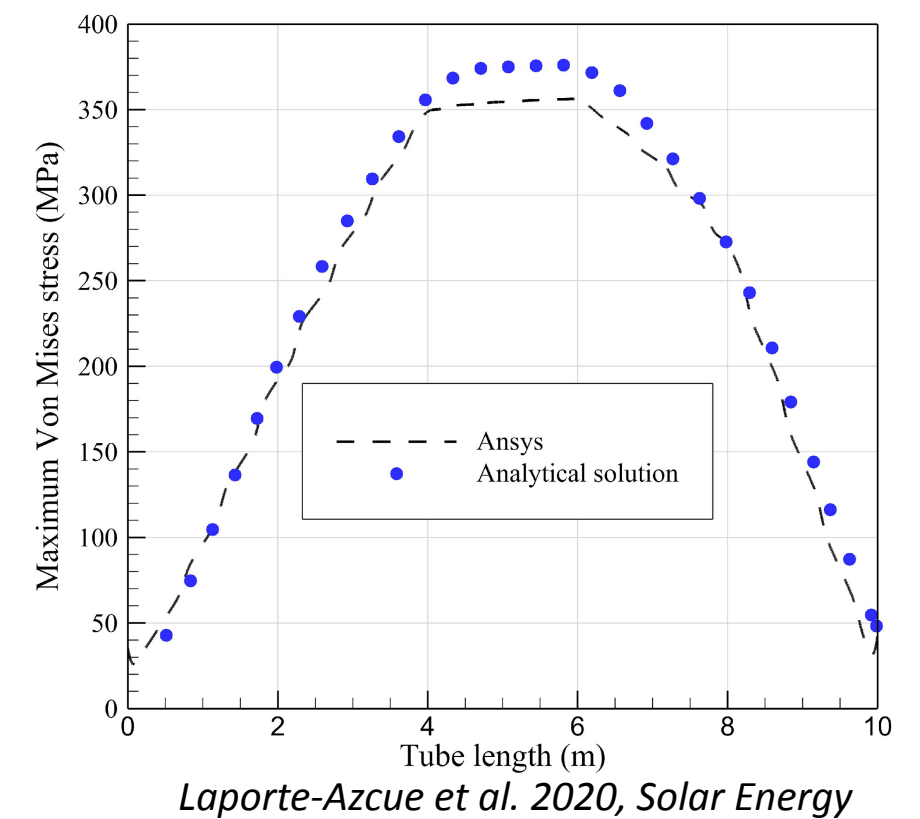
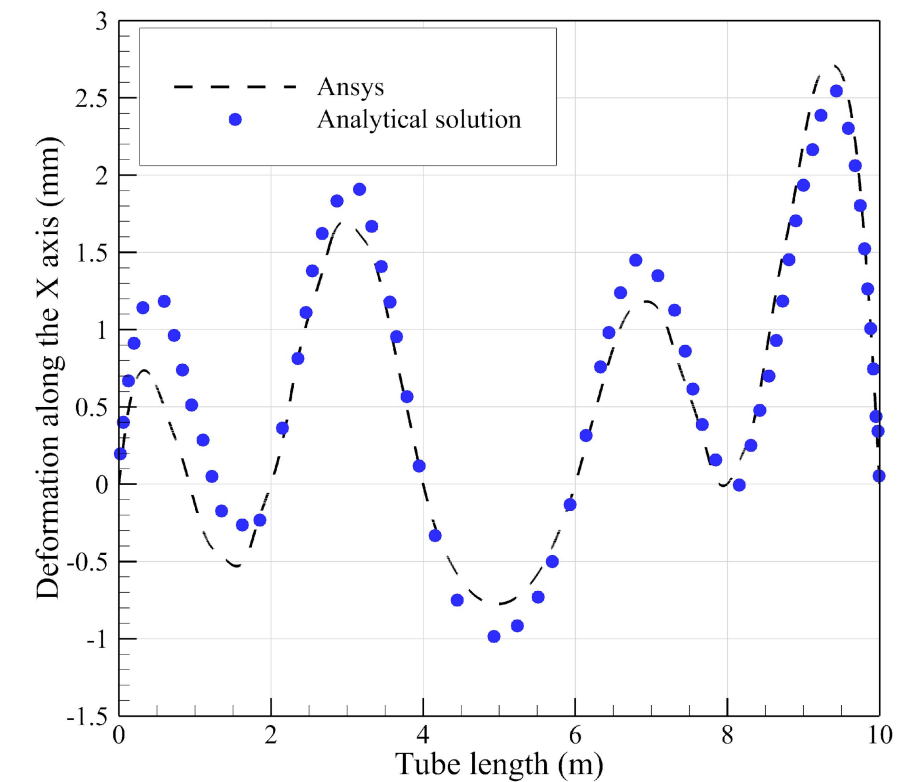
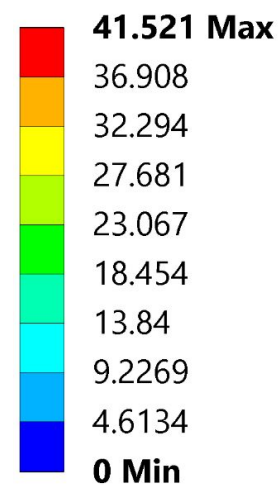


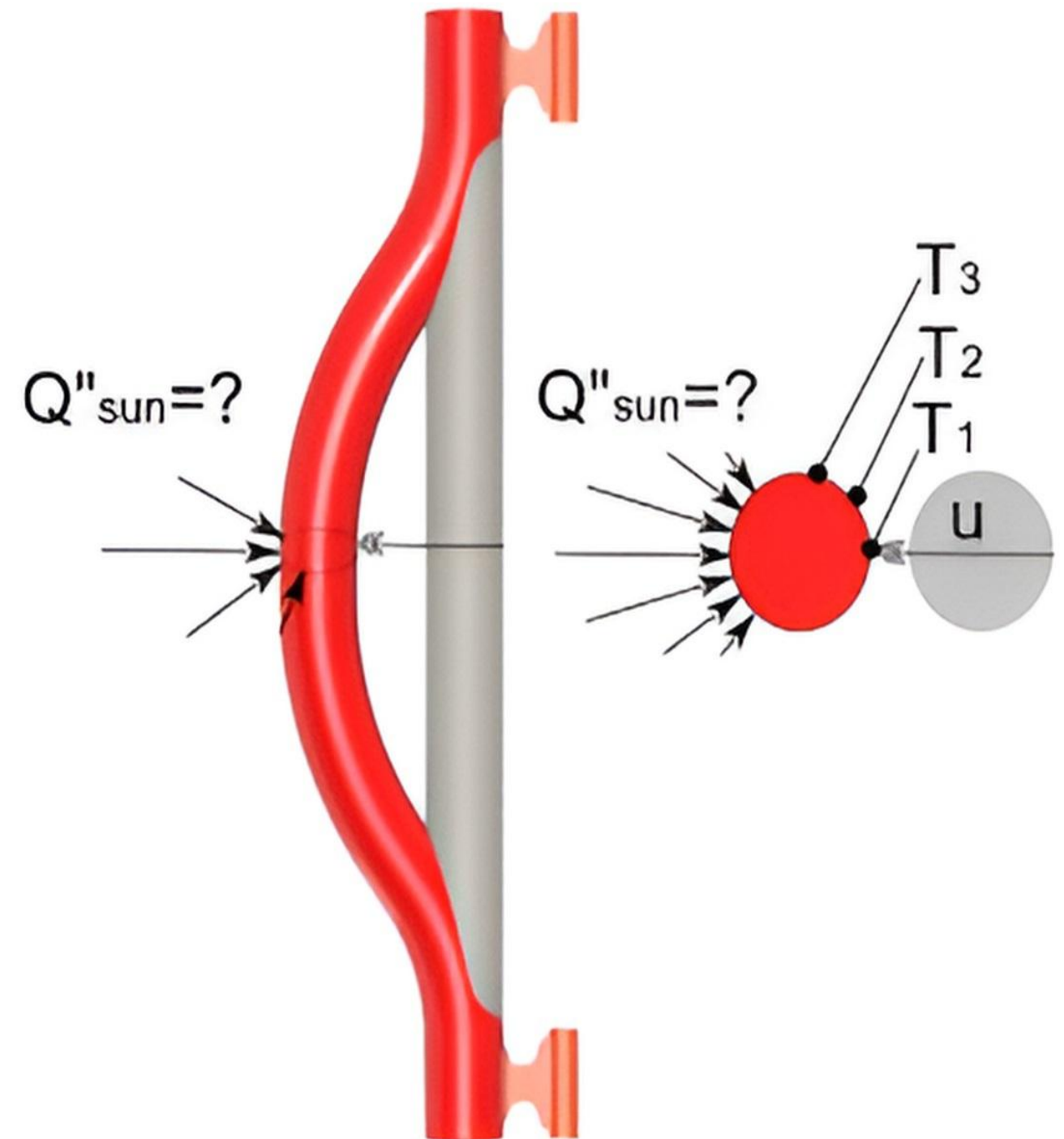
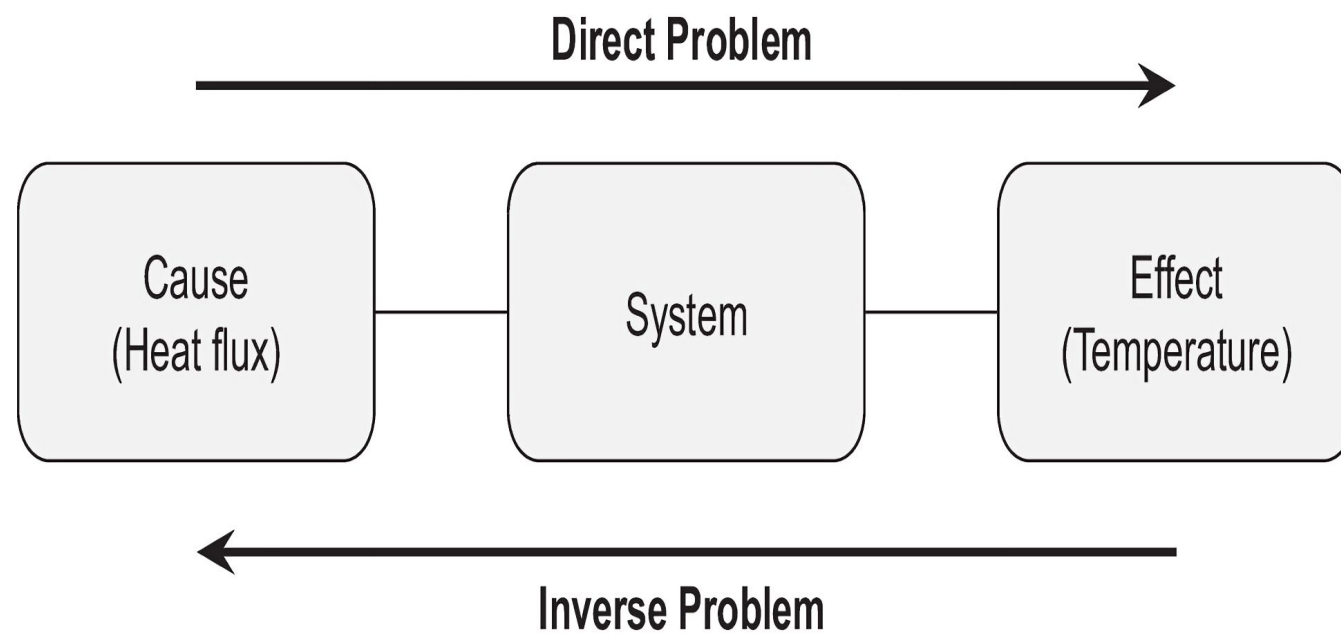


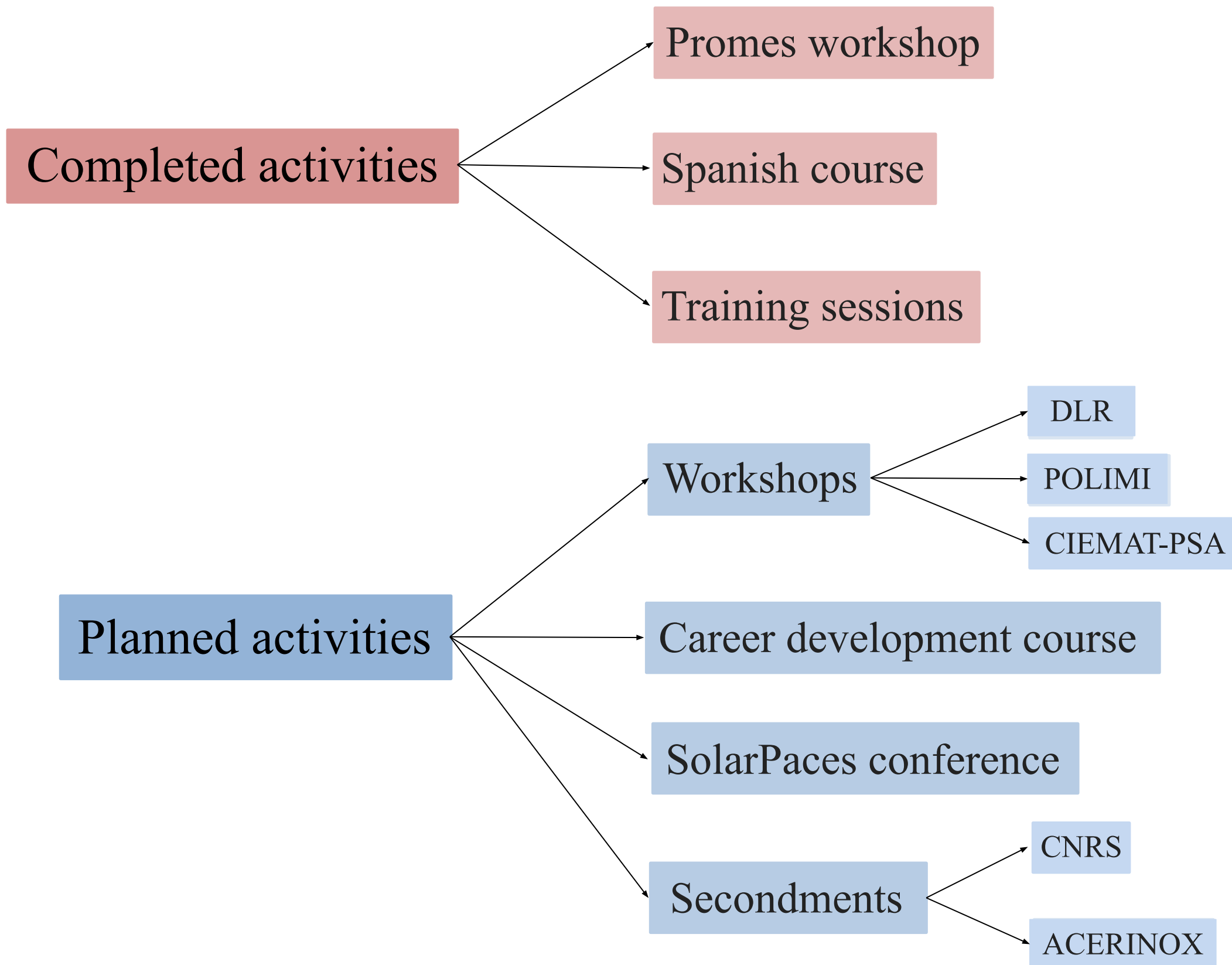
ANSYS Structural Result Validation



Total deformation (mm)









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**Thank you so much for your
attention!**

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