

Center for Advanced Turbomachinery and Energy Research



Recent Activities on sCO₂ Systems and Components at UCF

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CATER / University of Central Florida

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(focusing only on non-combustion topics)

9th International Supercritical CO₂ Energy Technologies Symposium

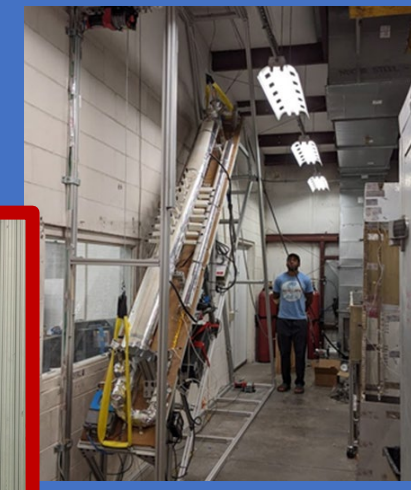
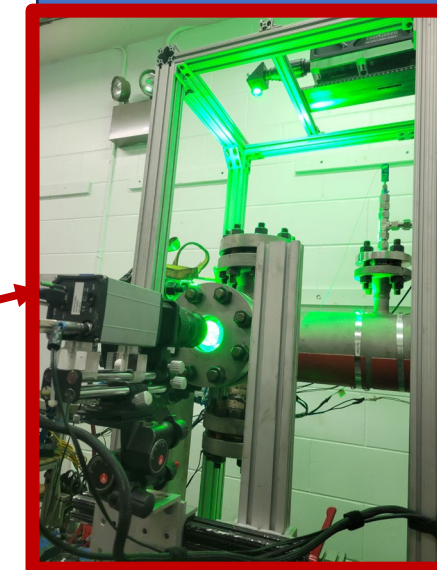
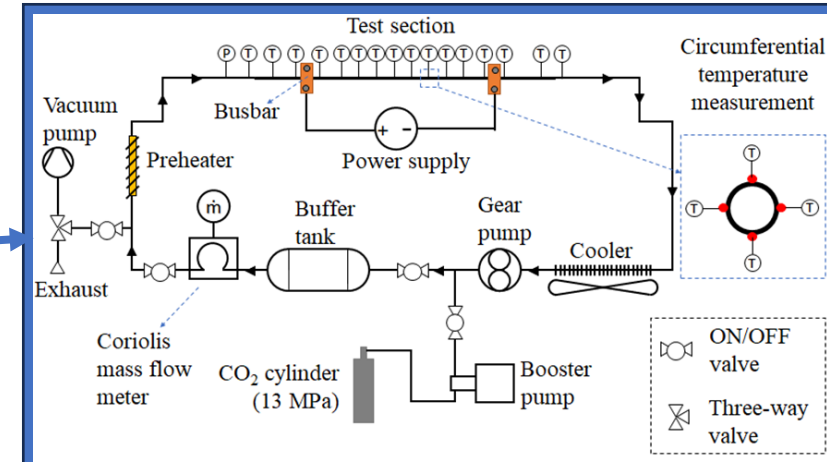


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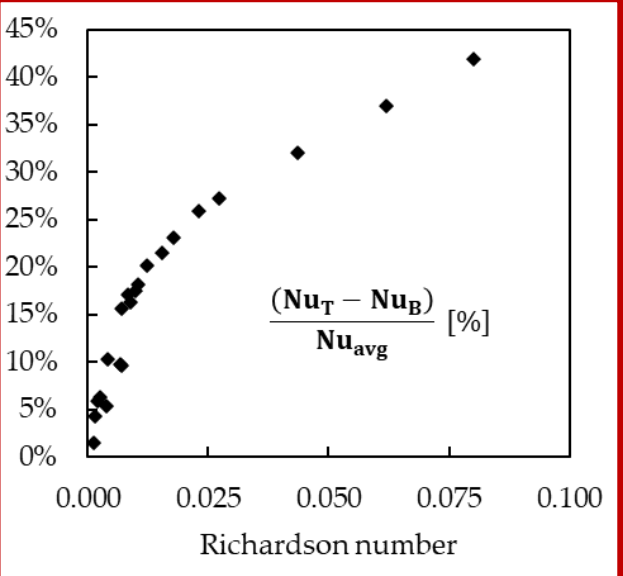
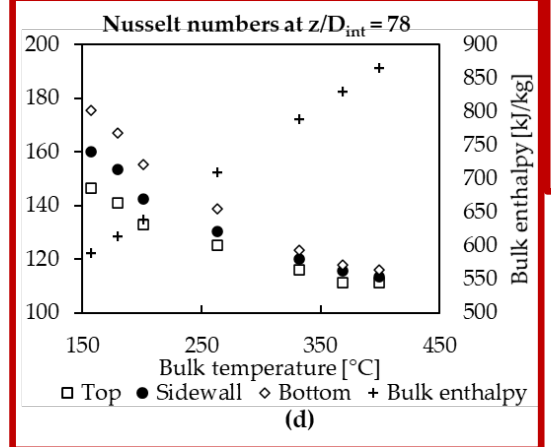
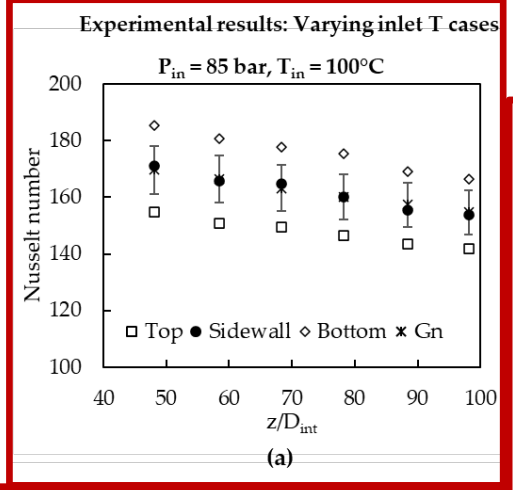
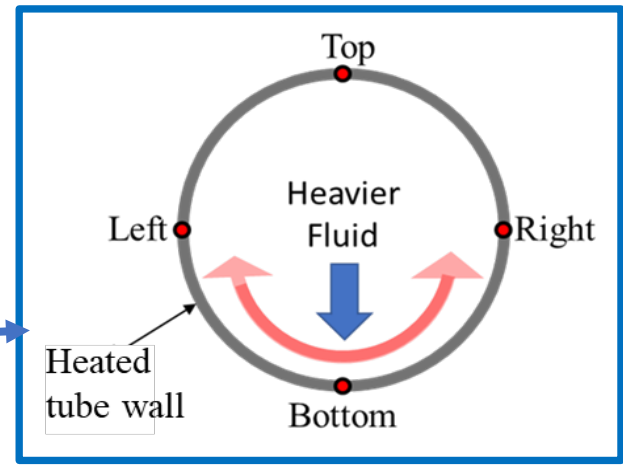
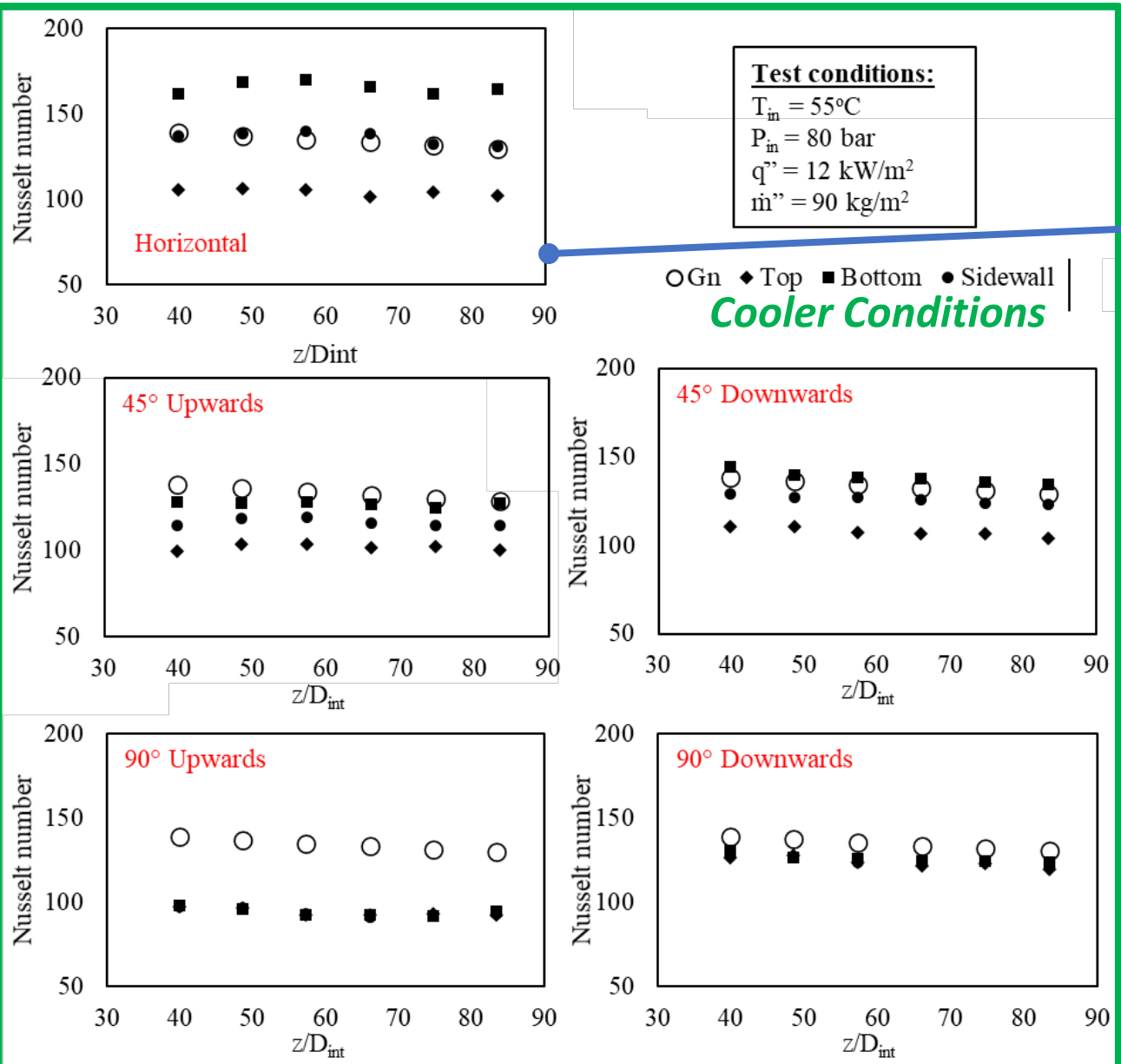
Experimental sCO₂ Facilities: Flow/Heat Transfer/SFS, System/Component Testing

- Primary CO₂ Loops
 - Loop 1 (UCF Main Campus) – High Pressure/Temperature (UTSR)
 - Impact of Buoyancy, heat transfer correlations on Heat Transfer
 - 240 bar, 700°C
 - Loop 2 (UCF Main Campus) – Near-Critical (ONR)
 - Impact of Buoyancy and Inclination Angle on Heat Transfer
 - Can go transcritical
 - Loop 3 (CERT Facility @Valkaria Airport) – Testing of indirect-fired sCO₂ power cycle
 - [REDACTED]
 - Loop 4 (CAPE Facility @Sanford Airport) – to be operational in summer
 - 170 bar, ~2.5 kg/s (**Thanks to SNL Brayton Lab**)
 - Mid-TRL testing of seals, combustor nozzle, cooling concepts etc.
 - In conjunction with Siemens Energy **Moss** Facility
- Turbine Blade Cooling Techniques (SwRI/NETL) – correlation development
 - Pin-Fin Array, Film cooling, Jet Impingement
- Compressor Cascade Testing Near Critical Point (SETO)
- Recuperative Heat Exchanger Testing



PIV within 150 bar enclosure

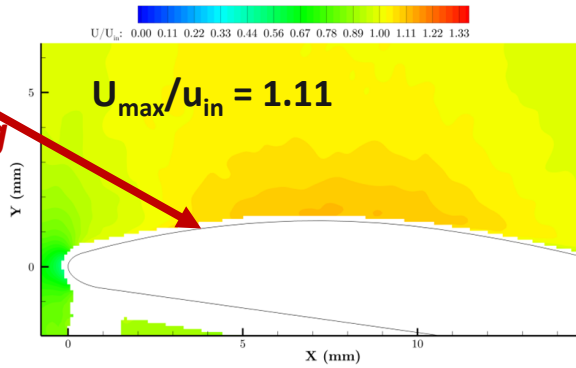
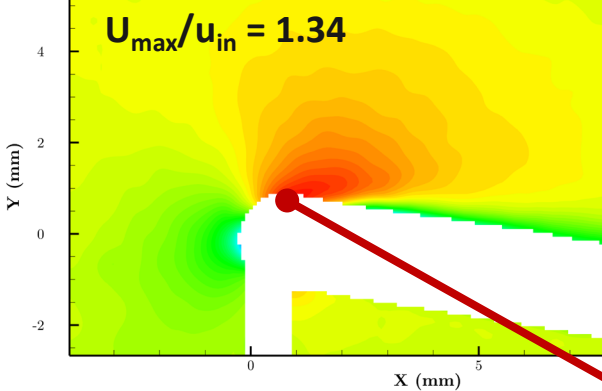
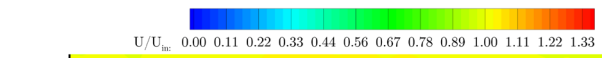
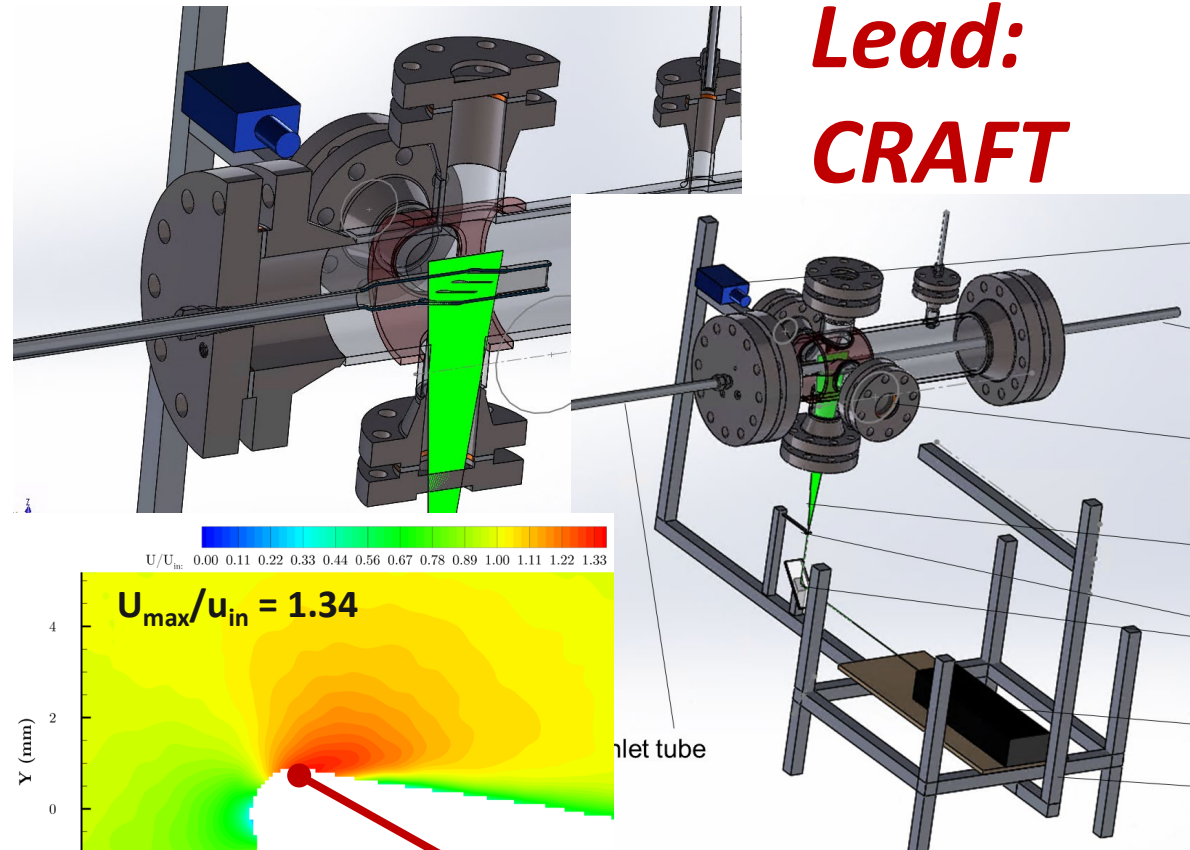
Impact on Heat Transfer



- ✓ **HT Deviation near critical pt.**
- ✓ **Departure scales with Ri**

Quantitative Flow Viz is not Easy!

Lead:
CRAFT

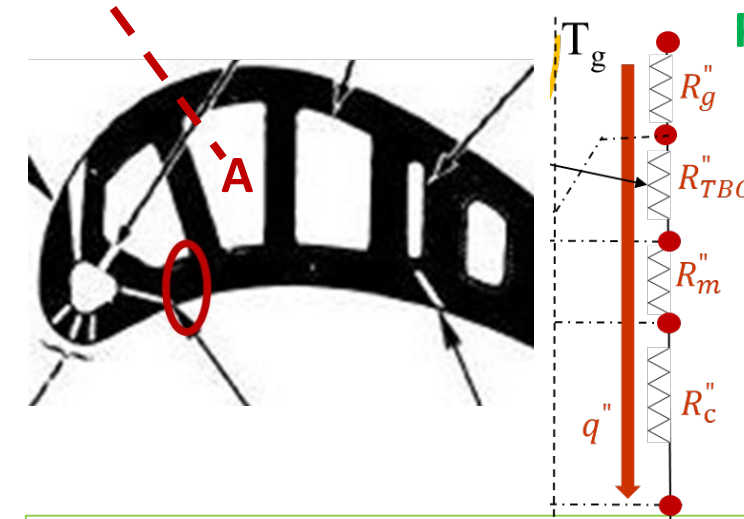


Leading Edge Contouring

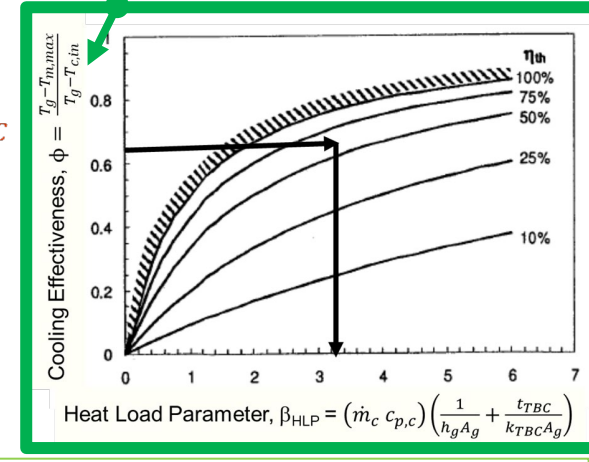
Simultaneous measurement of flow field and temperature is underway

All traditional cooling techniques are not equal for sCO₂

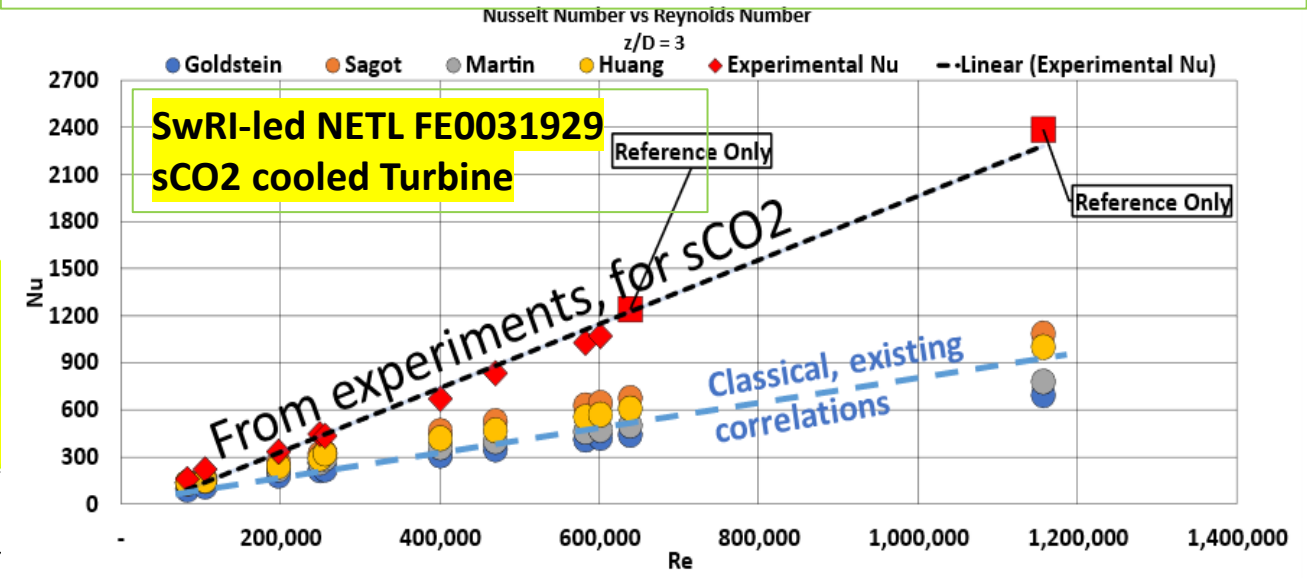
B₁ (high Re -> high h_{gas} -> requires high h_{coolant} - Bad News)



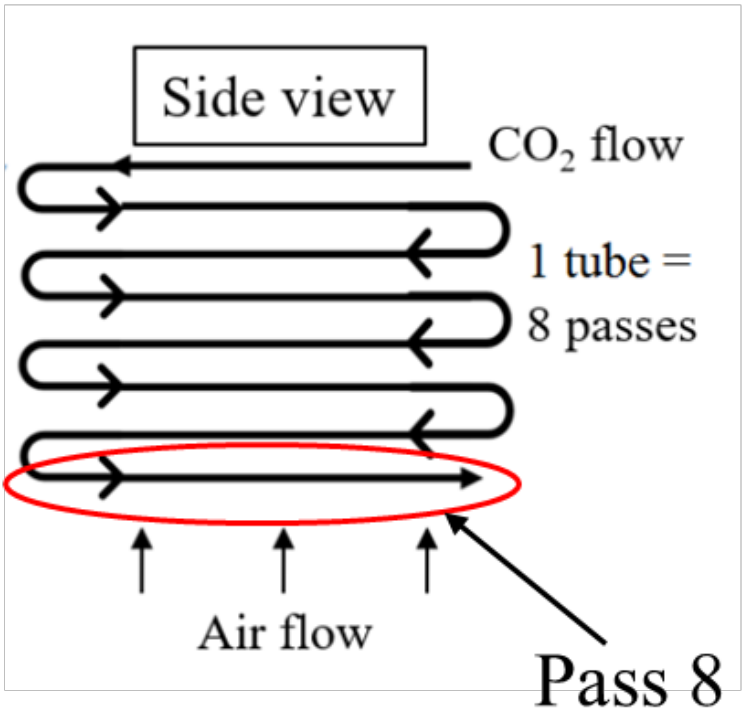
Potentially high: good news



Impingement Heat Transfer for Internal Cooling



Transient Performance Analysis

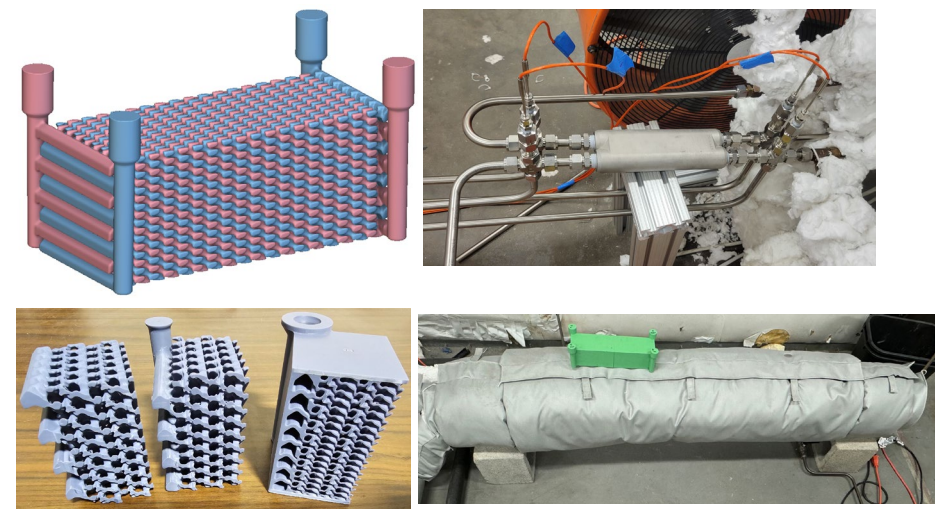


Heat Transfer Coefficient Peaks at Different Nodes at Different Times

Pinch point moves inward during the transient process

AM TPMS Recuperator

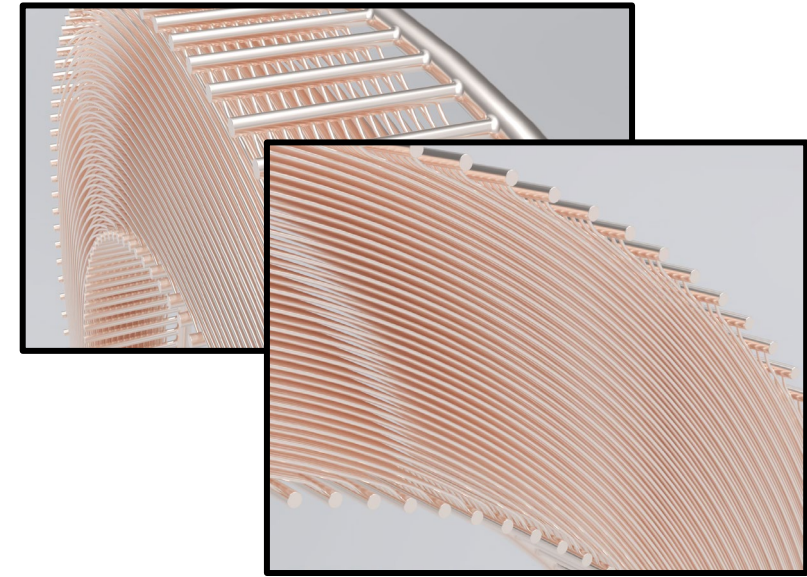
Funded by ARPA-E (lead: Siemens T; UCF, Siemens E)



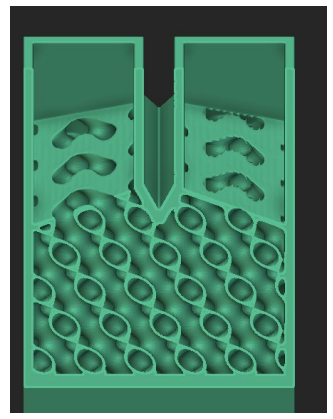
- Topology optimized based on Diamond TPMS
- Designed for 250/80 Bar with hot inlet temperature of 800C
- 90 kW Duty at full flow
- >80% Effectiveness

PHX: Thermal Interface

NASA "ALFA" Project (B737-8 with GE Leap-1B: exhaust heat recovery)



With Siemens E "MOSS" Project molten salt to sCO₂ HEX





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