Compression System Design and Testing for sCO_2 CSP Operation

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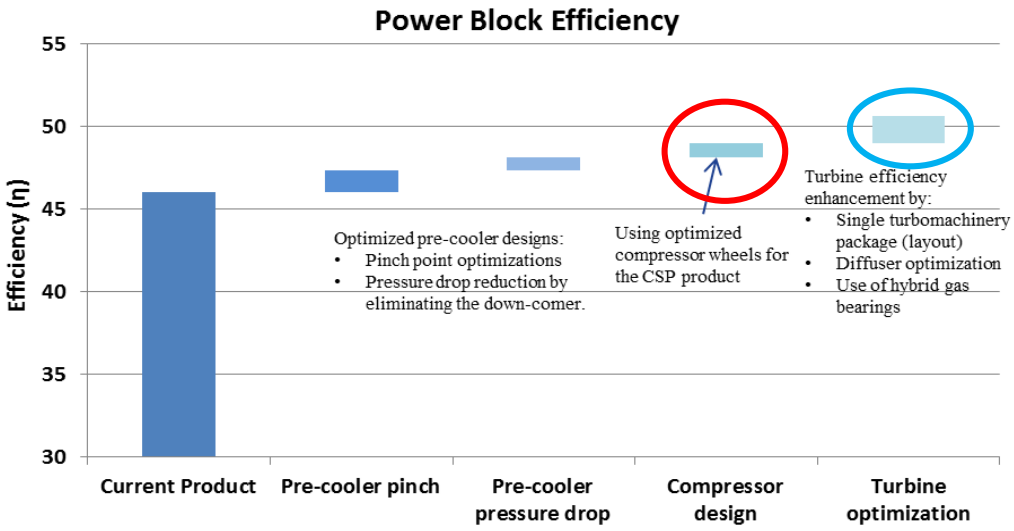
Why, What and How

Activities:

- Develop high efficiency full scale compressor package, 76% to 80%
- Off-design strategy to enable wide ambient range performance at high efficiency
- Main compressor validation test
- Mature process lubricated gas bearing technology to TRL3 to enable future increased efficiency potential

Phases:

- Phase 1 – Compression system design
- Phase 2 – Test loop and turbomachinery construction
- Phase 3 – Performance Testing

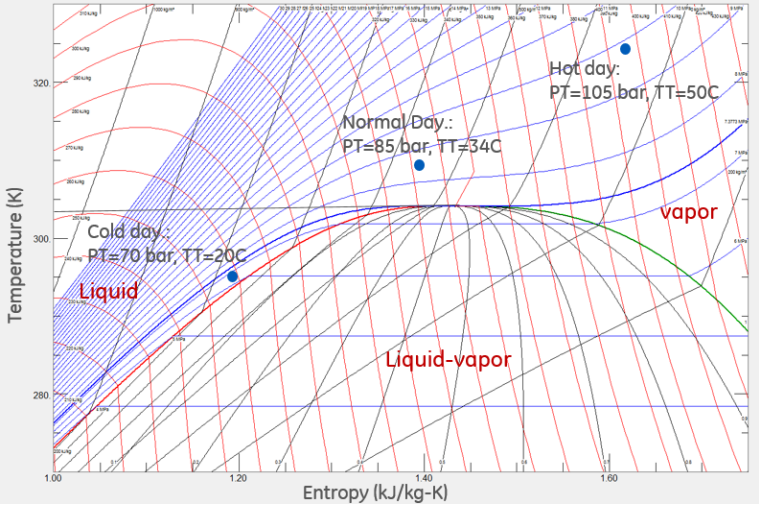


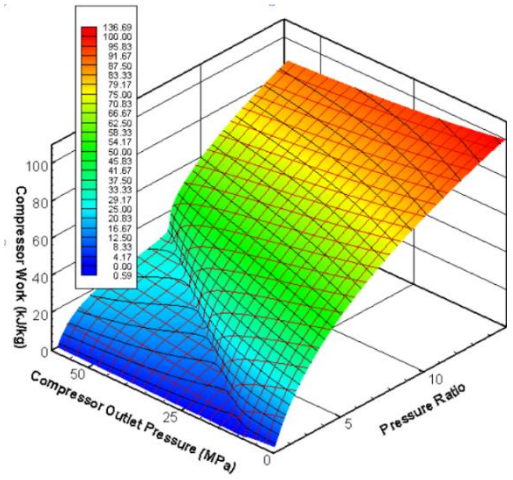
Project Details:

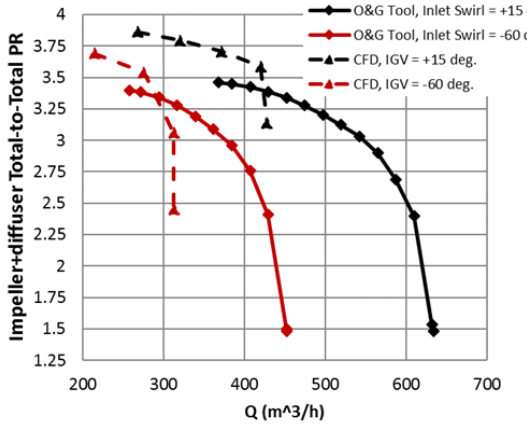
- GE Research, prime
- Southwest Research Institute (SwRI)
  - Design, build and testing partner
- Baker Hughes GE (BHGE), OEM guidance

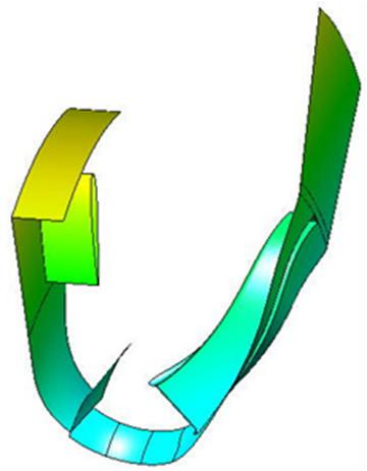
Program specifically targets two areas to decrease CSP LCOE

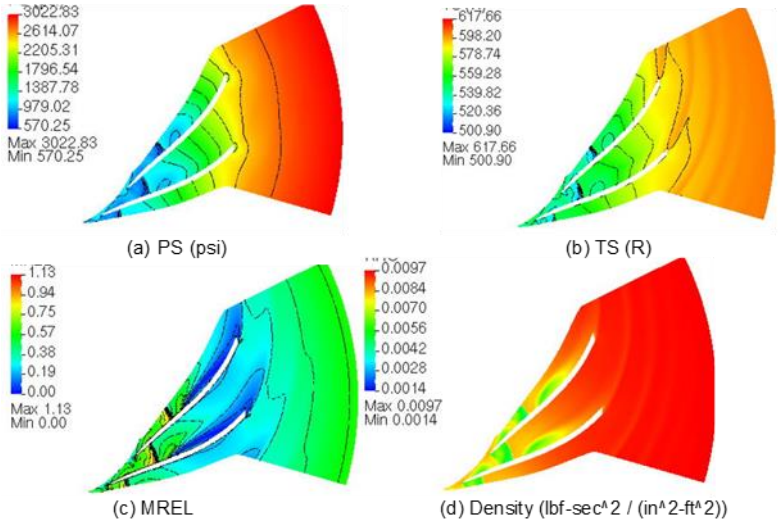
Impact of Real Gas Properties





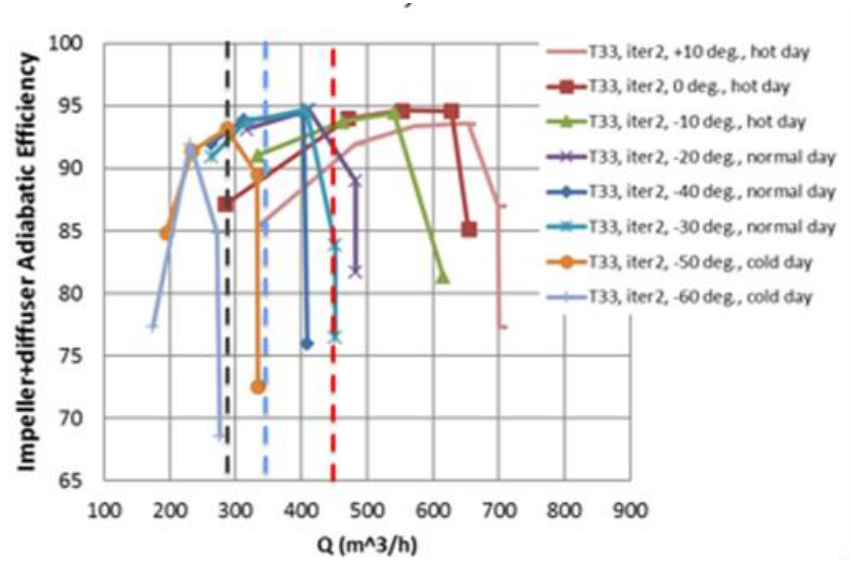


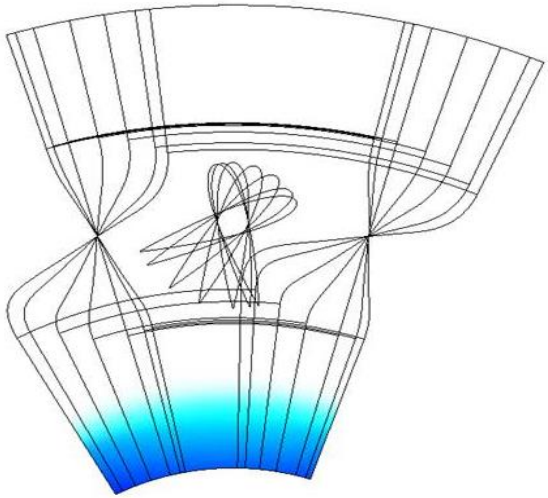


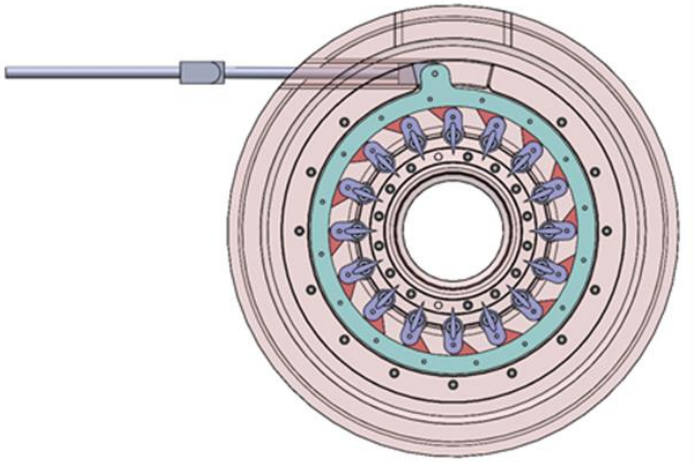


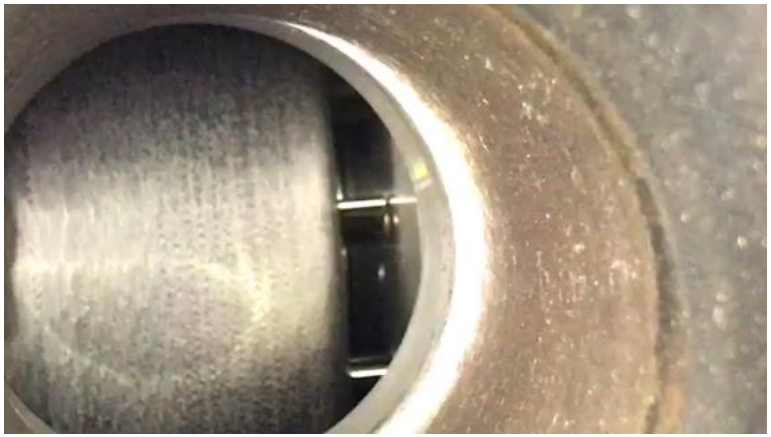
Normal day is very close to the critical point – Cold day the liquid saturation line
Real gas properties are critical and analyzed with CFD

Challenges Inherent in CSP Cycle



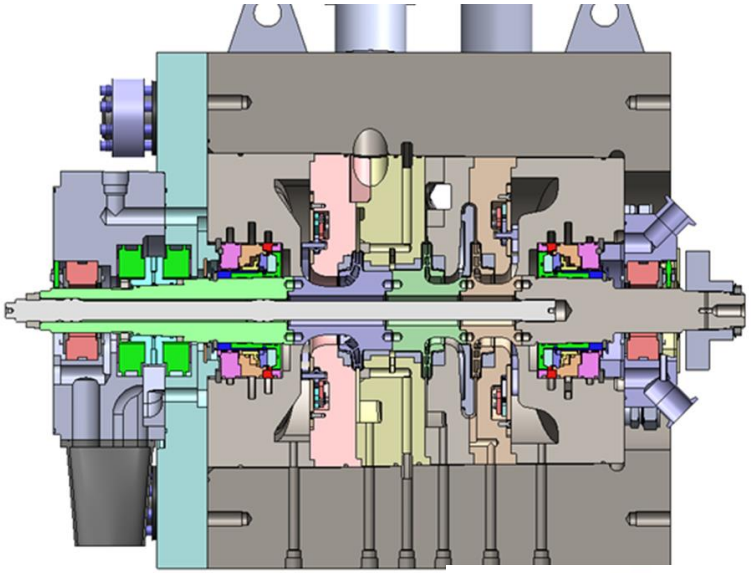


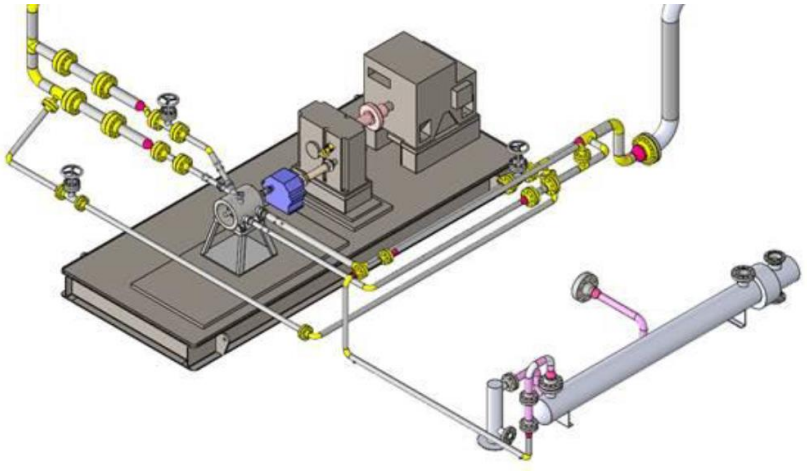




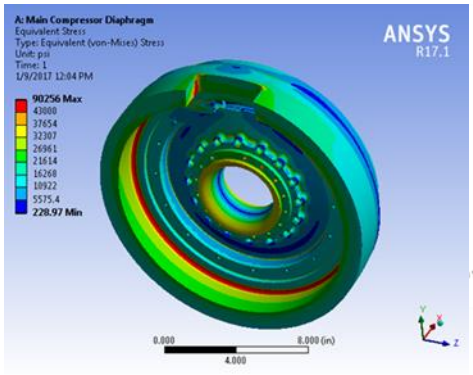
Large variation requires use of IGV mechanism to adjust aero solution for all ambient conditions

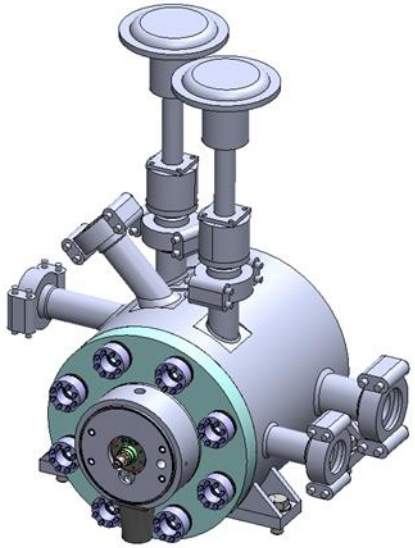
Compressor Design and Test Loop

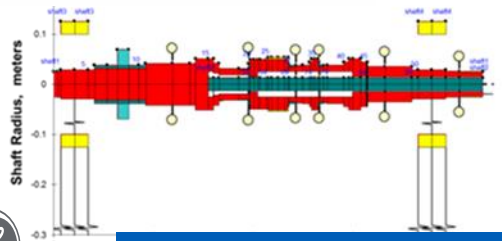




Southwest Research Institute (SwRI) sCO_2 Test Loop

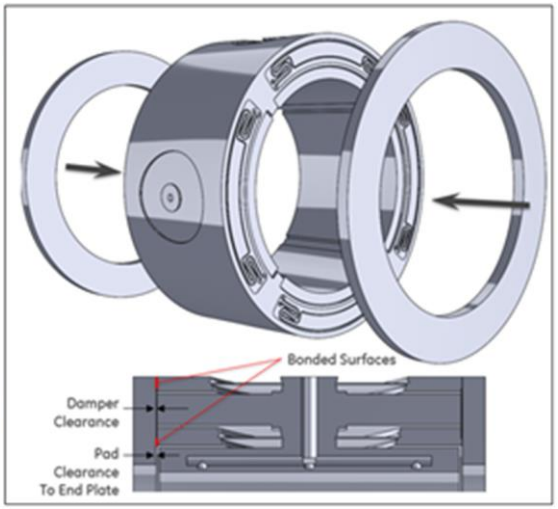


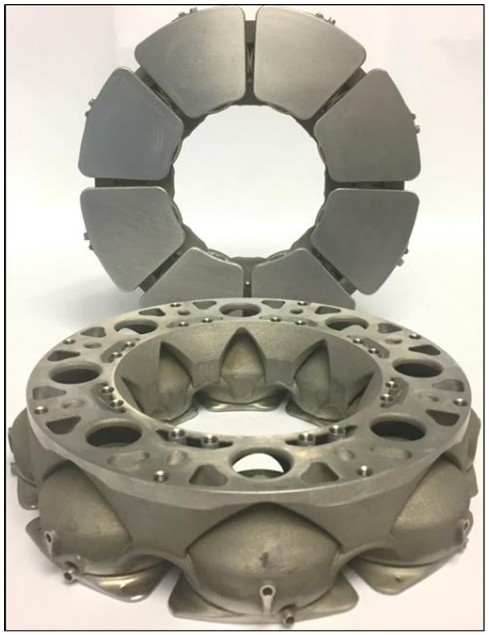




Testing will leverage existing SwRI Sunshot loop with modifications

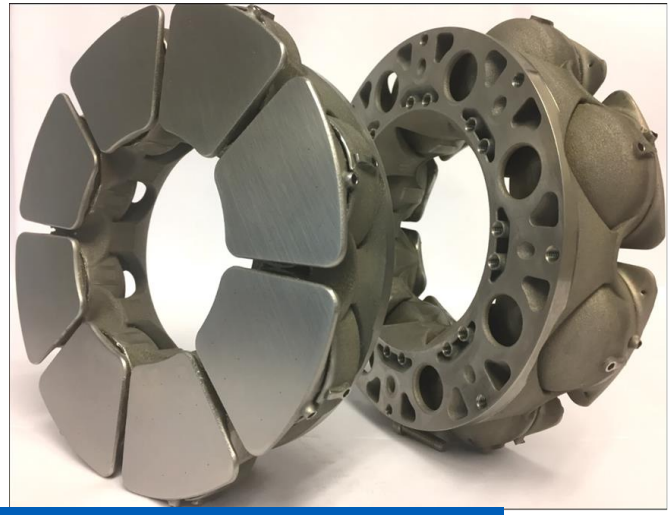
Process Lubricated Gas Bearings





Radial bearing solution:

- Manufacturing complete
- Testing complete

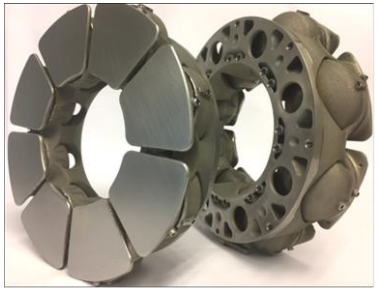


Additive manufactured thrust bearing

- Manufacturing Complete
- Testing Complete

Driving process lubricated bearings to TRL3 to meet long term Sunshot goals

Summary Status:



< Radial and thrust gas bearings manufactured and tested.

< First results to be released IGTI 2019

> Compressor manufactured and assembled.

> First roll April 2019

Figure Of Merit (FOM) supporting Sunshot (CSP) goals:

FOM	Success Value	Predicted Value
Isentropic Efficiency: $\eta = \frac{(h_2 - h_1)_s}{(h_2 - h_1)_{actual}}$	≥ 80%	82 +2.5 / -2
Off design operability = (Min-Flow)/(Design Flow Rate)	≤ 60%	52%
Weighted Compressor Efficiency: $\eta_w = \frac{\int_{T_1}^{T_2} W \eta dT}{\int_{T_1}^{T_2} W dT}$	≥ 66%	79.41 +2.5 / -2
Cost Definition (AACE level 4)	≤ $250/kW	$234/kW +41/-30