ASCENT Project 068

Combustor Wall Cooling with Dirt Mitigation

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Cost Share Partner: Pratt & Whitney

Objective:

Dirt accumulation on the surfaces of gas turbine components severely diminish the performance of various cooling technologies. The objective of this study is to investigate new cooling designs that are insensitive to dirt accumulation effects.

Project Benefits:

The expected benefit from this study is a cooling design for combustor walls that is insensitive to dirt accumulation, as well as an gaining an understanding as to why particular designs may be insensitive to the dirt accumulation. These results will lead to reduced turbine maintenance.

Research Approach:

The research approach for developing new cooling designs for the combustor liner is: testing of a range of cooling technologies at engine scale using a multi-phase flow that contains small dirt particles downselecting the most promising design; measuring detailed flow and heat transfer measurements of the most promising design; scaling the most promising design for integration into an annular configuration for testing in a laboratory test turbine.

Major Accomplishments (to date):

Computational and experimental methods have been established to ensure repeatable results using a generic combustor liner geometry. Two different dirt feeds were developed to include continuous and slug flows of the dirt. Several liner coupons with each having a unique cooling design have been manufactured.

Future Work / Schedule:

Testing of the combustor liner coupons will begin in May and extend throughout the summer.

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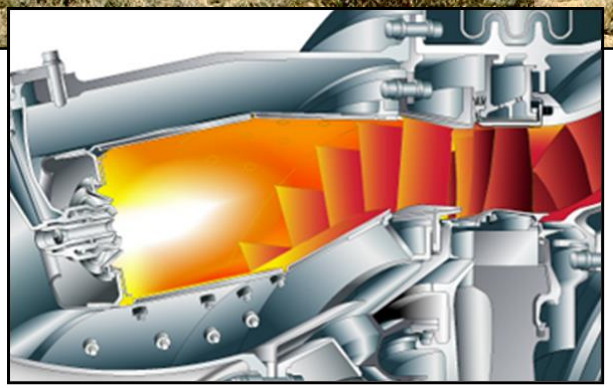
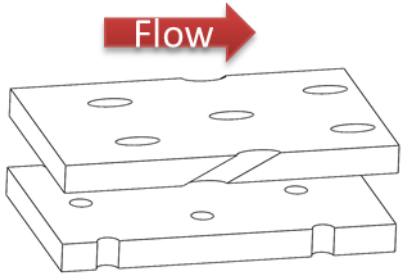
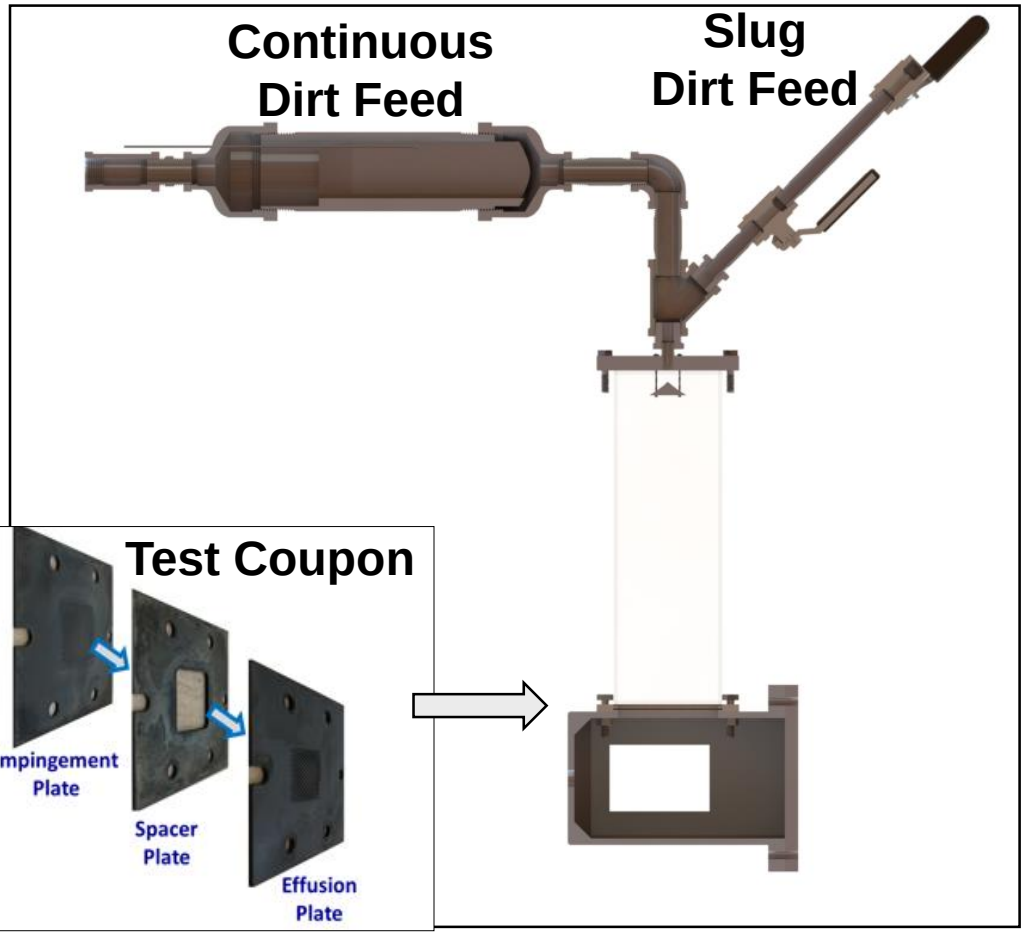
A test rig was developed that to evaluate liner coupons fed by dirty air

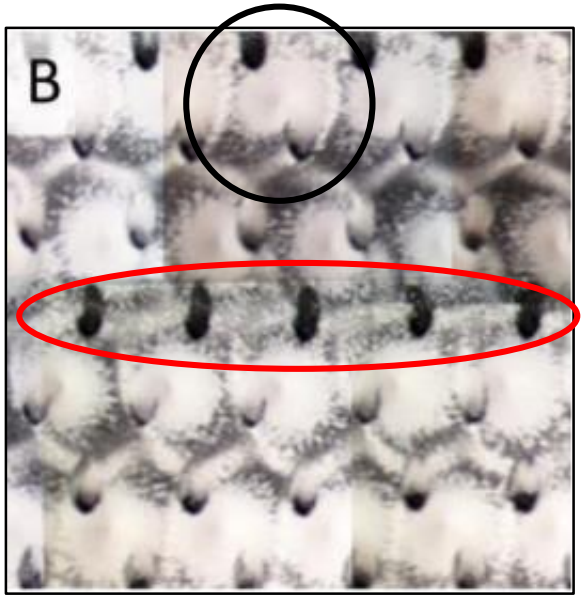


Double-Walled Combustor Liner

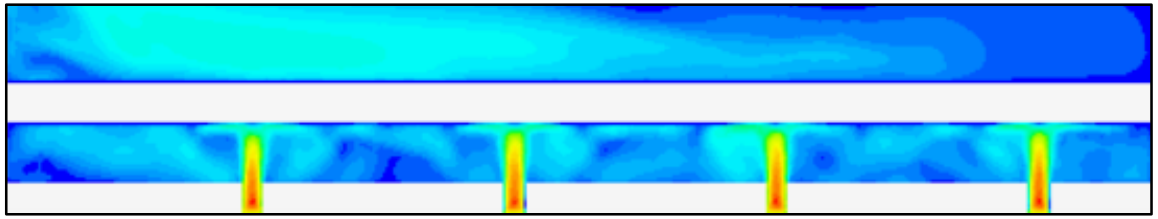




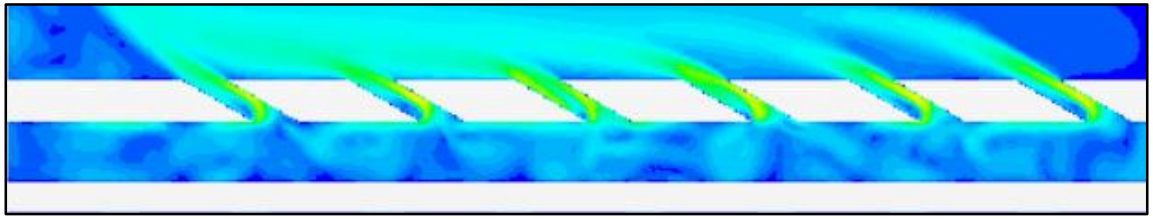
A computational model was developed to guide our concept designs

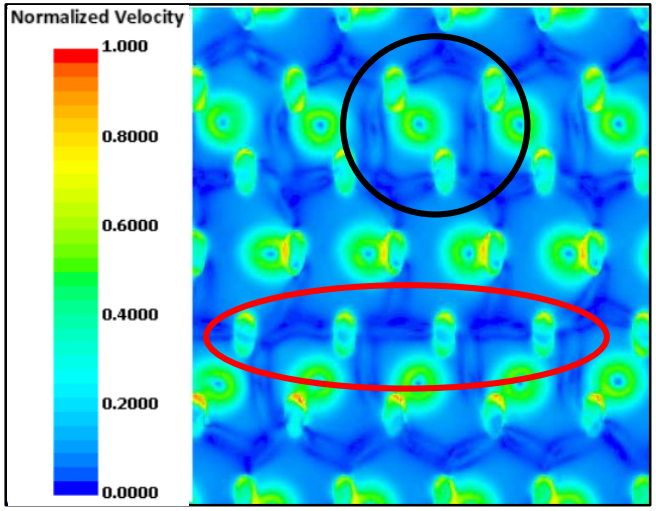


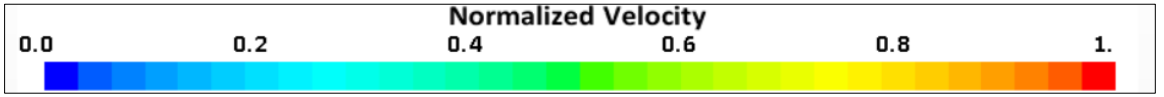
Impingement Jet Contours



Effusion Hole Contours

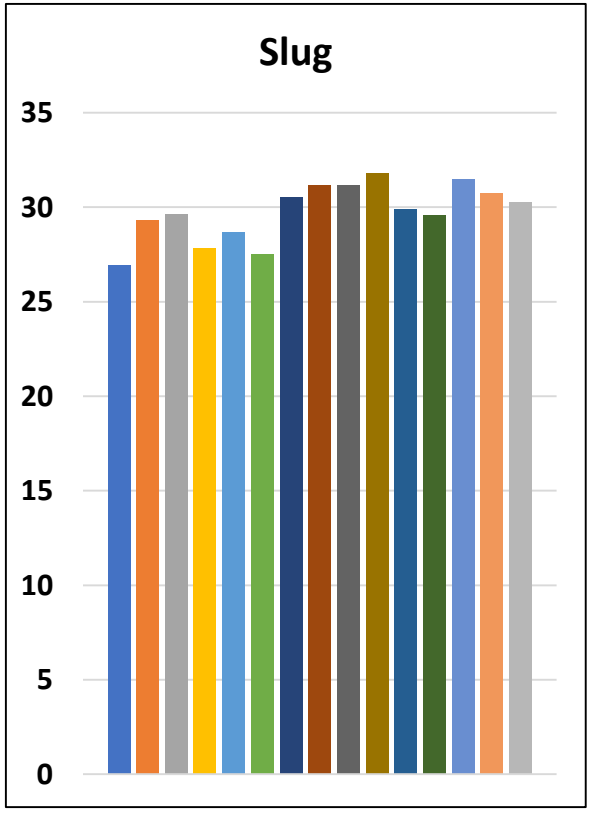


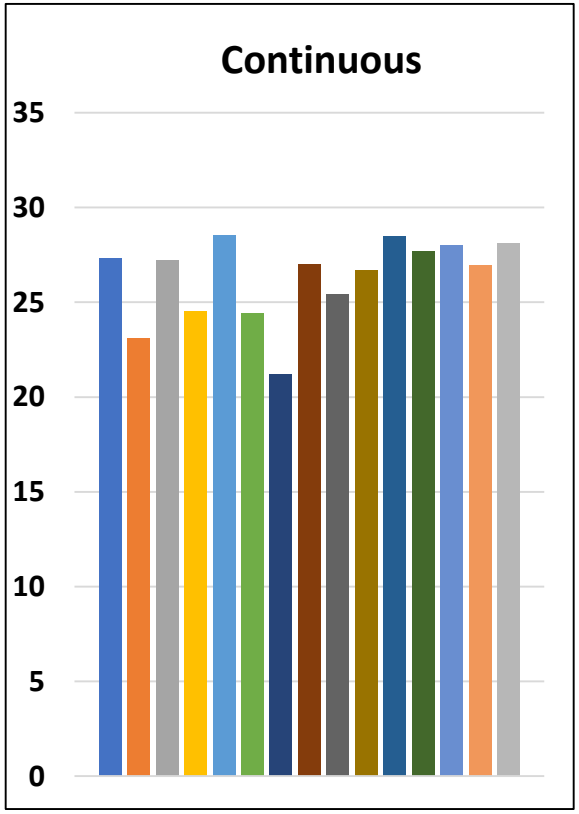




Data shows repeatability of capture efficiencies below 6% using 3 tests

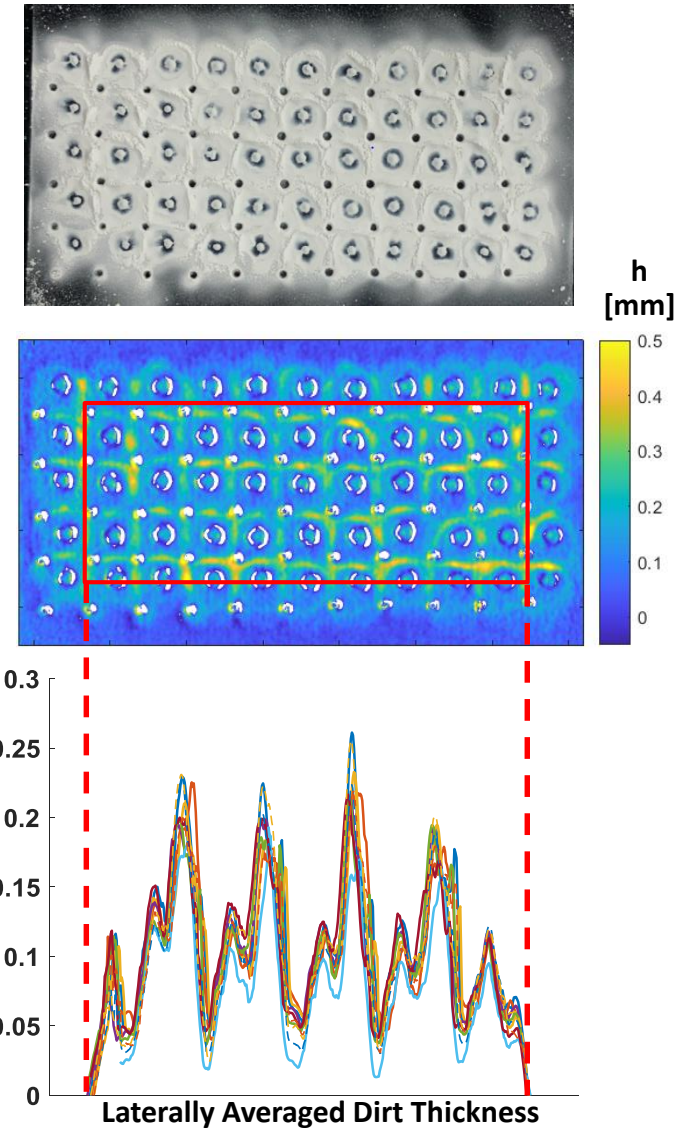
$$\eta_c\,(\%) = \frac{\text{Dirt Captured on Effusion Plate}}{\text{Dirt Injected}}$$





Slug	
Mean	% Repeatability
29.8	5.63

Continuous	
Mean	% Repeatability
26.5	8.10



Tests show 4% reduction in flow for two different pressure ratios

$$BFM = \left[\frac{P_{up}+P_{down}}{P_{down}} - 1\right] * 100$$

$$\text{Flow Parameter (FP)} = \frac{4\dot{m}\sqrt{T_{oc}R}}{\pi P_{up} N D^2}$$