Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Redesigning a Film-Cooled Airfoil Trailing Edge using MRI Techniques[1] MICHAEL BENSON, United States Military Academy, CHRISTOPHER ELKINS, JOHN EATON, Stanford University — Trailing edges of modern gas turbine blades are film cooled through cutback slots on the airfoil pressure surface. The slots are spanwise divided, forming rectangular wall jets separated by tapered lands. The 3D wall jets mix rapidly with the mainstream flow reducing the cooling effectiveness. Experiments were conducted to document the 3D mean velocity and coolant concentration fields on a baseline configuration using Magnetic Resonance Imaging (MRI) in a water flow with Re = 110,000 based on airfoil chord length. Critical flow features causing rapid mixing were identified: a separation bubble behind the slot lip, and a pair of strong longitudinal vortices formed just downstream of the slot breakout. The geometry was modified to improve film cooling surface effectiveness obtained from the concentration field. The first redesign modified the slot lip and land shapes to minimize the slot lip separation bubble size and reduce 3D effects. The other redesigns modified the land shape to reduce the strength of the longitudinal vortices. These latter two designs produced a substantial reduction in the mixing rate of the coolant jet with the mainstream flow, improving the cooling system performance. The highly detailed concentration and velocity fields available with MRI-based experiments can be used to understand the flow physics and derive significant system improvements.

[1]This work was generously supported by GE Aviation under the GE-USA program and the Army Research Office.

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Date submitted: 29 Jul 2011 Electronic form version 1.4