Experimental Research on unsteady Film Cooling

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To produce more power per gas turbine engine unit mass, we need to enhance turbine thermal performance. Nowadays, it can be mainly done by increasing the turbine inlet gas temperature.
The main problems in experimental development of film cooling for turbine blades are the high costs and the time intensive process. The steady film cooling effects have been thoroughly researched and understood. The unsteady interaction between strong pulsations in the main flow and the emerging film cooling jets has a noticeable influence on the film cooling performance. This field has not been researched in detail due to restrictions in access to real turbines and the requirement of very complex experimental machinery and measurement systems.
The aim of this research is to build an experimental facility to produce flow and heat data of the periodic unsteady mixing of typical film cooling conditions. The hope is to gain better understanding of discrete unsteady film cooling effects. This data will be used to calibrate a film cooling model that is implemented in a CFD-code to simulate global film cooling on a turbine blade.
This is done with the novel experimental facility GEMINI. This test rig has the capability to simulate and vary all relevant film cooling flow parameters like density ratio, Mach number, reduced frequency, boundary layer thickness and momentum flux ratio. The geometric parameters are variable as well to allow studies on their influence. Different measurement systems are utilized. A 3D PIV system acquires data about the flow structure, thin film gauges acquire the surface heat flux, fast pressure probes acquire the surface static pressure and access to different probes like FRAP and total temperature probes is given.