3D Flow Visualization of Gas Turbine Blade Internal Cooling Flows utilizing Magnetic Resonance Velocimetry

Wontae Hwang[1,2,3†]

[1]Department of Mechanical Engineering, Seoul National University, Seoul, 08826, South Korea
[2]Institute of Advanced Machines and Design, Seoul National University, Seoul, 08826, South Korea
[3]Institute of Engineering Research, Seoul National University, Seoul, 08826, South Korea

†Email address for correspondence: wthwang@snu.ac.kr

Abstract

Jet engines and gas turbines operate at very high temperatures to increase thermodynamic efficiency. The high-temperature flow passing through the turbine blades is much higher than the melting point of the metal materials. Therefore, internal and external cooling of the blades is essential to maintain blade life. In this lecture, I will introduce a method to qualitatively visualize and quantitatively analyze the cooling flow inside a turbine blade using a medical MRI scanner. Magnetic resonance velocimetry (MRV) is a technique that can noninvasively visualize complex flow structures in three dimensions. Since millions of velocity vectors can be obtained within a few hours without optical windows or tracer particles, this technique can be used for quantitative validation of computational fluid dynamics (CFD) analysis results. The technique of analyzing and evaluating the complex serpentine passage and trailing edge internal cooling flow structures of gas turbine blades using MRV has already been utilized in the development of power generation gas turbines and will be used in the development of advanced jet engines in the future.

Keywords: Gas turbine, cooling flow, magnetic resonance velocimetry

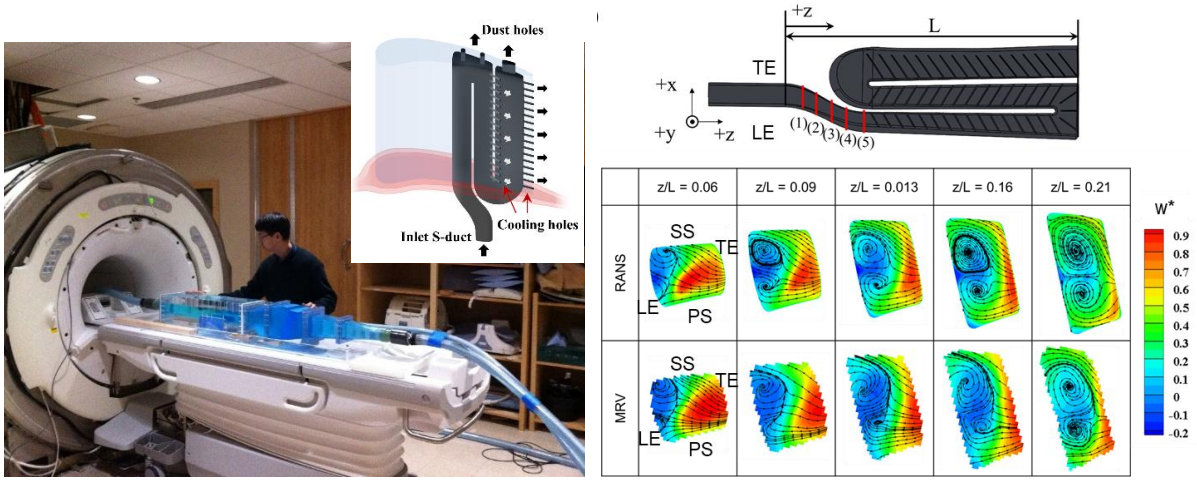

Figure 1. Magnetic resonance velocimetry experimental setup and turbine blade trailing edge internal flow

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