Probabilistic CFD Analysis of a High-Pressure Compressor under Consideration of Manufacturing and In-Service Variability

Lukas Schlüter, Technische Universität Dresden

The impact of geometric variation of compressor airfoils due to manufacturing scatter and operational effects on the aerodynamic performance is a well-addressed topic in the research field of turbomachinery. Thereby, the airfoils' leading edge (LE) shapes are highly relevant to their aerodynamic behavior, potentially causing increased losses and separation. In previous probabilistic computational fluid dynamics (CFD) analyses, the LEs are usually modeled as semi-circles or semi-ellipses, whereas their noticeable deviation from these simplified shapes is given comparatively little attention.

This shortfall has recently been resolved by the introduction of an advance LE shape parameterization as part of the TUD in-house analysis tool Blade2Parameter. Taking this extension into account, a probabilistic CFD analysis of a 10.5-stage High Pressure Compressor (HPC) has been conducted in order to determine the impact of geometric variabilities on the HPCs performance objective. The results of this sensitivity analysis are discussed along with the impact of the sample size on the probabilistic results, as well as the impact of characteristic differences within the underlying baseline model.