NUMERICAL INVESTIGATION OF THE PERFORMANCE AND STABILITY OF A SINGLE STAGE LP AXIAL COMPRESSOR

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In order to fulfill new requirements with respect to noise, fuel consumption and pollutant emission, it becomes essential to work on new engine architectures and concepts to replace the standard Direct Drive Turbofan (DDTF). One can quote the Counter-Rotating Turbofan (CRTF), the Geared Turbofan or the Open Rotor engine. Each of these new technologies obviously comes along with aerodynamical and mechanical challenges which radically modify the whole engine design. In that prospect, different projects have emerged as the European DREAM project (valiDation of Radical Engine Architecture systeMs), which aims at validating new engine architectures and advanced design and technology concepts for more efficient turbomachinery components.

In that framework, the von Karman Institute is in charge of the performance testing of a single stage low-pressure axial compressor designed by Techspace Aero. This stage is representative of the state-of-the-art booster designs for the next generation turbofan engines. The main focus of this work is the numerical assessment of the steady performance of the stage from choke to stall at cruise speed. For this investigation, the CFD software FINE/Turbo from NUMECA International is used.

The full compressor stage has been modeled including IGV, rotor and stator. Two rotor configurations have been computed with a nominal tip clearance of 0.3 mm and a reduced tip clearance of 0.03 mm to assess its effect on performance and stability. For the nominal clearance, a detailed flow field analysis is performed (spanwise distributions and blade-to-blade distributions). Finally, the stall inception is investigated. Pertaining to the performance of the stage, the results are compared with Techspace Aero's data. Because the next step of this work is the experimental investigation in the VKI-R4 facility, data are linked to previous experimental results performed on a different booster. This study highlights that improvements can be achieved to decrease measurement uncertainties.

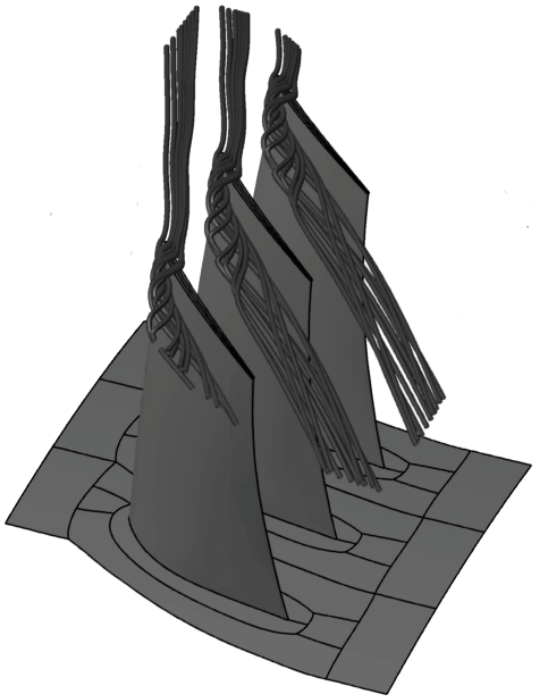

Figure 1: 3D view of tip clearance vortex streamlines