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TOWARDS MITIGATION OF ALTITUDE-EXCITATIONS IN TRANSONIC COMPRESSORS

***Philipp L. Nel[1], Patrick Grothe[2] and Paolo Adami[3]**

[1] Rolls-Royce Deutschland, Eschenweg 11, PhilippLeonard.Nel@rolls-royce.com
[2] Rolls-Royce Deutschland, Eschenweg 11, Patrick.Grothe@rolls-royce.com
[3] Rolls-Royce Deutschland, Eschenweg 11, Paolo.Adami2@rolls-royce.com

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At high altitudes, a laminar boundary layer persists on the suction side of a transonic fan, leading to a laminar shock boundary layer interaction (SBLI). The interaction may lead to excitation of the rotor due to an oscillating passage-shock impinging on the fore-pressure side and aft-suction side of the rotor blades.

Altitude excitations may be mitigated by roughness-promoted transition of the suction-side boundary layer upstream of the SBLI. It is foreseen that roughness-promoted transition may be simulated by directly resolving roughness elements [1]. However, modelling requirements in this regard are not well understood.

This work presents the first step in which the problem is broken down into a smooth transonic cascade and a canonical channel flow with a rough endwall. These two fundamentally different cases are investigated towards understanding modelling requirements for LES CFD of a transonic cascade with surface roughness directly resolved. To this end, a test case of a transonic cascade at engine-representative conditions is used for the smooth cascade validation, with emphasis on transition and shock oscillation. Results from the in-house code; *Rolls-Royce Hydra* are compared with experimental results from the DLR *TFAST*-cascade [1, 2]. Turbulent and transitional RANS/URANS simulations are used to find the boundary conditions for the LES domain. High speed PIV and shadowgraphs are compared with the LES results in order to validate transition and shock unsteadiness.

Finally, modelling requirements for roughness-promoted transition over directly resolved roughness elements are investigated in a canonical channel flow with 3D endwall roughness topography. The work represents an integral first step in understanding requirements for the simulation and mitigation of performance-limiting altitude-excitations.

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