Numerical Analysis of Unsteady Turbulent Internal and External Flows: Challenges of Turbine and Airfoil Flows

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Conference Room, 3rd floor
The Sirindhorn International Thai-German Graduate School of Engineering (TGGS)
King Mongkut's University of Technology North Bangkok (KMUTNB)

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In the beginning, the unstructured hierarchical Cartesian cut-cell/level-set method is concisely discussed and the new features which are a must to tackle multiphysics and multiscale problems are addressed. Then, internal and external flow problems are analyzed.

First, the flow field in a complete one-stage axial-flow turbine with 30 stator and 62 rotor blades is investigated by large-eddy simulation (LES) (Fig. 1). The focus of the numerical analysis is on the flow inside the rim seal between the stator and the rotor disks. Full 360° computations of the turbine stage are performed for two rim seal configurations. The impact of the mesh resolution on the LES results is analyzed for the single lip rim seal configuration. Then, the LES results are compared to experimental data, followed by a detailed analysis of the unsteady flow field. At the same operating condition a modified configuration with a double lip rim seal is investigated and compared to the reference configuration to demonstrate the impact of the rim seal geometry on the overall flow field.

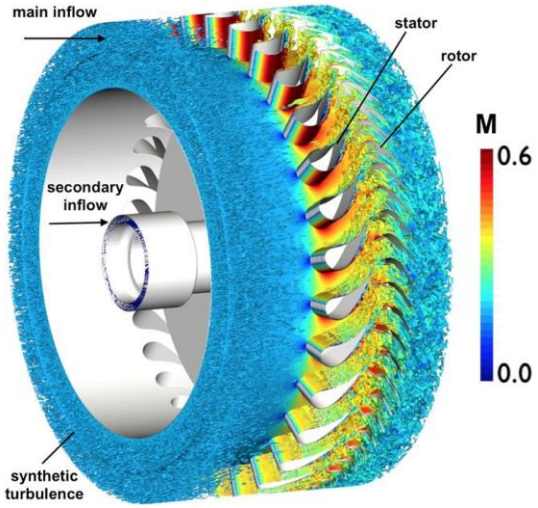

Fig.1: Stator-rotor and rim seal flow

Second, the flow over a DRA2303 wing section at a Reynolds number of Re = 400,000, which is actively controlled by spanwise traveling transversal surface waves, is investigated by a high-resolution large-eddy simulation (Fig. 2). Approximately 75% of the solid surface on both sides of the wing section is deflected by a sinusoidal space- and time-dependent function in the wall-normal direction. The turbulence intensities and wall-normal vorticity fluctuations are significantly reduced and a shift from one-dimensional turbulence to two-dimensional turbulence is observed. Besides a viscous drag reduction by 8.6% with a strong decrease of skin-friction in the favorable pressure gradient region and an overall drag decrease by 7.5%, a slight increase in lift is achieved.

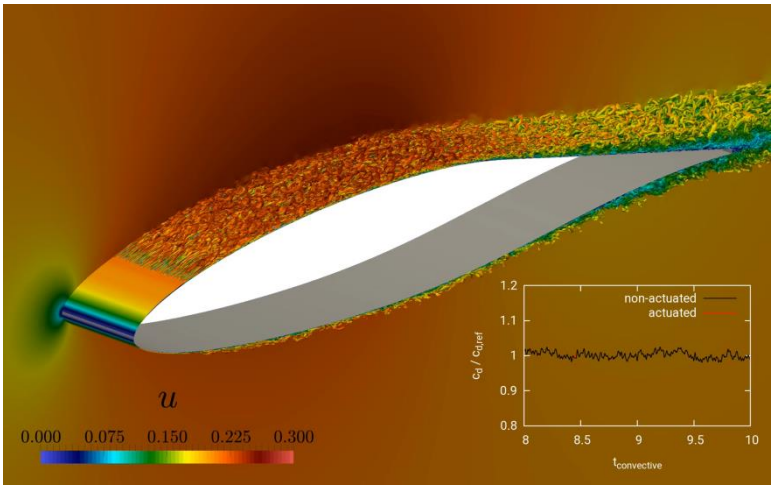

Fig.2: Actuated wing flow