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Application of the discontinuous Galerkin method to 3D compressible RANS simulations of a high lift cascade flow

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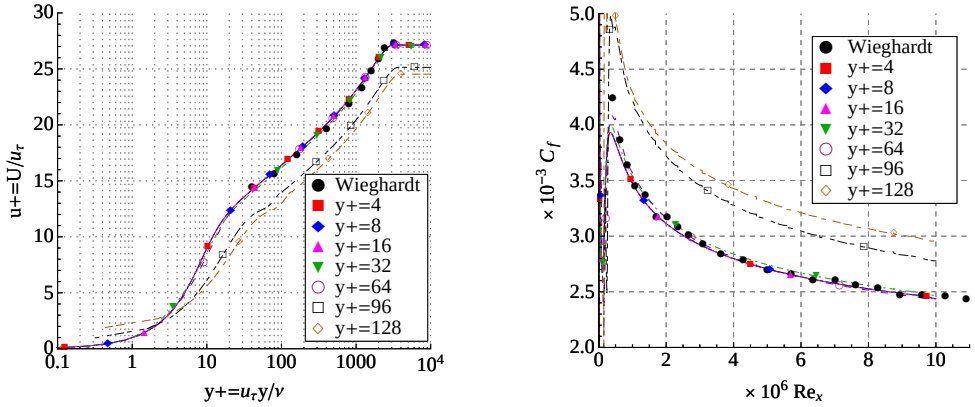

(a) Velocity profile

(b) Friction coefficient

Figure 1: Flat plate computations (M=0.2 and Re=5×10^6) with 4^{th} order polynomials on structured quadrangular grids.

A 3D high-order RANS solver in conservative variables has been developed, based on a discontinuous Galerkin/Symmetric Interior Penalty discretisation. The turbulence model is the well-known one-equation Spalart-Allmaras model. It is shown that in order to stabilise the discretization scheme, it is necessary to adapt the transpose penalty term, which introduces an explicit dependency of the continuity equation on the turbulent viscosity.

The grid convergence of the method is illustrated by computations for a turbulent flat plate (M=0.2 and Re=5×10^6). Fig. 1 shows the velocity profile and the skin friction distribution for different off-wall spacings y^+ of the first element in the case of 4^{st} order polynomials and structured quadrangular grids. We observe that results stay in excellent agreement with experimental measurements, even for meshes which are much coarser ($y+ = 64$) and have much more severe stretchings (here 1.6) than the corresponding finite volume grids.

A second application demonstrates the performance of the presented method for complex 3D cases. Thereto the turbulent flow in a 3D compressor cascade (M=0.1 and Re=8.4×10^5), featuring secondary flow and hub stall is computed, and detailed comparison with state of the art finite volume solvers are presented.