Air traffic is rapidly increasing, with no sign of slowing down, resulting in higher emission of green-house gases. With emission criteria becoming stricter every year, the aircraft design is subjected to a continuous improvement. One aspect in improving the aircraft is by increasing the aircraft's engine efficiency.

The engine consists of different modules, where the focus in this thesis is put on the intermediate compressor duct. As computational resources are becoming more accessible, an integrated design can be considered. The integrated design lowers the need for modeling the interaction between modules, giving more realistic flow behaviour. To take further advantages of the increasing computational resources, higher fidelity models such as the Delayed Detached Eddy Simulation (DDES) model will be considered for future unsteady simulations.

An experimental test rig, representing the compressor duct, which has not been studied to the same extent as the surrounding components, is simulated using an in-house code called G3D::Flow. The simulations are performed using the Spalart-Allmaras (SA) one-equation turbulence model, which has been implemented and verified using simple test cases. The SA model was chosen as it is easily altered to a DDES model and has proven to be efficient when used in turbomachinery applications. Furthermore, to give confidence in G3D:Flow, the code's performance is compared to CFX. The simulations are performed at two different off-design conditions, where mass-flow is extracted through a bleed-pipe upstream of the duct. The mass-flow extracted in the two cases are $10\%$ and $40\%$. The results from the two solvers agree well for the $10\%$ bleed case with significant differences due to strong instabilities in the G3D::Flow results for the $40\%$ bleed case.

To further ensure the capabilities of G3D::Flow and to serve as a benchmark case for the unsteady simulations, the steady state results from G3D::Flow were compared to experimental data ($10\%$ and $31\%$ bleed). The simulated results compare well to the experimental data for the lower bleed fraction whereas there are strong pressure fluctuations present in the higher bleed fraction. Those effects where suspected to be caused by the short bleed pipe, affecting the boundary condition.

As a step towards analysing the ICD using the DDES model, a single blade module was simulated. This work was conducted to analyse the performance of the DDES model on a smaller scale than the whole test rig, and to be more precise, the transition location between the RANS and LES modes. A modification to the original DDES model was suggested by literature, where stronger shielding of the boundary layer is applied, resulting in improved performance of the model.