EXPERIMENTAL STUDY OF THE PERFORMANCES AND STABILITY OF A LOW PRESSURE AXIAL COMPRESSOR FOR A CONTRA-ROTATING TURBOFAN ENGINE ARCHITECTURE

Nicolas Van de Wyer, Belgium
Promoter: Prof. T. Arts (UCL)
Supervisor: Prof J.F. Brouckaert

The aircraft industries have been investing substantial research into reduction of turbofan noise and emission in order to comply with the increasingly strict environmental regulations already for several decades. A potential solution for the noise reduction is the use of the new engine architecture of contra-rotating turbofan, which might enable substantial noise reduction by lowering the fan speed. That imposes highly loaded booster stages preserving the stall margin.

The objectives of this thesis are the study of the performance and stability of the new blade geometry used for contra-rotating turbofan engines. Furthermore the possibility of stability increase by using casing treatments and influence of hub seal leakages on the performances will be investigated.

To perform this experimental study, a 1:2 scale one stage compressor representative of typical booster designed for the contra-rotating architecture was set up in the test facility R4. This close loop facility permits an independent control of Reynolds and mach numbers. A very large range of slow and fast probes, sensors and systems of carriages are used for the flow and stage characterization. Slow probes are used to determine the general performance of the stage and steady flow study, while the fast probes are used to scan the unsteady flow and stall inception parameters.

The steady and unsteady characterizations of the flow for a smooth casing and for a circumferential groove casing treatment are performed. A comparison with numerical calculations shows a good agreement. Fast pressure sensors placed in the casing and fast total pressure probe were used to determine the tip vortex characteristics in both casing configurations and permits the study of the influence of casing treatment on it.

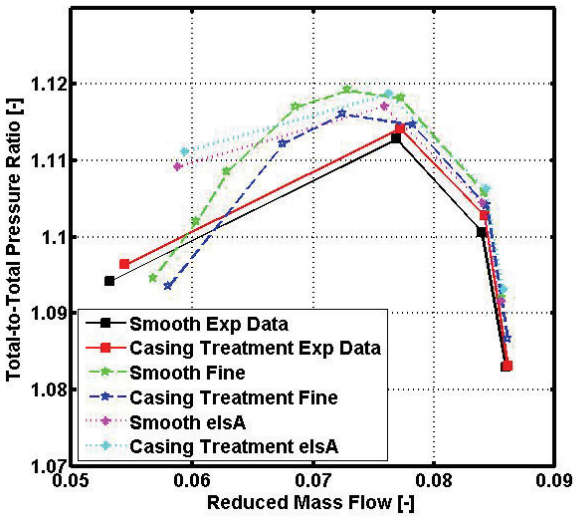

Figure 1: Performance Map

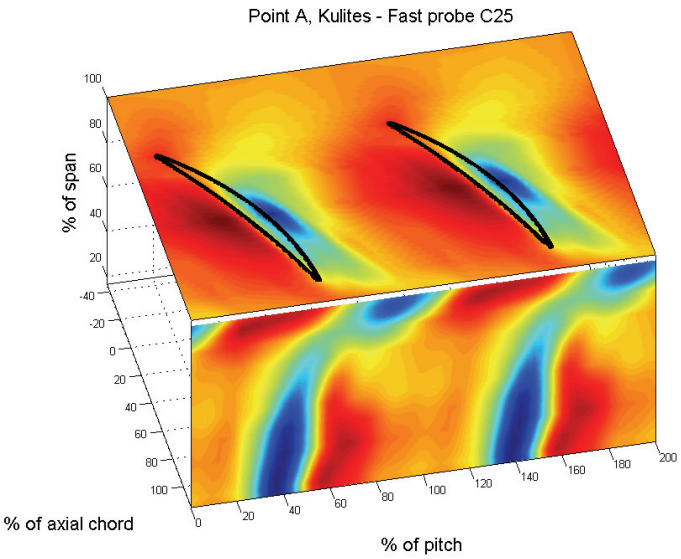

Figure2: Unsteady Casing Pressure Distribution and Rotor Exit Total Pressure Fluctuations