CLOCKING EFFECT ON THE TIME-AVERAGED AND TIME-RESOLVED PRESSURE FIELD OF A SECOND STATOR IN A TRANSONIC TURBINE

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The relative motion between rotor and stator airfoils introduces periodic fluctuations in the flow, such as the pressure of airfoil wakes and trailing edge shock waves. These flow unsteadiness should be taken into consideration for a correct evaluation of high cycle fatigue problems. The understanding of pressure fluctuations associated with blade row interactions is therefore fundamental to improve both the aerodynamic performance and mechanical integrity of future generations of aero-engines.

The experimental characterization of the time-averaged and time-resolved pressure flow field on the second stator of a 1 & 1/2 high-pressure turbine stage is performed. The effect of "clocking" (relative pitch-wise position of the first stator with respect to the second stator) and its influence on aerodynamic and mechanical behaviours are discussed.

Tests were carried out in the VKI Compression Tube Facility CT3. This facility allows full-scale tests at representative Reynolds number, Mach number, gas to wall and gas to coolant temperature ratios. The test program includes 4 different clocking positions. The vane static pressure field is measured with 54 fast response pressure sensors located at three different blade heights: 15%, 50% and 85%.

Time-averaged results show differences on the pressure side and on the front part of the suction side due to clocking, which point out to changes in incidence and inlet Mach number. This effect is especially noticed at 15% span (Figure 1-left). The unsteady data is analysed using the phase-locked averaging technique. The results show fluctuations of static pressure up to 43% of the total pressure at the inlet of the second stator. The unsteady flow field at the rotor trailing edge and its interaction with the second stator explain the propagation of disturbances along the blade surface (Figure 1-right). The location of the maximum static pressure fluctuations is strongly affected by the clocking. Important differences on the estimated forces applied on the blade are found, which could lead to an optimization from a mechanical integrity point of view.

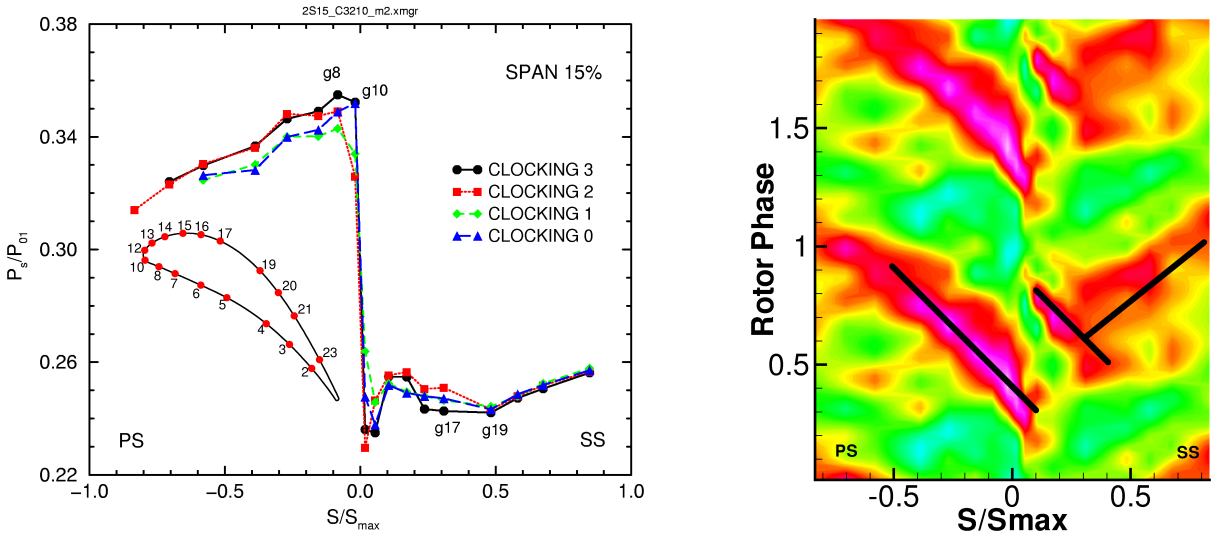

Figure 1: Time-averaged static pressure distribution for different clockings (left) and propagation of disturbances along blade surface at 15% span (right)