DESIGN OF A HIGH PRESSURE TURBINE STAGE WITH REDUCED ROTOR/STATOR INTERACTION

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In transonic turbine stages, stator/rotor interaction is responsible of large fluctuations of the rotor aerodynamic unsteady force due to the periodic chopping of the vane trailing edge shock. This may enhance considerably the high cycle fatigue and may result in unexpected blade failure.

The aim of this project is to investigate how the stator and rotor blade designs can be used to reduce this interaction. For this purpose, a number of computational fluid dynamic tools are used.

The new design starts from the existing BRITE transonic stage that is currently tested in the VKI CT3 facility.

The first step is the redesign of stator blade profile to reduce the vane exit pitchwise static pressure gradient. Several approaches were applied and the most effective results are obtained using an optimization procedure using an Artificial Neural Network. The optimization is performed on the stator blade Mach number distribution. A modest reduction is achieved.

More promising results were obtained on the rotor. The original rotor profile is redesigned for two stagger angles while keeping the inlet and exit blade metal angles unchanged (see Figure 1). For each geometry, the unsteady force is quantified using an unsteady quasi 3D Euler code. The comparison between the original stage and the new configurations shows that the best results are obtained with the low stagger angle rotor blade. A decrease of ~50% of the magnitude of the force fluctuation is achieved (see Figure 1).

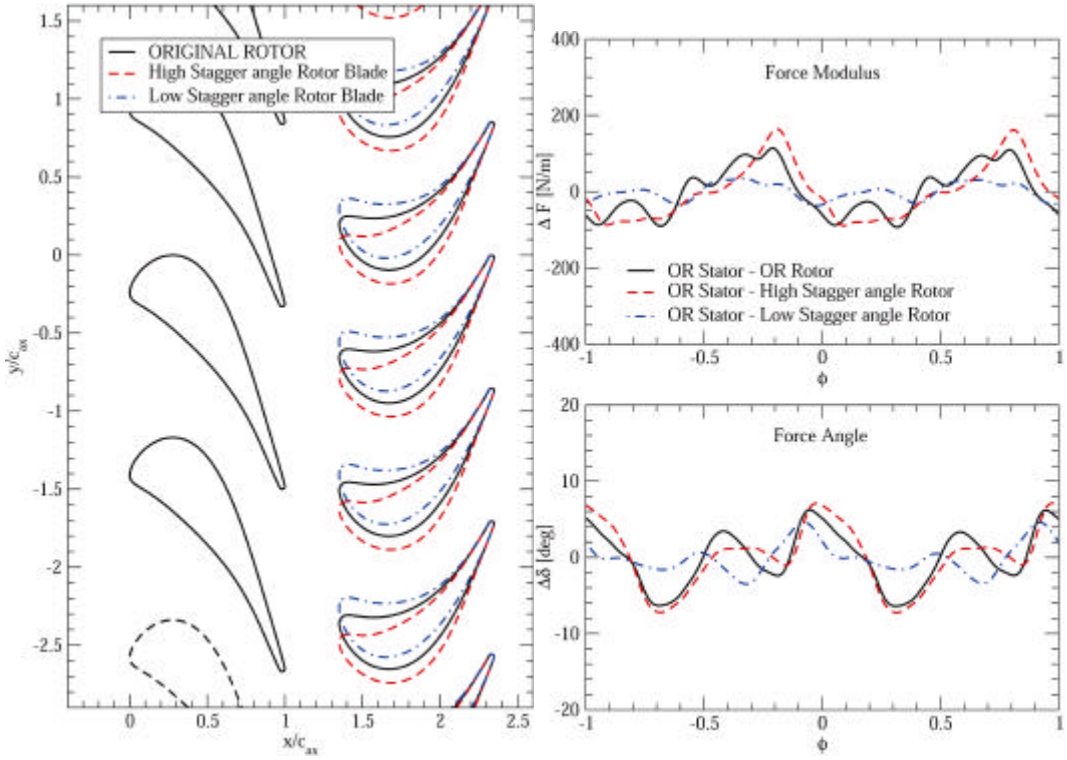

Figure 1: Unsteady aerodynamic force fluctuations on the rotor blade: comparison between different rotor blade using the same stator blade