PhD Proposal

Simulation of pulsated and severe transient flows in turbines

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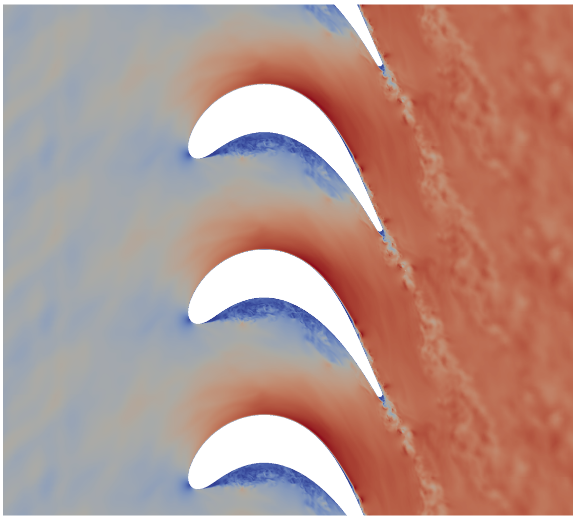
A promising way for the increase of engine performance and efficiency is to develop new cycles with combustion at constant volume. This combustion method needs to design and control unsteady and pulsated flows in various parts of the engine. Other systems such as Pulse Detonation Engine (PDE) and Rotating Detonation Engine (RDE) require the same kind of investigations. Most of these unsteady phenomena involve pressure wave or even shock waves which propagation and interaction with walls and boundary layers are essential to predict.

The proposed work is to study various cases of internal flows with severe unsteady conditions with highly resolved numerical simulations (LES or DNS). The aim is to analyze and understand to following issues :

— propagation of pressure wave and/or shock waves,
— interaction with a boundary layer,
— reflection and diffraction of shock waves,
— identification of transient effects on guide vane compared to steady flow.

The performance of blade row will be determined by the effective angle of deflection of the flow downstream the row. These flow properties will highly depend on the behavior of the boundary layer, its ability to remain attached according to the flow acceleration and the pressure gradients.

This work will be scheduled with a set of configurations of increasing complexity. The numerical background to settle or trigger pressure waves needs to be investigated. Then, the interaction of traveling shock waves with boundary layers will be first analyzed in channels with varying sections or elbows in order to focus on wall and boundary layers interactions. Finally, the more complex interaction with blades will be analyzed. This work will lean on the expertise of the CFD team of the departement, using massively parallel tools which have been developed[3,1] and further improved[4] to increase its high resolution capabilities.



Computation of turbulent flow around T27 blade

Références

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[2] Nicolas Binder, Sebastien Le Guyader, & Xavier Carbonneau. *Analysis of the variable geometry effect in radial turbines.* Journal of Turbomachinery, **134**(4), 041017, 2012.

[3] I. Bermejo-Moreno, J. Larsson, L. Campo, J. Bodart, R. Vicquelin, D. Helmer, & J. Eaton. *Wall-modeled large eddy simulation of shock/turbulent boundary-layer interaction in a duct.* Annual Research Briefs, Center for Turbulence Research, Stanford University, 2011.

[4] Raphaël Lamouroux, Jérémie Gressier, & Gilles Grondin. *A High-Order Compact Limiter Based on Spatially Weighted Projections for the Spectral Volume and the Spectral Differences Method.* Journal of Scientific Computing, pages 1–29, 2015.