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TRANSITION LOCATION EFFECT ON SHOCK WAVE-BOUNDARY LAYER INTERACTION

ORGANIZER: PIOTR DOERFFER

Title of the Presetation: effect of the transition location on a shock-boundary layer interaction

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ABSTRACT

Shock wave-boundary layer interactions with separation are often detrimental to aeronautical systems because they most often lead to strong low-frequency oscillations of the separated region and of the shock. This problem is more concerning for future high-performance jets that have high cruise altitude: regions with laminar boundary layer will increase in size because of the lower Reynolds number, resulting in a higher probability of separation. One possible solution to alleviate this drawback is to trigger the transition to turbulence upstream of the interaction with the shock.

The TFAST project founded by the European Community includes several numerical studies designed to address this question. The one described in this abstract relies on a Large-Eddy Simulation modelling a future experimental setup with a M=1.63 shock reflection on a $Re_x=1.3\times10^6$ boundary layer. The bypassed transition is triggered by adding perturbations to a Blasius profile at the inflow of the computational domain. Inflow perturbations are generated using a Synthetic Eddy Method and the location of the transition is set by adjusting their amplitude, with typical RMS values ranging from 0.05% to 0.4% of U_∞. The resulting boundary layers range from laminar to fully turbulent at the shock-impingement location.

Computation have been performed using three meshes, a reference one, an enlarged one and a refined one, with respectively 29M, 58M and 71M grid points. They have been first carried out for a laminar boundary layer impinged with 4.5° flow deviation shock, resulting in a separated interaction with transition located in the separation bubble. For each of the three computations, the amplitude of the inflow perturbations is set such as to obtain the same separation length. Using this procedure, the results are found to be almost mesh-independent with similar low-frequency unsteadiness.

For each of the three meshes, three additional computations relying on perturbation amplitudes multiplied by α=3, 5 and 7 with respect to the previous computations have been considered. The location of the transition is found to be mesh-independent and occurs just upstream of the interaction region for α=3, while the boundary layer is fully turbulent when entering the interaction region for α=5 and 7. For all cases, it will be shown that the flow remains fully attached in the interaction region. The presentation will also include a discussion on the effect of transitional and turbulent boundary layer for interaction with shock stronger enough to achieve separation for these kinds of boundary layers.