École Centrale Lyon

Numerical Methods in Mecanics
Invinscid Bump
Report

BE SU2

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1 Question 1

SU2 uses the finite volume method for discretization. The numerical scheme used here is the Jameson-Schmidt-Turkel (JST) scheme, which is centered. The time discretization is implicit : the method used is Euler implicit. The value of the normalized time step is 50 (CFL).

2 Question 2

Here is the plot :

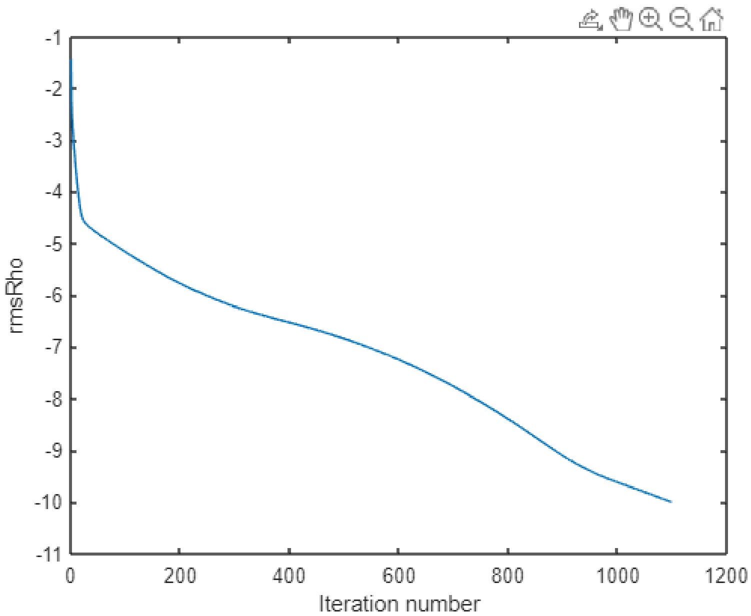


FIGURE 1 – Evolution of the density residual against the iteration number.

The density residuals are a measure of the convergence of the solution, and the goal of the simulation is to minimize these residuals and obtain an accurate solution. Thus, the decrease in the density residuals over the number of iterations in an inviscid bump simulation in SU2 is a normal and expected behavior.

3 Question 3

When we open the *flow.vtu* file with the PARAVIEW software, we get the following diagram :

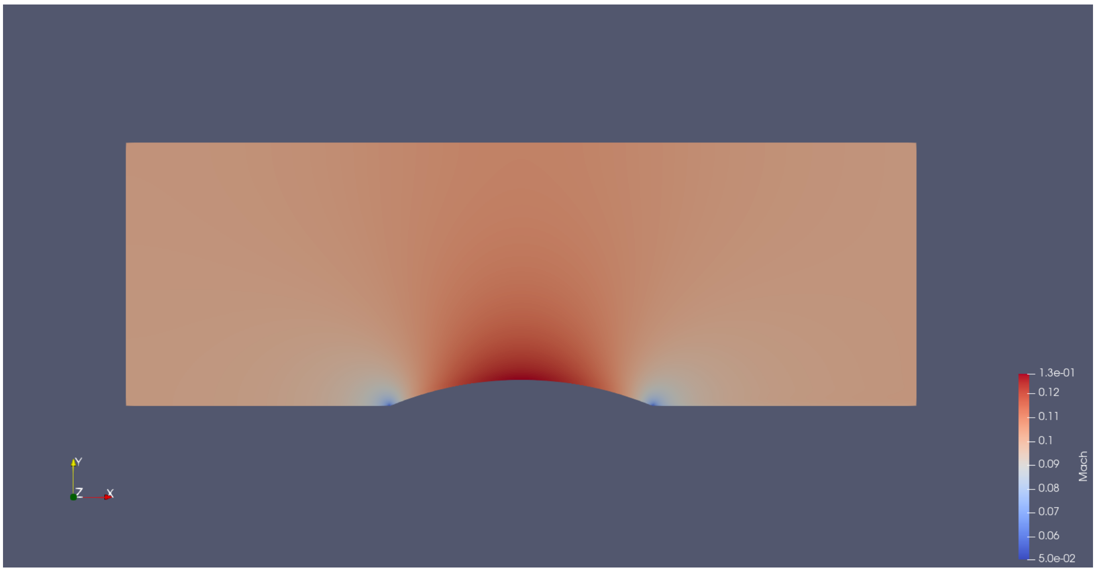


FIGURE 2 – Mach number in the flow.

4 Question 4

We now perform a new simulation by changing the input pressure and temperature values. The flow has changed. The line of pressure discontinuity located around 75% of the bump length is a shock wave caused by the compression of the flow around the bump. It is a physical phenomenon that occurs when the flow encounters an obstacle that creates a sudden change in the cross-sectional area or curvature of the geometry.

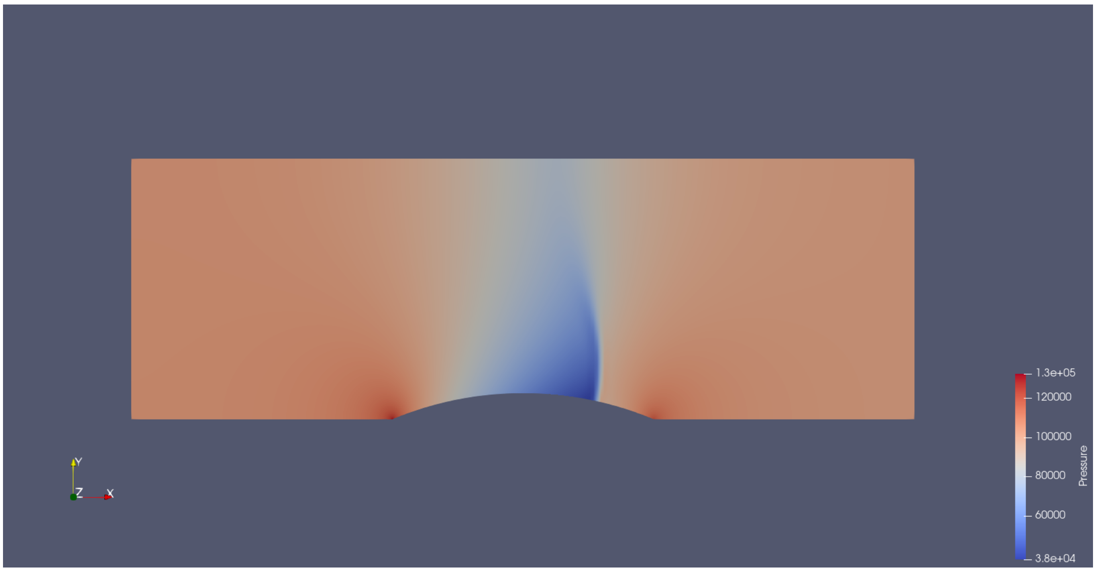


FIGURE 3 – Pressure in the flow.

5 Question 5

The boundary condition applied at the walls is the Euler wall condition. The Euler wall boundary condition assumes that the fluid particles at the wall have zero velocity and zero heat flux, which corresponds to an impermeable and adiabatic wall.

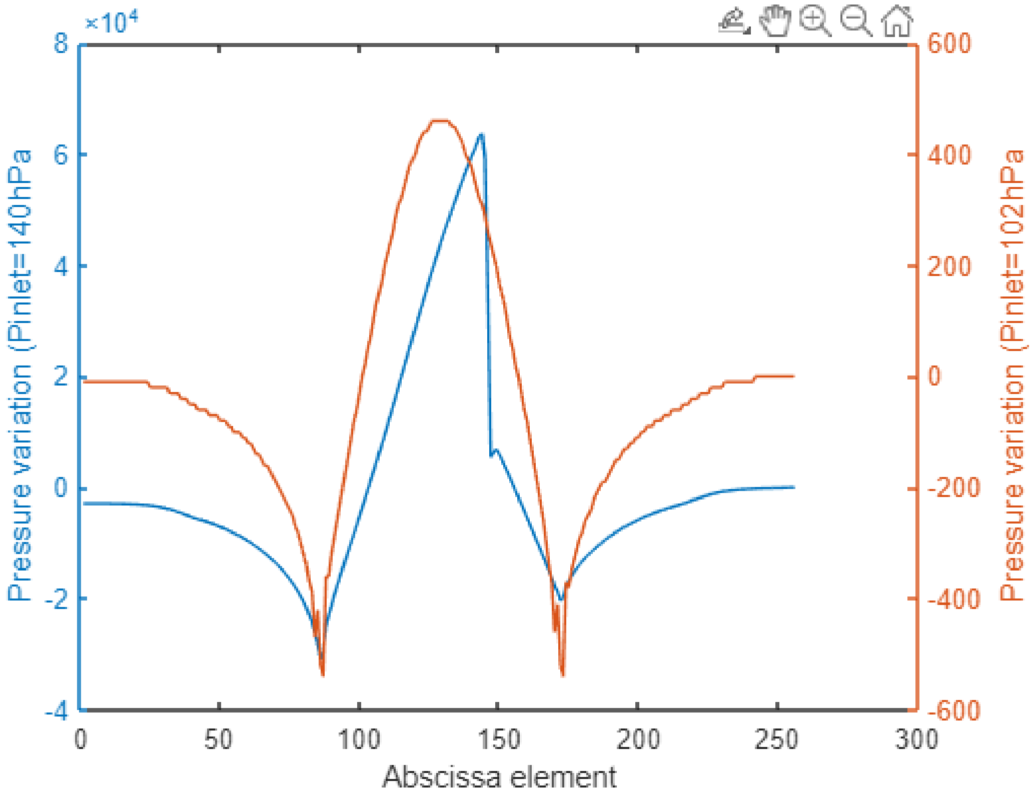
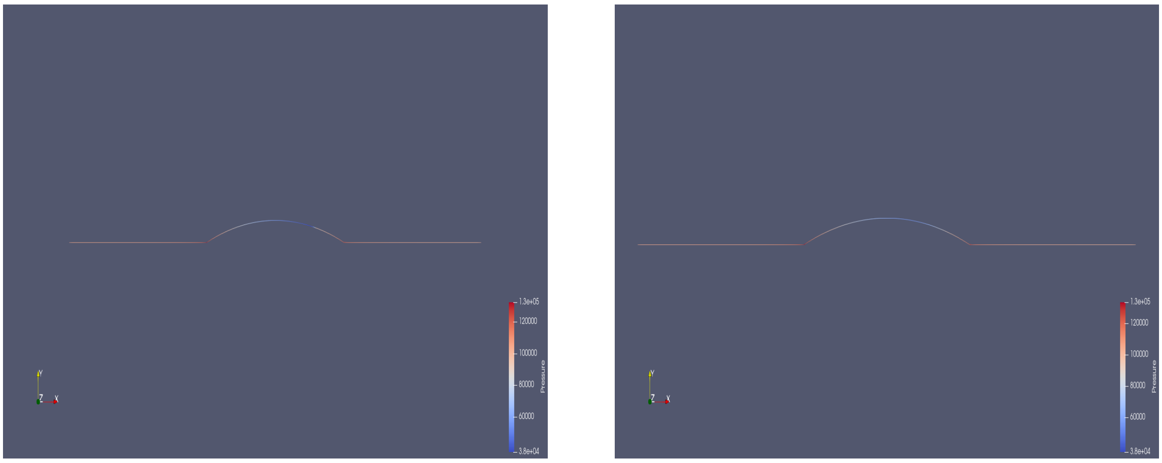


FIGURE 4 – Comparison of the distributions of $P_s - P_{outlet}$ on the lower wall.

Even though the scales are different, the trend of the two curves is similar. Moreover, we can see the shock wave located around 75% of the bump length shown by the abrupt loss of pressure for the curve tracing *InvBump2*.

6 Question 6

We now perform a new simulation with the same inputs as QUESTION 4 by changing the scheme to a *LAX-FRIEDRICH* one. Here we can see the difference in the wall pressure between the two simulations :



(a) Pressure wall in the second simulation. (b) Pressure wall on the third simulation

FIGURE 5

It is quite difficult to observe, but there are differences around 75% of the bump length. As observed in the measurement made in Question 4, there is an abrupt change in pressure before and after the shockwave. On the other hand, the new simulation shows a smoother pressure change. This is due to the lower order of the *LAX-FRIEDRICH* scheme, which results in lower accuracy.