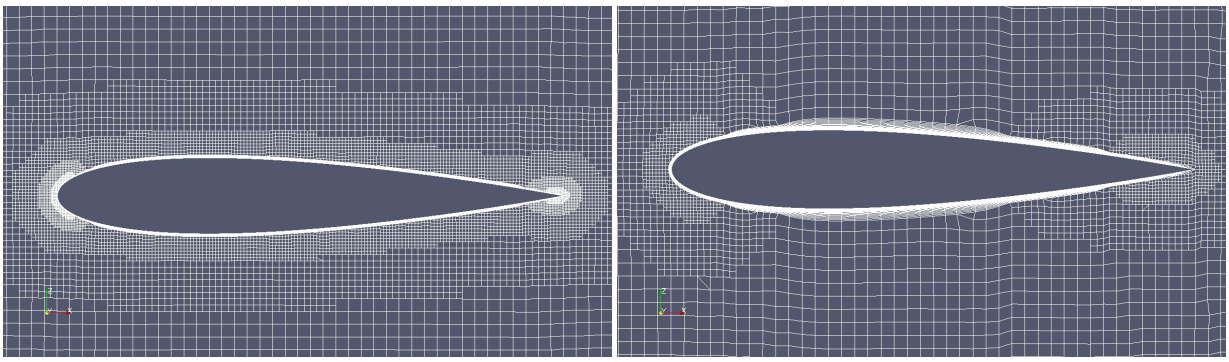
Comparison results between 2D and 3D case of NACA0012 airfoil

In this report a comparison between the results of NACA0012 2D and 3D is made, using OpenFOAM 3.0.1. For each case the mesh has been generated using *snappyHexMesh*, as explained in the previous report about how to generate a mesh with that tool. For the 3D case the spanwise is 2 meters. In fig. 1a is shown the mesh for both cases, while in tab. 1 are reported the number of points and cells for both mesh and on the airfoil surface.



(a) 2D (b) 3D

Figure 1: Mesh generated using *snappyHexMesh* tool

Table 1: Comparison between 2D and 3D mesh cells.

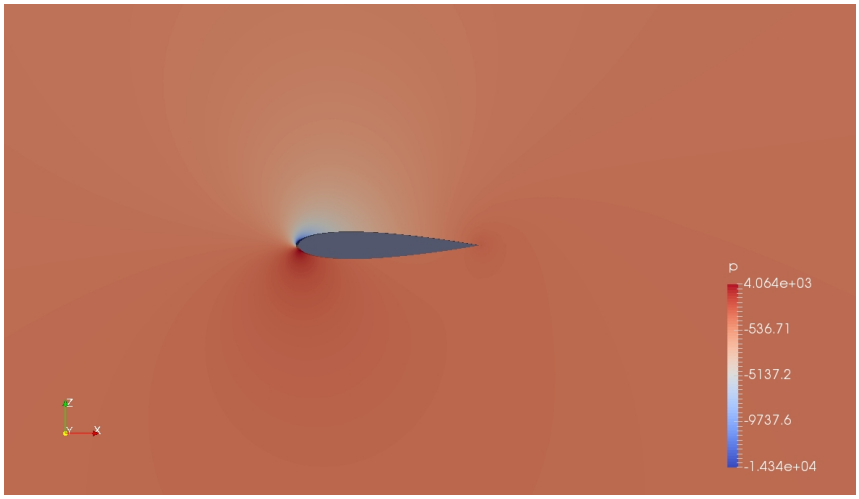
	Cells
2D	163 652
3D	3 693 638
2D airfoil	324
3D airfoil	168

The model was used is $k-\omega$, since in 2D analysis it was the model that matched better the experimental results, while the routine is *pimpleFoam*.
In tab. 2 are reported the forces coefficient: the lift coefficient is smaller since there's the three-dimensionality effect, while the drag coefficient is higher.

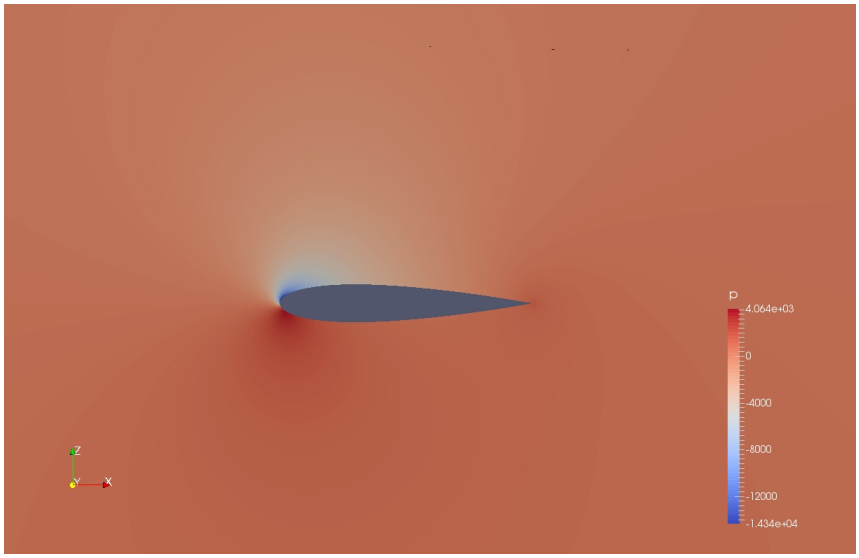
Table 2: Comparison between 2D and 3D mesh cells.

	C_D	C_L
2D	0.0122	1.090
3D	0.0125	1.022

In figg. 2-3 are shown the pressure and velocity field, using the same scale; in 3D it has been considered the middle station. From figg. 4-5, instead it is possible to note that for the 3D case on the wing the fields seems to be 2D station per station, and this is expected from theory.

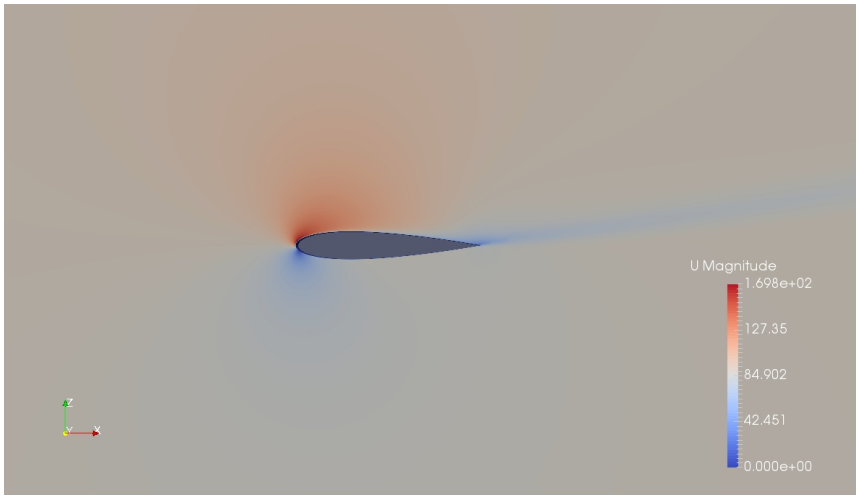


(a) 2D

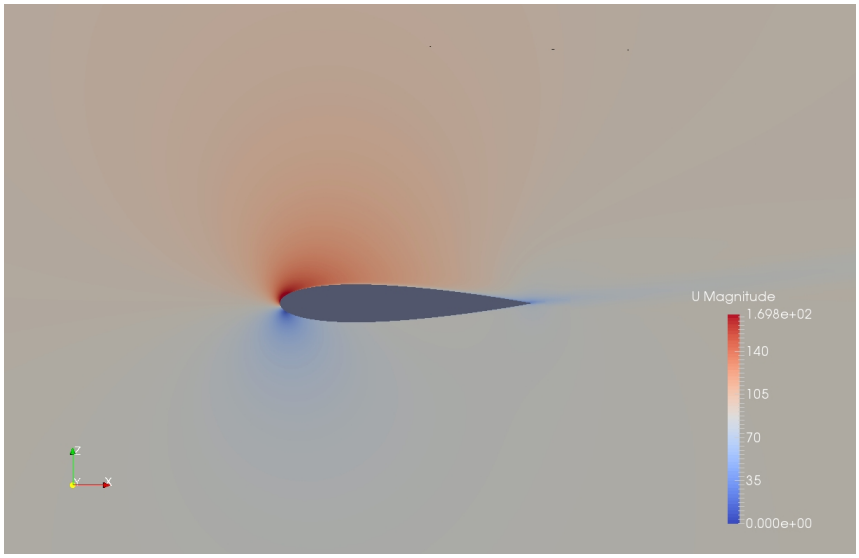


(b) 3D

Figure 2: Pressure field around the airfoil



(a) 2D



(b) 3D

Figure 3: Velocity field around the airfoil

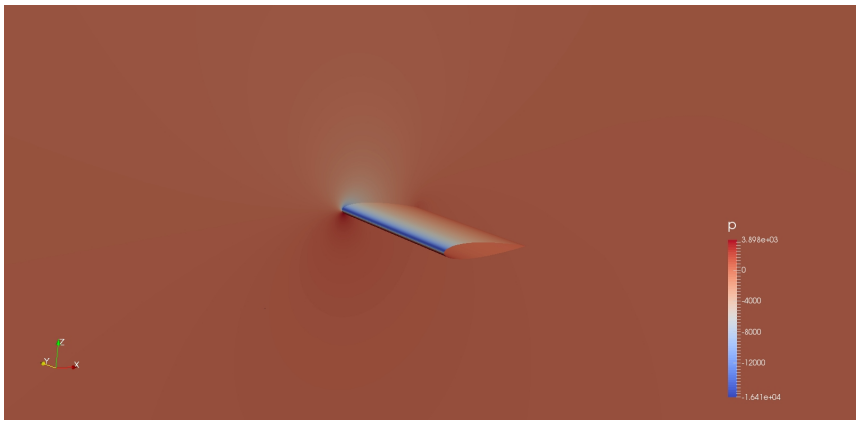


Figure 4: Pressure field around the wing

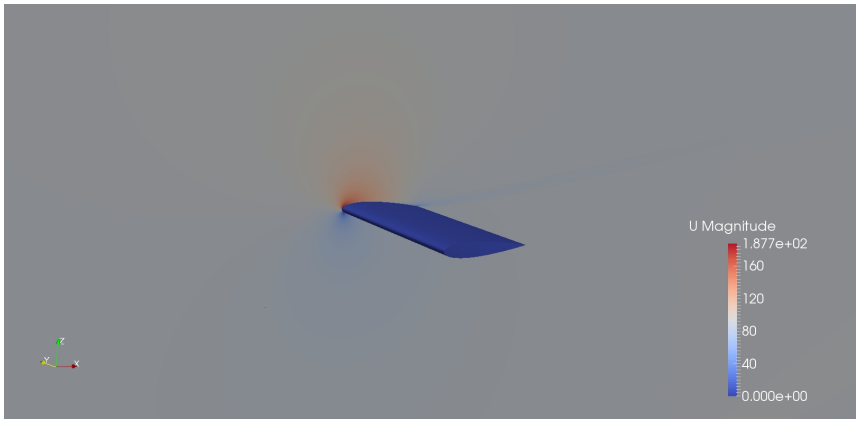


Figure 5: Velocity field around the wing

Finally, the pressure and friction coefficient have been evaluated at the middle station of the wing, and have been compared with the 2D case: results are shown in figg. 6-9, while some particular around the leading edge are shown in figg. 7-8-10. Also here the results are comparable: note that the peak at leading edge is higher in 3D case than in 2D.

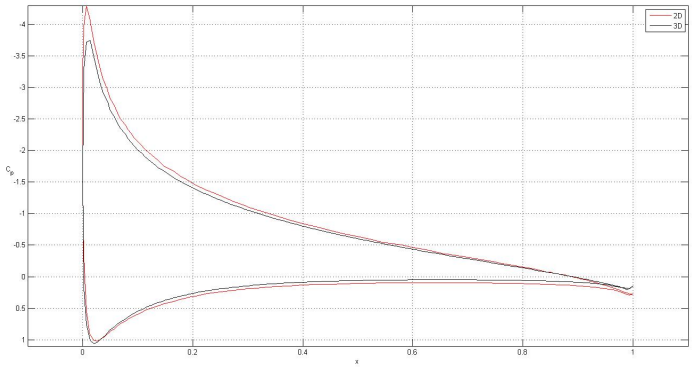


Figure 6: Pressure coefficient around the airfoil

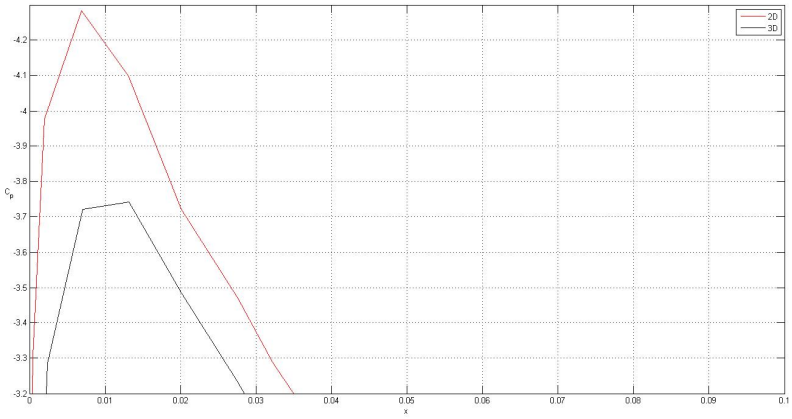


Figure 7: Particular of expansion peak

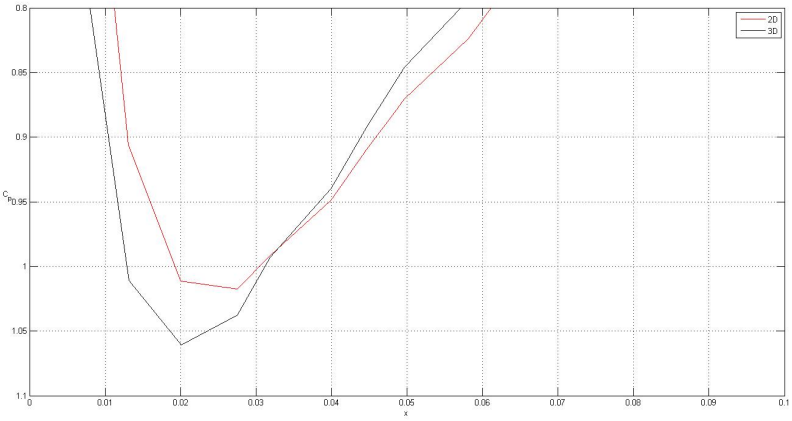


Figure 8: Particular of compression peak

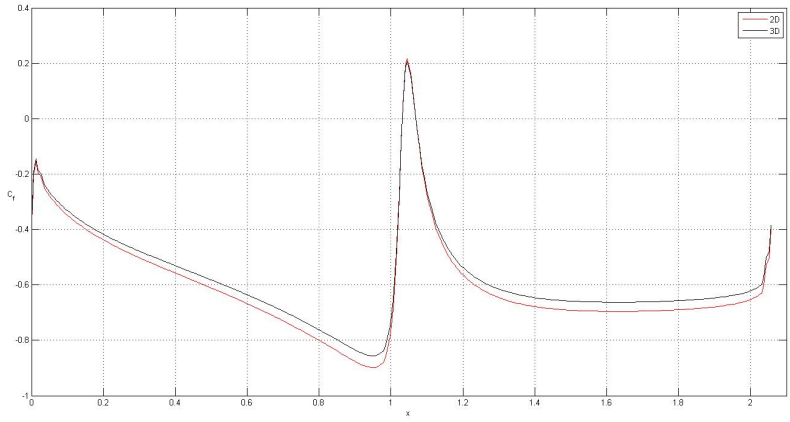


Figure 9: Friction coefficient around the airfoil

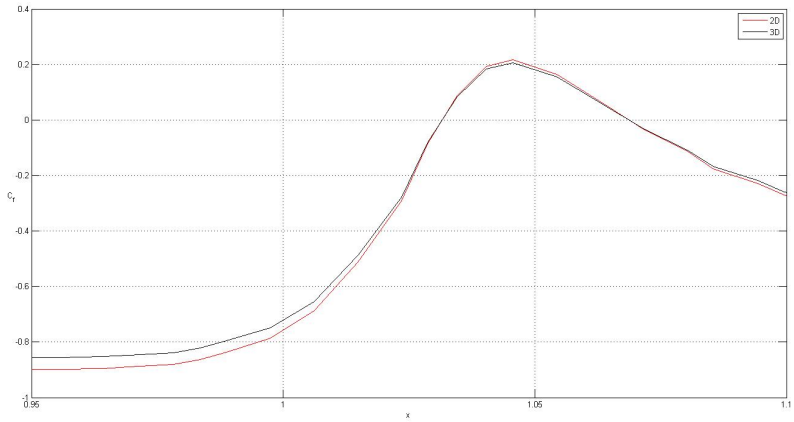


Figure 10: Particular of friction coefficient around the leading edge