



# VALIDATION OF CFD NUMERICAL MODEL IN ORDER TO VALUE THE EFFECT OF THE VORTEX GENERATORS NEAR THE BLADE TIP WITH ROUGHNESS

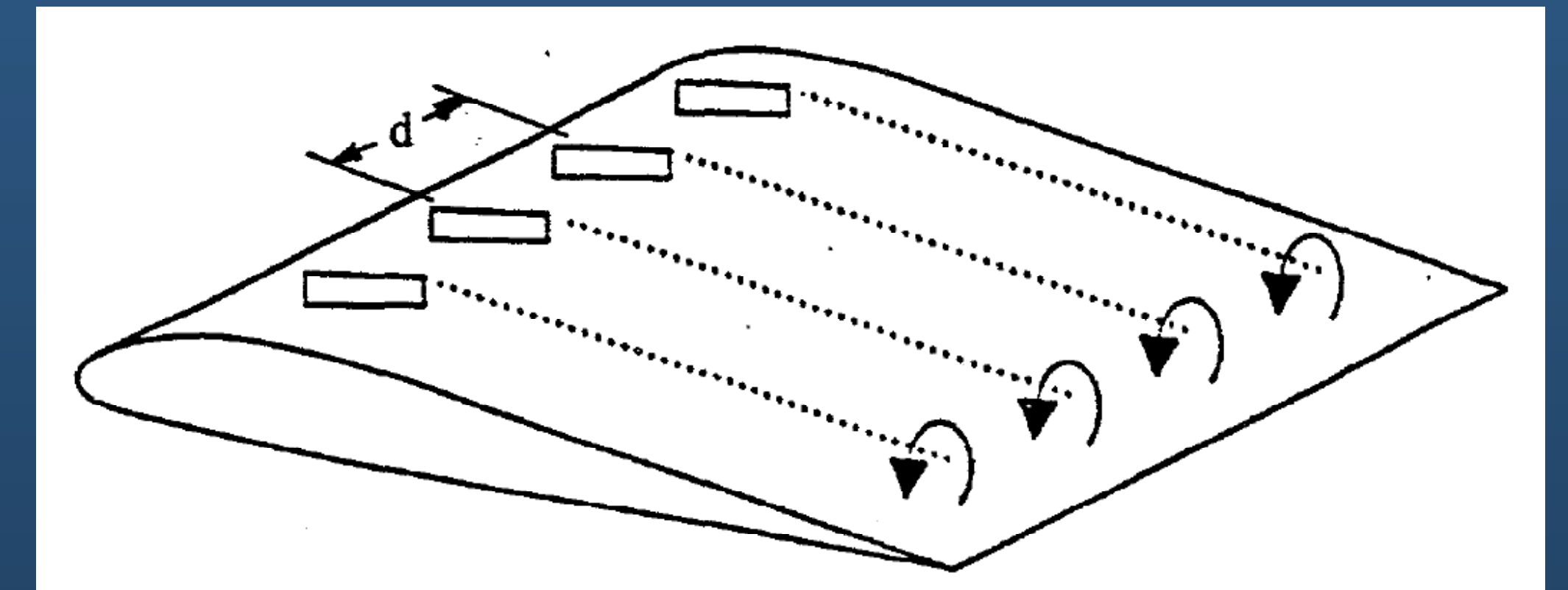


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## SUMMARY

A CFD numerical model was used (fluent) to simulate a wind tunnel and used to perform the lift coefficient of a wind turbine blade for several angles of attack for smooth and rough surfaces. Firstly, the result obtained with our CFD numerical model has been compared with experimental measurements performed at the OSU tunnel. Later, this model was used to evaluate the effect of the placement of vortex generators near the tip of a wind turbine blade. In this research one disposition of vortex generators were considered. The figures show a comparison between the experimental and calculated values as well as the improvement of the lift coefficient with vortex generators and roughness on the surface, since vortex generators were conceived to improve the lift coefficient in these conditions. It is necessary to outline that the results obtained with the numerical model are lightly lower than experimental values but they present a reasonable level of agreement. In the same manner it must be noticed that this model shows that the placement of vortex generators improve the lift coefficient with roughness in the whole interval of interest, even though to performing experiments in a wind tunnel would be desirable to corroborate this affirmation

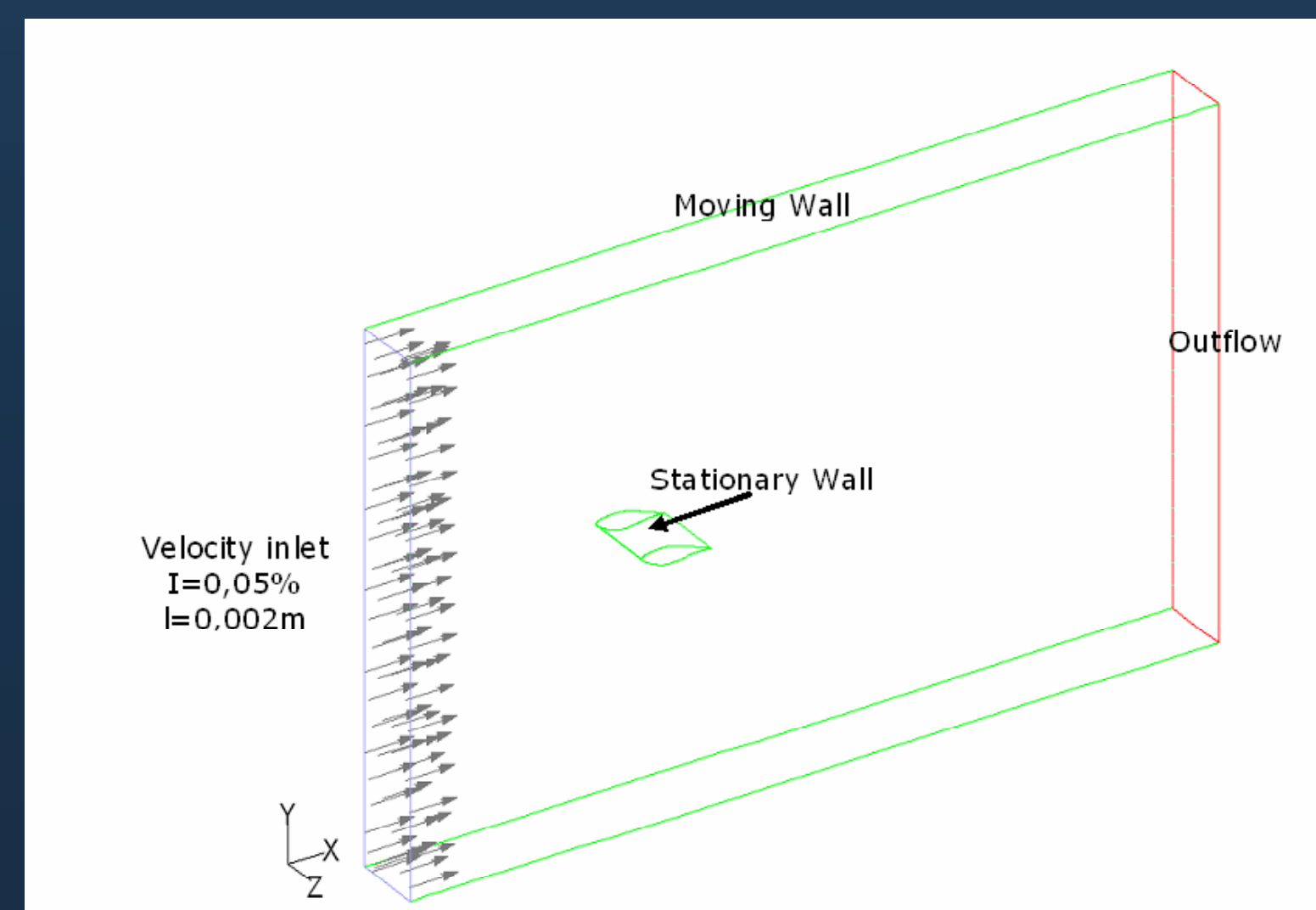


Schematic of Co-rotational VGs array

## CFD

$I$  = Turbulence intensity and  $I = 0.05\%$   
 $L$  = turbulence length scale.  $L = 0.002$  m.

- ✓ Mesh type: unstructured mesh (tetrahedron).
- ✓ Turbulence model: k- $\epsilon$  Realizable.
- ✓ Solver: Segregated.
- ✓ Pressure interpolation method: Standard.
- ✓ Velocity interpolation method: QUICK.
- ✓ Pressure-velocity coupling: SIMPLEC.



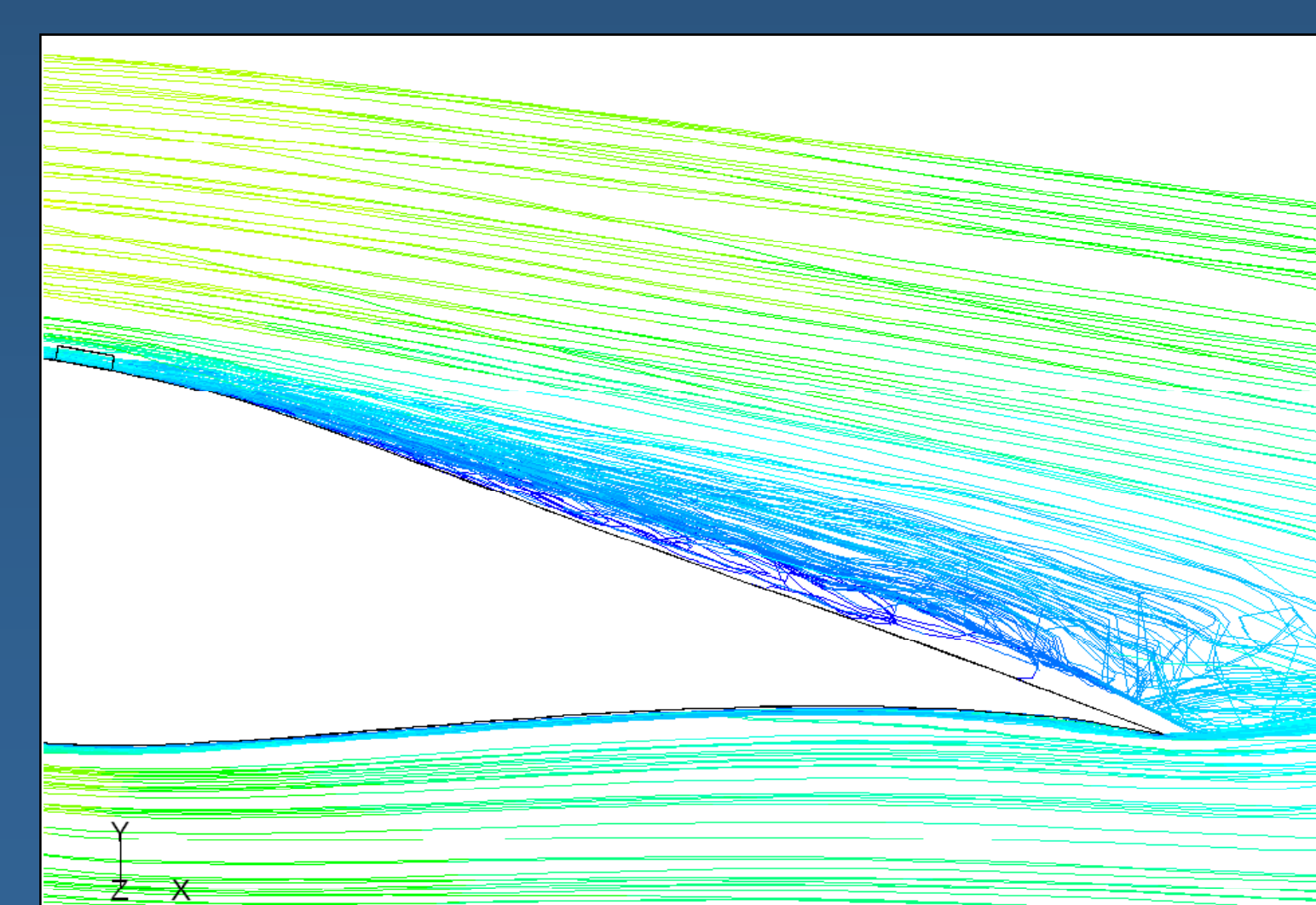
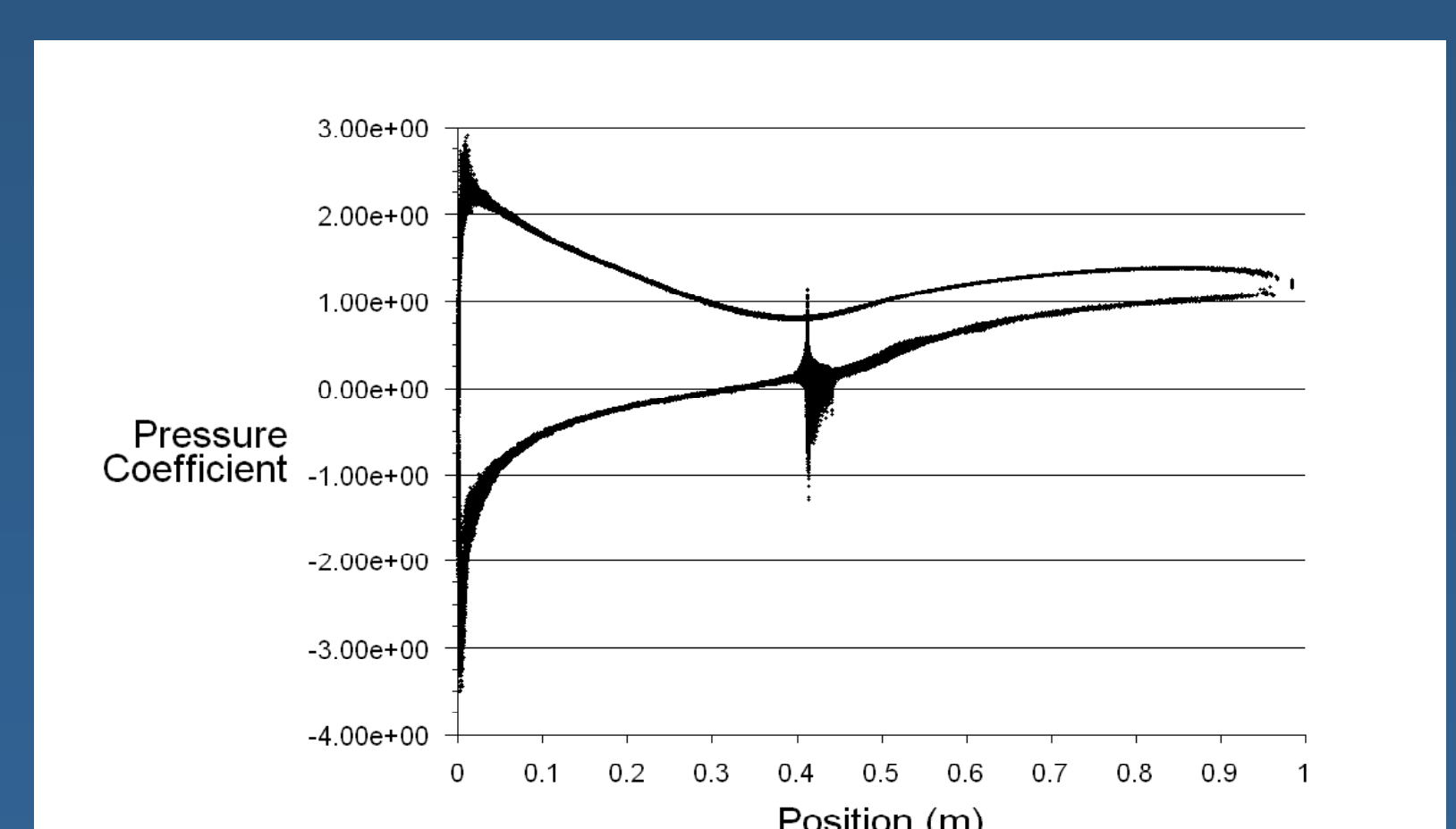
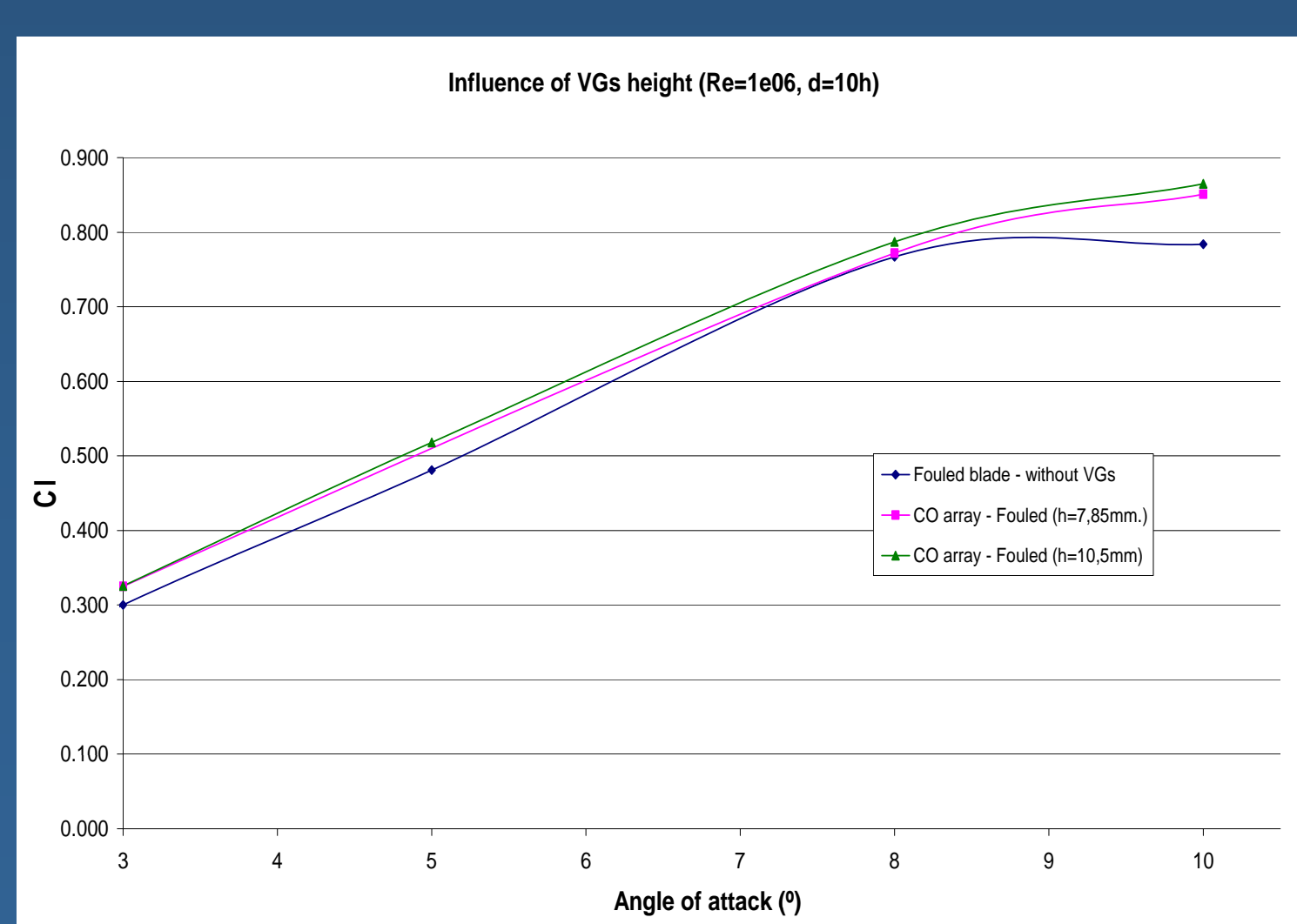
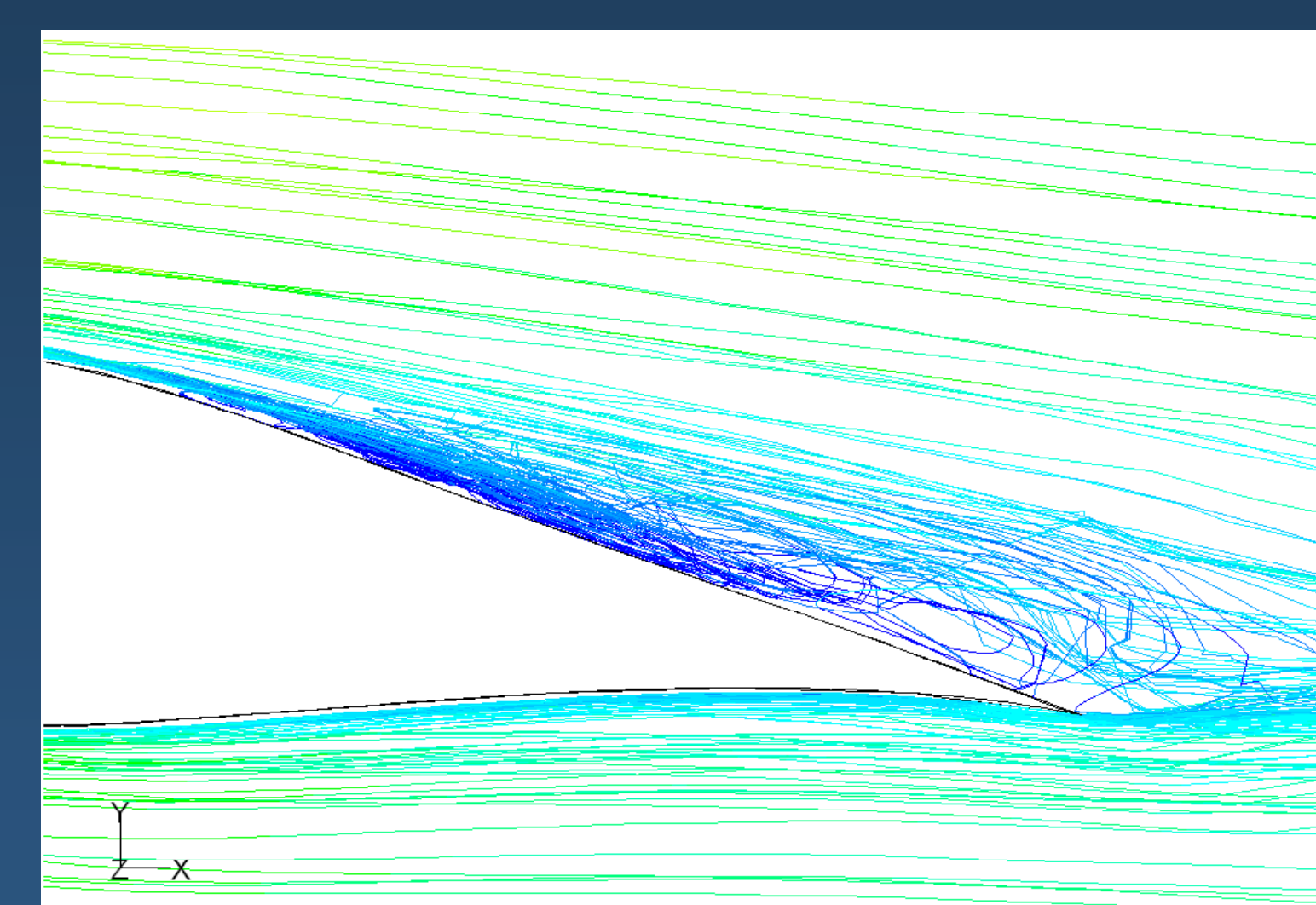
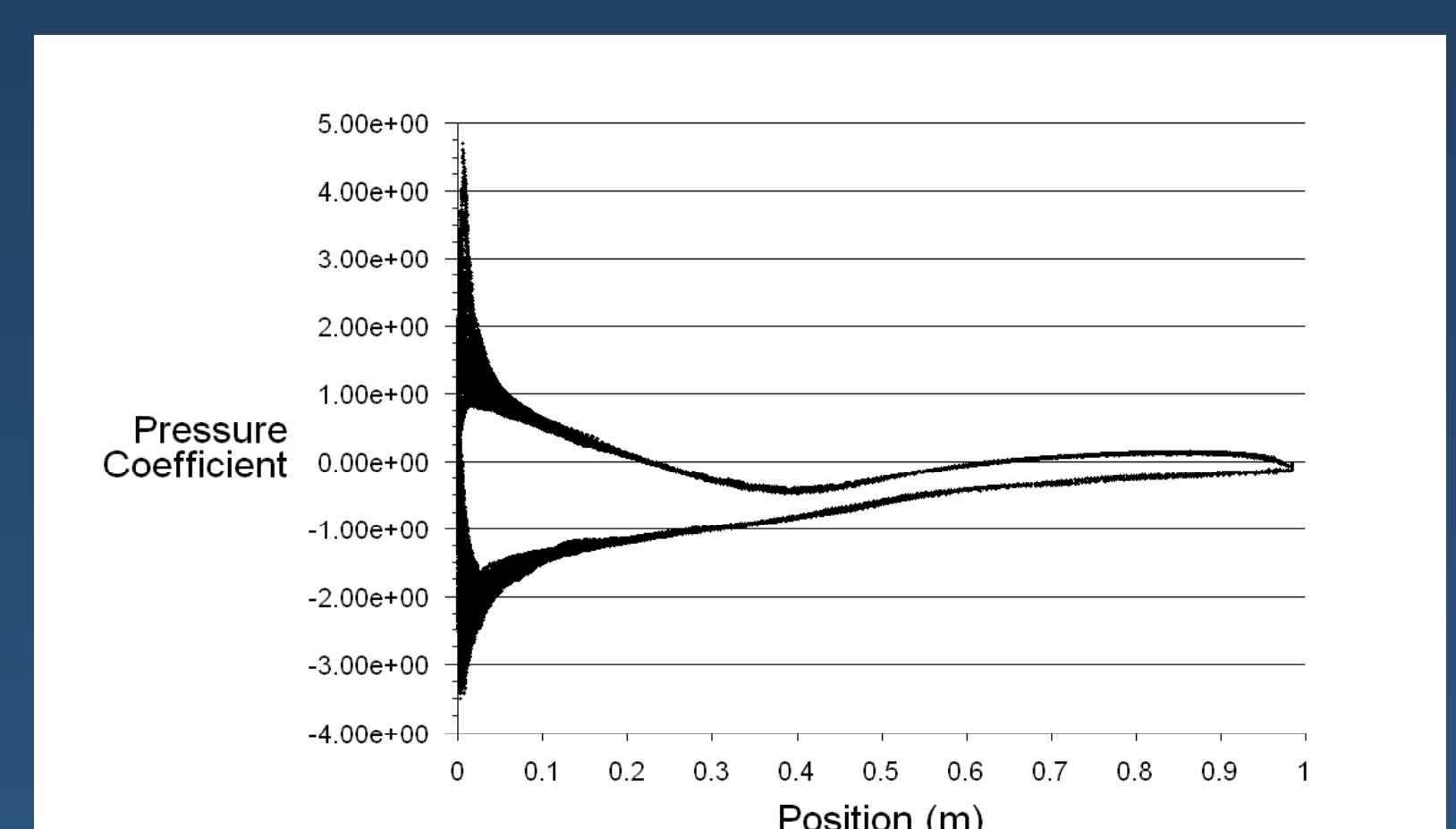
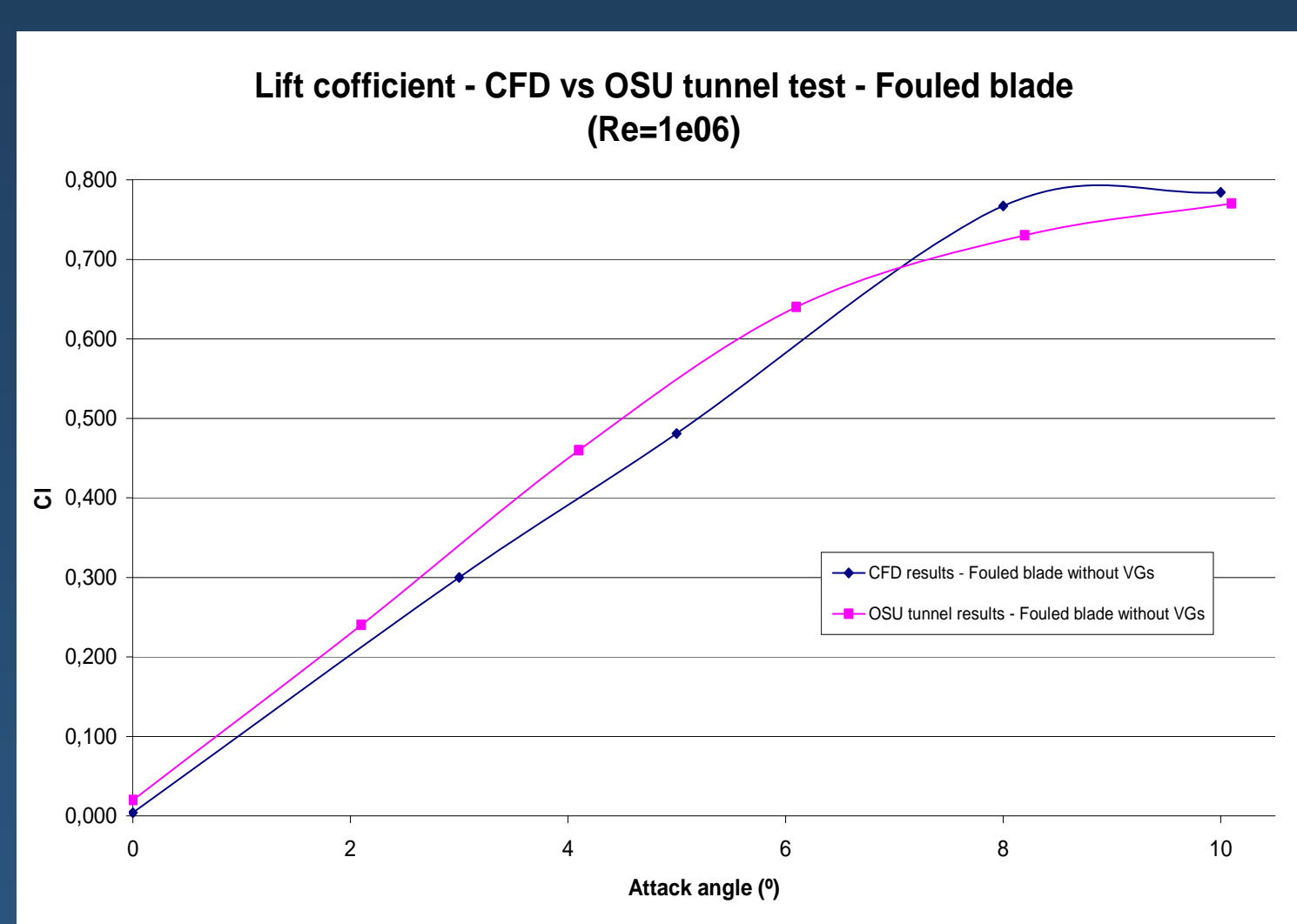
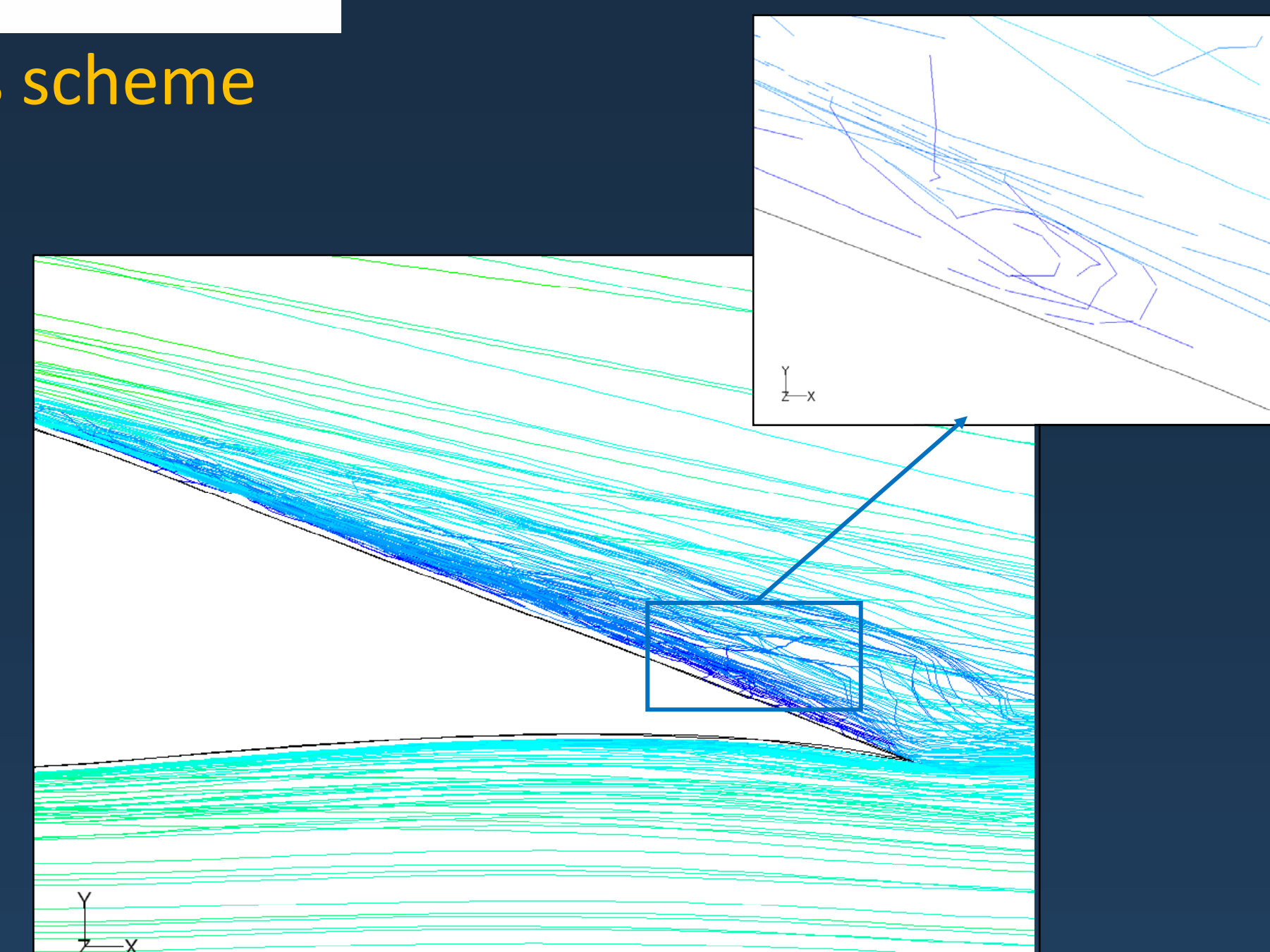
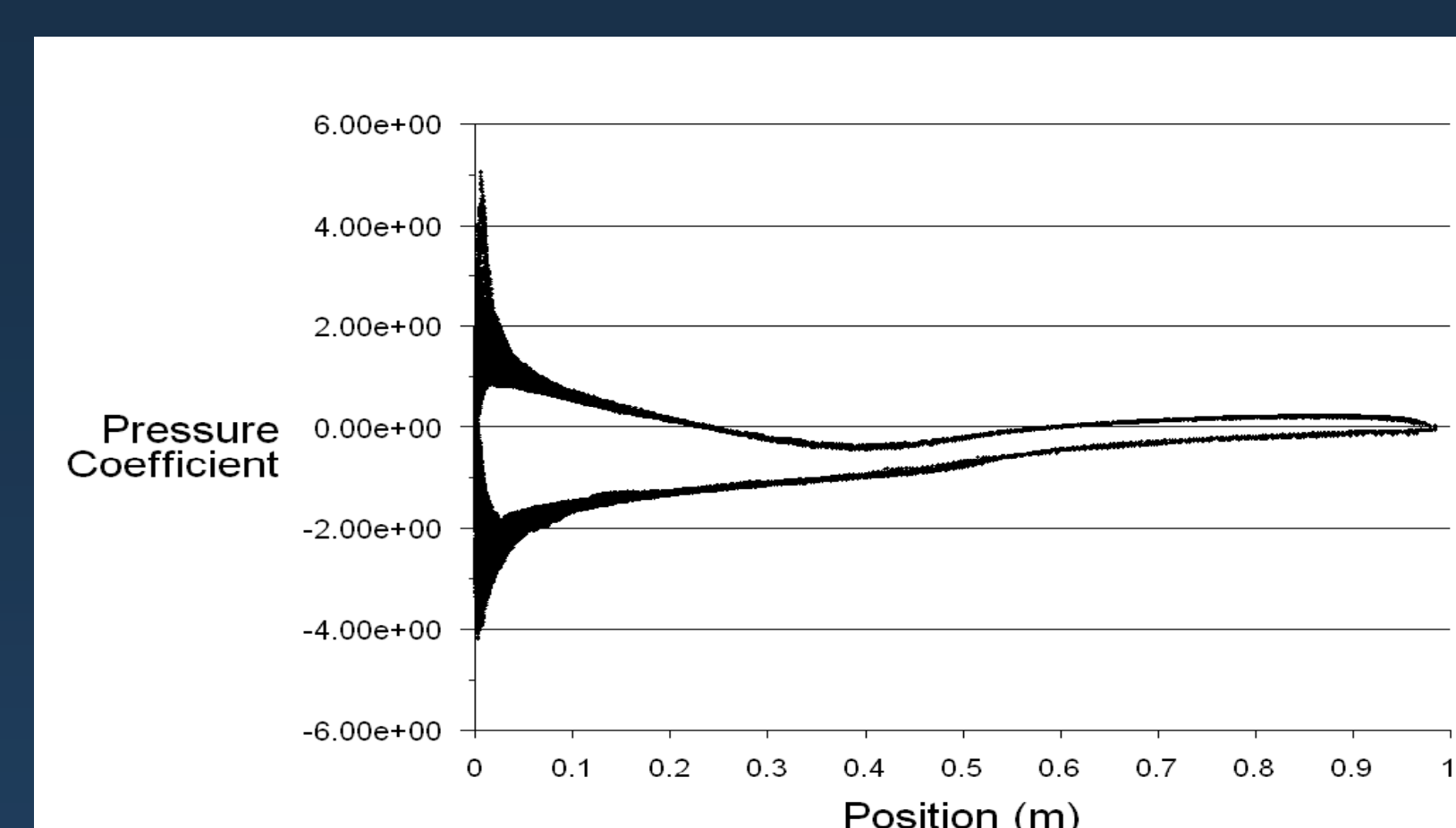
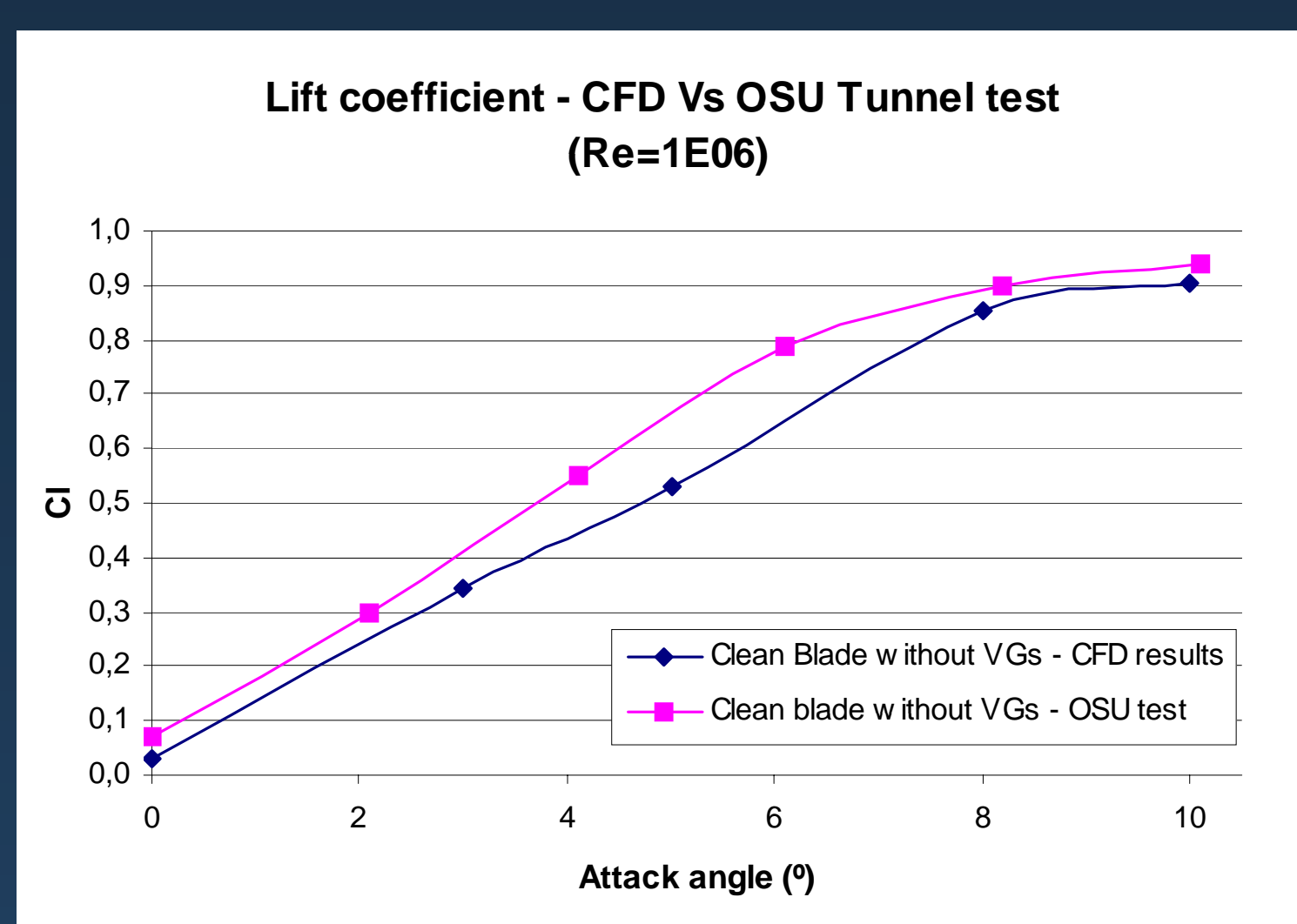
Boundary conditions scheme

## CONCLUSIONS

A potential benefit of vortex generators (VGs) is to improve the performance of fouled blades. Although the new NREL airfoils are less sensitive to fouling than earlier airfoil families, fouling losses are still present, increasing the drag coefficient and decreasing the lift coefficient. The inclusion of vortex generators shows an improvement of the lift coefficient under fouled blade conditions. The present article demonstrates this effect by means of computational methods. In our particular case, the analysis zone is around the 75% of the blade length, where the fouling effect is more important, due to the fact that the linear velocity of the blades is higher and the blade impacts with external agents like insects are more frequent. The VGs reduce the lift coefficient loose due to this phenomenon.

As far as Reynolds number is concerned, it must be noted that the increasing of the Reynolds number causes a lift coefficient increasing, a predictable behaviour in advance, but those increments are lower as the Reynolds number is higher.

The lift coefficient is slightly dependent on the VGs height and spacing. In our particular case of study, increasing the height of the VGs and decreasing VGs density led to a small increase in the lift coefficient.



## REFERENCES

- (1) Sullivan, t.i., Effect of Vortex Generators on the Power Conversion Performance and Structural Dynamics Loads of the MOD-2 Wind TURBINE, NASA TM,83680, 1984.
- (2) Gyatt, G. W., Development and testing of Vortex Generators for Small Horizontal Axis Wind Turbines, Aero Vironmente Inc, Nasa CR-179514, July, 1986.