Drag Fluctuations of a Fully Deployed Flow Actuator Embedded Inside Turbulent Boundary Layer Flow

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Introduction: CFD modeling of 2D flow around a fully deployed flow actuator using COMSOL Multiphysics CFD module. The results of COMSOL modeling is also compared with the experimental data of the same dimensions actuator. The 100mmX2mm rectangular actuator is placed inside a turbulent boundary layer flow as shown in (figure 1). The experiments modeled here, were taken place inside wind tunnel running at free stream air velocity of 3.74 m/s.

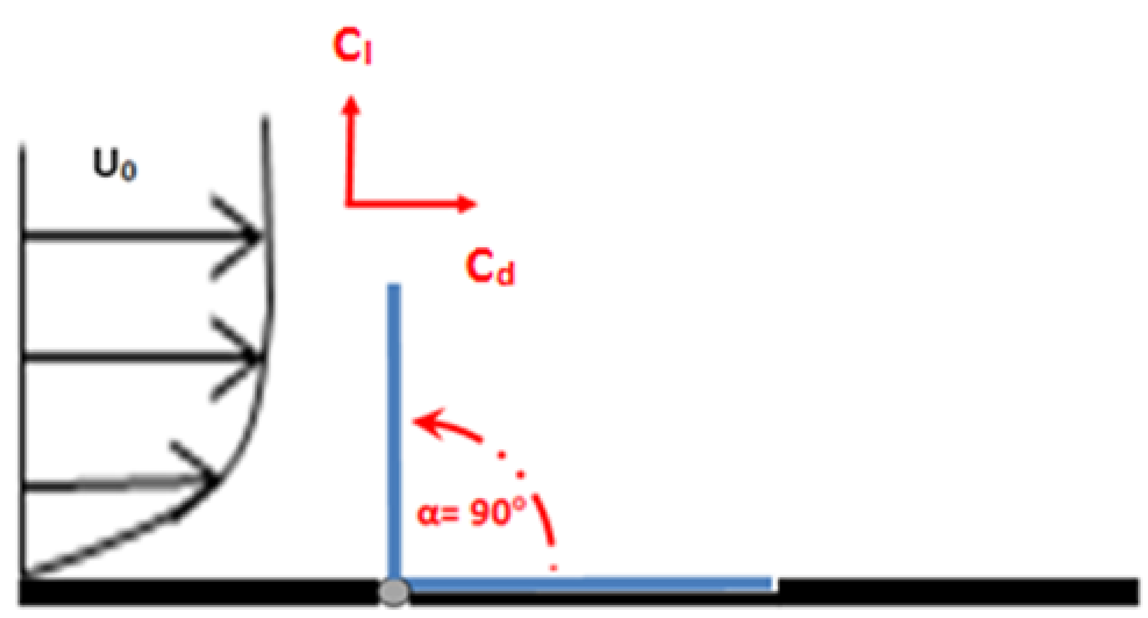

Figure 1. Schematic of TBL flow over a deployed flow actuator

Computational Methods: The problem is solved using time dependent model to be able to investigate flow characteristics and structures. Intensive boundary layer meshing is used around all walls due to the significant effect of the boundary layer in the flow output. k-ε model for turbulent flow from CFD Module is used to model the air flow around the actuator.

Adaptive mesh refinement was chosen Due to the particular interest in investigating the flow structure for time dependent turbulent flow analysis. Figure 2 shows the starting mesh (13,315) compared with the last mesh (32,851) at time 0.5 sec.

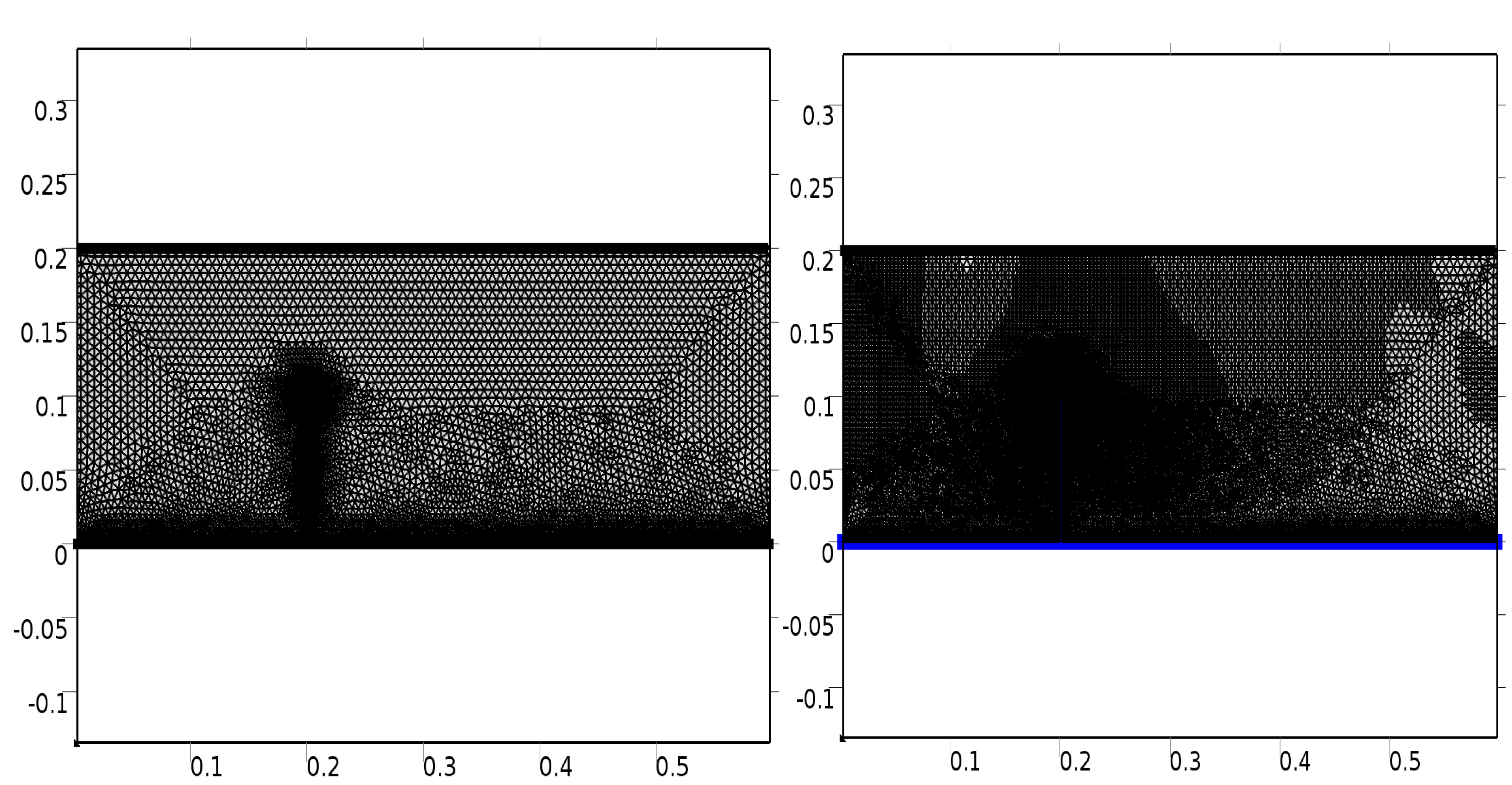

Figure 2. Adaptive mesh refinement Mesh 1 (left) Mesh 11(Right)

Results: Initial results for time dependent case of the flow described showed the development of some flow characteristics similar to those seen in the experimental case; the front vortex is clearly developed as well as the tip vortex as seen in figure 3.

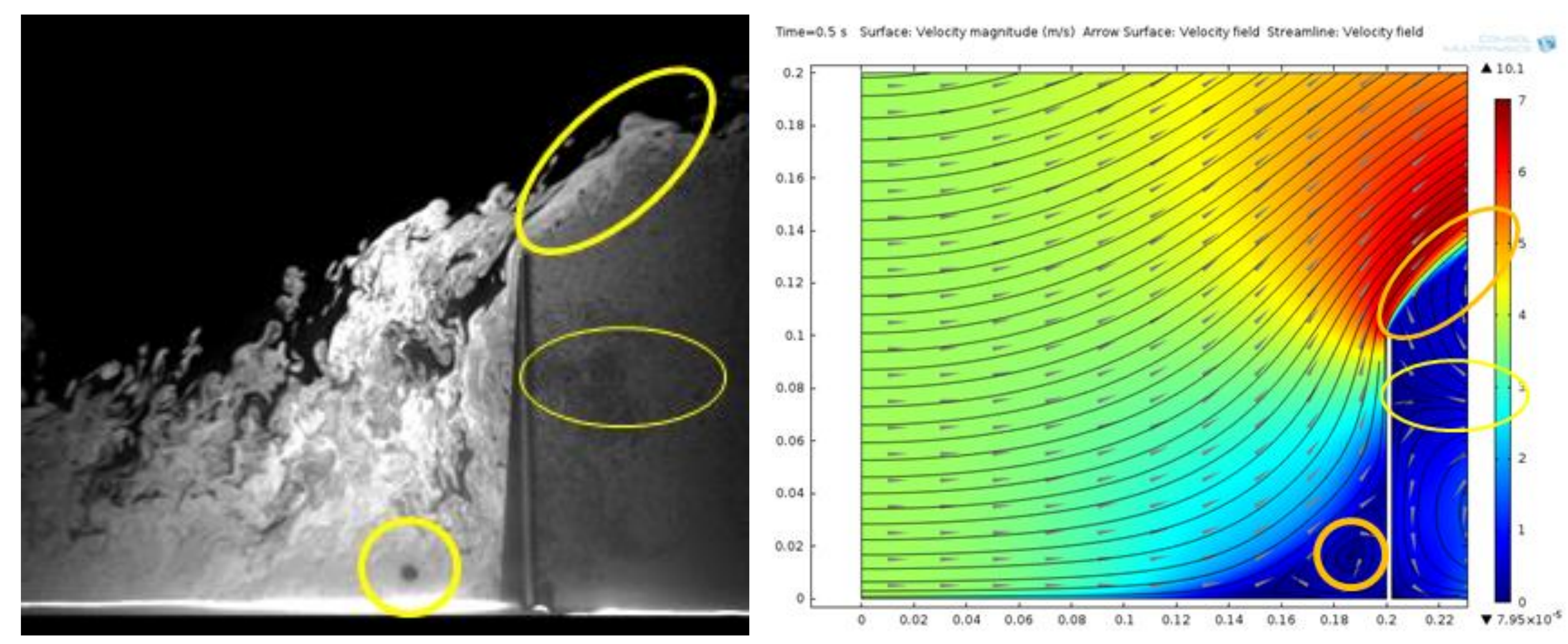

Figure 3. flow structure flow visualization experiment *(left)* and CFD model *(right)*

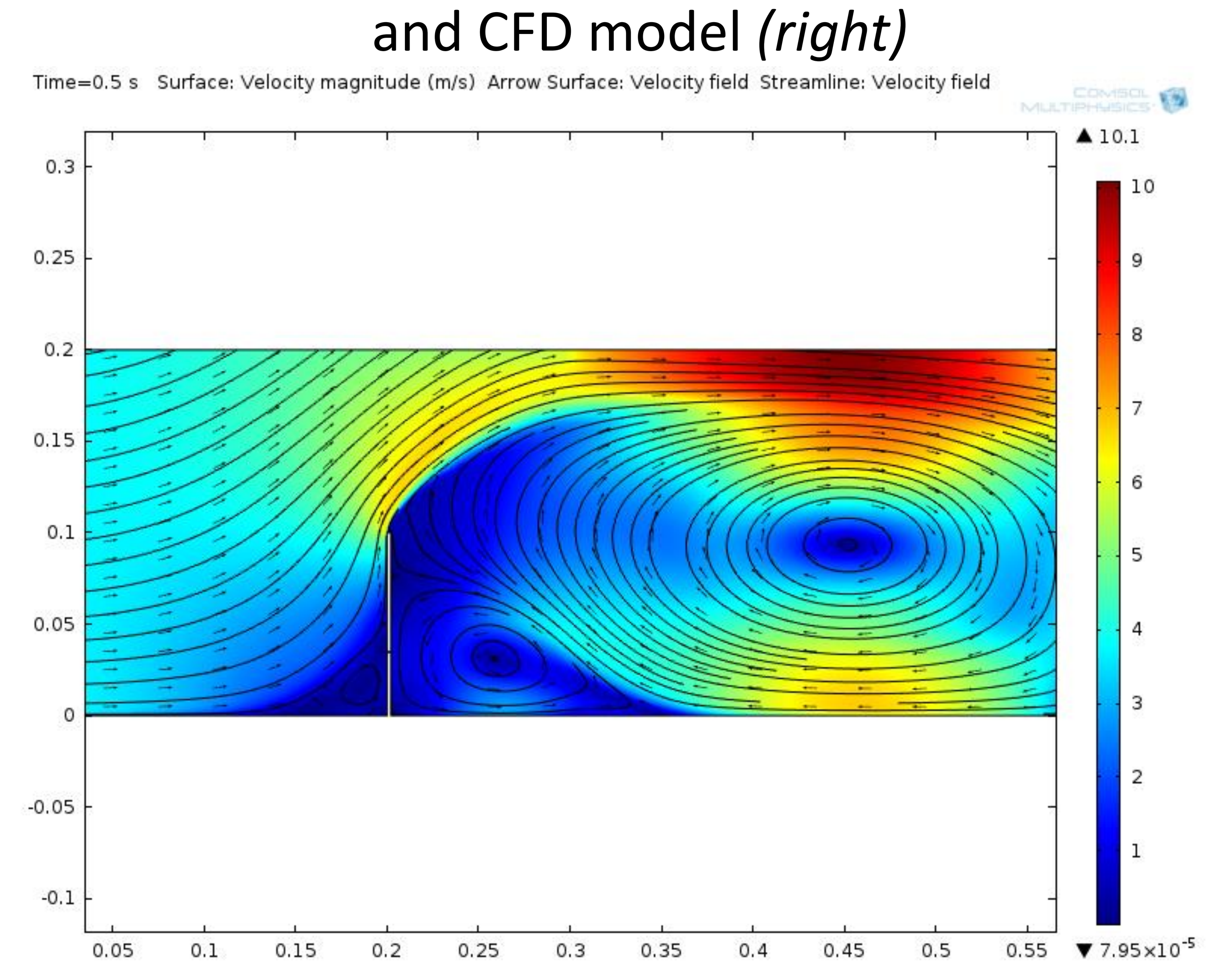

Figure 4. Velocity Contours for the entire domain with stream lines at t= 0.5 sec

Conclusions: The time dependent modeling of the flow around the actuator showed similar flow characteristics that is seen in the experimental case; an extension to run time is needed to understand how is the flow develops through time, particularly that the flow has many time dependent features such as the tip vortex.

References:

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