

# Reynolds-Average Navier-Stokes Analysis of Leading Edge Inflatable Kites

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## Introduction

A significant lack of understanding exists surrounding leading edge inflatable (LEI) kite flows. These flows are challenging for two reasons.

- The low aspect ratio and large anhedral of the kite means that 3D effects are significant.
- The high angles of attack often encountered lead to significant flow separation.

This project uses Reynolds-Average Navier-Stokes (RANS) methods in order to attempt to resolve the viscous flow effects present.



Figure 1: The TUD-25mV3 LEI kite in flight (Photo: R. Schmehl).

## Finite Volume Mesh

Structured O-meshes of 2D LEI airfoils were created using Pointwise®. An example mesh is shown in Figure 2.

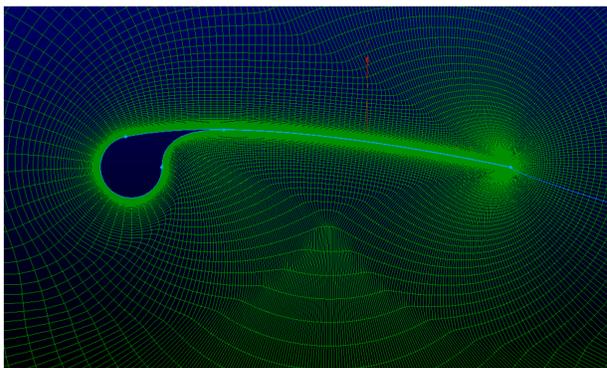


Figure 2: 2D structured mesh of ILE150428.

## Flow Solver

The open source CFD package OpenFOAM® was used to solve the incompressible, steady-state RANS equations. Fully turbulent flow was assumed and the  $k - \omega$  SST turbulence model

was used to close the system. A realistic Reynolds number of  $Re = 3 \times 10^6$  was used. The flow recirculation behind the leading edge tube is shown in Figure 3.

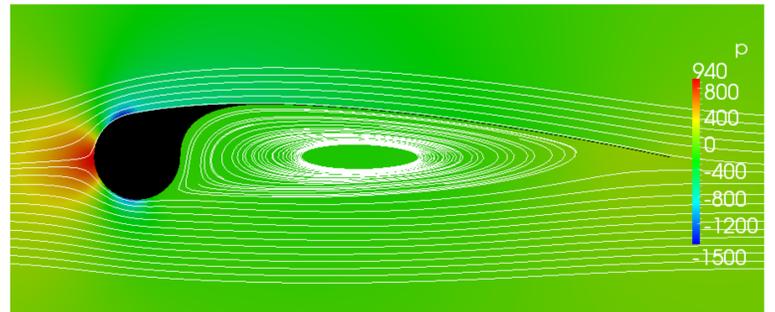


Figure 3: Flow recirculation behind the leading edge tube, colored by pressure.

## Conclusion

One conclusion from this work is the importance of a smooth transition from the leading edge tube to the canopy curvature. This transition can cause abrupt flow separation which can have significant performance and aeroelastic consequences. The effect on lift and drag can be seen in Figure 4.

**STALL: Abrupt flow separation has significant aeroelastic consequences.**

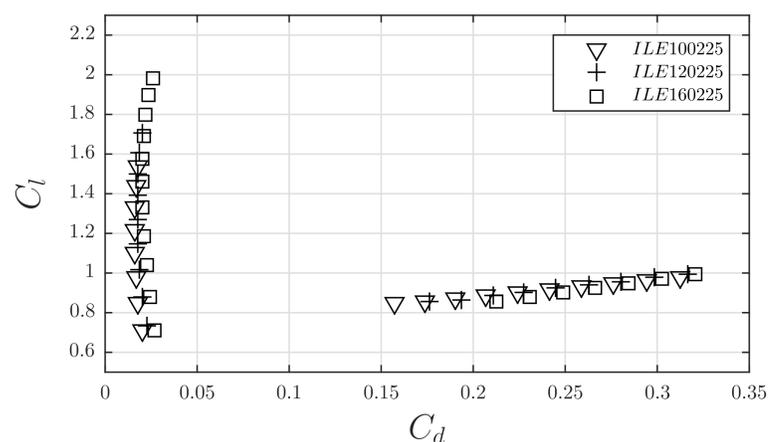


Figure 4: Lift and drag polars of LEI airfoils showing the effect of abrupt flow separation.

This work will be expanded to three dimensions in order to better understand the three dimensional flow phenomena present.