

EXPO Skin Friction Rivet Analysis Using Oil Film Interferometry

engineering design



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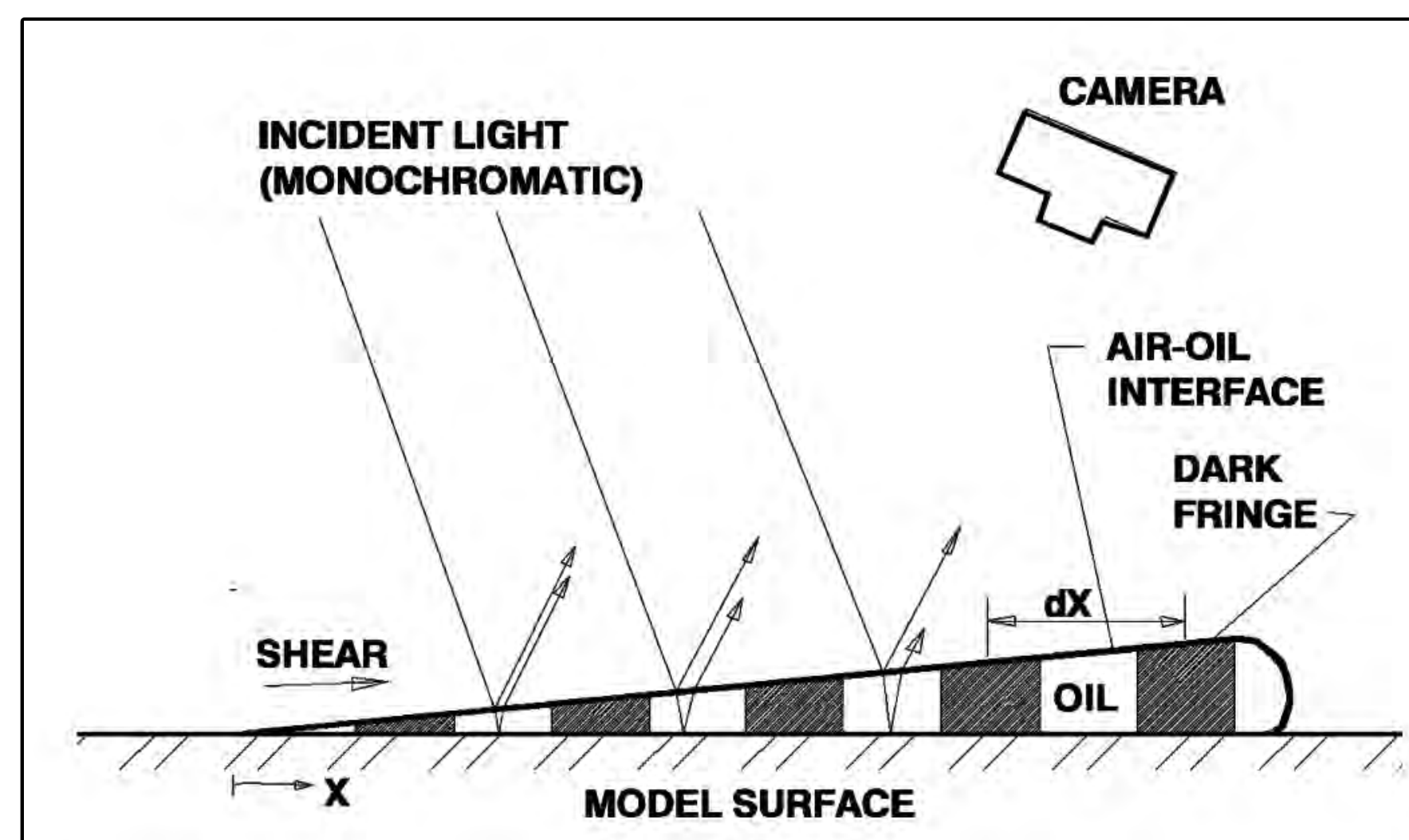
Acknowledgements: Dr. Vibhav Durgesh, Dr. Paulo Yu, Rodrigo Padilla, Wind Tunnel Lab

Value Proposition

This project aimed to investigate the drag effects of riveted versus smooth aircraft surfaces using oil film interferometry (OFI). Through comprehensive testing, we aimed to provide Kodiak with insightful quantitative data to inform a major manufacturing decision.

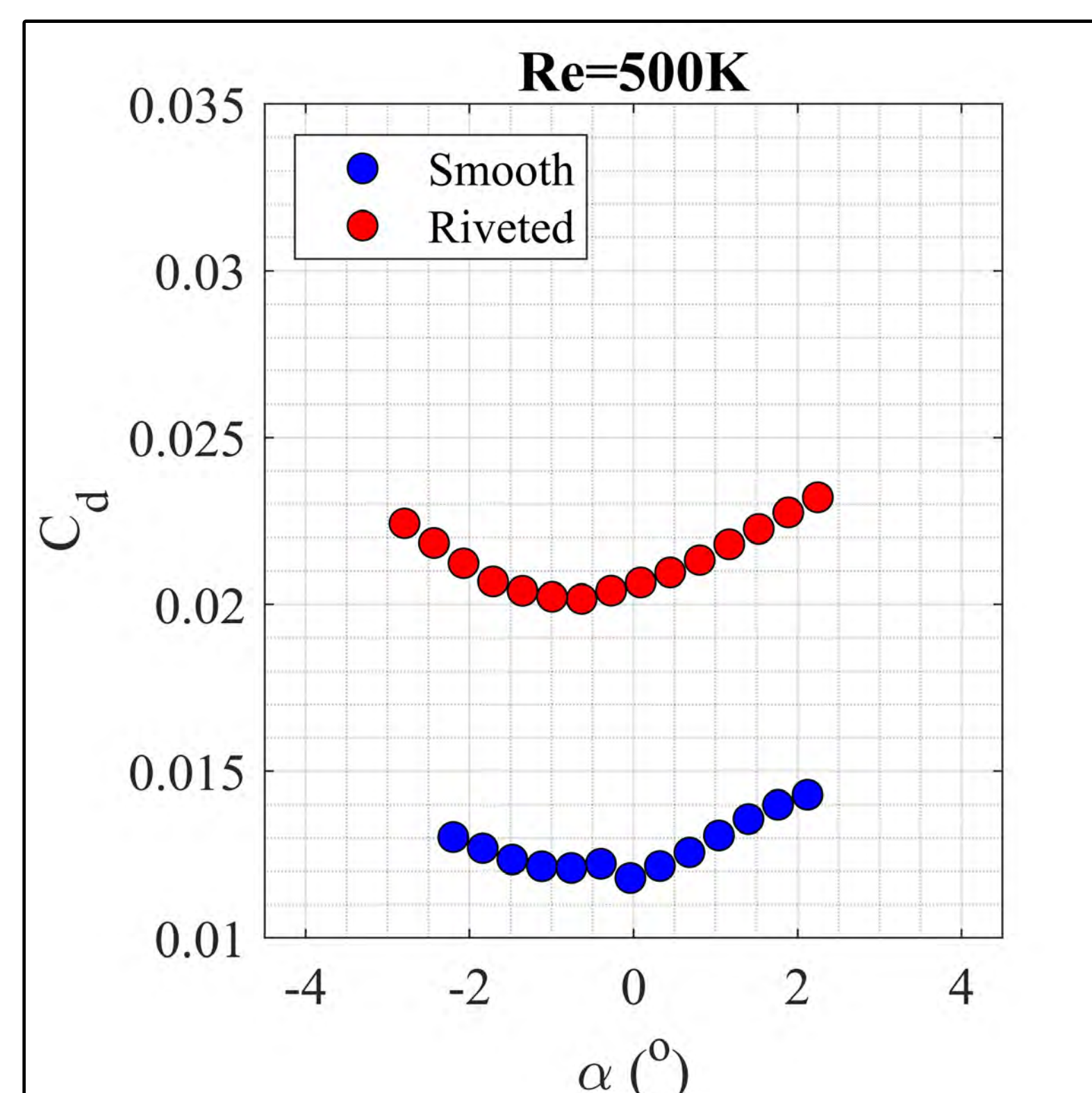
OFI Theory

Oil film interferometry (OFI) is a technique used to visualize and quantify thin oil film distribution on surfaces. OFI relies on interference patterns formed by coherent light passing through the oil film, revealing details about film thickness, flow patterns, and surface conditions with exceptional sensitivity. OFI offers advantages such as non-intrusiveness



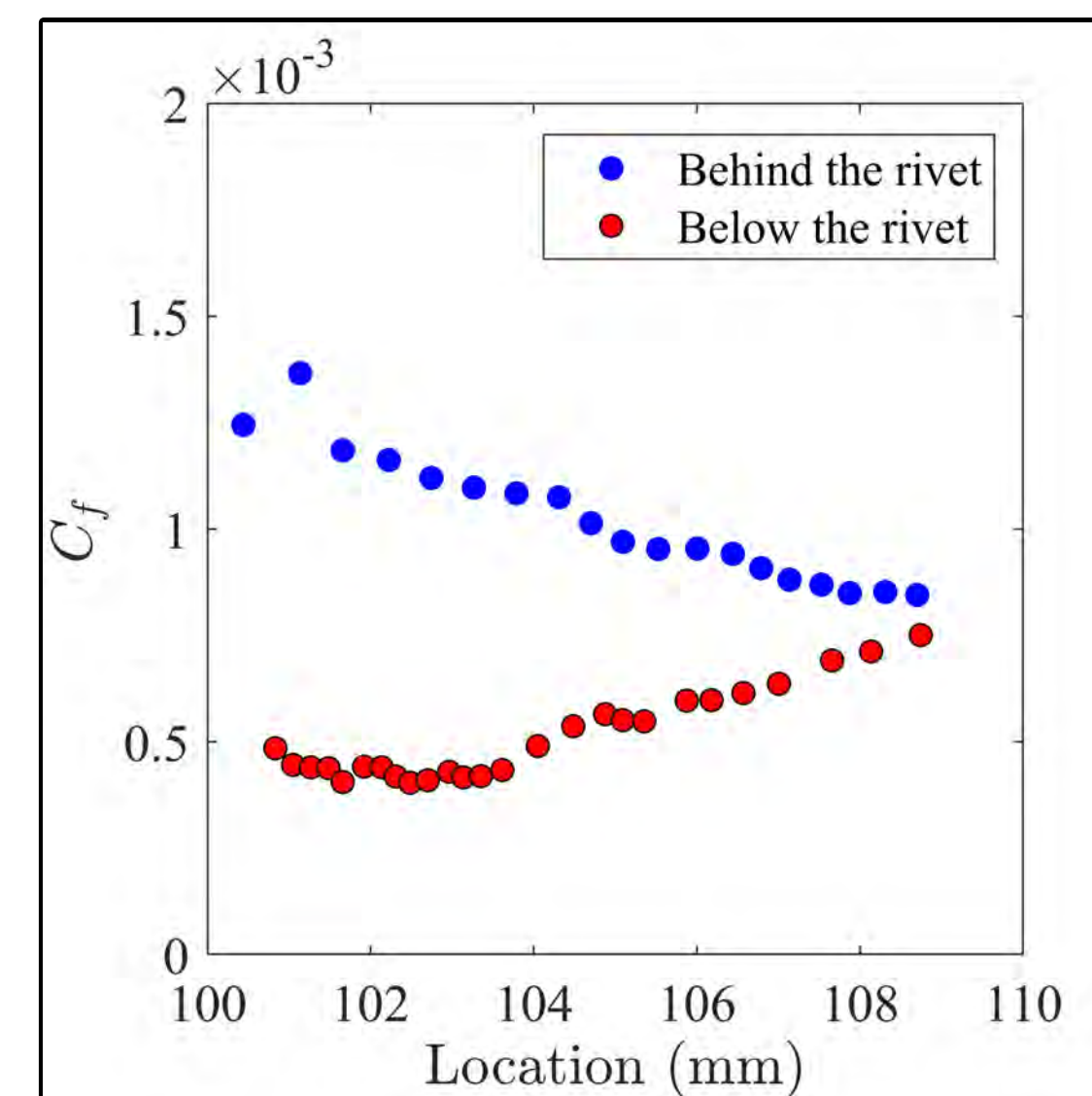
Schematic of oil-film and interference pattern

Airfoil Validation

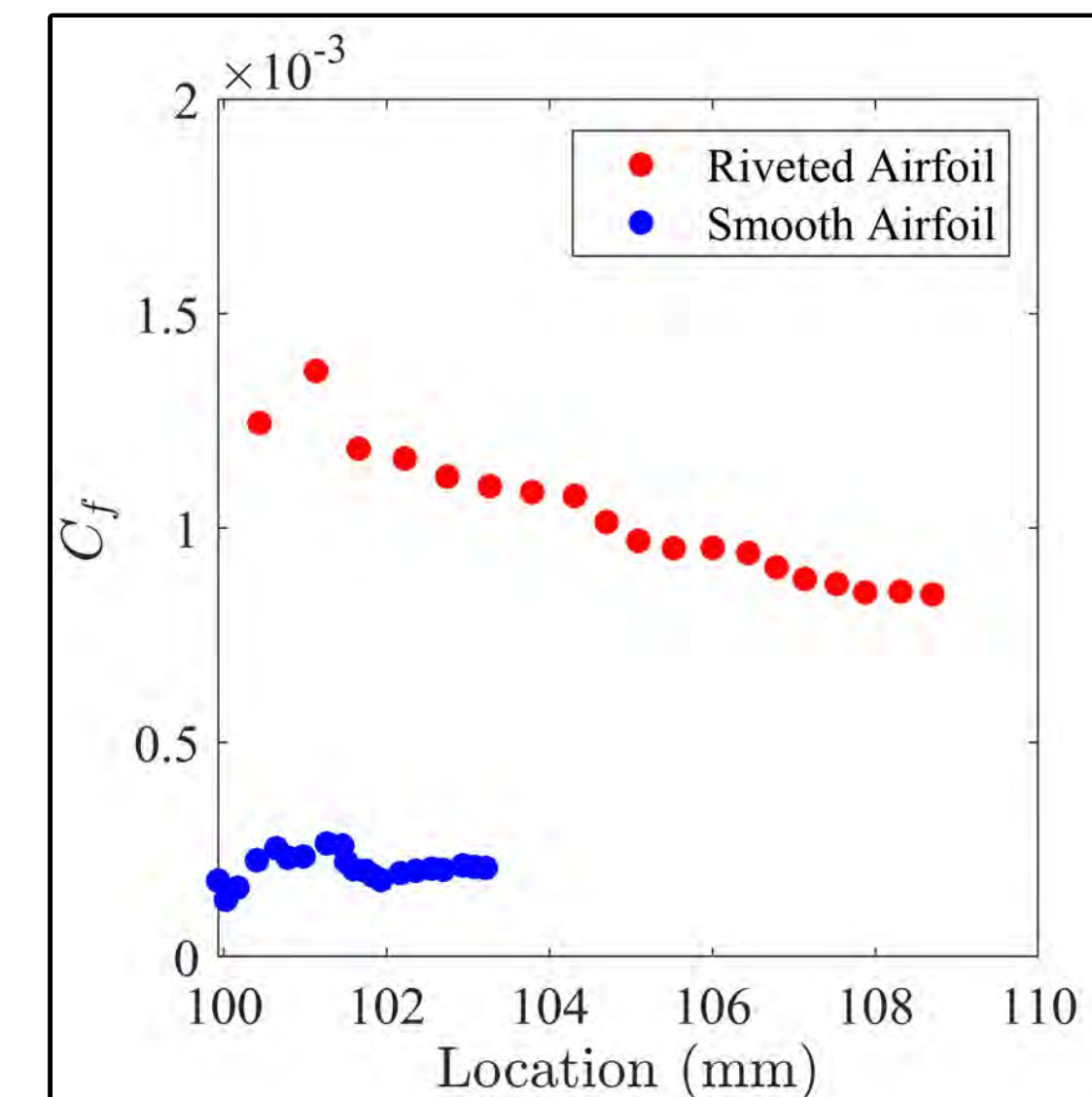


Coefficient of Drag vs Airfoil Angle Using Loadcell Data

Results



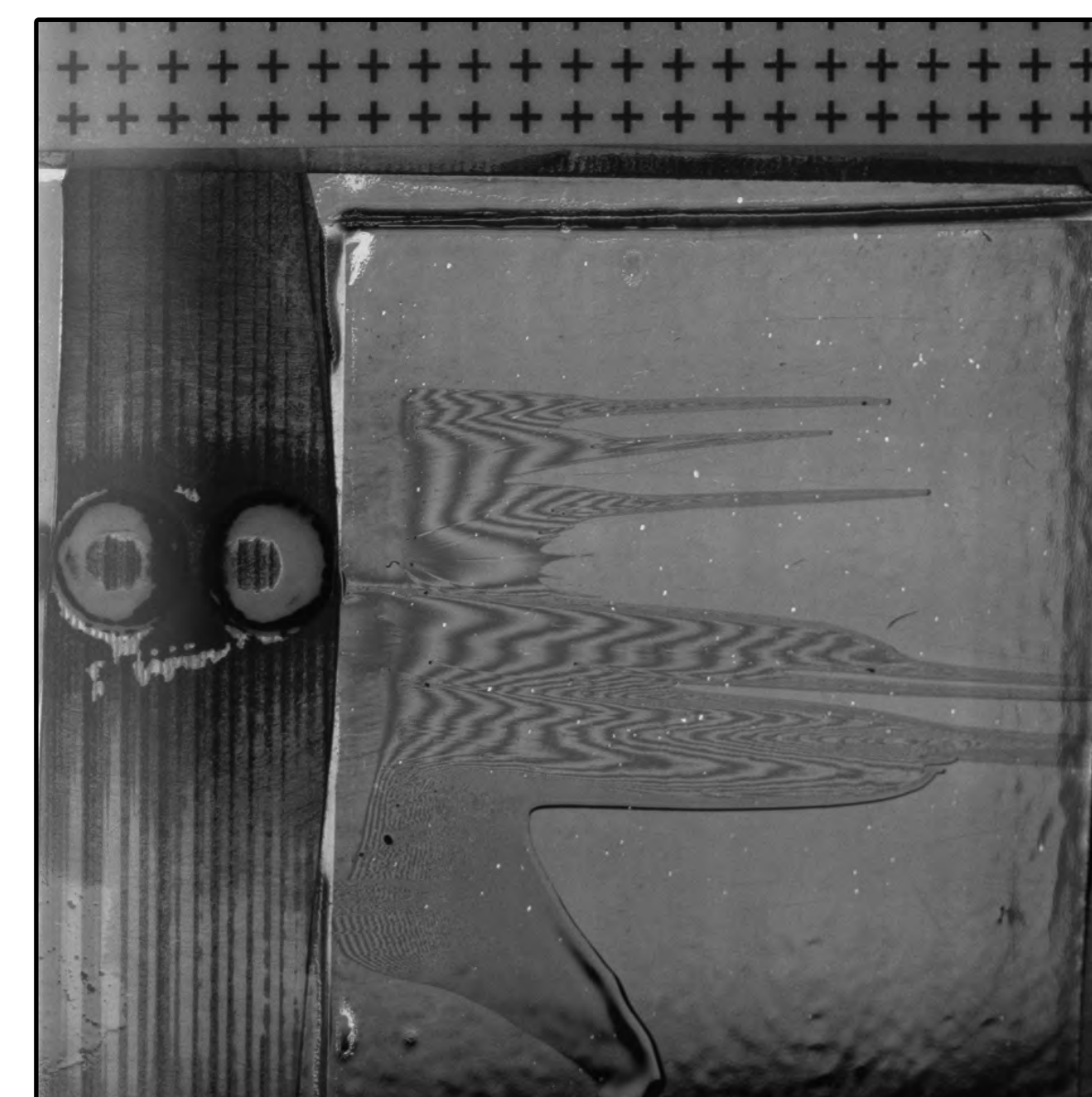
Coefficient of Drag vs Location on Riveted Airfoil Using OFI



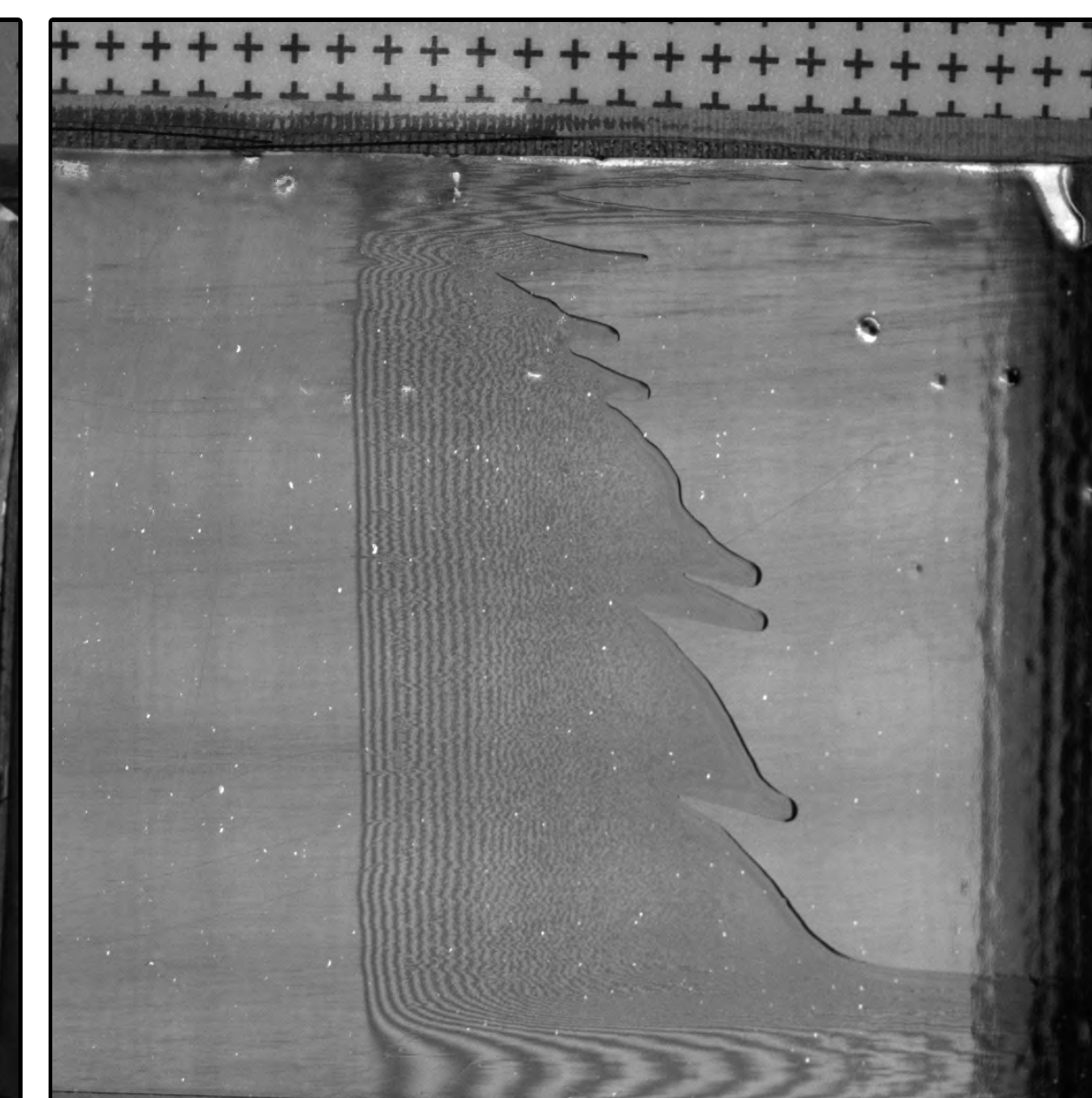
Coefficient of Drag vs Location for Smooth and Riveted Airfoil

**80% Increase in Coefficient of Drag
when Rivets are Introduced**

OFI Testing



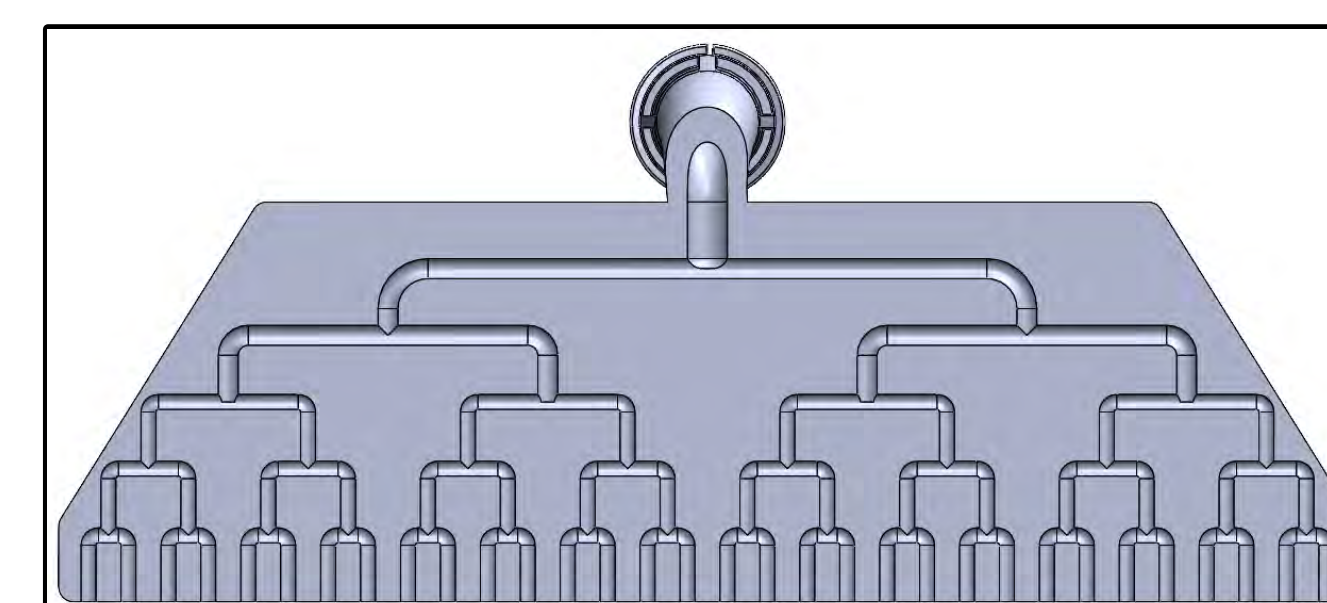
OFI test using a Riveted Airfoil



OFI test using a Smooth Airfoil

Oil Applicator Design

The oil applicator is 3d printed using a resin-based process that allows high resolution parts to be manufactured. This was designed to make application of the oil more consistent than previous methods.

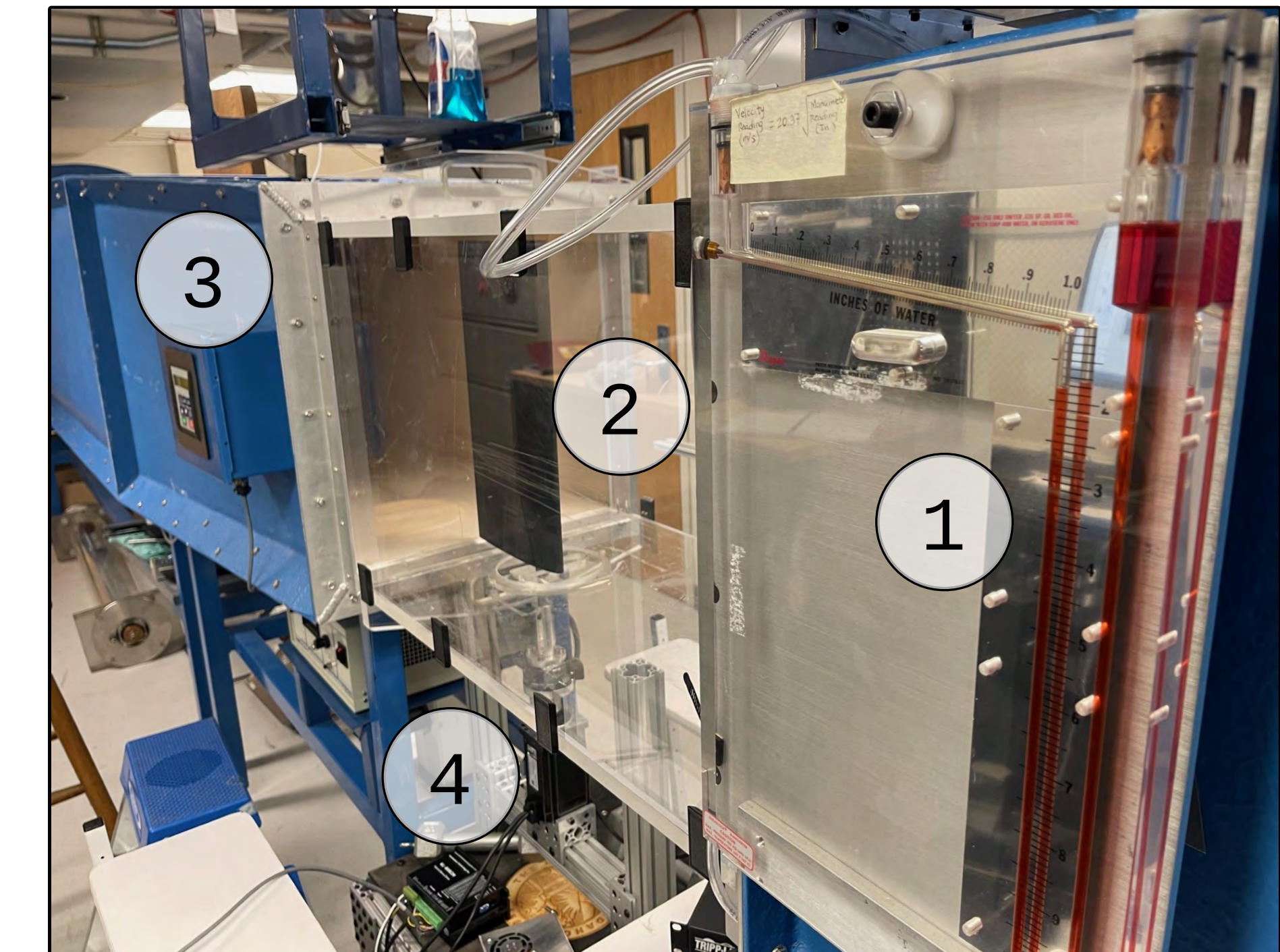


Large Oil Applicator Applied to Airfoil



Large Oil Applicator Applied to Airfoil

Wind Tunnel Setup



1: Manometer

2: Airfoil

3: Wind Tunnel Control Panel

4: Servo Load-Cell Assembly

Summary

This project successfully assessed the drag effects of riveted versus smooth aircraft surfaces using oil film interferometry (OFI). The coefficient of drag increased by 80 percent with rivets. Additionally, the oil applicator was developed to enhance the OFI process. This data provides valuable insights for Kodiak's manufacturing decisions, contributing to aerodynamic research and aircraft design optimization.

Flat Plate

Before performing OFI on curved surfaces, a flat plate testing fixture was made to validate our testing and post-processing procedures. The flat plate was designed in SolidWorks and then printed in three parts. It houses a polished square of stainless steel which acts as the testing surface.



Flat Plate



2024 Capstone Project