Group 5
Enhanced Agility of MAV's Using Adaptive Structures

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Overview

- Motivation
- Introduction
- Experimental Setup
- Results
- Conclusion
- Future Work

Motivation

- Sponsor: Air Force Research Laboratory (AFRL)
- Unmanned Aerial Vehicle (UAV) operating limitations

Figure 1

Figure 2

Introduction: Project Focus

- Implementation and testing of adaptive structures in Micro-Air Vehicles (MAV)
  - Delaying Stall, Increase Lift (Verification)
  - Induce Roll
- Adaptive Structure:
  - Dielectric Elastomer

Introduction: Dielectric Elastomer

- Dielectric Elastomer
  - Two Electrodes: Carbon Grease
  - Membrane: 3M VHB 4910 300% strain

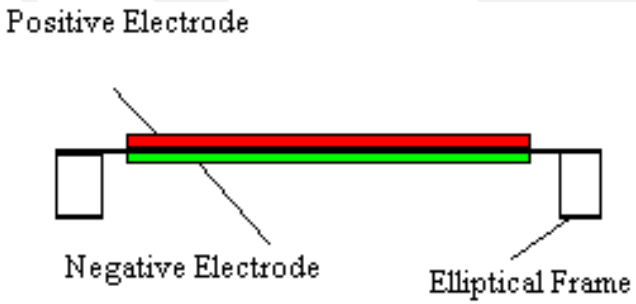


Figure 3

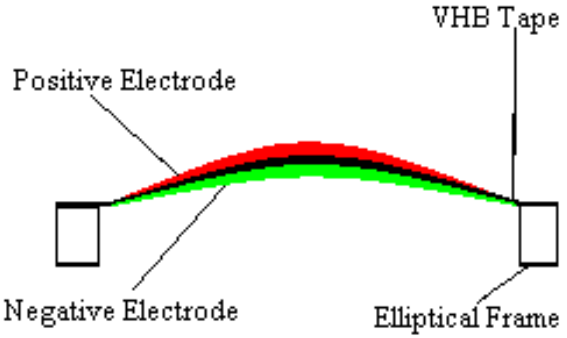
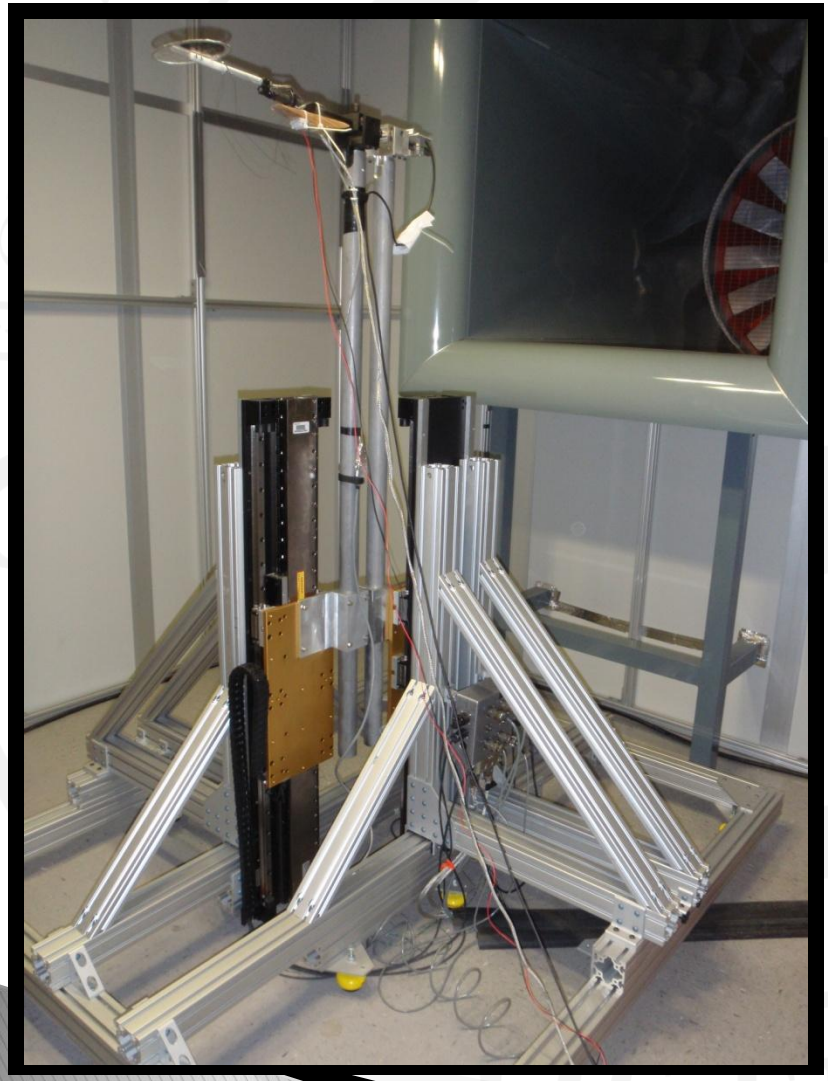
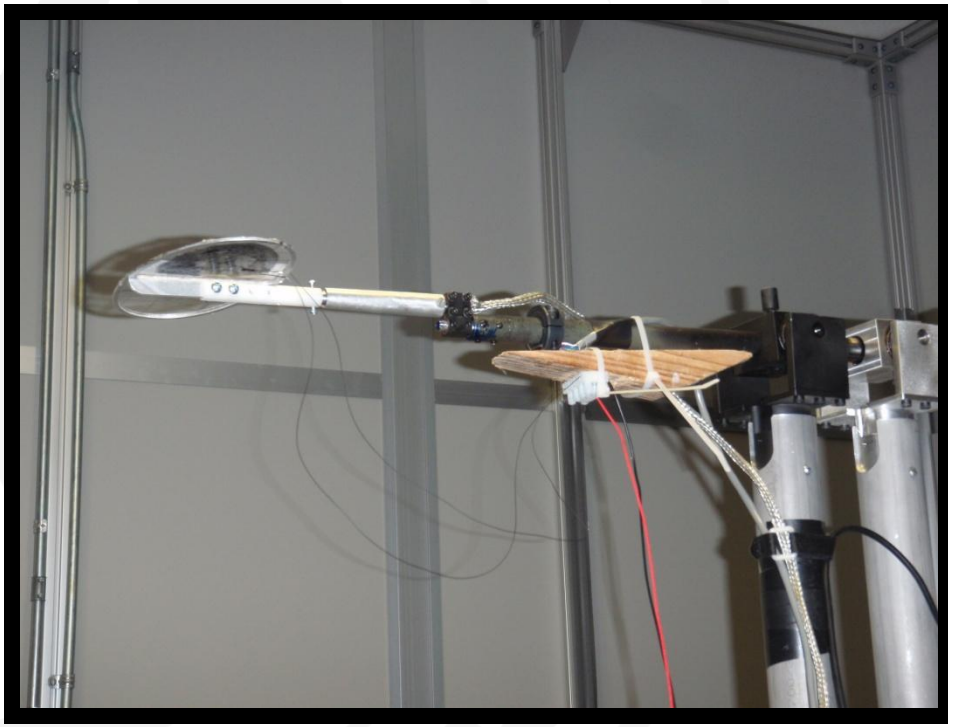


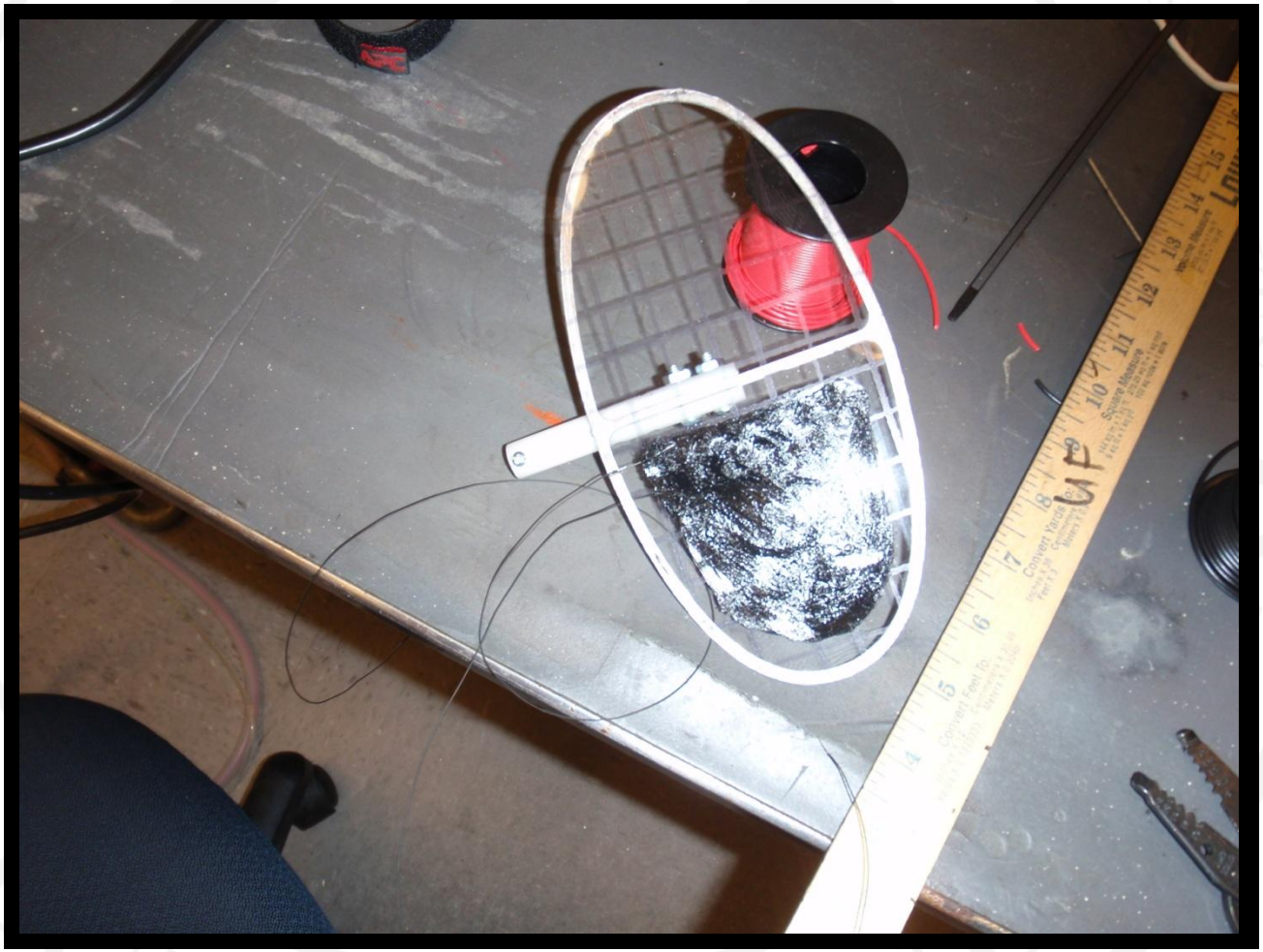
Figure 4

Experimental Setup: Test Platform



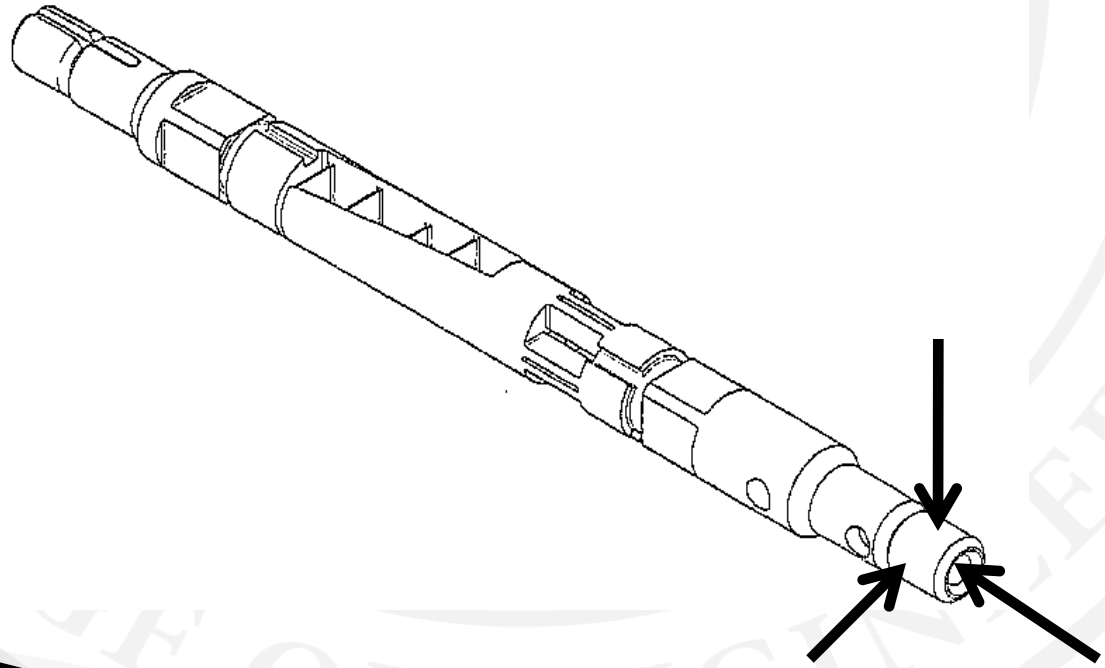


Experimental Setup: Wing Frame (Roll)



Experimental Setup: Sting Balance

- Measures
  - Three moments
  - Three forces



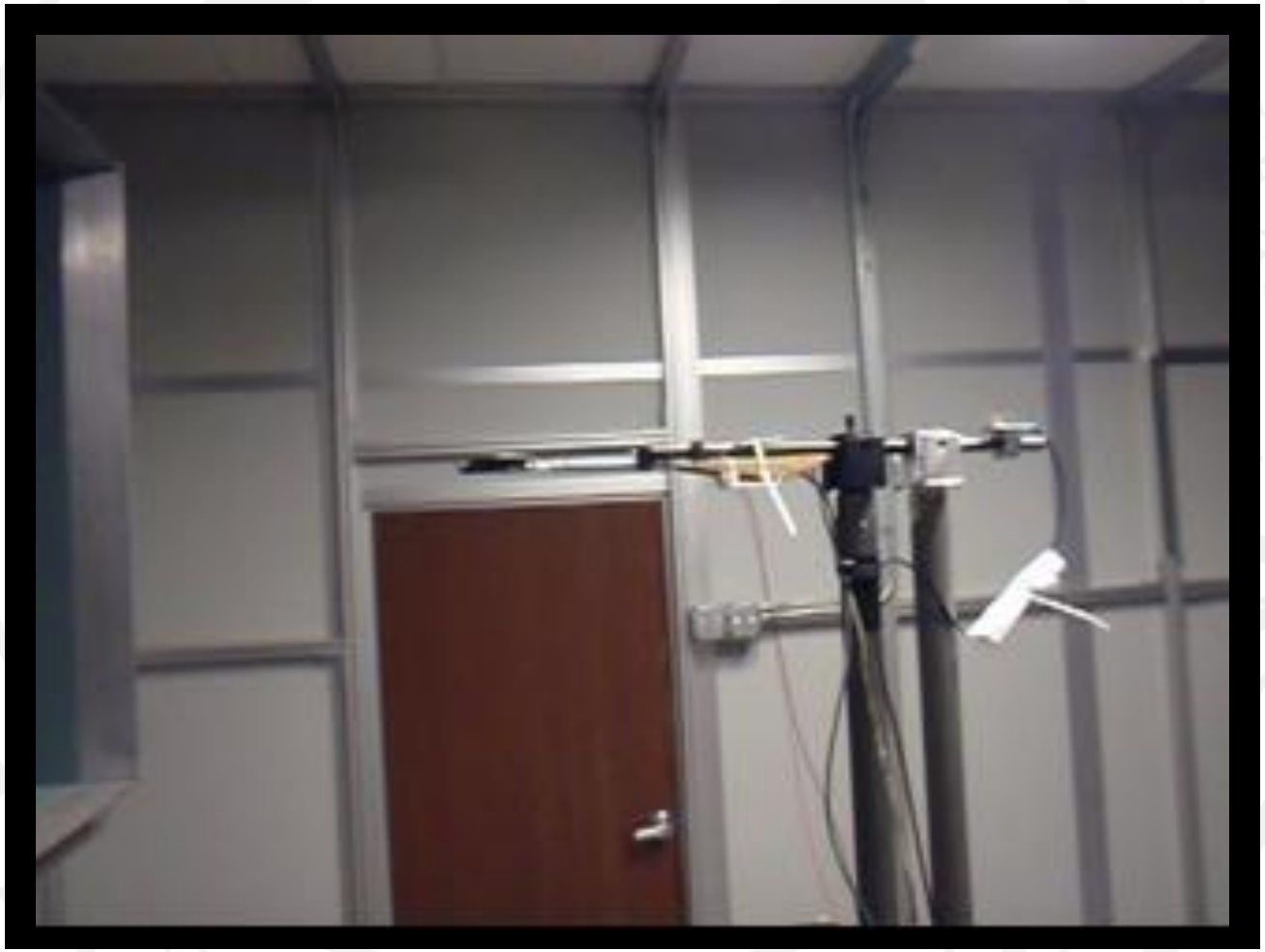
Experimental Setup: Test Parameters

- Angle of Attack: 0 to 22 degrees
- Time at each angle: 30 seconds
- Wind Velocity: 5 to 10 m/s
- Sample Rate: 100 samples per second
- Voltage: 0 to 6.5 kV
- Outputs: Coefficient of Drag, Lift, and Rolling Moment

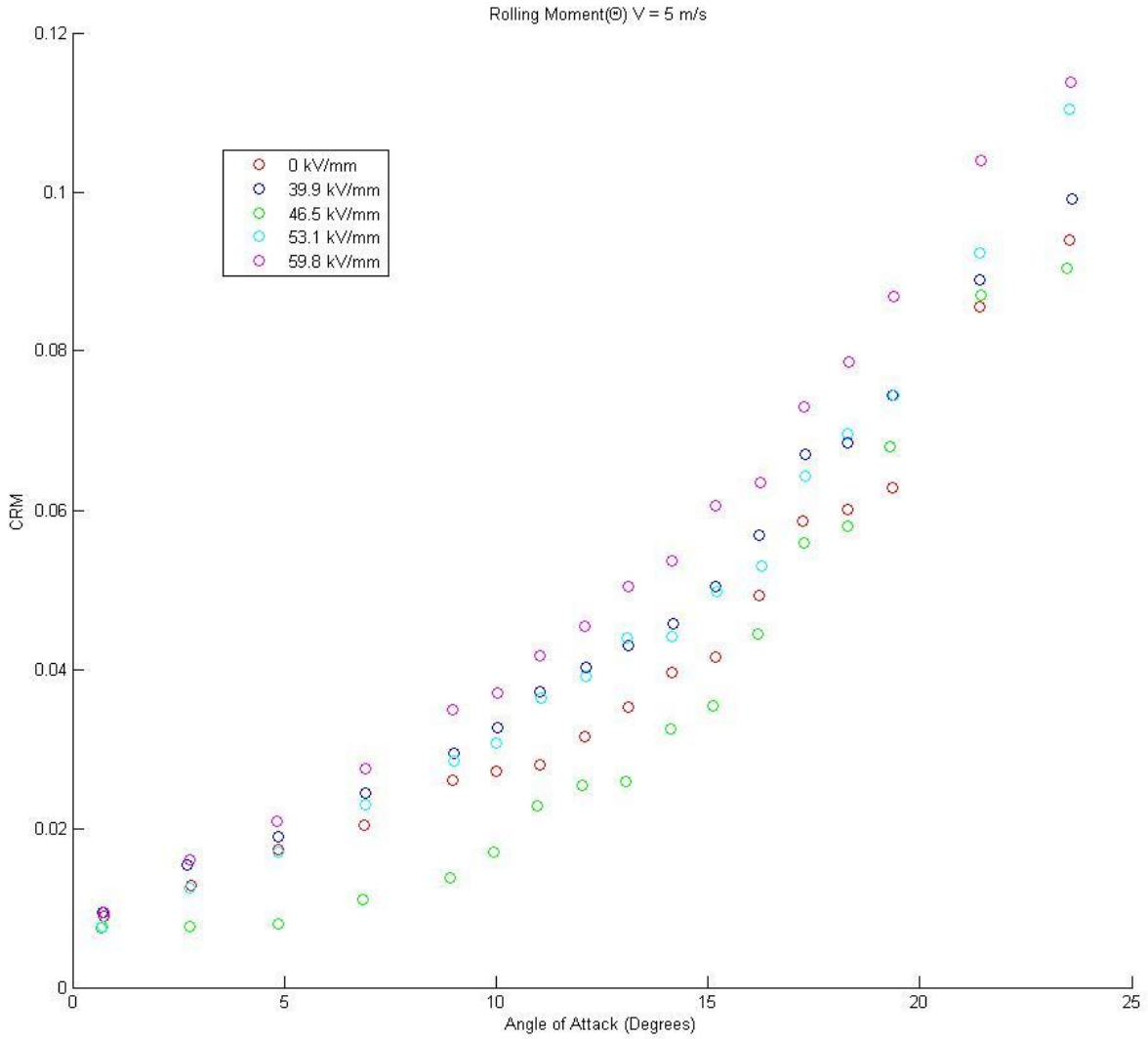
Experimental Setup: Test Parameters

- Step 1: Tear Run
- Step 2: Base Line Run Variable Velocity
- Step 3: Fixed Voltage Variable Velocity
- Step 4: Change Voltage Repeat Step 3

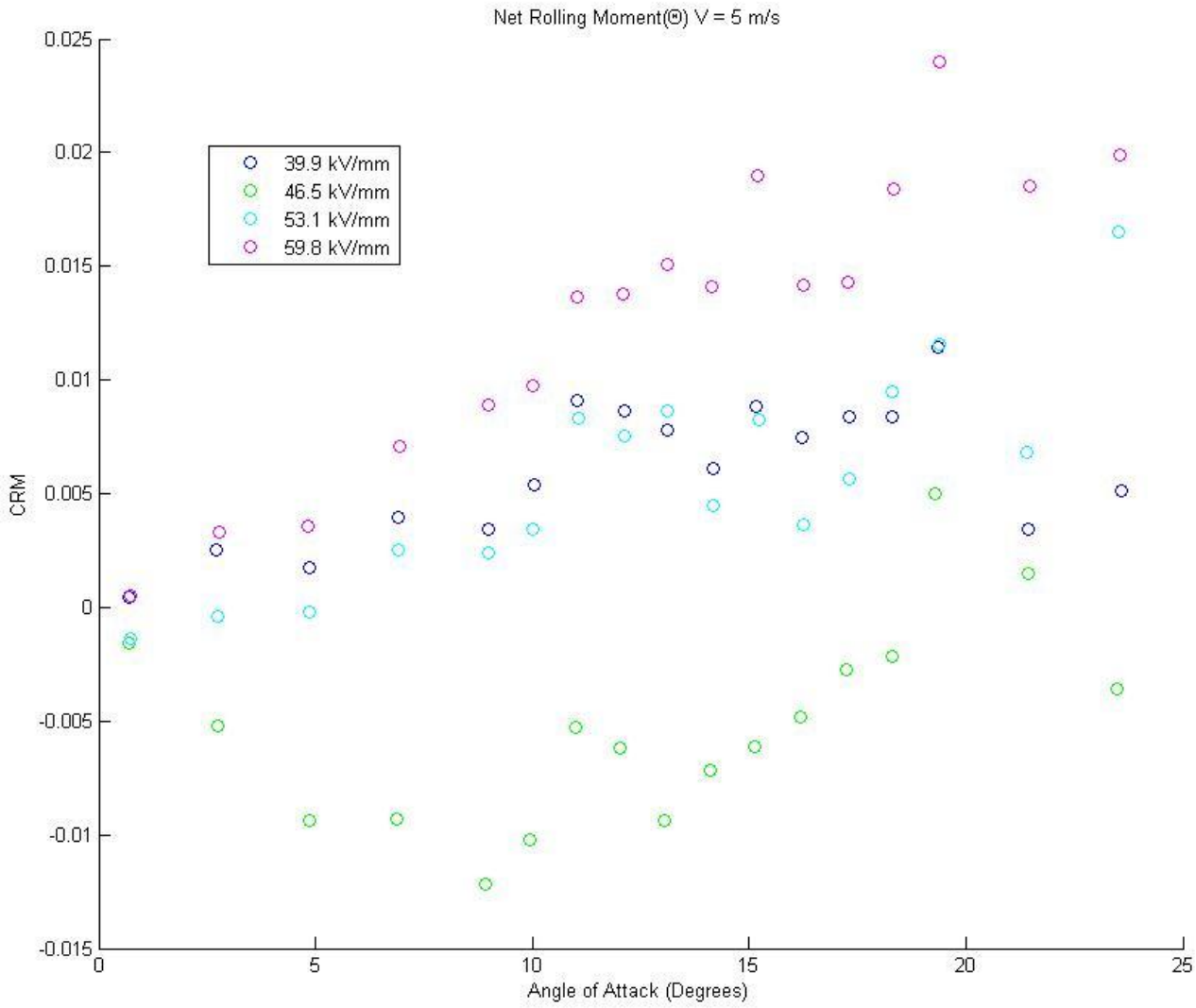
Experimental Setup: Test Parameters



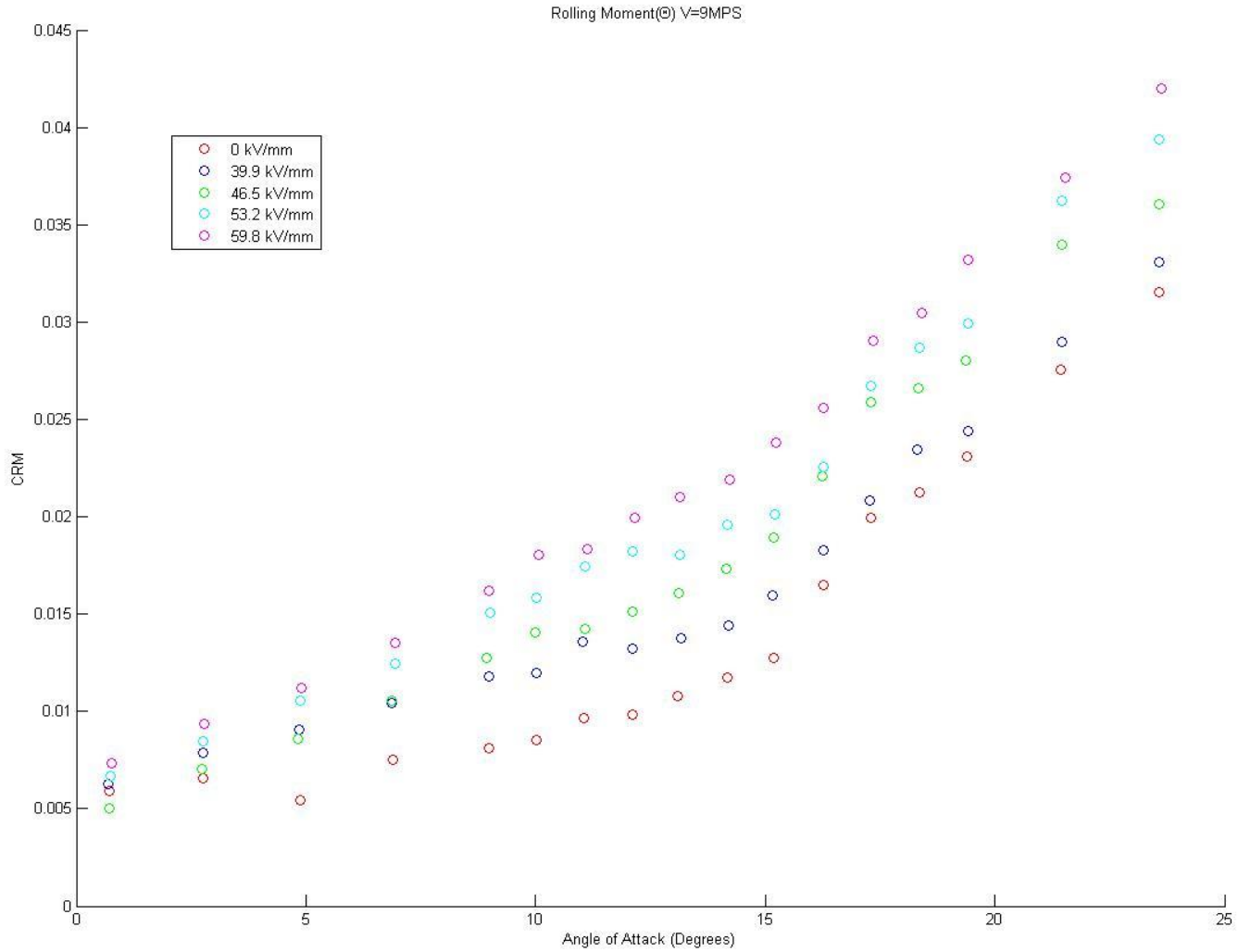
Results


Rolling Moment(Θ) V = 5 m/s
0 kV/mm
39.9 kV/mm
46.5 kV/mm
53.1 kV/mm
59.8 kV/mm
CRM
Angle of Attack (Degrees)
0
0.02
0.04
0.06
0.08
0.1
0.12
0
5
10
15
20
25

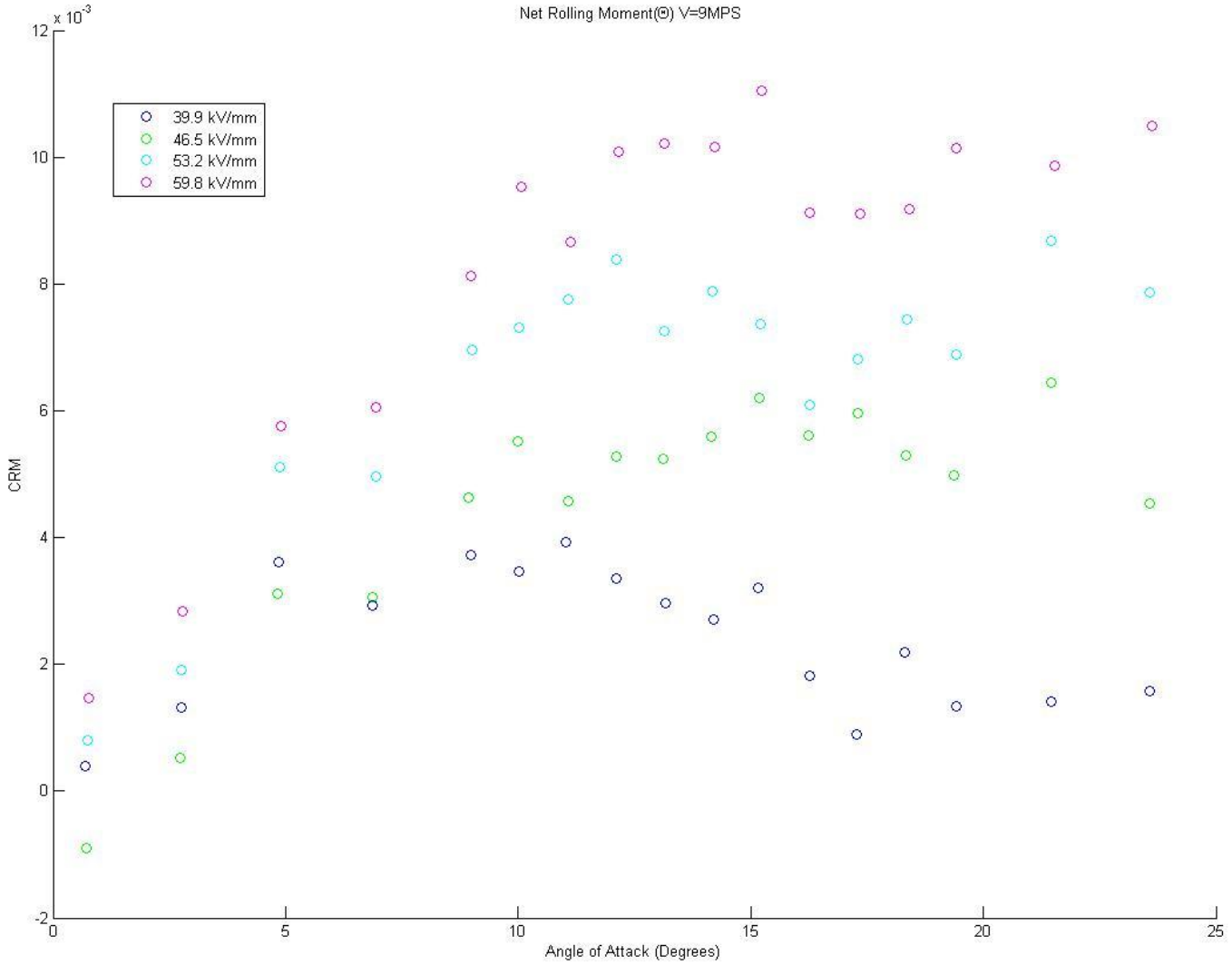
Results


Net Rolling Moment(⊖) V = 5 m/s
39.9 kV/mm
46.5 kV/mm
53.1 kV/mm
59.8 kV/mm
CRM
0.025
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
0
5
10
15
20
25
Angle of Attack (Degrees)

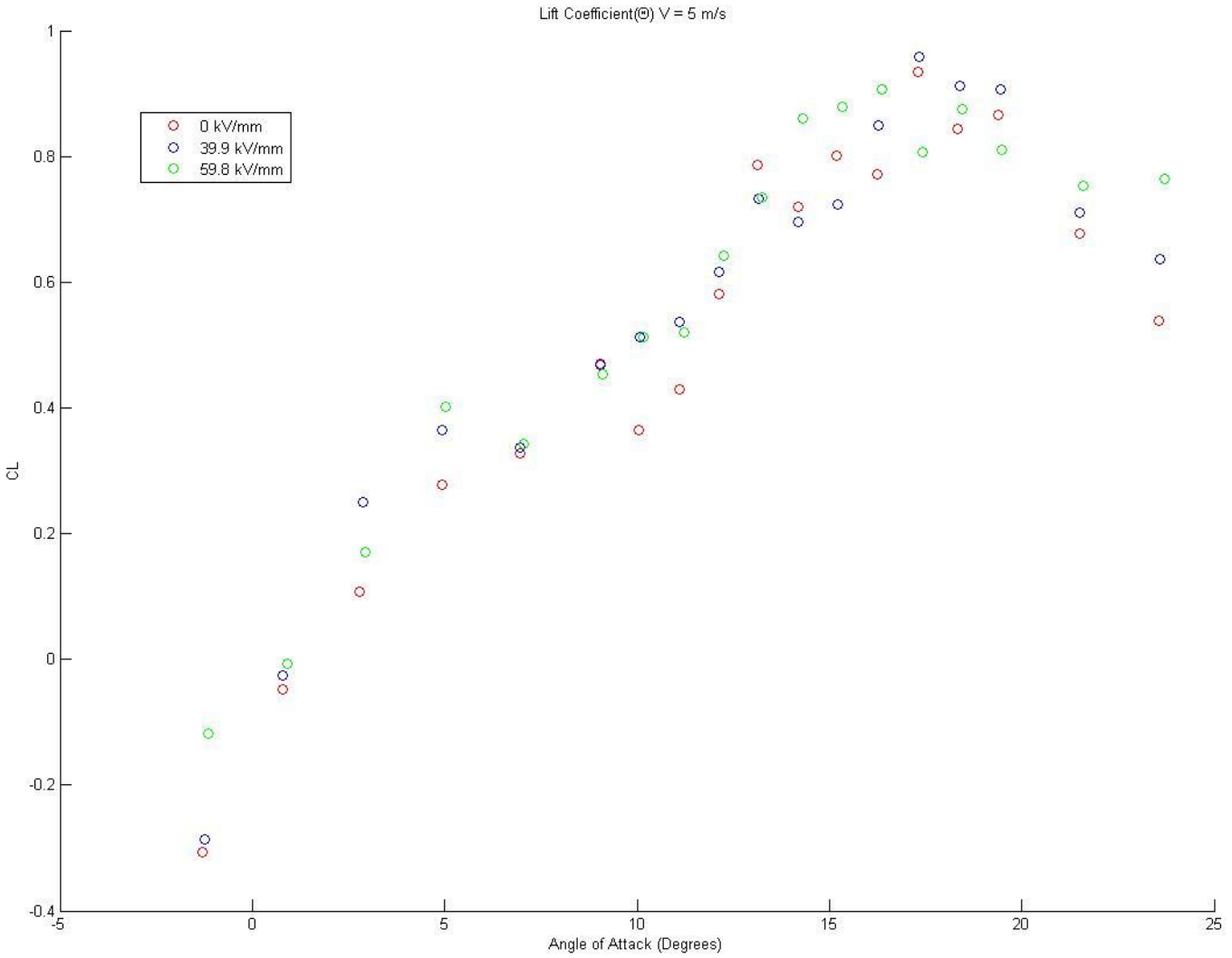
Results


Rolling Moment(⊙) V=9MPS
0 kV/mm
39.9 kV/mm
46.5 kV/mm
53.2 kV/mm
59.8 kV/mm
CRM
Angle of Attack (Degrees)
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0
5
10
15
20
25

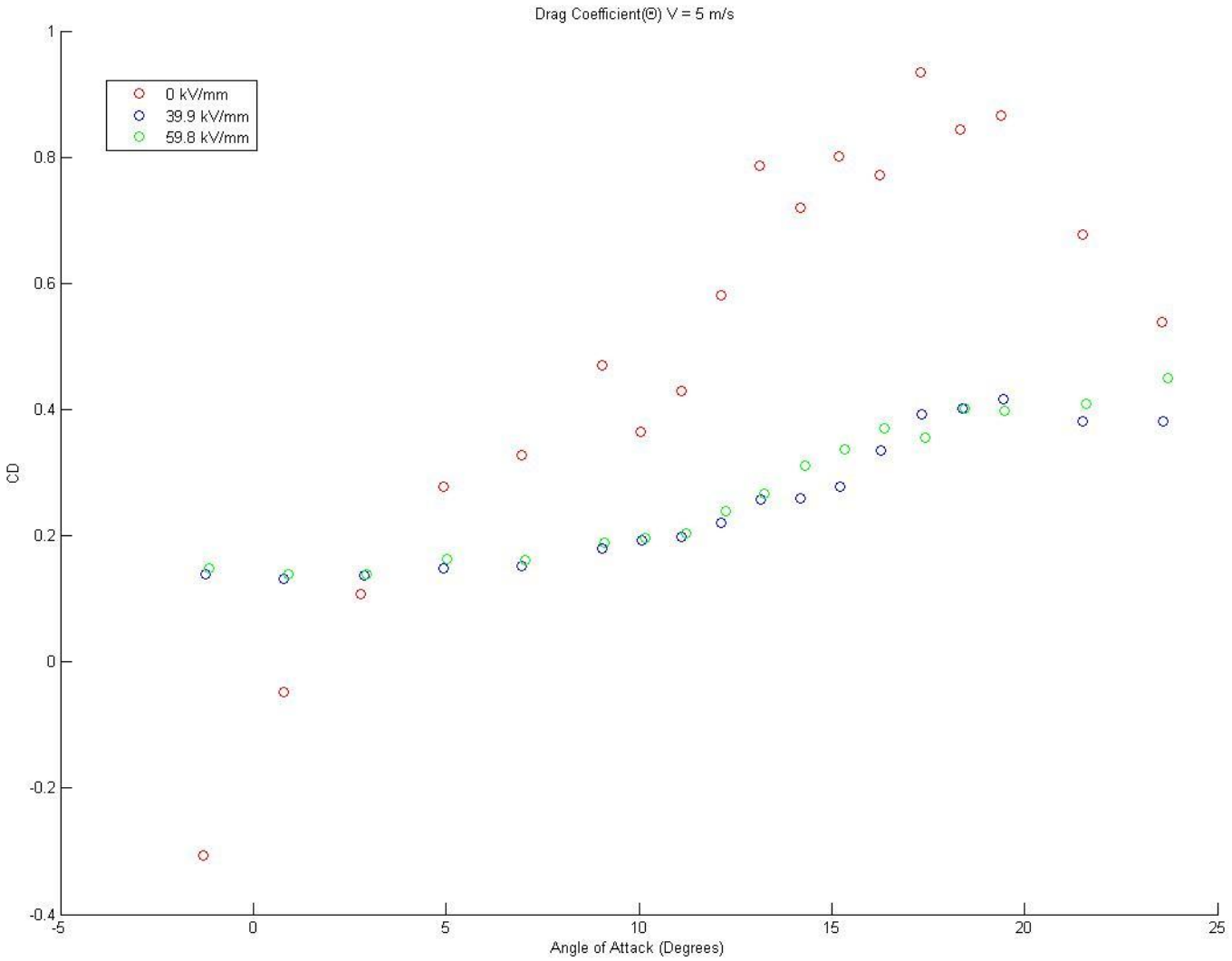
Results


Net Rolling Moment(⊙) V=9MPS
x 10^-3
CRM
Angle of Attack (Degrees)
39.9 kV/mm
46.5 kV/mm
53.2 kV/mm
59.8 kV/mm
12
10
8
6
4
2
0
-2
0
5
10
15
20
25

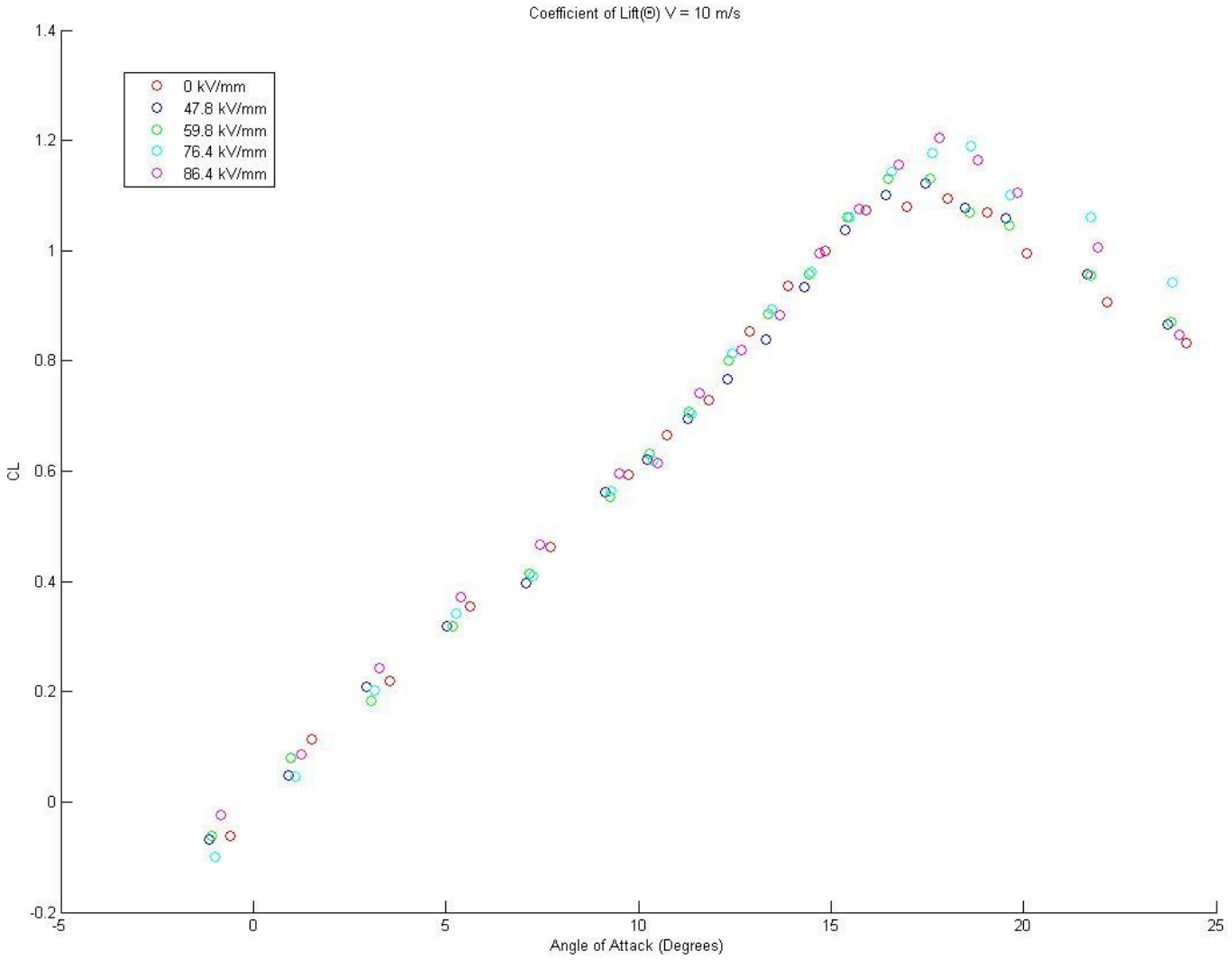
Results


Lift Coefficient(Θ) V = 5 m/s
0 kV/mm
39.9 kV/mm
59.8 kV/mm
CL
Angle of Attack (Degrees)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-5
0
5
10
15
20
25

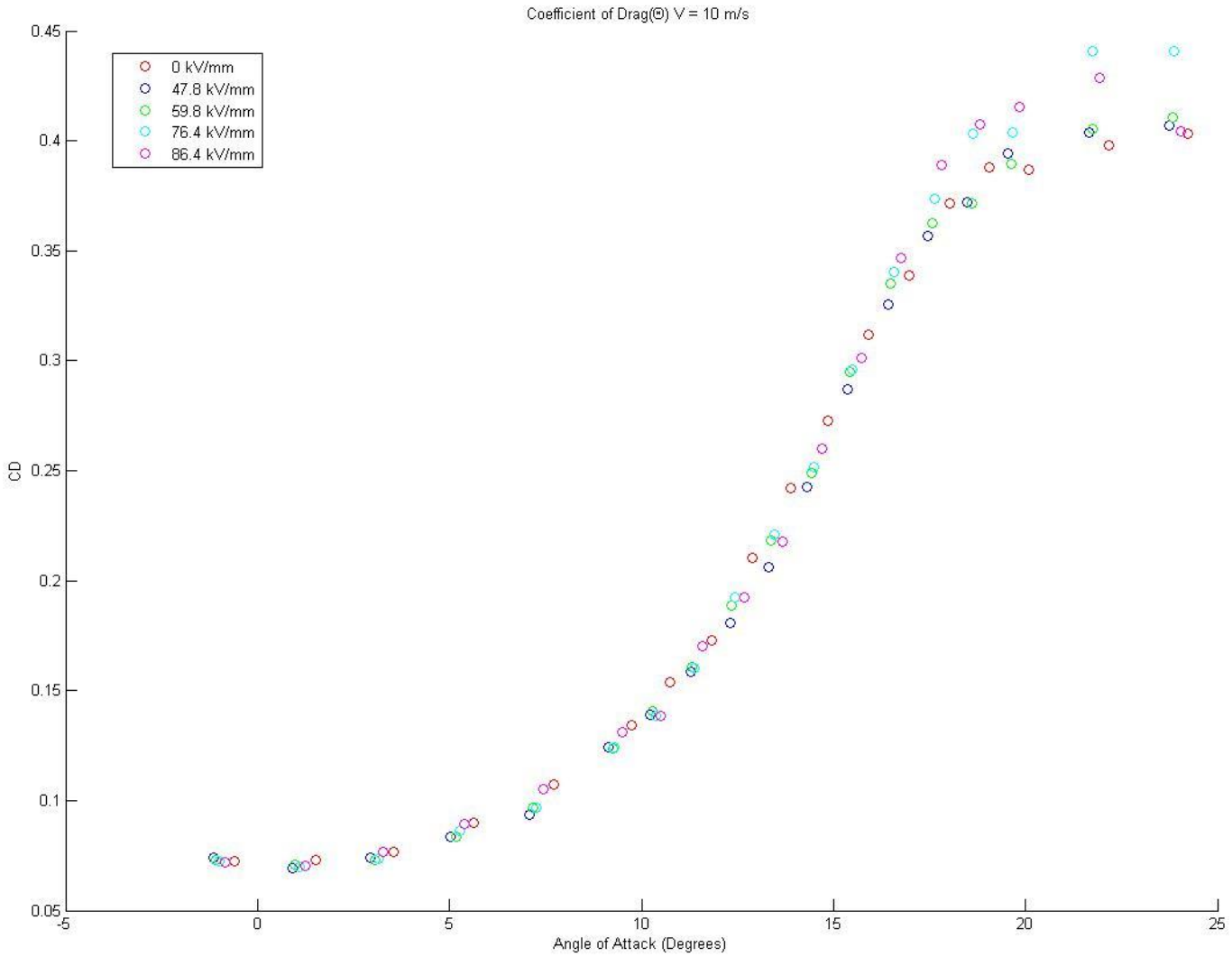
Results


Drag Coefficient(Θ) V = 5 m/s
0 kV/mm
39.9 kV/mm
59.8 kV/mm
CD
Angle of Attack (Degrees)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-5
0
5
10
15
20
25

Results


Coefficient of Lift(Θ) V = 10 m/s
0 kV/mm
47.8 kV/mm
59.8 kV/mm
76.4 kV/mm
86.4 kV/mm
CL
Angle of Attack (Degrees)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-5
0
5
10
15
20
25

Results


Coefficient of Drag(⊙) V = 10 m/s
0 kV/mm
47.8 kV/mm
59.8 kV/mm
76.4 kV/mm
86.4 kV/mm
CD
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
-5
0
5
10
15
20
25
Angle of Attack (Degrees)

Conclusion

- Roll
  - 9 m/s: as voltage increases, roll coefficient increases
  - 33% Increase over baseline
  - Data inconclusive when V < 9 m/s
- Lift
  - 10 m/s: as voltage increases, roll coefficient increases
  - 20% Increase over baseline
  - Delayed Stall 3 degrees
  - V = 6 m/s general trend but no conclusive result

Future Work

- Dynamic Controls
- Different electrode material
- Flow Visualization
- Different test platform

Special Thanks

- Dr. William Oates
- Dr. Ben Dickinson
- Michael Hayes

Questions

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