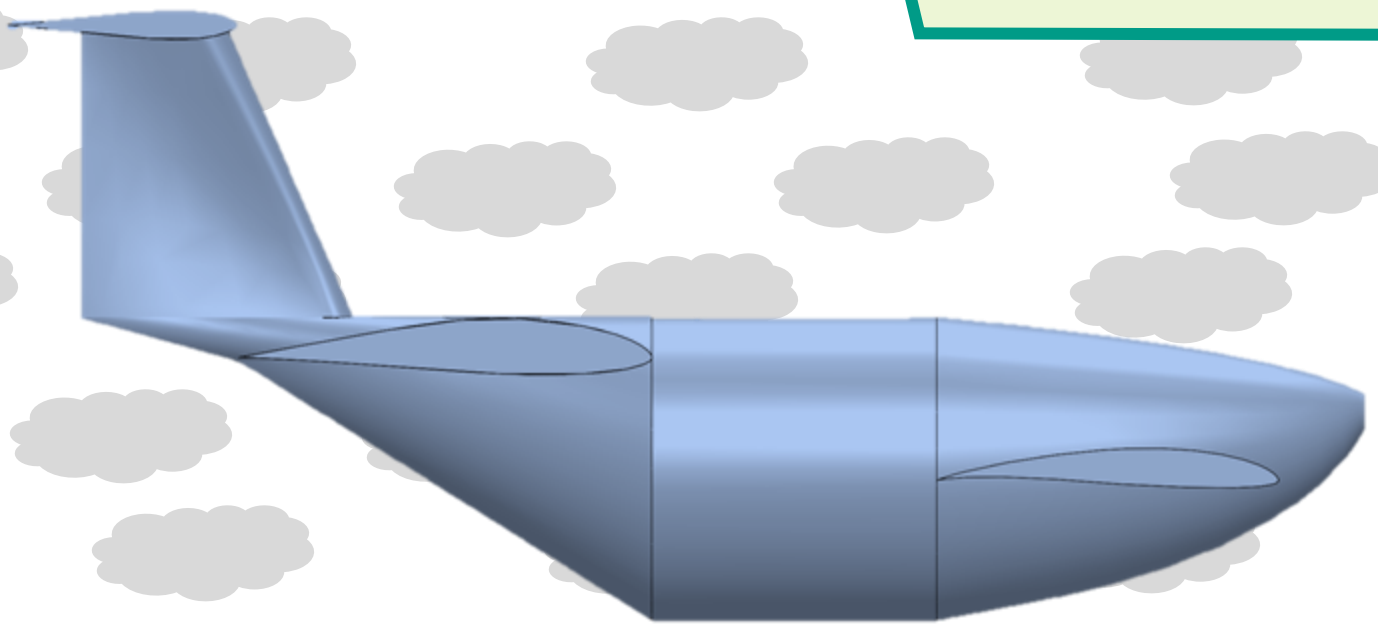
Technical Presentation



Team 057 - SAE Aero Design Competition

Team Introductions

Aerodynamics & Propulsion Team

Sasindu Pinto:
Project /Aeronautics/Propulsion Engineer

Noah Wright:
Aerodynamics Engineer

Michenell Louis-Charles:
Thermal Fluids Engineer/Financial Chair

Cameron Riley:
Materials/Hardware Engineer

Adrian Moya:
Systems/Hardware Engineer

Team Introductions

Geometric Integration

Lauren Chin

Lift and Control Surface Engineer/Meeting Coordinator

Joseph Figari

Fuselage and Payload Engineer/Financial Chair

Jacob Pifer

Project Engineer (Geometrics) and Manufacturing Engineer

Sponsor and Advisors

Florida Space Grant Consortium: Funding Sponsor

Seminole RC Club - Tallahassee: Equipment/Personnel Sponsor

Dr. Chiang Shih: Professor & AME Center Director Advisor

Dr. Simone Hruda: Professor & Undergraduate Advising Coordinator

Noah Wright

Team Objective

The objective is to design a 3-D printed plane that takes off, completes the flight path, and lands safely while carrying a payload.

Cameron Riley

Key Goals and Assumptions

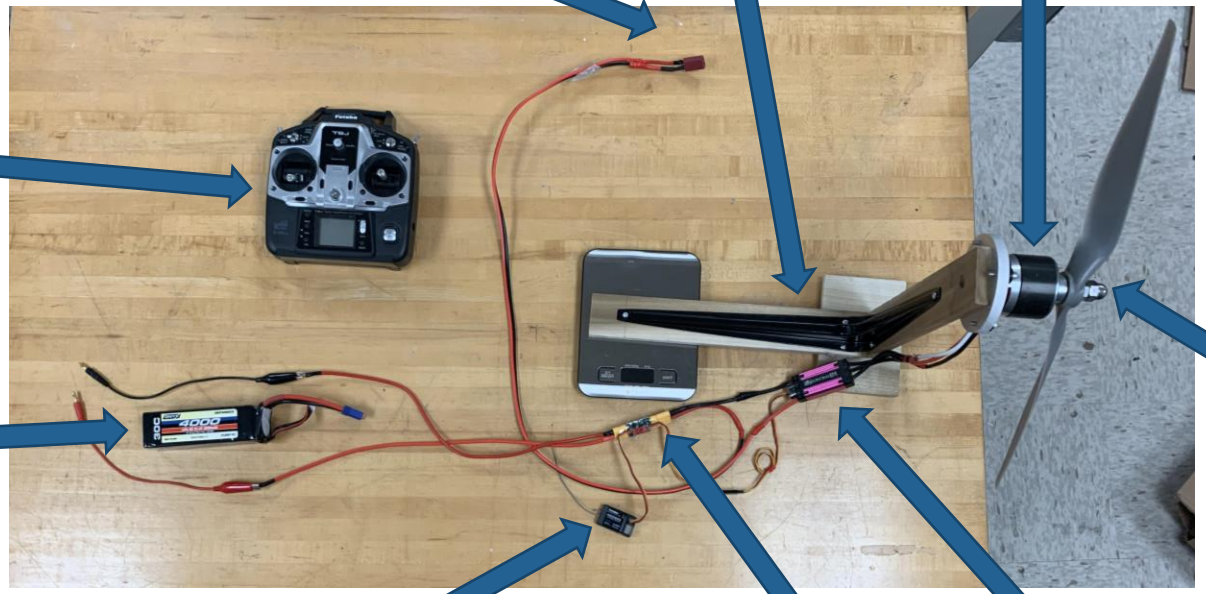
- Achieve lift
- Maintain stability in air
- Printing error tolerance 0.02 in
- Weighs less than 15 lbs
- Will be flown in atmospheric conditions at sea level

Cameron Riley

Design Process

Design Process

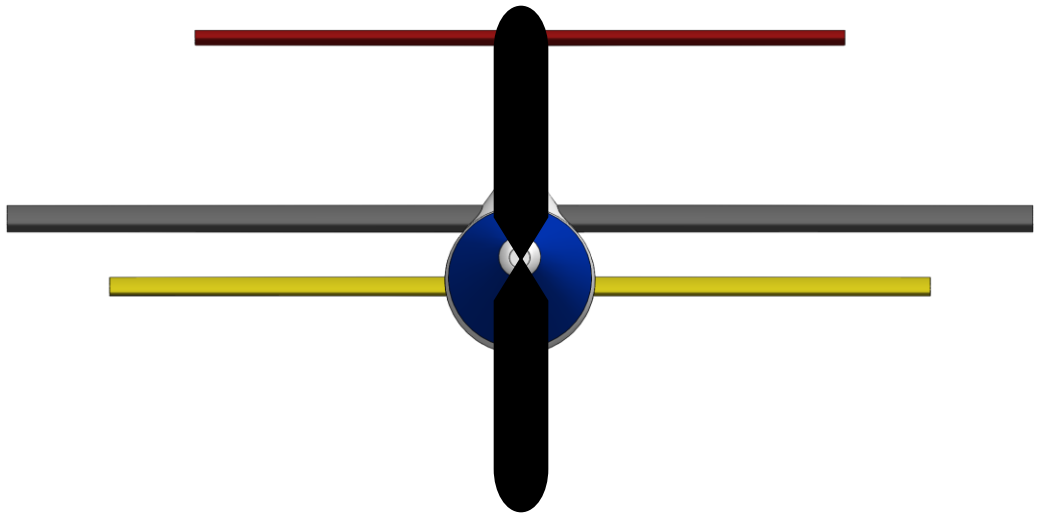
Thrust Test - Setup

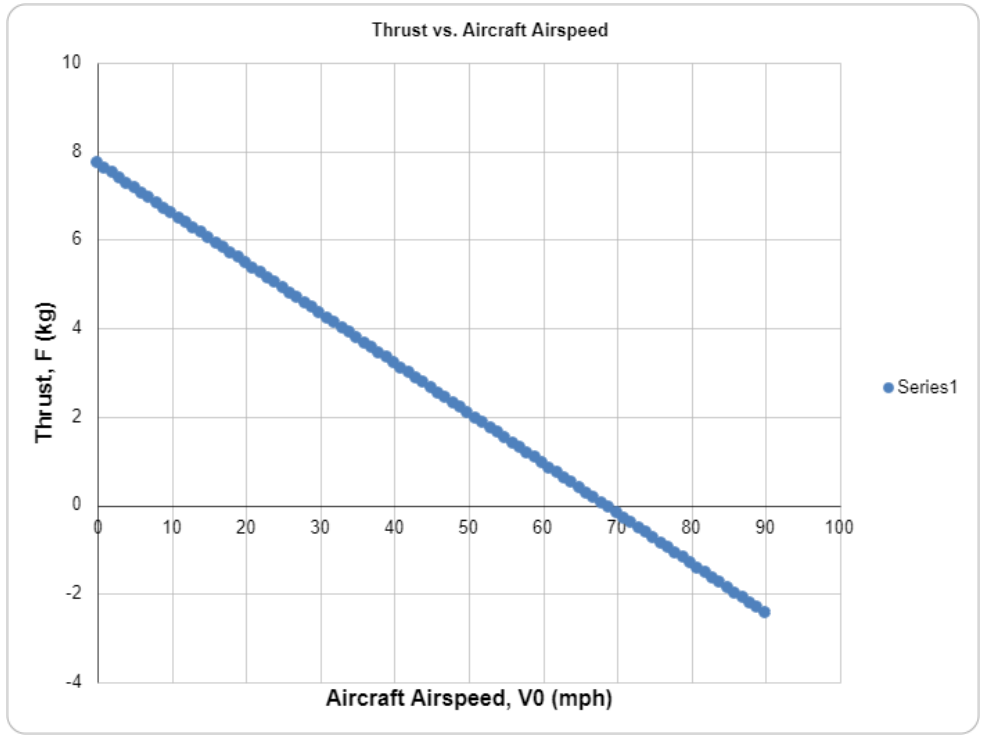


Cameron Riley

Design Process

Thrust Test





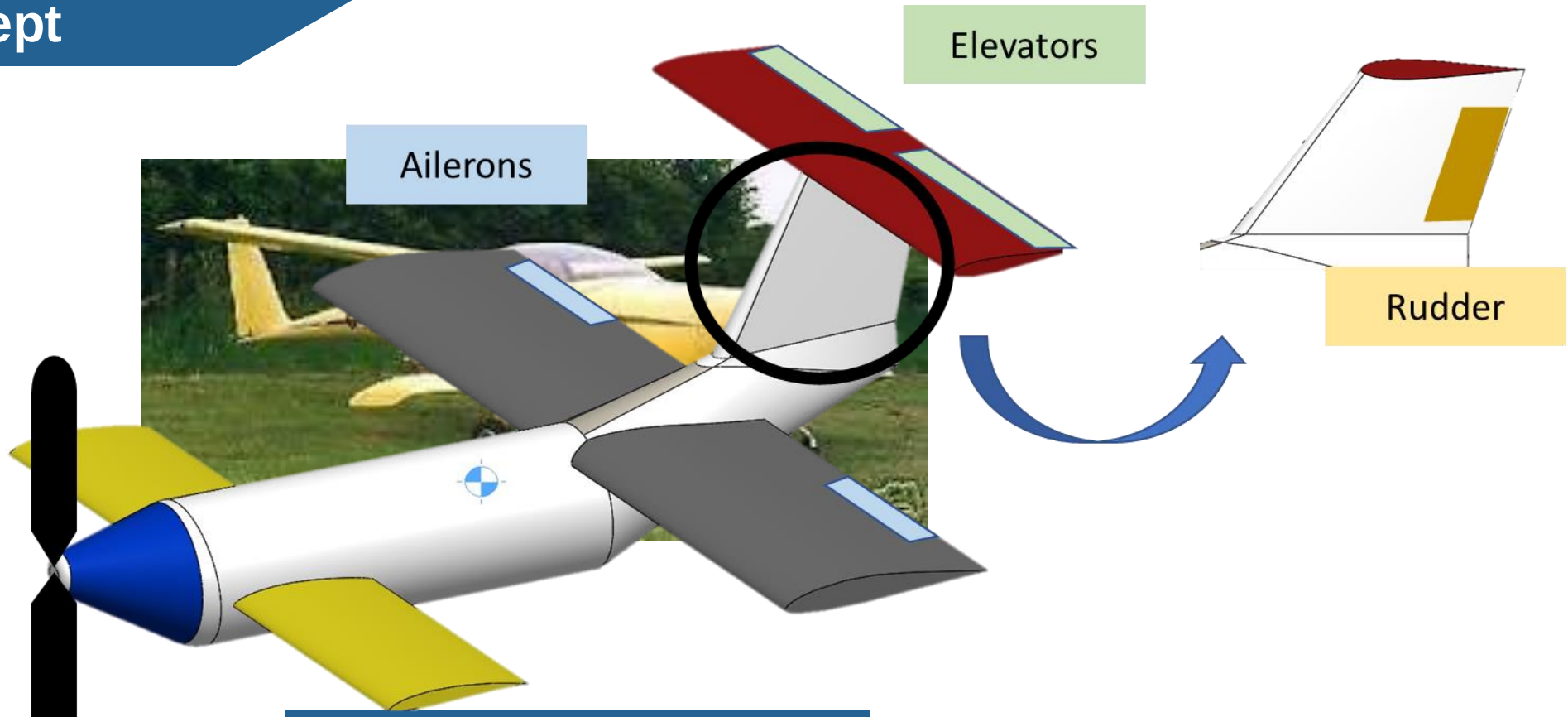
Experimental Thrust ~ 222 lbf

Calculated Static Thrust ~ 167 lbf

Cameron Riley

Design Process

Concept

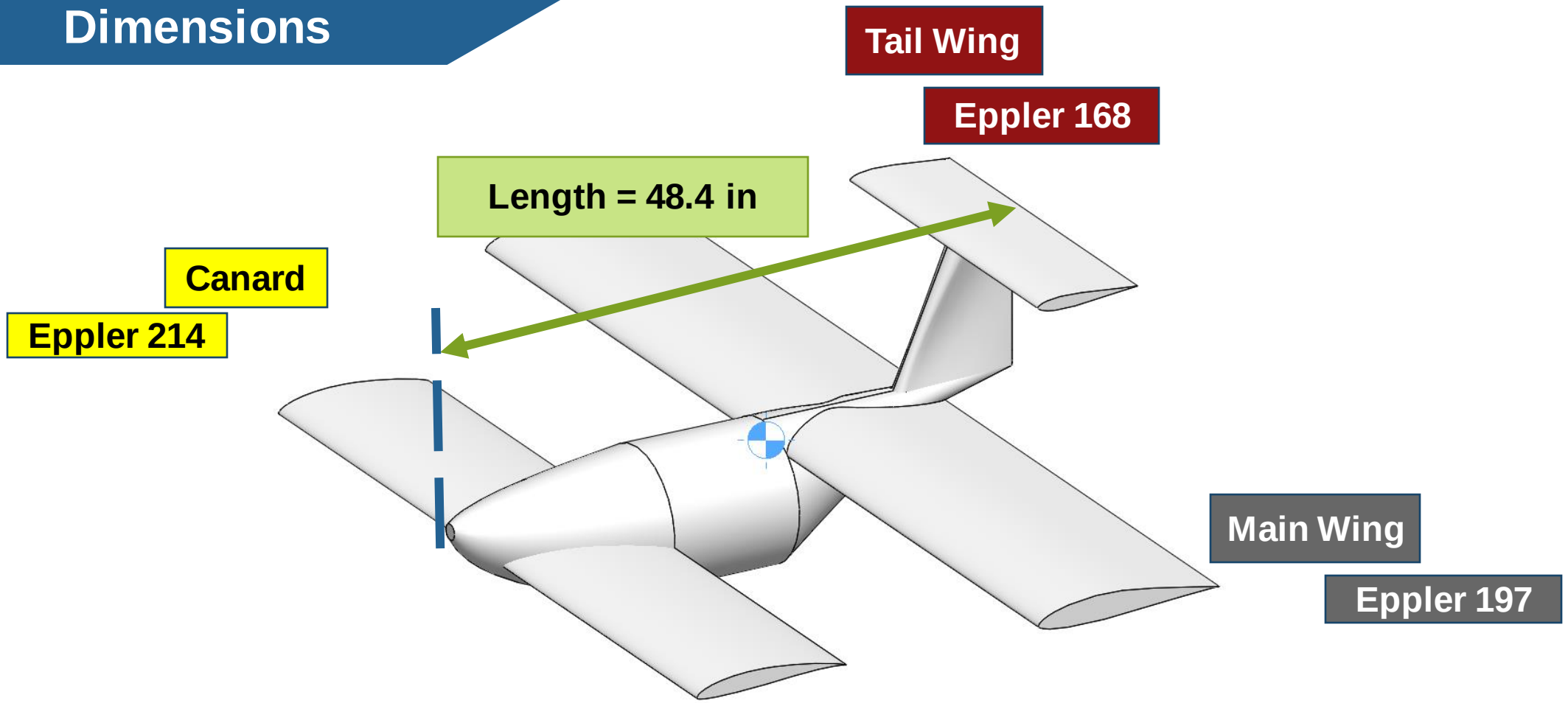


Rutan Quickie Q2

Sasindu Pinto

Design Process

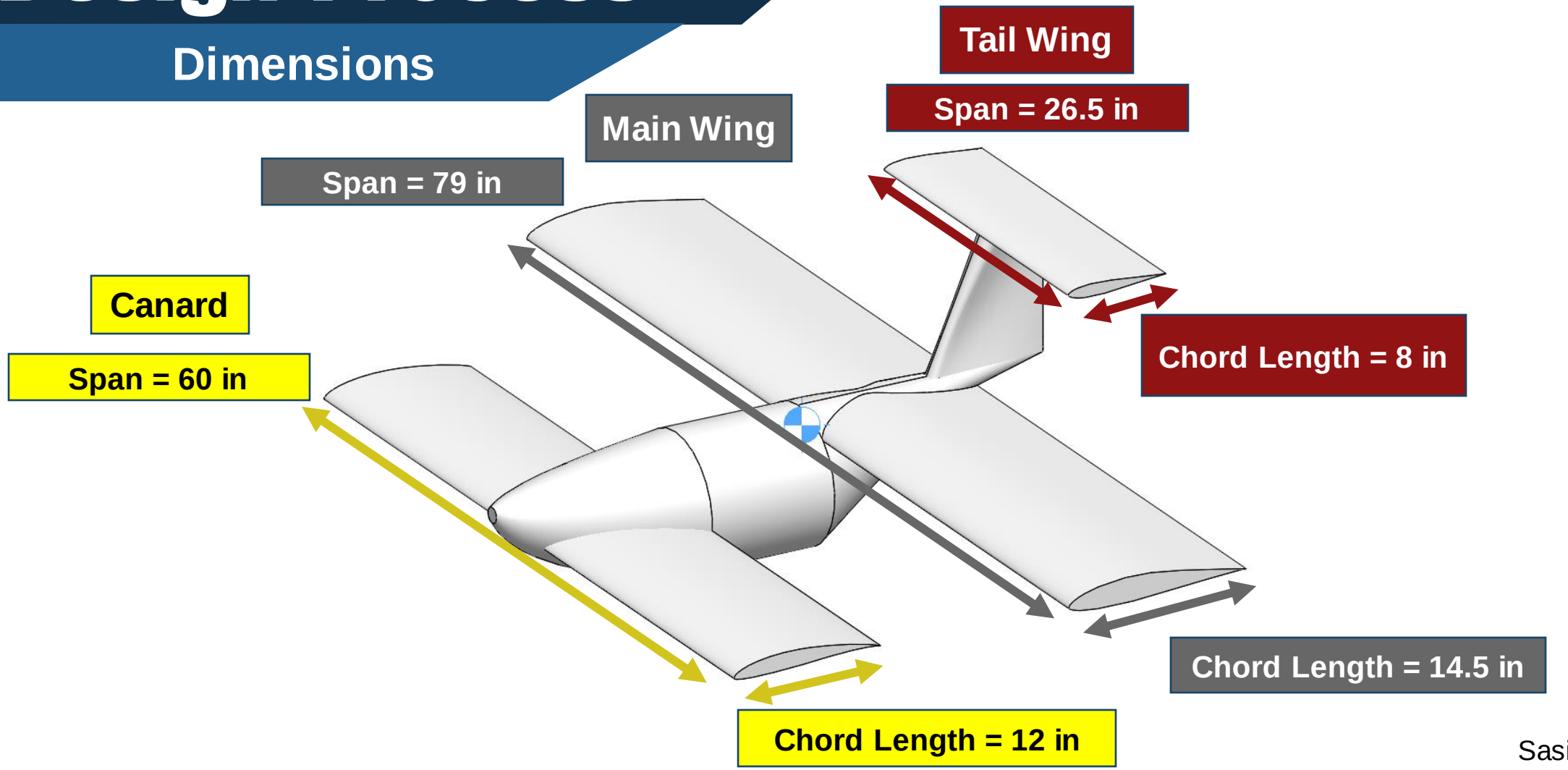
Dimensions



Sasindu Pinto

Design Process

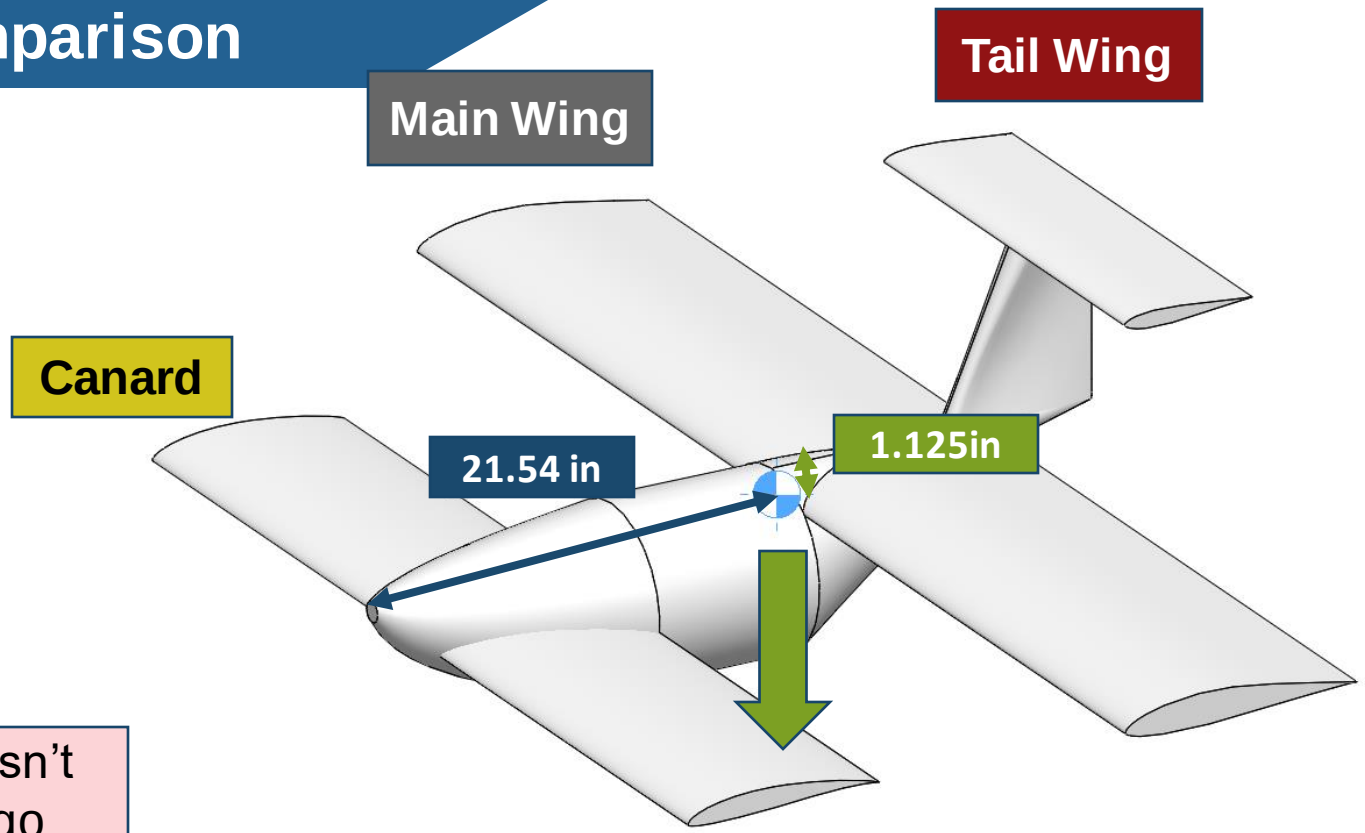
Dimensions



Sasindu Pinto

Design Process

Comparison



CG location doesn't change with cargo

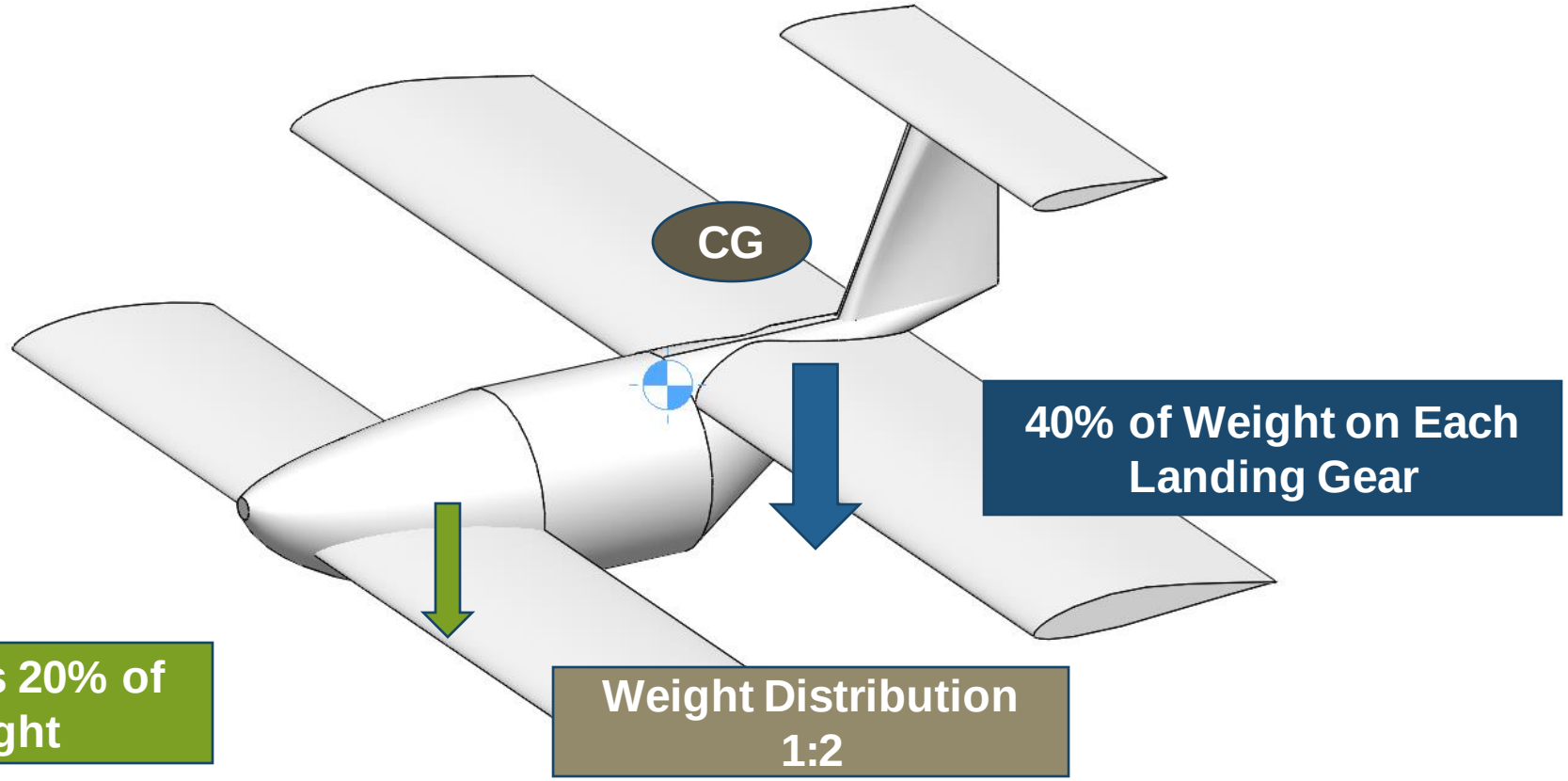
Weight Without Cargo ~ 12 lbs.

Weight With Cargo ~ 14 lbs.

Sasindu Pinto

Design Process

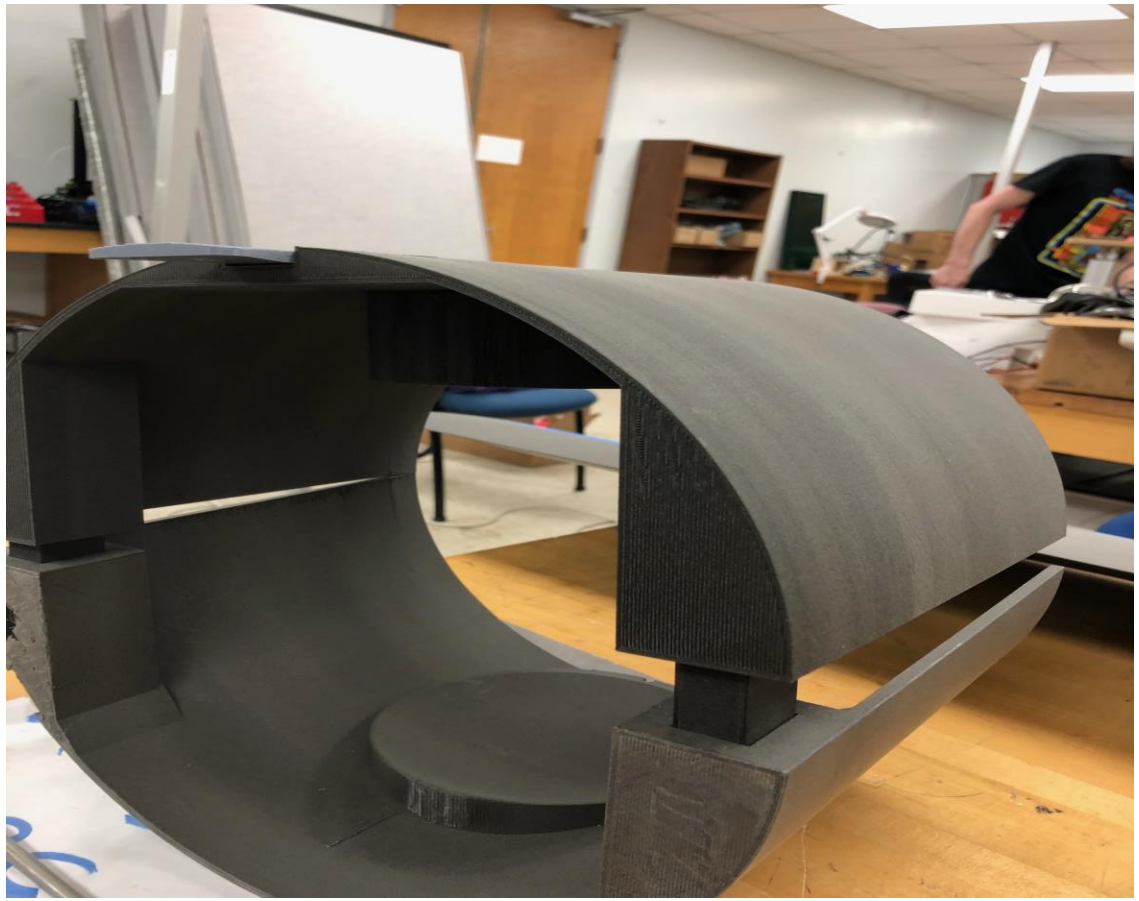
Landing Gear Weight Distribution



Sasindu Pinto

Design Process

Cargo Hatch



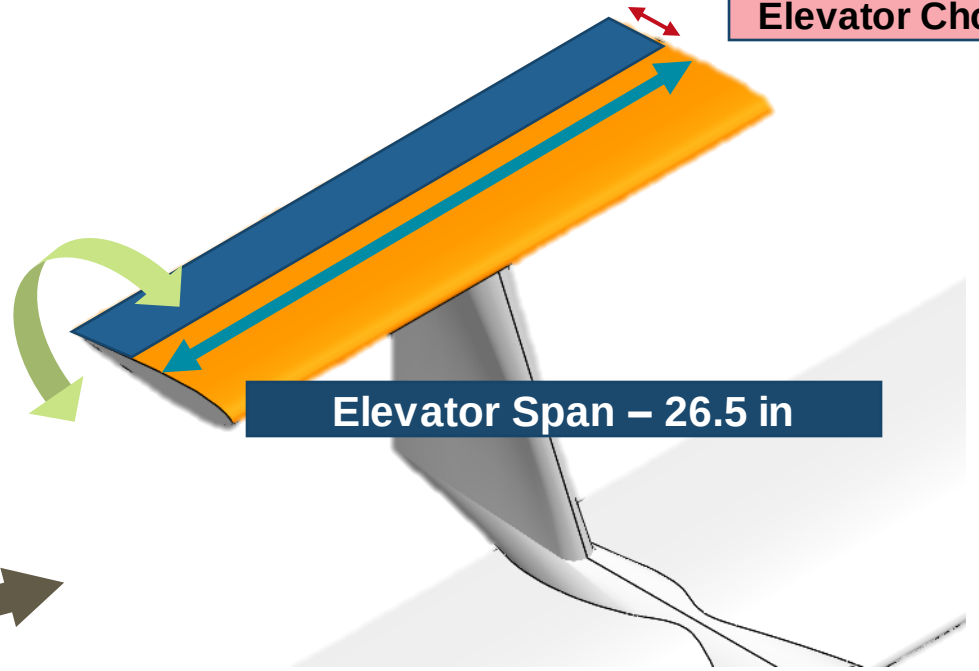
Noah Wright

Design Process

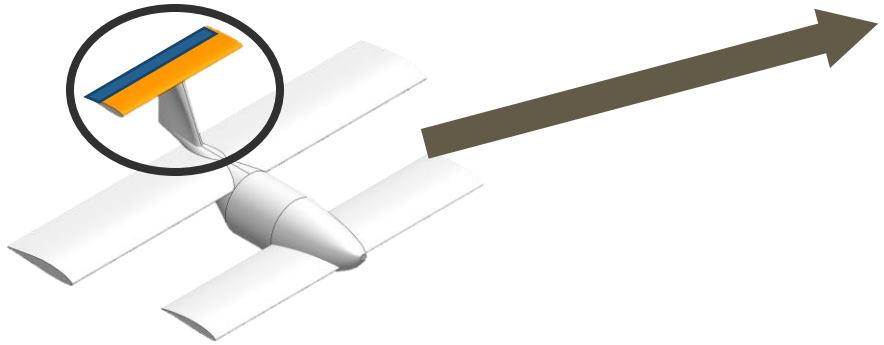
Pitch Stability

Elevator Chord Length – 3.2 in

Deflection angle – 30 deg



Elevator Span – 26.5 in

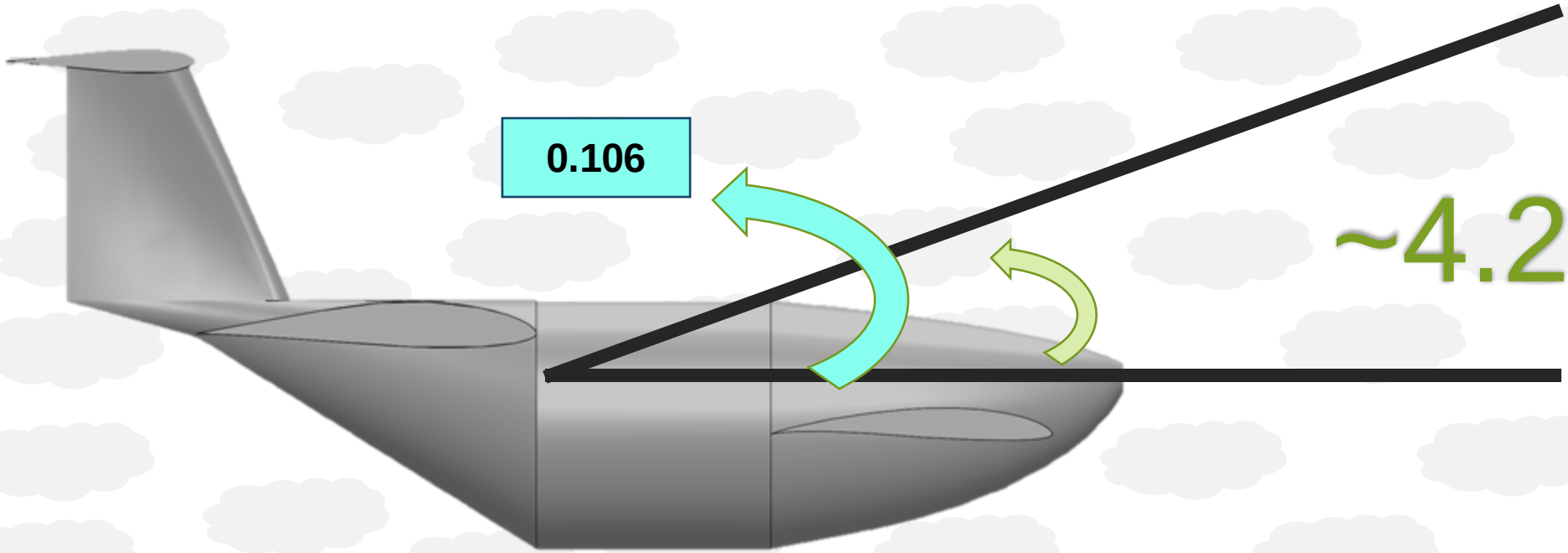


Sasindu Pinto

Design Process

Pitch Stability

Equilibrium Angle of Attack

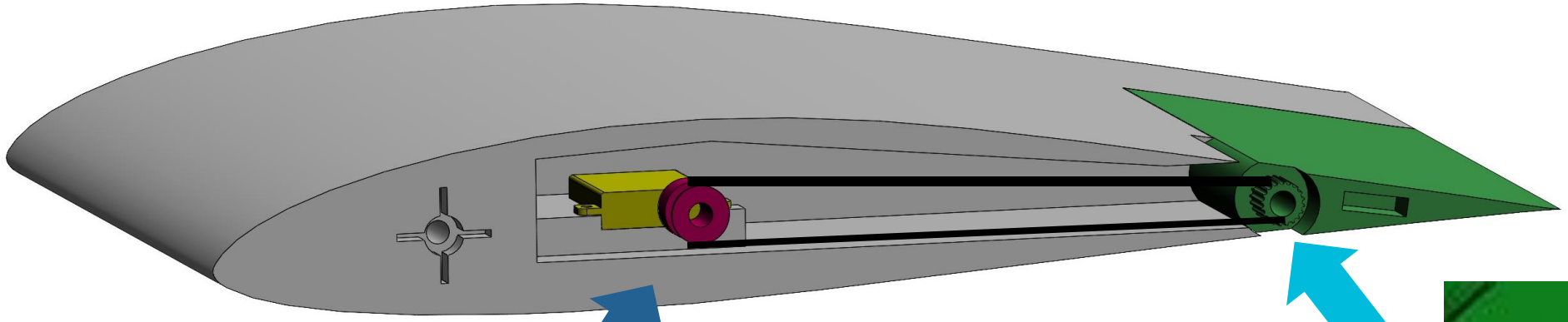


~4.25 deg

Sasindu Pinto

Design Process

Control Surface Motion



Belt

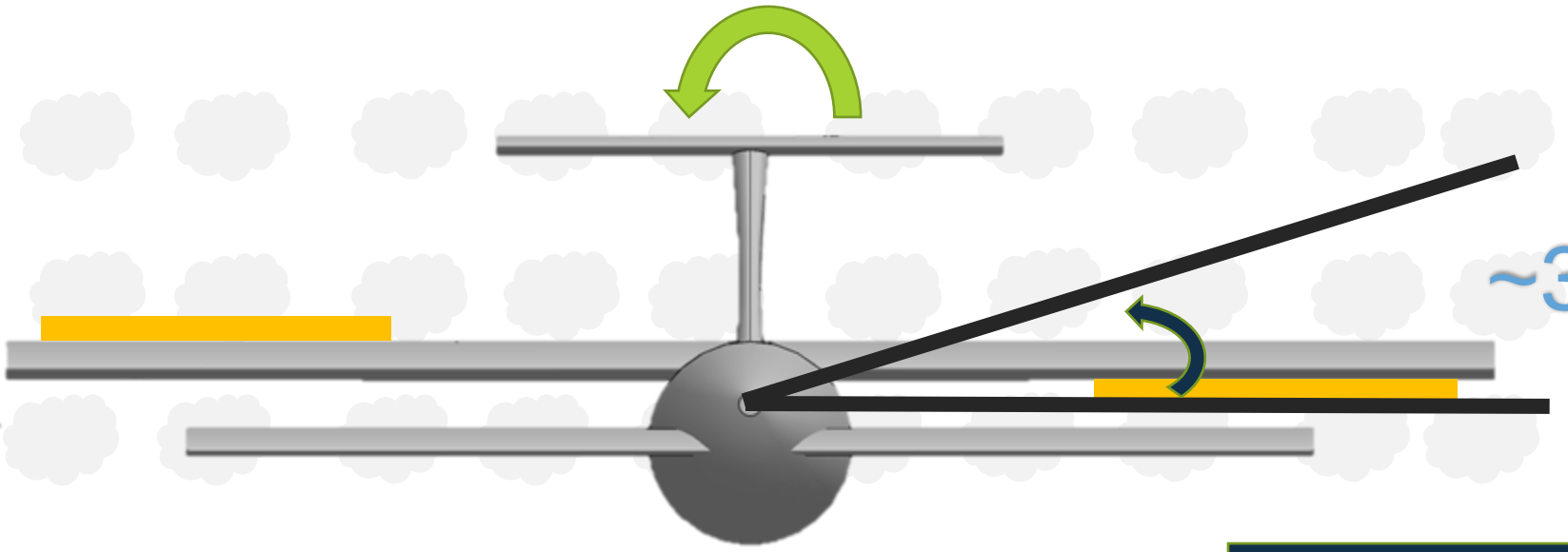
Control Surface Gears

Sasindu Pinto

Design Process

Roll Stability

Roll Rate: 4.75 deg/s



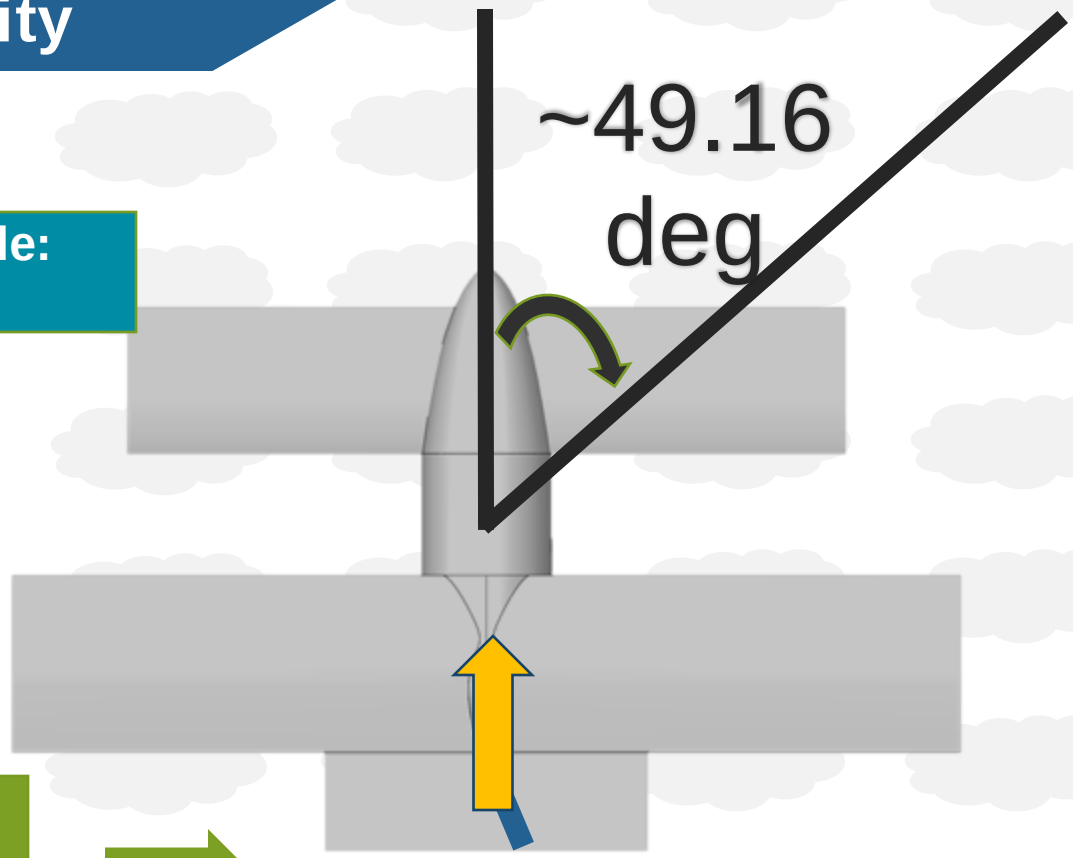
~38.7 deg

Stable Roll Angle

Sasindu Pinto

Design Process

Yaw Stability



Landing Angle: 49.16 deg

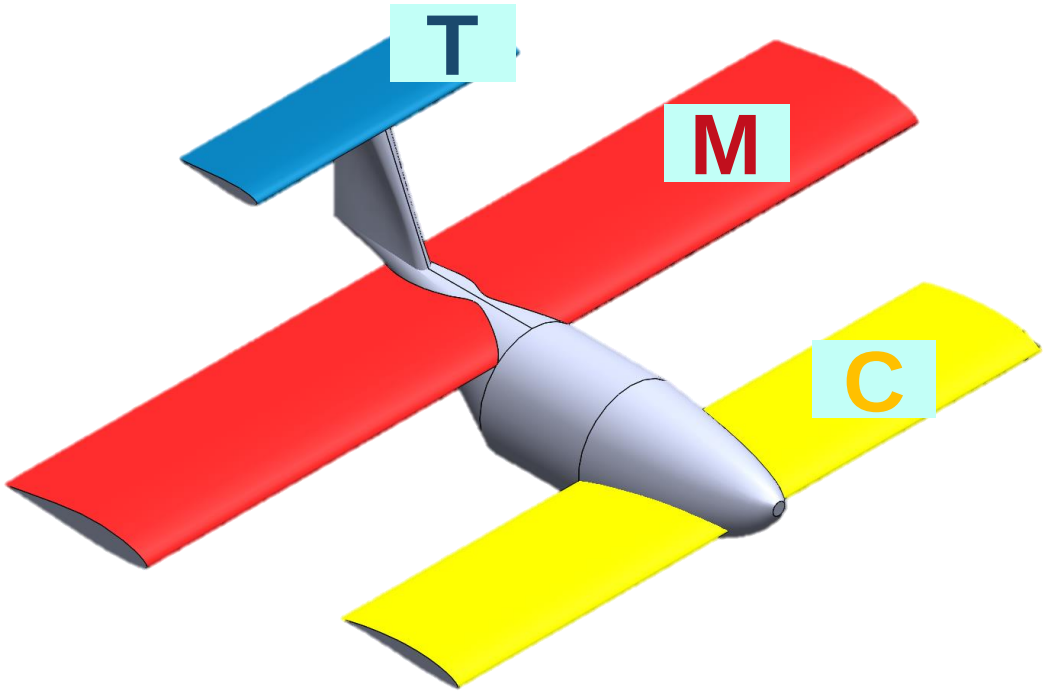
30 mph Cross Wind

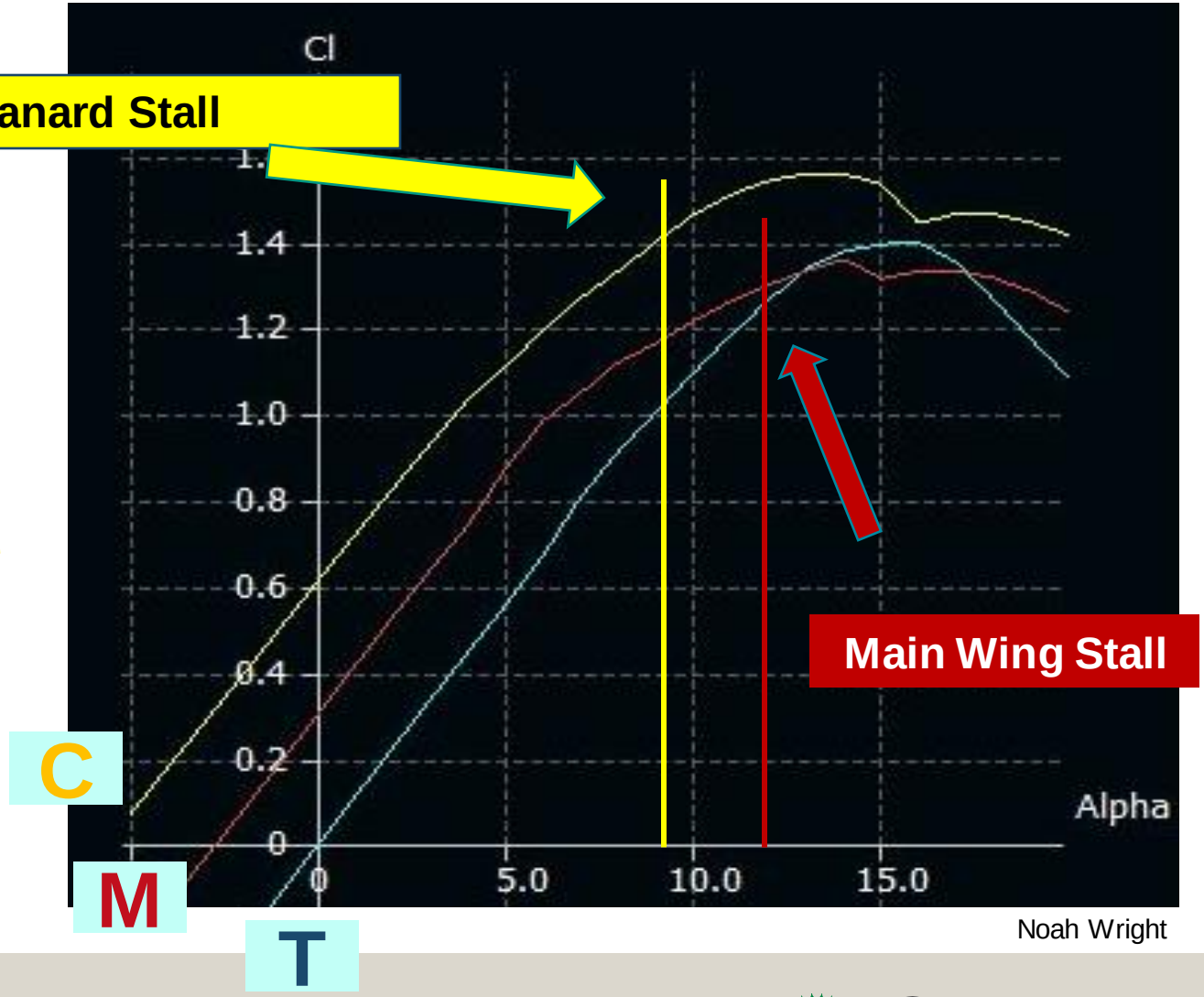
Rudder Deflection – 12.1 deg

Sasindu Pinto

Design Process

Xfoil Analysis

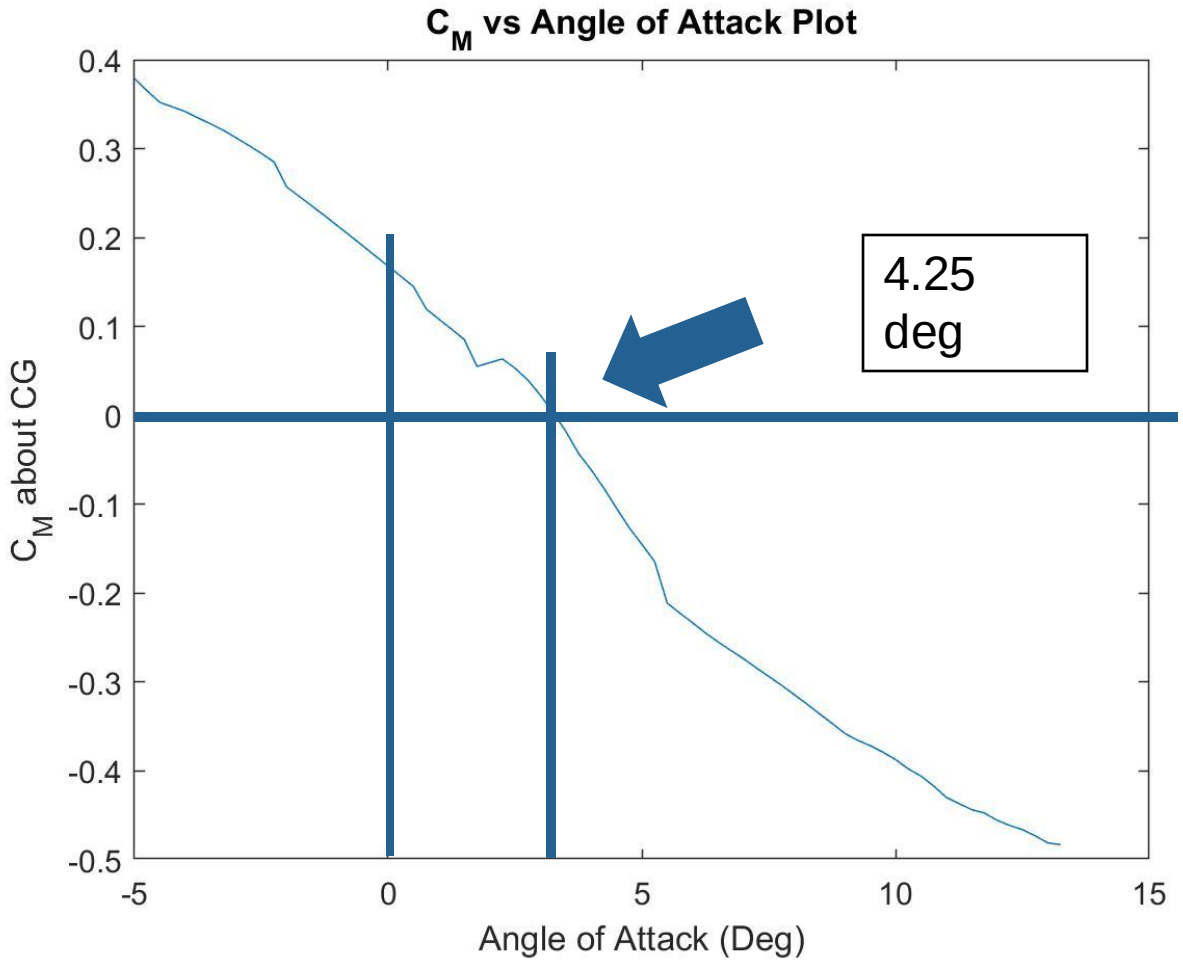




Noah Wright

Design Process

Stability Plot



Noah Wright

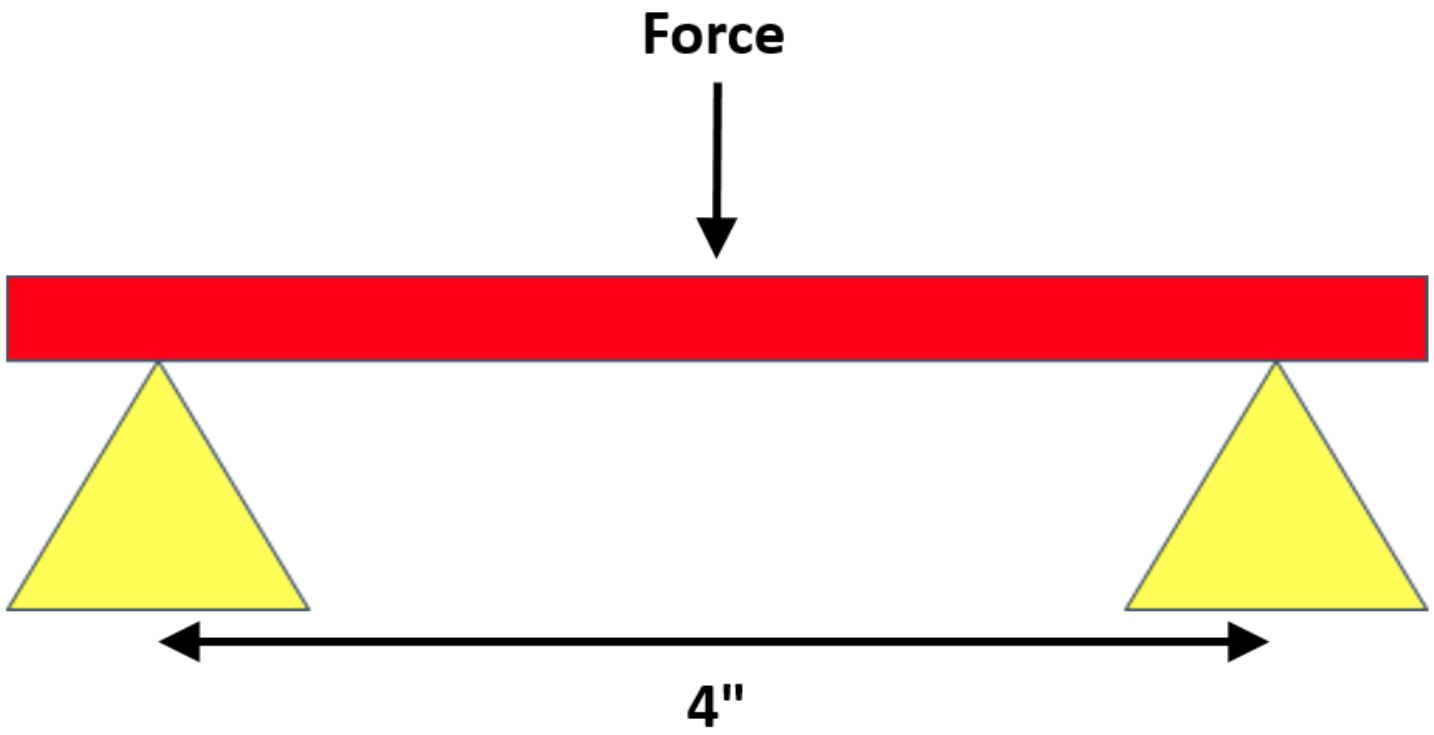
Material Selection

Material Selection

- House of Quality found weight to be the most important design factor
- Two possible filaments could be used within project budget and competition materials rules
  - PLA
  - LW – PLA
- Torsion and bending tests done to compare strengths

Jacob Pifer

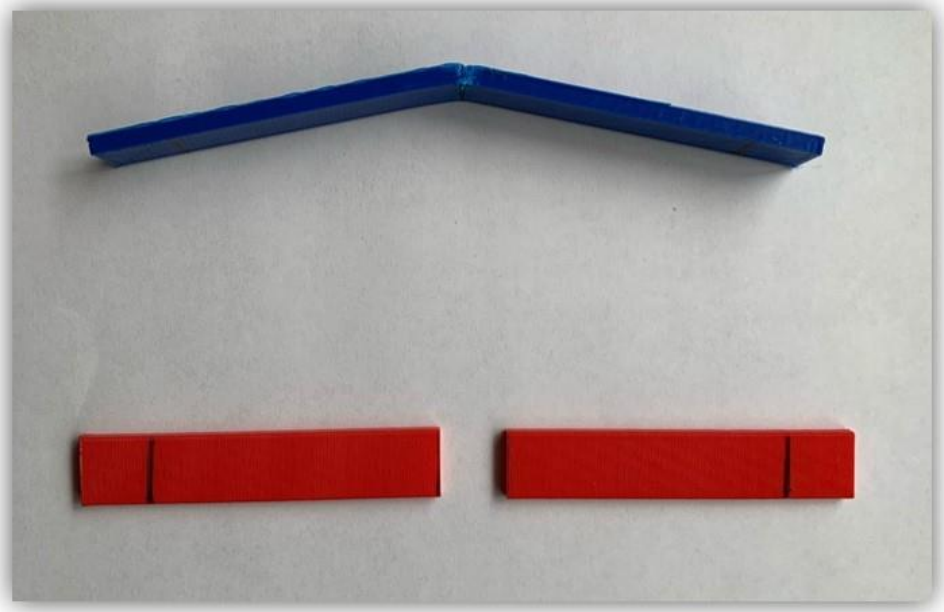
Three-Point Bending Test



Jacob Pifer

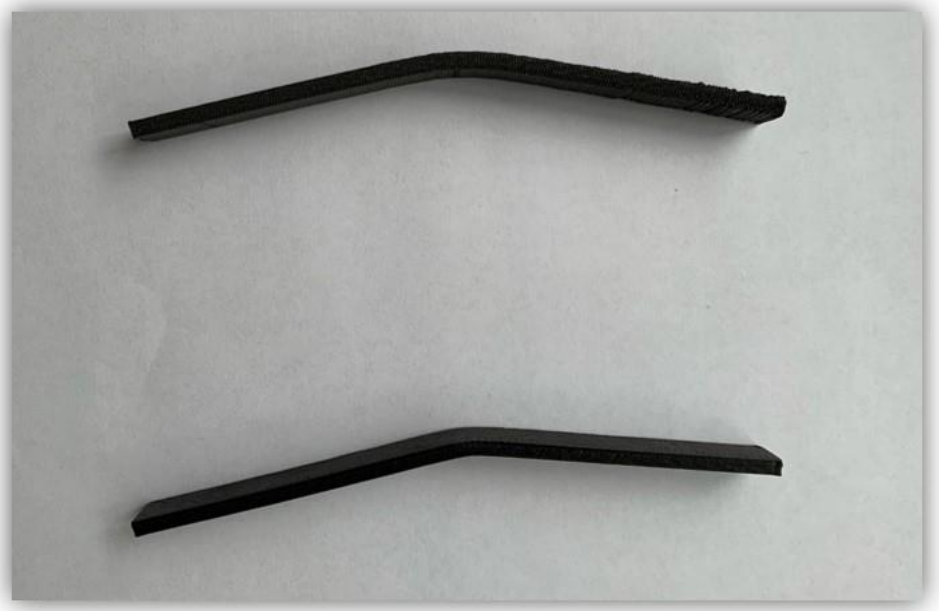
Three-Point Bending Test

PLA



Stress parallel to printing direction: 8,350 psi
Stress perpendicular to printing direction: 3,360 psi

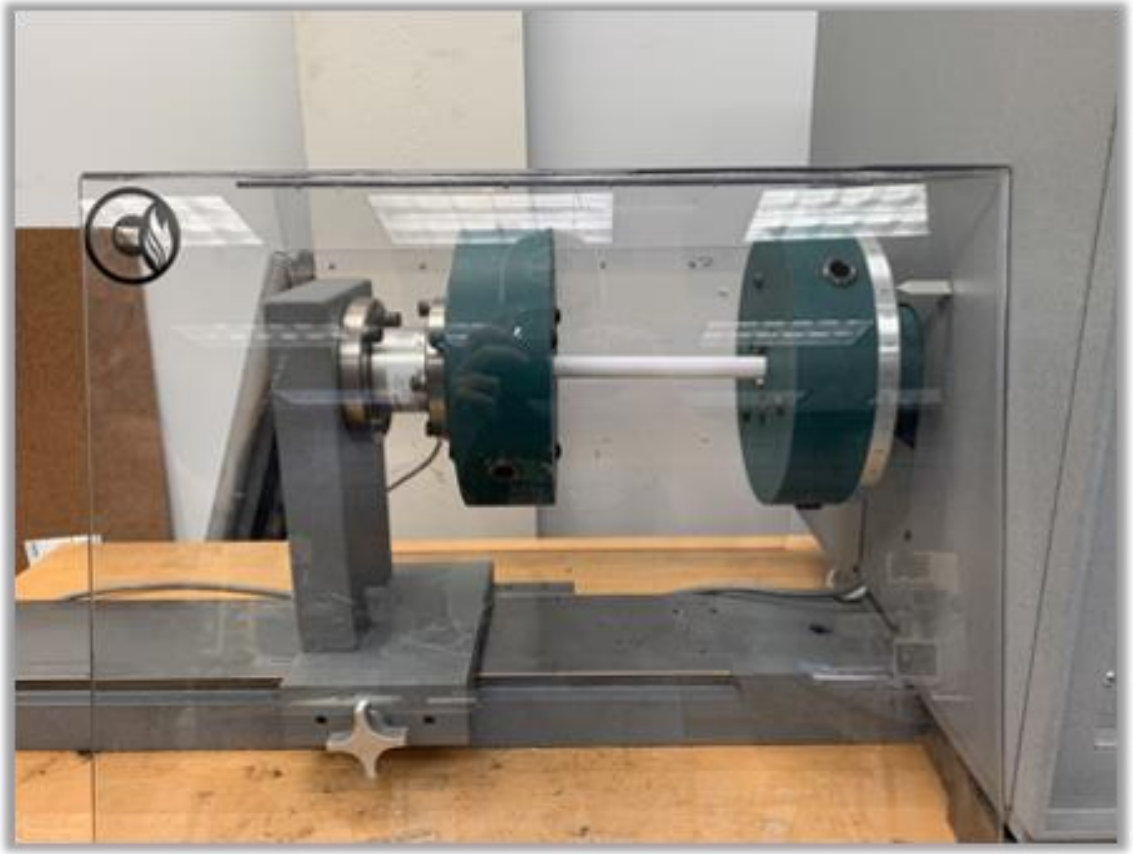
LW-PLA



Stress parallel to printing direction: 6,120 psi
Stress perpendicular to printing direction: 3,380 psi

Jacob Pifer

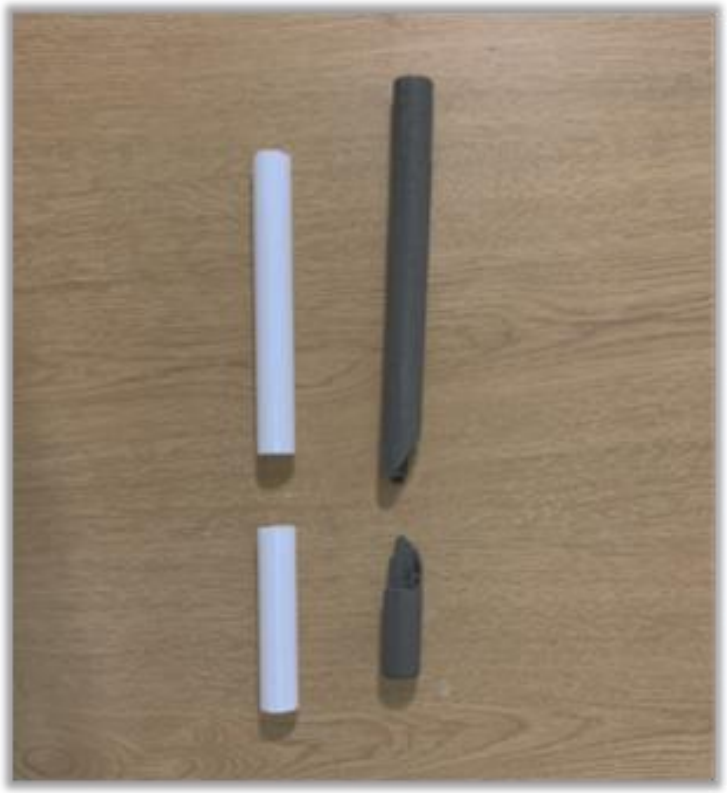
Torsion Test

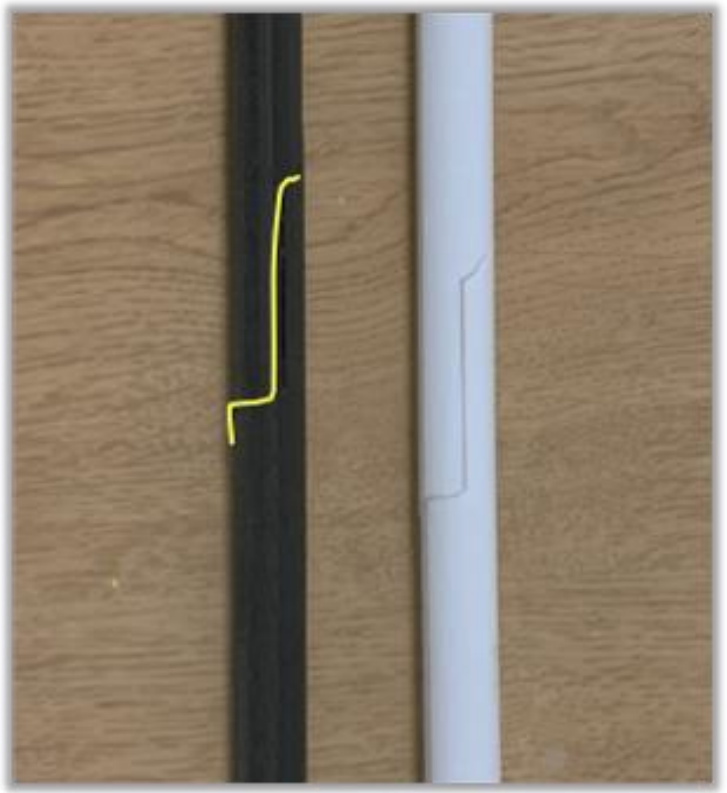


- Tinius – Olsen Machine used to collect data
- Same types of samples used

Jacob Pifer

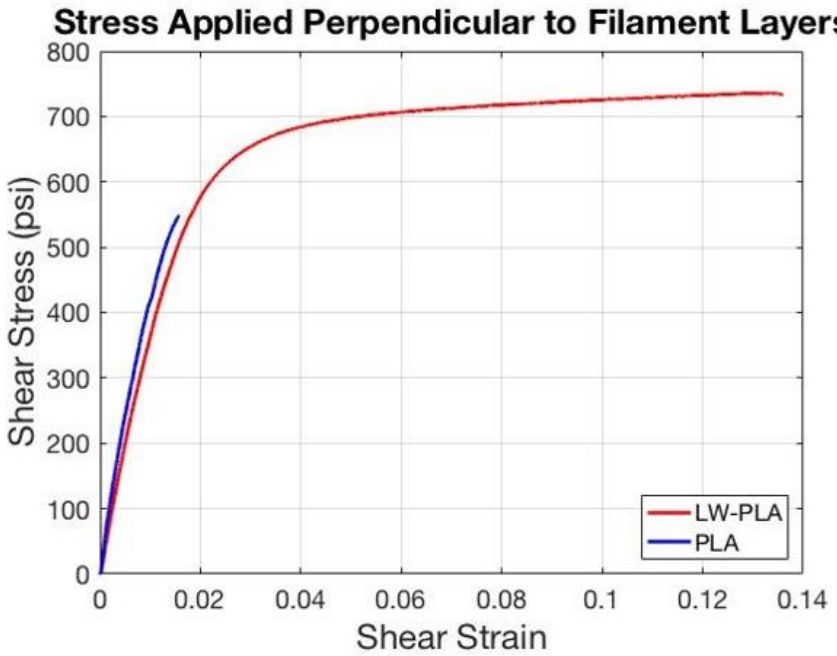
Torsion Test





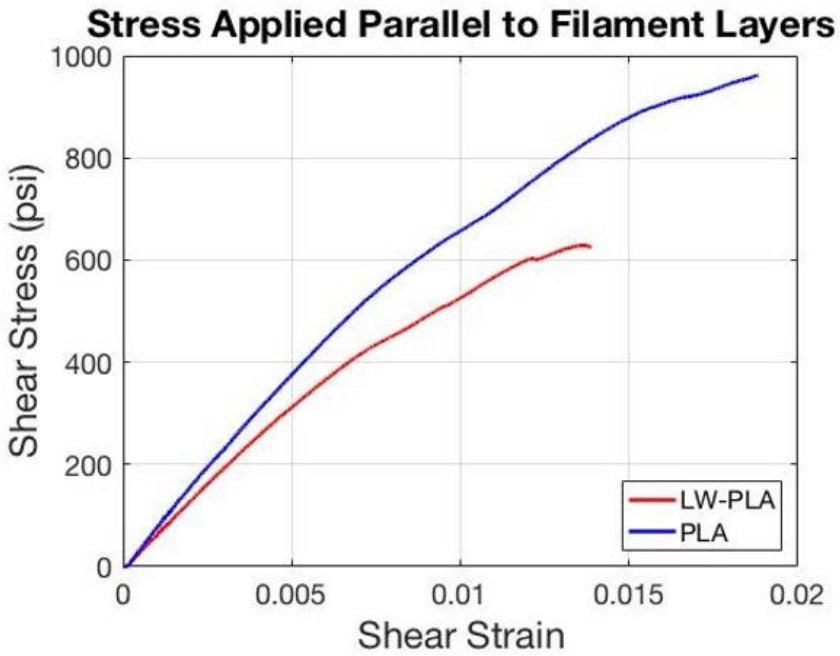
Jacob Pifer

Torsion Test



PLA failure stress: 412 psi

LW-PLA failure stress: 552 psi



PLA failure stress: 721 psi

LW-PLA failure stress: 471 psi

Jacob Pifer

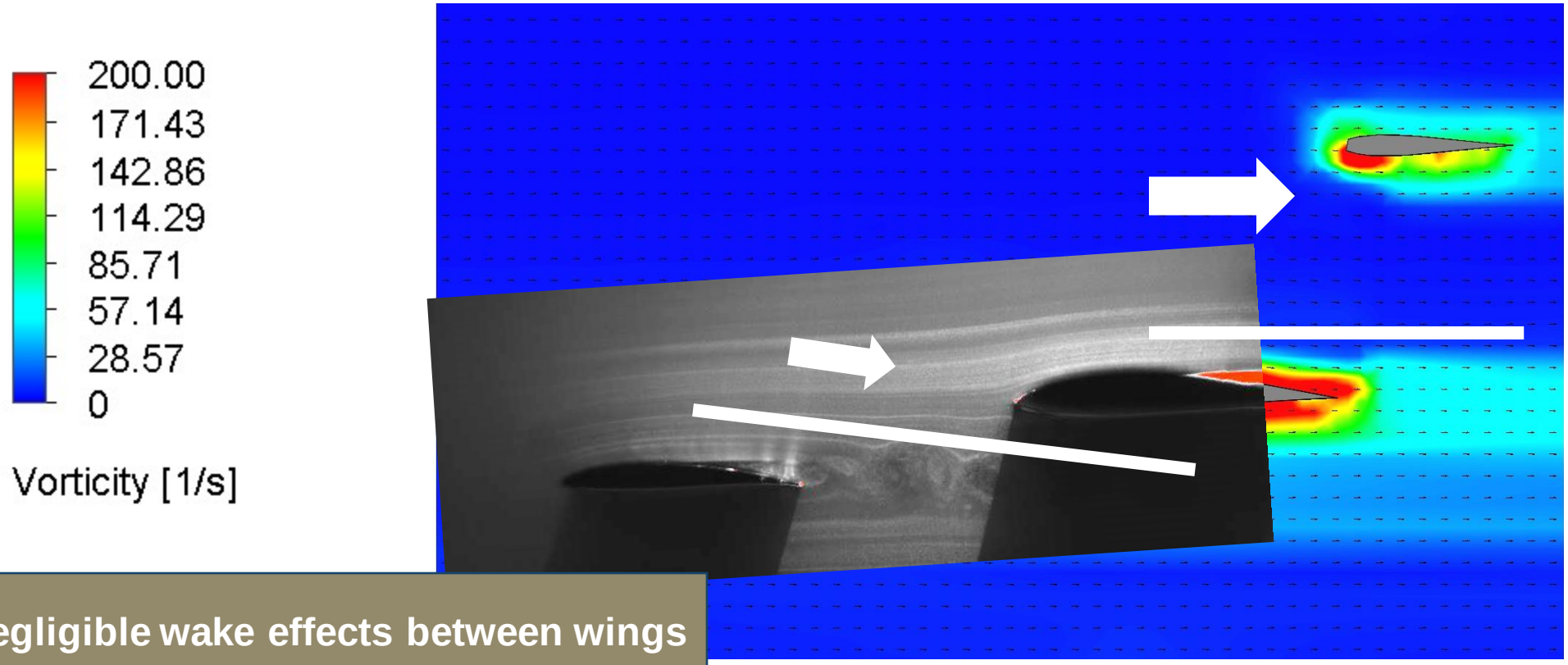
Validation and Electronics

Validation and Electronics

Air Flow – 0 deg AoA

CFD

Wind Tunnel Test



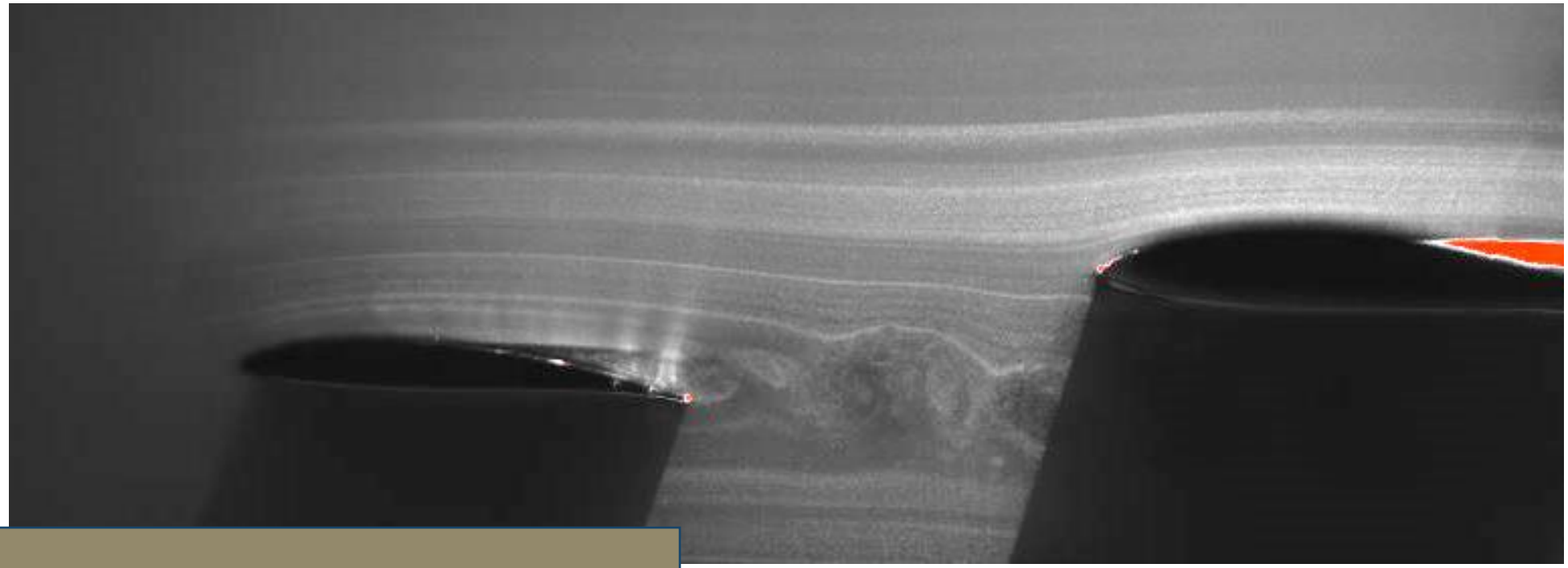
Negligible wake effects between wings

Noah Wright

Validation and Electronics

Air Flow – 0 deg AoA

Wind Tunnel Test



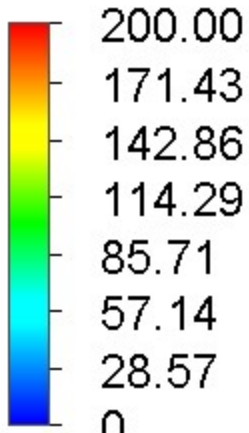
Negligible wake effects between wings

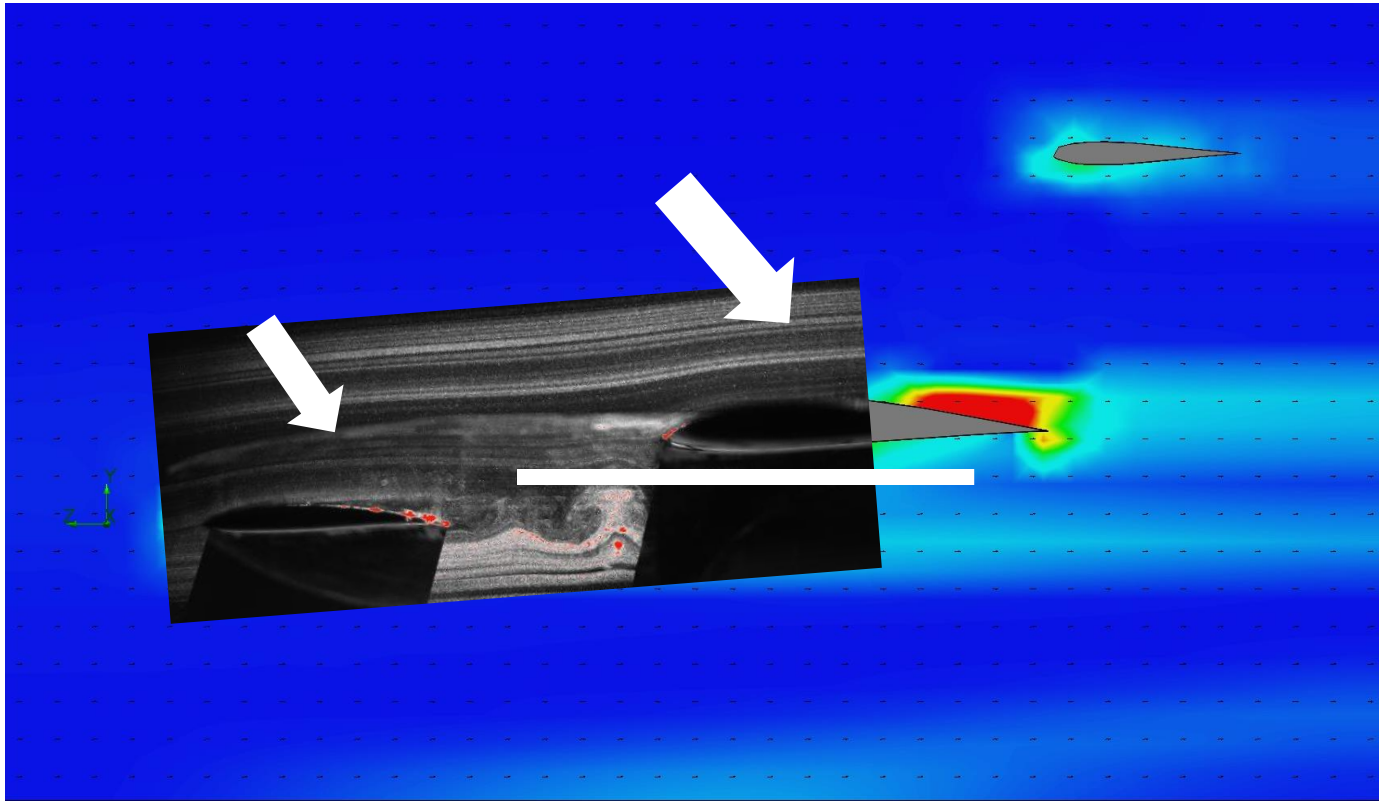
Noah Wright

Validation and Electronics

Air Flow– 5 deg AoA

CFD **Wind Tunnel Test**





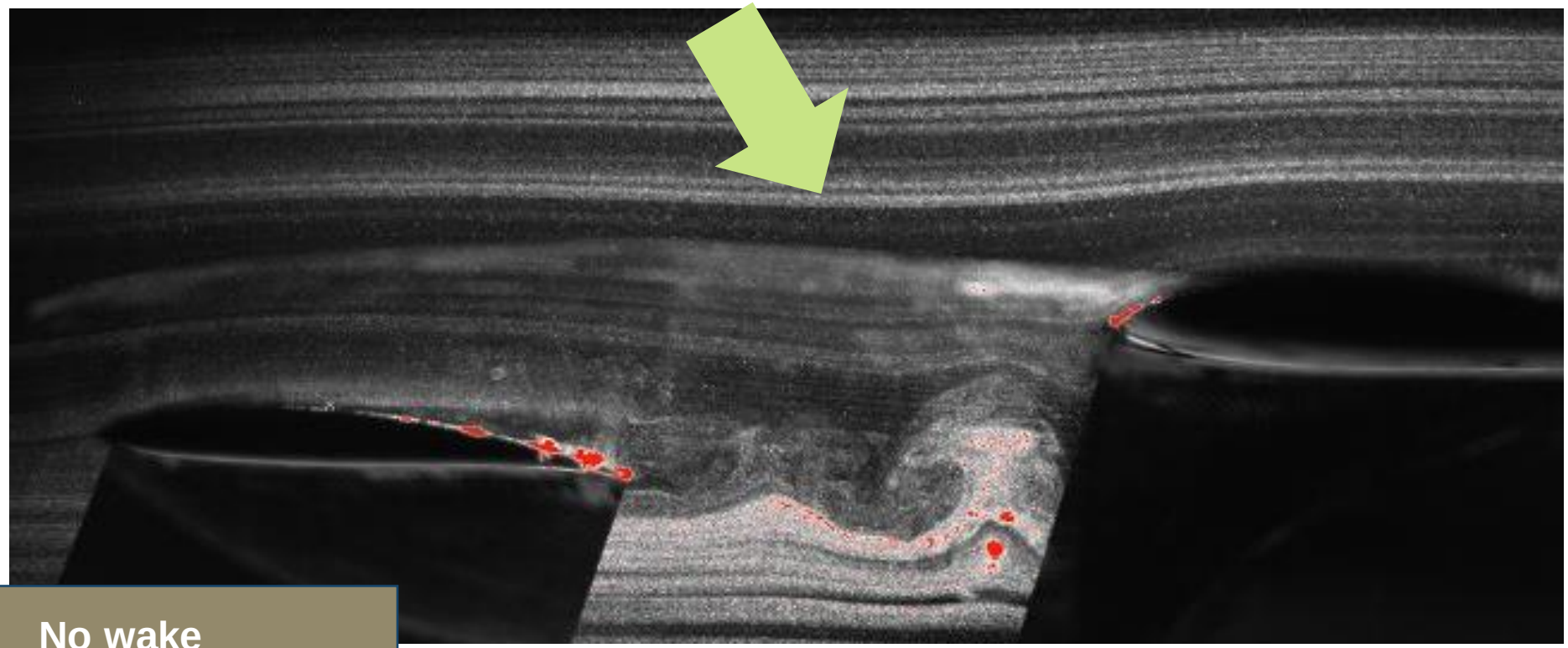
Flow Attached & No Wake

Noah Wright

Validation and Electronics

Air Flow– 5 deg AoA

Wind Tunnel Test



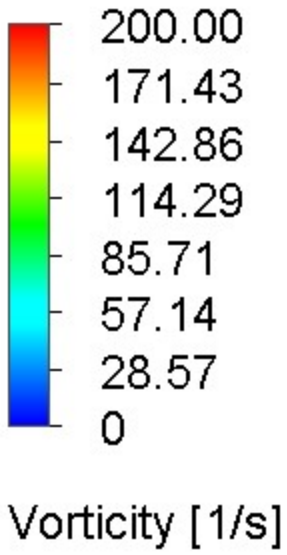
No wake

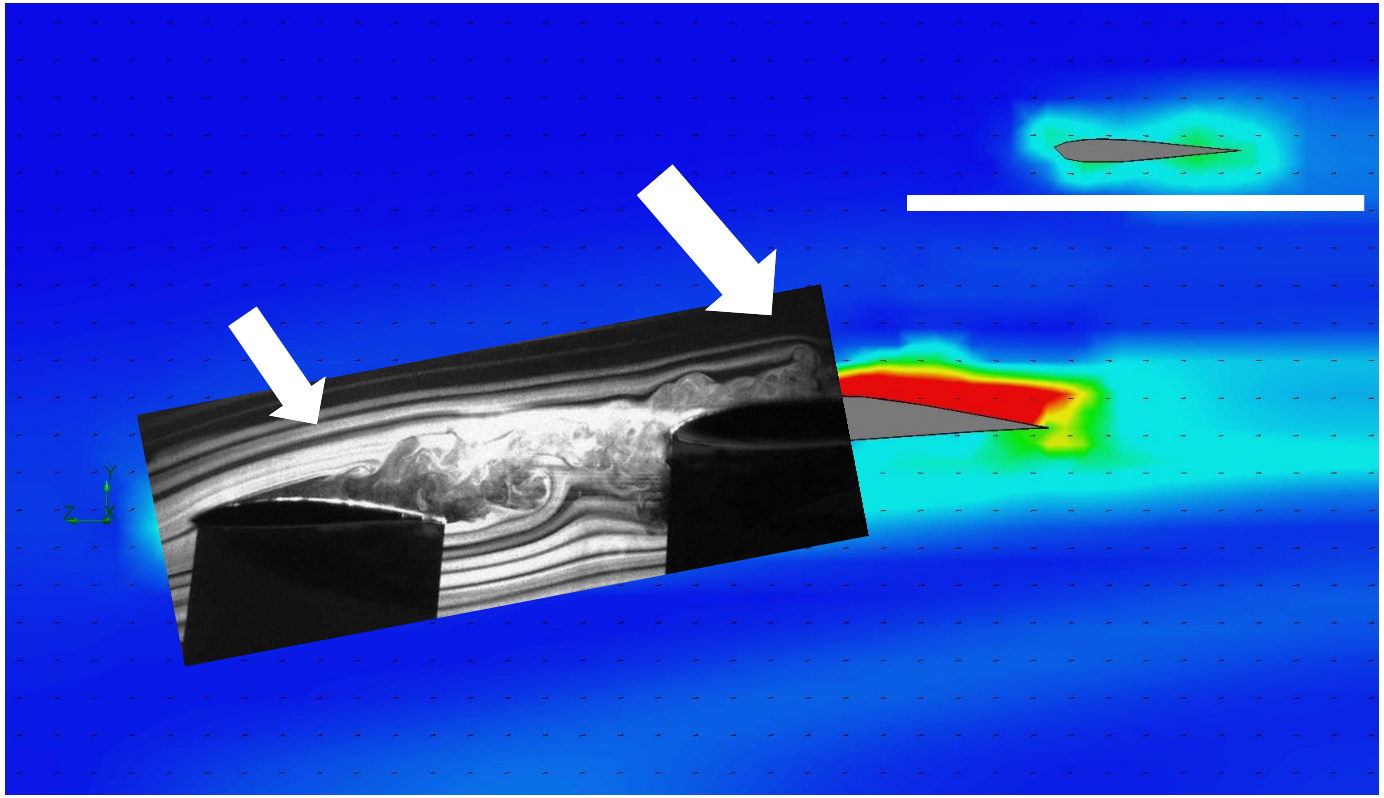
Noah Wright

Validation and Electronics

Air Flow – 12 deg AoA

CFD **Wind Tunnel Test**





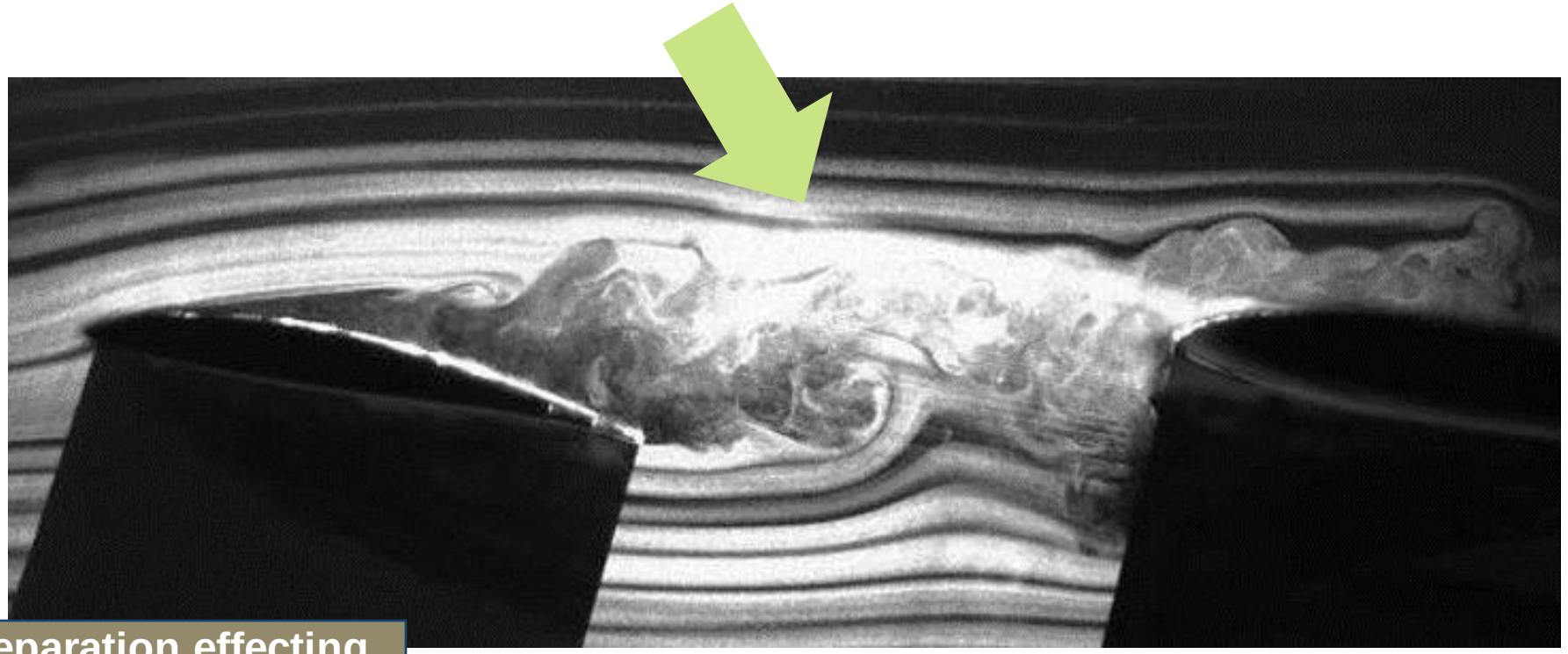
Flow not attached to the wings - Stall

Noah Wright

Validation and Electronics

Air Flow – 12 deg AoA

Wind Tunnel Test



Flow separation effecting the main wing

Noah Wright

Validation and Electronics

Controller Setup

Throttle (up/down)
Yaw (left/right)

Thrust-cut Button

Pitch (up/down)
Roll (left/right)

Programming the transmitter settings to favor our plane

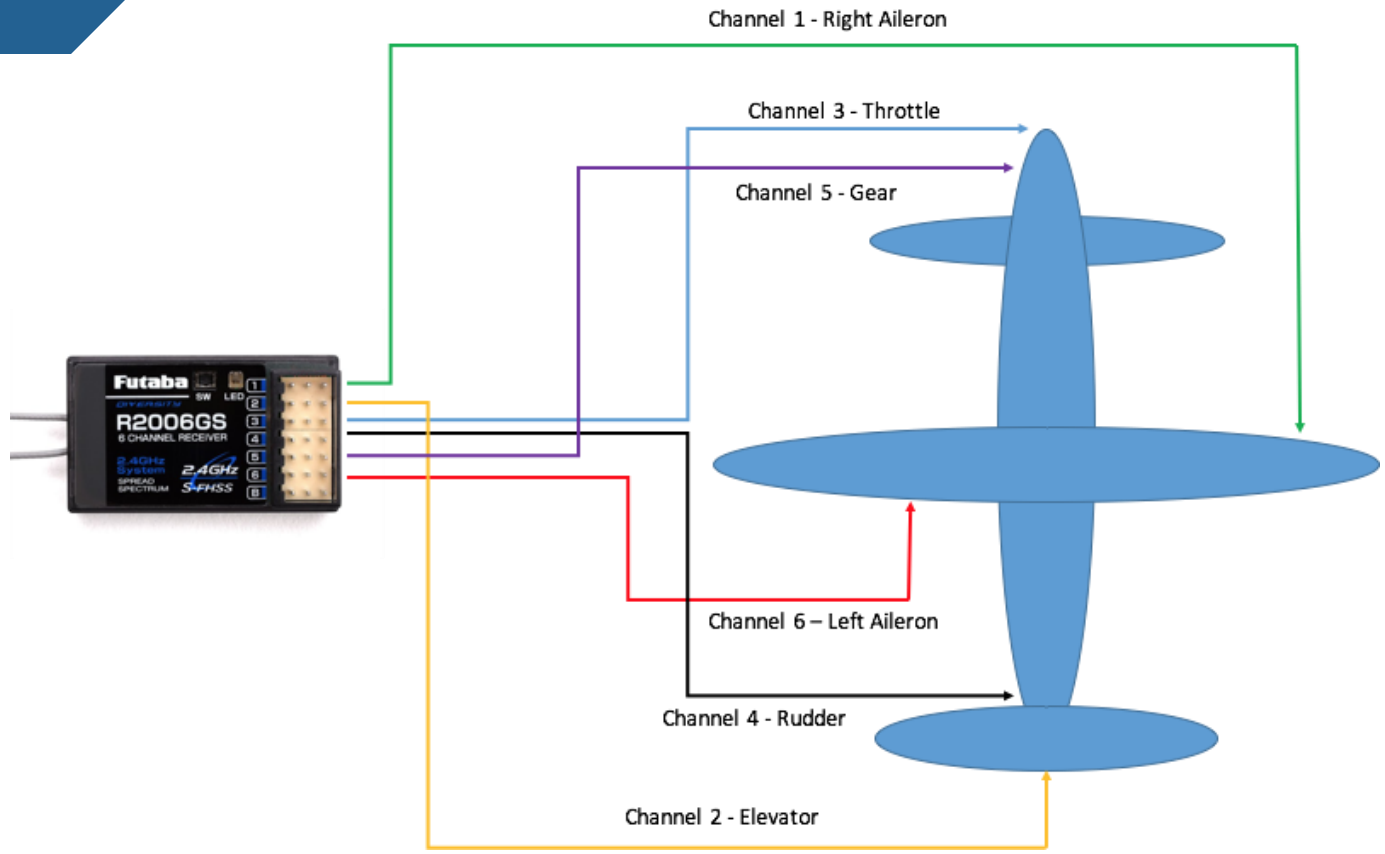
Cameron Riley

Validation and Electronics

Wiring

Method of splicing wires

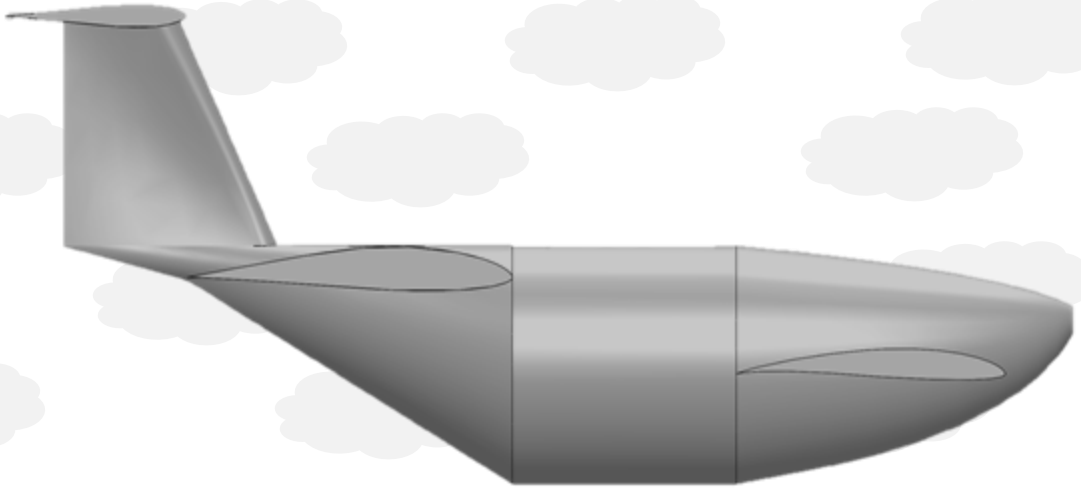
Servo Extension Wires



Cameron Riley

Summary

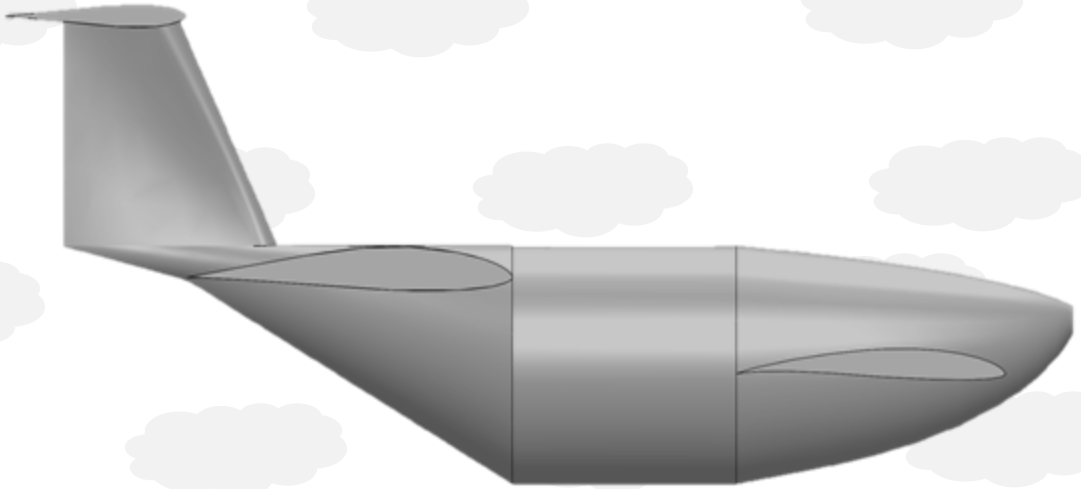
- A Canard Design is possible
  - Tail wing needed for this layout
- Cargo bay between 2 major wings makes the plane stable
- Battery and cargo plate locations are adjustable to alter CG position
- Gear/belt mechanism used to operate control surfaces



Cameron Riley

Summary

- LW-PLA & PLA used in making the plane
- Landing gear set up meets the weight distribution guidelines
- We are working to do a test flight with the Seminole RC Club



Jacob Pifer

LinkedIn Information

Sasindu Pinto

Cameron Riley

Michenell Louis-Charles

Noah Wright

Adrian Moya

Jacob Pifer

Lauren Chin

Joseph Figari

Backup Slides

References

Aircraft Design: A Systems Engineering Approach. M.H. Sadraey. 2013. 1st Edition. John Wiley Publications.

Basics of RC Model Aircraft Design: Practical Techniques for building better models. A. Lennon. 1999. Air Age Inc.

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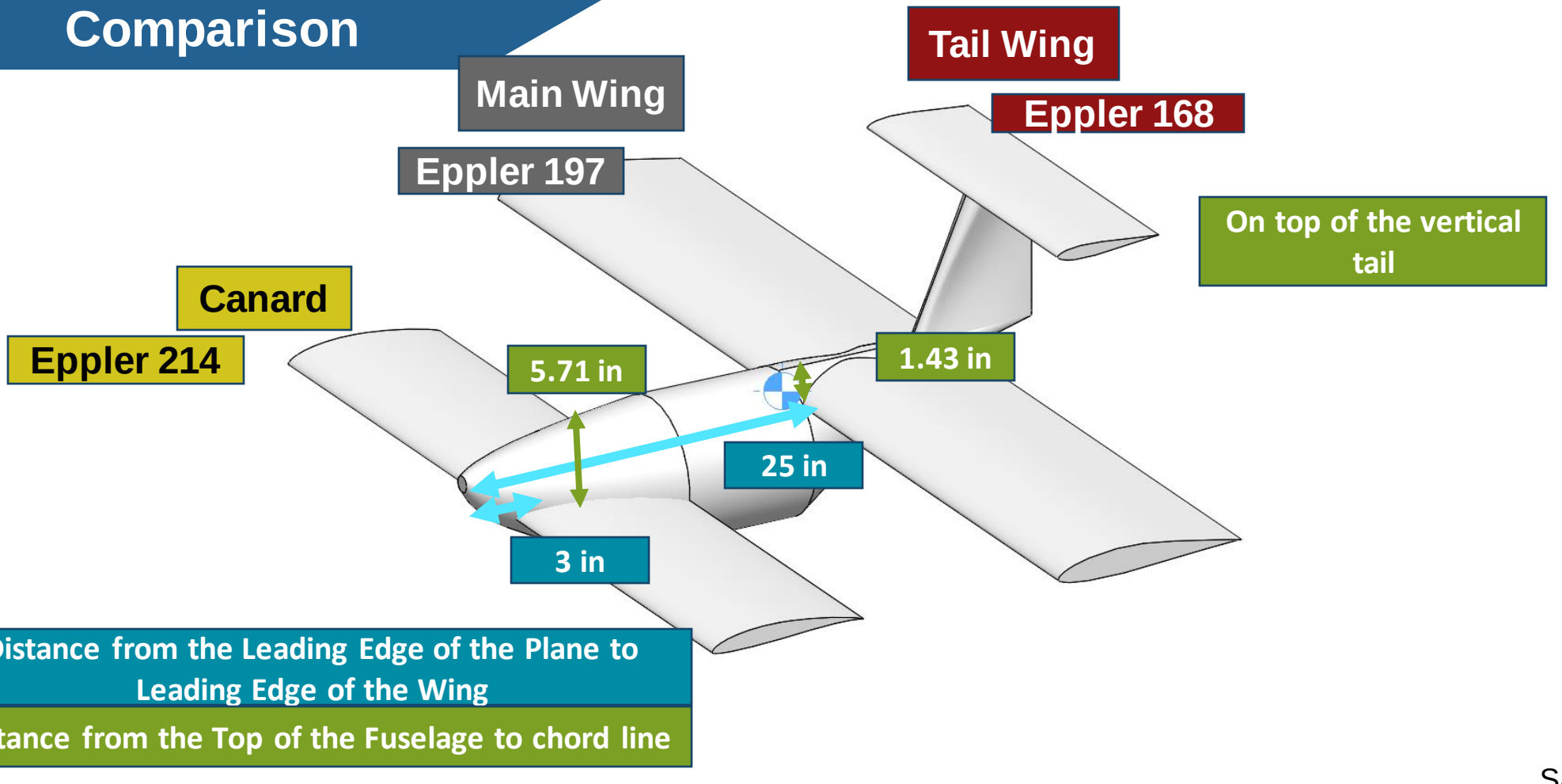
Tail Types. What-When-How. N.d. http://what-when-how.com/flight/tail-designs/

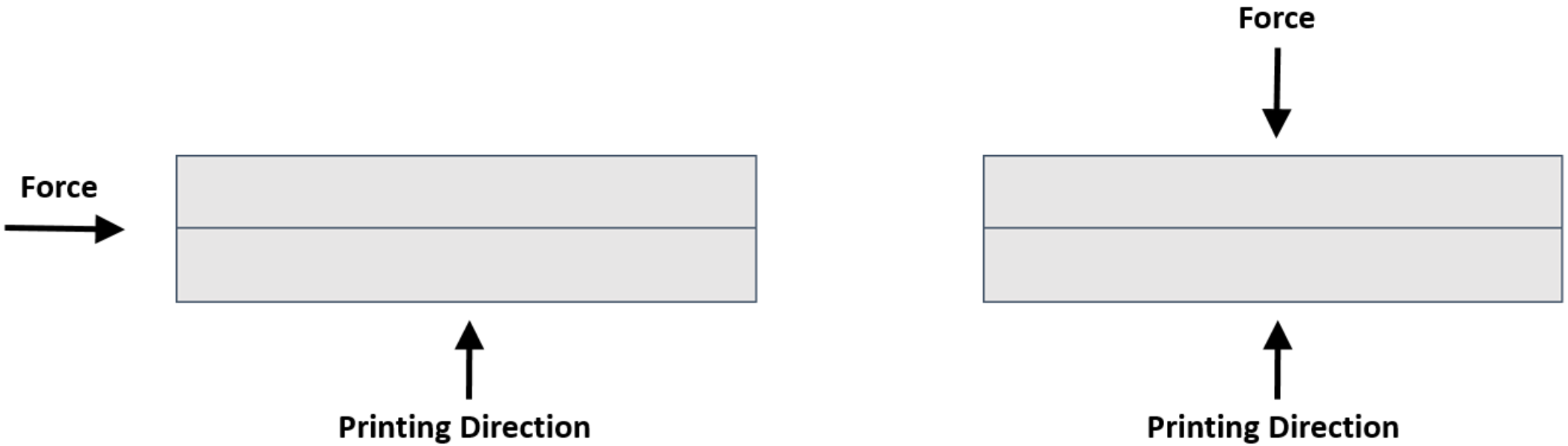
Redesigned Plane Analysis

Comparison



Sasindu Pinto

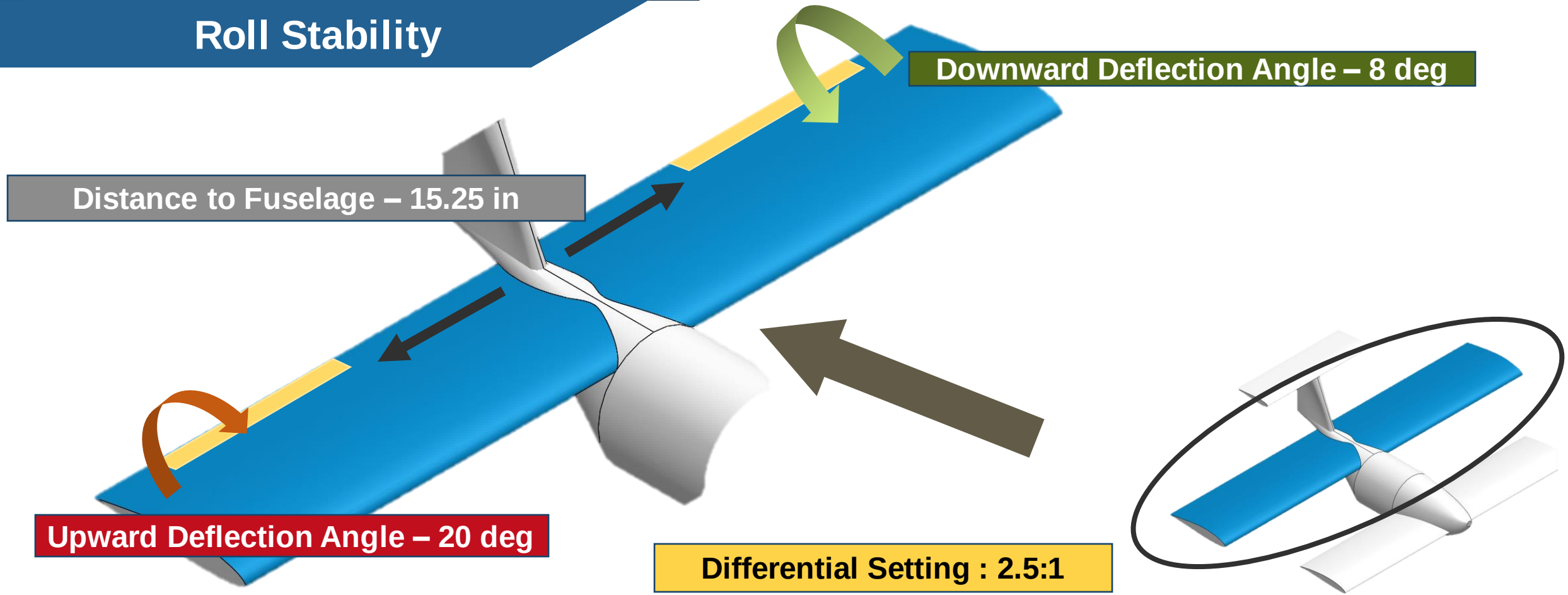
Stress & Printing Direction



Jacob Pifer

Design Process

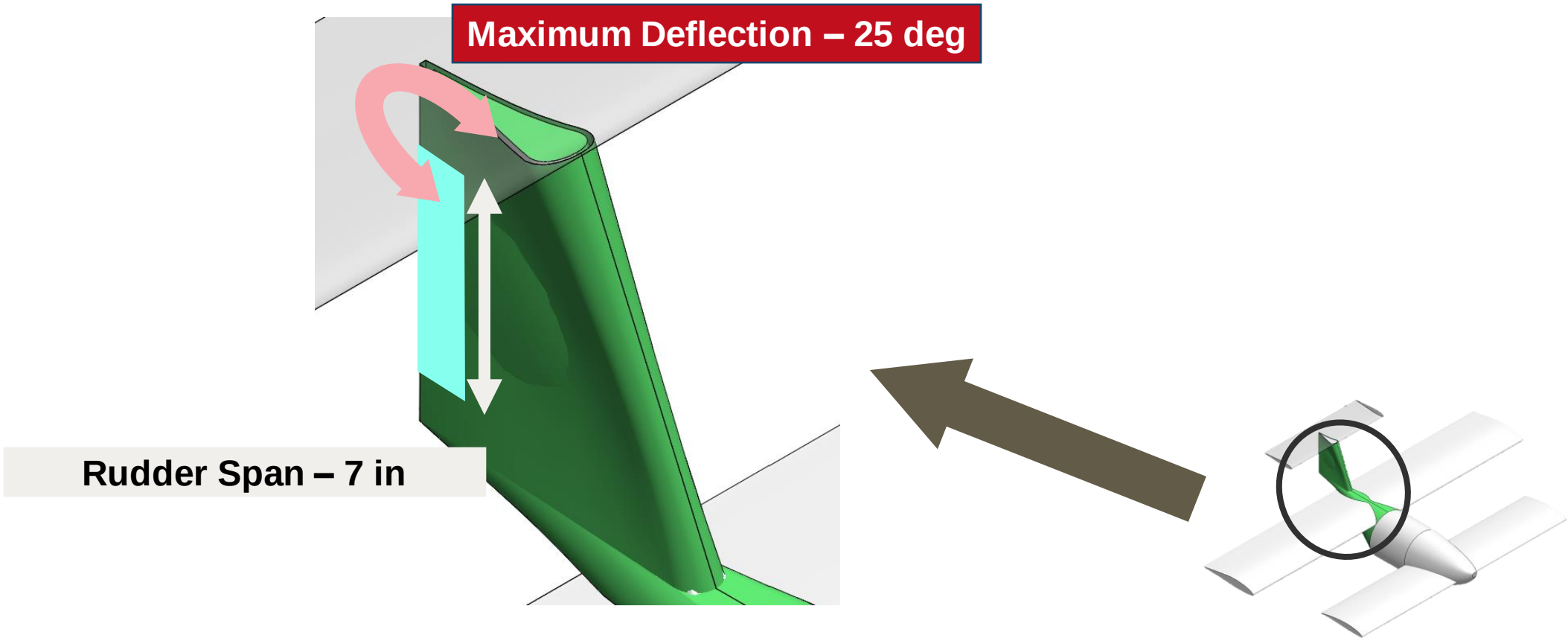
Roll Stability



Sasindu Pinto

Design Process

Yaw Stability



Sasindu Pinto

Validation and Electronics

Wind Tunnel Test – Smoke Test

Michenell Louis-Charles

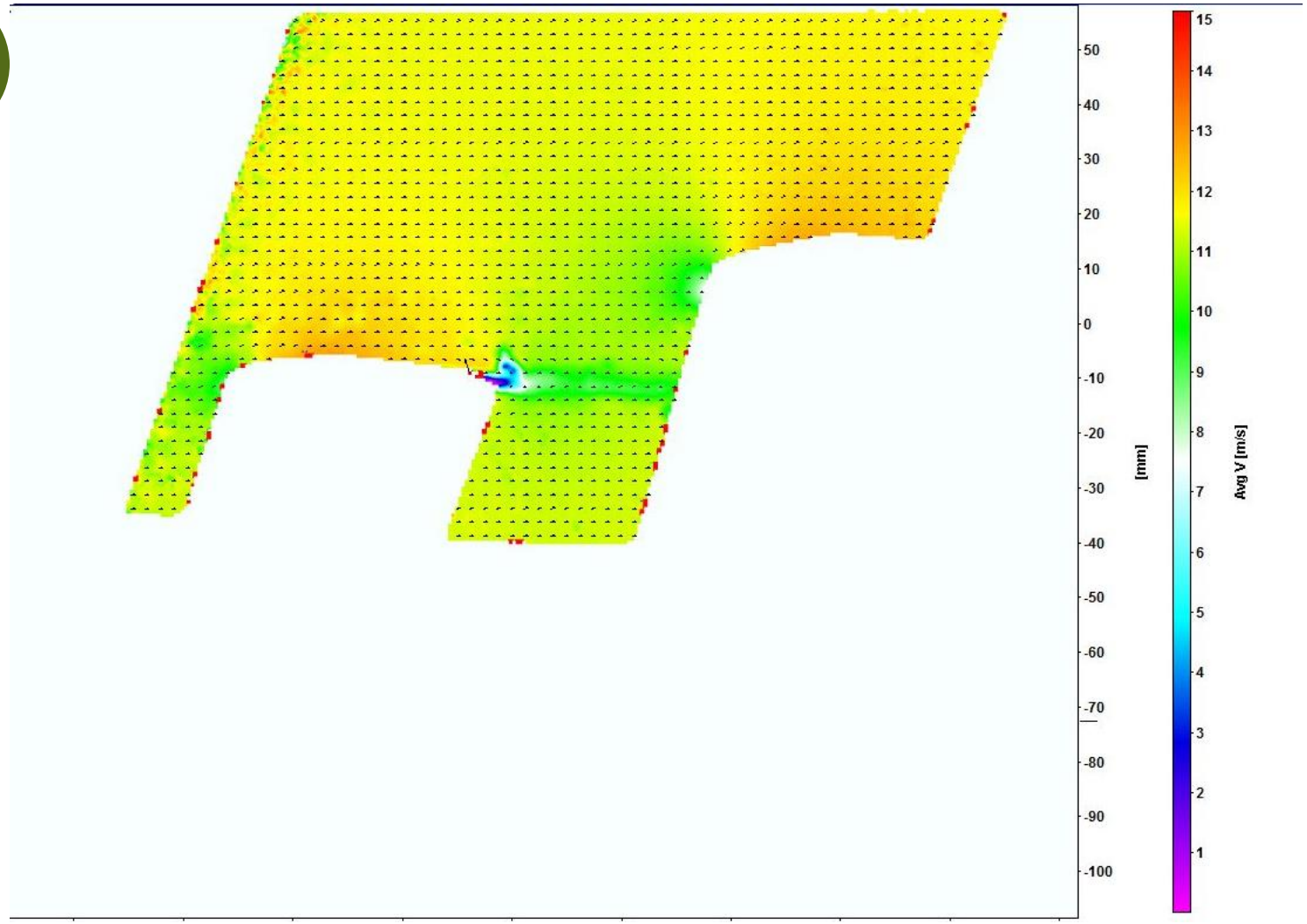
PIV Analysis

Wind Tunnel Test – PIV Test Video

Photosensitive Video

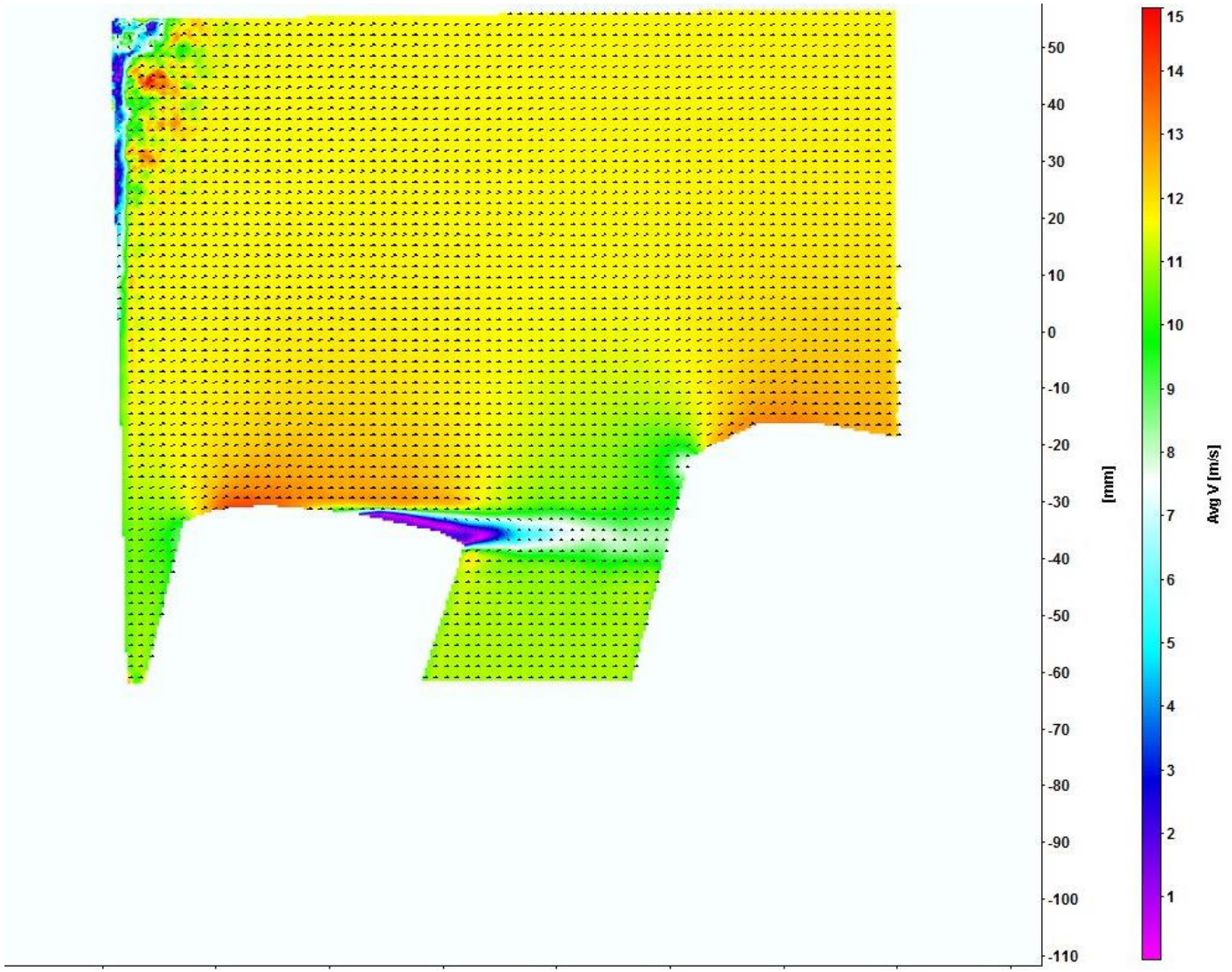
PIV Test

Wind Tunnel Test – PIV 0 deg



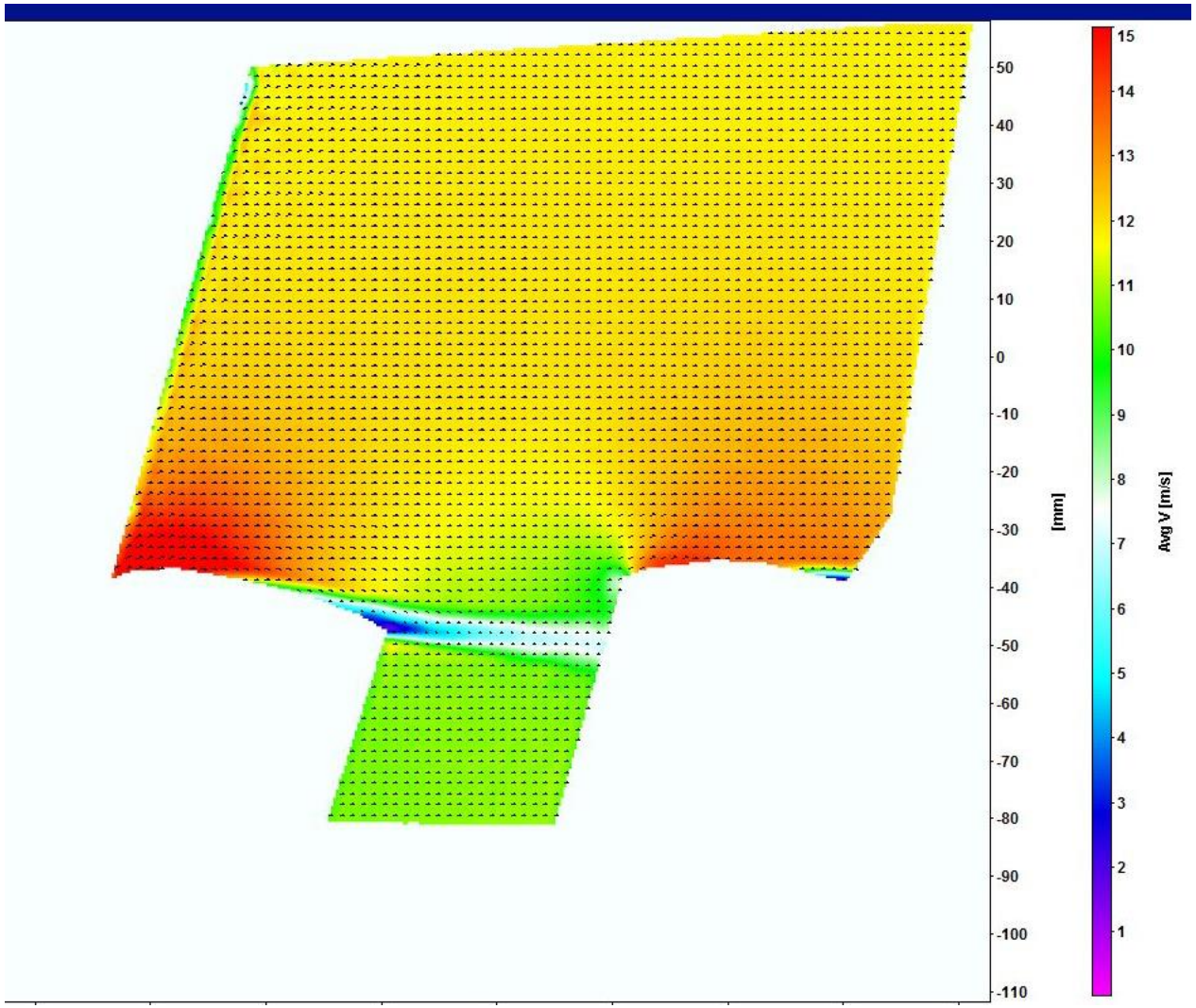
PIV Test

Wind Tunnel Test – PIV 5 deg



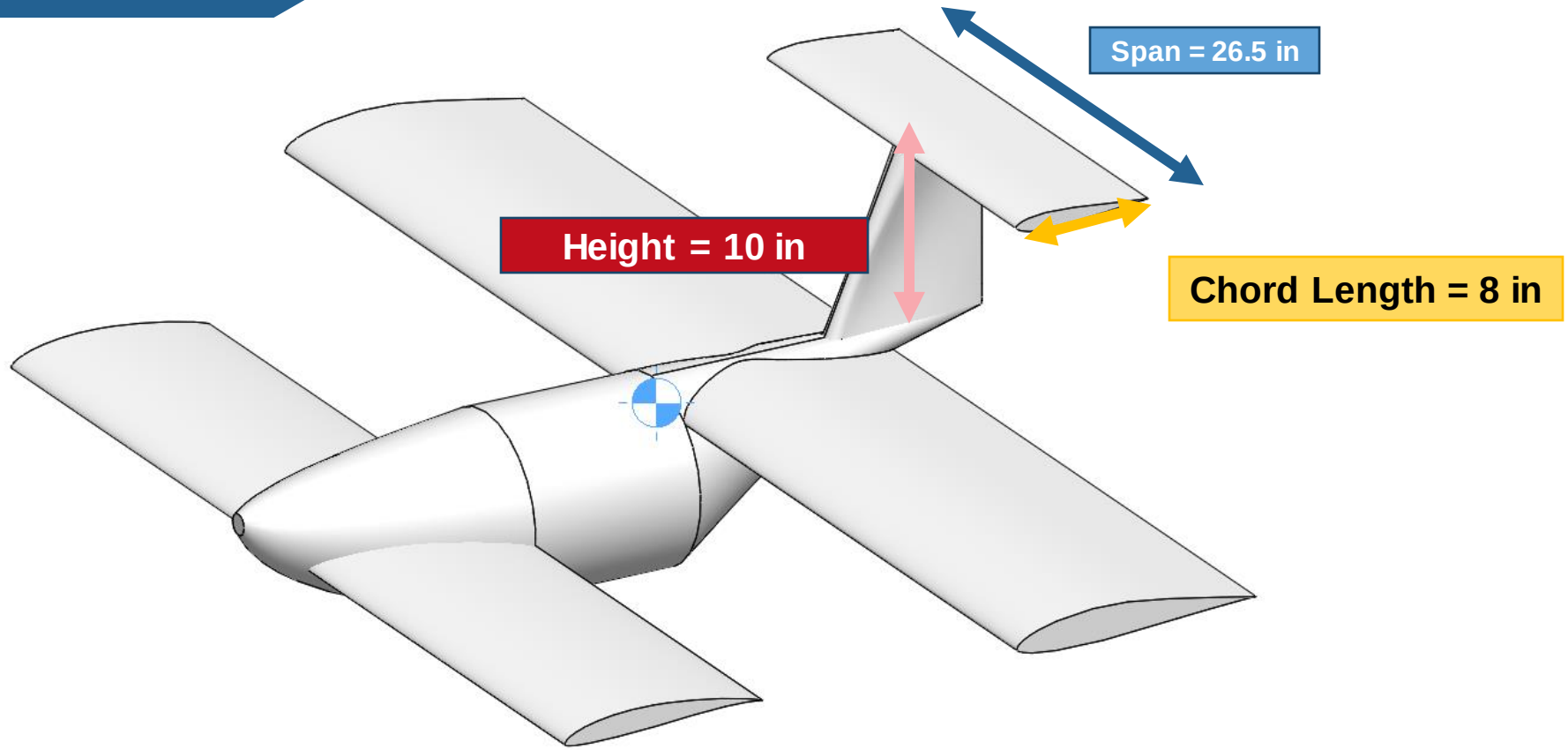
PIV Test

Wind Tunnel Test – PIV 12 deg



Design Process

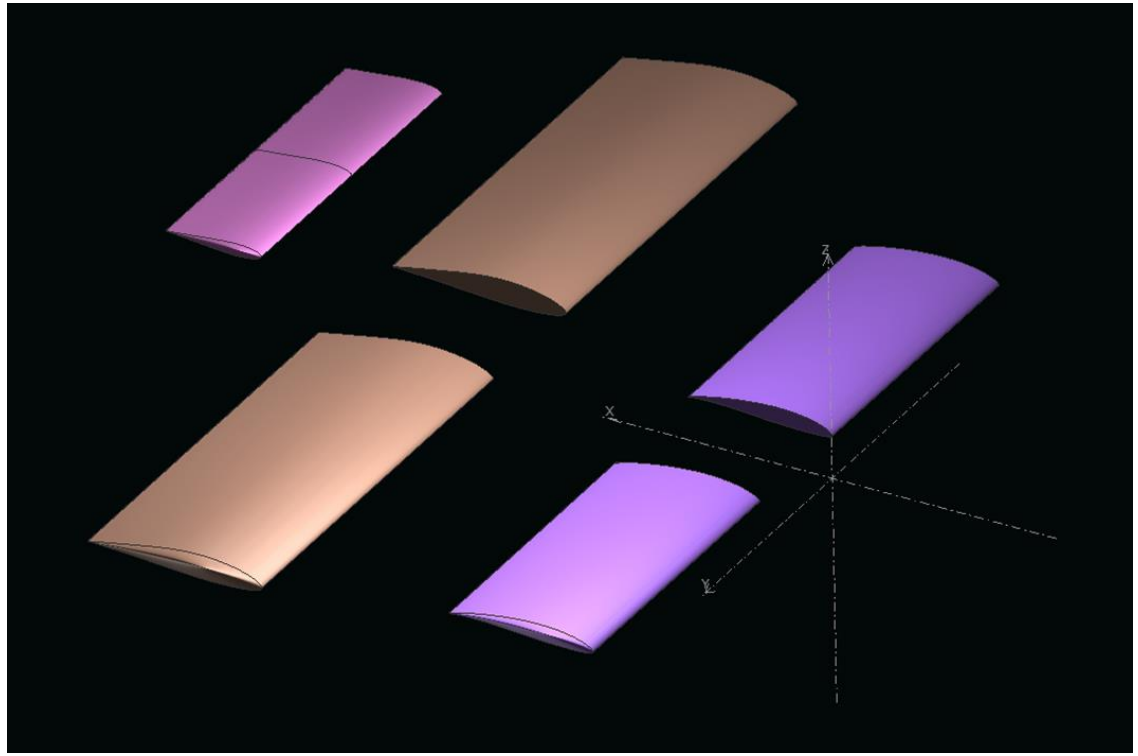
Comparison



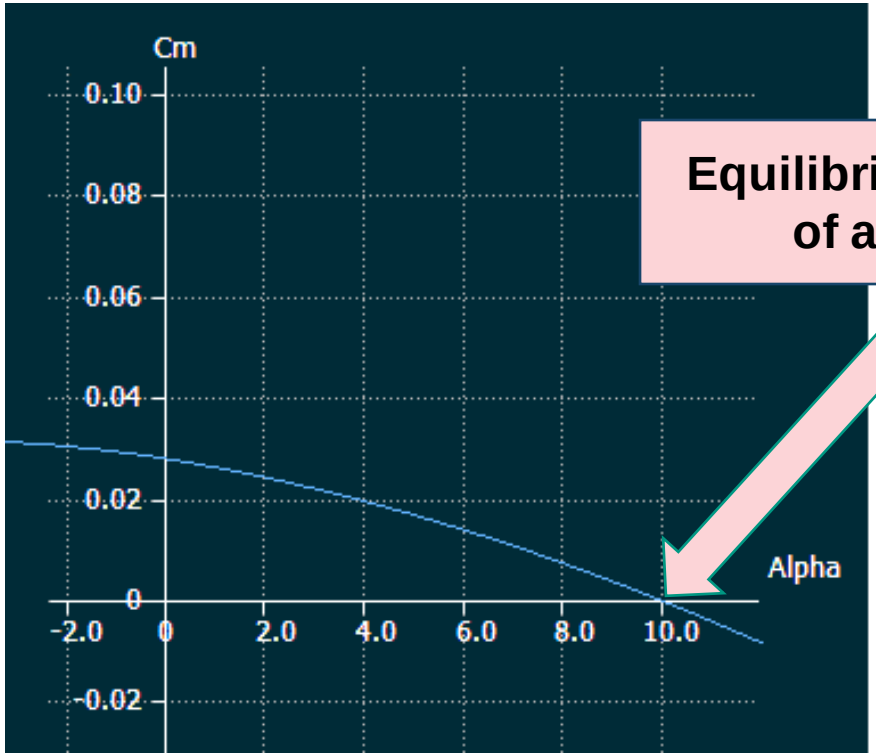
Sasindu Pinto

Design Process

XFLR5 Analysis



Current Wing Layout in XFLR5

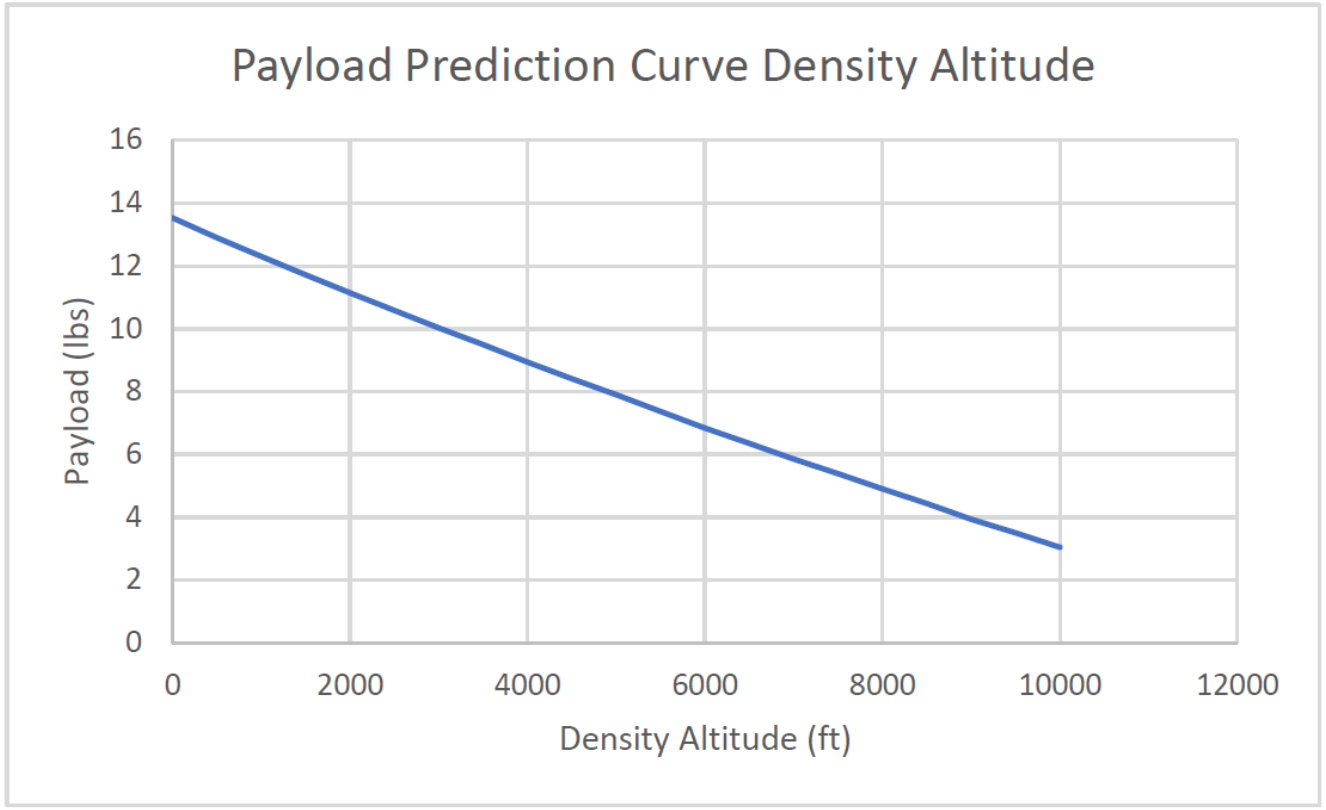


Coefficient of Moment Plot

Noah Wright

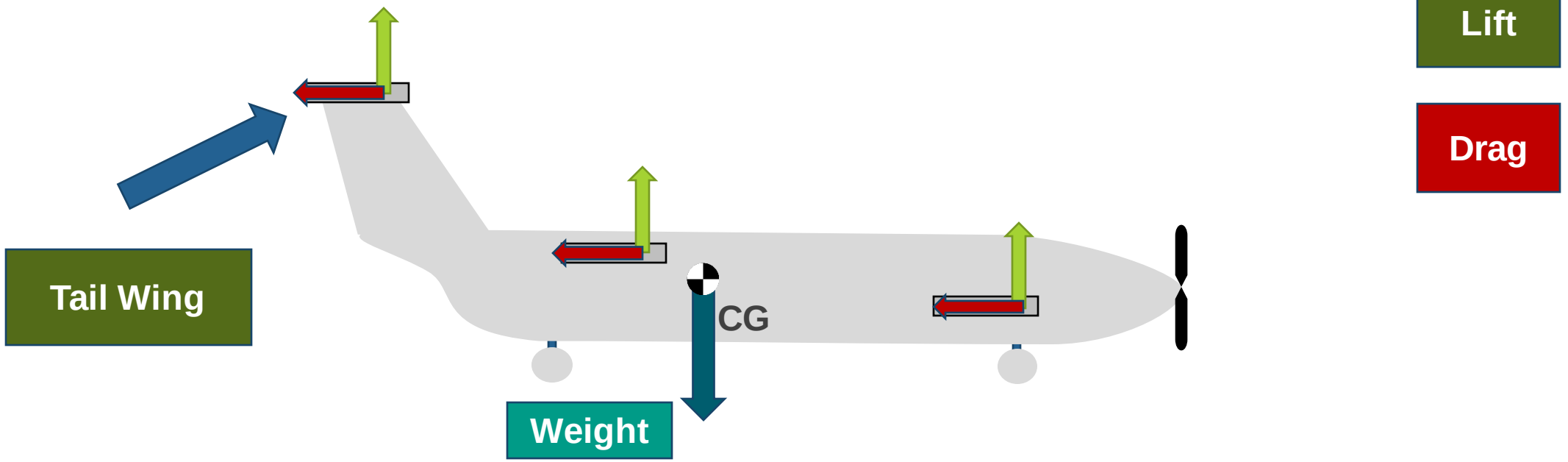
Payload Prediction

Assuming Constant Temperature



Stability

Stability Plot – No Tail



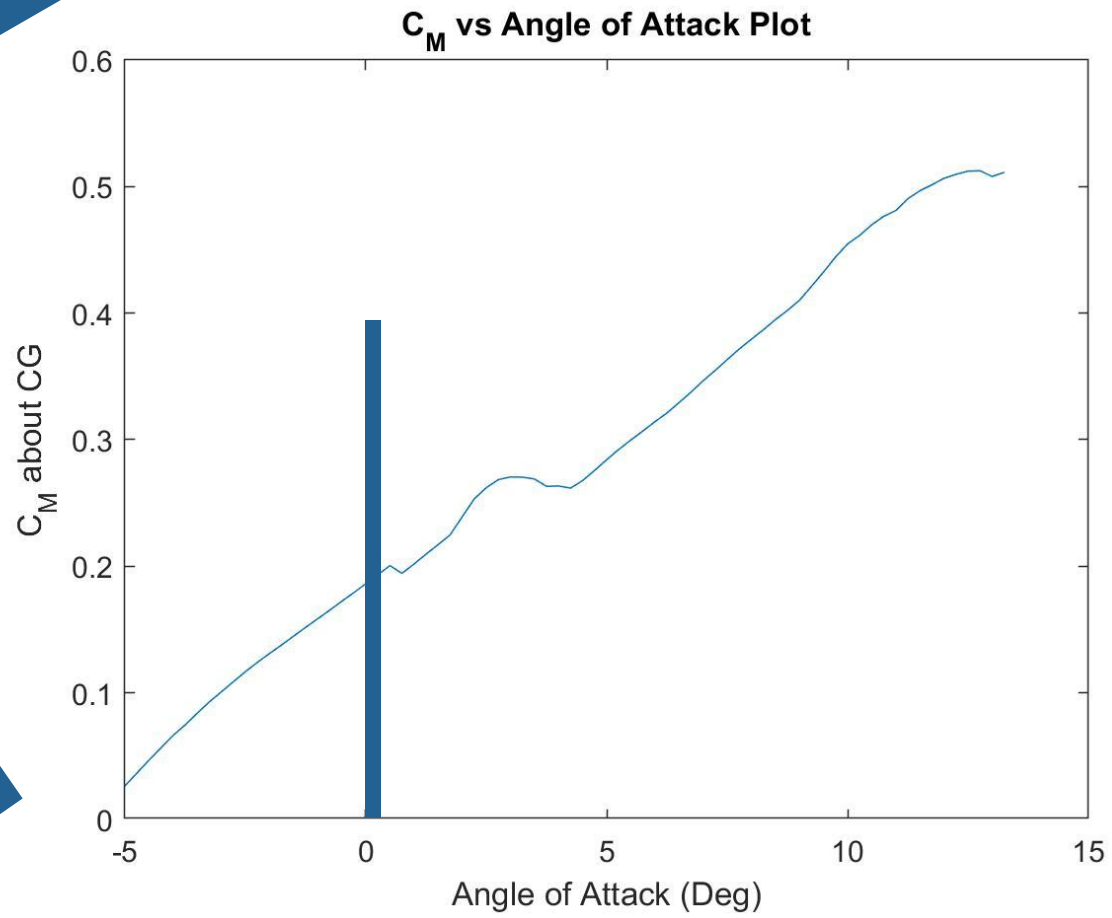

```
%Moment about CG
M_CG=L_c*x_c + L_c.*(alphaR).*y_c - D_c*y_c + D_c.*(alphaR).*x_c - L_a*x_a - L_a.*alphaR.*y_a...
    + D_a*y_a - D_a.*alphaR.*x_a - L_t*x_t - L_t.*alphaR.*y_t + D_t*y_t-D_t.*alphaR.*x_t...
    + M_AC_C + M_AC_M + M_AC_T;

%Coefficient of Moment about CG
C_M_CG = M_CG./(q*S_aft*Chord_aft);
```

Stability

Stability Plot – No Tail

No positive Equilibrium



Stability

Neutral Point