

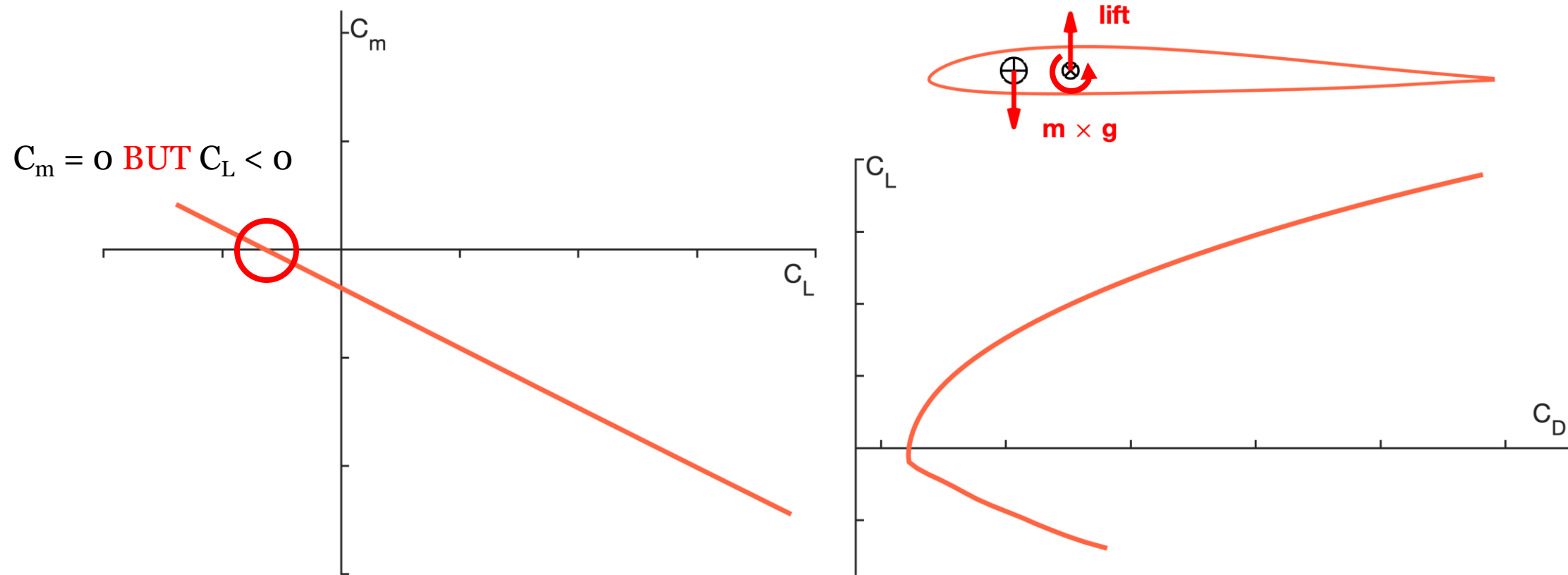
Aerodynamic Efficiency of Longitudinally Unstable Tailless Aircraft

Stefan Riethausen

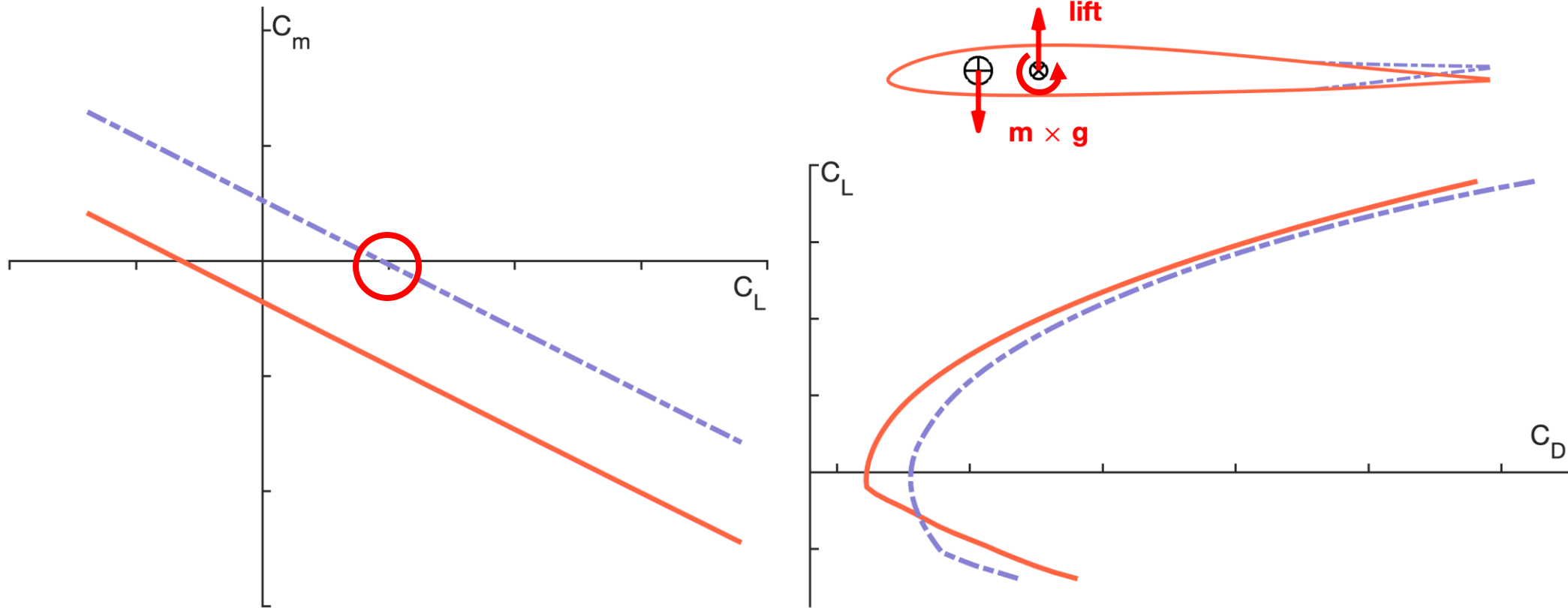
Agenda

1. Background & Reasoning
2. Test Aircraft Introduction
3. Modelling
4. Flight Tests

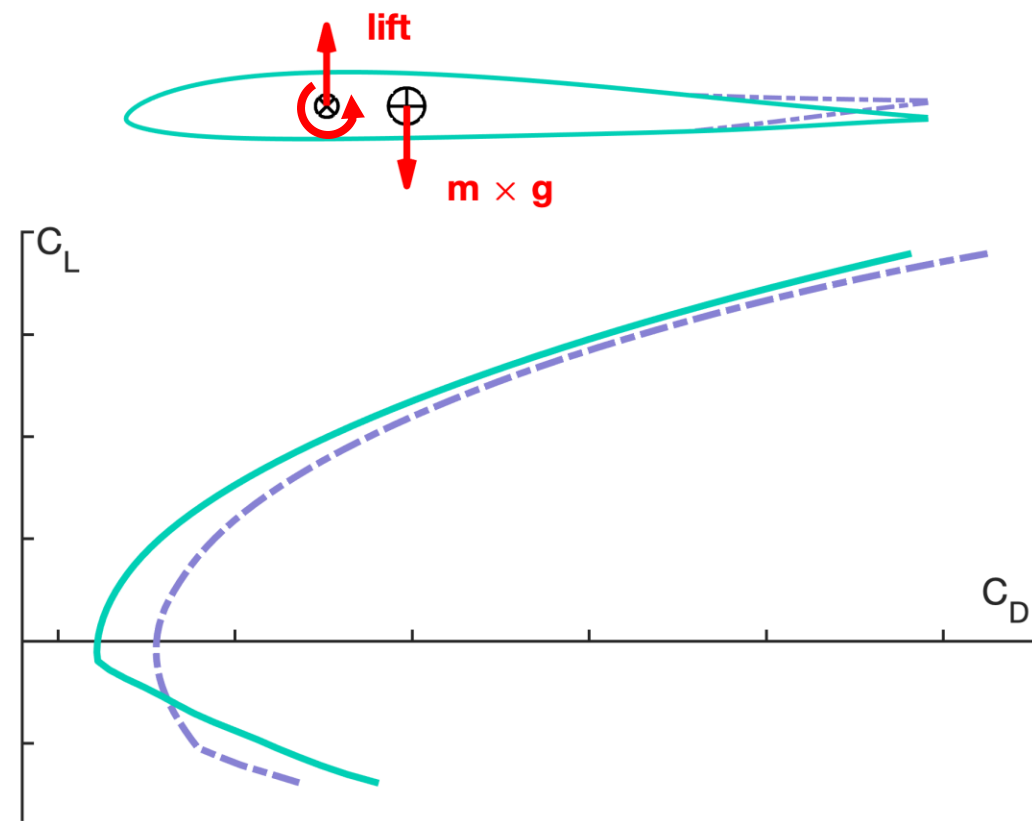
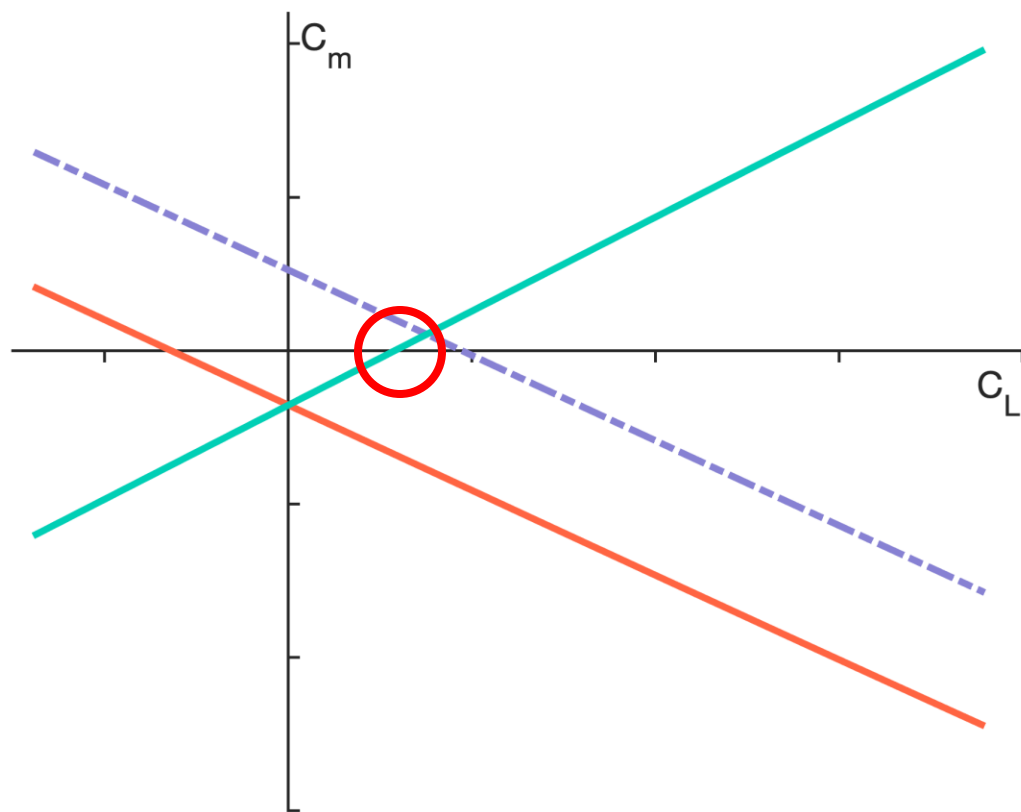
Background - Why Unstable?



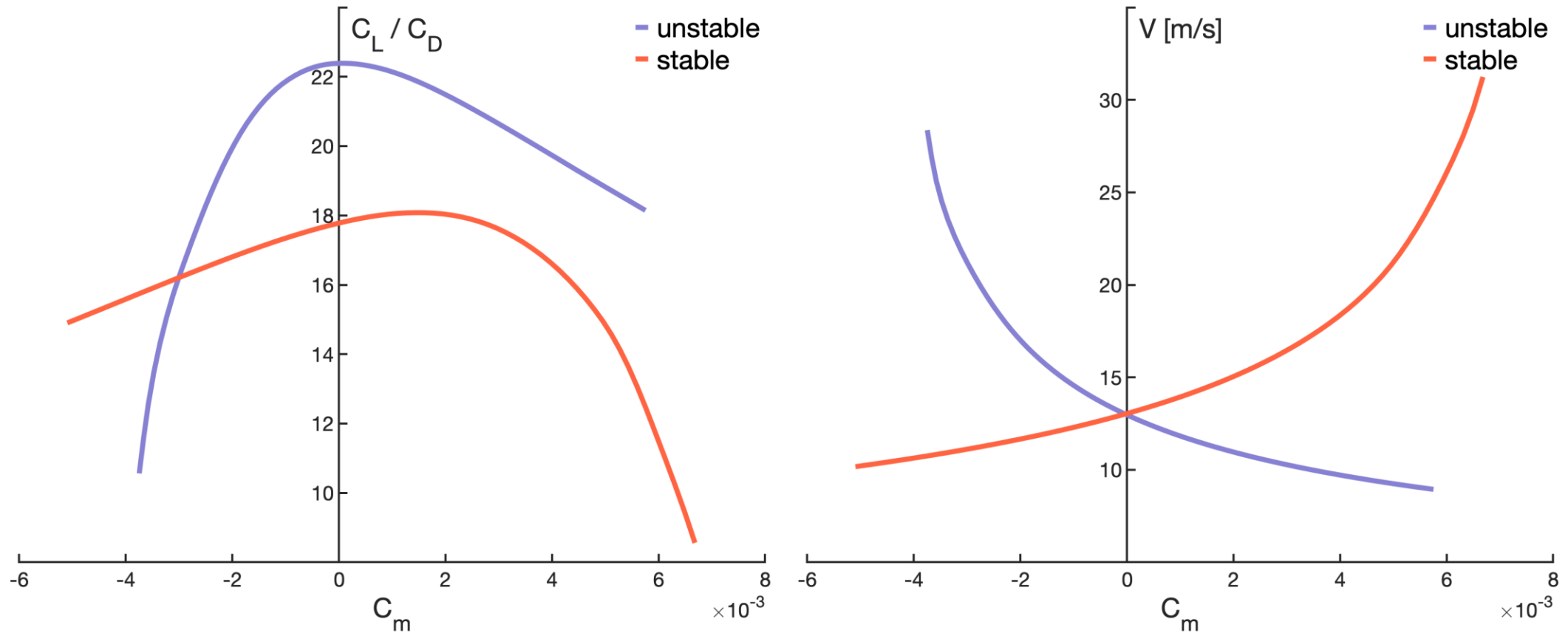
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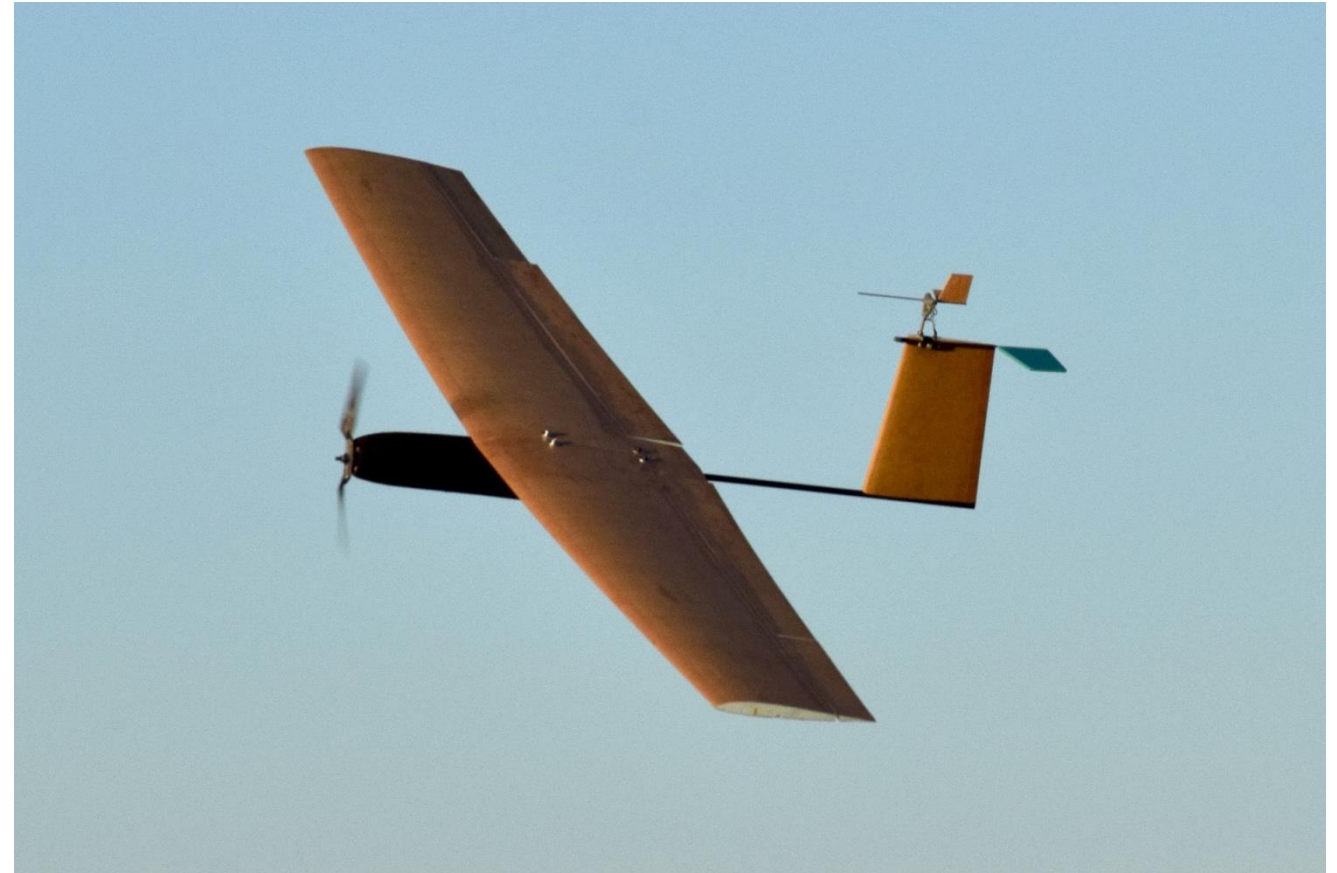


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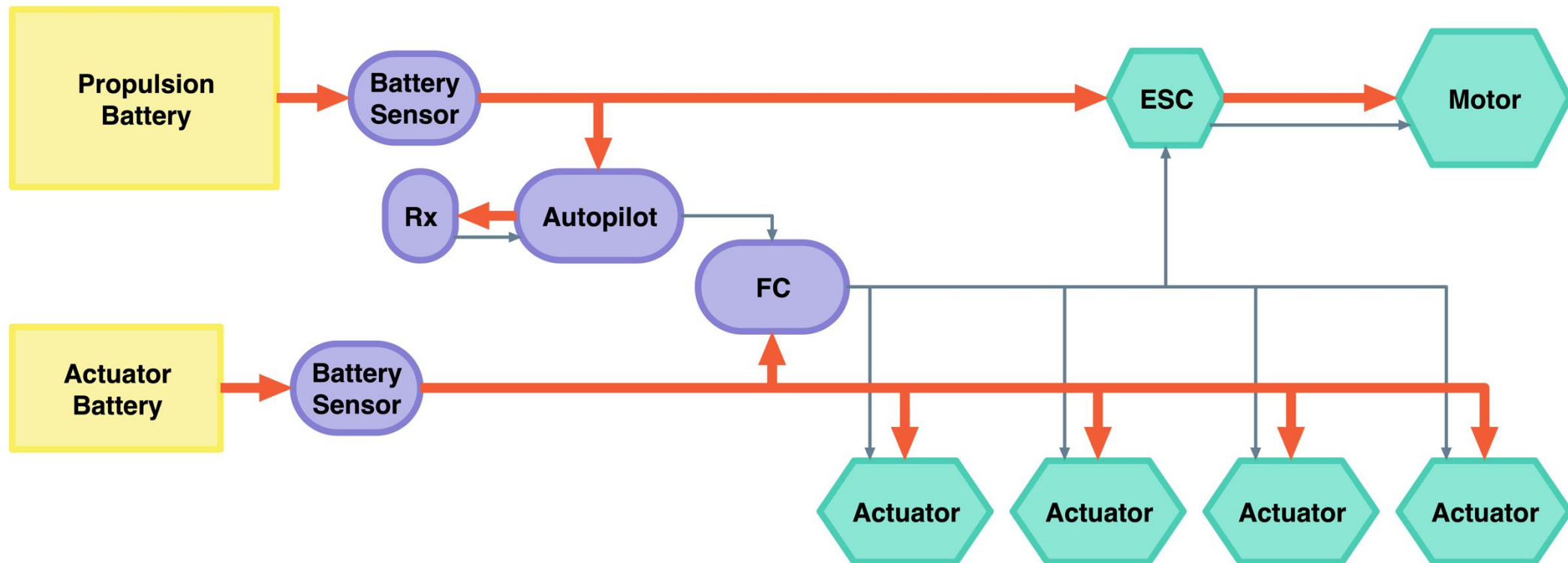


Test Aircraft

- Wingspan: 1.9 m
- Wing Area: 0.57 m²
- Mass: 1.92 kg
- Static Margin: 5.1% & -3.8%

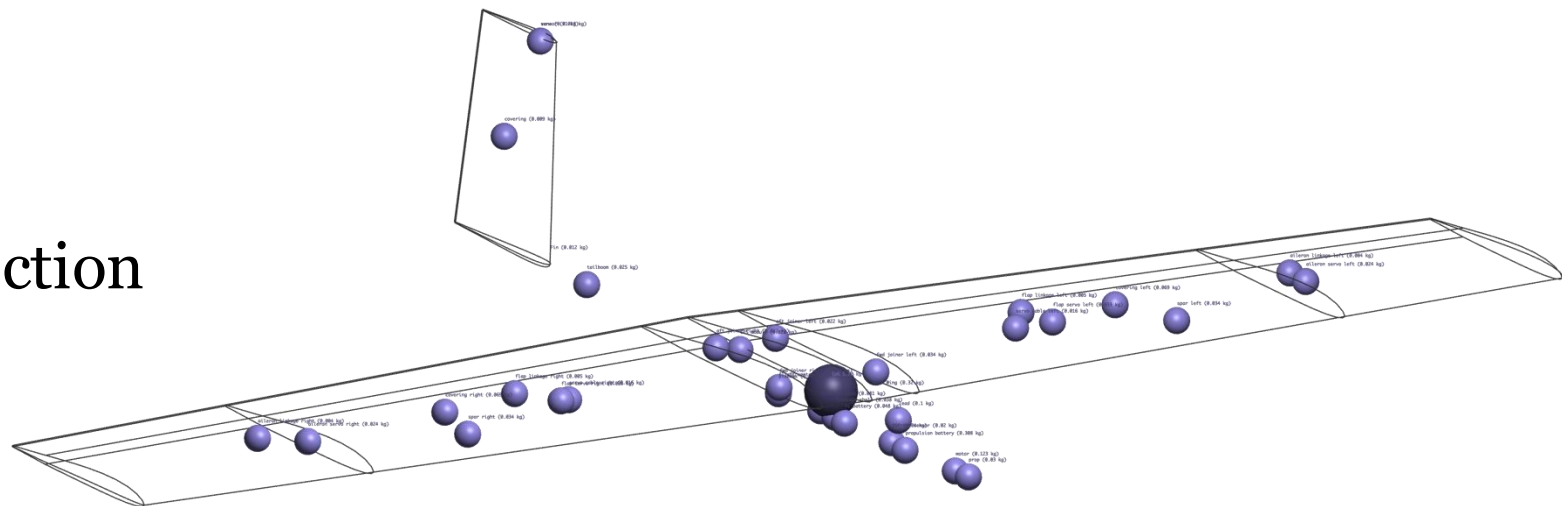


Test Aircraft– System Overview

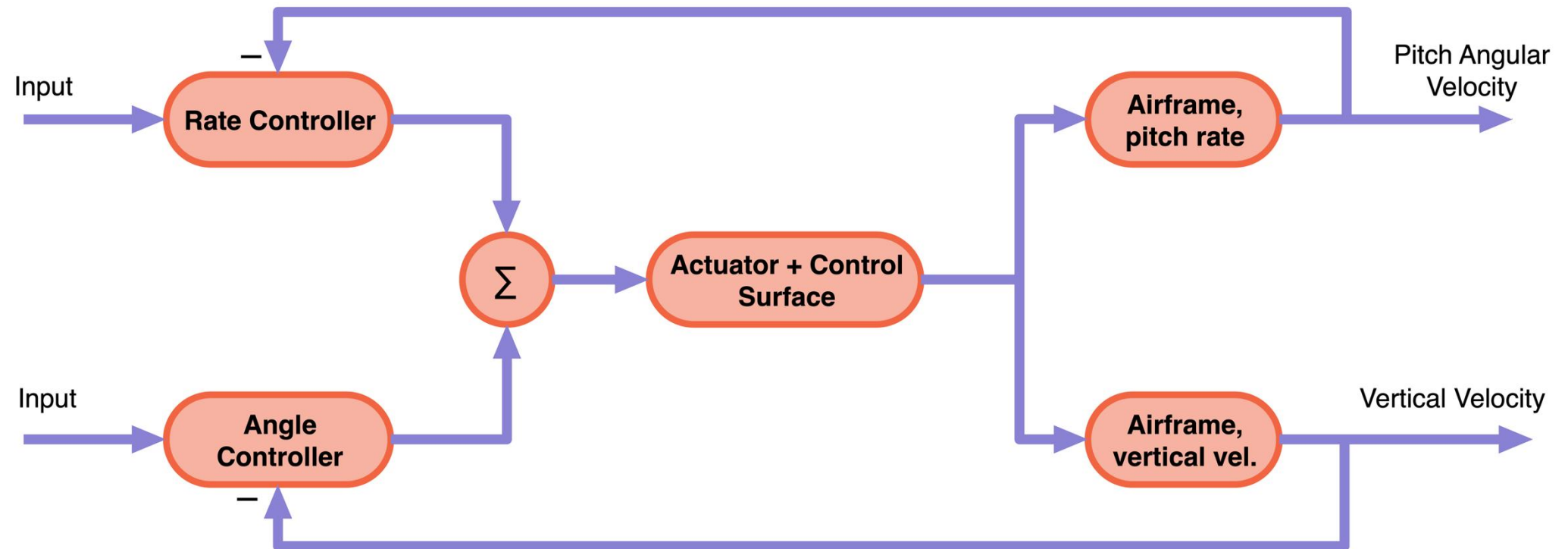


Modelling – Airframe

- Inertia model
 - Mass points
- Stability & control prediction
 - Panel method

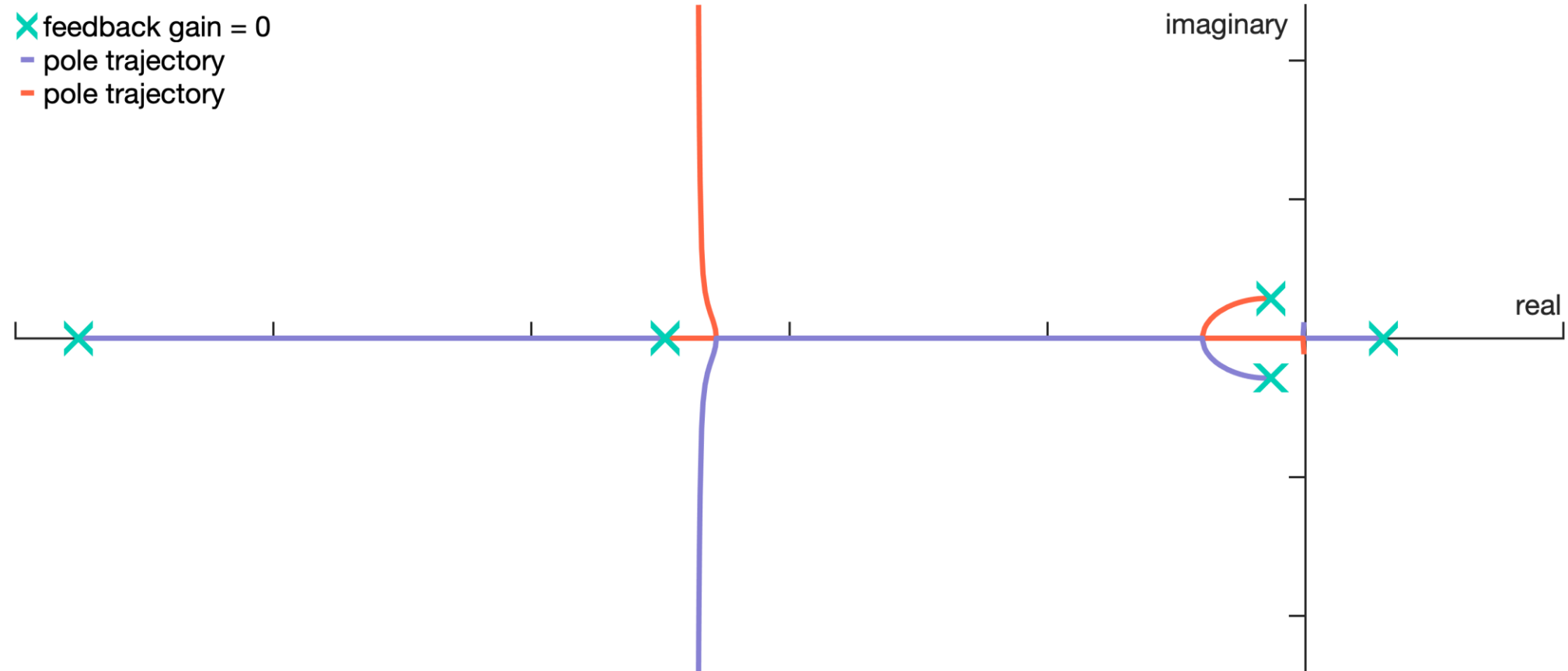


Modelling – System Model



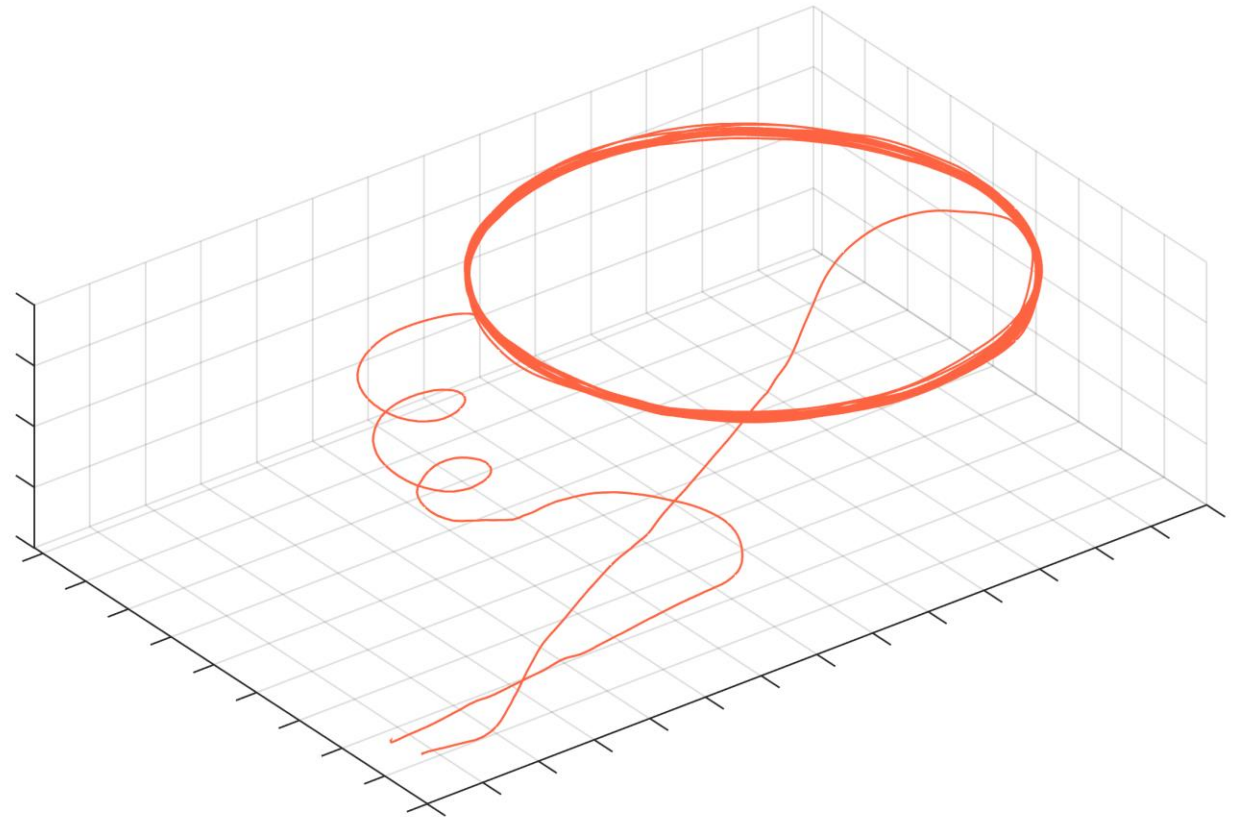
Modelling – Finding Controller Parameters

- ✕ feedback gain = 0
- pole trajectory
- pole trajectory

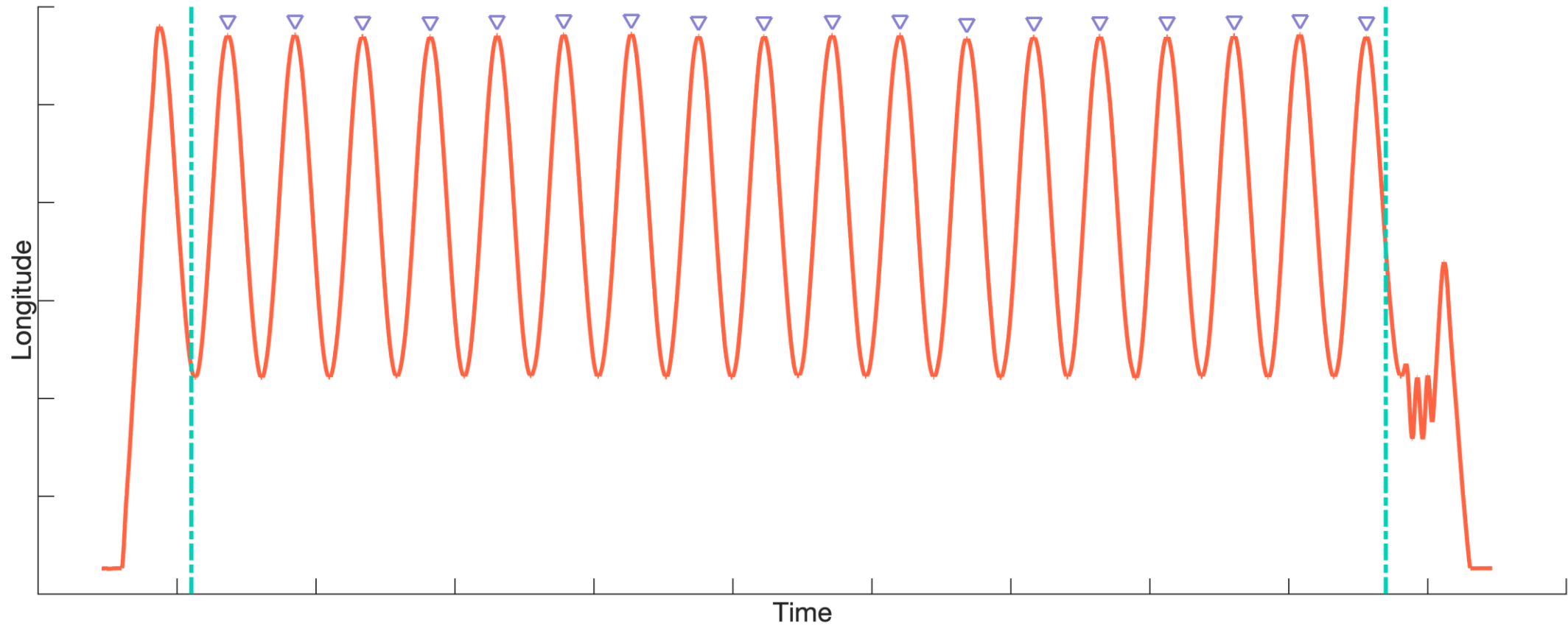


Flight Testing – Testflight Overview

- Circle Diameter: 200 m
- Altitude: 80 m
- Airspeed: 13 m/s
- Flight Duration: ≈ 15 min

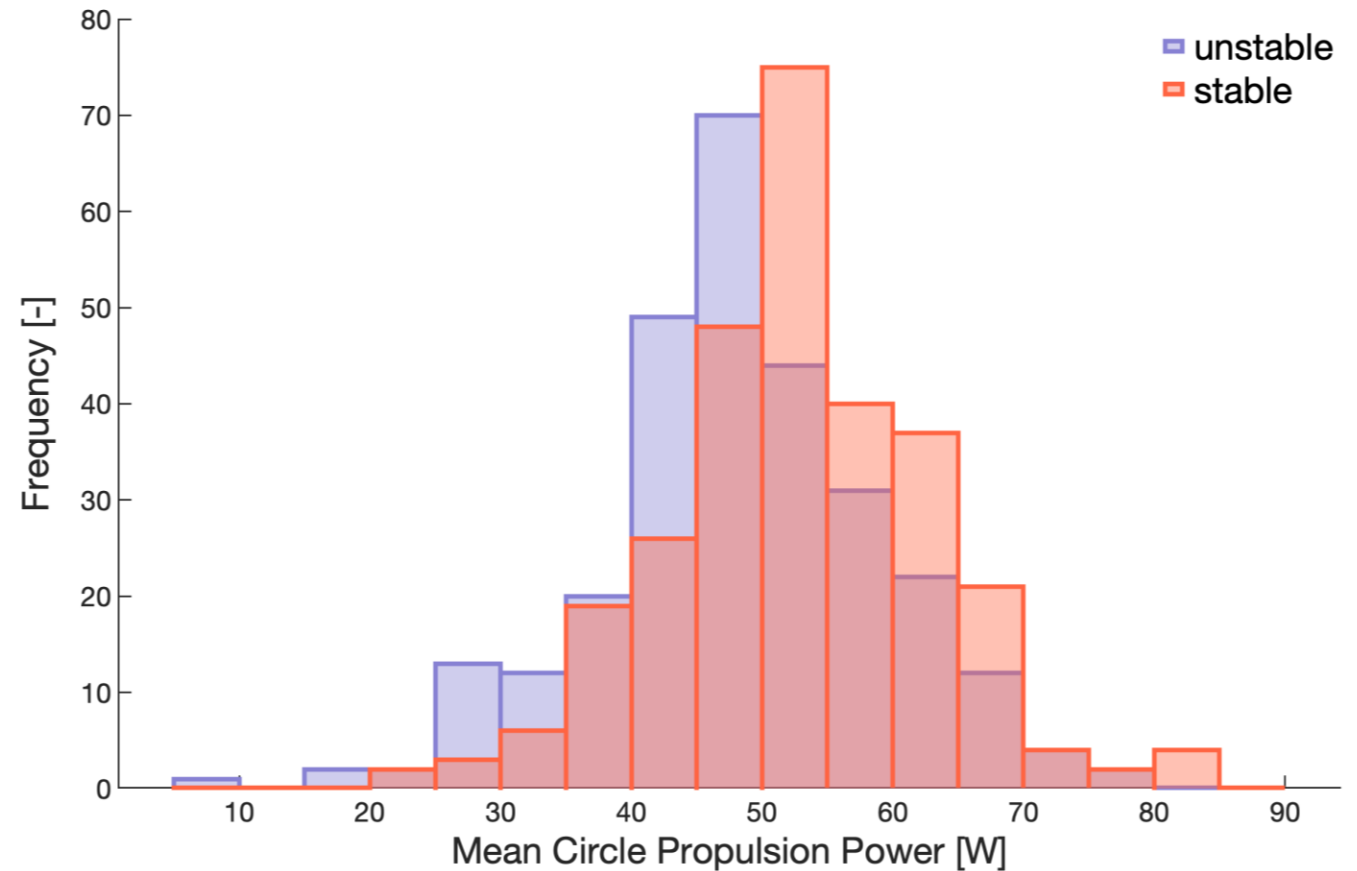


Flight Testing – Data Processing



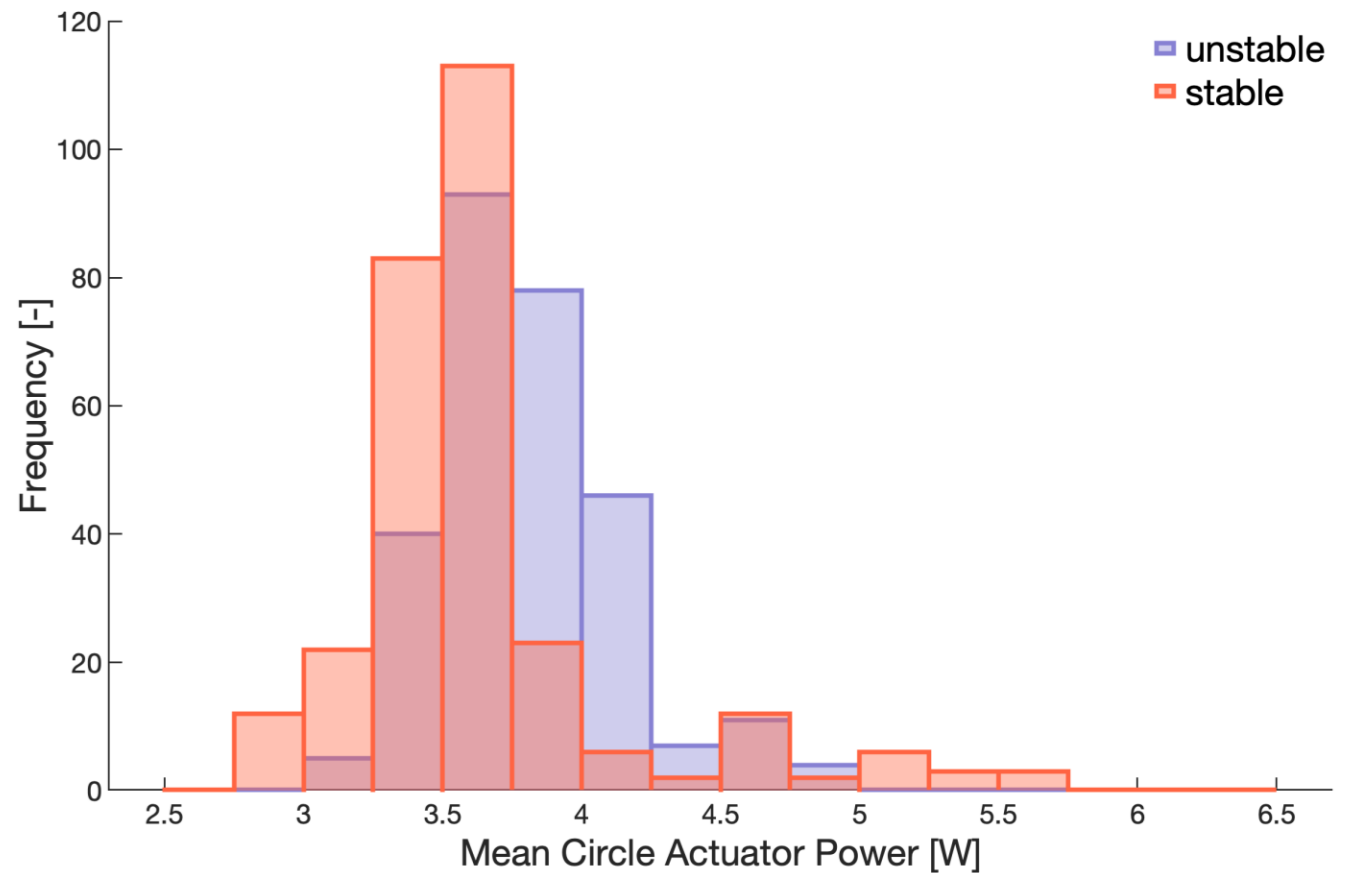
Flight Testing – Results Propulsion

- Mean power (unstable):
48.34 W
- Mean power (stable):
52.87 W
- Difference: 8.94%



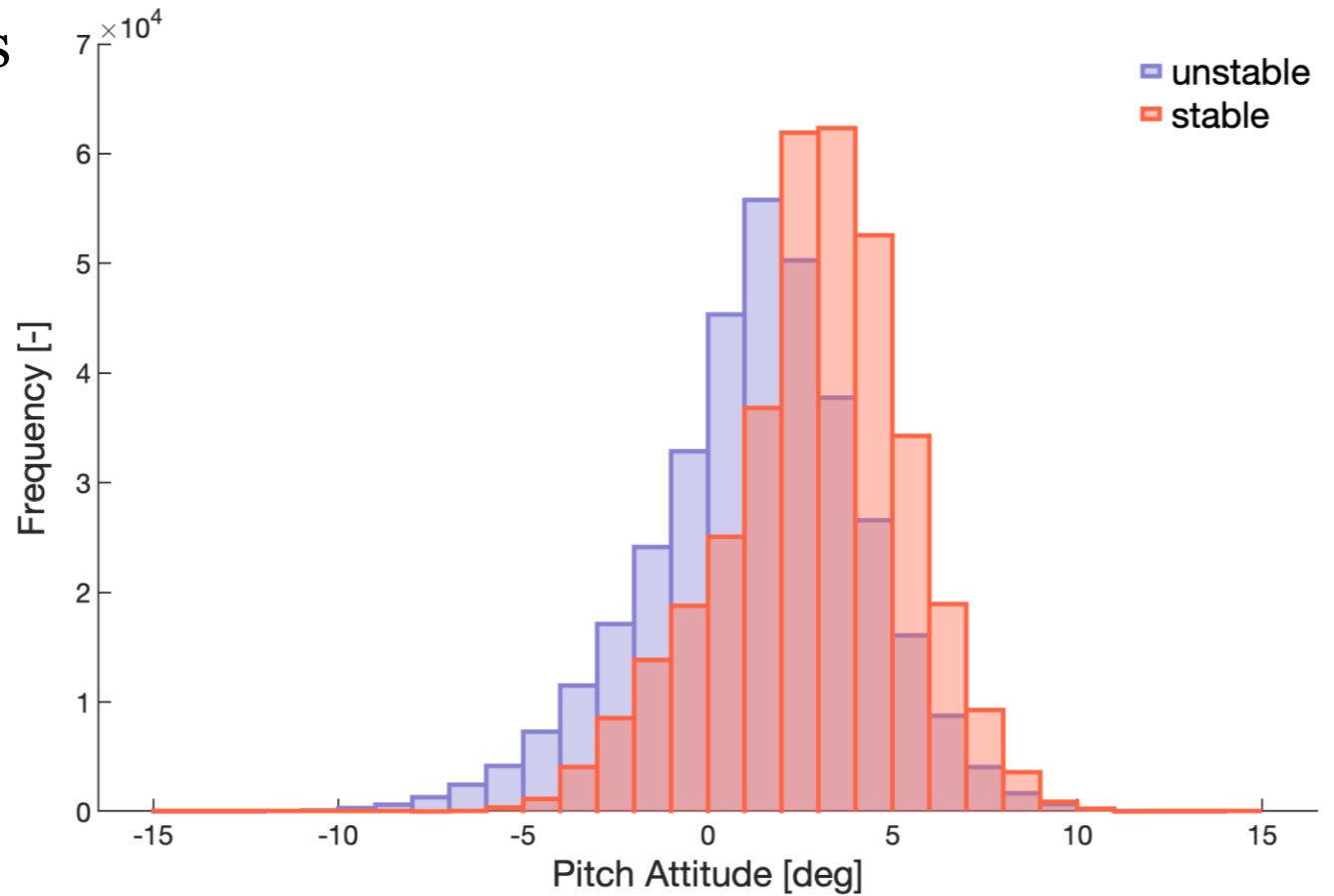
Flight Testing – Results Actuators

- Mean power (unstable):
3.80 W
- Mean power (stable):
3.64 W
- Difference: -4.27%



Flight Testing – Caveats

- Oscillations in unstable flights
- Pitch standard deviation
 - Unstable: 2.95 deg
 - Stable: 2.50 deg

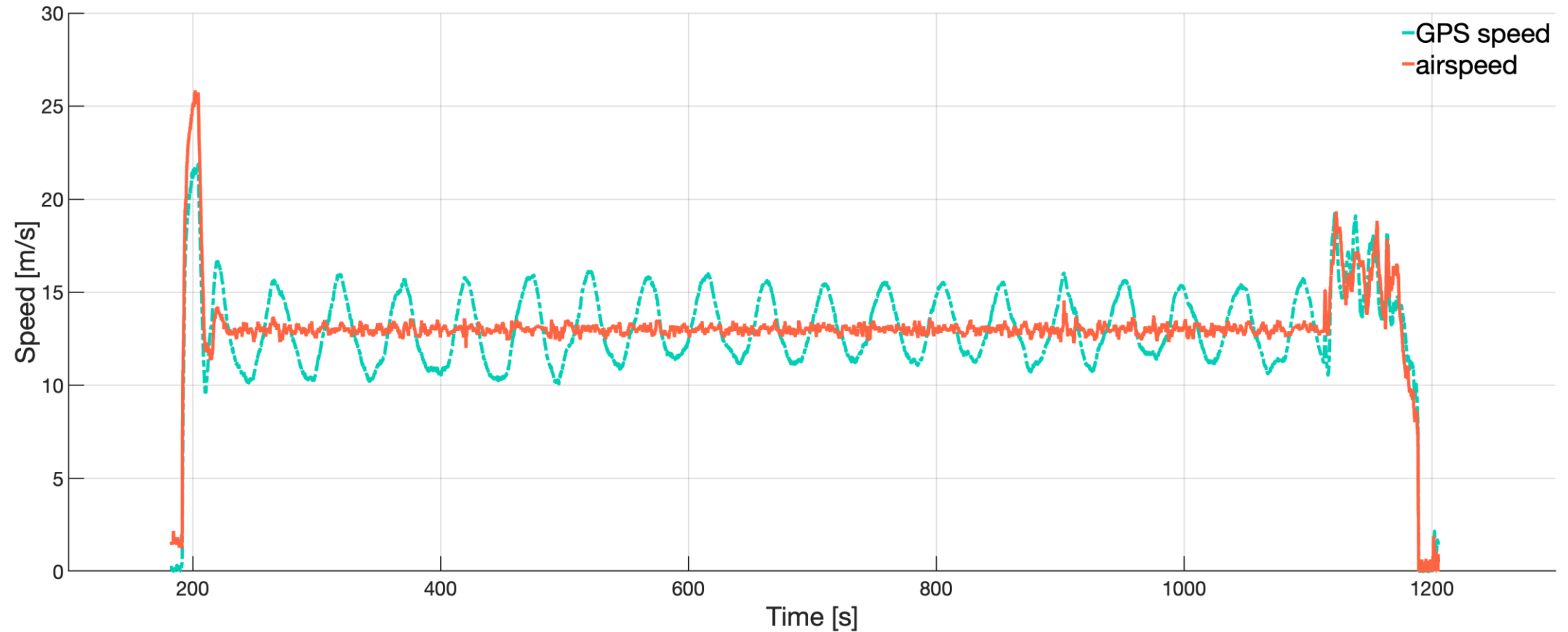


Conclusion & Outlook

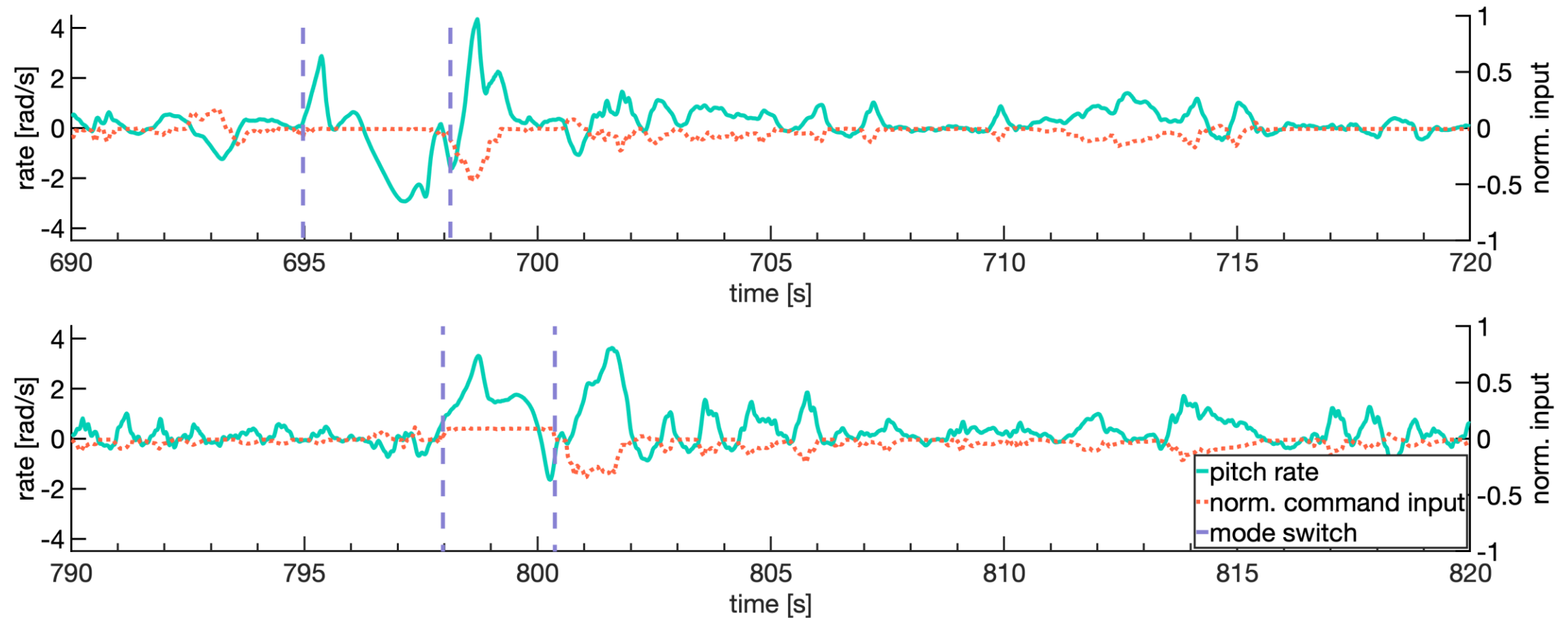
- **Test aircraft overall 8% more efficient when unstable**
- Potential to be higher:
 - use different airfoil: optimised for unstable case
 - better controller tuning: less oscillations

Thank You!

Airspeed Data & Calibration



Flight Tests – Instability Demonstration



Flight Tests – Instability Demonstration

