Wind tunnel testing of non-conventional aircraft tail configurations

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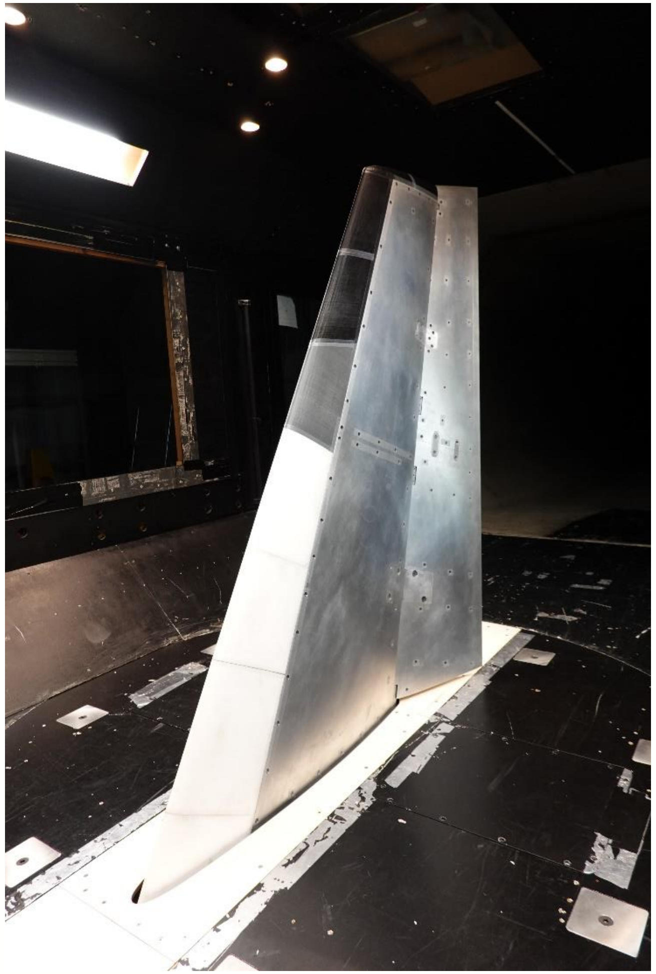
H2020 Tailsurf Project (October 2019 – March 2023)

- Study of non-conventional tail configurations for commercial aircraft
- In collaboration with Airbus, University of Nottingham and Univeristy of Bristol
- Three models tested at the deHavilland 9ft by 7ft WT at UofG:

  - Model 1: Vertical fin model, floor mounted, rigid, for the study of passive and active devices to delay stall onset. Multiple rudder settings.
  - Model 2: Horizontal Stabiliser model, floor mounted, aeroelastically tailored to increase perfomance. Variable sweep.
  - Model 3: Reconfigurable sting-mounted model to test several tail configurations. Traditional HS+ fin, V-tail with various dihedral angles, forward or back-swept. Settable rudder and elevator-ruddervator angles.
  - Wind tunnel testing September 2022 to March 2023

Tailsurf Model 1



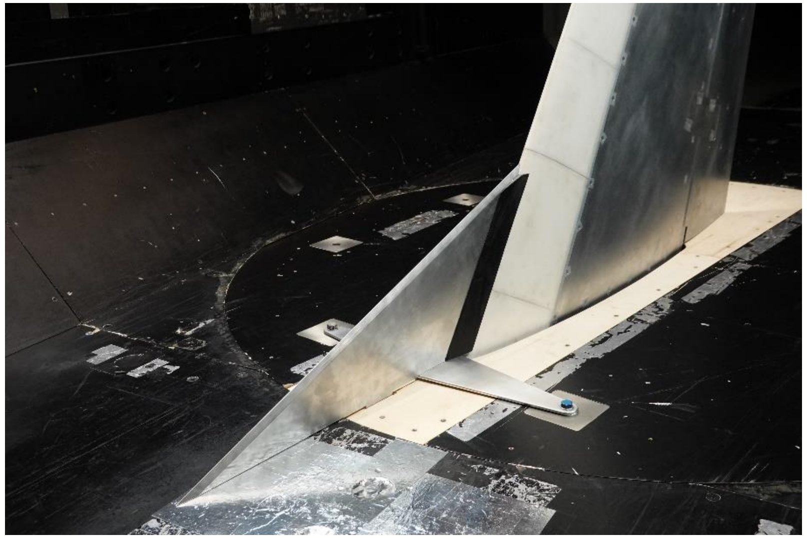
- Vertical fin model, rigid.
- 1.6 m span, 1.5 m^2 surface, 0.94 m MAC
- Turntable allows for change in side-slip angles β
- Rudder can be deflected in 5 deg increments from 0° to 30°
- Floor-mounted on a 6-component platform load-cell to monitor performance
- Pressure tappings on the rudder to monitor control authority
- Tested at 35 m/s, Re = 2.15M (no measurable Re effect above this speed)

- Goal: Test several passive (Leading-edge extensions, Leading edge modifications, rudder slats, tip) and active (Plasma actuators) to delay stall onset.

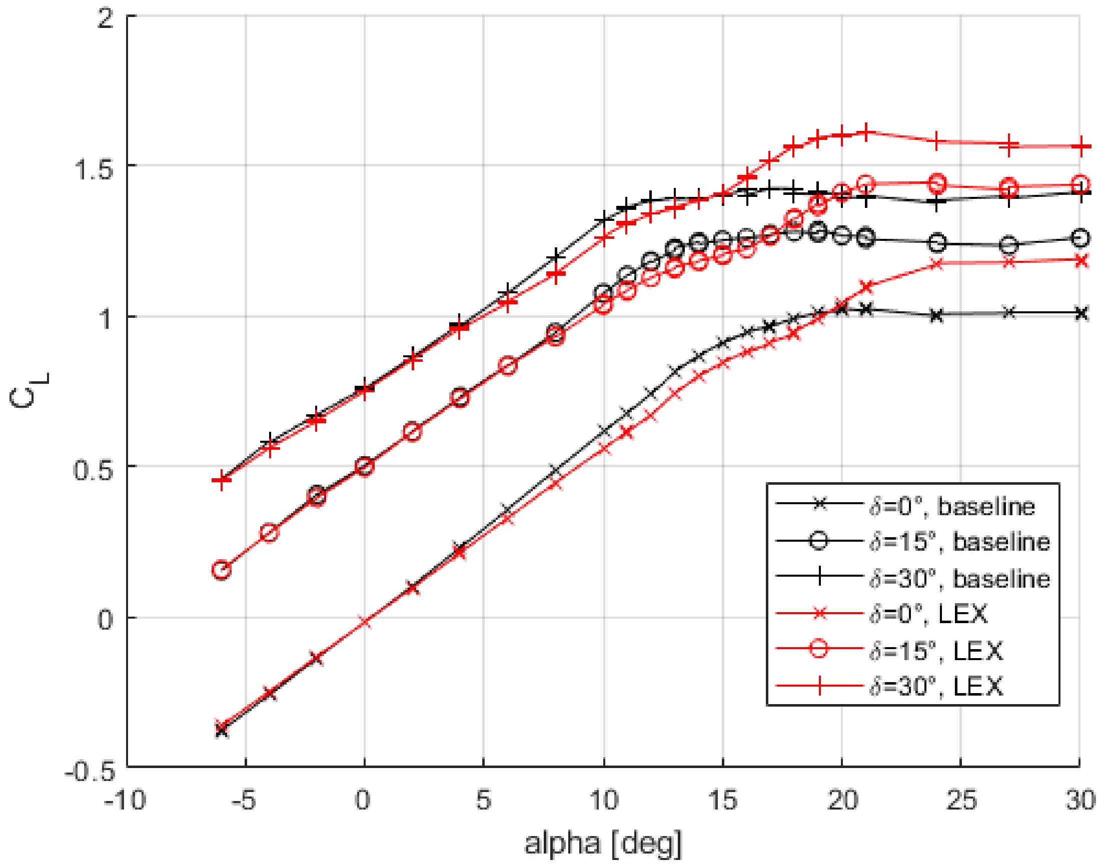
- For the baseline case, stall develops at the tip and then propagates to the root as β is increased

Model 1 - Passive devices

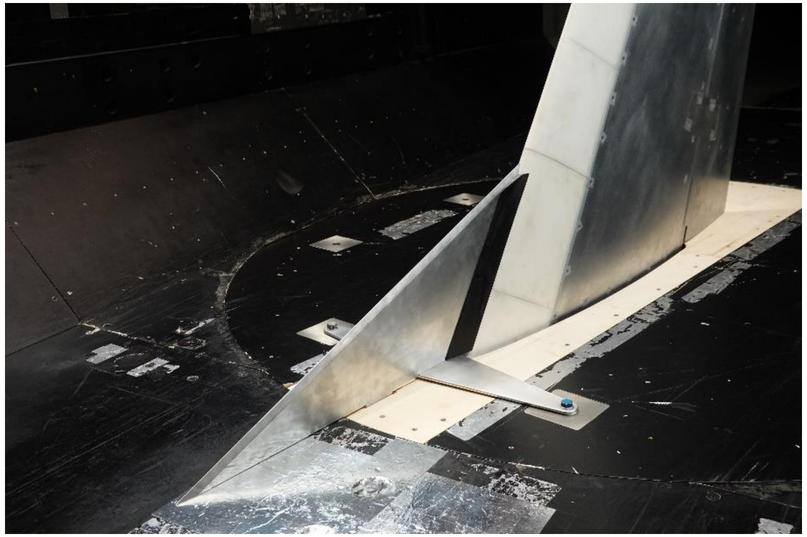
Commercial confidence, cannot show them all….



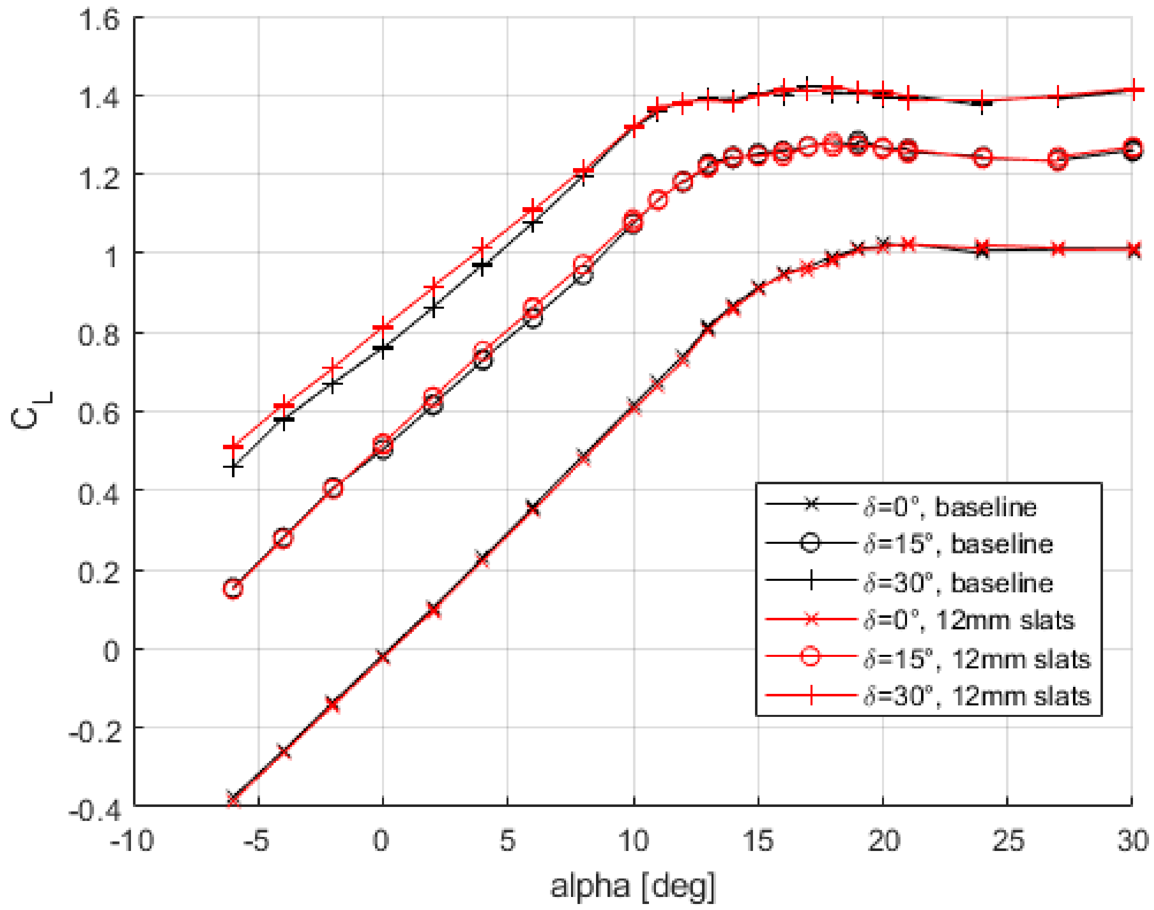
Model 1: Performance Results, LEX



- The loads on the LEX are not measured by the balance
- Initial degradation of performance up to developed stall, when the stalled regior in not allowed to completely extend to the root area.



Model 1: Performance Results, rudder slats



- Slat positioned on the rudder LE
- Thet reduce the severity of the local stall on the rudder at large rudder deflections.
- They become ineffective when the whole wing stalls.

Tailsurf Model 2

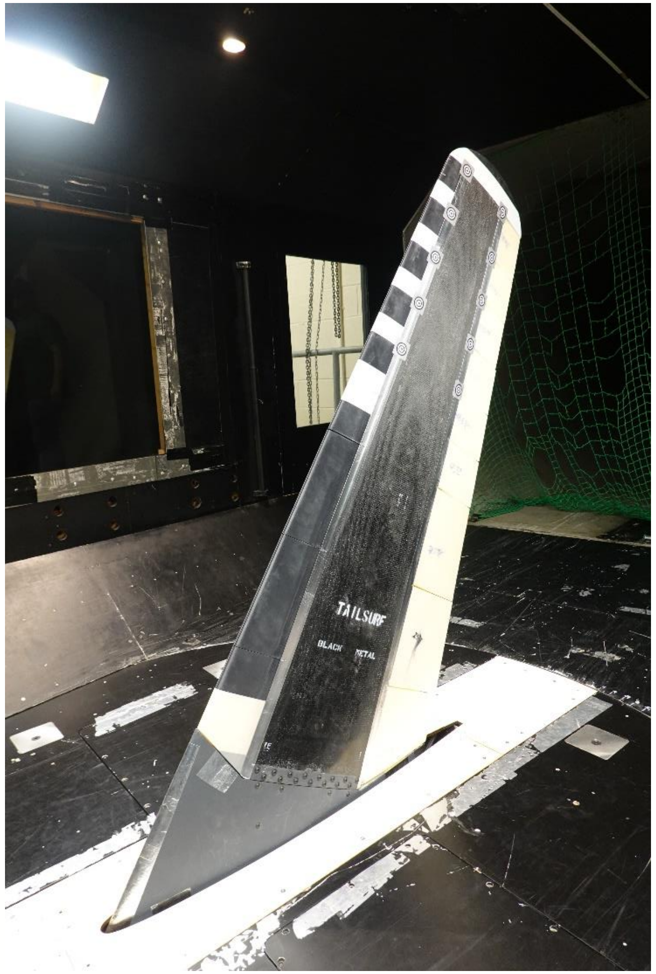
- Horizontal stabiliser model, aeroelastically tailored.
- 1.6 m semi-span, 0.85 m^2 surface, 0.53 m MAC
- Turntable allows for change in side-slip angles β
- Floor-mounted on a 6-component platform load-cell to monitor performance.
- DIC system to monitor wing deflection and torsion
- 3 multi-axial accelerometers to monitor mode excitation.
- Tested at a range of velocity speeds ranging from 20 m/s to 48 m/s, Re 700k to 1.7M
- Backward, forward and no-sweep configurations can be tested

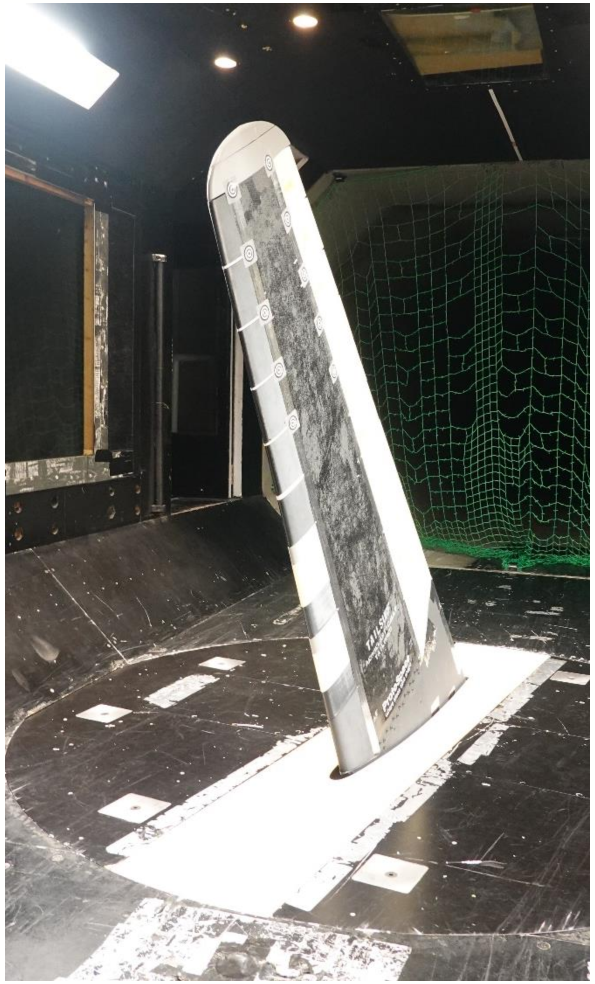
- Goal: Test the feasibility of an aerolastically tailored composite wingbox in order to promote torsion-bending coupling for increased performance, in terms of increase in lift slope with respect to a non-tailored one.

- Best results expected for a forward swept wing, due to the the aerodynamic centre lying in front of the elastic axis.

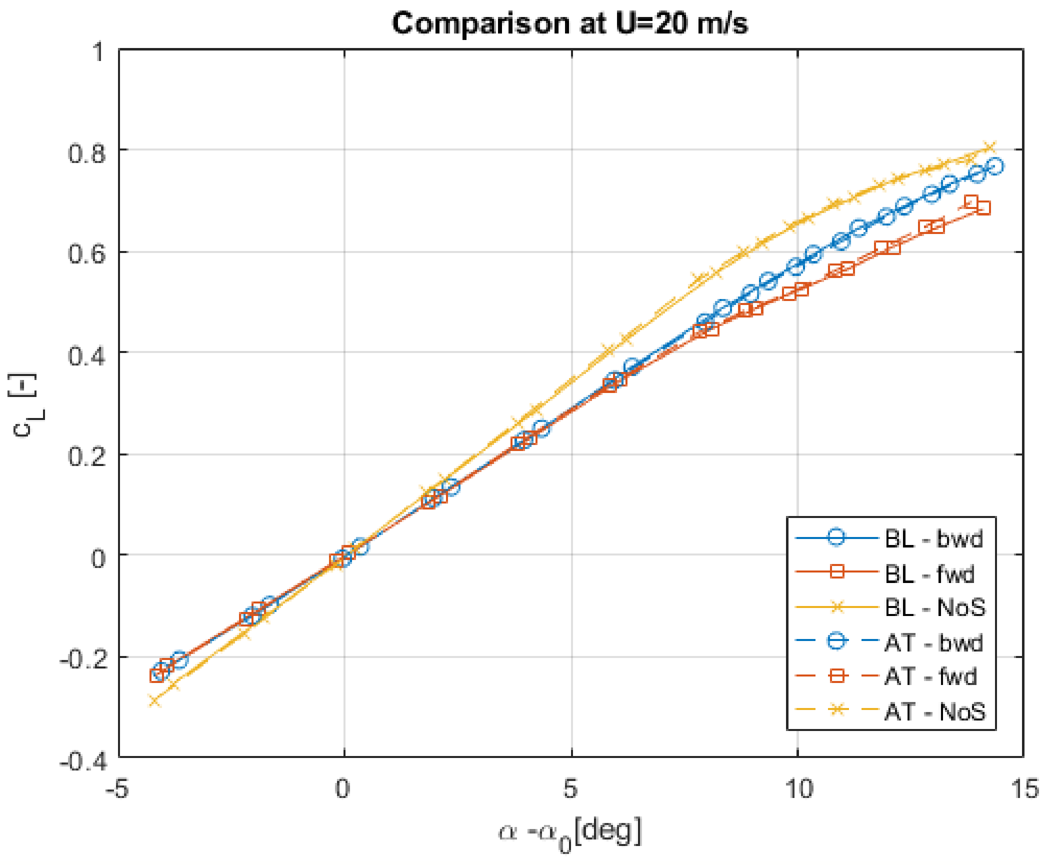
University of Glasgow

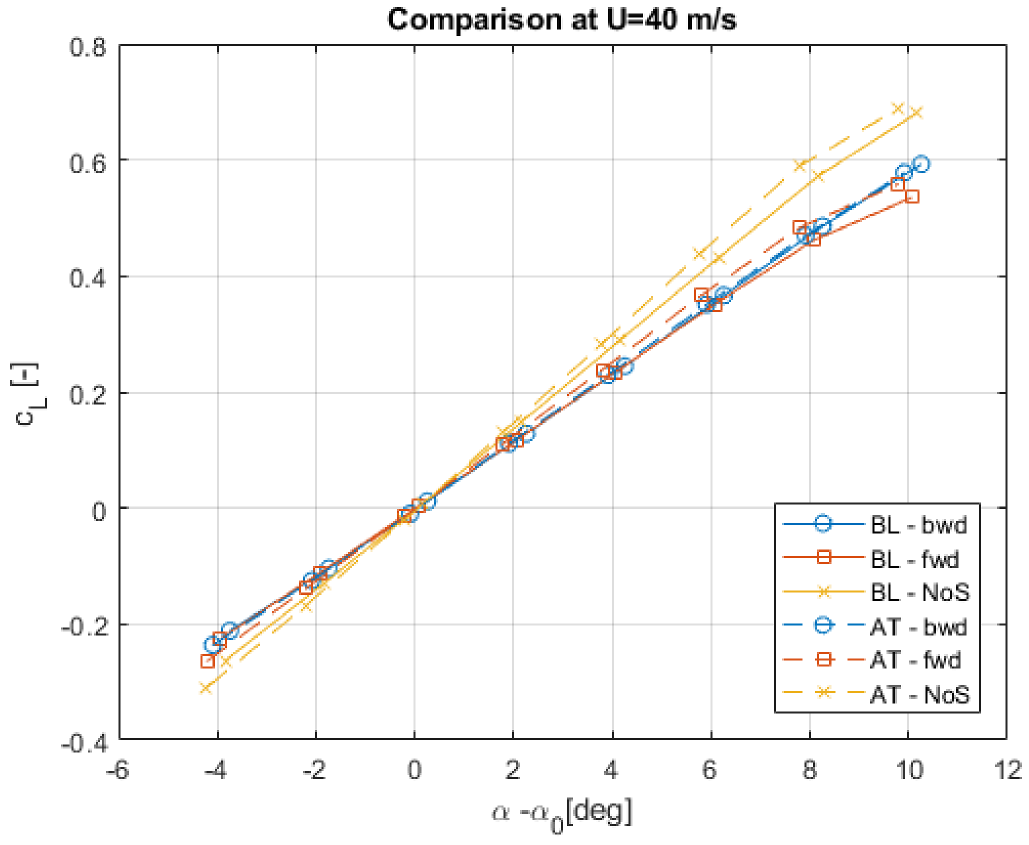
Tailsurf Model 2



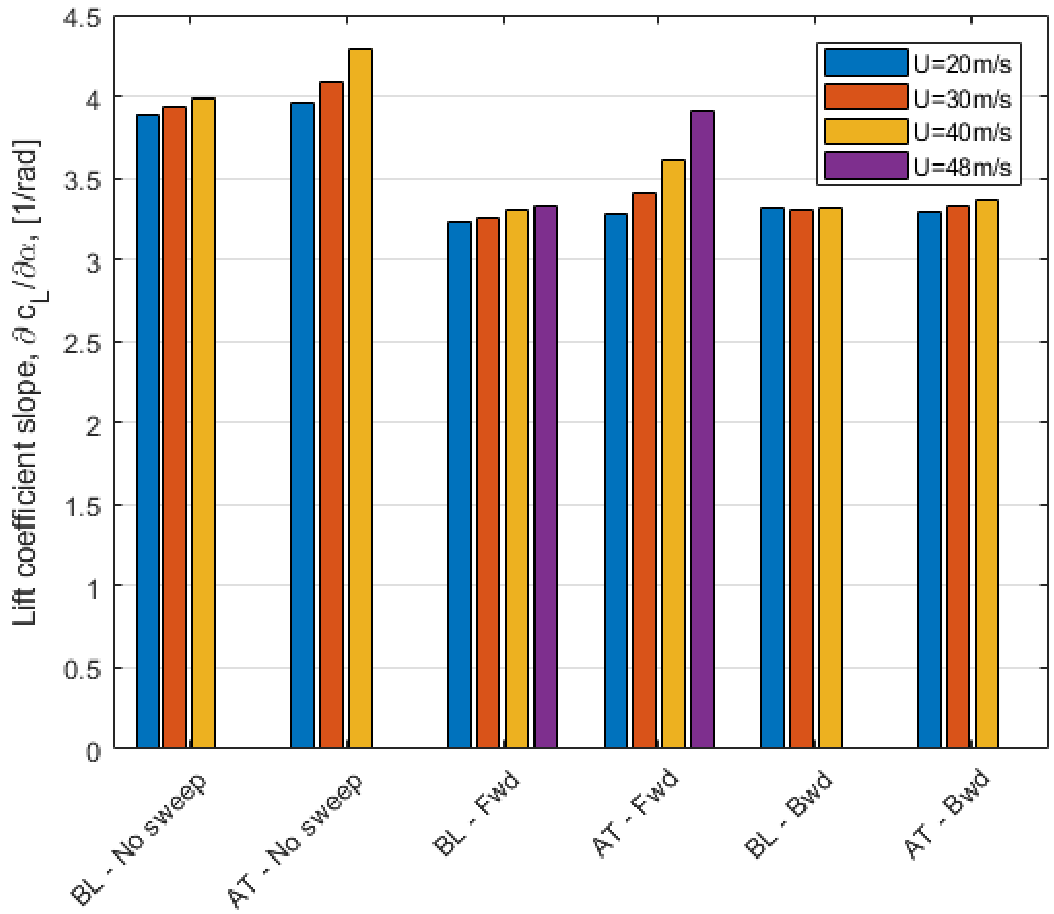


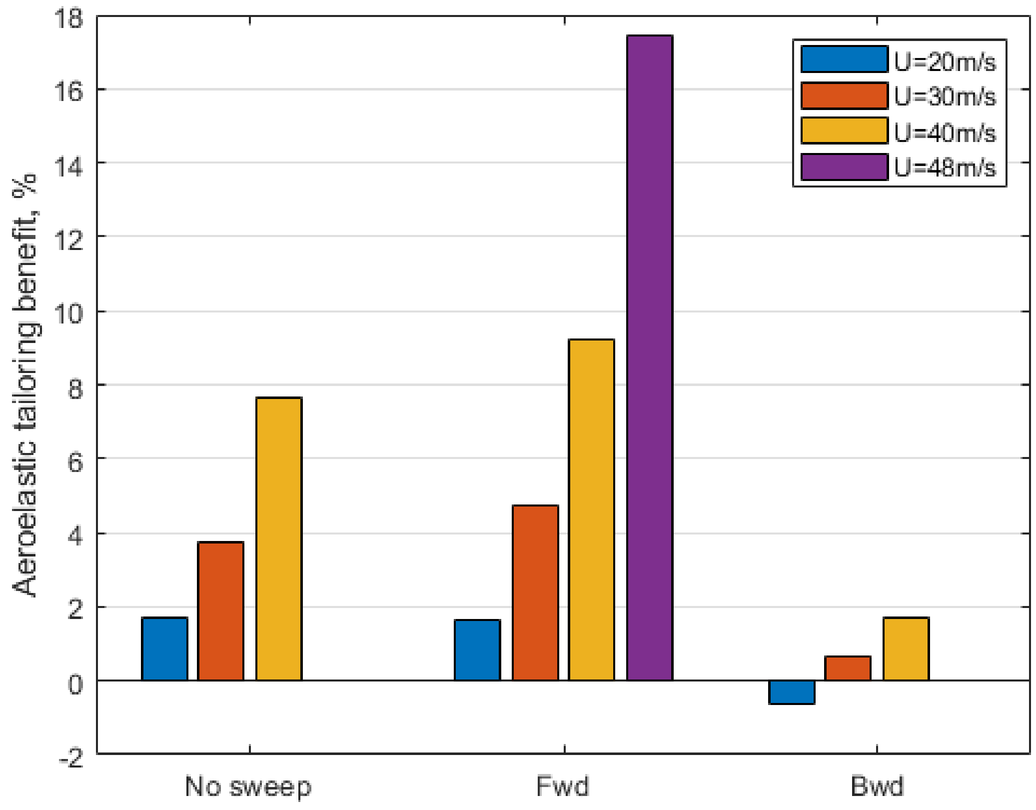
Model 2 – Load Measurements



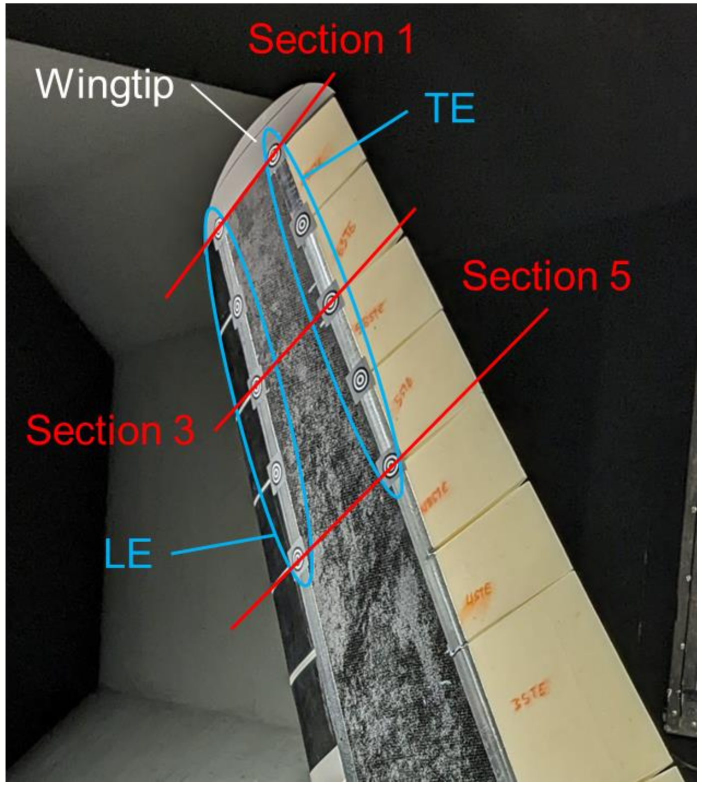


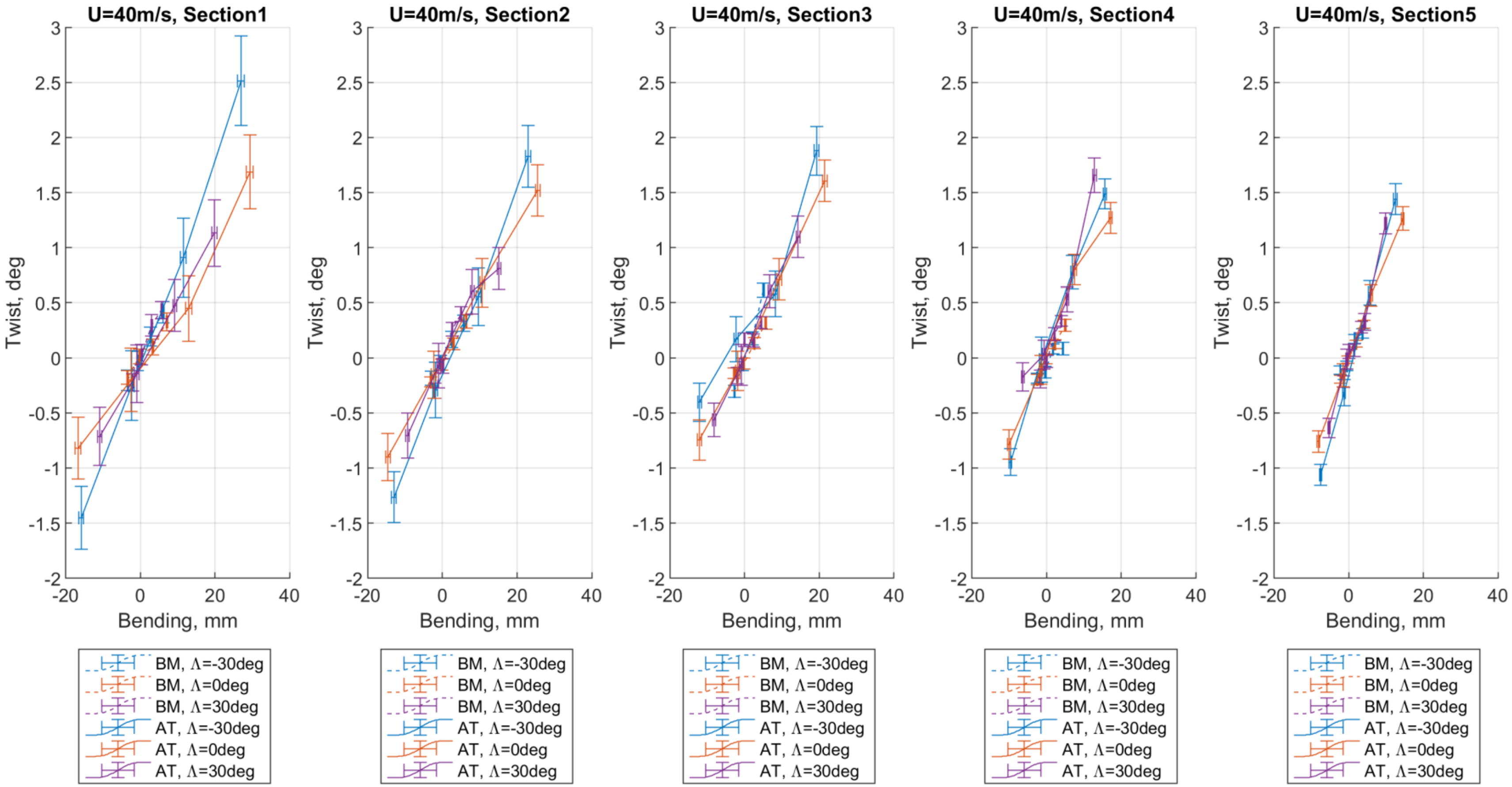
Model 2 – Load Measurements



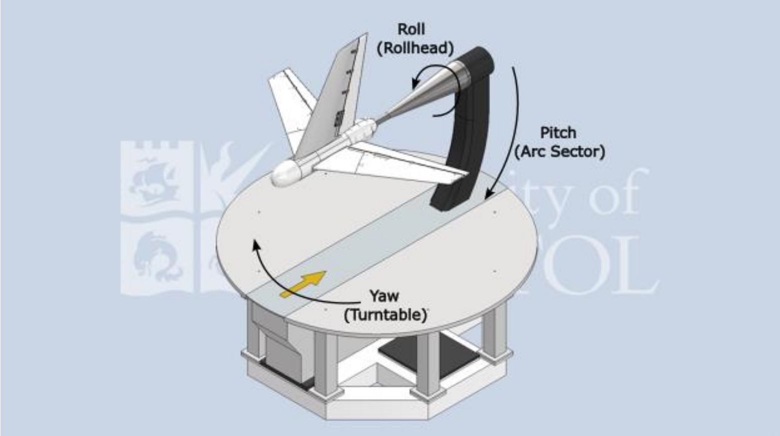


Model 2 – DIC measurements





Tailsurf Model 3

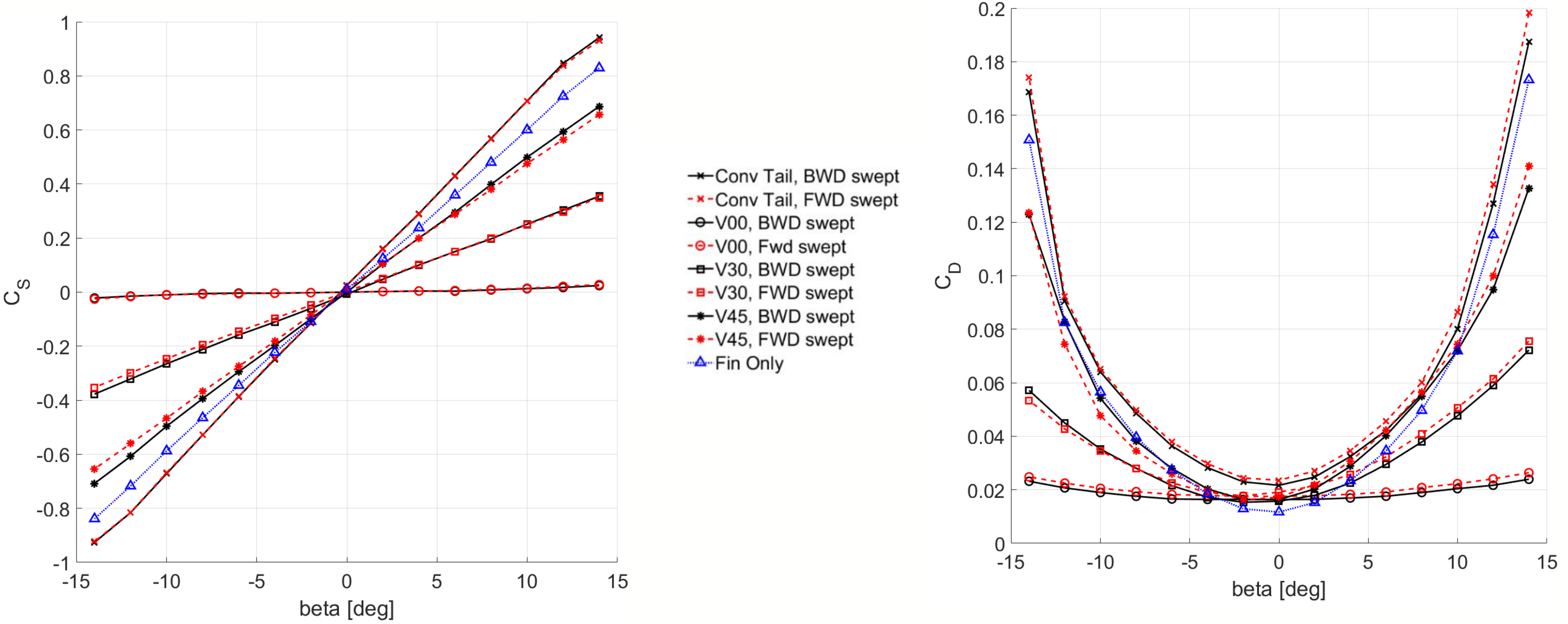


- Reconfigurable full tail configuration model
- 1.6 m HS span, 0.44 m^2HS surface, 0.31 m HS MAC
- 0.256 m^2 fin surface, 0.4 m fin MAC
- Turntable, Arc sector and rollhead allow change in yaw, pitch, roll respectively
- Sting-mounted on a 6-component balance to monitor performance.
- Tested at 50m/s, Re=1M
- Traditional and V-tail configurations, with different dihedral angles
- Both forward and backward swept configurations possible
- Elevators and rudder can be individually set, ruddervator in V configuration.

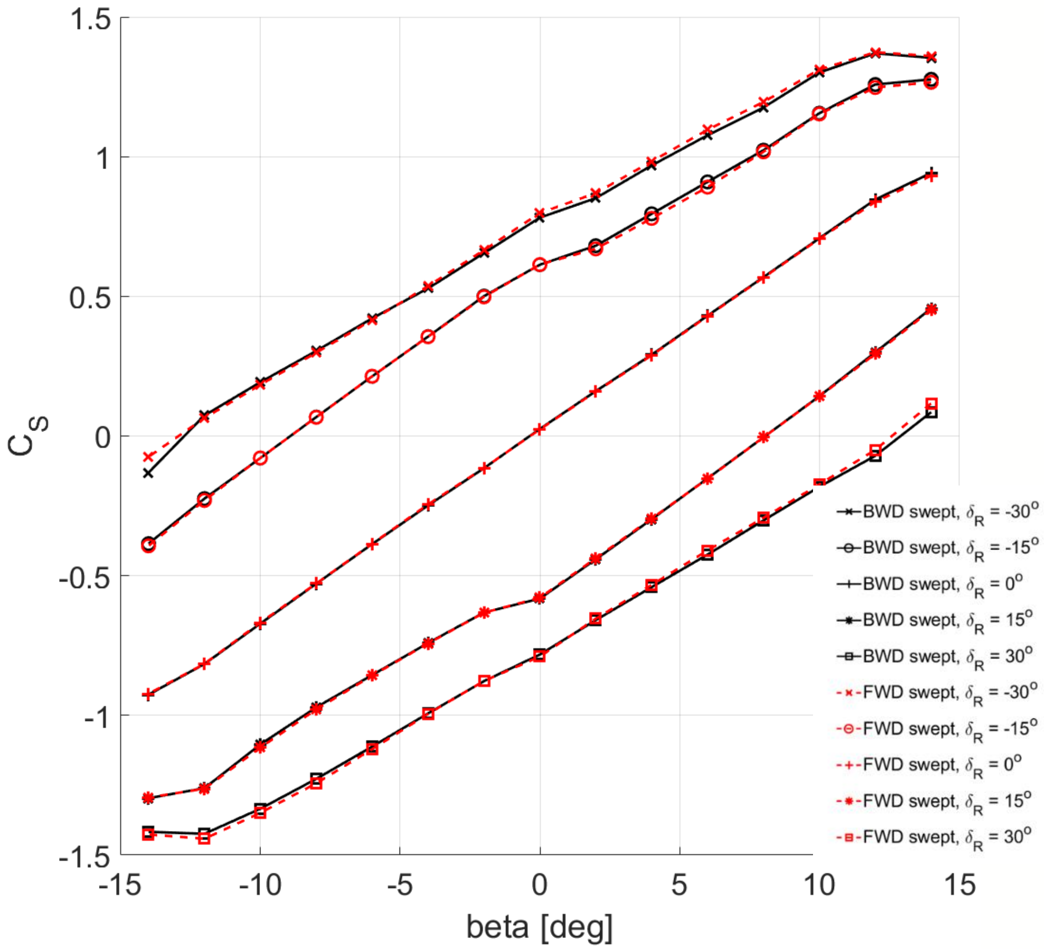
- Goal: Test the feasibility, in terms of stability and control authority, of tail configurations that requires fewer lifting surfaces, e.g. V-tails

- Lateral control can be achieved by an anti-symmetric ruddervator deployment
- Longitudinal control can be achieved by a symmetric ruddervator deployment

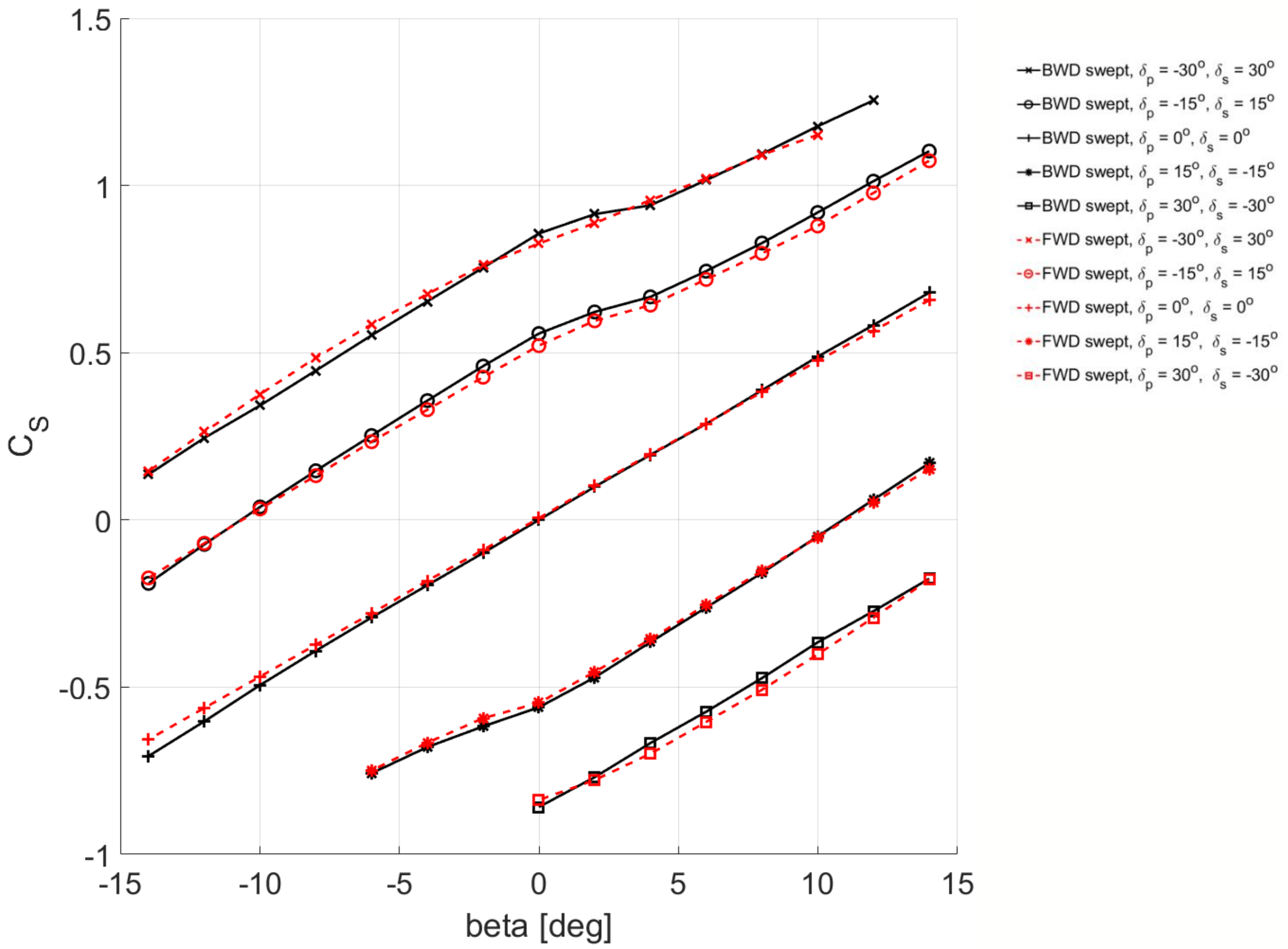
Model 3: Lateral stability



Model 3: Lateral control



Traditional Tail



V45 Tail

TAILSURF: continued work

- Intensive test programme over 6 months, only completed recently
- Data analysis to continue
- Model 3 especially has a large range of test configurations (V-angles, ruddervator settings)
- Set of valuable wind tunnel models

Thank you. Any questions?