Contribution to HiLiftPW-3

Benedikt König and Ehab Fares
Exa GmbH, Stuttgart, Germany

Mitsuhiro Murayama and Yasushi Ito
Japan Aerospace Exploration Agency (JAXA), Tokyo, Japan

013

3rd High Lift Prediction Workshop
Denver, CO June 3-4, 2017

Summary of cases completed: PowerFLOW, custom grid, LBM-VLES

Case	Alpha=8, Fully turb, grid study	Alpha=16, Fully turb, grid study	Other
1a (full gap)	no	no	
1b (full gap w adaption)	no	no	
1c (partial seal)	no	no	
1d (partial seal w adaption)	no	no	
Other			

Case	Polar, Fully turb	Polar, specified transition	Polar, w transition prediction	Other
2a (no nacelle)	yes	no	yes*	*Different AoA
2b (no nacelle w adaption)	no	no	no	
2c (with nacelle)	yes	no	yes*	*Different AoA
2d (with nacelle w adaption)	no	no	no	
Other				

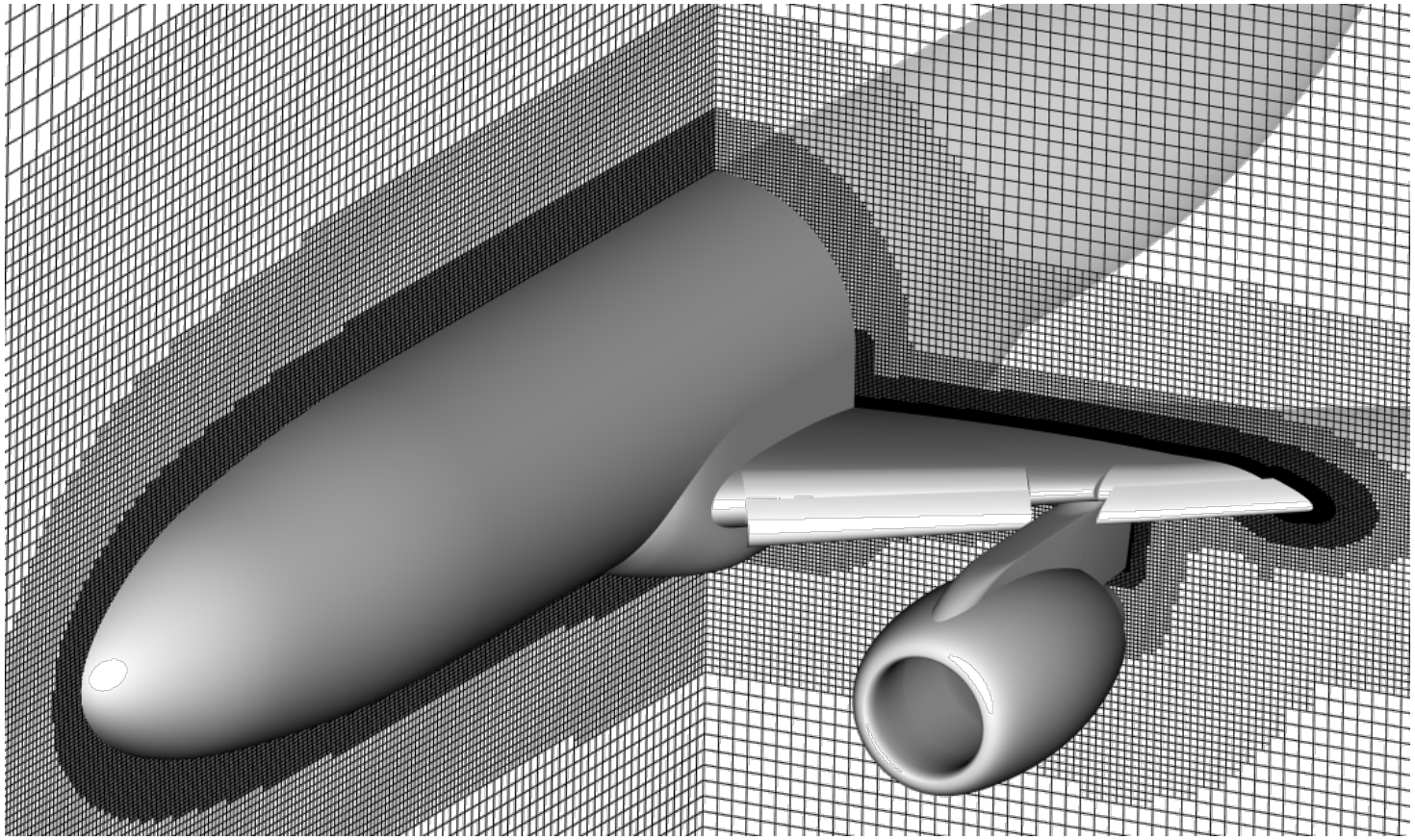
Case	2D Verification study	Other
3	no	
Other		

Summary of code and numerics used

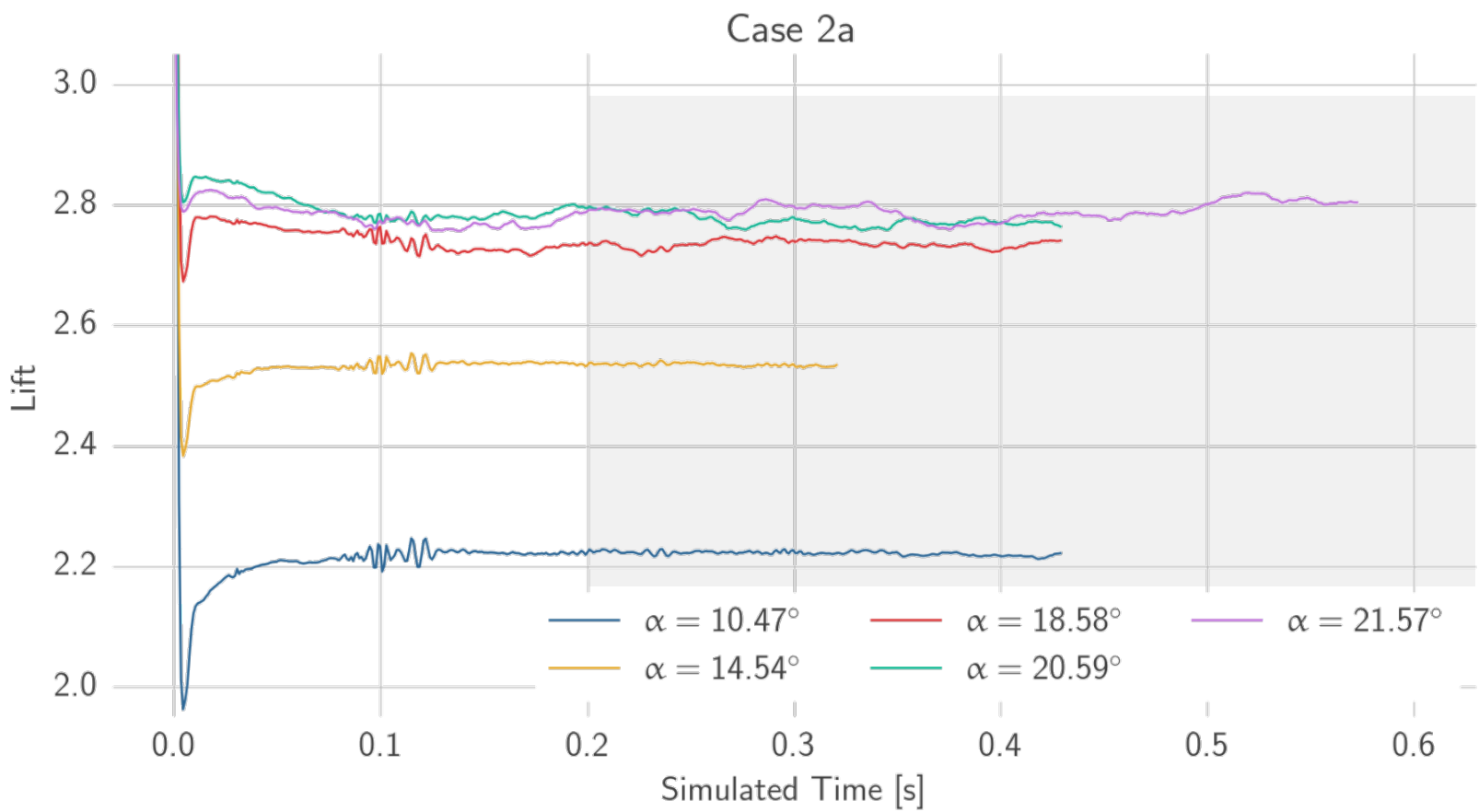
- Lattice Boltzmann based solver PowerFLOW® 5.4a
  - D3Q19 LBM
- Gird Approach
  - Cartesian Grid with Cubic Volume Cells (Voxels)
  - Automatic meshing of complex geometries
- Fully transient
- Turbulence Model: LBM-VLES
  - Modified RNG k-ε model for unresolved scales
  - Swirl model
  - Extended wall model

Brief overview of grid system(s)

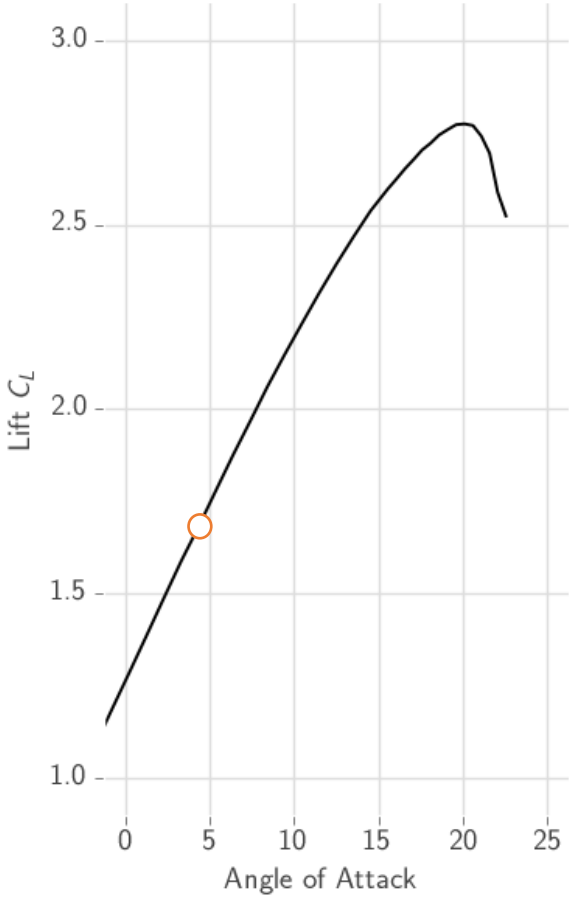
Grid System	Case(s)	If committee grid, report any problems/issues If user grid, reason for generating grid system
Committee (Grid name)		
User (Grid type/description)	2a, 2c	Automatic meshing, tied to flow solver
Other		

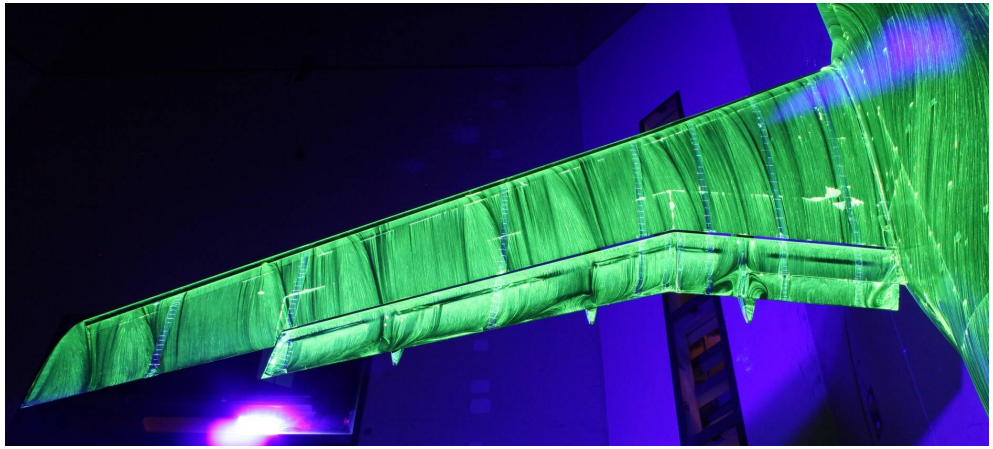


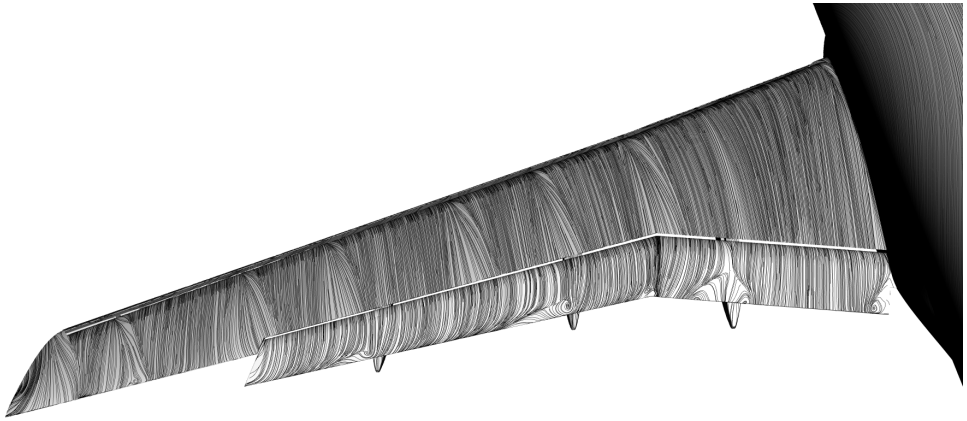
Force history



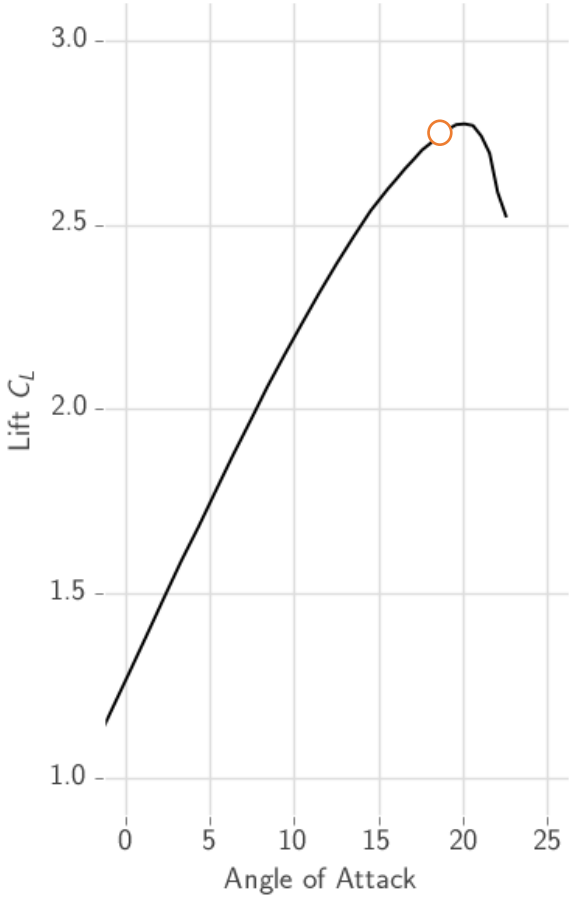
Surface Flow Visualization

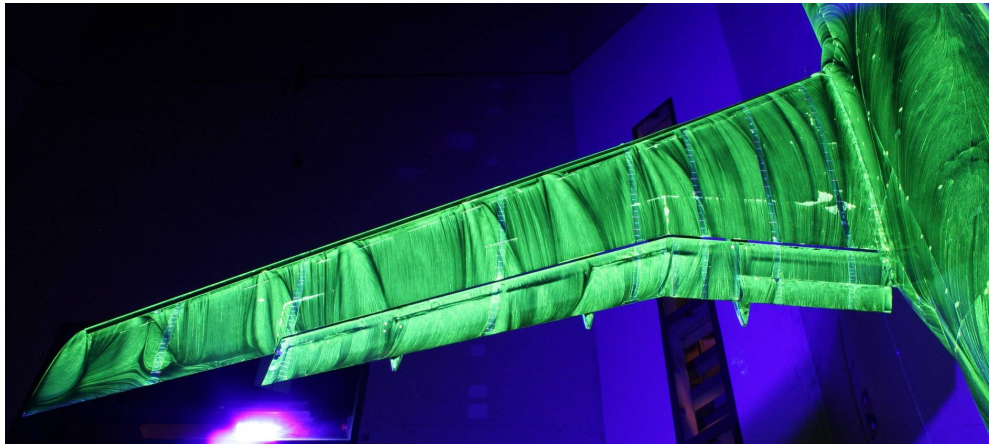


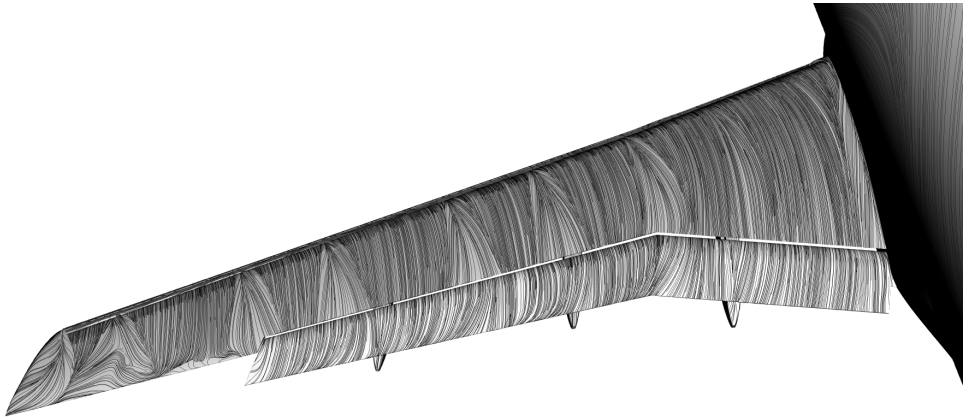




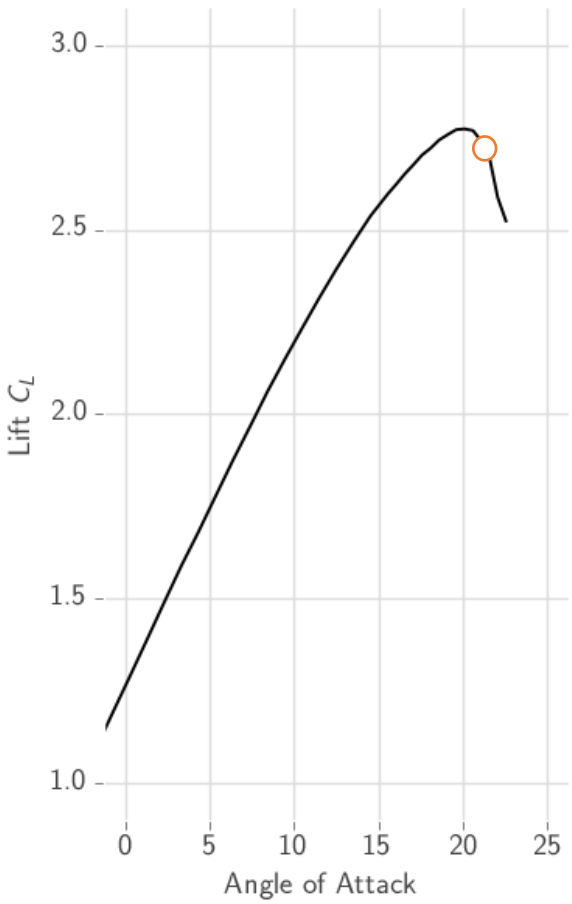
Surface Flow Visualization

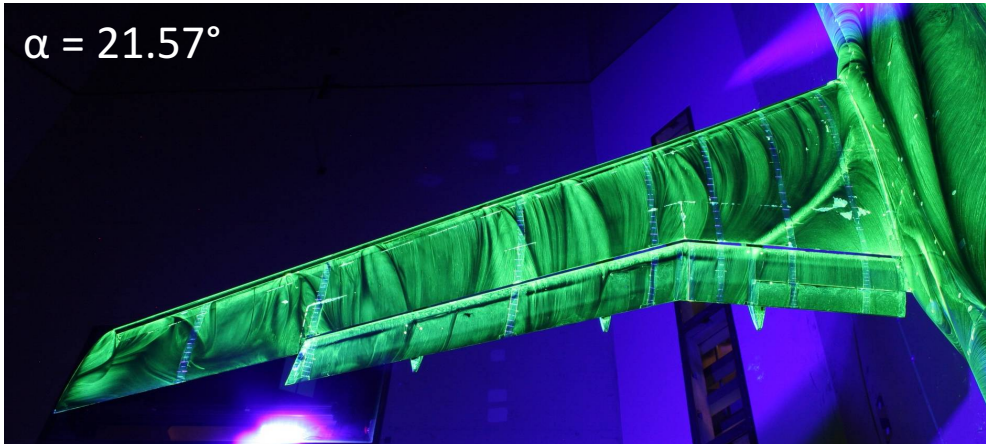


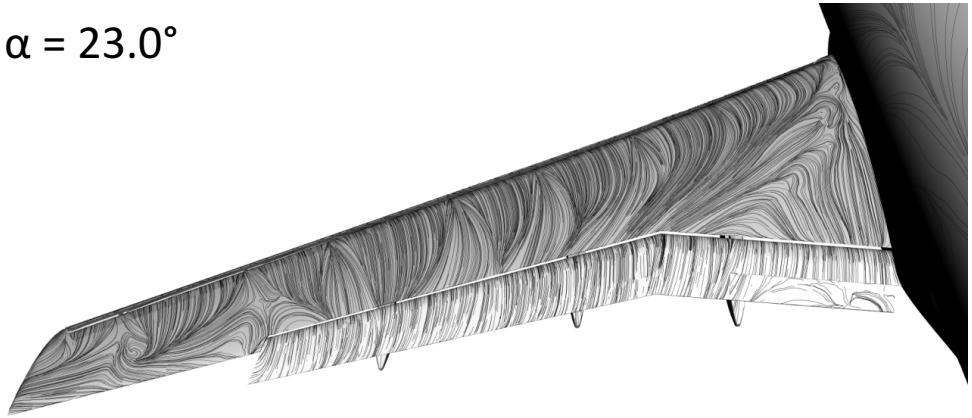




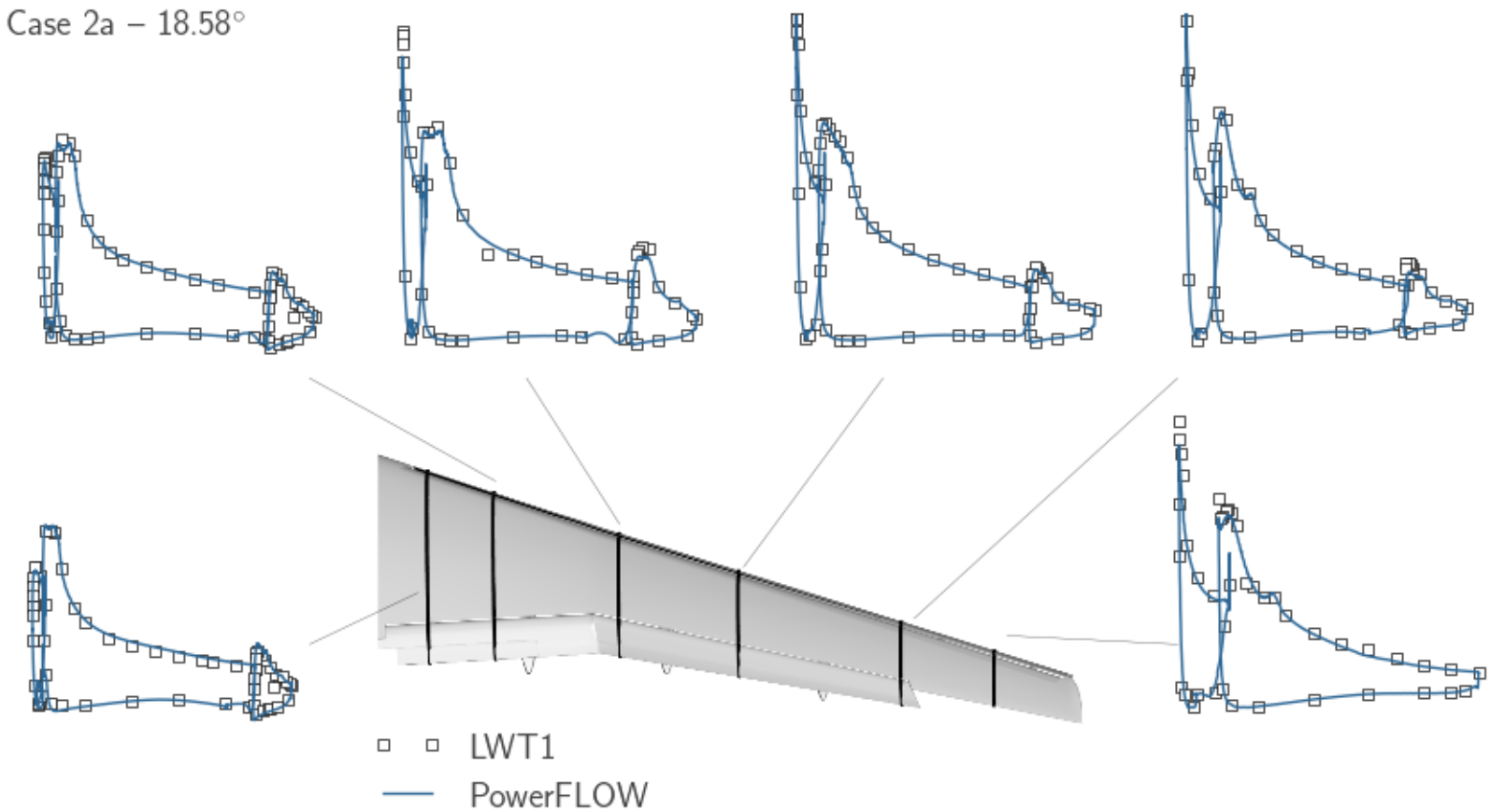
Surface Flow Visualization



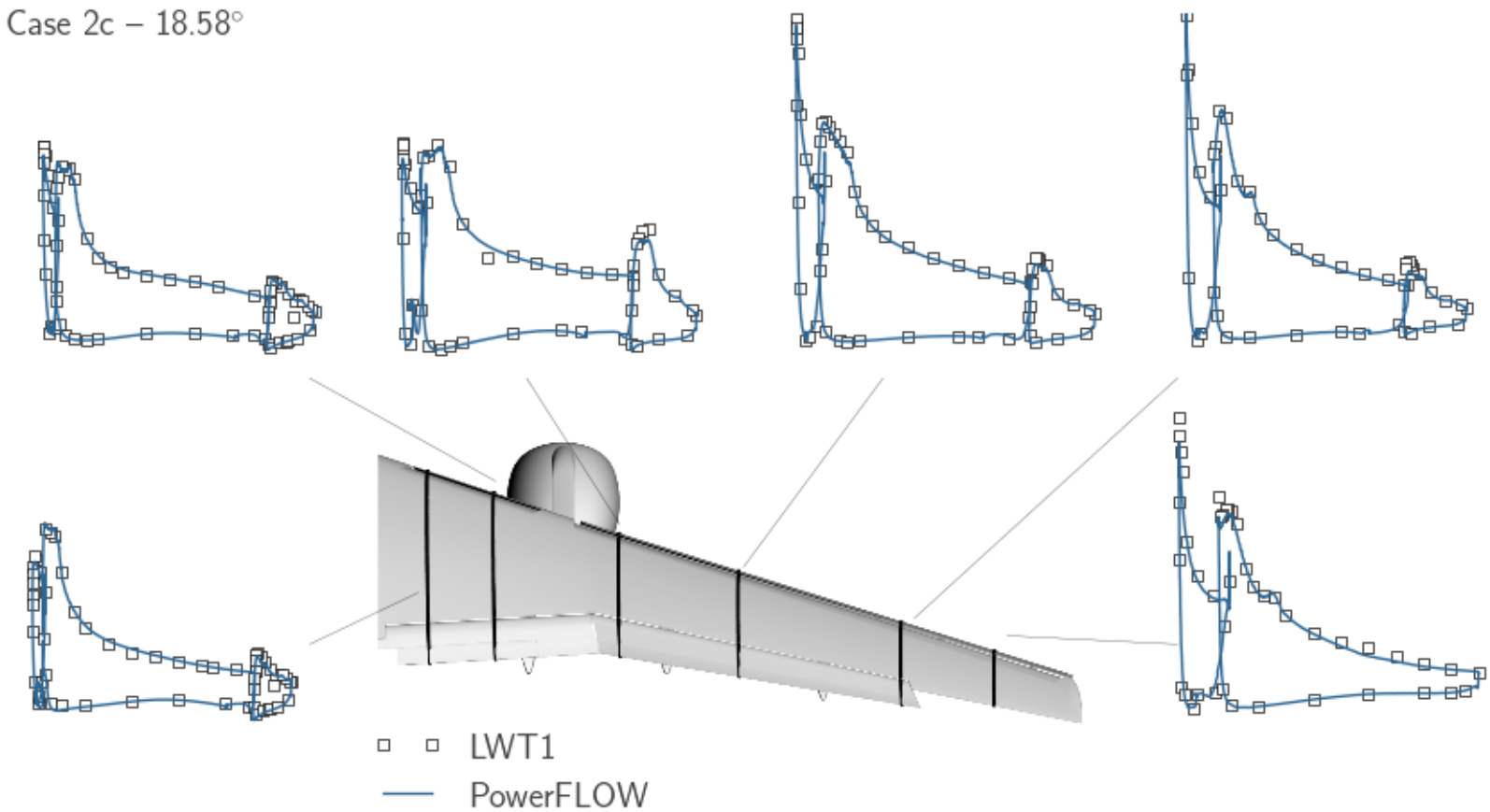




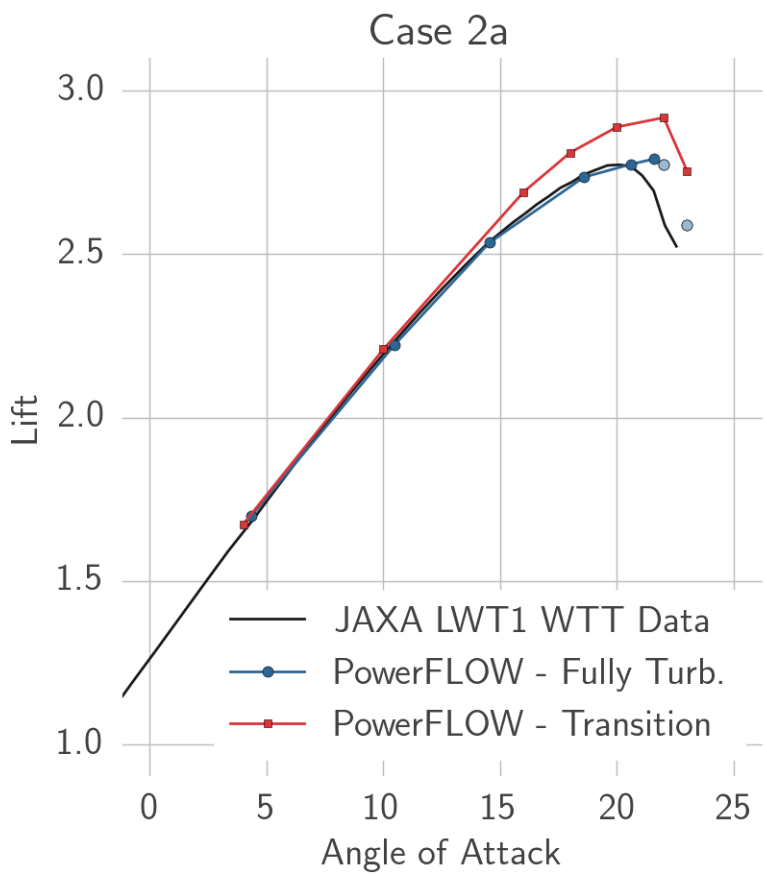
Pressure Distribution – Case 2a

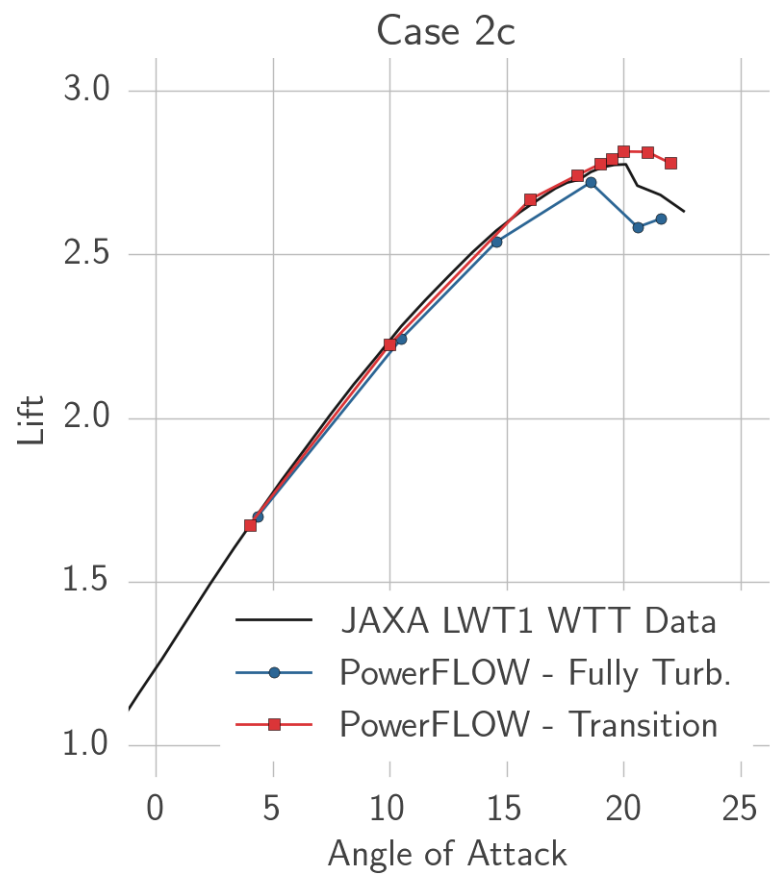


Pressure Distribution – Case 2c

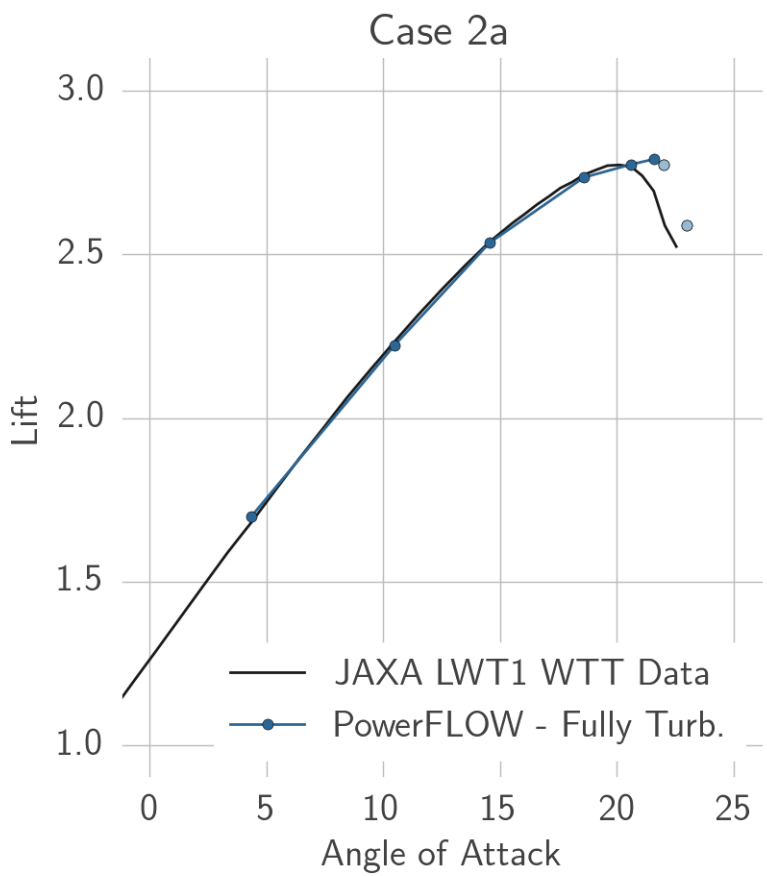


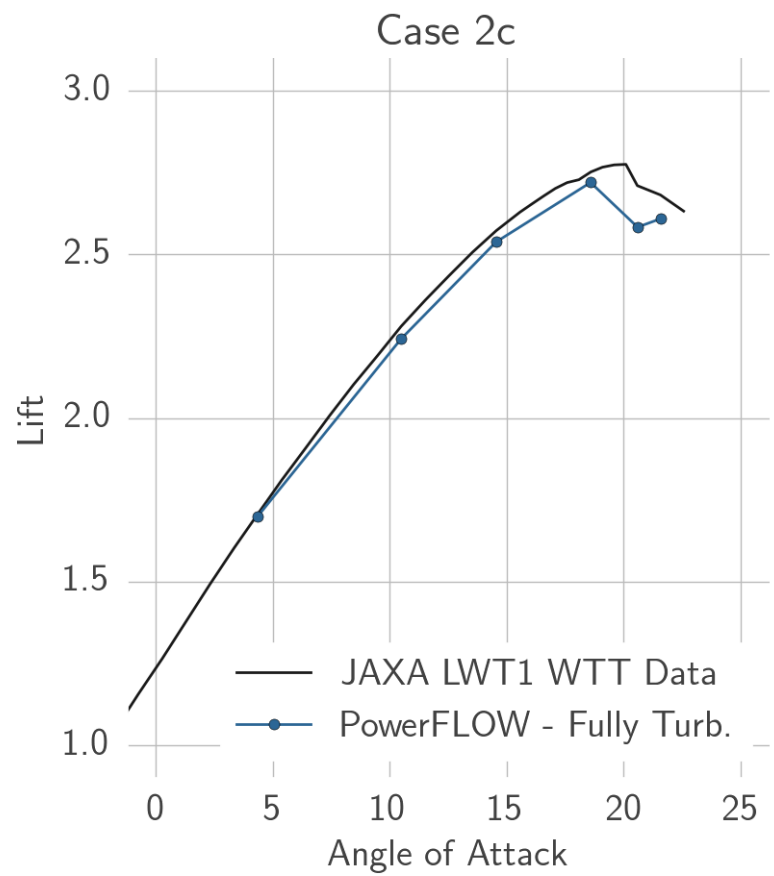
Cases 2a/2c – Lift





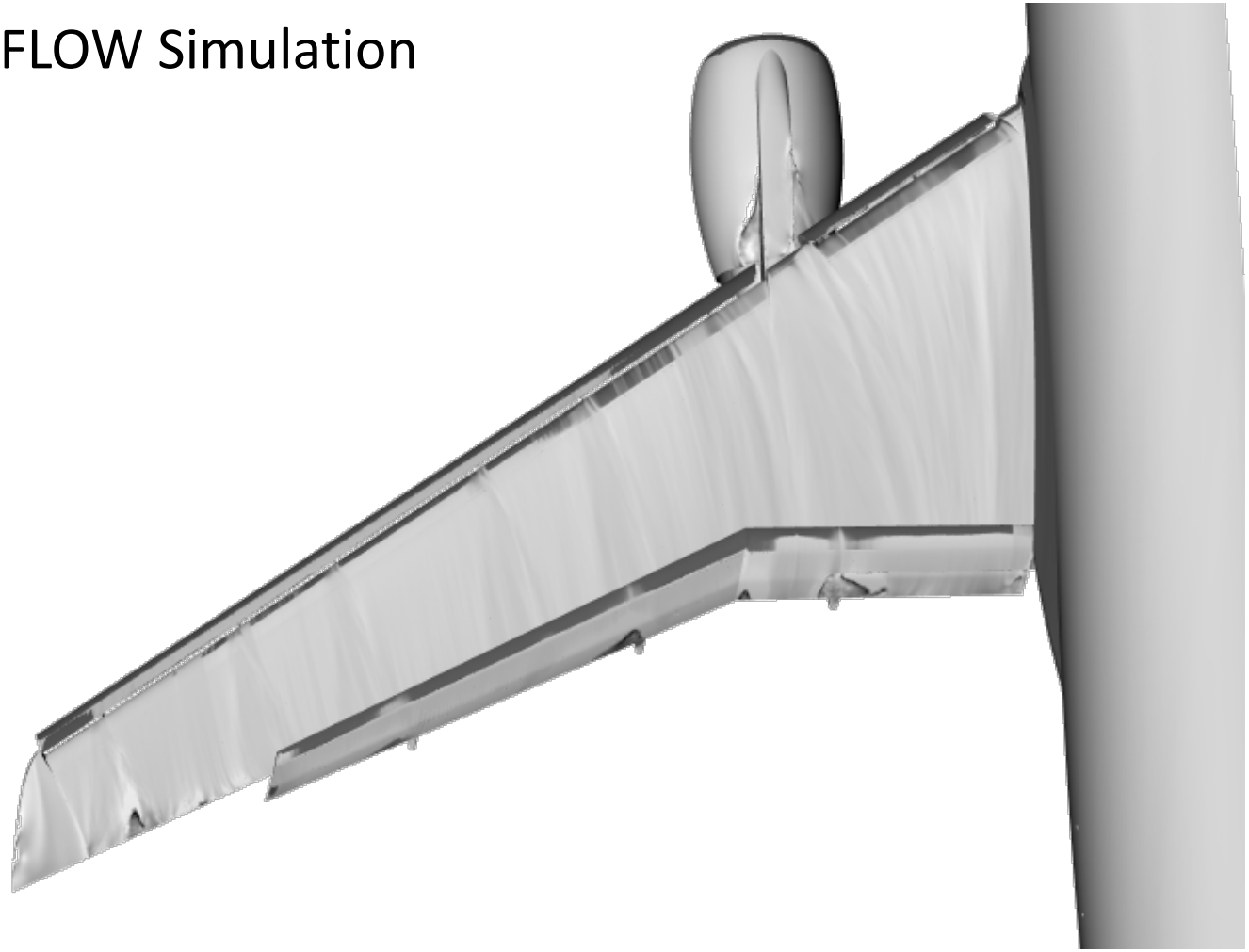
Cases 2a/2c – Lift



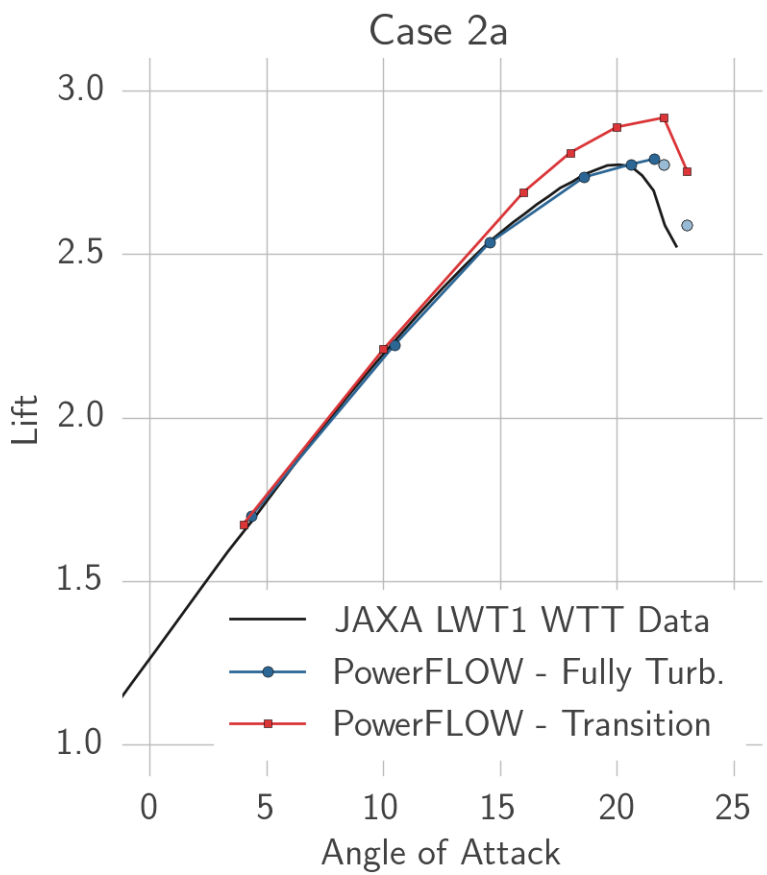


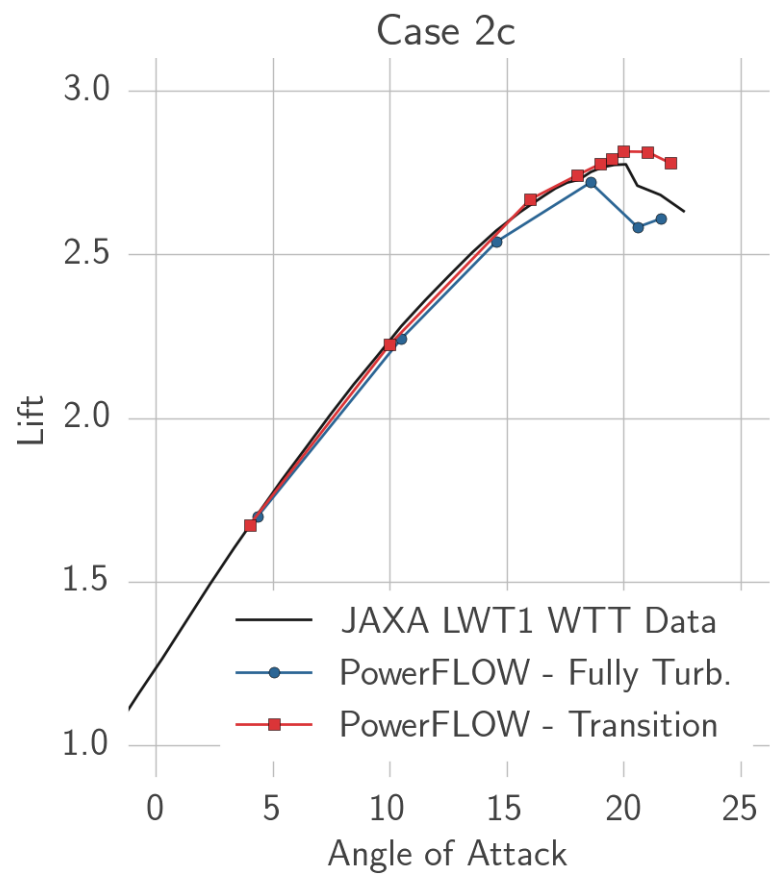
Transition Visualisation

PowerFLOW Simulation

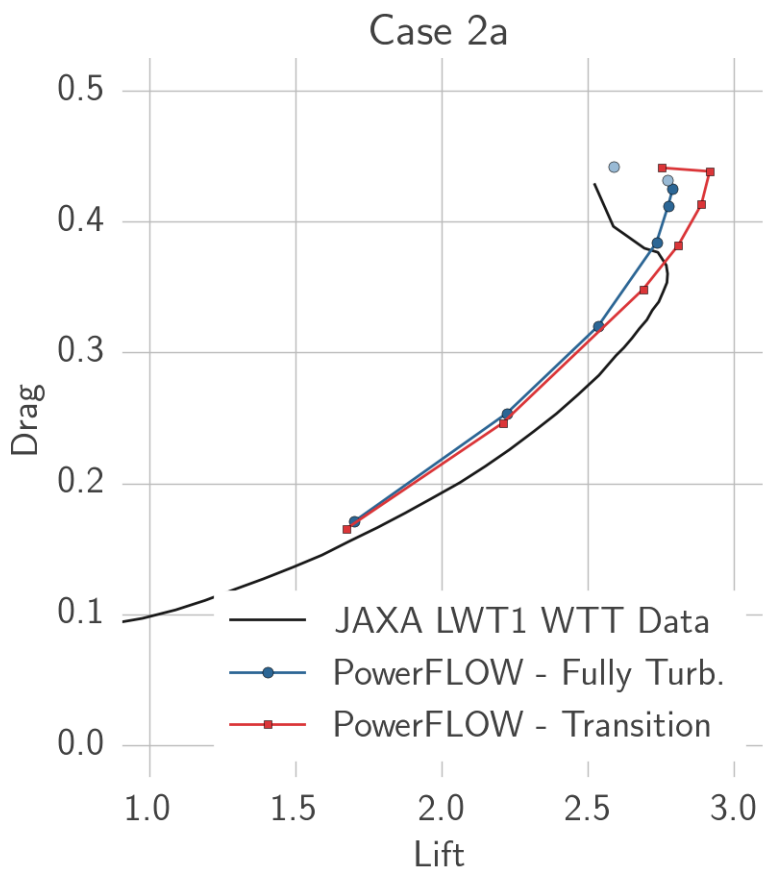


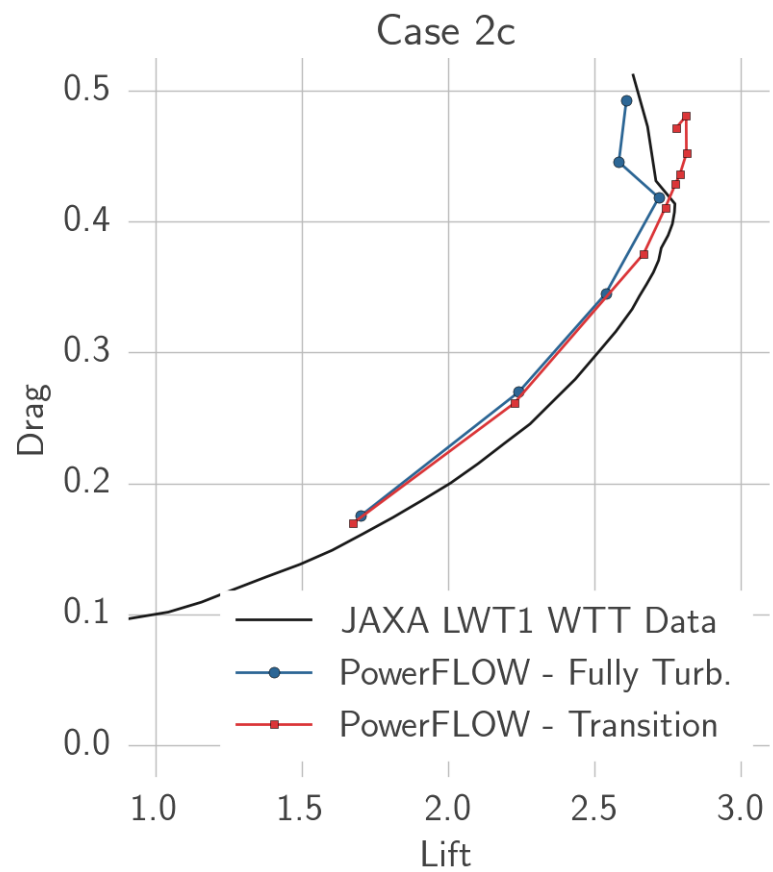
Cases 2a/2c – Lift



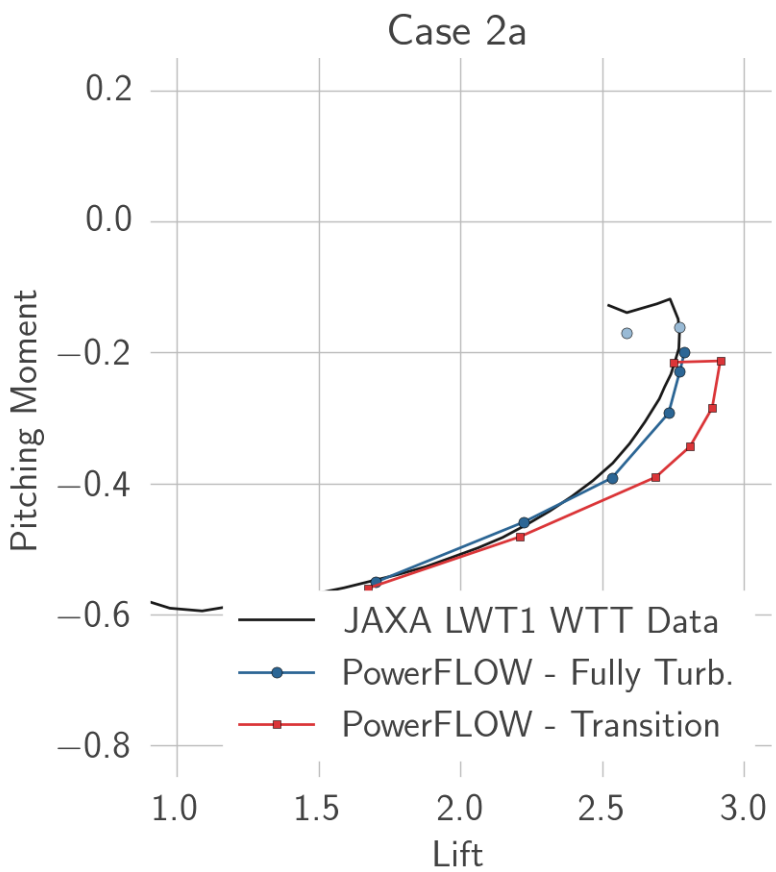


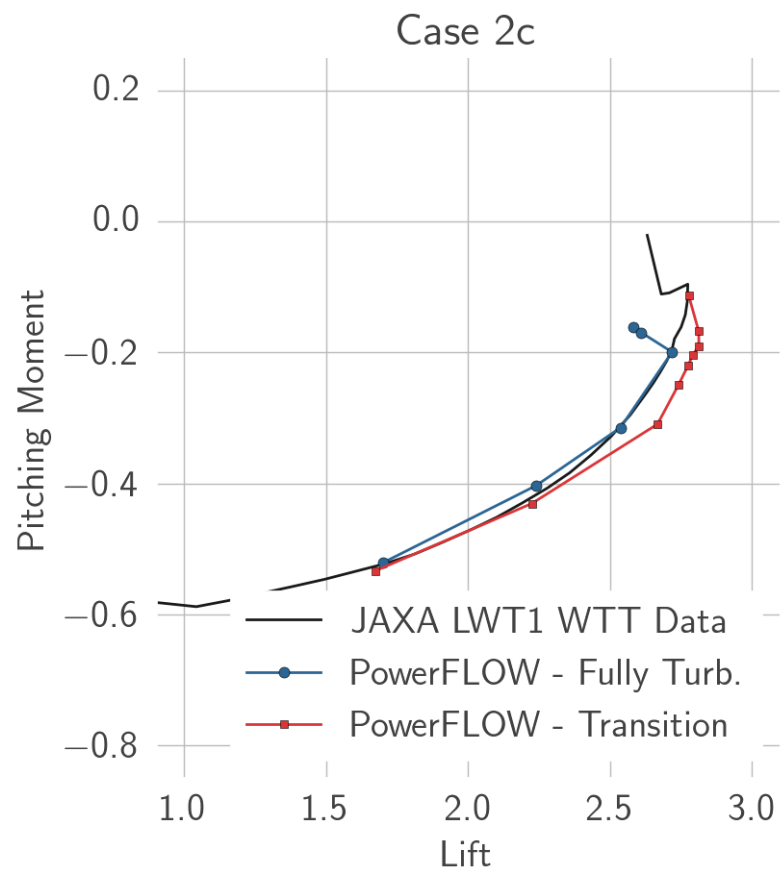
Cases 2a/2c – Drag





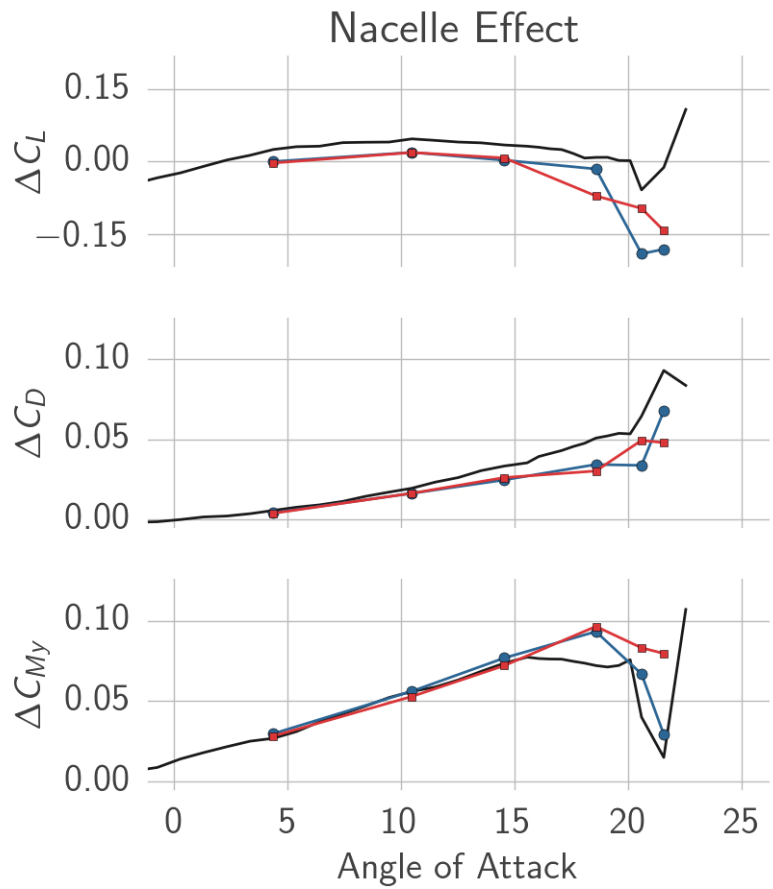
Cases 2a/2c – Pitching Moment





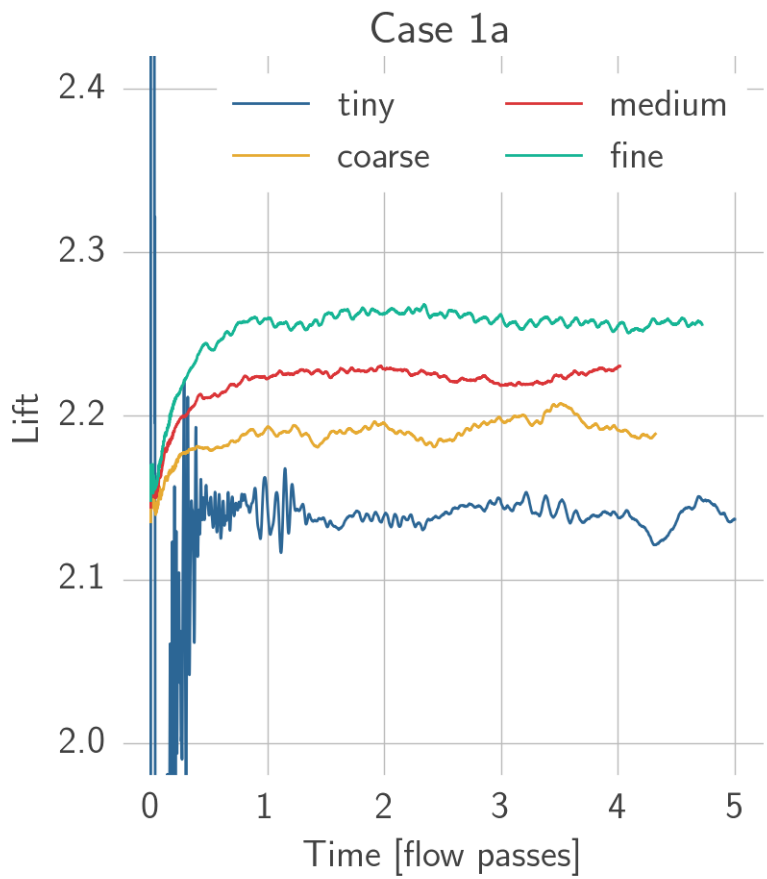
Nacelle/Pylon Effect

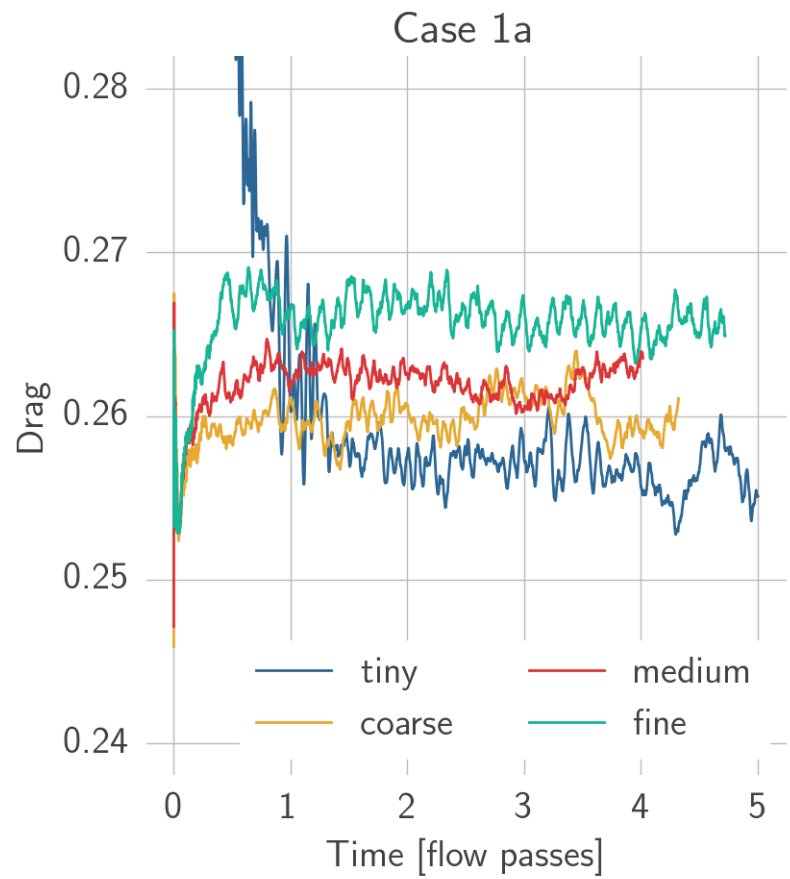
- Nacelle effect well captured
- ΔC_L affected by case-dependency of transition



Brief overview of HL-CRM results

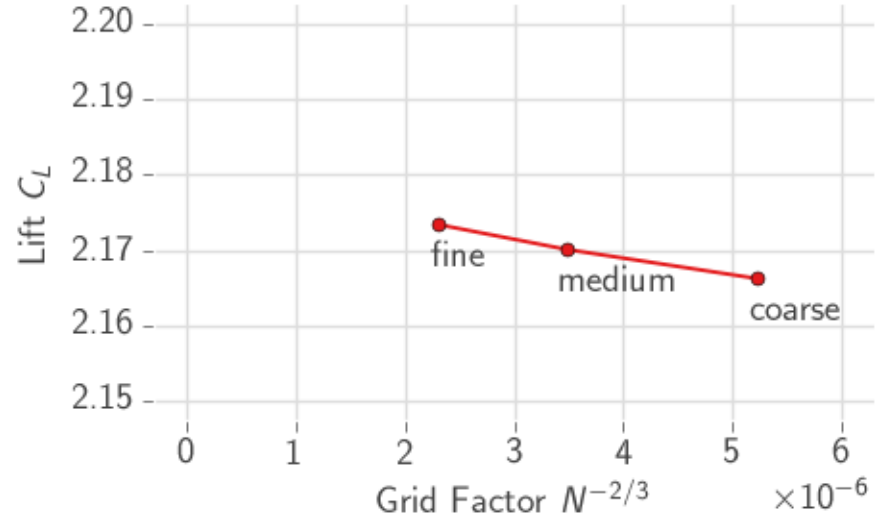
- Simulated case 1a at α=16°, but:
  - Significant unsteadiness requires *much* longer averaging than expected
  - Could not conclude due to resource limitations

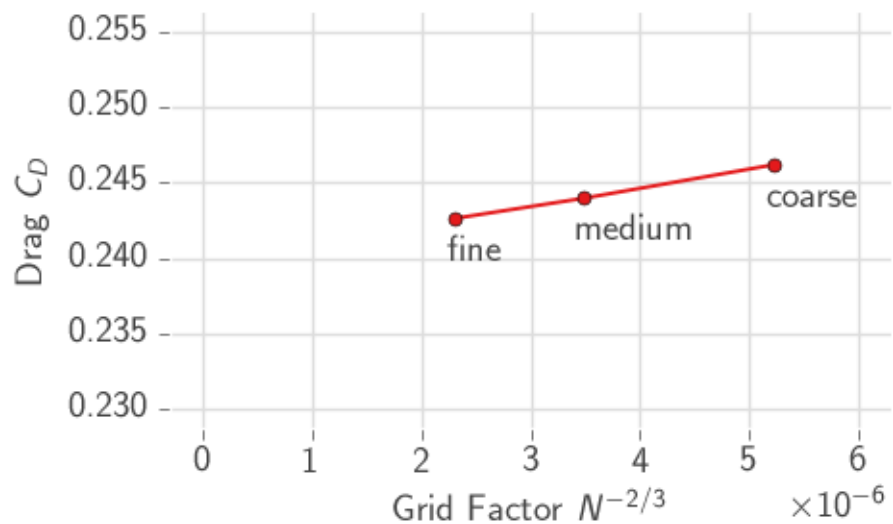




Grid Convergence Study - Alternative

- Previous study done on JSM
- Grid convergence shown for lower angle of attack (10°)



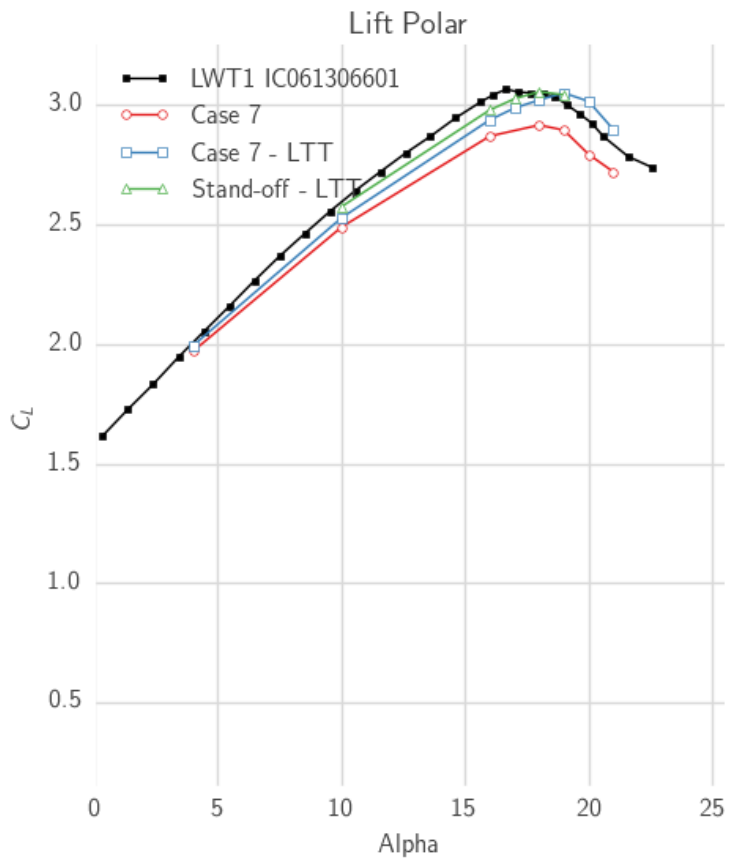


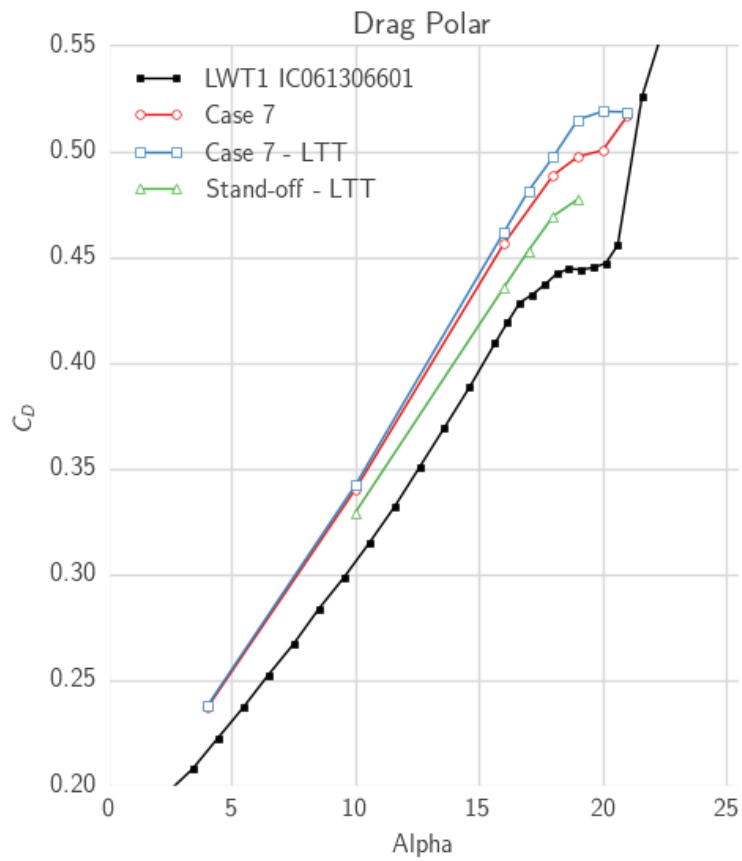
Summary

- JSM configuration well suited for CFD validation
- Integral forces well matched
  - Case-dependent transition effect present
  - C_{Lmax} good, depending on transition
  - C_D consistently over-predicted
  - Nacelle/pylon effect well captured
- Flow topology and Cp well matched
- Grid convergence at high angles of attack requires long averaging time

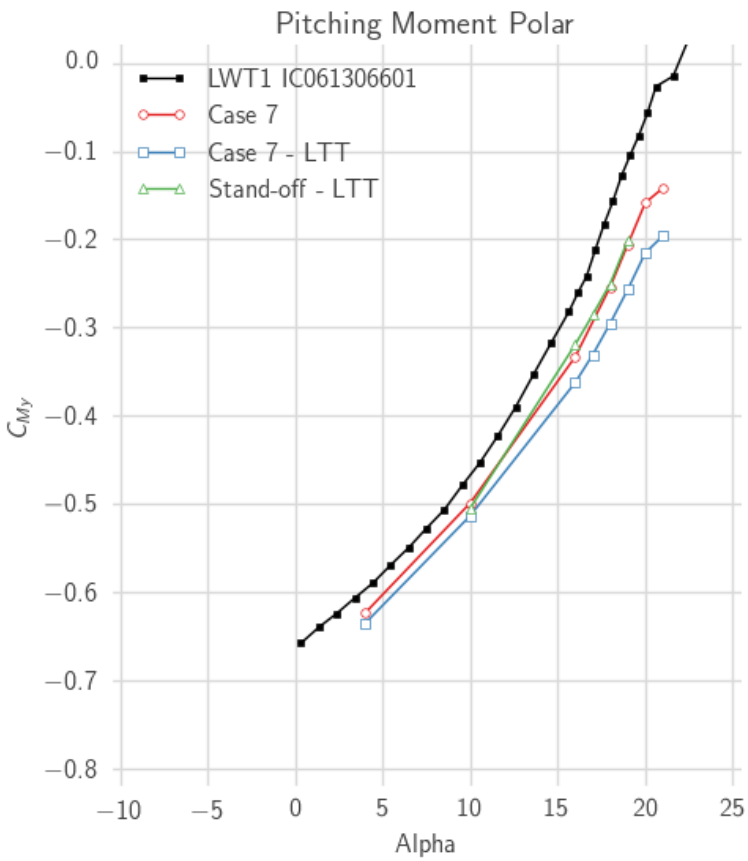
Thank you

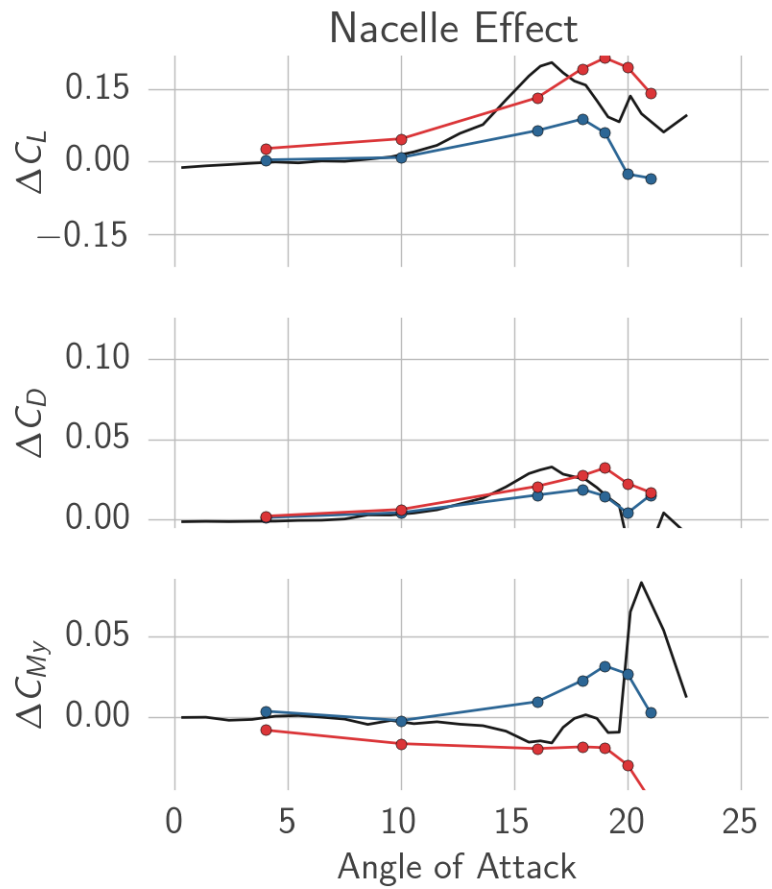
Beyond HiLiftPW-3 – Stand-off





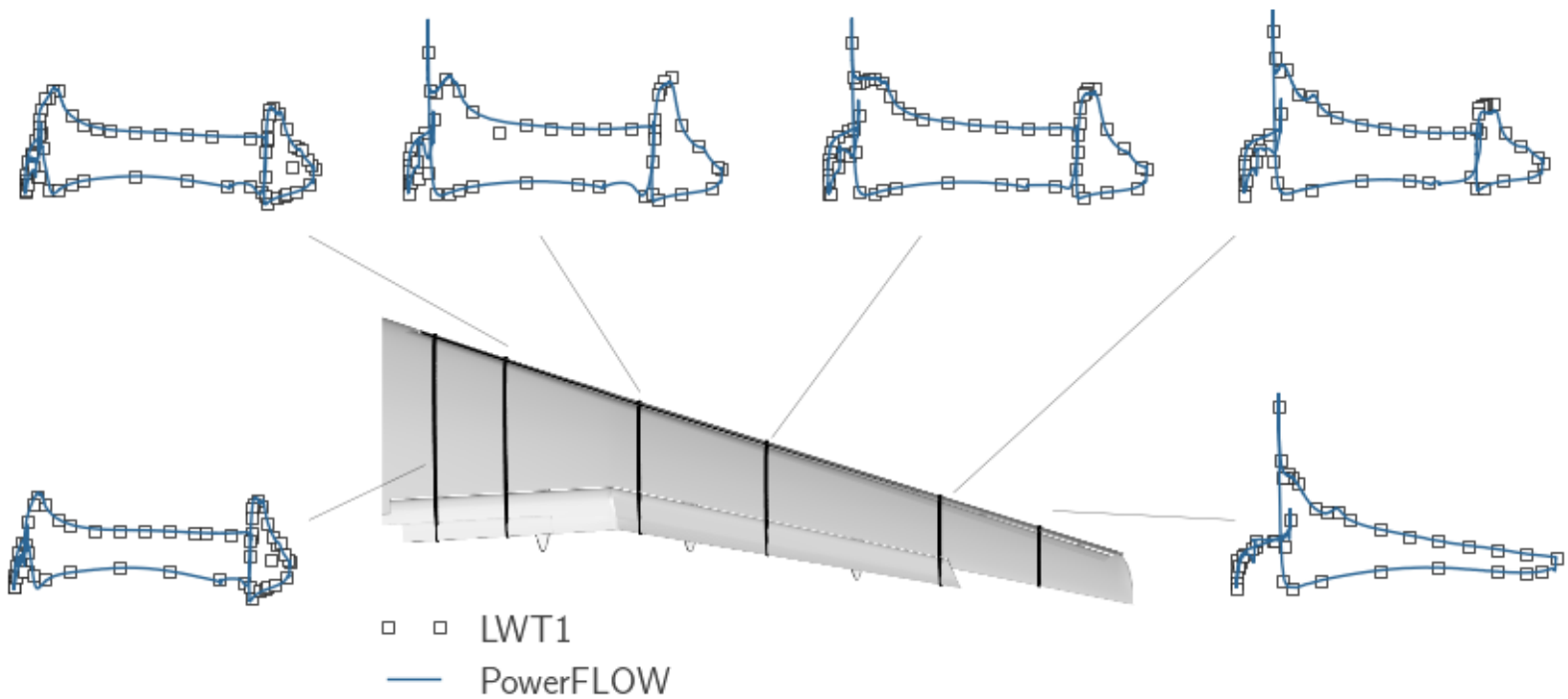
Beyond HiLiftPW-3 – Stand-off





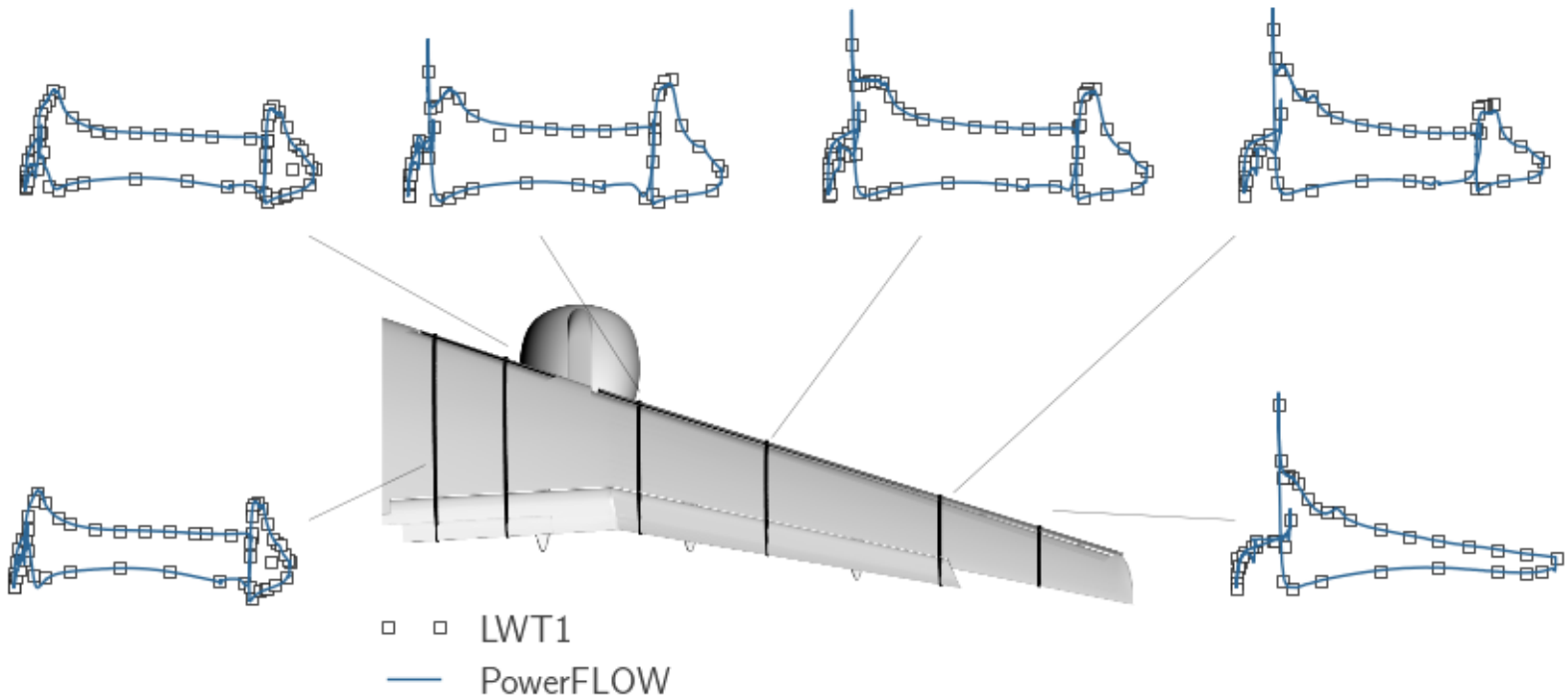
Pressure Distribution – Case 2a

Case 2a – 4.36°

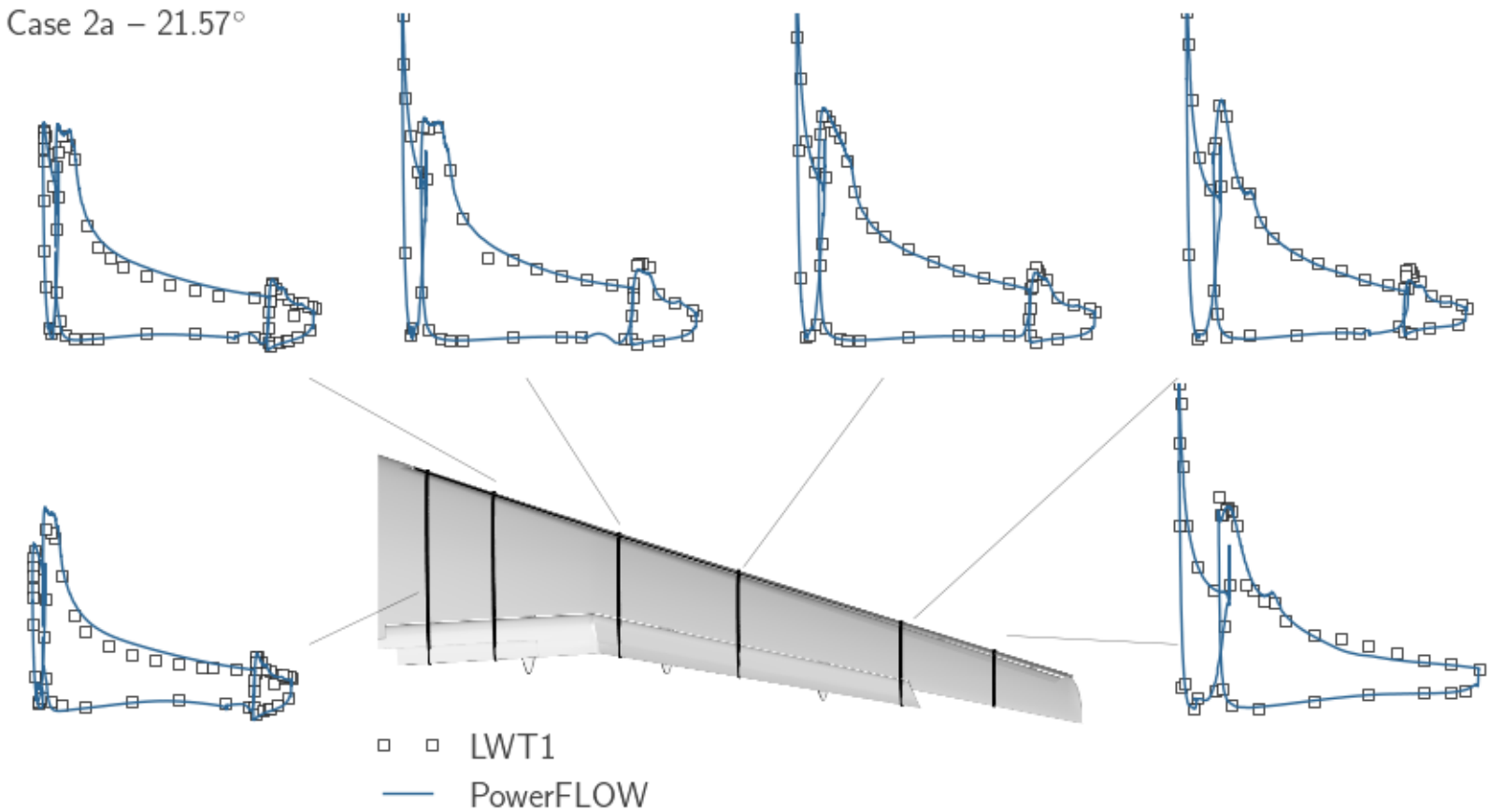
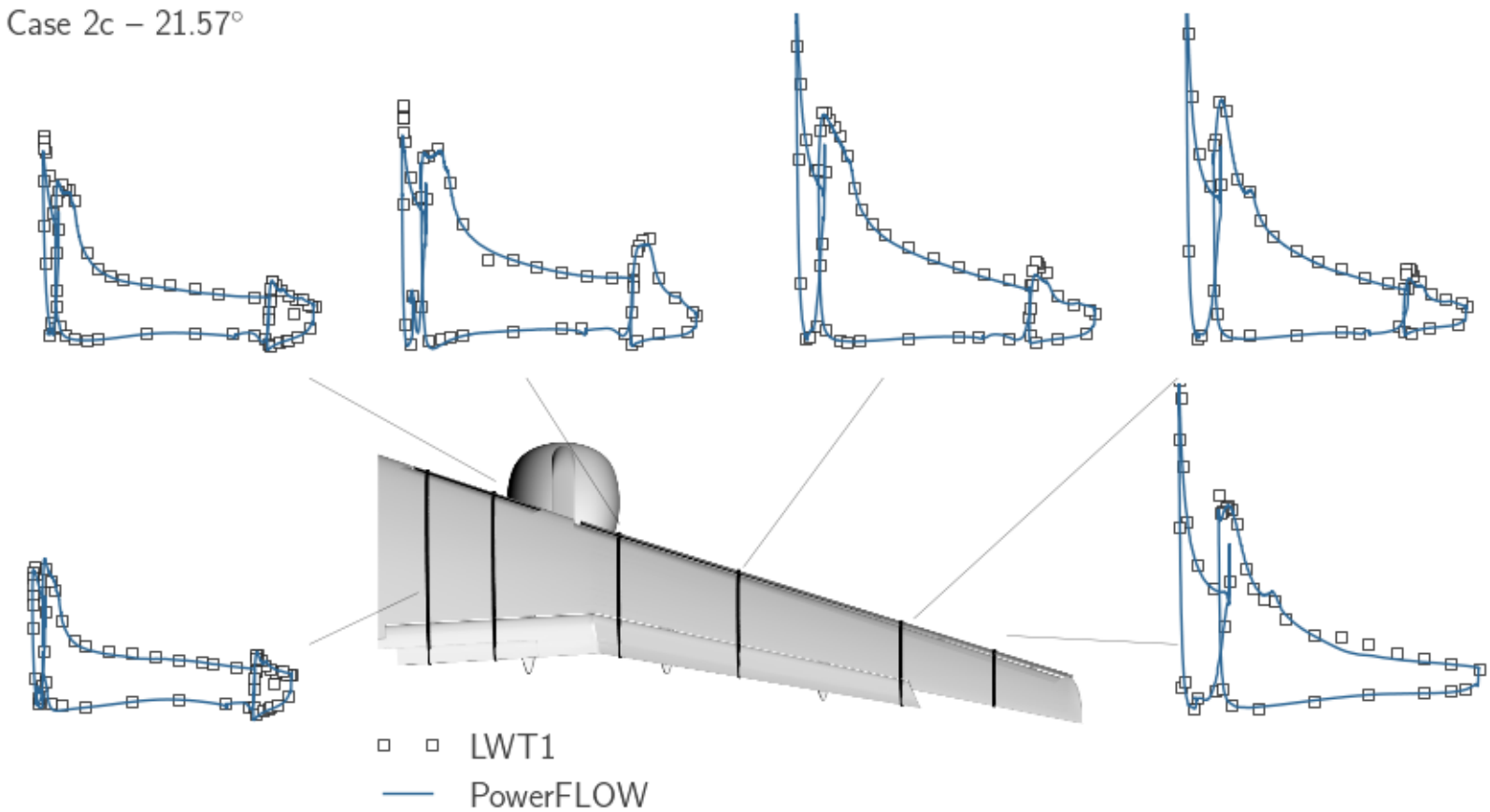


Pressure Distribution – Case 2c

Case 2c – 4.36°



Pressure Distribution – Case 2a



Pressure Distribution – Case 2c