Wind Tunnel Test Result Summary for the NASA Common Research Model

2023 AIAA Aviation Forum
San Diego, CA

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June 12, 2023

Outline

- Background
- Experimental Tests
- Results
  - NTF 197
  - Ames 216
  - NTF 215
  - NTF 229
  - ETW
- Concluding Remarks

Background

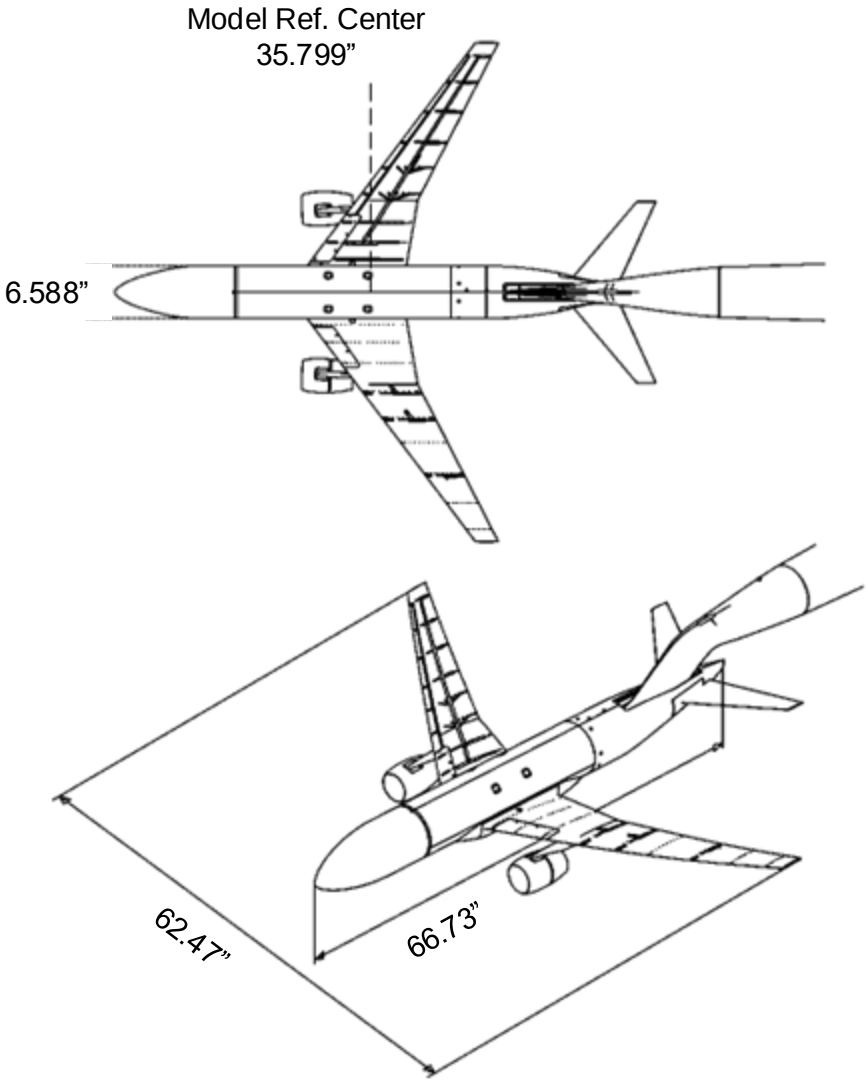
- Motivation for creation of the Common Research Model
  - modern/industry-relevant data
  - open/public geometries
- Design was led by NASA and Boeing before being frozen in 2008
- NASA's initial commitment: complete two tests that would provide data for the international Drag Prediction Workshop (DPW)-IV (2009, blind calculations)
- Tests
  - 2010, National Transonic Facility (NTF) at the NASA Langley Research Center, NTF 197
  - 2010, 11-Foot Transonic Wind Tunnel Facility (11-Ft) at the NASA Ames Research Center, Ames 216
  - 2013, NTF to provide test-to-test repeatability data, NTF 215
  - 2014, European Transonic Windtunnel (ETW) as part of an EU initiative
  - 2019, NTF to provide test-to-test repeatability data after facility upgrades, NTF 229
- To facilitate the dissemination of the acquired data, a website was set up to provide a place where people from all over the world can retrieve information specifically related to their needs

Background

- Many organizations worldwide have embraced the CRM geometry for both computational and experimental research
  - industry
  - academia
  - government agencies
- Variations of the original CRM have been fabricated and tested in facilities all over the world
- Further CRM-based collaborations and use of the configuration are wide and varied – far beyond the initial expectations in 2007 when the concept was conceived

Background
Model Description

- Common Research Model



- S_{ref} = 3.01 ft^2
- c = 7.45 in
- b = 62.46 in
- AR = 9.0
- Designed for M_∞ = 0.85 and C_L = 0.5

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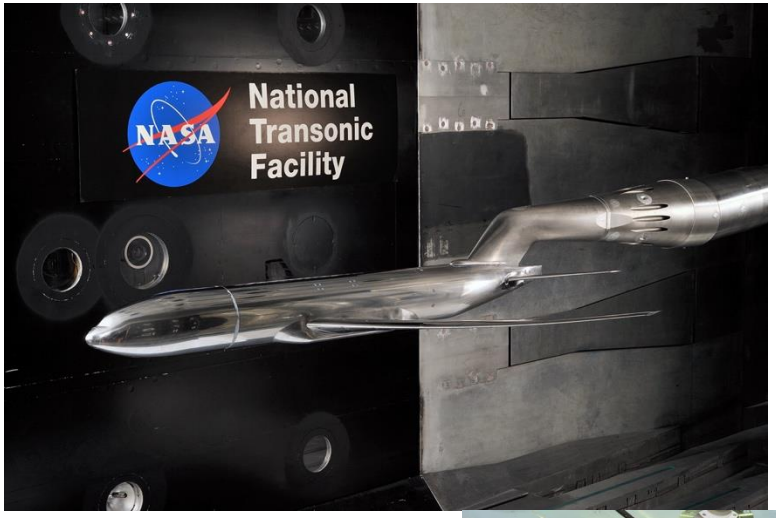
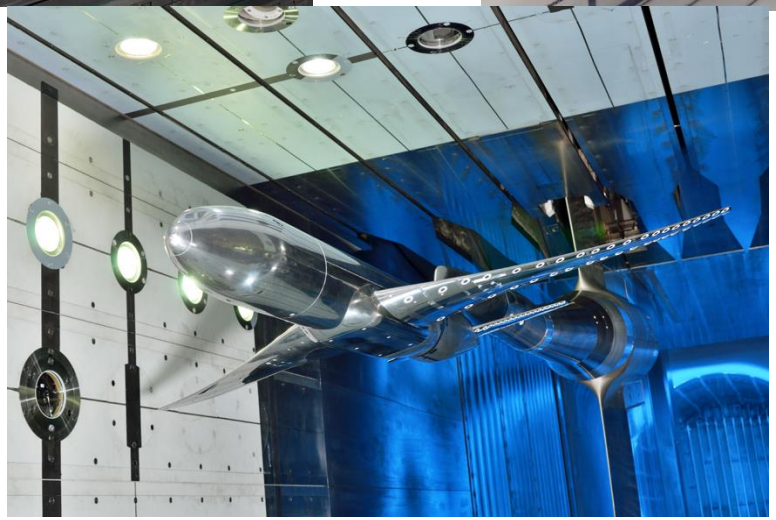
Experimental Tests

Test	Mach	Re_c, million	α	T_t, °F	Configurations Tested
NTF 197	0.7 to 0.87	5, 19.8, 30	-3° to +12° @ low Re_c -3° to +6° @ high Re_c	-250 up to 120	WB, WBNP, WBT0, WBT-2, WBT+2
Ames 216	0.7 to 0.87	5	-3° to +12°	100	WB, WBNP, WBT0, WBT-2, WBT+2
NTF 215	0.7 to 0.87	5, 19.8, 30	-3° to +12° @ low Re_c -3° to +6° @ high Re_c	-250 up to 120	WB, WBNP, WBT0
NTF 229	0.7 to 0.87	5, 19.8, 30	-3° to +12° @ low Re_c -3° to +6° @ high Re_c	-250 up to 120	WB, WBT0
ETW	0.25 to 0.87	5, 19.8, 30	-3° to +12° @ low Re_c -3° to +6° @ high Re_c	-249 to 84	WBT0

Experimental Tests

- More details can be found in AIAA 2010-4218, AIAA 2011-1126 and AIAA 2015-1093





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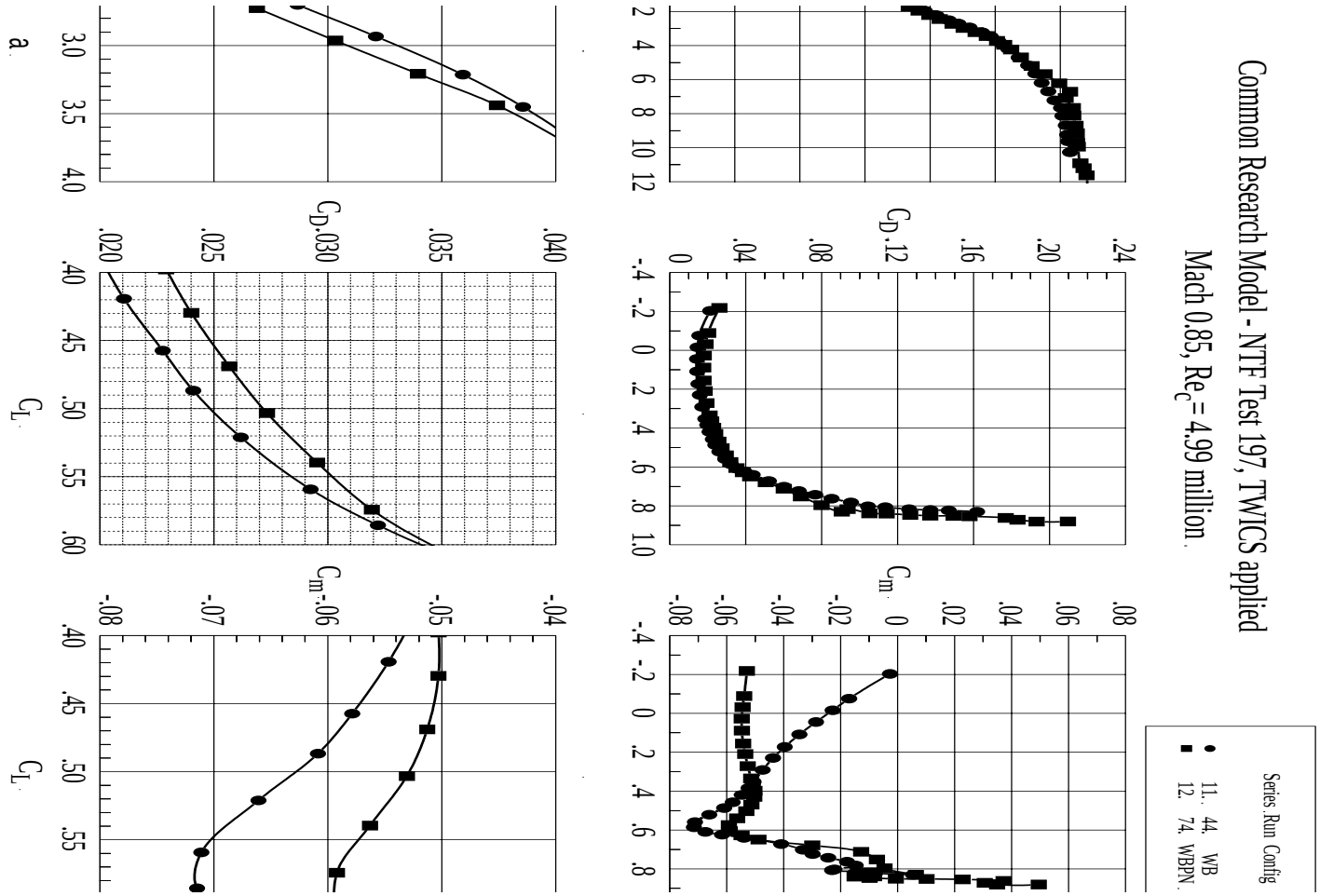
Results & Discussion

NTF 197 Pylon/Nacelle Effects

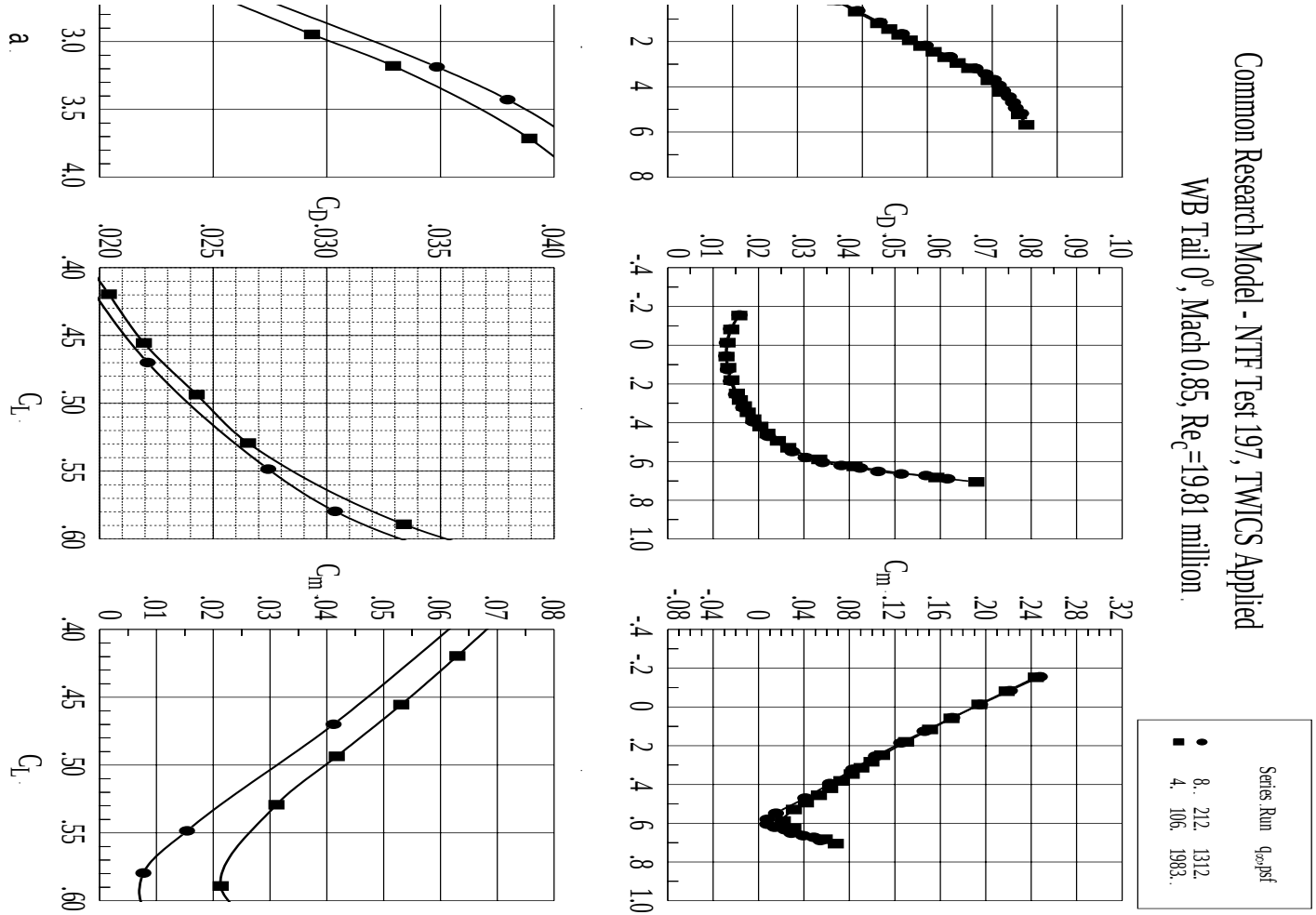
- $M_\infty = 0.85$, $Re_c = 5x10^6$
- Adding a pylon/nacelle lowers C_L, increases C_D, and gives a lower nose down C_m around the design point of $C_L = 0.5$



Results & Discussion

NTF 197 Aeroelastic Effects

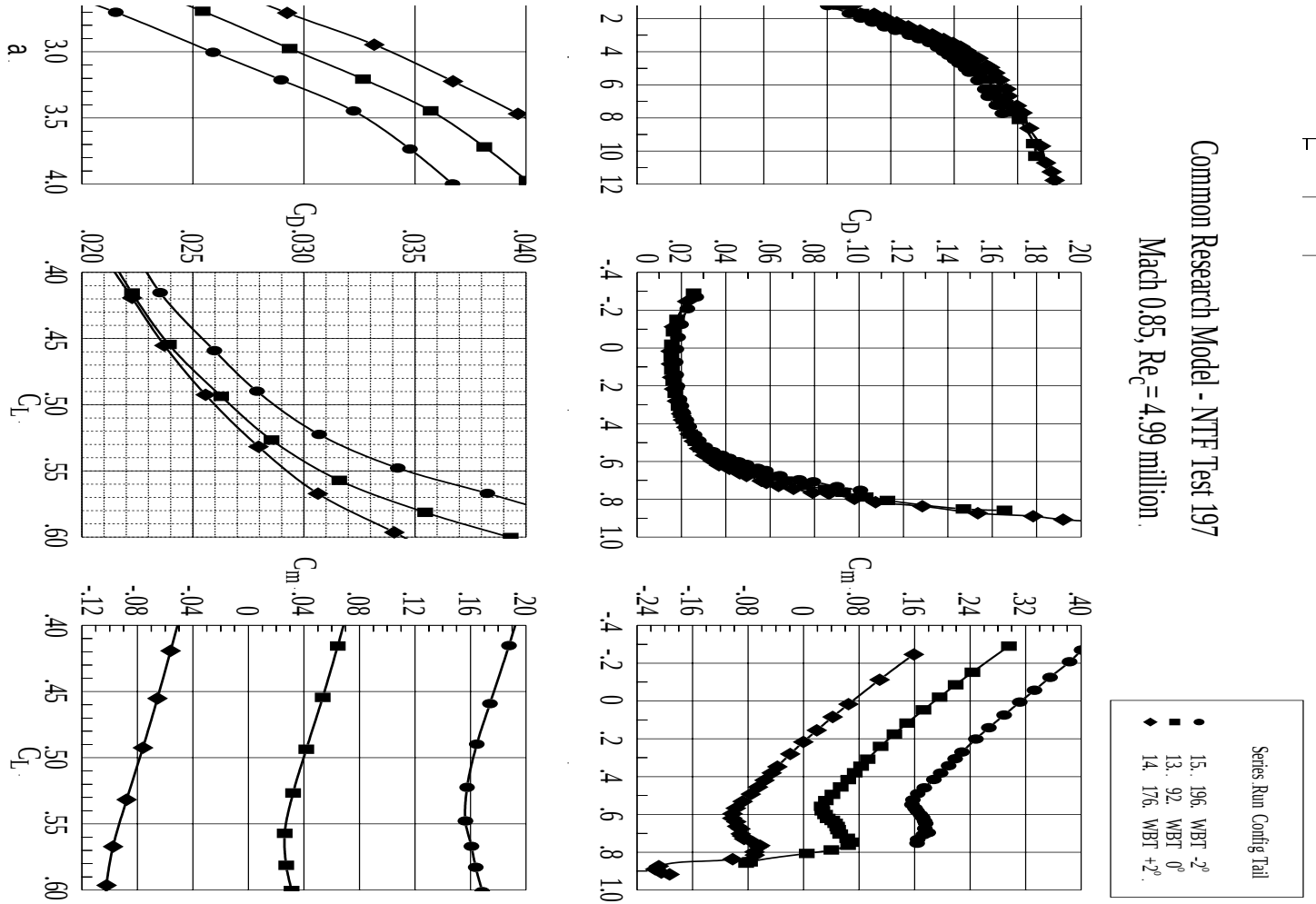
- WBT0, $M_\infty = 0.85$, $Re_c = 19.8 \times 10^6$
- Increase in q_∞ gives a lower C_L, a higher C_D value, and a lower nose down pitching moment for this configuration



Results & Discussion

NTF 197 Tail Effects

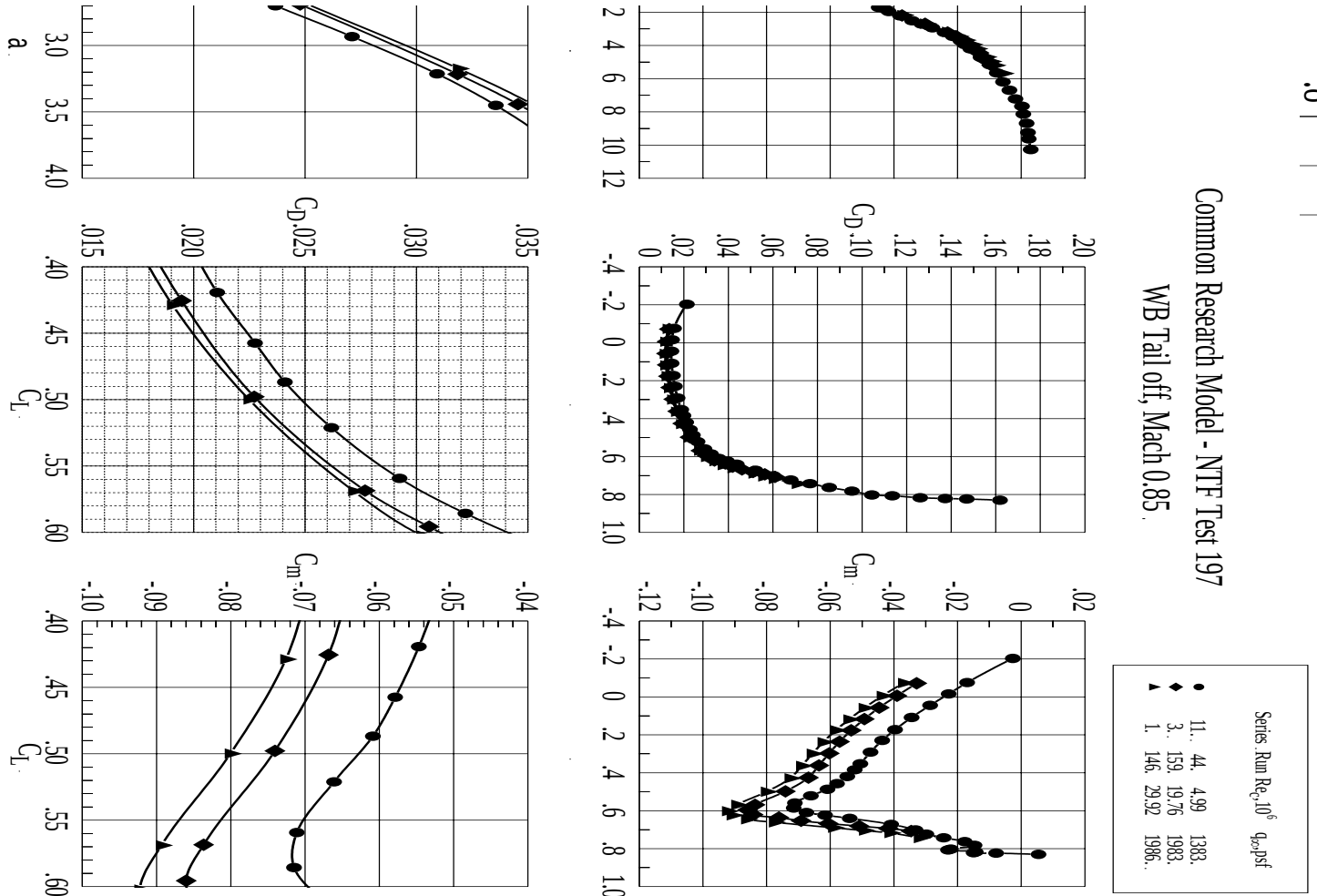
- $M_\infty = 0.85$, $Re_c = 5x10^6$
- Going from a -2˚ to a +2˚ tail setting gives an increase in C_L, shows a decrease in C_D, and gives an increase in nose down C_m for both wind tunnels



Results & Discussion

NTF 197 Reynolds Number Effects

- WB, $M_\infty = 0.85$
- Increase in Re_c gives an increase in C_L, decrease in C_D and an increase in nose down pitching moment



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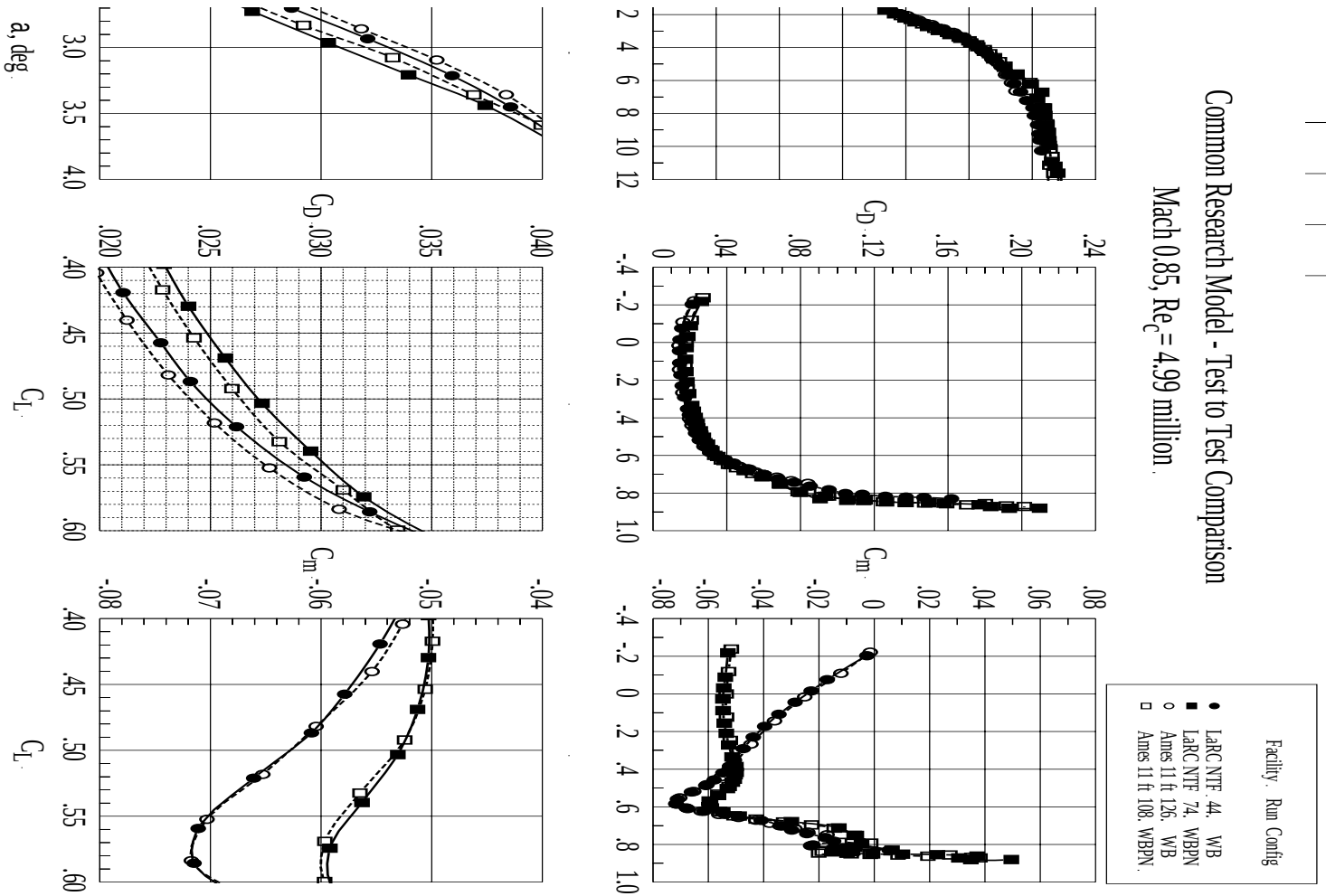
NTF 197 and Ames 216 Nacelle/Pylon Effects

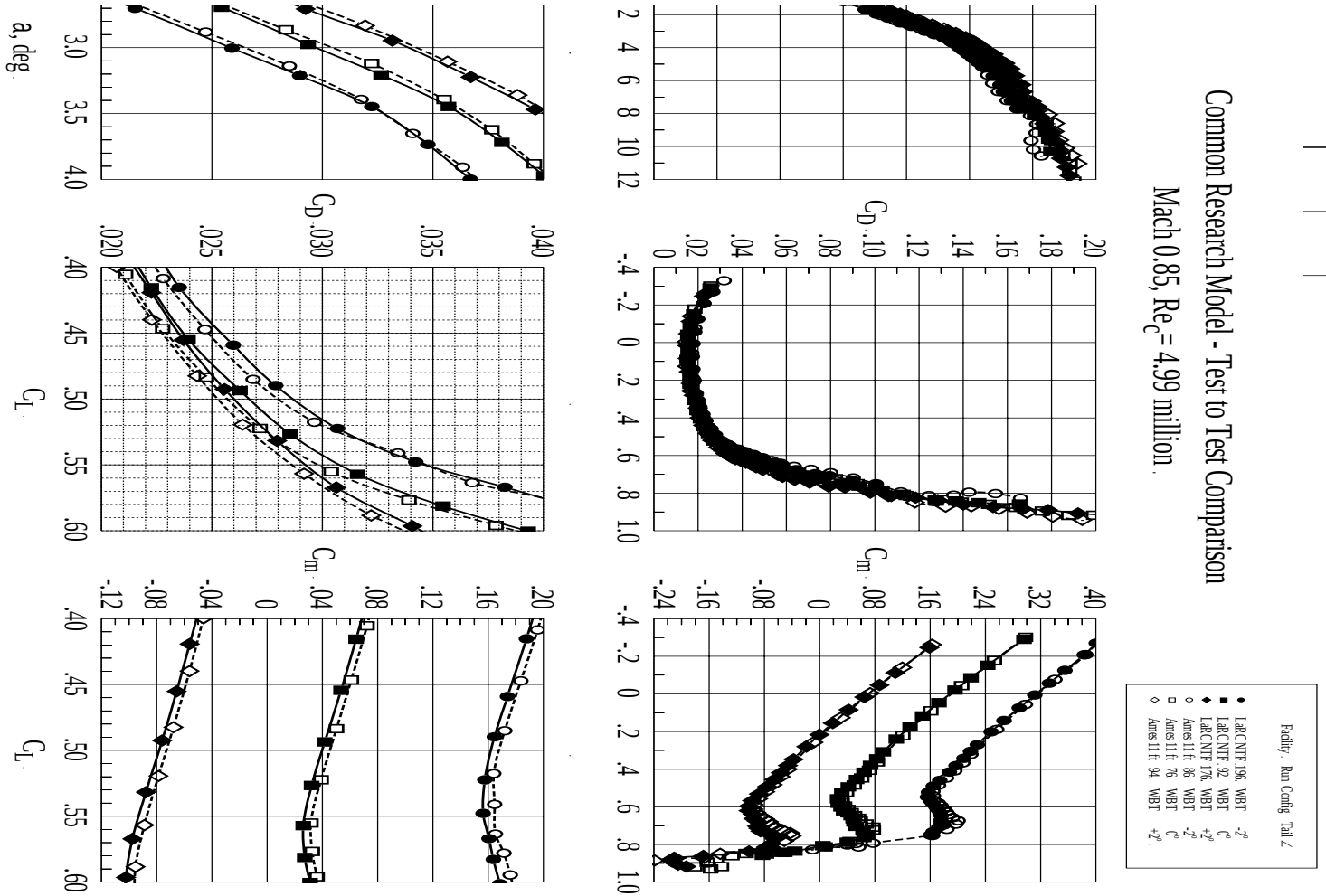
- $M_\infty = 0.85$, $Re_c = 5x10^6$
- Adding a pylon/nacelle gives a decrease in C_L, an increase in C_D, and a lower nose down C_m in both wind tunnels



Results & Discussion

NTF 197 and Ames 216 Tail effects

- $M_\infty = 0.85$, $Re_c = 5x10^6$
- Going from a -2˚ to a +2˚ tail setting gives an increase in C_L, a decrease in C_D, and an increase in nose down C_m for both wind tunnels



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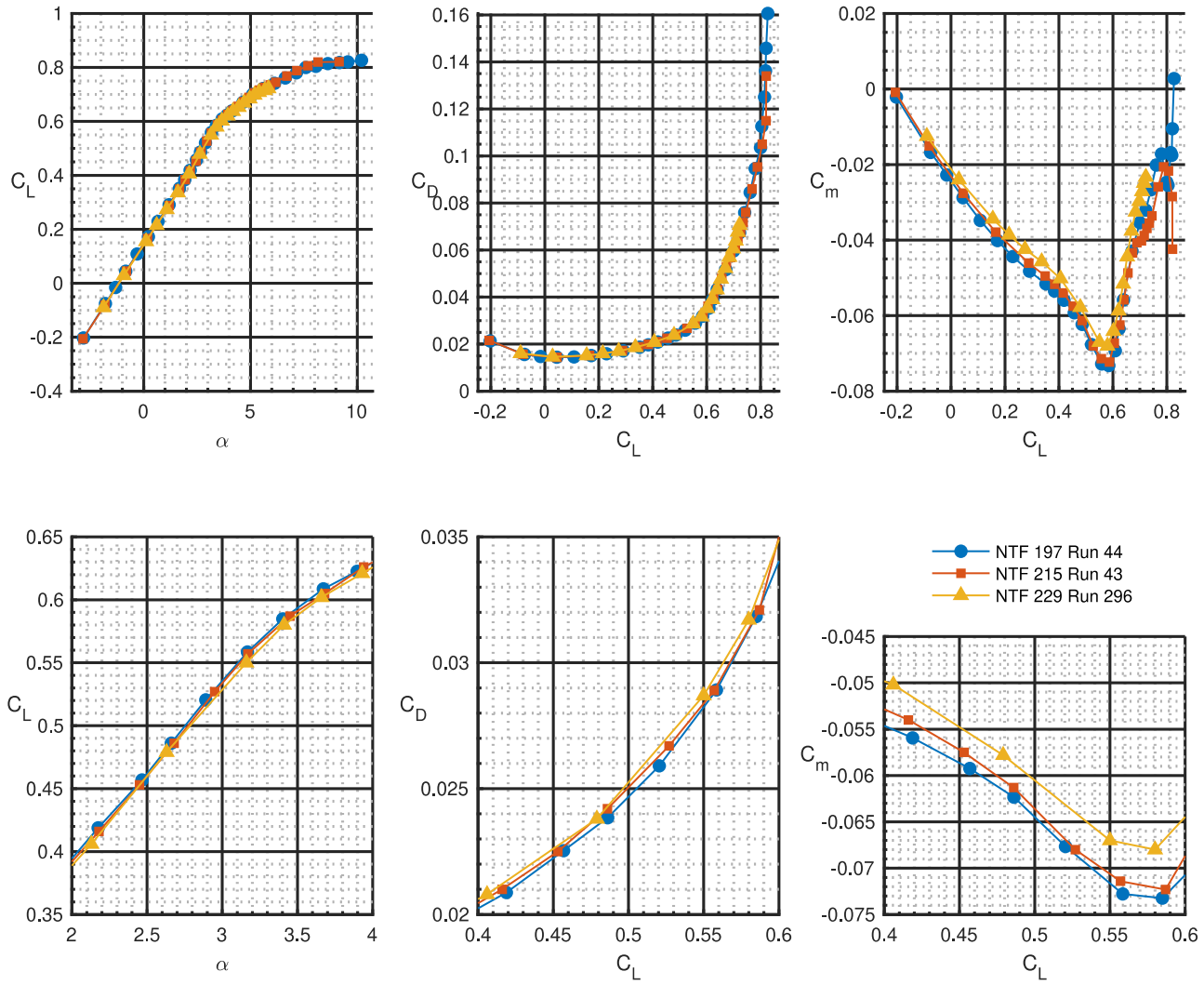
Results & Discussion

NTF 197, NTF 215 and NTF 229 Test-to-Test Comparison

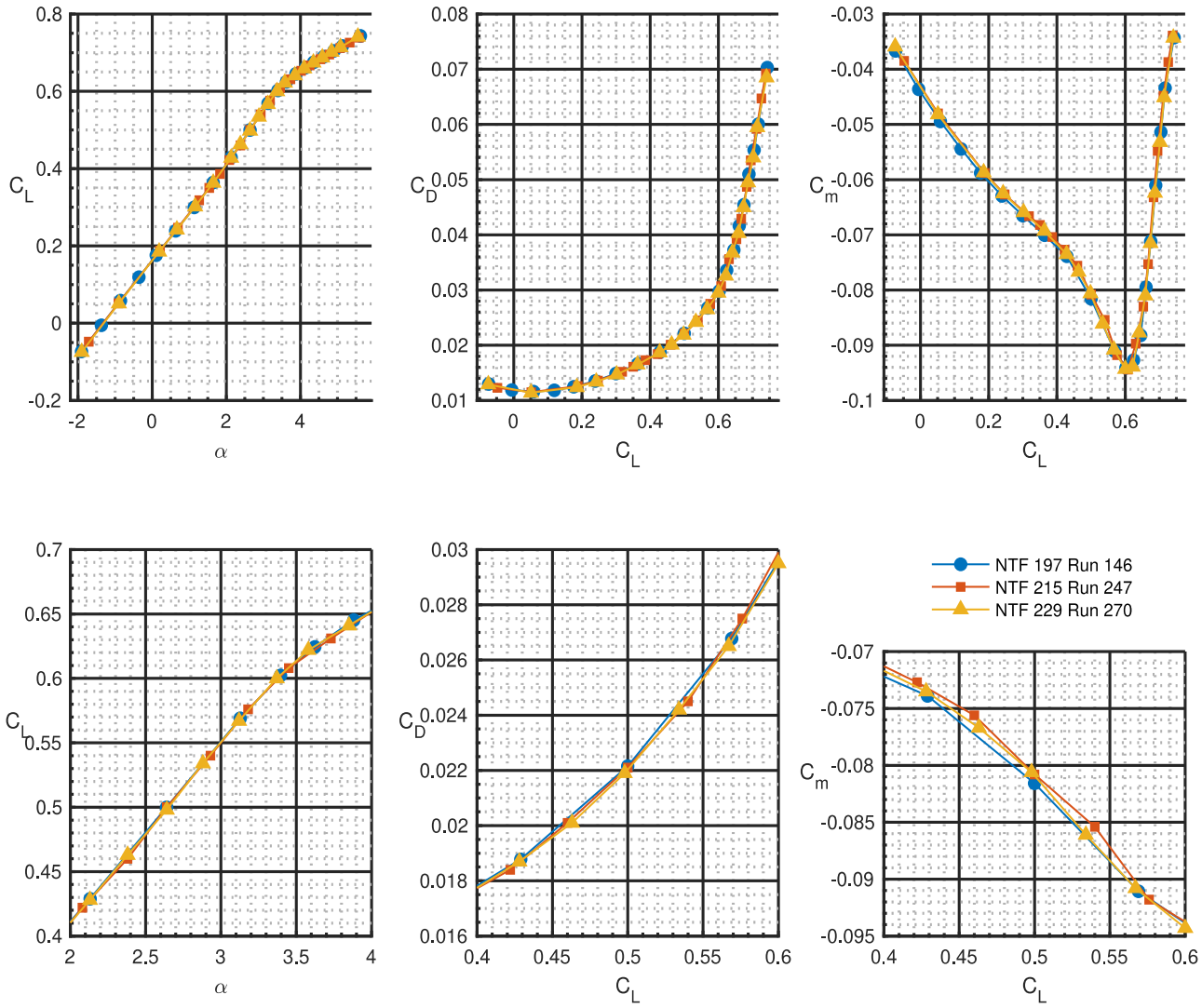
- WB, $M_\infty = 0.85$, $Re_c = 5x10^6$



Results & Discussion

NTF 197, NTF 215 and NTF 229 Test-to-Test Comparison

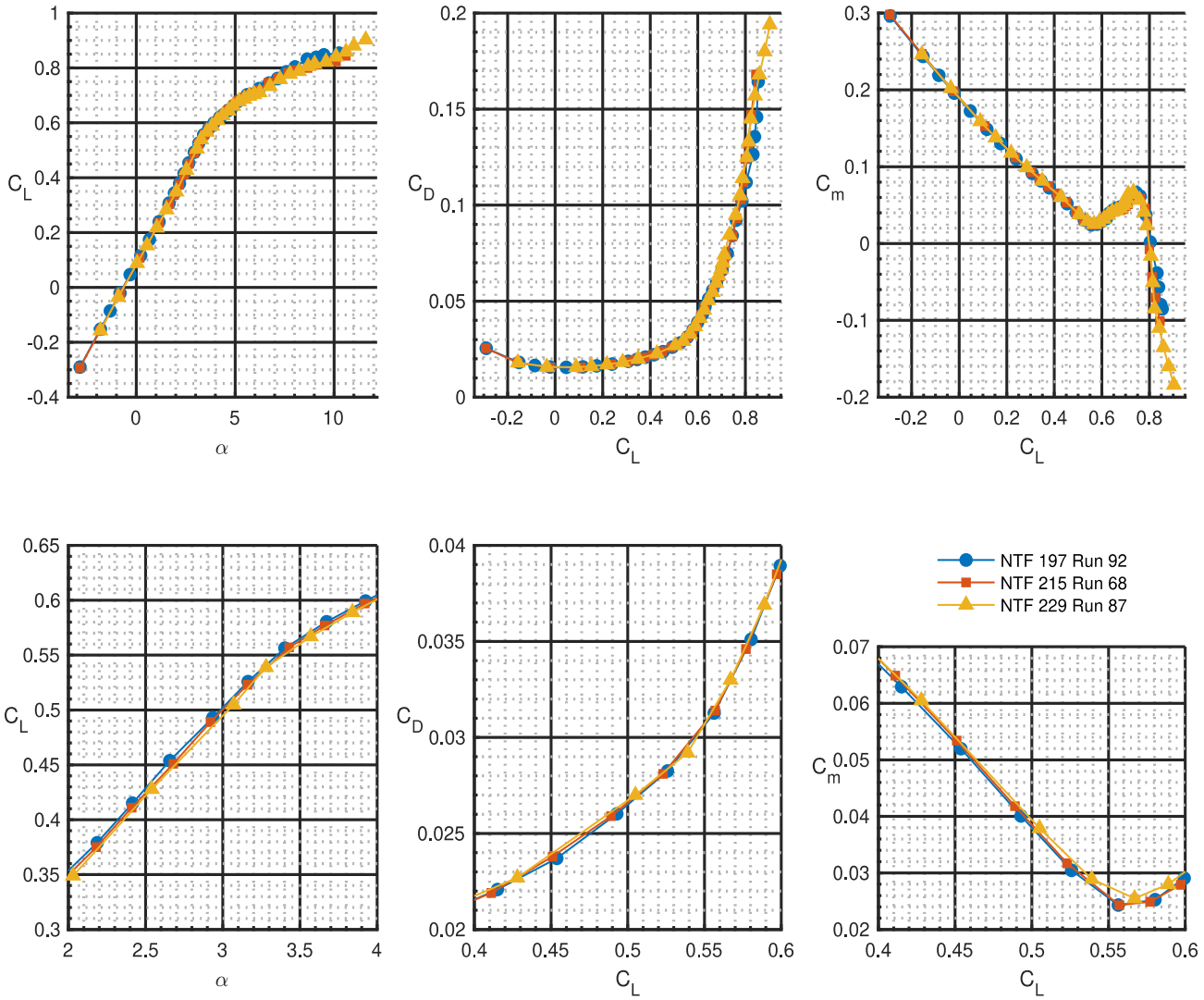
- WB, $M_\infty = 0.85$, $Re_c = 30x10^6$



Results & Discussion

NTF 197, NTF 215 and NTF 229 Test-to-Test Comparison

- WBT0, $M_\infty = 0.85$, $Re_c = 5x10^6$



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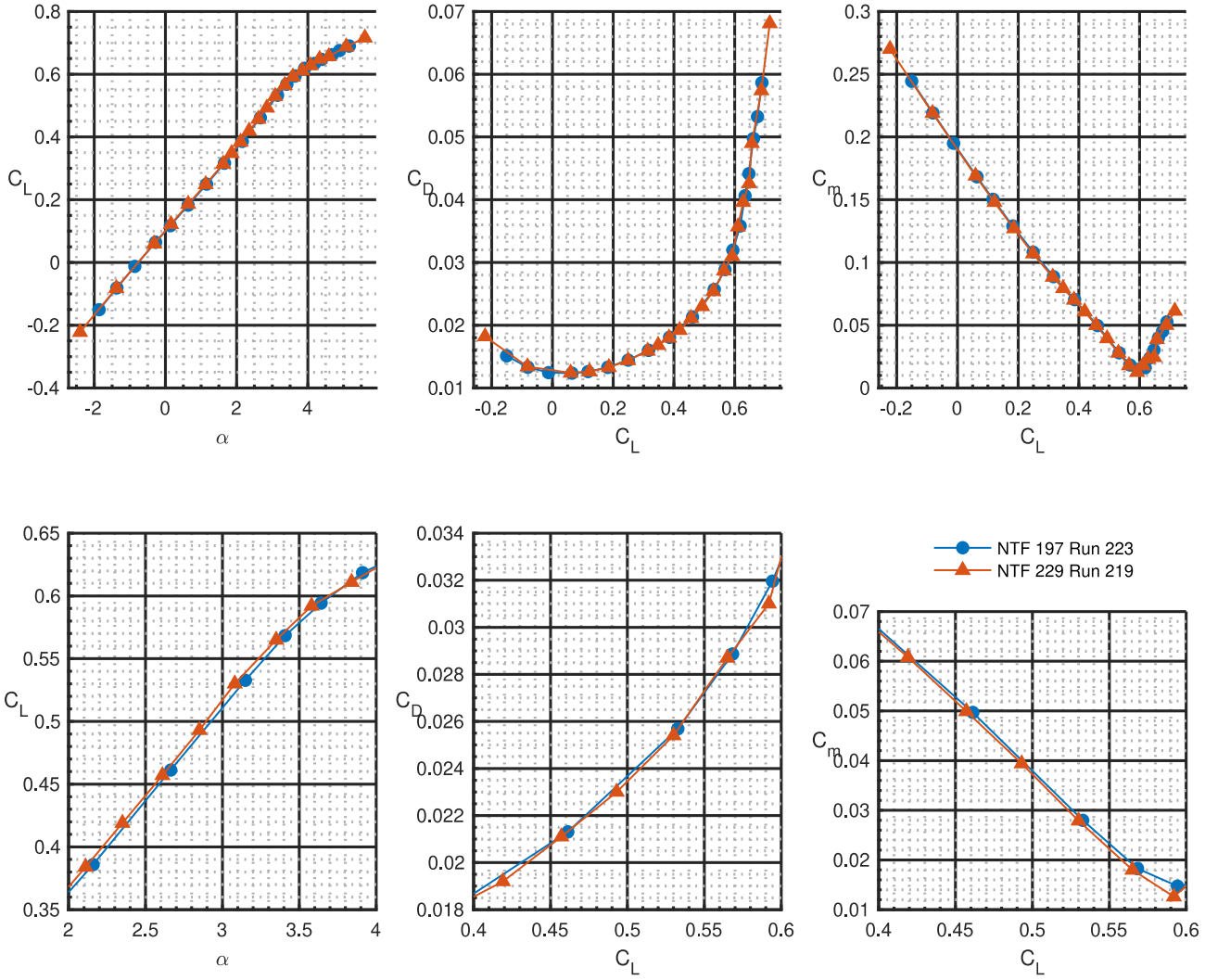

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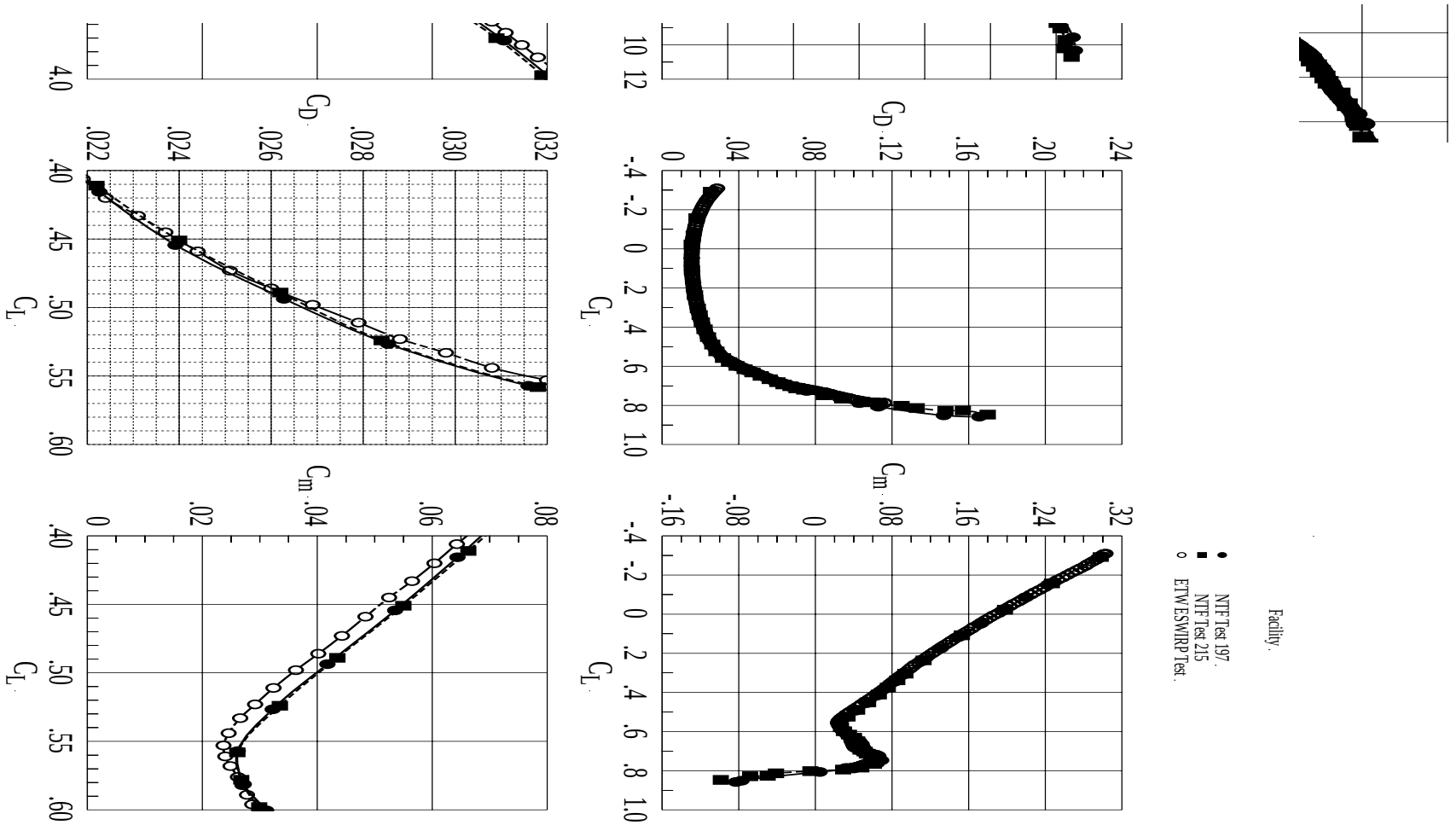

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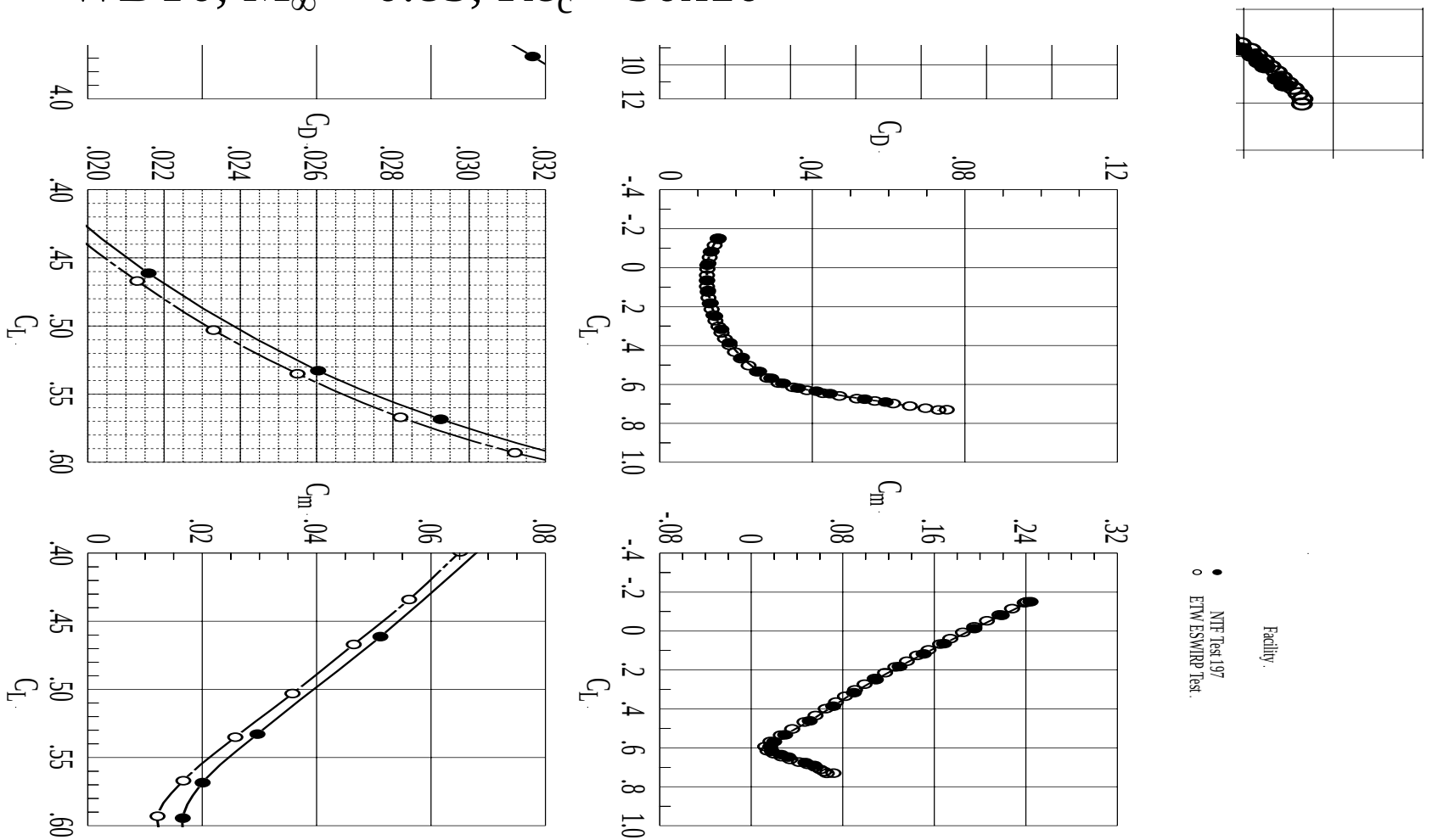

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Concluding Remarks

- CRM created to provide modern/industry-relevant data and open/public geometries
- Same model tested in three different facilities worldwide
- Extensive database has been developed for both computational and experimental research
- CRM derivatives continue to be developed and tested