Aerodynamic Characteristics of a Grid Finned Projectile from Free-Flight Tests at Supersonic Velocities

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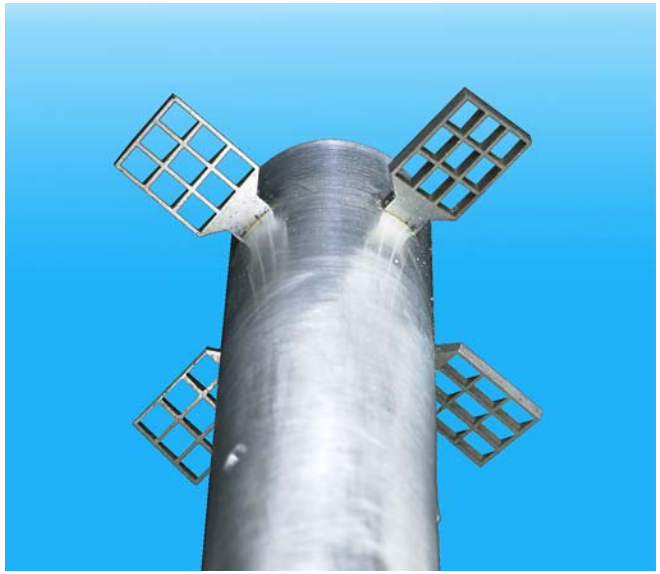
OUTLINE

- Background
- Model Configuration
- Experimental Tests
- Results
  - Grid finned
  - Planar (Air Force Finner)
- Conclusions

BACKGROUND



- Grid fins are being studied by several organizations

- Favorable lift characteristics at high α
- Low hinge moments
- Good storability

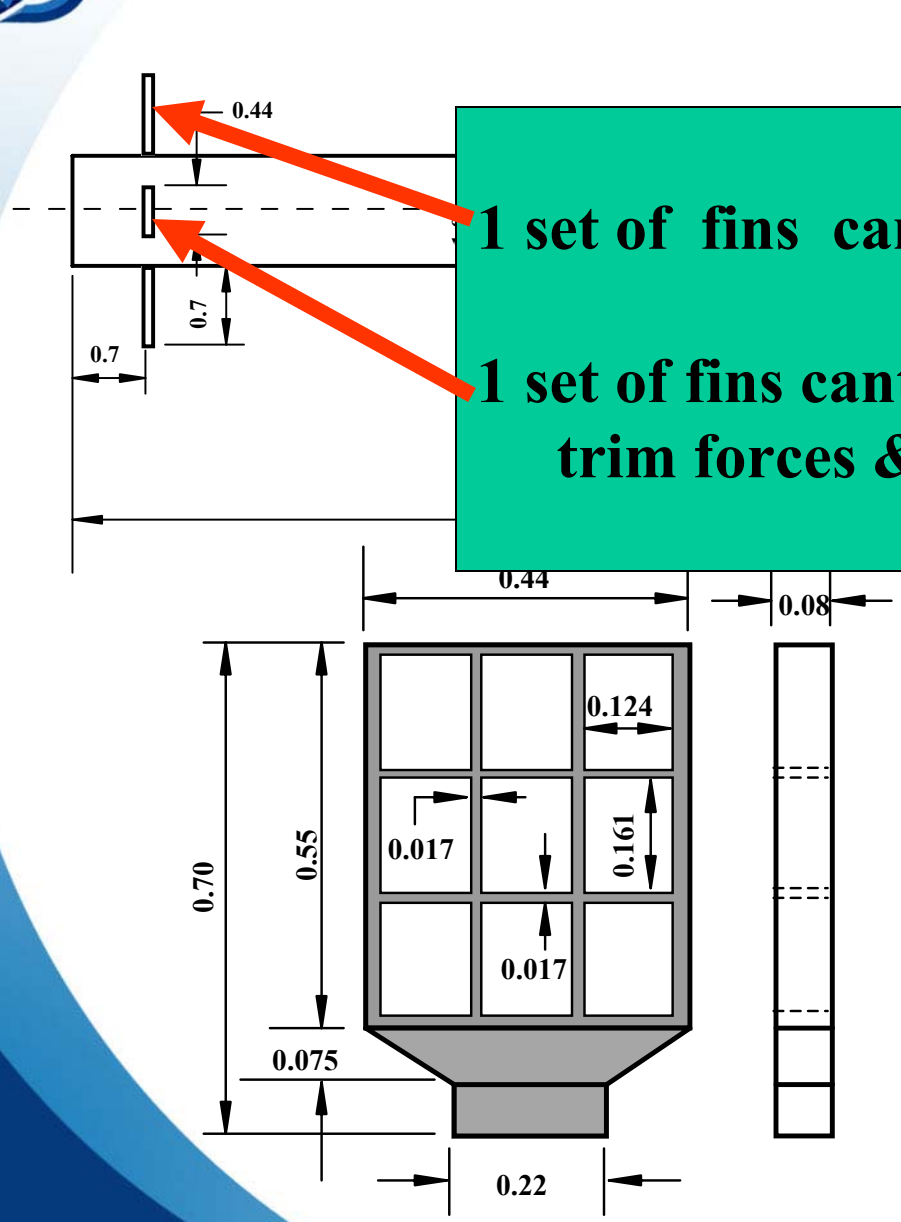
- High drag (can be minimized through web tailoring)

- Prior research include wind tunnel tests and recently CFD
  - Results presented at last 3 ISBs

OBJECTIVES

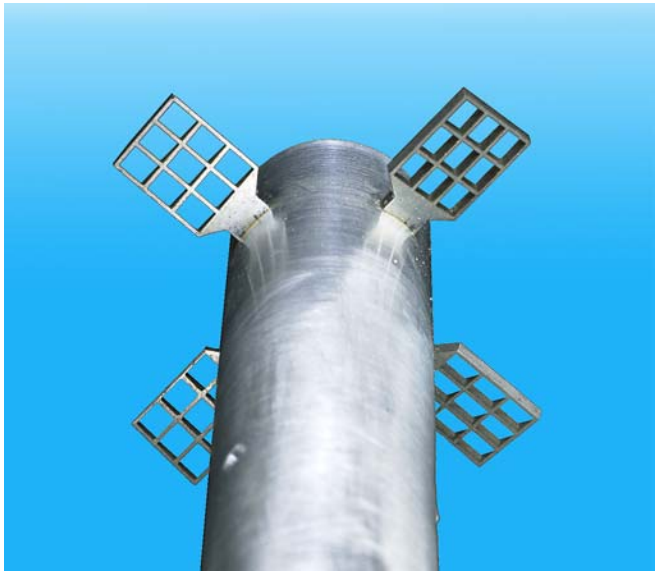
- Obtain Aero. Coeffs. & Stability Derivatives
- From Free-flight Tests
  - DRDC Aeroballistic Range
- Establish Data base to compare WT andCFD results

CONFIGURATION



1 set of fins canted at 2.0° to produce roll

1 set of fins canted at 0.5° to produce trim forces & moments



PHYSICAL PROPERTIES

(A/B model)

d (mm)	m (g)	I_x (g-cm^2)	I_y (g-cm^2)	l (mm)	CG from nose (X_{CG} /l)
30.0	881.2	954.55	64517.07	300.0	0.405

DRDC AEROBALLISTIC RANGE

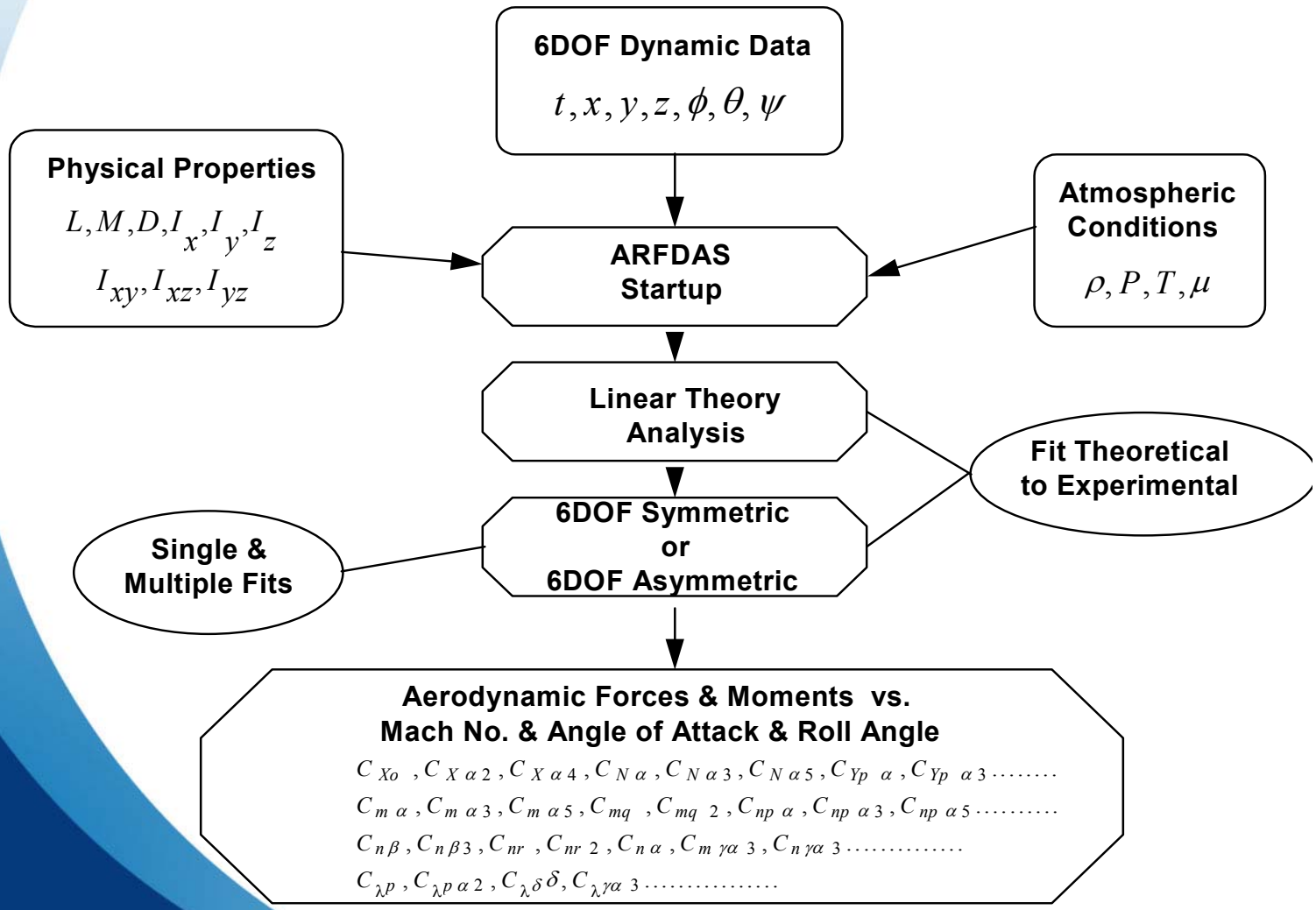
- Length: 250 m
- Model size: 5.56 mm to 155 mm
- Speeds: up to Mach 7.0
- Temperature et humidity controlled

DRDC AEROBALLISTIC RANGE

- Instrumented length: 220 m
- Section: 6 m x 6 m
- 54 Stations: Indirect orthogonal shadowgraphs
- 4 Schlieren stations
- at least 4 firings/day

DRDC AEROBALLISTIC RANGE

ARFDAS - Aeroballistic Range Facility Data Analysis



A/B TESTS

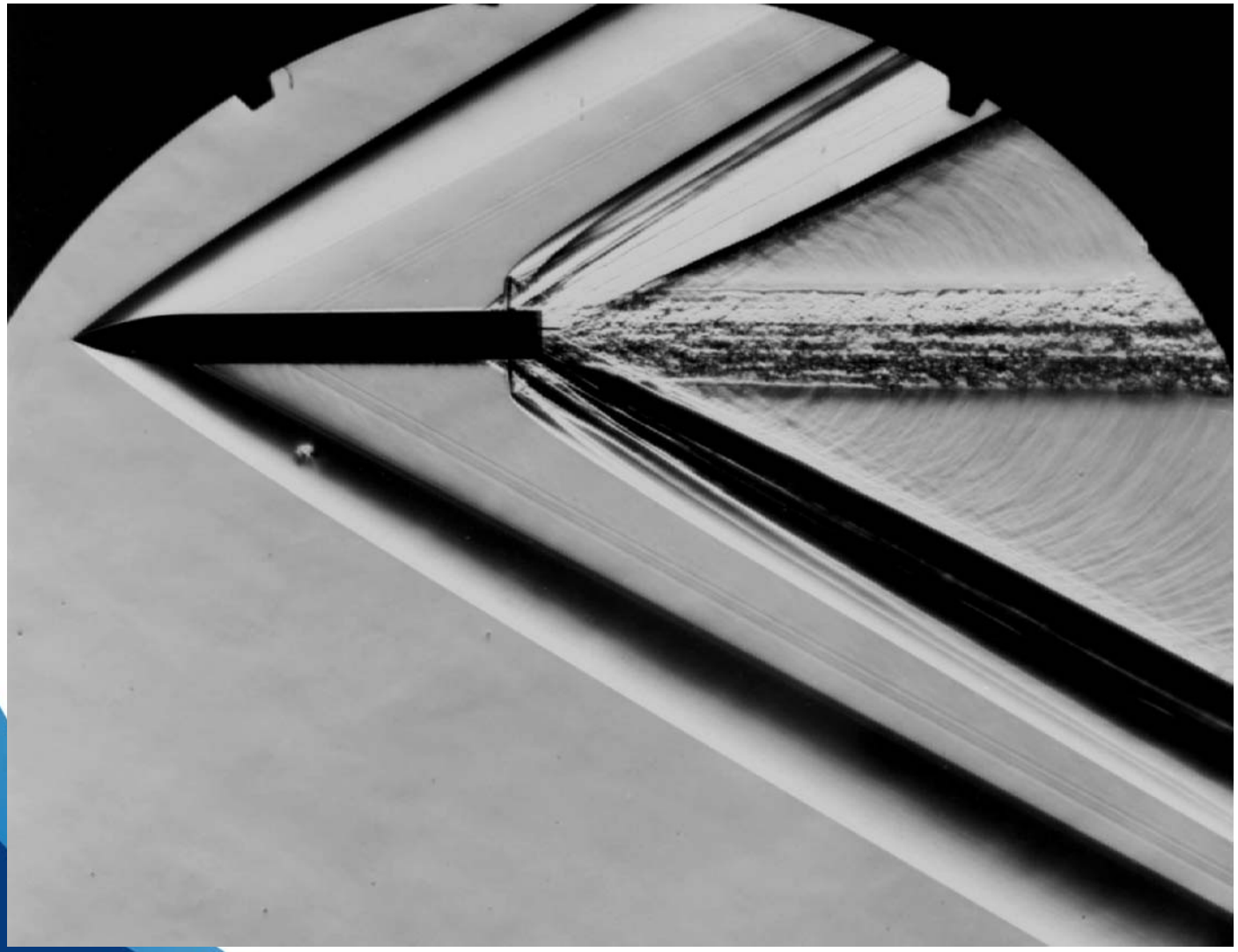
- 11 projectiles fired
  - Mach 1.4 to 3.5
- 110 mm Smooth Bore Gun
- First Max Yaws ranged from 2.4° to 10.5°
- Down range spin rate 20.0 °/m

A/B TESTS

V_{MUZ} = 1215 m/s

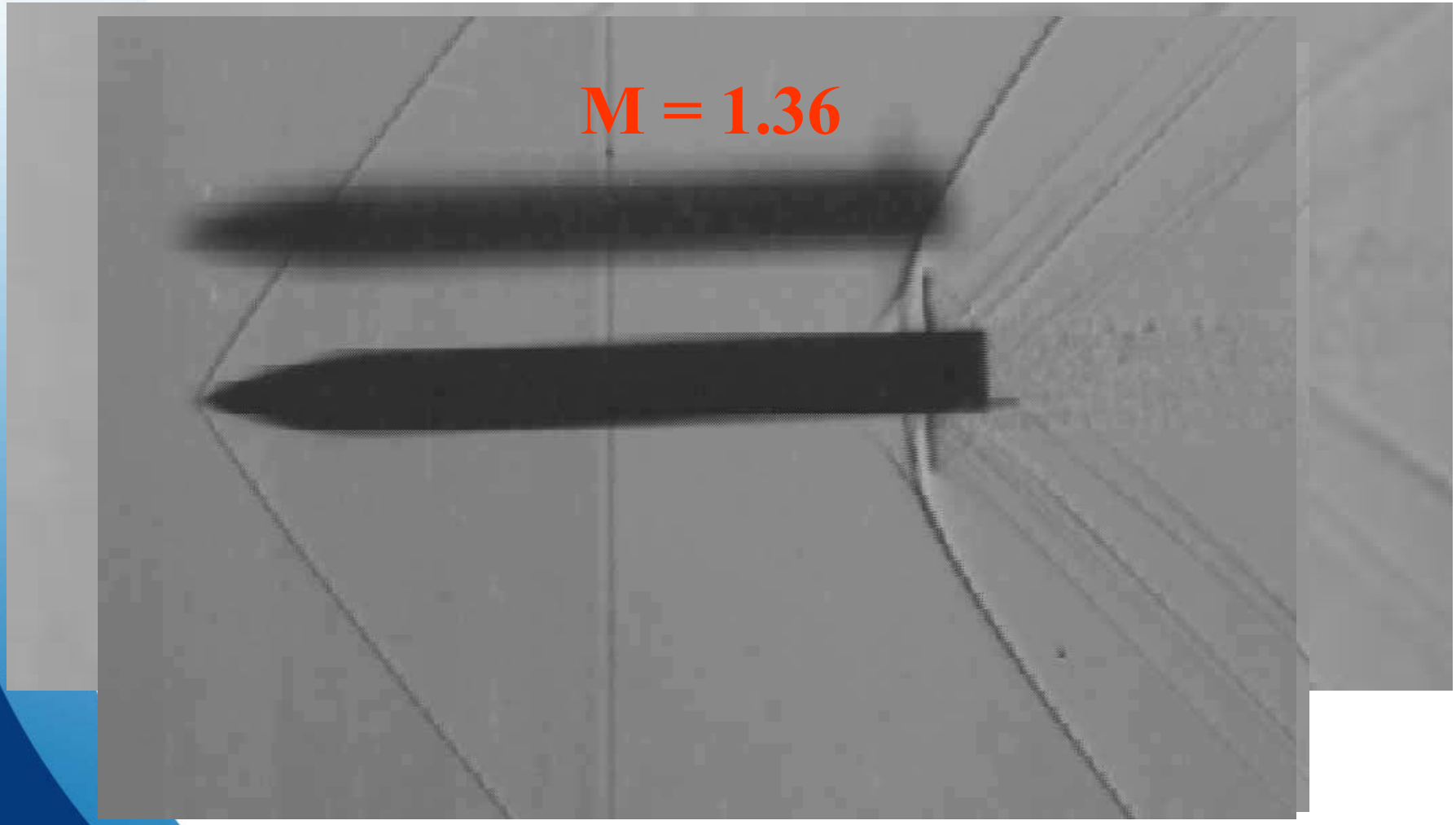
A/B TESTS

M = 2.12



Shot K01

A/B TESTS

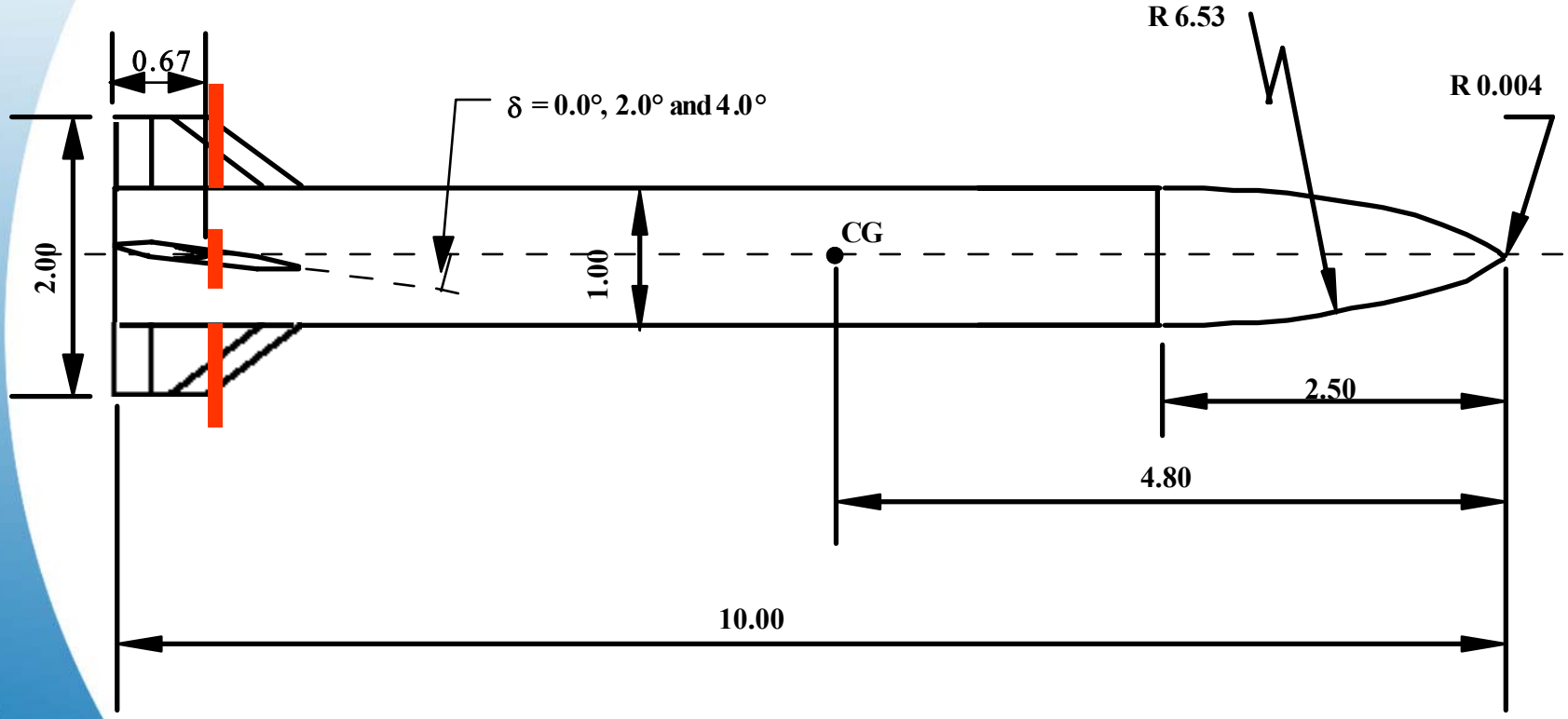


RESULTS

- Grid Finned Results

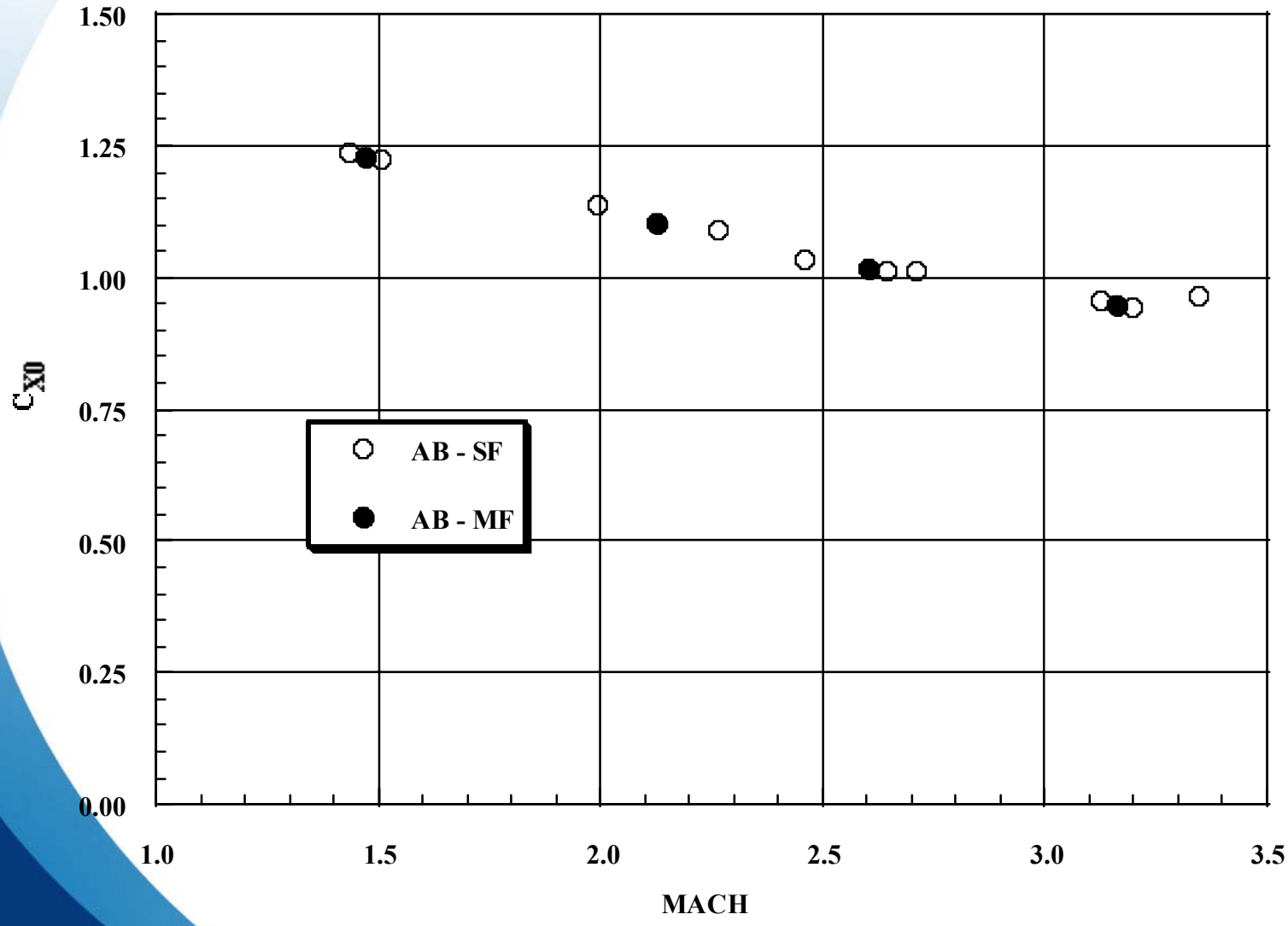
- Compare with Air Force Finner
  - Tested in DRDC and Eglin Air Force Base Free-Flight Ranges

AIR FORCE FINNER

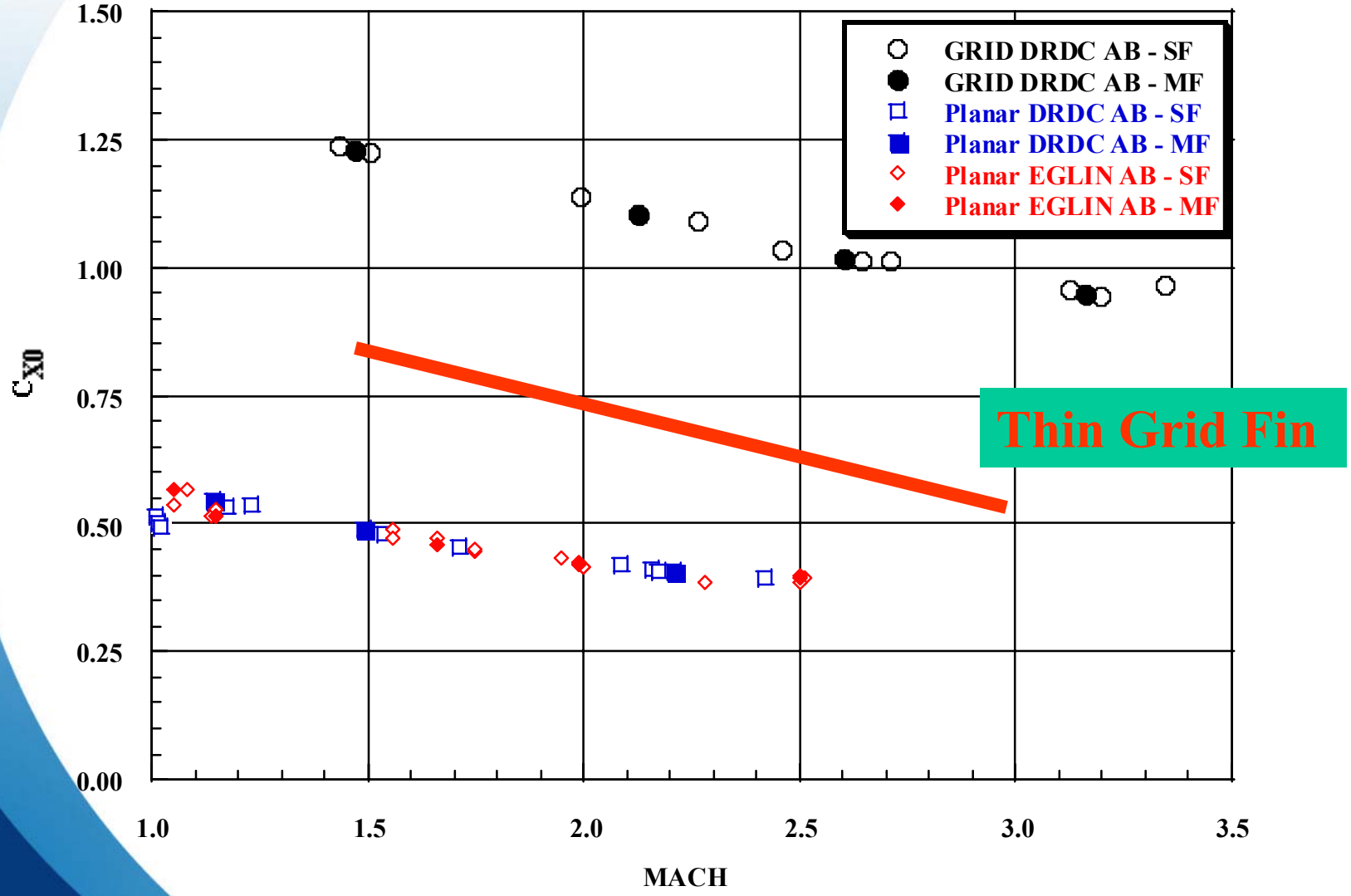


(All moments transferred to 4.05 cal from nose)

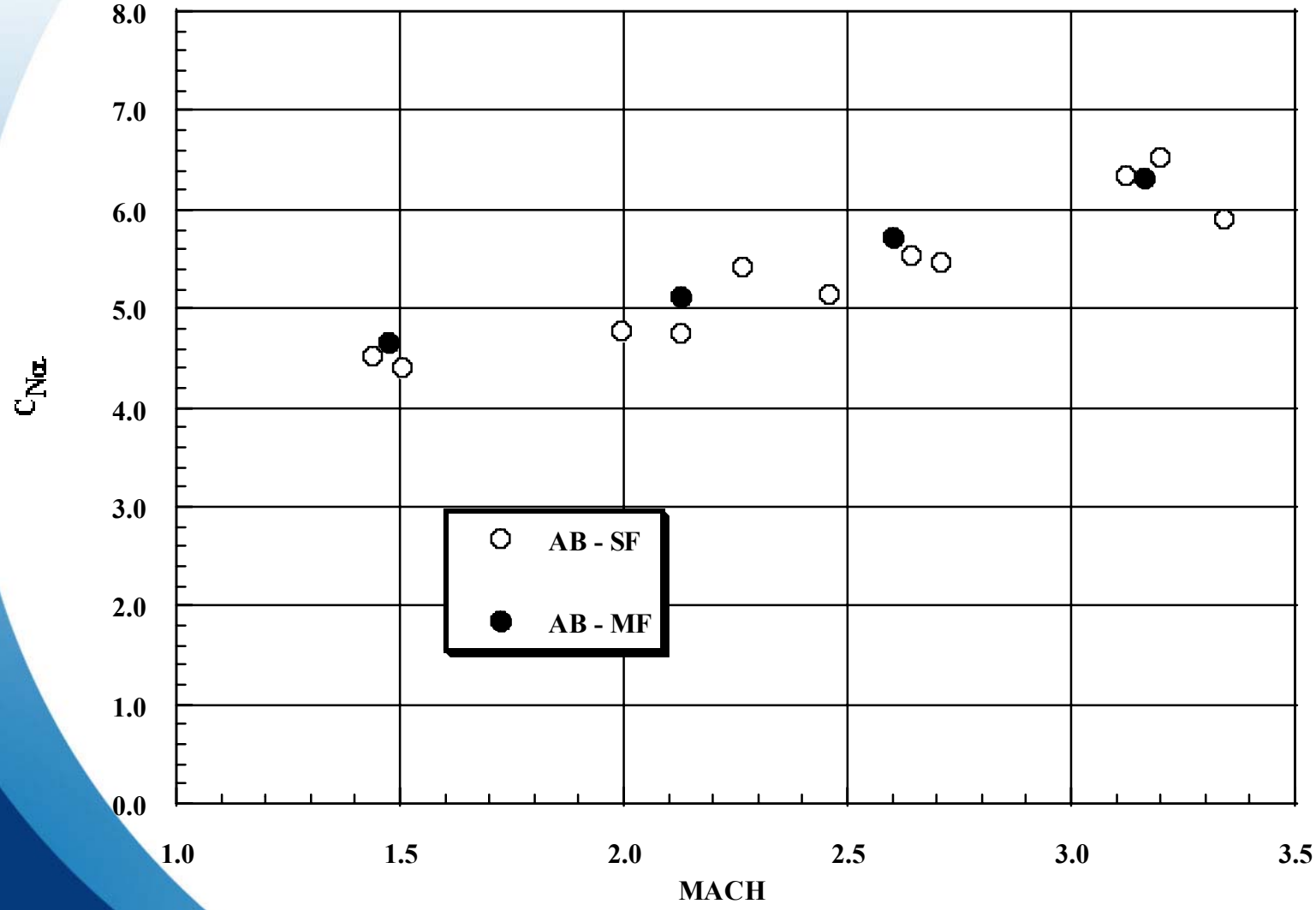
AXIAL FORCE



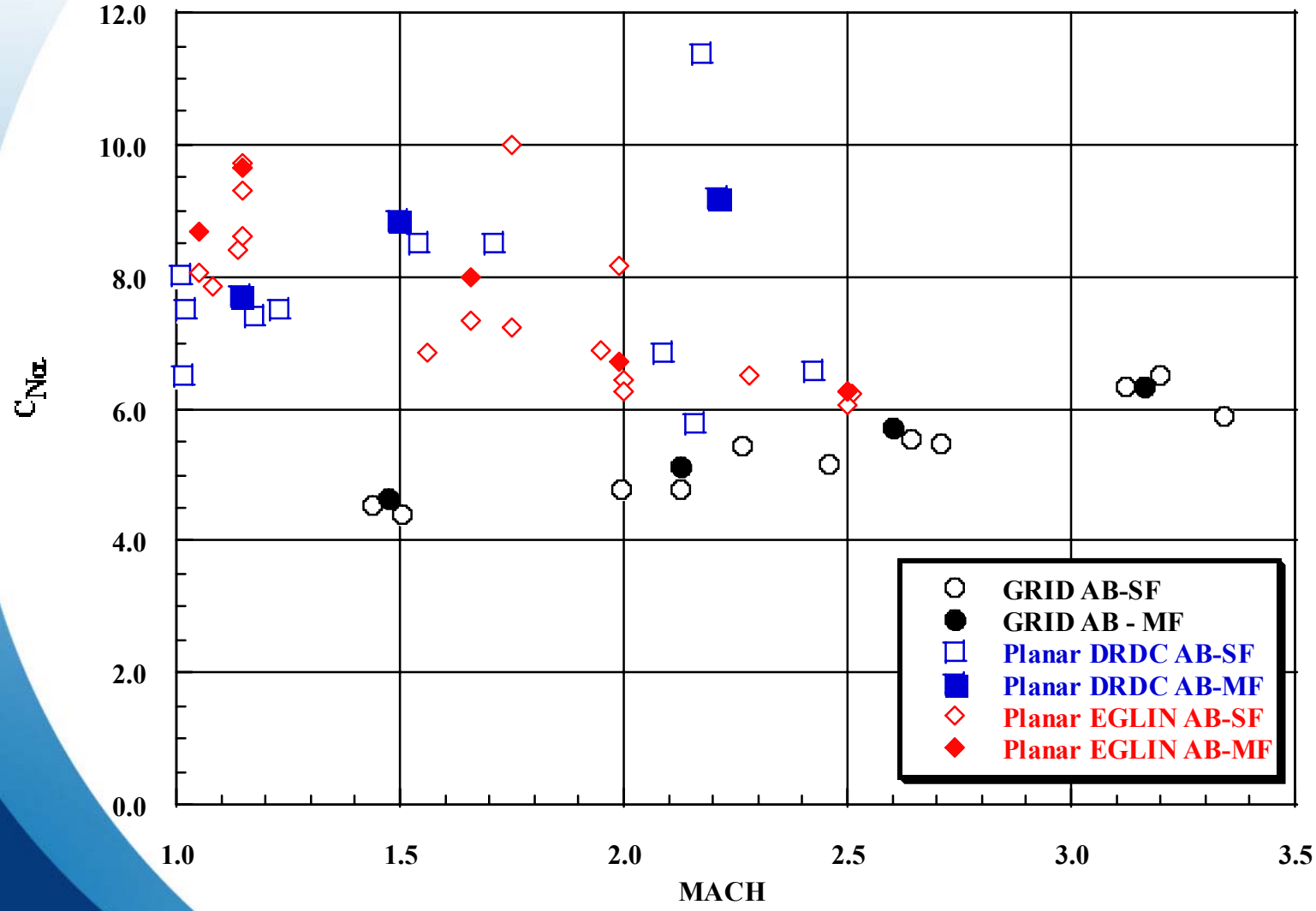
AXIAL FORCE


GRID DRDC AB - SF
GRID DRDC AB - MF
Planar DRDC AB - SF
Planar DRDC AB - MF
Planar EGLIN AB - SF
Planar EGLIN AB - MF
Thin Grid Fin
C_{X0}
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1.0
1.5
2.0
2.5
3.0
3.5
MACH

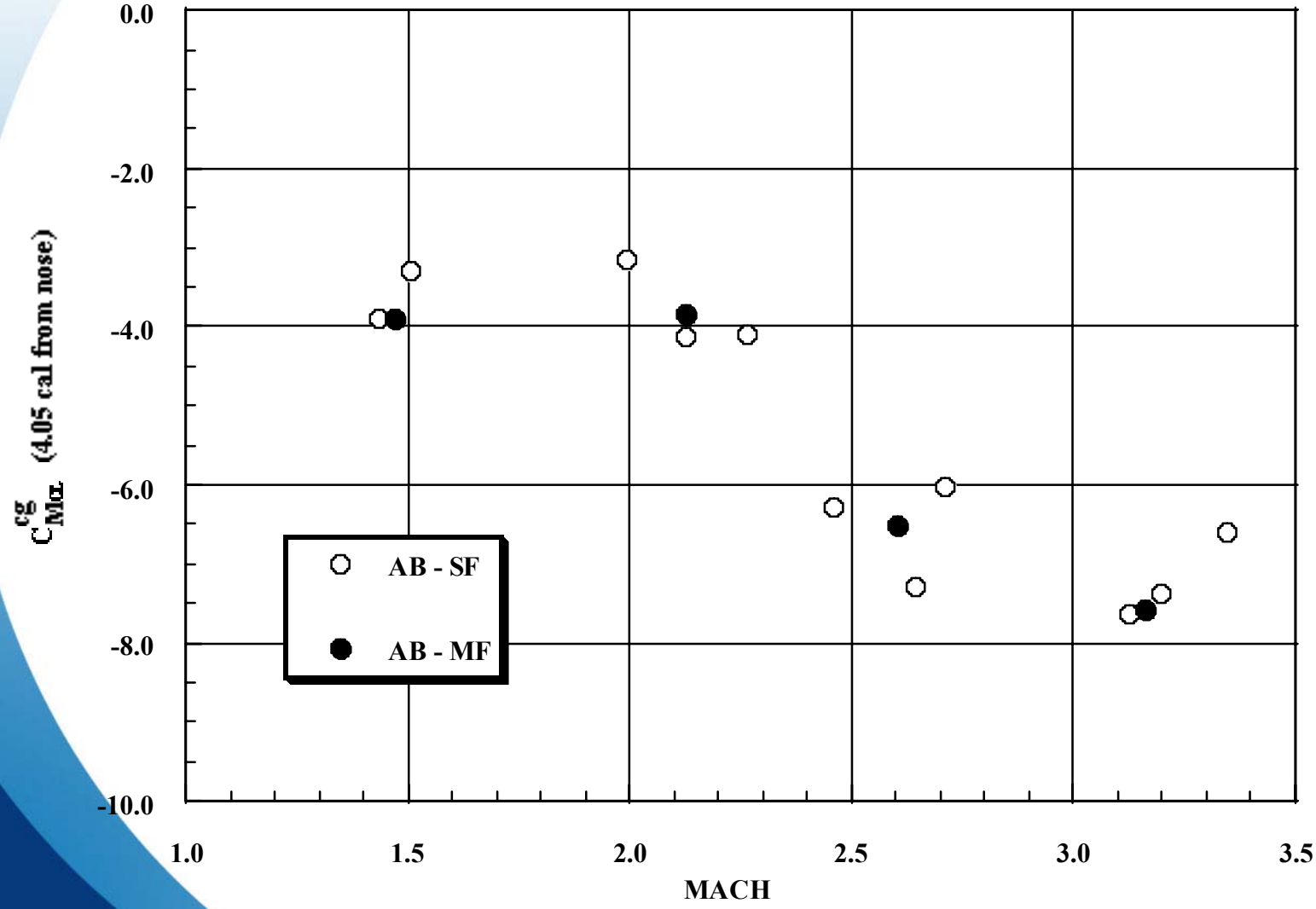
NORMAL FORCE SLOPE



NORMAL FORCE SLOPE



STATIC PITCH MOMENT COEFFICIENT SLOPE



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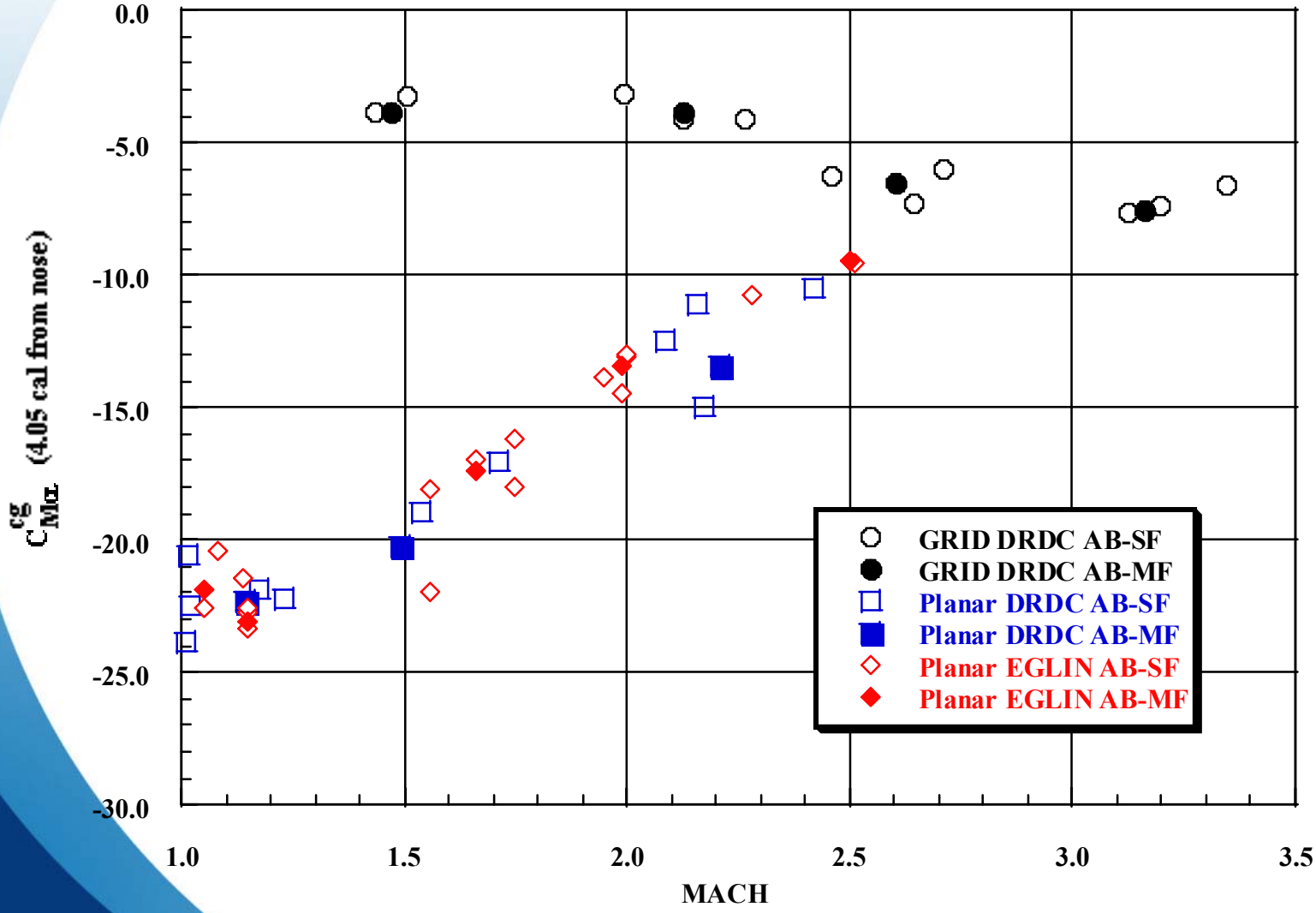
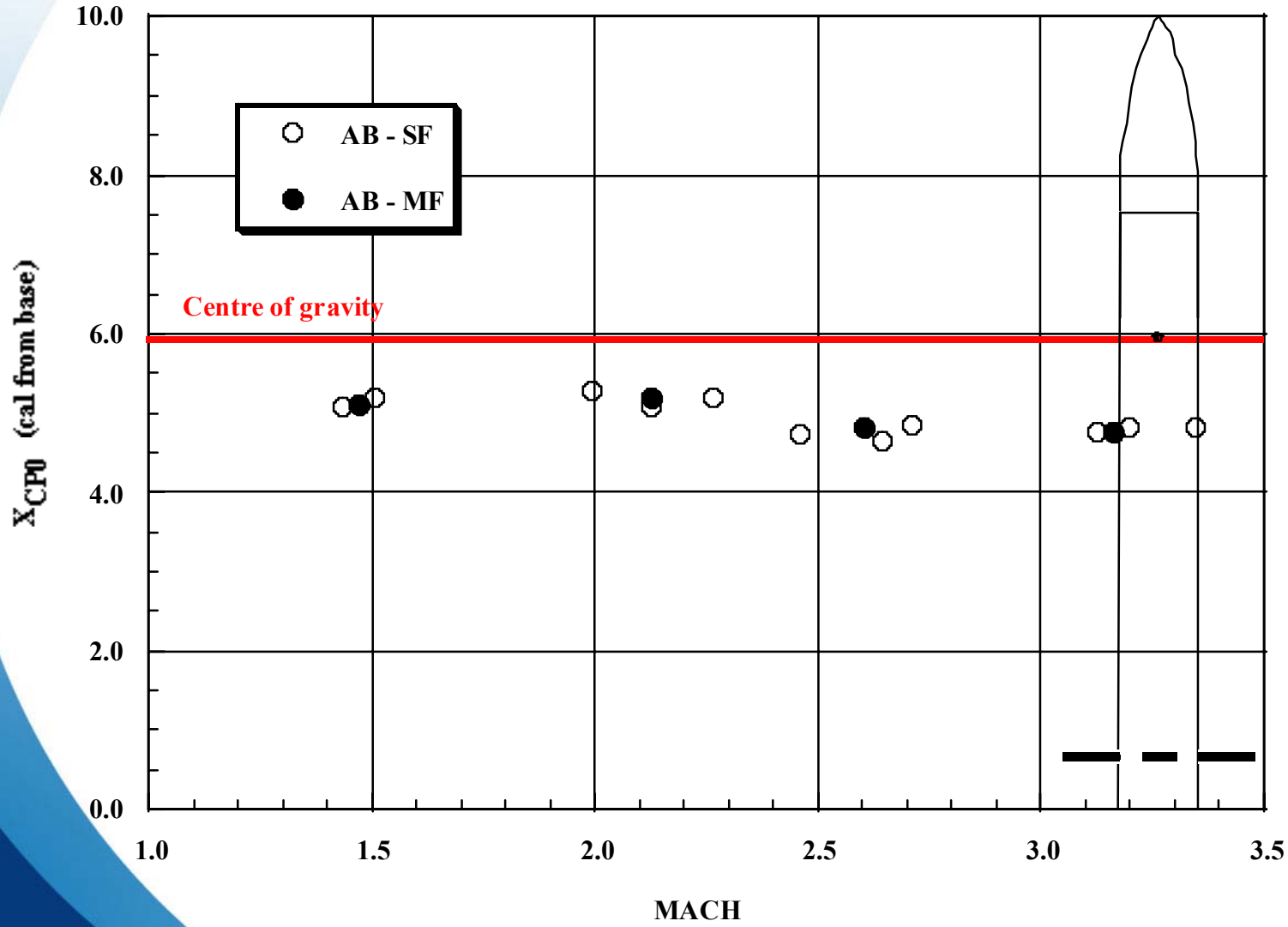


CENTER OF PRESSURE



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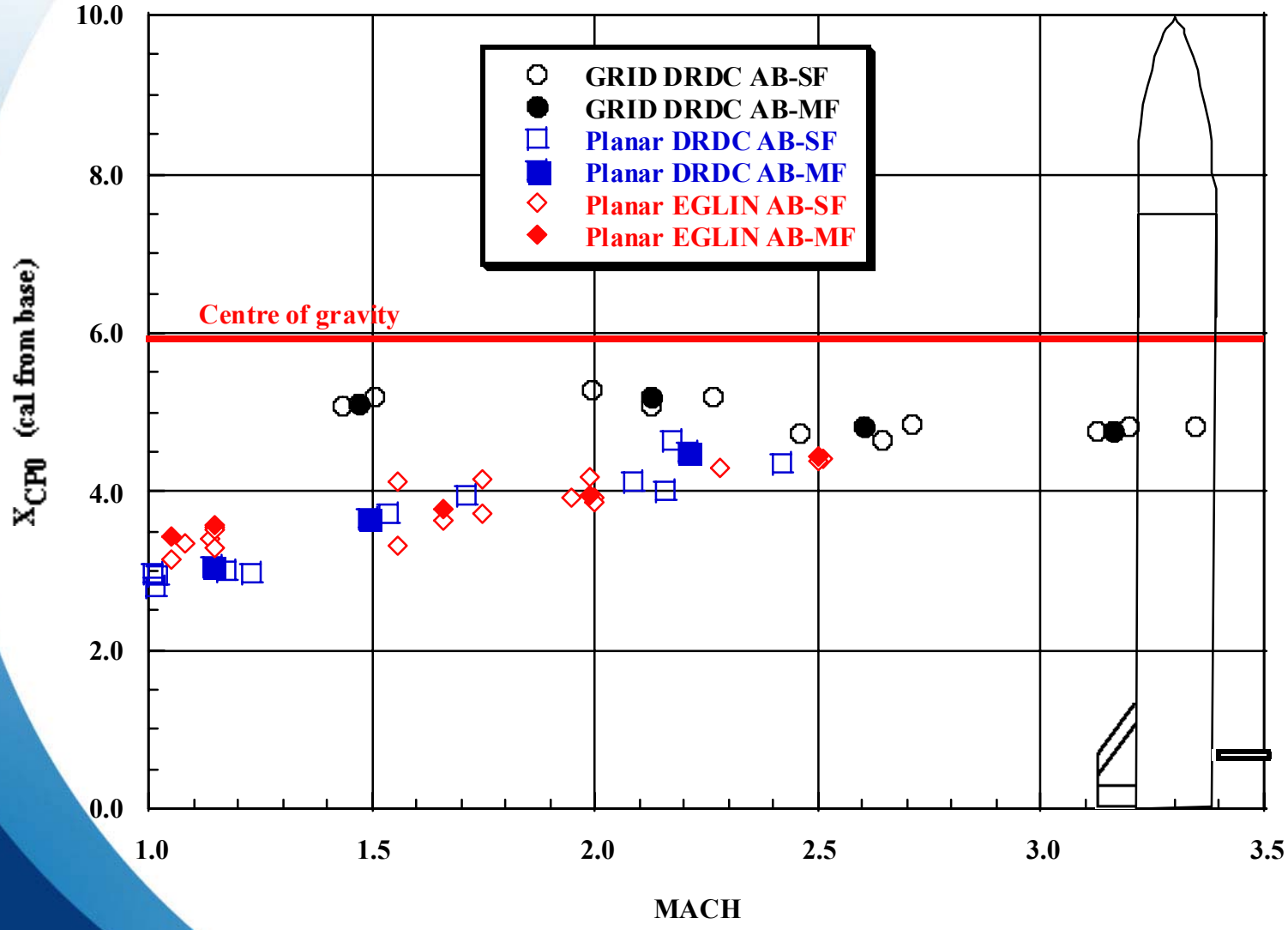
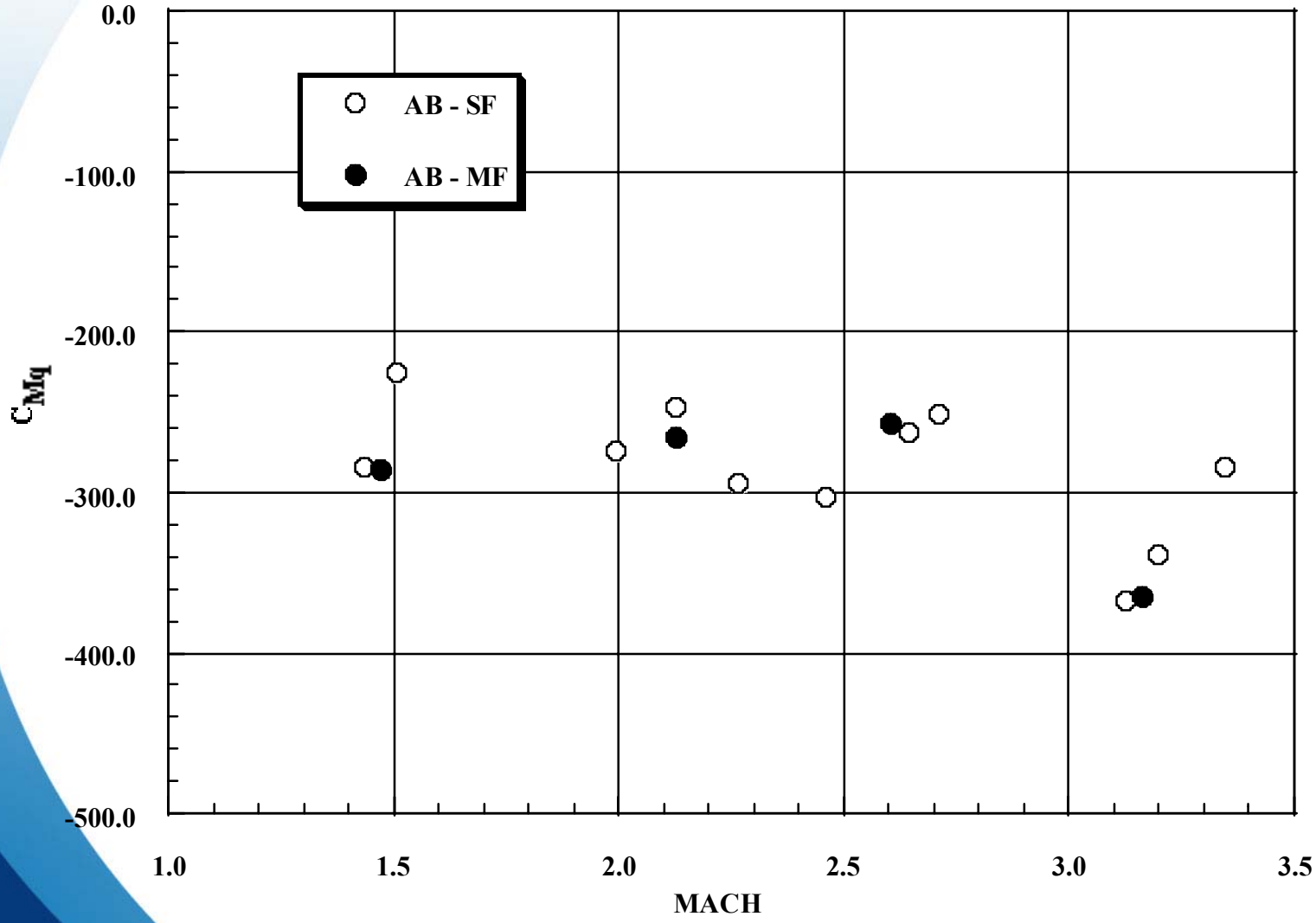


PITCH DAMPING MOMENT



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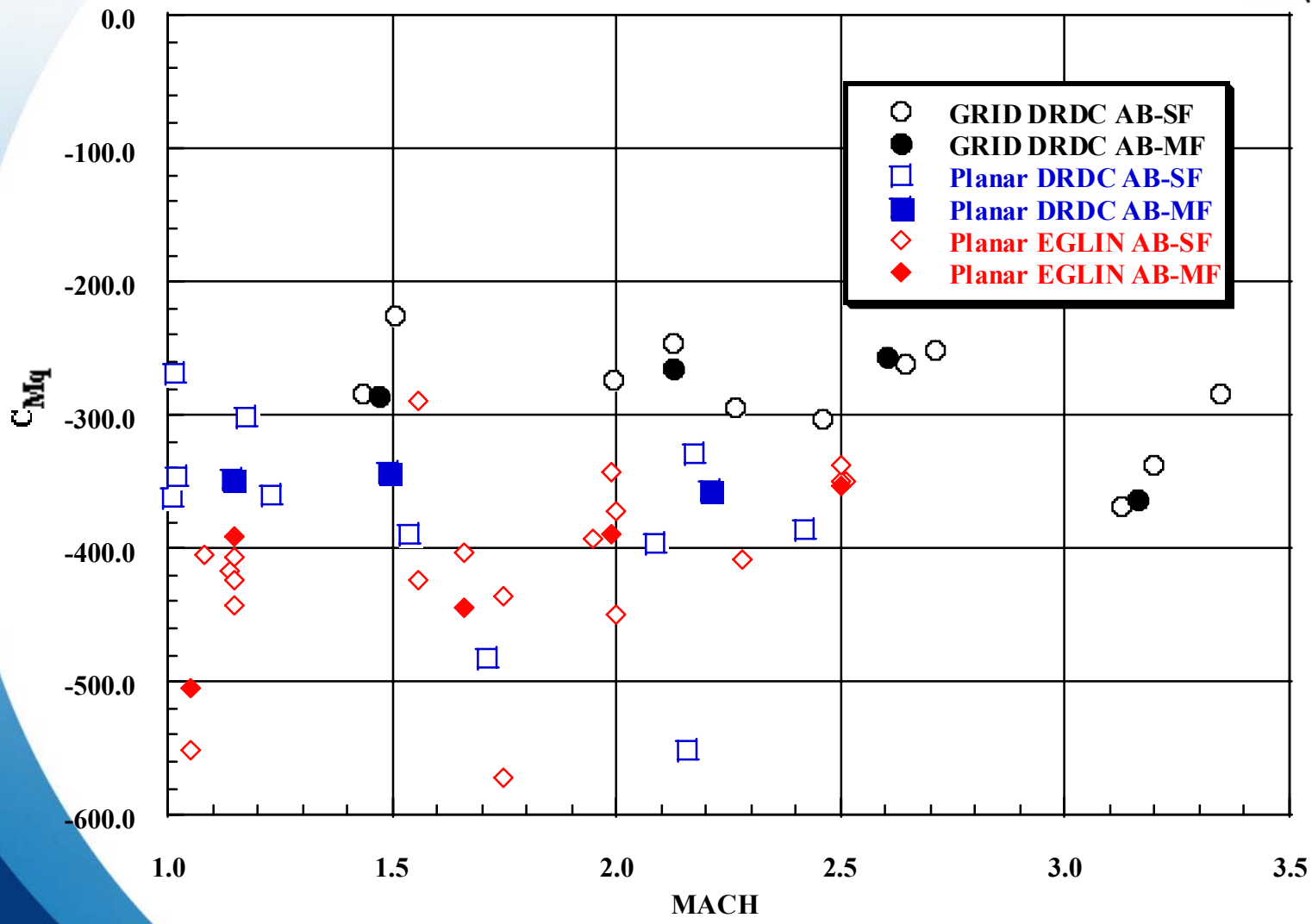
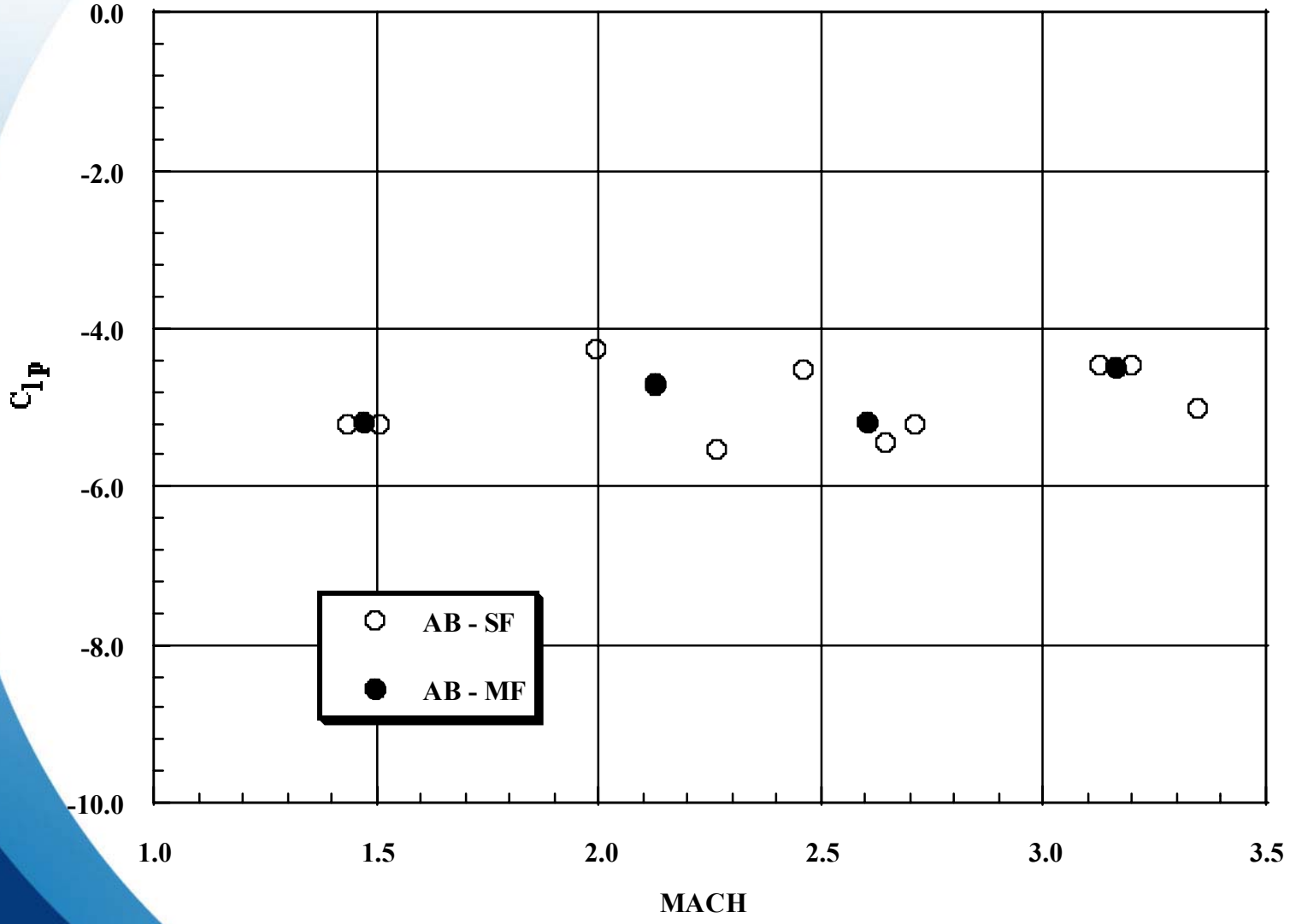


ROLL DAMPING MOMENT



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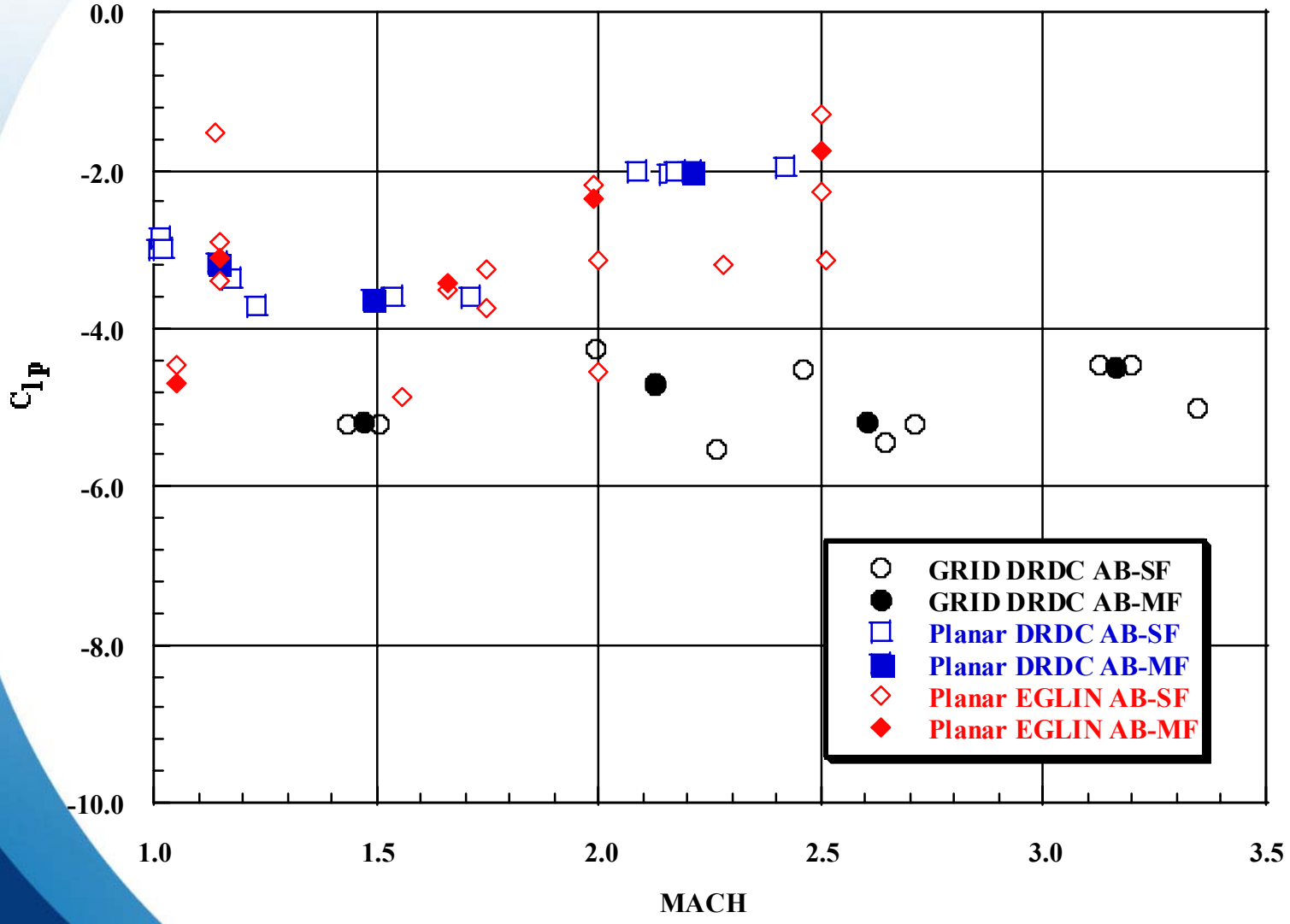
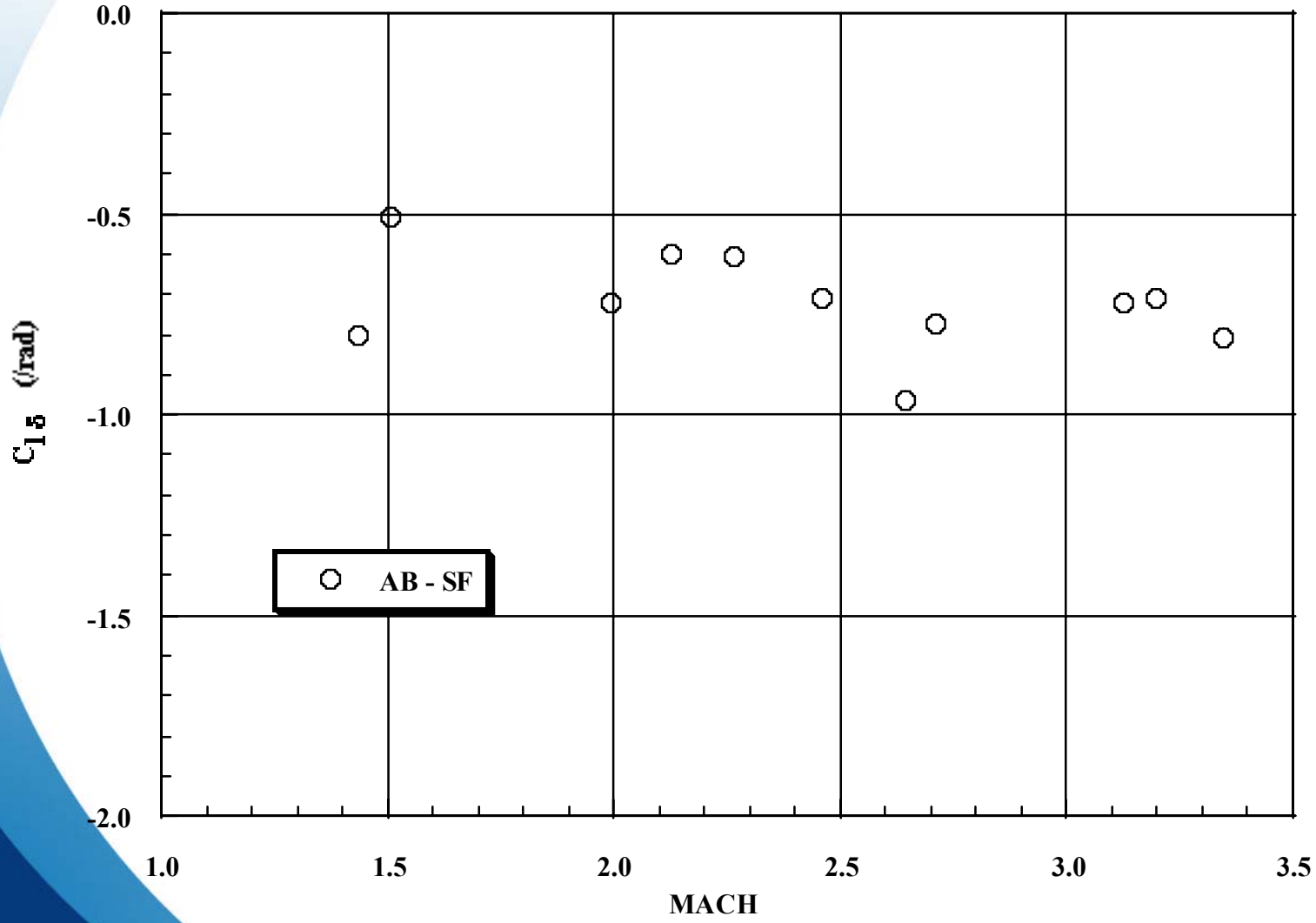


ROLL PRODUCING MOMENT



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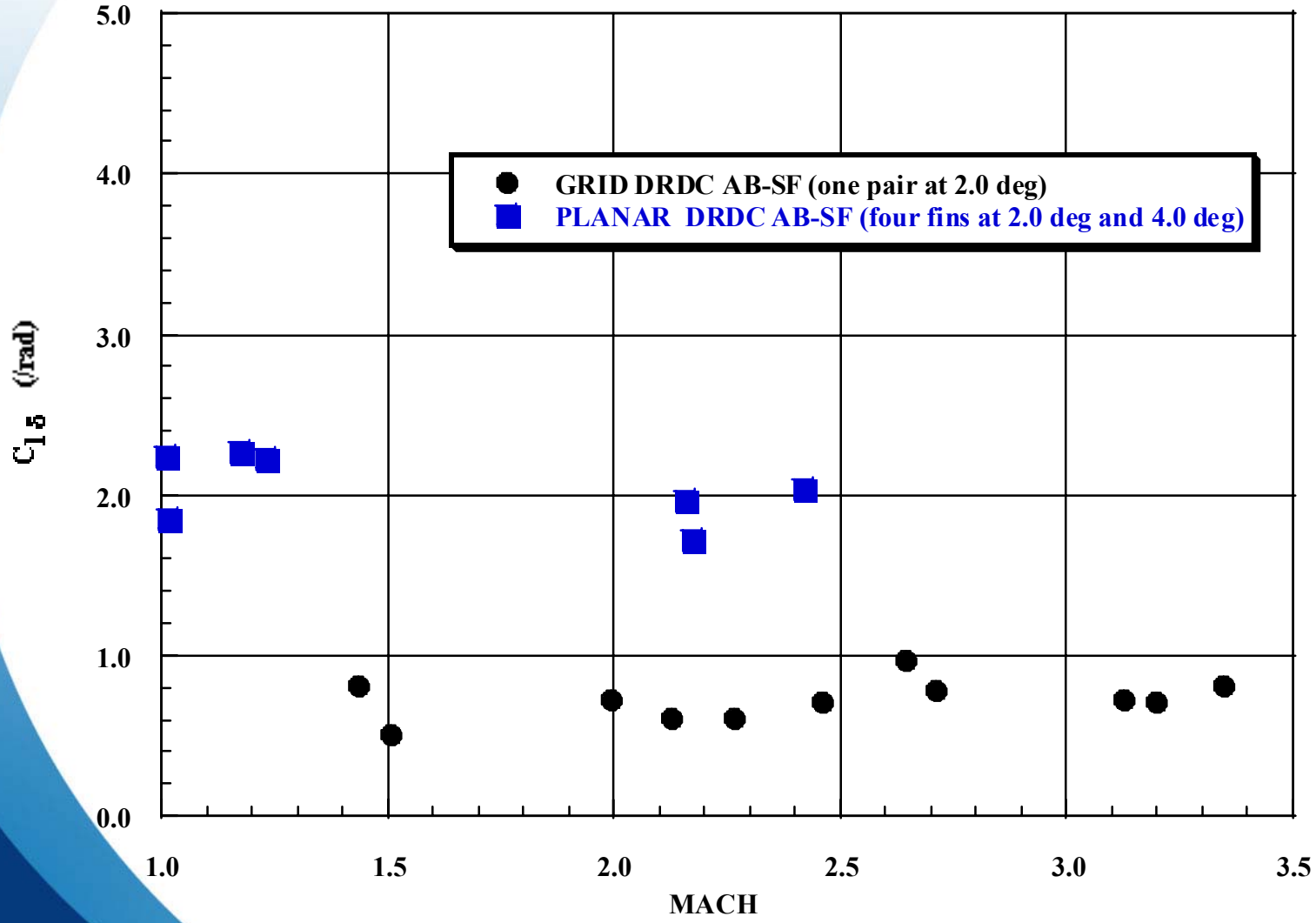

CONCLUSIONS

- 11 Projectiles Fired Mach 1.4 to 3.5

- All Main Aerodynamics well Determined
  - First Time for Reliable C_{Mq} & C_{lp}
  - Some nonlinear ones also

- Comparison with Planer Fin Model