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Impact of Nose-Mounted Micro-Structures on the Aerodynamics of a Generic Missile

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Canada

Presentation Overview

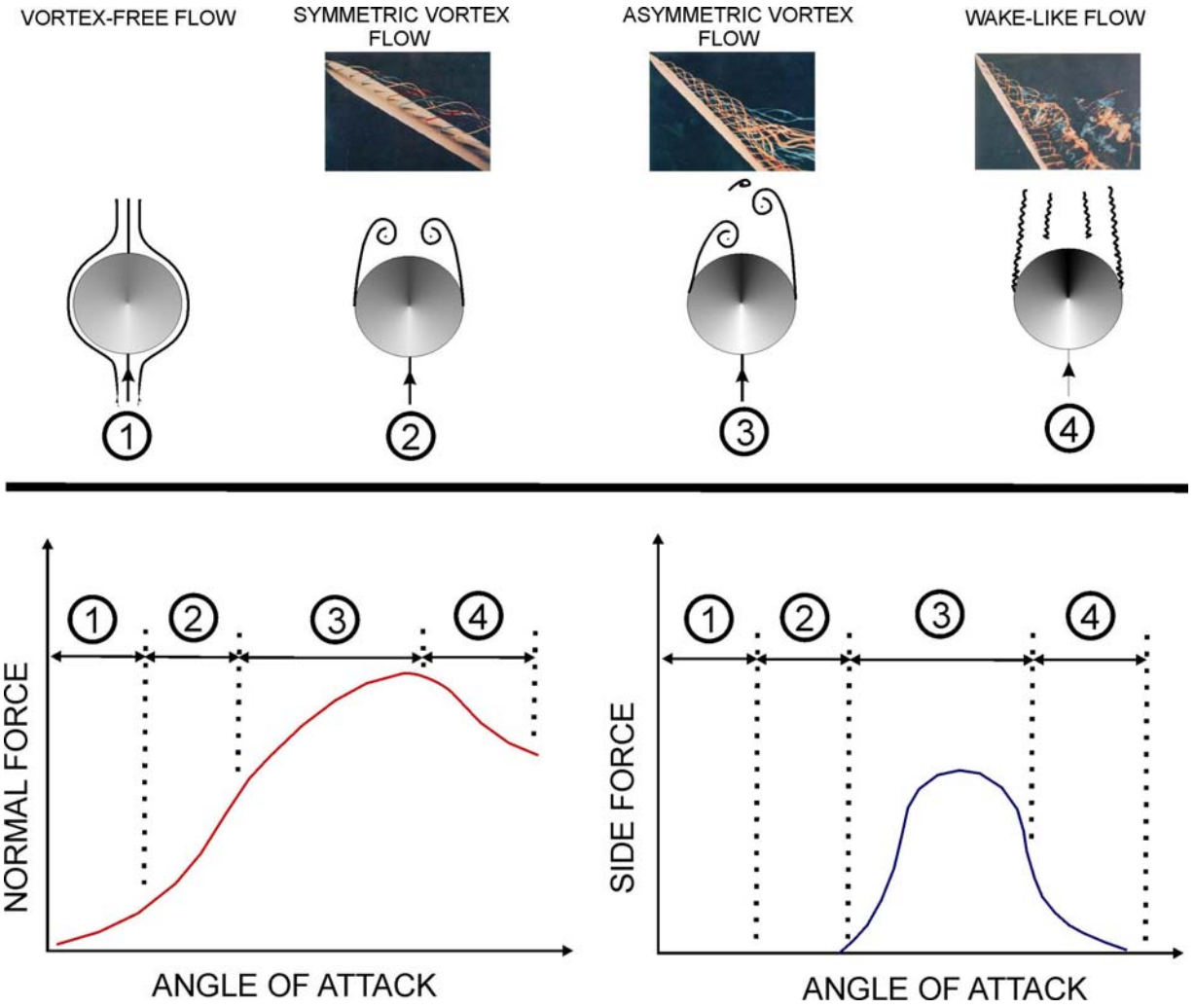
- Objectives
- Background
- Experimental apparatus
- Missile configuration
- Experimental results
- Conclusions

Objectives

- Determine: Optimum flow effector configurations
- Determine: Range of AOA for which a side force is generated
- Evaluate: Use of vortex-induced side force to achieve yaw control

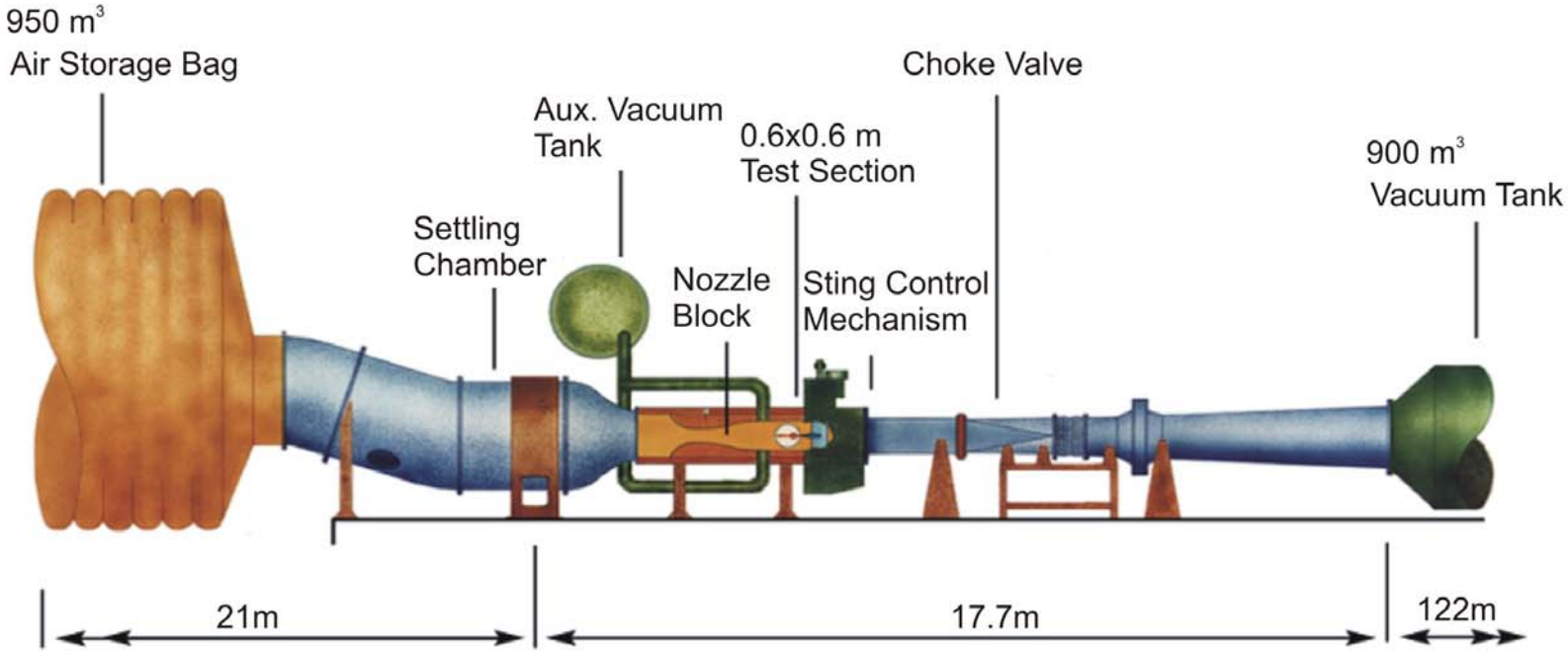
Background

Slender Body Vortex Shedding



Test Setup and Instrumentation

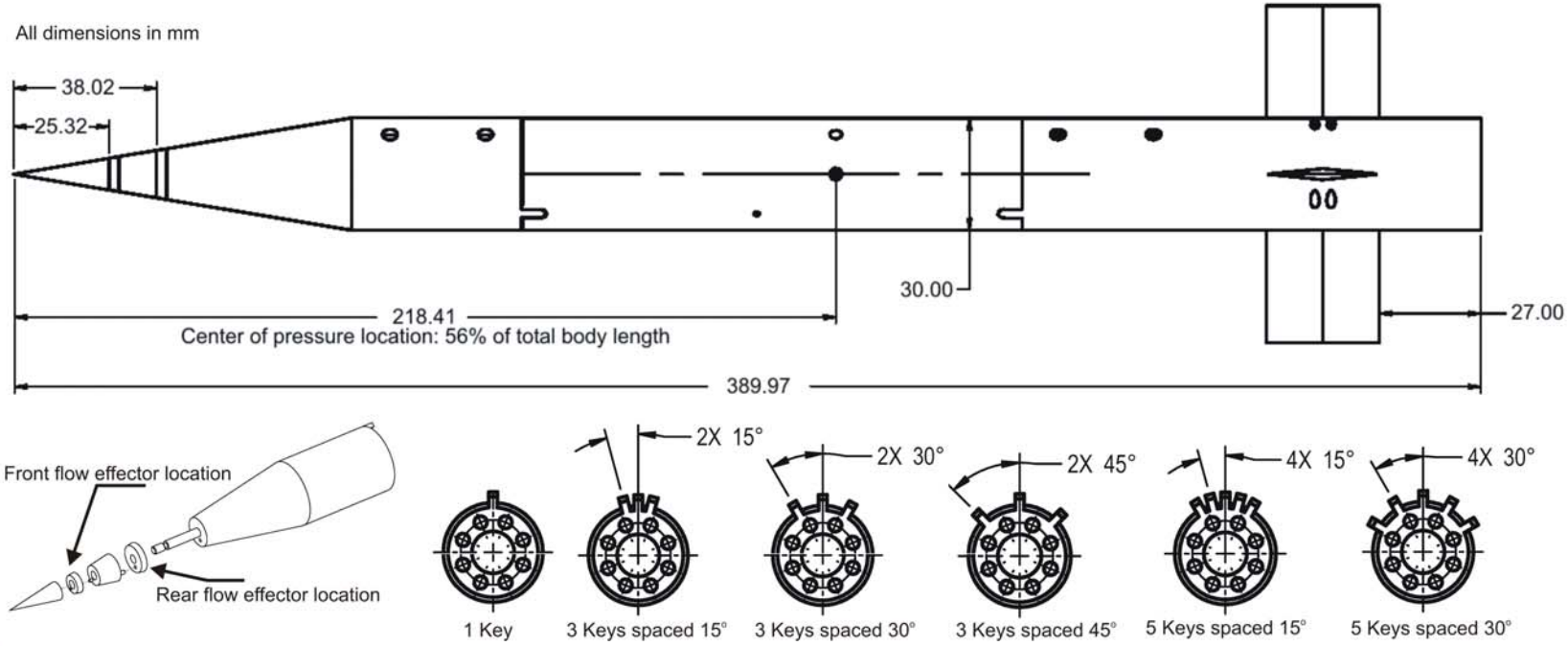
DRDC Trisonic Wind Tunnel



- Indraft wind tunnel
- Test section: 0.6m x 0.6m
- 0.2 < Ma < 4.0
- -20° < AOA < +20 °
- Test duration: 5 – 11 sec
- Turnaround time: 30 min.

Missile Configuration

Baseline Geometry With Conical Nose



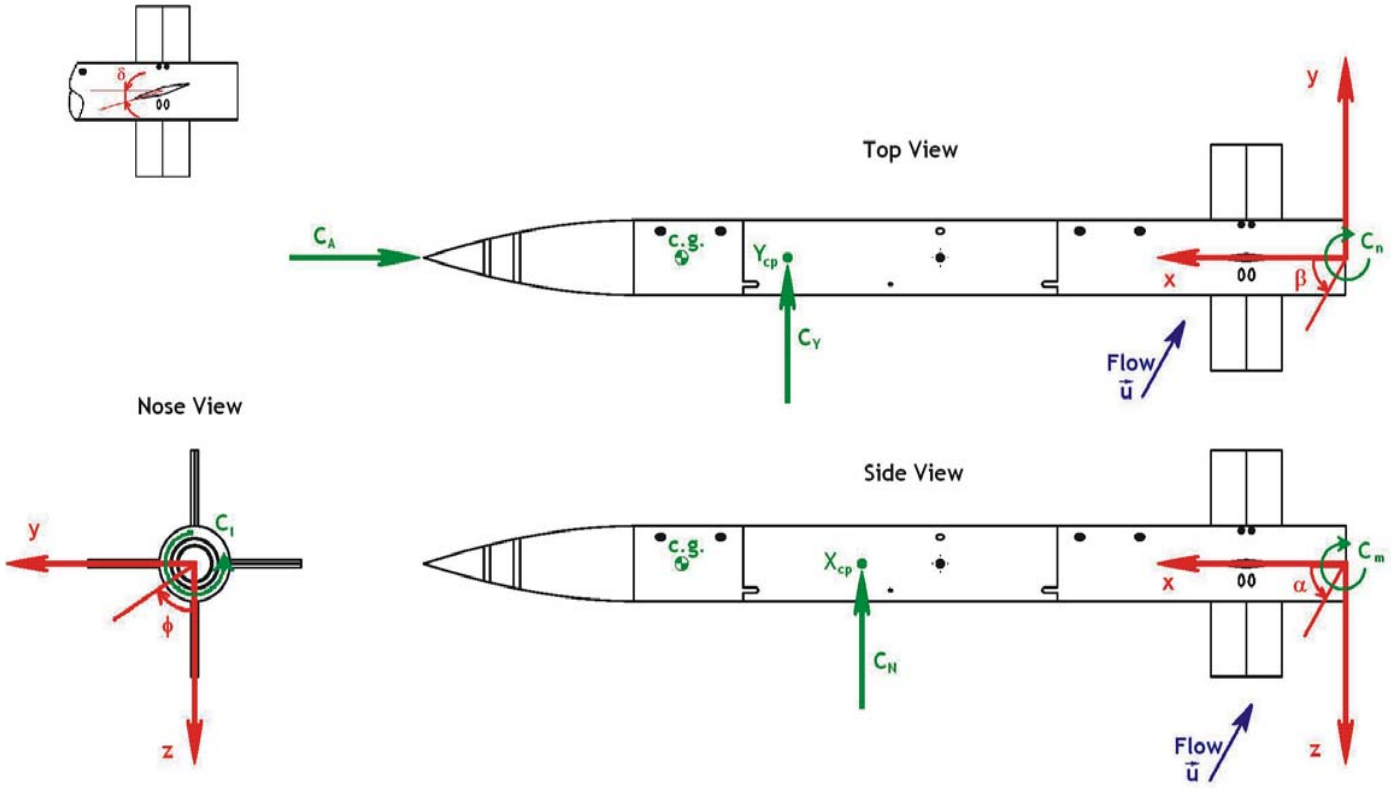
- Aspect Ratio L/D = 13.0
- Nose Aspect Ratio L_N/D = 3.0
- Conical Nose
- 4 Fins in + Configurations (Removable)

Missile Configuration

Baseline Geometry With Conical Nose

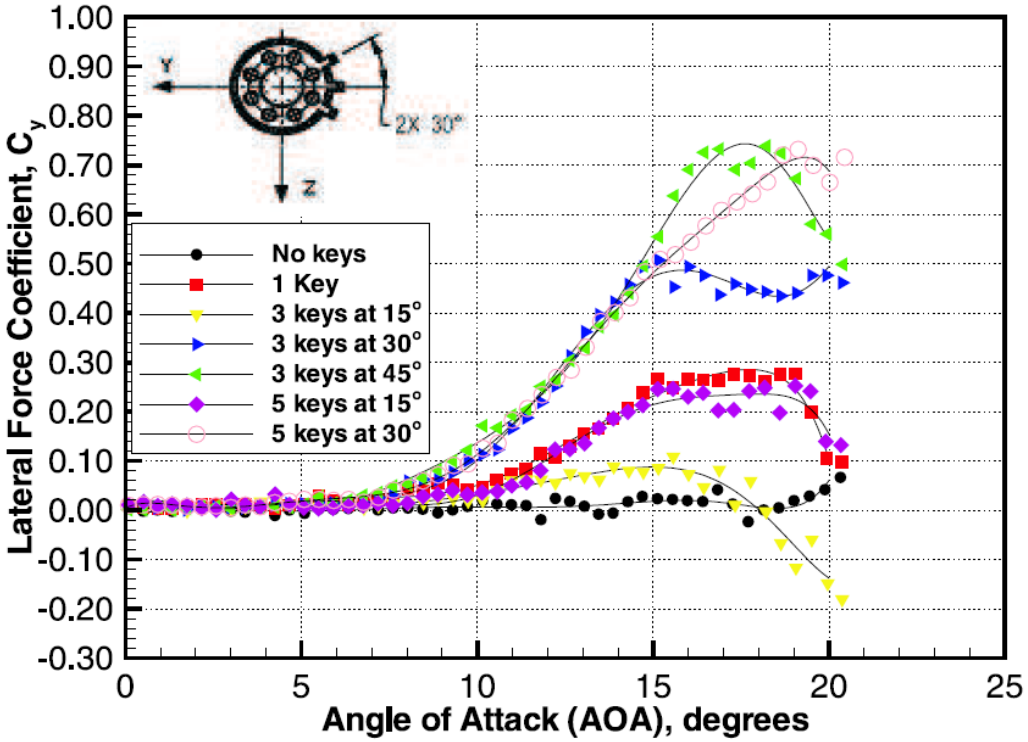
Missile Configuration

Nomenclature: North East Down Coordinate System



Experimental Results

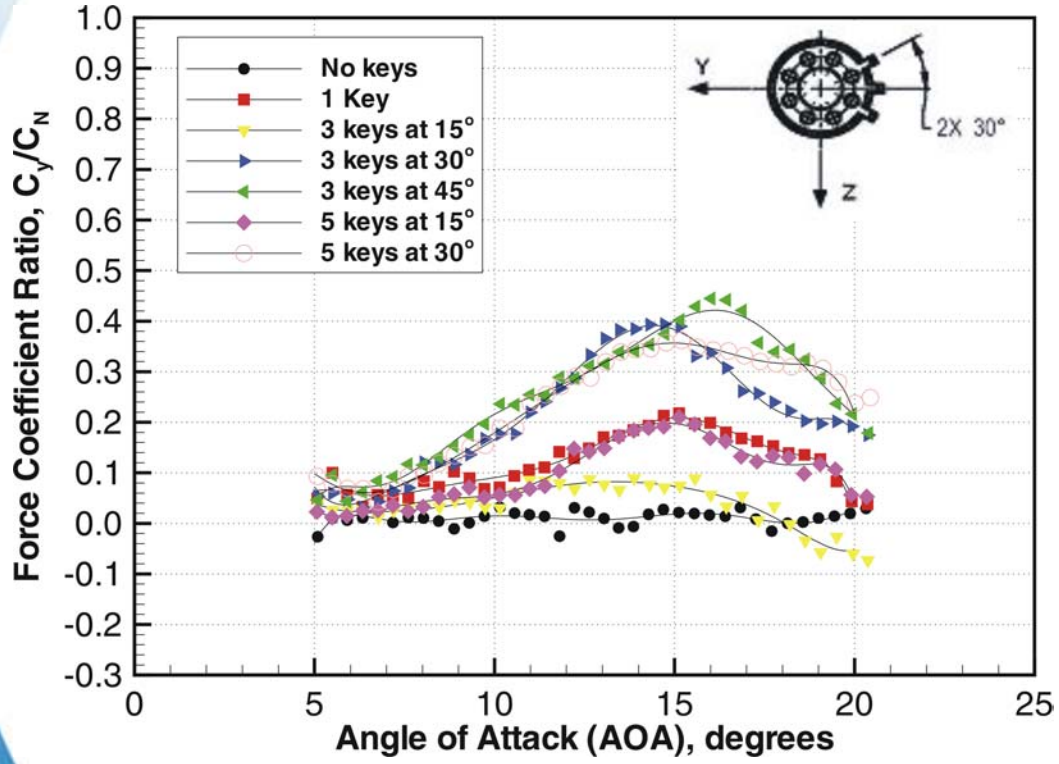
Lateral Force Coefficient vs AOA



- No fins
- Conical nose L_N/D= 3.0
- Flow effectors centered at 270°
- Front row
- Ma= 1.5
- Re/m= 15.2×10^6

Experimental Results

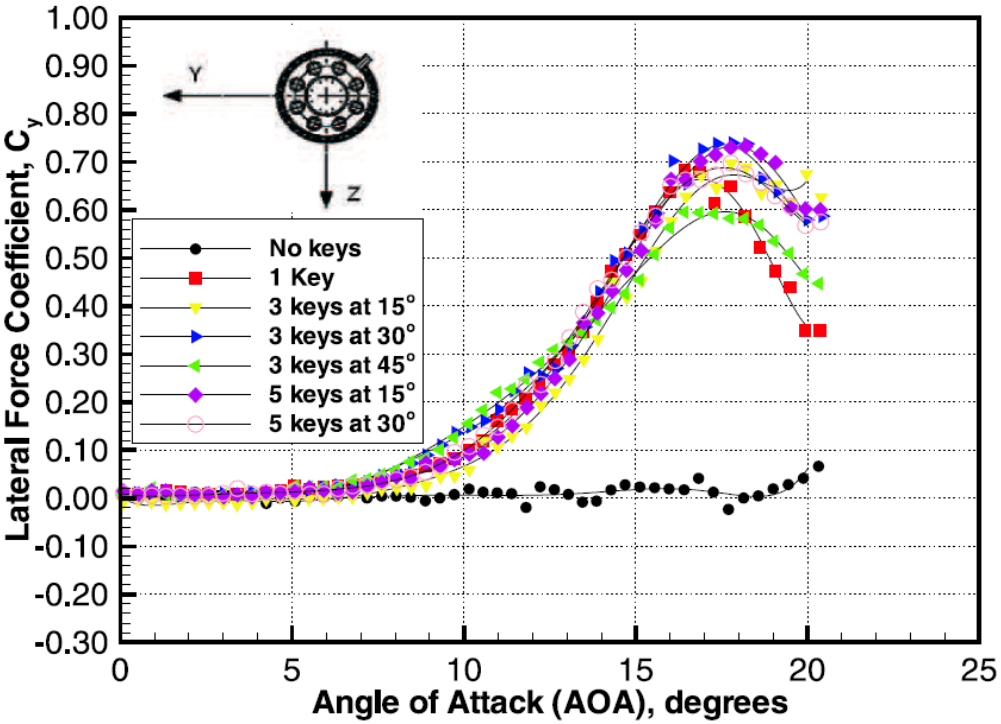
Lateral Force Coefficient vs AOA



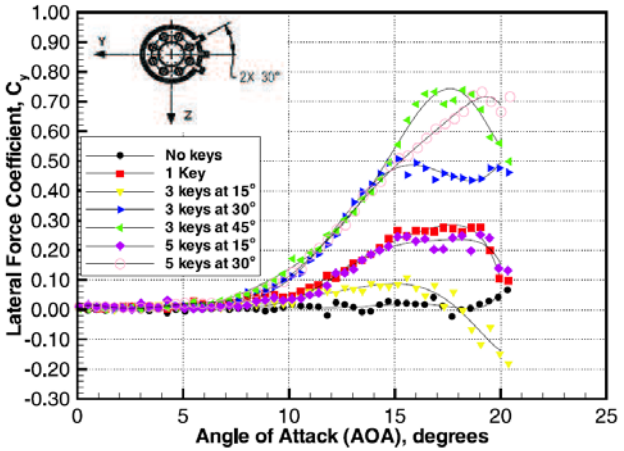
- **No fins**
- **Conical nose L_N/D= 3.0**
- **Flow effectors centered at 270°**
- **Front row**
- **Ma= 1.5**
- **Re/m= 15.2×10^6**

Experimental Results

Lateral Force Coefficient vs AOA

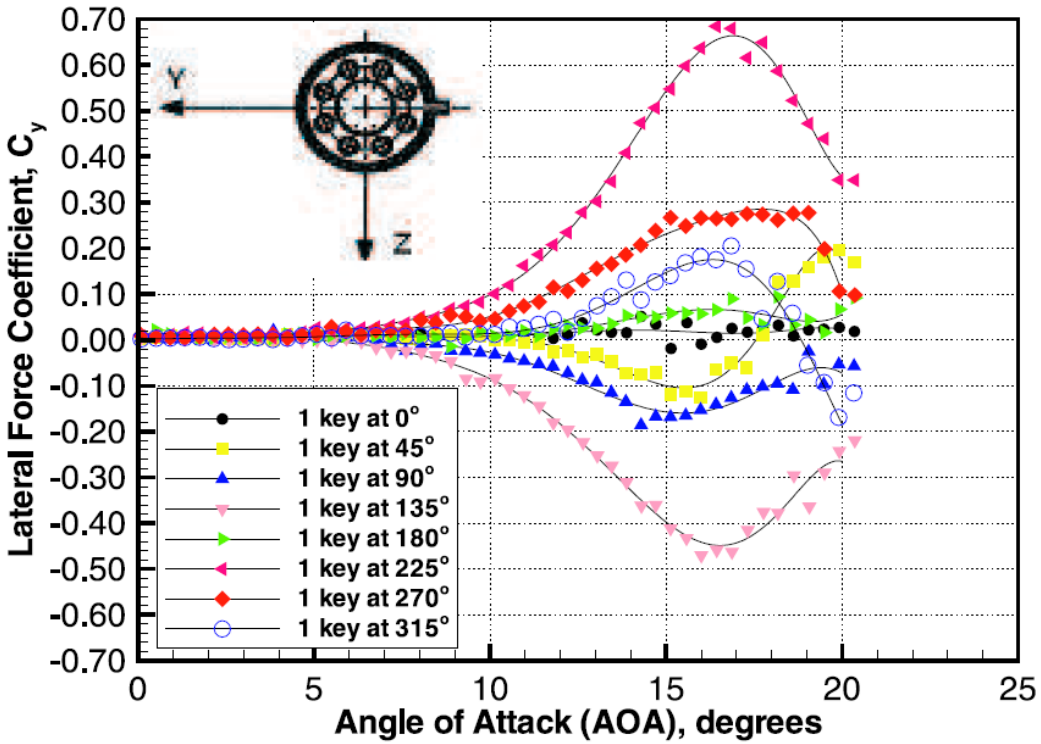


- No fins
- Conical nose L_N/D= 3.0
- Flow effectors centered at 225°
- Front row
- Ma= 1.5
- Re/m= 15.2×10^6



Experimental Results

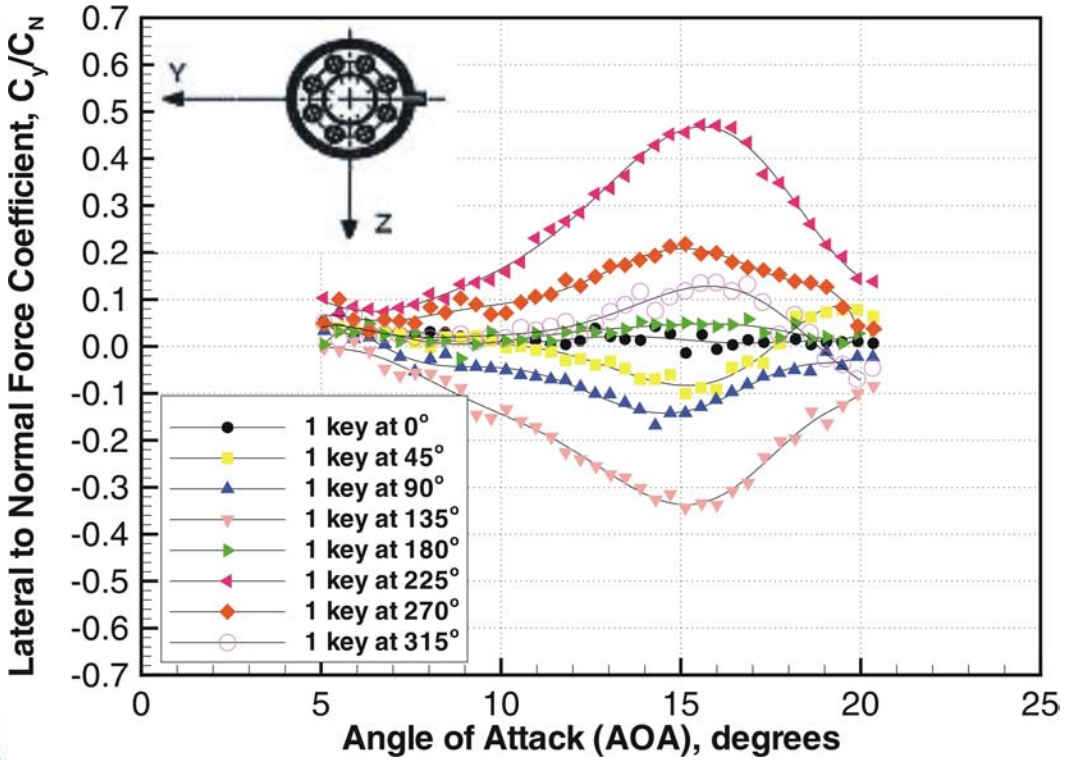
Lateral Force Coefficient vs AOA



- No fins
- Conical nose L_N/D= 3.0
- Flow effector: 1 key
- Front row
- Angular position: 0° - 360°
- Ma= 1.5
- Re/m= 15.2×10^6

Experimental Results

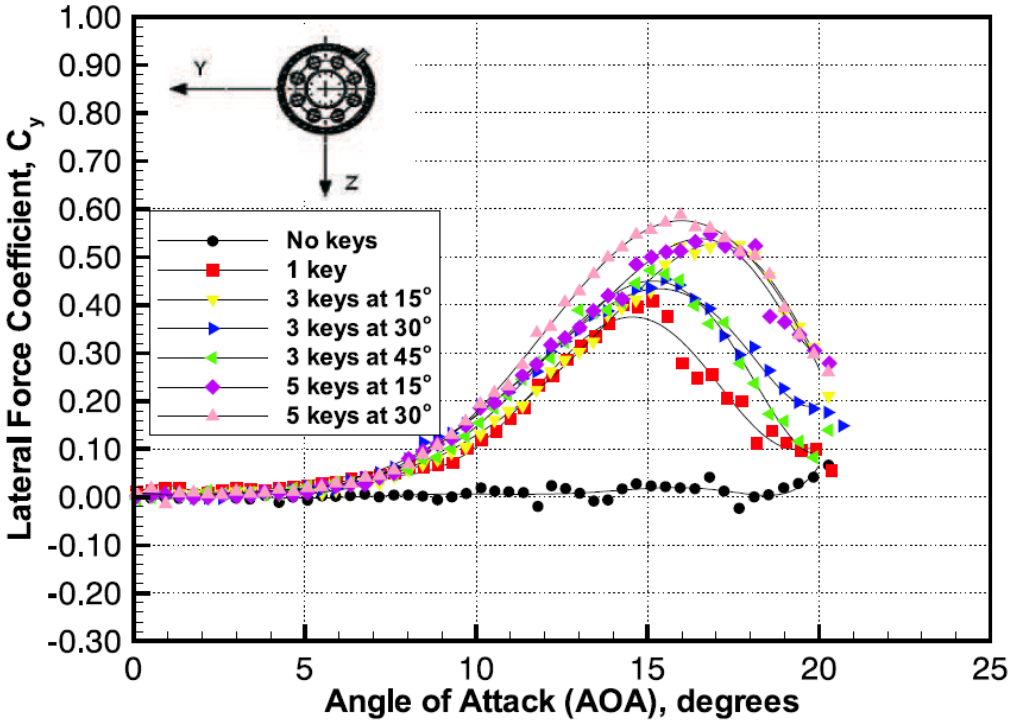
Lateral Force to Normal force Coefficient Ratio vs AOA



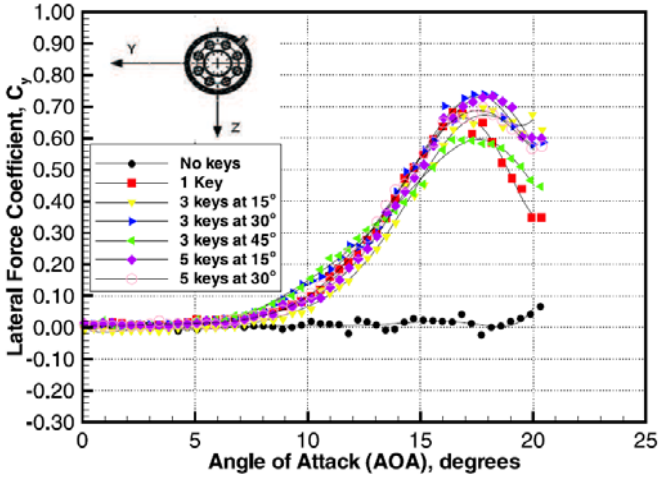
- No fins
- Conical nose L_N/D= 3.0
- Flow effector: 1 key
- Front row
- Angular position: 0° - 360°
- Ma= 1.5
- Re/m= 15.2×10^6

Experimental Results

Lateral Force Coefficient vs AOA

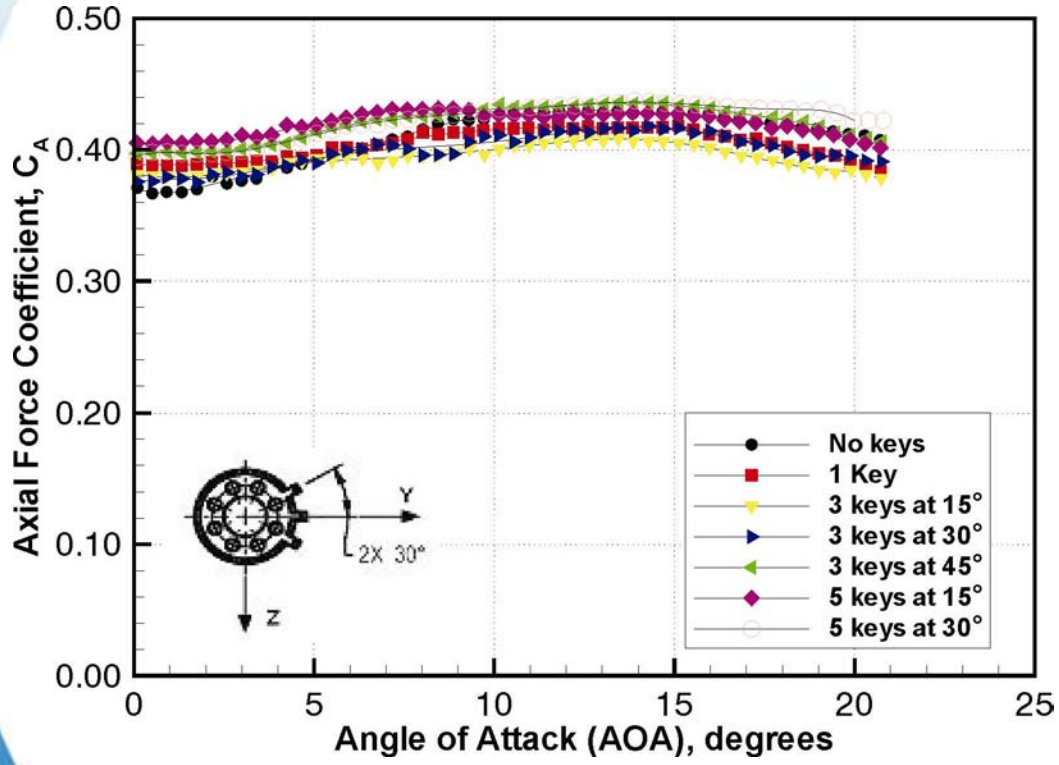


- No fins
- Conical nose L_N/D= 3.0
- Flow effectors centered at 225°
- Aft row
- Ma= 1.5
- Re/m= 15.2×10^6



Experimental Results

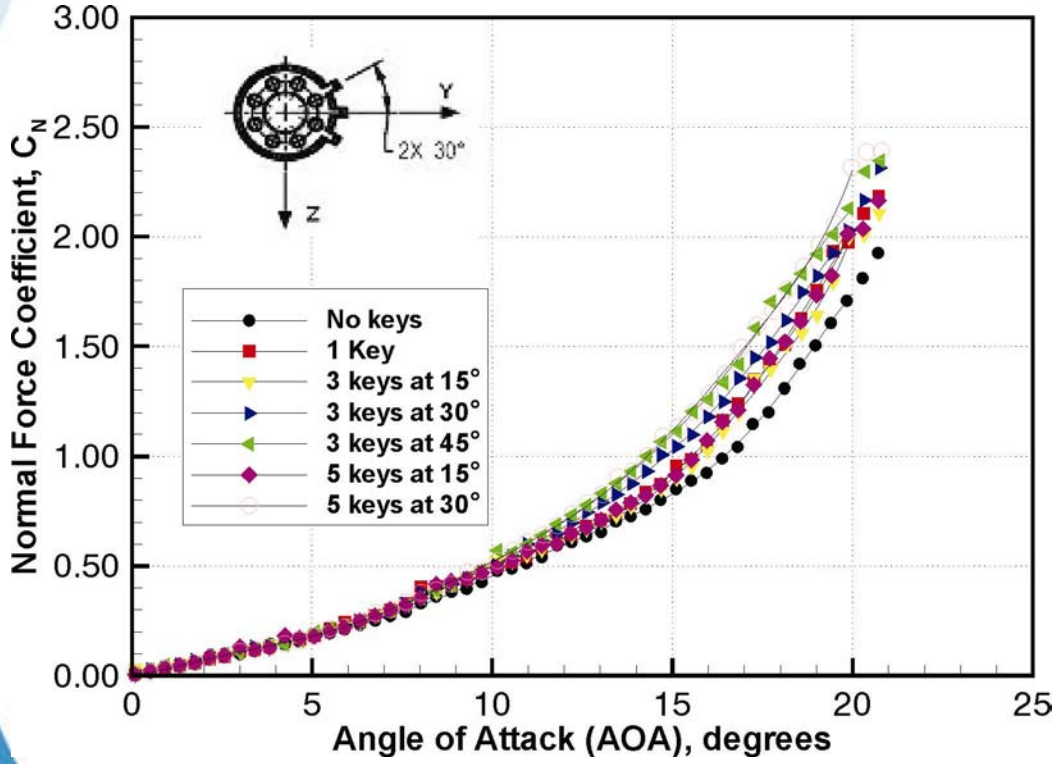
Axial Force Coefficient vs AOA



- No fins
- Conical nose L_N/D= 3.0
- Flow effectors centered at 270°
- Front row
- Ma= 1.5
- Re/m= 15.2×10^6

Experimental Results

Normal Force Coefficient vs AOA



- No fins
- Conical nose L_N/D= 3.0
- Flow effectors centered at 270°
- Front row
- Ma= 1.5
- Re/m= 15.2×10^6

Conclusions

- Peak Side force magnitude measured between AOA of 15.0° and 20.0°
- Locating the flow effectors closer to the nose tip results in higher side forces
- Maximum side forces measured at an angular position of 225°
- Side forces generated by the micro-structures are symmetric for complementary flow effectors angular position
- Apart from side force, the nose-mounted micro-structures have little impacts on the other aerodynamic coefficients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