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# Experimental Aerodynamic Analysis of a Fighter Aircraft with a Canard, Forward Swept Wing and Dorsal Intake operating at high incidences.

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# ABSTRACT


A wind tunnel tests were carried out in order to analyze the aerodynamic characteristics of a fighter aircraft model with Canard, Forward Swept Wing and Dorsal Intake operating at high incidences.

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The model was designed at Aircraft Design Group of the Aeronautical Engineering Department of EESC-USP as a proof of concept to understand the flight characteristics of this configuration when operating at high incidences angles.

The model has a wing span of 1.20m, a NACA 0012 wing profile in both wing and canard.

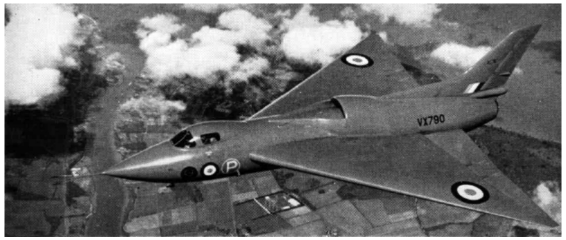
The wind tunnel is a low speed closed circuit with a 1.30m X 1.70m X 3.0m working section, turbulence level of 0.2% and max speed at 45m/s.

The tests conditions were set at 40m/s with the model at -5 to 23 degrees of incidences with the canard incidence varying from -25 to 25 degrees for each model incidence angle.

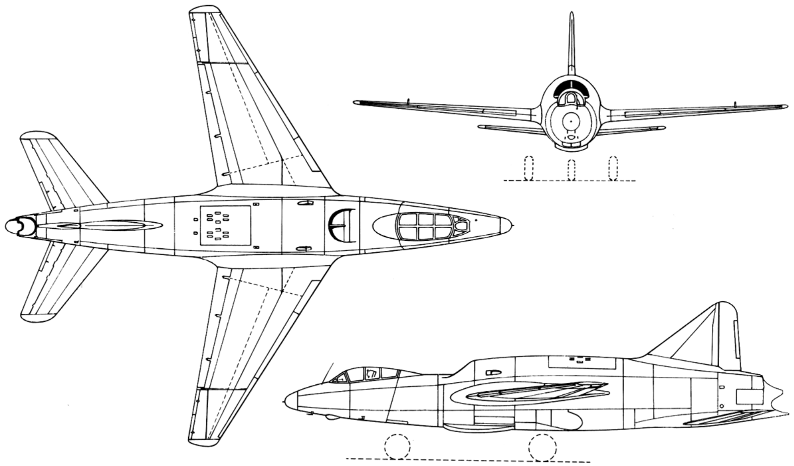
# INTRODUCTION

Dorsal Intake is not a new idea:

AVRO 707



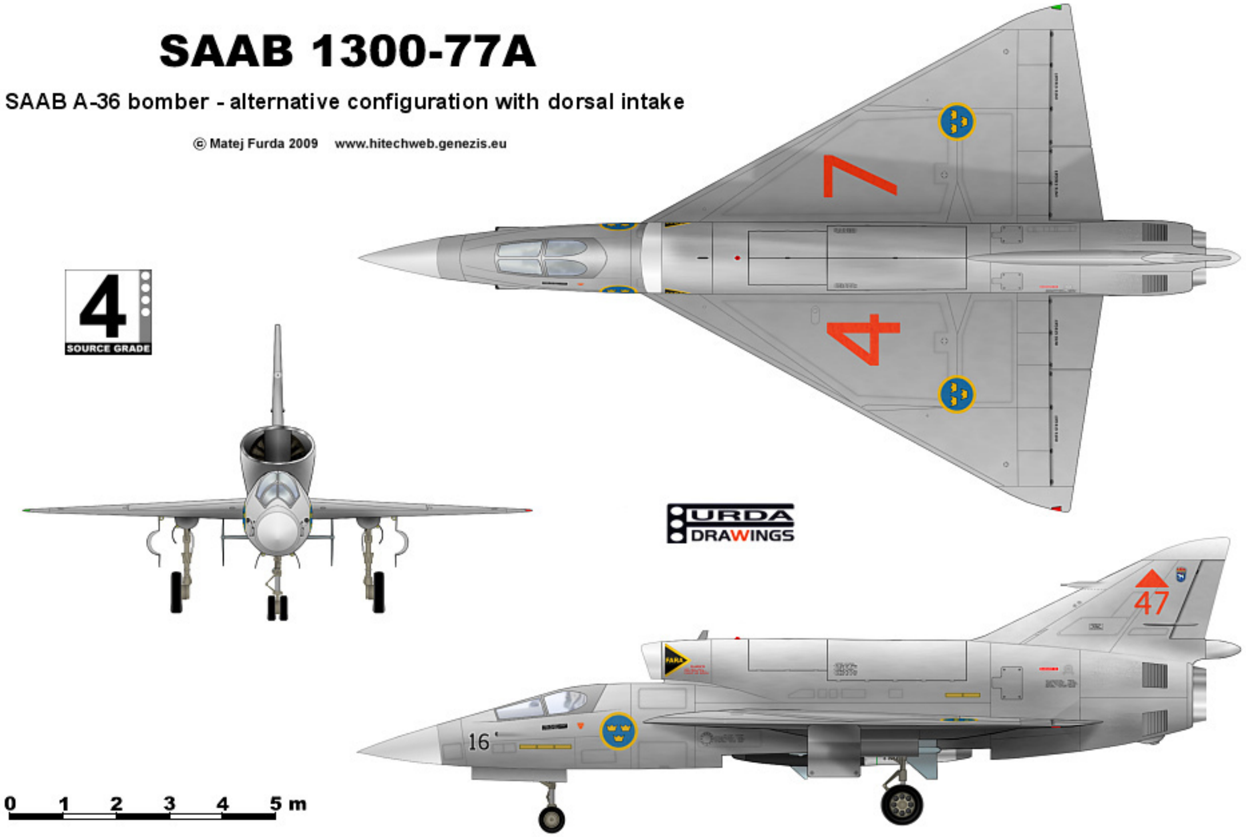
Sud-Est Grognard



# INTRODUCTION

Dorsal Intake is not a new idea:


North American F107

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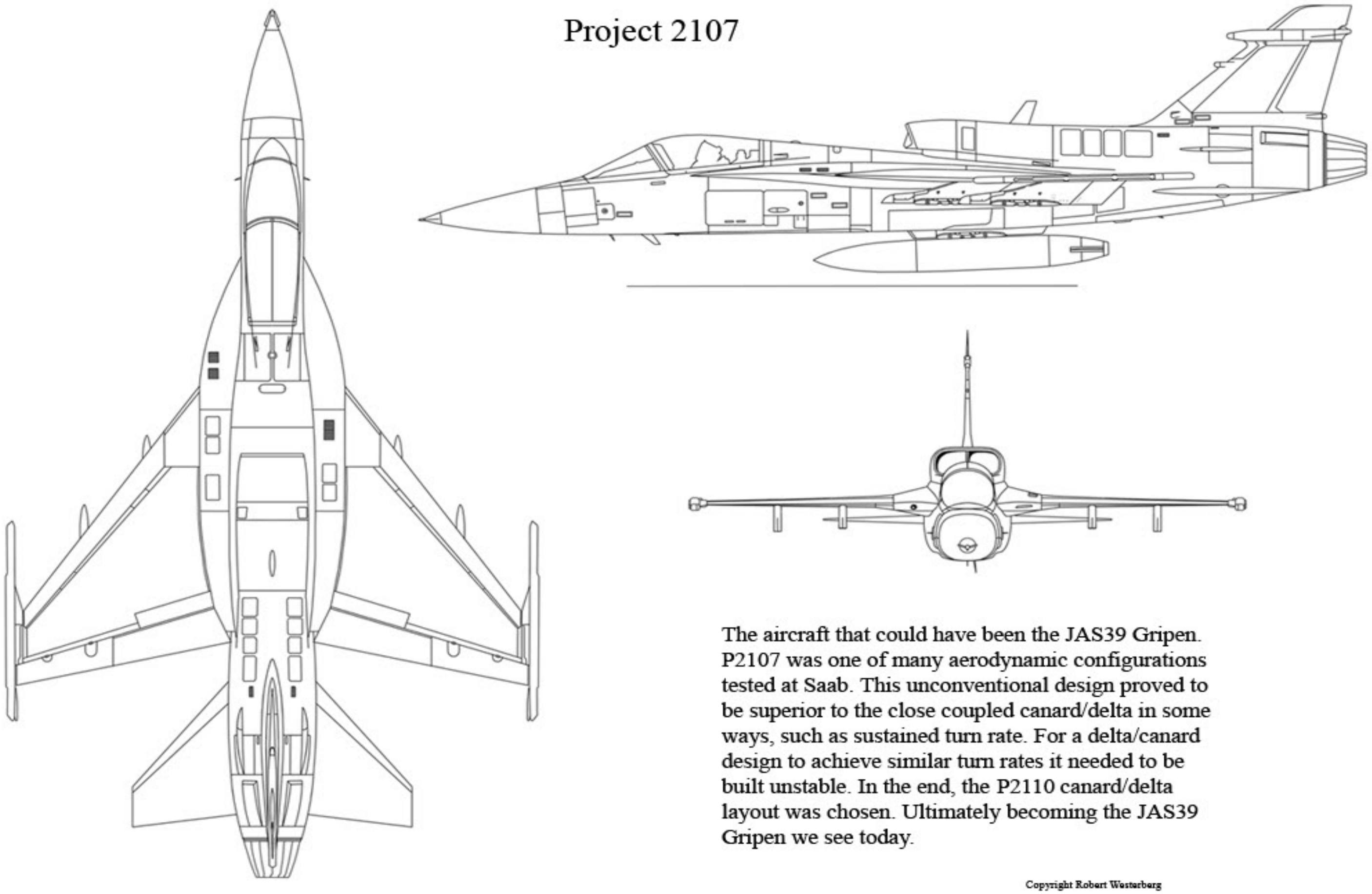
# INTRODUCTION



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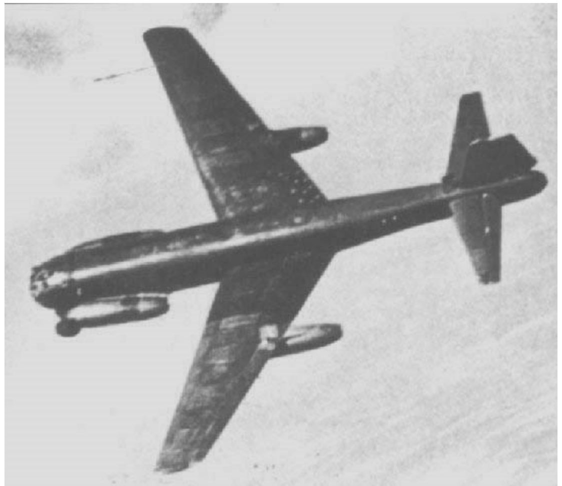
# INTRODUCTION

Forward Swept Wing also is not a new idea :



Ju 287

X-29

Su-47

# METHODOLOGY

**Model Design**

- The model was designed optimizing a shape for a wind tunnel model that already existed in the Lab.

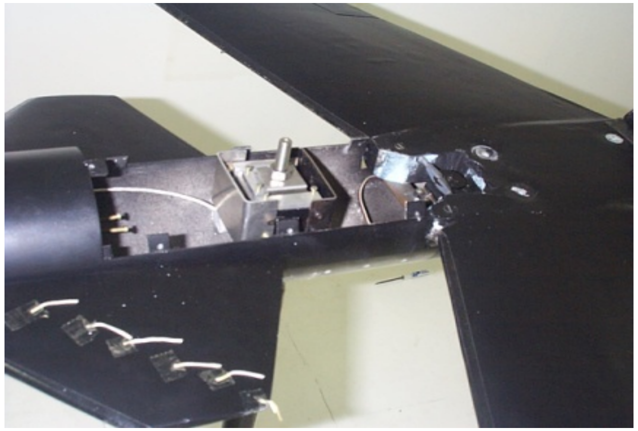
**Flow through engine duct**

- No propulsion sistem at this phase

**Wind tunnel testing**

- Static forces and moment measurements.
- Flow visualization Tufts and oil flow.
- Non-steady mesurements (in near future)

# The Model Designing and construction

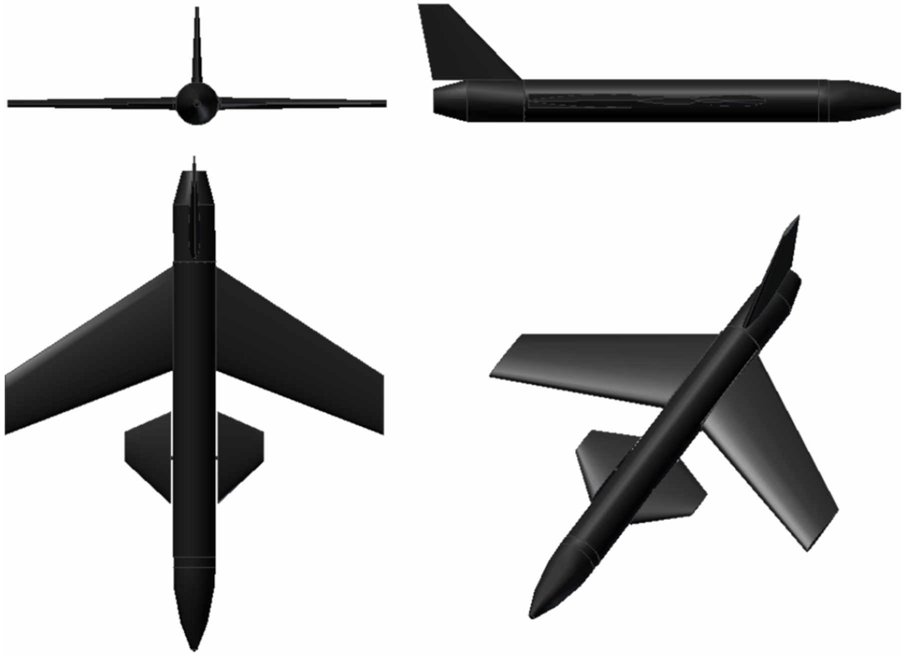


Stability Augmentation System

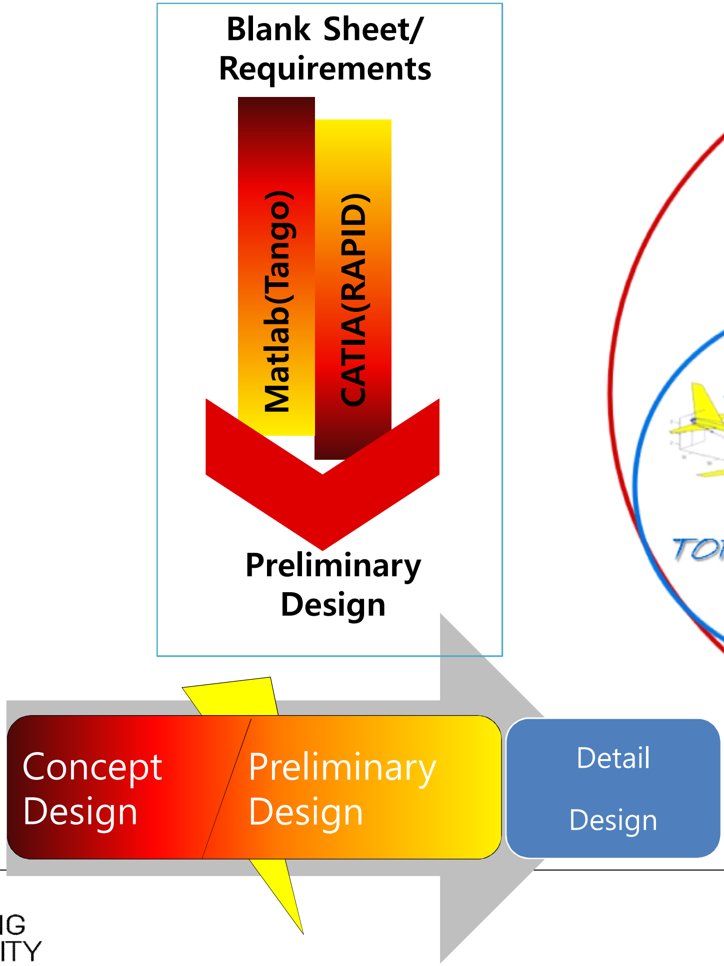
# MODEL GEOMETRY

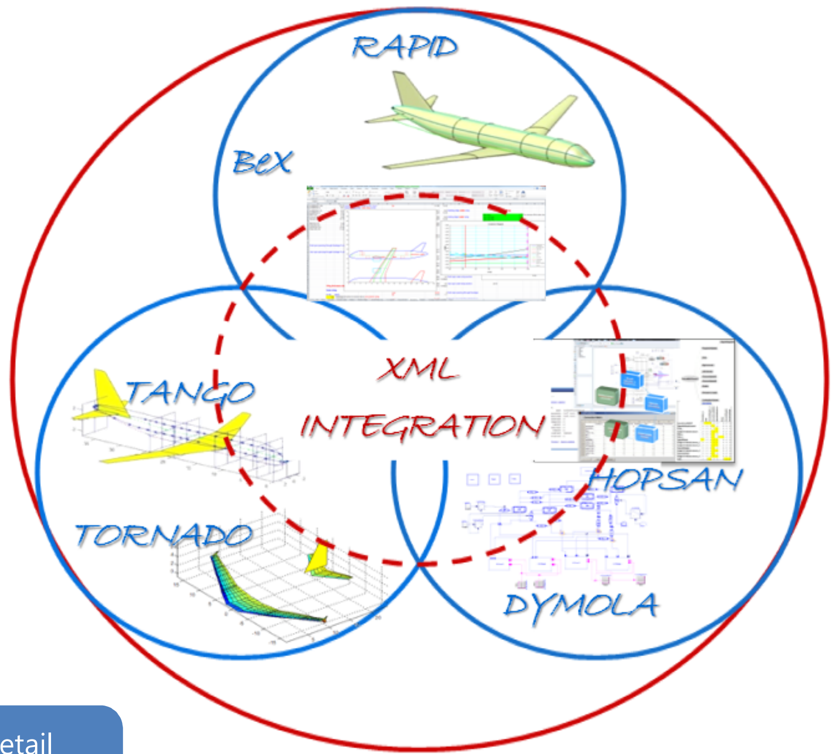
| Canard | |
|---|---|
| Reference area | 0,0288 ($m^2$) |
| Span | 0,32 (m) |
| Mean chord (c) | 0,16 (m) |
| Aspect ratio | 1,6 |
| Leading edge sweep angle | 42,5º |
| Sweep angle at c/4 | 30º |
| Taper ratio | 0,2 |
| **Vertical fin** | |
| Reference area | 0,0232 ($m^2$) |
| Mean chord (c) | 0,1429(m) |
| Aspect ratio | 1,4 |
| Leading edge sweep angle | 43º |
| Sweep angle at c/4 | 37º |
| Taper | 0,33 |
| Rudder area | 0,0061 ($m^2$) |
| **Fuselage** | |
| Length | 1,03 (m) |
| Max diameter | 1,016 (m) |
| Ellipsoid shape nose | |

| Wing geometrical parameters | |
|---|---|
| Reference area | 0,1483 ($m^2$) |
| Span | 0,912 (m) |
| Mean chord (c) | 0,19 (m) |
| Aspect Ratio | 4,8 |
| Leading edge sweep angle | -20º |
| Sweep angle at c/4 | -23º |
| Taper ratio | 0,61 |
| dihedral | 0º |
| Airleron area | 0,0085 ($m^2$) |

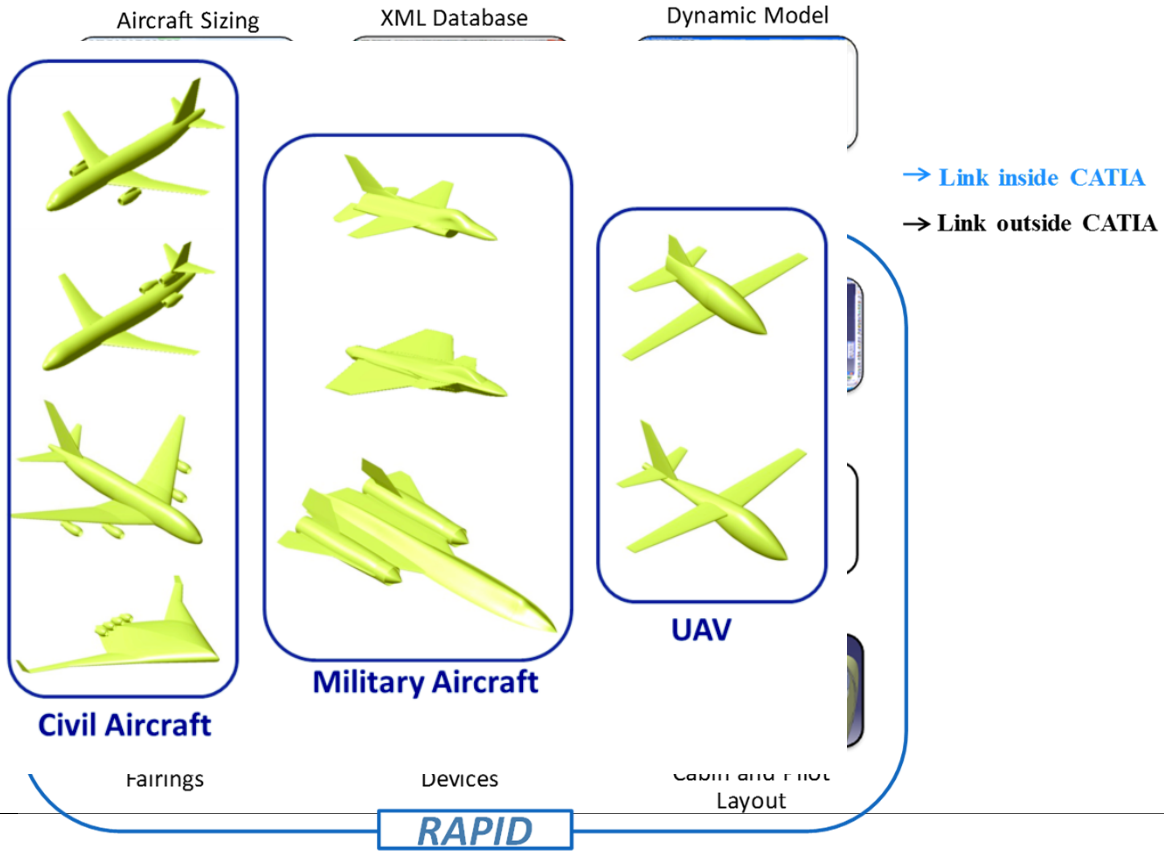


# Knowledge-Based Integrated Aircraft Conceptual Design Framework



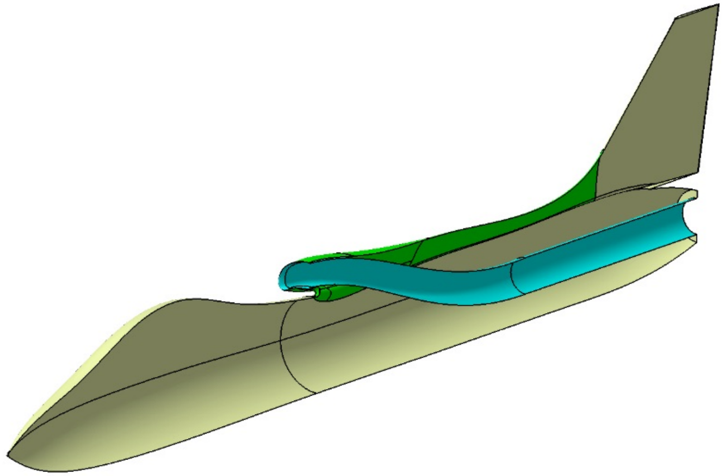
# Knowledge-Based Geometry Design

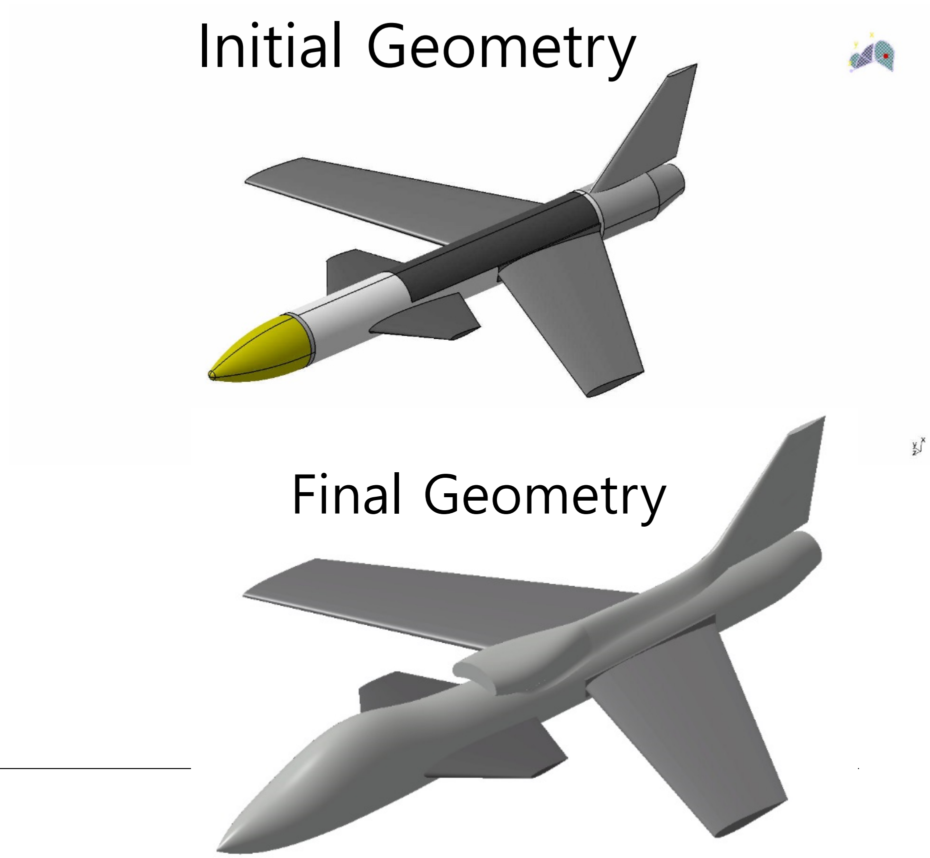


# Updated Geometry in RAPID for Wind tunnel model

- Capture area to Engine face area 2:1

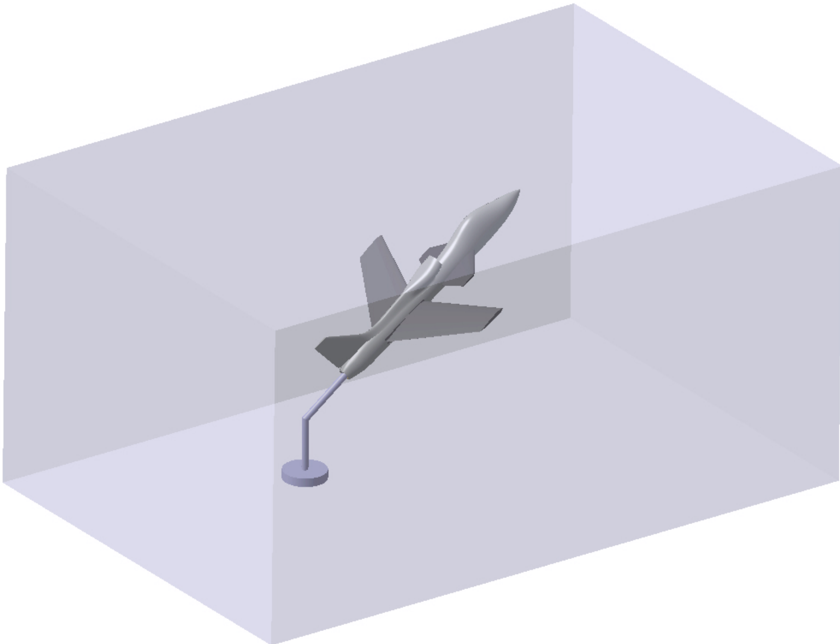
Updated Fuselage in RAPID

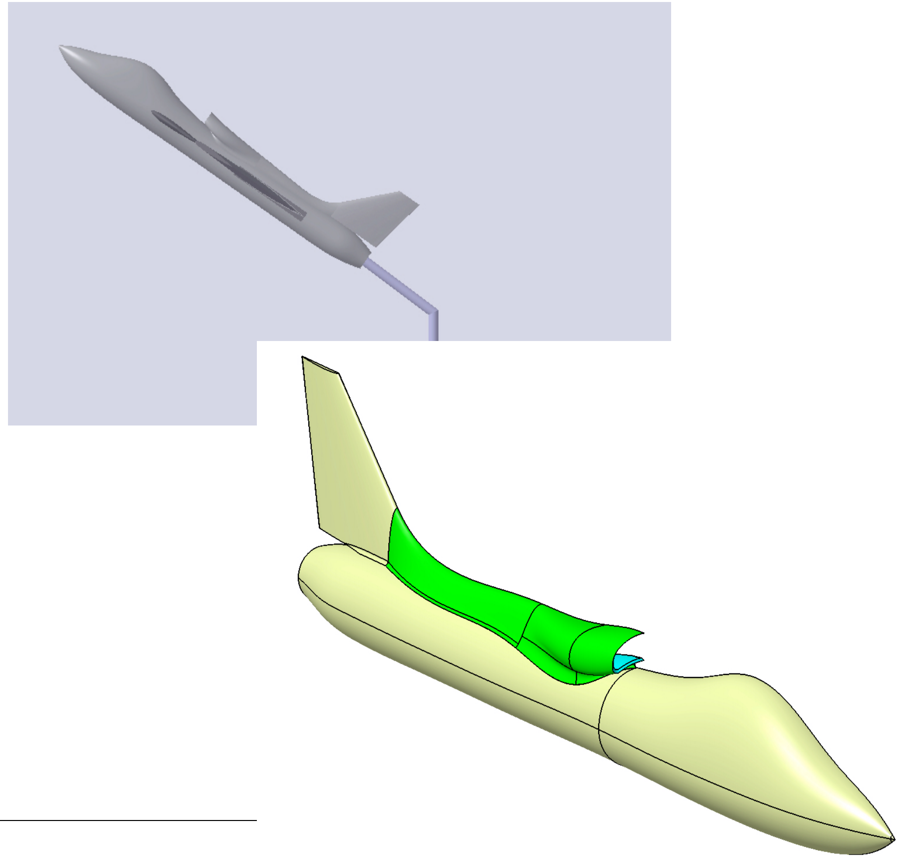




# CANOPY / DORSAL INLET DESIGN

## Updated Geometry in RAPID for Windtunnel model





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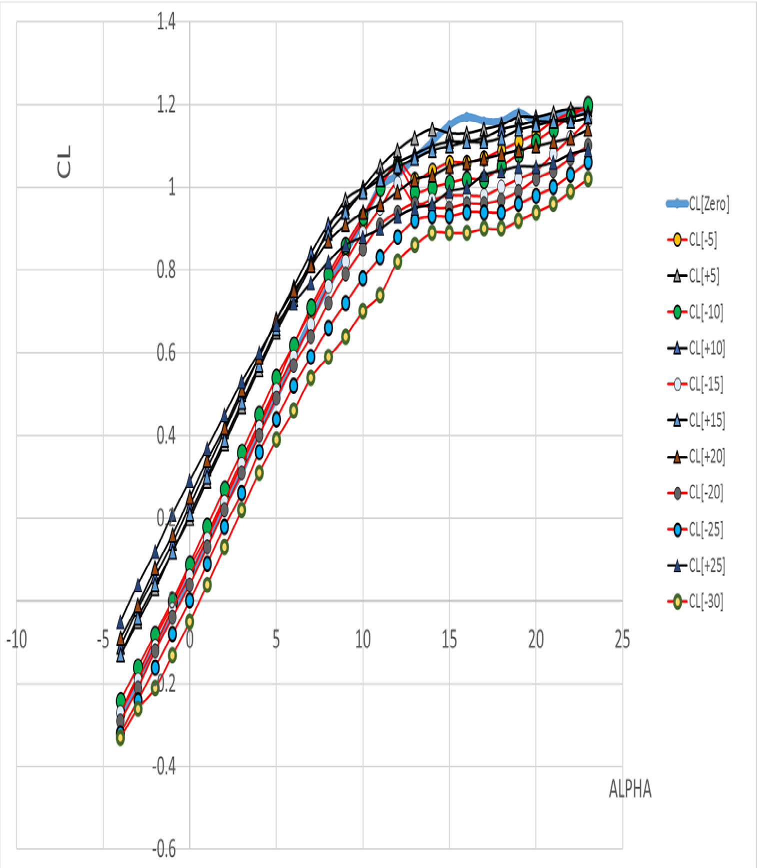
# CANOPY / DORSAL INLET DESIGN

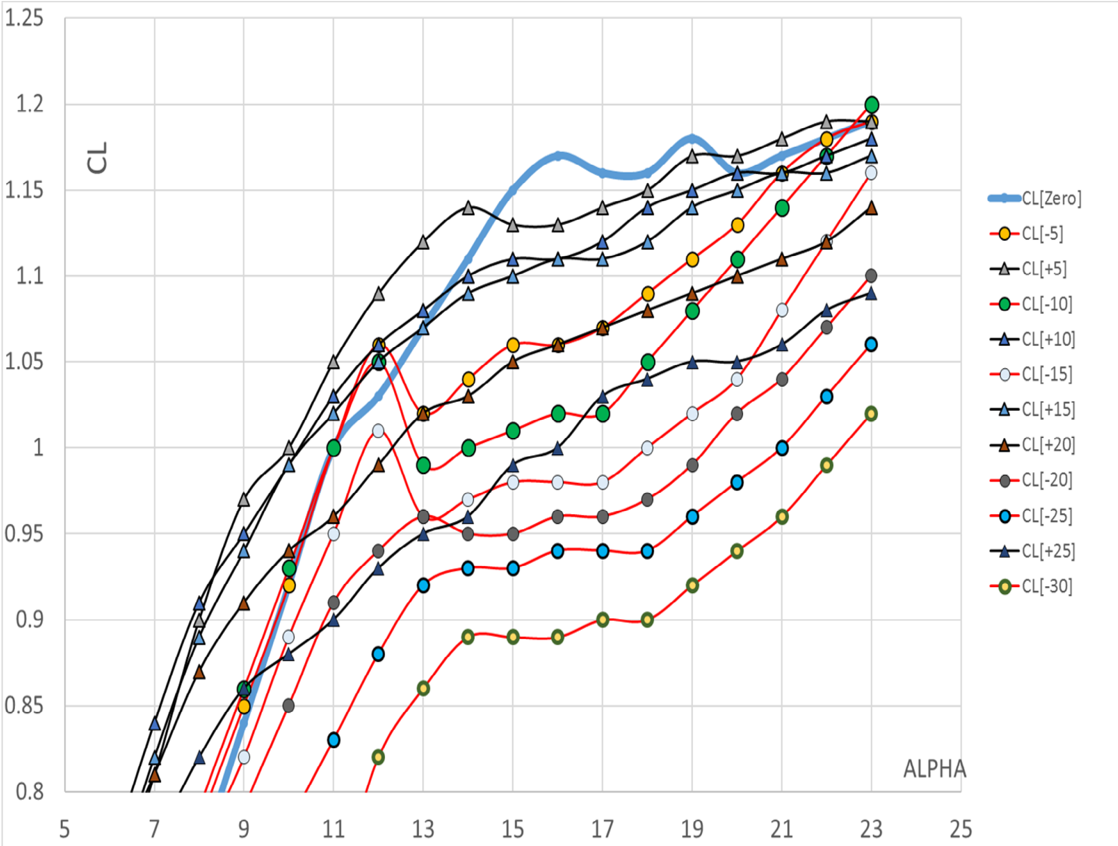
- Drawings were sent to rapid prototyping for making the model and was attached to the former model:

At the workshop

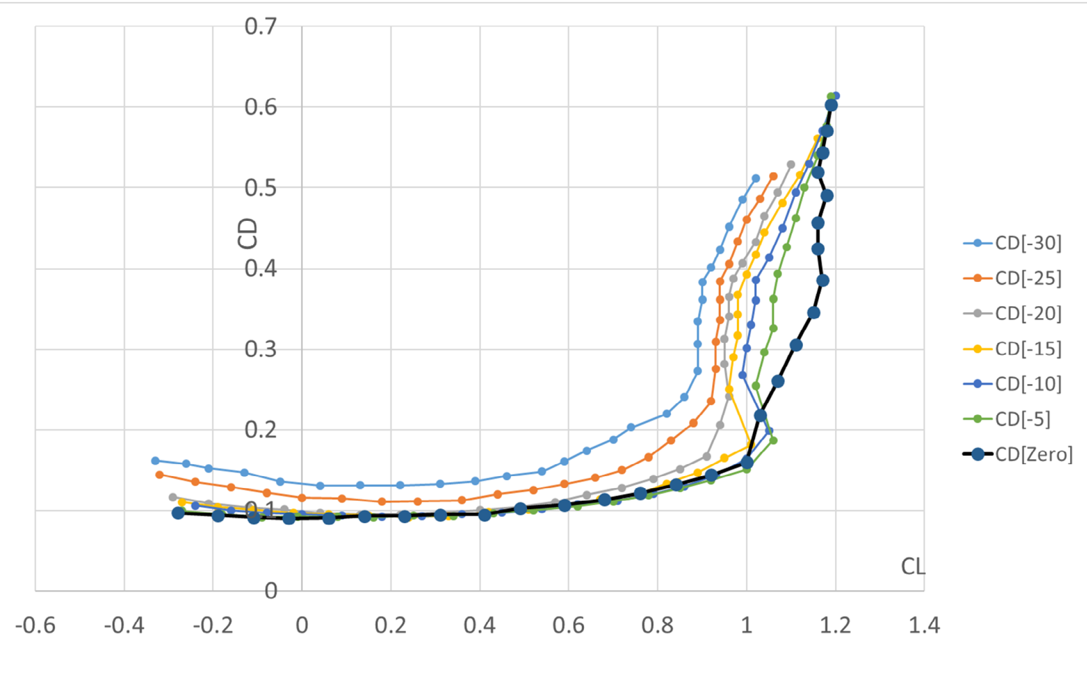

In the Wind tunnel

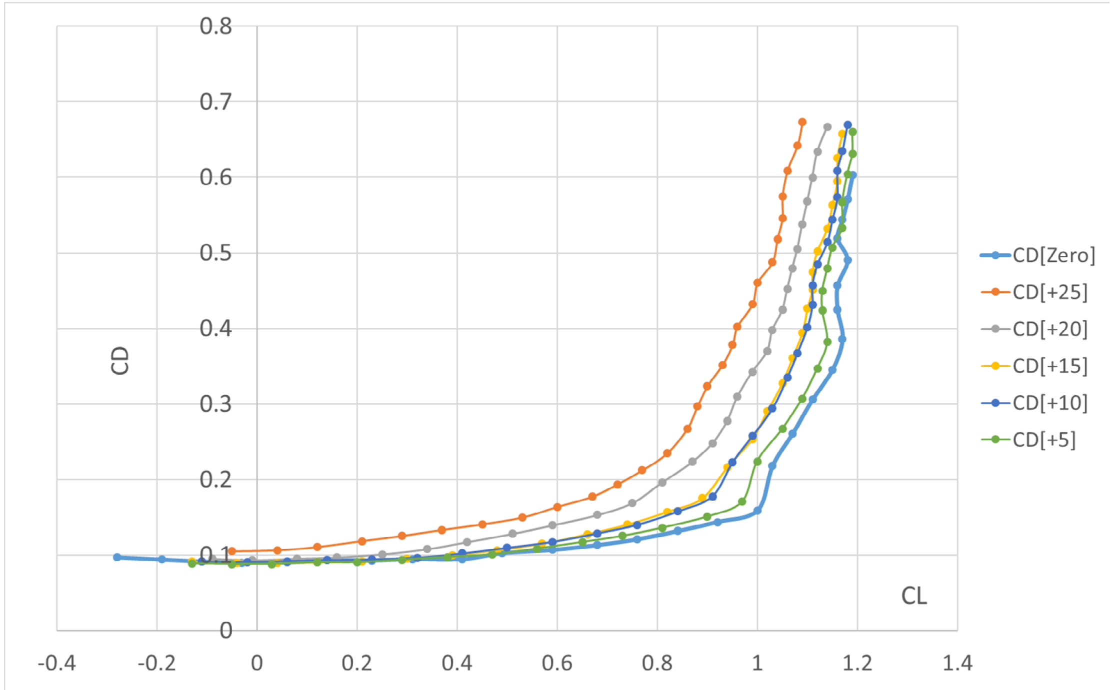
# PRELIMINARY RESULTS (Lift Coeficient)



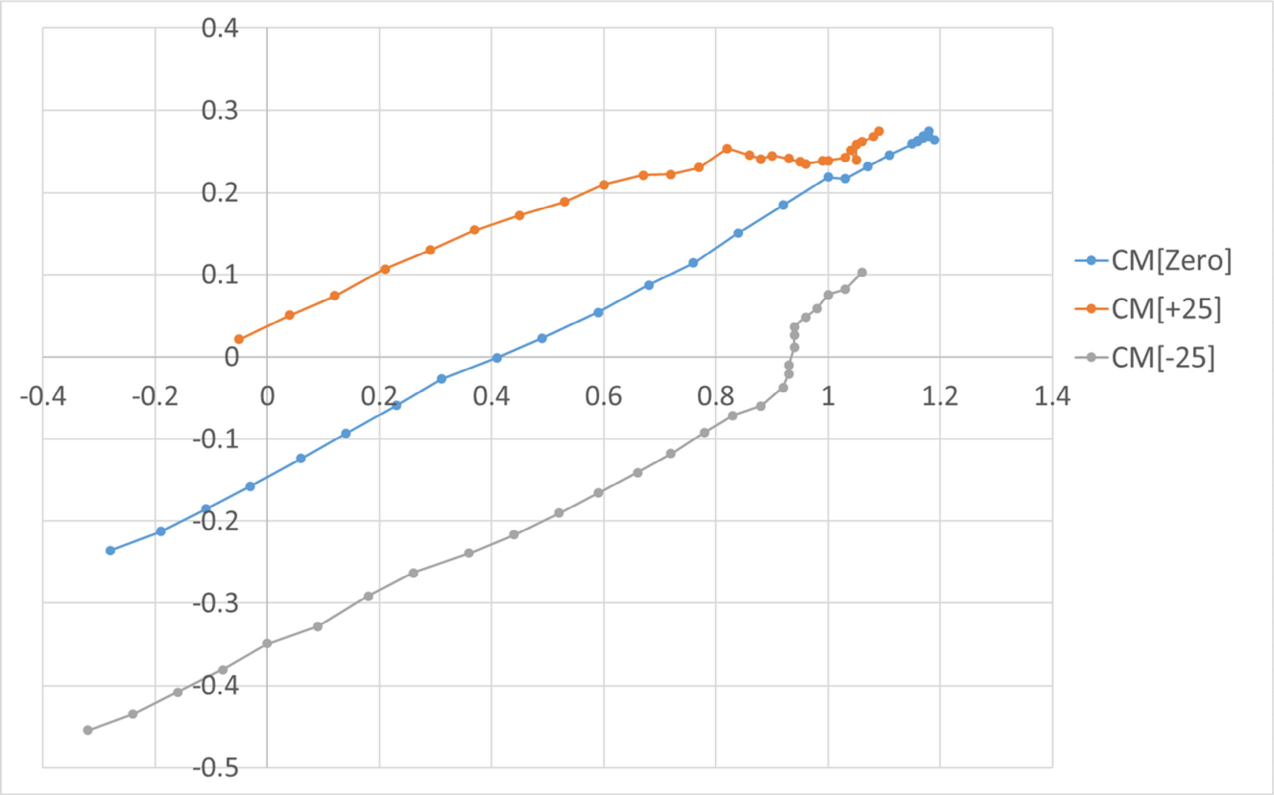



# PRELIMINARY RESULTS (Drag Polar)



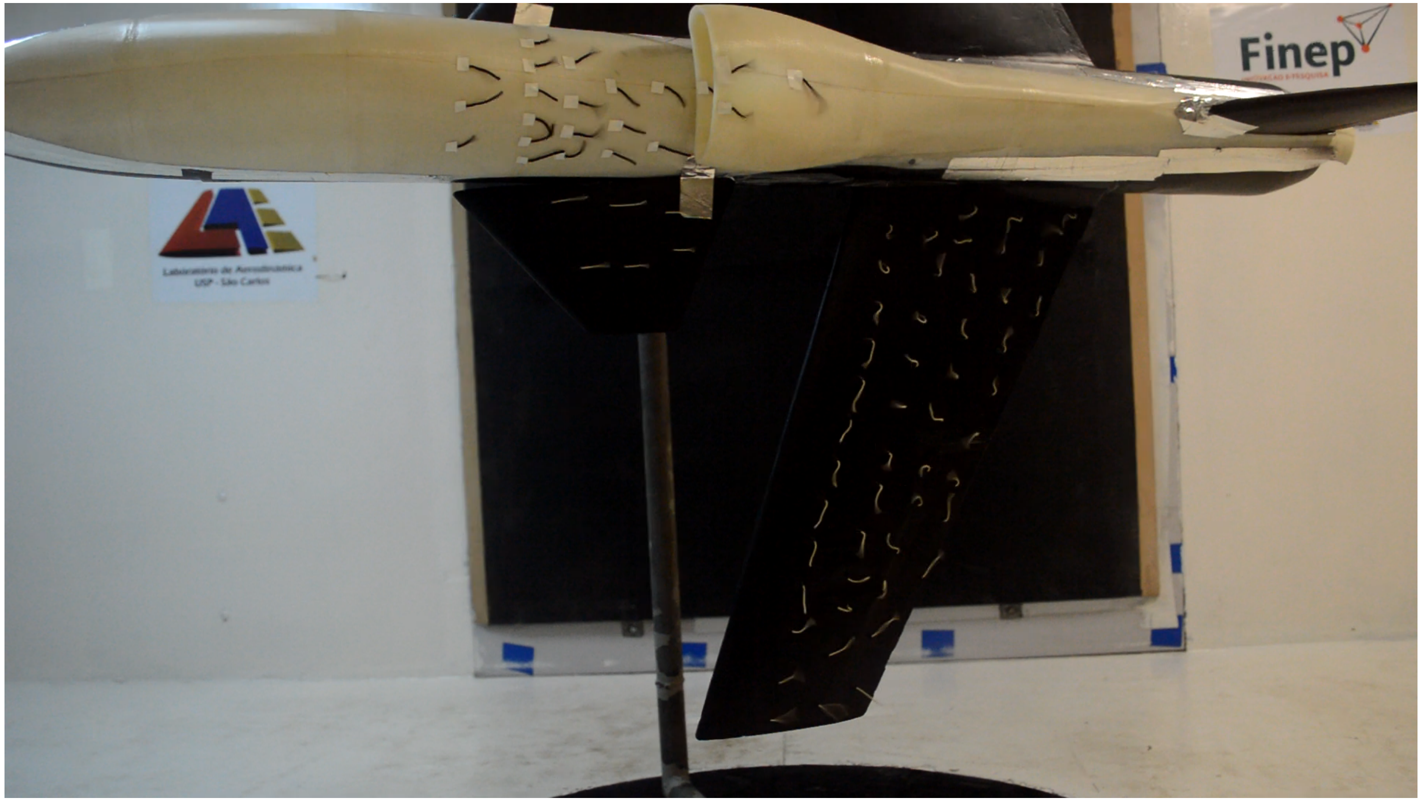



# PRELIMINARY RESULTS (CM)



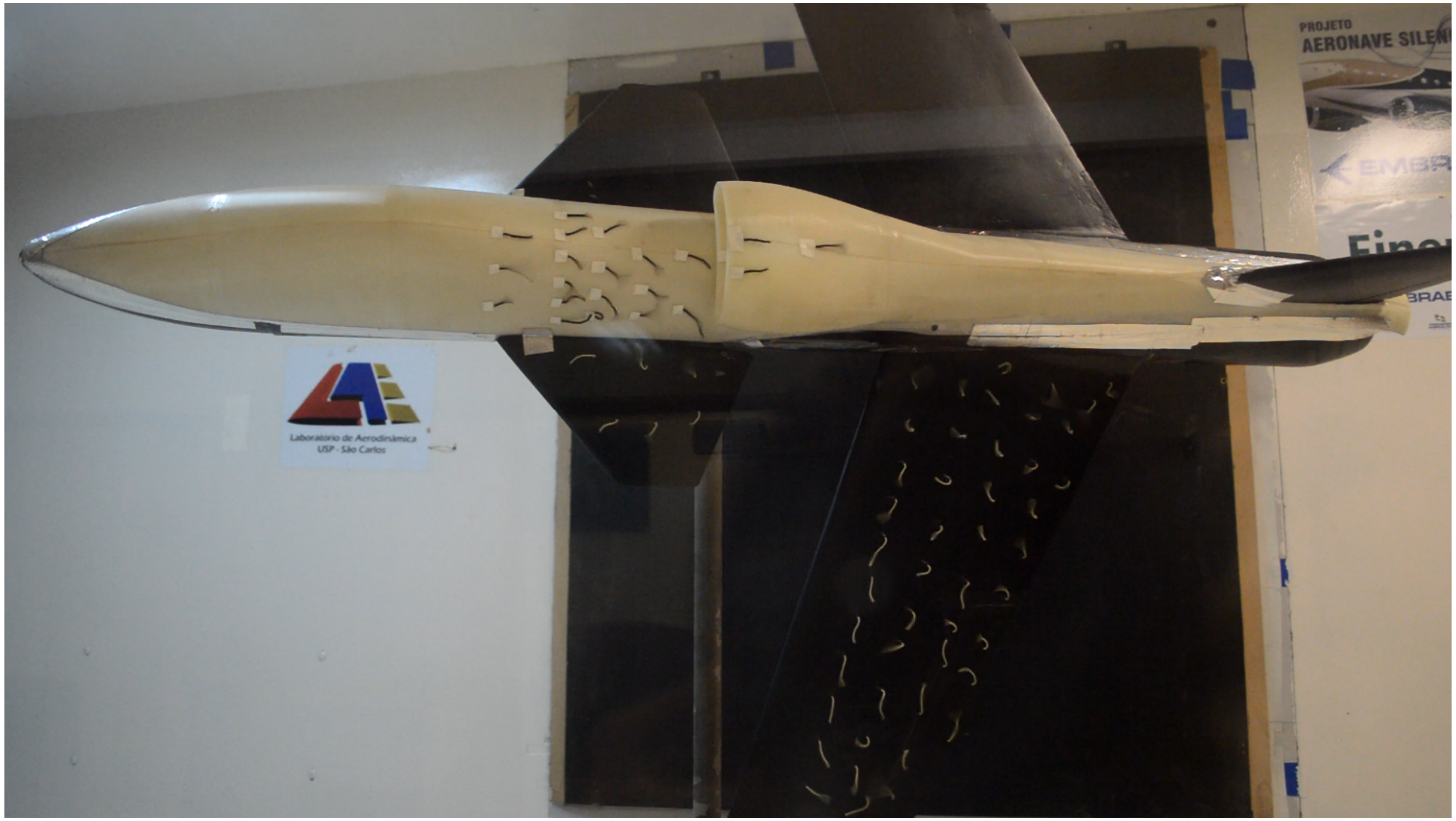
# Flow viz

Negative canard incidence



# Flow Viz (tufts)

Positive canard incidence



# CONCLUSIONS

Preliminary results showed that the intake + canopy should be redesigned to avoid intake lip separation.

The vertical position of the canard should change in order to get better flow at wing root.

The dorsal intake aerodynamics affect the single vertical stabilizer and buffet effects must be addressed. Also, the la teral/directional stability can be affected by this interaction.

Combined the two concepts, dorsal intake and forward swept wing may be a good option for low radar signature fr om the engine compressors and high alpha maneuvers.