Who & Where?

- Sergio Esteban Roncero
  - Education:
    - Bachelor of Sciences in Aerospace Engineering – Univ. Of Missouri Rolla (1999)
    - Master of Sciences in Aerospace Engineering – Univ. Of Missouri Rolla (2002)
      - Thesis: Nonlinear Flight Control Using Adaptive Critic Based Neural Networks, S. N. Balakrishnan
    - PhD in Aerospace Engineering – Univ. of Seville (2011)
      - PhD: Three-Time-Scale Nonlinear Control of an Autonomous Helicopter on a Platform: J. Aracil Santonja y F Gordillo Álvarez.
  - University of Seville: +15 years
    - Currently Associate Professor: Aerospace Engineering Dpt. @ University of Seville
  - Research interests: +20 years
    - Aircraft Design (commercial, UAV, VTOL, WIG, Airship)
    - Guidance Navigation and Control (non-linear control strategies, Optimum control, Time-scales)
    - Wind Tunnel Experiments (aerodynamic and propulsive modelling)
    - Teaching: Project Based Learning/Teaching Methodologies.
      - Aircraft Design: 15 years of experience using PBL methodologies
      - Other: Introduction, Flight Dynamics, Helicopters & Propulsion

What do we do?

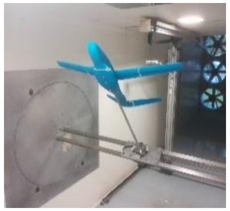
- SOAR Group (Stability Oriented Aircraft design Research)
- Main Focus on R&D Activities:
  - Oriented Multidisciplinary Aircraft Design
    - Philosophy
      - Generate information that needs to be used in the Aircraft Design Process
      - Provide sensitivity studies: NOT AI that generates automatic designs.

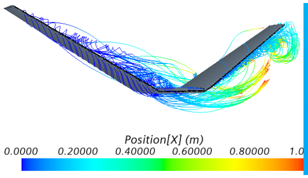
ENGINEERS NEED TO LISTEN TO THE EQUATIONS!!
EQUATIONS Talk to you, just need to learn how to listen

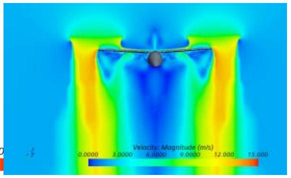
      - ENGINEERS NEED TO LISTEN TO THE EQUATIONS!! - > They Talk to you, just need to learn how to listen
    - Multidisciplinary Approach
      - Flight Dynamics & Control (FDC): Design to meet responses
      - Aerodynamics & Propulsion: obtain precise models to feed FDC and M&S
      - Performance: design to optimize performance
      - Weights: design decision affect the weight of the aircraft that affects the rest of the design
      - Manufacturing: design having into consideration manufacturing process
      - Modeling and Simulators (M&S): validate design with advance models
    - Development of Tools
      - Dedicated software: MATLAB based tools, Python, Machine Learning Algorithms.
        - Academic Performance, Academic Stability, Academic Structures.
      - Coordination: Git Hub

How do we do it?

- SANAID - Stability ANalysis interactive AIrcraft Design Tool
- Tool that coordinates
  - Flight Dynamics & Control (FDC): Academic Stability
    - 6DOF, 3DOF, Equilibrium Eqns
  - Aerodynamics & Propulsion:
    - Theory models: LLT, VLM CFD
    - Wind Tunnel Models
  - Performance: Academic Performance
    - Flight Mechanics Dynamics
  - Weight Estimation
    - Academic Structures: Estimation of weights
  - Modeling and Simulators (M&S):
    - Validates all elements



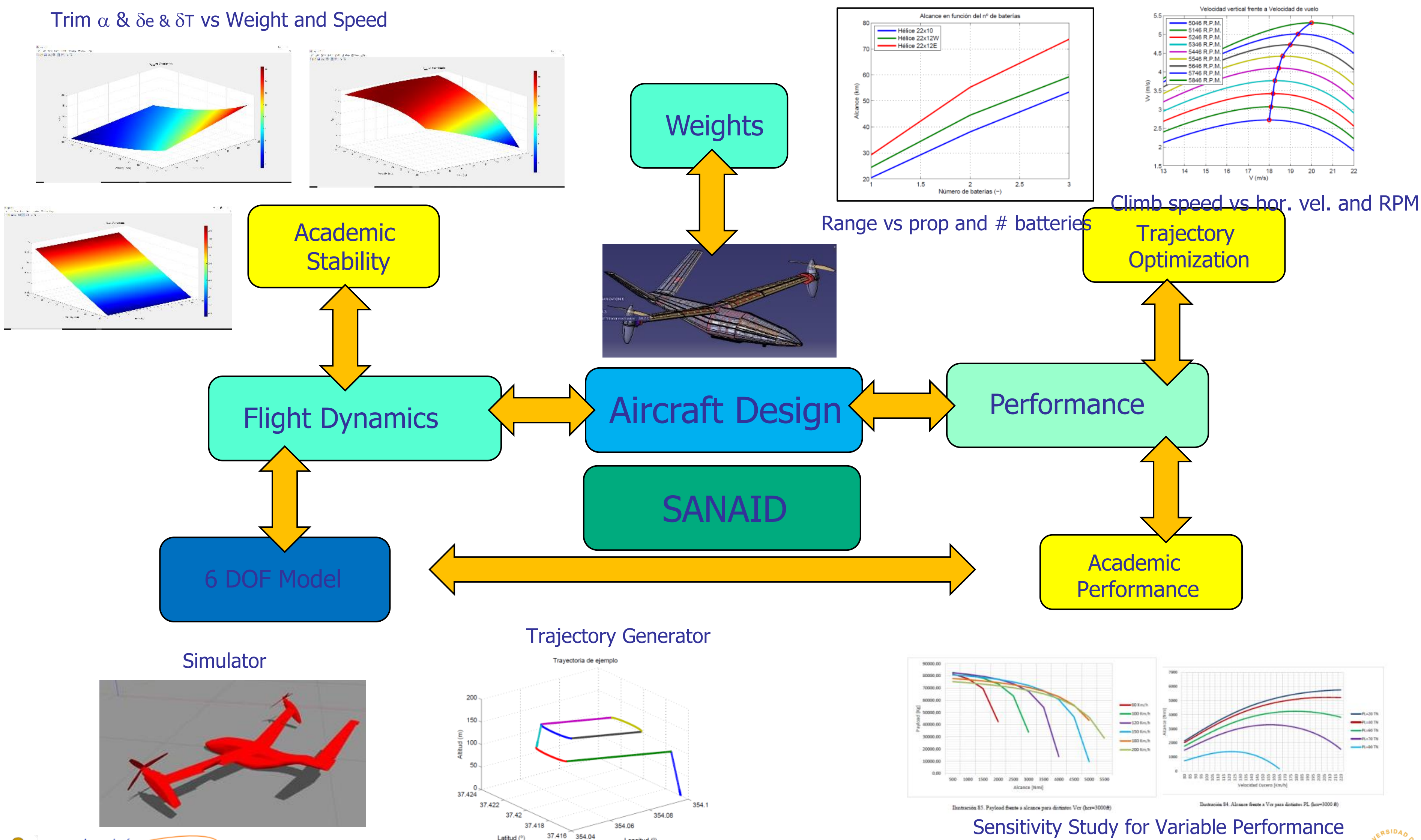




- Philosophy
  - Provide sensitivity studies: NOT AI that generates automatic designs!
  - Modularity: Models easy to interexchange: Always a Plan B,C,…
    - Superposition principle
    - Approximation Models (Reduce Order Models)
    - Derive Theory Models
    - Obtain Experimental Models (Validate)

SANAID

SANAID - Stability ANalysis interactive AIrcraft Design Tool

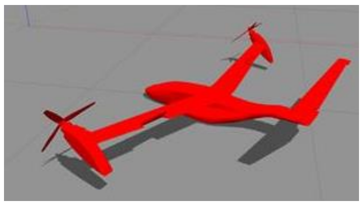


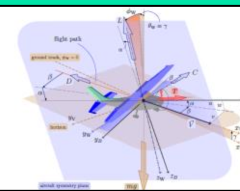
SANAID

Always Double Check

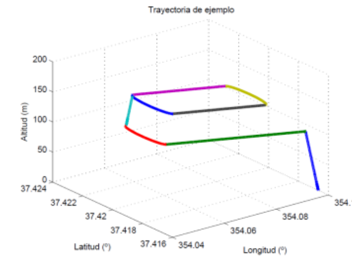
Redundancy

Simulator





Trajectory Generator



6 DOF Model

Aerodynamic & Propulsive Forces

$$\{F_T\}_B = \begin{Bmatrix} X_T \\ Y_T \\ Z_T \end{Bmatrix} \qquad \{F_A\}_W = \begin{Bmatrix} -D \\ C \\ -L \end{Bmatrix}$$

Aerodynamic & Propulsive Moments

$$\mathcal{L} = \mathcal{L}_A + \mathcal{L}_T, \quad \mathcal{M} = \mathcal{M}_A + \mathcal{M}_T, \quad \mathcal{N} = \mathcal{N}_A + \mathcal{N}_T$$

$$\begin{cases} \dot{u} = \dfrac{1}{m}(X_A + X_T) - wq + vr - g\sin\theta \\ \dot{v} = \dfrac{1}{m}(Y_A + Y_T) - ur + wp + g\cos\theta\sin\phi \\ \dot{w} = \dfrac{1}{m}(Z_A + Z_T) - vp + uq + g\cos\theta\cos\phi \end{cases}$$

Velocity in Body-Axis

$$\begin{cases} \dot{V} = \dfrac{1}{m}\Big[-D\cos\beta + C\sin\beta + X_T\cos\alpha\cos\beta + Y_T\sin\beta + Z_T\sin\alpha\cos\beta \\ \qquad - mg\big(\sin\theta\cos\alpha\cos\beta - \cos\theta\sin\phi\sin\beta - \cos\theta\cos\phi\sin\alpha\cos\beta\big)\Big] \\ \dot{\alpha} = q - \tan\beta\,(p\cos\alpha + r\sin\alpha) \\ \qquad + \dfrac{1}{Vm\cos\beta}\Big[-L + Z_T\cos\alpha - X_T\sin\alpha + mg\big(\cos\theta\cos\phi\cos\alpha + \sin\theta\sin\alpha\big)\Big] \\ \dot{\beta} = +p\sin\alpha - r\cos\alpha \\ \qquad + \dfrac{1}{Vm}\Big[D\sin\beta + C\cos\beta - X_T\cos\alpha\sin\beta + Y_T\cos\beta - Z_T\sin\alpha\sin\beta \\ \qquad + m\,g\,\big(\sin\theta\cos\alpha\sin\beta + \cos\theta\sin\phi\cos\beta - \cos\theta\cos\phi\sin\alpha\sin\beta\big)\Big] \end{cases}$$

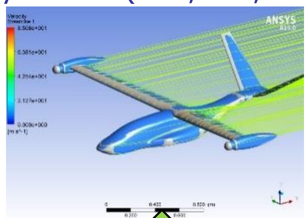
Velocity in Wind Axis

$$\begin{Bmatrix} \dot{p} \\ \dot{q} \\ \dot{r} \end{Bmatrix} = \frac{1}{\det[I]_B}\begin{bmatrix} I_1 & I_2 & I_3 \\ I_2 & I_4 & I_5 \\ I_3 & I_5 & I_6 \end{bmatrix}\left(\begin{Bmatrix} \mathcal{L}_A + \mathcal{L}_T \\ \mathcal{M}_A + \mathcal{M}_T \\ \mathcal{N}_A + \mathcal{N}_T \end{Bmatrix} - \sum_k I_k^r \dot{\omega}_k^r \begin{Bmatrix} i_x^r \\ i_y^r \\ i_z^r \end{Bmatrix}_k - \begin{bmatrix} 0 & -r & q \\ r & 0 & -p \\ -q & p & 0 \end{bmatrix}\cdot\begin{bmatrix} I_x & -I_{xy} & -I_{xz} \\ -I_{xy} & I_y & -I_{yz} \\ -I_{xz} & -I_{yz} & I_z \end{bmatrix}\cdot\begin{Bmatrix} p \\ q \\ r \end{Bmatrix} - \sum_k I_k^r \omega_k^r \begin{bmatrix} 0 & -r & q \\ r & 0 & -p \\ -q & p & 0 \end{bmatrix}\cdot\begin{Bmatrix} i_x^r \\ i_y^r \\ i_z^r \end{Bmatrix}_k\right)$$

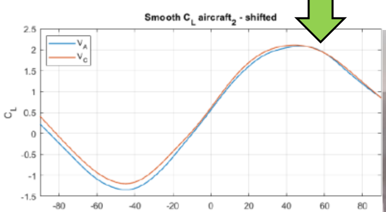
Angular Velocity in Body-Axis

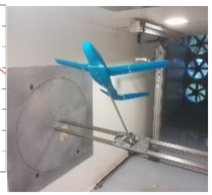
SANAID

Theory Models (CFD, LLT, VLM)



Aerodynamic Models





Wind Tunnel Exp

$$C_L = \frac{L}{\frac{1}{2}\rho_\infty V^2 S} = f(\alpha) = \sum_{i=0}^{n} a_i \alpha^i$$
$$C_D = \frac{D}{\frac{1}{2}\rho_\infty V^2 S} = g(\alpha) = \sum_{i=0}^{n} b_i \alpha^i$$
$$C_M = \frac{M}{\frac{1}{2}\rho_\infty V^2 S c} = h(\alpha) = \sum_{i=0}^{n} c_i \alpha^i$$

Moments

$$\bar{L} = \frac{1}{2}\rho V^2 S_{ref} b_w C_l$$
$$M = \frac{1}{2}\rho V^2 S_{ref} \bar{c} C_m$$
$$N = \frac{1}{2}\rho V^2 S_{ref} b_w C_n$$

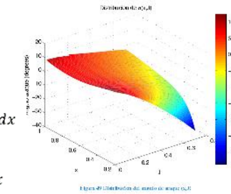
6 DOF Model

$$L = \frac{1}{2}\rho V^2 S_{ref} C_L$$
$$D = \frac{1}{2}\rho V^2 S_{ref} C_D$$
$$Y = \frac{1}{2}\rho V^2 S_{ref} C_Y$$

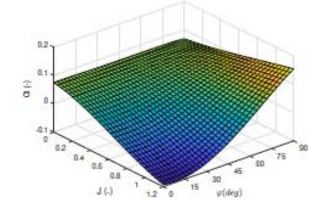
Forces

Theory Models

$$C_l(x) = C_{l_\alpha}(\alpha - \alpha_0) = C_{l_\alpha}\left(\theta - \arctan\left(\frac{\lambda}{x}\right) - \alpha_0\right)$$
$$C_d(x) = \delta_0 + \delta_1\alpha + \delta_2\alpha^2 + \delta_3\alpha^3 + \delta_4\alpha^4$$
$$C_T = \int_0^1 \frac{1}{2}\sigma(x)\sqrt{x^2 + (\lambda_c + \lambda_i(x))^2}\left(C_{l_\alpha}\alpha(x)x^2 - (\lambda_c + \lambda_i(x))C_d(x)\right)dx$$
$$C_P = \int_0^1 \frac{1}{2}\sigma(x)\sqrt{x^2 + (\lambda_c + \lambda_i(x))^2}\left(C_l(\lambda_c + \lambda_i(x))x + C_d(x)x^2\right)dx$$



Propulsive Models

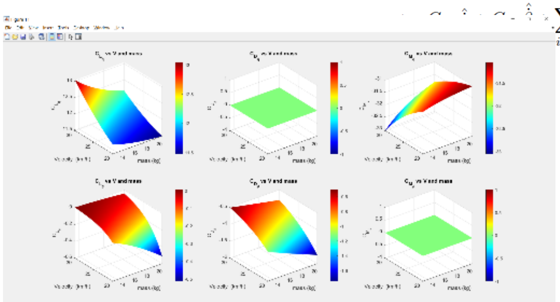


Wind Tunnel Exp

$$C_t(J,\varphi) = f(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} a_{ij} J^i \varphi^j$$
$$C_q(J,\varphi) = g(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} b_{ij} J^i \varphi^j$$

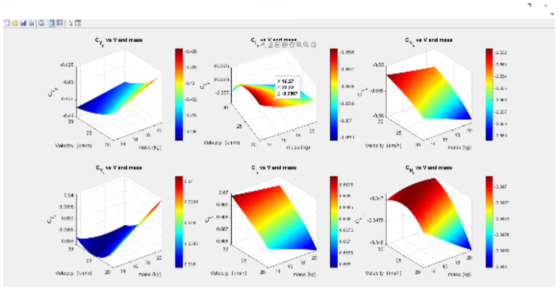
$$C_l = C_{l_0} + C_{l_\alpha}\alpha + C_{l_\beta}\beta + C_{l_h}h + C_{l_V}V + C_{l_p}\hat{p} + C_{l_q}\hat{q} + C_{l_r}\hat{r} + C_{l_{\dot\alpha}}\hat{\dot\alpha} + C_{l_{\dot\beta}}\hat{\dot\beta} + \sum_{i=1}^{n} C_{l_{\delta_i}}\delta i \quad (28)$$
$$C_M = C_{m_0} + C_{m_\alpha}\alpha + C_{m_\beta}\beta + C_{m_h}h + C_{m_V}V + C_{m_p}\hat{p} + C_{m_q}\hat{q} + C_{m_r}\hat{r} + C_{m_{\dot\alpha}}\hat{\dot\alpha} + C_{m_{\dot\beta}}\hat{\dot\beta} + \sum_{i=1}^{n} C_{m_{\delta_i}}\delta i \quad (29)$$
$$C_N = C_{n_0} + C_{n_\alpha}\alpha + C_{n_\beta}\beta + C_{n_h}h + C_{n_V}V + C_{n_p}\hat{p} + C_{n_q}\hat{q} + C_{n_r}\hat{r} + \sum_{i=1}^{n} C_{n_{\delta_i}}\delta i \quad (30)$$

$$C_L = C_{L_0} + C_{L_\alpha}\alpha + C_{L_\beta}\beta + C_{L_h}h + C_{L_V}V + C_{L_p}\hat{p} + C_{L_q}\hat{q} + C_{L_r}\hat{r} + C_{L_{\dot\alpha}}\hat{\dot\alpha} + C_{L_{\dot\beta}}\hat{\dot\beta} + \sum_{i=1}^{n} C_{L_{\delta_i}}\delta i \quad (25)$$
$$C_D = C_{D_0} + C_{D_\alpha}\alpha + C_{D_\beta}\beta + C_{D_h}h + C_{D_V}V + C_{D_p}\hat{p} + C_{D_q}\hat{q} + C_{D_r}\hat{r} + C_{D_{\dot\alpha}}\hat{\dot\alpha} + C_{D_{\dot\beta}}\hat{\dot\beta} + \sum_{i=1}^{n} C_{D_{\delta_i}}\delta i \quad (26)$$
$$C_Y = C_{Y_0} + C_{Y_\alpha}\alpha + C_{Y_\beta}\beta + C_{Y_h}h + C_{Y_V}V + C_{Y_p}\hat{p} + C_{Y_q}\hat{q} + C_{Y_r}\hat{r} + C_{Y_{\dot\alpha}}\hat{\dot\alpha} + C_{Y_{\dot\beta}}\hat{\dot\beta} + \sum_{i=1}^{n} C_{Y_{\delta_i}}\delta i \quad (27)$$



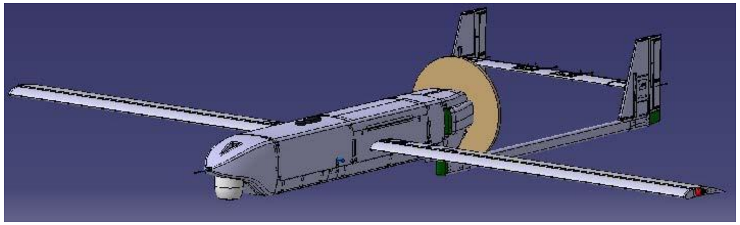
Theoretical Models
Stability Derivatives

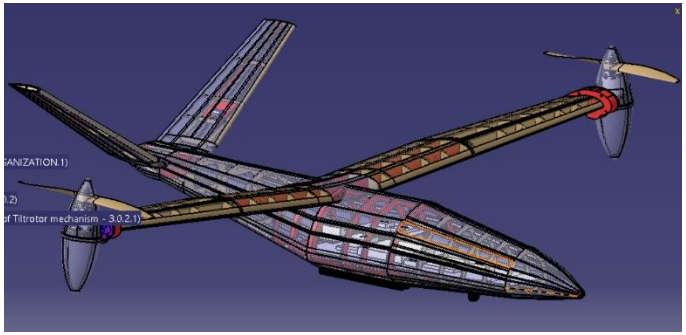
Academic Stability



Aerospace Research Lines

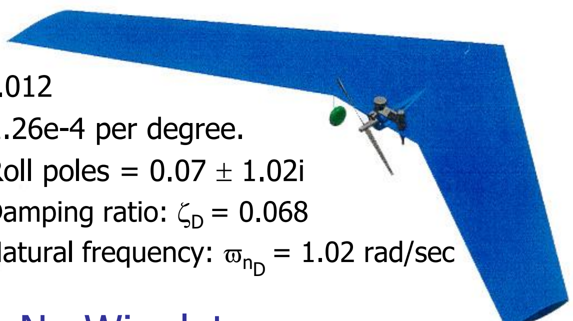
- Ala Voladora
- AAVG
- Proyecto Céfiro I & II
- Céfiro III
- Airship Designs
- Proyecto Emergentia





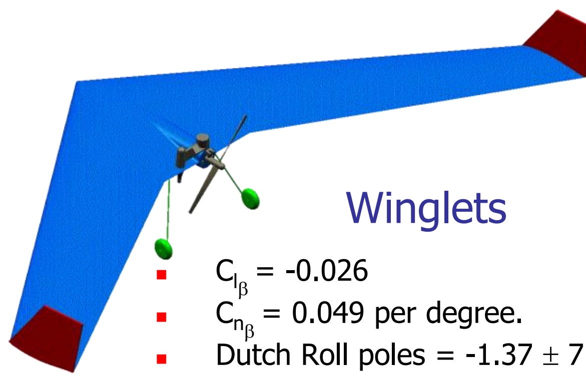
Flying Wing

- Ala Voladora (1998-1999)
  - Senior Design at Univ. Of Missouri – Rolla
  - Aircraft Design: Challenges
    - Challenge: design build and fly a flying wing in open loop
    - Convince aerodynamics dept. (and the rest of the Tailless Wonders Team) that could not fly **WITHOUT VERTICAL SURFACES** (in open loop) & **NO RUDDER**
    - **Do it before FREEZING DESIGN**
    - Develop: 1st version of SANAID
      - Stability Analysis of non-conventional A/C
      - Design Oriented Static and Dynamic Stability Analysis
      - Determine appropriate Vertical Surface Selection for Desired Flying Qualities



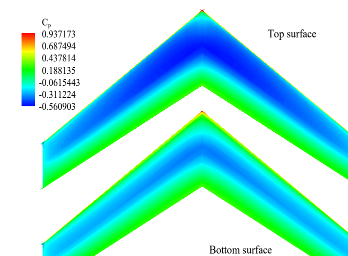
- $C_{l_\beta} = -0.012$
- $C_{n_\beta} = -1.26e{-4}$ per degree.
- Dutch Roll poles = $0.07 \pm 1.02i$
  - Damping ratio: $\zeta_D = 0.068$
  - Natural frequency: $\varpi_{n_D} = 1.02$ rad/sec

No Winglets

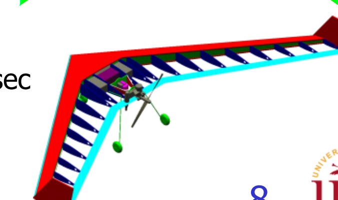


Winglets

- $C_{l_\beta} = -0.026$
- $C_{n_\beta} = 0.049$ per degree.
- Dutch Roll poles = $-1.37 \pm 7.09i$
  - Damping ratio: $\zeta_D = 0.19$
  - Natural frequency: $\varpi_{n_D} = 7.22$ rad/sec

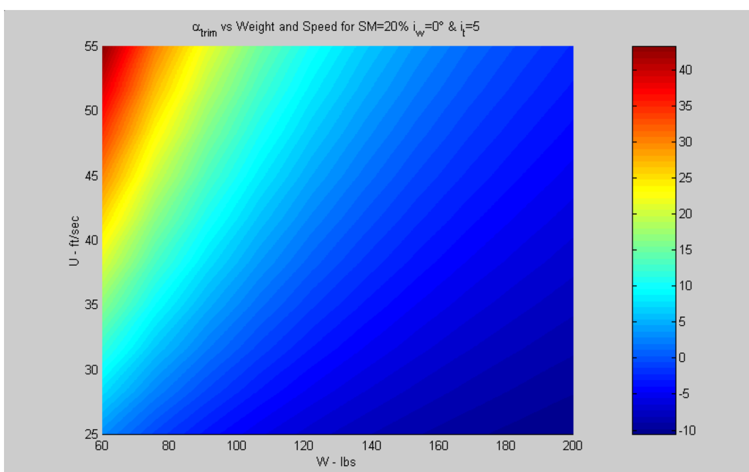


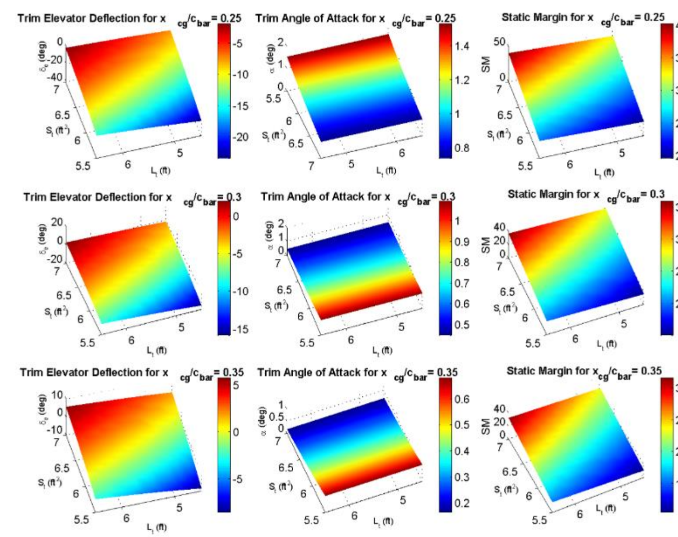
Pressure coefficient for Ala Voladora.



AAVG

- AAVG (1999-2003)
  - Master @ Univ. Of Missouri – Rolla
  - Formula Student SAE Competition: Heavy Open Class
    - Challenge: design build and fly an aircraft capable of carrying large loads
    - Restricted to RFP: engine size 1.2 in^3, payload volume (300 in^3), Takeoff within 200 ft, 360 deg circle, Landing 400 ft, **DO NOT LOOSE ANY COMPONENT.**
    - Weights: Empty Weight: 40 lbs & Payload: Predicted 100 lbs
  - Aircraft Design Oriented: New Challenges (Develop 2nd iteration SANAID)
    - Satisfy desired Flying Qualities
    - Obtain desired performance: Takeoff, Cruise, Turning, Trim and Landing
    - Design Limitations: Available payload and location
    - Variables: Tail boom length, Xcg location, Payload weight and location, aircraft speed, SHTP and incidence of HTP





Céfiro

- Céfiro (2008-2009)
  - Universidad de Sevilla
  - Research and Teaching Needs:
    - Research needs @ Dept. of Aerospace Engineering @ Univ. of Seville are:
      - Trajectory optimization, ATM, Aircraft design, Aircraft dynamics and engine performance modeling, Automatic flight control systems.
      - Low availability of adequate commercial off-the-shelf scaled aerospace platforms -> designing and building custom UAV testing platforms.
  - Aircraft Design Oriented: New Challenges (Develop 3rd iteration SANAID)
    - Satisfy extended RFP
      - Desired performance: Takeoff, Cruise, Turning, Trim and Landing, Range & Endurance
      - Desired Flying Qualities
      - Large payload (7.5 kg)
      - Desired Modularity and transportation qualities
      - Desired Manufacturing process
    - Multidisciplinary interaction: Aerodynamics, Propulsive, Manufacturing CAD/CAM process, Stability and Control, Systems Integration,

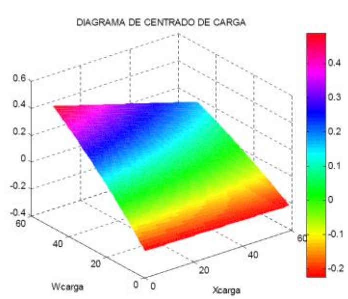
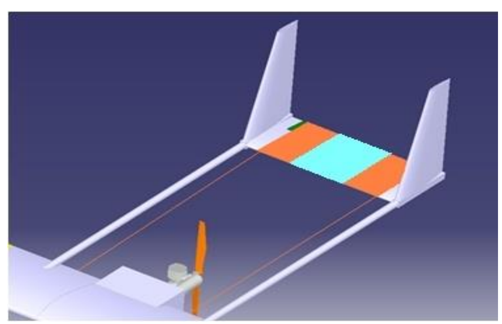
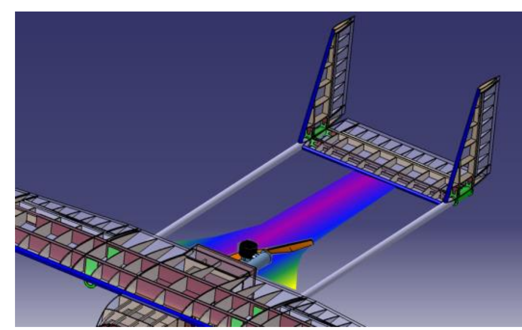


Figura 4.29. - Centrado carga de pago delantera estimada





Hybrid Airships - I

- Hybrid Airships (2016-2018)
  - Universidad de Sevilla & University of Cranfield
  - Objectives
    - Aircraft Design Optimization Tools (University of Seville)
      - Fast Conceptual Design
      - Trade Studies based on: Weight Requisites: Mission and Payload, Client Requisites & Mission, payload, technologies, geometry, design modifications
      - Optimization Tools: solving series of equations with restrictions related to Aerodynamics, Performance, Stability and Control, Weights
    - Wind Tunnel Experiments (University of Cranfield)
      - Experimental Identification of directional aerodynamic dynamic derivatives of the Airlander 10 of Hybrid Air Vehicles

- Transport
- Turism
- Surveillance.
- Humanitary Missions

Endurance

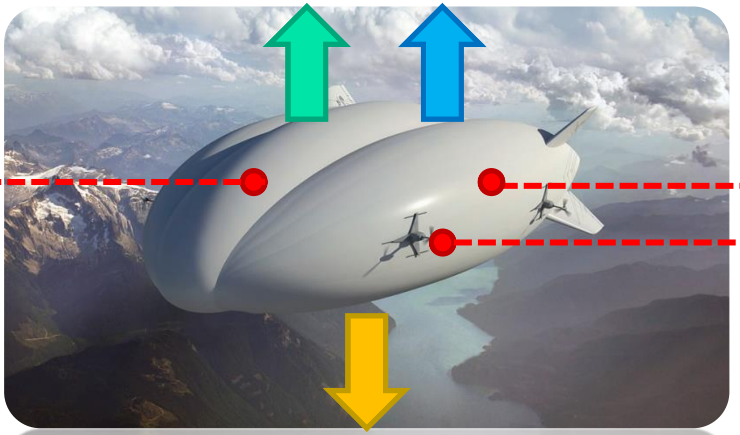
Capacity

Landing versatility

Hybrid Airship - Combines aircraft characteristics with weight reduction technologies.

Aerodynamic Lift

Floating lift



Peso

Airfoil shaped lobes

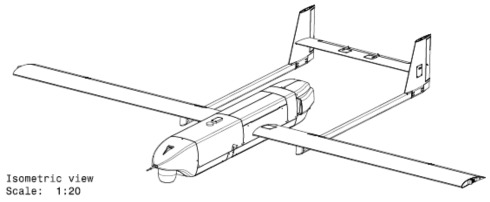
Floating Ratio

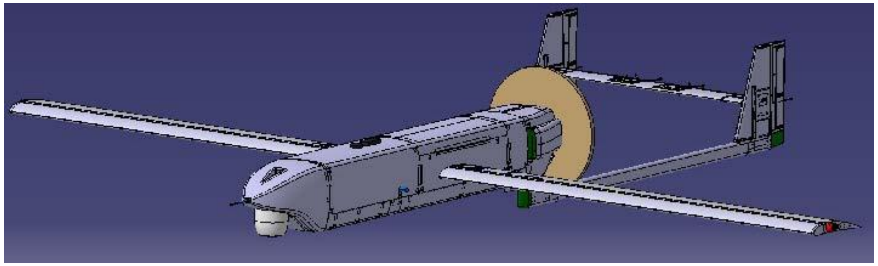
$$BR = \frac{L_{aero}}{L_{aero} + L_{flot}} \sim 0.7$$

Vector propulsion

Céfiro - III

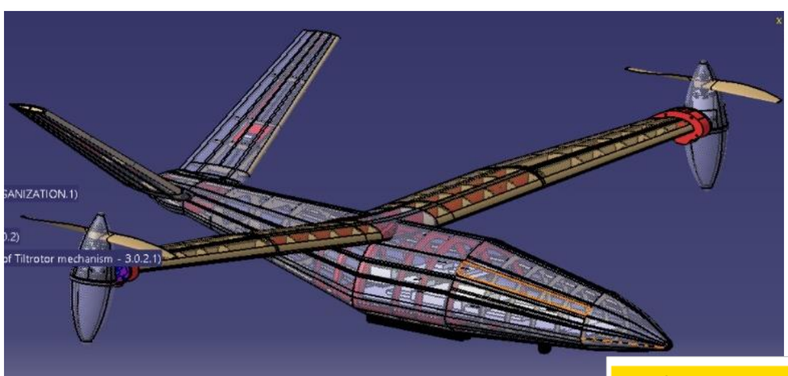
- Céfiro III (2014-2016)
  - Universidad de Sevilla-> Aertec SOLUTIONS (TARSIS)
  - Application of Aircraft Design Oriented to Industry Requirements:
  - Validation of Methodology (of SANAID)
    - Design of Custom UAV for Requirements
      - Versatile configuration: Conventional and launched Take off
      - Extended Endurance (12 hrs)
      - Large Payload (12 kg)
    - Multidisciplinary interaction: Aerodynamics, Stability and Control, Propulsion, Performance, Structures, Systems Integration.





ProVANT - EMERGENTIA

- Project EMERGENTIA (2014-2021)
  - Development of Unmanned Convertible Aircraft for Rapid and Efficient Deployment in Emergency Situations: Project EMERGENTIA
  - Grant *RTI2018-101519-A-I00* funded by MCIN/AEI/ 10.13039/501100011033 and by "ERDF A way of making Europe".
  - Universidad de Sevilla, UFMG, UFSC and other Universities
    - Develop a series of tools that permit to design convertible UAVs
    - Design of an UAV prototype with convertible capabilities (fixed wing VTOL) specifically designed for emergency, search and rescue missions (SAR).
      - Reduced Dimensions
      - Versatility
      - Simplicity
      - Compliance with airworthiness requirements



MINISTERIO DE CIENCIA E INNOVACIÓN

UNIÓN EUROPEA

FONDO EUROPEO DE DESARROLLO REGIONAL

AGENCIA ESTATAL DE INVESTIGACIÓN

Other Projects

- Projects Contrato 68/83 (subjected to NDA)
  - Aertec, solutions, S.L.
    - UAV-Aertec- Asesoramiento técnico en el diseño de sistemas aéreos no tripulados (Currently in progress)
    - BAT: (Currently in progress)
- Projects PTA
  - AIRBUS OPERATIONS
    - Subproject: Estudios Paramétricos de Mecánica de Vuelo (Currently in progress)
    - Project: ONEIre
    - Call: Plan Tecnologico Aeronautico" (PTA).
  - Swarming Technologies/ZELENZA
    - Subproject: EIRE - Planificadores Óptimos (Currently in progress)
    - Project: INVESTIGACION Y DESARROLLO EN INTELIGENCIA ARTIFICIAL Y OTRAS TECNOLOGIAS DIGITALES Y SUS INTEGRACION EN LAS CADENAS DE VALOR
    - Call: Convocatoria de Ayudas 2021 de RED.es
  - SIMIDEA R&D
    - Subproject: Aircraft Design (Currently in progress)
    - Project: ZEROEMITIONS- Aeromateriales Avanzados con Capacidades Acústicas Extremas para la Industria Aeronáutica Civil
    - Call: "Plan Tecnologico Aeronautico" (PTA).

Motivation - I

- Emergency Situations:
  - Hostile Environments: Elevated Risk
- Diversity of scenarios
  - Natural disasters
  - Accidents in high mountains
  - Wild Fires
  - Nuclear Catastrophes.
  - Epidemic
  - Humanitarian aid
- Require Search and Rescues (SAR) missions
  - Enviromental Costs
  - Economic Costs
  - Human Costs

EARTHQUAKE HAITI (201

FUKUSHIMA DAIICHI (2011)

EARTHQUAKE NEPAL (2015)

COAST GUARD ASTURIAS

"GREIM" ESPAÑA (2014)

Motivation - II

- What needs to be improved in SAR?
  - **Efficiency**
    - Reducing the timing of emergency services.
    - Arriving earlier to "Zero Zone" and implementing optimum search methodologies
      - Intelligent search algorithms, triage, geographic and demographic mapping,…
  - **Sustainability**
    - Reducing economic and environmental costs resulting from the complex deployments of SAR missions.
    - Helicopters, ships and aircraft of great size and high cost of operation.
  - **Security**
    - Reducing potential human costs.

Efficiency + Sustainability + Security = Effectiveness

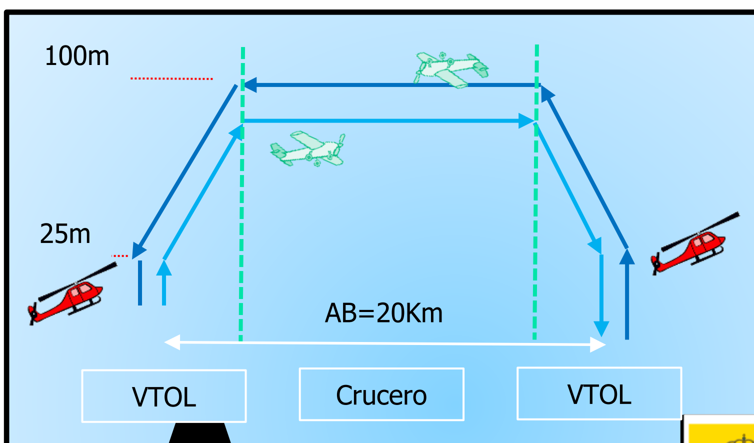
Need to listen to the FINAL USERS – Emergency Response Teams

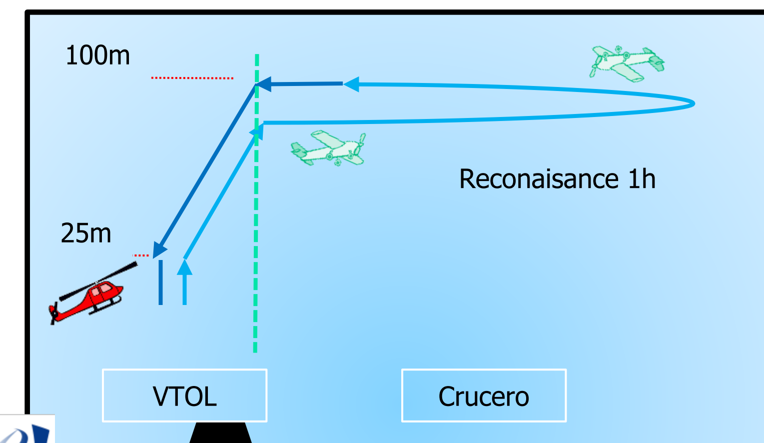
Objectives

- Develop a series of tools that permit to design convertible UAVs
  - SCIENTFIC INNOVATION that will lead to TECHNOLOGICAL INNOVATION
- Design of an UAV prototype with **convertible capabilities** (fixed wing VTOL) specifically designed for emergency, search and rescue missions (**SAR**).
- After a throughout **brainstorming** study with the Spanish Emergency Services (**SAMU**) that provide support in catastrophic events, it was determined that the UAV should have the following **characteristics**:
  - **Reduced dimensions**
    - Transported in a medicalized vehicle,
    - Integrated within the fast response coordinated measures that are carried in emergency situations.
  - **Versatility**
    - Carry out a diversity of SAR missions, from monitoring to surveillance, transportation of medical payloads, or deployment of sensors, with the greatest possible autonomy and range.
  - **Simplicity**
    - A health professional can use it without the need for additional training.
  - **Compliance** with **airworthiness requirements**.

EMERGENTIA-ProVANT

DevElopment of an unManned convERtible aircraft for rapid and efficient deployment in emerGENcy situaTIons





Objectives

- Based on these requirements the following specific objectives have been determined for project EMERGENTIA:
  - Definition of design requirements and protocols for the use of RPAS in SAR missions (O1).
  - Development of biomedical payloads for the different missions (O2),
  - Advanced development of a VTOL-CP (O3) platform
  - Study and optimization of the performance of the VTOL-CP platform (O4)
  - Development of highly efficient embedded cyber-physical systems (O5).
  - Development of renewable energy generation and management systems (O6).
  - Development of strategies for autonomous control and guidance (O7).
  - Development of a Hardware-In-the-Loop Simulation Platform (O8).

⇩

Tools to generate SCIENTIFIC INNOVATION

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Work Packages

- To achieve the objectives, a work plan has been developed in 12 work packages (**WP**):

JMS	**WP1. DEFINITION OF PROTOCOLS OF OPERATION IN SAR MISSIONS (JMS)**	**CONCEPTUAL DESIGN**
CCR	**WP2. STUDY AND PRELIMINARY DESIGN AND DEFINITION OF DESIGN REQUIREMENTS**	
MPS	**WP3. STUDY OF THE AERODYNAMICS OF PROTOTYPES**	**PRELIMINARY DESIGN**
ACT	**WP4. PARAMETRIC STUDY OF THE PROTOTYPES PERFORMANCES**	
JJE	**WP5. STUDY OF THE STRUCTURE OF THE PLATFORM**	
JMH	**WP6. DEVELOPMENT OF EMBEDDED CYBER PHYSICAL SYSTEMS**	
CBA	**WP7. DEVELOPMENT OF GENERATION AND MANAGEMENT OF ENERGY SYSTEMS**	
GVR	**WP8. DEVELOPMENT OF AUTONOMOUS GUIDANCE, NAVIGATION AND CONTROL SYSTEMS**	
SER	**WP9. ADVANCED DETAIL DESIGN**	**DETAIL DESIGN**
SGNR	**WP10. HARDWARE-IN-THE-LOOP SIMULATORS**	
SER	**WP11. FLIGHT TESTS OF THE DEMONSTRATOR**	
SER	**WP12. MANAGEMENT AND DISSEMINATION OF THE PROJECT**	

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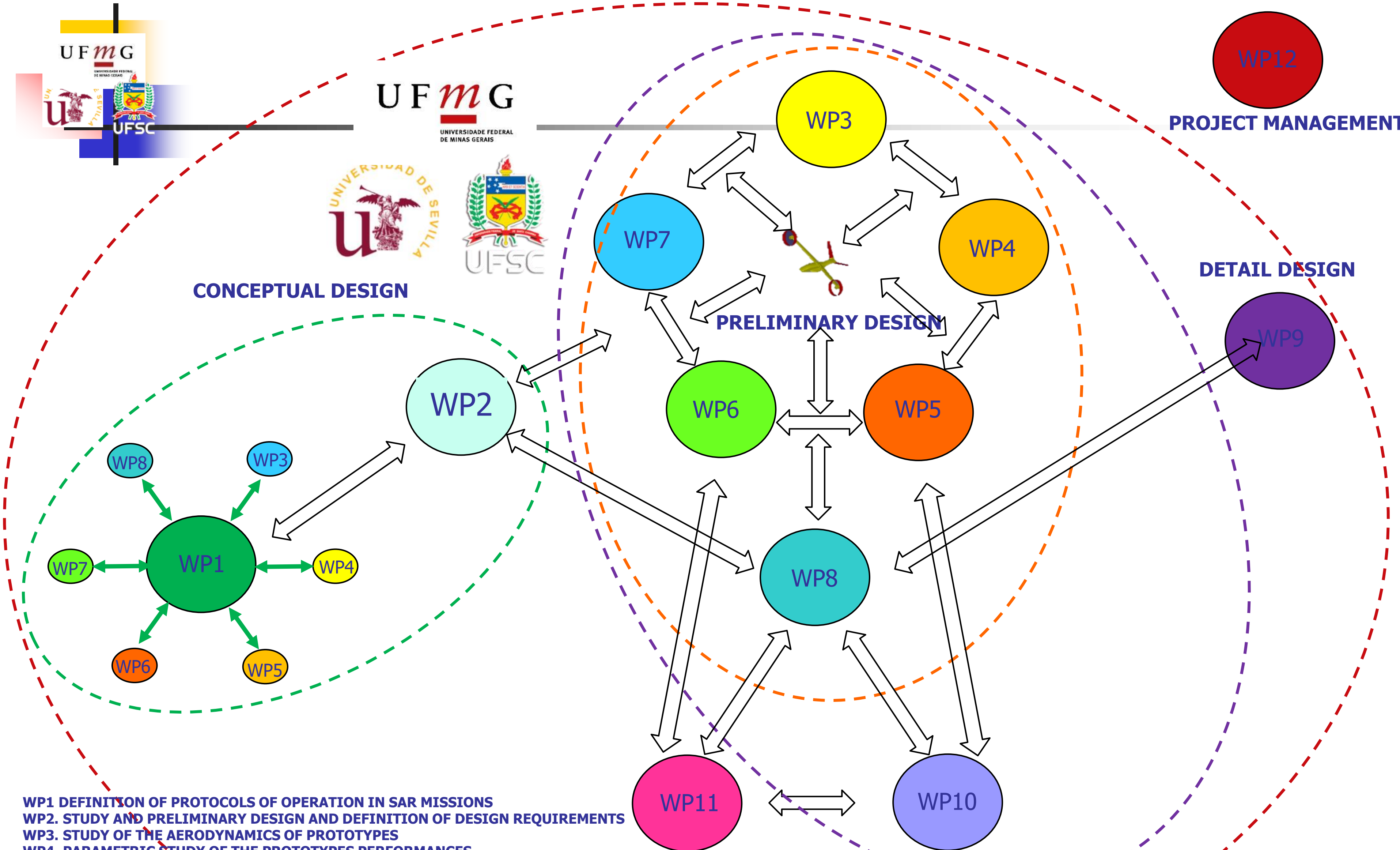

WP1 DEFINITION OF PROTOCOLS OF OPERATION IN SAR MISSIONS
WP2. STUDY AND PRELIMINARY DESIGN AND DEFINITION OF DESIGN REQUIREMENTS
WP3. STUDY OF THE AERODYNAMICS OF PROTOTYPES
WP4. PARAMETRIC STUDY OF THE PROTOTYPES PERFORMANCES
WP5. STUDY OF THE STRUCTURE OF THE PLATFORM
WP6. DEVELOPMENT OF HIGH EFFICIENCY EMBEDDED CYBER PHYSICAL SYSTEMS
WP7. DEVELOPMENT OF GENERATION AND MANAGEMENT OF ENERGY SYSTEMS
WP8. DEVELOPMENT OF AUTONOMOUS GUIDANCE, NAVIGATION ANC CONTROL SYSTEMS
WP9. ADVANCED DETAIL DESIGN
WP10. "HARDWARE-IN-THE-LOOP" SIMULATORS
WP11. FLIGHT TESTS OF THE DEMONSTRATOR
WP12. MANAGEMENT AND DISSEMINATION OF THE PROJECT

Multidisciplinary Group

- **Universidad de Sevilla**
  - Departamento Ingeniería Aeroespacial y Mecánica de Fluidos de la ETSI (GIA)
    - Sergio Esteban, Miguel Pérez-Saborid
  - Departamento de Ingeniería Electrónica de la ETSI (GIE);
    - Juana María Martínez (JMH), José Luis Mora
  - Departamento de Ingeniería de Sistemas y Automática (DIESA)
    - Carlos Bordons, Manolo Gil Ortega, Manuel Vargas, Miguel Ángel Ridao
  - Departamento de Elasticidad y Resistencia de Materiales.
    - Jesús Justo, Luis Arístides Távara, José Reinoso, Israel García
  - Departamento de Ingeniería Mecánica y Fabricación
    - Daniel García Vallejo y Francisco José Morales Sánchez
  - Departamento de Ingeniería Gráfica
    - Cristina Torrecillas
  - Departamento de Maquinas y Motores
    - Miguel Torres García
  - Departamento de Enfermería de la Facultad de Enfermería, Fisioterapia y Podología.
    - Juana Macías Seda
- **Universidade Federal de Minas Gerais (Brazil)**
  - Departamento de Engenharia Eletrônica:
    - Guilherme Vianna Raffo, Janier Arias, Luciano Pimenta, Bruno Adorno, Patrícia Pena
  - Departamento de Engenharia Mecânica
    - Guilherme de Souza Papini
- **Universidade Federal de Santa Catarina (Brazil)**
  - Departamento de Automação e Sistemas del Centro Tecnológico de UFSC.
    - Leandro Buss Becker, Julio Elias Normey Rico

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Multidisciplinary Group

- **Universidad Politécnica de Madrid**
  - Departamento de Aeronaves y Vehículos Espaciales (DAVE) de la ETSI. Aeronáutica y del Espacio de la UPM
    - Álvaro Cuerva, Óscar López, Cristina Cuerno, Cristóbal José Gallego, Sergio Ávila, Alejandro Sánchez
- **Universitat Politèctinca de Valencia**
  - Departamento de Ingeniería de Sistemas y Automática (DISA)
    - Xavier Blasco, Sergio García-Nieto
  - CMT – Motores Térmicos
    - Luis Miguel García-Cuevas González <luiga12@mot.upv.es>
- **CEFET-MG - Centro Federal de Educação Tecnológica de Minas Gerais (Brazil)**
  - Dvn Depto de Engenharia Mecatrônica
    - Valter Leite Junior
- **University of Bergamo (Italy)**
  - Management, Information and Production Engineering
    - Antonio Ferramosca
- **University of Pavia (Italy)**
  - Identification and Control of Dynamic Systems Laboratory
    - Davide M. Raimondo
- **SAMU (Servicio de Atención Médica de Urgencia) (Spain)**
    - Carlos Álvarez Leiva, Juan González de Escalada Álvarez

Scientific Production
Final Thesis Degrees and PhD Thesis

Just on the University of Seville

AERODYNAMIC Studies

Generación Científica: TFGs, TFMs

1. "Estudio computacional de las fase de vuelo en crucero y en transición de una aeronave convertible: Proyecto EMERGENTIa." AUTOR: FERNANDO PEREZ RUBIO, TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO 2019
2. TÍTULO: "Estudio aerodinámico en túnel de viento de un UAV VTOL-CP para misiones SAR (proyecto EMERGENTIa).", AUTOR: VICTORIA MARIA PRIETO RUEDA ,TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA AÑO: 2019.
3. TÍTULO: "REALIZACIÓN DE EXPERIMENTOS AERODINÁMICOS EN TÚNEL DE VIENTO PARA LA CARACTERIZACIÓN DIRECCIONAL DE UN UAV CONVERTIBLE PARA TAREAS DE EMERGENCIAS: PROYECTO EMERGENTIA." AUTOR: FRANCISCO JAVIER ALMAGRO GUERRERO,TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2020.
4. TÍTULO: "REALIZACIÓN DE EXPERIMENTOS AERODINÁMICOS EN TÚNEL DE VIENTO PARA LA CARACTERIZACIÓN LONGITUDINAL DE UN UAV CONVERTIBLE PARA TAREAS DE EMERGENCIAS: PROYECTO EMERGENTIA", AUTOR: LORETO VAZQUEZ DEL REY PERDOMO, TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA AÑO: 2020.
5. TÍTULO: "Estudio aerodinámico en túnel de viento para la caracterización longitudinal-lateral del fuselaje de un UAV convertible. Proyecto EMERGENTIa." AUTOR: VICENTE FERNANDEZ RAMOS, TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2021.
6. TÍTULO: "Estudio aerodinámico en túnel de viento para la caracterización longitudinal-lateral de una cola en V de un UAV convertible. Proyecto EMERGENTIa." AUTOR: DIEGO CABRERO CABRERO,TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2021.
7. TÍTULO: "Estudio aerodinámico en túnel de viento para la caracterización longitudinal y direccional de un UAV VTOL-CP. Proyecto ProVANT EMERGENTIa" AUTOR: CLAUDIA PEREZ RUS, TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2022.
8. TÍTULO: "Estudio Aerodinámico en túnel de viento para la caracterización longitudinal de la cola en V con deflexiones de un UAV RPAS. Proyecto ProVANT EMERGENTIa" AUTOR: PAULA CALLEJO HERNANDO,TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2022.

Propulsive Studies

Generación Científica: TFGs, TFMs

1. TÍTULO: "DISEÑO Y CONSTRUCCIÓN DE UNA BANCADA DE PRUEBA DE MOTORES HÉLICE PARA EXPERIMENTOS EN TÚNEL DE VIENTO" AUTOR: Raimundo blanco Hacar. TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2015.
2. TÍTULO: "ENSAYOS DE PLANTA PROPULSORA DE MOTOR ELÉCTRICO Y HÉLICE EN TÚNEL DE VIENTO CON ÁNGULO DE INCIDENCIA VARIABLE" AUTOR: Daniel Pinazo Jiménez. TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2016.
3. TÍTULO: "Ensayos de Planta Propulsora de Cabeza de Helicóptero en Túnel de Viento con Ángulo de Cabeceo e Incidencia Variable para Velocidades de Vuelo de Transición entre Vuelo de Avance y Vuelo Vertical" AUTOR: DAVID BAREA VIZUETE TUTOR: Sergio Esteban Roncero. TITULACION: I GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2017.
4. TÍTULO: "Desarrollo de la herramienta RAPTOR para procesado de datos de Ensayos en Túnel de Viento de Cabeza de Helicóptero con Ángulo de Cabeceo e Incidencia Variable y Comparación con Teoría de Helicópteros." AUTOR: DANIEL PINAZO JIMENEZ, TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2019.
5. TÍTULO: "Implementation of Machine Learning Techniques for data processing of propulsive wind tunnel experiments to obtain multivariate analytical propeller performance models for UAVs" AUTOR: DIEGO MANZANO DELGADO, TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2020.
6. TÍTULO: "ESTUDIOS DE DIMENSIONADO Y SENSIBILIDAD PROPULSIVA PARA UAV ELÉCTRICO CON CAPACIDAD VTOL: PROYECTO EMERGENTIA" AUTOR: ALVARO MARTINEZ BLANCO TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA AÑO: 2020.

Flying Qualities Studies

Generación Científica: TFGs, TFMs

1. TÍTULO: "Modelado y Simulación de un Vehículo Aéreo Convertible para Misiones de Búsqueda y Rescate" AUTOR: Juan Diego Sánchez Mingorance. TUTOR: Sergio Esteban Roncero y Manuel Vargas Villanueva. TITULACION: INGENIERIA AERONAUTICA. AÑO: 2018.
2. TÍTULO: "Estudio de sensibilidad de las condiciones de equilibrio de un aeronave convertible durante las fases de vuelo longitudinal: avance, axial y transición." AUTOR: MARTA NUÑEZ REYES, TUTOR: Manuel Vargas Villanueva y Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA, AÑO: 2019.
3. TÍTULO: "Diseño y evaluación de un banco de ensayos para la identificación en túnel de viento de derivadas de estabilidad dinámicas de aeronaves. Proyecto EMERGENTIa." AUTOR: ALBERTO RODRIGUEZ CASQUERO,TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA AÑO: 2021.
4. TÍTULO: "Study and analysis of Aircraft Flight Dynamics developing tools based on 6DOF simulator" AUTOR: ALEJANDRO LUCENA GOMEZ, TUTOR: Sergio Esteban Roncero. TITULACION: MÁSTER EN INGENIERIA AERONÁUTICA. AÑO: 2022.
5. TÍTULO: "Desarrollo del Modulo de Actuaciones para la herramienta SANAID - Stability ANalysis interactive AIrcraft Design Tool" AUTOR: PABLO NOGALES CRIADO, TUTOR: Sergio Esteban Roncero. TITULACION: MÁSTER EN INGENIERIA AERONÁUTICA. AÑO: 2022.

CAD-CAM Studies

Generación Científica: TFGs, TFMs

1. TÍTULO: "Estudio y Diseño de la Estructural de un Aeronave Convertible: Proyecto EMERGENTIA" AUTOR: JAVIER MORA HIDALGO TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA AÑO: 2020.
2. TÍTULO: "Diseño del Proceso de Fabricación CAD/CAM del Proyecto ProVANT-EMERGENTIA" AUTOR: Mario Romero Cornejo,TUTOR: Sergio Esteban Roncero. TITULACION: MÁSTER EN INGENIERIA AERONÁUTICA. AÑO: 2022.
3. TÍTULO: "Desarrollo de Procedimientos de Fabricación e Instrucciones Técnicas de Ensamblado para la Fabricaciónn Aeronave Convertible: Proyecto EMERGENTIA" AUTOR: JAVIER MORA HIDALGO TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AERONÁUTICA AÑO: 2022.

Digital Twin Studies

Generación Científica: TFGs, TFMs

1. TÍTULO: “Diseño y construcción de un sistema de adquisición de datos de motores hélice para experimentos en túnel de viento” AUTOR: Lidia Parrilla Benítez, TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2016.
2. TÍTULO: “Estudio y modelado del Control de Motores Brushless para una Aeronave UAV VTOL” AUTOR: Laura María González Ruiz, TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2017.
3. TÍTULO: “Estudio y mejora del diseño de un sistema de medida de ángulo de ataque para aeronaves no tripuladas” AUTOR: Cristina Hiedra Priego,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2017.
4. TÍTULO: “Estudio y Modeladodel Control de Motores Brushless para una Aeronave VTOL” AUTOR: Laura María González Ruiz,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2017.
5. TÍTULO: “Optimización del acoplamiento entre hélice y motor eléctrico de un UAV VTOL” AUTOR: Diego Manzano Delgado,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2018.
6. TÍTULO: “Desarrollo de convertidor con tecnología GaN para alimentación de motores UAV VTOL” AUTOR: Alejandro Remujo Castro, TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2018.
7. TÍTULO: “Estudio, Modelado y Comparación de Estrategias de Control de un Motor BLDC” AUTOR: Dunia López Navas,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2018.
8. TÍTULO: “Desarrollo de Convertidor DC-DC con Tecnología de Nitruro de Galio para Aplicación UAV” AUTOR: Joaquín soriano López,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2018.
9. TÍTULO: “Estudio y Modelado del Control sin Sensores de un Motor BLDC para un UAV VTOL” AUTOR: María morillo Mora,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2020.
10. TÍTULO: “Diseño de bancada de pruebas y estimación de parámetros de motores BLDC para UAVs” AUTOR: Sergio Camargo Navajas,TUTOR: Juana María Martínez Heredia. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2020.
11. TÍTULO: “Design of the general architecture for the systems integration, functional tests, and flight tests campaigns for a tilt-rotor UAV prototype: Project EMERGENTIA-ProVant.” AUTOR: ANTONIO ALBARRAN MERCHAN, TUTOR: Sergio Esteban Roncero. TITULACION Grado en Ingeniería Aeroespacial, AÑO: 2021.
12. TÍTULO: “Diseño y desarrollo de pruebas funcionales para aviónica modular en UAV-VTOL” AUTOR: Pablo Kratzer Martín,TUTOR: Juana María Martínez Heredia. TITULACION: Grado en Ingeniería de las Tecnologías de Telecomunicación.AÑO: 2022.

Energy Generarion Studies

Generación Científica: TFGs, TFMs

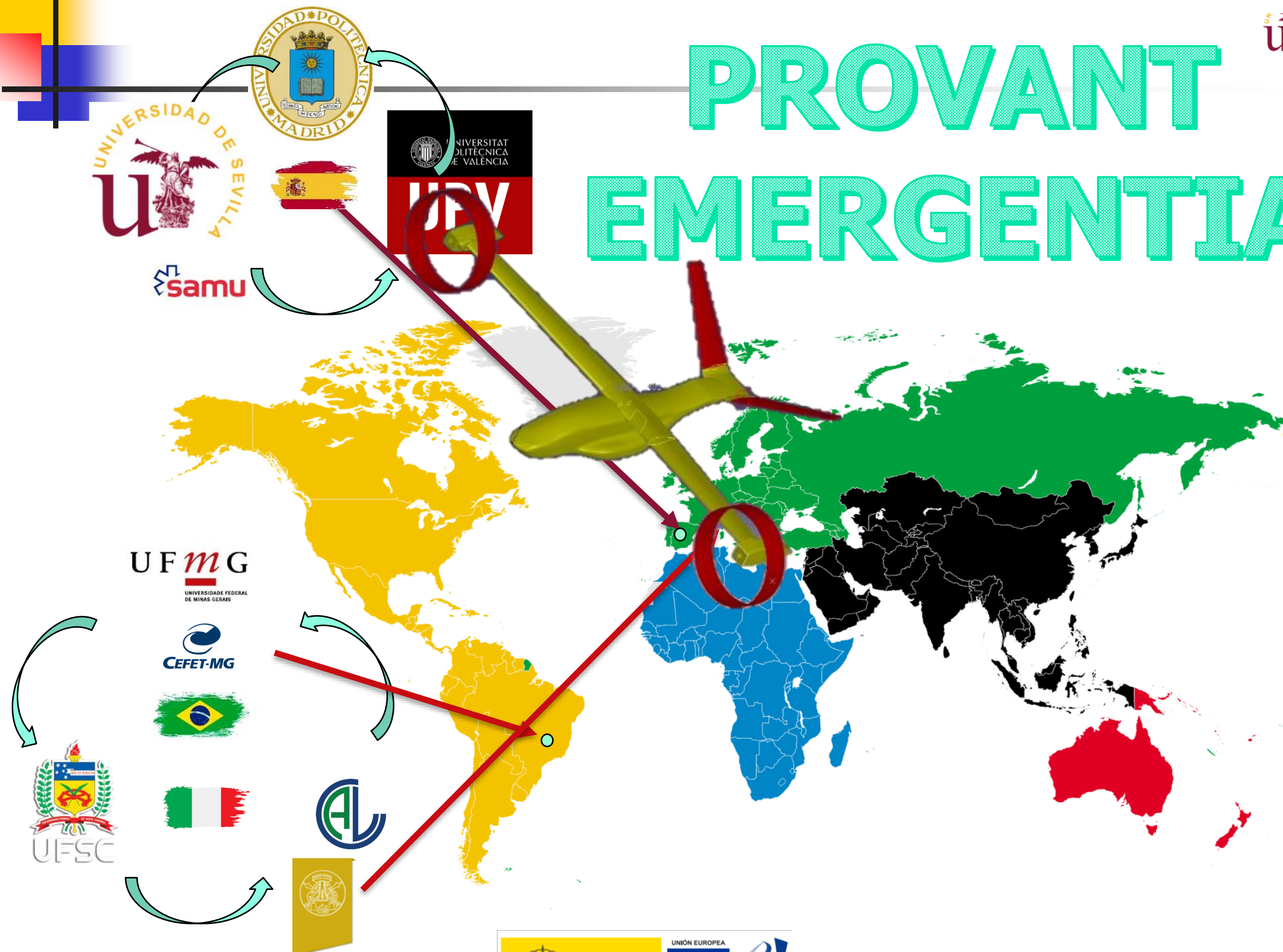
1. TÍTULO: "Integración de Pilas de Combustible para Propulsión en una Aeronave" AUTOR: Juan Ramón Parra Vilar,TUTOR: Carlos Bordons Alba. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2017.
2. TÍTULO: "Realización de una bancada de ensayos para propulsión híbrida de aeronaves con baterías y pila de combustible" AUTOR: Guillermo Hernández Lorente,TUTOR: Carlos Bordons Alba. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2020.
3. TÍTULO: "Diseño del Sistema de Gestión de Energía de una Aeronave con Pila de Combustible" AUTOR: Pablo Torné Alaminos,TUTOR: Carlos Bordons Alba. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2019.
4. TÍTULO: "Diseño de Bancada y Sistema de Control de Plantas de Potencia Híbridas para Sistemas de Propulsión en Vehículos Aéreos No Tripulados" AUTOR: Javier Quintana,TUTOR: Carlos Bordons Alba y Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2022.

Control Strategies Studies

Generación Científica: TFGs, TFMs

1. TÍTULO: DESARROLLO DE UNA HERRAMIENTA ACADEMICA PARA EL ESTUDIO DE LA ESTABILIDAD DE AERONAVES MEDIANTE INTERFAZ GRAFICA BASADA EN MATLAB: AS.gui. AUTOR: PABLO GARCIA MASCORT . TUTOR: Sergio Esteban Roncero. TITULACION: INGENIERIA AERONAUTICA. AÑO: 2014.
2. TÍTULO: " ACTUALIZACIÓN DE LA HERRAMIENTA ACADÉMICA AS.GUI PARA ESTUDIO DE LA ESTABILIDAD DE AERONAVES : ASPRO" AUTOR: Álvaro Fernández Cobo. TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AEROESPACIAL. AÑO: 2015.
3. TÍTULO: "DESARROLLO DE ESTRATEGIAS DE CONTROL AVANZADAS PARA EL CONTROL DE VEHÍCULOS AÉREOS NO TRIPULADO" AUTOR: LUIS MANUEL GARCIA-BAQUERO CORREDERA,TUTOR: Sergio Esteban Roncero. TITULACION: GRADO EN INGENIERIA AEROESPACIAL.AÑO: 2018.
4. TÍTULO: "Development of Control Strategies based on SDRE and Theta-D Time Control Strategies for a Tilting Rotor Aircraft, in longitudinal and lateral-directional flight modes.." AUTOR: GERARDO ANDRES PENA MONTES DE OCA,TUTOR: Sergio Esteban Roncero. TITULACION: Grado en Ingeniería Electrónica, Robótica y Mecatrónica (UMA-US) AÑO: 2021.
5. TÍTULO: "Desarrollo de Estrategias de Control por Escalas de Tiempo para una Aeronave de Rotores Basculantes, en los modos de vuelo longitudinal y lateral-direccional." AUTOR: GUILLERMO GIL GARCIA,TUTOR: Sergio Esteban Roncero. TITULACION: Grado en Ingeniería Electrónica, Robótica y Mecatrónica (UMA-US) AÑO: 2021.
6. PhD: "Robust Control for Convertible Unmanned Aerial Vehicles", Alumno: Daniel Neri Cardoso: Co-directores: Guilherme V. Raffo y Sergio Esteban Roncero, Institución: Universidade Federal de Minas Gerais, Escola de Engenharia, Belo Horizonte - MG, Brazil, Fecha defensa:24 Julio de 2021

PROVANT EMERGENTIA



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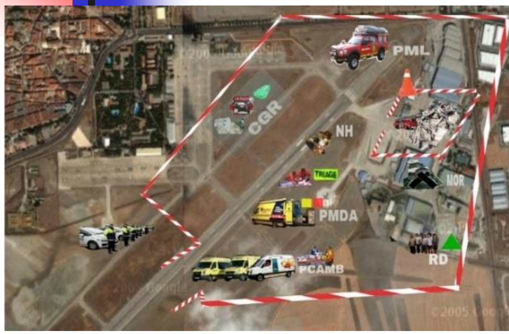
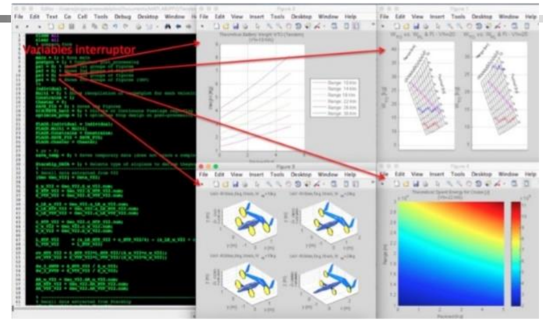
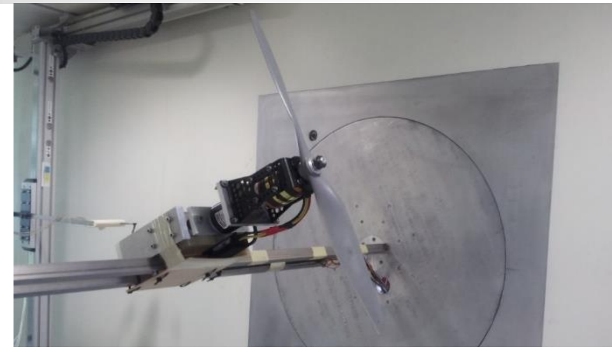
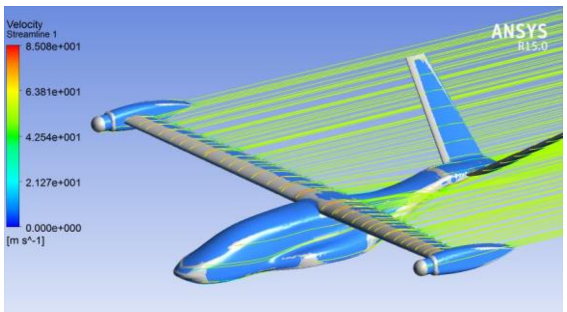
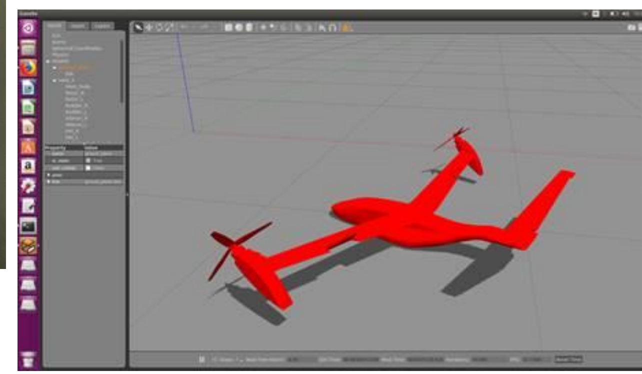
Research Lines

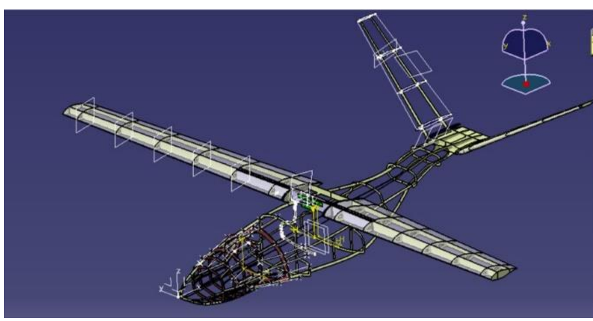


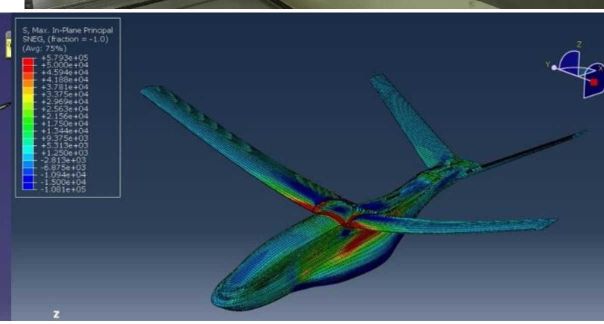


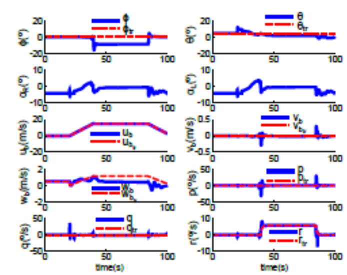


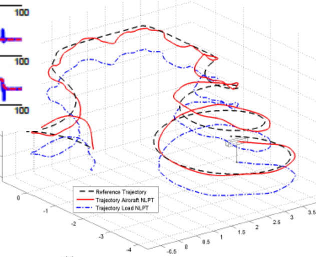






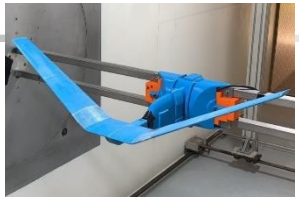
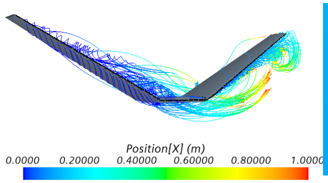


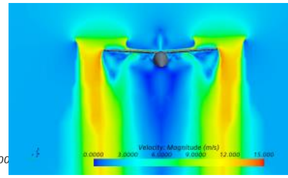




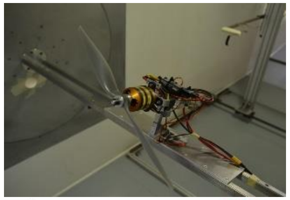
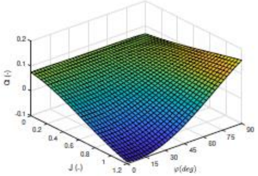
Research Lines

- Aerodynamic Studies: wind tunnel and CFD

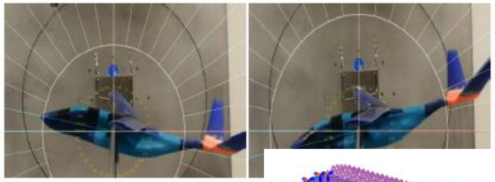
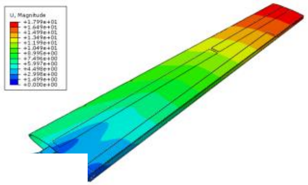
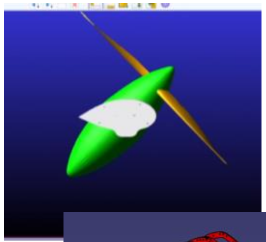





- Propulsive studies: wind tunnel and theoretical models

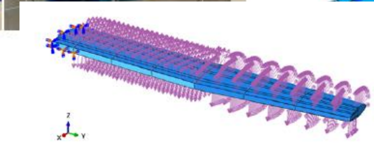
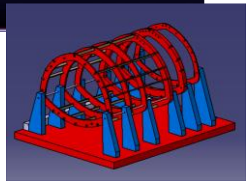



- Flying Qualities Studies: wind tunnel and 6DOF Models

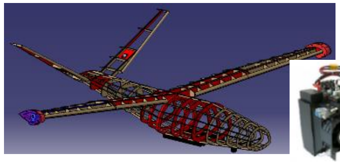




- Structural Studies: FEM

- Mechanical Analysis

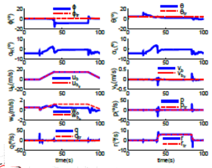



- CAD-CAM process: multilevel BOM, CTI, ATI, manufacturing

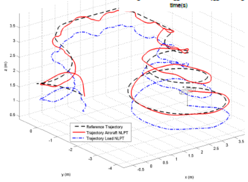


- Embedded Cyberphysical systems Design

- Generation and Management of Energies: hibridization of battery and fuel cell

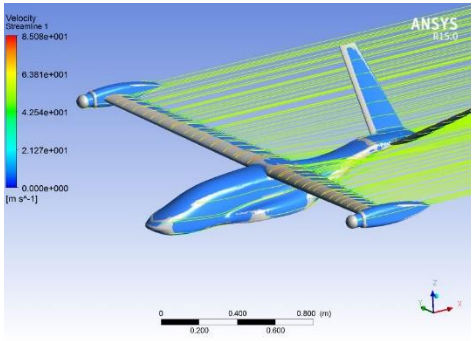


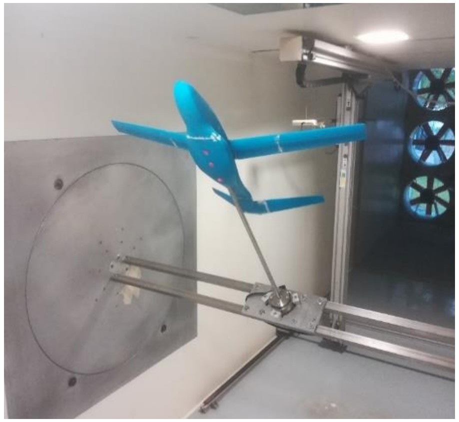
- Autonomous Guidance, Navigation and control

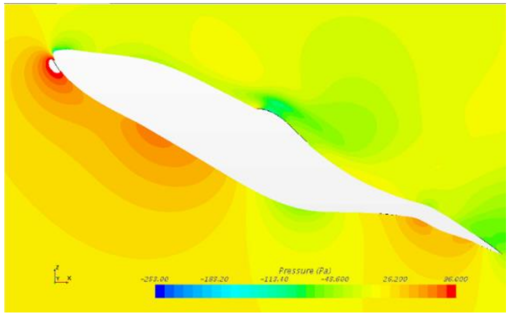



AERODYNAMIC Studies

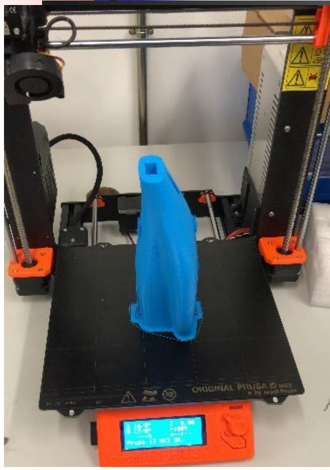
- Objectives:
  - Detailed study of the aerodynamics:
    - Fuselage, aerodynamic and stabilizing surfaces, engine nacelles and rotors
    - Complete flight envelope: different angles of attack, side slip, Reynolds number and Mach number.
  - Use of computational tools (CFD) along with experiments in wind tunnel later to validate results.
  - Generate advanced dynamic models using aerodynamic studies (theoretic and experimental)
    - Analyze both the stability and performance of the VTOL-CP in its entire flight envelope:
      - Forward flight, axial flight, transition flight
    - Determination of aerodynamic loads for structural studies.

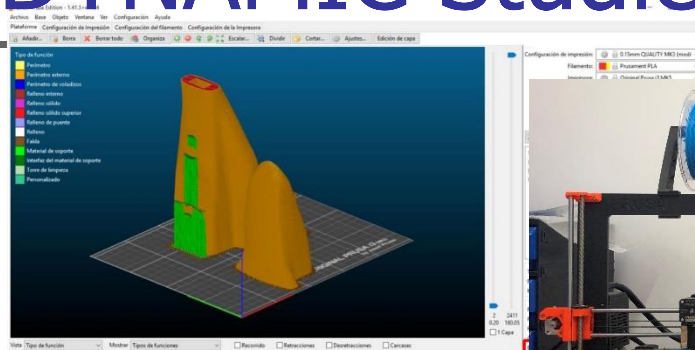


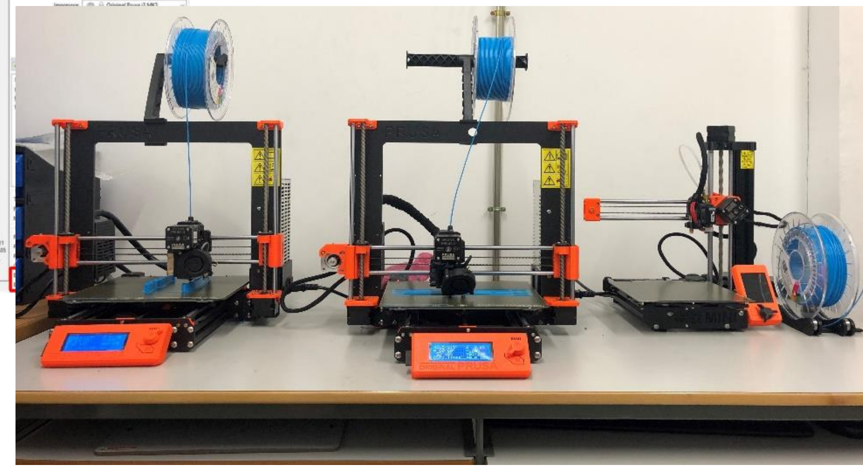


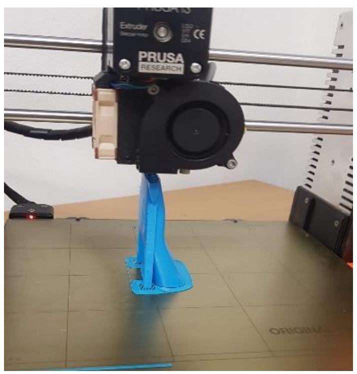


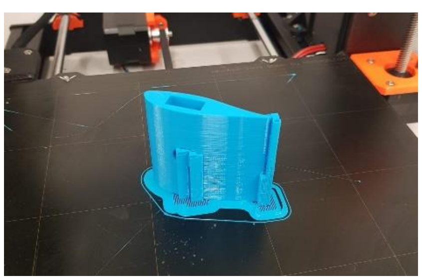
AERODYNAMIC Studies

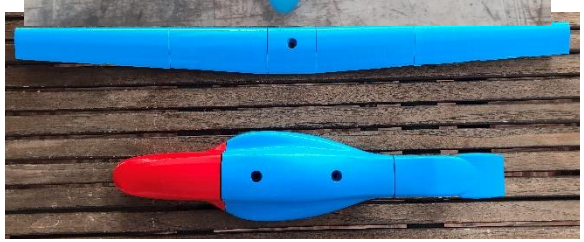


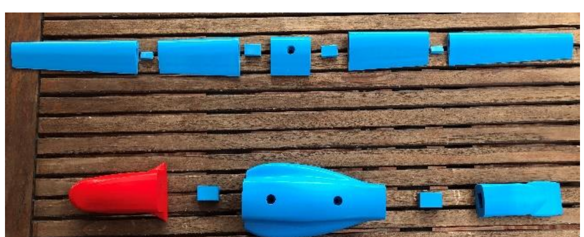










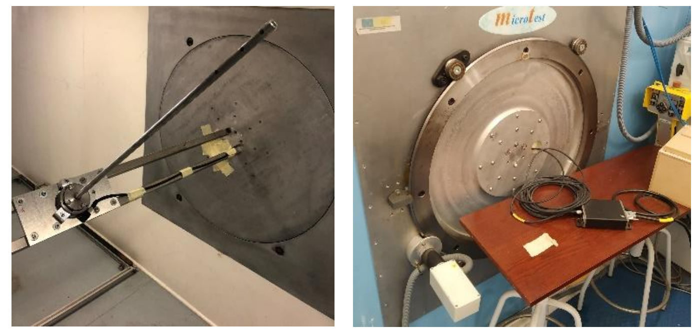


3D printing Capabilities

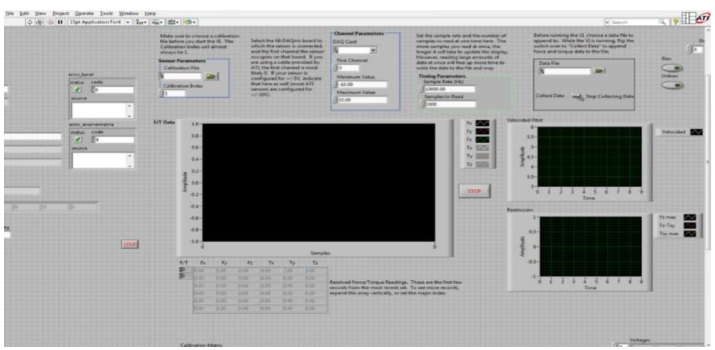
AERODYNAMIC Studies

Wind Tunnel Facilities

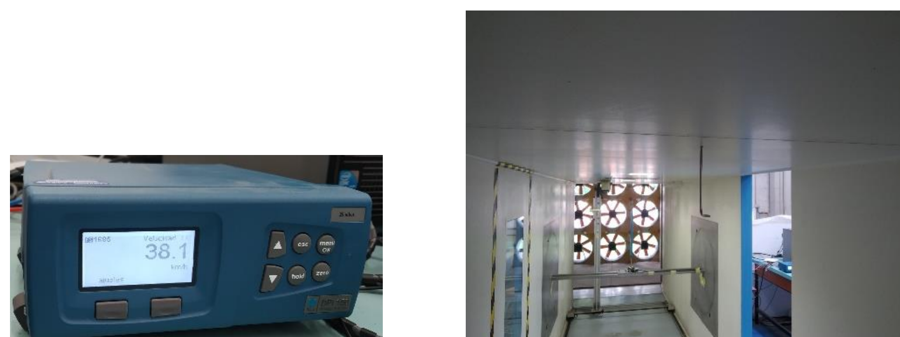
Assembly System



Positioning System



Labview Force and moments SetUp

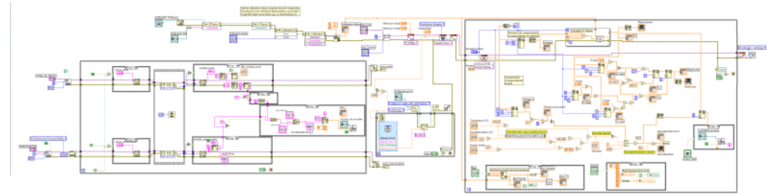


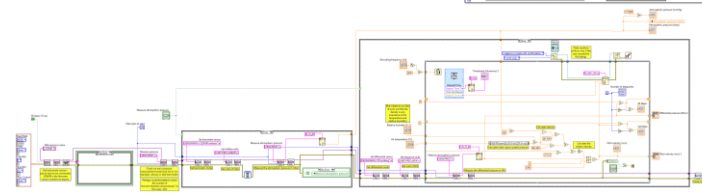
Velocity Adquisition system

AERODYNAMIC Studies

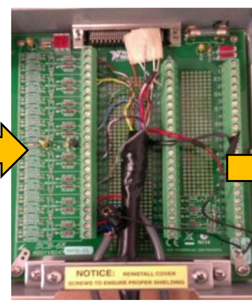
Wind Tunnel Facilities
Measuring Equipment

LabVIEW: adquisición, transformación y grabado

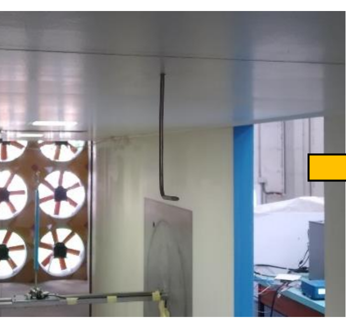


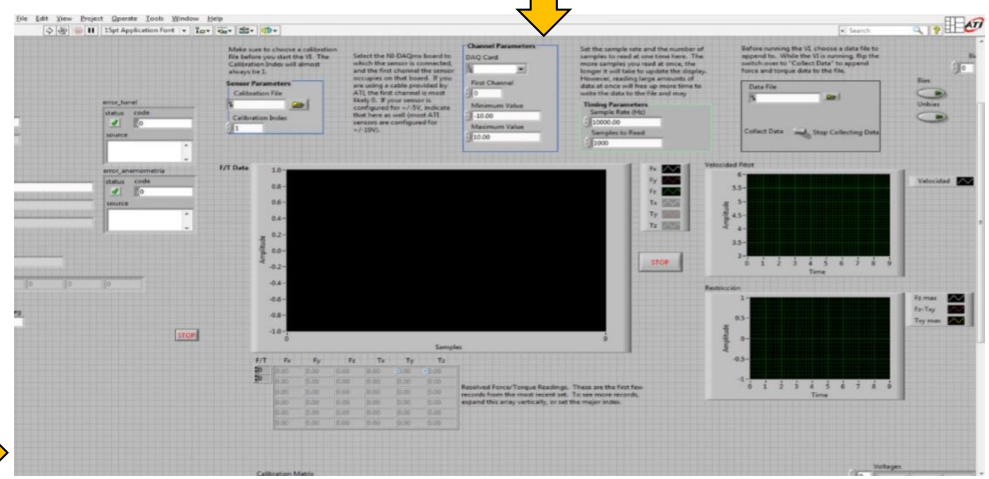


Forces and Moments



Velocities

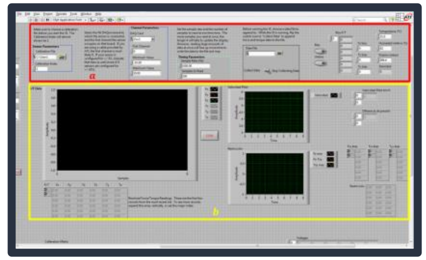




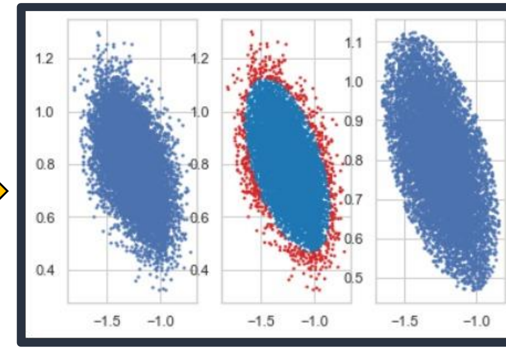
Labview Force and moments SetUp

AERODYNAMIC Studies

Data Adquisition

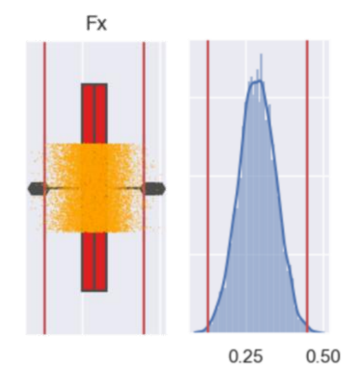


Data Filtering

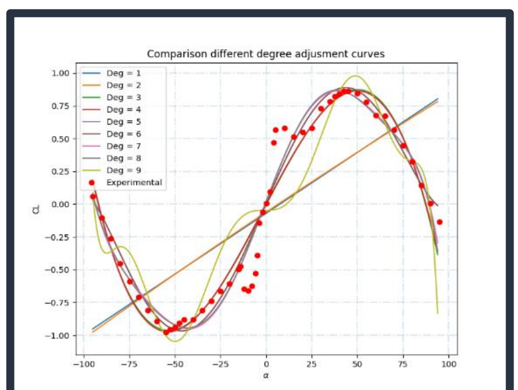


Campaign 2

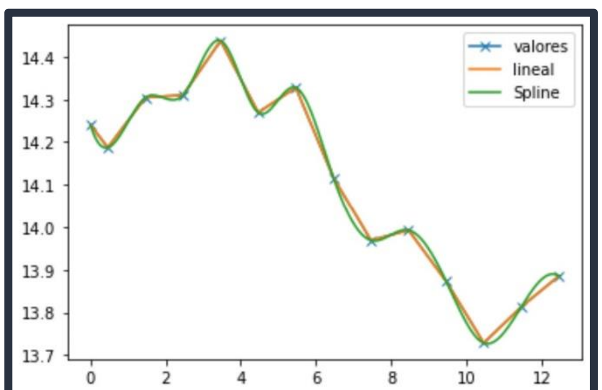
PYTHON



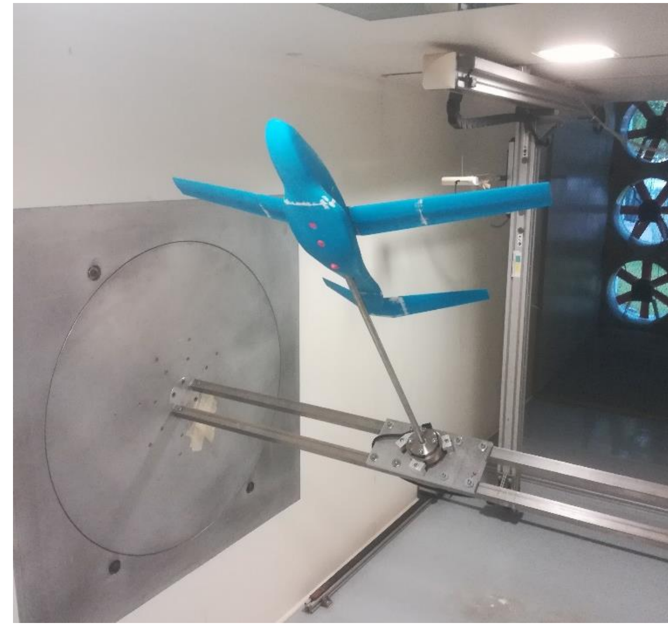
Data Post-processing



Data Fitting



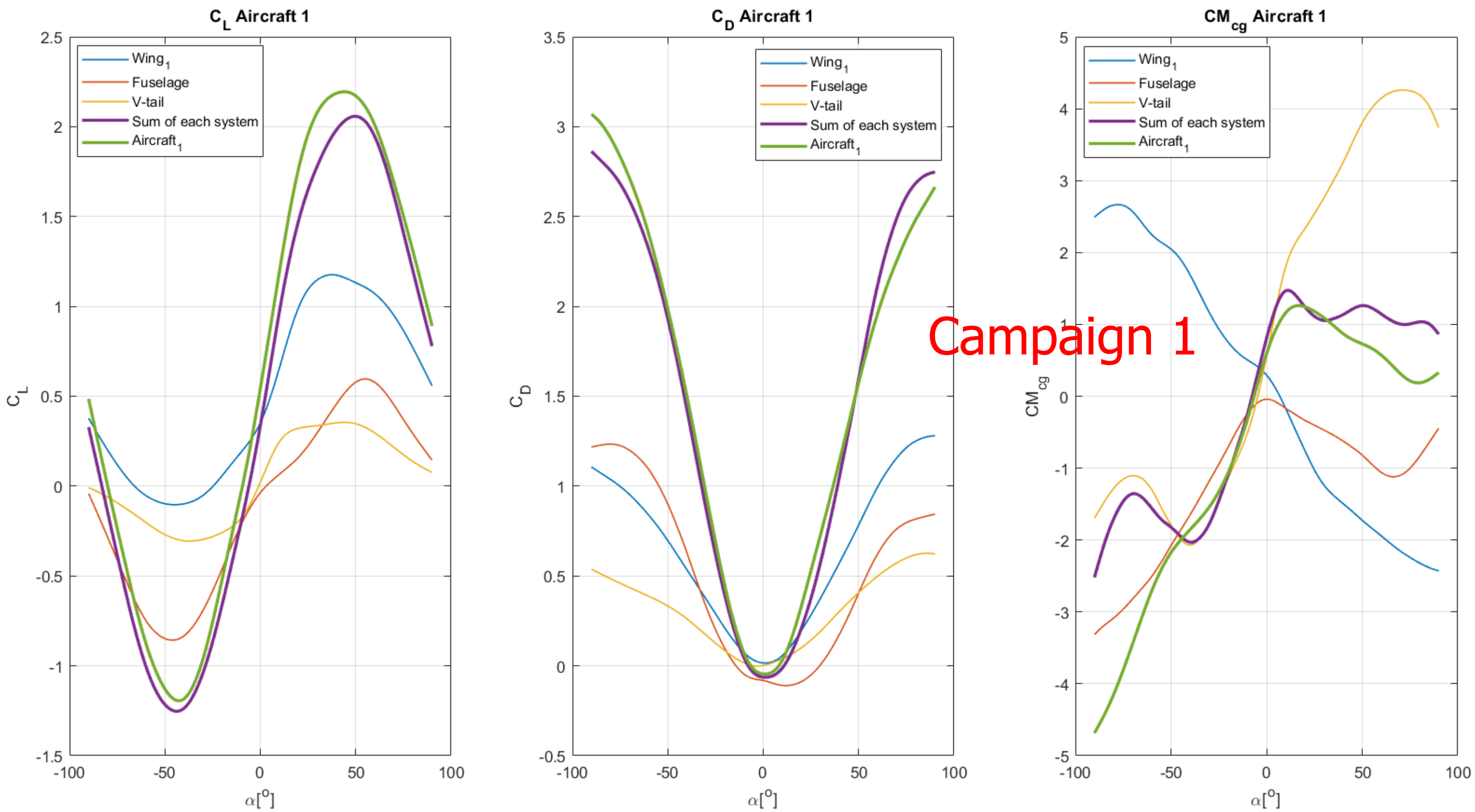
AERODYNAMIC Studies



Wind Tunnel Experiments

AERODYNAMIC Studies

Superposition Contribution



$$C_{L_{a/c}} = C_{L_{fus}} + C_{L_{vee}} + C_{L_{wing}} + C_{L_{interference}}$$

$$C_{D_{a/c}} = C_{D_{fus}} + C_{D_{vee}} + C_{D_{wing}} + C_{D_{interference}}$$

$$C_{M_{a/c}} = C_{M_{fus}} + C_{M_{vee}} + C_{M_{wing}} + C_{M_{interference}}$$

$$C_L = \frac{L}{\frac{1}{2}\rho_\infty V^2 S} = f(\alpha) = \sum_{i=0}^{n} a_i \alpha^i$$

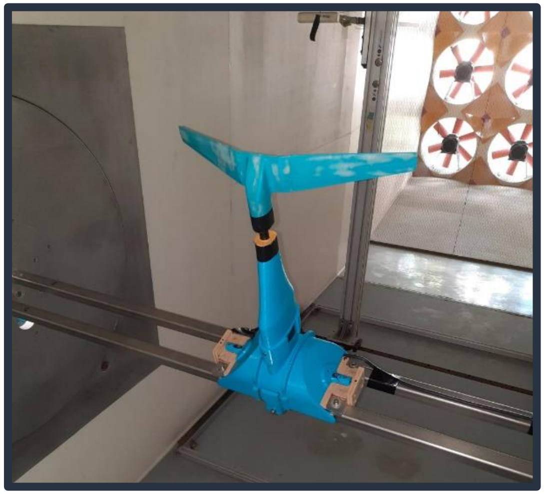
$$C_D = \frac{D}{\frac{1}{2}\rho_\infty V^2 S} = g(\alpha) = \sum_{i=0}^{n} b_i \alpha^i$$

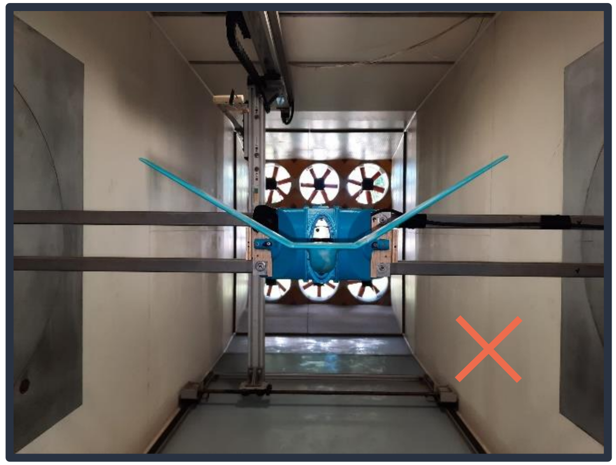
$$C_M = \frac{M}{\frac{1}{2}\rho_\infty V^2 S c} = h(\alpha) = \sum_{i=0}^{n} c_i \alpha^i$$

AERODYNAMIC Studies

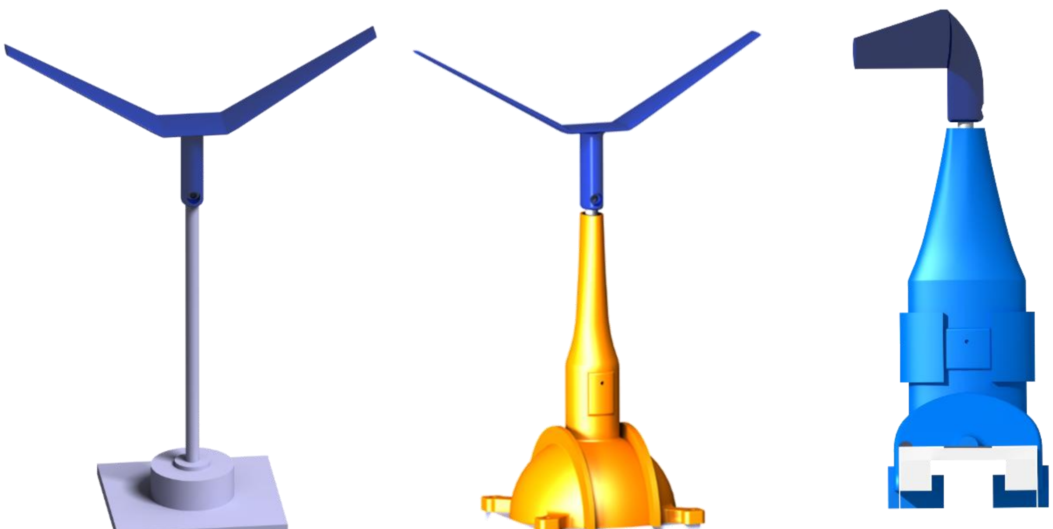
Wind Tunnel Experiments

Campaign 2 - V-tail



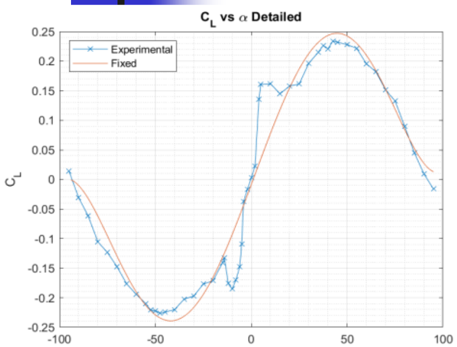


Fairing designs for drag reduction

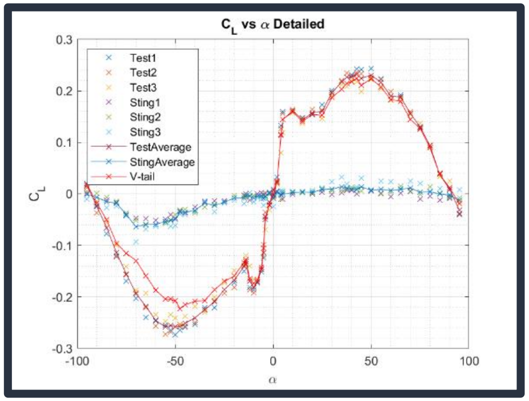


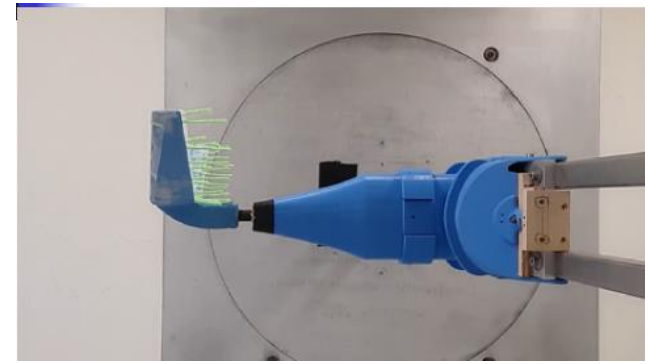
AERODYNAMIC Studies

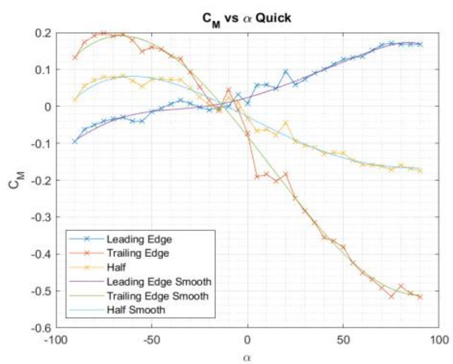
Wind Tunnel Experiments

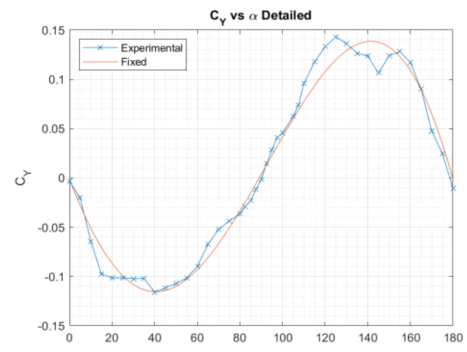


Campaign 2 - Vtail

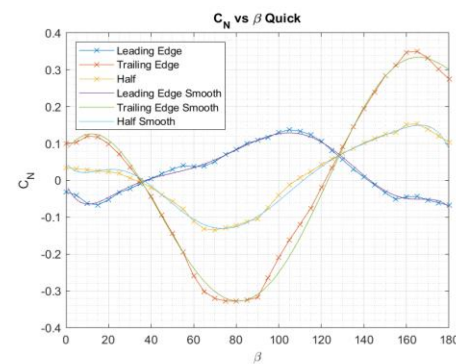


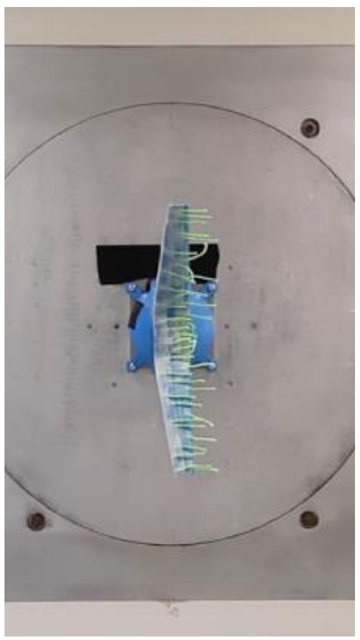


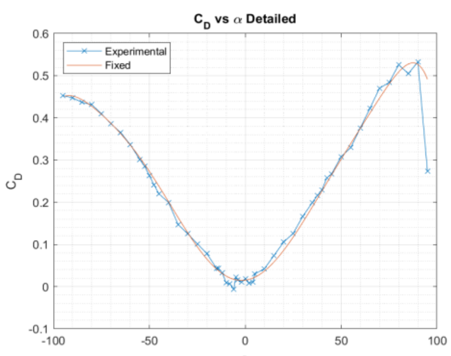


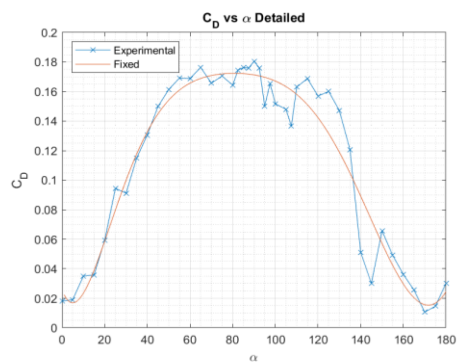


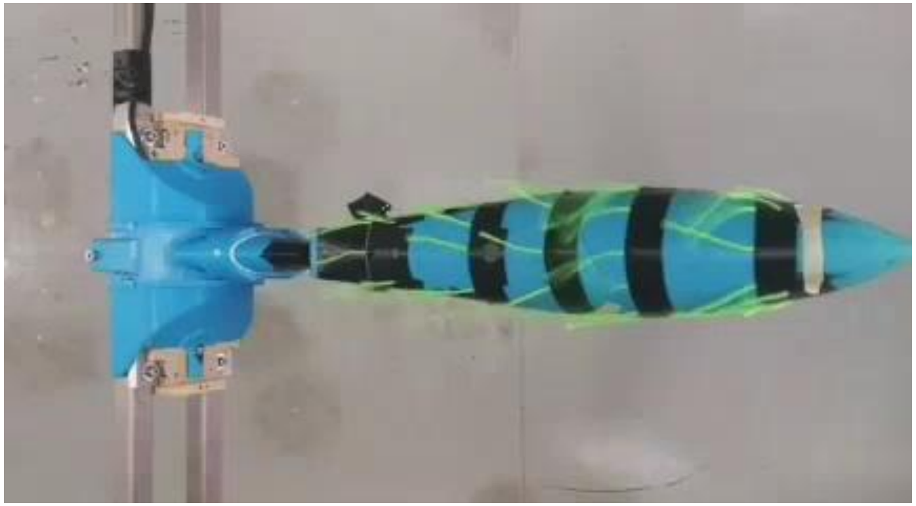
Tuft used only for flow visualization









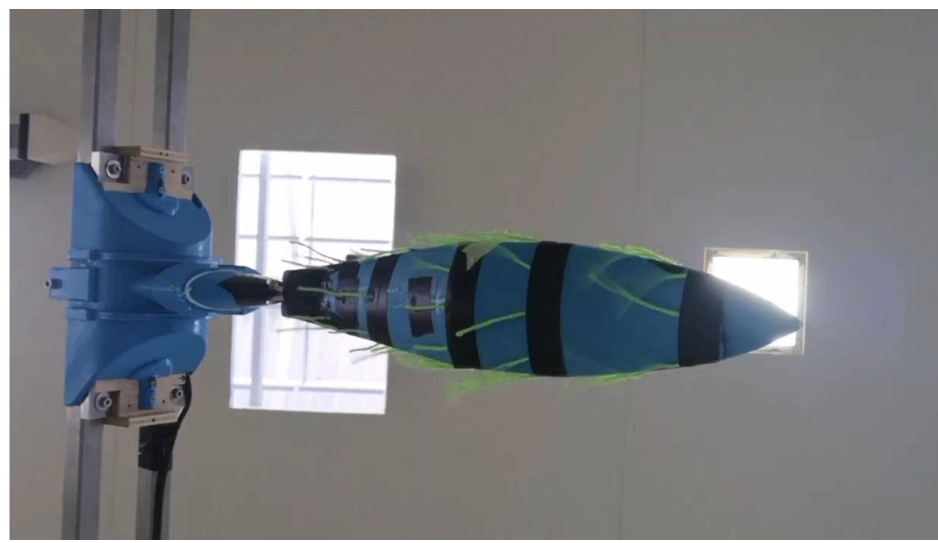


Campaign 2 - fuselaje

Test from α=-45º through α=-60º

Test α=45º through α=60º

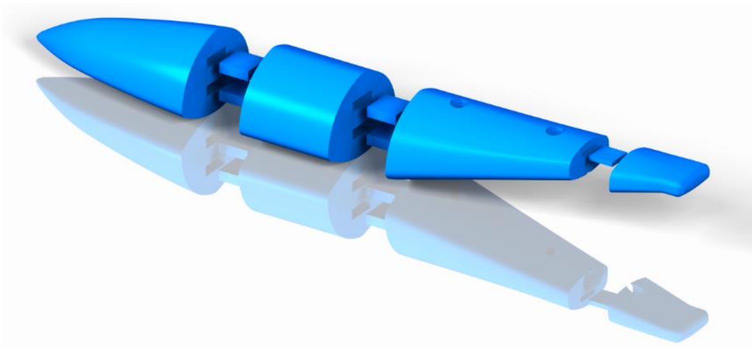
Tuft used only for flow visualization

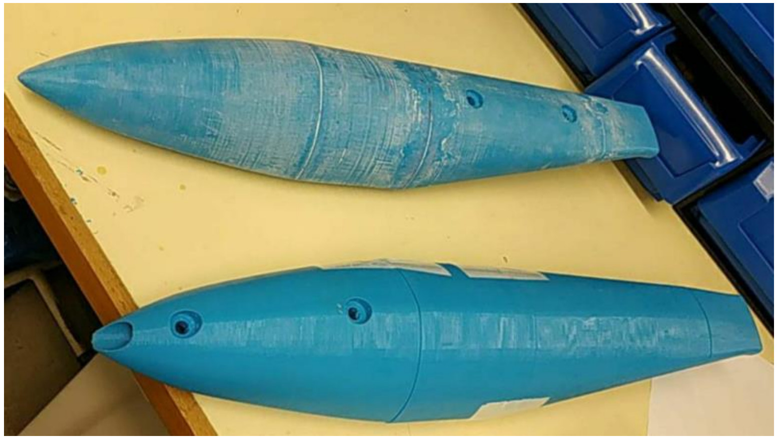


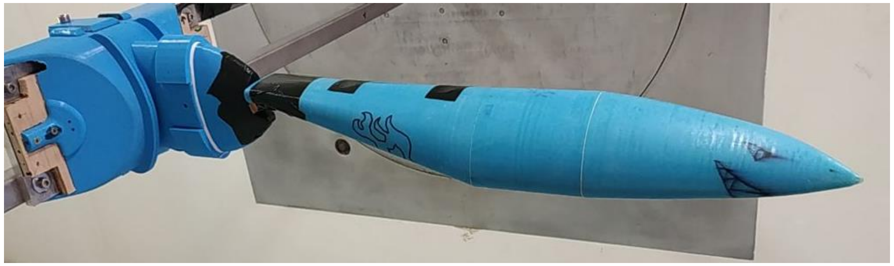
AERODYNAMIC Studies

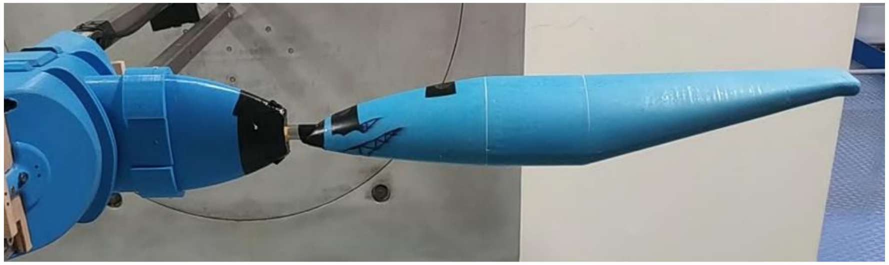
Campaign 2 - fuselage

Wind Tunnel Experiments



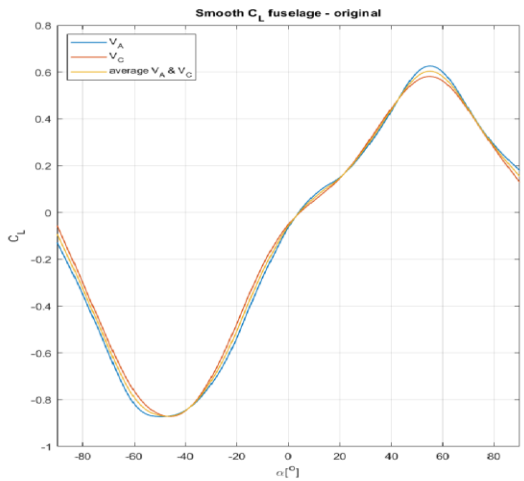


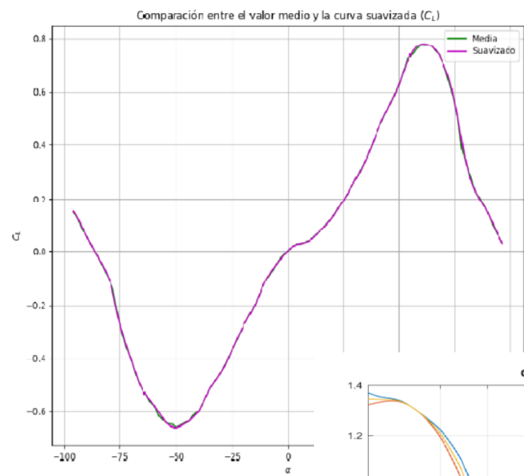




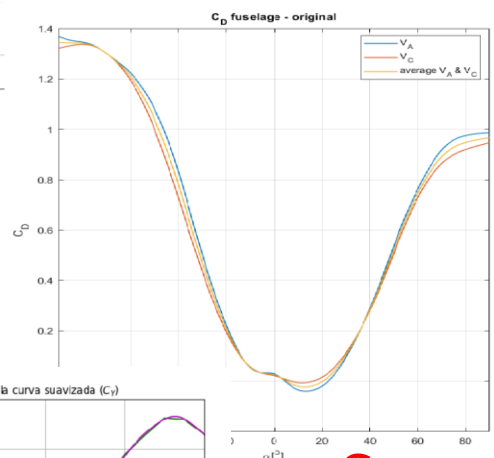
AERODYNAMIC Studies

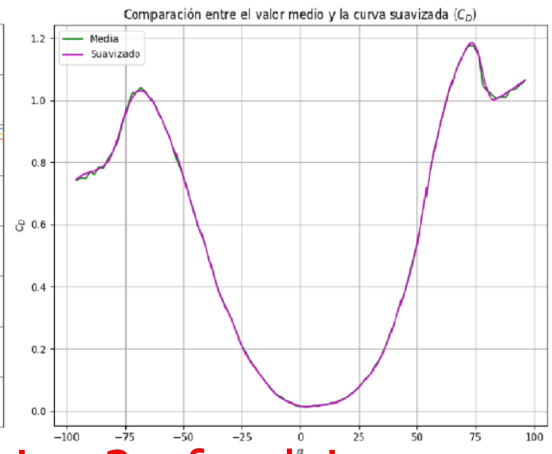
Wind Tunnel Experiments

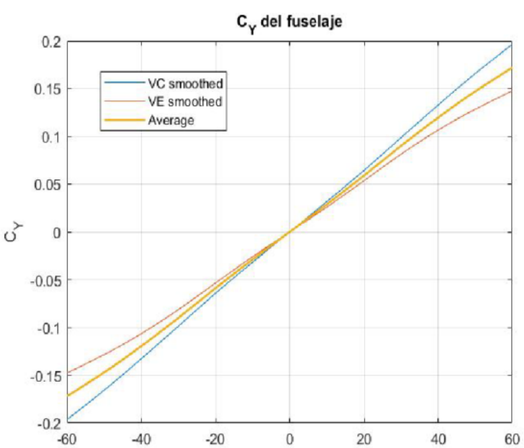


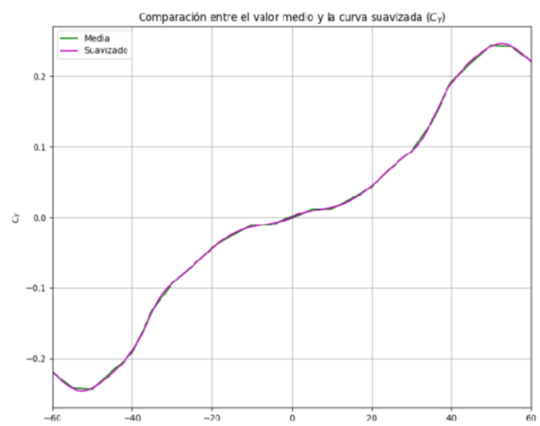


Tuft used only for flow visualization

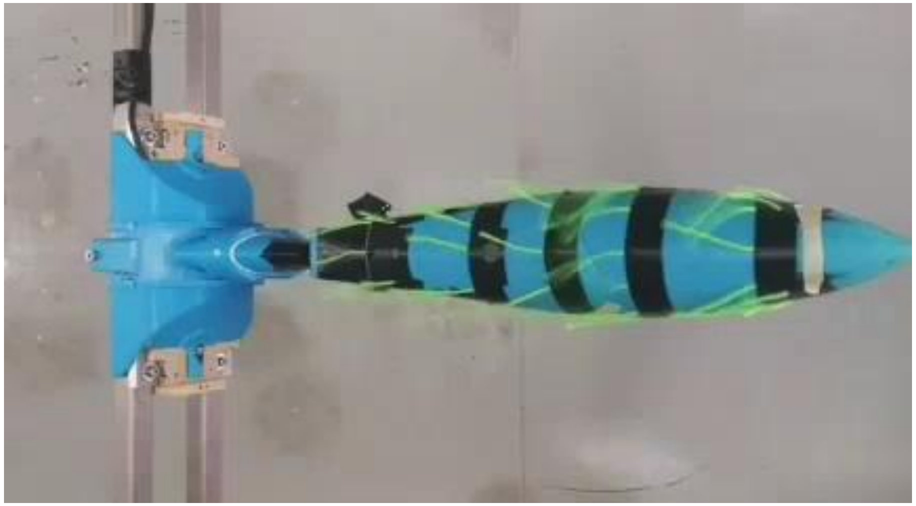








Campaign 2 - fuselaje



Campaign 2 - fuselaje

Test from α=-45º through α=-60º

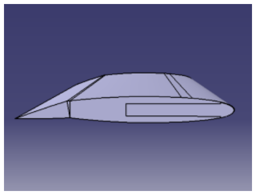
Test α=45º through α=60º

Tuft used only for flow visualization

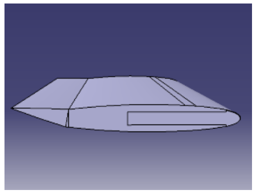
AERODYNAMIC Studies

Campaign 3 – Vtail w deflections

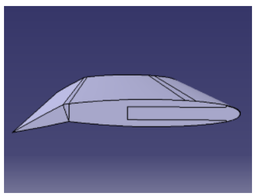
Wind Tunnel Experiments



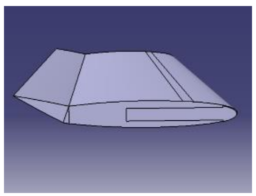
$\delta = 10°$



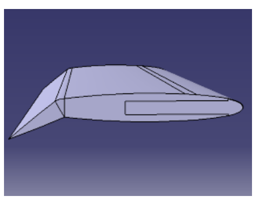
$\delta = -10°$



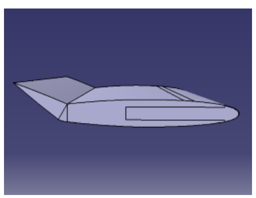
$\delta = 20°$



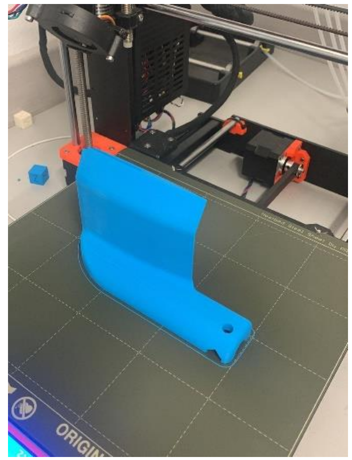
$\delta = -20°$

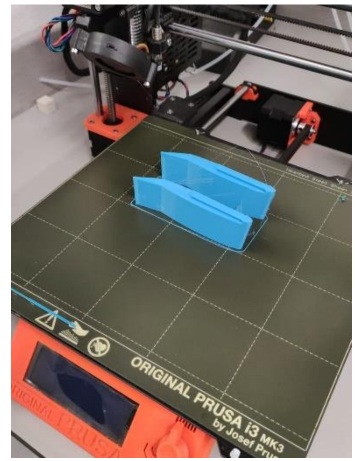


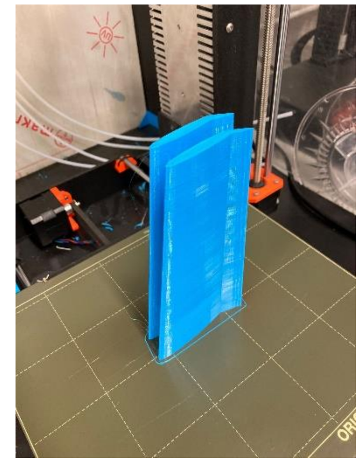
$\delta = 30°$

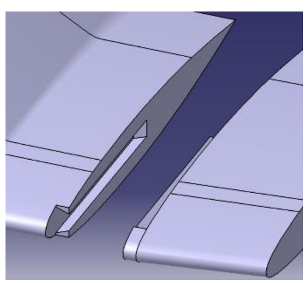


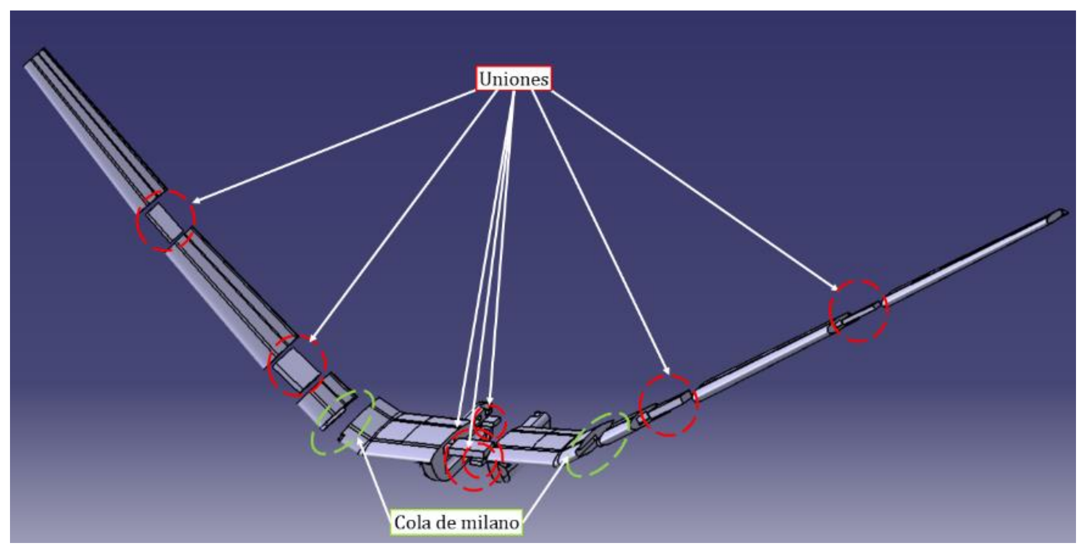
$\delta = -30°$







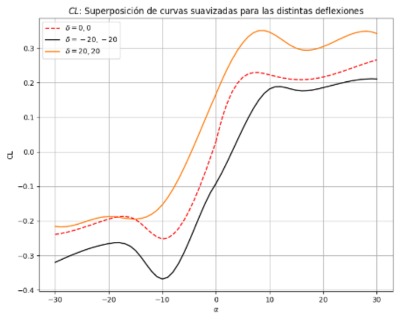


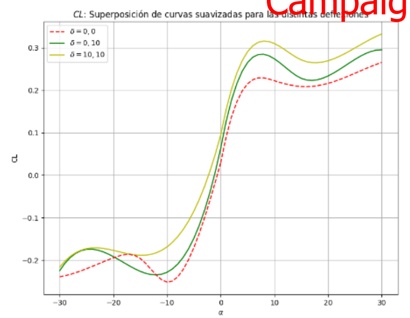


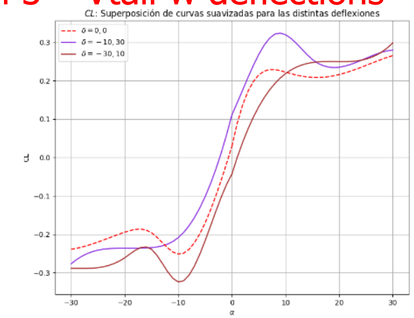
AERODYNAMIC Studies

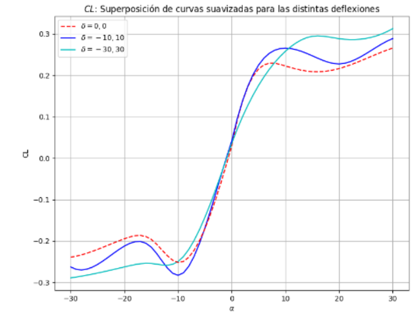
Wind Tunnel Experiments

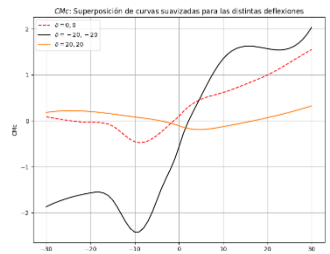
Campaign 3 – Vtail w deflections

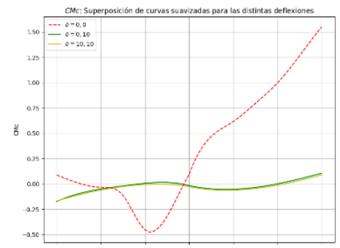


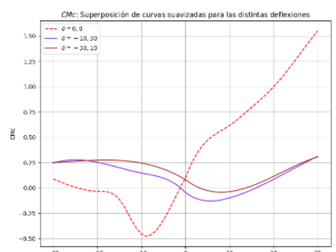


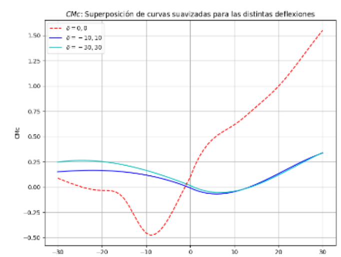


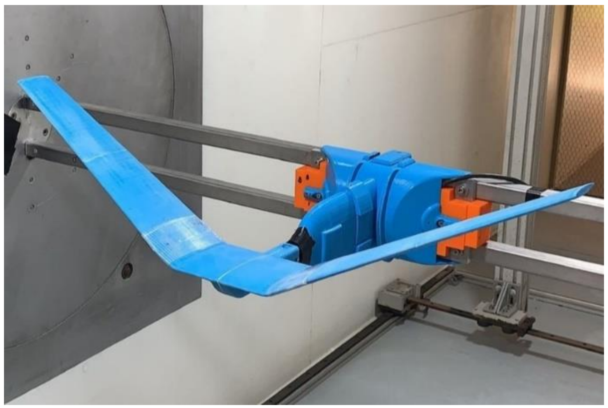


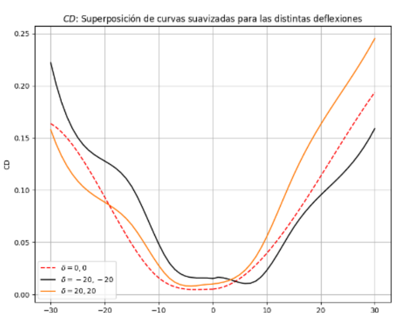


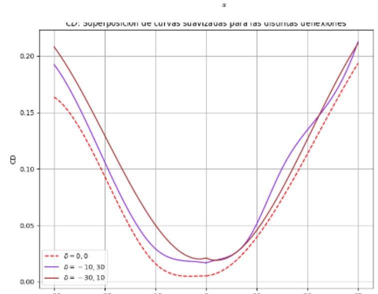


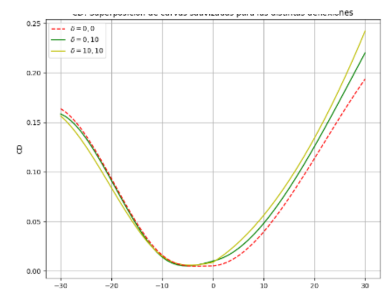


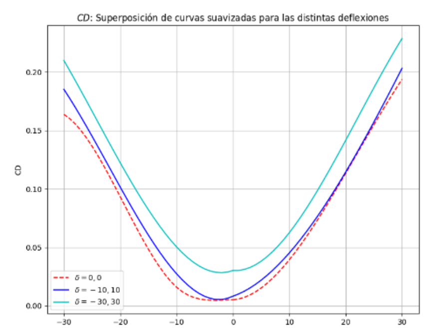






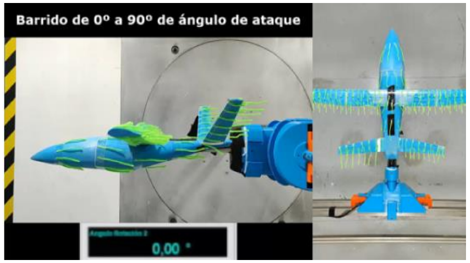




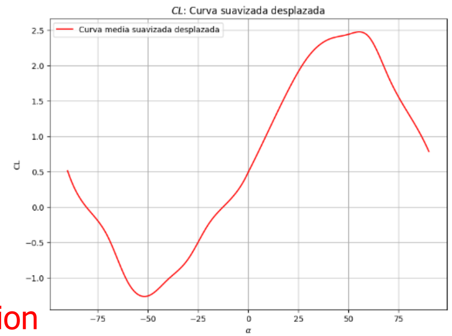


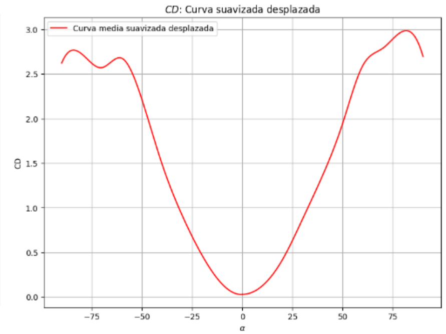
AERODYNAMIC Studies

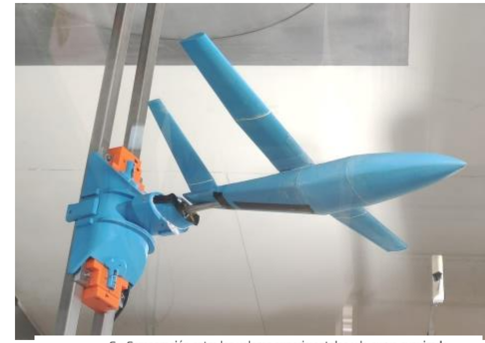
Wind Tunnel Experiments   Campaign 3 – Complete Aircraft

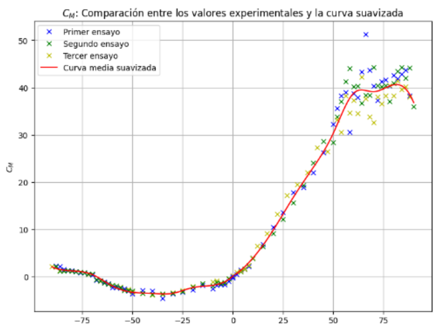


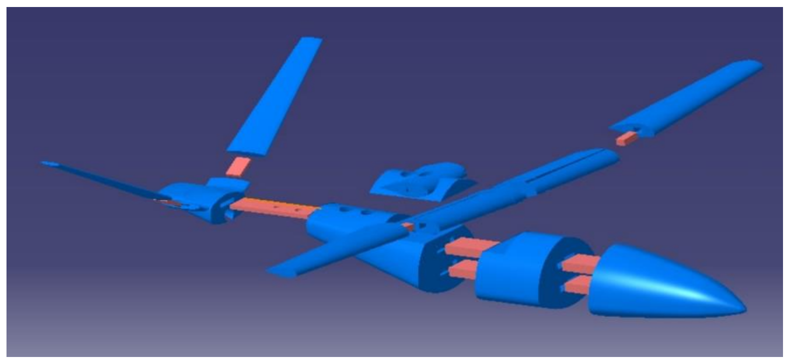
Tuft used only for flow visualization

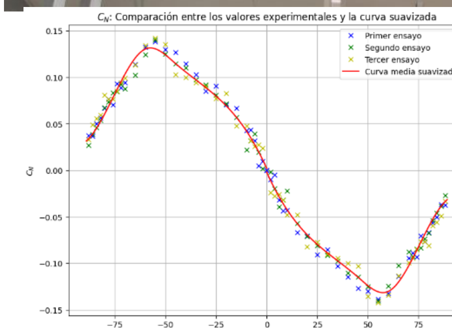


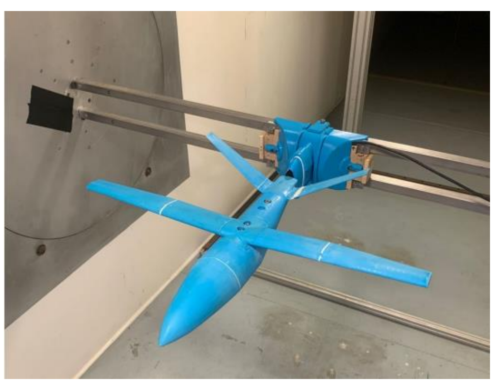


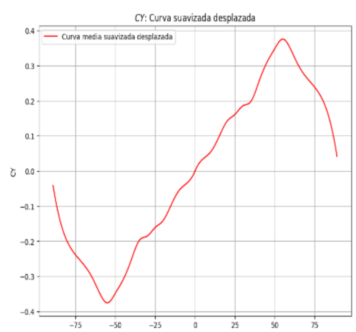


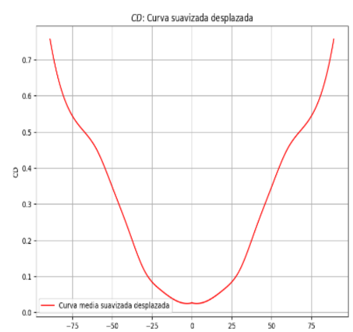


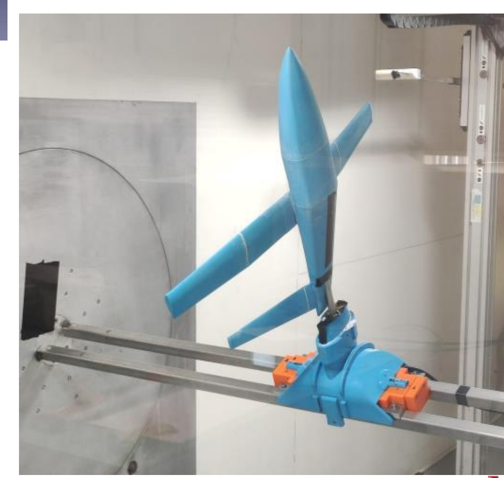






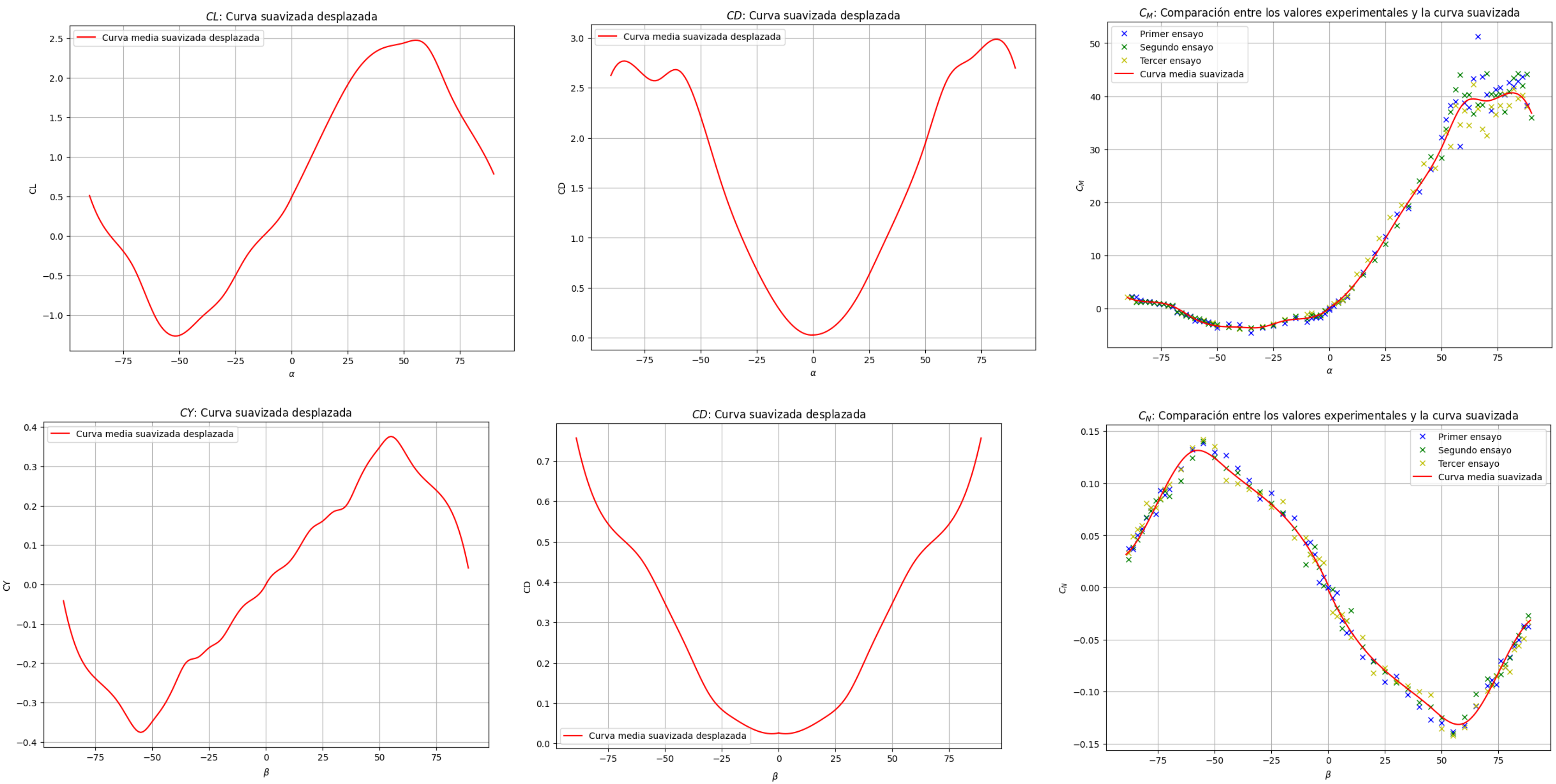






AERODYNAMIC Studies

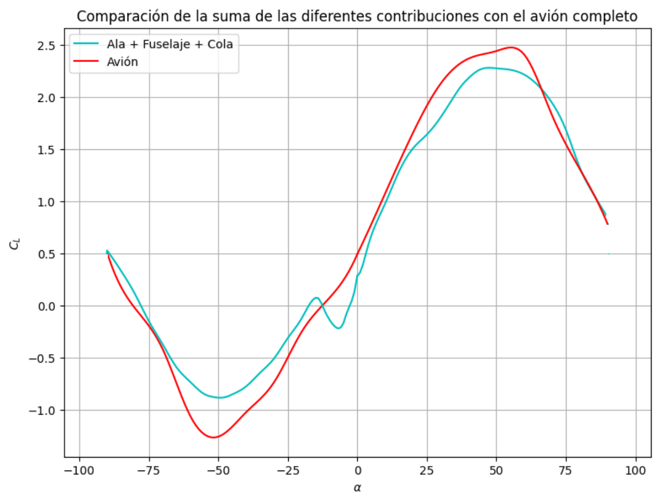
Campaign 3 – Complete Aircraft

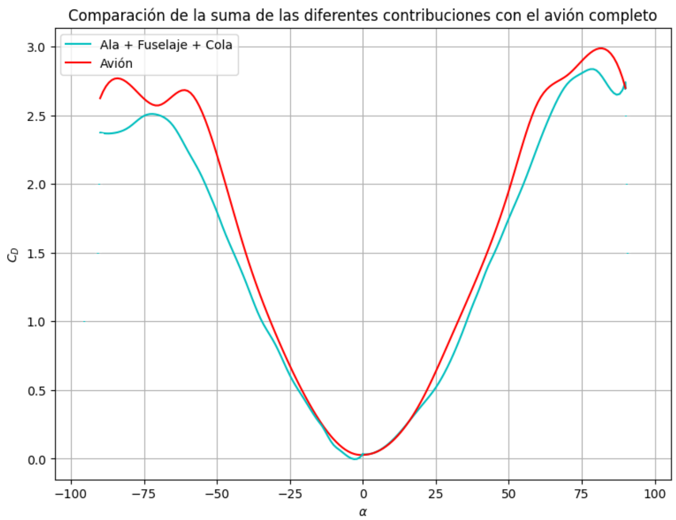


AERODYNAMIC Studies

Wind Tunnel Experiments

Campaign 3 – Complete Aircraft



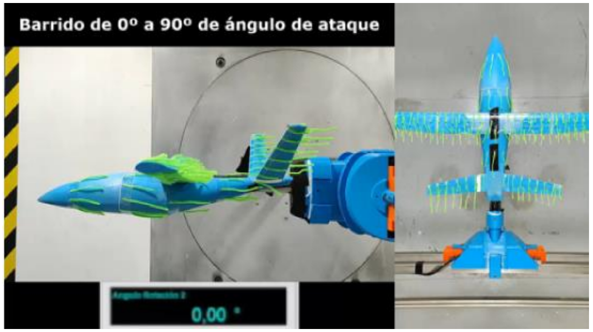


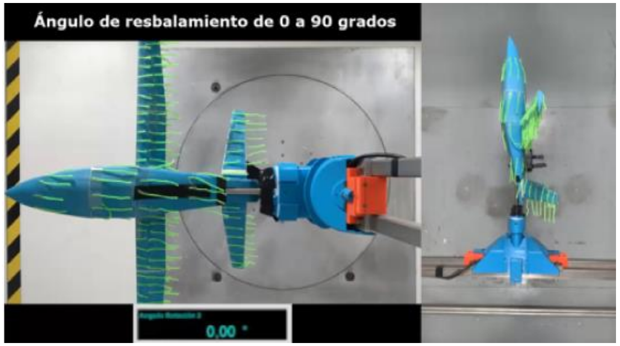
$$C_{L_{avin}} = C_{L_{ala}} + C_{L_{fuselaje}} + C_{L_{cola}} + \Delta C_{L_{interferencias}}$$

$$\Delta C_{L_{interferencias}} = C_{L_{interferencias}}[\alpha]$$

$$C_{D_{avin}} = C_{D_{ala}} + C_{D_{fuselaje}} + C_{D_{cola}} + \Delta C_{D_{interferencias}}$$

$$\Delta C_{D_{interferencias}} = C_{D_{interferencias}}[\alpha]$$





Tuft used only for flow visualization

AERODYNAMIC Studies

Wind Tunnel Experiments

Campaign 3 – Vtail w deflections

Deflection δ=20, 20; sweep from α=–30° a α=30°

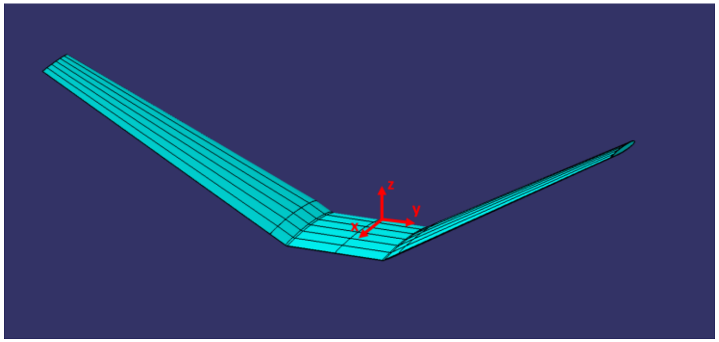
Deflection δ=-20, -20; sweept from α=–30° a α=30°

Tuft used only for flow visualization

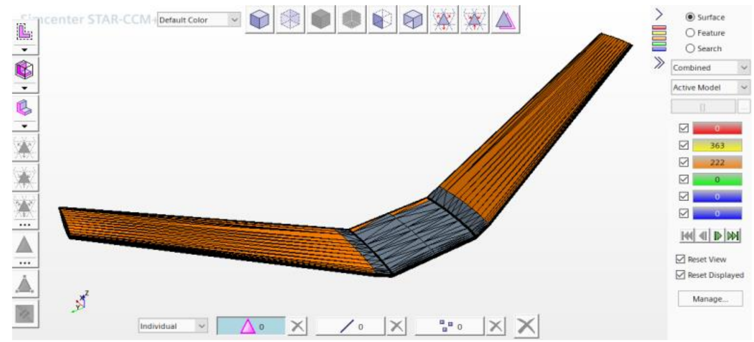
AERODYNAMIC Studies

Vtail CFD Longitudinal

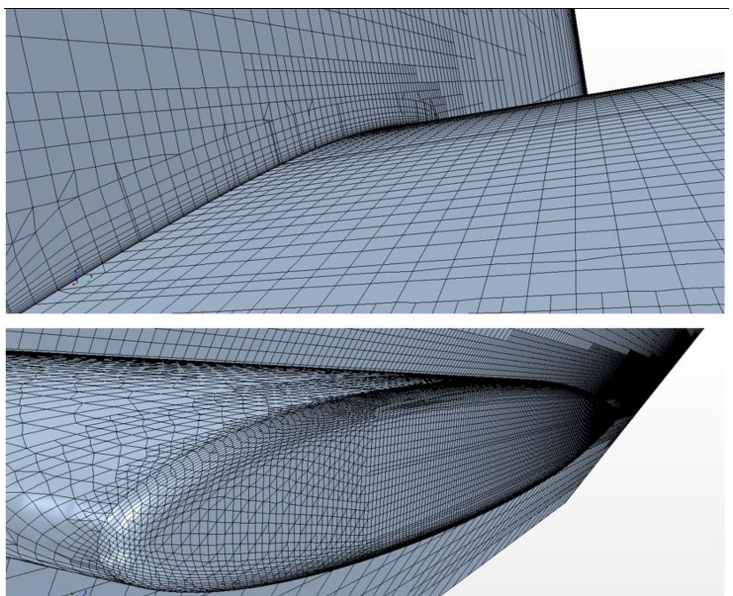
CFD Studies



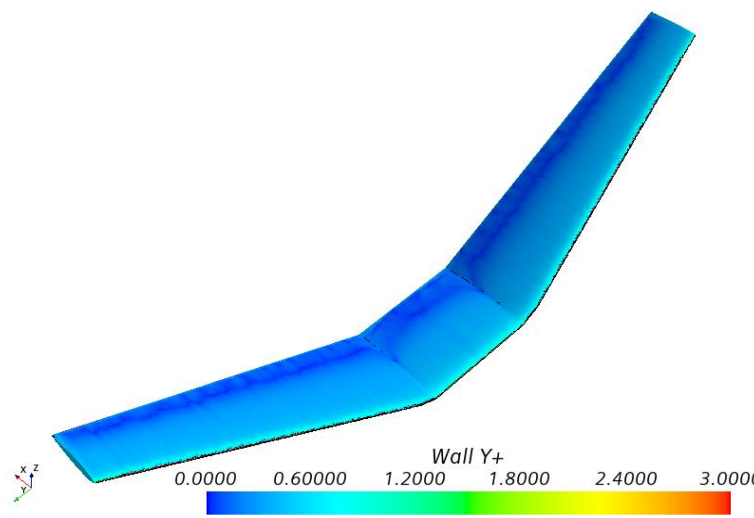
CAD



Star CCM+



Mesh

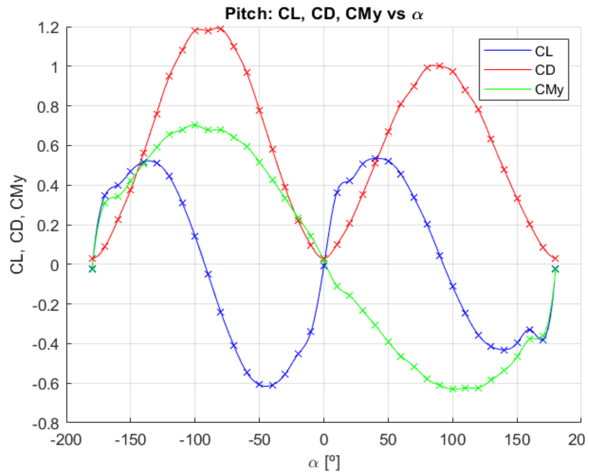


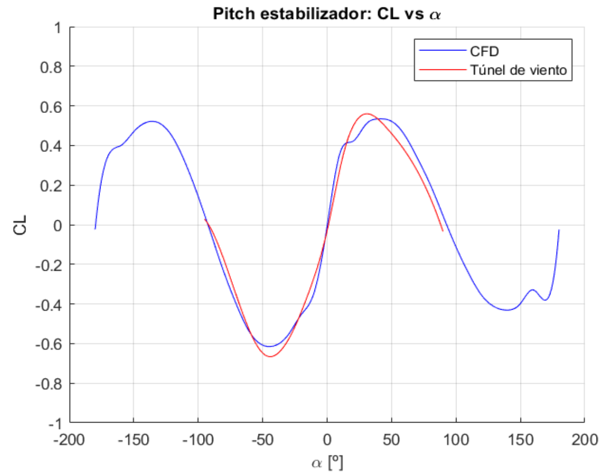
Y+

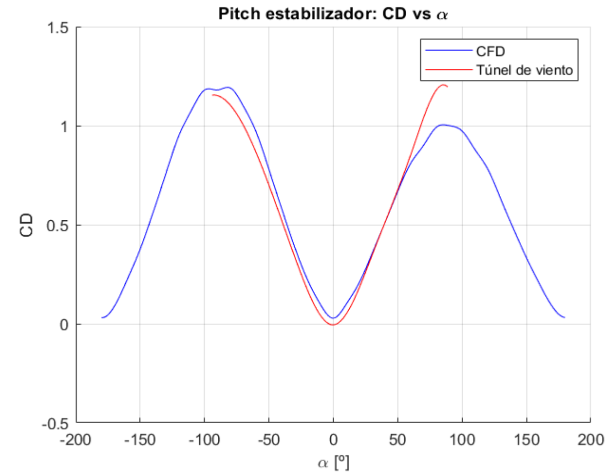
AERODYNAMIC Studies

CFD Studies

Vtail CFD Longitudinal

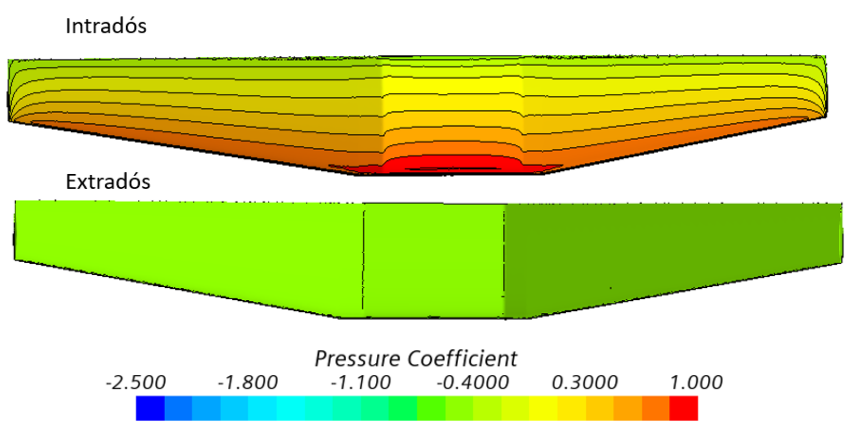


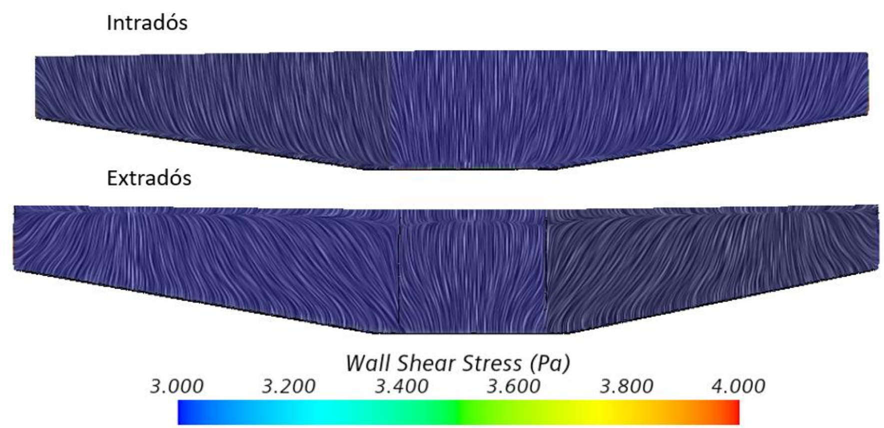




Vtail CFD Studies

Comparisson CFD Studies & wind tunnel results



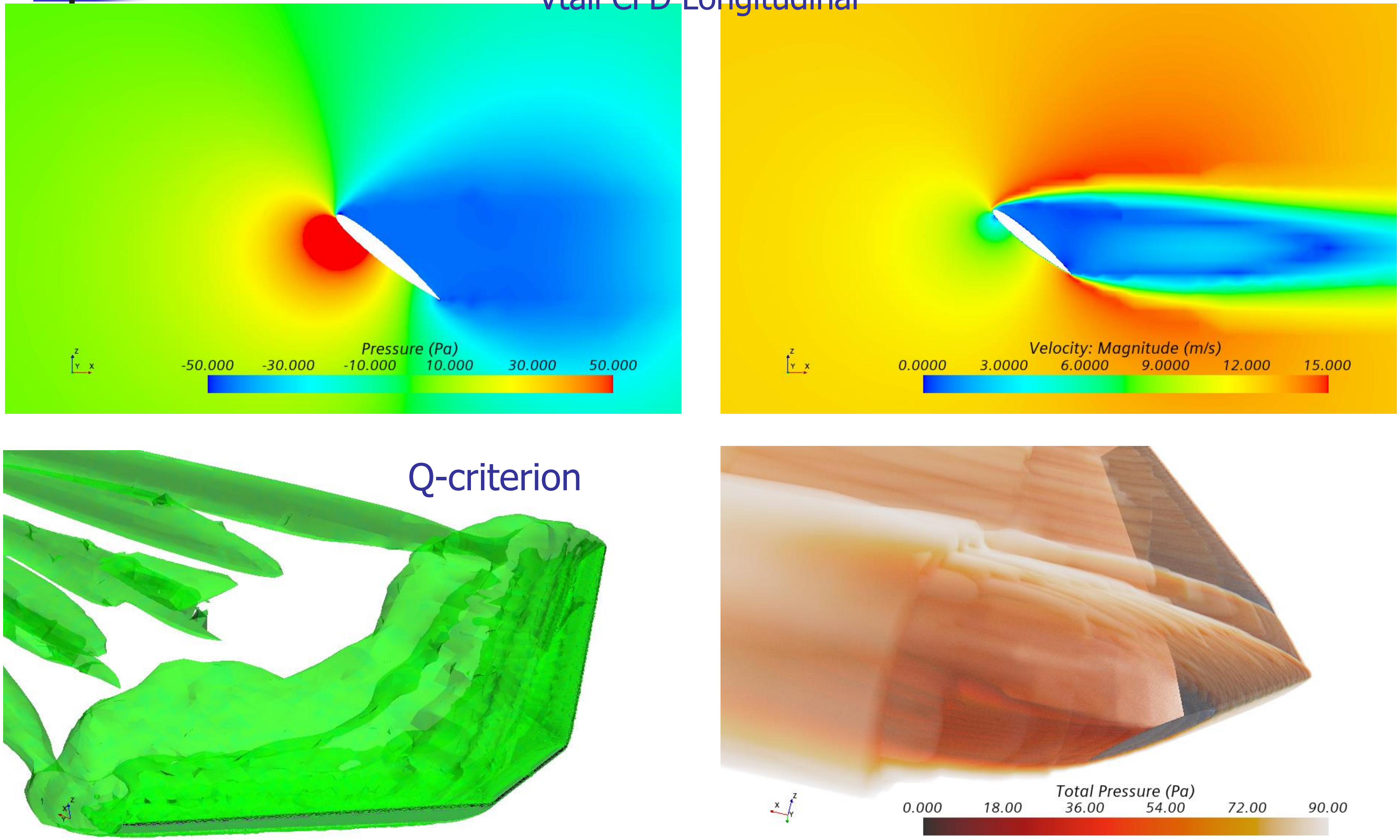


Vtail CFD results samples @ 40 deg of angle of attack

AERODYNAMIC Studies

CFD Studies

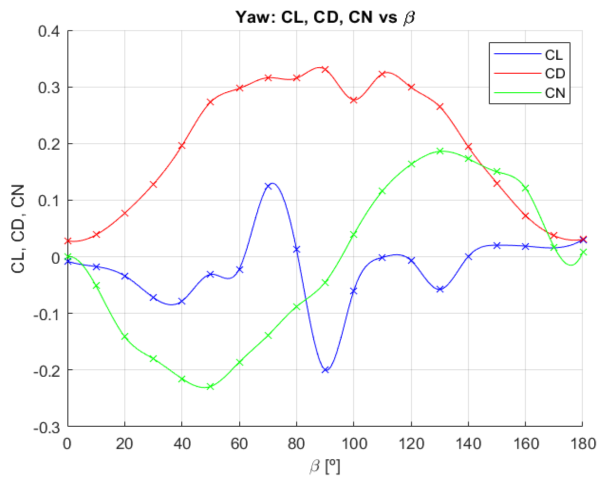
Vtail CFD Longitudinal

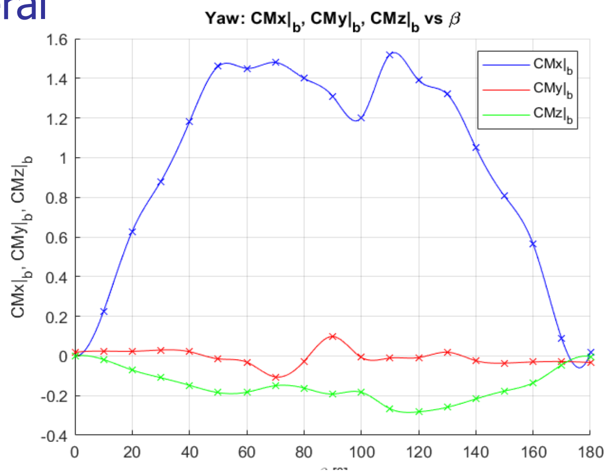


Vtail CFD results samples @ 40 deg of angle of attack

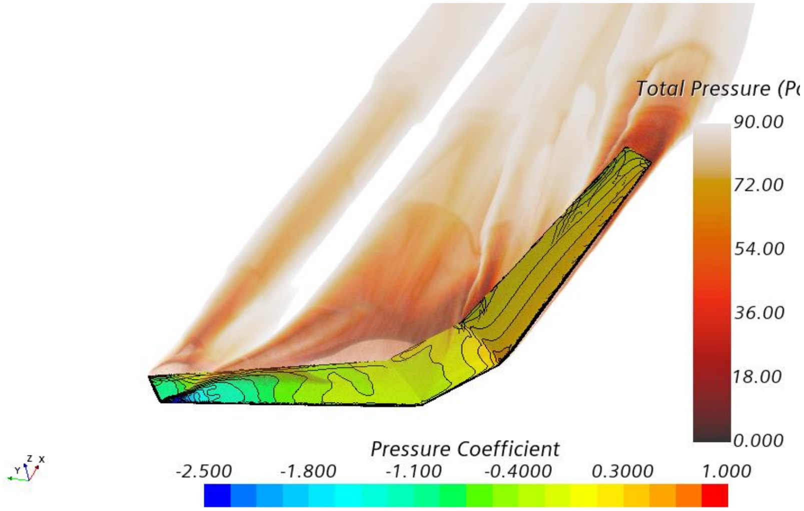
AERODYNAMIC Studies

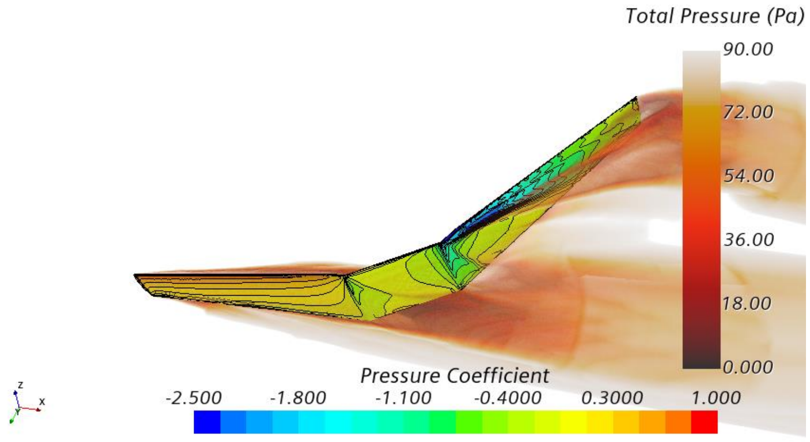
Vtail CFD Lateral





Vtail CFD Studies

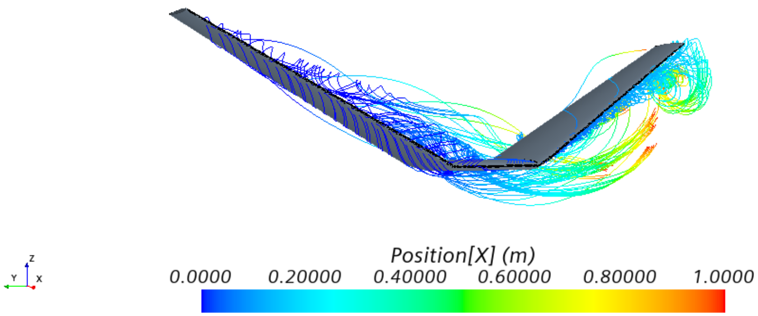


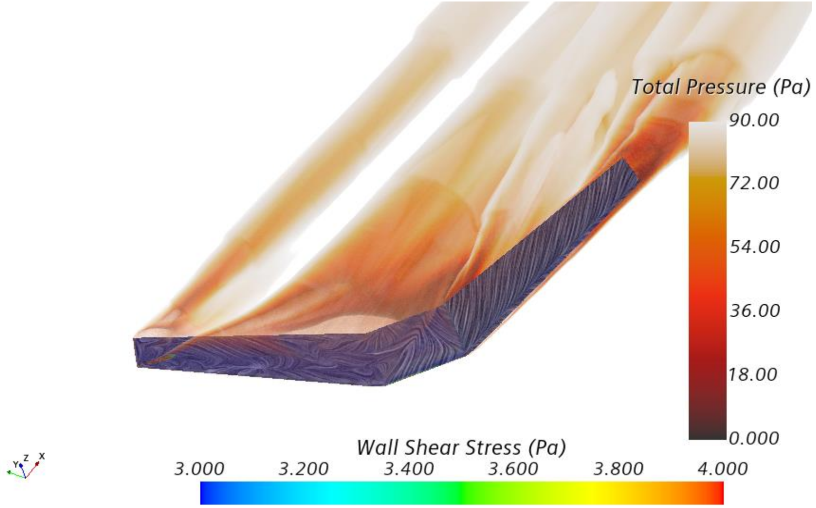


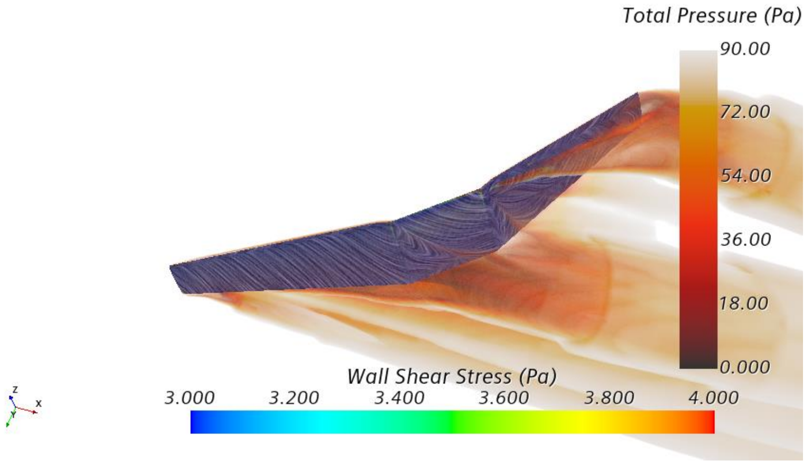
Vtail CFD results samples @ 50 deg of sideslip angle

AERODYNAMIC Studies

CFD Studies

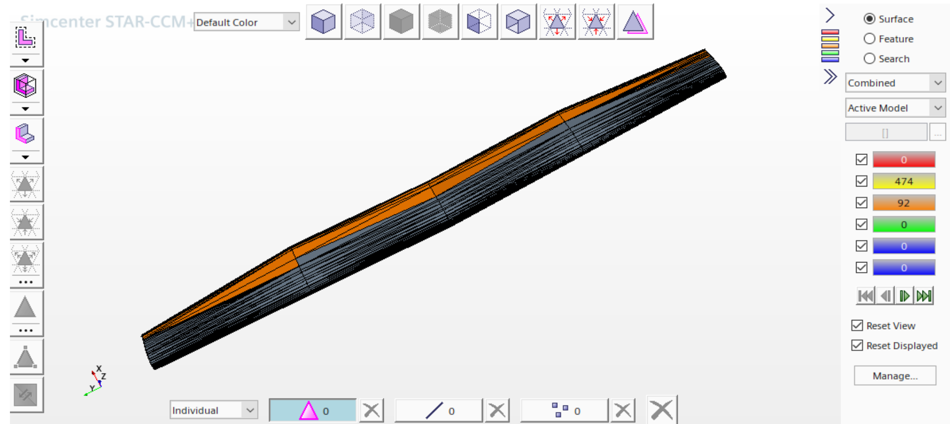




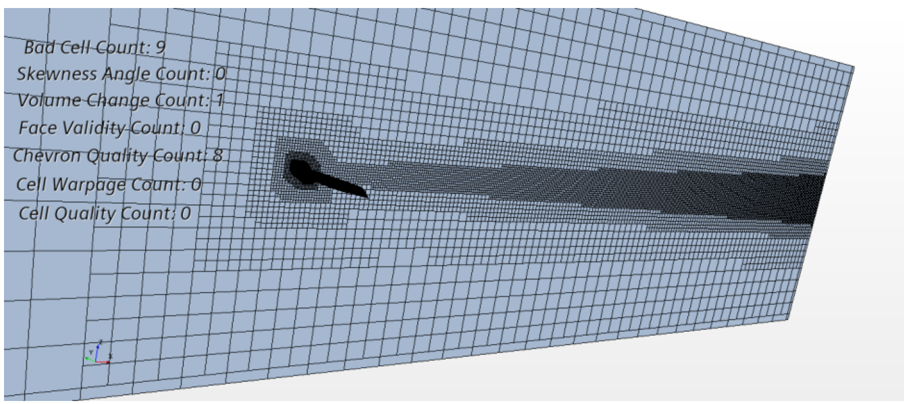


Vtail CFD results samples @ 50 deg of sideslip angle

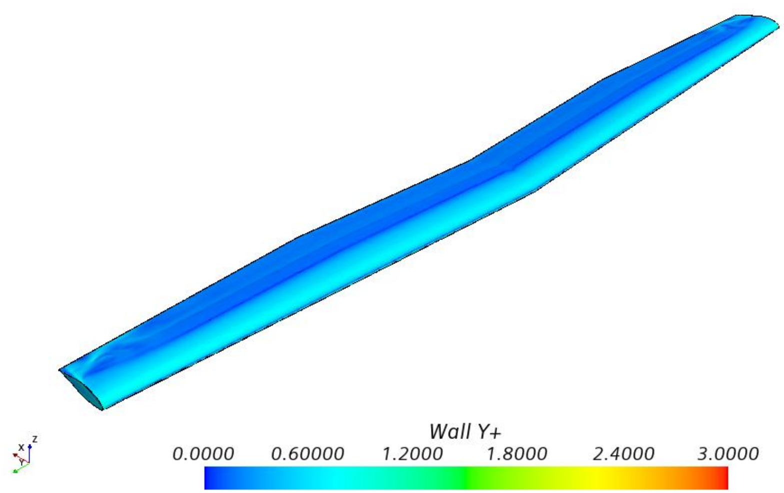
Wing CFD Longitudinal



Star CCM+



Mesh

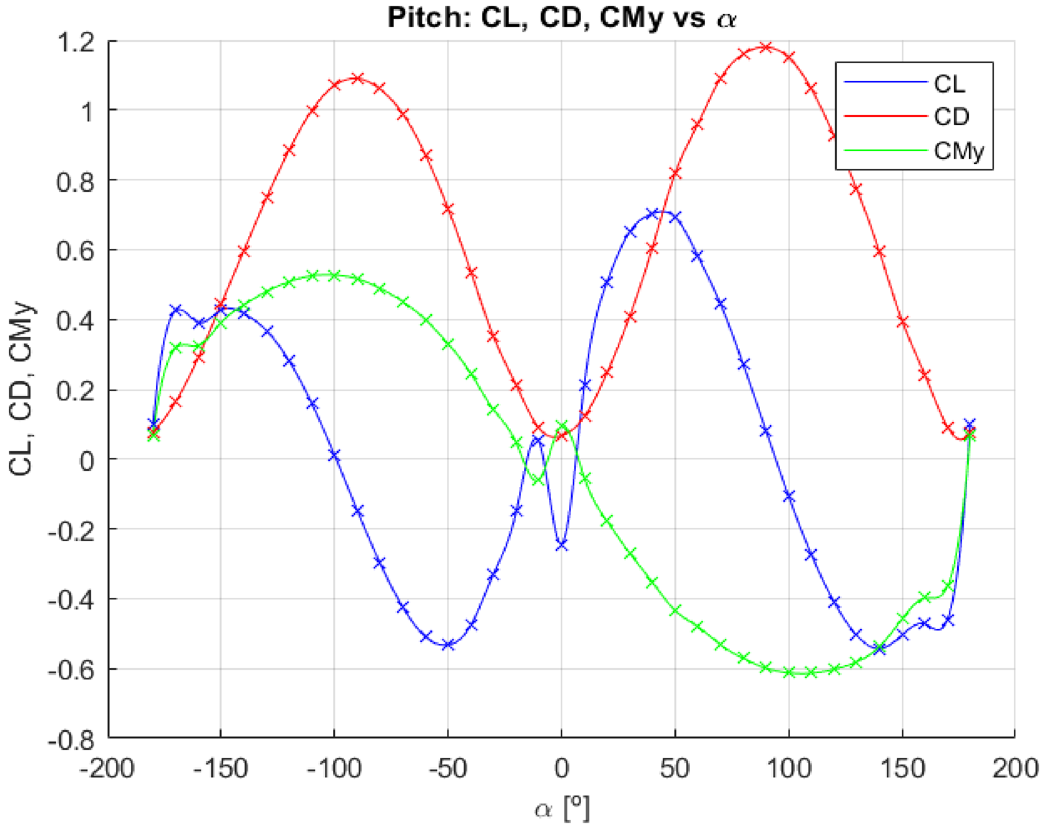


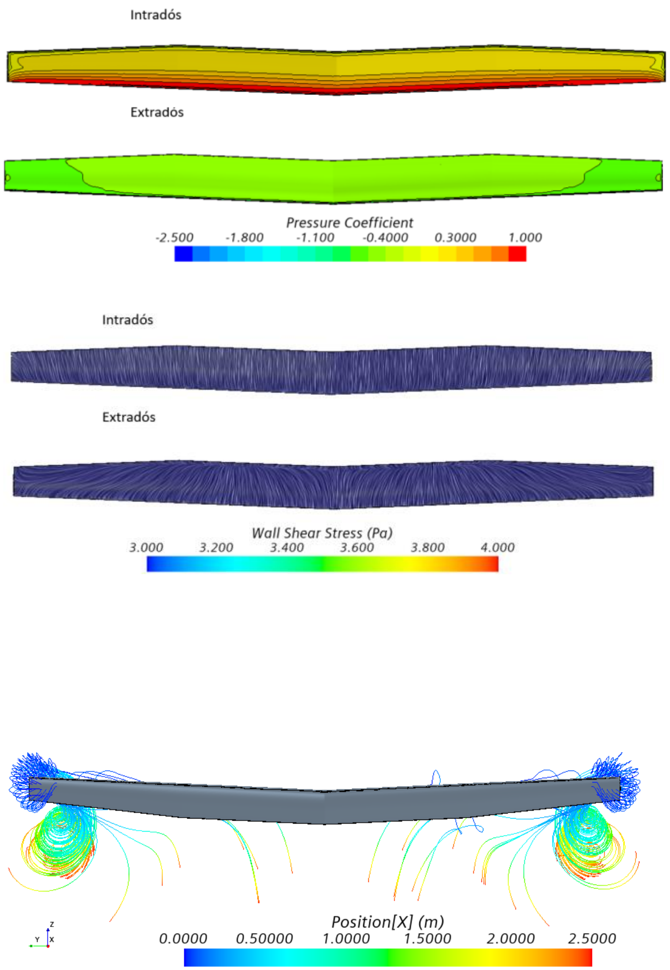
Y+

AERODYNAMIC Studies

CFD Studies

Wing CFD Longitudinal

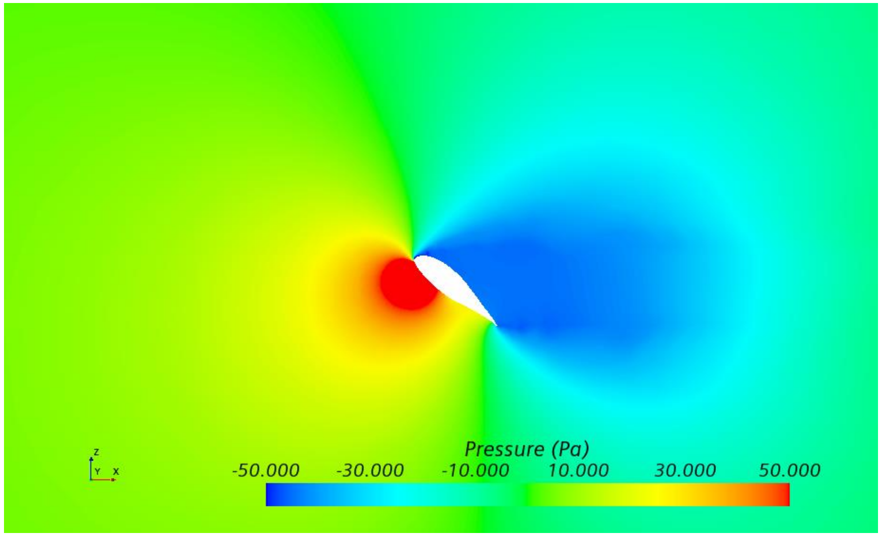


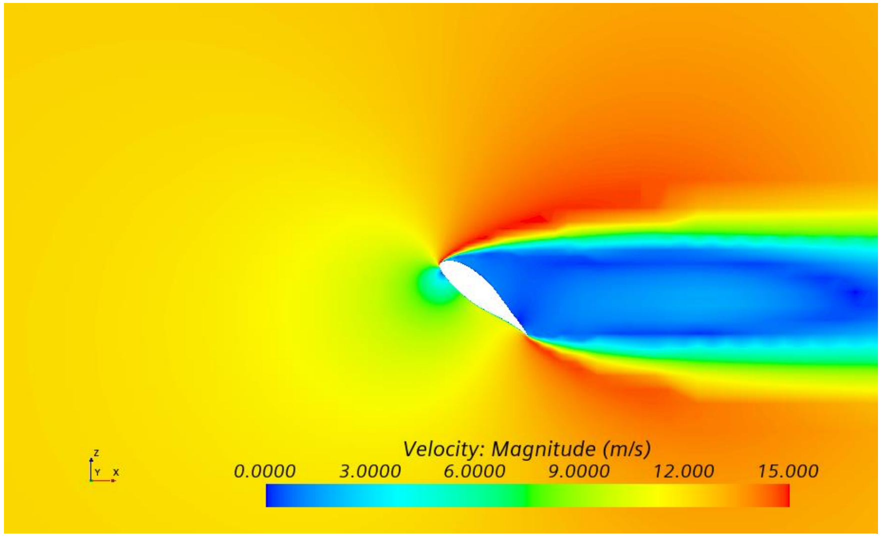


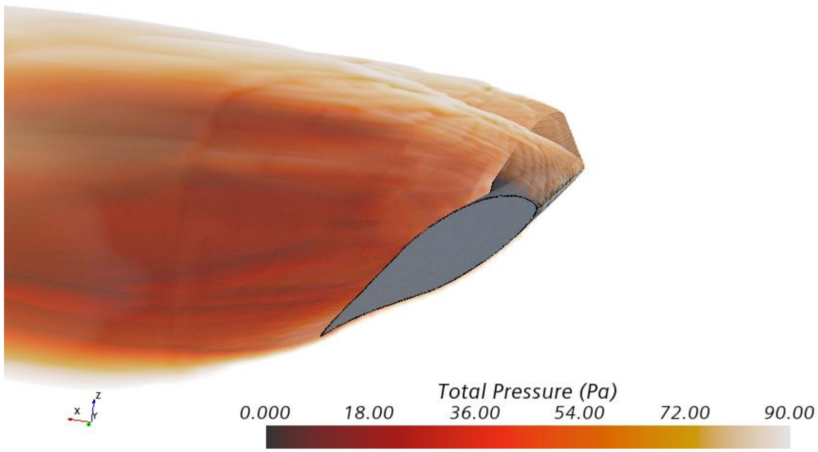
Wing CFD results samples @ 40 deg of angle of attack

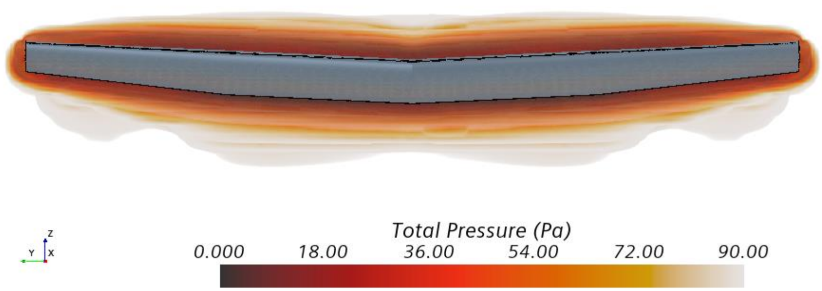
AERODYNAMIC Studies

Wing CFD Longitudinal



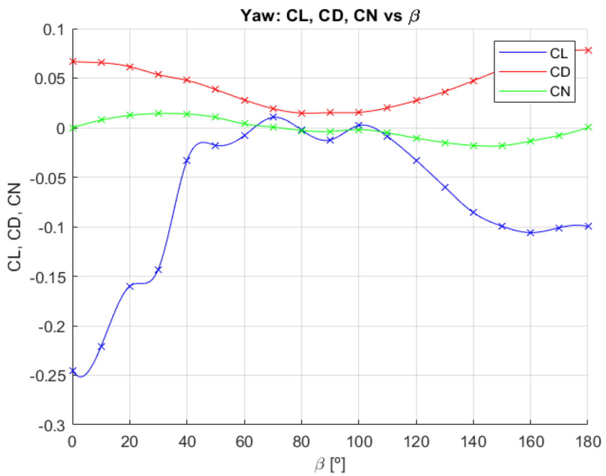


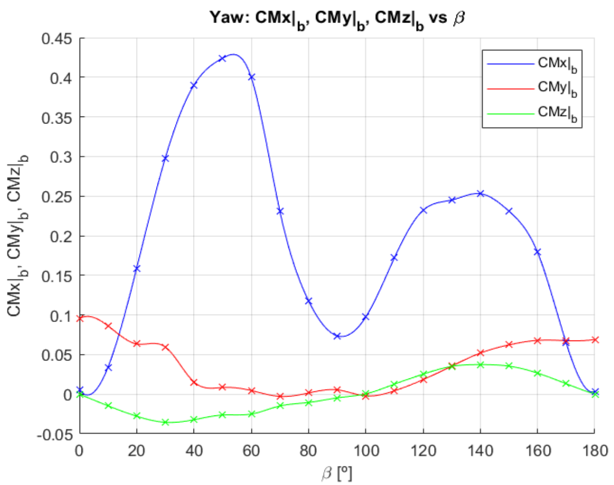


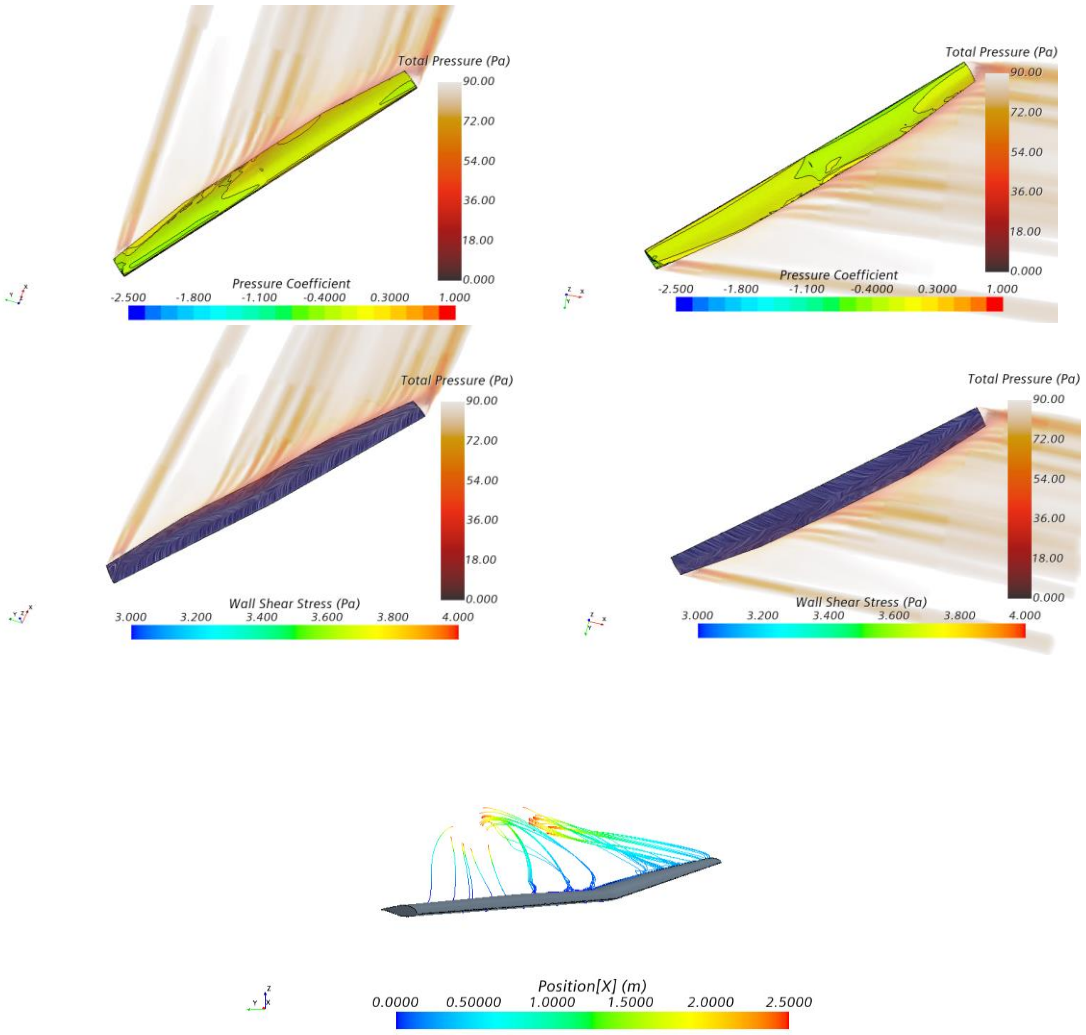


Wing CFD results samples @ 40 deg of angle of attack

Wing CFD Lateral





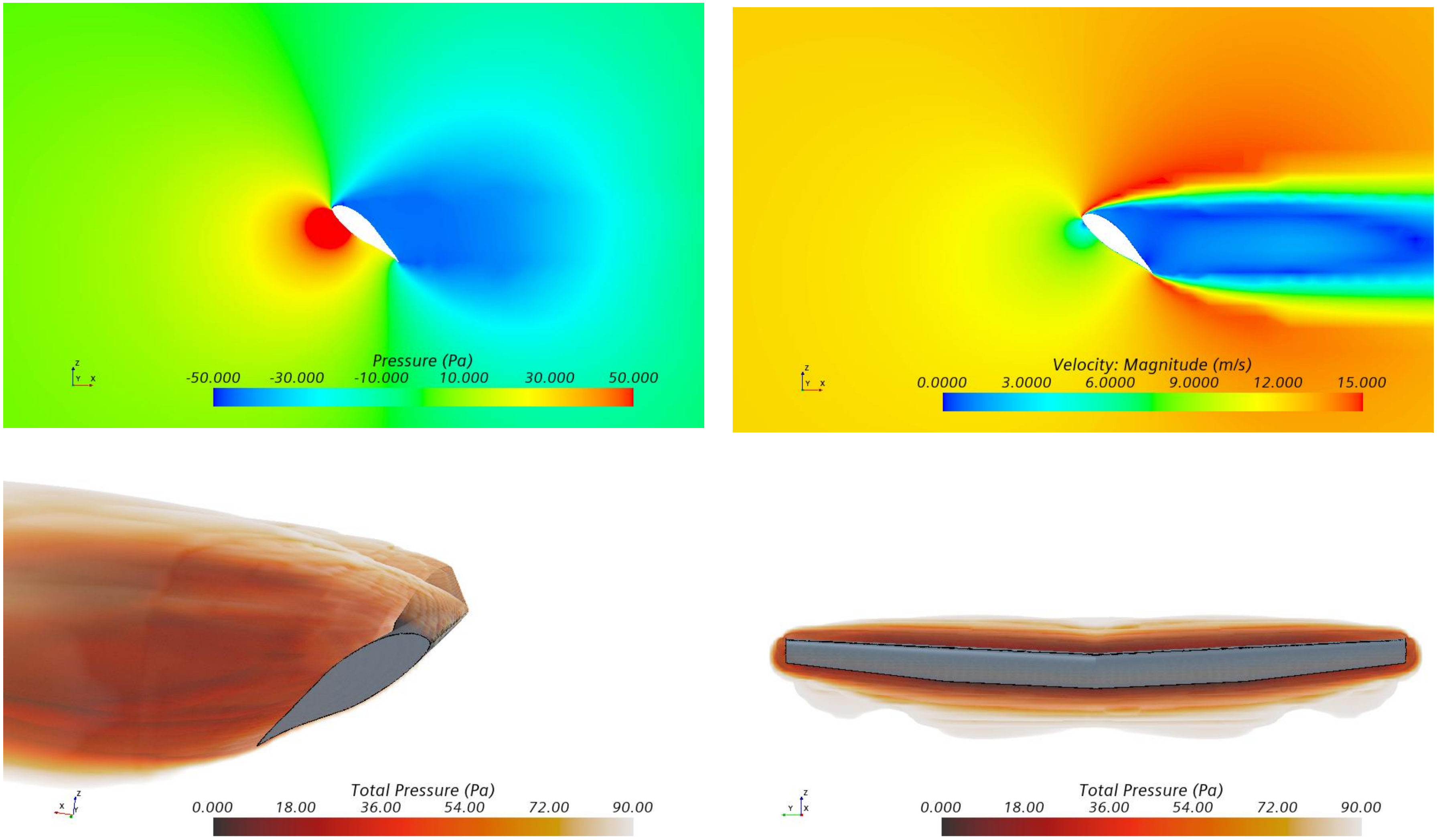


Wing CFD results samples @ 50 deg of sideslip angle

AERODYNAMIC Studies

CFD Studies

Wing CFD Longitudinal

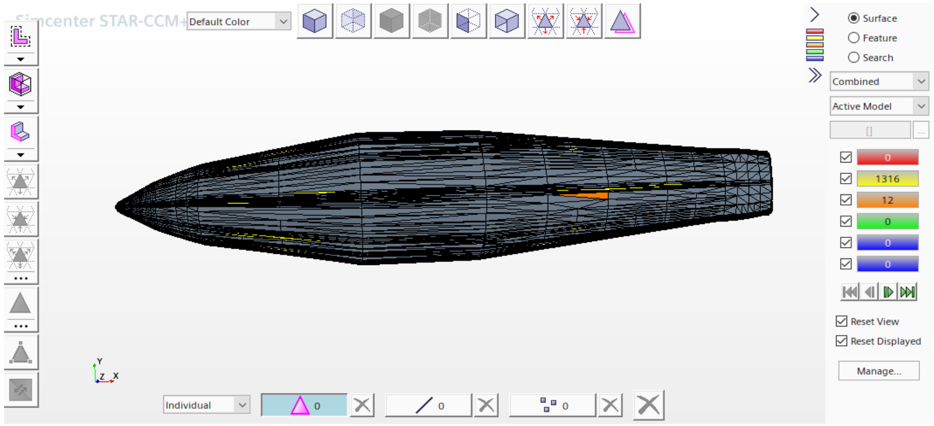


Wing CFD results samples @ 40 deg of angle of attack

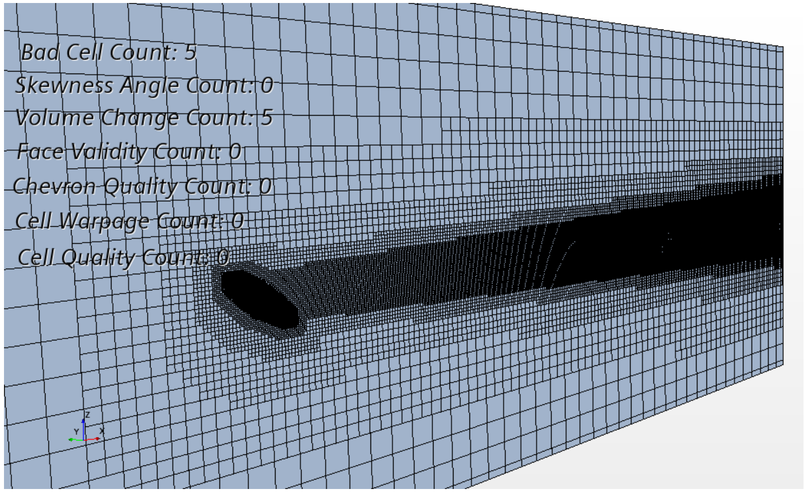
AERODYNAMIC Studies

CFD Studies

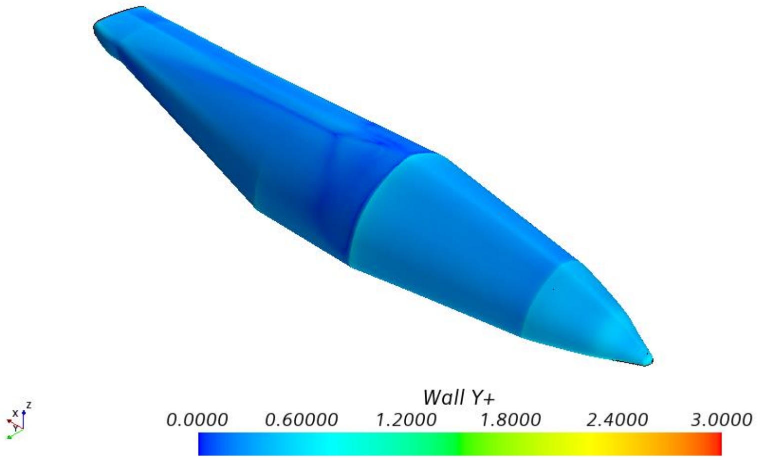
Fuselage CFD



Star CCM+



Mesh

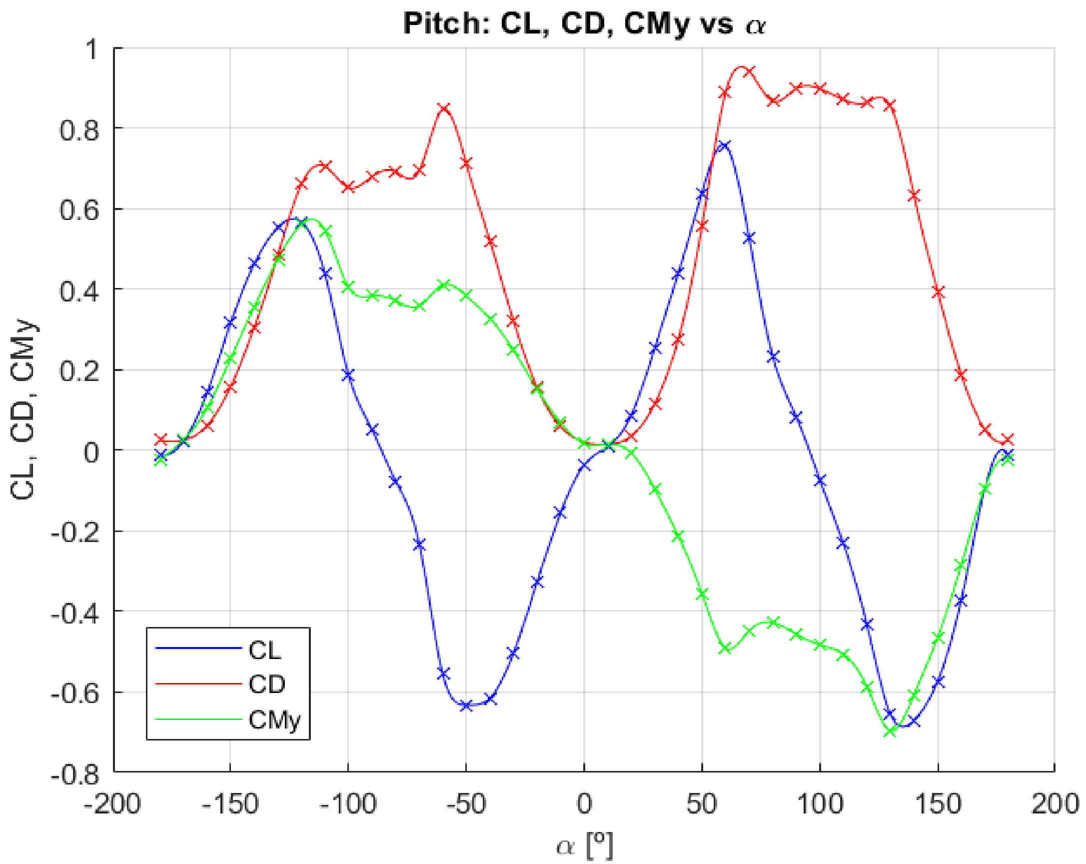


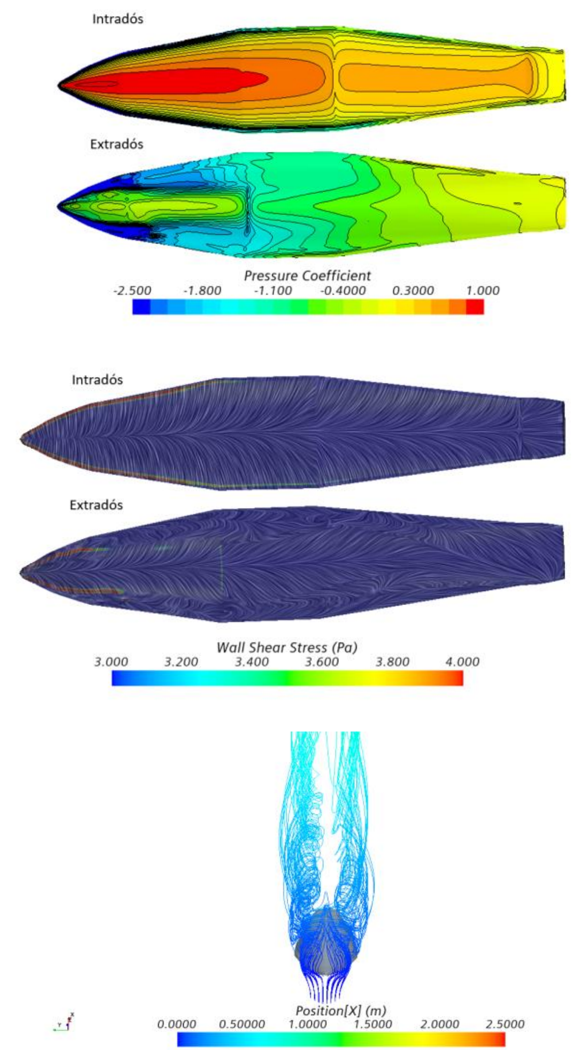
Y+

AERODYNAMIC Studies

CFD Studies

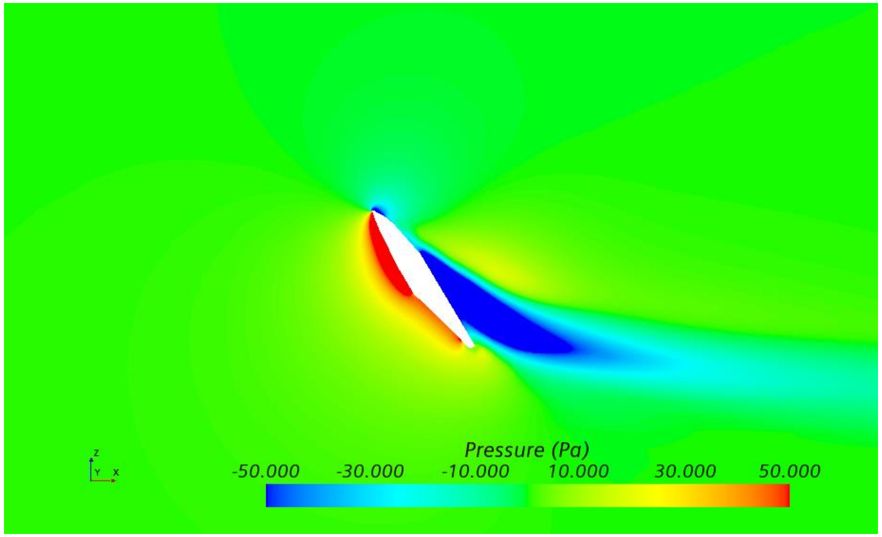
Fuselage CFD Longitudinal

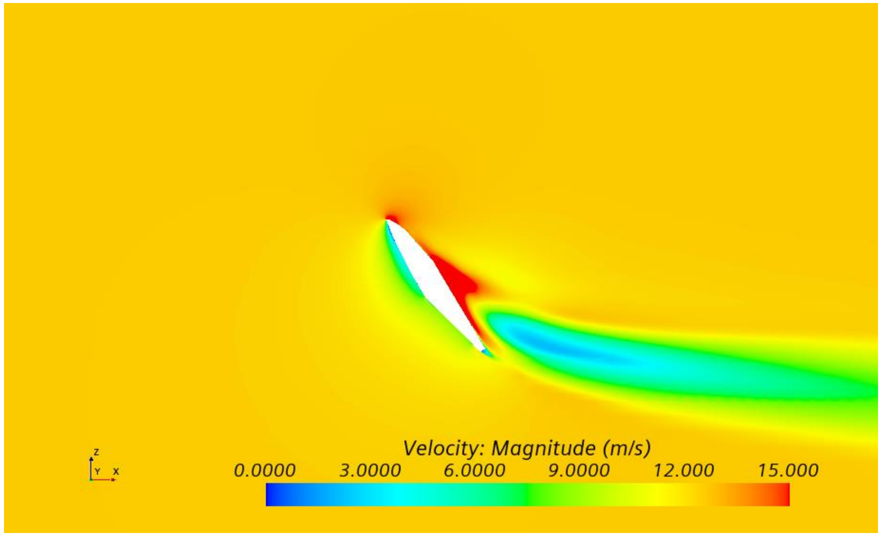


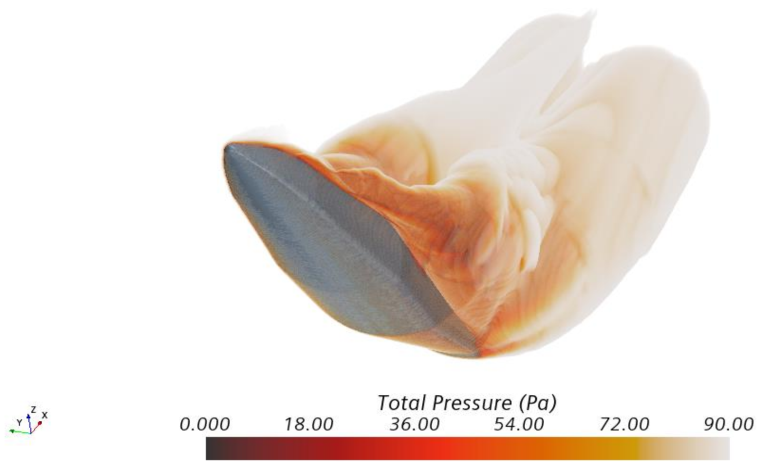


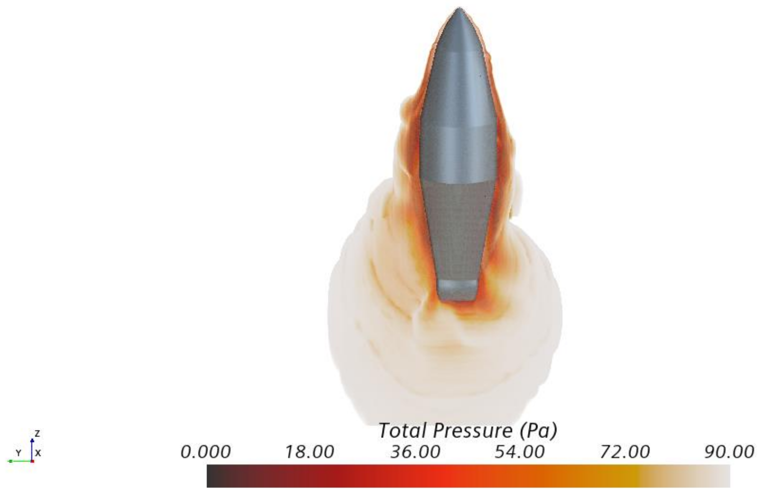
Fuselage CFD results samples @ 60 deg of angle of attack

Fuselage CFD Longitudinal



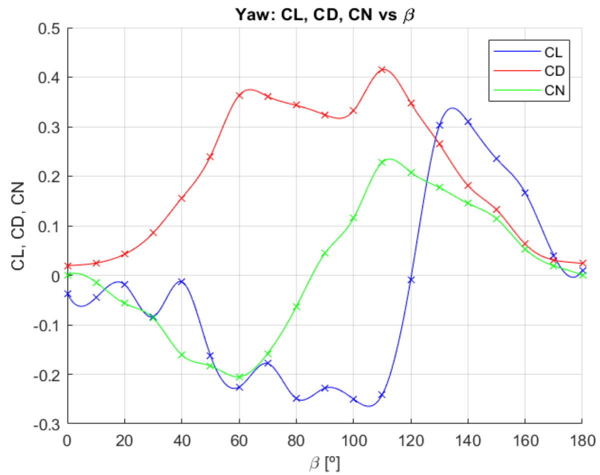


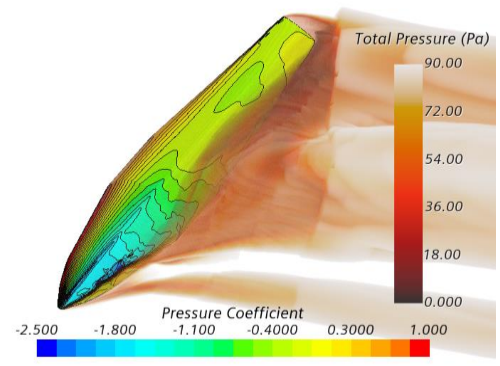


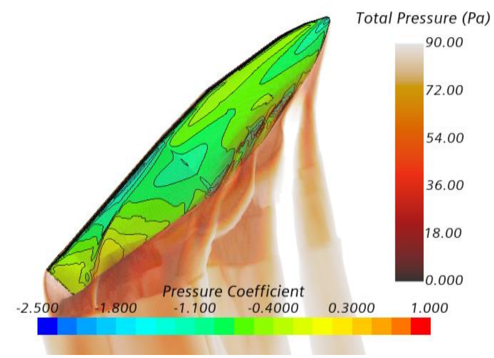


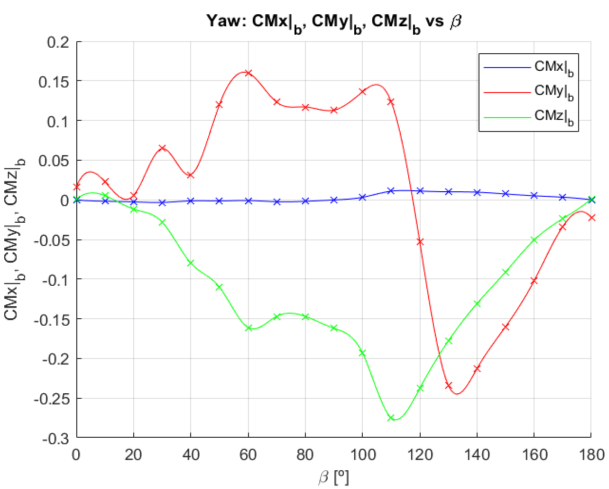
Fuselage CFD results samples @ 60 deg of angle of attack

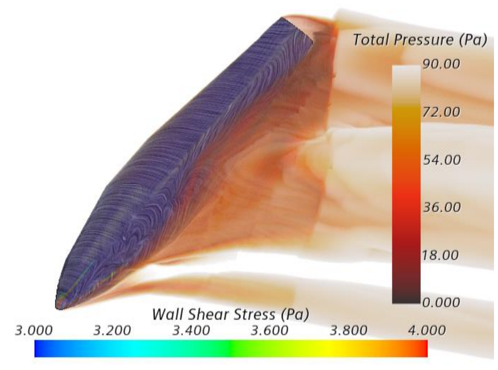
Fuselage CFD Lateral

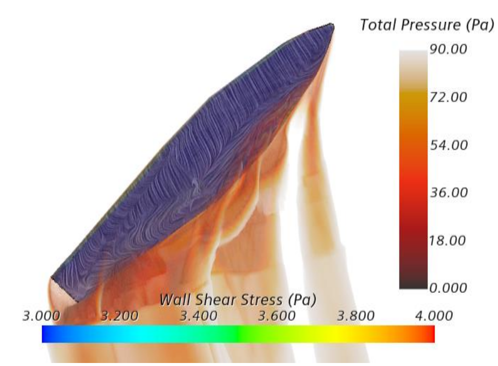










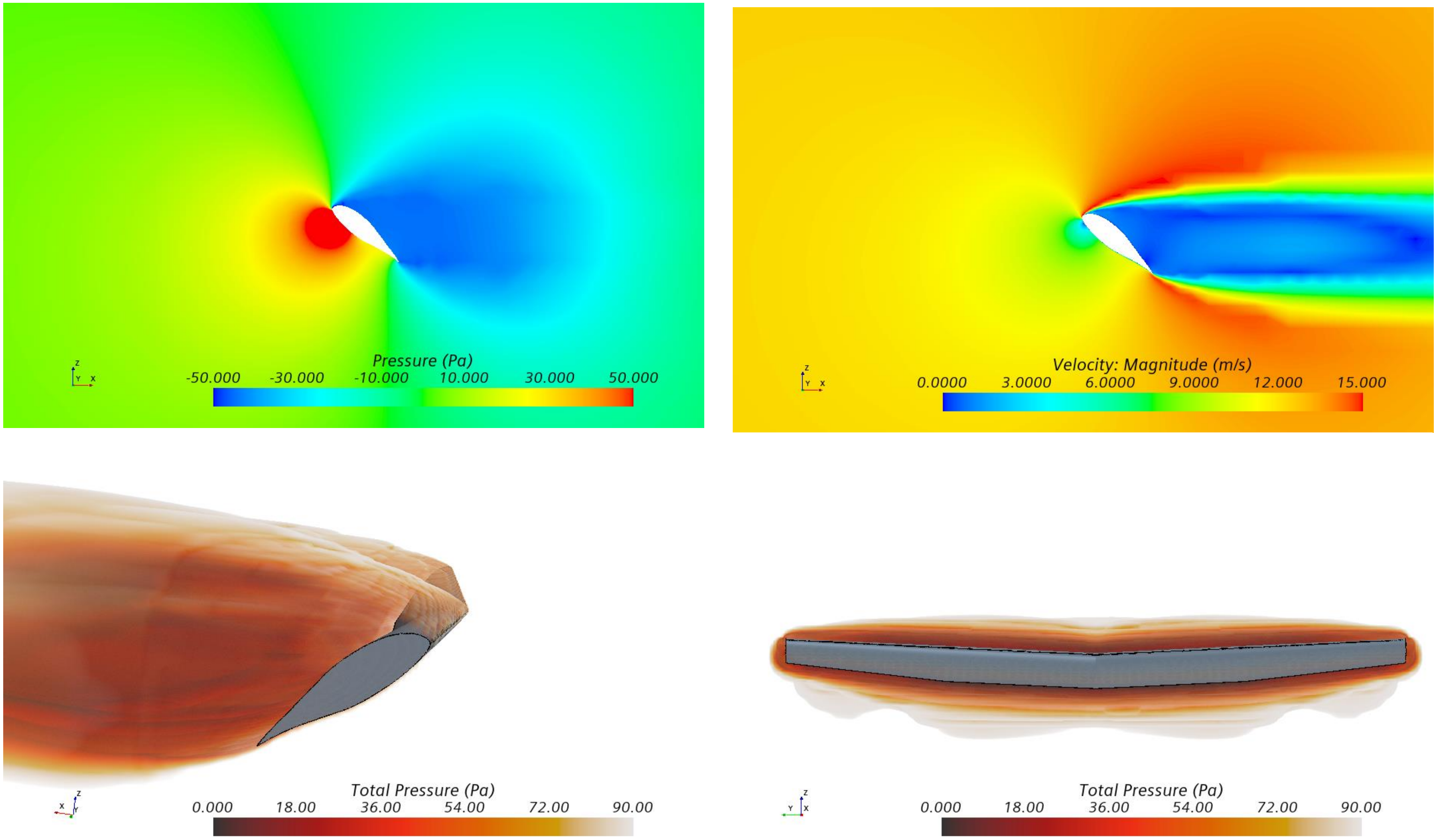


Fuselage CFD results samples @ 60 deg of sideslip angle

AERODYNAMIC Studies

CFD Studies

Wing CFD Longitudinal

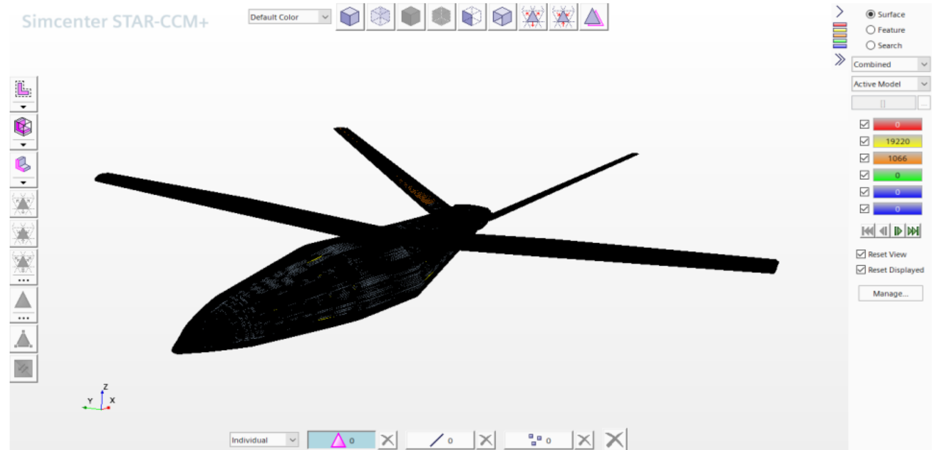


Wing CFD results samples @ 40 deg of angle of attack

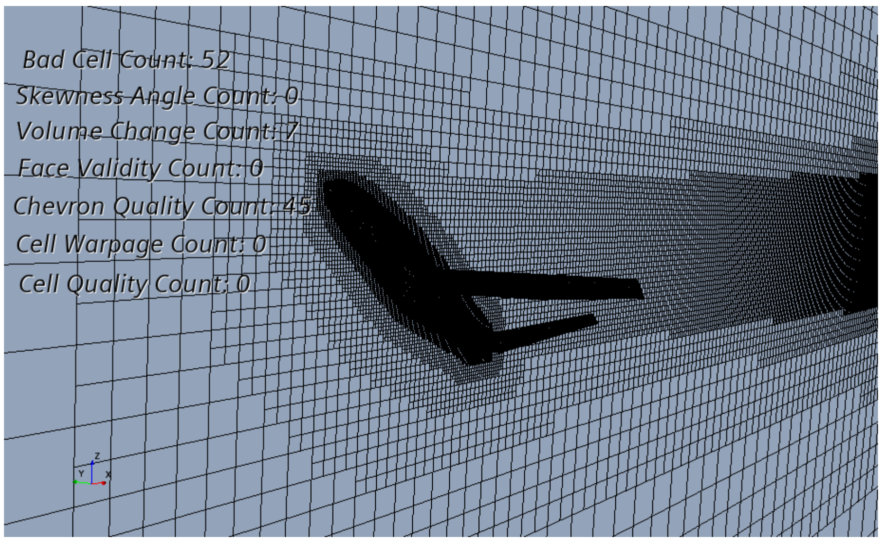
AERODYNAMIC Studies

Complete Aircraft CFD

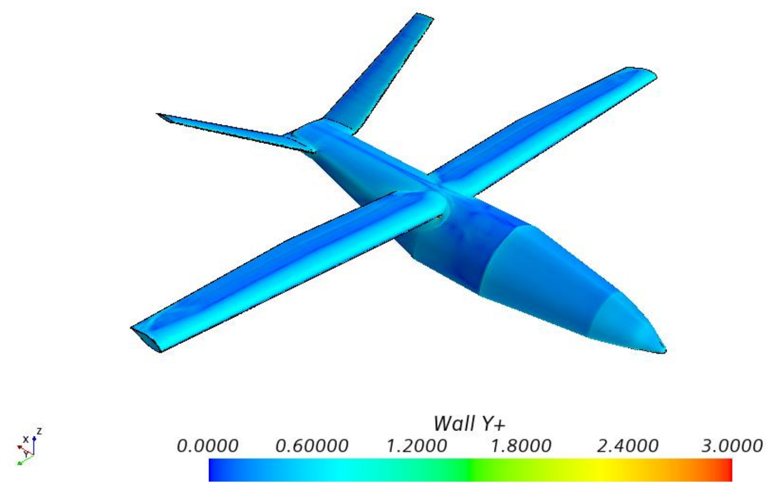
CFD Studies



Star CCM+



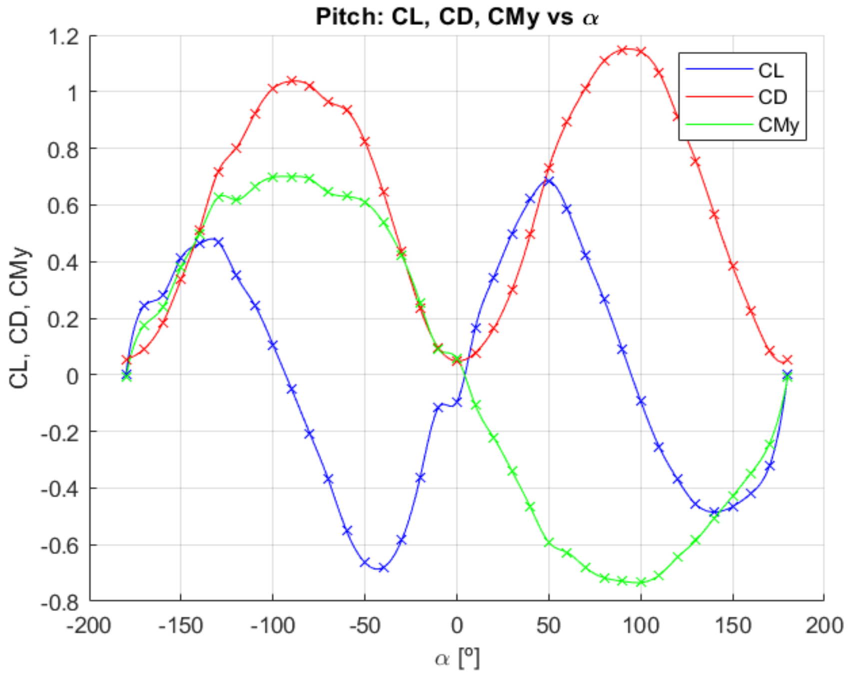
Mesh

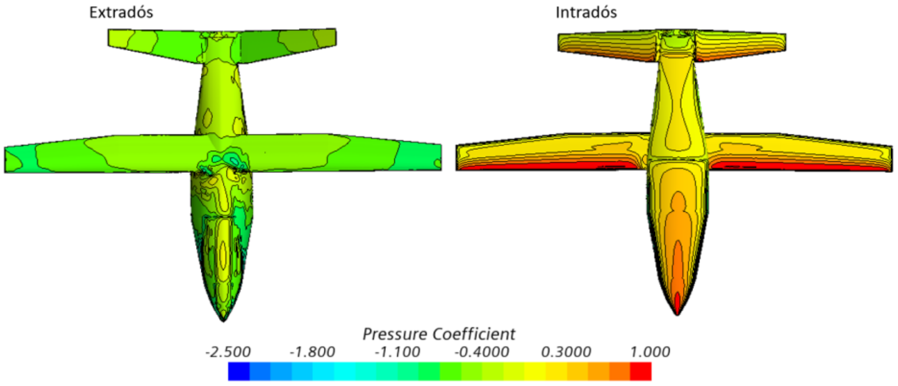


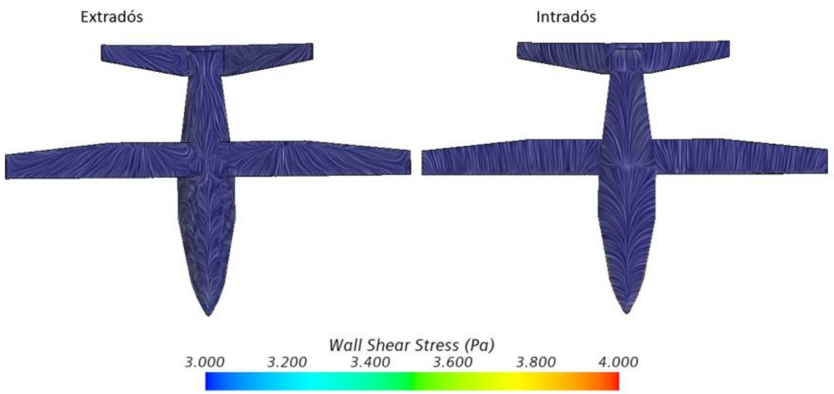
Y+

AERODYNAMIC Studies

Complete Aircraft CFD Longitudinal





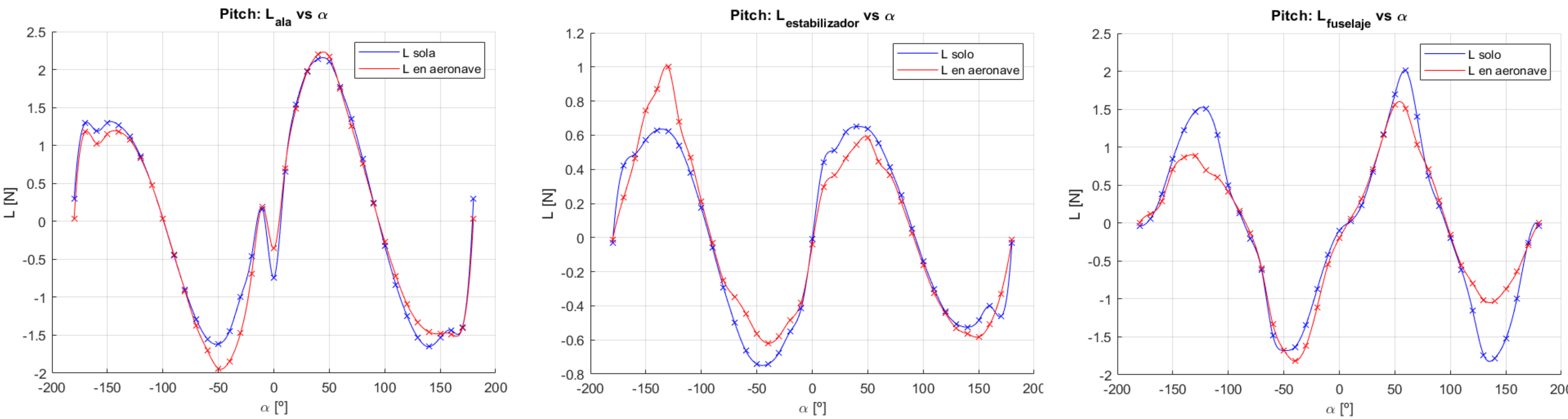


Complete Aircraft CFD results samples @ 40 deg of angle of attack

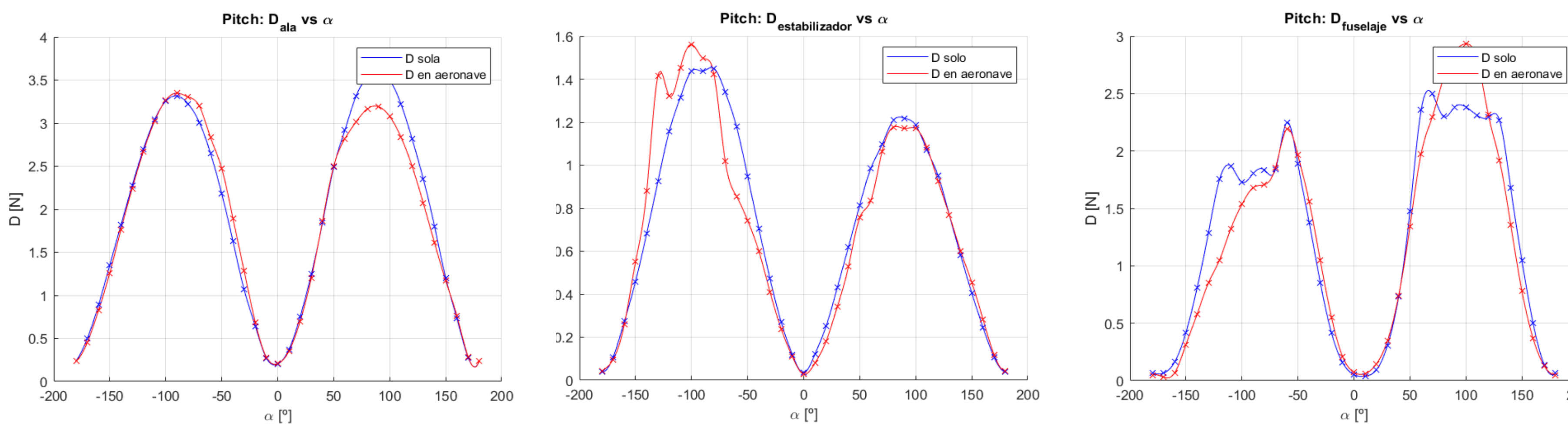
AERODYNAMIC Studies

CFD Studies

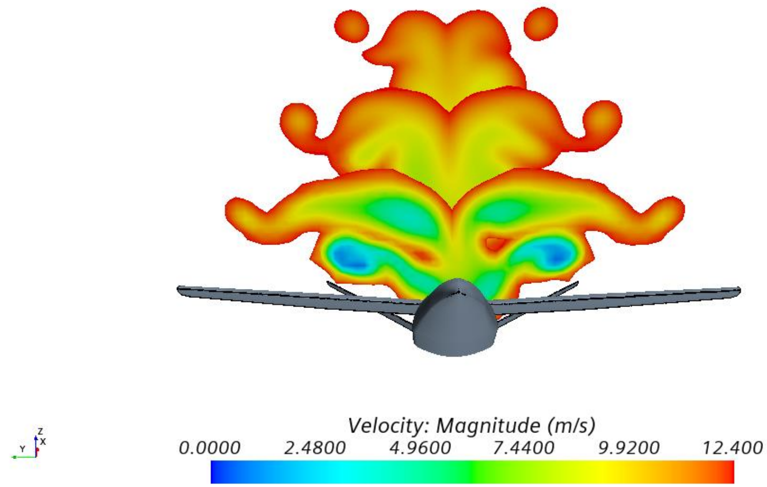
Complete Aircraft CFD Longitudinal

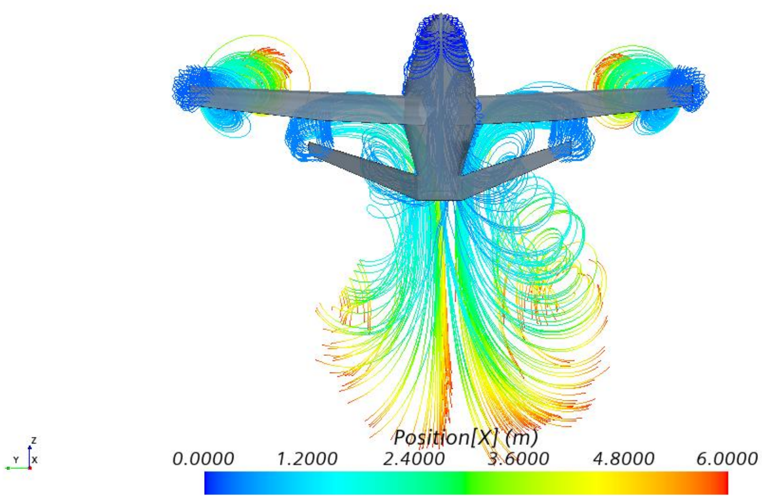


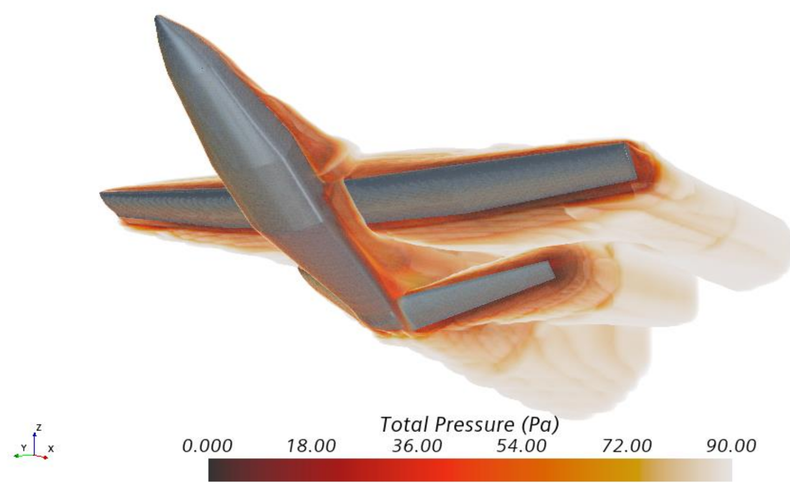
Contributions alone and with aircraft interference



Complete Aircraft CFD Longitudinal





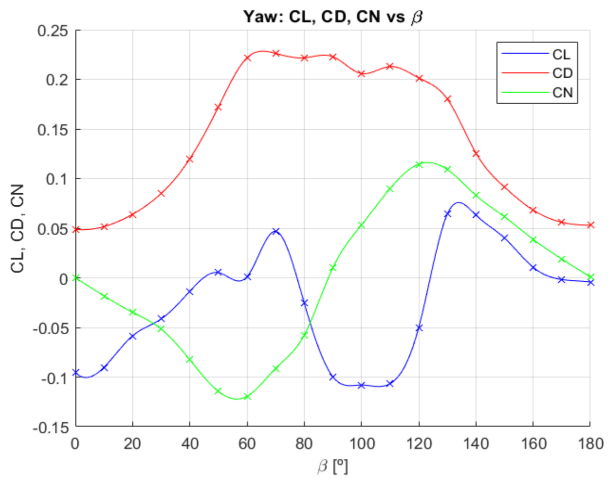


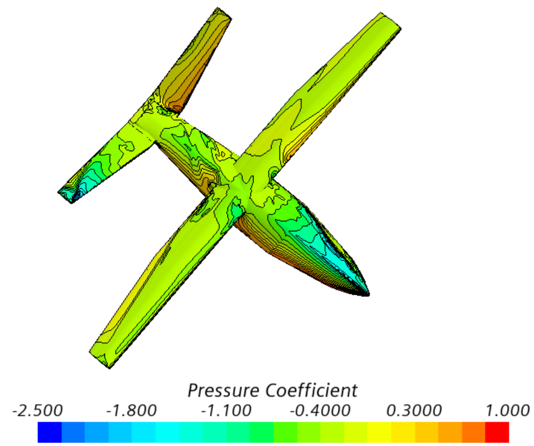
Complete Aircraft CFD results samples @ 40 deg of angle of attack

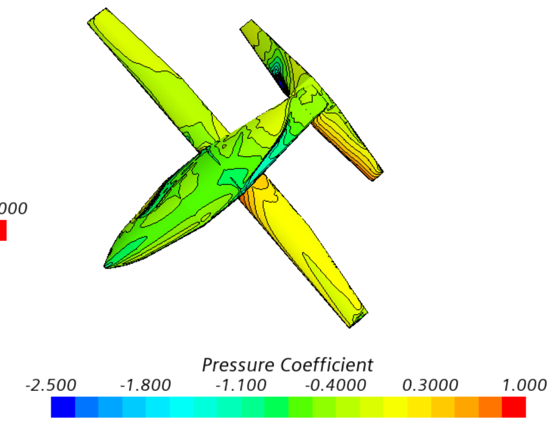
AERODYNAMIC Studies

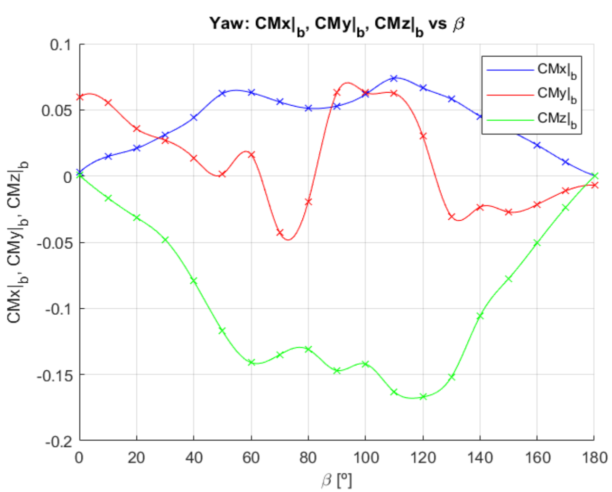
CFD Studies

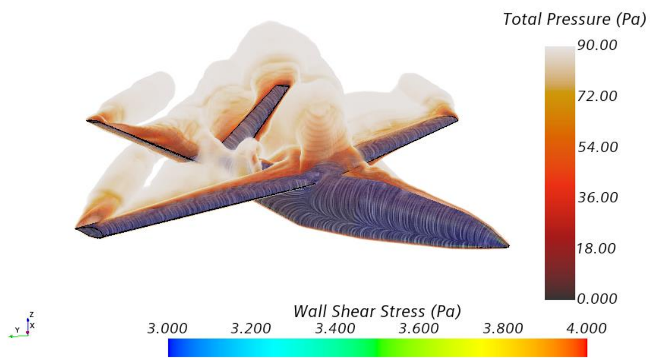
Complete Aircraft CFD Lateral









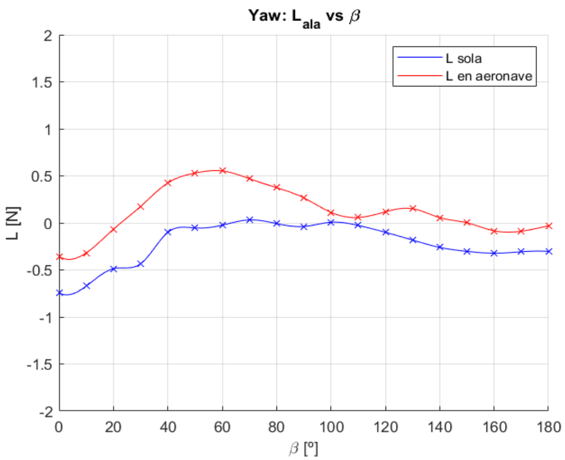


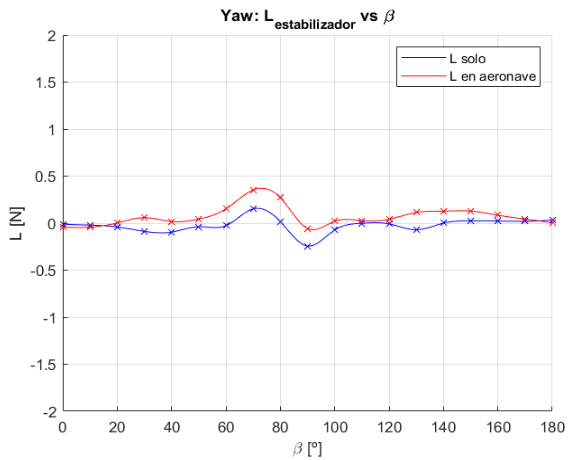
Complete Aircraft CFD results samples @ 50 deg of sideslip angle

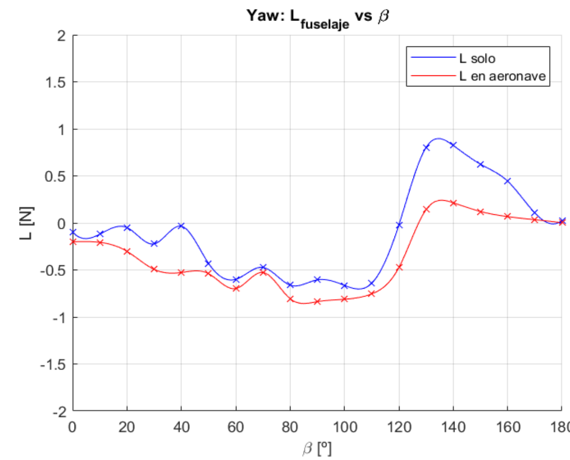
AERODYNAMIC Studies

CFD Studies

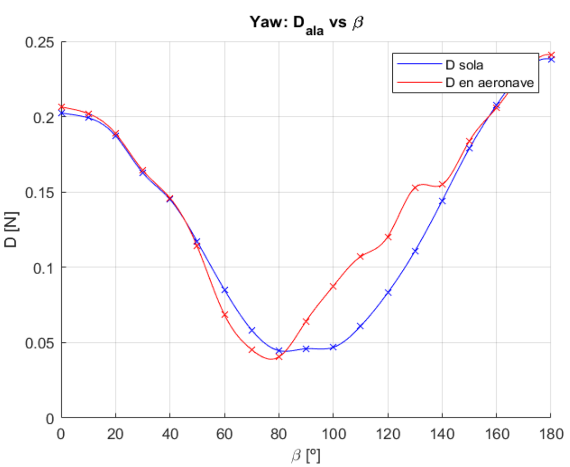
Complete Aircraft CFD Lateral

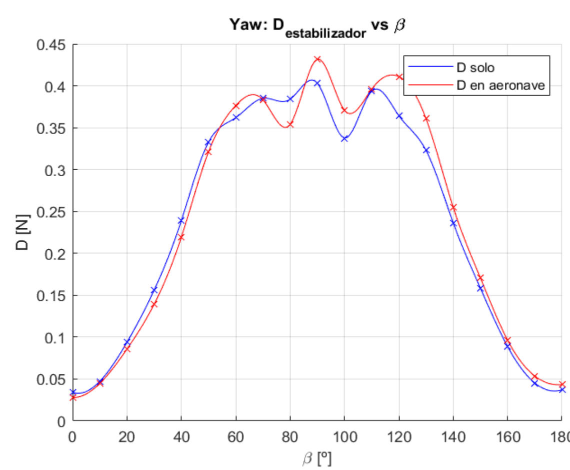


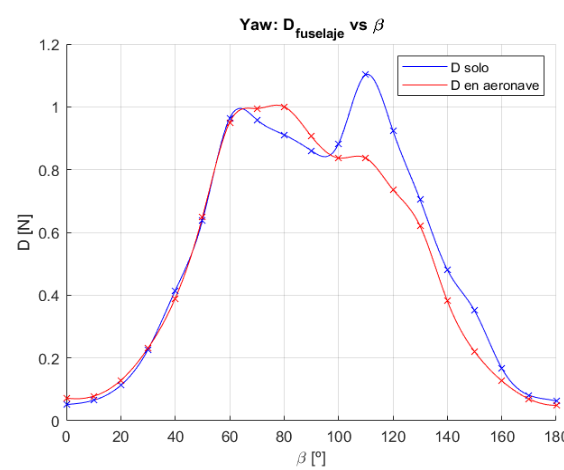




Contributions alone and with aircraft interference



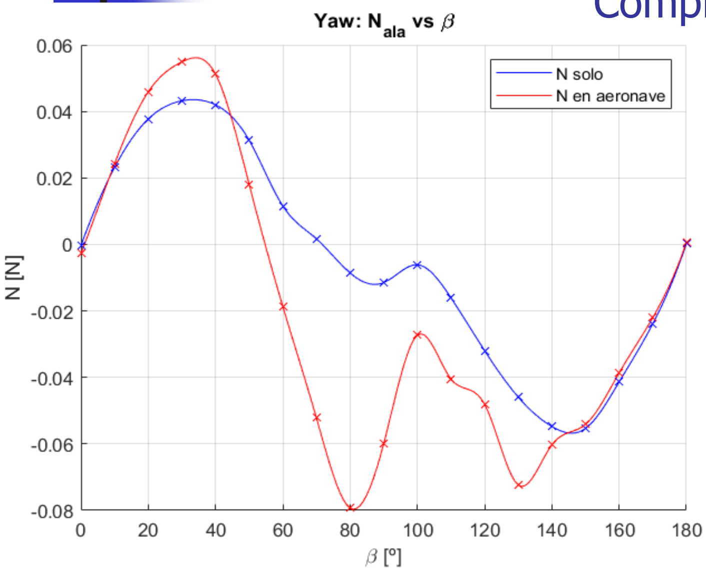


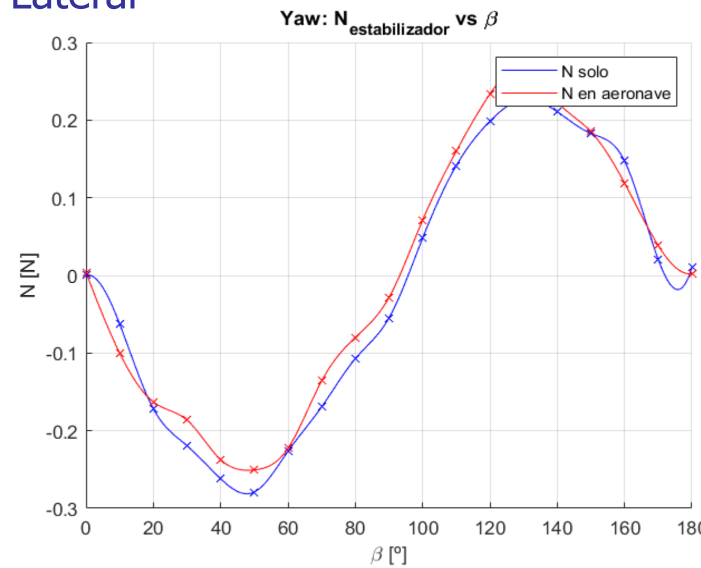


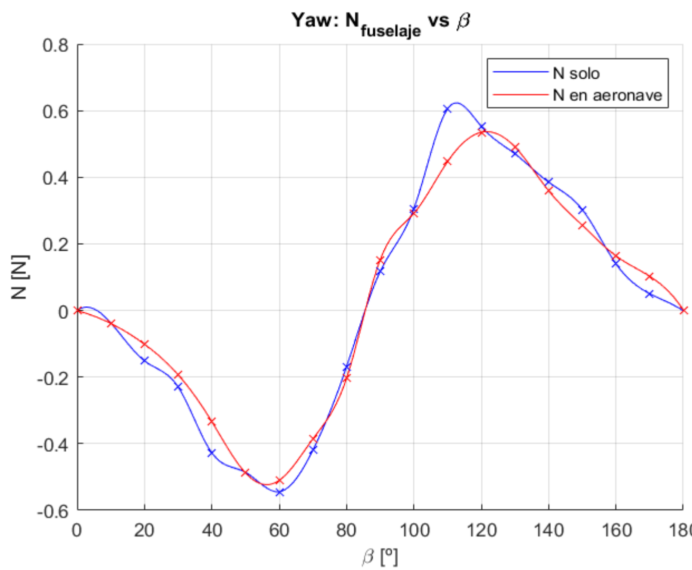
AERODYNAMIC Studies

CFD Studies

Complete Aircraft CFD Lateral





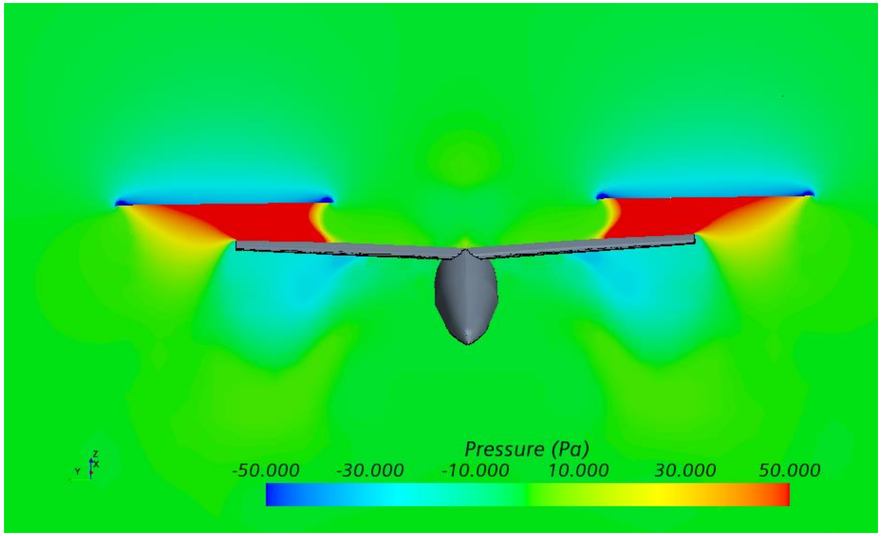


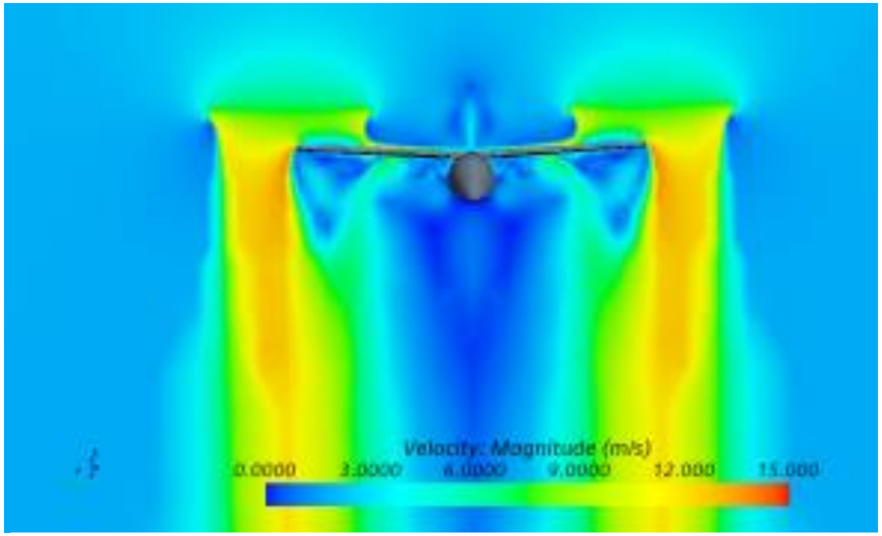
Contributions alone and with aircraft interference

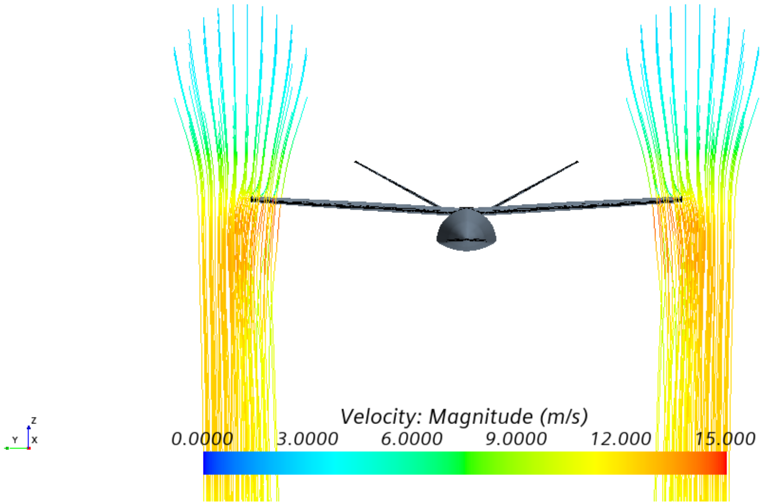
AERODYNAMIC Studies

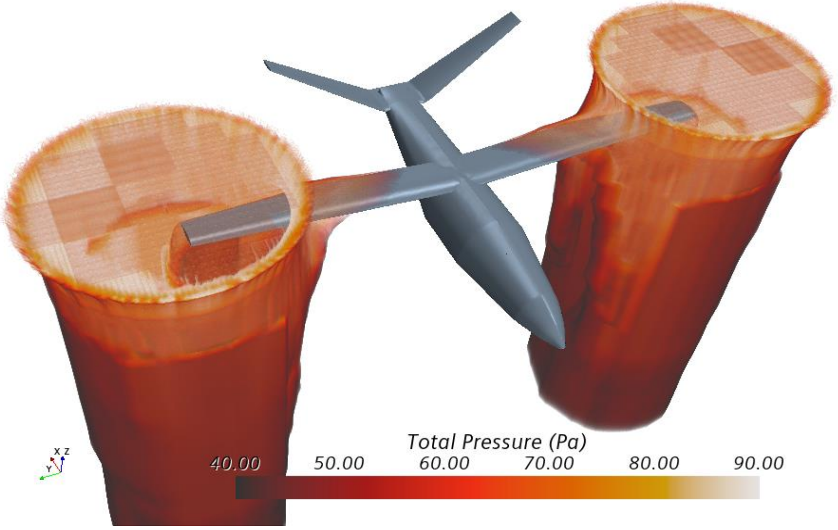
CFD Studies

Complete Aircraft CFD – Prop interaction – VTOL – Presure Flow rate curves





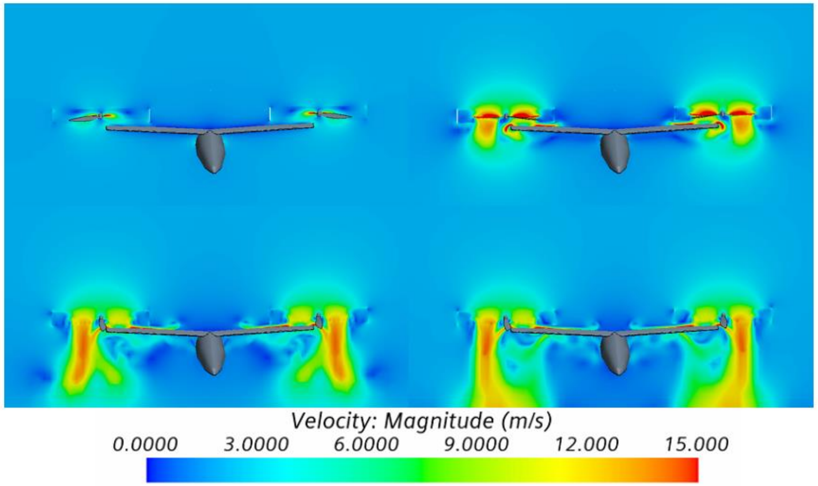


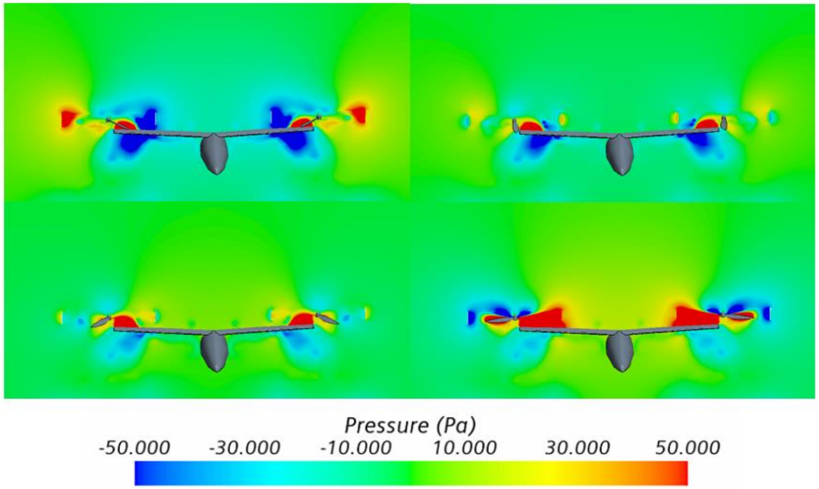


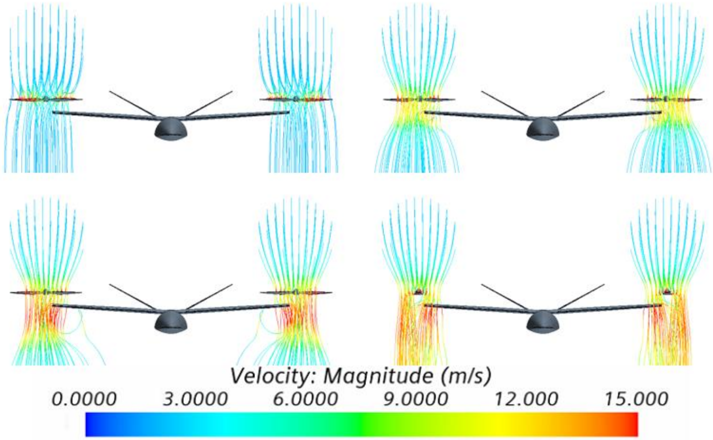
AERODYNAMIC Studies

CFD Studies

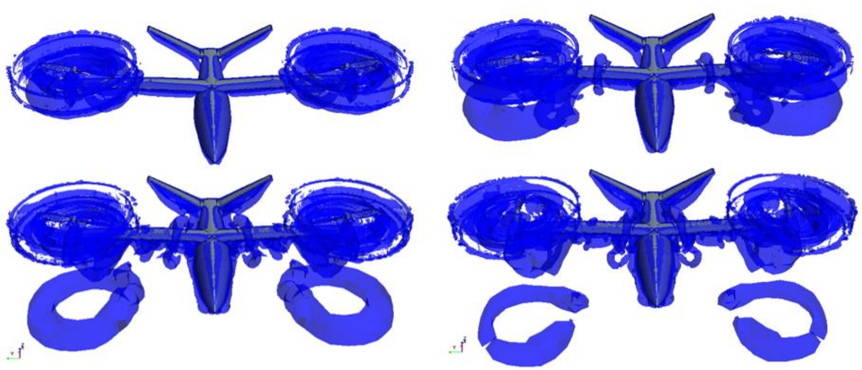
Complete Aircraft CFD – Prop interaction – VTOL – Propeller Model







Stream lines

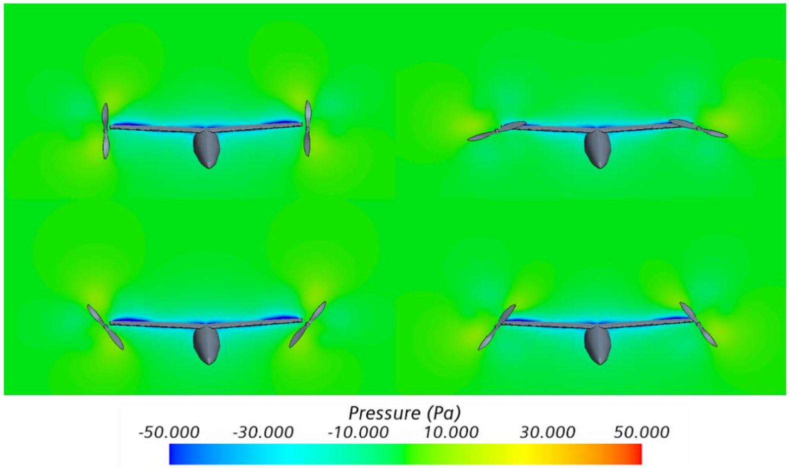


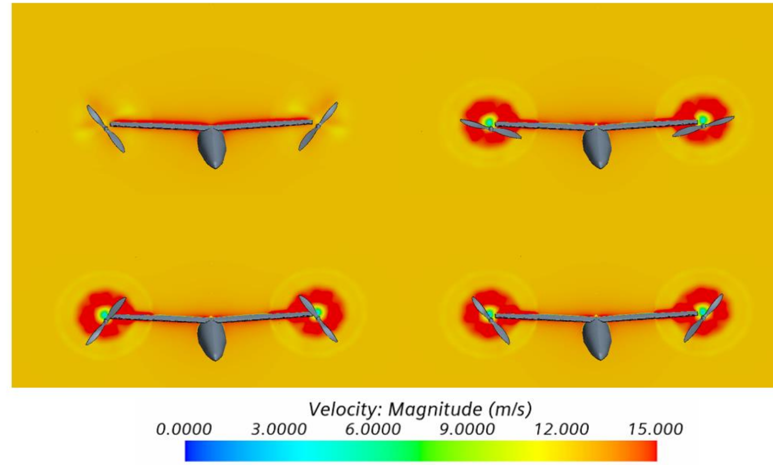
Q-factor

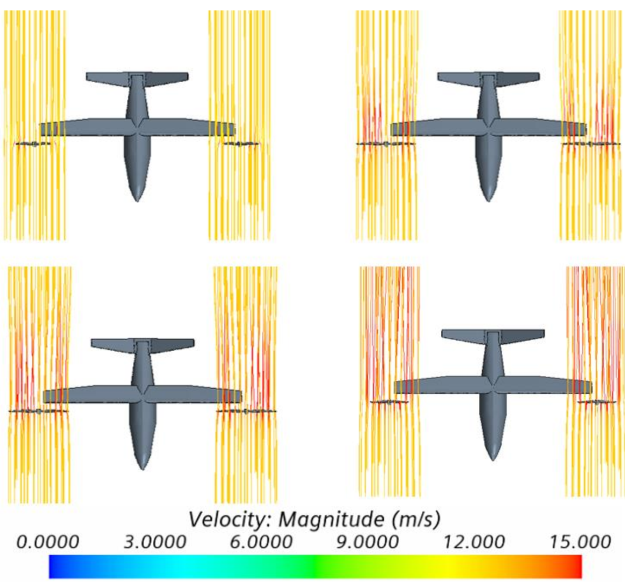
AERODYNAMIC Studies

CFD Studies

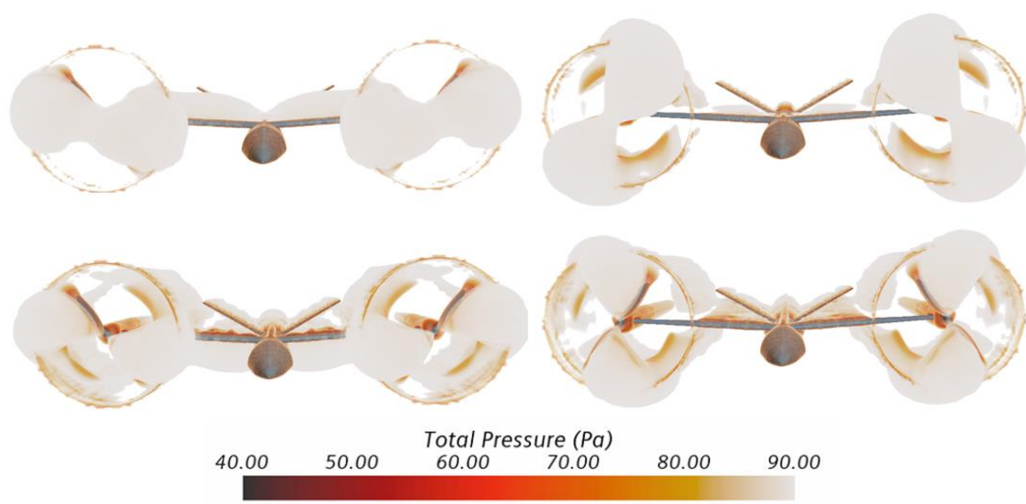
Complete Aircraft CFD – Prop interaction – Cruise – Propeller Model







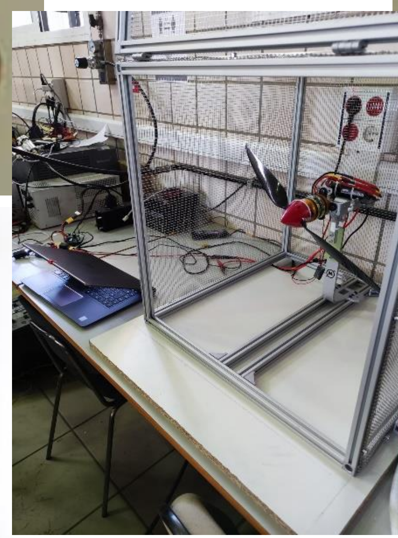
Stream lines



PROPULSIVE Studies

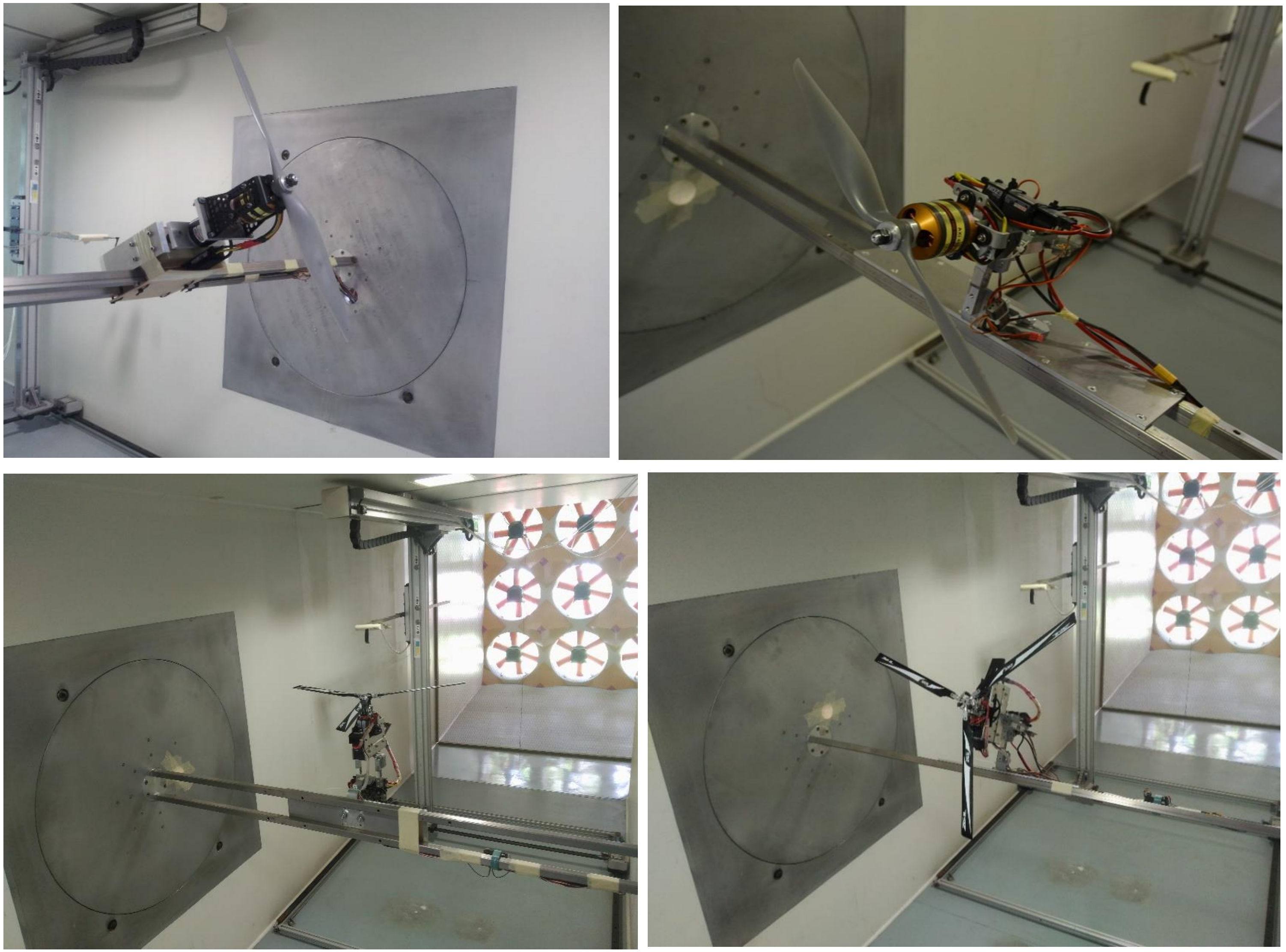
Wind Tunnel Experiments

- Objectives:
  - Propulsive Characterization over the entire flight envelope
  - Tilt-Rotor Propulsion sensitivity studies: fixed and variable pitch
    - Design and construction of a test-bench for prop-testing in wind tunnel
    - Several speeds (0-22 m/s)
    - Several blade pitch angles: 0,4,8,12, degrees:
    - Several tilt angles: 0,5,10,15,20, 30, 45, 60, 75, 90 degrees:



Commercial available test bench (RC Bench Mark Dynamometer Series 1580)

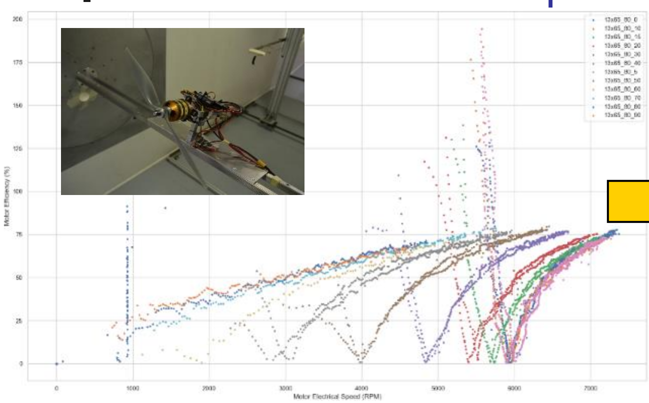
PROPULSIVE Studies



Wind Tunnel Experiments

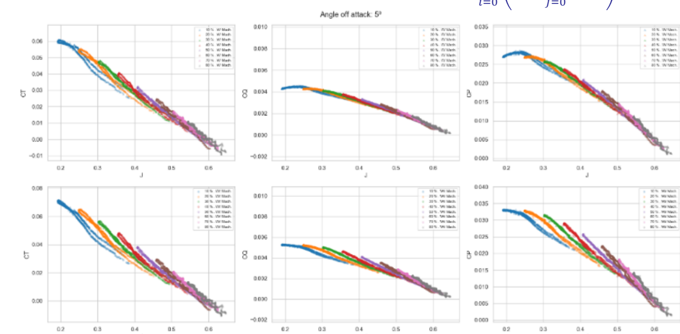
PROPULSIVE Studies

Wind Tunnel Experiments

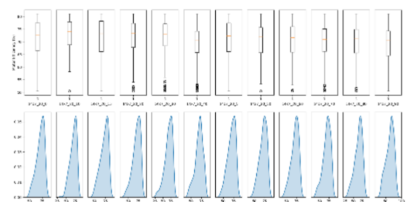


Regression Algorithms

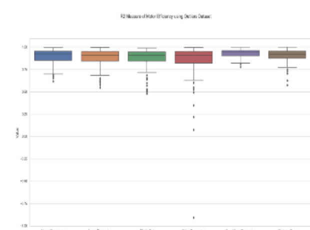
$$\sum_{i=0}^{N}\left(y_i - \sum_{j=0}^{M} x_{ij} W_j\right)^2$$

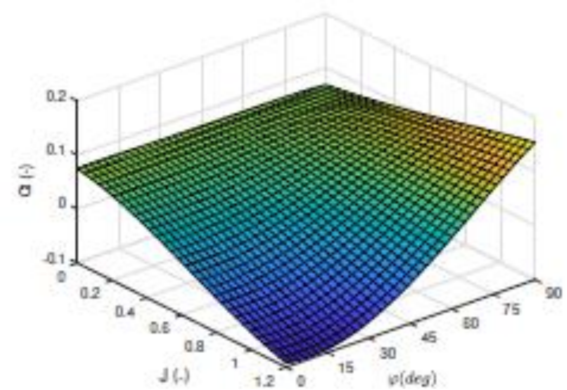


Detection of Outliers



Metrics



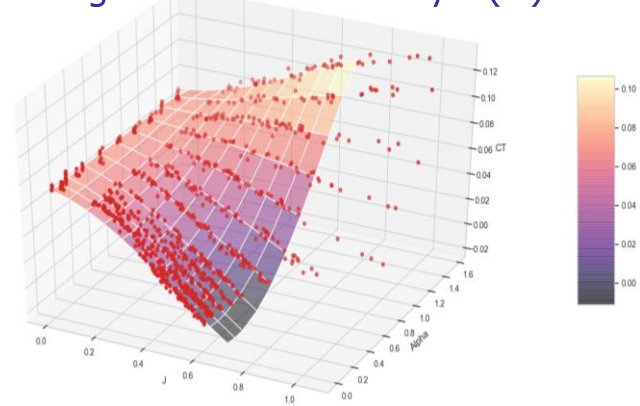


$$C_t(J,\varphi) = f(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} a_{ij} J^i \varphi^j$$

$$C_q(J,\varphi) = g(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} b_{ij} J^i \varphi^j$$

$$T = \rho_\infty n^2 D^4 C_t(J,\varphi); \qquad Q = \rho_\infty n^2 D^5 C_q(J,\varphi)$$

Regresión Models → α y J (M)

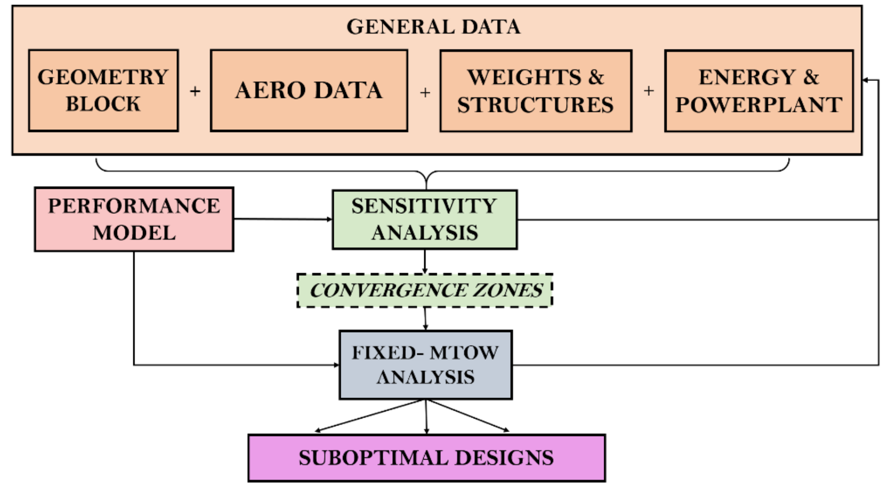


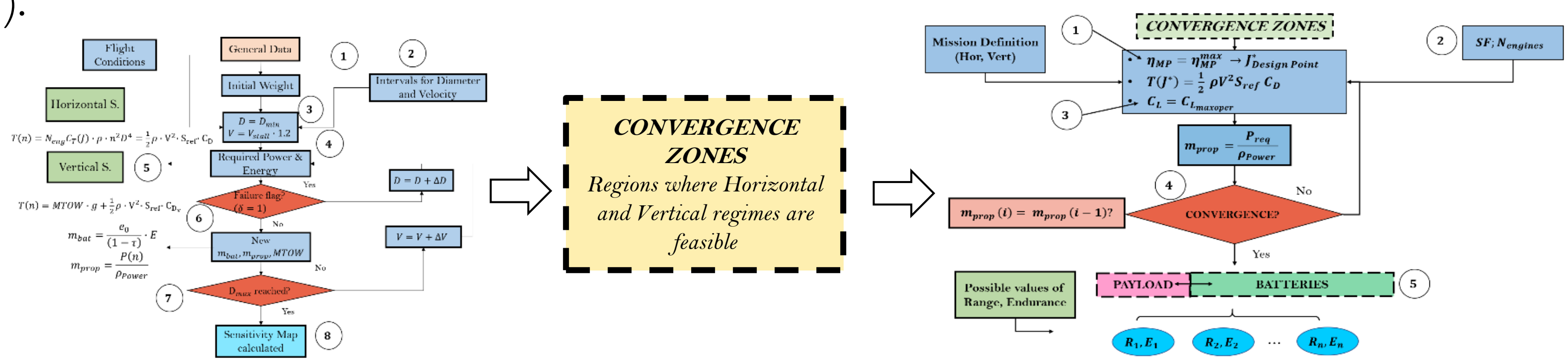
Propulsion Optimization Tool

-**Four Data structures** model the Aircraft to be studied.

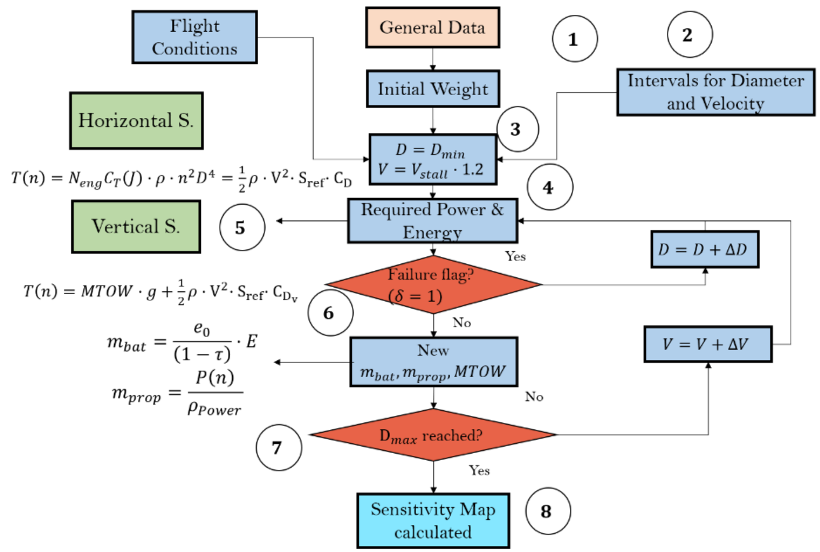
-The **Flight Mechanics** equations get particularized in the *Performance Model*

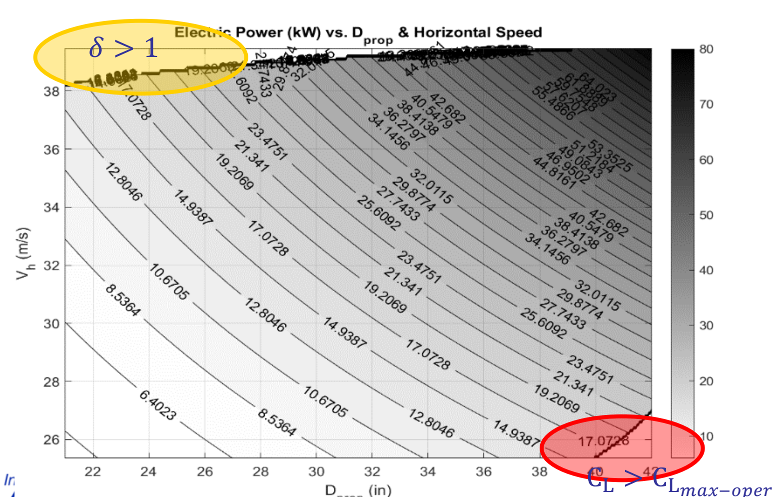
-These are the **ingredients** included in **both studies** (Sensitivity & Fixed-MTOW Analyses).

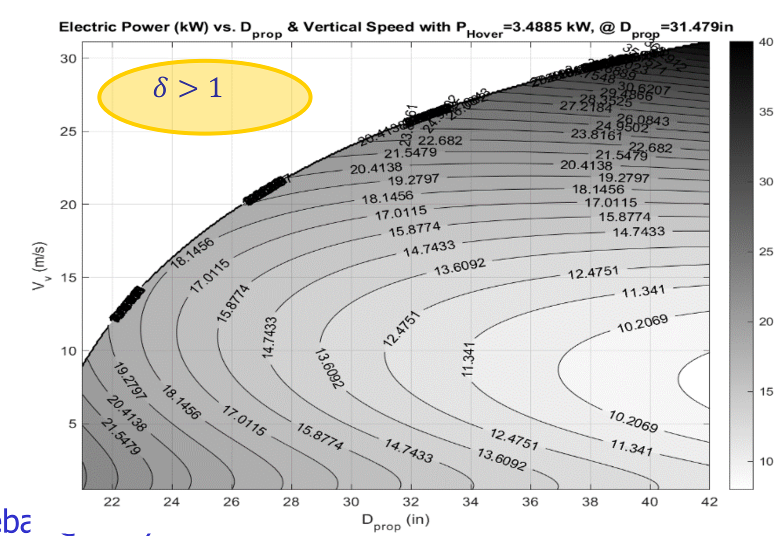




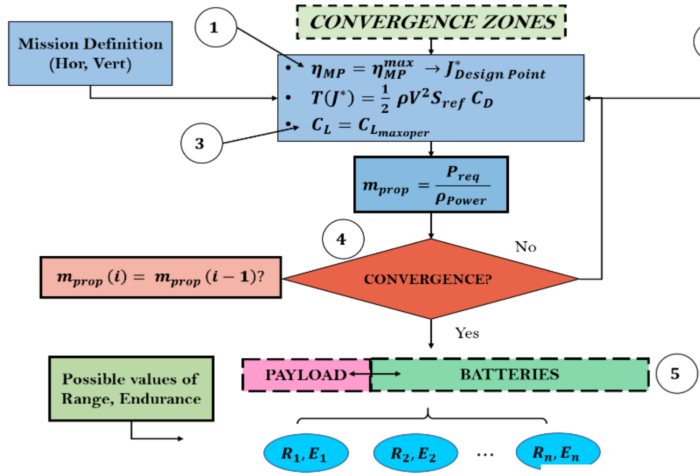
Sensitivity Analysis Algorithm





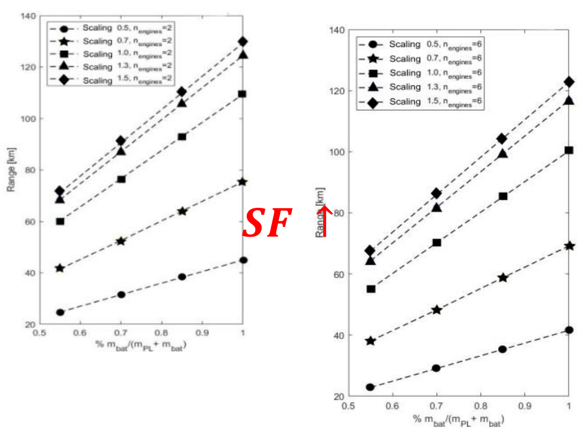


Fixed-MTOW Analyses

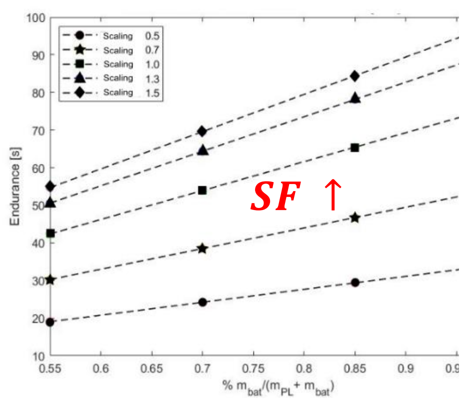


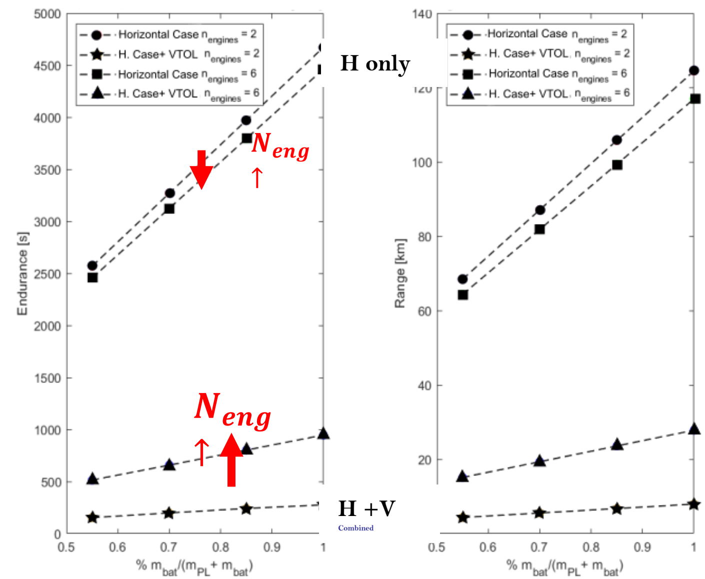
Range (Horizontal Flight)

Endurance (VTOl



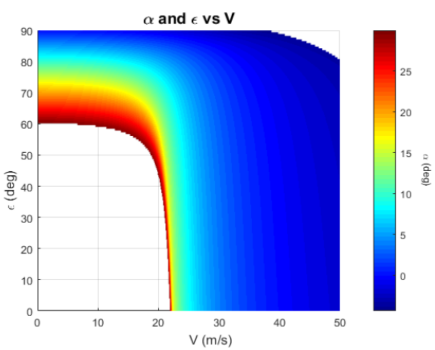
$N_{engines} = 2, 4, 6$

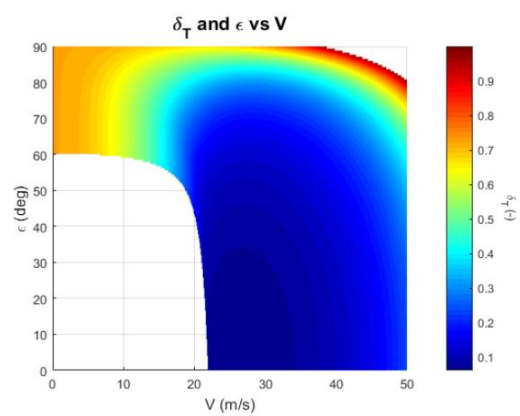


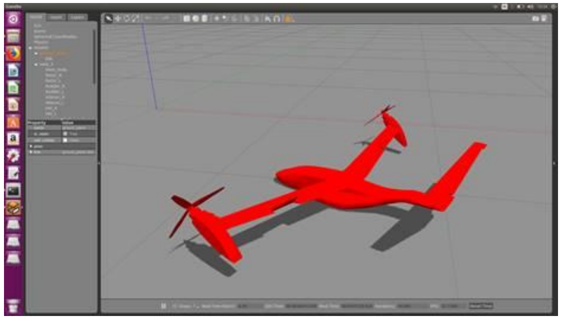


Flying Qualities Studies

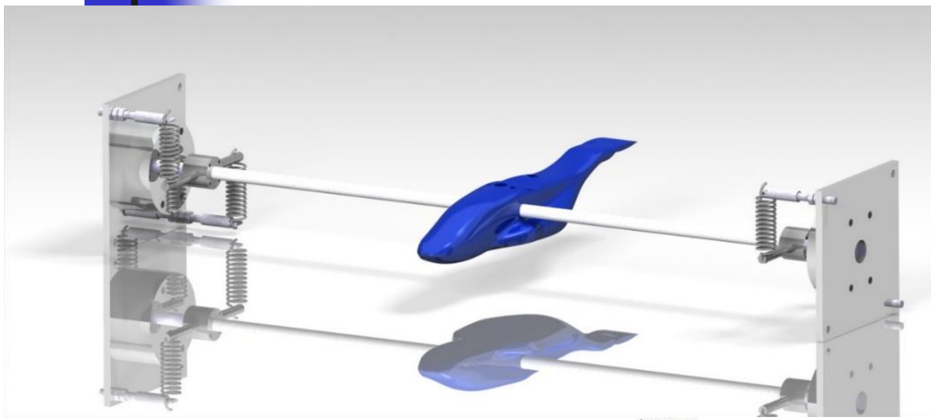
- Objectives:
  - <u>Parametric analysis</u> on the different considered design options
  - Study of aircraft flight dynamics with special emphasis on the <u>complexity of transition maneuvers</u>.
    - Develop advanced and complete 6DOF Model
      - Develop Reduced Order Models
    - Conducts Static and Dynamic Stability Studies along with Performance analysis of the aircraft different flight segments
      - Trim Problem: longitudinal and Lateral-dynamics
      - Dynamic Response Analysis
      - Sensitivity Study under geometry modifications
      - Modification of Design to achieve desired Flying Qualities

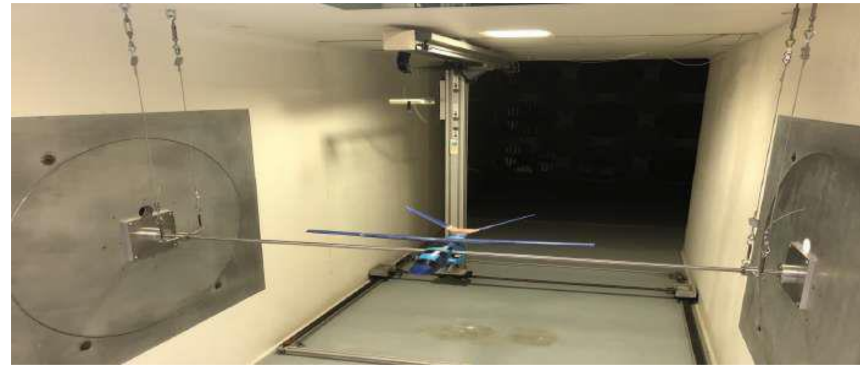


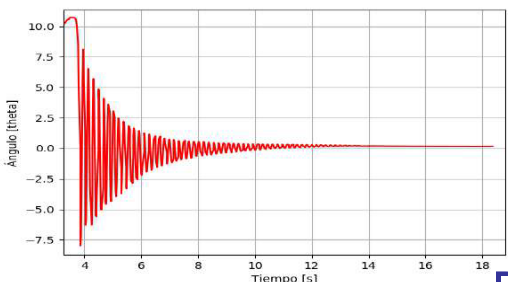


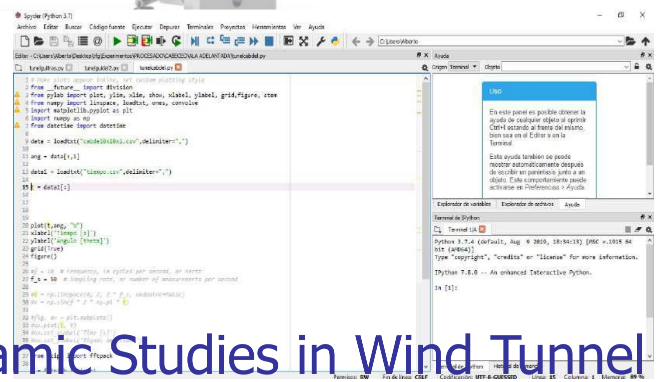


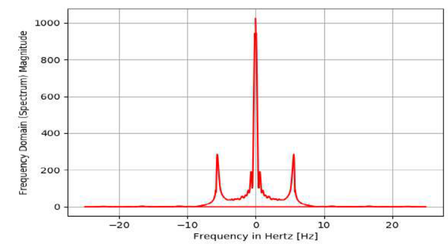
Flying Qualities Studies







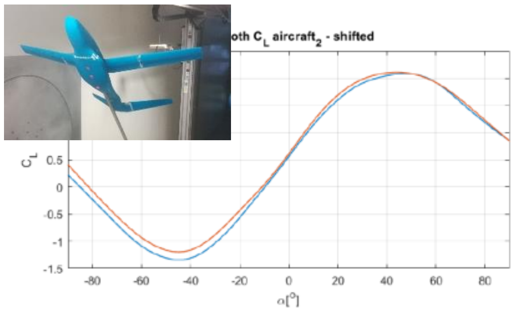


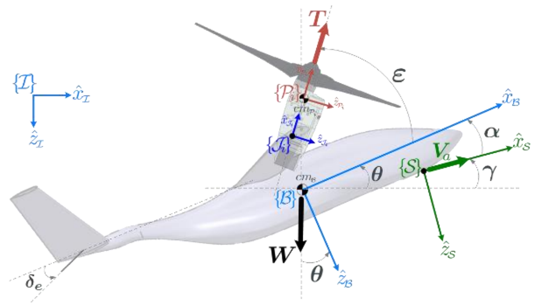


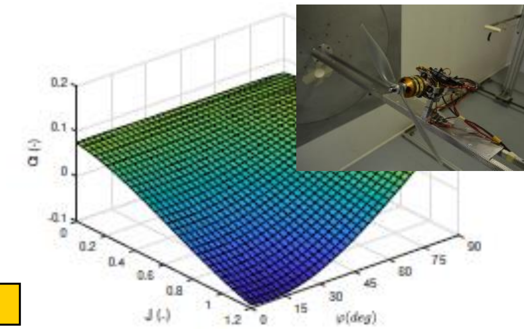
Dynamic Studies in Wind Tunnel

Flying Qualities Studies

- Example: Longitudinal (and Lateral) Trim Problem:
  - Using non-linear experimental (wind tunnel) models → Dedicated resolution software



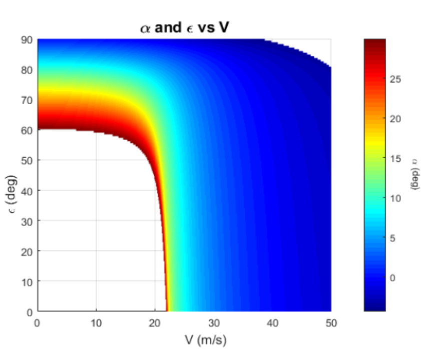


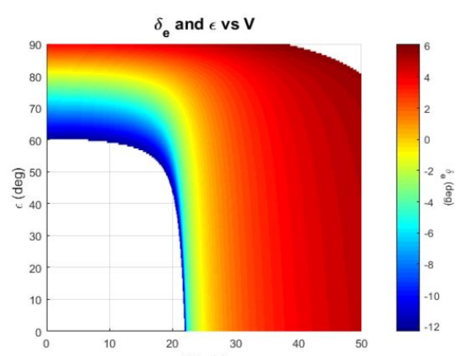


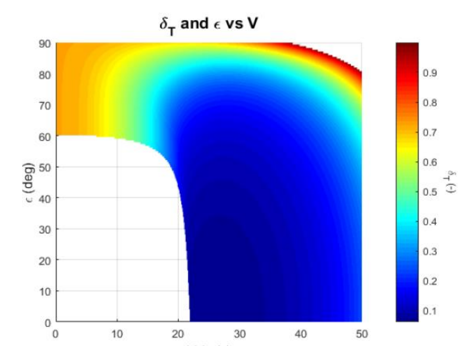
$$C_L = \frac{L}{\frac{1}{2}\rho_\infty V^2 S} = f(\alpha) = \sum_{i=0}^{n} a_i \alpha^i$$
$$C_D = \frac{D}{\frac{1}{2}\rho_\infty V^2 S} = g(\alpha) = \sum_{i=0}^{n} b_i \alpha^i$$
$$C_M = \frac{M}{\frac{1}{2}\rho_\infty V^2 S c} = h(\alpha) = \sum_{i=0}^{n} c_i \alpha^i$$

$$0 = T\cos(\alpha+\varepsilon) - D - mg\sin\gamma$$
$$0 = T\sin(\alpha+\varepsilon) + L - g\cos\gamma$$
$$0 = M$$

$$C_t(J,\varphi) = f(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} a_{ij} J^i \varphi^j$$
$$C_q(J,\varphi) = g(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} b_{ij} J^i \varphi^j$$



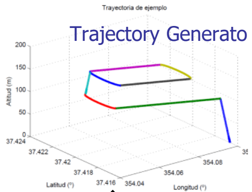


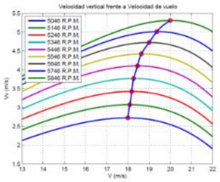


RESUME - I

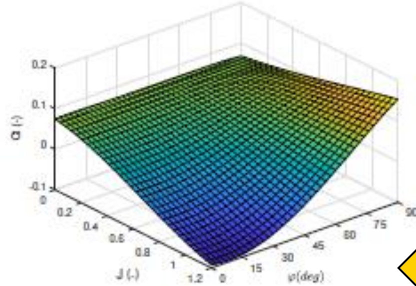
Wind Tunnel Experiments: US

Trajectory Generato

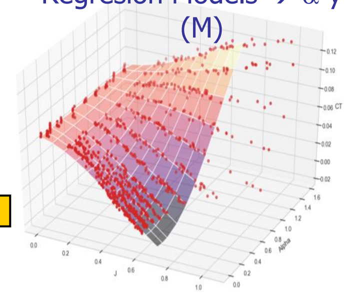


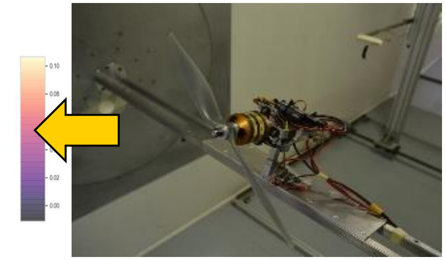


Climb speed vs hor. vel. and RPM



Regresión Models → α y J (M)





Wind Tunnel Experiments: Propulsion

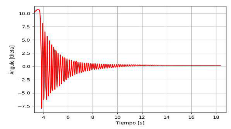
Propulsive Mathematical Models

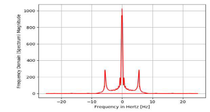
$$C_t(J,\varphi) = f(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} a_{ij} J^i \varphi^j$$

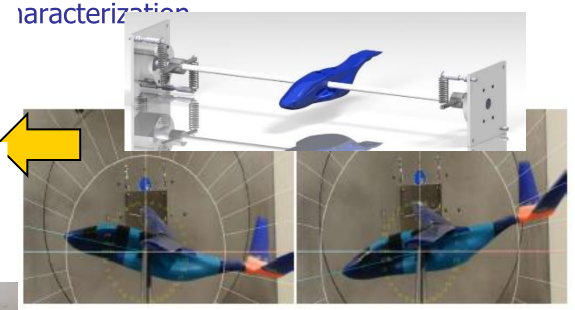
$$C_q(J,\varphi) = g(J,\varphi) = \sum_{i=0}^{4}\sum_{j=0}^{4} b_{ij} J^i \varphi^j$$

6DOF Model & GAZEBO Simulator @ UFMG & US

Wind Tunnel Experiments: Dynamic Characterization







Aerodynamic Mathematical Models

$$C_L = \frac{L}{\frac{1}{2}\rho_\infty V^2 S} = f(\alpha) = \sum_{i=0}^{n} a_i \alpha^i$$

$$C_D = \frac{D}{\frac{1}{2}\rho_\infty V^2 S} = g(\alpha) = \sum_{i=0}^{n} b_i \alpha^i$$

$$C_M = \frac{M}{\frac{1}{2}\rho_\infty V^2 S c} = h(\alpha) = \sum_{i=0}^{n} c_i \alpha^i$$

Control Strategies Evaluation

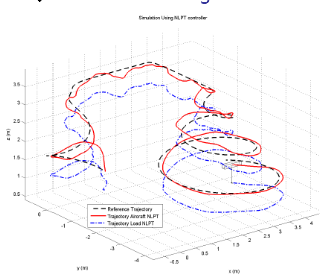
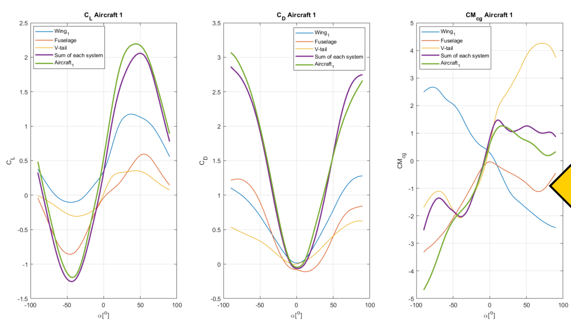
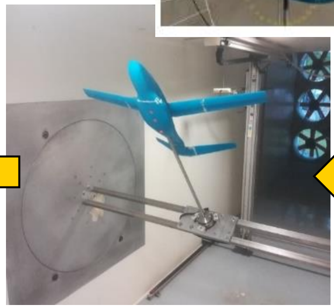
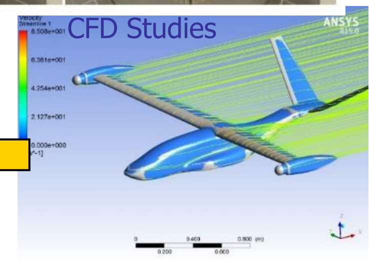


Figure 5.2: Path tracking of the aircraft for the LKFUI simulation.





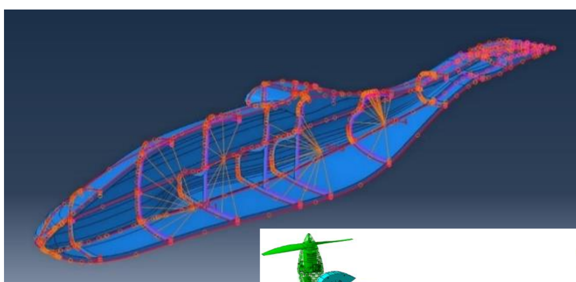
CFD Studies

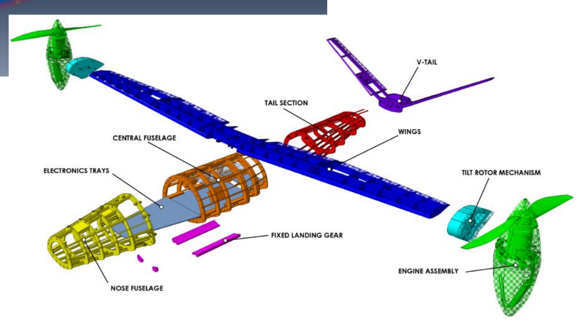


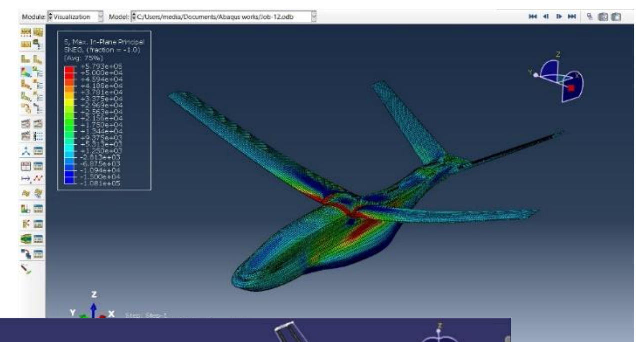
Wind Tunnel Experiments: Aerodynamic

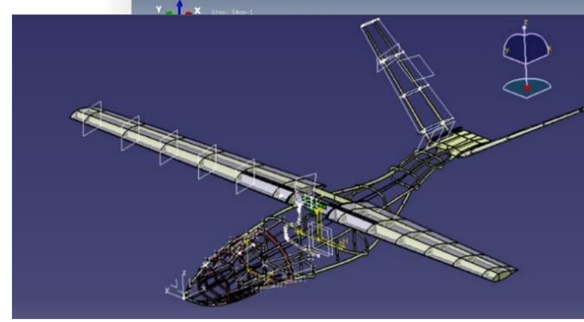
Structures Studies

- Objetives:
  - Advanced structural study with computational tools (FEM) of the aircraft
  - Defining the structure of both the fuselage and the aerodynamic surfaces capable of supporting both the ground and in-flight loads of the two prototypes along the entire envelope of the VTOL-CP.
  - Candidate for structure in CAD and manufacturing processes.
  - Develop CAD-CAM process with a Multilevel BOM: Guarantee Repeatability
    - Cutting Technical Instructions: Jigs, structures
    - Assembly Technical Instructions: jigs instructions
    - Traceability: all parts allocated with code number in BOM

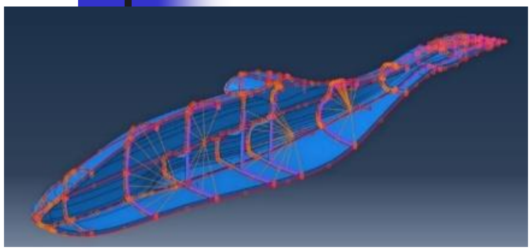


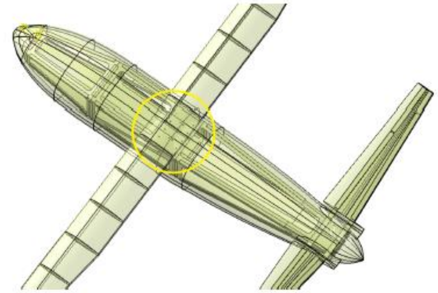


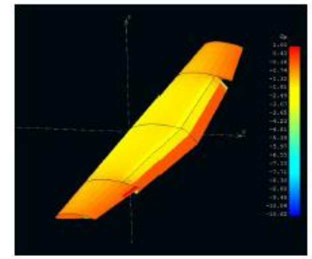


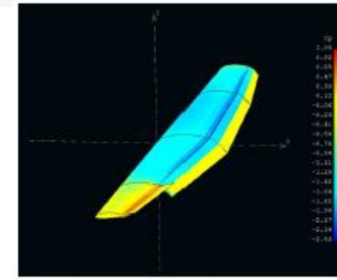


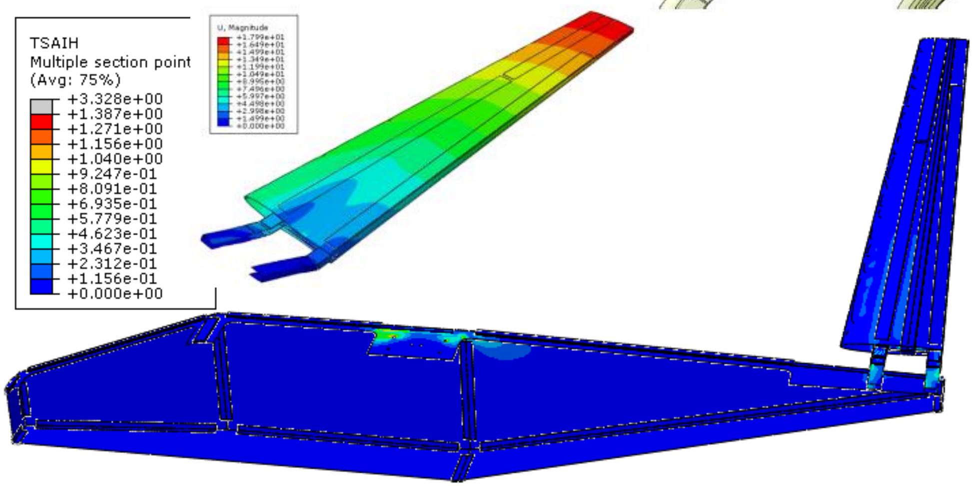
Structural Analysis

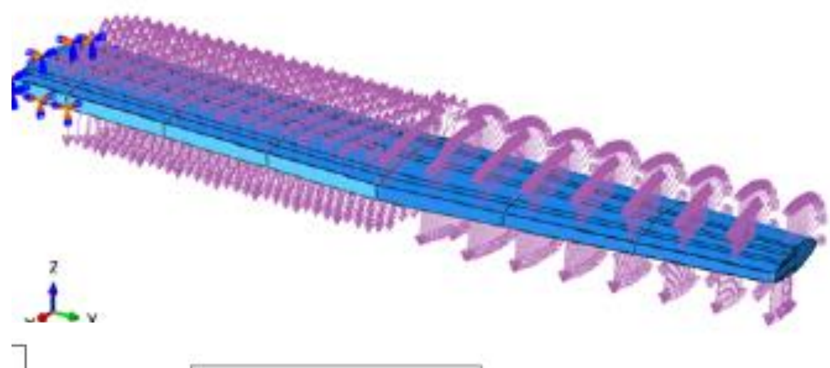


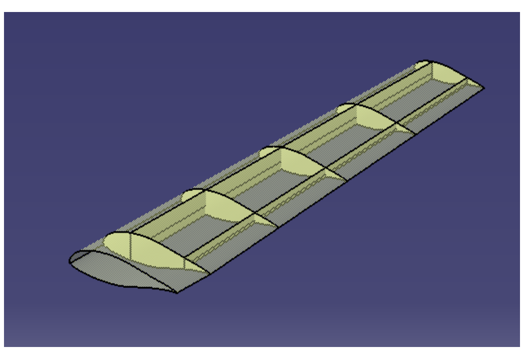


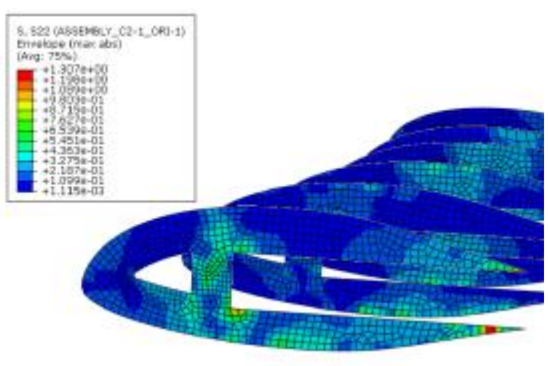


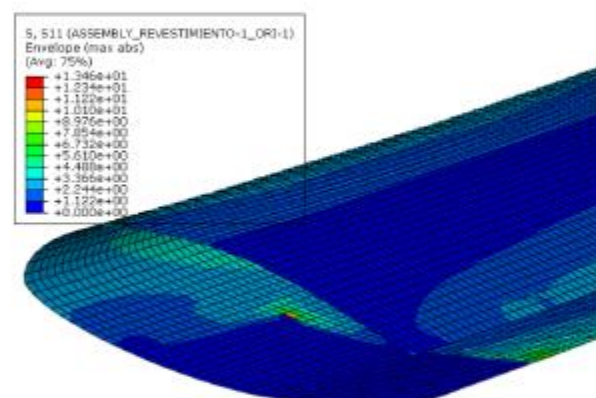




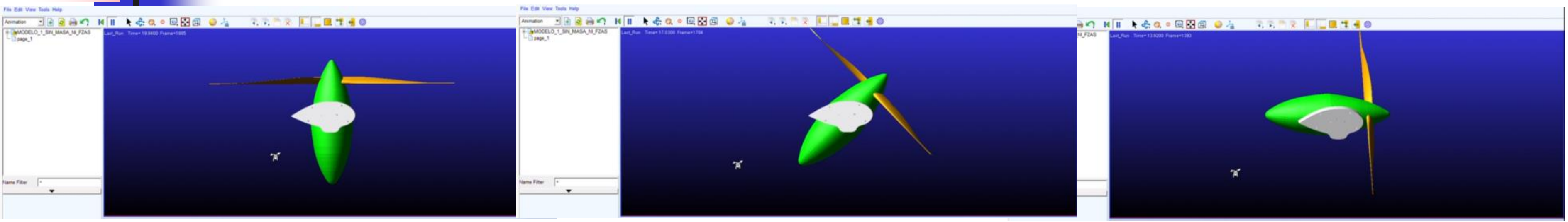


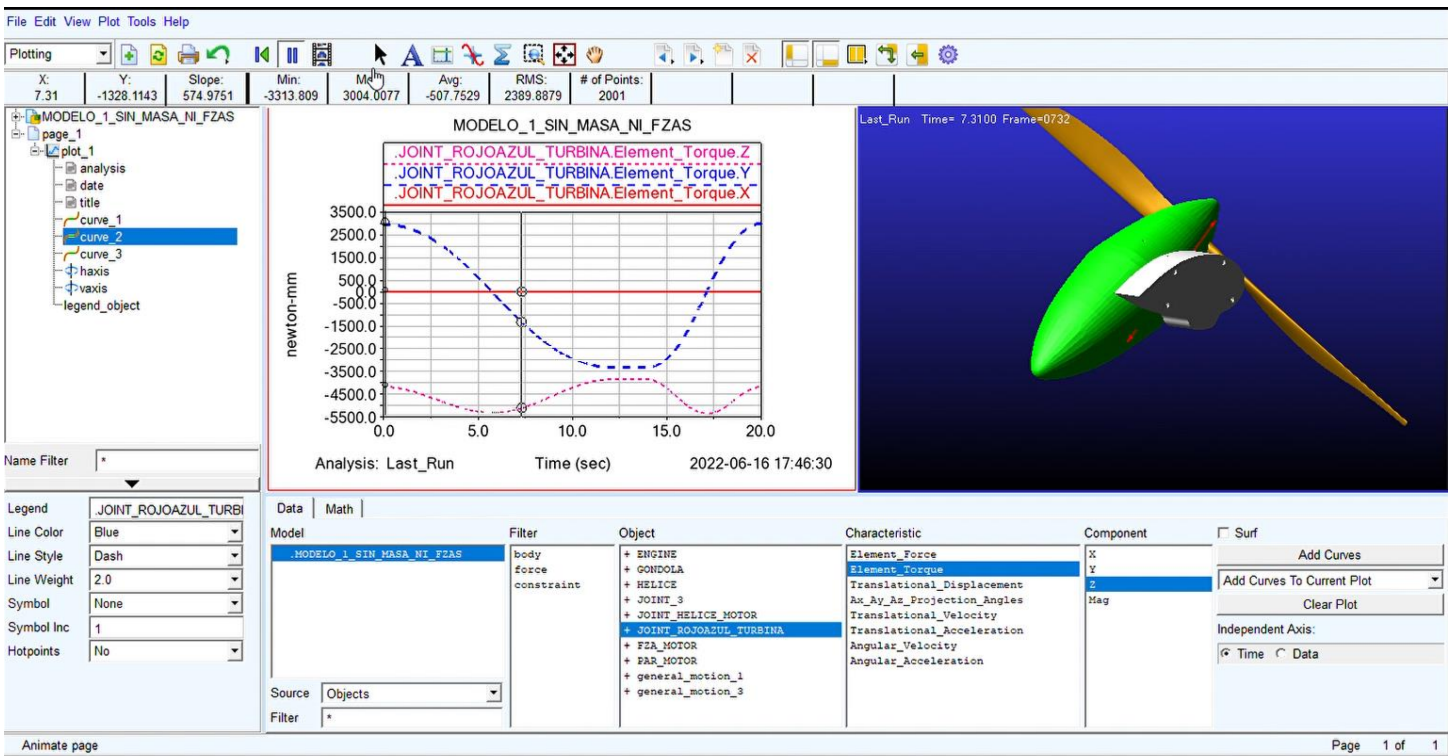






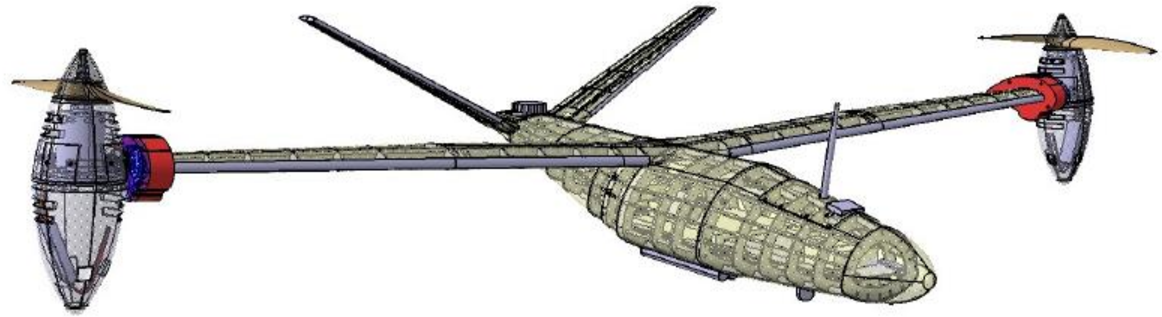
Mechanica Analysis



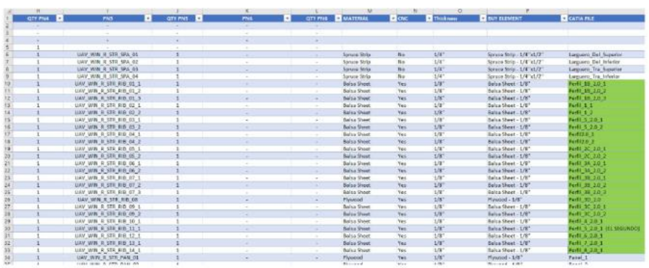


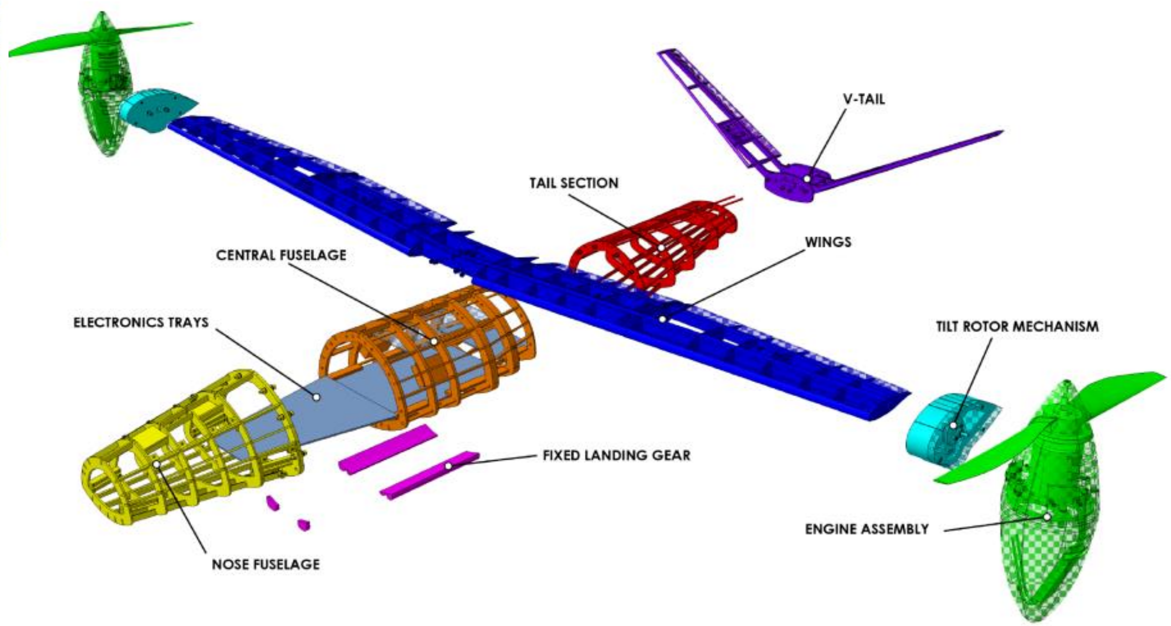
CAD-CAM Process with Multilevel BOM

Cutting Technical Instructions



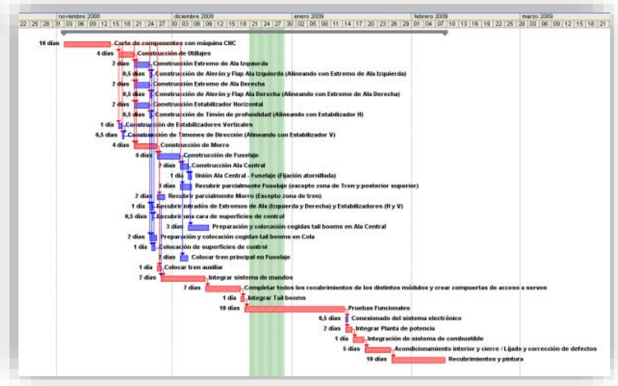
BOM

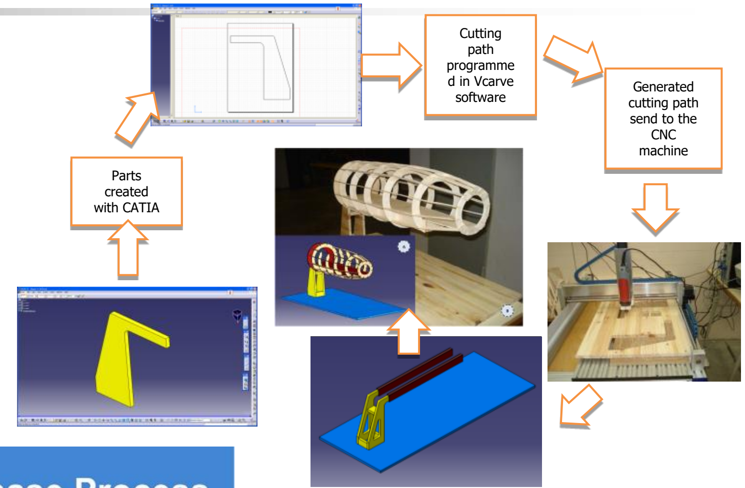


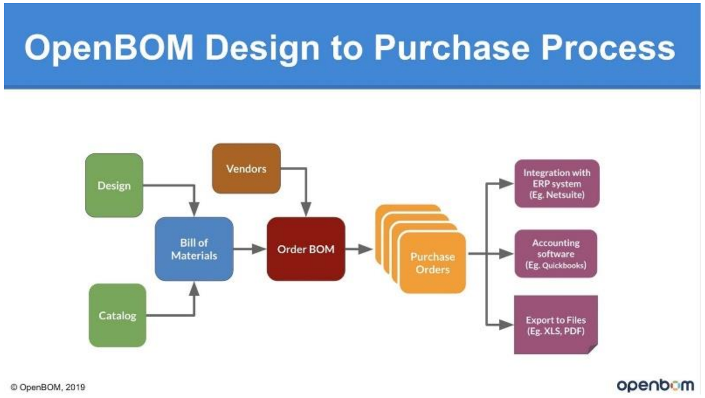


Assembly Technical Instructions

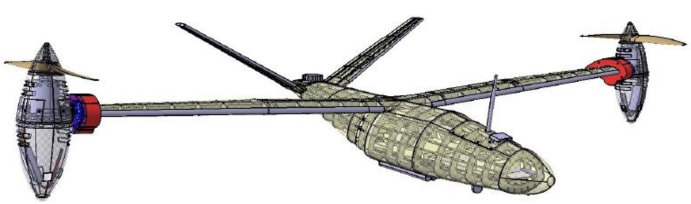
Production & Systems Integration







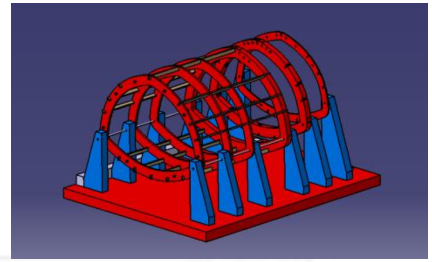
Multi-level BOM

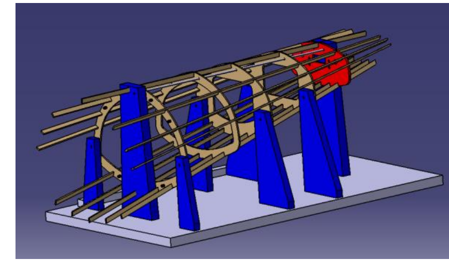


Cutting Technical Instructions

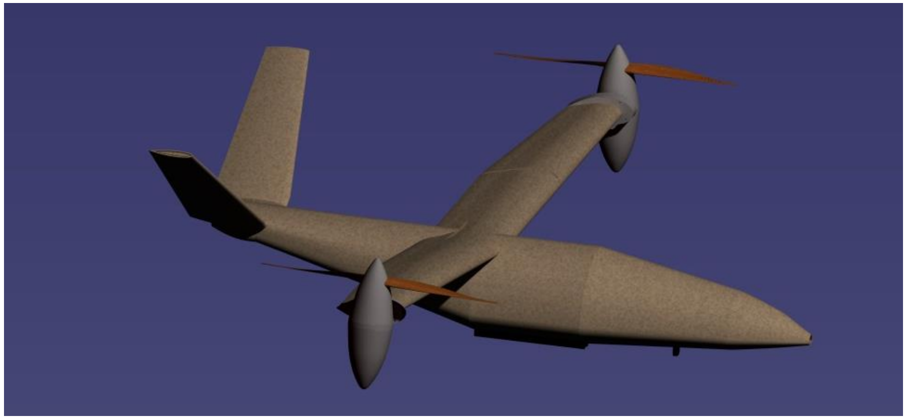
BOM

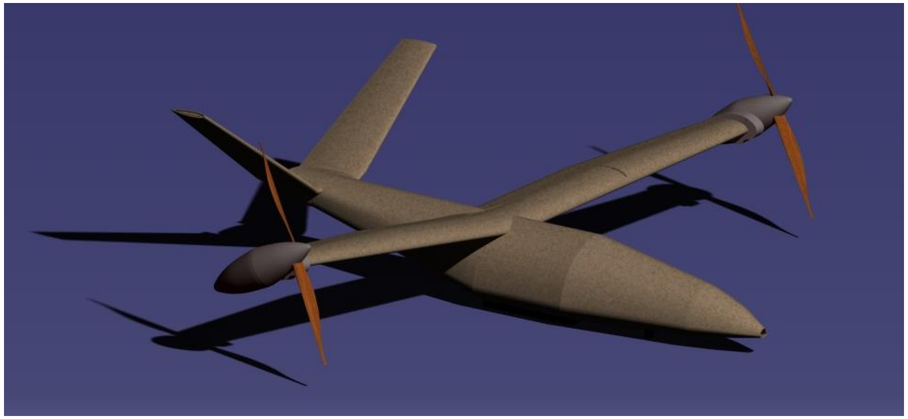
Assembly Technical Instructions

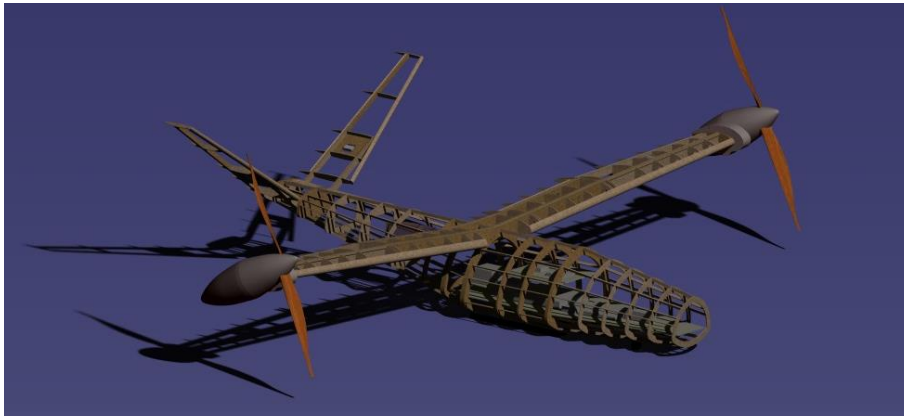


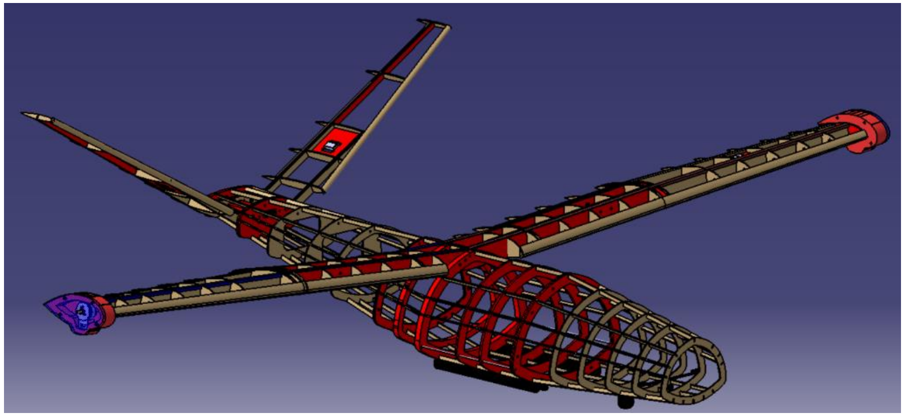


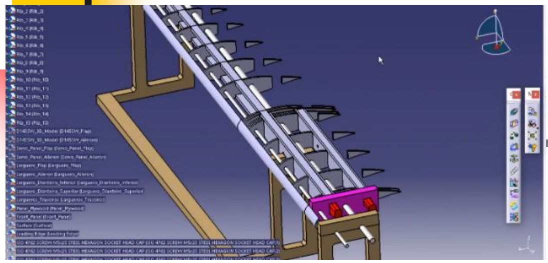
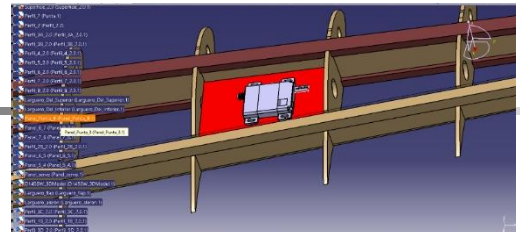
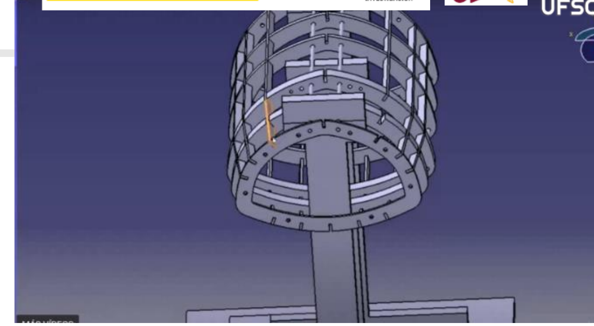
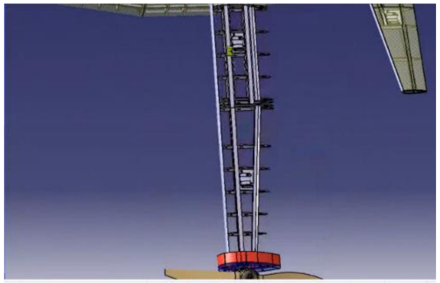
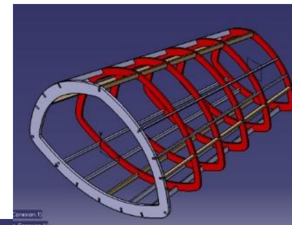
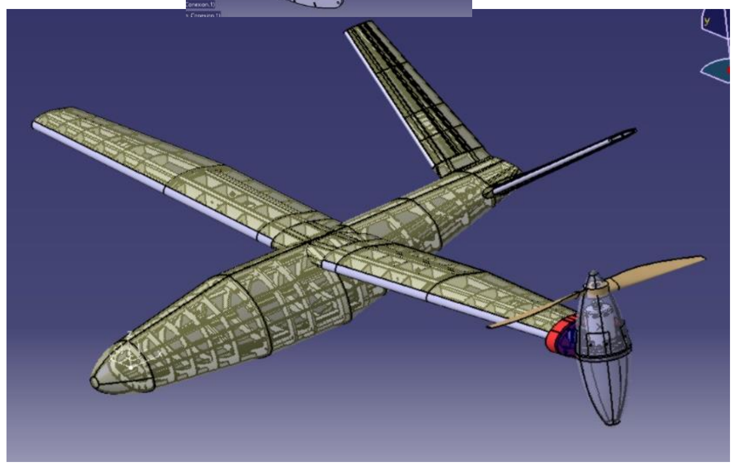
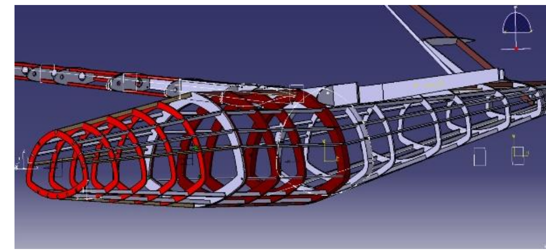
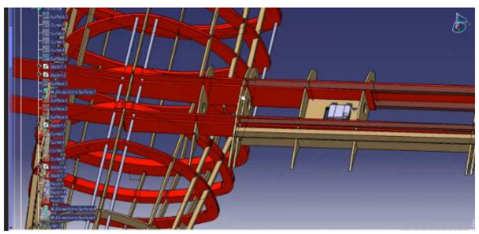
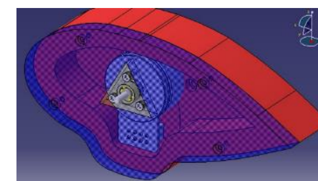
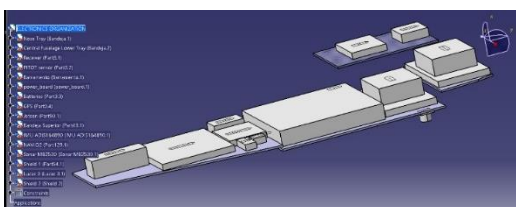
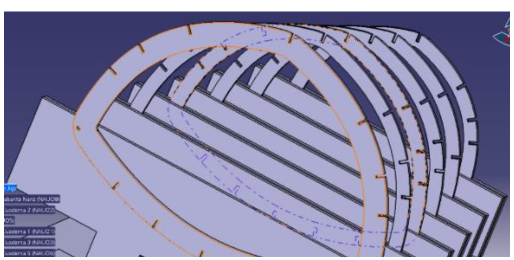
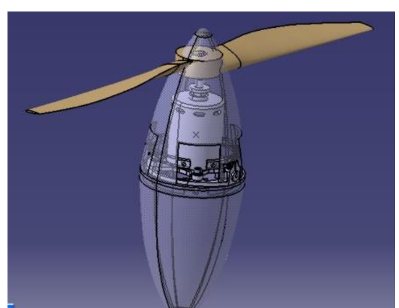
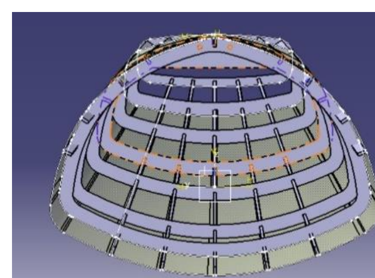
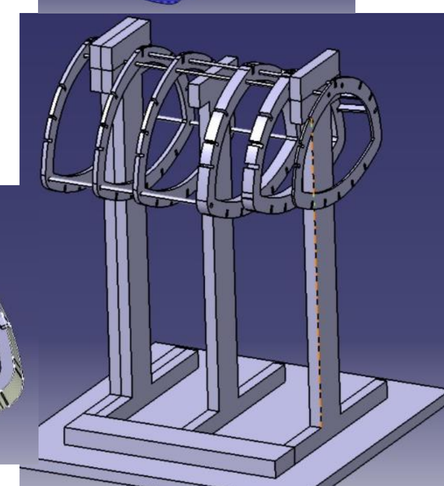
BOM

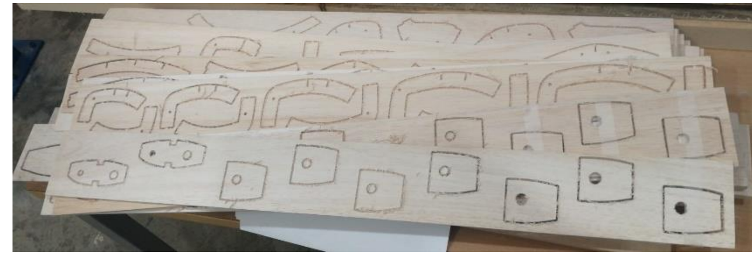




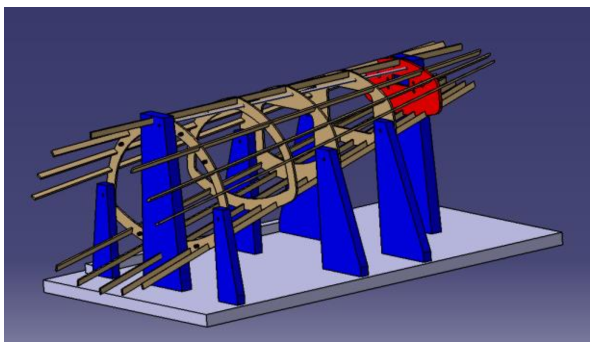


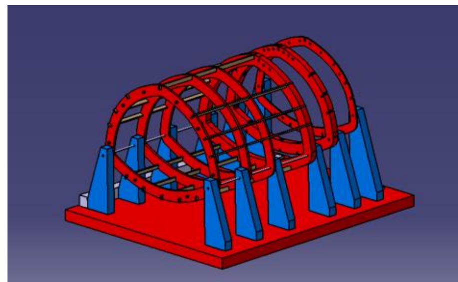


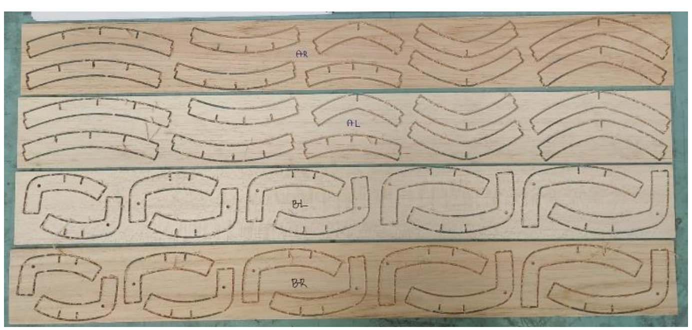















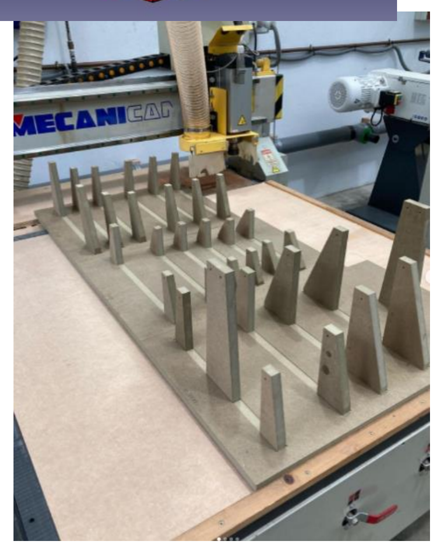


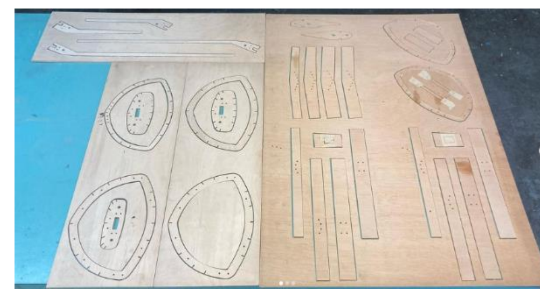
CNC Manufacturing Capabilities

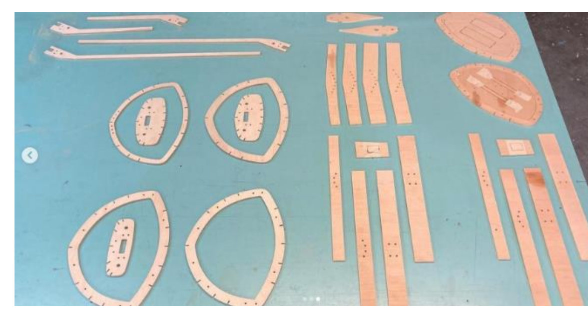




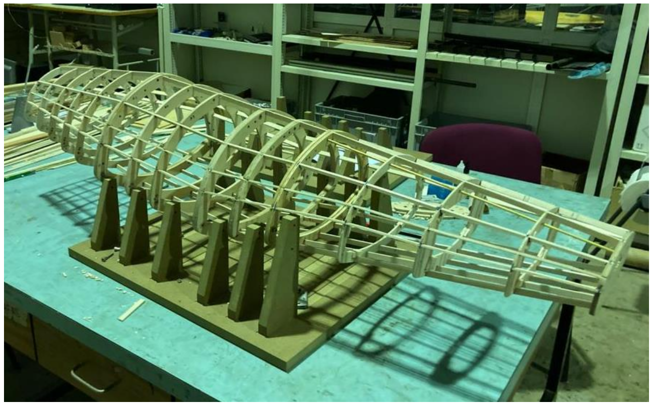








CNC Manufacturing Capabilities



CNC Manufacturing Capabilities

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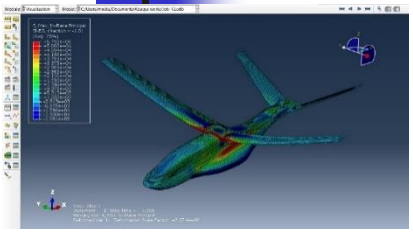
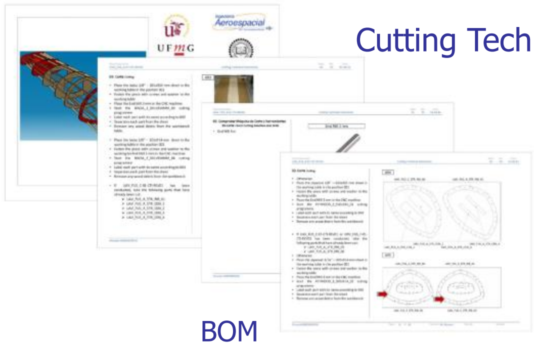
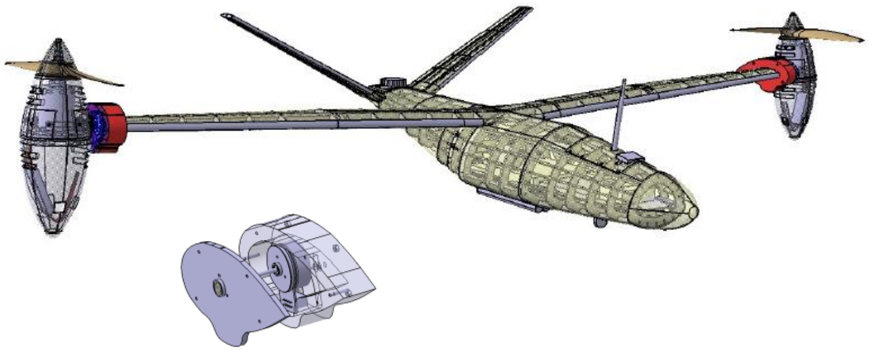
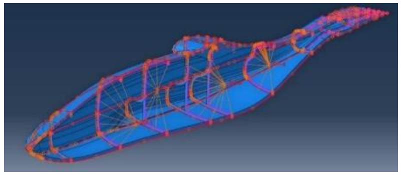




Cutting Technical Instructions





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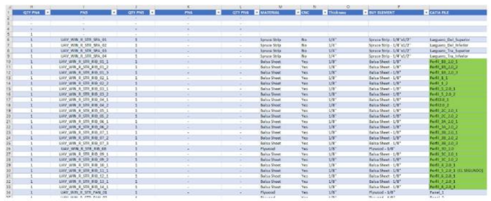
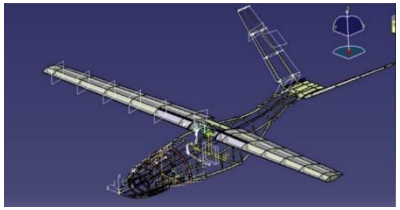
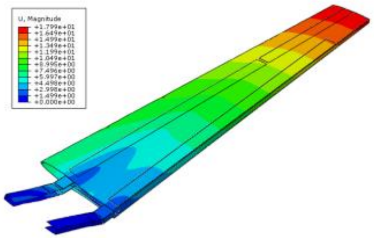
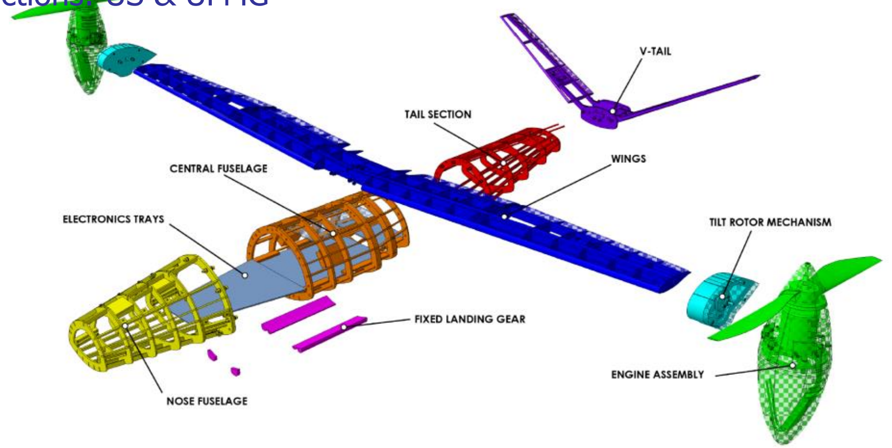




Assembly Technical Instructions: US & UFMG





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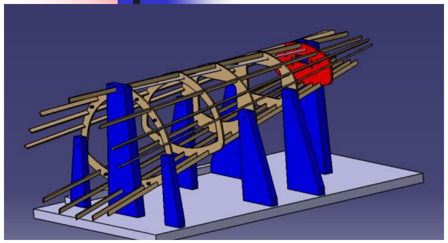
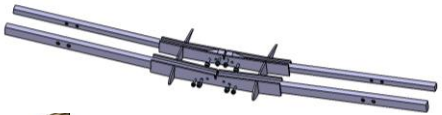
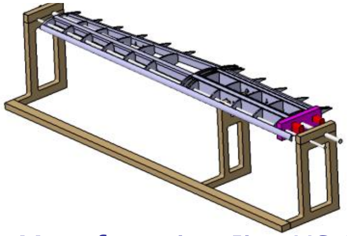
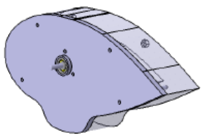
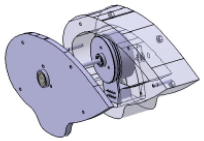
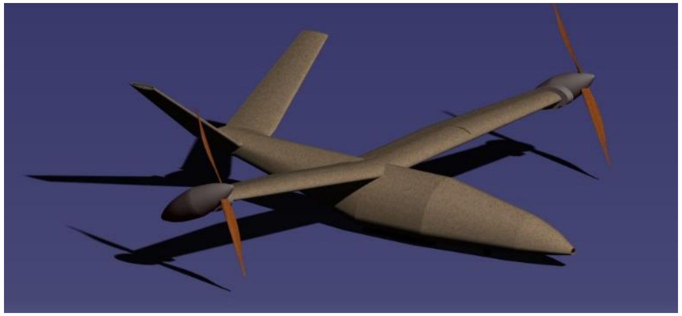


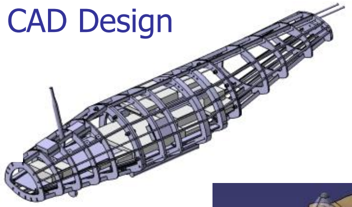








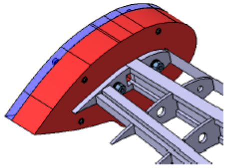


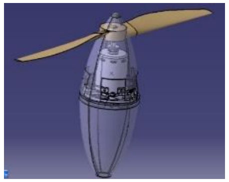


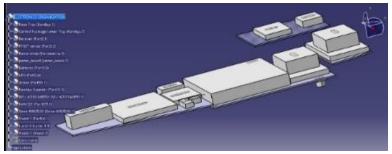
CAD Design

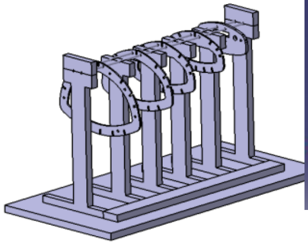
Manufacturing Process @ US & UFMG

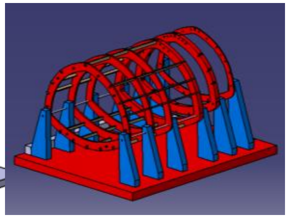
Manufacturing Jigs US & UFM

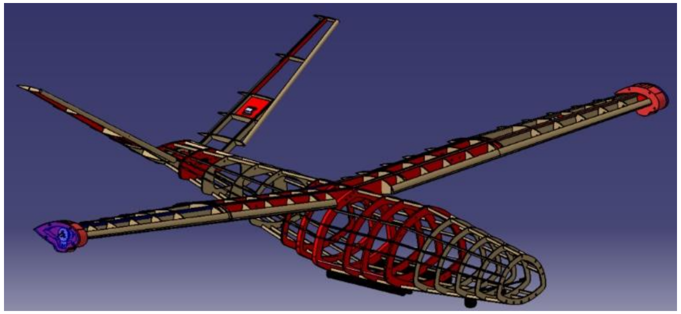


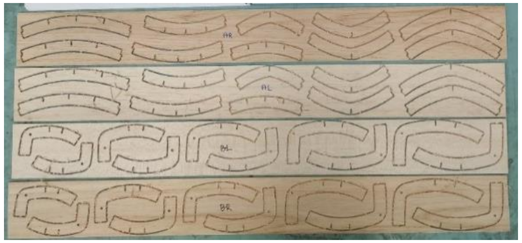






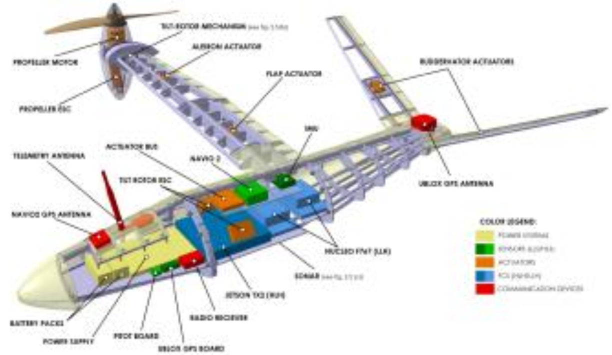


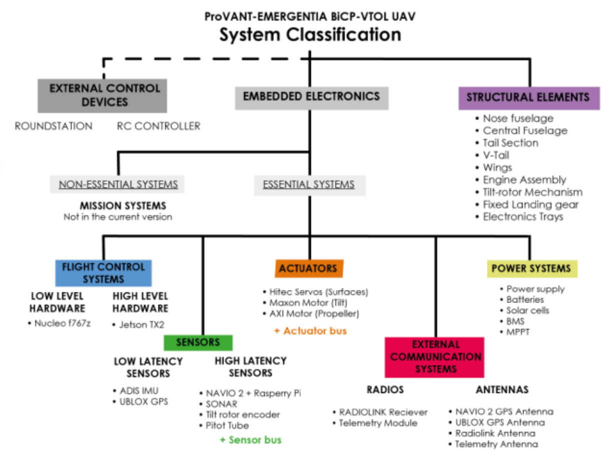




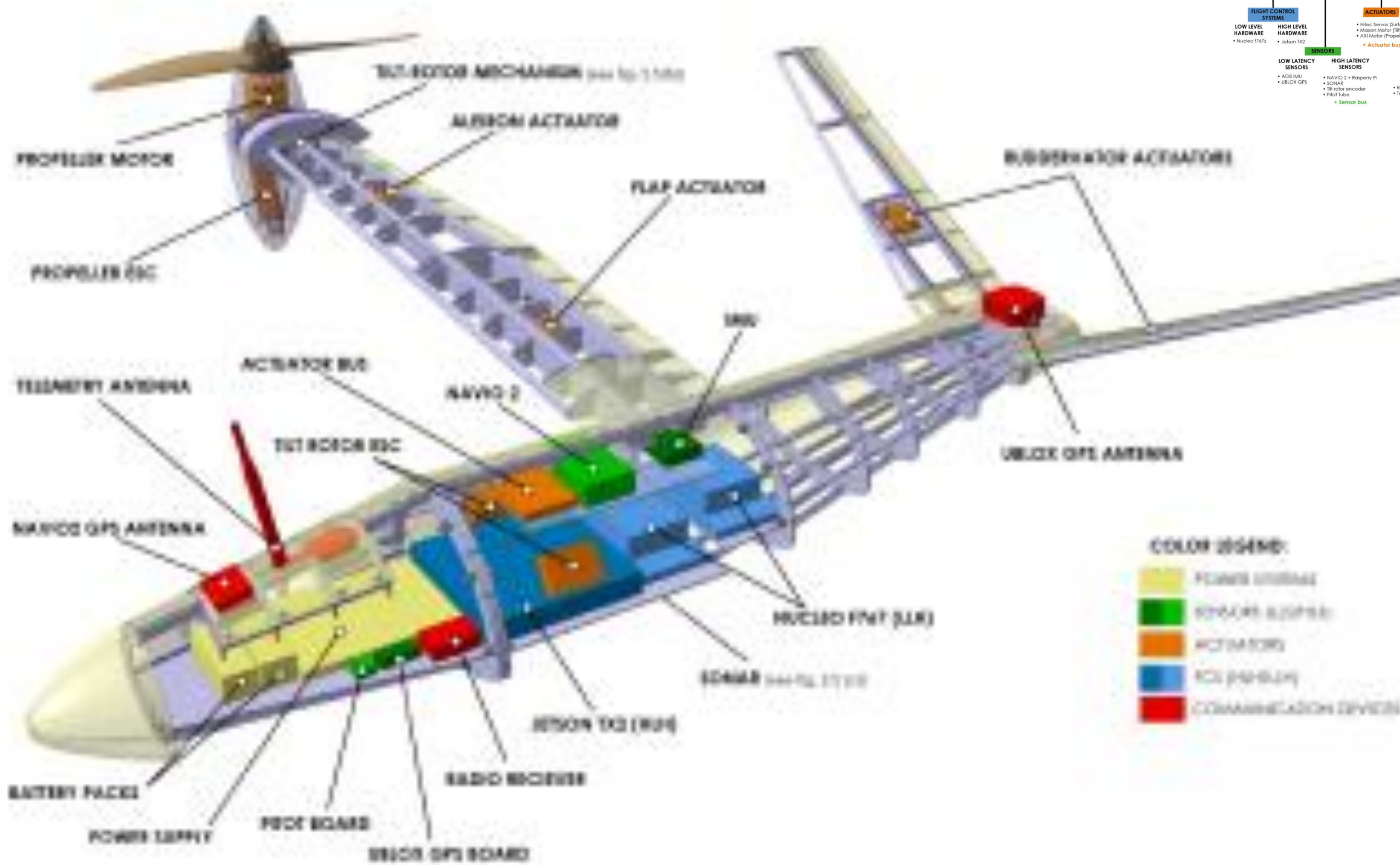
Embedded Cyber Physical Systems

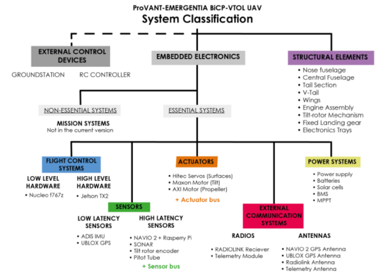
- Objetives: Development of cyberphysical systems
  - Development of embedded computer systems, of hardware and software architectures.
  - Development of Cyber security allowing secure communications between bases, between uavs, between uav systems, fault tolerant embedded systems, power electronics, esc.s, current converters.
  - Development of efficient onboard electronics for advanced avionics that allows reducing energy consumption, optimizing the ability to perform missions with high ranges and autonomies without losing payload capacity.
  - The necessary hardware and electronic systems architecture will be developed, as well as technological demonstrators that allow validating the chosen architectures.
  - Develop Systems Integration and Validation Functional Tests to guarantee quality of product: V & V





System Classification – I





System Classification - II

ProVANT-EMERGENTIA BiCP-VTOL UAV

System Classification

EXTERNAL CONTROL DEVICES
- GROUNDSTATION
- RC CONTROLLER

EMBEDDED ELECTRONICS

NON-ESSENTIAL SYSTEMS

MISSION SYSTEMS
Not in the current version

ESSENTIAL SYSTEMS

FLIGHT CONTROL SYSTEMS

LOW LEVEL HARDWARE
- Nucleo f767z

HIGH LEVEL HARDWARE
- Jetson TX2

SENSORS

LOW LATENCY SENSORS
- ADIS IMU
- UBLOX GPS

HIGH LATENCY SENSORS
- NAVIO 2 + Rasperry Pi
- SONAR
- Tilt rotor encoder
- Pitot Tube

+ Sensor bus

ACTUATORS
- Hitec Servos (Surfaces)
- Maxon Motor (Tilt)
- AXI Motor (Propeller)

+ Actuator bus

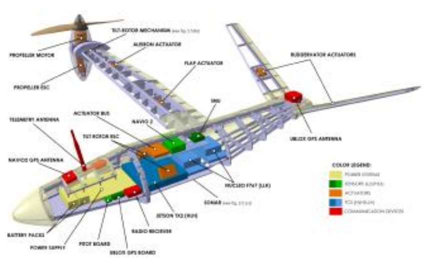
EXTERNAL COMMUNICATION SYSTEMS

RADIOS
- RADIOLINK Reciever
- Telemetry Module

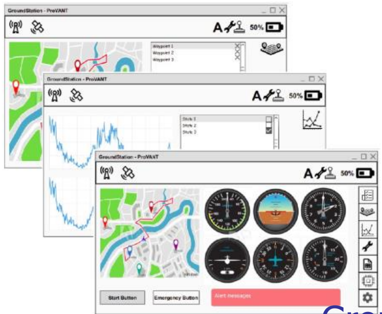
ANTENNAS
- NAVIO 2 GPS Antenna
- UBLOX GPS Antenna
- Radiolink Antenna
- Telemetry Antenna

POWER SYSTEMS
- Power supply
- Batteries
- Solar cells
- BMS
- MPPT

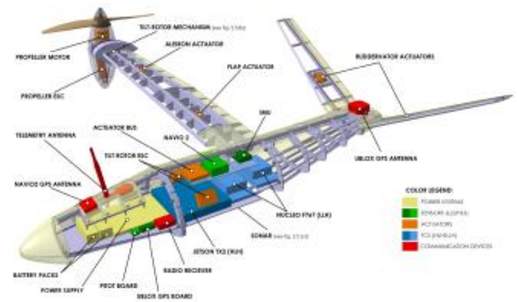
STRUCTURAL ELEMENTS
- Nose fuselage
- Central Fuselage
- Tail Section
- V-Tail
- Wings
- Engine Assembly
- Tilt-rotor Mechanism
- Fixed Landing gear
- Electronics Trays

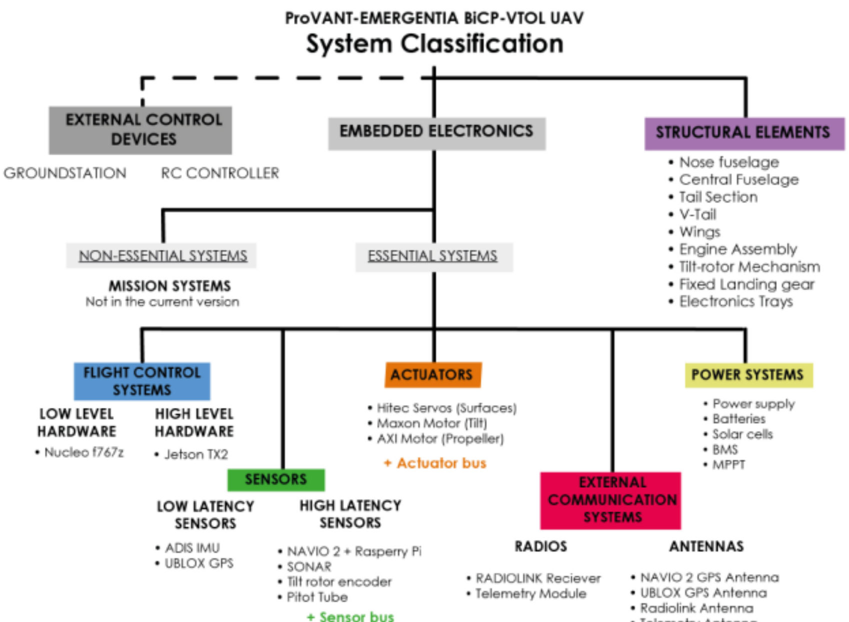


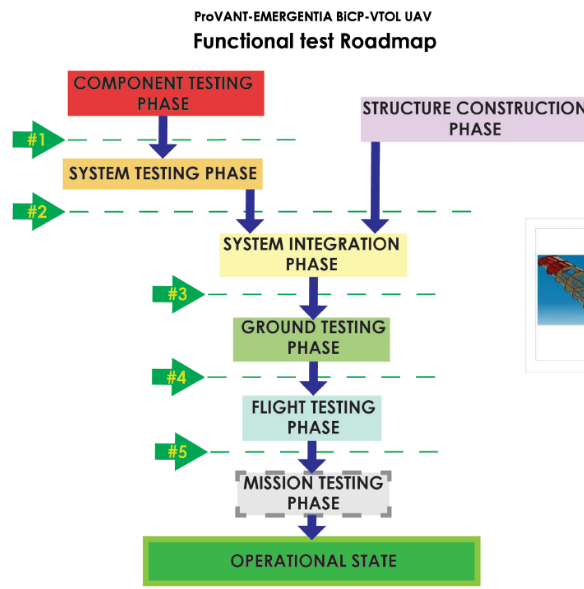
RESUME - III



Ground Station
UFMG

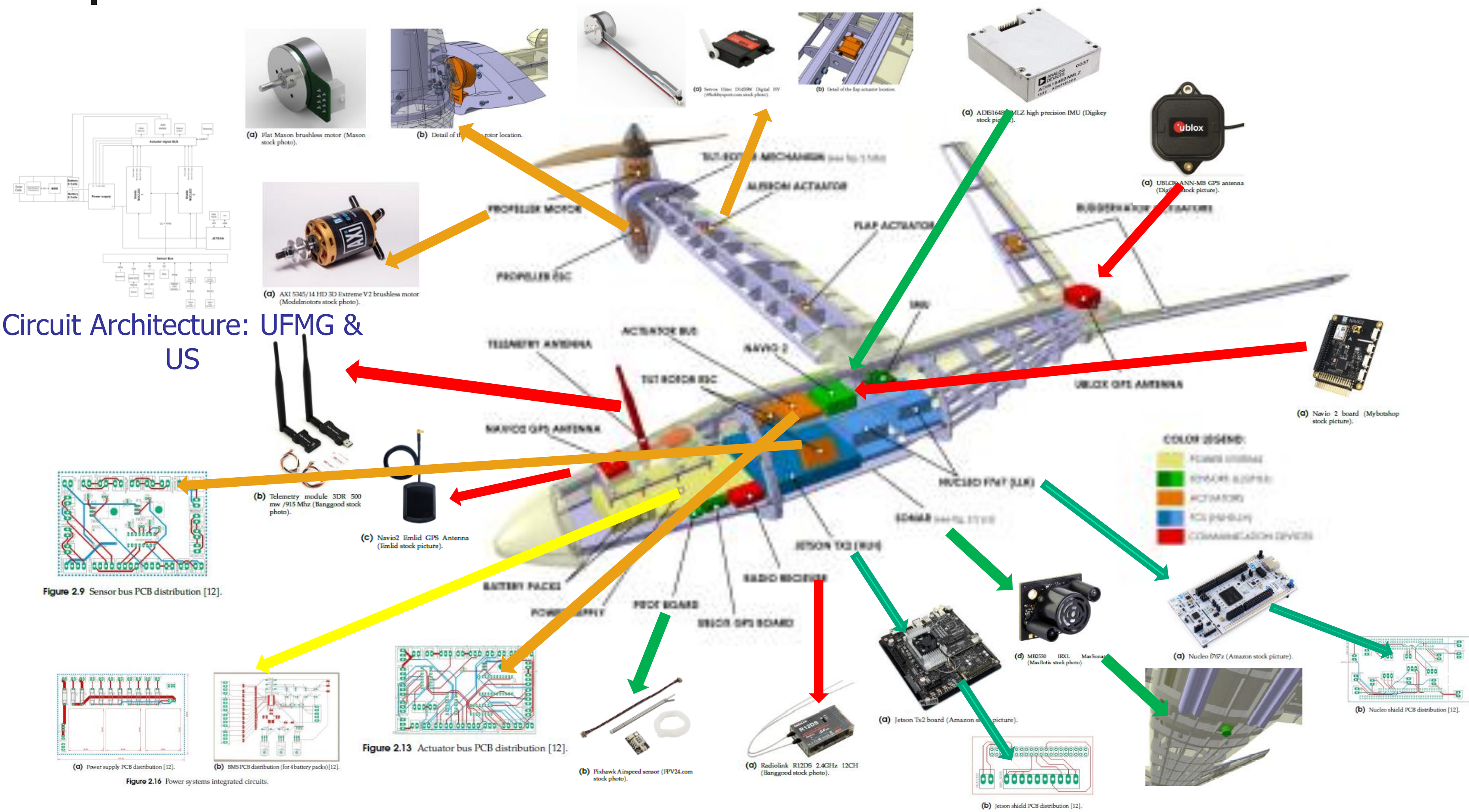






Functional Tests US &
UFMG

RESUME - IV

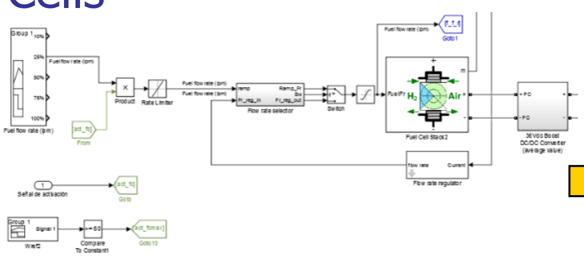


Circuit Architecture: UFMG & US

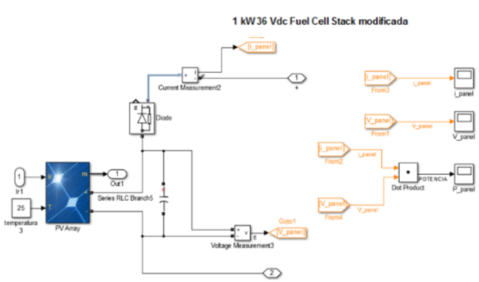
- Objetives:
  - Development of energy generation and management systems
    - fuel cells and solar cells and batteries
    - evaluation of the feasibility of using different energy storage systems.
  - Development of the energy systems and the hybridization logic
    - Allowing use of different energy sources depending on mission requirements, while ensuring extended endurance and life cycle of the energy system.

Batteries

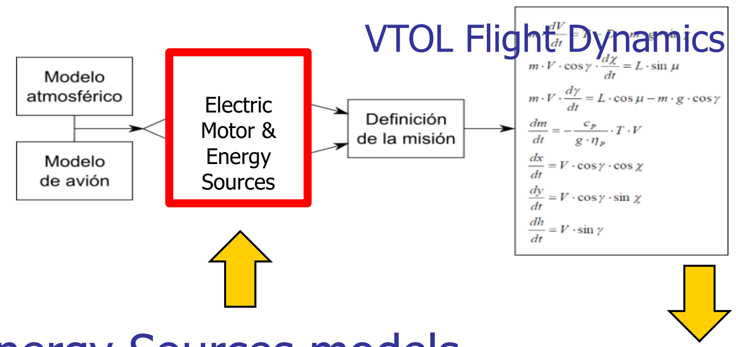
Fuel Cells



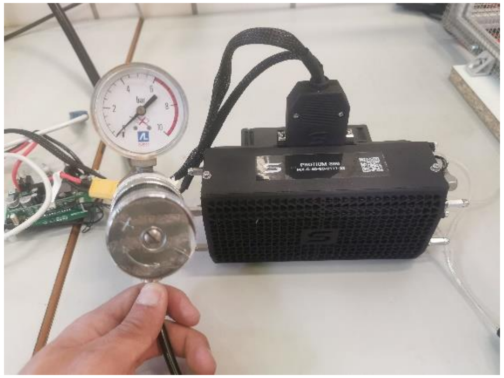
Solar Cells

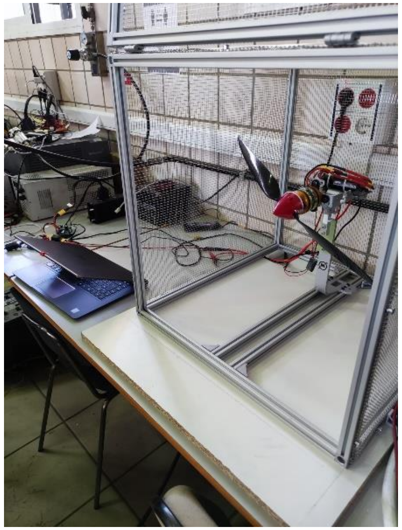


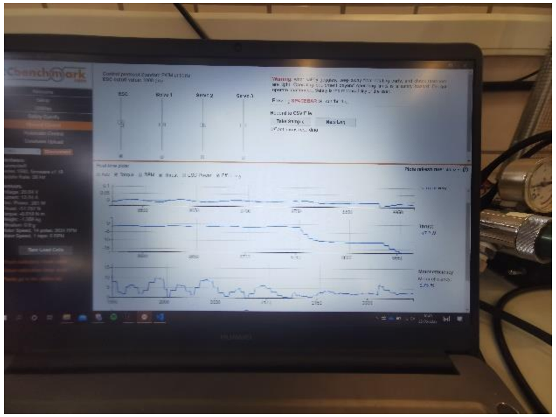
VTOL Flight Dynamics Simulator



Energy Sources models



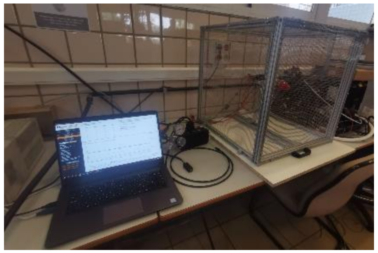


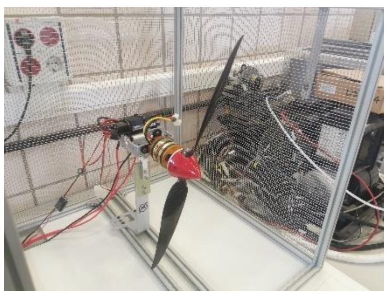


Fuel Cell integration in Electric propulsión Experiments

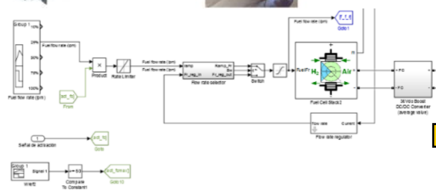
RESUME - V

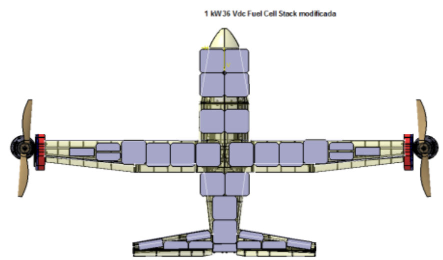
Fuel Cells Experiments @ ETSI



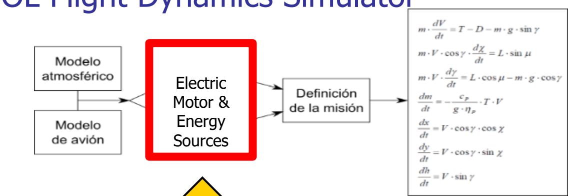


Batteries

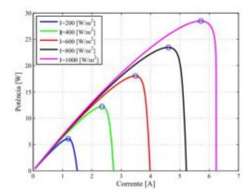


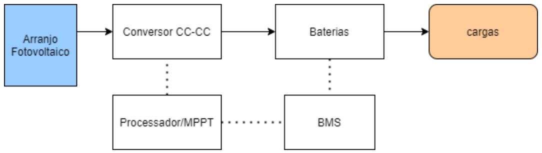


VTOL Flight Dynamics Simulator

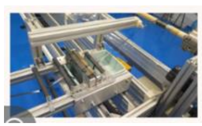


Energy Sources models



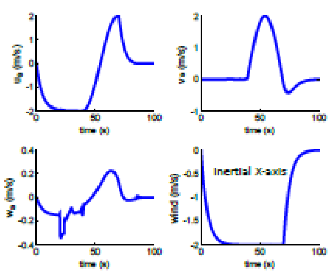


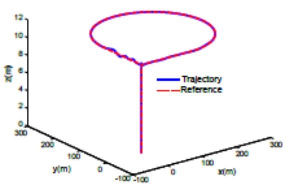
Solar Cells

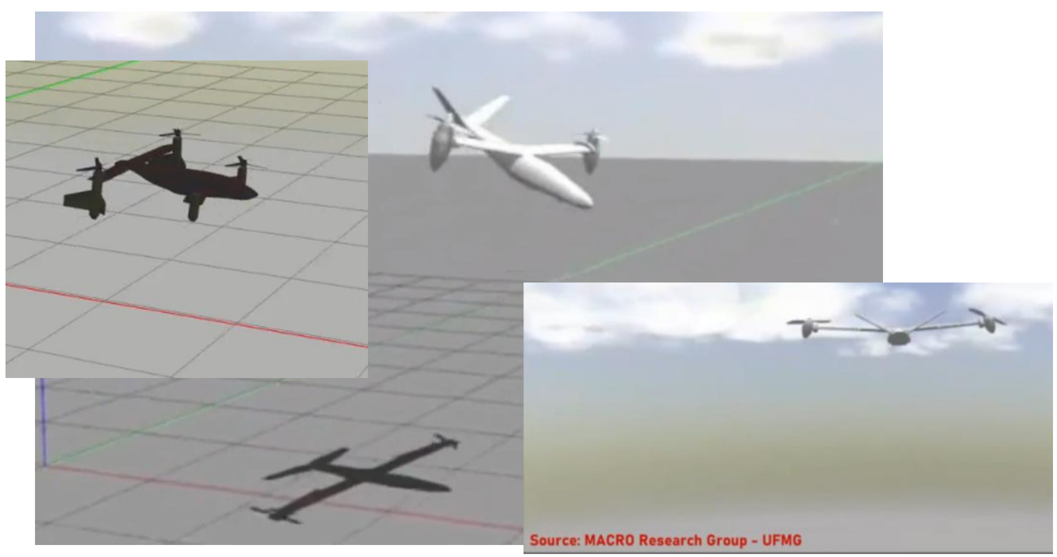


Hydrogen Storing System: Go Ahead Engineering SL

- Objectives:
  - Development of a Autonomous Guidance Navigation and Control System (GNC) for the safe and autonomous operation of the aircraft in SAR missions.
  - Design of the required architecture, development of a simulation model of the control system that captures the behavior of this unconventional aircraft during critical phases such as the transition between airplane mode and rotating wing mode, low speed flight.
  - Low-level control systems will be developed to stabilize the aircraft, as well as guidance systems to fulfill the mission entrusted, with minimum energy consumption.







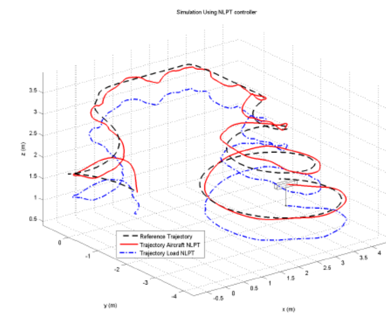
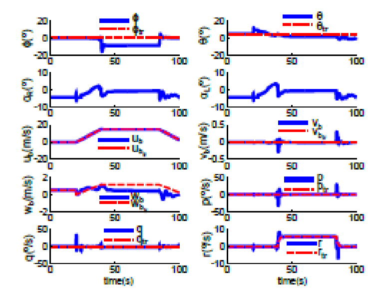


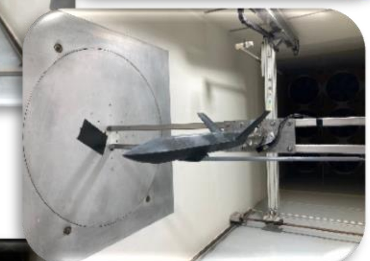
Figure 5.2: Path tracking of the aircraft for the LKFUI simulation.

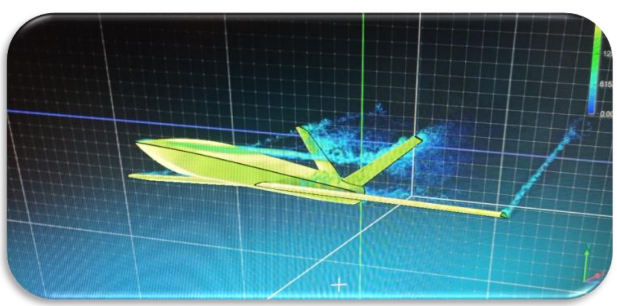
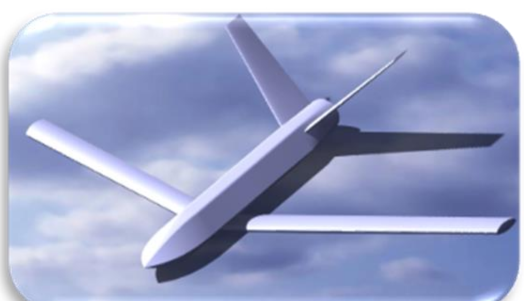
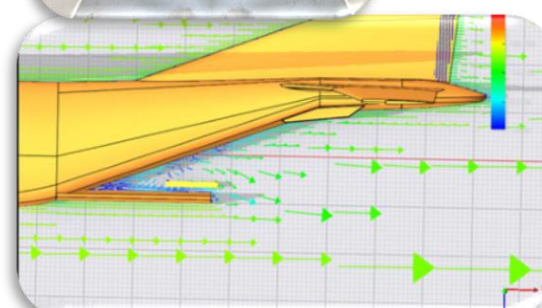


Remote Carrier Small

- Universidad de Sevilla: Phd (2019-20XX) (NDA)
- Validation of Methodology (of SANAID)
  - Design of Custom UAV for Requirements
    - Low RCS and IR signature
    - Modular payload
    - Aerial launch and recovery
    - Foldable wing
    - Novel manufacturing techniques
    - MUT/Swarming
  - Multidisciplinary interaction:
    - Aerodynamics, Stability and Control, Propulsion, Performance, Structures, Systems Integration.



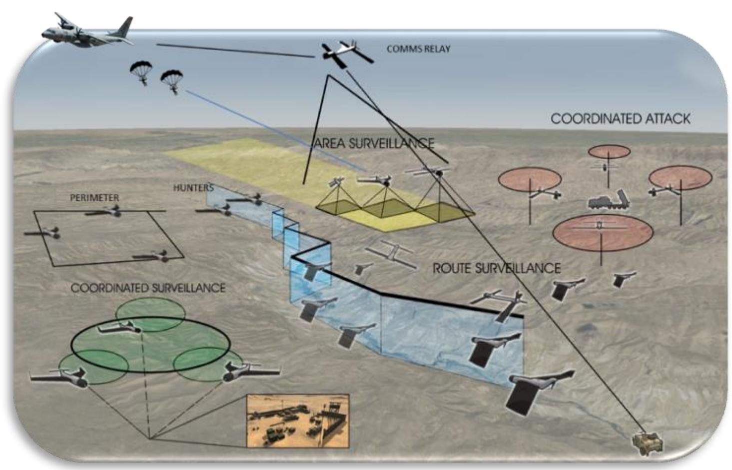


Swarming

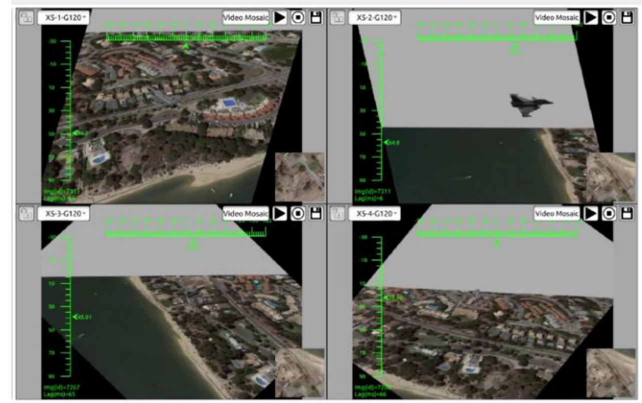
Payload flight formation: Fighter & MUT

- Universidad de Sevilla: Phd (NDA)
- UAVs Onboard intelligence (Edge computing):
  - Intelligence, Reconaissance and Surveillance missions.
  - Distributed decision making: Automatic resource allocation.
    - Route changes, divert resources automatically
    - Sweep areas
  - Mission planning: Automatic mission planning and retasking depending the objective and mission.
  - Automatic target detection: Based in IA methods.
  - Targeting and prioritisation
- Distributed C2 comms
- Transparent to autopilots and comms system
- Scalable: In range, number of elements and aircraft sizes
- Capacities:
  - Collision avoidance: Collaborative and predictive
  - Automatic take off and landing
  - 3D No fly zone & 3D Geofence
- Status
  - Simulator operative
  - Not ready to fly yet.



Manned Unmanned Teaming

Payload flight formation: Fighter & MUT



- Universidad de Sevilla: Phd (NDA)
- MUT System
  - Two approach
    - High dynamic: Formation flight
      - Fighter + Remote Carriers (flight formation)
    - Low dynamic: Swarming
      - Autonomous mission distribution
    - Both approaches can occur in same mission and aircraft
  - Capabilities
    - Specific HMI(Human Machine Interface) based in safety
      - No fly area
    - Different formations
    - Distributed coordination
  - Status
    - Ready to flight test (soon)
    - Simulator operative