

ERCOTAC Autumn Festival 2026

National Technical University of Athens

School of Mechanical Engineering, Athens, Greece



ERCOTAC

European Research Community On
Flow, Turbulence And Combustion



Laboratory of Fluid Mechanics and Turbomachinery

School of Mechanical Engineering

Aristotle University of Thessaloniki

Research activities in fixed-wing UAV
design, optimization and flight testing

Pericles Panagiotou
Kyros Yakinthos



Introduction

- Aristotle University of Thessaloniki
 - Laboratory of Fluid Mechanics and Turbomachinery (LFMT)
 - UAV integrated Research Center (UAV-iRC)
- Research personnel
 - Professors
 - Postdoc researchers
 - Dipl. Mechanical Engineers
- Fixed-wing-UAV-related activities
 - Design and synthesis of experimental prototypes (clean-sheet)
 - Ground and flight testing of fixed-wing UAVs
 - Design-for-airworthiness and compliance evaluation
 - Interdepartmental Master's "Aerial Autonomous Systems" on UAV layout design/analysis, sensors, communications and airworthiness



AUTH campus



CIRI AUTH

Fixed-wing UAVs

- Fixed-wing UAVs vs manned aircraft
 - Lack of crew on-board
 - Reduced weight
 - Operation in hazardous environment
 - Reduced operating costs
 - **Increased endurance**

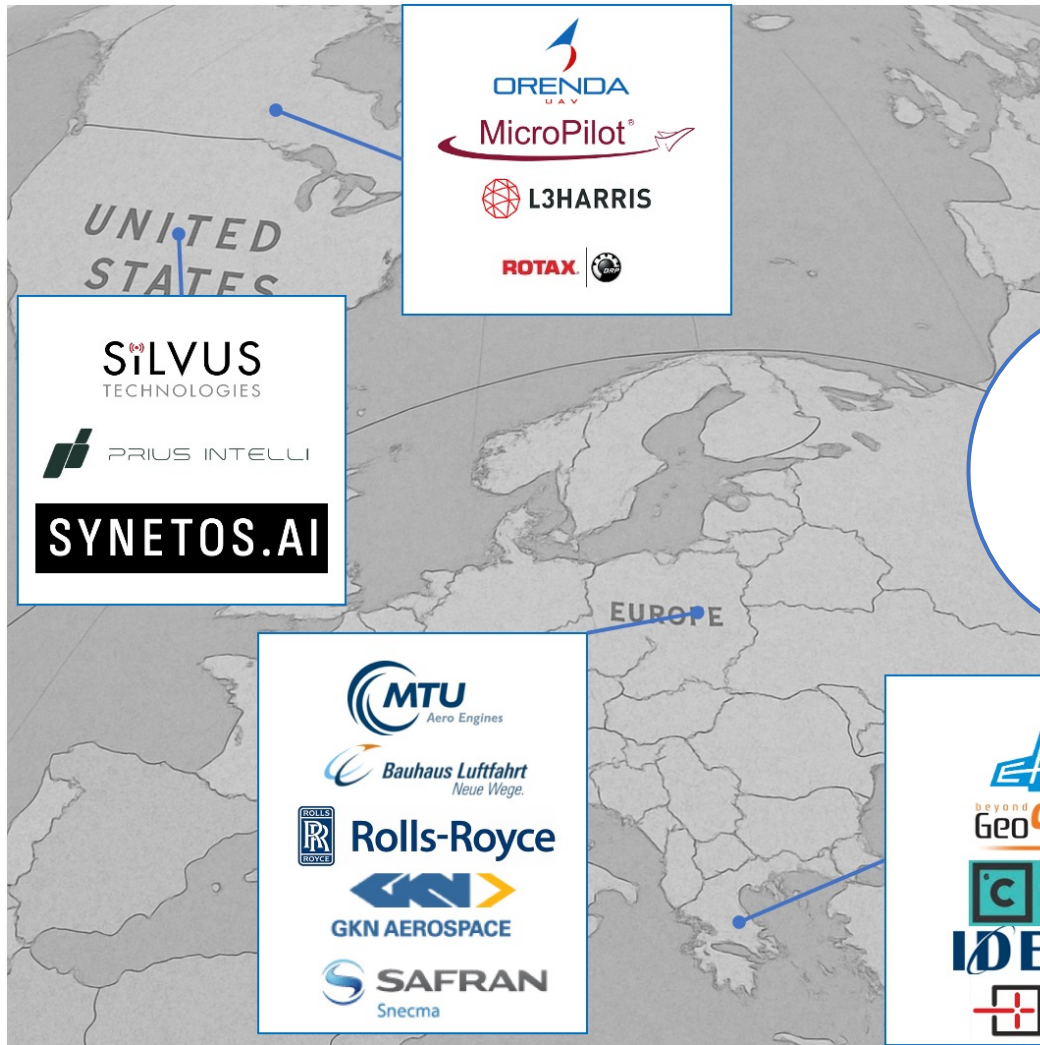


Fixed-wing UAVs

- Fixed-wing UAVs vs manned aircraft
 - Lack of crew on-board
 - Reduced weight
 - Operation in hazardous environment
 - Reduced operating costs
 - **Increased endurance**
- Large variety of (fixed-wing) configurations



Projects and partnerships



Industry

- Contract with Synetos Defense (2025)
- Contract with ORENDA UAV (2022-2027)
- Contract with HAI (2023-2025)
- Contract with MTU Aeroengines (2022-2025)
- Contract with HAI (2021-2025)
- Contract with ALTUS LSA (2021-2023)
- Contract with IDE (2017-2020)

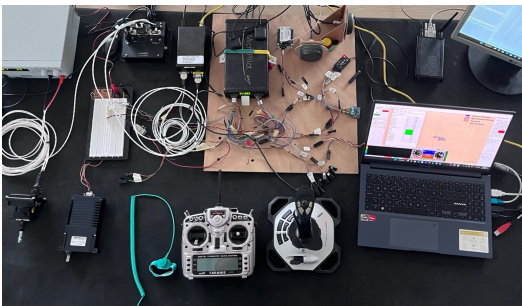
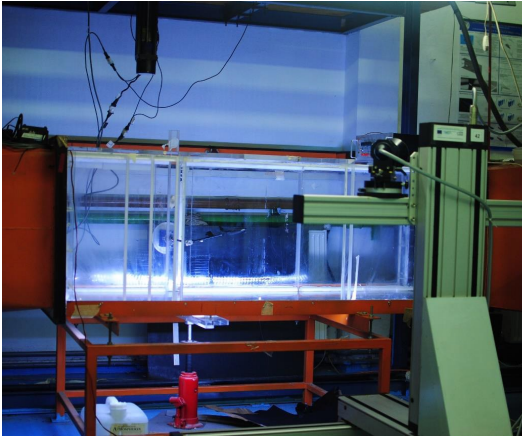
EU-funded

- EXAELIA (2025-2028)
- MINIMAL (2022-2027)
- SWITCH (2023-2026)
- LOTUS (2020-2026)
- ULTIMATE (2015-2020)
- LEMCOTEC (2011-2017)

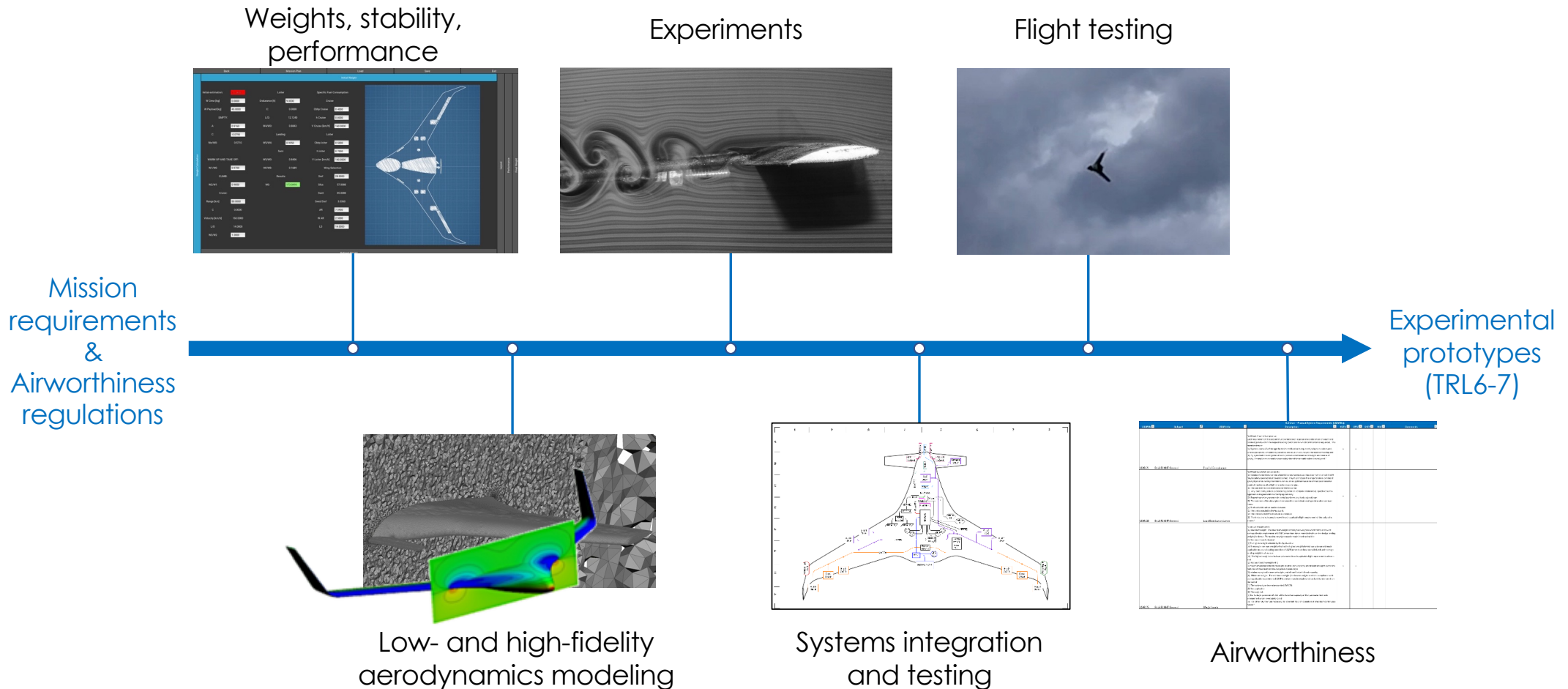
National

- INDIANA (2023-2025)
- RADAERO (2019-2022)
- DROMEAS (2020-2024)
- EURRICA (2020-2023)
- DELAER (2018-2022)
- MPU (2018-2022)
- HCUAV (2013-2016)

Facilities



Design & testing roadmap and tools



Design & testing roadmap and tools

The roadmap is supported by 7 key pylons

Mission
requirements
&
Airworthiness
regulations

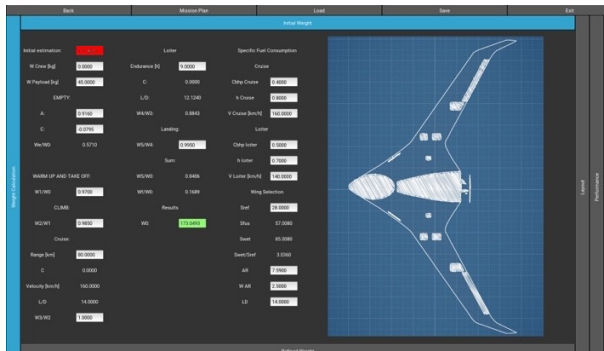
1. Layout design, synthesis and performance
2. Aerodynamic, stability & thermal analysis
3. Ground testing of UAV components and systems
4. Flight testing and evaluation
5. Low-observability analysis
6. Novel configurations (Blended Wing Bodies) & VTOLs
7. Physics-aided Machine Learning optimization suite

Experimental
prototypes
(TRL6-7)



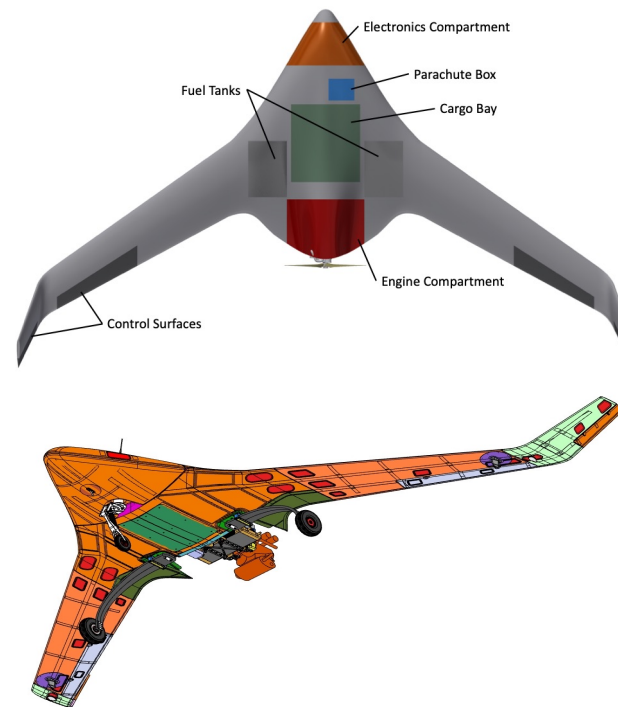
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1. Layout design, synthesis and performance

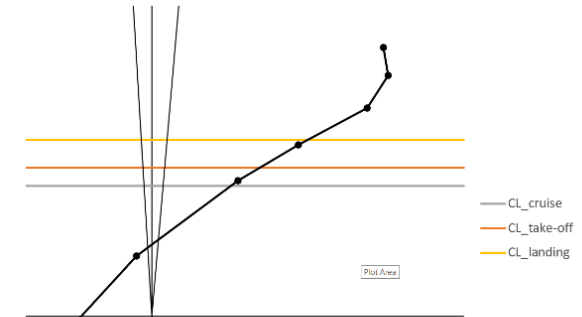


UAS AIRWORTHINESS REQUIREMENTS		NATO STANDARD AEP-4671		Propeller		REVISION 0
SUBPART	USAR	SYSTEM	TEST	(BLANK)	REQUIREMENT	RESOURCES
B	UAV FLIGHT	33	70-20-00	F	A. Propellers not controllable in flight - During take-off and initial climb at the all-engine(s)-operating climb speed specified in USAR.65, the propeller must limit the engine rpm, at full throttle or at maximum allowable take-off manifold pressure, to a speed not greater than the maximum allowable take-off rpm. - During a closed throttle glide at maximum achievable speed, MAX propeller rpm < 110% of maximum speed. B. Controllable pitch propellers without constant speed controls - The lowest possible pitch allows compliance with sub-paragraph A.1. - The highest possible pitch allows compliance with sub-paragraph A.2. C. Controllable pitch propellers with constant speed controls - With the governor in operation, the governor must limit the maximum engine rpm to MAX allowable take-off rpm by design. - With the governor inoperative, there must be a means to limit the maximum engine speed to 103% of the maximum allowable take-off rpm with the propeller blades at the lowest possible pitch and with takeoff power setting, the UAV stationary, and no wind.	

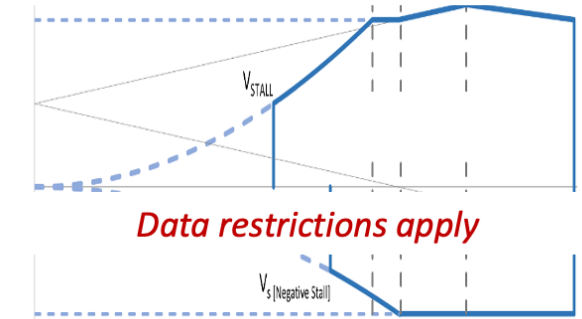
I. Design for airworthiness (0D-1D in-house tools)



II. Layout design and synthesis (3D commercial + in-house tools)



Data restrictions apply



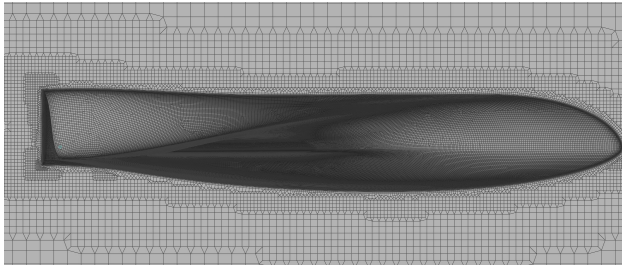
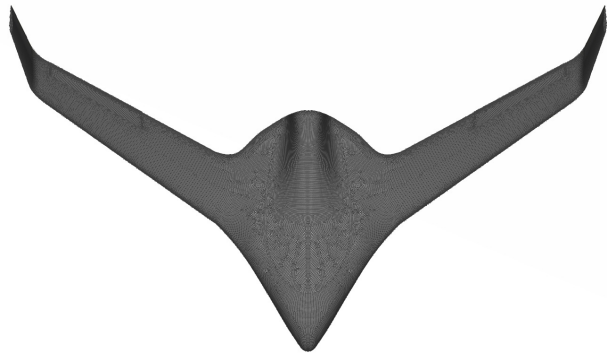
Data restrictions apply

III. Complete & on-demand performance analysis (0D-1D in-house tools)

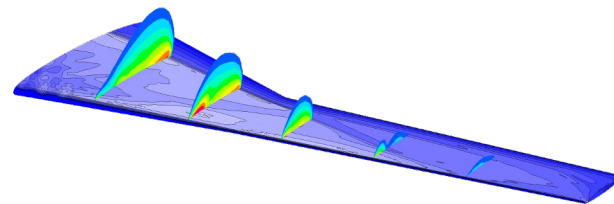
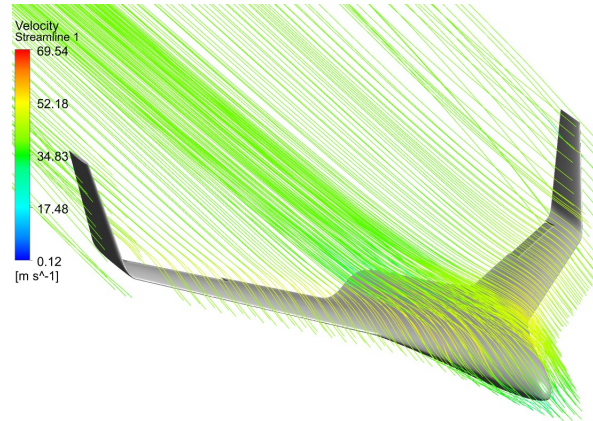
Panagiotou, P.; Mitridis, D.; Dimopoulos, T.; Kapsalis, S.; Dimitriou, S.; Yakinthos, K. Aerodynamic Design of a Tactical Blended-Wing-Body UAV for the Aerial Delivery of Cargo and Lifesaving Supplies. In Proceedings of the AIAA Scitech 2020 Forum; American Institute of Aeronautics and Astronautics: Orlando, FL, January 6 2020.

Panagiotou, P.; Kaparos, P.; Salpingidou, C.; Yakinthos, K., Aerodynamic Design of a MALE UAV. Aerospace Science and Technology 2016, 50, 127–138.

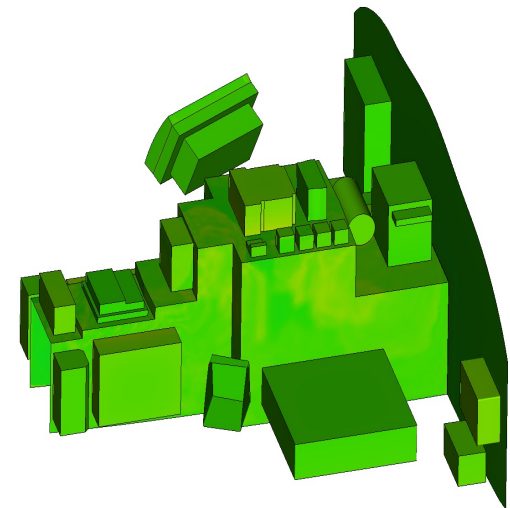
2. Aerodynamic, stability & thermal analysis



I. Complete and streamlined pipeline from design-to-analysis



II. Low- and high-speed aerodynamic and stability investigations validated against test flight data



III. Targeted thermal analyses for components and engines cooling

Dimitriadis, G.; Panagiotou, P.; Dimopoulos, T.; Yakinthos, K. Aerodynamic Stability Derivative Calculations Using the Compressible Source and Doublet Panel Method. *Journal of Aircraft* 2024, 61, 1034–1046, doi:10.2514/1.C037747.

Dimopoulos, T.; Paliakos, D.; Christou, V.; Kaparos-Tsafos, P.; Panagiotou, P., Experimental and Computational Investigation of the Vortical Structures Generated from a Blended-Wing-Body UAV Model. *Aerospace Science and Technology* 2023, 139, 108377, doi:10.1016/j.ast.2023.108377.

3. Ground testing of fixed-wing UAV components

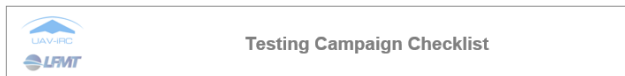


Complete in-house methodology and infrastructure for static engine testing



Complete in-house methodology and infrastructure for comms and flight control systems (autopilots) ground testing

4. Flight testing and evaluation



Testing Campaign Checklist

Testing Campaign Details

Company / Institution name	UAV-IRC
Ref. Application Form No. (Ref doc: 4-31)	
Testing Campaign Name	DROMEAS flight tests
Testing Field	
Testing Date	

Test Crew & Test Crew Positions

Test pilot	
Test planning	
Telemetry	
Integration	
Video	

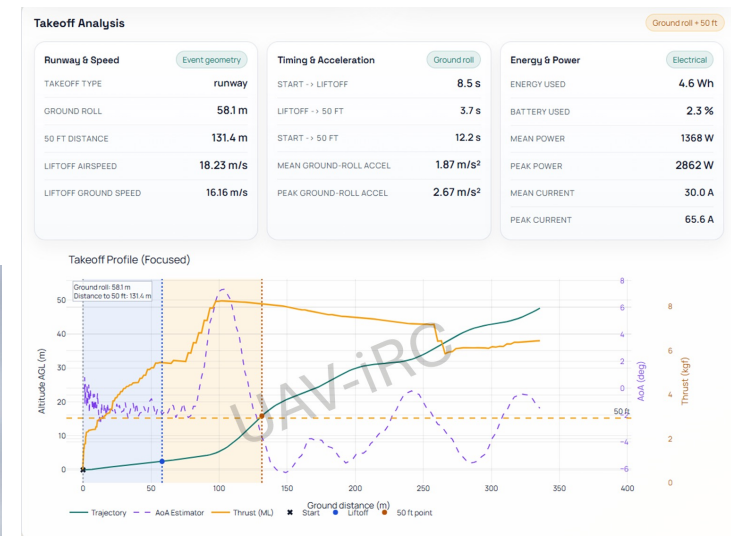
Technical Characteristics (fill any specific characteristic of the experiment / flight test)

Model name	DROMEAS	-
Span	3	m
Length	1.39	m
MTOW	17.8	kg
CG(x,w,z) (from nose)	650	mm
Fuel weight	2.5	deg
L/D _{max}	18.22 (@8 deg)	-
W/S	4.89 (23.87)	lb/ft ² (kg/m ²)
V _{max}	19.13 (69)	m/s (km/h)
P/W	0.34	hp/kg
V _{stall}	36 (130)	m/s (km/h)
V _{max}	44.44 (160)	-
Elevon trim @Cruise	See respective table	deg
Rudder/aileron trim @Cruise	N/A	deg
Engine	DLA58UA	-
Ecu Battery	3 cells, LiPo, 3300mAh	-
Ignition Battery	6 cells, LiPo, 5000mAh	-
Primary Propeller	XOAR 20x10 3Blade	in
Fuel (type)	Gasoline / Lubrication ratio: 40:1-50:1	kg
Autopilot mode	Manual control / flight data acquisition	-
Payload	None	-
Sensors	Pixhawk, GPS, pilot, power module, ECU	-



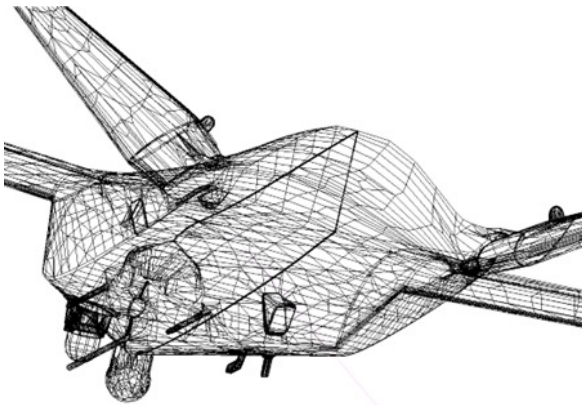
In-house protocols for testing campaigns, including permits acquisition

Complete in-house methodology for full-scale and subscale UAV prototypes testing



In-house AI-aided model for post-flight analysis and design validation

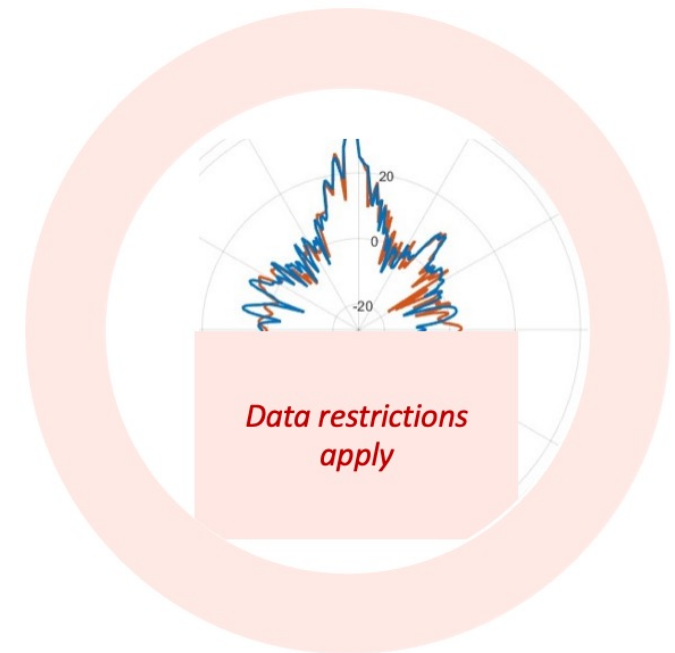
5. Low observability analysis



I. Complete and streamlined pipeline from design-to-analysis



II. Complete and validated Radar Cross Section analyses at various frequency and orientation ranges



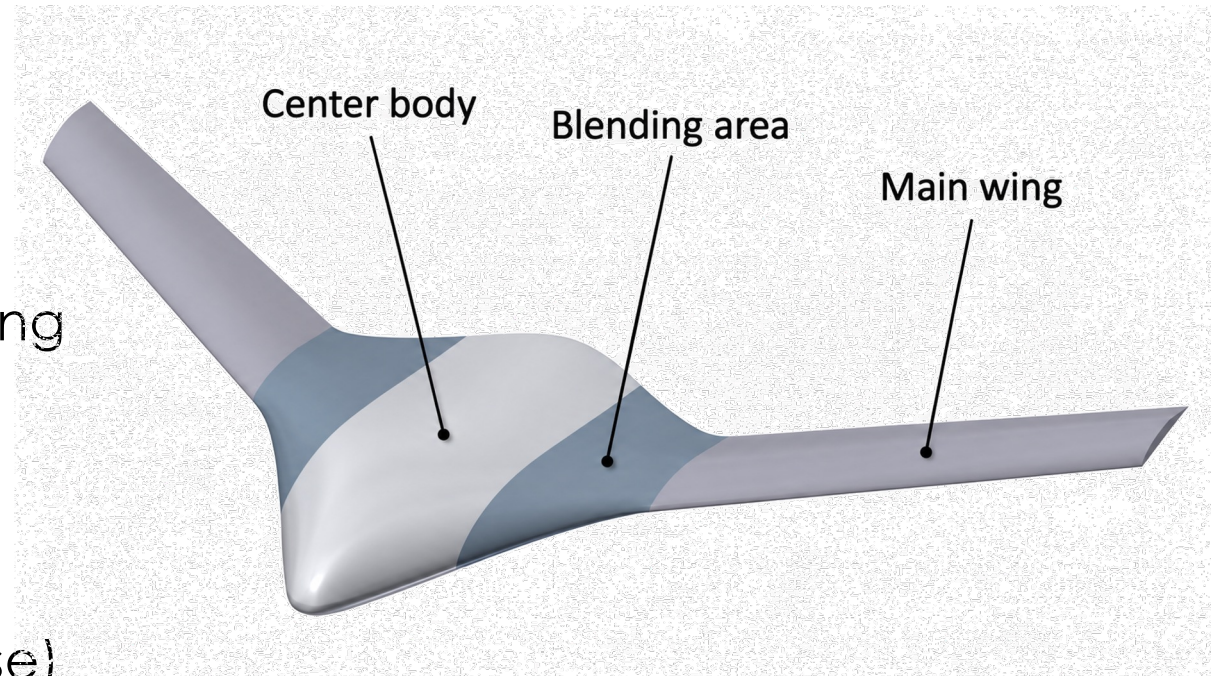
6. Novel configurations

The blended-wing-body configuration was introduced by Douglas in the 90s

- 16-20% increase in peak operating cruise L/D
- 20%-30% reduction in fuel burn compared to TNW
- 40% increase in internal volume (volume-to-wetted-area increase)

Liebeck., Design of the Blended Wing Body Subsonic Transport, *Journal of Aircraft*, 2004

Ahuja et al., Comparison of blended wing body and tube-and-wing performance characteristics, *The aeronautical journal*, 2025

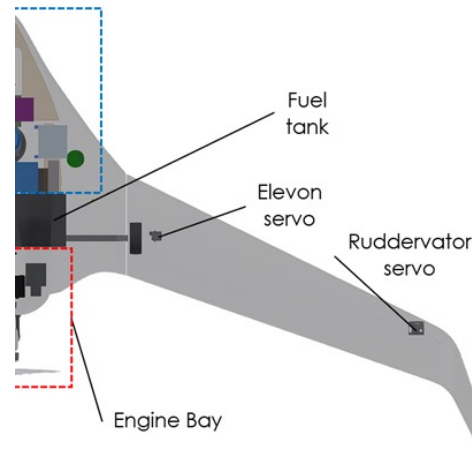


Panagiotou et al., Conceptual design of a Blended Wing Body MALE UAV, *Aerospace Science and Technology*, 2018

6. Novel configurations (Blended Wing Bodies) & VTOLs



Unique database of Blended-Wing-Body layout trends, populated by in-house parametric analyses



Unique knowhow on flying wing and BWB stability, aided by topology optimization algorithms

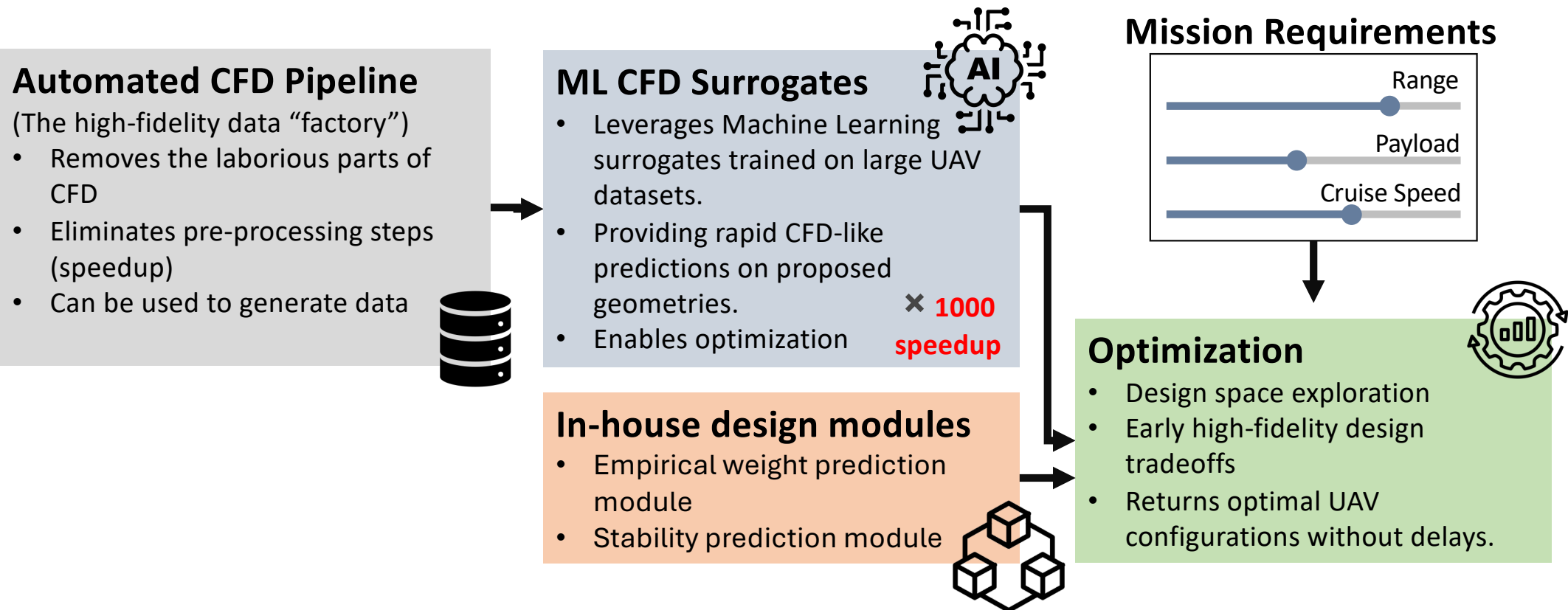


Extensive knowhow on clean sheet VTOL fixed-wing UAV design and power management/optimization

Kapsalis, S.; Panagiotou, P.; Yakinthos, K. CFD-Aided Optimization of a Tactical Blended-Wing-Body UAV Platform Using the Taguchi Method. *Aerospace Science and Technology* 2021, 108, doi:10.1016/j.ast.2020.106395.

Panagiotou, P.; Fotiadis-Karras, S.; Yakinthos, K., Conceptual Design of a Blended Wing Body MALE UAV. *Aerospace Science and Technology* 2018, 73, 32–47, doi:10.1016/j.ast.2017.11.032.

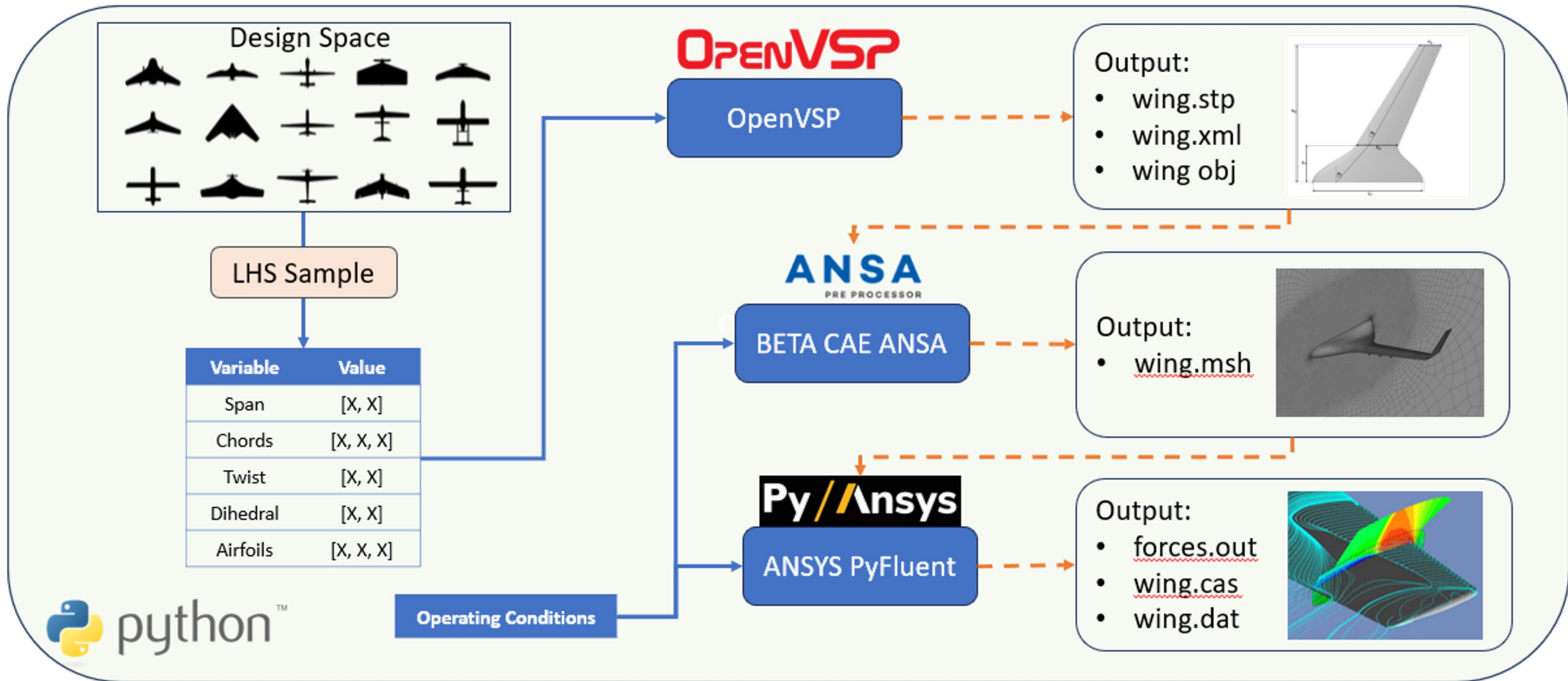
7. Physics-aided Machine Learning optimization suite



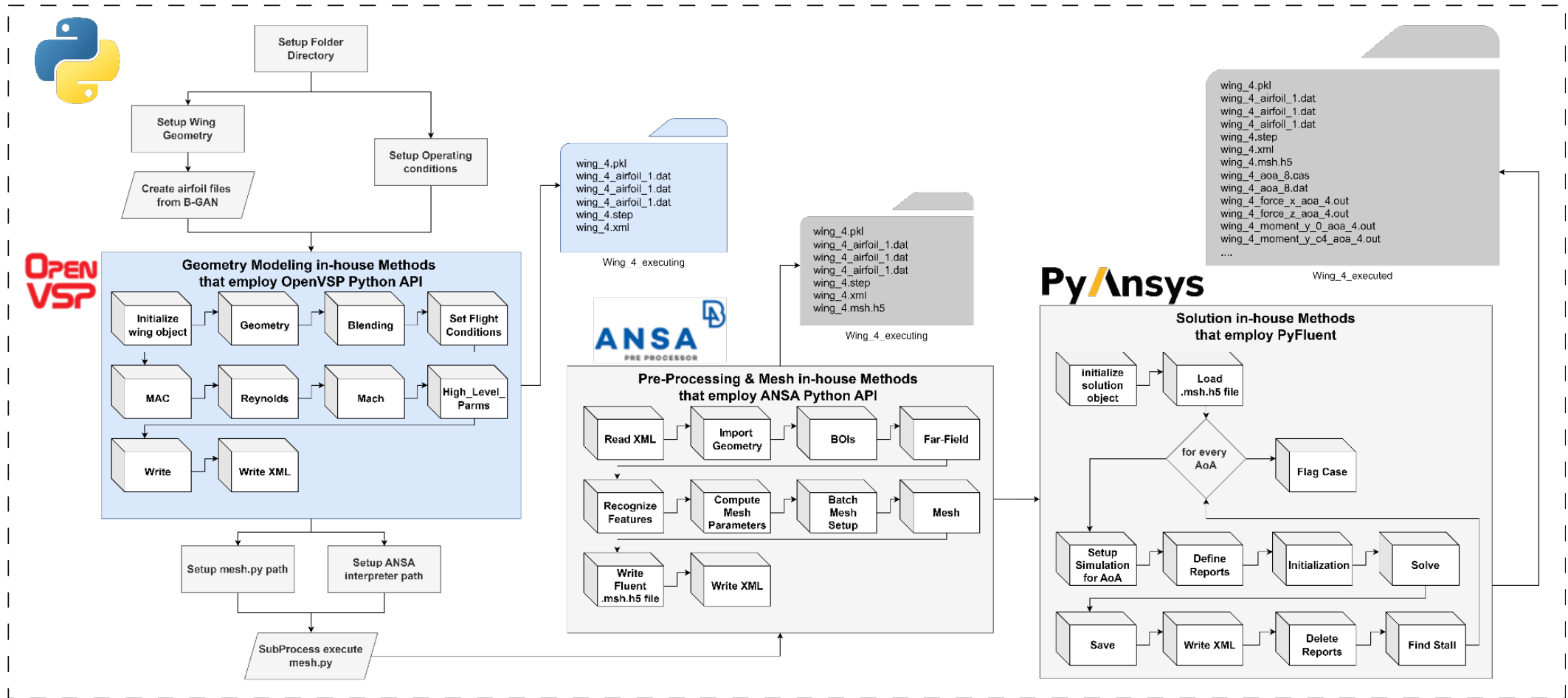
Pliakos, C.; Efrem, G.; Dimitriadis, G.; Panagiotou, P., Physics-Enhanced Neural Networks for Aerodynamic Shape Optimization of UAV Wings. In Proceedings of the AIAA AVIATION FORUM AND ASCEND 2025; American Institute of Aeronautics and Astronautics: Las Vegas, Nevada, July 29 2025.

Pliakos, C.; Efrem, G.; Terzis, D.; Panagiotou, P., An Automated Framework for Streamlined CFD-Based Design and Optimization of Fixed-Wing UAV Wings. *Algorithms* 2025, 18, 186, doi:10.3390/a18040186.

7. Physics-aided Machine Learning optimization suite



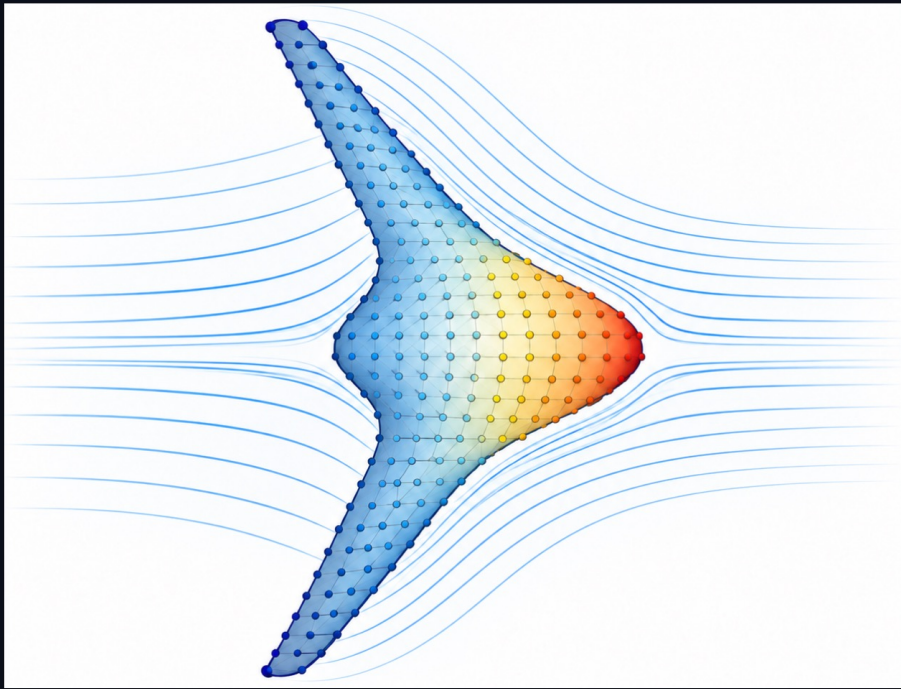
7. Physics-aided Machine Learning optimization suite



7. Physics-aided Machine Learning optimization suite

UAV-AID-100

UAV-AID-100 is the full-CFD public release of the UAV Aerodynamic Information Dataset (UAV-AID).



Dataset Overview

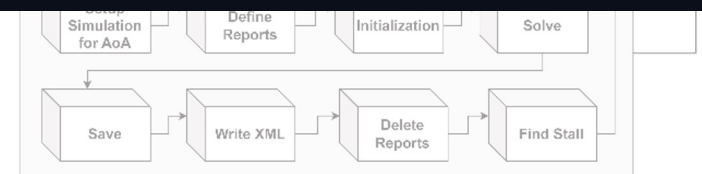
UAV-AID was generated using an automated three-dimensional CFD workflow for fixed-wing UAV lifting surfaces. ("An Automated Framework for Streamlined CFD-Based Design and Optimization of Fixed-Wing UAV Wings")

The complete UAV-AID design-space registry contains **10,000 wing configurations** spanning conventional, flying-wing and blended-wing-body (BWB) geometries.

CFD production was initiated for **5,572 configurations**, of which **5,448 produced at least one aerodynamic solution**, resulting in **64,422 wing-angle-of-attack CFD records**.

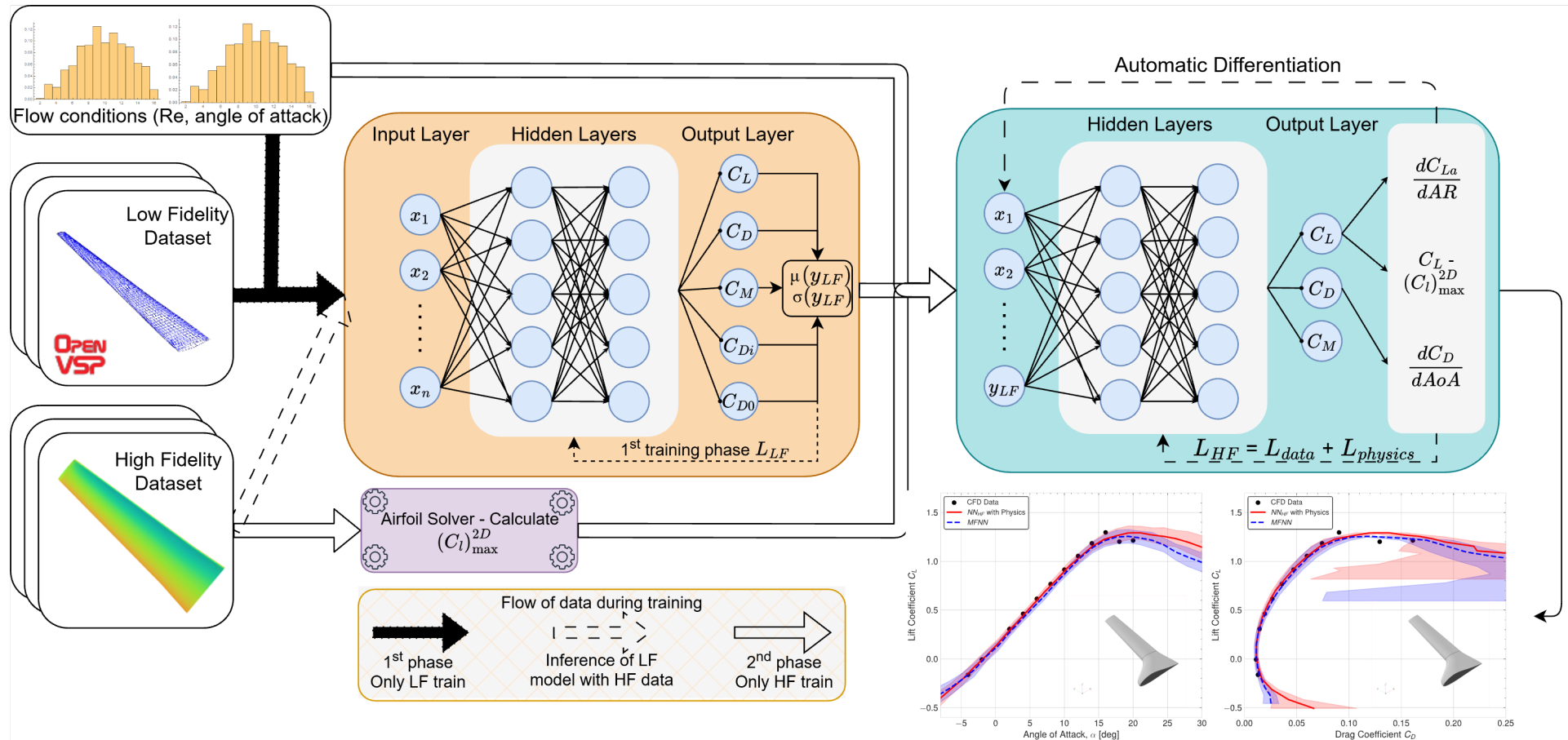
wing_4.pkl
wing_4_airfoil_1.dat
wing_4_airfoil_1.dat
wing_4_airfoil_1.dat
wing_4.step
wing_4.xml

Write XML

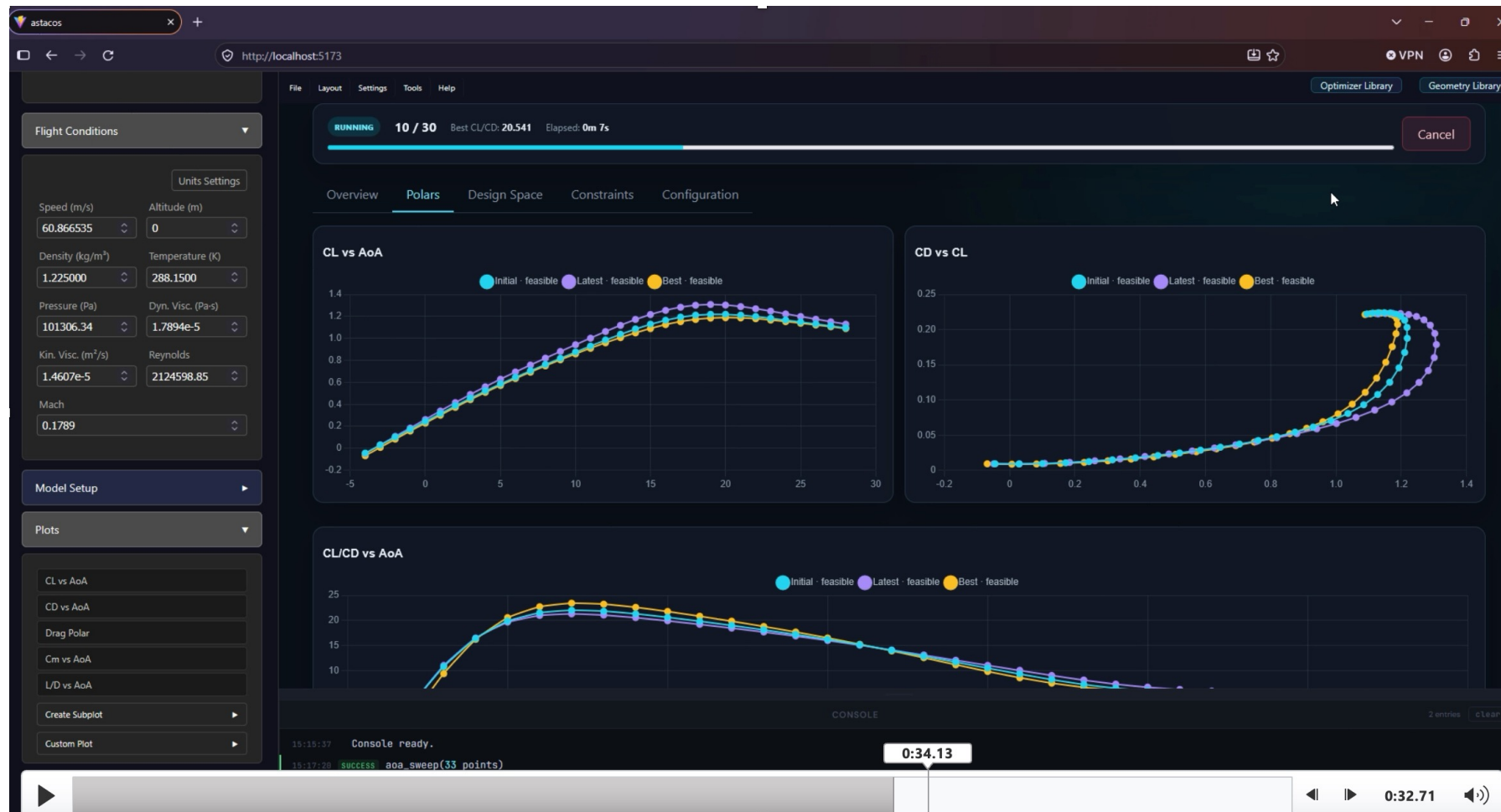


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7. Physics-aided Machine Learning optimization suite



7. Physics-aided Machine Learning optimization suite



Fixed-wing UAVs experimental prototypes



HC UAV RX-1

Layout: Conventional
Mission: Surveillance
GTOW: ~200kg



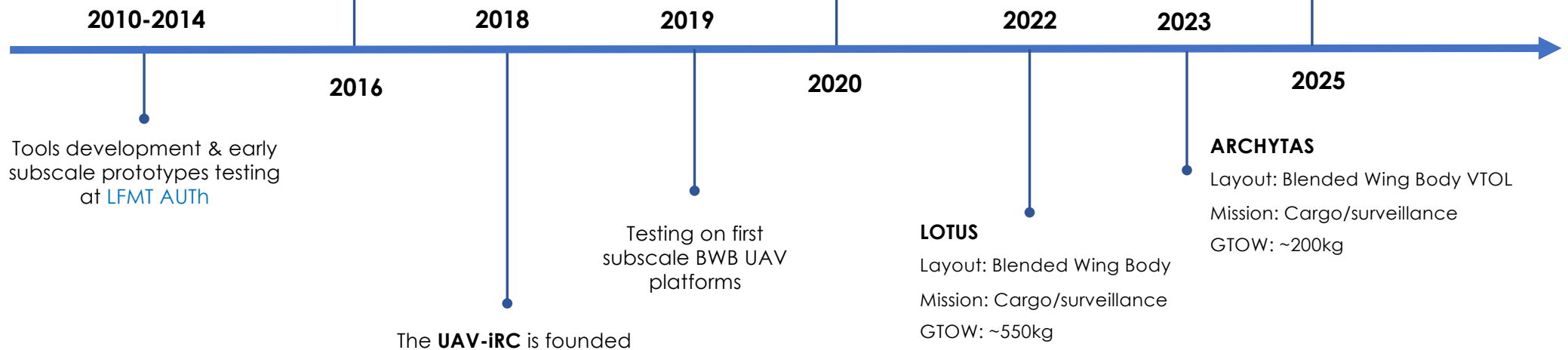
RX-3

Layout: Blended Wing Body
Mission: Cargo / Surveillance
GTOW: ~250kg



ORENDA UAV

Layout: Blended Wing Body
Mission: Cargo/surveillance
GTOW: ~650kg



Fixed-wing UAVs portfolio

Platform callsign	Configuration layout	Mission	W_p/W_0	Wingspan [m]	Funding type	Indicative image
HCUAV RX-1	Conventional	ISR	0.19	6.4	National	
S-3m	BWB	ISR	0.2	2.4	Greek industry	
RADAERO	Conventional	Demonstrator	N/A	2	National funding	

Fixed-wing UAVs portfolio

Platform callsign	Configuration layout	Mission	W_p/W_0	Wingspan [m]	Funding type	Indicative image
EURRICA	BWB	Demonstrator	N/A	2.4	National	
RX-3	BWB	Cargo	0.19	7.2	National	
RX-4	VTOL fixed-wing	ISR	0.17	2.4	National	

Fixed-wing UAVs portfolio

Platform callsign	Configuration layout	Mission	W_p/W_0	Wingspan [m]	Funding type	Indicative image
DROMEAS	BWB	Cargo/ISR	0.20	3	National	
LOTUS MAP	Hybrid	Cargo/ISR	*	>10	EU	
ARCHYTAS	VTOL BWB	Cargo/ISR	*	*	Greek Industry	

Fixed-wing UAVs portfolio

Platform callsign	Configuration layout	GTOW [kg]	W_p/W_0	Wingspan [m]	Funding type	Indicative image
ORENDA UAV	BWB w canards	Cargo/ISR/ Other	*	>10	Canadian Industry	

In total:

30+ testing campaigns of fixed-wing experimental prototypes

- 2 fixed-wing UAVs based on conventional layout
- 6 fixed-wing UAVs based on BWB layout
- 2 fixed-wing VTOL UAVs
- Hundreds hours of flight testing/data

TRL out:

- TRL6 (clean-sheet designed aerial vehicles)
- TRL7 (COTS components, autopilots, avionics, electronics, comms (COTS))

Thank you for your attention

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