

Aerodynamic Design of Propellers for Distributed and Hybrid-Electric Propulsion

PhD Student: Pablo Moreno Escolástico
Supervisor/s: Rodrigo Castellanos, Andrea Cini & Marco Raiola

PhD Aerospace Engineering UC3M
Doctoral Meetings 2026
2nd and 3rd June 2026

Propulsion Systems Optimization for Sustainable Aviation

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New Aircraft
Architectures



New Propulsion
Architectures



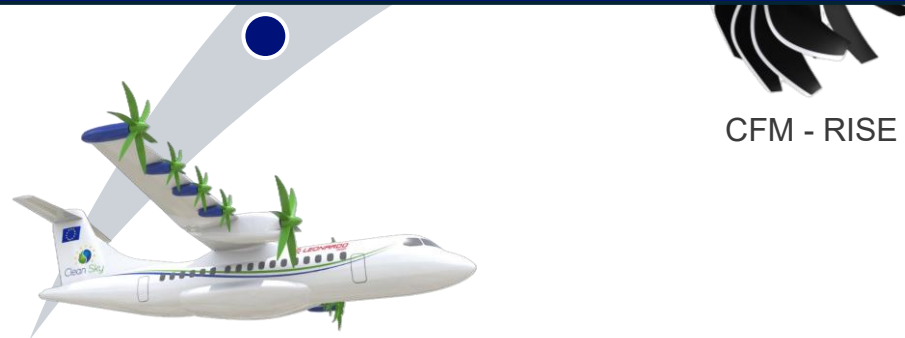
Need for design
methodologies





Need for design
methodologies

How can we design the next generation of sustainable
aviation propulsion systems?



CFM - RISE

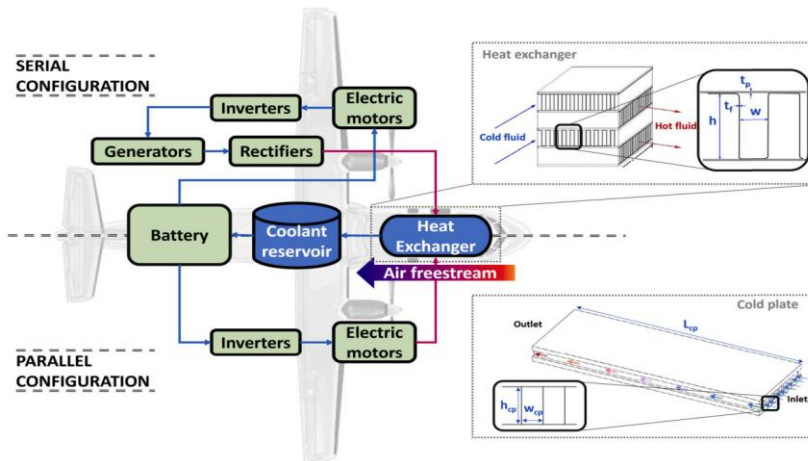
State of the Art

1. Propulsion system design has become a multidisciplinary problem
2. Multidisciplinary Design Optimization (MDO) is becoming the standard
3. Current design is based on sequential sizing or fixed correlation coefficients

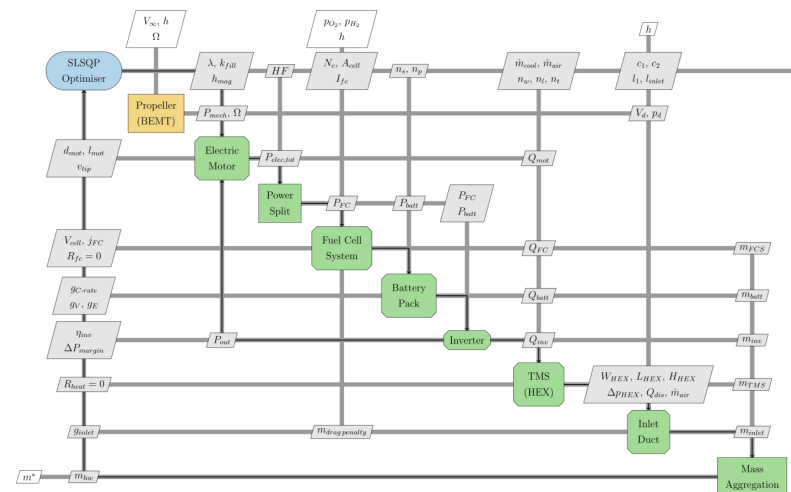


Research gap:

- Lack of physics-based multidisciplinary sizing tools
- Sequential design fails to capture discipline interactions

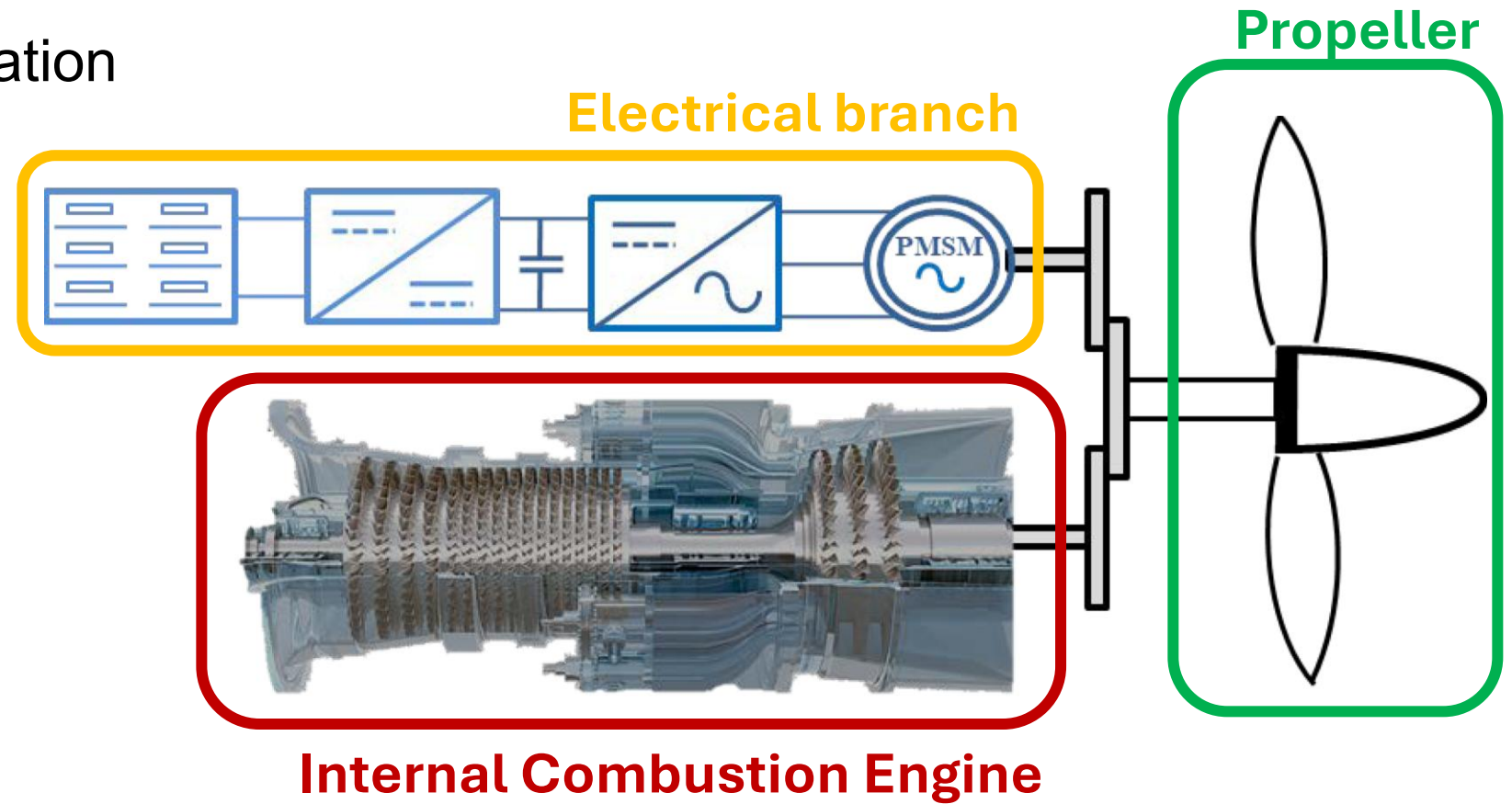


(Quibén et al., 2024)

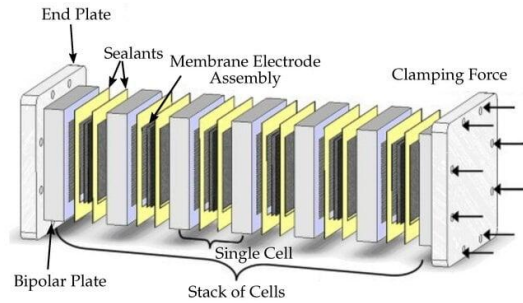


Preliminary design tool:

- Physics-based
- Simultaneous optimization
- Modular
- Mechanical sizing
- Mass estimation

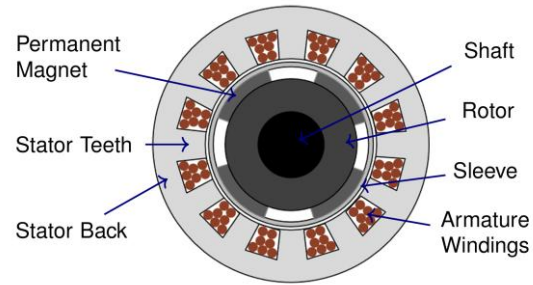


Fuel Cell System

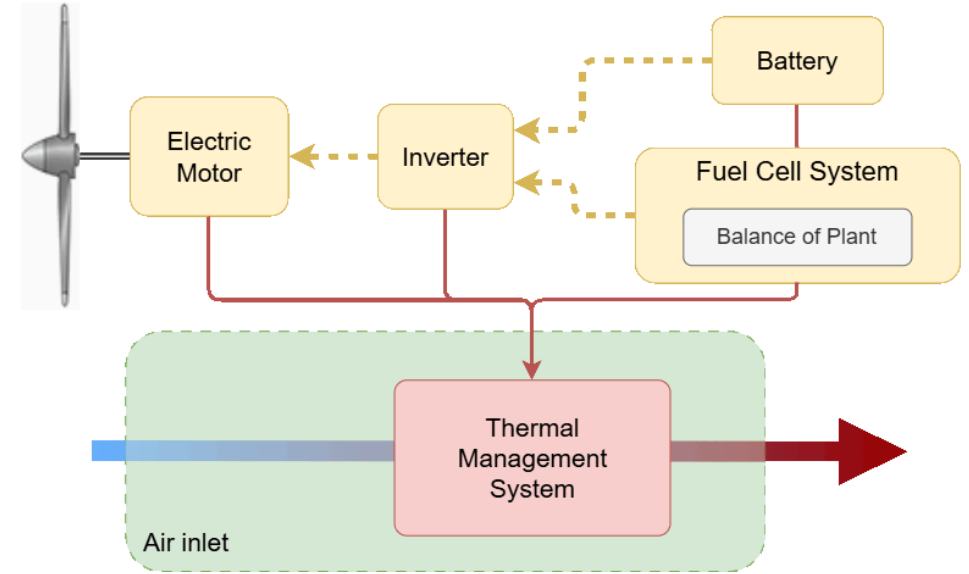


(Hoff et al., 2022)

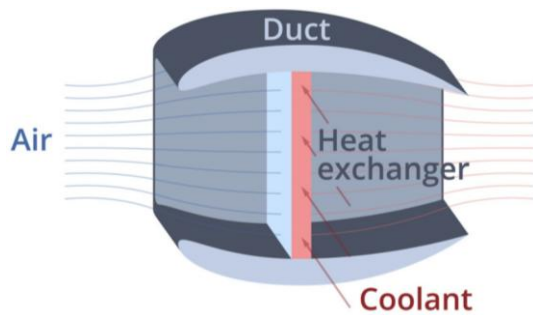
Electric Motor



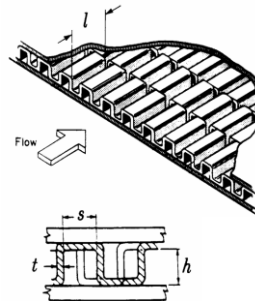
(Bahrs et al., 2022)



Thermal Management System



(Adler et al., 2025)

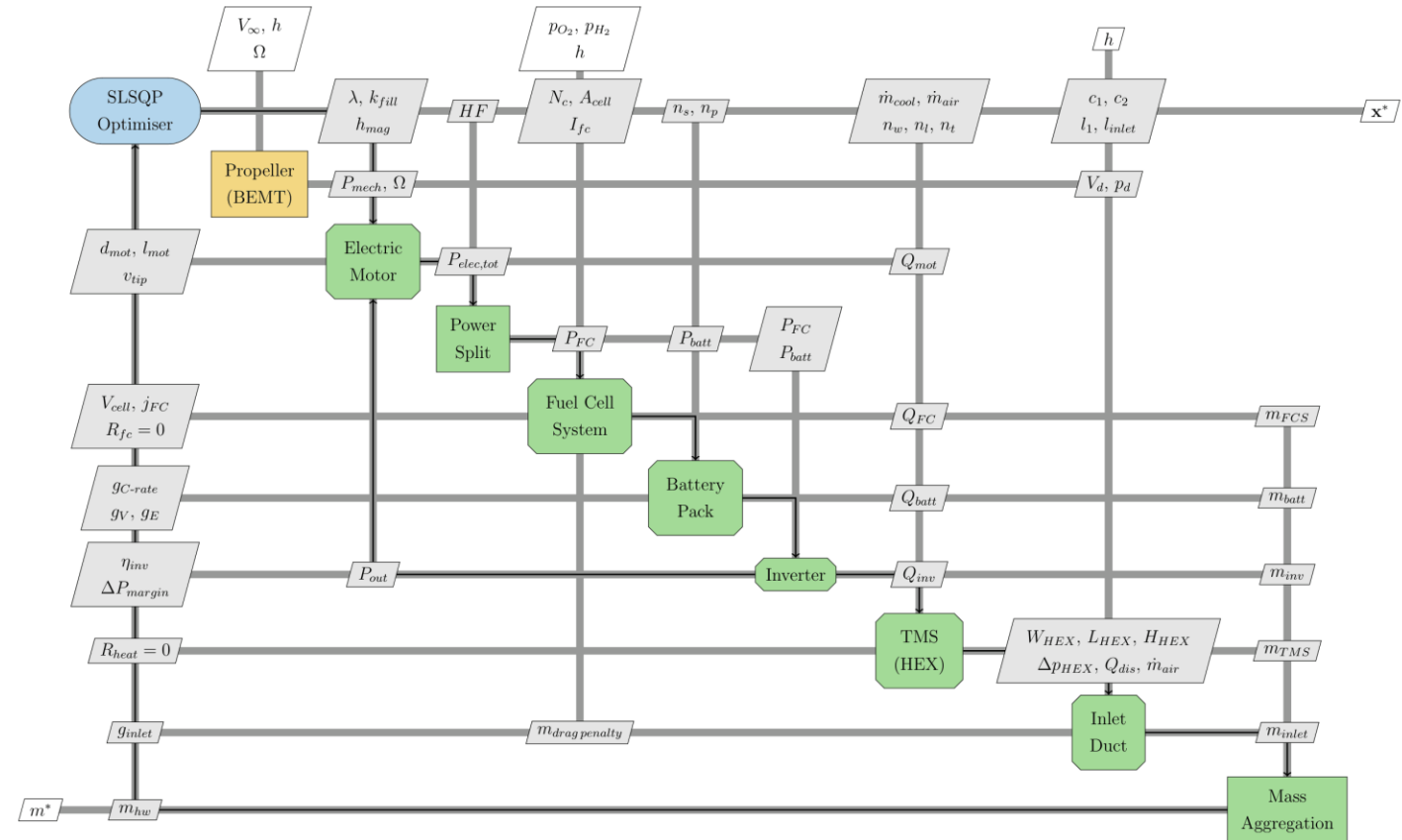
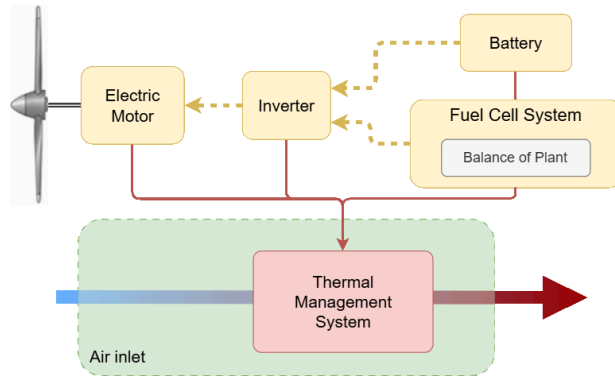


(Manglik and Bergler, 1995)

Hybridization Factor:

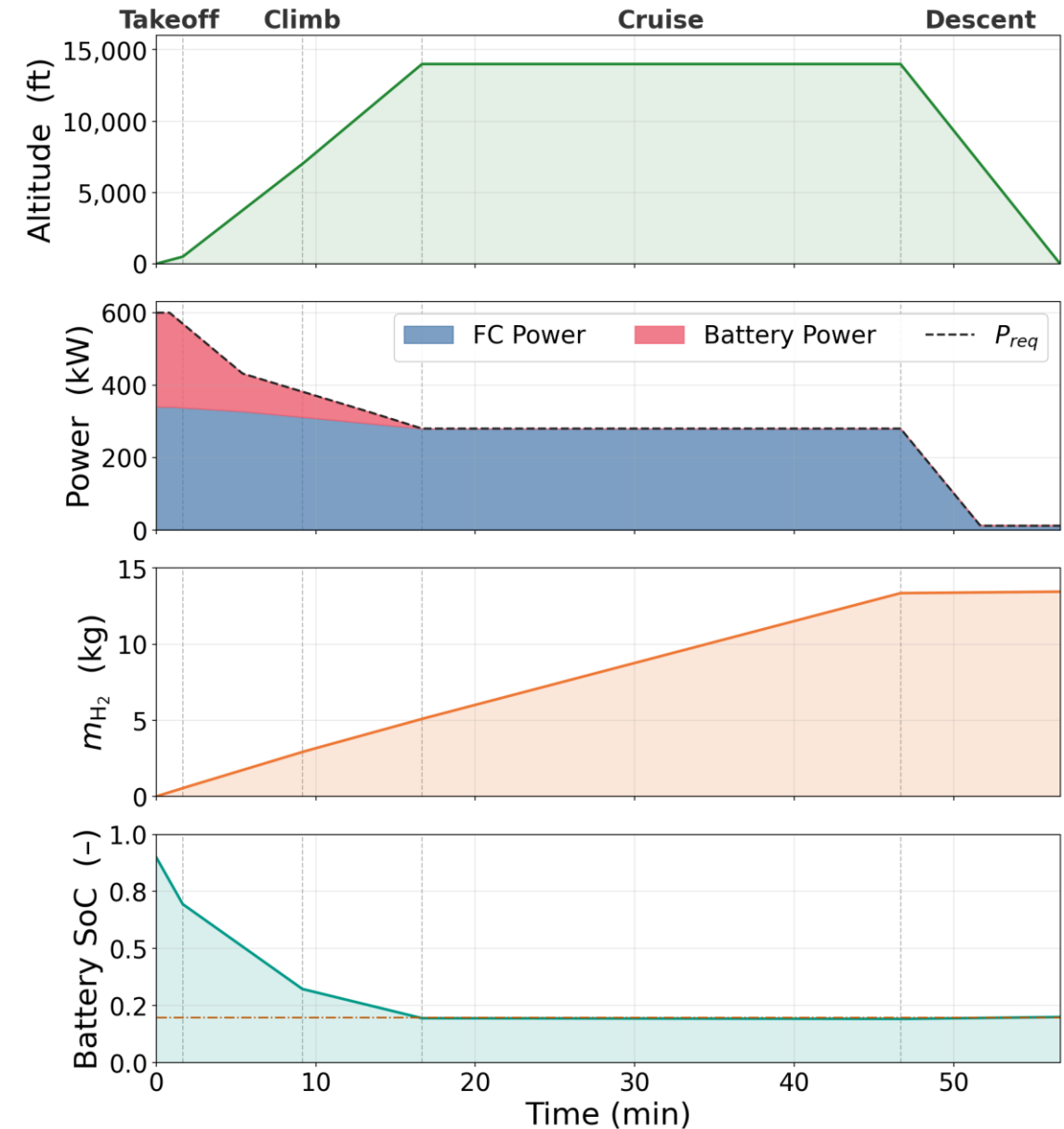
$$HF = \frac{P_{fuel\ cell}}{P_{fuel\ cell} + P_{battery}}$$

Modular H₂-electric propulsion system MDO framework

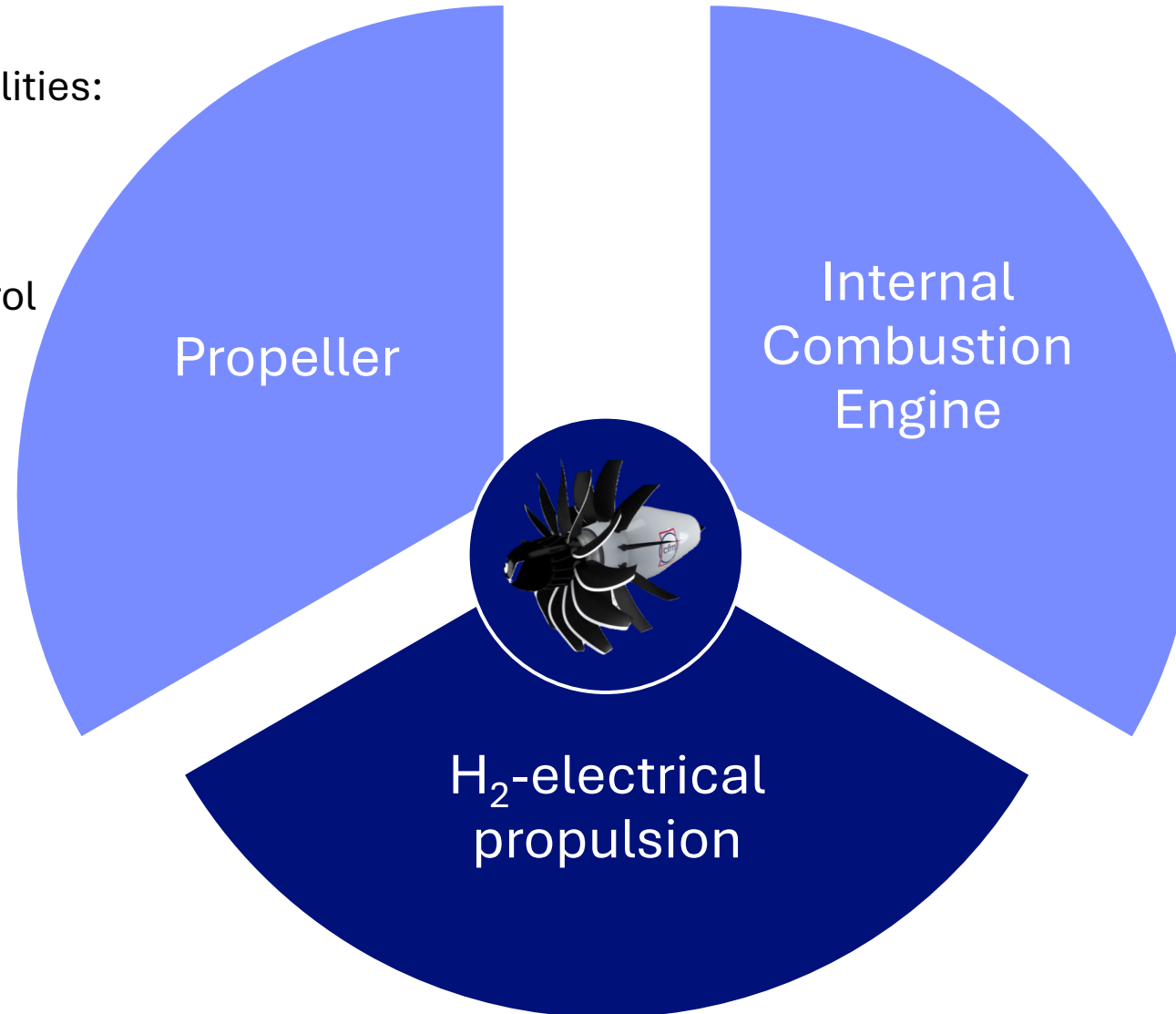


Use case:

- Aircraft: Dornier Do228
- Powered by: 2x TPE331 (~570 kW each)
- Powertrain sizing condition: Take-Off
- HF optimization each mission segment



- Expand BEMT capabilities:
 - Structural
 - Aeroacoustics
 - Optimization
 - Pitch/RPM control



- Turbomachinery design
- Different fuels: Jet-A1, SAF, H₂
- Different engines: Turbofan, Turboprop, Propfan

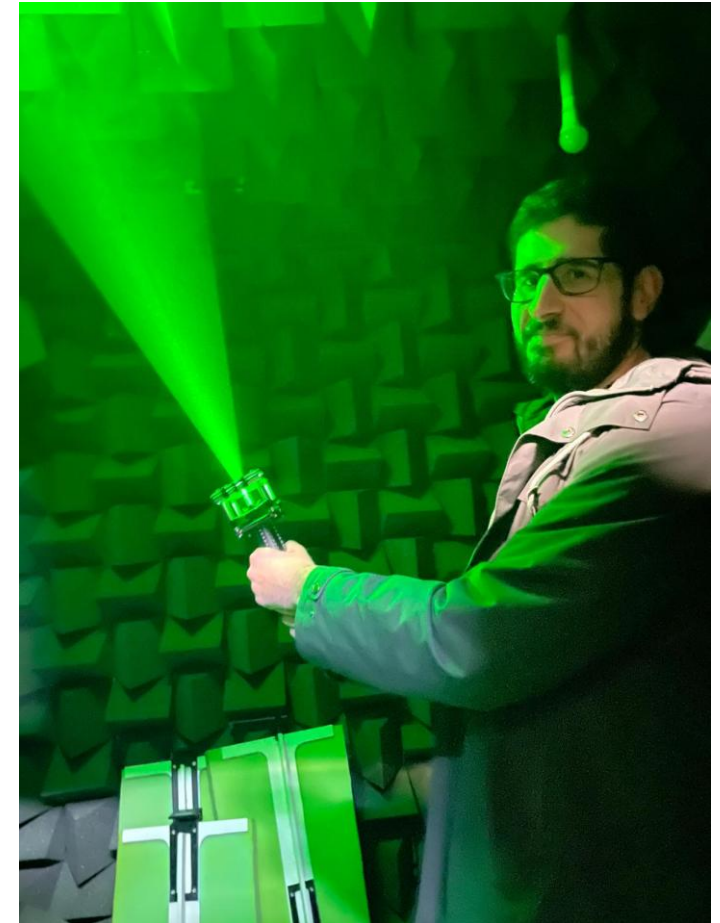
- Conferences contributions
 - **17th World Congress on Computational Mechanics and 10th European Congress on Computational Methods in Applied Sciences and Engineering**, 19th – 24th July 2026, Munich, Germany – Accepted
 - **35th Congress of the International Council of the Aeronautical Sciences**, 13th – 18th September 2026, Sydney, Australia – Accepted
- Dissemination activities:
 - *Ciencia del empuje en acción: cómo funciona un motor de avión*, **Semana de la Ciencia y la Innovación de Madrid 2025** – 11/11/2025
- Courses attended:
 - **An Introduction to Statistical and Variational Methods for Assimilation and Real Time Modeling**, Universidad Carlos III de Madrid, 2nd June 2025
 - **From Optimal Control to Learning-Based Control: A Unified Perspective on Adaptive Control and Reinforcement Learning**, Universidad Carlos III de Madrid, 1st June 2026

Before finishing...

Special Thanks



The Master





Thank you!
Questions?

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