Integration Challenges, Cooling and Structural Requirements for Hybrid Powertrain Installations on a GA Airframe

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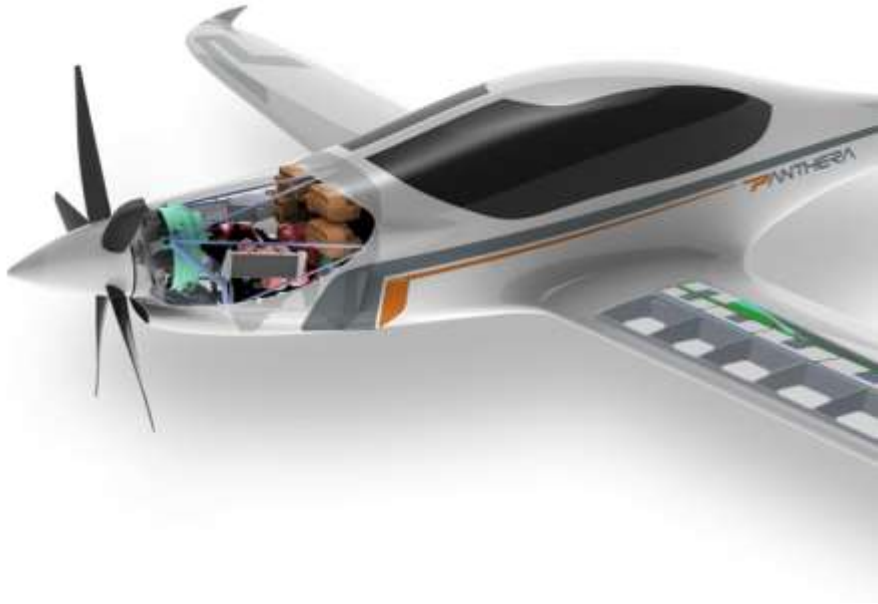


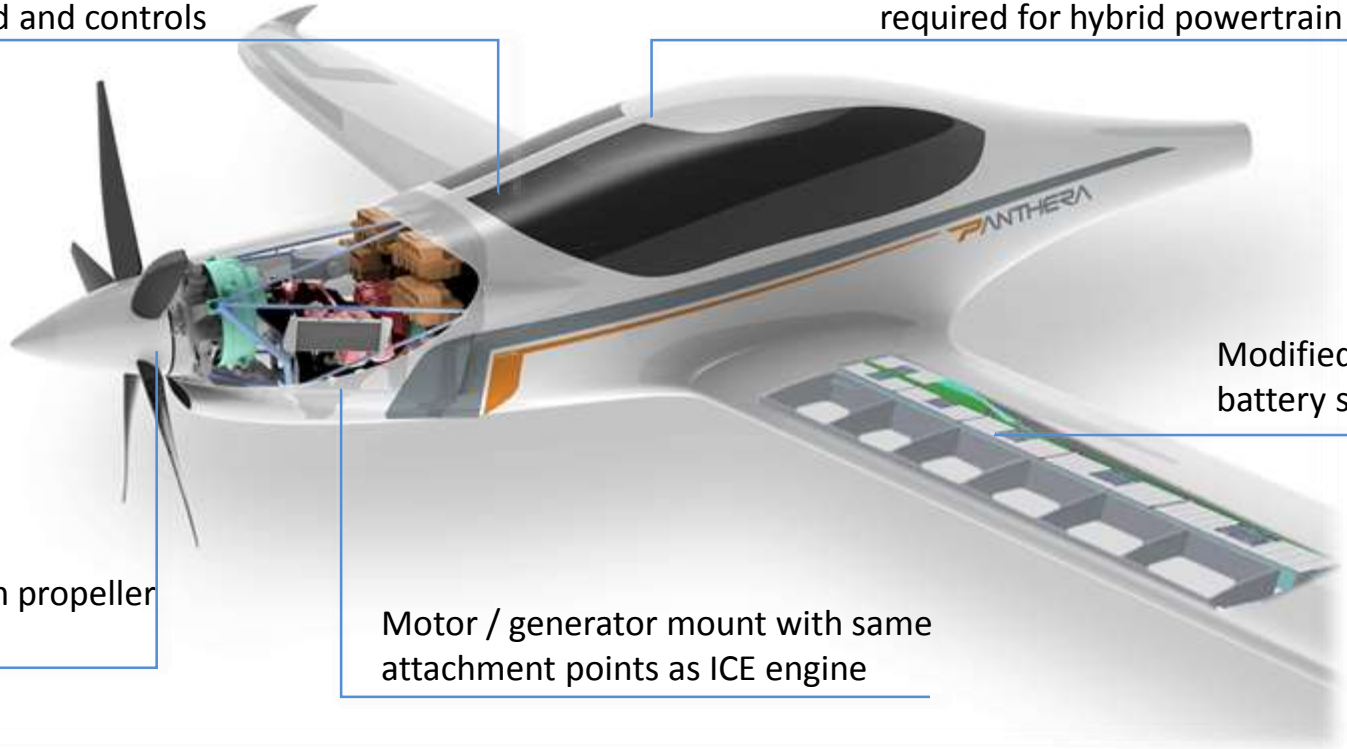
Overview

- Hypstair concept
- Baseline configuration
- Design iterations to final configuration
- Installation of real components and power-up
- Next steps

HYPSTAIR Installation Platform Concept

HMI integration with modified dashboard and controls

Fuselage with few modifications required for hybrid powertrain



Modified wing structure for battery system integration

Low rpm propeller design

Motor / generator mount with same attachment points as ICE engine

HYPSTAIR Serial Hybrid Drive Components

SIEMENS

200 KW MTOP
electric motor

4 inverters for a
fail-safe design

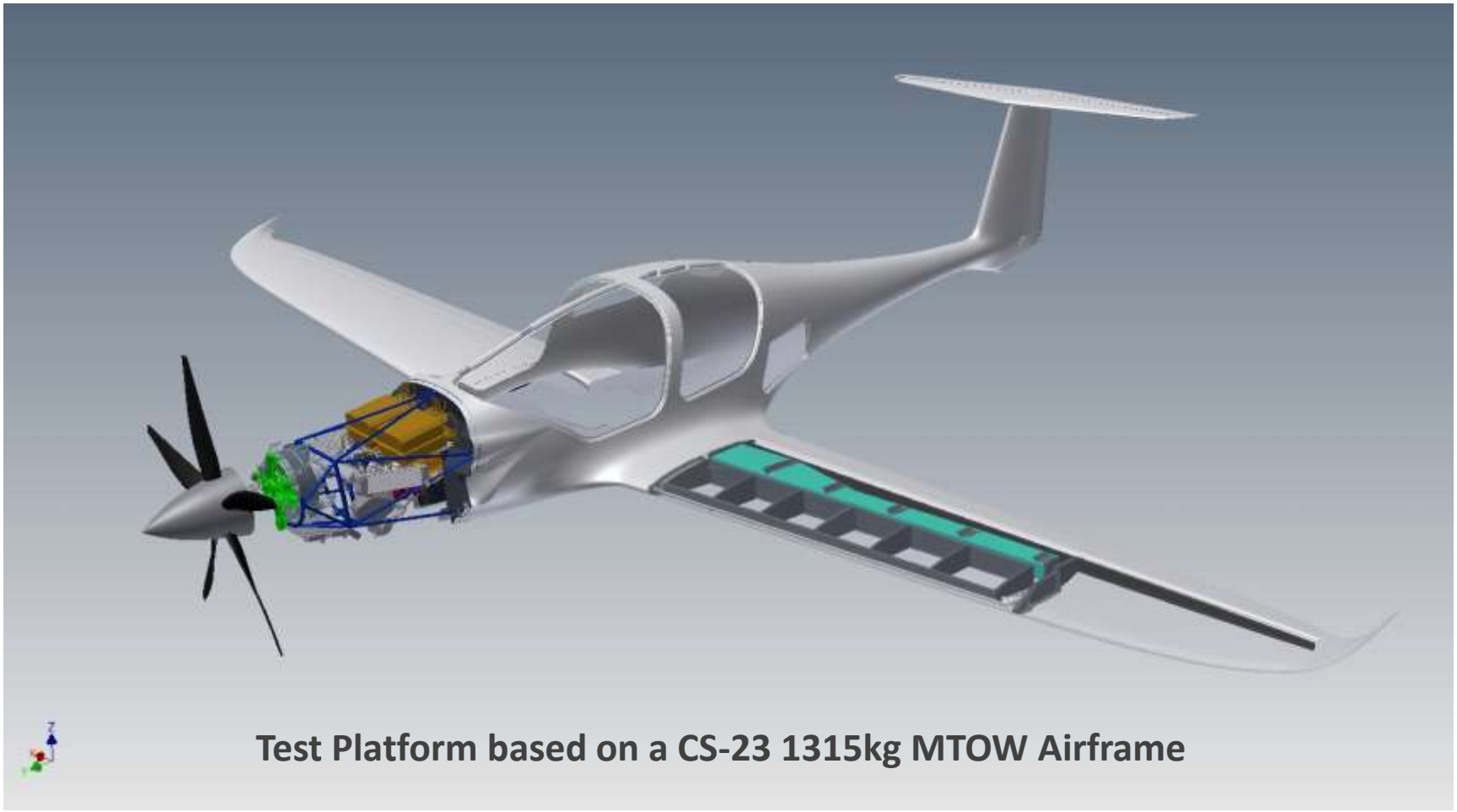
100 KW generator for charging
batteries/powering the motor

Turbonormalized ICE
as Range Extender

Hybrid architectures: serial vs parallel

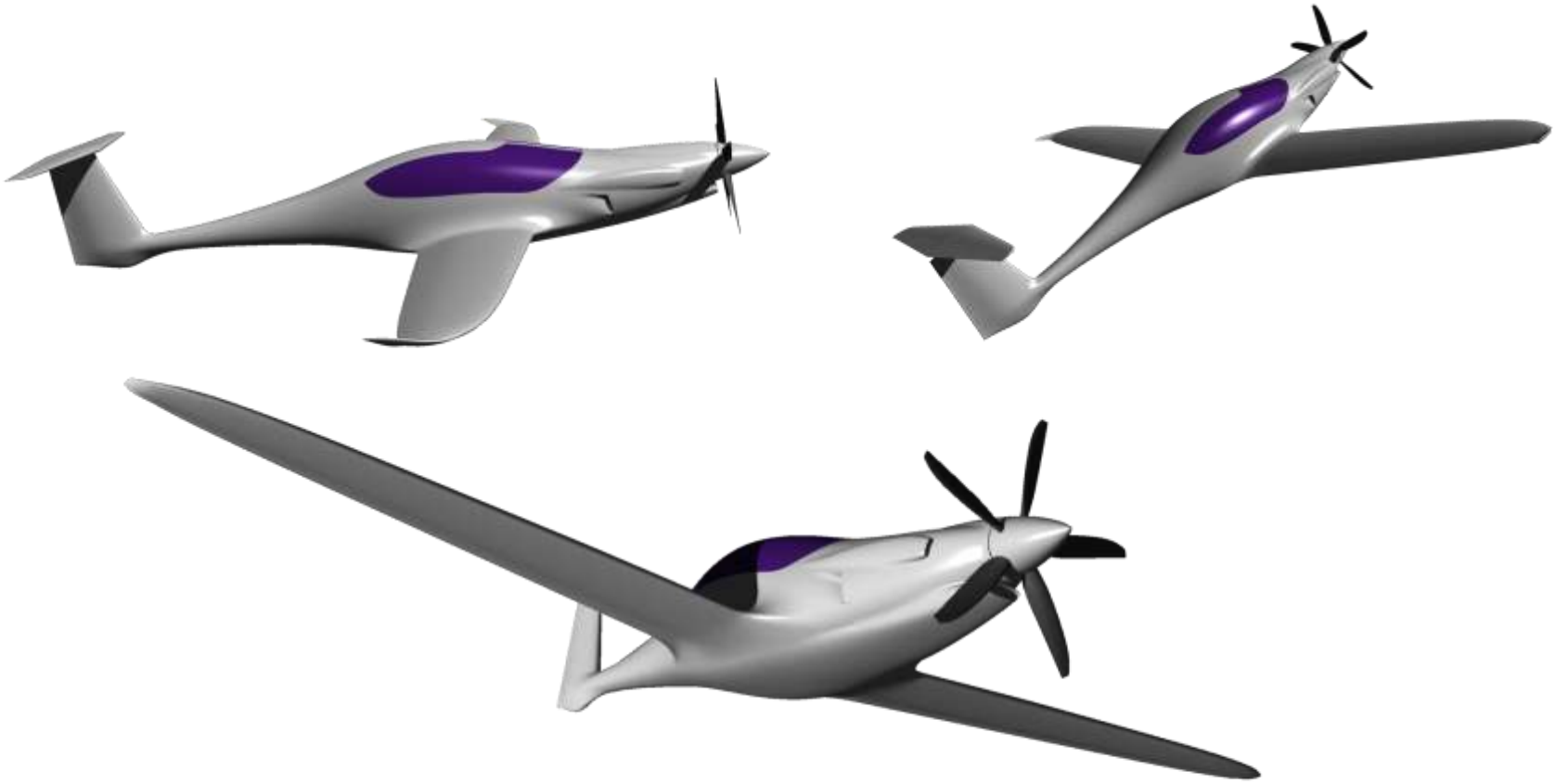
Serial Hybrid (HYPSTAIR)	Parallel Hybrid
+ Two independent energy sources	- Closely coupled
- Electric generator	+ No electric generator
- At least two inverters	+ One inverter
+ Cruise RPM is not linked to the ICE	- Cruise RPM linked to the ICE
+ Optimum propeller efficiency from take-off to cruise	- Oversized propeller for cruise
+ Low noise (pure electric take-off), low cruise RPM	- No big difference to classic engine
+ Suitable for new aircraft configurations (e.g. distributed propulsion)	- Classic configurations only

Configuration of the Hypstair Platform (Baseline)

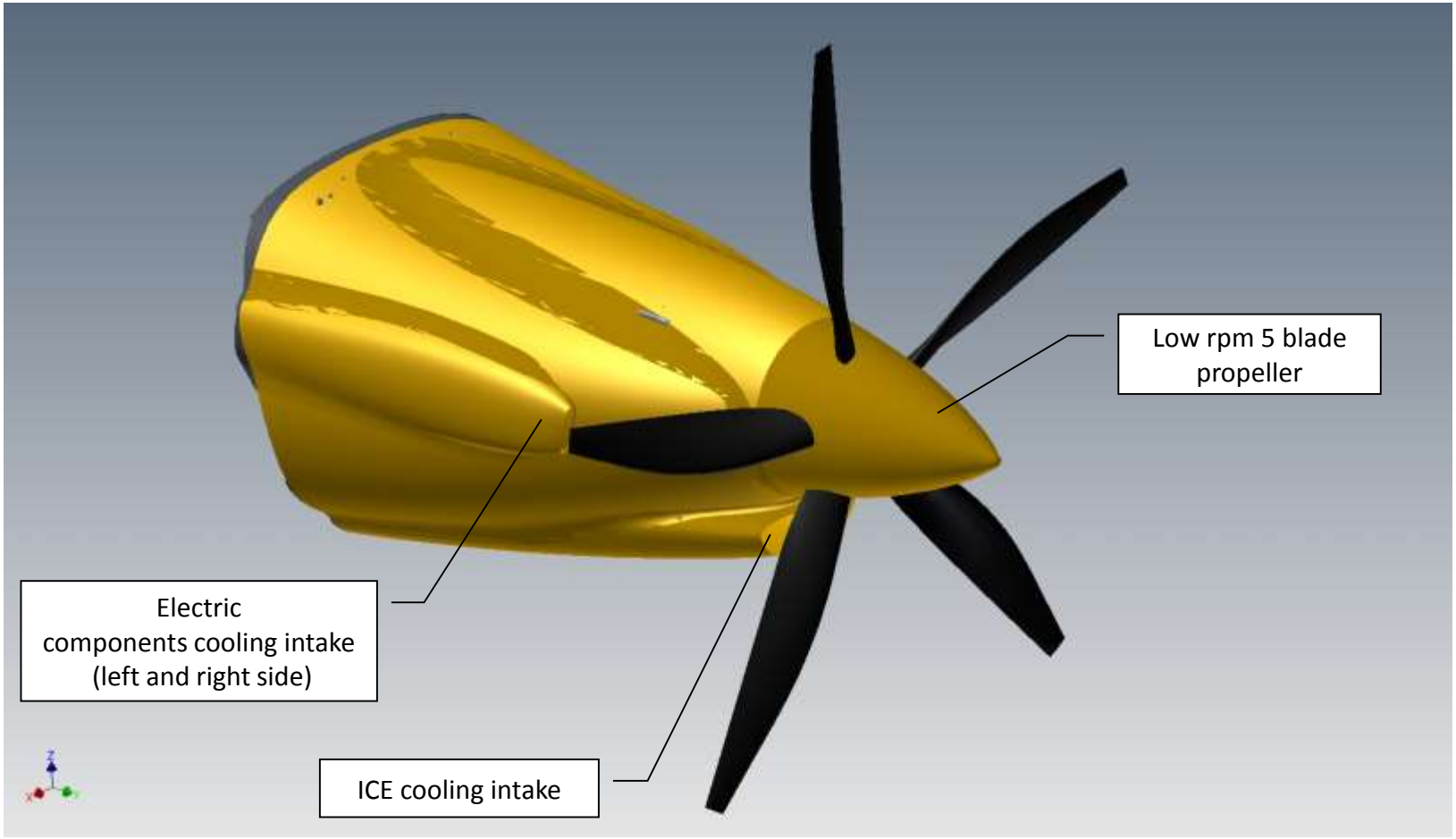


Test Platform based on a CS-23 1315kg MTOW Airframe

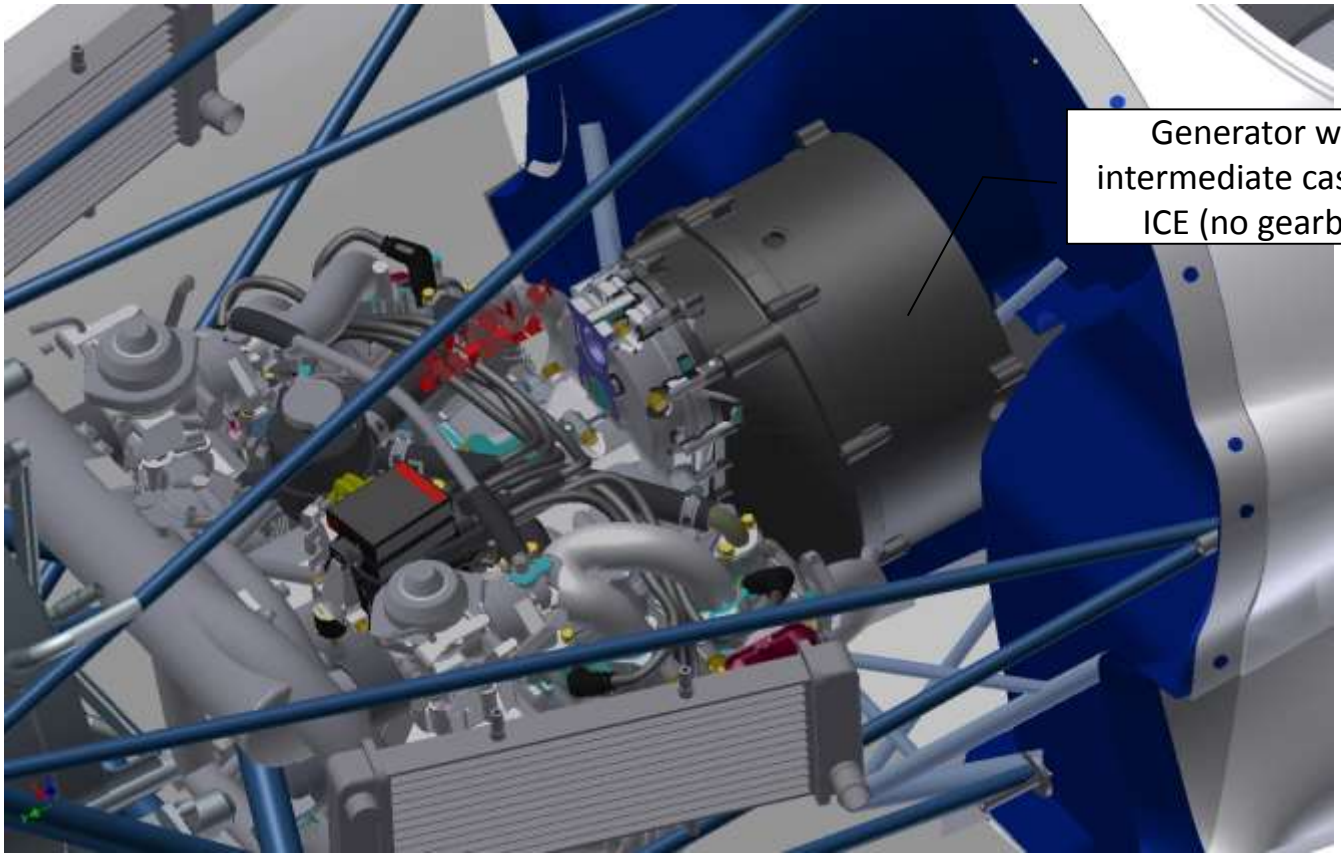
Aerodynamic Shape Concept (Baseline)



Cooling Air Intakes

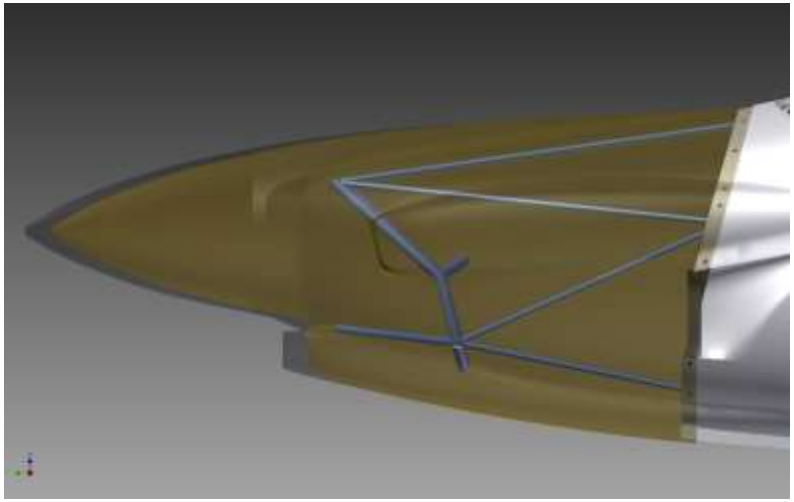


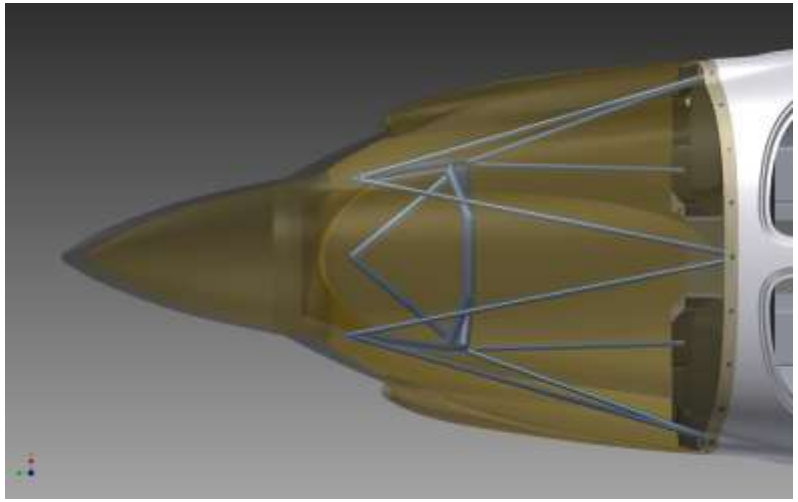
ICE and Generator Integration



ICE and generator mounted in direction opposite to flight to simplify integration and enhance accessability

Three Design Iterations to Optimize Packaging



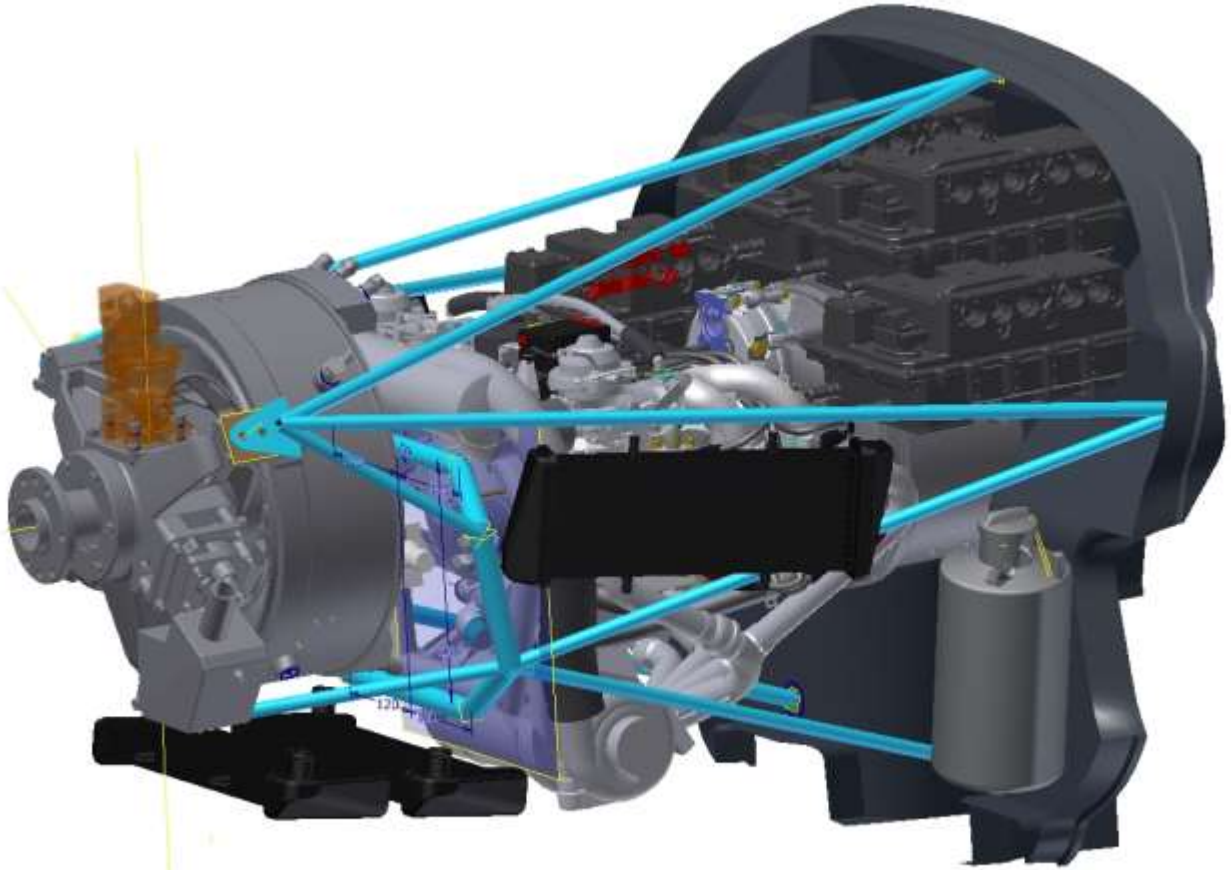


Iteration two (grey) and three (brown)

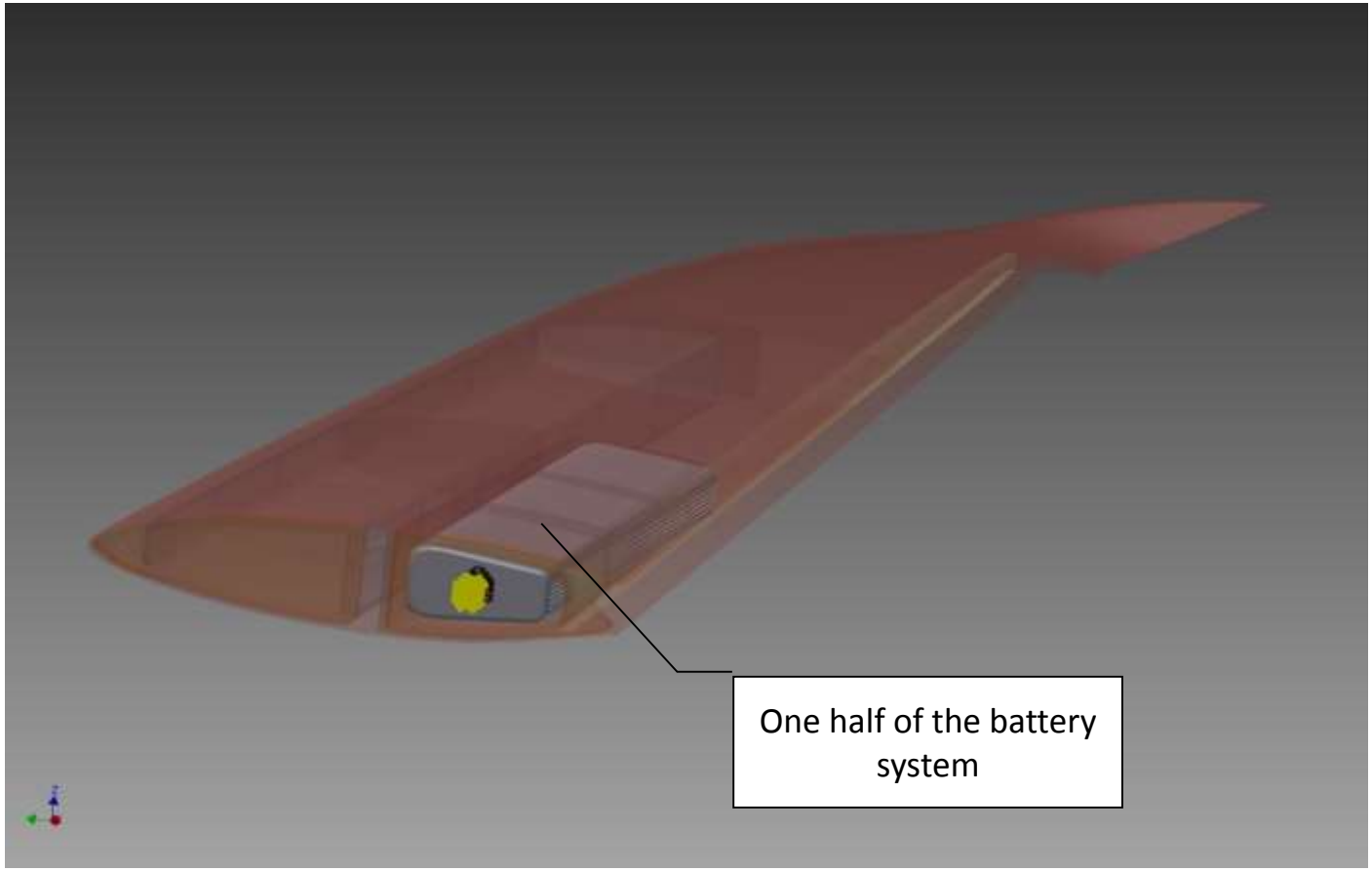
A total reduction of 150 mm in length was achieved by:

- Simplification of engine mount due to stiff mounting of the electric motor
- Front mounting of electric motor accessories (governor, coolant and oil pump)
- Repositioning of ICE, generator and inverters
- Combining cooling circuits with heat exchangers

Final Configuration: Firewall Forward



Final Configuration: Battery System



Weight comparison: Hypstair vs. Piston Engines

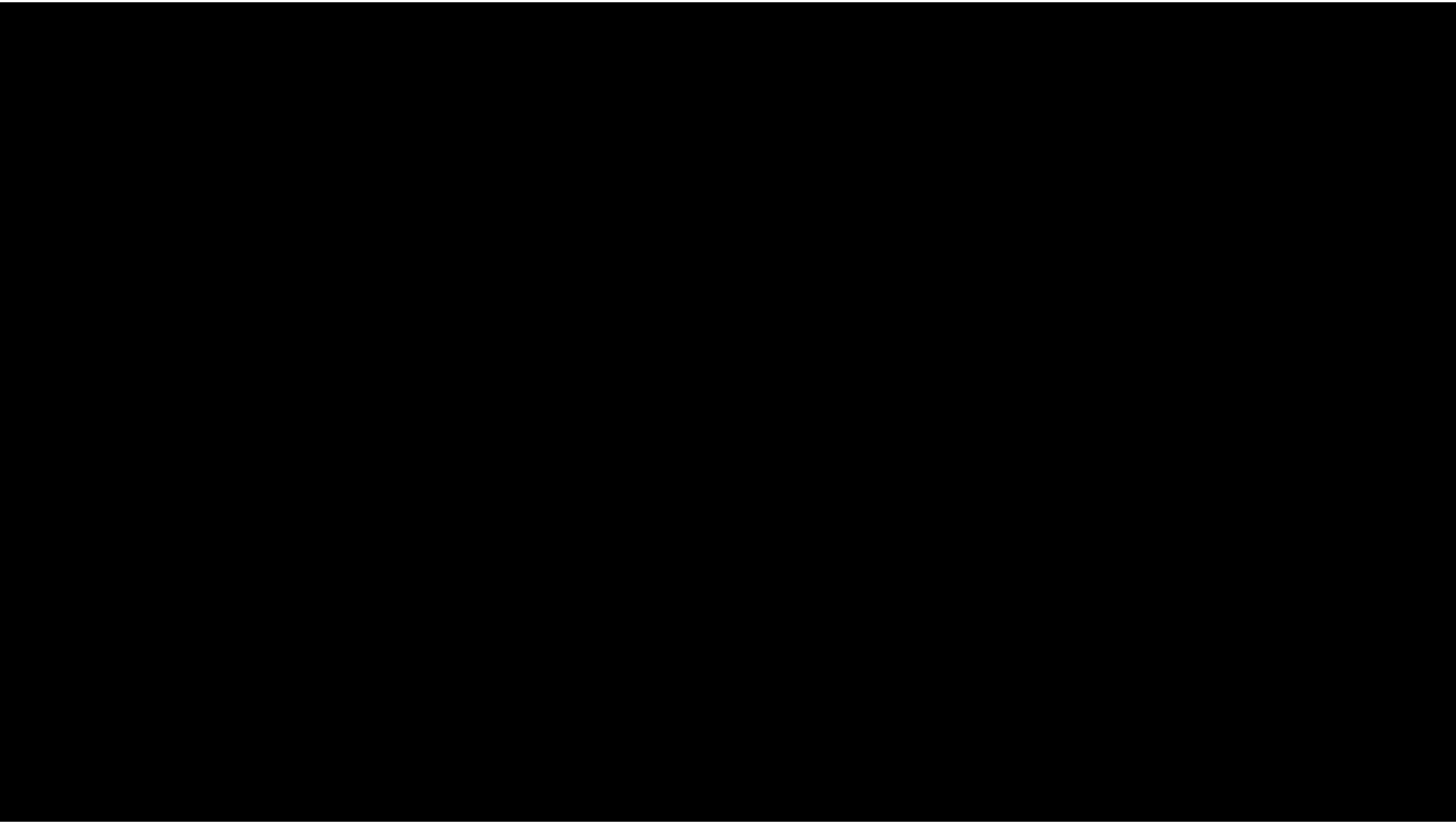
	Gasoline Engine e.g. Lycoming 260 HP	**Diesel Engine** e.g. SMA 230 HP	**HYPSTAIR** 200 kW (270 HP)
dry weight	190 kg	210 kg	160 kg
batteries	-	-	100 kg
accessories	20 kg	35 kg	15 kg
liquids	6 kg	8 kg	5 kg
starter battery	11 kg	11 kg	-
Total	**227 kg**	**259 kg**	**280 kg**

Physical Integration of Components and Power-up

- All components for initial power-up were installed
- Component tests (inverters, electric motor, ICE, generator, battery) were successful
- Successful runs on battery power
- Successful battery charging from generator on ICE power
- First successful run on combined battery and generator power

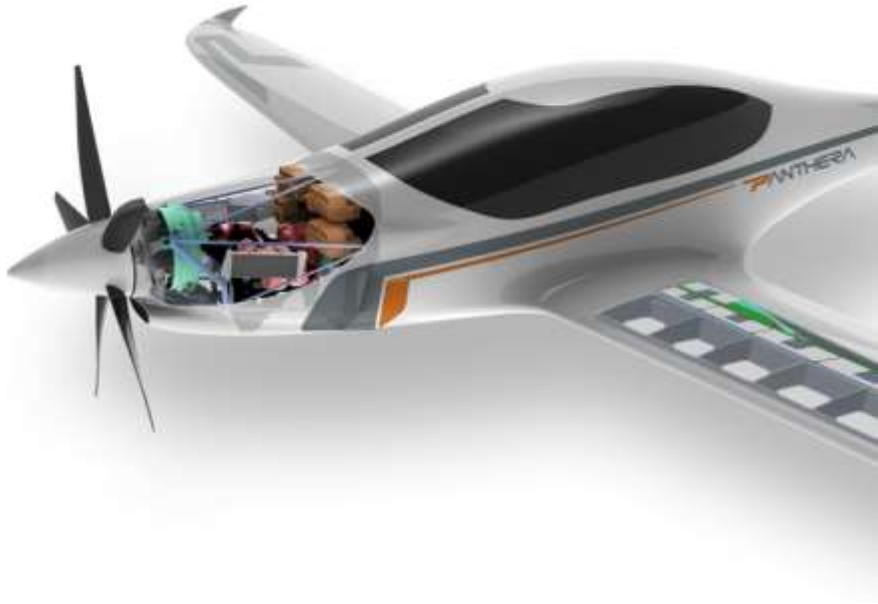
High Power Runs with Propeller Installed

Bird‘s Eye View of the Hypstair Platform



Next Steps

- Installation of remaining components
- HMI Integration
- Cowling and intake ducts installation
- System level testing



HYPSTAIR

PIPISTREL

SIEMENS

MBVision

Thank you for your attention. Questions?

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