HERMES

MERCURY

43rd Annual VFS Student Design Competition

Hybrid Electric Tiltrotor

Sponsored by: LEONARDO

UNIVERSITY OF MARYLAND

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Academic Course:
ENAE634: Helicopter Design (3 Credits)

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To the Vertical Flight Society:

The members of the University of Maryland Graduate Student Design Team hereby grant VFS full permission to distribute the enclosed Executive Summary and Final Proposal for the 43rd Annual Student Design Competition as they see fit.

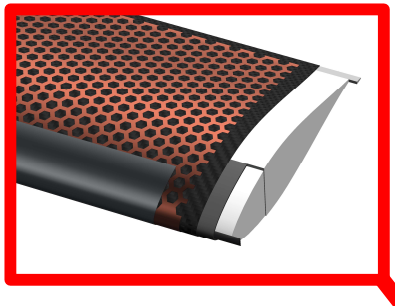
Sincerely,

The UMD Graduate Design Team

Mercury: Key Features

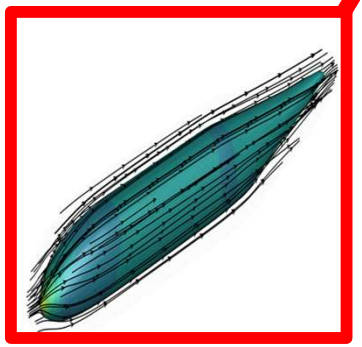
MERCURY

Efficient Hybrid Powerplant



High Performance Proprotor with Novel Airfoils

Low Vibration Gimbaled Hub



Low-drag Airframe

Supercritical Shafting

Swift Steps into a Hybrid Future

HERMES MERCURY

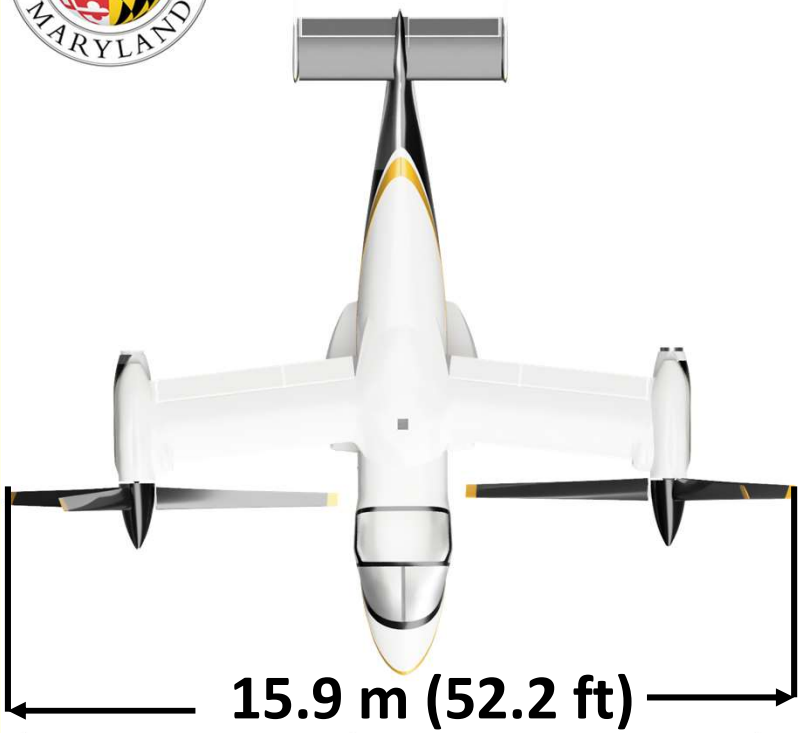
Hermes is a parallel hybrid evolution of the XV-15, maintaining the original 13,000 lb gross weight while integrating a central electric motor and battery system. A **parallel hybrid architecture** employs the hybrid principle: keeping the thermal engine at its most efficient point throughout the mission, with turbine engines and electric motor mechanically driving the rotor, minimizing complexity and weight. A **supercritical cross-shaft** transmission provides engine-out redundancy, while a 40% rotor speed reduction, enabled by a proven gimbaled hub design, in cruise unlocks high-speed flight at 156 m/s (260 KCAS, 303 KTAS) over a 306 nm mission. Empty weight is lower than the original XV-15, despite the added hybrid components.

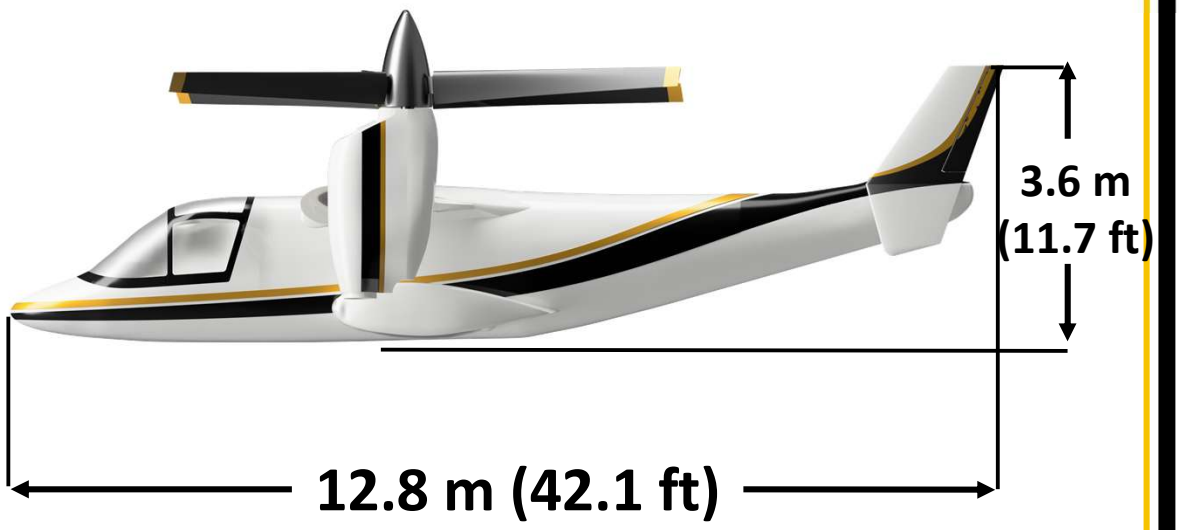
Where Hermes refines, **Mercury** reimagines. Built clean-sheet on the same hybrid-electric foundation, Mercury sheds 15% of gross weight, cuts total drag by 28%, and improves hover and propulsive efficiency through an advanced composite rotor and an optimized **narrow-body fuselage**. A carbon-composite wing remains whirl-flutter free past 350 knots. Fly-by-wire controls and FADEC enable automated hybrid power management, removing pilot workload.

Together, Hermes and Mercury trace a credible development path from constrained hybrid integration to a purpose-built aircraft, demonstrating that hybridization is a strong candidate for the next generation of civil vertical-lift.

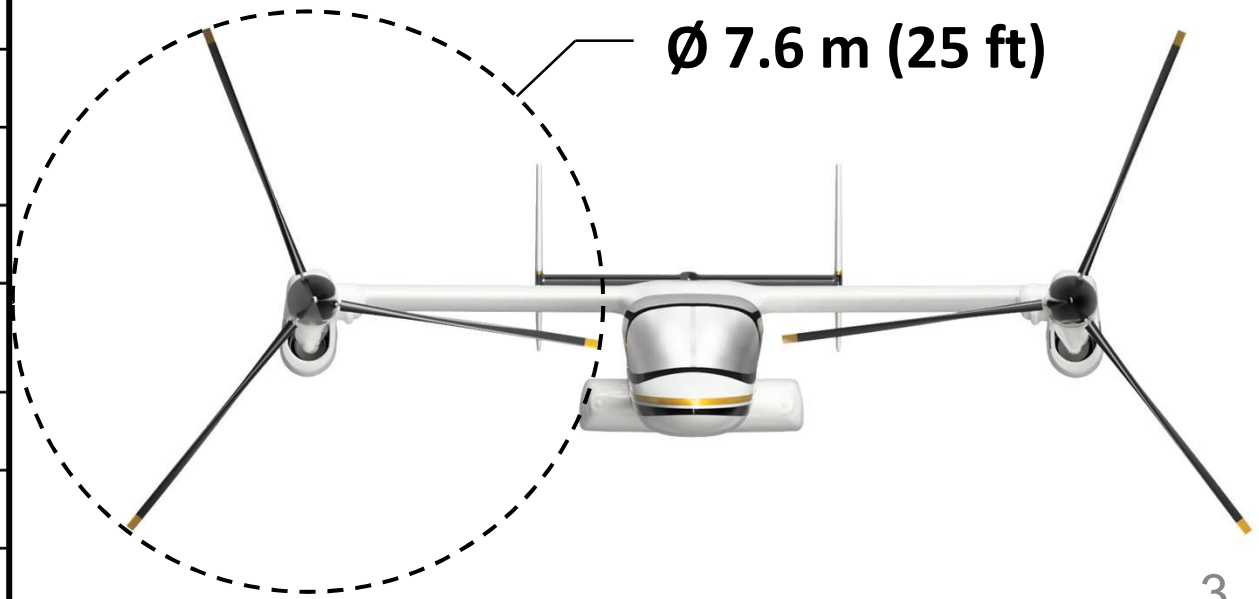
Hermes Overview, Phase 1

HERMES

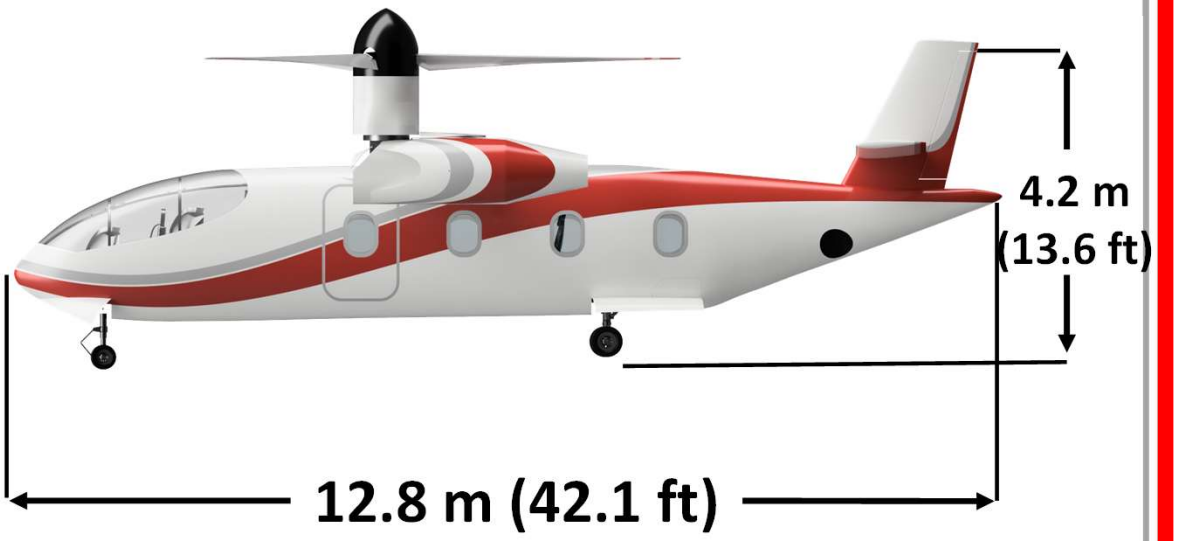




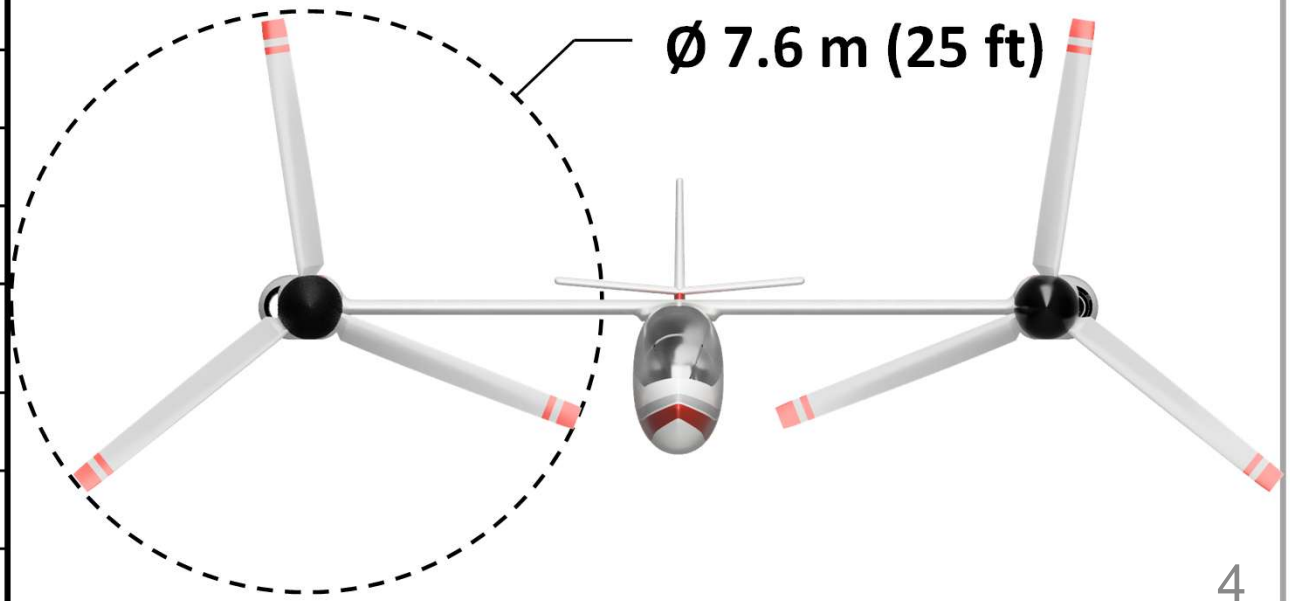
Characteristics	Value
GTOW	5897 kg (13000 lb)
Payload	509 kg (1123 lb)
Fuel Weight	834 kg (1839 lb)
Turboshaft Power	1864 kW (2500 hp)
Electrical Power	180 kW (241 hp)
Range	1308 km (706 nm)
Max Speed	163 m/s (317 kts)



Mercury Overview, Phase 2



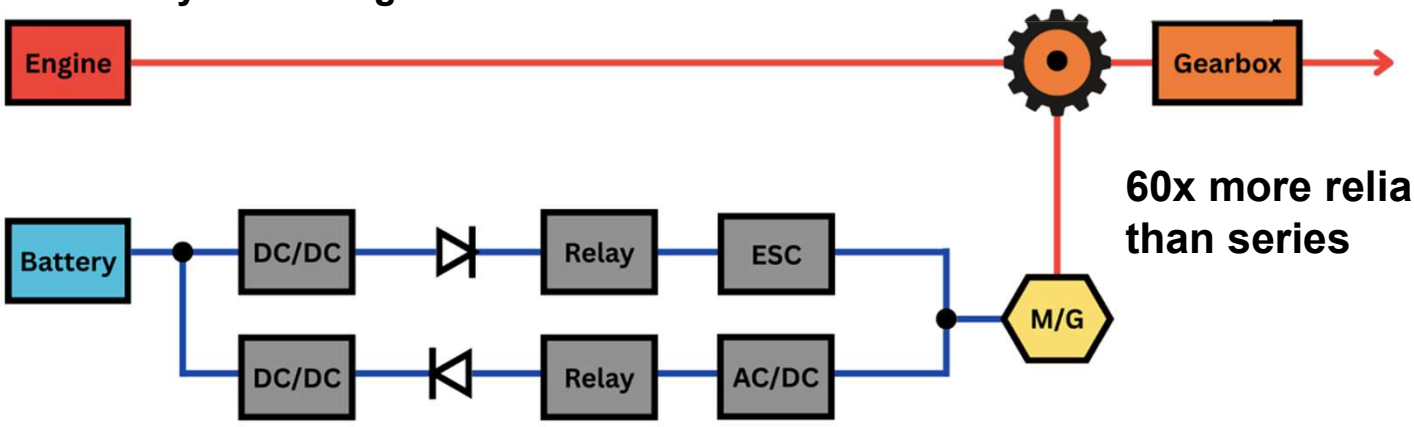
Characteristics	Value
GTOW	4939 kg (10891 lb)
Payload	726 kg (1600 lb)
Fuel Weight	3599 kg (1355 lb)
Turboshaft Power	1341 kW (1798 hp)
Electrical Power	180 kW (241 hp)
Range	1063 km (574 nm)
Max Speed	180 m/s (350 kts)



Hybrid Strategy: Maximizing Turbine Efficiency

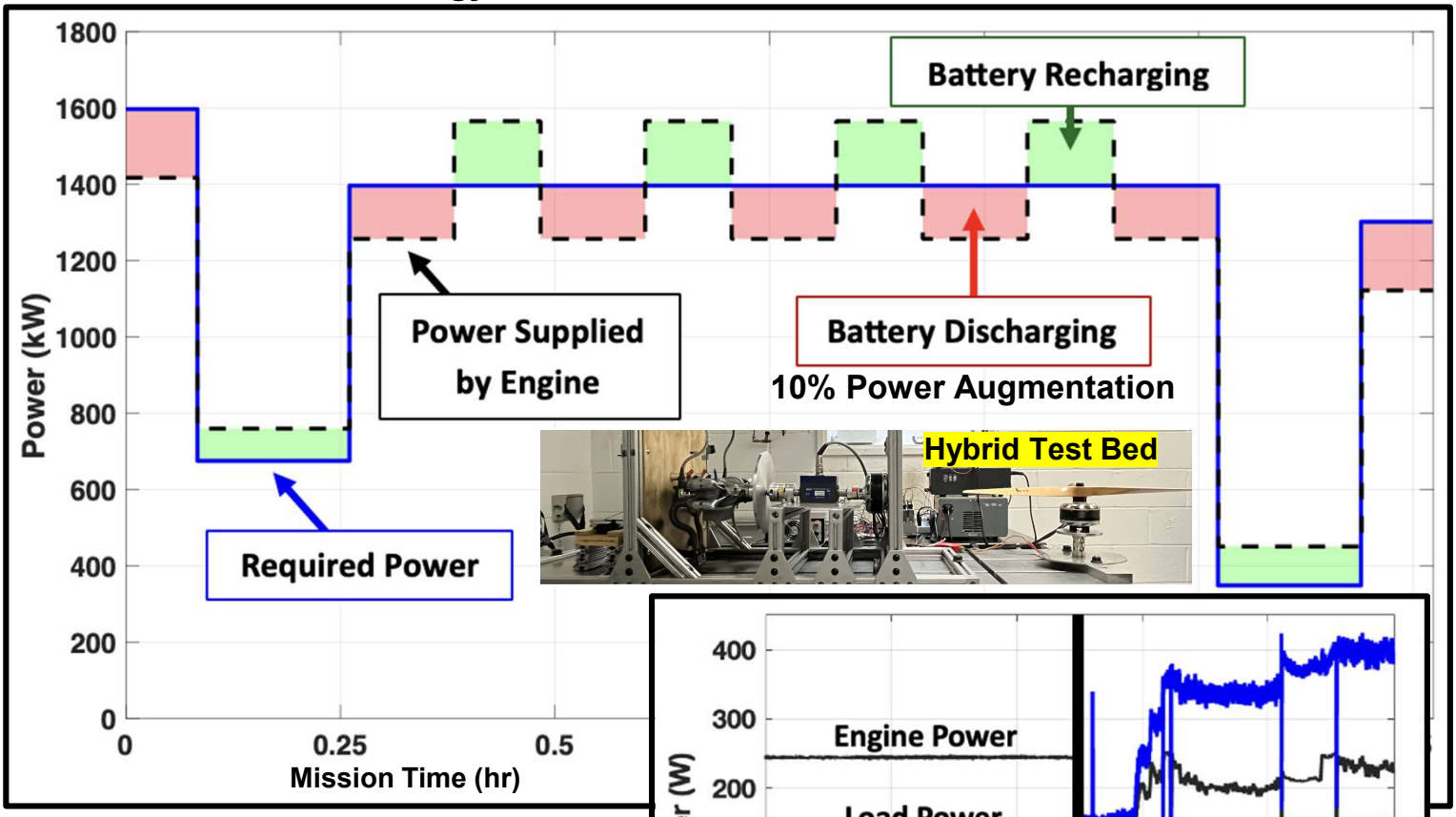
HERMES MERCURY

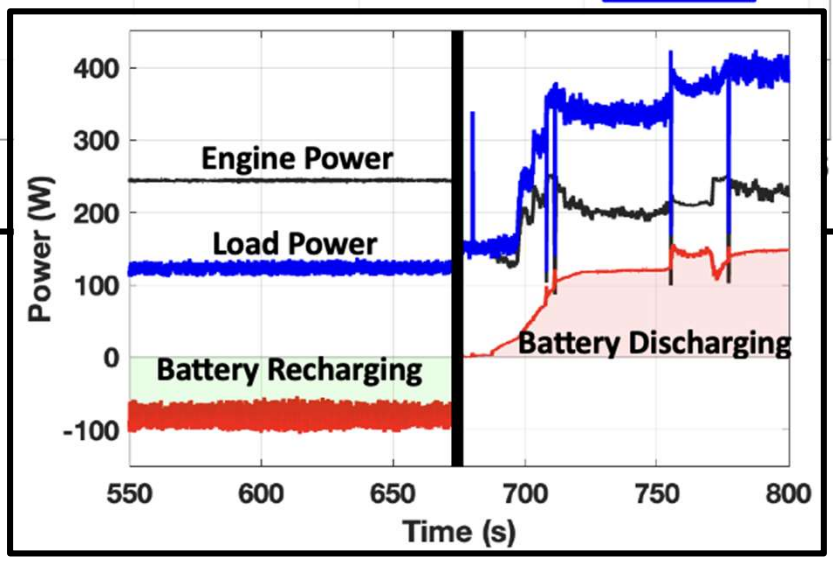
Parallel Hybrid Configuration:



60x more reliable than series

Power Distribution Strategy:

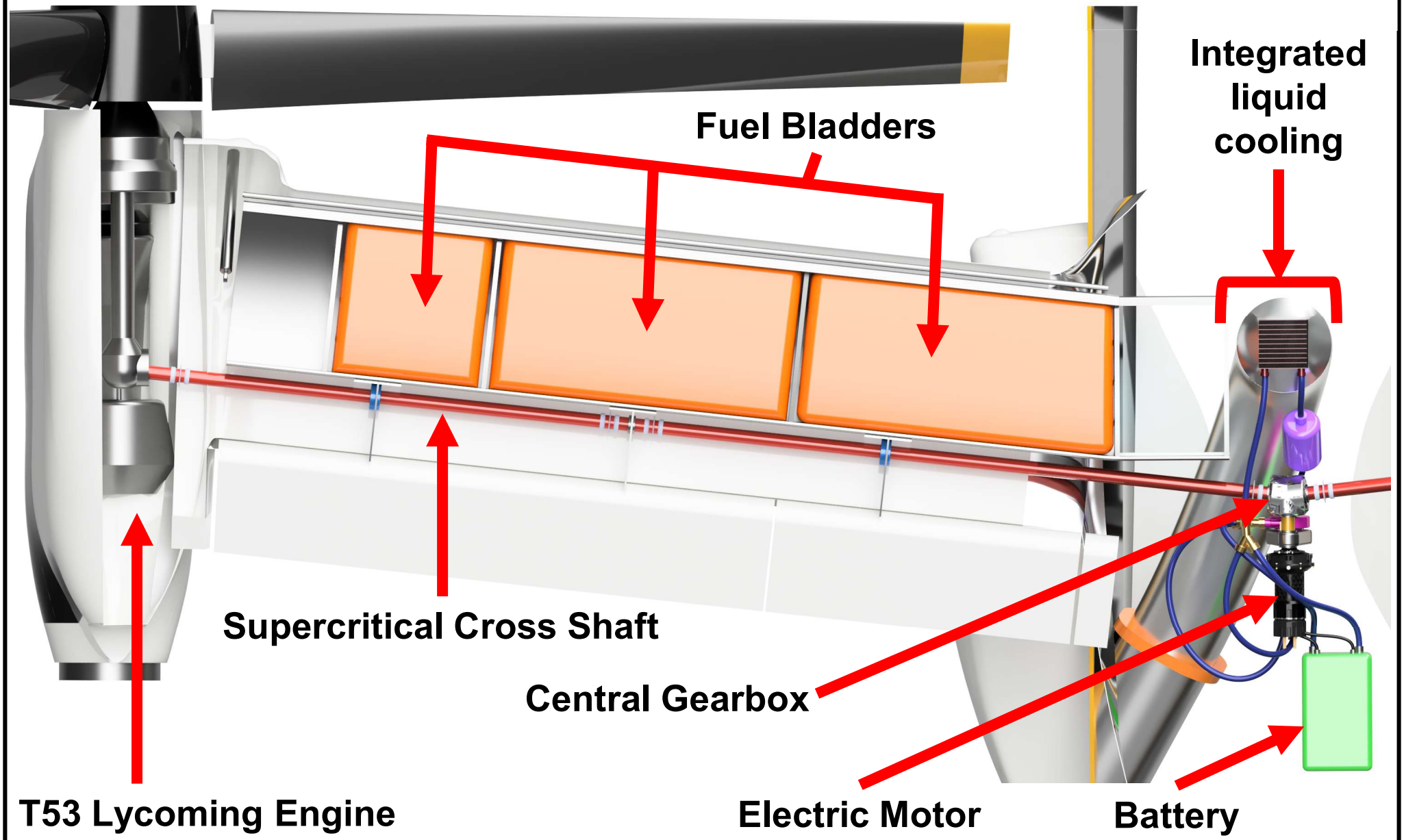




- 8% increase in maximum continuous power over XV-15 through electrification
- Charging/discharging cycles maximize turbine efficiency

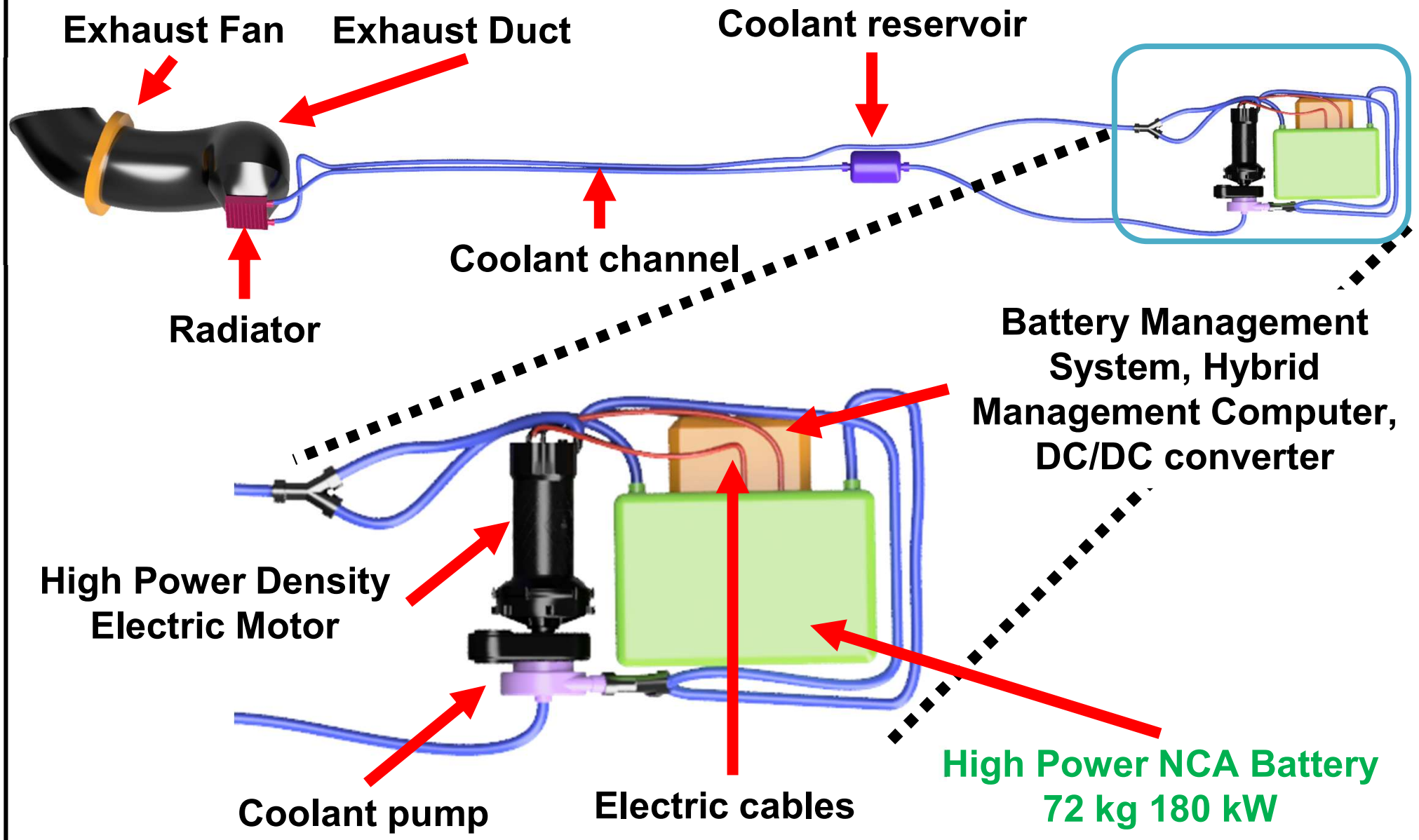
Integrated Parallel Hybrid Powertrain

HERMES MERCURY

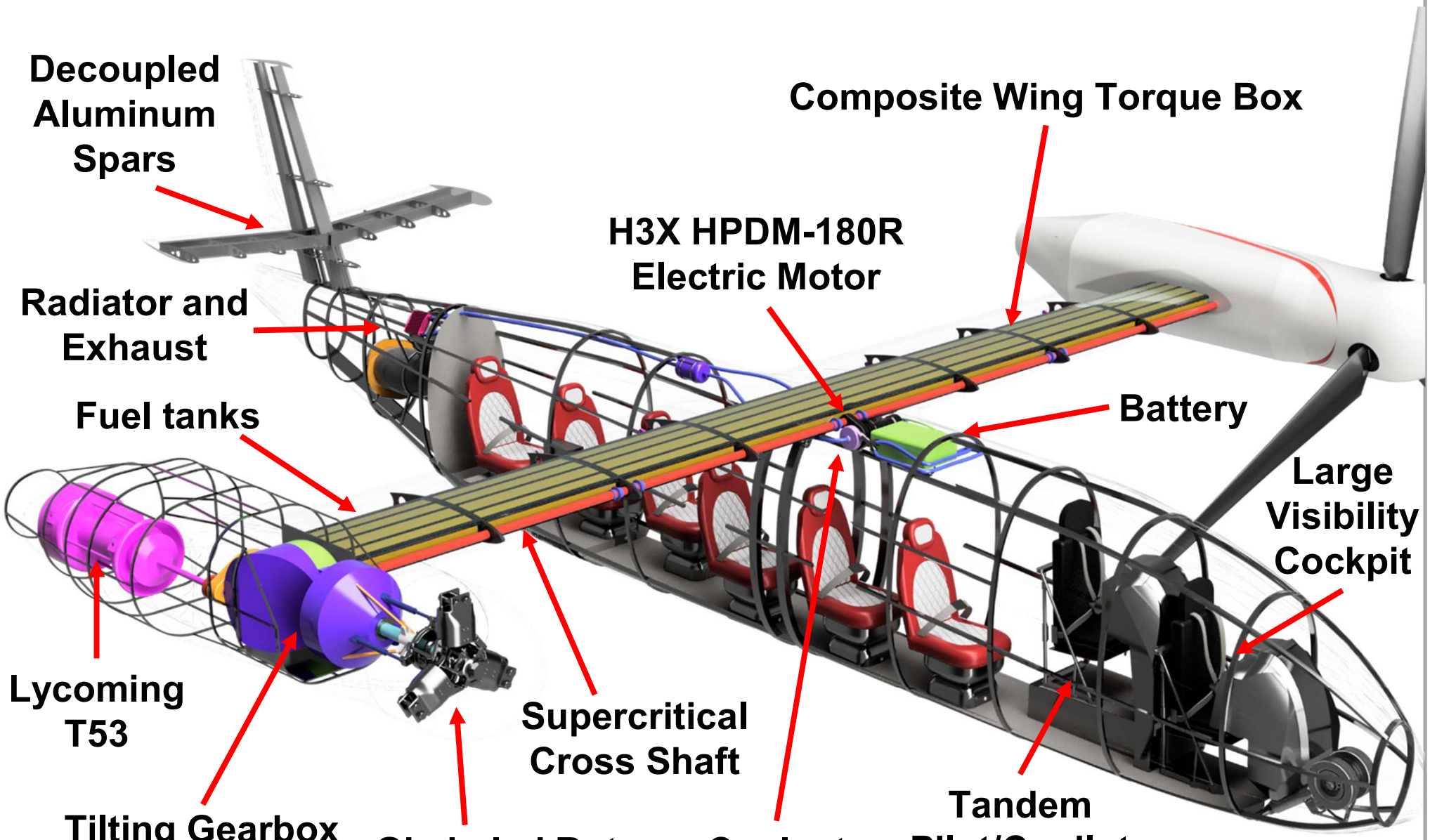


Liquid Cooling for Maximum Electrical Performance

HERMES MERCURY

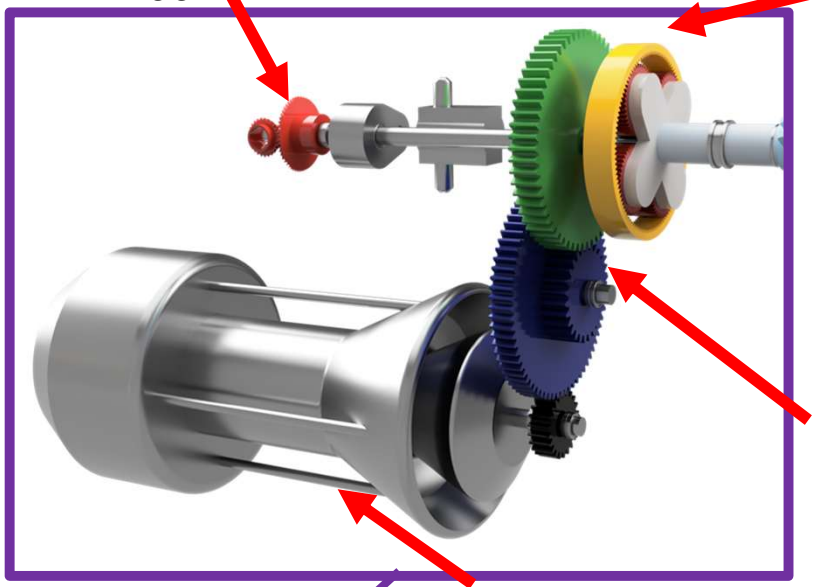


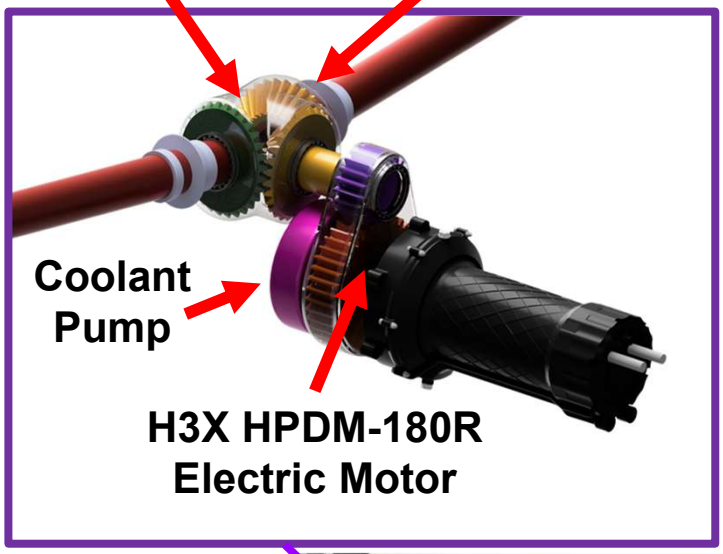
Detailed Internal Layout

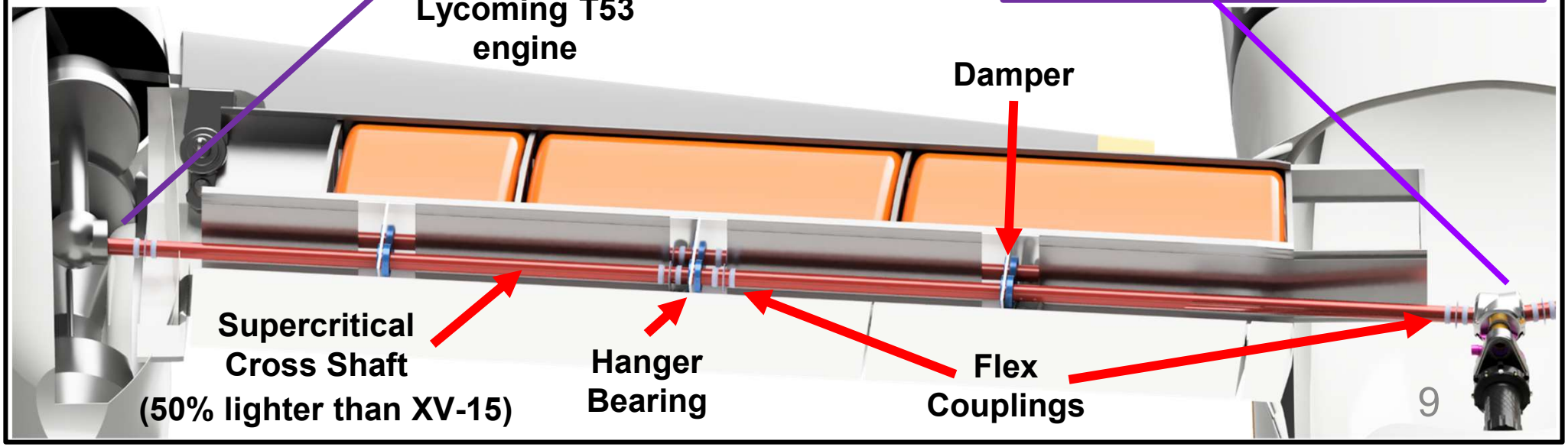


Lightweight Electro-Mechanical Drivetrain

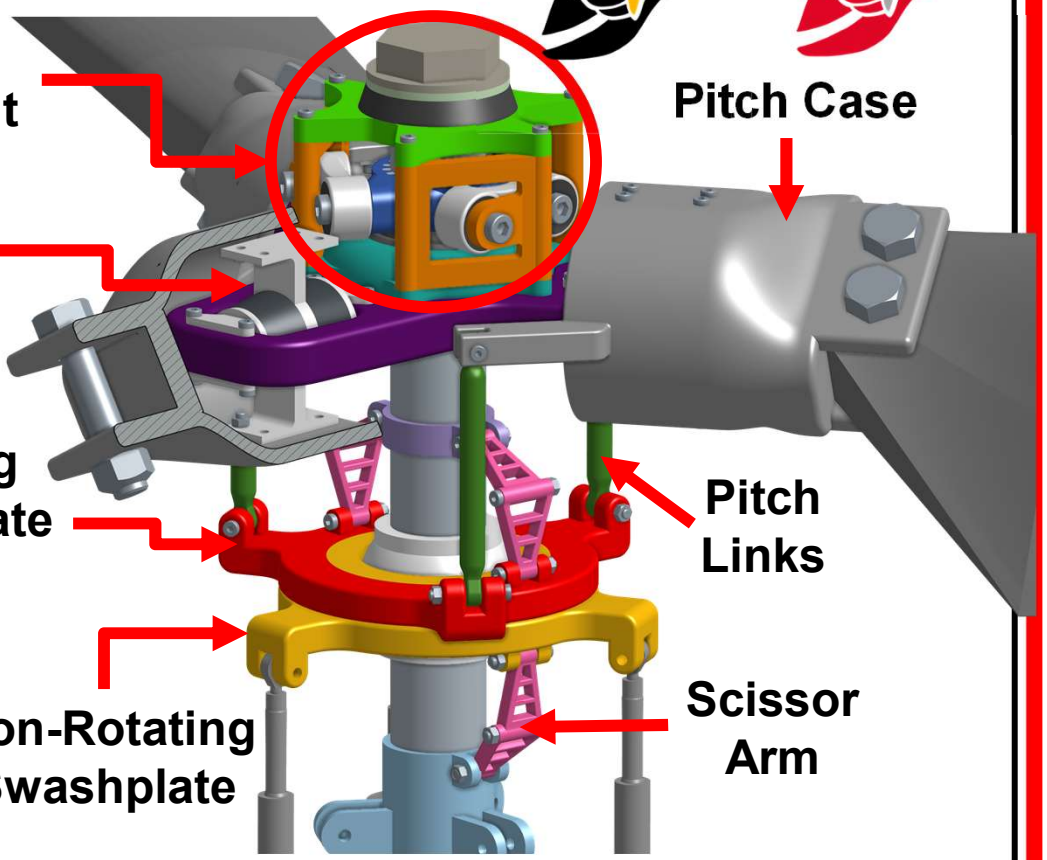
HERMES MERCURY

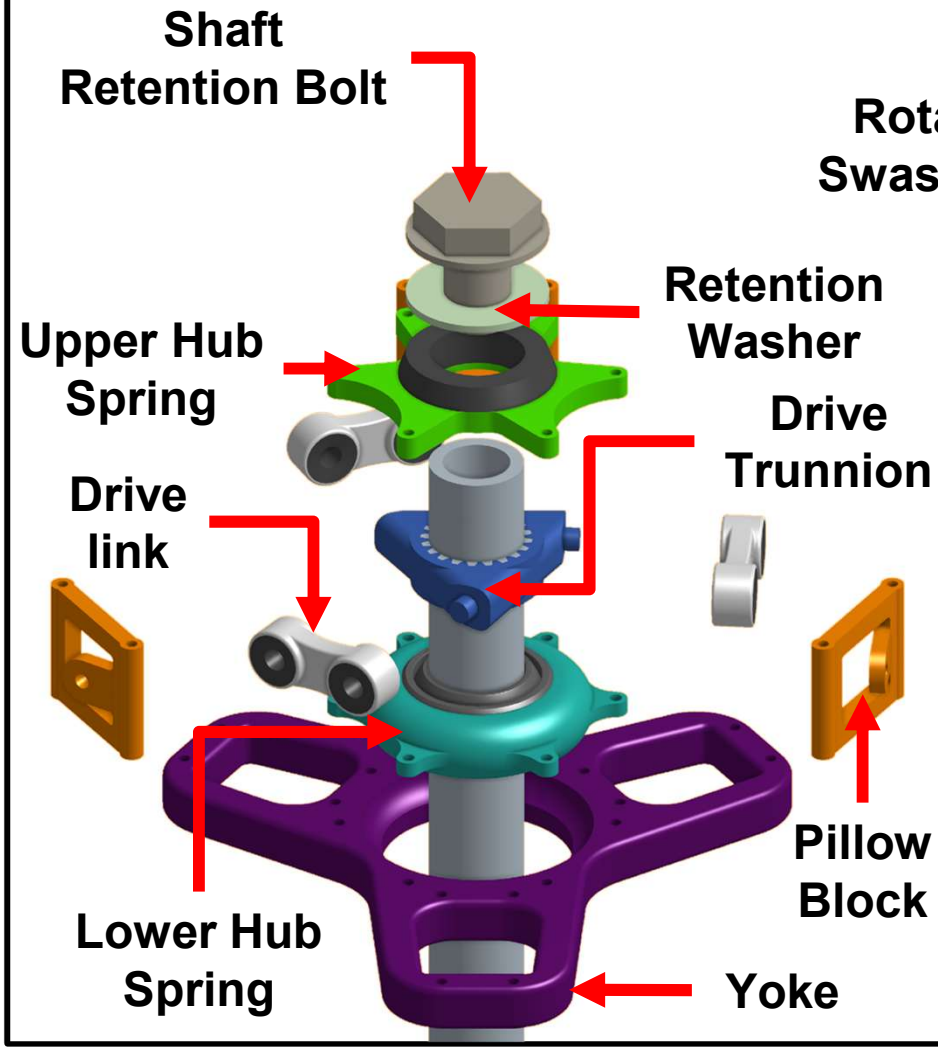






Low Vibration Gimbaled Hub





- Homokinetic constant velocity torque transfer
- 60° collective range

Dual-Speed Optimized Proprotor Blades

MERCURY

Improving c_l / c_d

Improving FM & η_p

HERMES Rotor blade Airfoils

GA Optimizer

ML based airfoil Surrogate

Newly Designed AGRC airfoils

Hermes Blade Planform

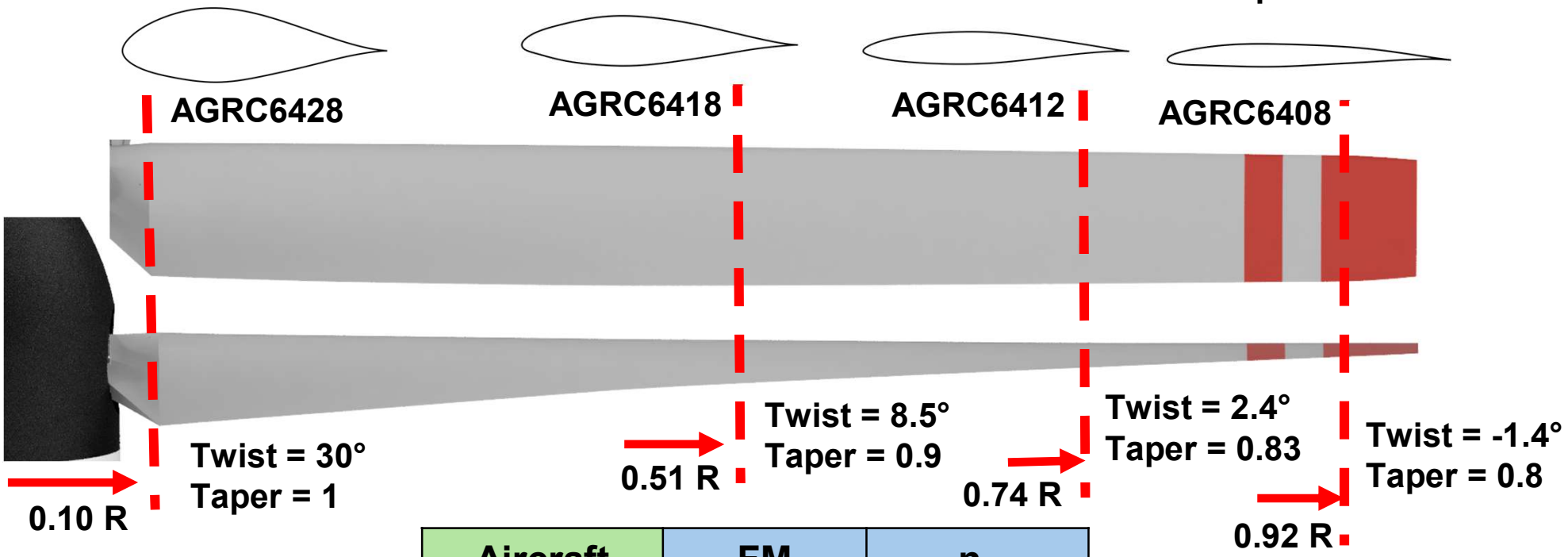
NSGA-II Optimizer

Coupled with aircraft trim

MERCURY Rotor Blade

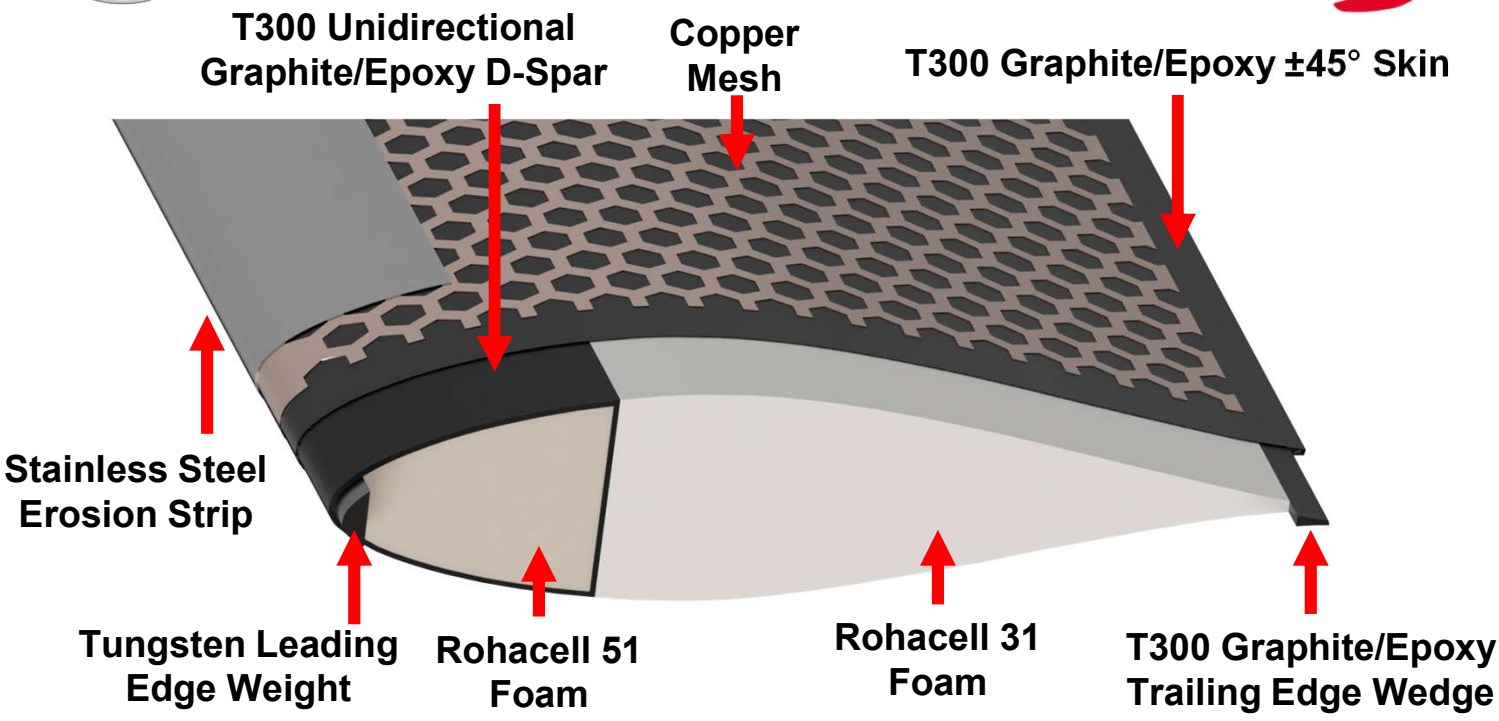
Airfoil Design

Planform Optimization

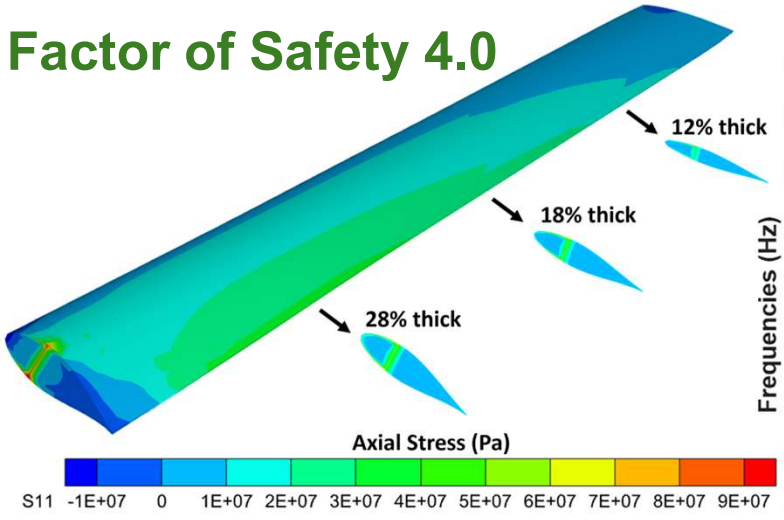


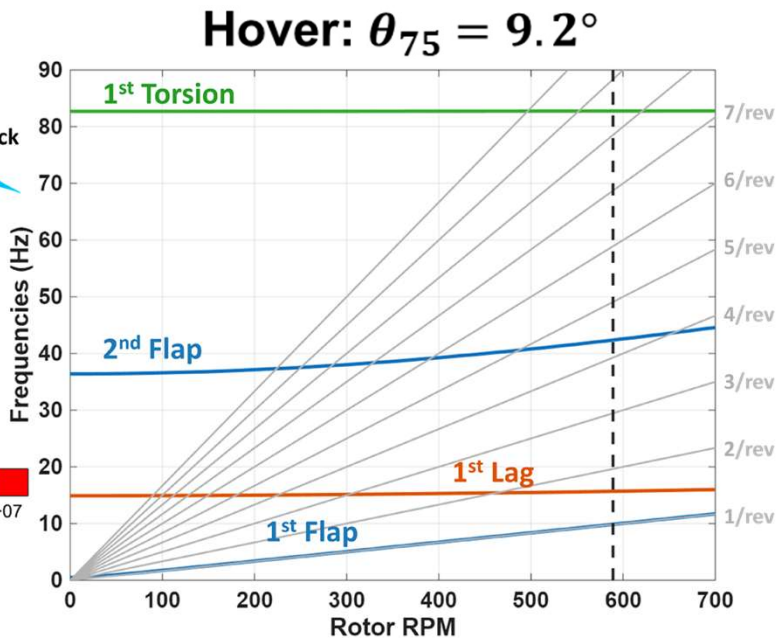
Aircraft	FM	η_p
HERMES	0.79	0.81
MERCURY	0.84	0.83

Lightweight Composite Rotor Blades



Factor of Safety 4.0





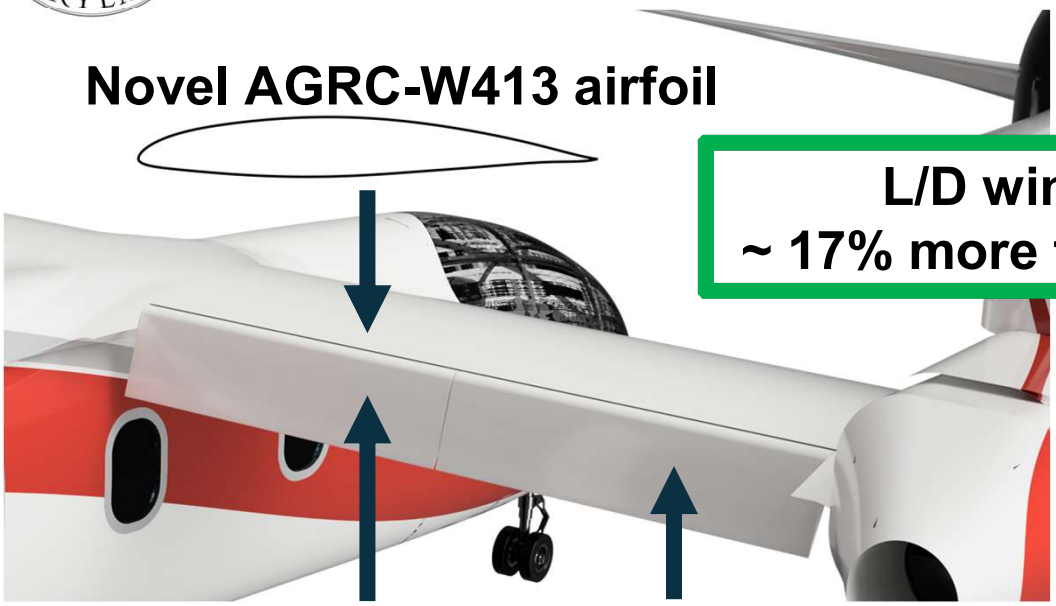
Tailored ply layup ensures variable-RPM resonance-free, fatigue-free operation

Mode (/rev)	Hover (589 RPM)	Cruise (343 RPM)
1F	1.00	1.01
1L	1.60	2.52
2F/2L	4.32	8.34
1T	8.43	14.46

Thin, Optimized, Flutter-Free Wing

MERCURY

Novel AGRC-W413 airfoil

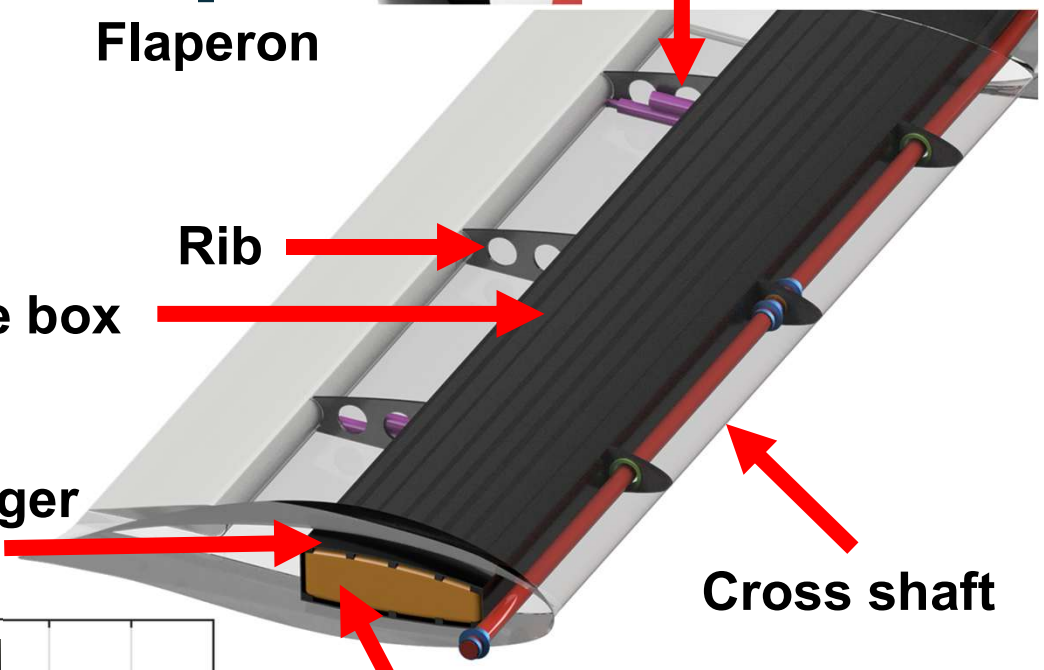


L/D wing = 17.5
~ 17% more than *HERMES*

Flap

Flaperon

Flaperon Actuator



Rib

Composite torque box

Spar cap and stringer

Cross shaft

Fuel Bladder

Test Data

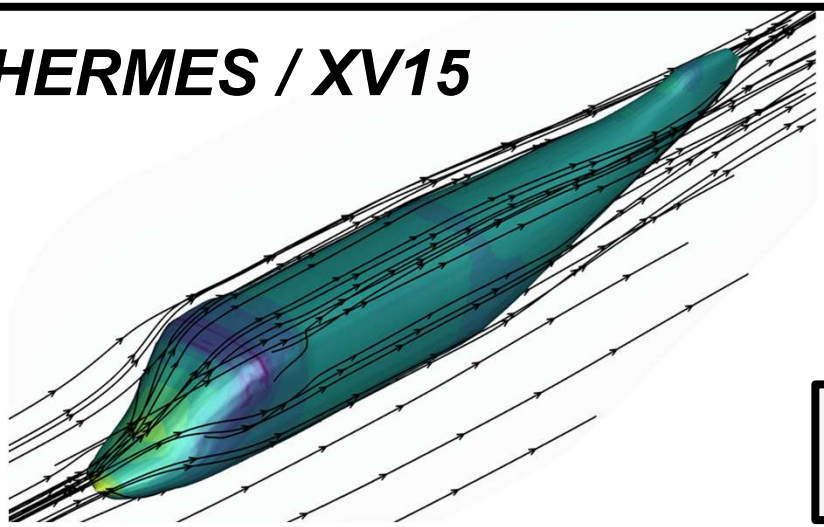
UMD Tiltrotor Rig test ensures flutter-free wing design

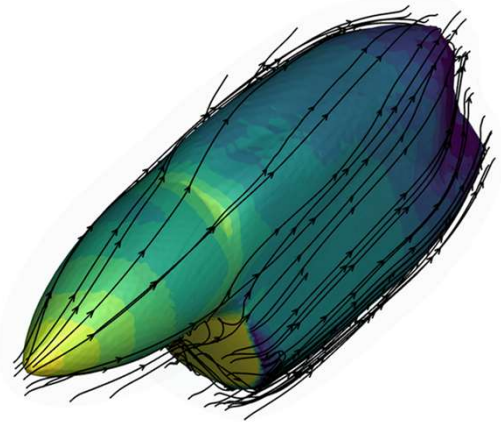
Machine Learning/CFD Optimized Airframe

MERCURY

Fuselage shape optimization using Genetic Algorithm with Machine Learning based surrogate (24,000 design evaluations)

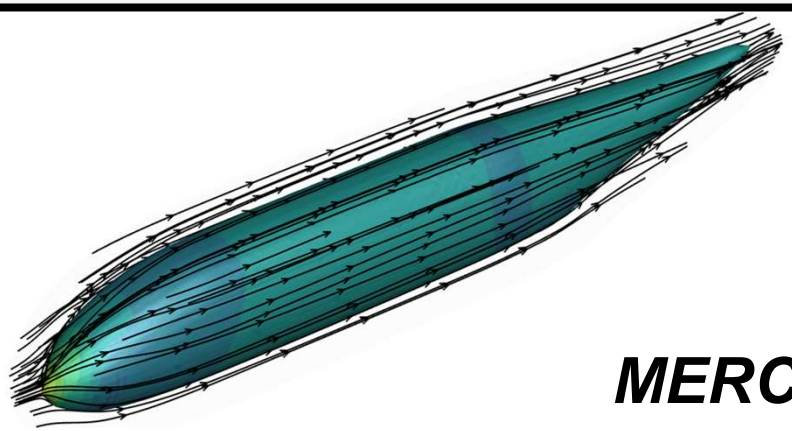
HERMES / XV15





Slimmer streamlined nacelle
25% drag reduction

Tandem Pilot + Staggered passenger seating
30% width reduction => 29 % drag reduction



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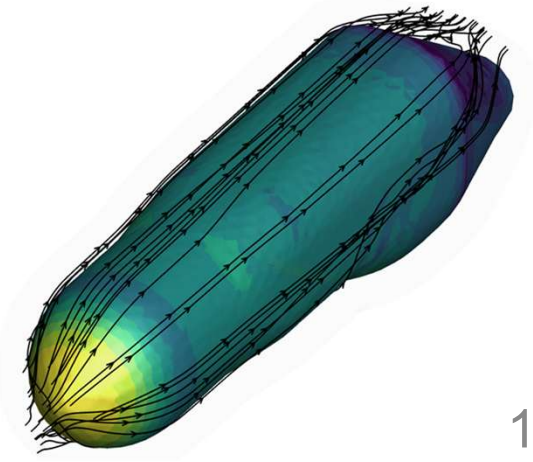
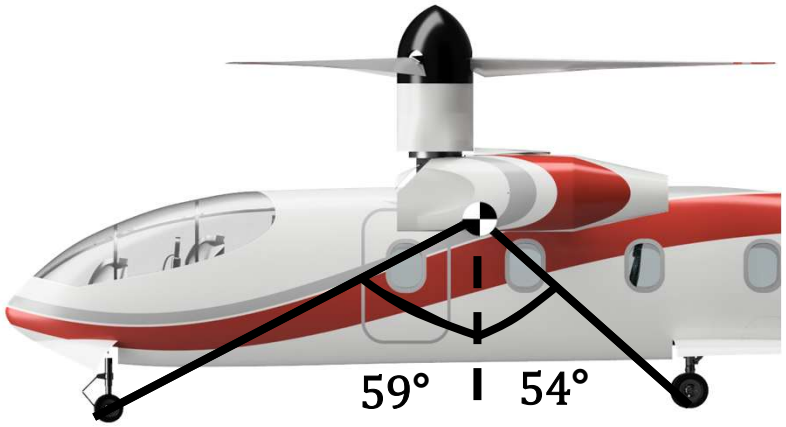
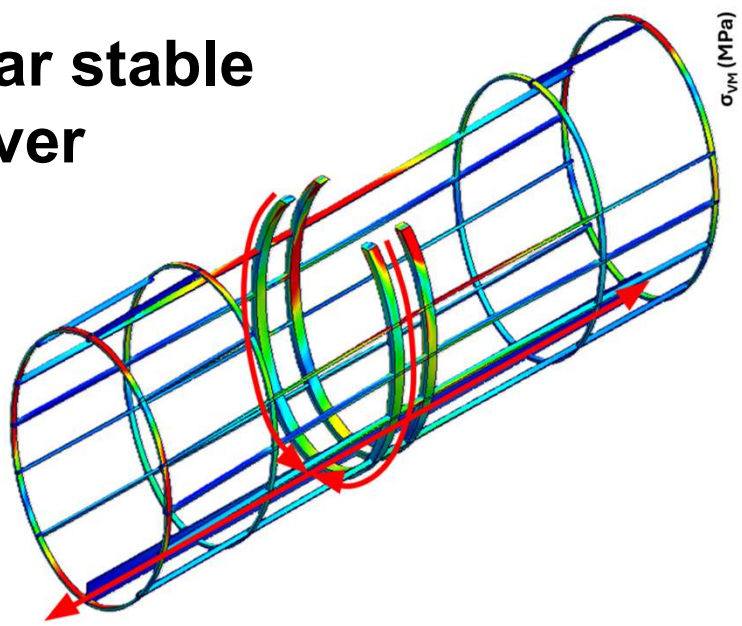
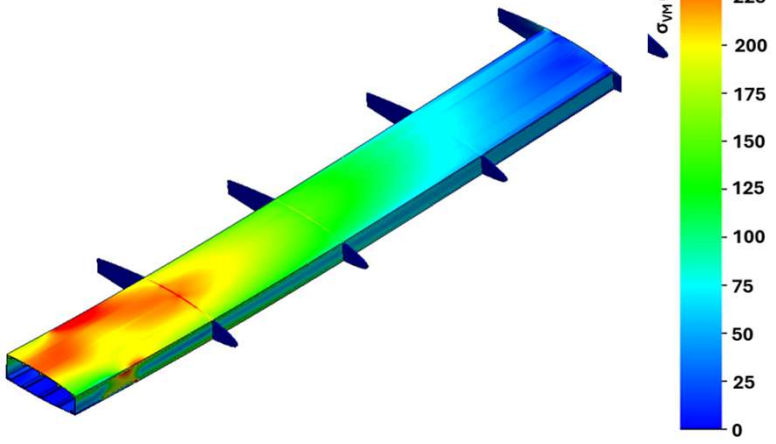


Rollover Resistant and High Factor of Safety Airframe Structure

Tricycle landing gear stable from dynamic rollover



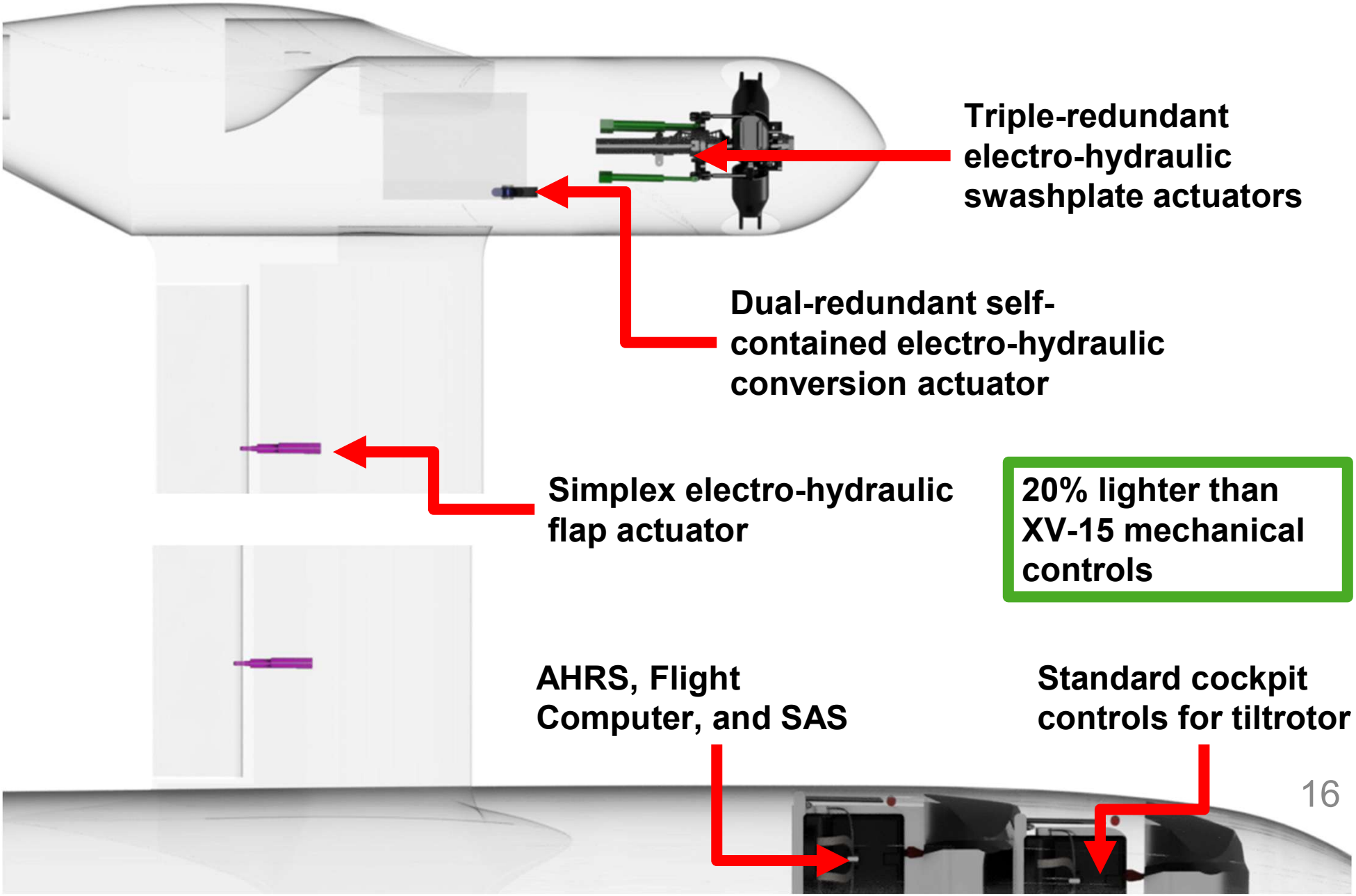




- Maneuver load factor of 3.5g
- Complies with FAA powered lift/ standard flight maneuver requirements

Fly-by-Wire: Safer with Low Pilot Workload

HERMES MERCURY



Triple-redundant electro-hydraulic swashplate actuators

Dual-redundant self-contained electro-hydraulic conversion actuator

Simplex electro-hydraulic flap actuator

20% lighter than XV-15 mechanical controls

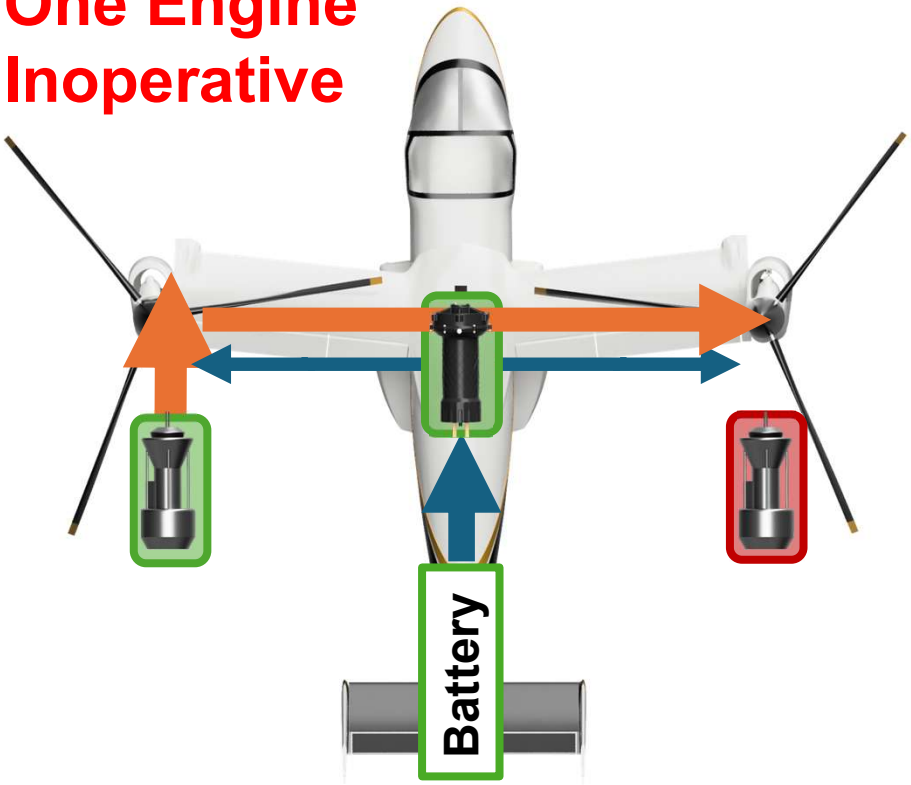
AHRS, Flight Computer, and SAS

Standard cockpit controls for tiltrotor

Safety Ensured Under Dual-Engine Failure

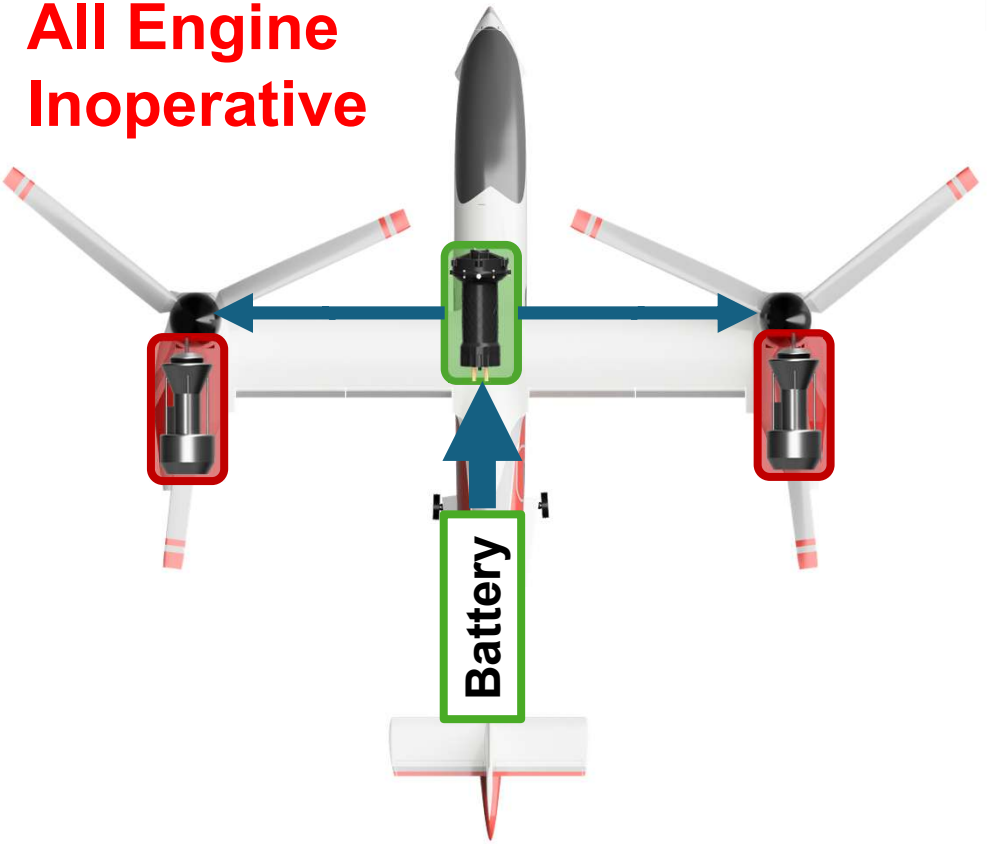
HERMES MERCURY

One Engine Inoperative



- Motor and surviving engine provides instantaneous power reserve
- Sufficient power for HOGE and climb with no altitude loss

All Engine Inoperative



- Motor sustains rotor speed for autorotation
- Flight computer commands an emergency conversion to helicopter mode

Tandem Cockpit with Intuitive Human Machine Interface

MERCURY

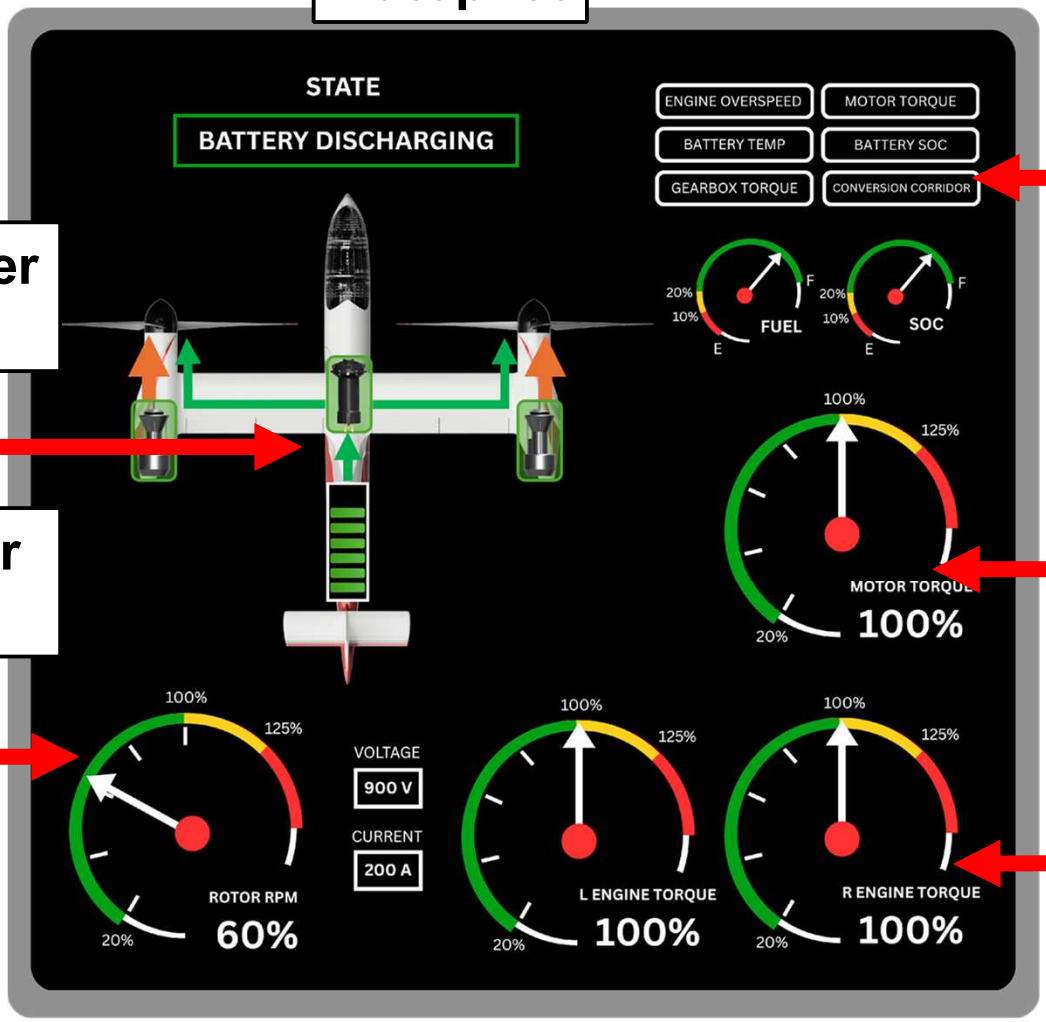
Tandem seating enables sleek cockpit

Hybrid Monitoring

PFD

MFD

Autopilot



Power Flow

Rotor RPM

First Limit Indicator

Motor Torque

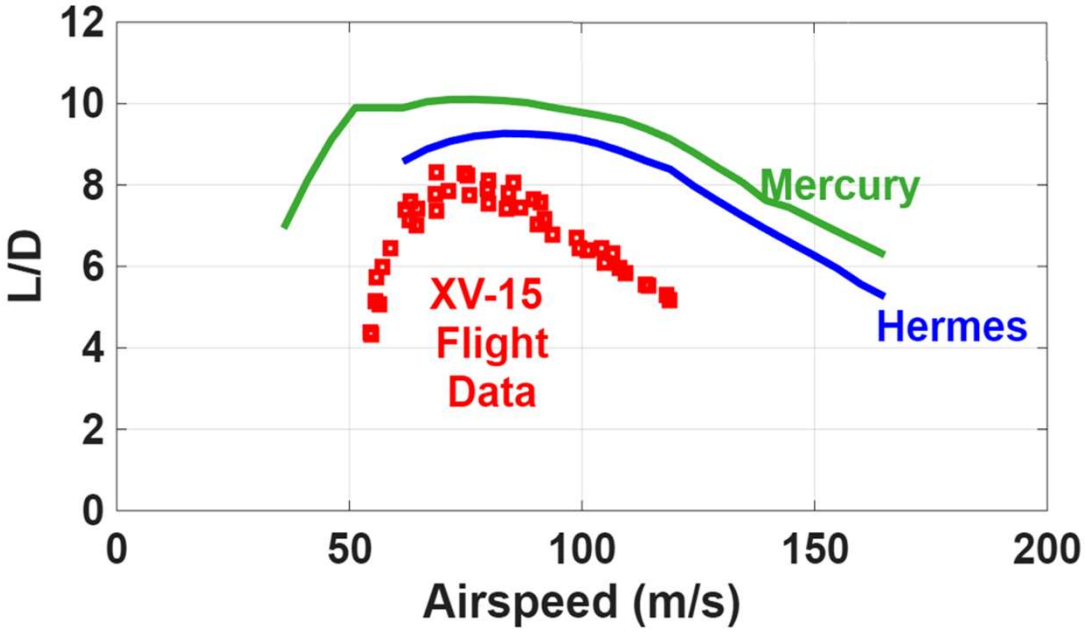
Engine Torque

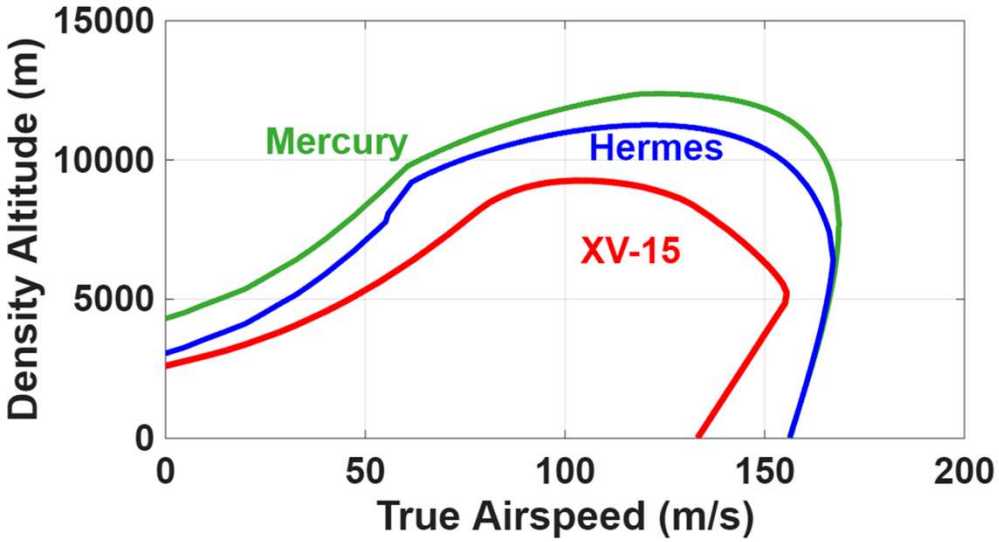
High Speed Cruise, Uncompromised Efficiency

HERMES MERCURY

Improved L/D:

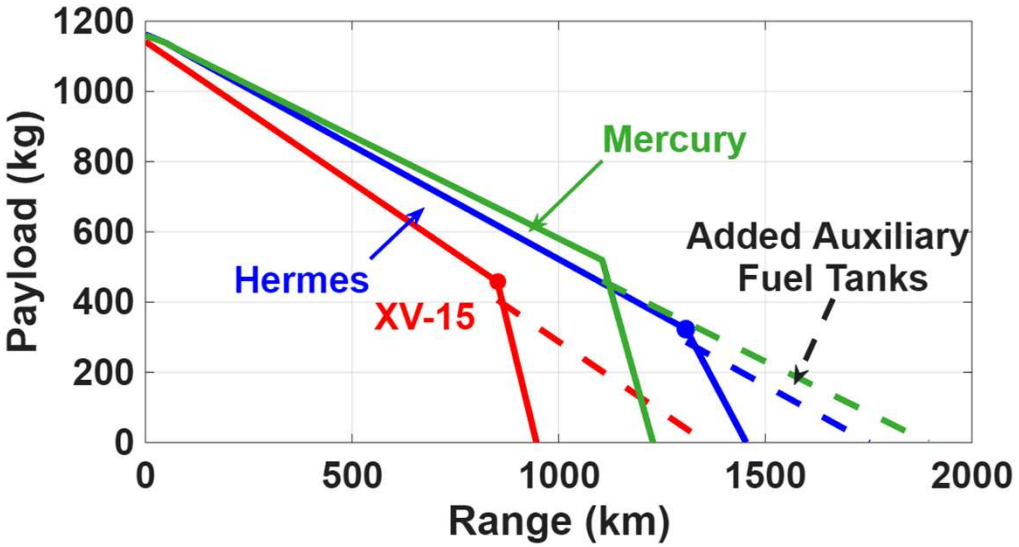
- **Optimized fuselage**
- **Flutter free wing**
- **40% RPM reduction**





Battery enables superior H-V curve

Parallel hybrid ensures maximum fuel efficiency



HERMES MERCURY

Summary

Mercury is a hybrid-electric tiltrotor designed to maximize hover performance and high-speed cruise efficiency.

High Speed Performance
- 5000 kg gross takeoff weight, 15% lighter than the XV-15
- 28% reduction in overall drag
- 1000 km range and 5 hr endurance with full crew and payload

Affordability
- $15.3 million USD
- $5,500 USD per flight hour

Mercury: multi-mission capable

Offshore Energy Logistics

Intercity VIP Transport

EMS & SAR