HEATheR

High-efficiency Electric Aircraft Thermal Research

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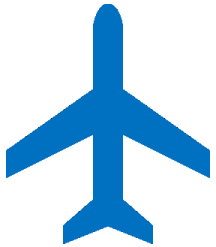
Electric Aircraft Propulsion reduces emissions and expands air travel.

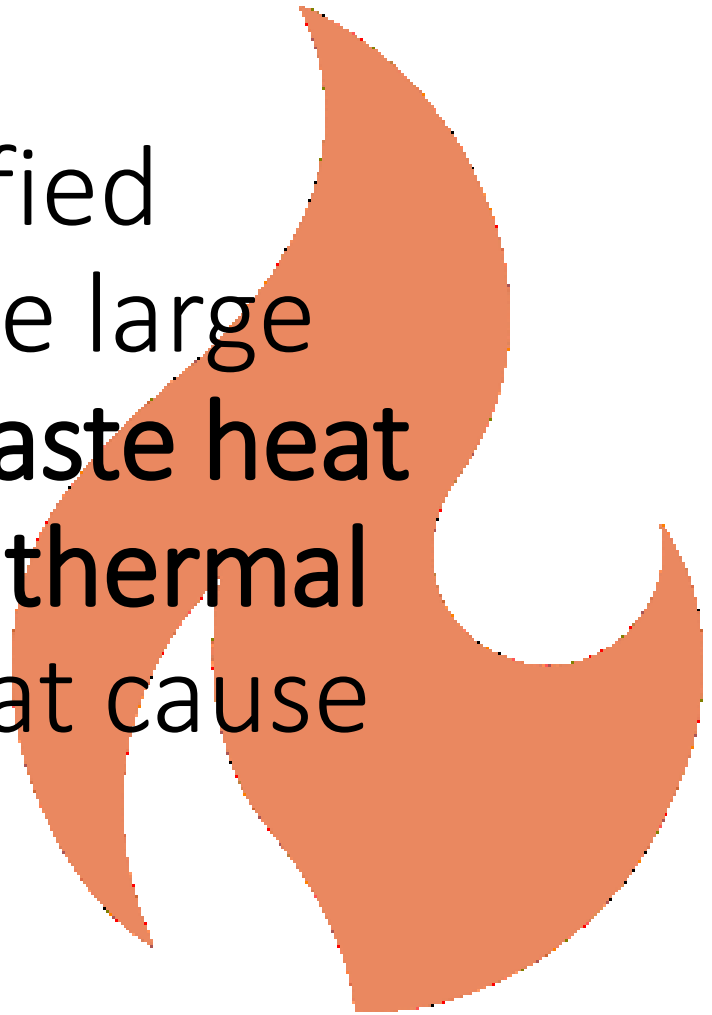
→**Commercial:** reduction in emissions and fuel burn

→**Short Haul:** lower operating costs for regional operations

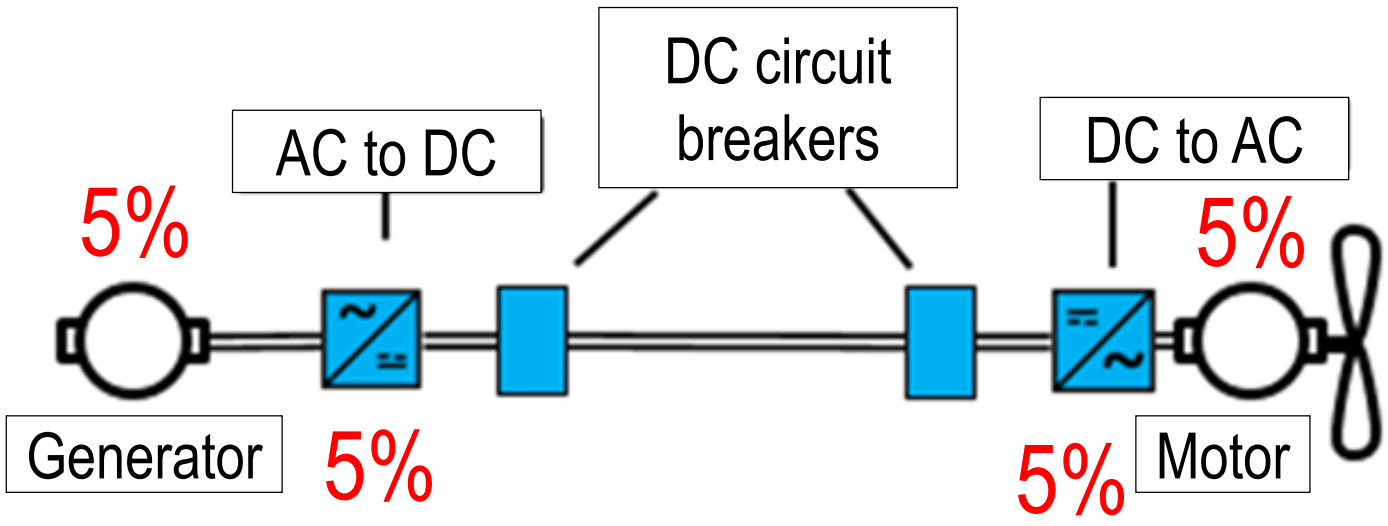
→**Urban Air Mobility:** distributed electric propulsion for VTOL vehicles



Problem: Current electrified aircraft concepts produce large amounts of **low-grade waste heat** and require **large, heavy thermal management systems** that cause drag.

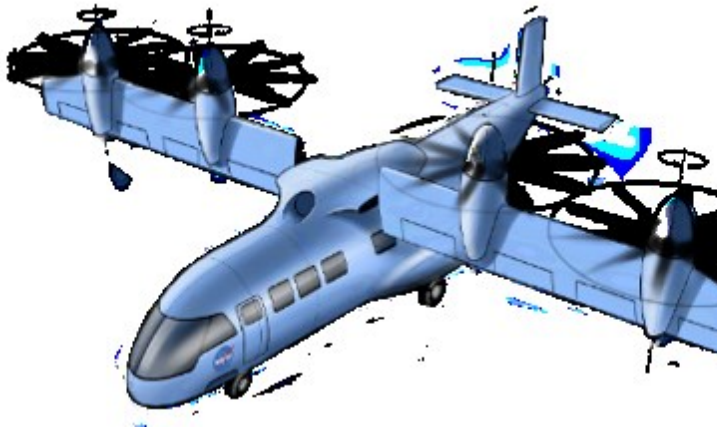


Current electrified aircraft concepts produce large amounts of **low-grade waste heat**



20% Heat

This problem spans markets:



Urban Air Mobility
1 MW power
200 kW heat

Short Ha
3 MW pc
600 kW l

Current electrified aircraft concepts require **large, heavy thermal management systems** that cause **drag**

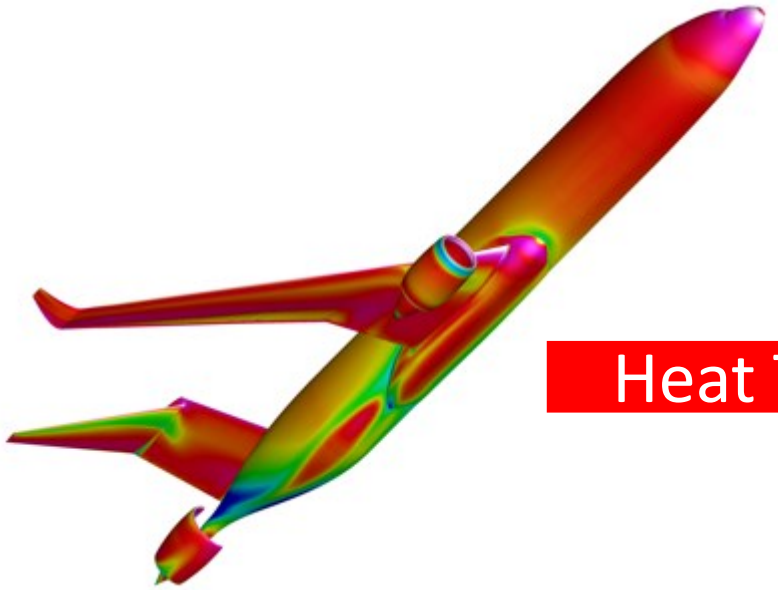
New thermal management technology

Fluid cooling

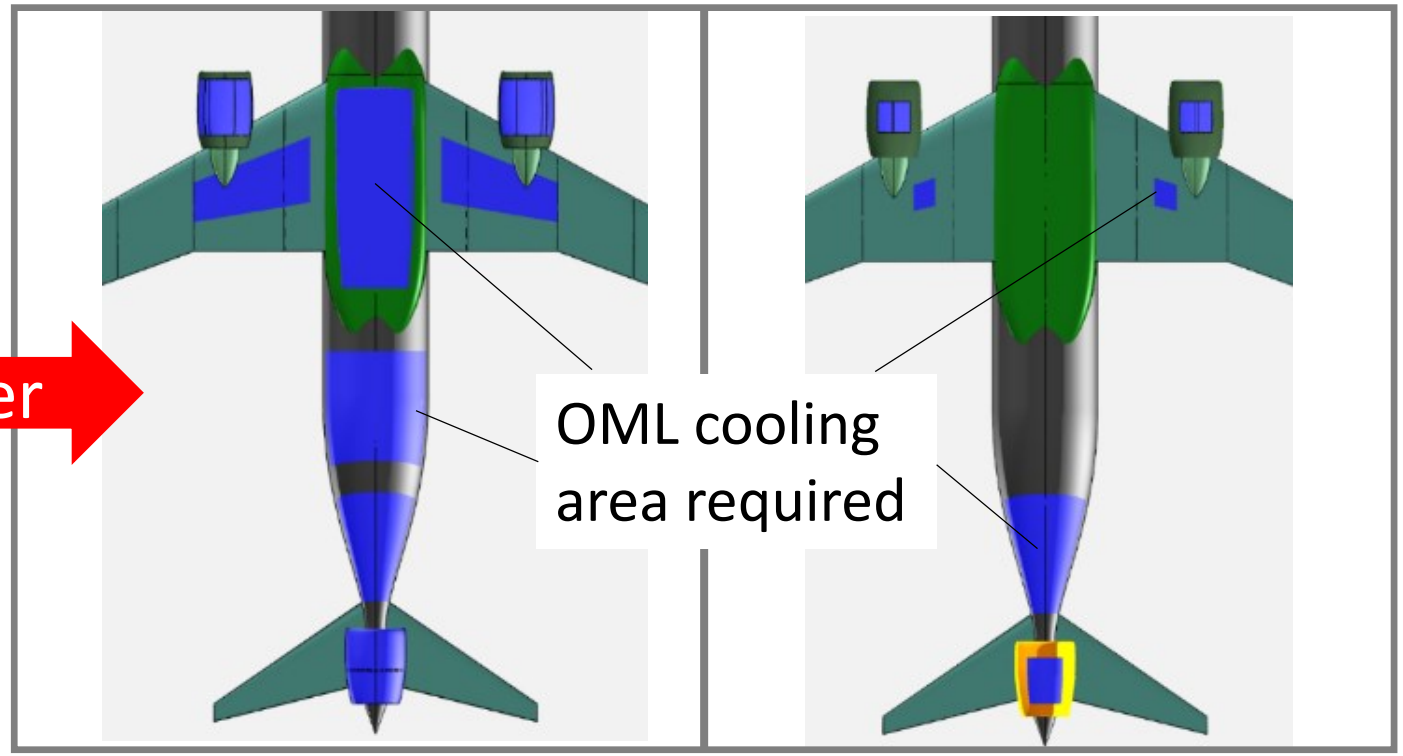
Air cooling

Outer Mold Line (OML) Cooling

Idea: Build a power system with 4x lower losses to enable OML cooling



Heat Transfer



State of the Art

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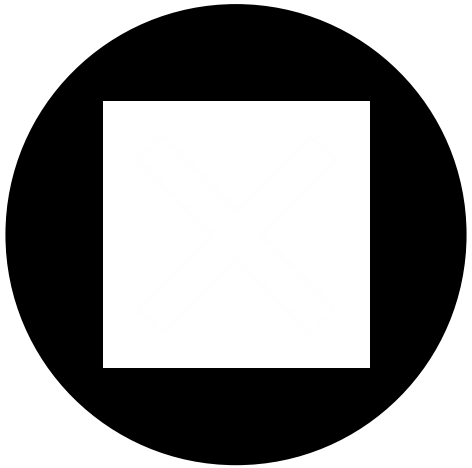
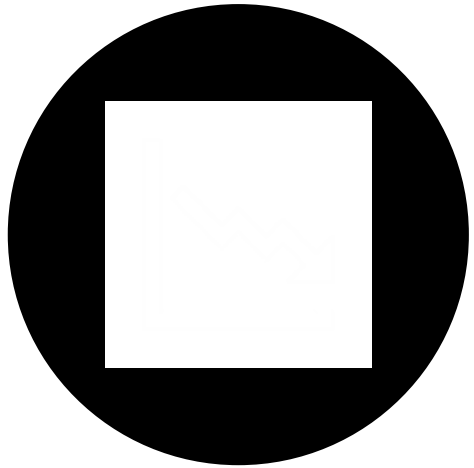
Idea: Build a power system with 4x lower losses to enable OML cooling

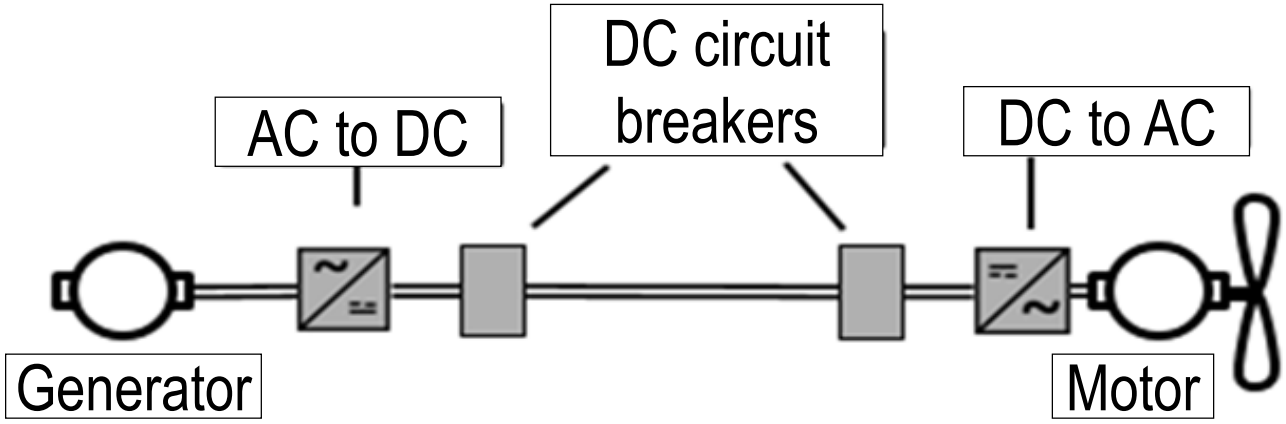


ELIMINATE HALF OF THE CONVERSION STEPS AND COMPLEXITY

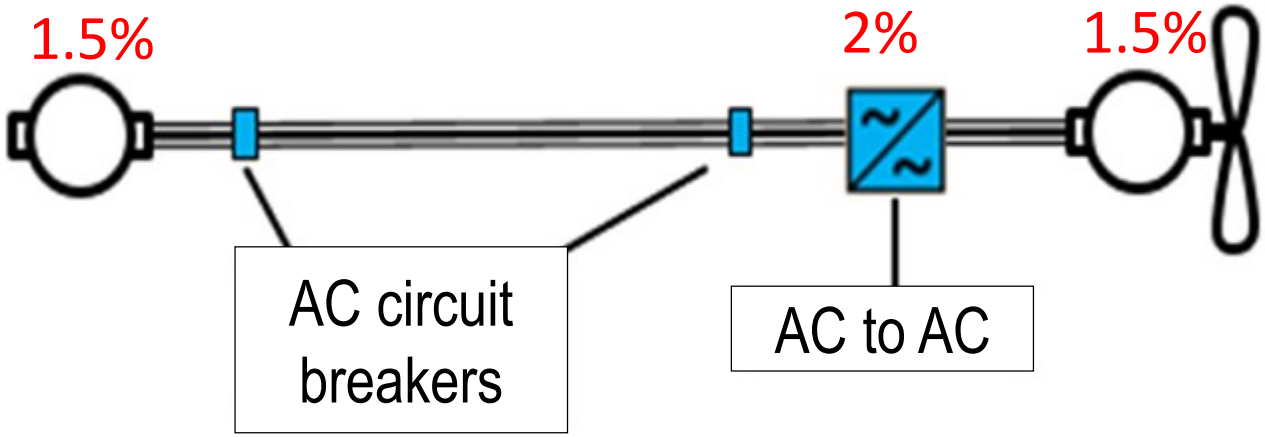


MAKE EXTREMELY LOW LOSS COMPONENTS

Idea: Build a power system with 4x lower losses to enable OML cooling



20% Heat

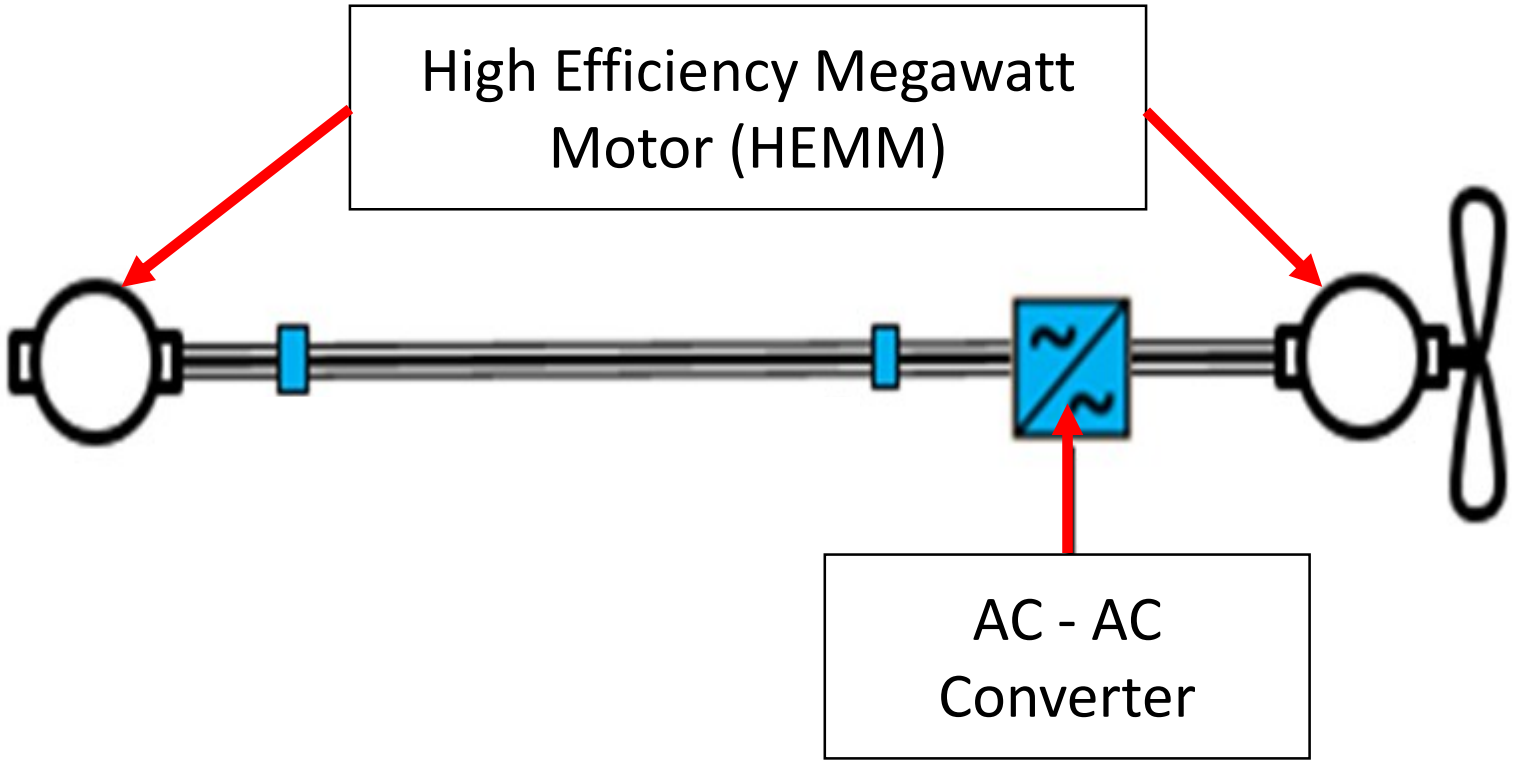


< 5% Heat

Aircraft level performance improves with reductions in **HEAT** and **WEIGHT**

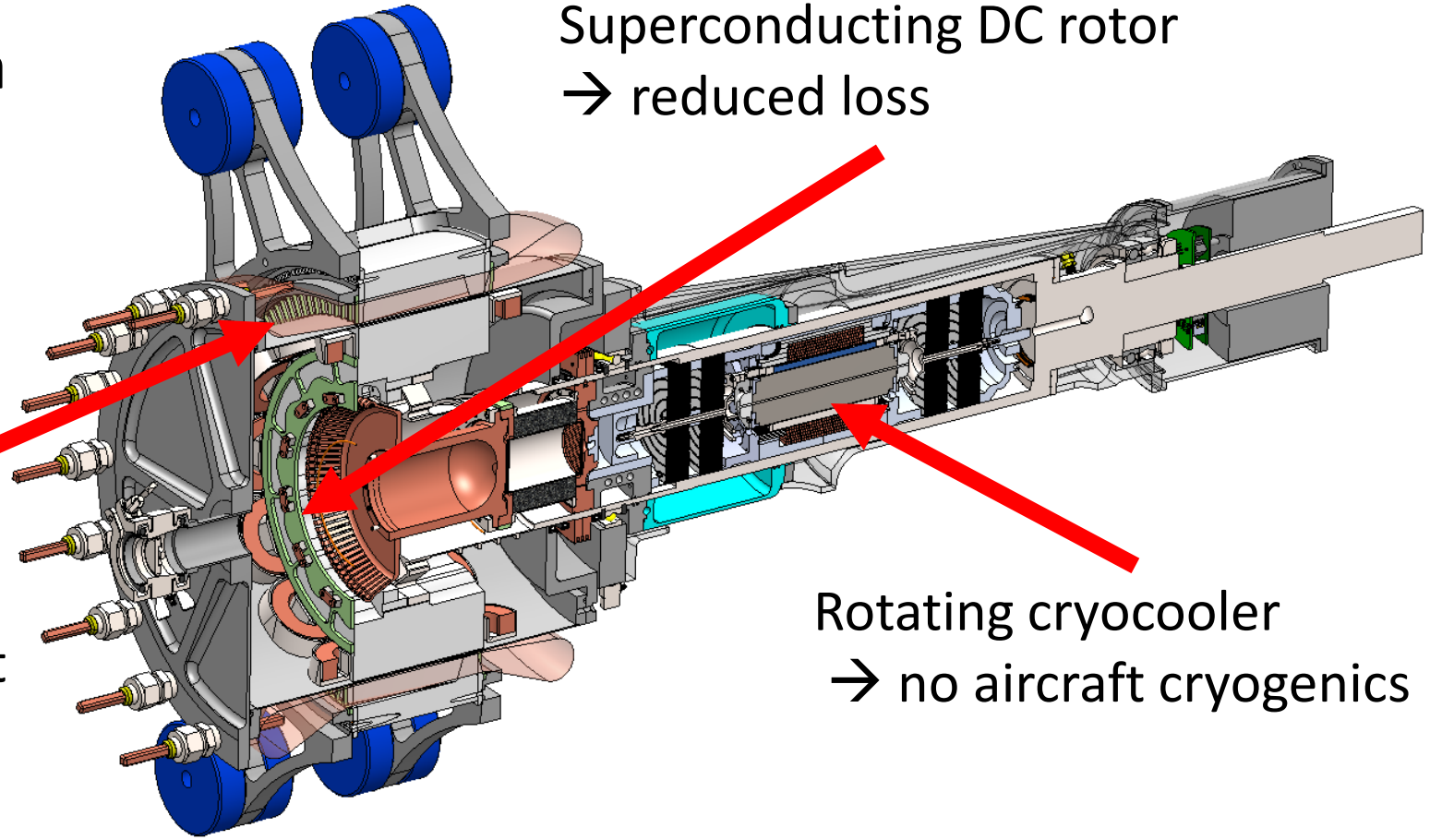
- Heat reduction of 75 percent
- Power system weight reduces by 40 percent
- Thermal management system weight reduces by 60 percent

Two key technologies being developed:



1) HEMM: High Efficiency Megawatt Motor

Key Performance Goa
- 99% efficient
- 16 kW/kg

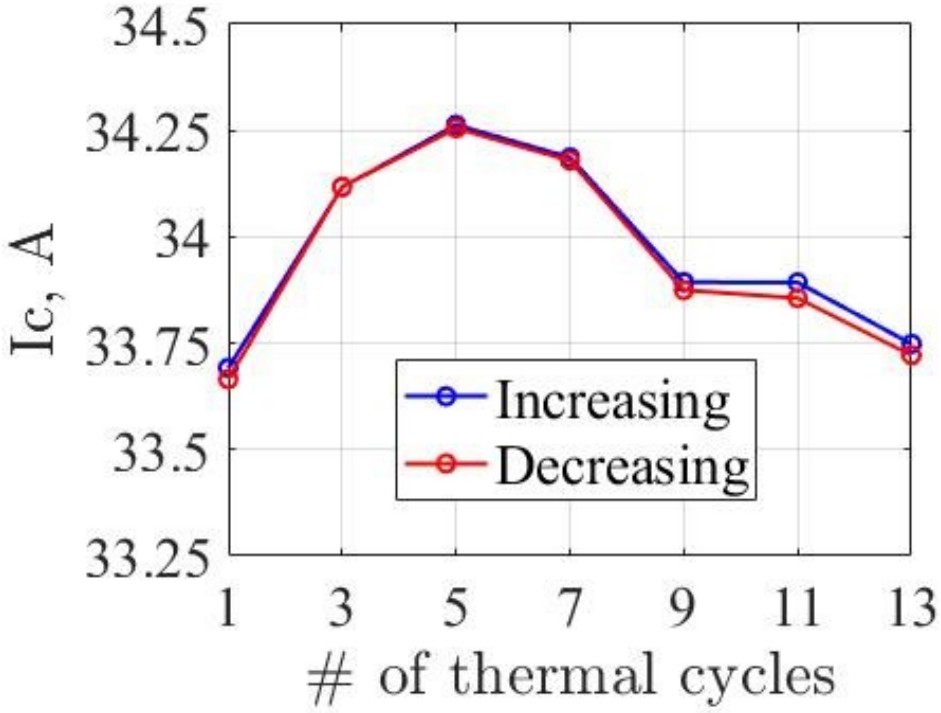


Superconducting DC rotor
→ reduced loss

Slotless stator
→ low ripple current

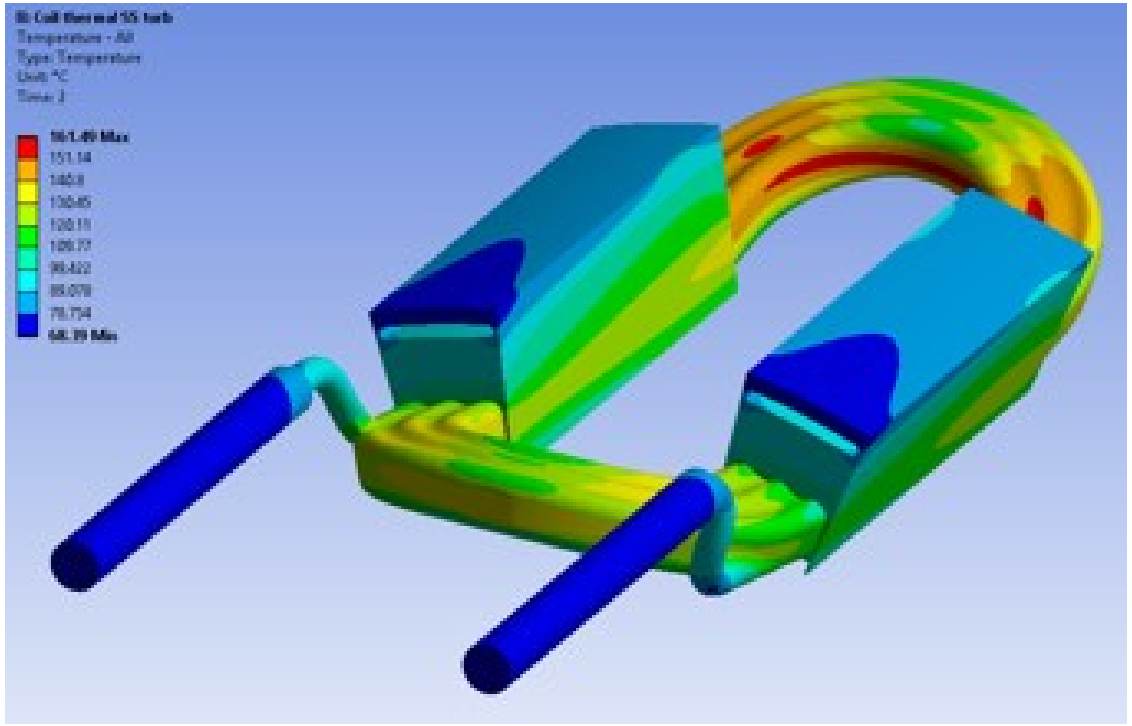
Rotating cryocooler
→ no aircraft cryogenics

HEMM Progress - Rotor



No detectable degradation in superconductor thermal cycling

HEMM Progress - Stator



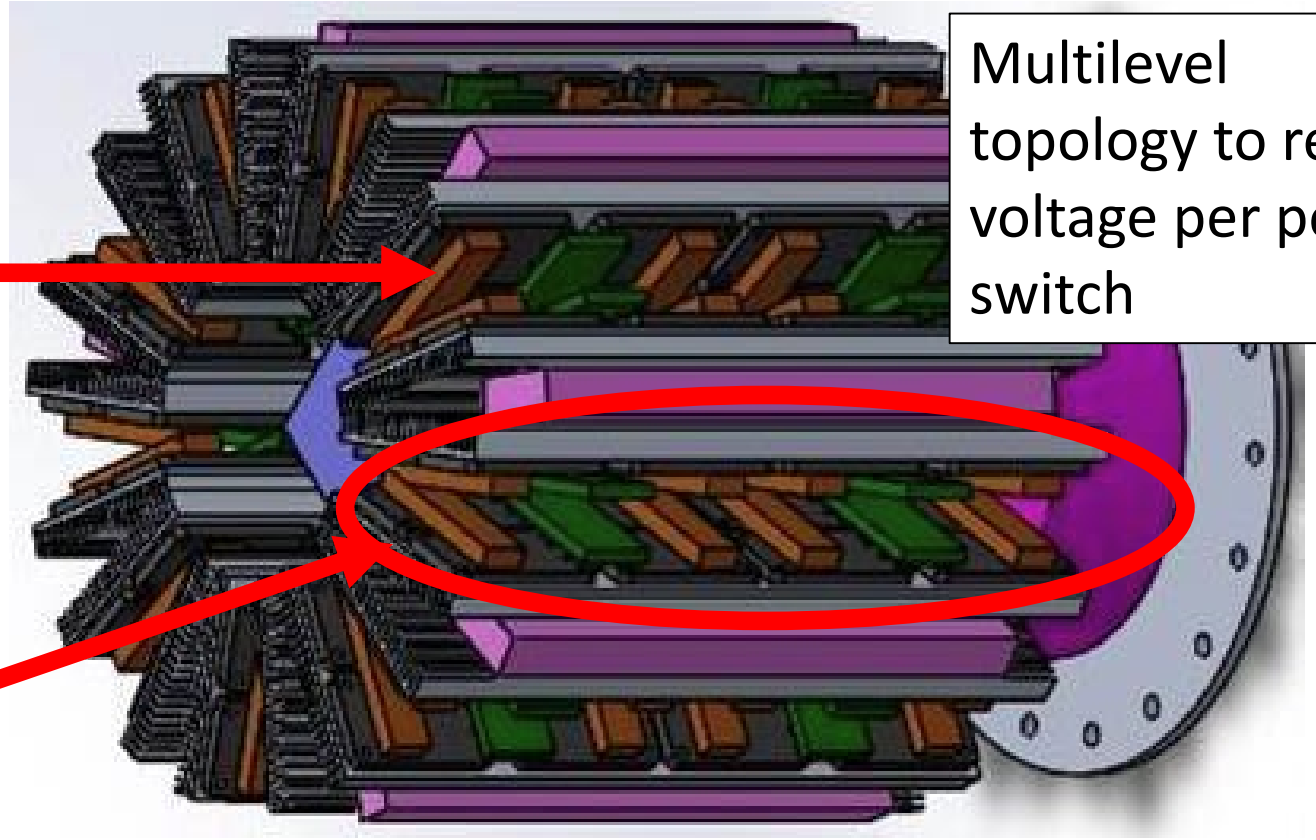
Demonstrated ability to stay under temperature limit at full current and improved potting process.

2) AC-AC Converter

Key Performance Goals:

- 99% efficient
- 10 kW/kg

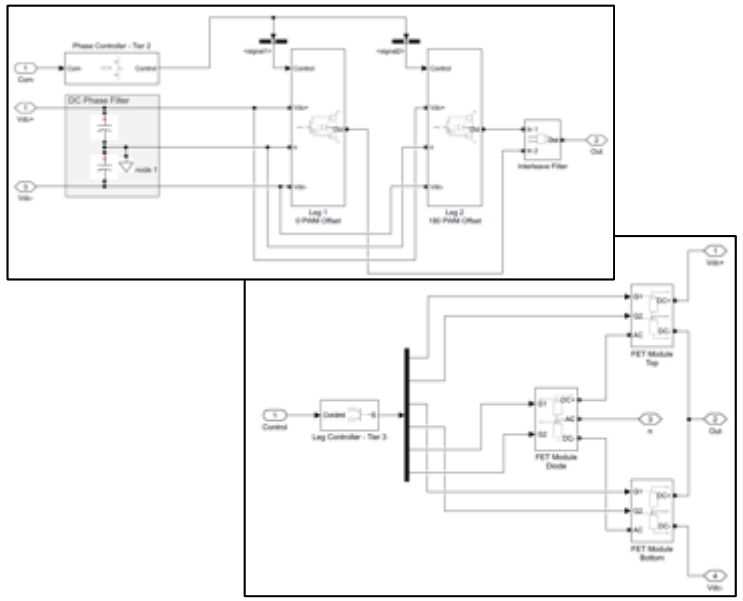
Utilizing most advanced SiC FETs



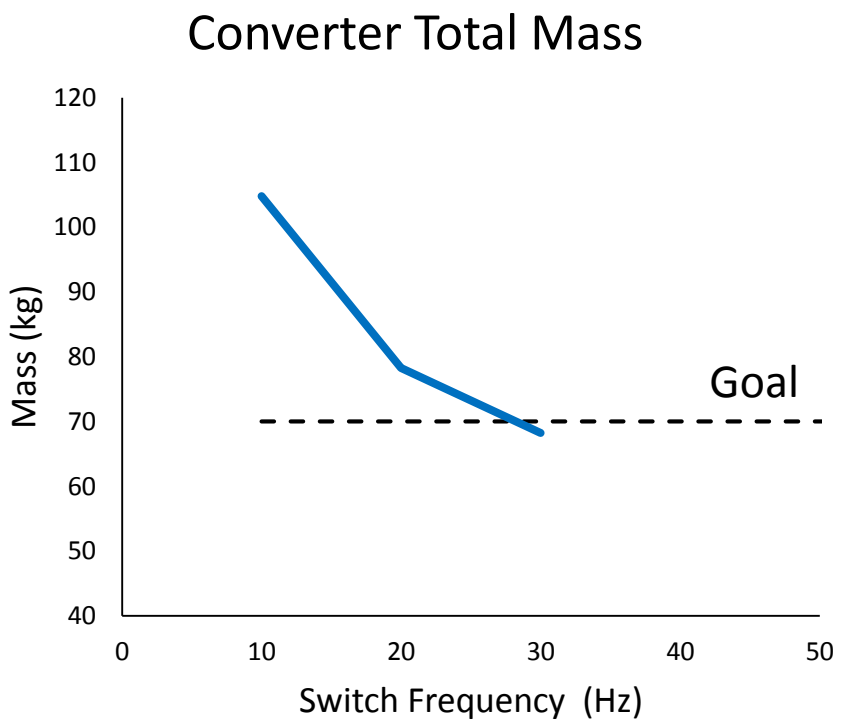
Multilevel topology to reduce voltage per power switch

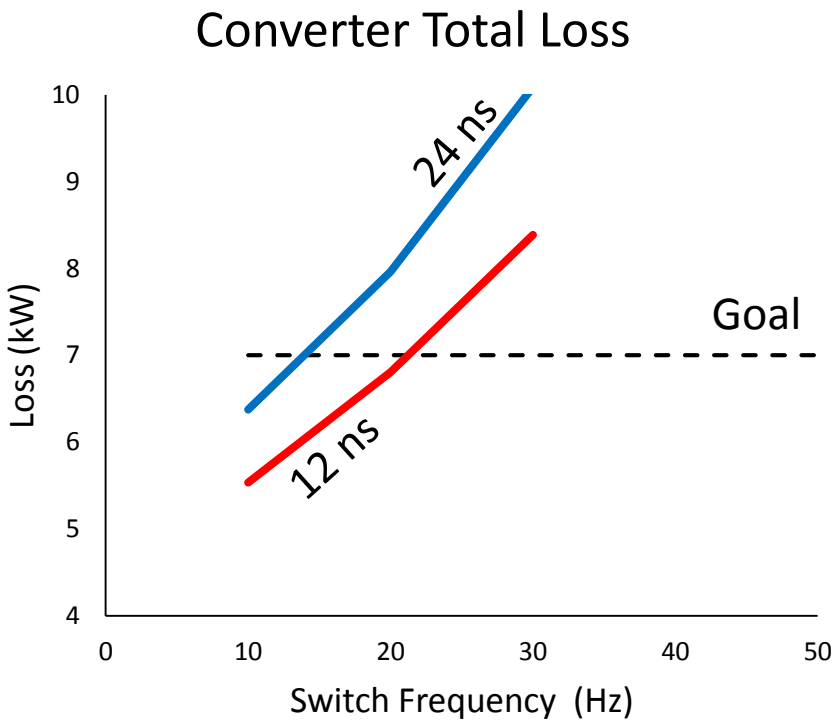
Interleaving to allow large power switches to have a higher effective switch frequency

AC-AC Converter Progress



Identified concept design that will hit performance goals.





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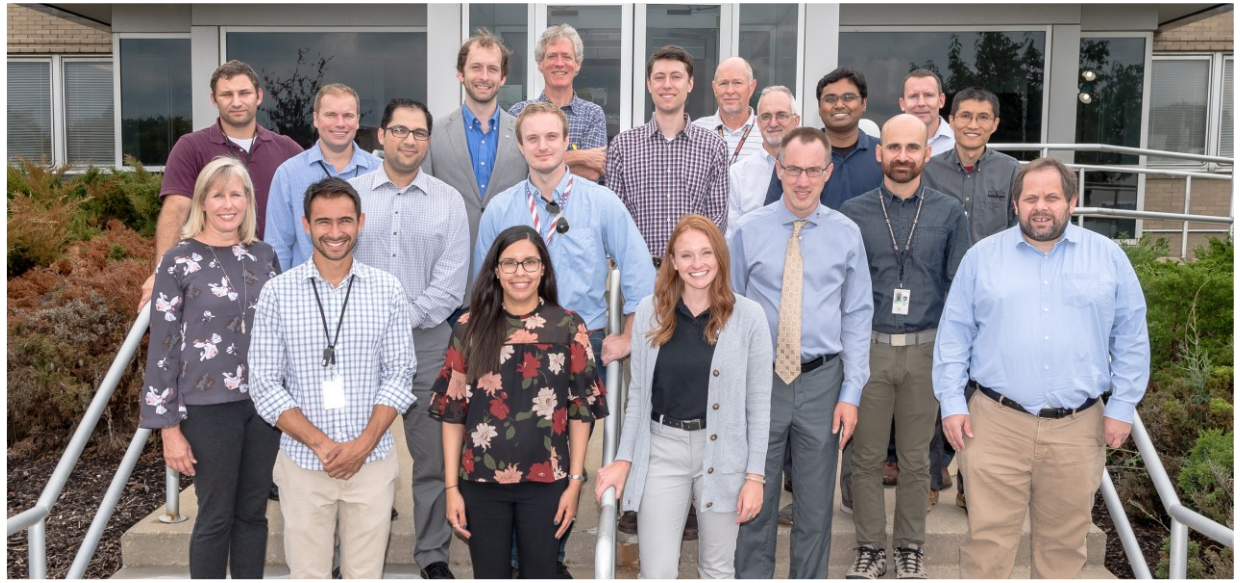

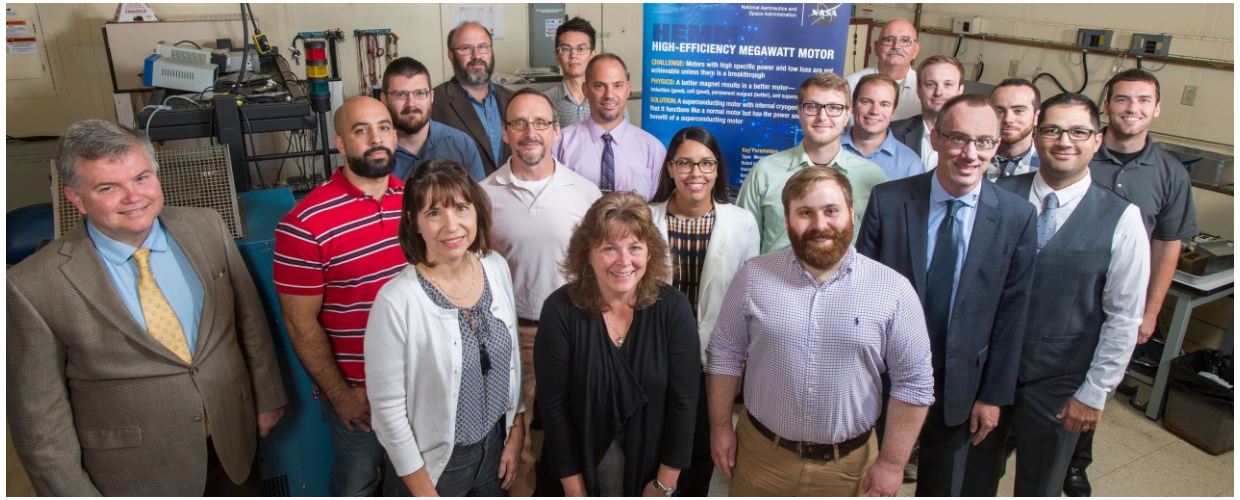

External Partners

Aurora Flight Sciences

United Technologies Research Center

Parker Aerospace

PCKA

Transfer of technology development

PUBLICATIONS

PATENTS

AIRCRAFT MODELING TOOLS

Thank you

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