Transformative Aeronautics Concepts Program

Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA)

Active Technology Project (2019 - 2022)

Project Introduction

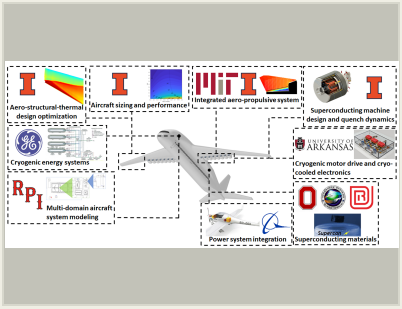
The aeronautics industry has been challenged on many fronts to increase efficiency, reduce emissions, and decrease dependency on carbon-based fuels. With subsonic transports serving as the dominant contributor to the fuel consumption and carbon footprint of global aviation, the need for environmentally-responsible transportation has been met with a boom of research in the field of aircraft propulsion electrification across industry, government, and academic organizations. However, adoption of electrified propulsion systems for large commercial aircraft today is unattainable, due to the lack of motors and power electronics appropriately sized for these vehicles, high weight requirements of conventional electrical energy storage systems, and new principles required to design these classes of aircraft.

The mission of the Center for High-Efficiency Electrical Technologies for Aircraft (CHEETA) program is to develop, mature, and design disruptive technologies for electric commercial aviation. The associated technologies being researched include distributed aero-propulsion system integration, high-efficiency electrochemical power conversion, flight-weight electric machines and power electronics, materials and systems for superconducting high-efficiency power transmission, and methods for complex system integration and optimization. Additionally, the current program is investigating the use of unconventional energy storage and power generation architectures, such as liquid hydrogen fuel and high-efficiency fuel cell systems.

The research program provides a direct line-of-sight to not only achieving, but potentially even exceeding the aviation community goals for transition to alternative propulsion and energy through convergence of various novel technologies. The end result of maturation and integration of these technologies is an aircraft system with a quiet, efficient propulsion system that produces zero carbon dioxide, nitrogen oxides, and particulate matter emissions at the vehicle level.

Anticipated Benefits

Through this project, an entirely new class of electrical machines and drive systems will be developed, which can be applied to future electric aircraft or other markets such as wind energy, marine and ground transportation systems, remote power generation, and space systems. The research through this program on distributed propulsion and aero-propulsive integration will produce more energy-efficient commercial aircraft with improved safety and tolerance to failures. Development of superconducting technologies will also facilitate dramatic improvements in power density of electric machines and ultra-efficient high-power electrical transmission. Finally, the research being conducted through this study represents a brand new technology field which, if matured, will lead to US leadership in product development and export.



Study Components

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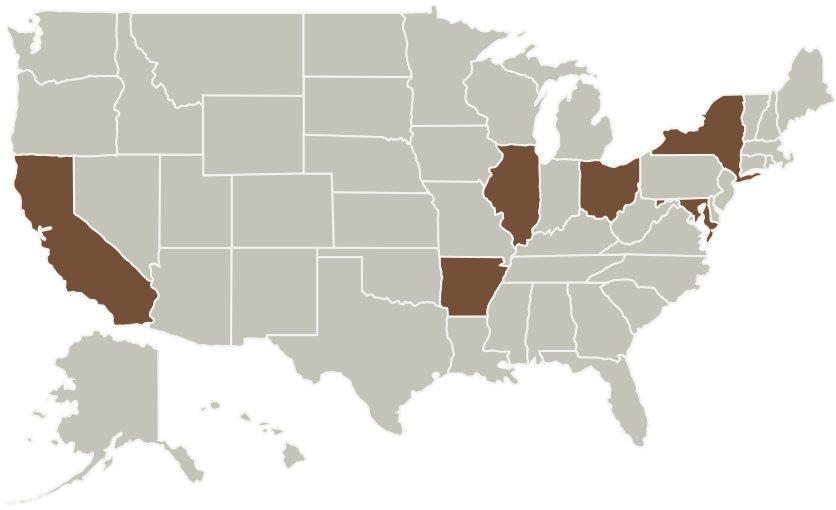
Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Aeronautics Research Mission Directorate (ARMD)

Lead Organization:

University of Illinois

Responsible Program:

Transformative Aeronautics Concepts Program

Project Management

Program Director:

John A Cavolowsky

Project Manager:

Koushik Datta

Principal Investigator:

Phillip Ansell

Continued on following page.

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Organizations Performing Work	Role	Type	Location
University of Illinois	Lead Organization	Academic	Champaign, IL
Boeing	Supporting Organization	Industry	Chicago, IL
Chicago State University	Supporting Organization	Academic	Chicago, IL
General Electric(GE)	Supporting Organization	Industry	Boston, MA
Massachusetts Institute of Technology(MIT)	Supporting Organization	Academic	Cambridge, MA
Ohio State University	Supporting Organization	Academic	Columbus, OH
Rensselaer Polytechnic Institute	Supporting Organization	Academic	Troy, NY
University of Arkansas	Supporting Organization	Academic	Fayetteville, AR
University of Dayton	Supporting Organization	Academic	Dayton, OH

Primary U.S. Work Locations	
Arkansas	California
Illinois	Maryland
New York	Ohio

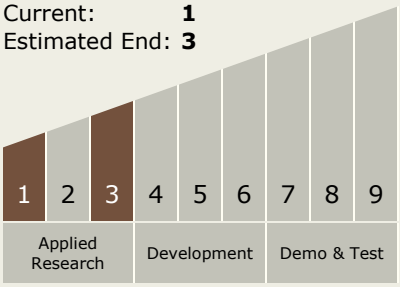
Project Management *(cont.)*

Co-Investigators:

Arijit Banerjee
Edward Greitzer
David Hall
Kiruba Haran
Kai James
Fang Luo
Jason Merret
Mike Sumption
Bang-hung Tsao
Luigi Vanfretti
Valerie Goss
James M Falcone
Mary Ann Sebastian
Ernst W Stautner
Alan Mantooth
Shailesh Atreya

Technology Maturity (TRL)

Start: **1**
Current: **1**
Estimated End: **3**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion

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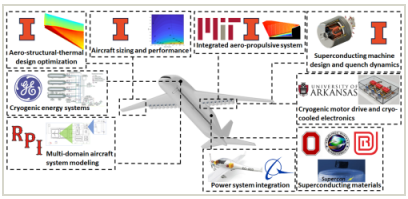
Images

CHEETA Concept Vehicle
A rendering of CHEETA vehicle concept
(https://techport.nasa.gov/image/40617)



Showcasing the CHEETA Study Components
Study Components
(https://techport.nasa.gov/image/40619)

Links

A fully superconducting air-core machine for aircraft propulsion
(https://iopscience.iop.org/article/10.1088/1757-899X/756/1/012030)

Co-design of an Integrated Direct-drive Electric Motor and Propeller for Aircraft Propulsion
(https://arc.aiaa.org/doi/abs/10.2514/6.2020-3560)

Cryogenic Characterization and Modeling of Silicon Superjunction MOSFET for Power Loss Estimation
(https://arc.aiaa.org/doi/abs/10.2514/6.2020-3660)

Project Website:

https://cheeta.illinois.edu

Technology Areas *(cont.)*

└ TX01.3.8 All Electric Propulsion

Target Destination

Foundational Knowledge

Supported Mission Type

Push