Emissions Reductions through High-Efficiency Gas Turbine Research at Penn State

Mechanical Engineering, Aerospace Engineering, Material Science and Engineering, Engineering Science and Mechanics, Energy and Mineral Engineering, Applied Research Lab

Gas Turbines and Climate Change

- *As the world moves towards renewable energy sources, gas turbine engines remain critical components of global energy infrastructure.*
- *Currently, gas-turbine power and propulsion plants emit billions of tons of CO2 each year, and account for about 25% of global greenhouse gas emissions.*
- *Accordingly, technology measures to reduce emissions from gas-turbines will have a significant role in the global CO2 drawdown portfolio.*
- *Stable, efficient, clean gas turbines have an important role to play in addressing climate change in two ways:*
  1) *Improved efficiency leads to lower CO_2 emissions for the same power output*
  2) *Augmenting the adoption of renewables (i.e., wind and solar), as high-efficiency, fast-response plants to offset user demand and solar/wind power variations.*

Penn State's Role

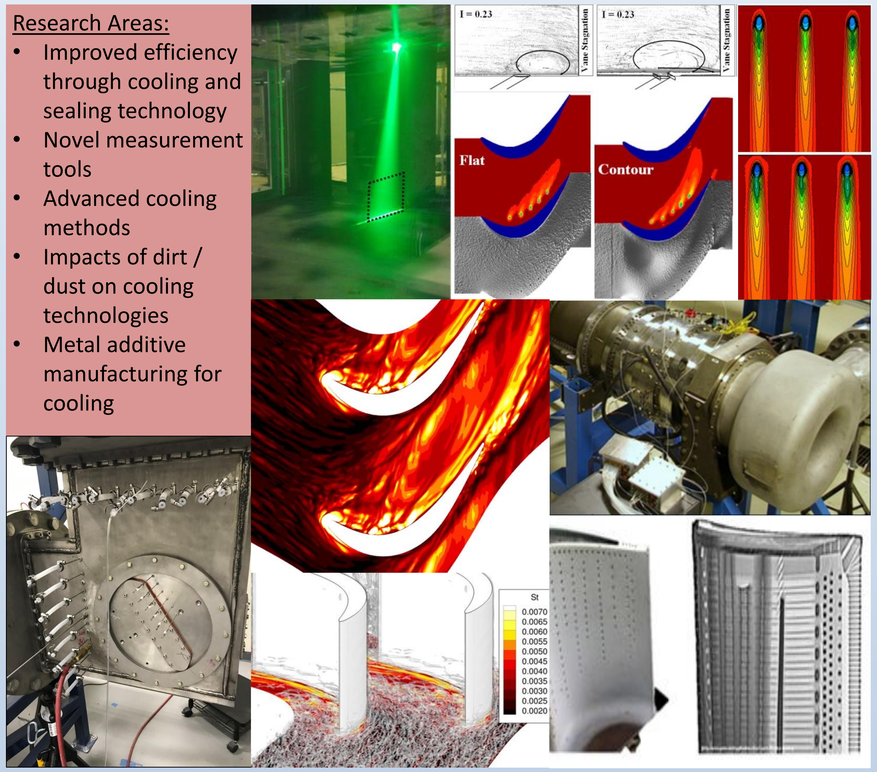
- *At Penn State, a significant research enterprise is ongoing in the areas of gas turbine combustion, heat transfer, compressor and turbine aerodynamics, computational modeling, to further improve gas turbine responsiveness and efficiency. This research is summarized here*
- *Penn State is a Center of Excellence for research sponsored by United Technologies – Pratt and Whitney and Solar Turbines, which positions PSU at the forefront of technology development for power generation and propulsion applications.*
- *Ultimately, gas turbine research efforts at Penn State are actively contributing to global needs of reduced emissions outlined by Project Drawdown.*

Research Areas

Turbine Aerodynamics and Heat Transfer

Faculty:
Karen Thole, Steve Lynch, Reid Berdanier, Nicholas Jaffa

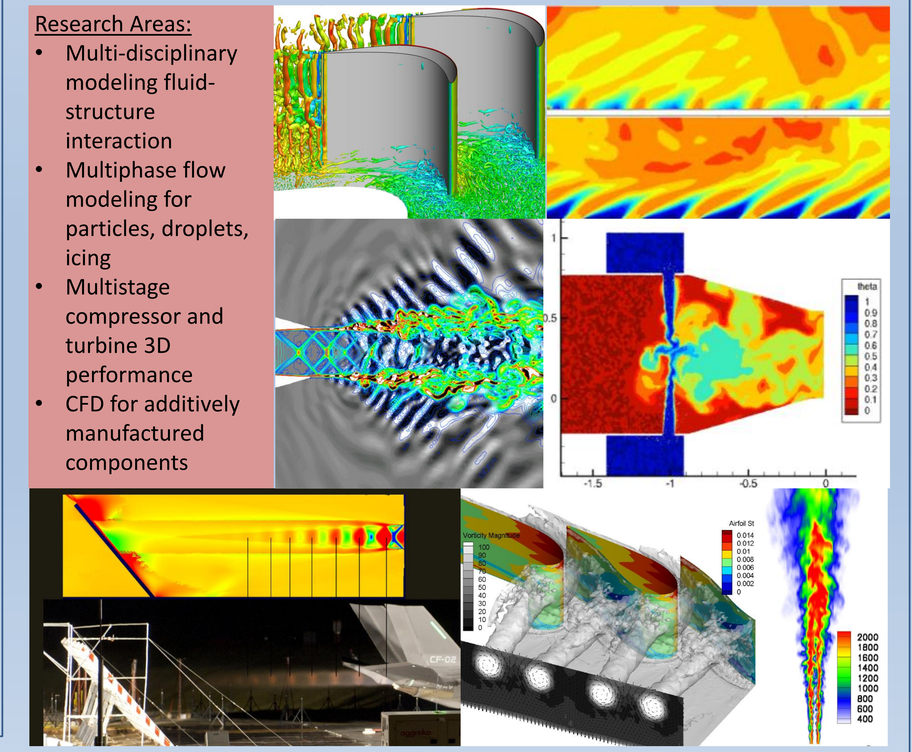
Research Areas:
- Improved efficiency through cooling and sealing technology
- Novel measurement tools
- Advanced cooling methods
- Impacts of dirt / dust on cooling technologies
- Metal additive manufacturing for cooling



Computational Fluid Dynamics

Faculty:
Rob Kunz, David Williams, Xiang Yang, Yuan Xuan, Steve Lynch, Phil Morris

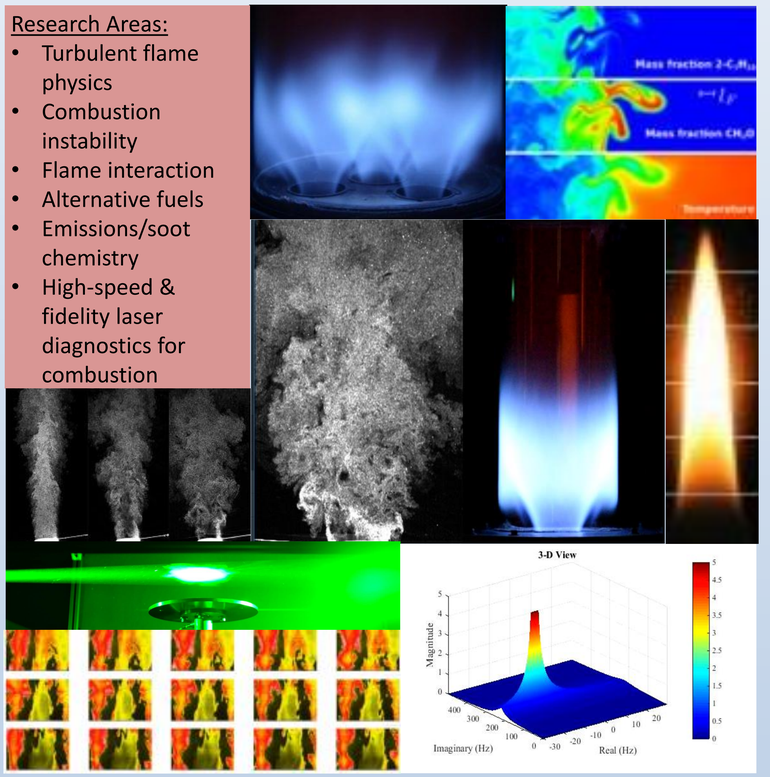
Research Areas:
- Multi-disciplinary modeling fluid-structure interaction
- Multiphase flow modeling for particles, droplets, icing
- Multistage compressor and turbine 3D performance
- CFD for additively manufactured components



Combustion

Faculty:
Jacqueline O'Connor, Rich Yetter, Yuan Xuan, Adri van Duin, Dan Haworth, Randy Vander Wal

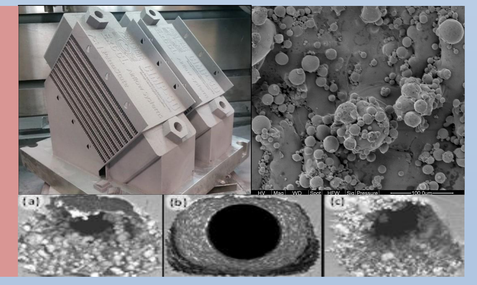
Research Areas:
- Turbulent flame physics
- Combustion instability
- Flame interaction
- Alternative fuels
- Emissions/soot chemistry
- High-speed & fidelity laser diagnostics for combustion



Materials and Manufacturing

Faculty: Tim Simpson, Amrita Basak, Guha Manogharan, Doug Wolfe, Allison Beese, Long-Qing Chen, Zi-Kui Liu, Todd Palmer

Research Areas:
- Additive manufacturing
- Blade and vane repairs
- Ceramic matrix composites
- Hybrid manufacturing
- Thermal barrier coatings
- Functionally graded/ hybrid materials



Diagnostics and Controls

Faculty: Asok Ray, Karl Reichard, Chris Kube

Research Areas:
- Robust control of combustion instabilities
- Neural-network-based control of combustion
- Non-destructive testing and online monitoring
- Prediction-based maintenance