AFRL/DOE RDE Collaboration

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NETL University Turbine Systems Research Program Workshop

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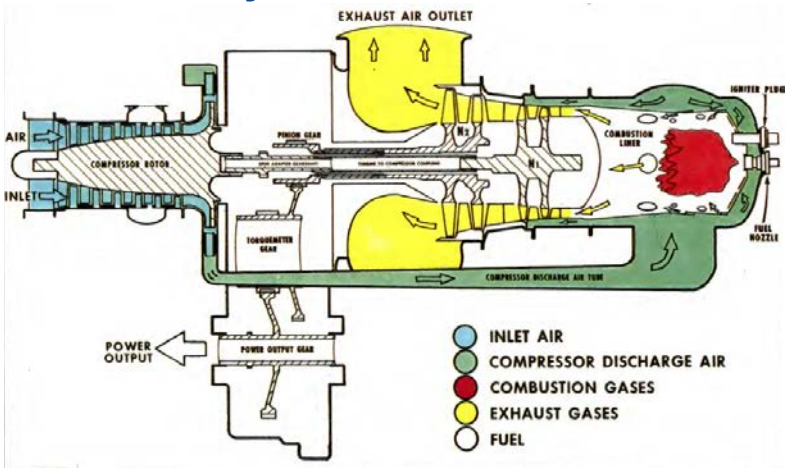
AFRL RDE Research Interests

- Interests span from fundamental to applied research
- Analytical and experimental determination of RDE wave structure
- Quantifying and expanding operational maps
  - Inlet conditions (pressures, temperatures, velocities)
  - Equivalence ratios
  - Reactants (including liquid fuel/air)
- Performance quantification and improvement
  - Reduced inlet pressure losses
  - Combustion efficiency improvements
- Thermal management
  - Quantifying thermal loads
  - High temperature material assessments
- RDE integration assessments

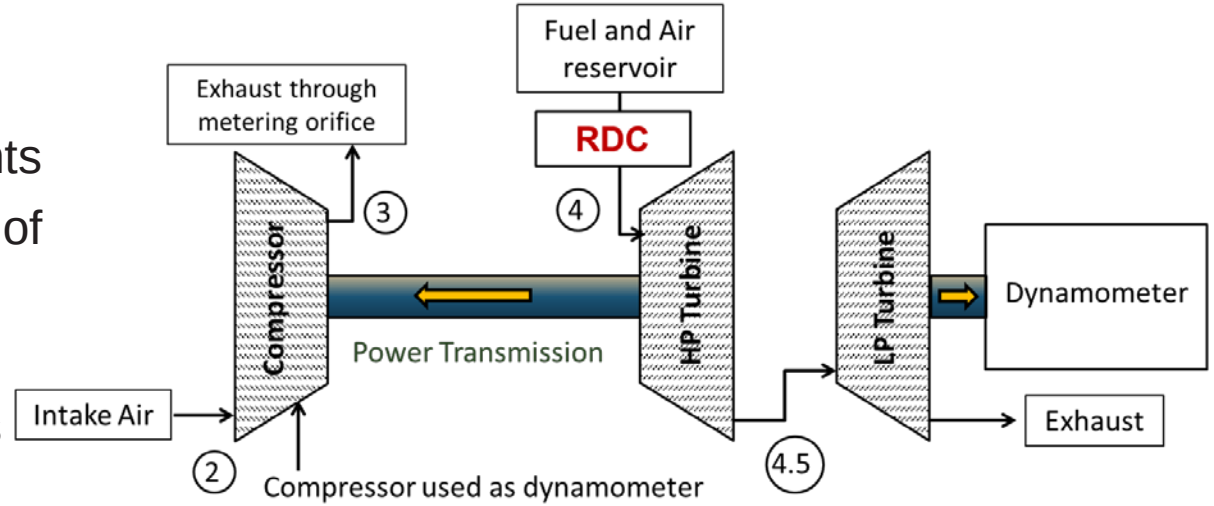
AFRL/DOE RDE Turbine Interaction Study

- Goal: assess impact of RDE exhaust on turbine performance

- T63 engine used as a test bed
  - Low OPR machine
  - Stock turbine used
  - H_2/Air RDE used
- Operated in an open loop configuration
  - Reduces RDE performance requirements
  - Necessitates the testing of multiple configurations
- Performance compared by matching station 4 conditions

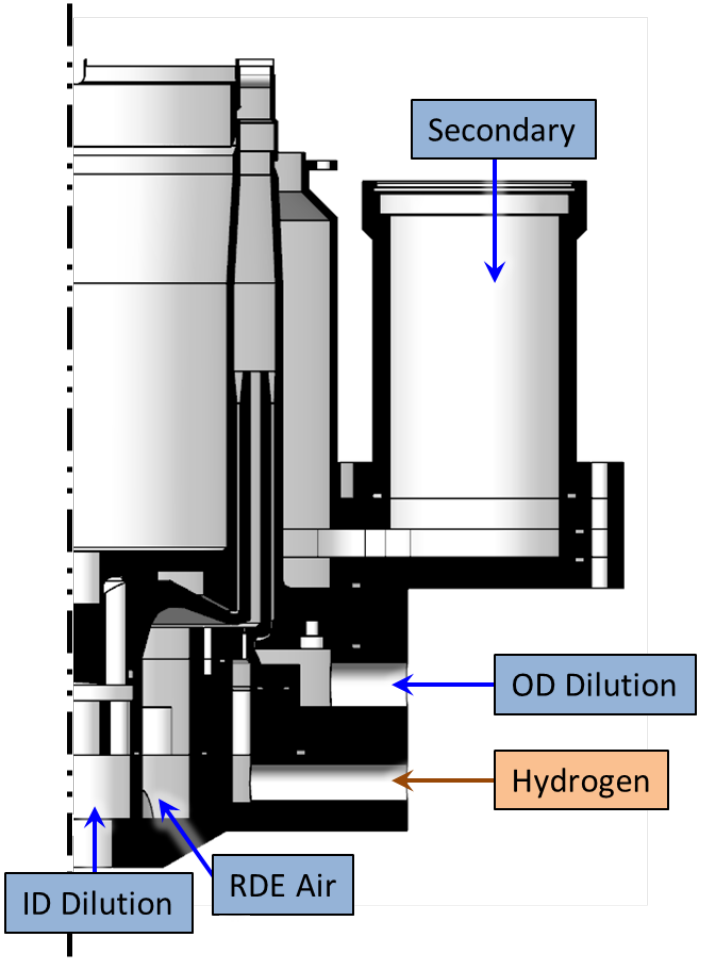


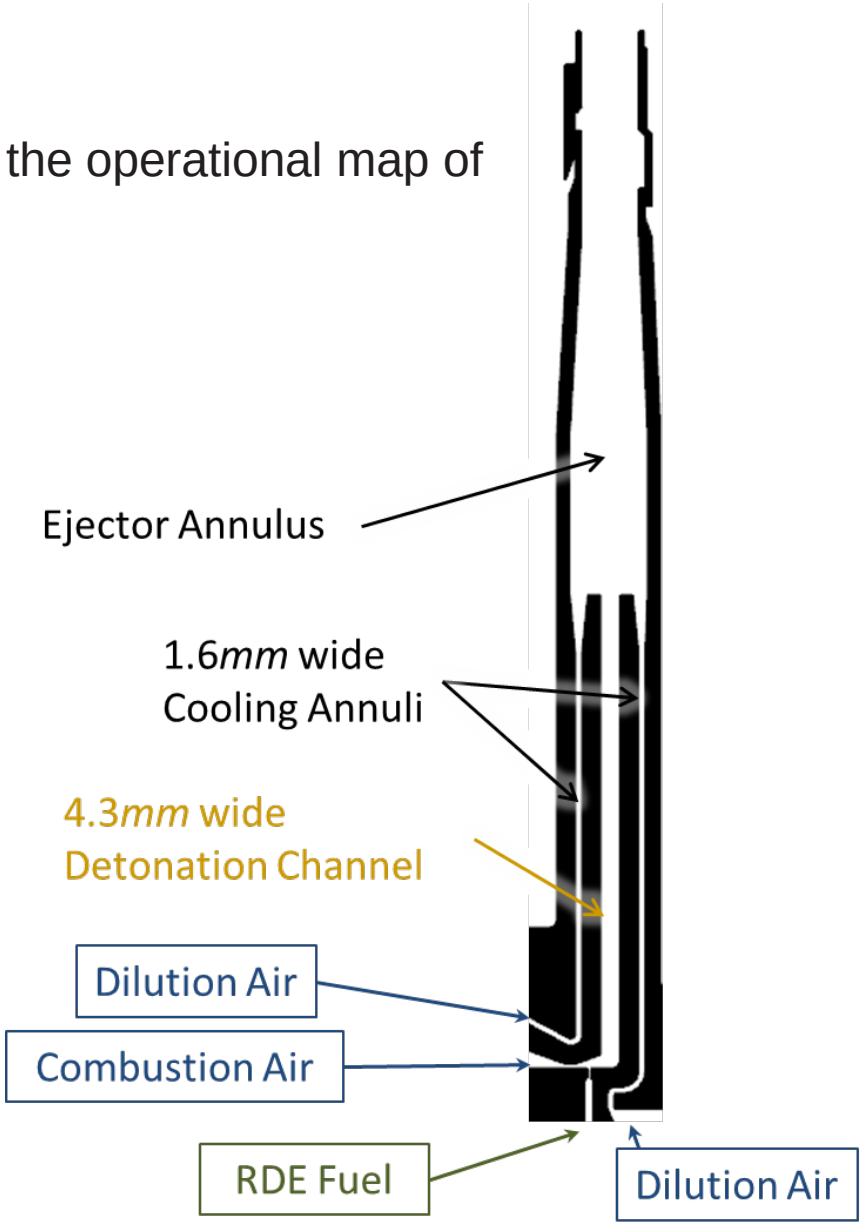
"T63 Turbine Response to Rotating Detonation Combustor Exhaust Flow" Andrew Naples, Ryan Battelle, John Hoke, Fred Schauer, Turbo Expo 2018 Proceedings, GT2018-75534



T63 RDE

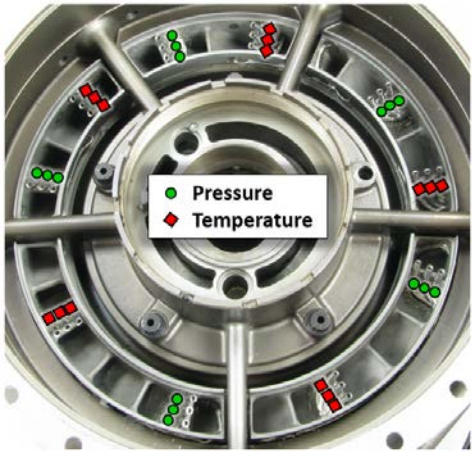
- Multi-stream RDE developed to match the operational map of the T63 gas turbine



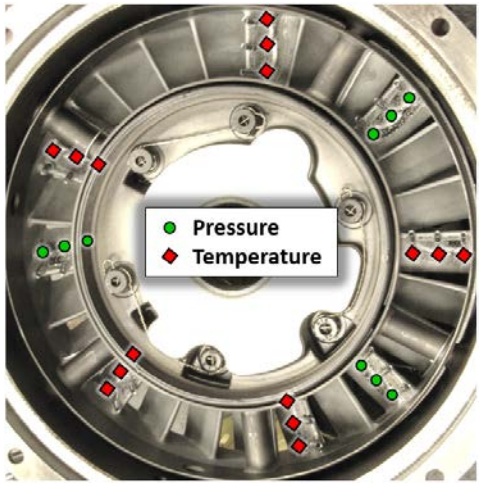


Added Instrumentation and Example Operation

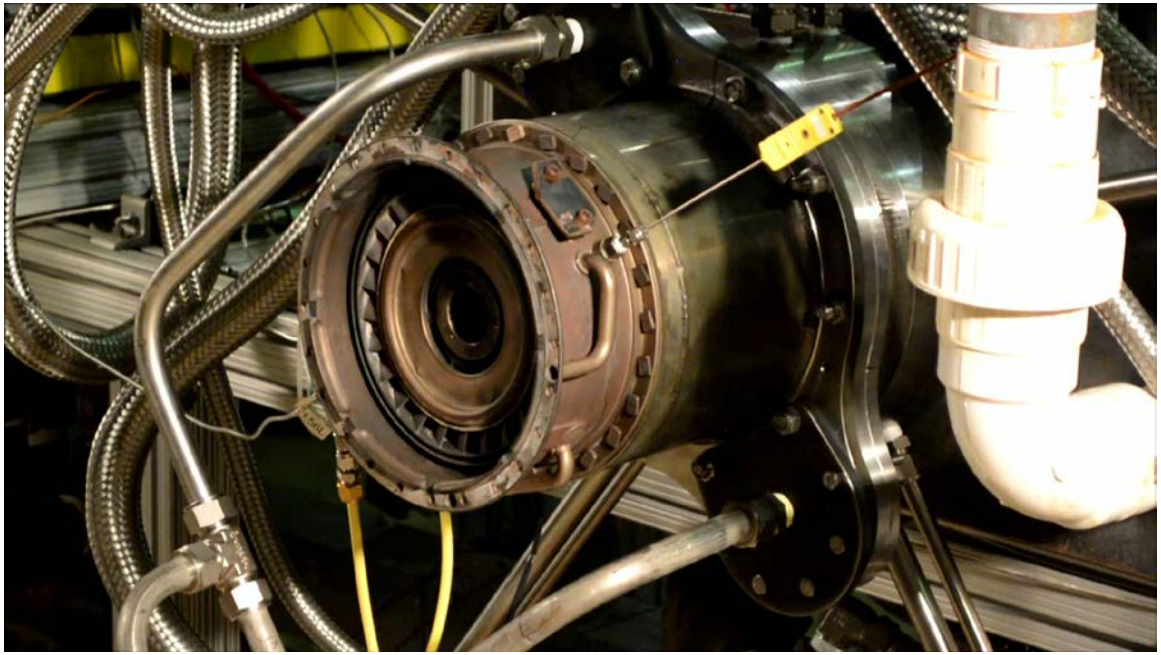
HPT In



HPT Out

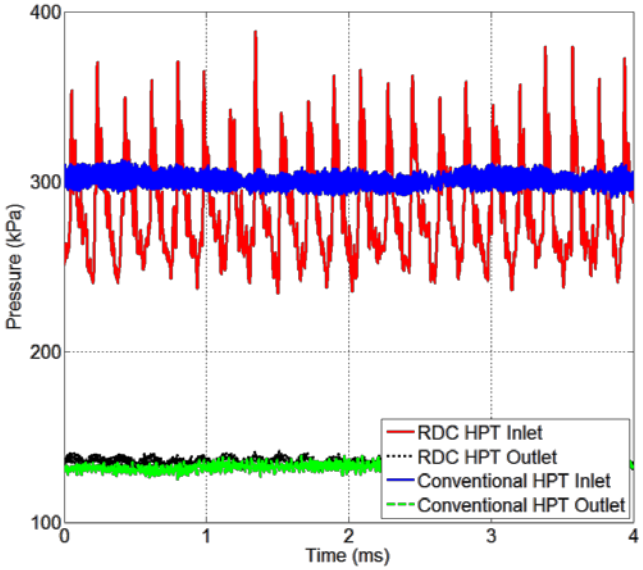


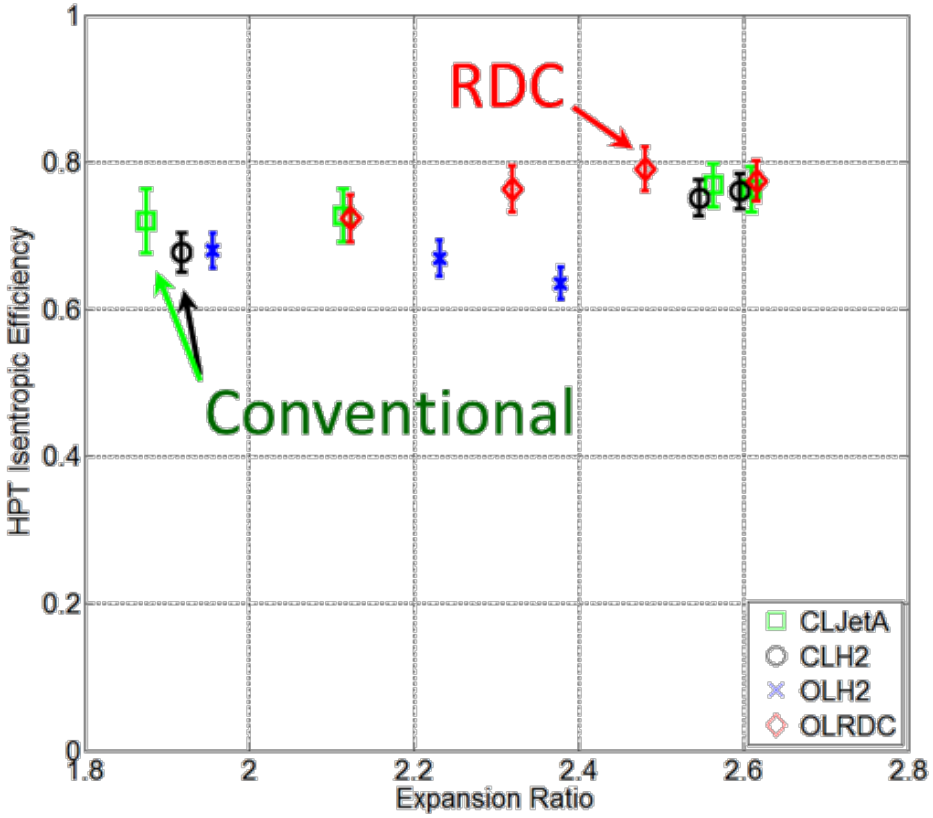
- Light-off for the engine is at 50% RPM
- Max rated sustained power is 90% RPM



RDE-Turbine Interaction Results

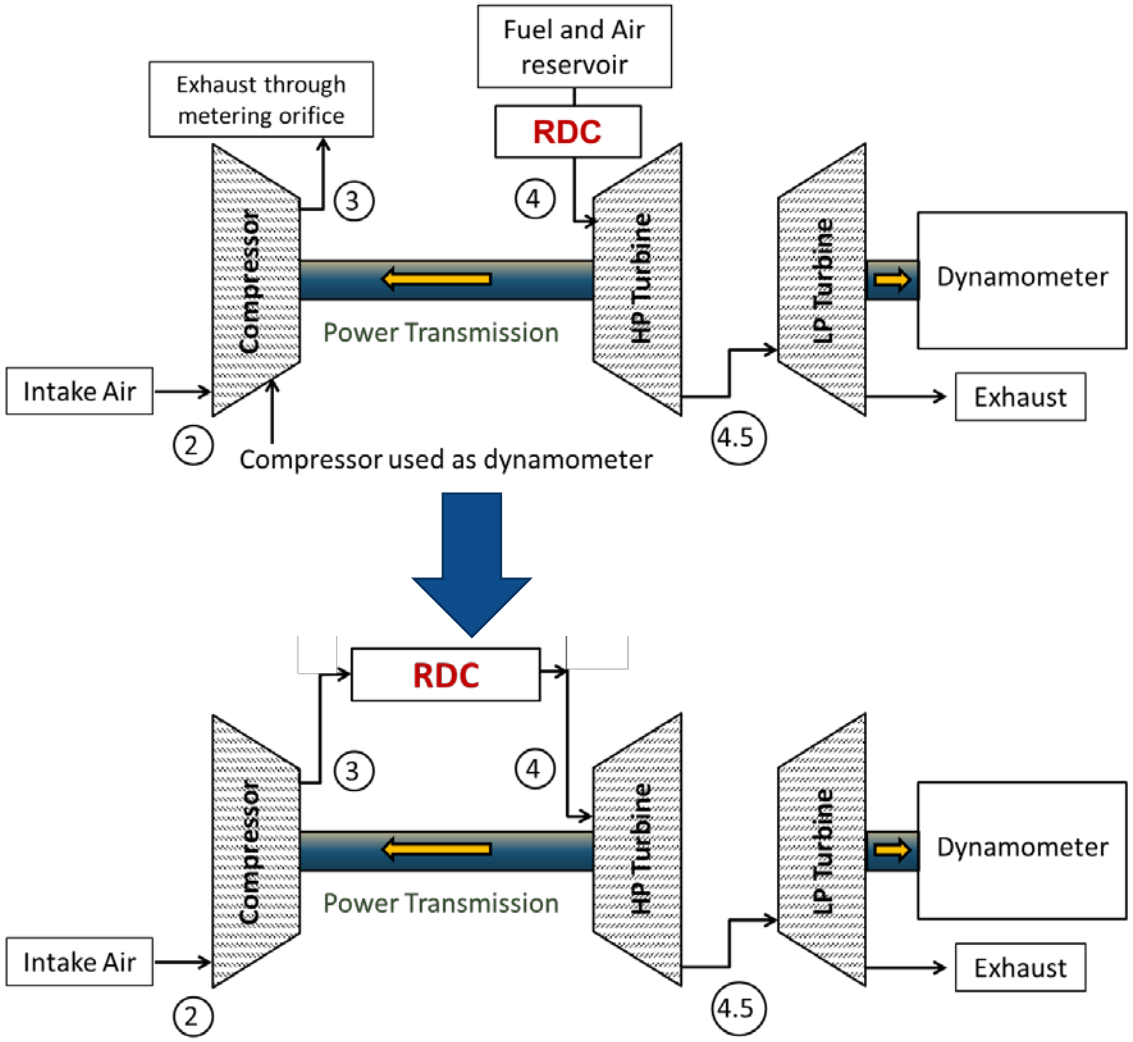
- No measurable impact of the RDE unsteadiness on turbine efficiency
- RDC pressure fluctuation (30-45%) 10x that of conventional combustor(5%)
- RDC unsteadiness attenuated 65-85% in HPT





RDE Gas Turbine Integration Next Steps

- Leverage previous learning to fully integrate a RDE into a T63 gas turbine
- RDE challenge
  - System scale still necessitates H_2/Air RDE
  - Needs to be low loss
  - Wide operational map
- Compressor/HPT balance
  - May require active bleeds to maintain balance



Discussion

Backup

RDE Operational Map Challenge

- T63 baseline combustor pressure drop is low
- T63 operational map is low OPR, equivalence ratio, and air flows