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High-Efficiency Gas Turbine Engine Components

U.S. ARMY RDECOM

ARL open campus

S&T Campaign: Sciences for Maneuver
Energy and Propulsion

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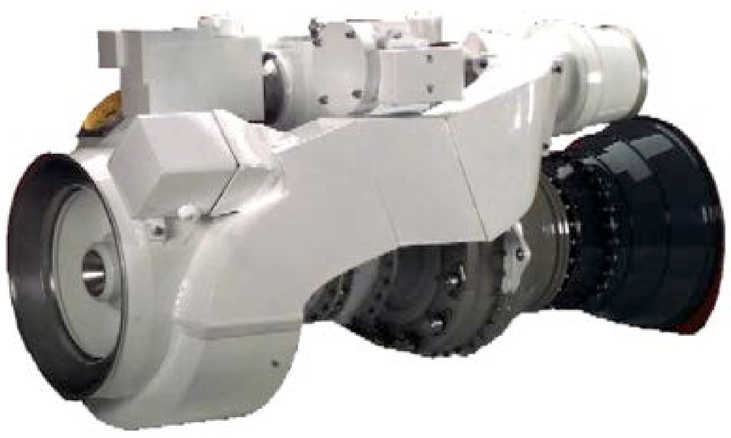
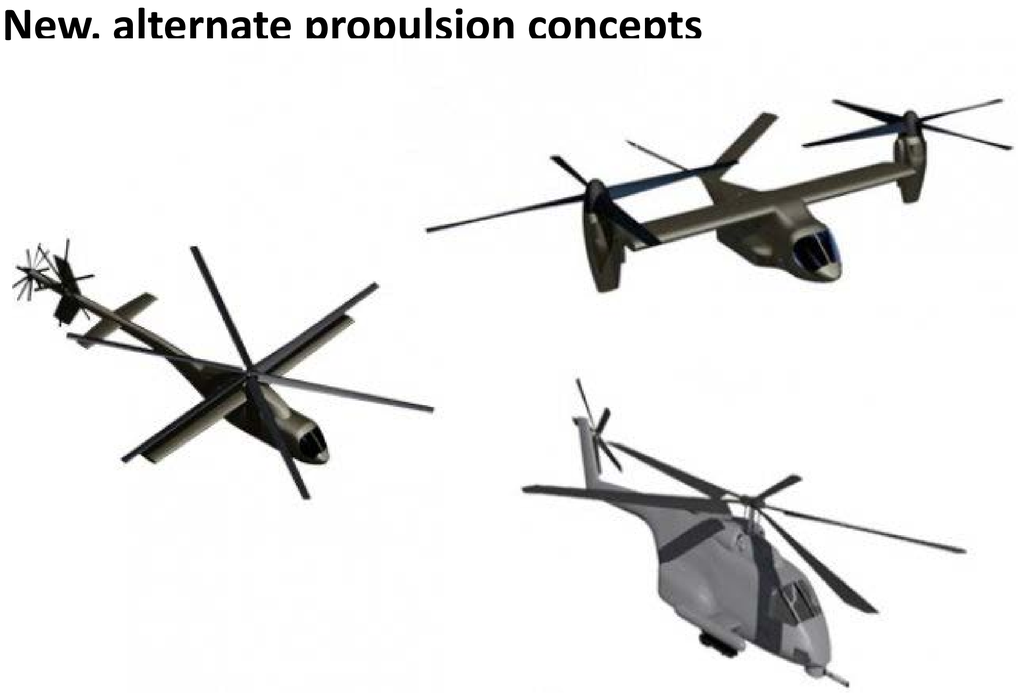
Research Objective

- **Conduct rotorcraft-unique propulsion research to discover innovative and maturate high-risk novel concepts technology beneficial to concepts to enable Army Transonic Hover Efficient Next Generation Aircraft (ATHENA) Engines (near sonic operation)**
- **Revolutionizing reduction in specific fuel consumption and increasing engine power density**

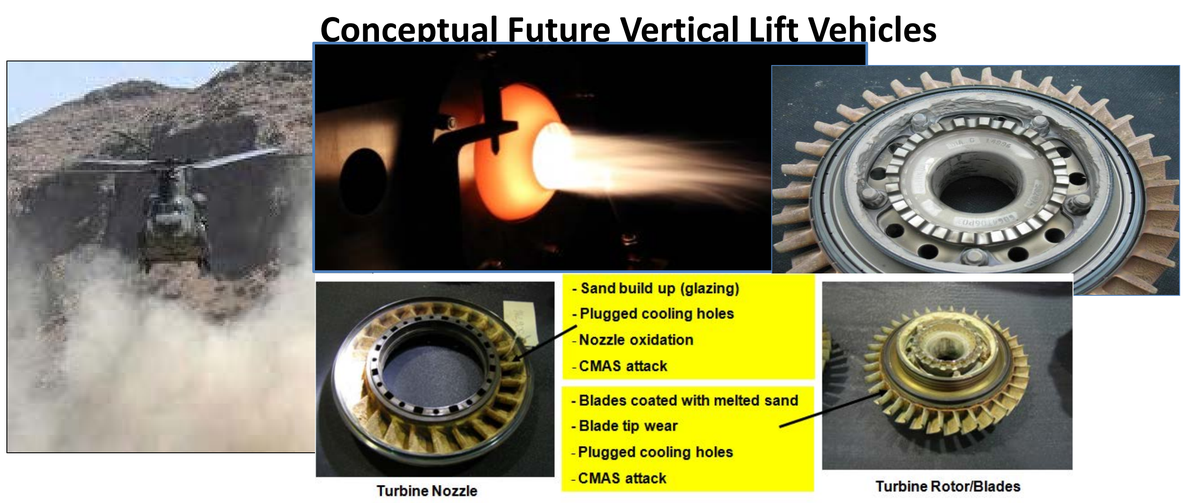


Challenges

- **Efficient, compact, durable, lightweight turbomachinery**
- **High Temperature Turbomachinery Components, Functionally Graded Materials and Sensing**
- **Engine On Demand (EOD) concepts**
- **High heat release, compact combustors**
- **New, alternate propulsion concepts**



Conceptual Future Vertical Lift Vehicles



ARL Facilities and Capabilities Available to Support Collaborative Research

- **High Temperature Propulsion Components Laboratory at ARL, APG, MD**
  - Atmospheric jet burner rig with 3,000 deg F max temperature
    - Hot gas mass flows from 0.3 to 0.75 lbs/sec
    - Mach numbers of approximately 0.3 to 0.8
    - Impinging velocities of approximately 200-519 m/s
  - Thermomechanical fatigue testing system with 2,732 deg F max sustaining temperature
  - Scanning Acoustic Microscopy for near and subsurface materials characterization
  - FLIR IR imaging system (calibrated to 2000 deg C)
  - Pyrometry (metallics and ceramic composites)
  - Hot Particulate Ingestion Testing System (salt and sand) with water dust collection system
  - Air Jet erosion rig for ambient temperature particulate erosion substantiation
- **Transonic Turbine Blade Research Facility at NASA Glenn Research Center**
  - Air supply and exhaust pressures 16.5 psia and 2 psia
  - Test section designed for airfoils with a span of 6 inches
  - Test section is equipped with boundary layer bleed
  - High degree of airflow turning, infinitely adjustable incidence angle, and high transonic flow rates
- **Small Engine Compressor Research Facility at NASA Glenn Research Center**
  - Compressor speeds up to 60,000 rpm achieving overall pressure ratios up to 30:1.
  - Atmospheric intake, a 40-psig pressure source, or 10-psig refrigerated air system.
  - Compressors up to 20 inches in diameter.
- **Combustion Research Facility at NASA Glenn Research Center**
  - Inlet air up to 450 psig and 1100 deg F non-vitiated
  - Air flows up to 20 lb/s
  - Jet-A, JP-5, JP-8, synthetics and blends.
  - Optical access for non-intrusive measurements, planar laser-induced fluorescence (PLIF) imaging, Planar Mie scattering, Phase/Doppler particle analysis (PDPA), focused Schlieren imaging and light sheet photography
- **Turbomachinery Heat Transfer Tunnel (GRC)**
  - Simulates turbine flow passages or transition ducts
  - Flow rates up to 10 lb/sec
  - Transient and steady heat transfer measurements

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- **Expertise in**
  - Advanced propulsion concepts/cycles, advanced hybrid electric technologies
  - High temperature smart materials for articulating turbine blade mechanisms, Biomimicry
  - Sand phobic coatings/components
  - Surface finish and dimensional tolerance potentials of stationary flow-path components for turbine engines fabricated with additive manufacturing
  - Additive manufacturing capability for components
  - Non-intrusive measurement techniques (*e.g.*, compact laser anemometry, wireless measurement reporting)
  - Flow physics modeling, high coupled fluid structure interaction physics under extreme temperature and pressure and high speed rotation
  - High temperature turbomachinery components, functionally graded materials and sensing

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