

OVERVIEW OF NASA'S PROPULSION 21 EFFORT

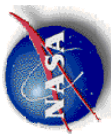
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Overview of NASA's Propulsion 21 Effort

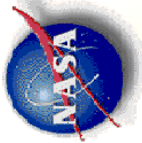
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Propulsion 21

Propulsion 21: Partners & Purpose



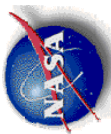
GE Aircraft Engines



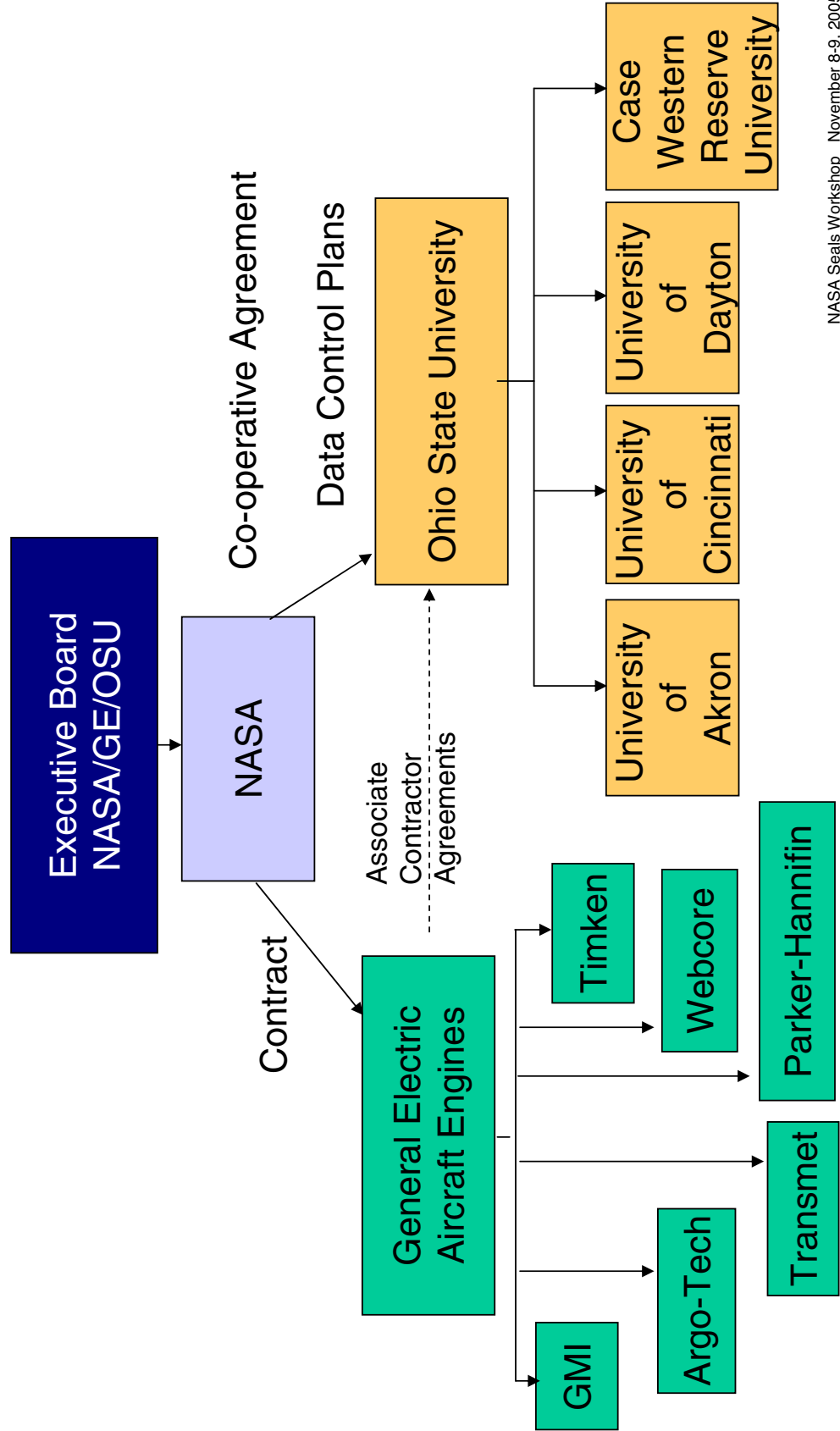
State-wide coalition focused on research and development aimed at three aircraft engine-related goals:

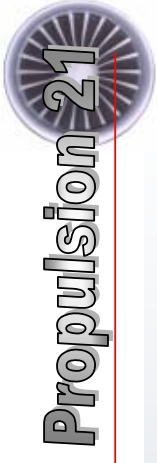
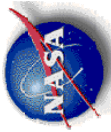
- more **energy efficient**
- **quieter**
- more **reliable**





Management Structure





Propulsion 21 Technologies

Turbine Engine Prognostics

- Disk Life Meter
- Sub-System Health Management

Active Controls for Emissions and Noise reduction

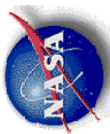
- Intelligent Combustor
- Active Noise Reduction

Active Structural Control

- Turbine Cooling Control
- Smart Containment System
- High Pressure Turbine Clearance Control

Modeling, Analysis and System Studies

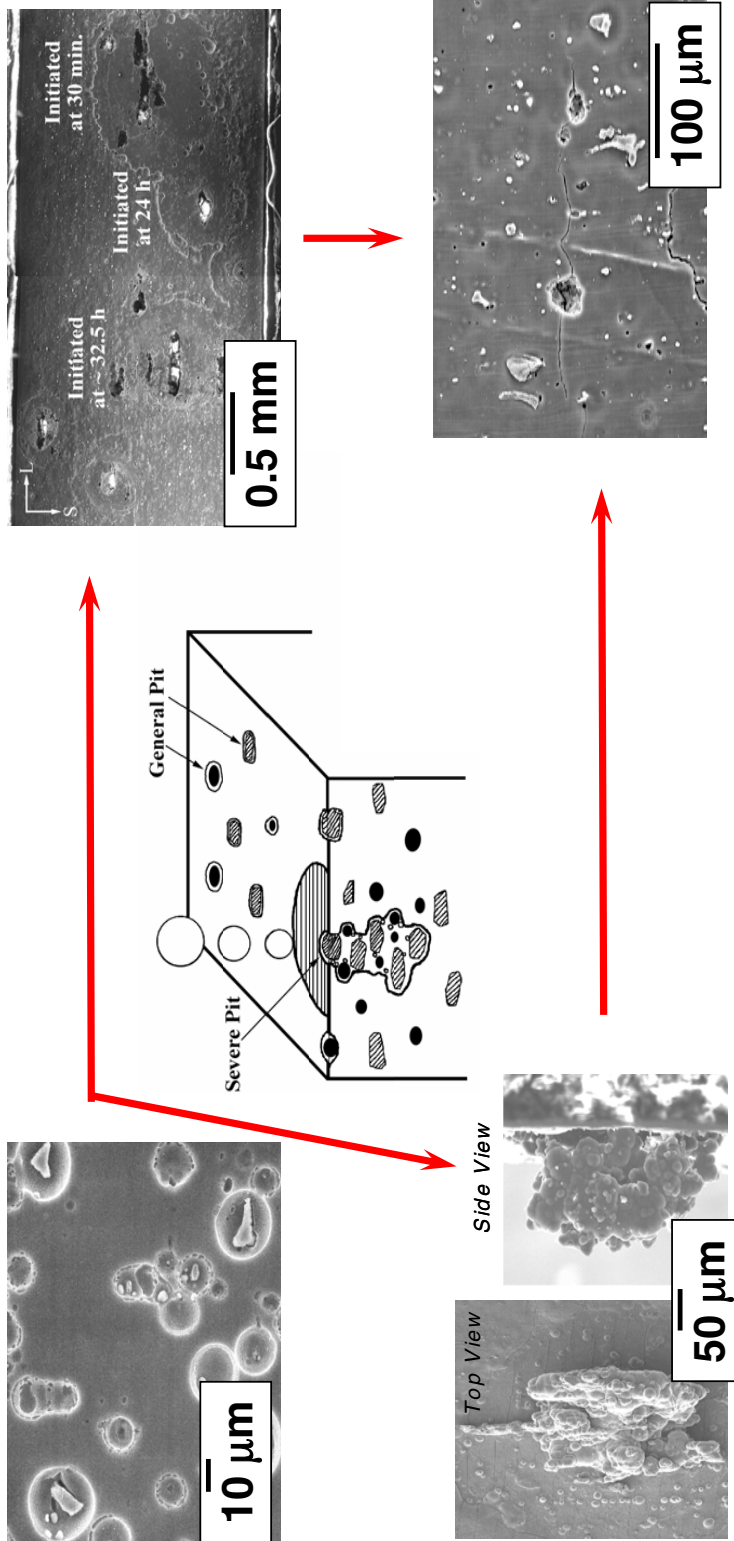
- System Studies



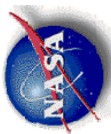
Disk Life Meter

Objective:

Develop materials models and sensors to measure remaining life in turbine disk materials at sustained high operating temperatures.



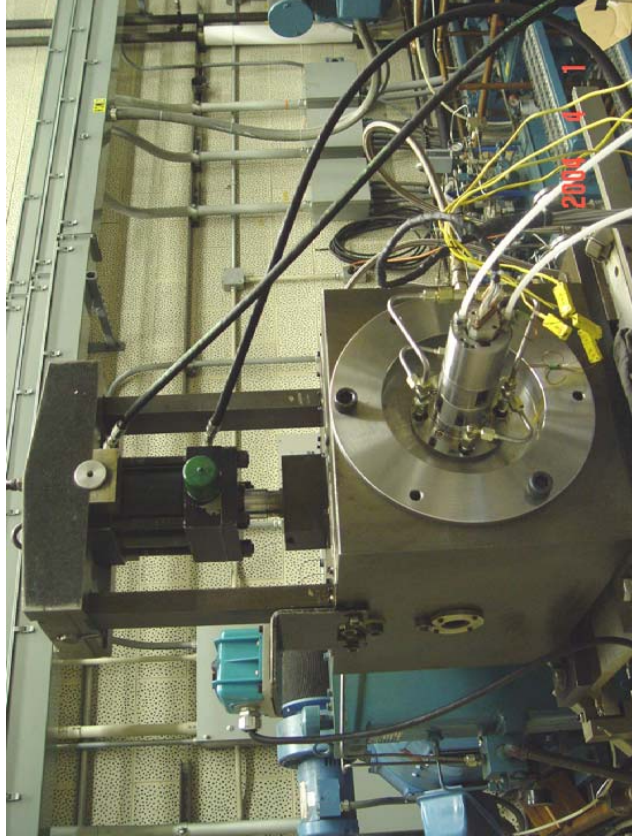
Pit Formation and Growth Now Need to Be Understood



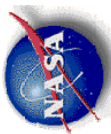
Sub System Health Management

Objective:

Develop bearing diagnostics and health monitoring system for inter-shaft bearings to provide early detection of impending bearing failure. Demonstrate a conceptual monitoring system for a differential roller bearing.



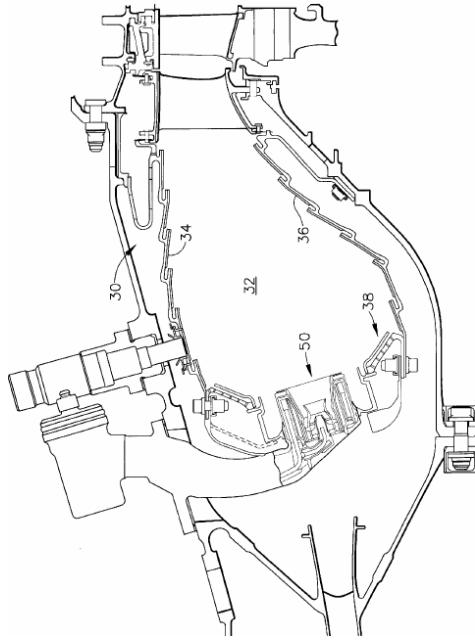
Assembled Bearing Test Rig



Intelligent Combustor

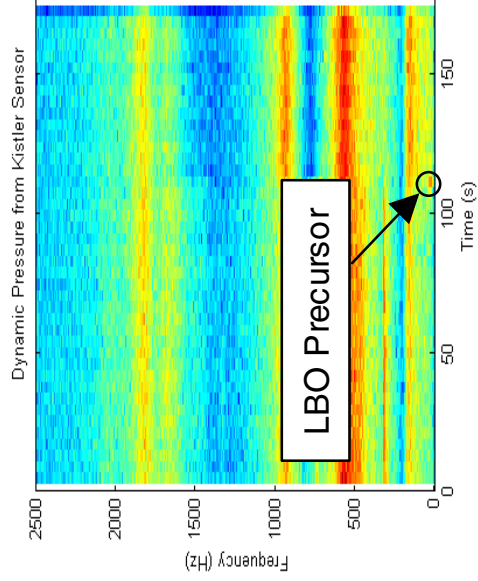
Objective:

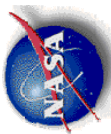
Develop a combustor incorporating advanced diagnostics and active combustor control to reduce NOx emissions by 85% relative to 1996 ICAO standards, while retaining the performance of existing combustors.



New swirler concepts

Lean blow-out precursor identification

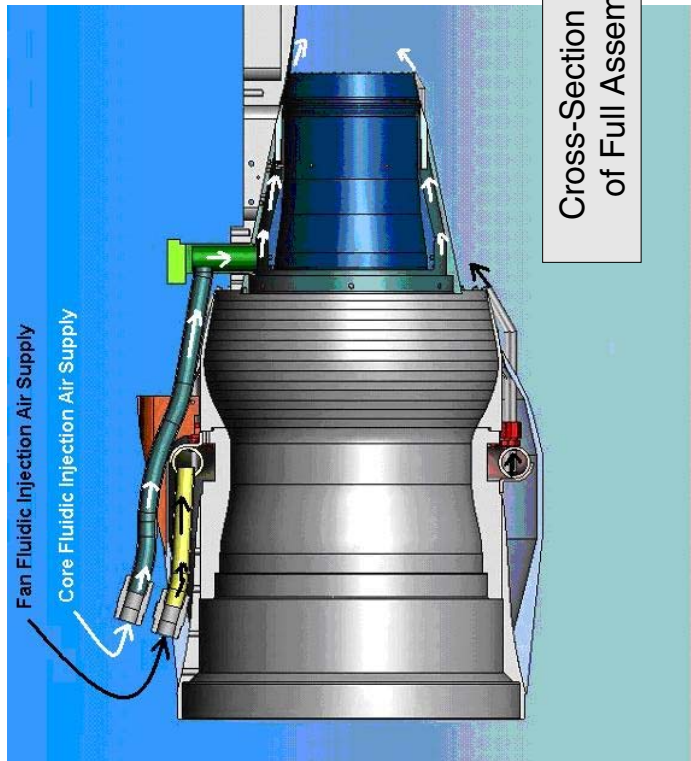




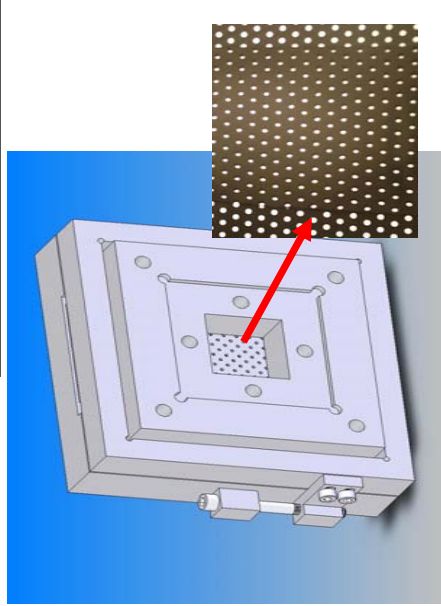
Active Noise Control

Objective:

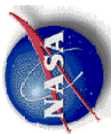
Use fluidic injection, shape memory alloys, and/or plasma actuators to enhance exhaust nozzle jet mixing to actively reduce jet engine noise. Incorporate active/smart concepts into acoustic liner design to increase liner acoustic performance.



Cross-Section View of Full Assembly



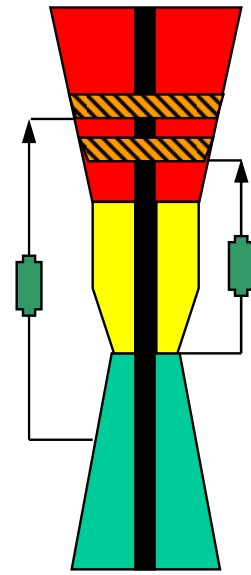
SMA Sliding Face-Sheet Fixture



Turbine Cooling Control

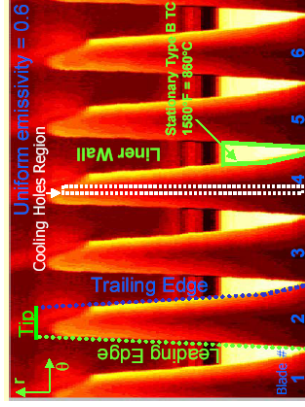
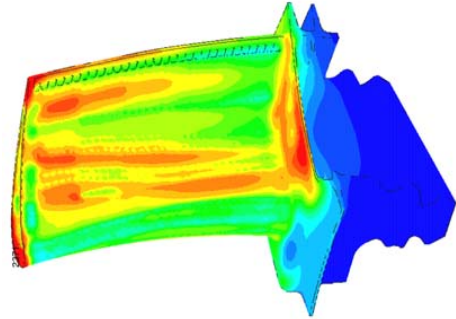
Objective:

Develop and demonstrate innovative turbine system and component cooling technologies with active flow and temperature control, including prognostic / diagnostic sensors, for improved engine fuel burn and emissions.

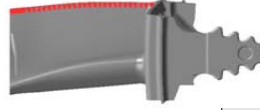


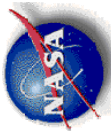
Thermal Management & 3D System Simulation

Advanced Cooling Concepts
Cooled Cooling Air, Active Flow Control, Next-Gen Airfoil Cooling



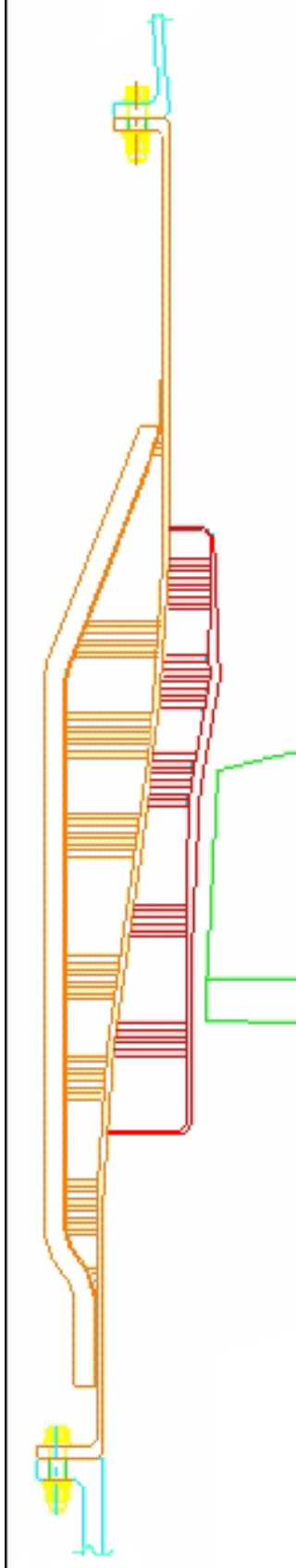
Sensors for Active Control & Prognostics



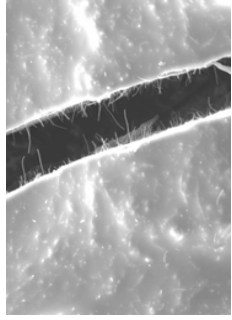


Smart Containment System

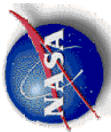
Objective:
Develop an innovative “smart” softwall containment system that capitalizes on the anisotropic nature of composites.



Conceptual design of smart containment system

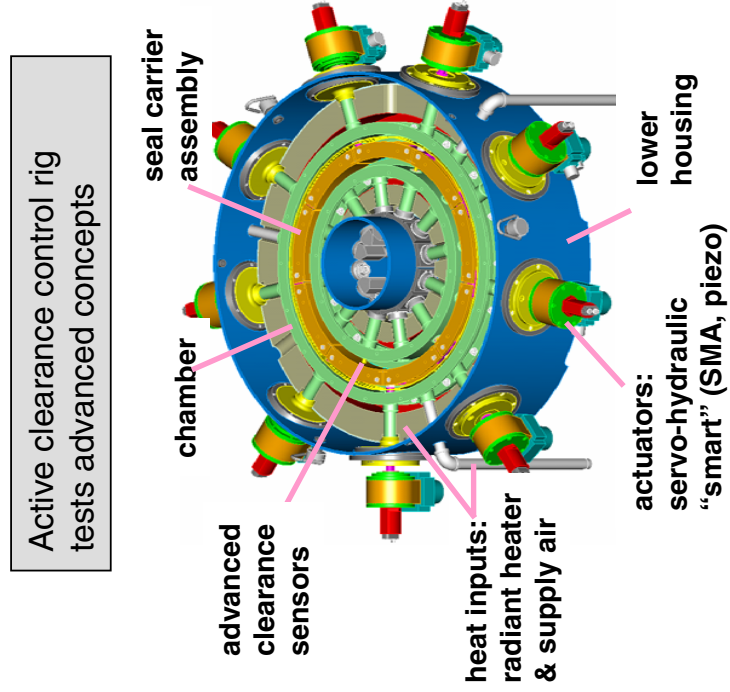
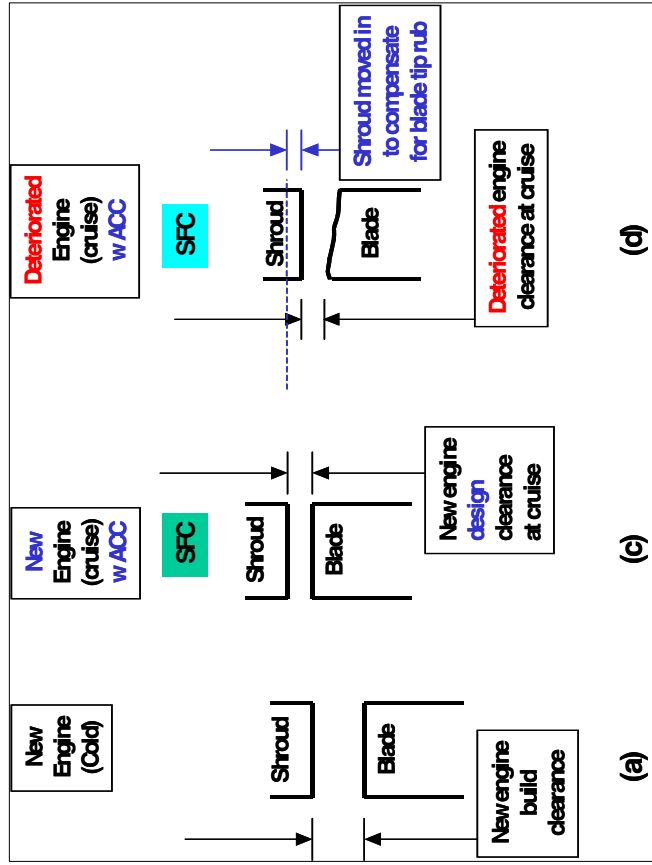


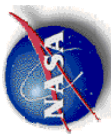
Nanofiber circuit diagnostic grid



High Pressure Turbine (HPT) Clearance Control

Objective:
Develop an HPT clearance control system that can adapt to changing environment/requirements.





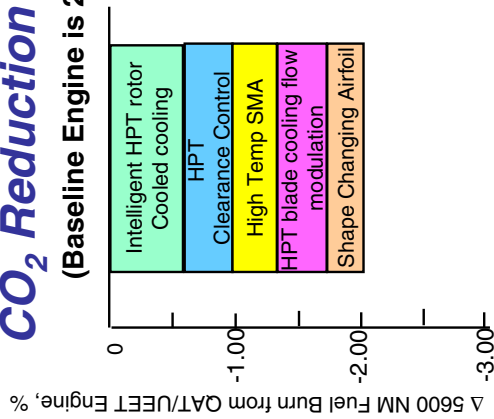
System Studies

Objective:

Perform technology assessment and identify needed modeling improvements to handle adaptive technologies.

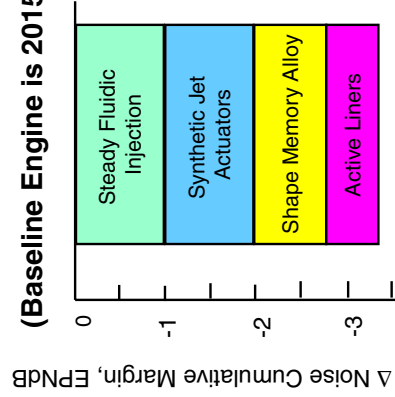
CO₂ Reduction (Fuel Burn)

(Baseline Engine is 2015 QAT/UEET)



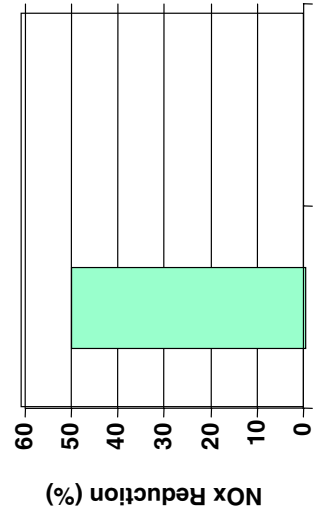
Noise Reduction

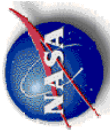
(Baseline Engine is 2015 QAT/UEET)



NOx Reduction

(Baseline Engine is 2015 QAT/UEET)





Summary

- **Propulsion 21 technologies contribute to reducing CO₂ and NO_x emissions and noise**
- **Integrated Government/Industry/University research efforts have produced promising initial technical results**
- **Graduate students from 5 partnering universities will benefit from this collaborative research--> educating the future engineering workforce**
- **Phase 2 Efforts scheduled to be completed 3QFY06**