National Aeronautics and Space Administration

Sensors and Rotordynamics Health Management Research for Aircraft Turbine Engines

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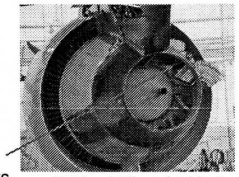
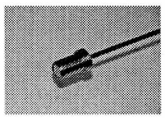
Objective:
Develop Advanced Sensor Technology and rotordynamic structural diagnostics to address existing Aviation Safety Propulsion Health Management needs as well as proactively begin to address anticipated safety issues for new technologies

Microwave Blade Tip Clearance / Tip Timing Sensor

- Blade Tip Clearance to monitor blade growth & wear
- Blade Tip Timing to monitor blade deflection & vibration
- Goal is to detect precursors to faults and prevent a blade / disk "event" before it happens



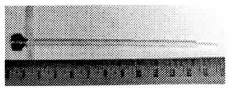
Engine Failure Incident
June 2, 2006

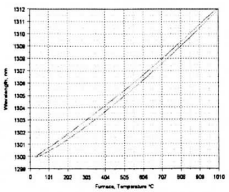


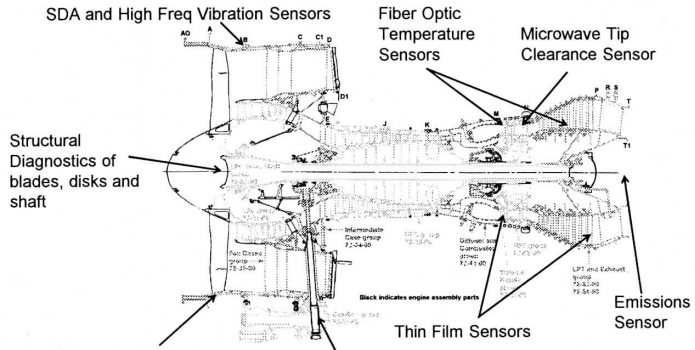
Microwave Tip Clearance Probe

Fiber optic sensors mitigate potential reliability & performance issues associated with conventional sensors and have integration advantages

Developed & demonstrated high temperature optical sensors operational at 1000 C for up to 1000 hours







Emissions Sensors to Quantify composition of critical constituents in turbine engine exhaust products, E.G., CO, CO_2, NOX, O_2, HC (unburned Hydrocarbons)

CO Sensor

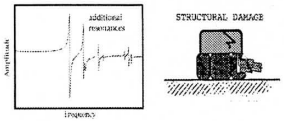
SiC Hydrocarbon Sensor

CO2 Sensor

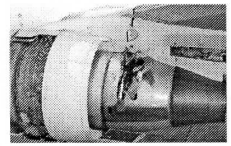
Vehicle Integrated Propulsion Research (VIPR) engine tests (2011 to 2013)
as a part of Technology Development

- ***Engine testing is a necessary and challenging component of VHM technology development.***
- **Test Objective:** Demonstrate multiple structural and gas path health management sensors in an operating engine environment. Integrate sensor / detection technologies with Structural and Gas Path diagnostics.
- **Approach:** Perform engine ground tests using commercial derivative engine. Conduct normal engine operations and also operations that have seeded mechanical and gas path faults (simulated).

Self Diagnostic Accelerometer: For mission critical decisions, such as an engine being shut off due to anomalous acceleration readings, ensuring sensor heath is critical.



On-Component **Thin Film Sensors** for monitoring degradation and damage that develops over time in hot section components



PdCr strain sensor to T=1000°C

Rotordynamics for Structural Health Management Diagnostics - Crack Signatures obtained through Subscale Engine Disk Spin Rig