Sensatek
Propulsion Technology, Inc.

Extreme (-302F to 3732F) Passive Wireless Resonant Sensors: Ground Test to Commercial Flight Instrumentation

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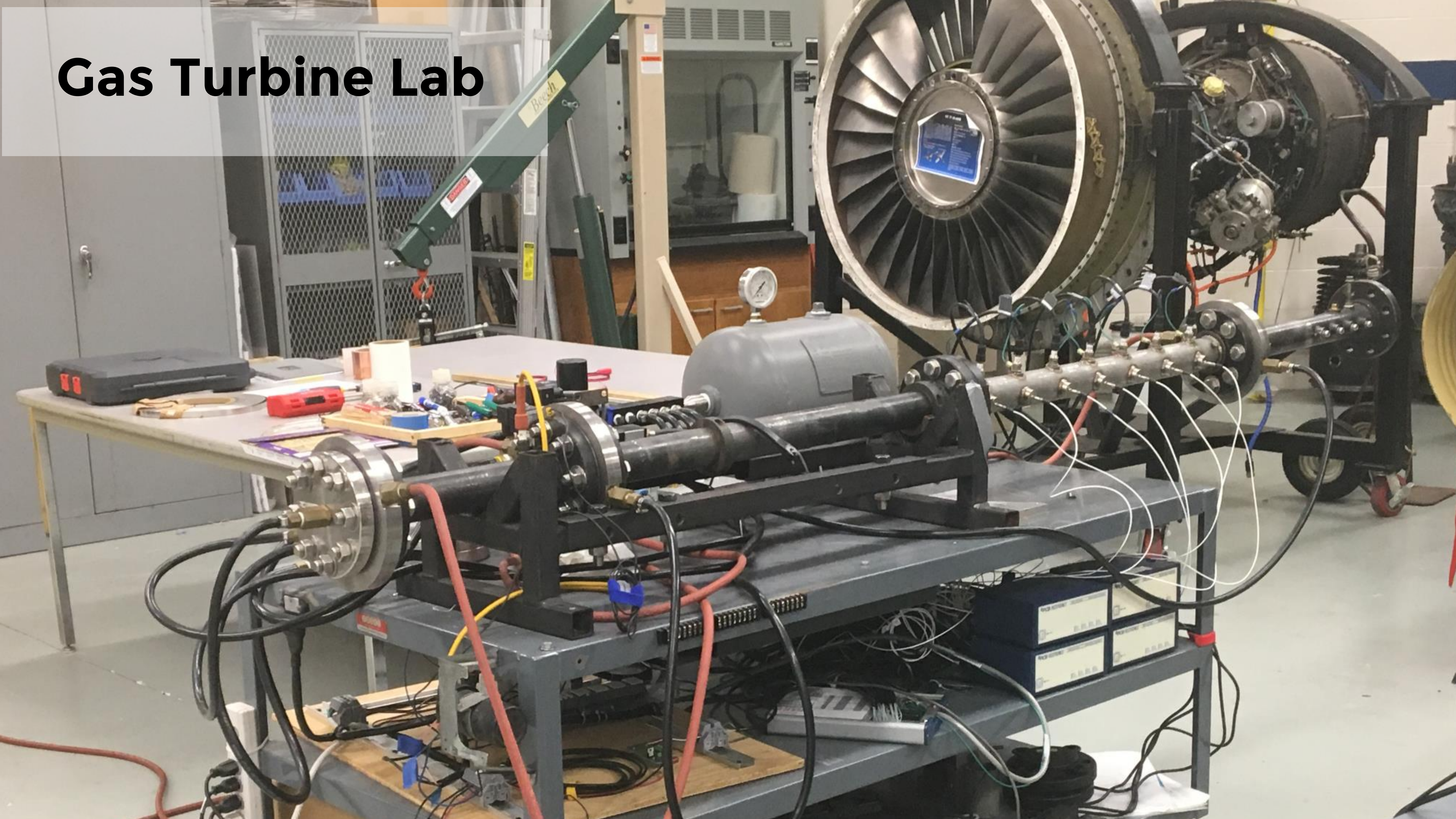
Who I am?


EMBRY-RIDDLE
Aeronautical University

Gas Turbine Lab

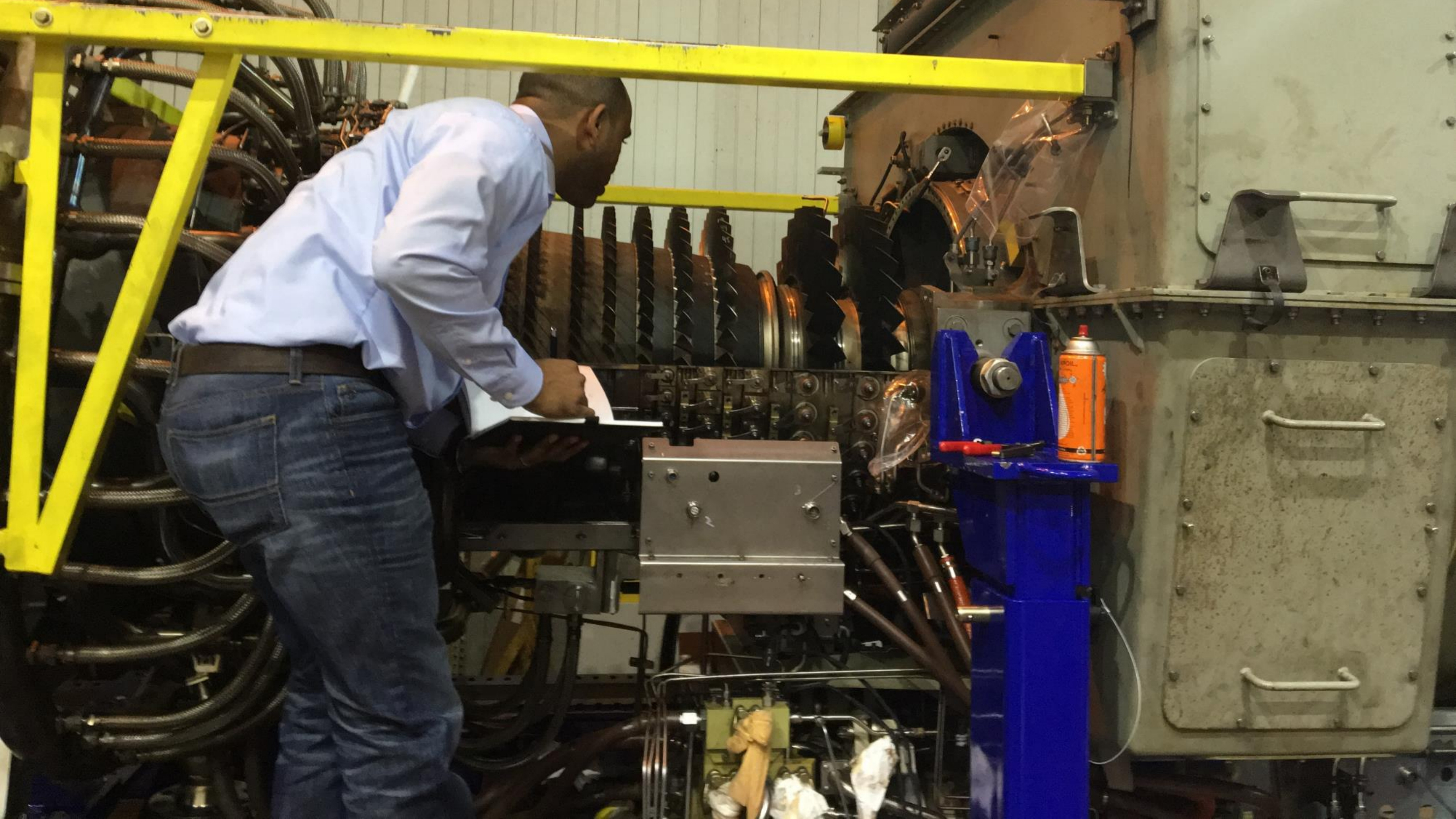


Overheated Components

PDE Rings

Blades

Combustion Chamber

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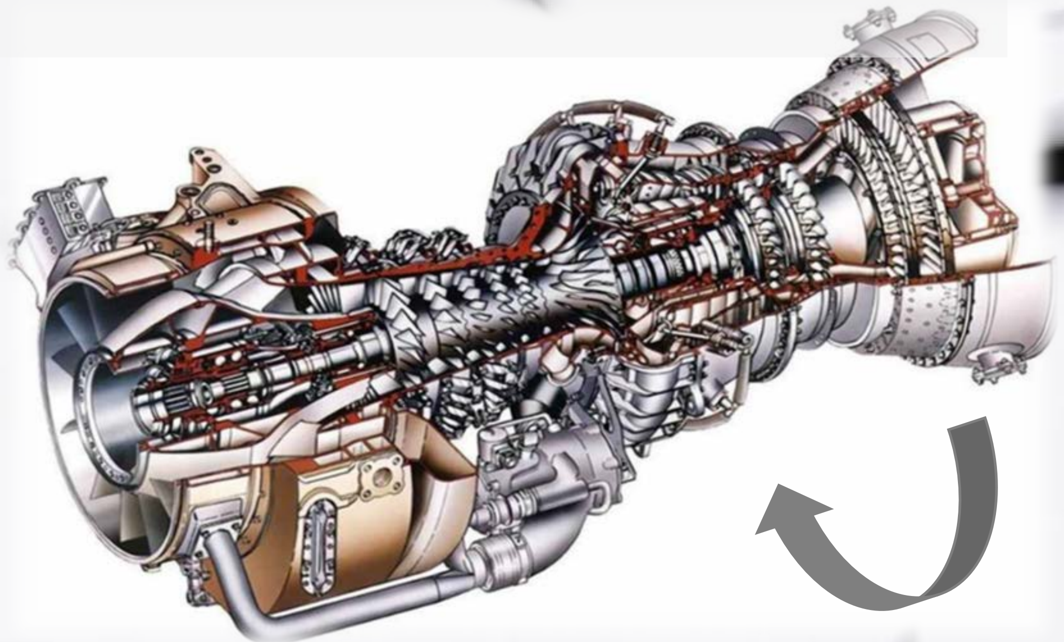
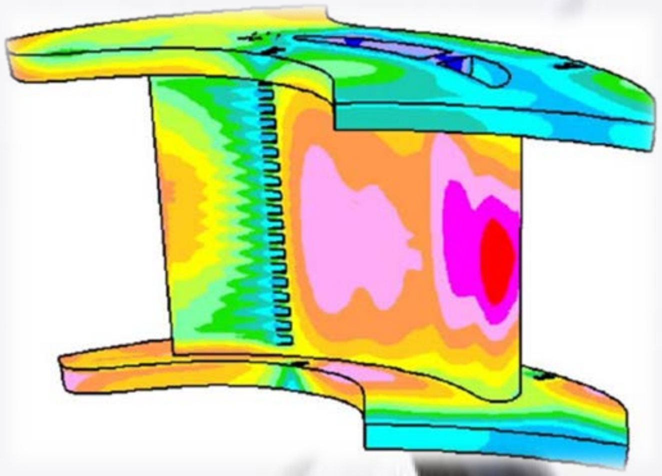
NEAREST RECRUITING STATION

Get out of the building!

Life Cycle Costs

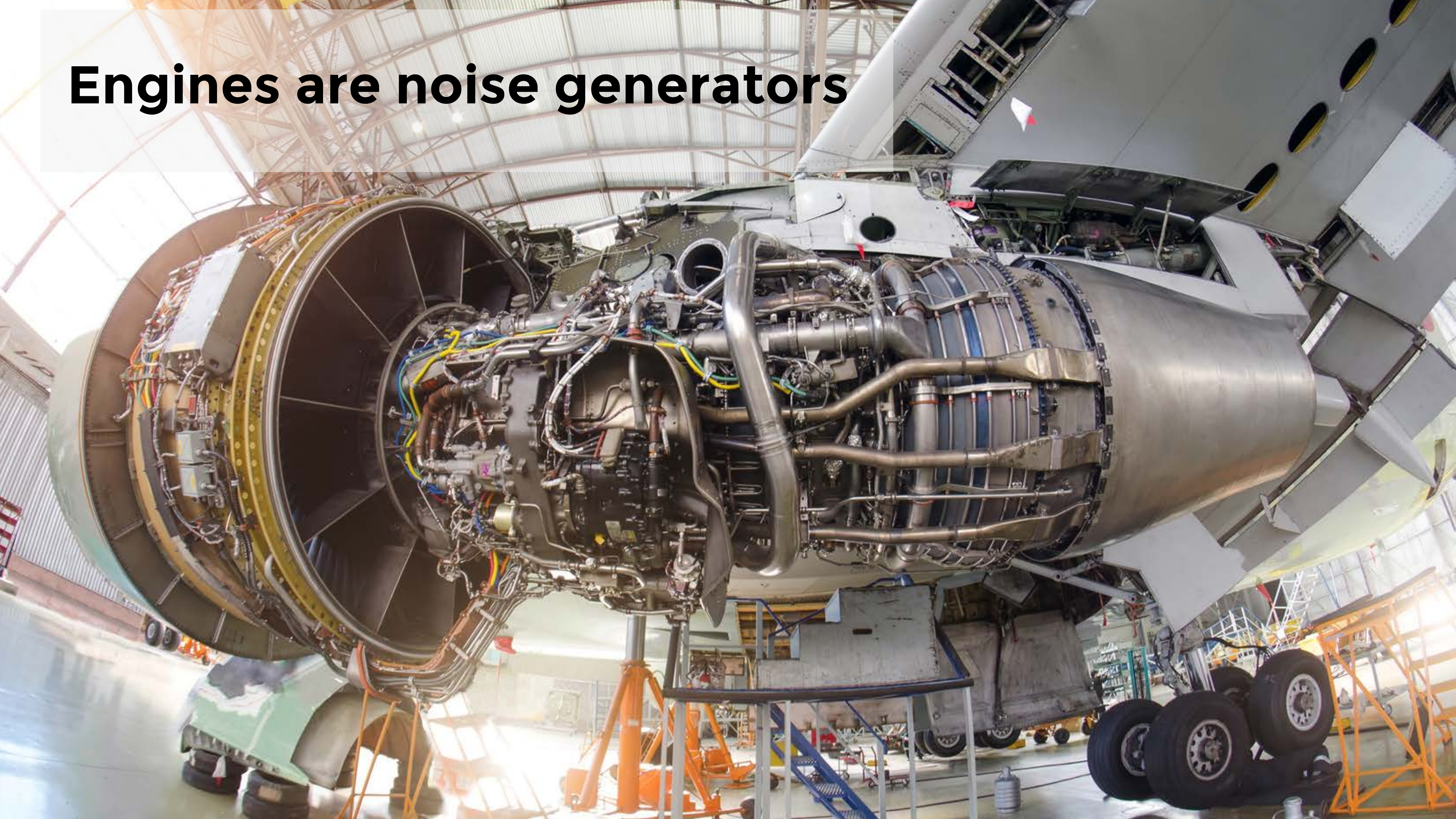




Lengthy Lead Times

Airline Performance

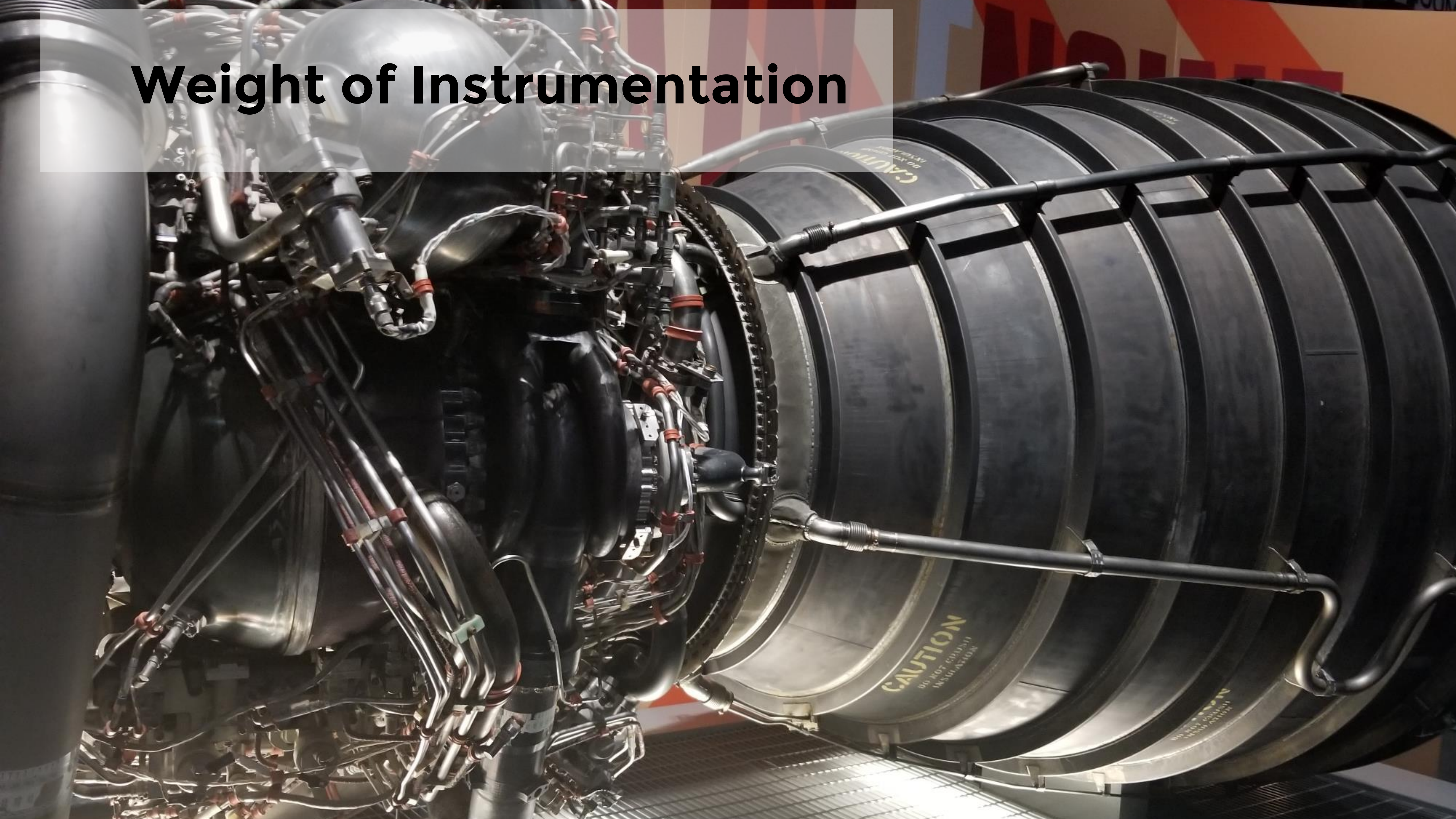
Engines are noise generators



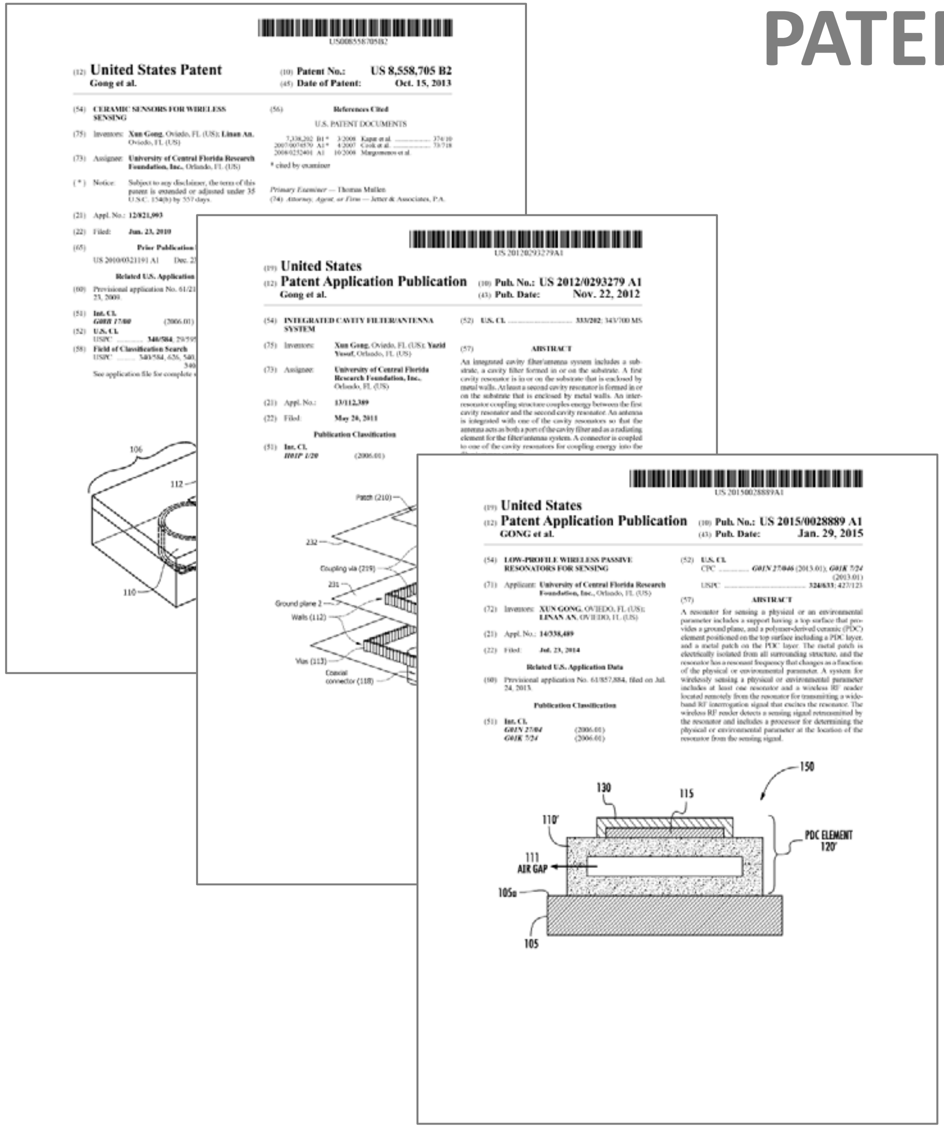
Engines are shrinking

Rocket Test Stand

Weight of Instrumentation



PATENTS AND PUBLICATIONS



United States Patent
Gong et al.
Patent No.: US 8,558,705 B2
Date of Patent: Oct. 15, 2013
CERAMIC SENSORS FOR WIRELESS SENSING

United States
Patent Application Publication
Gong et al.
Pub. No.: US 2012/0293279 A1
Pub. Date: Nov. 22, 2012
INTEGRATED CAVITY FILTER/ANTENNA SYSTEM

United States
Patent Application Publication
GONG et al.
Pub. No.: US 2015/0028889 A1
Pub. Date: Jan. 29, 2015
LOW-PROFILE WIRELESS PASSIVE RESONATORS FOR SENSING

Wireless Passive Temperature Sensors Using Integrated Cylindrical Resonator/Antenna for Harsh-Environment Applications

Haitao Cheng, Student Member, IEEE, Xinhua Ren, Member, IEEE, Siamak Ebadi, Member, IEEE, Yaohan Chen, Linan An, and Xun Gong, Senior Member, IEEE

Sensors and Actuators A: Physical

Evanescent-mode-resonator-based and antenna-integrated wireless passive pressure sensors for harsh-environment applications

Haitao Cheng, Gang Shao, Siamak Ebadi, Xinhua Ren, Kyle Harris, Jian Liu, Chengying Xu, Linan An, Xun Gong

Sensors and Actuators A: Physical

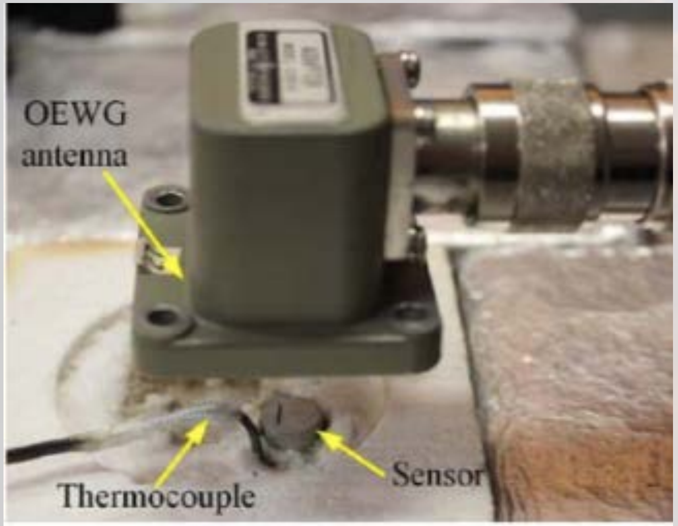
Wireless passive high-temperature sensor based on multifunctional reflective patch antenna up to 1050 degrees centigrade

Haitao Cheng, Siamak Ebadi, Xinhua Ren, Xun Gong

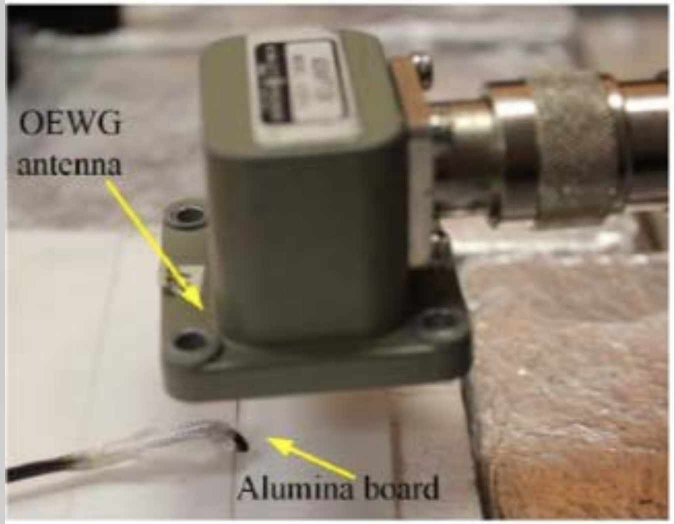
WIRELESS HIGH-TEMPERATURE CERAMIC SENSOR

Published in IEEE Sensors Journal March 2015

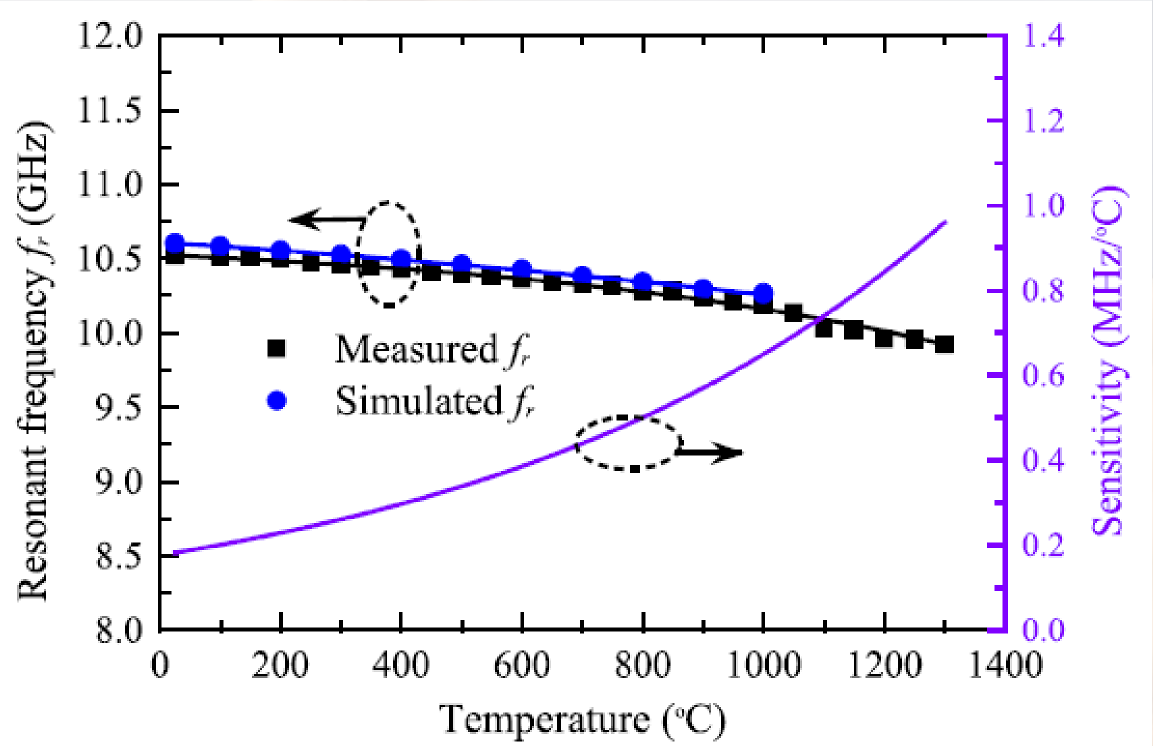
High-Temperature measurement using heat pad and X-band OEWG antenna



(a)



(b)



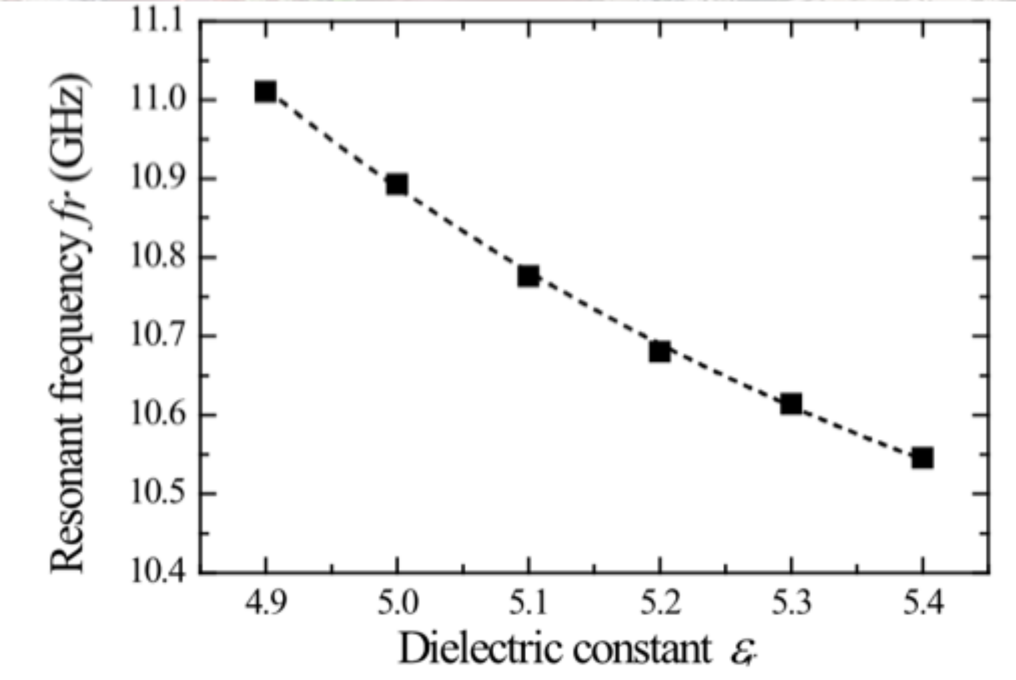
WIRELESS HIGH-TEMPERATURE CERAMIC SENSOR

Published in IEEE Sensors Journal March 2015

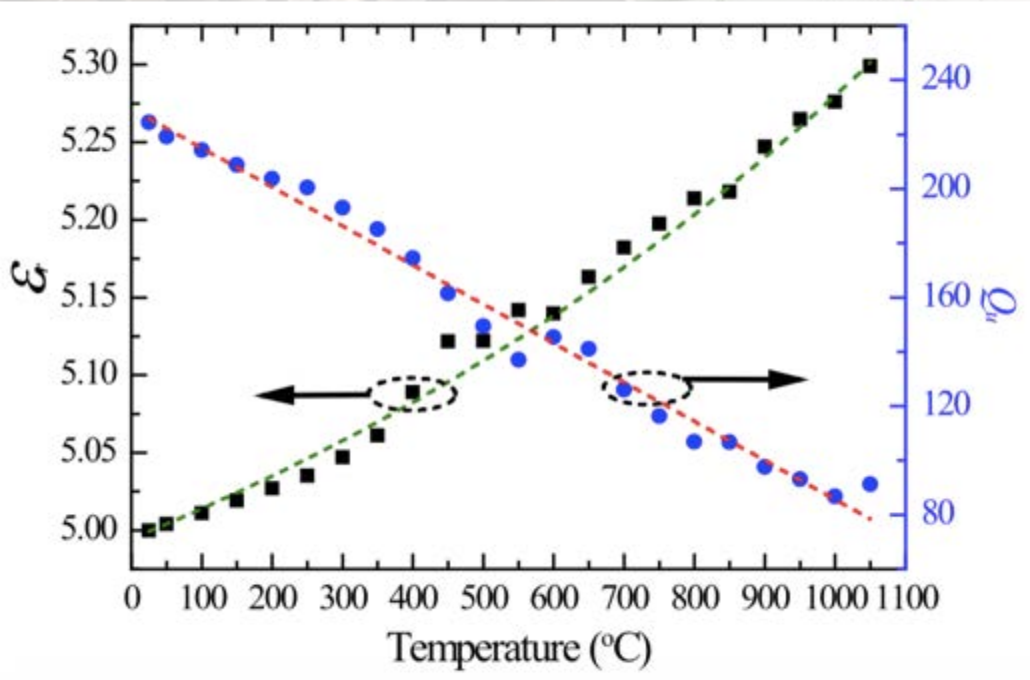
Step 1 → Detects Resonant Frequency, **RF**

Step 2 → Compares **RF** to Characterized Data

Measured **RF** Versus Dielectric Constant



Characterization of Ceramics at High Temperatures



Step 3 → Determines Temperature

Resonant Frequency is inversely proportional to Dielectric Constant, ε_r

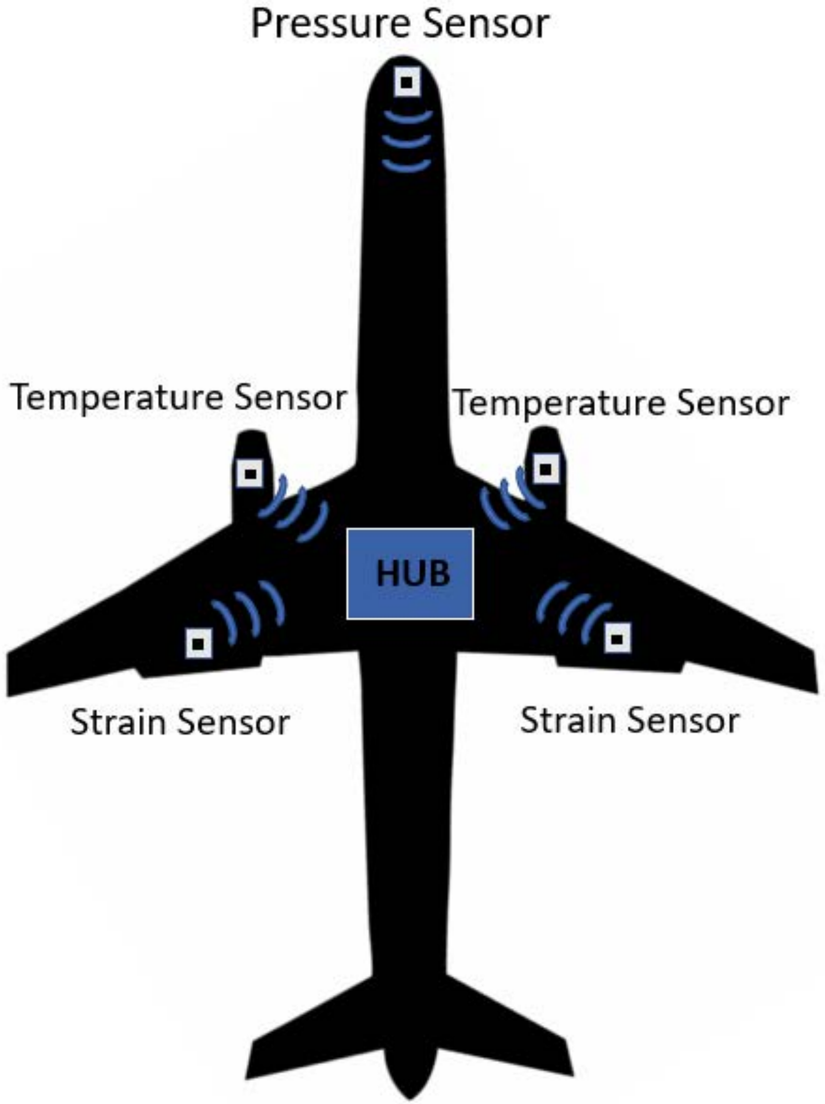
$$f_{TM010} = \frac{c p_{01}}{2\pi a \sqrt{\varepsilon_r}}$$

Wireless Aviation Intra-Communications (WAIC)

- Local Radio communication between avionics components and systems on-board the same aircraft.
- Only safety and flight operations related applications, not for passenger communication.
- Low Transmission Power (10 dBm)

Motivation & Advantages:

- 30 % of wires are potential candidates for replacement.
- Aircraft wiring usually features double, triple redundancy through different route.
- Having wireless communication enables redundancy while mitigating risk of single point of failure.
- For space missions, increases useful payload capacity, improves economy for commercial aviation applications.

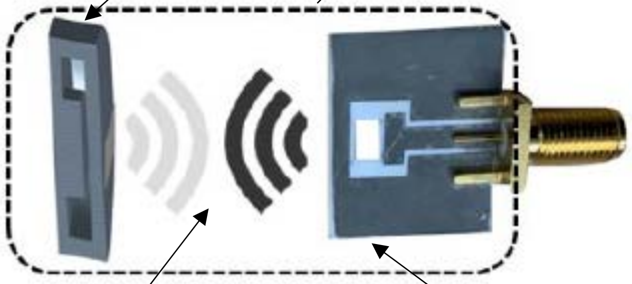


Sensatek Sensors Suite enabling WAIC

Sensatek Sensor System for WAIC applications

Sensatek Sensor
-Customizable Frequency & Size

Can be packaged together



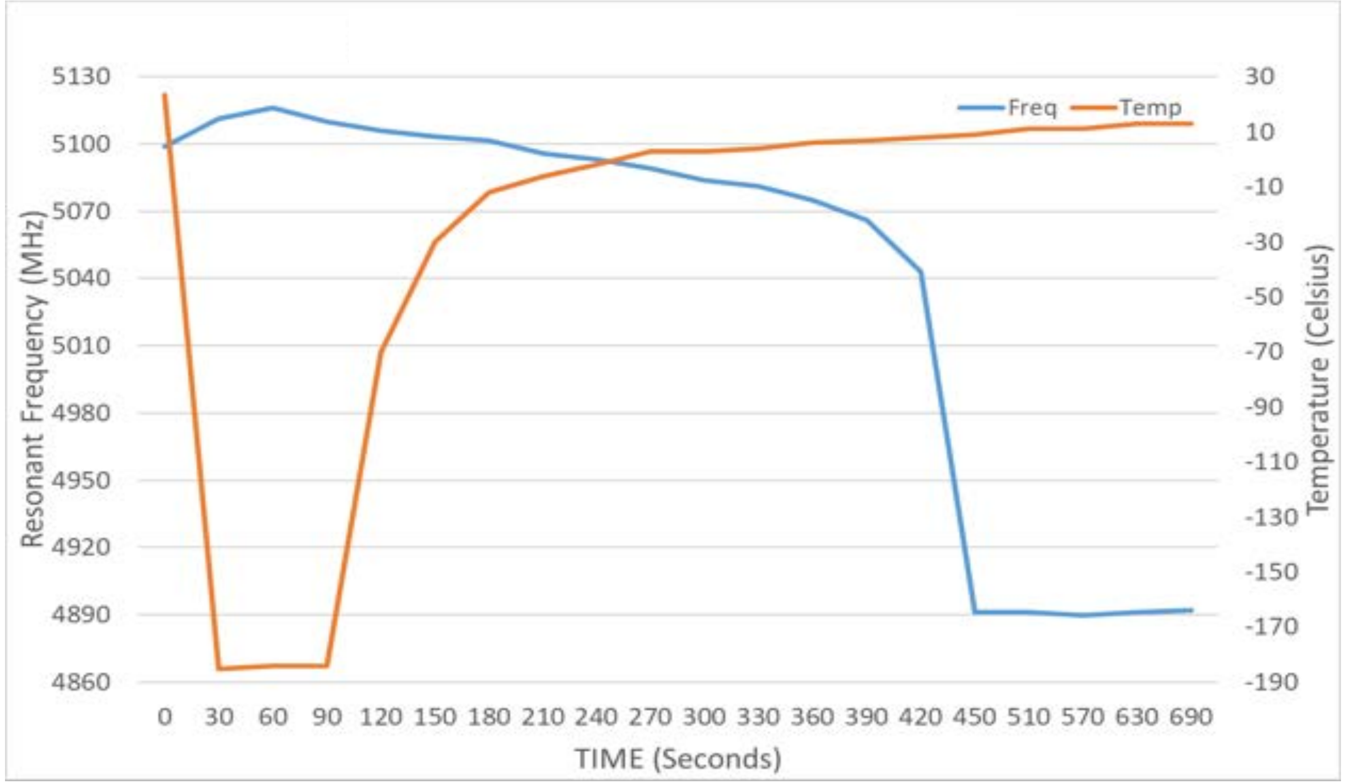
Low Power(0.1 mW)
Very short distance transmission

Sensatek Interrogation Antenna
-Low Profile

Sensatek Data Transmitter to HUB
-WAIC compatible frequency (4.2-4.4 GHz frequency)
-Directional antenna to minimize interference
-Low powered and encrypted signal

Cryogenic Testing

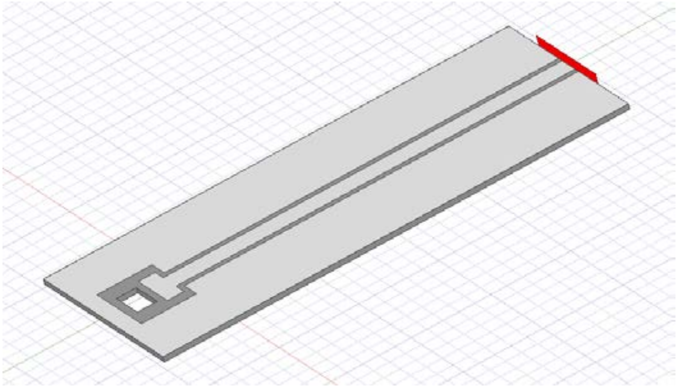
- Quick Proof-of-concept test using Liquid Nitrogen
- Liquid Nitrogen Poured over sensor placed on an Inconel component in a Pyrex Container
- Temperature recorded wirelessly for sensors using waveguide and independently using K-type thermocouple attached to DAQ
- Test duration was 12 minutes, readings recorded every 30 secs.



Sensor response for cryogenic temperatures.

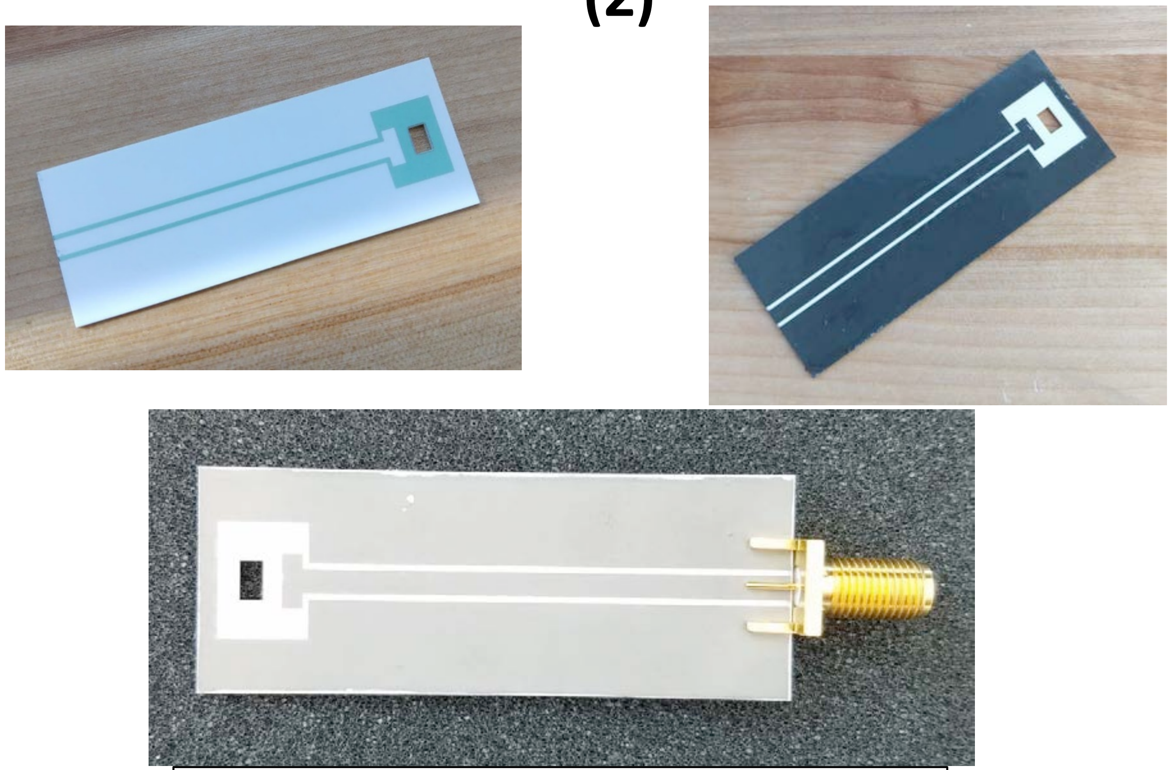
Harsh Environment Antenna Design and Manufacturing

(1)



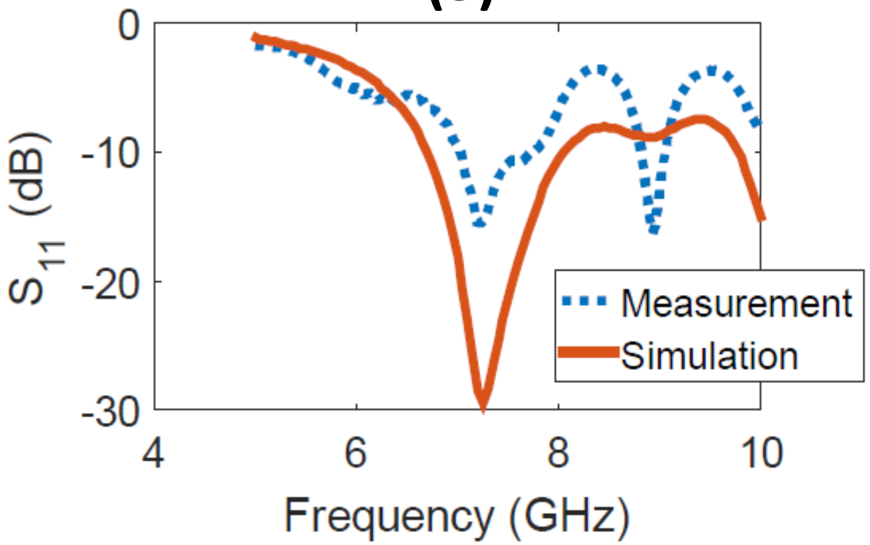
CAD Model of the antenna

(2)



Manufacturing Process of the antenna

(3)



Simulated Vs Manufactured

Proof of Demonstration: Survivability on Rotating Microturbine Wheel


SIEMENS
25

Meet The Team

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M.S. Aeronautics

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CHIEF TECHNOLOGY OFFICER

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PhD. Materials Scientist

Christian Pierre
Research Assistant

Locke Lord LLP

GT GreenbergTraurig

JAMESON & COMPANY

James Moore
Certified Public Accountants and Consultants

What’s next?