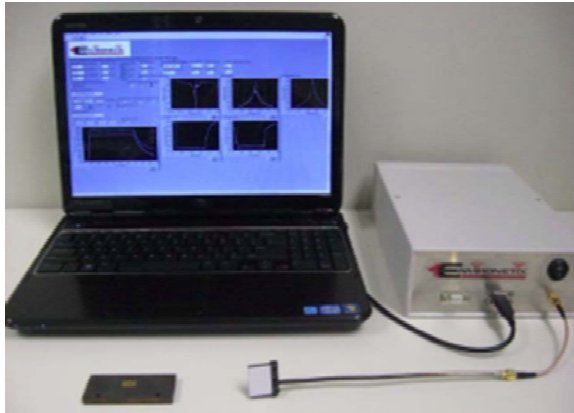




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www.environetix.com

WIRELESS MICROWAVE ACOUSTIC SENSOR SYSTEMS FOR HARSH ENVIRONMENTS



EVHT-100

WIRELESS TEMPERATURE SENSOR SYSTEM

- ✓ Stable and reliable operation up to 900°C (1650°F)
- ✓ Multiple sensors with integrated RF antennas
- ✓ Wireless RF interrogator electronics
- ✓ Custom installation on rotating or static parts
- ✓ User-friendly data output on laptop PC
- ✓ Proprietary sensor packaging and attachment
- ✓ Prototype strain, pressure, corrosion sensors under development



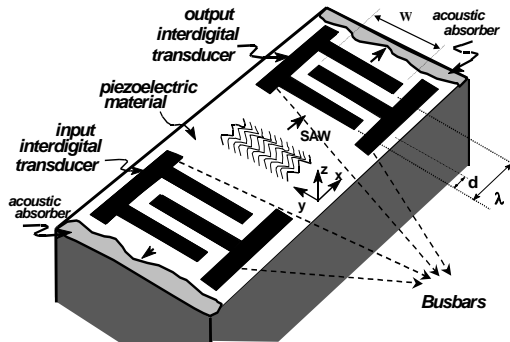
OPERATION IN HARSH ENVIRONMENTS



ATTACHMENT ON ROTATING AND STATIC PARTS

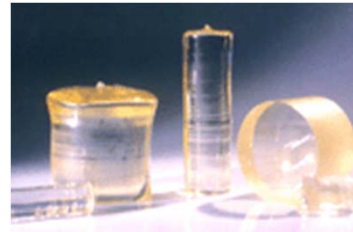


VALIDATED IN FURNACES, TURBINE ENGINES, AND POWER PLANT WATER WALLS



SURFACE ACOUSTIC WAVE PROPAGATION

Measures T, P, ϵ



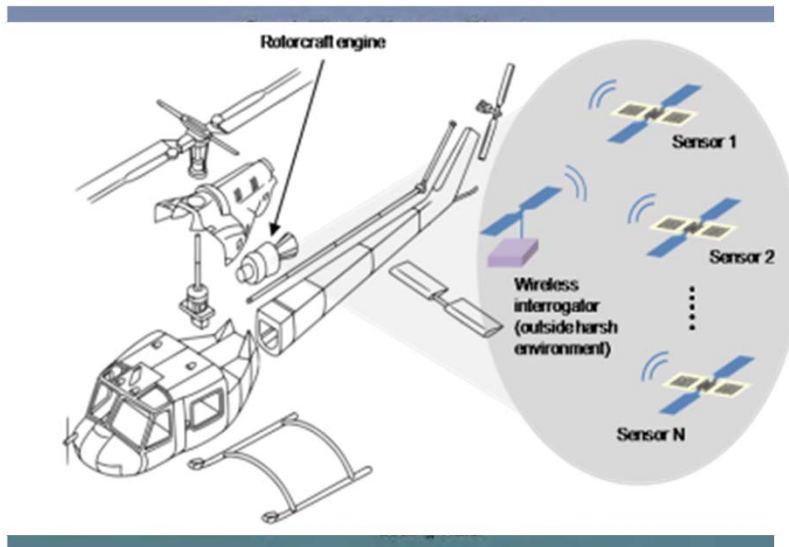
LANGASITE $\text{La}_3\text{Ga}_5\text{SiO}_{14}$ PIEZOELECTRIC CRYSTAL

- ✓ Stable up to 1400°C
- ✓ Thermal shock resistant



SAW SENSOR & ANTENNA

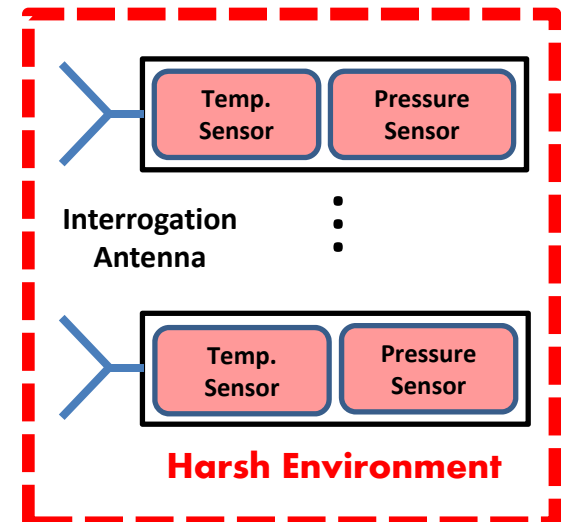
Low profile package



Base Station
Multi-Sensor
Data Acquisition & Display

hardwired or wireless
(ZigBee/Bluetooth, etc.)

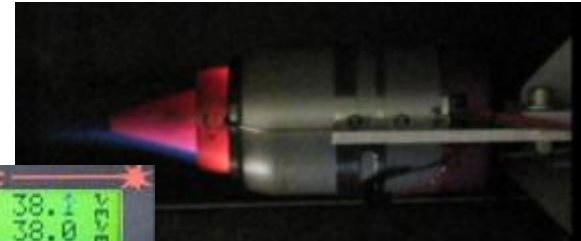
RF Interrogation
Data Processing
Electronics



TESTING IN TURBINE ENGINES: STATIC & ROTATING PARTS



ARMFIELD CM-4 TURBINE ENGINE



JETCAT P-70 & P-80 TURBINES



TMC85-1 GAS TURBINE ENGINE



90,000 RPM ROTATION / 53,000 G TANGENTIAL LOADS

JETCAT ENGINE TEST FACILITY



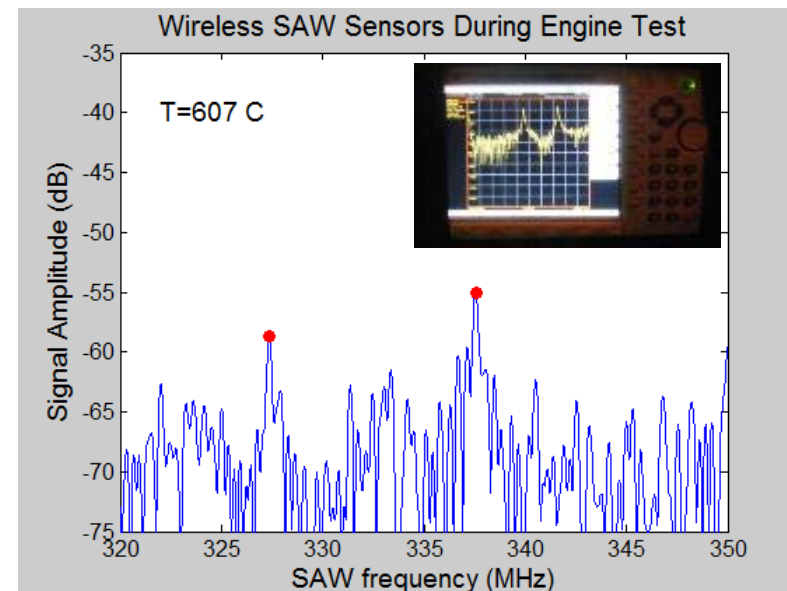
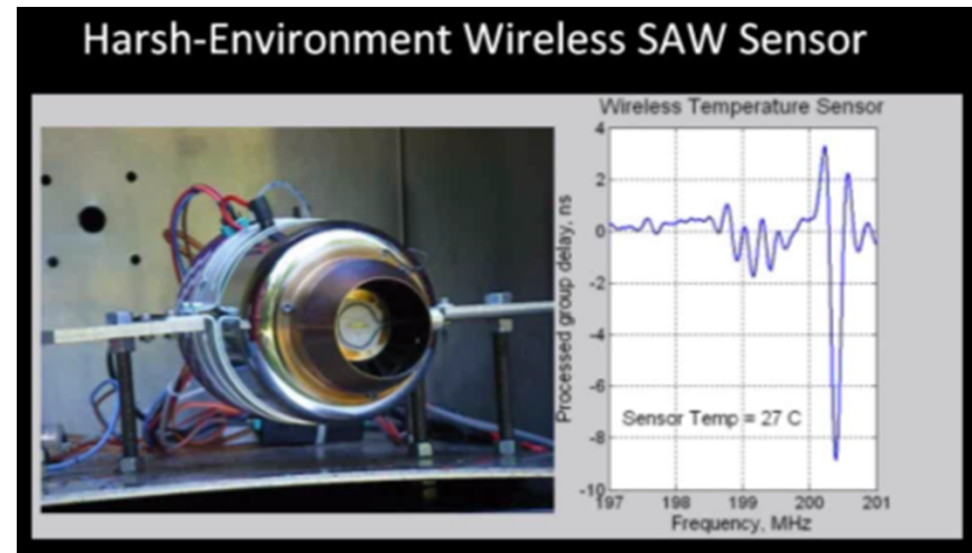
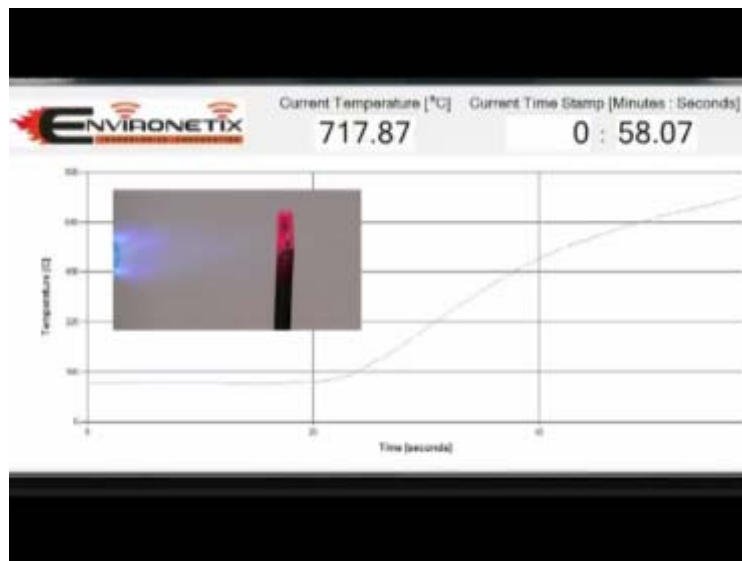
GE CT7 / T700 ENGINE



DEMONSTRATION OF WIRELESS SAW

SENSOR INTERROGATION ON THE
INTEGRALLY BLADED ROTOR (IBR) WITHIN
A JETCAT P-70 TURBINE ENGINE

REAL TIME WIRELESS SAW SENSOR RESPONSE DURING
THERMAL SHOCK TESTING WITH BLOW TORCH





INSTALLATION OF ENVIRONETIX
SENSORS IN MERC POWER PLANT

**Maine
Energy
Recovery
Company
(MERC)**



**power plant that burns
municipal solid waste**



ENVIRONETIX WIRELESS SENSOR
PROBE IN MERC WATER WALL

CONDITION BASED MONITORING

furnace tubes and piping
superheater / reheater tubes
heavy wall piping

TESTING RESULTS

5 wireless sensors currently installed at MERC
survived 3 rounds of TNT boiler cleaning
sensor operation > 5 months

BOILER CONDITIONS

erosive/corrosive exhaust gas
temperatures up to 1200°C (2200°F)

NETL/DOE BURNER

Exhaust gas
temperatures up to
1000°C (2200°F)

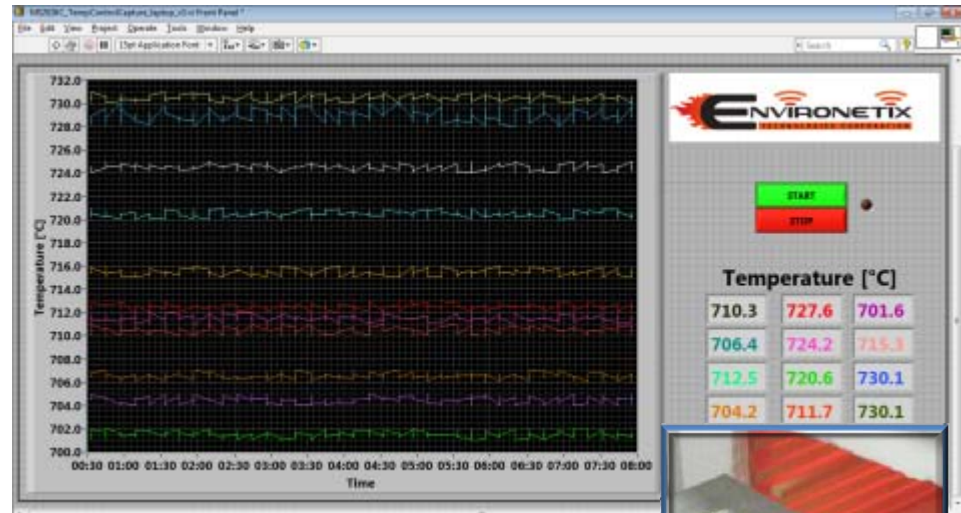
ENVIRONETIX EVHT-100 SENSOR SYSTEM
boiler tubes & parts temperature monitoring
water wall temperatures

OPERATION ENVIRONMENTS:

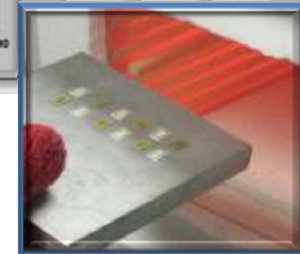
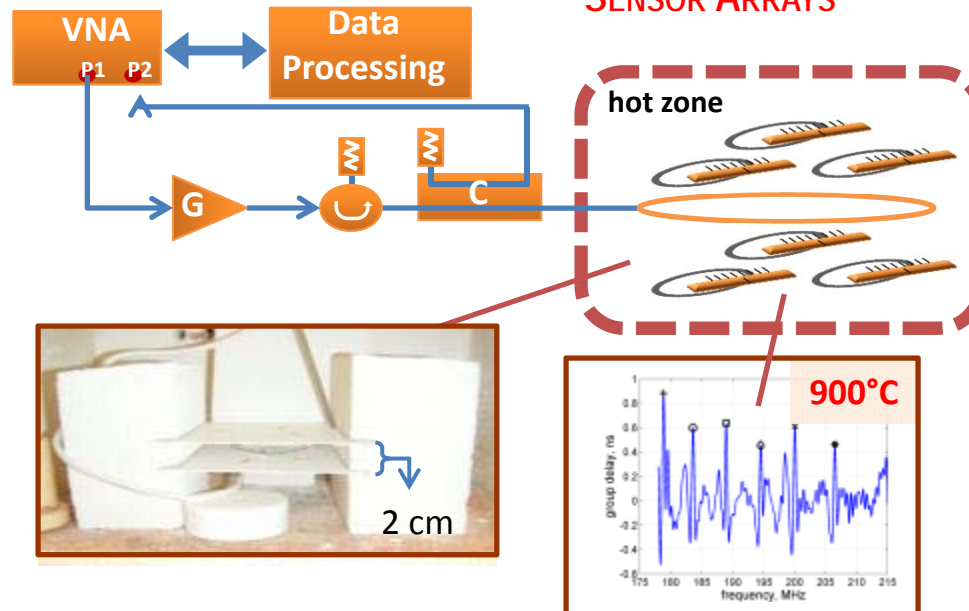
furnaces, engine exhausts,
rotating and belt moving parts
up to 900°C (1650°F)



**HIGH T / HIGH P
ATMOSPHERE FURNACE**
up to 1500°C
vacuum to 750 psi

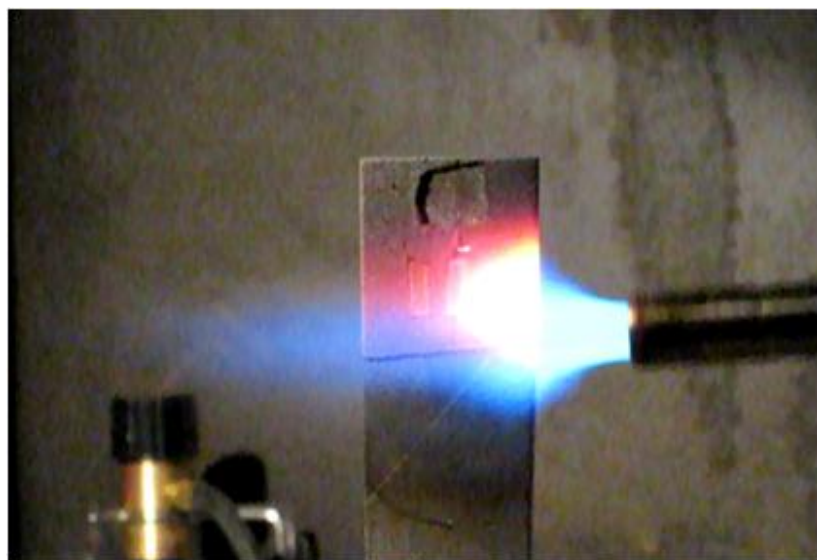


MULTIPLE SENSORS & SENSOR ARRAYS



THERMAL SHOCK

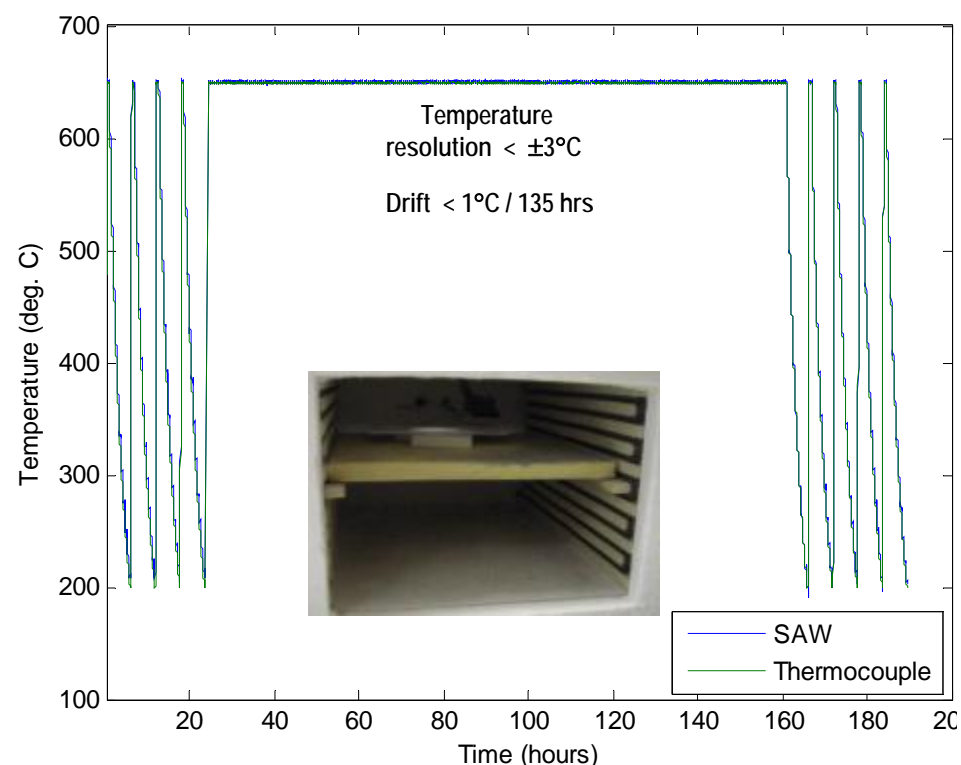
Propane Torch & Nitrogen Quench



Lithium Niobate & other common piezo materials
CRACK under similar & much less severe conditions

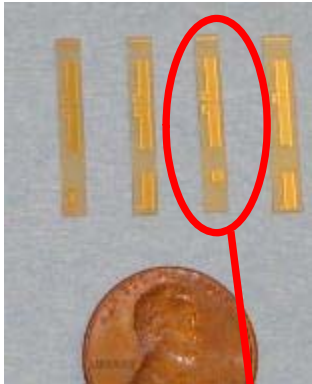
THERMAL CYCLING

Wireless SAW Sensor & Thermocouple

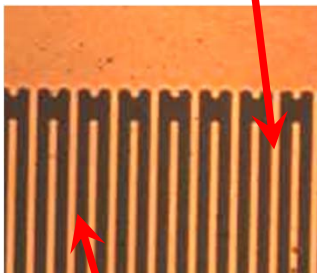


RELIABILITY AND SENSOR LIFETIME

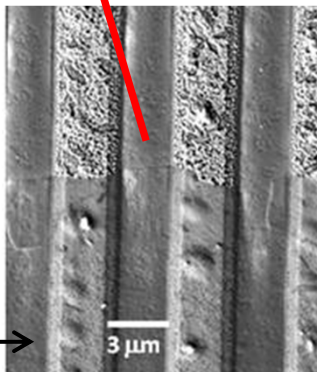
SAW sensors



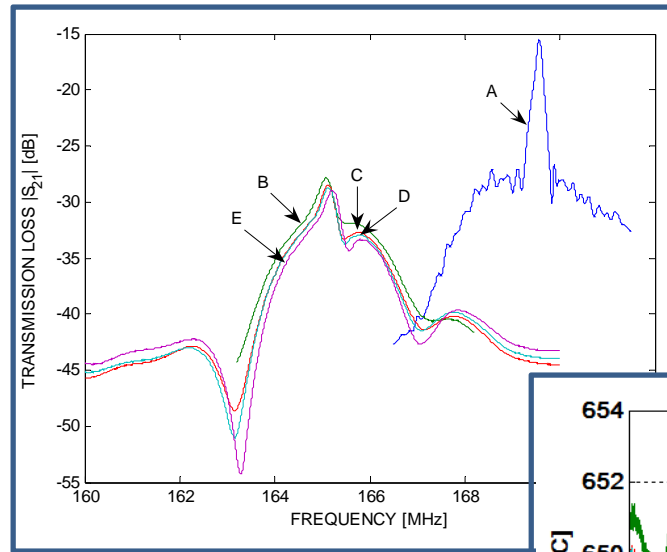
microfabricated transducer electrodes



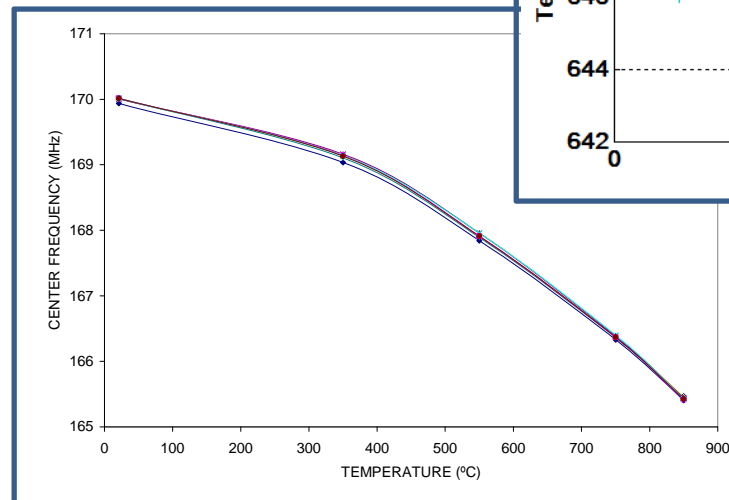
conductive nanocomposite alloy film



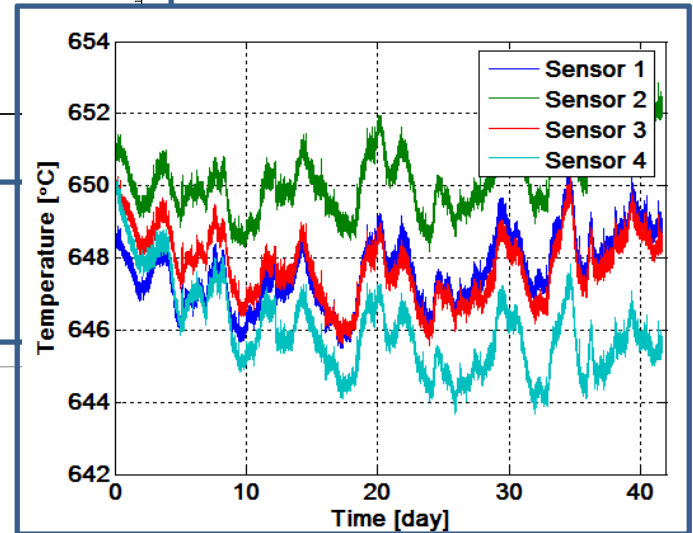
with passivation coating



CONSISTENT MULTIPLE
SENSOR READINGS



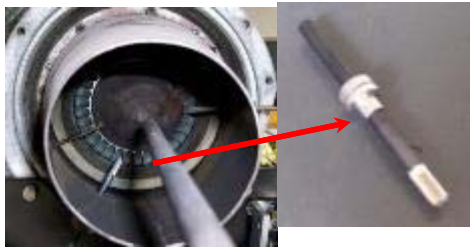
STABLE OPERATION
DEMONSTRATED FOR 5½ MONTH
IN 800°C BOX FURNACE



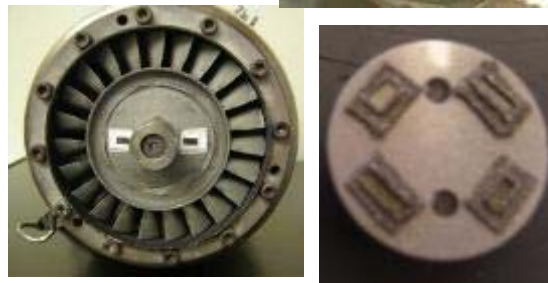
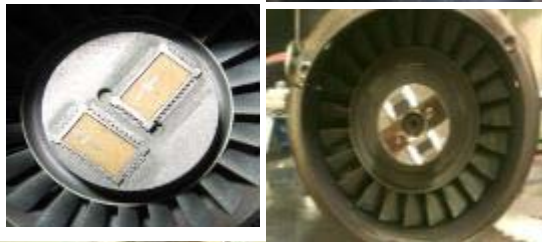
REPETITIVE, STABLE
RESPONSE

MULTIPLE PROPRIETARY ATTACHMENT TECHNIQUES TO MEET CUSTOMER REQUIREMENTS

STATIC PARTS



ROTATING PARTS



SAW SENSORS ATTACHED TO INCONEL BLADES

Third Part Packaging Test

VEXTEC

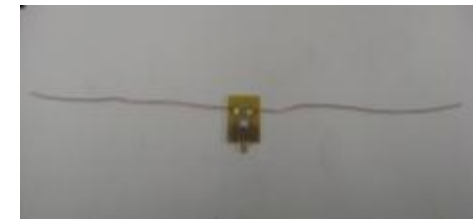
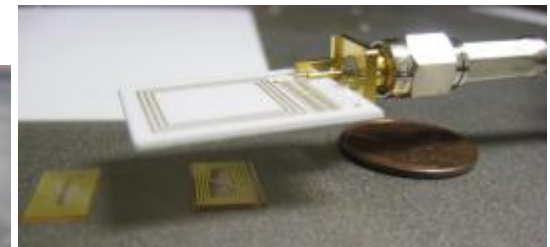
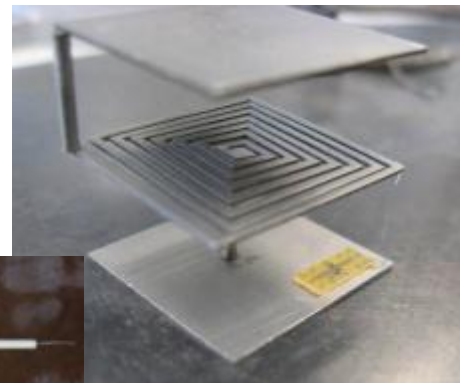
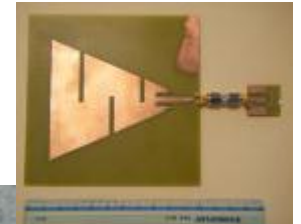
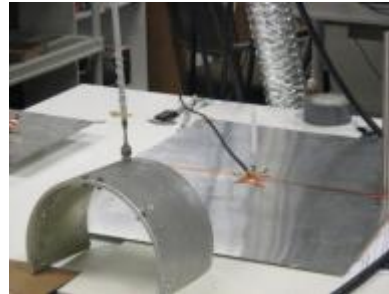
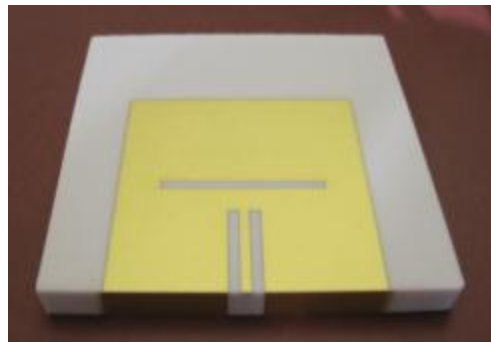
Integrated 22" radius
bladed turbine rotor

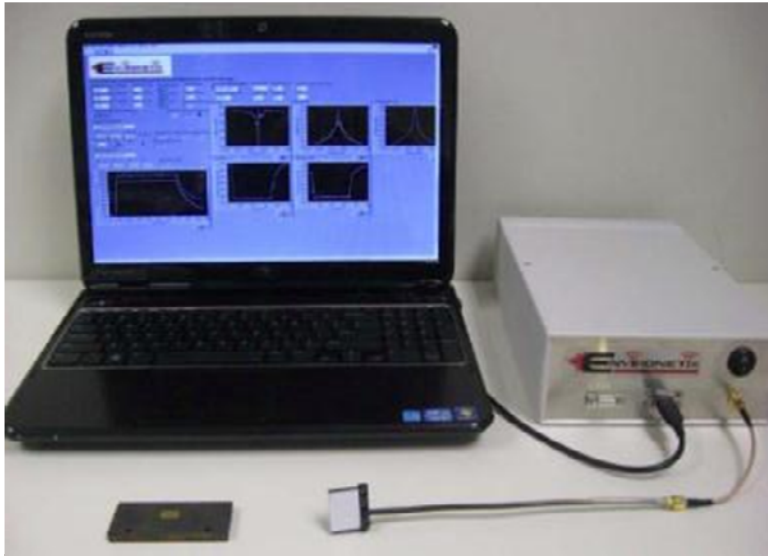


PACKAGING ADHESION VERIFICATION

- ✓ g Levels = 14k, 26k, 40k, 58k
@ 800°F (425°C) & 1200°F (650°C)
- ✓ up to 60min dwell at 1200°F
(650°C) and 58 k g's
- ✓ temperature snap action tests

- Frequency of Operation: from 100MHz to 1GHz
- Diverse types and sizes of antenna used, depending on the harsh environment application and environment
 - ✓ Sizes range from a few mm to several inches



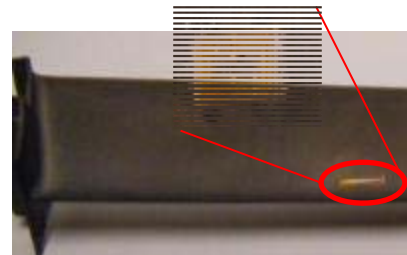


EVHT-100

WIRELESS TEMPERATURE SENSOR SYSTEM

temperature range: 150°C (300°F) to 900°C (1650°F)
accuracy: $\pm 10^{\circ}\text{C}$ over full range
resolution: within $\pm 5^{\circ}\text{C}$
long term drift: $< 1^{\circ}\text{C} / 150$ hours
operating life: > 500 hours
insensitivity to pressure: 0 to 750 psi with $< 1^{\circ}\text{C}$ error
operating frequency: 100 MHz to 1 GHz
sampling rate: 1 Hz to 100 kHz
rotation: up to 53,000g's

Multiple wireless, harsh environment, microwave acoustic temperature sensors with integrated RF antennas (system expandable to 100s of sensors)

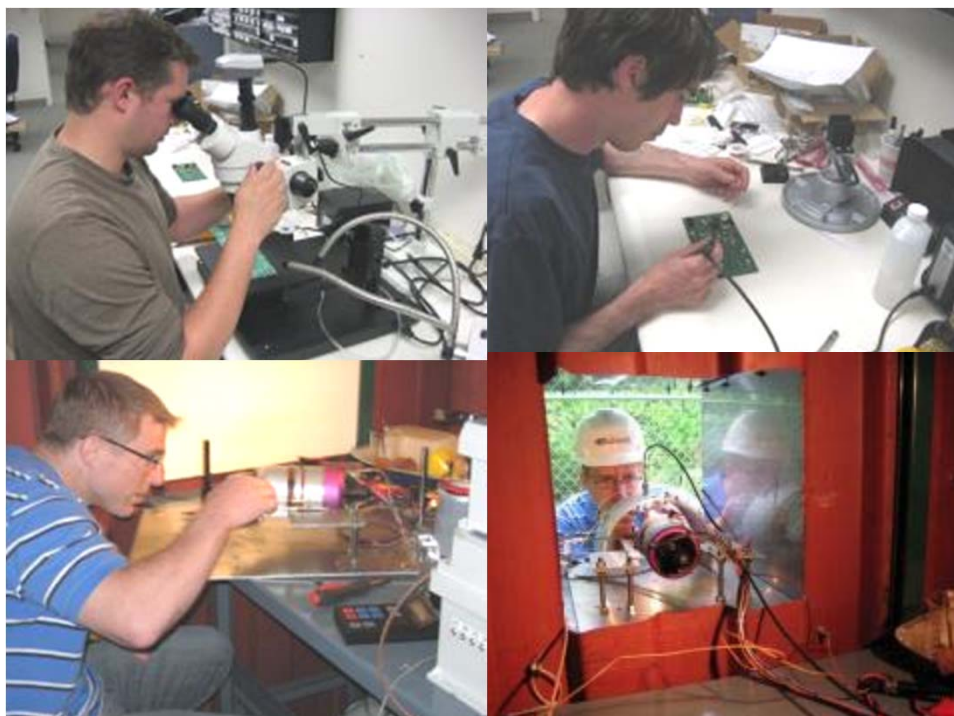




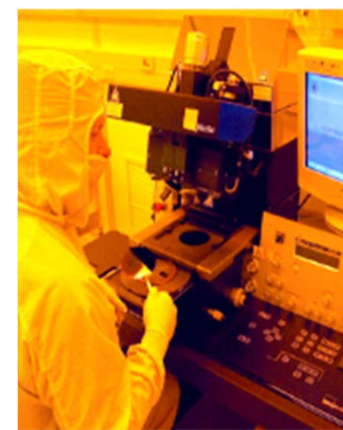
Established 2009
6 technical staff
2 business/admin



*Target Technology Center
20 Godfrey Drive
Orono, Maine*



SENSOR SYSTEM MANUFACTURING AND INSTALLATION



SAW DEVICE FABRICATION



APPLICATIONS OF ENVIRONETIX SENSOR SYSTEMS



COMBUSTION ENGINES



POWER PLANTS



INDUSTRIAL PROCESSES



HIGH T PROCESSING



SPACE VEHICLES



GAS/OIL EXTRACTION

Wireless Sensor Systems -- Built for Customer Needs

*Contact us to discuss sensor array size, interrogation range,
sensor attachment location and profile, and user interface
for your specific application*

Dynamic Strain, Corrosion, and Pressure Sensors under Development

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