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Innovators of Passive RF Sensors for Extreme Environments

Featured In:

Forbes

POWER Engineering

Turbomachinery International

U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy

Orlando Sentinel

Orlando Business Journal

The Daytona Beach News-Journal

Experienced Problem First Hand

Challenges in Capturing Blade Information

List of Problems	Today's Solution	New Solution
Post Processing Engine Test Data	Paints/crystals only record highest temperature experience, requires engine teardown	Real-time temperatures, requires insertion probe
Managing and Routing Cables	Machining/drilling for thermocouple wire routing	No wires; only casing-flush insertion probe.
Uncertainty in Predicting Component Life	IR/Fiber Optic – accuracy issues at higher temperatures	More accurate and durable.
Testing & Validation Data Translating into Field Usable Prognostics	Useable in test stands only	Low profile and durability enable full engine life deployment with periodic real time interrogation
Accuracy	Sensor height changes measurand. Optical measurements have emissivity errors	Low profile sensors avoid aerodynamic heating

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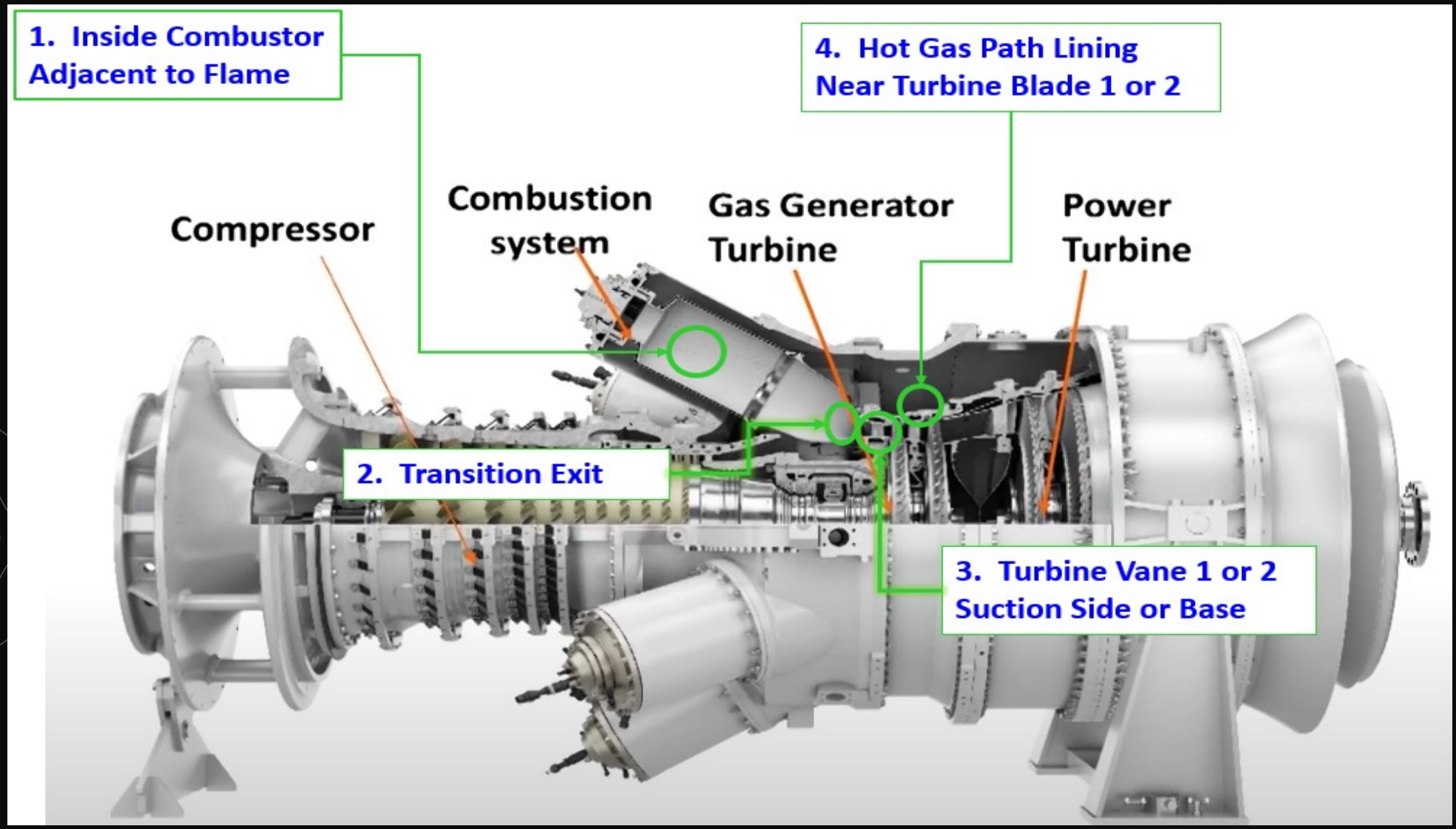
Major Activities

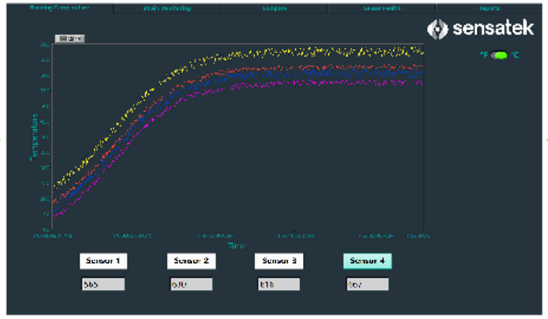
Determined Sensor Locations



How It Works

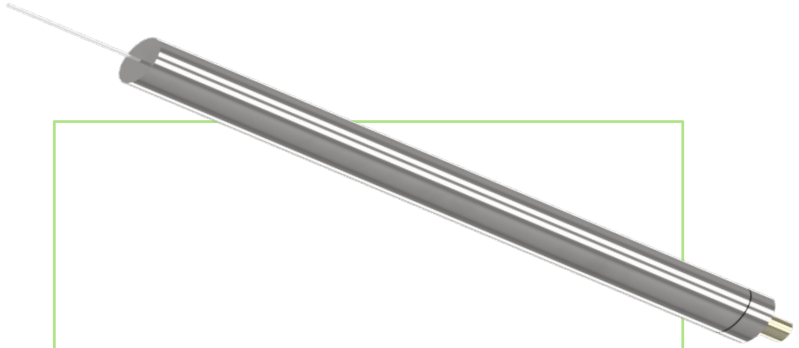
A low-profile slot resonator and reflective patch antenna and behaves as both a resonator (sensor) and an integrated antenna. An interrogation circuit (transceiver) sends out a pulsed wave which contains a wide frequency spectrum surrounding the resonant frequency of the reflective patch sensor.

When the temperature in the sensor increases, the resonant frequency reduces — a result of the increasing dielectric constant of the substrate material as the temperature rises (on the turbine blade). These resonance changes are tracked by software that displays detailed, real- time, highly accurate temperature measurements of the blades.

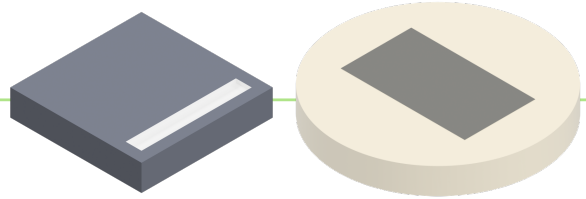


Software

High-Speed RF Transceiver Electronics



High-Temperature Interrogation Antenna



Ultra-High Temperature and Pressure Sensor

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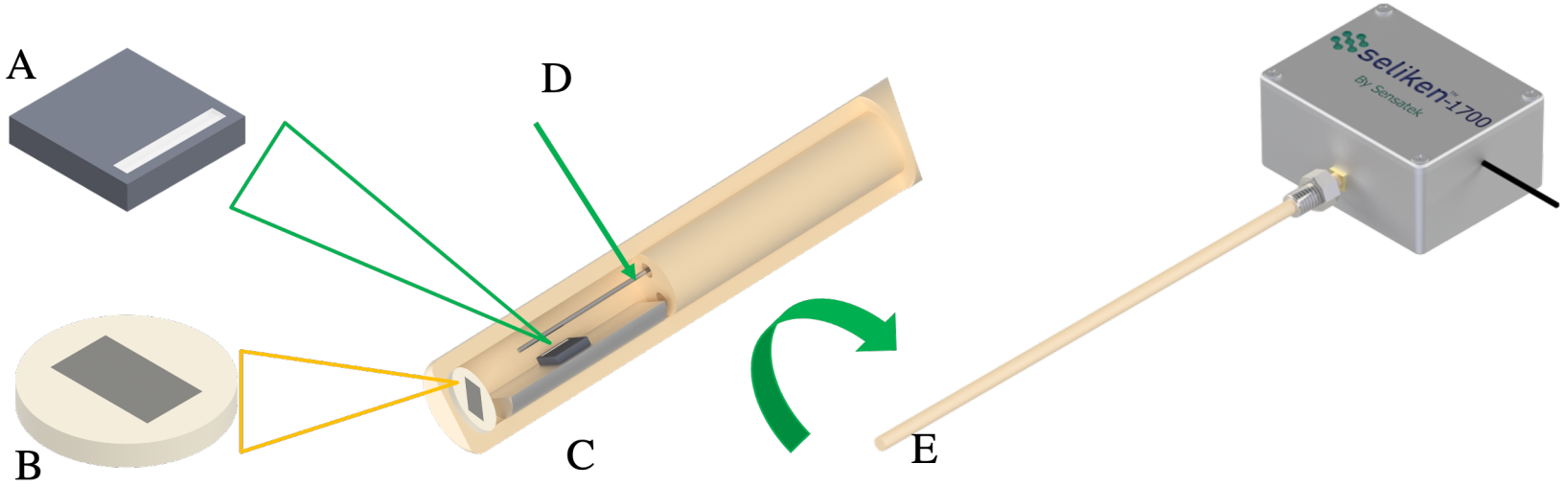
Immersion Probe Design



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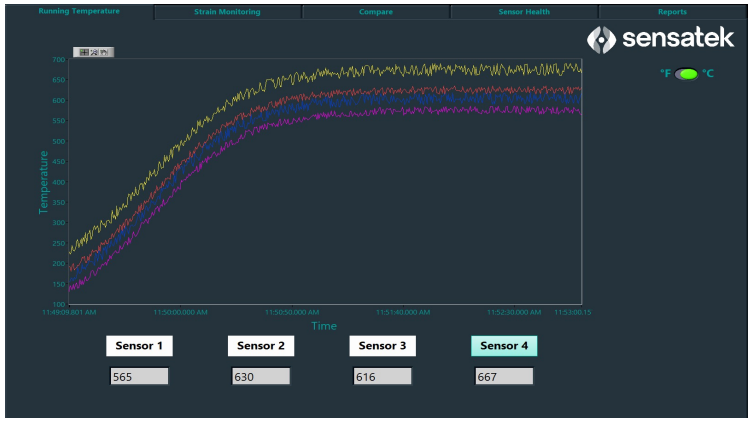
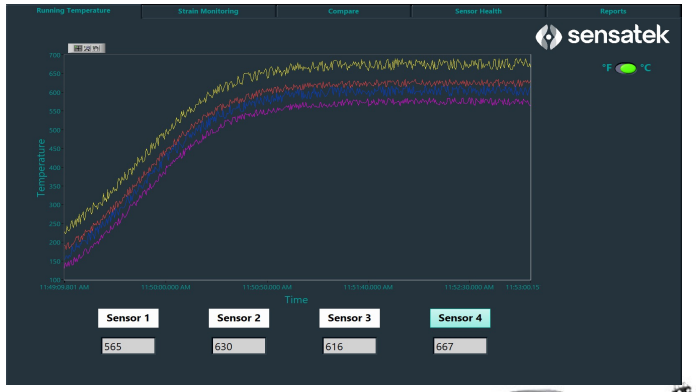
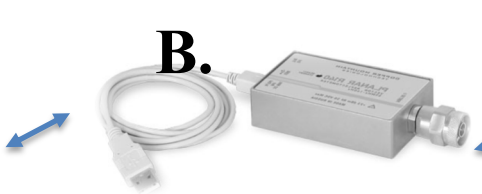


On-Blade Design

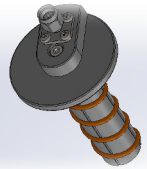


A.



B.

C.



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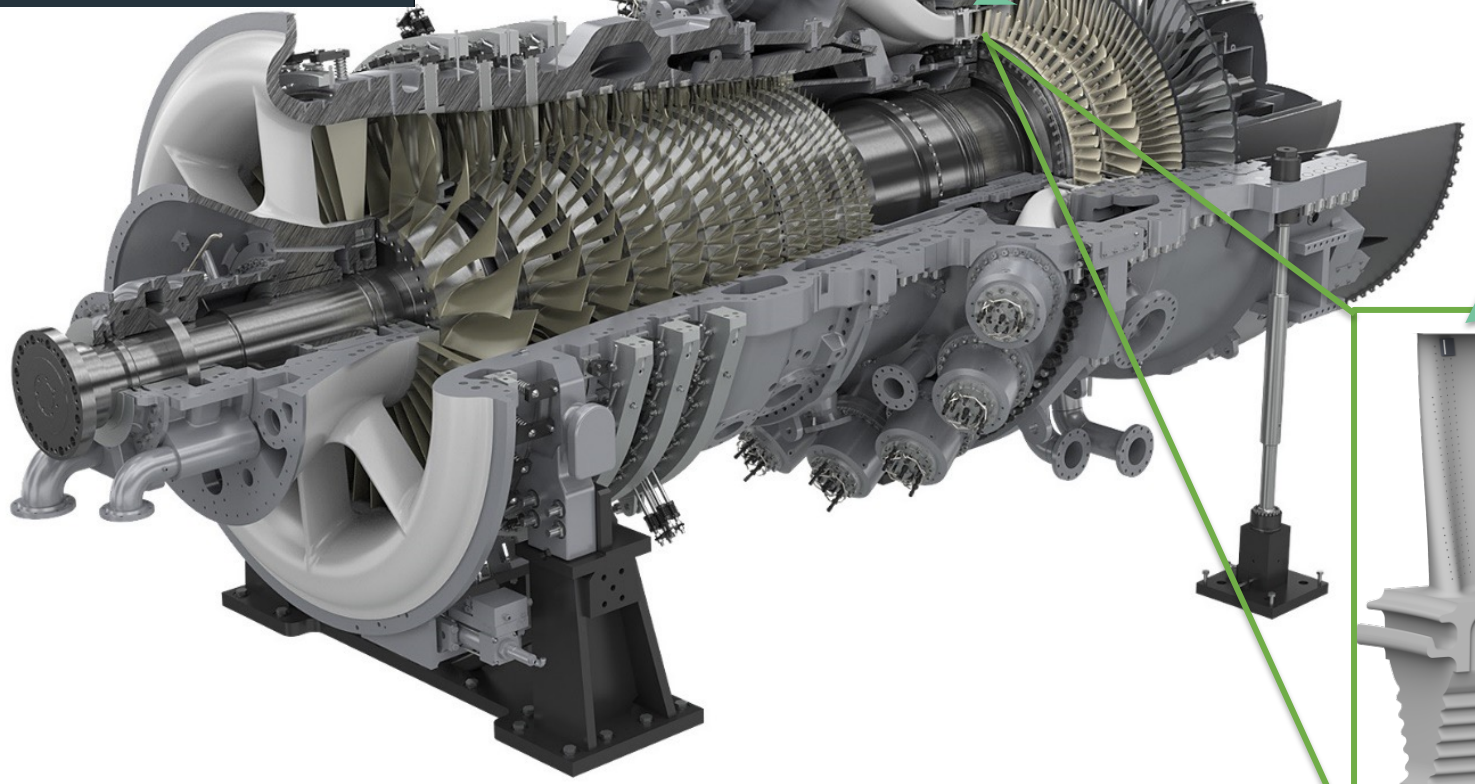

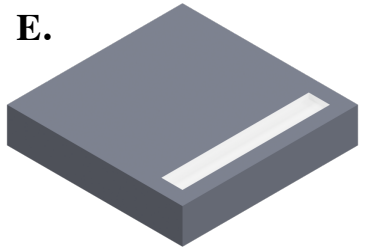

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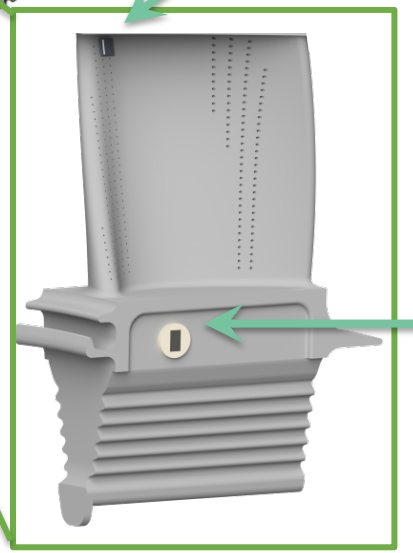
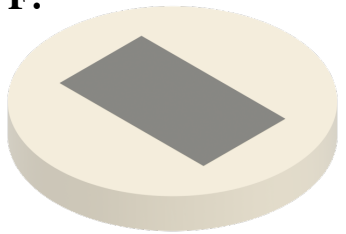


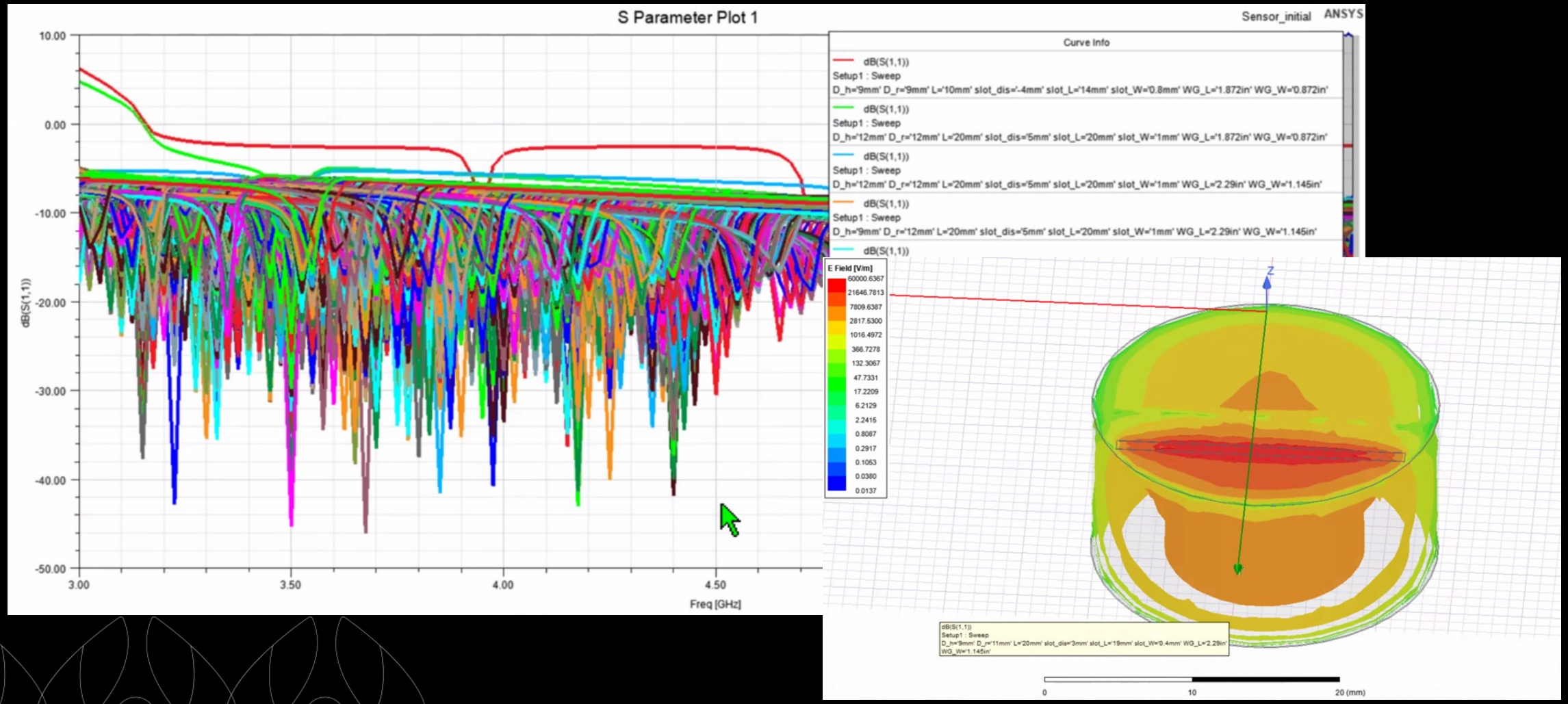
G.



F.

Major Activities

Designed and Fabricated Wireless Temperature Sensor up to 1,700℃



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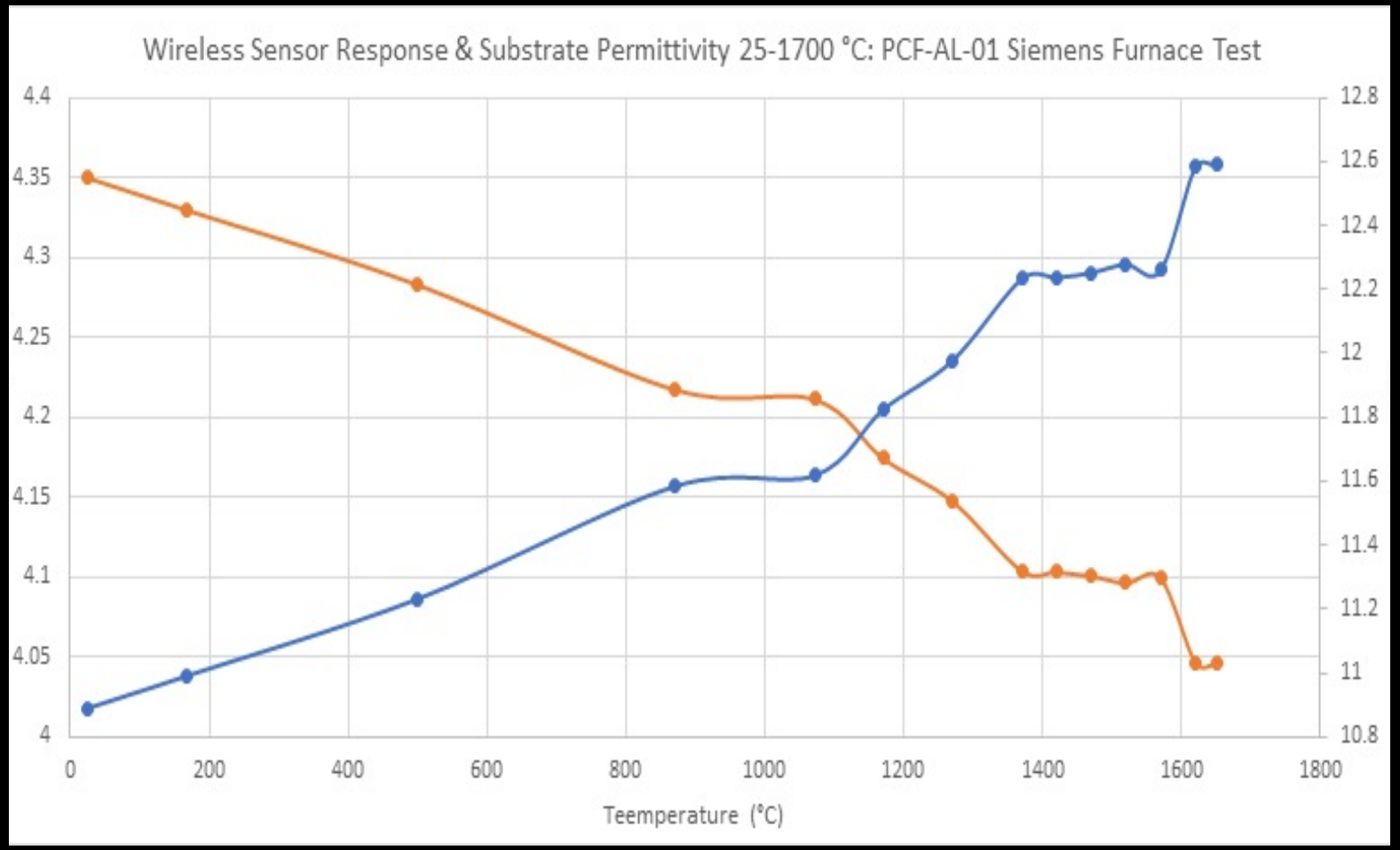
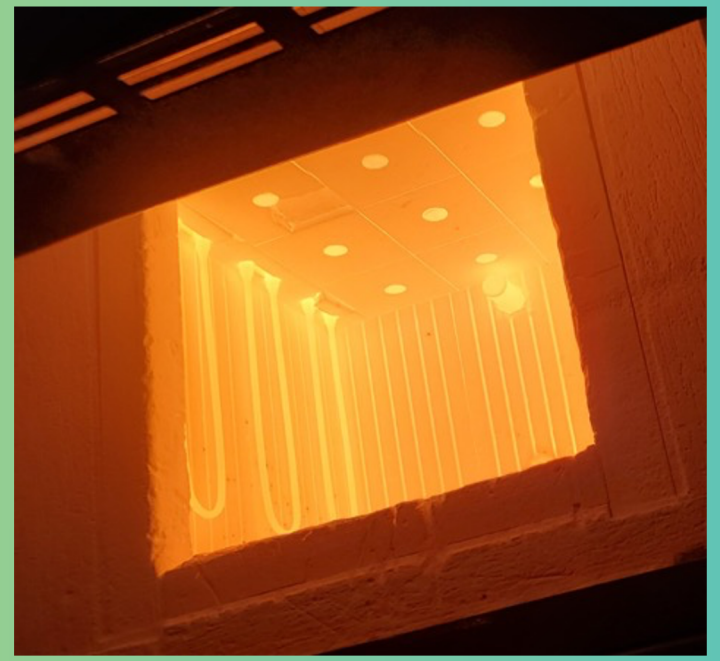
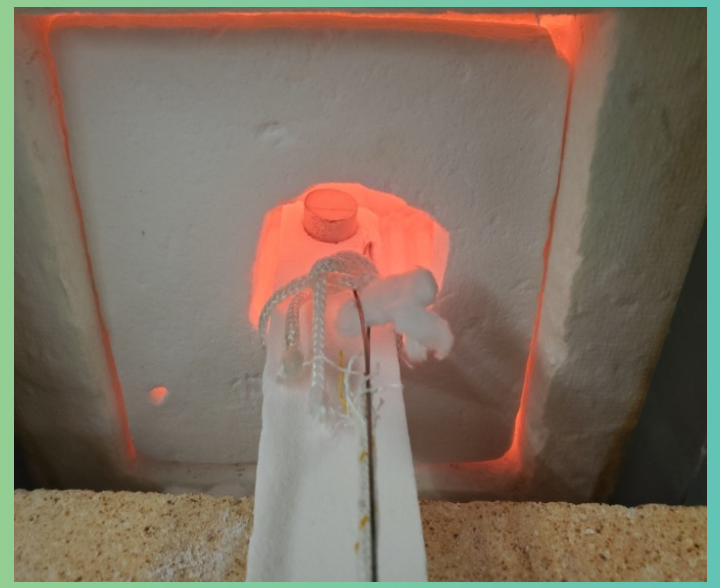
Major Activities

Sensor shows response to 1,700°C







Patent: US 8,558,705 Ceramic Sensors for Wireless High Temperature Sensing

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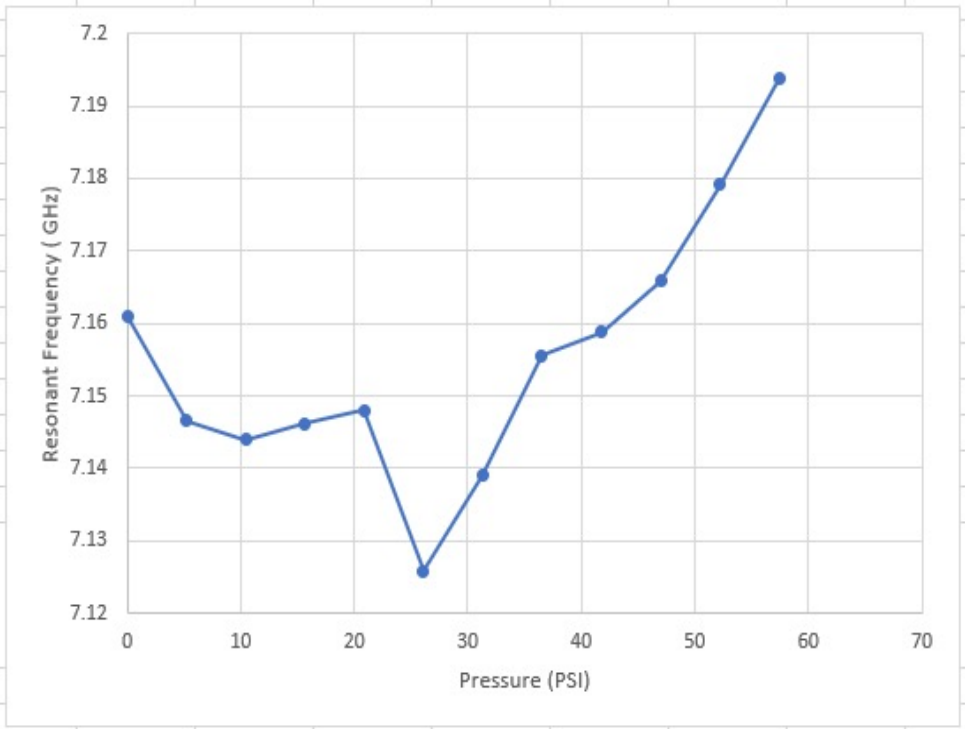
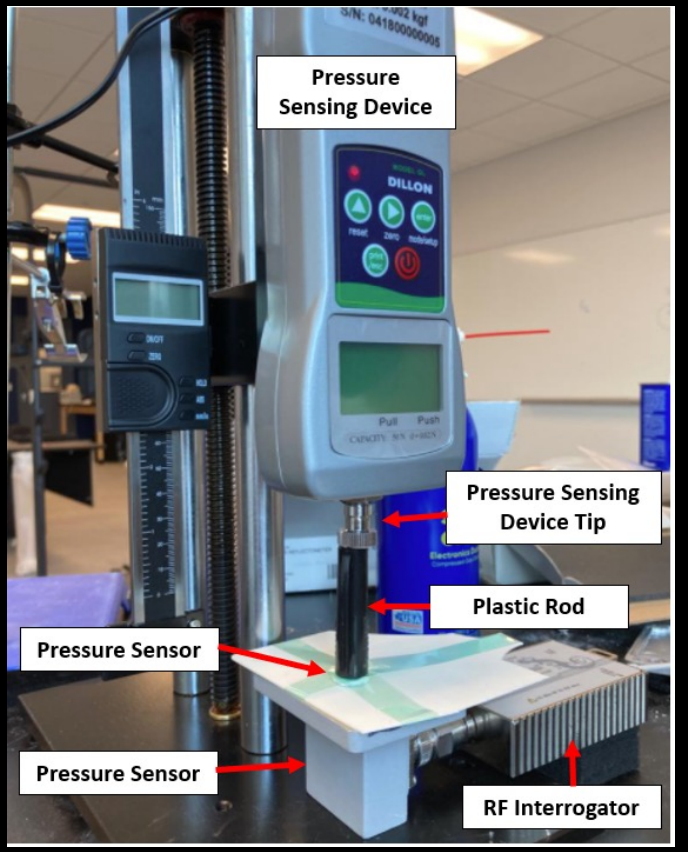
Major Activities

Designed and Fabricated a Wireless Pressure Sensor up to 1,700℃

Force	Pressure (Pa)	Pressure (PSI)	RF (GHz)
0	0	0	7.161
5	35989.50103	5.21984525	7.1466
10	71979.00206	10.4396905	7.144
15	107968.5031	15.65953575	7.1462
20	143958.0041	20.879381	7.148
25	179947.5051	26.09922625	7.1258
30	215937.0062	31.3190715	7.139
35	251926.5072	36.53891675	7.1556
40	287916.0082	41.758762	7.1588
45	323905.5092	46.97860725	7.1658
50	359895.0103	52.1984525	7.1792
55	395884.5113	57.41829775	7.1938

Diameter of Pressure Gauge Connector	Area	Pascal to PSI
1.33E-02	0.000138929	0.000145038





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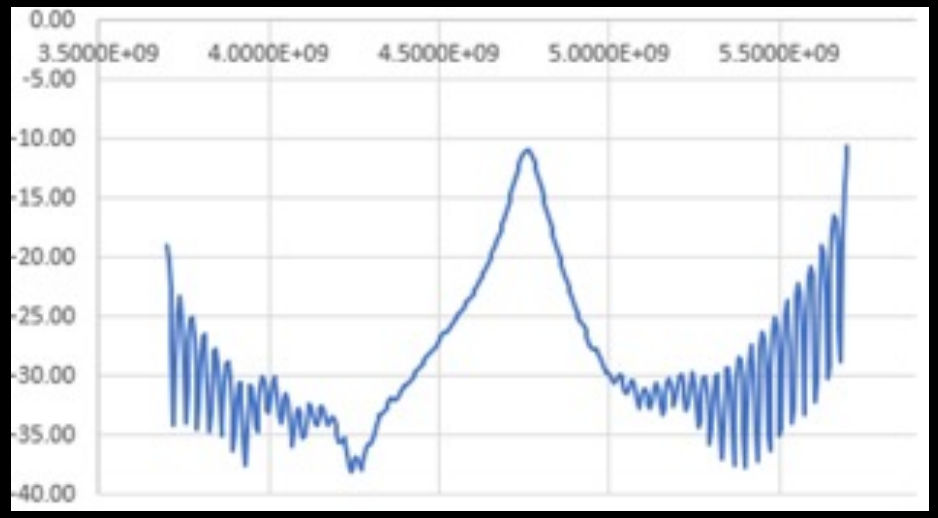
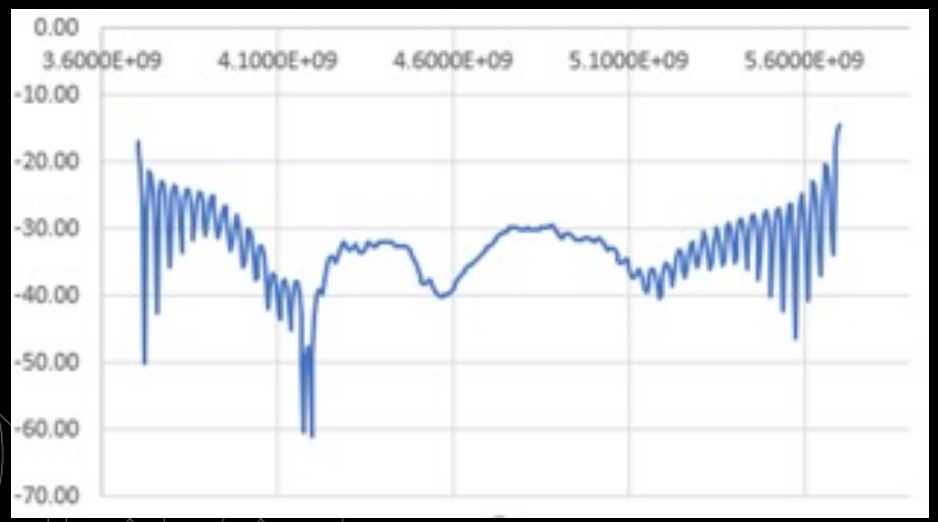
Major Activities

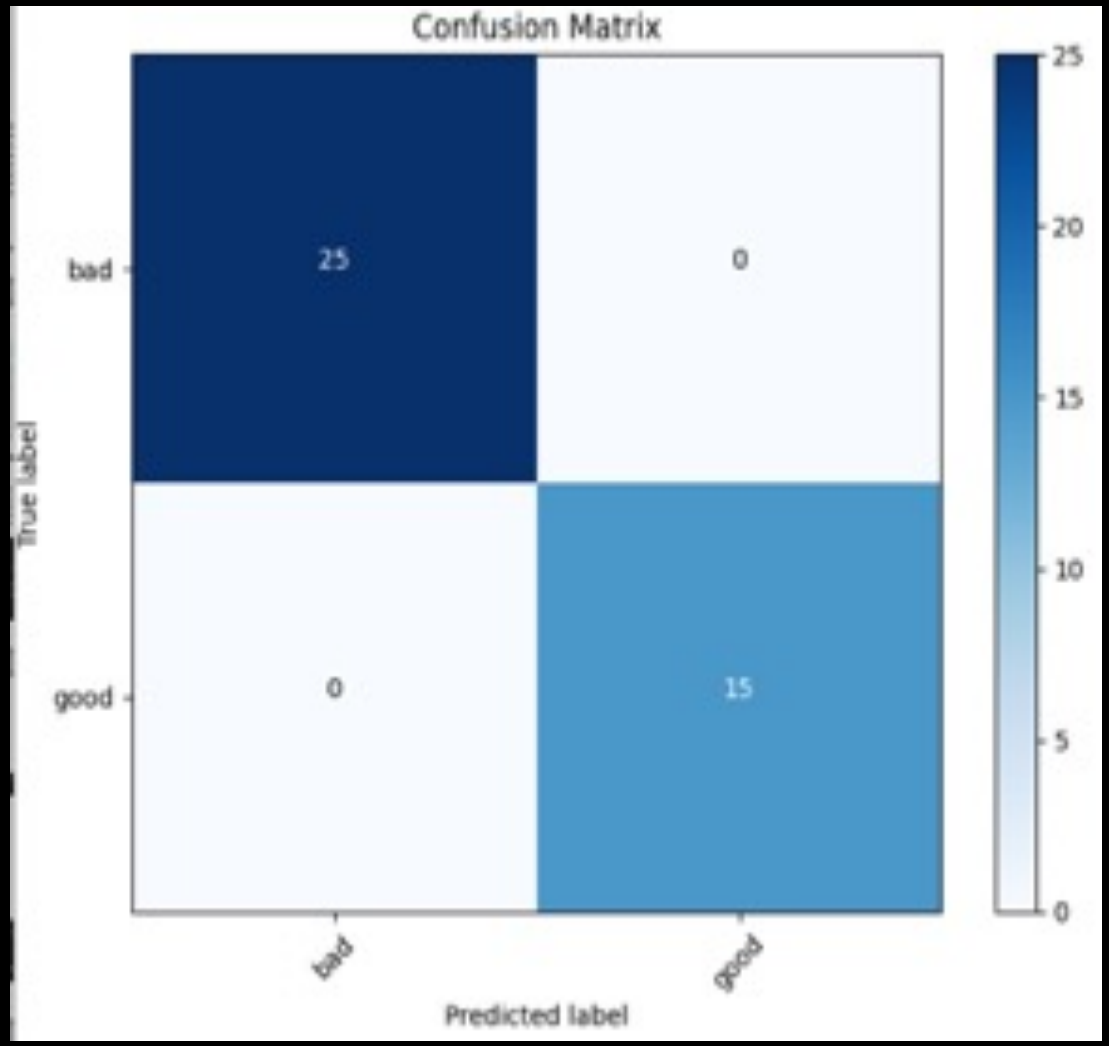
Framework for Creating Real-Time Machine Learning Modules to Distinguish Different Sensor Failure Modes

Good Reading



Bad Reading





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Microturbine Engine Test

Bond Test @75K RPM

135,000G

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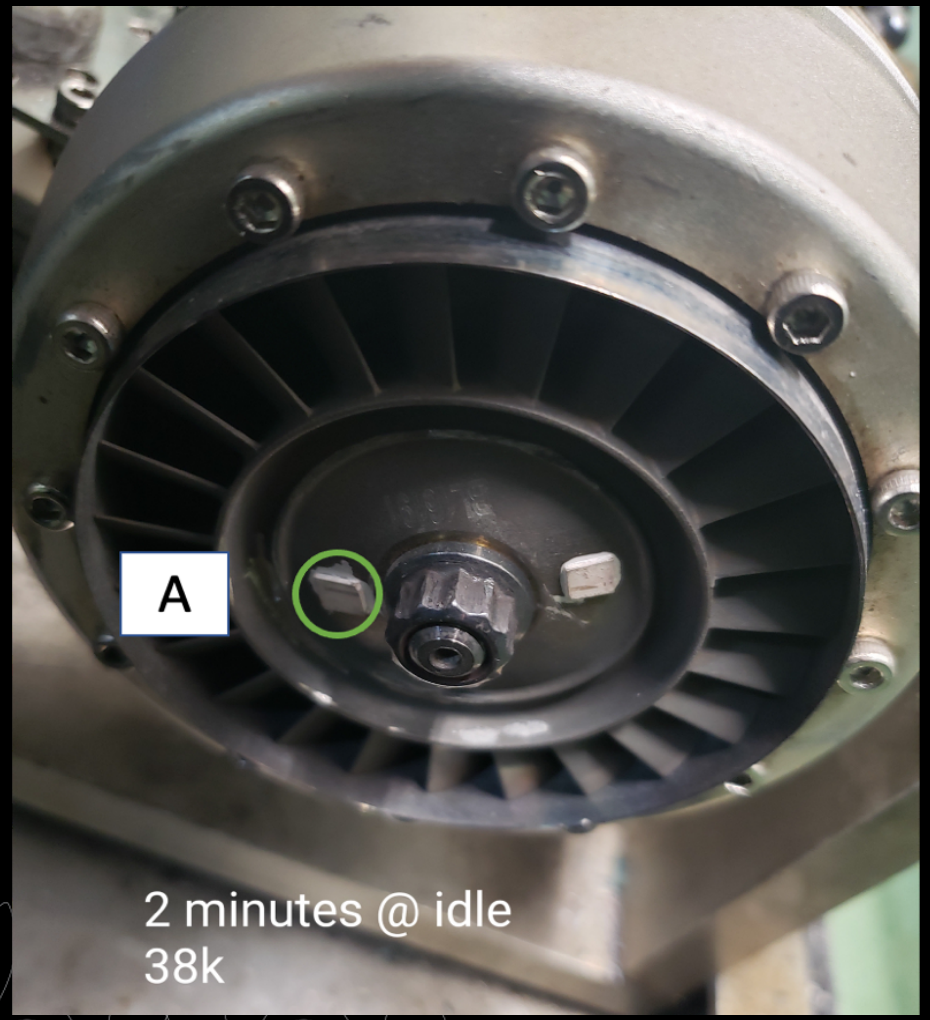
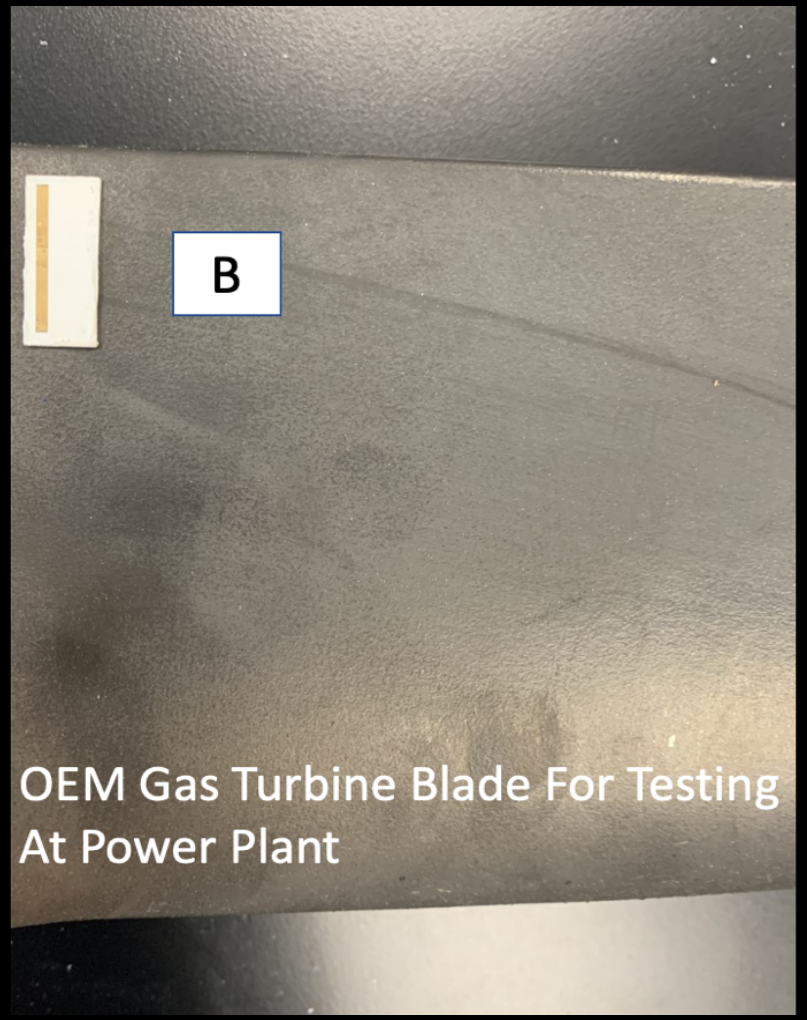
Major Activities

Currently Demonstrating Wireless Temperature Sensor On-Blade of Fielded Gas Turbine Engine at Power Plant





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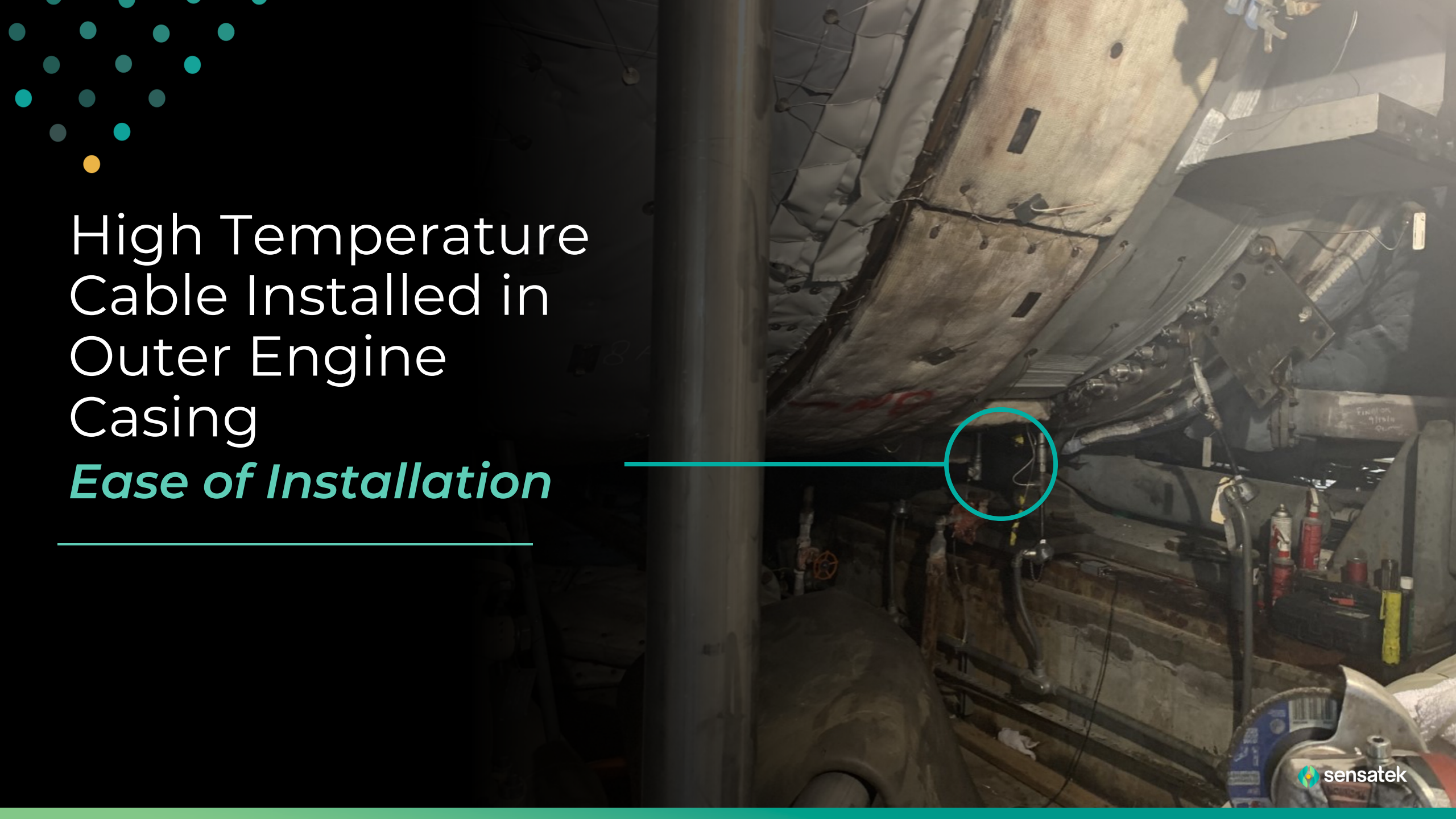
High Temperature Cable Installed in Outer Engine Casing

Ease of Installation



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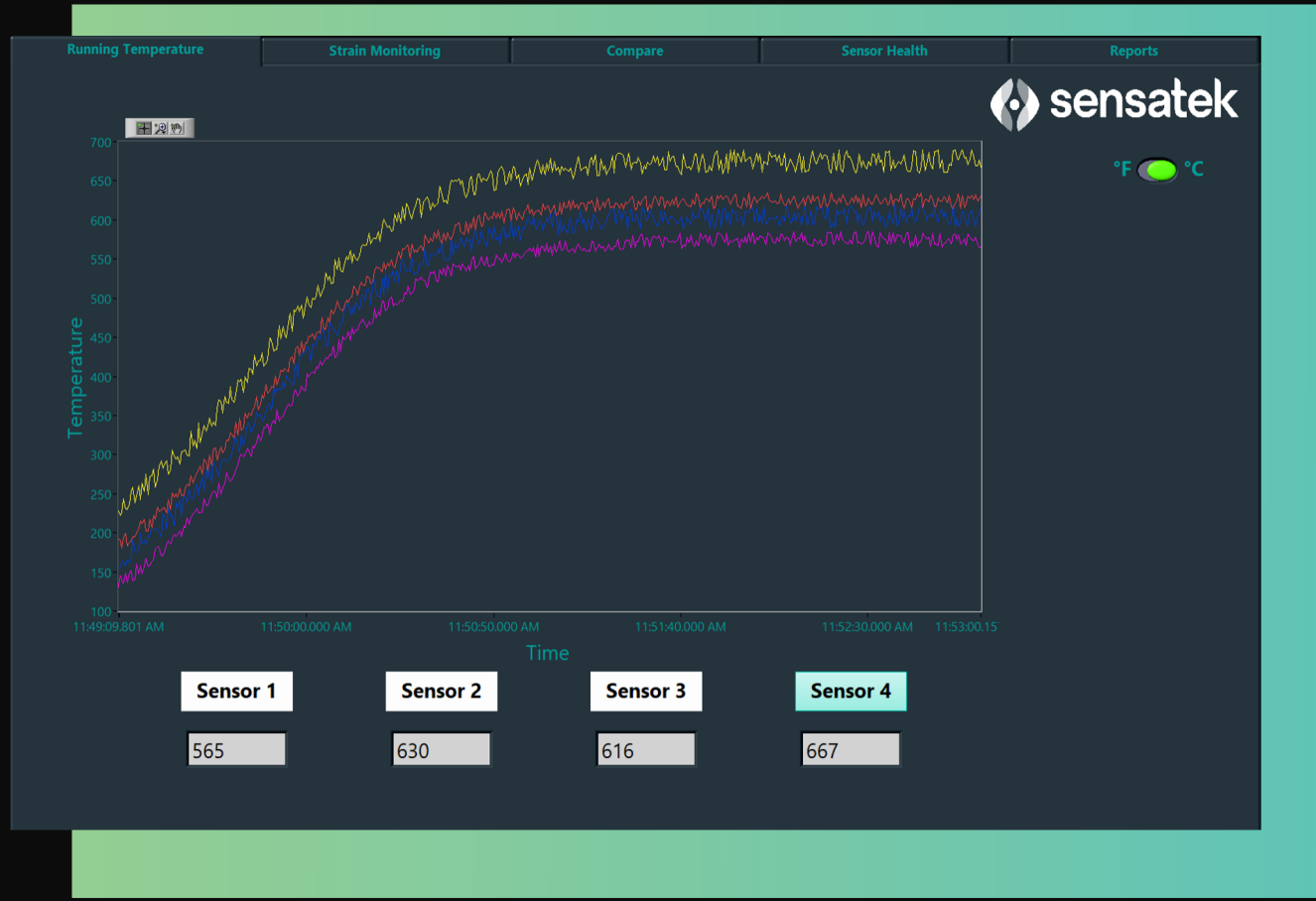
Real Time Data Displays

New Data Fuels Your Insights

- Set Temperature Limit Alarm Thresholds.
- Report temperatures in real time in the units you prefer.
- Display multiple sensor readings simultaneously.



Value Beyond The Numbers

Beyond the economic value in cost-effectiveness of engine maintenance, Sensatek sensors were designed to enable test engineers to be more efficient and accurate with their work.

We're currently providing a valuable pilot program to demonstrate firsthand the many key advantages of the Sensatek sensor system, including:

- Accelerate engine development cycles
- Improve energy efficiency of power systems
- Reduced installation setup times
- Reduced instrumentation test failure
- Reduced risk of engine failure
- Reduced maintenance costs
- Early prediction of maintenance needs
- Extended running time between maintenance outages
- Improved measurement survivability (over alternatives)
- Improved ability to predict component life in testing
- Improved detection of changes to thermal barrier coatings
- Improved data on internal cooling performance
- Increased energy production (and revenue)

Blade thermal performance relies upon a temperature life model. The potential benefits of improved machine efficiency, maintenance prediction, data quality (history of temperatures endured), and real-time insights are difficult to understate.

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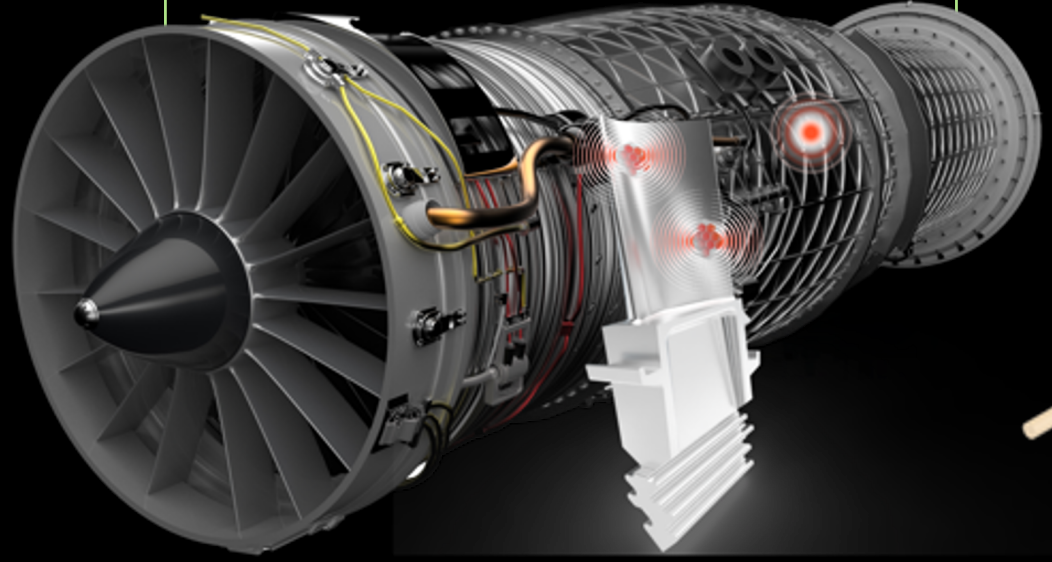
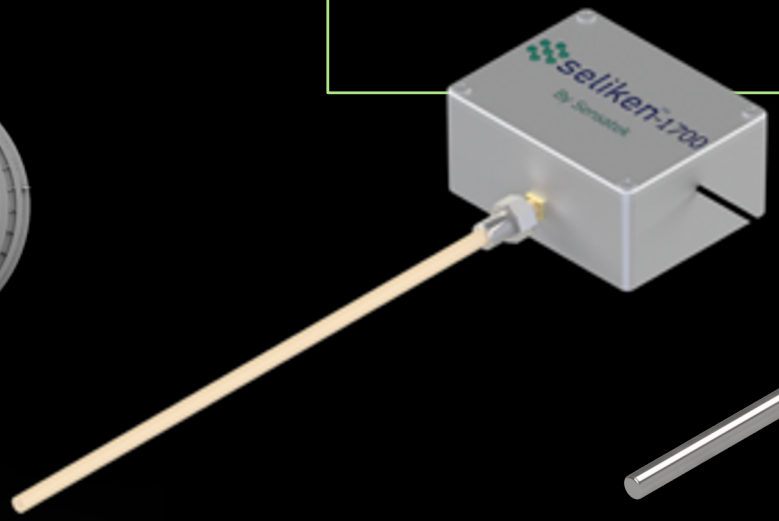
RF Passive Sensor Product Lines

Enabled by seliken High Temperature Material Systems

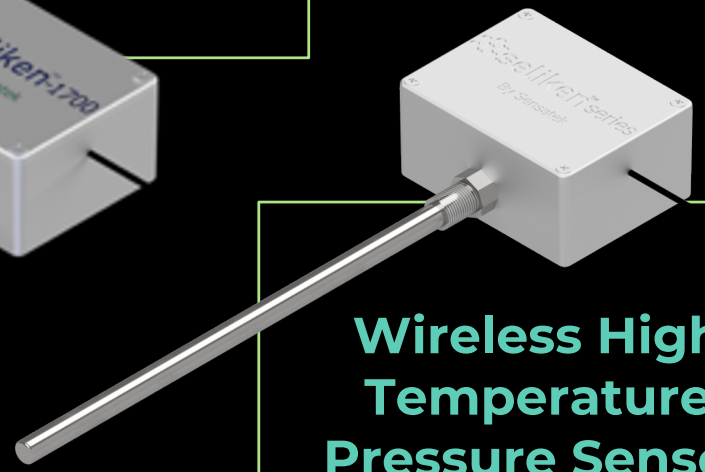
Embedded On-Blade Temperature Sensors



Wireless Ultra High Temperature Immersion Probe Sensors



Wireless High Temperature Pressure Sensor



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We're Here to Serve.

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