

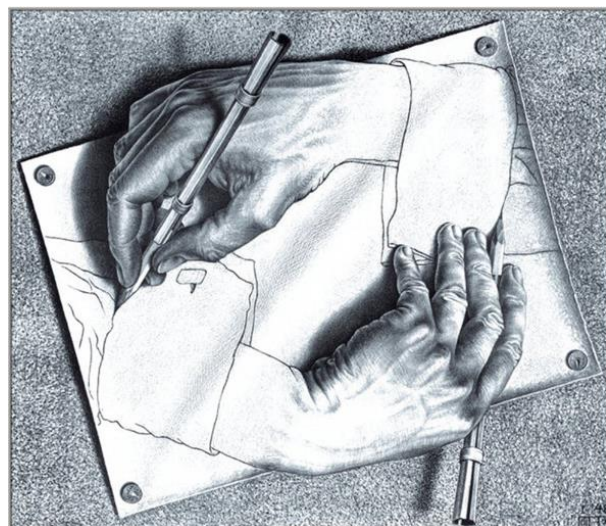
Challenges and Opportunities for Fiber Optics in Harsh Environments

19-20 April 2023, Porto, Portugal

The Challenge-Opportunity Transform

$$CH(\omega) = T \int_0^{\infty} OP(t) e^{-i\omega t} dt$$

$$OP(t) = W \int_0^{\infty} CH(\omega) e^{i\omega t} d\omega$$



$CH \equiv$ Challenge as a function of cost

$T \equiv$ fundamental constant of costs. It resides in the complex plane. Its Real part is usually orders on magnitude higher than its Imaginary part.

$OP \equiv$ Opportunity as a function of time

$W \equiv$ fundamental constant of time. It resides in the super complex plane. This behavior of this constant variable leads to confusion especially when considering the adage “time is money”.

Further confusion is eminent when considering the Challenge to be a function of time and Opportunity as a function of cost. Thus, an analytical solution to the equations is impossible.

In practice, for most of us, the opportunity is a manifestation of the challenge. For the rest of us the Challenge is a manifestation of the Opportunity.

Which Harsh environment?

Combustion Turbines and Generators used in power production:

- High pressures
- High temperatures
- Contaminants
- Rotating
- 1300 MW
- 27 kV
- Hydrogen atmosphere

Why Fiber Optics?

- All dielectric material
- Intrinsically safe
- Passive
- Low cost (relatively)

Τηλεφόλκωσιν τῆς βαχικῆς τῆς ροομχανῆς σῆς τῆς

Case Study: Generator Endwinding Vibration



Case Study: Generator Endwinding Vibration

Play video

STA_Core_Animation.mov



Case Study: Generator Endwinding Vibration



Case Study: Generator Endwinding Vibration

Play video

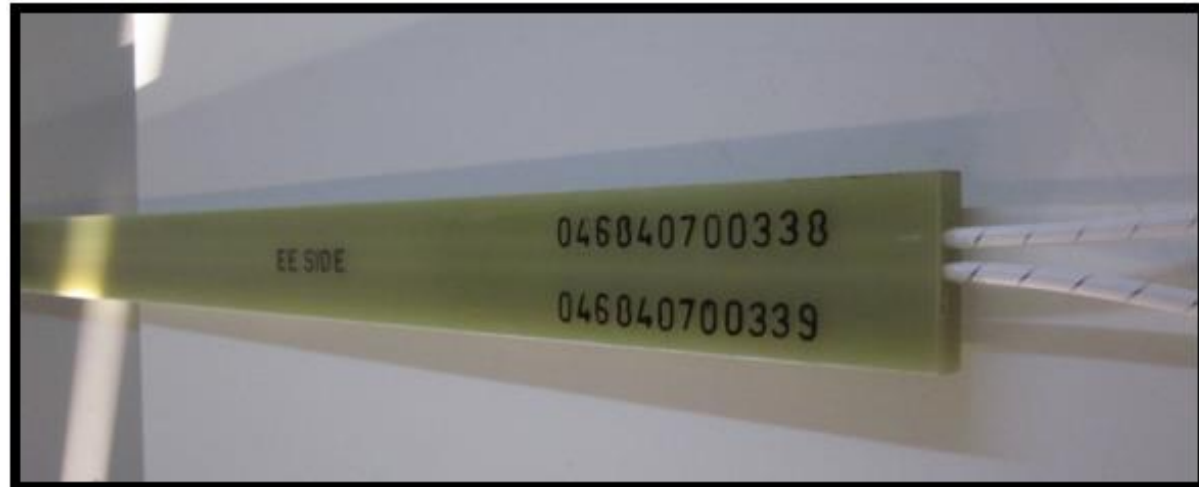
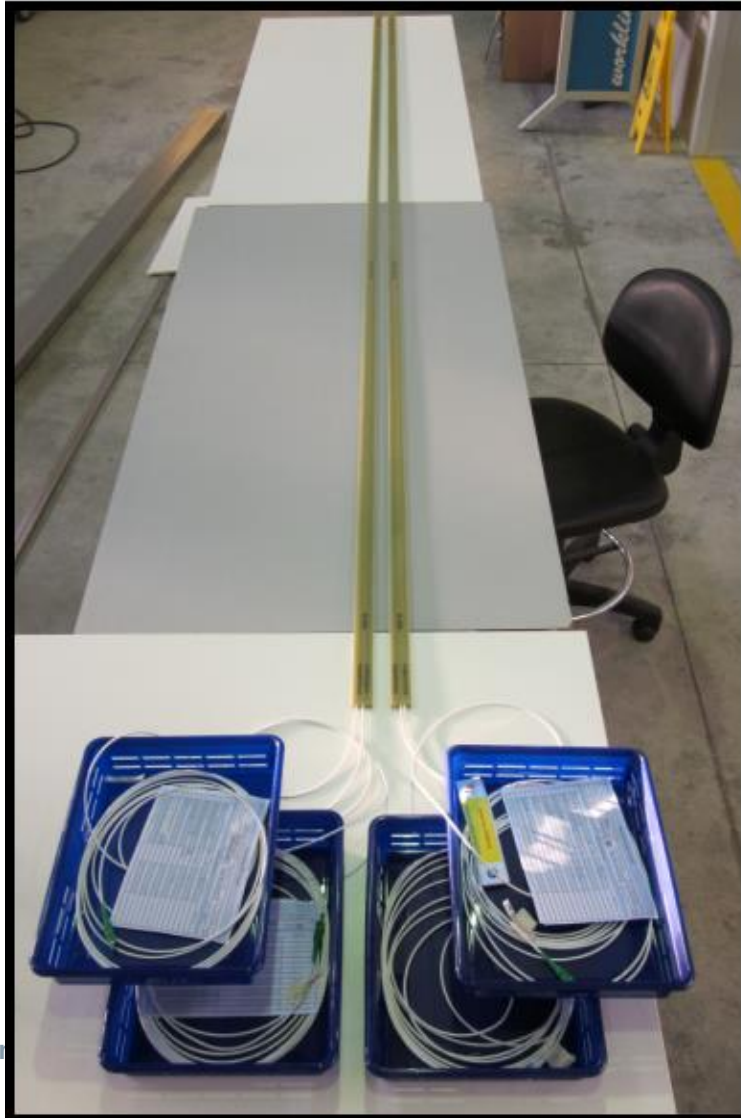
Generator_Endwindings-2.mpg



Case Study: Generator Endwinding Vibration Failures

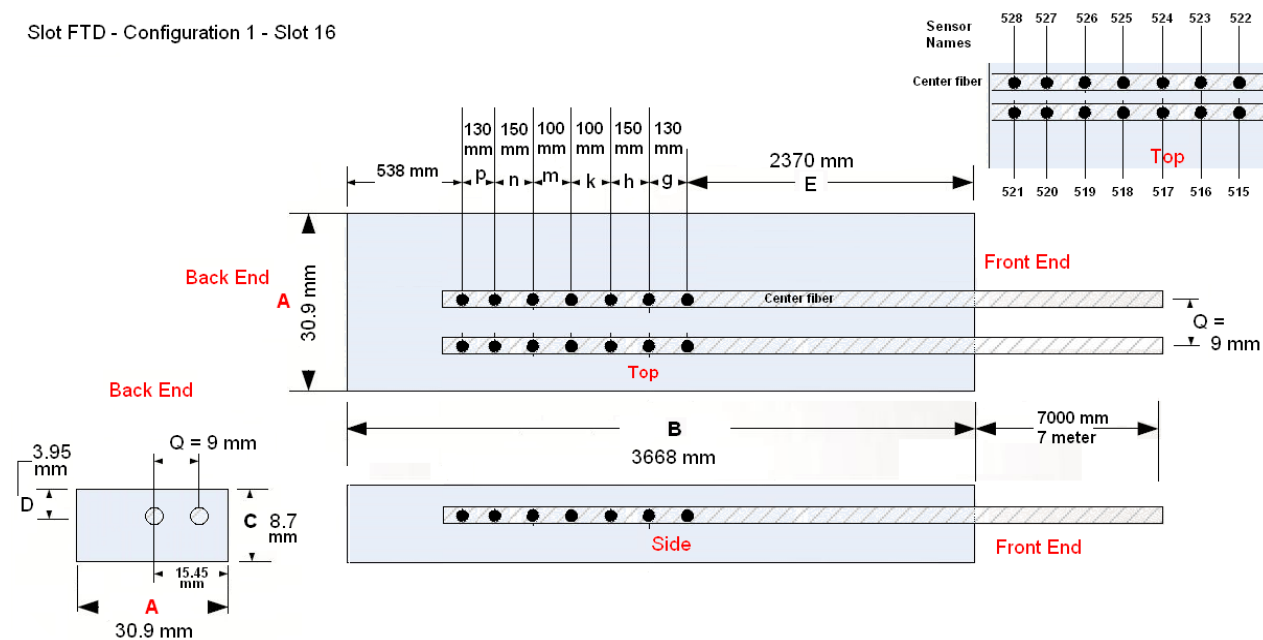


Case Study: Generator Stator Slot Temperature

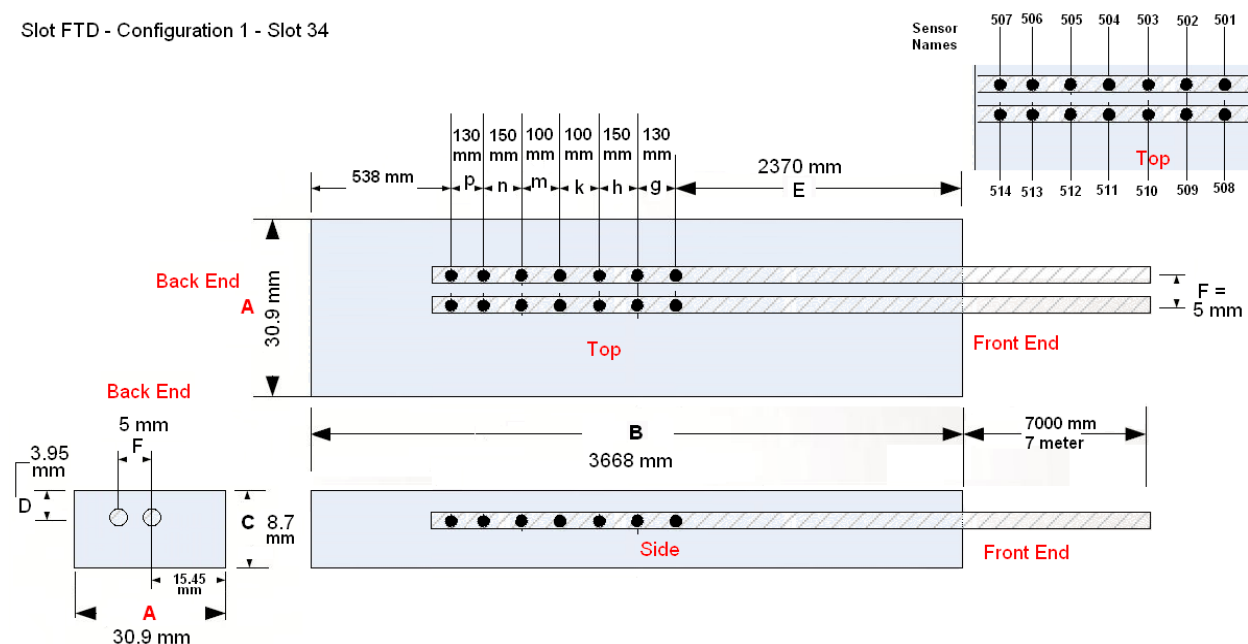


Case Study: Generator Stator Slot Temperature

Slot FTD - Configuration 1 - Slot 16



Slot FTD - Configuration 1 - Slot 34

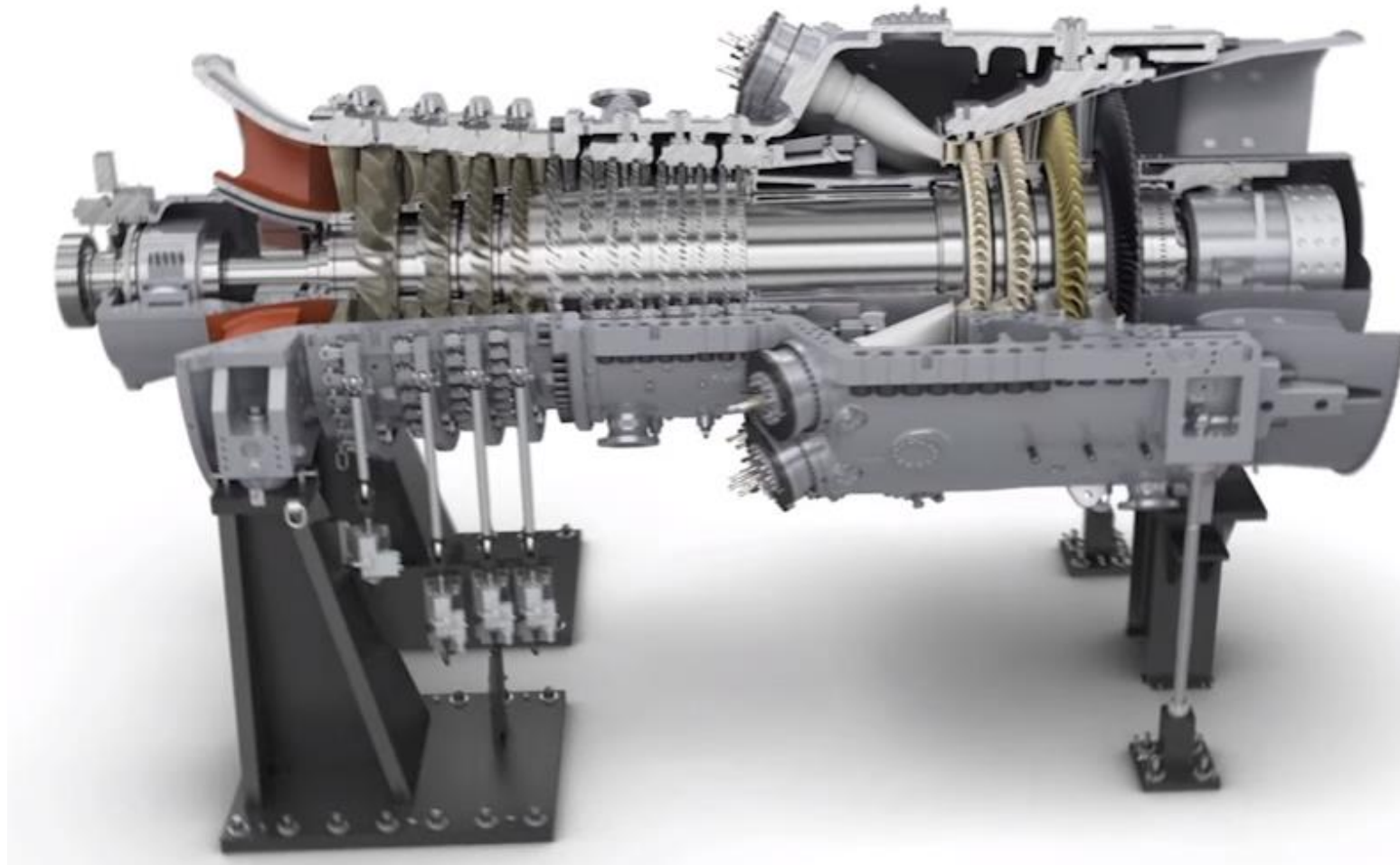


Case Study: Gas Turbine Compressor Wear

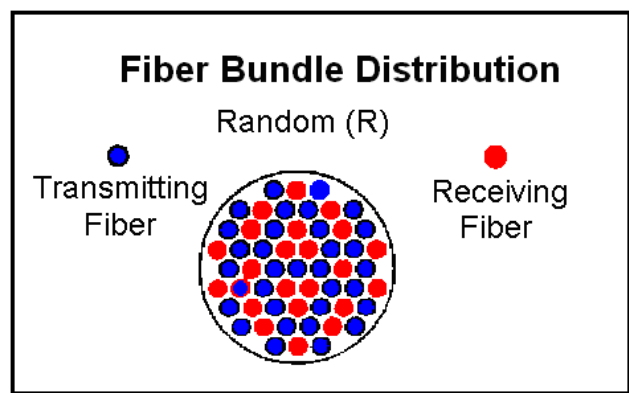
Play videos

Section1_Feature6.mov

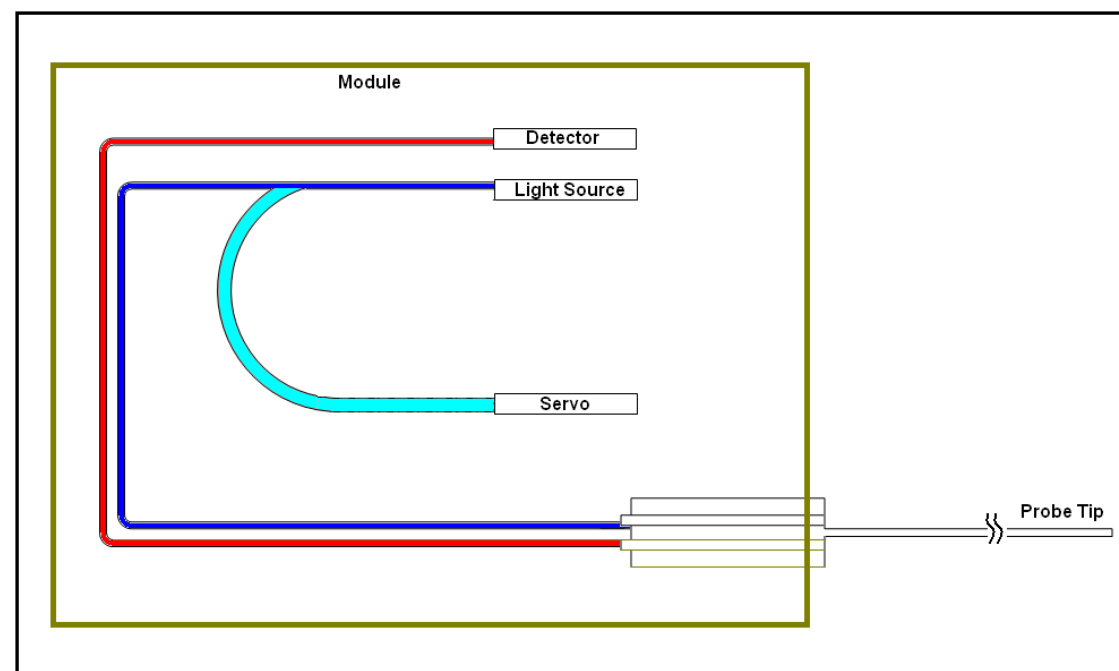
Section5_Feature3.mov



Case Study: Gas Turbine Compressor Wear

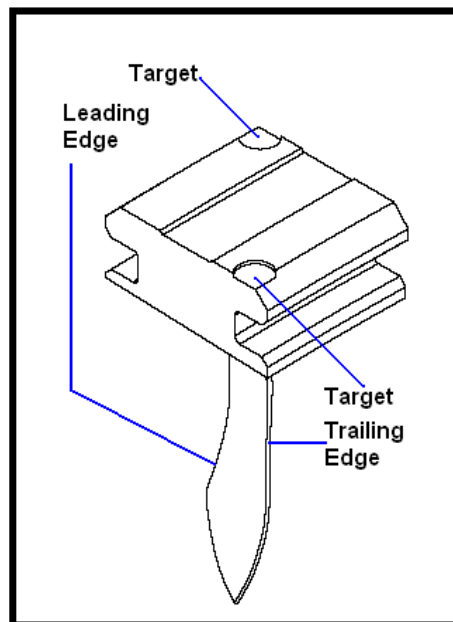


Fiber bundle configuration at the probe tip.

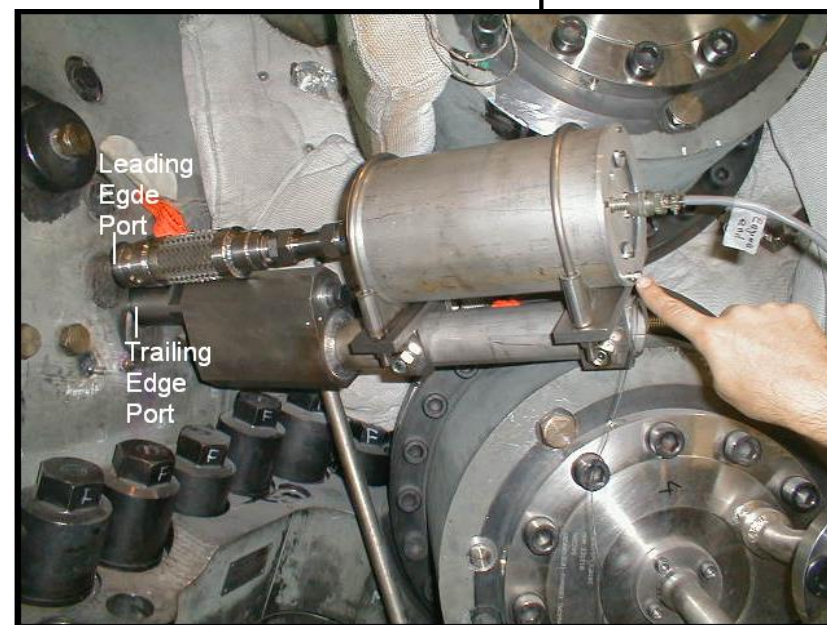
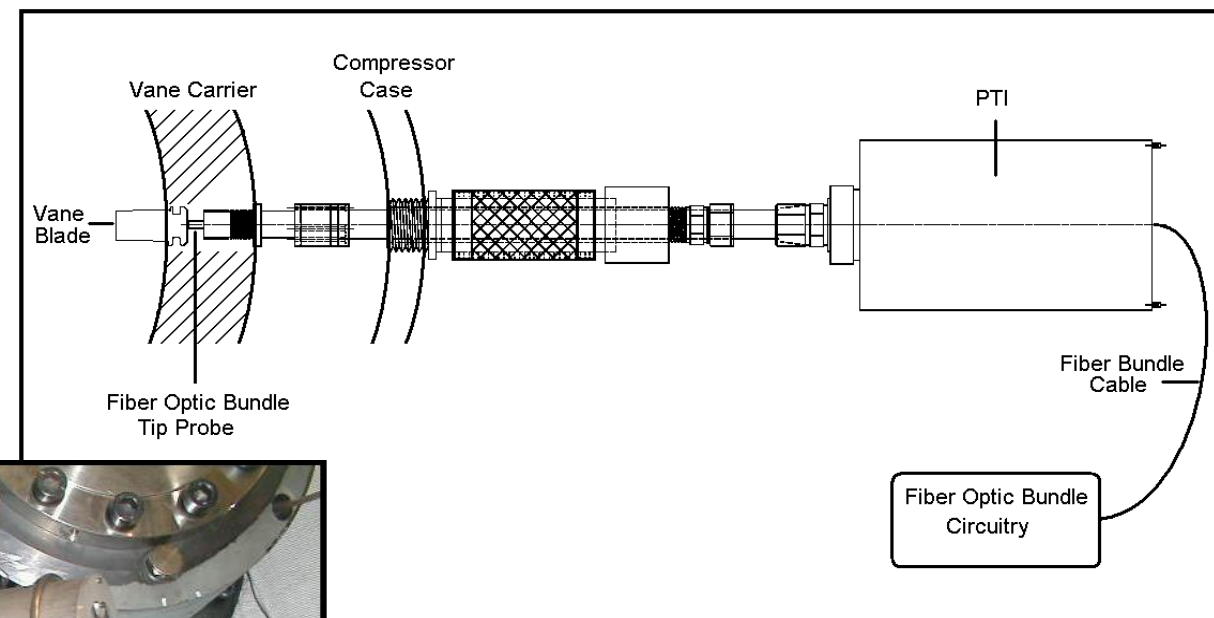


Fiber bundle probe and module showing the bifurcation, servo, detector, and light source connections.

Case Study: Gas Turbine Compressor Wear

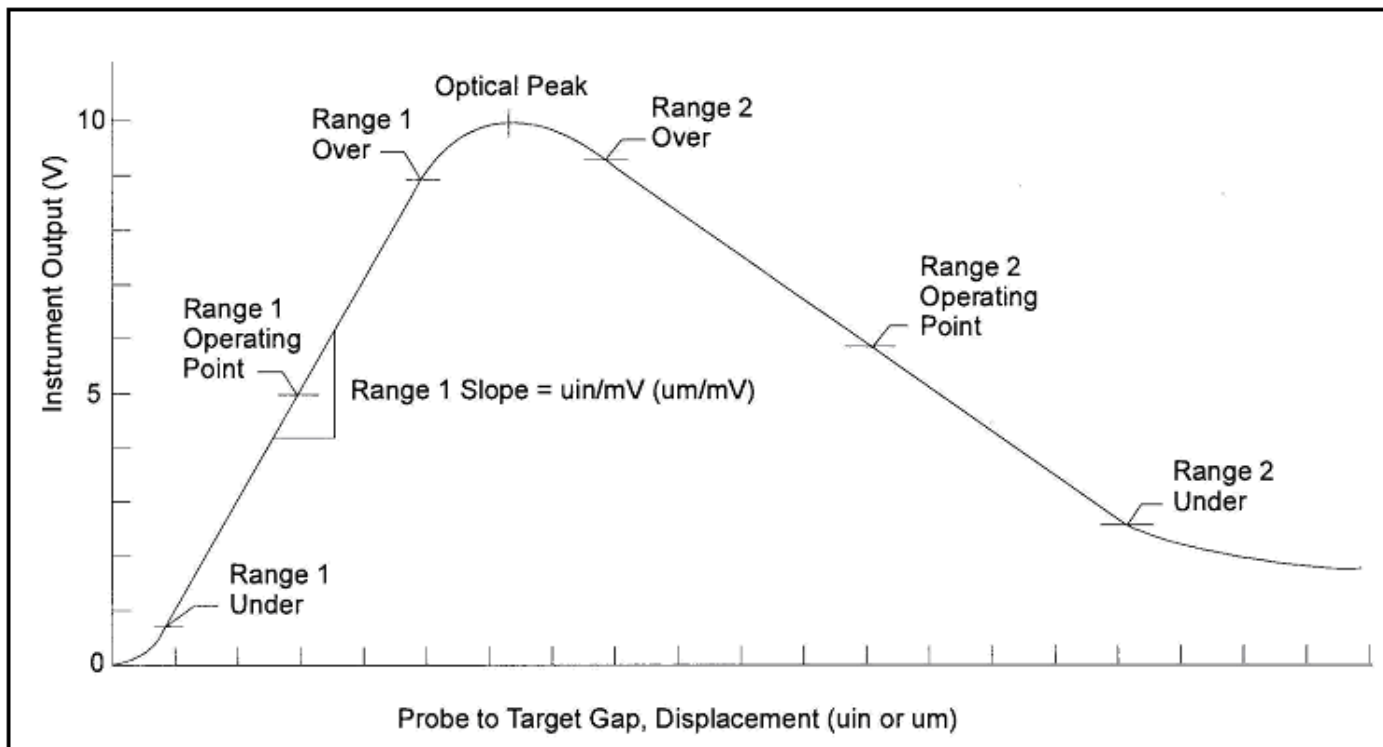


Aspect of target vane showing optical target location relative to LE and TE.

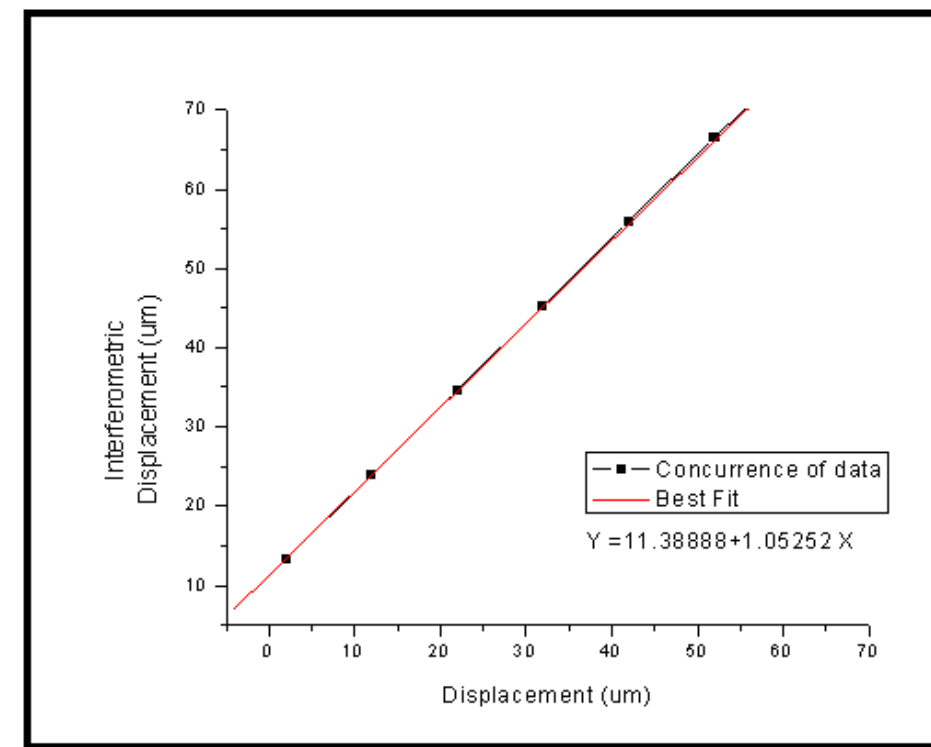


Aspect of the monitoring system during operation. The fiber optic probe is integrated with the PTI and the monitor is then fixed onto the engine.

Case Study: Gas Turbine Compressor Wear



Typical Output VS Displacement curve for the sensing system.

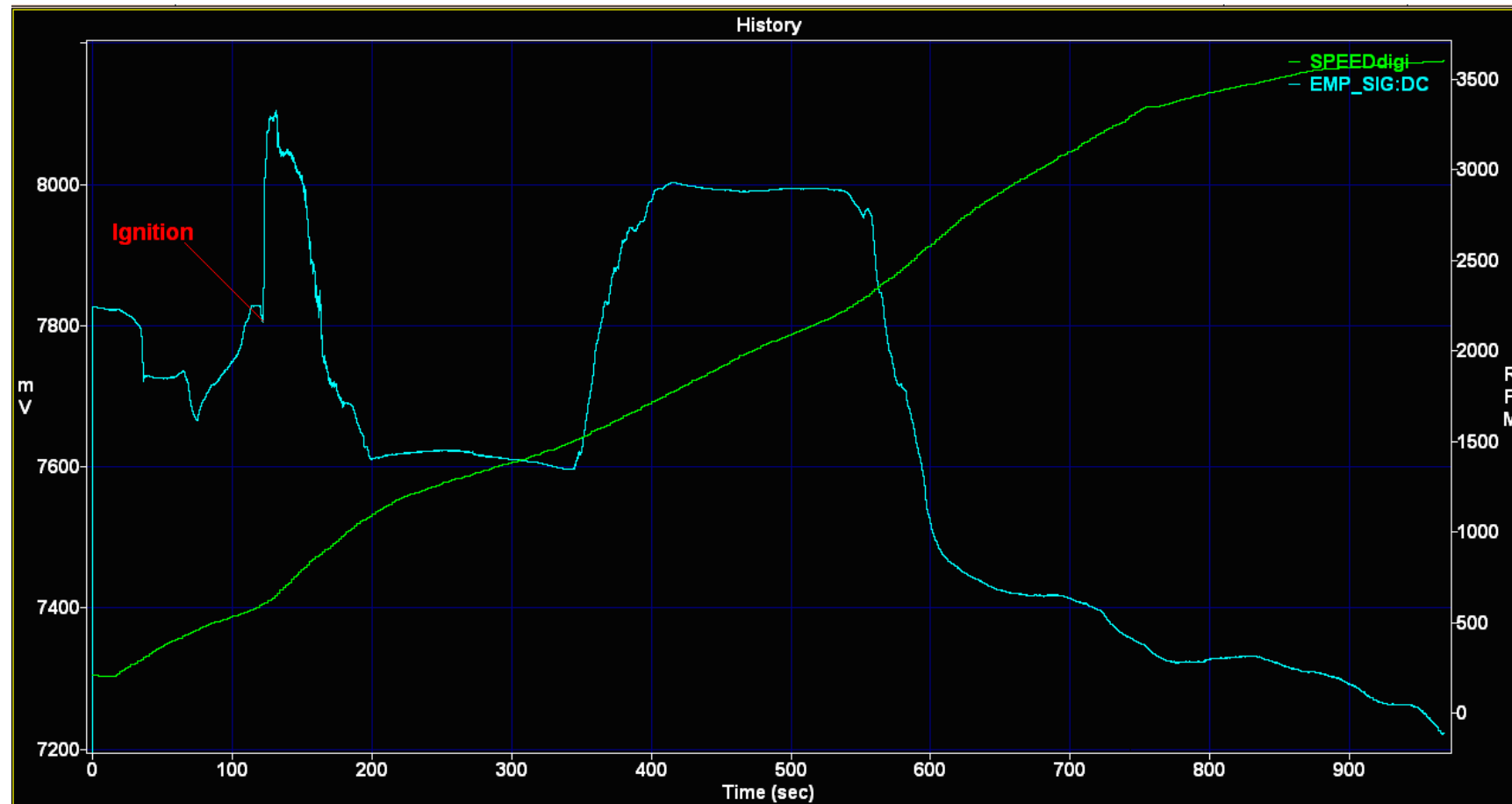


Concurrence of data between interferometric measurement and Fiber Bundle probe.

Case Study: Gas Turbine Compressor Wear

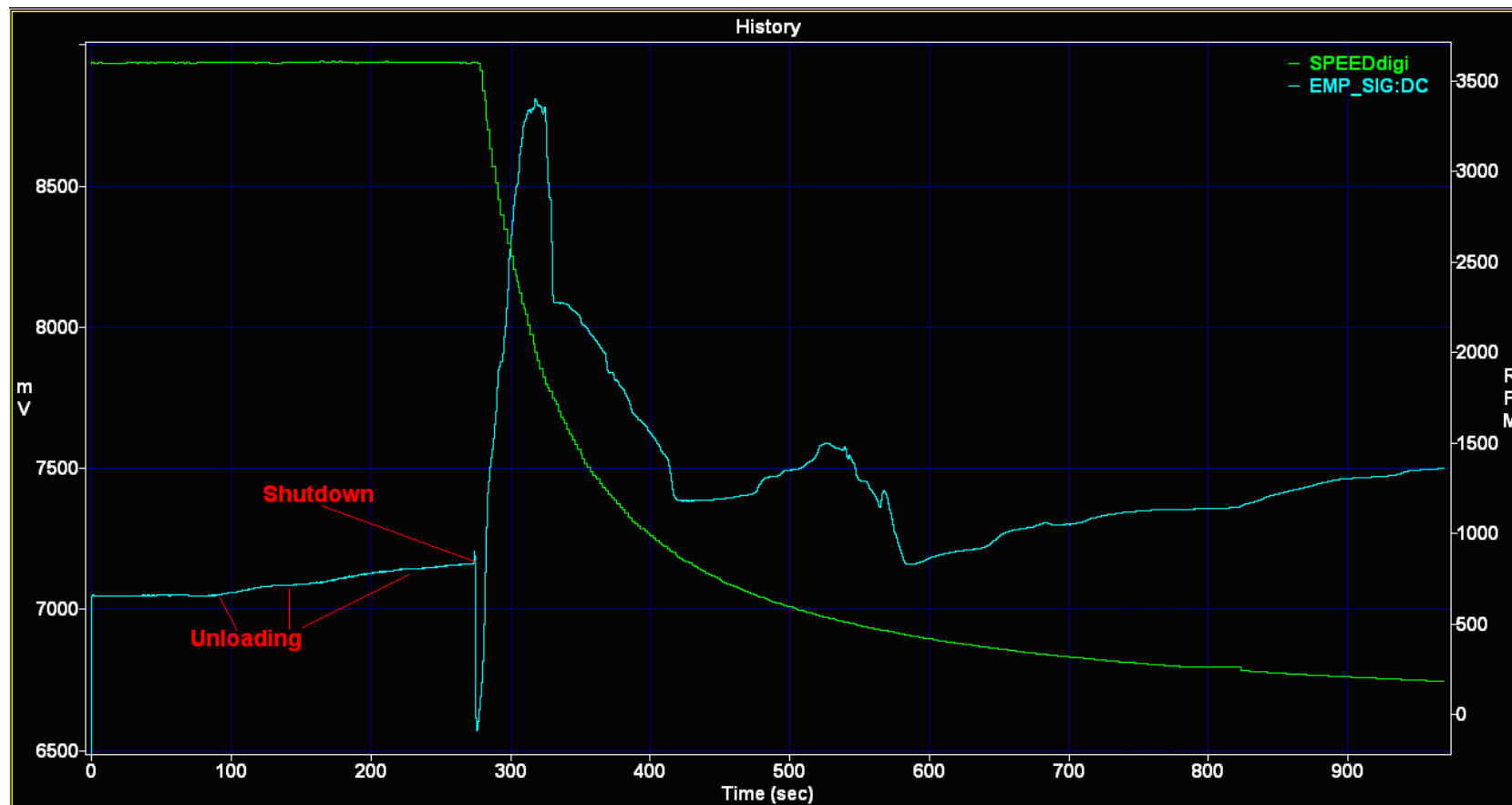


Test vane TE; Displacement and engine RPM versus time; Startup to FSNL.



Case Study: Gas Turbine Compressor Wear

Test vane TE displacement; Shutdown
from FSNL. Total displacement
0.7435 mm.



Obrigado



Obrigado

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