A NEW SENSOR TECHNOLOGY FOR LOAD MONITORING "LOADWATCH"

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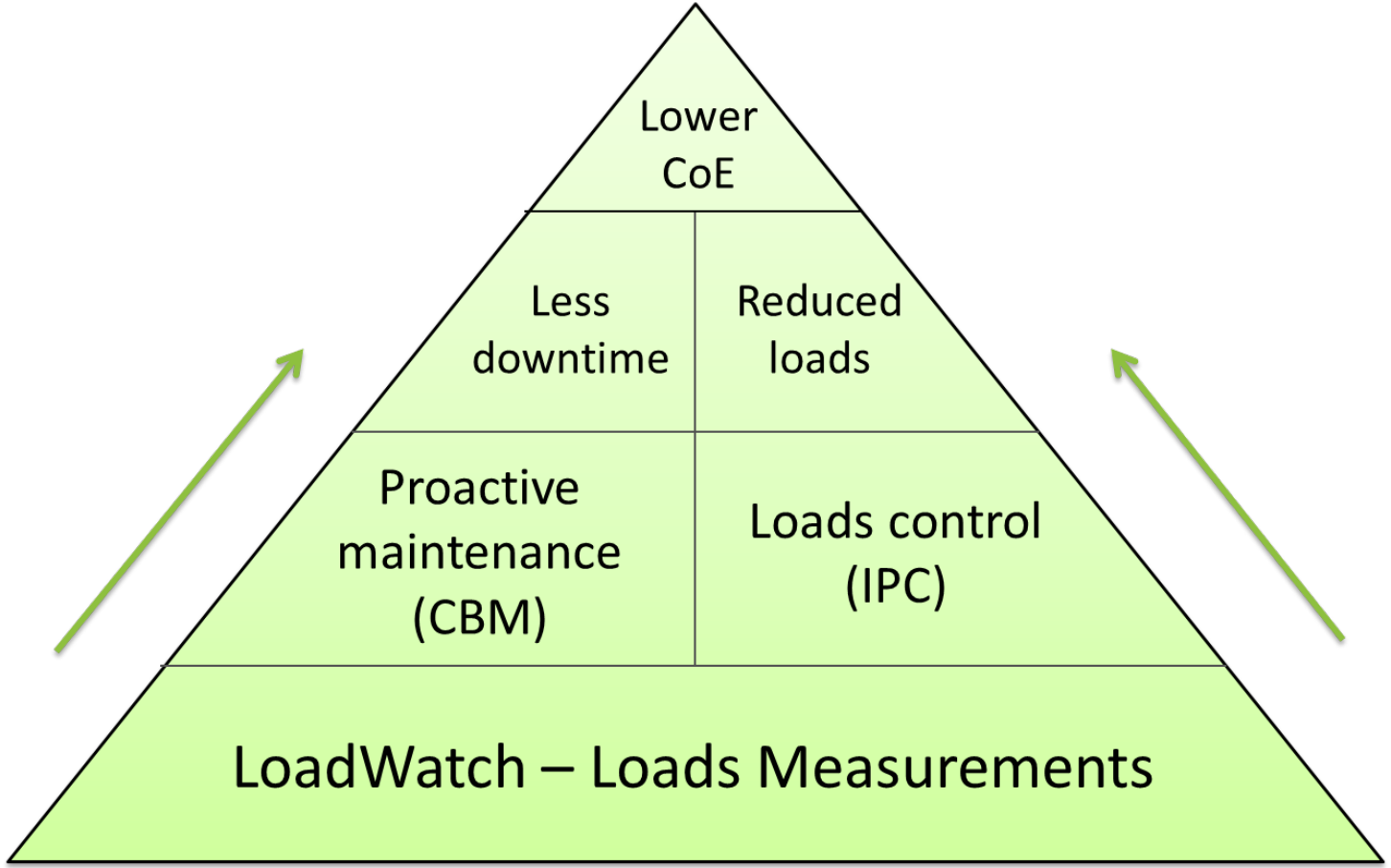
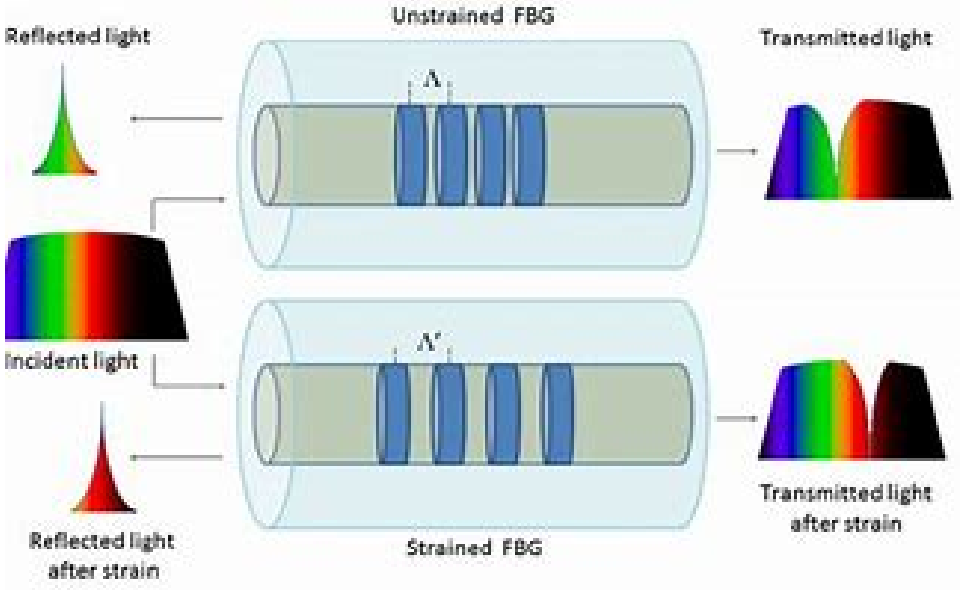
CONTENT

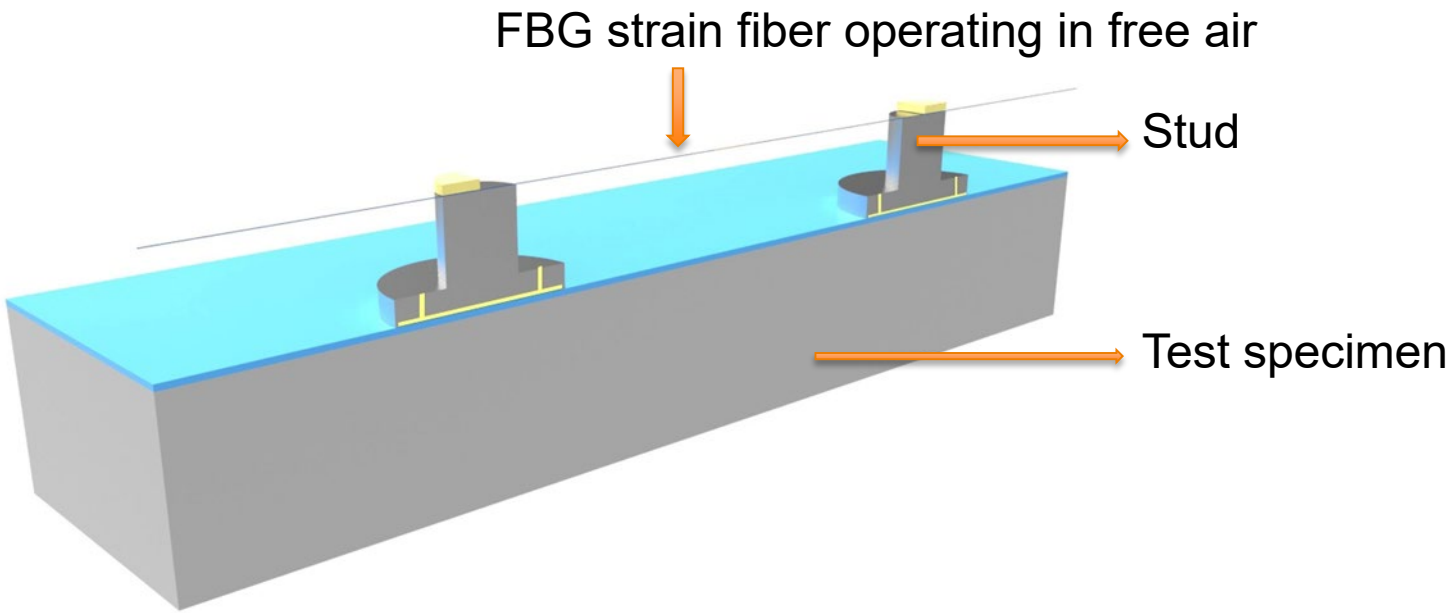
- Load sensing by optical fiber technology
- Introduction of LoadWatch sensor
- Measurement campaign in 2.5 MW research turbine
- Adverse effect of glue/encapsulants on strain measurements
- Concluding remarks


Lower CoE
Less downtime
Reduced loads
Proactive maintenance (CBM)
Loads control (IPC)
LoadWatch – Loads Measurements

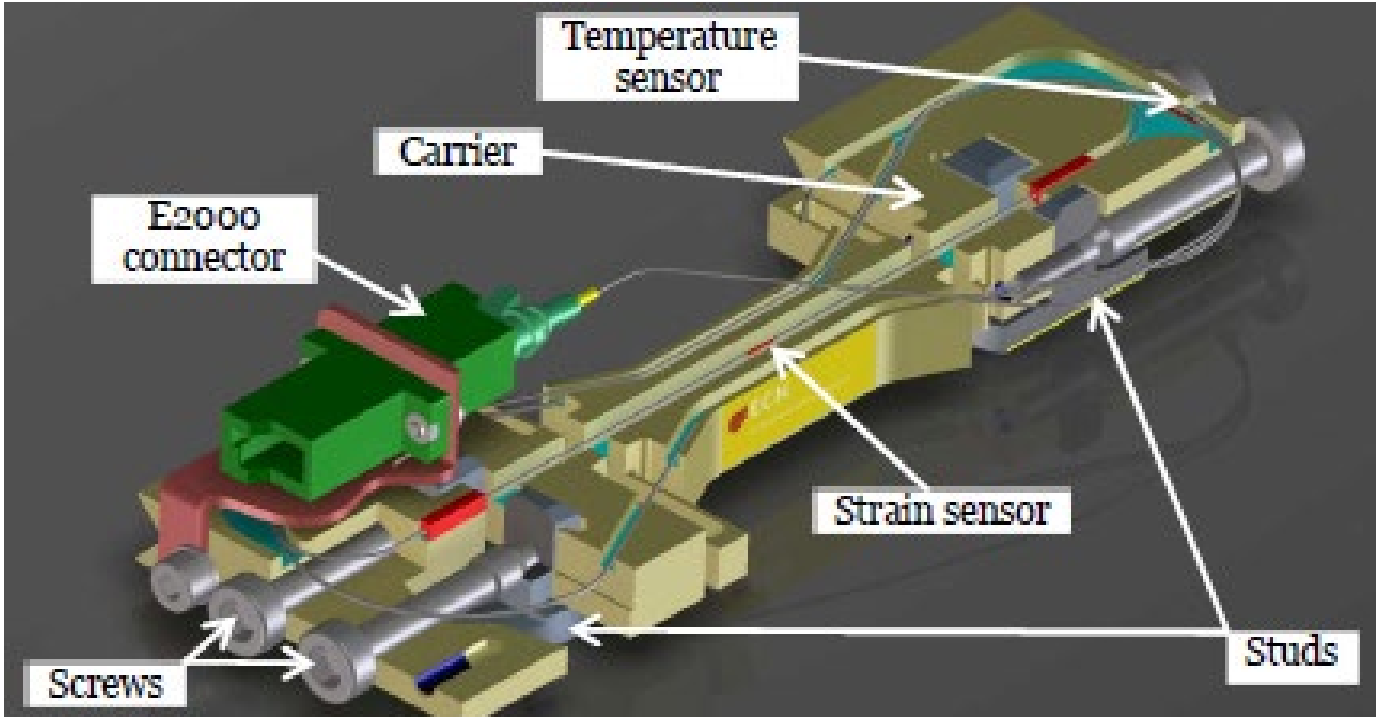
OPTICAL FIBER BRAGG GRATING



LOADWATCH PRINCIPLE

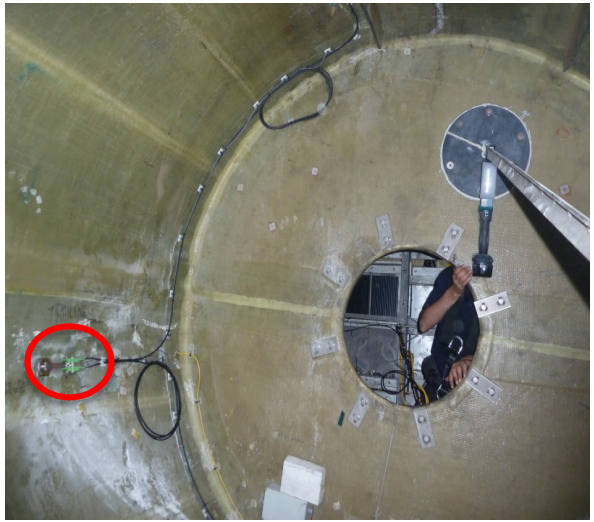


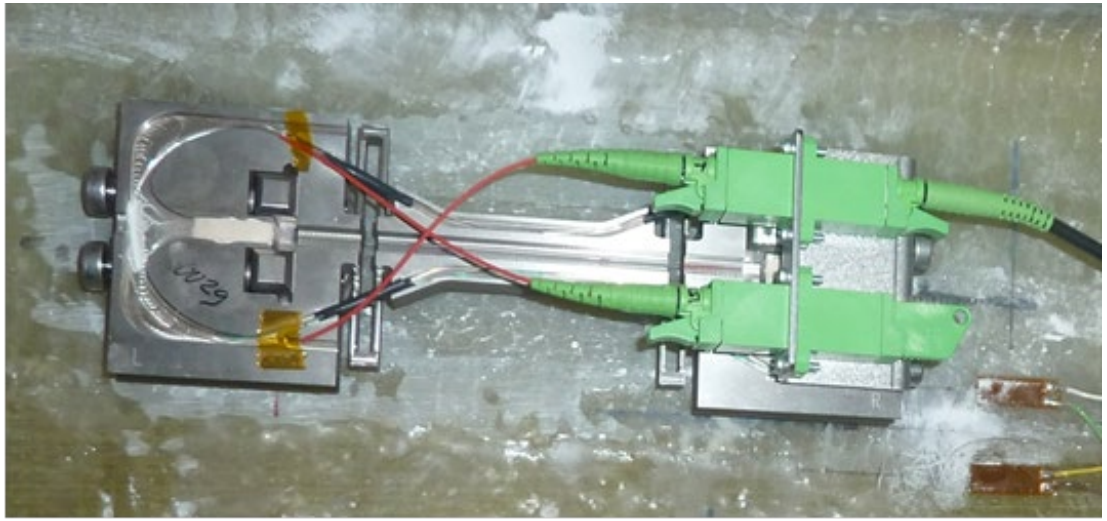
LOADWATCH DESIGN (PATENT)



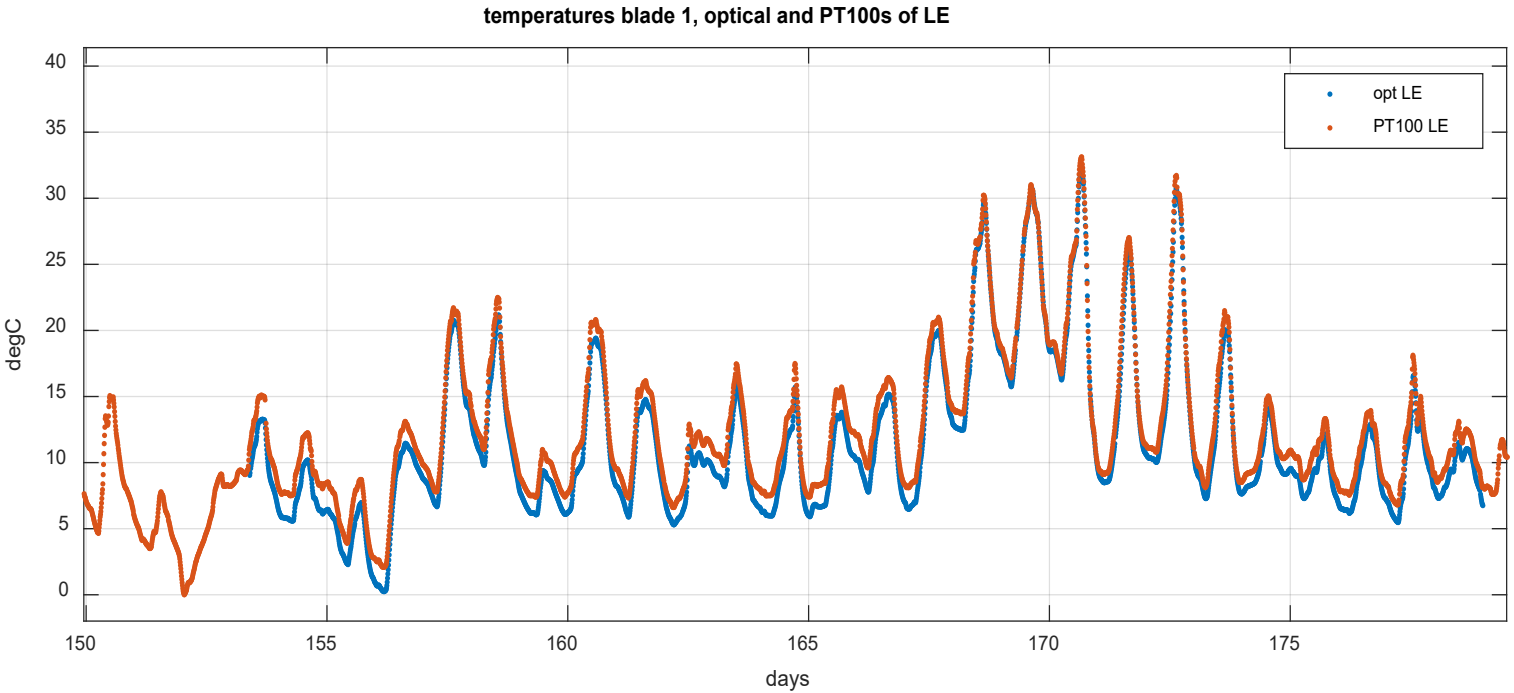
FIELD DEMONSTRATION
2.5 MW R&D TURBINE, SPRING 2018

SENSOR INSTALLATION IN BLADE ROOT AREA

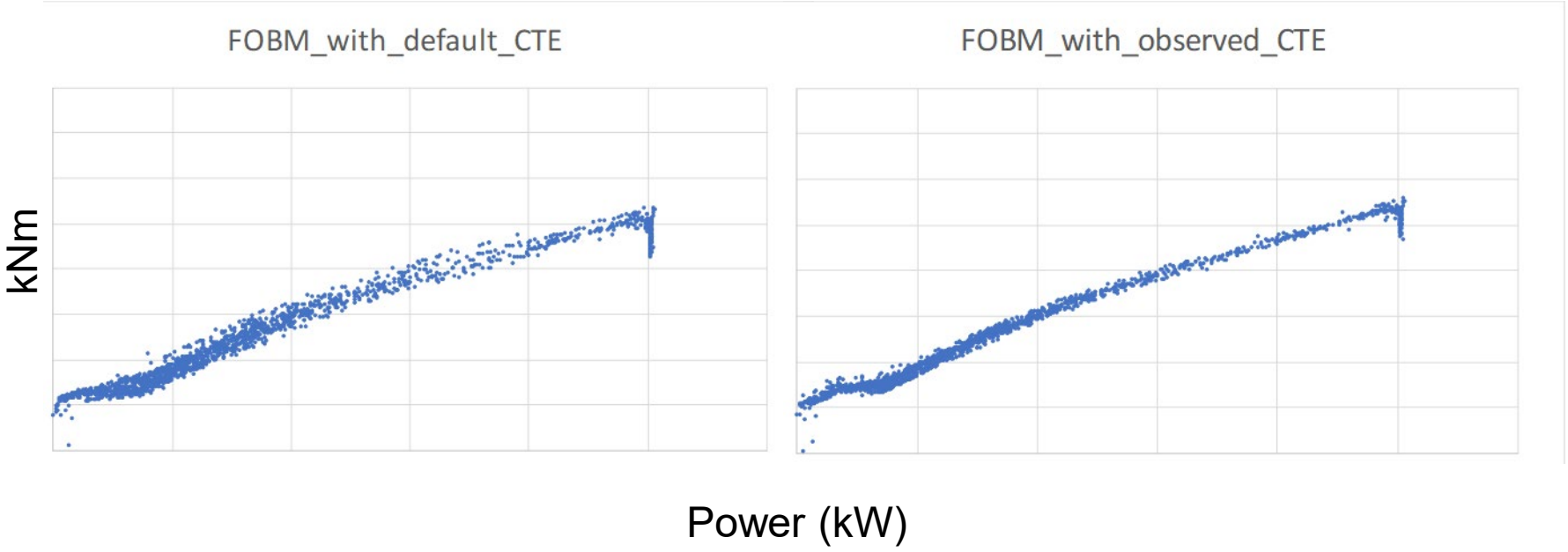




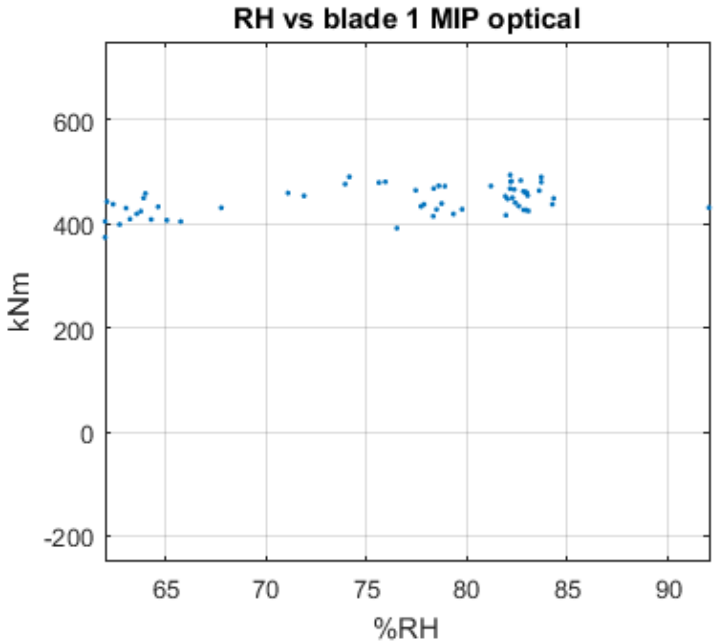
TEMPERATURE BY LOADWATCH & PT100

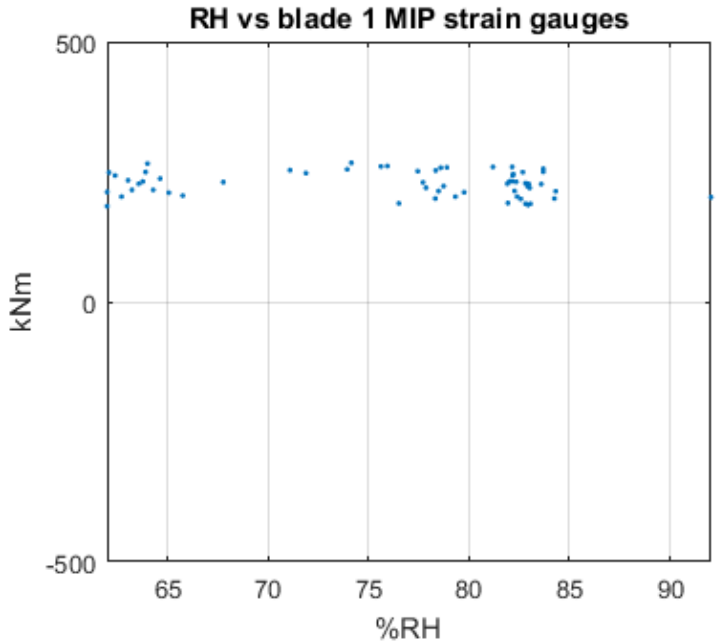


EFFECT OF THERMAL EXPANSION COEFFICIENT (CTE) OF BLADE

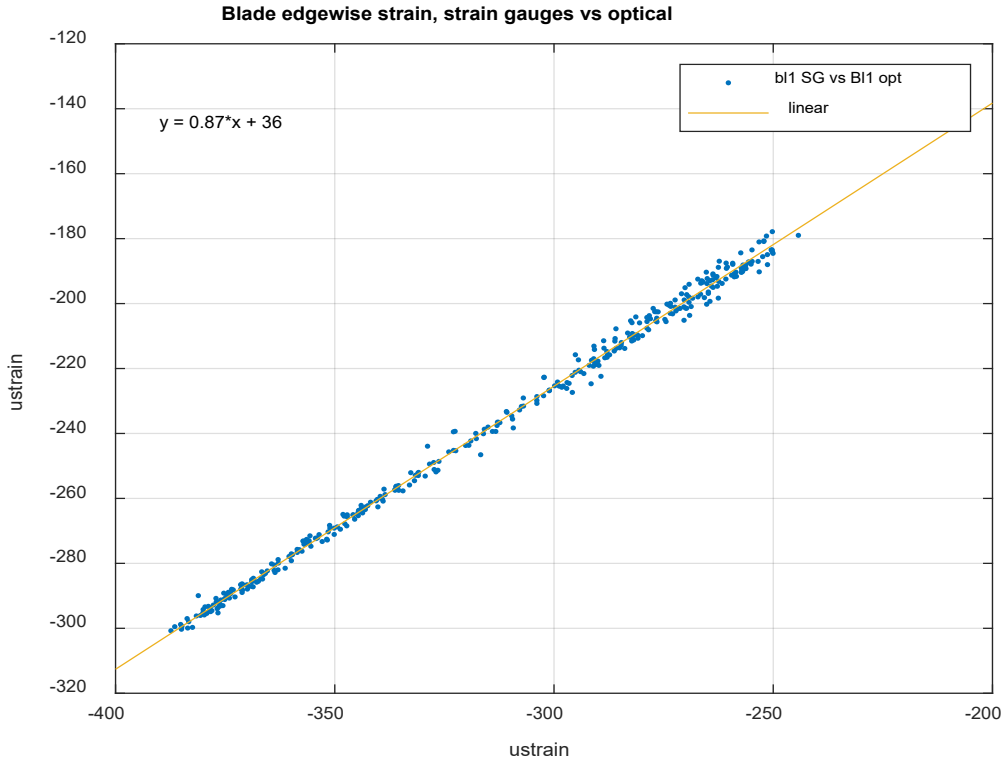


EFFECT OF RELATIVE HUMIDITY
(LOADWATCH AND CU-STRAIN)



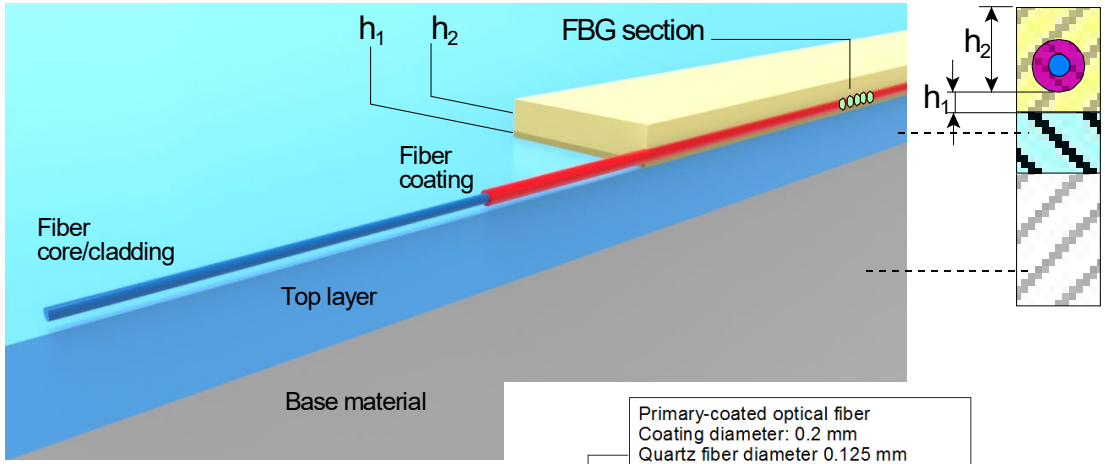


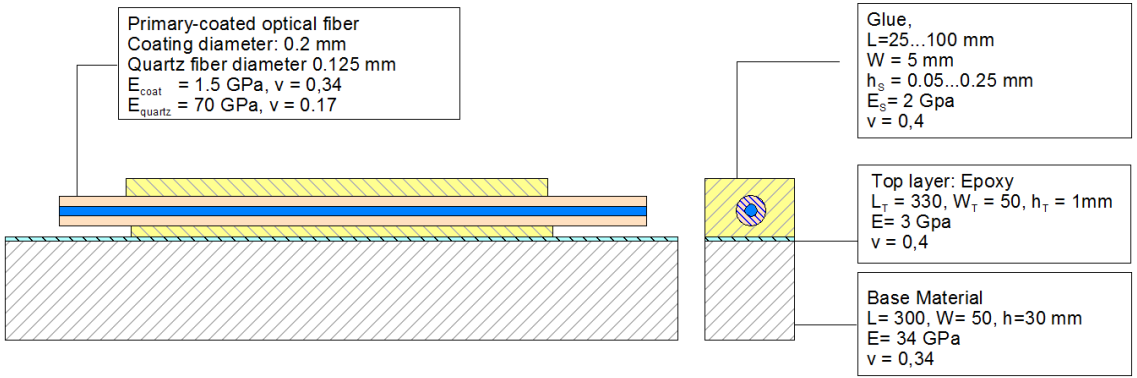
COMPARISON LOADWATCH & COPPER STRAIN GAUGE



ADVERSE EFFECT OF GLUE LAYER ON ACCURACY

CASE : DIRECTLY BONDED FBG FIBER ON BLADE





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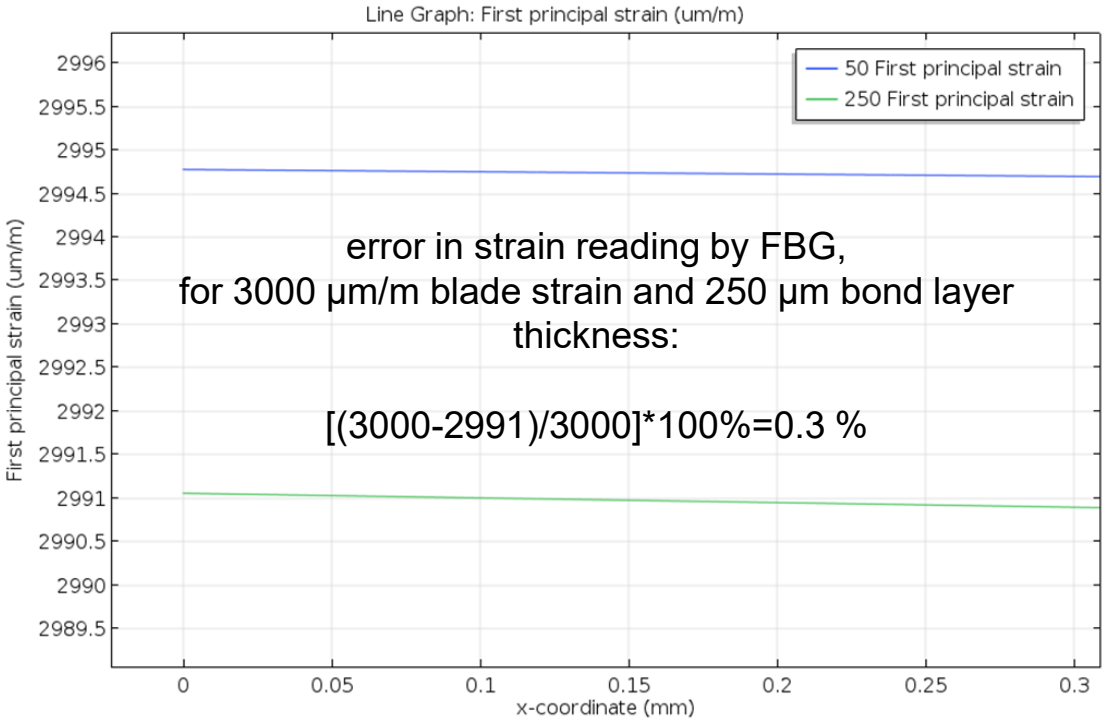
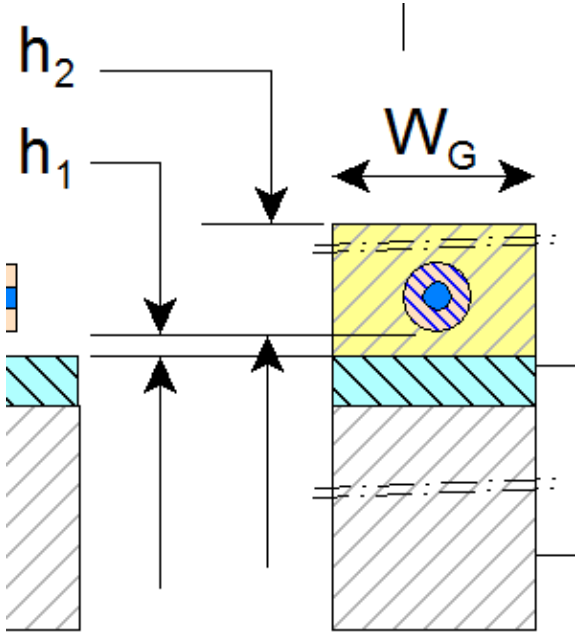


error in strain reading by FBG,
for 3000 μm/m blade strain and 250 μm bond layer thickness:

[(3000-2991)/3000]*100%=0.3 %



MAIN ACHIEVEMENTS LOADWATCH SENSOR DEVELOPMENT

Direct measurement of strain through working principle of pair of studs (patented)

In-situ compensation for temperature, humidity and thermal expansion of test material

Extensive field demonstration in 2.5 & 5 MW wind turbines

Good comparison with copper-strain gauges and FBG-pads

High accuracy since not based on gluing and encapsulated FBG fiber

Competitive through improved sensor design, manufacturing process and applicability

Evaluation load measurement technologies

	Cu-strain gauge	FBG-Pad	FBG-LoadWatch
Ease of installation	x/√	x/√	√
Load sensing over uneven surfaces	x	x	√
EMC/RFI immunity	x	√	√
Load sensing over inhomogeneous strained surfaces (& varying lengths)	x	x	√
One sensor for multiple spot load measurements	x	x	√

CONCLUDING REMARKS

LoadWatch sensor advantages arise from:

- Use of permanent studs on the test specimen
- FBG strain & temperature fibers operating in free air (i.e., not glued on surface/not encapsulated)

Commercialization of FOBM is foreseen in Spring 2020

If you are interested to test FOBM, please contact: ton.veltkamp@tno.nl

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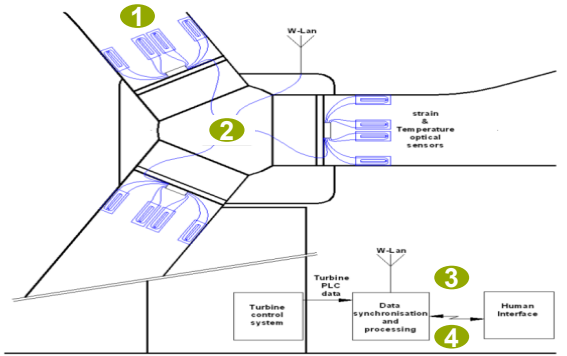
Haliade-X 12 MW
Courtesy GE Renewable Energy

ONE POSSIBLE SET-UP OF FOBM



This typical measurement system consists of:

-12 FOBM sensors

-Interrogator

-PC with Wi-Fi

-Proprietary software

FOBM sensor

- Patented sensor assembly: 4 strain and 4 temperature sensors per blade

Interrogator

- The interrogator reads out the 12 fibre optic sensors and generates measurement data. These are commercially available. ECN has successfully used interrogators from different suppliers.

PC with Wi-Fi

- This computer gathers the strain data from the interrogator and PLC data from the wind turbine and translates this into load data.

ECN's proprietary software

- Sophisticated software developed by ECN for data processing, integration with turbine's SCADA data to generate load statistics for other components than the blades and to provide dashboard and statistics to operator for O&M optimization.