

THE WEBINAR WILL BE STARTING SHORTLY

3 MUST-HAVES FOR RELIABLE MEASUREMENTS

Cristina Barbosa



Advanced Structural Health Monitoring

3 MUST-HAVES FOR RELIABLE MEASUREMENTS


Cristina Barbosa




Housekeeping - Audio

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Audio Connection ×

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More Options

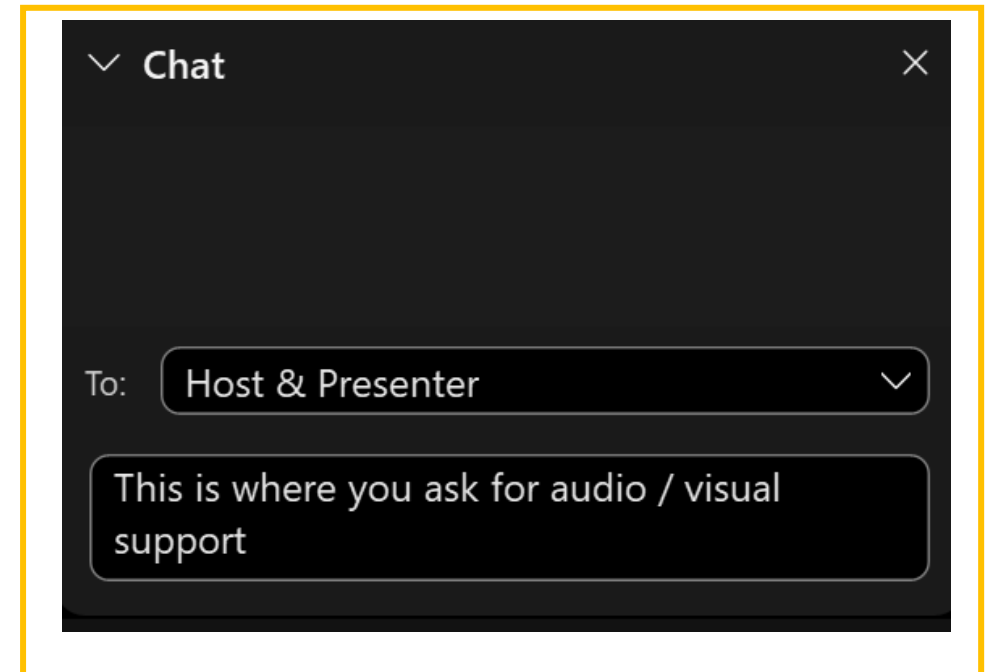
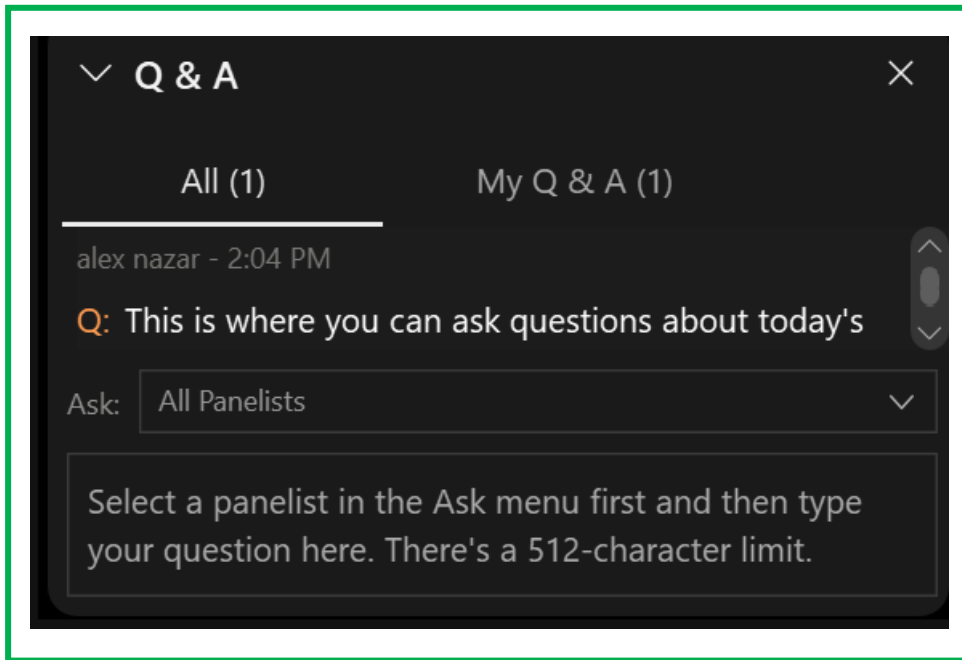
Housekeeping – Asking Questions

Ask the presenter a question:

- Send questions to the presenter via the **Q&A** panel

For issues with WebEx:

- Send messages or questions privately to the webinar host using the **chat** panel.



Introductions – Cristina Barbosa

- ▲ Product Manager, Optical Business
- ▲ Degree in Civil Engineering
- ▲ +15 years of experience in optical measurement solutions within HBK FiberSensing

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Structural Health Monitoring

BENEFITS AND CHALLENGES

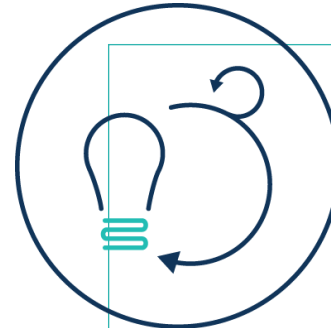


Benefits of Structural Health Monitoring



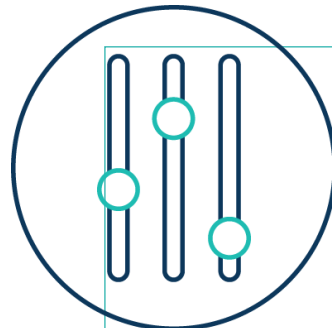
SAFETY

- Ensure safety whilst boosting lifetime
- Detect damage at early stage allowing a timely response



LEARNING

- Continuously observe and retrieve data for understanding, correcting models and improving design



OPTIMIZING

- Plan and perform predictive maintenance
- Confidently try new designs



SAVING

- Reduce on maintenance and insurances
- Reduce downtime for repair
- Reduce accidents

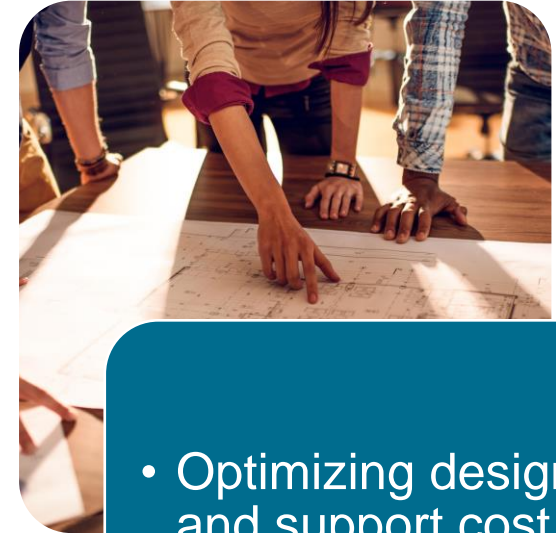
Purposes of Structural Health Monitoring



- Extending lifetime by continuously measure or predicting through fatigue monitoring

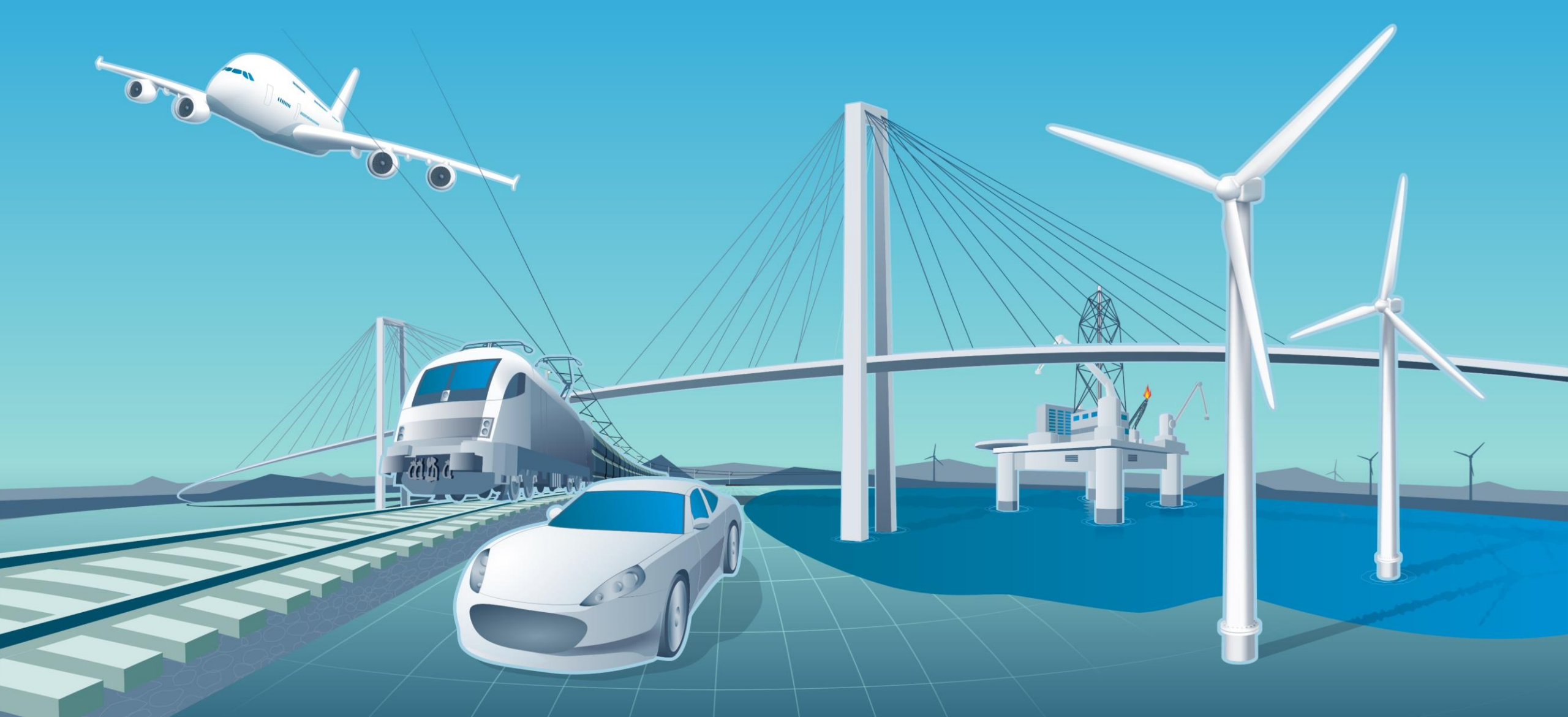


- Improving maintenance and inspection by performing condition-based planning

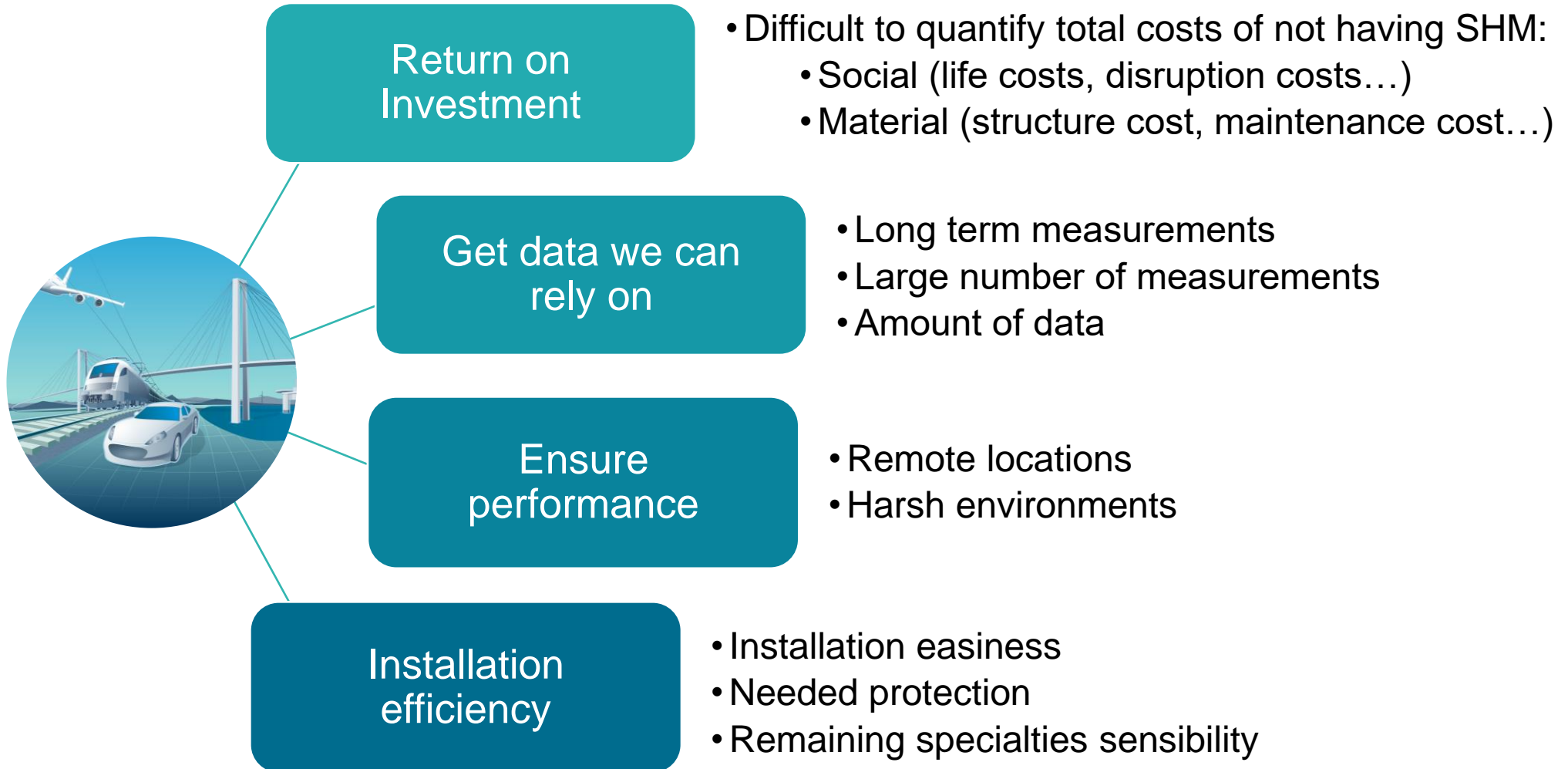


- Optimizing design and support cost effective solutions

Structural Health Monitoring for all structures!



Challenges of Structural Health Monitoring



Commonly Measured Parameters

APPLICATION EXAMPLES FROM
HBK FIBERSENSING



Strain

- Most common measurement
- Effort calculation
 - Moment
 - Shear
 - Torsion
- Principal stress



Strain

FS70PKF

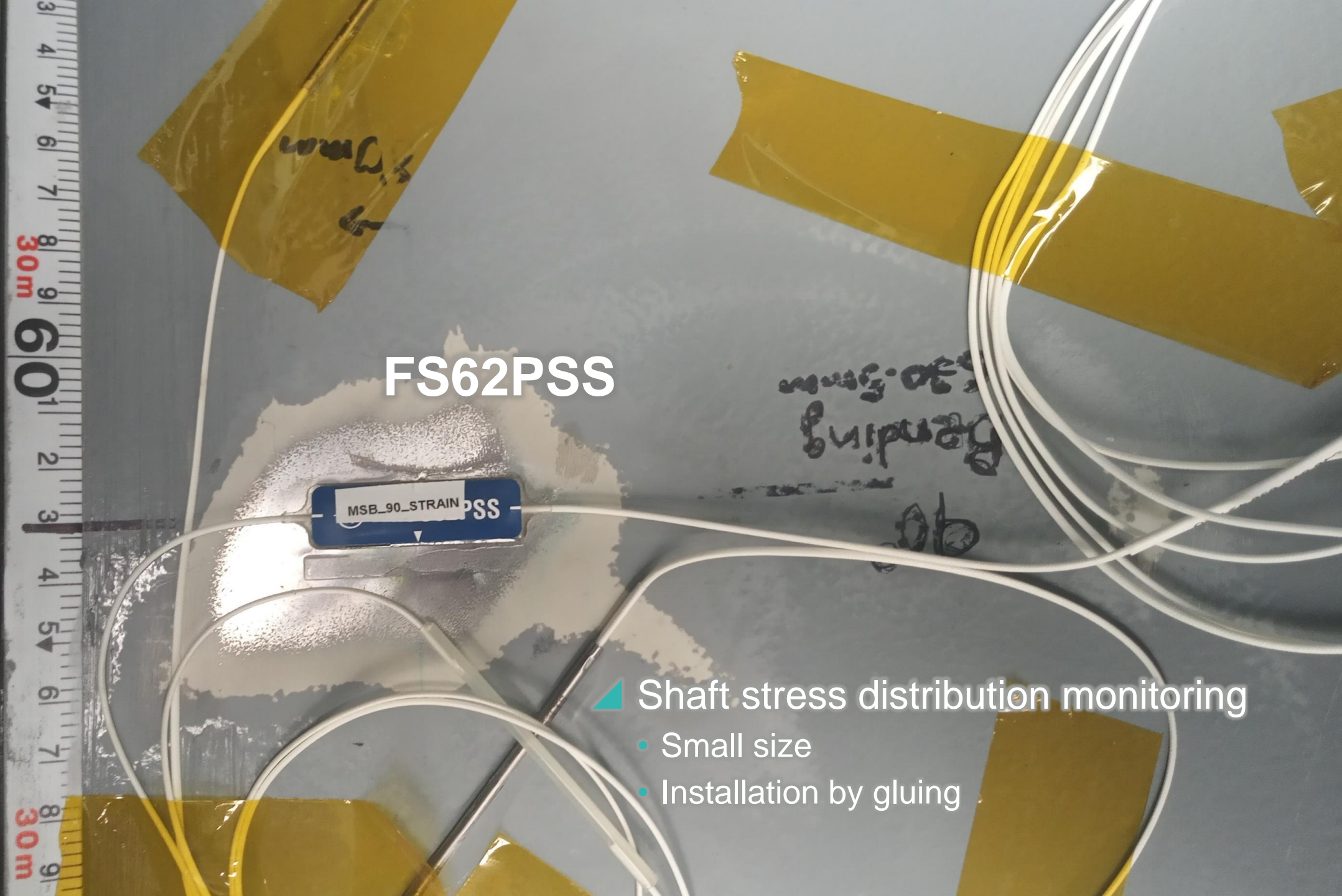
- ▲ Bending strain at blade root
 - Several FBG in series
 - Rugged coating
 - Installation by gluing

Strain

FS70FBG

- ▲ Longitudinal strain along a pipe
- Several FBG in series
- Small size
- Customized distances
- Installation by gluing
- Also fitted for embedding in composite structures

Strain



FS62PSS

- ▲ Shaft stress distribution monitoring
 - Small size
 - Installation by gluing

Strain

FS62CSS

▲ Ship hull stress analysis

- Rugged sensors
- Long gauge length for inhomogeneous materials
- Installation by gluing

Strain

FS62WSS

- ▶ Penstock strain monitoring
 - Rugged sensors
 - Resistant to water
 - Installation by spotwelding

Strain

FS62RSS Embedded

- ▲ Bridge deck strain measurement in critical sections
 - Rugged sensors
 - To be embedded on concrete

Strain

FS62RSS Surface Mount

- ▲ Strain and sub-millimetric displacements measurements
 - Rugged sensors
 - To be bolted
 - Installation on existing structures
 - IP68

Strain

- ▲ Ship hull offshore monitoring
 - Unknown principal stress directions
 - One sensor – 3 measuring directions
 - Save installation time
 - Save costs
 - Save space
 - Installation by gluing

FS62PSR



Strain

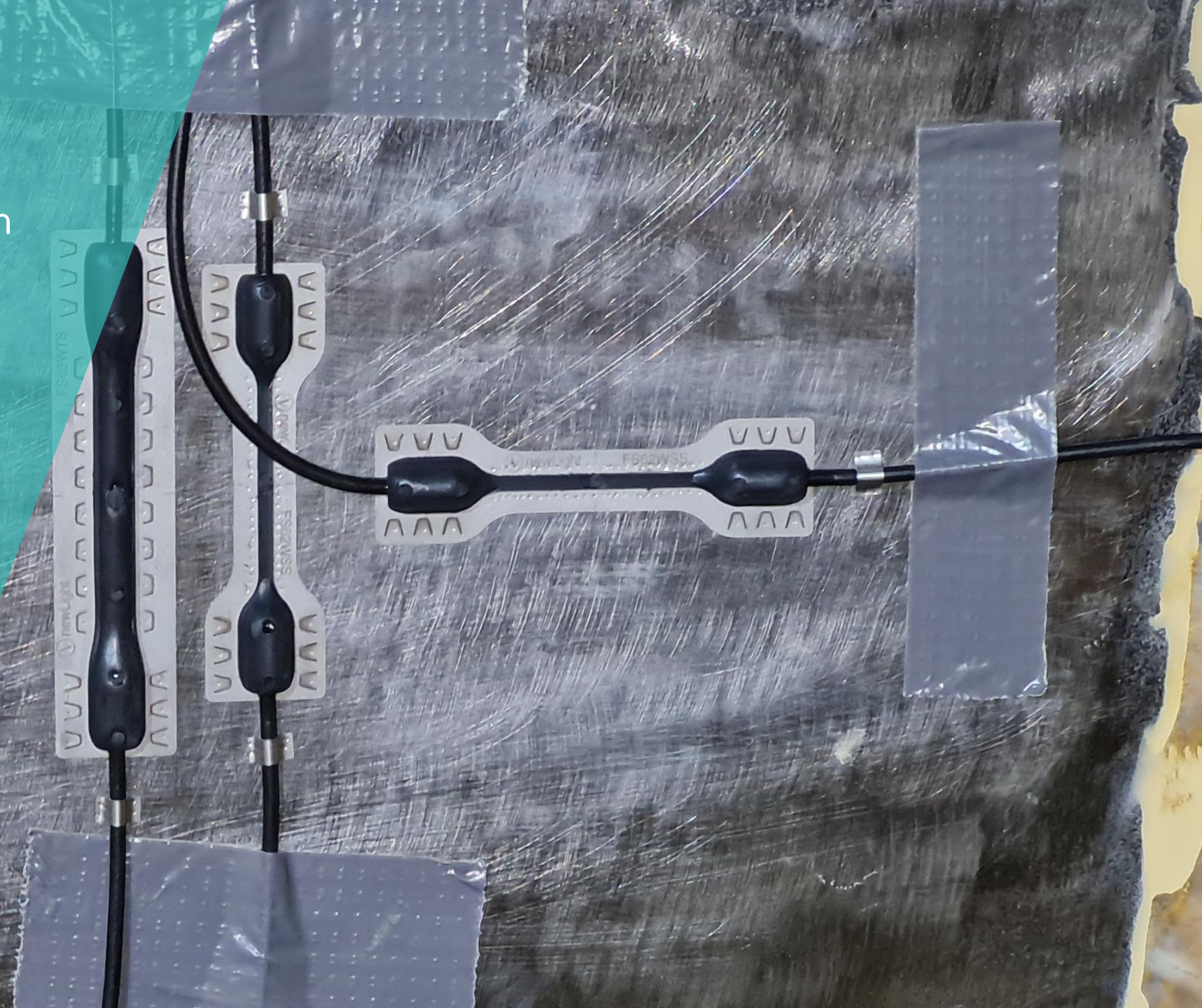
▲ Stress analysis with strain rosettes

- Unknown principal stress directions
- One sensor – 3 measuring directions
 - Save installation time
 - Save costs
 - Save space
- Installation by spotwelding

FS62WSR

Temperature

- Temperature compensation
- Thermal performance
- Temperature control



Temperature

FS63WTS

- ▲ Temperature compensation
- Multipurpose in-series connection
- Compatible format with strain sensors
 - Laboratory
 - Weldable
 - Composite
 - Rugged

Temperature

FS63RTS

▲ Temperature profile for scouring monitoring

- Several sensors in series
 - Both ends accessible for redundancy
- Specified distances
- IP68



Temperature

FS63LTS

- ▲ Temperature gradients over tunnel slab width
- Several sensors in series
- Attached to a stiff rod for installation

Displacement

- Linear relative movements
 - Bridges
 - Walls, slopes
 - Nuclear power plants
 - Wind turbines structure
 -



Displacement

▲ Joint movement

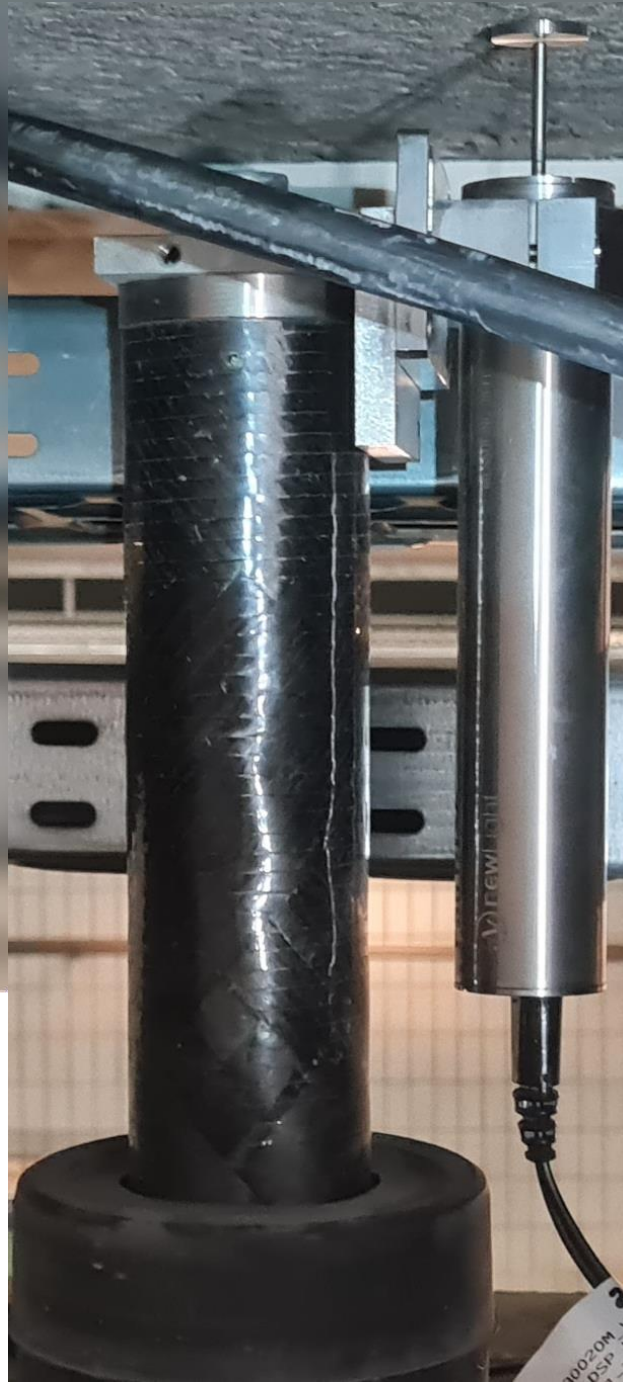
- Linear displacement measurement
- Temperature compensated
- Simple installation

FS61DSP

FS61DSP

MEASURING DIRECTION

Displacement



FS61DSP

- ▲ Vertical settlement
 - Linear displacement measurement
 - Temperature compensated
 - Simple installation

Tilt

- Inclination towards the vertical
 - Pillars
 - Walls
 - Tall buildings



Tilt

▲ Offshore platform monitoring of vertical elements

- Two tiltmeters for biaxial measurements
- In series connection
- Thermally compensated measurements

FS64TLS

Tilt

FS64TLS

- ▲ Sustaining wall monitoring
 - 24/7 Inclination measurements for safety
 - Monitoring as extension of service life

Acceleration

- Small amplitude, low frequency vibration movements
 - Ambient vibration of cables
 - Bridge vibration monitoring



Acceleration

FS65ACC

- Monitoring of an offshore structure
 - Triaxial mounting
 - In series connection
 - Simple installation

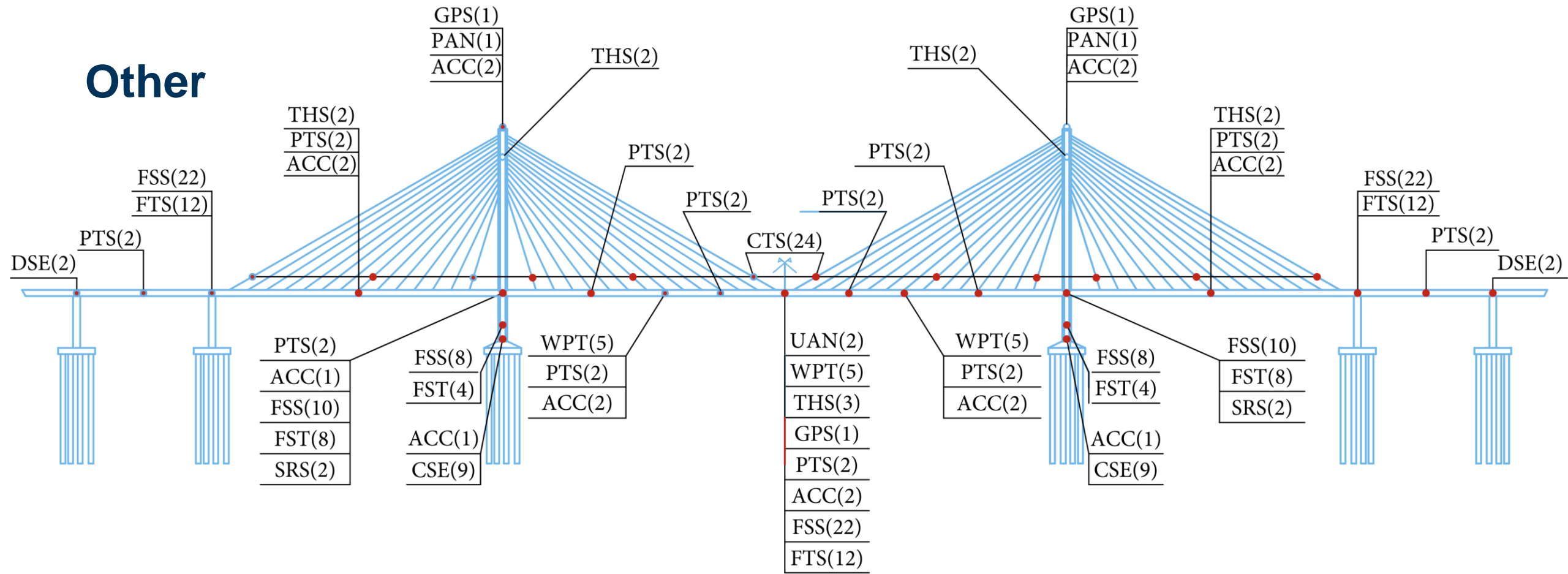


Acceleration

FS65ACC

- ▲ Vibration monitoring of cables
 - Remote locations
 - Long term monitoring

Other



FTS: fiber Bragg grating temperature sensor
 FSS: fiber Bragg grating strain sensor
 THS: temperature and humidity sensor
 PTS: pressure transmitter sensor

DSE: displacement sensor
 SRS: support reaction sensor
 WPT: wind pressure transducer
 UAN: ultrasonic anemometer

CSE: corrosion sensor
 PAN: propeller anemometer
 CTS: cable tension sensor
 ACC: accelerometer

GPS: global positioning system

From open access article

Weather
(wind, humidity...)

Load

Pressure

Corrosion

GPS

Etc...

3 Must Haves

FOR RELIABLE MEASUREMENTS IN SHM



For reliable measurements

#ACCURACY

#STABILITY

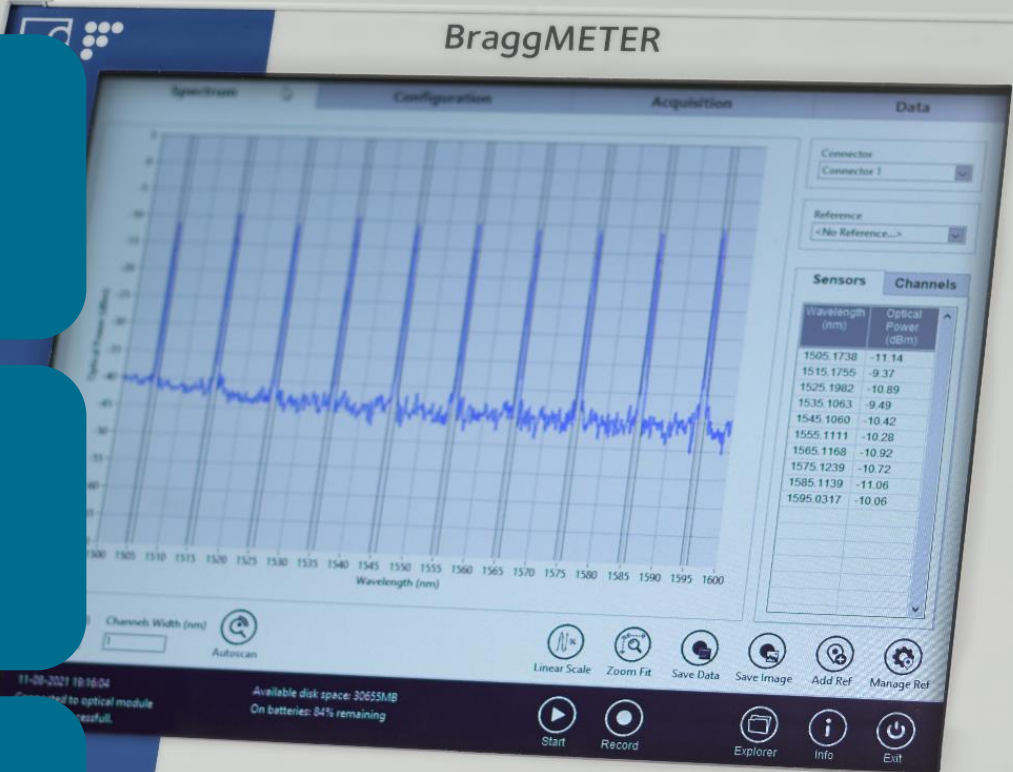
#DURABILITY

Optical Technology

#ACCURACY

#STABILITY

#DURABILITY





**AFTER A
FEW YEARS**

Long periods of operation

Silica



Resistant

BraggMETER

Long periods of operation

Wavelength

MEASURING
WAVELENGTH



BraggMETER



Long periods of operation

Wavelength

BraggMETER



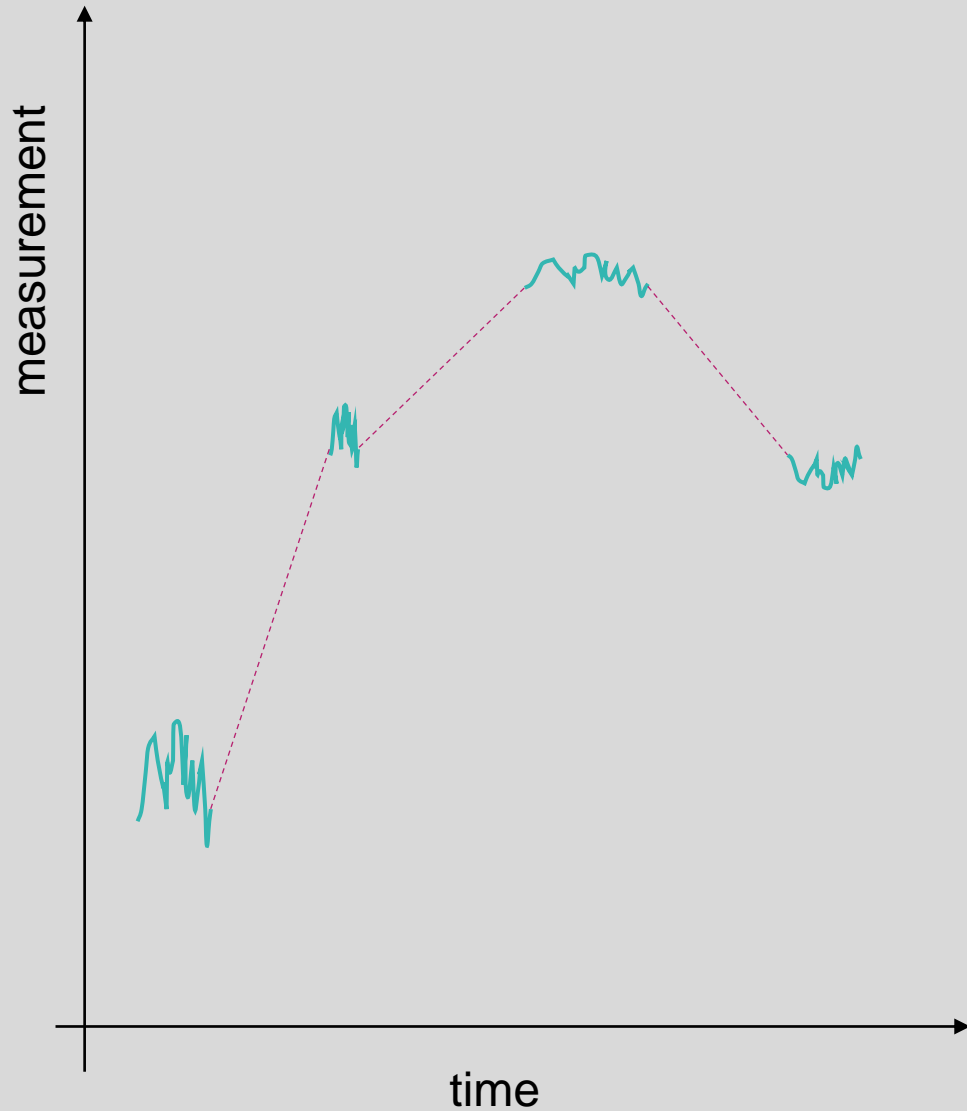
Long periods of operation

Wavelength



Insensitive to losses

Long periods of operation

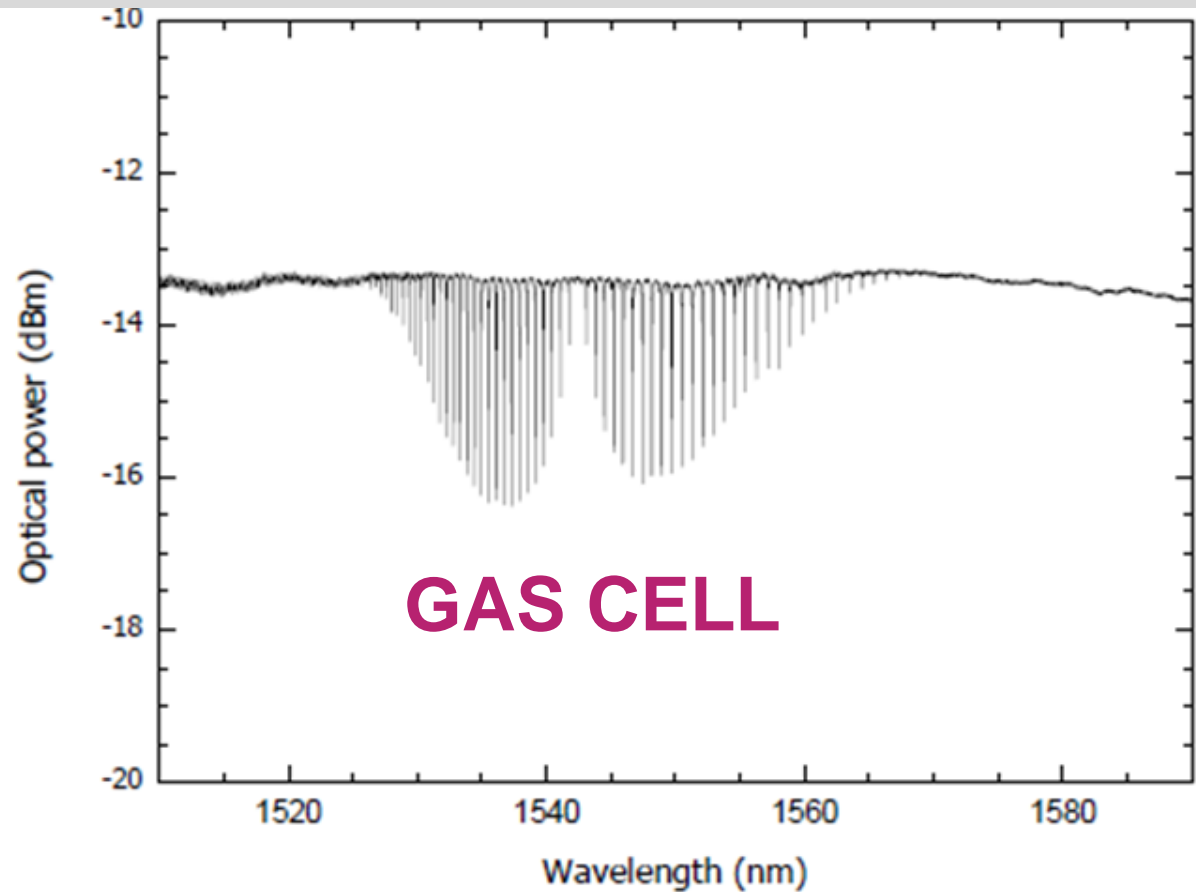


Wavelength



Referenced
Measurement

Long periods of operation



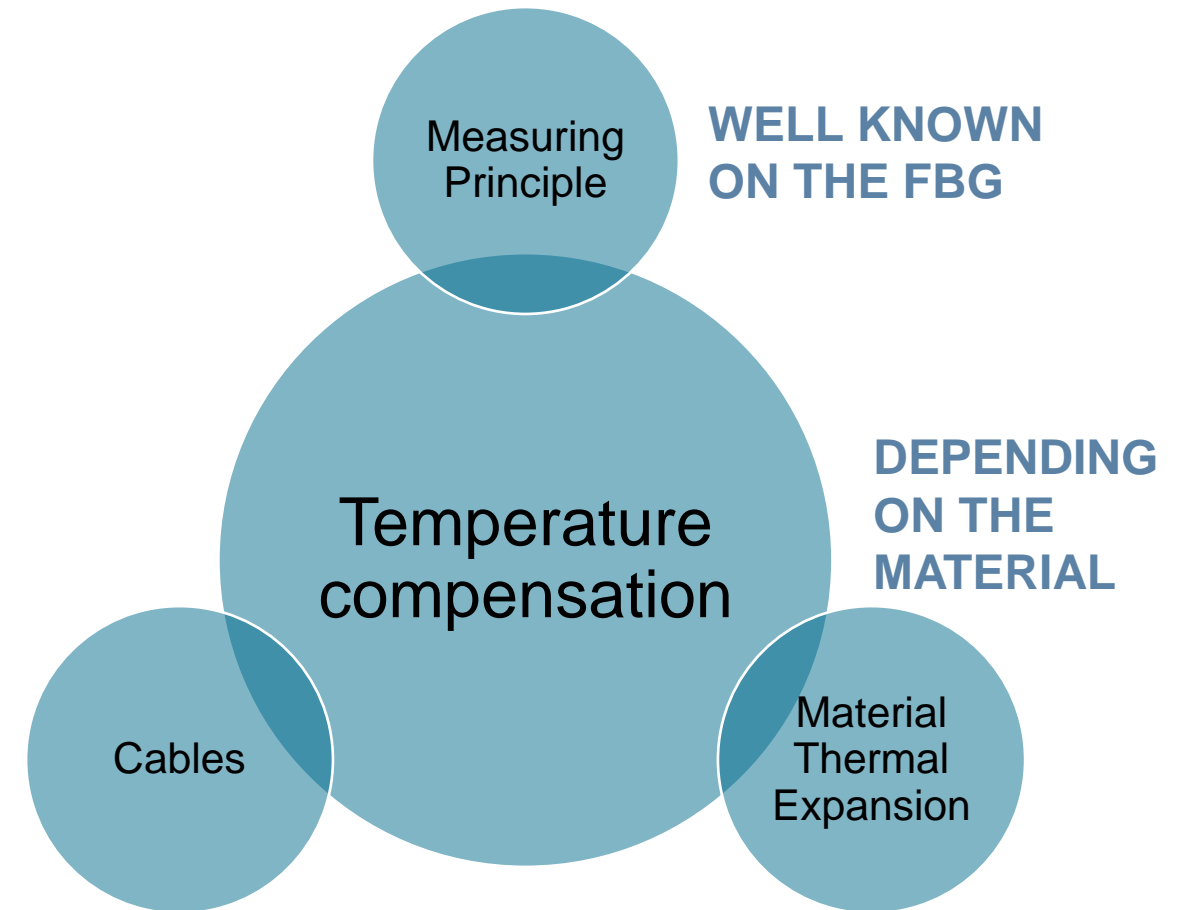
Wavelength

Built in
Reference

No Drift



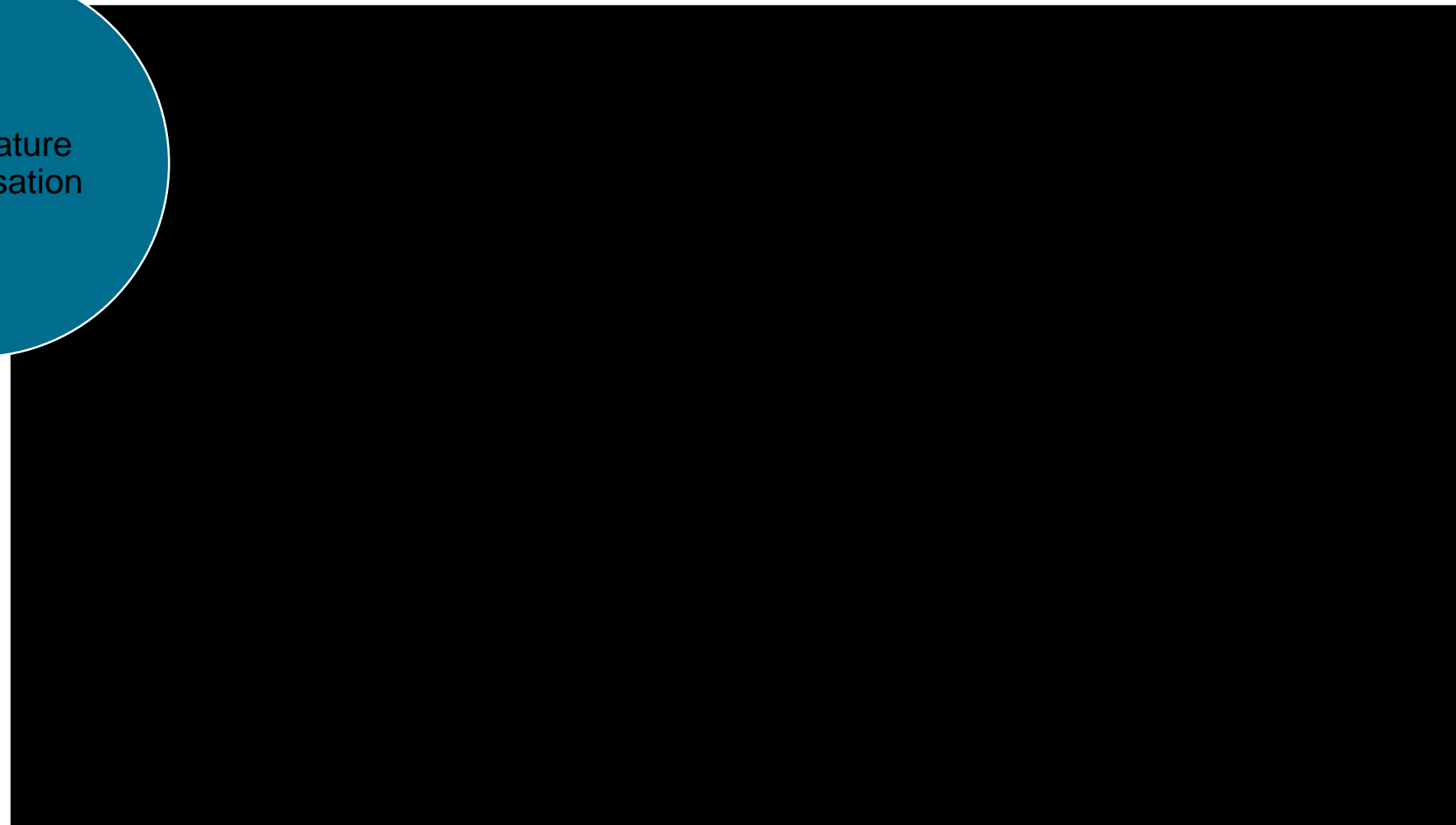
Long periods of operation



NON-EXISTING ON
OPTICAL TECHNOLOGY

Long periods of operation

Temperature
compensation



Video [link](#)

Harsh Environments

WATER

SALT

**RF/EM
INTERFERENCES**

EXPLOSIVE

CRYOGENIC

VACUUM

RADIATION

Long distances

- ▲ Long structures
- ▲ Remote locations
- ▲ No power supply

Low attenuation of optical fibers:

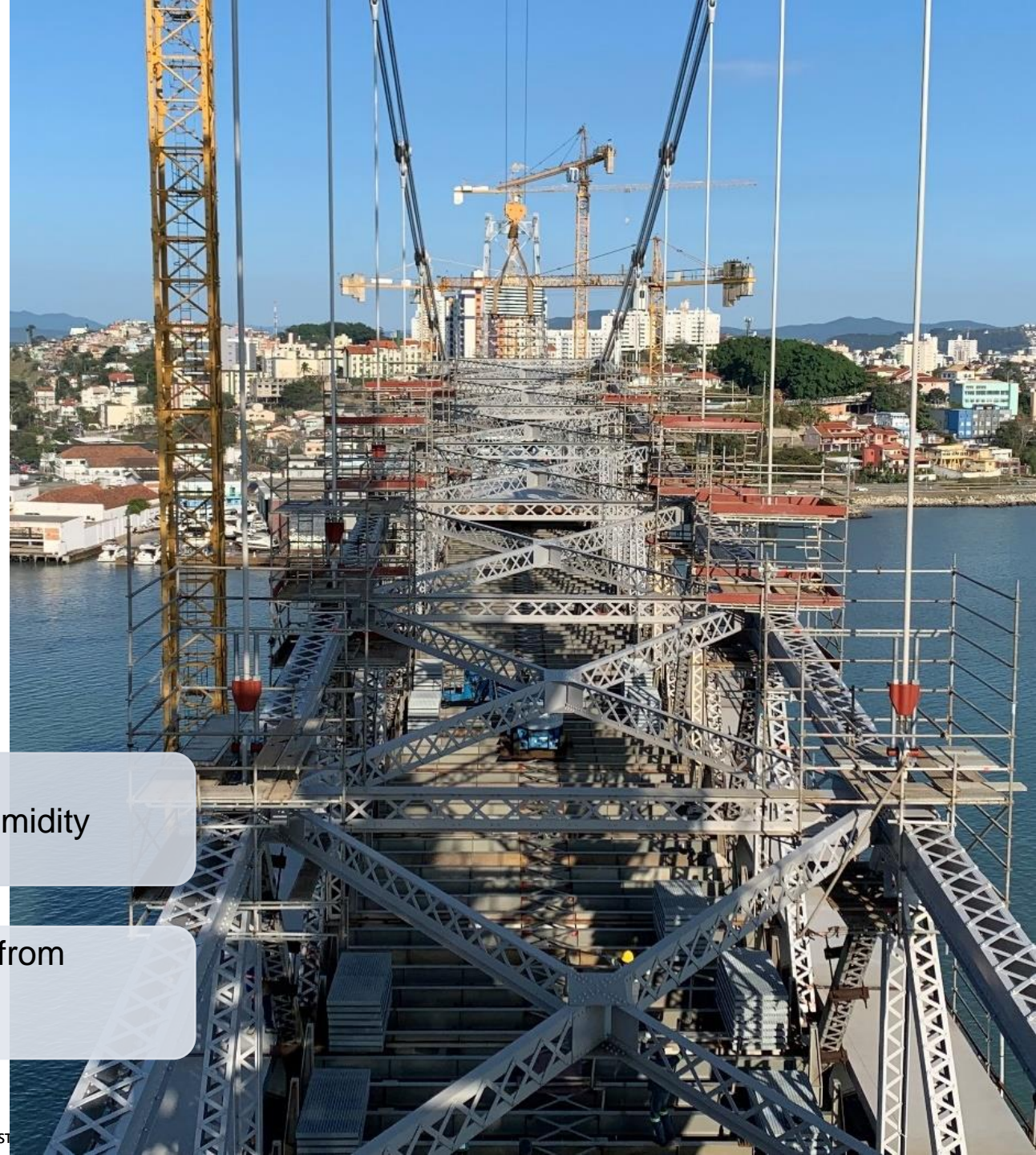
No heavy equipment on accessible locations

Concentration of devices on one controlled location

- Access control
- Temperature and humidity control

Scattered sensors

- Data acquisition far from sensors
- Sensors far apart





Replicated sections

Large sensor count



Multiplexing

Multifunctionality

Large sensor count

32

Conventional
sensors

128

Wires

45

FBG sensors

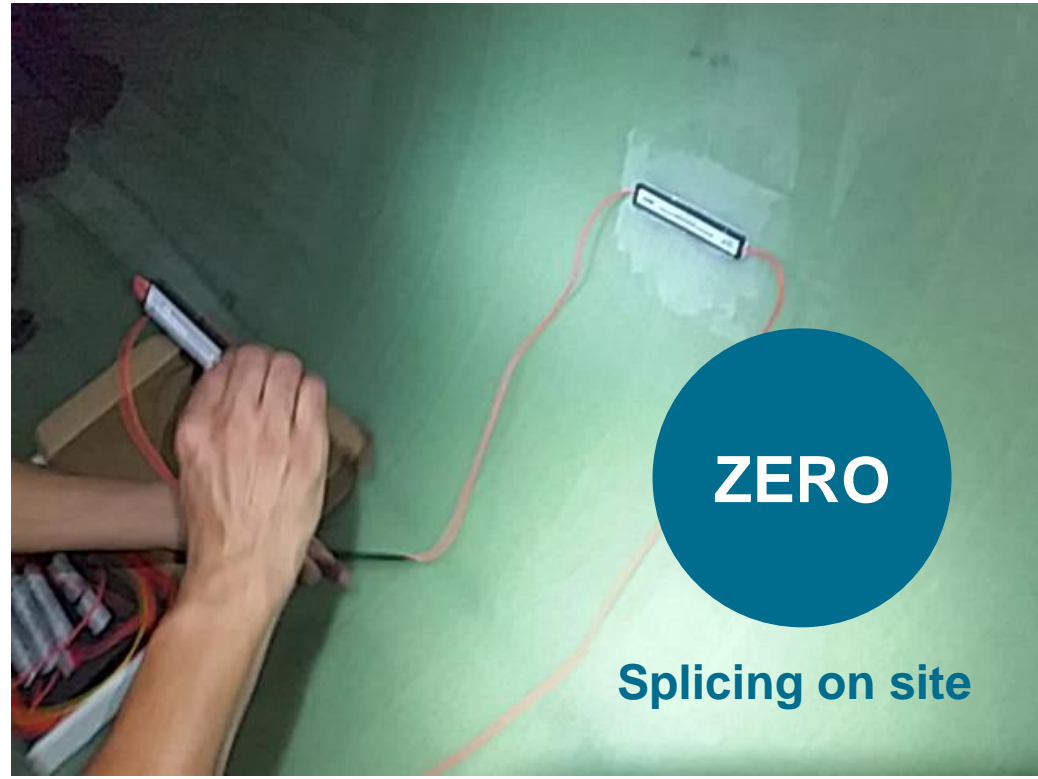
4

Wires



Installation efficiency

Preassembled
arrays of sensors



Splicing on site

Data Management



Q & A

Thank You

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