

They can hit us hard, but we shall prevail!

HOW FIBER BRAGG GRATING (FBG) SENSORS CAN BE A FITTING PARTNER FOR MONOPILE MONITORING.

Cristina Barbosa
October 13th 2021



Monopiles

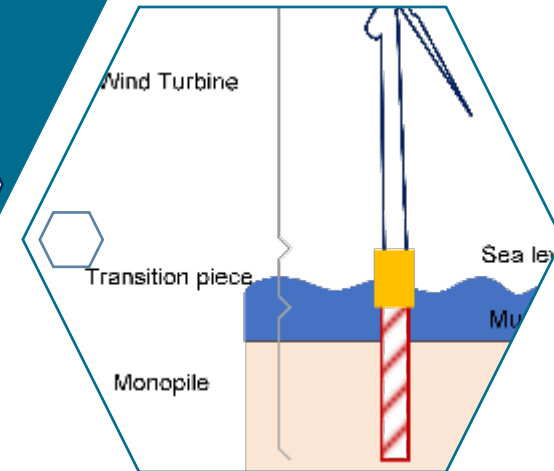
Monopiles are extremely common type of foundation used on offshore structures



Source:
www.eurekaert.org

metallic
tube

embedded
into the
seabed





Monopiles

Simple
Structures



“Easy” to
install

Monopiles



Simple
Structures



“Easy” to
install

Monopiles



Simple
Structures

“Easy” to
install

Monopiles



Simple
Structures



“Easy” to
install



Monopiles

▲ Challenges

Installation and design

- Geotechnical uncertainties
- Noise

Durability

- Fatigue
- Scouring

Source: www.ihciqip.com

Opportunity: Race to net zero

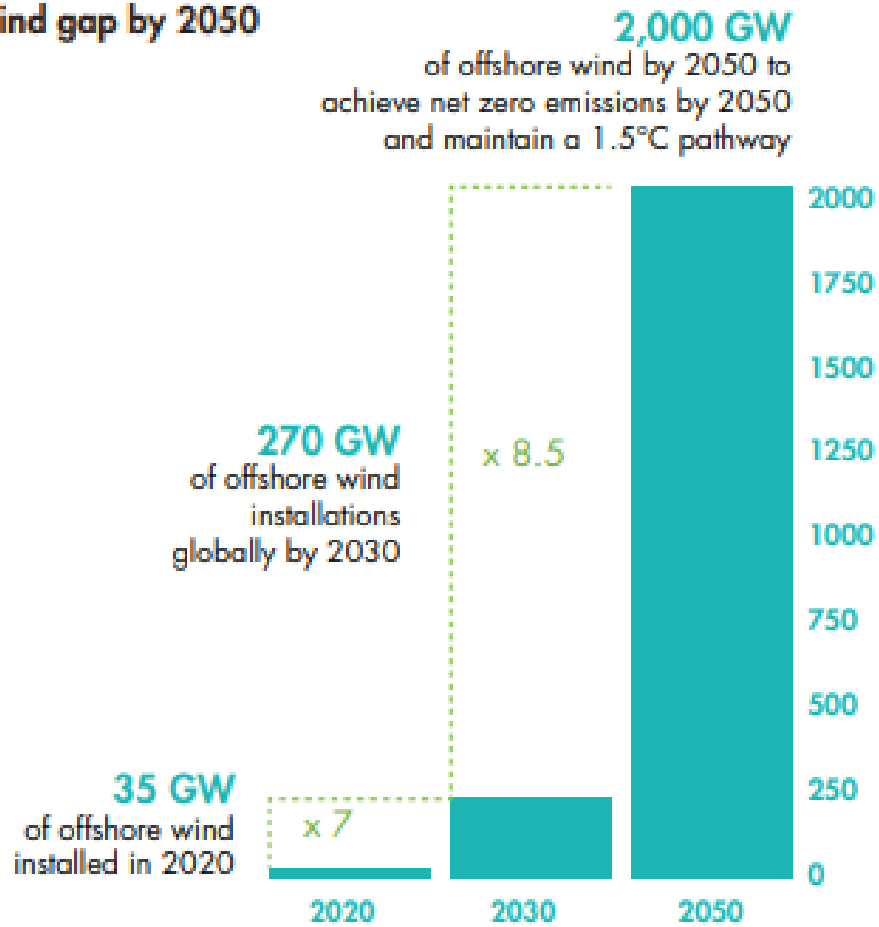
- ▲ International Energy Agency targets
 - Wind and solar PV energy supply



Offshore wind

Closing the offshore wind gap by 2050

Unit: GW



Source: GWEC Market Intelligence; IRENA World Energy Transitions Outlook 2021.

Source: www.texasmonthly.com

Offshore wind

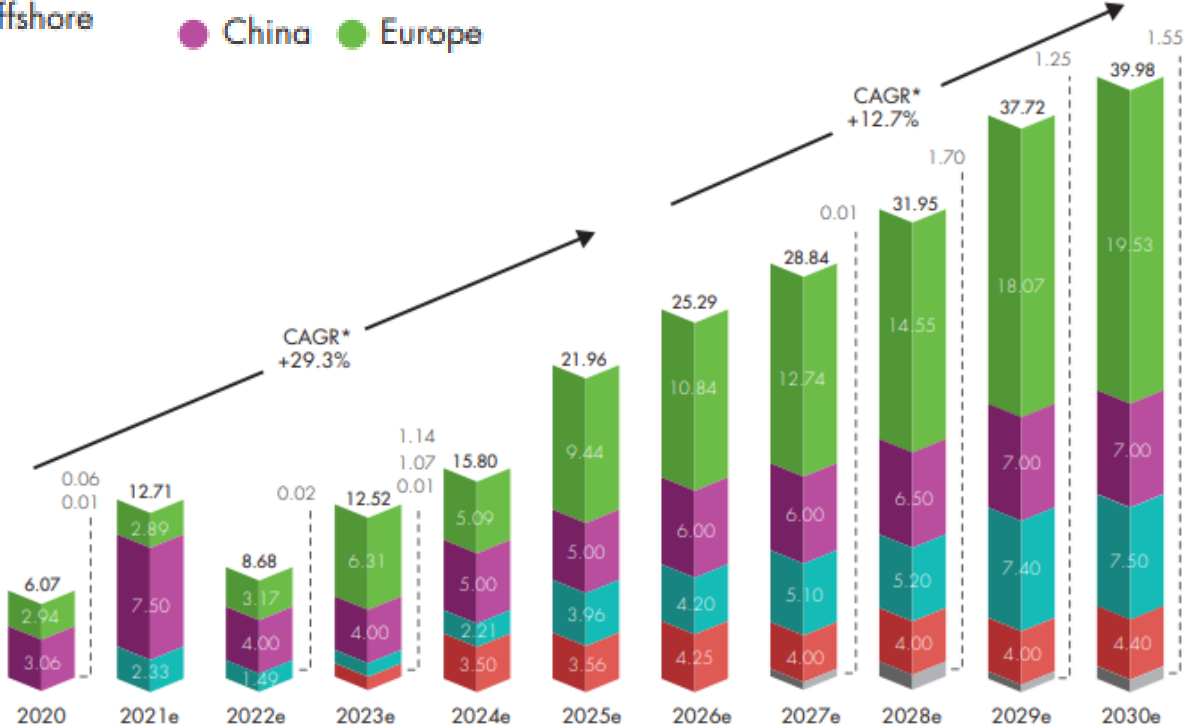
Global growth



Global offshore wind growth to 2030

New installations GW, offshore

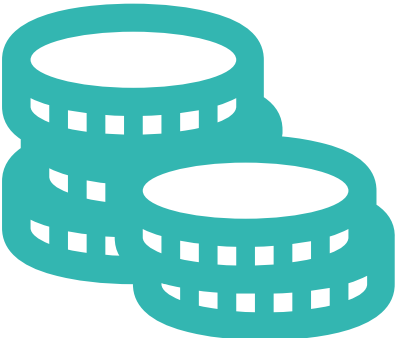
- Other
- North America
- Asia ex China
- China
- Europe



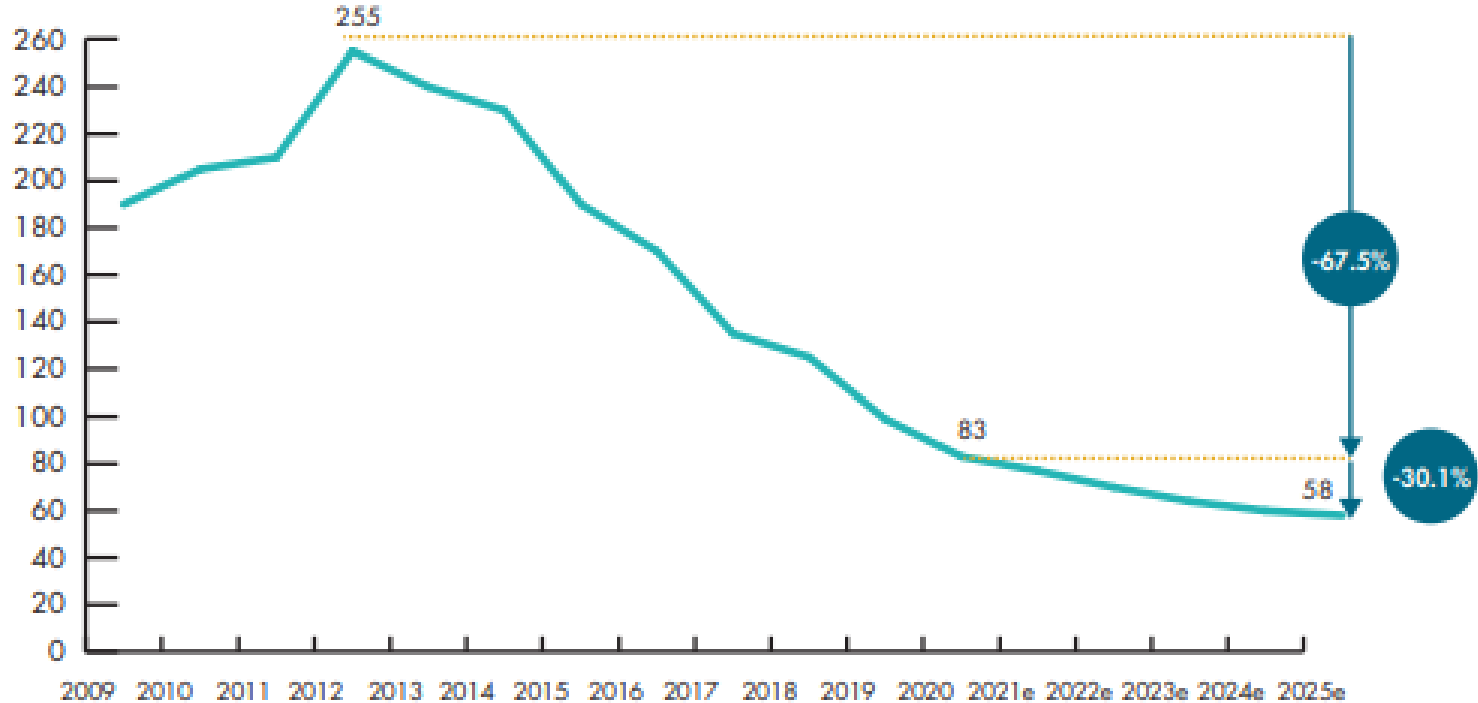
*CAGR = Compound Annual Growth Rate
Source: GWEC Market Intelligence, July 2021

Offshore wind

▲ Cost reduction



Levelised cost of electricity offshore wind
USD/MWh

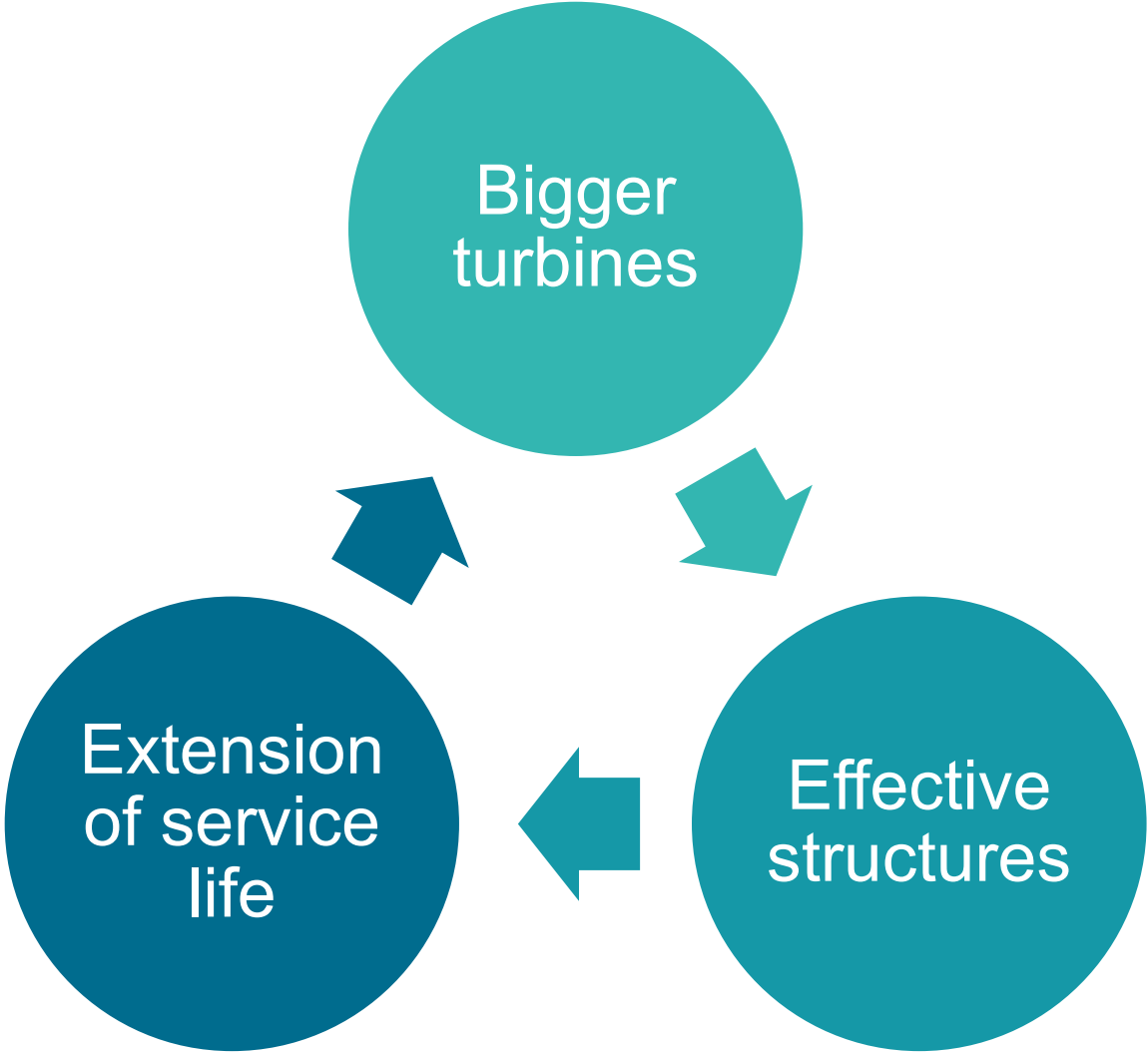
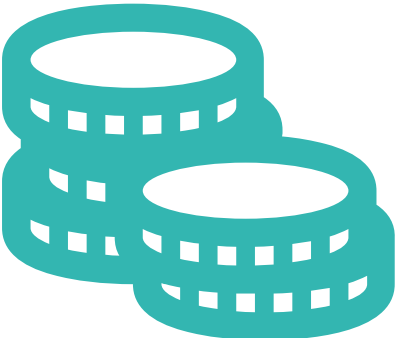


Methodology: BNEF LCOE scope for offshore wind farms includes all transmission costs up to the project's onshore substation, which is also included. The outlook from 2020-2025 is a fitted curve best reflecting future levelized auctions bids (it mixes auctions including and excluding the cost of transmission to shore).

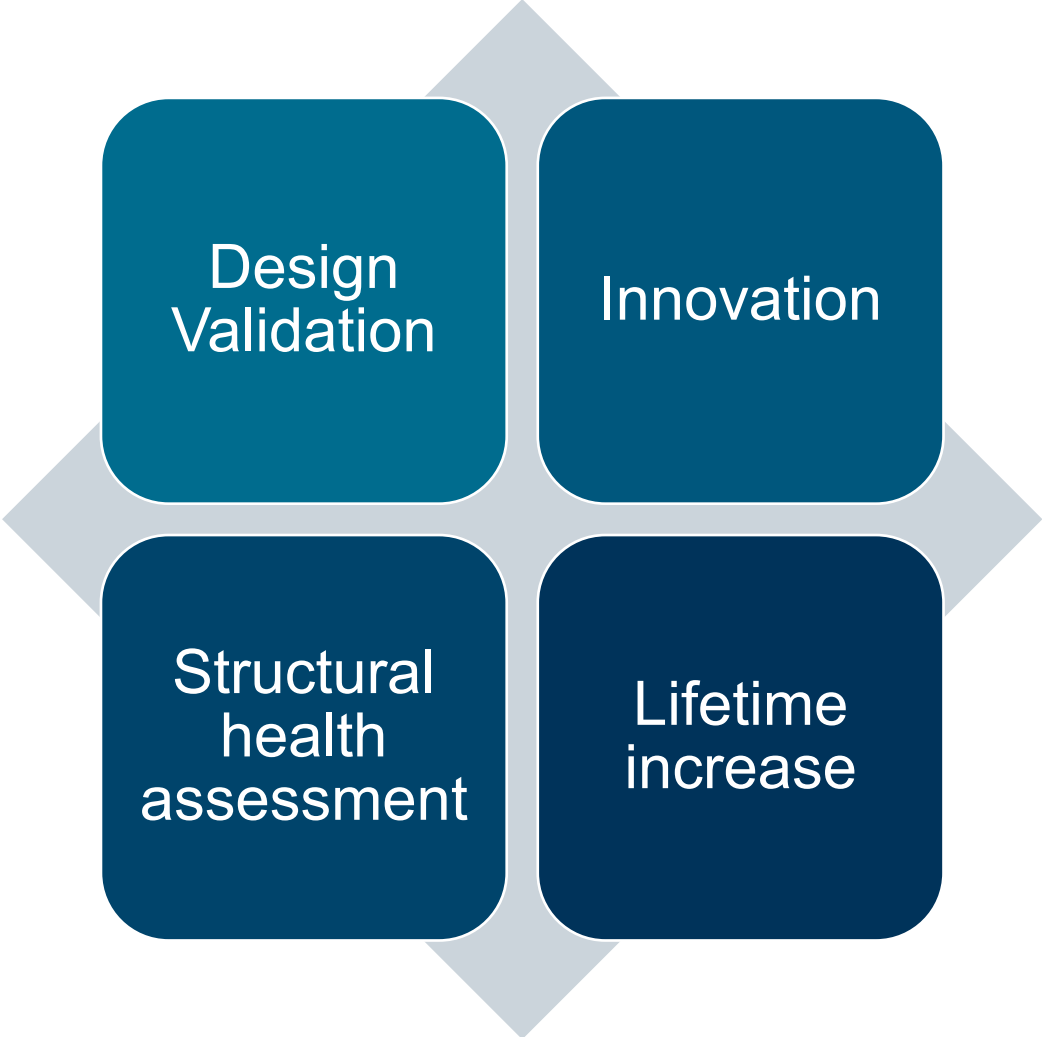
Source: BNEF LCOE Database Jan 2020, GWEC Market Intelligence

Offshore wind

▲ Cost reduction



Monitoring for data



Monitoring for data

Survival rate

Remote

Long term

Seawater

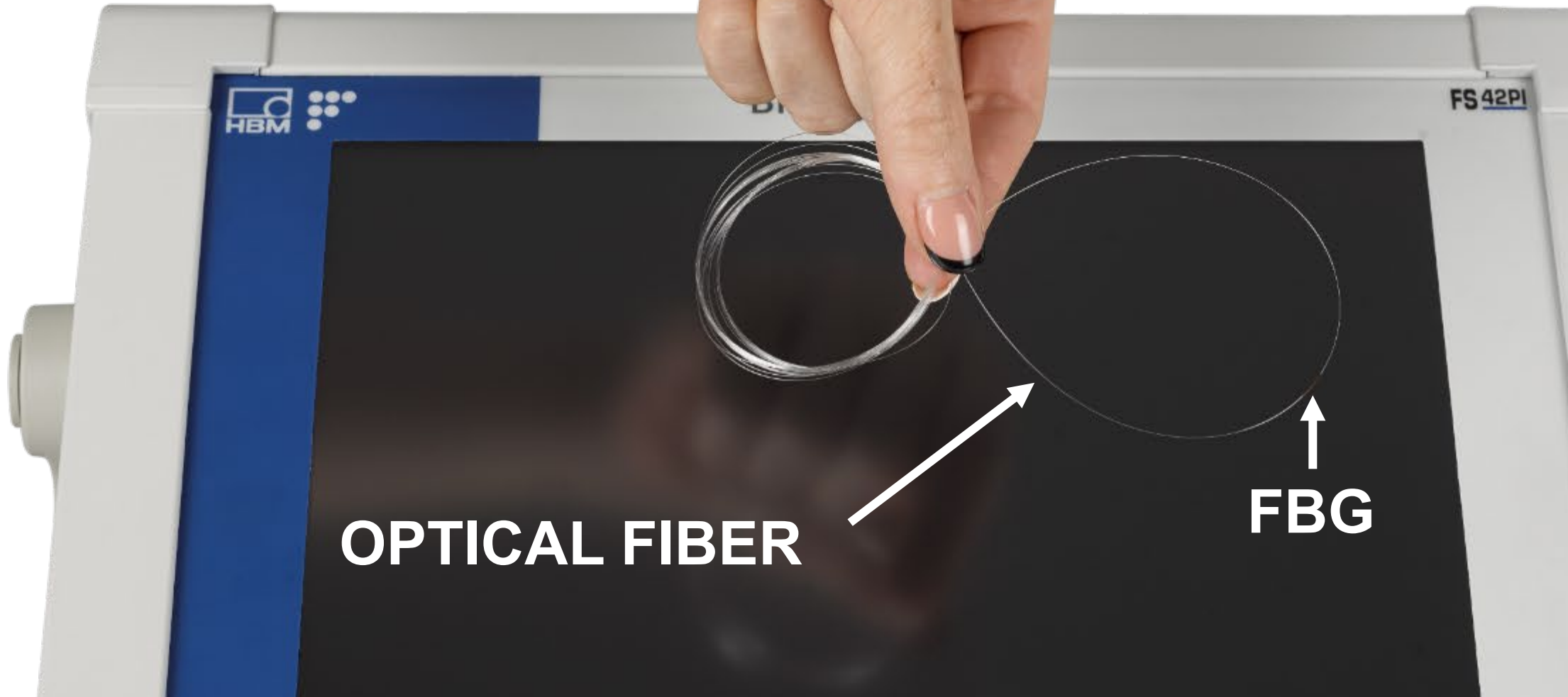
Buried



Fiber Bragg Grating Technology

Fiber Bragg Grating

Microstructure permanently printed on the core of an optical fiber



Fiber Bragg Grating

Reflects a narrow spectrum of light at a certain wavelength

**REFLECTED
PEAKS**



Fiber Bragg Grating

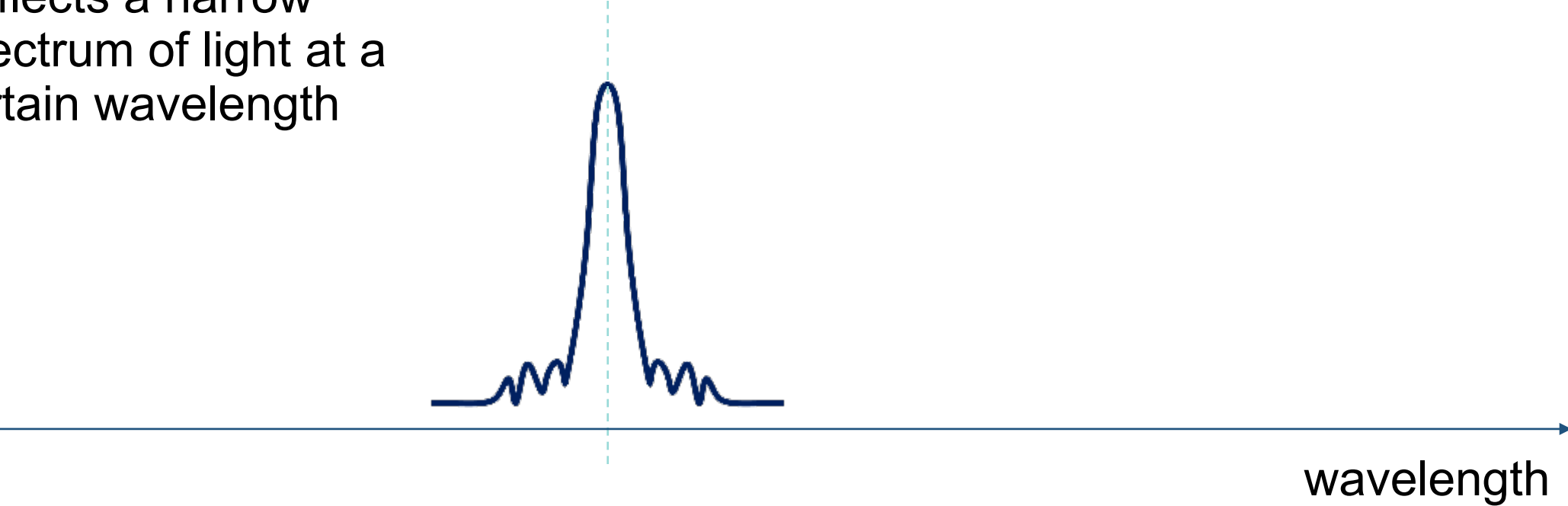
Reflects a narrow spectrum of light at a certain wavelength

**REFLECTED
PEAKS**



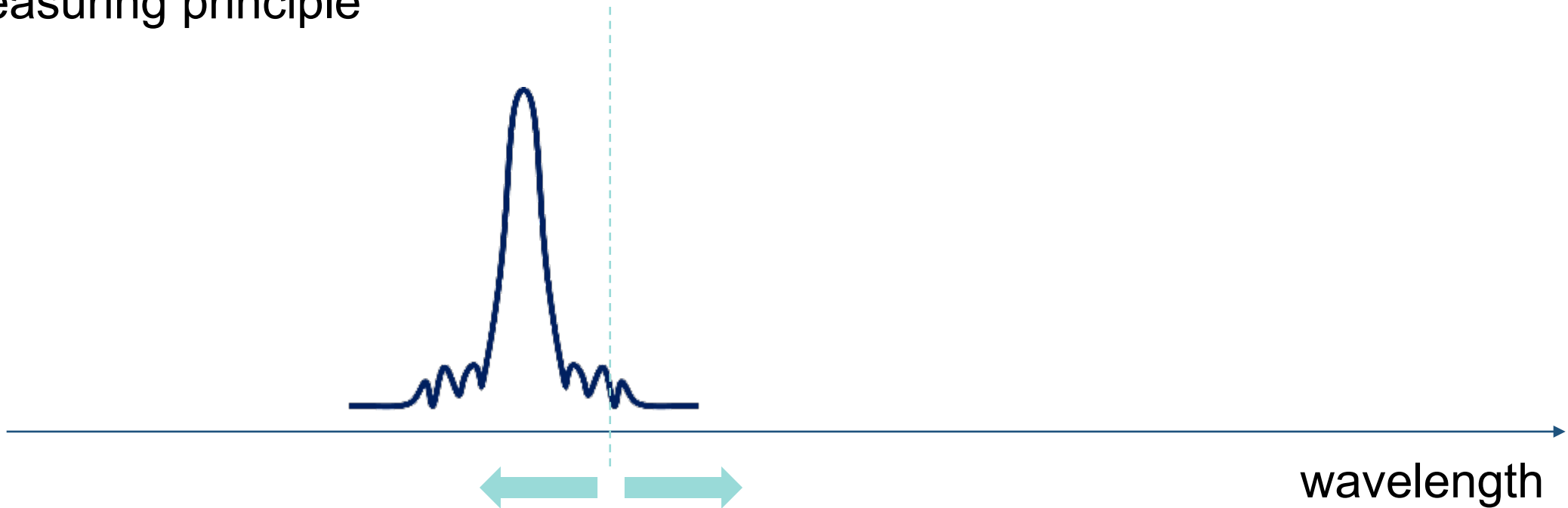
Fiber Bragg Grating

Reflects a narrow spectrum of light at a certain wavelength



Fiber Bragg Grating

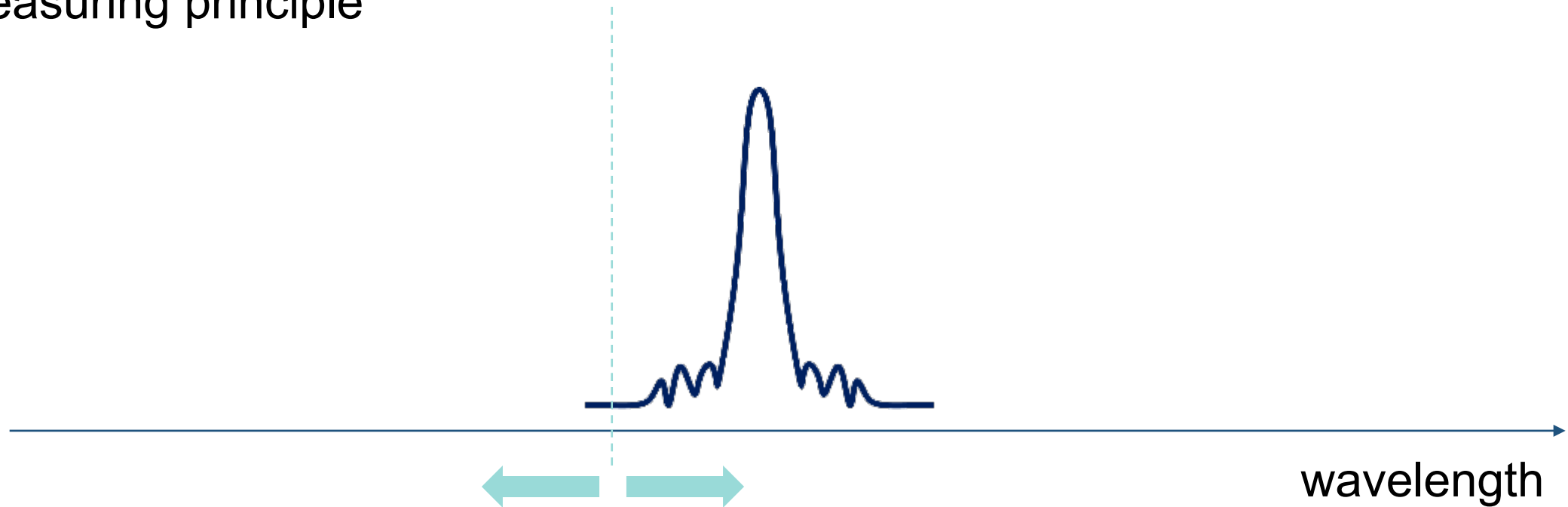
Measuring principle



Wavelength changes when strain or temperature variations are applied

Fiber Bragg Grating

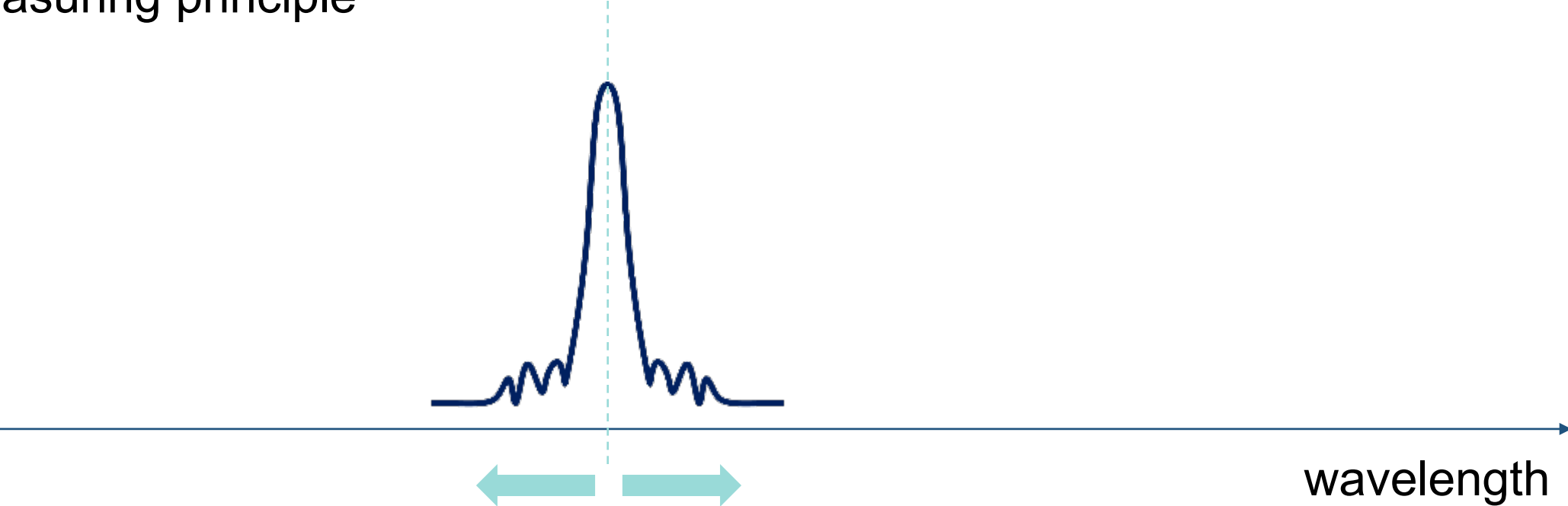
Measuring principle



Wavelength changes when strain or temperature variations are applied

Fiber Bragg Grating

Measuring principle



Wavelength changes when strain or temperature variations are applied

Added Value

Signal stability

Wavelength measurement

Temperature compensation



Added Value

Resistance

Shock

- low mass

Water and
salt

Long
distances



Added Value

Cost effectiveness

Large sensor count

- Multiplexing

Redundancy



The full measurement chain

HBK Offer

THE FULL MEASUREMENT CHAIN



Sensors

WELDABLE STRAIN SENSORS

Spot welded

Ready-to-measure

Long term resistance

A close-up photograph of three FS62WSS strain sensors mounted on a brushed metal surface. Each sensor is a small, black, cylindrical device with a grey plastic housing, secured to the metal by two spot welds. The sensors are connected to black cables. The model number 'FS62WSS' and the 'newLight' logo are visible on the grey housings. The background shows the texture of the metal and the connection points of the sensors.

FS62WSS

Sensors

TEMPERATURE COMPENSATION

Signal stability/ accuracy

Shock-proof

Simple configuration

In series deployment

FS62WSS



FS62WSS+TC plate

Sensors

DELIVERED AS PRE-ASSEMBLED ARRAYS

Faster installation

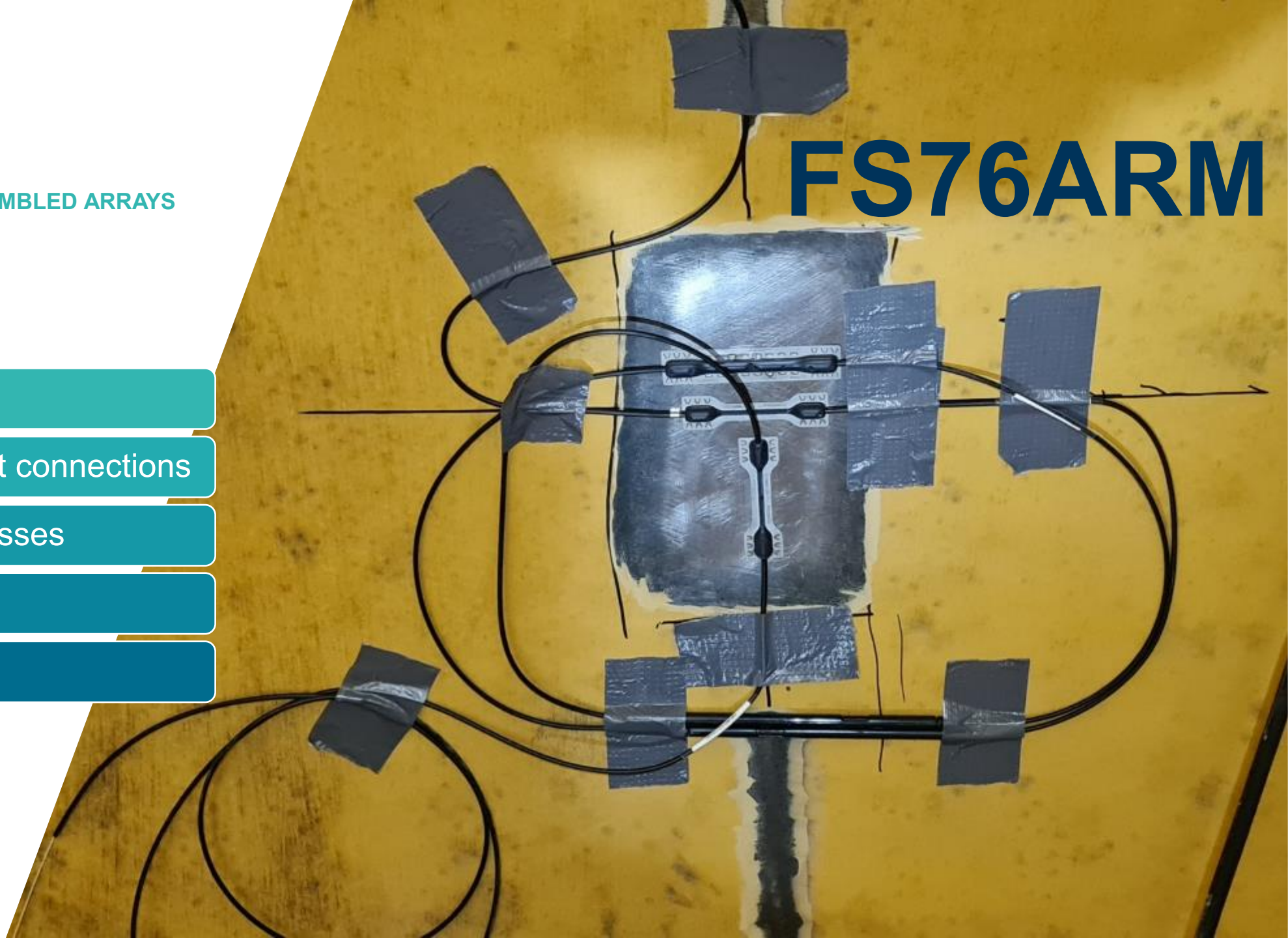
Long term resistant connections

Minimum optical losses

Long cable leads

Redundancy

FS76ARM



Sensors

ROSETTE STRAIN MEASUREMENT

Stress analysis

Small footprint

**OR-WA
(FS62WSR)**



Sensors

SIMPLE FBG

Several FBG

Peek coating

Small diameter

Groove installation



FS70PKF

Sensors

MULTIFUNCTIONALITY

Displacement

Strain

Temperature

Tilt

Acceleration

Load



Accessories

FOR EFFECTIVE AND RESISTANT SETUP

Racks

UPS

PCs

Special tools



Accessories

FOR EFFECTIVE AND RESISTANT SETUP

Sensor protection

Optical cables

Enclosures

...



Optical Interrogators

PORTABLE BRAGGMETER

FS42PI

Installation support

Carrying bag

Battery

Touchscreen

BraggMONITOR PI



Optical Interrogators

INDUSTRIAL BRAGGMETER

Static (1S/s) or Dynamic (1000S/s)

ST or RM form factors

Large number of sensors

SCPI commands

BraggMONITOR

Catman software



FS22

Optical Interrogators

QUANTUMX BRAGGMETER

MXFS

Modular concept

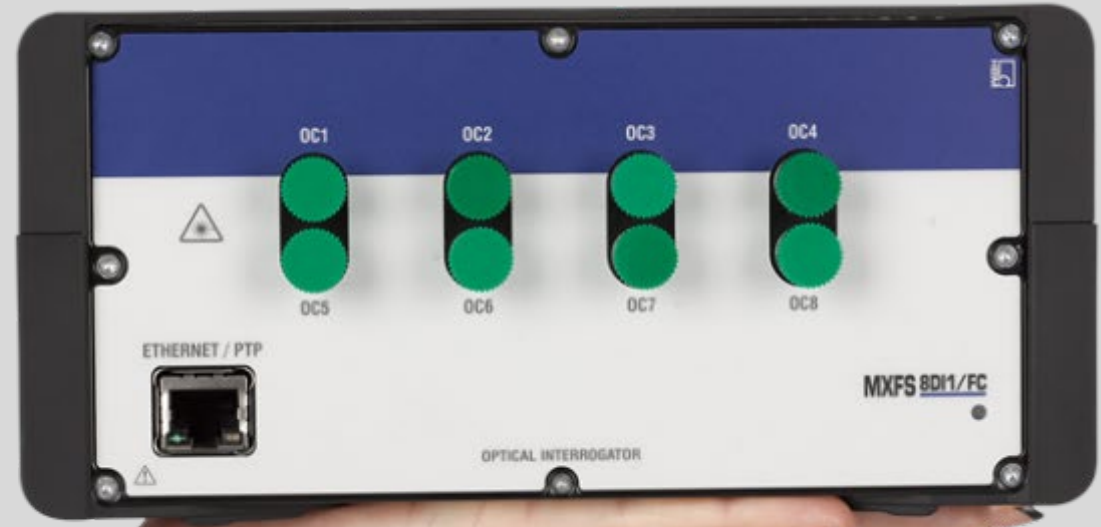
100 S/s and 2000 S/s

128 sensors

Catman software

Common API and Labview drivers

Communication protocols



Software

DATA ACQUISITION SOFTWARE

Complete data acquisition software

Easy setup

Powerful visualization

Configurable recordings

Flexible data analysis



Services

INSTALLATION SUPPORT

Experienced teams

Global

Certified

Services

TECHNICAL TRAININGS

In house

On site

At HBK



Thank You

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