



Tailored Fiber Optic Sensing
Components & Solutions

FBG sensing in structural health monitoring “closing the gap”

07.11.2022



We are

a developer and manufacturer of fiber optic sensor components and fiber optic sensor solutions



We are vertical from raw materials to software



We do

Temperature sensing



Shape sensing



Strain sensing

Force sensing



Pressure sensing

For

Medical



Process Industry



Civil engineering

Transportation



Energy



FBGS North America (Montreal)
Sales and applications
(North American market)

FBGS Belgium (Geel)
Sales and applications
Development and assembly of measurement systems (interrogators)
Sensing Solution
Engineering and R&D Work



FBGS Germany (Jena)
Company Headquarter
DTG® and FSG® production
R&D location for special fibers and FBGs

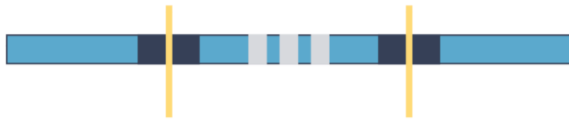


FBGS China (Suzhou)
Sales and applications
(Chinese customers)



Classical FBG sensing in SHM

Sensing point



Single point sensing

One sensing point in the fiber
 e.g. strain sensor or displacement or temperature, etc.

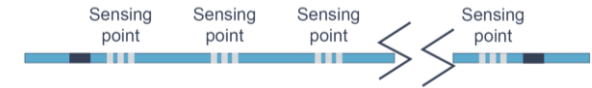
Sensing lengths: few **m** to **~10m**



Multipoint

From 2 to 10 sensing points in the fiber
 e.g. strain chain or temperature chain, etc.

Sensing lengths: few **10's m** to **~100m**

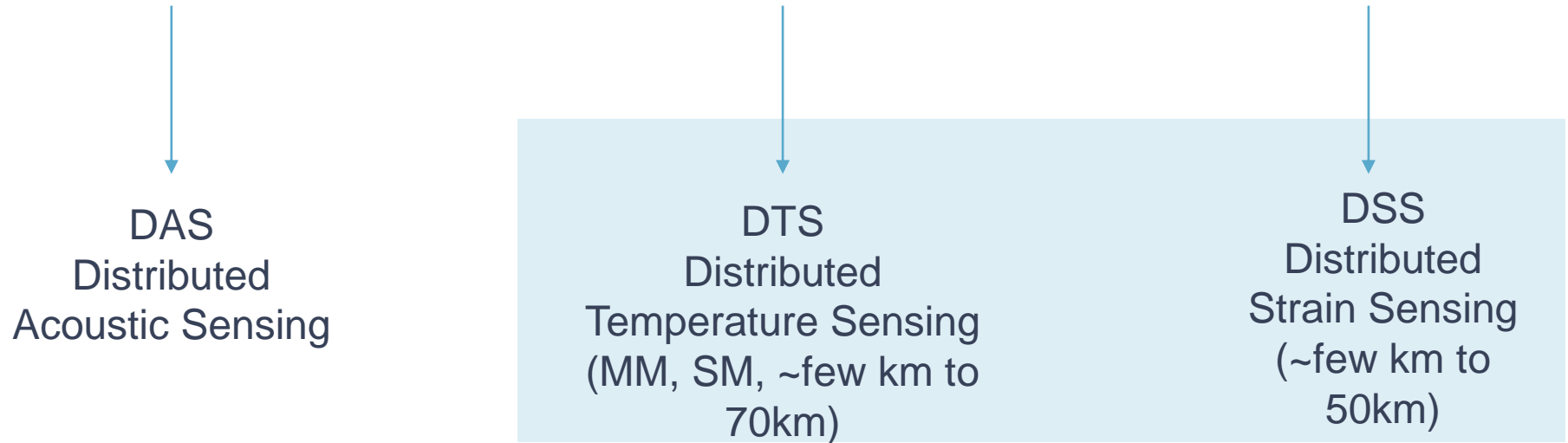


Quasi distributed

From 10 to 50 sensing points in the fiber
 Strain cable or temperature cable, etc.

Sensing lengths: few **10's m** to **~500 m max.**

Distributed sensing



Based on Rayleigh, Brillouin & Raman scattering
Optical time-domain reflectometry or optical frequency-domain reflectometry

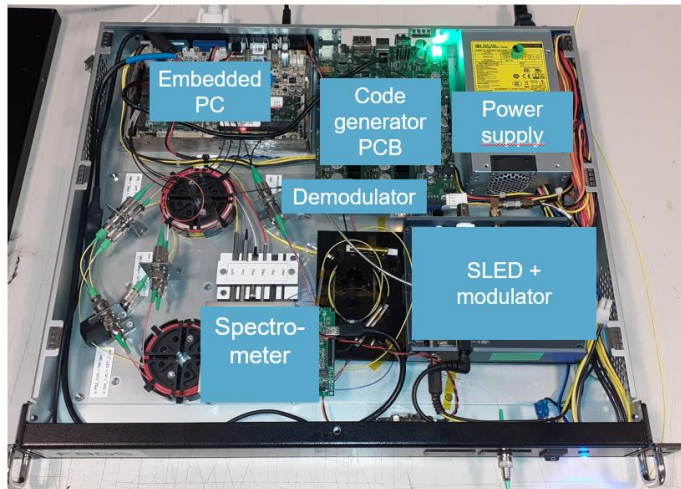
Gap between classic FBG sensing and distributed sensing technologies for sensing system between **0.5km** and maybe **5-10** kilometers

“Code Division Multiplexing” based WDM interrogation (CDM-WDM)

Working Principle

- Spectrometer based WDM interrogation scheme + “smart” light modulation enable that multiple WDM section can be combined in one fiber and individually addressed

- >2000 sensors in one fiber possible
- Measurement speed depending on the number of repeating WDM sections
- Advantage to classical TDM always 50% of the light used



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(54) Title: INTERROGATION OF OPTICAL FIBER SENSOR NETWORKS

FIG. 2

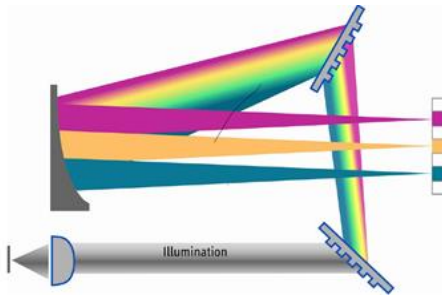
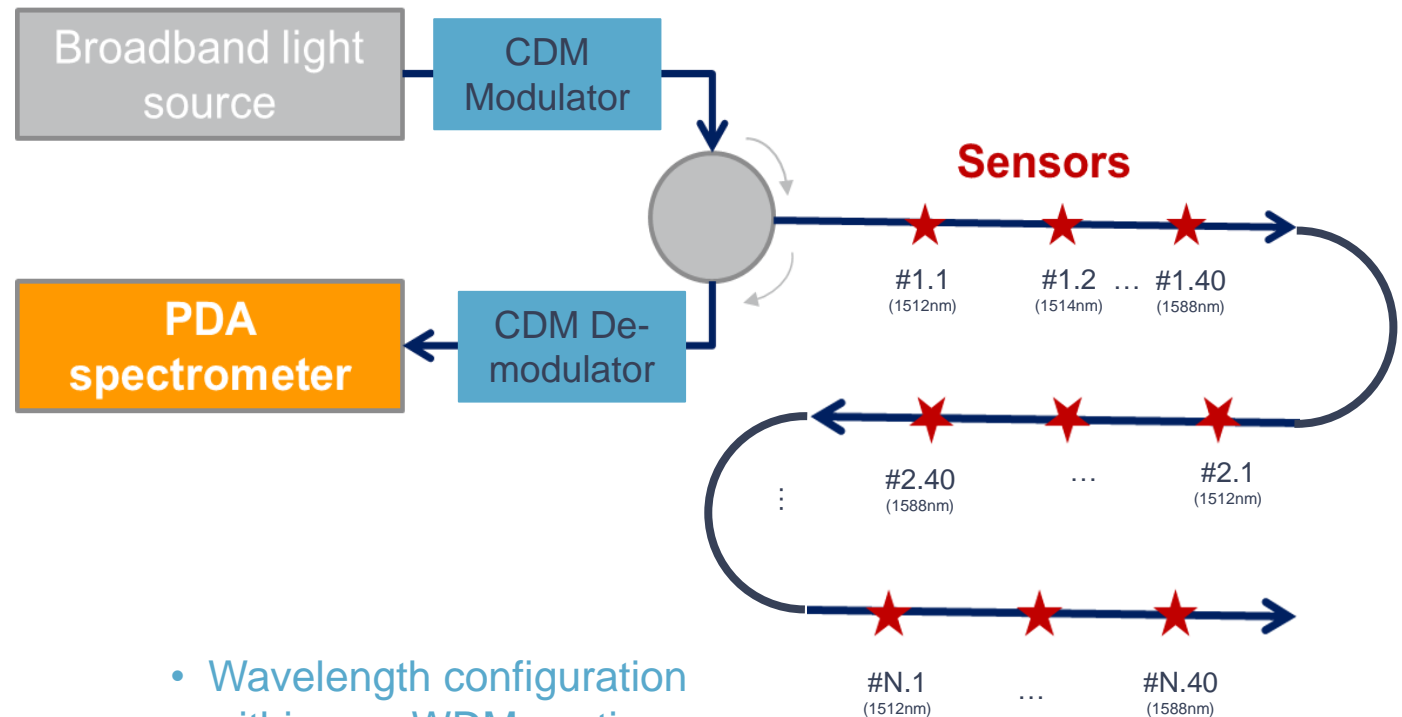
(57) Abstract: A system (100) for interrogating sensors in a fiber optical sensor network (200) is described. The fiber optical sensor network (200) comprises several groups of sensors, wherein the sensors in one group are operating at different wavelengths and the sensors of different groups may have overlapping wavelengths. The system comprises a light source (110) for generating a broadband light signal, an input and output means (130) for guiding the broadband light to the fiber-optical sensor network for illuminating the sensors and for coupling the light signal coming from the sensors of the fiber-optical sensor network (200) to the detection system and a detection system (180) for detecting the received light signal, during a detection integration time. The system is arranged for selecting pre-dominantly the received light coming from the different sensors of a selected group of sensors using a code-division multiplexing technique and for simultaneously detecting sensors of the selected group of sensors using a wavelength-division multiplexing technique.

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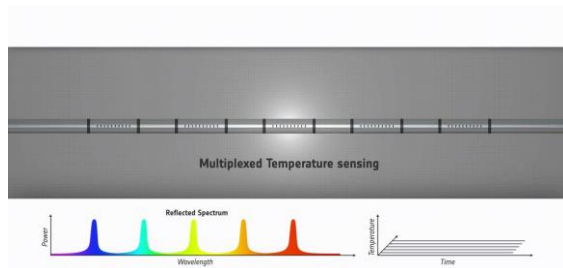
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Patent granted - WO2020/070293

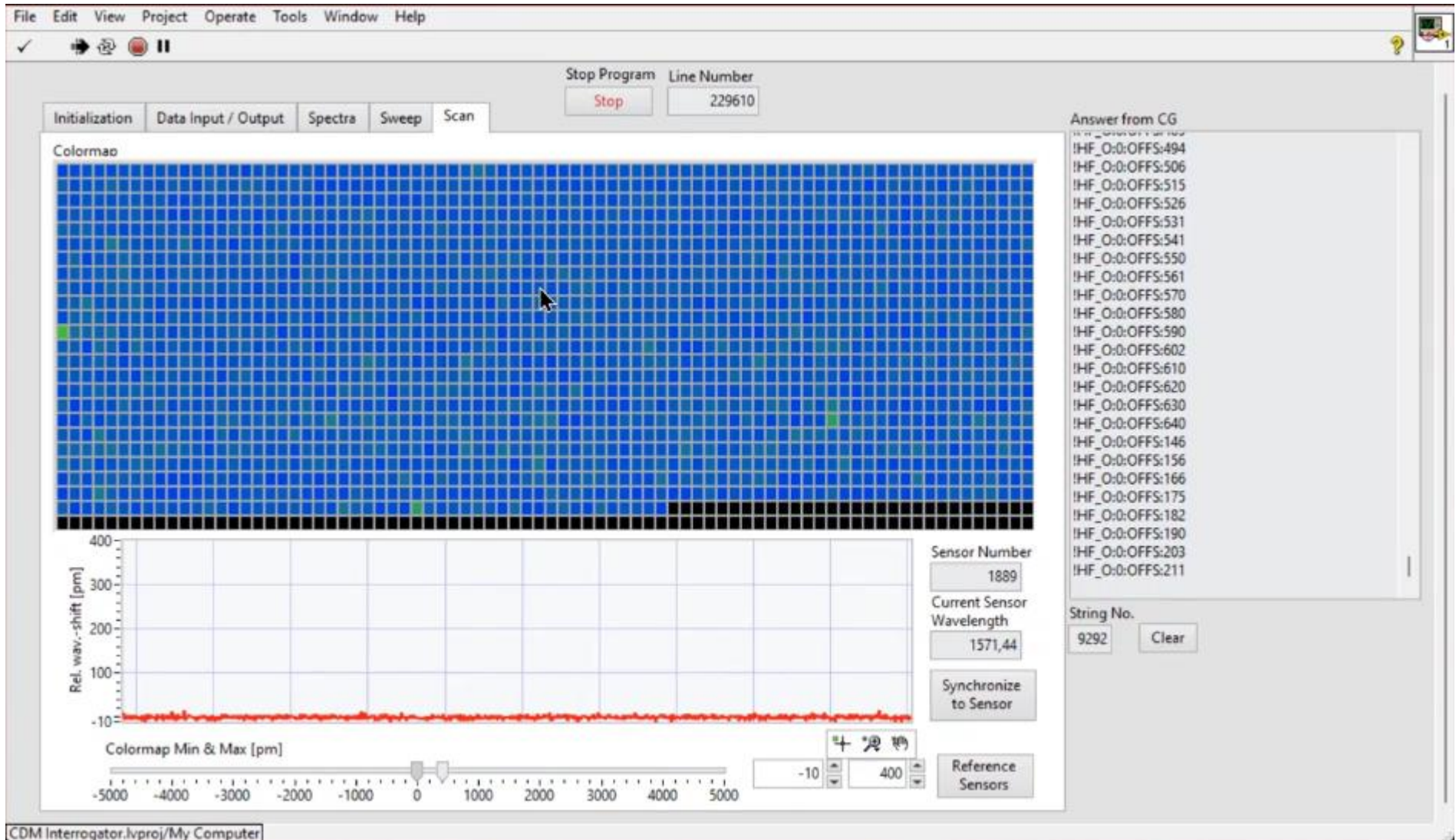
Code Division Multiplexing” based WDM interrogation (CDM-WDM)



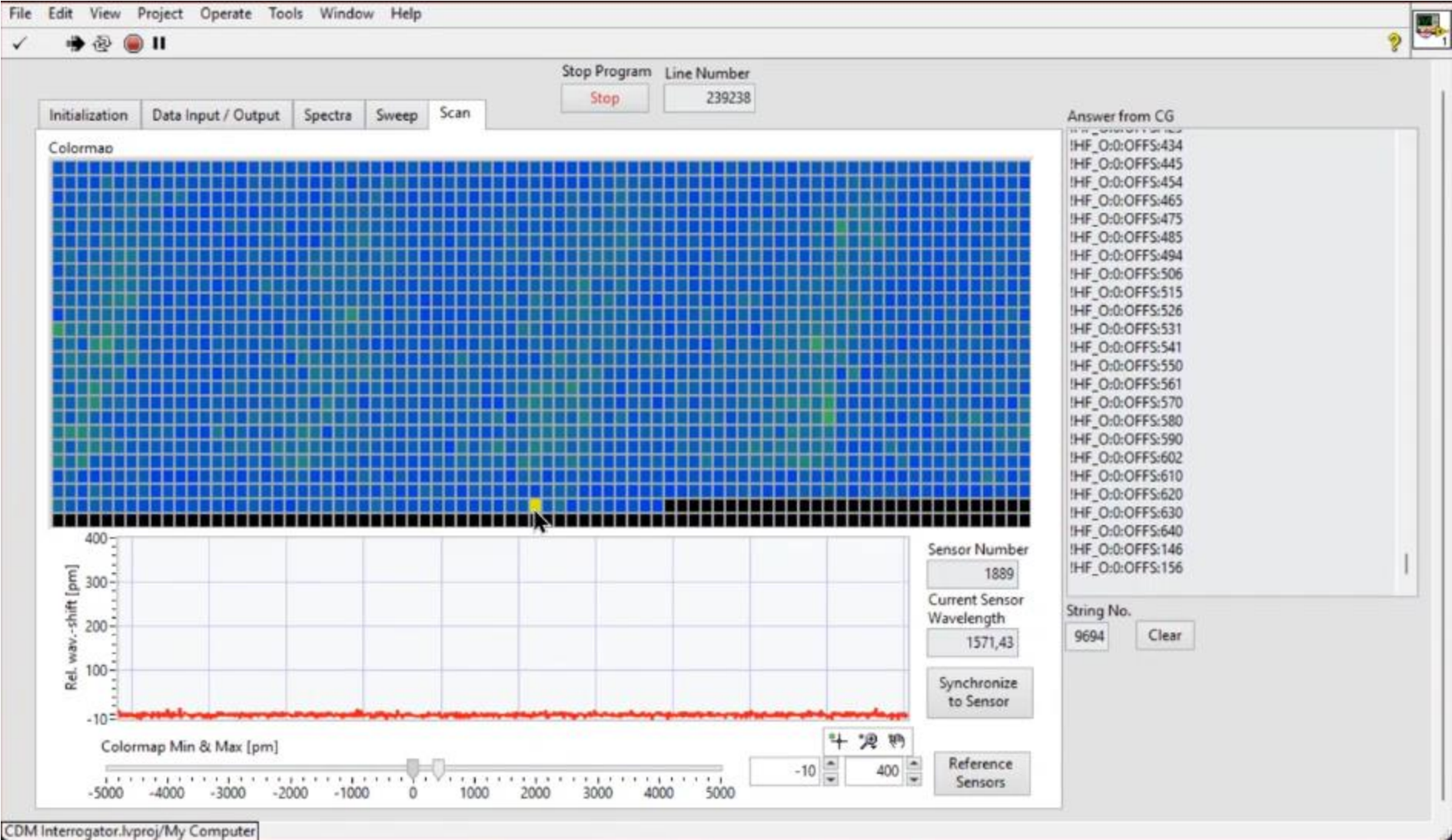
- Wavelength configuration within one WDM section freely selectable
- Each DTG is individually addressable (no overlapping spectra)
- Up to 40 sections with up to 50 sensors per section



Temperature test on fiber spool with 1889 FBGs



Recording – Tapping one sensor “1879”



FBGS INFINITY-SCAN

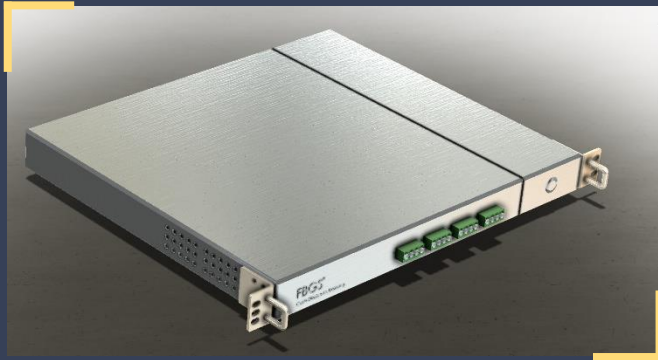


Combining the best of both distributed and quasi distributed sensing using multiple 1000's of FBGs

Measurement device closes gap / market need for monitoring lengths from 0.5km to 5 or even 10 km

Answers market needs with:

- . > 2000 FBGs in one fiber possible
- . Sensor spacing from 4cm to 10's m
- . Sensor lengths from 50m to 5km (longer on request)
- . Measurement speed for big networks >20Hz for 2000 sensors
- . Single WDM section measurement speed up to 1kHz



Preliminary design

Parameters	FBGS INFINITY-SCAN
Total number of sensors	2 000
Maximum number of WDM-sections	25
Sensor length range	25 m > 1 000 m
Minimum distance between WDM-sections	1 m
Wavelength range	1 510 nm – 1 590 nm
Wavelength precision (1s)	± 3 pm
Wavelength linearity	10 pm
Absolute wavelength accuracy	40 pm
Minimum wavelength spacing	0.8 nm
Dynamic range	>30 dB (user selectable control)
Maximum sampling rate (all sections)	20-50Hz at 2000 sensors (single section 1kHz)
Degree of polarization at the output	< 5%
Optical connector	LC / APC
Laser class (IEC 60825-1)	1

↓ Parameters are preliminary and subject to changes

Application fields



Civil engineering

- . Dam monitoring
- . Roads & bridges monitoring
- . Measurement in mines and tunnels
- . Intrusion detection
- . Perimeter security



Process industry

- . Fire detection (tunnels, mines)
- . Temperature sensing
- . Liquid level sensing
- . Leak detection



Energy

- . Oil & gas pipeline monitoring
- . Hydrogen tank monitoring
- . Partial discharge in power cables
- . Flexible pipelines
- . Energy infrastructure monitoring



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