AGRICULTURE

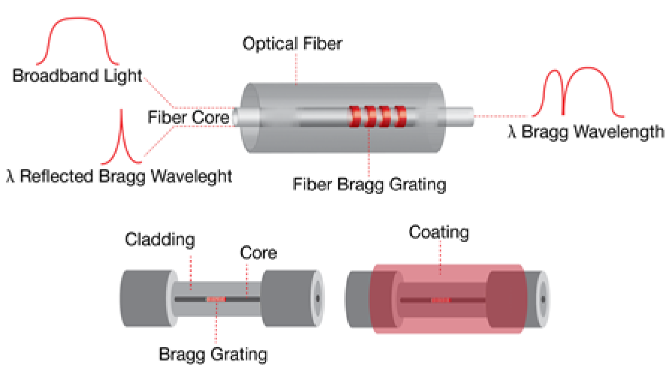
From CMS to Soil: Using Sensor Technology to Optimise Irrigation Systems in Lebanon

(//cds.cern.ch/images/CMS-PHO-GEN-2017-007-2)

One technician from UniSannio and two from LARI on the ground at the LARI experimental field in the Bekaa Valley to ensure seamless installation and functioning of the FOSS equipment. (Image: FOSS4I)

A collaboration of scientists is using CMS sensor technology to improve the efficiency of irrigation systems and help save water.

Various sensors, including fibre optic sensors (https://en.wikipedia.org/wiki/Fiber_optic_sensor), constantly monitor the extremely-controlled environment of the CMS detector (http://cms.cern/detector). Any unexpected fluctuations in humidity, temperature, or other factors could compromise its performance. Many systems in the detector are laced with metres of optical fibres (https://en.wikipedia.org/wiki/Optical_fiber) about 2 millimetres thick.



The CMS's fibre optic sensors use fibre Bragg gratings (FBG) (https://en.wikipedia.org/wiki/Fiber_Bragg_grating), a sensing technique that was invented in 1978. To make an FBG sensor, microscopic reflectors are etched into the core of an optical fibre using a laser. When light is shone into one end of the fibre and the light meets an FBG sensor, some of it reflects back at a specific wavelength of light (determined by the spacing between reflectors) and the rest continues through the fibre (see diagram to the left). The reflected light reaches the sensors where a data acquisition system (DAQ) (http://www.ni.com/data-acquisition/what-is/) translates it into electric signals that can be analysed by humans.

A rise or fall in temperature will cause the optical fibre to expand or contract, respectively. This changes the amount of spacing between the reflectors, like how spots on a polka-dotted balloon will get farther apart as the balloon inflates. This change in separation will cause the DAQ to sense a shift in wavelength of the reflected light, signaling to scientists that the environment around the sensors has changed.

FBG's usefulness is not limited to the CMS, but due to the high cost of the DAQ its marketable potential has only been moderately explored—until now.

In January 2017, nine groups from Italy, Switzerland, and Lebanon (including CERN and CMS) signed on to start the FOSS4I collaboration (http://irc.uklebhub.com/foss4i): Fibre Optic Sensors System for Irrigation. The collaboration aims to create an optimised irrigation system by using the CMS's Fibre Optic Sensors System (FOSS) to monitor temperature, humidity, and other parameters in the soil of cultivated fields.

FOSS for I
Fibre Optics Sensor Systems for Irrigation

The FOSS can provide up to 100 kilometres of minimally-disruptive humidity sensors that do not need to be powered, making installation and operation much simpler than for the monitors that are commonly used today and require power every few yards. Ideally, the system will save water while also increasing crop yield by telling farmers when they can turn the irrigation water system on or off.

The FOSS4I project began in April 2016 with laboratory tests to make the FOSS compatible with Lebanese soil, particularly its high clay content; next, the FOSS was tested in experimental fields in Lebanon. Eventually, researchers would like to streamline the DAQ to make it more affordable, perhaps even integrating it with a smartphone app. They also hope to develop "smart fibres" that will be able to sense concentrations of fertiliser and pesticides in the soil.

Ideally, FOSS4I will stimulate much-needed job opportunities and technology-driven economic growth in Lebanon while helping to improve the FOSS in the CMS detector. Not only is CMS technology contributing to water-saving research, but that research is also giving back to the CMS.

(//cds.cern.ch/images/CMS-PHO-GEN-2017-007-1)

Representatives of the institutes involved in the "Fibre Optic Sensor Systems for Irrigation" (FOSS4I) project met on 11 January in Beirut, Lebanon, to sign a collaboration agreement. (Image: Georges Abi Aad/UKLTH)

Find out more:

- How can high energy physics help the water shortage? (https://home.cern/about/updates/2017/01/how-can-high-energy-physics-help-water-shortage), Corinne Pralavorio (2017), CERN Updates
- FOSS4I - IRC (https://www.youtube.com/watch?v=8Ir6-3Wp_1E) (video), UK Lebanon Tech Hub (2017)
- "Fiber optic sensors structural monitoring of the beam pipe in the CMS experiment at the CERN (http://ieeexplore.ieee.org/document/7322062/)", F. Fienga et al (2015), IEEE
- FBG Optical Sensing Overview (https://www.youtube.com/watch?v=ZKsInPJ7ilk) (video), National Instruments (2011)

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