

# ***Fibre Optic Sensors (FOS) for ITk humidity monitoring – Update***

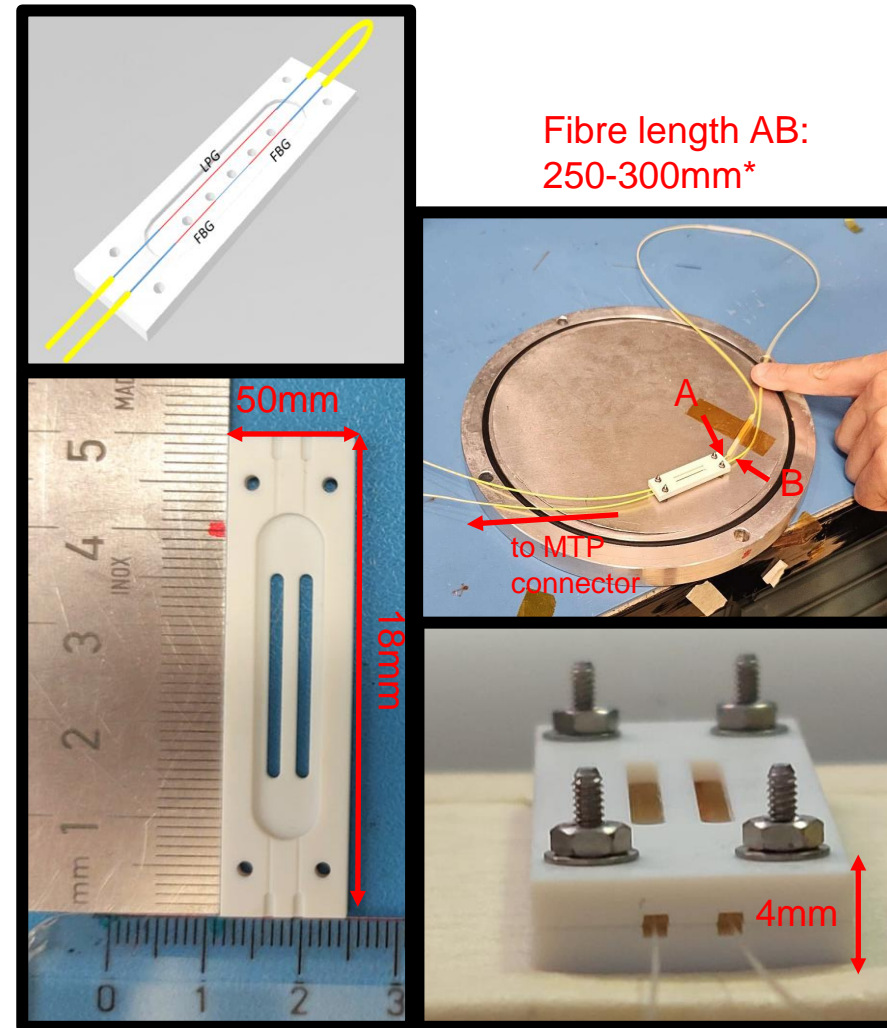
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Unwuchola<sup>2</sup>, Xola Mapekula<sup>1</sup>, Matt Connell<sup>1</sup>,  
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# The FOS Package

## The FOS package:

- 1x Pt10k – conventional temperature sensor
  - 1x Honeywell HIH400 – conventional humidity sensor
  - 1x LPG (long period grating) – FOS to measure humidity
  - 2x FBG (Fibre Bragg Grating) – 1 Radiation-soft (to measure dose), 1 Radiation-hard (to measure temperature)
  - 2x Neoceram plates (50x18x4mm), tightened with titanium screws
- NOTE: fibre **minimum** bend radius 15mm

\*Discussed further at end of talk



Package dimensions

# Procurement Status



- All ingredients are ordered up to 25%
- Final FDR concerns need to be addressed before 75% order

Item	Source	#	25%	Status	75%	Status	Lead time (weeks)
MTP Connector	Via CERN	12	-	-	-	Arrived	3
LPG	University of Sannio	64	16	Ordered: 21 Dec 2023	48	To order	7 – 14
FBG Radiation soft	FiberCore, FBG UV from Fibercore B/Ge 1250/1500 fiber, <b>Laser Components</b>	64	16	Ordered: 23 Jan 2024	48	To order	6-8
FBG Radiation hard	FBG FEMTO written on Fujikura rad-hard fiber RRSMB from <b>Engionic Femto Gratings</b>	64	16	Ordered: 23 Jan 2024	48	To order	6-8
NeoCeram Plates	TOP SEIKO CO., LTD	70	-	-	-	Ordered: 13 December 2023	10
PEEK Wire, type 0	Polyflour	-	-	-	1km twisted double 1km twisted triple	Ordered: 08 August 2023	18
HIH4000	RS-Online	64	16	Arrived	48	To order	1
Pt10k	IST-AG P10K.520.2K.Y.1400.D.S	64	16	Arrived	48	To order	-

**25% FOS production to begin as soon as FBG and LPGs are delivered.**

## Production process

- Package assembly: **2-3 hours**
- Calibration tests: **3 days**
- Packaging: **1 hour**
- Currently done in batches of 2 sensors – looking to move to 4

## Personnel at CERN

FOS packages are assembled at the EP-DT lab, Meyrin Bdg. 168, R-G14

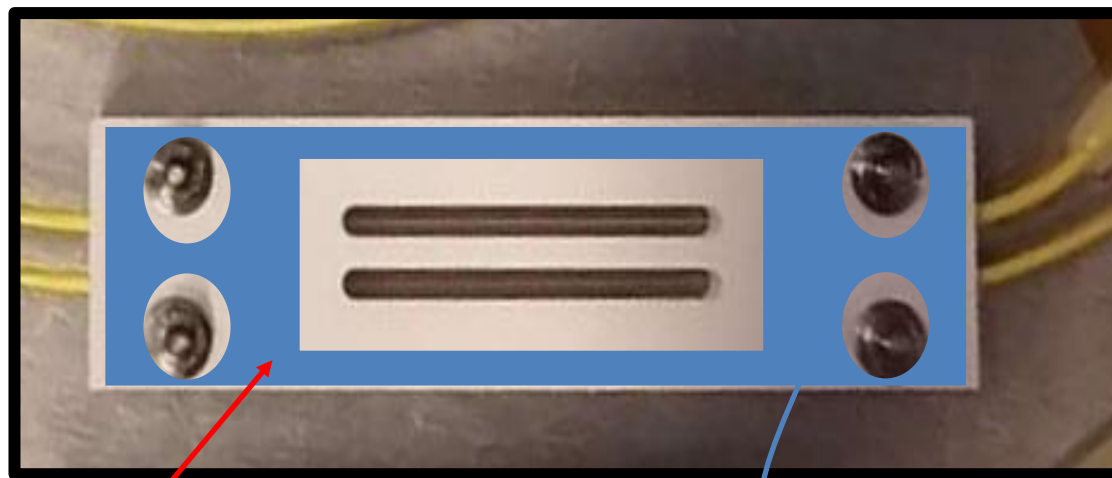
- Xola: Present – July 16<sup>th</sup>
- Doornull: Feb. 5<sup>th</sup> – May
- Matt: Feb. 2<sup>nd</sup> – April 30<sup>th</sup>
- 2 more students will be trained in FOS assembly.

## Code package

- Automates full process of raw data
- Goal is for it to be easily downloaded and used by non-experts.

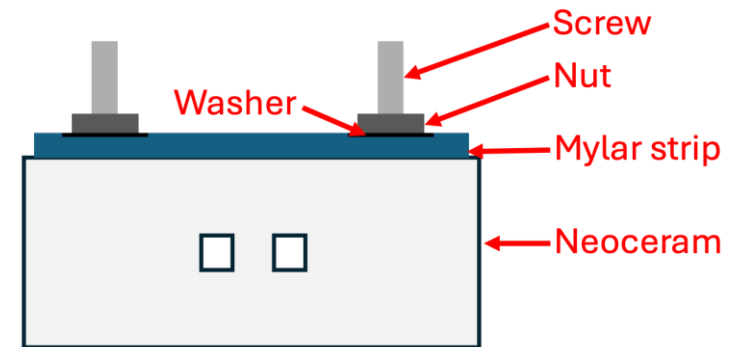
## Issue raised recently by Strips

- Titanium screws may become charged under radiation.
- Must be grounded to avoid this.
- Proposed solution: use an aluminised Mylar strip and wire to ground the screws to the carbon fibre (CF) structure.
- Strip can be secured by the nuts
- Can be incorporated into the assembly process.



Aluminised mylar strip

Grounding wire to carbon fibre (CF)



Viewed from the side

Designs not finalized – the holes around the screws are exaggerated to make screws visible (LEFT) and thickness is exaggerated (RIGHT)

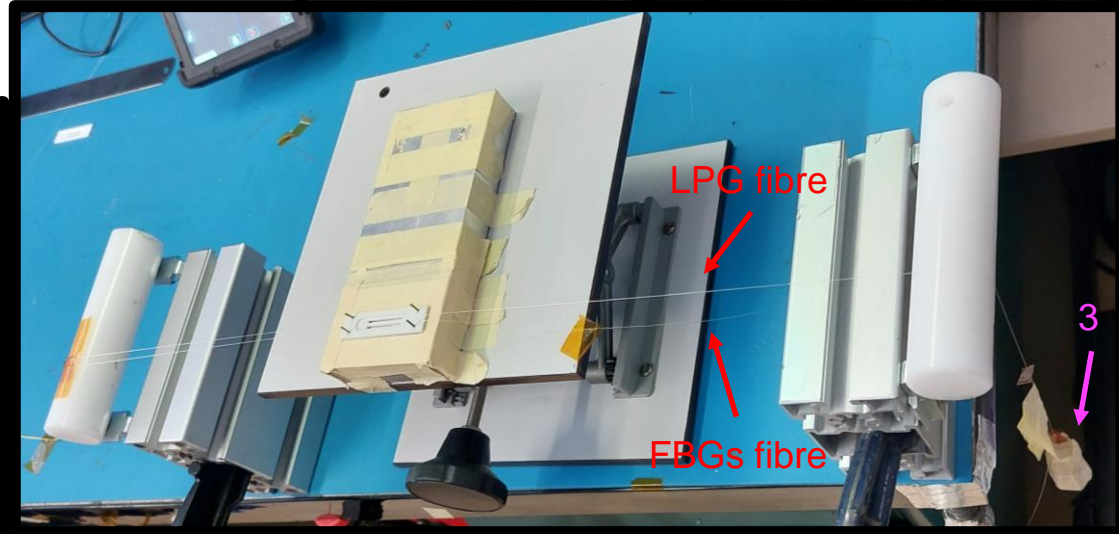
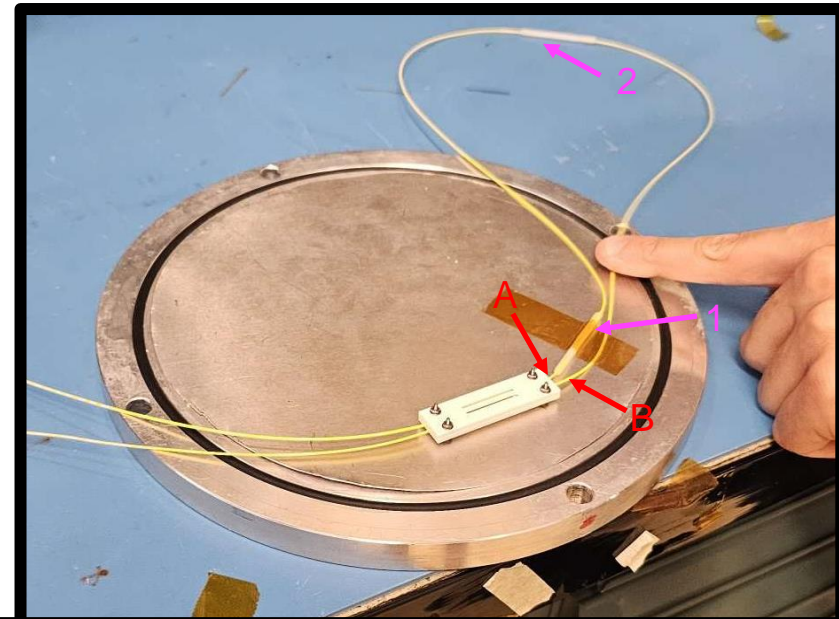
Minimum bend radius 15mm

Fibre length AB: 250-300mm

## Securing sensors in the package:

1. LPGs ordered with extra fibre spliced to the sensor (hence splice 1).
2. LPG is on a separate fibre to FBGs – this is because it requires a pre-strain.
3. Sensors are secured in the Neoceram.
4. Finally, the two fibres are joined: (hence splice 2) – to fit in the splicer you need a decent length of fibre (bottom left image)

Bottom right: FOS assembly, pre-strain applied with a weight (3).



# Shortening the length AB

Minimum bend radius 15mm

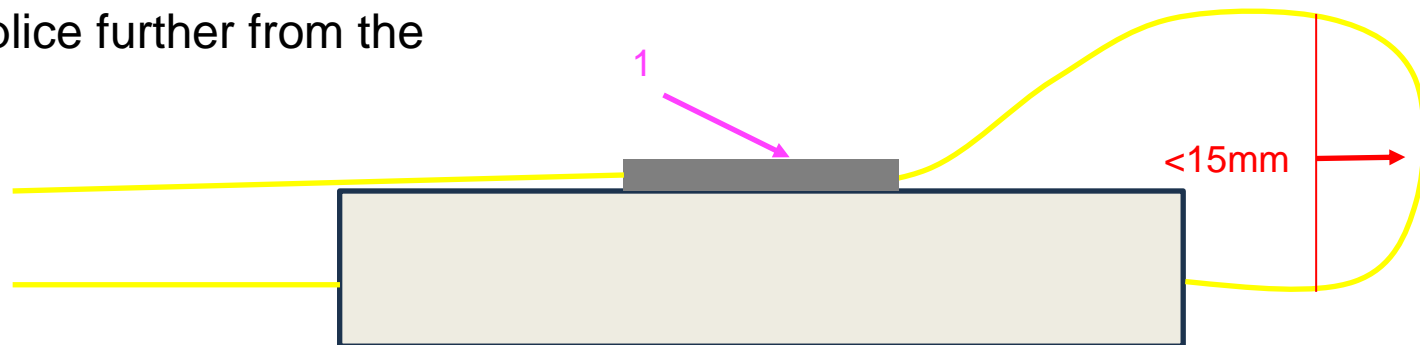
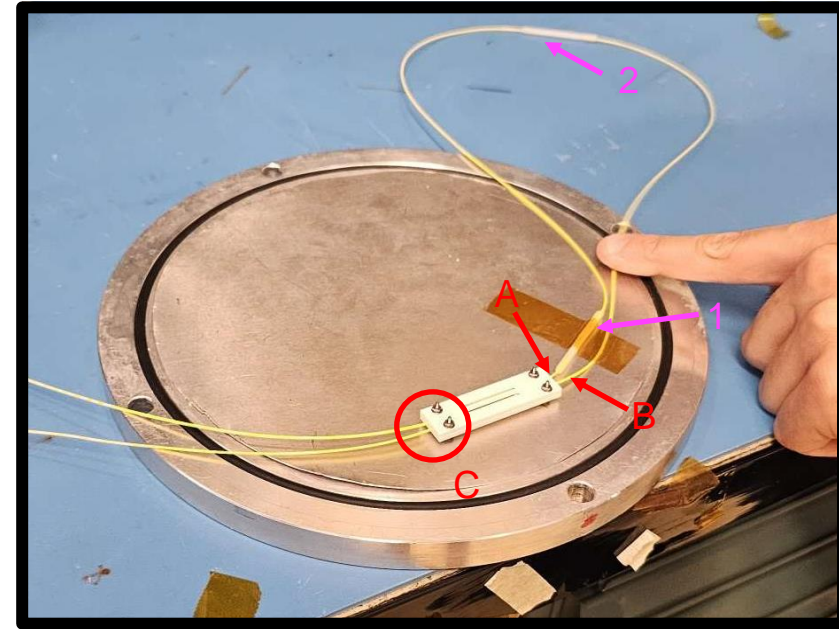
## Simple changes

- AB length easily reduced to 200mm
- Splices easily reduced to 30mm, potentially 20mm.

## Possible further changes

1. Different assembly process – splice fibres before applying pre-strain to LPG
  - Would require a lot of testing
  - Likely very tricky
2. Fold AB over the Neoceram
  - Must keep in mind min. bend radius
  - Request LPG splice further from the sensor itself

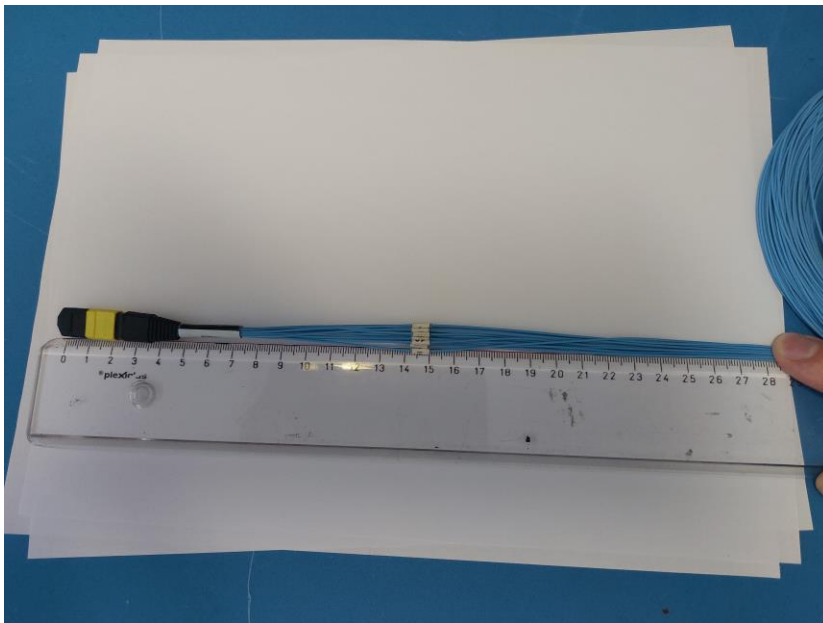
Fibre length AB: 250-300mm\*



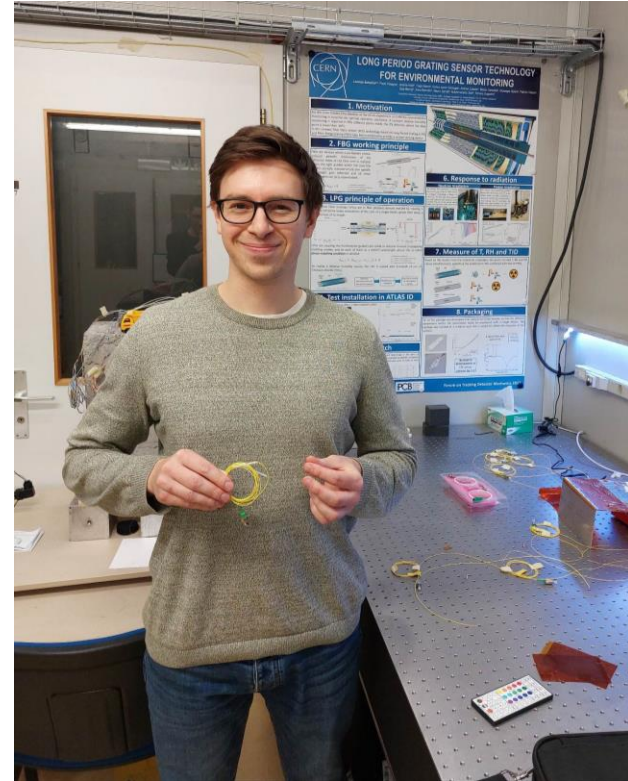
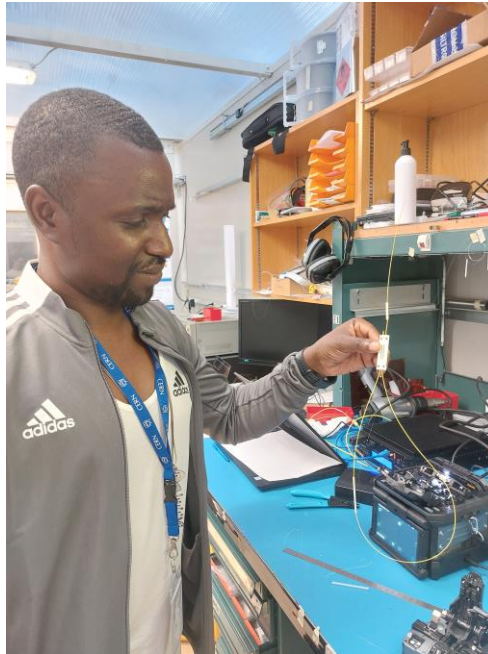
# *Backup*



- FOS are affected by temperature, dose and relative humidity.
- Knowing initial values of these variables, the combination of LPG and both FBGs can be used to extract variations in all three variables.



Thank you!



## Code package

1. Takes in raw spectra (LabVIEW, enLIGHT)
2. Develops calibration plots
3. Extracts Relative Humidity, Temperature and Dose from FOS
4. Compare to reference sensors
5. Returns all the above as series of plots

## Aims

- Make it easy to use by non-experts
- Automated spectra analysis for peak acceptance.