Status of the test of GEM and frames for CYGNO04

CYGNO Annual meeting - Frascati 04-06 December 2023

Luigi Benussi

Outlines

- CYGNO04 support frame design
- FBG…What are they?
- Preliminary results
- To-do list (asap)

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We start to make it seriously …

- GEM dimension 80x50 cm^2
- Stretching technology CMS like (already used in LIME)
- Triple GEM (2-2-2 gas gap)

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- GEM foils with low radioactivity Extra cleaning after the etching process to remove all the K residuals
- New internal frames material (FR4 in LIME)

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We start to make it seriously …

- What’s the CMS stretching technology?

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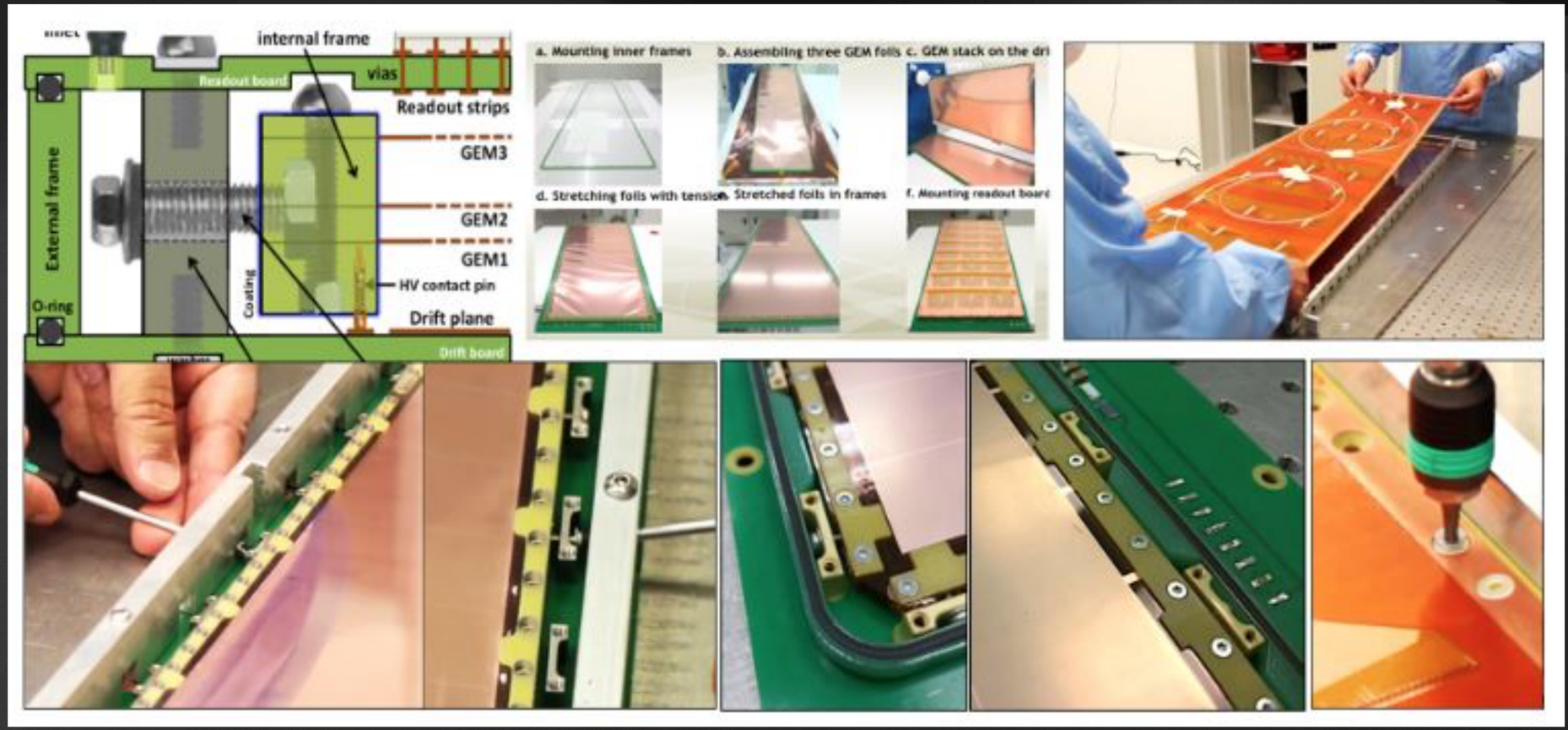
We start to make it seriously …

- What's the CMS stretching technology?



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We start to make it seriously …

- Each pulling screw will apply a mechanical tension of 10N which requires a strong mechanical structure to effort the total load
- Plexyglass frame as been decided to be chosen to avoid FR4

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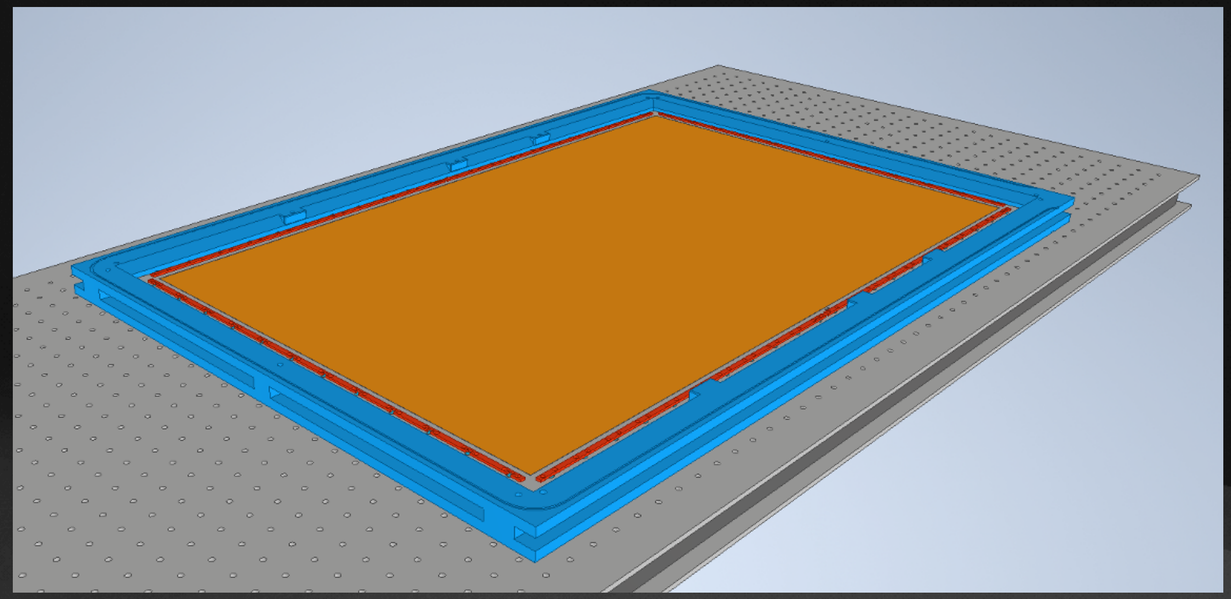
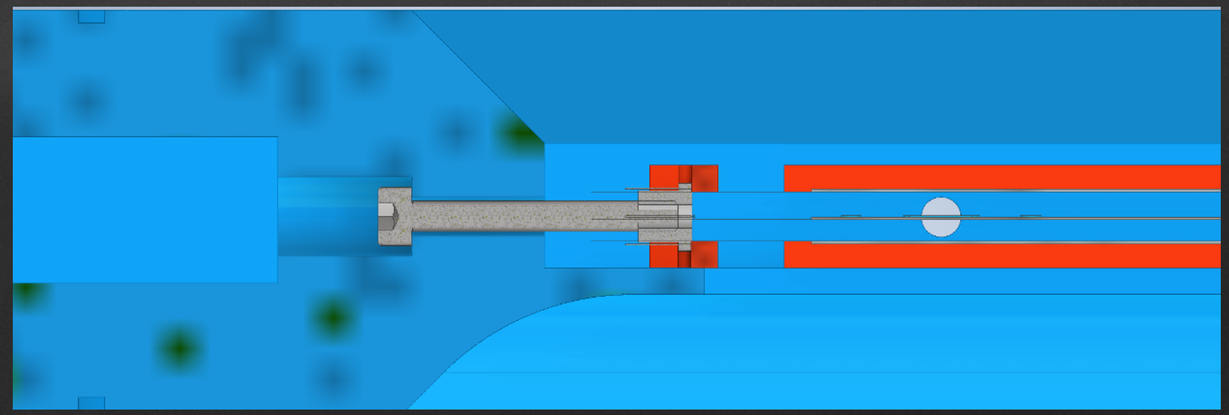
We start to make it seriously …

- Each pulling screw will apply a mechanical tension of 10N which requires a strong mechanical structure to effort the total load
- Plexyglass frame as been decided to be chosen to avoid FR4. This mechanical structure from now on will be called external frame





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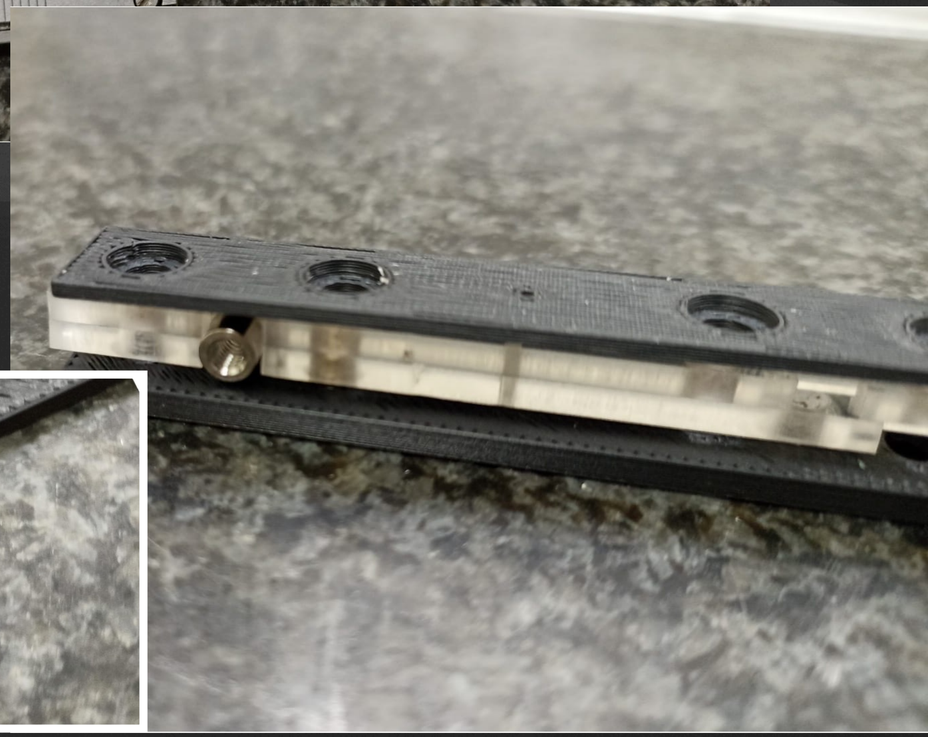
We start to make it seriously …

- Also internal frames have been redesigned to avoid FR4
- NB!! This material is not the final one. It is just a test to verify the feasibility to use 3D printing to produce the pieces. Under investigation a material to be proposed as the final choice



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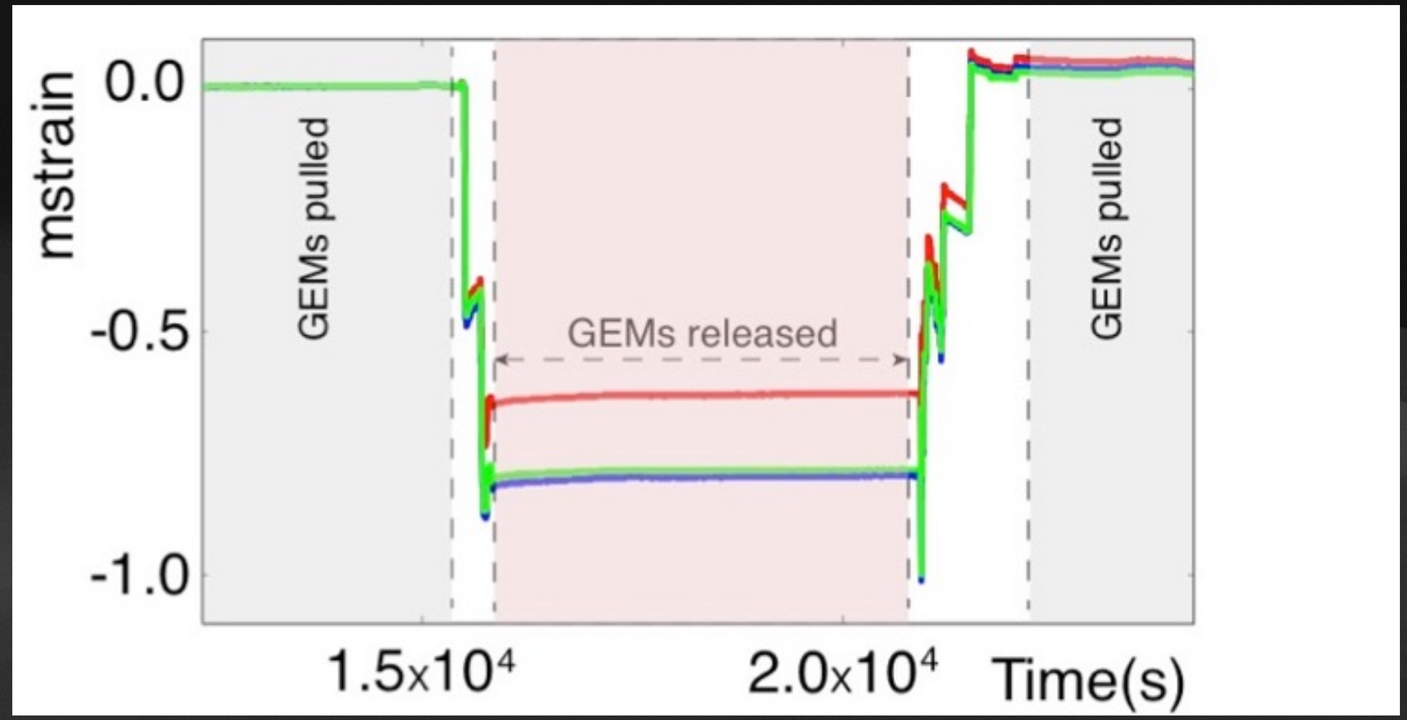
We start to make it seriously …

- To test that the external frame we are using FBG (Fiber Bragg Grating) sensors
- We used FBG to validate the CMS stretching technology and results as been published



A novel application of Fiber Bragg Grating (FBG) sensors in MPGD

Proceedings, 4th International Conference on Micro Pattern Gaseous Detectors (MPGD2015) : Trieste, Italy, October 12-15, 2015

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We start to make it seriously …

- What are FBGs?

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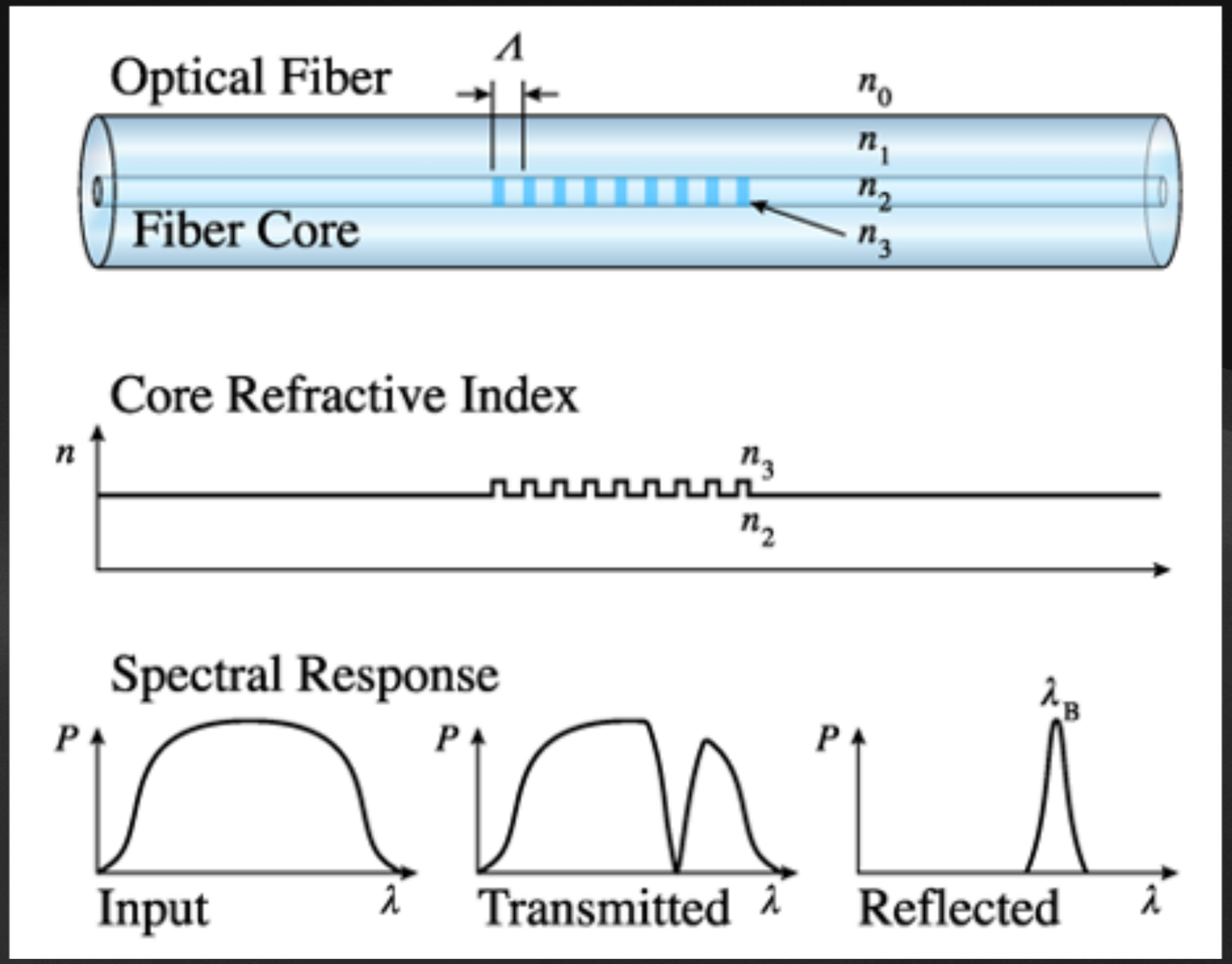
We start to make it seriously …

- What are FBGs?

A Fiber Bragg Grating (FBG) is a type of distributed Bragg reflector constructed in a short segment of optical fiber that reflects particular wavelengths of light and transmits all others. This is achieved by creating a periodic variation in the refractive index of the fiber core, which generates a wavelength-specific dielectric mirror. A fiber Bragg grating can therefore be used as a strain measurement tool, since variation of the Bragg grating translates into different light frequency response. The sensitivity of FBG in terms of strain (relative elongation w.r.t the initial position) is of the order of 0.1 micron.



Fiber Bragg Grating (FBG) sensors have been so far mainly used in high energy physics as high precision positioning and re-positioning sensor and as low cost, easy to mount and low space consuming temperature sensors. FBGs are also commonly used for very precise strain measurements

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We start to make it seriously …

- Test setup

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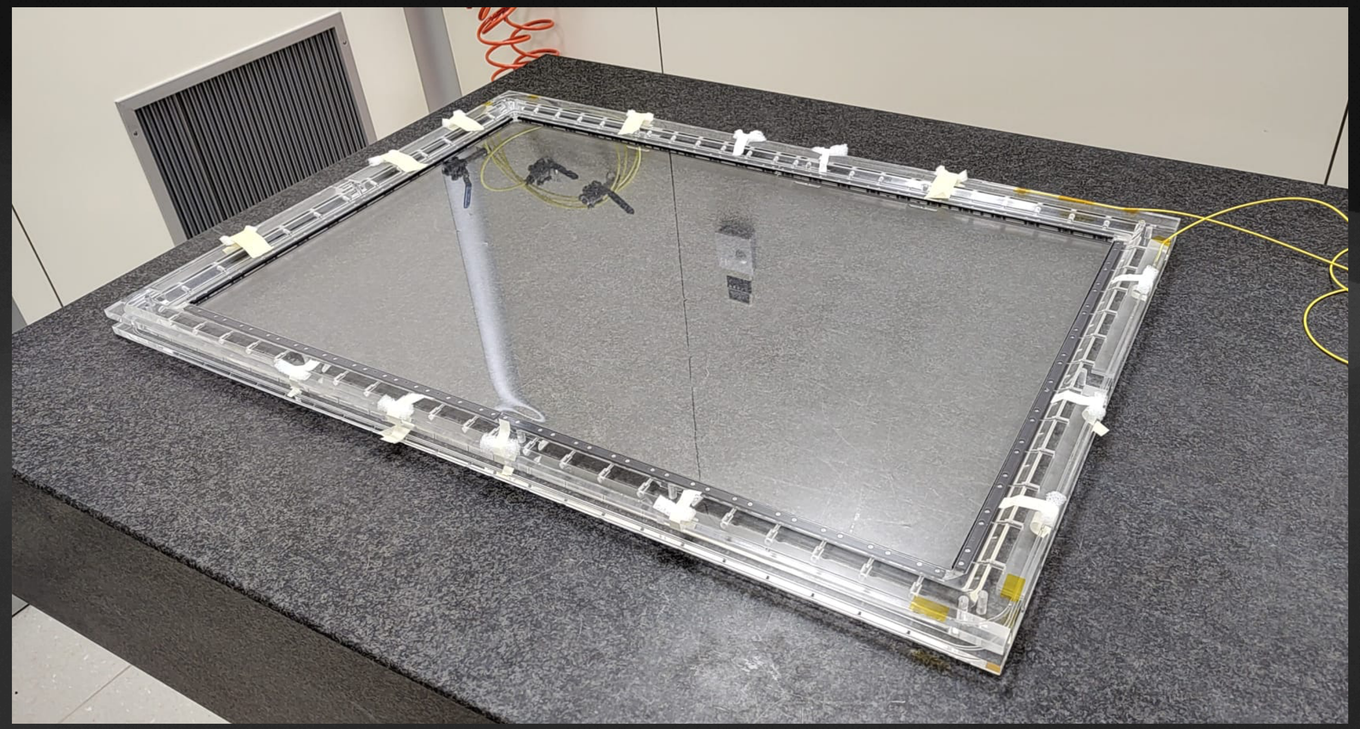
We start to make it seriously …

- Test setup
- FBG sensors are arranged in two chains of 5 FBG each.
- FBG sensors in a chain have different typical wavelengths
- The sensors are glued in the groove along the external frame perimeter.



CYGNO04

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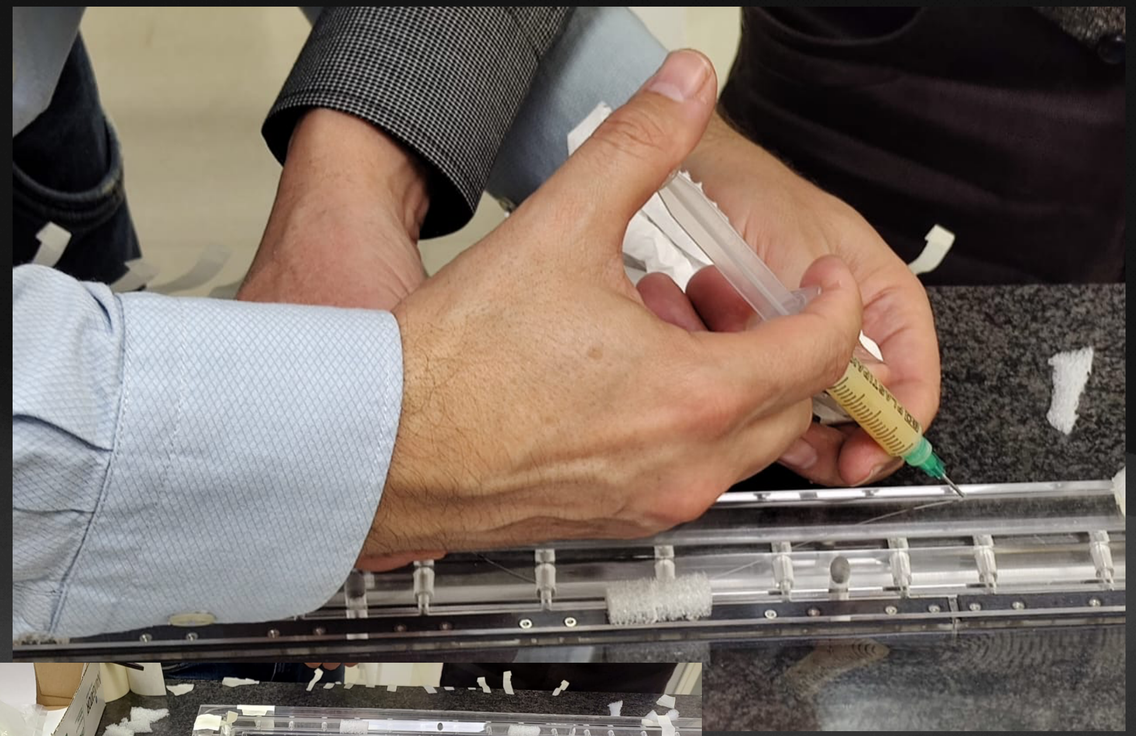
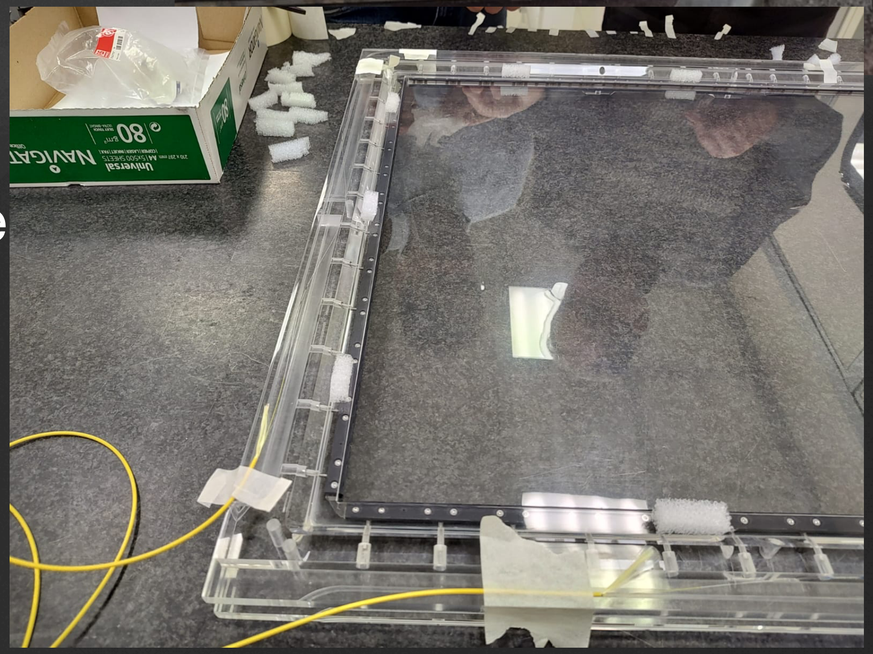
- FBG sensors are arranged in two chains of 5 FBG each.
- FBG sensors in a chain have different typical wavelengths
- The sensors are glued in the groove along the external frame perimeter.
- The GEM foils are replaced by a Mylar foil (110 μm thick) and stretched using the internal frame





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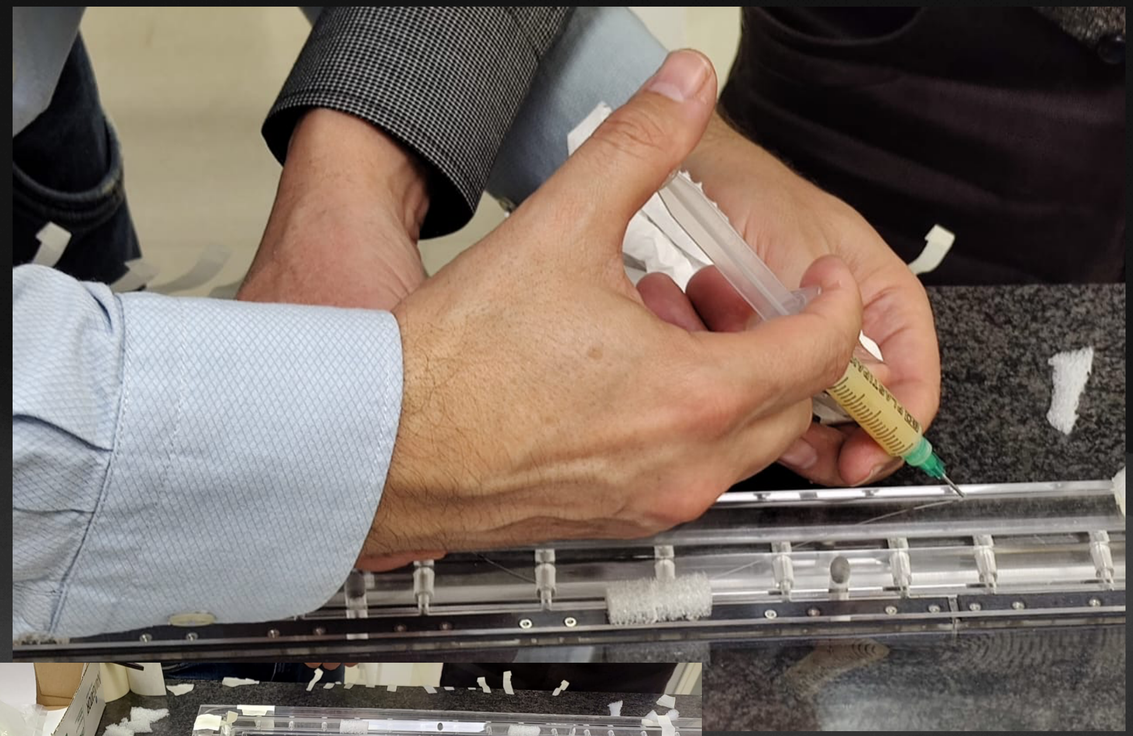

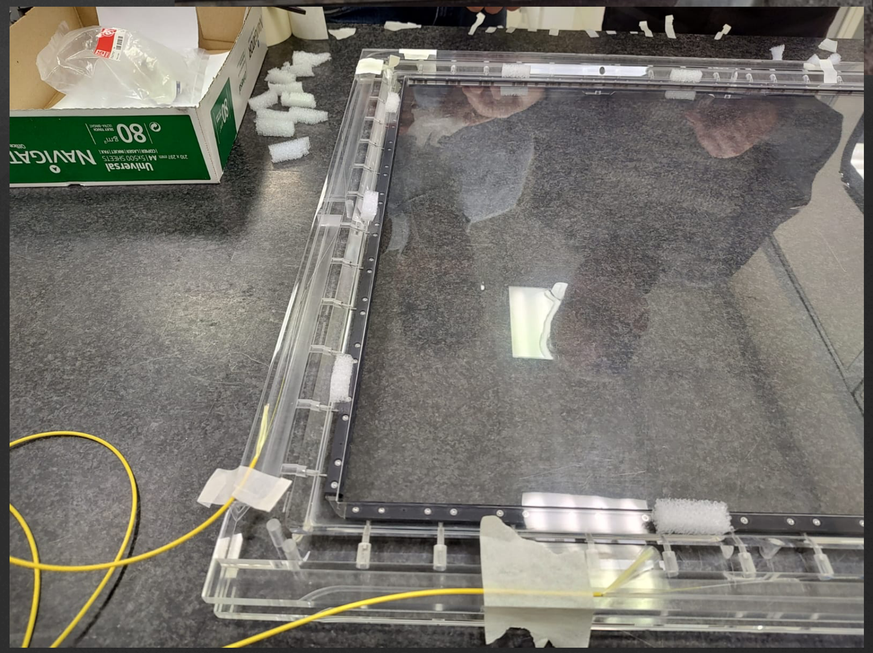

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We start to make it seriously …

- Test procedure

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We start to make it seriously …

- This is a preliminary test. The aim is to verify the sensitivity of the FBG for our purposes and to get some preliminary infos about the external frame design
- The FBG were reading during any operation done on the frame
- T, and RH on the room also monitored

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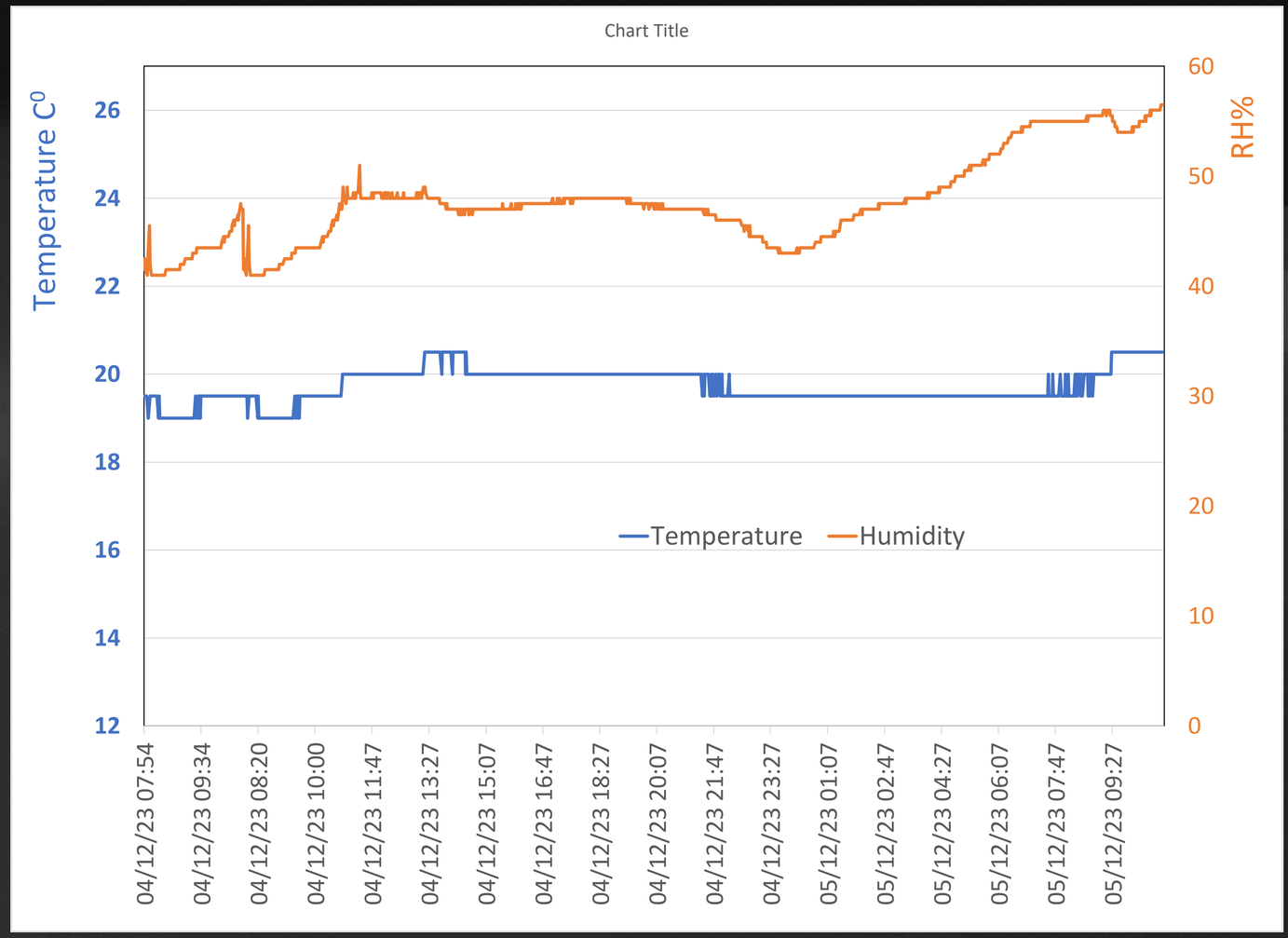
We start to make it seriously …

- Environmental status was quite stable. Temperature is the main source of systematic for this kind of test
- The test lasted two days



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We start to make it seriously …

- Preliminary results
- FBGs measure strain. For this particular FBG the strain is $1/10^9$ of the initial length.
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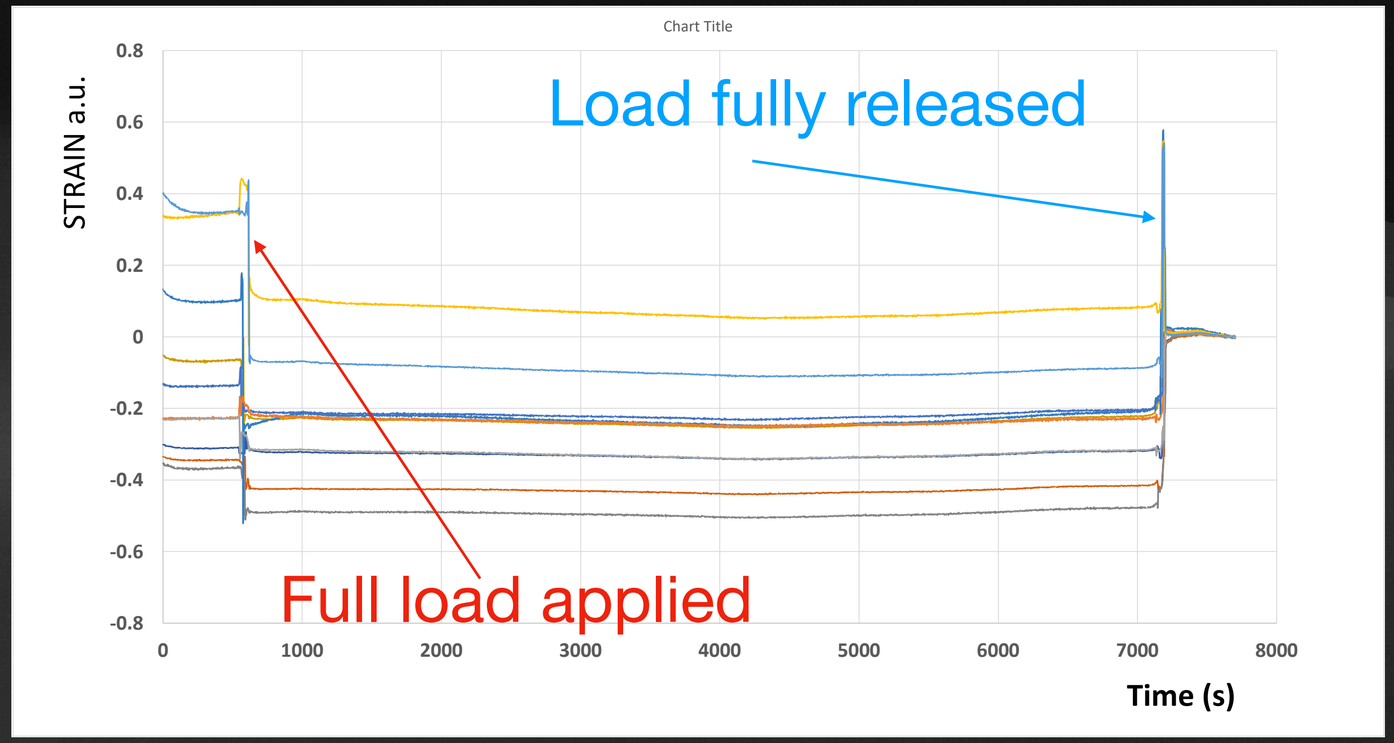
CYGNO04

We start to make it seriously …

- Preliminary results….and to-do asap

- The behaviour is very similar to the expected one. Due a mistake the gluing of the FBGs was done not with the foil fully unloaded
- However the main and good result is the stability of the FBGs response in the between of the two regions when the mechanical load has been applied and removed.

- We are planning a better and more complete test with two FBG chains (both faces of the frame) and on the fake GEM.



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We start to make it seriously …

- Concluding….
- So far so good. The frame design is demonstrated to fit the requirements to keep the load applied.
- The FBG on the frame will be kept there and the plan is to use them as monitor also in CYGNO04 final setup.
- Another and most likely final test will be done once the new internal frames with the new plastic material will be ready (March 2024?)

Big thanks to Daniele Pierluigi for the external frame and internal frame design. Big thanks to Roberto Tesauro and Emilaino Paoletti for helping in the mechanical assemble and to Roberto Campagnola for the help during the test…This made it a piece of cake