Construction Status of the GEM cylinders for the BESIII layer 2

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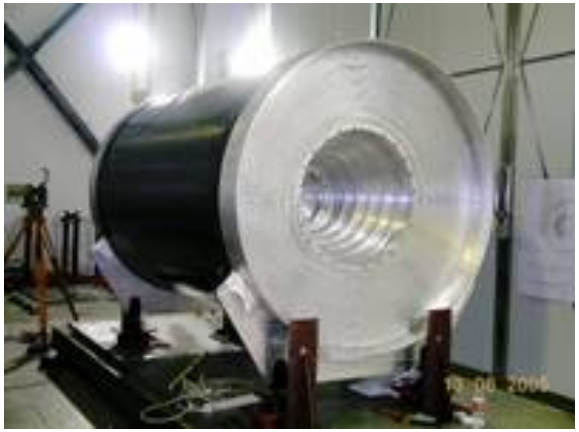
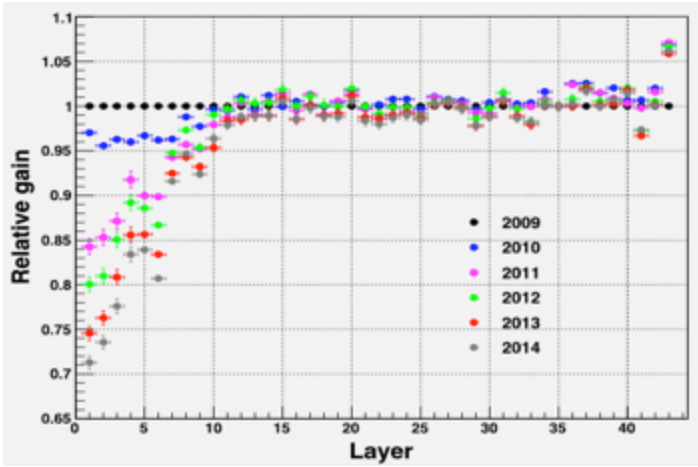
4th LNF Workshop on Cylindrical GEM Detectors,
Frascati, November 16th 2015

The BESIII CGEM Inner Tracker project

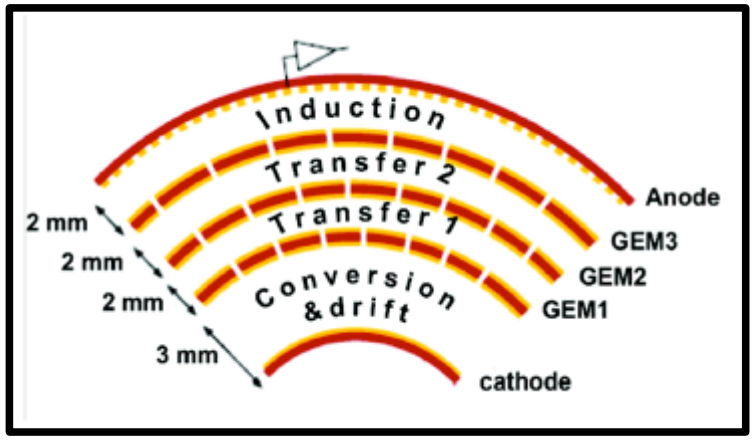


Due to the aging of the gas mixture, the inner part of the DC must be replaced



Requirements:

- Radii from 78 mm to 179 mm
- Geometrical acceptance: 93% 4π
- $\sigma_{r\phi}$~120 mm
- σ_z ~ 1mm
- X_0 < 1.5 %
- ~ 10^4 Hz/cm^2 rate capability



GEM:

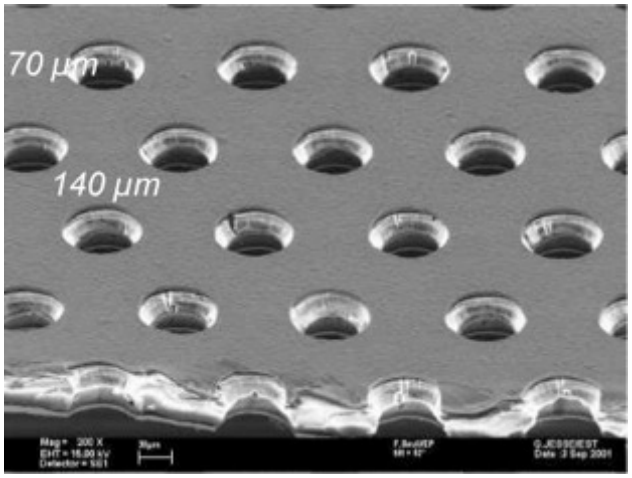
- 3 layers of CGEM
- X-V strips-pads readout

GEM: principle of operation

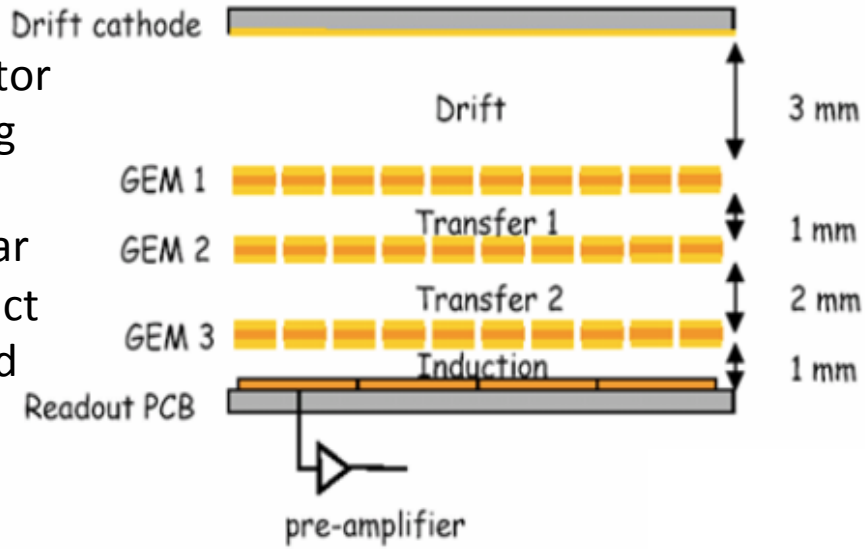
The GEM (Gas Electron Multiplier) [F.Sauli, NIM A386 (1997) 531] is a thin (**50 μm**) metal coated kapton foil, perforated by a high density of holes (**70 μm** diameter, pitch of **140 μm**) standard photo-lithographic technology.

By applying **400-500 V** between the two copper sides, an electric field as high as **~100 kV/cm** is produced into the holes which act as multiplication channels for electrons produced in the gas by a ionizing particle.

Gains up to 1000 can be easily reached with a single GEM foil. Higher gains (and/or safer working conditions) are usually obtained by cascading two or three GEM foils.

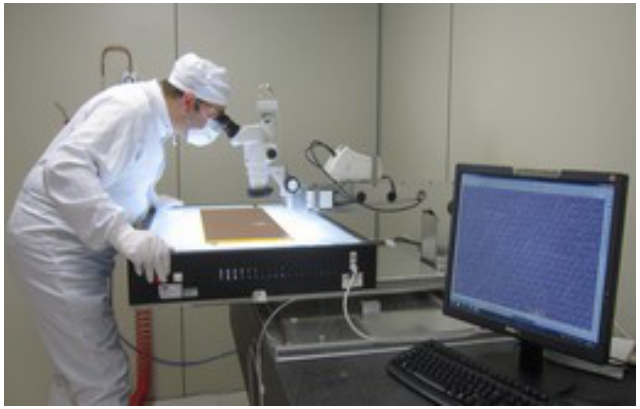


A Triple-GEM detector is built by inserting three GEM foils between two planar electrodes, which act as the cathode and the anode.

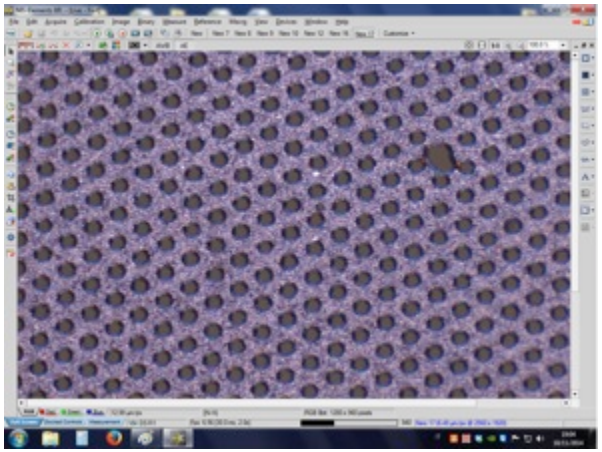


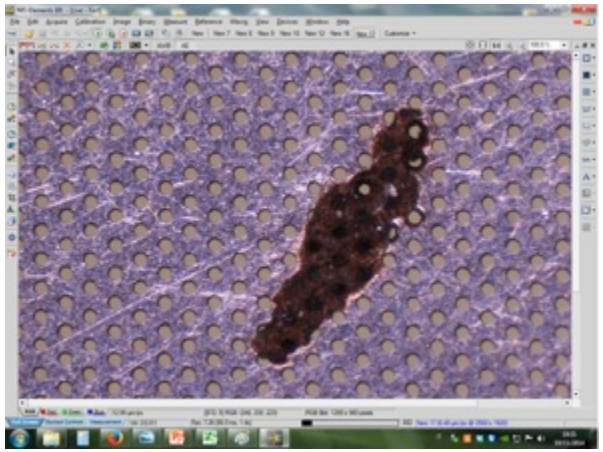
Quality check

The quality checks are the same introduced for the GEMs used in LHCb and for the ones used for the KLOE-2 Inner Tracker.
The foils are first optically checked on an enlightened table: the light points out mechanical defects (holes “connected”, black spots)

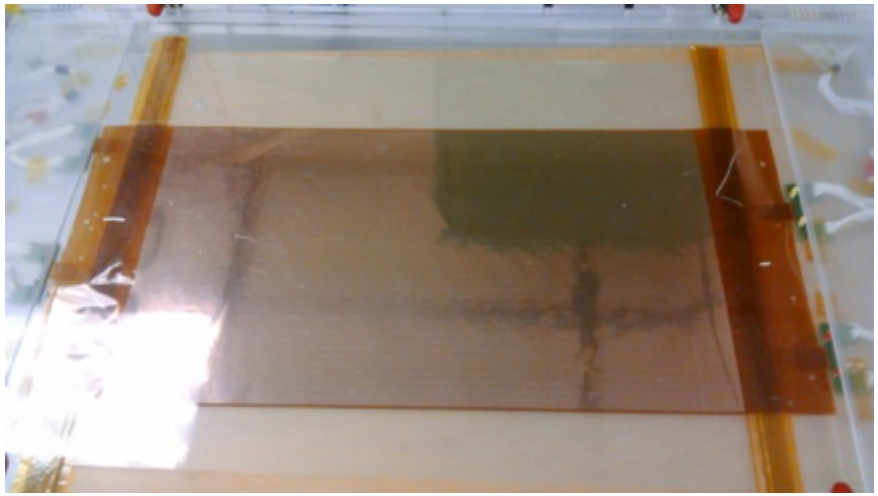


courtesy of KLOE-2



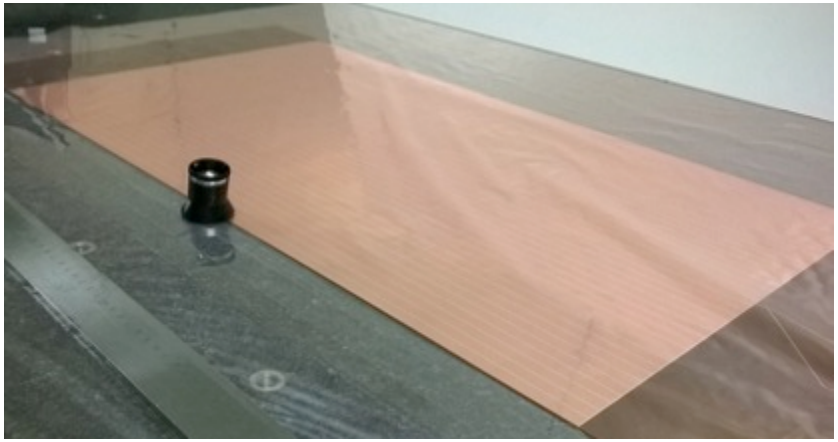


HV test performed in a N_2 environment, supplying each sector with up to 600 V. Discharge and current monitoring

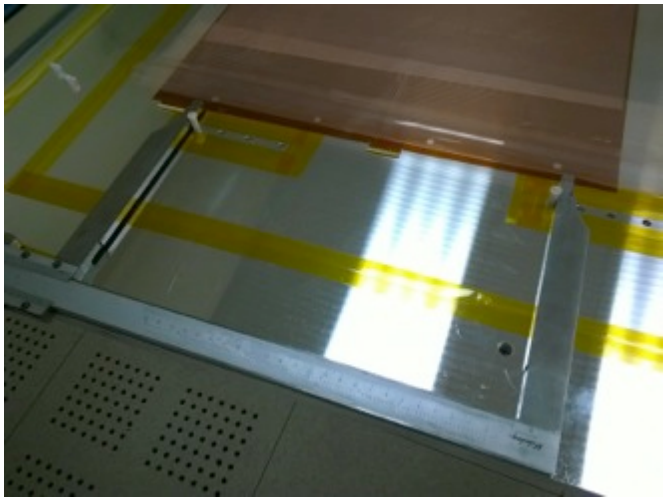


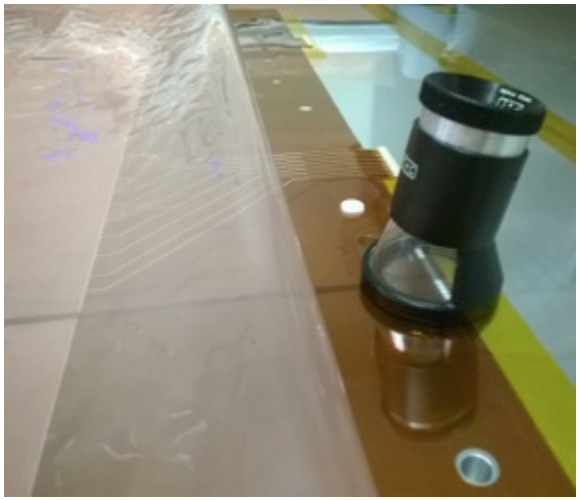
The intermediate step

We start from hand-made cutting of a single GEM foil.



Both long sides of a single gem are about 2.8-2.9mm wide

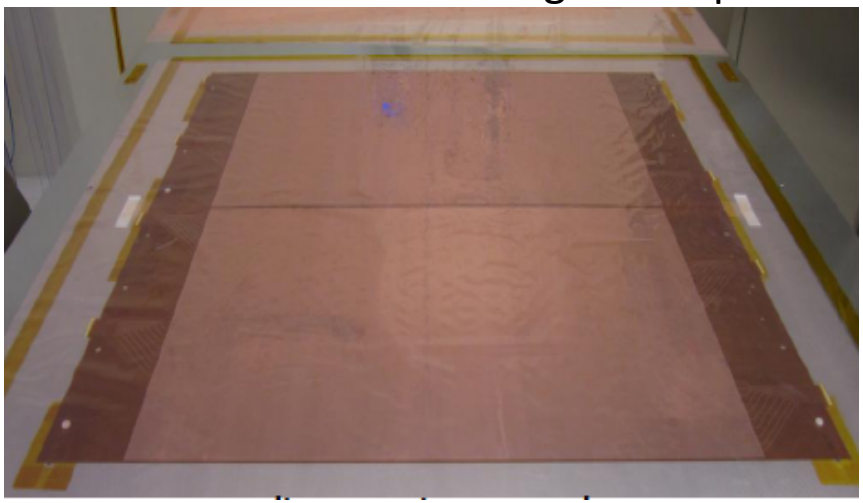


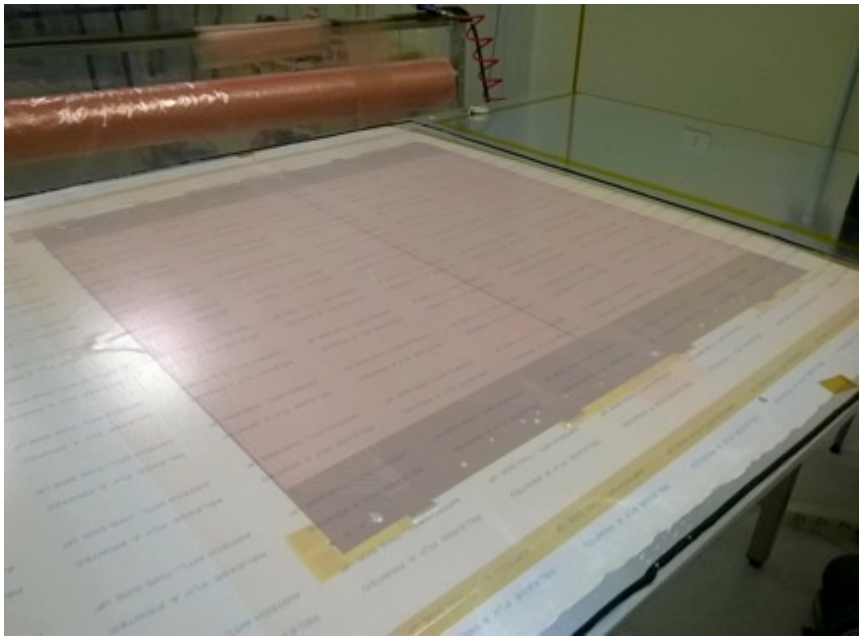


Foils spliced together on the planar gluing table

Planar gluing (GEM)

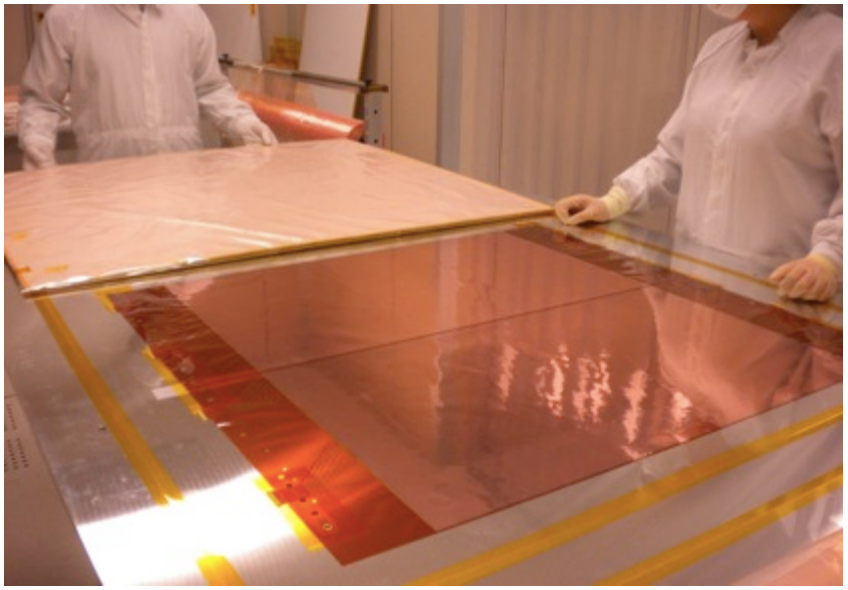
The foils are spliced together and then glued with an overlap of 3 mm. The epoxy is spread on a 2 mm wide region. The curing cycle occurs with the vacuum bag technique.

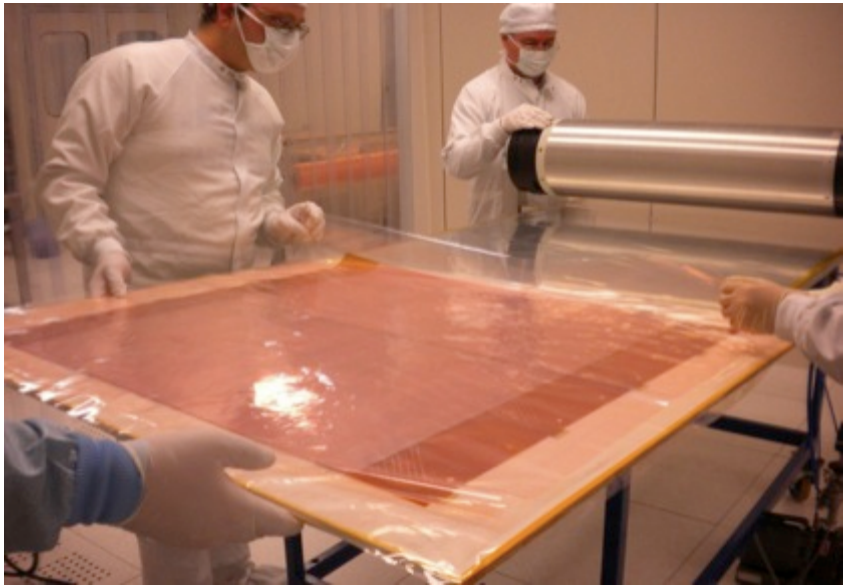


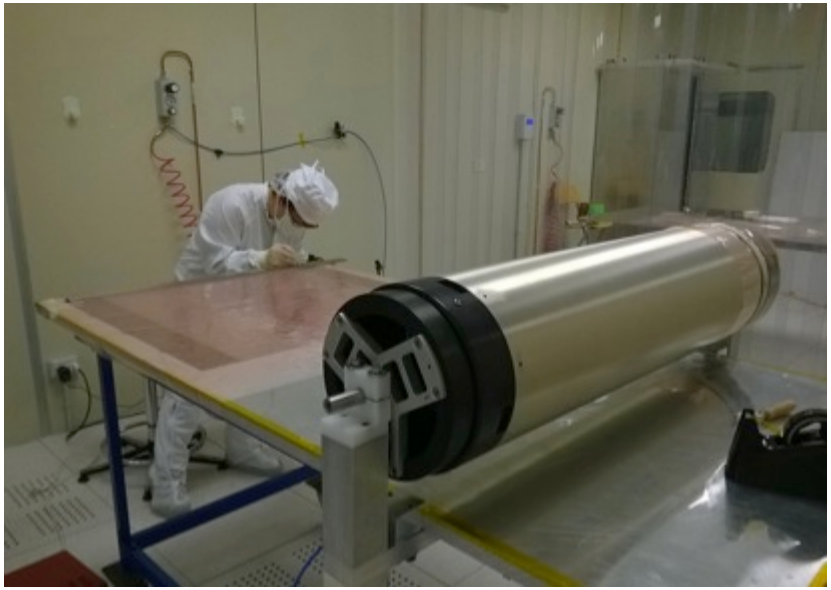


Cylindrical gluing (GEM)

Once ready, the large planar GEM is moved to the dedicated table and rolled on its mould

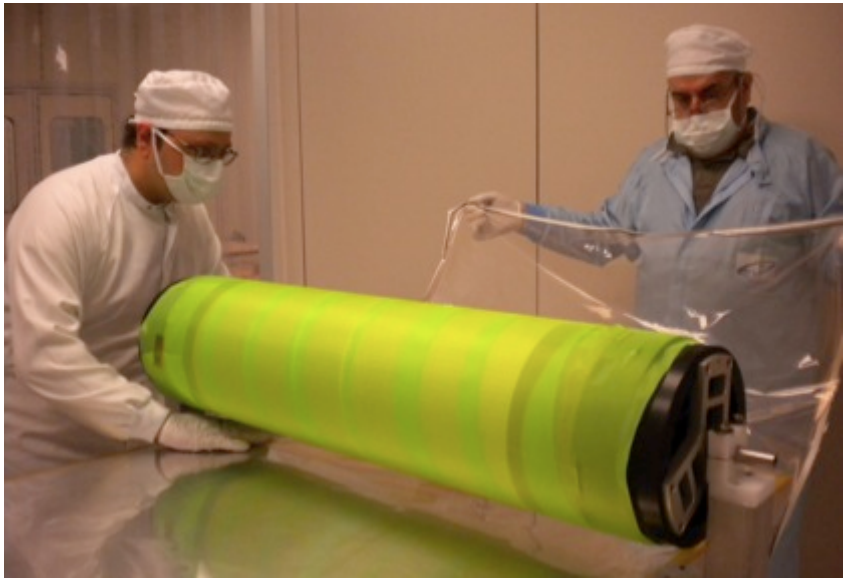


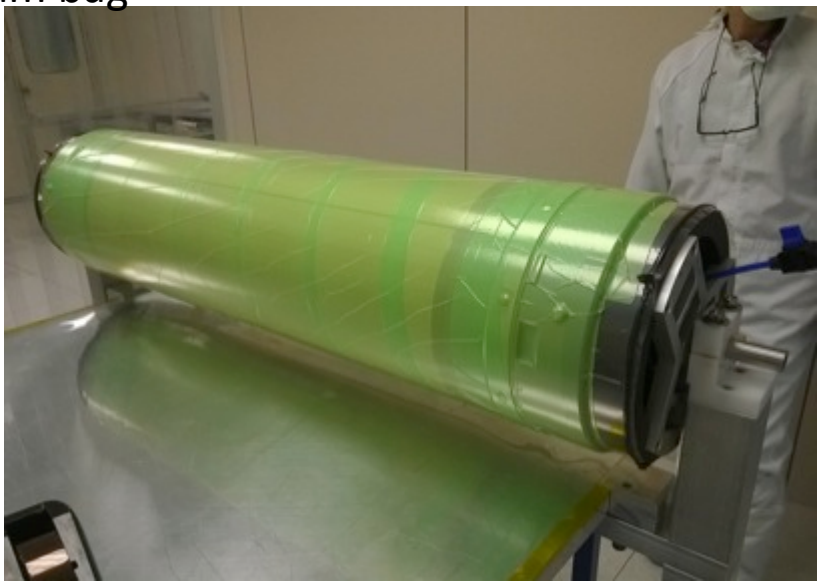


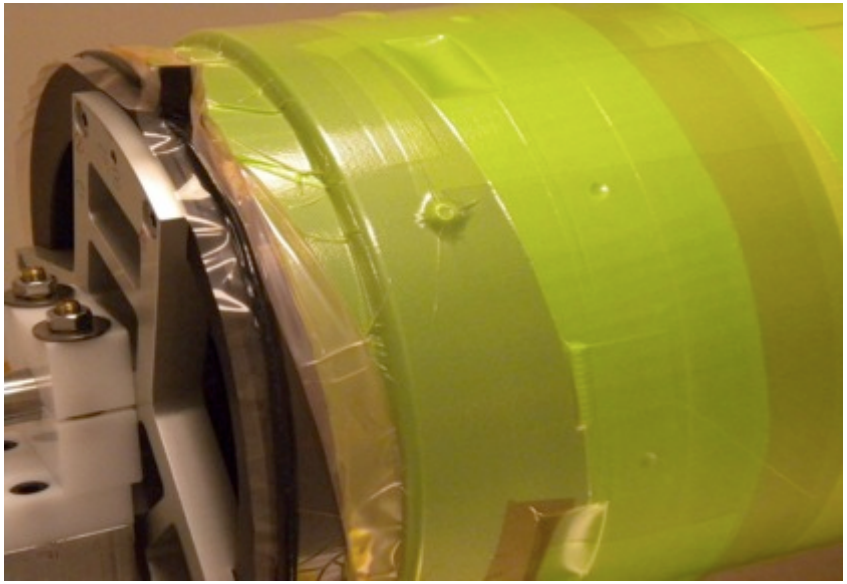


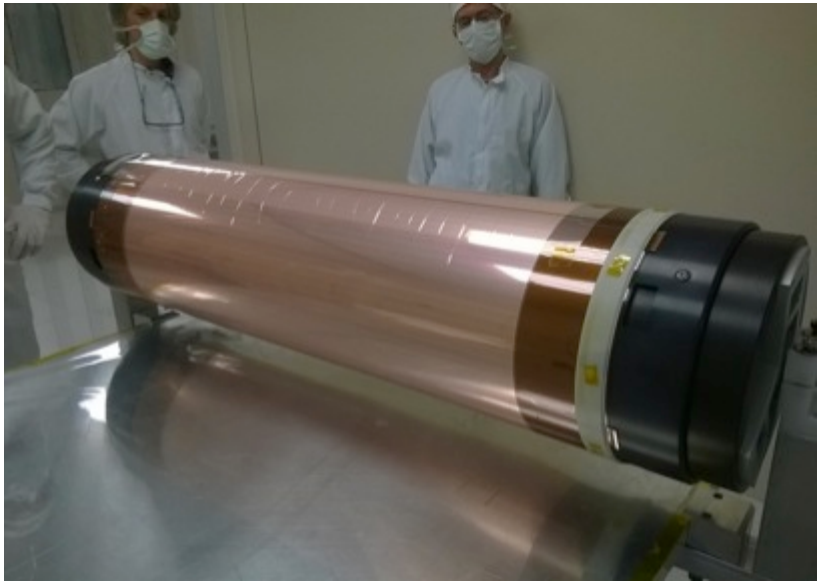
Cylindrical gluing (GEM)

The GEM is then wrapped with the geen tissue necessary to “drive” the air inside the vacuum bag



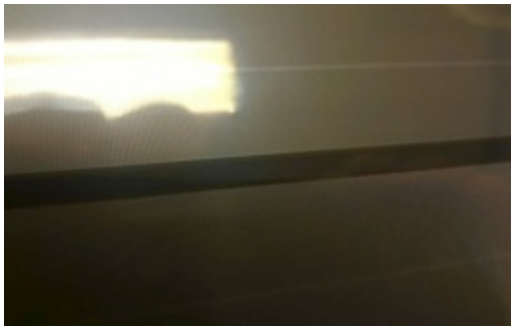




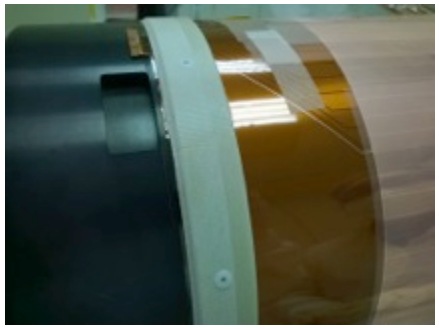


Cylindrical gluing (GEM)

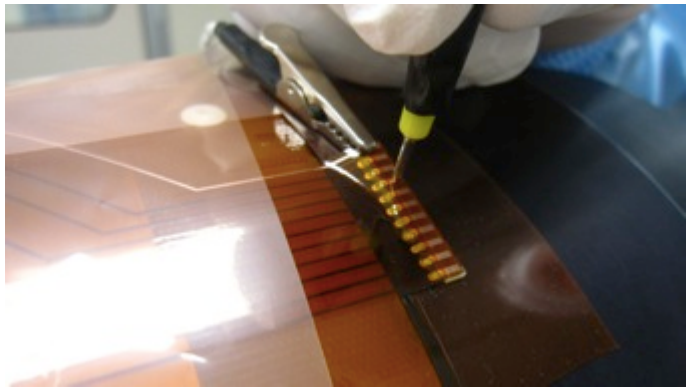
The first cylindrical GEM for the BESIII experiment



Detail of the overlap



The detail of external ring



A new HV test (< 1 nA @ 300 V in air) is done on the cylindrical GEM to check if any problem occurred during the curing cycle in the vacuum bag

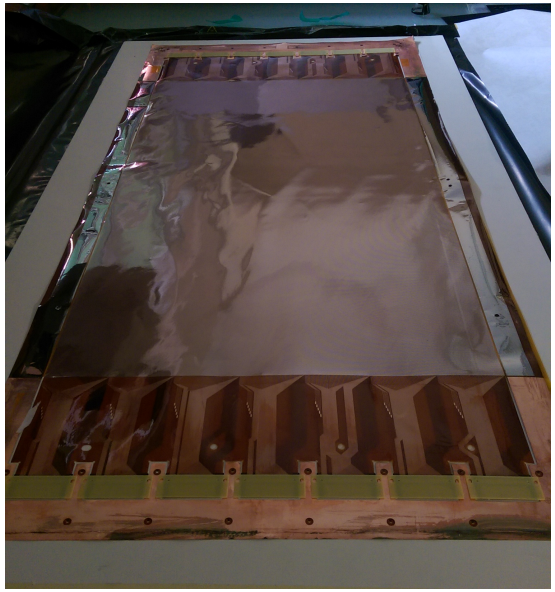
Cylindrical gluing (GEM)

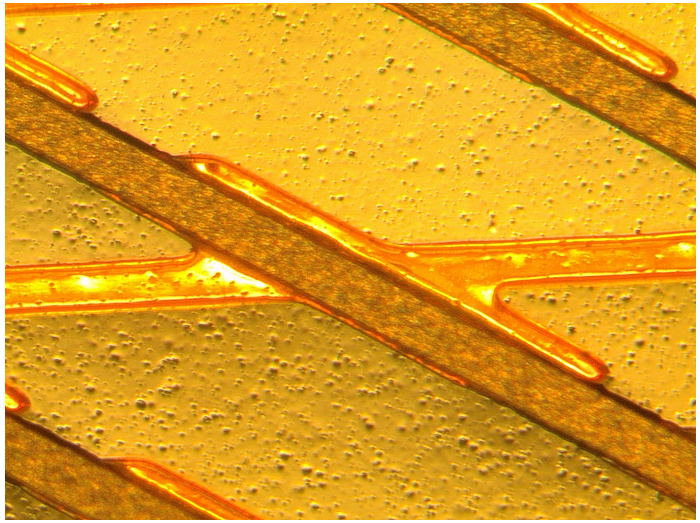
The three cylindrical GEMs are ready for the assembly in the vertical insertion machine

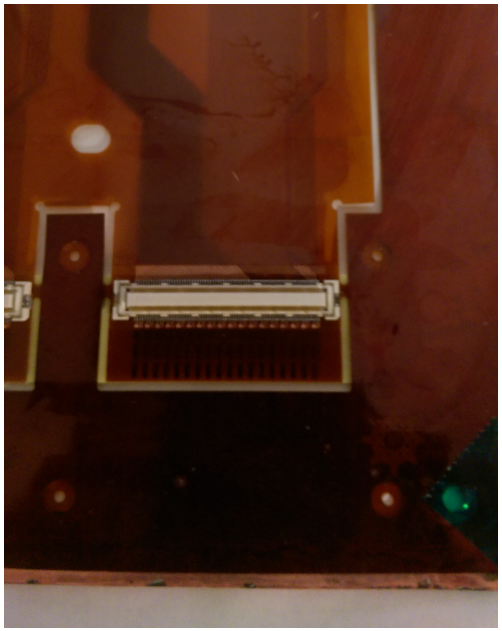
Status of the readout foils

Last update: November 11th

- A problem in the etching of the active area delayed the delivering of the foils
- The two foils are ready
- The connectors have been soldered







Status of the Vertical Insertion Machine

Drawn for the assembly of the KLOE-2 CGEMs, the VIM has been modified in order to match the geometrical parameters of the BESIII GEM foils.

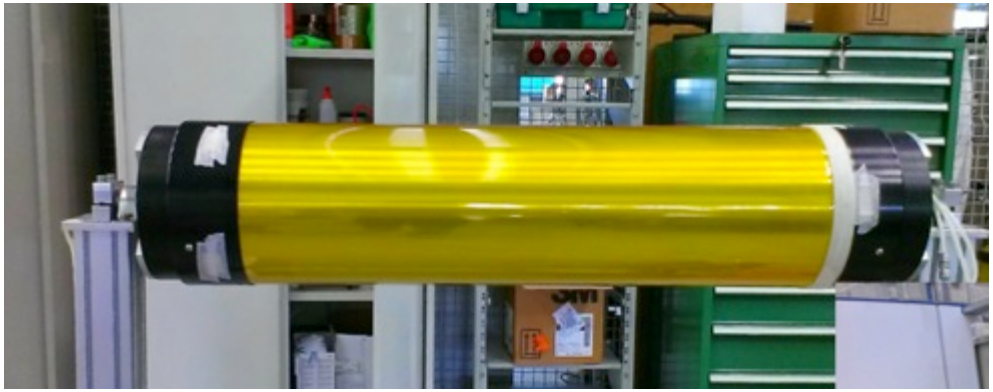
- The adapting flange to host the anode of the prototype has been realized and already mounted
- The height has been extended
- A check of the misalignment between the slide and the axis of the mould (< 0.1 mm along 1 m length) has been performed
- An "extension" of the mould flanges, needed to fix a polarization angle for the moulds during the assembly, has been delivered

Conclusions

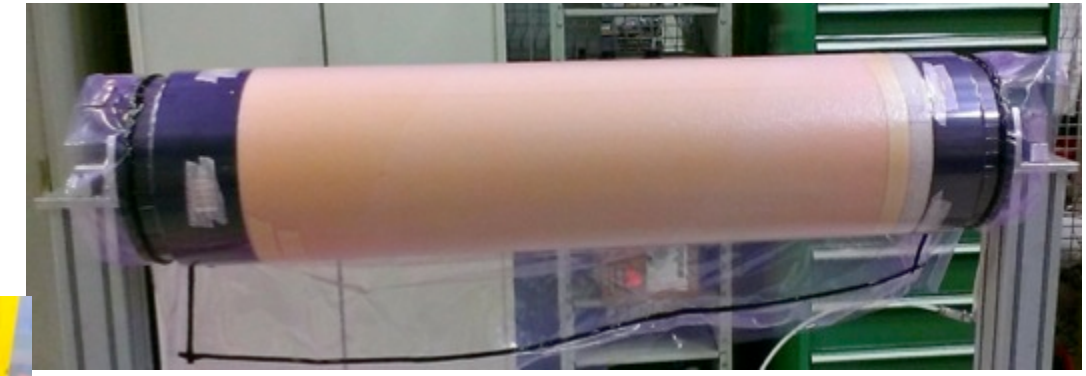
- The three cylindrical GEMs are ready on their moulds
- A first cylindrical cathode has been completed with the Rohacell lamination in Ferrara
- The readout foils will be delivered this week
- The construction of the cylindrical anode is scheduled for next week
- Finally assembly hopefully early next year

Spare

Cathode construction



- 12.5 micron kapton foil around the aluminum mold; that is the most critical part



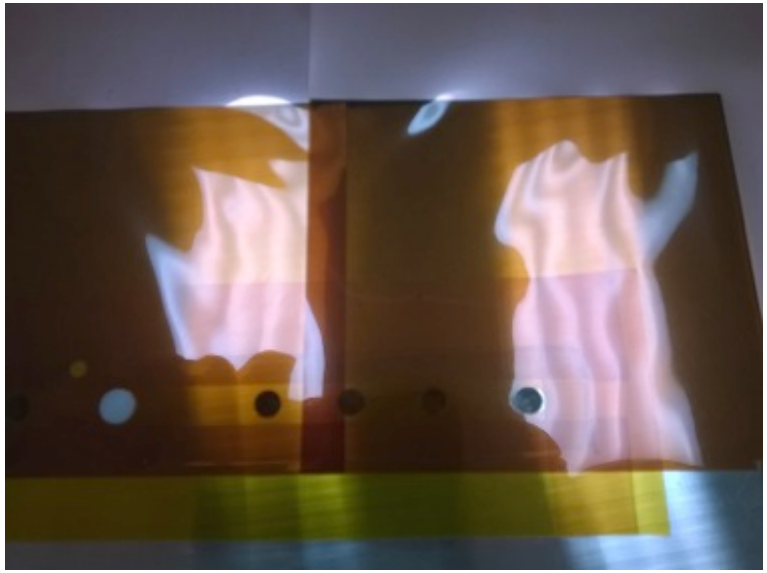
- the Rohacell plane is glued under vacuum on the kapton

- the Rohacell plane is machined with a high precision milling machine

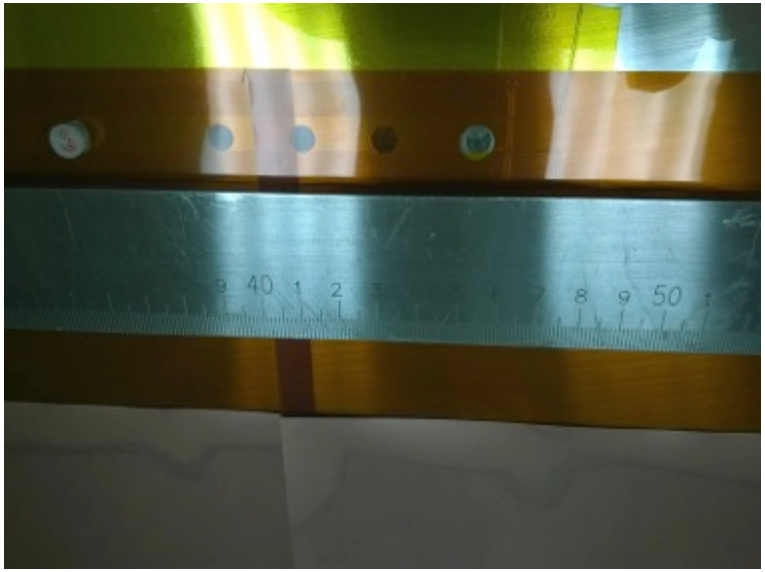
Picture from INFN-Ferrara assembly site

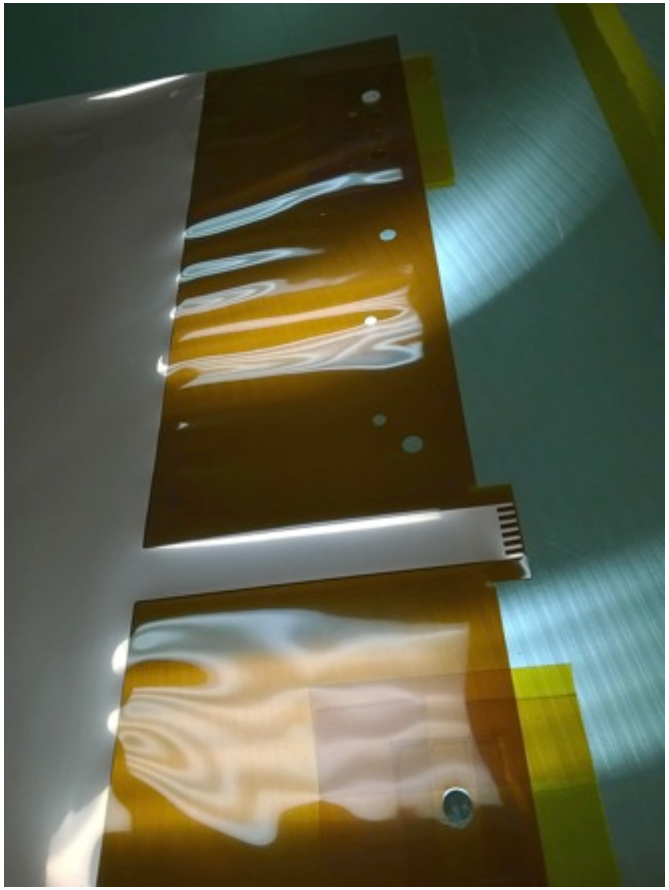
A new cathode has been built with an overlap of 10 mm

Cathode construction



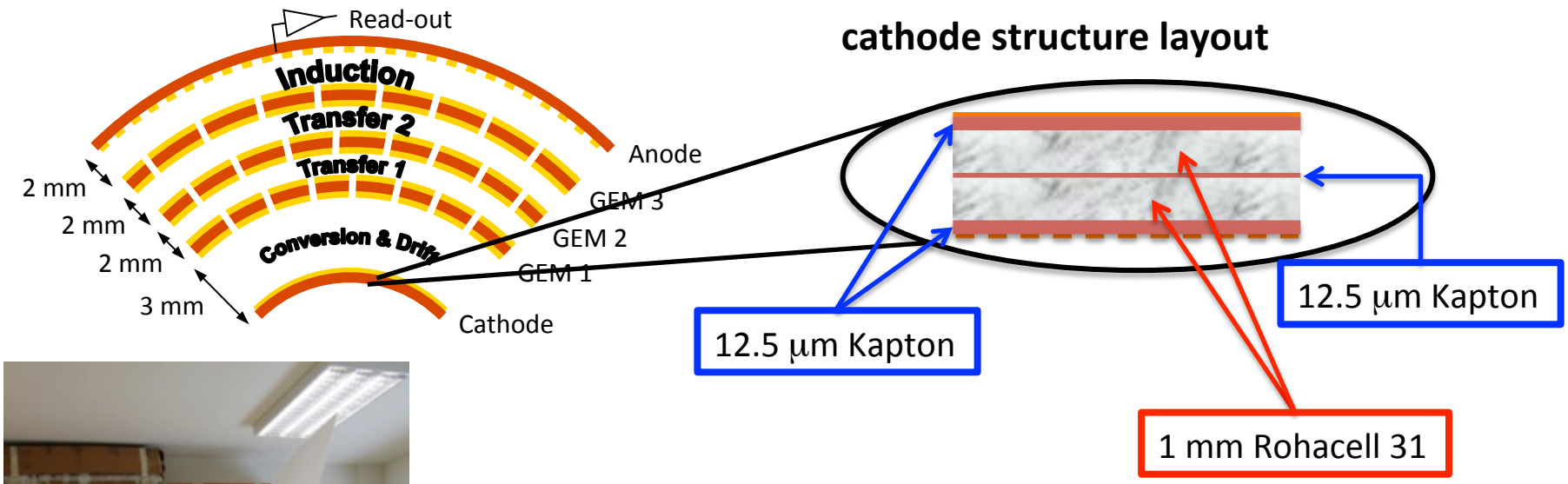
Detail of the overlap (10 mm)





The new cathode foils are drawn with a different HV connection to the active area: one only wider copper strip rather than three narrow strips to reach a better mechanical strength

The Rohacell structure



Rohacell is a very light material (density of 31 kg/m^3) that will be replace the honeycomb in the cathode and anode construction with substantial reduction of the thickness of the detector.

	BESIII	KLOE-2
# of X_0 for 1 layer	0.33	0.49
# of X_0 for 3 layers	0.99	1.47

This technique has been successfully tested in Ferrara