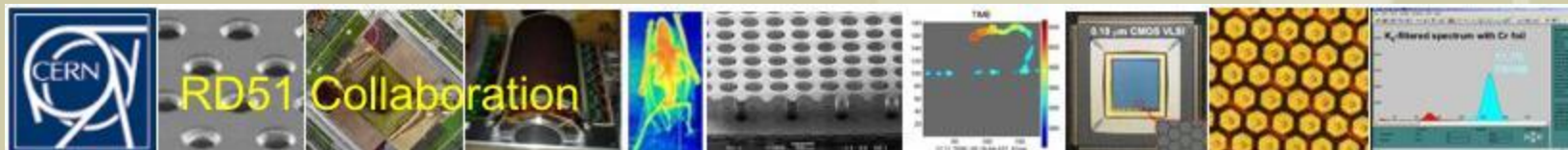


Results on a Large Area triple-GEM Detector at LNF

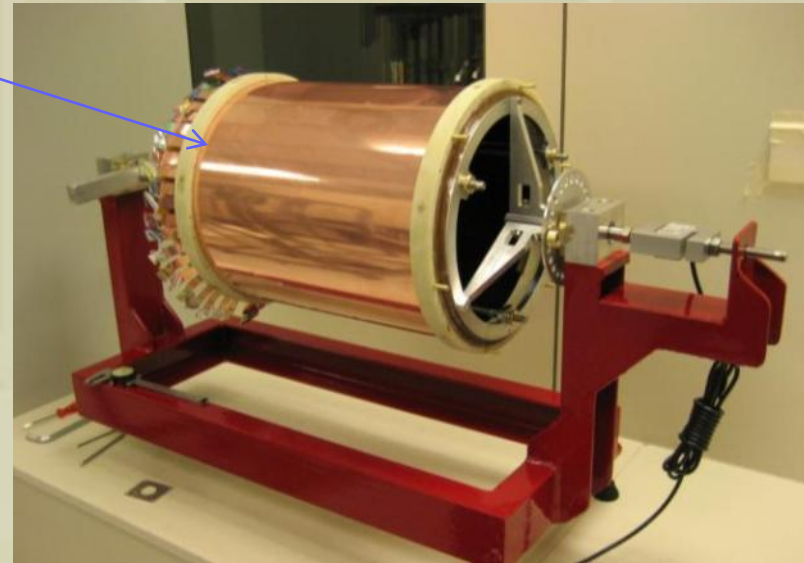
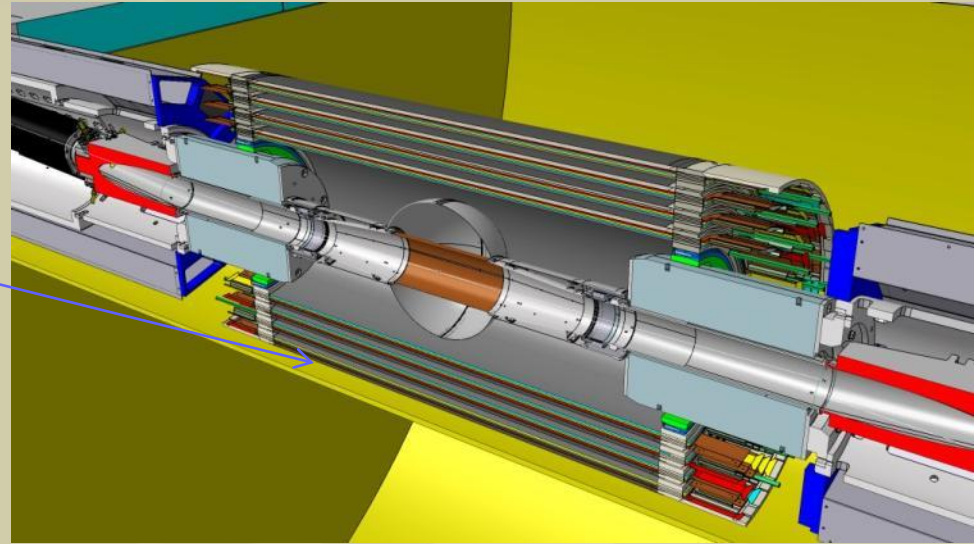
5th RD51 Collaboration Meeting
Freiburg, 25 May 2010

D. Domenici - LNF



The Cylindrical-GEM for KLOE-2

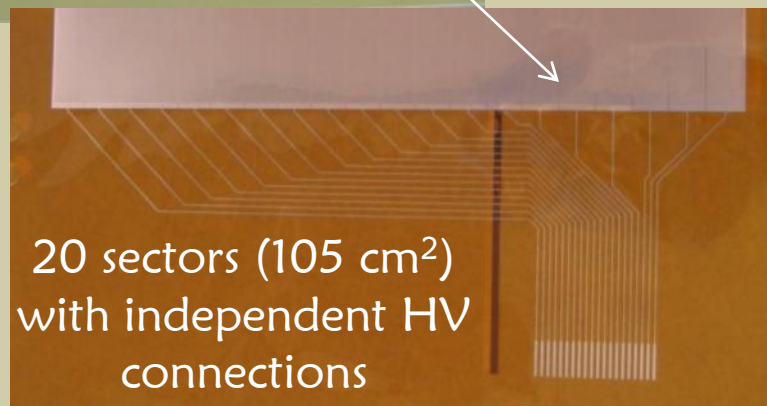
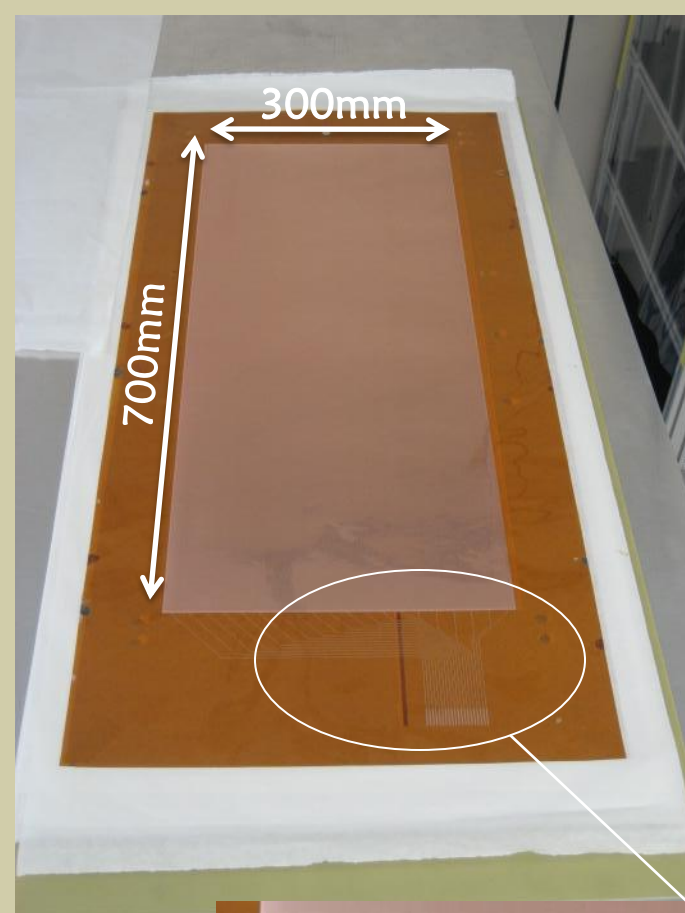
- We are developing a **Cylindrical-GEM** detector to be used as Inner Tracker device in the KLOE experiment upgrade
- A C-GEM prototype has been already built with small ($200 \times 240 \text{ mm}^2$) double-mask foils
- For the final IT foils as large as $350 \times 700 \text{ mm}^2$ are needed (3 are spliced to get 1 electrode)
- We want to test large GEM of the same dimensions on a planar chamber



Large GEM

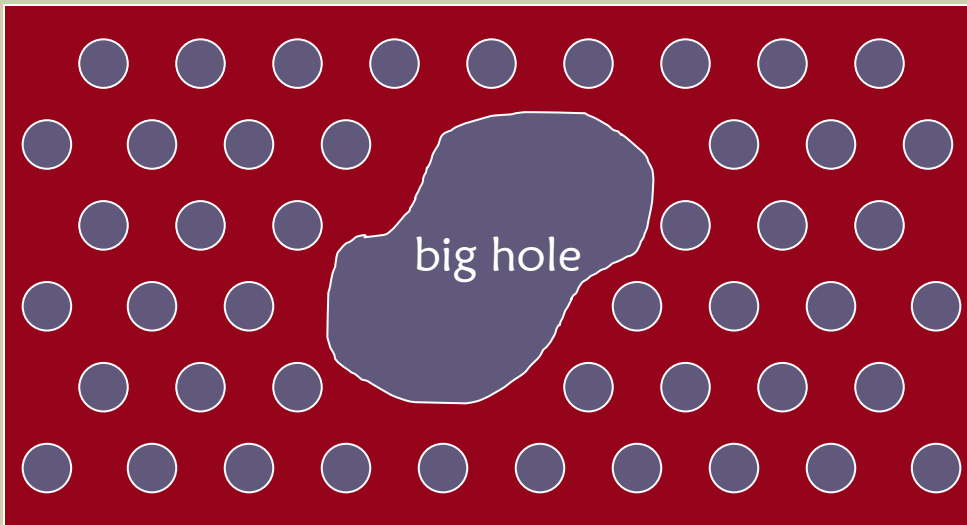
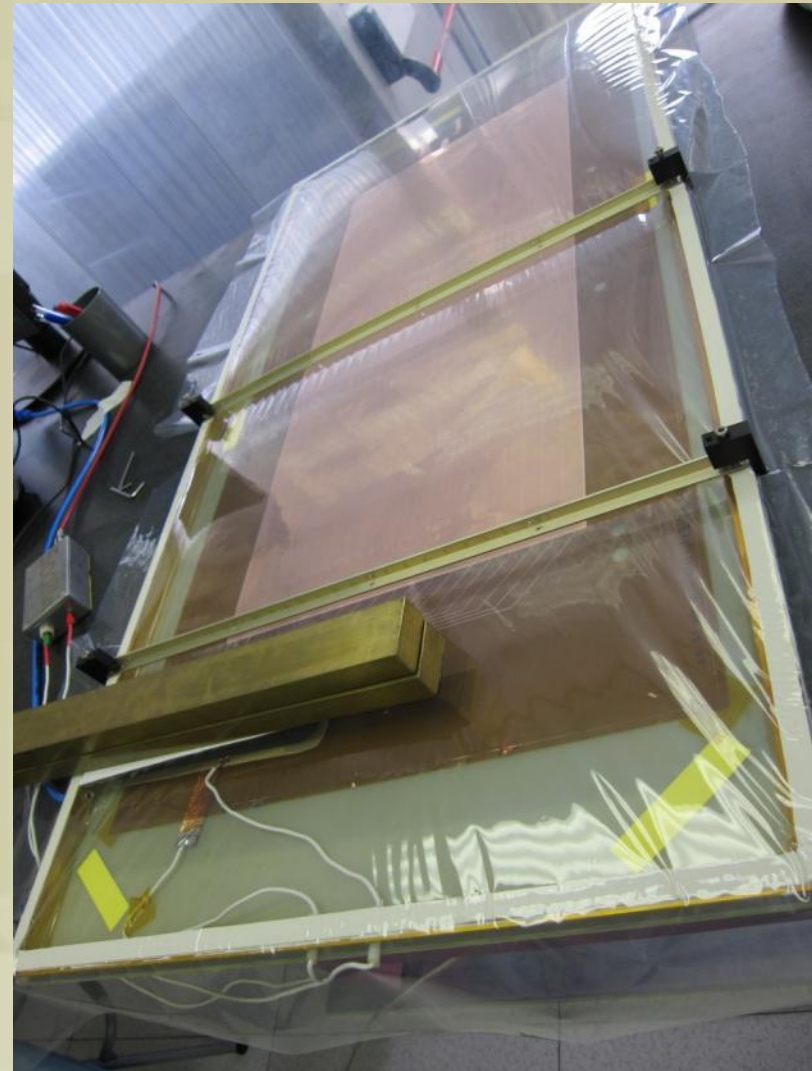
- Validation of the new GEM is of upmost importance for our project
- 6 foils of latest single-mask GEM have been delivered in April

Very large GEM: 0.21 m²



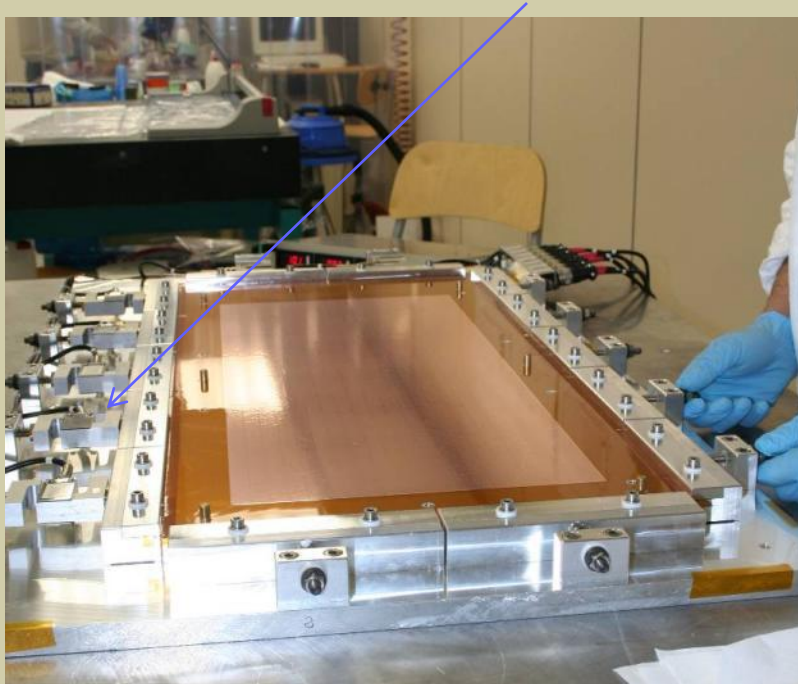
HV test in Nitrogen box

- GEM are tested in a N_2 flushed box: current of the sector $< 1nA$ at 600 V with $T=23\text{ }^\circ\text{C}$ – $RH<20\%$
- Few temporary shorts found due to dust. Brief conditioning of the foil is needed, allowing discharges
- Large and irregular holes found (clearly visible to the naked-eye) give no discharge



Stretching the GEM

GEM are stretched on a custom-made machine with a tension of $\sim 1\text{kg/cm}$ measured by load-cells

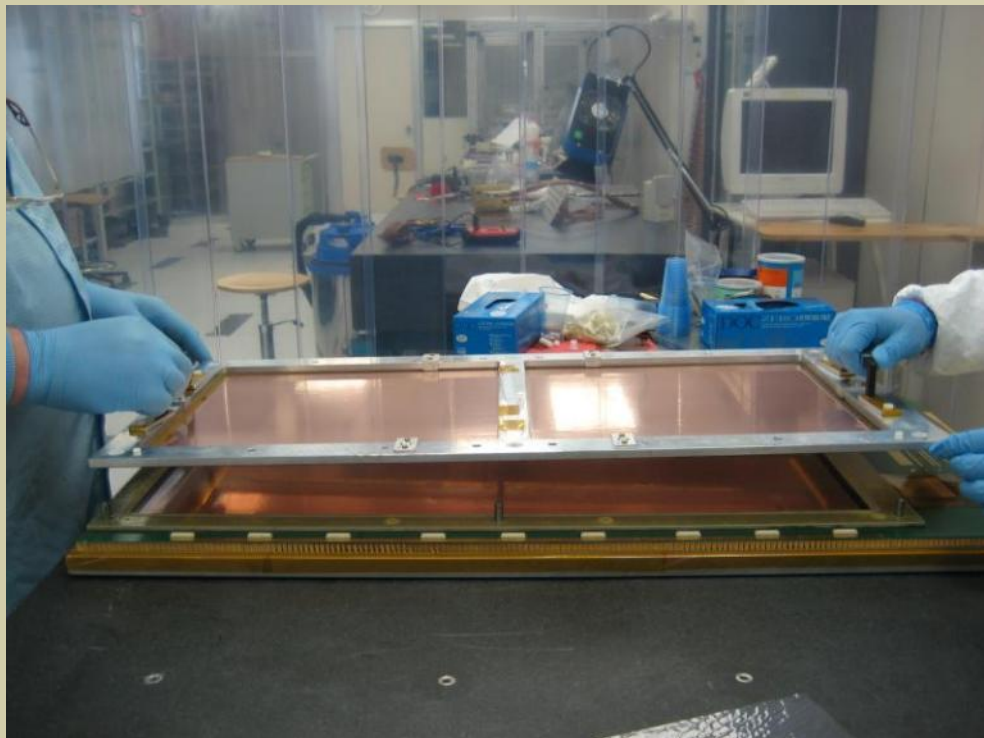


Note the perfect “mirror” surface

FR4 frame is glued on the GEM in a vacuum-bag
The stress is unloaded on an aluminum stiffener when the foil is removed (0.7mm frame deformation on the long sides)



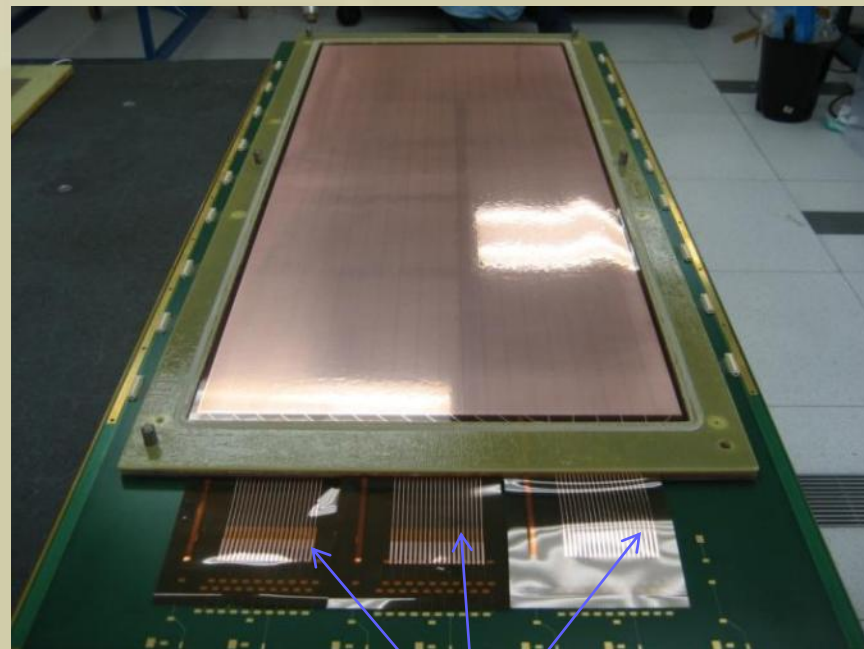
Assembling the triple-GEM



Stiffener is also used to handle the GEM.

The foil is kept stretched by metal pins during the glue curing cycle.
Pins are eventually removed

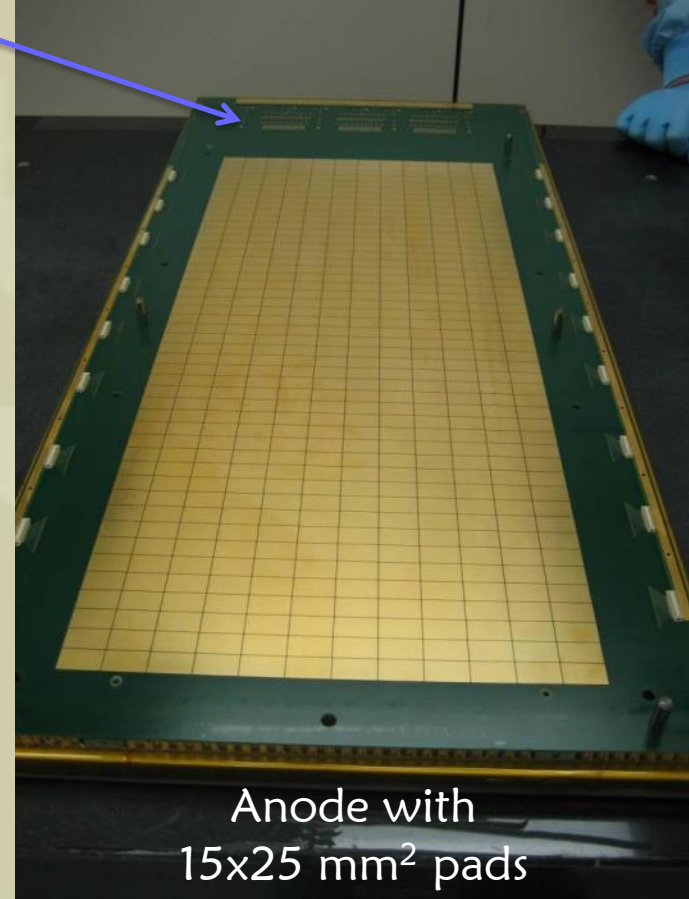
3 GEM foils framed



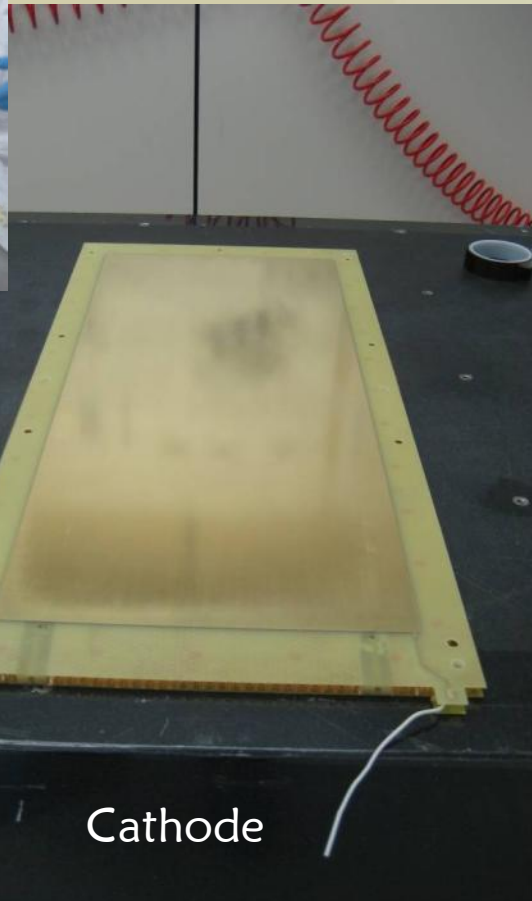
HV connections

Cathode and Anode panels

HV board integrated
on anode PCB

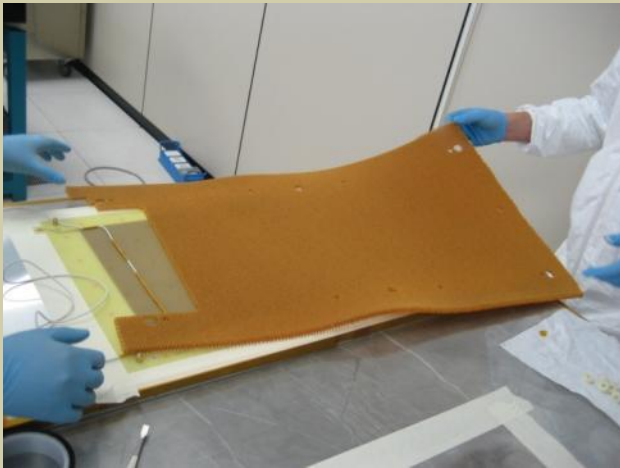


Anode with
 $15 \times 25 \text{ mm}^2$ pads



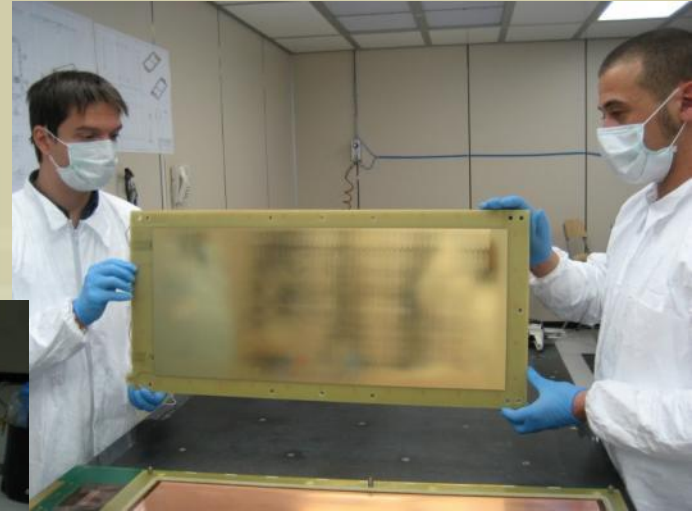
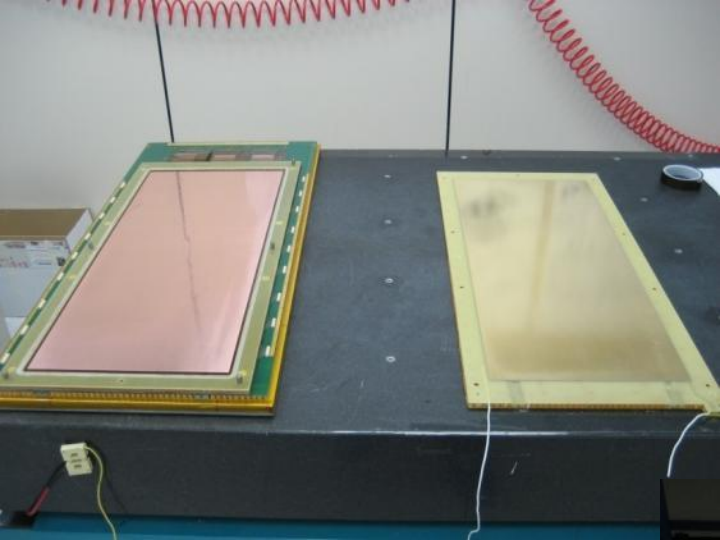
Cathode

Manufacturing of
the FR4 cathode
panel with
honeycomb

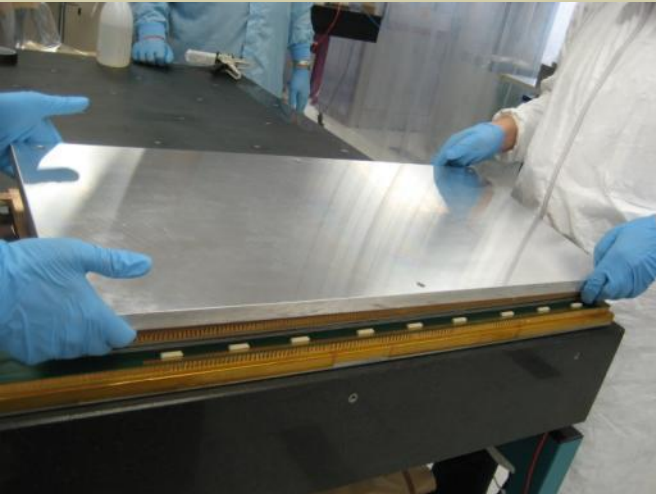


Final assembly

Closing of the chamber



A heavy Al plate is placed to distribute the pressure

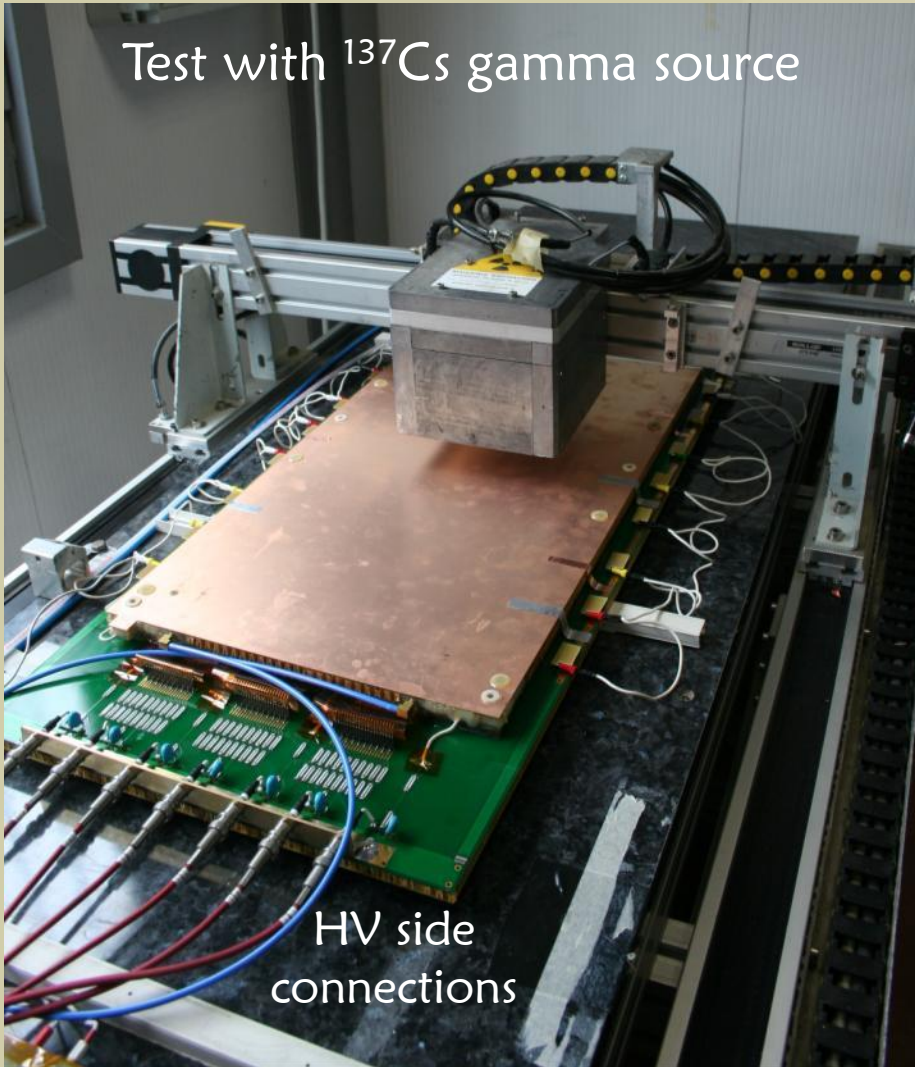


~350 kg of lead bricks for the final gluing



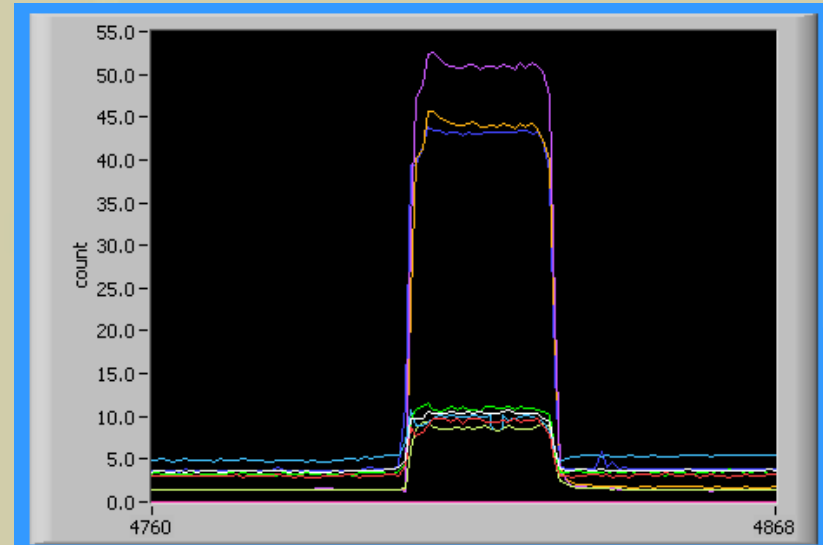
Source test

Test with ^{137}Cs gamma source



HV side
connections

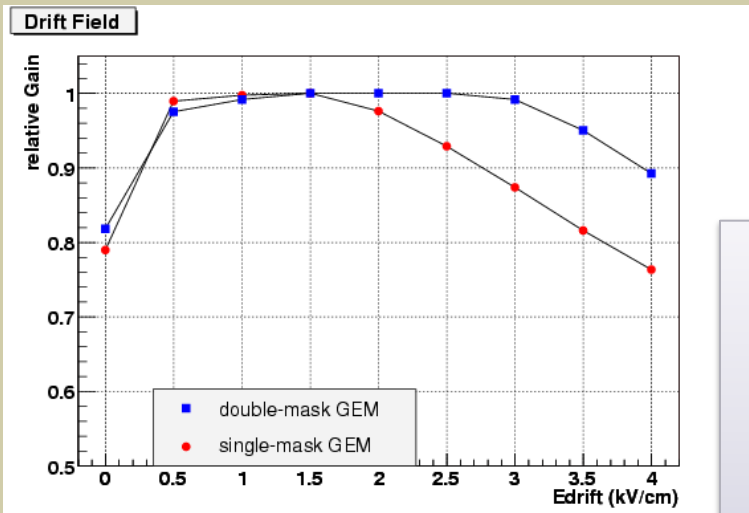
Electrode currents



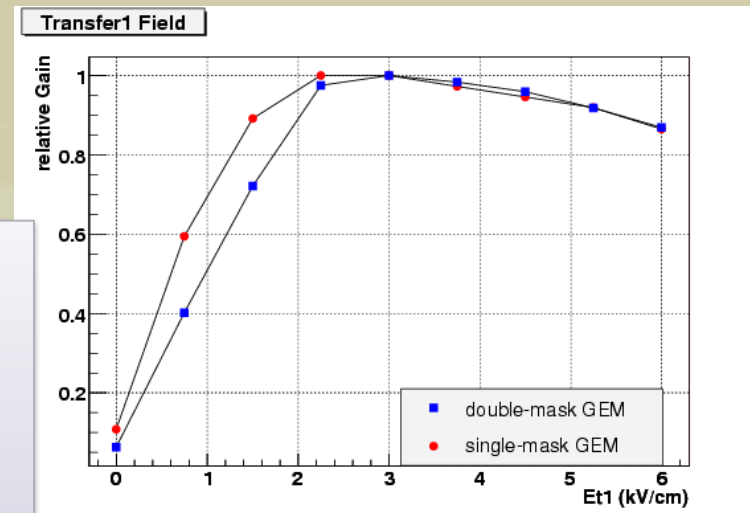
The detector has been flushed with Ar/CO_2 (70/30) and tested in current-mode with a ^{137}Cs source (660 keV photons)

A $10 \times 10 \text{ cm}^2$ chamber with double-mask foils has been used for reference and normalization of performance

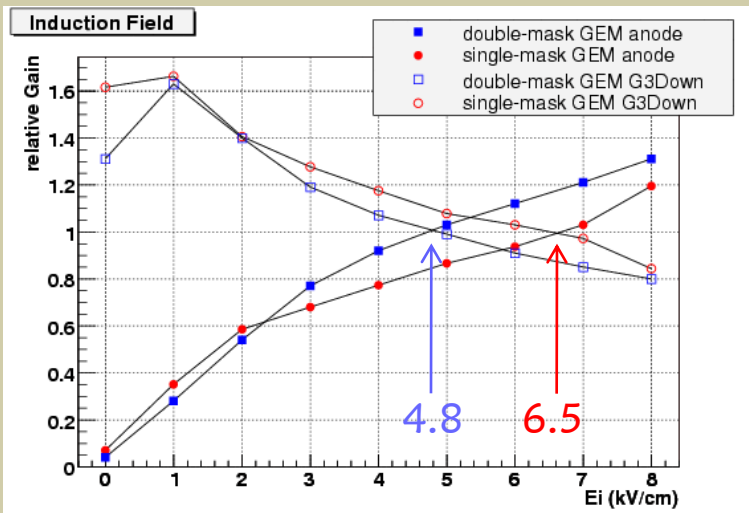
Optimization of the fields



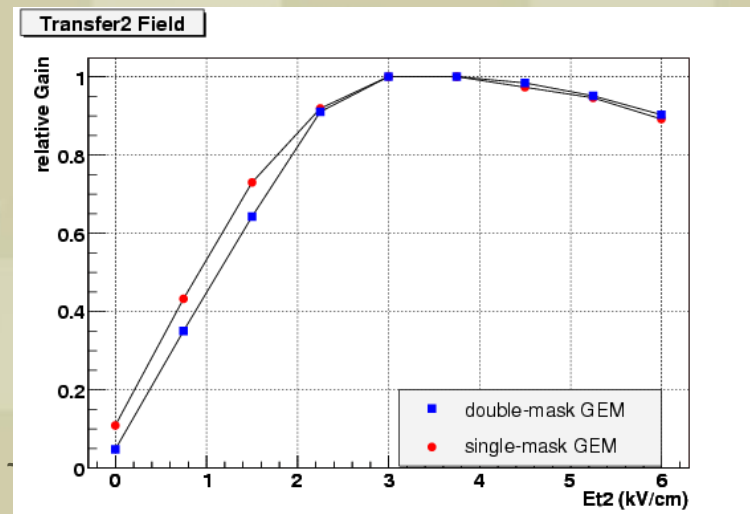
Only slight difference between the two GEM (due to different hole shapes?)



Final operating fields values:
1.0 – 3.0 – 3.5 – 6.5 kV/cm
(Drift – Transf1 – Transf2 – Induction)

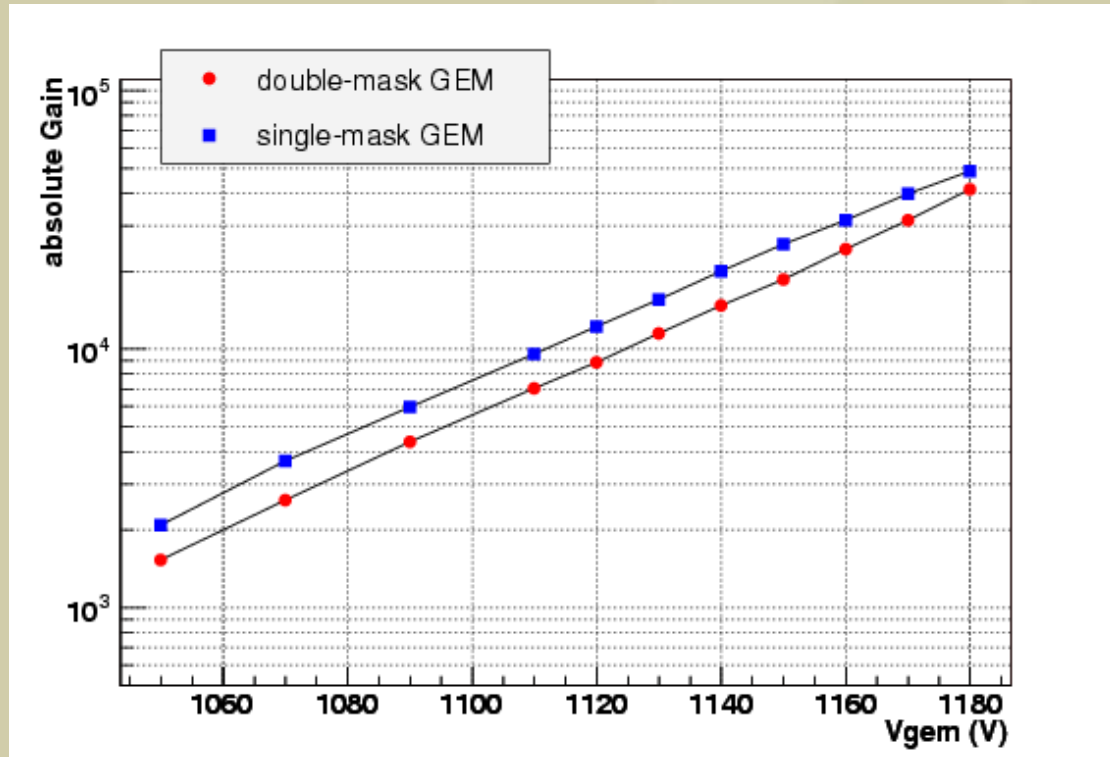


Equal charge sharing occurs at higher induction field in the single-mask



Gain

- Gain \sim 25% lower in single-mask GEM (minor charging-up effect? hole diameter?)
 - Only \sim 20 V increase in the operating voltage needed to reach same gain
 - NO discharge observed up to 40000 gain



Very stable operation

Gain Uniformity

15800	16300	15500	15000
15600	15700	15200	14800
15500	15700	15000	14800

12 positions scanned with gamma source ($\sim 100 \text{ mm}^2$ spot)

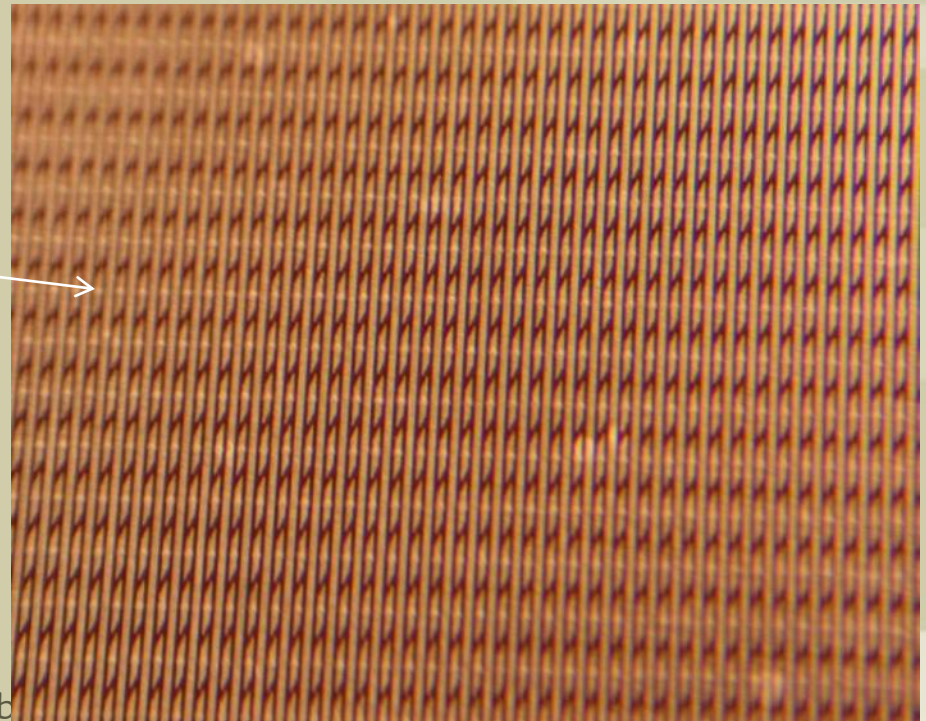
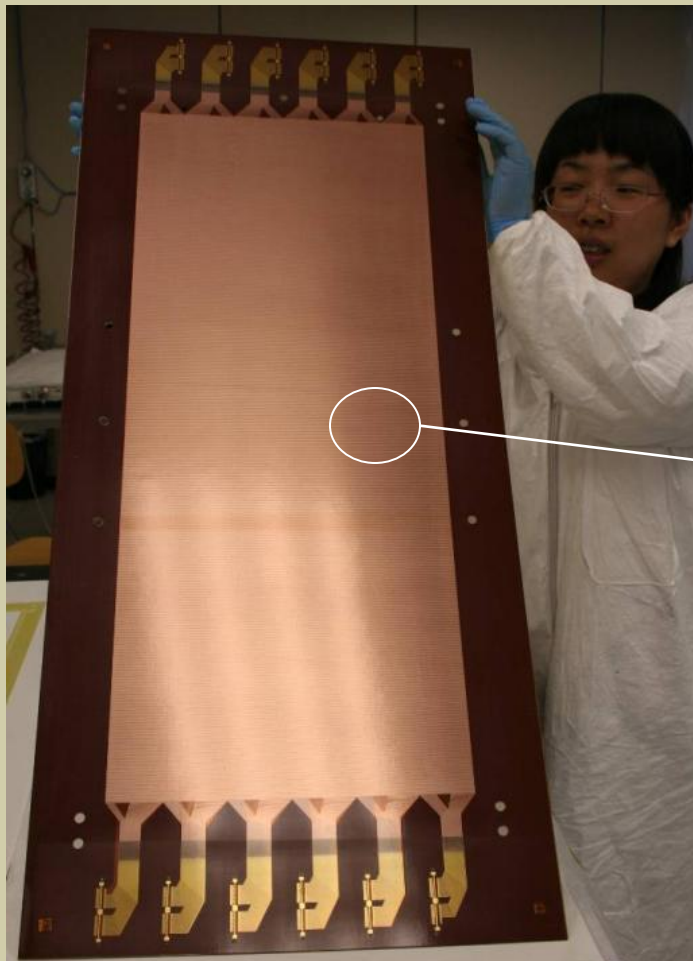
Maximum difference (~ 1000) is of the same order of magnitude of the estimated single error (~ 800)

Further test needed with more collimated source

XV readout

A second prototype (same dimensions) will be assembled with the final KLOE-2 readout: XV strips-pads with 650 μm pitch on a kapton substrate.

It will be tested in a PS testbeam in october equipped with the 64 channels release of GASTONE ASIC



Conclusion and next steps

- KLOE-2 and the Cylindrical-GEM project are approaching steadily the finalization
- A mandatory step is the validation of the new single-mask GEM technology
- A first planar prototype with 300x700 mm² foils (same dimensions for the cylindrical Inner Tracker) has been built
- The chamber has been tested in current mode with a ¹³⁷Cs source showing good stability, uniformity and a gain ~25% lower than double-mask GEM
- Considering the large surface, at a first glance the new GEM are surprisingly stable and well-performing (high gain, no discharge)
- A second prototype will be assembled with the anode electrode patterned with the XV strips-pads readout for the KLOE-2 IT and equipped with the 64 channels GASTONE for FEE
- In October a testbeam at PS is foreseen for an exhaustive and realistic test of all the DAQ chain (including off-detector electronics) under particle fluxes up to 10 kHz/cm²

New Hole Shape

