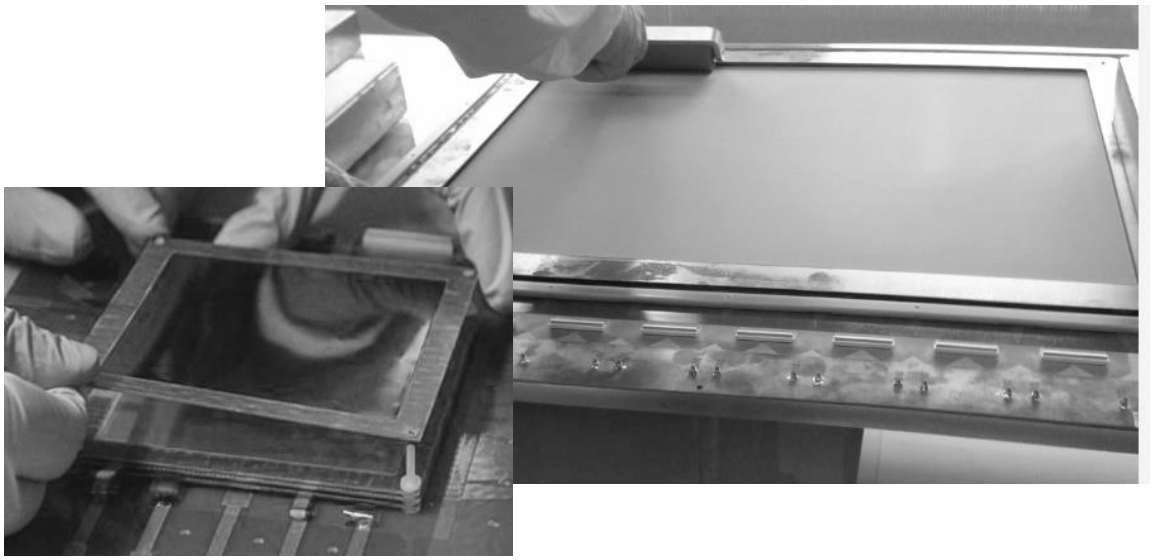


GEM and Micromegas standard detectors from the CERN workshop

Silvia Franchino

on behalf of the

CERN Micro-Pattern workshop

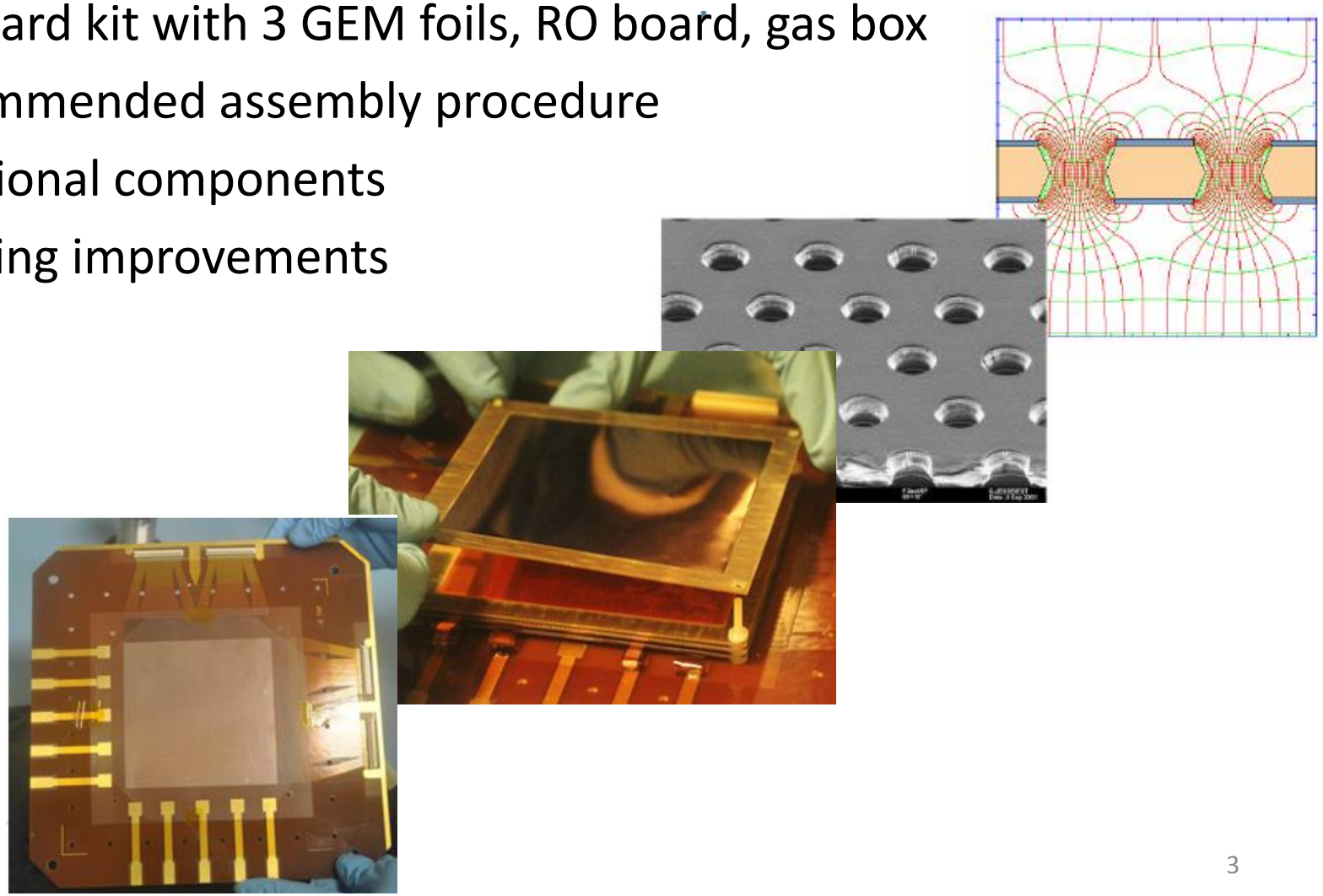
14th RD51 Collaboration Meeting,
29 October 2014, Kolkata, India

Outline

- Standard (10cm*10cm) triple GEM
  - Recommended assembly procedure
  - Additional components
  - Suggested modifications
- Standard resistive micromegas
  - 10cm*10 cm bulk detector
  - New design exchangeable mesh 50cm*40cm

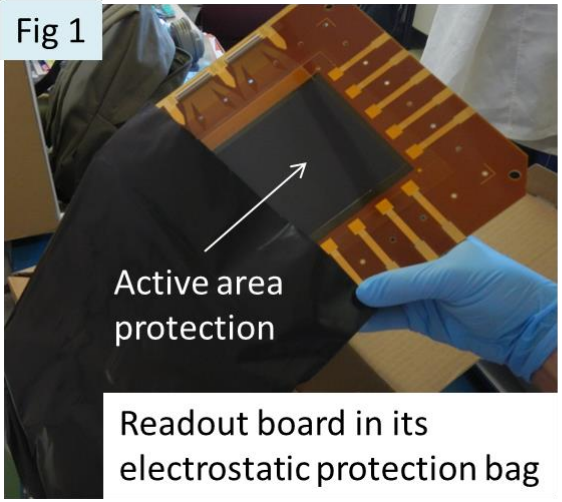
10cm* 10 cm triple GEM

- Standard kit with 3 GEM foils, RO board, gas box
- Recommended assembly procedure
- Additional components
- Ongoing improvements



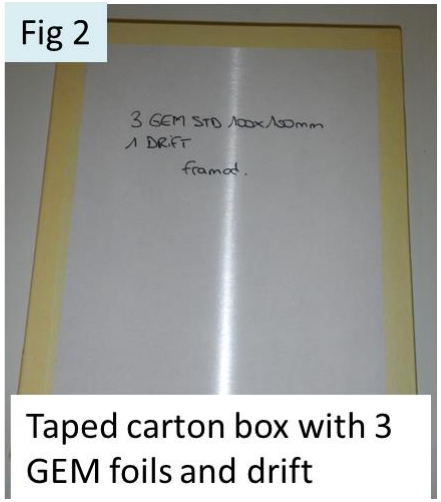
Triple 10cm*10cm GEM standard kit

Fig 1



Readout board in its electrostatic protection bag

Fig 2



Taped carton box with 3 GEM foils and drift

Fig 5

2x Viton O-rings

Fig 6

2xM3 gas connectors
2x gas connector adapters
4x nylon screws and nuts

Fig 7

Washers (0.5mm thick) for z spacing between GEMs and drift

Fig 3

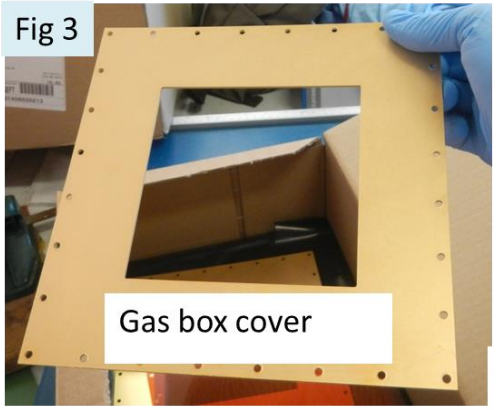
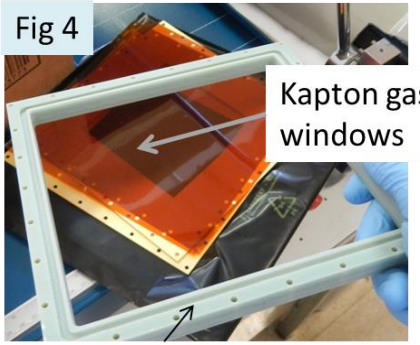


Fig 4



Epoxy gas box frame with O-ring grooves both sides and three gas inlets

Fig 8

Fig 9

28x M3 screws + 28x M3 nuts or inserts (right picture) depending on different kit versions

Recommended assembly procedure

Recommended assembly procedure

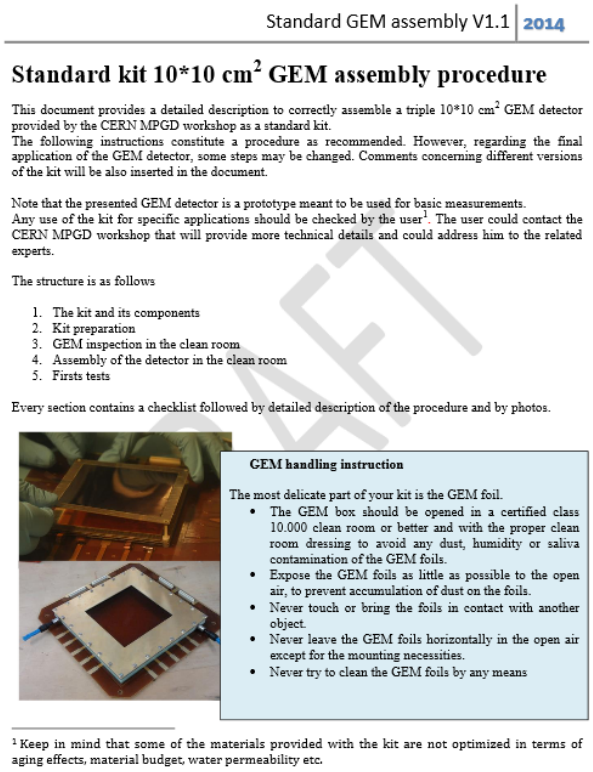
A draft of a document on recommended procedure on how to assemble a standard triple GEM can be found here:

http://franchin.web.cern.ch/franchin/MPDG/GEM_assembly_DRAFT.pdf

An outcome of frequent interactions and discussions between GEM experts and users.

Thanks for all the material/pictures/suggestions and discussions to:

- MPGD workshop (CERN)
- GDD lab (CERN)
- CMS GEM collaboration (CERN);
- ALICE GEM coll. (Zagreb, Mumbai and Kolkata)



Standard GEM assembly V1.1 | 2014

Standard kit 10*10 cm^2 GEM assembly procedure

This document provides a detailed description to correctly assemble a triple 10*10 cm^2 GEM detector provided by the CERN MPGD workshop as a standard kit.
The following instructions constitute a procedure as recommended. However, regarding the final application of the GEM detector, some steps may be changed. Comments concerning different versions of the kit will be also inserted in the document.

Note that the presented GEM detector is a prototype meant to be used for basic measurements.
Any use of the kit for specific applications should be checked by the user[1]. The user could contact the CERN MPGD workshop that will provide more technical details and could address him to the related experts.

The structure is as follows

1. The kit and its components
2. Kit preparation
3. GEM inspection in the clean room
4. Assembly of the detector in the clean room
5. Firsts tests

Every section contains a checklist followed by detailed description of the procedure and by photos.

GEM handling instruction

The most delicate part of your kit is the GEM foil.

- The GEM box should be opened in a certified class 10.000 clean room or better and with the proper clean room dressing to avoid any dust, humidity or saliva contamination of the GEM foils.
- Expose the GEM foils as little as possible to the open air, to prevent accumulation of dust on the foils.
- Never touch or bring the foils in contact with another object.
- Never leave the GEM foils horizontally in the open air except for the mounting necessities.
- Never try to clean the GEM foils by any means

[1] Keep in mind that some of the materials provided with the kit are not optimized in terms of aging effects, material budget, water permeability etc.

Chapters

1. The kit and its components
2. Kit preparation
3. Inspection of GEM foils
4. Detector assembling
5. Test of the assembled detector

Clean room

For each chapter there is a checklist followed by description and pictures

STEPS TO DO	MORE IN DETAIL	DETAILS
Before entering in the clean room	Check the necessary equipment before entering in the clean room	Sec. 3.1
	Wear the proper clean room dressings	Fig 17
Check each of the three GEM foils	Open the GEM box, and extract the first GEM foil	See Tab 4
	Optically check the foil and keep in vertical position	
	Perform a capacity (~ 5.8 nF) and leakage test (~1 min @ 600V)	Sec 3.3
	Put back in the box the first foil and repeat the checks for the others *(keep the box closed in the meantime)*	

Table 3: Inspection of GEM foils before the assembly

3.1 Before entering in the clean room

To proceed, go to a certified cleanroom of class 10.000 or better. You must wear (Fig 17)

- a vest
- a head cover
- a shoe cover
- gloves and
- a mask

Fig 17: example of clean room mask (left) and dressing (right)

It is very important to keep the GEMs as little as possible in open air, even inside the cleanroom avoid any dust accumulation. Then, it is recommended to open the GEM box after having checked prepared everything that will be needed during the test and the assembly.

Kit preparation

- Prepare the gas box
  - Check O-rings
  - Cover
  - Gas connectors
  - Cleaning
- Prepare the readout board
  - Optical inspection
  - Nylon screws
  - Define the orientations, gaps
- Gas tightness test


Fig 10

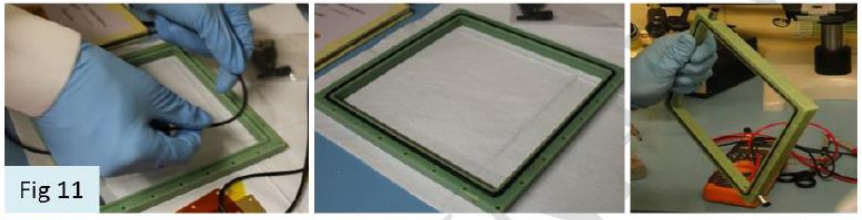


Fig 11

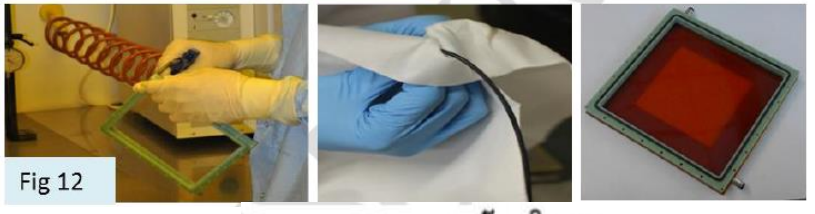
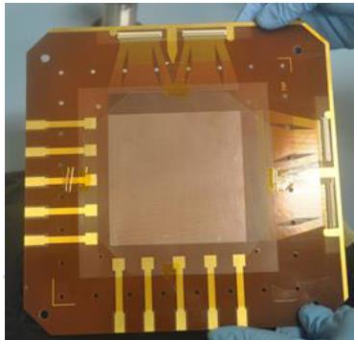
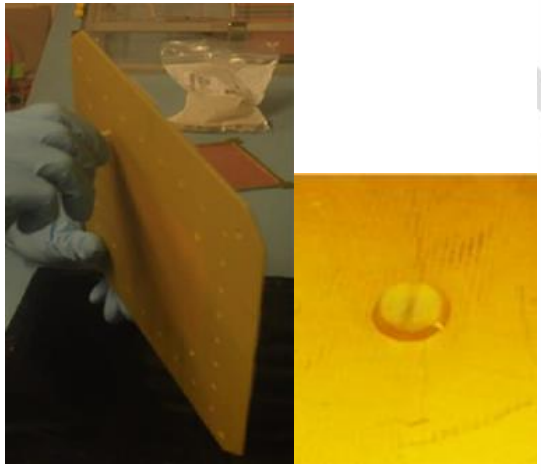
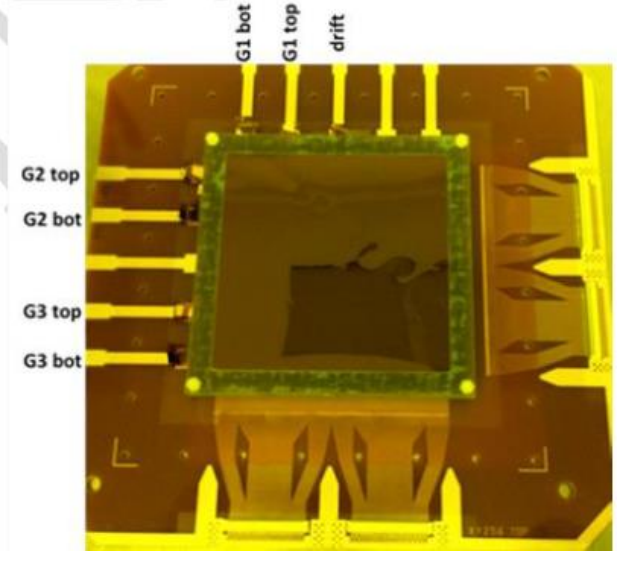


Fig 12







Inspection of GEM foils

Clean room

For each GEM foil

(keep the others in the closed box):

- optically inspect
- Capacity and leakage test (~1min @600V)

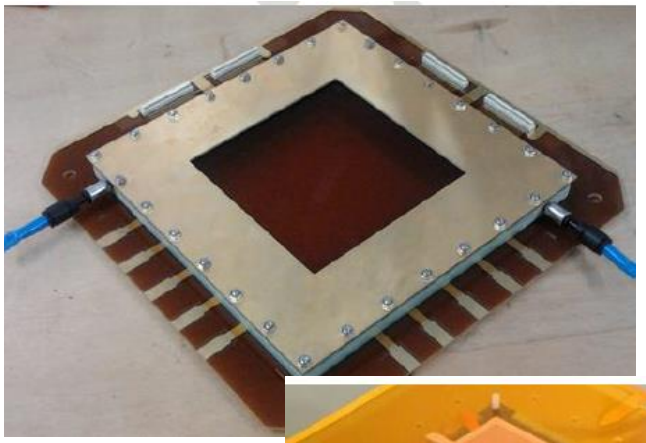
GEM handling instructions
Open GEM box only in a certified class 10.000 clean room or better
Proper clean room dressing to avoid any contamination of the GEM foils
Expose the GEM foils as little as possible to the open air, keep them vertically
Never touch or bring the foils in contact with another object
Never try to clean the GEM foils by any means.

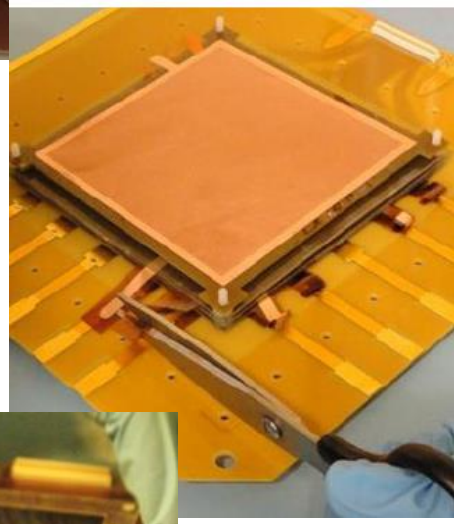
Detector assembling

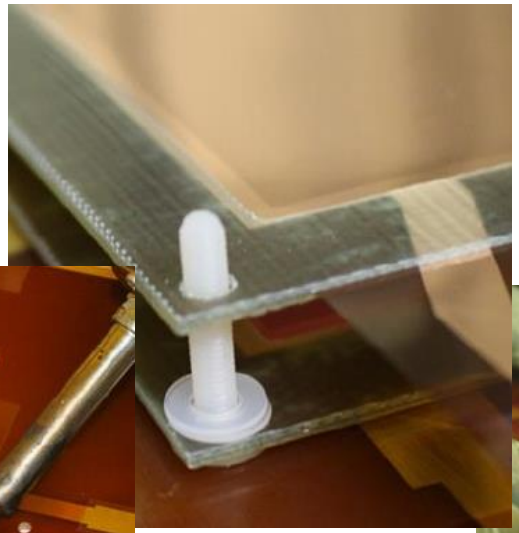
Clean room

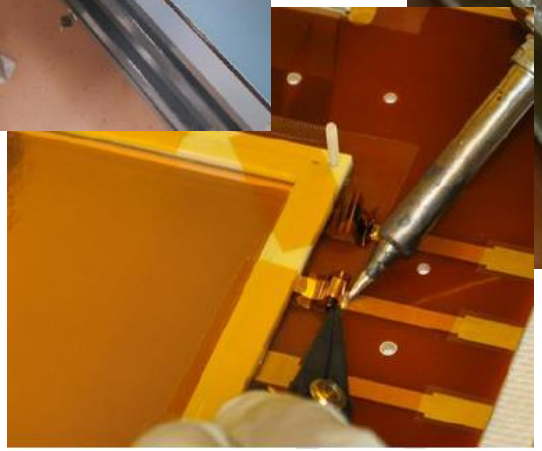
- Preparation
- GEM3 positioning and test

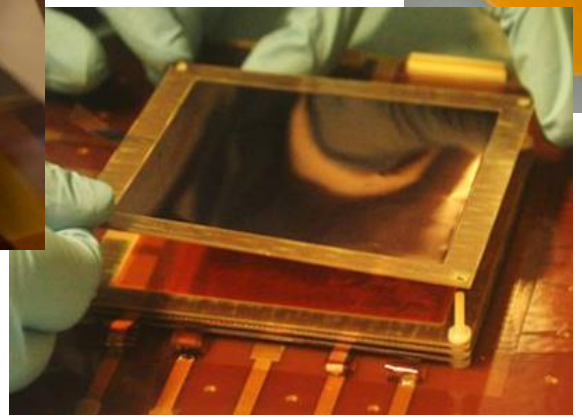
  (cover it while soldering and testing)
- Repeat for GEM2, GEM1, drift
- Close the stack
- Close the gas box



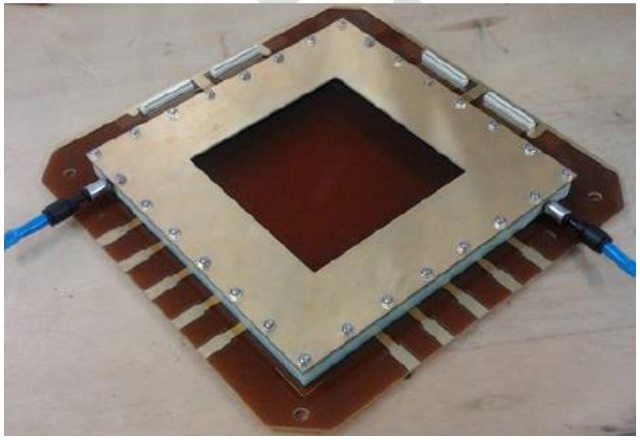








Final tests



- Longer leakage tests
- Gas leaks
- ready to start with the detector

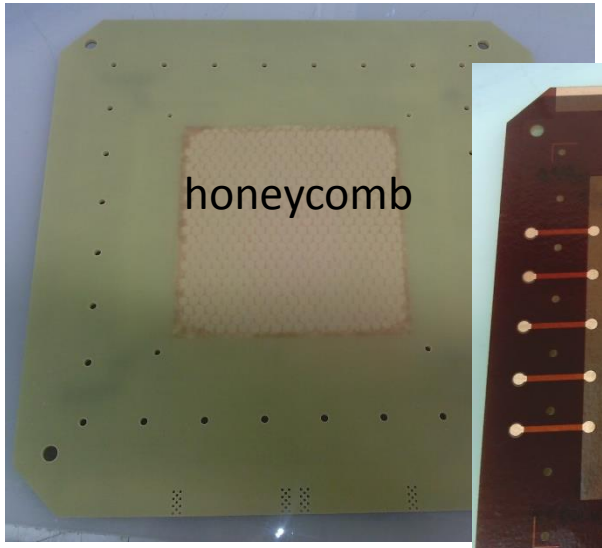
Comments

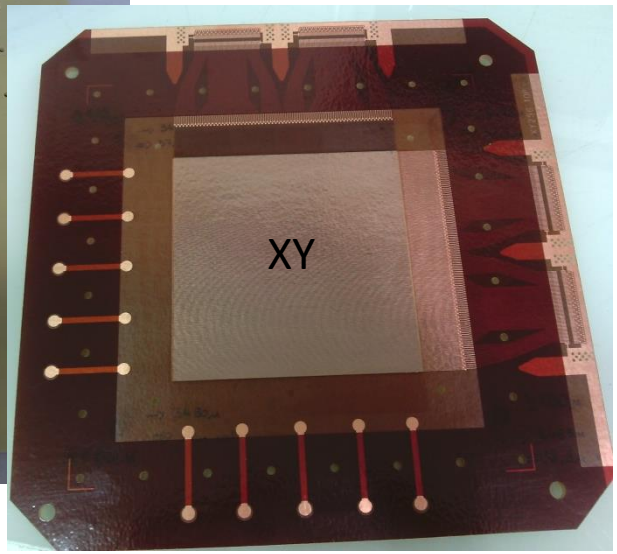
The document is still a DRAFT,
work in progress,
Any comment would be useful

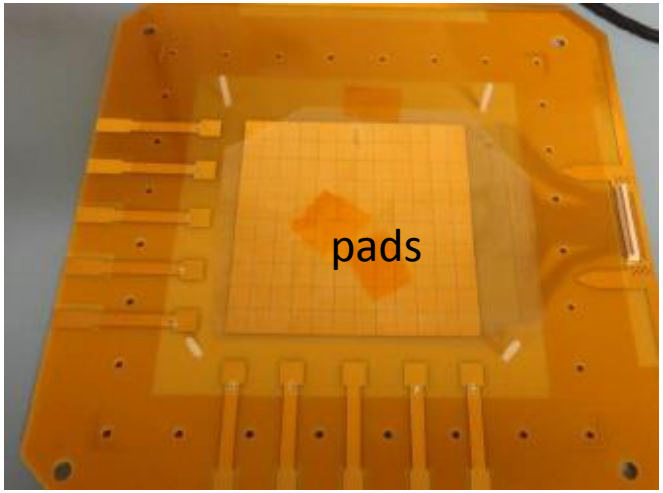
Additional components/modifications to the standard kit

Readout board

- Standard readout: 1 cm^2 pads, XY strips, X strips
- If required:
  - low budget material readout board (Honeycomb, rohacell)
  - XUV strips
  - Smaller pads (up to 3mm * 3mm)



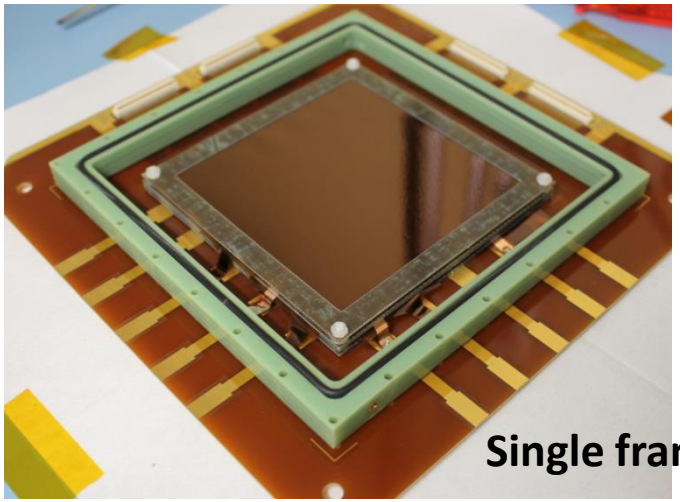


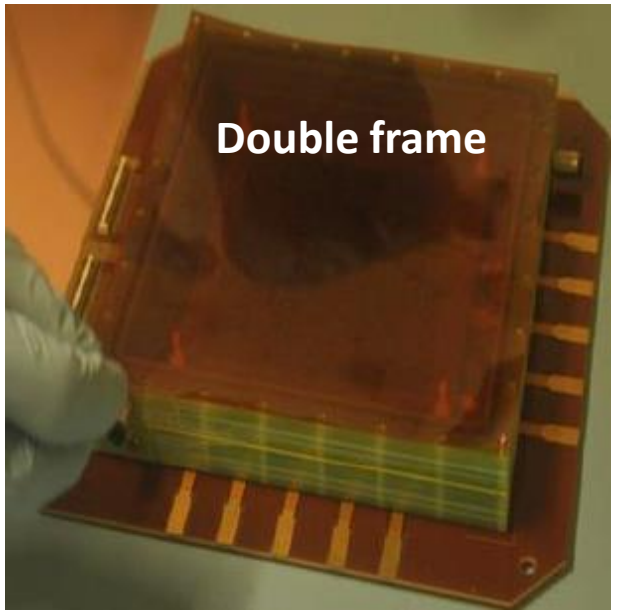


Gas box

- **Standard frame**: 12.5 mm thick, vetronite (enough to host a 3222 stack) two sides O-ring grooves

- **If required**: if one want to host 4 GEM foils or higher gaps: double frame is needed (One normal one, one with O-ring groove only on one side)

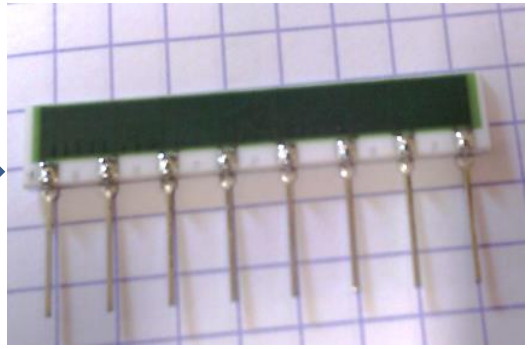




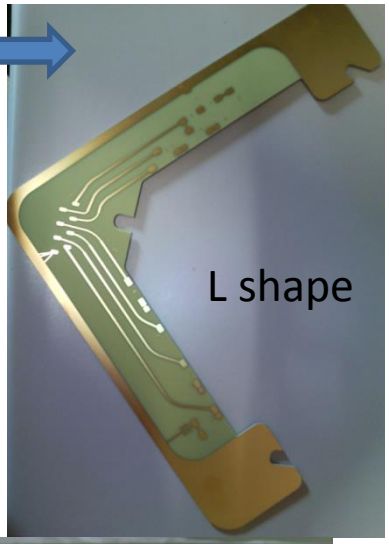
Additional components (1)

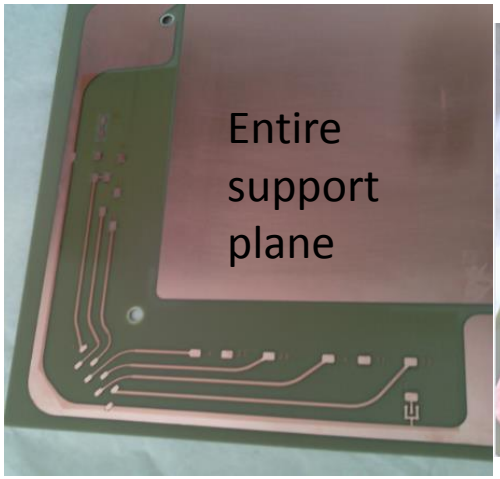
- Ceramic voltage dividers
  - compatible with 3222mm, 3121 mm gaps

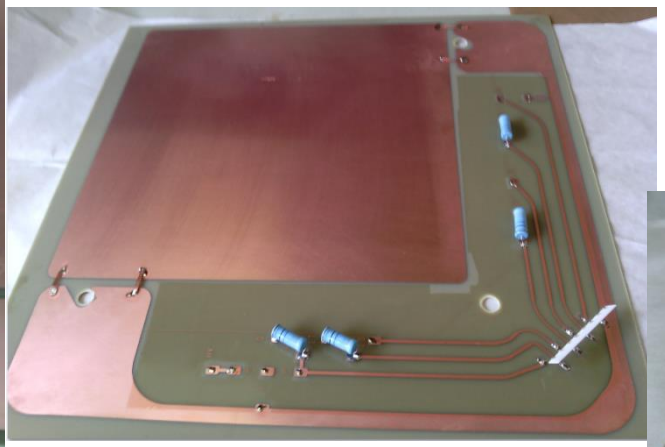
  1mA polarization current



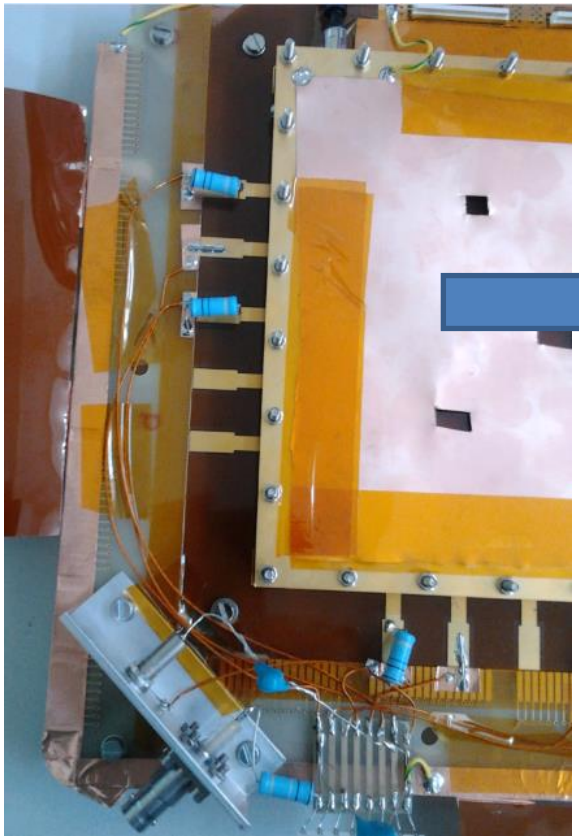
- PCB boards for ceramic voltage divider
  - pads to plug V divider and to root lines in front of GEM connectors, pads for protection resistors
  - Could be produced in L shape or as a plane where to fix the readout board

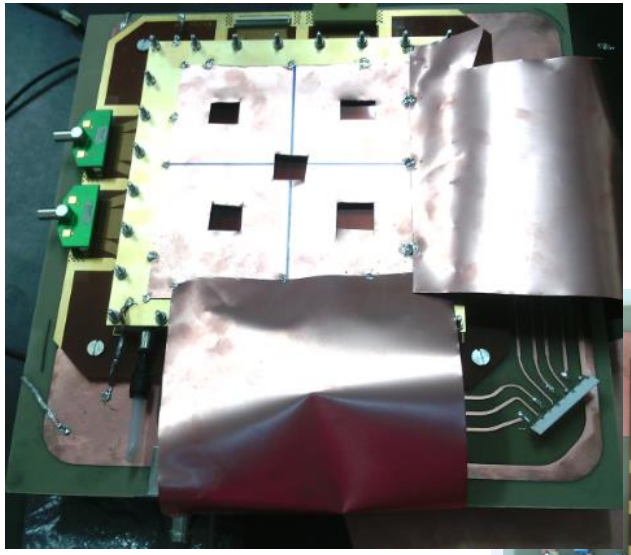


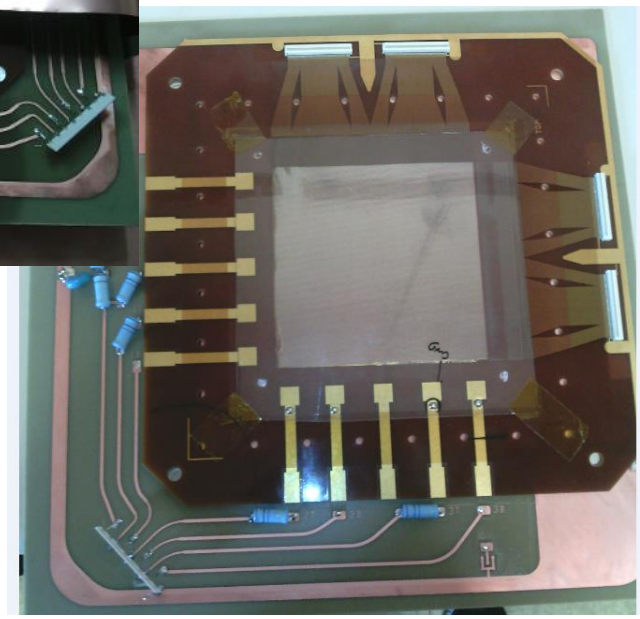




Additional components (2)







Ceramic V divider without the new PCB:

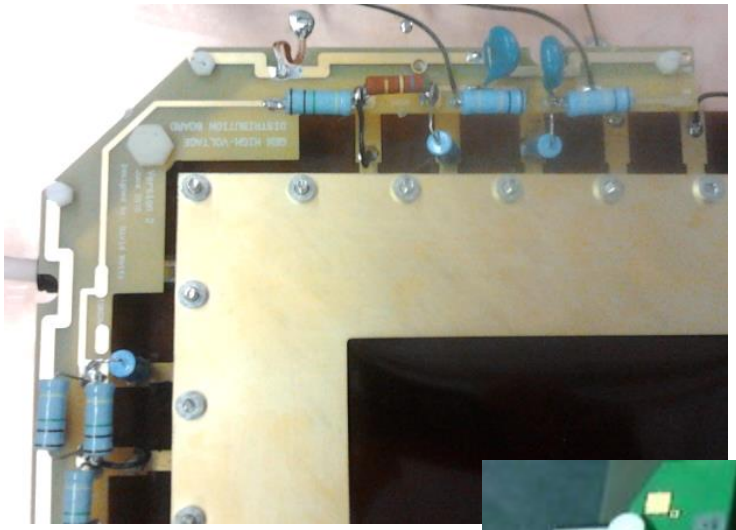
- many cables to root around,
- some spurious signals,
- sparks in the V divider at high voltages

Example of GEM detector mounted on the PCB support,

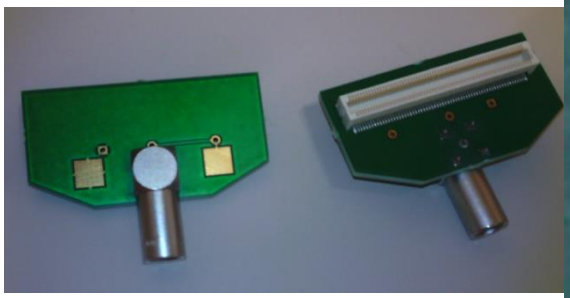
- more clean signal
- No sparks seen

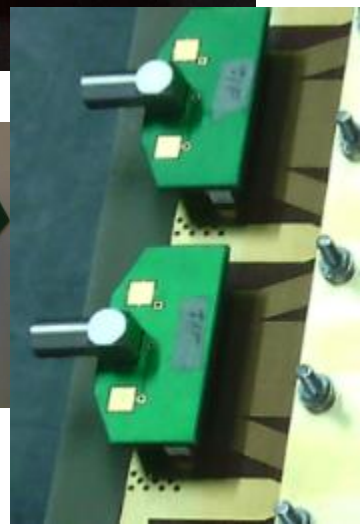
Additional components (3)

- PCB board for voltage divider with standard resistors
  - Advantage to separate it from RO board, test before plugging GEMs
  - Wrt ceramic V divider: advantage to change fields
  - Pads for V divider Resistors, protection Res, Capacitor for GEM3 bot (will be re-designed soon to host 4 GEMs)



- Panasonic
  to lemo adapters
  - For preliminary tests,
  - E.g. to look signal in the oscilloscope
  - add all RO lines together



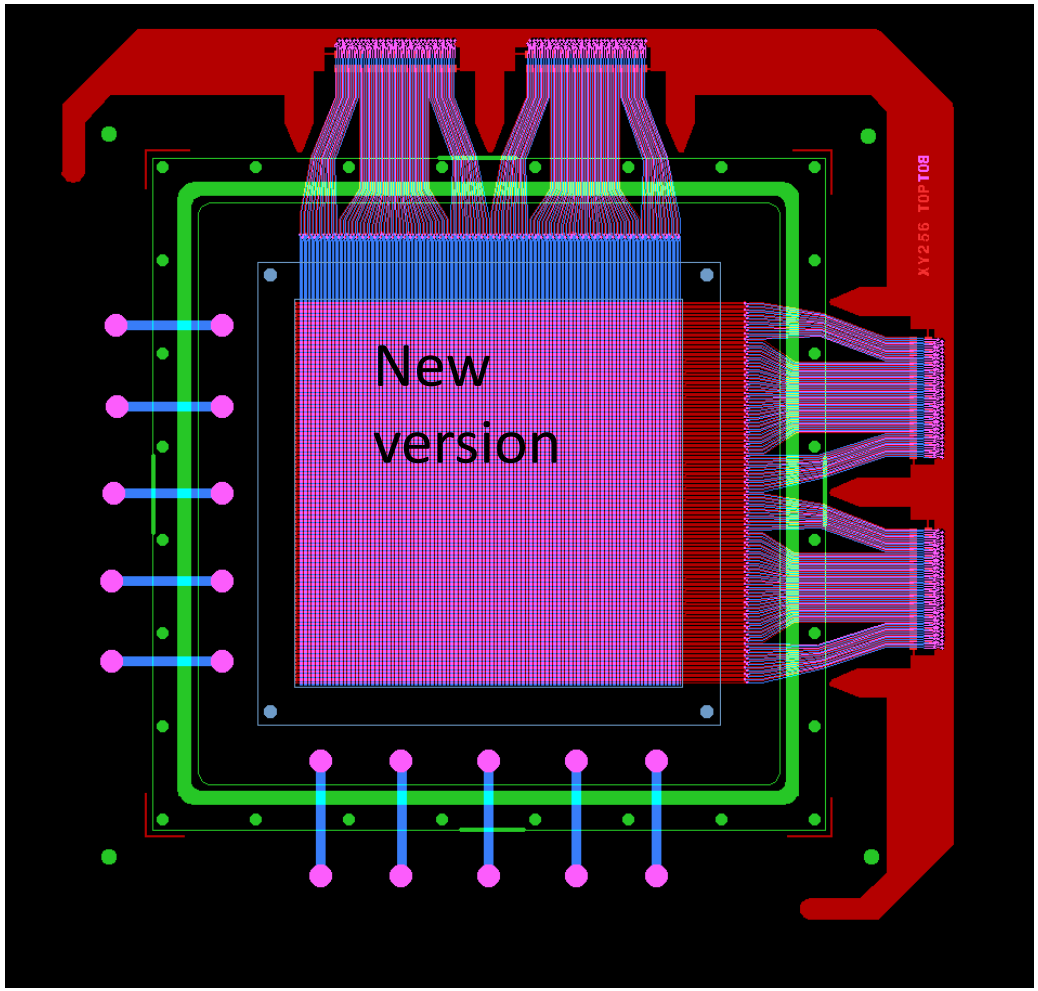


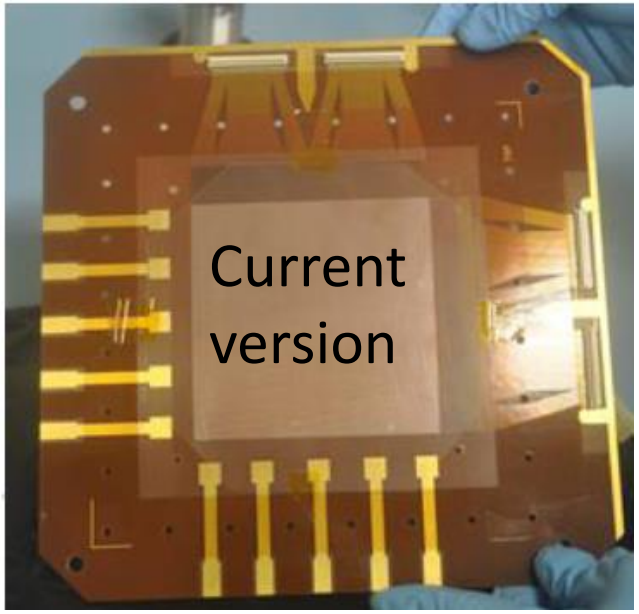
Proposed and ongoing modifications

Thanks to the feedback from
the CERN GDD lab
and the users

Any other comment/proposal will be useful

Modified RO board

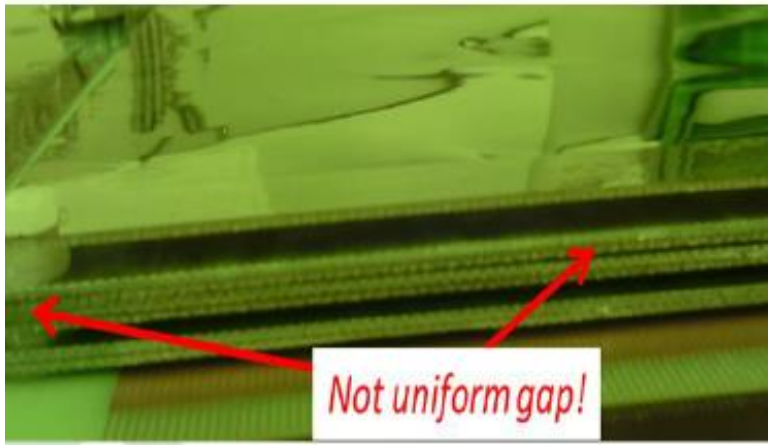




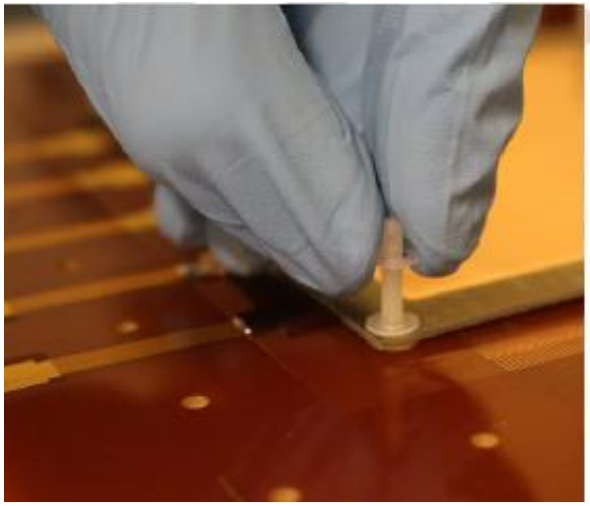
- More GND
- Changed shape of HV lines
- Changed dielectric material between HV lines and gas box
- Change width X, Y strips to optimize charge sharing (to be done)

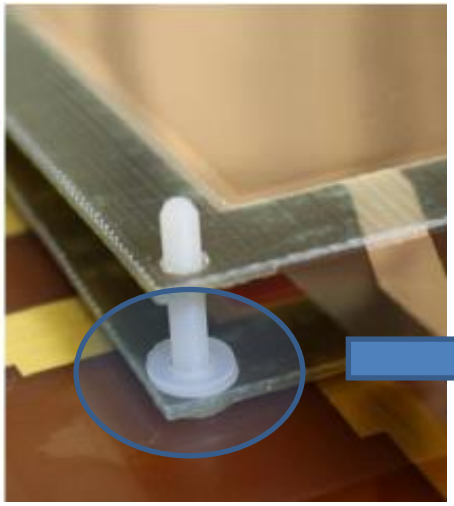
Gap spacers

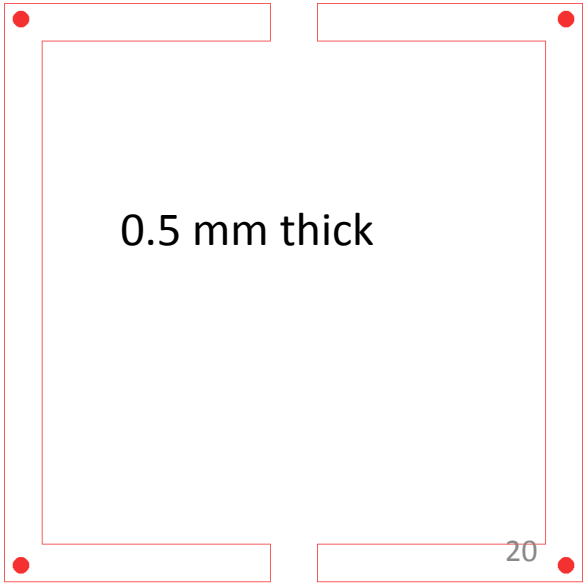
To overcome possible problems of non parallel foils



Proposed modification, substitution of washers with half frames
Ongoing production, still to be tested

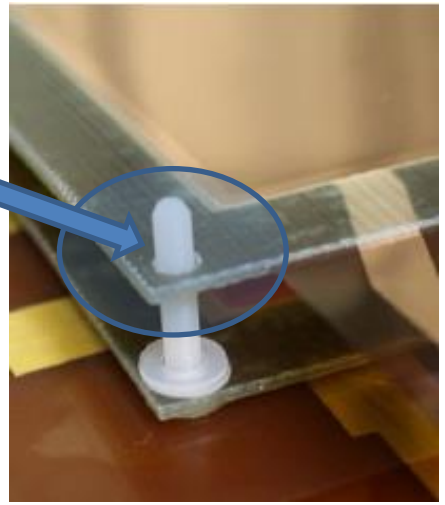


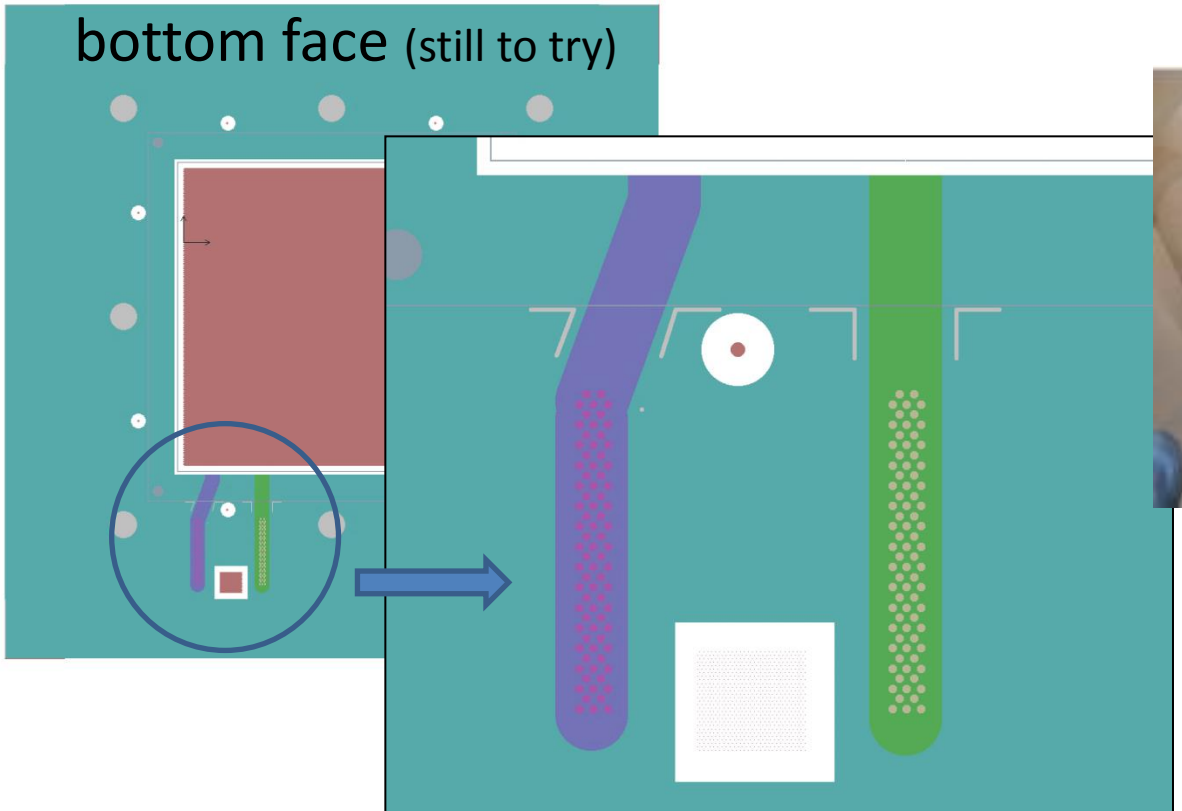


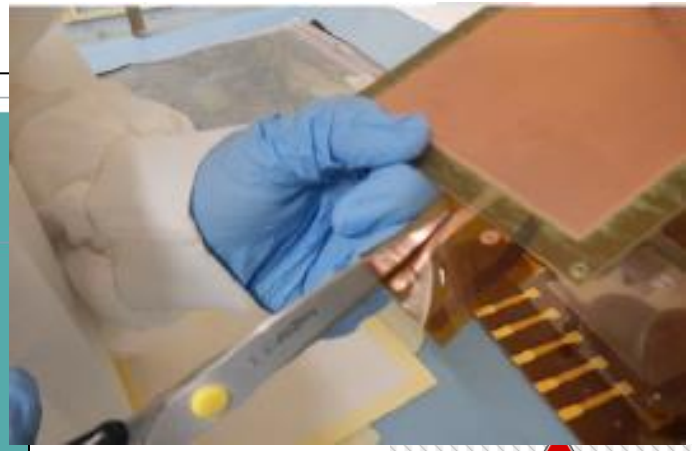


Gem foil modified layout

- Bigger frame holes to avoid dust during mounting (from 3.2 to 3.5 mm)
- Edges of fanout etched in the kapton (to make easier and safest the cutting procedure)
- GEM sample provided with the GEM
- Holes in the Cu fanout to make easier to solder the bottom face (still to try)



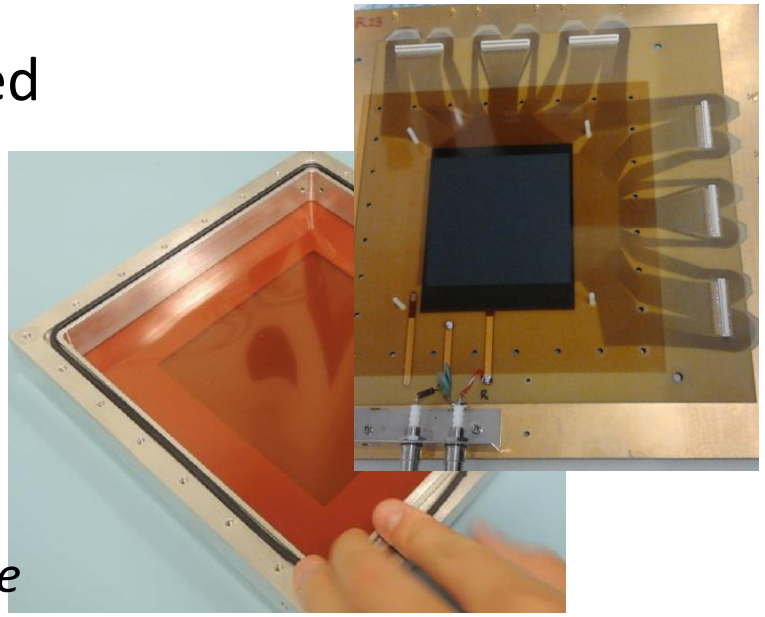


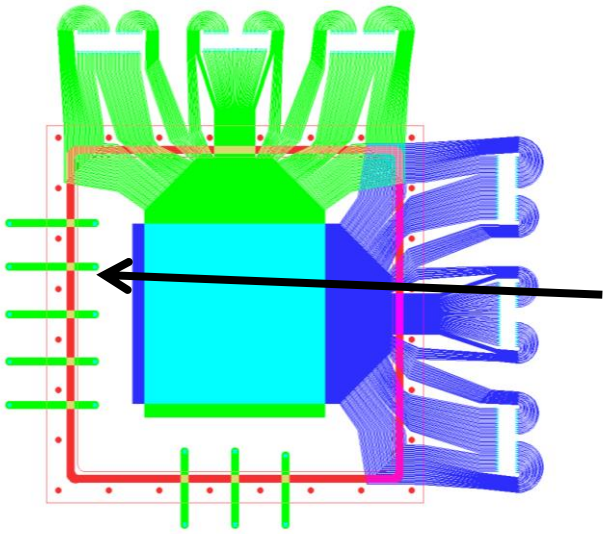


Resistive micromegas

R-micromegas 10cm*10cm std detector

- Like GEMs, standard MM kits are provided with the detector and the gas box
- Readout:
  - X, XY strips, or 1cm*1cm pads
- Little ongoing modifications in the production technique (especially in resistive strips), following ATLAS R&D *(see also talk of Joerg in WG2)*





R-layer: Screen printing on kapton, and then pressing, or filling procedure (depending on the pitch)

Aluminium gas frame

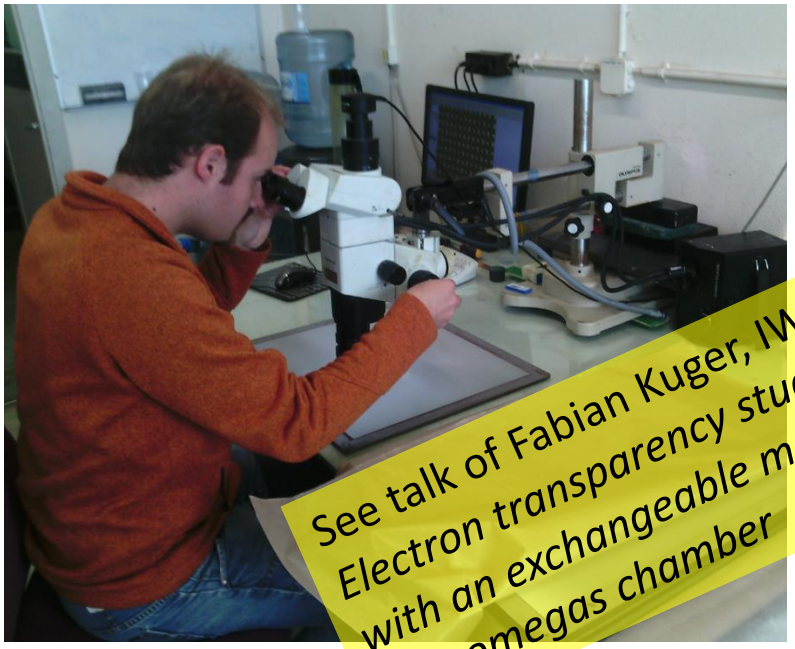
Possibility to add GEMS on top of the MM

BULK micromegas, not possible to change anymore the layout once is done

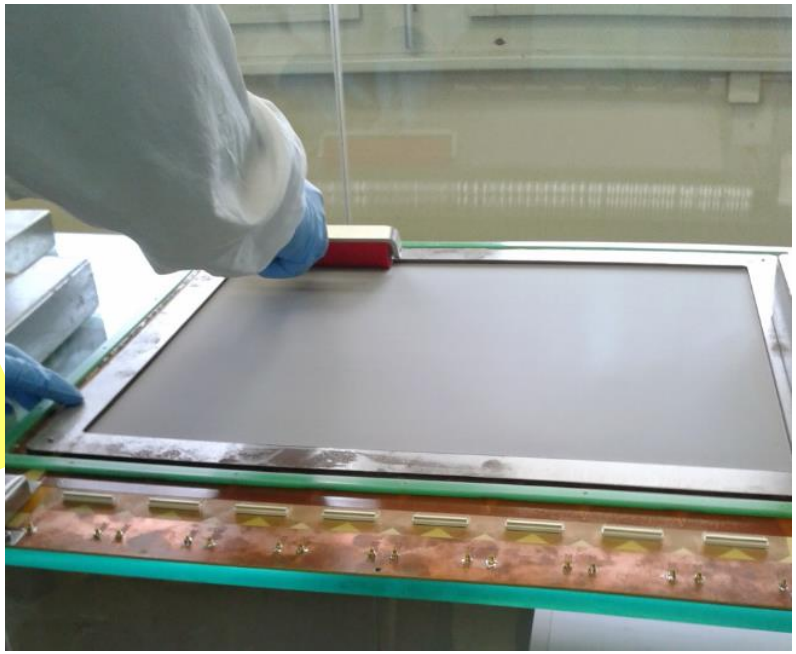
Exchangeable mesh MM

NEW

- Developed for ATLAS
- Can become a standard detector for whom are interested to carefully study MM properties (e.g. changing the mesh geometry)
- Easy to clean (can be opened, no bulk)
- Bigger detector (40cm*50cm) provided with all the components



See talk of Fabian Kuger, IWAD: Electron transparency studies with an exchangeable mesh Micromegas chamber



*Realization of an **Ex**changeable **Me**sh MM (ExMe)*

Drift panel

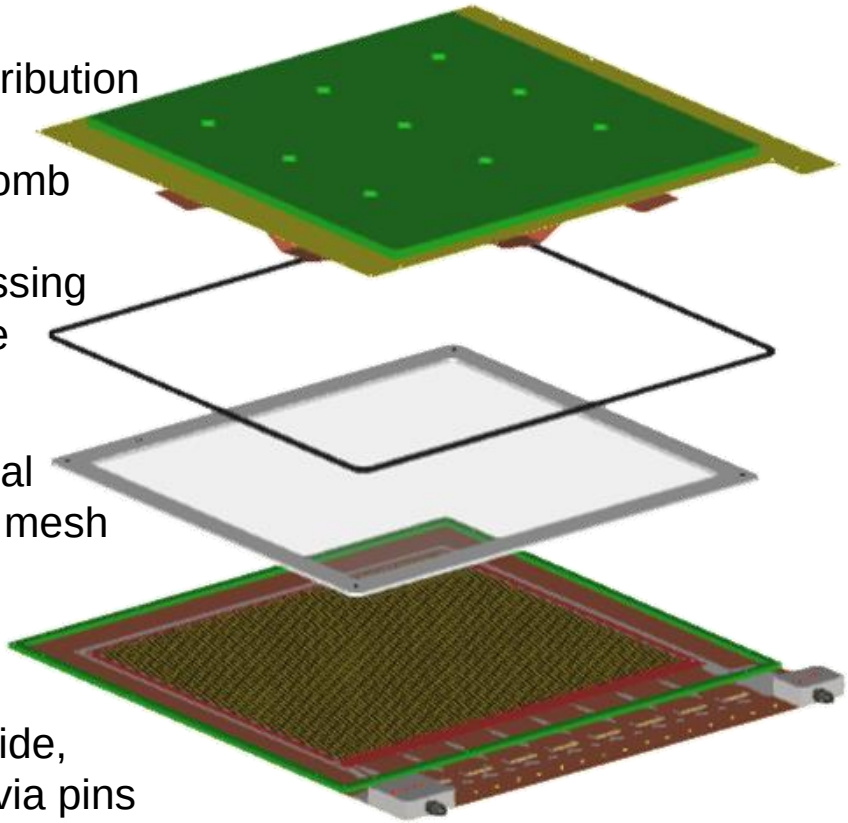
- with internal gas distribution and HV conduct
- mounted on honeycomb + FR4 stiff-back
- carrying springs pressing down the mesh frame

O-ring

placed between external FR4 frame (5mm) and mesh frame (4mm+springs)

Mesh frame

Mesh glued on lower side, aligned with r/o board via pins in the corner.
Ground contact to copper ground on r/o plane.

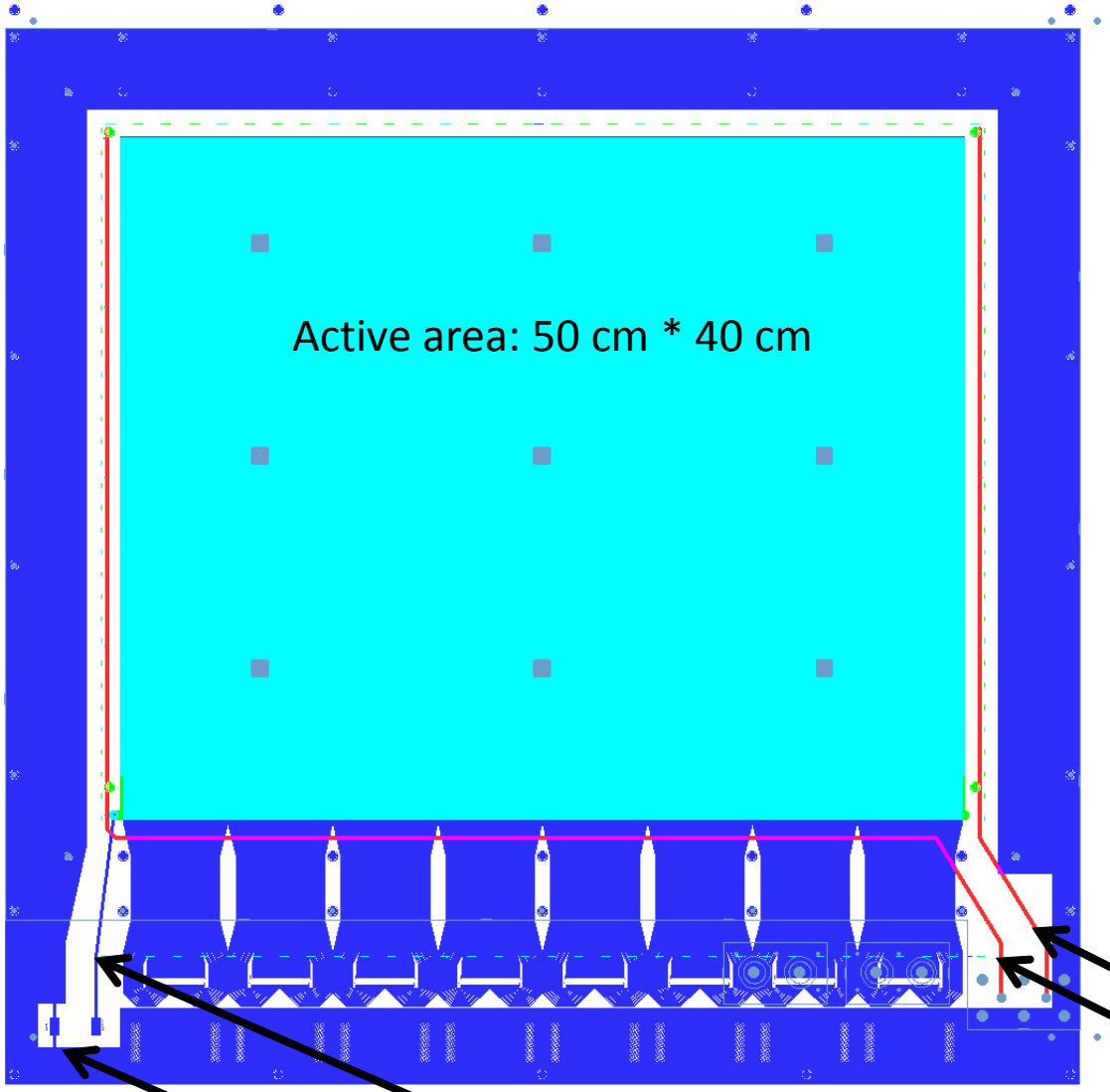


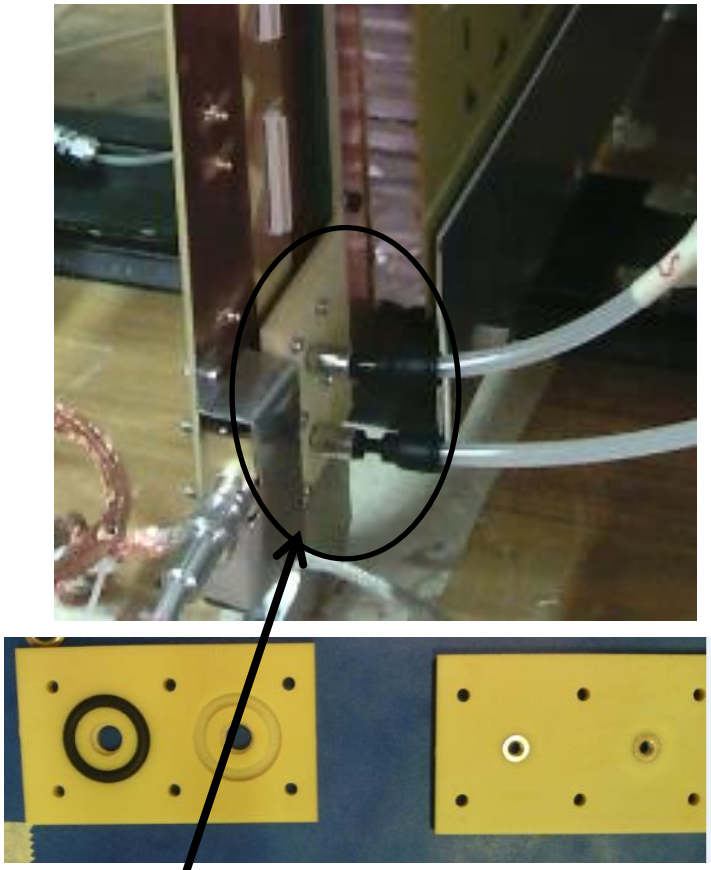
Readout panel

- copper readout strips routed to Panasonic connectors
- Kapton™ foil with sputtered resistive pattern
- coverlay (128µm pyralux) with pillar structure and 'frame' to define mesh boarder heigth
- glued outer FR4 frame
- connectors for HV, r/o (Panasonic) and grounding

From Fabian Kuger talk

Layout





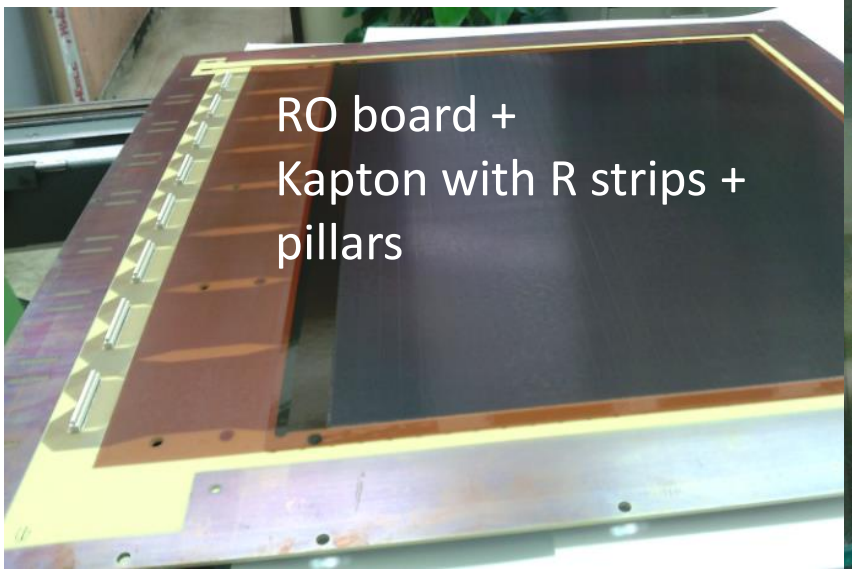
Gas system:
Grooved drift plane

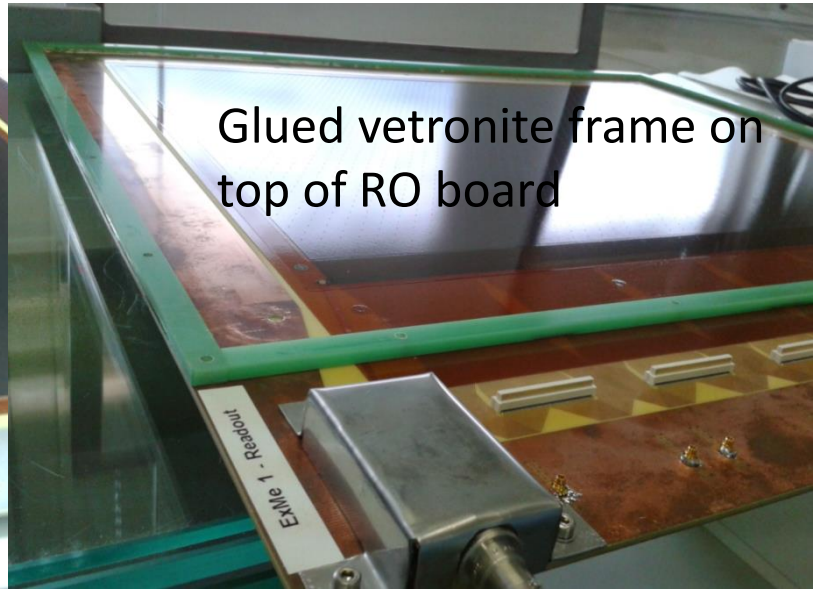
R strips

HV connections

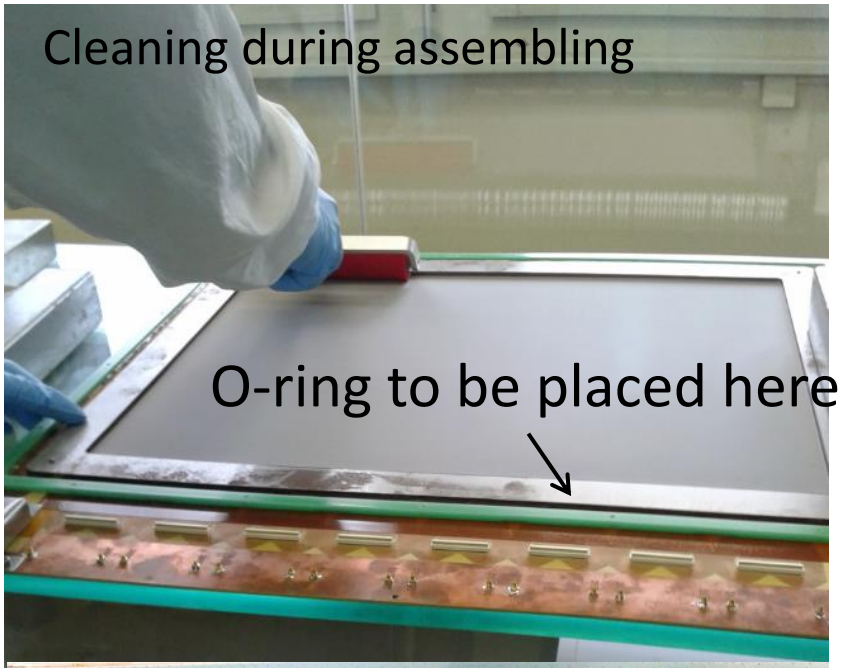
Mesh (GND)

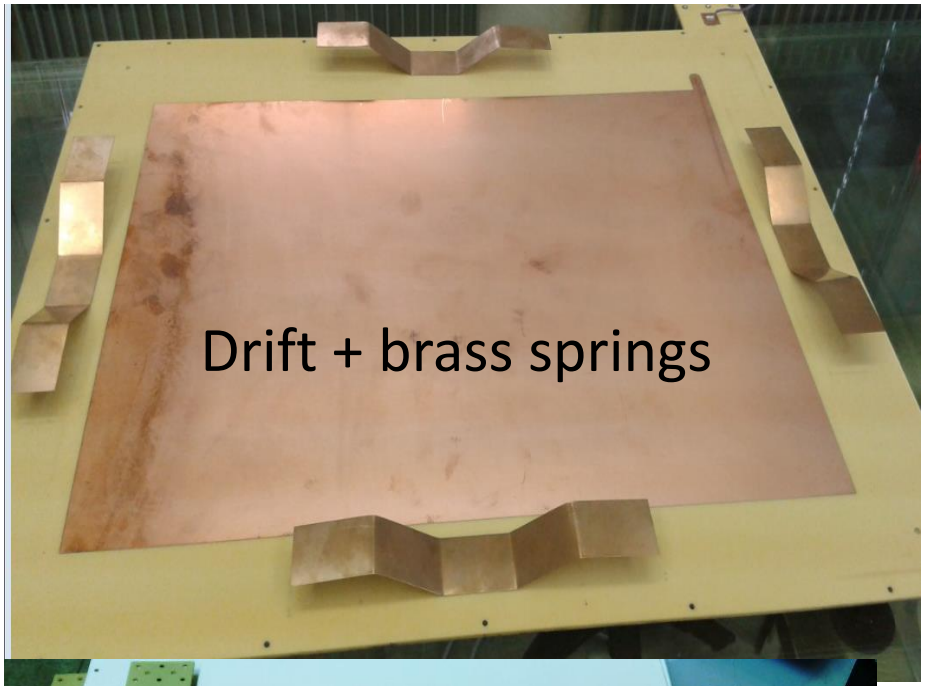
Some pictures ATLAS prototype (1)

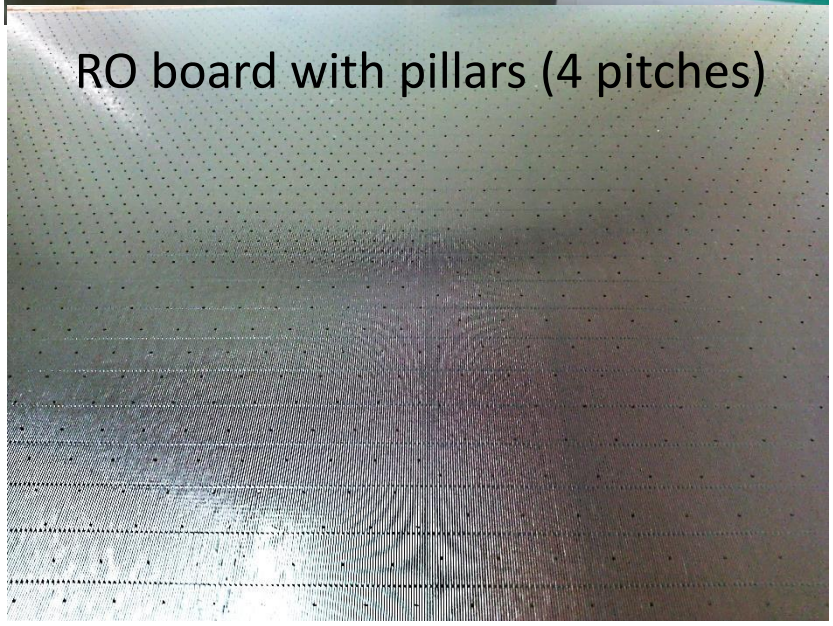




Some pictures ATLAS prototype (2)



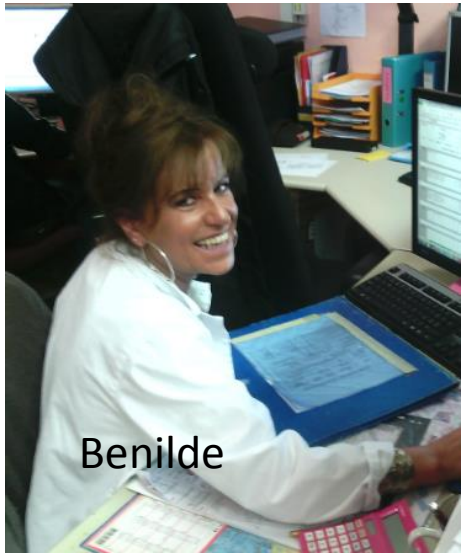


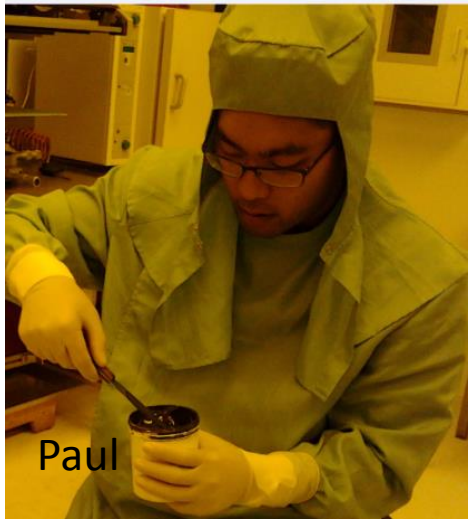


The CERN MicroPattern technology workshop team (concerning GEM and MM)

The CERN workshop, FSU team

Some of the people involved in some steps of GEMs and MM (standard PCB steps)

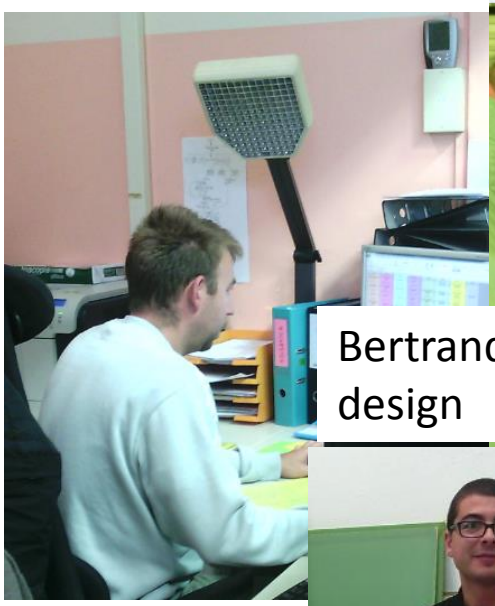


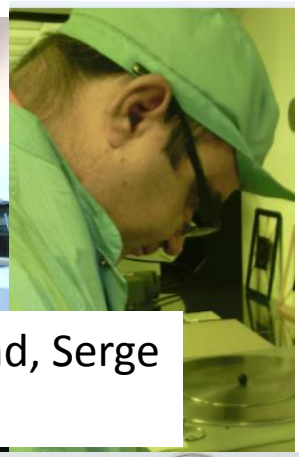


+ Ercan, Franc, Xavier …

The CERN workshop

Rui, supervisor





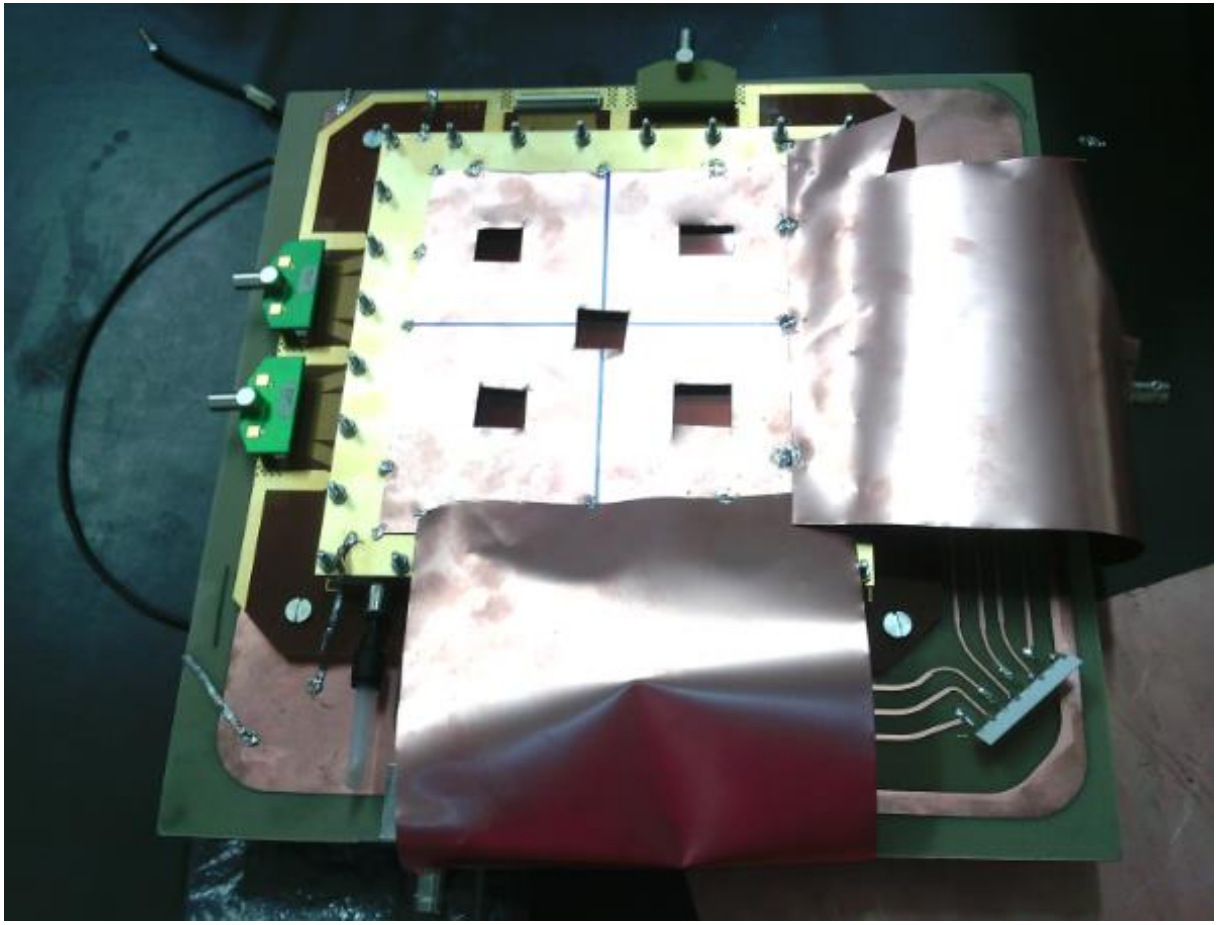
Bertrand, Serge design

People deeply involved in design and production of standard MM and GEM

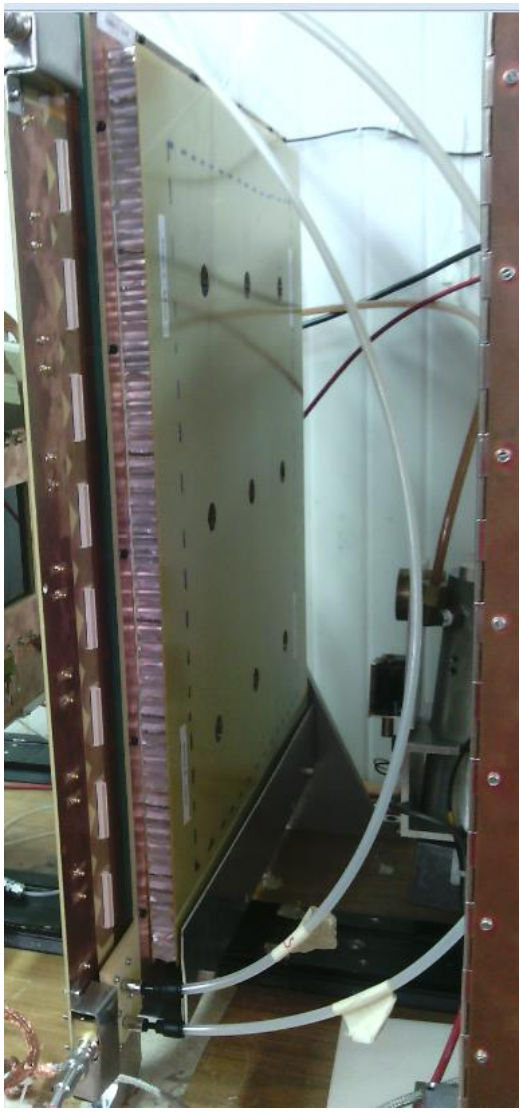
Cedric, Alexis GEM

Olivier, Antonio Micromegas

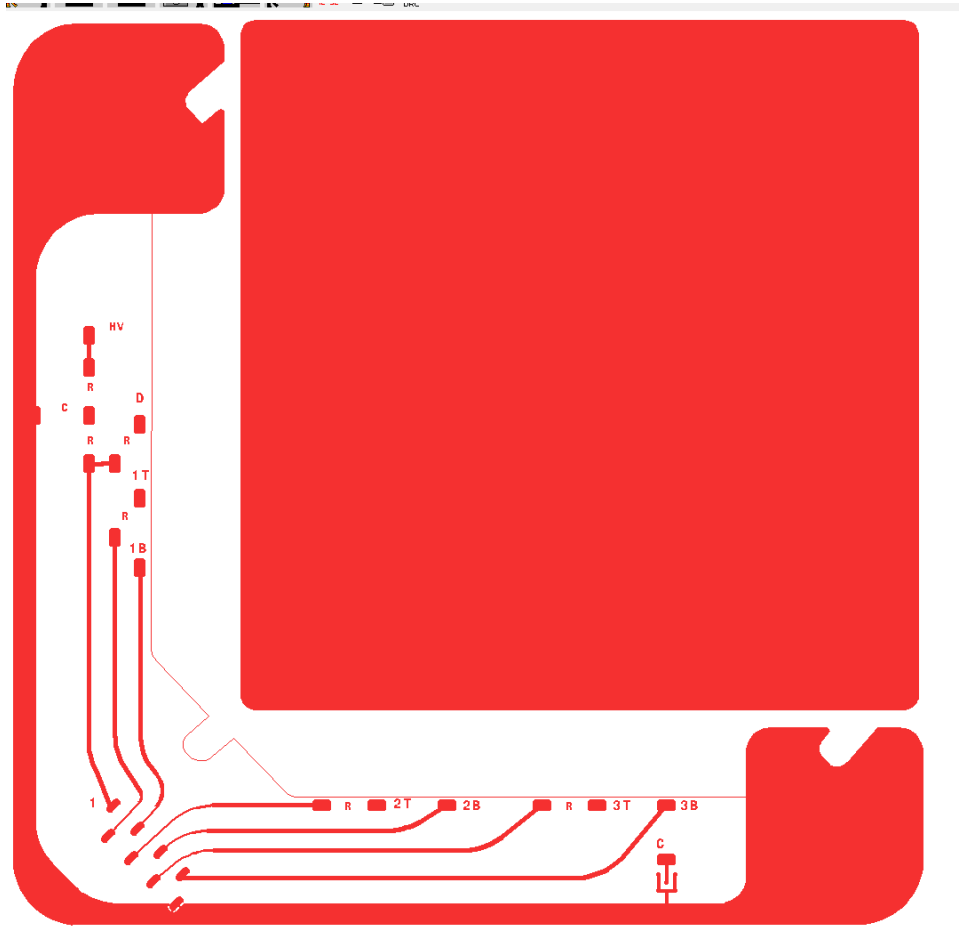
Backup slides

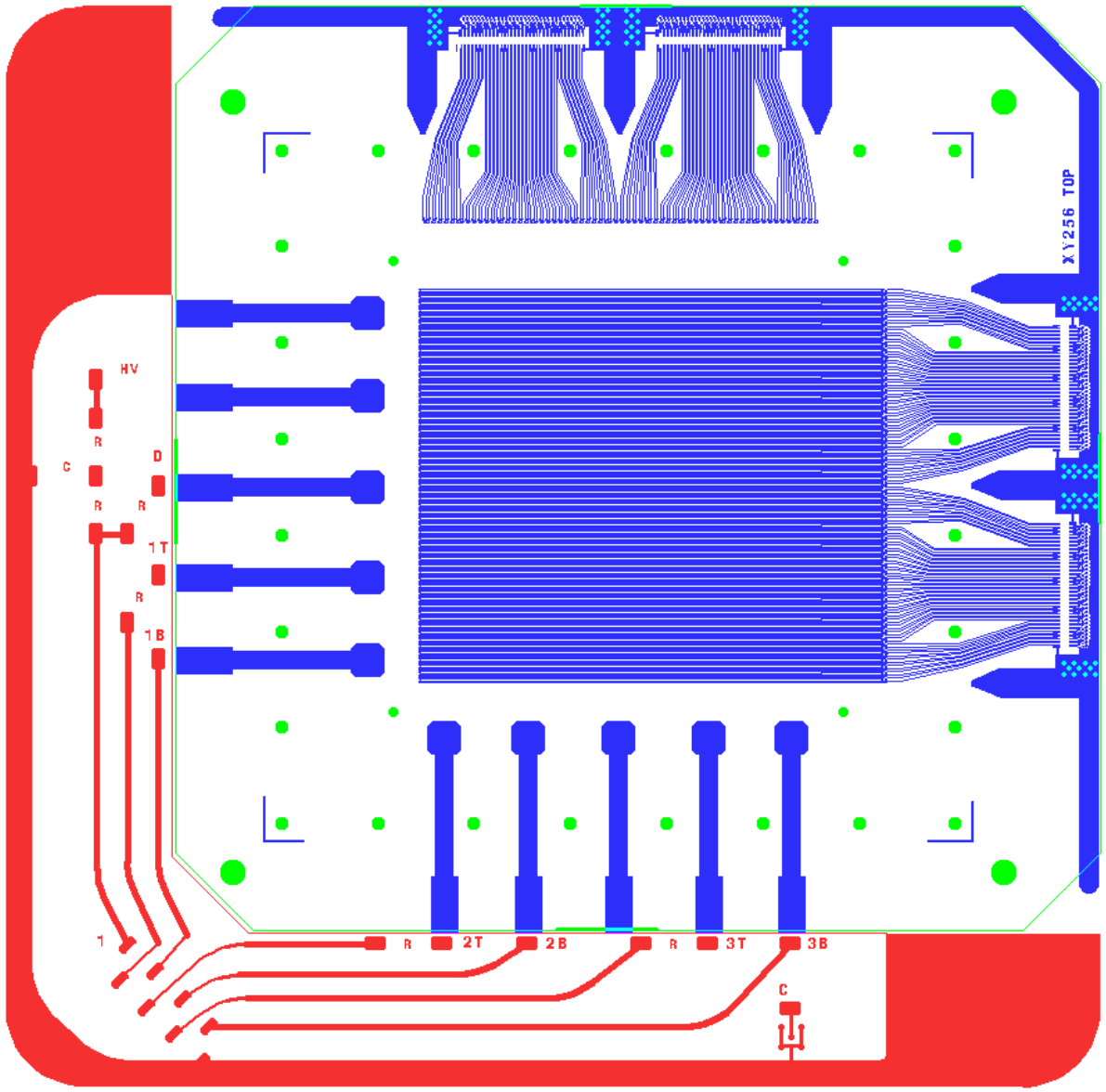


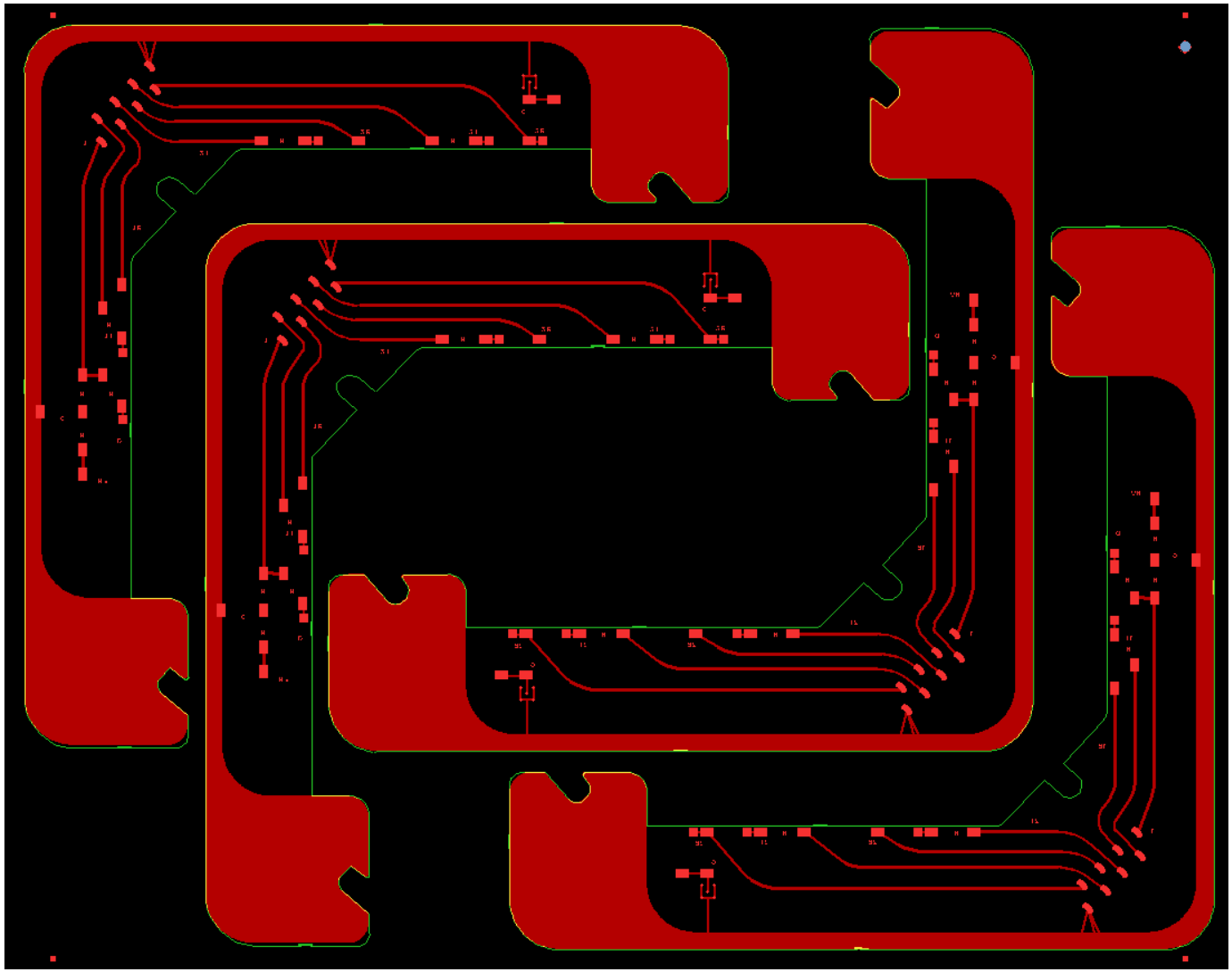
Micromegas 40cm*50cm



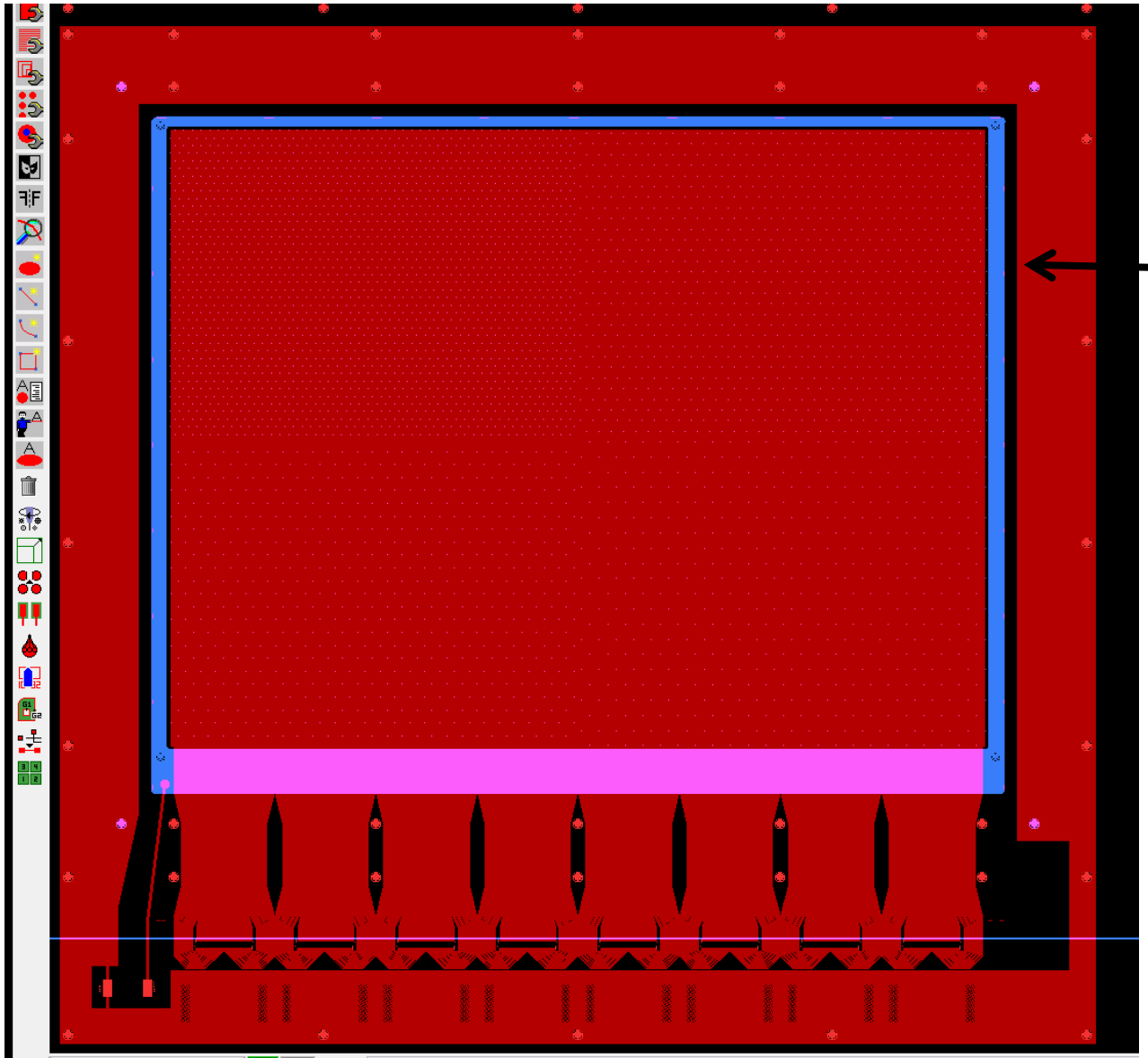
Pcb for ceramic v divider




XY256 TOP
HV
R
C
D
R
R
1T
R
1B
1
R
2T
2B
R
3T
3B
C



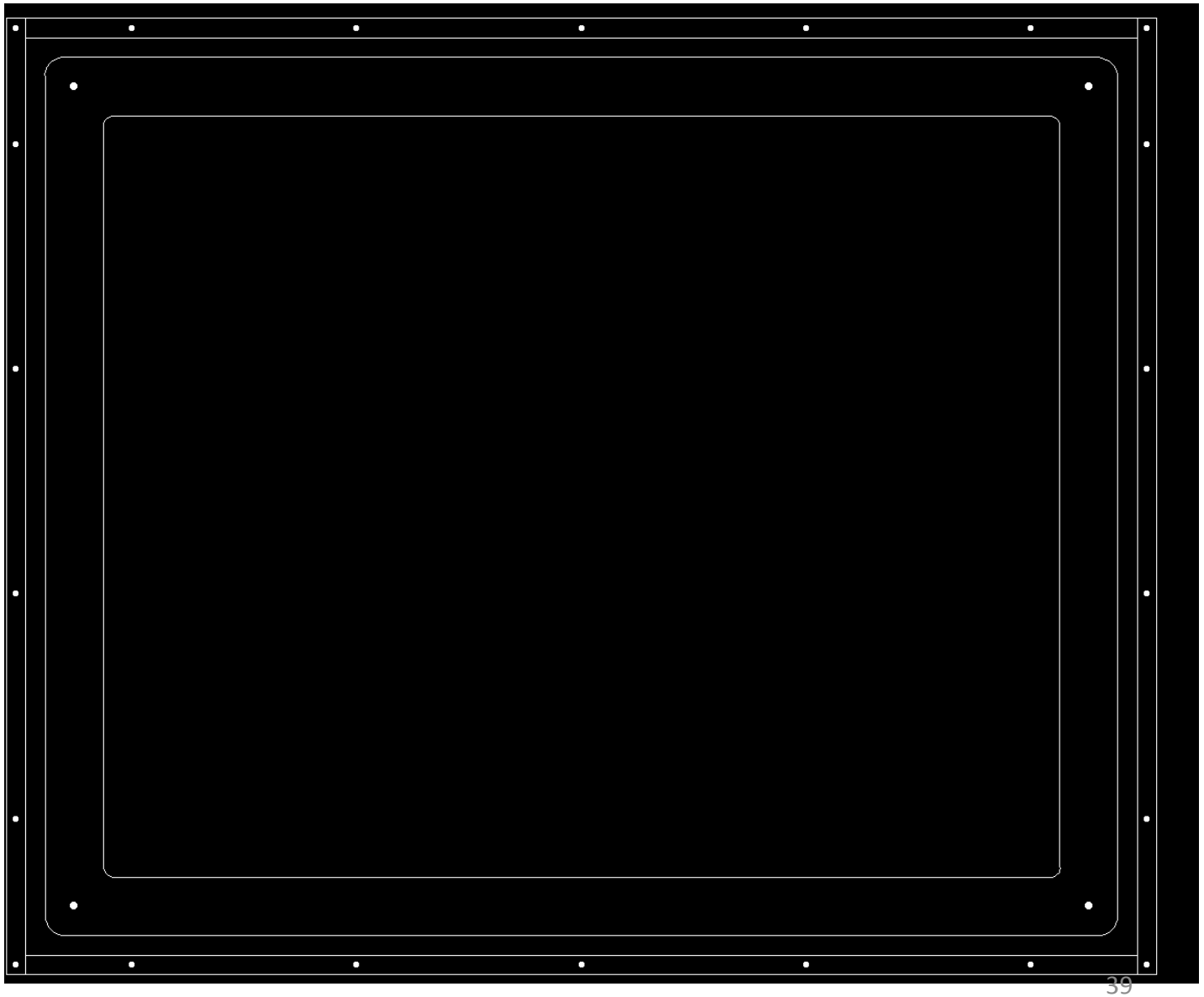
~ 63mm large


mesh

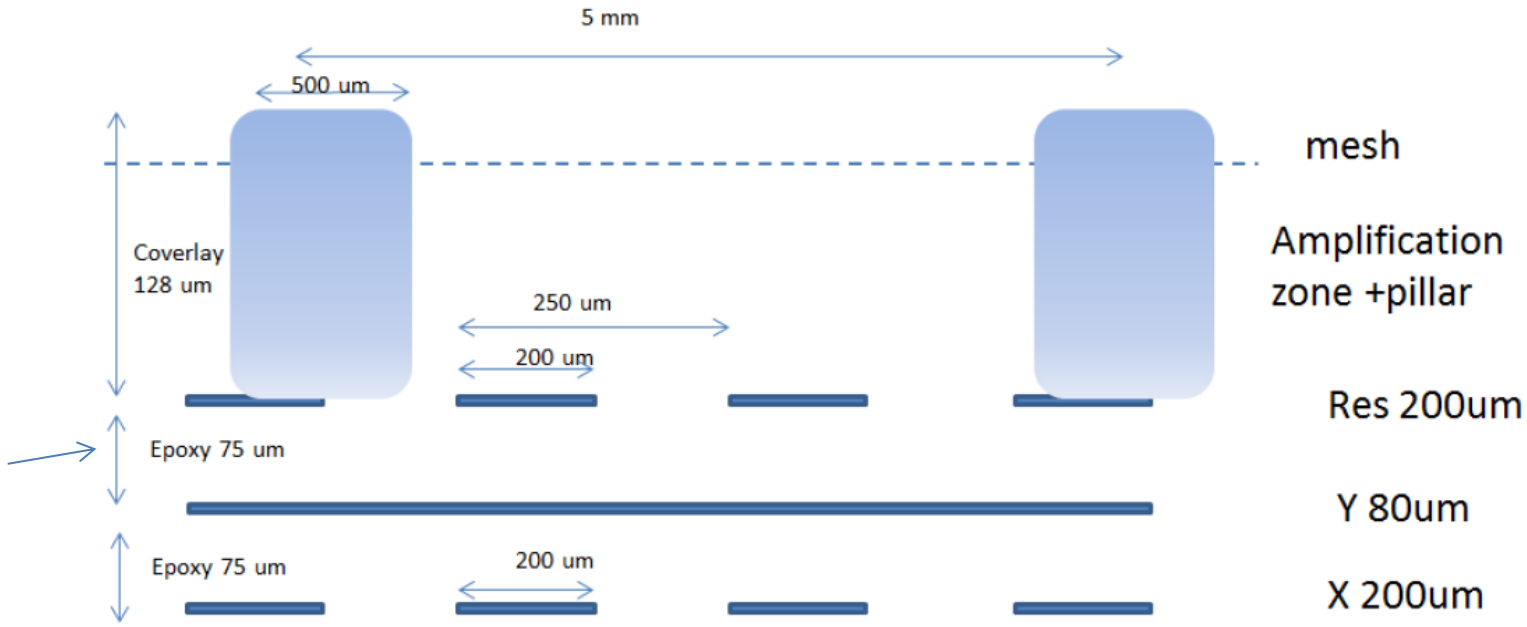
External frame:

vetronite
Glued on the readout

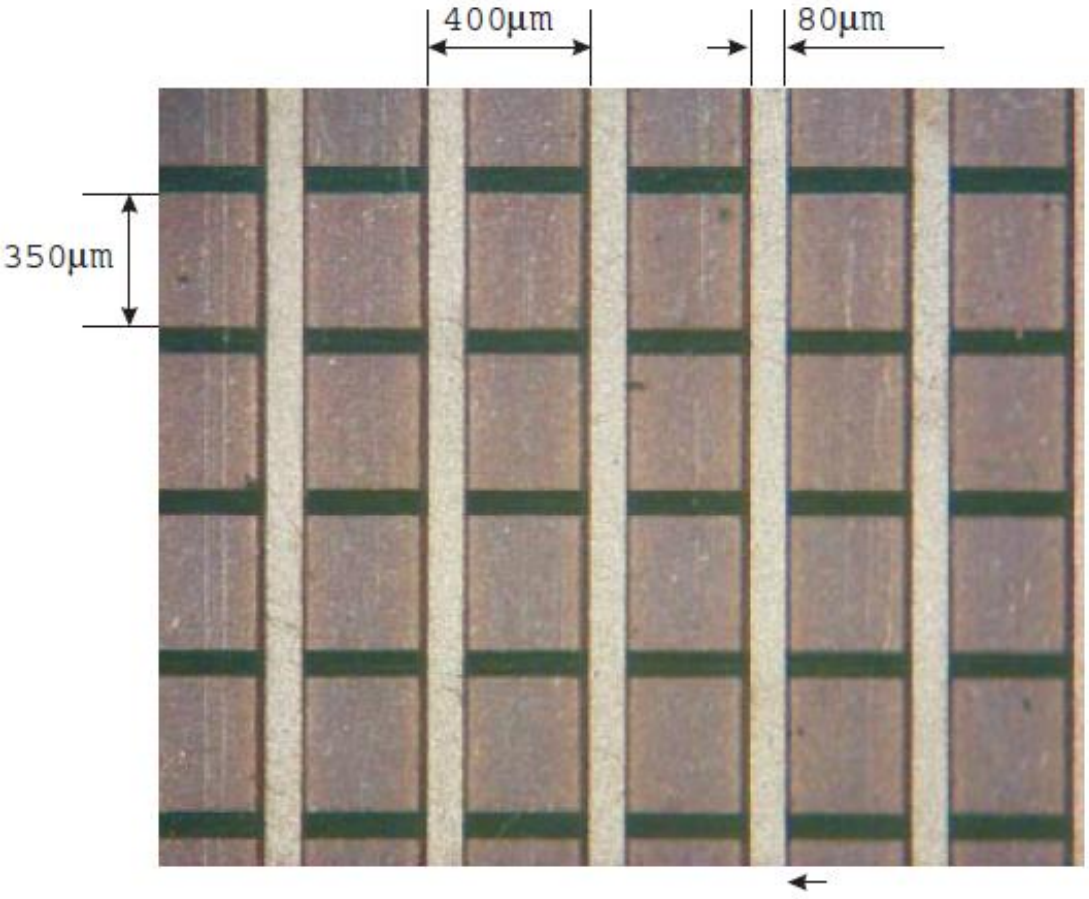
O-ring in the middle between the two frames



Standard MM XY strips



Changed with 50 um kapton


400µm
80µm
350µm