RD 51 December mini week 2015

Resistive protections

Rui de Oliveira

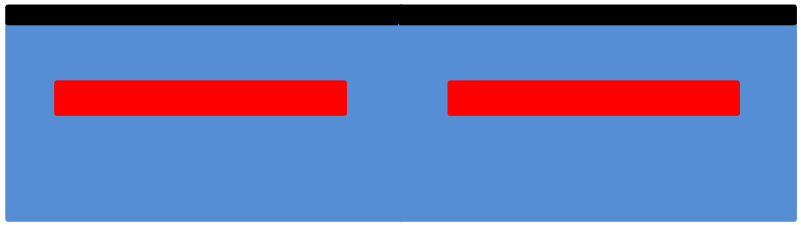
09/12/15

outline

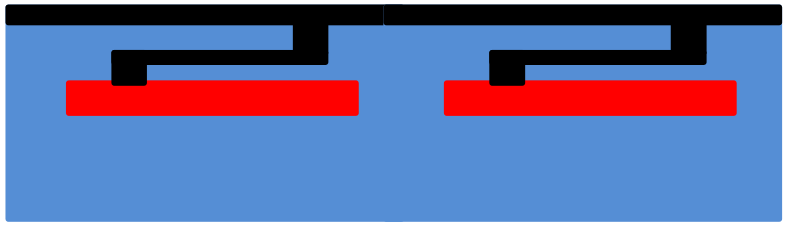
- Resistive protection in Micromegas
- Resistive protection with well detectors
- Resistive MSGC development status
- Conclusion

Surface or embedded resistor for low or High rate applications

Surface resistor



2 layers with one embedded

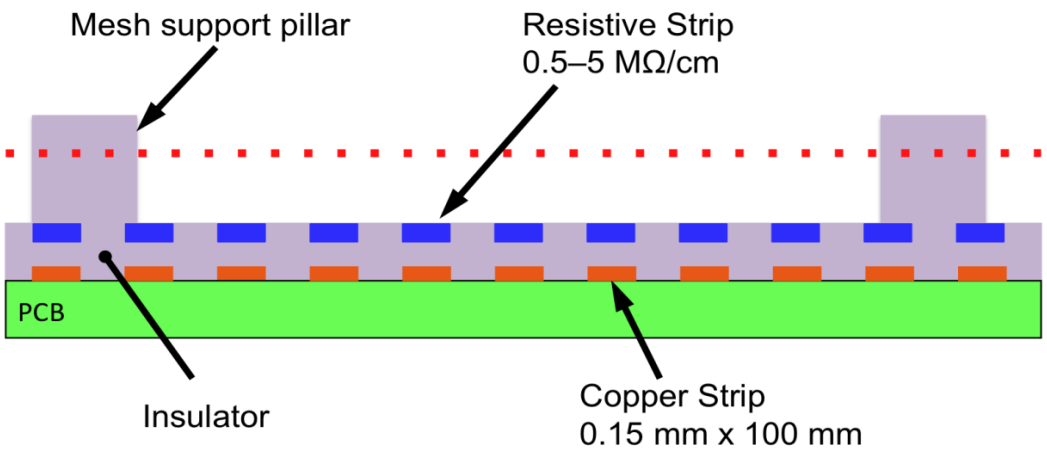


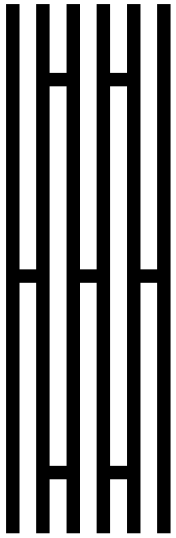
-The thickness above the pad is similar in both structures

-Around 50 to 75um to minimize the signal loss

Surface protection

Resistive lines
(see Silvia Franchino &… study)



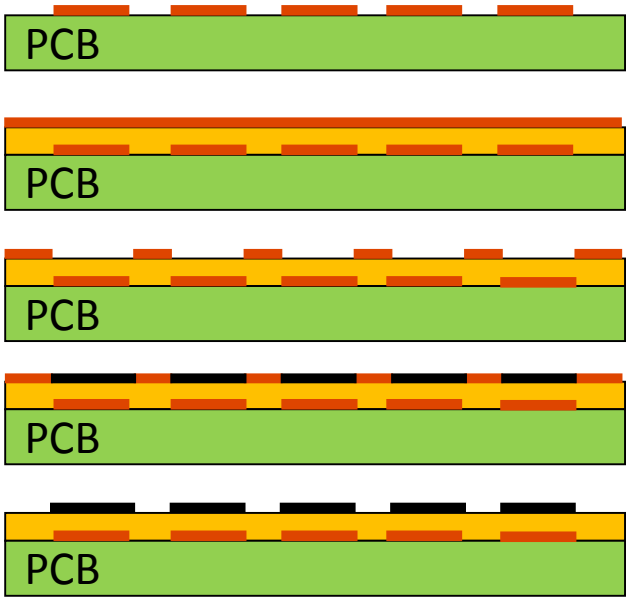


- **Smaller signals by 10-20% related to insulator thickness**
- **Gives the possibility to ground the mesh or the drift**
- **Resistive lines are connected together**

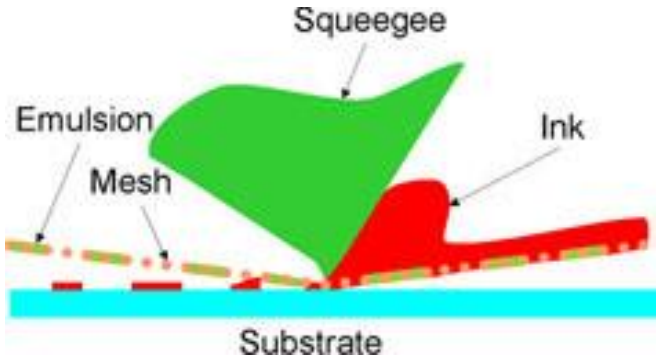
Resistive strips production :

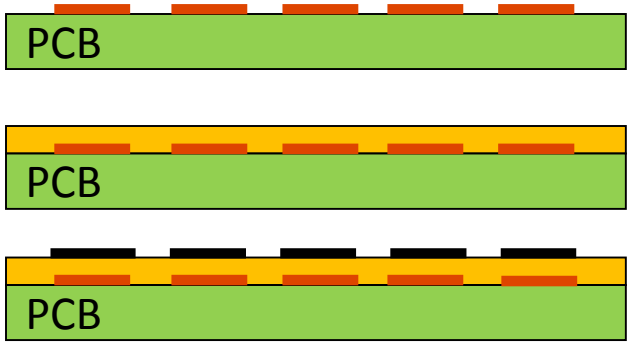
Photolithography

Possibility to go down to 0.1mm pitch

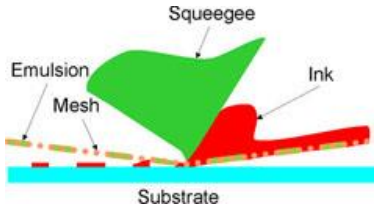


Screen printing





Screen printing :

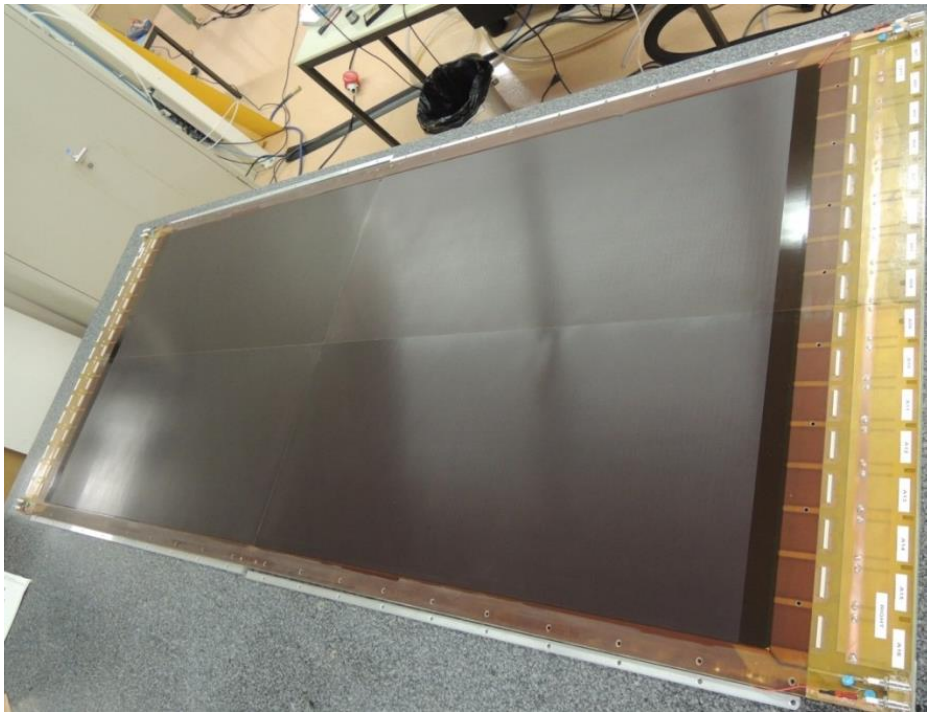


Semi automatic machine
20 boards/hour
Printing area 1.5m x 0.9m

Full automatic line also available. On going study.
Many hundred foils/hour possible rate

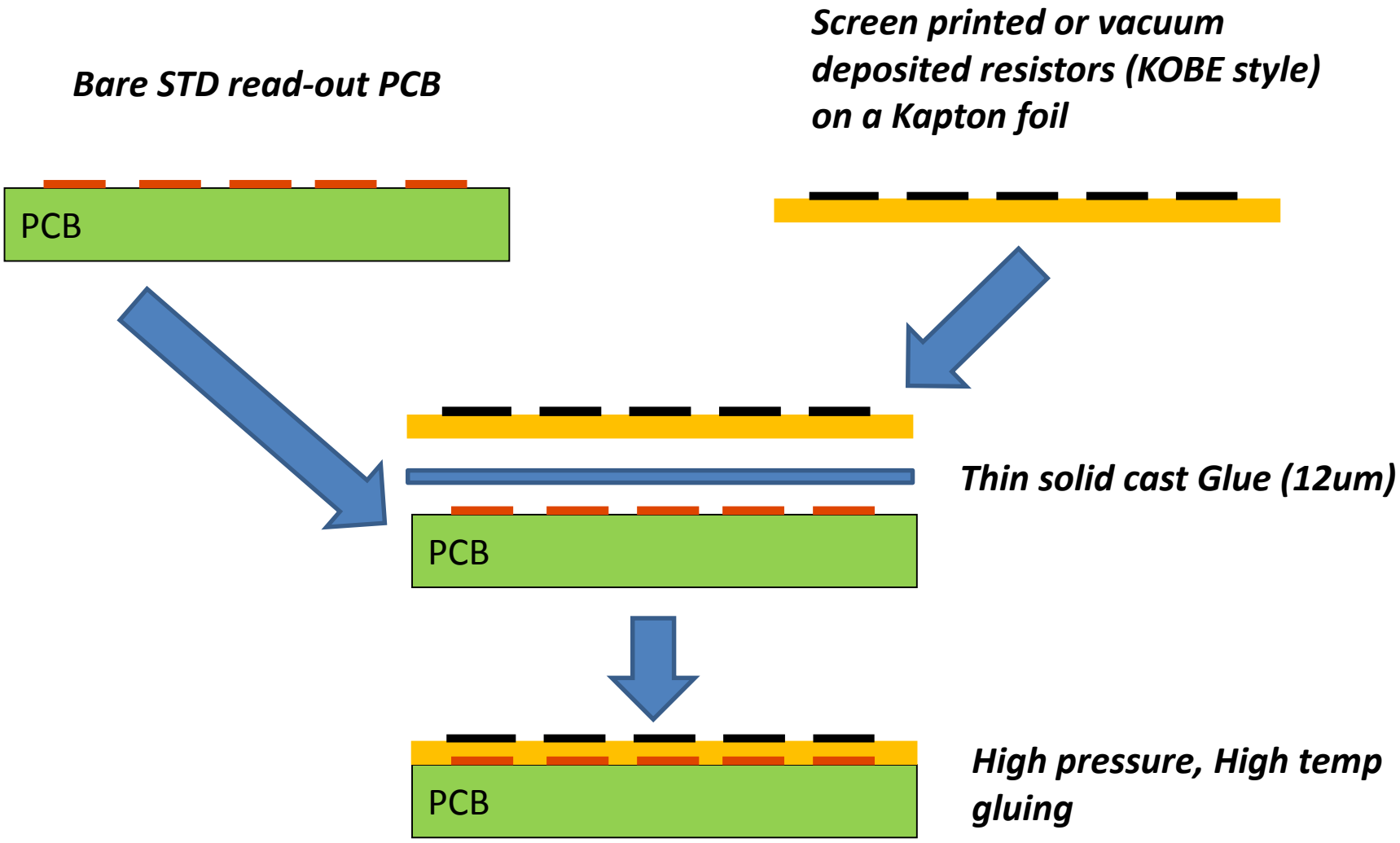
Subcontracted to the company Charbonney near CERN

Maximum sizes

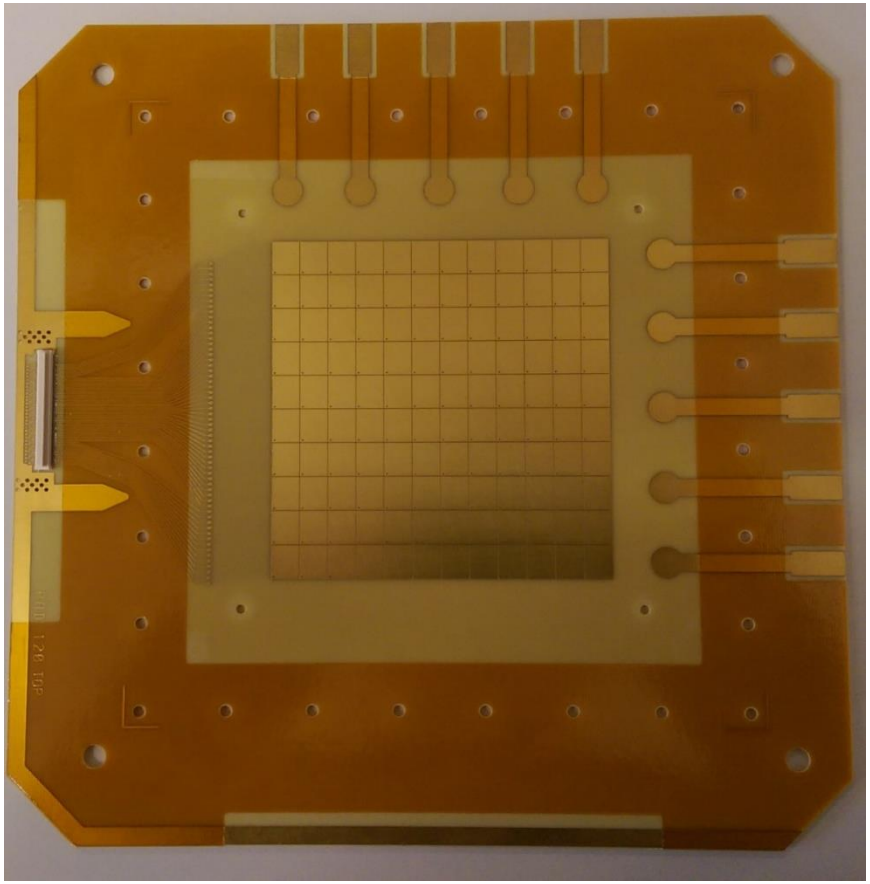


- Picture : 2m x 1m x 0.5 mm
  read-out board with pillars in 4 parts
- 10 mm thick Aluminum honeycomb
- Max size for 1 PCB : 2.2m x 0.6m

Resistive layer for mass production :



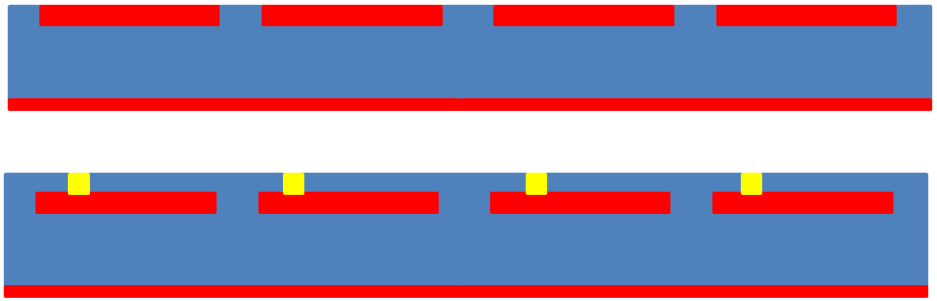
Embedded resistor with LAPP



Production steps

Bare PCB

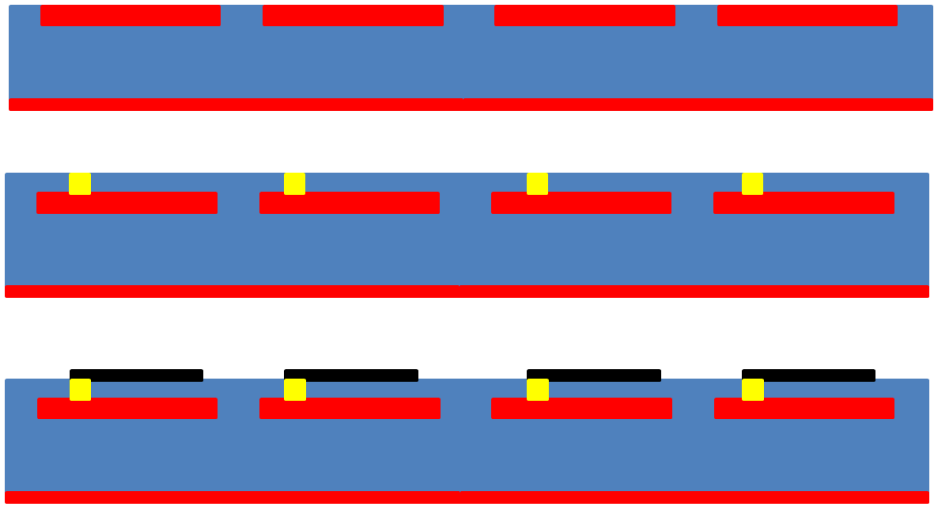
Production steps



Bare PCB

Coverlay gluing + via fill

Production steps

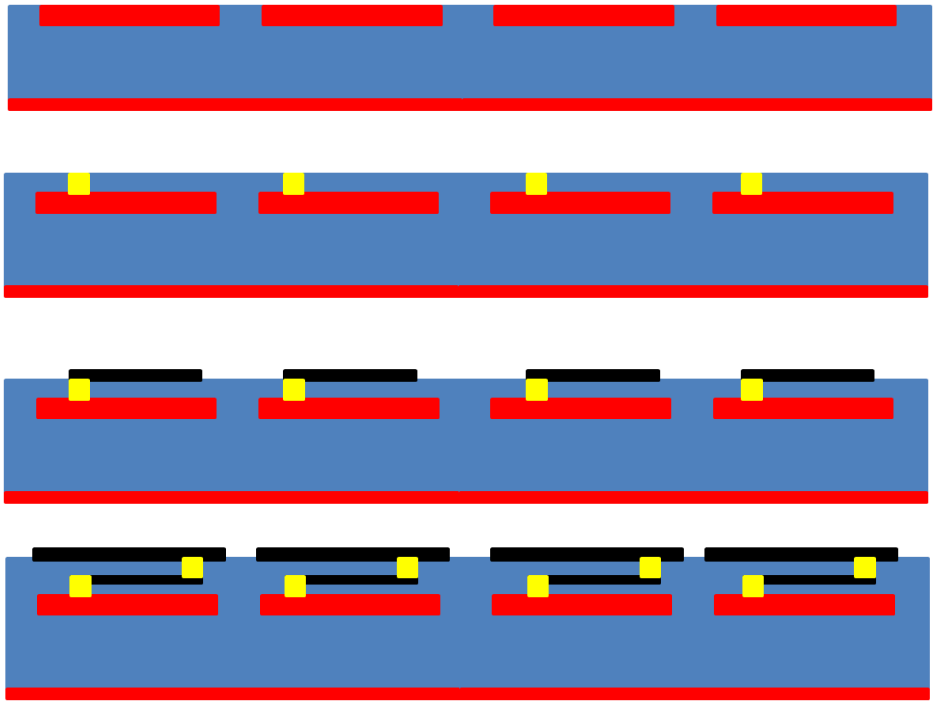


Bare PCB

Coverlay gluing + via fill

Inner resistor printing

Production steps



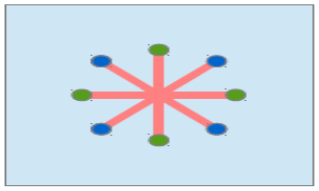
Bare PCB

Coverlay gluing + via fill

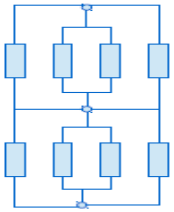
Inner resistor printing

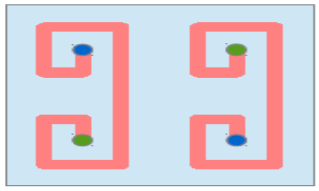
Coverlay gluing + via fill
+top resistive layer print

Shapes and values for embedded resistor R1 Detectors for the LAPP

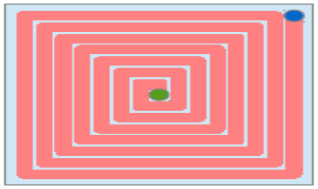


L_{eff} ~ 0.13 cm
R(100 k/sq) ~ 400 kOhm
R(1 k/sq) ~ 4 kOhm

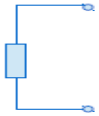




L_{eff} ~ 1.3 cm
R(100 k/sq) ~ 4 Mohm
R(1 k/sq) ~ 40 kOhm



L ~ 13 cm
R (100 k/sq) ~ 40 MOhm
R (1 k/sq) ~ 400 kOhm



Real values:
40 to 60 KOhms with 10KΩ/Sq
400 to 750 KOhms With 100KΩ/Sq

Real values:
400 KOhms with 10KΩ/Sq
4 MOhms With 100KΩ/Sq

Real values:
4 MOhms with 10KΩ/Sq
40 MOhms With 100KΩ/Sq

Results with embedded resistors in Micromegas

- Results are corresponding to expectations
- Up to 11 mega events per cm2 with good linearity (rate VS current) have been measured
- For deeper details please contact Maxime Chefdeville at LAPP.

outline

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- Resistive protection with Well detectors
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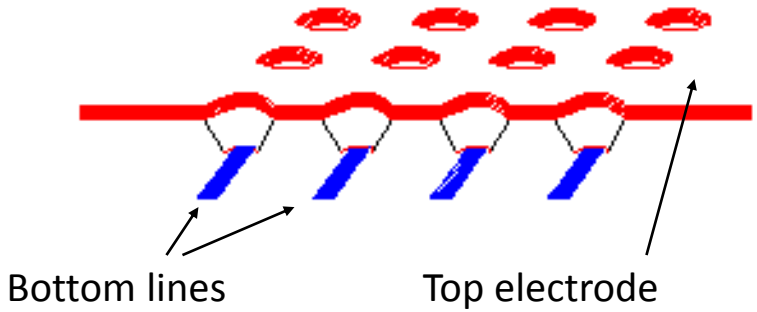
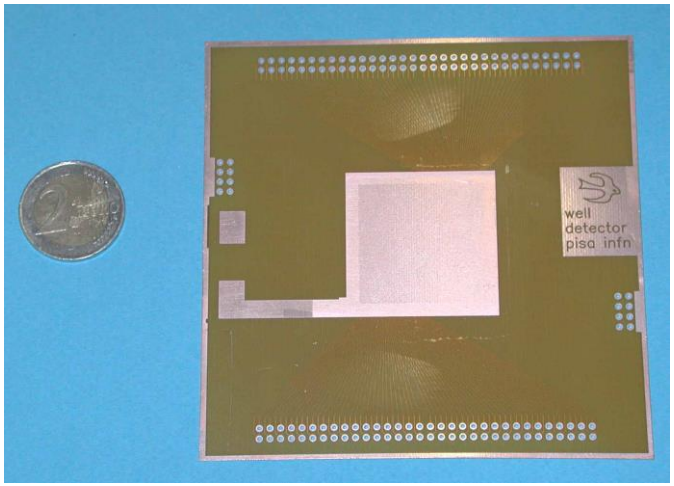
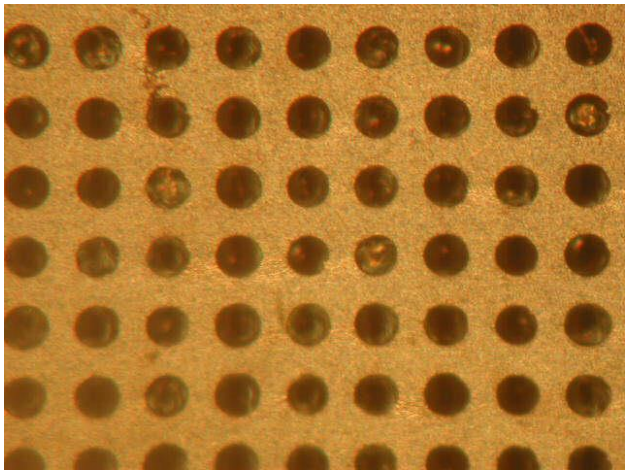
Well detectors

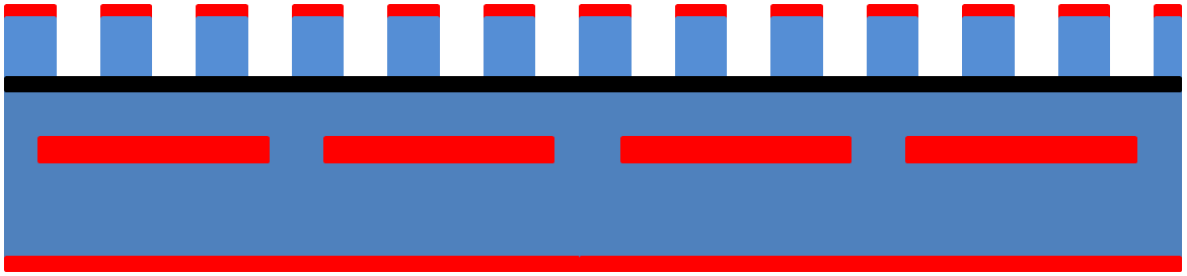
- Introduced by Ronaldo Bellazini in 1997
- Simple and accurate structure
- Single stage amplification
- More robust than MSGC
- But suffering anyway from spark



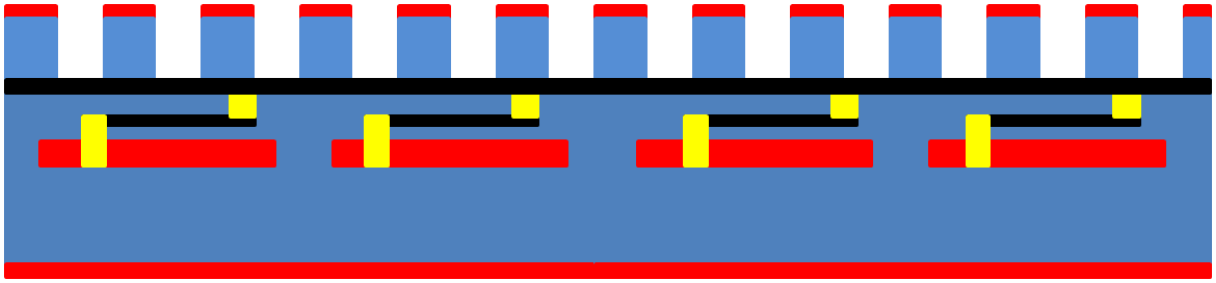




Embedded resistors in well structure



Medium rate

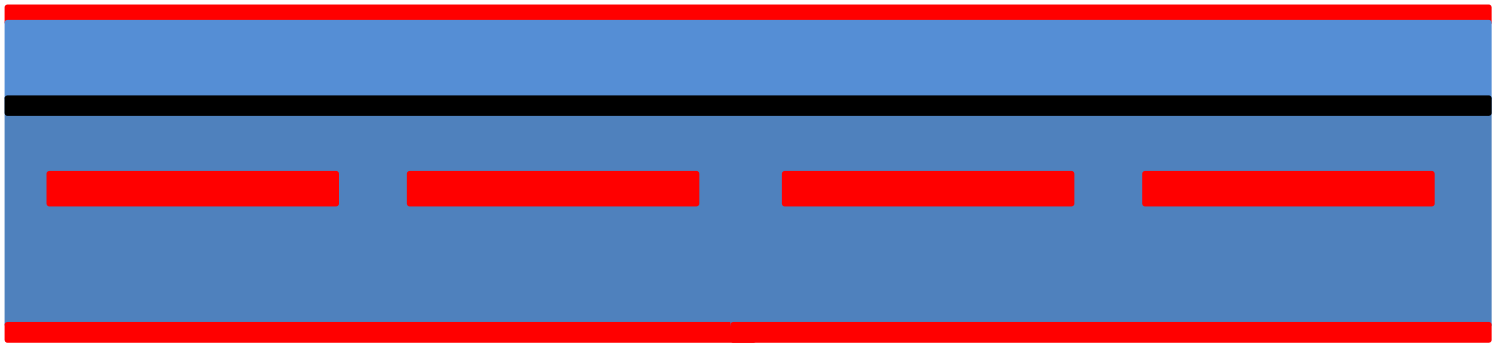


High rate

Process medium rate

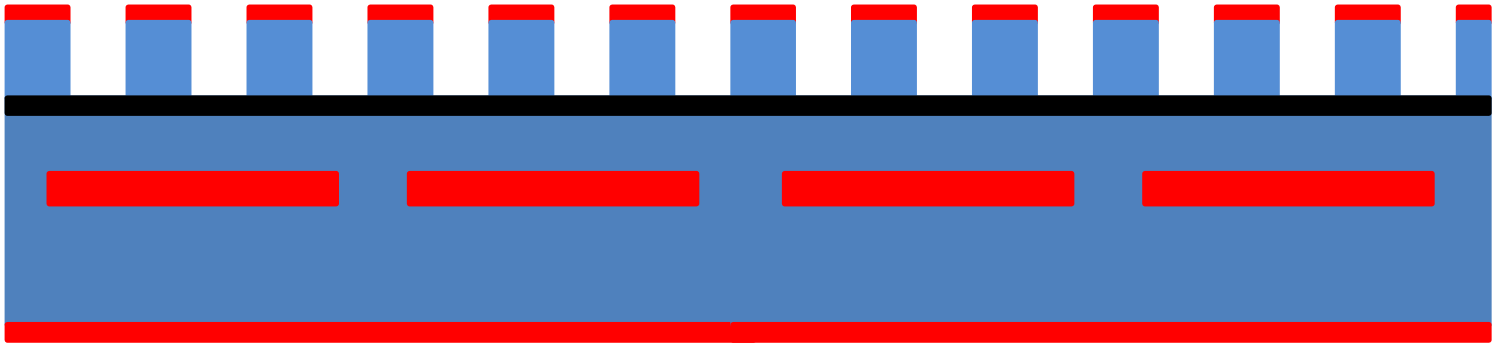
Bottom resistive DLC deposition on 50um Kapton

Process medium rate



Glue to read-out board

Process medium rate



Top layer patterning + kapton etching

Process high rate

Bottom resistive deposition

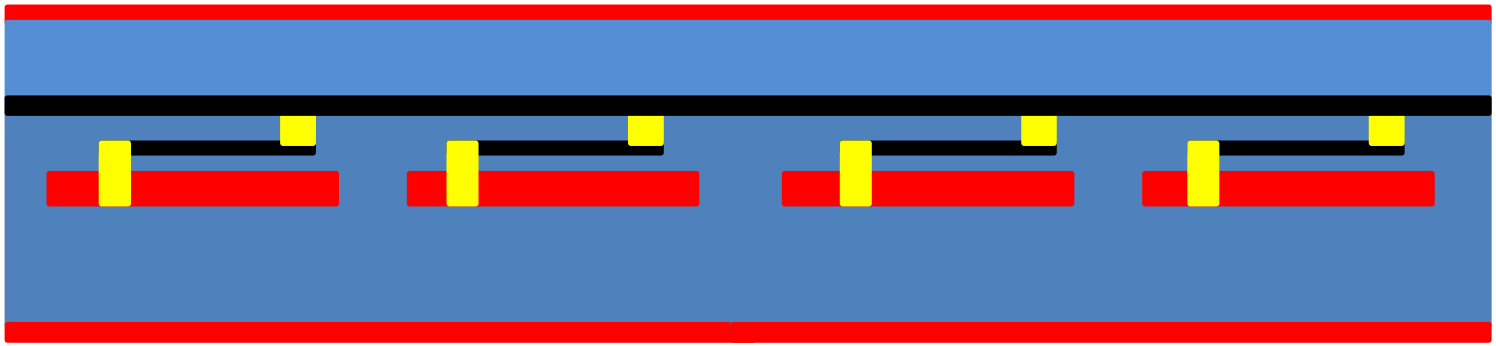
Process high rate

Bottom coverlay + via fill + second resistive layer print

Process high rate

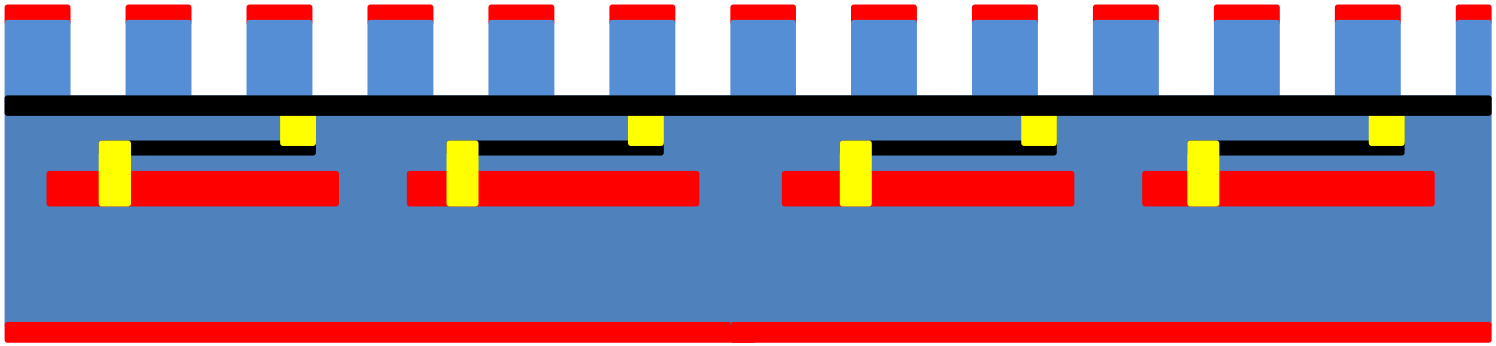
Strip or pad flex gluing + via fill

Process high rate



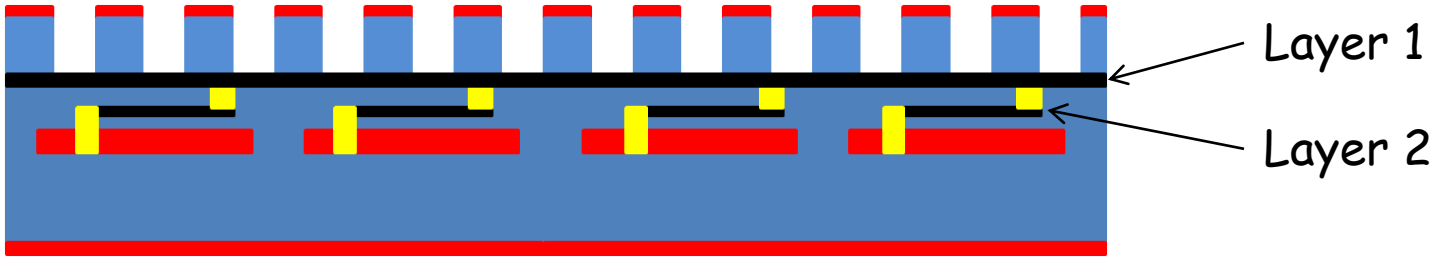
Rigidizer gluing if needed

Process high rate



Top layer patterning + kapton etching

Problems in first high rate production



-due to the multiple gluing steps and the high value targeted (80Mohm/square) the first resistive layer value increased in a non controllable way

-after many test we have discover that the 1MOHMS/square paste is polluted by the glue

-new samples are planned , we will use DLC resistor for the fist layer. The Second one will be screen printed with 100Kohms paste

-For preliminary results please contact Giovanni Bencivenni

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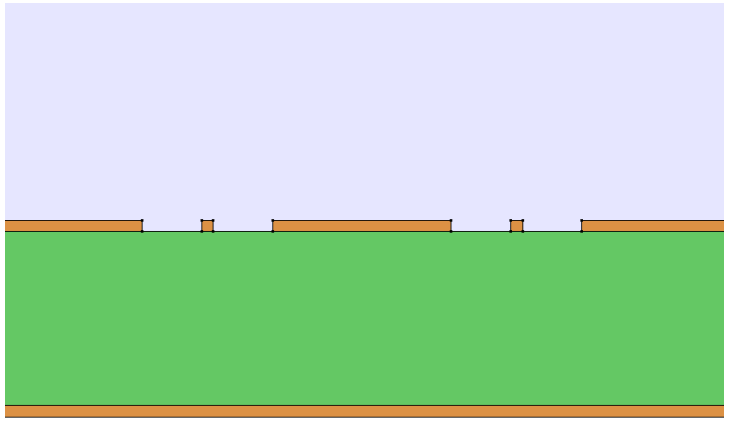
MSGC



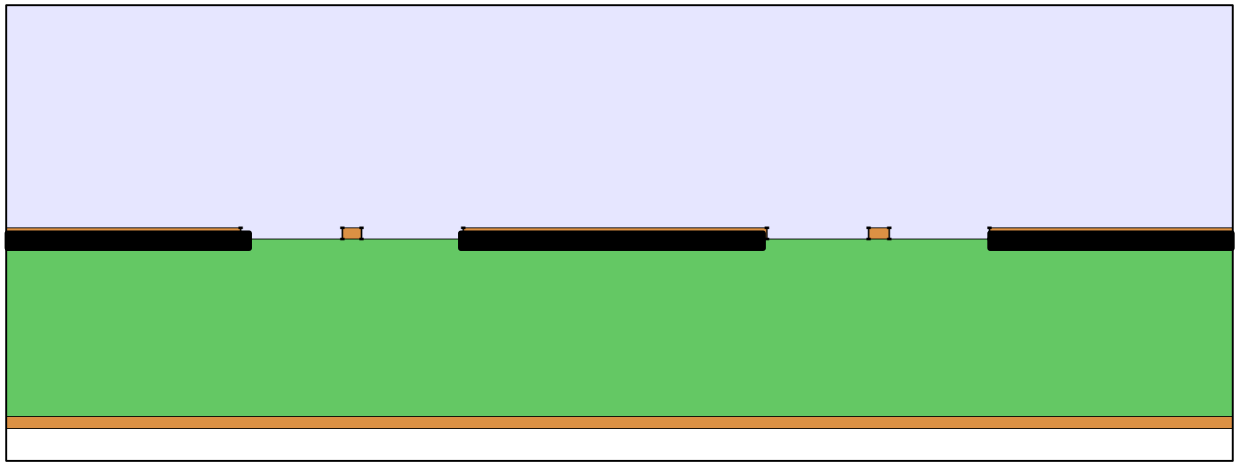
No introduction needed

We are still investigating this device because it is still one of the simplest existing MPGD

MSGC production with PCB technologies

- We have produced many samples with PCB technologies and materials
- They work as expected:
  - Good gain
  - Good energy resolution
  - They suffer from spark damages
  - They charge up
  - They show polarization effects

First improvement



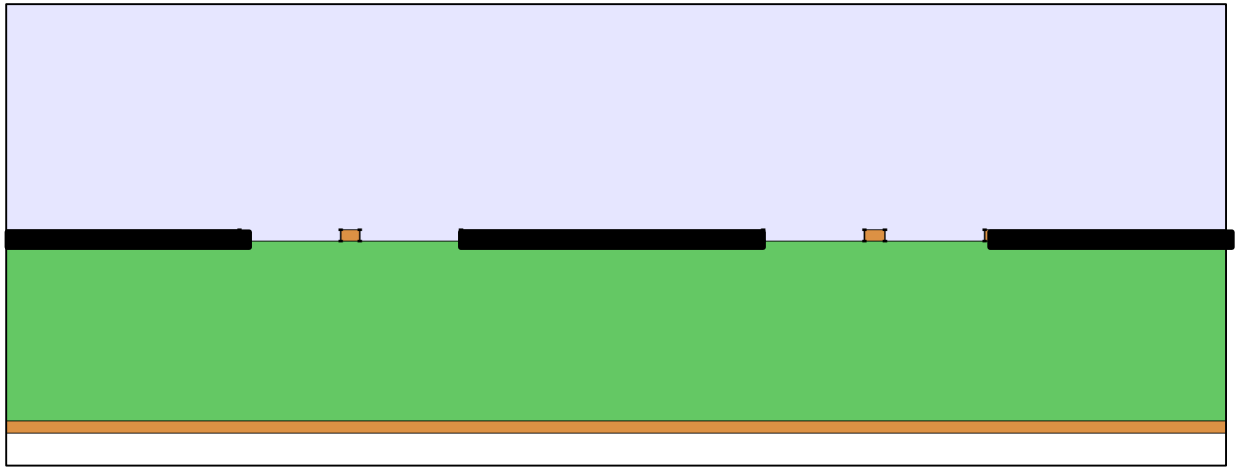
-We have change the material of the cathode electrode.
From metal we went to 100Kohms/square paste

-This modification solved the spark problem

-But we were still suffering from charging up and polarization

-Looking in literature we have found a lot of papers dealing with this problem and giving solutions ,one of them was to deposit a thin resistive high value layer over the full structure

After resistive deposition



-We have subcontracted resistive Vacuum deposition in 2 institutes .

-We have discovered that one of them already did in the past the deposition on Glass MSCG mentioned in literature

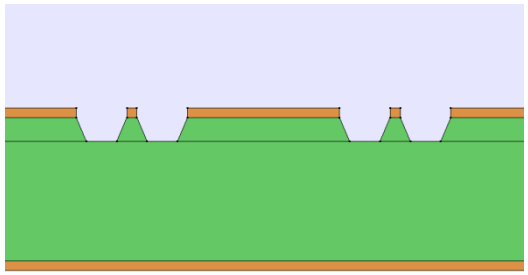
-We have asked for 4 different resistive value depositions on 20 small pieces from 10^12 to 10^15 ohms/square

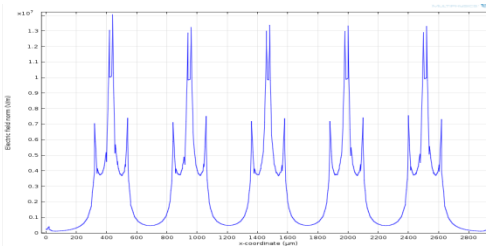
-After this coating 2 situations appeared : high values do not improve the behavior
low values are showing the expected effect
but totally degrading the device at the same time

-None of the suppliers were ready to guaranty their resistive value

-Due to the last statement this direction is abandoned (still ALD deposition could be investigated but completely out of our budget)

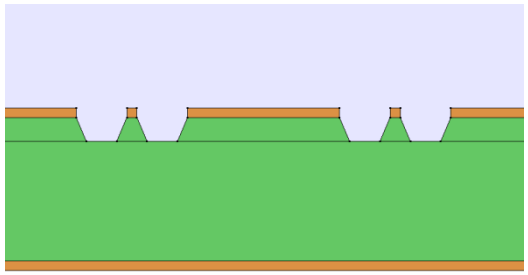
New direction:
remove material between electrodes where charges are attaching

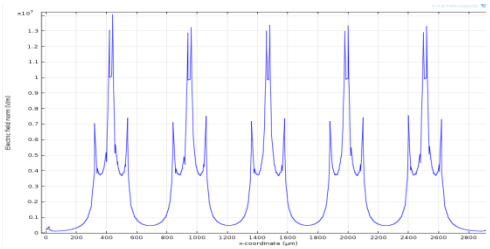




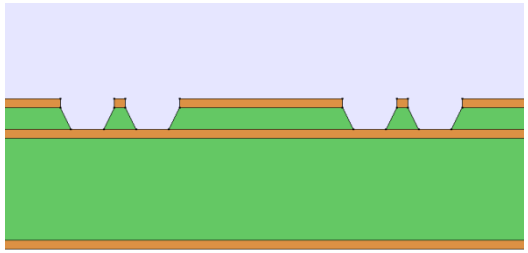
Type 1
etching the substrate

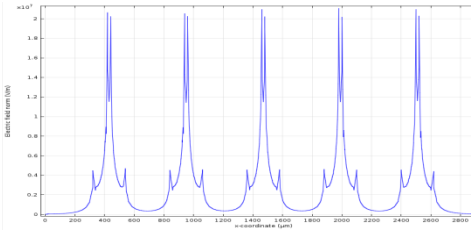
New direction:
remove material between electrodes where charges are attaching





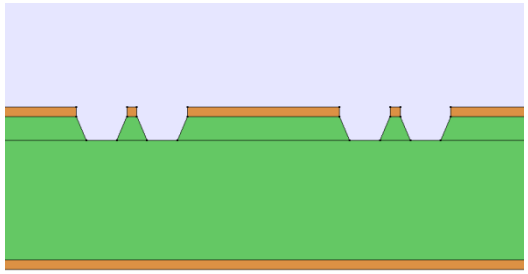
Type 1
etching the substrate

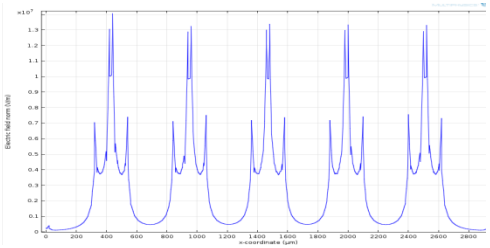




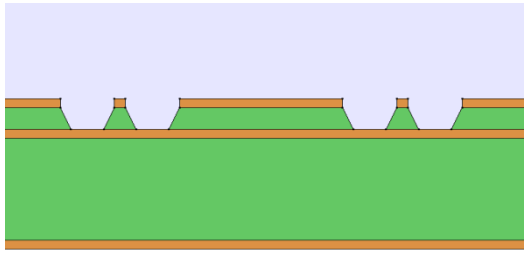
Type 2
etching the substrate
Adding an electrode

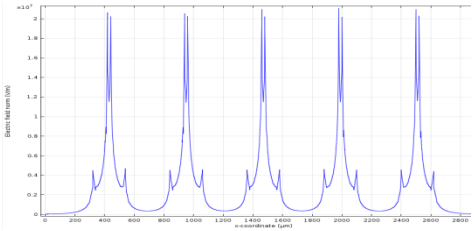
New direction:
remove material between electrodes where charges are attaching



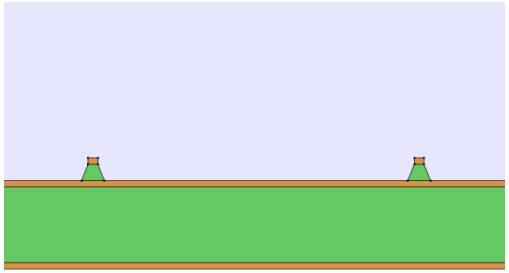


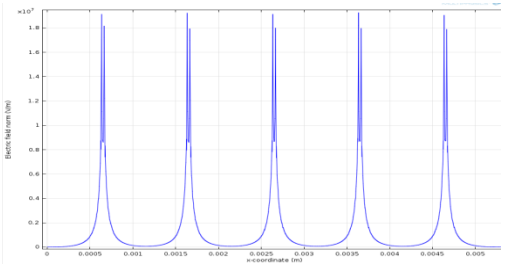
Type 1
etching the substrate





Type 2
etching the substrate
Adding an electrode



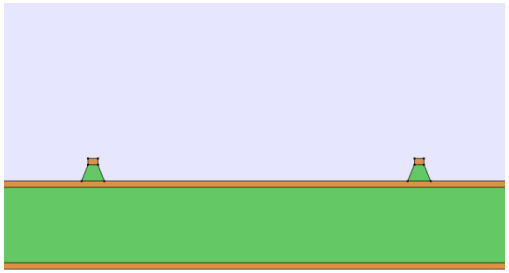


Type 3
Removing top electrode

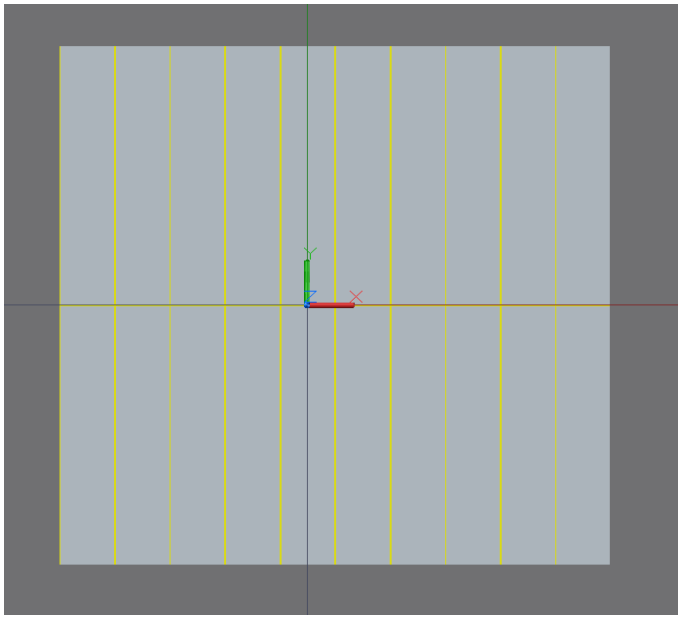
Micro gap

- Even more simple than MSGC
- We are now producing some micro-gap structures
- This time we will study first that the charging up and polarization effects are as expected negligible by construction .
- We will then introduce the resistive layer for spark protection

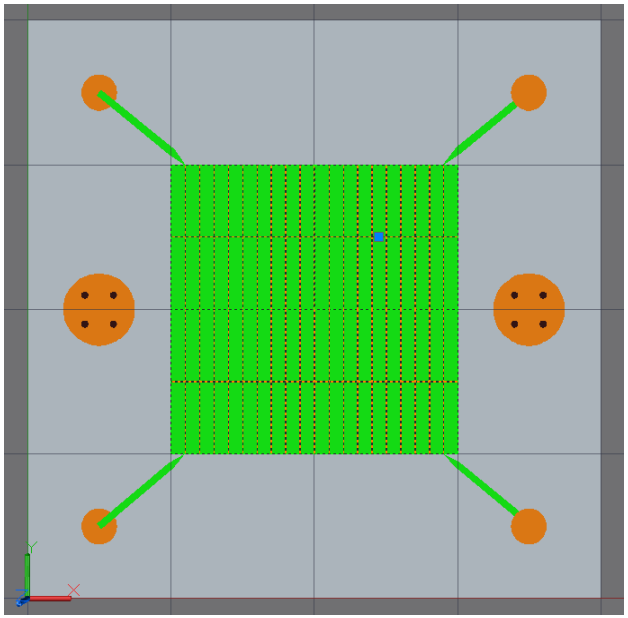
Micro gap pad prototype layout



1cm x 1cm pad structure



4 pads structure



Micro gap production

- We expect some samples in the coming weeks
- STD qualification test will be then performed
  - Gain
  - Energy resolution
  - Rate
  - Stability in time and rate
- If OK we will produce a resistive version

Conclusion

- We know 2 ways of resistor deposition
- We have applied them to Micro megas , R-Well and THGEM successfully
- We are trying to apply it to Micro Gap detectors

Thank you