Micromegas Pad Resistive Read-Out with Embedded Protection Resistor Production

summary

- 3 Processes For Embedded Resistors(R1,R2,R3)
- Process already used :Pressing/Screen Printing(R1)
  - 2 examples of Micromegas for Mr Theodoros and Mr Chefdeville
  - Process R1
  - How to Choose Resistive Values
  - Limits Of the Pressing Steps
- New Process: full screen printing (R2)
- Conclusions and future

Processes for Embedded Resistors

Pressing/Screen Printing
R1

- Build up the detector on a R/O PCB
- Insulators already drilled ,glued by pressing « Coverlay » (*minimum* vias diameter 500*µm)*
- Via filled by screen printing silver paste
- Resistors screen printed minimum pitch 400 *µm*
- Standard BULK on

All done at CERN
We have already done around 15 detectors ,currently in test beam

Screen Printing
R2

- Build up the detector on a R/O PCB
- Insulators screen printed (minimum vias diameter 250 *µm)*
- Via filled by screen printing silver paste
- Resistors screen printed minimum pitch 400 *µm*
- Standard BULK on

All done at CERN
We are processing 2 detectors

Laser Drilling/Screen Printing
R3

- Build up the detector on a R/O PCB
- Kapton Insulators drilled (100 *µm)* by laser, glued by pressing
- Via filled by screen printing silver paste
- Resistors screen printed minimum pitch 400 *µm*
- Standard BULK on

The Laser drilling has to be Subcontracted

Example 1
R/O Specifications

- 2 layers PCB
- Active area 10cm/10cm
- Pads 9.8mm/8.2mm
- Vias 600 μm
- Insulators Coverlay (12.5/12.5)
- Resistive Pastes 10kΩ/Sq , 100KΩ/Sq
- Minimum lines 100 microns
- Numbers of lines : 120

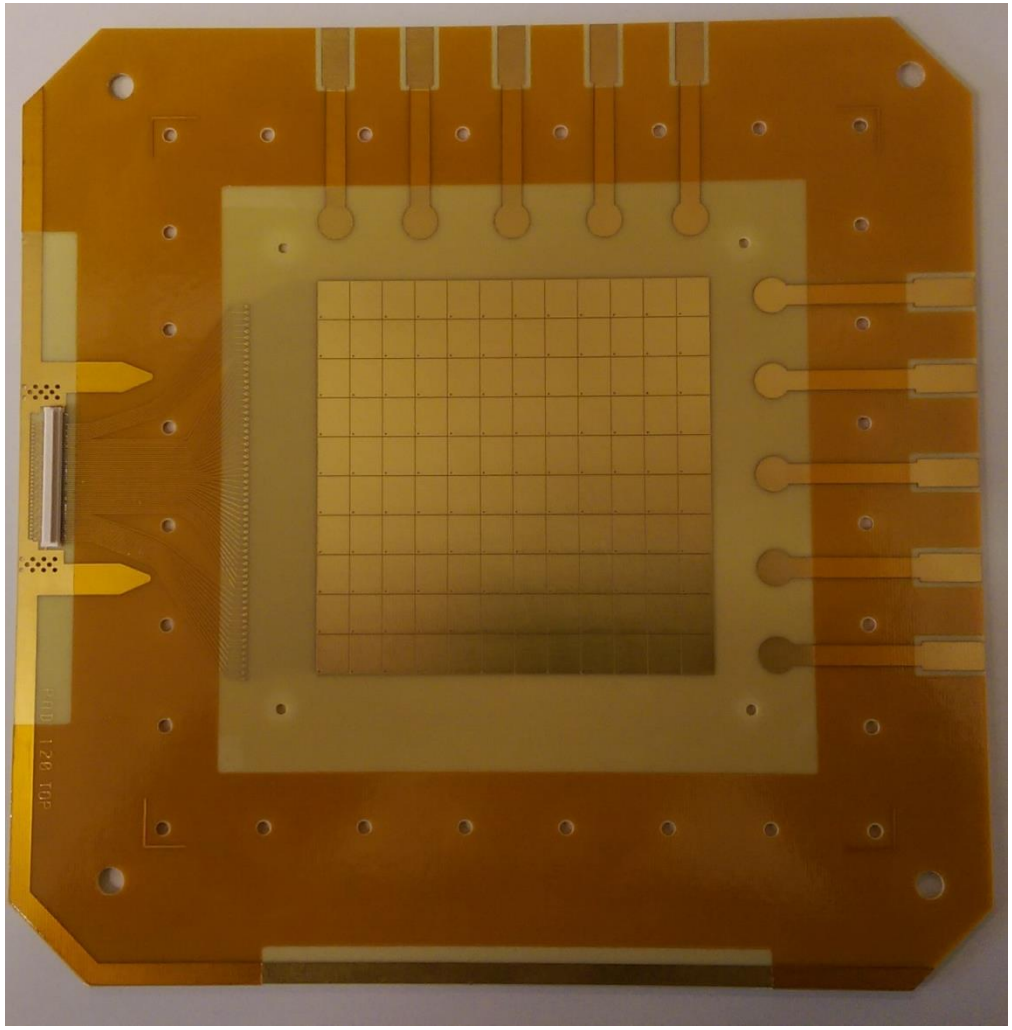
- We can use the Process R1

Pressing/Screen Printing R1

- Build up the detector on a R/O PCB
- Insulators already drilled ,glued by pressing « Coverlay » (vias diameter until 500μm)
- Via filled by screen printing silver paste
- Resistors screen printed
- Standard BULK on

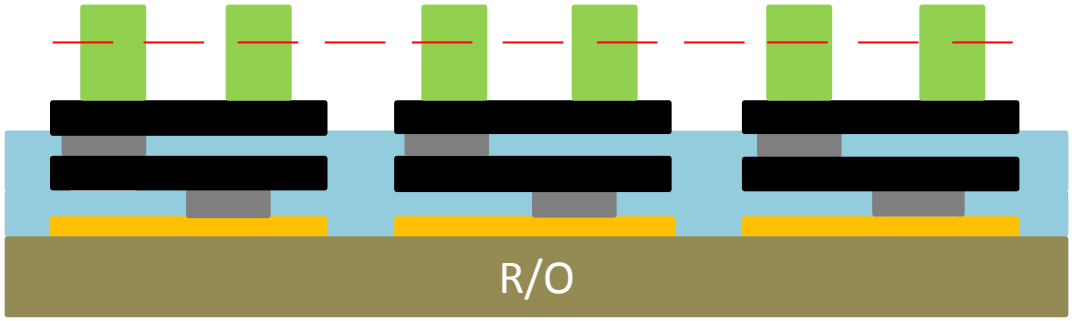
All done at CERN
We have already done around 15 detectors , some in test RD51 beam

Picture R/O



Manufacturing steps R1

1. Press the Coverlay already drilled on the PCB R/O board
2. Screen print the vias (fill the holes with Silver paste, polymerized 1h at 170 degrees)
3. Screen print the embedded resistors (polymerized 2 h at 170 degrees)
4. Press the Coverlay already drilled
5. Screen print the Vias (polymerized 1h at 170 degrees)
6. Screen print the top layer resistors (pads or another shape,polymerized 2 h at 170 degrees)
7. manufacture the BULK .

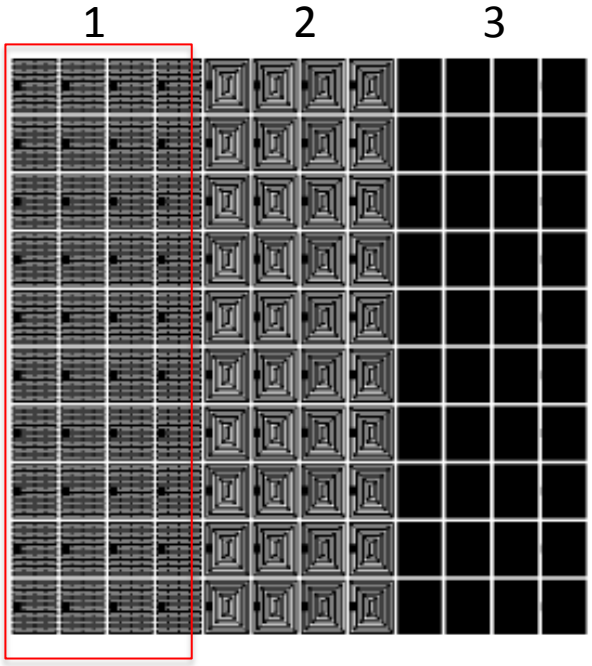


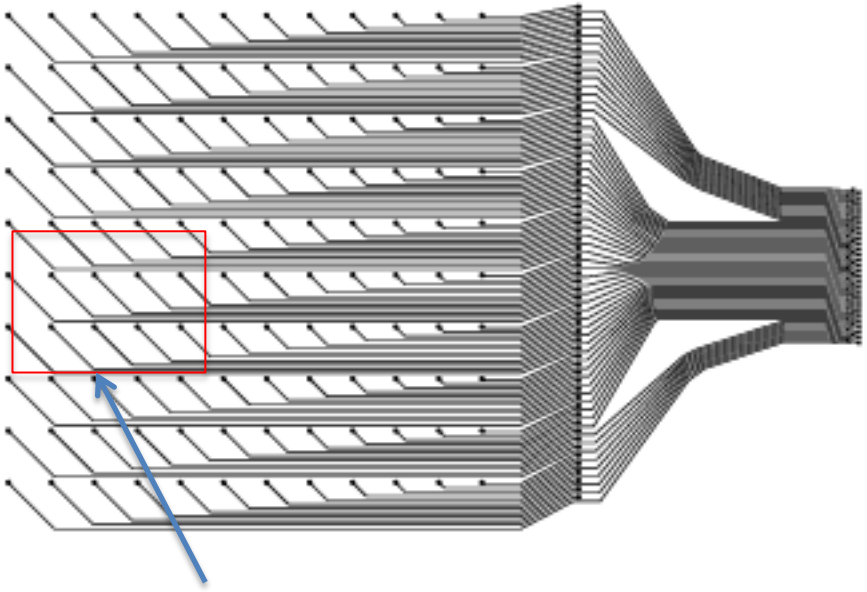
How to choose the resistive values

- We design the R/O board
- We choose a large panel of resistive values for the embedded and surface resistors
- We design the shapes corresponding to the resistive values
- We manufacture several detectors with different shapes and resistive pastes
- the physicist chose the best region on the detector and then we make a complete detector with his requests

First Detector R1 for Mr Theodoros from LAPP

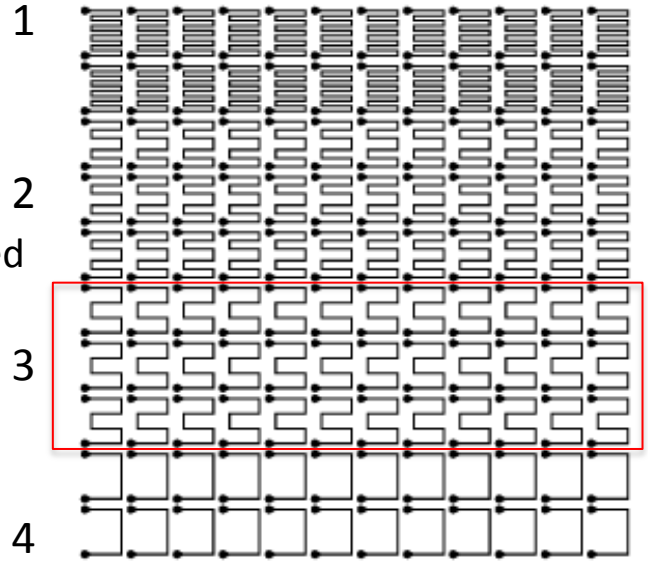
Surface resistors





Best region

Embedded resistors



Region 3 in buried and 1 in surface (we call it 31) gives the best linearity in response

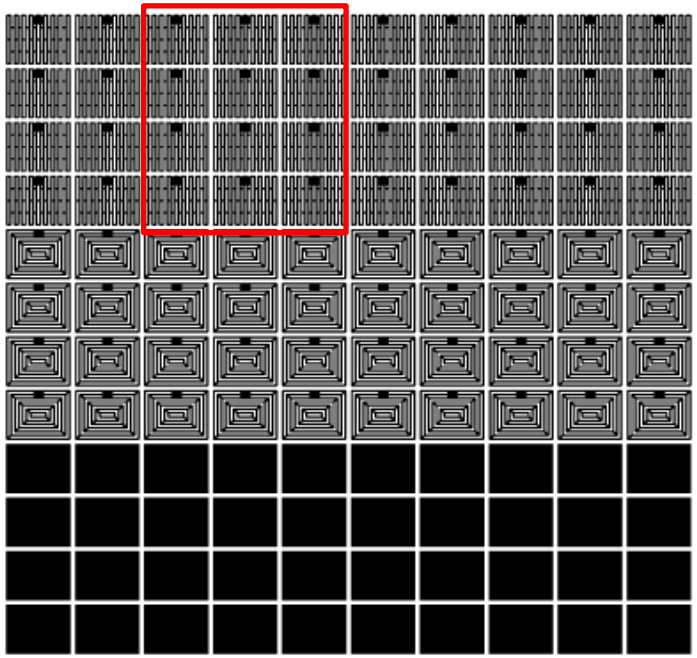
From your schematic we believe we have:

Buried = 1.7 MOhm

Surface = 6 Mohm

We have done 1 complete detector with this 2 shapes

Panel of resistive values



Surface values

11,4 M	10,2 M	14,5 M	14,6 M	15,2 M	18,5 M	18,9 M	18,5 M	24,6 M	23,7 M
11 M	10,2 M	14,8 M	15 M	15,7 M	18,9 M	19,4 M	18,5 M	24,5 M	24,1 M
11,5 M	9,9 M	15,2 M	15,6 M	16 M	19,2 M	19,3 M	19,6 M	25,3 M	25,6 M
12,1 M	11,2 M	16,3 M	16 M	16,7 M	20,8 M	21,3 M	20,4 M	26,8 M	25,6 M
13,6 M	12,8 M	17,5 M	18,2 M	17,9 M	22,4 M	22,7 M	22,1 M	28,2 M	28,5 M
13 M	13,1 M	18,2 M	19,2 M	19 M	22,7 M	23 M	22 M	28,9 M	27,4 M
13,5 M	13 M	18,3 M	18,5 M	18,5 M	23,4 M	22,5 M	22,5 M	28,5 M	29,1 M
13,5 M	13,7 M	18,7 M	18,8 M	20 M	23,4 M	23,4 M	23,5 M	30,6 M	29,1 M
12 M	10,4 M	15,2 M	15,8 M	16,8 M	19,4 M	20,5 M	19,5 M	26,8 M	25,7 M
11,2 M	11,1 M	15,9 M	16,2 M	16,9 M	19,8 M	21,1 M	20,2 M	26,7 M	25,8 M
11,1 M	11,4 M	15,8 M	15,8 M	16,2 M	19,4 M	19,7 M	19,6 M	26,3 M	25,1 M
12,3 M	11,5 M	16,8 M	17,7 M	17,1 M	21,7 M	22,3 M	21,1 M	29 M	27 M

5 et 6 M

4 et 5 M

450 K (surface)

Resistance top + embedded

Example 2 Mr Chefdeville R1 Detectors R/O Specifications

- 2 layers PCB
- Active area 10cm/10cm
- Pads 9.8mm/9.8mm
- Vias 600 *µm*
- Insulators Coverlay (12.5/12.5)
- Resistive Pastes 10kΩ/Sq , 100KΩ/Sq
- Minimum lines 100 microns
- Numbers of Pads : 96

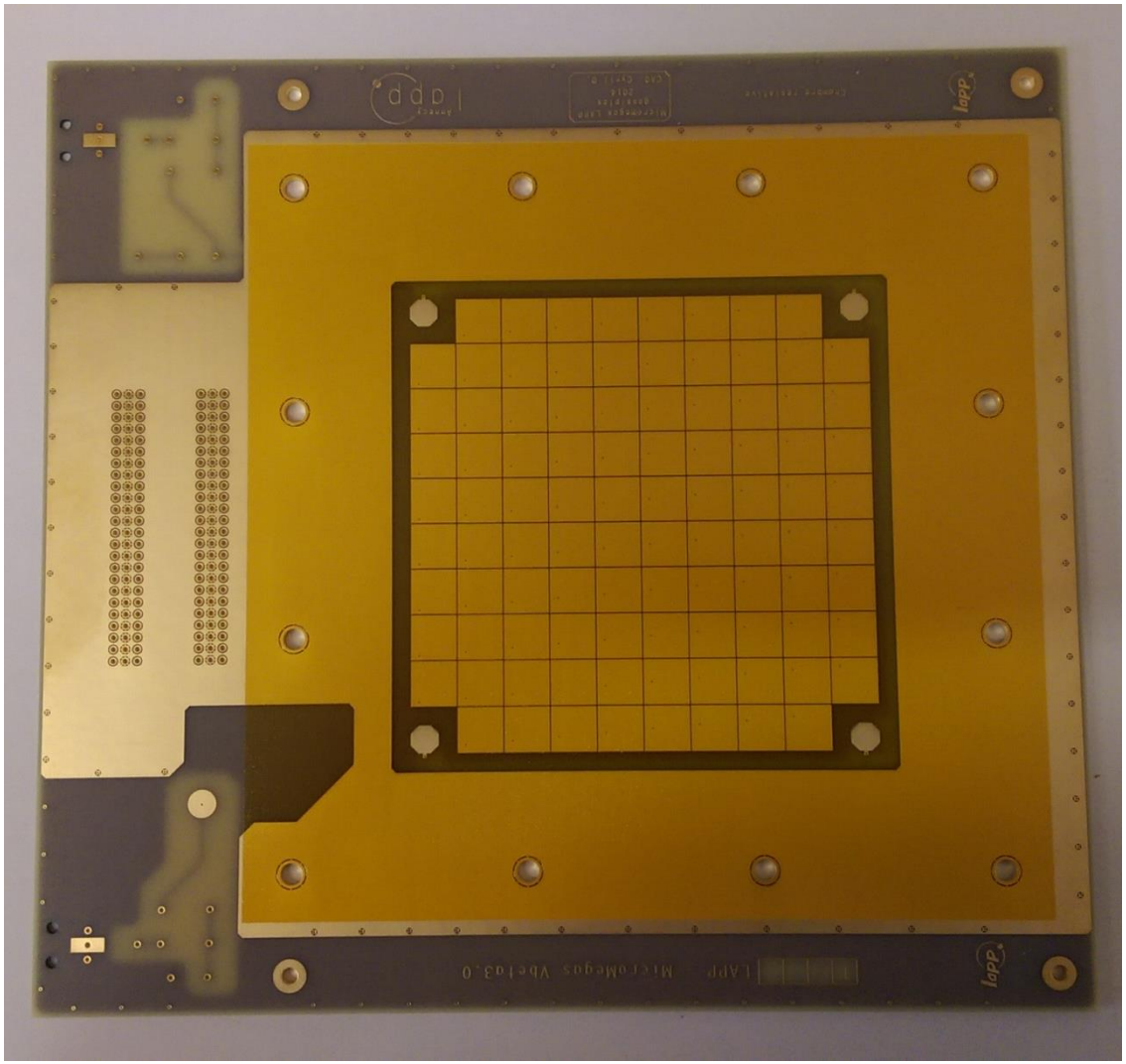
- We can use the Process R1

Pressing/Screen Printing R1

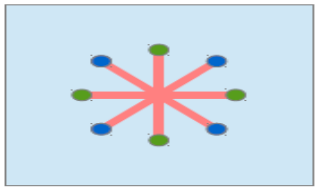
- Build up the detector on a R/O PCB
- Insulators already drilled ,glued by pressing « Coverlay » (*minimum* vias diameter 500*µm)*
- Via filled by screen printing silver paste
- Resistors screen printed
- Standard BULK on

All done at CERN
We have already done around 15 detectors , some in test RD51 beam

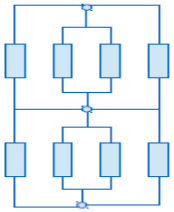
Picture R/O with the first Coverlay pressed on

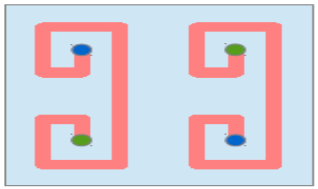


Shapes and values
Mr Chefdeville R1 Detectors for the LAPP

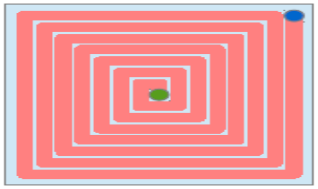


L_{eff} ~ 0.13 cm
R(100 k/sq) ~ 400 kOhm
R(1 k/sq) ~ 4 kOhm

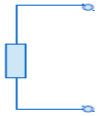




L_{eff} ~ 1.3 cm
R(100 k/sq) ~ 4 Mohm
R(1 k/sq) ~ 40 kOhm



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

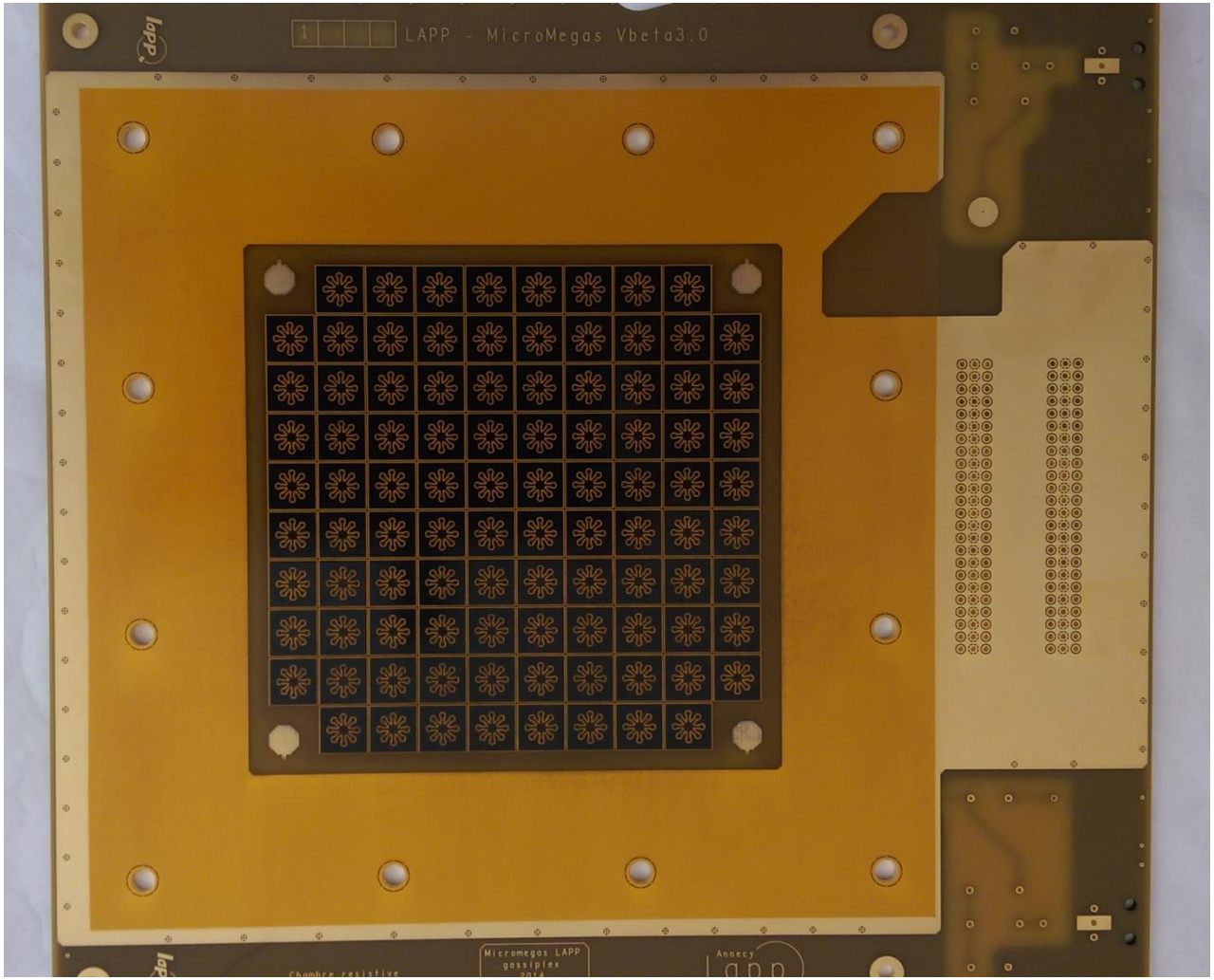


Real values:
40 to 60 KOhms with 10KΩ/Sq
400 to 750 KOhms With 100KΩ/Sq

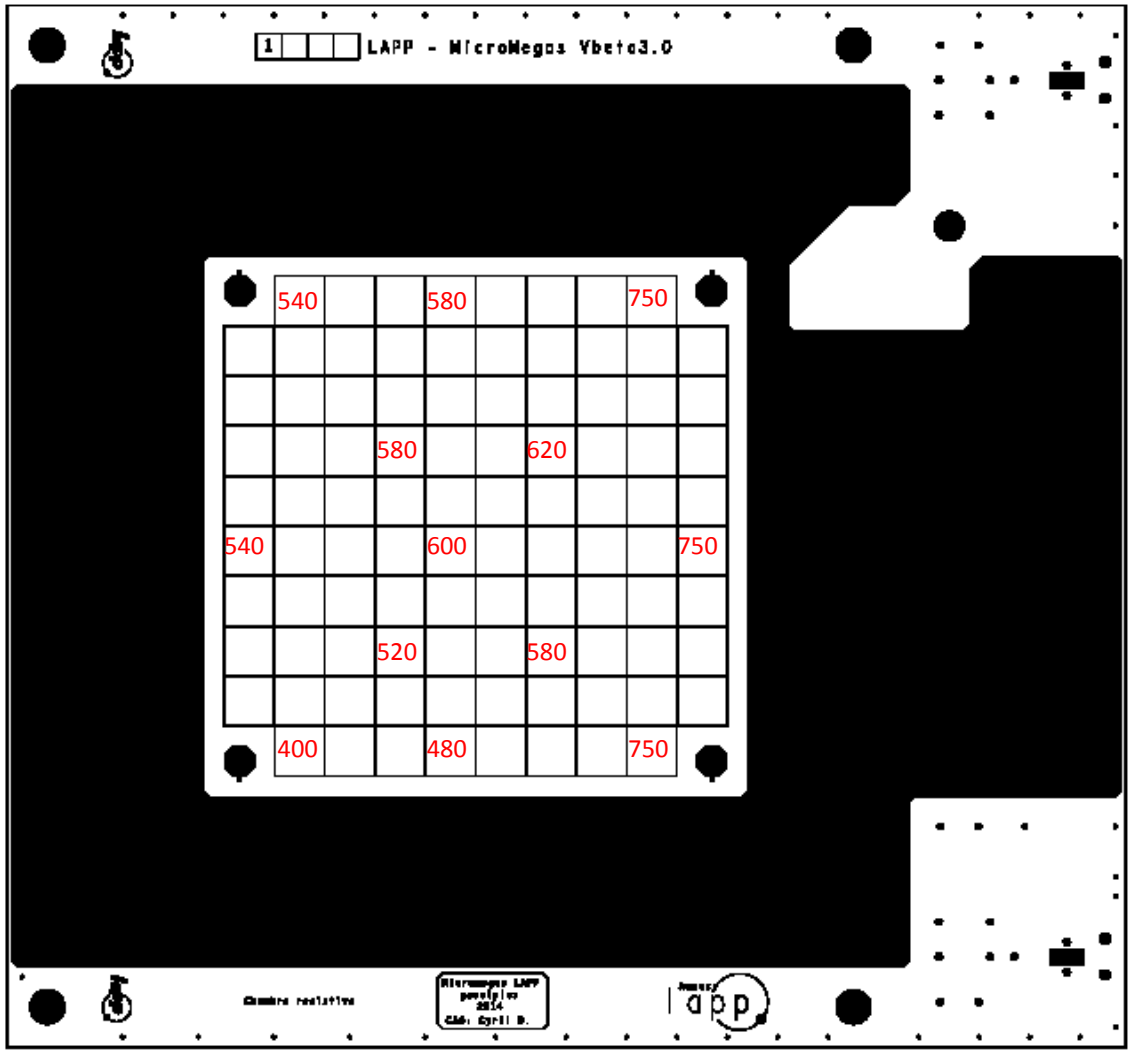
Real values:
400 KOhms with 10KΩ/Sq
4 MOhms With 100Ω/Sq

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

Picture Embedded Resistors



Resistive Values “star” Shape

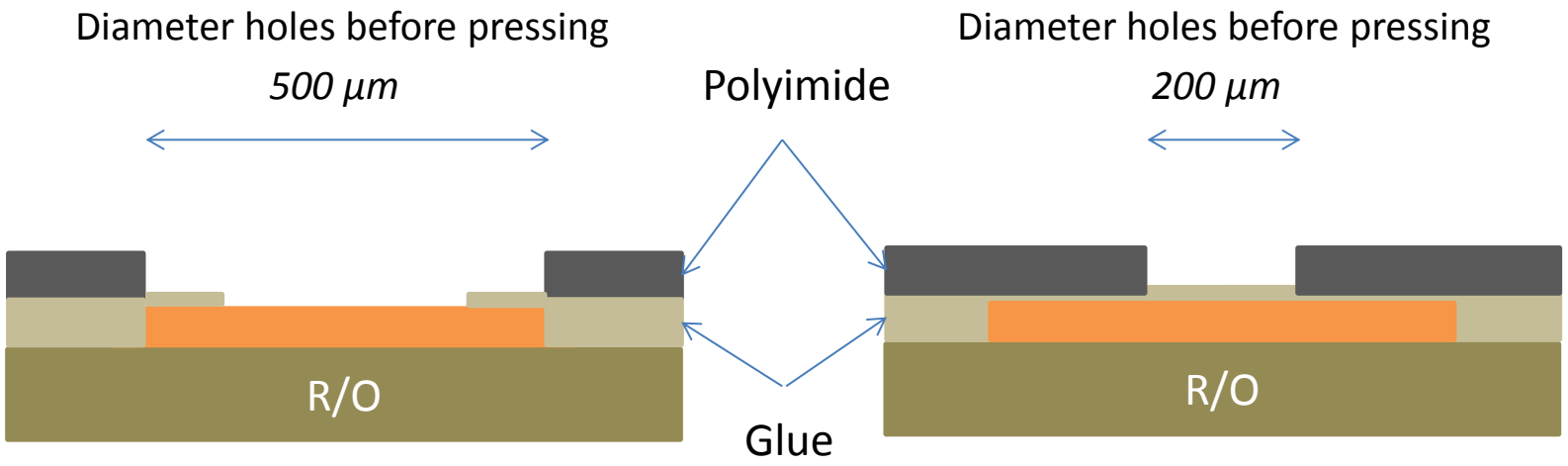


KOhms

Currently in beam test

Limits of the pressing steps

- The Glue Creeping 500*µm* vias decrease to 300*µm* and 200*µm* vias completely close



- The Resistive Value grows up about 10 to 20 % during the Pressing Steps
- The alignment between the Coverlay and the R/O is very difficult

(on small pads 1mm/3mm)

For a smaller pitch we have to use the process R2 Full Screen Printing

New Process: Full Screen Printing
R/O Specifications

- 4 to 6 layer PCB
- Active area 5cm/5cm
- Pads 0.9mm/2.9mm
- Vias 300 *µm*
- Resistive Pastes 10kΩ/Sq , 100KΩ/Sq
- Minimum lines 80 microns
- Numbers of Pads: 768

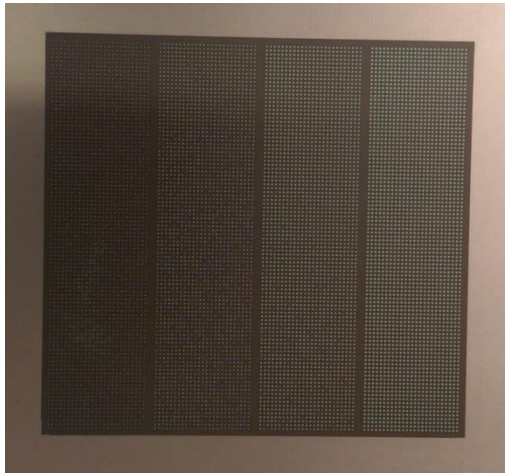
Very difficult to use the pressing Process ,we Have to use the R2 screen printing one

Screen Printing R2

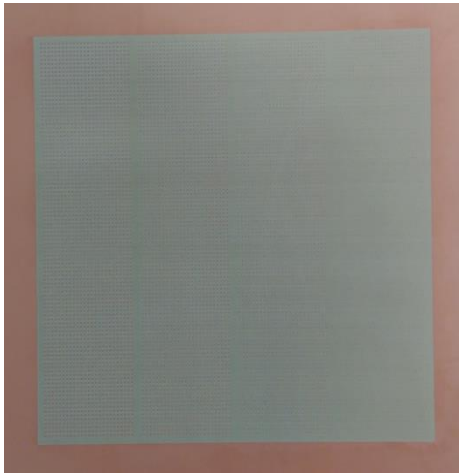
- Build up the detector on a standard R/O PCB
- Insulators screen printed (minimum vias diameter 250 *µm)*
- Via filled by screen printing silver paste
- Resistors screen printed
- Standard BULK on

All done at CERN
We are processing
2 detectors

New Process: Full Screen Printing

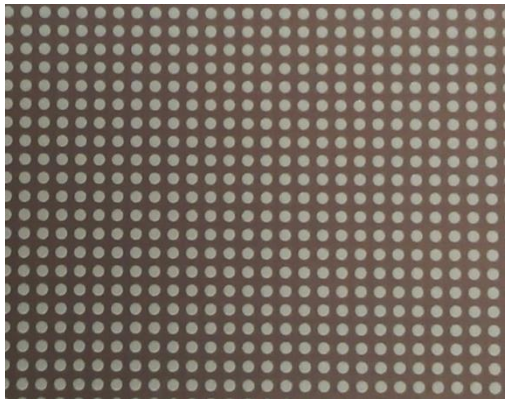


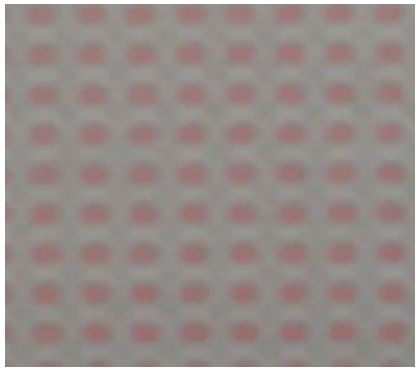
10 cm



600µm *500µm* *400µm* *300µm* Vias diameter *600µm* *500µm* *400µm* *300µm*

300µm vias filled by silver paste





300µm vias

With this test We have seen that it's possible to process small pitches

Screen-printing

NOW
The machine we are using

Maximum active area 20 cm/20cm

Next Year
The machine we have purchased

THIEME SERIE 3000S - FORMAT IMPRESSION 1500 x 2000 cm

Matériel entièrement reconditionné

Composants électriques, électroniques neufs

Le bâti de la machine est de construction rigide et constituée de profilés acier soudés, usinés et boulonnés. Toutes les parties extérieures sont peintes (peinture époxy).

Le cadre supérieur est commandé électroniquement et se relève parallèlement jusqu'à la position de nettoyage à 350 mm

RACLAGE Inversion pneumatique de la racle et de la contre-racle. Réglage fin de la pression pneumatique de la racle avec mise en parallèle automatique. Les angles de la racle et de la contre-racle sont réglables séparément. Elles sont maintenues à l'aide de fixations rapides, aucun outil n'est nécessaire pour leur montage ou démontage

Les vitesses de raclage et de nappage ainsi que les positions d'arrêt sont programmables sur le pupitre de commande mobile

Afin de s'adapter à la tension de l'écran et à l'épaisseur du support, le hors contact est réglable de 4 à 35 mm sur le pupitre de commande

Le pilotage de l'automate programmable se fait aisément depuis un pupitre mobile. Tous les paramètres requis sont programmés sur un clavier à touches sensitives

FORMAT IMPRESSION 1500 x 2000 cm

Maximum active area 1500cm/2000cm

conclusions

- Currently we can use 2 Processes in house
  - insulators pressed with screen printed layers
  - full screen printed
- We can choose the shape and resistors values
- We can choose the thickness of the insulators
- We can do 20cm/20cm active area with the machine we already have
- Next year we will be able to grow up to 50cm/50cm (to start) and larger with the new machine.
- We are waiting for the first test beam results coming soon from LAPP

Thank You