CERN MPT workshop
DRD1-WG6
20/06/2024

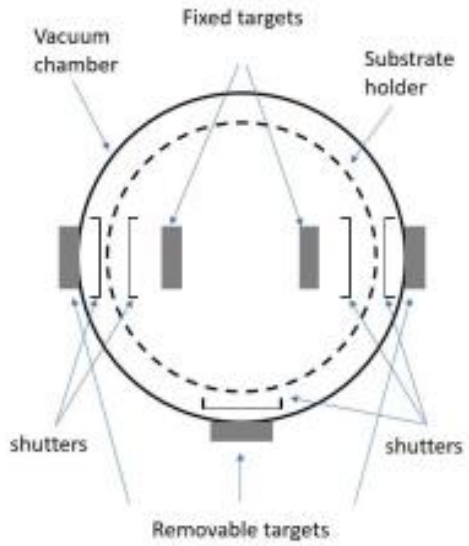
Louise Viezzi
Serge Ferry
Rui De Oliveira

- Vacuum deposition machine
- DLC deposition status
- uRgroove detectors

Machine configuration reminder

The graphite target

The three external cathodes



Drum:
55cm diameter
70cm height
1.7m circumference

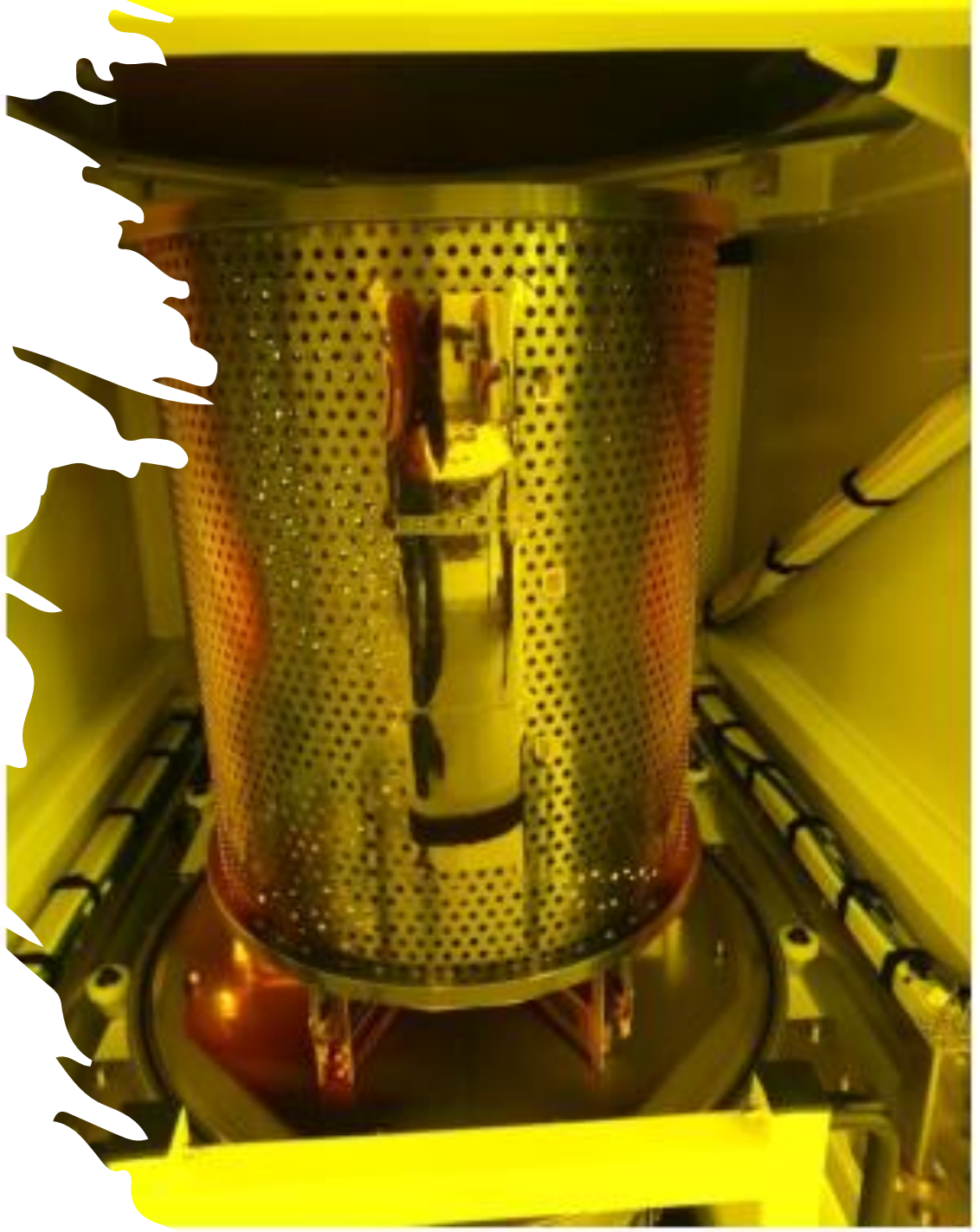
- Test samples to tune the recipes
  - Vertical samples, 60 x 10 cm2
  - APICAL NP polyimide 50um thick
  - Sample preparation → drying 220 deg for 4 days
- Main steps during a RUN

  1/ Ar based plasma sample cleaning

  2/ Ar based plasma + graphite target cleaning

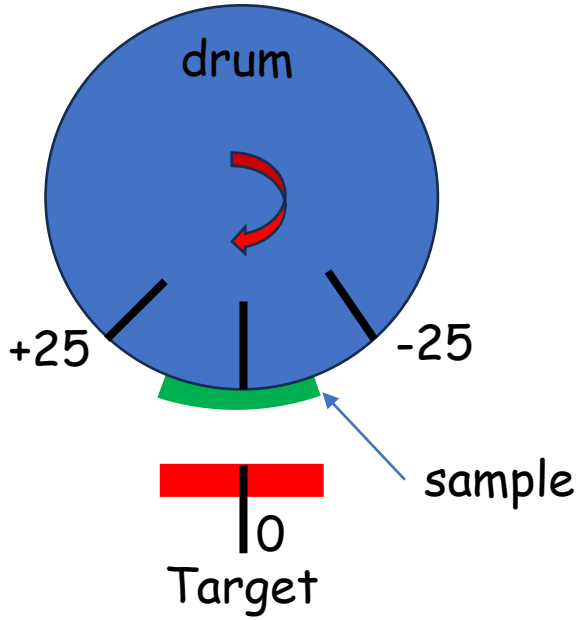
  3/ Ar/C2H2 plasma + graphite target cleaning

  4/ Ar/C2H2 plasma + final sputtering process
- Post RUN
  - Direct resistivity measurements
  - Baking samples to stabilize the value
  - Monitoring of the resistivity during the following days (stability check)



3 deposition methods
Oscillation/step by step/rotation

Oscillation:
Adjustable angle : 0 to +/-90deg
Adjustable speed
Adjustable time



Step by step:
0 to 360 deg
Adjustable steps
Adjustable static time

Ex: -25 to +25 in 10 steps of 90s

Rotation:
Constantly rotating
Adjustable drum speed
Adjustable time

1 – Sample cleaning:

Shutter closed
Target power: off
RF power : 500W
t = 600 sec
Ar = 150ml/min

→ RF power stopped for 15s to evacuate species in the chamber

2 – Target pre-sputtering cleaning:

Shutter closed
Target power: 500W
RF power : 300W
t = 300 sec
Ar = 150ml/min

3- Pre-sputtering @ nominal parameters

Shutter closed
Target power : 1200W
RF power : 500W
t = 60 sec
Ar = 200ml/min
C2H2= 2ml/min

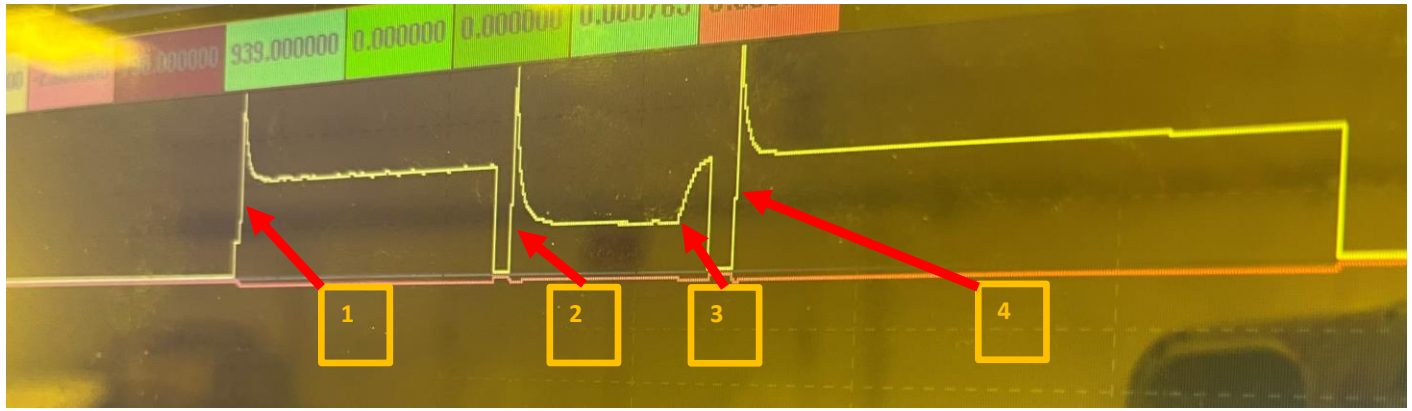
→RF and Target power stopped for 15s to evacuate species in the chamber

→ open the shutters

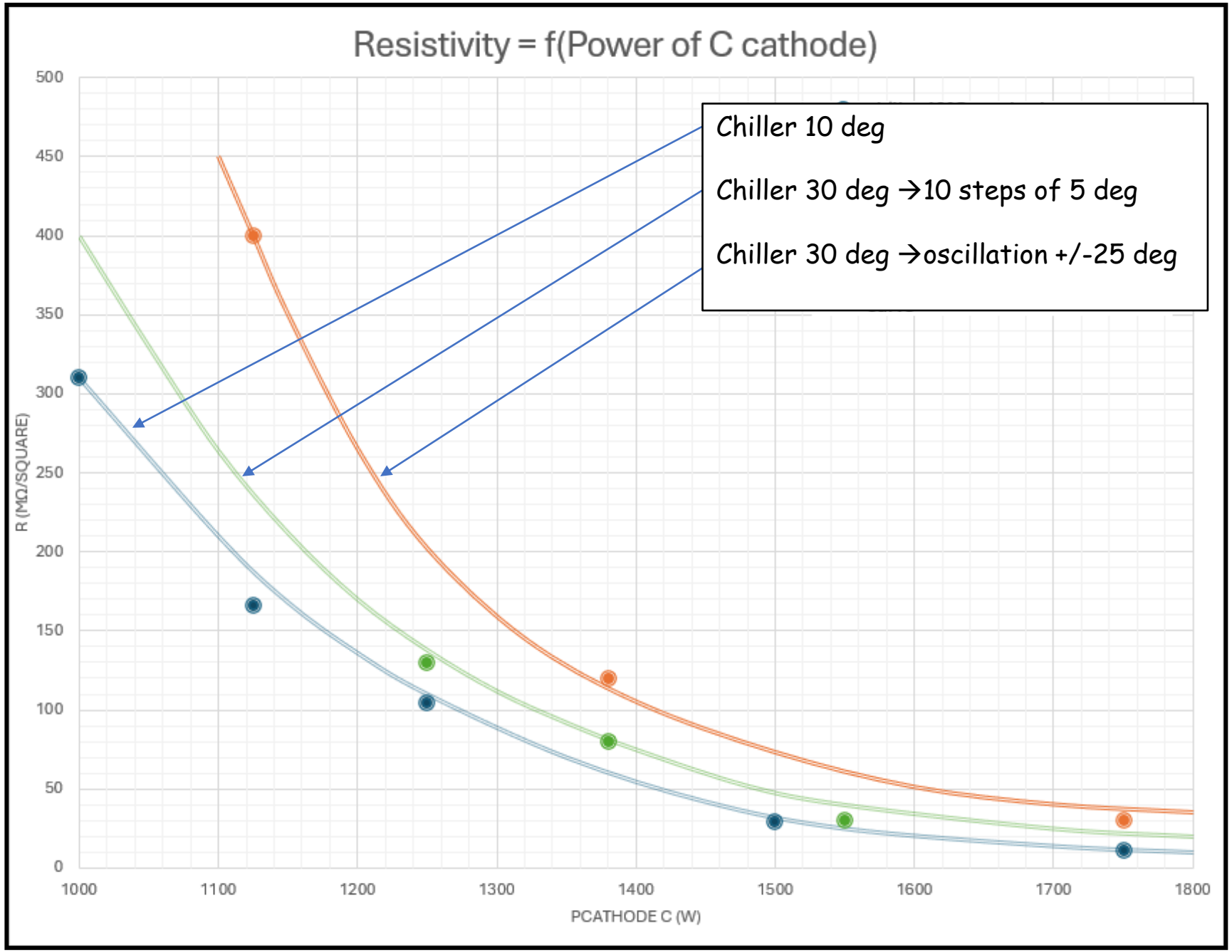
4 – DLC deposition :

Target power : 1200 W
RF power : 500 W
t = 900 sec
Ar = 200ml/min
C2H2= 2ml/min

Chamber pressure : 5.10^{-3} m.bar.
Drum speed 1 turn/min
Oscillation : +25deg to -25deg
Chamber pressure regulation 52% of the maximum



RF power profil during DLC coating



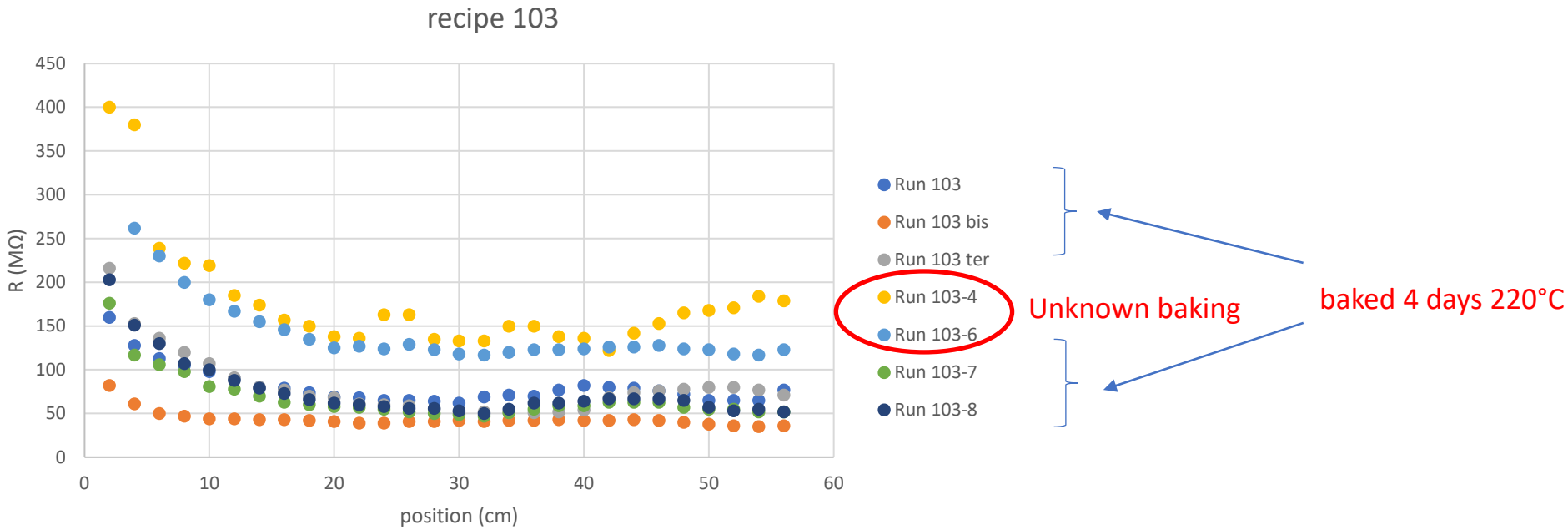
P = 5.10-3mbar
Ar = 200ml/l
C_2H_2 = 2ml/l
RF power = 500W
t = 900s deposition time

These are typical curves:

Test samples should be produced before each production to fine tune.

A large range of resistive values can be reached:
-10K to 10G

Repeatability



The repeatability is obviously much better if no water is present during deposition . We are now drying the foils 4 days at 220°C , this treatment is probably excessive .

We got problems to apply this baking cycle to APICAL with copper on one side. Tests are going on to reduce temperature and optimize the time to reach the optimum drying.

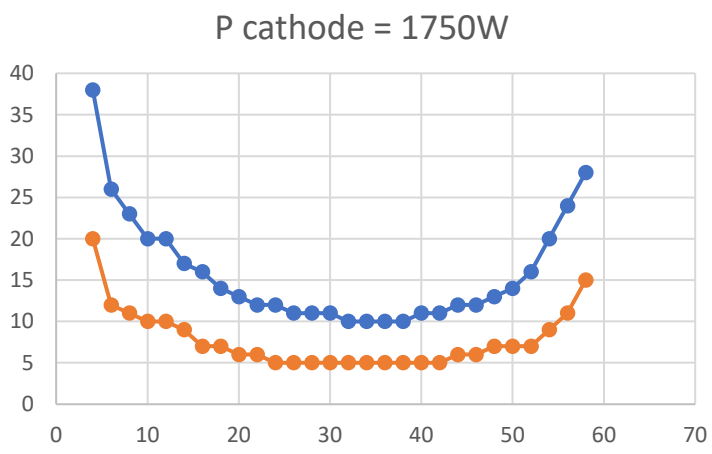
From the document : Moisture pick-up and minimum drying conditions from ESA, I have extracted the following info :

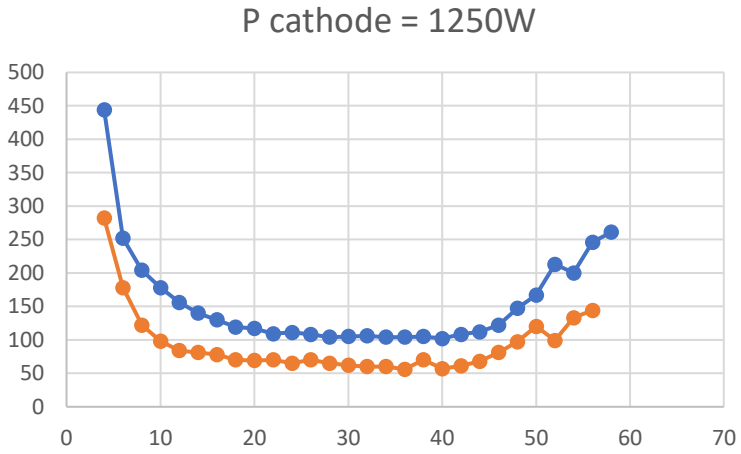
-At 120 deg the PI should be sufficiently dry after 5 days .
-120 deg/12hours correspond to 105 deg/48 hours
-rule : the time should be multiplied by 2 each time the temperature is reduced by 7.5 deg.

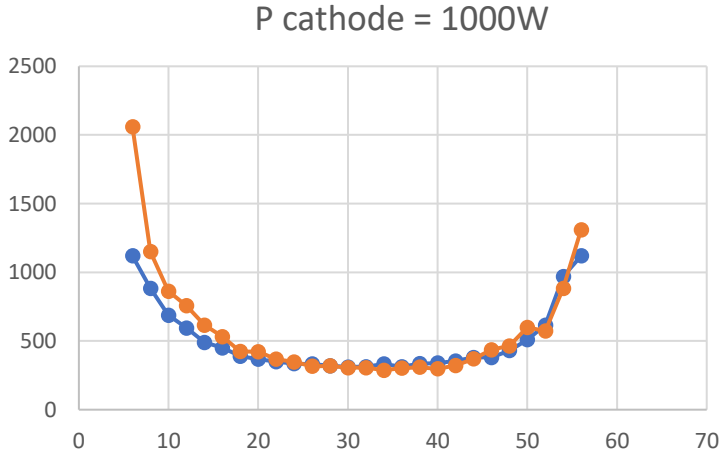
Post baking

Resistivities are divided by 2 after baking 2h 220deg.

Except thinner layer with high values (????).



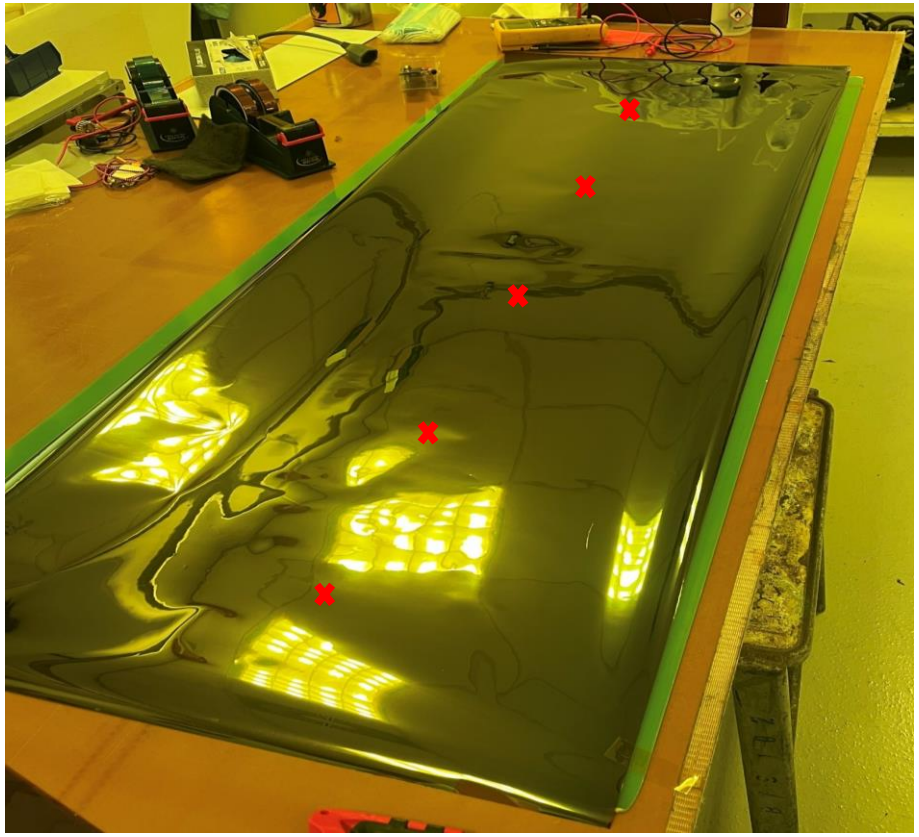




Blue before baking
Orange after baking

Large foils :

as expected, good homogeneity along the 1.7m axis



298 MΩ

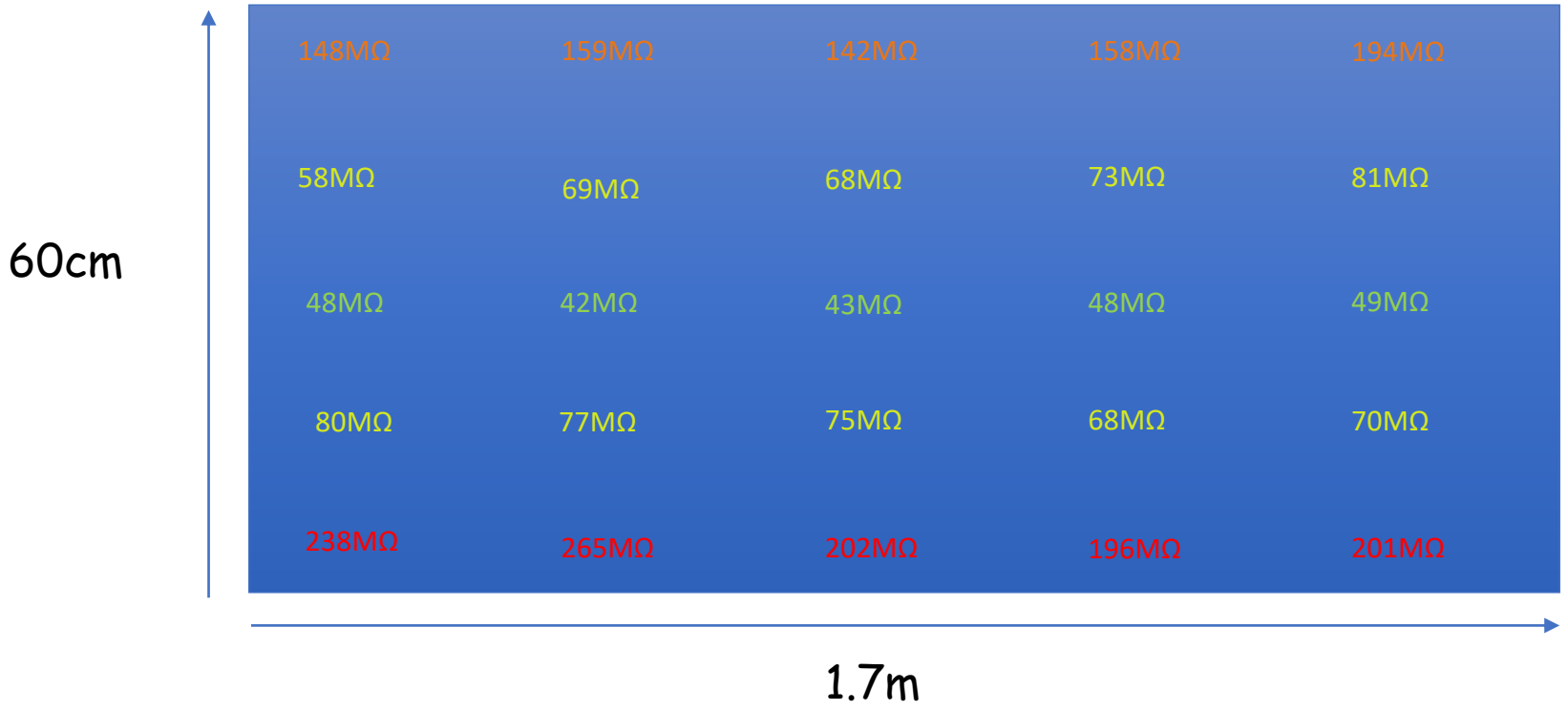
304 MΩ

324 MΩ

330 MΩ

304 MΩ

Second large foil – 1700mmx610mm – DLC ≈ 60 MΩ +/-30% over 45cm



• Situation with DLC coatings

- <u>DLC on APICAL NP 50um for medium rate Micromegas</u>
  - tests nearly finished → detectors in production
  - Up to 600mm x 600mm OK
  - Need some more tests to stabilize 1.7m x 0.6m

- <u>DLC/Cr/Cu on APICAL NP 50um for high rate Micromegas</u>
  - tests nearly finished → perfect adhesion → detectors in production
  - Up to 600mm x 600mm OK
  - Need some more tests to stabilize 1.7m x 0.6m

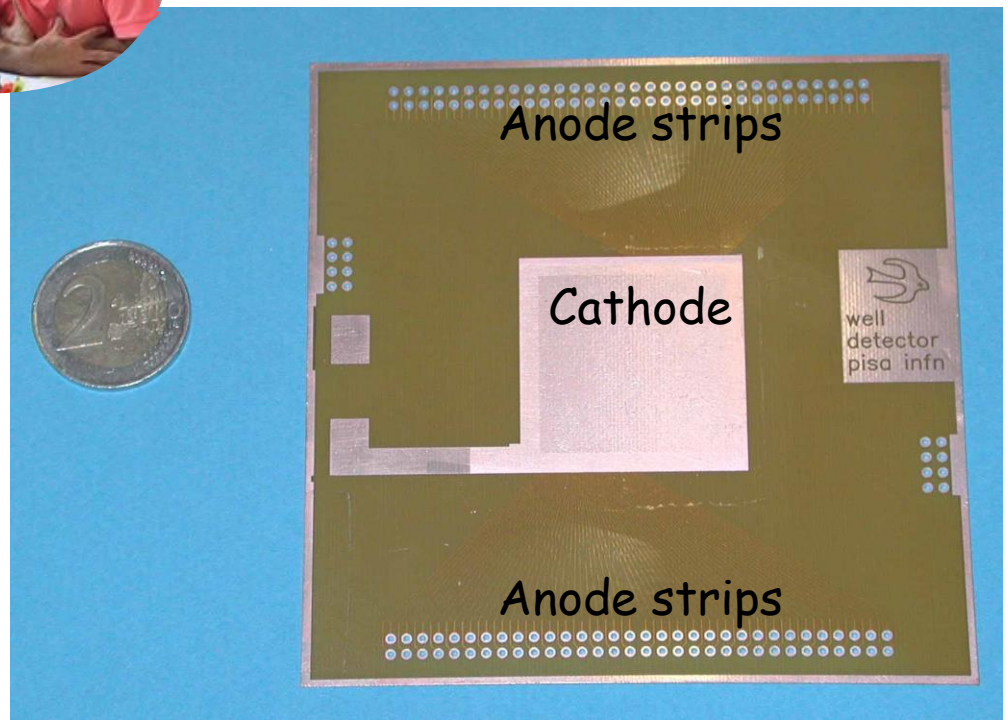
- <u>DLC on APICAL NP 50um with 5um on one side for high rate uRwells or uRgrooves</u>
  - Still need some time to improve repeatability → pre-drying optimisation
  - Detectors in production soon

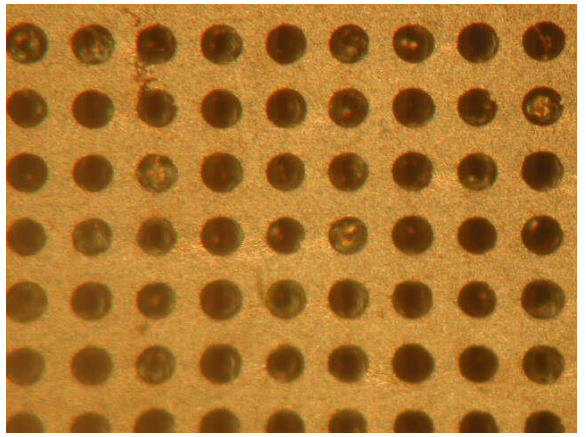
- <u>Improved DLC uniformity.</u>
  - Target → +/-10% over 60cm instead of the present +/-30% over 45cm
  - We will start soon; and we have good ideas
    - Mask on the shutter → there is an effect but not fully satisfactory
    - Mask on the target → to be tested

Mask deposition done this week
by Frascati team
3GOhms/square
Polyimide mask

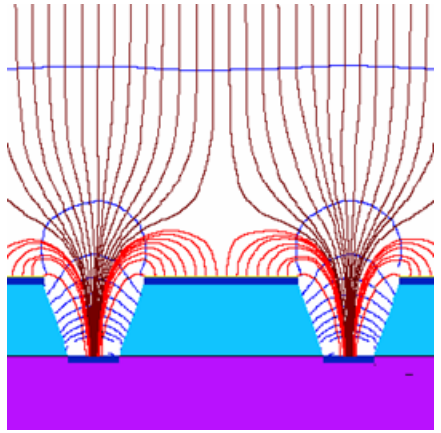
uRgrooves

1999→Micro-Well (Ronaldo Bellazzini)

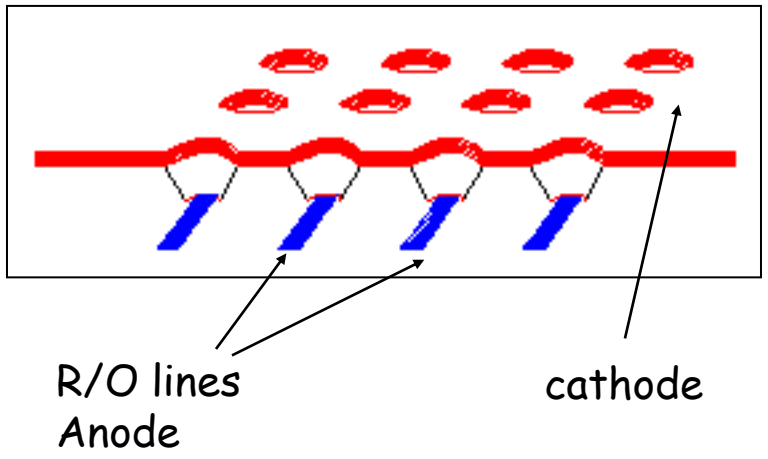




Close-up view
Square pattern used
in the early days

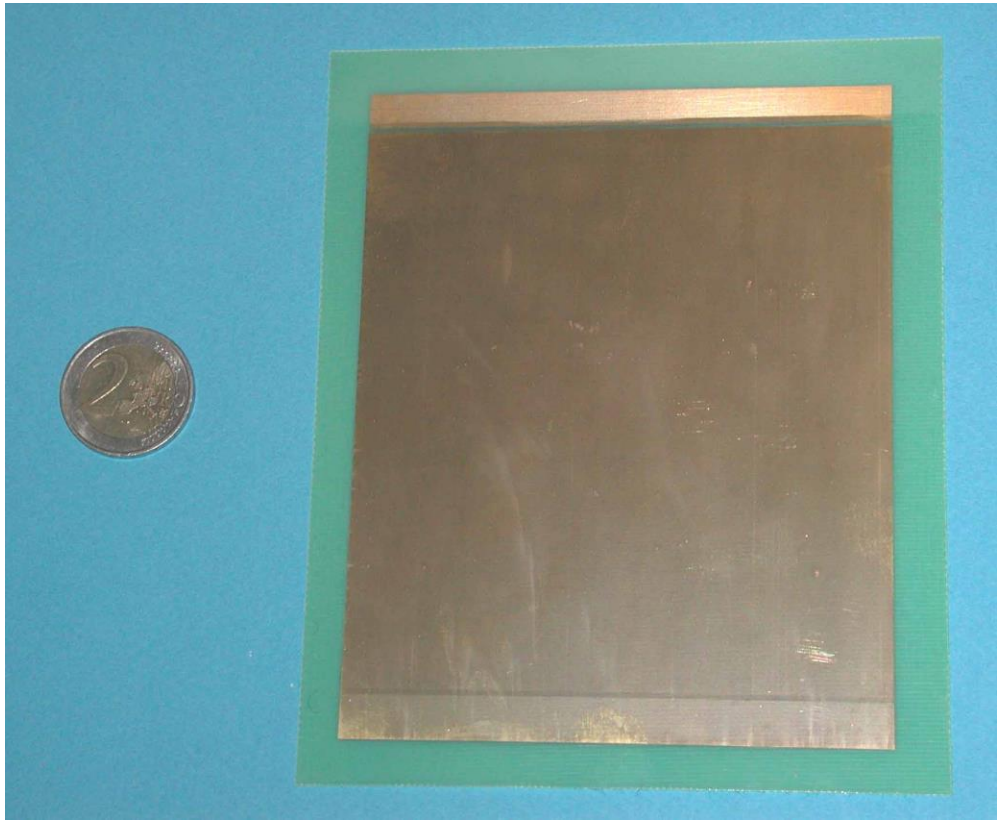


-3 x 3 cm Micro-well detector
-Produced at MPT with GEM processes
-Really simple but abandoned due
to the difficulty to mitigate sparks

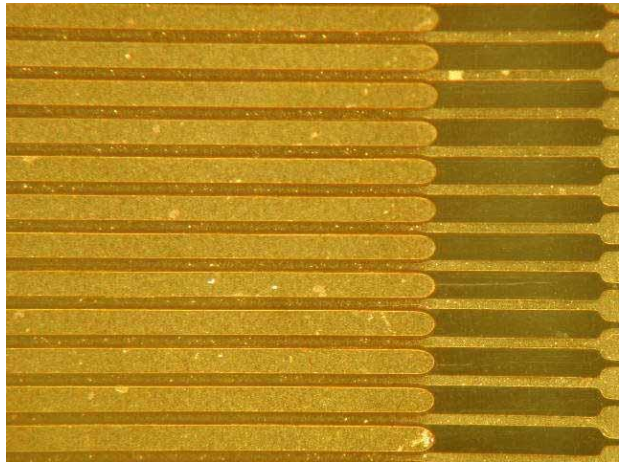


A year before→Micro-Groove (Ronaldo Bellazzini)

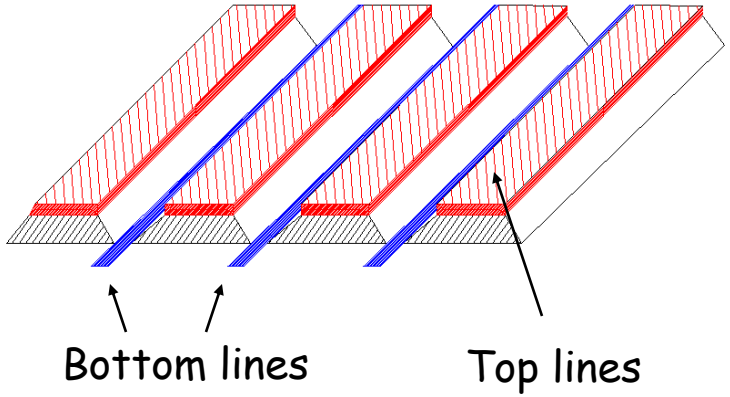
The idea to cross the lines at 90deg was not yet envisaged.
→ MSGC heritage



12 x 10cm groove detector



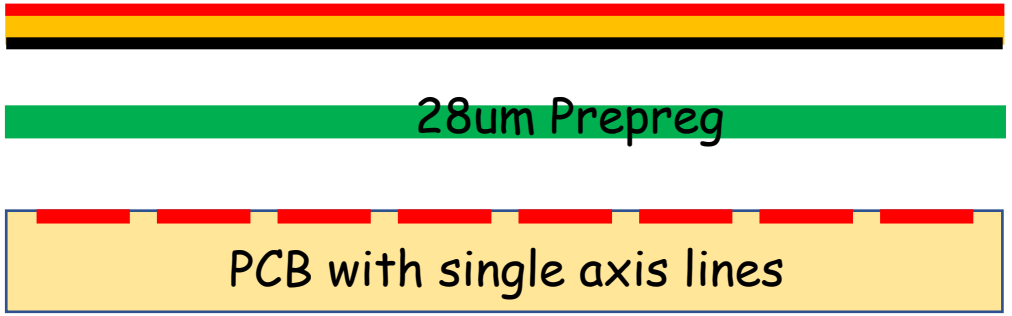
Close-up view

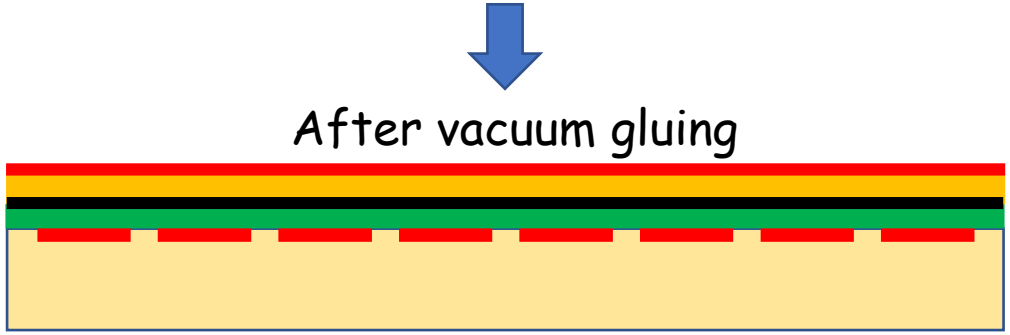


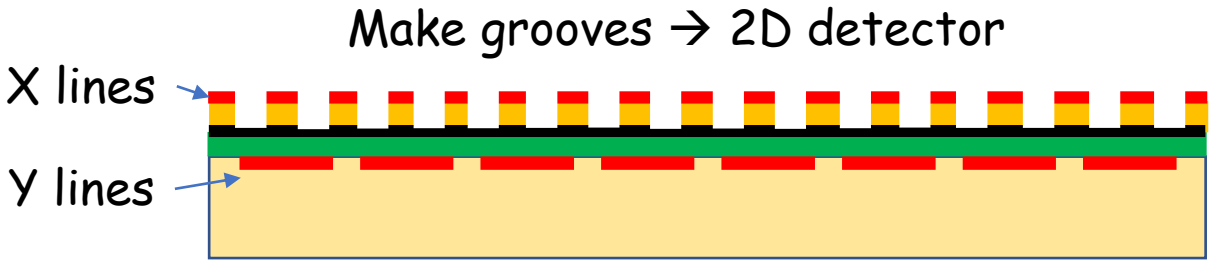
2015→Resistive layer introduction (Giovanni Bencivenni)

uRwell/uRgroove

Polyimide coated foil: copper top , DLC bottom





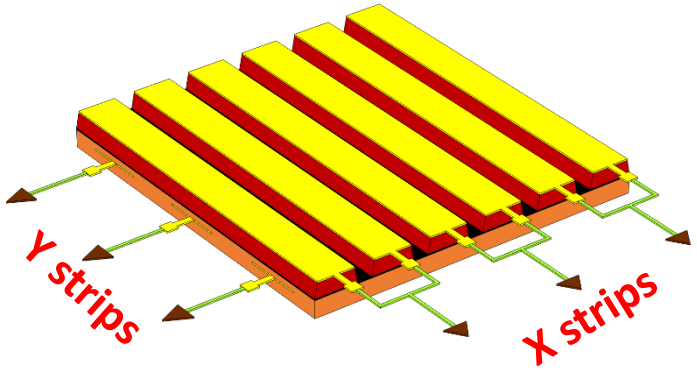


uRgrooves → good space resolution , less production steps , perfect X/Y ratio , less material ,
-Possibility to reduce strips capacity by reducing the width of Y and X strips (TBC).

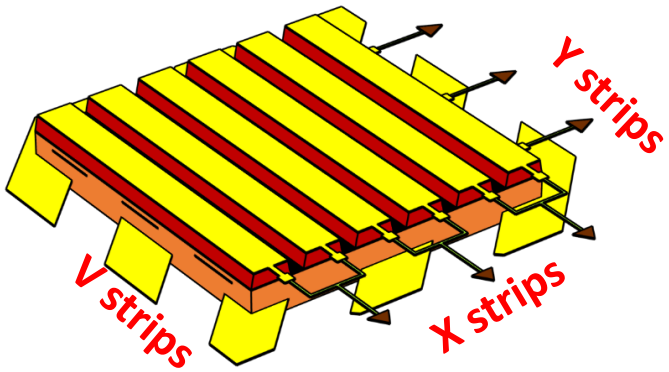
Design of 10cm×10cm uRgrooves prototypes

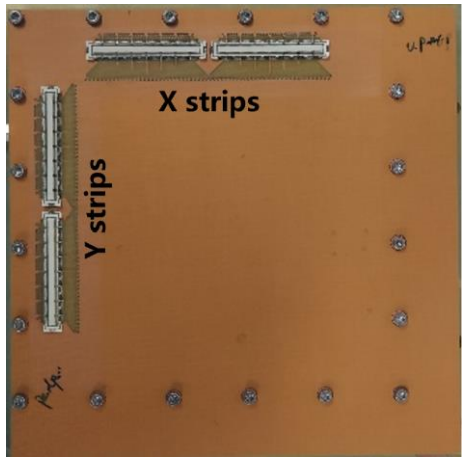
(Siqi He's slide , Zhou Yi team) (detector produced @CERN)

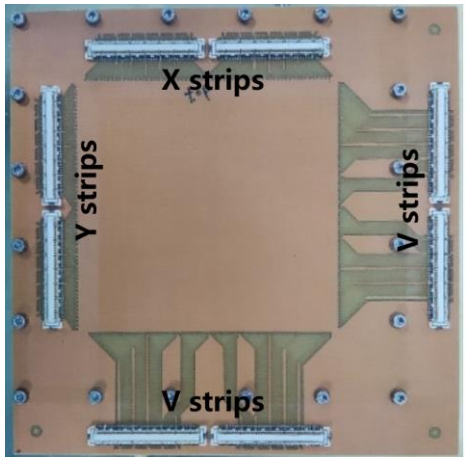
2D-readout (XY) µRGroove



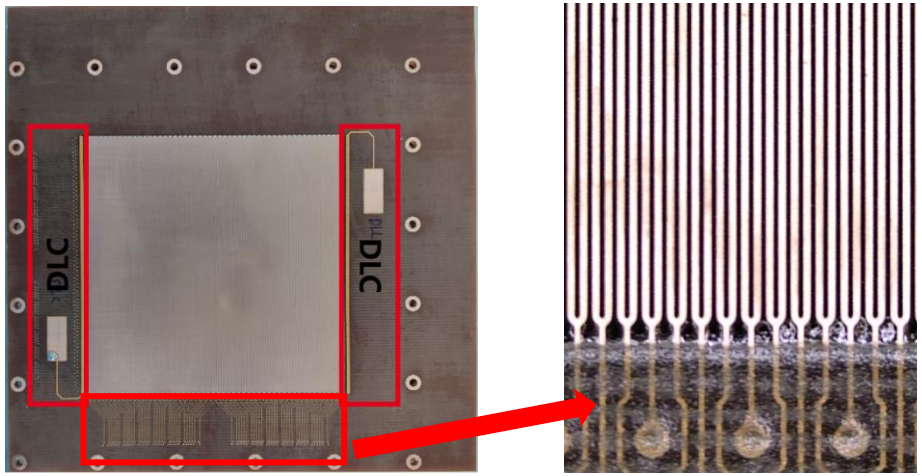
3D-readout (XYV) µRGroove





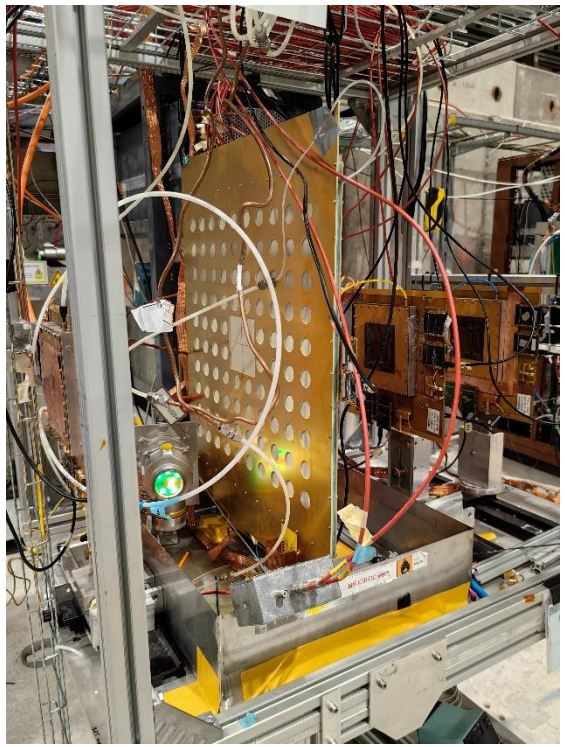


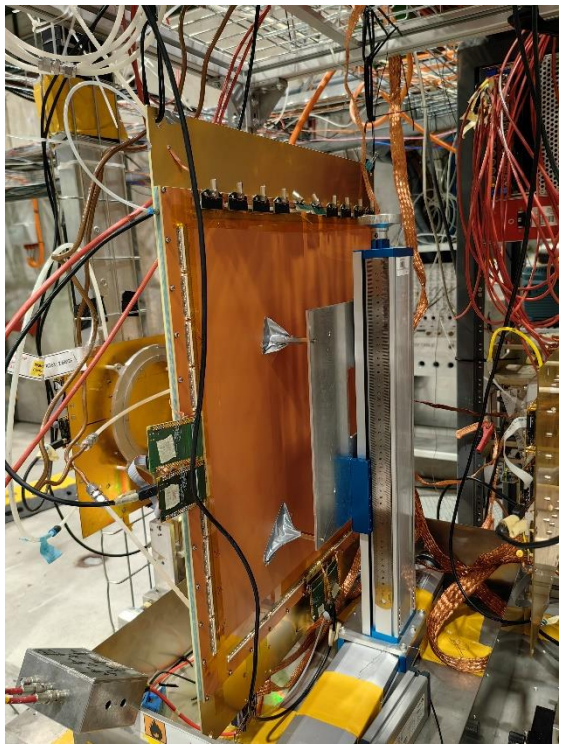
- **Two version prototypes of 10cm×10cm**
- **Groove pitch: 200µm, 2 grooves are connected making 1 strip**
- **2D-version, Y and X pitch: 400µm**
- **3D-version, X/Y/V pitch: 400µm , V angle: 45°**
- **Verify µRGroove structure and charge sharing effect.**

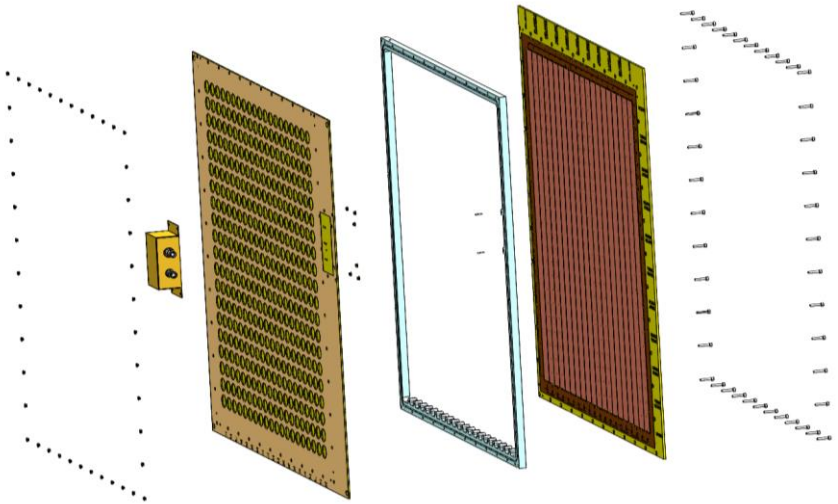


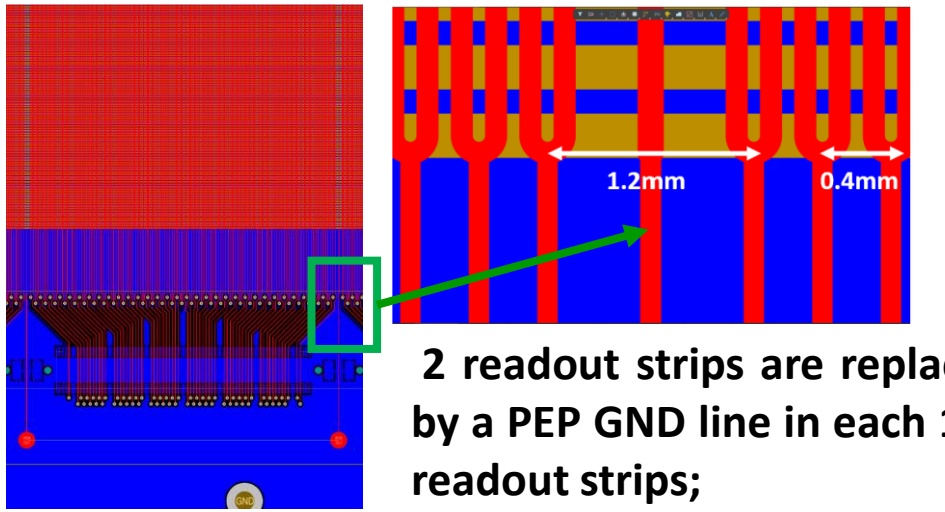
50cm×50cm 2D-μRGroove

(Siqi He's slide, Zhou Yi team) (detector produced @CERN)









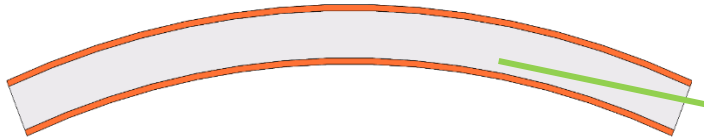
- **The central 10cm×10cm area is connected to the electronic system for testing with the rest readout strips grounded**
- **Same setup of beam test**

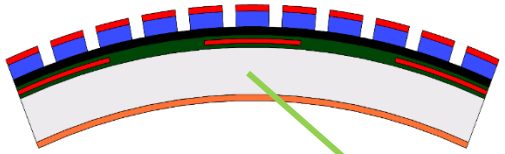
2 readout strips are replaced by a PEP GND line in each 128 readout strips;

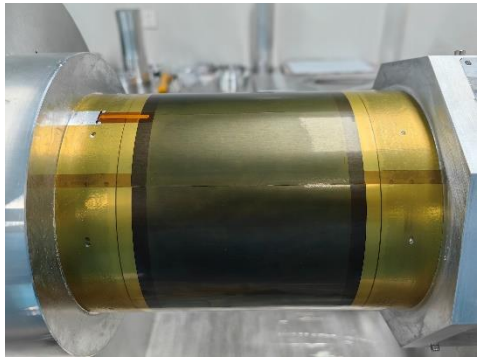
Dead Area (TOP): 2/128=1.5625%

Cylindrical-μRGroove: Manufacture

(Siqi He's slide, Zhou Yi team) (detector parts produced @CERN)

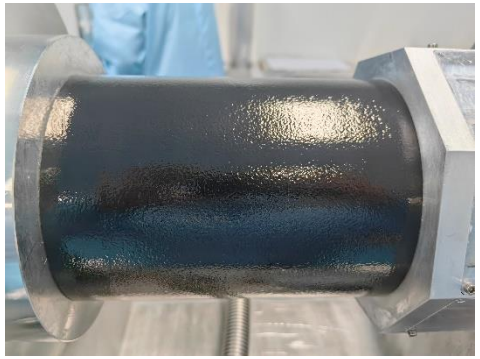






Drift electrode

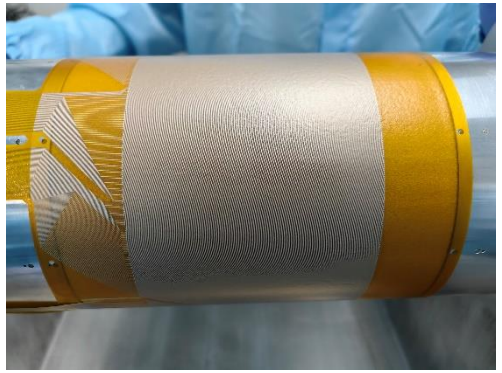
Rohacell foam



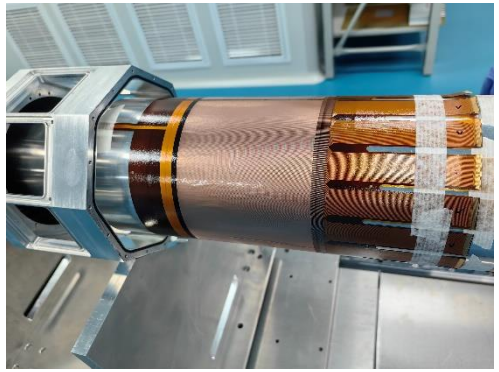
Kapton/GND

Kapton/GND

Rohacell foam



V strip film



Det.&U-strip film

✓ **Total material budget: ~0.23%X_0**

Electrical cleaning

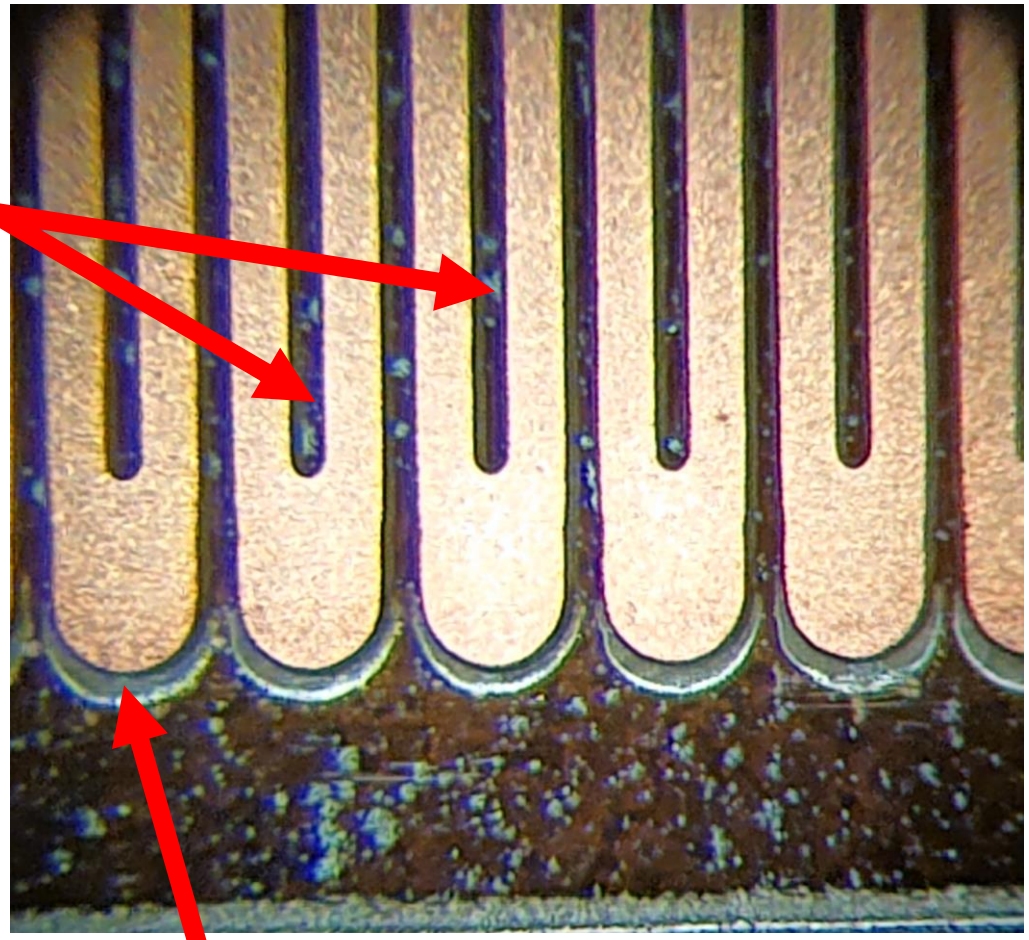
-Improves the max voltage (typ: from 580V to 670V in hot air@90deg).

-It materializes the places with high parasitic fields.

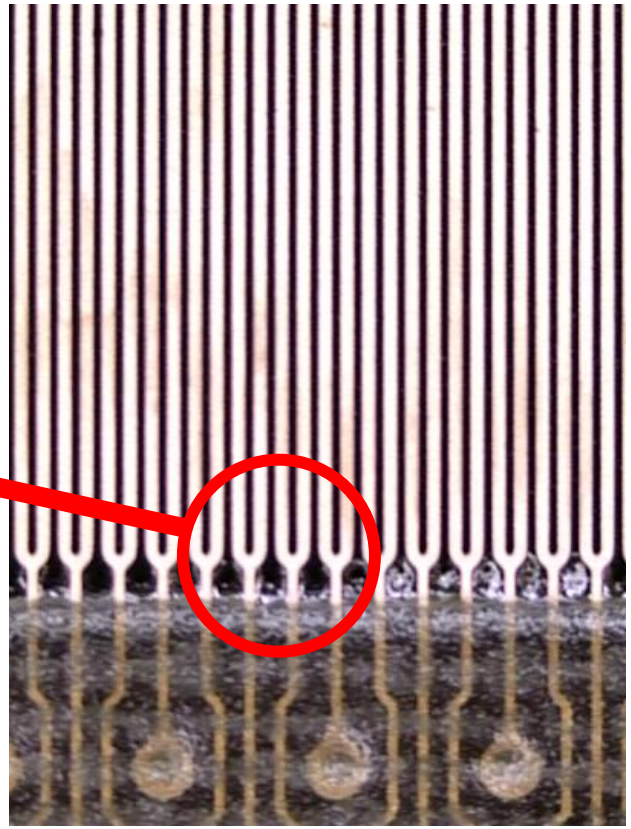
-It is a powerful tool to optimize the detector design.

After 2mA constant cleaning current at 680V during a full week

DLC in grooves not affected



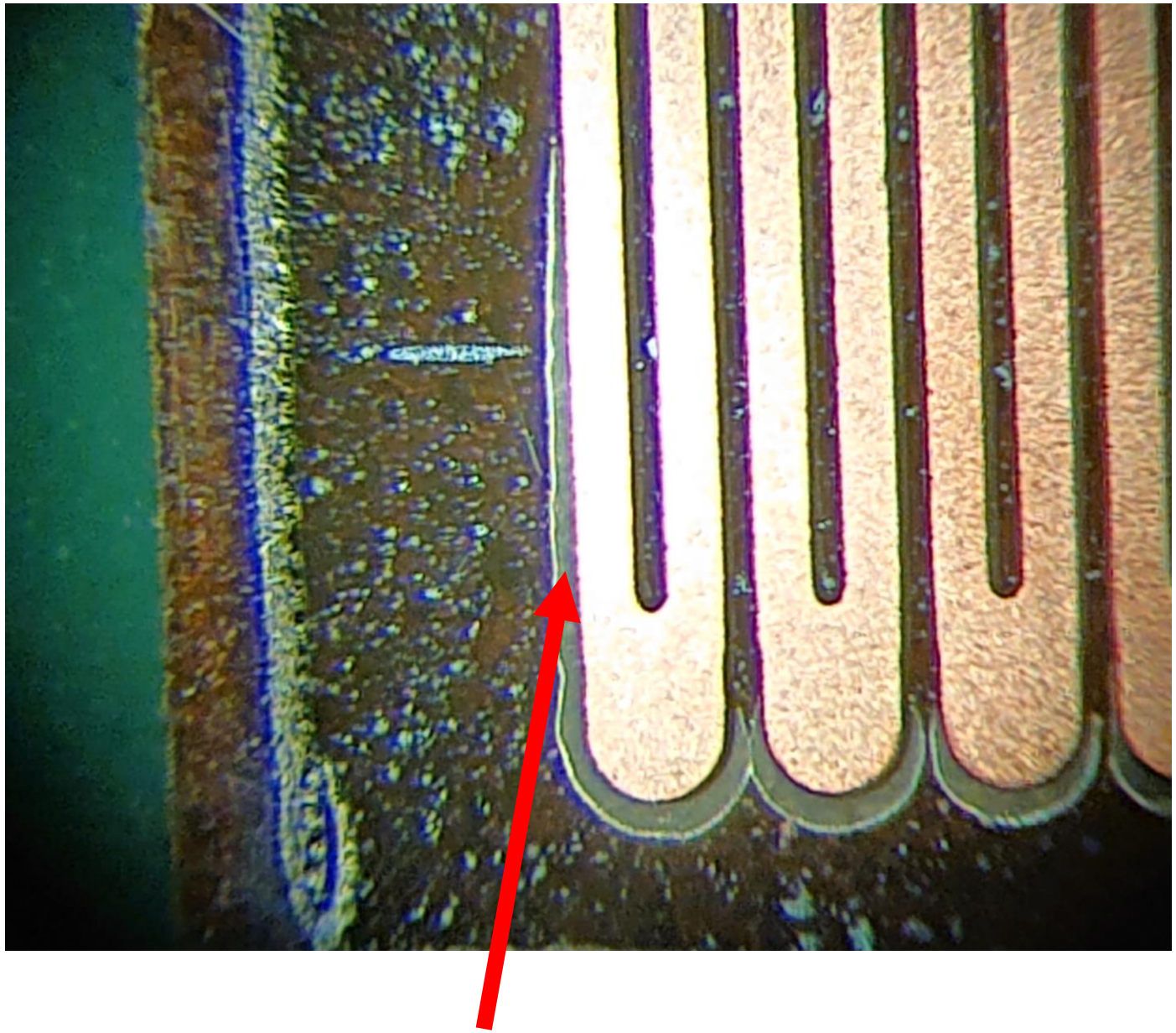
2D uRgroove



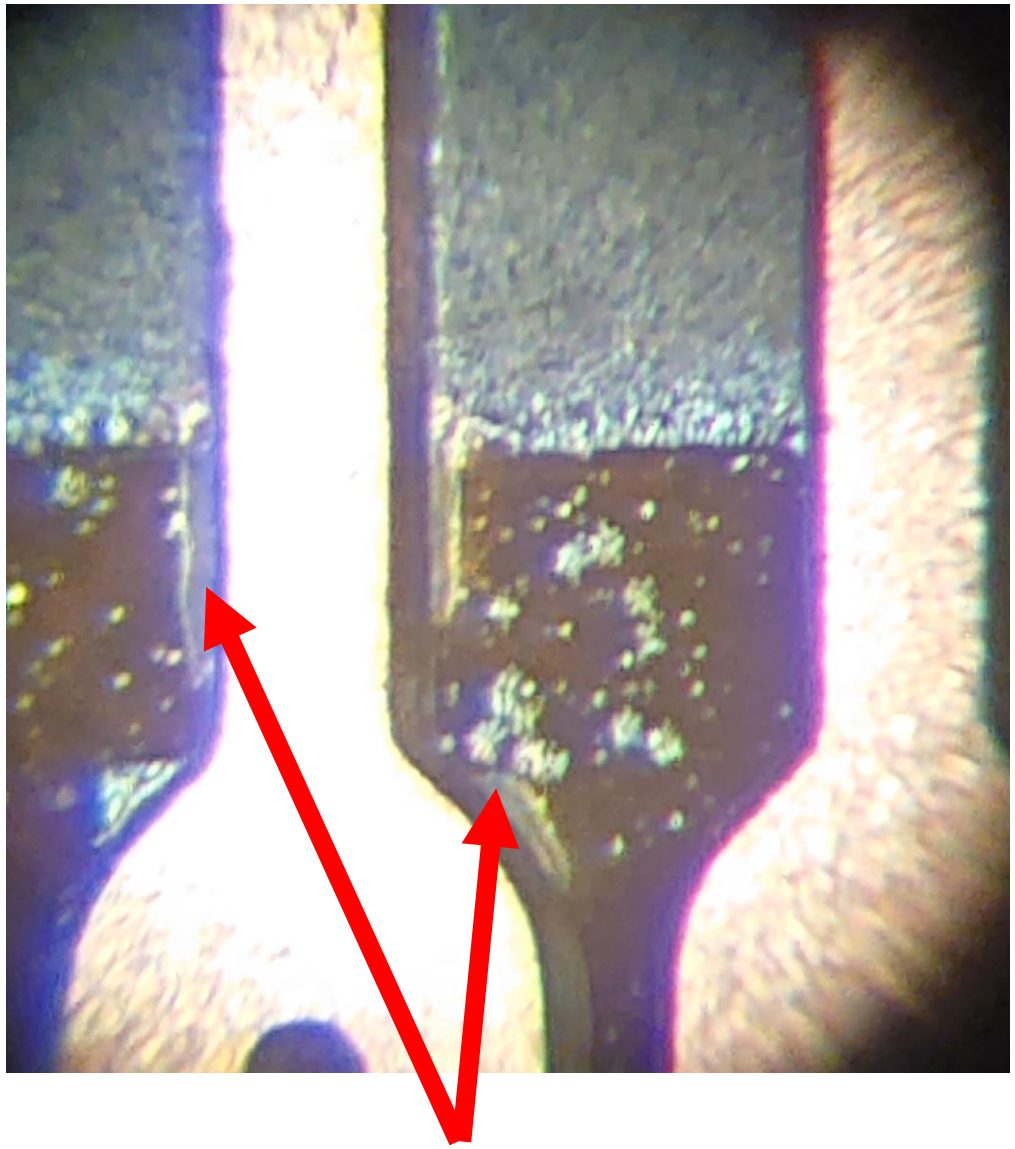
DLC removed by electro cleaning , the fields are clearly higher at this location.

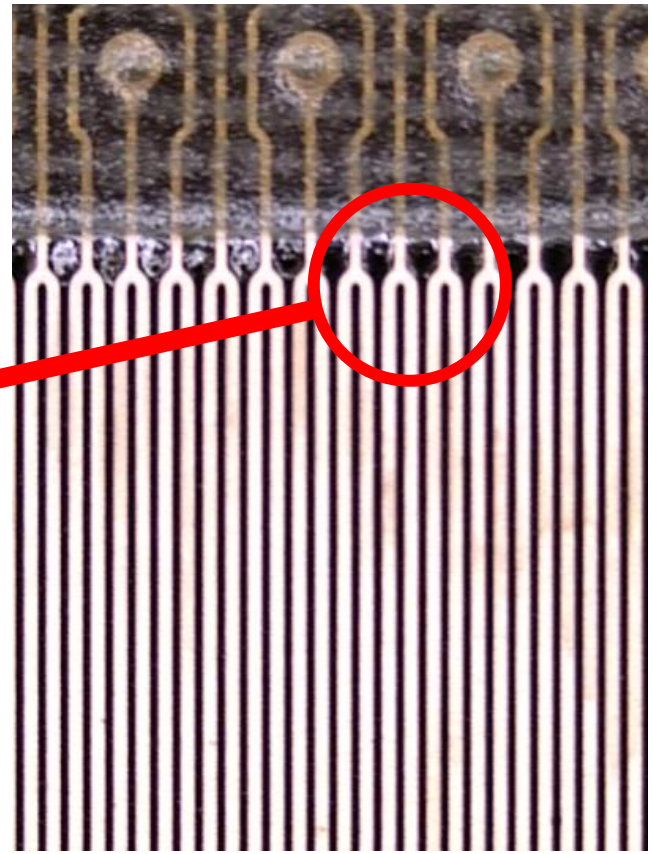
-The detector at the end was operational and the maximum voltage have been recovered.

-Based on this observation we have optimized the layout → we have kept the polyimide hiding the DLC at this location.



DLC Removed → the field on the last strip is higher → conclusion : we must also keep the Kapton at this location.



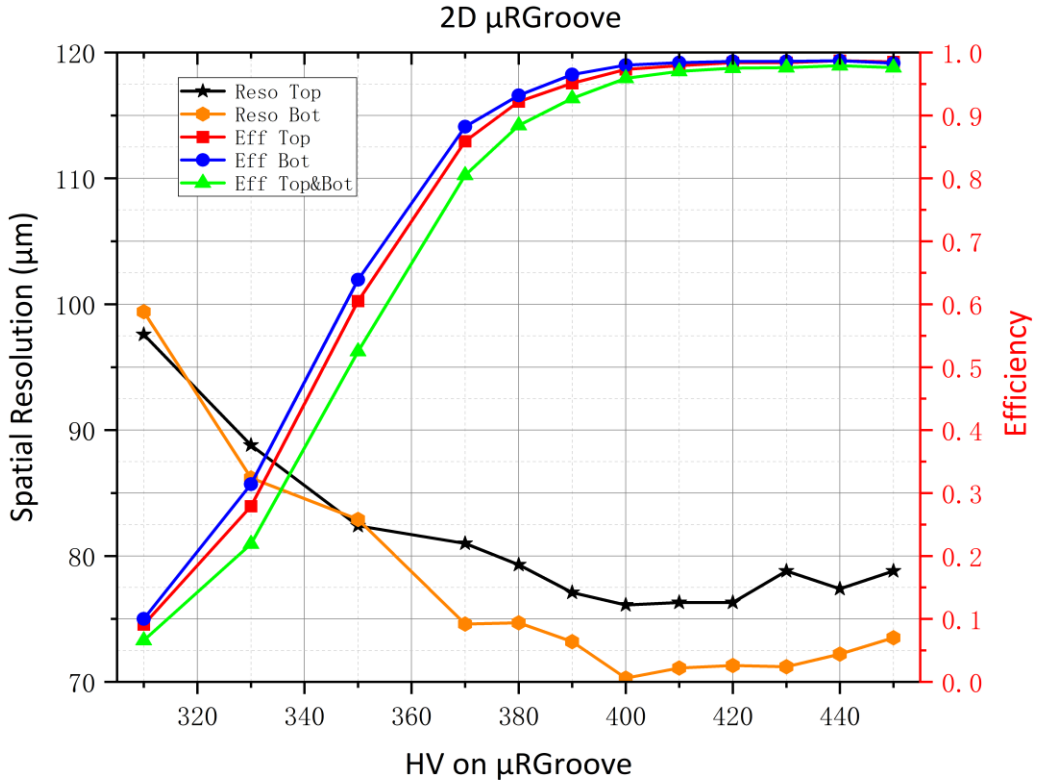


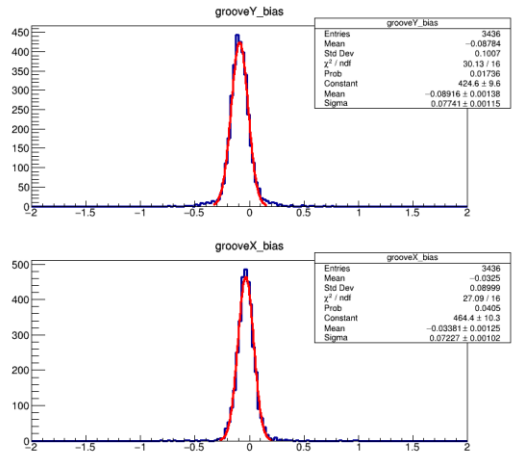
DLC a bit removed → conclusion : in the active area we must keep constant grooves of 70um

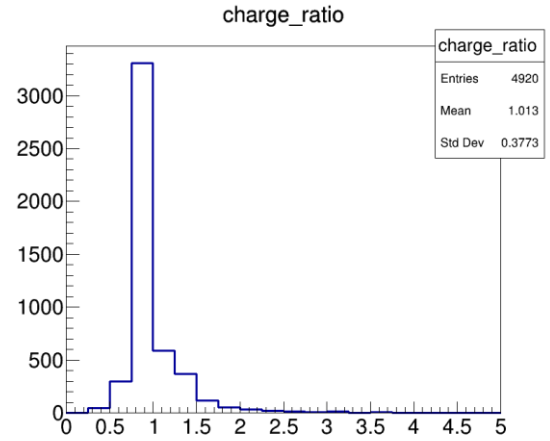
-It would be nice to confirm all these observation with Comsol.

Beam test: Result of 2D-μRGroove (10cm x10cm) improved layout

(Siqi He's slide, Zhou Yi team)







➢ **Drift electric field is 2kV/cm with 5mm gas gap.**

The detector is slightly tilted due to setup issues

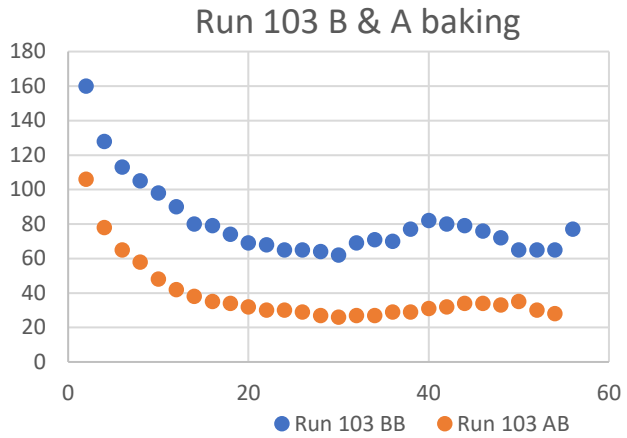
- ✓ The combined efficiency is about 97.9% and enter plateau at ~410V
- ✓ Spatial resolution is ~76μm for top readout and 70μm for bot readout
- ✓ Charge radio of X/Y is about 1.013

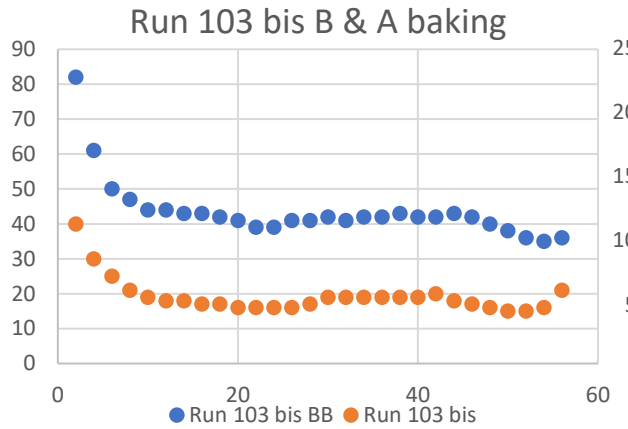
Gas mixture during this test beam : Ar/C4H10 (90/10).
Possible other gas mixture: Ar/CO2/CF4 (45/15/40).
Also recently tested with same results : Ar/C4H10 (98/2), nonflammable.

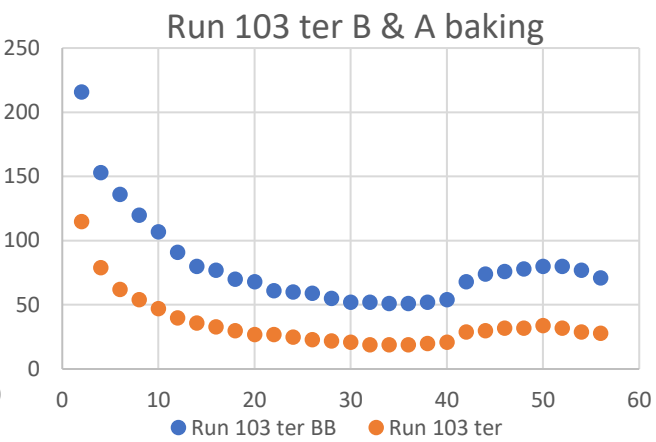
Conclusions

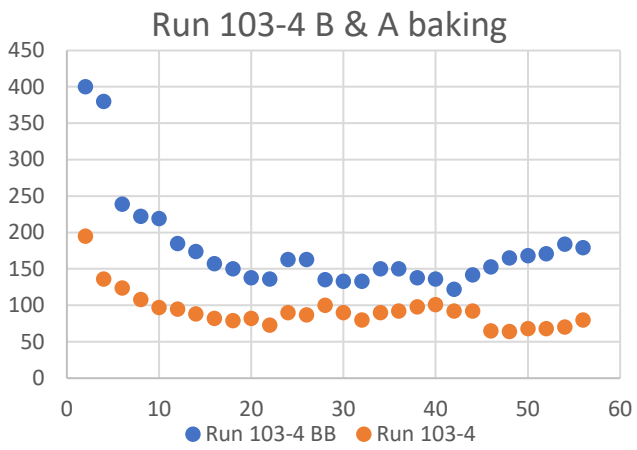
- We have made good progresses with DLC deposition. We are about to finish optimizations.
- Large foils of 1.7m x 0.6m can be produced.
- We know now that we can reach a throughput of 3 to 4 large foils per day.

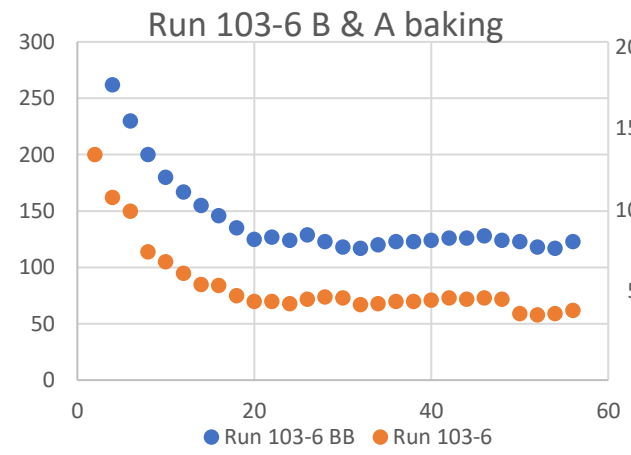
- uRgroove detectors seems to beat uRwell detectors on many aspects.

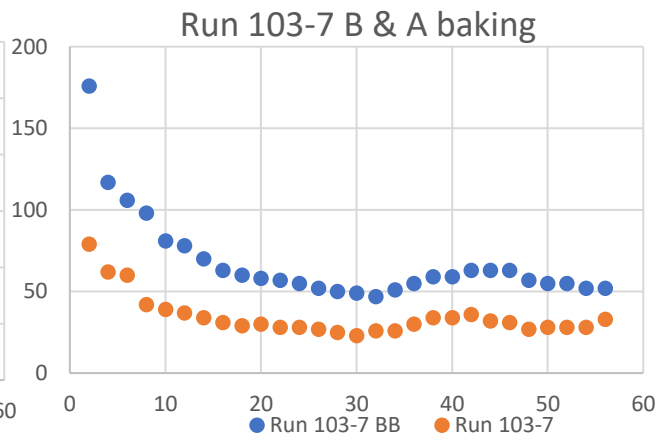

Run 103 B & A baking
180
160
140
120
100
80
60
40
20
0
0
20
40
60
Run 103 BB
Run 103 AB

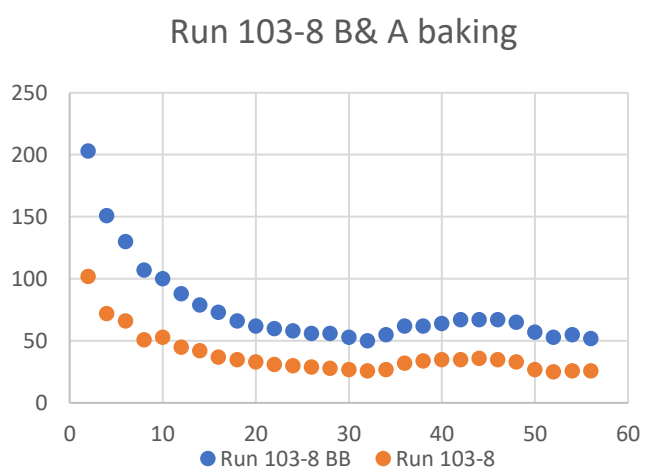

Run 103 bis B & A baking
90
80
70
60
50
40
30
20
10
0
0
20
40
60
Run 103 bis BB
Run 103 bis


Run 103 ter B & A baking
250
200
150
100
50
0
0
10
20
30
40
50
60
Run 103 ter BB
Run 103 ter


Run 103-4 B & A baking
450
400
350
300
250
200
150
100
50
0
0
10
20
30
40
50
60
Run 103-4 BB
Run 103-4


Run 103-6 B & A baking
300
250
200
150
100
50
0
0
20
40
60
Run 103-6 BB
Run 103-6


Run 103-7 B & A baking
200
150
100
50
0
0
10
20
30
40
50
60
Run 103-7 BB
Run 103-7


Run 103-8 B& A baking
250
200
150
100
50
0
0
10
20
30
40
50
60
Run 103-8 BB
Run 103-8