RPC assembly for the ATLAS Phase-II upgrade

Lagarde François

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山东省, 青岛市

Outline

- Introduction
- Readout panel production
- BIS singlet assembly

High-Luminosity LHC

High-Luminosity LHC (Phase-II) is expected to start in 2029 after LHC Long Shutdown 3 (LS3) :

- Instantaneous luminosity is expected to increase from 2.10^{34} $s^{-1}cm^{-2}$ up to $7.5.10^{34}$ $s^{-1}cm^{-2}$.
- Peak pile-up of up to 200 compared to 60 in the current run.

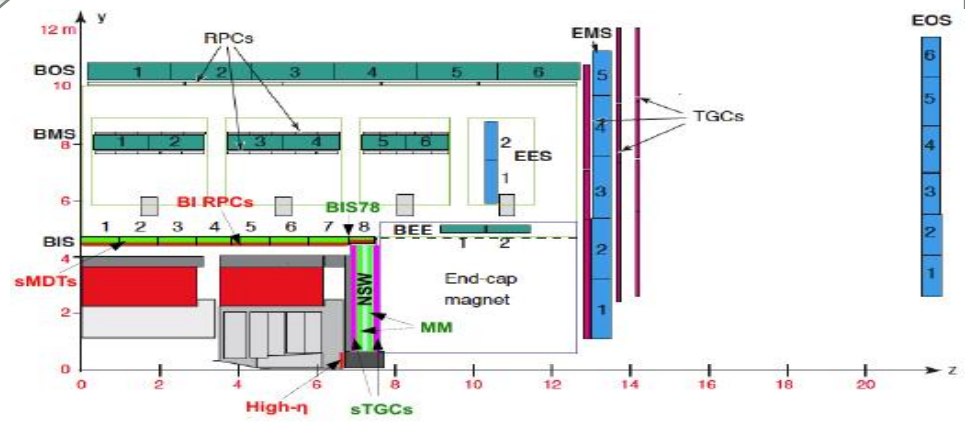
➡ **Upgrade of ATLAS is necessary !**

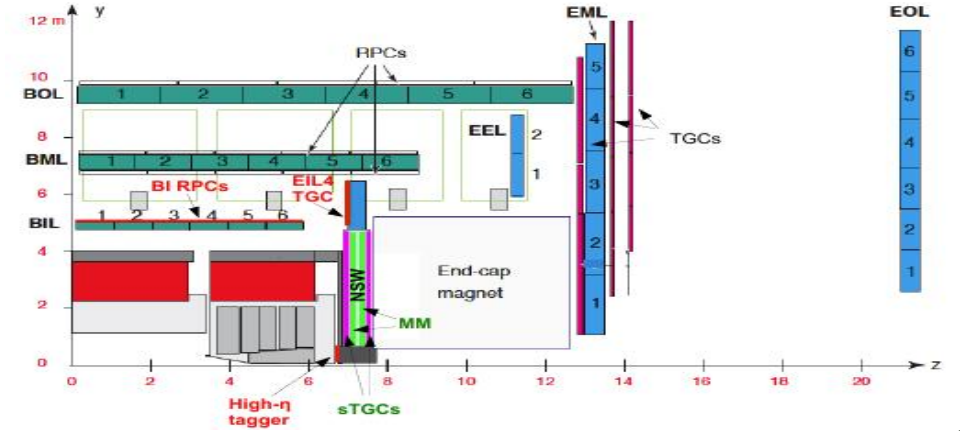
For the RPC system :

Maintain low trigger momentum thresholds while keeping the trigger rates at a manageable level

Install triplets of new-generation RPCs in the inner layer of barrel chambers (BI-RPC)

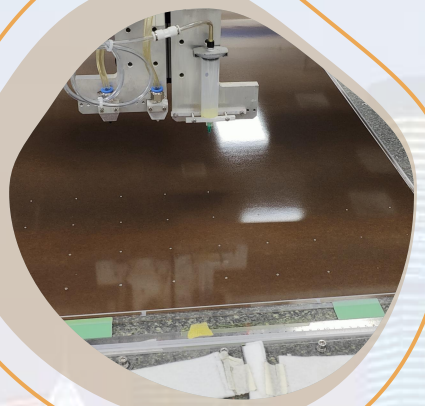
- 130 BIL + 96 BIS + 80 BOR/BOM chambers.
- 1 chamber is composed of 3 singlets.
- 1 singlet = 1 gas gap + 2 readout panels.



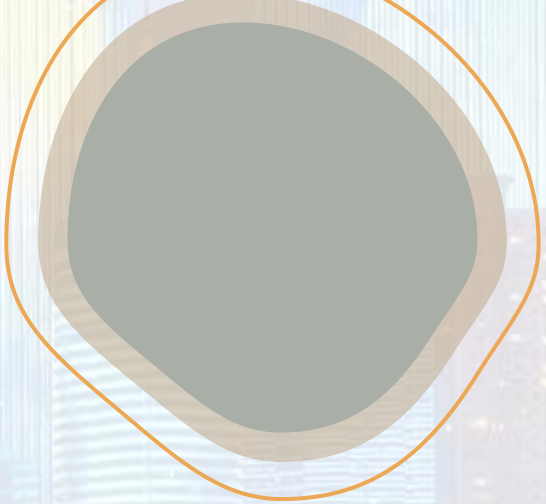


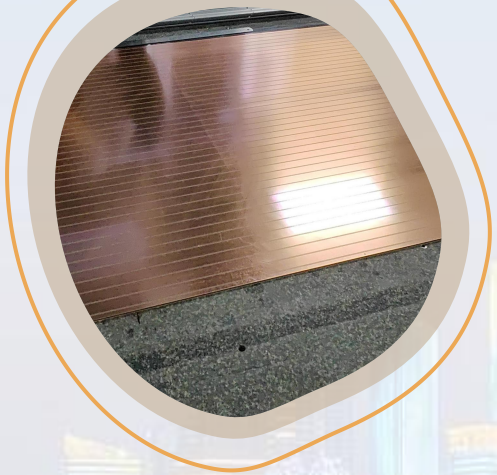
Tasks undertaken by the Chinese cluster (USTC/SDU/SJTU)

Production and Qualification of 72 gas gaps
see Dongshuo Du slides



Manufacture and test of about 5000 front-end boards





Production and Qualification 932 strip panels (50%) (BIL/BIS/BOM/BOR)

Assembly of 360 singlets

Production plan

Strip panels :

- 336/576 BIS panels have already been produced and qualified in China. The remained ones will be produced before the end of the the first semester 2025.

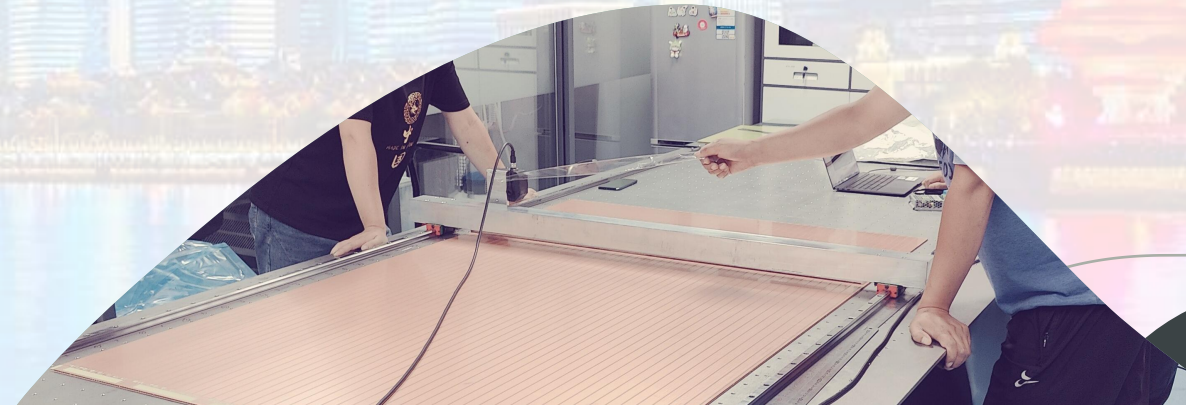
Gas Gaps :

- 7 RPC gas gaps has been produced by USTC and will be delivered to CERN for Irradiation test @ GIF++ in the following days

BIS Singlets :

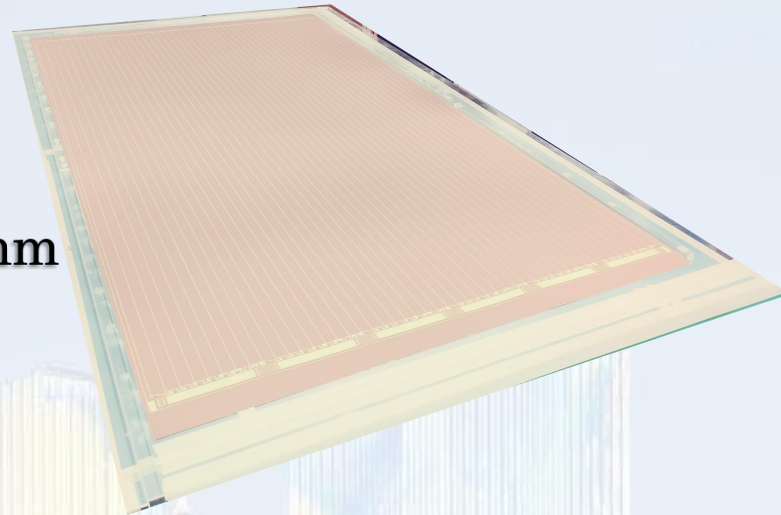
- BIS singlets assembly without FEE will start in the coming days @ CERN

Readout Panel Production



Material

- PBC : 1706x1072mm² (BIL) / 1706x890mm² (BIS)thickness ~0.45mm
- Honeycomb : 3 mm thick
- Glue : Araldite® 2011 (~180g/side)



Centrifugal Mixer
THINKY ARE-310


Araldite® 2011

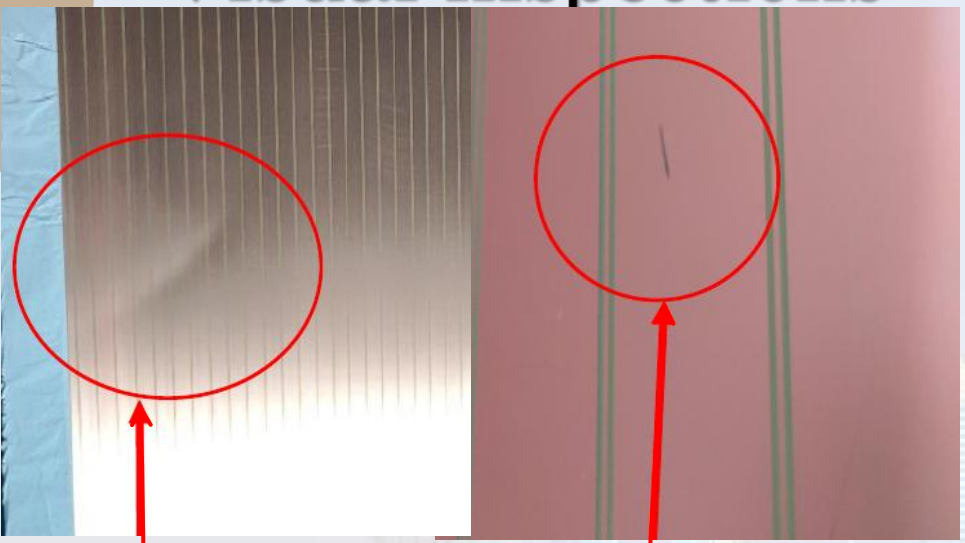

Cell size : 5 mm (side to side)
Density : 32 kg.m^{-3}

Specifications and tolerances

- **Flatness : < 0.1mm in 7cm x 7cm range**
- **Length and width : +/- 1mm**

PCBs Checks

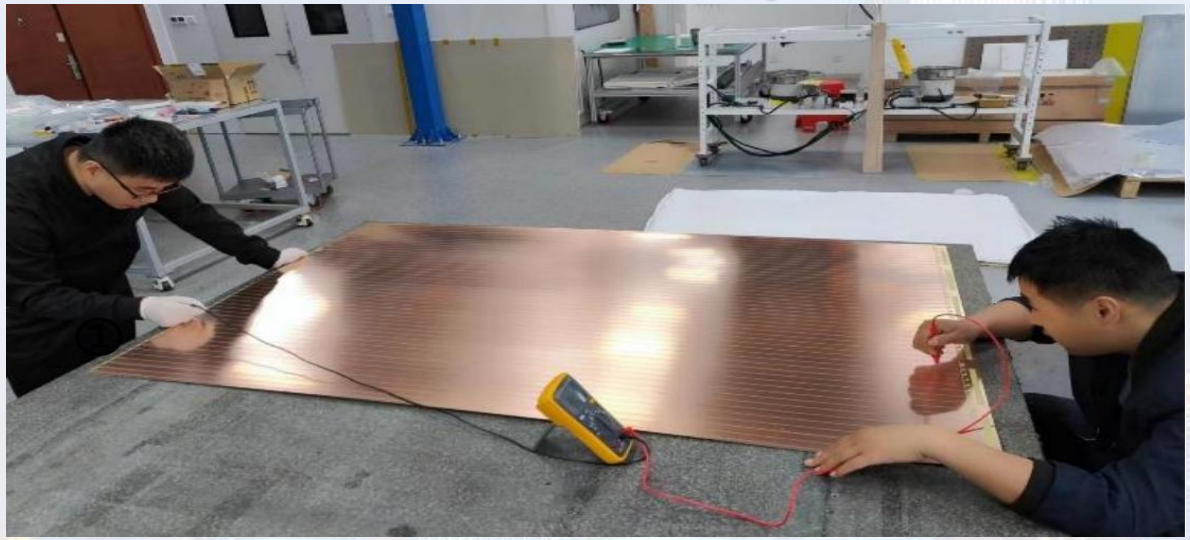
Visual inspections



slight folds

Small scratches

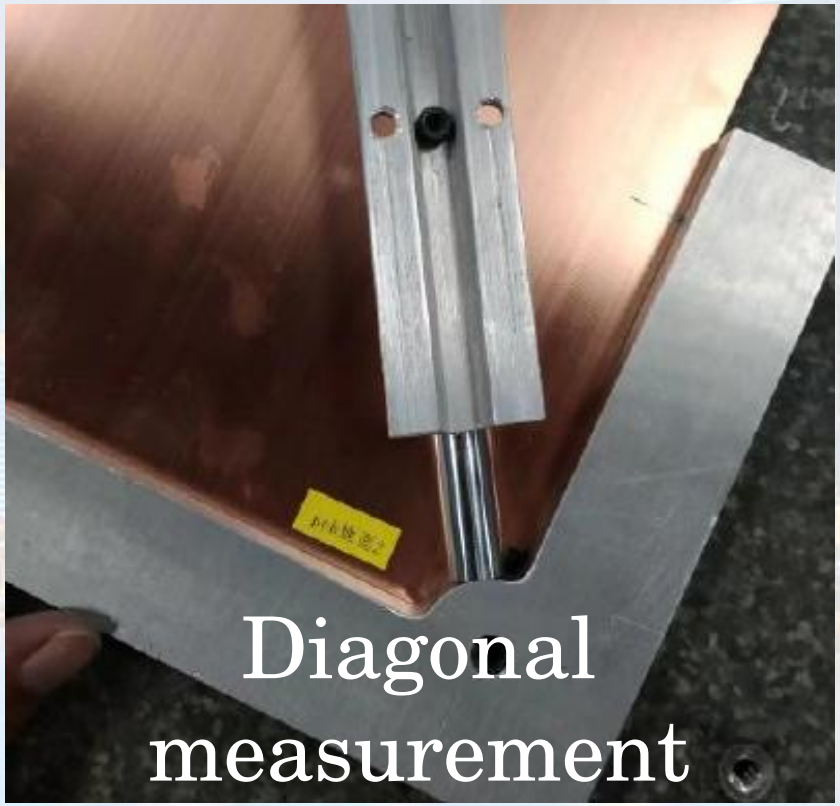
Electrical continuity checks



Dimension checks

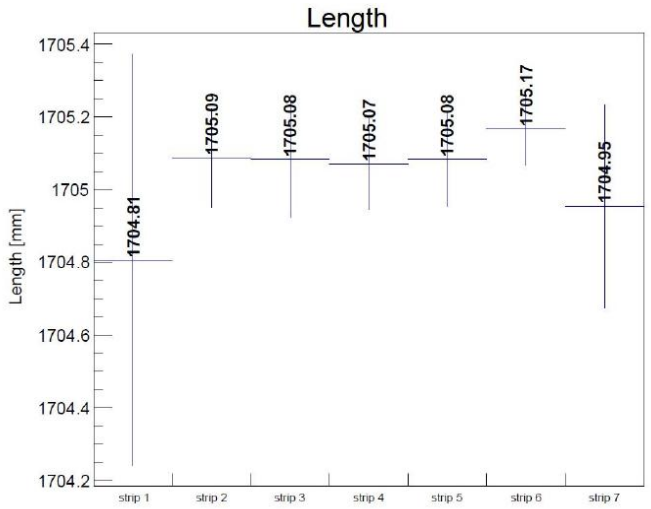
Dimension Checks

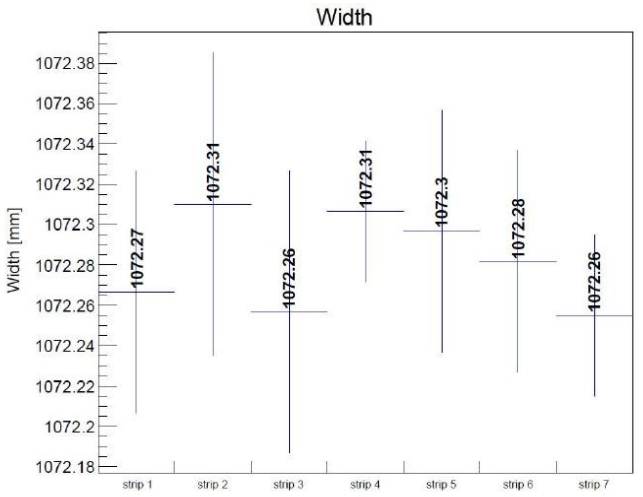
Three bars are used to perform dimension checks

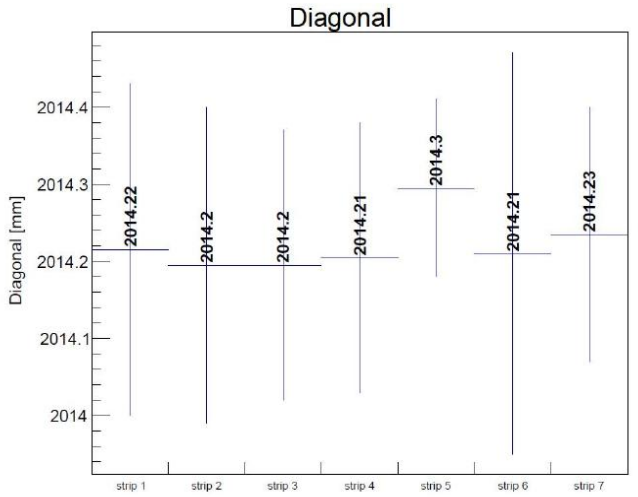


Results

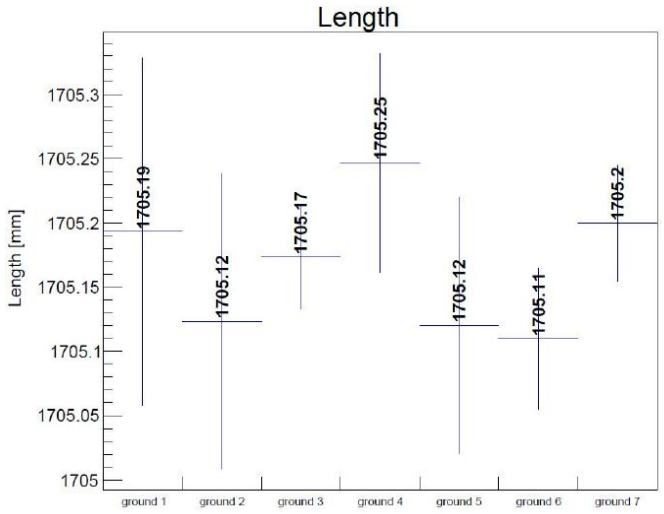
Strip side

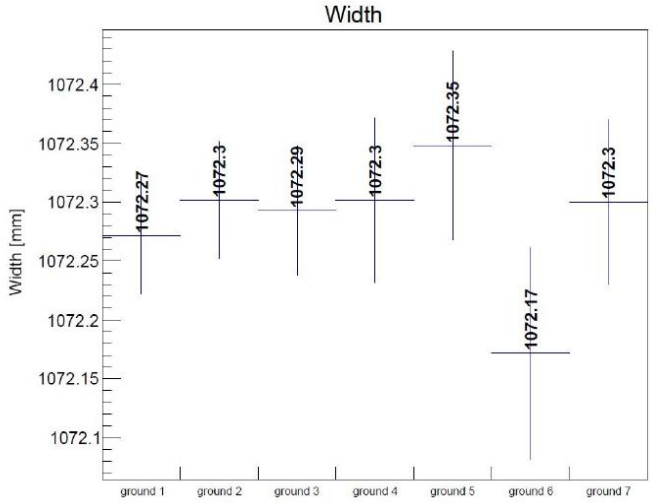


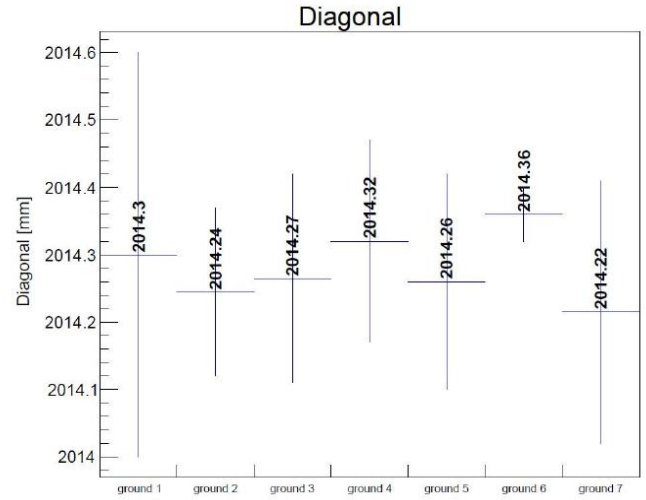




Ground side







All the measurements are within the tolerances

Honeycomb Paper Dimension Check

- Honeycomb paper size : 1220*2440*3mm²
- Thickness measurement is performed using a micrometer gauge on a marble table
- 5 samples has been tested : All are good quality !

#1	X_1	X_2
Y_1	3.03	3.067
Y_2	3.05	3.07
Y_3	3.036	3.067
Y_4	3.022	3.074
Y_5	3.05	3.067
Y_6	3.038	3.055
Mean	3.038	3.067

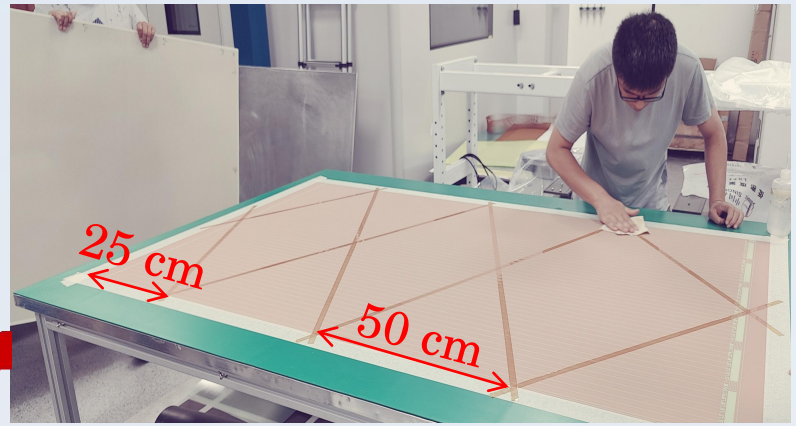
#2	X_1	X_2
Y_1	3.102	3.091
Y_2	3.087	3.076
Y_3	3.072	3.049
Y_4	3.078	3.067
Y_5	3.07	3.041
Y_6	3.071	3.043
Mean	3.08	3.061

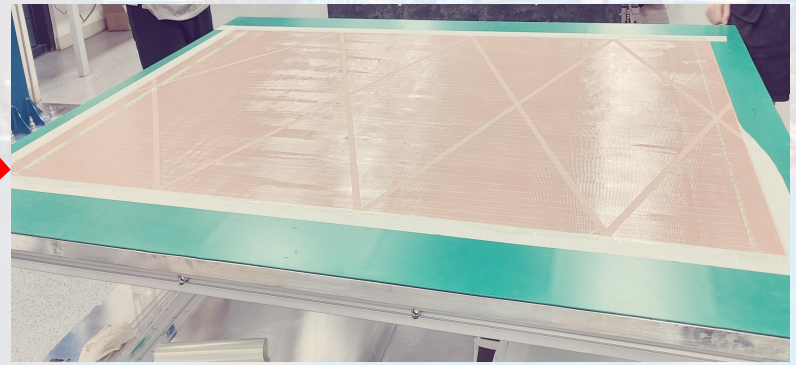
#3	X_1	X_2
Y_1	3.062	3.043
Y_2	3.066	3.065
Y_3	3.057	3.049
Y_4	3.064	3.044
Y_5	3.06	3.057
Y_6	3.068	3.059
Mean	3.063	3.053

#4	X_1	X_2
Y_1	3.039	3.076
Y_2	3.063	3.074
Y_3	3.054	3.082
Y_4	3.061	3.092
Y_5	3.075	3.088
Y_6	3.078	3.079
Mean	3.062	3.082

#5	X_1	X_2
Y_1	3.107	3.103
Y_2	3.096	3.099
Y_3	3.074	3.097
Y_4	3.079	3.097
Y_5	3.106	3.107
Y_6	3.106	3.119
Mean	3.095	3.104

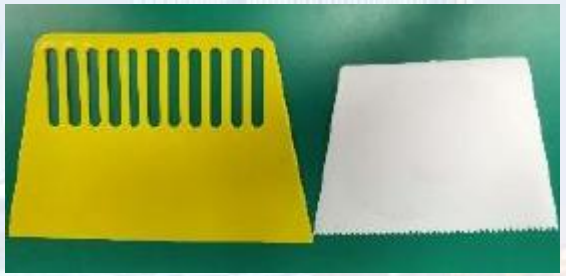
Strip panel production





1) Create X shapes with tape on the strip and ground panels

- Distance between parallel tapes : 50 cm
- PCB egdes are protected with 3mm tape mask

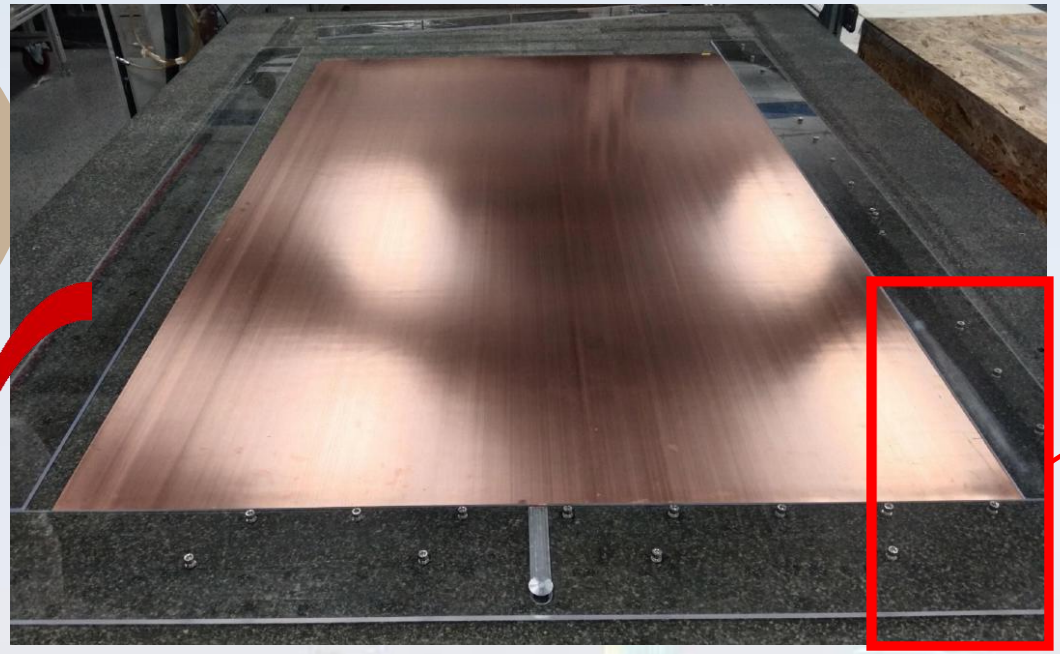


2) Apply the alradite glue on PCB

- Plastic spatula (yellow one) is used to spread the Araldite glue
- Plastic toothed spatula (white one) is used to improve glue layer uniformity.

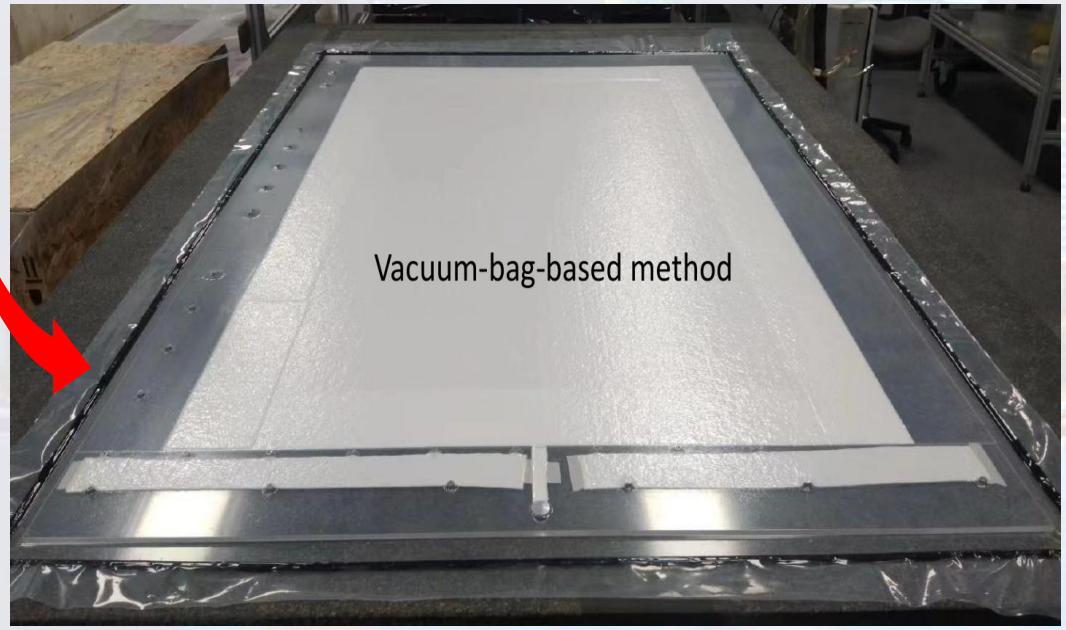
3) Removing of the X shapes and the 3mm edge tape mask

Strip panel production



4) Alignment of the 3 layers (2PCBs +Honeycomb)

Very good alignment
All the layers glued at once



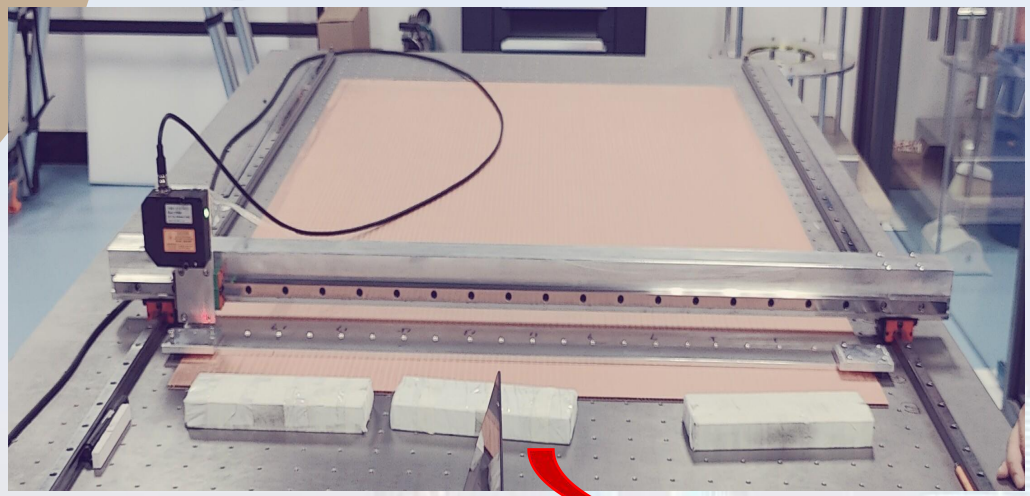
5) Gluing of the layers

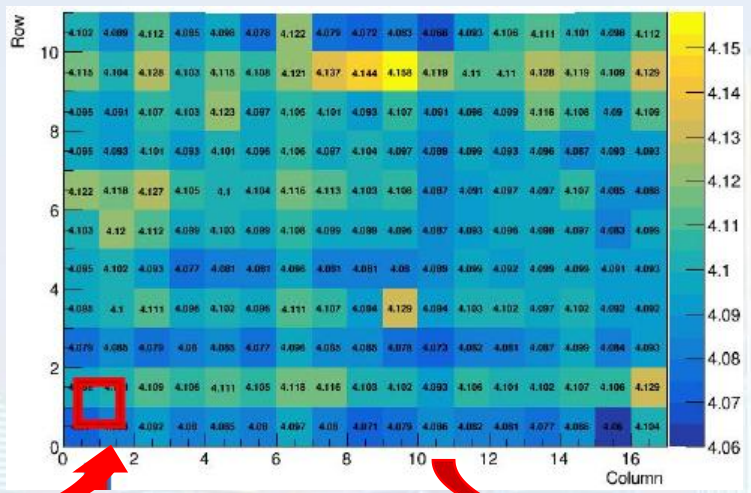
- 1 atm vacuum
- 6 hours of curing within the vacuum bag

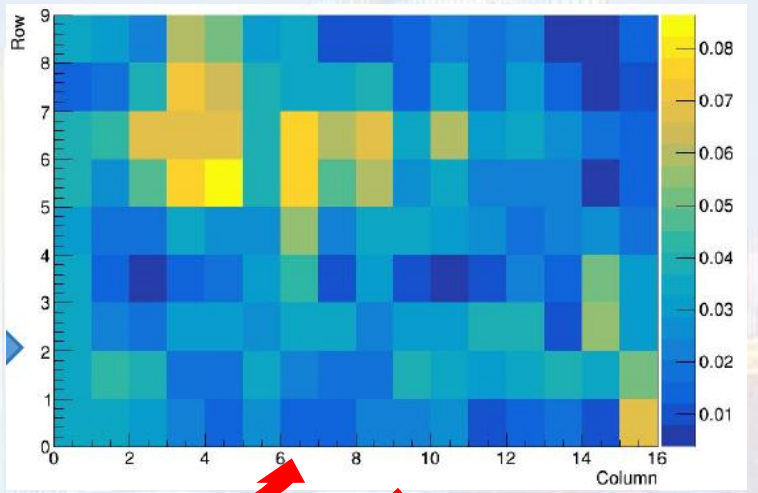
Good pressure uniformity all along the panel

Overall Panel Thickness Measurement

- The 3D thickness map is measure on 7*7cm² cells basis by laser sensors
- The 2D Flatness (Maximum variation of 4 adjacent 7*7cm² cells)
- Histogram of 1D Flatness

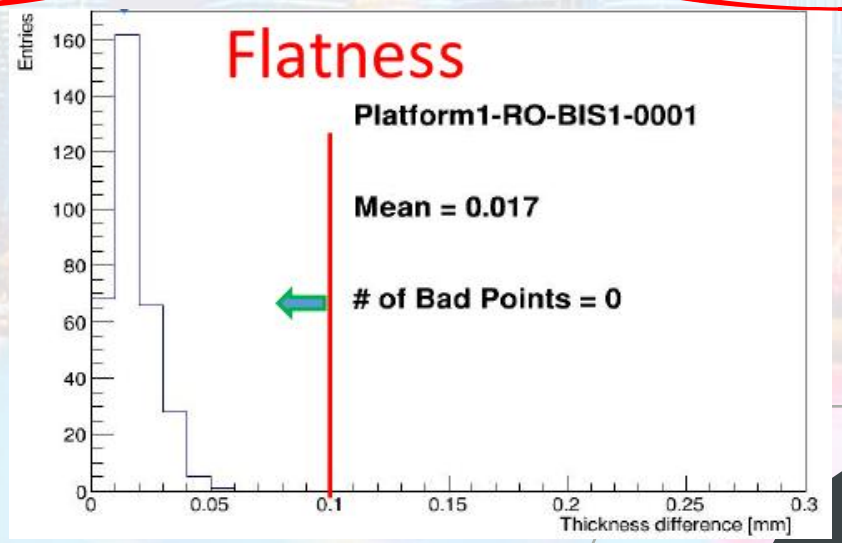






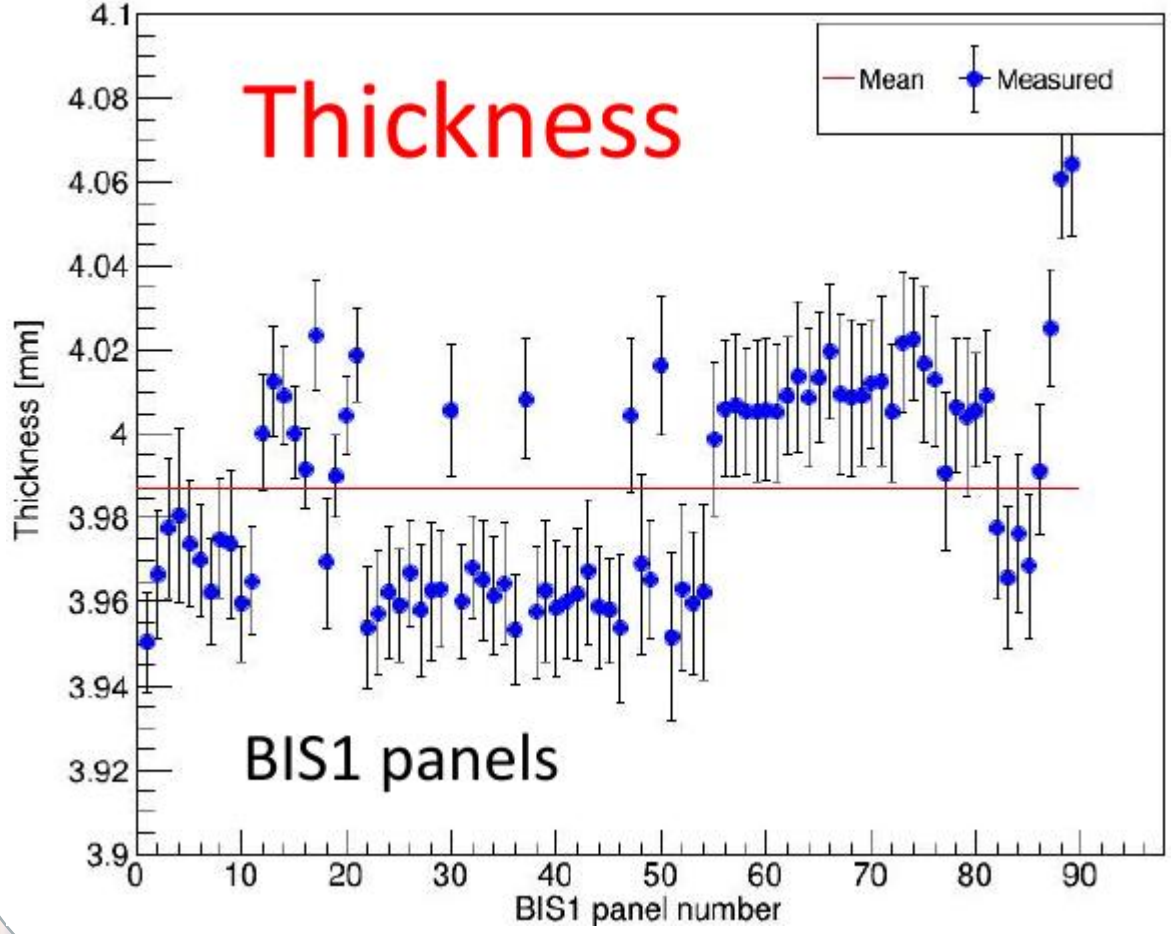
Requirement :

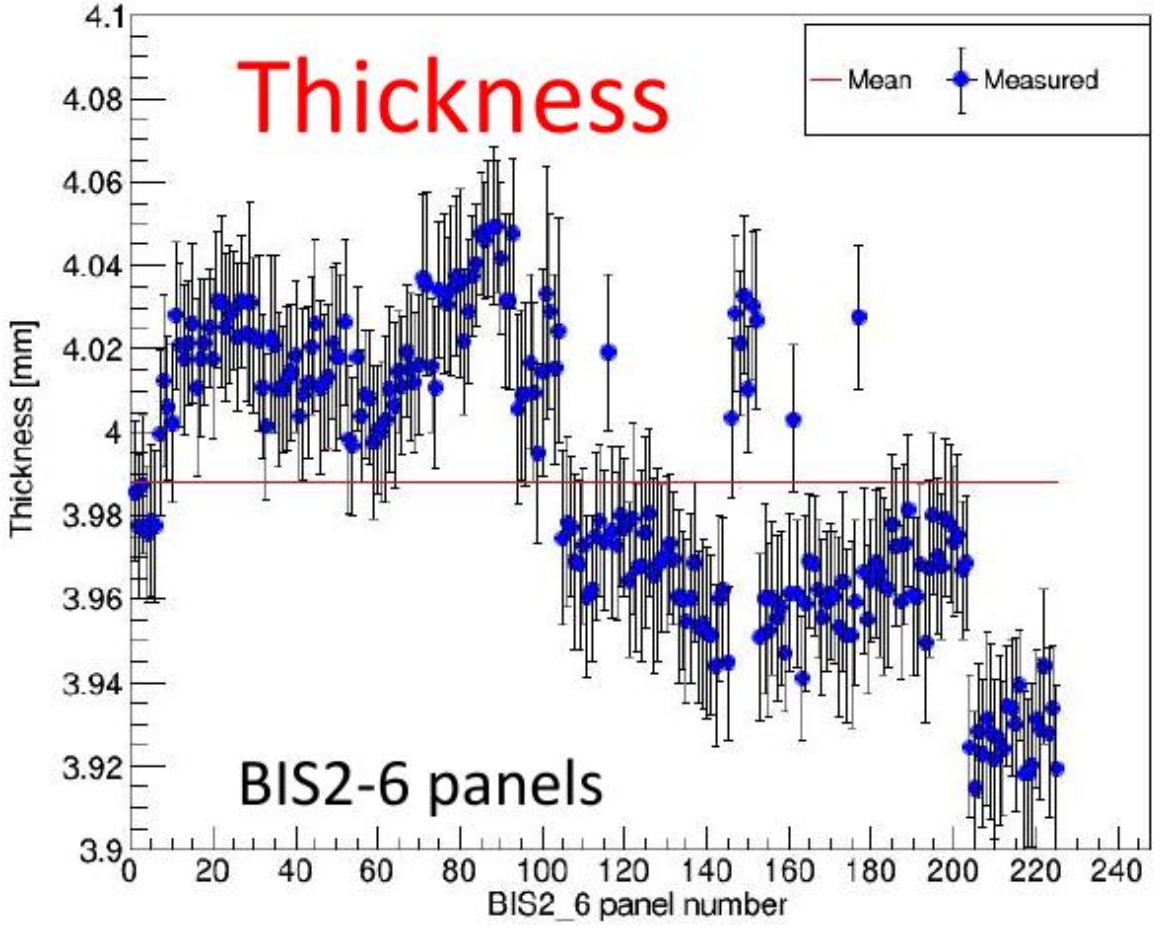
Flatness < 100 μm



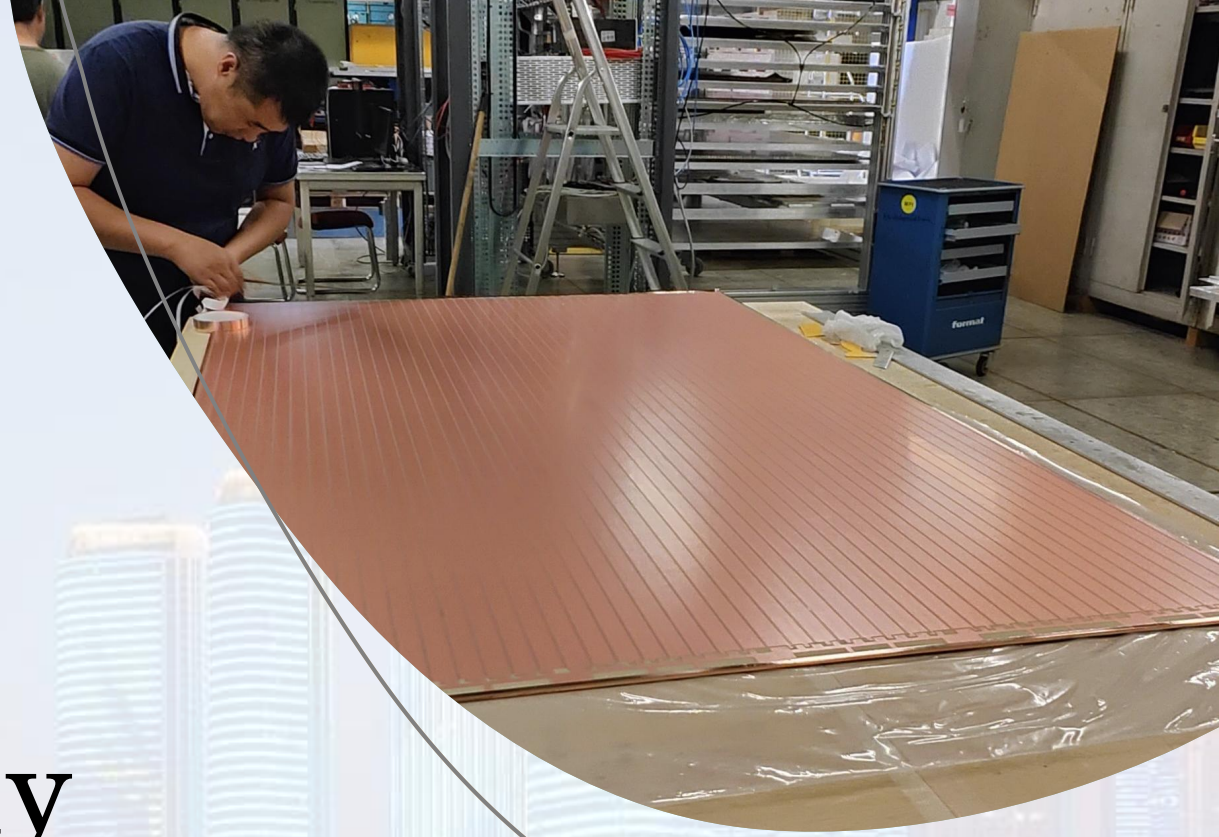
Panel Thickness Measurement

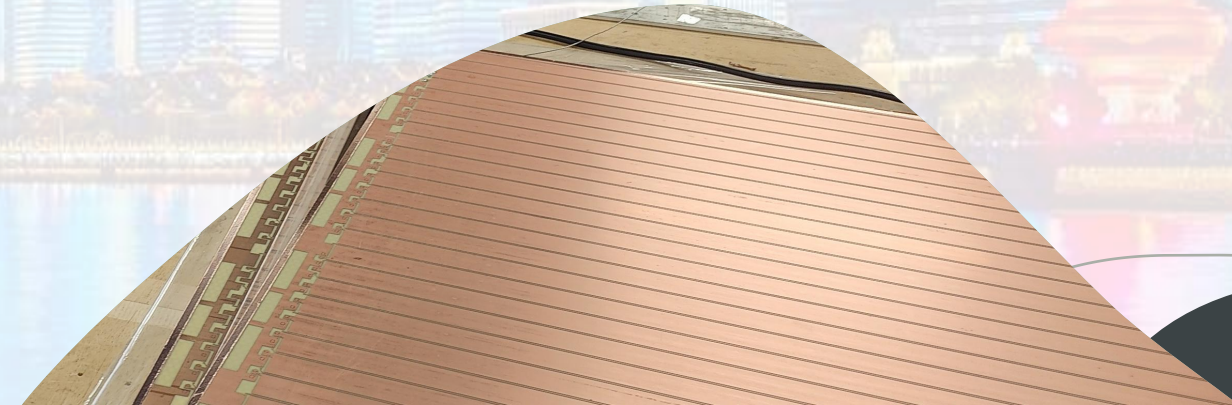
More than 300 readout panels have already been built by an external company :





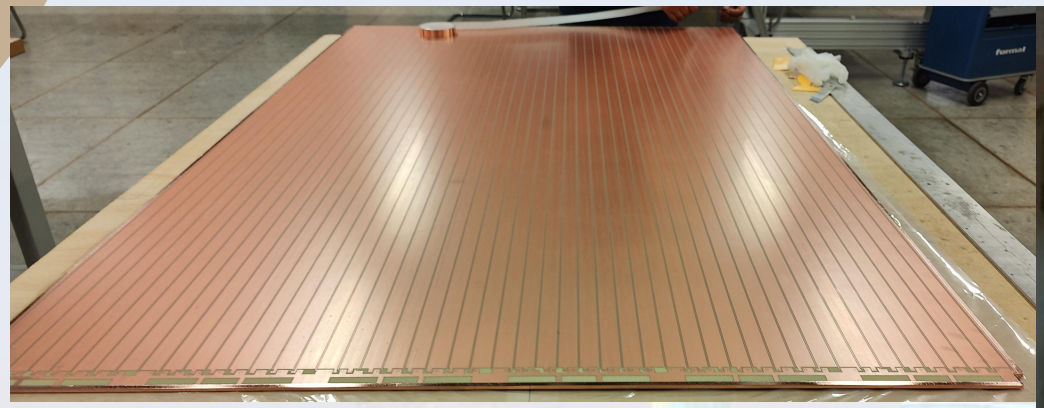
BIS Singlet Assembly

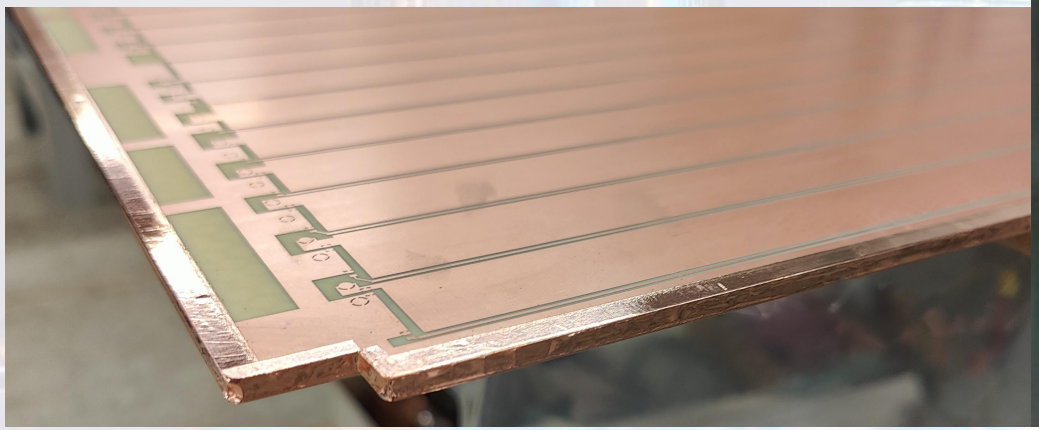




BIS singlet assembly

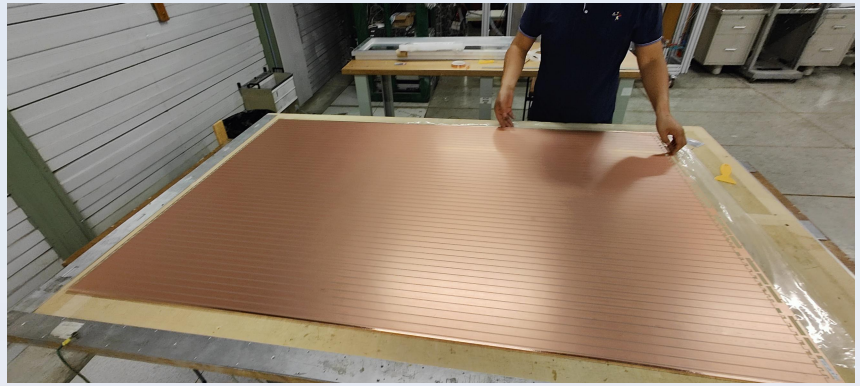
1. Connect the border of strips side to the ground side.
2. Solder the resistance at the 2 ends of the strips : time consuming 1 strip panels 194 resistors (~1.5h), 1 singlet 388 resistors, one chamber 1164 resistors ! Moving to a new method using masks



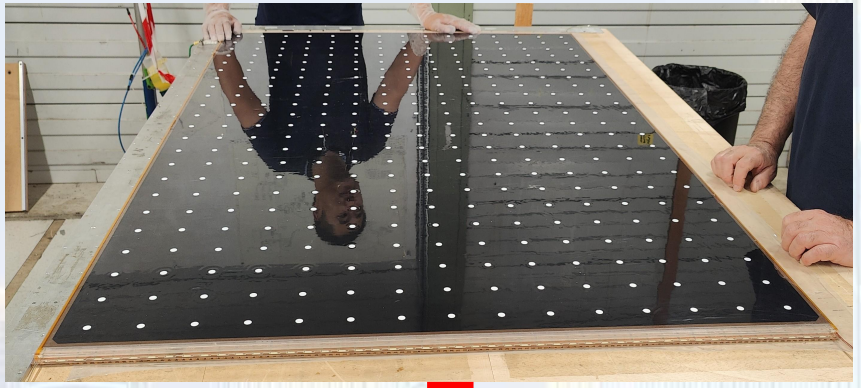


BIS singlet assembly

Put the readout panel on the table



Place the RPC chamber on top of the strip panel

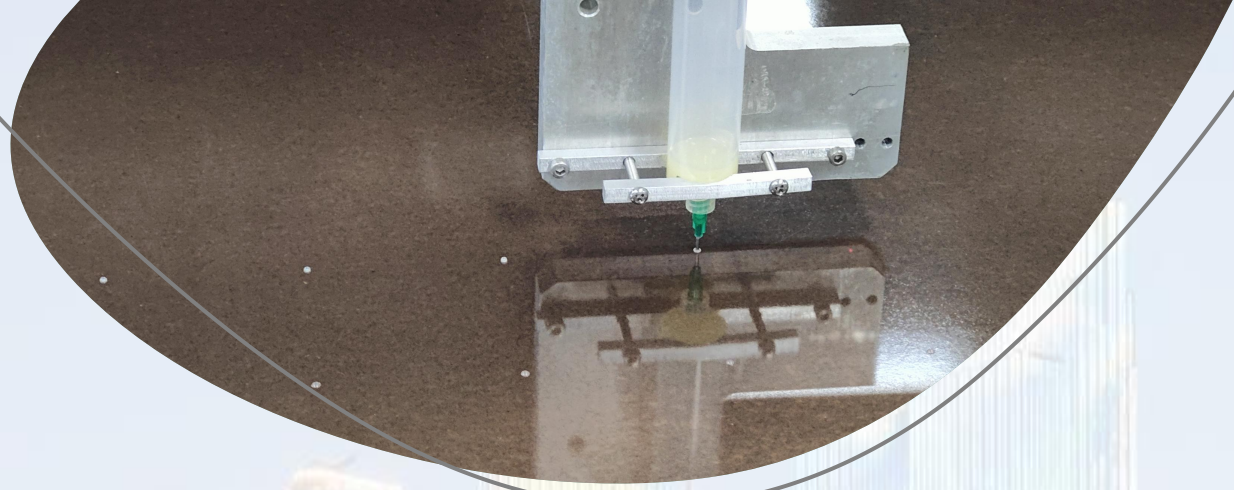


Add the second strip panel

Cover the borders with aluminium tape

Production will start next week at CERN with a first batch of 24 BIS singlets !

Summary

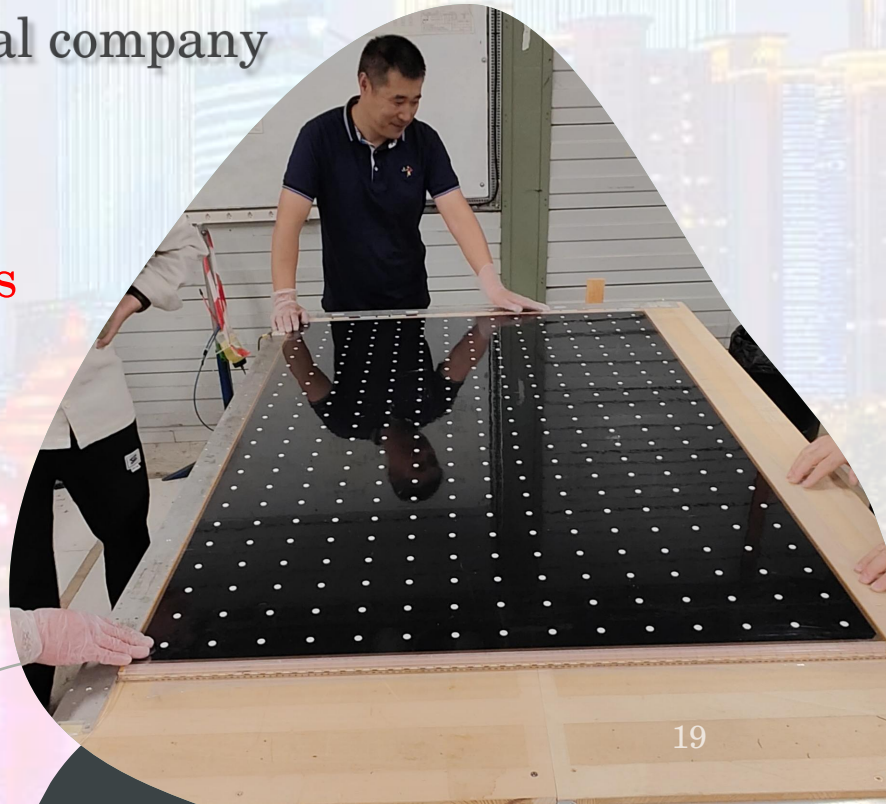


Readout panel :

- The vaccum-bag method has been setup at USTC and further optimized.
- More than 500 readout panel have been produced in an external company
- The flatness is bellow the specification (<100 um)

Gas gap production at USTC : see Dongshuo Du slides

- 7 130*68 cm^2 gas gap prototypes has been produced
- Ready to be tested under irradiation at GIF^{++}, CERN



BIS Singlet Assembly :

- Singlet assembly training will start next week at CERN

Thank You