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QC on small NSW prototypes current production

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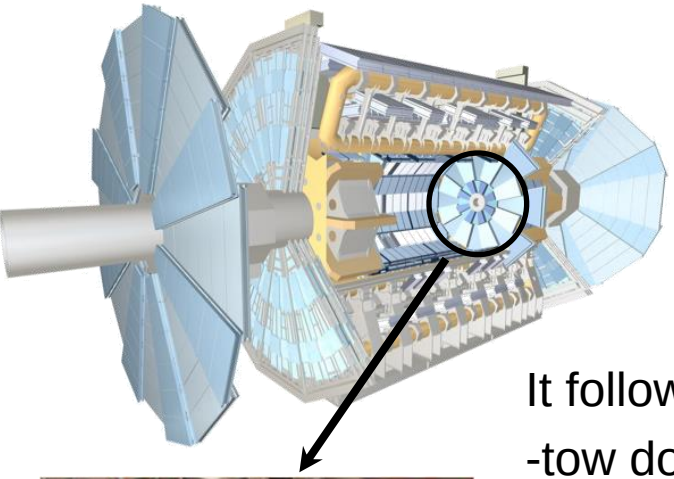
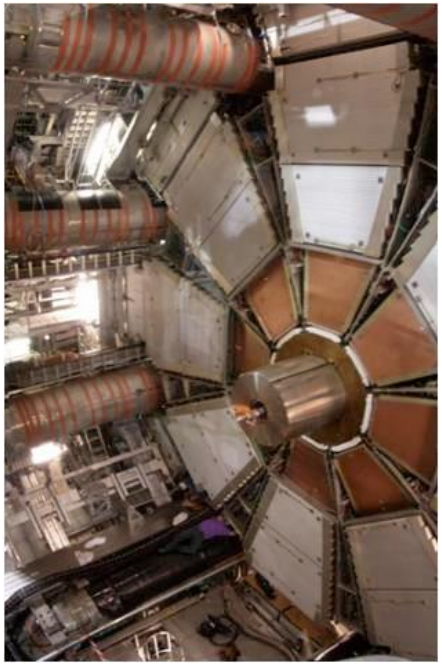
The small NSW prototype



During the NSW upgrade the first layer of the ATLAS forward muon system will be equipped with Micromegas.

A ‘small’ (120x50 cm^2) MM quadruplet prototype, under construction, will be installed on the current SW.



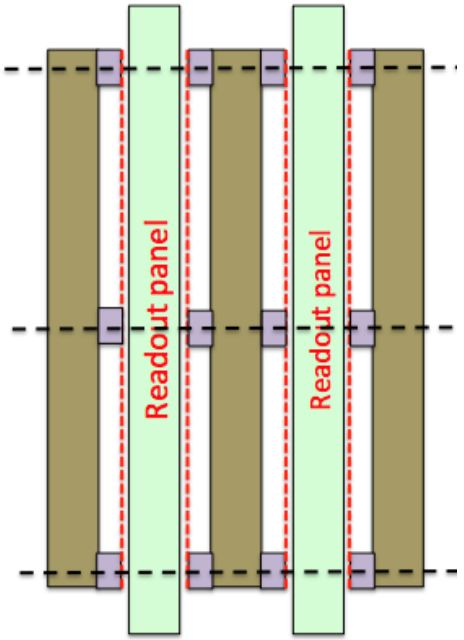
It follows the NSW MM construction baseline and consists of

-tow doublets in back-to-back configuration

- two eta & two stereo boards per quad.

-1024 strips per board (415µm pitch)

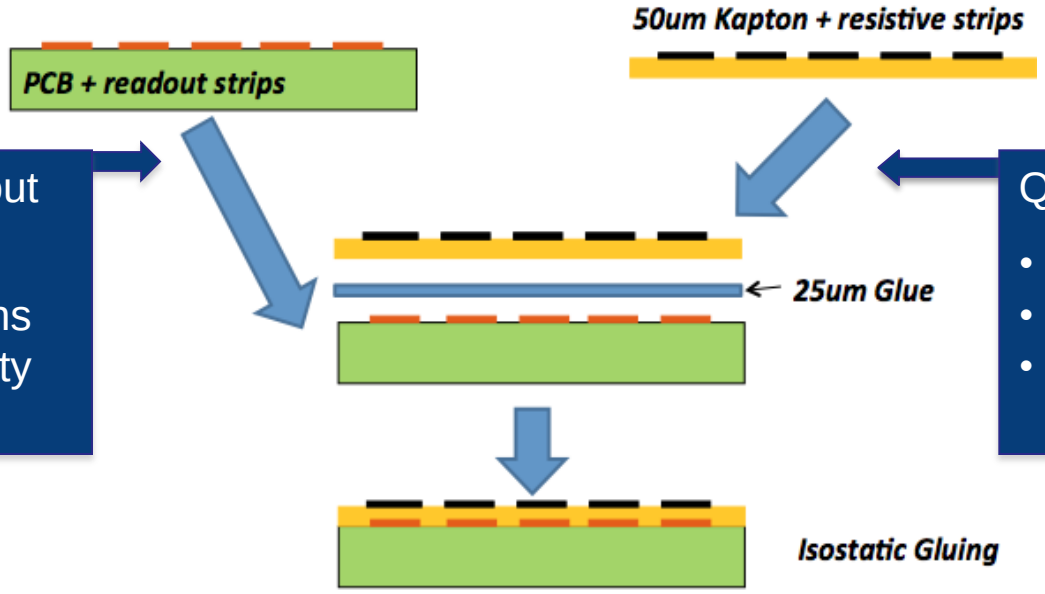
-With a total thickness <8cm, and high flatness requirements



Ideal circumstances to invent, test and improve QC tools, setups and methods.

The results of this QC run can provide vital information for supplying industries.

Steps in PCB production & QC



QC 1: PCB + readout

- board thickness
- board dimensions
- strips conductivity
- strips pattern

QC 2: resistive foil

- resistivity
- HV stability
- strips pattern, pitch, length & width

QC 3: PCB + foil

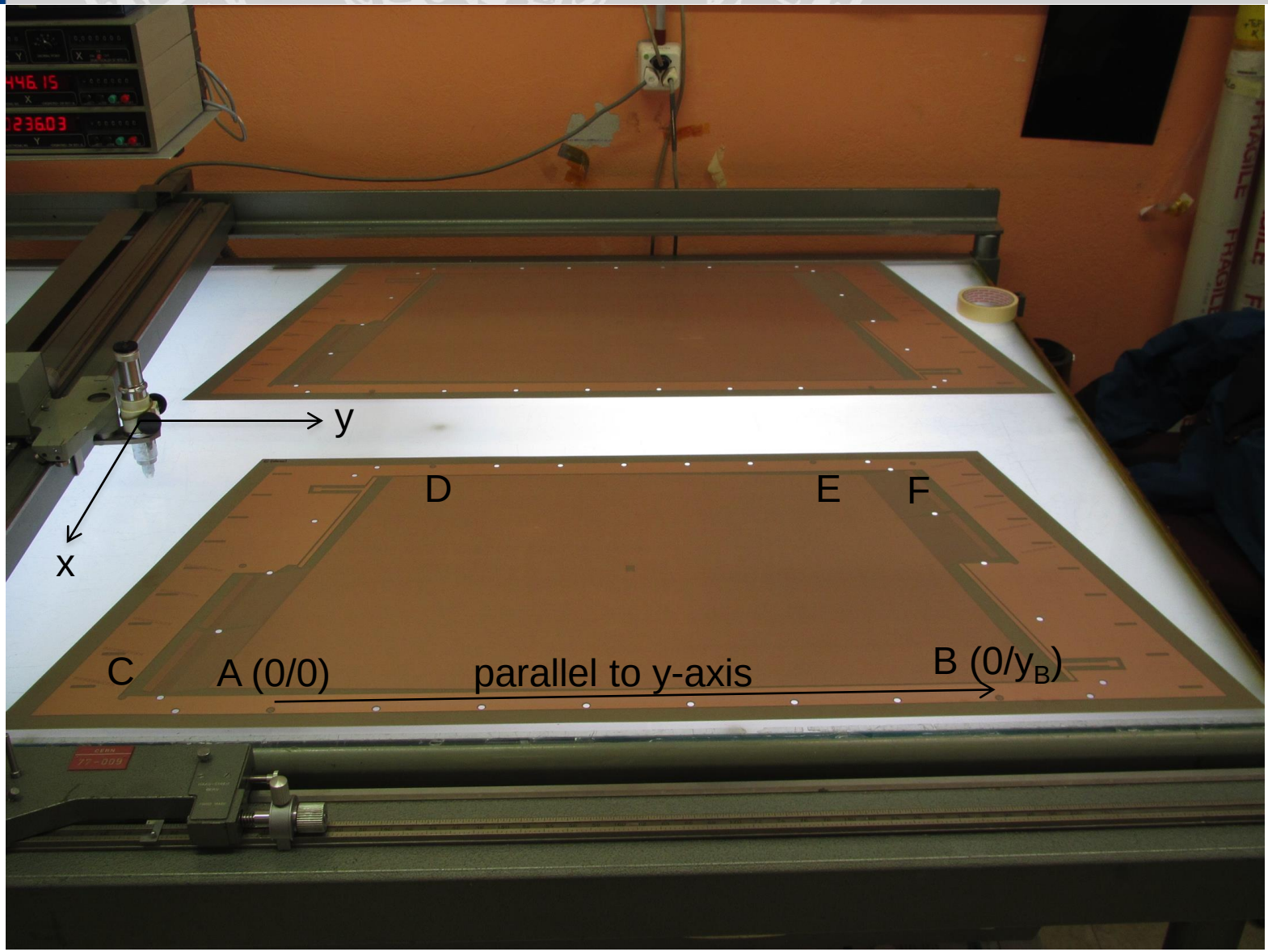
- board thickness
- HV stability
- (resistivity changes)

QC 4: finished PCB

- missing pillars
- pillar height
- HV instable spots

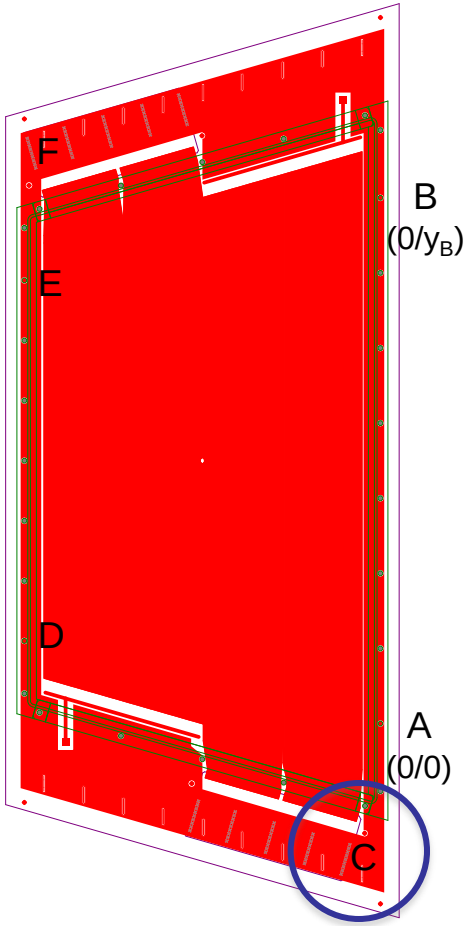
Additional: QC on panels (flatness, deformation…) and meshes during production assembles modules (gain uniformity, tightness …)

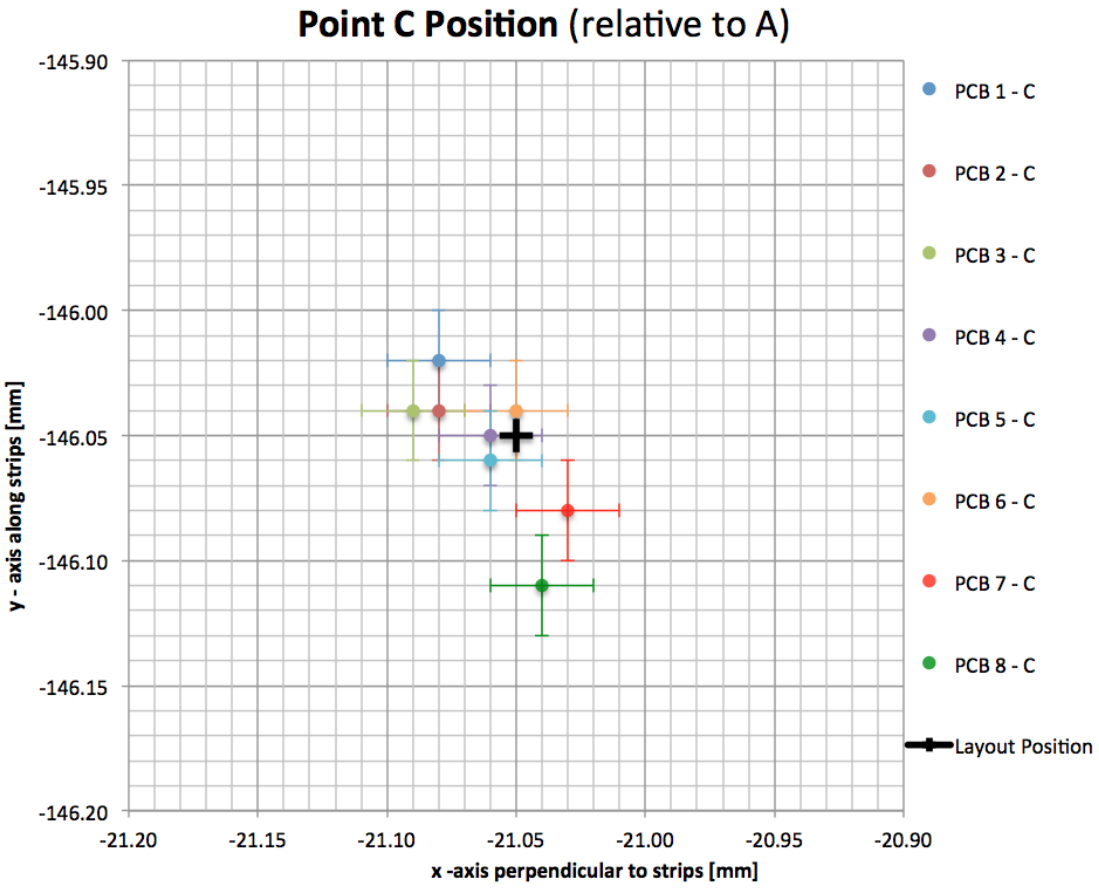
QC on PCBs



QC on PCBs

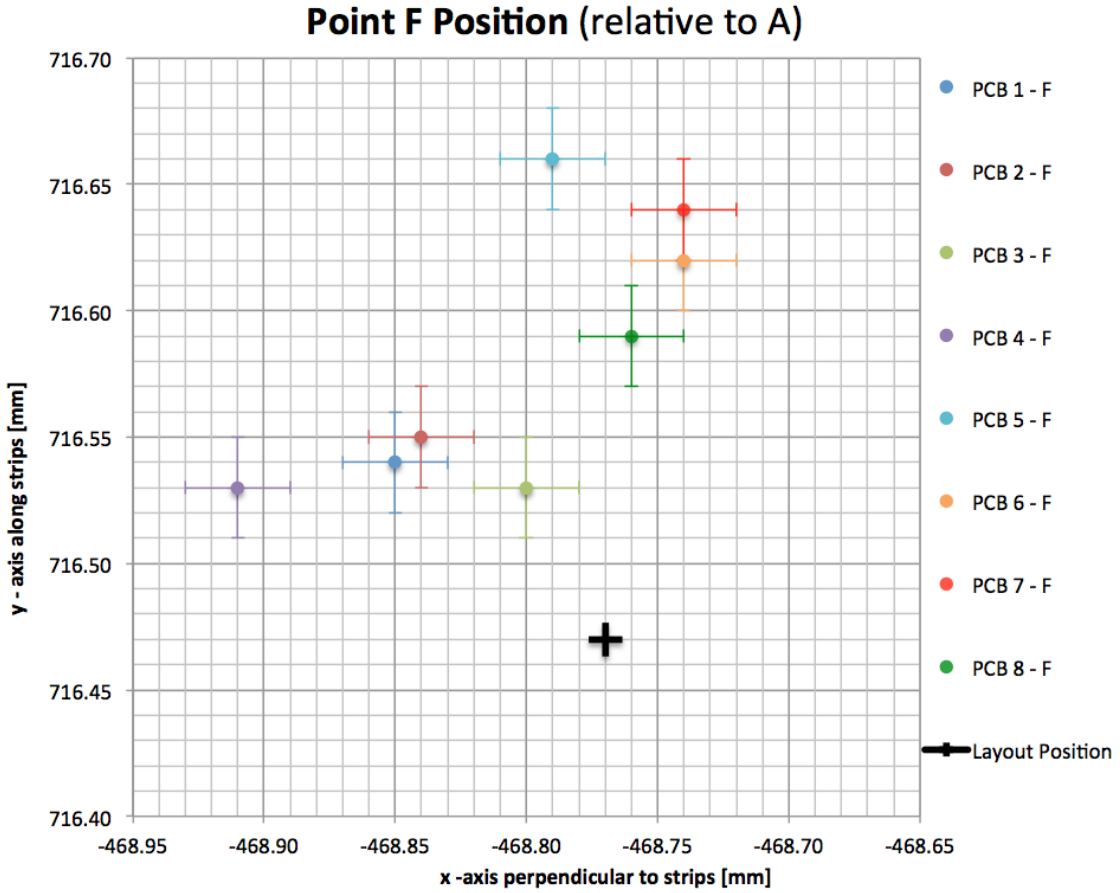
Position of precision target C:

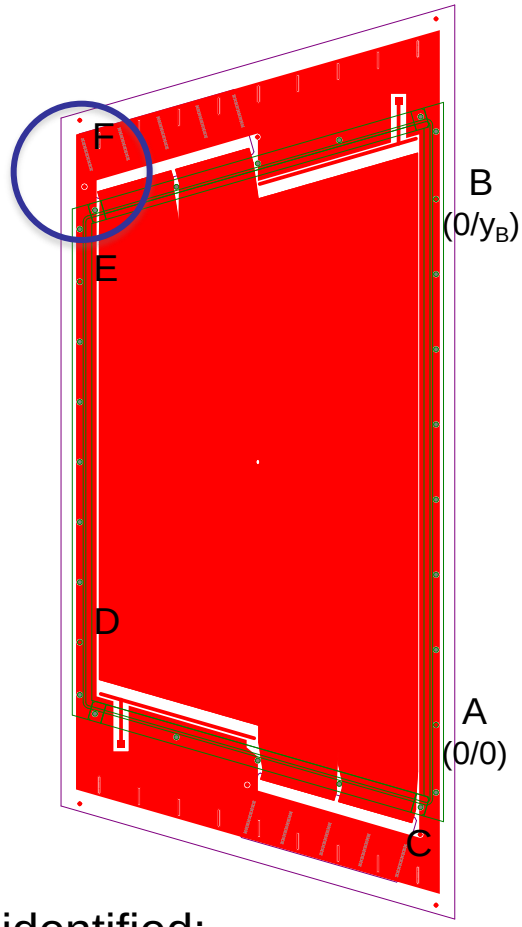




Targets in proximity to reference point A are within 50µm to layout position.

QC on PCBs

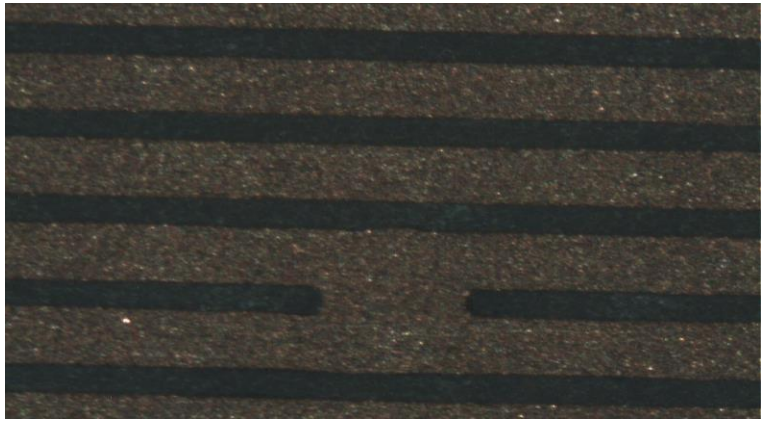




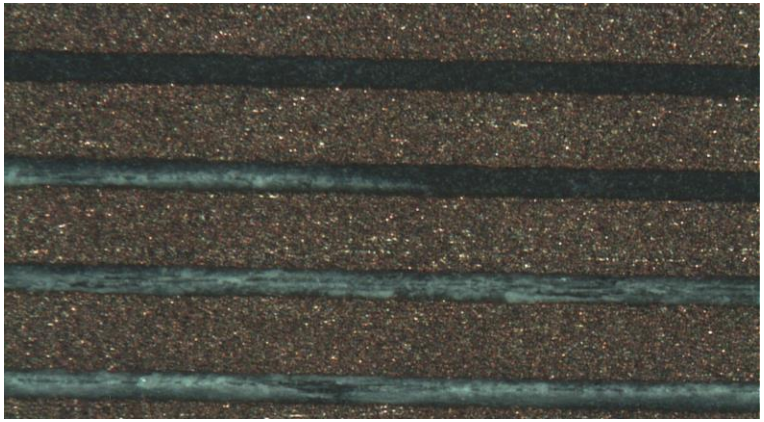
For the more distant targets two groups of point can be identified:
→PCB 1-4 (eta), PCB 5-8 (stereo): Both board types (masks) behave different
→Deviation in in the order of 0.2- 0.3‰ (200-300µm/m)

QC on PCBs

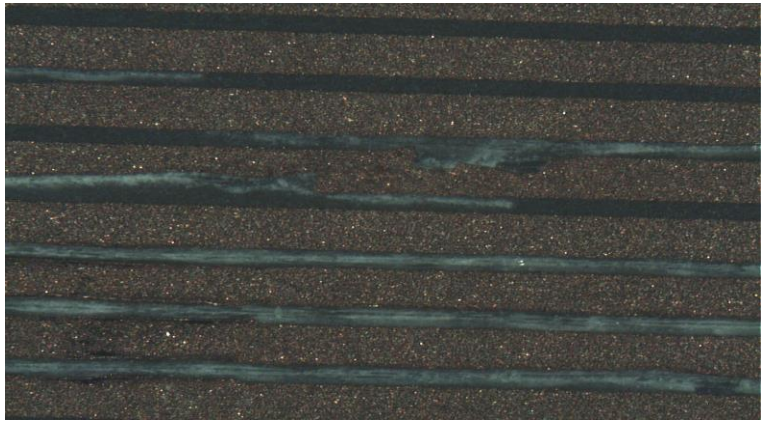
Besides systematic dimension deviations local defects on the PCBs are a QC issue:



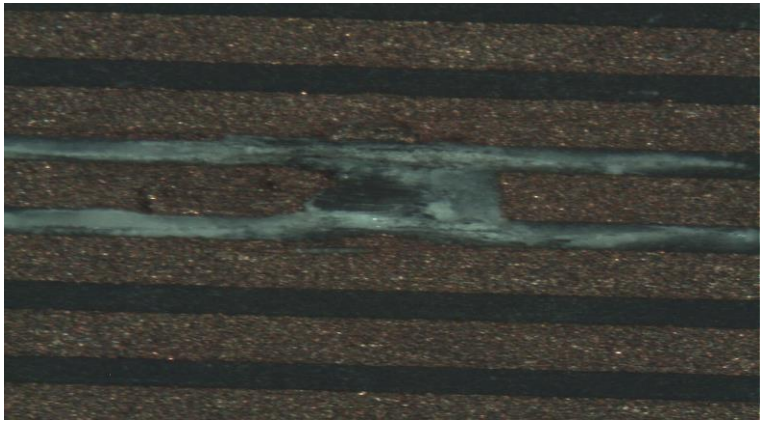
Defect: Interconnected strips



Repaired lines are straight, width variations are small



Damaged strip, huge width variation



Strip is broken → dead channel

Sub - Summary - QC on PCBs

- Systematic deviations in the order of 200 – 300µm/m are visible, pointing to a thermal expansion effect (board ~ 15-20µm/m K, mask ~ 60-70µm/m K)

- Local reproducibility (same mask, same prod. batch) is in the order of ± 50µm

→ Targets can not be used to drill alignment holes

→ Stating constrains (e.g. temperature, humidity) will be necessary to improve the board quality

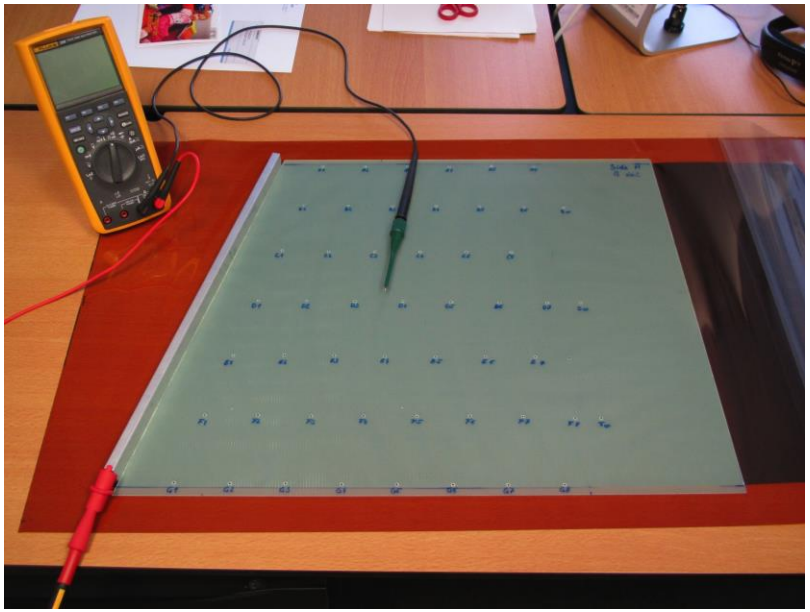
- Number of (repaired) shortcuts is already acceptable, Quality of repair was very well in average, one dead channel in 8 boards observed

→ Experience and classified pictures can be used to set up constraints

QC on resistive foils

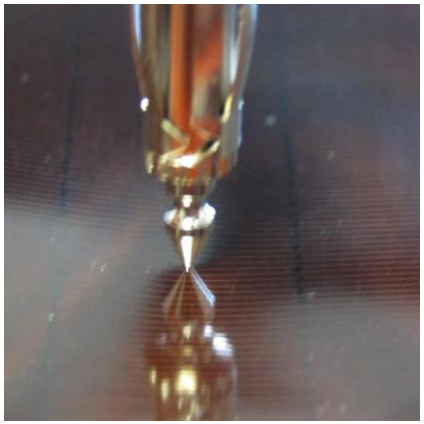
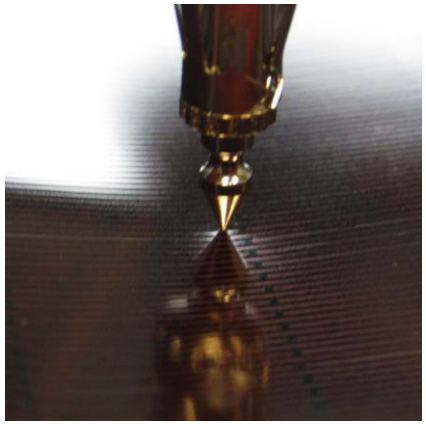
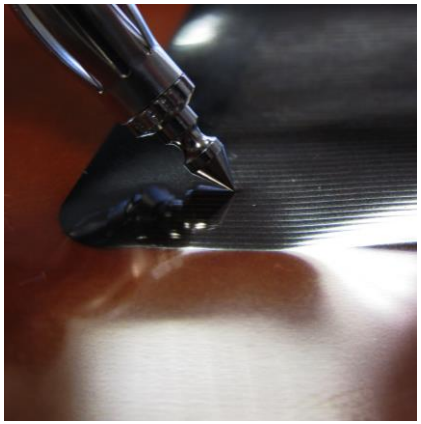
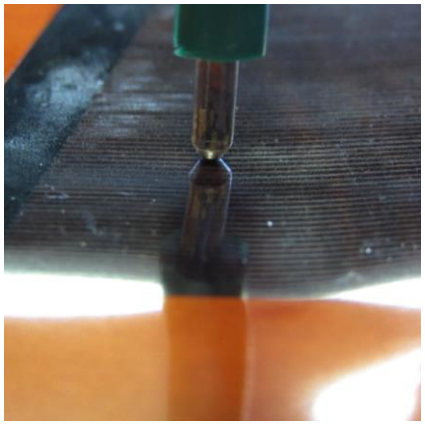
Very preliminary / improvised setup to map the resistivity of the Kapton foils produced with sputtering, addresses:

- in homogeneities / systematics
- nominal values (stated by producer)
- comparability of the foils



Main problem in this simple setup:

Position and contact shape of the sensor tip is not best suited for the measurement

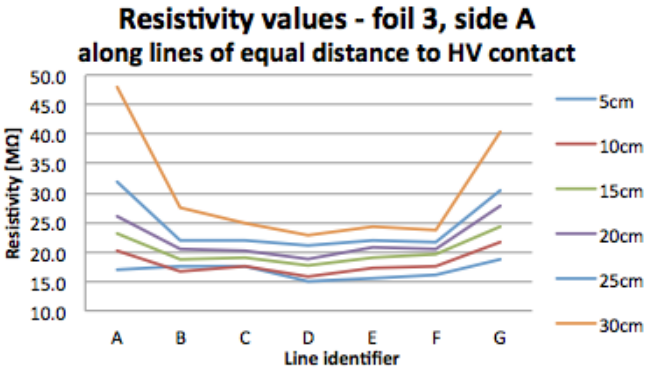





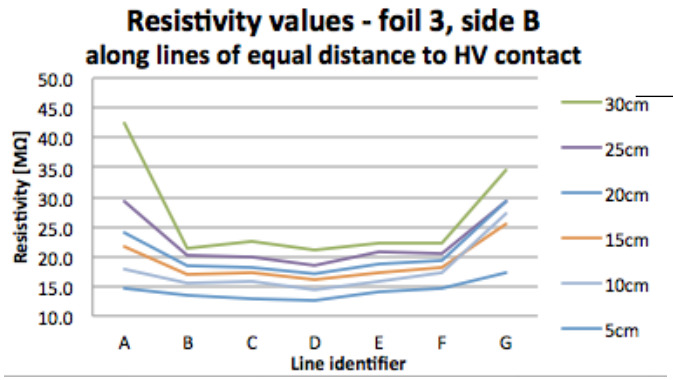
QC on resistive foils

HV connector

Foil 3 Side A

	1 5cm	2 10cm	3 15cm	4 20cm	5 25cm	6 30cm	7 35cm	8 40cm
A	16.9	20.1	23.2	26.1	31.9	48.1		
B	17.5	16.7	18.8	20.4	22.1	27.5		
C	17.7	17.5	18.9	20.2	22.1	24.9		
D	15.0	15.8	17.7	18.8	21.1	22.8	29	
E	15.6	17.4	19.1	20.7	21.9	24.2	26.9	
F	16.0	17.7	19.5	20.4	21.8	23.7	26.2	44.7
G	18.7	21.6	24.2	27.9	30.5	40.3	40.3	46.8



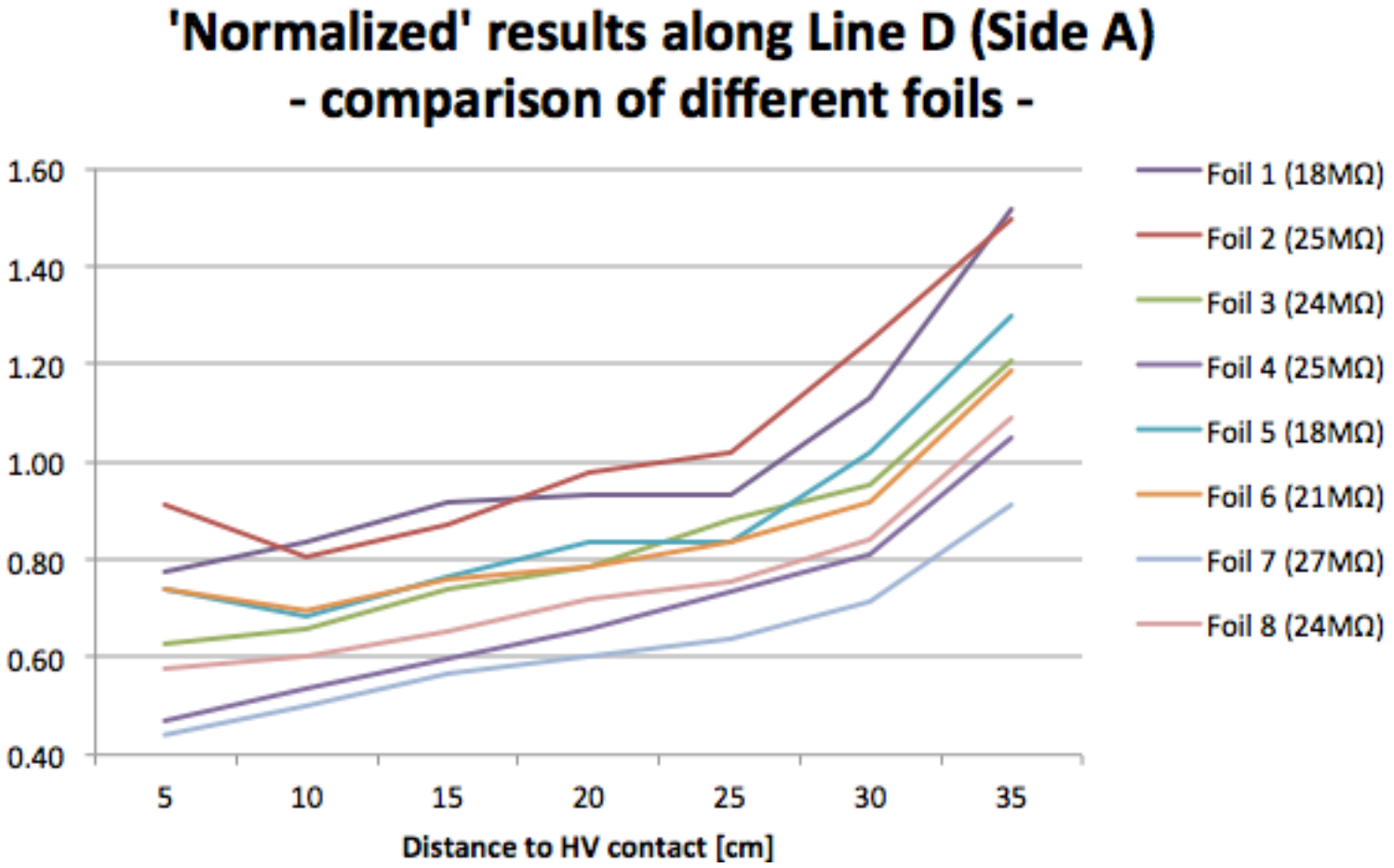


Foil 3 Side B

	8 40cm	7 35cm	6 30cm	5 25cm	4 20cm	3 15cm	2 10cm	1 5cm
A			42.4	29.2	24.0	21.7	17.8	14.6
B			21.4	20.3	18.4	17	15.5	13.4
C			22.5	20.0	18.3	17.2	15.7	13
D		26.6	21.1	18.5	17.1	16	14.4	12.6
E		25.7	22.3	20.7	18.8	17.4	15.9	14
F	37.7	25.0	22.4	20.6	19.3	18.1	17.2	14.6
G	45.2	39.2	34.6	29.2	29.3	25.6	27.1	17.2

HV connector

QC on resistive foils



'Normalized' by dividing the measured resistivity values [MΩ] by the nominal resistivity value per length [MΩ/cm], as stated by Atsuhiko.

These values should be only geometry/position dependent!

Sub - Summary - QC on Foils

- Overall resistivity variations are acceptable!
- The resistivity pattern is as expected (according to PSpice simulations)
- Some local problems with the pattern (optically) and the attachment of the Carbon layer to the Kapton have been observed

→ Reported to producer

QC on pre-streched meshes

Problem with the mesh tension:

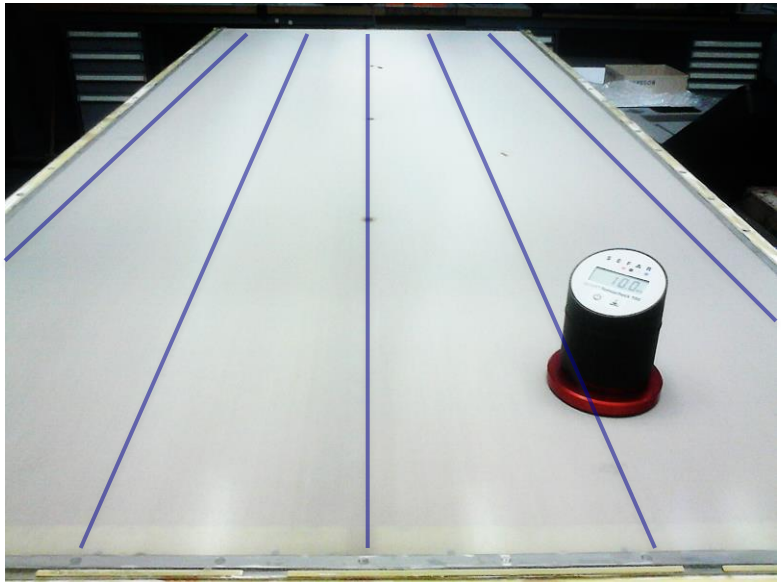
-To low tension results in ‘unflatness’ and sagging due to electrostatic forces

→Not uniform amplification gap

-High tension leads to deformation of the panels

→Different size of the drift gap

→Introduces error in the strip position



Auflösung Resolution Résolution Resolución	< 30 N/cm > 30 N/cm	= 0.2 N/cm = 0.5 N/cm
Messbereich/Toleranz (N/cm) Measuring range/Tolerance (N/cm) Plage de mesure/Tolérance (N/cm) Campo de medida/Tolerancia (N/cm)	3 - 19.8 N/cm 20 - 29.8 N/cm 30 - 39.5 N/cm 40 - 50 N/cm	= +/- 0.4 N/cm = +/- 0.6 N/cm = +/- 1.0 N/cm = +/- 1.5 N/cm

QC on pre-streched meshes

Tension map of Mesh 1 (measurement points every 20x20 cm)

Dez 2013

Mesh 1

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	21.0	18.2	16.0	19.0	21.4
25	16.6	15.2	12.6	15.6	17.2
45	10.2	10.6	9.2	11.2	12.6
65	8.0	9.0	7.8	8.8	8.8
85	7.2	7.8	7.0	7.8	7.4
105	7.0	8.2	7.4	8.0	8.6
125	17.4	16.0	12.8	15.2	17.8
	6.0	15.0	24.0		

QC on pre-streched meshes

Mesh 1

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	21.0	18.2	16.0	19.0	21.4
25	16.6	15.2	12.6	15.6	17.2
45	10.2	10.6	9.2	11.2	12.6
65	8.0	9.0	7.8	8.8	8.8
85	7.2	7.8	7.0	7.8	7.4
105	7.0	8.2	7.4	8.0	8.6
125	17.4	16.0	12.8	15.2	17.8
	6.0	15.0	24.0		

Mesh 2

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	17.8	14.4	13.6	15.4	18.0
25	12.2	11.2	10.6	11.8	13.0
45	15.2	13.4	12.8	15.0	16.4
65	12.6	10.2	10.4	11.8	13.0
85	12.6	10.8	10.2	11.6	13.0
105	16.0	14.4	13.2	15.2	17.8
125	14.4	16.0	15.4	17.4	21.1
	6.0	15.0	24.0		

Mesh 3

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	20.2	18.2	15.0	16.6	18.8
25	18.4	17.6	14.8	15.8	17.8
45	15.6	15.8	12.8	13.8	16.0
65	15.0	13.8	11.8	12.4	14.6
85	12.6	10.8	10.0	10.2	11.0
105	6.4	8.0	7.2	7.2	7.8
125	14.4	13.2	10.4	10.4	13.6
	6.0	15.0	24.0		

Mesh 4

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	17.0	14.4	11.8	13.4	17.0
25	16.4	14.6	12.4	13.4	15.4
45	14.8	13.8	11.2	12.8	14.8
65	14.6	13.8	10.8	12.0	14.0
85	13.4	12.6	9.8	10.6	12.0
105	9.2	10.2	8.6	8.8	10.0
125	11.6	10.8	8.4	8.8	10.2
	6.0	15.0	24.0		

Mesh 5

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	17.4	15.8	14.6	13.8	17.8
25	15.4	14.2	13.2	12.4	15.2
45	13.4	12.6	12.0	11.6	14.0
65	14.0	13.2	12.8	11.8	14.2
85	12.8	12.2	11.8	10.6	13.2
105	9.4	9.4	9.6	8.6	10.0
125	11.2	10.4	9.8	8.2	11.4
	6.0	15.0	24.0		

Mesh 6

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	19.0	15.8	13.6	14.8	18.0
25	16.6	15.2	12.4	13.6	15.8
45	14.4	14.4	11.6	13.0	14.8
65	16.2	15.2	11.4	12.4	15.0
85	16.2	16.0	11.8	12.8	15.0
105	14.8	16.6	11.6	13.0	15.4
125	18.6	20.2	14.2	16.0	19.6
	6.0	15.0	24.0		

Mesh 7

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	18.2	15.4	14.4	13.0	17.8
25	14.4	12.6	11.8	11.0	14.2
45	11.4	10.6	10.2	9.6	11.8
65	14.4	12.6	11.8	10.6	13.6
85	12.4	11.2	10.8	9.6	12.2
105	11.2	10.4	10.4	9.2	11.6
125	13.8	12.4	11.4	10.0	13.6
	6.0	15.0	24.0		

Mesh 8

	left	mid-left	center	mid-right	right
	5 cm	25 cm	45 cm	65 cm	85 cm
5	22.8	18.6	16.6	19.4	23.6
25	19.2	16.6	15.0	17.8	20.0
45	14.4	12.4	11.2	14.2	16.4
65	14.0	12.2	10.4	13.2	14.8
85	14.6	12.6	10.8	13.6	15.4
105	12.8	12.6	10.2	13.0	15.2
125	16.8	16.0	12.0	16.4	19.4
	6.0	15.0	24.0		

QC on pre-streched meshes

Tension map of Mesh 1 (measurement points every 20x20 cm)

Dez 2013

Mesh 1

	left 5 cm	mid-left 25 cm	center 45 cm	mid-right 65 cm	right 85 cm
5	21.0	18.2	16.0	19.0	21.4
25	16.6	15.2	12.6	15.6	17.2
45	10.2	10.6	9.2	11.2	12.6
65	8.0	9.0	7.8	8.8	8.8
85	7.2	7.8	7.0	7.8	7.4
105	7.0	8.2	7.4	8.0	8.6
125	17.4	16.0	12.8	15.2	17.8
	6.0	15.0	24.0		

Jan 2014

Mesh 1

	left 5 cm	mid-left 25 cm	center 45 cm	mid-right 65 cm	right 85 cm
5	22.0	18.0	16.2	19.0	22.0
25	16.6	14.8	13.2	15.6	17.8
45	10.8	11.0	9.6	11.6	12.4
65	8.6	9.0	7.8	9.0	8.8
85	7.6	8.0	7.2	8.0	7.8
105	7.8	8.6	7.8	8.8	8.6
125	18.2	16.2	13.2	15.8	18.6
	6.0	15.0	24.0		

Difference

Mesh 1

	left 5 cm	mid-left 25 cm	center 45 cm	mid-right 65 cm	right 85 cm
5	1.0	-0.2	0.2	0.0	0.6
25	0.0	-0.4	0.6	0.0	0.6
45	0.6	0.4	0.4	0.4	-0.2
65	0.6	0.0	0.0	0.2	0.0
85	0.4	0.2	0.2	0.2	0.4
105	0.8	0.4	0.4	0.8	0.0
125	0.8	0.2	0.4	0.6	0.8
	-2.0	0.0	2.0		

Sub - Summary - QC on meshes

- Mesh tension varies between 6 and 20 N/cm, for 10 N/cm nominal value

→ Systematic hints to problems during industrial mesh stretching
→ Feedback to industries in ongoing
- No tension loss over 8 weeks has been observed (good glue!)

- Small increase of tension can be explained due to different expansion behavior of the stainless steel and the aluminum frame

Summary & Outlook

- Components of the prototype have been used to identify QC items and test first measurement methods to collect experience.

- Feedback to industries could be given, improvement in production methods is in progress

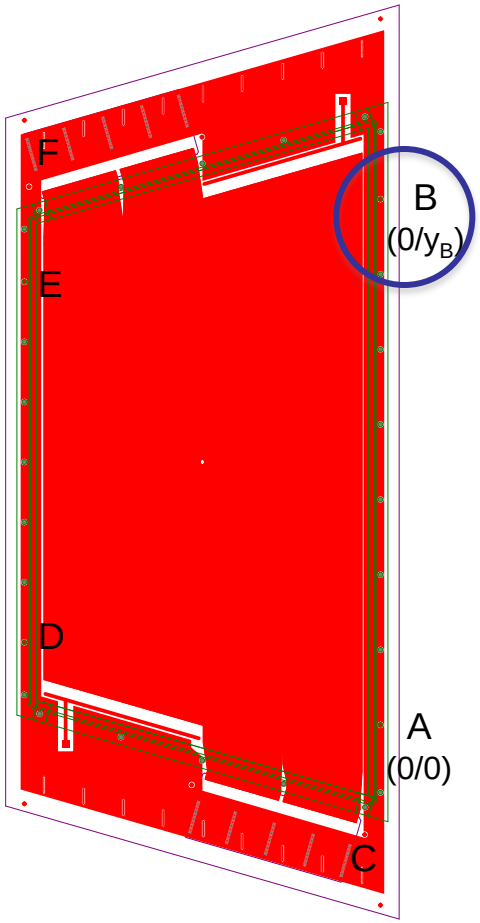
- QC will go on with the upcoming steps:
  - finished PCB's with pillars (under production)
  - panels (dummy finished, functional panels under construction)
  - fully assembled quadruplet
  - etc.

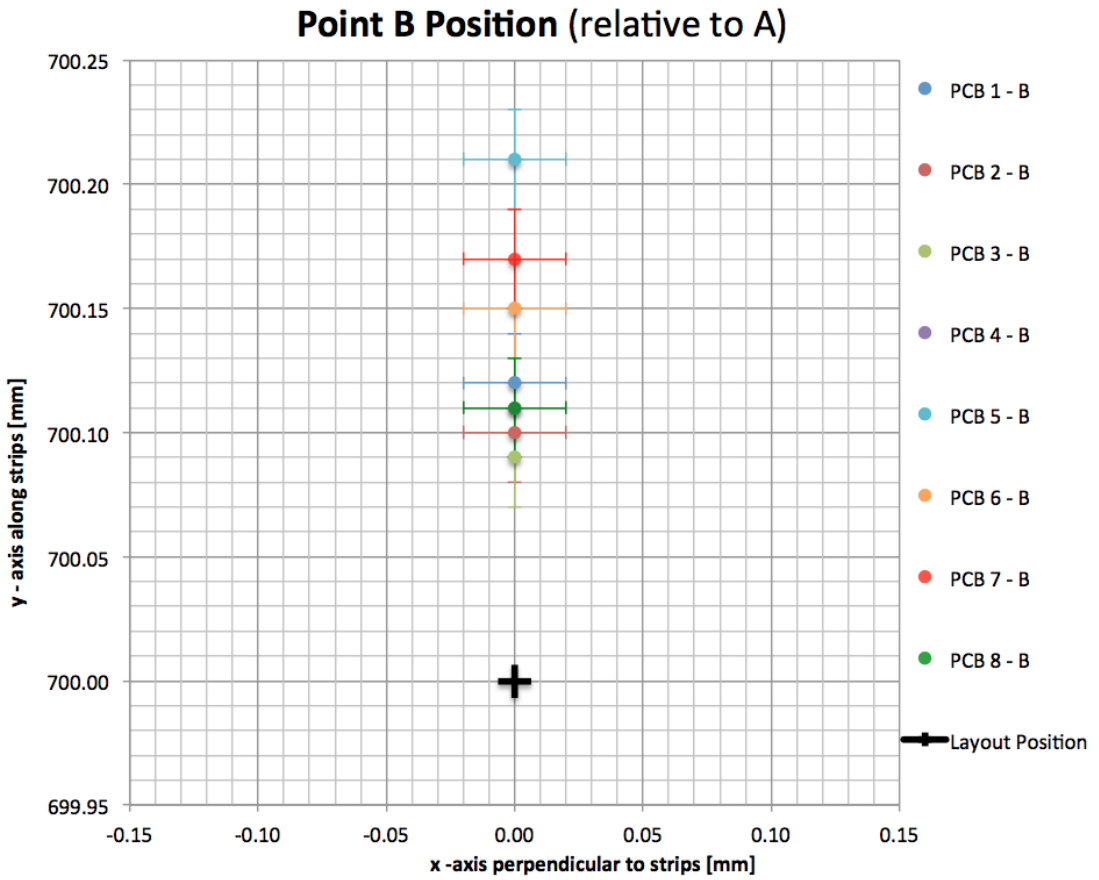
- Tools for the QC will be improved and full size 'prototype setups' shall be ready before module0 production in end summer / begin autumn

Thank you for your attention!

QC on PCBs

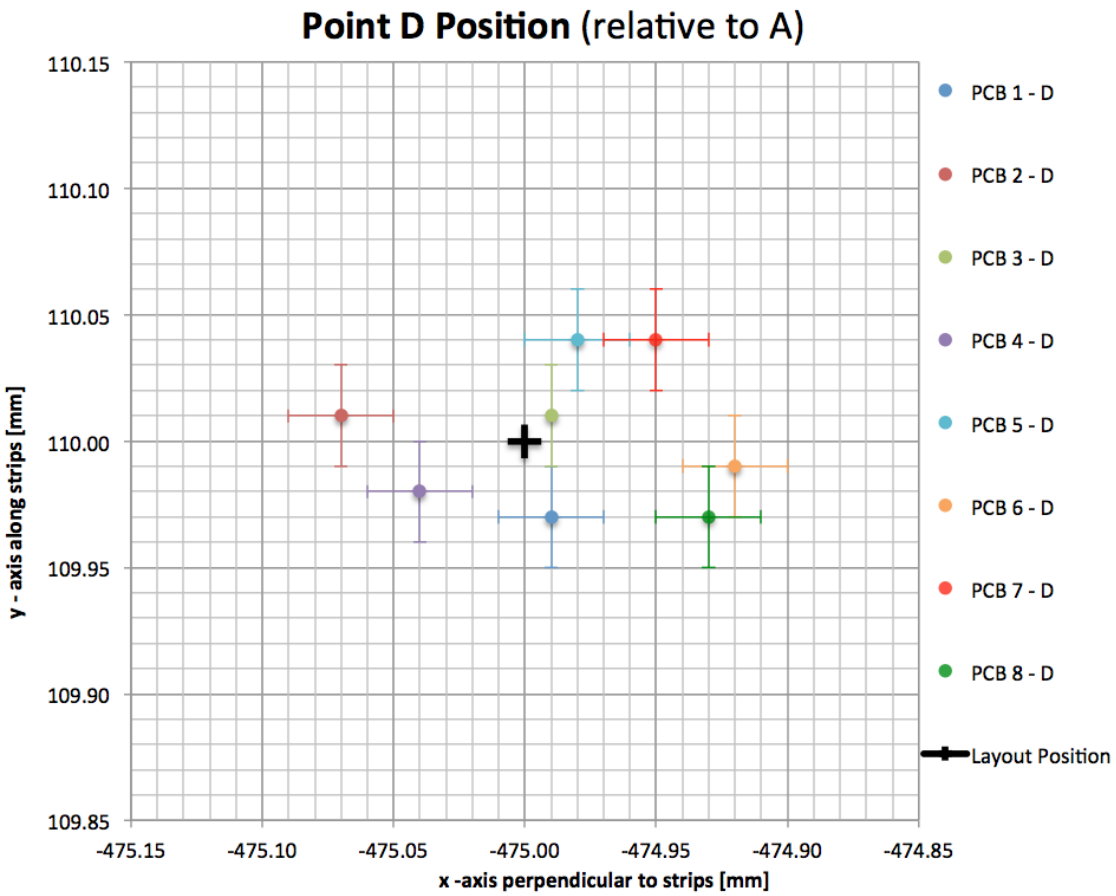
Position of precision target B (0, y_B):

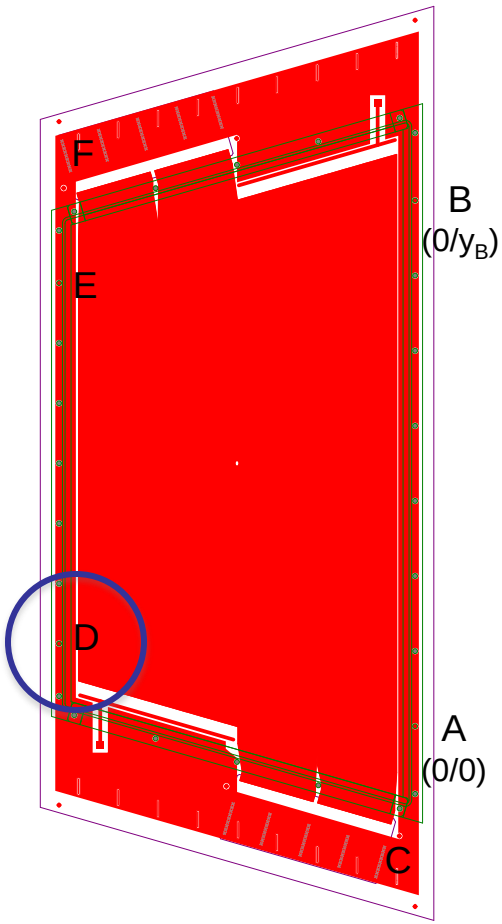




Hints to a systematic deviation in y direction: order of 200µm over 700mm → 0,3‰

QC- PCB – Positioning of D





QC- PCB – Positioning of E