MEASUREMENTS ON PRINTED RESISTIVE STRIPS

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SUMMARY

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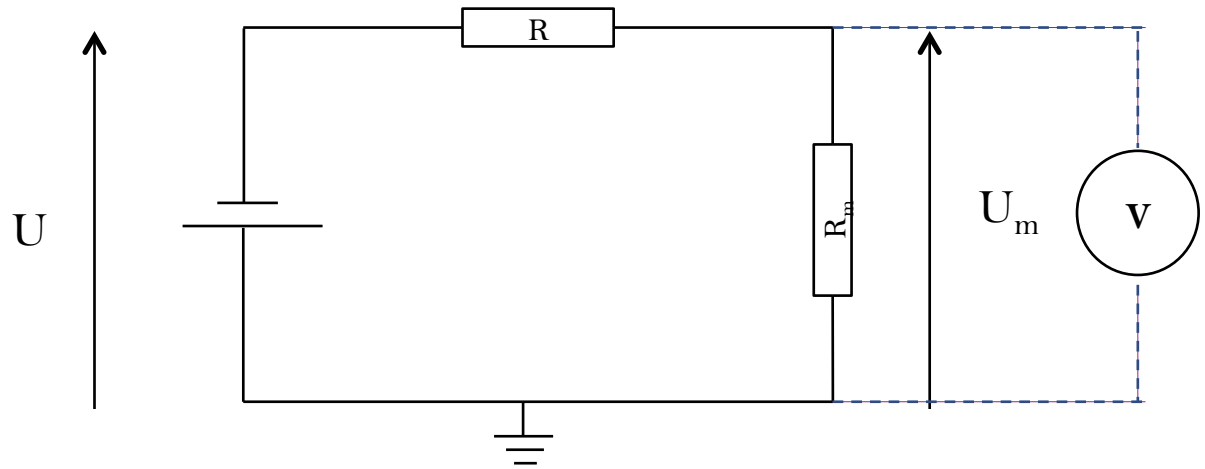
CONTEXT

- Resistive strips samples to validate:
  - Manufacturing process
  - Homogeneity of strip width, strip gap, strip resistance/resistivity
- Samples from:
  - Elvia / Bree
  - Cern / Charbonney
- Same resistive ink: 100 kΩ/□
- Measurements:
  - Geometry with a microscope (Mitutoyo)
  - Resistivity → voltage measurement through a divider bridge

RESISTIVITY MEASUREMENT METHOD

- Divider bridge: R=109,8 MΩ and U=10 V
- $U_m \rightarrow R_m$

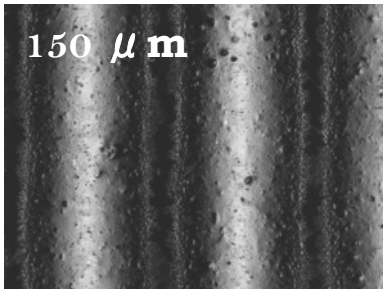


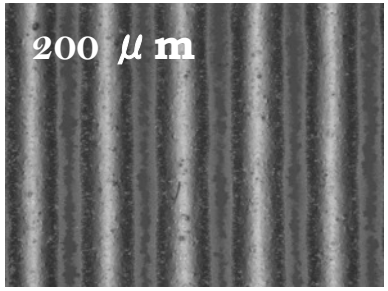
$$R_m = (U_m R) / (U-U_m)$$

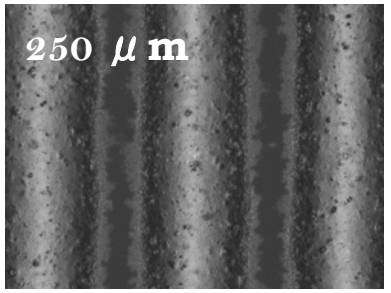
Elvia (Bree)

1ST TRY

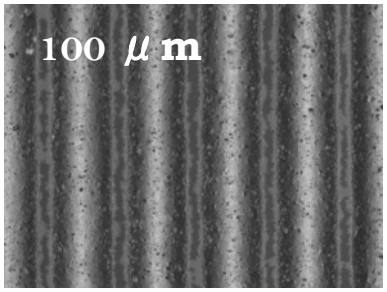
- Pitch: 500 µm
- Length: 30 cm
- 2 boards
- Cylindrical shape ~30 µm

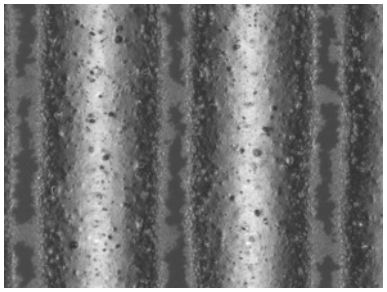


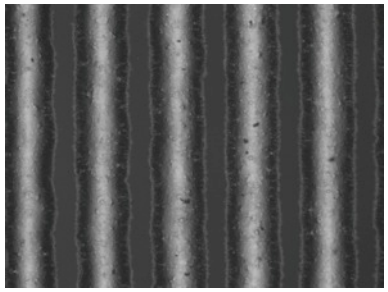


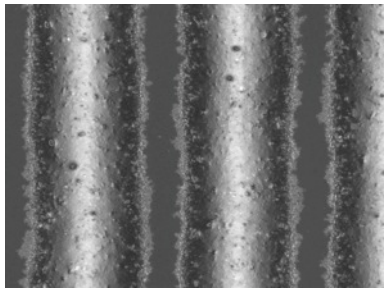


Board 1

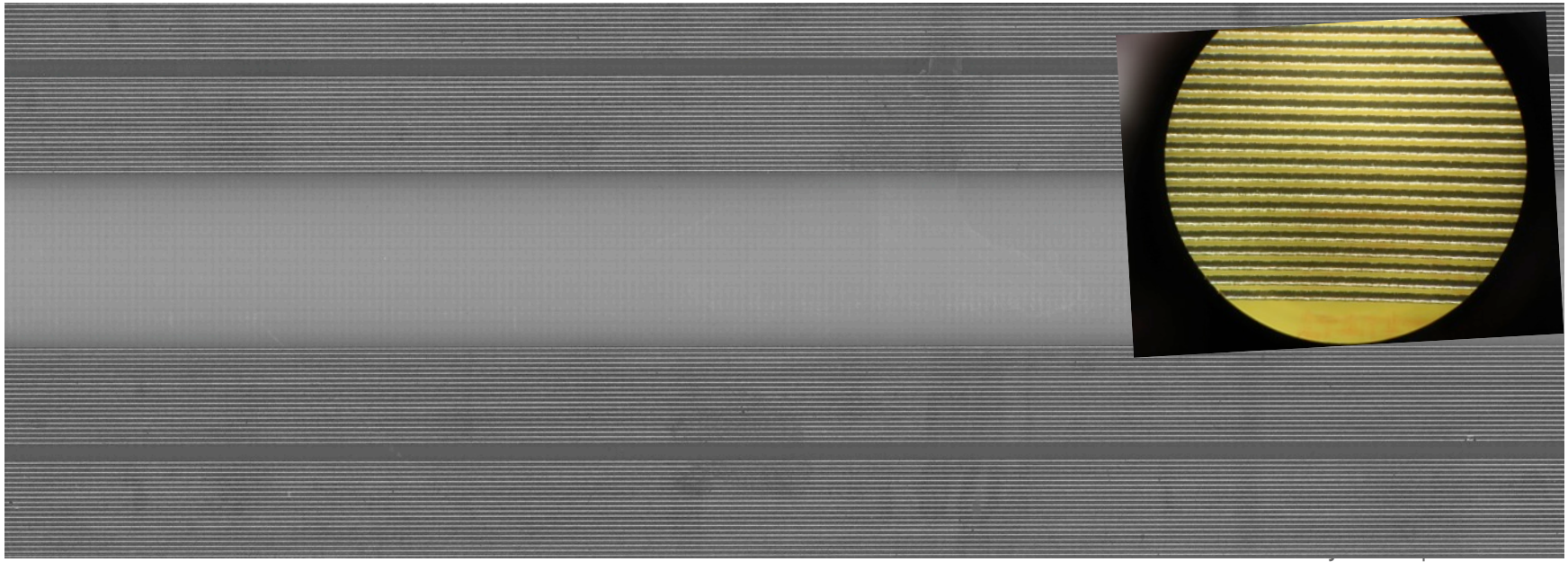




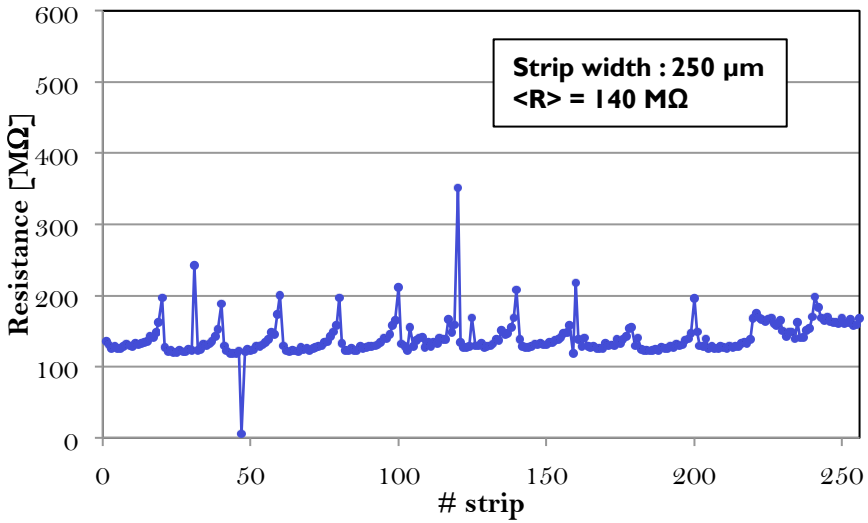


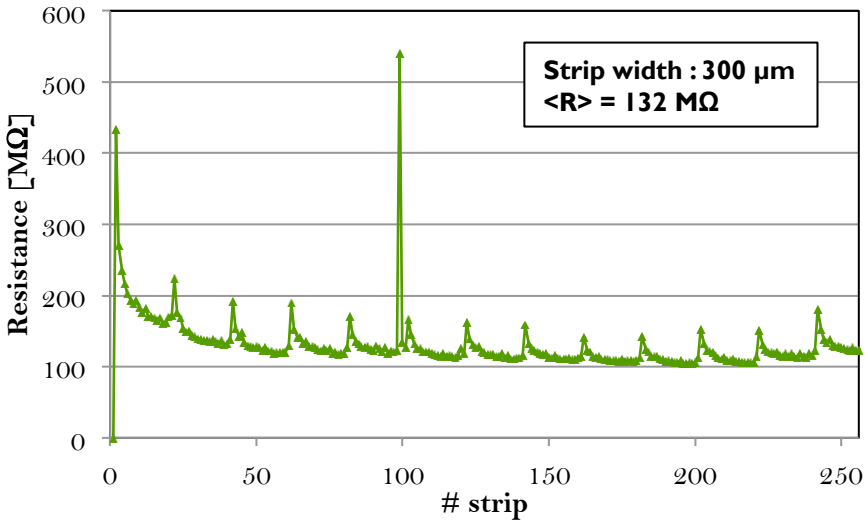


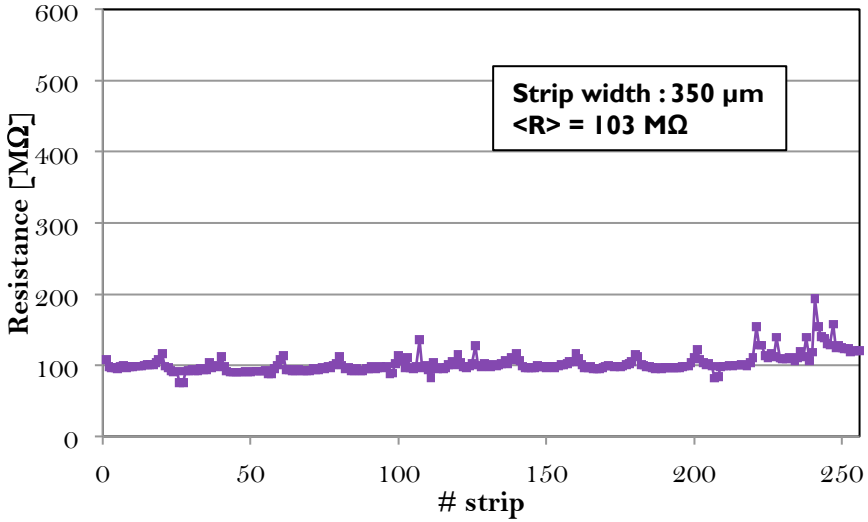
Board 2

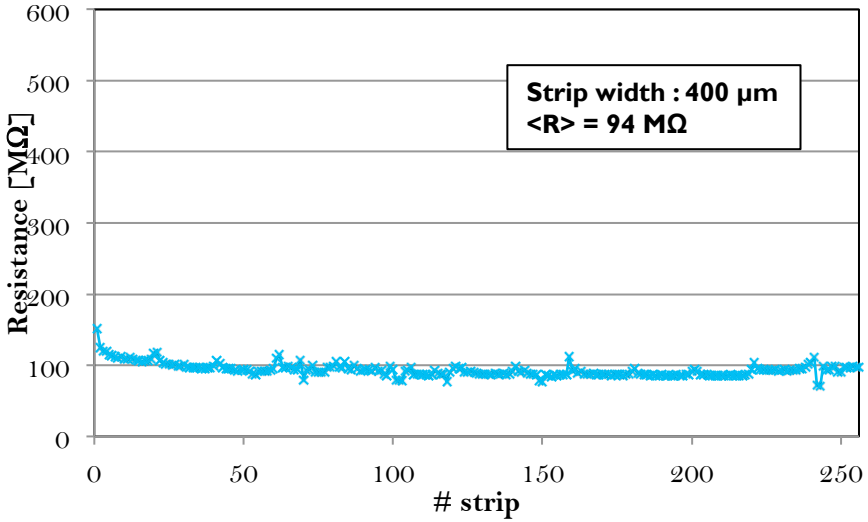


RESISTANCE MEASUREMENTS (1)



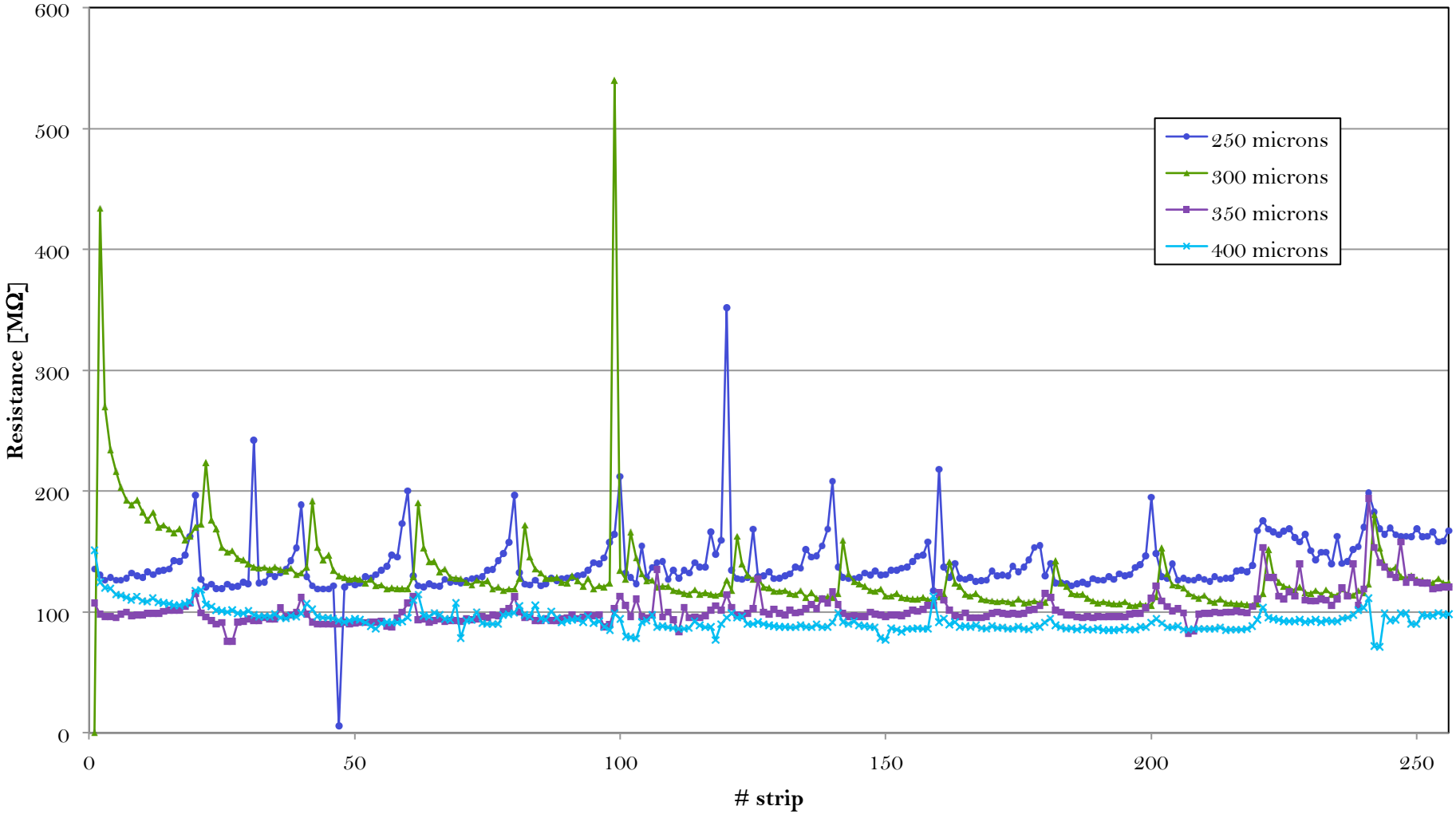






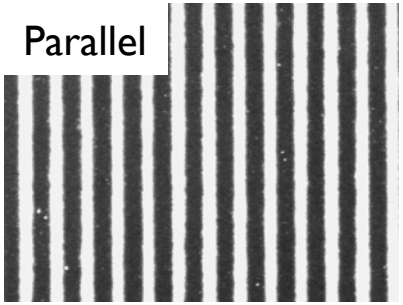
RESISTANCE MEASUREMENTS (2)

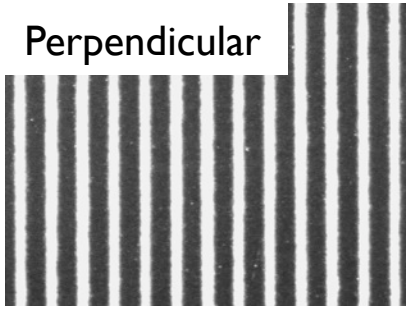
- Resistance measurement with divider bridge for all strips
- Strip length : 30 cm

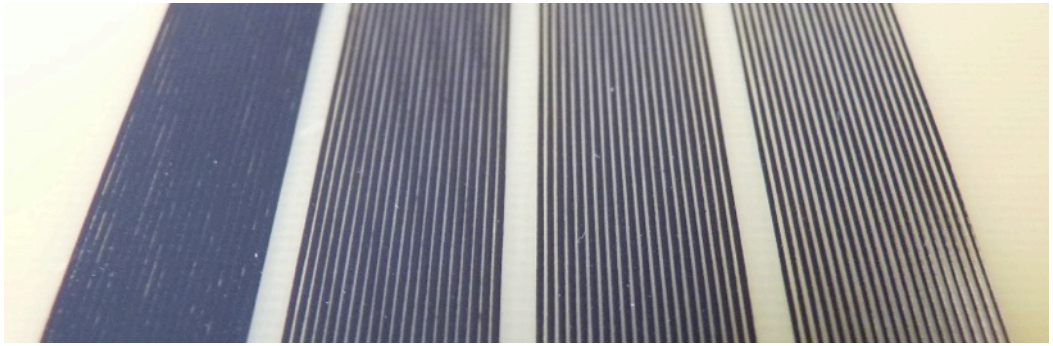


2ND TRY

- Pitch: 500 µm
- Strip length:
  - Parallel → 30 cm
  - Perpendicular → 10 cm



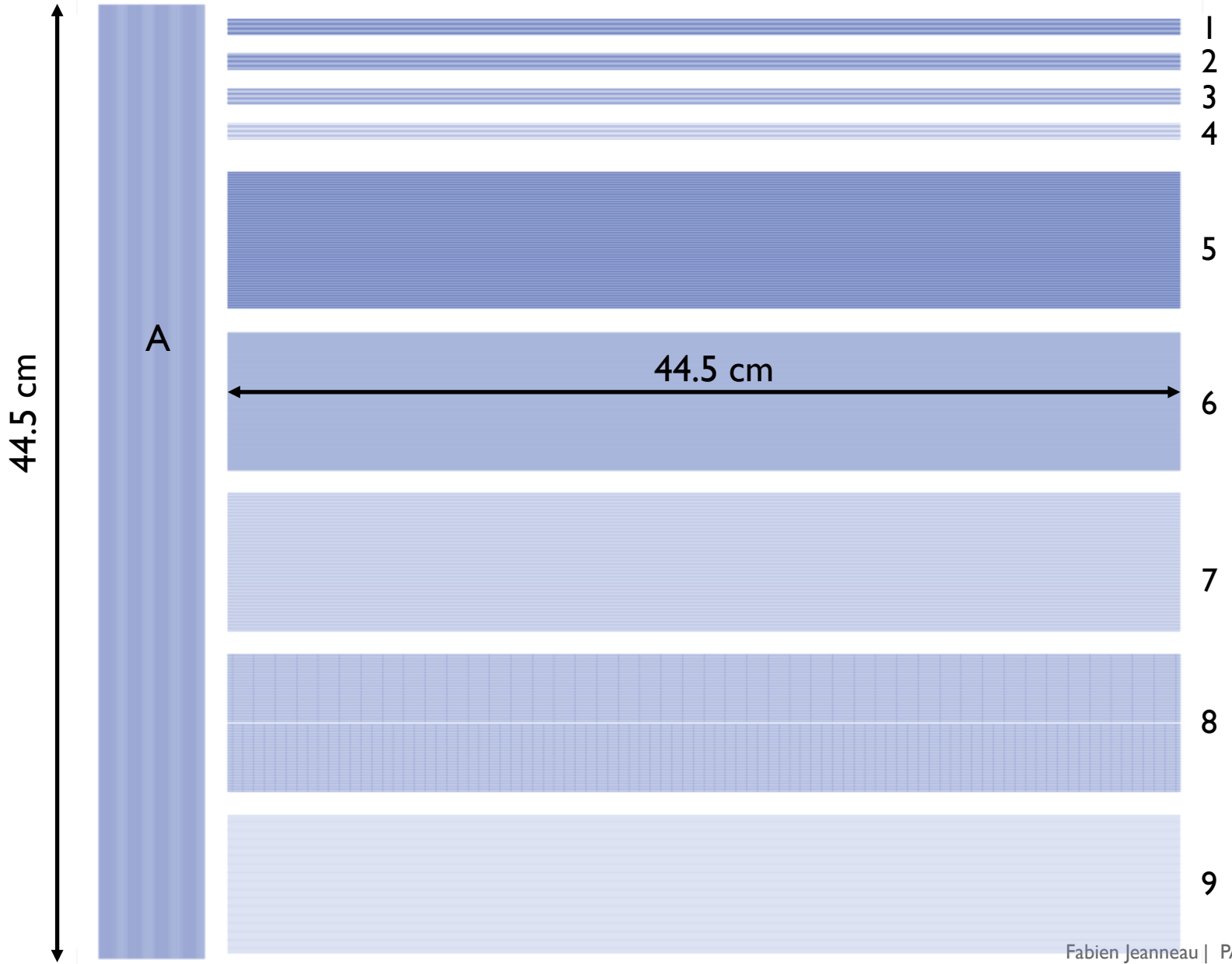




pitch=500 µm	Strip width / Strip gap (µm)			
Mask	250/250	300/200	350/150	400/100
1 pass, along the strips	350/150	380/120	Contact	Contact
1 pass, across the strips	350/150	380/120	Contact	Contact
2 passes, along the strips	380/120	400/100	Contact	Contact
2 passes, across the strips	400/100	430/70	Contact	Contact

Cern (Charbonney)

PRINTING MASK (CERN)



PRINTING MASK:VALUES

									Ladders		
Board "160"	**Group**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**
	Pitch	650	650	650	650	900	500	300	360	235	540
	Strip width	490	450	350	250	740	340	140	200	75	380
	Strip gap	**160**	200	300	400	**160**	**160**	**160**	**160**	**160**	**160**

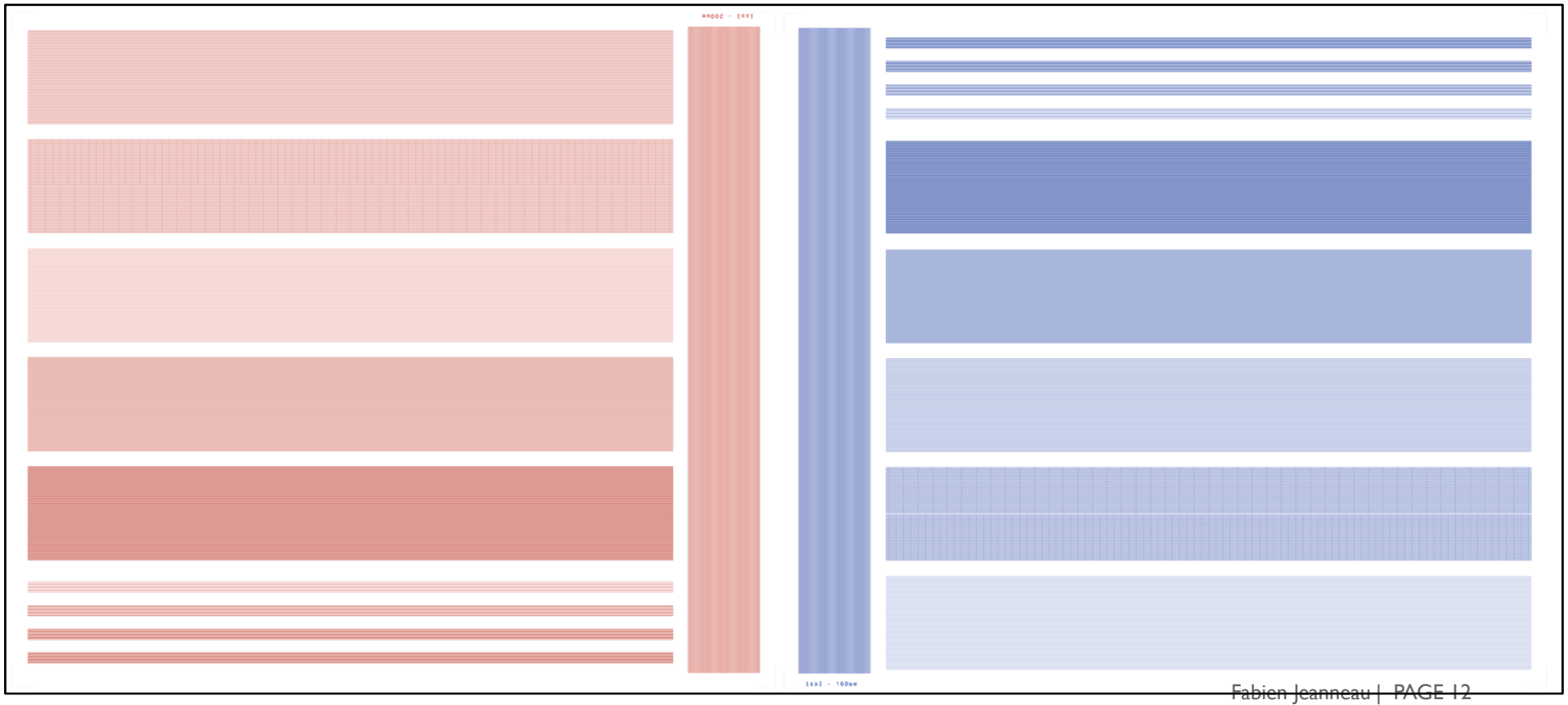
									Ladders		
Board "200"	**Group**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**
	Pitch	650	650	650	650	900	500	300	400	400	540
	Strip width	490	450	350	250	700	300	100	200	200	340
	Strip gap	160	**200**	300	400	**200**	**200**	**200**	**200**	**200**	**200**

SERIGRAPHY BY CHARBONNEY

- One single FR4 board: 500x1000 mm^2, thickness 200 µm
- Screen thickness: 18-20 µm
- Resistive ink: 100 kΩ/□

Scrapping direction

Board "200" PCB Board "160"



RESISTANCE/RESISTIVITY – BOARD "160"

- Strip resistance measurements with divider bridge (12 samples): **[Mask][Measure]**
- Strip length: 44.5 cm

Resistance (MΩ)

Pitch	900	209 ± 31	650	345 ± 54	650	410 ± 71	650	560 ± 60	650	754 ± 37
Strip width	740		490		450		350		250	
Strip gap	160		160		200		300		400	

Pitch	540	569 ± 73	500	742 ± 120	360	To do (ladders)	300	841 ± 115	235	Dashed strips
Strip width	380		340		200		140		75	
Strip gap	160		160		160		160		160	

Resistivity (MΩ/cm)

Pitch	900	5 ± 1	650	8 ± 1	650	9 ± 2	650	13 ± 1	650	17 ± 1
Strip width	740		490		450		350		250	
Strip gap	160		160		200		300		400	

Pitch	540	13 ± 2	500	17 ± 3	360	To do (ladders)	300	20 ± 3	235	Dashed strips
Strip width	380		340		200		140		75	
Strip gap	160		160		160		160		160	

RESISTANCE/RESISTIVITY – BOARD "200"

- Strip resistance measurements with divider bridge (12 samples): **[Mask][Measure]**
- Strip length: 44.5 cm

Resistance (MΩ)

Pitch	900	366 ± 35	650	463 ± 63	650	489 ± 75	650	763 ± 162	650	1487 ± 302
Strip width	700		490		450		350		250	
Strip gap	200		160		200		300		400	

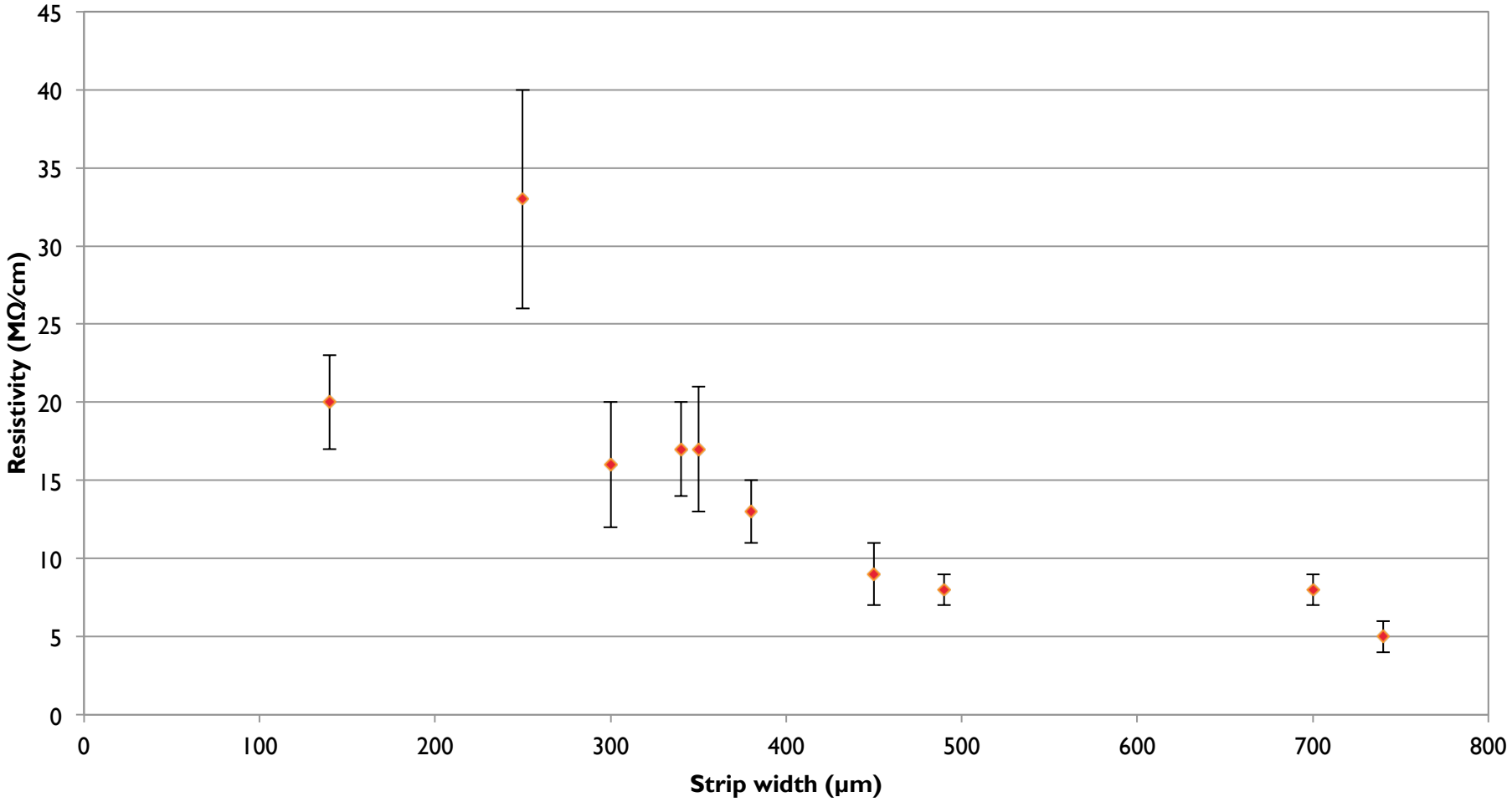
Pitch	540	750 ± 58	500	720 ± 157	400	To do (ladders)	400	To do (ladders)	300	To do
Strip width	340		300		200		200		100	
Strip gap	200		200		200		200		200	

Resistivity (MΩ/cm)

Pitch	900	8 ± 1	650	10 ± 1	650	11 ± 2	650	17 ± 4	650	33 ± 7
Strip width	700		490		450		350		250	
Strip gap	200		160		200		300		400	

Pitch	540	16 ± 1	500	16 ± 4	400	To do (ladders)	400	To do (ladders)	300	To do
Strip width	340		300		200		200		100	
Strip gap	200		200		200		200		200	

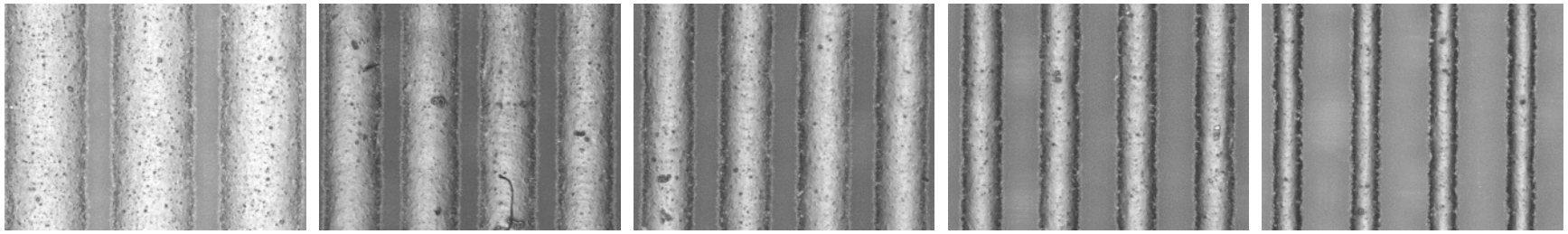
Width (µm)	**140**	**250**	**300**	**340**	**350**	**380**	**450**	**490**	**700**	**740**
Resistance (MΩ)	841 ± 115	1487 ± 302	720 ± 157	742 ± 120	763 ± 162	569 ± 73	410 ± 71	345 ± 54	366 ± 35	209 ± 31
Resistivity (MΩ/cm)	20 ± 3	33 ± 7	16 ± 4	17 ± 3	17 ± 4	13 ± 2	9 ± 2	8 ± 1	8 ± 1	5 ± 1



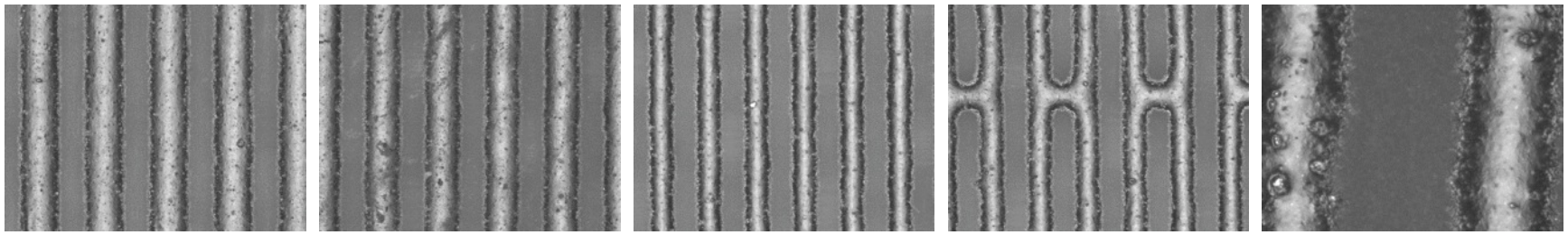
GEOMETRY MEASUREMENTS – BOARD "200"

- Strip geometry measurements with microscope (5 to 10 samples): **[Mask][Measure]**

Pitch	900	897 ± 9	650	651 ± 5	650	652 ± 5	650	649 ± 4	650	654 ± 7
Strip width	700	710 ± 17	490	481 ± 5	450	445 ± 6	350	339 ± 8	250	253 ± 10
Strip gap	200	187 ± 18	160	169 ± 5	200	206 ± 9	300	310 ± 7	400	401 ± 11



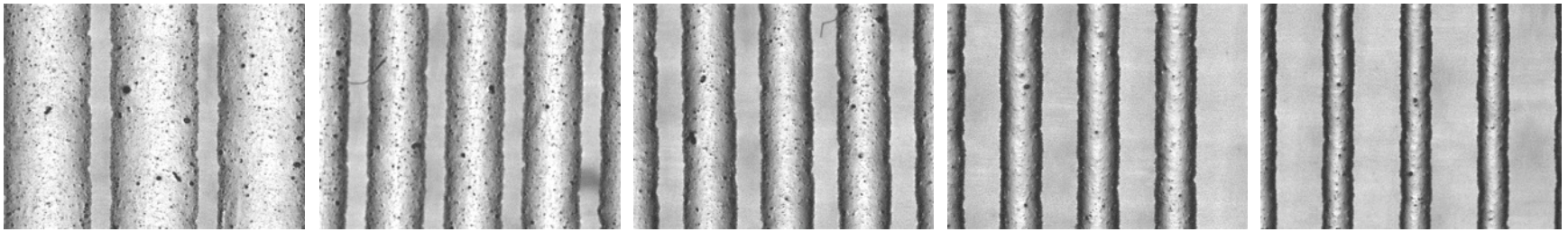
Pitch	540	538 ± 5	500	501 ± 8	400	404 ± 9	400	404 ± 9	300	305 ± 7
Strip width	340	324 ± 6	300	299 ± 9	200	210 ± 5	200	192 ± 9	100	119 ± 13
Strip gap	200	214 ± 9	200	202 ± 11	200	188 ± 10	200	212 ± 9	200	186 ± 10



GEOMETRY MEASUREMENTS – BOARD "160"

- Strip geometry measurements with microscope (5 to 10 samples): **[Mask][Measure]**

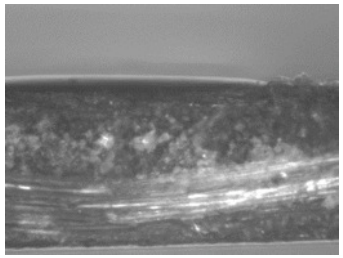
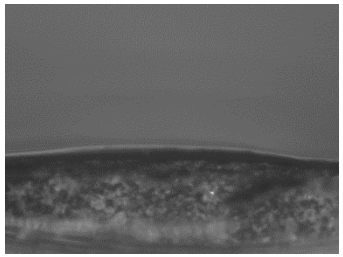
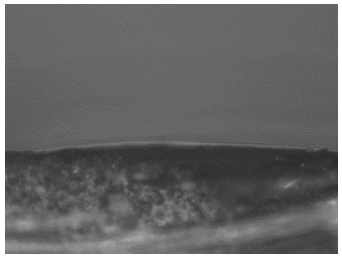
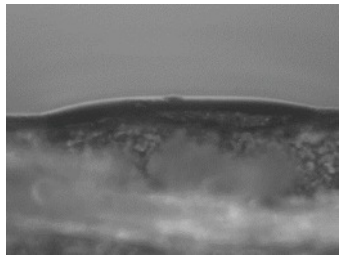
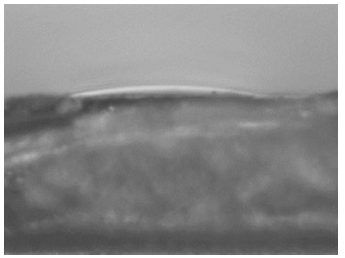
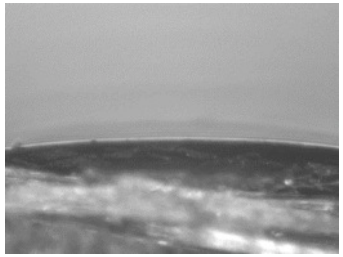
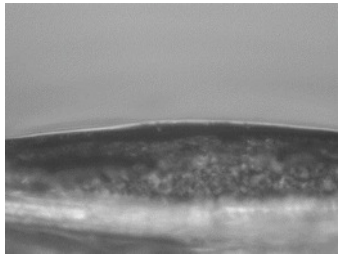
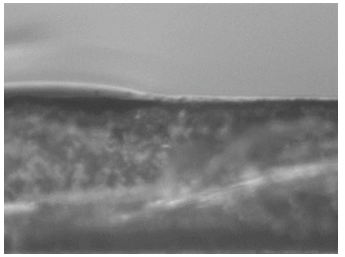
Pitch	900	901 ± 6	650	646 ± 3	650	650 ± 7	650	653 ± 3	650	645 ± 5
Strip width	740	736 ± 9	490	485 ± 5	450	452 ± 3	350	343 ± 17	250	250 ± 2
Strip gap	160	165 ± 7	160	162 ± 5	200	198 ± 10	300	310 ± 19	400	395 ± 5



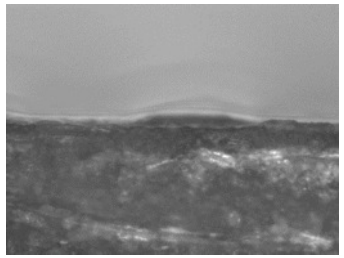
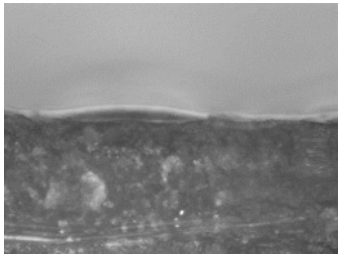
Pitch	540	540 ± 4	500	499 ± 9	360	356 ± 9	300	303 ± 15	235	232 ± 9
Strip width	380	371 ± 6	340	338 ± 9	200	213 ± 7	140	173 ± 12	75	92 ± 25
Strip gap	160	169 ± 6	160	161 ± 6	160	144 ± 8	160	130 ± 8	160	139 ± 25

STRIP HEIGHT – BOARD "160"

Pitch	900		650		650		650		650	
Strip width	740	17 ± 2	490	16 ± 3	450	19 ± 6	350	18 ± 5	250	16 ± 1
Strip gap	160		160		200		300		400	

Pitch	540		500		360		300		235	
Strip width	380	-	340	13 ± 2	200	21 ± 5	140	18 ± 3	75	9 ± 4
Strip gap	160		160		160		160		160	

CONCLUSION

Elvia / Bree:

- Manufacturing process is ok for 30 cm
- Homogenous resistance and resistivity
- Geometry ok taking into account the spreading of the ink
- Towards longer strips…

Cern / Charbonney:

- Manufacturing process is ok for 45 cm
- Homogenous resistance and resistivity
- Geometry ok except for very small strip width
- To do: finish the measurements (strips on kapton foil)