DE LA RECHERCHE À L'INDUSTRIE

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STUDY OF 2D/3D BIO-INSPIRED DNA NANO-SCALE ASSEMBLY FOR ELECTRONICS INTERCONNECTIONS

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OUTLINE

Objective - Demonstrator

Step 1 – DNA digestion / extraction / purification

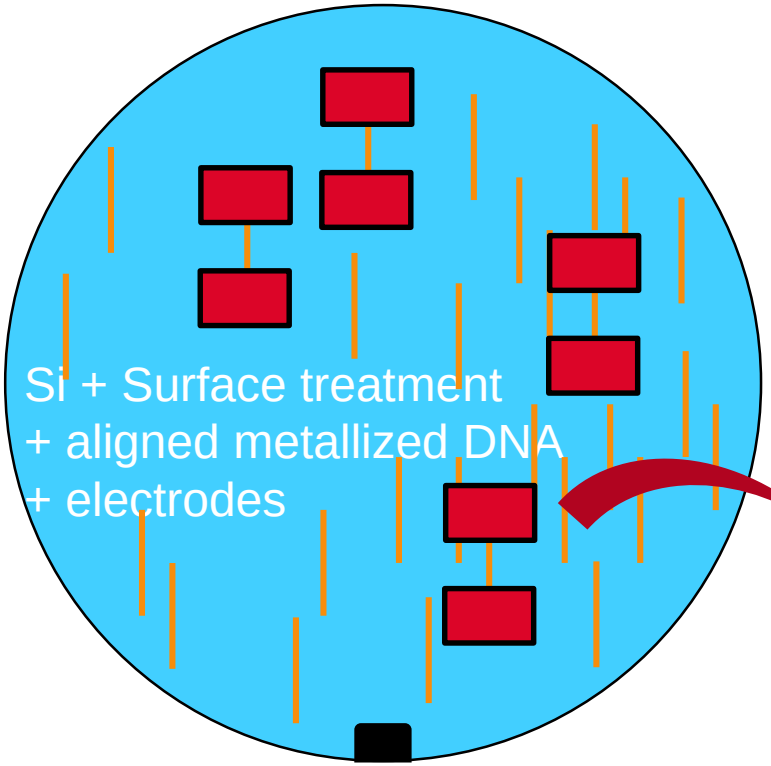
Step 2 - Surface treatments and DNA alignment

Step 3 – DNA metallization

Step 4 – DNA characterization

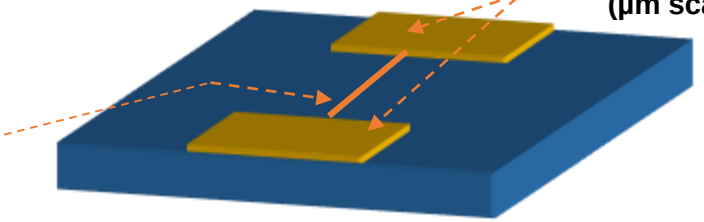
OBJECTIVE - DEMONSTRATOR

INTRODUCTION - CONTEXT



Metallic pads
(µm scale)

Interconnection :
Metallic DNA based nanowire **(nm scale)**
D = 10-50 nm
L= 1-10 µm



DNA based nanowire between two metallic electrodes

Control all nanowire parameters (alignments, length, diameter)
+
Statistical extraction of DNA based nanowire electrical properties

Aligned and metalized DNA molecules on Si substrate treated hydrophilic or hydrophobic

STEP 1

DNA DIGESTION / EXTRACTION / PURIFICATION

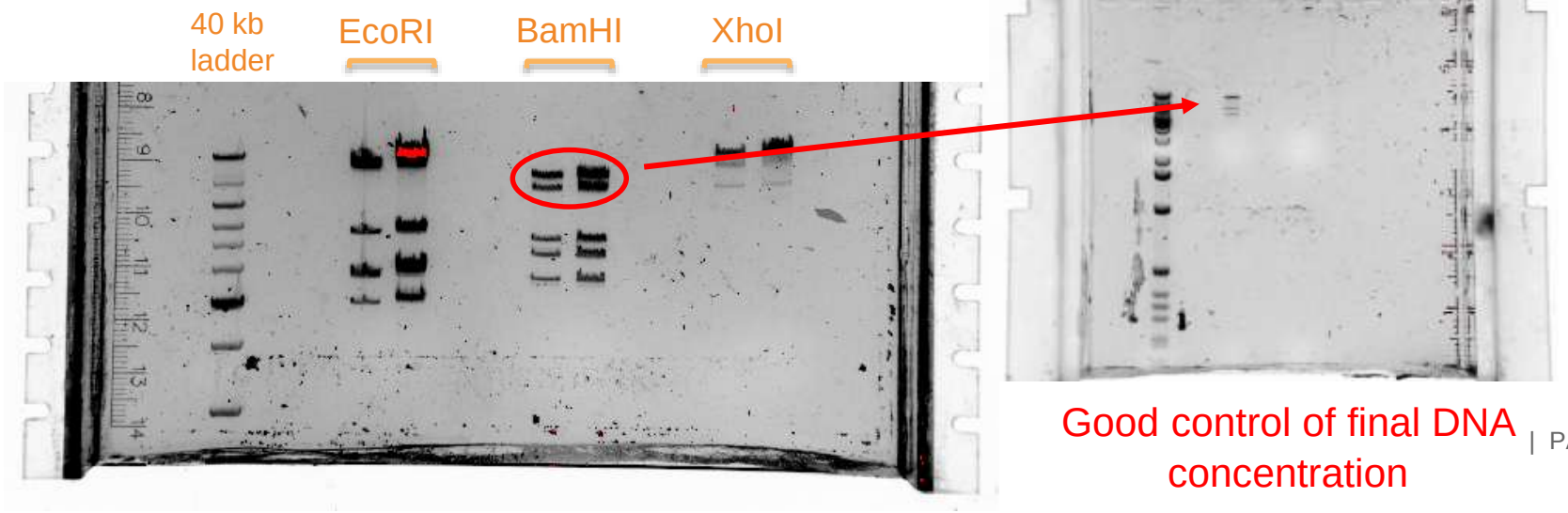
STEP 1 – DNA DIGESTION / EXTRACTION / PURIFICATION

- The objective is to access to 5 nanowire lengths: 1, 2, 5, 10 and 16 µm

Length /µm	Restriction site 1	Restriction site 2	Length achieved /µm
1	EcoRI	EcoRI	1.6 (4878 bp)
2	EcoRI	EcoRI	2.5 (7421)
5	BamHI	BamHI	5.7 (16841)
5	XhoI	End	5.1 (15005)
10	Start	XhoI	11.4 (33497)

2 contact lengths

- Digestion by enzymes done

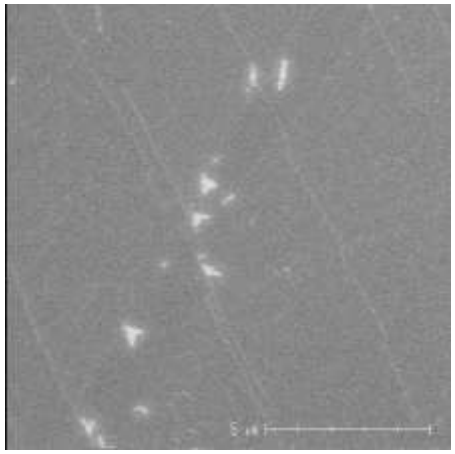


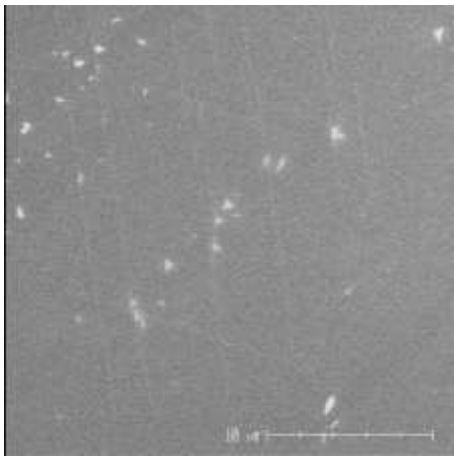
Good control of final DNA concentration

STEP 2
SURFACE TREATMENTS AND DNA ALIGNMENT

STEP 2 – SURFACE TREATMENTS AND DNA ALIGNMENT

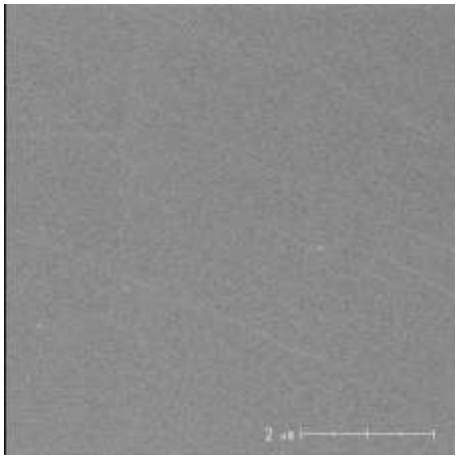
- DNA combing on HMDS treated Si surface by wetting and drop techniques

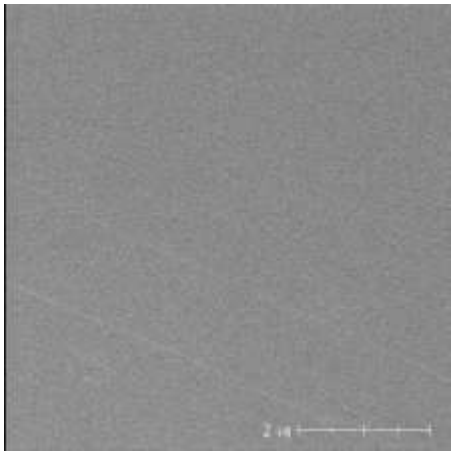




DNA combing by drop technique
(pH 5.5, C=7.5 ng/µL)

- Correct alignment up to few dozen of microns
- Correct DNA concentration
- Wafer not perfectly clean at the water drop deposition
- DNA material deposited only at the drop location



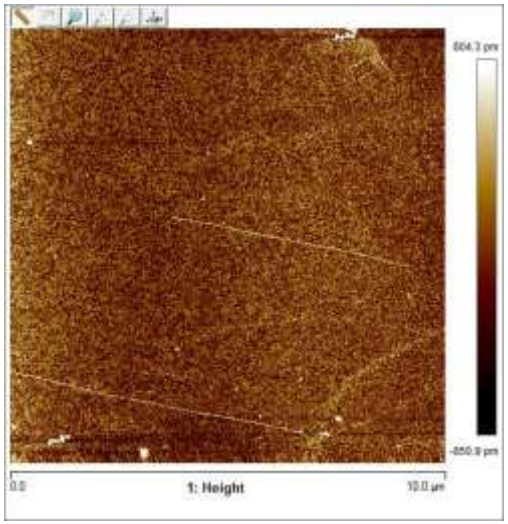


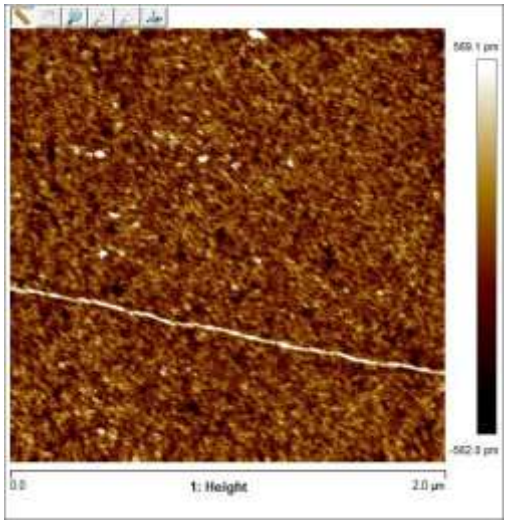
DNA combing by wetting technique
(pH 5.5, C=7.5 ng/µL)

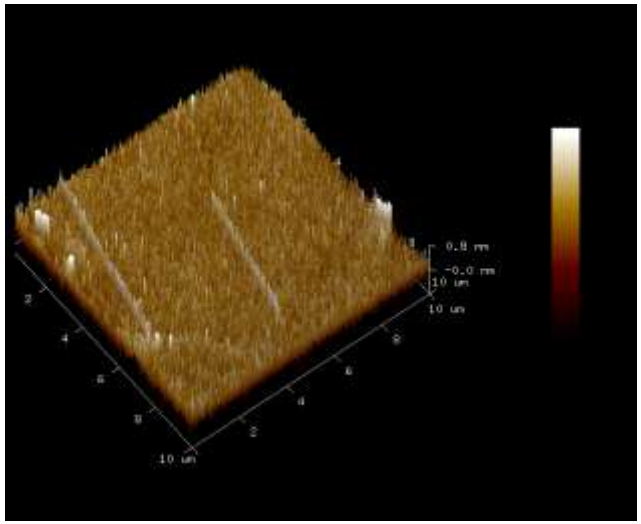
- Correct alignment up to few dozen of microns
- Correct DNA concentration
- Wafer perfectly clean
- DNA material deposited everywhere on the surface

STEP 2 – SURFACE TREATMENTS AND DNA ALIGNMENT

- DNA combing on HMDS treated Si surface by wetting and drop techniques



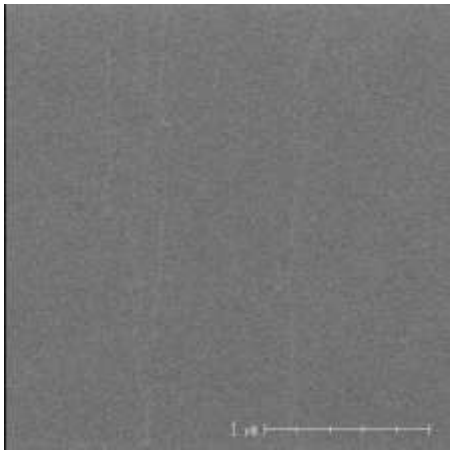


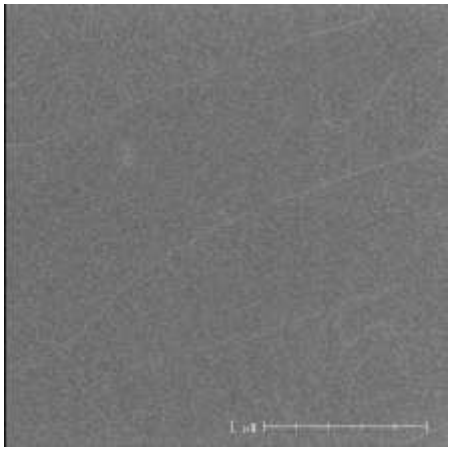


- 1-nm high average
- 15-nm diameter average -> error due the probe size (10 nm)
  -> DNA diameter is about 4-6 nm

STEP 2 – SURFACE TREATMENTS AND DNA ALIGNMENT

- DNA combing on HMDS treated Si surface by wetting and drop techniques





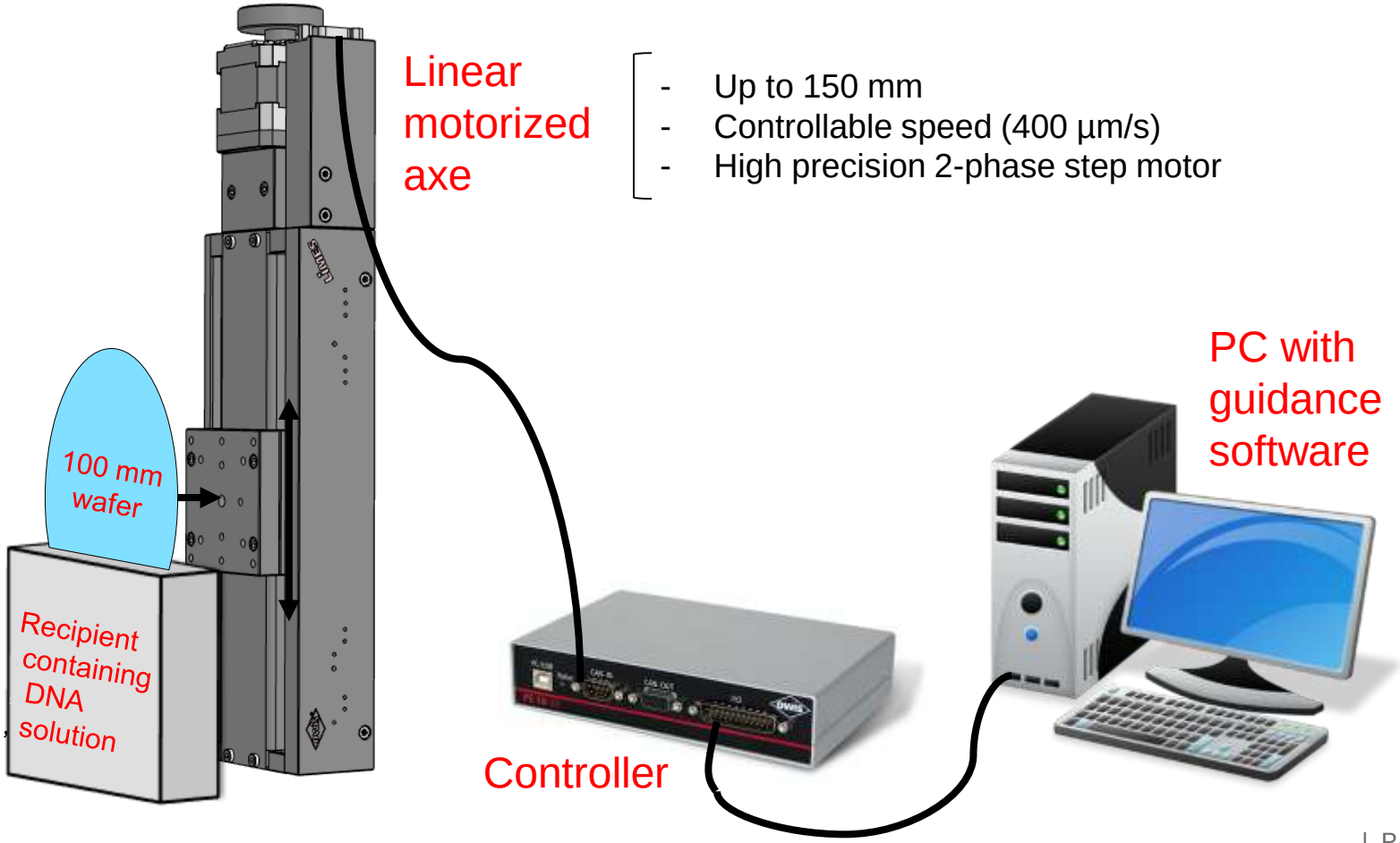
DNA combing by wetting technique
(pH 5.7, C=15 ng/µL)
+ increase of NaCl concentration

- Correct alignment
- Increase DNA concentration
- Wafer not perfectly clean at the water drop deposition
- DNA material deposited everywhere on the surface

→ Set up an equipment dedicated to DNA alignment

STEP 2 – SURFACE TREATMENTS AND DNA ALIGNMENT

- Set up an equipment dedicated to DNA alignment for better repeatability



STEP 3
DNA METALLIZATION

STEP 3 – DNA METALLIZATION

- First try

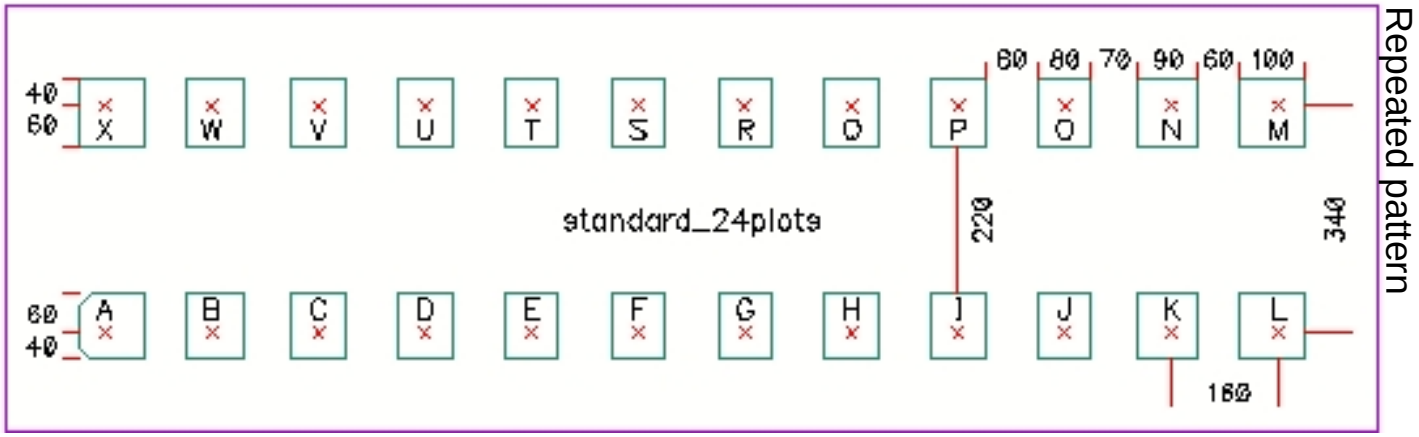
- palladium nanowire:
  * potassium tetrachloropalladate(II)
  * borane-dimethylamine complex

No success.. To be continued

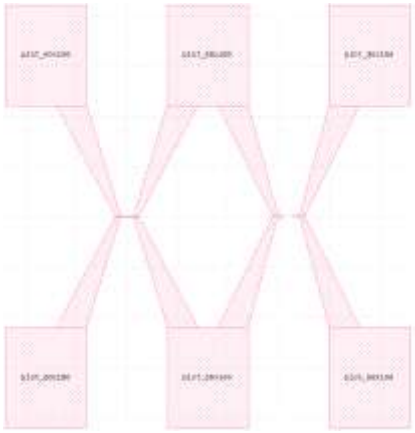
STEP 4
DNA CHARACTERIZATION

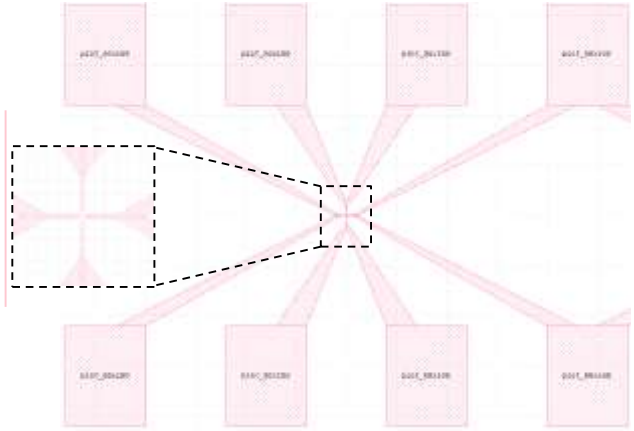
STEP 4 – DNA CHARACTERIZATION

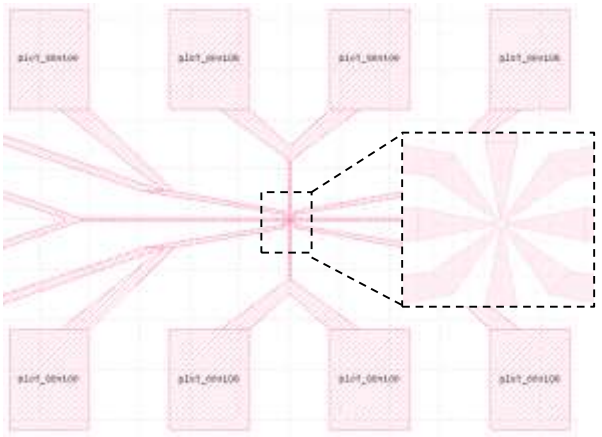
- PTA equipement formation starting this week
- Mask design in progress: 2x12 fixed pads as template for automatic and statistic DC characterization



Smallest object
600 nm

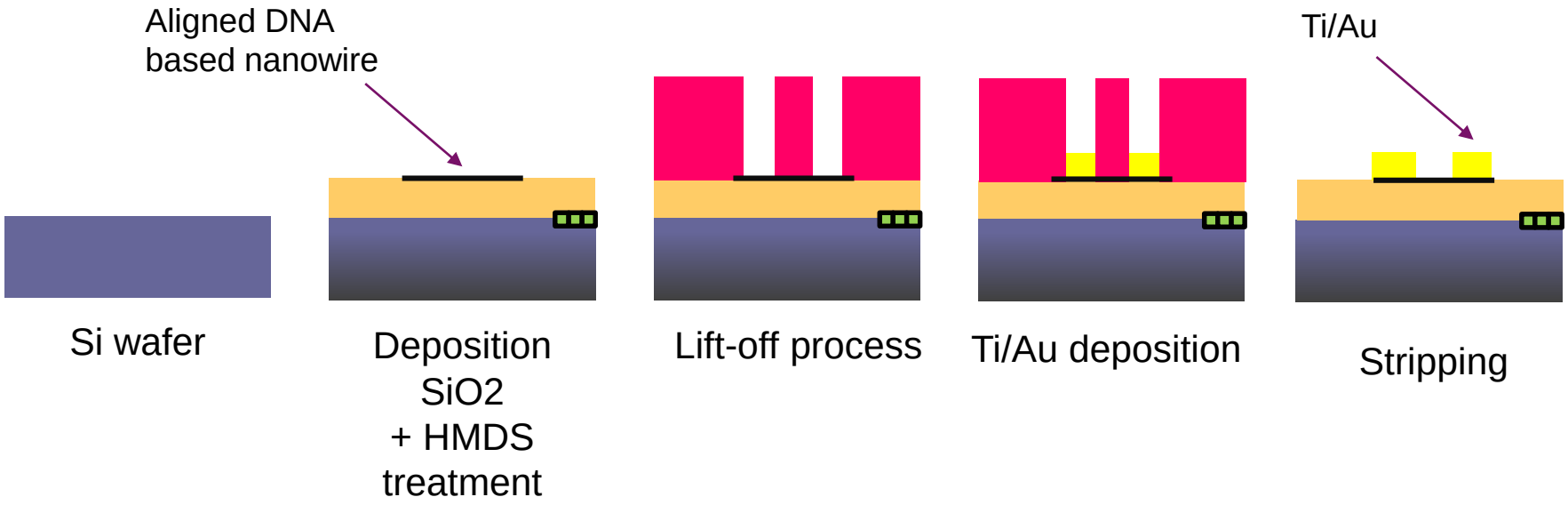






STEP 4 – DNA CHARACTERIZATION

- Process flow for gold electrodes fabrication:



Electrode thickness: 200 nm Ti + 200 nm Au ?