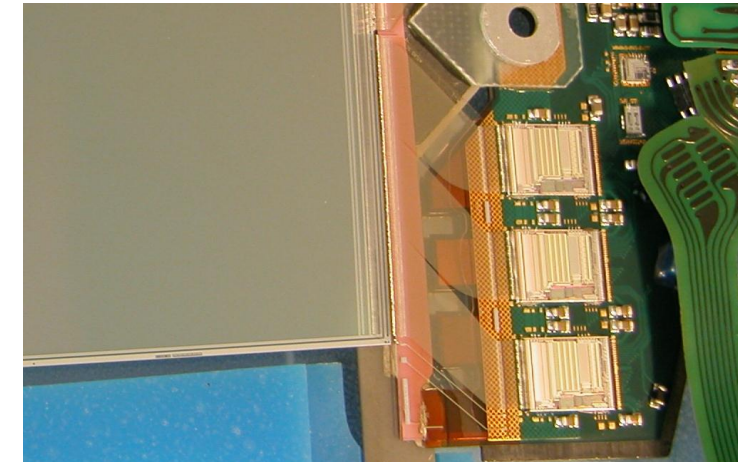


## INTRODUCTION

### FRAMEWORK

- ◆ In current ATLAS-SCT modules, pitch adapters are used
  - ✓ Provide pitch adaptation
  - ✓ Facilitate the bonding
- But
  - ✗ Double the number of bonds
  - ✗ Increase material budget
  - ✗ Increase tooling and costs
- ◆ In the ATLAS Upgrade groups want to avoid pitch adapters
  - ✗ Difficult bonding
  - ✗ Risk of yield reduction
  - ✗ Increase of repairs



### PROPOSAL:

- Embedded Pitch Adapters:
  - Our proposal is to build the pitch adapters inside the sensor
- Facilitate bonding
- Same number of bonds
- Insignificant material budget increase
- No new tooling

### CHALLENGES

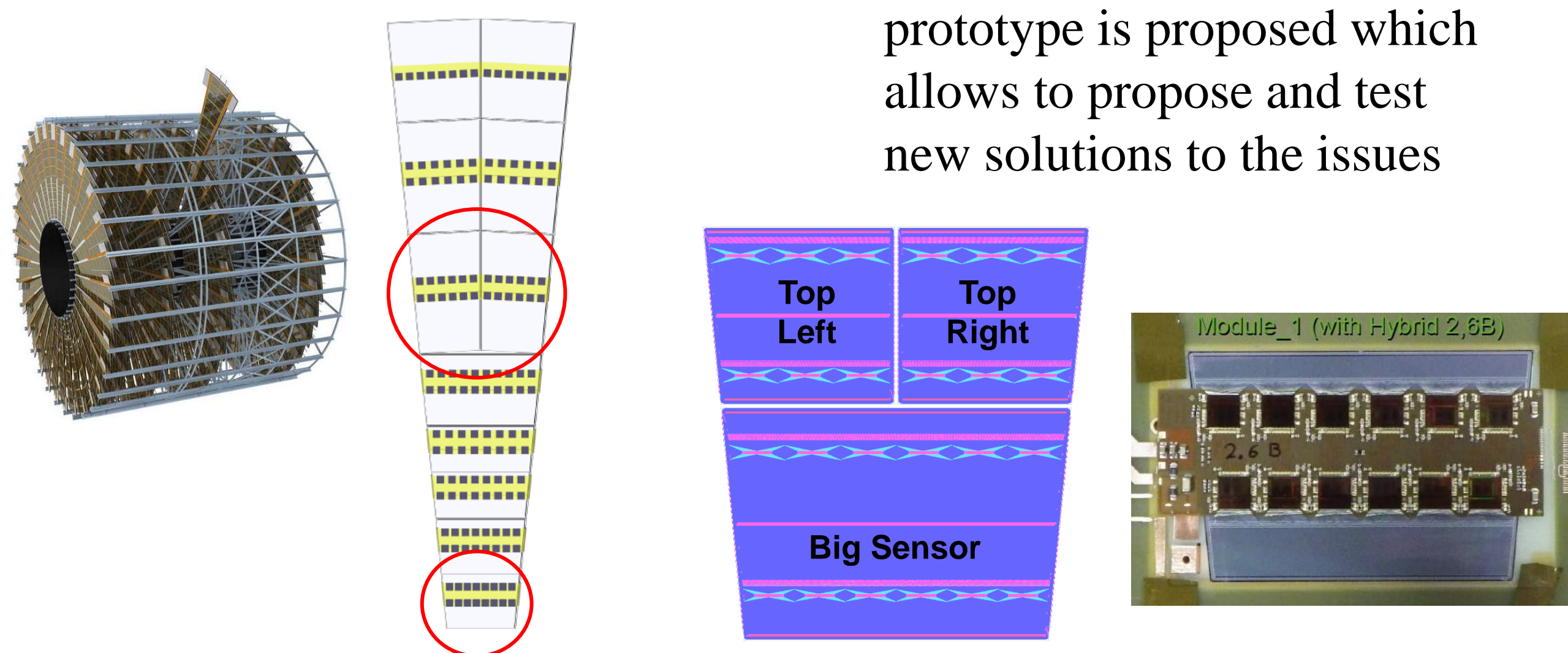
- Inter-metal layer – PECVD SiO<sub>2</sub>
- Cross-talk: signal transfer between crossing metal tracks
- Signal pickup: In the second metal layer

## EXPERIMENT

### PETALET PROTOTYPE

ATLAS Upgrade End-Cap section will be made of petal-shape structures

To concentrate on a smaller concept the “**petalet**” prototype is proposed which allows to propose and test new solutions to the issues

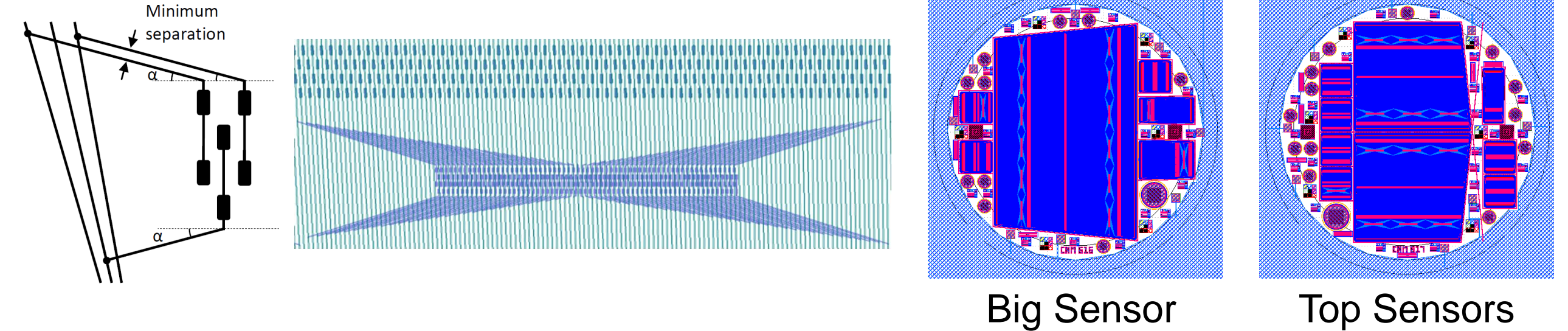


### DESIGN

- Built-in fanins on the detector, using second metal layer
- Optimization criteria
  - ✓ Minimum track length.
  - ✓ Maximum crossing angle
- Design method: Constant track angle: Maximum keeping the minimum distance between tracks (20 μm).

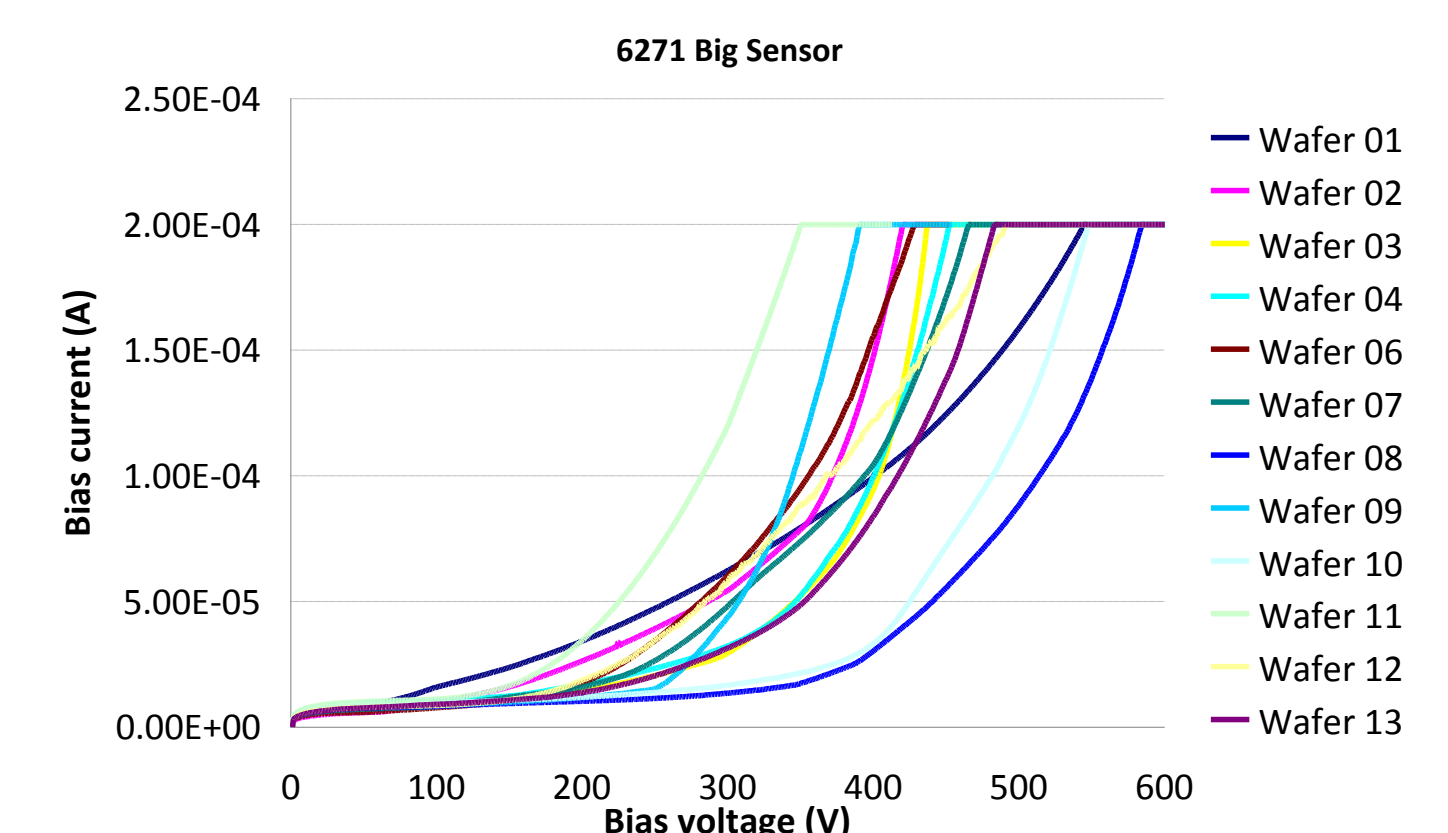
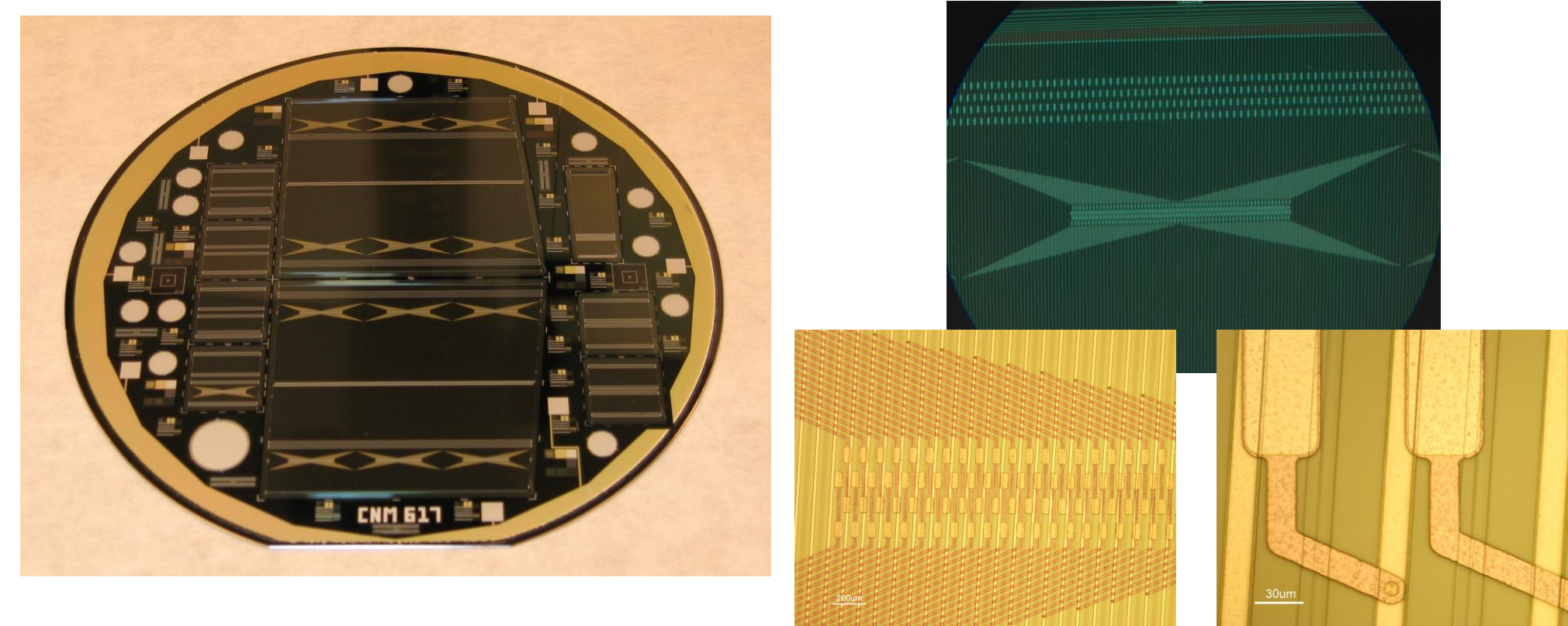
Minimal embedded track area fill ratio:

- Big Sensor: 4.5%
- Top Sensors: 5.4%



## FABRICATION

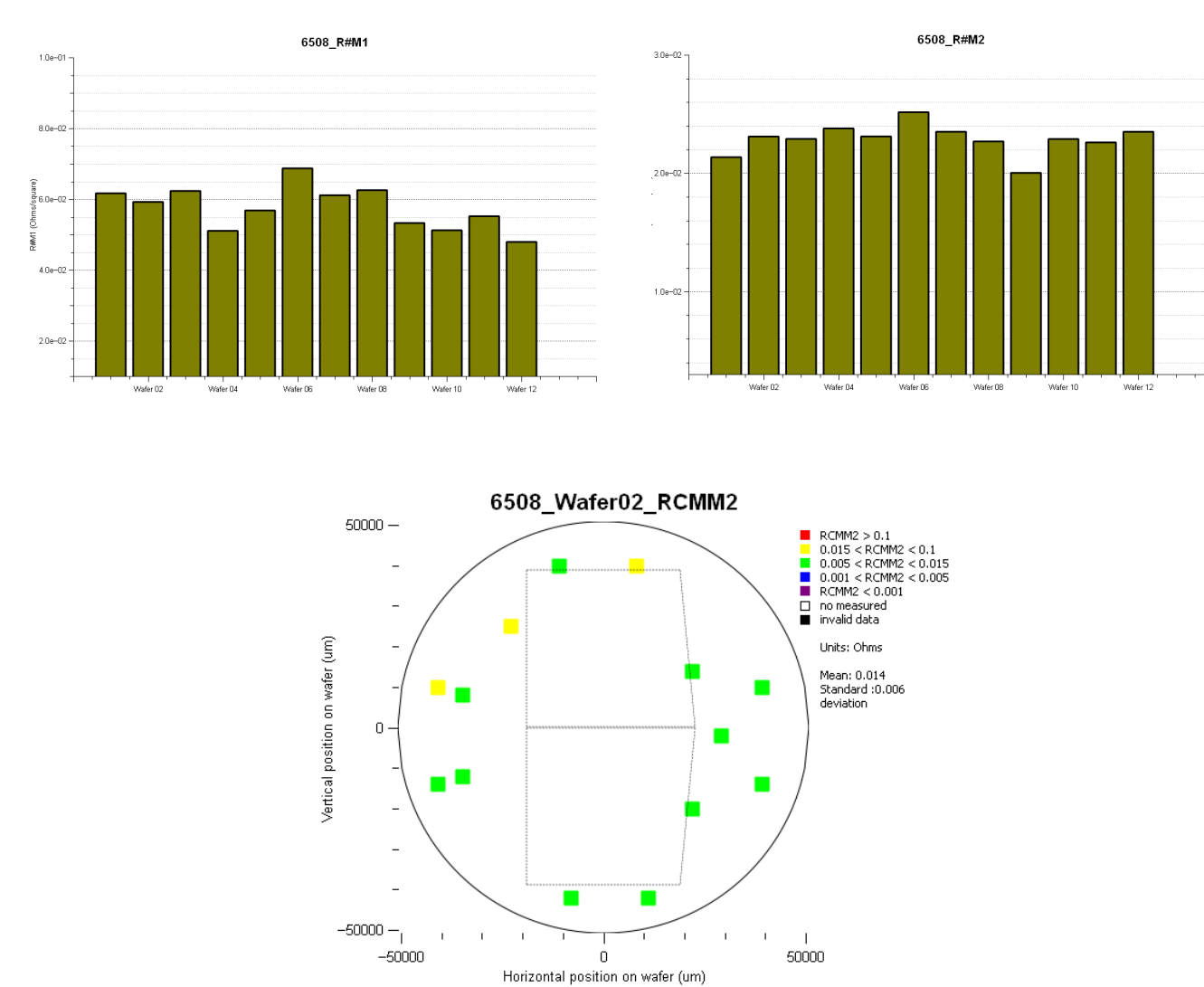
- Clean Room facilities at CNM-Barcelona.
- 300 μm thick Si high-resistivity wafers.
- Several batches with and without double metal
- P-stop Boron implant doses: 4 e13 /cm<sup>2</sup>
- 9 photolithography steps for 2 metals technology.



## TEST

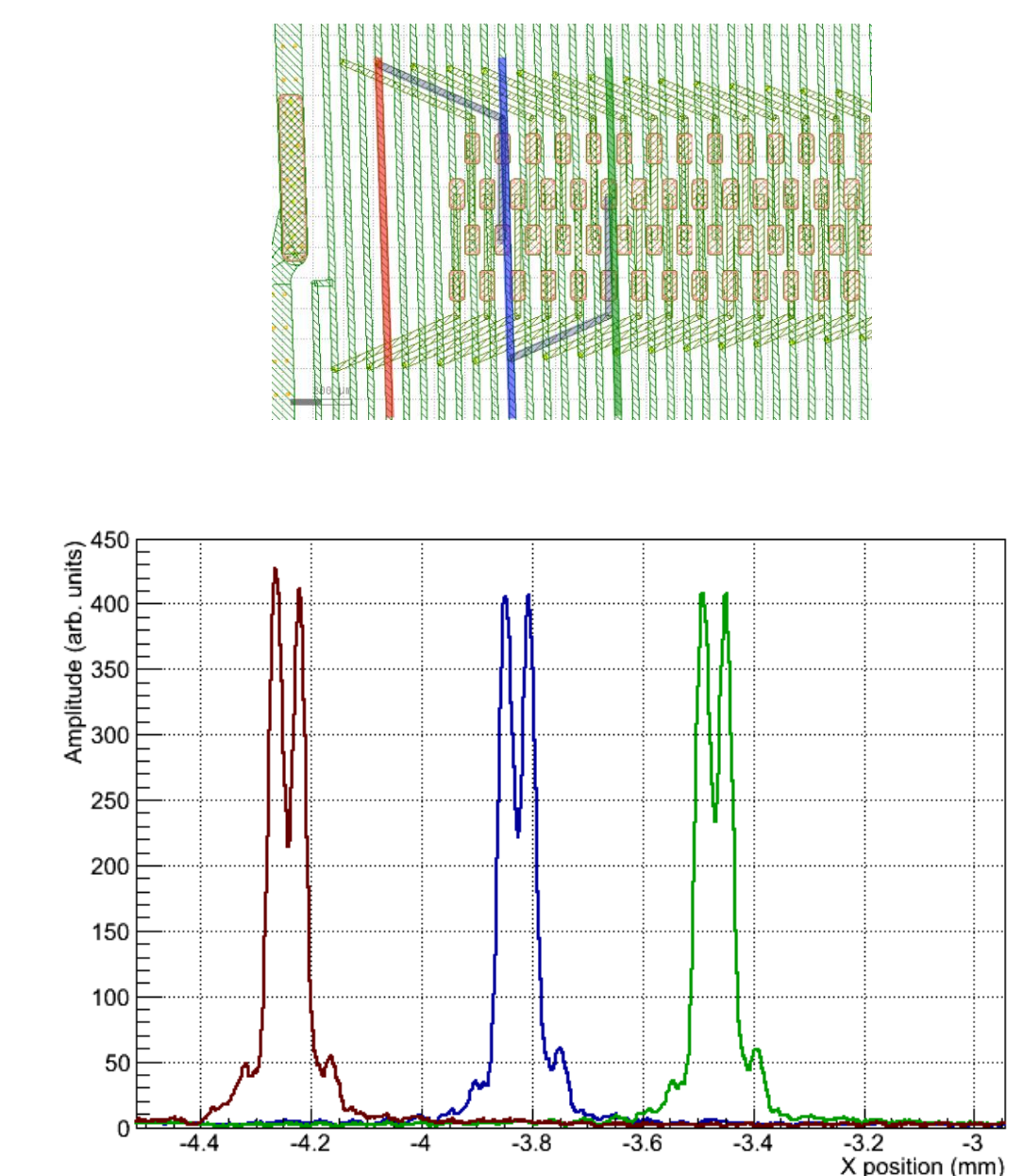
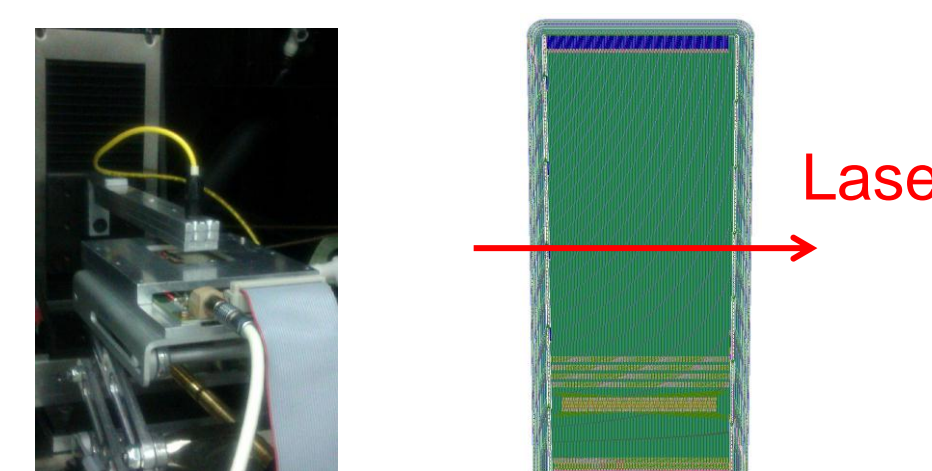
### TECHNOLOGICAL TEST

- Metals Sheet Resistance:
  - Metal-1: 0,055 +/- 0,003 Ω/□**
  - Metal-2: 0,021 +/- 0,001 Ω/□**
- M1-M2 Via Resistance:
  - 0,046 +/- 0,023 Ω**
- Capacitance M1-M2:
  - 3700 +/- 100 pF/cm<sup>2</sup>**
- Yield:
  - Optical inspection: 1 possible defect in 1 via in ~3000 channels



### PERFORMANCE TEST

- Cross-talk
  - Laser tests:
    - Signal readout in every channel
    - No signal seen in crossing channels



### CONCLUSION

- A method to facilitate the interconnection between sensors and Front-end electronics avoiding the use of pitch adaptors has been proposed.
- Embedded pitch adaptors have been designed and fabricated on prototype sensors for the ATLAS Upgrade Inner Tracker
- Technological test show satisfactory results
- Cross-talk and pickup remains within manageable values

### FUTURE WORK

- Build petalet prototypes with embedded pitch adaptors
- Test Beam
  - o Efficiency loss
- Try different interlayer materials:
  - o BCB, SU8, laminates,...