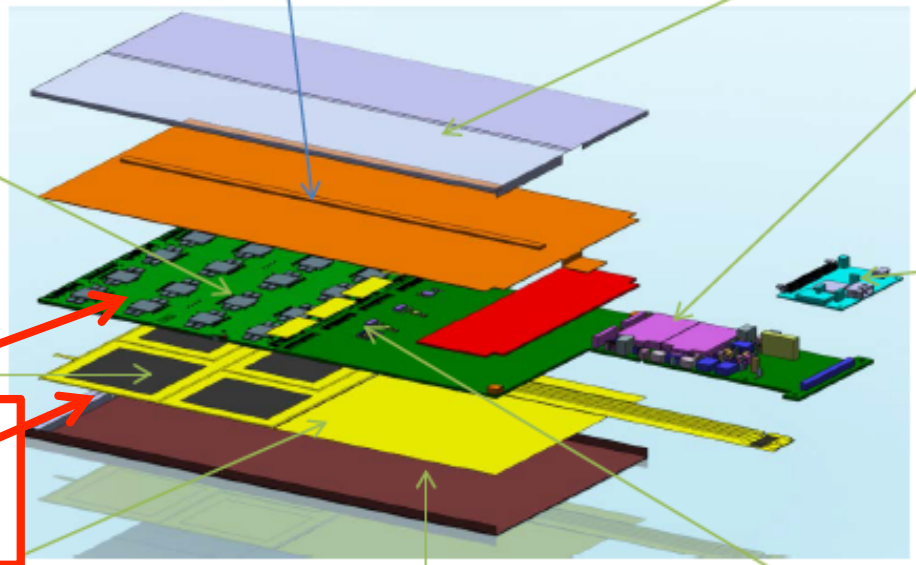
Si-W electromagnetic calorimeter
Status report on the assembly process
Gluing – Electrical and Geometrical measurements

Contribution in the development of an assembly line for highly granular calorimeters with semiconductor readout

- Gluing robot system
- Metrology of the PCB
- Electrical tests
- Quality Insurance
- Industrialization of the gluing process

Didier Lacour – LPNHE – Munich, September 2015

Description of one layer



Coper sheet for cooling

Cover (EMI shielding)

Power pulsing circuitry (400 mF)

PCB 1024 chn. 16x **SKIROC2**

Detector Interface (DIF)

Si PIN diodes

1PCB
4 wafers

Front-end, DAQ, TFC Not shown

HV kapton

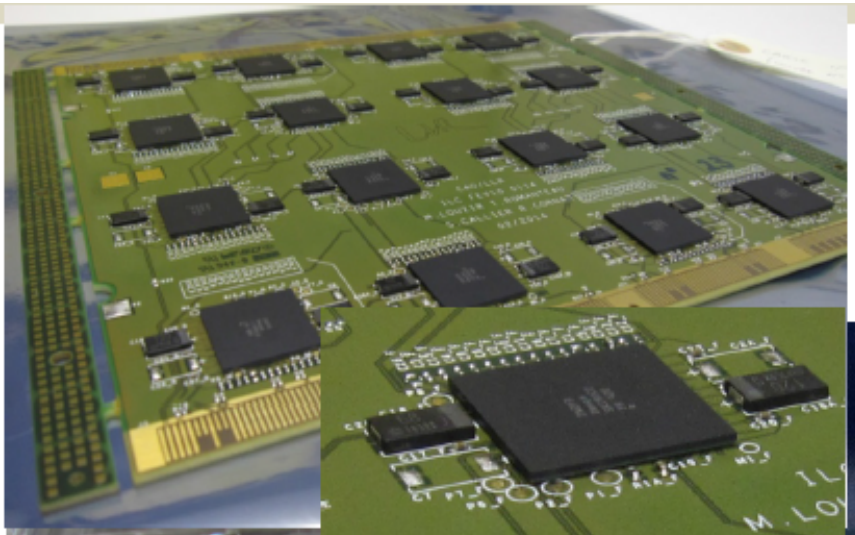
A "short SLAB"

FCC Interconnects

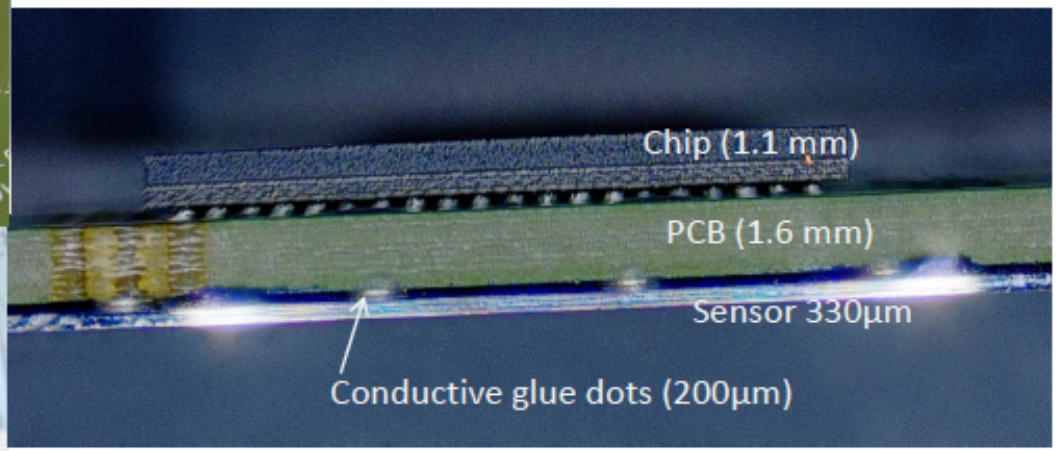
Stiffener, Absorber Carbon fiber + W

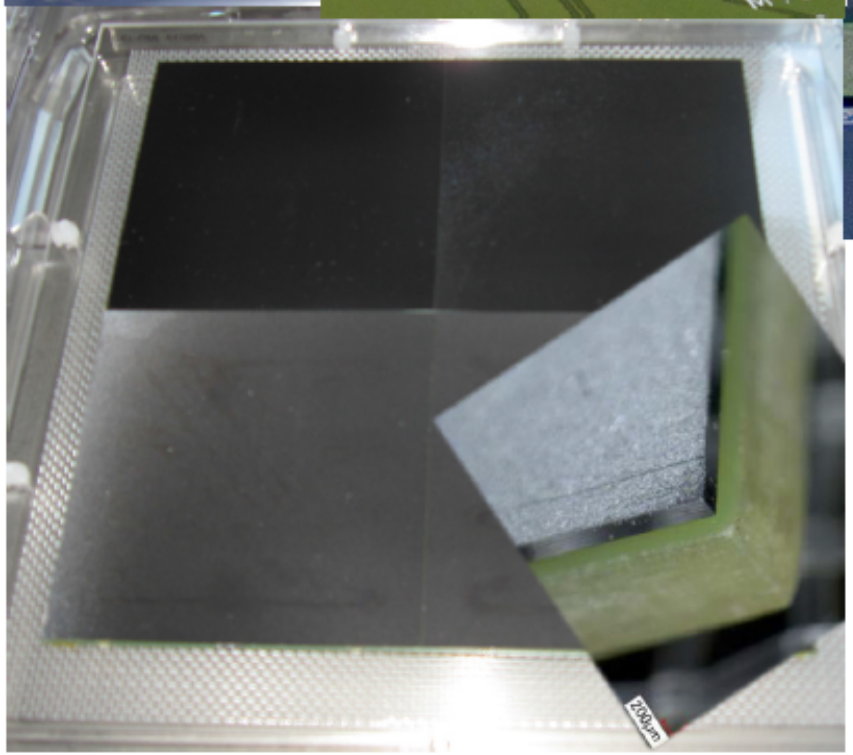
Single layer, 'U' stiffener

Detector module assembly



Robots for gluing sensors are developed

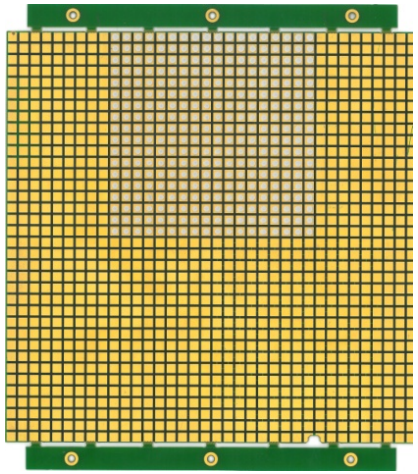


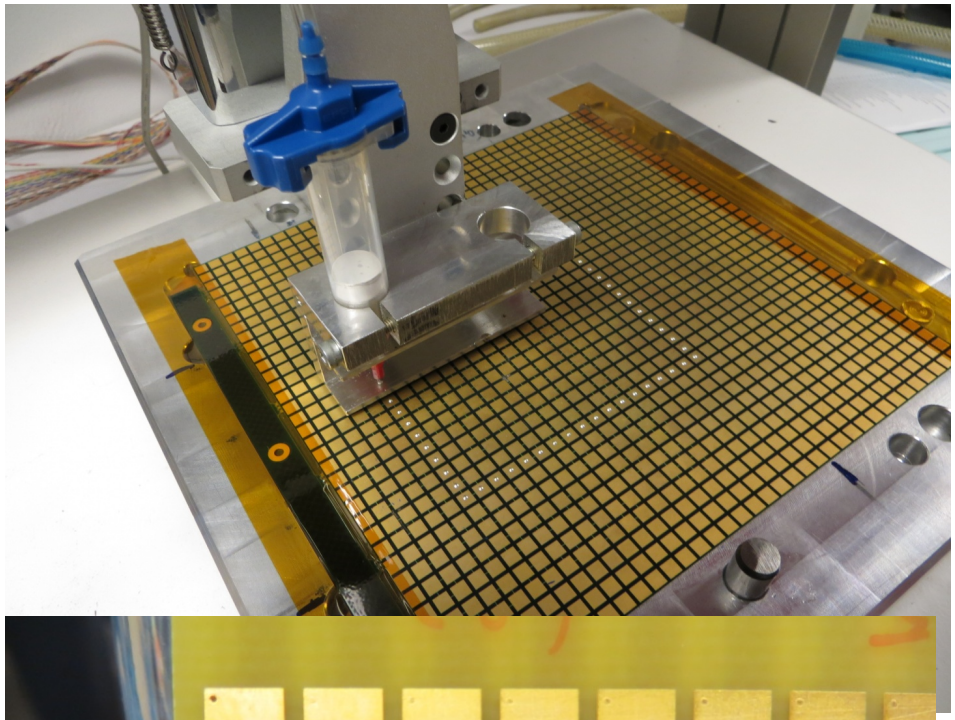


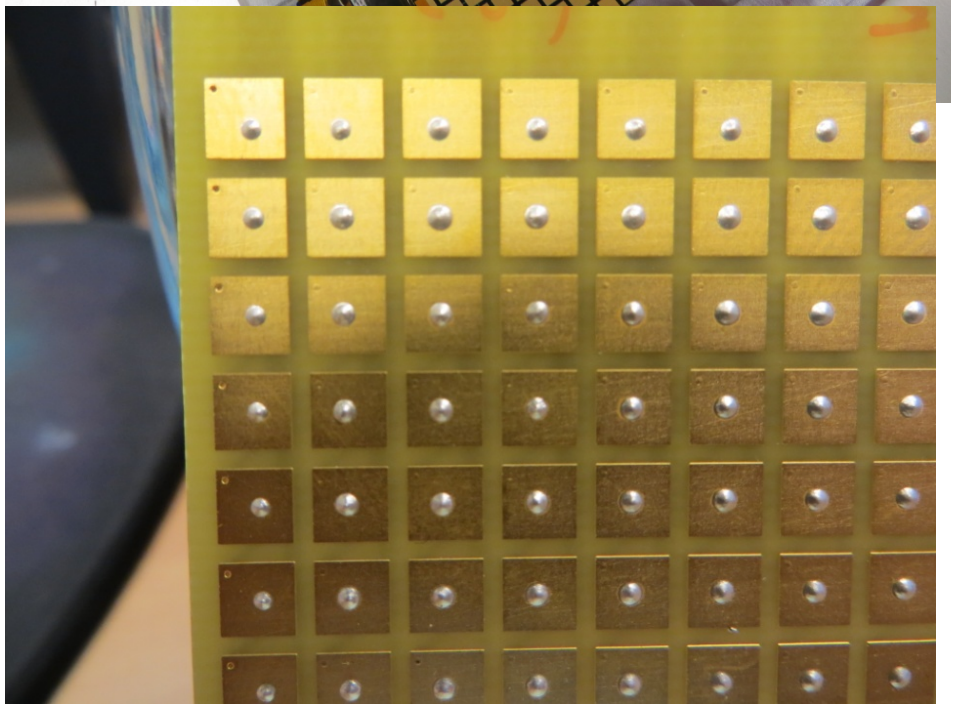
4 wafers 9cm x 9 cm wide can be glued with a 20 µm precision and reproducible process.
Glue is dispensed in order to form 200 µm thick dots

First step : one wafer glued per PCB

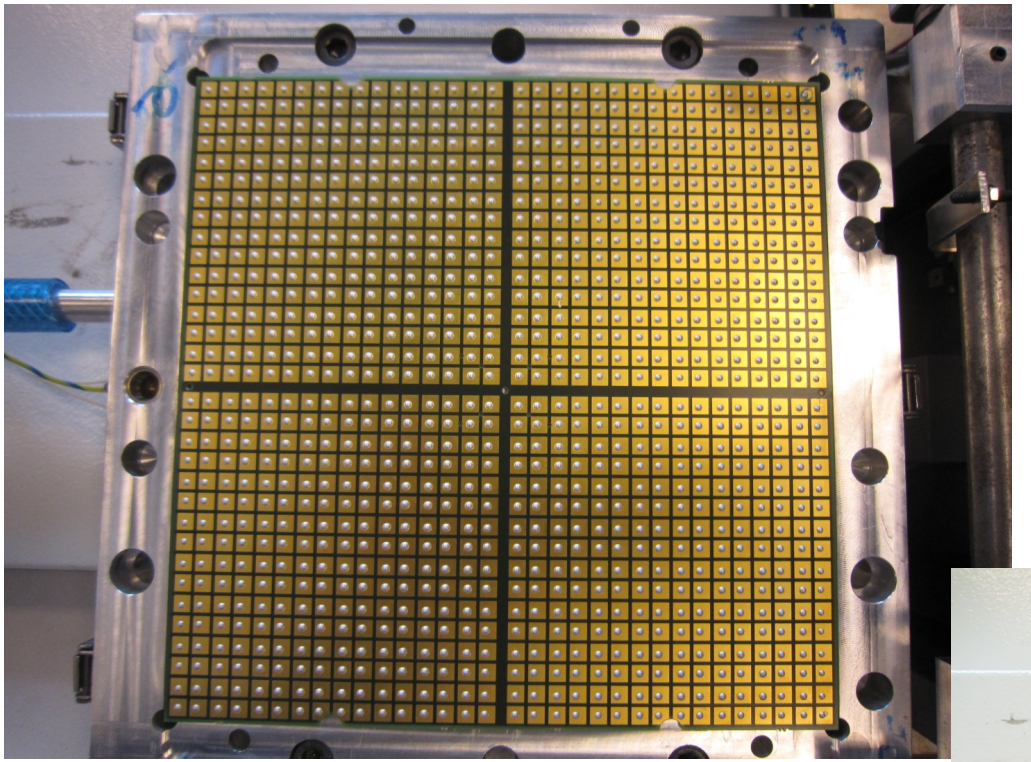
- The parameters of the gluing robot have been optimized to glue a silicon sensor (18x18 pads) on a PCB
- The constraints on the PCB geometry have been identified:
  - Flatness
  - Parallelism of the edges
  - Uniform height of the ASIC soldered on the board



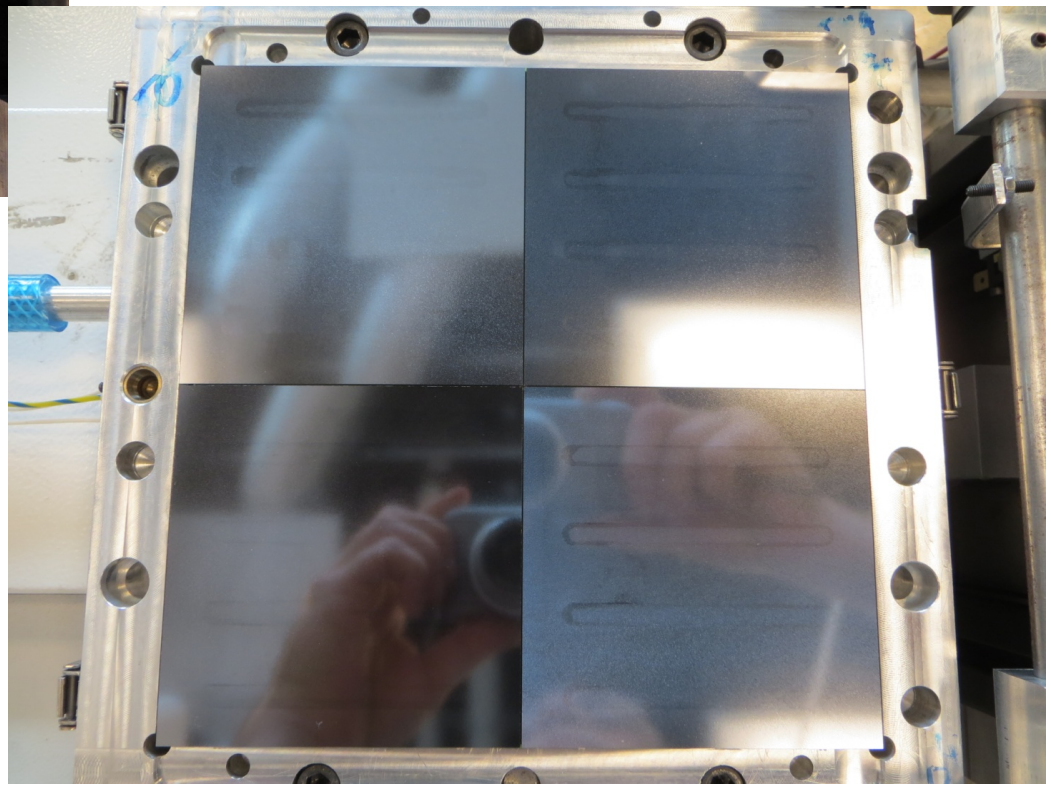




Second step : 4 wafers per PCB



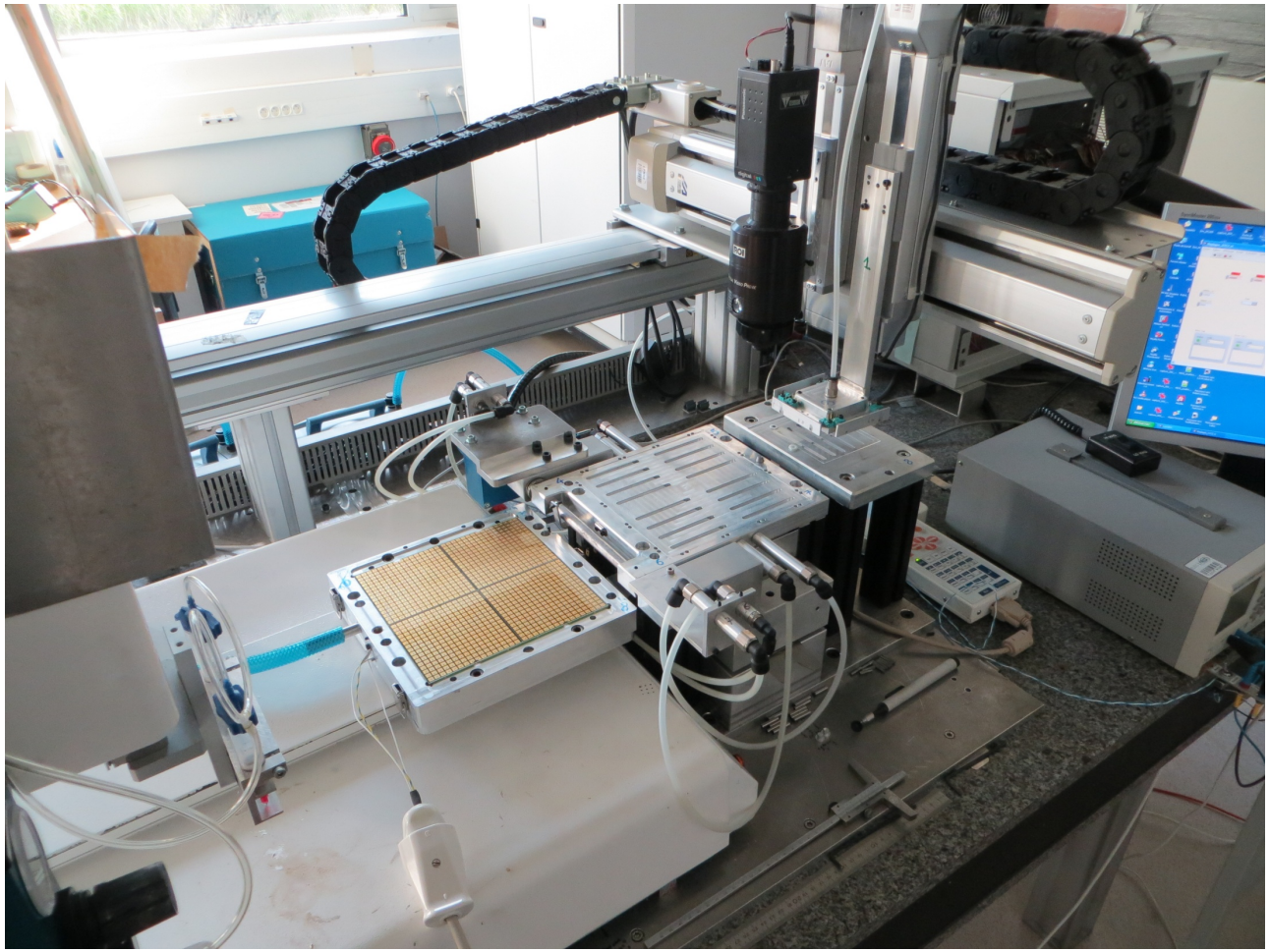
- Deposit of glue on the PCB
  256 X 4 = 1024 dots



- Move the plate with the 4 wafers on the PCB
- The alignment is fundamental :
  - PCB = 180.3 mm maximum
  - Wafer = 90 mm

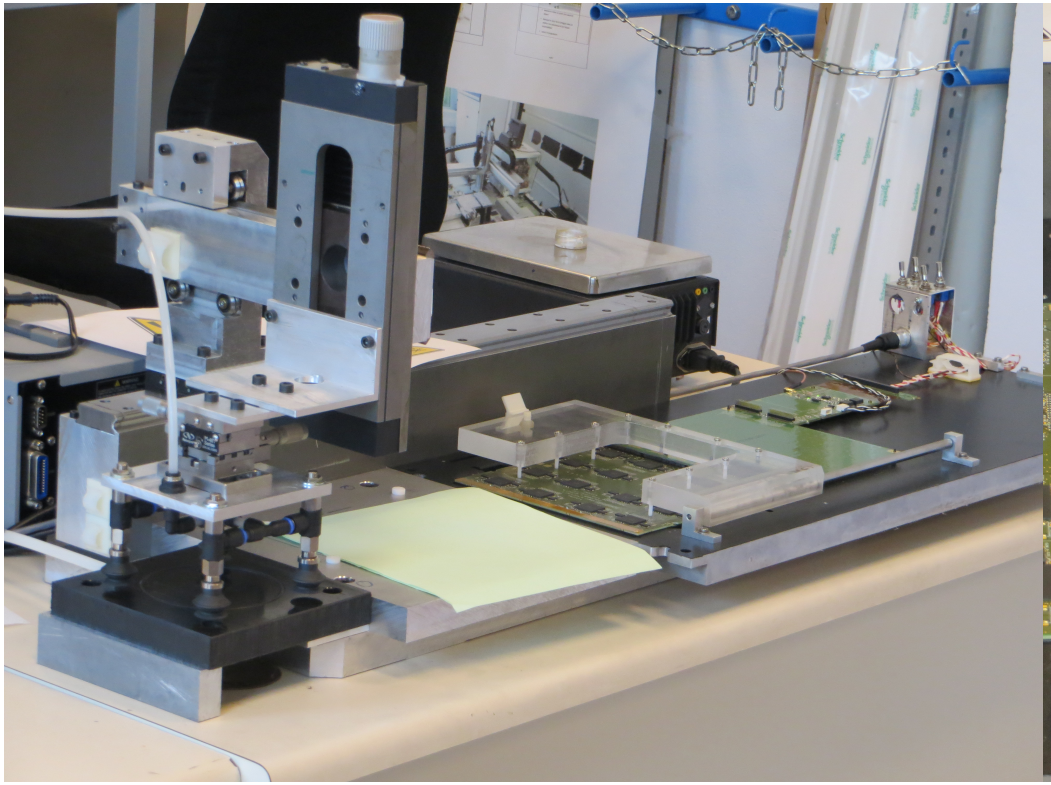
Gluing and positioning automated process

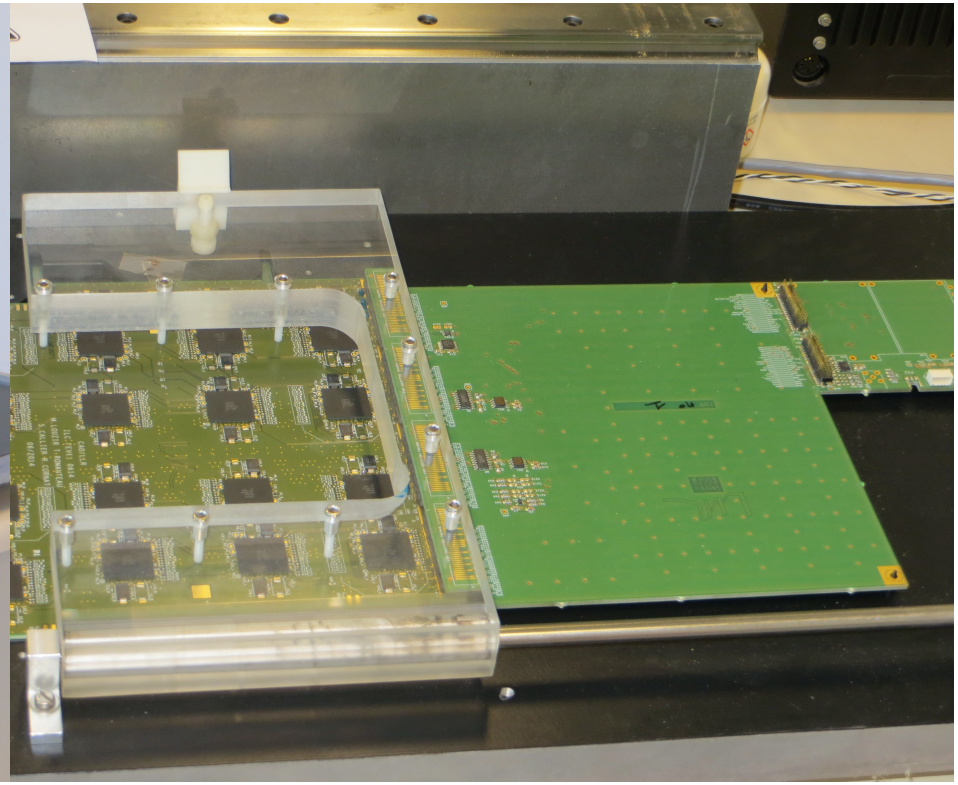
- Software (Labview) for the gluing robot has been implemented
- The second robot for positioning, alignment, and handling has been assembled and its software developed



Electrical tests bench

- A dedicated electrical test system is used
  - to control the wafers before gluing
  - to check the short cuts immediately after gluing
  - to measure the I(V) curves of each wafer and all 4 wafers
- sourcemeter Keithley 2450 + LLR Bench



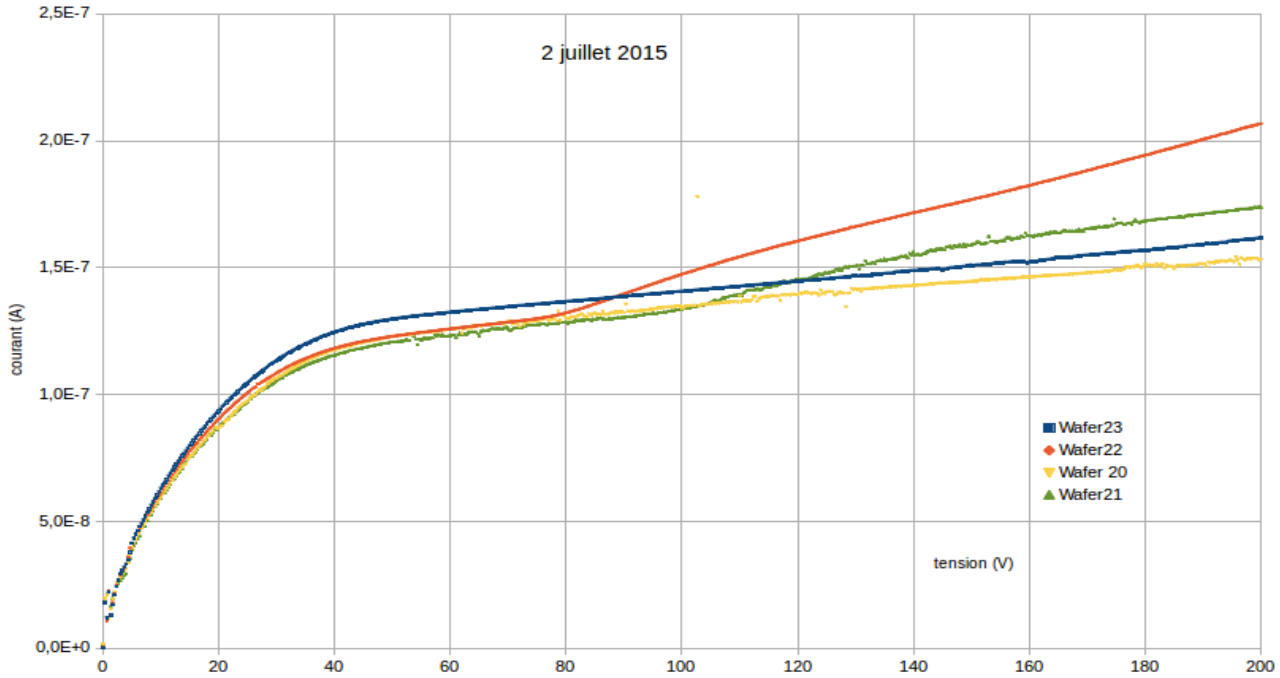


Electrical tests results

- Measurement after gluing onto the PCB
  - 4 ASU tested, all functional (no short cut).
  - Waiting for further tests (mip detection)

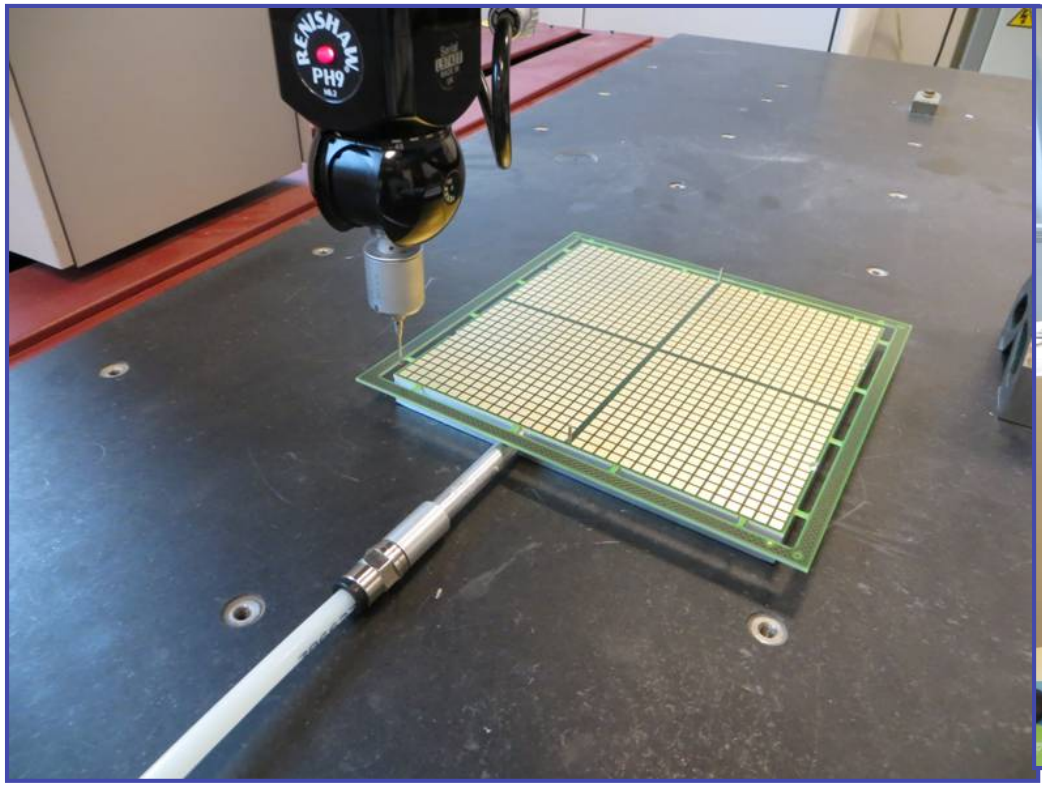
ASU	23	33	34	42
I total (µA) @140V	1.9	11	15	5

- I(V) measurement for each wafer before gluing – leakage current 150 nA @ 140 volts



PCB Metrology

- Development of an automatic process using a coordinate measuring machine (tri-dim machine)
- Before cabling :
  - Squaring
  - Parallel edges
  - Size
  - Thickness (flatness in depression)
  - Flatness
- After cabling : flatness and thickness

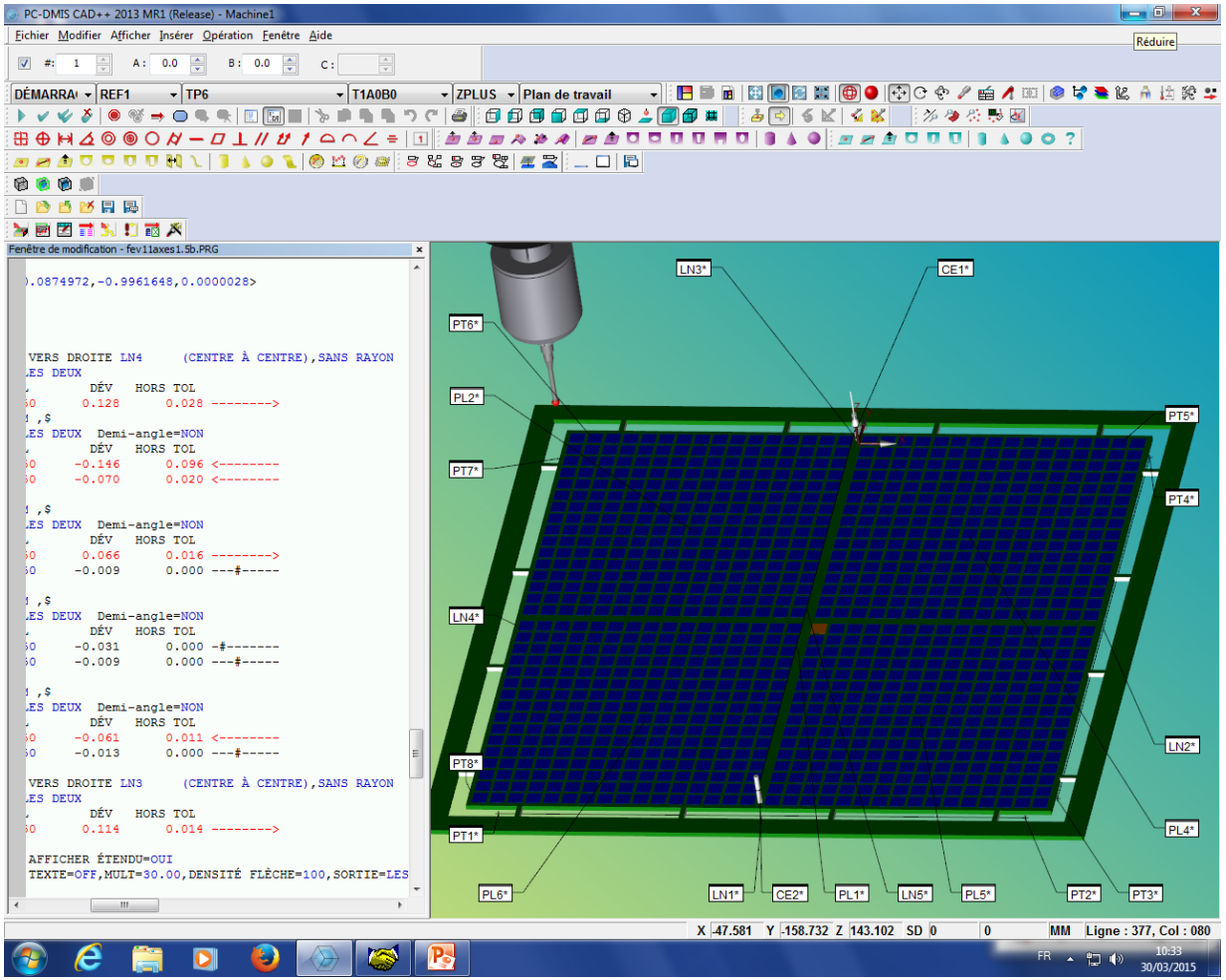


PCB Metrology results

40 PCB controlled

Criteria (measurements before cabling)

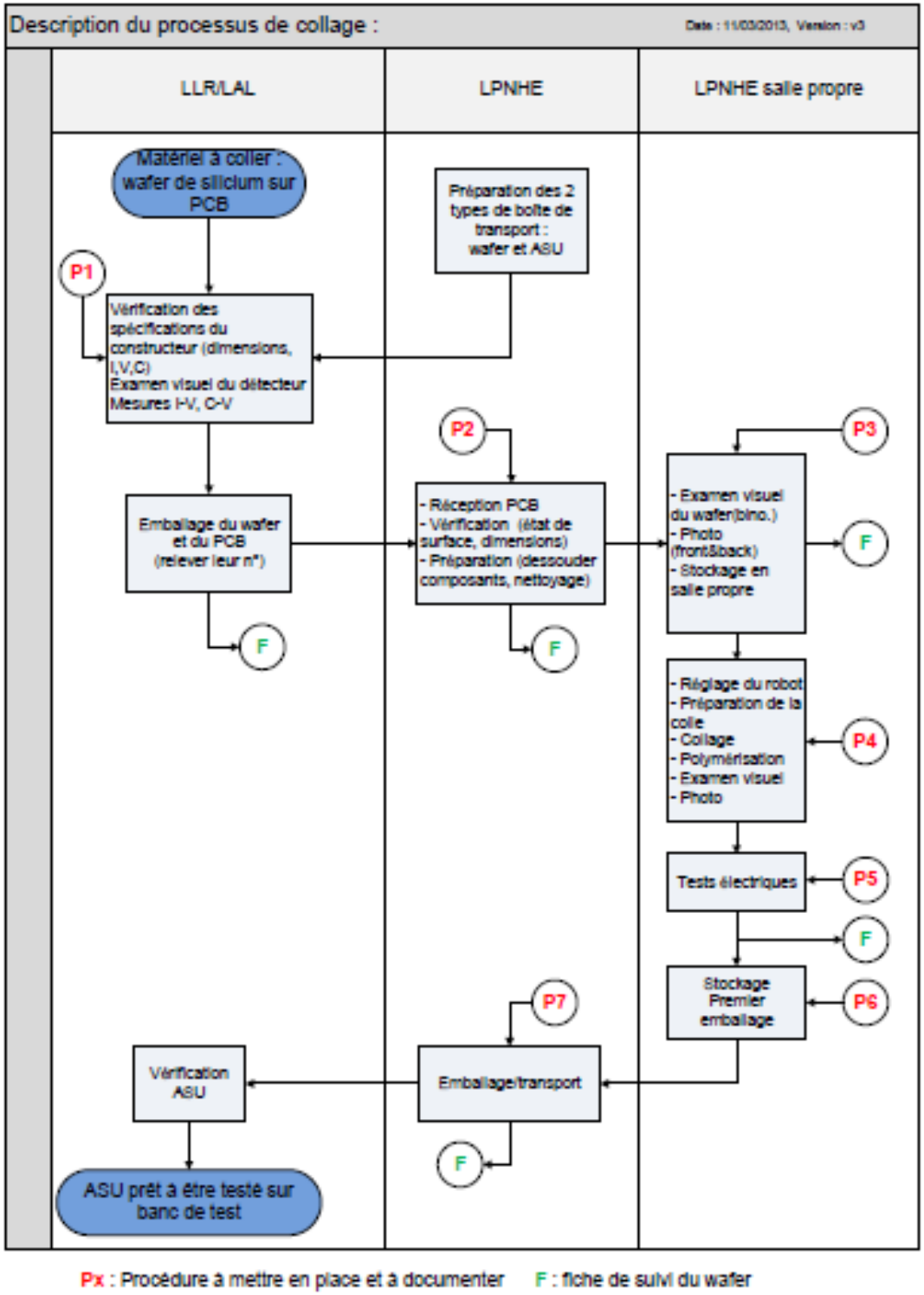
- Planarity tol.0.4 mm
- Size : 180.20 to 180.30 mm
- Thickness: 1.55 to 1.70 mm
- Squaring: tol. 0.05 mm
- Edge parallelism tol.0.05 mm



Rejection yield : ~40% (essentially due to a too large size for alveola)

Quality insurance

- Task flow completed
- Reception and gluing procedures for 1 and 4 silicon sensors written
- Operation on PCB monitored (follow up)
- Gluing tests registered
- ….



Industrialization

- First contact (LLR/LPNHE) with éolane

- Offer an industrial gluing process for mass production

- EOLANE would have the ability to dedicate one production line to our gluing process.

- Study of the compatibility of its know-how with
  - the material (glass then silicon)
  - the large dimension of PCB
  - the repeatability of the alignment
  - the quality of the glue and its heat treatment

Conclusion - Summary

- A fully automated gluing process is operational at LPNHE
  - Many tests have been performed with glass plates and with one wafer glued per PCB
  - The system is now used for the standard configuration (4 wafers / PCB)
  - 4 ASU have been done and will be used in test beam
  - 3 ASU will be done in the coming weeks

- Quality Insurance and controls put in place
  - PCB geometrical measurements
  - Electrical tests
  - Procedures
  - Data bookkeeping

- Contacts for industrialization of the gluing process started