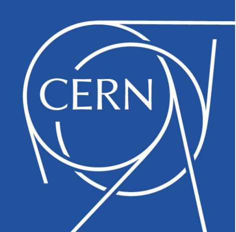

Institut de Física d'Altes Energies IFAE

Discarding low performance 3D sensors before bump bonding

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Outline

- IBL procedure to discard low performance 3D sensors before bump bonding
  - FBK
  - CNM
- Alternative method after UBM to investigate CNM sensors
- Results
- Conclusions

IBL procedure to discard low performance 3D sensors before of bump bonding

(Technical Specifications and Acceptance Criteria for the 3D Sensors of the ATLAS IBL)

- I-V measurements shall be performed on each detector at the wafer scale with a probe station by the manufacturer.

- It is needed a method to allow having all pixels at the same potential. (26.880 pixels/sensor)

Manufactures need to place an additional structure on the sensor to allow that.

CNM sensors: Guard ring selection method

FBK sensors: Temporary metal selection method

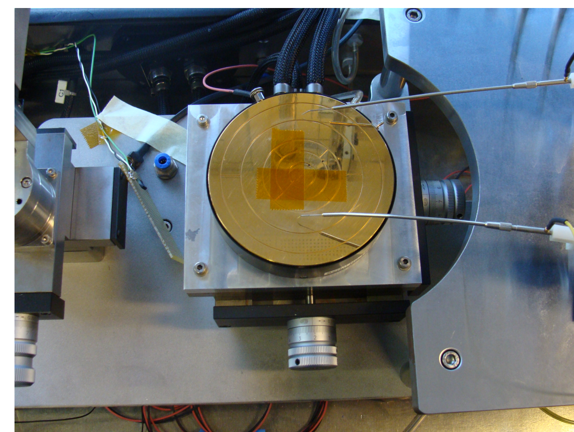


Fig 2. Top view of a probe station

FBK sensors
Temporary metal selection method

- A metal line deposited after the completion of the process for each column.
  (1mask, deposition, metal attack ≈ 25 €/ sensor ≈ 10% sensor cost)

- Probing pads are used to measure the I-V at the column level.

- This operation is performed automatically on the 80 columns. After the I-V curves are obtained, the temporary metal is removed.

- Full current drawn by the sensors is measured.

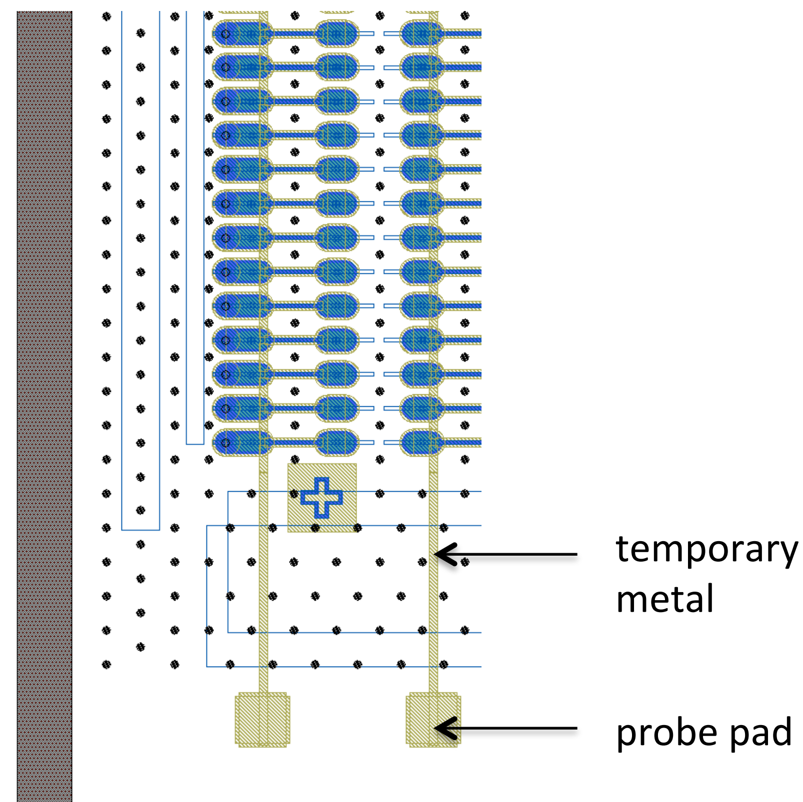
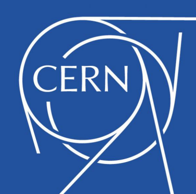


Fig2. Top view of FBK sensor



CNM sensors Guard ring selection method

- Guard ring structure: n implantation connected by metal is placed surrounding the sensor active area. (No additional cost)
- It is not meant to represent the full current drawn by the sensors.

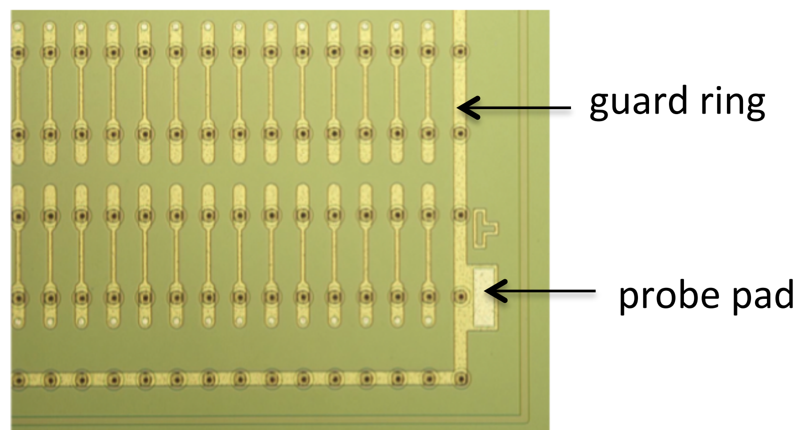
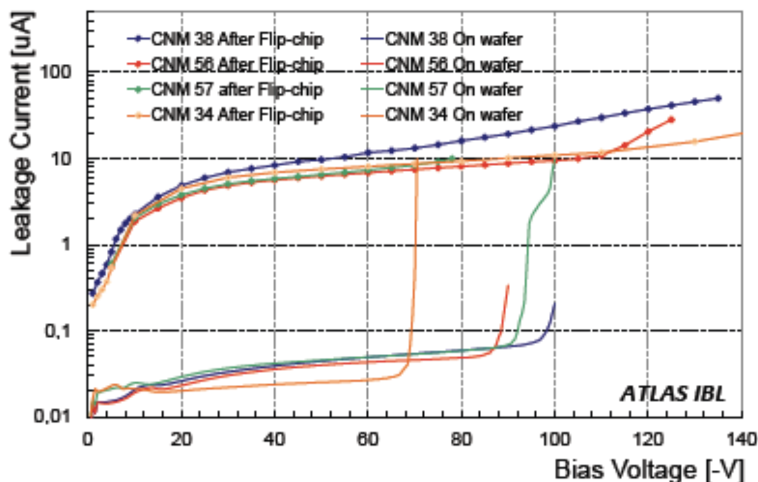
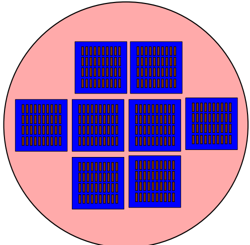


Fig3. Top view of CNM sensor



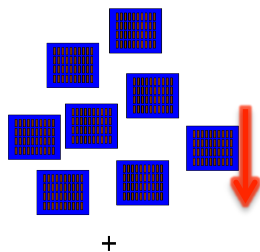
(2012 JINST 7 P11010)

- It is based on the assumption by punch through effect almost all defects were detected
- Good results in IBL pre production
- During IBL production no correlation found

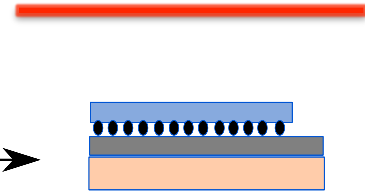


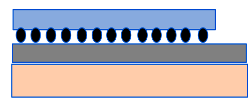
Alternative method after UBM

a) Sensor production in wafer

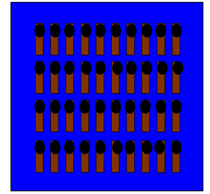


b1) Dicing





c) Flip chipping



b) UBM (6-8 µm Cu)

Fig 3. Fabrication process before flip chipping

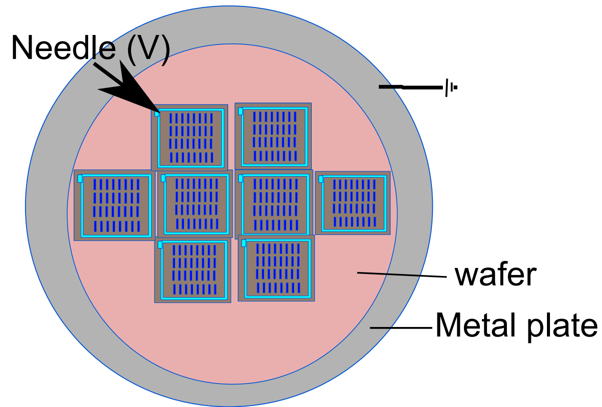
Alternative method: I-V after UBM

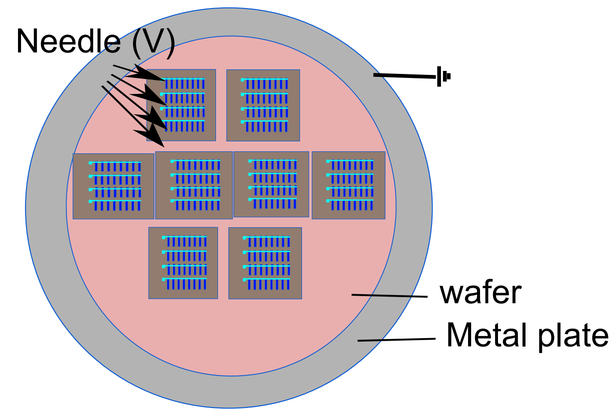
- After UBM every pixel owns a metal pad
- By placing the pixel sensor side on a metal chuck all pixels are grounded.
- All active area current is measured
- Drawback: dirtiness on the bump surface

IBL procedure: I-V at the wafer scale

Guard ring method

Temporary method

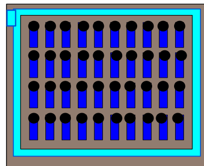




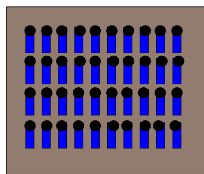
at wafer stage

New method -after UBM

CNM sensor



FBK sensor



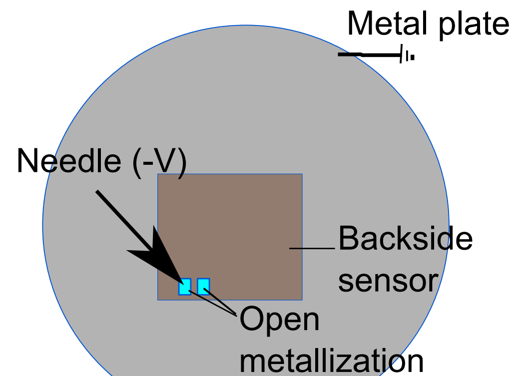


Fig 4. Measurements on a probe station by the guard ring, temporary and new method

Measurements performed

CNM sensors (x 10)

- IV measurements on guard ring (wafer)
- IV measurements after UBM

FBK sensors (x 4)

- IV measurements on temporary metal (wafer)
- IV measurements after UBM

Results on CNM samples

✓ A lower breakdown voltage was found by performing I-V's by the new method in comparison with the guard ring method at the wafer stage.

CNM samples

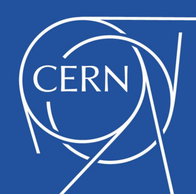
V_bd Pixel method [V]

<V_bd Guard ring method [V]

✓ The method was implemented in IBL. It was decided to re-test all CNM sensors after UBM.

72 green + 120 yellow/red sensors were sent from IZM to CNM to be re-tested.

92 sensors were back from CNM to IZM to be flip chipped (47%)



Results on FBK samples

- ✓ Similar breakdown voltage was found by performing I-V's by the new method in comparison with the temporary method at the wafer stage.

FBK samples

V_bd Pixel method [V]

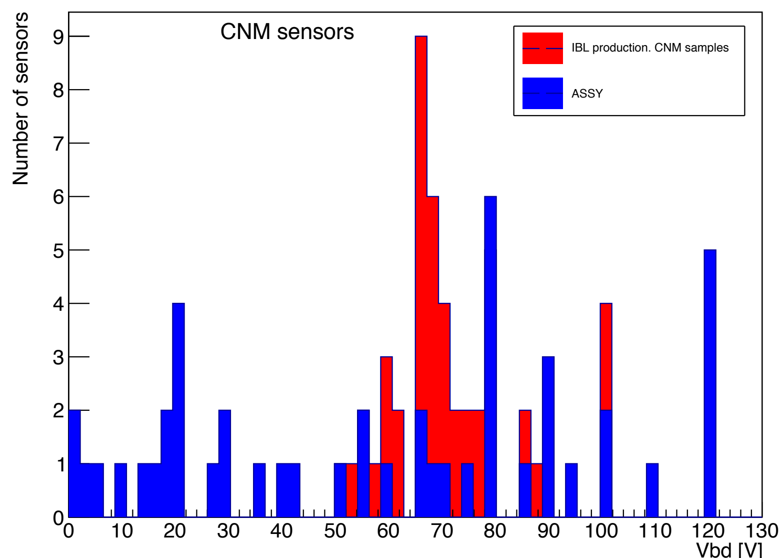
80
70
60
50
40
30
20
10

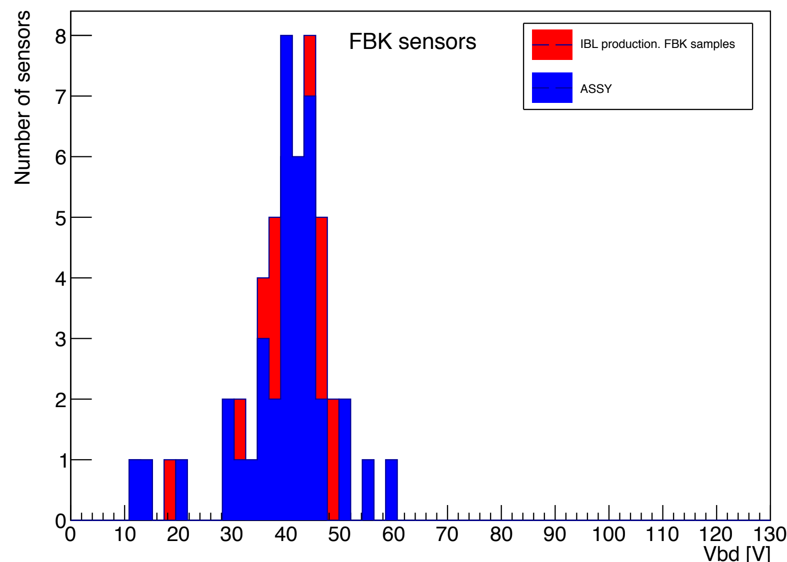
10 20 30 40 50 60 70 80

<V_bd Temporary method [V]

From the IBL production

- ✓ Breakdown voltages values were compared between wafer production and after full assembly. (47 CNM samples & 39 FBK BEFORE the re-testing of CNM ones)



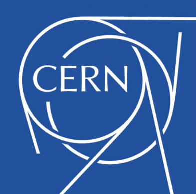


- ✓ CNM sensors show no correlation, while FBK ones do. That is what it was saw with the new method.

- ✓ Interesting to analyze the same for CNM ones after re-testing

Conclusions

- ✓ To test the method reliability, more statistics & I-V measurements after flip chipping are mandatory.
- ✓ Guard ring (at wafer) – measurement after UBM presents no correlations. The Guard ring structure is not as useful as it was thought.
- ✓ Temporary metal (at wafer) – measurement after UBM presents correlations. Preliminary data analysis on the IBL production shows the same.



Thank you.

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