Performance of high-density indium bump-bonding

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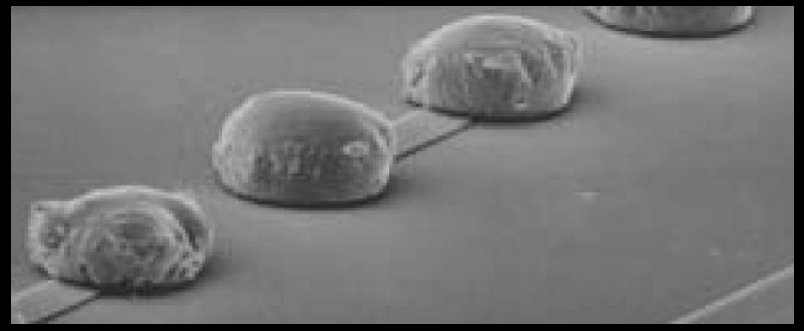
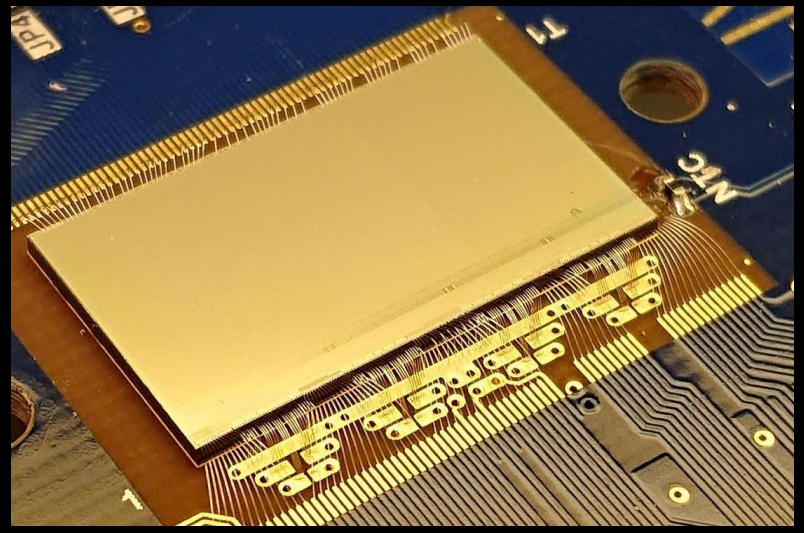
Flip-chip bump-bonding

- The bump-bonding techniques:
  - Electrically and mechanically connect sensor and front-end chip
  - Work at the contact density required for the ATLAS high granularity pixel detector (40 000 contacts/cm^2, with a pixel size of 50 x 50 µm^2)
  - Two different bump-bonding technologies:
    - Solder bump (Sn-Ag)
    - Indium bump ⇒ analyzed in this presentation and poster
- Issues:
  - Planarity between FE and sensor during flip-chip
  - Deformations coming from internal stress of the chip

  Are critical parameters due to:
  - Large sensor and chip size (minimum size ~ 20 x 21 mm^2)
  - Low components thickness (100 – 250 µm)
  - Working temperature (~ 90° C for In bump)



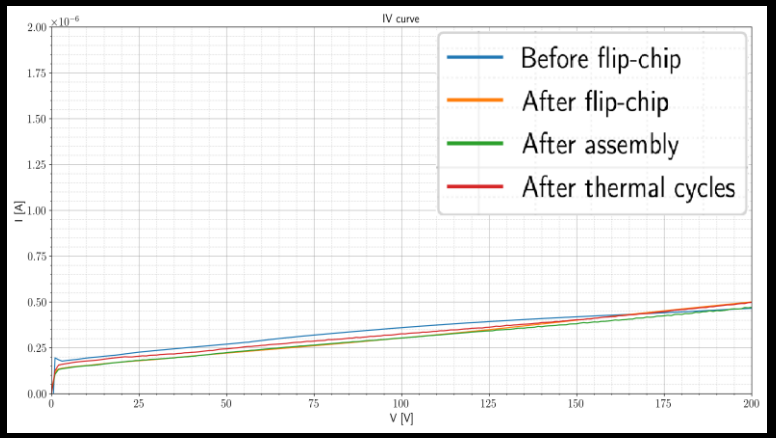


It is necessary to estimate bump contacts failure!

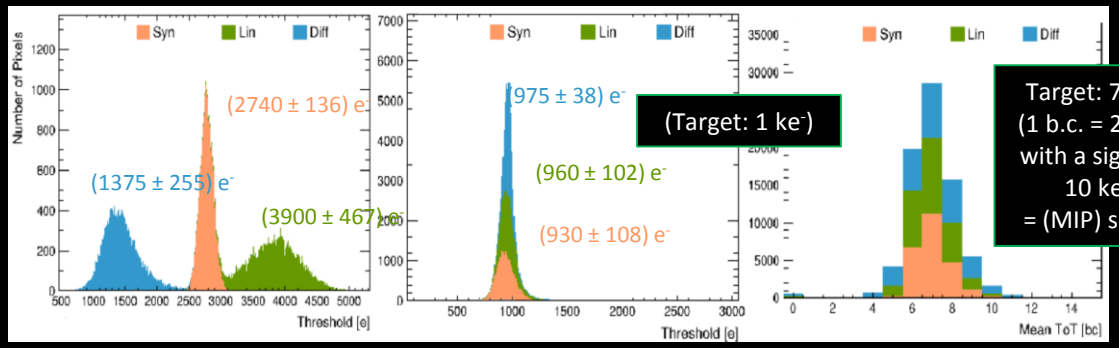
Testing procedure and results

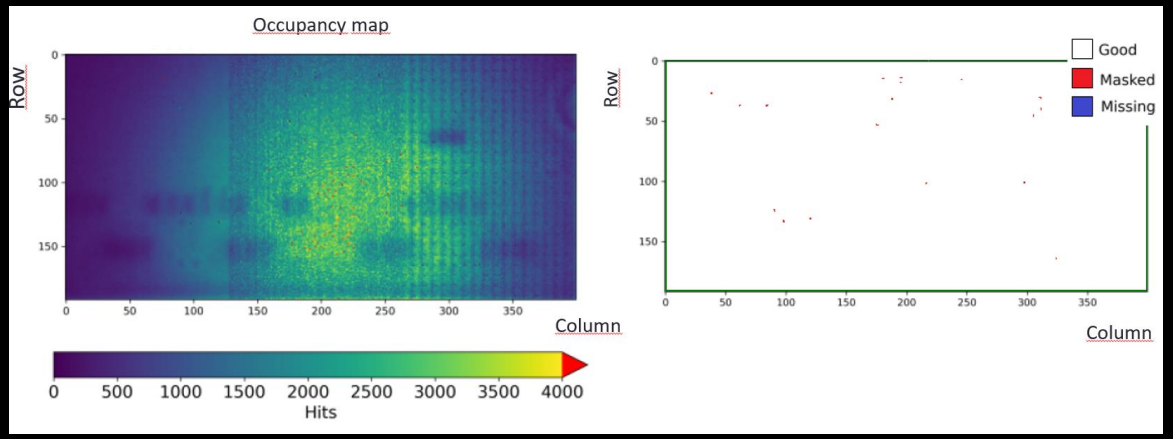
1) I-V characteristics at different production stages show breakdown > 200 V
2) Threshold and Time Over Threshold (ToT) tuning. If read-out electronics does not work as aspected ⇒ pixel is disabled
3) X ray (or radioactive source) show pixels with no hit. It is crucial to distinguish
   - Missing bump (pixel with bad or no bump connection)
   - Disabled pixel (masked during tuning scans)

✓ Measured failure rates (10^{-5} for *single-chip module* and 8×10^{-4} for *dual-chip module*) much better than ATLAS specifications ($< 8 \times 10^{-3}$)



Th. distrib. before tuning | Th. Distrib. after tuning | ToT distrib. after tuning





Backup

Indium bump-bonding production steps