

Extra flip-chip bonding results

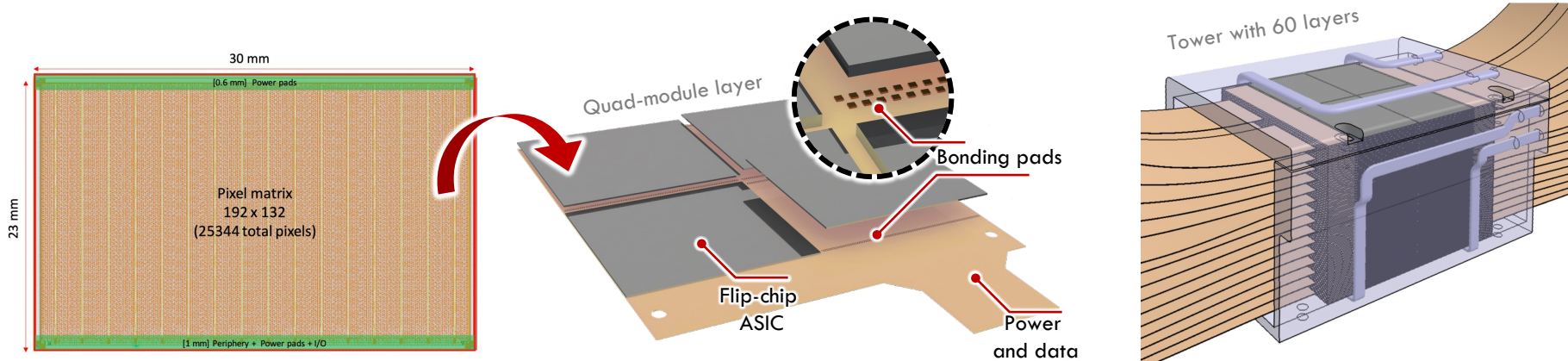
The 100µPET scanner

ASIC, module/layer, tower

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Multi-layer stack of CMOS imaging sensors

- **100µPET MAPS: 130 nm SiGe BiCMOS; 2.3 x 3 cm²; 150 µm pixel pitch; 270 µm thick; 4 kOhm*cm p-substrate; ~0.5W power**
 - Designed foreseeing flip-chip bonding, the size and pitch of the bonding pads allows integration with standard PCB/FPC production
- Single silicon detection layer composed by **2x2 ASICs flip-chip** to a flex printed circuit, covering **24 cm²**
 - In addition to the thin MAPS, a **50 µm thick layer of Bismuth** is added above the MAPS to increase the photon conversion rate
- **60** detection layers + cooling block compose each scanner **tower**, with 4 towers per scanner (for a grand total of **960 chips!**)



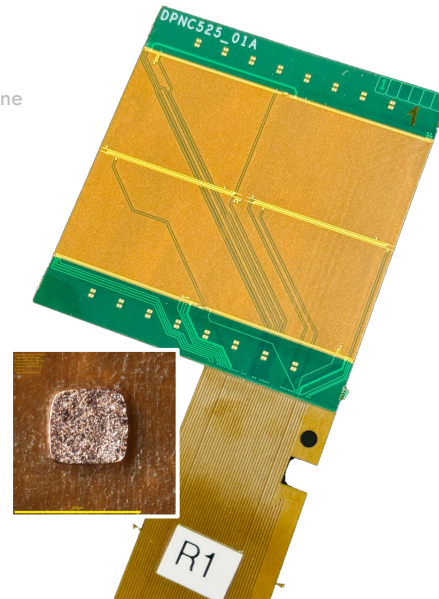
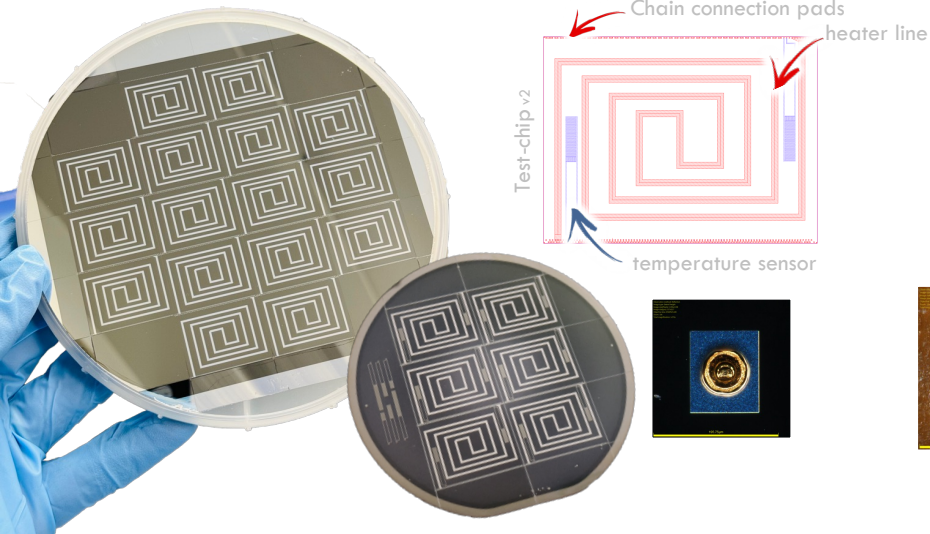
100µPET module demonstrator

Design and production

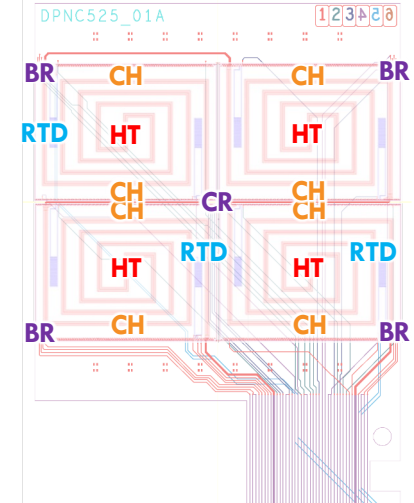
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- **240x 300 µm thick test chips:**
 - 4x 4-wire single-bond resistance, 1x resistive heater (1 µm thick Al), 2 RTDs (PT1000-ish), 1x 162-pads chain and 1x 82-pads chain
 - 4x 4-inch wafers produced at NMP-FCBG and 15x 6-inch wafers from CMi (no RTDs)
- **60x test flex (+ 2x beck-end prototype system)**



- 3x Resistive Temperature Detectors
- 5x Bond Resistance (4-wires)
- 4x Heaters in series
- 8x Chains (4x w/ 162 pads, 4x w/ 82)

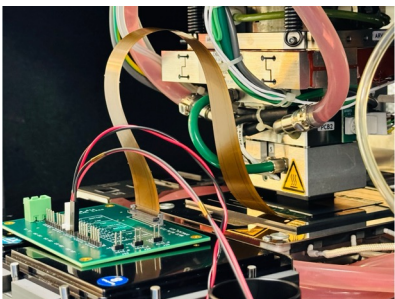
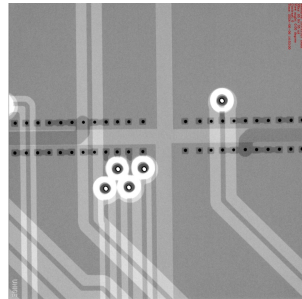
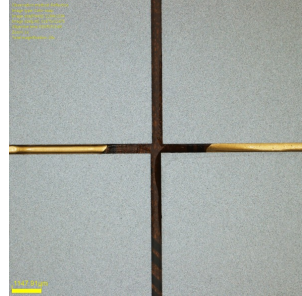
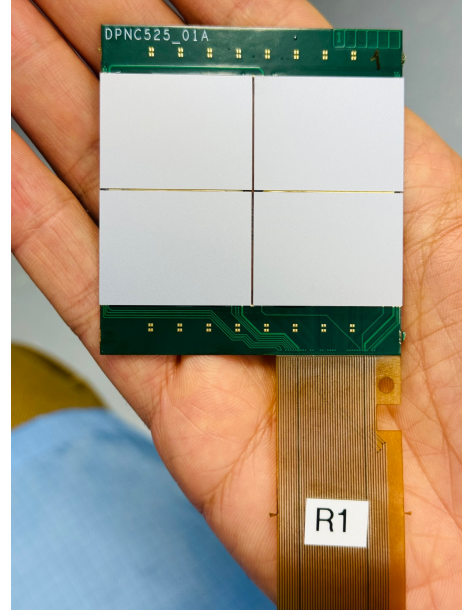
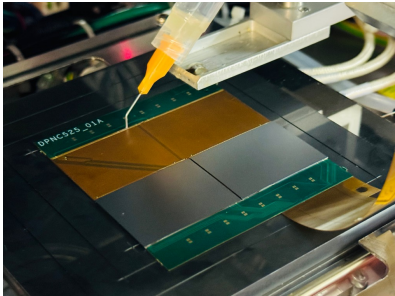


100 μ PET module demonstrator

Reference module



- Bonding reference module with flip-chip machine
 - ▣ We are putting in place the data-base tracking, handling the temporary storage, module quality control tests and etc



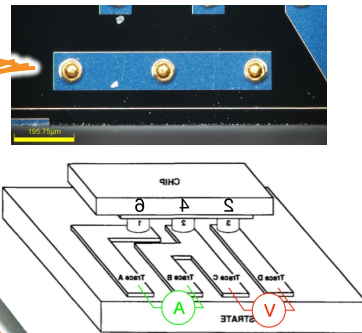
100µPET module demonstrator

Reference module characterization

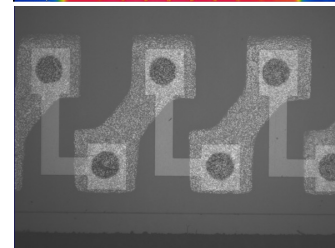
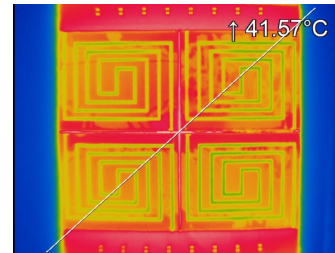
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- ❑ Bond resistance of ~10 mOhm and uniform over module's 4 corners and center
- ❑ Chains of pads indicating no open connection in ~1000 pads (**bonding yield >99.9%**)
- ❑ Heater system is working as expected, with 8°C increase in temperature at nominal module power (2W)
- ❑ New assembly jig for simultaneous 4-chip bonding (we need 240 4-chip modules in total!)

Pads for single-bump 4-wire measurement

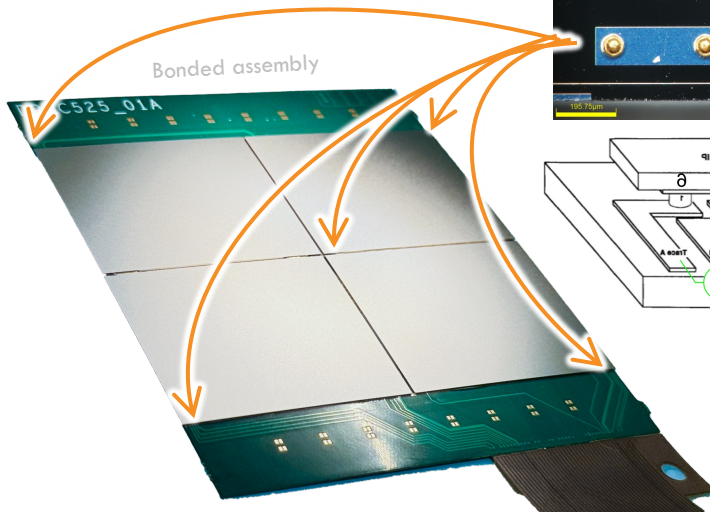
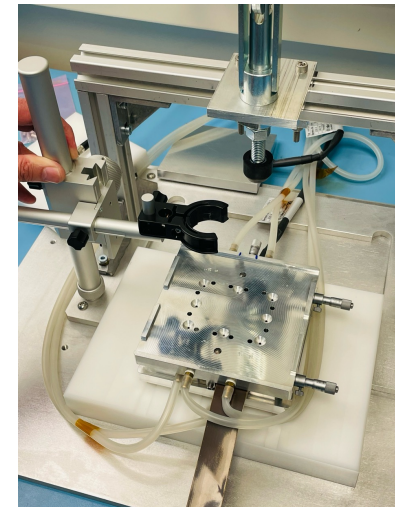


Power injection on heater and thermal image



Pads for chain continuity test

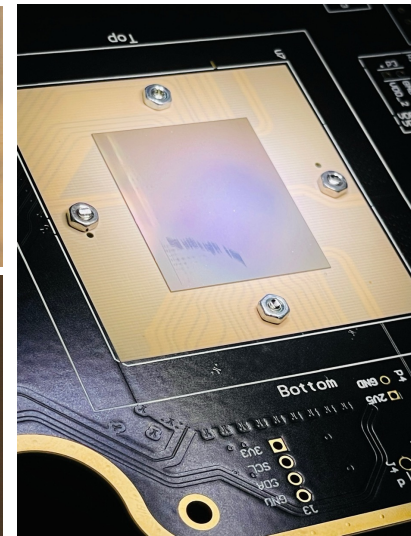
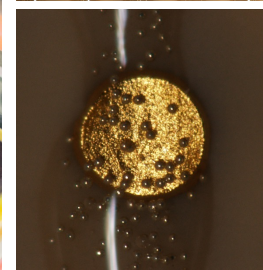
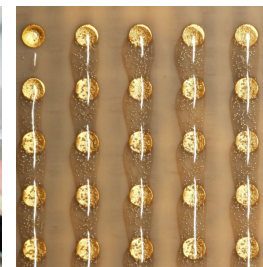
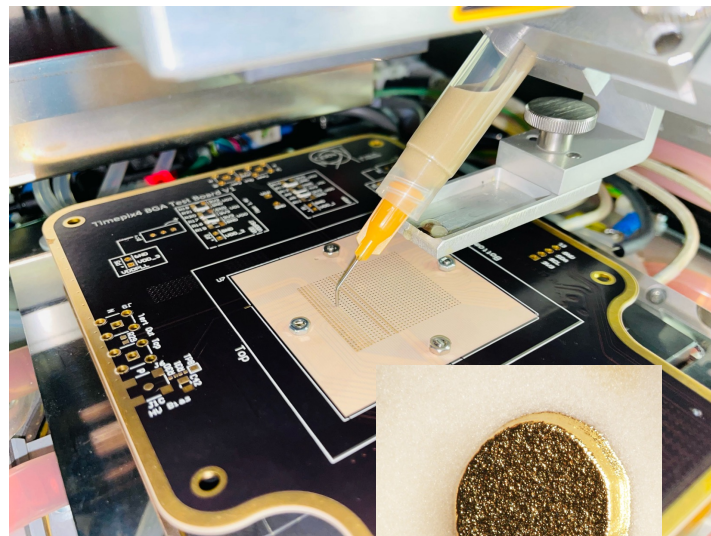
4-chip bonding tool



Timepix4 TSV bonding with ACP

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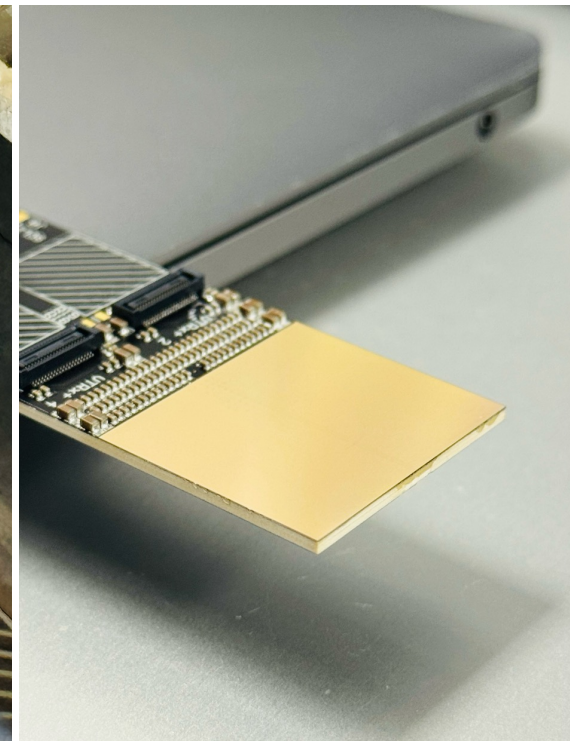
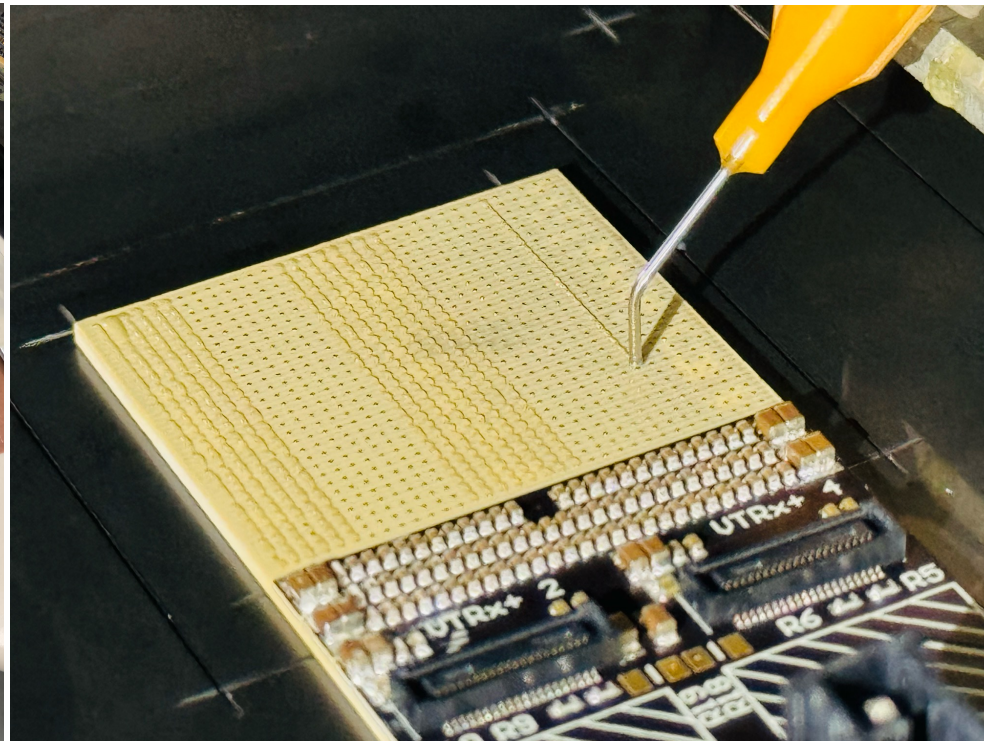
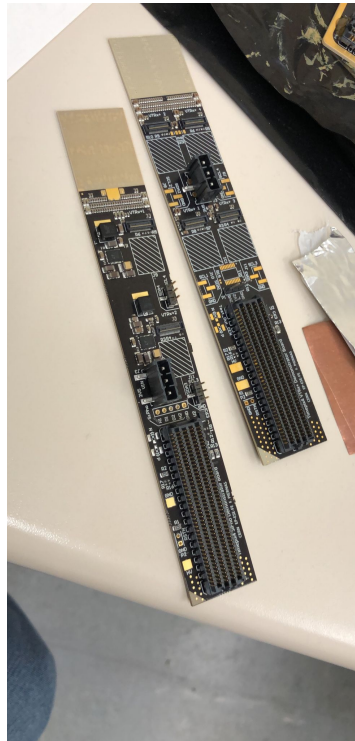
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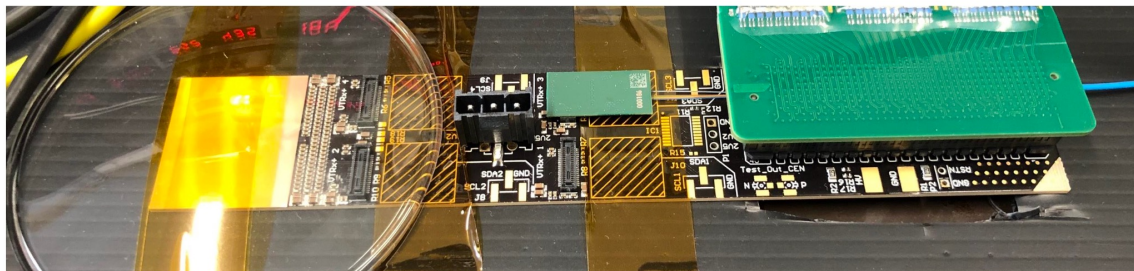


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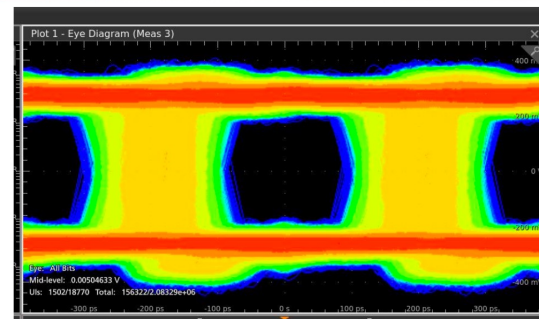
5. First Results and Future Work



Opto-demonstrator module

Timepix4.1 TSV, bonded with ACP glue

- Eye diagram through **optical fiber** at 2.56Gbps.
- This version of the chip has **problems with jitter**.
- Waiting for TSV processing of Timepix4 V3



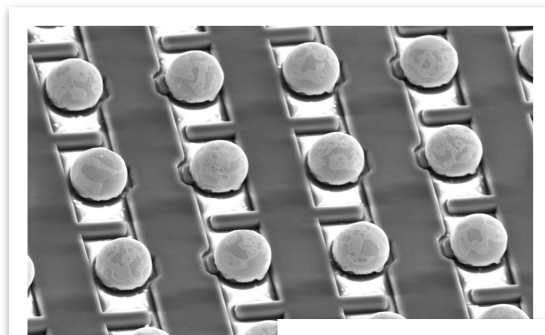
Timepix4 Hybridization with Cu pillars

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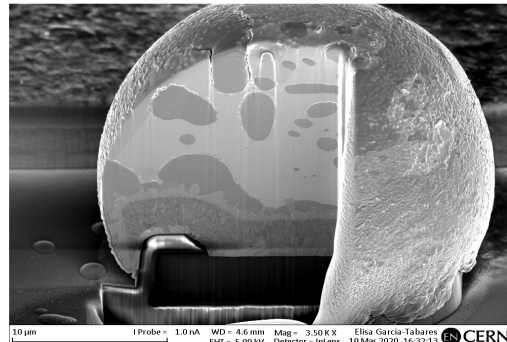
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Hybridization pads/bumps

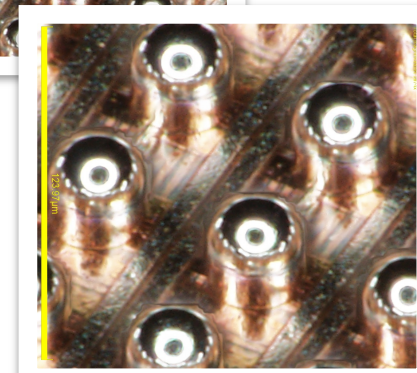
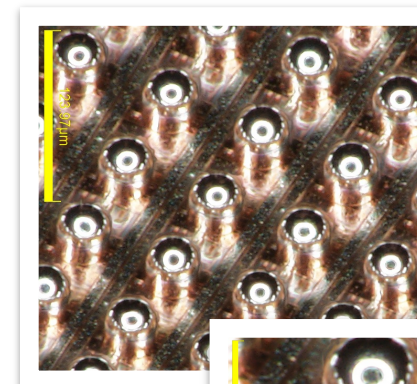
Standard (SnPb) bump-bonds



20 μm EHT = 20.00 kV
WD = 28.0 mm
Aperture Size = 60.00 μm



*“New” copper pillars
(with Sn1.8Ag caps)*

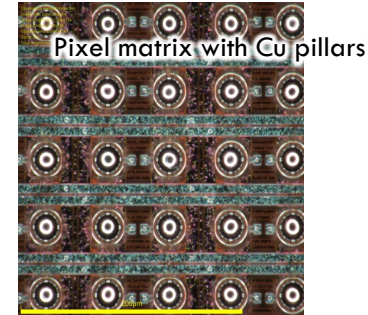
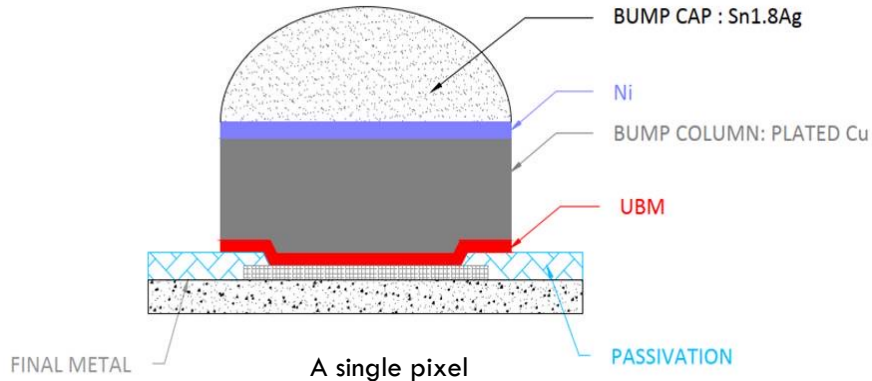
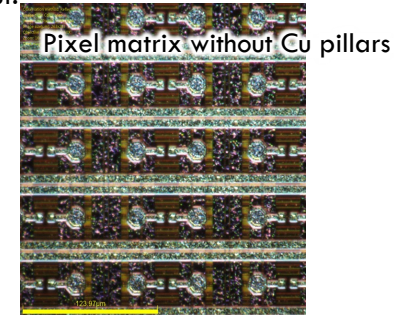
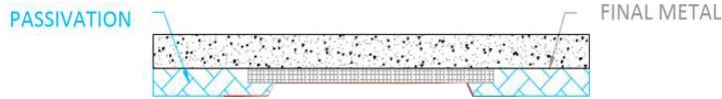


Timepix4 Hybridization with Cu pillars

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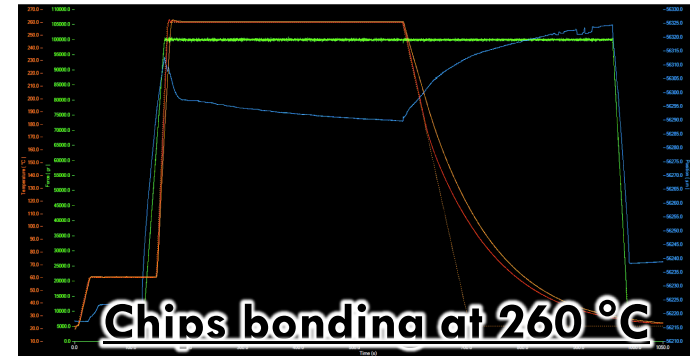
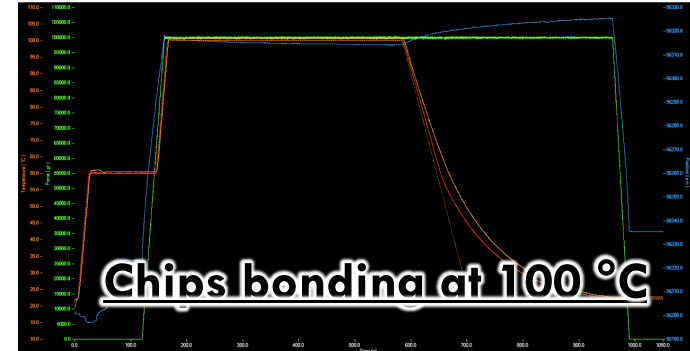
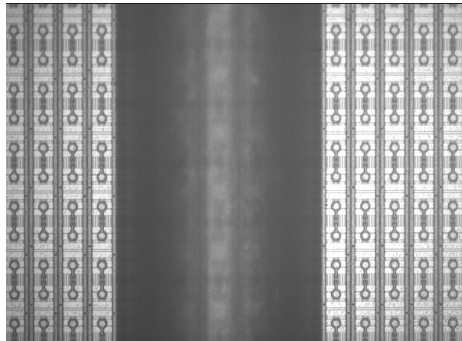
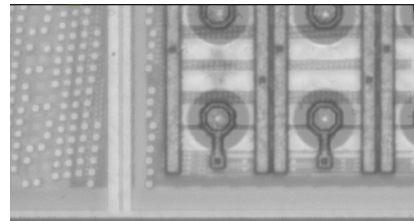
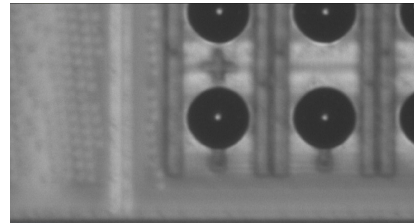
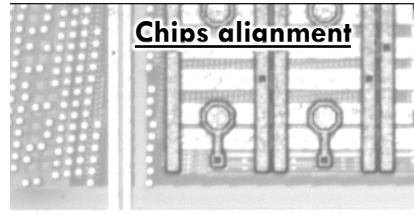
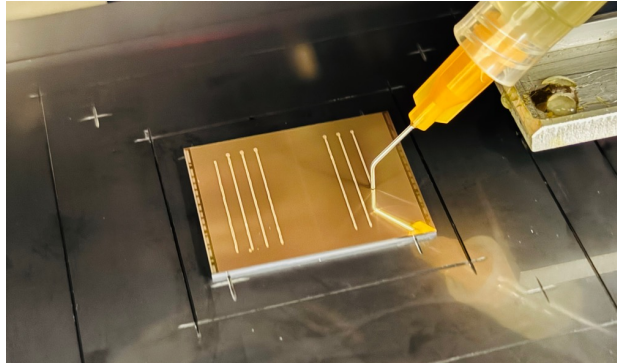
The plan: Bonding two Timepix4, one with Cu pillars and the other without.



Timepix4 Hybridization with Cu pillars

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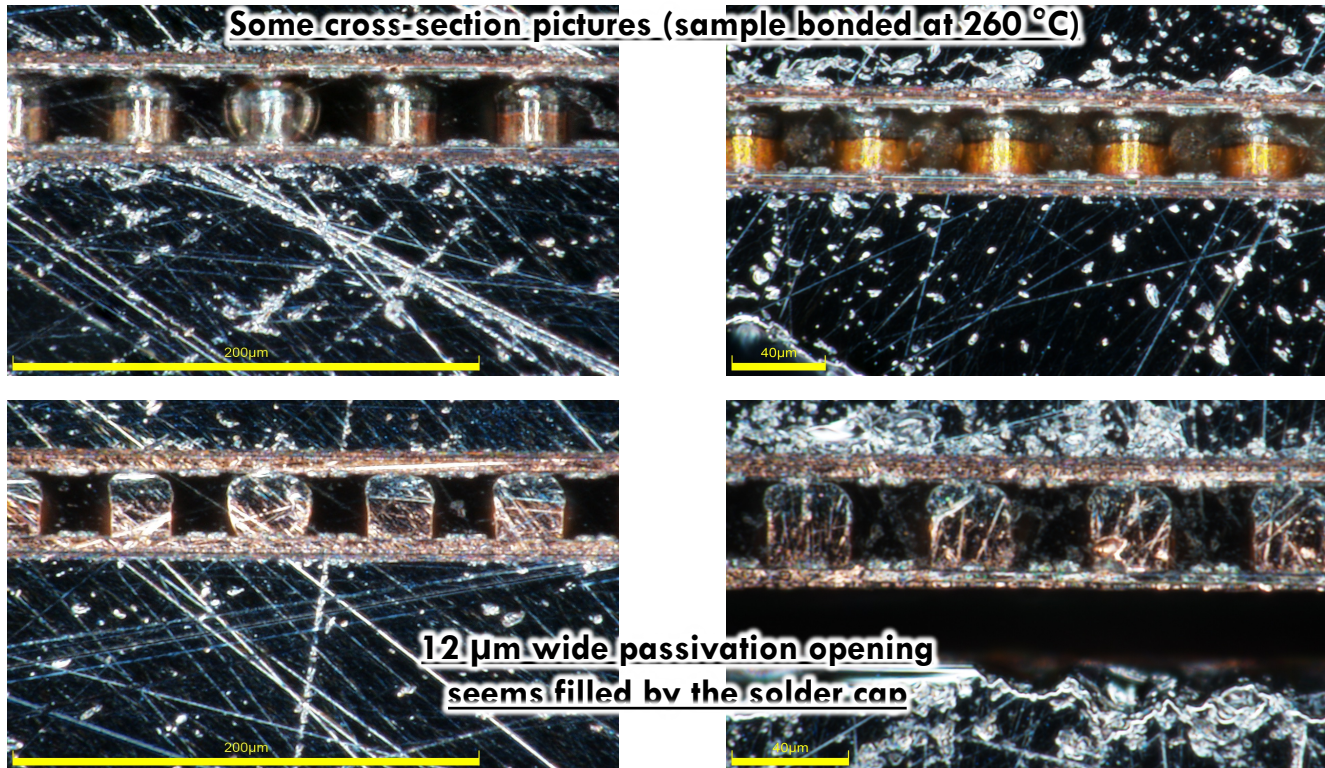
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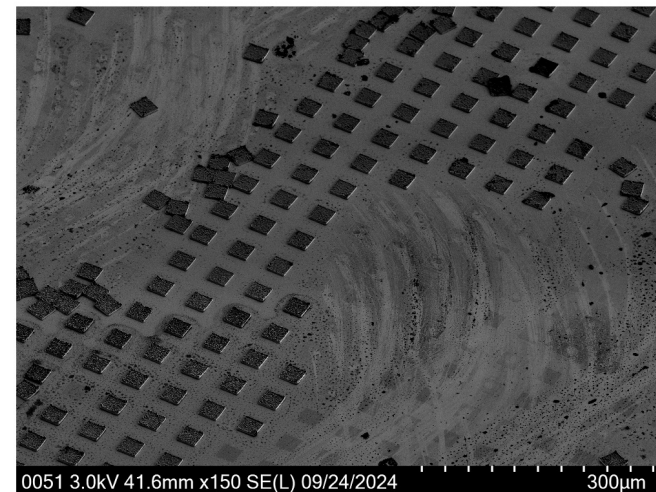
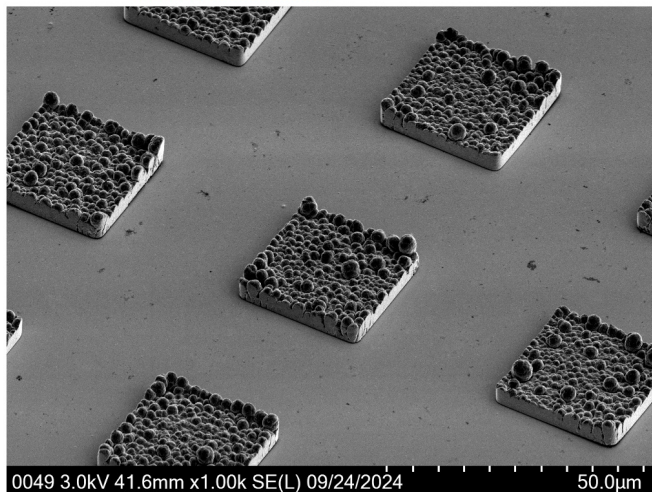
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Targeting 10 μ m

- Comments:
 - Correct Height
 - poor Adhesion



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Time calculation and observation

20 minutes process gives approximately $20\mu\text{m}$

- Comments:
 - The pillars grew higher than the pattern because of a too long process time
 - Non-uniform coating
 - Weak adhesion

