Interconnections and multi-chip flex developments

1st DRD3 week – Interconnect technologies: WG7

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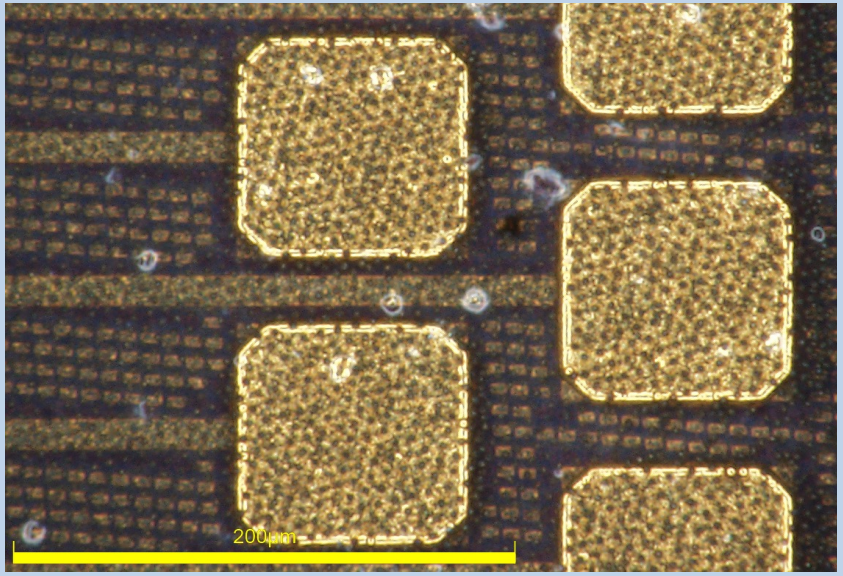
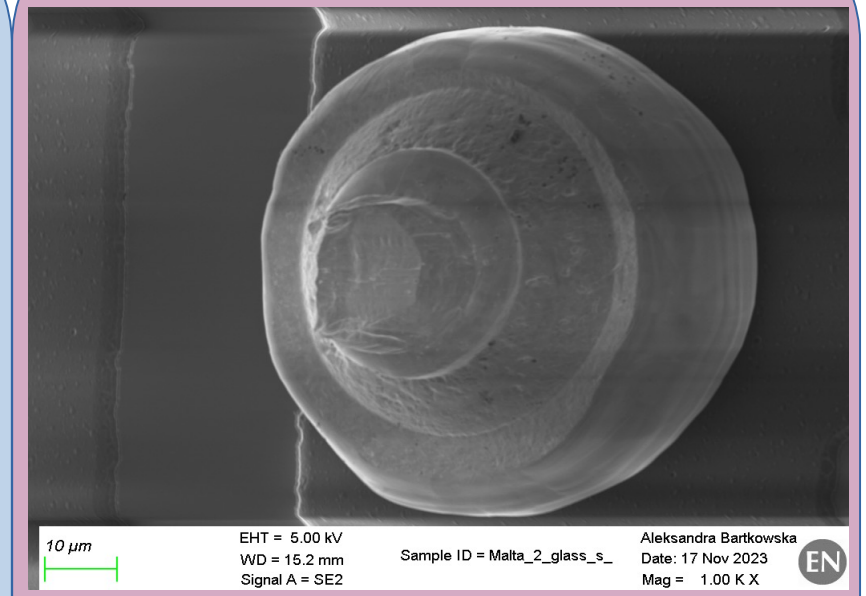
Interconnection technologies for modules

ACF



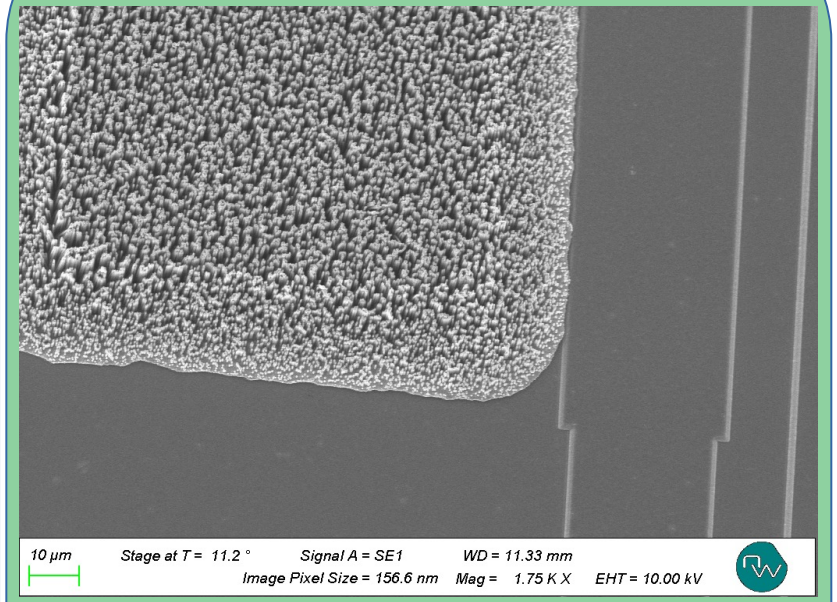
- **Cost effective**
- **In-house** processing
- **No mask** needed

Gold studs



- **Individual** pad selectable
- **Touch before** bond possible
- **No mask** needed

Nanowires (NW)



- **Low** resistance and parasitic
- **Glue-free** process available
- **Chip** and **wafer** level

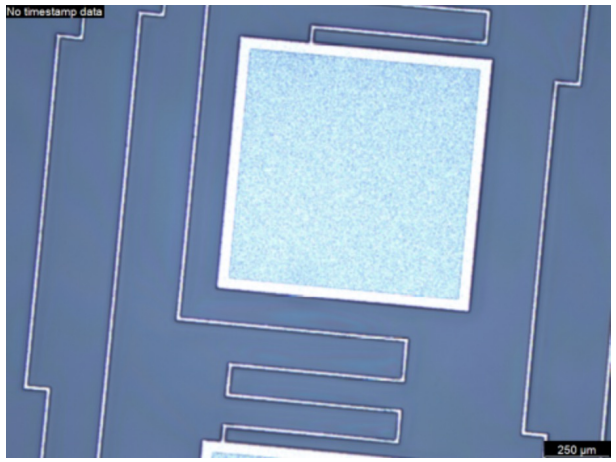
Conpart
We connect.
Dexerials

- **Scalable** on chip-chip or flex-chip
- **Glue support** for mechanical stability
- **Fast** interconnection
- Suitable for **large number of pads**

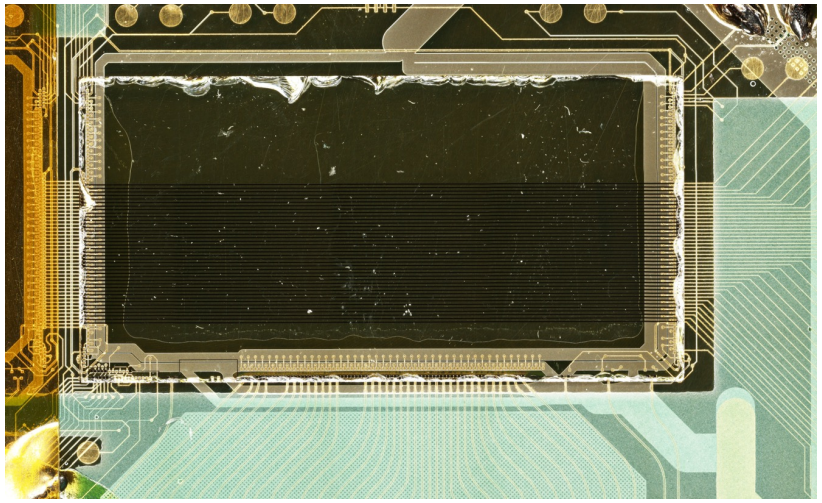
nanowired
connects...
.swiss, it's who we are !
HYBRID.swiss

Test structures

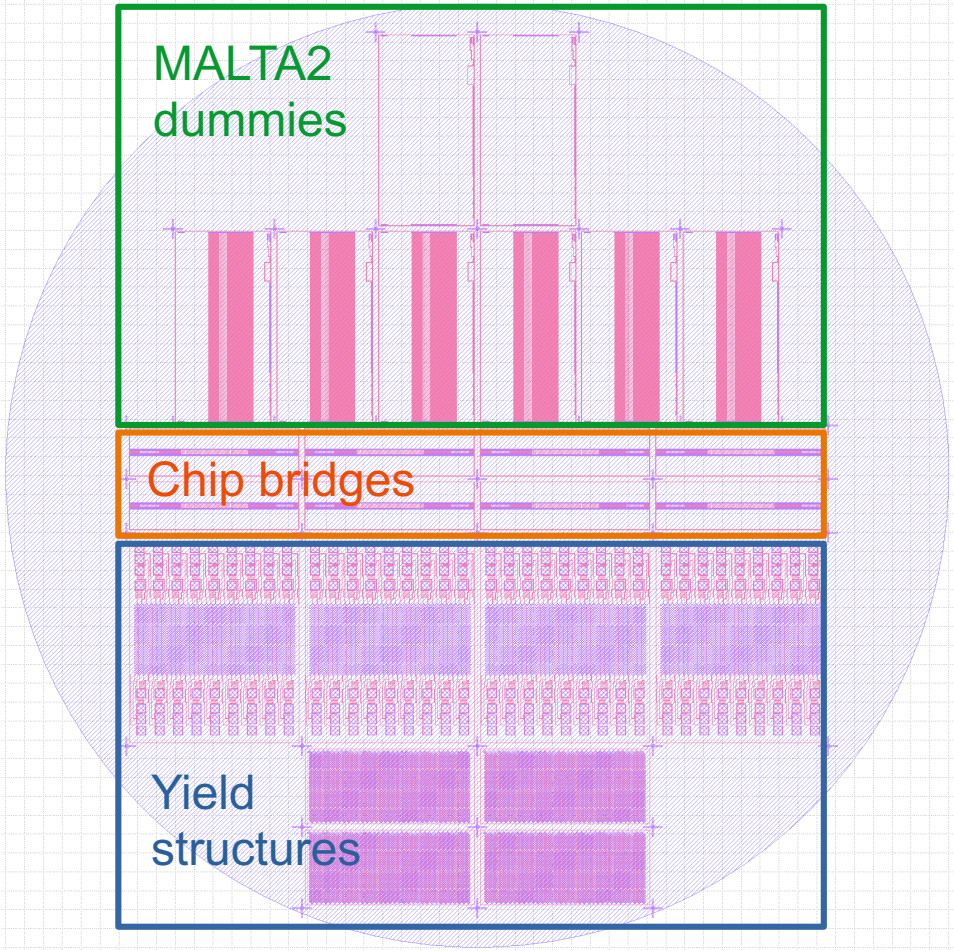
- Test structures have been produced by us at CMi in Lausanne
- 14 process steps
- Single layer Aluminium with SiO_2 passivation
- Evaluating connection yield, mechanical tests and bonding process optimization
- Produced 4 wafers with ~100 test structures



Test pad with SiO_2 opening



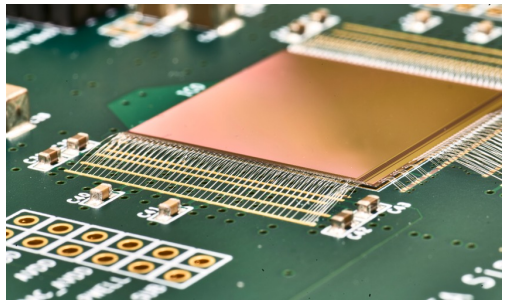
Bonded test structure on flex



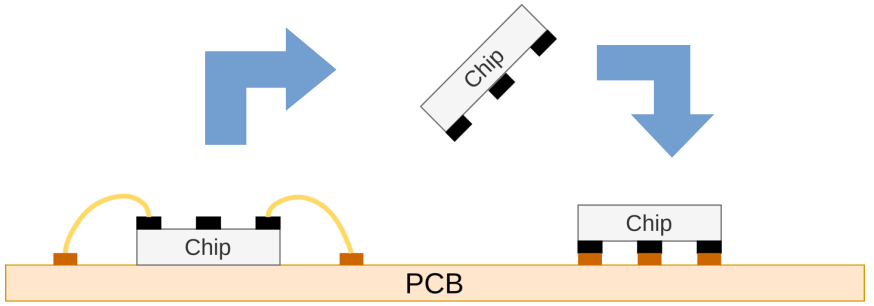
Ultra-thin module flex development

A flip chip mounted module provides:

- **No minimal spacing requirements between the chips**
- A **scalable interconnection**
- Interconnection is **not mechanically exposed**



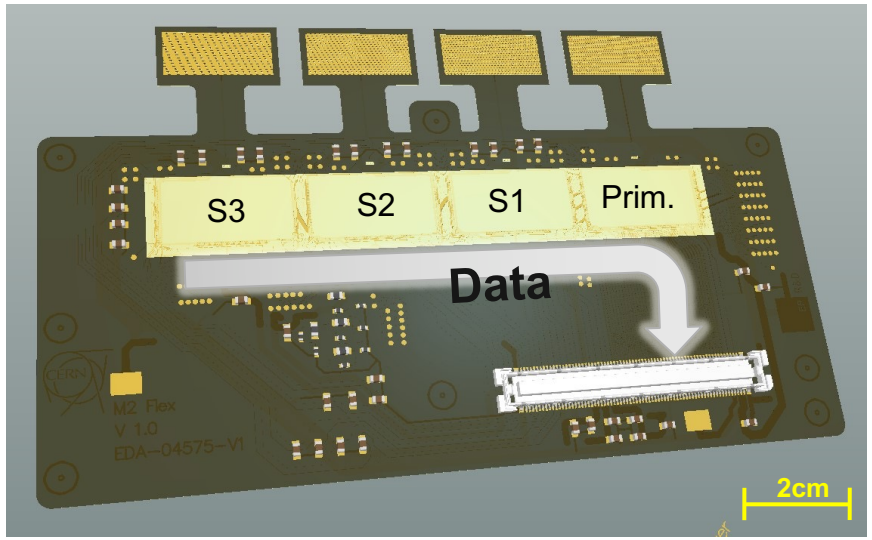
Wire bonding approach



Flip chip approach

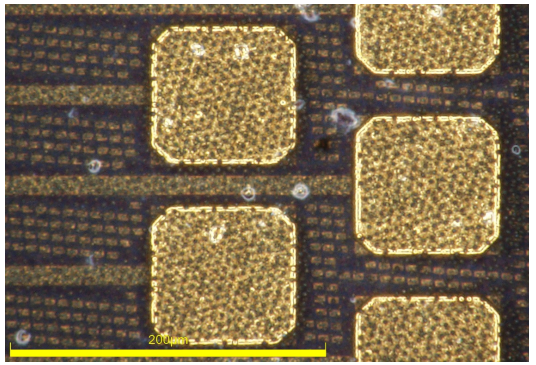
Designed dedicated flex PCB for a 4-chip module compatible with flip chip mounting.

- Design goals are **low-mass**, **large active area** module integration
- **Two-layer** layout ~30µm high with 17µm trace width and spacing

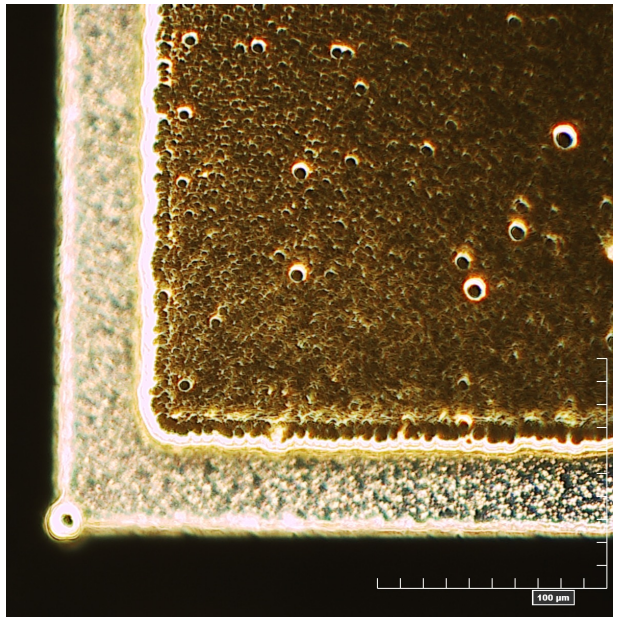


Data transfer from chip to chip

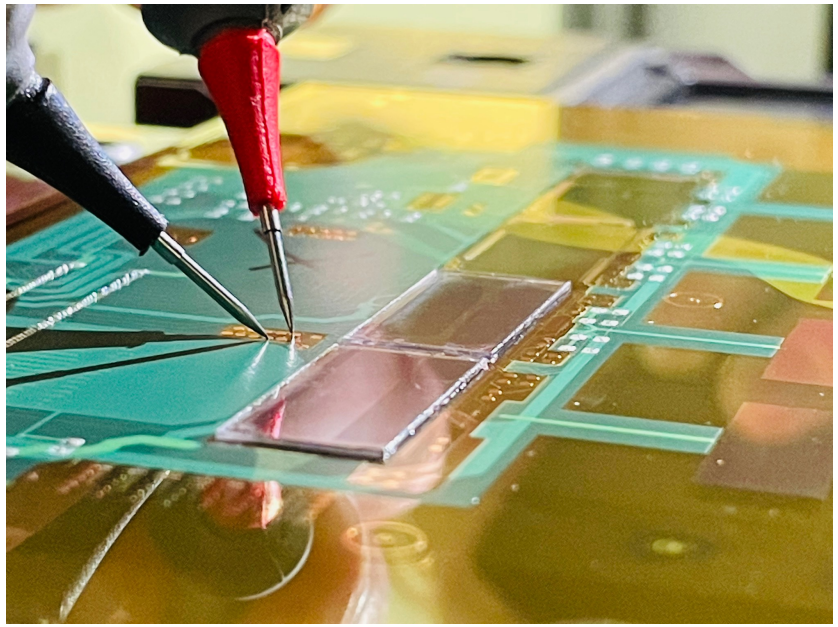
ACF bonding on flex



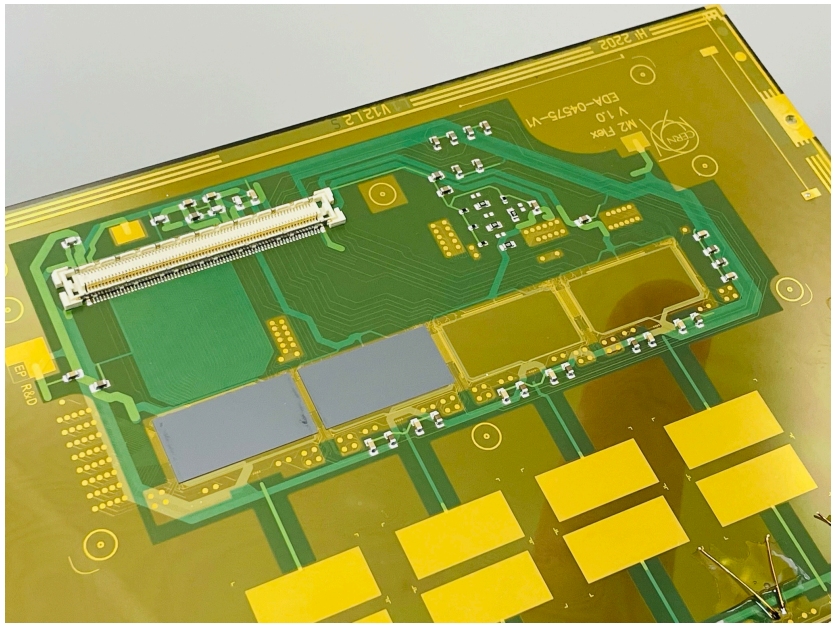
- Successfully bonded test structures and sensors using ACF
- Successful configuration of sensor and reference bit triggering
- In-house ENIG plating used as pad elevation for ACF process



In-house ENIG plating

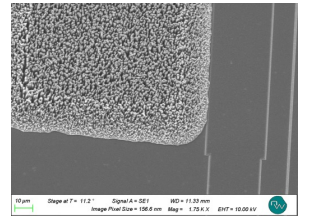


Electrical characterization of interconnection

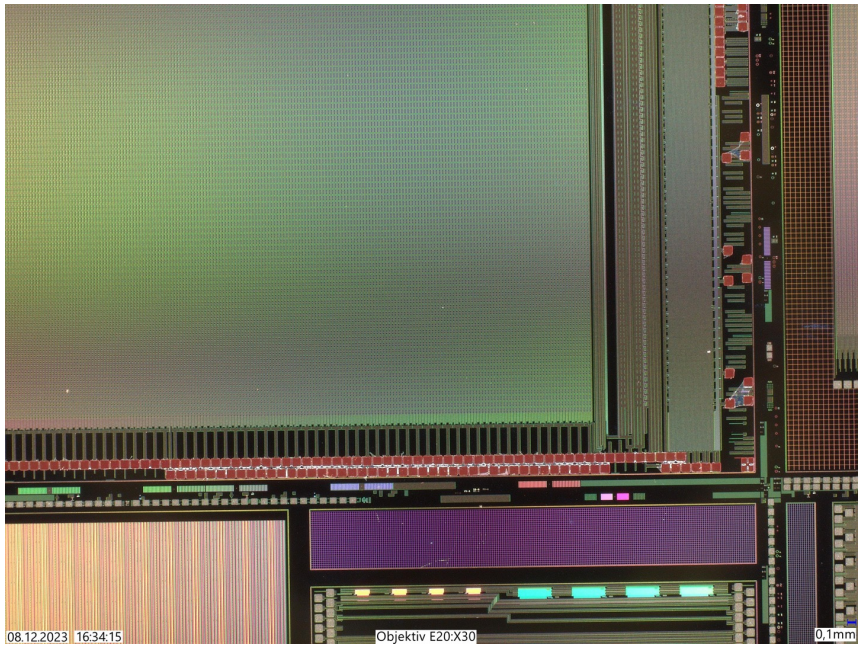


ACF-bonded chips on flex

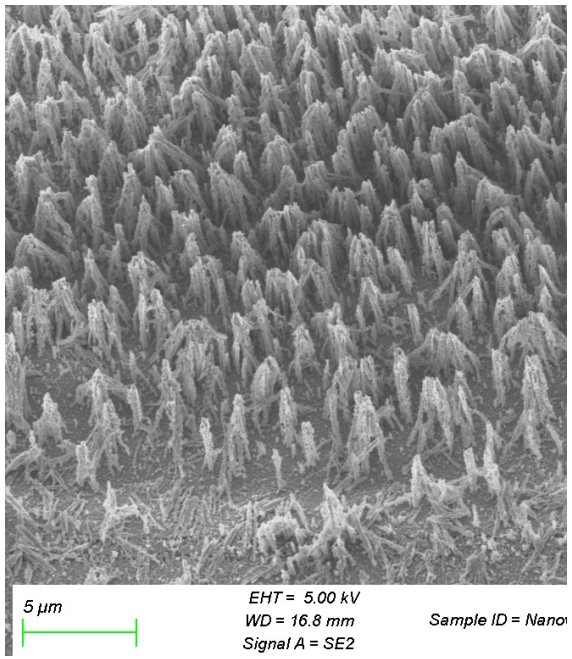
Nano-wires deposited on wafers



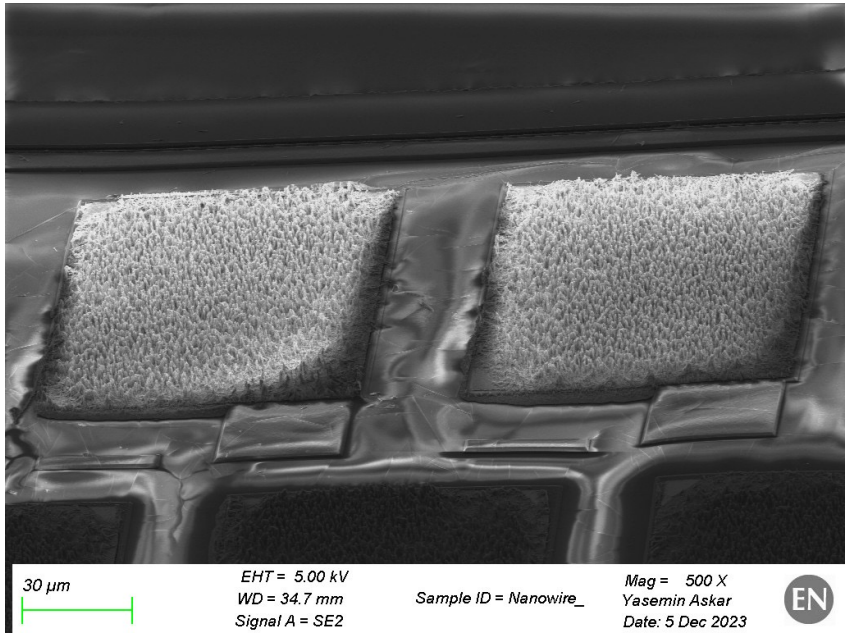
- MALTA2 **wafers** processed (88µm x 88µm aluminum pads with 32µm spacing)
- Currently **>90% pads** with perfect coverage, pads with **partial coverage that are still bond able** – no impact on MALTA2 performance
- Possible to **probe wired pads** with probe-card



Wafer scale wire deposition

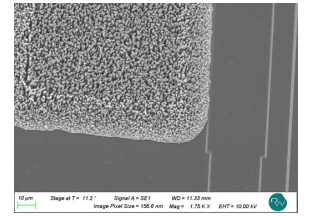


Close view



Nano-wires on chip pads

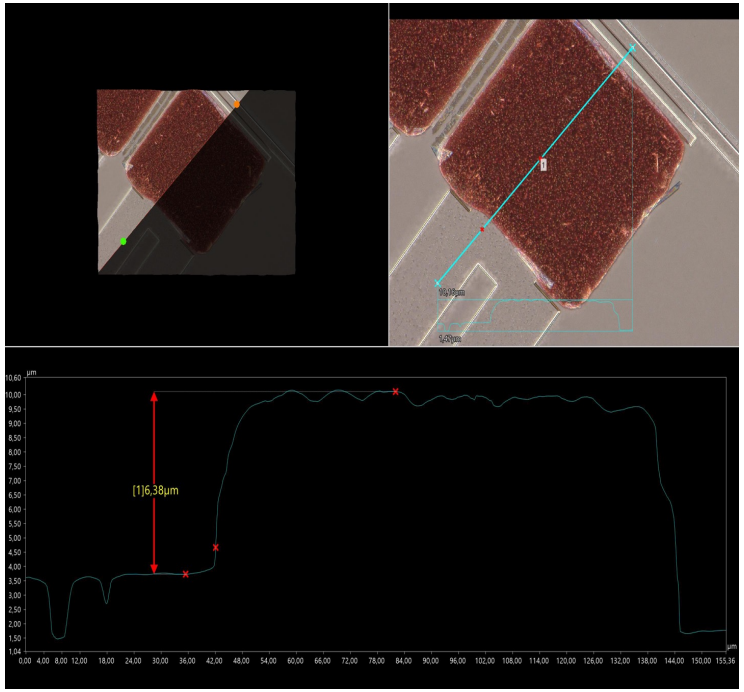
Nano-wire bonding of a chip on flex

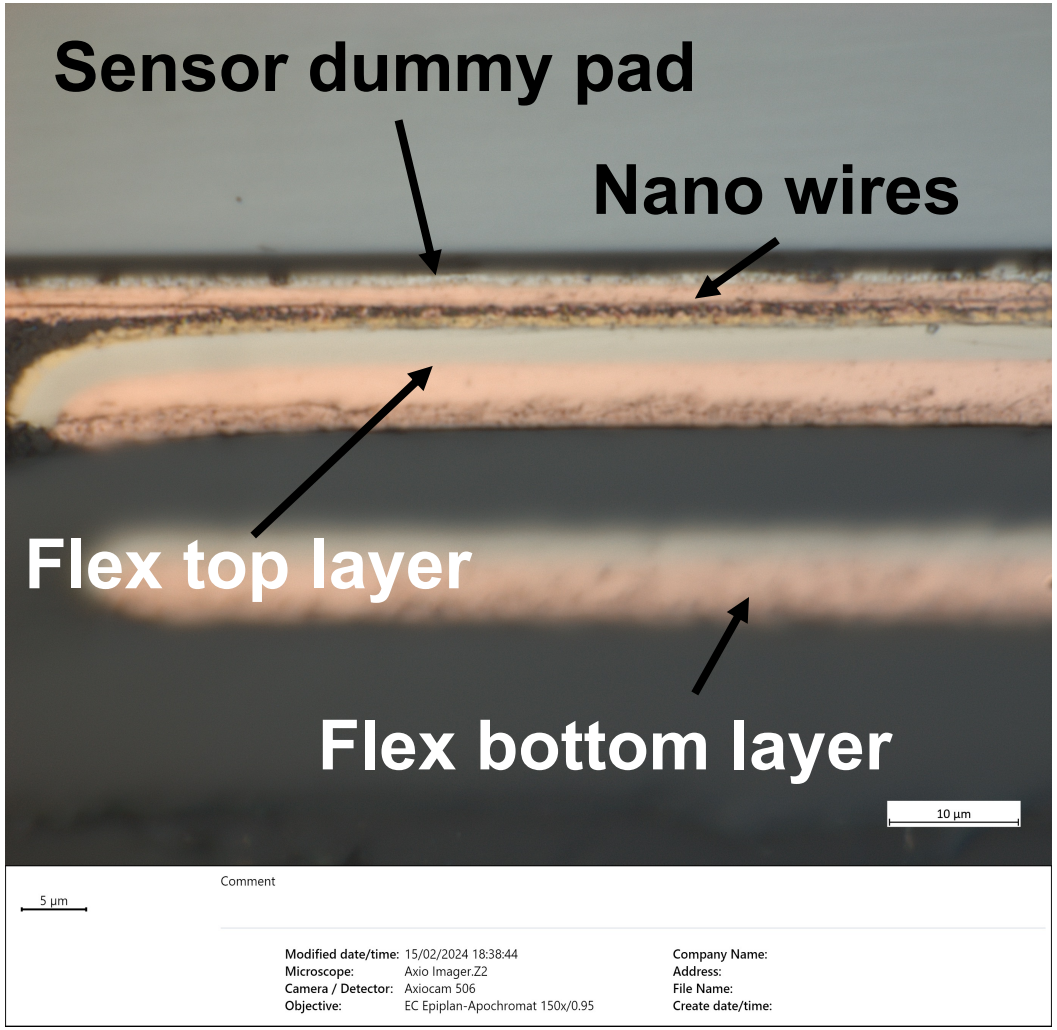


- Successful **bonding** of nano-wired MALTA2 pads onto flex PCB pads using the g**lue assisted process**
- Practically every **non-conductive glue** can be used for the bonding process

Different bonding options:

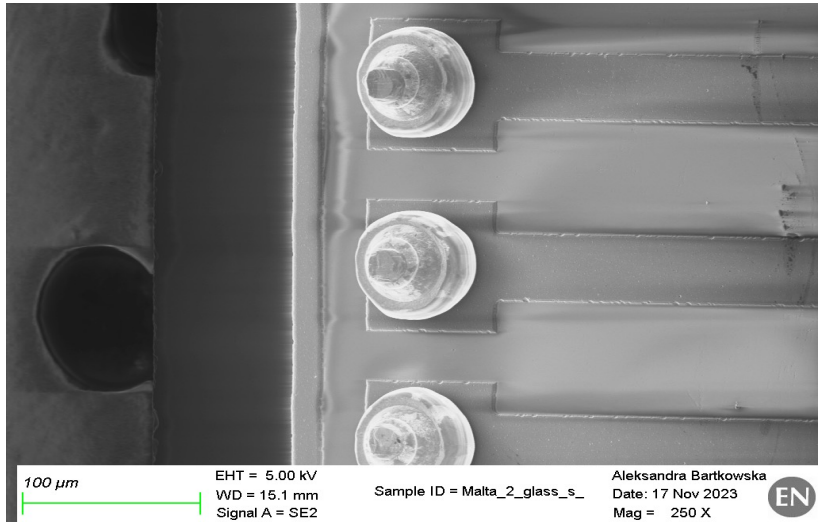
- **Sintering** (glue-free)
- **Cold welding** (glue-free)
- **Glue supported**



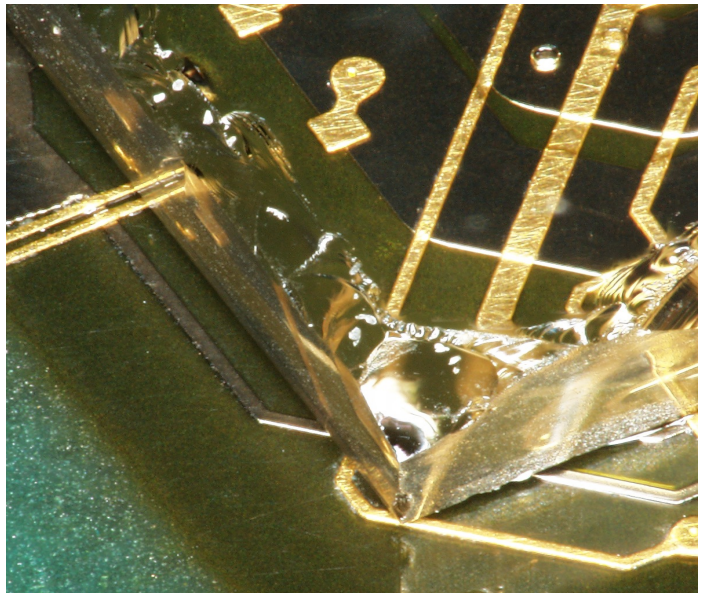


Gold studs

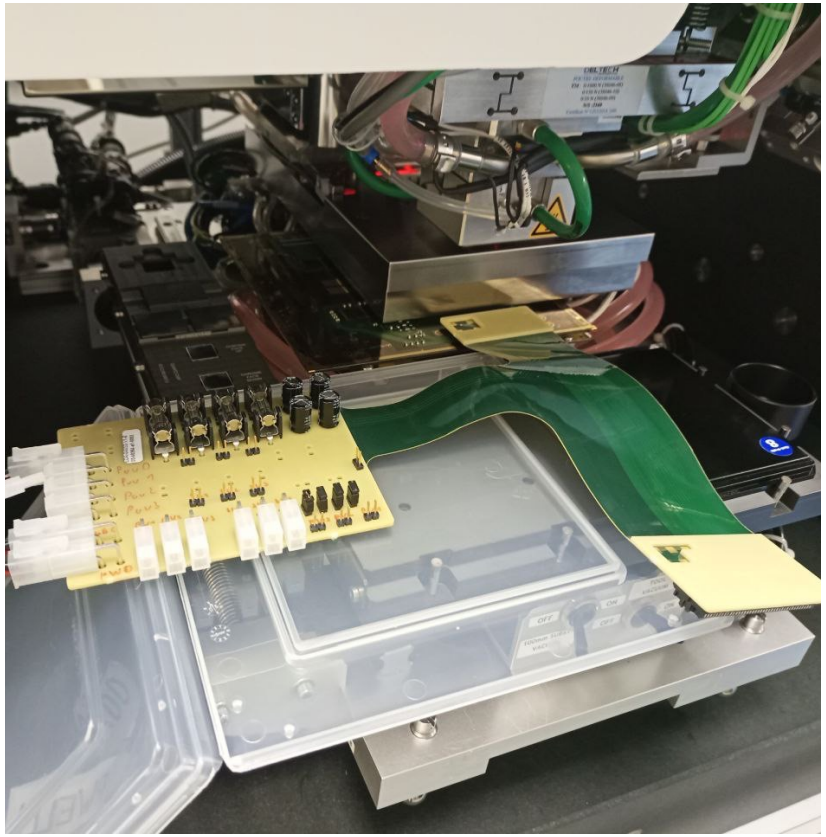
- **Individual pad** selection possible on application phase
- **Successful bonding** of test structures and MALTA2 sensors onto flex
- Verified **in situ pre-bonding verification**
- Bonded using **epoxy under-fill** Araldite 2011



Gold studs with flat head on test structure



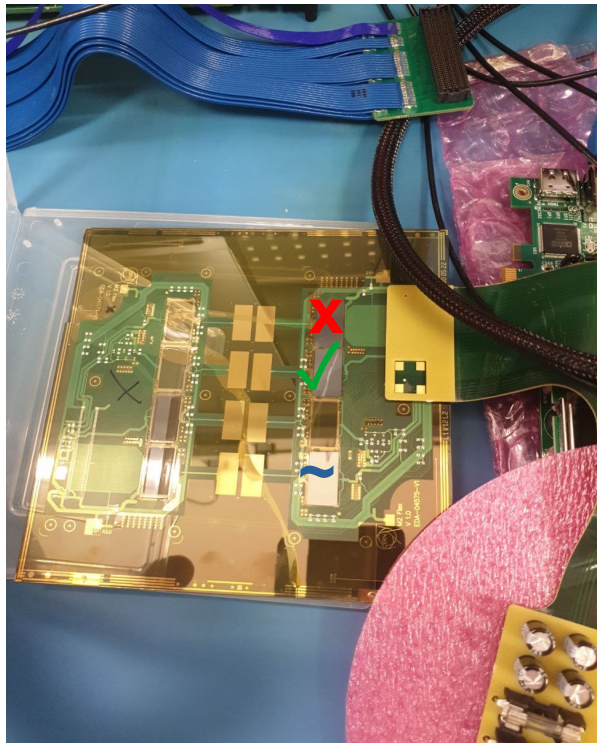
Test structure connected to flex using gold studs



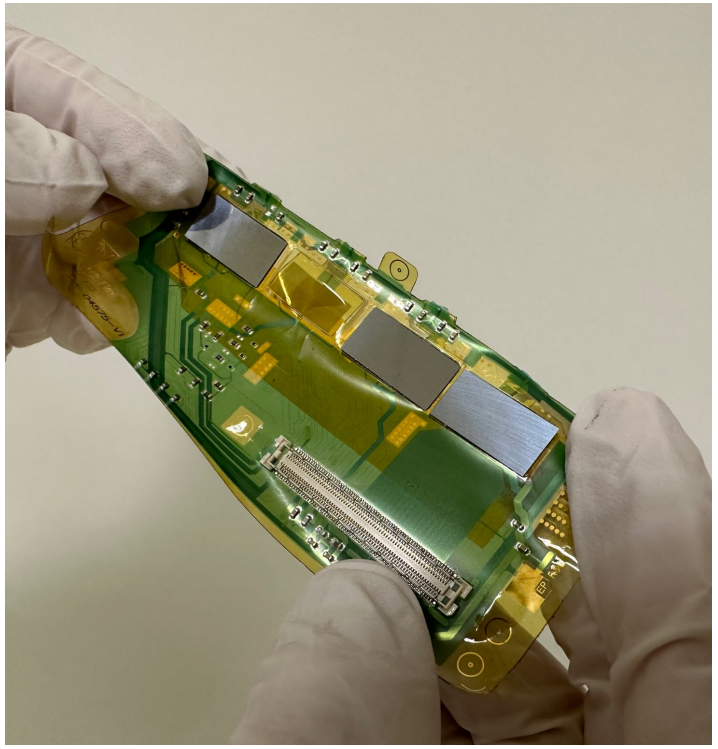
In situ pre-bond verification

Electrical testing and detached flex

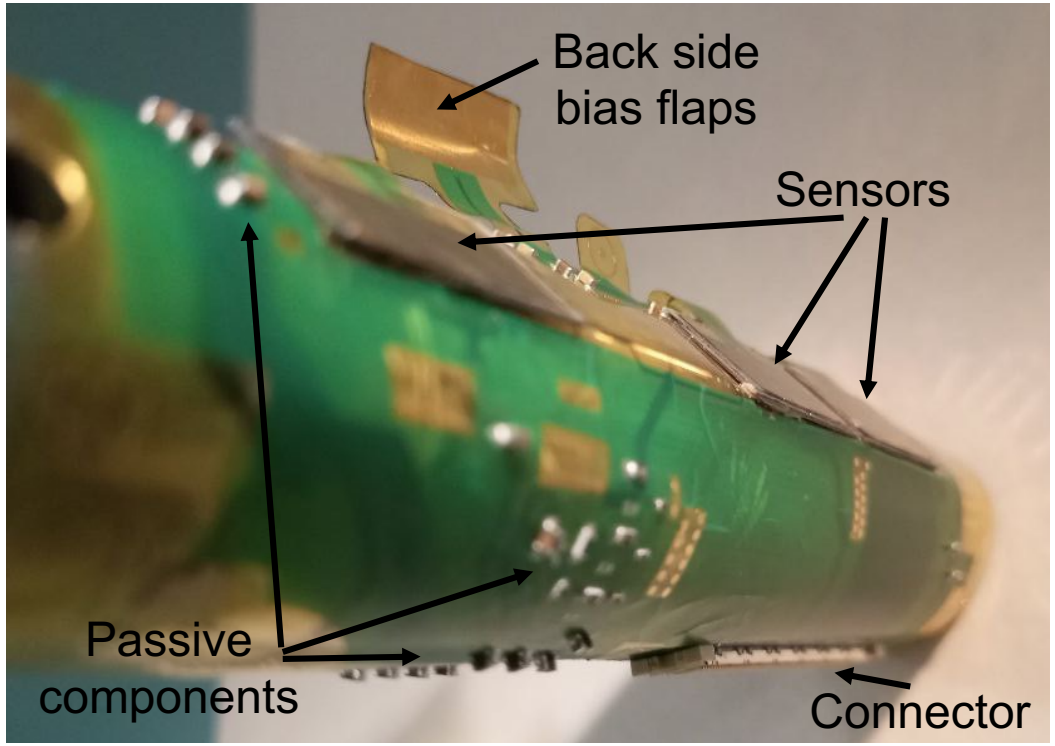
- Electrical tests verified the ability to **communicate** with the sensors
- Partial chip **read-out** conducted
- Peel of conducted **after flex assembly**



Electrical testing



Detached flex



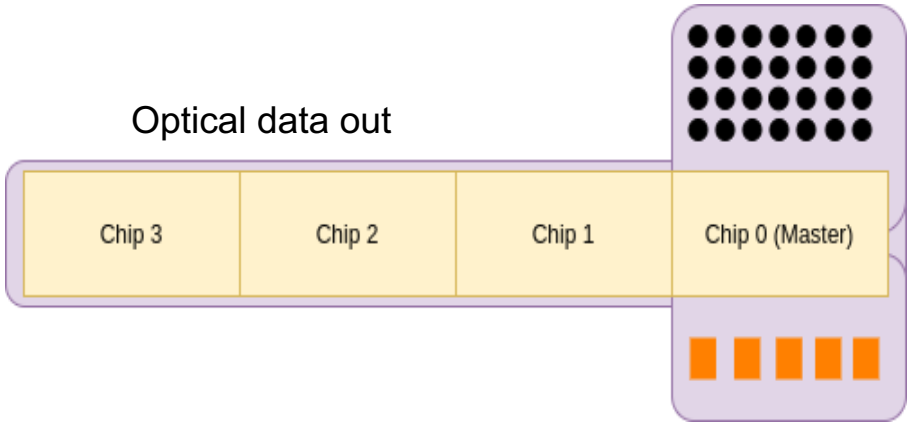
Detached flex

Future work

Next steps

- Build **demonstrator module** equipped for testing in lab and test beam
- **Interconnection toolbox** ready, next step is to develop more **in-house process for manufacturing a flex**
- Enabling fast modularization with different chips, **hybrid and monolithic**.

Optical flex



Flex with integrated optical data link