

Summary of the ITk pixel group activities

M.Antonello for the Milan ITk group
15/10/2020

ATLAS ITk Pixel Detector

For the **HL-LHC** phase, the central tracking system will be entirely upgraded

In particular, the new Pixel Detector will be based on the “**hybrid pixel module**” design:

- **Bare module** (silicon sensor + FE read-out chip)
- **Module flex** (a flexible PCB)

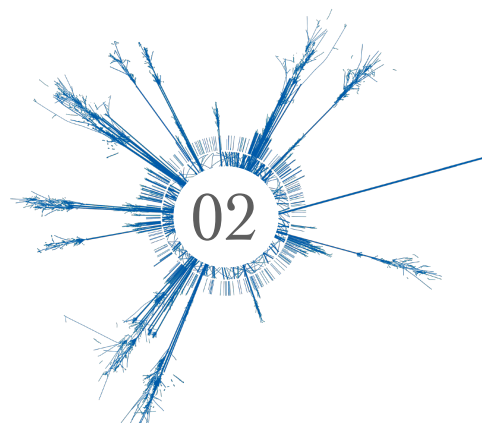
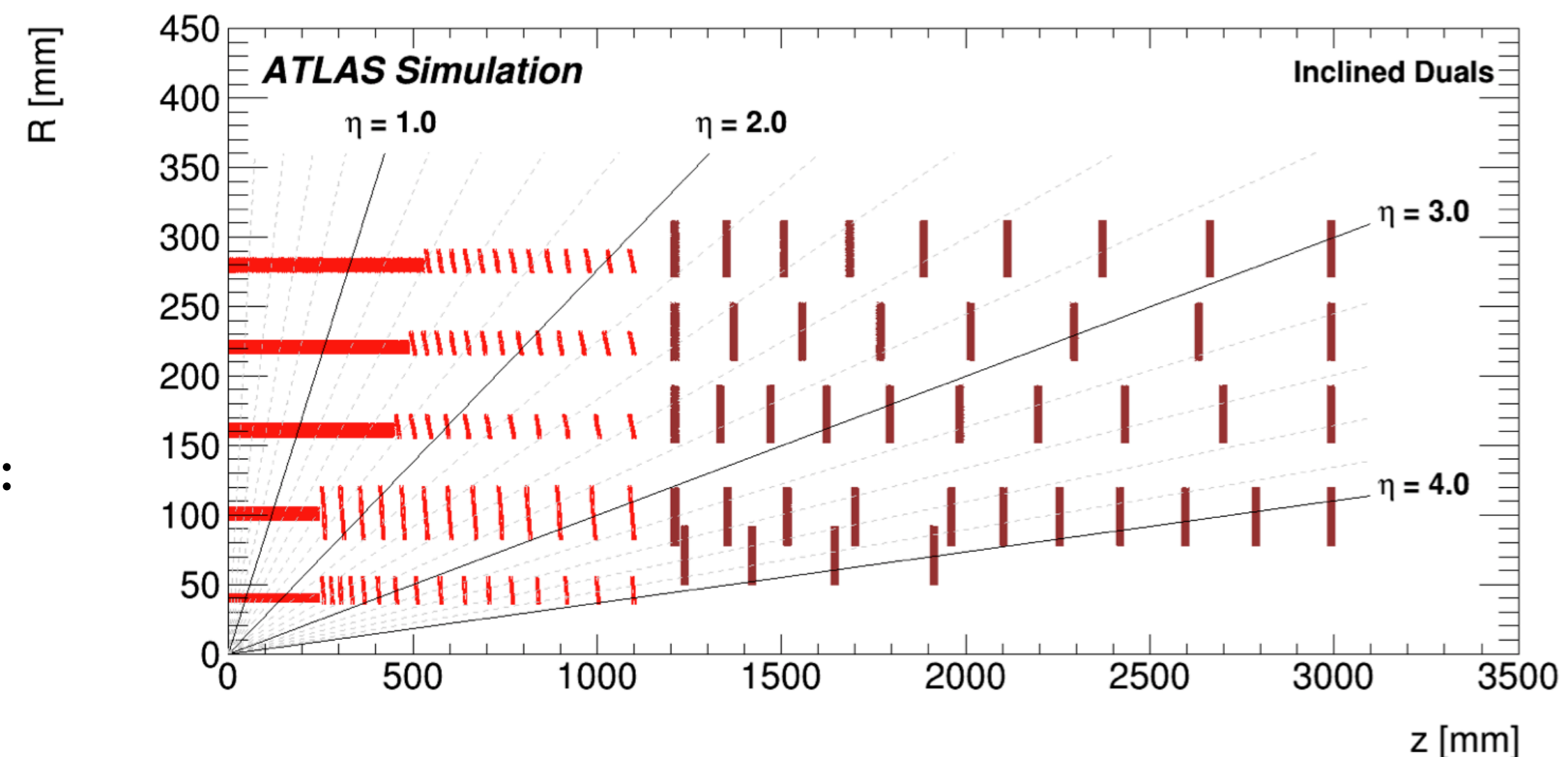
Two different **types of modules**:

- **Quad modules** (4 FE chips, 1 sensor of $4 \times 4 \text{ cm}^2$)
- **Single modules** (1 FE chip, 1 sensor of $2 \times 2 \text{ cm}^2$)

Three **sensor types** (pixels of $50 \times 50 \mu\text{m}^2$ and $25 \times 100 \mu\text{m}^2$):

- **3D** for the innermost layer (thickness of $250 \mu\text{m}$)
- **Planar** (thickness of $100 \mu\text{m}$ for layer 1)
- **Planar** (thickness of $150 \mu\text{m}$ for other layers)

INFN is involved in sensor development for the inner part (FBK) and will build one of the two endcaps






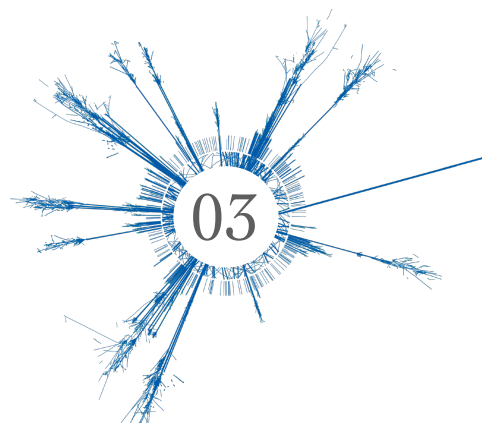
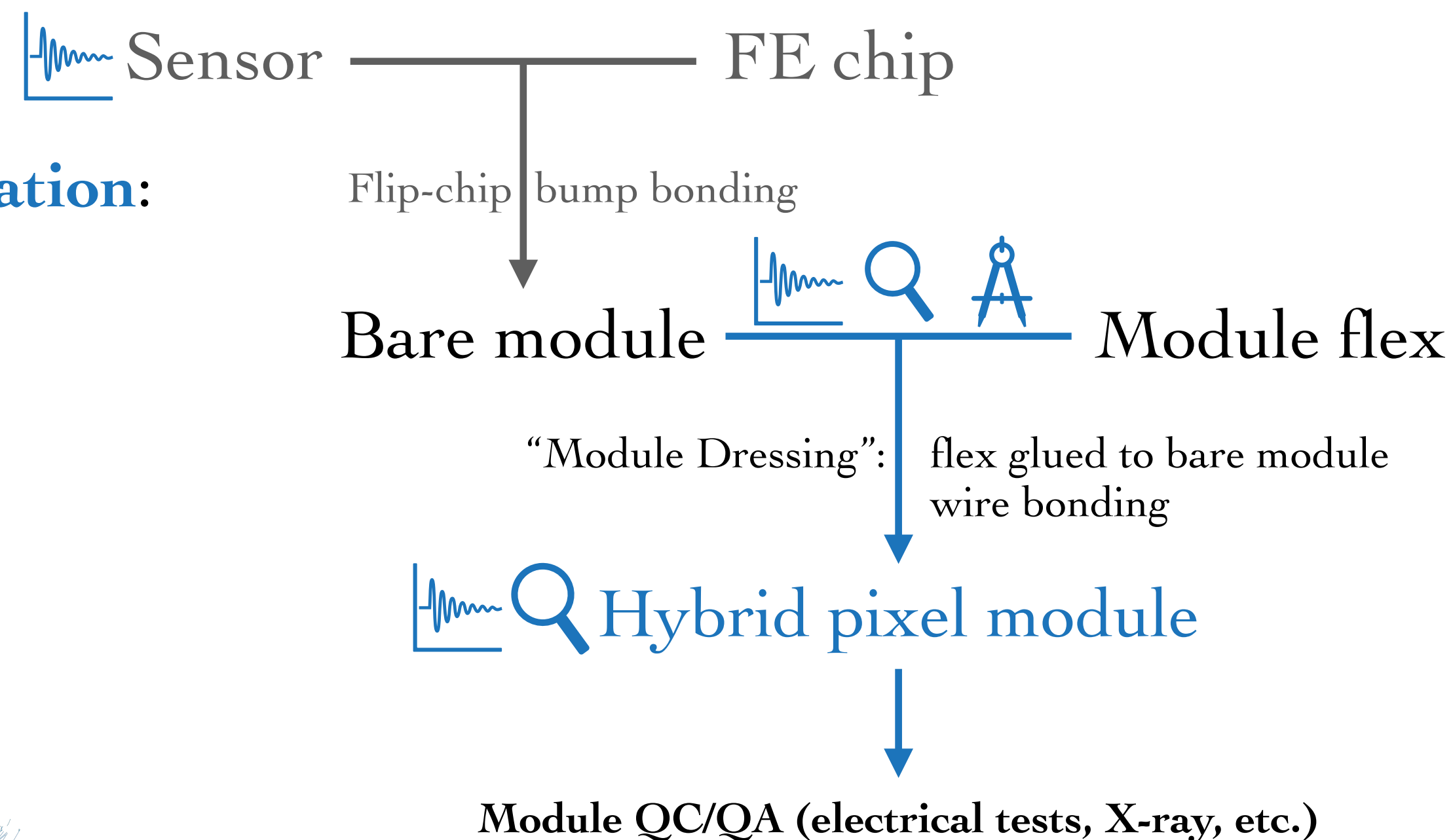
ATLAS ITk Milan

The INFN Milan is currently involved in:

- **Bump bonding:** vendor qualification (assembling and testing dual modules for Market Survey)
- **Module assembly:** 3D triplets, quads and duals (both 100 and 150 μm sensors)
- **Production site qualification (for all the module types):** development and test of dedicated tooling for each type; finalization of many testing/assembly procedures; module QA/QC

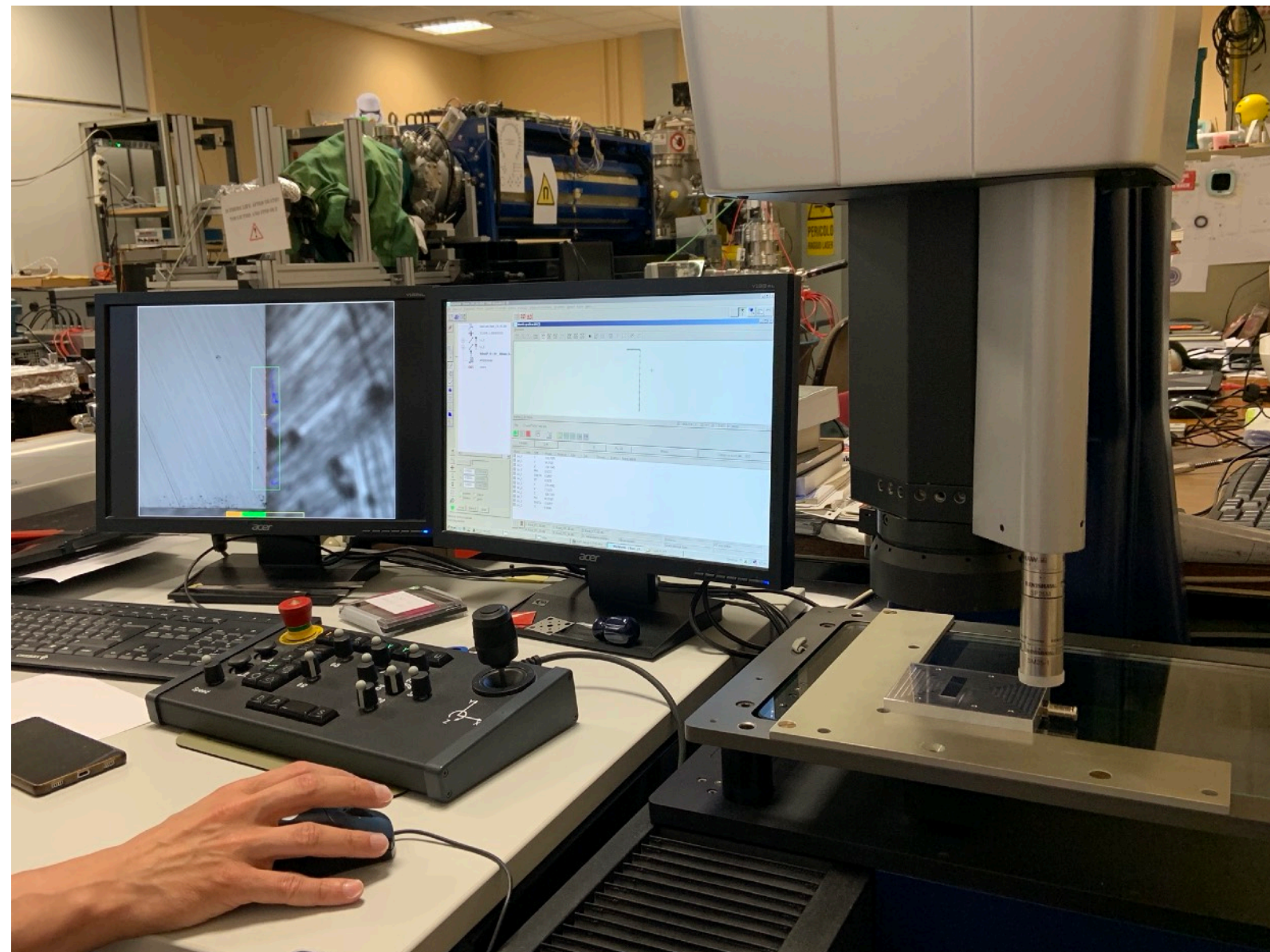
Main activities for a module construction & characterization:

- IV curves 
- Metrology (especially for MS) 
- Visual Inspection 
- Assembly of flex and bare modules
- Wirebonding
- Hybrid module electrical tests & validation
- Other aspects as: parylene deposition, cold-test, etc.

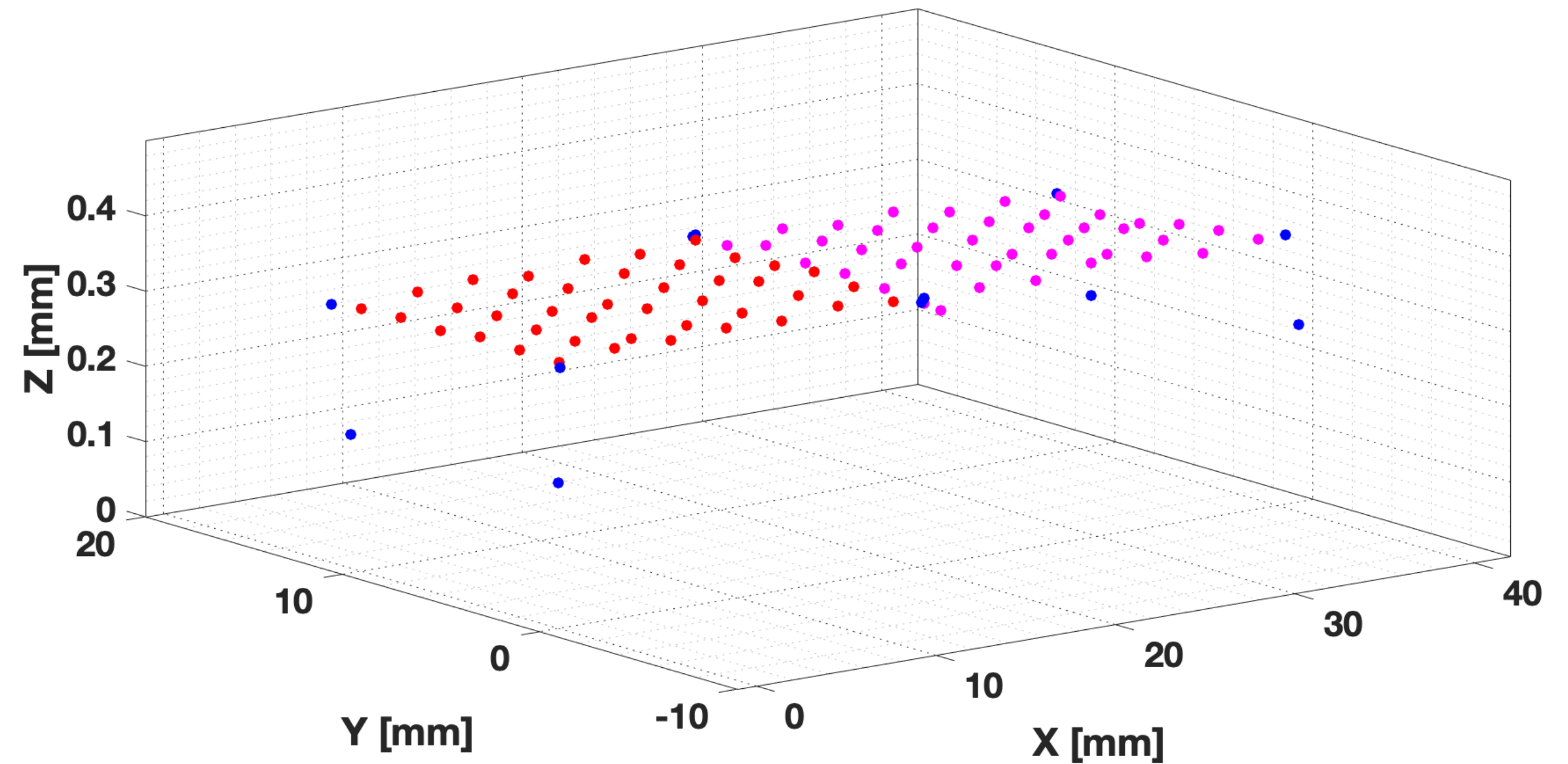


Metrology

For each different type of module we are developing a dedicated **semi-automatic measuring program** to check both the quotes and the planarity of the flip-chip bump bonding procedure performed by the vendor
We are also developing the program for the raw data analysis to provide an automatic **module metrology report**

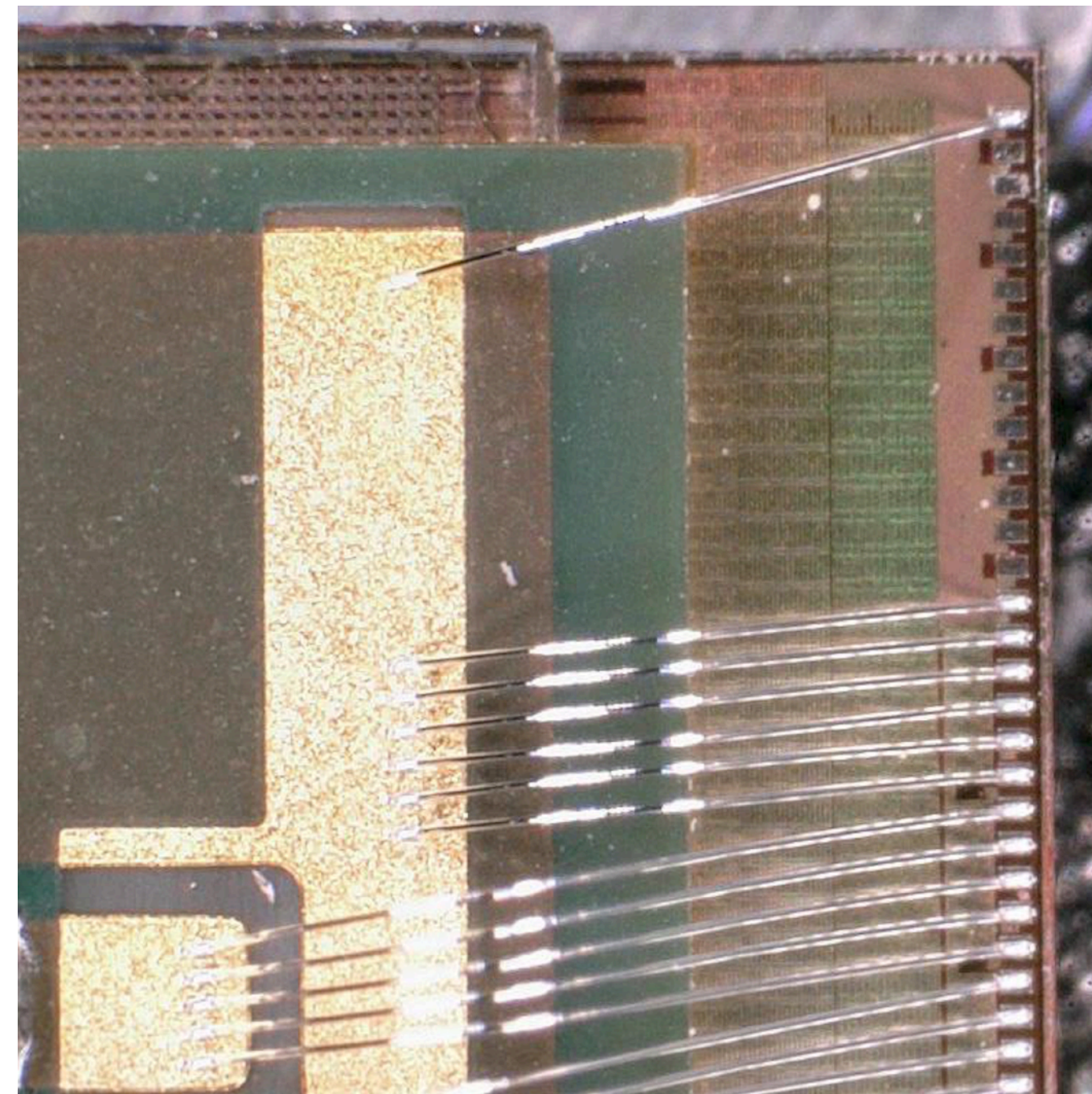
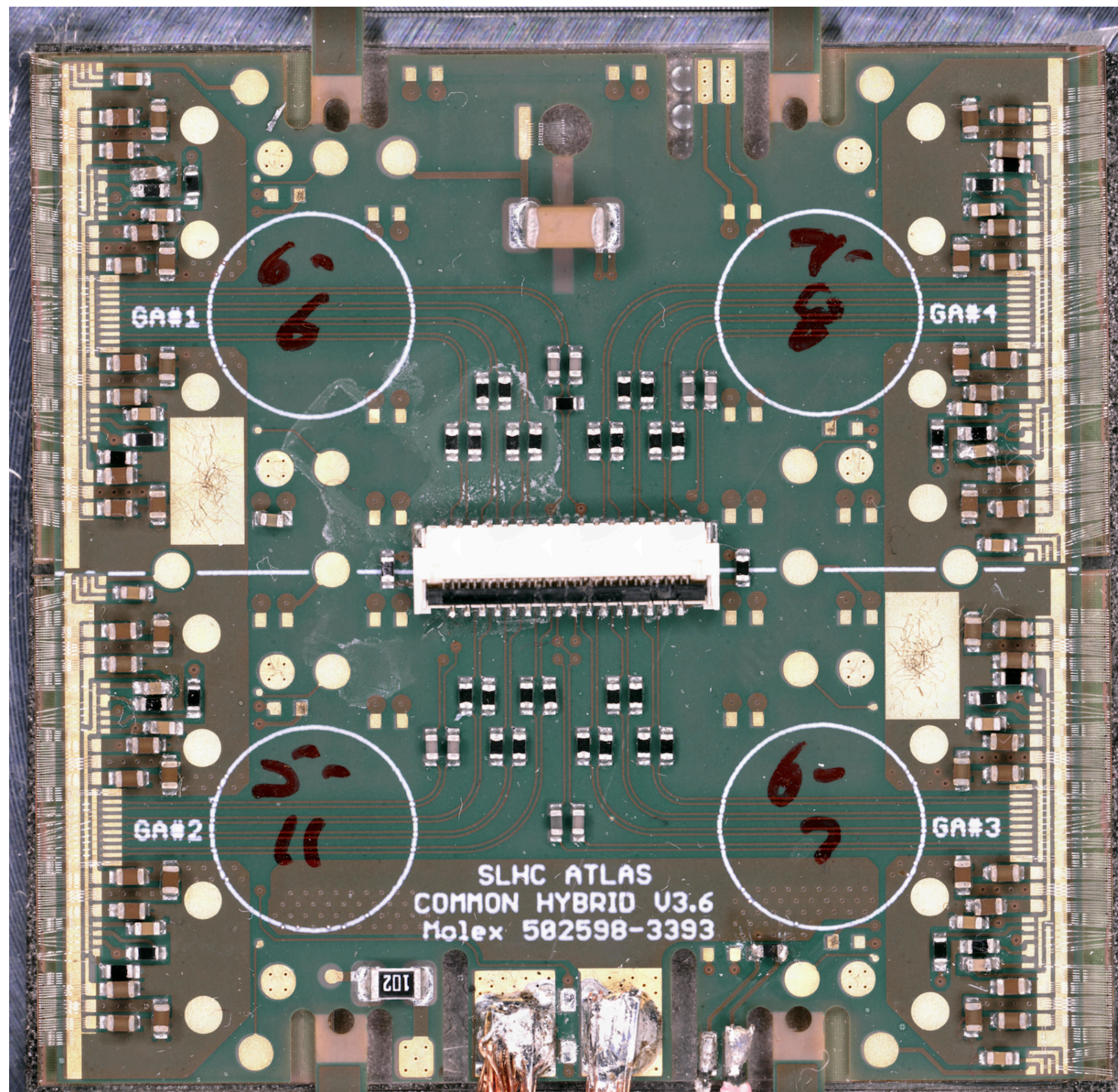


Werth ScopeCheck

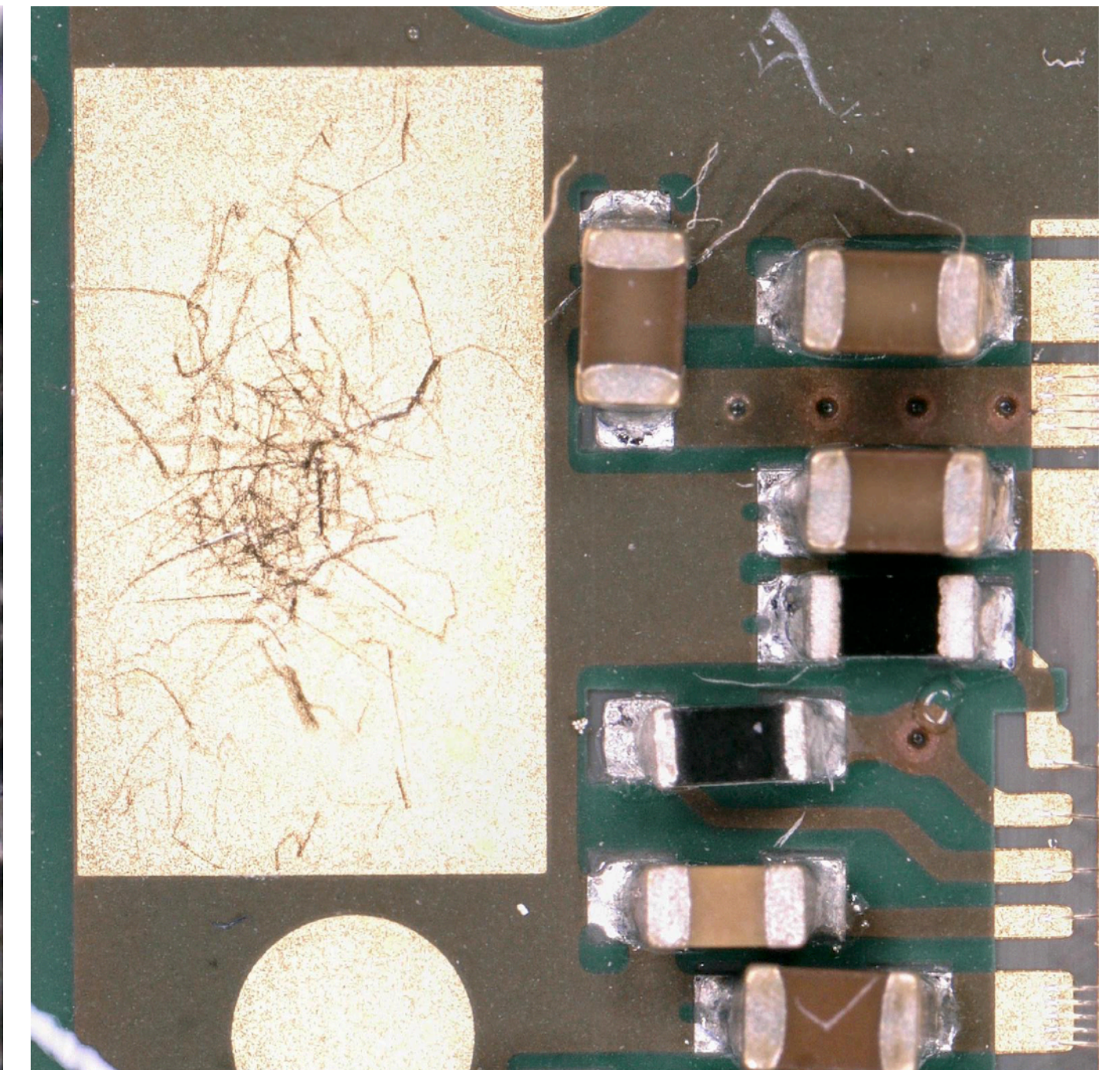


Visual Inspection

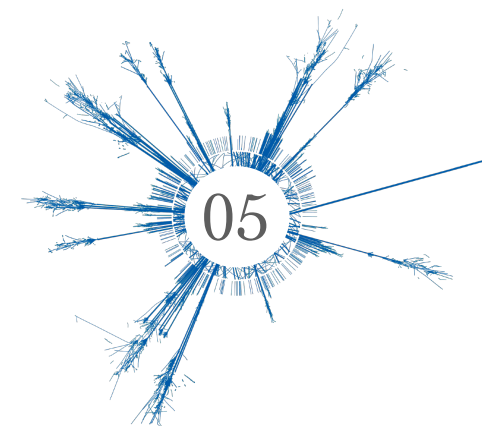
The **aim** of this step is to check and document for potential damage/anomalies of both sensor and flex components
The VI is performed through our digital microscope (**KEYENCE VHX-600**)



✓ wirebonds

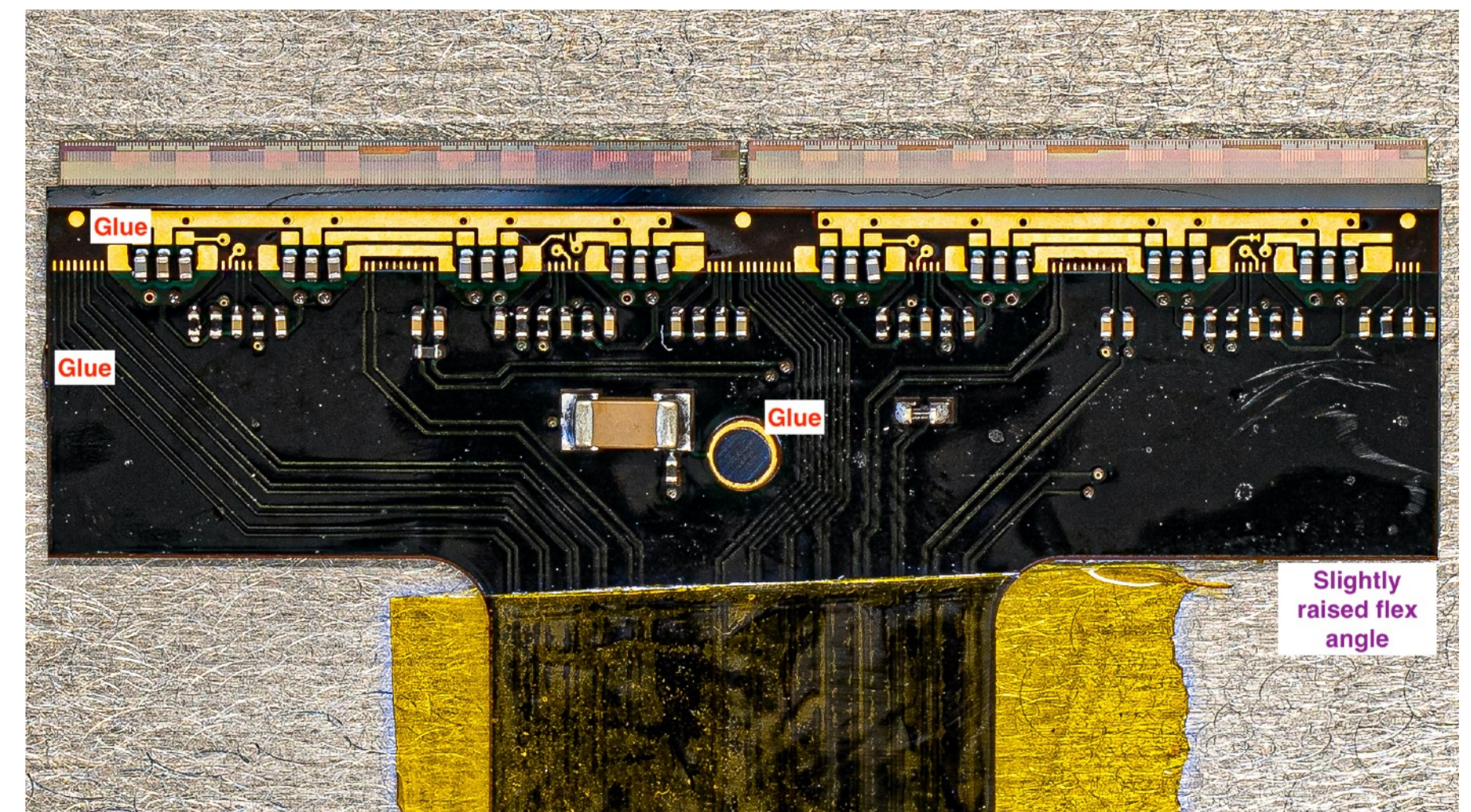
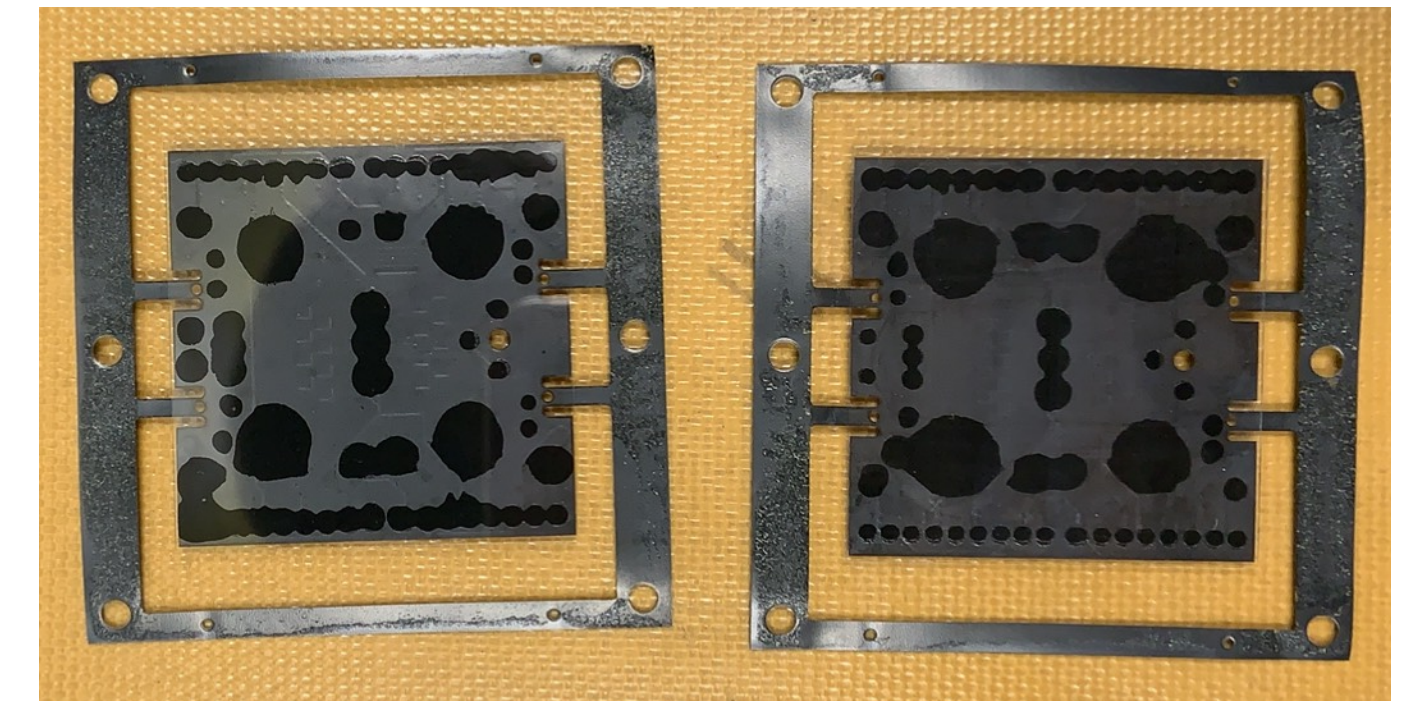
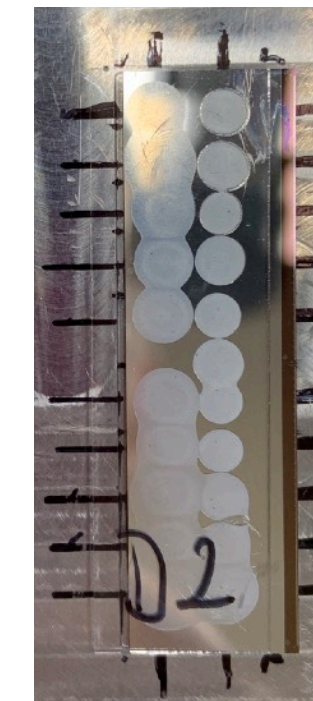
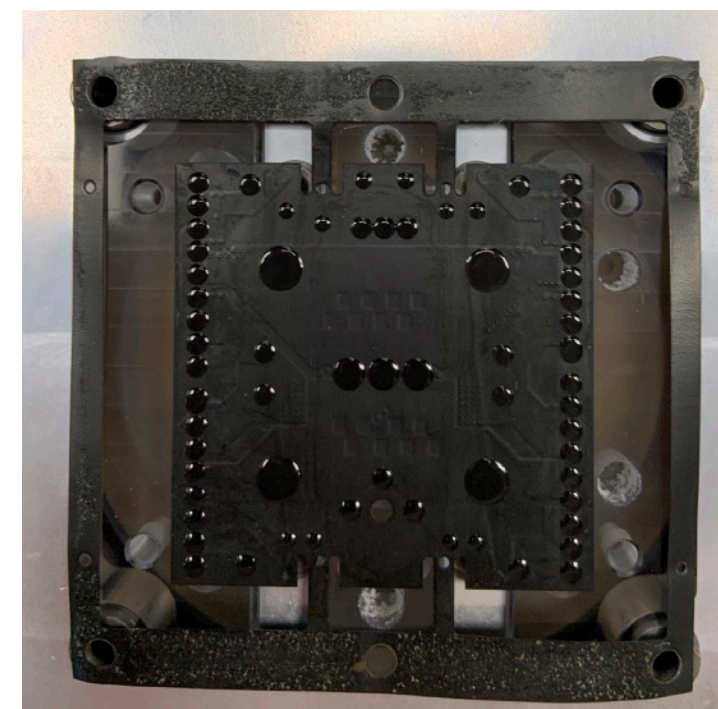
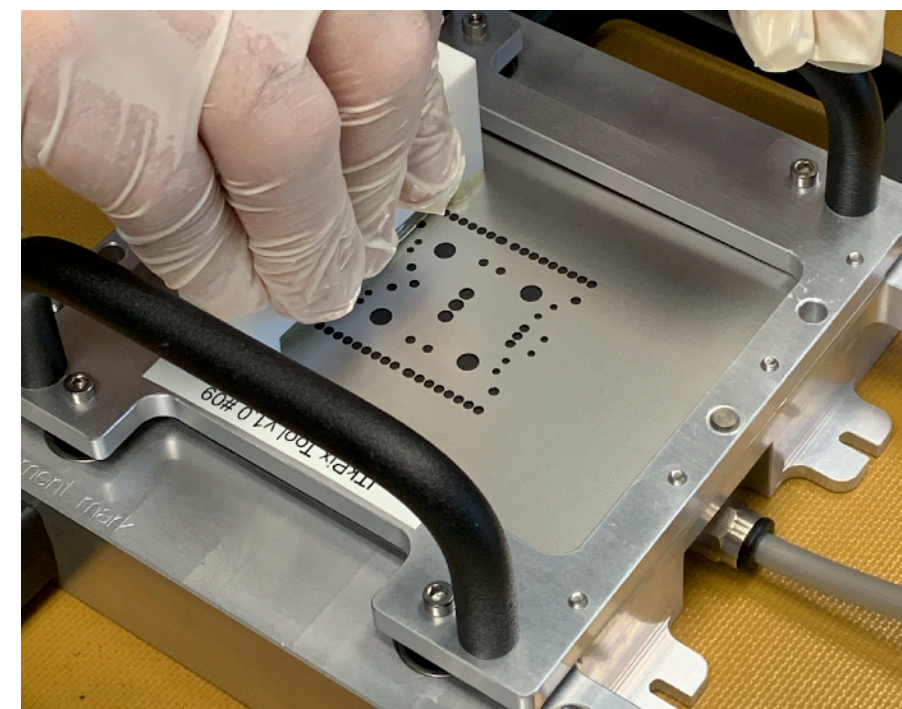
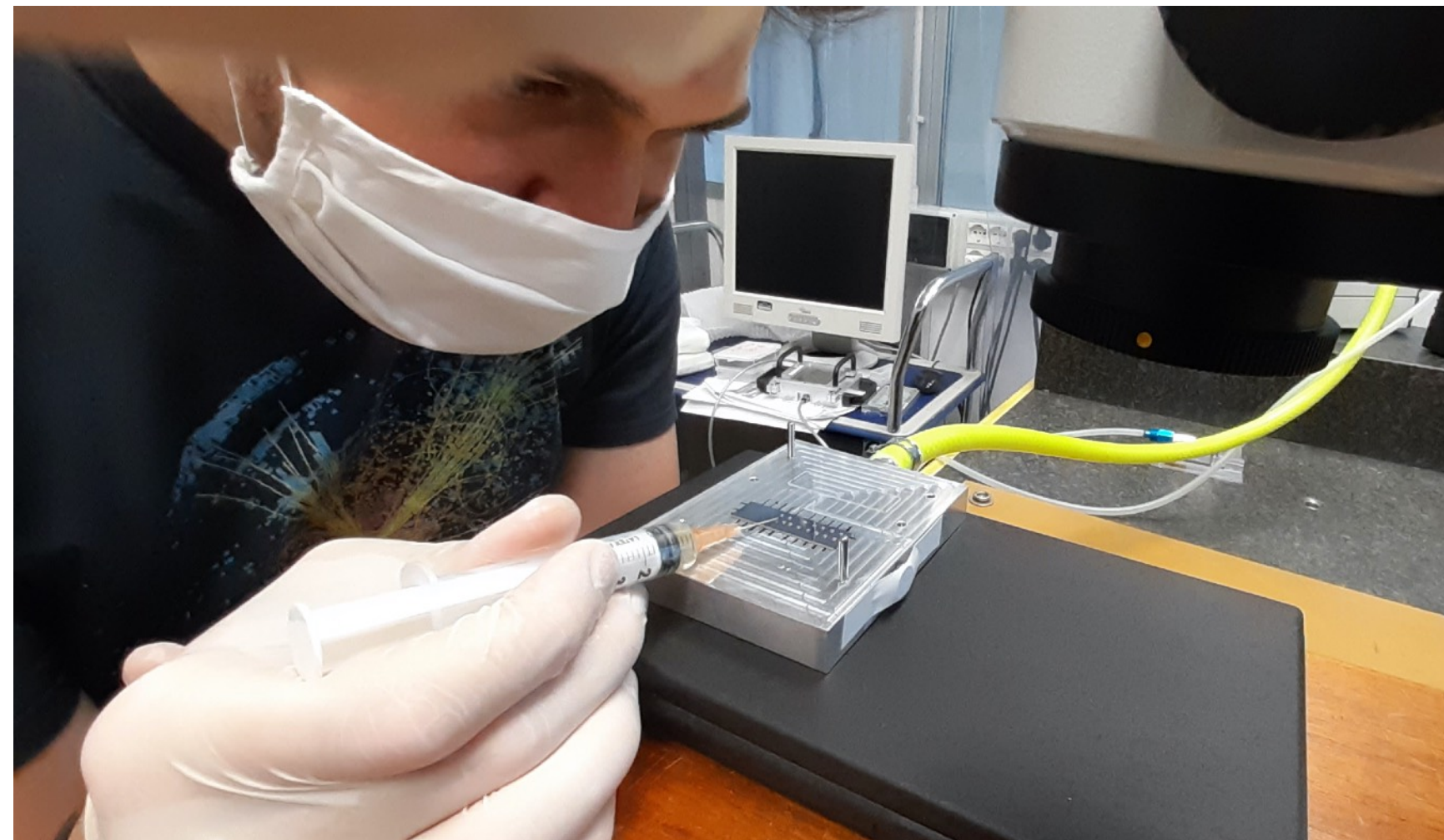


✓ scratches and SMD components



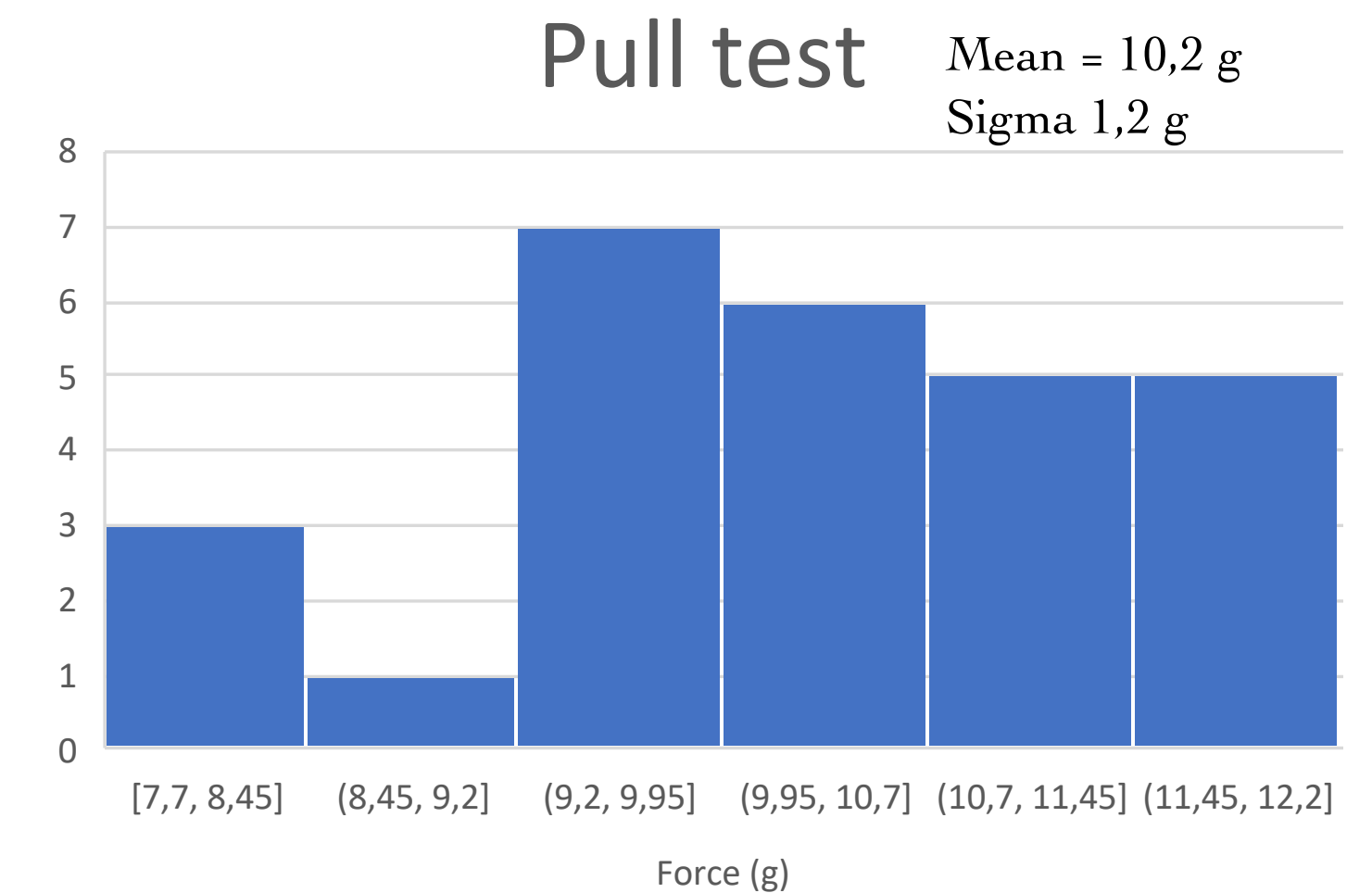
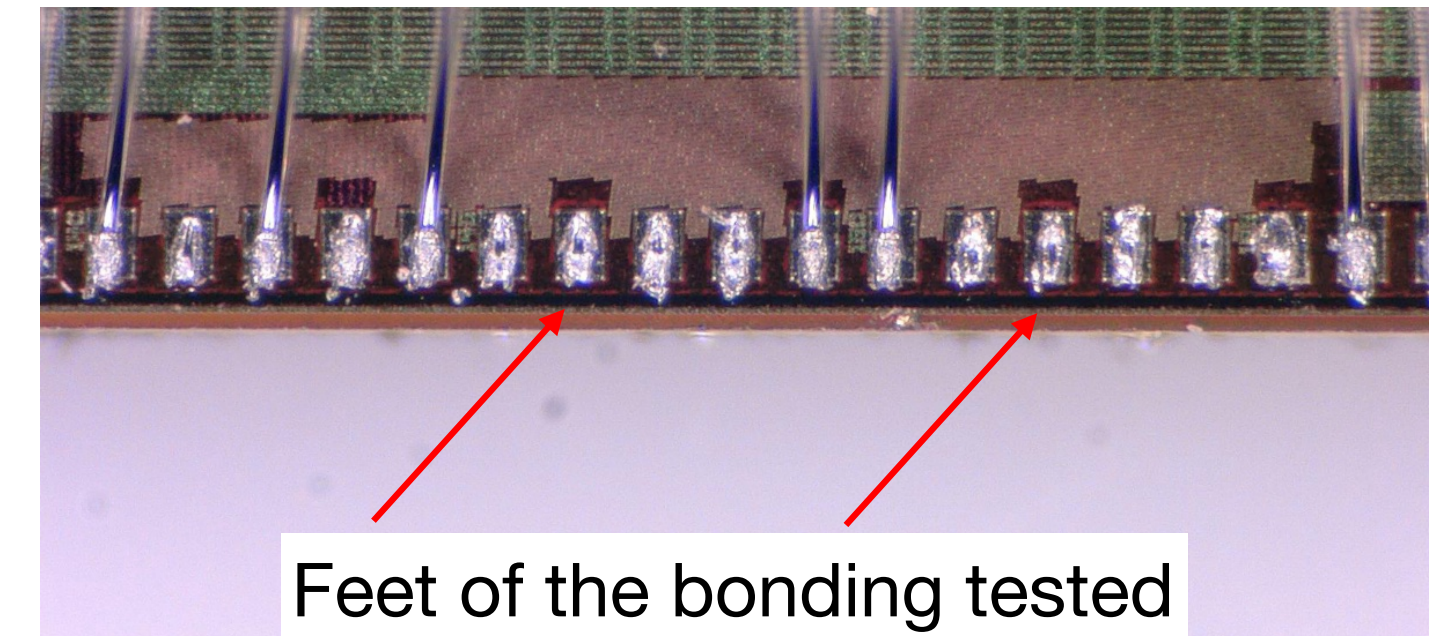
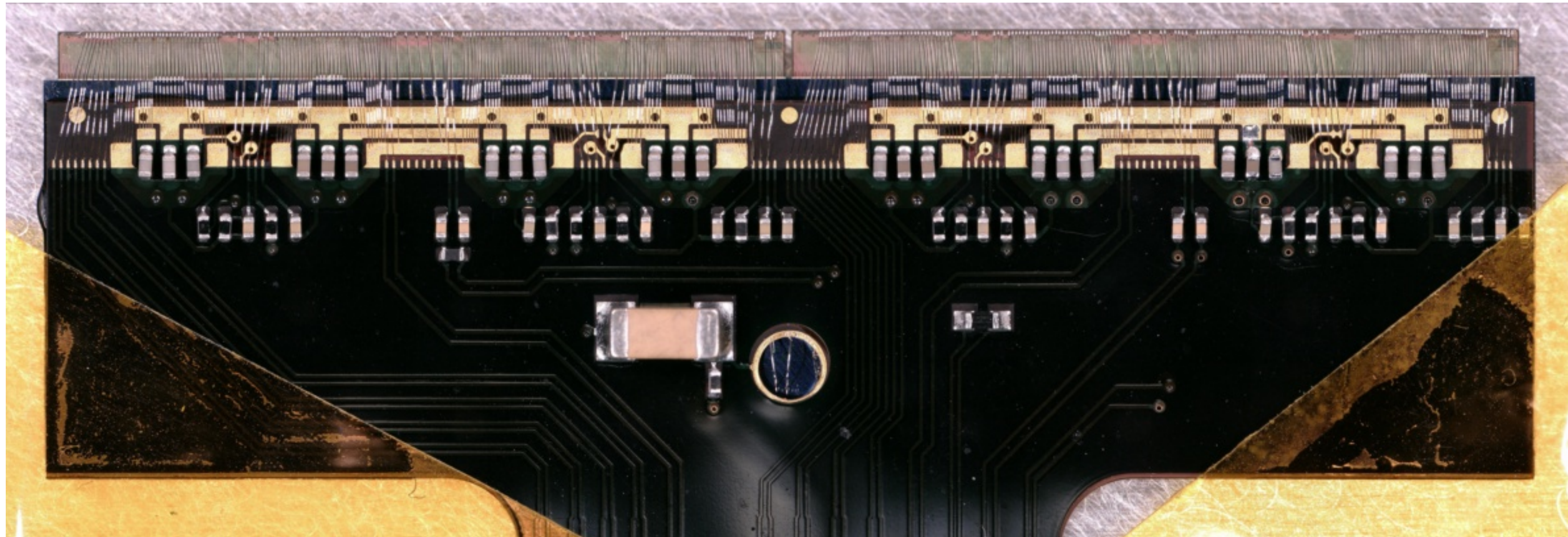
Module assembly

We are developing the module assembly procedure and we are **qualifying as an ATLAS assembly site** for: Dual modules (**already qualified**), Quad modules (**currently in progress**) and Triplets (soon)



Wirebonding

After the module-flex assembly, the electrical connection between chips and the flex has to be done
We are developing an **automatic wirebonding procedure** for each module type to do it
Moreover we check the quality of the bonding with the so called **pull tests**

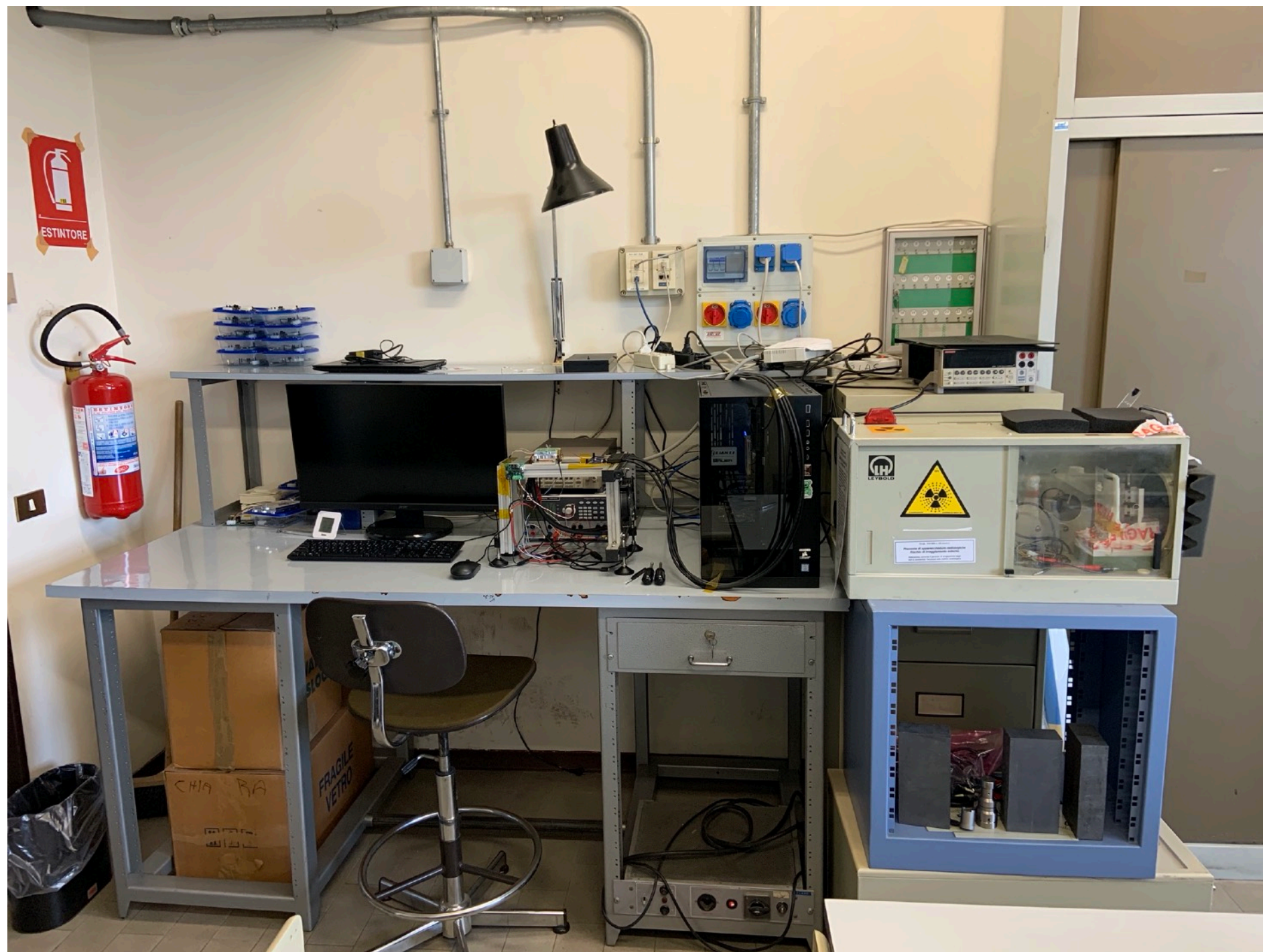


Module testing

Finally **the module test, tuning and validation**
We currently have 2 working stations:

“YARR” Setup:

Single modules (SCC) - Quad modules (and triplets)



“BDAQ” Setup

Single modules (SCC) - Dual modules

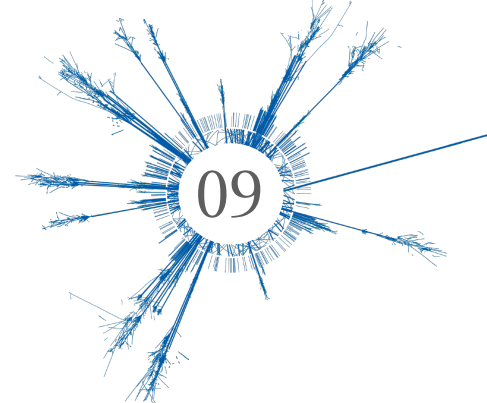
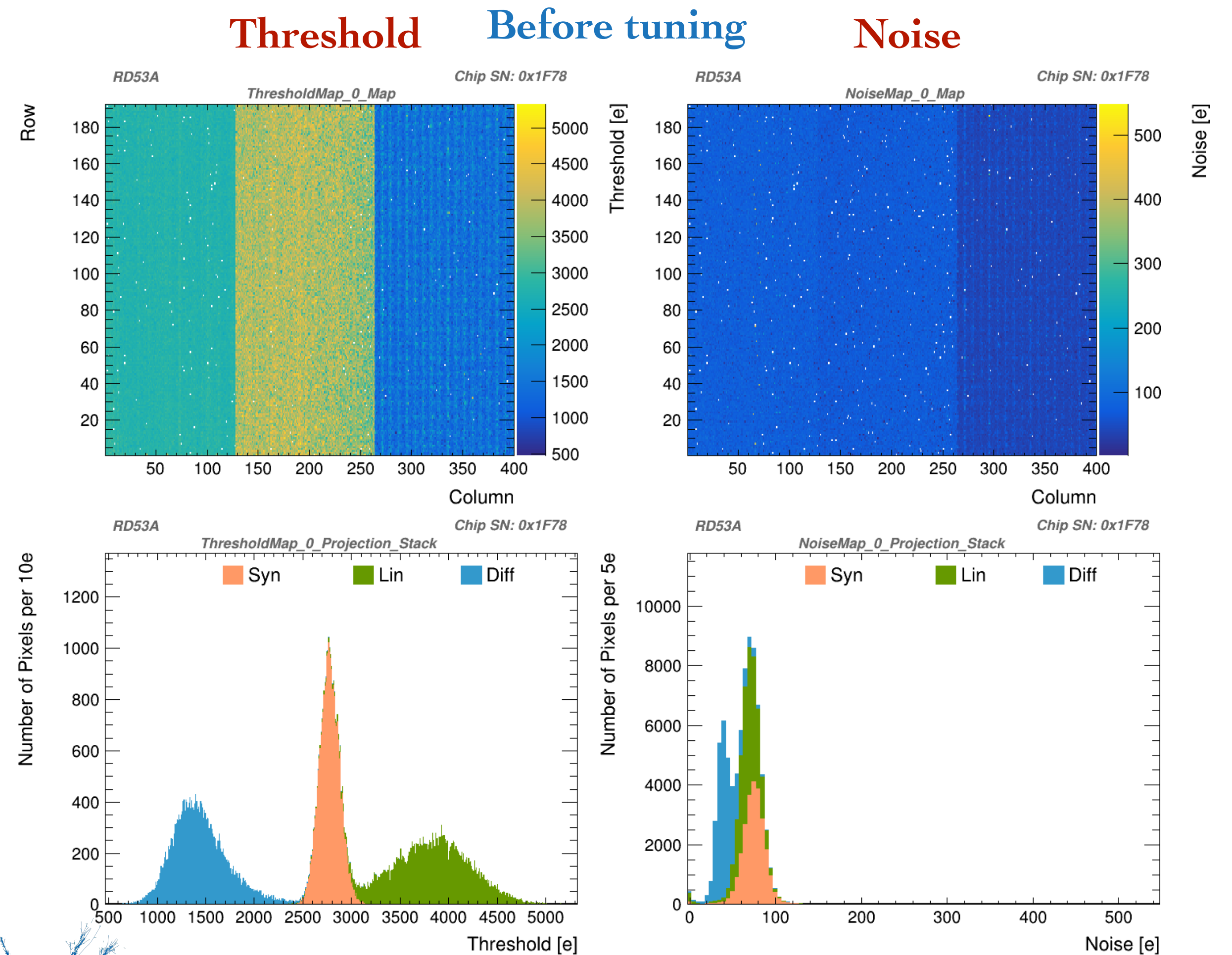
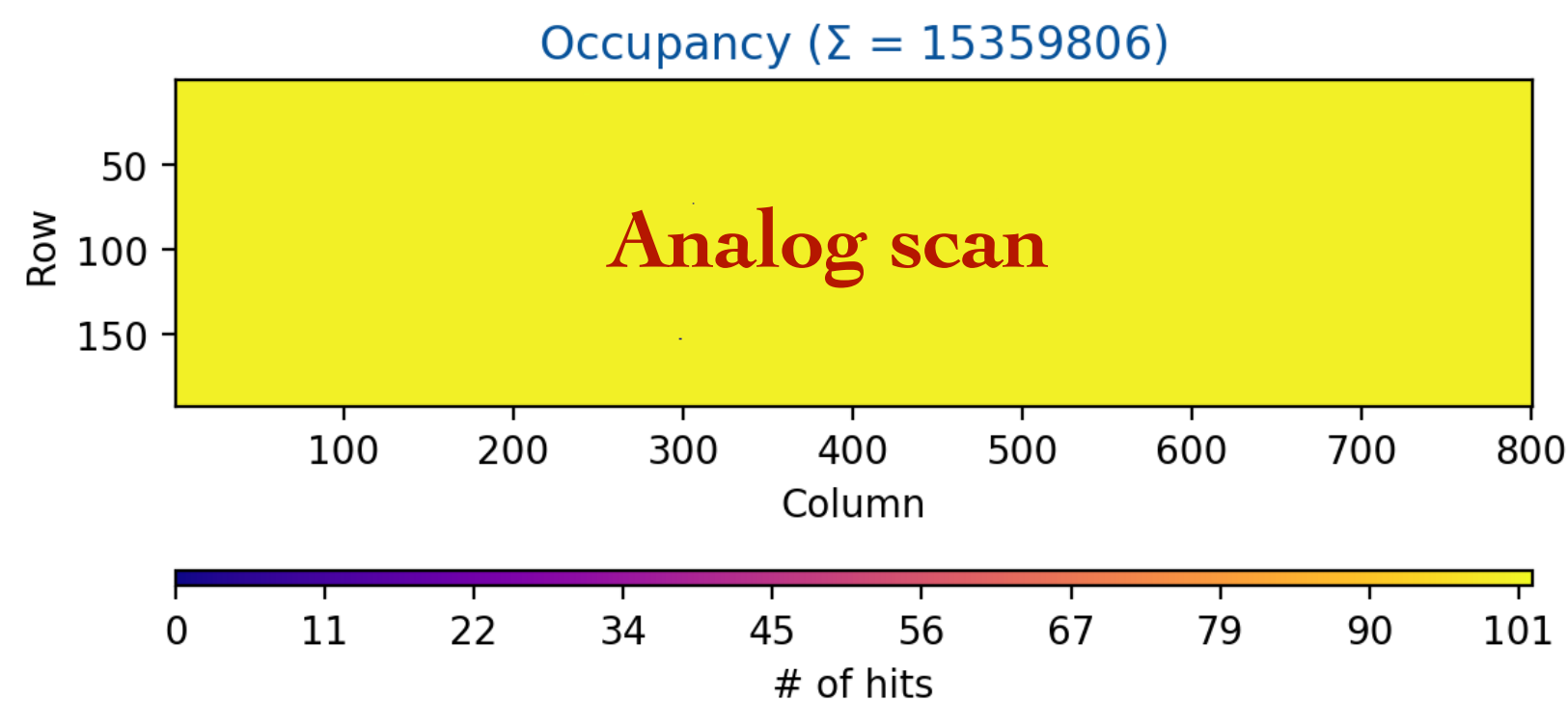
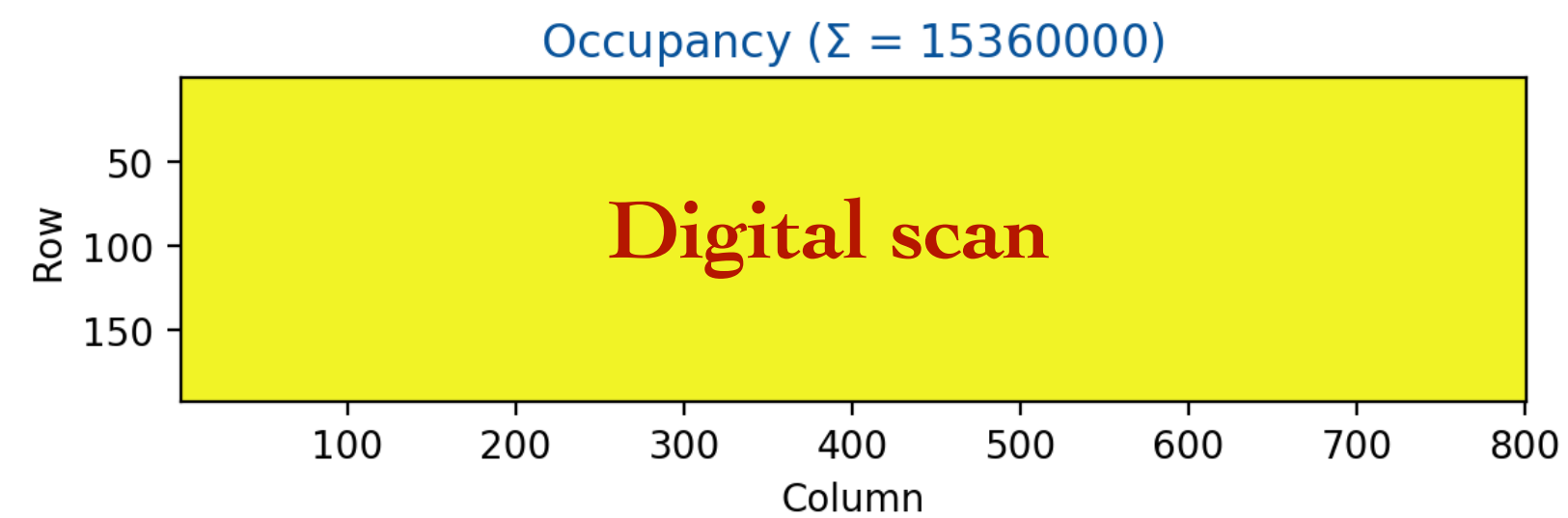


Module tuning

For each module we performed a tuning routine to check the quality of module overall response

The **tuning routine** is composed by a series of scans:

- Pre-Tuning scans (digital, analog, threshold)
- Tuning scans (RD53a chips with 3 FE)
- Post-Tuning scans (threshold, noise, crosstalk)

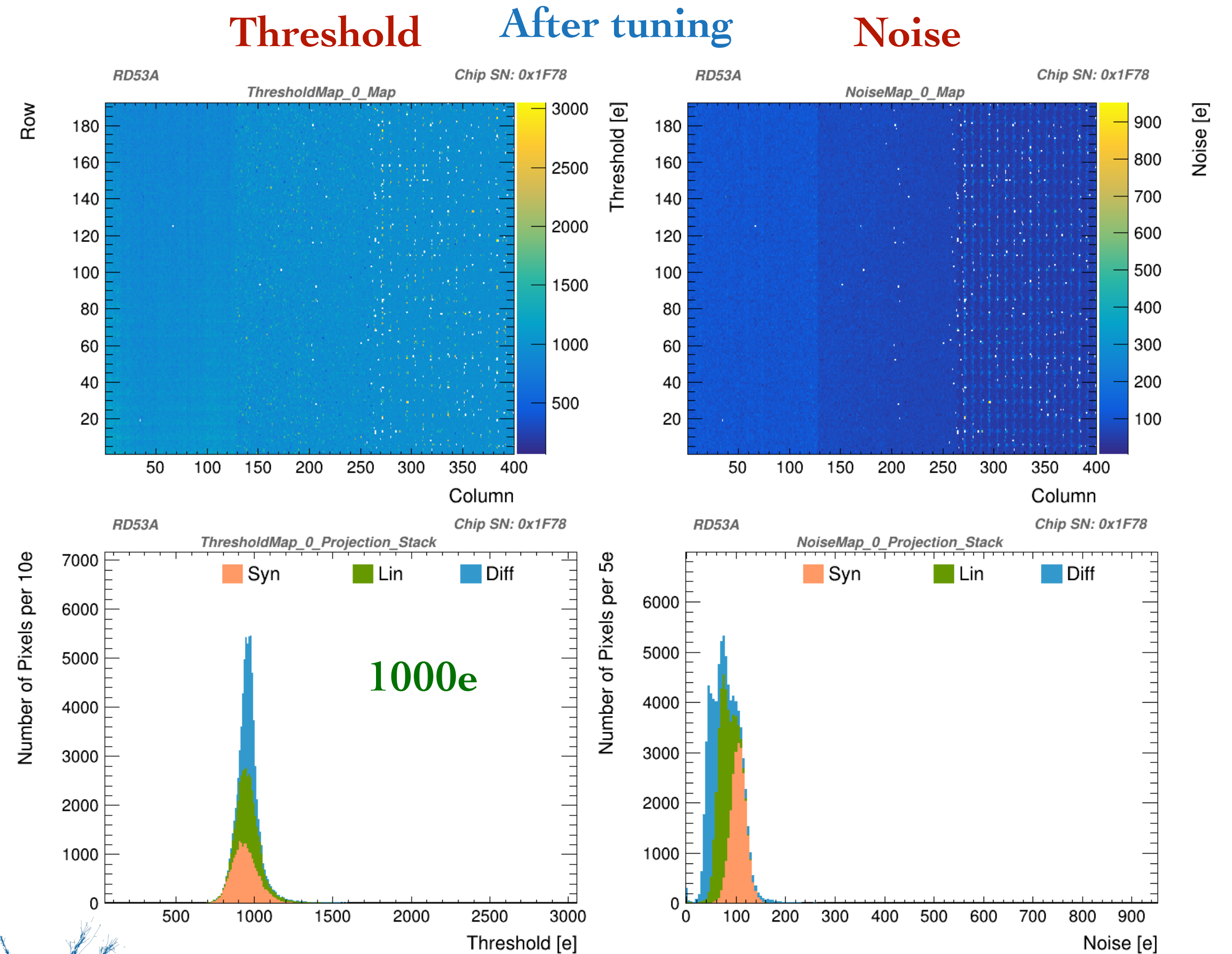
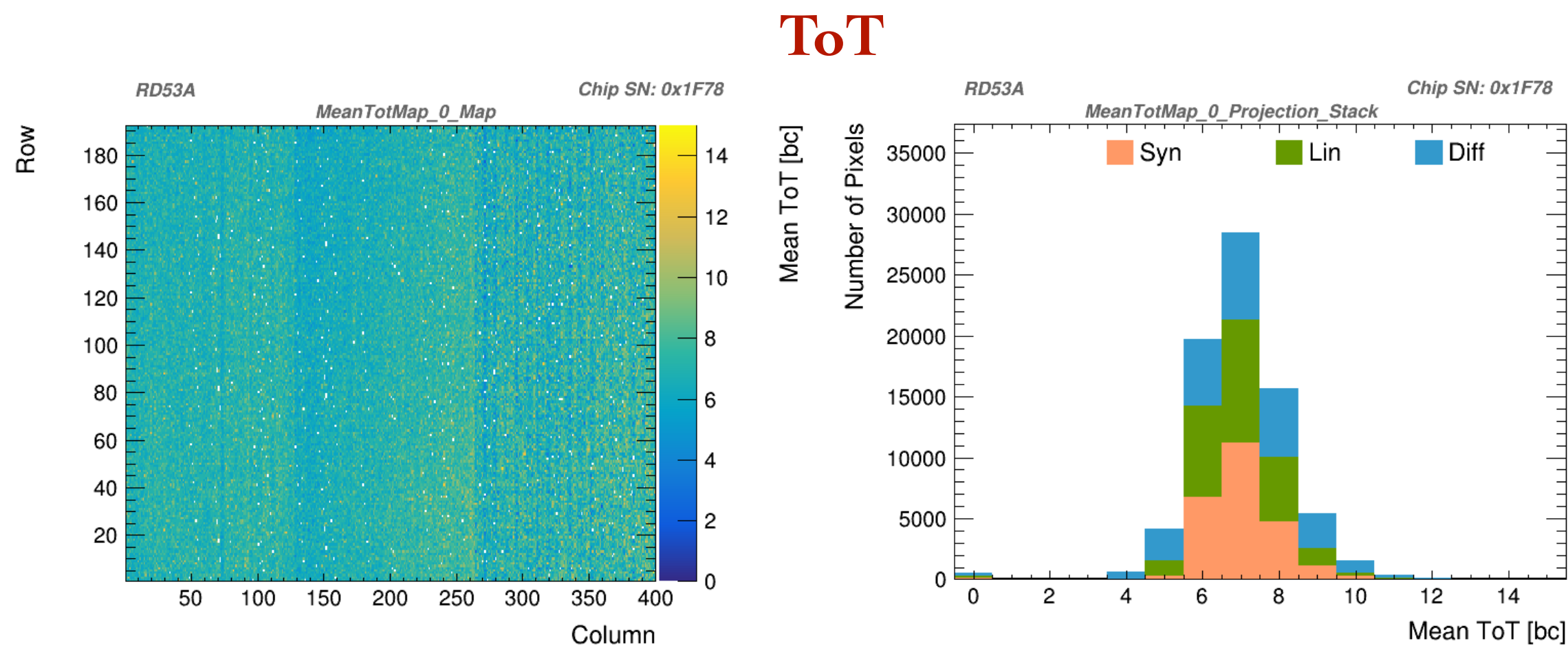


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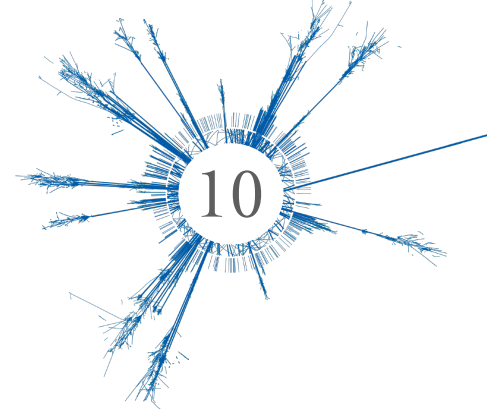
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!!! GOOD NEWS !!!

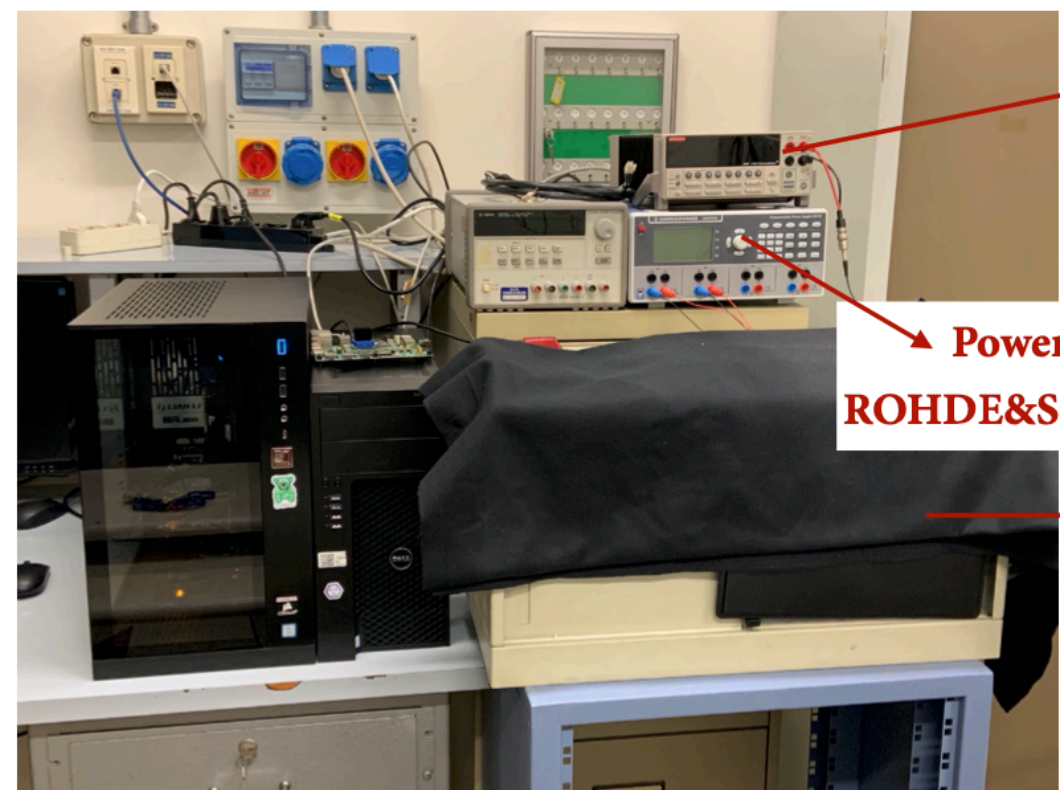
This week we **qualified** as an **ATLAS** site
for the **quad module testing** (1st stage)



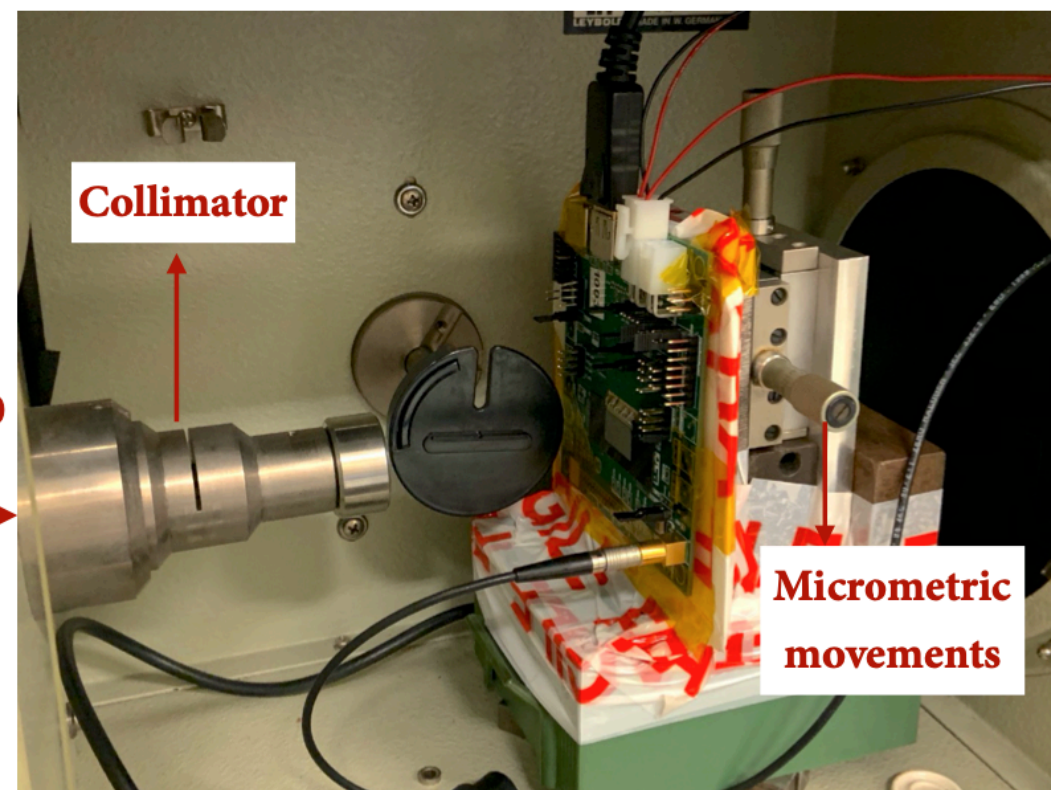
Module test with X-Ray unit

More infos in B.Cervato talk

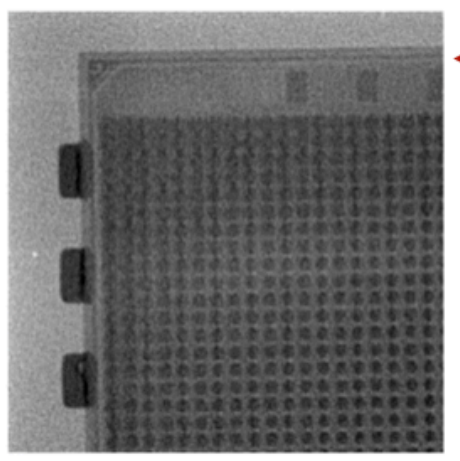
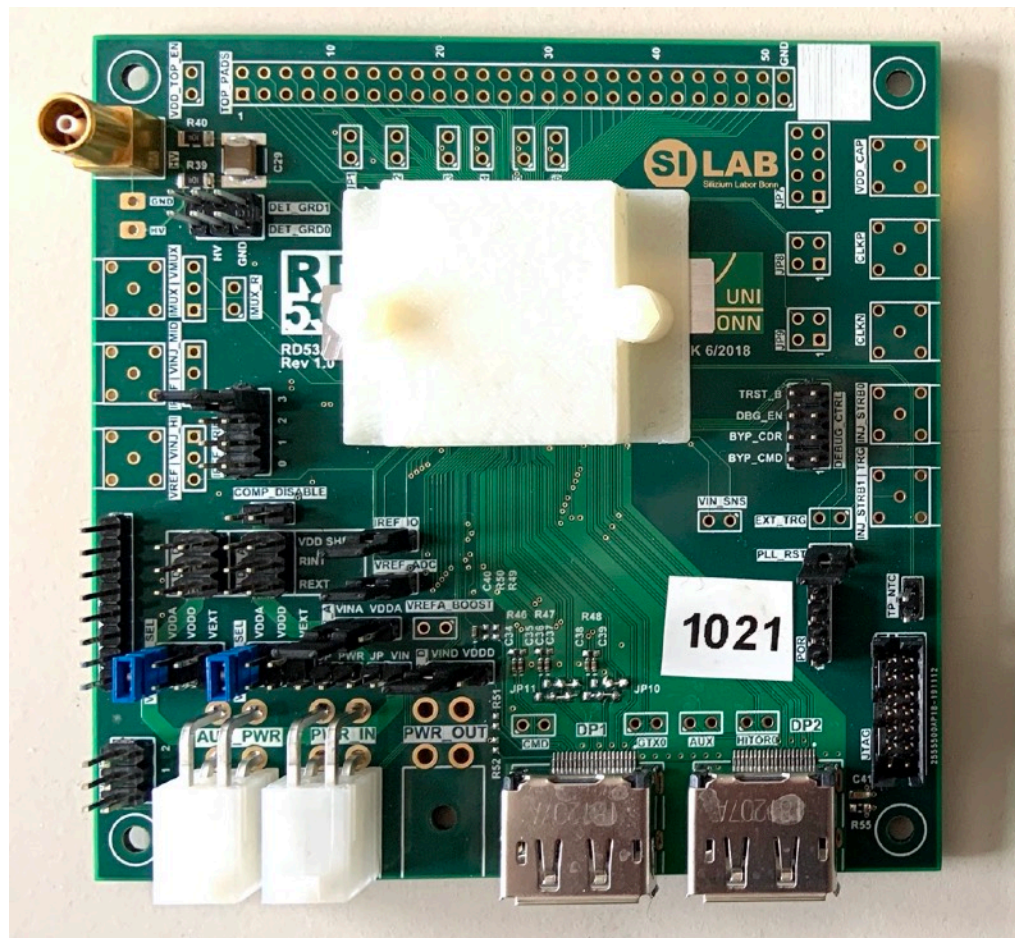
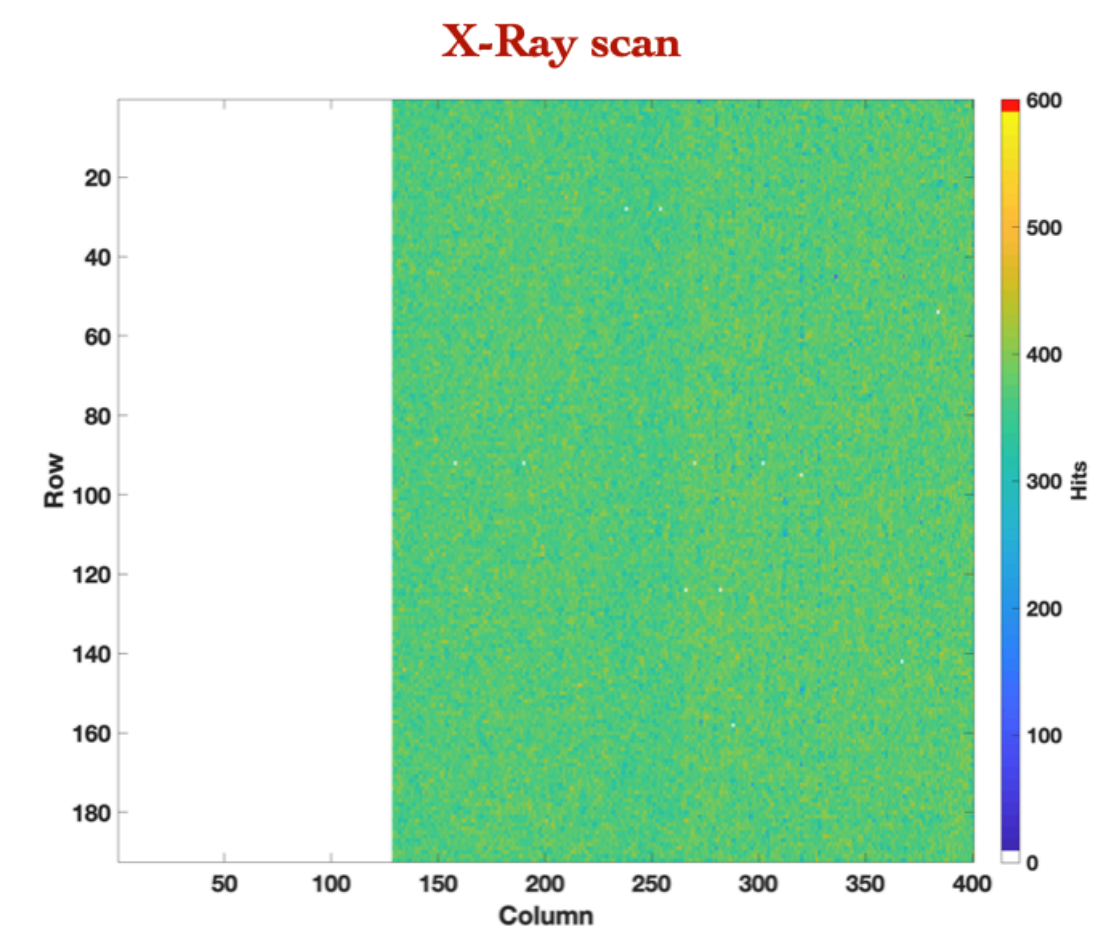
Tests with **X-Rays** to check damages, missing and/or disconnected bumps
Through a **Leybold 554-90 42 kVp X-Ray unit**



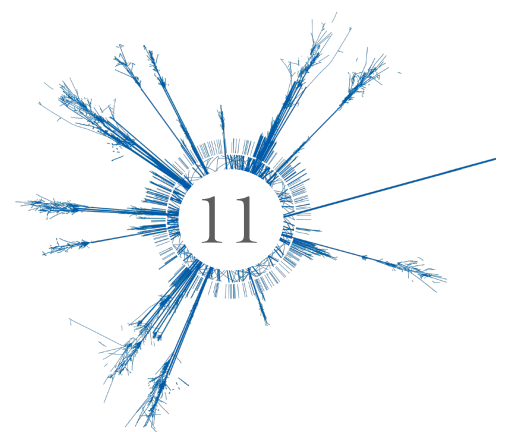
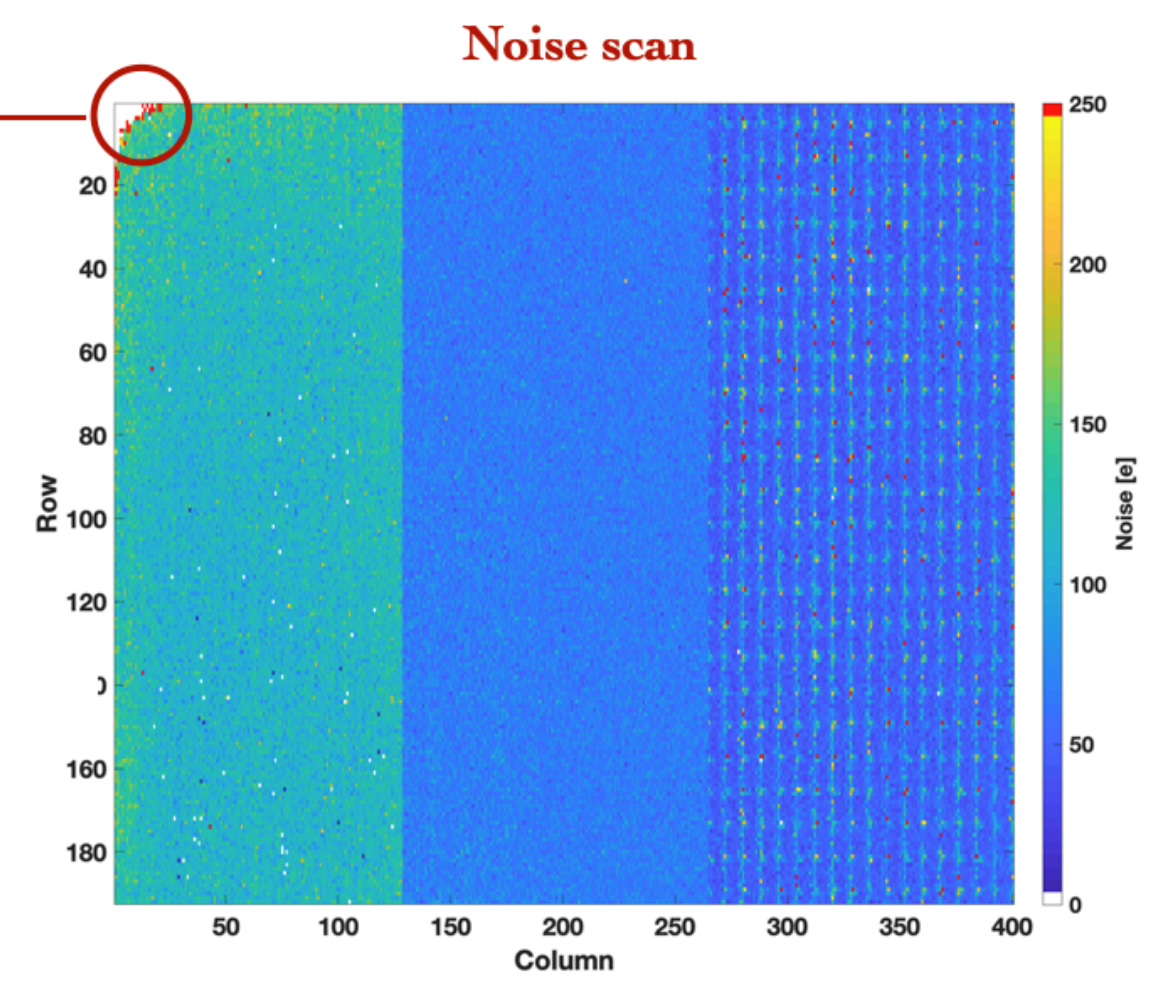
HV
KEITHLEY 2410
Power supply for chip
ROHDE&SCHWARZ HMP 4040

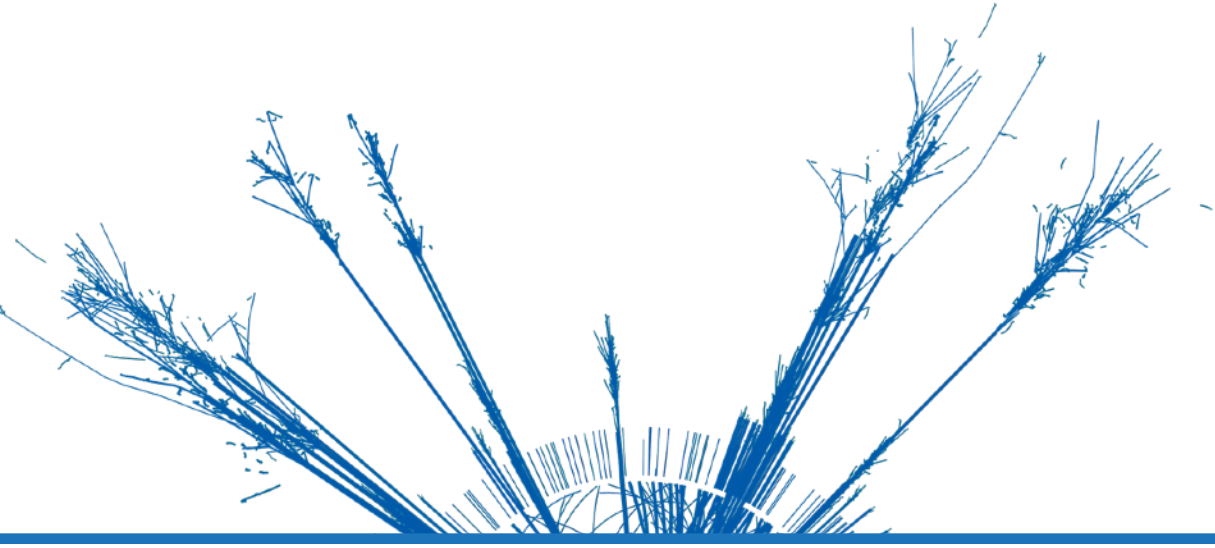


Collimator
Micrometric movements



Merged bumps.





Thank you

