

Reda Mekouar^{1,2} on behalf of IHEP-USTC HGTD Module Assembly and Loading Team

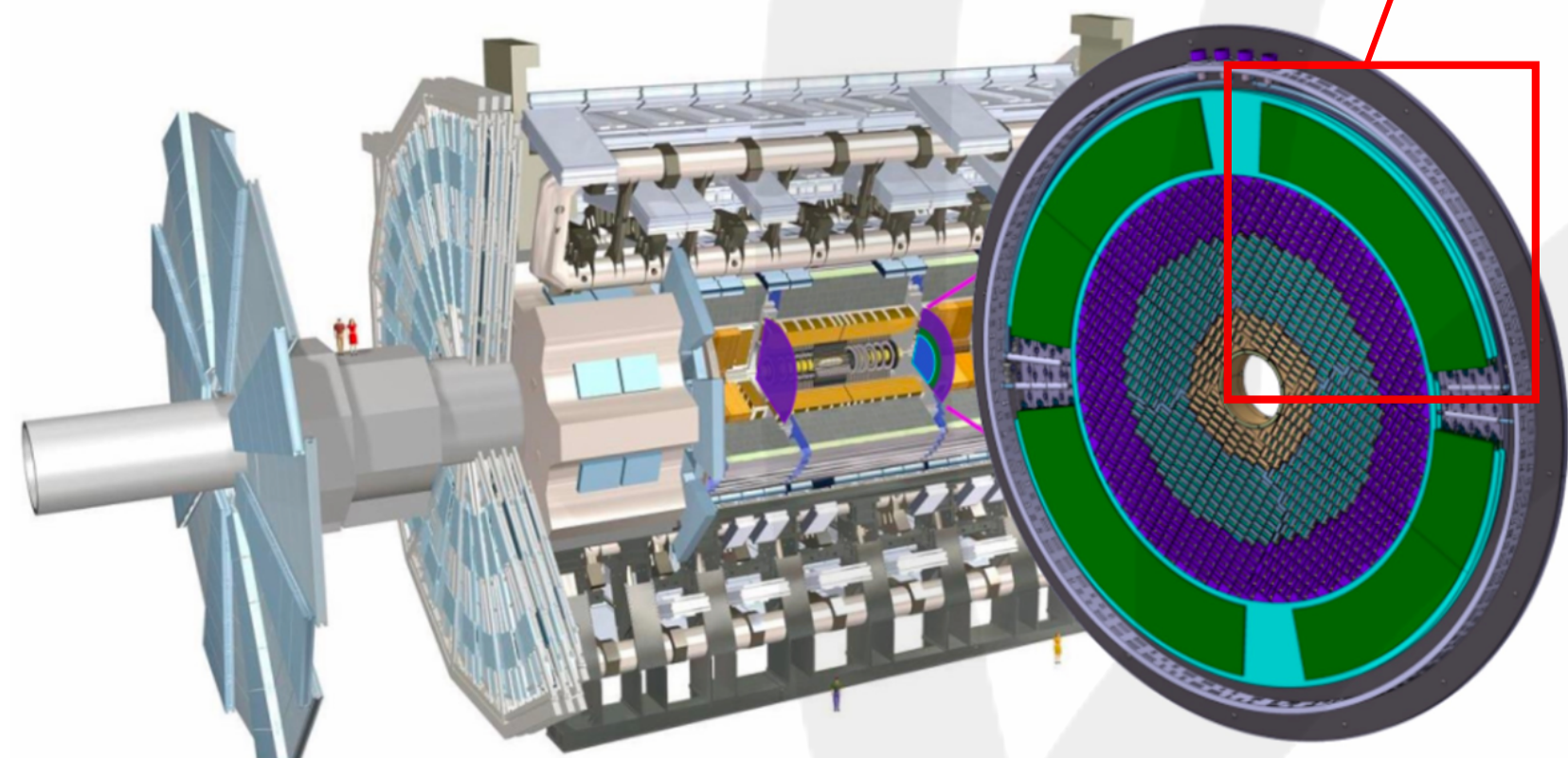
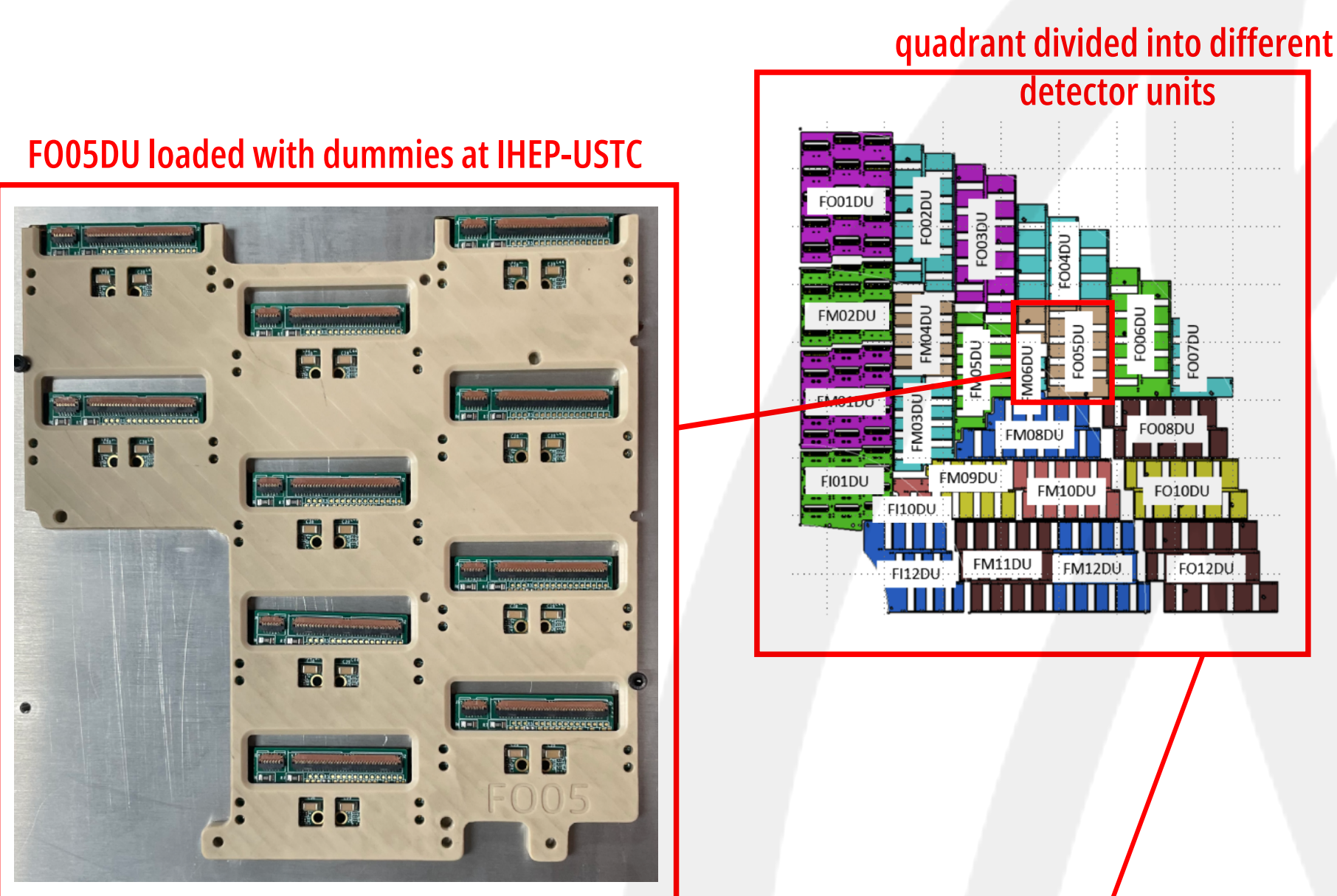
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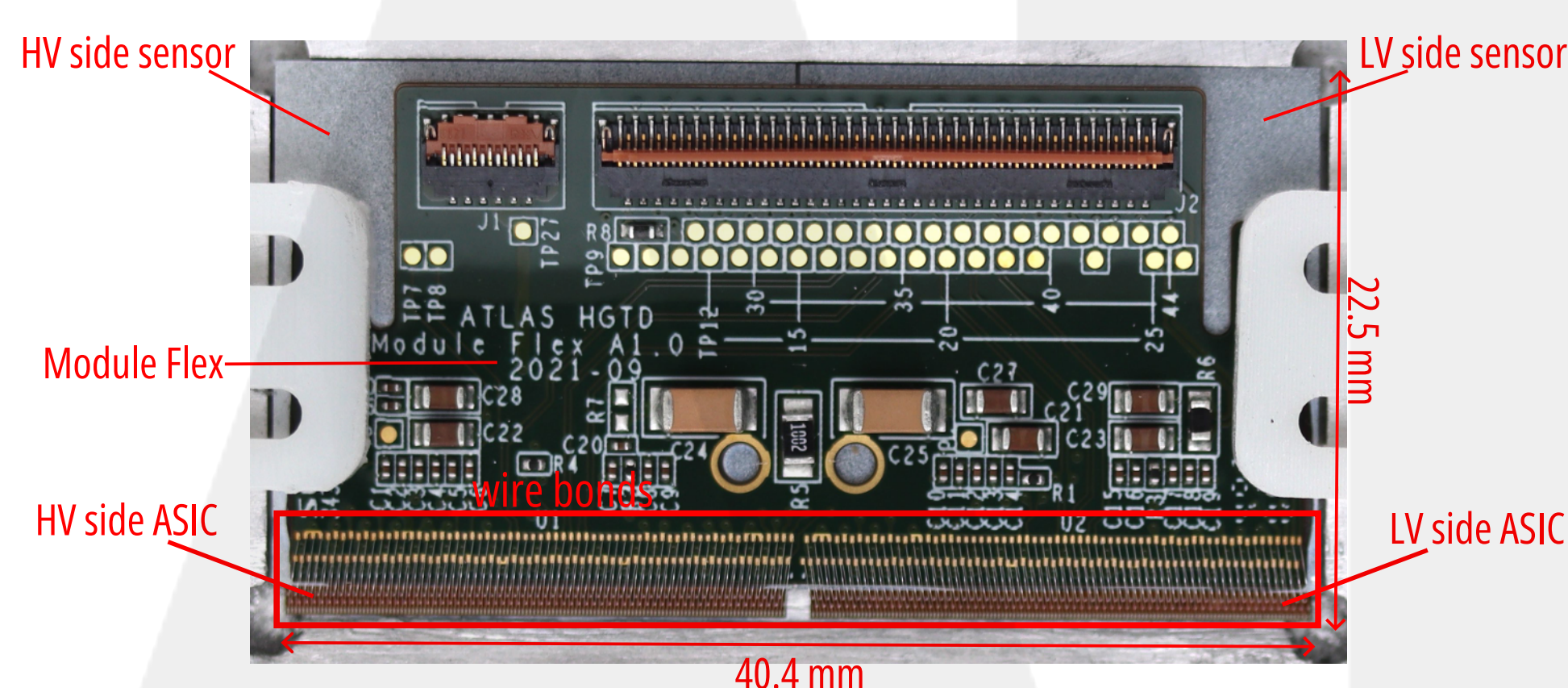
1. HGTD Wheel

- High Granularity Timing Detector, a core element of the **ATLAS Phase-II Upgrade** for HL-LHC.
- **Objective:** mitigate pile-up with 30-50 ps timing resolution per track.



- Two wheels flank the ATLAS inner tracker, each split into 2 sides $\times$ 4 quadrants.
- Each quadrant holds 24-25 detector units (DUs), formed by gluing modules to a support unit.
- **Production Share:** IHEP-USTC produces ~44% of HGTD modules and DUs.

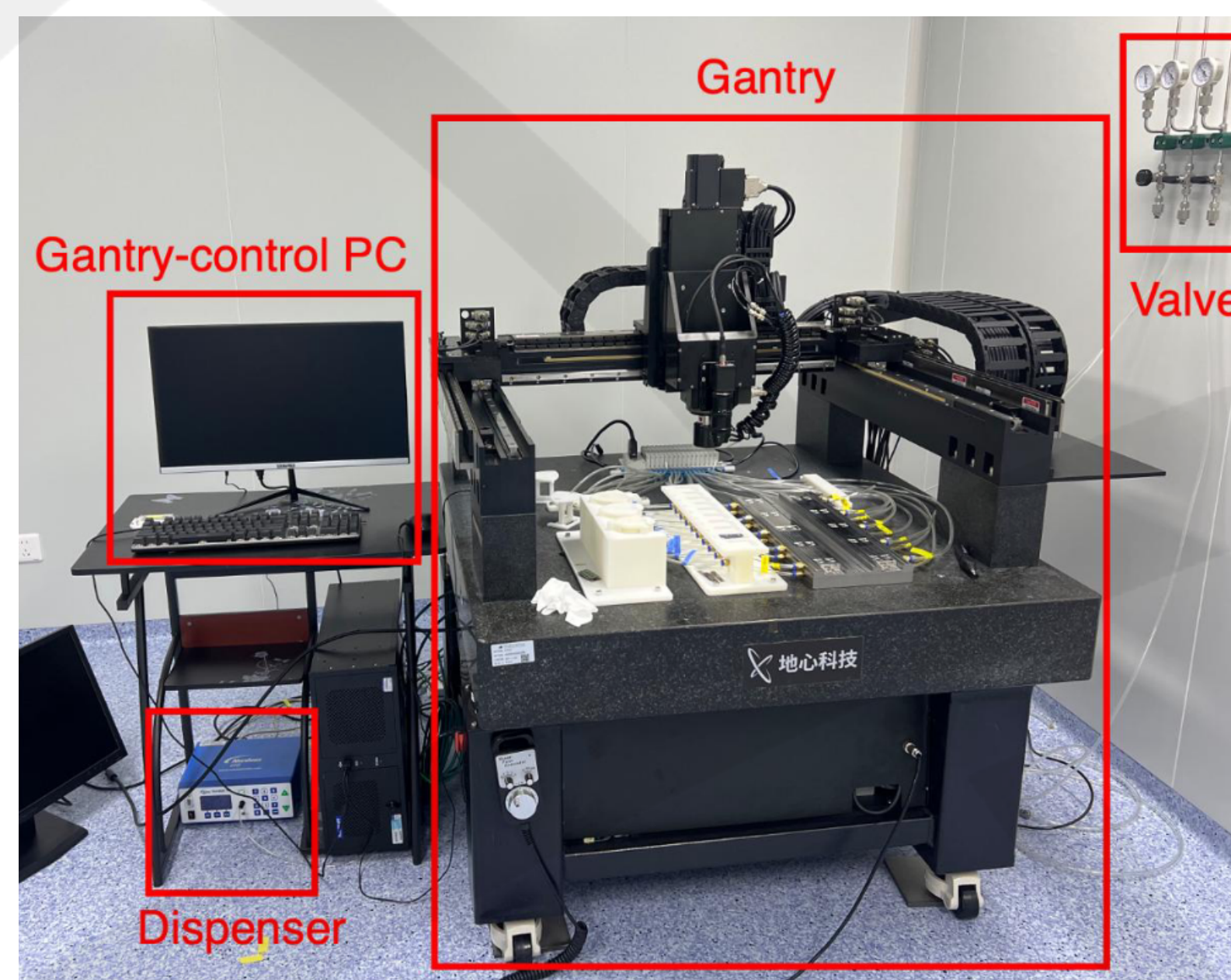
2. Module components



- Each module = 1 flex PCB + 2 hybrids.
- Each hybrid pairs a $2 \times 2 \text{ cm}^2$ **ASIC (ALTIROC A)** [2] with a same-size **LGAD sensor** [3] ($1.3 \times 1.3 \text{ mm}^2$ pixels).
- The sensor, a **silicon Low Gain Avalanche Detector**, is bump-bonded to the ASIC to form a hybrid.
- Hybrid pairs (HV & LV) are glued to PCBs; wire bonds link the flex to sensors and ASICs.

3. Gantry system

- A robotic gantry automates module assembly and loading at scale.

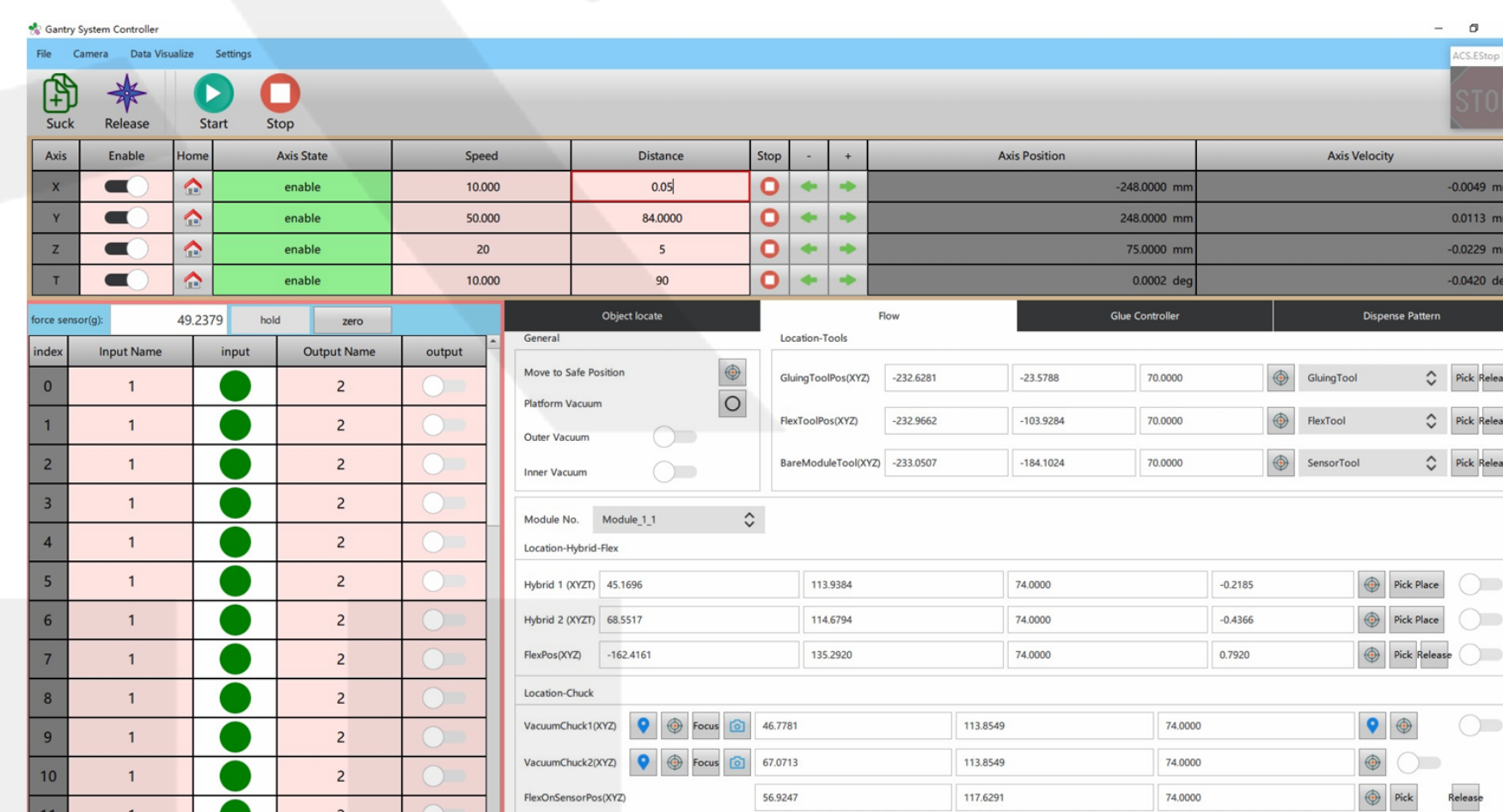


Gantry features:

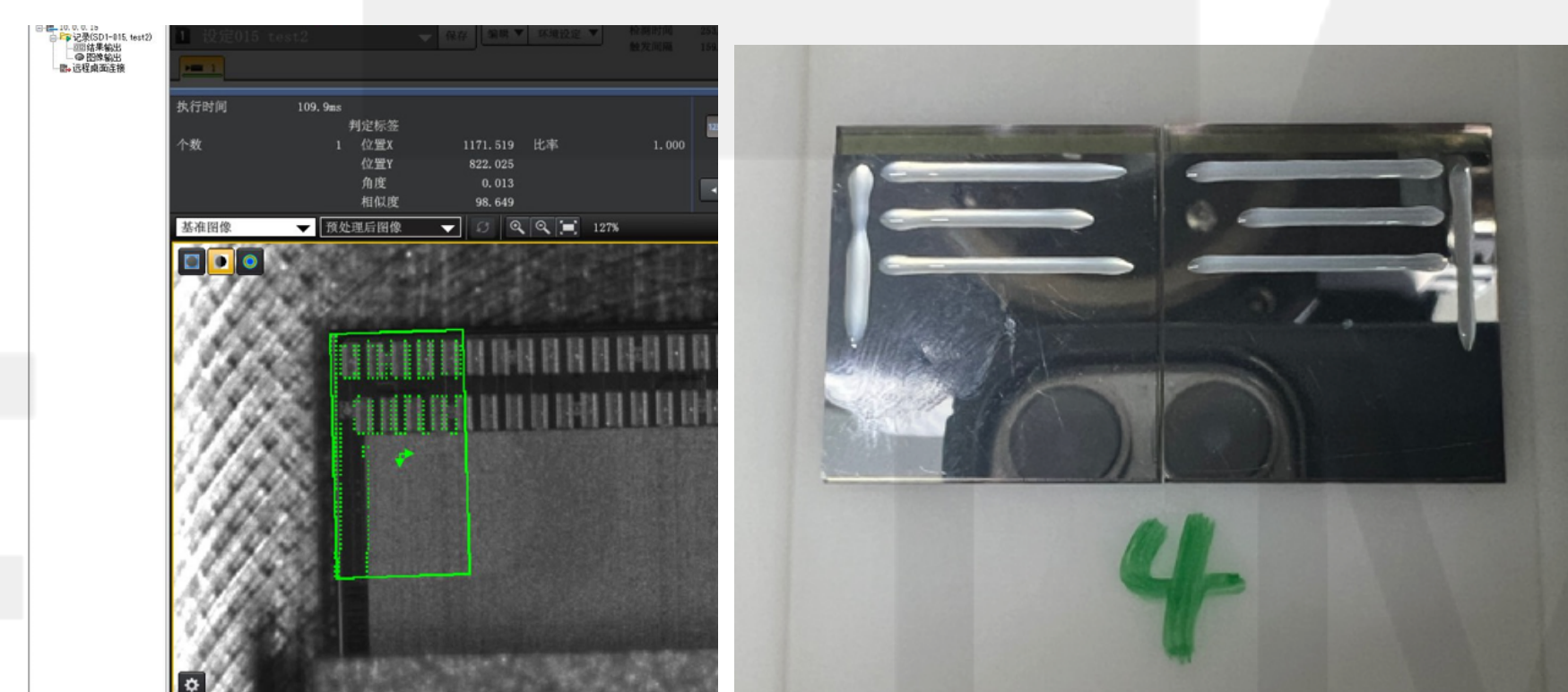
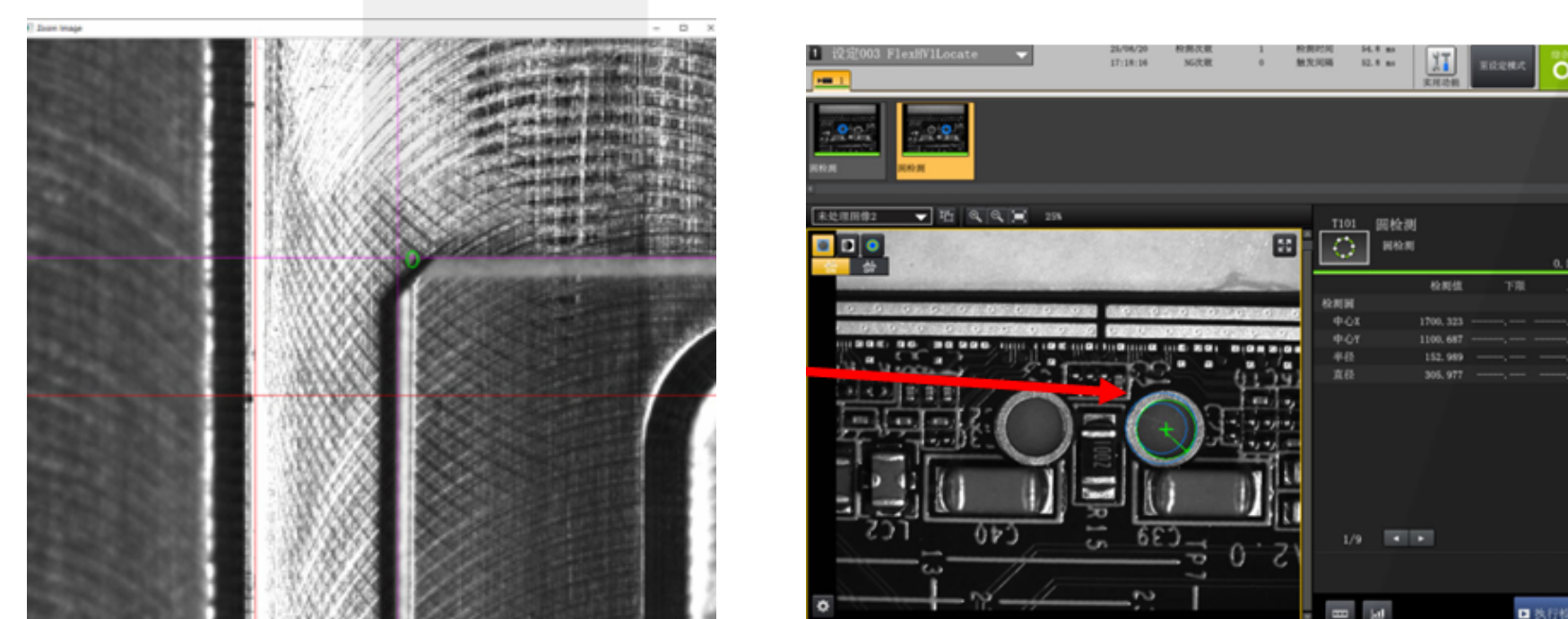
- **Precision:** Coretech gantry + ACS controller, $\sim 1 \mu\text{m}$ resolution ($500 \times 500 \times 150 \text{ mm}$, 340°).
- **Integration:** Keyence vision, pressure sensors, Nordson EFD dispensing, 32-channel vacuum system.
- **Control:** custom C++/Qt GUI for modules, hybrids, flexes.

4. Assembly procedure

- Assembly is integrated with gantry software for a fully automated workflow.



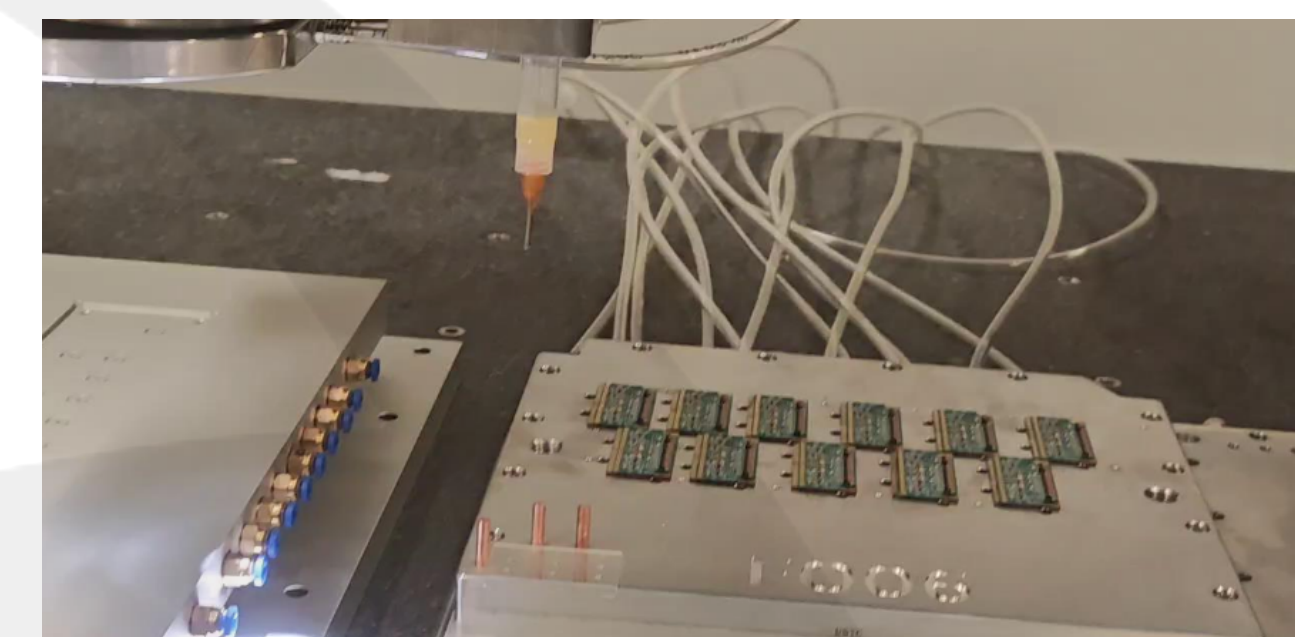
- High-precision pick-and-place and gluing of module components via dedicated gantry tooling.



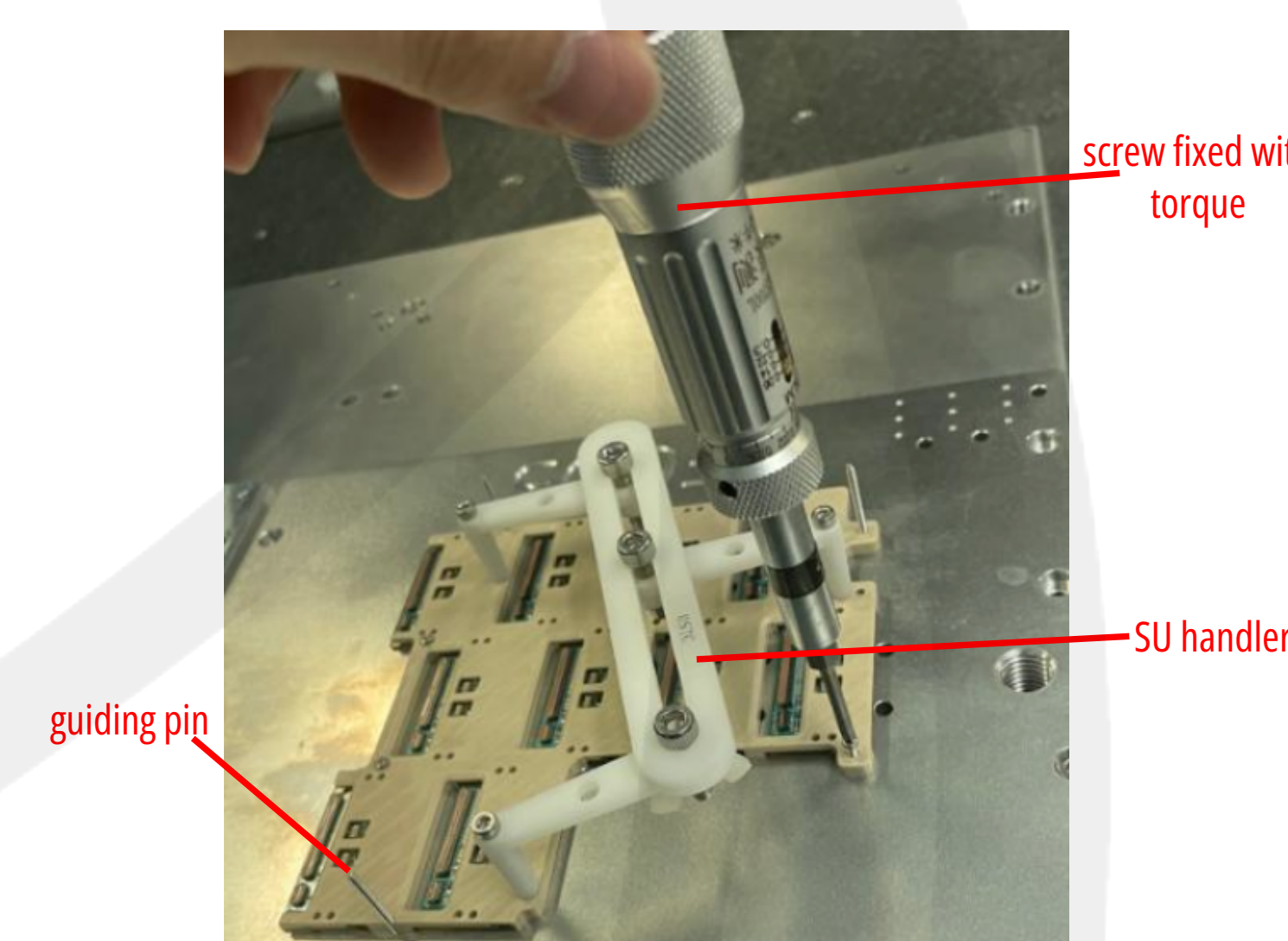
- Pre-production will have iterations of software for more precise and automatic hybrid locating and better glue calibration and dispensing.

5. Loading procedure

- Like assembly, loading uses a gantry system.



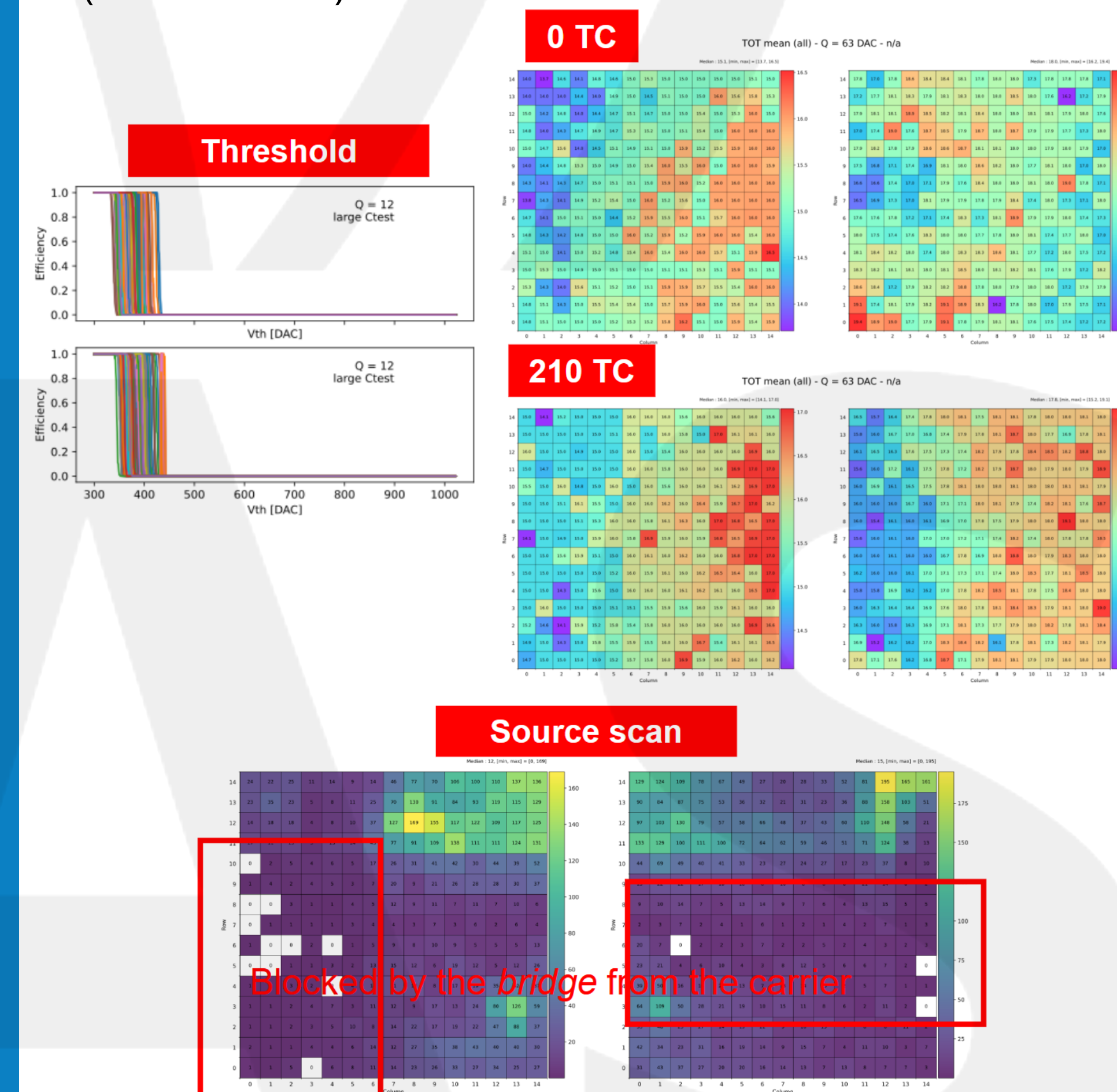
- Vision-guided locating and placing of modules, then gluing, SU covering, and screwing.



- Currently loading pre-production SUs with dummy modules; more SUs still in production.

6. Testing

- Results for a module assembled at IHEP-USTC (20WMOHP10009):



- Electronic testing and thermal cycling show excellent threshold uniformity and stable TOT performance after 210 cycles.
- Source scans confirm high pixel functionality; localized hit drops trace to shadowing by the test carrier bridge.

7. Summary

- Pre-production is ramping toward full production at IHEP-USTC.
- The fullchain at IHEP-USTC (modules, testing, DU loading) will deliver HGTD units by early 2027.

References:

- [1] Technical Design Report: A High-Granularity Timing Detector for the ATLAS Phase-II Upgrade, Geneva, 2020, <https://cds.cern.ch/record/2719855>
- [2] C. Agapopoulou et al., "Performance of a front-end prototype ASIC for the ATLAS High Granularity Timing Detector," JINST 18 (2023) P08019, arXiv:2306.08949
- [3] G. Pellegrini et al., Technology developments and first measurements of Low Gain Avalanche Detectors (LGAD) for high energy physics applications, Nucl. Instrum. Meth. A 765 (2014) 12

Acknowledgments:

