ATLAS ITk Strip Hybrid Production Progress

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(on behalf of Tsinghua/IHEP Group)

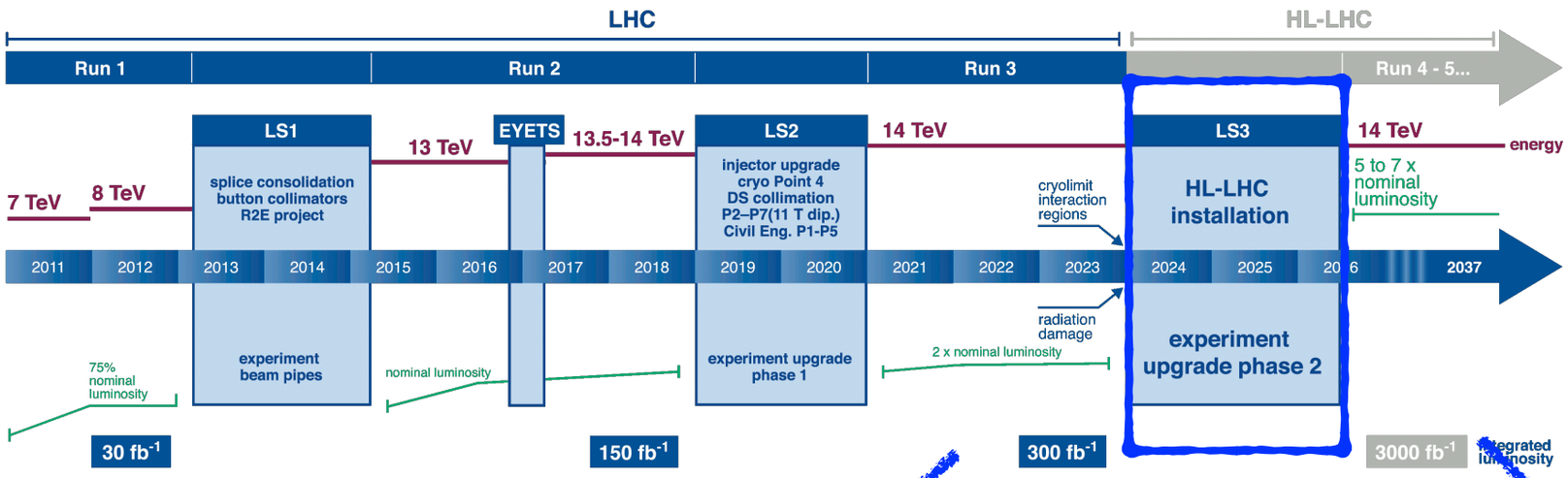
July 1, 2019

LHC Detector Upgrade Workshop, Qingdao

Outline

- Overview of ATLAS ITk Upgrade and ITk Strip
- Overview of Hybrid on Strip Module
- Hybrid Assembly Steps
- Hybrid Production and Test Status
- Summary and Outlook

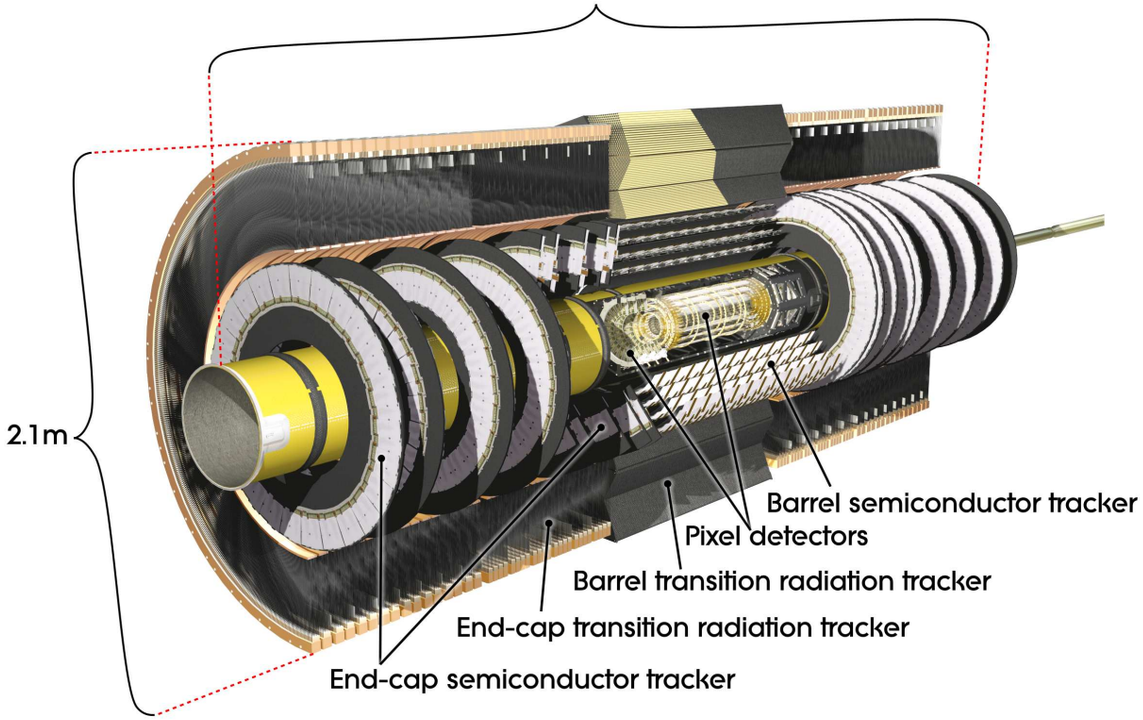
LHC Phase II Upgrade on ATLAS ITk

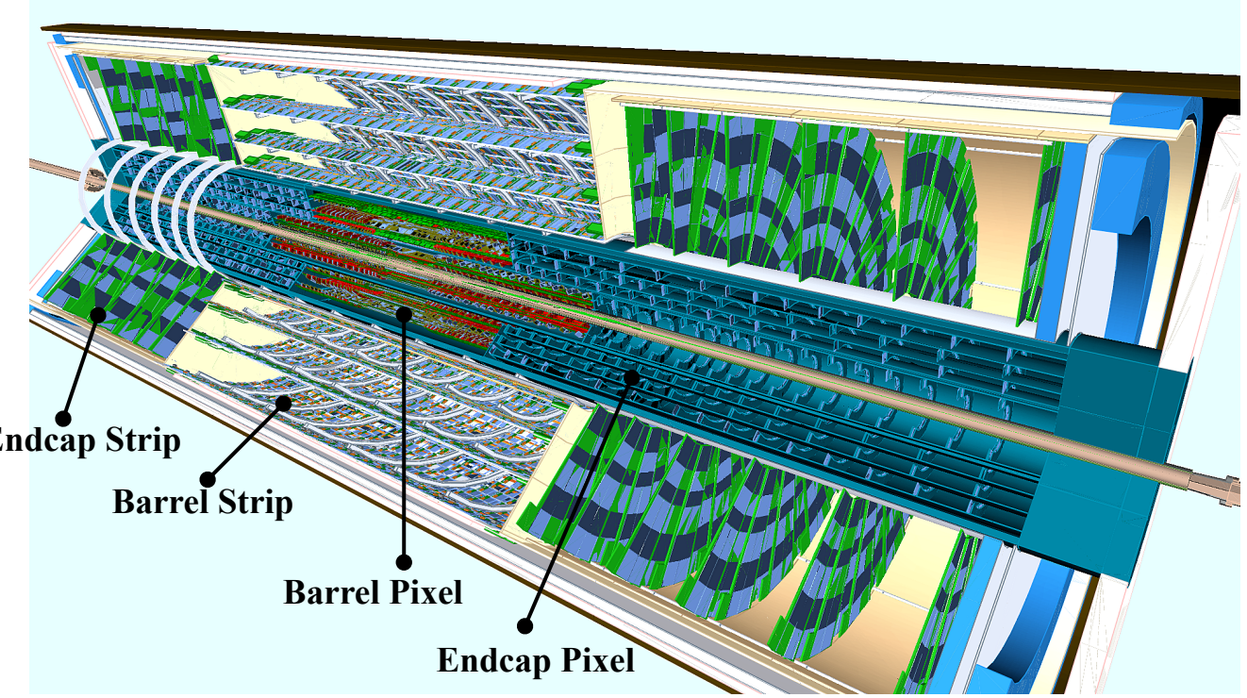


HL-LHC:

- $\mathscr{L}$=5-7.5×10^{34} cm^{-2}s^{-1}
- 3000 fb^{-1} for 10 years
- >10 times radiation

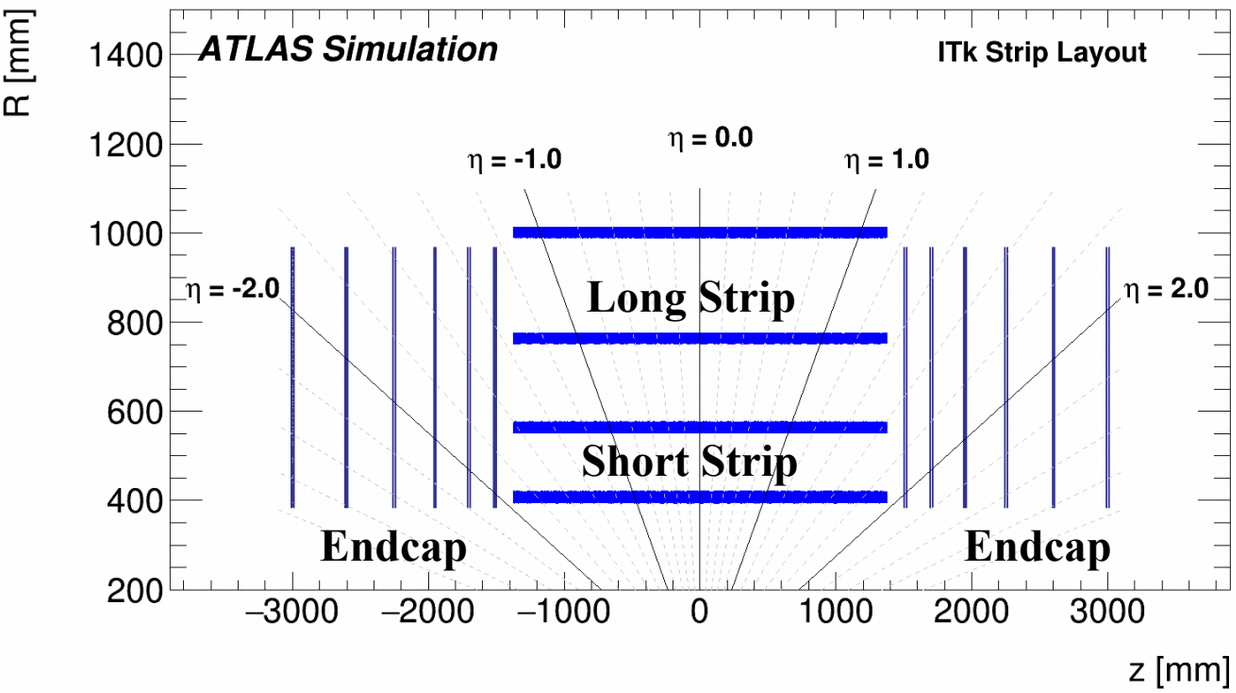
Phase II Upgrade: 2024-2026



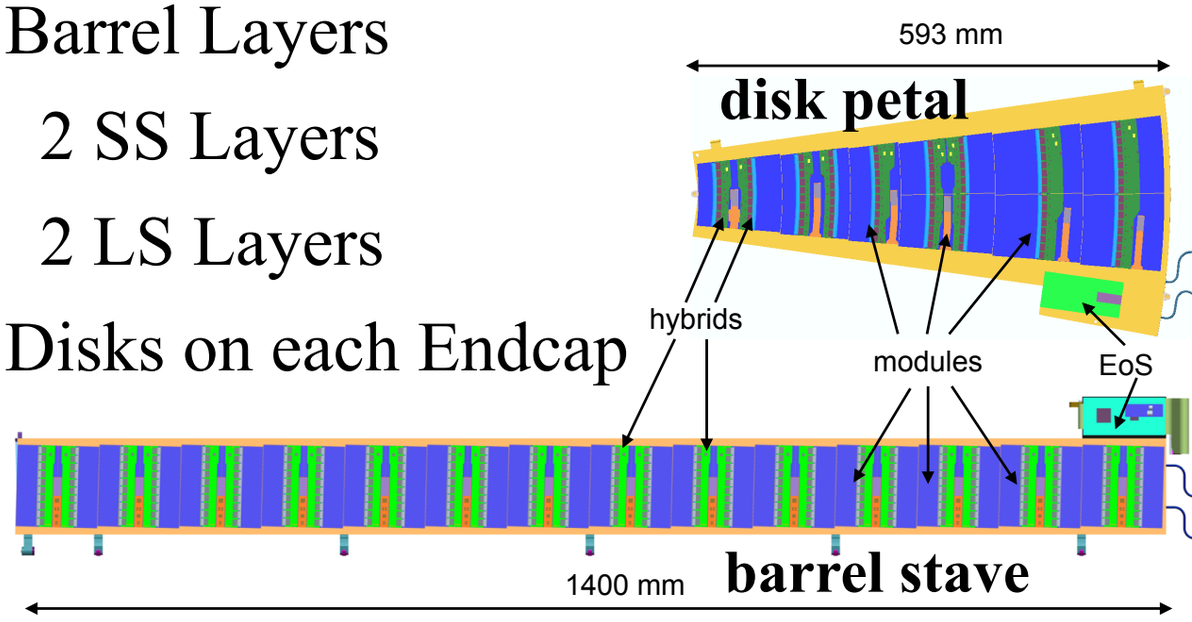


- Pixel • SCT • TRT
  |η|<2.7
- ITk Pixel • ITk Strip
  |η|<4

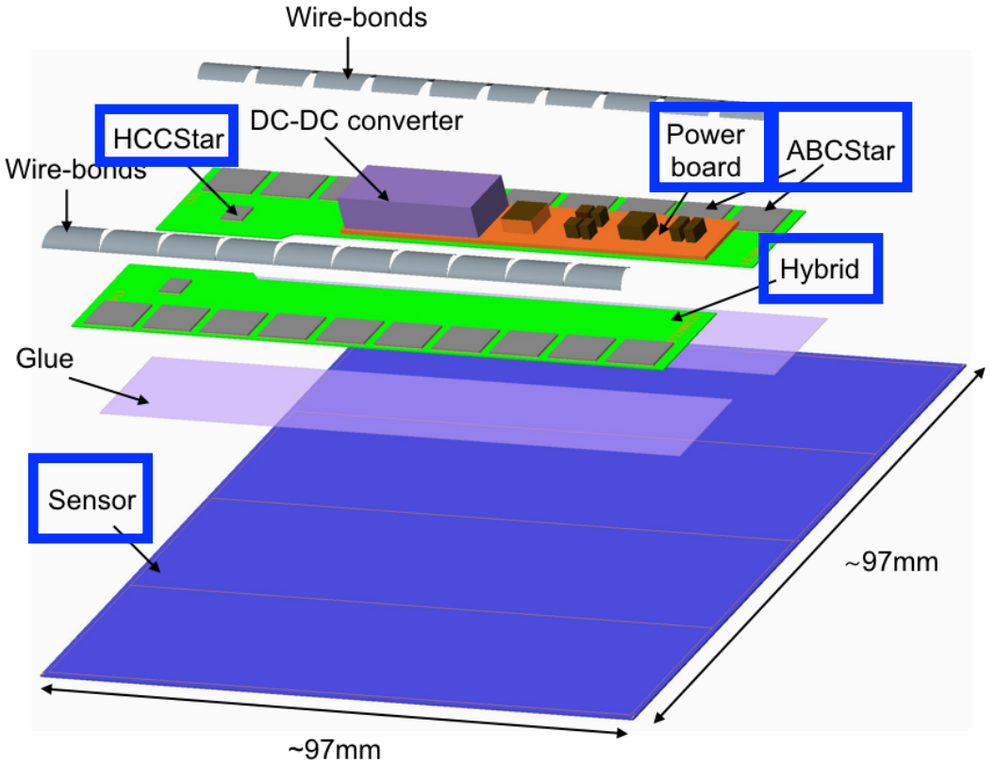
ITk Strip



- 4 Barrel Layers
  - 2 SS Layers
  - 2 LS Layers
- 6 Disks on each Endcap



- **500 Barrel Modules produced at IHEP**



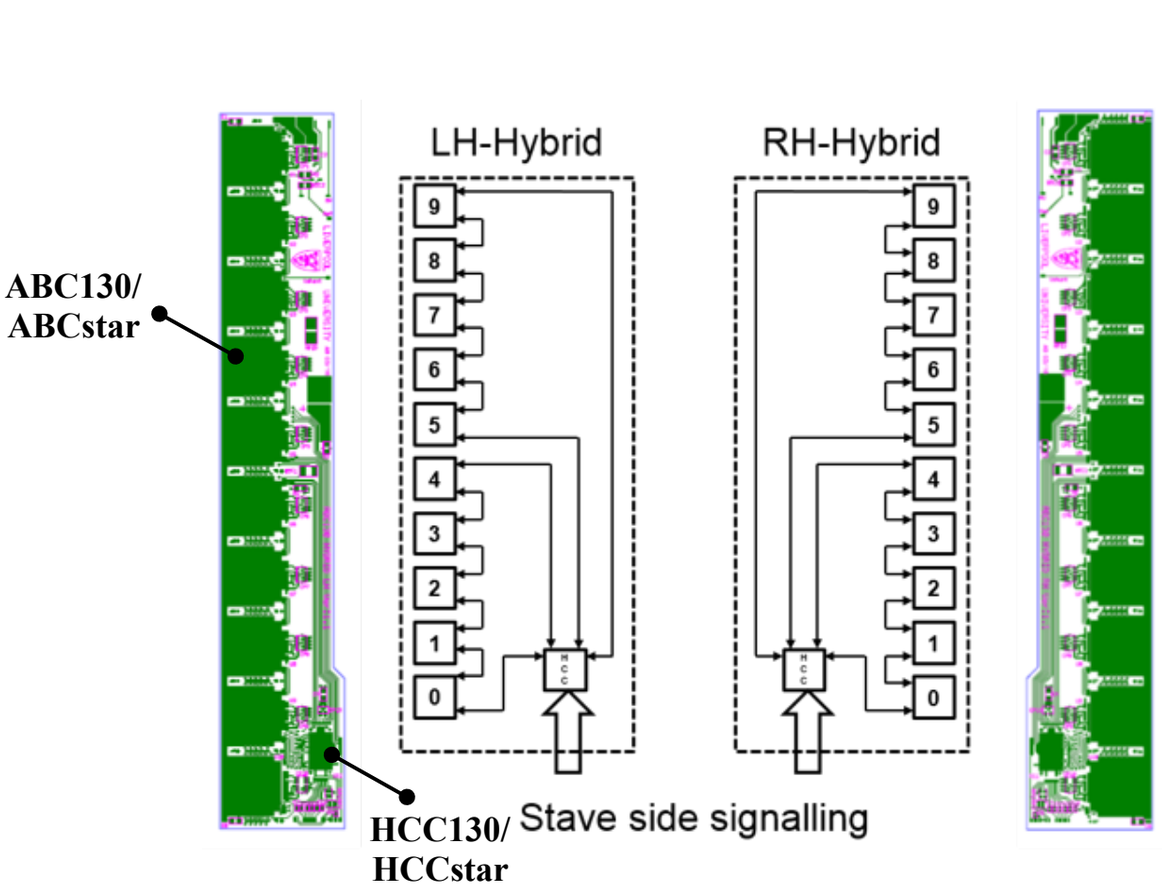
Module Assembly Steps:

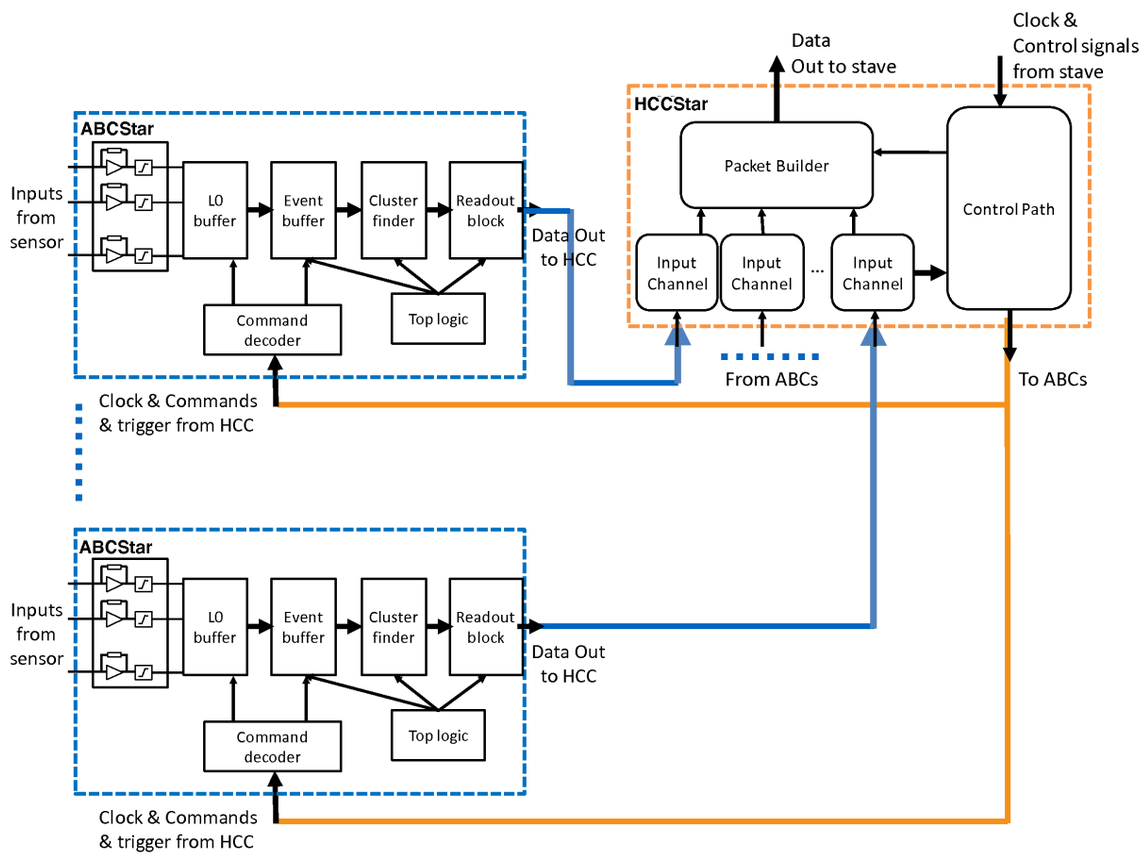
1. Glue ASICs(ABC/HCC) onto Hybrids,
2. Test Hybrids electrically,
3. Glue Hybrids and power board onto sensors,
4. Wire bond ASICs onto sensors,
5. Test the Full Strip Module.

Hybrid on ITk Barrel Strip Module

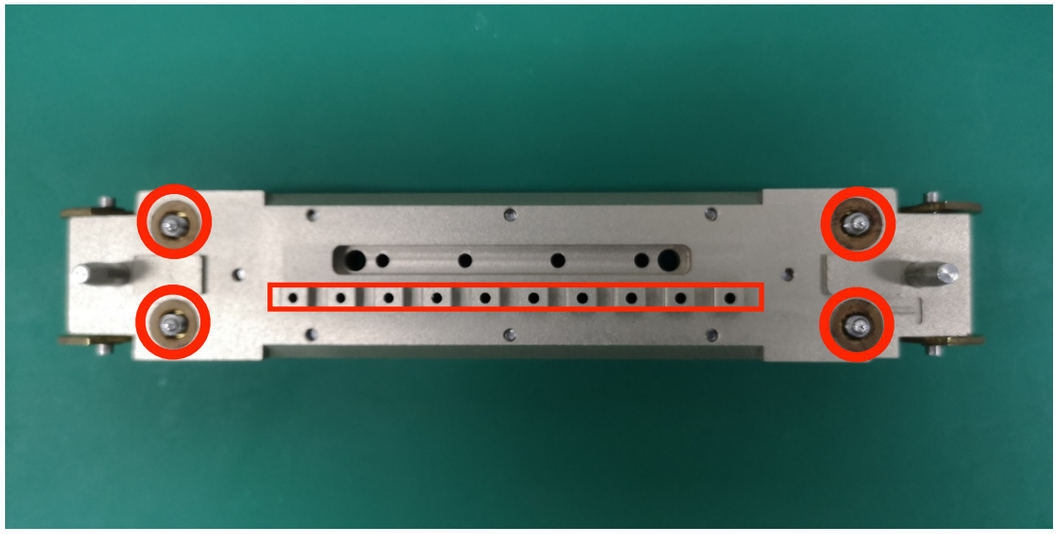
Tsinghua University

- One Hybrid on long-strip module,
- Two Hybrids on short-strip module,
- 10 front-end readout ASICs(ABC130/ABCstar) and 1 HCC(HCC130/HCCstar) glued on each hybrid,
- **IHEP made significant contributions to the ABCstar chip.**

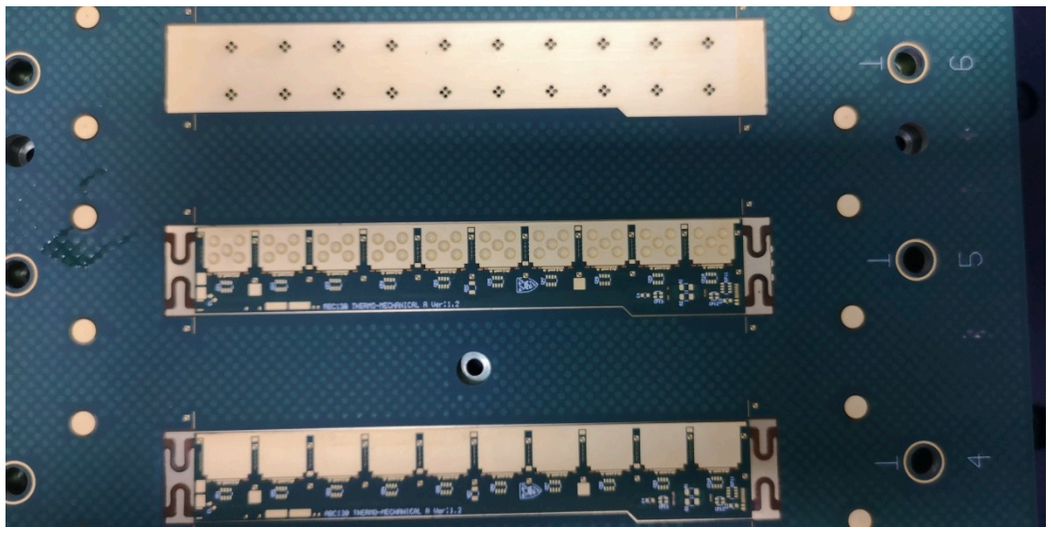




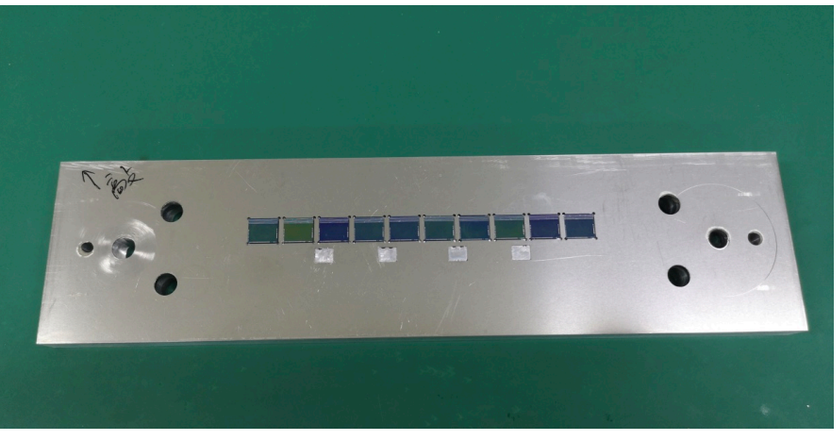
Hybrid Assembly Steps



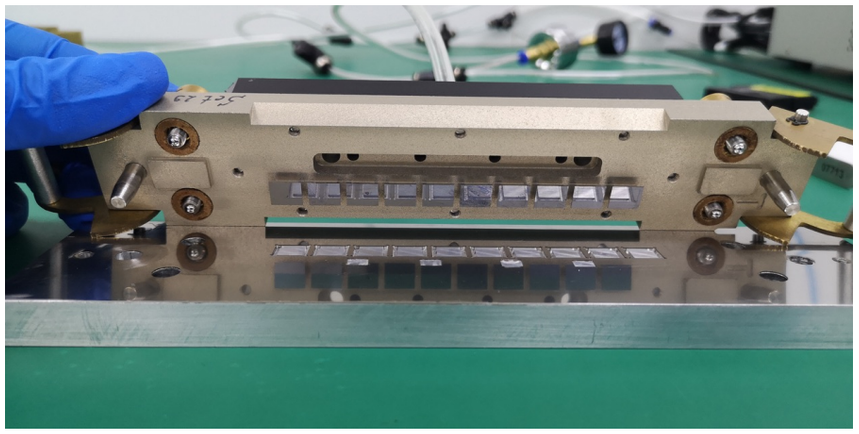
1. Metrology



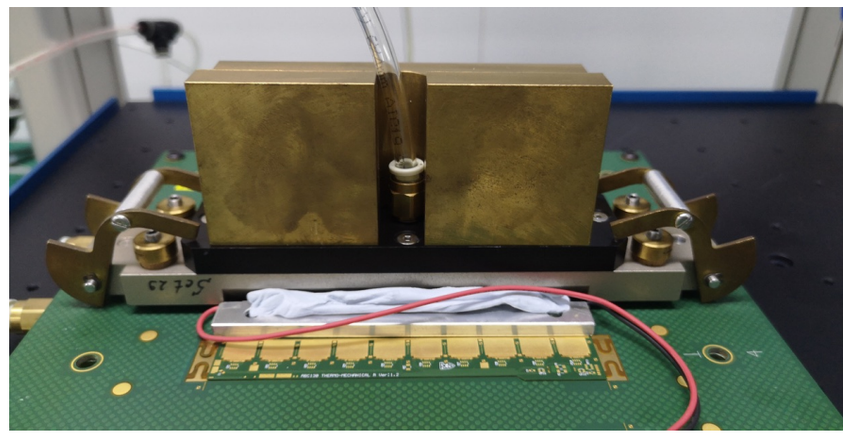
2. Dispense glue



3. Align ASICs in mask



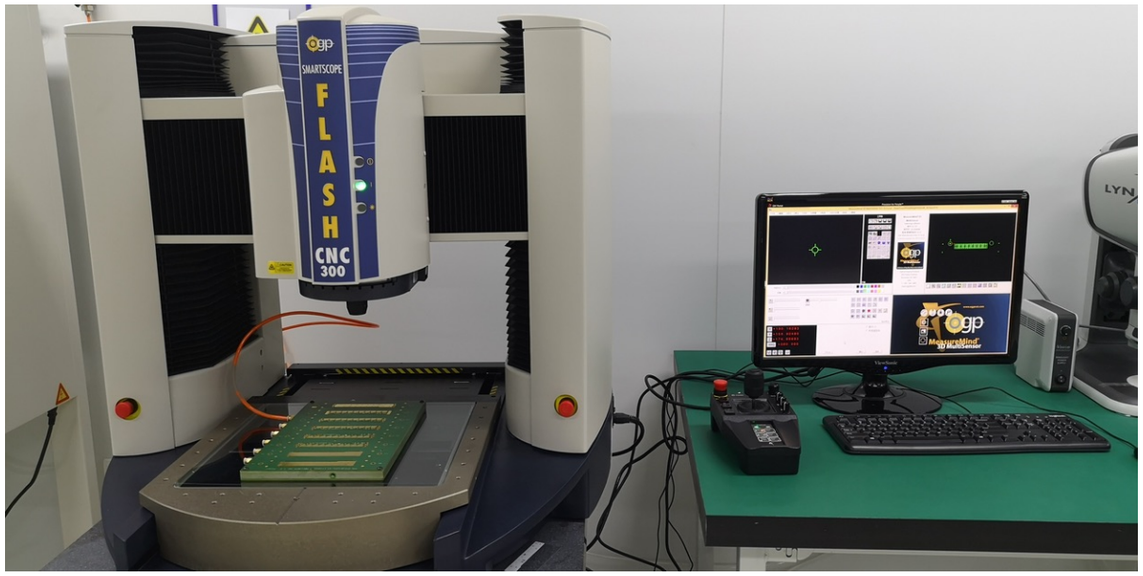
4. Pick up the ASICs

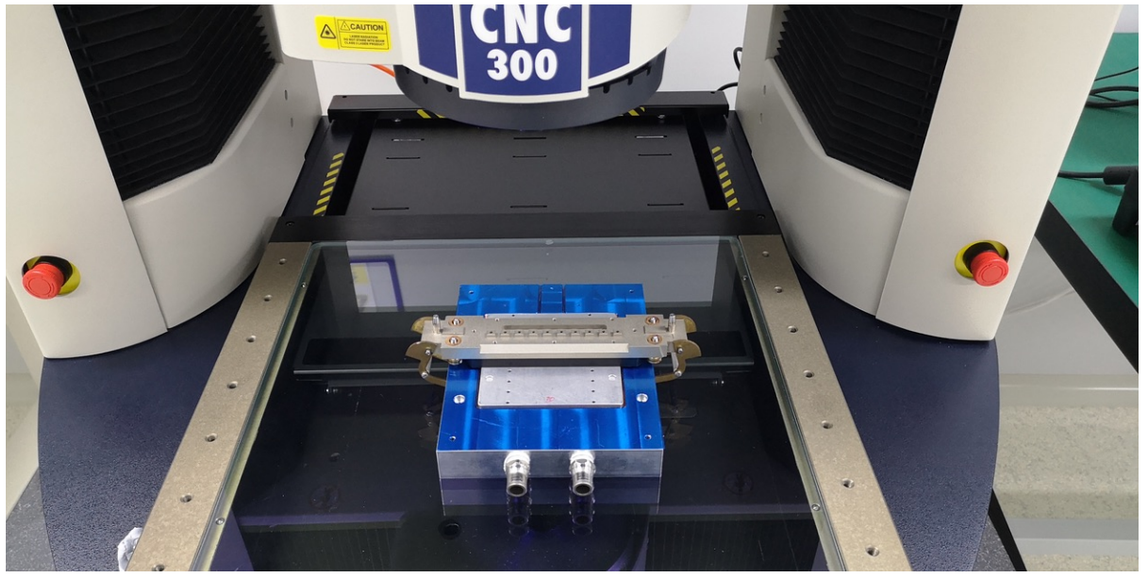


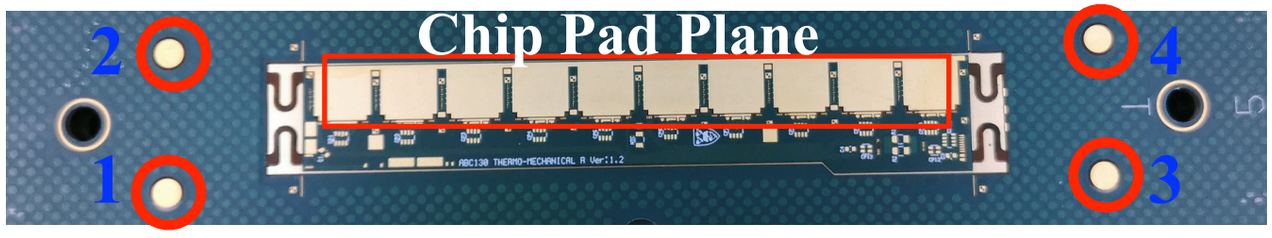
5. Attach and Cure

Hybrid Assembly Step 1-Metrology

- OGP Smartscope CNC 300 (Laser Ranging)
- Resolution: 2-3 μm



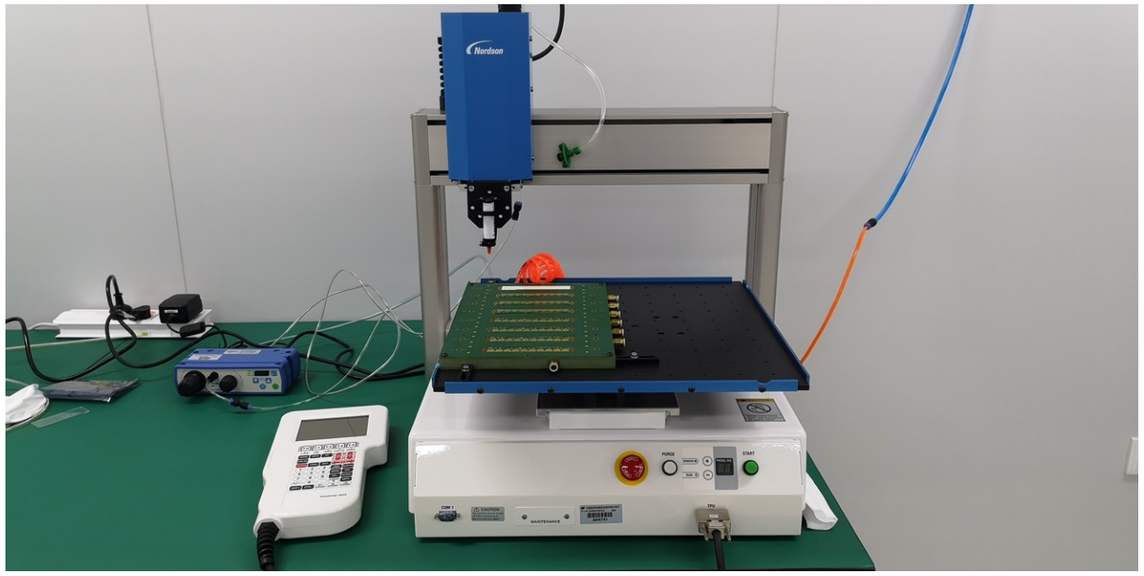


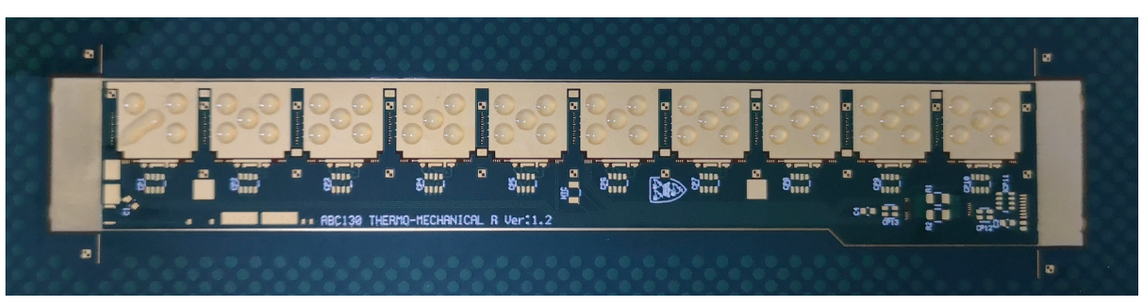


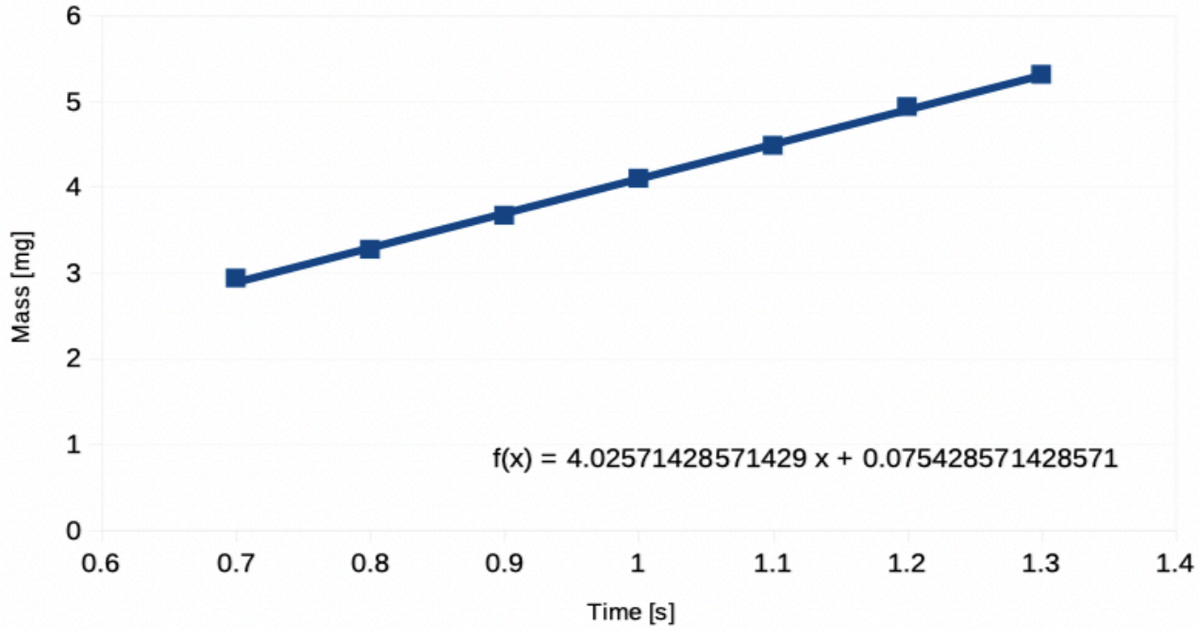
- Measure Height of Touch Points to Chip Pad Plane on Panel,
- Measure and adjust Height of Pins to Chip Pickup Plane of Pickup Tool,
- Until the distance of two planes is 310 μm(ASICs) + 120 μm(Glue).

Hybrid Assembly Step 2-Dispense Glue

Nordson Glue Dispenser

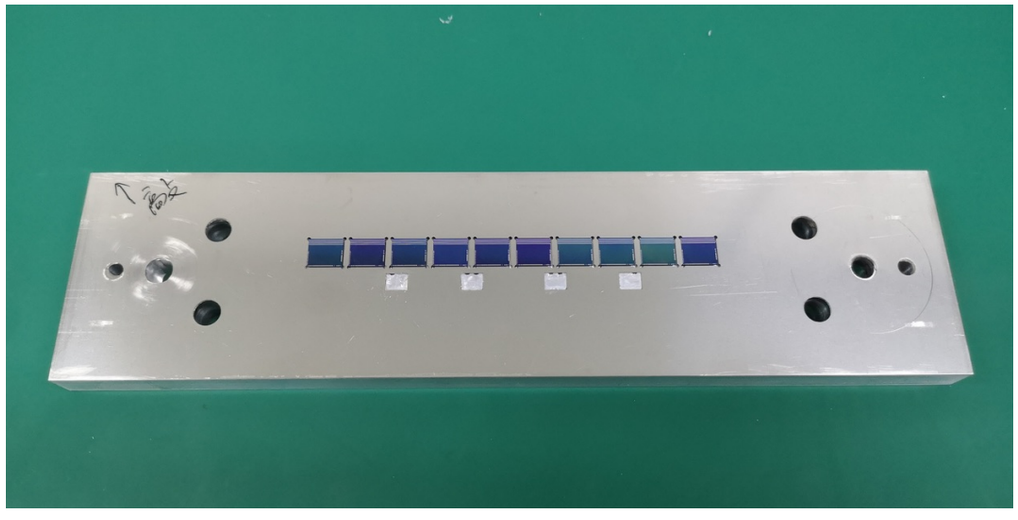


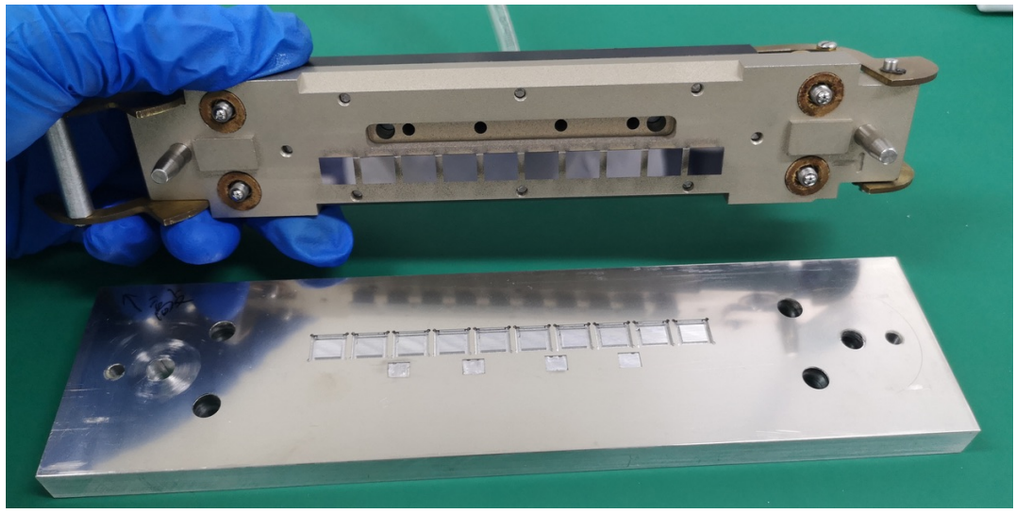




- Loctite 3525 UV Glue(dedicated to glue ASICs),
- Dispense 5-dot patten on each Chip Pad,
- Glue weight/5-dot: 4.3 mg,
- Coverage: 50%-80%(Glue thickness is 120 μm).

Hybrid Assembly Step 3&4-Align and Pick up ASICs



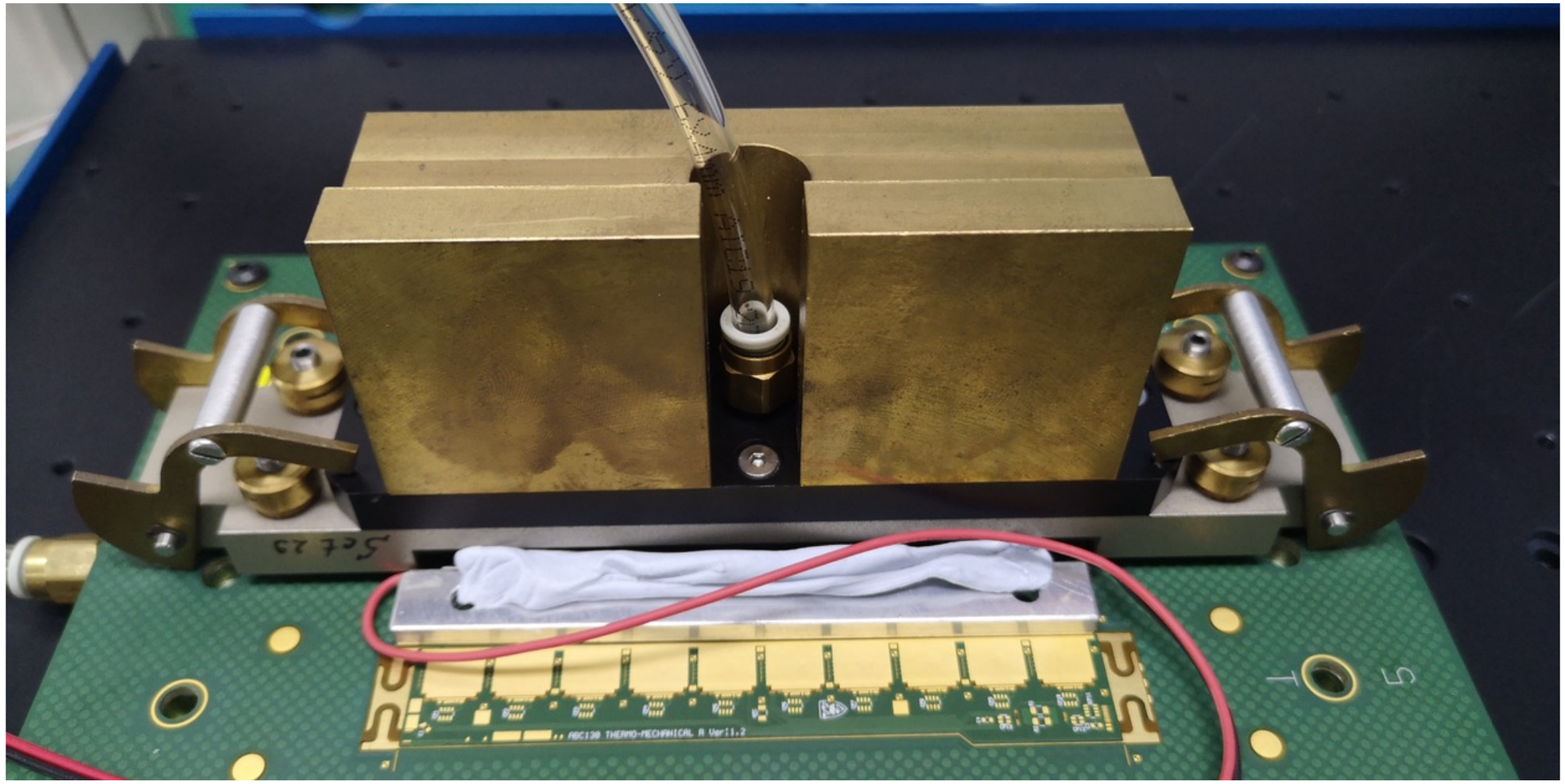


- Step 3: Align the ASICs to top left corner of mask, to match with the Chip Pad.
- Step 4: Pick up the ASICs by the Pickup Tool(switch on vacuum).

- **Mechanical Chips made in China, distribute to other institutes,**

- Practice with these mechanical chips can save much cost.

Hybrid Assembly Step 5-Attach and Cure

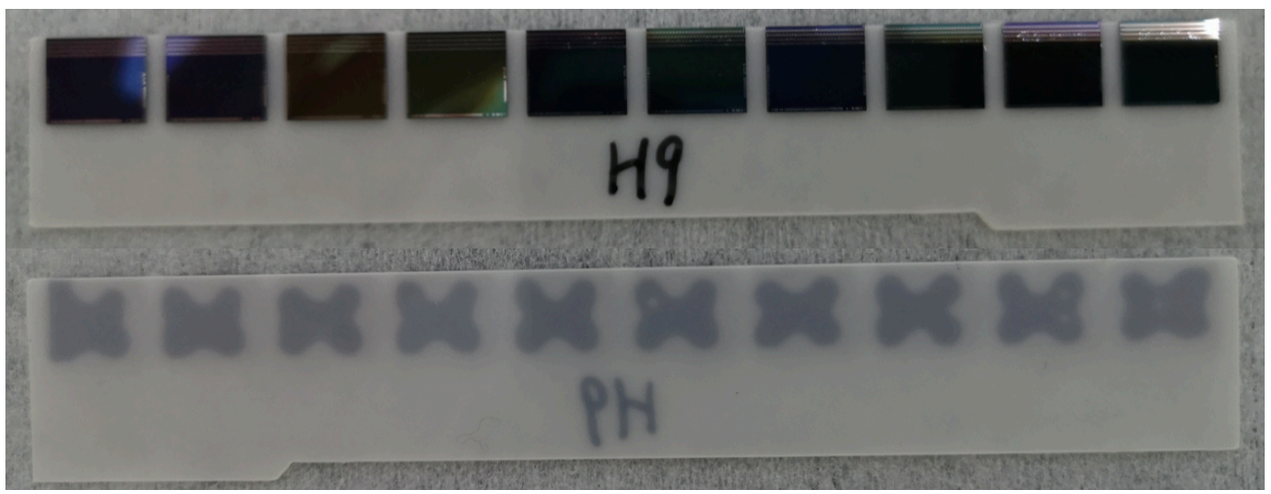


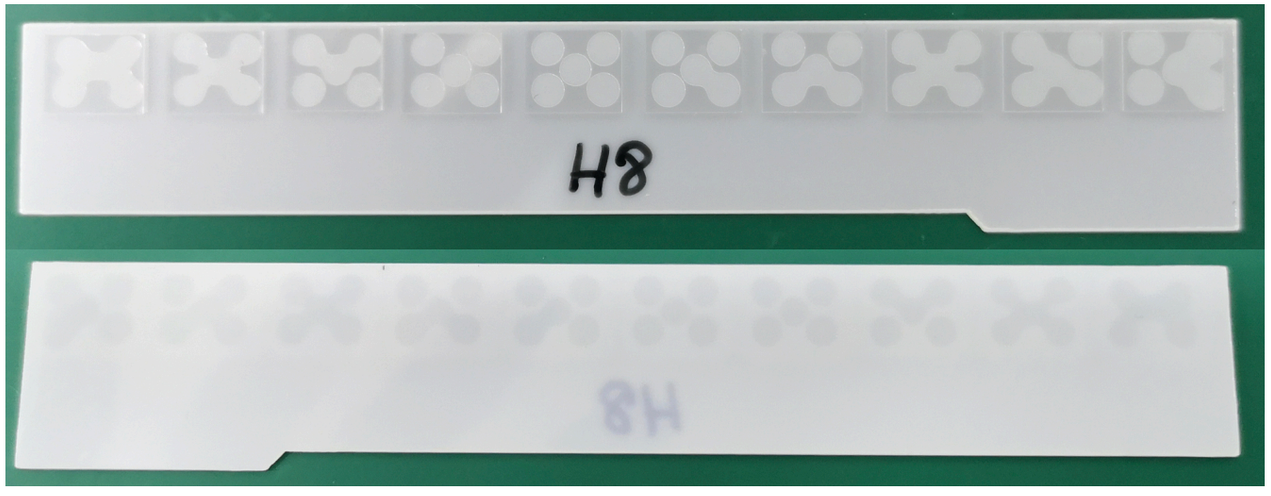
- Match precision holes on the panel and pins of the pickup tool to align x-y direction,
- Lower the ASICs onto the hybrid,
- Expose the UV light to glue on each side for ~ 6 minutes to cure glue.

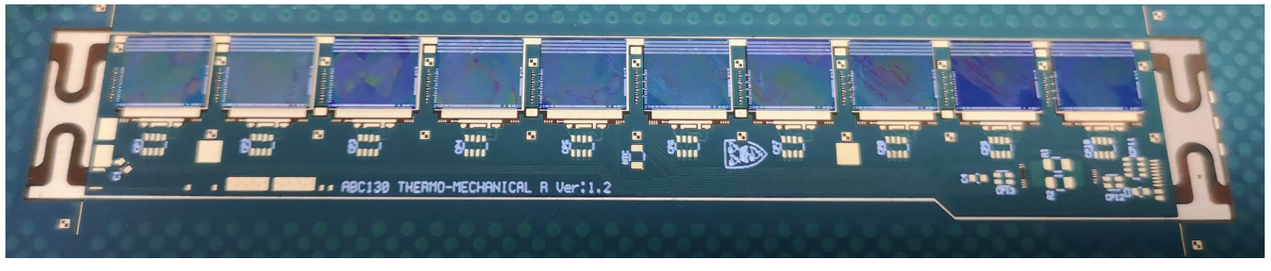
Hybrid Production Status

清華大學 Tsinghua University

Dummy and Mechanical Hybrids at IHEP:





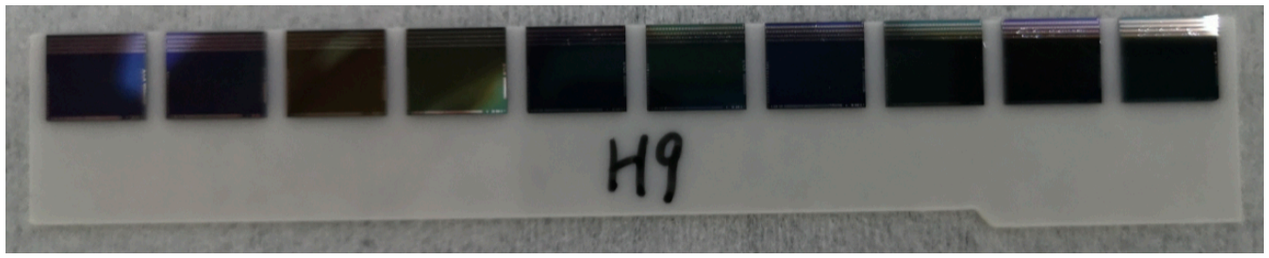


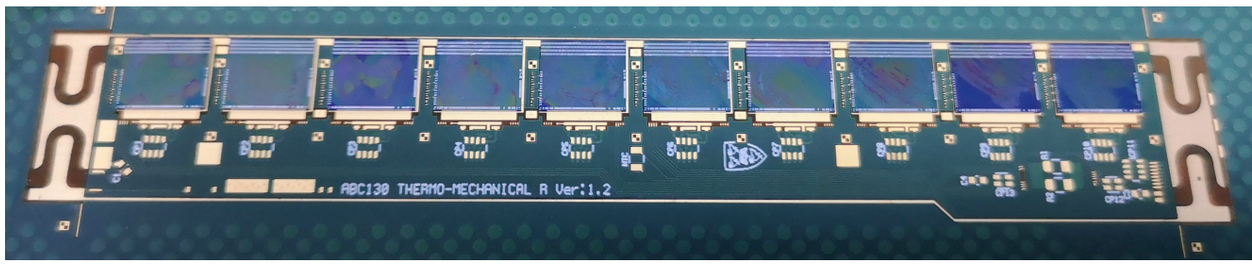
Dummy and Electrical Hybrids at RAL:

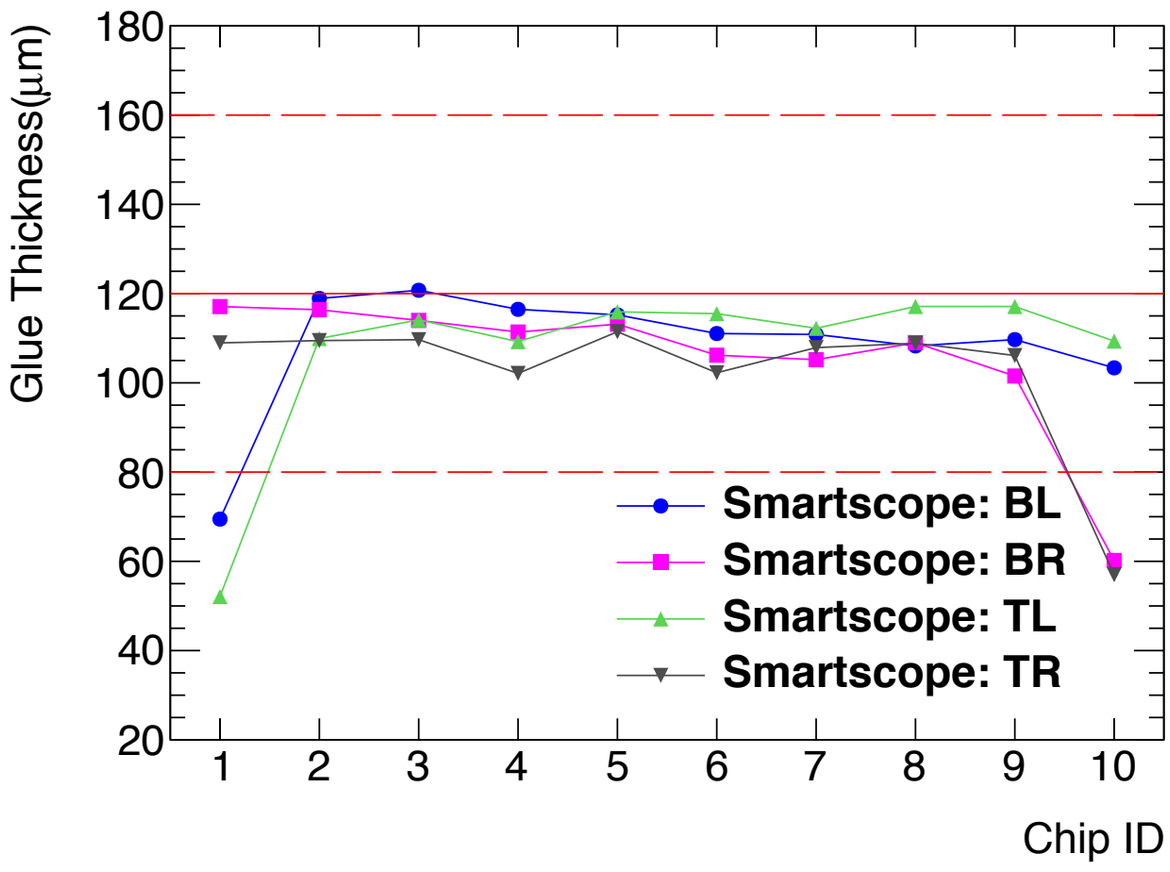
Electrical Hybrid with ABCstar

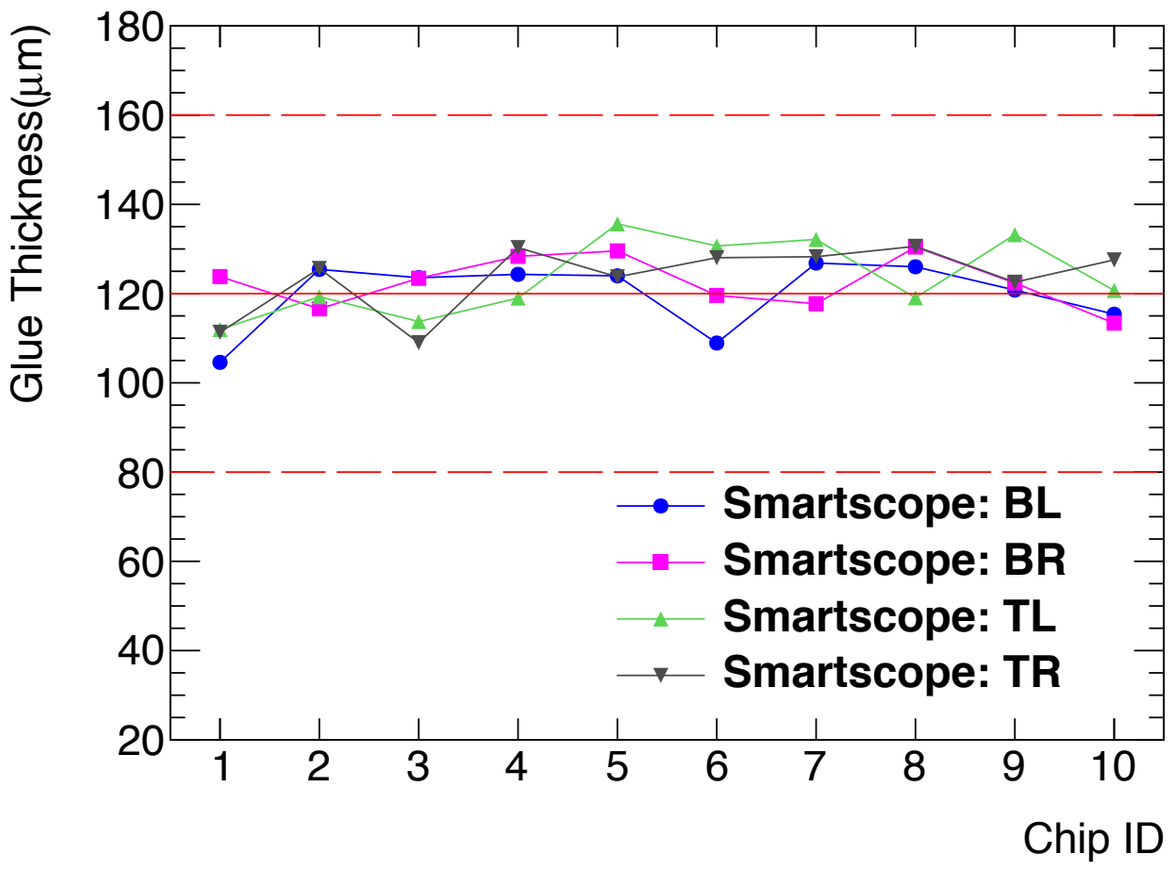
Hybrid Metrology-Glue Thickness

- Expected Glue Thickness:120±40 μm





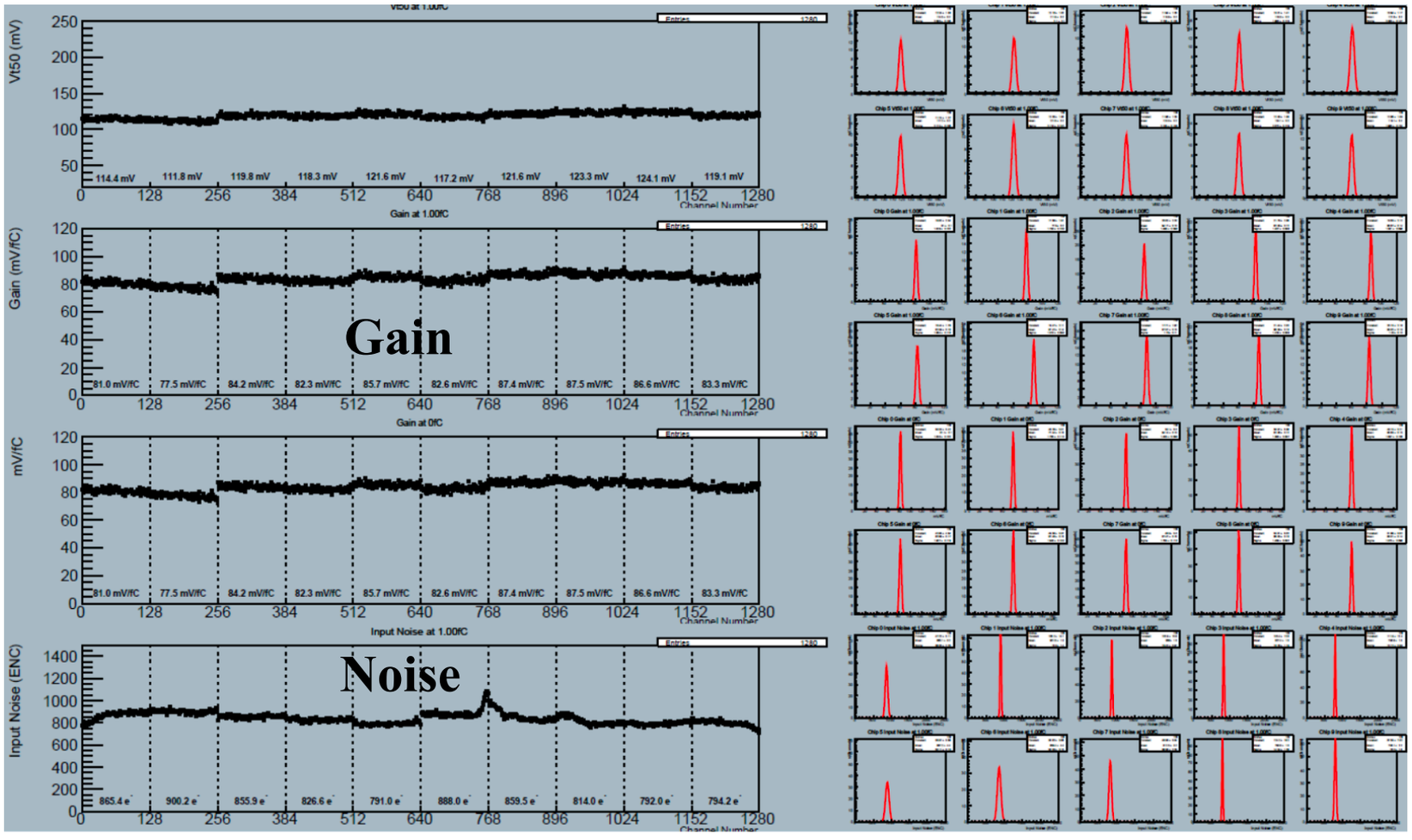




Hybrid Electrical Test

After wire bonding Hybrid, starting the Hybrid electrical test to check front-end chip functionality:

- Chip Communication
- Strobe delay
- Three Point gain
- Noise Occupancy



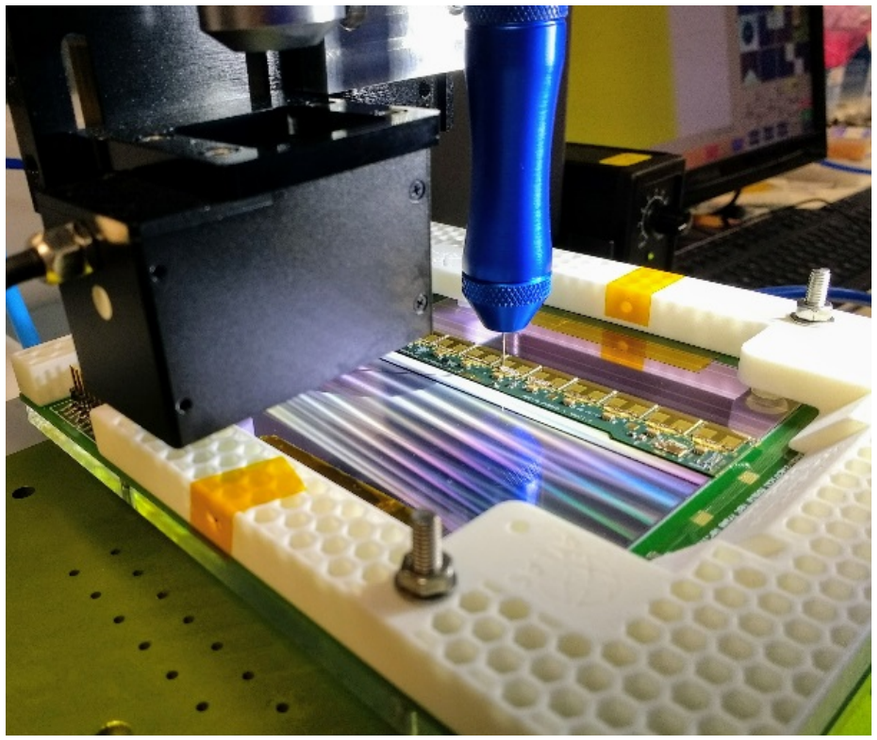
Hybrid Electrical Test at IHEP

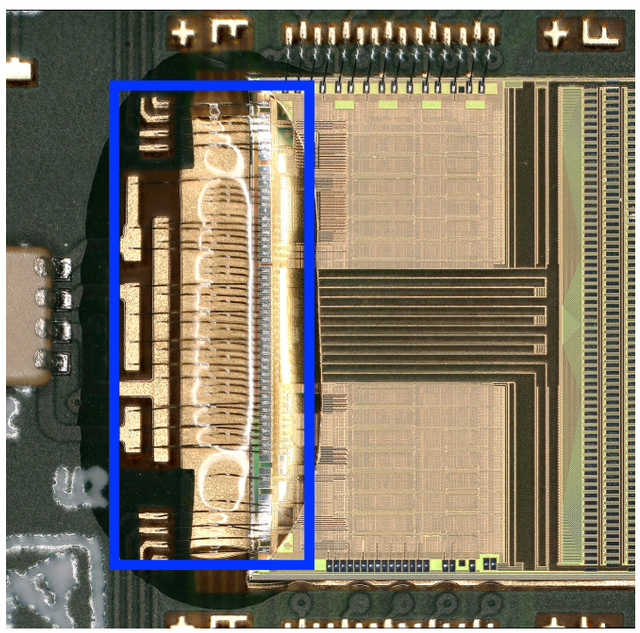
- Assemble the Electrical Hybrid with ASICs(ABC130 and HCC130),
- Test the Electrical Hybrid on Electrical Panel.

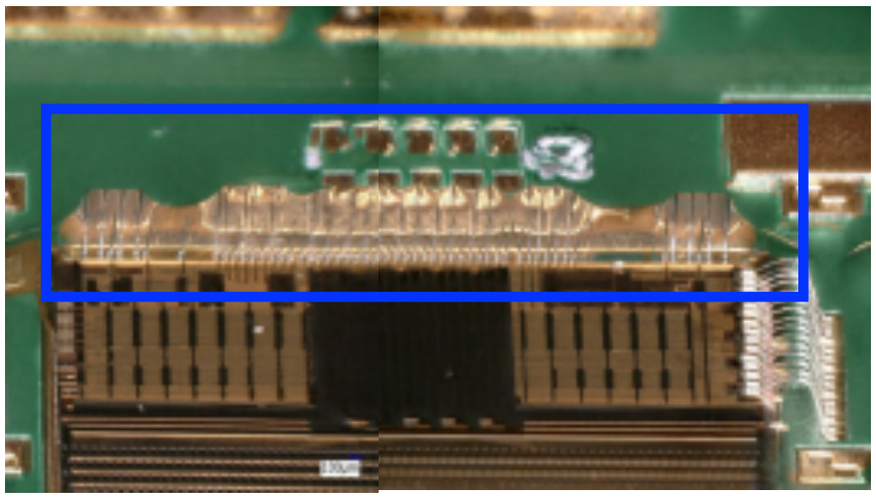
Electrical Panel	✓
Electrical Hybrid	✓
ASICs(ABC130 and HCC130)	✘
Data Cable	✓
Power Cable	✓
Power Adapter	✓

- Cables and adapters just arrived at IHEP last Friday,
- **ASICs just arrived at Beijing, processed for custom clearance.**

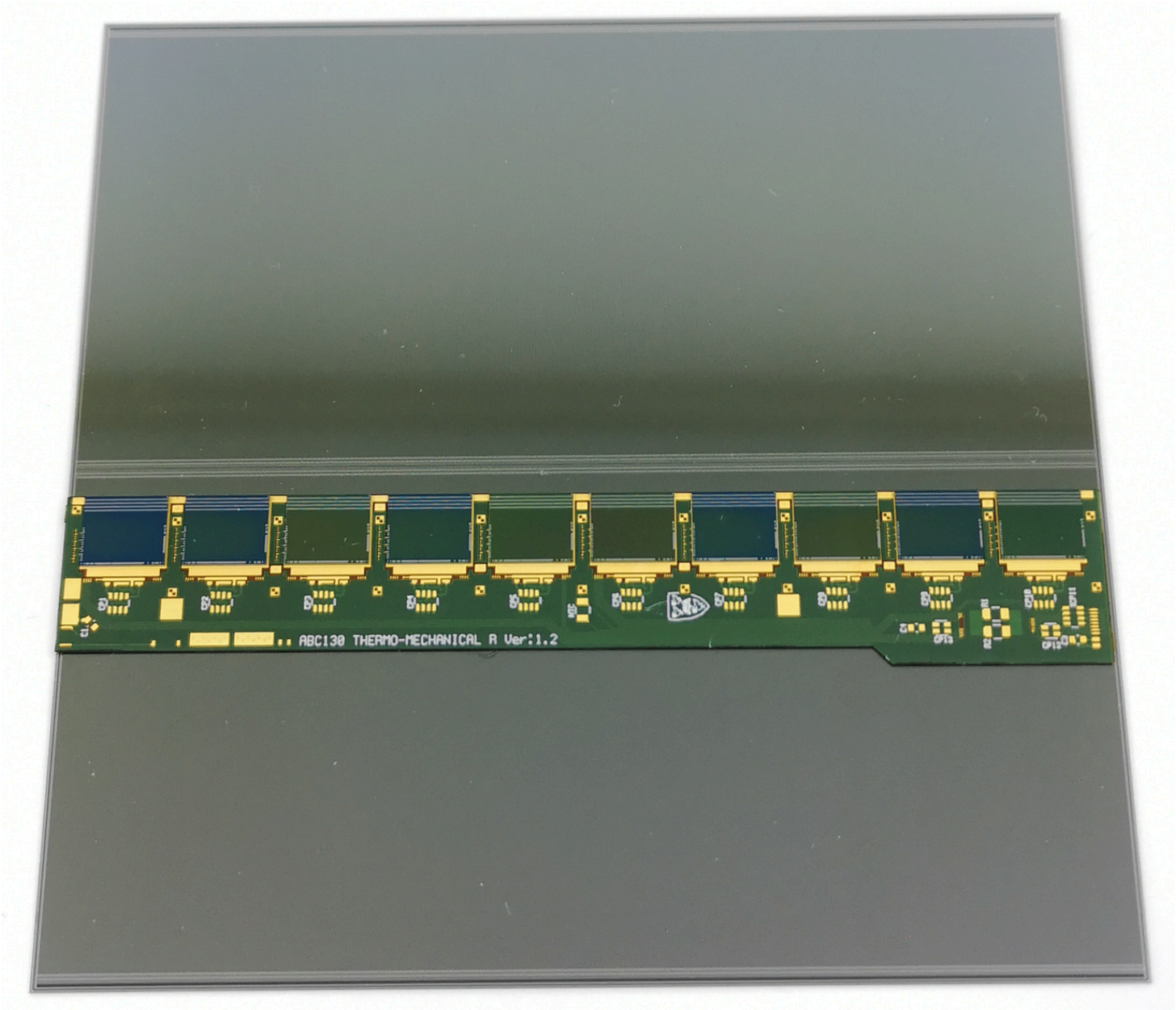
Protect wire from corrosion-dispense glue on wire bond





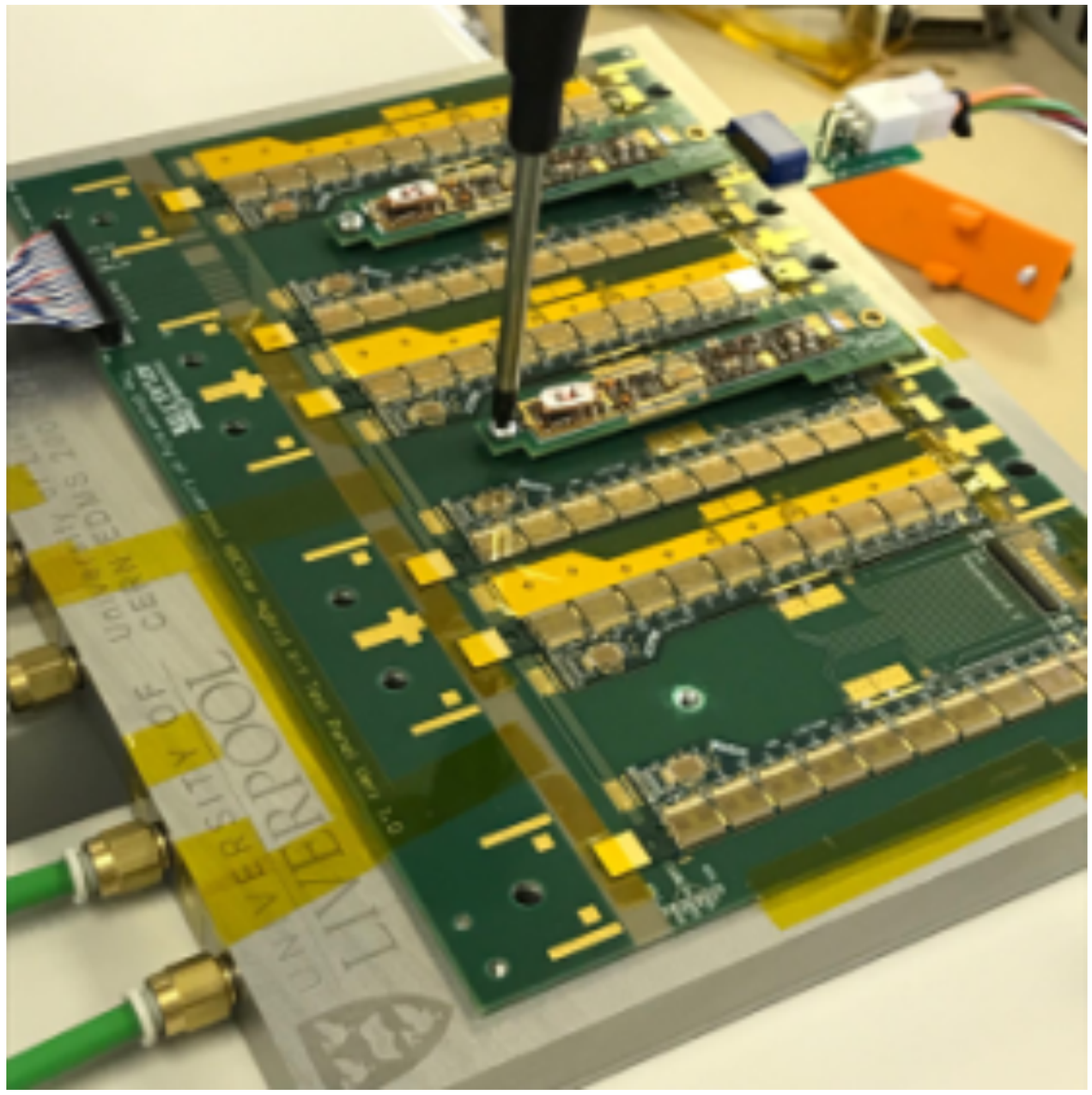


- Next step is to glue the Hybrid onto Sensor.



See Yuzhen YANG's Talk

- **First Hybrid Panel** at RAL with ABCstar and HCCstar Chips



Collaborated with RAL colleagues

Summary and Outlook

- Went through the full Hybrid Assembly Steps,
- Made some Dummy, Mechanical and Electrical Hybrids,
- Carried out the Hybrid Metrology and Electrical Test,
- Plan to assemble Electrical Hybrids and carry out test at IHEP,

- Thanks the supports from MOST, NSFC, Tsinghua University and IHEP.

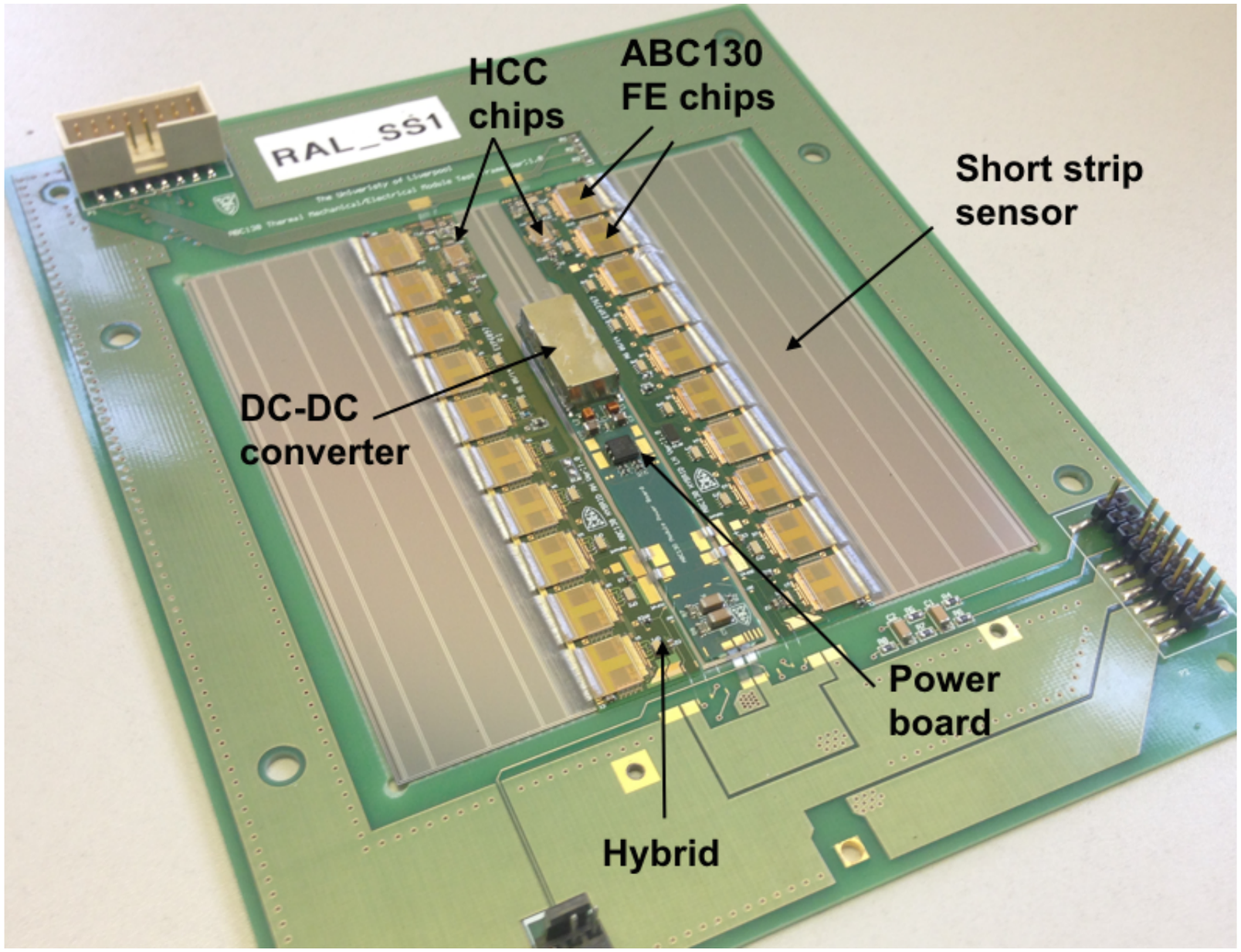
Thanks

Backup

Short Strip Module Prototype

Tsinghua University

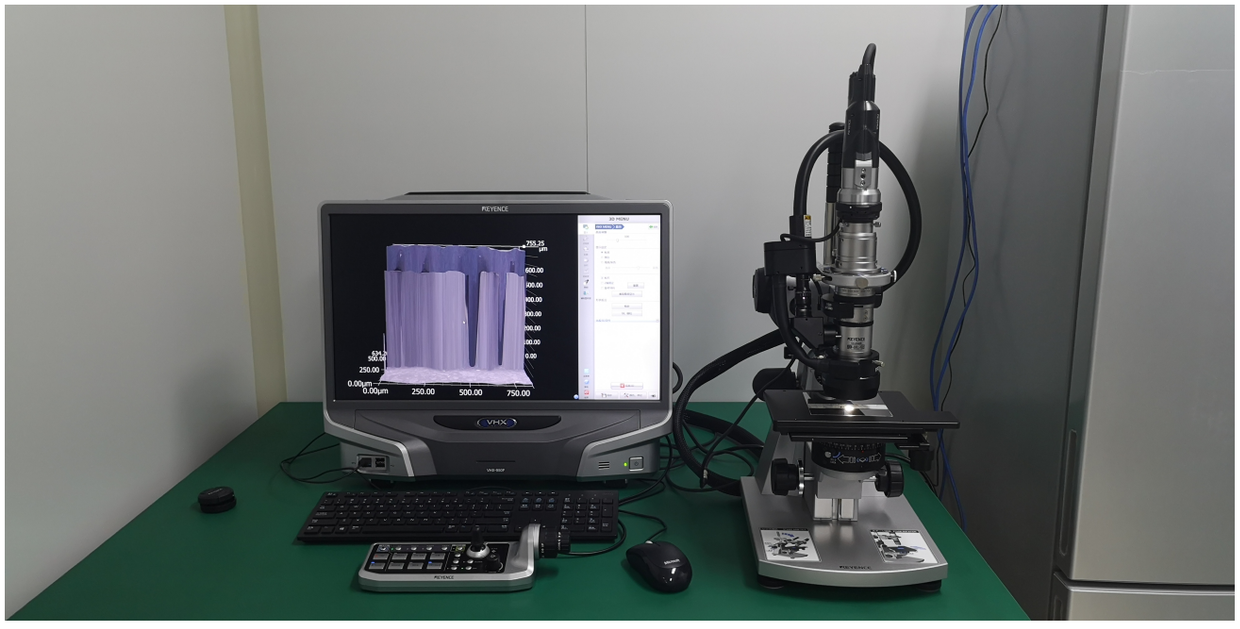
Fully assembled short-strip barrel module with ATLAS12 sensor and ABC130 chips including power board.



Tsinghua University

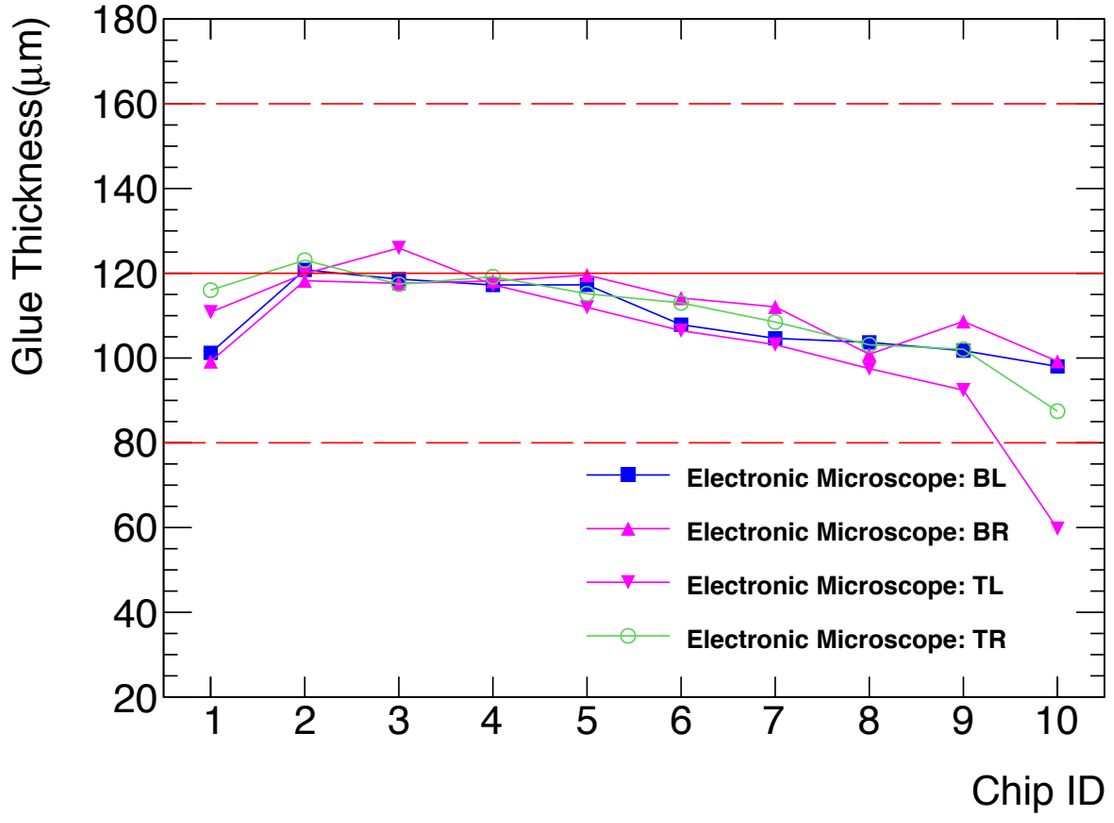
Dummy Hybrid with Dummy Chips:

KEYENCE Microscope

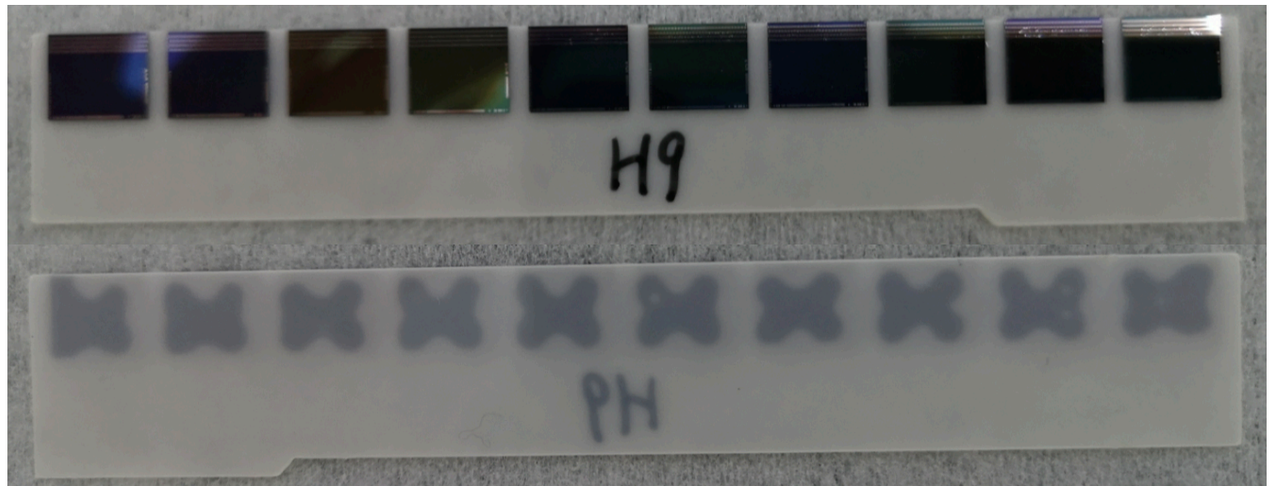


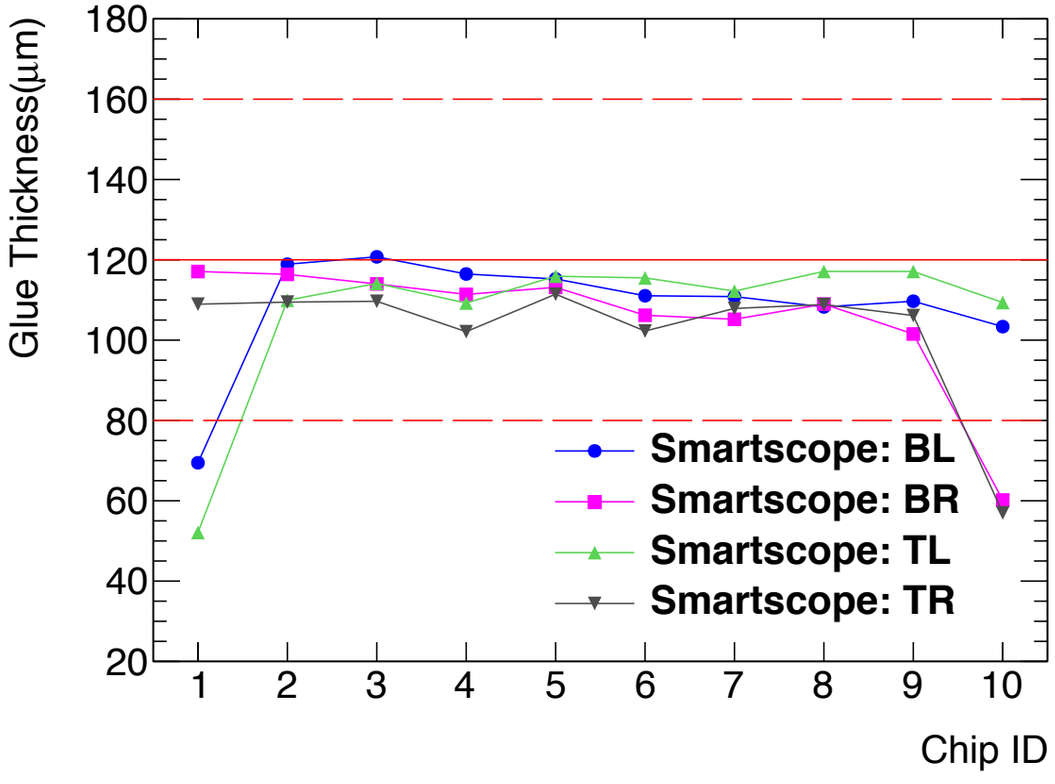
Resolution: 2-3 μm

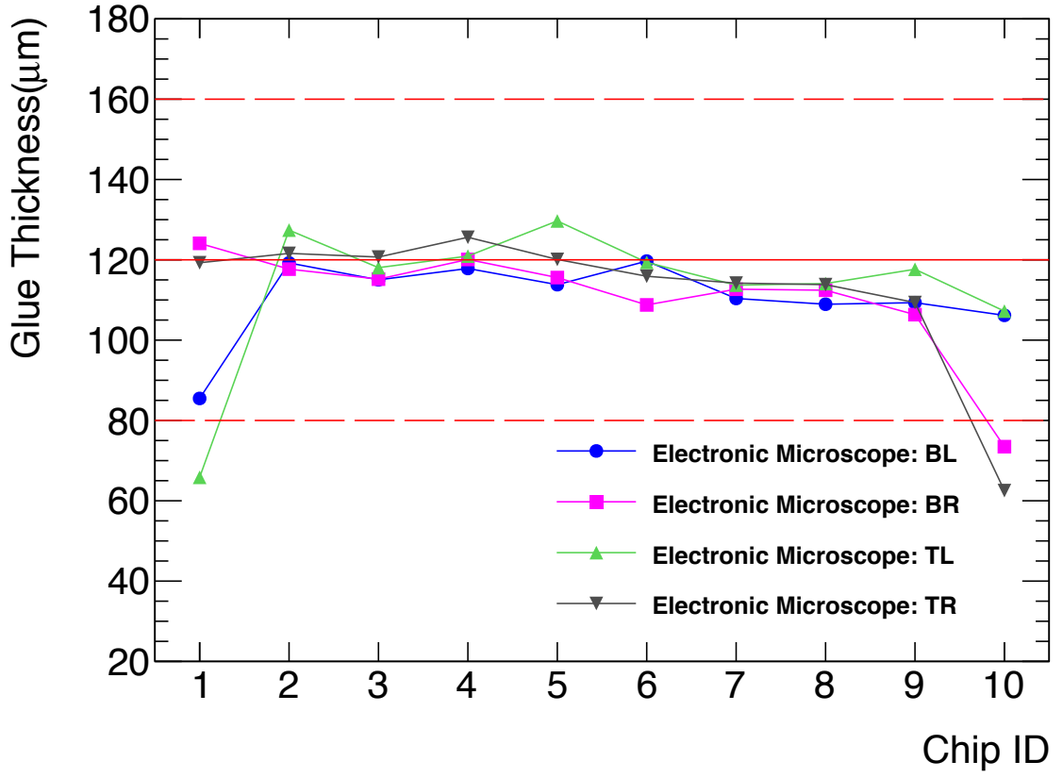
Expected Glue Thickness:120±40 μm



Dummy Hybrid with Mechanical Chips:







Thicknesses from Smartscope and Microscope are consistent.

- Environmental test chamber