# The status of ITk for ATLAS Phase-II upgrade

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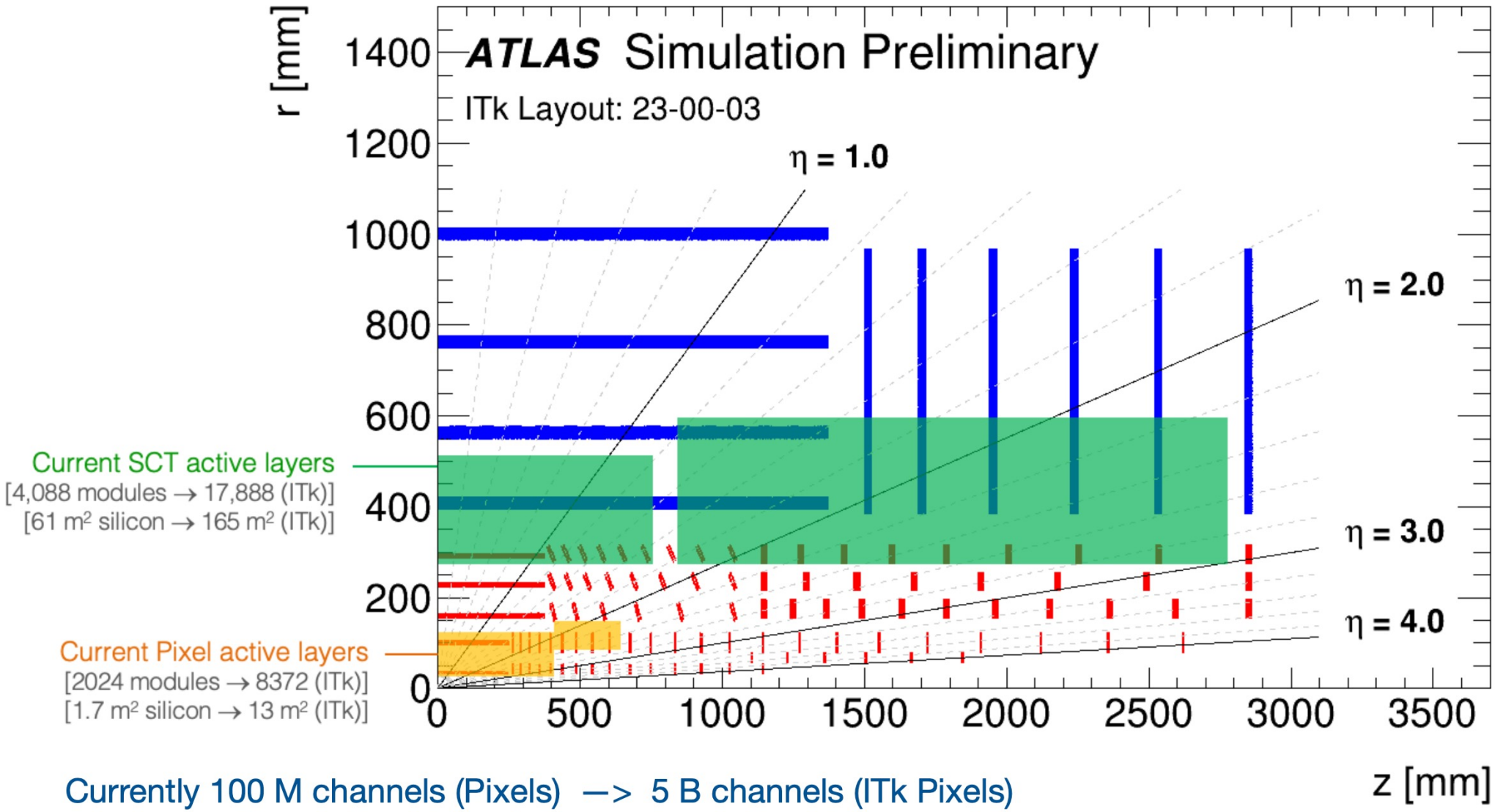
On behalf of subtask 2 Team




5 December 2025

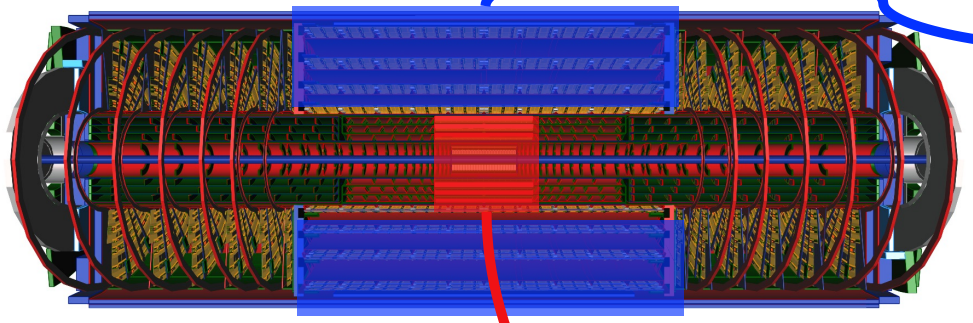
MOST ATLAS Detector Upgrade Project Internal Meeting

# ATLAS New Inner Tracker (ITk)



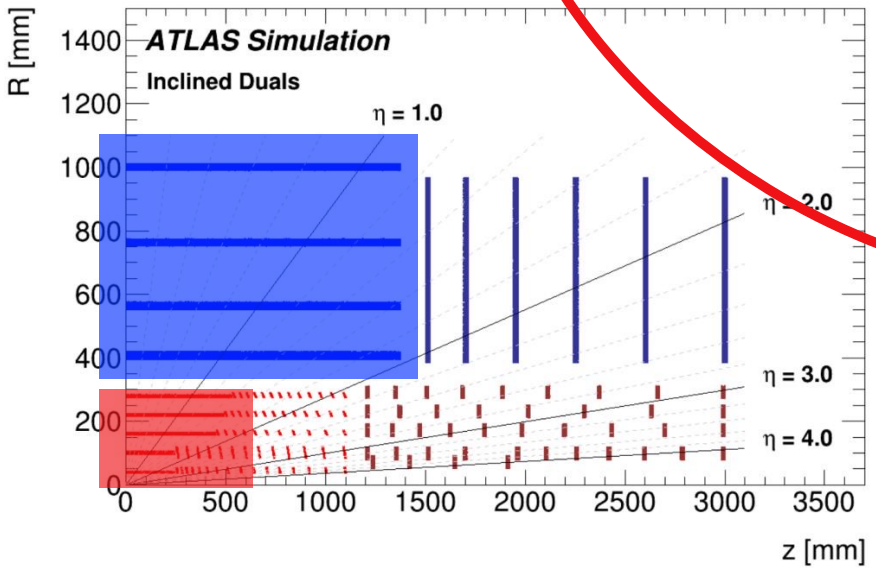

Currently 100 M channels (Pixels) —> 5 B channels (ITk Pixels)

# Subtask 2: Inner Tracker (ITk) Upgrade



## 2.1 ITk Strip Barrel Detector

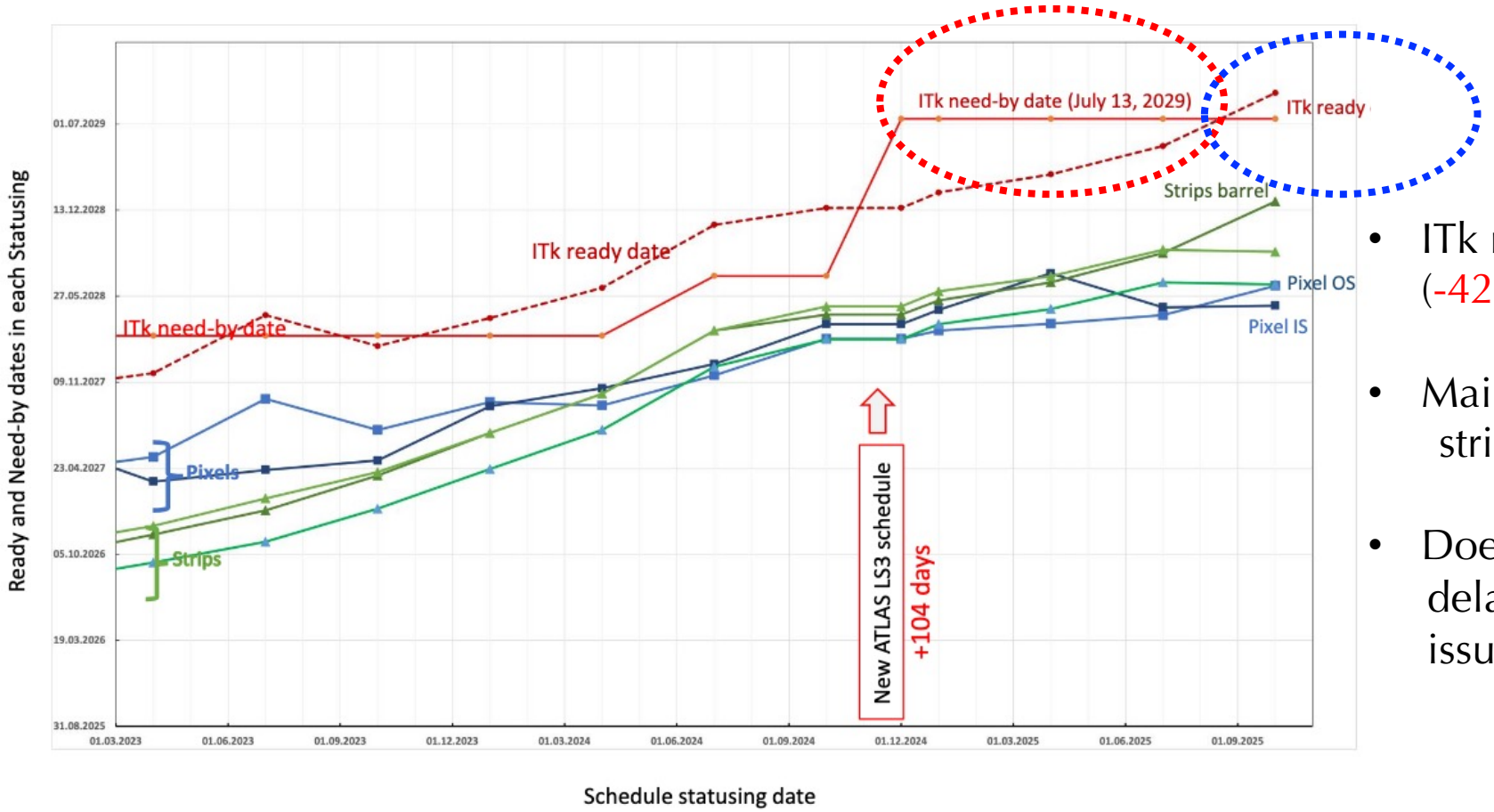
- Radiation hard sensor and ASIC study
- Strip detector module production
- Complex silicon tracker system integration




## 2.2 Timing Pixel Detector

- Pixelated LGAD sensor R&D
- Fast front-end electronics R&D

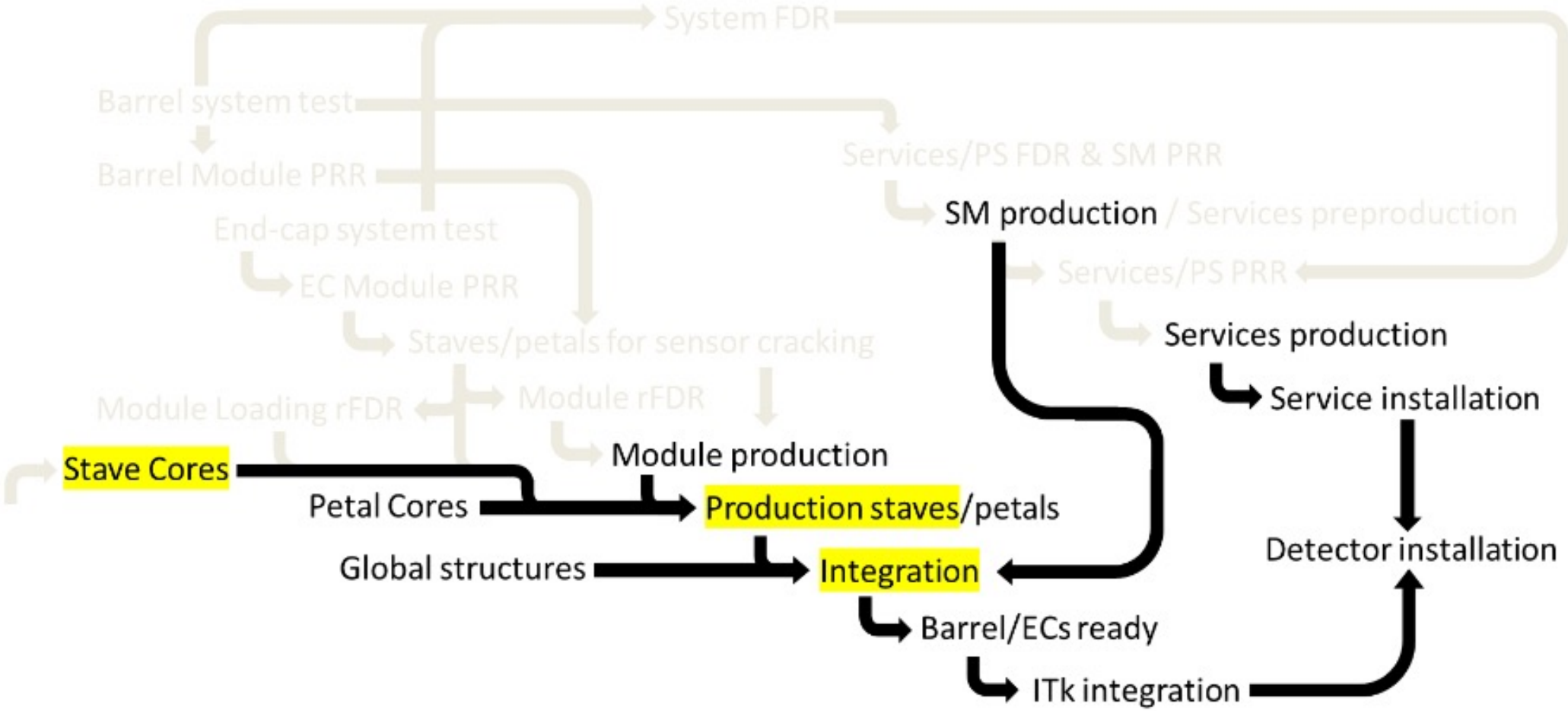
# ATLAS ITk Strip schedule




- ITk ready : 10 Sep 2029 (-42 wd float)
- Mainly driven by strip barrel
- Does not include potential delays due to bPOL12V issues

- ITk Strips Barrel ready for installation: ~~28 June 2028~~ 10 Sep 2029
- ITk Strips Barrel need-by date: ~~06 November 2028~~ 13 July 2029

# Critical Paths – October 2025



# ATLAS ITk Strip Project World Wide

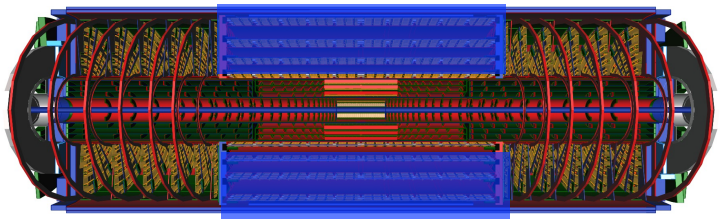
16 Funding Agencies and 50 Institutes

China: IHEP, THU, SYSU, TDLI, SDU
1000 Modules (10m² Silicon Surface Area)

UK/China Cluster
50% Barrel Strip Detector


- Xin Shi as UK/China Cluster Manager since 2022

# 2.1 ITk Strip Barrel Detector

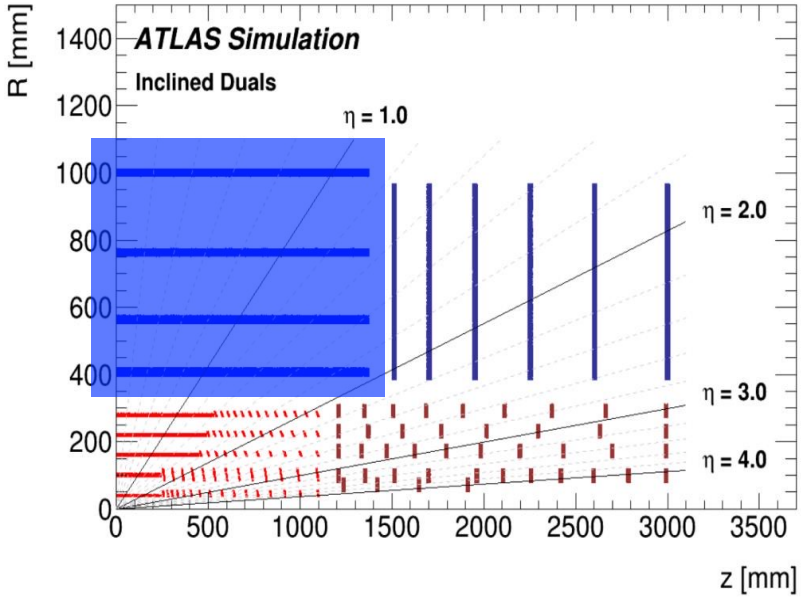


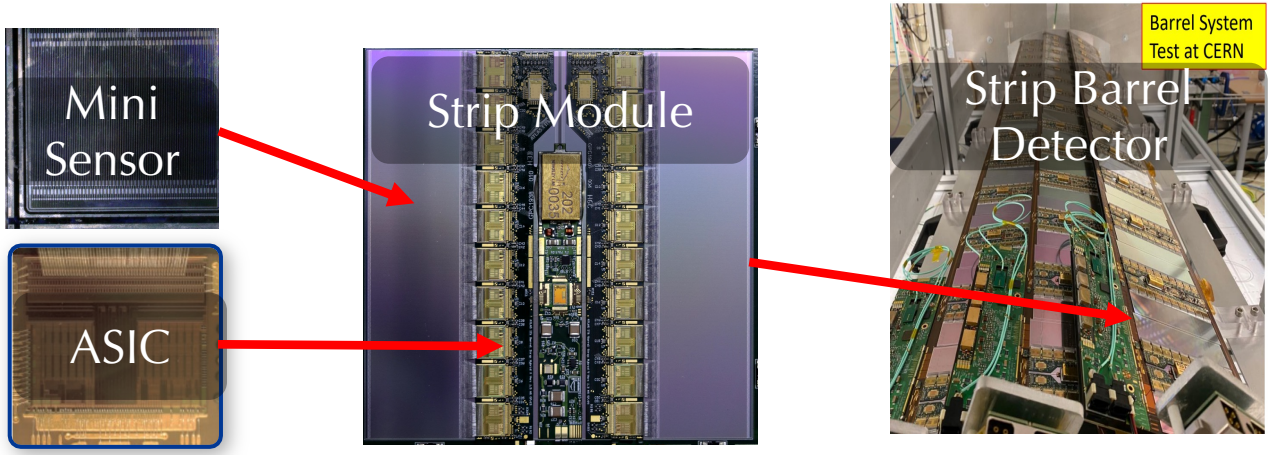
**Deliverables**

- Complete strip barrel detector with 25μm spacial resolution
- Provide strip module spacial resolution evaluation report

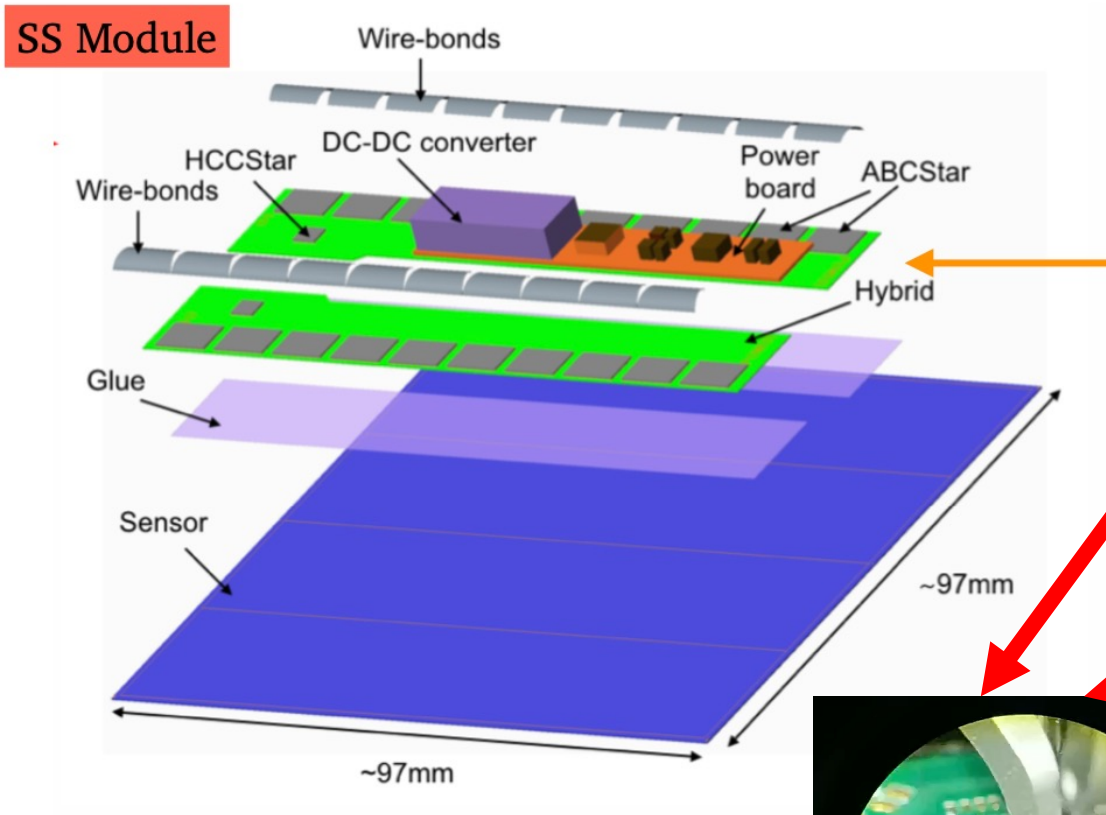
**Contents**

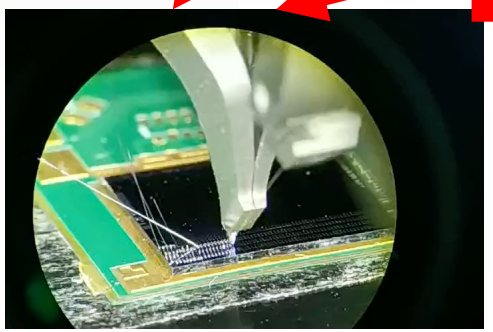
- Radiation hard sensor and readout ASIC study
- High performance strip detector module production
- Complex silicon detector system integration

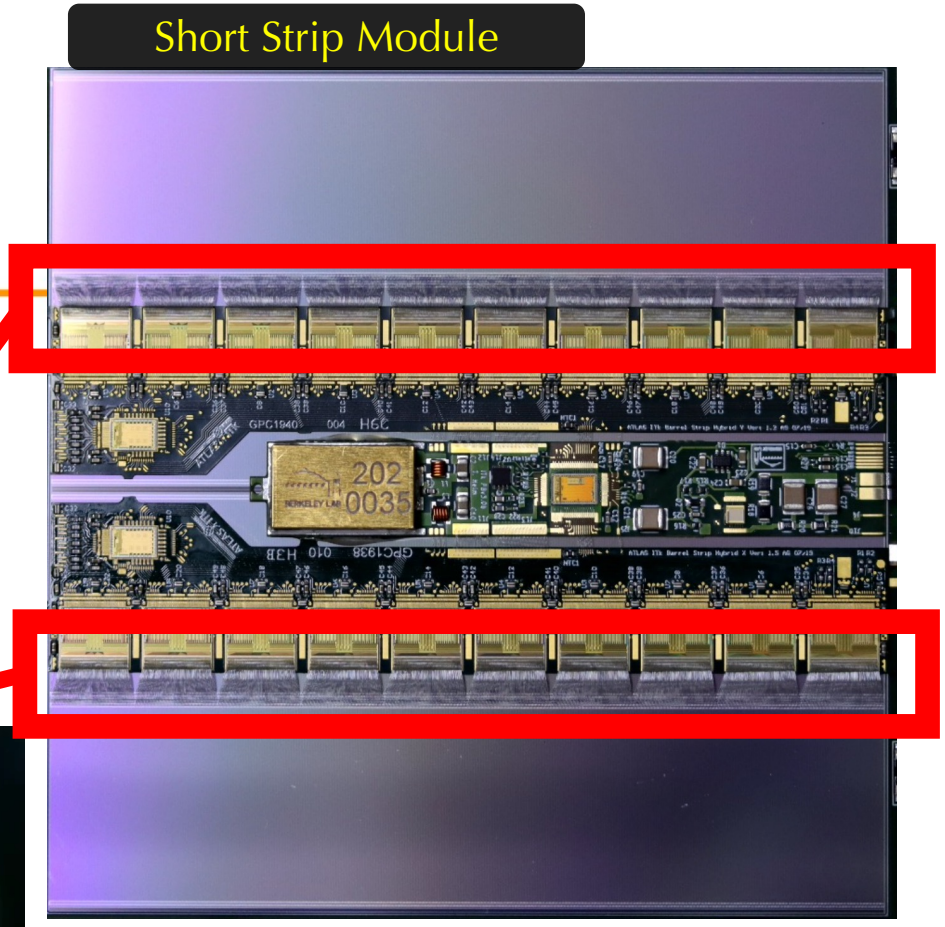


# Strip Module Component

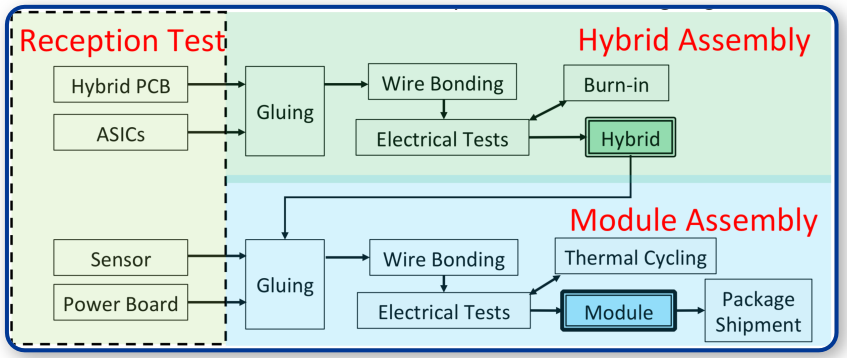




# ITk Strip Module Production Procedure

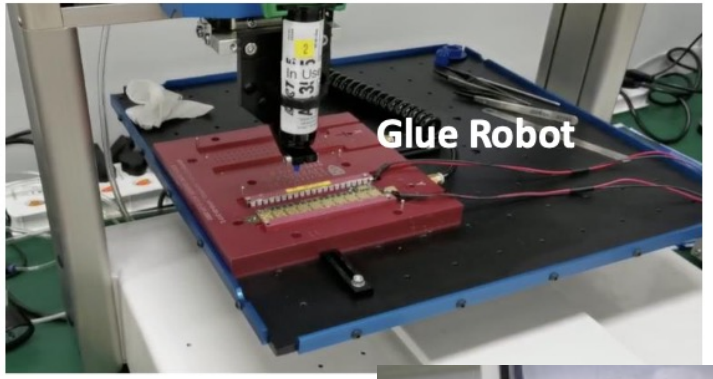
- Well defined module production steps to ensure High Quality Modules




| Step Number | Qualification Step | Review End Date |
|---|---|---|
| 3.2 | Sensor Storage | finished: 2021-06-17 |
| 6.1 | PB Reception | finished: 2022-01-11 |
| 6.2 | PB E tests | finished: 2022-07-14 |
| 6.3 | PB Vis Insp | finished: 2021-12-16 |
| 6.4 | PB Storage | finished: 2021-06-17 |
| 8.2 | Storage + shipping of glue | finished: 2021-08-26 |
| 8.3 | Assembling hybrids | finished: 2021-11-20 |
| 8.4 | Glue weight measurements | finished: 2021-11-21 |
| 8.5 | Bonding procedures: hybrids | finished: 2022-05-31 |
| 8.6 | Metrology: hybrids | finished: 2023-03-07 |
| 8.7 | Visual inspection: hybrids | finished: 2021-08-06 |
| 8.8 | Hybrid Burn-In | finished: 2023-05-25 |
| 8.10 | Hybrid Storage | finished: 2021-06-17 |
| 8.11 | hybrid QC: single panel testing | finished: 2022-08-25 |
| 11.1 | Storage of modules | finished: 2021-06-17 |
| 11.2 | Cleaning module jigs | finished: 2021-06-16 |
| 11.4 | Storage of modules | finished: 2021-11-29 |
| 11.5 | Removing hybrids from panel | finished: 2021-12-09? |
| 11.6 | Module Assembly | finished: 2022-02-25 |
| 11.7 | Metrology: modules | finished: 2023-07-10 |
| 11.8 | Bonding procedures: modules | finished: 2022-05-25 |
| 11.9 | Visual inspection: modules | finished: 2021-07-19 |
| 11.10 | Module Thermal Cycling | finished: 2023-10-29 |
| 11.11 | Single Module Electrical Test | finished: 2022-10-23 |
| 12.1 | Shipping modules | finished: 2022-04-25 |
| 13.1 | Cleanroom standards | finished: 2021-11-25 |
| 13.2 | ASIC Compliance & Handling | finished: 2021-06-03 |
| 13.3 | Bond Pulling Procedures | finished: 2021-12-03 |
| 14.1 | Module Reception | Finished: 2022-01-25 |

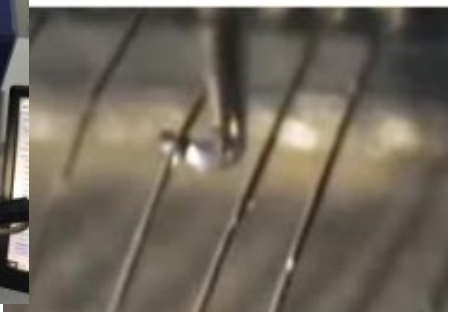
29 Steps

Calibration of glue amount

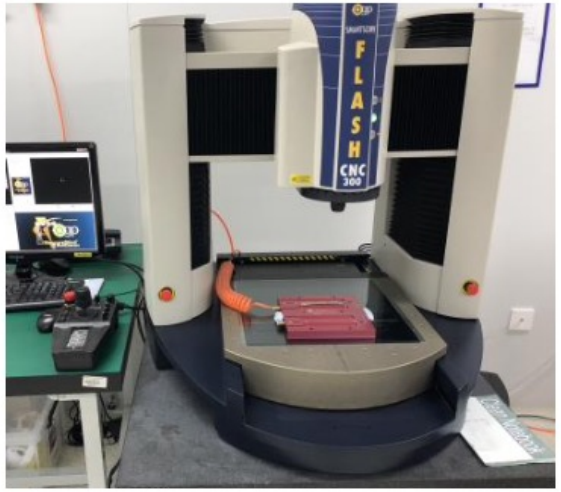




Pull force test

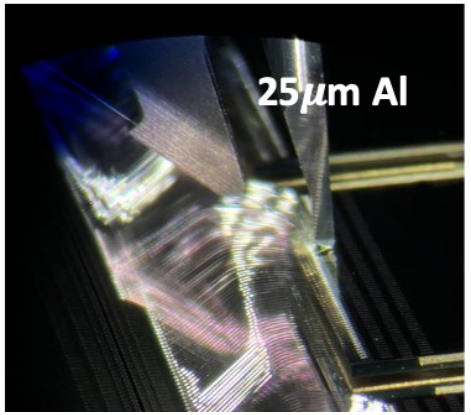


Metrology of glue thickness





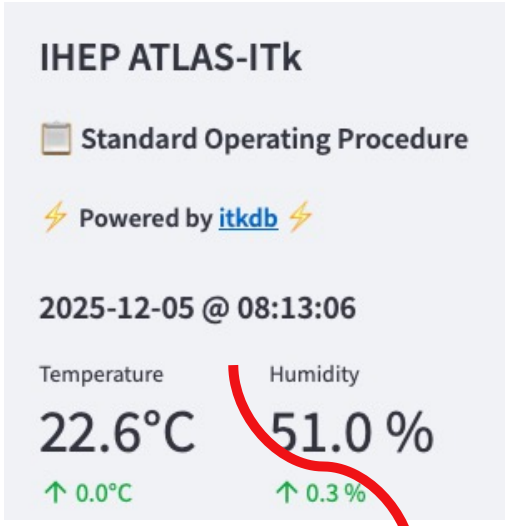
Wire bonding



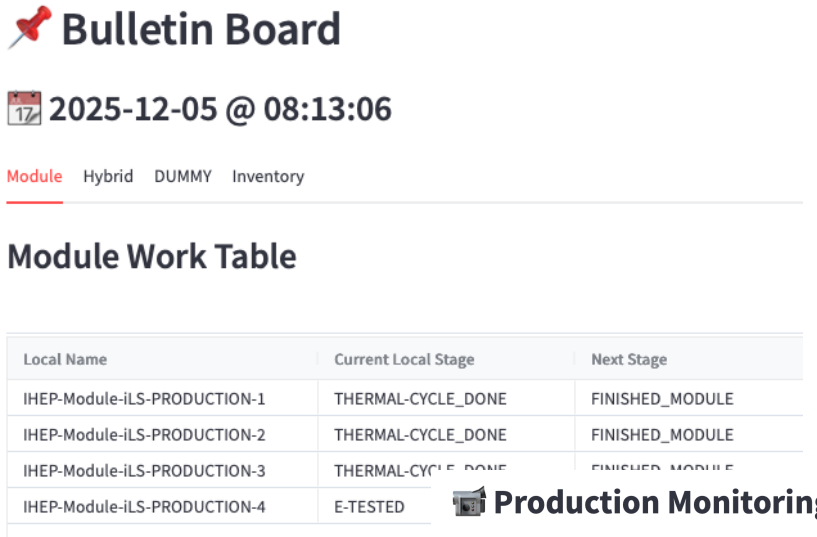
# Standard Operating Procedure (SOP)

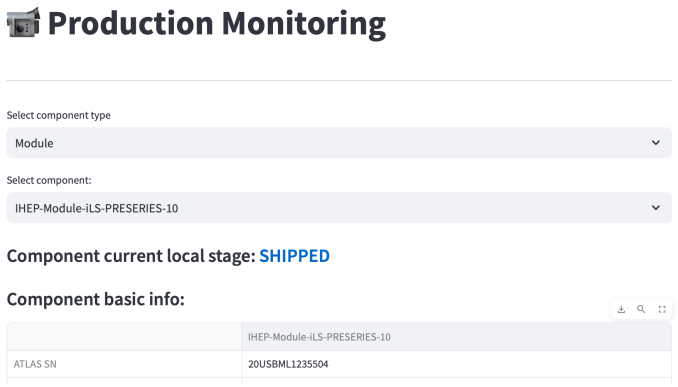
- Developed at IHEP for local production
  - Accessible to PC and Tablets with internal network
  - All SQ 29 steps have been implemented in SOP

http://atlasitk.ihep.ac.cn

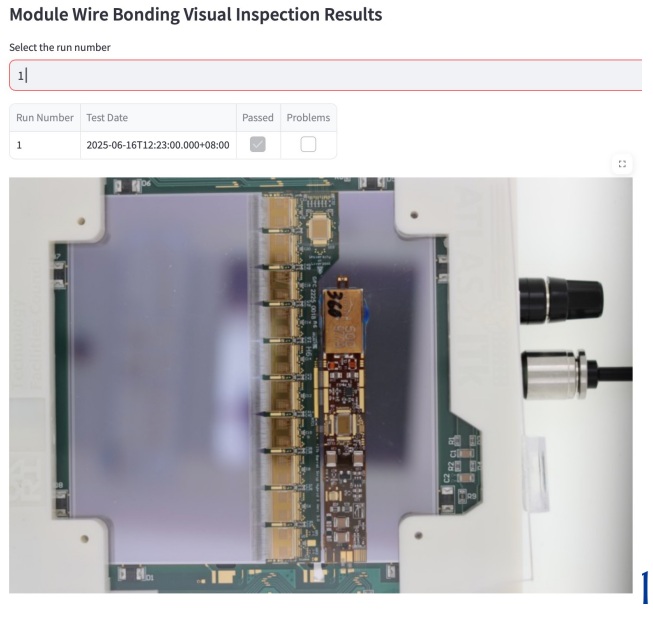



Connect to ITk Production Database



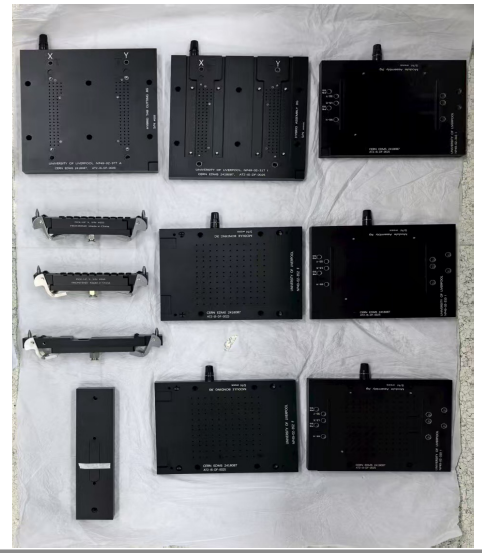







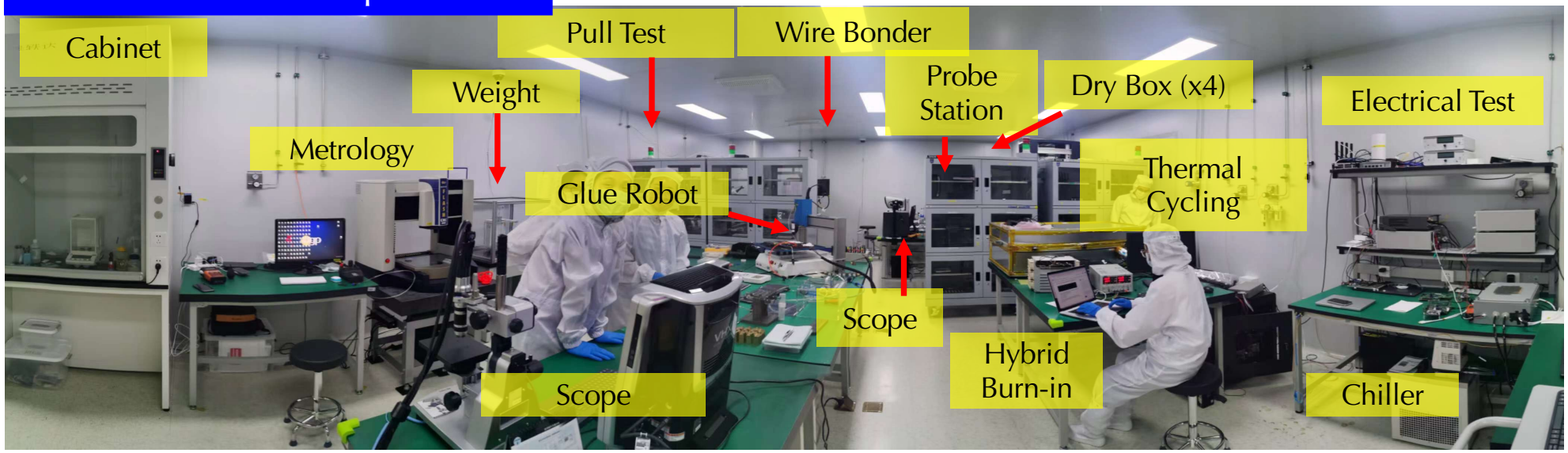
# IHEP Site Module Production Status

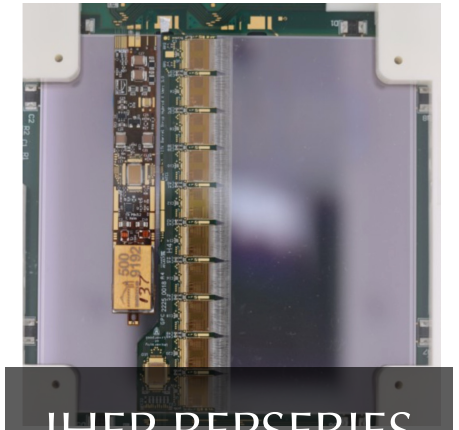
- Passed PRESERIES stage for Module production
  - Produced 15 PRESERIES modules
  - Contributed to 150 PRESERIES modules at RAL
- Produced 4 PRODUCTION modules
- Manufactured 11 production tooling in China



New tools made in China

IHEP Site for ITk Strip Module

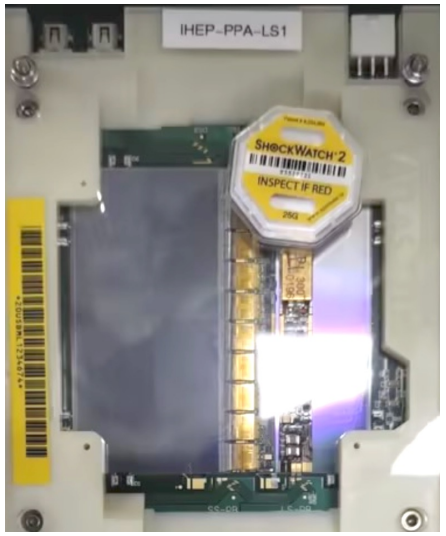


IHEP REPSERIES Module (x15)

# Modules @ IHEP

- 8 prototype modules
- 16 Pre-Production Modules
- 15 PRESERIES modules
- 4 PRODUCTION modules
  - ~70 PRODUCTION hybrids









More details in Weiguo's talk.

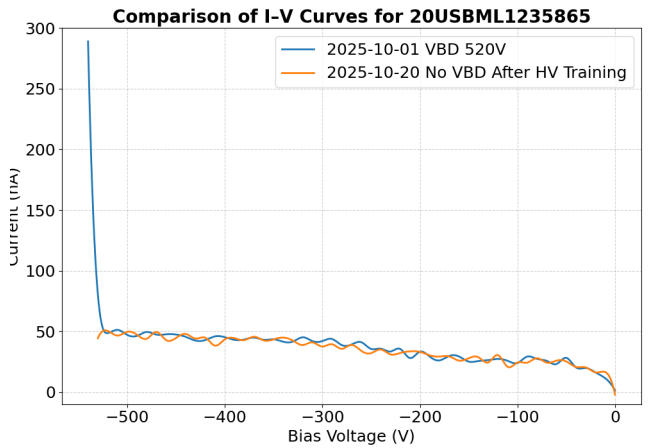
# Tooling Production and Metrology

- 11 pieces of tools produced in China
- All passed the metrology qualification

| Tools | Amount | Part Number | Comment |
|---|---|---|---|
| Hyb Asm Jig | 1.0 | NP49-02-316 | 1 for asm, 1 for metro |
| X Hyb Pku Tool | 2.0 | NP49-02-327 | 1 for hyb asm, 1 for mod asm |
| Hybrid Tab cut Jig | 1.0 | NP49-02-376 | |
| Sensor Jig | 3.0 | NP49-02-309 | 2 for mod asm, 1 for metro |
| PB Pku Tool | 1.0 | AU-1012-3985 | |
| PB Jig | 1.0 | AU-1012-5646 | |
| Module Jig (Wire-bond) | 2.0 | NP49-02-351 | |

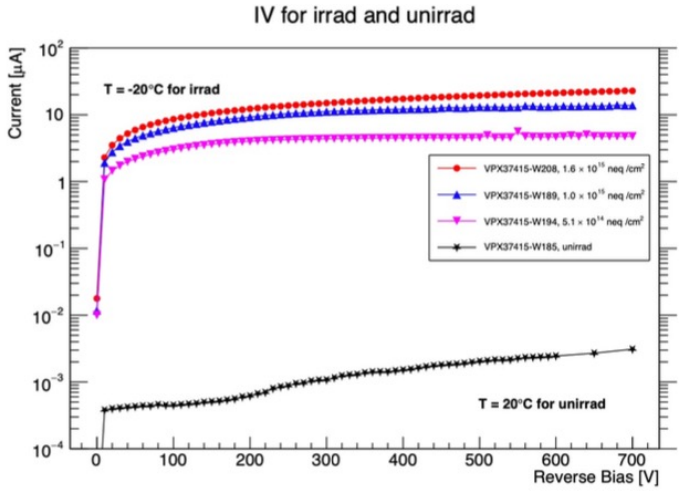
# RAL Status

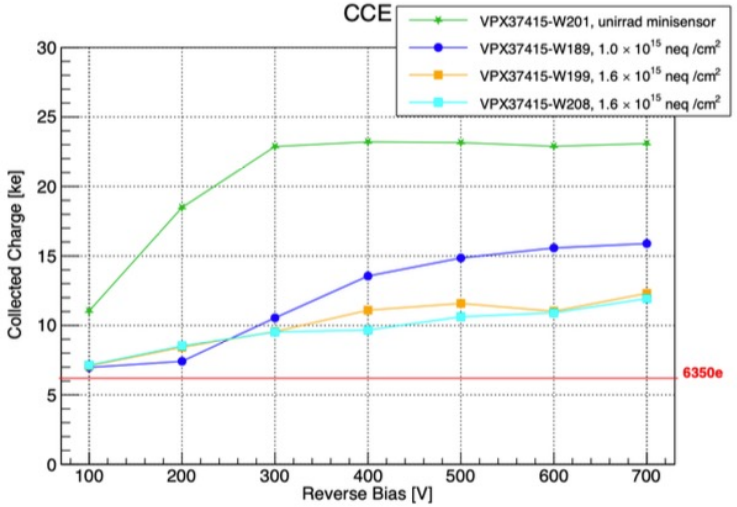
- Two FTEs from China based at RAL
- Participate on module assembly and testing
- Receive modules from production sites, conduct visual inspections and electrical tests for subsequent stave assembly
- Implemented UV light exposure setup for strip module HV breakdown recovery
- Assist in shipping components for module production from CERN or other sites and ensure their delivery to IHEP

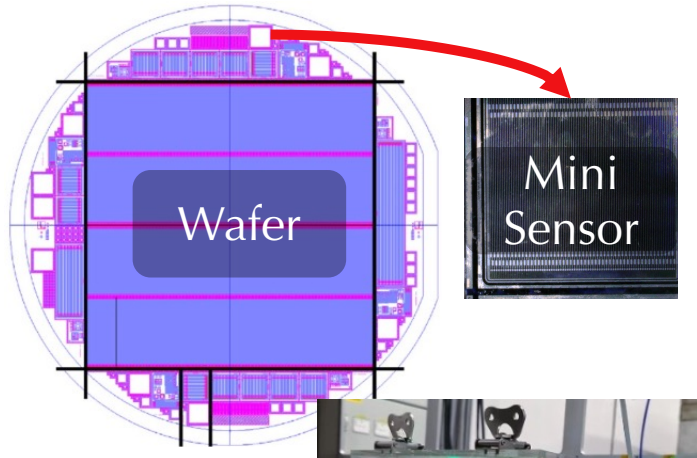



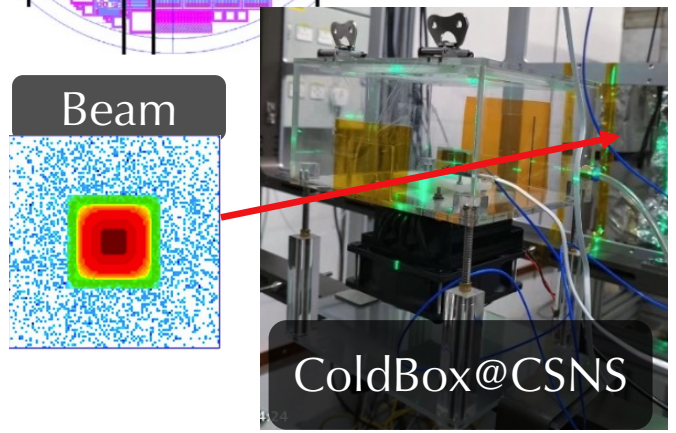
# Strip Sensor Irradiation Study

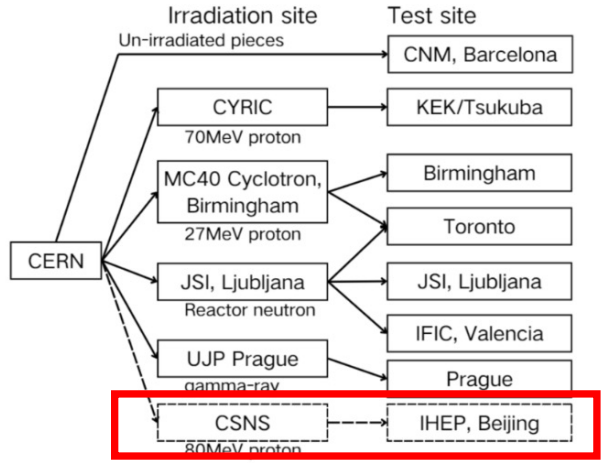
- Proton irradiation of strip mini-sensor at CSNS for quality assurance (QA) site
- Sensor characterization at IHEP
- CSNS and IHEP have been qualified as sensor QA site



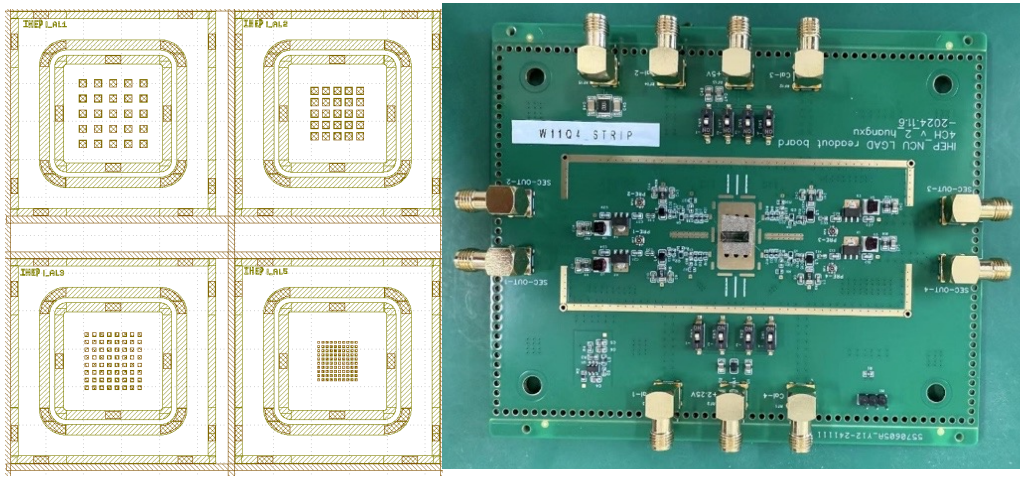



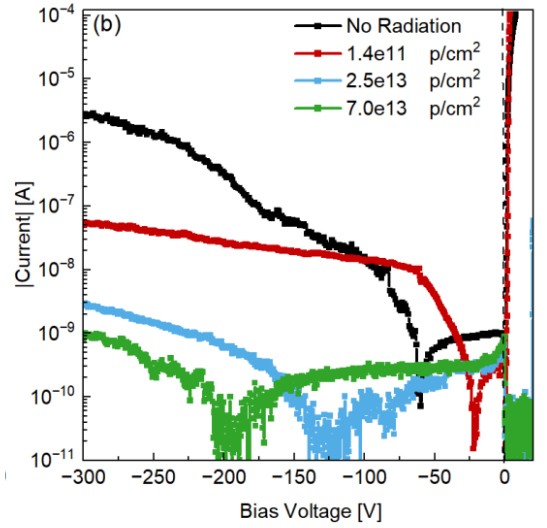

- Received 10 batches of sensor samples for irradiation
  - Irradiation was not performed due to the CSNS beamline
  - CSNS beamline upgrade will resume early next year

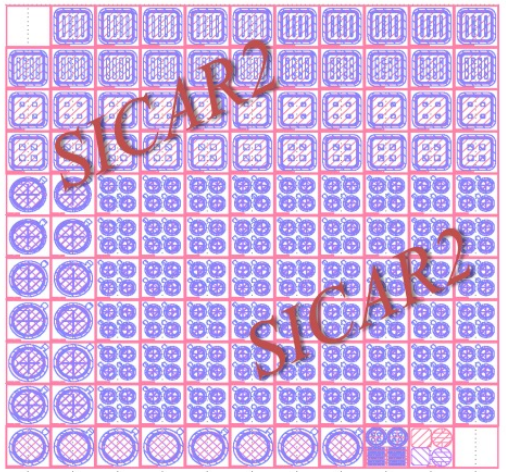
# 2.2 Timing Pixel Sensors – AC-LGAD R&D

- Pixelated AC-LGAD R&D
- New design with different pad-pitch size
  - 55um, 100um, 150um, 200um
  - Expectect to receive at the end of 2025
  - Completed the PCB for multichannel readout



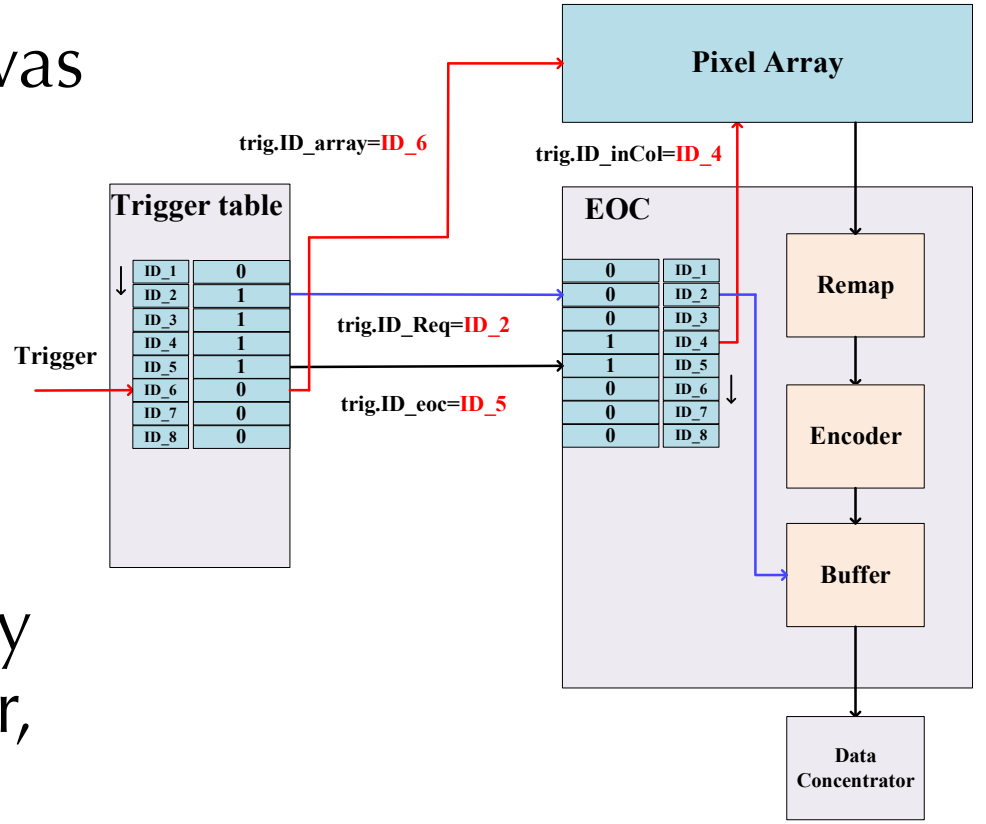
- SiC-LGAD R&D
  - Irradiation study performed on SICAR1
  - Desinged first AC-LGAD SICAR2
  - Expect to receive early next year



# 2.2 Timing Pixel Readout Electronics

- The technical route of using time discrimination combined with a TDC was determined
- the scheme design of the analog front - end circuit was completed
- Based on the scheme of shared memory and Huffman coding proposed last year, the core circuit design of the digital readout section was completed




More details in Zhe's talk.

# Schedule and Plan for 2026

- 2025
  - Evaluate the performance of strip sensor and ASICs after irradiation, participate in the reliability test during production; produce long strip module; receive, test and ship the barrel stave to CERN, complete the workflow. - DONE
  - Complete design of the first sensor, finish the prototype design of the first front-end electronics. – DONE

- 2026
  - Start to assemble the LS module, ship to RAL for stave loading
    - may not able to start the SS module from the second half of 2026 as planed
  - Taper out the first batch of LGAD sensor and evaluate the first ASICs

- Mid-Term expectation
  - Strip module: spatial resolution 25μm
  - Timing pixel: temporal resolution better than 1ns

# Potential Issues

- Strip Module Assembly & Test
  - Componets shipping from RAL to IHEP, potential delays with glue, etc
  - bPOLV12 issue to reduce the production rate and overall delay for ITk
  - Interposed PB and HB introduced additonal variation leads to frequent tooling tunning
  - Thermal Cycling Hardware stability and aging
- Timing Pixel R&D
  - Potential delay with the return of first batch ASIC and AC-LGAD sensors
- Powersonpower
  - 3 experienced students from IHEP will leave next summer, need to train new members especially towards ramping up the production
- Budget
  - Overbuget on the labor fees -> reduce the postdoc numbers from next year
  - Expense on the supporting cleanroom, shipping, maintaince, electricity, etc