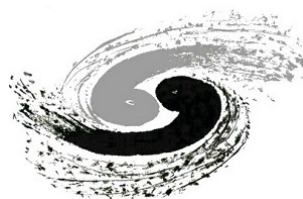


The ATLAS Inner Tracker Strip Detector System

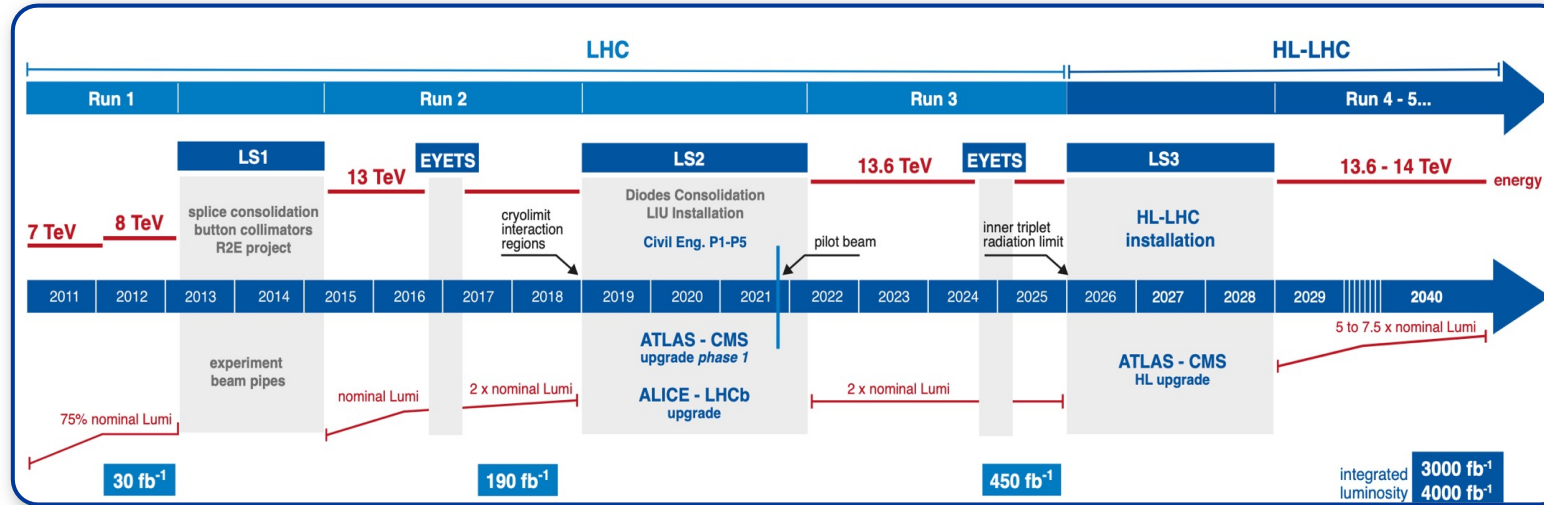
Xin Shi

On behalf of IHEP/THU ATLAS ITk Group



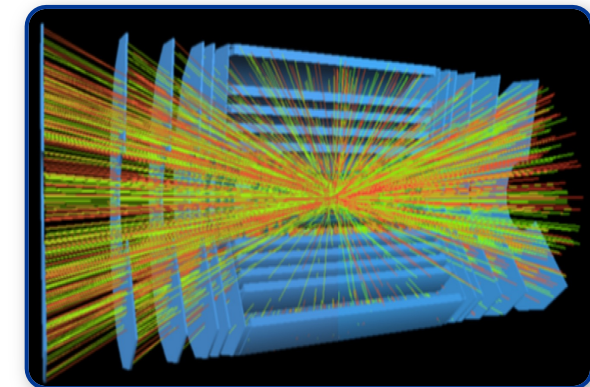
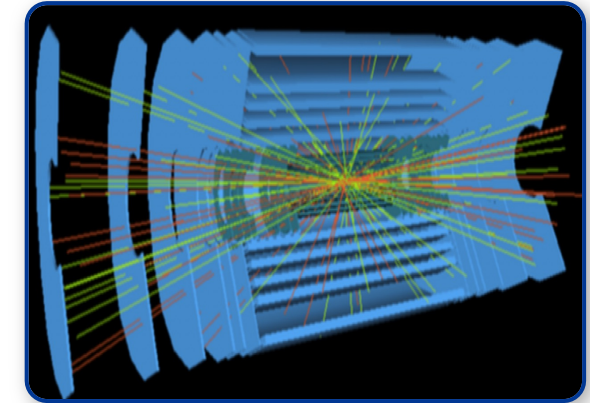
The 11th China HEP Meeting (CHEP11)

Challenge for High Luminosity LHC



<https://hilumilhc.web.cern.ch/article/l3-schedule-change>

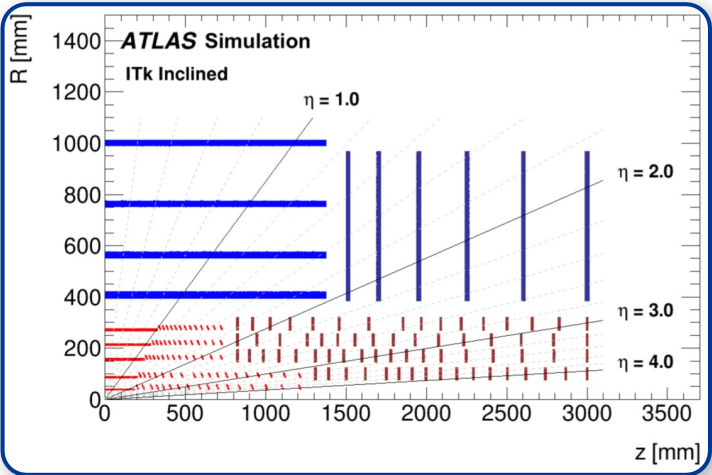
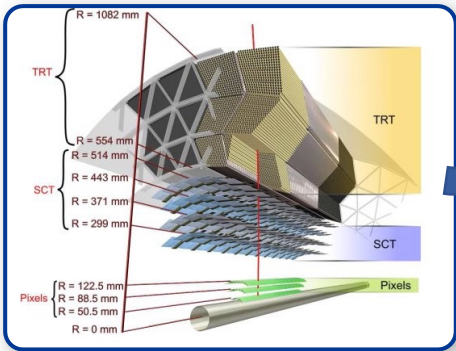
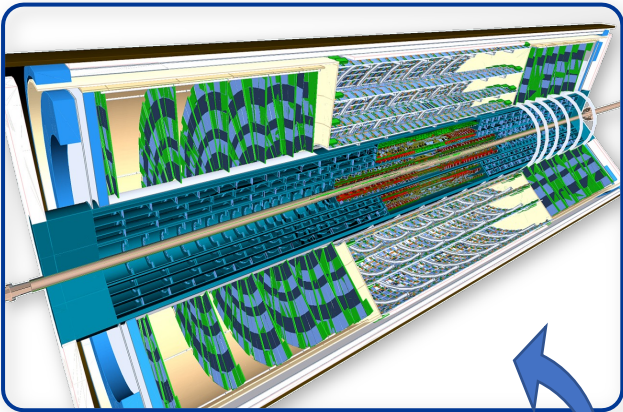
- HL-LHC will start in ~ 2029
- Instantaneous luminosity $7.5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$, 5~7.5x increase
- Average number of interactions per bunch crossing (pile-up events) reach 200



ATLAS Inner Tracker (ITk) Upgrade

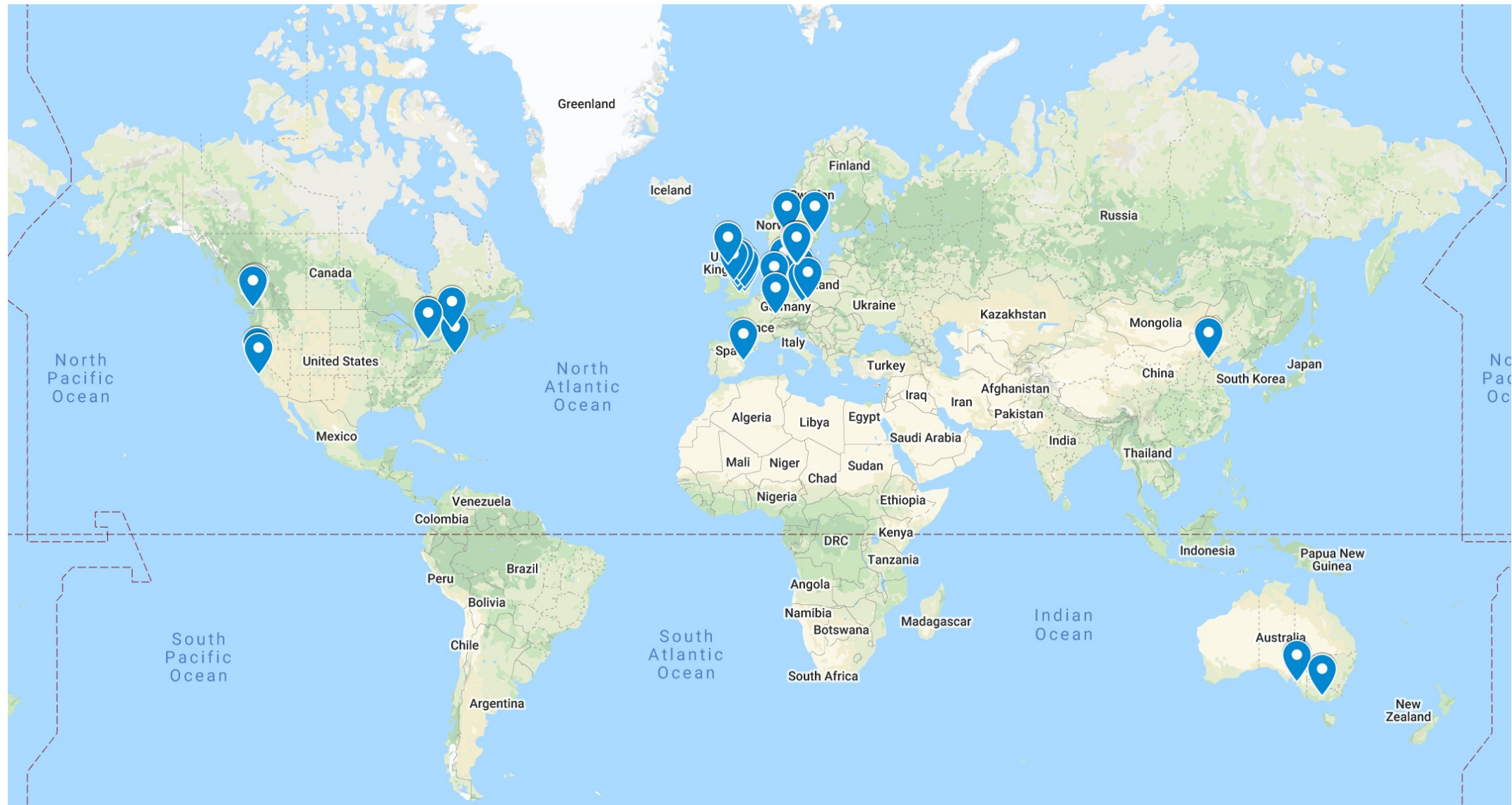
- The new inner tracker (ITk) will be an all Silicon tracker system
- 2T magnetic field, ~6m long, ~1m radius & up to $|\eta|=4$
- 5 Central and multiple Forward Pixel layers
- 4 Central and 6 Forward Strip layers
- Strip system consists of
 - ~18k Modules
 - ~60M channels
 - 165m² of Silicon
 - 50 institutes from 16 funding agencies

(IHEP/THU will contribute 1000 modules)

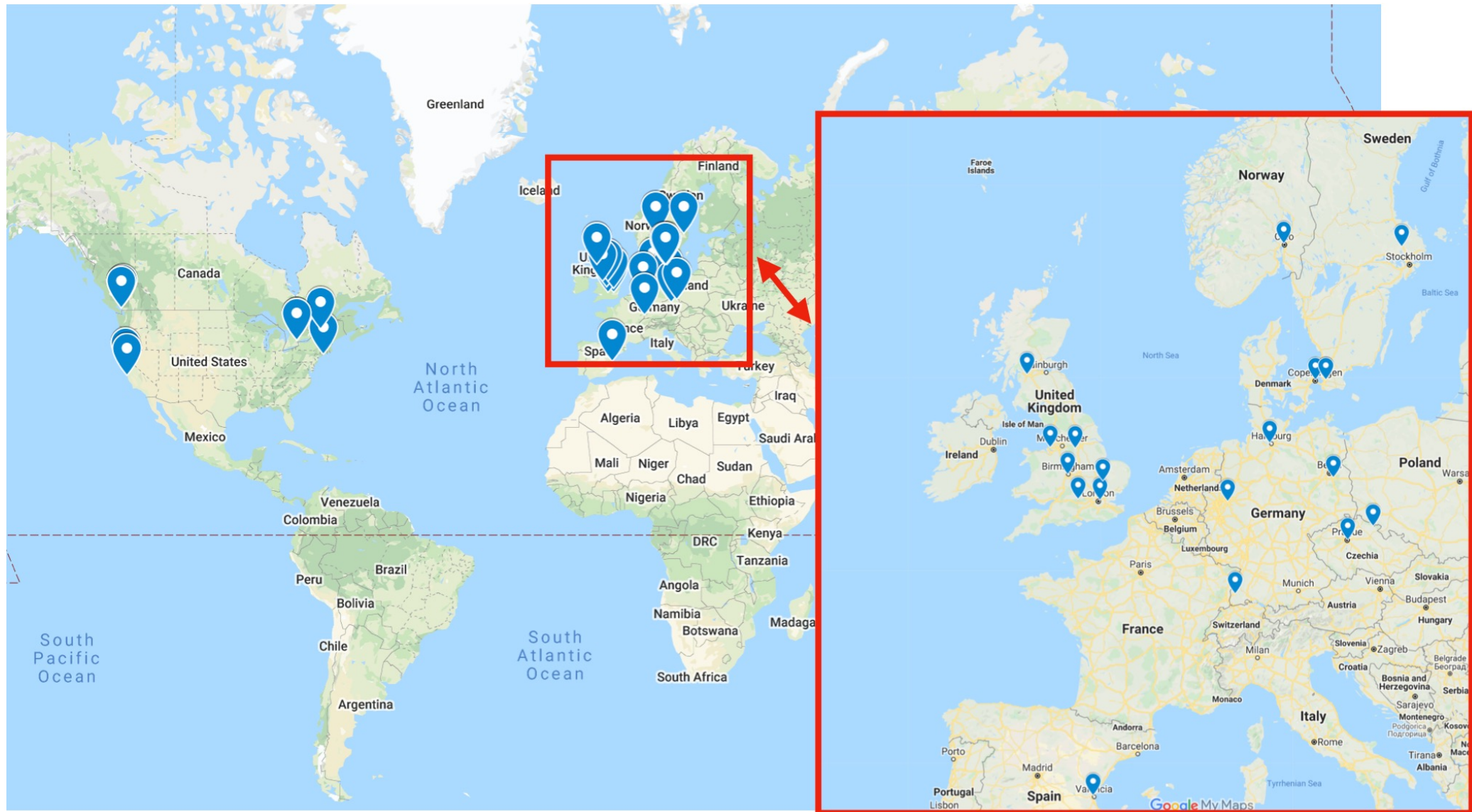


Strip detector comparisons	Current Inner strip tracker (SCT)	Future ITk strip tracker
Radial distance	300-560mm	400-1000mm
Channels	~8 millions	~100 millions
Modules	4 thousands	~20 thousands (165m ² silicon)

Worldwide ITk Strip Production Sites

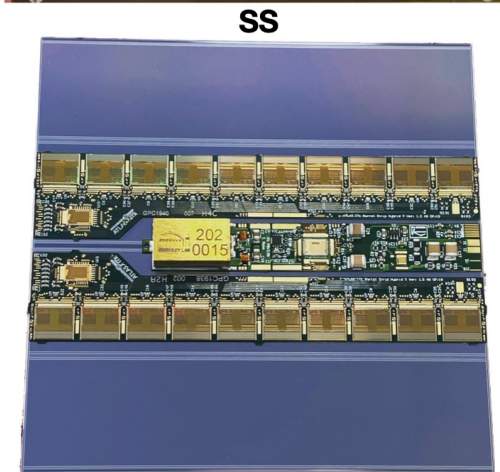
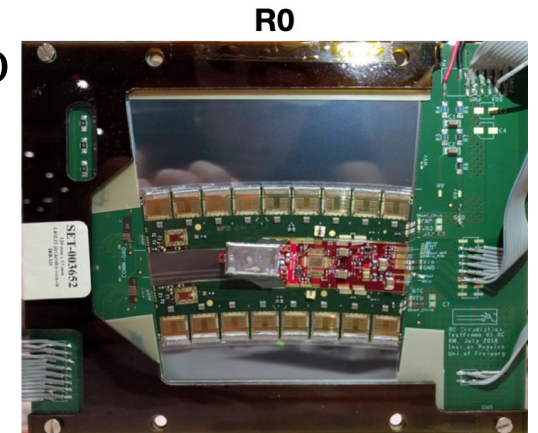
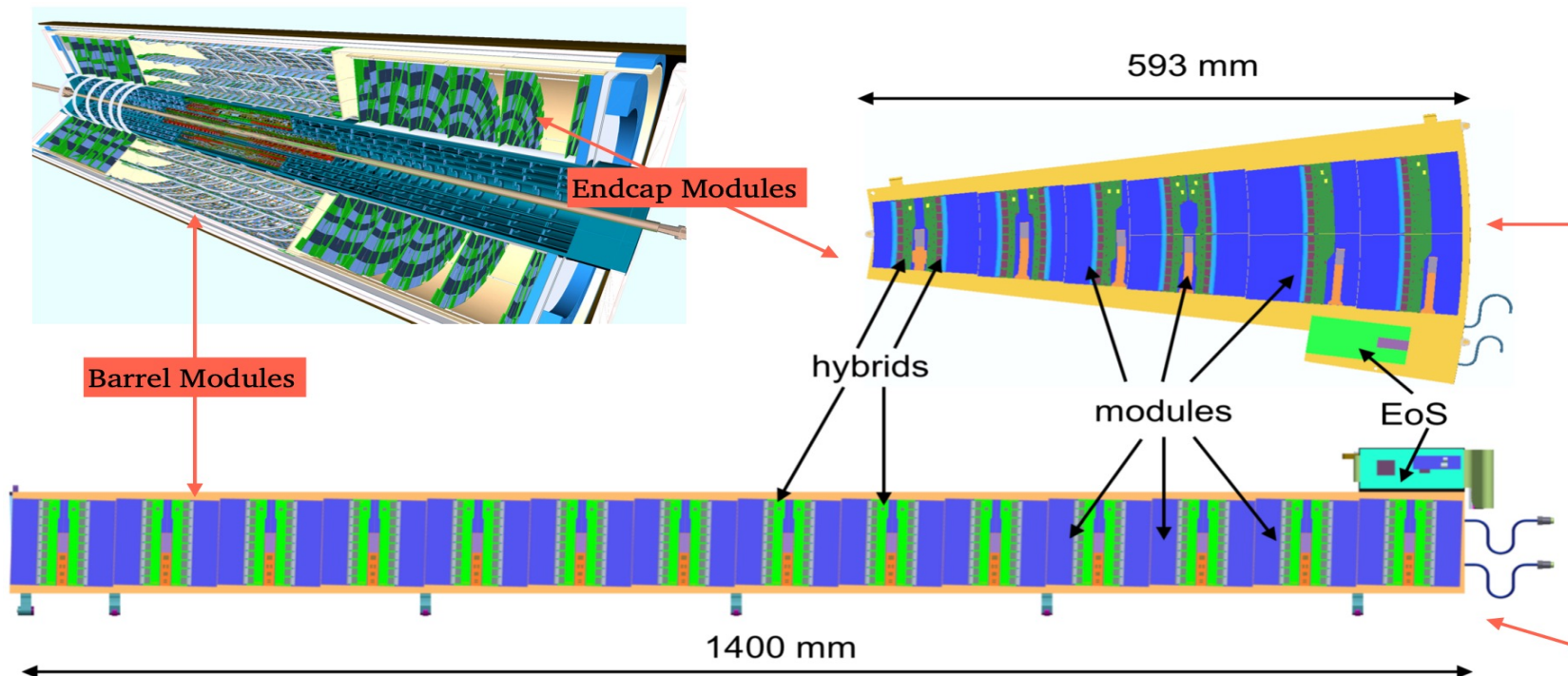


ATLAS ITk Strip Production – UK & EU

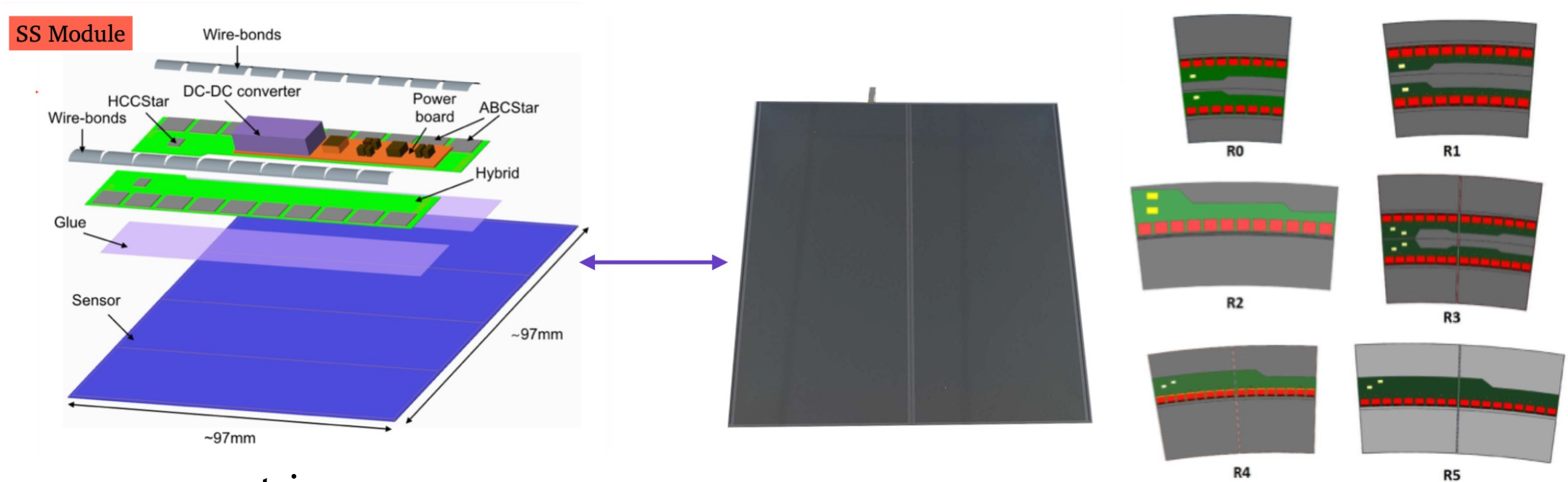


ITk Strip Barrel and Endcap

- Strips are in the outer regions with Barrel and Endcap type modules
- Around 18000 individual strip modules need to be produced
- 2 different designs for barrel and 6 different designs for the endcap



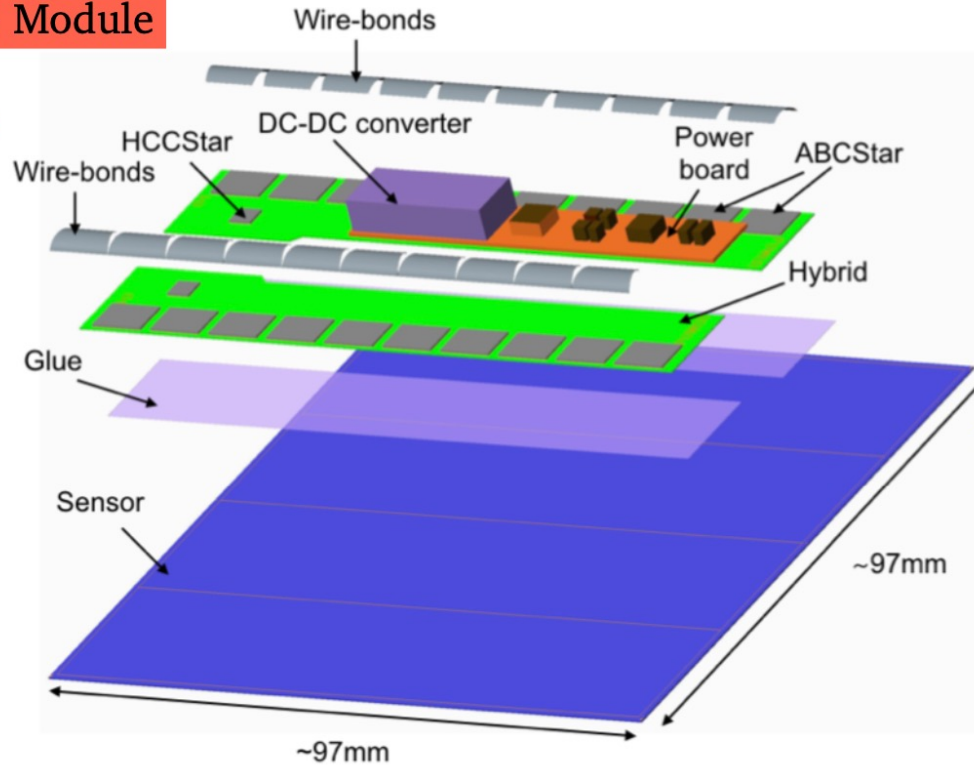
Basic Module Design - Sensor



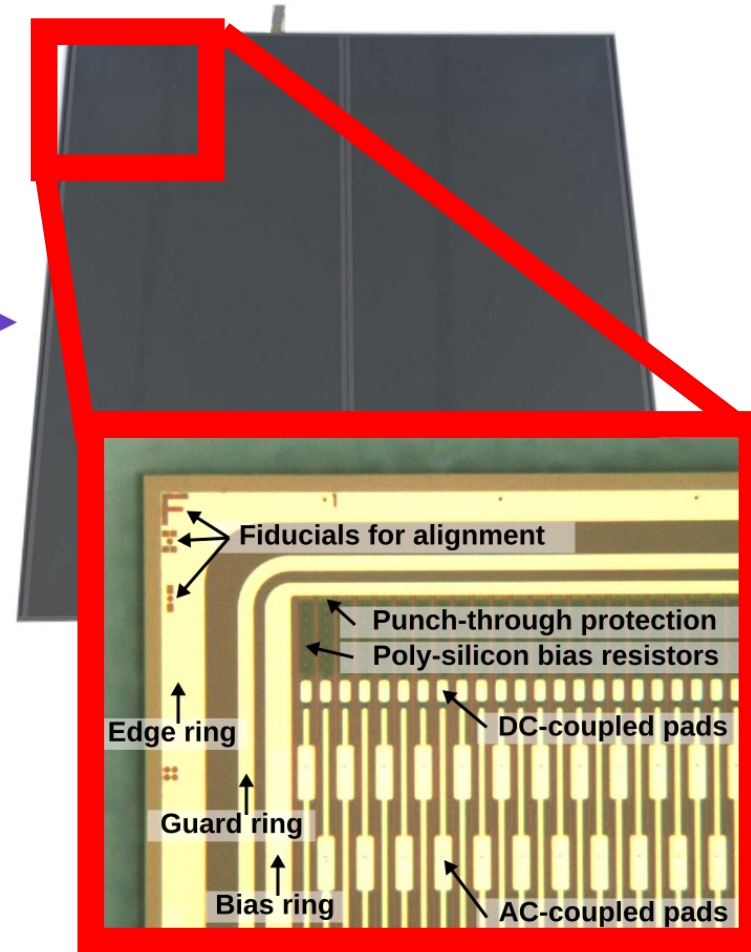
- n+ on -p strip sensor
- 320 μm thick
- Manufactured by Hamamatsu (HPK)
- Strip pitch and length depend on module type

Silicon Sensors

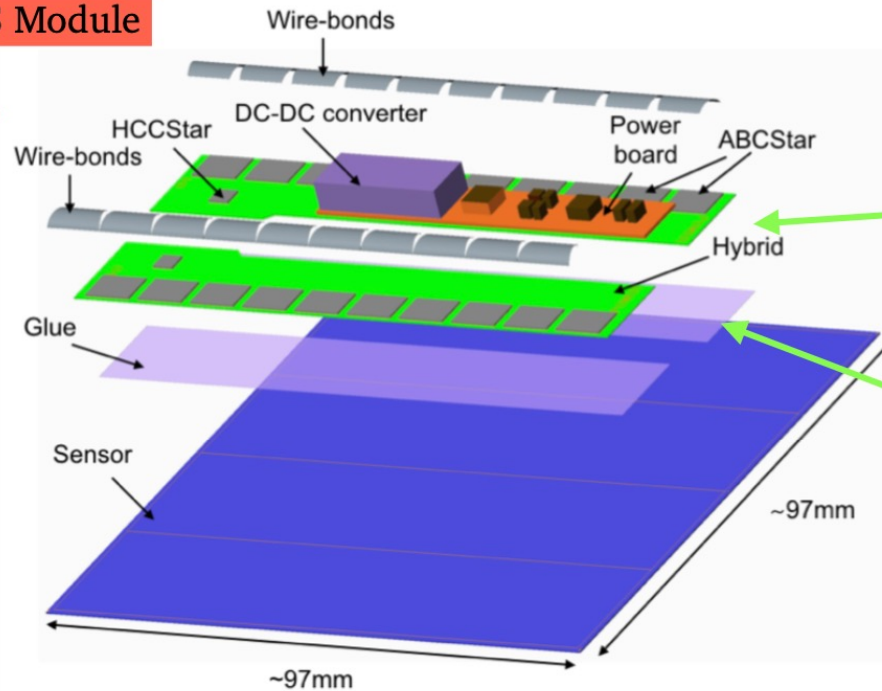
SS Module



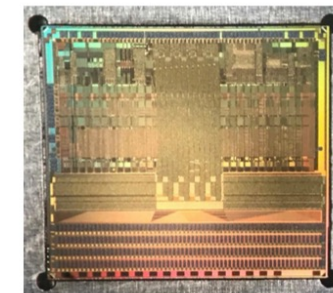
- Type : n+ on p
- Width : 320 μm
- Length : Long strip (LS) 5 cm
Short strip (SS) 2.5 cm
- Pitch : 75 μm



Module Component - Hybrid

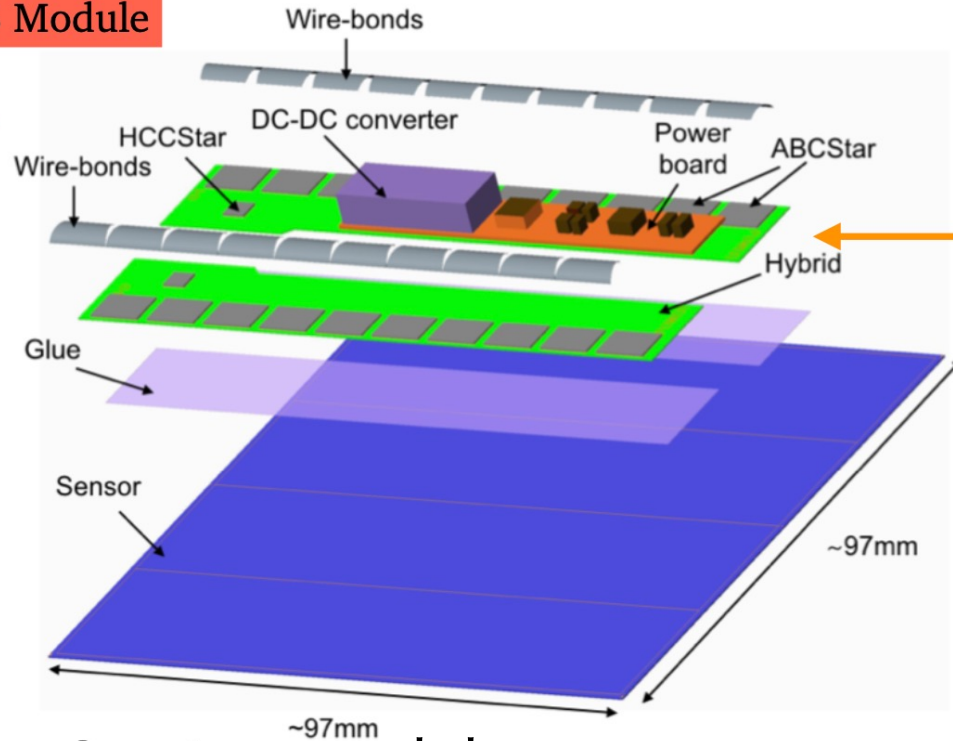


- 10 ABCStars (ATLAS Binary Chips)
 - Converts incoming charge signal into hit information
- 1 HCCStar (Hybrid Controller Chip)
 - Interface between ABCStar and bus-tape



Module Component - Powerboard

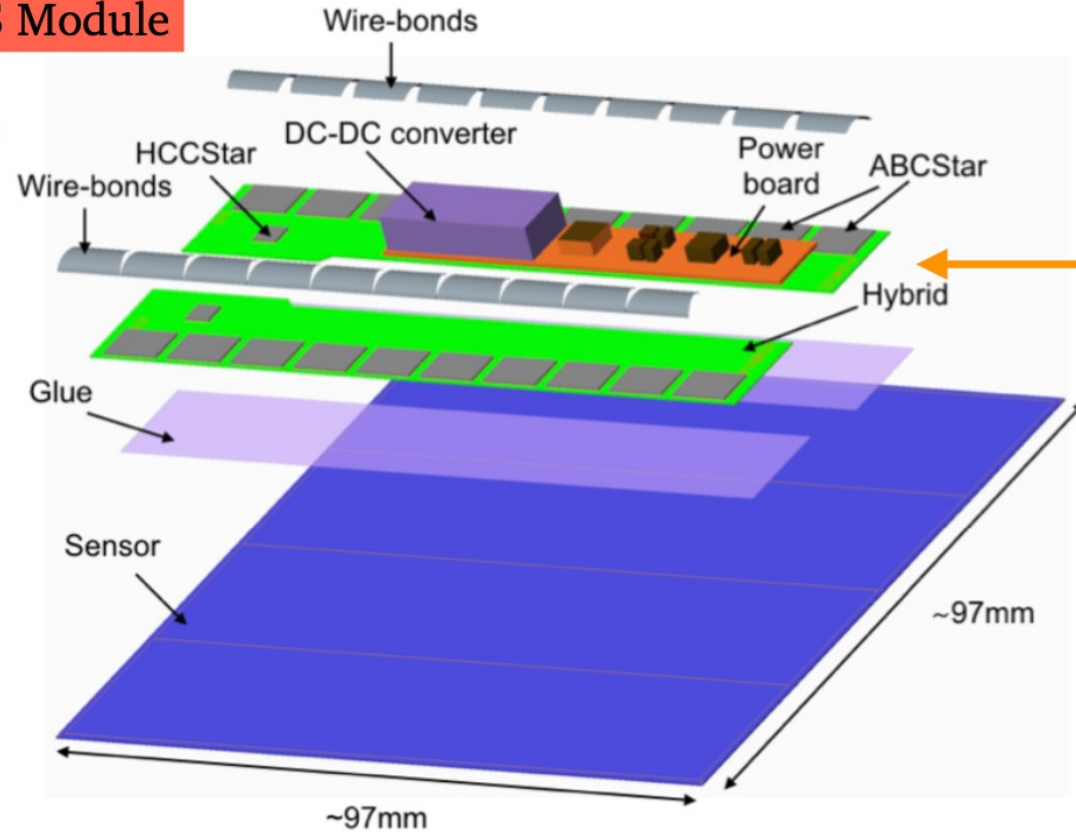
SS Module



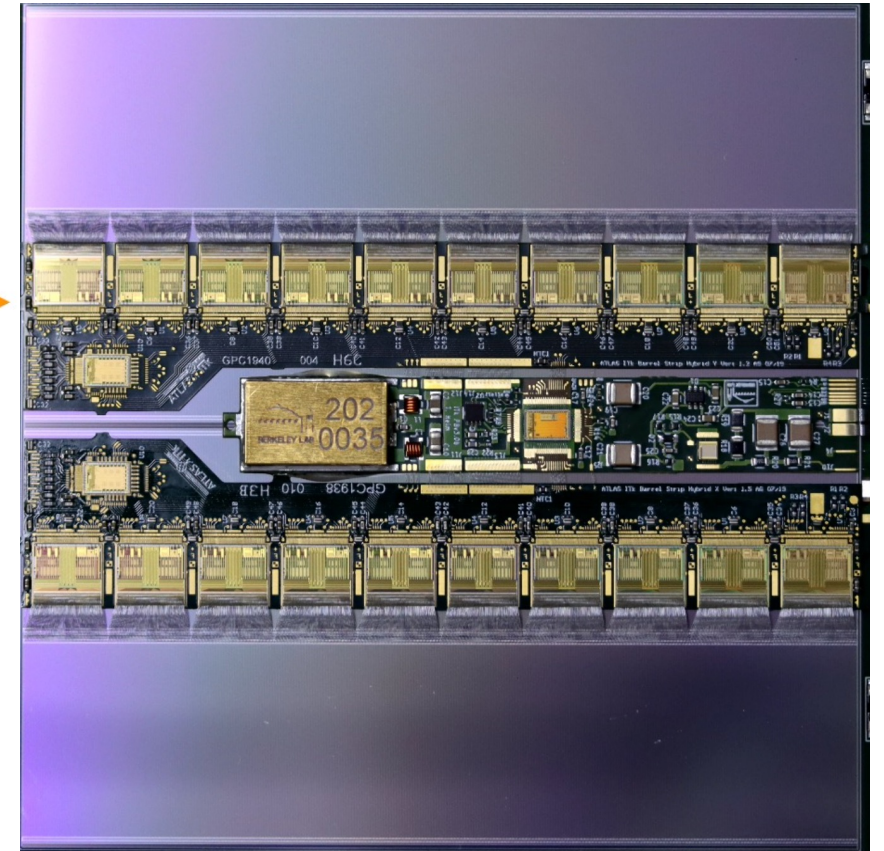
- One per module
- Provides low voltage for the ASICs
- Switchable sensor HV bias
- Hosts an AMAC (Autonomous Monitor And Control)
 - Monitors temperature, voltages and currents

Module Component – Full piece

SS Module

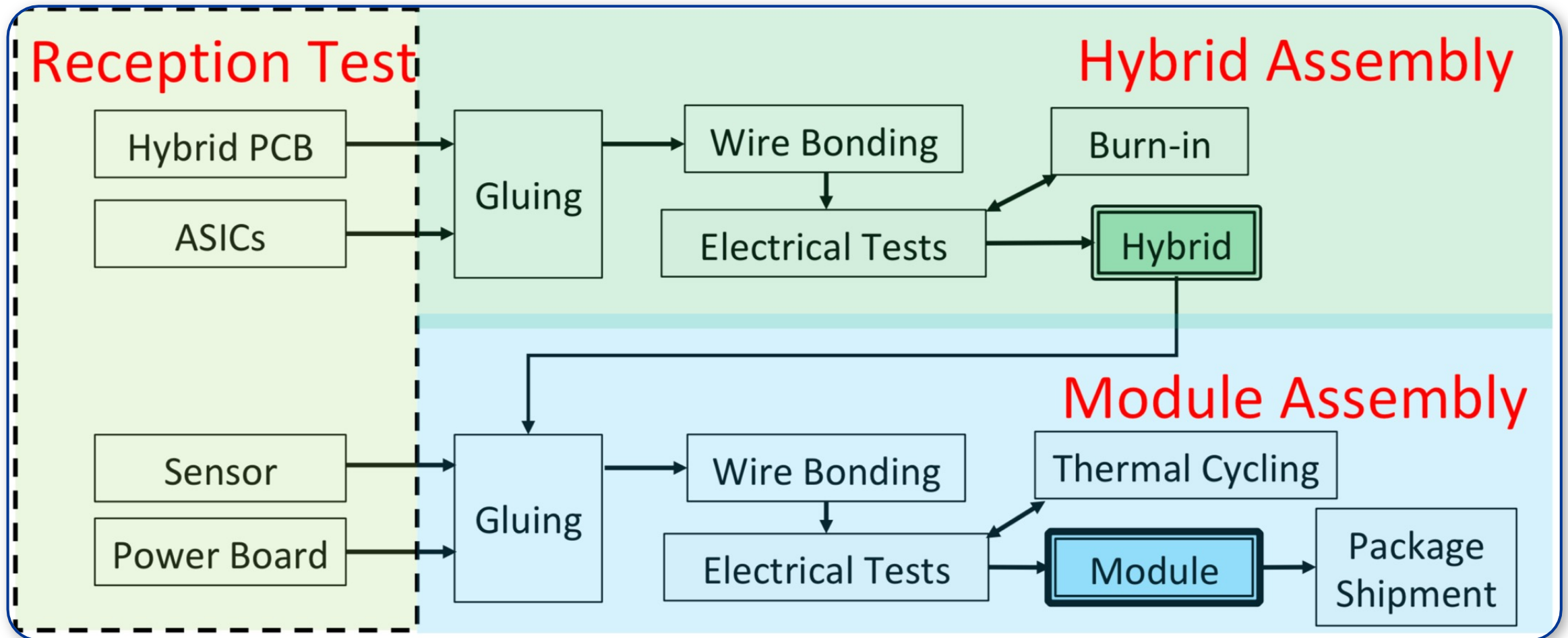


SS Module



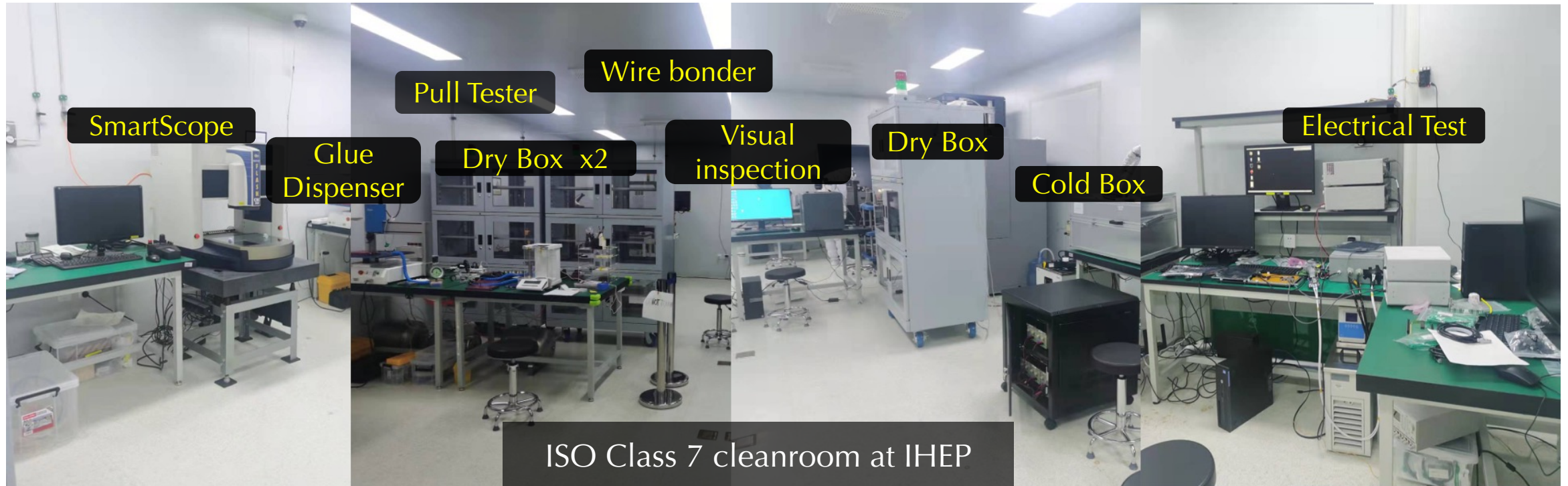
Production Flow

- Well defined module production steps to ensure High Quality Modules



Infrastructure Readiness

- Constructed ISO Class 7 clean room at IHEP
- Most of the instruments required for module production in place
- Production Site Qualification in progress : 22 of 28 have passed



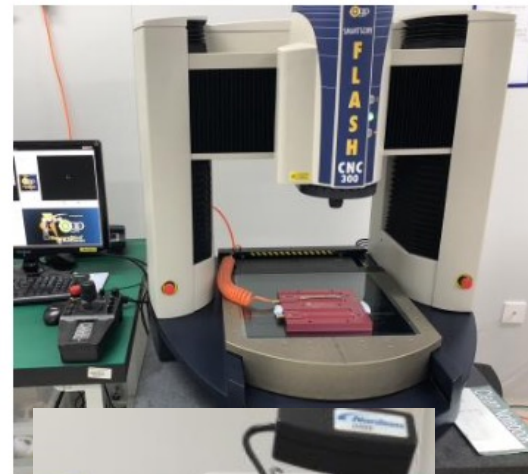
Module Prototyping

- Producing module prototypes exactly following the Quality Control steps
- Produced fully functional electrical modules

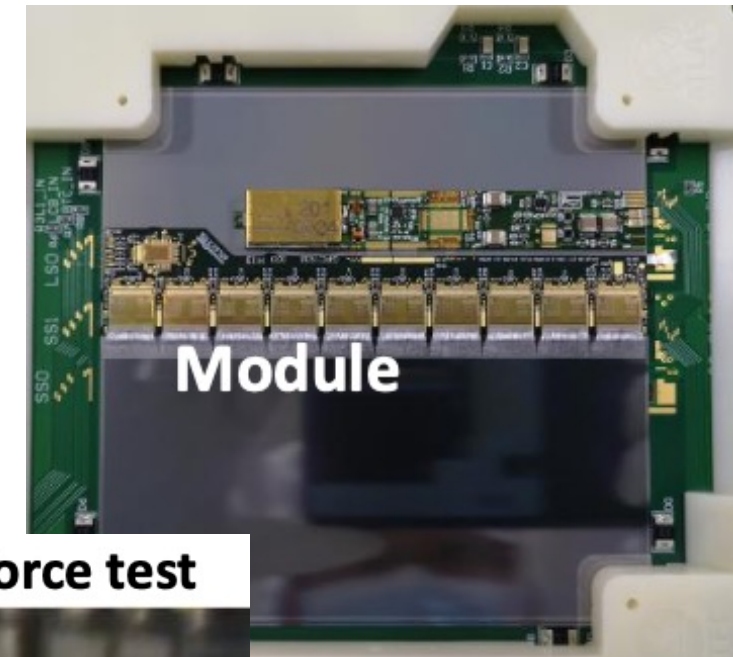
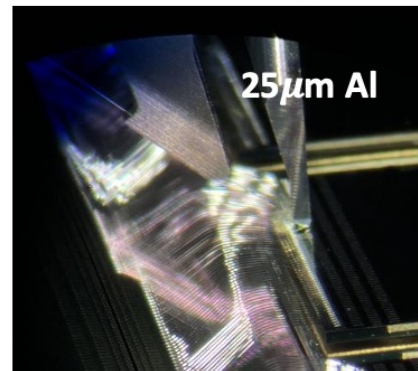
Calibration of glue amount



Metrology of glue thickness



Wire bonding

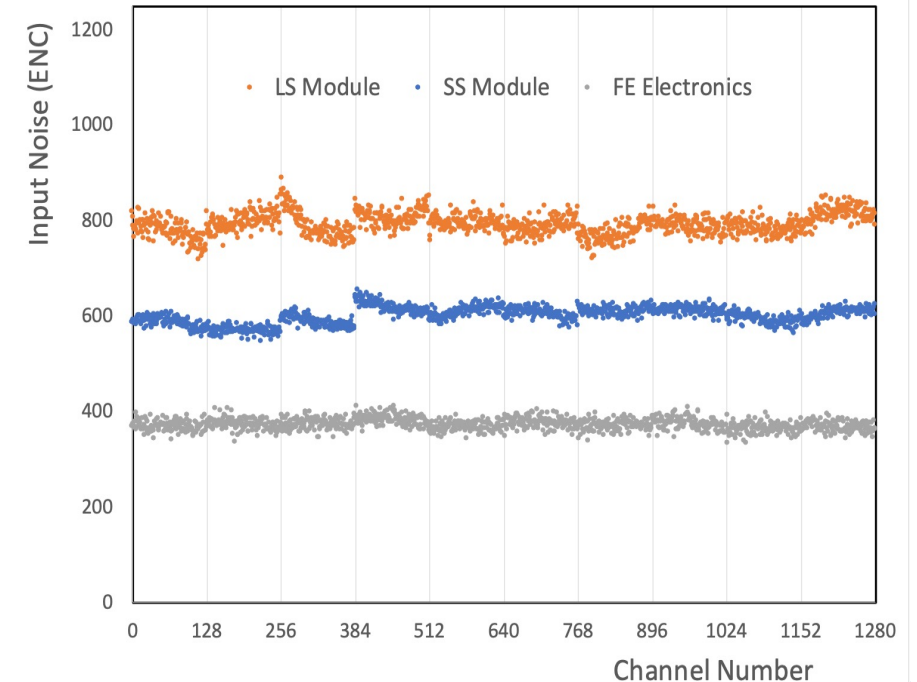
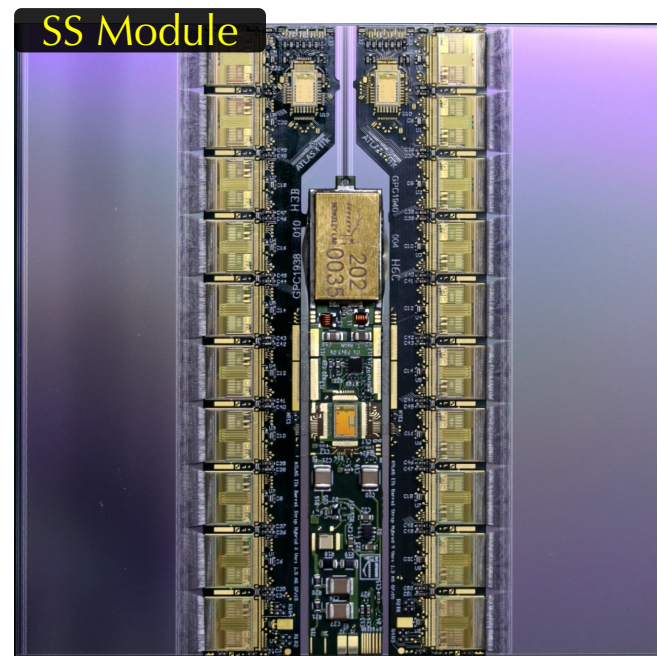
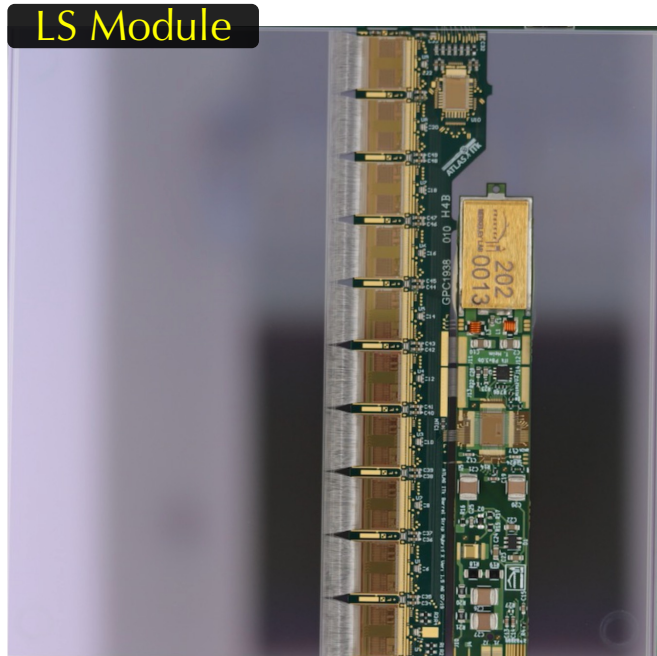


Pull force test

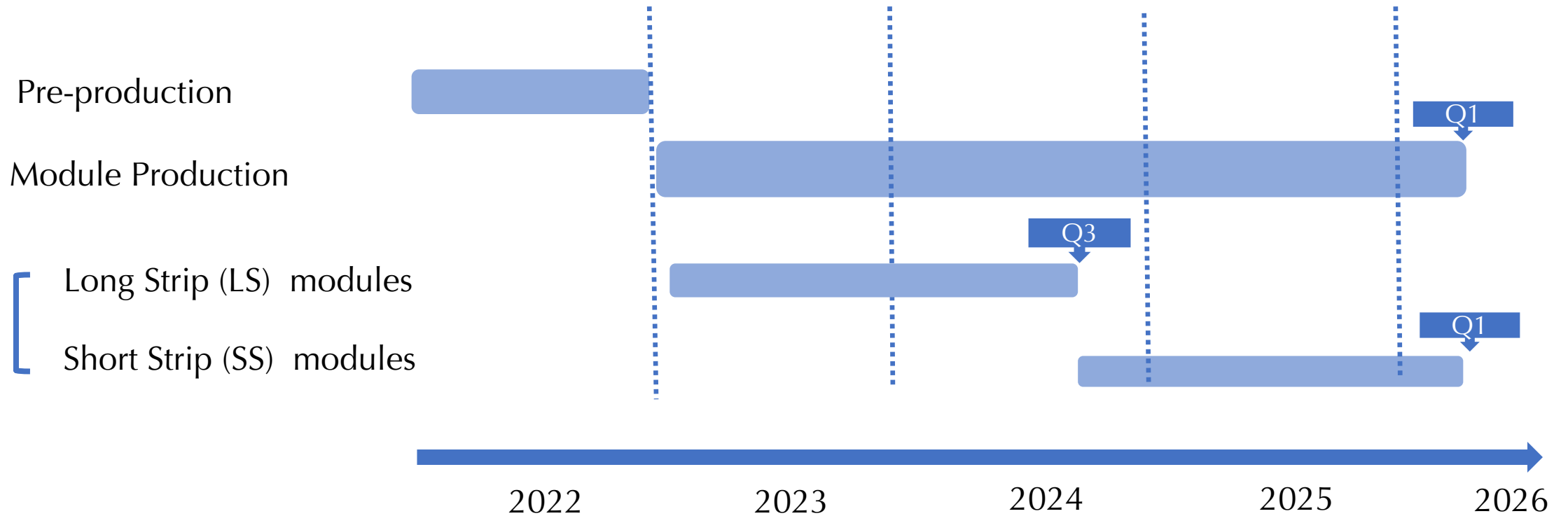


Produced Modules in IHEP

- 5 LS Modules + 3 SS Modules
 - 2 prototype LS Modules
 - Passed electrical tests with expected noise level
 - SS modules have been sent to UK for stave construction



Module production schedule



Summary and Plan

- ATLAS will upgrade to all-silicon tracker (ITk) to cope with HL-LHC
- China (IHEP/THU) is contributing to 10% (~1000) barrel modules production

Plan

- ASIC and Sensor Irradiation study with CSNS proton
 - See Weiguo's talk for ASIC and Hui's poster for Sensor
- Pass the site qualification steps and gain experience with pre-production modules
 - See Zhan's poster for production rate study
- Contribute to the module production and stave building at RAL

