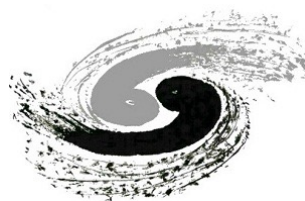


The ATLAS Inner Tracker Strip Detector System

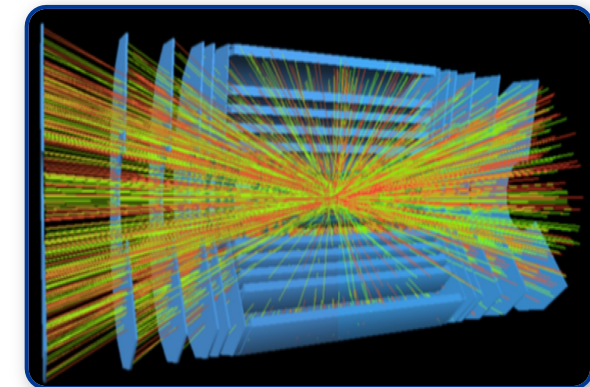
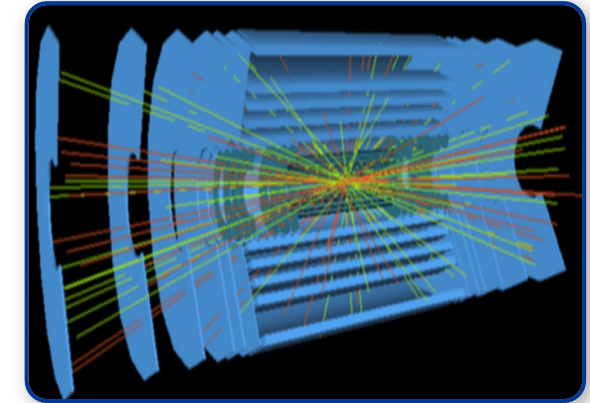
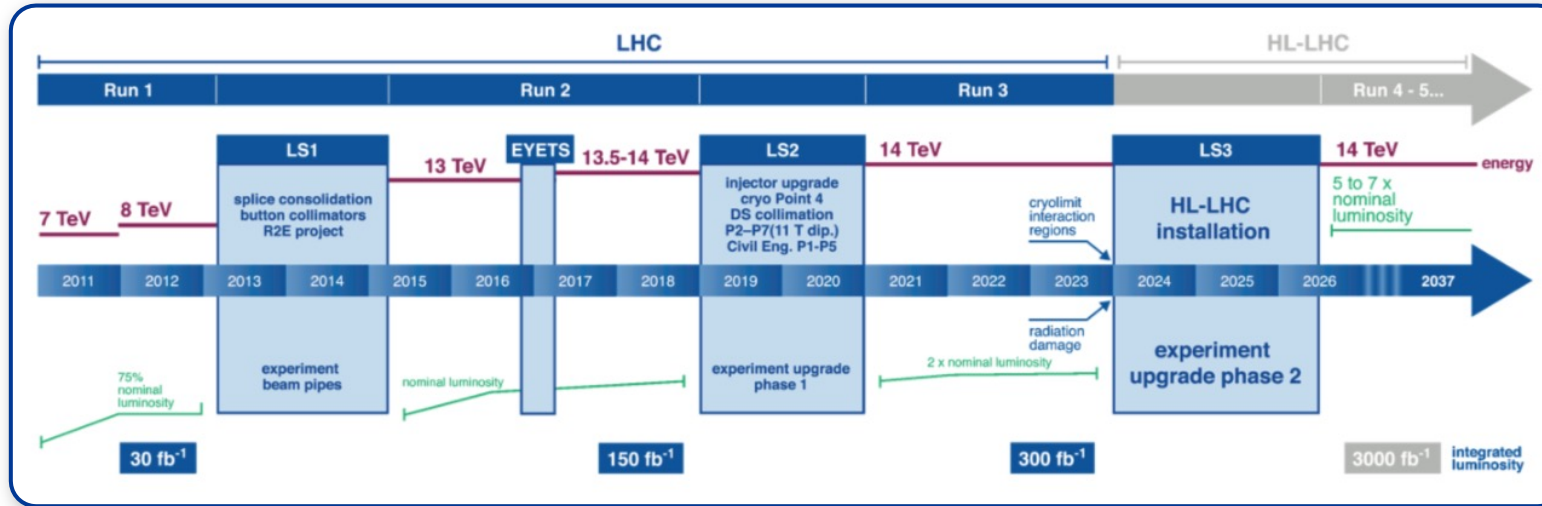
Xin Shi

On behalf of IHEP/THU ATLAS ITk Group



The 7th China LHC Physics Workshop (CLHCP2021)

Challenge for High Luminosity LHC

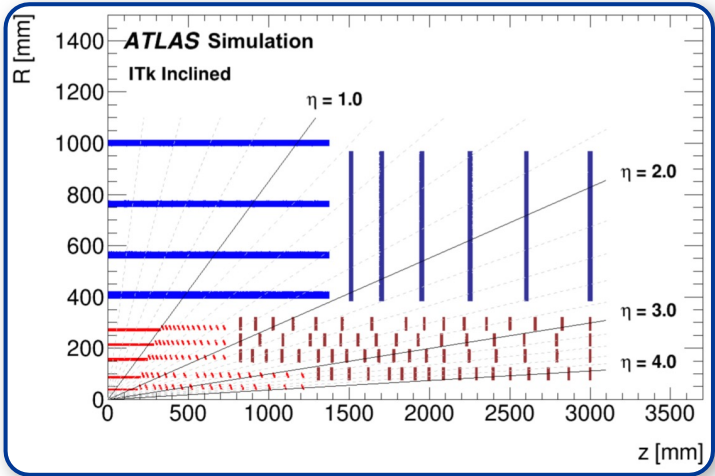
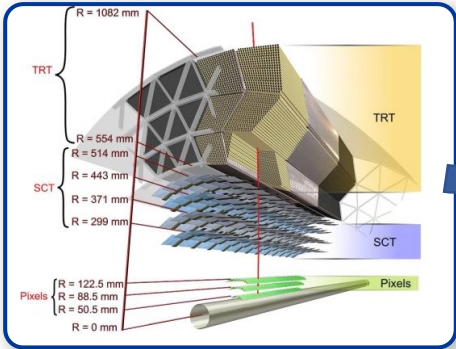
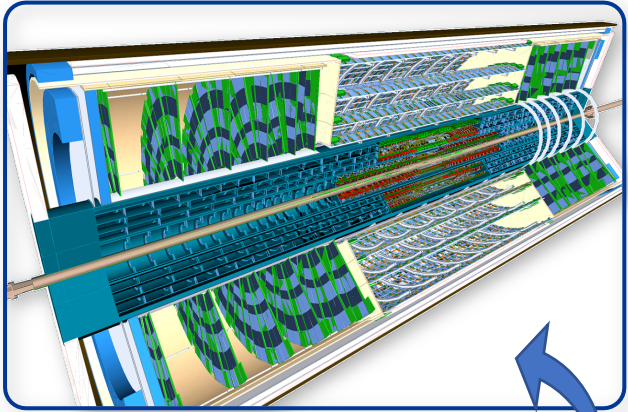


- HL-LHC will start in ~ 2027
- Instantaneous luminosity $7.5 \times 10^{34} \text{ cm}^{-2}\text{s}^{-1}$, 5~7.5x increase
- Average number of interactions per bunch crossing (pile-up events) reach 200

ATLAS Inner Tracker (ITk) Upgrade

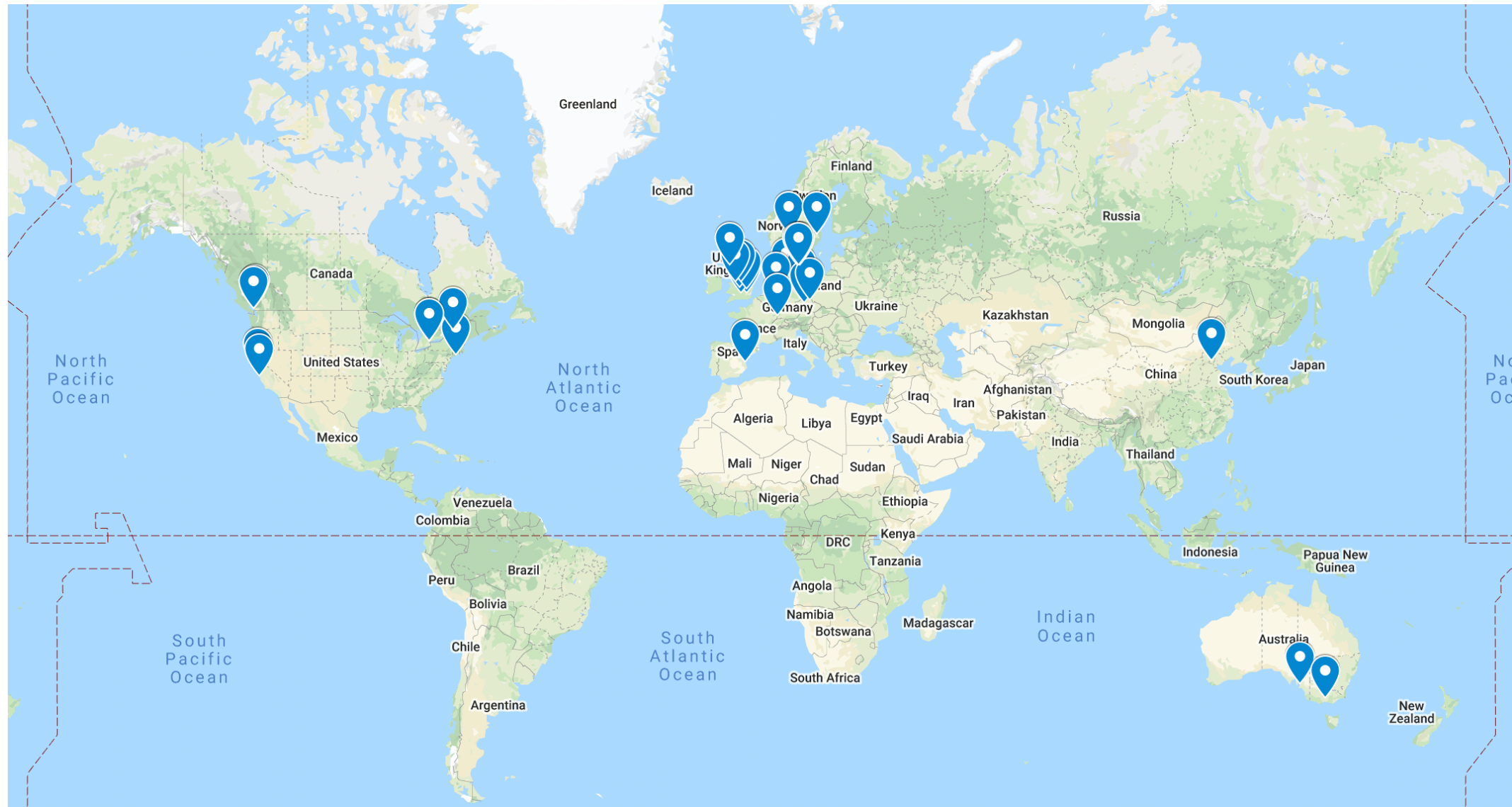
- The new inner tracker (ITk) will be an all Silicon tracker system
- 2T magnetic field, ~6m long, ~1m radius & up to $|\eta|=4$
- 5 Central and multiple Forward Pixel layers
- 4 Central and 6 Forward Strip layers
- Strip system consists of
 - ~18k Modules
 - ~60M channels
 - 165m² of Silicon
 - 50 institutes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

(IHEP/THU will contribute 1000 modules)

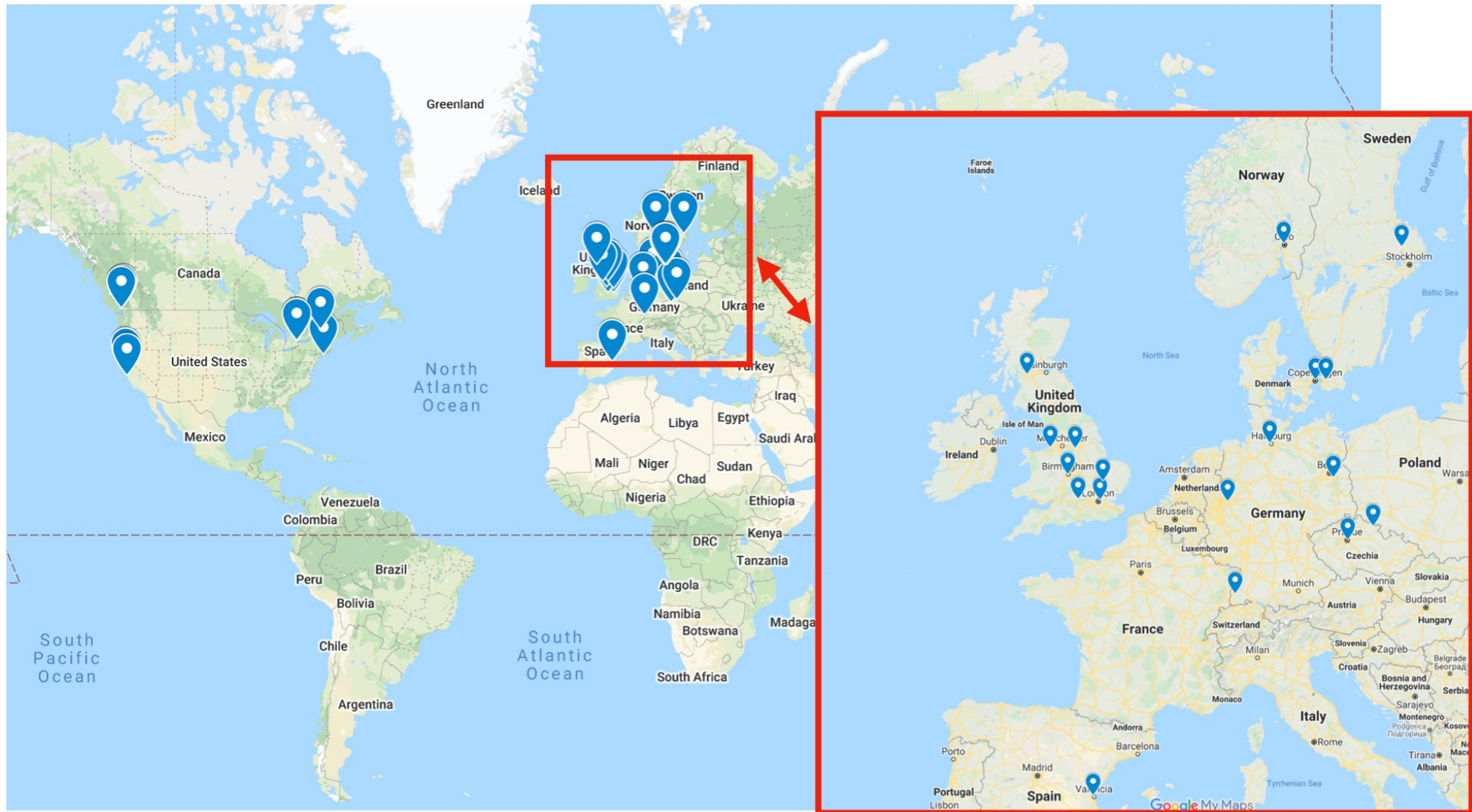


Strip detector comparisons	Current Inner strip tracker (SCT)	Future ITk strip tracker
Radial distance	300-560mm	400-1000mm
Channels	~8 millions	~100 millions
Modules	4 thousands	~20 thousands (165m ² silicon)

Worldwide ITk Strip Production Sites

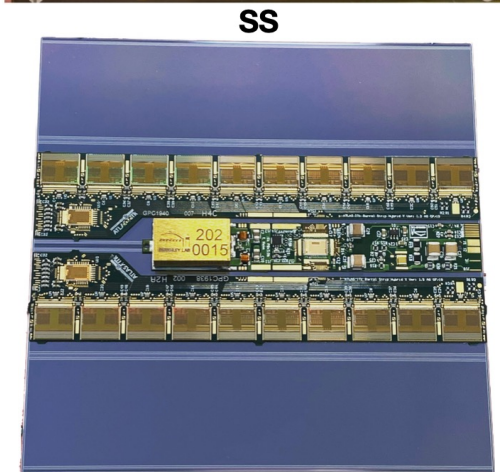
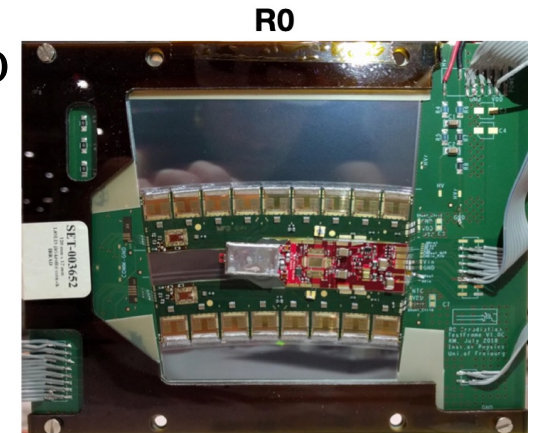
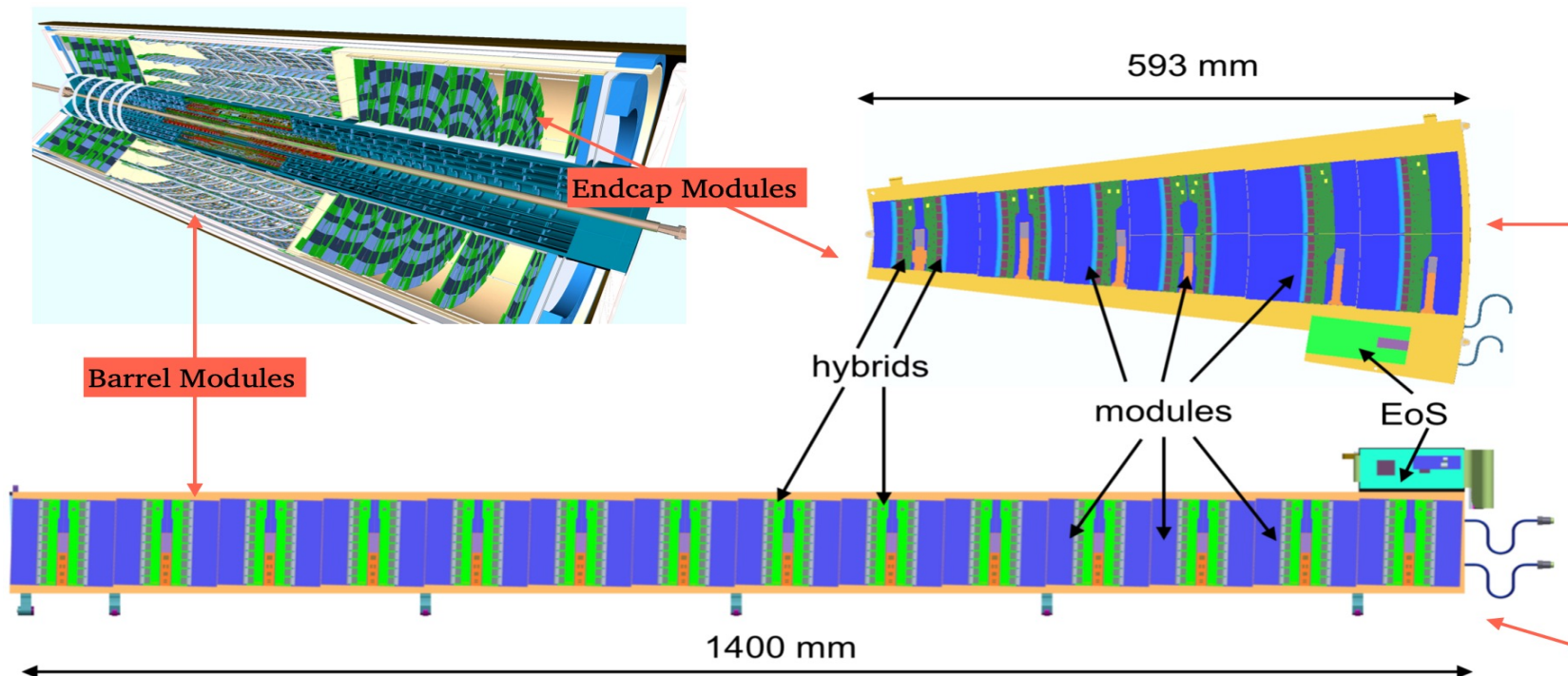


ATLAS ITk Strip Production – UK & EU

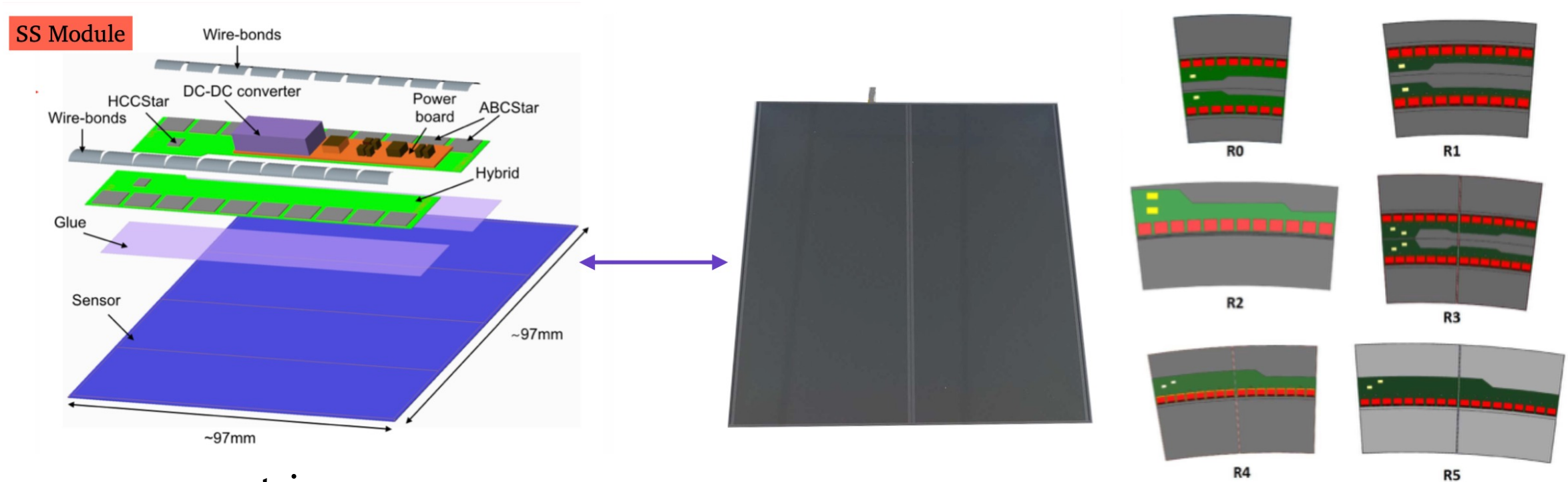


ITk Strip Barrel and Endcap

- 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



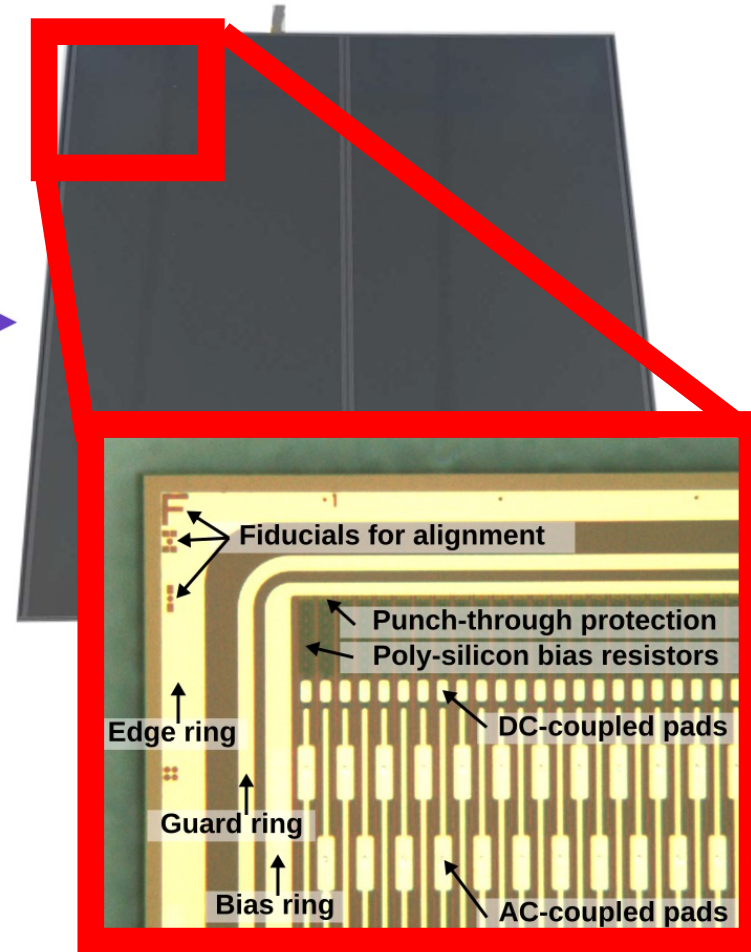
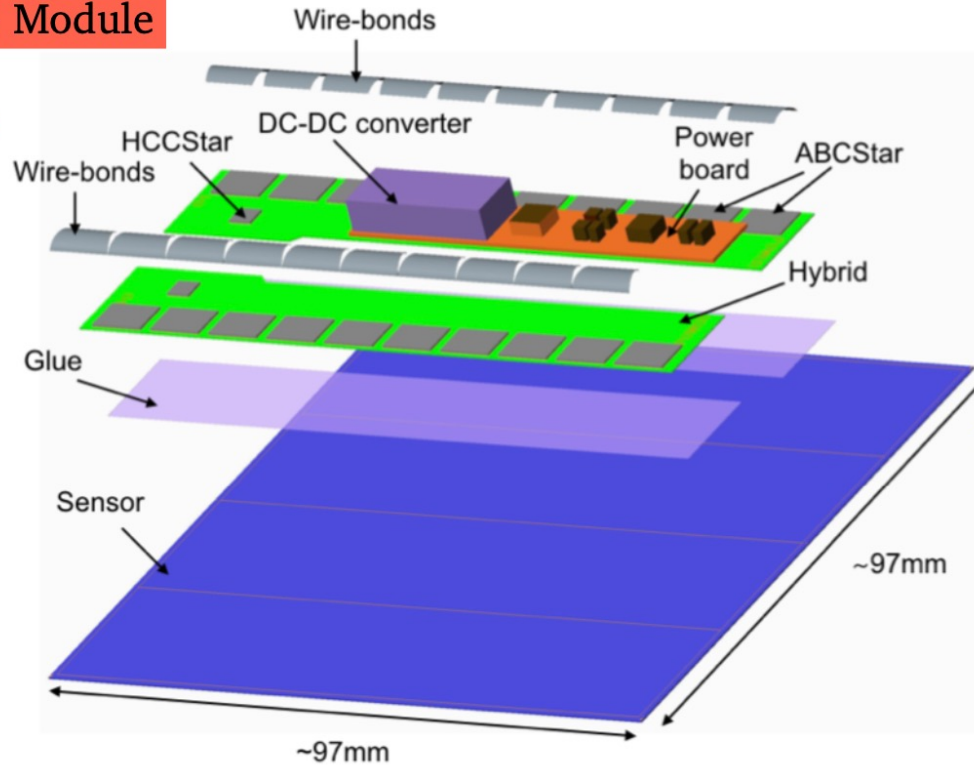
Basic Module Design - Sensor



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

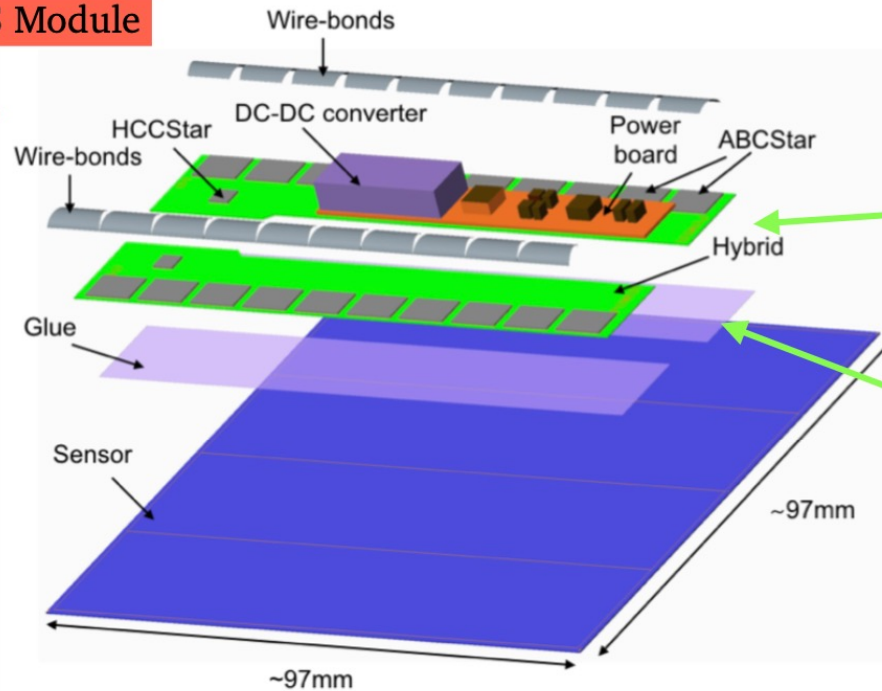
Silicon Sensors

SS Module

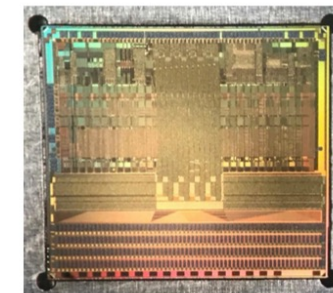


- Type : n+ on p
- Width : 320 μm
- Length : Long strip (LS) 5 cm
Short strip (SS) 2.5 cm
- Pitch : 75 μm

Module Component - Hybrid

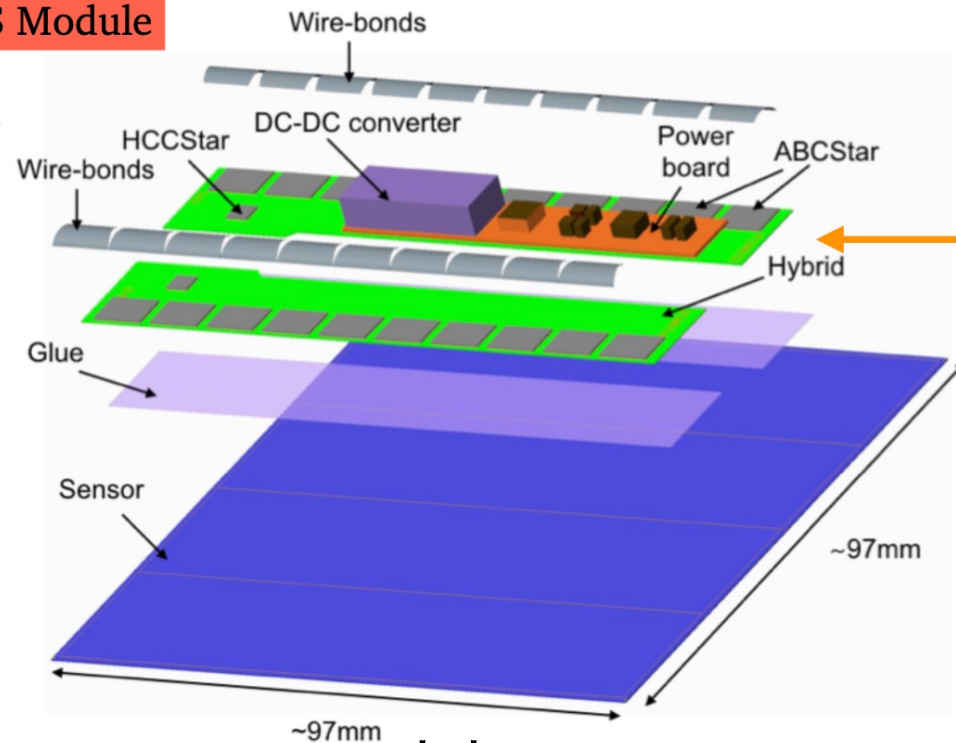


- 10 ABCStars (ATLAS Binary Chips)
 - Converts incoming charge signal into hit information
- 1 HCCStar (Hybrid Controller Chip)
 - Interface between ABCStar and bus-tape



Module Component - Powerboard

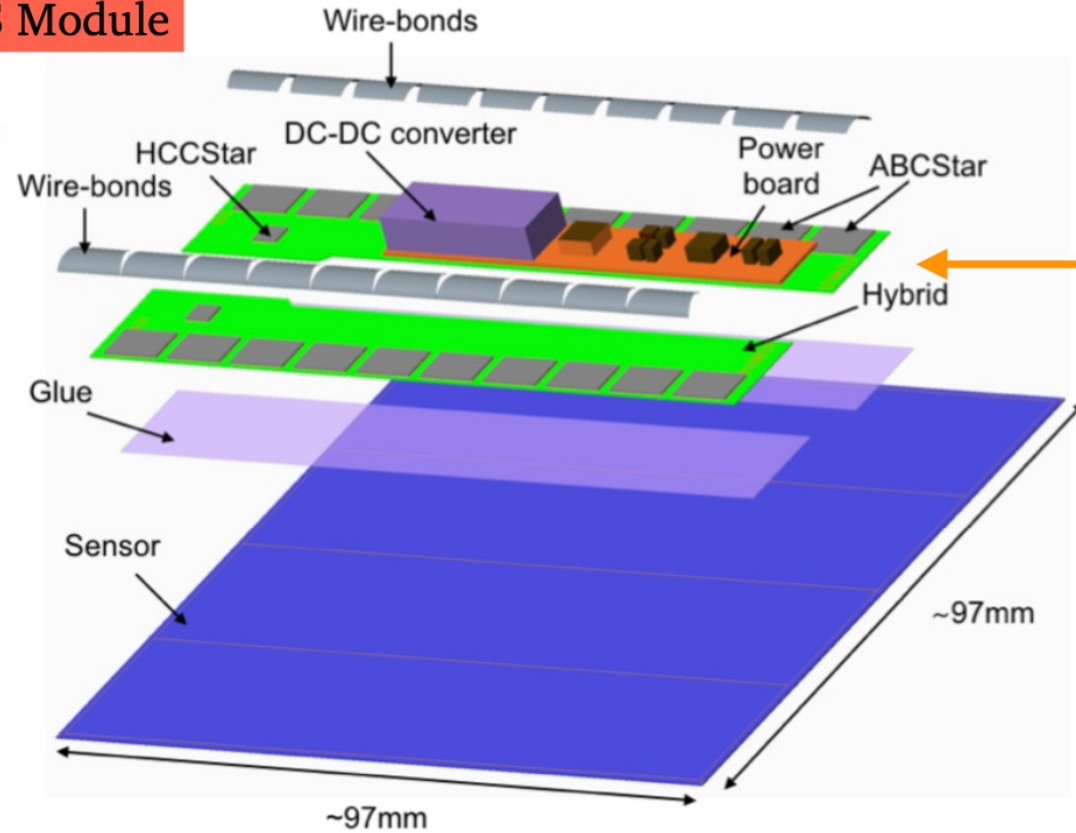
SS Module



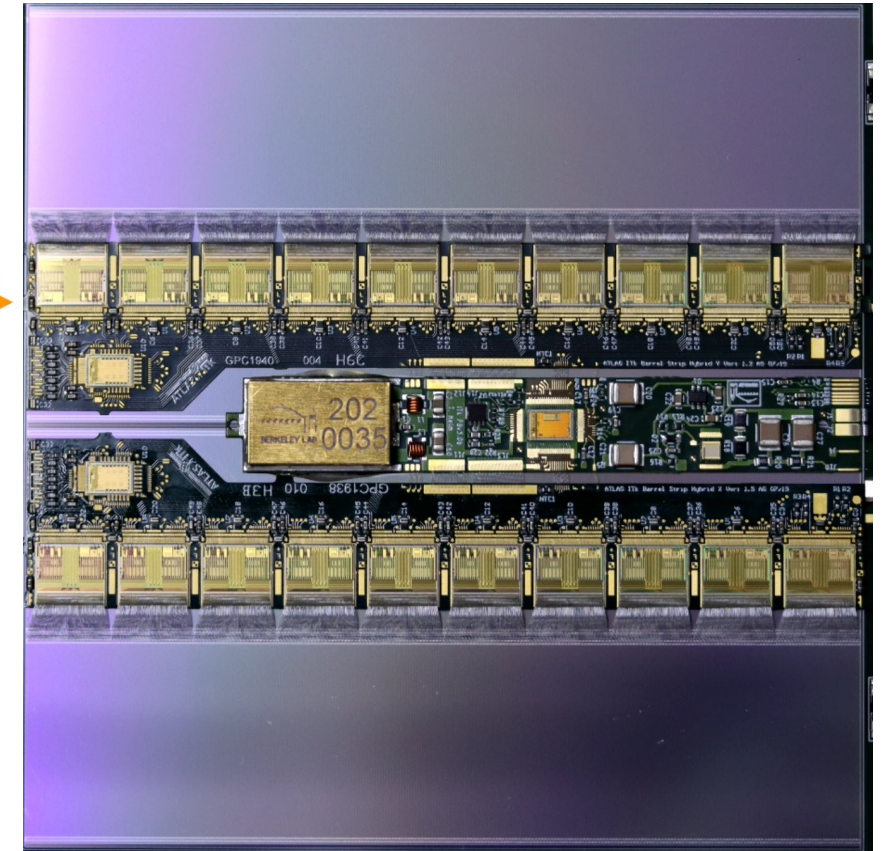
- One per module
- Provides low voltage for the ASICs
- Switchable sensor HV bias
- Hosts an AMAC (Autonomous Monitor And Control)
 - Monitors temperature, voltages and currents

Module Component – Full piece

SS Module

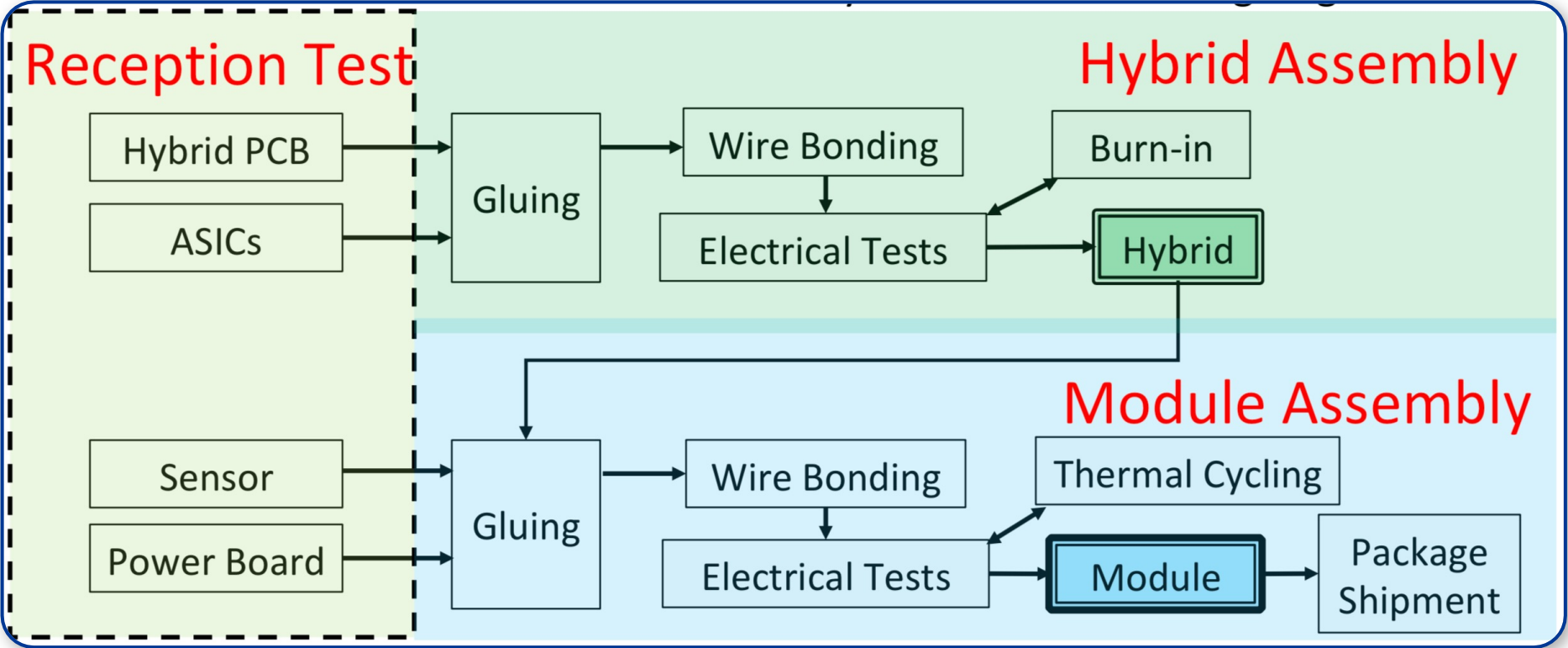


SS Module



Production Flow

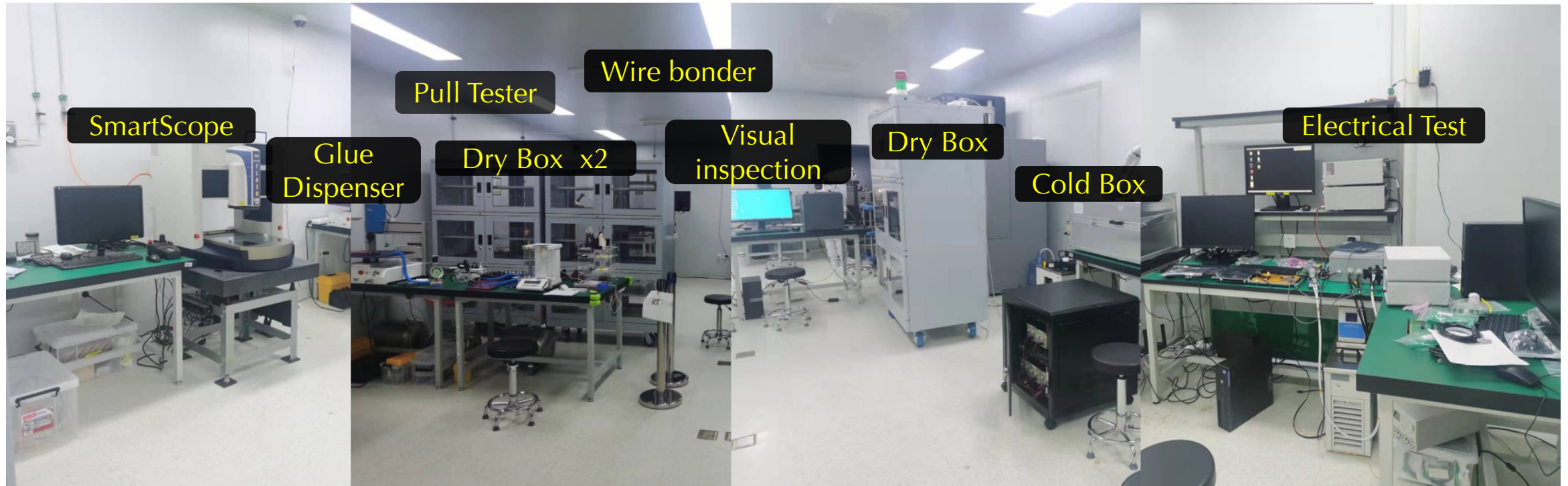
- Well defined module production steps to ensure High Quality Modules



Step Number	Qualification Step
3.2	Sensor Storage
6.1	PB Reception
6.2	PB E tests
6.3	PB Vis Insp
6.4	PB Storage
8.1	Tools
8.2	Storage + shipping of glue
8.3	Assembling hybrids
8.4	Glue weight measurements
8.5	Bonding procedures: hybrids
8.6	Metrology: hybrids
8.7	Visual inspection: hybrids
8.8	Hybrid Burn-In
8.10	Hybrid Storage
8.11	hybrid QC: single panel testing
11.1	Storage of modules
11.2	Cleaning module jigs
11.4	Storage + shipping of glue
11.5	Removing hybrids from panel
11.6	Module Assembly
11.7	Metrology: modules
11.8	Bonding procedures: modules
11.9	Visual inspection: modules
11.10	Module Thermal Cycling
11.11	Single Module Electrical Test
12.1	Shipping modules
13.1	Cleanroom standards
13.2	ASIC Compliance & Handling
13.3	Bond Pulling Procedures
14.1	Module Reception

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



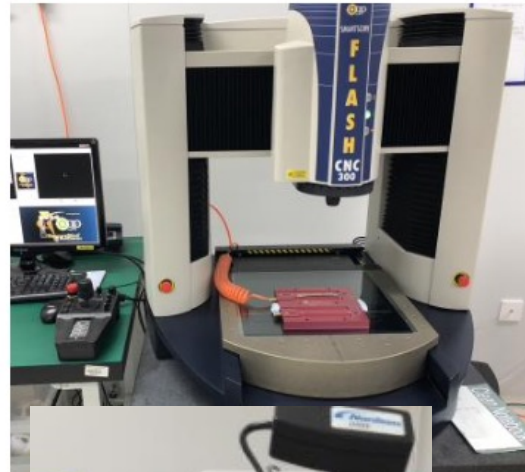
Module Prototyping

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

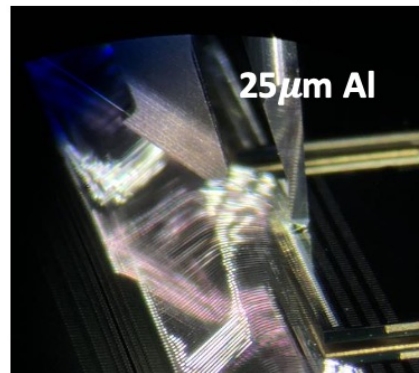
Calibration of glue amount



Metrology of glue thickness



Wire bonding



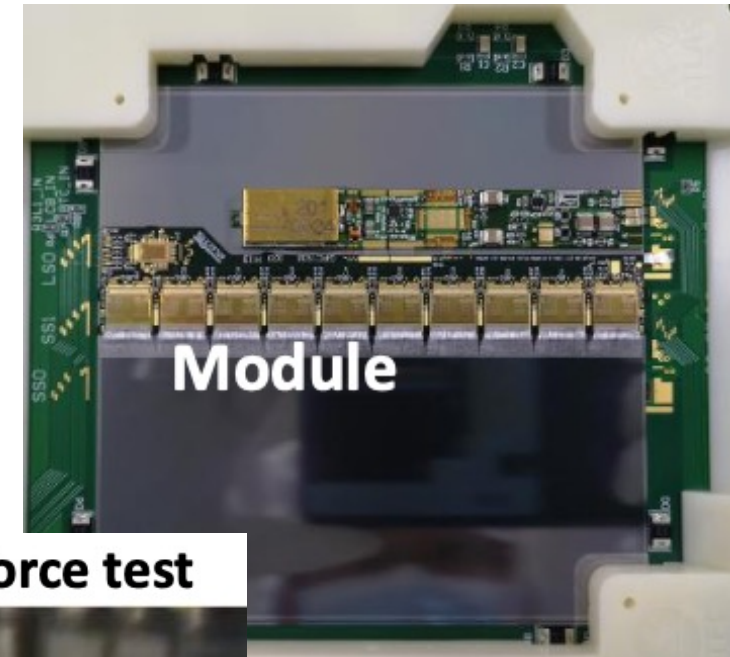
Pull tester



Pull force test

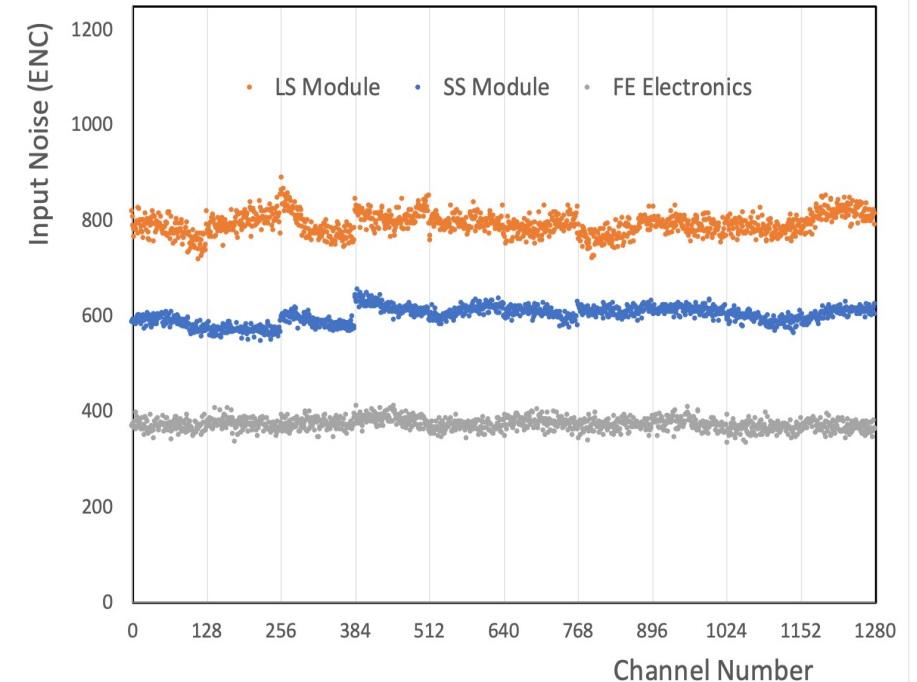
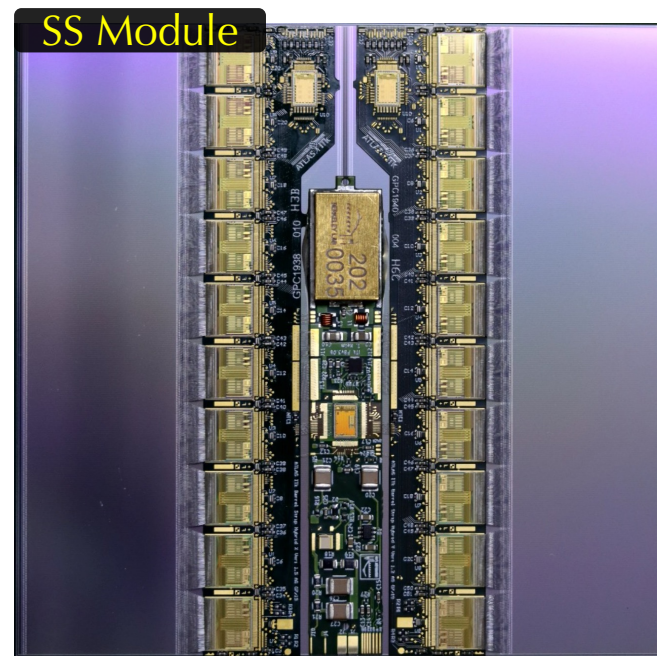
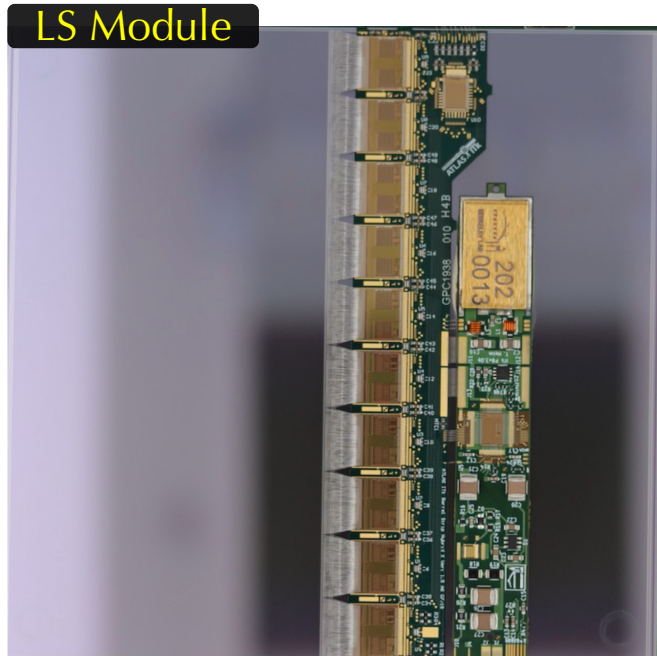


Module

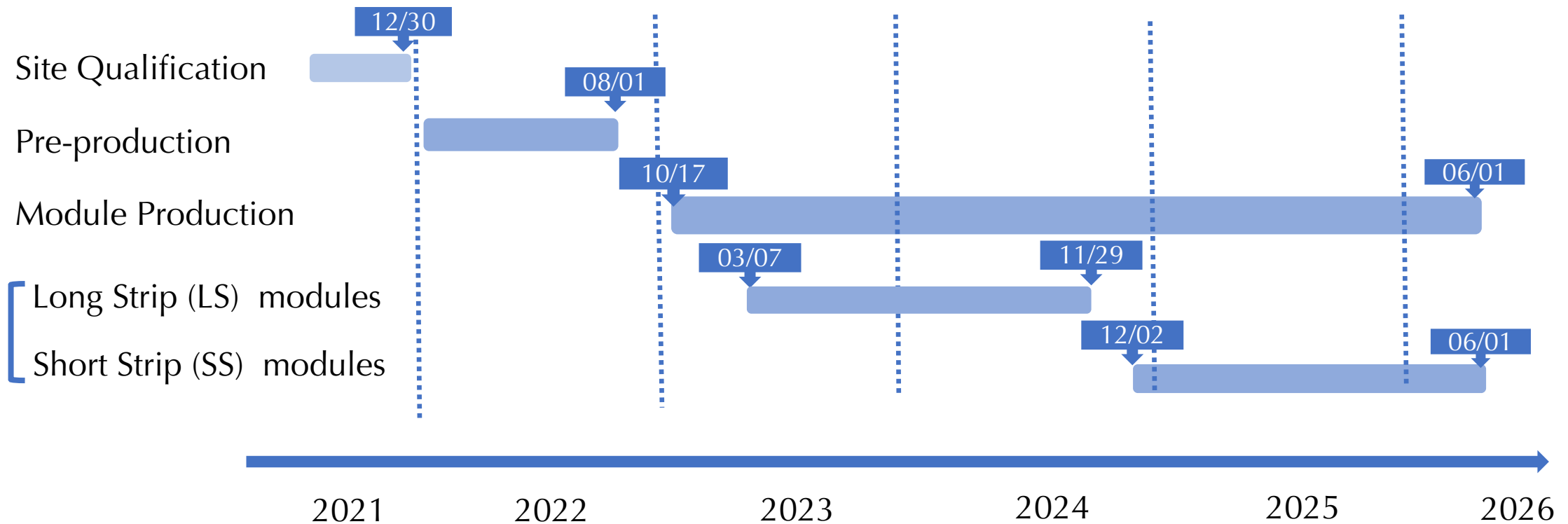


Produced Modules in IHEP

- 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

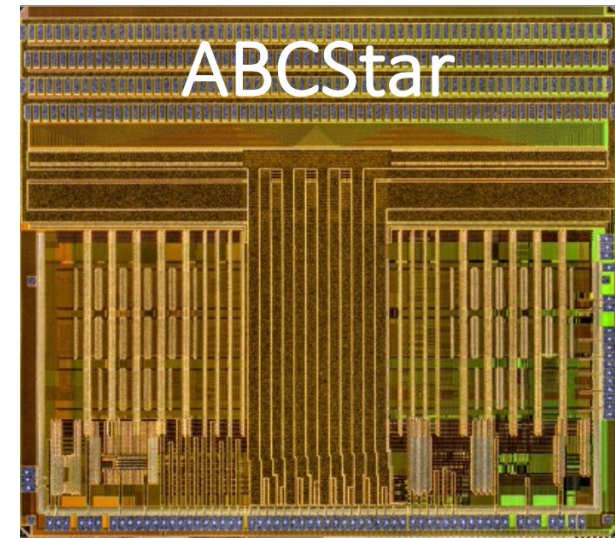
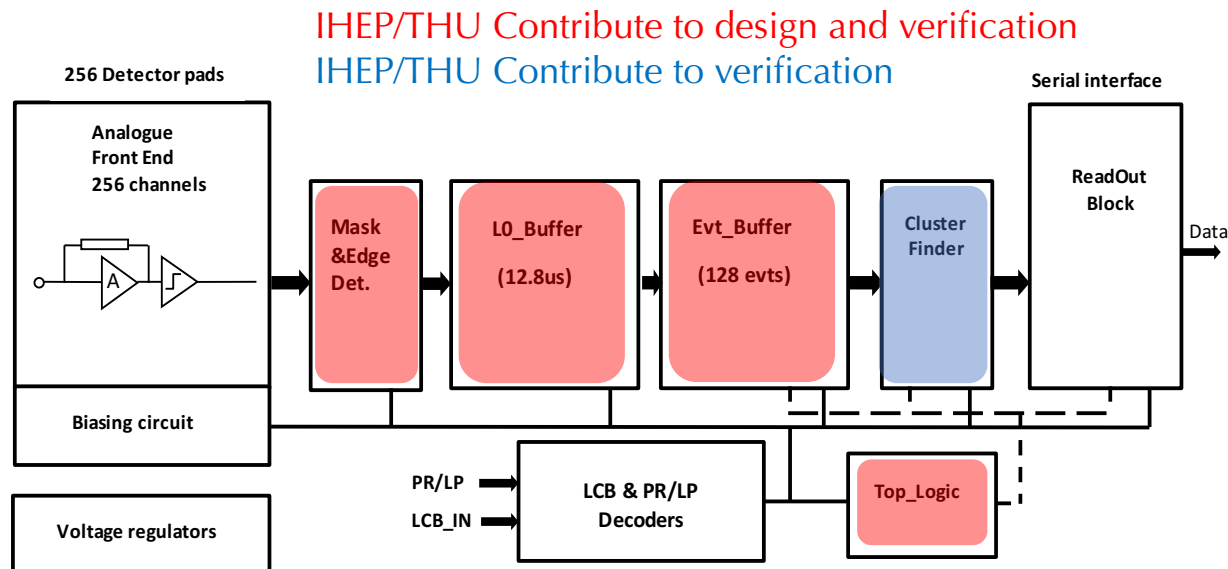
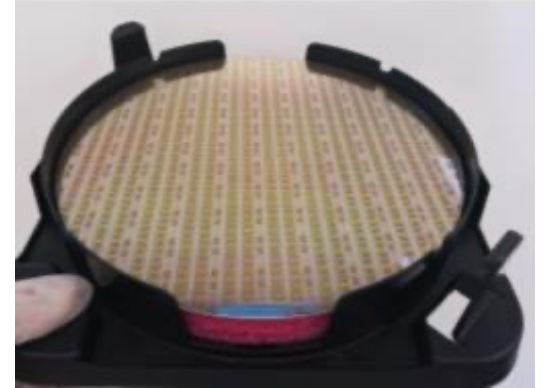


Module production schedule



Radiation Hard FE ASICs

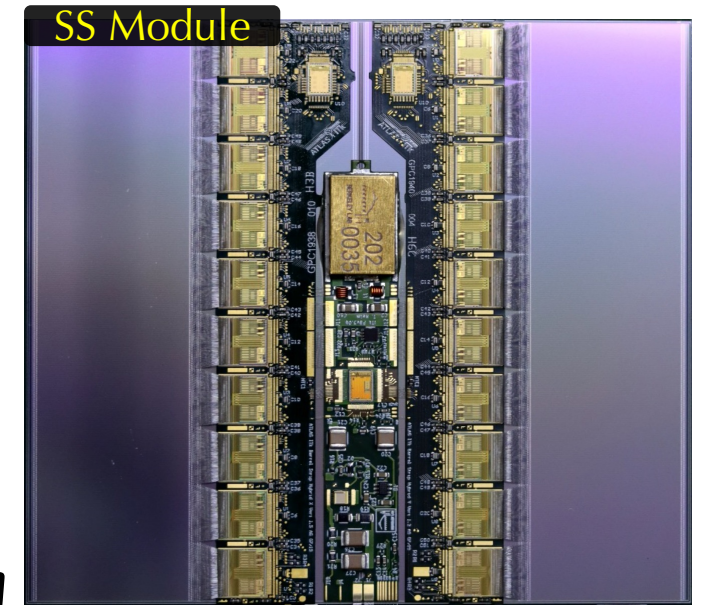
- ABC-STAR chips with readout architecture redesigned to cope with the increased trigger rate
- Significant contributions to design and verification of digital blocks
- Passed Production Readiness Review (PRR) on Oct 2022
Ready to launch production of ABCStarv1



Export license available for shipment of chips from CERN to IHEP

Summary

- To cope with the challenge in HL-LHC, ATLAS will upgrade to all-silicon tracker (ITk)
- Producing around 18000 strip modules need world-wide effort
- China (IHEP/THU) is contributing to 1000 modules
 - Established strong connection with RAL(UK)
2 FTE / year, will produce 500 modules
 - Site Qualification at IHEP in steady progress
 - Involved in ASIC design and beam tests
- Will contribute to detector system integration



Looking forward to a productive 2022!