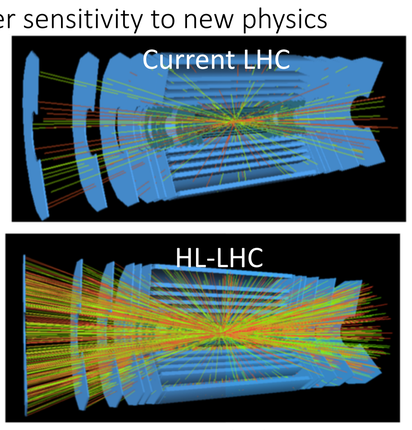
Process of ATLAS Inner Tracker Strip Module Production

Yuzhen Yang, on behalf of ATLAS collaboration
Institute of High Energy Physics, CAS, Beijing, China 100049

Introduction

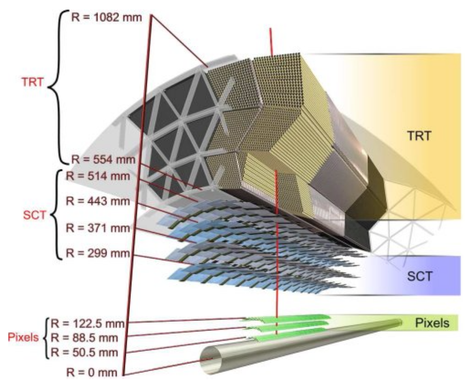
ATLAS Upgrade Background

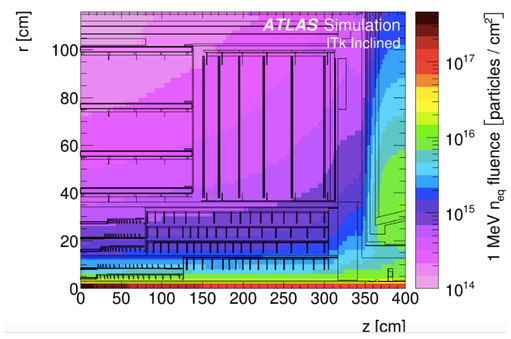
- High Luminosity-LHC (HL-LHC) is foreseen to be completed in 2026.
  - Aim to increase the integrated luminosity to about ten times the original LHC design.
  - improve the precision of the Higgs measurement, better sensitivity to new physics
- Radiation damage
  - Current strip tracker is designed up to 2*10^{14} Neq/cm^2
  - HL-LHC requirement is up to 2*10^{15} Neq/cm^2
- Detector occupancy
  - Current tracker is designed to accommodate ⟨μ⟩ ~ 23
  - increased granularity is required for HL-LHC ⟨μ⟩ ~ 200



ATLAS Inner Tracker (ITk)

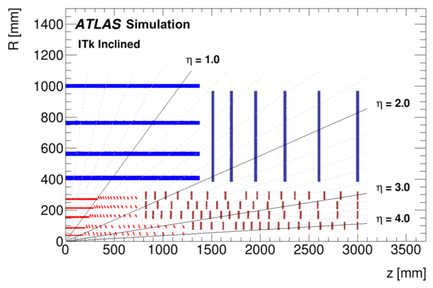
- New all-silicon Inner Tracker (ITK) will replace current ATLAS inner detector (ID)
  - Technical Design Report for ITK strip detector approved by LHCC (CERN-LHCC-2017-005)

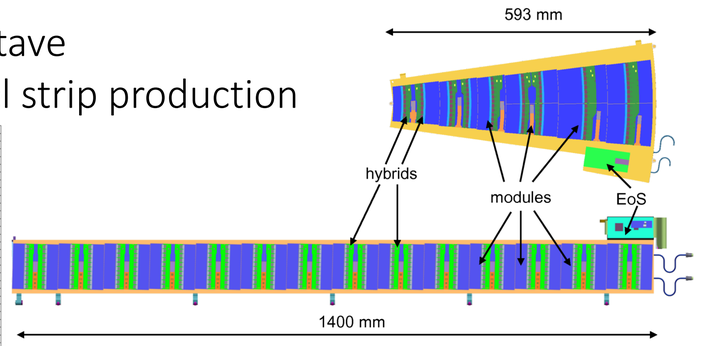




ITk Strip tracker layout

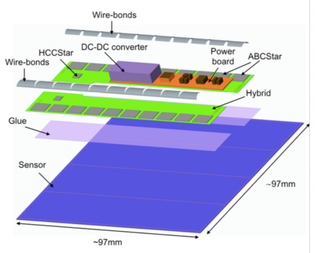
- Strip Track coverage up to |η| = 2.9
- 4 strip layers in Barrel (two inner short strip layer, two outer long strip layers)
- 6 endcap strip disks
- module will load on stave
- IHEP attend the barrel strip production

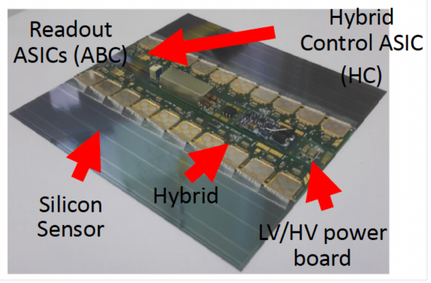




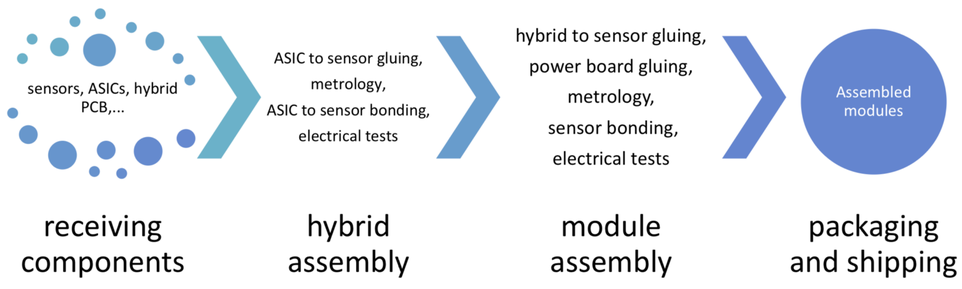
Strip Module Assembly

- Basic Strip Module Unit
  - low-mass Kapton hybrid with ABCStar (ATLAS Binary Chip) and HCCStar (Hybrid Controller Chip) ASICs
  - Power-Board including DC-DC Low Voltage (LV) Power Block, monitoring ASIC , and HV multiplexer



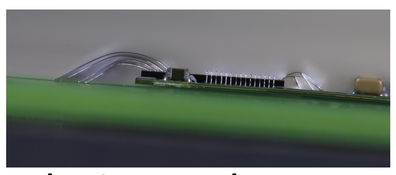


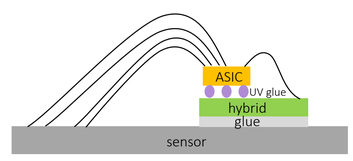
- Assembly process

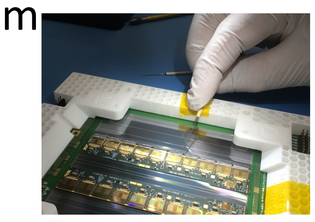


Wire bonding

- 25um aluminum wire
- 4-row front-end bonded to sensor to readout
  - Long strip: 1280 channels
  - Short strip: 2560 channels
- bond pad size of ABC130: 60um*200um

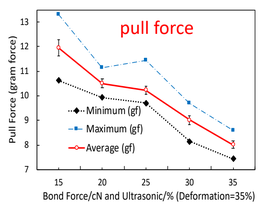


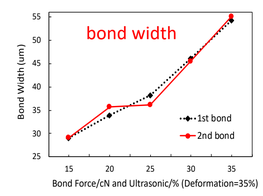




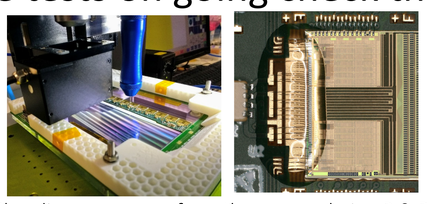
- design and setup 2*2 jig to improve production efficiency

- optimize the parameters for wire bonding: test wire pull strength and bond width
  - bond force
  - deformation
  - ultrasonic power





- Encapsulation for quality assurance (R&D with Oxford)
  - Fully encapsulate ASIC back-end wires (ASIC to hybrid)
  - More tests on going check the performance before and after



Glue dispenser to perform the encapsulation R & D

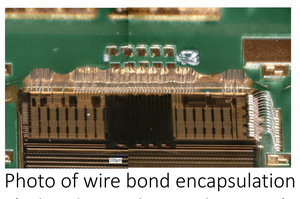
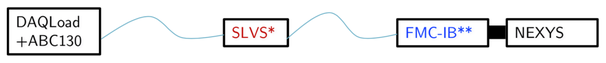
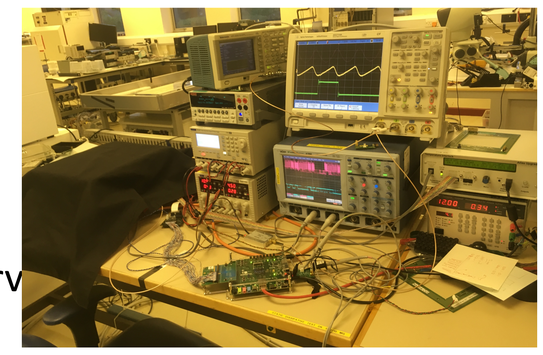


Photo of wire bond encapsulation (Sylgard 186 Silicone Elastomer)

Electrical test

- ITSDAQ: the software used in the development of the ATLAS ITk strip detector read-out.
- Software Configuration:
  - Initial, Hybrid/Module, Chip
- Calibration Tests Essentials:
  - Strobe Delay
  - Trim Range
  - 3-point gain and response curv
  - Noise Occupancy

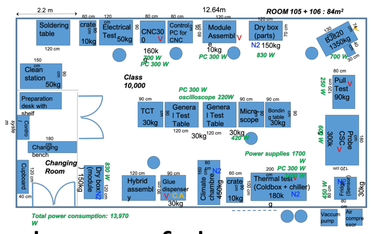




IHEP/THU process

- IHEP cooperate with RAL closely
  - Undertake 50% of 1k barrel strip modules in China
  - IHEP person working in RAL
  - Invite RAL staff to visit IHEP

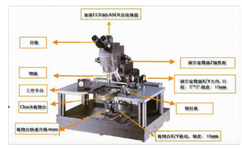
- Cleanroom built in IHEP (with THU)
  - Structure of cleanroom is almost ready
    - Wire bonder (BondJet820)
    - Smart scope
    - Probe station



layout of clean room

BondJet820

Smart scope



Probe station