The ATLAS ITk Strip Detector System for the Phase-II LHC Upgrade

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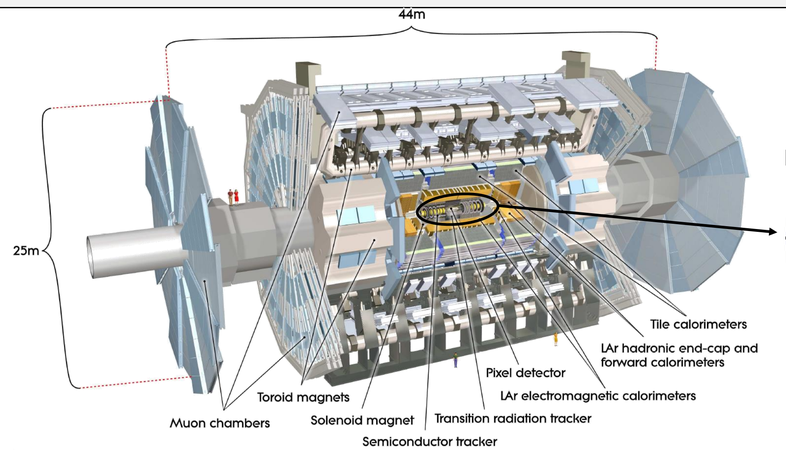
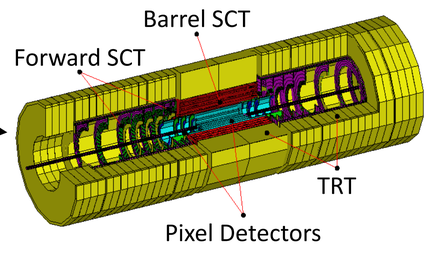
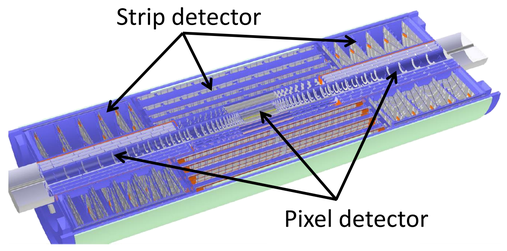
The Phase II Upgrade of the ATLAS ITk Strip Tracker





Phase I tracker

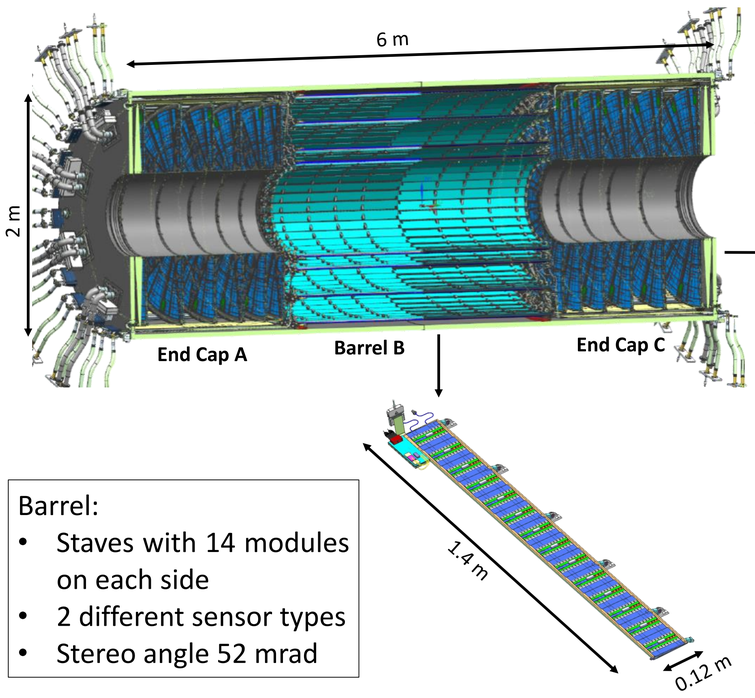


Phase II Inner Tracker (ITk)

The High Luminosity Large Hadron Collider (HL-LHC) upgrade will require an upgrade of the ATLAS Inner Detector system. An integrated luminosity of 4000 fb^{-1} and about 10 times higher track density compared to Phase I requires high granularity and high radiation tolerance of the Phase II tracker.

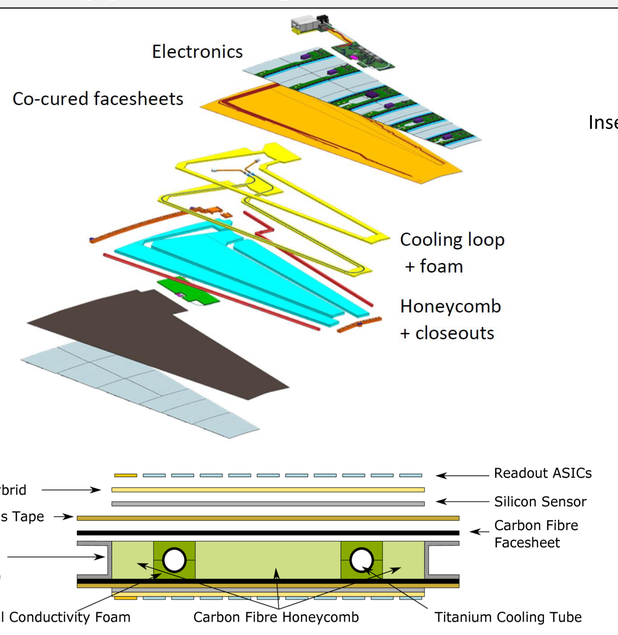
The new ATLAS tracker will be the all-silicon Inner Tracker (ITk) that will replace the current Pixel Detectors, SCT, and TRT. ITk will be comprised of a pixel detector surrounded by a strip detector. The strip detector will consist of 4 Barrel layers and 6 disks for each End Cap with 160 m^2 silicon and 50 M channels.

ITk Strip tracker layout, support, integration

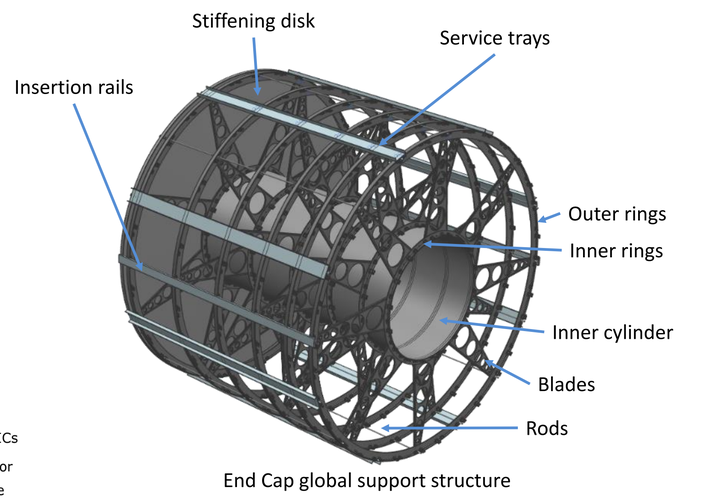


Barrel:
- Staves with 14 modules on each side
- 2 different sensor types
- Stereo angle 52 mrad

End Caps:
- Petals with 9 different modules on each side
- 6 different sensors types
- 32 petals per disk
- Stereo angle 40 mrad



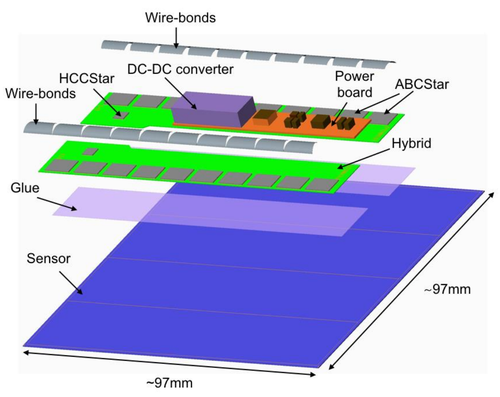
Modules mounted on both sides of carbon fiber core with embedded evaporative CO_2 cooling form a stave/petal

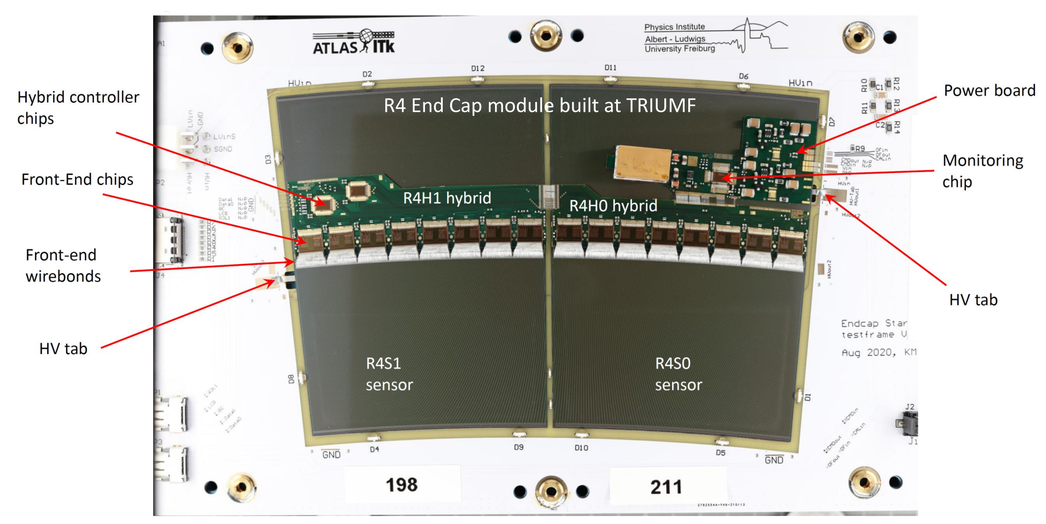


End Cap global support structure

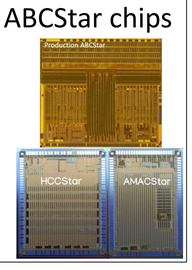
Assembled staves and petals with End of Substructure (EOS) card for powering and data links are inserted to low mass global structure made from carbon fiber-reinforced polymer

ITk Strip modules





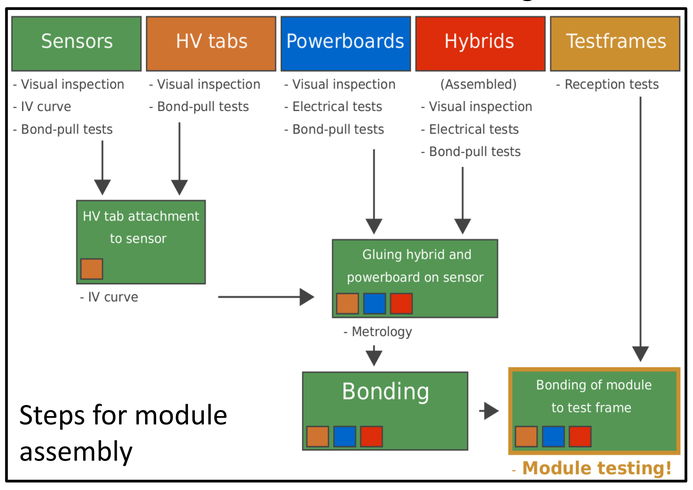
- n^+p silicon strip sensors
  - Barrel pitch 75,5 µm, End Cap mean pitch 75 µm, 320 µm thick
  - See posters #40, #46, #47 for more information on sensors
- Hybrid PCBs glued onto the sensors populated with
  - ABCStar: Radiation-hard 130 nm front-end chips with 256 binary strip read-out channels
  - HCCStar: Hybrid Controller Chip collects data from ABCStar chips and communicates with EoS
- Powerboard glued onto sensor with
  - AMACStar power control and monitoring chip
  - High voltage filter and switch
  - Low voltage DCDC converter



Production status & QA/QC

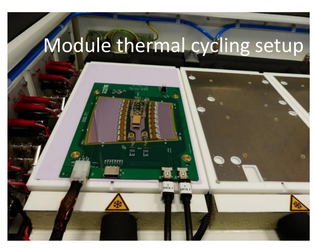
Industrial-scale production of the ITk strip detector is shared across many institutes and companies on 4 continents.
Production sites have built up their infrastructure in recent years and are undergoing site qualification steps. Currently, the pre-production phase is ongoing, during which production sites have to demonstrate they can build parts which pass all QA/QC tests.
Production will run from 2023 - 2027 after which ITk will be installed into the ATLAS detector at CERN.

QA/QC for module building



Steps for module assembly

Hybrid burn-in



Module thermal cycling setup

- Extensive QA tests for all components before and after mounting on module
- After module assembly thermal cycling QA step: -35°C to +40°C for 10 cycles

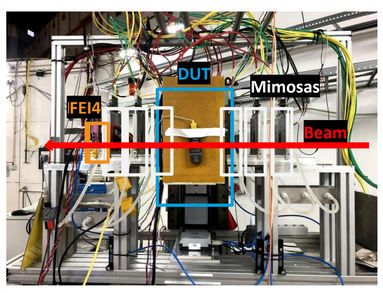
Lab infrastructure

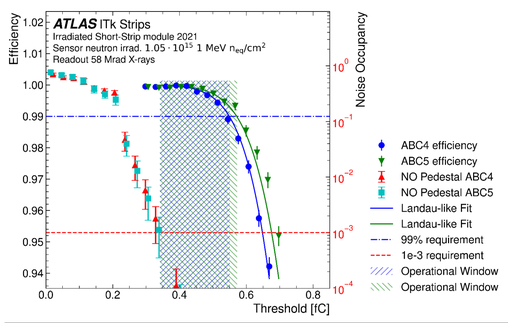
Production lab DESY Zeuthen (ISO6)

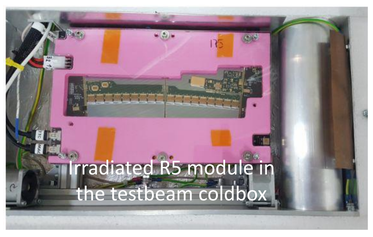
Wirebonding setups DESY Zeuthen

Lab infrastructure:
- Clean rooms with dry storage
- Pick&place & glue dispensing robots
- Wirebonder/bond pulling machines
- Metrology setups
- Production street with custom tools, vacuum etc. services
- And much more

Testbeam



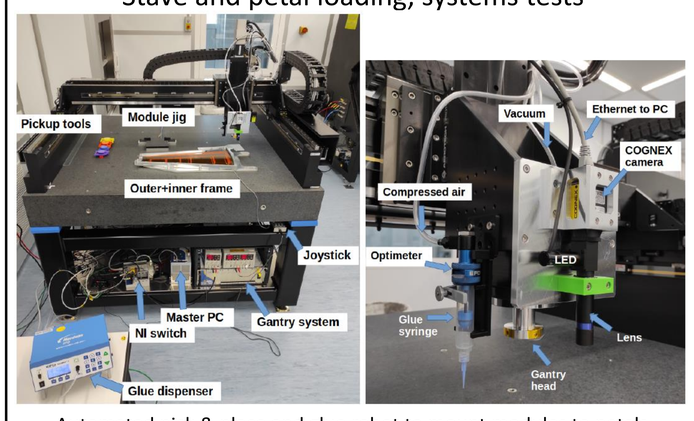




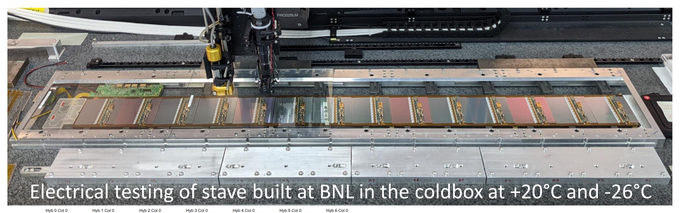
Irradiated R5 module in the testbeam coldbox

- Testbeam to validate performance of all module types irradiated to end-of-life fluence and TID
- Results for 40% of modules ready
- 2022 testbeam at DESY for remaining module types

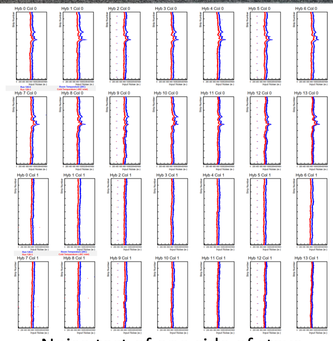
Stave and petal loading, systems tests



Automated pick & place and glue robot to mount modules to petals



Electrical testing of stave built at BNL in the coldbox at +20°C and -26°C



Noise test of one side of stave

End Cap systems test setup

- Electrical and cooling tests of fully populated staves/petals
- Systems test setups for staves/petals loaded onto global structure

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