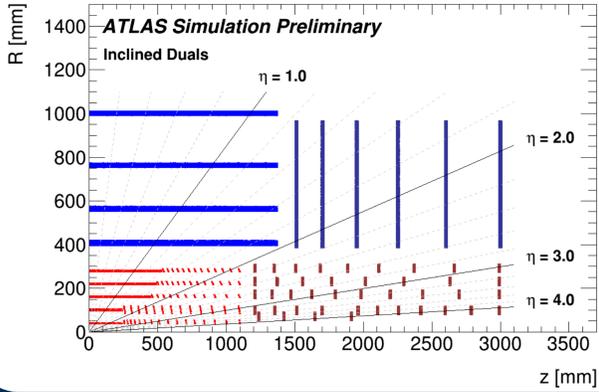


Prototype Strip Barrel Modules for the ATLAS ITk Strip Detector

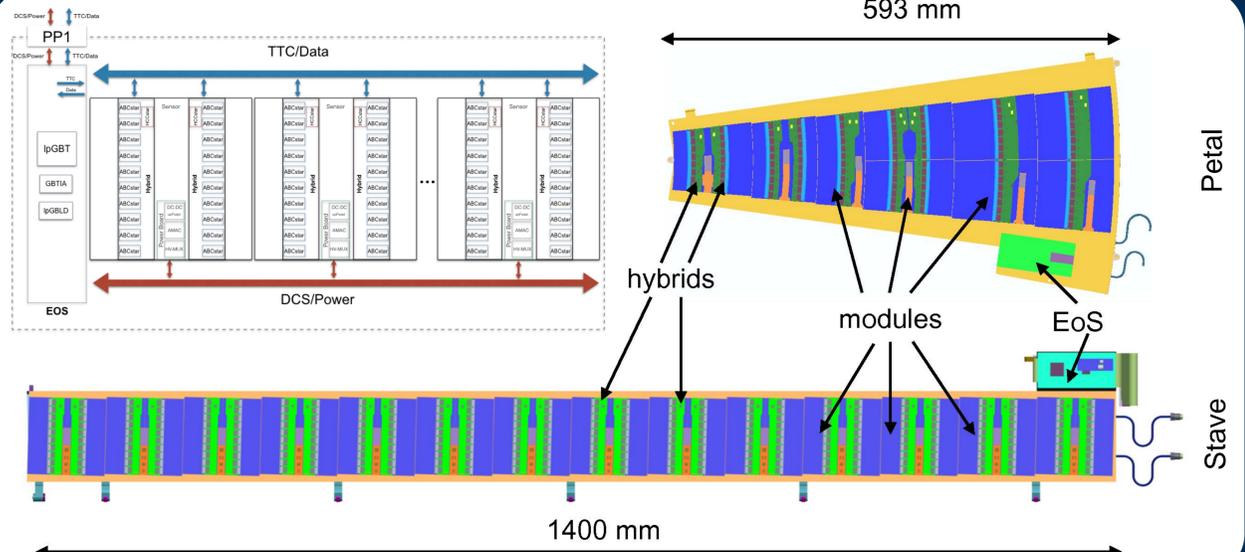
Craig Sawyer & Peter W. Phillips, STFC Rutherford Appleton Laboratory
on behalf of the ATLAS ITk Collaboration

The ATLAS Inner Tracker Upgrade



- Inner Tracker (ITk) is planned for HL-LHC in 2026
- Current layout includes:
 - 5 pixel barrel layers
 - Pixel end-cap with up to 11 half-rings (dependent upon radius)
 - 4 strip barrel layers
 - Inner 2 layers short (2.4cm) strip modules
 - Outer 2 layers long (4.8cm) strip modules
 - 6 strip end-cap disks

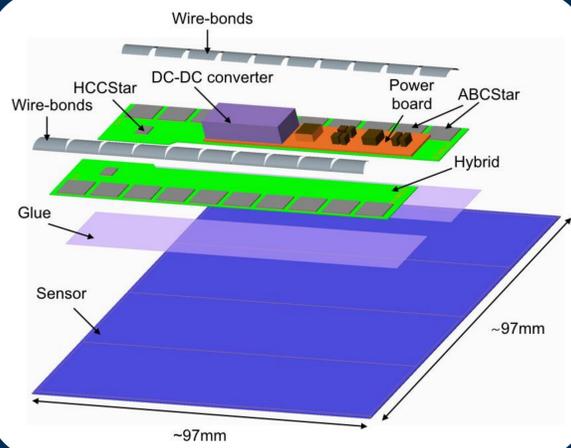
Local Support Concept



Strip tracker built up from staves (barrel) and petals (end-cap); carbon fibre local supports with integrated cooling pipes, covered with polyimide flex circuits providing cooling, powering, control and readout.

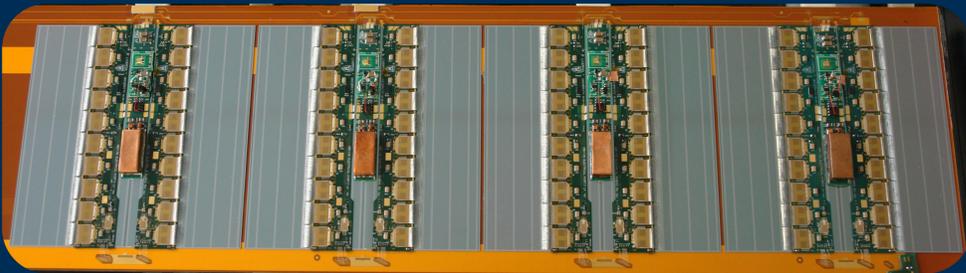
Barrel Short Strip Module Concept

- 1 Silicon Strip Sensor
 - n⁺ in p, 97mm x 97mm approx
 - 4 banks of 1280 strips, 24.1mm long
 - 75.5 micron pitch
- 2 Polyimide Flex Hybrids
 - 1 Hybrid Controller Chip (HCCStar)
 - Star architecture: each ABCStar chip has a dedicated 160Mbit/s data path to HCC
 - 10 ATLAS Binary Chips (ABCStar)
 - 256 channels of trimmable preamplifier / discriminator, pipeline and control logic
 - Dual low dropout regulators (LDOs) to produce separate 1.2V analogue and digital voltages



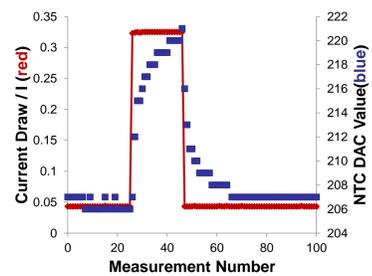
- 1 Power Board
 - Buck Point of Load DC-DC converter (bPOL12V)
 - formerly known as upFEAST, 12V maximum input
 - HV Multiplexer switch "HV-MUX"
 - Radiation hard GaNFET to disconnect failing sensor from HV bus
 - Autonomous Monitor And Control chip (AMACv2)
 - Multichannel Wilkinson ADC
 - Digital logic to turn on/off LV and/or HV to hybrids in response to commands or anomalous ADC readings (temperatures, voltages, currents)
 - Includes sensor bias current monitoring
 - Dual Linear Point of Load regulator (linPOL12V)
 - Power AMAC & HV-MUX independent of DC-DC

Prototype Barrel Modules on Local Support

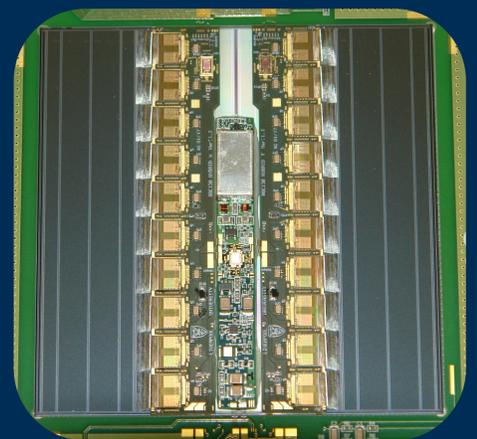


- Double-sided stave with 4 prototype short-strip modules on each side
 - ABC130/HCC prototype chipset
 - Power boards with commercial control circuitry (instead of AMAC)
 - All modules on one side equipped with HV-MUX switch
- Module behaviour consistent on and off local support
- Novel aspects of the module design shown to have no ill effects in terms of noise
 - Power board on-module with DC-DC and HV-MUX
 - Sensor return current monitoring in HCC

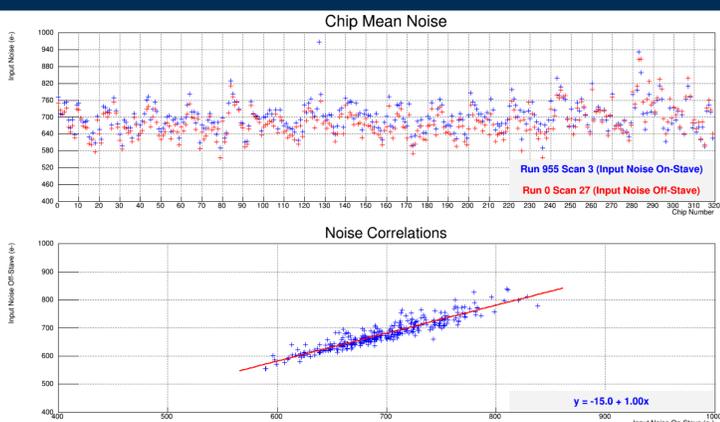
Prototype Modules with AMACv1b



The current drawn by a module falls when AMAC disables the DC-DC converter in response to the temperature having exceeded the set threshold.



Modules have now been built using a prototype AMAC chip. All control, monitoring and autonomous interlocking functionality has been successfully demonstrated.



Summary & Outlook

- Using the prototype chipset, ABC130/HCC
 - Prototype short-strip and long-strip modules successfully tested
 - An eight module double-sided short-strip stave has been demonstrated
 - 13 module short-strip staves with optical readout to be assembled early 2018
 - 14 module long-strip staves in mid-2018
 - 3 stave system tests to be performed by the end of 2018
- Production chipset in final stages of design
 - AMACv2 submitted November 2017
 - ABCStar and HCCStar submission in Q1 2018
 - Targeting first "Star chips" modules for Q3/4 2018
- On track to begin production in 2020