Prototype Strip Barrel Modules for the ATLAS ITk Strip Detector

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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

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