ASSEMBLY AND ELECTRICAL TESTS OF THE FIRST FULL-SIZE FORWARD MODULE FOR THE ATLAS ITk STRIP DETECTOR

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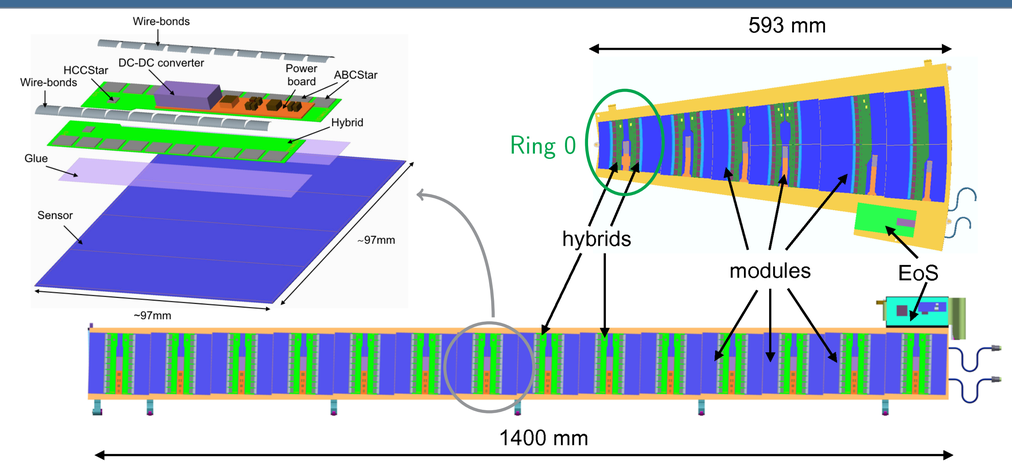
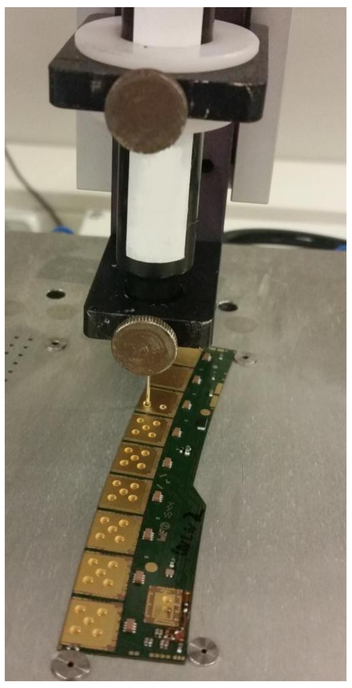
The ATLAS ITk Strip Detector

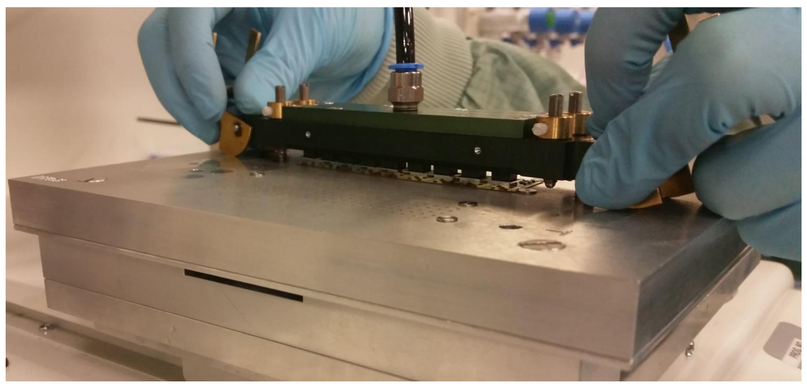
- All-silicon detector with around 70 million read-out strips.
- Modular design with modules assembled in larger structures: staves and petals.
  - Four barrel layers and six end-cap discs per side.
  - Integrated cooling and electronics.
- Modules are made from one silicon sensor and one or more hybrid circuits.
- Read-out chips glued onto the hybrids and wire bonded for electrical connections.
- Forward region uses "Stereo Annulus" shaped sensors and modules.
  - Different number of strips leads to different number of read-out chips.
  - Changing strip pitch and length for each segment.
  - Here, we focus on **Ring 0**.



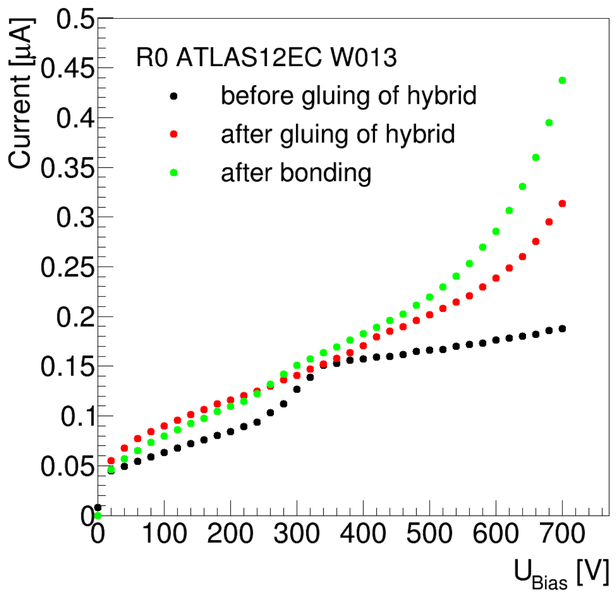
Hybrid Building



- **UV-cured glue** for hybrid-ASIC attachment.
- **Glue dispensing** robot.
- Special tooling for **precise positioning** and glue height control.
- **Wire-bonding**.
- Electrical **testing**.

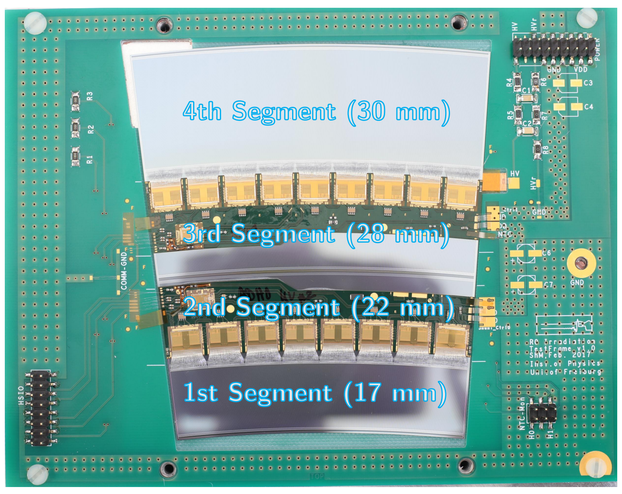


Sensor Testing



- **Bare sensor** measured on probe station: I/V and C/V curves.
- C/V used to determine **full depletion voltage**: ≈ 300 V.
- **I/V** of bare sensor, after gluing hybrids and after wire-bonding.
  - Used to determine **whether there is damage** to the sensor.
- Slightly worsening of the I/V after gluing and wire-bonding.
  - Signs of potential mechanical stress on the sensor.
  - Sensitivity to humidity is another source of increased current.

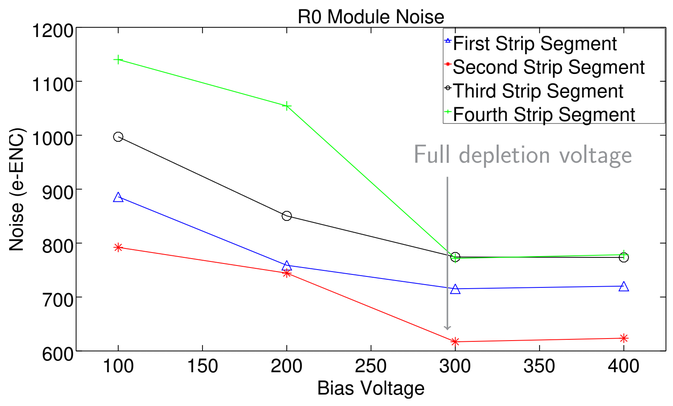
Module Building



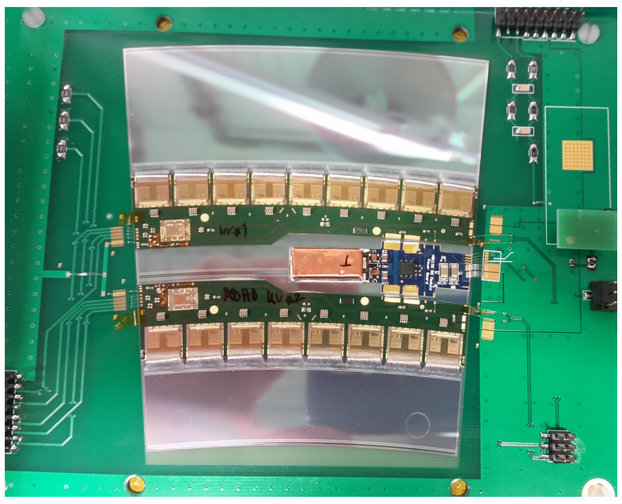
- **Sensor held** on precisely machined tool with vacuum.
- **Epoxy** glue cured for 10 hours.
  - Hybrid glued on sensor **active area**.
- Electrical connections: **four row wire-bonding** of front-end channels.
- **Noise** increases with strip length and decreases with hybrid-sensor glue thickness.

Initial Electrical Tests

- Characterisation by: **Input Noise** (Equivalent Noise Charge, ENC) and Noise Occupancy.
- Tests: **Response Curve** and Noise Occupancy Scan.
  - With **changing sensor bias** voltage.
  - Noise **behaves as expected** with bias and strip length.



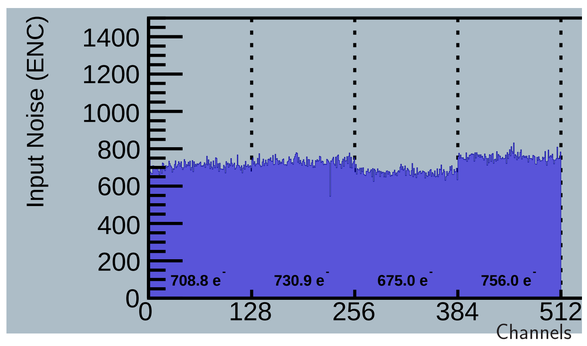
Final Module Assembly



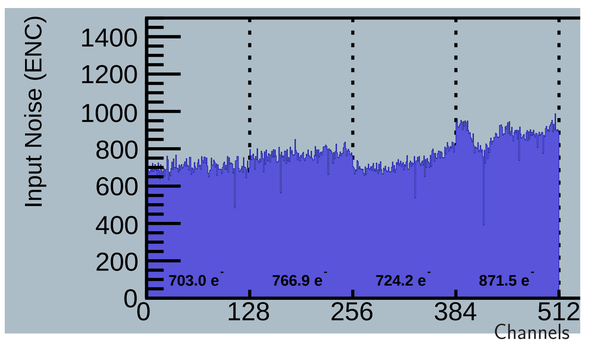
- Addition of **power board for DC-DC conversion**.
  - Buck converter using a coil for energy storage.
- Glued **on top of the sensor active area** with Epoxy glue.
- Wire-bonded to both hybrids and to test frame.

Electrical Tests With Power Board

- Slight **noise increase** in areas underneath the power board.
- Small **B-field leakage** measured next to the power board.
- We expect some noise reduction by **improving the shielding**.



Without power board



With power board

Conclusions

- The electrical tests performed so far on the first prototype end-cap sensors show good performance.
- Module building procedure is under control: precision mounting of chips, gluing to sensor and wire-bonding.
- The module noise performance is consistent with the sensor characteristics.
- Addition of a power board on top of the sensor introduces some extra noise which we expect to be able to control by improving the shielding.