Mechanical precision is a key-aspect of the high-rate capable Micromegas detectors for the upgrade of the Small Wheels of the ATLAS muon spectrometer. 32 SN2 quadruplets will be built by four German institutes with cathodes and strip-anodes made of stable honeycomb sandwiches. To achieve a single plane resolution below 100µm, the deviation from planarity of a single detector plane must not exceed 300µm over the whole active area and the global position of the readout strips has to be within 30µm for a single readout-plane of 3 PCB’s, as well as between all four planes of a quadruplet.

Precison tooling is used for the correct positioning of readout PCB’s and readout sandwich planes. For quality control of the planarity of the sandwich planes a laser distance sensor combined with a coordinate measurement system has been developed. Deviation from planarity below 10 µm can be easily resolved.

We will present key features of the challenging construction procedure to achieve this high level of precision as well as our alignment strategies. This includes the construction and commissioning of a 2.5 m² lightweight rigid structure (stiffback), which has an overall planarity below 20 µm RMS and the measurement of the the blow up of outer planes of a quadruplet due to 2 mbar overpressure of the Ar:CO₂ detector gas, the standard situation in ATLAS.

**WORKING PRINCIPLE OF RESISTIVE STRIP MICROMEGAS DETECTORS**

- Ionization of ≈ 100 e⁻/cm² in Ar:CO₂, 93:7
- Electron drift velocity vₑ = 47 cm/ns
- Collection of avalanche charges on resistive strips (anode)
- Capacitive coupling between resistive and copper readout strips
- Pulseheight and timing information
- Strip width 300 µm, Strip pitch 425 - 450 µm
- Resistivity of strips ≈ 10Ω/cm

**COORDINATE MEASUREMENT MACHINE (CMM)**

- Laser triangulation sensor on a XYZ translator (CMM)
- Dimensions of the CMM: X = 2720 mm, Y = 1680 mm, Z = 120 mm
- Measurement accuracy: < 10 µm
- Topology scan – object surface scan – granite table surface scan
- Calculation of RMS relative to best fit plane

**TOPOLGY MEASUREMENT OF STIFFBACK**

- Measurement of a 2 m² plane; duration: 1.45 h with a modularity of ≈ 1.5 cm, 7000 data points
- Repetition accuracy of measurement: < 30 µm
- Deviation from a measurement with a tactile sensor:
  - σ tactile-tactile = 15 µm
- RMS of stiffback: 14.3 µm

**INTERCONNECTS**

- Panel sucked to granite table during measurement
- Side 1: RMS 21.7 µm, Δµm – flatness = 100 µm
- Side 2: RMS 24.8 µm, Δµm – flatness = 100 µm
- Correction of systematic effect in future

- Overpressure of detector gas inside Micromegas 2 – 3 mbar
- Blow up of Micromegas
  - Need of fixation to keep surfaces flat
  - Six interconnects at dedicated positions to minimise blow up
- ANSYS simulation shows ≈ 50 µm blow up

**RESISTIVITY OF STRIPS**

- Resistivity of strips ≈ 10Ω/cm
- Collection of avalanche charges on resistive strips (anode)
- Capacitive coupling between resistive and copper readout strips
- Pulseheight and timing information
- Strip width 300 µm, Strip pitch 425 - 450 µm
- Resistivity of strips ≈ 10Ω/cm

**POSITIONING OF ALIGNMENT WASHERS ON READOUT PCBs**

- Need of a precise alignment between readout PCBs
- Parallelism requirement: 2µm ≈ 10⁻³
- Positioning of two washers per PCB on precision markers on PCB
- Using of telecentric camera to locate marker through PCB
- Washer positioning accuracy < 5 µm
- Alignment of PCBs with an alignment frame

**TOPOLOGY OF TESTPANEL**

- Panel sucked to granite table during measurement
- Side 1: RMS 21.7 µm, Δµm – flatness = 100 µm
- Side 2: RMS 24.8 µm, Δµm – flatness = 100 µm
- Correction of systematic effect in future

- Overpressure of detector gas inside Micromegas 2 – 3 mbar
- Blow up of Micromegas
  - Need of fixation to keep surfaces flat
  - Six interconnects at dedicated positions to minimise blow up
- ANSYS simulation shows ≈ 50 µm blow up

**ALIGNMENT FRAME FOR PRECISE RELATIVE AND GLOBAL POSITIONING OF THREE PCBs**

- Aluminum frame with inserts for precision pins
- Machining of all inserts in a single step (eight inserts)
  - Precise positions
- Aligning PCBs by attaching pins in frame to washers on PCBs

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