Construction of a Precision Four-Layer Floating Strip Micromegas Chamber

J. Bortfeldt[1], O. Biebel[1], B. Flierl[1], F. Klitzner[1], Ph. Lösel[1], R. Müller[1], A. Zibell[2], R. Hertenberger[1]

[1] LS Schaile - LMU Munich, [2] University Würzburg

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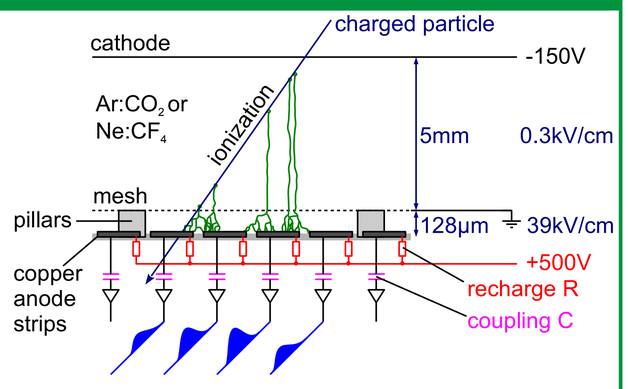
FLOATING STRIP MICROMEGAS DETECTOR

Micromegas principle
- charged particles
  → ionization
- gas amplification 10^3
- charge signal on strips
  single strip readout
  → spatial resolution O(50µm)
  → timing O(ns)
- thin amplification region & fine segmentation
  → fast drain of positive ions
  → high-rate capable



challenge: discharges
- charge density ≥ $2 \cdot 10^6$ e/0.01mm² (Raether limit)
  → streamer development
- conductive channel between mesh & anode
  → potentials equalize
- non-destructive, but dead time
  → efficiency drop, especially at high particle rates or in high-rate background

solution: floating strip Micromegas
- strips individually connected to HV via 22MΩ resistors
- readout electronics coupled via pF capacitors

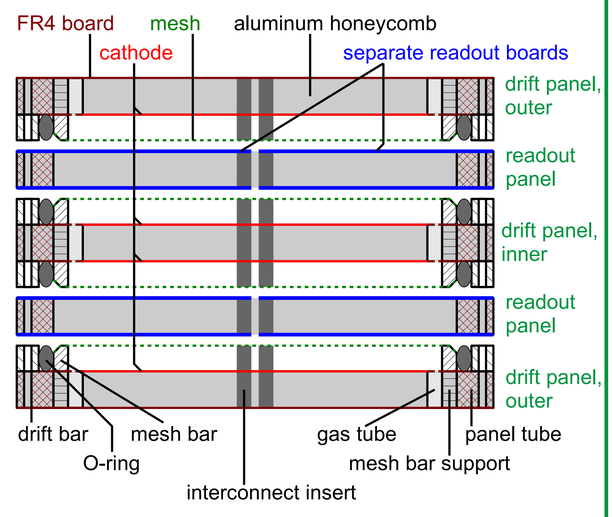
→ strips can "float" in a discharge
→ fast streamer quenching
→ only one to three strips affected
→ fast recovery

MOTIVATION & DESIGN

motivation
- investigate suitability and performance of large-area floating strip Micromegas detectors
- construction of 2m² resistive strip Micromegas quadruplet for ATLAS Muon New Small Wheel ongoing

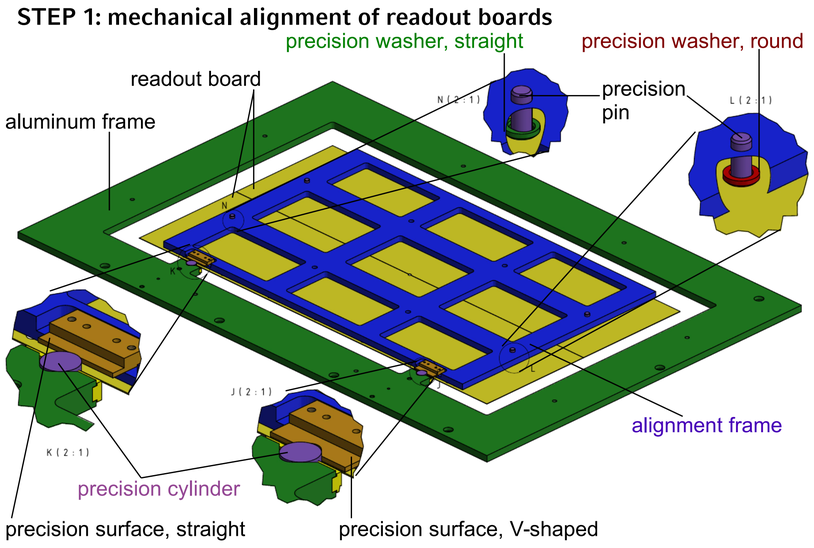
→ develop, test and qualify construction and alignment procedures

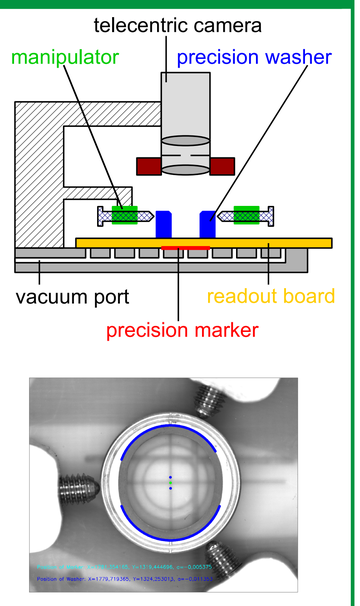
chamber concept
- 414x755x75mm³
- active area 534x338mm² per layer
- 768 strips per layer, 440µm pitch
- two outer drift panels, cathode and mesh on one side
- one inner drift panel, cathode and mesh on both sides
- two double-sided readout panels, consisting of two separate readout boards per layer
- glue panels (=FR4 + aluminum honeycomb) on precise (<30µm) table
- drilling and milling of holes after gluing
- vertical assembly



ASSEMBLY OF THE READOUT PANEL

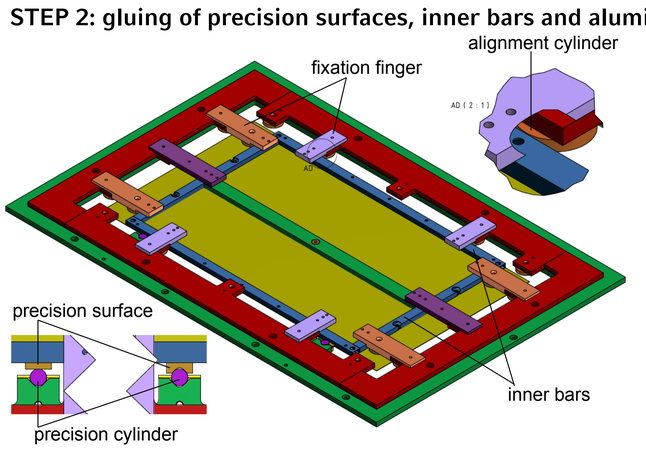
STEP 1: mechanical alignment of readout boards





- glue two precision washers onto **precision markers** on readout boards
- aluminum frame with two **precision cylinders**, mounted on table
- **alignment frame** (<50µm) with four pins & two precision surfaces
  → alignment of boards wrt each other & the precision cylinders
  → suck boards to table & take off frame

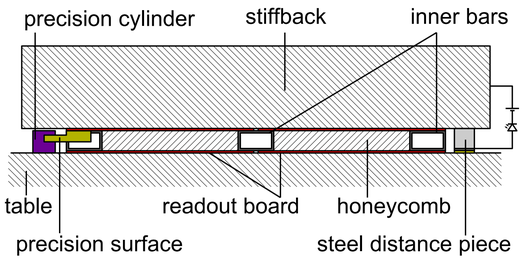
STEP 2: gluing of precision surfaces, inner bars and aluminum honeycomb



- glue two precision surfaces on readout boards, fixation by aluminum fingers
- apply 300µm thick layer of Araldite glue, structure with notched trowel
- 40mm distance pieces (~100µm) for alignment of bars
- place bars & honeycomb
- fingers for fixation of bars
- exert little force while curing: load with 20kg plate

STEP 3: alignment of boards for second layer
- repeat the procedure, described in step 1 for two additional readout boards

STEP 4: alignment of both readout layers and final gluing of the panel

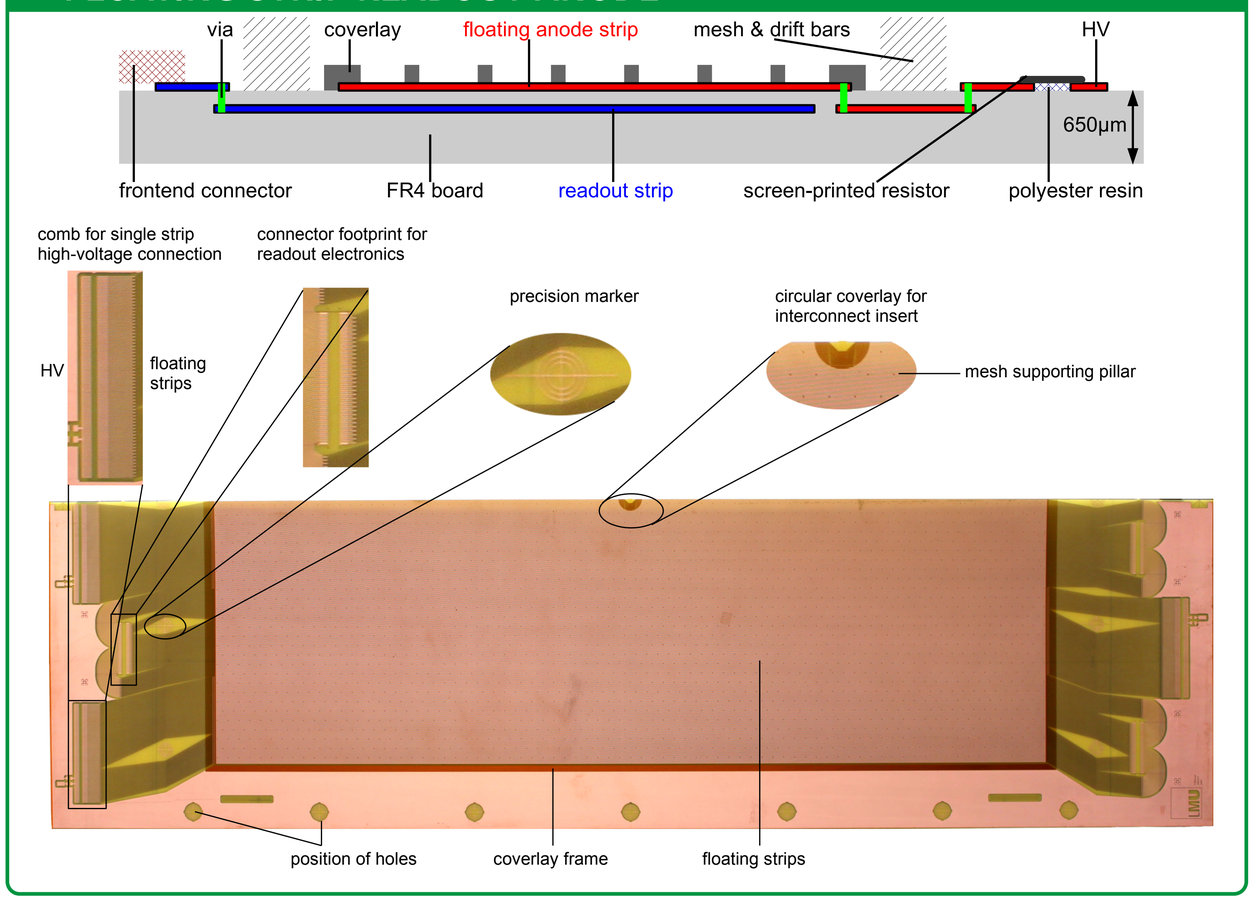


- suck semi-panel against precise (<10µm) and light-weight stiffback
- apply 300µm layer of Araldite glue, structured
- place stiffback + panel onto the table
- align stiffback + panel wrt the second layer readout boards by using the precision surfaces on the first layer readout boards
- parallelism and thickness ensured by precise distance pieces with contact monitor

STEP 5: drilling & milling of mounting and alignment holes into the panel

STEP 6: cleaning of the panel with solvent & high-pressure deionized water

FLOATING STRIP READOUT ANODE



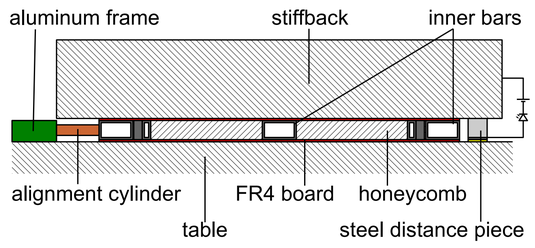
ASSEMBLY OF THE DRIFT PANEL

STEP 1: alignment of copper clad FR4 board/cathode
- alignment wrt aluminum frame on table using 35mm distance pieces
- suck boards to table

STEP 2: gluing of inner bars and aluminum honeycomb
- equal to step 2 for the readout panel

STEP 3: alignment of copper clad FR4 board/cathode for second layer
- repeat step 1 for an additional FR4 board

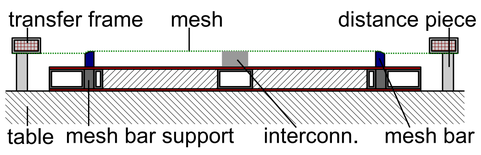
STEP 4: alignment of both layers and final gluing of the panel



- equal to step 4 for the readout panel, only difference: align stiffback + panel wrt the second layer FR4 board by using 40mm alignment cylinders between bars and aluminum frame on table

STEP 5: drilling & milling
- drilling of mounting holes
- milling of threads and alignment holes
- milling of the cathode structure

STEP 6: screwing of mesh bars and gluing of the mesh

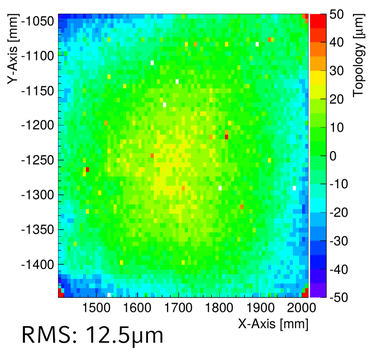


- screwing & gluing of the mesh bars onto the panel
- gluing of the interconnect insert
- gluing of the pre-stretched mesh onto the bars and the insert

STEP 7: cleaning of the panel with solvent & high-pressure deionized water

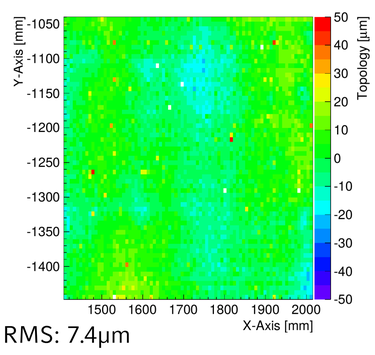
MEASURED ACCURACY OF A DRIFT PANEL

topology side 1



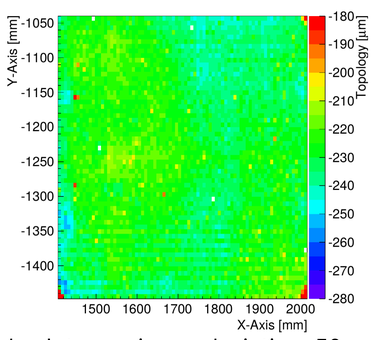
RMS: 12.5µm

topology side 2



RMS: 7.4µm

parallelism of both sides



absolute maximum deviation: 50µm
→ well within specification

- measured with a laser distance sensor on a coordinate measurement machine, accuracy O(15µm)

SUMMARY

- a **precision four-layer floating strip Micromegas** chamber is developed and constructed
- serves as procedure **study** for construction of resistive strip Micromegas quadruplets for the **ATLAS Muon New Small Wheel**

- panel **assembly procedures** have been developed and are defined
- all **facilities** such as clean room, precise table, stiffback, alignment tools & cleaning cabin are **ready**
- two **drift panels have been assembled** and investigated with a coordinate measurement machine, drilling and milling yet to be done
- precision washer alignment on precision marker works
  → assembly methods work up to now
  → desired **accuracy is reached**