Rebuild of a layer-1 HADES drift chamber, enhancement through a high precision planar fibre-composite milling facility*

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The 4-layer MDC tracker is an essential element of the HADES detector arrangement [1,2]. Each MDC-layer consists of 6 trapezoidal drift chambers arranged around the symmetry axis of the spectrometer just behind the RICH detector and is optimized for low-mass tracking. The MDC chambers themselves comprise 13 multi wire planes of cathode, anode and sensing wires, oriented in 6 different stereo angles The cell sizes increase with the layer number, the first layer features a cell size of 5 x 5 mm^2.The currently operating MDC modules are assembled as a sandwich of 16 frames, see Fig. 1, where the outer ones carry a Mylar window, whereas the sandwiched ones provide the tension for the wire planes. Due to the large acceptance required by the HADES setup the width of these frames is limited, which places a major challenge on the technical design w.r.t. mechanical stability and gas tightness especially for modules of layer 1. The entire stack is O-ring sealed between the planes to allow for disassembly in case of wire failure. It is the unsatisfactory precision of these seals together with the overall length of sealing line of about 40 m that has caused severe problems or sometimes even complete malfunction of these chambers (layer 1) in the past.

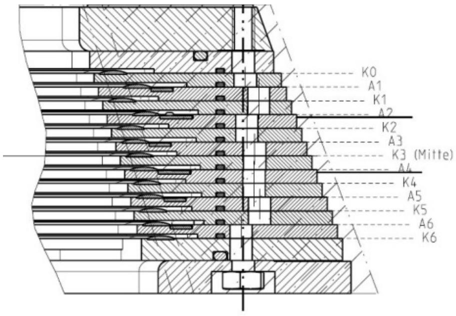

Figure 1: Stack-up of the HADES MDC frames. Alignment and wire tension is provided by means of cotter pins in the middle of the drawing.

Towards a future upgrade of this system and the operation of HADES at FAIR, a prototype MDC is under construction at the detector laboratory. This work addresses these issues through the establishment of CAD-CAM large area precision machining for these frames. The full frame is made of Vetronit EGS-103 sheets and occupies an area of about $1m^2$. It is sealed to the next one in the stack by means of a circumferential O-ring of 1.0 mm diameter. For the full stack to assure wire-plane spacing as well as sealing, the material was ground to thickness by the manufacturer. For machining grooves for the O-ring, signal connecting flex cables as well as for in-frame counting gas distribution, high precision milling on an area of about 1 m^2 on both sides of the frame is indispensable. To this end, a precision vacuum table with alignment pins was constructed for the existing CAD-CAM milling station at the detector lab. Smooth finish machining in this fibered material can be achieved through very high spindle speeds and diamond enhanced tools. Pre-ground fibre composite sheets may be vacuum clamped to this table, using an adequate underliner vacuum fleece for homogeneous clamping. Provisions are added so that even a cut out frame may be securely held this way.

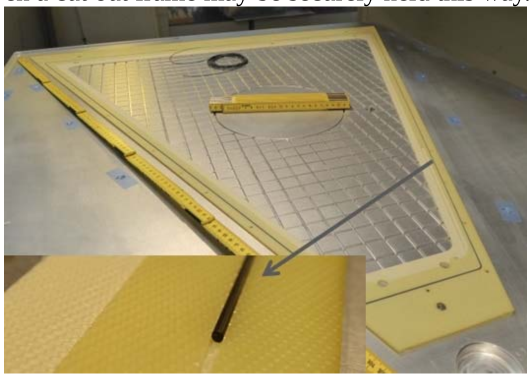

Figure 2: An MDC layer-1 wire frame made of Vetronit EGS-103 composite. The inset depicts a zoom of the O-ring sealing groove to hold the 1 mm diameter seal.

Machining results were evaluated on the first MDC frames. The depth of the O-ring groove proved a precision of less than 20µm, where about half this value may be attributed to the limit of precision for the raw material employed.

Conclusion

The procedures and tools prepared allow for adequate machining of fibre composite sheets into large detector frames. This is an enabling capability for future FAIR gaseous detector construction as well as a possible HADES MDC upgrade.

References

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