PROCEEDINGS OF SCIENCE

# First Results on a Prototype MicroMegas Chamber with Two Readout Planes in a Common Gas Volume

**Bernard Brickwedde***
*Johannes-Gutenberg-Universitaet Mainz (DE)*
*E-mail:* bernard.brickwedde@cern.ch

The design and the performance of a prototype detector based on MicroMegas technology with two detection layers in a common gas volume, suited for applications in small spatial volumes in high rate environments at, for example at the ATLAS detector, is discussed in this proceeding. Each detection layer has an active area of 9 x 9 $cm^2$ with a two-dimensional strip readout and is separated by a common gas region with a height of 14 mm. A micro-mesh, working as a cathode, is placed in the middle of the common gas volume separating it into two individual cells. This setup allows for a precise angle reconstruction of incoming particles with a precision of up to 1.9° using a detector with reduced material budget, compared to current detector designs. In addition, we present first results of performance studies on the prototype detectors based on cosmic muon measurements at the cosmic ray measurement facility at the University of Mainz. It should be noted that this design reduces multiple scattering with makes the detector also suitable for the measurement of low energy beam experiments.

*Fourth Annual Large Hadron Collider Physics*
*13-18 June 2016*
*Lund, Sweden*

*Speaker.





PoS(LHCP2016)193

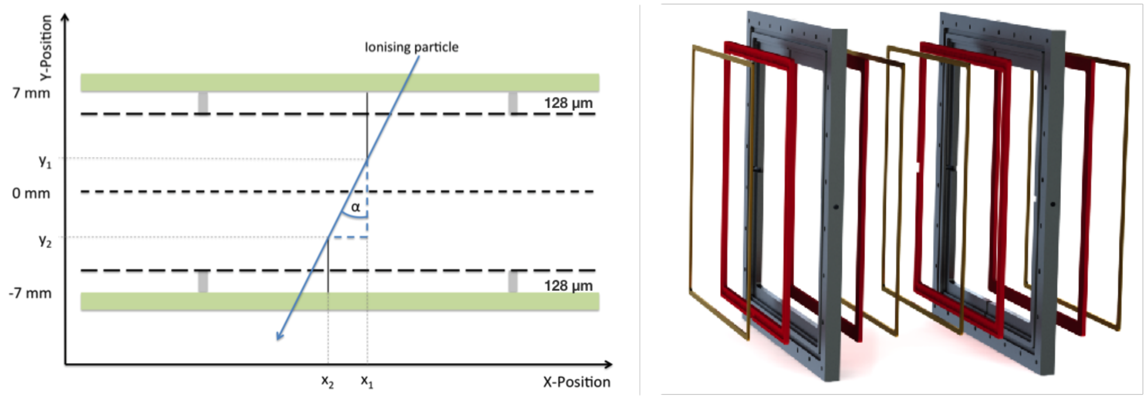


**Figure 1:** MicroMegas detector doublet with common gas volume layout (left figure) and rendering (right figure). The layout also features the dimensions of the doublet including the definition of the angle of incident particles.

## 1. Introduction

Standard MicroMegas detectors [1] allow the measurement of the incoming angle of traversing particles using the so-called MicroTPC method [2]. However, this approach allows for a precision on the measurement of the incident angle in the order $5-10°$. We designed and constructed a prototype MicroMegas detector, which uses two independent readout layers separated by a 14 mm high common gas volume(Figure 1). This design allows for a precise angle reconstruction due to its spatial separated readout planes, but still has a similar material budget and size compared to a standard MicroMegas detector. The prototype detector withstands high rates, provides a good spatial- and pointing-resolution, has a low material budget and is optimized for space constraints. Hence it makes it an interesting option for tracking detectors in the forward region of LHC detectors. The layout, the construction and first test results are briefly described in the following sections. A detailed discussion is currently prepared in [3].

## 2. Detector Layout and Simulation

The featured detector prototype is a combination of two MicroMegas detectors in one common gas volume with two independent readout layers. This layout decreases multi scattering between the detection layers and reduces the dimensions of the detector to less than 4 cm in height. Due to this layout the angle of incident particles can be measured directly without the usage of the MicroTPC method. Its layout and a rendering of all detector parts forming the gas volume can be seen in Figure 1.

Two XY readout layers with an active area of 9x9 cm$^2$ and 360 readout strips per dimension per layer collect the electron avalanches and as a result measures the position of the primary gas ionization of incident particles. Having information in both readout layers enables a direct angular measurement of incident particles as shown in Figure 1. Before building the detector prototype its performance is simulated using GARFIELD++ and GEANT4. The simulations focus on the key parameter of MicroMegas operation like the number of clusters detected and the size of the electron avalanches. The position is then determined by fitting a gaussian distribution to the collected charge

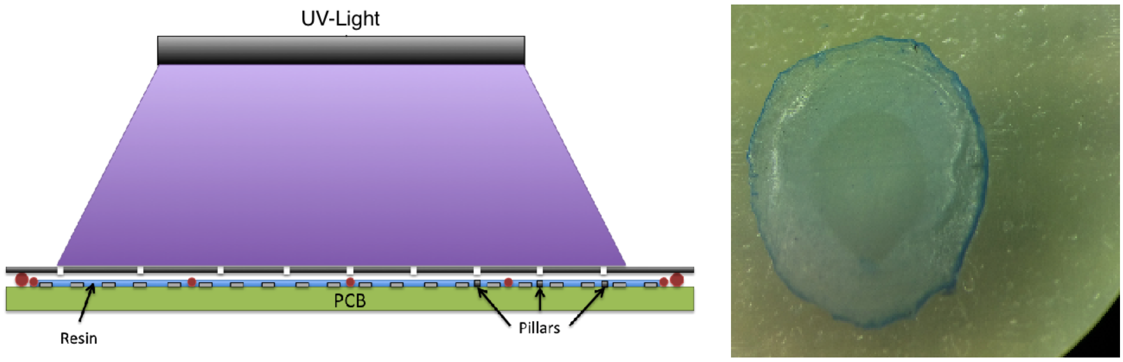


**Figure 2:** Schematic illustration of new pillar printing method (left) and photo of one pillar produced with this method (right).

per readout strip. The reconstruction of the incident angle is based on the reconstructed points of primary ionization in both detector planes and consequentially readout layers. Simulations show an expected spatial resolution of 70 $\mu$m and hence an angular resolution of 1.5°.

## 3. Detector Construction

The prototype of this detector was fully built at the University of Mainz. While most construction steps are well known, a new method to print distance pieces, known as pillars[1], was developed. This additive manufacturing method features a fluid resin hardened by UV light, which is schematically illustrated in Figure 2. This method allows an arbitrary height of the amplification region and is independent from the typically used mylar foils. The method was tested with both a moving UV laser and a stationary UV light, where the latter was used in combination of a metal mask with holes. Further details on the detector construction can be found in [3].

## 4. Detector characteristics

Following the assembly of the detector, initial tests with cosmic ray muons were performed to ensure the functionality of the detector. The data of the MicroMegas detectors is read by APV-25 chips connected to an SRS system. A setup of the detector together with an external setup of scintillators in coincidence is used to trigger the measurements. The results from simulations could be confirmed.

Additionally the efficiency of the readout layers was measured comparing the number of registered avalanches to the number of measurements triggered by the scintillators. The single layer efficiency was measured to be greater than 95 %, but with one layer showing an efficiency below 80 % due to broken readout strips.

Further detector characteristics have been measured at the DESY test-beam facility in May 2016 with a 4.4 GeV electron beam. One additional MicroMegas chamber was used as reference for these measurements. Additionally a dedicated beam telescope containing six pixel detectors was used to measure the beam position. The spatial and angular resolution were measured using

[1] which keep a defined distance between the readout layer and the amplification mesh

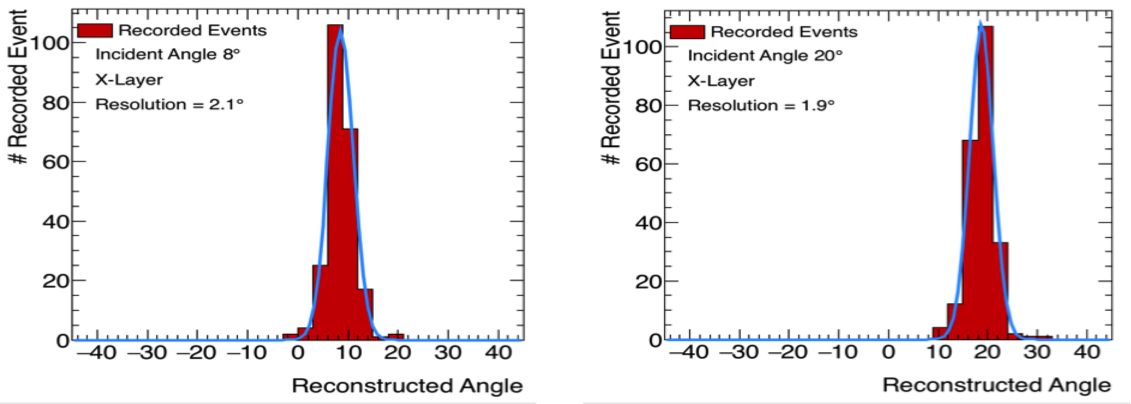


**Figure 3:** Angular resolution of incident particles for incident angles of 10° (left) and 20° (right) are shown.

105000 recorded events per each of 10 different incident angles. The results the angular resolution for one layer and two different incident beam angles are shown in Figure 3. The spatial- and angular resolution are measured to be 100 $\mu$m and 2° respectively, however, multiple scattering effects are not yet taken into account.

## 5. Conclusion

A MicroMegas prototype with reduced material budget and good angular resolution was constructed and tested. The characteristics of the prototype detector are suited for the high rate environments with limited available space, such as present in the forward regions of the LHC detectors. This detector features a low material budget due to the combined gas volume, which will reduce the amount of multi scattering. Parallel to the development of this detector, a new methodology with an inhouse solution to print support pillars for the micromesh has been developed. The results of testbeam measurements at DESY confirm the suitability of this detector as for conditions, present in the forward region of the LHC detectors.

## References

[1] Y. Giomataris, P. Rebourgeard, J. Robert and G. Charpak, *Micromegas: a high-granularity position-sensitive gaseous detector for high particle-flux environments*, *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment* **376** (1996) 29 – 35.

[2] J. Bortfeldt, *Development of Floating Strip Micromegas Detectors*. PhD thesis, LMU München, 2014.

[3] B. Brickwedde, A. Düdder, M. Schott and E. Yildirim, *Design, construction and performance tests of a prototype micromegas chamber with two readout planes in a common gas volume*, *In Final Preparation* (2016) 1–12.

PoS(LHCP2016)193