Alignment Studies for the Cosmic Ray Test Telescope

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The Cosmic Ray Telescope [1] of the LMU-ATLAS group will provide a calibration of the position of wires within a muon chamber which meets the specifications [2] to achieve the required momentum resolution of the ATLAS muon spectrometer.

A measurement period of 10-20 hours is necessary to determine the wire position with an accuracy O(10μm). Therefore it is essential to monitor possible movements of the chamber during this measurement period. The chamber being tested is measured in two positions (see Fig. 1). One time the test chamber is moved by a quarter of its width to the left, the other time an equal amount to the right. This is done to get sufficient statistics at the edges of the chamber.

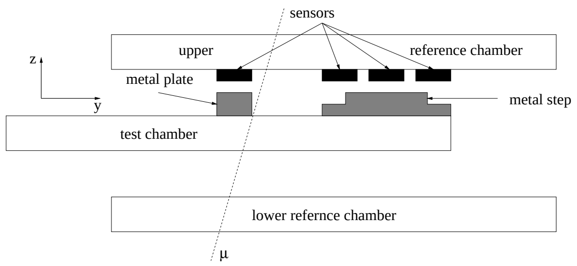

Fig. 1: Test of one chamber

For the alignment of the upper reference chamber with respect ot the test chamber capacitive sensors are used. The sensors measure the distance to a grounded conducting surface by measuring the capacity between the sensor and this surface.

The sensors are glued onto the bottom of the upper reference chamber. The metal plates are placed on the test chamber. Putting such plates for both measuring positions onto the test chamber, allows a quick change of position of the test chamber. When a new chamber arrives minimal preparation is needed to monitor the position.

The sensors are read out with an amplifier card which measures the reactance. The reactance is then converted into a proportional voltage, which is finally measured by a voltmeter. We have constructed a calibration set-up, to calibrate the sensors over a metal plate and the step. With this set-up we can move the sensors along the x and z direction indepenently with two micrometer screws. The accuracy of the sensors was measured with this set-up.

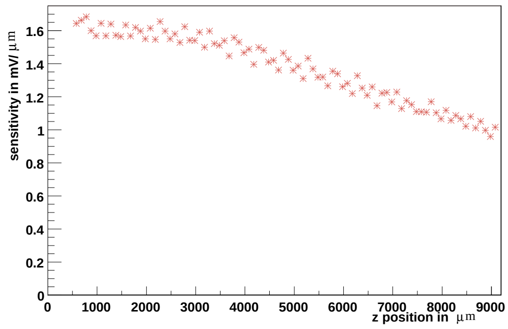

Fig. 2: Vertical calibration

The sensitive range of the sensors is 0-9 mm for vertical movements with a precision of 1 μm. The sensitivity is virtually constant for a z-distance below 3 mm and linearly decreasing farther away.

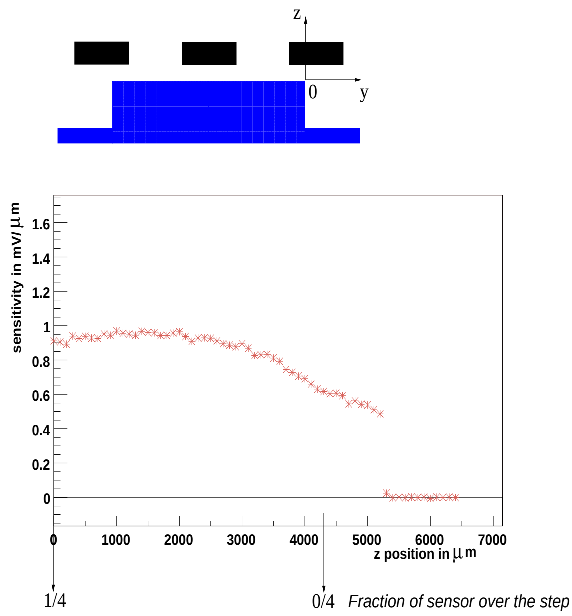

Fig. 3: Horizontal calibration (z = 4 mm)

Having a step in the metal plate it is possible to measure also horizontal movements. Because the capacity will not only change with the distance z, but also when the sensor area facing the near part of the metal plate decreases.

The accuracy depends on the vertical distance from the step, for which we choose 4 mm. Around the position where the center of the sensor is 1/4 of the sensor diameter away from the step, the sensitivity to horizontal movements is nearly constant. With a preliminary set-up a precision of 2μm has been obtained (see Fig. 3).

References

[1] T. Trefger *et al.*, Jahresbericht 1999, p. 106
[2] see also: ATLAS proposals