GEM Muon Tracking R&D

Progress Report

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1. Introduction

We have evaluated the suitability of open profile CSCs for the GEM muon system by constructing a small (0.5 m x 1.0 m) prototype and testing it with cosmic ray muons. The measured spatial resolution surpassed the GEM requirement of 75 μm . We compared the test results to Monte Carlo simulations and found good agreement. We have just begun to study the timing properties of the prototype.

2. Construction of the Prototype

The prototype was constructed with three layers of precision of cathode strips interspersed with three layers of open profile chambers. The precision strips were manufactured by Microwave Printed Circuitry (MPC) at Lowell, MA by standard lithographic techniques. We verified by survey measurements that the strips met our specification ($\pm 25 \mu\text{m}$). The open profile chambers were produced at SCARF at Houston. The chambers were manufactured by special runs in which the resistivity was controlled to a value of about 4 k Ω per square. The three strip boards were each bonded to a 1/2" honeycomb panel for rigidity and aligned by four bolts precisely machined in reference to fiducial marks etched on the strip boards. Details of the construction are given in ref 1.

3. Test Results

The prototype was tested at the Texas Test Rig (TTR), a cosmic ray test facility at SSCL, using cosmic ray muons. We obtained resolutions which are significantly below the GEM specifications. For example, for muons at normal incidence (± 2 degrees), the resolution at 3.3 kV was found to be 38 μm , well below the GEM specification of 75 μm . The resolution is well within the GEM requirement if muon tracks up to 8 degrees are included. Details of the test results are described in ref 1.

4. Cost Analysis

We have performed a cost estimate for a GEM muon system based on open profile chambers and found significant savings. The sources of cost savings arise from the fully-automated production for the open profile chambers and less stringent flatness requirement for the honeycomb panels. The honeycomb panels used for the prototype were off-the-shelf items, and measured to have a flatness of 100 μm . Details of the cost estimate are given in ref 2.

5. Timing Studies

The GEM muon system is required to be a stand-alone system which also provides a trigger with a precision of one bunch-crossing (16 ns). Since our prototype has only 3 layers, limited by the budget, we performed the timing study using a 6-layer mock-up at UH instead. Our preliminary results, obtained with similar chambers operating in the streamer mode in a gas mixture of argon, carbon dioxide and isobutane, showed that over 95 % of the events met the timing requirement. We will continue the study with a more realistic set-up in the near future.

6. Simulation

We have done extensive simulation for open profile CSCs. We developed an algorithm based on a linear combination of 3 and 4 strip pulse height centroids. The observed systematic correction due to finite strip width agreed quite well with the calculations. We also performed a Monte Carlo simulation for the timing in the barrel and found that 4 layers of 0.5 cm cells will meet the 16 ns requirement.³ The present GEM barrel muon system assumes a trigger signal of 4 layers out of a total of 6 layers.

7. Gas and High Voltage Studies

We have made a conceptual design for the gas and high voltage systems for the GEM muon chambers. We concluded that the CSCs need online monitoring for environmental (temperature and pressure) changes, and this could be best achieved by adjusting the HV. Details are given in ref 4.

8. References

1. K. Lau *et al.*, *TTR Test Results of a UH CSC prototype*, GEM TN-93-392.
2. K. Lau *et al.*, *Proposal to Use Separated Profile Strip Chambers for the GEM Muon System*, GEM TN-93-281.
3. K. Lau, *Monte Carlo Simulation of Timing Resolution of CSC's in the GEM Muon Barrel*, GEM TN-92-227.
4. R. Weinstein, *Need for Dynamic Control of the High Voltage Supply for the GEM Strip Chamber Muon Detector*, GEM TN-93-273.

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