Contribution ID: **54** Type: **Oral**

Design and Performance of the VMM1 ASIC for Micropattern Gas Detectors

Thursday 26 September 2013 11:35 (25 minutes)

Measurements of the first prototype VMM1 ASIC designed at Brookhaven National Laboratory in 130 nm CMOS and fabricated in spring 2012 are presented. The 64-channel ASIC features a novel design for use with several types of micropattern gas detectors. The data driven system measures peak amplitude and timing information in tracking mode including sub-threshold neighbors and first channel hit address in trigger mode. Several programmable gain and integration times allows the flexibility to work with Micromegas, Thin Gap Chambers (TGCs), and Gas Electron Multiplier (GEM) detectors. The IC design and features are presented along with measurements characterizing the performance of the VMM1 such as noise, linearity of the response, time walk, as well as calibration and performance measurements taken with a Micromegas detector.

Summary

The VMM1 is the first in a series of front-end ASICs designed for use with Micromegas and Thin Gap Chambers (TGCs) for ATLAS Upgrade. It features a range of gains and peaking times to allow use with other types of micropattern gas detectors as well. It incorporates several innovative features to allow operation in a fast trigger mode in the ATLAS Level 1 trigger as well as in a time projection mode for precision track reconstruction. The VMM1 features smart token passing reading out only those channels above threshold and their nearest neighbors in order to reduce the bandwidth and increase the potential for new physics.

The VMM1 design incorporates many features including an adjustable response that can be chosen based on different applications. The expected signal on a strip varies depending on the type of gaseous detector, detector capacitance, geometries such as gas gap and strip spacing, and gas amplification properties to name a few examples. The VMM1 can be tuned to optimize signal processing to take advantage of the full measurement range in order to get the most precise measurement values. For example, the simulation of the design performance predicts a charge resolution of approximately 5000 e- for a 25 ns peaking time and 200 pF capacitance and a timing resolution of 1 ns for a 1 V signal amplitude.

The first iteration of the VMM was very successful with positive results in test bench and test beam conditions with Micormegas, TGC's, and GEM detectors. Measurements of the performance of the peak/time detection including noise, linearity, and time walk will be presented. The functionality of the threshold trims and threshold sub-hysteresis features will also be demonstrated. The performance will also be assessed using Fe55 and Sr90 with a Micromegas detector for calibration and signal resolution. Finally, we will give a summary of the new features of the VMM2, which is expected to be fabricated in fall 2013.

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Session Classification: ASICs