PHENIX Muon Tracking Calibration Requirements

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1 Introduction

The muon tracking has three separate systems which will require calibration: the fine cathode planes, the coarse cathode planes, and the anode planes. In addition, the muon alignment system detectors may require some form of calibration.

2 Fine Cathode Plane Calibration

The ADC calibration of all strips relative to each other in a given chamber will need to be known to less than 1% in order to obtain a 100 μm resolution from the fine cathode planes, if the readout pitch is 1 cm. To achieve this, all strips will have to be pulsed with a common pulser over several pulseheights spanning the range of the ADC. The strips in a given chamber may be pulsed in sets of every fourth (or more) strips at a time to avoid cross talk. If a calibration error less than 1% is to be achieved, a precision pulser must be used, and the capacitive coupling of the pulse to the strips must be such that the error in the known capacitance is less than 1%. This can be achieved either by using precision capacitors which are uniform to the sub-1% level or by using capacitive strips whose area is known to less than 1% and whose distance from the strips is constant.

The North muon arm consists of approximately 16000 channels of fine cathode strips, and we would like to take calibration data for approximately 30 different voltage levels and on the order of 300 data points at each voltage. This gives a total of 1.44×10^8 data points required for ADC gain calibration. Twice this number of data points will be required for both the North and South muon arms to be calibrated.

In addition to the ADC gain calibration, the pedestal levels of all fine cathode channels must be known. To do this we would like to take approximately 1000 data points at zero voltage. This same measurement will allow us to measure the noise levels of all channels, which is a critical measure of how well the system is performing. To do the pedestal calibration a total of 1.6×10^7 data points will be needed.

The data stored for each fine cathode strip will be: 1) the fit parameters for the ADC gain calibration (one parameter if it is very linear, more likely a few parameters) 2) the pedestal values and 3) the sigmas of the pedestal values. This adds up to approximately 80,000 calibration constants for the fine cathode planes.

The calibrations should probably be performed bi-monthly at a minimum since the performance of the chambers depends so strongly on a good fine cathode calibration and low noise levels (which would be checked with a calibration). It would also be useful to track a small fraction of the channels on a short time scale in between calibrations to make sure that calibrations are not drifting significantly. This would be especially useful if the full calibration can only be performed infrequently.

3 Coarse Cathode Calibration

The coarse cathode planes will be read out with a latch so they will not require as good of a calibration as the fine cathode planes. However, the threshold levels should be set uniformly across a given chamber, so the strips should be pulsed at a given voltage with several threshold settings to calibrate the system. Either the strips can be pulsed directly, or the front end electronics can be pulsed. There are approximately 8000 coarse cathode channels, and we would like to pulse the system at one voltage and five threshold settings, with 300 data points at each threshold setting. This gives a total of 1.2×10^7 data points required for calibration. In addition, we would like to have the capability to pulse the coarse cathodes at different voltage levels for test purposes, but will probably only need a single voltage level for a standard calibration run.

The data stored for each coarse cathode strip is the threshold value at which the channels fire 50% of the time (8000 calibration constants). The calibration should be performed approximately monthly or on the same schedule as the fine cathode calibration.

4 Anode Calibration

The anode wires will also be read out with a latch and will require a calibration which is very similar to the coarse cathode calibration. The front end electronics should be pulsed at a common voltage and several threshold settings so that a common threshold can be set for all wires in a given chamber. There are approximately 8000 channels of anode wire readout giving a total of 1.2×10^7 data points required for calibration.

The data stored for each anode wire is the threshold value at which the channels fire 50% of the time (8000 calibration constants). The calibration should be performed approximately monthly or on the same schedule as the fine cathode calibration.

5 CSC Calibration Data Taking

Since all strips and wires must be pulsed for calibration, and most will be simultaneously pulsed for simplicity, the calibration data should be taken separately from physics data taking. The number of channels read out at a time may be as small as 1/4 of one plane of an octant or as large as 1/4 of all of the fine cathode planes in the system. Since the calibration will have to be taken separately from physics data, the calibration process should be completed within approximately 1 hour.

6 Alignment Detector Calibration

The muon arms may contain as many as 112 straightness monitors to monitor the alignment of the tracking stations. The electronics which are used to read out the light sensitive detectors may need to be calibrated on a regular basis in order to maintain the position resolution required. It is currently not known what level of calibration or frequency of calibration might be required since the detector has not yet been chosen, but since the number of channels is fairly small it is not expected to significantly impact data taking.

7 Alignment Monitoring

The alignment of the tracking stations in the muon arms will need to be monitored on a regular basis so that the 25 μm survey tolerances in the x-y plane can be met. This will be done with as many as 112 straightness monitors which will be attached to the tracking chambers. The position of a given straightness monitor should be measured several times to reduce any error caused by air currents or other random errors in the detection and readout chain. It is expected that a set of alignment data for the entire system can be collected in approximately 15 minutes. The data can be taken at the same time as the physics data or it can be taken with calibration data since it does not affect the chamber performance. However, since the frequency of alignment measurements required will depend on the stability of the muon system which will not really be known until the detector is fully assembled and taking data, we would like to have the option of monitoring the alignment on a daily basis.