Mapping for a Cylindrical Micro-Resistive Well Detector

Test Document

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1. Introduction

1.1 Purpose

The purpose of this document is to define the tests for a data processing system designed to analyze the efficiency and spatial resolution of a cylindrical micro-resistive well detector. This document will establish the black-box testing, and performance testing via stress testing, and other testing.

1.2 Scope

This project aims to provide support for physicists so their data can be more easily accessed and visualized. The proposed software will operate as an analysis tool to be used after data acquisition. Therefore, although external interfaces are described in this document, we will not interact with the hardware directly.

1.3 Definitions

The following terms, acronyms, and abbreviations will be used frequently throughout this document and future communications regarding the product.

Detector- A detector is a device used in particle physics to measure the position of charged particles.

µRWELL (Cylindrical micro-resistive well detector)- µRWELL is a type of micro-pattern gaseous detector that combines gas electron multiplication with a resistive protection layer and a segmented readout structure to measure charged particles with high precision [1]. Designing a detector that is cylindrical is the novelty here.

Tracker- In the context of this project, a tracker refers to an external planar detector. Four trackers are used to create a reference system for evaluating the efficiency of the cylindrical detector.

Readout board- A readout board is an electronic circuit board that collects signals from detector channels. The readout board hosts APV chips and interfaces between the detector strips and the data acquisition system. Each readout board can only capture a single plane of the data. So in planar detectors, typically there is one for x and y positions, respectively.

Channels/strips- Channels or strips are the readout elements on the detector surface that collect charge from ionization events. Each strip is connected to a specific APV channel. Strip signals are used to reconstruct particle hit positions.

APV chip (Analog Pipeline Voltage chip)- An APV chip samples analog signals from each channel on the readout board in time bins.

Time bin- A time bin is a discrete time sample recorded by the APV chip. Typically, 12-16 time bins are used to reconstruct the pulse shape of a beam.

ADC (Analog to Digital Converter value)- ADC represents a numerical value for the current recorded on a particular strip.

AMORE-SRS (Analysis and Monitoring Of Readout Electronics and Scalable Readout System)- AMORE-SRS is a live data acquisition framework for monitoring and organizing the data from the APV chips into a root file for analysis.

Root file- The root file stores event data such as strip information, ADC values, and metadata. The data is organized into branches that correspond to specific variables.

3D Pulse plot- A 3D pulse plot is a visualization of a single event where the x axis is time bin, the y axis is the strip number, and the z axis is the ADC value.

Resolution plot- A resolution plot is a reconstruction of the 2d hit positions represented as a heat map.

Efficiency plot- Efficiency plots compare the detectors efficiency against other performance characteristics such as amplification or drift field. Efficiency itself is defined as the ratio of the number of events with strip clusters seen in all five detectors divided by the number of events with strip clusters seen in just the four trackers [2].

2.1 Functional Requirements Test

Channel Mapping

- Input: 1 root file
- Method: black-box testing, focusing on comparing the pulse plots to the pulse plots of baseline detectors
- Expected Output: pulse plots should look the same
- Unexpected Output: pulse plots look vastly different

Hit Reconstruction:

- Input: 1 root file
- Method: black-box testing, focusing on comparing the hit reconstruction plots to expected fan-like shape of beam.
- Expected Output: hit reconstruction graph resembles fan-like shape.
- Unexpected Output: hit reconstruction looks any different than a fan-like shape.

Resolution plots:

- Input: 1 root file
- Method: black-box testing, focusing on comparing resolution plots to baseline plots
- Expected Output: should look like a more detailed hit reconstruction plot.
- Unexpected Output: loses resolution or loses fan-like shape.

2.2 Reliability Tests

good events:

- Input: 1 root file
- Method: unit testing
- Expected Output: there are > 1 useful events
- Unexpected Output: there are 0 useful events, terminate program with error.

Bad data:

- Input: 1 root file
- Method: unit testing
- Expected Output: data is in between expected boundaries.
- Unexpected Output: data is out of bounds, terminate program with error.

Root branch sizes stay consistent:

- Input: 1 root file
- Method: unit testing

- Expected Output: when accessing an event the branch data size should be the same throughout all branches of the event.
- Unexpected Output: any of the branches has a different data size, missing data terminate program with error.

2.3 Performance Tests

Testing multiple root files together in a folder:
- Input: multiple root files ~20
- Method: stress testing
- Expected Output: files should be processed in less than or in 10 minutes
- Unexpected Output: files take more than 10 minutes to be processed