MU2E/PHYSICS/xxxxx
version 1.0 October 19, 2023

Commissioning of the Mu2e Data AcQuisition system and the Vertical Slice Test of the straw tracker

11. Mu2e ROC simulation

version 1.0 October 19, 2023

Abstract

This note presents an analysis of data coming from the teststand of the motherboard and the comparison with ROC simulation.

Contents

1 Notes for the authors

1.1 Revision history

- v1.01: initial version

2 Introduction to the analysis

In this note, we present an analysis of the data derived from the readout teststands of the motherboard. This analysis was performed with the aim of characterizing the functionality of the Data Acquisition (DAQ) system. A signal generator was employed to send pulses and we tried to understand the output and non-output of the DTC. Our study centered on testing the performance of ROCs and DTCs, actually we were reading 1 ROC (96 channels), which is the equivalent of one panel or 2 ROCs. The analysis was executed employing a single DTC. During the analysis, we had the capability to change different generator's features. We varied the event window duration between successive pulses and modulated the generator's operating frequency. Specifically, we could operate with two distinct frequencies: 31.29 MHz/(2^7+1), resulting in approximately 250 kHz, and 31.29 MHz/(2^9+1), 60 kHz.
The selection of the event window duration and the frequency played an important role in determining the number of hits per event, considering that the ROC buffer possessed a storage capacity for up to 255 hits. The relationship between the generator and readout counts can be summarized as follows:

- $N_{gen} < 255$: $N_{readout} = N_{gen}$;
- $N_{gen} \geq 255$: $N_{readout} = 255$.

3 Time distribution

After a preliminary observation of the data time distribution, as illustrated in Fig. **??**, the initial though was the occurrence of a cessation in data acquisition for specific channels at a certain time.

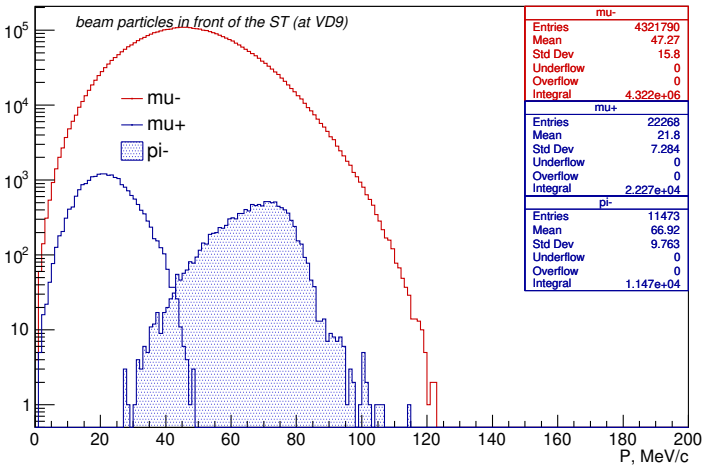

Figure 1: Left: momentum distributions of particles reaching VD9; Right: momentum distributions at VD9 of particles stopped in the stopping target

At this point we have plotted the number of hits versus the channel number in the order that we expected, as we can see in Fig. **??**.

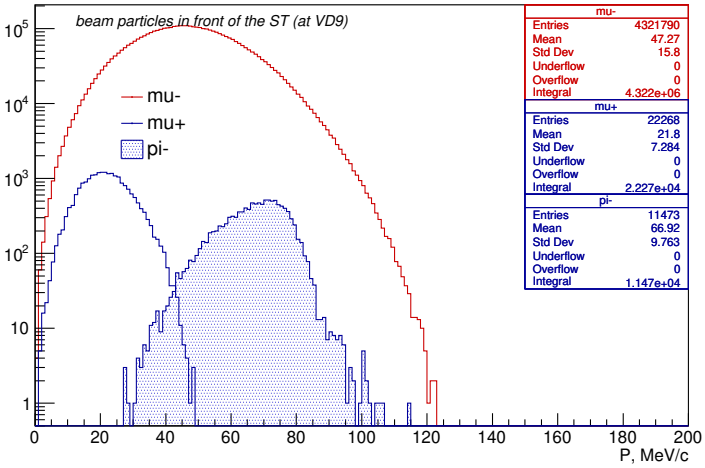

Figure 2: Left: momentum distributions of particles reaching VD9; Right: momentum distributions at VD9 of particles stopped in the stopping target

We thought it was necessary to characterize the apparatus with a Monte Carlo simulation for our Data Acquisition (DAQ) system, in order to understand the interruptions.

4 Datasets

The results presented in this note are based on the analysis of the μ^- beam **bmum0** family of SU2020 datasets [**?**], resimulated with the increased statistics of 1×10^9 protons on target. The family includes the following datasets:

- bmum0s11b0: output of Stage1 simulation: muons produced in pA interactions at the production target are traced to the plane in front of the TS31 collimator
- bmum0s21b0: output of Stage1 simulation traced to the plane in front of TS5 collimator
- bmum0s36b0: events with $p > 100\mathrm{MeV/c}$ electrons produced at Stage1 traced up to VD9 (virtual detector in front of the stopping target)
- bmum0s37b0: (bmum0s27b0-bmum0s28b0) events traced up to VD9. Those are events without $p > 100\mathrm{MeV/c}$ electrons in the end of Stage2
- bmum0s38b0: events with $p > 100\mathrm{MeV/c}$ electrons produced at Stage2 traced up to VD9
- bmum0s39b0: strip from bmum0s37b0, events with $p > 100\mathrm{MeV/c}$ electrons produced in TS5 and in the DS before the stopping target
- bmum0s3ab0: strip from bmum0s37b0. Event withs $p > 100\mathrm{MeV/c}$ negative muon at VD9. The dataset used to estimate background from muon scattering in the stopping target
- bmum0s3ab0: strip from bmum0s37b0. Event withs $p > 100\mathrm{MeV/c}$ negative muon at VD9. The dataset used to estimate background from muon scattering in the stopping target
- bmum0s47b0: (bmum0s37b0 - bmum0s39b0) traced to VD10, virtual detector right after the stopping target. Those are events which didn't have $p > 100\mathrm{MeV/c}$ at VD9

- bmum0s4bb0: strip from bmum0s47b0. Events with $p > 70\mathrm{MeV/c}$ mu- P>70 MeV/c at VD10. The dataset used to estimate background from muon decays in flight.
- bmum0s56b0: bmum0s36b0 traced through DS, selection of events with $p > 100\mathrm{MeV/c}$ electron entering the detector (tracker+calorimeter) envelope volume. Resampling factor of 10,000
- bmum0s58b0: bmum0s36b0 traced through DS, selection of events with $p > 100\mathrm{MeV/c}$ electron entering the detector (tracker+calorimeter) envelope volume. Resampling factor of 10,000
- bmum0s59b0: bmum0s36b0 traced through DS, selection of events with $p > 100\mathrm{MeV/c}$ electron entering the detector (tracker+calorimeter) envelope volume. Resampling factor of 10,000
- bmum0s5ab0: bmum0s3ab0 traced through DS, selection of events with a $p > 100\mathrm{MeV/c}$ muon entering the detector envelope volume. Resampling factor of 10,000
- bmum0s5bb0: bmum0s4bb0 traced through DS, selection of events with a $p > 100\mathrm{MeV/c}$ electron entering the detector envelope volume. Resampling factor of 1,000.

5 Momentum distributions of the beam particles

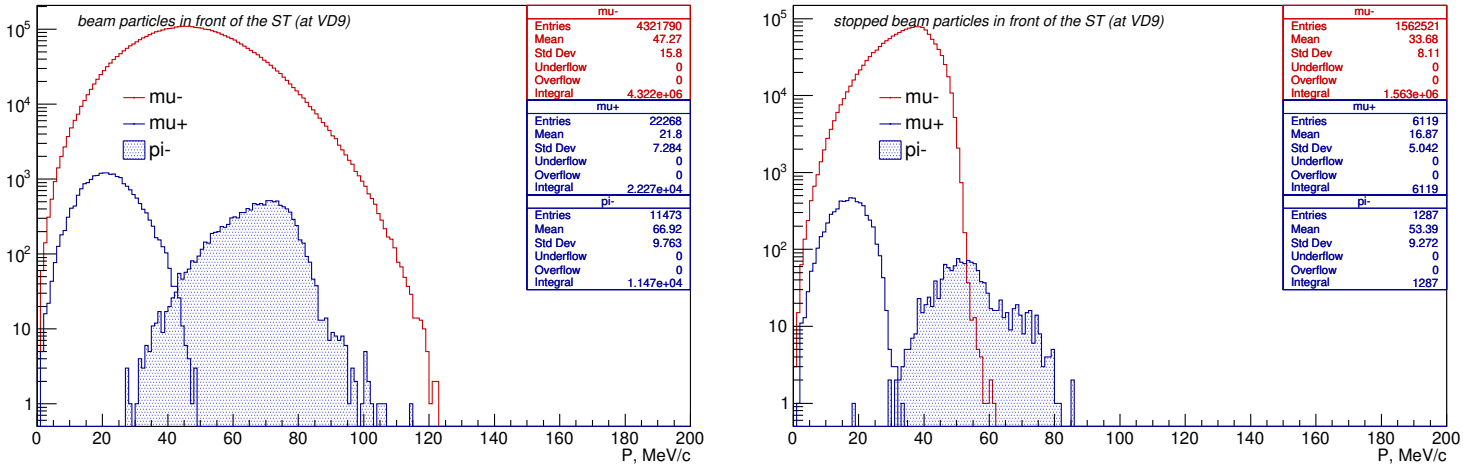

Figure 3: Left: momentum distributions of particles reaching VD9; Right: momentum distributions at VD9 of particles stopped in the stopping target

6 Beam electrons

6.1 Electrons Entering the Detector Envelope

7 Summary

Upper bounds on the direct beam-related backgrounds are as follows:

- background from beam electrons scattered in the stopping target < 1×10^{-3}
- background from muon decay in flights < 1×10^{-3}
- background from beam muons scattered in the stopping target < 1×10^{-5}