Contribution ID: **69** Type: **not specified**

Development of the data acquisition system for the Mu2e STM detector

Thursday, 16 February 2023 16:00 (20 minutes)

The observation of a significant deviation in the muon g-2 relative to the Standard Model (SM) e+e- prediction is perhaps a harbinger of new muon interactions beyond the SM and in many models of physics beyond the SM (BSM) a significant rate of charged lepton flavour violating (CLFV) muon interactions is predicted. The Mu2e experiment at Fermilab will extend the sensitivity to BSM CLFV interactions by 4 orders of magnitude by seeking to observe the neutrinoless transition of a muon to an electron when captured by an aluminium target. Critical to this measurement is the determination of the number of muons captured by the aluminium target. This cannot be estimated very reliably from simulation since the rate of the parent pions is model dependent and there are uncertainties in the collection and transmission efficiencies of the solenoids. However, muons captured are accompanied by distinctive X-rays which can be used to determine the muon flux. X-rays of 347 keV, 844 keV and 1809 keV will be measured by the Stopping Target Monitor (STM), a High Purity Germanium detector (HPGe), to determine the muon rate. The X-rays create transient pulses in the detector, the height of which is related to the incident energy of the X-rays. To determine the rates of the three X-rays I have implemented a Moving Window Deconvolution (MWD) algorithm. The input parameters of this algorithm have been tested on real X-ray data from 137-Cs and 152-Eu radioactive sources and beam data from the HZDR gELBE bremsstrahlung facility and optimised using simulated data. Testing this algorithm on a simulation based on the physical processes taking place in the detector has allowed the MWD resolution and efficiency to be determined as a function of rate. Furthermore, the pulse shapes expected in the HPGe STM detector have a long decay tail and the amount of data generated is bigger than the available disk space available. I have developed a Zero-Suppression (ZS) algorithm to reduce the amount of raw data being stored and analysed. This algorithm has also been tested on real data and simulation. I will present performance results from the ZS and MWD algorithms and how these will be used to accurately determine the muon flux at Mu2e.

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Session Classification: Young Researchers Session