Automated Calibration System for Beam Current Monitor

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Abstract

The Beam Current Monitor (BCM) measures the instantaneous current in a beam. This work aims to develop an automated calibration system for the BCM to address the need for calibration without interrupting beam operation. We strive to create a synchronous calibration method integrated into the master timeline by utilizing the pulsed nature of synchrotrons to run calibration pulses during inter-pulse gaps. This improvement should enhance operational efficiency, ensure safe operation, and help mitigate beam loss, all by enabling intermittent calibration during the operation of the accelerator.

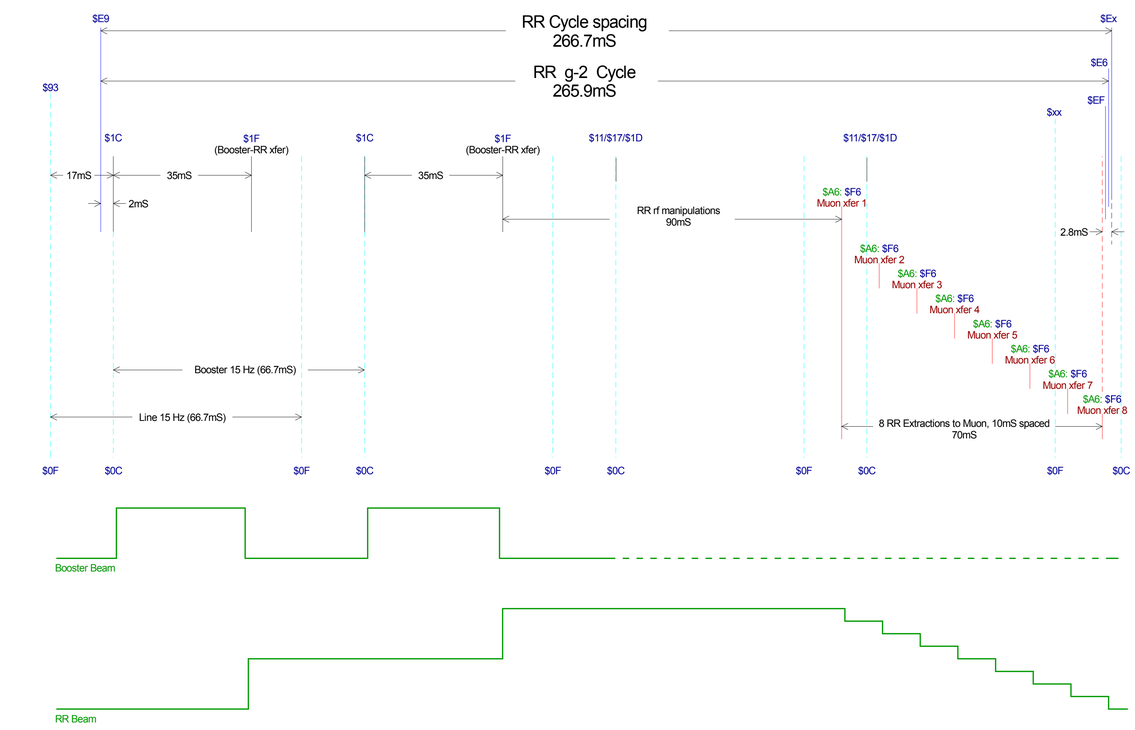

Figure 1 - Timing diagram of the Muon g-2 experiment

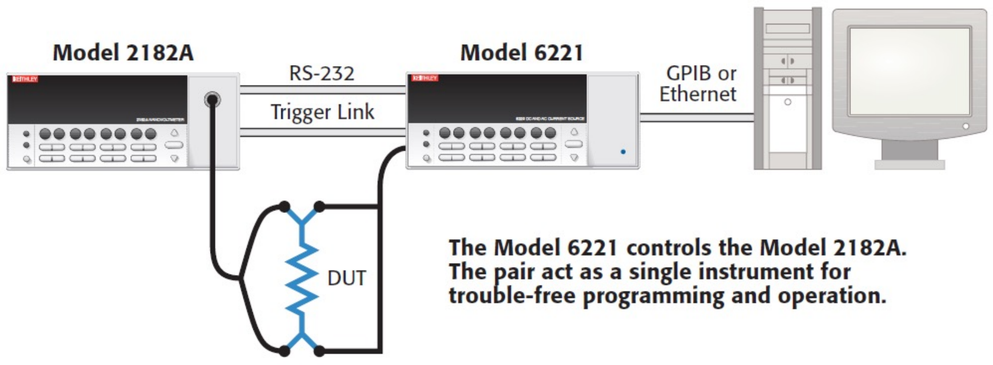

Figure 2 - Instrument setup diagram

Feasibility and Progress

- Successfully demonstrated proof-of-concept pulsed IV Sweep and DC linear sweep.
- Overcame challenges in timing, precision, and data processing speed.
- Developed a Python-based program that runs a pulsed IV sweep or a DC linear sweep and collects, stores, and graphs the resultant data.

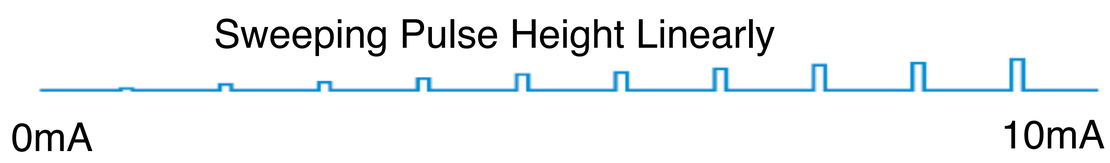

Figure 3 - Linear staircase sweep diagram

Methodology

- Software Development: Create a Python-based control system for the Keithley 6221 and 2182A to configure and run both pulsed IV sweeps and linear staircase sweeps and collect the resultant data.
- Synchronization: Integrate a timing system to trigger calibration externally to enable triggering during an inter-pulse gap.

Calibration Process

- Inject known current pulses during the 67 ms gap
- Measure BCM response using the Keithley 2182A
- Compare measured values to injected current
- Calculate and apply calibration factors

Results

- Achieved DC Sweep calibration in 30ms.
- Developed a Python program that runs two different sweeps to enable calibration of both the ACCT and DCCT beam current monitors.

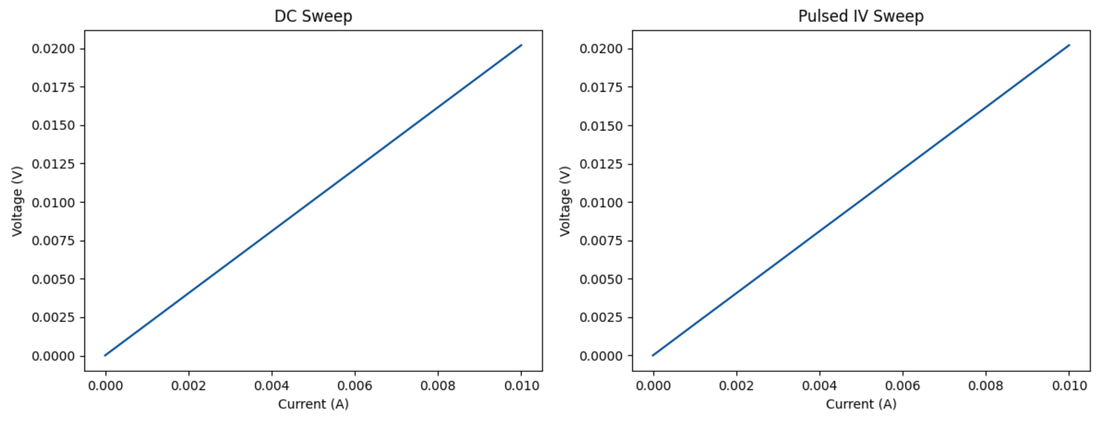

Figure 4 - Graphed results of DC Sweep and Pulsed IV Sweep

Future Work

- Extend the calibration system to calibrate multiple BCMs simultaneously using a multiplexor
- Integrate the completed program as an instrument during normal operation
- Explore applications to other accelerator diagnostic tools
- Develop a user-friendly interface for accelerator operators

Conclusion

The Automated Calibration System for Beam Current Monitor significantly enhances accelerator performance by enabling frequent, non-intrusive calibrations. This approach improves measurement accuracy, minimizes beam loss, and contributes to overall operational efficiency and safety.

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