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LANSCE HIGH DENSITY EMITTANCE INSTRUMENTATION SYSTEM*

L. Montoya†, S. Baily, S. Johnson, H. Leffler, H. Watkins, D. Zimmermann
Los Alamos National Laboratory, Los Alamos, NM, USA

Abstract

The Los Alamos Neutron Science Center (LANSCE) is currently upgrading the existing emittance stations with a high-density instrumentation system for emittance measurements in the low energy beam transport region. Emittance measurements were obtained using obsolete legacy equipment. For motion control a switching station with a mechanical mux to switch actuators was used. This caused a single point of failure for all emittance stations and is becoming increasingly unreliable. For data acquisition, two sets of signal conditioning and digitizers were employed and had to be shared between 7 emittance stations. Physical cable swapping was necessary when taking measurements from station to station. A system was developed using dedicated Quad Actuator Controller (QAC) chassis, capable of driving four (4) actuators, and dedicated data acquisition (DAQ) chassis capable of signal conditioning and digitizing up to 80 channels simultaneously. Details of the system development are presented.

INTRODUCTION

Emittance diagnostics have long been operating using aging instrumentation with limited spares available with the need to be upgraded with modern electronics to avoid obsolescence and increase reliability of measurements.

The emittance instrumentation upgrade aims to extend the lifetime and capability of beam diagnostic equipment by replacing antiquated systems that are now in obsolescence with modern equipment and to improve operational efficiency and performance with the ability to automate previously labor-intensive tasks to initialize measurements on the legacy system. The reliability of the equipment would be greatly improved as the National Instruments (NI) compact Reconfigurable Input/Output (cRIO) controllers are inherently more robust than the legacy equipment and reduces the amount of potential failure and is more easily maintained as components in each chassis are readily available off the shelf.

SYSTEM LOCATION AND OVERVIEW

Locations

There are 11 emittance stations in the H- dome, Low Energy Beam Transport (LEBT), and Transition Region (TR) which corresponds to 44 unique devices associated with the upgrade. Locations upgraded during the 2023 outage are shown in green, and planned upgrades to be completed during the 2024 outage are shown in yellow in Fig. 1.

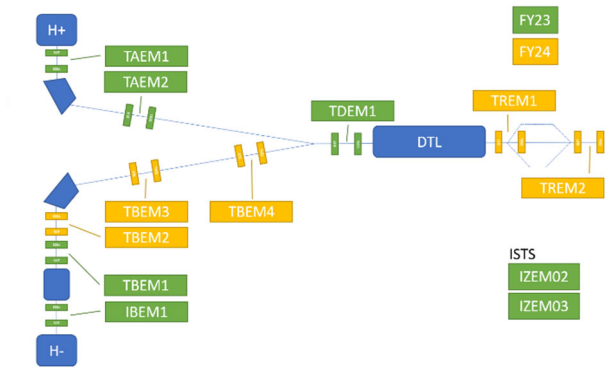

Figure 1: Emittance location map.

System Overview

Emittance stations are beam interceptive devices, thus are comprised of actuators in both horizontal and vertical axes with sensor payloads at the head of each device. Emittance measurements provide necessary information to tune the beam by providing beam parameters such as beam position, shape, angle, and intensity in both transverse and longitudinal planes through the beam pulse.

CONTROLLER HARDWARE

Using recently developed Quad Actuator Controllers (QAC) and Data Acquisition (DAQ) instrumentation chassis, the existing system is to be completely replaced and condensed with increased density of electronics [1]. The hardware diagram of the emittance system is shown on Fig. 2.

The QAC chassis will provide actuator control for a single emittance station, driving vertical and horizontal slits and collectors. In doing so, the legacy actuator switching station will be retired, removing it as a single point of failure in the system. Each emittance station was deployed a dedicated DAQ chassis removing the need to rely on the Sample and Hold chassis and shared digitizers used for all emittance measurements [2]. Both horizontal and vertical collectors in the emittance station are wired in parallel such that excitation of one axis can be read at a time and allow for a single 80 channel DAQ to read in 76 sensor inputs from the collector.

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† lucasm@lanl.gov. LA-UR-23-30153

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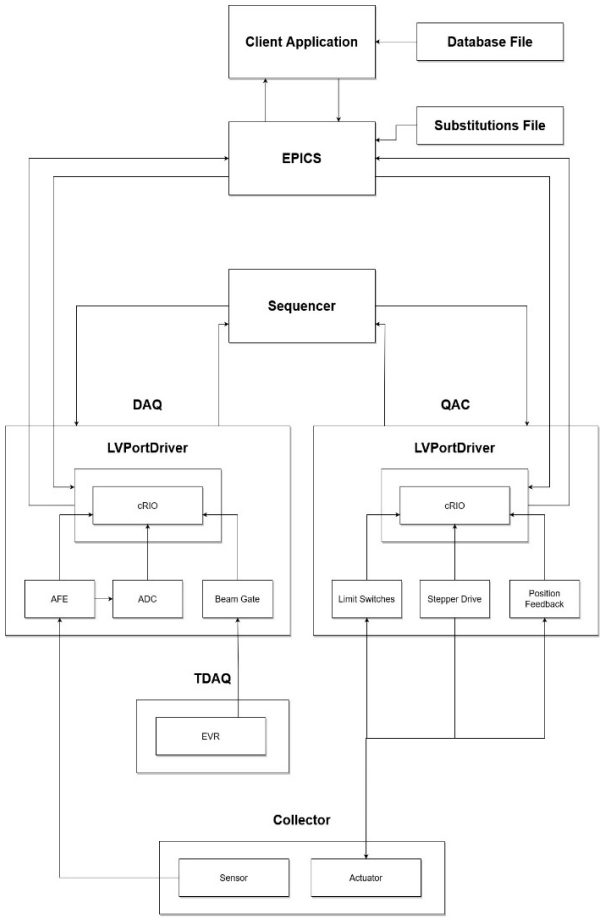

Figure 2: Emittance hardware block diagram.

The DAQ maintains acquisition capabilities as developed on the Isotope Production Facility emittance upgrade project from which it was initially developed [3]. Live waveform data can be observed as shown in Fig. 3 where a collector can effectively be utilized as a harp device.

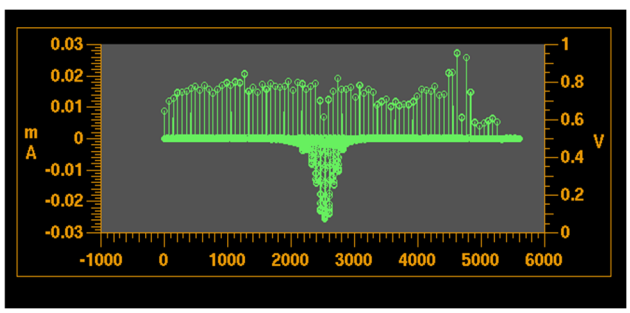

Figure 3: DAQ emittance waveform.

BEAM MEASUREMENT RESULTS

Emittance measurements were taken using chopped and un-chopped beam in the LEBT using both H+ and H- beams. Figure 4 shows IBEM01 horizontal emittance scan on the cRIO system with similar measurements being produced from previous years confirming the viability of the system and allowing for a total replacement of all legacy hardware.

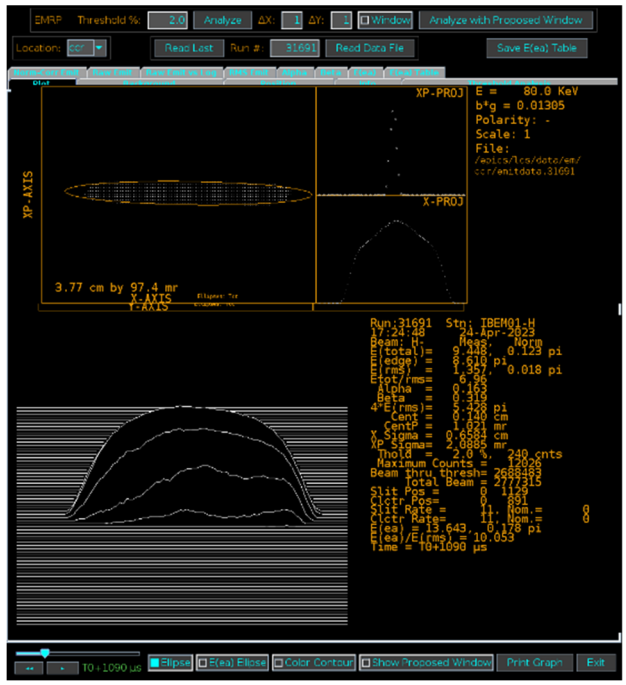

Figure 4: IBEM01 horizontal emittance scan.

CONCLUSION

With a successful commissioning of the emittance stations, work is planned to complete the remaining stations and upgrade harp devices using the QAC and DAQ platform. With all LANSCE beam interceptive devices on the same platform, diagnostics will become easier to maintain with fewer hardware types to learn and have spares more readily available.

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