LANSCE QAC/DAQ Wire Scanner Instrumentation Upgrade*

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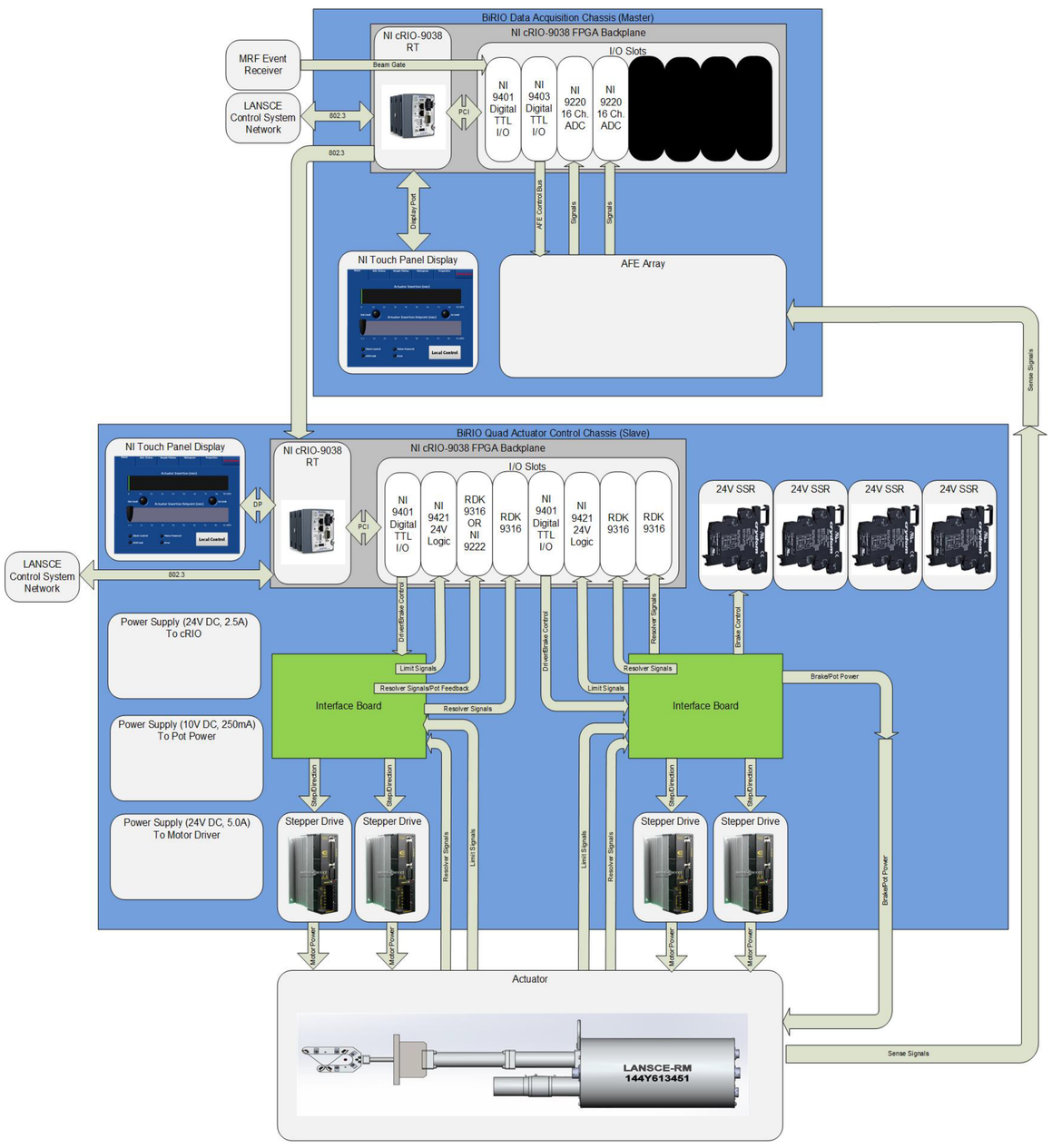
Abstract

High density instrumentation has been developed to upgrade wire scanner beam diagnostic capability in all areas downstream of the Coupled Cavity LINAC (CCL). Transverse beam profile measurements were originally obtained using legacy electronics known as Computer Automated Measurement and Control (CAMAC) crates. CAMAC has become obsolete, and a new wire scanner diagnostic system was developed as a replacement. With high wire scanner device density located in each area, instrumentation was developed to meet that need along with the ability to interface with legacy open-loop controlled actuators and be forward compatible with upgraded closed-loop systems. A high-density system was developed using a Quad Actuator Controller (QAC) and Data Acquisition (DAQ) chassis that pair together using a sequencer when taking measurements. Software improvements were also made, allowing for full waveform functionality that was previously unavailable. Deployment of 52 wire scanner locations in 2022 increased device availability and functionality across the facility. Hardware and software design details along with results from accelerator beam measurements are presented.



Wire Scanner Hardware Diagram

System Overview

Wire scanners are electro-mechanical beam interceptive devices that provide cross-sectional beam profile measurements that describe beam shape and position. A wire scanner system consists of an actuator to drive the sense wires across the beam, and data acquisition to obtain the wave-form data from the current induced by the secondary emitted electron yield from the proton beam current im-pinging on the wire.

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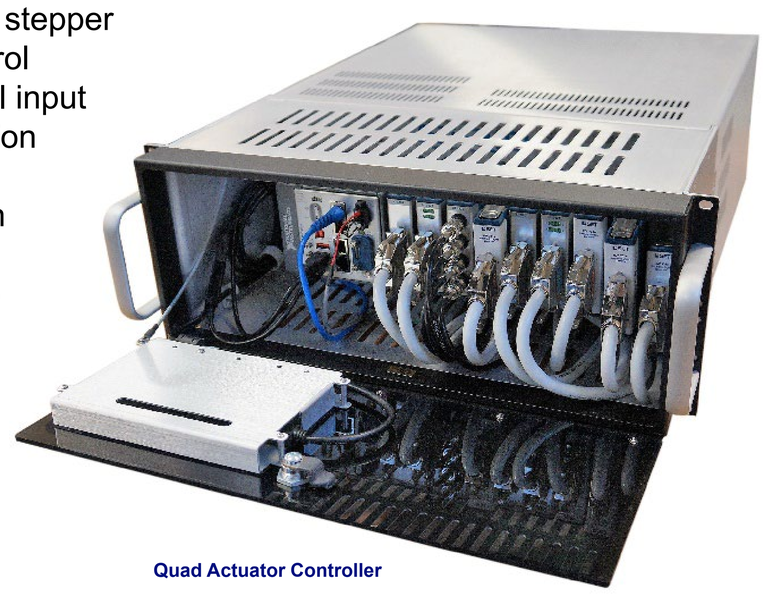
Controller Hardware

The electronic hardware consists primarily of two separate chassis, each controlled using a National Instruments (NI) 9038 compact Reconfigurable Input/Output (cRIO) packaged in 4U rack mountable enclosures configured as input output controllers (IOC).

Quad Actuator Controller

The QAC chassis was designed to control up to four stepper motor actuators, two actuators simultaneous. The chassis is compatible with both open loop and closed loop motion control. Within the cRIO controller on the QAC is housed NI I/O modules, and serve as the interface between the wire scanner actuator and the cRIO and perform the functions as follows:

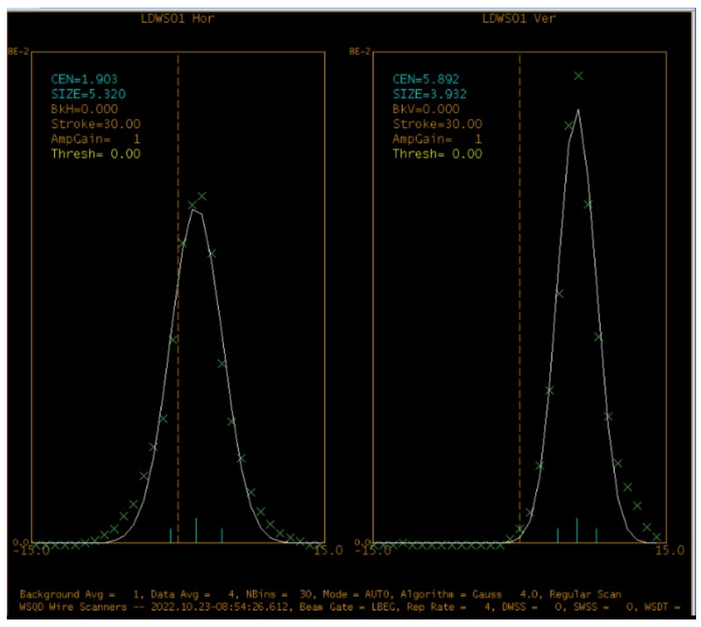
- NI 9401 digital I/O for stepper motor and brake control
- NI 9421 sinking digital input for limit switch indication
- NI 9222 voltage input potentiometer position feed-back
- RDK 9316 resolver to digital converter



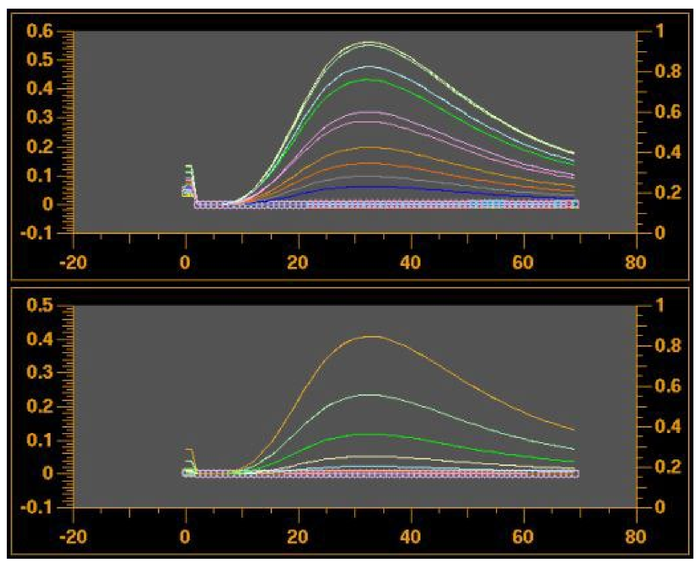
Quad Actuator Controller

Data Acquisition

The DAQ chassis is capable of 32 channel, 100 kS/channel, simultaneous waveform acquisition (10µs resolution) with a cPCI backplane with two high density 16 channel each, gain adjustable, 2 kΩ input impedence Analog Front End (AFE) conditioning card capable of reading from 270 µA down to 3 µA current levels.



Vertical and Horizontal Axis Beam Profiles



Vertical and Horizontal Axis Waveform

Results

Beam profile measurements were taken using Long Bunch Enable Gate beam, set to 4 Hz rep rate with 150 µs beam length a Gaussian profile was obtained.

The full waveform can be seen for the same scan taken with each trace a waveform from a separate beam pulse as the wire scanned across the beam.

All 52 wire scanner locations have been successfully upgraded with each device tested and validated with beam, providing beam profile measurements for each location this past run cycle.