# Implementation of Transimpedance Analog Front – End Card for Los Alamos Neutron Science Center Accelerator Wire Scanners

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## Abstract

The Los Alamos Neutron Science Center's (LANSCE) Accelerator Operations and Technology division - Instrumentation and Controls (AOT-IC) team executed a project that implemented a new Analog Front-End (AFE) card for their wire scanner's Data Acquisition (DAQ) system. The AFE accommodates the signal amplification and noise reduction needed to acquire essential measurement data required for beam diagnostics for LANSCE accelerator. Wire Scanners are electro-mechanical beam interceptive devices that provide cross-sectional beam profile measurement data fitted to a Gaussian distribution that is then extrapolated to provide beam shape and position. The beam shape and position information allow the operator to adjust parameters such as acceleration, steering, and focus to provide optimized beam delivery to targets. The project included software and hardware implementation that eliminated the dependency on legacy systems and consolidated various AFE designs for diagnostics systems into a single design with 11 gain settings ranging from 100nA to 40mA at 10V full scale to accommodate its future applications on other diagnostics systems.

## Need for New Design

During the implementation of the QAC (Quad Actuator Controller) and DAQ system for wire scanner systems in the transition region and down-stream areas, the LANSCE Harp AFE was used. The LANSCE Harp AFE was adequate in performing wire scanner scans of the LBEG (Long Bunch Enabled Gate) beam but not for MPEG (Micro Pulse Enabled Gate).

LBEG is a higher current beam with 50 times greater macro pulse average current and 100 times greater charge per pulse than MPEG

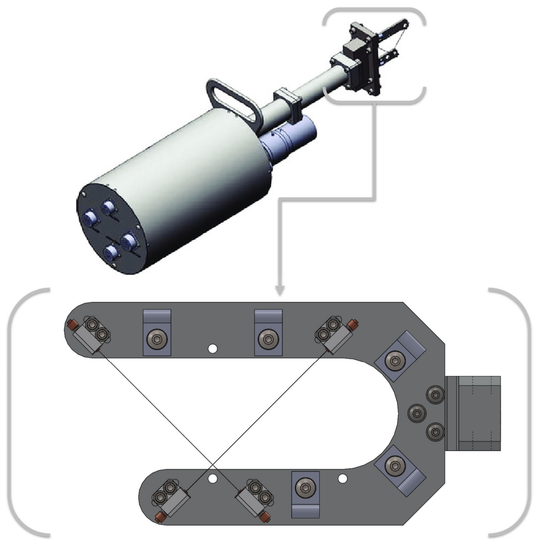

**Figure 1:** Wire Scanner and Sensor Fork Assembly

## Final Design

Based on Transimpedance Amplifier (TIA) circuit design to convert and amplify low current output of sensors to usable output voltage level.

The design includes 11 selectable gains divided between seven high and four low bandwidths.

Figure 2 shows the final single-channel layout of the TIA circuit and Fig. 3 shows the final fabricated assembly of the new AFE design.

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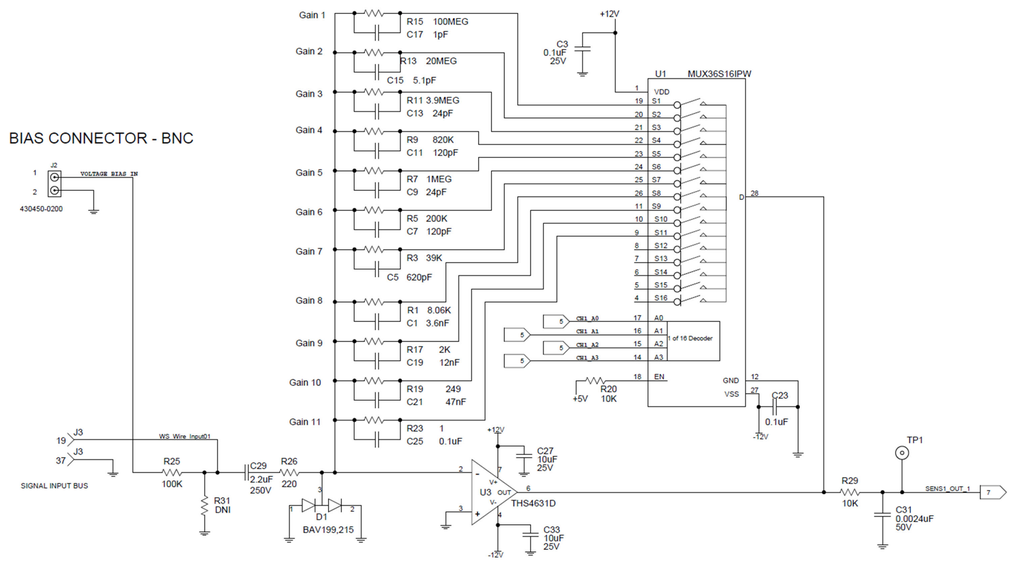


**Figure 2:** Single Channel Layout of New Transimpedance AFE

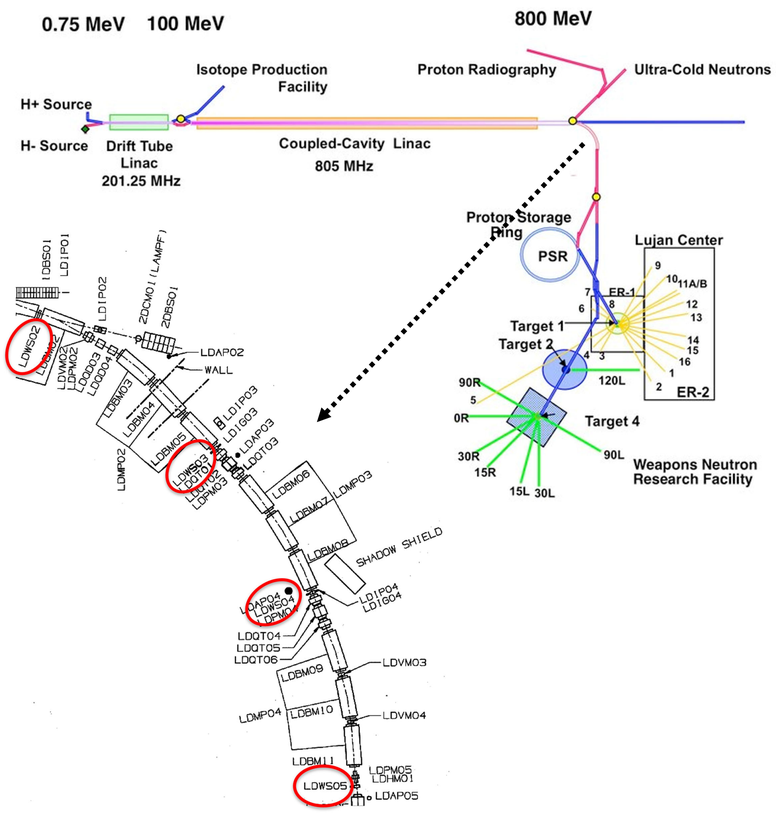


**Figure 4:** LANSCE Site Map (Line D North)

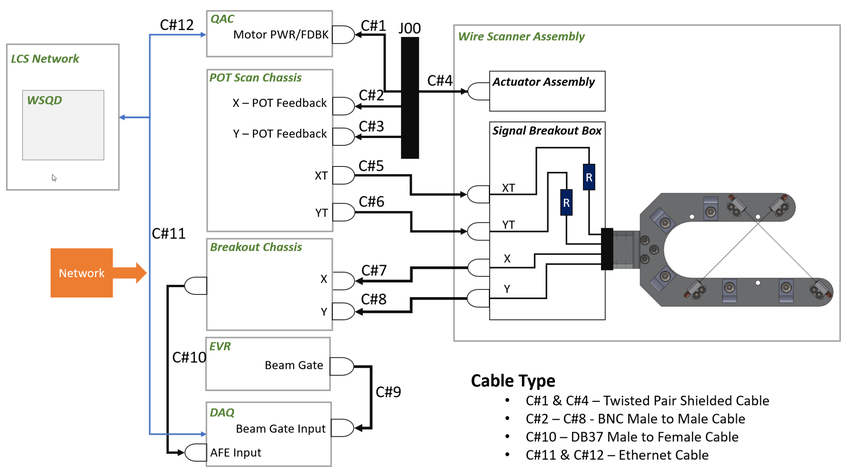


**Figure 5:** Wire Scanner System Block Diagram

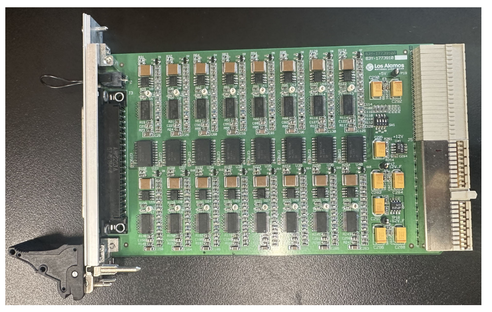

**Figure 3:** New TIA AFE Assembly

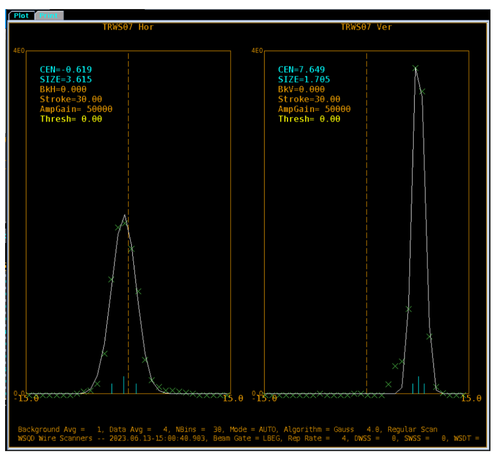


**Figure 6:** LBEG Beam scan of TRWS07 Wire Scanners

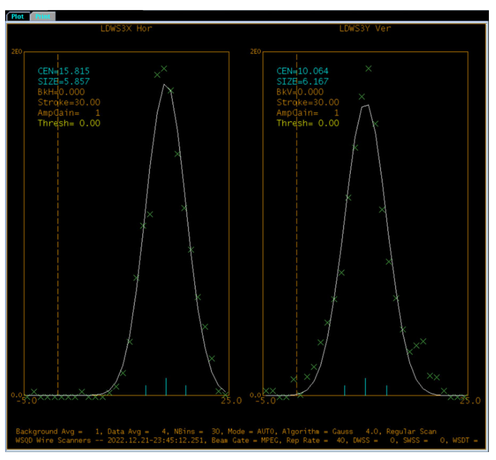


**Figure 7:** MPEG Beam scan of LDWS3X and LDWS3Y Wire Scanners

## Conclusion

During the V&V (Verification and Validation) of the new AFE, hardware and software implementation it showed that the new Transimpedance AFE design for the DAQ system met all the design requirements. Figure 6 and Fig. 7 show successful wire scanner scans with LBEG and MPEG beam taken during beam development time. Both scans show a good Gaussian fit with a clear beam center and size for horizontal and vertical axes providing essential data for beam tuning. The new design has adequately addressed design and functional limitations of the LANSCE Harp AFE providing a dynamic gain range to measure the induced sensor current with accuracy and stability.

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