SSCL Linac Commissioning Diagnostic Cart

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Abstract

A portable diagnostic system is under development and construction for use in commissioning the SSCL LINAC. This system is being used during the construction of the LINAC, and will be used to commission each section of the accelerator as assembled. The diagnostic system consists of a portable ultra high vacuum system, high speed actuators, high density (128 channel) diagnostic heads, x-ray detectors, and high density VXI 128 channel amplifier arrays. Various innovative designs will be described. These designs led to high density wire spacing, high frequency, wide bandwidth, low cost amplifiers, and compact systems. State of the art manufacturing techniques were employed as a result of the joint interaction between the SSCL and Allied-Signal.

Introduction

The SSCL LINAC diagnostic cart is an experimental station that is designed as a flexible platform on which an experimenter will configure various components to perform experiments. One such experiment was for the Bunch Shape Monitor for the SSCL LINAC [1].

The over all system consists of a portable platform, high vacuum chamber and vacuum system, precision actuators, diagnostic heads, electronic packages, and support systems.

The system is designed to allow high speed measurements of the H^- beam in order to minimize the effects of radiation production due to the interaction of the beam and diagnostic heads, and to measure pulse to pulse instability of the beam.

System Components

The Cart

The portable platform is a wheel mounted aluminum test stand with locking feet. The platform is 1 meter wide, 2 meter long, and 1 meter tall, with 3 individual equipment bays. Two of the equipment bays are configured to accept standard 19 inch rack mounted packages on both sides, while the third contains the high vacuum pump, vacuum pump controller, vacuum gauges, air and water meters and controls. While the present system contains a 500 liter per second vacuum pump, the cart will accept vacuum pumps that exceed 2000 liter per second. The diagnostic chamber is constructed from 10 inch diameter knife edge flanges with 8 inch diameter tubing and 4 ½ inch diameter knife edge flanges with 2 ½ inch diameter tubing. The chamber is mounted over the first bay of the diagnostic cart. Mounting of a viewing port or diagnostic is possible on any of the 10 inch flanges perpendicular to the beam and all of the 4 ½ inch flanges. See figure 1.

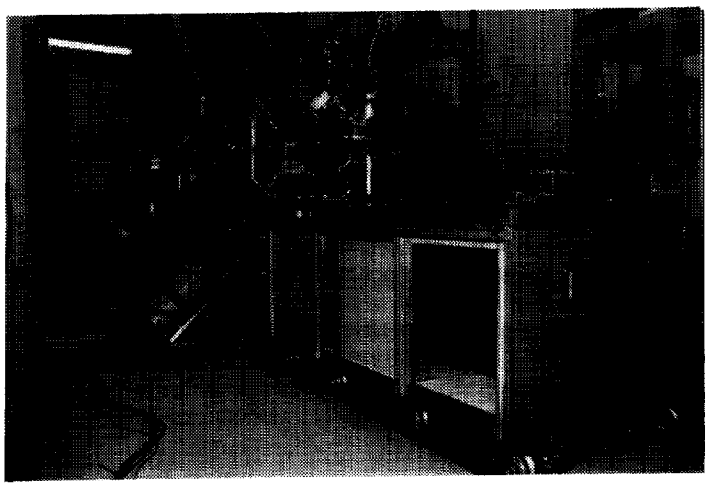

Figure 1.

The SSCL LINAC diagnostic cart connected to the exit end of the RFQ.

Actuator

Several of the diagnostics used with the commissioning cart during commissioning of the Linac are actuator mounted. One of the actuators used is configured to position a diagnostic head, such as a slit, collector, wire scanner, or harp. These actuators have a foot print of 80 mm by 130 mm and allow diagnostic heads with more than 128 signal wires and liquid cooling lines mounted on 2 1/8 inch knife edge flange to be positioned into the beam. The actuator will position a diagnostic head to each data position within 50 milliseconds. An example of one of the actuators used on the diagnostic cart was constructed by a team of engineers from the SSC and Allied-Signal's Kansas City Plant.

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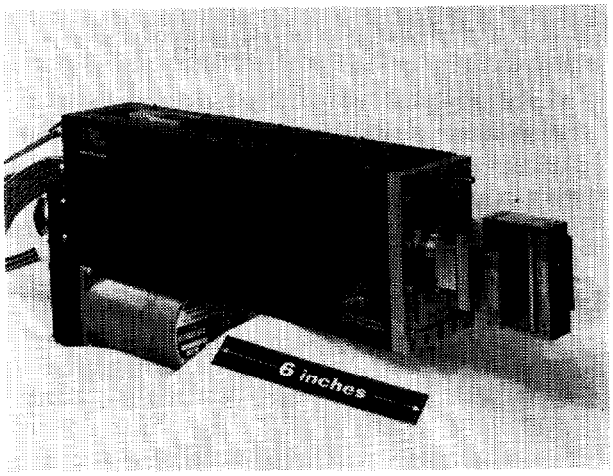

Figure 2.

Diagnostic Cart Actuator with a 128 element collector attached.

Diagnostic Heads

Slit and Collector

Utilizing the interchangeable diagnostic head feature of the actuator, a set of diagnostic heads has been designed and constructed. These diagnostic heads include a slit and collector, wire scanner, and harp. Each element of the slit can be electrically isolated from each other and biased separately all electrical connection can be made outside the vacuum system. The collector's design allows for the 128 electrically isolated copper elements to thermally connect to the collector's copper frame. Each collector element is 50 mm wide, 0.1 mm thick and 20 mm deep. Electrical isolation is achieved by utilizing 0.1 mm thick natural mica or mica paper. See figure 3.

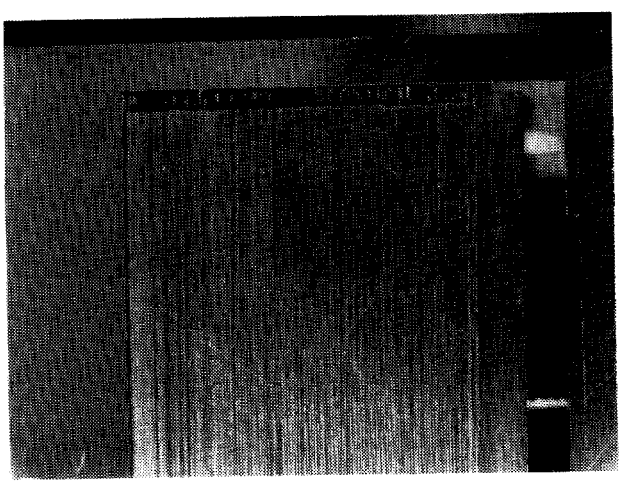

Figure 3

The collector contains 128 copper elements that are .1mm thick with .09 mm thick natural mica or mica paper.

Wire Scanner and Harp

With the need for higher resolution in profile measurements for the SSCL LINAC, [3] the concept of utilizing hybrid microcircuit (HMC) technology was chosen in the design of the diagnostic cart's wire scanner and harp. See figure 4. Using this process for the design and construction of a wire scanner, a harp with 128 individual 33 μm diameter carbon wires with calibration resistors is under construction with the Department of Energy's manufacturing center in Kansas City, MO.

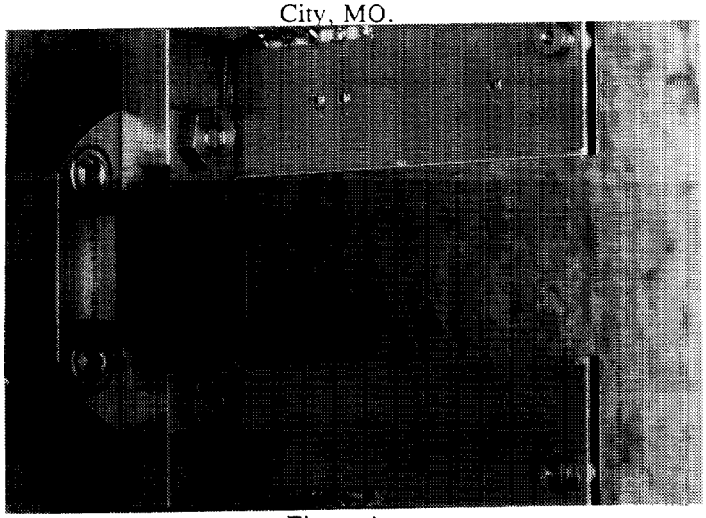

Figure 4.

Diagnostic Cart Wire Scanner fabricatied using HMC technology with wird bonding.

High Density VXI Amplifier Array

In order to integrate a diagnostic head with 128 wires an amplifier array was needed. The solution selected was an eight channel 20 million samples per second (MSPS). Using this approach, an entire 128 channel amplifier array was constructed into a VME Extenuation for Instrumentation (VXI) system. See figure 5

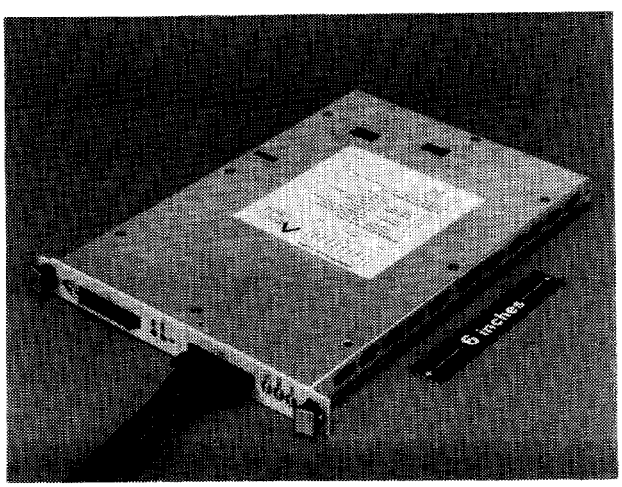

Figure 5

The Modular Input VXI digitizer contains 8 bipolar channels.

This amplifier circuit is designed to accept a bipolar differential current signal from 10 μA to 10 mA. For maximum flexibility the circuitry for this module is divided into two separate functions; the mother board and daughter board. See figure 6 and 7. The mother board contains all of the digital signal function including the buffer circuitry to the VXI interface, memory, 10 bit analog to digital converters and the interfaces to the daughter boards, while, the daughter board contains all analog signal conditioning and amplifying the current signal for a wide variety of diagnostic heads

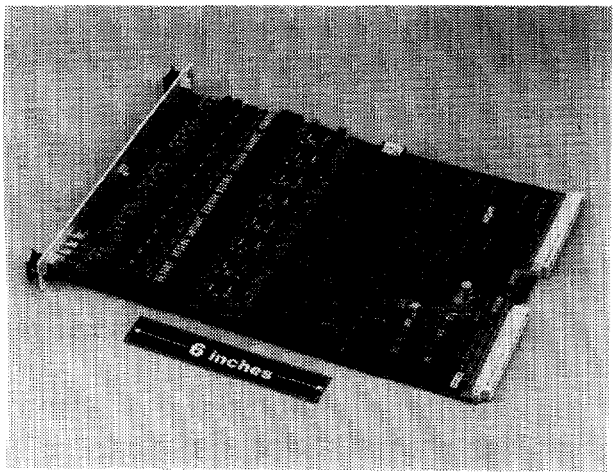

Figure 6

The MIX mother board can accept four daughter boards.

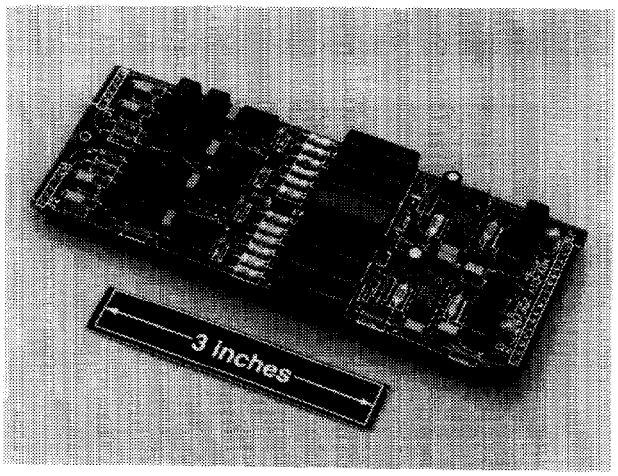

Figure 7.

Each daughter board contains circuitry for two differential channels of $\pm$10 μA to 10 mA

Conclusion

We are using some of the diagnostic tools on the commissioning cart, developed at the SSCL and other laboratories for the LINAC and the SSCL. Early results of the LINAC commissioning were aided as a result of this needed platform and many improvements to the LINAC diagnostics will be facilitated with this flexible research tool.

Acknowledgments

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References

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[2] C. Fritsche et. al., "High Density Harp for SSCL LINAC", these proceedings.

[3] A. VanDeusen et. al., "High Density Data Monitoring for SSCL LINAC", these proceedings.

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