BPM ELECTRONICS UPGRADE FOR THE FERMILAB H- LINAC BASED UPON CUSTOM DOWNCONVERTER ELECTRONICS *

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Abstract

As part of the Fermilab Proton Improvement Plan, the readout electronics for the beam position monitors (BPMs) in the Fermilab H^- Linac have been upgraded. The new custom electronics provide a low cost solution to process the 2nd harmonic of the 805 MHz RF. A single four-channel NIM-bin module is used to readout each four-plate stripline BPM pickup. Each module is locked to the external 805 MHz machine reference from the low level RF. A number of measurements at each BPM are provided, including average horizontal and vertical position, average intensity, and average relative phase for variable pulse lengths up to 50 µsec. The system is being exploited in a number of ways with new operations applications.

Specifications

- Position resolution: 0.1 mm,
- Long-term stability: 0.25 mm,
- Phase resolution of 0.2°.

This has been achieved.

Hardware Overview

- 67 identical modules in Linac/Booster
- 15 NIM crates
- Modules synced to Linac 805MHz RF
  - *Selects 2nd harmonic for analysis*
- Obtain I and Q for each plate
- IF = 3.125 MHz
  - *IF digitized at 50 MHz (805 MHz/16)*
- Processed by Altera Cyclone FPGA
  - *64MB DDR RAM*

Microcontroller in the modules:

- Configuration & control :
  - *ARM Cortex-M3 µp*
  - *80 MHz*
- Master and up to five slaves
- Slaves talk with Master via LVDS serial data link
- 1kB Flash for configuration parameters
- Command and control for the expert via
  - *Telnet connection*
  - *USB connection (locally)*

Data from every BPM at 15Hz:

- Five scalar, floating-point readings
  - *Horizontal and vertical positions*
  - *Beam phase and beam current*
  - *Pulse length*
- Decimated data vectors of the beam positions (H and V) within the Linac beam pulse.

Open-Access Client Front End at 1Hz

- Status & control
  - *Registers, flash memory, calibration*
- Large data sets
  - *50MHz traces*

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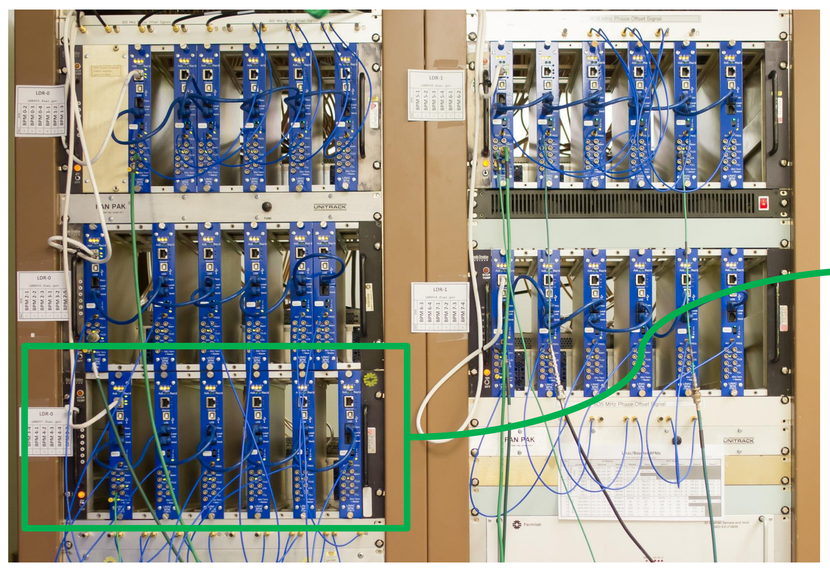
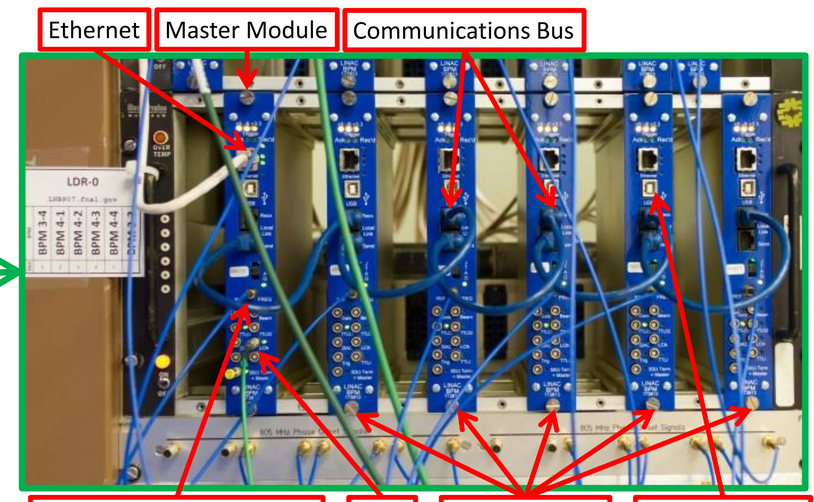
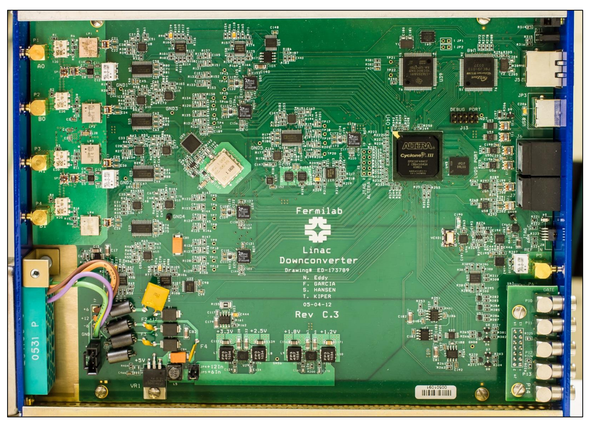
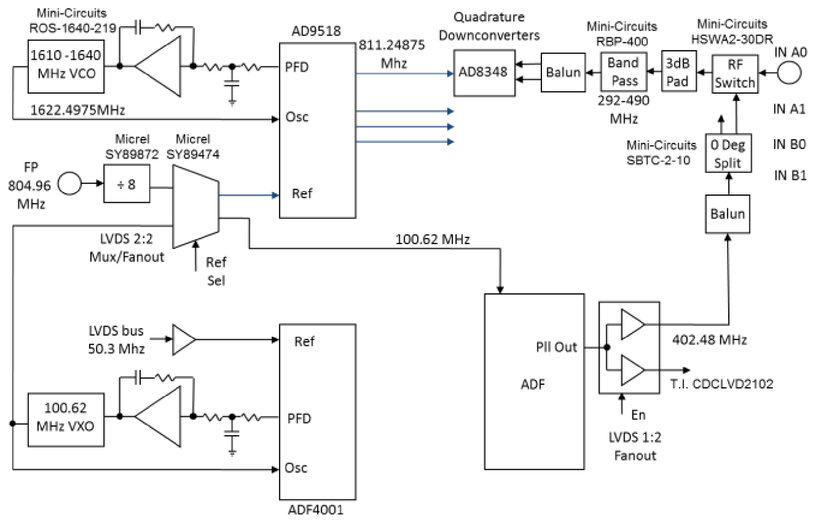
BPM Electronics Modules

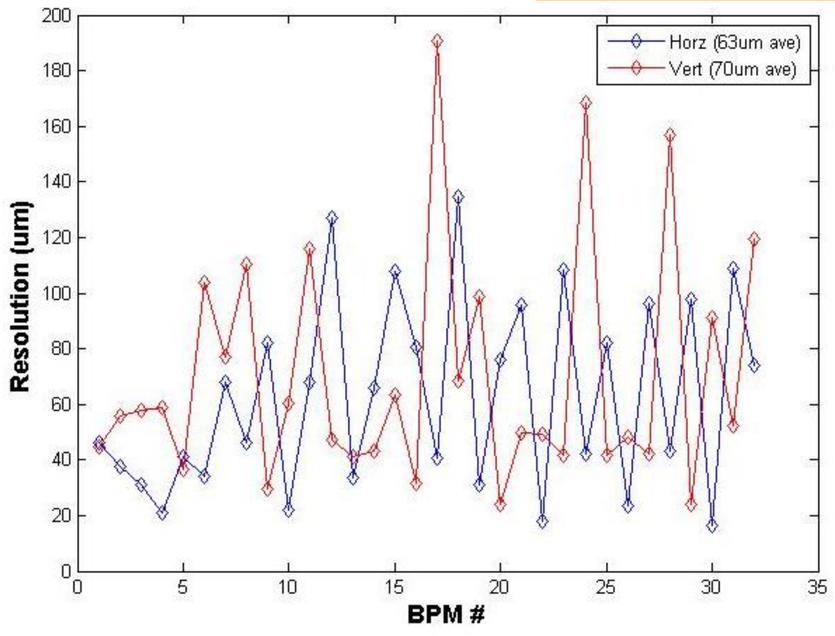




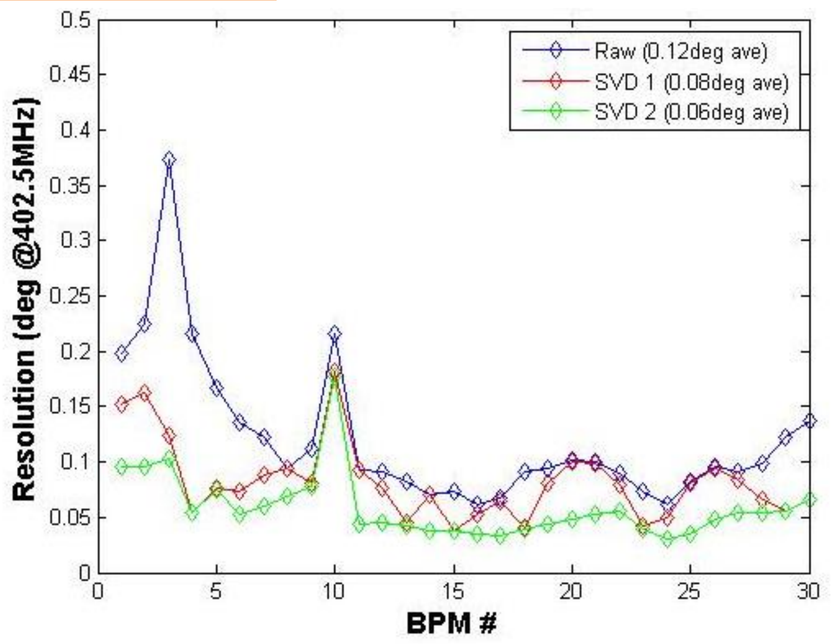




BPM Resolution



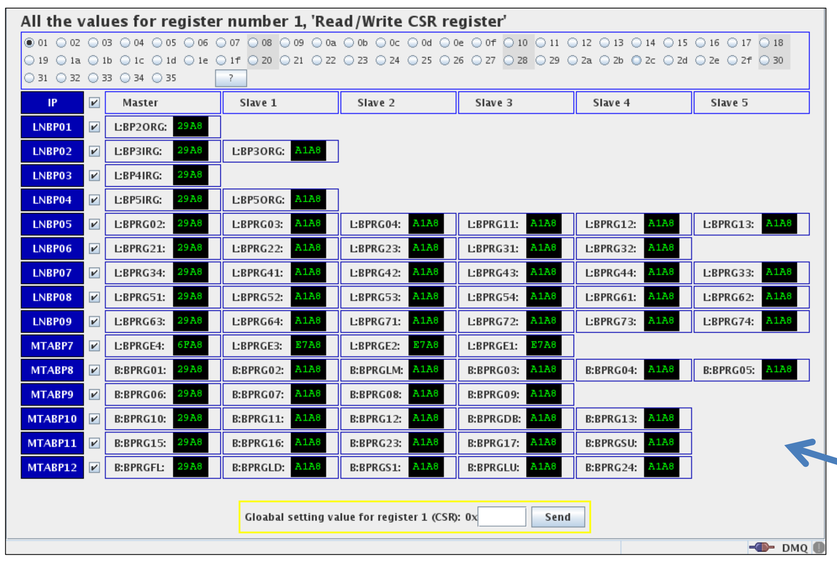
BPM position resolution from SVD analysis

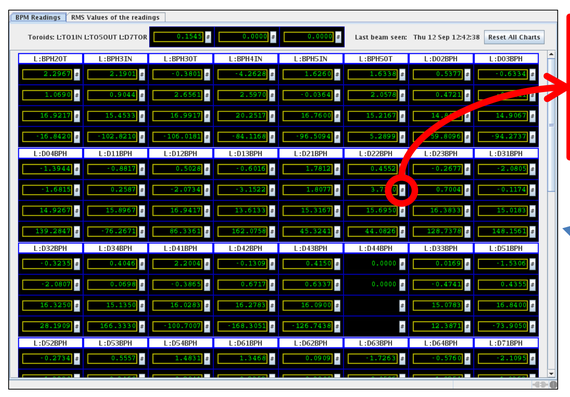


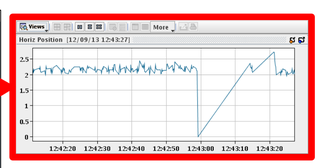
Phase resolution from SVD analysis

Operations Software

In Java







Application	Summary
Linac BPM Simple Display	Show summary data from the BPMs during normal operations
Linac BPM Expert	Display and control of the registers, flash memory and calibration of the BPMs, one BPM at a time.
Linac BPM Expert Overview	Shows the value of one register for each BPM in the entire system. An expert-only application.
Linac BPM Multiplex WF Control	Control the setup of the multiplexed waveforms and show these waveforms. An operations application.
Linac BPM Sync DAQ	Control and display of the Synchronous DAQ Waveforms throughout the system.
Linac BPM All Readings	Show the readings and the RMS deviations of the scalar values produced by all the BPMs. An operations application.