A VME and FPGA Based Data Acquisition System for Intensity Monitors

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Abstract

A universal data acquisition system supporting toroids, DCCTs, Faraday cups, scrapers and other types of instrumentation has been developed for reporting beam intensity measurements to the Fermilab Accelerator Controls System (ACNet). Instances of this front end, supporting dozens of intensity monitor devices have been deployed throughout the Fermilab accelerator complex in the Main Injector, Recycler, Fermilab Accelerator Science and Technology (FAST) facility and the PIP-II Injector Experiment (PXIE). Each front end consists of a VME chassis containing a single board computer (SBC), timing and clock module and one or more 8 to 12-channel digitizer modules. The digitizer modules are based on a Cyclone III FPGA with firmware developed in-house allowing a wide range of flexibility and digital signal processing capability. The front end data acquisition software adds a list of new features to the previous generation allowing users to: take beam intensity measurements at custom points in the acceleration cycle, access waveform data, control machine protection system (MPS) parameters and calculate beam energy loss.

Data Acquisition Front End

- Front End VME system is responsible for acquiring data from intensity monitor devices and delivering measurements to the Fermilab Accelerator Controls System (ACNet)
- Each Front End consists of:
  - VME Crate
  - MVME 5500 Single Board Computer running VxWorks RTOS
  - Timing Module
  - One or more in-house designed digitizer modules
- 8 deployments across Fermilab accelerator complex supporting over two dozen intensity monitors

6U VME Digitizer Module

- In-house design based on Altera Cyclon III FPGA, 125MS/s 8 channel and 250MS/s 12 channel variations
- Supports custom signal processing for calculating beam intensity and current
- Support for pulse-to-pulse and continuous beam intensity measurements
- Provides integrated intensity and beam pulse waveform data
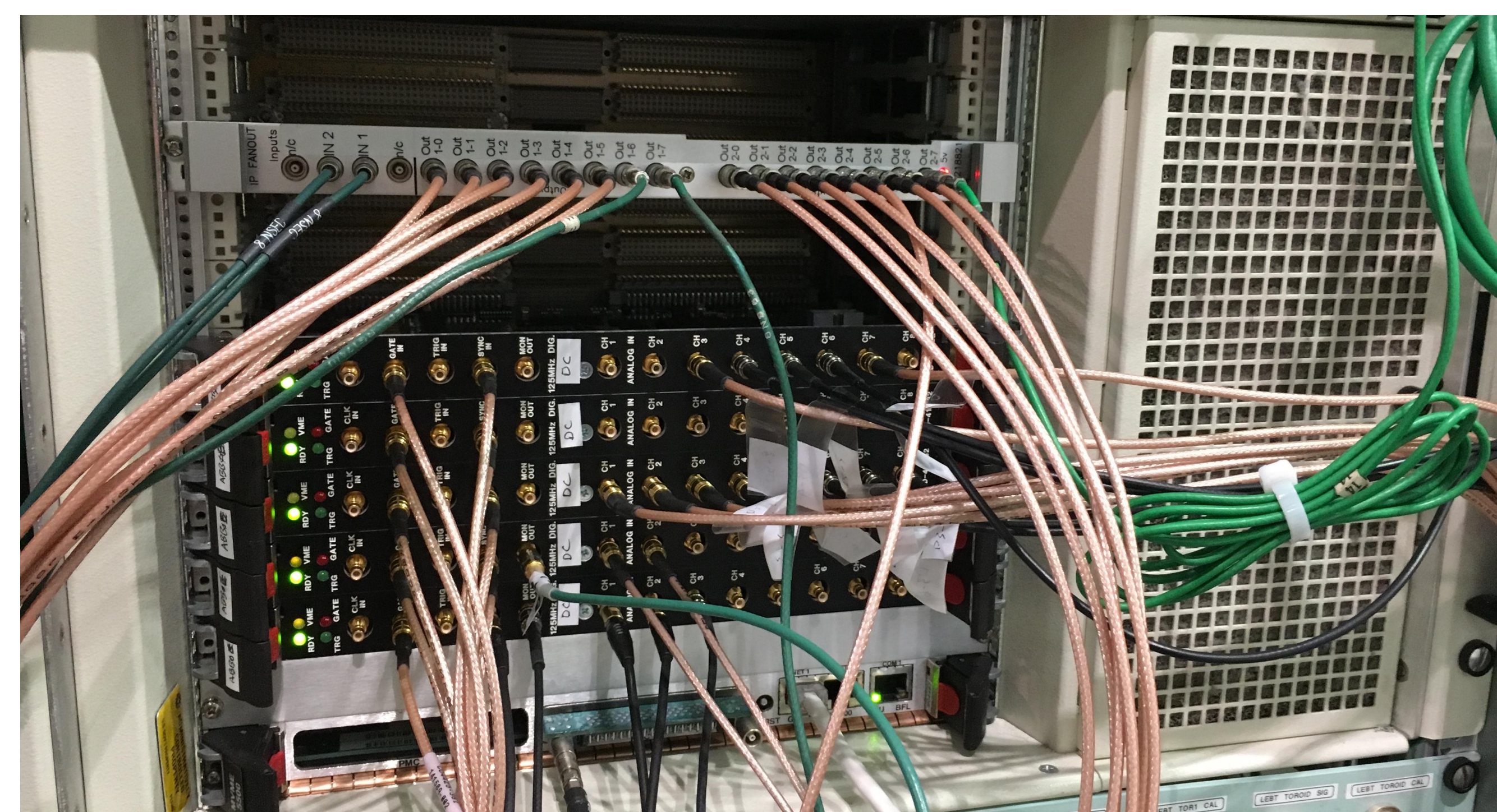
PXIE Intensity Monitor Data Acquisition Front End with 5 VME digitizer modules, timing module and MVME 5500 Single Board Computer
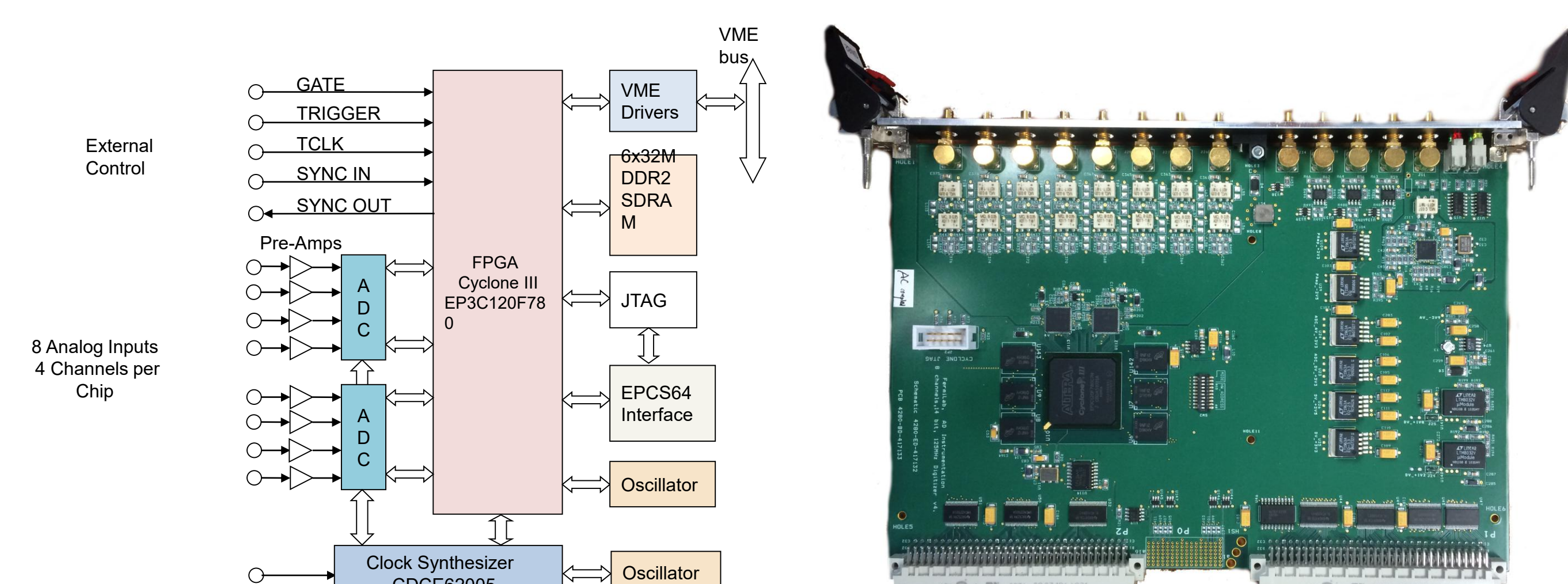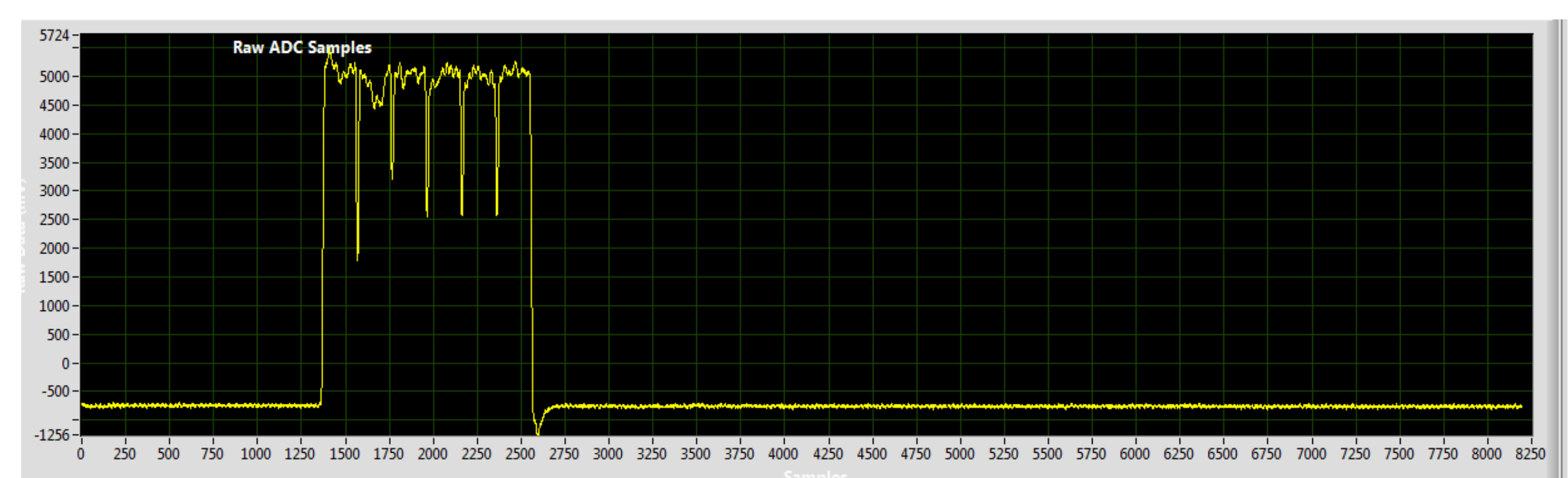

Fermilab Accelerator Division / Instrumentation 125MHz / 8-Channel 6U VME Digitizer Module
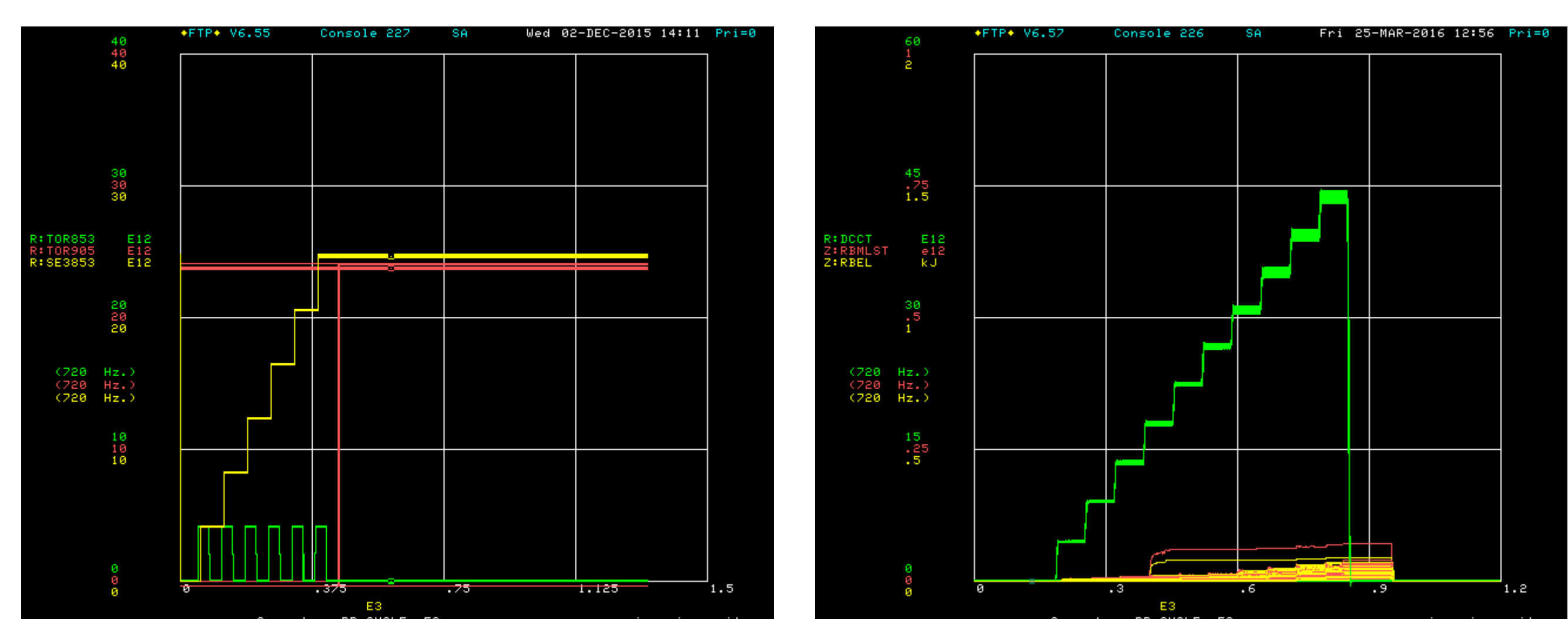
(Left) Real time plot of beam injected into the Recycler from the Booster measured by the injection line toroid and summed to show the total amount of beam injected

(Right) Beam measured by the Recycler DCCT showing injections, beam loss and beam energy loss measurements

Wave form data recorded by the 125MHz / 8-channel digitizer module from the Recycler to Main Inject extraction line toroid showing 6 batches of beam.

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