Booster BLM Upgrade

Booster Group Presentation

September 22, 2011

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What is Not Changing

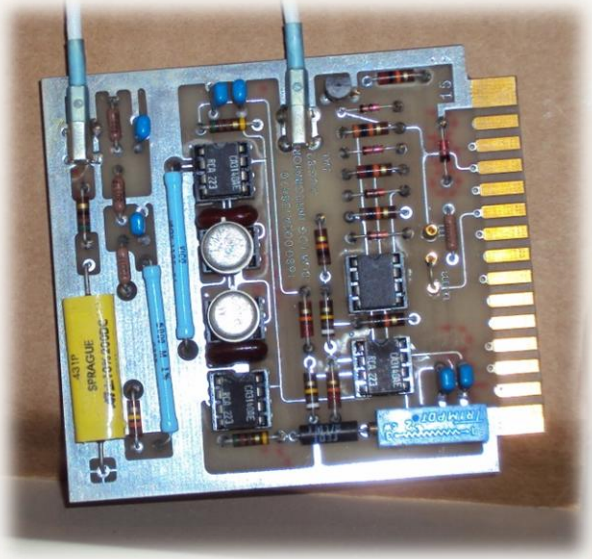
- The loss monitor devices and cabling in the tunnel.
- The high voltage distribution for the loss monitors
- The cabling from the tunnel to the gallery

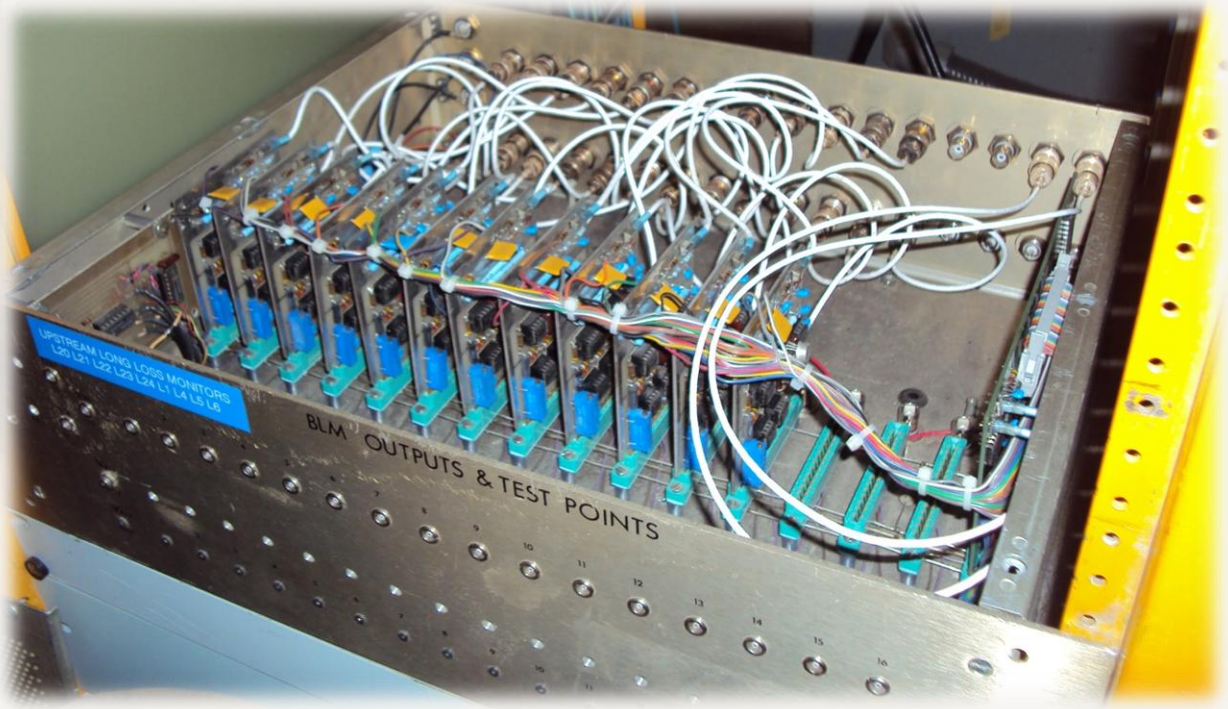
What is Not Changing (cont.)

- The way that BLM readings are displayed in ACNET and the Control Room.
- The ACNET names for the BLM's.
  - However, some IRM names will go away.
- The scaling of the BLM measurements.
- Support for existing applications that use Booster BLM data.

What is Changing

- The 30 year old Log Integrator chassis and daughter boards are going away.





What is Changing (cont.)

- The BLM data will no longer be digitized by MADC's or IRM's.
- Only 60 of the Booster BLM's will be changed initially.

What is Changing (cont.)

- These integrators are being replace with the new VME Integrator Digitizers.

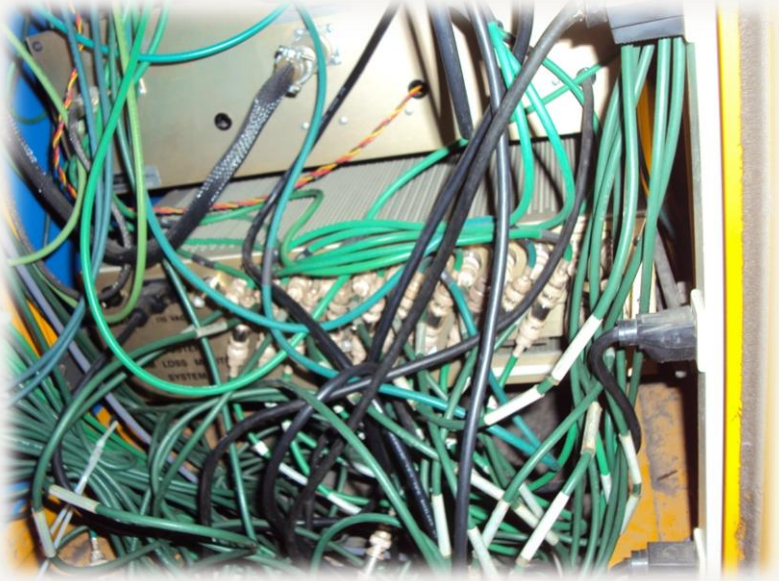
- A new VME front-end processor will collect the data from the Digitizers, process the data into the different forms, and serve the data to ACNET applications

Changes to Racks in the Gallery

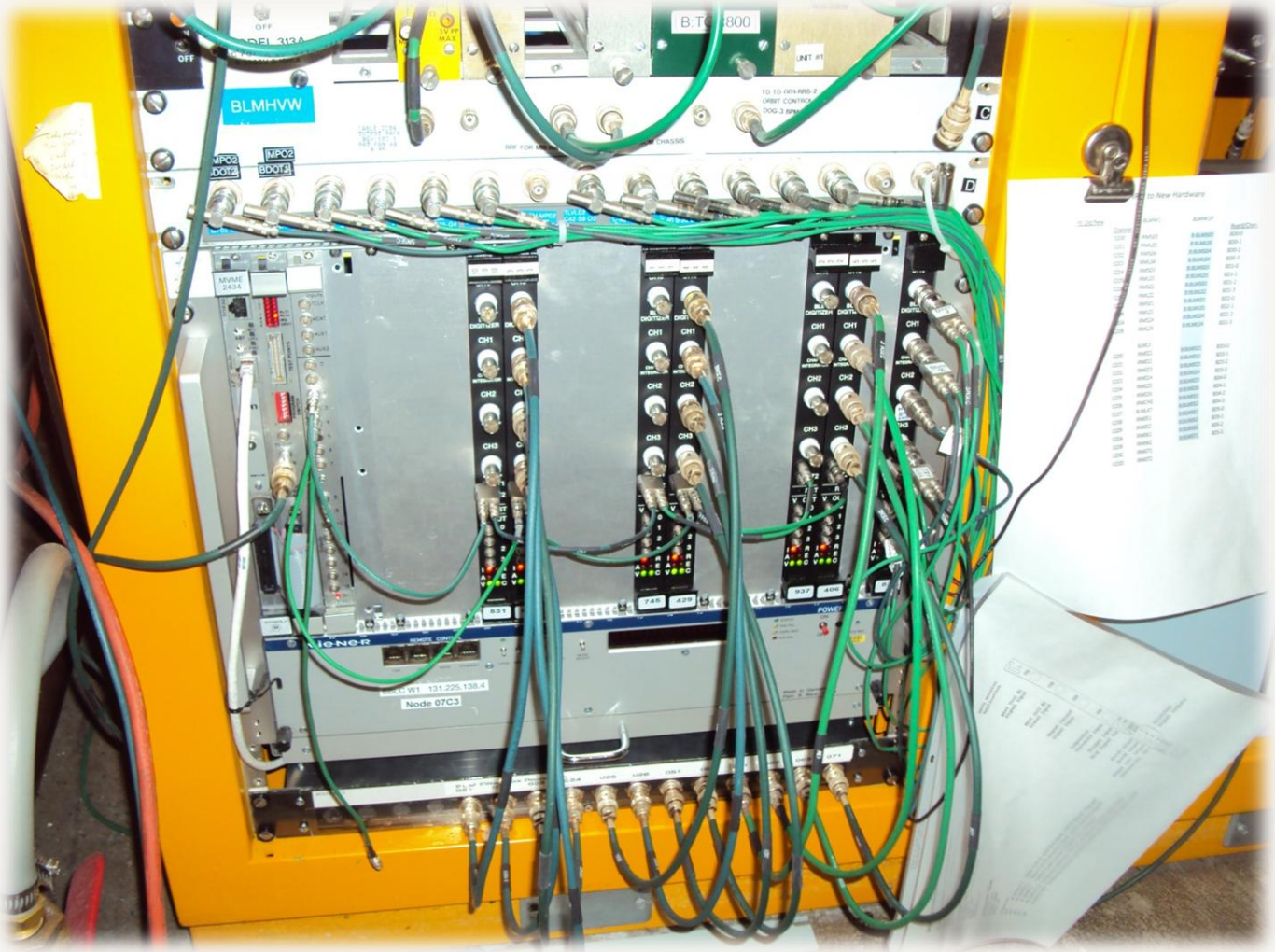
- New VME chassis with the new modules have been (or will be) installed at periods 1, 11, 17 and 20.

Location: G02-RR1

Location: G01-RR6



Location: G01-RR6 New VME Chassis



Location: G11-RR6

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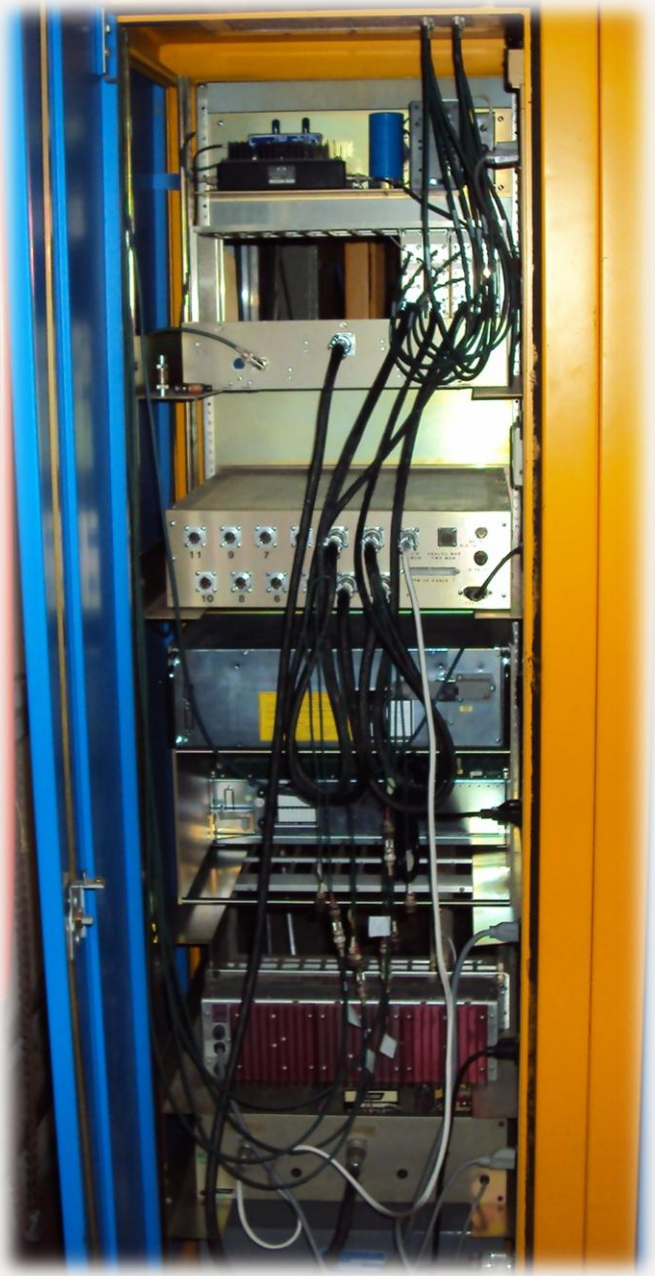
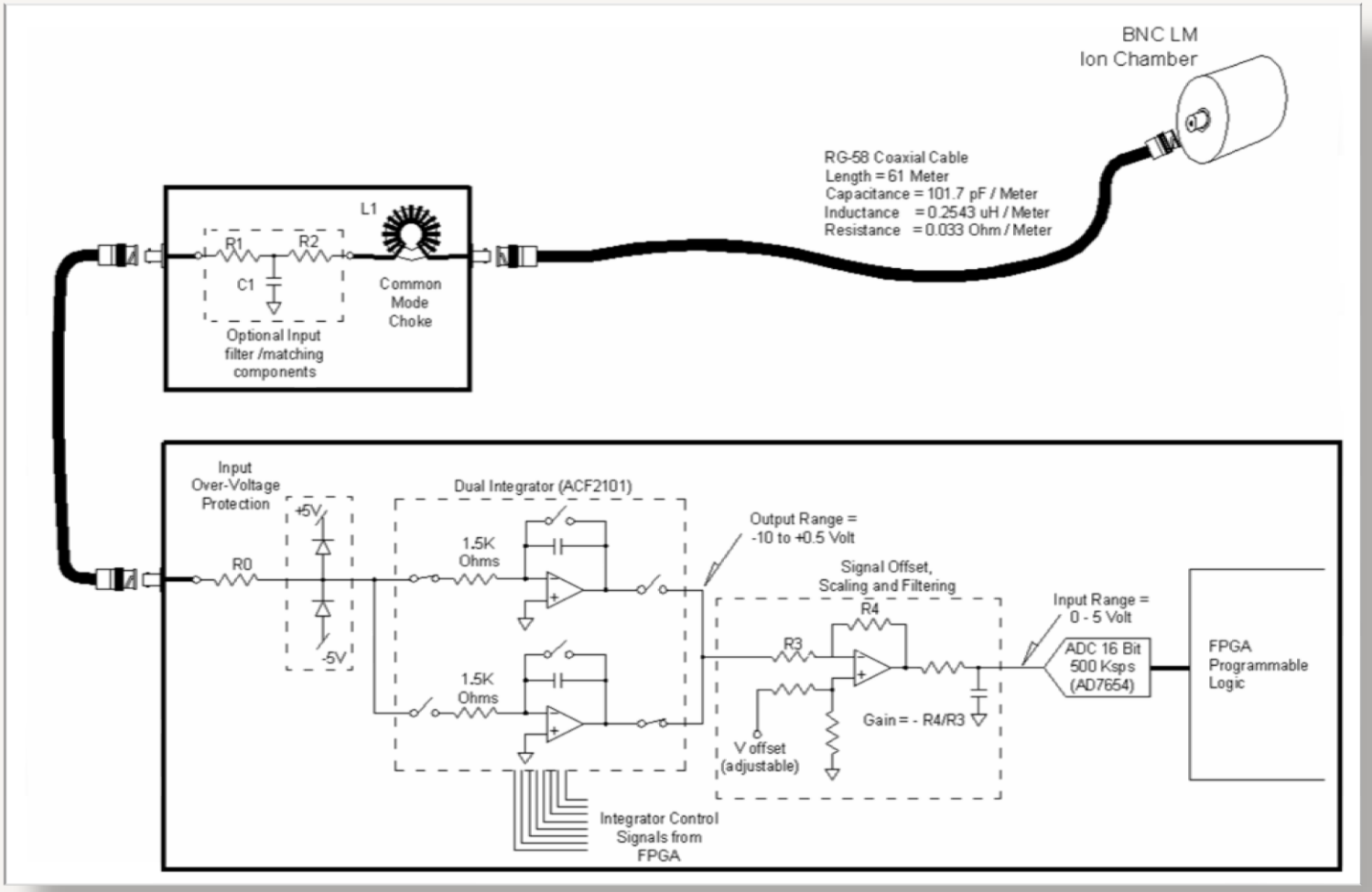


Location: G17-RR2

Location: G20-RR1

How does it work?



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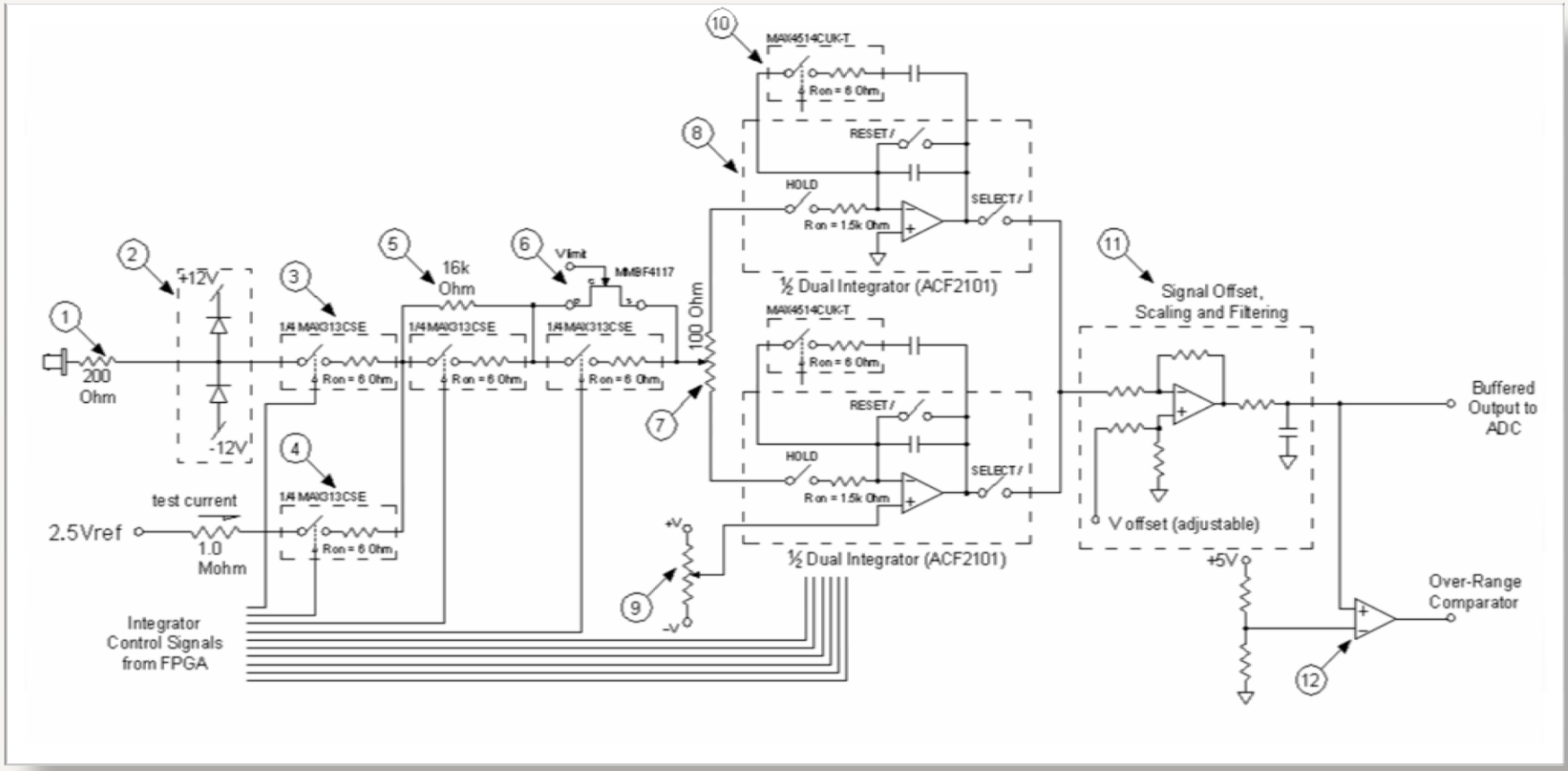
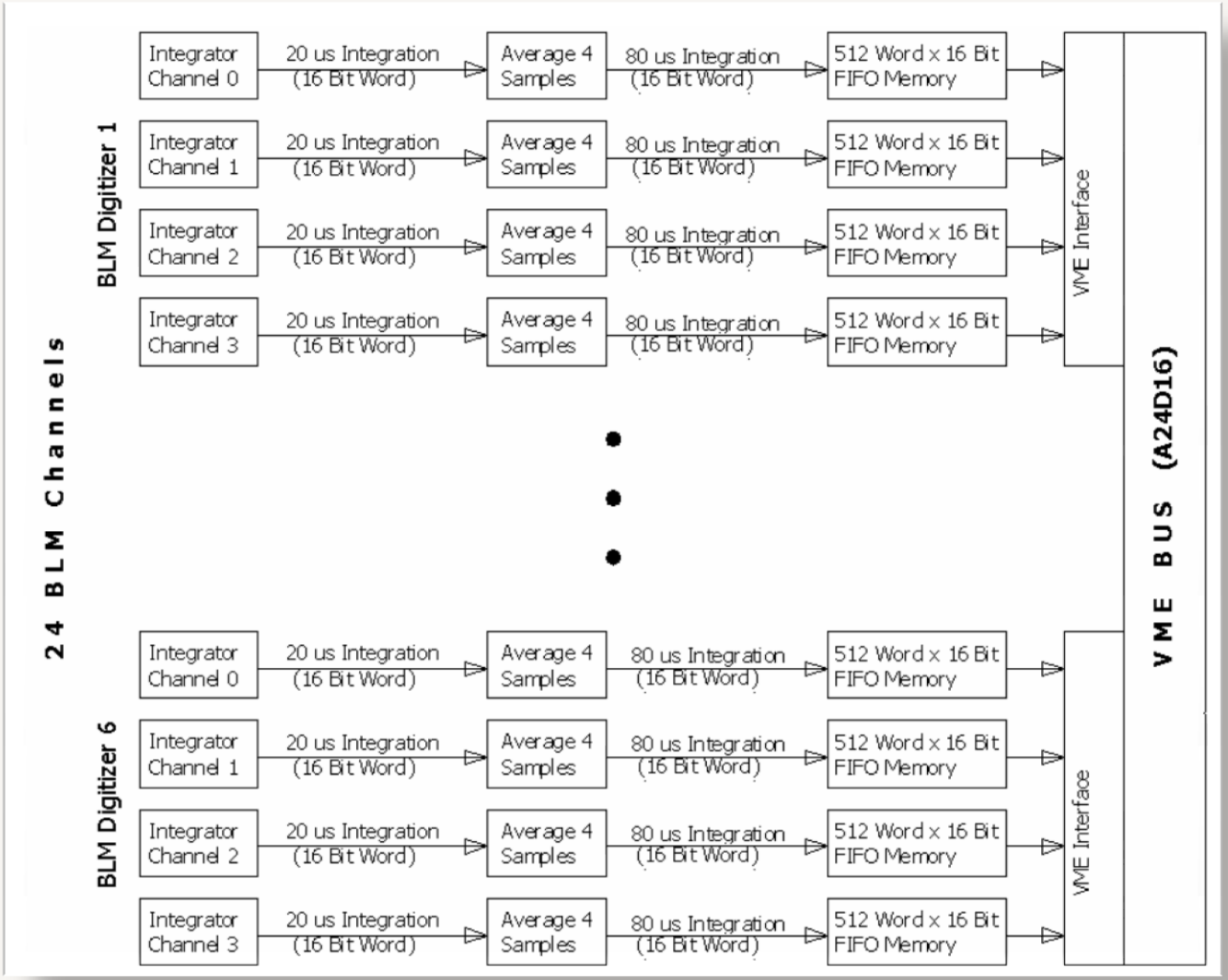


4 Channel Integrator Digitizer

On Board Processing



Front-End Processing

- BLM Data Formats
  - The base 80 us integration samples.
    - Base data for computing the other sums.
  - The full cycle sampled accumulation
    - Data for Snap Shot plots. Used when tuning the Booster.
    - ACNET Devices B:BLMxxx
    - The Log(y[i]) is delivered to ACNET for plotting and pages.

$$y[i] = y[i-1] + float(x[i]), for\ i = 1 \ldots 499$$

$$y[0] = float(x[0])$$

where $y[i]$ are the continuously integrating signal samples and $x[i]$ are the 80 μs integration samples. There is a 500 point buffer of this kind for each of the 24 Booster channels.

Front-End Processing (cont.)

- The 1 ms integration samples
  - Data delivered to the BLM data logging application BLMLOG.
  - ACNET Devices B:BLxxx4 and B:BLxxxD
  - Ref "Booster Loss Monitor Data Logging", K. Cahill March 11, 2002.

Each cycle, the data is summed into 40 each 1 ms sums. That is,

$$w[0] = x[0] + x[1] + \cdots + x[11]\ (sum\ of\ 12\ values)$$

$$w[1] = x[12] + x[12] + \cdots + x[23]\ (sum\ of\ 12\ values)$$

$$w[2] = x[24] + x[25] + \cdots + x[35]\ (sum\ of\ 12\ values)$$

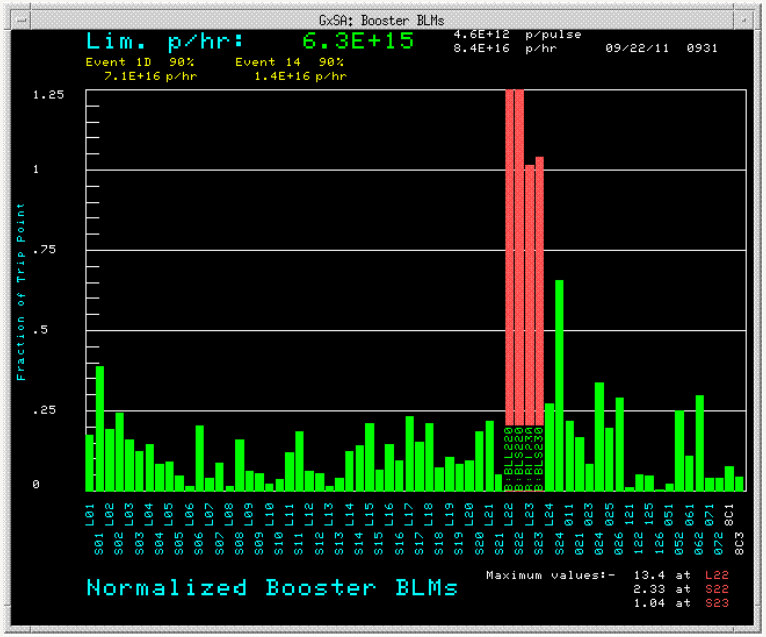
$$\vdots$$

$$w[39] = x[488] + x[489] + \cdots + x[499]\ (sum\ of\ 12\ values)$$

where $w[i]$ are the 1 ms sums. These sums are double precision floating point values. There is a 40 point buffer of this kind for each of the 12 Booster cycle types, for each of the 24 BLM channels in a crate. That is 288 (=12 x 24) of this kind of buffer per crate.

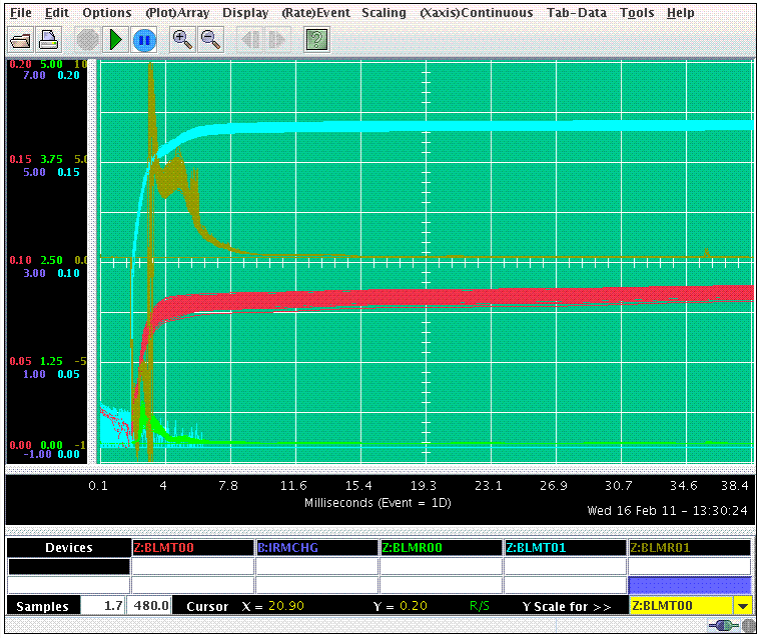
Front-End Processing (cont.)

- The 100 second moving sums
  - Used in Booster performance and BLM Alarms, App. B88.
  - ACNET Devices B:BLxxx0
  - Ref. http://www-ad.fnal.gov/proton/booster/blms

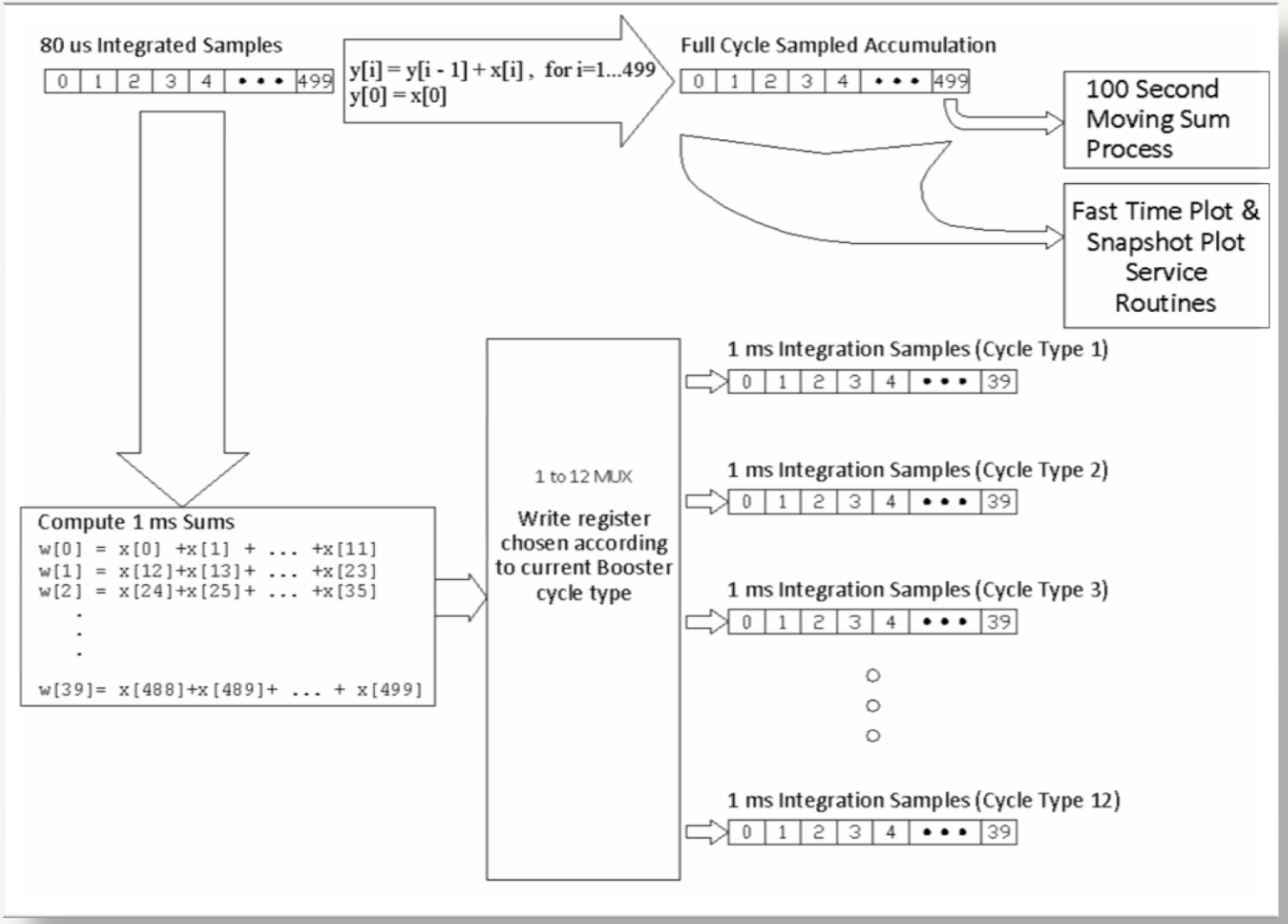


Front-End Processing (cont.)

- The 7.5 Hz Waveform Buffers (RETDAT)
  - IRM process for delivering time stamped data, synchronized across front-ends. Used by App. B136 and other JAVA based programs.
  - Ref. R. Goodwin, "BLM Correlated Data", Nov. 1, 2002

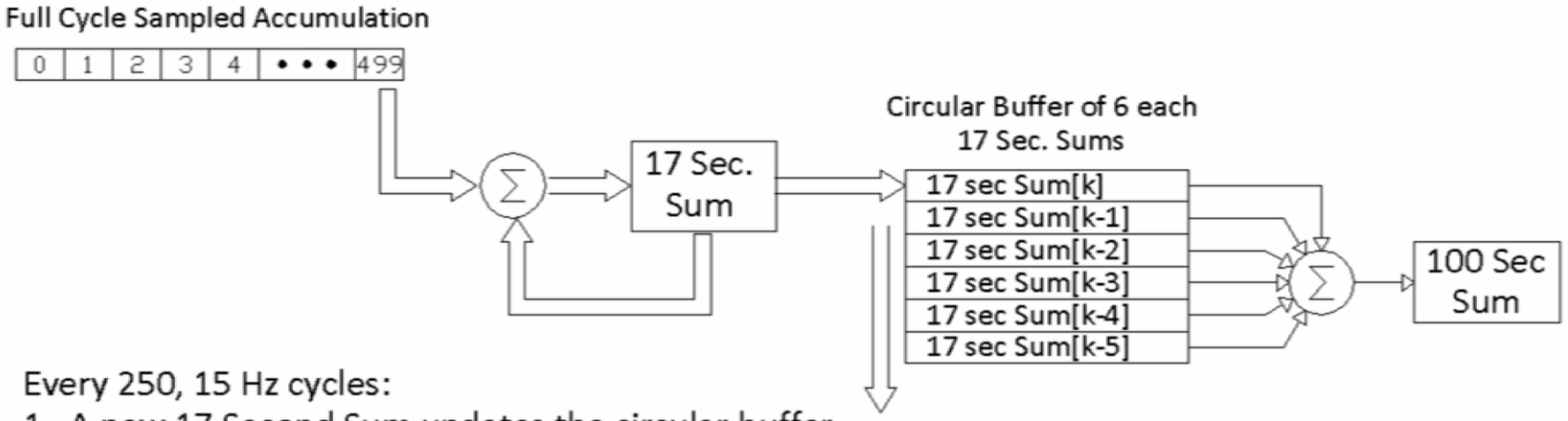


Front-End Processing (cont.)



Front-End Processing (cont.)

100 Second Moving Sum Process



Every 250, 15 Hz cycles:

1. A new 17 Second Sum updates the circular buffer .
2. The 100 Second Sum is updated.
3. The 17 Second Sum register is cleared.

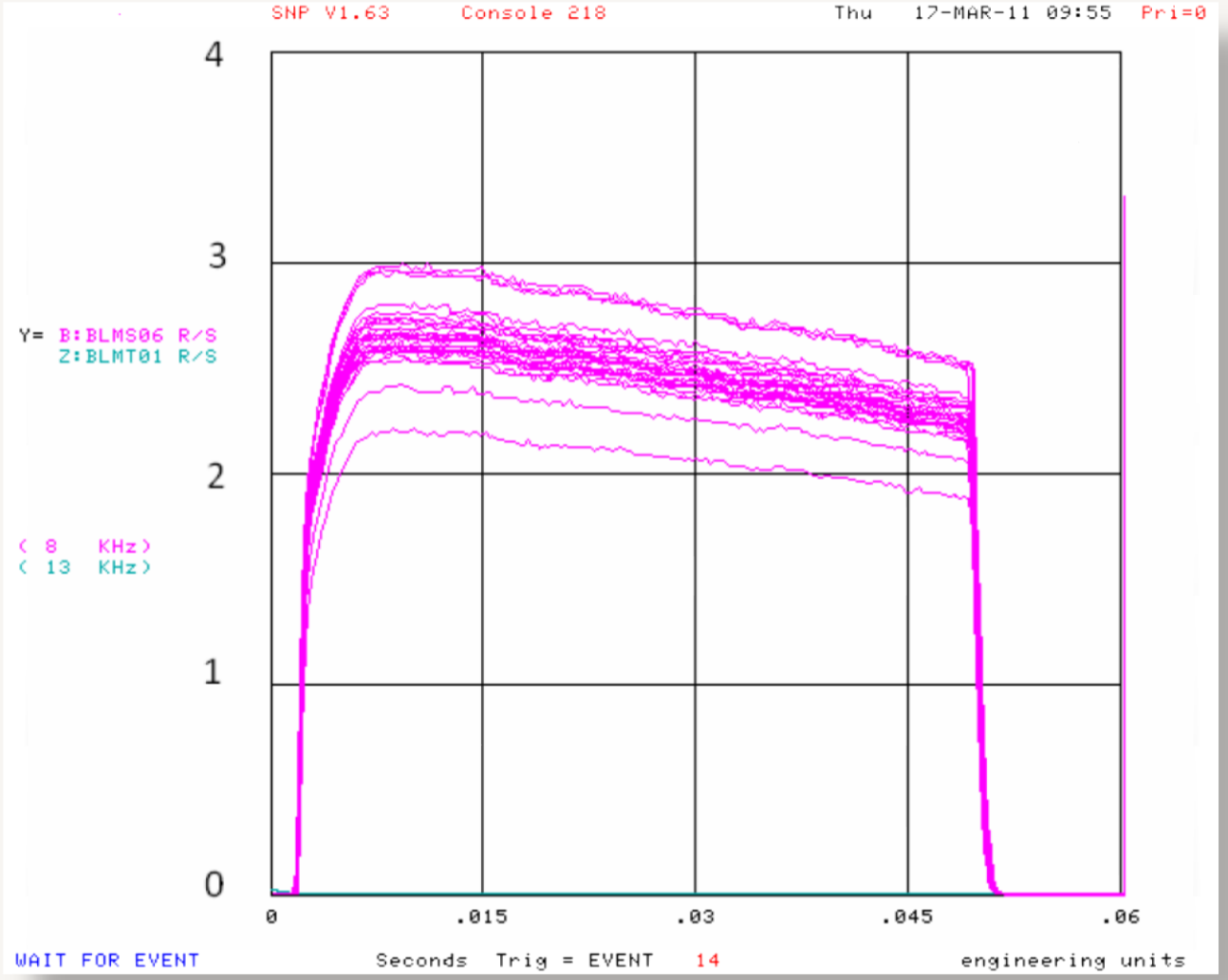
BLM Application Checkup

- Do we know about all the BLM Applications?

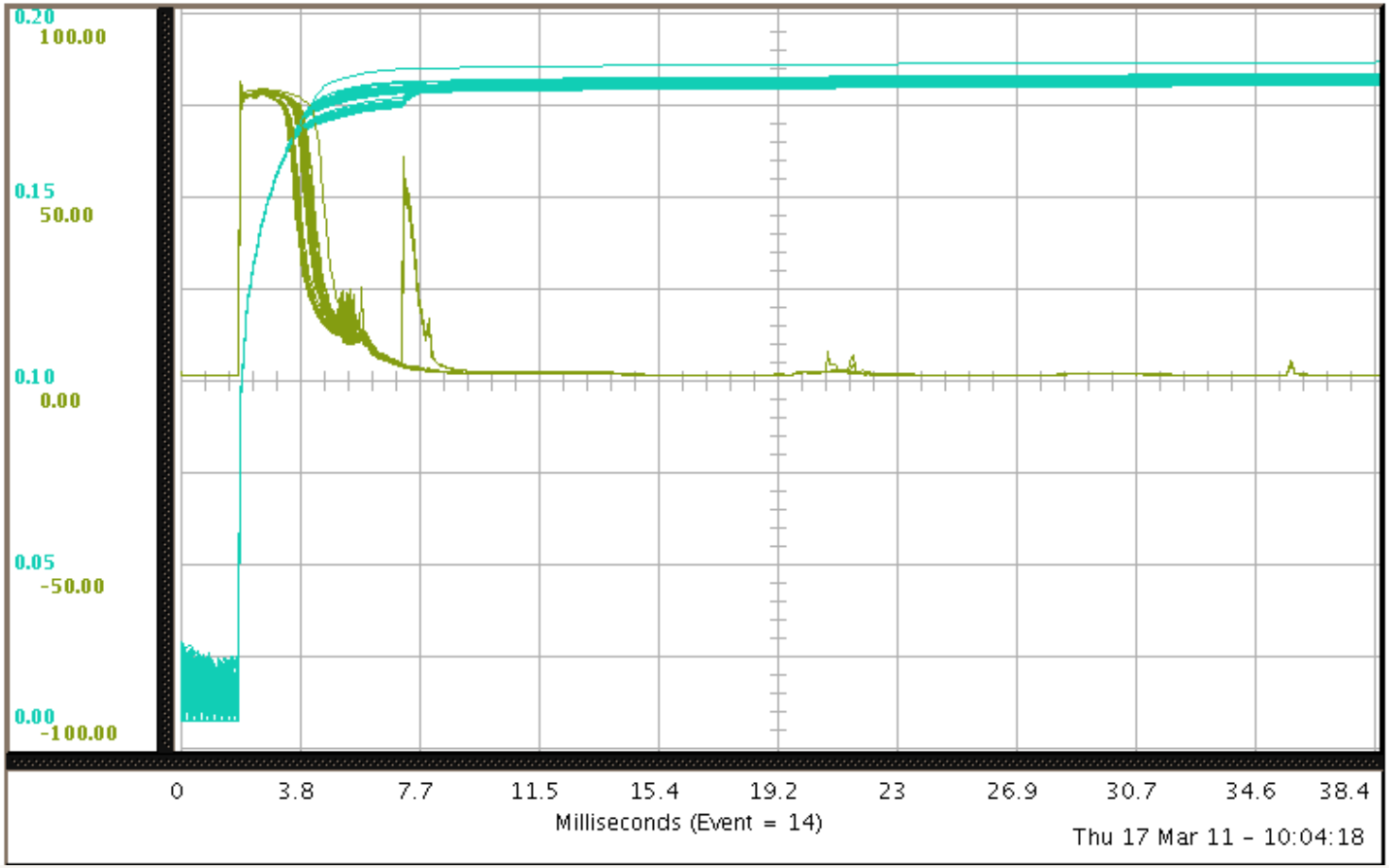
Testing with Booster BLM's

- B:BLMS06

  Rads/Sec



B:BLMS06



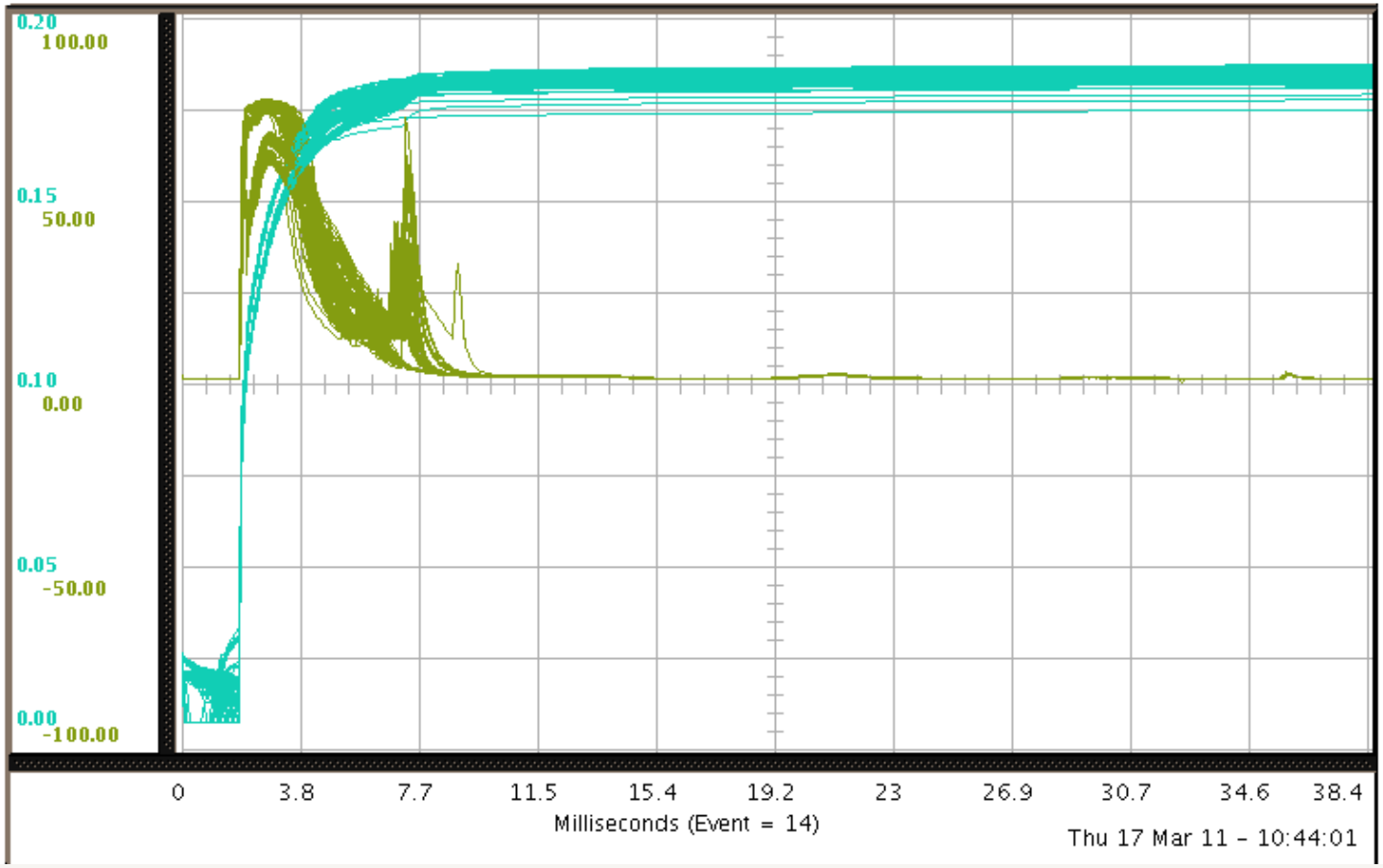
This is the BLMS06 loss monitor signal into the VME Integrator module in the default configuration.

The VME front panel LED indicates that the channel is going into the overrange mode with this signal.

Z:BLMT01 (cyan) is the Log of the integrated (summed) result. The units on this trace are supposed to be rads/second, but we need to look into the scaling.

Z:BLMR01 (olive) is a plot of the 80 microsecond integration samples as read from the VME integraotr FIFO's. The units for the trace are in percent of full scale.

B:BLMS06



In this plot we have the 15k Ohm series resistor preceding different values of capacitors connected from signal to ground.

The capacitor values were 1000pF, 10,000pF and 47,000pF.

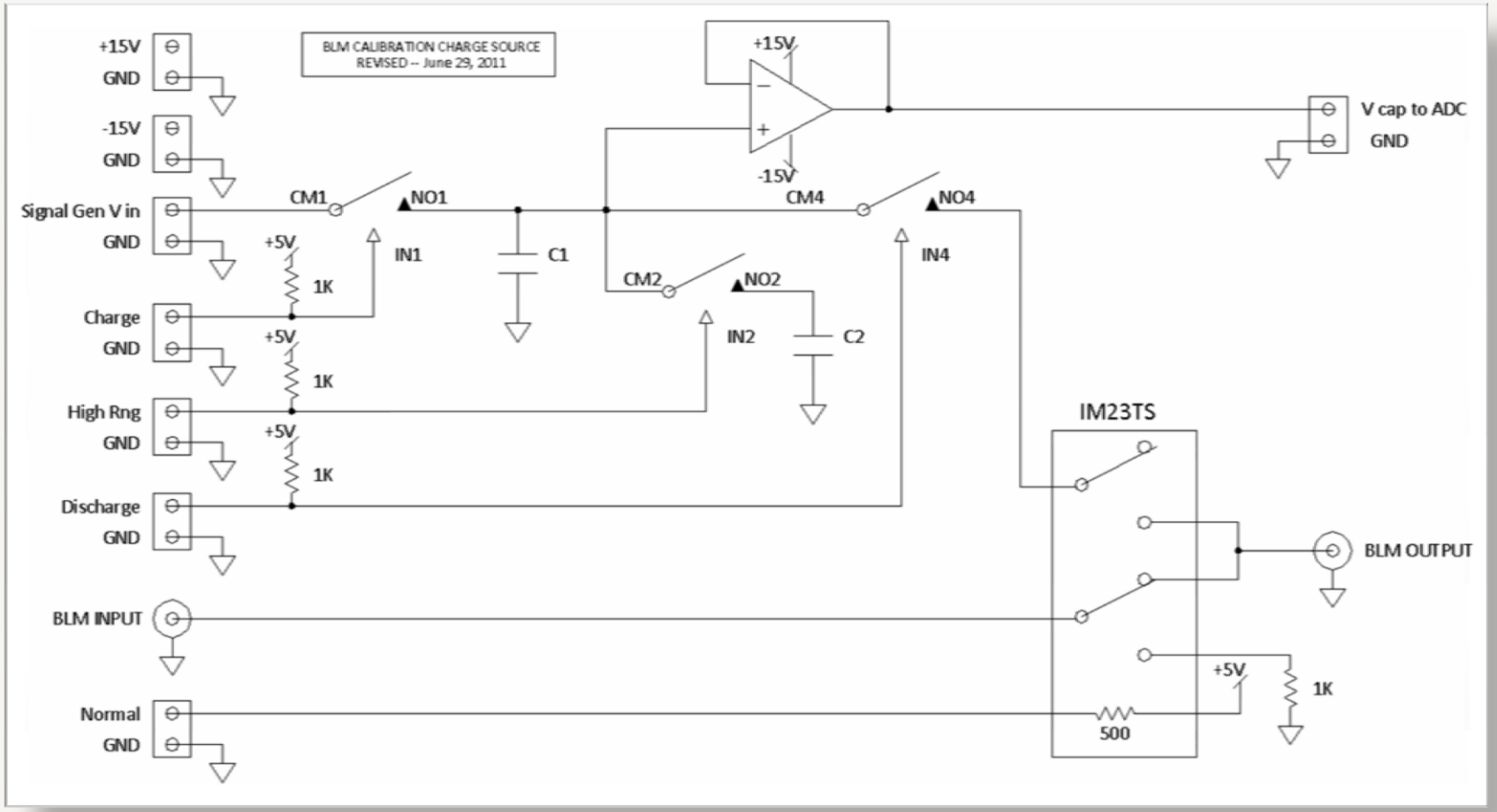
Only the combination of the 15k Ohm and 47,000pF provided enough of a time constant to delay the charge in the initial 80 microsecond integration from triggering an overrange condition in the channel.

Ref. Beams-doc-3795-v1

Ensure The New BLMs are Scaled Like the Current BLMs

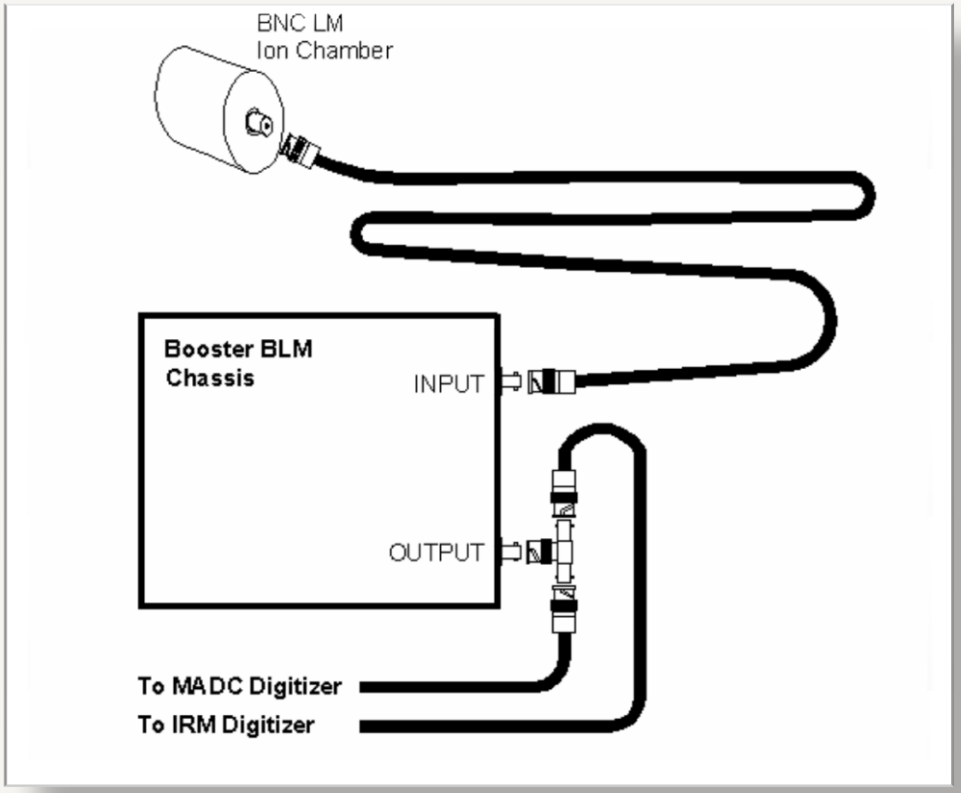
- The current BLMs have been correlated with the activation of areas in the tunnel.
- The new BLMs should be scaled the same as the current BLMs so as not to undo our understand.
- Effort is being made to get an "as-found" measurement of the current BLM's scaling.

Automated Measurement of Log Integrator Scale Factors



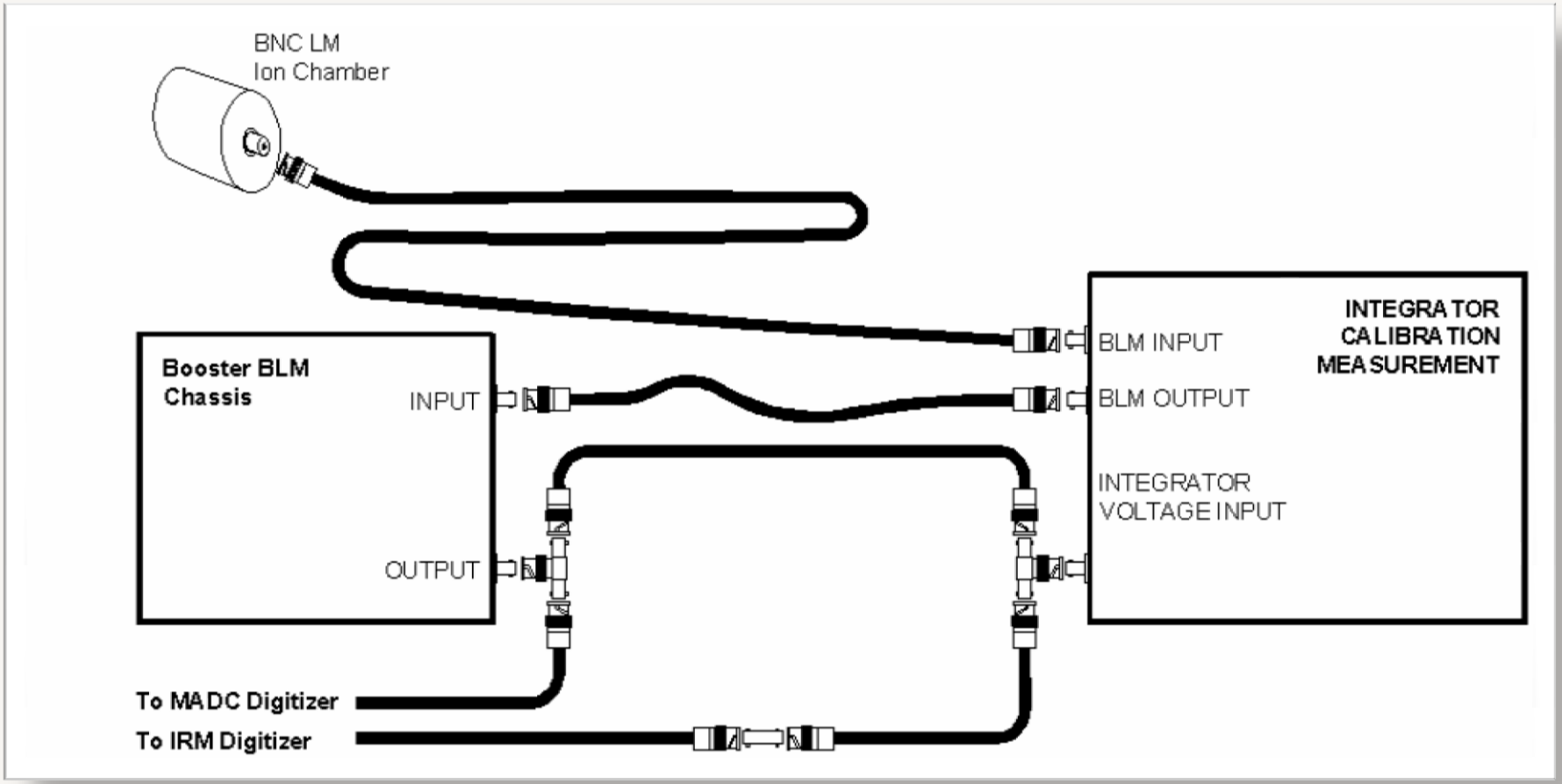
Automated Measurement of Log Integrator Scale Factors

Standard BLM Cabling

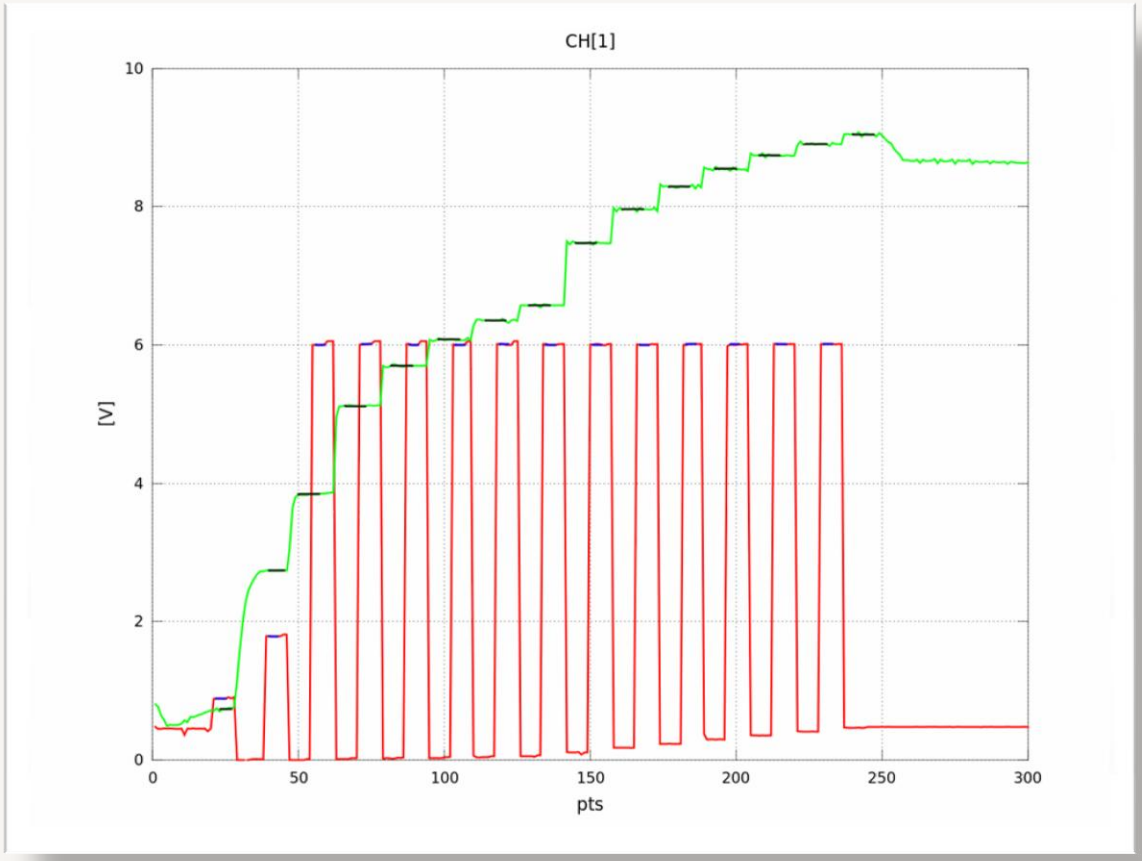


Automated Measurement of Log Integrator Scale Factors

Cabling in 1 of 4 channels into the calibration unit.

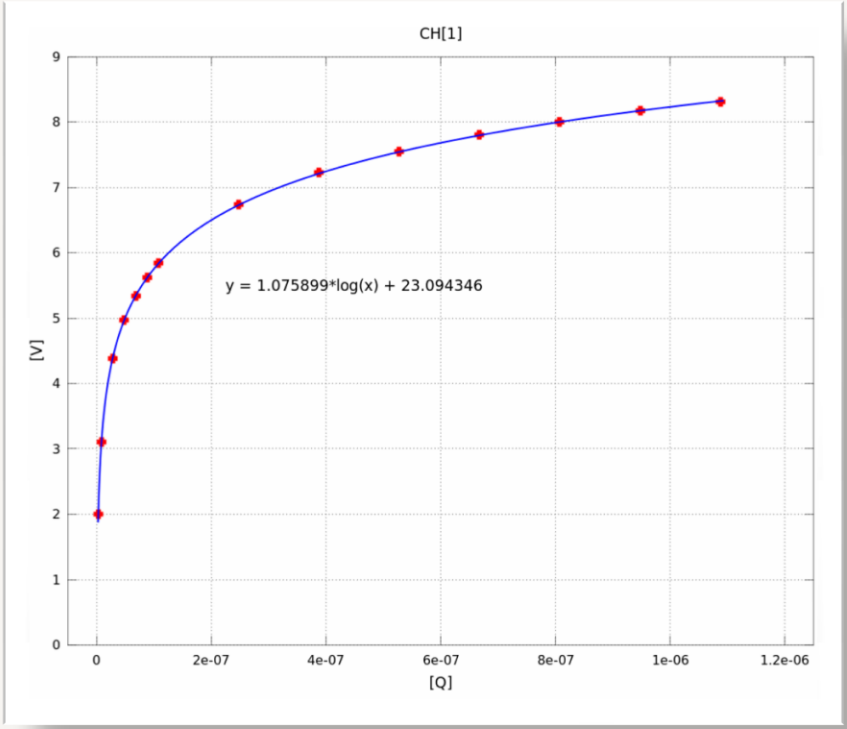


Automated Measurement of Log Integrator Scale Factors

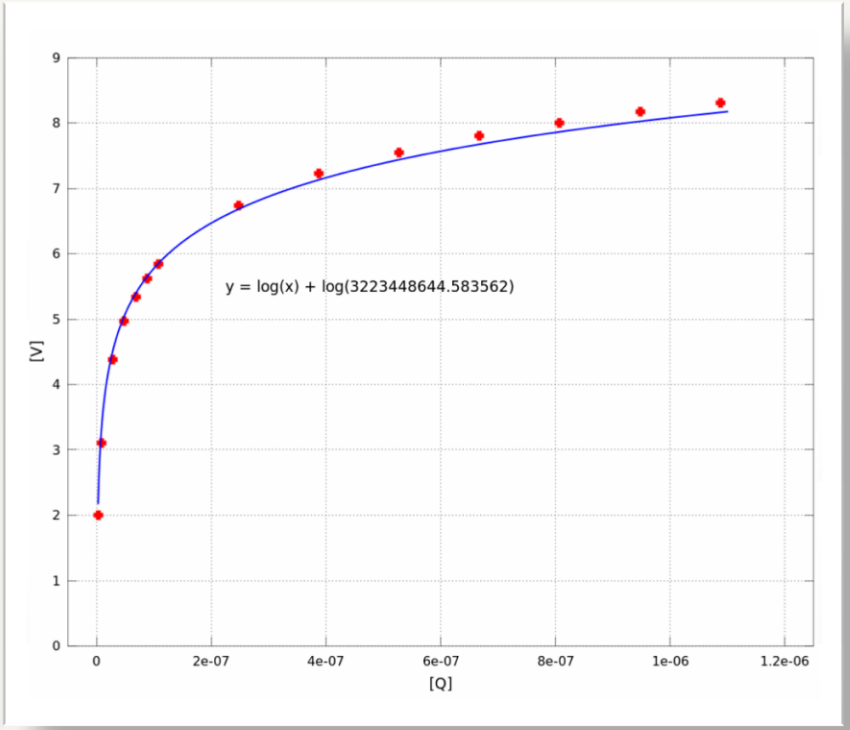


Integrated Output Voltage and Vcap vs. Time

Automated Measurement of Log Integrator Scale Factors

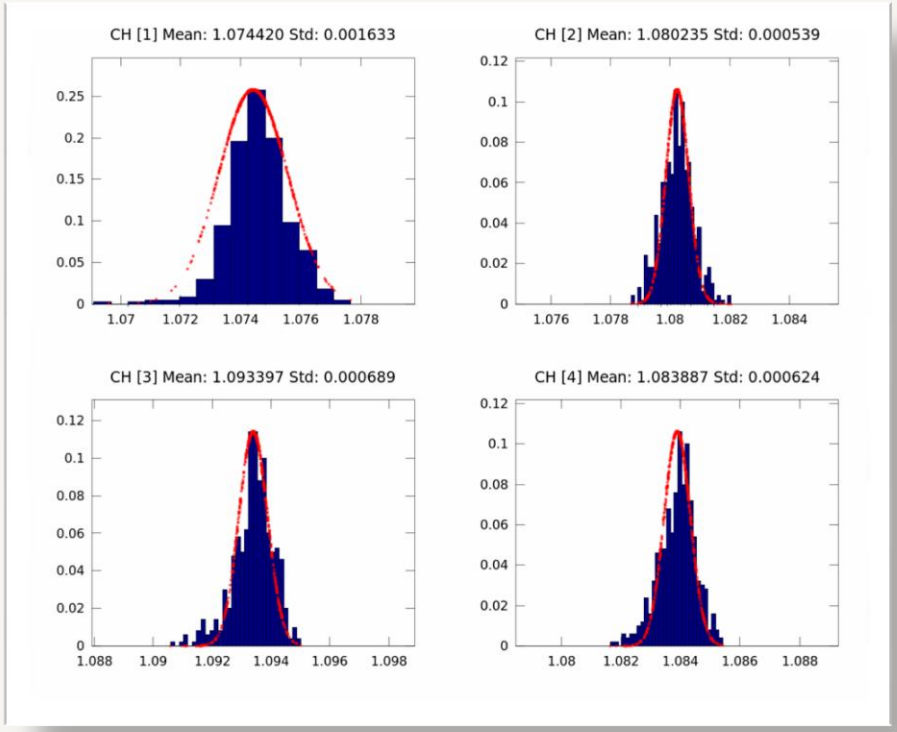


$Y = C1*Log(x) + C2$

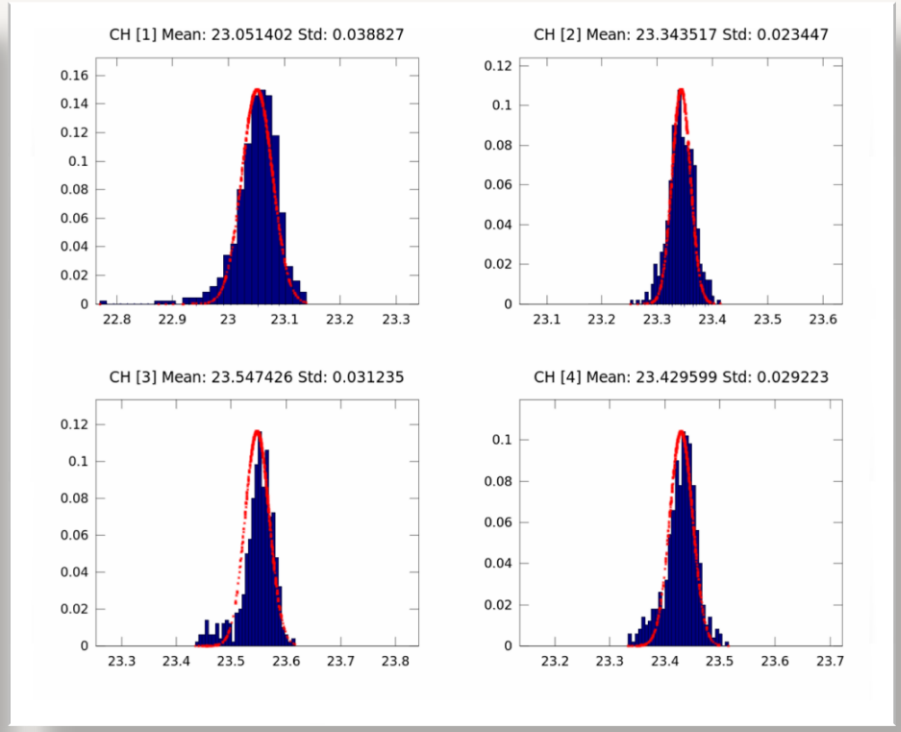


$Y = Log(x) + C2$

Automated Measurement of Log Integrator Scale Factors



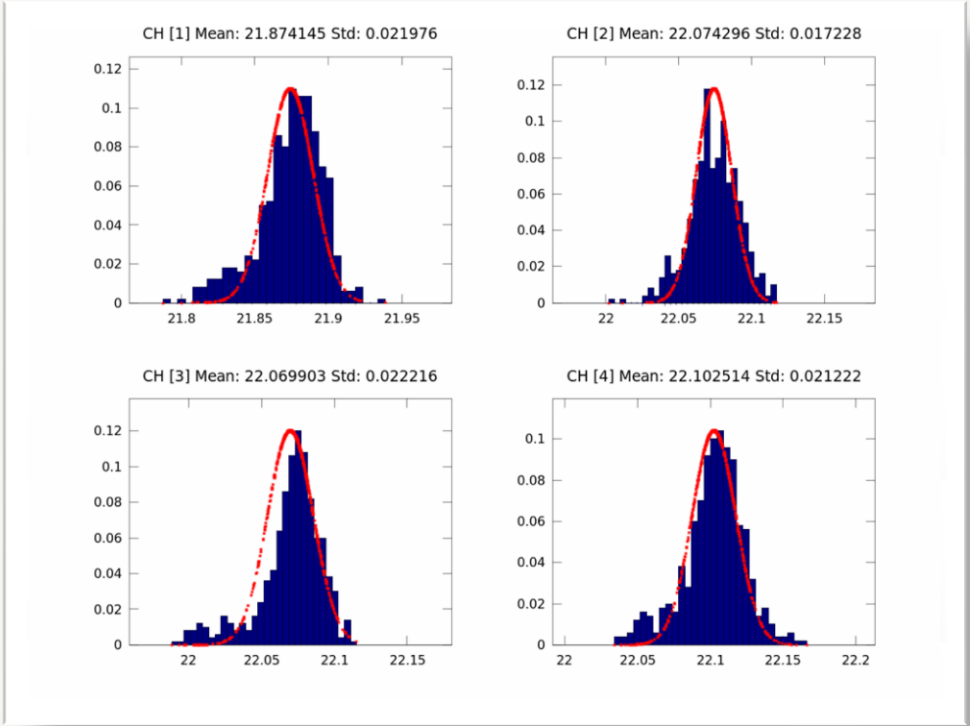
C1



C2

$$Y = C1*\mathrm{Log}(x) + C2$$

Automated Measurement of Log Integrator Scale Factors



C2

$$Y = \mathrm{Log}(x) + C2$$

What's Next ?

- Proceed with the "as-found" measurement of the current BLM Log integrators.
  - Finalize and document the current scaling, scaling for the new integrators and the conversion between the two.

- Program and test the scaling for the new integrators.
  - Temporarily assign "Test" BLM devices to one set of 12 BLMs so that the current system can continue to run.
  - Check that the scaling of the new system gives the desired results by moving the BLM input cables between the old and the new.

What's Next ?

- Make the leap to the new integrators in one location.
  - Dabbel-up the front-end with the final ACNET devices.
  - Move the cables.
  - Evaluate for 1 week.
- Change over the remaining 48 BLMs.
- Get more BLM equipment from the Tevatron and upgrade the remaining Booster BLMs.