5/4/11 - Director’s review for mu2e

6/16/11 - first TLM meeting

6/29 - first 2 TLMs installed with 6 decade rate BLM cards

7/14/11 - first TLM signal

7/19/11 – second meeting

7/19/11 – first BLM integration cards installed

8/18/11 - Chipmunk digitizer circuit installed (Blue box)

8/25/11 – third meeting

8/26/11 - Installed 16 bit VME scalar for higher counting rate from blue box (1 kHz)

9/1/11 - Installed third TLM of different length 103 m (338’)

9/2/11 - Standardized ACNET TLM responses on all electrometers to nC

9/13/11 – changed to 32 bit VME scalar

10/6/11 – Tried to pressurize TLMs – 6 psig 0.1 lpm

10/11/11 – reverted to unpressurized TLMs – 0.05 lpm

10/14/11 - Meeting with ES&H Section to get turnover for blue box construction

10/18/11 – Strategy for setting trip levels becomes apparent

10/26/11 – installed 1’ TLM at A2B7

10/31/11 – begin plateau measurements – suggested by ES&H section

10/31/11 – Established remote operation of TLM HV supply

11/18/11 – sequencer driven data collection for plateaus established

11-21/11 – low and medium intensity plateaus completed

11/23/11 – TOR910 rescaled for high intensity

12/8/11 – Marv provides 6517B electrometer for high intensity plateaus – suggested by ES&H section

12/8/11 – ES&H Section requests charge collection time measurement (TLMS on scope terminated in to 50 Ω)

12/15/11 – 4th meeting

12/21/11 – Started data collection for high intensity plateaus with 6517B

1/3/12 – nonlinear response of TLMs at high intensity becomes a concern

1/5/12 – observed HV sag for high intensity pulses

1/5/12 - measured TLM response with scope terminated into 50 ohms

1/6/12 - added in line capacitance to HV supply to reduce HV sag

1/9/12 - Started making measurements with 6517B in voltage mode using capacitor voltage divider circuit

2/1/12 – Finished draft of TLM dynamic range requirements document

2/3/12 – General TLM requirements drafted (P. Czarapata)

2/10/12 – 5th meeting

2/14/12 – TLM web page created

4/11 to 4/19/12 - Collected TLM response data for 1’, 10’, 125’, 250’ TLM at three intensities (2 decade range)

2/14/12 - Created TLM web page

4/11/12 to 4/19/12

Repositioned 125’ TLM to make measurement at A2B7

Built & installed 10’ TLM

Installed 1’ TLM

Completed plateaus for 10’, 125’, and 250’ TLMs

three intensities plateaus

With the beam loss at A2B7

Compare with 338’ high intensity response

Completed 1’ TLM plateau for middle intensity

Determined TLM detector end effects are not significant

6/12/12 - Developed plan for making TLMs leak-tight for detector gas (mu2e conceptual design)

7/18/12 – 6th meeting

Outlined basic design features for the TLM system, detector and electrometer

7-18-12 to 8-14-12

Meeting 7

Concurrence that scaling described in dynamic range requirement document is correct (Sam)

Produced a note on TLM background observations (Tony)

New parts for next generation TLM (Gianni)

Obtained quote for heartbeat resistor (Dan)

Ordered resistor for heartbeat (Dave)

Retrieved 10’ TLM to prepare for installation at LINAC (Dave/Tony)

10-12-12

Meeting 8

Developed and implemented heartbeat resistor in a test detector

Defined project responsibilities

Developed systems integration diagram for use with TLMs

11-27-12

Meeting 9

Completed detector preliminary design

Developed TLM over-range protection scheme

Began design search for digital and analog electrometers

Made 25 sets of TLM parts

12-20-12

Began prototype testing of digital electrometer design with 10’ TLM at Linac

2-13-13

Meeting 10

Discussed analog and digital prototype designs

Reported on progress for MARS calculations to support TLM applications

Initiated work on TLM electrometer block diagram

Developed complete project schedule for prototype development, testing, and ES&H approval Scheduled Project completion for February 2014

Identified resources:

 Analog electrometer designer – Dan Schoo

 Digital electrometer designer – Dave Peterson

lead engineer - Dave Peterson

electrometer support board logic designer - Glen Federwitz

drafting & board layout - Rick Divelbiss

board construction - Instrumentation Department or Interlocks Group

3-11-13

Dan’s version 1 analog electrometer prototype is installed in place of Dave’s digital design

3-15-13

A meeting was held with the ES&H Section to describe a TLM application example. We are encouraged to continue development work.

4-22-13

Dan’s version 2 analog electrometer prototype is installed on the LINAC TLM in place of the version 1 model.

6-17-13

LINAC TLM detector and all equipment are removed from the LINAC. The electrometer test continues at the NuMI Stub LLM.

7/11/13

Pbar TLMs are rebuilt using the mu2e preliminary design incorporating the heartbeat resistor. Background testing of the heartbeat resistor continues at pbar.

7/16/13

Electrometer board has been designed and drafting has made drawings. Purchase orders have been written (weeks ago) and parts for the board are ordered. Prototype electrometer boards are being produced. The monitor board electronics is being designed. Comparators, HV bias supply and other components have been identified for the monitor board.

7/23/13

A 178.5 foot TLM is constructed for installation in the Booster. The detector is staged in the Booster East Gallery and connected to ACNET to establish detector behavior (background run) with Argon gas and a bias of 500 volts.

8/1/13

178.5 foot TLM is installed in Booster at Periods 10-12 for a series of Beam studies.

8/19/13

Booster TLM detector gas is changed from argon to argon/CO2 and detector bias is changed to 800 volts.

8/23/13 – 1/13/14

The parallel set of LLMs are converted to TLMs. A long series of tests and system modifications are undertaken for the NuMI TLM detectors (4) connected in series. Humidity and atmospheric pressure variation is discounted as a source of background fluctuation while the grounding of interconnecting cables which create the series arrangement results in stable background counting rates. Gas system separation for LLM/TLM systems contributes to reaching expected background counting rate.

10/29/13

Documented” Booster 400 MeV TLM studies” – Beams-doc-4437-v5

11/7/13

Documented “TLM Response to a Booster High Field Beam Loss” – Beams doc-4478-v2

11/8/13

Documented “TLM Detector Response as a Function of Beam Loss Location” – Beams doc-4482-v1

12/5/13

Posted “TLM Electrometer Preliminary Design” Beams doc-4491-v1 actually created at an earlier date

2/5/14

Posted “TLM cable background measurements” Beams doc 4532.-v1 actually created at an earlier date

2/6/14

Posted “Preliminary Test Results, Dynamic Range Requirements, and TLM Electrometer Requirements for TLM Systems at Fermilab” Beams doc 4532-v1

2/12/14

Documented “TLM Cable Leakage Current, Expected Service Life, and Upper Limit of Detection” Beams doc-4539-v1

2/28/14

Documented “Comparison of 3 TLM Detector Responses in Parallel and Series Arrangements” Beams doc-4549-v1

3/23/14

Documented “Total Loss Monitor Response as a Function of Particle Fluence” Beams doc-4559-v1

4/1/14

Disconnected the three PBAR TLMs from HV supply and electrometers. Detector cables are uninstalled and stored during muon campus reconfiguration activities.

4/1/14

Resumed operation of the Booster L10 to S12 TLM.

4/3/14

10 foot TLM detector is installed at NML just downstream of the electron gun. A comparison of TLM response with scarecrow response is eventually developed. The question of a portable radiation check source is explored and answered.

4/15/14

Begin testing of full implementation, TLM electrometer chassis at ESH&Q Environmental chamber (ongoing as of 8/25/14)

**5/6/14**

**Received Preliminary Approval for TLM system from ESH&Q Section**

5/20/14

Full implementation TLM electrometer chassis is connected to the Booster Period 10-12 TLM detector

5/22/14

Installed TLM gas flow meter on Booster TLM on detector upstream gas inlet

6/1/14

Correlation of TLM & chipmunk response for NML electron gun installation determined

7/11/18

Installed 4 TLM detectors and 3 prototype electrometers at NML Cryomodule

7/22/14

Rerouted TLM flow meter to Booster Period 10-12 at gas outlet (nominal position)

7/22/14

Rerouted gas supply plumbing and restored argon/CO2 gas flow to NuMI TLMs following an extended period (3 months) of loss of detector gas flow. The effects of loss of detector gas flow can be observed.

7/23/14

Purchasing action begins for TLM detector cable, full coverage of the Booster Ring

8/21/14

Removed Booster TLM at Period 10-12 from service in preparation for installation of the Booster ring-wide, permanent TLM systems.