

November 2004 Report of the Tevatron BPM Upgrade  
wbs item 1.4.5.4 of the Run 2 Luminosity Upgrade Project  
Bob Webber, Stephen Wolbers  
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**Project Manager's Summary:**

The first TeV BPM upgrade crate was installed in the A3 service building on November 23. This crate consists of a VME crate, crate controller, 4 Echotek boards, 4 filter boards (prototype but functionally identical to the final design) and a timing card (also functionally identical to the final design). Cables and cable routing are also meant to be identical to the final design. The intent of the project is to be prepared for first beam in the Tevatron after the shutdown and to use it to commission the Tevatron BPM upgrade.

In November the project placed orders for the fabrication of the 150 filter boards and 38 timing boards. These boards are expected in early January, 2005. At that time the remaining 26 production crates can be assembled, tested, installed and commissioned.

All hardware required for the project except for the filter and timing boards, mentioned above, and for VME crate monitoring hardware, has arrived and most of the individual components have been tested. The Echotek boards (150) showed problems in testing that was identified and is believed to have been resolved by firmware updates to the FPGA. A few boards had hardware failures and were returned. Sample and some batch testing of the analog filters showed some problems with phase-matching of some filter pairs. The results are being transmitted to Lark for debugging and resolution. All of the 6 foot and 4 inch cables were tested for continuity/shorts and physical integrity. A handful (out of approximately 2000) cables failed and will be sent back for replacement.

A great deal of effort was devoted in November to commissioning preparations. A detailed note on all of the different modes of operation was developed and discussed and updated. Work to code the necessary software in the front-end, Echotek and online systems all proceeded. Calibration and diagnostics were investigated in some detail with the goal of implementing both as quickly as possible as the system is commissioned.

Work continues to investigate alternative schemes of making measurements by using different filtering and averaging in the Echotek and the front-end. It is expected that these techniques will be further investigated as the commissioning continues.

It is expected that 4 abstracts about the Tevatron BPM Upgrade will be submitted to the 2005 Particle Accelerator Conference.

### Resources Used in November 2004:

The total number of FTE-months devoted to the project in calendar November 2004 from the Computing Division was reported to be 9.9 FTE-months with 24 people contributing. The total number of FTE-months devoted to the project from the Accelerator Division was 1.8 FTE-months with 8 people contributing. The total effort from both Divisions was 11.7 FTE-months. The following table gives the estimated or reported effort for both divisions (in FTE-months) since August of 2003.

<u>Month</u>	<u>AD Effort</u>	<u>CD Effort</u>	<u>Total Effort</u>
August, 2003	1.2	2.3	3.5
September, 2003	1.4	4.1	5.5
October, 2003	5.4	6.0	11.4
November, 2003	1.6	5.0	6.6
December, 2003	1.4	4.4	5.8
January, 2004	1.7	5.1	6.8
February, 2004	2.3	6.7	9.0
March, 2004	2.1	7.6	9.7
April, 2004	2.0	7.7	9.4
May, 2004	1.4	8.3	9.7
June, 2004	1.6	8.7	10.3
July, 2004	2.0	8.1	10.1
August, 2004	1.5	8.0	9.5
September, 2004	2.3	8.4	10.7
October, 2004	1.1	10.5	11.6
November, 2004	1.8	9.9	11.7
SUM (through Nov)	30.8	110.8	141.6

The effort is consistent with the wbs estimates of approximately 10-12 FTE per month during this period. The effort listed here is time worked and does not include vacation, sick leave, holidays, etc.

**Purchase requisitions/procard obligations in November, 2004:**

<b>Req #/PO/Fermi</b>	<b>PO Date</b>	<b>Item</b>	<b>Cost</b>
<i>PO560711/175326+176277</i>	<i>11/18/04</i>	<i>TGF fabrication</i>	<i>\$53,105</i>
<i>PRN57014</i>	<i>11/17/04</i>	<i>Digikey parts</i>	<i>\$34</i>
<i>PO560712/175335</i>	<i>11/18/04</i>	<i>Filter card fabrication</i>	<i>\$20,482</i>
<i>PRN57279</i>	<i>11/24/04</i>	<i>Filter card components</i>	<i>\$177</i>

**Milestones:**

No DOE milestones in November, 2004.

**Meetings held, Reports Given:**

Meetings were held in November on the following dates:

Project Meetings: November 1,3,4,10,11,15,17,18,22,24.

**Documents:**

The following documents were written and added to the Accelerator Division Document Database in November:

[1114-v11 Test the Modified EchoTek Board Vince Pavlicek et. al. 29 Nov 2004](#)

[1060-v4 Tevatron BPM Online Software Specification Brian S. Hendricks 29 Nov 2004](#)

[1101-v8 Tevatron Beam Position Monitor Upgrade Offline Software Specification Robert K Kutschke 29 Nov 2004](#)

[1067-v19 Tevatron BPM Software Design Luciano Piccoli et. al. 29 Nov 2004](#)

[1381-v10 Echotek Board and Other Hardware Testing Status Timothy J. Kasza 24 Nov 2004](#)

[1381-v9 Echotek Board and Other Hardware Testing Status Timothy J. Kasza 17 Nov 2004](#)

[1381-v8 Echotek Board and Other Hardware Testing Status Timothy J. Kasza 10 Nov 2004](#)

[1381-v7 Echotek Board and Other Hardware Testing Status Timothy J. Kasza 3 Nov 2004](#)

[792-v10 Minutes from the Tevatron BPM Upgrade Project Meetings](#) [Steve Wolbers](#) *et. al.* 23 Nov 2004

[1451-v2 BPM Calibration Discussion](#) [Robert K Kutschke](#) 22 Nov 2004

[1451-v1 BPM Calibration Discussion](#) [Robert K Kutschke](#) 15 Nov 2004

[1067-v18 Tevatron BPM Software Design](#) [Luciano Piccoli](#) *et. al.* 18 Nov 2004

[1101-v8 Tevatron Beam Position Monitor Upgrade Offline Software Specification](#) [Robert K Kutschke](#) 18 Nov 2004

[1060-v4 Tevatron BPM Online Software Specification](#) [Brian S. Hendricks](#) 18 Nov 2004

[1114-v11 Test the Modified EchoTek Board](#) [Vince Pavlicek](#) *et. al.* 18 Nov 2004

[1463-v2 Transfer Line BPM upgrade Timing Generator Module Test Report](#) [Nathan Eddy](#) 17 Nov 2004

[1300-v1 Next Look at the New Echotek Boards in A3](#) [Robert K Kutschke](#) 15 Nov 2004

[1306-v1 Phase Pattern with the New Echotek Board](#) [Robert K Kutschke](#) 15 Nov 2004

[1434-v1 TeV BPM Upgrade: A Look at Uncoalesced Batches](#) [Robert K Kutschke](#) 15 Nov 2004

[1448-v1 How Mismatched Phases on the BPM Cables Affect Position Measurement](#) [Robert K Kutschke](#) 15 Nov 2004

[1414-v3 First Echotek readout with the "envelope" filter](#) [Gustavo Cancelo](#) *et. al.* 15 Nov 2004

[1450-v1 Tevatron BPM Modes of Operation](#) [Jim Steimel](#) 15 Nov 2004

[1446-v1 First Turn Timing in TeV BPM](#) [Jim Steimel](#) 12 Nov 2004

[1445-v1 Filter Board Measurements](#) [Vince Pavlicek](#) *et. al.* 11 Nov 2004

[1444-v1 Cable tests \(TeV BPM\)](#) [Marv Olson](#) *et. al.* 11 Nov 2004

[1358-v2 TeV BPM Data Registers](#) [Michael A. Martens](#) *et. al.* 04 Nov 2004

[1276-v2 Tevatron BPM Front End Software User's Guide](#) [Margaret E Votava](#) *et. al.* 04 Nov 2004

[1433-v1 Lark Filters Phase Matching Acceptance Test Data](#) [Tom Boes](#) 03 Nov 2004

[1431-v1 TeV BPM Upgrade](#) [Steve Wolbers](#) 02 Nov 2004

## **Subproject Leader Reports:**

### **Technical Coordinator: Jim Steimel**

This month was spent preparing the A3 service building and the BPM electronics for pilot installation and commissioning. The A3 crate was assembled and tested at FCC3. The crate was installed at A3 prior to the Thanksgiving holiday. Some problems with crate interrupts and back-plane communication were resolved simultaneously with beam arriving in the Tevatron following the shutdown. Work continues on the A3 system to provide reliable closed orbit positions to Tevatron operations.

### **Front-end/DAQ software: Margaret Votava**

During the month of November the DAQ group has made progress in the following areas: TCLK handling, raw data readout, timestamps, first turn measurement, production timing and filter boards testing. The A3 house commissioning required debugging and tuning.

The TCLK handling software section has been completed. It is in sync with the timing board firmware and is able to handle up to 16 different TCLKs. During the process the tests revealed that the TCLK interrupt could not be used with one of the interrupt registers of the timing board. There was a firmware fix that allowed TCLK interrupts to be used with any register.

Raw ACNET devices were added to the front-end, making it possible to retrieve I and Q values. It contains the same metadata as the devices that retrieve position and intensity information.

The timing board now provides the timestamp for turn-by-turn measurements. The counter is cleared at a specified BSYNC event and it counts at 106MHz. The timestamp for each turn is calculated by the processor taking in consideration the house and board delays. The channel delays are not yet functional.

The first turn measurement was [re]defined and implemented. There are two turn-by-turn buffers, the injection turn-by-turn and the regular turn-by-turn buffer. The later can be reused during a shot while the former contains data from the first turn only. The elements of the injection turn-by-turn buffer are available as position and intensity through the ACNET flash frame. The production tests for the timing and filter boards were defined. The group implemented most of the filter board testing and added more features to the timing board test.

On the A3 house commissioning work was performed to prepare the front-end by defining the ACNET variables for the system. A few name conflicts with old system variables were corrected (position and intensity FTP variables).

A couple of problems arose during the commissioning process. The first was due to the

timing board not decoding the turn markers, therefore avoiding data to be read out from the EchoTek boards. The following problem was more difficult to detect and could be solved after duplicating it on the FCC test stand. It was related to interrupt handling in the timing board firmware.

Other minor improvements were made on the front-end software that include: work on states devices; modification of the slow abort buffer to contain the average of the last hundred elements from the fast abort buffer; addition of TCLKs to clear profile and display buffers; ACNET return error value fixes; and definition of acquisition specification for the diagnostics application.

### **Online software: Brian Hendricks**

During the past month several bugs were found and fixed in the BPMUTI library. Also, the first database script to convert a house from the old system to the new was completed to begin commissioning of house A3. This file will now serve as the template for future houses. The page T39 display program (PA1048) has been modified to support all new data frame types and work is now underway to support a proton/pbar data retrieval switch. The page W25 diagnostic application was updated to support the acquisition specification. That program is complete except for the support for crate status readbacks which is waiting for hardware and front end software support to proceed. The T100 and W68 turn by turn display programs have been relinked and should be ready to read data.

### **Offline software: Rob Kutschke**

I used data taken before the shutdown to compare the closed orbit measurement made by the BPM, when the beam is in batch mode, to that made when the beam is in bunchmode. Aside from the known intensity dependent effects, the BPM system produces the same results for both batch and bunch operation. This was written up as Beams-doc-1434.

I calculated the position bias which results from a phase mismatch between the A and B signals. Using a simplified model, the effect is estimated to be of the order of tens microns per degree of phase shift at 53.1~MHz. The system is designed to have, at most, a few degrees of phase mismatch between any AB pair. Moreover it is expected that any phase mismatches in the system will be roughly constant in time. Therefore, so long as the system is manufactured to its design, this effect is well below the threshold for being important. However it will be necessary to be aware of this effect if boards or cables are swapped.

I discussed the calculation with Gustavo Cancelo who believes that the simplified model is sufficient for estimating the scale of the effect and that a more complete calculation is not necessary. This work is written up as Beams-doc-1448.

I started work on a plan for the calibration of the deployed system. This work has been discussed at two meetings of the BPM team. The working document for this study is Beams-doc-1451.

I completed the work begun in October to compare the response of the BPM system.

**Hardware tracking/testing: Tim Kasza**

Hardware tracking and testing for the month of November focused mainly on the testing of EchoTek A/D boards. The final number of the 150 TEV-BPM EchoTek boards were delivered, tagged and entered into CD's equipment tracking database (equipdb). In response to testing issues of bad raw ADC on random channels, EchoTek rolled out a new firmware update. Overall, acceptance testing has been proceeding with significantly fewer issues after installation of the new firmware. Next month, we will focus our effort toward installing the new firmware to boards (with old firmware) that previously passed acceptance testing. A small number of these boards will be retested to evaluate any gain differences per channel. To-date, 5 boards with LSB issues (fails Differential Non-Linearity) have been sent back to EchoTek for repair.

The remaining cables for the TEV-BPM upgrade project have been delivered. A small number of cables (6 foot and 4 inch) failed acceptance testing by AD personnel. These cables are in the process of being sent back to the vendor for replacement.