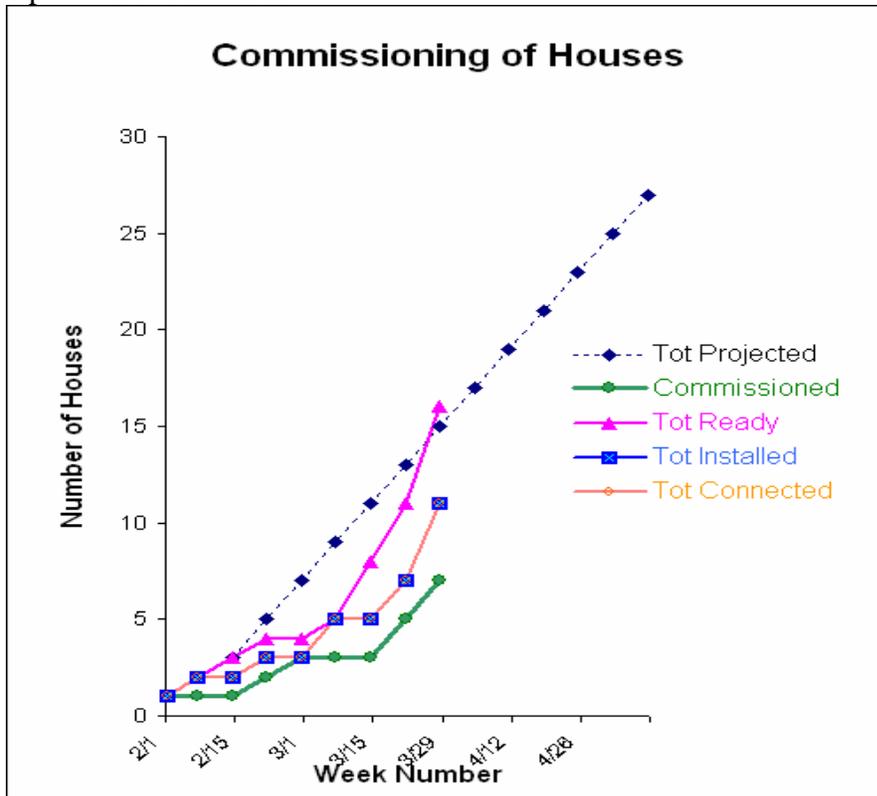


March 2005 Report of the Tevatron BPM Upgrade  
wbs item 1.4.5.4 of the Run 2 Luminosity Upgrade Project  
Bob Webber, Stephen Wolbers  
April 10, 2005

**Project Manager's Summary:**

March was a difficult but ultimately encouraging and productive month for the TeV BPM Upgrade project. The bulk of the month was spent investigating, debugging and finally solving a difficult problem in the injection turn-by-turn (TBT) measurements. The measurements were quite frequently incorrect, especially in the phases of the output of the Echotek board, indicating that the board was not properly reset on every turn. This problem was seen earlier in the commissioning and was thought to have been fixed by firmware changes on the Echotek board. A great deal of effort went into tracking the problem, building a test setup to recreate and debug it on the teststand, understand the sequence of events that occur before and during the problem, etc. Many people on the project were involved and the detailed reports in this month's summary as well as the email and meeting minutes contain many details.

The problem was solved on the day before the Easter weekend (March 25) and once it was seen that the TBT was working properly the go-ahead was given to install new systems in the houses as quickly as possible. By the end of March 11 of the 27 crates were installed and running. A plot of installation and commissioning progress as of April 1 is shown here:



A problem with the 53 MHz diagnostics signal that was found in February was fixed in March by changes to the timing board and the VME backplane. Capacitance was added to the 53 MHz driver on the timing board and resistance was added to the backplane line(s) used to propagate the signal to the filter boards. These changes lead to a much more uniform 53 MHz signal to all locations in the VME crate. A new board was fabricated to implement the resistive termination on the VME backplane. The filter boards were modified and all new installations have the new hardware and firmware. Some retrofitting of the first few BPM installations is not yet done.

Work continued in March to test all the equipment, to build crates for installation, to test those crates and to install them as requested. The final Echotek and filter boards and filters are being prepared. One Echotek board was ruined by the test stand accident in January.

On the software front a great deal of work was done on the TBT problem, already mentioned. Work also was done on the fast time plot (FTP) at 500 Hz, the diagnostics and calibration, and some early thinking about the “safe” or “asynchronous first injection” mode. Analysis of the data to understand the quality and reliability of the proton subtraction technique to measure antiproton positions continues.

### Resources Used in March 2005:

The total number of FTE-months devoted to the project in calendar March 2005 from the Computing Division was reported to be 8.6 FTE-months with 22 people contributing. The total number of FTE-months devoted to the project from the Accelerator Division was 1.3 FTE-months with 7 people contributing. The total effort from both Divisions was 9.9 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	9.7
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
December, 2004	1.1	7.5	8.6
January, 2005	1.1	10.0	11.1
February, 2005	2.5	10.9	13.4
March, 2005	1.3	8.6	9.9
SUM (through Mar, 2005)	36.8	147.8	184.6

The total effort is beginning to decline given that all of the hardware has been delivered and tested and systems are being installed, debugged and commissioned.

**Purchase requisitions/procard obligations in March, 2005:**

Req #/PO/Fermi	PO Date	Item	QTY	Estim. Cost
PRN61054	3/7/05	ADT Circuit Board/Terminator board	40	\$1,560.00
PRN61057	3/7/05	Resistor/Terminator Board	500	\$20.50
PRN61374	3/15/05	Altera EPM7064SLC44-10_FRT	25	\$142.50
Monthly Total				\$1,723.00

**Milestones:**

The March milestones will not be achieved due to the delay in installation and commissioning. All milestones will be achieved by the end of May, 2005. The old and new proposed dates are:

1.4.5.4.4.1.7 All Tev BPM crates functionally available (except for F bldg.) or Installed:

**Old date: 3/4/05      New date: 5/16/05**

1.4.5.4.5.1.4 Tev BPM Electronics commissioning complete

**Old date: 3/30/05      New date: 5/16/05**

1.4.5.4.6.8 Tev BPM Upgrade Operational

**Old date: 3/30/05      New date: 5/31/05**

**Meetings held, Reports Given:**

Meetings were held in March on the following dates:

Project Meetings: March 7,9,14,16,17,21,23,28

## **Documents:**

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

[1757-v2 Injection TBT Data after the Fixes of March 25, 2005](#) [Robert K Kutschke](#) 29 Mar 2005

[792-v12 Minutes from the Tevatron BPM Upgrade Project Meetings](#) [Steve Wolbers](#) *et. al.* 29 Mar 2005

[1753-v2 BPM Projects - Breakout Talk for March 2005 DOE Review of TeV Operations](#) [Bob Webber](#) 25 Mar 2005

[1752-v1 A Survey of the Capabilities of the Upgraded Tevatron BPMS](#) [Robert K Kutschke](#) 24 Mar 2005

[1751-v2 Tevatron BPM Upgrade \(talk at 3/24/05 Run 2 Meeting\)](#) [Steve Wolbers](#) 24 Mar 2005

[907-v2 Monthly Reports of the Tevatron BPM Upgrade Project](#) [Steve Wolbers](#) 23 Mar 2005

[1737-v2 Stuck Data in E3?](#) [Robert K Kutschke](#) 17 Mar 2005

[1739-v1 TeV BPM Calibration/Configuration Database Talk 2005-03-17](#) [Marc W Mengel](#) 17 Mar 2005

[1381-v24 Echotek Board and Other Hardware Testing Status](#) [Timothy J. Kasza](#) 16 Mar 2005

[1602-v1 Injection Cogging and Interaction Point of Tevatron](#) [Aimin Xiao](#) 11 Mar 2005

[1065-v8 Tev BPM VME Hardware Specifications](#) [Vince Pavlicek](#) *et. al.* 11 Mar 2005

[1598-v1 Cancellation of the Proton Contamination on the TeV BPM Anti-proton Channels](#) [Robert K Kutschke](#) 09 Mar 2005

## **Subproject Leader Reports:**

### **Electronics: Vince Pavlicek**

The electronics group assisted with installation by adding workers to installation teams to enable multiple sub racks to be installed in a short time.

Diagnostic signal rework was accomplished by changing firmware and over-terminating the back plane trace used to distribute the diagnostic signal to the filter cards. The change was implemented by adding parts on the timing card and adding a separate board inserted into slot 21 of the sub rack. Production of the boards was quick and all subsequent installations include this module. Some installed systems will need these boards added when time allows.

Six filter pairs were identified as not meeting the purchase requisition specifications and an RMA process started with the vendor, Lark Engineering. 20 filter modules were assembled without filters; five were subsequently produced for B0 and D0 houses which had out-of-the-ordinary signal levels. 15 filter modules await specifications for final assembly.

Timing module firmware was modified several times this month to assist with problem diagnosis and to correct one fault.

### **Hardware Tracking/Testing: Tim Kasza**

During the month of March, our hardware activities have been focused on the collaborative effort between AD and CD (ESS, ESE) to install complete BPM system crates. Our role has included assembling crates for system level acceptance testing and assisting in the initiative to install crates. So far 24 crates have been assembled, of which 11 have been installed in service buildings. Our efforts have kept pace with the hardware installation schedule.

The installation of an ECO (Engineering Change Order) was completed on all timing boards except for the two previously installed at A3 and B3. This modification was developed by the engineering group to resolve problems with the rise time and uniformity of the diagnostic signal.

Some loose ends remain with a small number of Echotek boards. Besides 2 boards already at Echotek for issues with loading firmware, we shipped 2 additional boards back under warranty repair. One of these boards was returned to Echotek for a second time, it exhibited the same stuck bit problem on channel 4. The other board was returned for problems with locking up and the overflow light remaining on.

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

The activities during the month of March were focused on resolving data taking problems at injection. The groups also worked on the following: definition of ACNET variables for remaining houses; commissioning problems and bug fixes; new ACNET variables for logging system status and versions.

The houses commissioned were not taking reliable data during the injection phase. In many cases the data readout from the Echotek cards had outlier point positions. It was also noticeable that the phase of the points did not match the expected five phase pattern.

There were several software modifications to catch the invalid data, but these modifications involved the check of every point during injection, which could lead to high front-end processing times. The software was not released to the commissioned houses, it was used only in the test stand. The group tried to reproduce the problem, which took a fair amount of time. After several discussions with the whole project a few clues emerged. First it was noticed that turn-by-turn measurements had the 'bad data' always after the front-end was used in the raw mode. That clue indicated lack of synchronization between the raw mode and the turn-by-turn mode of operation, i.e. before enabling the turn-by-turn mode the software must wait for the current raw (closed-orbit) measurement to finish. Along these lines, after suggestions from the group, the same problem was noticed when a turn-by-turn measurement was requested when the system was in the abort mode - in the abort mode the system is still taking closed orbit measurements. There was also a lack of synchronization between the abort and turn-by-turn modes. The abort/turn-by-turn transition is exactly the same when the system gets a request for injection turn-by-turn measurement. The problem was again the lack of synchronization between modes. The solution was put in place and the outlier points were not reported since.

The ACNET variables and download list was completed for all houses that have a processor assigned (all but last three houses). Scripts to modify variables used by the old system were provided and are used when houses are commissioned.

During the commission of the houses in March there were some problems found and resolved. The D3 house had one of the clock cables between the timing board and one Echotek card not fully connected. The software was waiting indefinitely for the Echotek board to initialize, which would not happen because of lack of clock signal. The driver was modified to retry a few times, give up and report the error.

During the E3 house commission it was noticed that ACNET settings through the W25 were not possible. It was detected that the software was setting channel pair delays of nonexistent Echotek boards. The software was corrected and only existing boards are set. A similar problem occurred on the C2 house. This time the software failed when setting the channel pair delay for the first pair of the last Echotek board. The fix involved the replacement of the Echotek board (same problem that happened during commissioning of C3 house).

The profile frames were reporting values that did not match with the beam condition. The problem was caused by wrong packing order in the front-end. The online software expected the first frame to be the oldest while the front-end sent latest frame as the first element.

On the last week of the month the group noticed that a few houses reported injection turn-by-turn data apparently was triggered earlier than the beam arrived. Usually the first five to six thousand turns contain no beam data. Only the first nine turns should have no beam data. The problem appeared after the synchronization between abort and turn-by-

turn modes was introduced. It may also be related to the missing TCLK problems which happened again once at the B3 and E3 houses.

New ACNET variables for reporting various software versions, system status, history and configuration were introduced. These variables should help users to verify whether a front-end is using the correct software versions.

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

During the past month, a few more bugs were fixed in the BPMUTI library. These primarily related to word swapping problems in handling the front end data and errors in preparing plot query information. Also, many of the database scripts for converting from old to new houses were prepared. The diagnostics program (W25) was modified to display software version information. In addition, Marc Mengel began designing the database tables to hold calibration information.

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

During March I continued to monitor the data from the installed systems, including closed orbit, turn by turn and injection turn by turn data. This work helped to uncover and characterize the various problems with these systems. These problems include the missing TCLK problem, the injection TBT outlier problem and the problem in which the injection TBT data appears near turn 6000.

I investigated further the subtraction of the proton contamination on the anti-proton cables. I found that the best values of the coefficients change significantly from BPM to BPM and I confirmed the earlier finding that the values usually vary significantly from shot to shot. I have developed a proposal to use the user frame buffer on the front end computers to acquire the data that is needed to compute the cancellation coefficients on a shot by shot basis. This will allow the anti-proton position data to be valid from the first anti-proton injection in each shot.

I have developed a new parameterization of the cancellation scheme in which the coefficients have a more intuitive physical meaning. The scheme works well and has the potential of a straightforward extension to a higher order correction.

This work also uncovered a handful of BPMs for which the algorithm for computing the cancellation coefficients will fail. Several options for dealing with these BPMs are under investigation.

The status of much of the above work was presented at the Run II meeting on March 24.

Marc Mengel has gathered the information he needs for the design of the calibration database and expects to have the first release of the database and its ancillary applications by mid April.