To:

From: William Pellico, PIP Leader

Bob Zwaska: PIP Deputy Leader, Fernanda G. Garcia: PIP Linac Manager, Keith Gollwitzer: PIP Booster Manager, Kenneth Domann: PIP Planning Controls

Subject: Proton Improvement Plan

Project Quarterly Summary FY13 Q1

Report #4 Jan 2013

Project Milestones

The PIP FY13 Q1 has continued to show considerable progress and completion rates. However, the issues with FY12, FY13 funding changes and carryover of funds did impact several tasks. The funding impact will be discussed below in the management summary but impact to milestones/planning is problematic. The decision to hold the purchase of the 201 MhZ klystron directly impacts the Linac RF Power task, Modulator task and the Linac 7835 tube task. Several other FY13 M&S tasks will also likely need to be adjusted to accommodate a feasible M&S solution. In addition, the loss of FY12 carryover cost PIP funding for two solid state cavities that will need to be funded out of FY13.

Table 1: PIP Level 0, 1, 2 Milestones - Summary for 1st FY13 Quarter

	Task	Level	Date	Milestone	Status
1.1.1.2	Linac Modulator	1	Nov-12	Select the best option	Dlyd
1.2.1.6	New Tuners	2	Nov-12	First batch of 10 tuners assembled and tested	Late
1.2.7.3	Solid State Modulator	2	Nov-12	Assemble and test 10 Modulators	Done

L2 milestones: during this quarter, two management L2 milestones were complete: Successfully delivered beam to NTF treatment and started the 400 MeV beam commissioning.

Below is a summary of FY12 Q4 milestones which were delayed into the FY13 Q1. Task 1.2.1.7 has been delayed due to labor and funding shortage. This task will likely be re-examined with the current budget guidance followed by an adjustment to the RLS. The Task 1.3 level 0 milestone was completed in FY13 Q1 and will be discussed in section below.

Table 2: PIP Level 0, 1, 2 Milestones - Summary for 4rd FY12 Quarter

WBS	Task	Level	Date	Milestone	Status
1.2.1.7	New Cavities	2	Jul-12	Initial cavity design	Late
1.3	RFQ Injector	0	Sep-12	Install of RFQ Injector	Done

PIP Highlights by WBS Section

WBS 1.1 Linac

The vulnerabilities associated with the LINAC are the 200 MHz accelerating system, including power amplifier tubes and other associated systems such as the modulator; utilities for power distribution and vacuum systems; better need for reliable instrumentation along the Linac to improve beam transport and realistic machine model supported by real beam measurements. There are four largest elements of WBS Level 2 in Linac which are further subdivided at Level 3.

WBS 1.1.1 200 MHz RF Power System

The 200 MHz RF Power System represents approximately 40% of the total scope of the PIP project. There are 3 level 4 elements which will be described below.

WBS 1.1.1.1 High Level RF

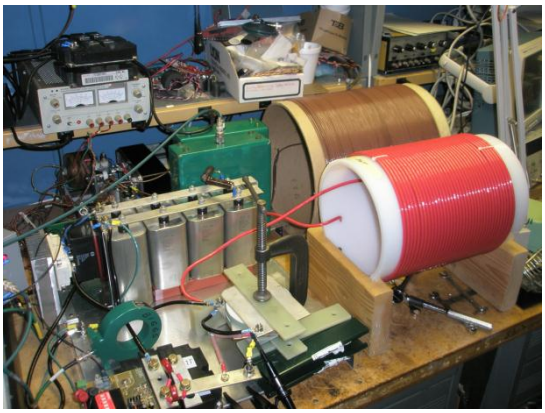
Early in this quarter, a requisition was submitted and received all the approvals necessary to make in to a purchase order. However, the order was put on hold and the funds were retrieved by the upper management early November. The unknown situation holds until the end of this quarter. In the meantime, the team has been thinking about ways to partially fund this project during FY13. Communication with CPI has been ongoing in order to help set a path for this task.

WBS 1.1.1.2 Linac Modulator

During this quarter efforts continue towards a 200 MHz Tube base Modulator design.

Fermilab EE Support Department

EE Support Department built one-cell to test the basic elements of the EE-Marx Generator design. The figure on the right illustrates the test apparatus. One of the major elements in this design is the usage of Insulated Gate Bipolar Transistors (IGBT). The first set of test was to validate the IGBT switching action. The test proved to work with acceptable transient voltages. Also confirmed is the IGBT short circuit current liming and safe turn-off.



SLAC National Accelerator Laboratory

With the tight budget expected for FY13, the management is currently finding a way to fund building a lower voltage 2-cell modulator prototype at SLAC.

WBS 1.1.1.3 7835 Procurement

Currently waiting the receipt of the tube purchased in FY12/Q4 period.

WBS 1.1.2 Accelerator Physics

WBS 1.1.2.1 Simulations and Studies

Work continues in evaluating the existing simulation code credibility. The simulation code, at first order, has been translated to TraceWin. In fact, this quarter was spent almost exclusively overcoming the initial learning curve on how to use the simulation code.

WBS 1.1.2.2 *Not Used*

Some WBS numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established during the period of setting up PIP.

WBS 1.1.2.3 Linac Notch Creation

During the first quarter of FY13 the team finished receiving all components for the OPG and the fiber laser pre-amp and 1st fiber amplifier stage. The equipment has been moved into the instrumentation laser lab at A0 and undergoing a safety review sign-off for powering the equipment.

WBS 1.1.3 Instrumentation

WBS 1.1.3.1 Beam Position Monitors

The Linac BPM module upgrade is nearing completion. We have fabricated all the modules and installed 29 out of 60 modules (most of the uninstalled modules will be for the Booster 400 MeV-line BPMs). The 805MHz phase reference line has been installed for each of these modules, including splitters and amplifiers. The Open-access client (OAC) has been installed and commissioned, and an ACNET application program has been written to give the expert access to these modules through the OAC. BPM signal cables have been verified and re-measured--we found three faulty signal cables. We await final reconfiguration of the controls parameters so that the new BPMs can be read out through ACNET. New scaling factors have been calculated.

WBS 1.1.4 *Not Used*

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WBS 1.1.5 Utilities

The Linac Utilities, such as power distribution and vacuum systems are composed of mostly 40 year-old equipment beyond its practical service life. There are two Level 4 elements in this WBS.

WBS 1.1.5.1 Power Distribution

L1 Substation:

During this period, the team has been attempting to assemble the LINAC substation out at the long-term storage area where it can be mechanically, electrically checked to make sure it works as designed. Another area that continues to make progress is related with the logistic setup in order to support the transformer installation. During this period, the team received quote from vendors for the hatch

purchase and installation cost. Also making progress is the civil engineer notes and verification that the building structure will not be compromised with the installation of the hatch. A mandatory D18 report is underway.

Motor Control Center (MCC):

During first quarter of FY13 the MCC was successfully installed and has been working as intended. In regards to the old MCC, the L4 manager is creating an assessment plan to evaluate how much rebuilding will be required for the buckets that were removed to be returned to service as spares.

WBS 1.1.5.2 *Not Used*

Some numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established.

WBS 1.1.5.3 Vacuum System

During this quarter, the Linac root blowers were installed in the Linac tunnel and they are operational. They have been working flawlessly.

The 400 MeV beam valves, scheduled to be delivery in December 2012, did not happen. The expectation is to have the valves at the laboratory sometime in January 2013.

WBS 1.2 Booster

Part of the PIP effort for the Booster Accelerator is to address the increase proton beam flux that will be demanded by the Fermilab program in the upcoming years. The increased flux will be achieved by providing beam on more/all of the Booster cycles; certain equipment will increase from an average 7.5 Hz to 15Hz. Overheating of old components is a major concern; several Booster PIP tasks are to upgrade/refurbish equipment to run at 15 Hz.

The aging original equipment and infrastructure of the Booster are vulnerable due to obsolescence and increase wear due to the increase of flux. Some of the PIP effort is to replace these possible reliability problems.

WBS 1.2.1 RF

WBS 1.2.1.1 Anode Supply

The design work, to be based upon the Main Injector anode supplies, will be done when manpower becomes available in FY13. The engineering is expected to start during the second quarter.

WBS 1.2.1.2 Bias Supply

The delivery of the heat sinks, silicon-controlled rectifiers (SCRs) and water-cooled transformers should begin during the second quarter.

WBS 1.2.1.4 *Not Used*

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WBS 1.2.1.4 Cavity Test Stand

The desired RF equipment from the Tevatron is not available to power the test stand. Due to the lack of funding available to purchase new power supplies, availability of personnel and that the cavity test stand would arrive too late to alleviate conflict in using the existing test stand, the cavity test stand task will not be done.

WBS 1.2.1.5 Cavity and Tuners Refurbishment

The refurbishment of the fourth cavity tuner set was done during this quarter. The time it takes to refurbish and test each set has decreased with the average of the last three taking twelve weeks. With each refurbishment, we are learning how to make the process better. The flange where each tuner connects to the cavity has been identified as needing major rework. The three flanges require additional material, added by a welder; the flange, within a tight space of the cavity opening and near radio-activated cavity components, is then lapped to smooth the additional material; a tin gasket is manufactured and instituted during the mating process of a tuner with the cavity flange. The refurbishment procedure has been amended to always do the flange work whereas before the flange was inspect and only worked upon if the cavity tuner set could not be certified at high gradient at 15 Hz.

WBS 1.2.1.6 New Tuners

Previously, a high power test stand for ferrite cores showed that one of four different core sets (two different permeabilities from two vendors) was acceptable. The acceptable core samples have been implemented into a tuner and been certified. A purchase order for one set ferrite cores which was validated has been done; delivery of these new cores will occur in FY13 Q2. A dialog with the two companies continues in a quest to produce ferrite cores with the high permeability. Additional material to construct several tuners has been purchased.

WBS 1.2.1.7 New Cavities

Comparison of a model developed for the current Booster RF cavities and the temperature measurements taken as part of the refurbishment task continue.

WBS 1.2.1.8 Cavity 1013

This low priority task requires the same manpower as the refurbishment task; discussions are on-going to locate manpower to complete this cavity.

WBS 1.2.2 Accelerator Physics

WBS 1.2.2.1 Simulations and Studies

Studies were done before the shutdown began. The main person doing the studies and analyses has left and a new person is to be named.

WBS 1.2.2.2 Alignment and Aperture

Part of the study period prior to the shutdown was devoted to moving a magnet and re-measuring the local aperture. The increase in aperture seen is in agreement with the expected predictions. A second magnet move will be done during the start-up period at the conclusion of the shutdown.

WBS 1.2.2.3 Booster Notcher

The notcher absorber has been assembled in the tunnel. Minor work concerning the surrounding components (corrector with beam position monitor, vacuum turbo pump port, and vacuum pipe/bellows) continues and will be done early in the second quarter. The re-locations of the notcher kickers and associated power system are almost complete. Procurement of parts for upgraded notcher kickers and associated power systems has started.

WBS 1.2.2.4 Booster Cogging

Based upon the current cogging equipment, initial code development for the new magnetic cogging method-system is in progress.

WBS 1.2.2.5 Booster Collimation

The collimation task is to control Booster beam loss after implementing the above notcher and cogging systems.

WBS 1.2.2.6 Radiation Shielding

There are on-going discussion and simulations of the material to be put into the Booster penetrations for shielding purposes as well as planning for beam studies to justify placement of radiation detectors.

WBS 1.2.3 Instrumentation

WBS 1.2.3.1 Beam Position Monitors

Design work for the Booster beam position monitor system will begin after completion of the Linac beam position monitor system.

WBS 1.2.3.2 Dampers

Studies to verify damper design choices were not done prior to the shutdown and have been postponed to the accelerator start-up period in FY13.

WBS 1.2.4 *Not Used*

Some WBS numbering is nonconsecutive at lower levels because of account closings and rearrangements after financial codes were initially established during the period of setting up PIP.

WBS 1.2.5 Utilities

WBS 1.2.5.1 Low Conductivity Water System

The physical work for this task is completed. There is minor software work associated with balancing the water system. This requires until the full water system to be connected and running; during start-up after the shutdown will the final balancing be done.

WBS 1.2.5.2 Power Distribution

Transformer design will be based upon recent new equipment implemented at Fermilab and will start after the Linac transformer work is done.

WBS 1.2.5.3 Vacuum System

Vacuum equipment was purchased and is expected to arrive in the second quarter. The goal is to replace some of the aged components during the shutdown.

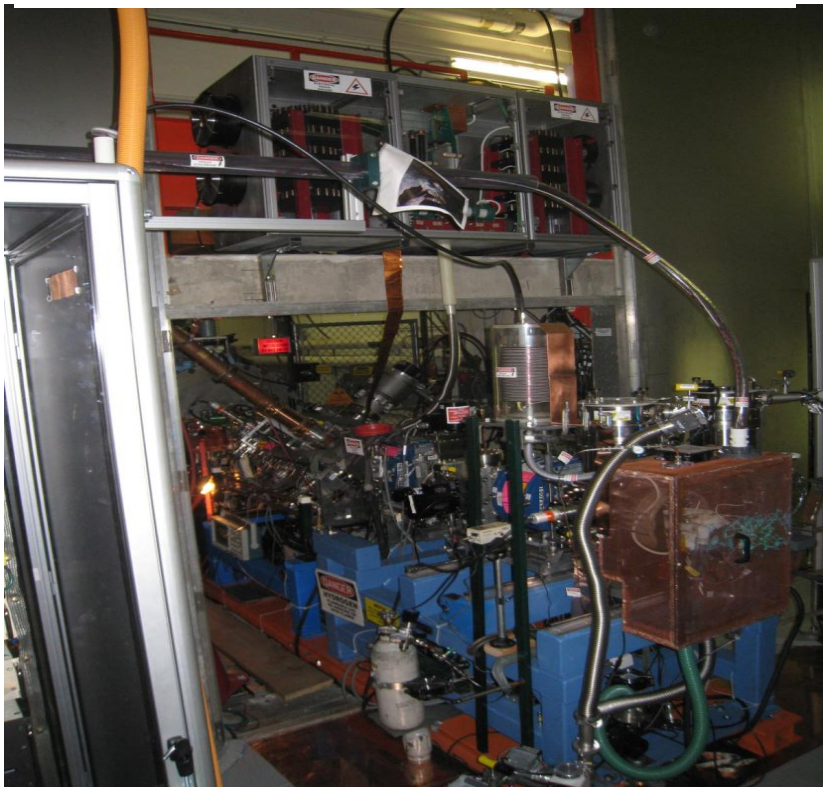
WBS 1.2.7 Solid State Upgrade

The Booster RF solid state upgrade has been going on piecemeal for several years with purchasing of enough components to assemble the main elements of the solid state system: power amplifier, driver module and modulator for several stations. With the Proton Improvement Plan, we have been able to buy components in quantities. The East gallery of the Booster has been upgraded. The West Gallery upgrade is in progress and expected to be finished prior to start-up during the second quarter. There are spare of the three main elements that will be assembled during the second quarter.

WBS 1.3 RFQ

As reported in the FY12 Q4 report, the schedule for the new RFQ injector had beam commissioning starting in FY13 Q1 and available for users by the end of November 2013. This schedule was met and we are currently in a commissioning stage. This accomplishment turns a page in the FNAL history books and we are now starting a new era of operations. After over 40 years of running the HEP program using the CWs we look forward to operating the program using this updated and improved RFQ injector system. Although there is improvements/tune-up of operating points to be made to the new system this new system removes a critical concern in the Proton Source (laboratory) and its ability to meet HEP demands. PIP management would like to thank all those involved in making this a successful effort.

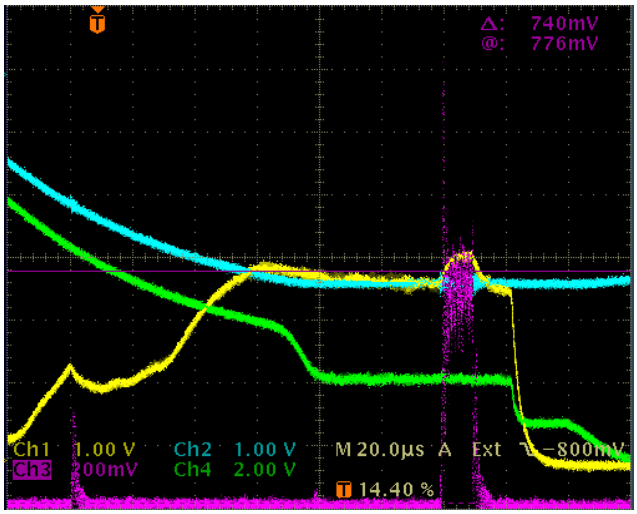
Figure 1 FNAL RFQ Injector



The photo of the newly installed and operating RFQ injector: Source A, LEBT, Einzel Lens, RFQ and MEBT. The source B is still being populated with components and is expected to be tested in February. Beam testing and measurements will continue though to HEP startup. It is also expected that Linac tuning will be needed and completed as injector tune-up is done.

The beam through the new injector was achieved on November 14 2013. The beam was then tuned to meet the NTF requirements for patient treatment on December 2013. The beam tune-up is now mostly operational but it is expected that issues discovered during the start-up will be addressed over the next several months and may require dedicated study periods.

Figure 2 Beam extracted from RFQ injector (Nov 2013)



PIP Budget – Costs and Obligations Updates (FY13 Q1)

The budget for FY13 Q1 is shown below. It was noted in the last quarter report that there was a significant amount of funds in carry-over. The status of about $1.4 million in funds allocated to purchase the 201 MHz klystron in FY12 Q4 is still undetermined. Funds set aside for solid state cavity install labor overhead cost (projected to be installed in FY12 Q4 but installed in FY13 Q1) also look to be in jeopardy of being removed from PIP. The net loss of about $2 million would need to be removed from other tasks and in an already severely reduced budget year will be difficult. Planning to re-adjust PIP to keep a practical schedule will necessitate significant changes to the RLS with delays of completion out at least two more years.

Table 3 Summary of PIP FY13 Q1 Budget

FY13 PIP OBL BUDGET K$	OBL BUDGET	YTD OBL	RIP	BUDGET BAL
M&S	2,727.3	437.4		2,289.9
Labor	4,289.7	1,137.5		3,152.2
FY13 Sums (End of Year)	7,017.0	1,574.9		5,442.1

A consistent effort of PIP management is to prioritize the tasks and adjust as needed resources to meet project goals. One example of PIP prioritization effort has been the solid state – which is nearing completion on time in FY13. However not everything can be shielded, the goal of 15 Hz Booster beam operation, which requires many tasks to be completed, looks to be slipping due to labor/funding reductions. These delays will be reflected in the adjustment to the RLS and project milestones.