To:

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Subject: Proton Improvement Plan

Project Quarterly Summary FY12 Q3

Report #2 July 30, 2012

Project Milestones

Shown in table 1 below is a list of all the level 0 through 2 milestones for PIP from April through end of June 2012. The third quarter summary has base lined 34 level 3 milestones. Nineteen level 3 milestones from the base lined RLS were not completed. The main reasons these were not met are the postponement of the start of the FY12 shutdown and the limited personnel available for PIP. One late L3 milestone in Linac will impact a major milestone (Level 1) in the next quarter. Mitigation of the delay's impact has been pursued vigorously at the end of this quarter report and carried over the first month of the 4th quarter.

Table 1: PIP Level 0, 1, 2 Milestones - Summary for 3rd FY12 Quarter

WBS	Task	Level	Date	Milestone	Status
1.1.1.1	High Level RF	2	Jun-12	Determine cost and risk, preliminary RLS for all options	Late
1.2.1.4	Cavity Test Stand	2	May-12	Assembled and Commissioned	Late
1.2.1.8	Cavity 1013	2	May-12	Tested	Late
1.3	RFQ Injector	2	Apr-12	Cockcroft Walton decommissioned	Late

The WBS 1.1.1.1 and 1.3 Q3 milestones are on schedule to be completed in Q4. The WBS 1.2.1.4 and 1.2.1.8 were delayed due to insufficient labor and with recent budget uploads look unlikely to happen until late FY13. A resource loaded schedule (RLS) that reflects changes to the PIP budget will be completed in FY12 Q4.

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.

WBS 1.1.1 200 MHz RF Power System

There are 3 level 4 elements in the 200 MHz RF Power System which will be described below.

WBS 1.1.1.1 High Level RF

In this quarter, the first draft of the cost estimate and RLS for both the klystron upgrade option and the Thales upgrade option has been completed. The first draft of the project summary template is 90% complete. This template will include the information contained in the cost estimates and schedules derived so far. A Level 2 milestone scheduled to happen this quarter was not achieved. The task was to determine cost and risk, preliminary RLS for all options. By the end of the quarter, about 70% of this

task was complete. This shift a major milestone (determine course of action, Level 1) originally scheduled to be complete in July 2012.

WBS 1.1.1.2 Linac Modulator

The group has narrowed down three options to replace the current 200MHz modulator that meet the specifications develop during FY2012 Q1.

Fermilab EE Support Department

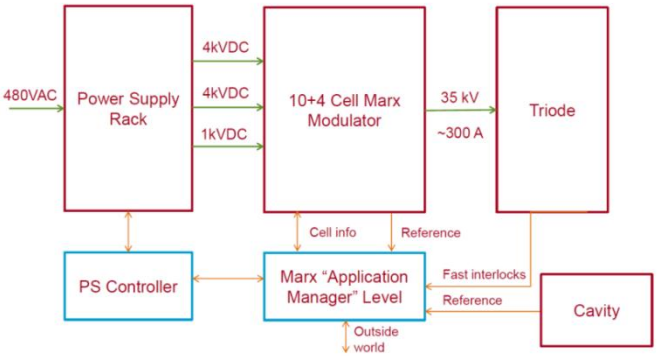
The preliminary design is complete. A significant change implemented is removing the bouncer style with Marx cells. More simulation/detailed study to determine the actual response of this type of modulator to the waveforms required for operation is needed. The current plan is to have a refined cost estimate by the end of August.

SLAC National Accelerator Laboratory

SLAC has made some significant progress on their engineer design. A significant change on the original design was implemented this quarter by replacing the bouncer with Marx cells to create the beam steps. Theoretically this idea should work, but will need more simulations to determine feasibility. Early June, the first simulation results of a Marx modulator without a bouncer were demonstrated as seen below.

The Fermilab Modulator (F1) has been designed to be 10+4 stage/cell modulator, with 3 DC High Voltage power supplies (HVPS).

- The first 10 states would work as a switches using 4 kV HVPS.
- The next 4 stages would create the beam step and overshoot. These stages will have 4 kV and 1 kV HVPS.
- To control the amplitude level throughout the pulse, there will be three parameters that control the waveform shape:
- 4kV Bus Voltage,
- IGBT Turn on/off timing for 10 main cells;
- Pulse Width Modulating (PWM) for correction (vernier) cells.



Continental Electronics Company (CEC)

Continental Staff visited Fermilab late April 2012 for a second meeting. A SOW was completed in June 2012. An engineer design to address many of the challenging specifications parameters needed for their solid state design with a final cost estimate is being prepared by the lead engineer.

For all the proposed options, project deliverable is expected early next quarter.

WBS 1.1.1.3 7835 Procurement

Both tubes purchased in Q1 were received at Fermilab during the third quarter. Upon receipt, the shipping crates were visually inspected for damage of other indication of mishandling during shipping. The tubes were then unpacked and a vacuum test was performed on each of the tubes. Test checked out ok and tubes were stored and set aside for storage until manpower is available for tube installation and RF conditioning. Due to the heavy workload during the lab yearlong shutdown, it is plausible to expect these tubes to be conditioned a year from now.

WBS 1.1.2 Accelerator Physics

WBS 1.1.2.1 Simulations and Studies

In this quarter the L4 manager assigned to this task left the laboratory. This is the second time this FY that this happened. Since then progress on this task slowed down significantly. A candidate was identified to carry this task over at 25% level.

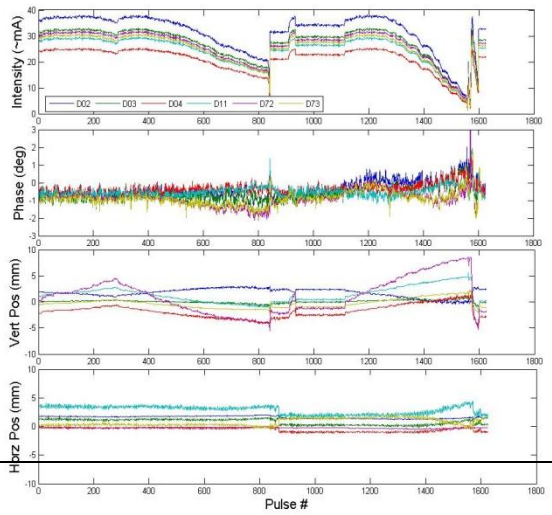
WBS 1.1.2.2 *Not Used*

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

The big news for this quarter is that Snake Creek lasers Phase II SBIR grants to develop a cryogenic solid state final amplifier for the Notcher system was not funded. Although this was the first choice for a final amplifier, a backup solution was thought out which is to use commercial diode pumped solid state (DPSS) amplifiers using Northup Grumman Cutting Edge Optical amplifiers. The group has worked with the company on a design of a final amplifier system that would be able to meet the needs in creating the required pulse energy and the proposed pulse structure. This serves to meet a L3 milestone for the selection of the free space amplifier technology.

The modulator system to be used to create the required notch pulse structure was been ordered in June. A mechanical engineer has been assigned to work on the vacuum system modification required to the upstream of MEBT. This area will be the final location for the optical cavity and the required view ports to bring the laser in and out of the vacuum system.



WBS 1.1.3 Instrumentation

WBS 1.1.3.1 Beam Position Monitors

A total of six prototype BPM electronics boards were installed and tested during Q3. These boards are functionally equivalent to the final

production boards. Before the beginning of the shutdown in May, the horizontal and vertical position readback for six Linac BPMs was switched to the new electronics. All necessary front end software was implemented to report positions, intensity, and relative beam phase from each pickup back to the controls system. This data was data logged by ACNET on each Linac pulse for the all six BPMs. Tests were also done to verify the operation of the existing controls BPM applications with the new electronics and software. As part of the testing, an intensity scan was performed. All data readback from BPMs instrumented with the new electronics is shown on the figure aside.

After completing the initial prototype testing, the order for the final board production was placed. The PCB boards were produced and the first golden sample was assembled. During testing of the golden sample, an error was found in the layout which required new PCBs. This delays the receipt of the final assembled boards until Q4.

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:

All approval drawings have been submitted, and construction has begun with a delivery date mid-August. Due to the estimated weight of the transformer, installation planning is at a standstill. The transformer is expected to weigh 17,700, which is more than the indoor lift and floor can safely handle. Several suggestions have been made that include cutting a hatch in the roof, or installing the substation outside. Both of these suggestions are being taken into consideration and will be addressed by FESS. Electrician time has been increased to two weeks due to added complexity in dismantling the transformer and putting it back together. All temporary power cable is in, and construction of a temporary panel board has begun. FESS will need to be used to disconnect cables to L1 as a single switch feeds three substations.

Motor Control Center (MCC):

All MCC drawings have been approved, and released to the factory. They expect the MCC to take 55-75 business days to complete after the drawings reach the factory floor; this timeframe gives a delivery date of mid-August to early September. Work continues in the process of getting quotes for the software that is needed as well as a spare PLC.

WBS 1.1.5.2 *Not Used*

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WBS 1.1.5.3 Vacuum System

During this quarter, two out three root blowers were procured. In addition, the N_2 dewar repair contract was finalized. There were delays to finalize the engineer package due to the FNAL/ES&H cryogenic safety subcommittee extensive revision of the engineer package in order to sign off on it and verify the company will comply with the weld procedures. Work also continued with the procurement of the 400 MeV beam valves. Two different drawings with different flanges were found and this required some extra checks in order to verify which drawing reflected what has been installed in the tunnel.

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 operation will increase from an average 7.5 Hz to 15 Hz. 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 operational rate. 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.

WBS 1.2.1.2 Bias Supply

Specifications for the heat sinks, silicon-controlled rectifiers (SCRs) and water-cooled transformers have been done in preparation for procurement.

WBS 1.2.1.4 *Not Used*

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WBS 1.2.1.4 Cavity Test Stand

ES&H approved the test stand layout. The desired RF equipment from the Tevatron is not available to power the test stand. Discussions of whether other existing equipment can be used. If not, PIP management will have to discuss investing in new power supplies.

WBS 1.2.1.5 Cavity and Tuners Refurbishment

The first cavity and tuner set was installed after the start of the shutdown; at the same time, a second set was removed for refurbishment. The work is progressing with a different set of problems than the first set. A repeat problem when poor RF-connection between the tuners and cavity occurred; a tin gasket to help ensure good RF-connectivity has been added to the refurbishment procedure.

WBS 1.2.1.6 New Tuners

A high power test stand for ferrites is being constructed. Old existing ferrites will be tested and results will be compared with the original testing done 40 years ago. Once the testing procedure is validated, ferrite samples from several vendors will be tested. After vendors for ferrites are qualified; we will order the first set of ferrites and procure the remaining materials for making tuners.

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 perform this task.

WBS 1.2.2 Accelerator Physics

WBS 1.2.2.1 Simulations and Studies

Studies were done before the shutdown began. These results are being compared to the simulations.

WBS 1.2.2.2 Alignment and Aperture

Part of the study period prior to the shutdown was devoted to a 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

Procurement of parts for the absorber has been going as scheduled. Preparations to pre-assemble the absorber are being done. After the shutdown started, the re-location of the notcher kickers and associated power system started and are on schedule.

WBS 1.2.2.4 Booster Cogging

Based upon the current cogging equipment, initial code development for the new magnetic cogging method-system has been done.

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.

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*

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WBS 1.2.5 Utilities

WBS 1.2.5.1 Low Conductivity Water System

With the start of the shutdown, the low conductivity water system upgraded commenced. Contract work and in-house work will be completed as scheduled.

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 is installed during the long shutdown.

WBS 1.2.5.3 Vacuum System

Vendor quotes have been acquired for vacuum equipment needed for the upgrade. Purchasing will occur soon. 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. Procurement is nearly complete and the main elements for all stations are being assembled. This parallelization of the assembly processes will decrease the overall time to complete the solid state upgrade. The increased production rate has been factor into the schedule and completion of the solid state is expected to be finished in FY13 Q2.

WBS 1.3 RFQ

The FY Q3 RFQ effort has continued in the area of LEBT and RFQ debugging. There was one level two milestone in the third quarter. This milestone was the decommissioning of the Cockcroft-Walton accelerator in preparation for the RFQ install. This milestone has been delayed due to the continuing issue with the RFQ energy (a level 3 milestone.) The new date for this milestone has been set for September 2012 which allows for completion of RFQ energy testing and tuning.

The RFQ output energy continued to be diagnosed during this time with additional simulations to help find some possible reasons for lower energy and efficiency. Systematic checks were also done on the RFQ rods such as alignment and aperture.

Work also continued on the LEBT vacuum with additional pumps being added. The drawings of the MEBT stand were completed and sent out for bids. A second magnetron H- source box was mounted on the LEBT stand. Vacuum pumps were attached and cabled to the second source box. The actual source will be installed in the FY12 Q4.

The next quarter will be critical in the RFQ task. The schedule requires that a decision be reached before September if installment this shutdown is to occur. Several areas of the RFQ are being investigated and look to potentially fix the low energy issue.

The MEBT stand is expected to given out soon and delivery in early September.

PIP Budget – Costs and Obligations Updates (FY12 Q3)

Table 2 and figure 1 below show the status of PIP budget through June 2012. The PIP M&S budget was reduced during the FY12 Q3 period (May) by about 10%. This required PIP management to modify the RLS to meet the new budget guidance. The figure below shows the PIP funding profile through to FY12 Q3. Although initially tracking very closely there has been a departure in budgeted M&S verses actual spending as well as requested labor and used labor. The main reason for the M&S divergence is due to the base lined RLS having budgeted the purchase ferrites for the Booster tuners in March of Q3. It

should also be noted that the requested labor does not meet the available labor. This is due largely to the shutdown and the demands from other laboratory projects on the available labor.

Table 2: Summary of current PIP FY12 Q3 budget

FY12 PIP OBL BUDGET K$	OBL BUDGET	YTD OBL	6/12 RIP	BUDGET BAL
M&S	6,793	3,038	96	3,659
Labor	6,403	5,036		1,367
FY12 Sums	13,196	8,074	96	5,026

Figure 1: PIP M&S and Labor Budgets and Obligations through FY12 Q3

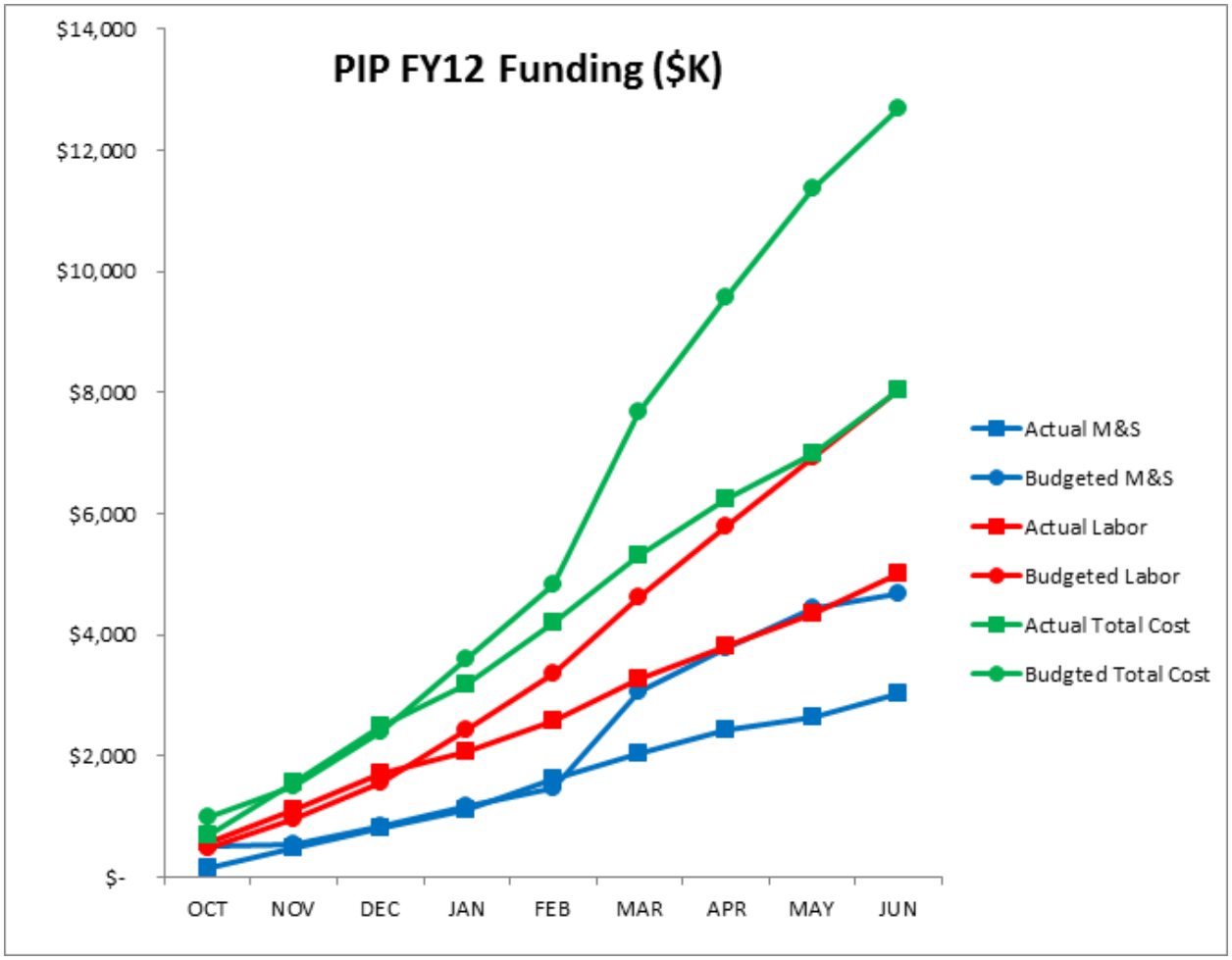

Table 3: Q1 and Q2 report shown in previous PIP quarterly report

FY12 PIP OBL BUDGET K$	*OBL BUDGET*	*YTD OBL*	*3/12 RIP*	*BUDGET BAL*
M&S	*7,595*	*2,044*	*298*	*5,253*
Labor	*6,884*	*3,253*		*3,631*
FY12 Sums	*14,478*	*5,297*	*298*	*8,884*

The table 3 above is given for reference. It was shown in the previous quarterly report and has slightly higher numbers in the obligated budget then the current PIP budget summary shown in table 1.

Recently PIP managers had been given notice of a 50 % reduction in funding for FY13. The resulting schedule changes will be shown in the next quarter. This budget cut will have a significant impact to the schedule.