To: Roger Dixon
From: Mike Church
Subject: Committee report -- AD internal review of Proton Plan (7/21/05 – 7/22/05)

Summary

Findings:

The Proton Plan (PP) team presented a series of talks outlining the program to improve proton production between now and 2008. The review agenda and review committee are listed in the Appendix at the end of this report. The PP team also submitted a written Design Handbook, Project Management Plan, Resource Loaded Schedule, and BoE costbook.

This committee finds that the following elements of this plan are well defined and documented. Despite some remaining technical questions, these elements are ready (or almost ready) for a more formal baseline review.

1) wbs 1.1.1 – Linac PA vulnerability
2) wbs 1.1.2 – Linac quad power supplies
3) wbs 1.2.2 – ORBUMP system
4) wbs 1.2.3 – Booster correctors
5) wbs1.2.11 – Booster dump relocation
6) wbs 1.3.1 – MI large aperture quads
7) wbs 1.3.2.1, 1.3.2.2 - MI-8 collimation system

The following elements require substantially more documentation, definition, and/or motivation in order to be baselined.

1) wbs 1.1.3 – Linac LLRF
2) wbs 1.2.4 – Booster 30 Hz harmonic
3) wbs 1.2.5 – Booster gamma-t
4) wbs 1.2.13 – Booster RF modifications
5) wbs 1.3.2.3 – MI collimation system
6) wbs 1.3.3 – Multibatch operation
7) wbs 1.3.4 – MI RF upgrade

The PP management has not yet obtained the necessary resources to carry out this plan in the schedule indicated. In particular, assigned RF engineering manpower is inadequate.

Comments:

Although many of the the talks were very good, some were not presented in an understandable fashion, and some speakers made remarks which were not appropriate for a formal baseline review.

Recommendations:

1) PP management should work with Division and Lab management to identify and assign the required manpower. We concur and have begun coordinating with AD Department heads.

2) Before the next review PP management should rehearse the talks with the speakers for length and content. For each subproject the motivation, requirements (or goals), and scope should be clearly stated at the beginning of each presentation. We concur and have scheduled a rehearsal on 8/18/05.
3) The Design Handbook should contain more technical detail. It should be the primary reference for the project and should be updated from time to time, as necessary. We concur. The Design Handbook will be updated as technical information is provided by the Level 3 managers.

Linac PA vulnerability

Findings:

The Accelerator Division Head assembled a Task Force to study and develop a plan for managing an accelerator vulnerability described in the Accelerator Division Proton Plan and previously in the Run II Vulnerabilities document. This vulnerability and the role of the Task Force are described in the Proton Plan from which the following is extracted:

> *"The first stage of the Linac uses five power amplifier tubes. These tubes fail at a rate of 6-8 tubes per year. Typically about 2/3 of the failed tubes can be rebuilt by the vendor; the others must be replaced with new tubes. The availability of replacement tubes has remained critical since the start of Run II. This lack of spares is a serious vulnerability, both in the immediate future and for the long-term viability of the experimental program. It is essential that Fermilab work with the vendor to increase tube production and testing, and build up an inventory of spare tubes. The scope of work may include improvements to the operating environment of the tubes at Fermilab, moving the acceptance testing to the production facility, and working with the vendor to address any bottlenecks in the production process.*
>
> *Solutions have been proposed for the longer term. The timescale for their implementation is of order three years, and the total cost is likely in the range $30-55M. A determination of the optimum solution requires balancing technical merit, cost, reliability and the horizon posed by the Proton Driver.*
> *This WBS element includes funds to build up an inventory in the mid-term, and a study to recommend a specific plan of action for the long term.*
>
> *The task force will define the scope of work for both of these time scales with expertise in technical, planning and procurement areas. A report on the mid-term plan will be reviewed by the Level 1 manager and presented to the Accelerator Division Head by February 2005 and on the long-term plan by July 2005. The cost included for the mid-term plan has 100% contingency assigned. The estimates will be updated in the February report. Once the recommendation presented in the July report is accepted, the long-term plan may require a significant increase in scope to the present plan."*

The Task Force delivered two documents to the Accelerator Division Head as charged. Included in the second report were two options for future implementation. The Proton Plan report states:

> *"The current scope of the Proton Plan does not include further development of either of these upgrade paths, so at present, we consider this task complete."*

Comments:

The Fermilab Accelerator Complex is comprised of a series of machines each one of which depend upon Proton generation from the Linac. While the current vulnerability appears to have eased, the rapidity with which the power amplifier tube situation manifested itself dictates continued monitoring. The issue for the laboratory transcends the proton plan in the sense it is not an upgrade that allows increased intensity but rather whether or not any program can be run. The recent sale of the company further exacerbates the potential for disaster. The task force offered a number of short and long range options.

The committee feels that the choice made by the PP team (ie, commission Burle to produce enough PA's for the FNAL progam), is the most cost effective solution to this vulnerability. However, it entails significant risk if Burle cannot, or will not, produce the required numbers of tubes. In view of this risk, it might be prudent to further investigate the Thales option to more definitively determine the costs and technical issues.

Recommendations:

1) The Proton Plan Leader should determine, in consultation with the Fermilab management, what further actions are needed to ensure the operation of the Linac. AD Division Headquarters is drafting a charge to initiate a new study group under WBS 1.1.1 that will be responsible for refining the cost and schedule of the Thales option. A placeholder task has been included in the PP to capture prototyping cost and effort.

Linac LLRF upgrade

Findings:

A plan was presented to replace the 1960's era 201.25 MHz Linac LLRF system with a modern system along the lines of the Linac Upgrade and other recent linac LLRF systems. The proposed system would include feed-forward beam loading compensation, and possibly improved feedback bandwidth on phase and energy regulation.

The main benefits of the upgrade are:

1) a reduction in the RF settling time following the onset of the beam loading transient from the current value of ~10 usec to a target value of ~2 usec. This would allow a 22% reduction in the linac beam pulse length (since linac beam must be thrown away during this settling time) and a corresponding reduction in linac beam losses.
2) A reduction in the residual phase/energy error (due to incomplete settling) that currently must be corrected in the 805 MHz linac.

The reliability of the current system is not a problem. The degree to which linac beam losses are a limiting factor in the performance of the Proton Source was not discussed.

Comments:

The plan was presented as a stand-alone project requiring development of new hardware and software. It may be desirable to fold the 201 MHz LLRF into a "next generation Linac LLRF" upgrade which shares common hardware and software platforms with LLRF upgrades for the entire linac. The 805 MHz Linac LLRF systems will be more than 15 years old on the time scale of the Proton Plan, and some spare parts are already unobtainable. Dealing with multiple frequencies is straightforward with digital systems sharing a common IF. A new generation of LLRF hardware might also share hardware and software platforms with the LLRF systems for SMTF, resulting in a significant reduction in overall manpower.

One minor technical issue in the sharing a common LLRF platform is that the 201 MHz systems operate with the tubes saturated, so that phase control is provided via the RF drive while amplitude control is provided via the modulator. This differs from the 805 MHz and other linacs where the RF drive provides both phase and amplitude control.

It is also possible that most of the benefits of feed-forward could be obtained by an "analog kludge" that injects a "hand-tuned" arbitrary waveform, scaled to beam current, into the modulator drive. A proof-of-principle along these lines may be desirable before embarking on an entirely new LLRF system.

Recommendations:

1. The benefits of no longer throwing away 10 usec of linac beam should be quantified and documented before the project is baselined. The benefit of not accelerating 8 microsec of beam is that Linac losses will be reduced by at least 22% at the highest booster intensity.

2. The benefits of this LLRF upgrade should be evaluated in competition with other potential LLRF upgrades (e.g. Booster) which might be incorporated into the Proton Plan. We concur.

3. Sharing of hardware and software platforms with other Linac LLRF efforts at FNAL should be investigated. The ability to share hardware and software is limited by the fact that the Linac PA's are "plate modulated" and the other RF systems being proposed are klystrons that are modulated by varying the RF drive. We will continue to look for possible commonalities.

4. Simple tests of "hand-tuned" feed forward should be made to ensure that the HLRF systems are capable of responding adequately (in phase and amplitude) to improved LLRF signals that will be available from an upgrade. These tests and measurements are under way. Al Moretti is modeling the system. Since the overall gain of the system varies, sometimes on an hour to hour basis, this needs to be automated so that it learns as the feed-forward does in the 805 Mhz systems. It will not be a simple waveform to buck out the slope in the gradient.

Linac Quad PS upgrade

Findings:

A scaled-down plan was presented to replace only the Control Cards (rather than the supplies themselves) for the Linac Quadrupoles. This plan addresses the major deficiencies of the existing system:

a) control card reliability, which accounts for most of the quad power supply failures.

b) Time and amplitude stability.

Comments:

The linac quadrupole supplies account for 5% of linac down time. Thus the situation is not an emergency, but rather "clean living" to increase the reliability and reproducibility of Proton Source operations.

The budget ($489,089 Labor + $155,208 M&S) seems very comfortable and possibly excessive.

Recommendations:

The Linac Quad Supply control card upgrade should proceed, but be given appropriate prioritization in terms of other competing demands on the EE support group. The control card upgrade may be a sufficiently self-contained project that it is a candidate for assistance from other Fermilab Divisions or even another Laboratory. We will proceed with the control card upgrade and communicate with Department heads and AD management regarding prioritization. We will explore the possibility of utilizing other Divisions for implementation of this project.

ORBUMP and 400 MeV line

Findings:
The Booster Injection scheme is being upgraded for 15 Hz capability. The new design replaces the four bump system with a three bump system. The three bump system eliminates the DC septum magnet and has the bump magnets running at half the current of the four bump design. The system is to be installed in the FY06 shutdown.

Comments:
This project is well motivated. The three bump design seems to be superior to the four bump design. It runs the two outer magnets at half the current, eliminates the DC septum and provides more spare bump magnets. The quadrupole component of the bump magnets is a concern.

Recommendations:
1. There needs to be a beam commissioning plan for the injection design. We agree with the committee recommendation. A commissioning plan is under development and the first draft has been circulating among the group. We expect to finalize the plan in September.
2. There needs to be a sensitivity analysis of emittance dilution to power supply jitter, incoming orbit variation (both position and angle), quadrupole component, etc...

The primary sources of emittance dilution that we considered are due to mismatch in the Twiss parameters (alpha and beta), dispersion function and its derivative (D and D'), power supply jitter, incoming orbit variation, quadrupole component of the bump magnets. Here is what we found:

(1) Mismatch in the Twiss parameters (alpha and beta) as well as in dispersion and its derivative (D and D').

We calculated the emittance dilution due to mismatches of these parameters. The major contribution came from not matching perfectly D' in the horizontal plan (~7% dilution). All the other parameters showed negligible dilution effects.

(2) Orbump Power supply jitter

The new power supply stability specification is +- 1%. This translates into a position variation of +- 0.5mm. Using as a reference Syphers' paper "Injection Mismatch and Phase Space Dilution", the +-0.5 mm gives rise to an emittance blowup of ~1%.
With the new injection scheme this jitter also gives rise to an angle change that is not negligible and combined with the position error the blowup becomes ~10%.

(3) Incoming beam position variations

Incoming position errors can be as large as 2 mm (according to BPM data) in both planes. This is attributable to linac momentum variations during the pulse and pulse-to-pulse. In consequence, the emittance blowup can be on the order of 10% in each plane.

The momentum variations that give raise to the position errors also gives a very small angle error but these are negligible.

(4) Quadrupole component of the bump magnet

The effect of the Quadrupole component in the Orbump magnets is to give a net dipole error during the injection period. During injection this error can be tuned out. After the beam is injected and the Orbump PS current is ramping down, the amplitude of the effective dipole error changes and will give rise to an orbit distortion of ~+- 2.5 mm. This is not expected to cause emittance dilution but will cause an effective decrease in the horizontal aperture. (With the new injection scheme we will have gained ~10 mm in horizontal aperture so the net gain is ~7.5 mm.)

(5) Closed orbit variations due to GMPS regulation. This source of error is very small, typically much less than 1 mm and is negligible.

The cumulative effects of these errors cannot be calculated analytically. We have requested tracking calculations combining the worst of the errors in order to get an estimate of the total effect.

ORBUMP supply

Findings:

The protons deliverable by Booster are limited by a number of items listed below:

Activation of beam line components
Rate at which certain elements are capable of running

- Currently limited to 7.5 Hz
- The injection bump (ORBUMP) system is a limiting factor!
- ORBUMP limitations

Magnets
•Limited to 7.5 Hz due to temperature
Power supply:
•Charging supply reliability questionable beyond ~ 9 Hz
•Age of electrical components raise longevity concerns

Comments:

The following specifications were given to the Electrical Support Department:

•Nominal pulse amplitude = 15 kA
Maximum pulse amplitude = 17.5 kA
Maximum flat top duration = 50 μsec.
•Pulse flatness = ±0.5%
•Rise time
Minimum = 30 μsec.
Maximum = 40 μsec.
•Fall time
Minimum = 30 μsec.
Maximum = 40 μsec.
•Nominal repetition rate = 15 Hz
•Pulse repeatability = ±1%
•Undershoot
Maximum amplitude = 5%
Minimum duration = 10 μsec

The proposed design from the Electrical Support Department is well thought out and has been modeled. The reuse of some components and use of components currently used in existing Booster supplies (MP01, MP02) will aid in ensuring the proper level of spares are available.

The critical path item now appears to be the delivery of the pulse capacitors. The schedule presented showed procurement starting in February with this phase ending in September. The progress to date shows a slip of approximately four months from the schedule on task number 1.2.2.2.7 "ORBUMP P.S. - procure capacitors".

One additional path is shown as slipping by approximately one month. Task number 1.2.2.2.5 "ORBUMP P.S. – Cabinet Layout" has slipped but may not be critical in that it appears to have sufficient float assigned.

The design incorporates both functional and safety improvements that will aid in accelerator operations.

The "pulse repeatability" requirement would better be stated as "rms pulse repeatability <.4%".

Recommendations:

1. Work with the capacitor vendor and Fermilab procurement to ensure timely delivery of the capacitors. We concur. Cezary Jach is following the procurements to ensure they are on schedule for planned delivery.

2. Determine if sufficient technician support is available as the shutdown approaches to prevent construction delays that may have a schedule impact. We concur. Linda Valerio and Cezary Jach are coordinating with Dave Augustine regarding labor needs required for the upcoming shutdown.

Booster correctors

Findings:
The Booster corrector magnets and power supplies are going to be replaced by stronger magnets and power supplies. In addition, sextupole and skew sextupole magnets are going to be included in each package so that all third order resonance lines can have compensation.

Comments:
There is no physics motivation for this talk. It is given by an engineer who only states the specifications but does not state why the specifications have those values. The quadrupole strength at 8 GeV seems to be way too small. There should be a physics study of exploring tune operating points. The quadrupoles should be able to explore a tune range of +/- 0.25 instead of +/-0.1. Quadrupole slew rate should be traded for quadrupole strength. With 288 (48 x 6) ramped correctors, there will have to be sophisticated programs to control the ramps. There has been no thought to what these programs look like and how much effort is required. The elimination of the gamma-t system should be reconsidered, especially in the light of the tight longitudinal emittance constraints of slip stacking.

Recommendations:

1. Explicitly show the benefit of ramped correctors on Booster performance (i.e. how much more aperture will be gained for how many millimeters of orbit control.) The original Proton Plan document (beamdoc # 1441) in section 4. Performance Projections, explicitly list the anticipated benefit of the corrector upgrade. This document will be revised to reflect the results of more recent studies.
2. Do a physics study exploring different tune working points. Re-evaluate the quadrupole strength specification based on this study. An analysis of the existing corrector design indicates that with a slightly more powerful supply, the quadrupole strength will be sufficient to hold both the horizontal and vertical tunes arbitrarily close to the vertical resonance throughout the acceleration cycle, as suggested by the review committee. We will make this change to the power supply specification.

   As for tune studies, they have been done in the past and no strong evidence has been found that a better working point exists. We will repeat these studies in the future. However, it should be noted that as both tunes approach the integer resonance, they will also be close to a number of coupled resonance lines, which could cause problems. In the case of the coupled third order resonances, our ability to control them will improve dramatically once we have sextupole correctors at all sub periods, so it is quite possible that we will have more success with different working points after the corrector upgrade.

3. Specify the software for ramp control and orbit control. Estimate the amount of programming resources that will be needed. Meetings with AD/Controls have started to begin the specification of the needed software. A first draft of the specification is being written now. Resources for this effort have been put into the schedule.
4. Do not lose the capability of a gamma-t jump. We will continue to evaluate the benefits of the Gamma T magnets through our efforts in WBS 1.2.5

Magnet work

Findings:
Three magnet projects were presented: a replacement set of ORBUMP magnets for the Booster, a multi-element corrector package, also for the Booster, and large aperture quadrupoles for high loss points (injection/extraction) in the Main Injector.

Six ORBUMP magnets will be built, 3 for installation and 3 spares. The installation plan calls for a complete ORBUMP magnet girder to be assembled and tested prior to the upcoming shutdown. All six magnets must be completed before girder assembly as it is desired to choose the 3 with the best strength match for installation.

The large aperture quadrupole (WQB) is a direct replacement for the existing quadrupoles. The requirements are straightforward. The integral strength has to match the IQB up the ramp and the magnet has to fit in the same space. Seven magnets will be installed, 4 in high energy extraction locations of the MI (P1, A1, Abort, NuMI), 2 at connections to the Recycler, and 1 at the injection location. Four to seven will be installed during the next shutdown. There are also two spares.

The Booster corrector project calls for 48 corrector packages. There are 6 "magnets" in each package consisting of normal and skew orientations for the 3 lowest order harmonics (dipole, quadrupole, sextupole). The package is contained in a spool piece which replaces existing corrector elements. A BPM is also installed in the package bore. Installation takes place in late 2007.

Comments:
Construction of the ORBUMP magnets is well along. Two have been tested at full current, a third is nearly complete. Final assembly has been delayed while an attempt is made to compensate for the quadrupole in the magnet lead end. A solution must be found in the next few weeks in order to meet the schedule for installation this fall.

None of the WQB are finished although 2 are greater than 90% complete. A third is about half done. The magnets themselves are straightforward. The integral field can be compensated by ±2% to match the IQB. Field uniformity will be compensated by adjusting pole ends if necessary. The project has suffered from a lack of resources. Vigilance will be necessary to insure that magnets are completed in time for installation, although the plan allows for installing a partial set of magnets if not all are ready.

The requirements for the Booster corrector magnet have been agreed upon and a conceptual design approved. Sample coils have been fabricated for testing of mechanical and thermal properties. A full prototype magnet will be completed in February. A full magnet test will follow. AC field measurements of the prototype will be required. The magnet is a complicated assembly. Rigorous control of quality will be needed. There is concern about inductive coupling between windings although if constructed correctly, this should not be an issue. Not all 48 locations are identical so one worries about a package not fitting somewhere. However, the proponents are well aware of this issue.

Recommendations:

1) Dithering about quadrupole compensation of the ORBUMP magnets is a serious risk to the schedule. Consideration should be given to a 2 phase replacement scheme in which the first phase is to install the magnets as is in the next shutdown. This would allow assembly of the 6 magnets to proceed; those with the best strength match would be installed. This would give a big improvement to Booster performance. Tuning of the end field could then be done on the remaining 3 which would be swapped in at a later time. A lot of effort has been put into finding a solution to minimize the quadrupole field in the ORBUMP magnets. However, the production continues normally without the presence of shims. TD engineers are exploring possibilities to install tapered shims in a location that will be easy to modify without compromising the aperture. Assuming the shutdown is 2 months away, the plan is to select the best 3 strength magnets for installation without any modification if a solution has not been found by then. This way tests can continue with the other spare magnets.

2) Steel for the WQB laminations has a different permeability than the IQB. The hysteretic behavior of the magnet will have to be checked as soon as one is finished. If field uniformity requires adjustment, a solution should be decided upon quickly. The scheme should be followed in all magnets. Measurements are now concentrating on aspects that can be adjusted with the removable pole shims, specifically the field shape and integrated strength. When those parameters are frozen, the same configuration will be applied to all magnets. The first measurement has shown that the remnant field is about twice that of the other quads. Detailed studies of the hysteresis, a property that we can no longer change, are planned on a subsequent magnet with the intention of providing the information needed for operations.

3) Low current field measurements to determine winding polarities in the Booster corrector package should be implemented as part of the production quality assurance plan rather than waiting for magnetic field measurements during final testing. The detailed quality assurance program for these magnets will include appropriate electrical and magnetic measurements at critical checkpoints in the traveler.

4) Proponents need to meet with magnet field measurement experts in the near future to discuss the test plan for the Booster corrector prototype. AC field quality measurements will require a significant fraction of this limited resource. Fabrication of test apparatus may also be necessary.

A reasonable time scale would be late summer or early fall. The test plan for the prototype will also need to allow additional time for implementation of these measurements. The proponents recognize the necessity of developing a measurement plan for both the prototype and production magnets in cooperation with the Magnet Test Facility. Discussions will begin when people have recovered from the summer vacation/workshop/conference season.

5) Management should consider whether larger than usual wastage factors are needed due to the complicated coil construction. Checking the experience of other accelerators which have built such a package is encouraged. Management will be developing a detailed procurement and fabrication plan using a wide range of information

Booster dump relocation

Findings:
The extraction system at Long 13, which is used for Tevatron short batch operation and Booster studies, will be removed and a new system will be located in the MI-8 line. The project will re-use some of the existing components such as the kickers. It will require a modest civil construction effort in the Booster West Towers for power supplies and cable penetrations. The project is aimed at increasing the Booster aperture and alleviating distortions in the lattice due to the edge effects of the present L13 extraction dog-leg magnets.

Comments:
This is a well motivated project. It removes a long-known aperture restriction from the Booster. The new extraction system will see only 8 GeV beam so apertures should not be a problem. The removal of the L13 dog-leg magnets from operation should help the lattice distortion but its effect will probably not be as important as the aperture increase.

Recommendations:

1. A 40 π-mm-mrad beam envelope should be tracked through the extraction region. A 40 pi beam is not a problem with the star beam pipe. 40 pi requires about 45mm, the star beam tube is about 75mm.
2. Aperture sensitivity to errors in the extraction lattice functions, and extraction positions should be examined. The issue of motion is not a concern because the only aperture issue is at the quad with the star beam pipe where the motion is less than 2 mm.

30Hz Booster harmonic

Findings:
Both theoretical and experimental studies carried out at Booster show that transition crossing becomes more difficult if the acceleration rate is slowed down.

Comments:
Adding 30 Hz harmonic to the booster magnetic cycle is aimed to reduce acceleration rate and, consequently, to reduce required accelerating voltage. This measure could be helpful in improving Booster reliability but it makes the transition crossing more difficult and most

probably will cause reduction of Booster intensity. Also note that this measure is not very helpful in reduction of peak RF voltage. Presently the peak voltage is achieved at the beginning of acceleration cycle and is rather determined by bunching than by the acceleration rate.

Recommendations:

1) We recommend removing this project from the proton plan. It would be more effective to direct the money and effort to improve RF reliability. We are currently performing studies to evaluate the necessity of 30 Hz Harmonic. We anticipate we will have conclusive findings by the end of the year. The schedule includes a project decision milestone in Early January 2006. At that time we will decide whether or not the 30 hz Harmonic work will proceed.

MI multibatch operation

Findings:

- A scheme of multi-batch slip-stacking for NuMI was presented which would increase the number of Booster batches available to NuMI from 5 to 9 per cycle. Including the 2 slip-stacked batches for pbar stacking, the total number of Booster batches in the MI will increase from 6 to 11. The total MI cycle time would be increased by 0.3sec.
- The MI-10 injection kicker cooling system, currently limited to 3.5Hz operation, will need to be modified to withstand the increased number of injections per cycle.
- The amount of beam loading compensation required for multi-batch slip stacking is unknown at this time.
- Due to the increase in intensity, beam losses will be a concern. These concerns are addressed in the "MI Radiation Issues" section of this report.

Comments:

- Multi-batch slip-stacking offers the largest increase in Protons on Target for NuMI, thus it is crucial to the overall success of the Proton Plan.
- The success of multi-batch slip-stacking for NuMI is dependent upon proper beam loading compensation by the MI RF system. The schedule presented did not show any relationship between the MI RF upgrades and the completion of NuMI multi-batch operation.
- The analysis of beam stability with doubled intensity was not carried out. The concern here is that if higher single bunch modes become unstable the present damper might not be sufficient to stabilize the beam.

Recommendations:

- The MI-10 injection kicker cooling system modifications should be completed during the 2005 shutdown to support multi-batch slip-stacking. We are planning to make all necessary modifications to the kickers in the MI tunnel and install cooling lines during the shutdown to minimize the shutdown resource needs. Final connections to the cooling skid will be made later.

- Multi-batch slip-stacking studies should begin with particular attention paid to beam loading compensation requirements and MI RF upgrade needs. We are ready to start beam studies with multi-batch slip stacking (we expect to start studies by the end of this month). We also developing the ESME simulations for the multibatch scheme we are planning to use. Those simulations were very successful in predicting the beam loading compensation requirements that were needed for the single slip stacking we are currently using.
- Experimental studies of beam stability for multi-batch slip stacking need to be carried out as soon as technically feasible. These studies need to be supported by theoretical insight into the beam stability problem. We have a model of the RF system that was developed for the original slip stacking. This model will be updated and expanded.

MI RF issues

Findings:

- A brief overview of the current MI RF system was presented. It consists of 18 cavities each tunable from ~52.812MHz to 53.104MHz with an R/Q of ~104 and a shunt impedance of 500 kOhms at 53.104MHz. Each cavity has an extra port to allow the installation of a second PA.
- Based upon the high intensity Robinson limit, a plot of allowable beam intensity versus acceleration rate was presented. At the present 205 GeV/sec acceleration, the Robinson limit is approximately 3.2 E13 protons. Based upon experimental measurements of beam intensity limits at decreased RF voltage with beam loading compensation, the allowable beam intensity for the current system was extrapolated to a prediction of 5.9E13 protons at 205 GeV/sec.
- Various plots were presented comparing the present 18 cavity system to a 20 cavity system. Among these plots was a graph of the moving bucket area versus acceleration. For the present system it is ~2.5 eV-sec and 1.25 eV-sec at 205 GeV/sec and 280 GeV/sec respectively.
- It was stated that, at intensities above 5E13, the modulator series tube anode dissipation limits are expected to be exceeded for the 4 RF stations that are currently used for slip-stacking. The plan that was presented is to upgrade the anode modulators and install the second PA on each of these 4 stations.

Comments:

- The modulator series tube dissipation at low cavity RF voltage may be reduced by decreasing the voltage across the series tube. This can be achieved by using an increased modulator output voltage to the PA tube and ensuring that the RF drive produces the same cavity voltage.
- It was not clear why the two-PA upgrade was associated with the solution for alleviating the modulator series tube dissipation. The two-PA upgrade rather should be investigated as a solution to beam loading compensation.
- The high intensity Robinson limit considers only one mode of longitudinal oscillations. Using the experimental measurements at present intensity limits to extrapolate to

expected intensity limits may not be justified. It is expected that the present cavity tuning loop will react differently to the increased beam intensity and will thus shift the fundamental mode impedance which is the ultimate driving term for the longitudinal coupled bunch instabilities. A full RF system model coupled with the longitudinal beam dynamics is needed to fully understand the issues with high beam loading. The modeling efforts for the MI RF upgrade may be able to be combined with modeling for the Linac LLRF upgrade.

- The comparison of the present 18 cavity system to a 20 cavity system does not make much sense; even more so since a 20 cavity system is not being proposed. A 20 cavity system would increase the overall impedance presented to the beam. Again, a full RF system model would reveal these implications.
- If the recent SSD upgrade for slip-stacking was designed to handle peak generator currents for 1E13 per batch, then questions which need to be investigated are: (1) can the current system handle the increased duty factor with multi-batch slip-stacking? (2) will the system be stable with the increased intensity and change in transient loading?, (3) what modifications to the existing hardware, such as the tuning control loop, will be necessary at the increased intensity and change in transient loading? A proper system model can help to answer these questions.
- The MI RF upgrade does not appear to be sufficiently understood or defined to be considered for baseline designation.

Recommendations:

- A complete model of the RF system and its interaction with the beam should be developed and used in conjunction with experimental measurements to guide and determine the RF upgrade path. We concur and are planning to perform this modeling in the next several months.

MI radiation issues

Findings:

An excellent presentation was given reporting on MI Radiation Levels and Trends, MI Radiation Monitoring Program, plans for Automation and Monitoring of Residual Radiation, Loss Monitor Status and Upgrades.

Plans for developing collimation systems in the Main Injector were also presented.

A brief report on the MI-8 Collimation System was given. The information was less detailed than that presented in the recent internal review of the MI-8 collimation system, which serves as an additional source of appropriate backup material.

Comments:
The Main Injector is entering an era where beam losses and machine activation will become a major (and perhaps dominant issue). Dealing with this will require a more systematic approach to loss monitoring, MI alignment, and quality control on the injected beam than has been

required in the past. Development of systematic, automated procedures for monitoring and minimizing all aspects of beam loss, including alignment, tune regulation, orbit regulation and real-time operator feedback should be continued and expanded. This could become an effort comparable in scope to Shot Data Analysis.

The lack of a momentum collimation system is a major weakness in the proton plan. RF capture losses are already a large component in total losses, and are likely to increase with more aggressive slip-stacking scenarios.

The lack of a dispersive straight section in the Main Injector lattice makes it likely that off-momentum beam will have to be dumped in a secondary collimator located inside a (rad-hardened version of a Main Injector dipole. Discussions with the Technical Division about the radiation limits of MI dipoles, and the feasibility of a radiation-hardened version, might be an excellent idea.

The MI-8 collimation system represents a useful, but far from complete, solution to 8 GeV losses. Some concern was expressed as to whether it would be operationally reasonable to keep the collimators as close as required to the injected beam. This might be addressed by studies of the operational orbit stability at the proposed collimation location, and by prototyping an application which regulates the MI-8 beam position at the collimation locations.

Since the major purpose of the MI-8 collimation system is to scrape away beam damaged by the Booster extraction magnets, additional thought might be given to either improving the field quality of these magnets or adding multipole correctors in the extraction line to undo some of the damage.

Recommendations:

1) Increase manpower allocated to MI radiation & collimation issues. An offer has been made to a Guest Scientist to work specifically on MI radiation and collimation issues.
2) Proceed with the MI-8 collimation system. We are proceeding.
3) Develop a detailed design for both momentum and betatron collimation in the Main Injector, and incorporate it in the proton plan ASAP. We have contacted Mokhov's group and have started looking into the loss mechanisms during slip stacking and what is the most effective way to design a MI collimation system. We starting regular meetings between his group and MI starting the end of this month.

Miscellaneous RF

Findings:

- The plans for upgrading the Booster RF system to handle the increased repetition rate from 7Hz to 9Hz as needed for NuMI multi-batch operation were presented. The modifications required include additional LCW cooling on the cavity drift tubes, upgrading the cavity mode dampers, and modifying Ferrite Bias supply waveforms. Additional concerns which need to be evaluated include cavity ferrite cone heating, Ferrite Bias supply transformer heating, 13.8kV to 480V transformer parameters, and low RF Gallery LCW flow.

- Modifications required for 15Hz operation of the Booster RF system include replacement of Ferrite Bias supply transformers, anode supplies and transformers, 3.8kV to 480V transformers, and the installation of cavity ferrite tuner cone cooling. Additional concerns include 480V distribution cabling and LCW differential pressure problems.
- A Booster Solid State Driver (SSD) upgrade was suggested to increase the reliability of the Booster RF system. Currently the Booster has the oldest (35 years) HLRF equipment between Booster, MI, and TeV. A prototype of such an upgrade exists at Booster Station 12 and uses existing technology that is currently used in MI.
- The plans for a 2-PA MI RF cavity prototype were presented. Modifications required include a new coupling loop and a modified station RF controller. The prototype tests would use a spare SSD rack and anode modulator at the MI-60 test station. The coupling loop is already fabricated. A new anode modulator design has not yet started. There currently is a lack of personnel.

Comments:

- Reliability has a direct impact on the success of NuMI multi-batch operation. The improved reliability that the Booster RF SSD upgrade may offer may indeed justify the upgrade. A cost and failure analysis is needed.
- The technical plans to support 9Hz operation of the Booster RF system appear to be well scoped.
- The plans to pursue a 2-PA MI RF cavity prototype appear well scoped; however, based upon the "MI RF Issues" section discussion, it is not yet well understood why it is needed for the 4 slip-stacking stations. It may well be determined that a 2-PA upgrade may be needed for increased intensity, but further investigations of a RF system model in conjunction with experiments on the current system should be used to determine this.

Recommendations:

- The upgrade for 9Hz operation of the Booster RF system should begin to support NuMI multi-batch operation. We concur. 9 hz operation requires cooling of the cavities which will be installed in the upcoming shutdown. In addition, miscellaneous electrical upgrades may be needed also as identified under WBS 1.2.1.
- A reliability and cost analysis should be performed to determine whether the Booster Solid State Drive (SSD) RF upgrade should be pursued. We concur. A reliability and cost study is ongoing.

Proton study group

Findings:

Comments:

The proton study group reviewed possible ways of utilizing infrastructure of the Tevatron complex to increase beam intensity for neutrino experiments. In the case that Fermilab will not get funding for a new linac based proton source it will be the only option for further intensity increase for the neutrino experiments. The group activity has been diminishing since May 2005.

Recommendations:
1) The work of the proton study group needs to be resumed if it becomes clear that funding for a new proton source will not be available in the near future (2007-2009). The Proton Study group will complete it's report in February 2006. This is based on the current schedule for the end of Collider operations in the Fall of 2009. The entire Proton Plan schedule will be revised if a decision is made to cease Collider operations earlier.

Cost, schedule, management

The Plan:

Findings:

There were shortcomings in presentation of the overall description, motivation, and coherence of the Proton Plan project.

Comments:

What is "the plan"? The Design Handbook appears to be intended to be maintained as the current plan, rather than the November, 2004 initial V1 document.

Why were certain elements included or not included? Priorities, cost-effectiveness with regard to Protons-on-Target, relative emphasis of needs of NuMI vs. BNB are not well documented. Some elements have been "de-scoped", i.e. WBS elements removed from the plan. Reasons for dropping these elements were only briefly described in the Design Handbook. The scope of the plan is still quite fluid and changing, especially considering there is approximately one month until the Director's Review of the Proton Plan Baseline.

Some of the Proton Plan activities rely on completion of previous elements still to be completed under Operating or Run II funding – how do they get put into schedule/critical path analysis?

All presenters briefly discussed Risks and their mitigation => Good.

The Proton Plan only provides for conceptual planning of major low-energy Linac reliability upgrades and for possible modes of operation and upgrades in a post-Collider and pre-Proton Driver time scale. The costs of these upgrades were definitely not included in the scope of the Proton Plan, but would have to be either new projects, or added to the scope of the Proton Plan at a later date. Going too deeply into the description of the options tended to divert the reviewers' attention from the stated Proton Plan.

The dual priorities of NuMI and BNB often lead to independent upgrade elements for the Booster.

There were no "quantitative" arguments of how an increase in reliabilitity (e.g. solid state power amplifiers for Booster RF) would translate into an increase in Protons on Target.

Recommendations:

1) The presentation by the Project Manager (Eric) and the Design Handbook should be more specific as to the purpose and the expected return (in terms of increased P.O.T.) for each upgrade element with an indication of the relative priority assigned to each element. We concur and are currently revising the PoT Projections section to include estimates of PoT increases from various subprojects. These subproject PoT Projections along with their associated estimated cost will allow us to develop metrics for prioritization based on cost effectiveness of a particular subproject. It should be noted that some subprojects are justified solely on reliability and will not directly impact the PoT projections (IE – 7835 tubes, Booster Transformer Replacement). These reliability subprojects are identified and justified separately.

Manpower:

Findings:

Although the Proton Plan has produced a time profile of the quantity and categories of required manpower, this profile has not yet been given to the Accelerator Division for integration in its manpower assignments, nor has any response (especially in cases where manpower will not be available) been given from AD to the Proton Plan as feedback to formulate a more realistic schedule. The MS Project Schedule is, therefore, just a wish list.

Comments:

Jeff Sims presented a discussion of the manpower requirements (pages 11-13), which presumably were included in the cost and schedule MS Project files. However, this tabulation remains only within the Proton Plan and not integrated into the entire Accelerator Division. These manpower requests/requirements have not been formally transmitted to the Accelerator Division to determine whether such manpower will be available. Subsequently, the impact of manpower availability has not yet been folded back into the schedule and cost tables. Some examples of possible manpower impacts on the Proton Plan schedules are:

> Ioanis Kourbanis, the L2 manager for 1.3 Main Injector Upgrades, stated that as Head of the AD/MI Department, he doesn't have manpower at this time to do multi-batch slip stacking for NuMI.
>
> Upgrading of the MI-10 injection kicker for operation at higher repetition rate is anticipated for the shutdown starting in November 2005. However, neither the AD/Mechanical nor AD/EE Departments have engineering assigned. Pat Hurh (AD/Mechanical) reports that manpower will have to be diverted from other projects and even then, the kicker upgrade still might not be ready for the shutdown.

Due to manpower limitations within the AD/Proton Source Department, the girder specifications for ORBUMP have just been submitted to the Technical Division, even though the new ORBUMP configuration had been reviewed and approved weeks ago, putting pressure on TD to deliver in time for installation during the upcoming shutdown.

The availability of RF manpower in the Accelerator Division is a concern. The Proton Plan increases the need for RF manpower in competition with accelerator operations, Run II Upgrades, Linear Collider, Proton Driver, Muon Collider, and A0 PhotoInjector. In fact, AD/RF doesn't have adequate manpower to even do the studies and planning necessary to develop this Proton Plan, let alone to execute it!

Recommendations:

1) The manpower requirements must be formally transmitted to the Accelerator Division (and Technical Division) and a timely preliminary indication returned by AD of the manpower intended to be allocated or committed to Proton Plan sub-projects. This will allow a series of iterations on the resource loading of the schedule, which so far has not been done.

We are currently coordinating all AD Labor resources for fully scoped subprojects with the appropriate AD Departments. Labor needs for developing (not fully scoped) subprojects and placeholders are less critical but will also be coordinated with AD Departments as they are expanded to ensure the Proton Plan schedule reflects accurate usage of manpower. AD HQ will be apprised of any lack of resources that affect the Proton Plan schedule. The Division Head may elect to re-allocate resources to the Proton Plan or to delay the schedule.

In addition, the labor resources for Proton Plan 2005 shut down related subprojects are being closely coordinated with MSD, EESD and Accelerator Operations via level 3 and level 4 managers. It is important to note that the exact start and duration of the 2005 shutdown is currently unknown and our latest plan estimates are not final. Ongoing coordination between AD headquarters and Proton Plan Project Management over the next several weeks is necessary to properly populate the resource loaded schedule with AD resources.

TD labor resources in the Proton Plan are provided by TD and are based on their latest understanding of labor usage.

Management and Documentation:

Findings:

Although there exist examples of many of the required management tools and procedures, many of these are very preliminary, lacking the required maturity.

Comments:

The participants of the Proton Plan have presented the listed documentation for this review. These documents have various degrees of maturity. There are inconsistencies between these documents and the presentations with regard to schedule and cost information (comments and suggestions below).

Proton Plan Design Handbook
Organizational Chart by WBS (why do some elements to L3 and some to L4?)
Proton Plan BOE Information (MS Project WBS, Cost, & Schedule – 9 pages)
Proton Plan Project Management Plan
Basis of Estimate Book

Much documentation and backup information is now available through the (internal) Proton Plan website. The participants intend to use this as the main vehicle of information exchange.

A general impression is that the information presented in this pre-review is still in a very preliminary form and could be expected to still change before the baseline review. It appears that the participants have only very recently prepared much of the documentation, and it has not been widely read within the group nor have there been internal quality checks. Most of the documents were available to this panel only the day before the review, many on the day of the review. There are obvious errors (1.1.4 LLRF on Org Chart, compared to 1.1.3 elsewhere). There are inconsistencies in figure references and lack of referred-to section numbers in the Project Management Plan. There are problems with consistency between costs (even accounting for with/without escalation in the MS Project output, the Project Management Plan (Table 2), Sims-p14, and Executive Summary of Design Handbook, and between completion dates 3/31/08 MS Project, 10/17/08 Sims-p8, 3/28/08 Project Management Plan Table 3, 2009 (FY? or CY?) Project Management Plan Section 1, and 3 year plan in Section 1 of Design Handbook.

How are non-AD personnel costs estimated, effort reported, and costed against Proton Plan? At this time the only non AD personnel in the Proton Plan are from TD. TD management provides Proton Plan management with there cost estimates of TD Labor. The resource loaded schedule contains job classifications with assigned hourly rates (eg- TDS Mechanical Technician, TD Mechanical Engineer). The hourly rates are averages of division job classifications based on information provided by Ann Nestander. MSP takes the resources assigned to each task converts it to hours and multiplies it by the hourly rate resulting in the base labor cost. The base labor cost is then multiplied by 1.5545 for Monthly job classifications (engineer) or 1.5876 for Weekly job classification (technician) to create the SWF cost. Escalation of 4.3% per year is applied to the SWF cost with the base assumed in FY05 dollars. TD machine shop charges are estimated by TD base on their most recent shop rates and are allocated and escalated as M&S. Is overtime for PPD/Alignment costed against Proton Plan within the AD budget? As M&S or SWF? PPD Overtime is not currently budgeted within the Proton Plan. We do not anticipate overtime for the alignment tasks we currently have in the Plan. If Alignment overtime is necessary during shutdowns and we are in jeopardy of overrunning our labor budget we will process a change request in the amount necessary to cover the additional labor as SWF (at 1.5 times the average base labor hourly rate without fringe – per Ellie) . It is assumed that other Divisions/Sections will cover SWF costs, which will be available to the Proton Plan management through effort reporting and the 32, 42, 52 project codes in other divisions. These should be spelled out in the Project Management Plan. We will provide Labor and M&S extractions of budget for each task by division and Fiscal year that will to be shared with TD and AD budget offices.

It was noted that the $26.9M total cost is spread over approximately 35 cost accounts giving an average of ~$700K per cost account. This may be too coarse for adequate tracking of progress and costs. $26.9 million is the cost with contingency but without indirect costs. When assigning budgets for subprojects we only utilize the base M&S/SWF escalated amount. To date only fully scoped subprojects have been assigned cost accounts. Many developing and placeholder accounts are shown at a high level. When they are fully scoped they will consist of many cost accounts. Proton Plan Project Management intends to maintain cost accounts with budgets no larger than $300K- M&S and $300k SWF per cost account with any one cost account less than $300k for the total of M&S and SWF escalated. The only exceptions are large M&S procurements (eg -7835 tubes [$1.4M], and fabrication subcontracts), work managed by TD regarding magnet fabrication (Orbump, WQB, correctors) and the labor on the ongoing Project Management account ($1M). Most of the existing project 22 AD cost accounts excluding the aforementioned exceptions have budgets less than $100k for SWF or M&S. In few cases the AD cost accounts are over $100k.

Magnet Production in Technical Division is a production oriented effort that is managed on a daily basis in a shop environment and consequently is allowed larger budget amounts for example - 1.03.01.01 – LAQ/WQB Fabrication - $270k M&S and $750k SWF.

Proton Plan Management will closely monitor the budget amounts assigned to all tasks for purposes of adequate tracking.

The Fermilab accounting system does not have the flexibility to add additional cost elements to a (parent) cost element which has already been accumulating costs. This puts the burden on the individual project to develop, from the start, a cost accounting structure that meets both the needs of project management and the Fermilab accounting system without ugly warping of the WBS logic. With the constant help of the AD budget office Proton Plan management develops the project WBS with this in mind. All new subprojects and revisions to existing subprojects WBS are planned carefully to ensure adequate cost accounting structure.

Rather than using the "light" version of earned value analysis as for Run II, the Proton Plan has chosen to use the full BCWS, BCWP, and ACWP to give more detailed understanding of the cost variance and schedule variance – Good!

Jeff Sims' presentation (page 10) gave an exaggerated tightness of schedule float. This included combining comfortable float for component fabrication and tight float for installation during a very constrained shutdown resulting in an overall tight float for that sub-element. Similarly, there are some elements that are dummy placeholders with zero float, e.g. Approval to Proceed on MI RF Upgrade (which has 10 months after completion and review of prototype testing and 5 months after development of the specific upgrade plan for this approval to be obtained). These should be addressed to give a more realistic impression of the tightness of schedule. We will include analysis of float for major fabrications and procurements along with installation related task float (10 days or less) in the baseline to establish a better understanding the tasks that can impact the projects critical path. We will not report float on developing or placeholder subprojects at the baseline review as they are not well enough established to truly understand their implications to the critical path.

What were the assumptions for dates and durations of shutdowns? They were based on an email from Steve Holmes to on June 9th 2005 and outlined in the BOE. Are the needs of the Proton Plan installation activities inputs to Program Planning? All level 3 and level 4 managers have been coordinating their shutdown related labor need with MSD and EESD. The starting dates and durations of shutdowns for installation activities should have an element of float built into the milestones, as described in MS Project, Project Management Plan, etc., to account for the flexibility of scheduling of accelerator operations.

The Basis of Estimate (BOE) presented is just a start. There are ~ 900 lowest level WBS elements in the MS Project which require either M&S or SWF estimates. The BOE summary sheet has only ~ 85 elements listed in diverse formats (embedded notes and web links which are also printed in the rear), making it difficult for a reviewer (or Proton Plan managers?) to navigate. Is the BOE book directly linked to the same database as the MS Project? The BOE information appears to be of the following classifications:

TD spreadsheets – in trustworthy form since TD has great experience in producing estimates.
Chez Jach – on ORBUMP Power Supplies – compiling history can be trustworthy
Vendor quotations or similar to previous purchased items – enough said
Engineer listing of materials and manpower estimates, based on prior experience - hard to understand how reliable

What would be nice to see would be the complete WBS, Name, M&S, and SWF tabulation from the MS Project printout on a BOE Summary spreadsheet with those elements using M&S or SWF having web links to a cost element dictionary (short description – see BTeV) and the basis of estimate reference. In that way, the managers/reviewers could see immediately what information was available or lacking from this summary table, and would be able to instantly view the desired info. An additional field on the BOE Summary spreadsheet would be a code for the type of estimate (mimicking the guidelines for contingency allocation on Jeff Sims page 19) indicating the type/quality of the estimate. We plan to add more BOE information to the notes for fully scoped tasks.

The schedule of the Proton Plan Program Management Group on the 2nd Thursday of each month may be a little tight in terms of getting the financial reports (especially COBRA) through the end of the previous month ready for presentation. Scheduling of such a broad meeting is problematic, but I anticipate that at least a few times the latest financial data will not be available for the PMG.

Recommendations:

1) The members of the Proton Plan should raise the level of maturity on all of these documents. The Basis of Estimate is particularly incomplete. We concur and we are currently meeting with all level 3 and level 4 managers to improve the maturity of the fully scoped subprojects.

Developing or placeholder subprojects estimates will be clearly identified as high level and will have assigned appropriately higher contingencies.

2) The members of the Proton Plan must take the time to perform quality assurance on all documents and presentations (proof-reading, cross-checks for consistency, review of each section/presentation by more than the preparer). We will perform additional quality checks within the documentation prior to the baseline review. In addition, we will be rehearsing the presentations prior to the review so we will have another opportunity to correct for errors.

3) The presentations should be rehearsed shortly before the Director's Review, with participation through all Level 3 managers, the AD/Program Office, and the AD/HQ. Rehearsals for the baseline review are tentatively scheduled for August 18th.

Change Control and Use of Contingency:

Findings:

The plan for holding and assigning (using) contingency is not adequately presented.

Comments:

The change control thresholds and procedures presented in the Project Management Plan were inadequate and, depending on interpretation, overly burdensome (unworkable). In private discussion, Jeff Sims was confused, but agreed for the need to have both flexibility for the Proton Plan managers and control by the Proton Plan and ultimately by the Directorate. There was no clear definition of what was the TPC – did it include the contingency or not? Is there contingency held by the Directorate, to be allocated to the Proton Plan as an operating contingency – at what level?, or to be allocated on an item-by-item basis by approval by the Change Control Board? Aren't codes 22/1.04.01 and 22/1.04.02 examples of "operating contingency" already allocated to the Proton Plan? A change to the change control threshold matrix in the PMP is currently being reviewed by AD Headquarters.

Recommendations:

1) Consider adapting the change control procedures and thresholds outlined in the Run II Upgrades Project Management Plan, where an individual element requiring a single change of $100K or a cumulative allocation of operating contingency passes $100K triggers a review/approval by the change control board. A change to the change control threshold matrix in the PMP is currently being reviewed by AD Headquarters based on the Run II model.

here's a RECOMMENDATION REQUIRING DIRECTORATE ACTION:

2) In addition, if the Directorate decides not to allocate contingency to the Proton Plan but to hold it itself, the Directorate's plan for contingency management should be explicitly included in the Proton Plan Project Management Plan, and the current level of contingency held, both for the

current year and future years, should be documented by the Directorate monthly at the Proton Plan PMG Meeting. This will minimize the confusion arising from the Directorate continuously "borrowing" from the Run II contingency that it holds. Proton Plan Management will revise the PMP as required by AD Headquarters when requested.

PHG Minor Comments & Suggestions:

Much information is available through the Proton Plan website, but many of the cost, schedule, and management items are INTERNAL – only available from the Fermilab site. This makes it difficult for external reviewers to do some homework before the review. Such external reviewers should be given at least temporary access to these documents.

Use brighter yellow for 1.2.2.1 on Org Chart. We used a lighter yellow intentionally to denote that it is TD work but is actually included and paid for by Run II.

Vertical is mis-spelled as verticle in many places. We will correct this.

The Design Handbook, Section 3 Cost and Schedule, presents specific numbers and dates. That is only desirable if these quantities are kept up to date. Is that automatically updated by the updating of the official MS Project? There should be a DATE applied to these tables since they will change. Also please date (header or footer) each page of your documents so a reader can recognize the version. The Baseline dates and costs will be used. A date will be added to the tables.

I am not authorized to view the BOE/index.html
However, when I input the filename for BOE elements, a pop-up says that I am not authorized to view, but that file opens anyway??? We have fixed these problems.

It was hard to follow labor SWF between MS Project and individual presentations with regard to escalation and contingency. Should be tightened up. We have added a PM cost view in MSP that shows clearly all of our base M&S and SWF, Escalated M&S and SWF, and Escalated M&S and SWF contingency.

Proton projections

Findings:
Cumulative proton projections for the Proton plan through 2011 were presented. The projections were based on the relative priority of collider, NUMI, and Booster Neutrino Beam. Design and base curves were presented. The projections are based on "peak" proton through-put modified with correction factors to take into account downtimes and inefficiencies.

Comments:
Overall, based on the information given and past experience, the projections look reasonable. However, there is not a clear connection between the success of sub-projects and proton output. The concept of separating "peak" capability modified by correction factors is confusing, misleading, and not well motivated.

Recommendations:

1. The effect on proton through-put for each of the sub-projects should be explicitly given. We concur and we are currently developing the PoT projections by subproject. This information will be included in the baseline review. It is important to note that reliability related improvements may not have PoT projections if it is not clear that they have a direct impact on PoT throughput.
2. The projections should be based on average running without any reference to "peak capability". However, specifications to each of the sub-projects should be based on "peak capability". We concur and we are currently revising the method of projecting PoT for the Proton Plan.

Appendix:

Agenda:

1) Introduction, Overview and Scope of Baseline (Prebys)
2) Linac Upgrades (Allen): 1.1.2, 1.1.4
3) PA vulnerability Task Force (Andrews): 1.1.1
4) ORBUMP and 400 MeV Line Upgrade (Garcia): 1.2.2
5) Booster Corrector Upgrade (Drennan): 1.2.3
6) Booster Dump Relocation (Pellico): 1.2.11
7) MI Multibatch Operation (Kourbanis): 1.3.3
8) MI RF Issues (Kourbanis): 1.3.4
9) MI Radiation Issues and Collimation (Brown): 1.3.2
10) Miscellaneous RF (Reid): 1.2.1, 1.3.4.1
11) Misc. Magnet Work (Harding): 1.2.2.1, 1.2.3.1,1.2.3.2,1.3.1.1
12) Misc. EE Support Power Supplies (Wolff): 1.2.2.2, 1.2.4, 1.3.1.3
13) Proton Study Group Status and Plans (Syphers): 1.5
14) Project Management (Sims): 1.4
    1) costing methodology, monthly tracking, change control, contingency analysis, critical path analysis, ……
15) Proton Projections (Prebys)

Committee:

M. Church (chair)
P. Czarapata.
D. McGinnis
T. Berenc
B. Foster
P. Garbincius
V. Lebedev
P. Schlabach