Briefing on the Proton Team Report to the UEC

Highlights of The Proton Team Report

http://www.fnal.gov/directorate/program_planning/studies/ProtonReport.pdf

University and Accelerator Collaboration

So What's Next?

Charge
Demands, Goals, Modifications, Collaboration, Organization

- 1) Identify users of protons over the period 2003-2010 and the demands represented by each.
- 2) Establish technical goals for delivery of protons, both from the Booster and Main Injector, over the period.
- 3) Identify major modifications to the Proton Source and Main Injector that will be required to meet these goals assuming availability of Fermilab resources at the few x $10M level over the period.
- 4) Identify possible resources and opportunities for collaboration by institutions outside Fermilab.

5) Suggest an organization for implementing a program of modifications, including opportunities for integration of collaborators outside Fermilab.

Proton Team

The Proton Committee was formed in February 2003 by the Fermilab Director to provide advice on the use of protons at Fermilab through the end of the decade.

By the summer of 2003, the committee was composed of David Finley (Chair), Janet Conrad, Doug Michael, Chuck Ankenbrandt, Jeff Appel, Greg Bock, Peter Kasper, Ioanis Kourbanis, Alberto Marchionni, Shekhar Mishra, Eric Prebys, and Ray Stefanski.

In addition over 30 people were “interviewed” for their input.

Ground Rules

1a. Ground Rules

The Chair set the following ground rules for the committee: 1) Antiprotons will be required for the entire time period considered by the committee, 2) A "New Proton Source" will not be the default solution to increasing proton demands during this time period, 3) Specific on-going activities will be supported as long as they are seen to fit sensibly into an overall view, and 4) This committee leaves physics decisions to the Director.

This committee is aware of another advisory panel for the Director, the Long Range Planning Committee (LRPC) chaired by Hugh Montgomery. This committee will try to hand off to the LRPC gracefully since its horizon extends well beyond that of this committee.

Schedules >>> Short / Mid / Long Term

Draft Multi-Year Fermilab Schedule

Program	Facility	2003	2004	2005	2006	2007
Tevatron Collider	C0					BTeV
	B0 & D0	CDF & Dzero	CDF & Dzero	CDF & Dzero	CDF & Dzero	CDF & Dzero
Neutrino Program	Booster	MiniBooNE	MiniBooNE	M B Open	Open	Open
	FMI			MINOS	MINOS	MINOS
Meson 120	MT	Test Beam	Test Beam	Test Beam	Test Beam	Test Beam
	MC	E907/MIPP	E907/MIPP	E907/MIPP	Open	Open

M&D (Shutdown) Installation Startup/Commissioning Run or Data

This draft is meant to show the general outline of the Fermilab accelerator and experimental schedules.
Major components include:
- 6-8 week shutdown each summer,
- 6-8 week shutdown for the installation of CDF and Dzero detector upgrades in 2006-7
- Starup of the NuMI operation with the MINOS detector.

Additional shutdown periods will be added, typically allowing 40 weeks of accelerator operation per year.
The draft schedule will be updated as more precise information is made available.

Draft Multi-Year Fermilab Schedule

Program	Facility	2008	2009	2010	2011	2012
Tevatron Collider	C0	BTeV	BTeV	BTeV	BTeV	BTeV
	B0 & D0	CDF & Dzero	CDF & Dzero	Open	Open	Open
Neutrino Program	Booster	Open	Open	Open	Open	Open
	FMI	MINOS	MINOS	Open	Open	Open
Meson 120	MT	Test Beam	Test Beam	Test Beam	Test Beam	Test Beam
	MC	E906	E906-Drell Yan	E906-Drell Yan	E906-Drell Yan	Open
	ME/MP	Open	CKM	CKM	CKM	CKM Open

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http://www.fnal.gov/pub/today/today03-11-18.html

Fermilab Today

Tuesday, November 18, 2003

Calendar

Only 3 days until the lab-wide party!

Tuesday, November 18

2:00 p.m. Fermilab Long Range Planning Committee Open Session: Accelerator R&D - One West

- Introduction (S. Geer)
- R&D at A0 and SCRF R&D (H. Edwards)
- MUCOOL and Neutrino Factory R&D (A. Bross)
- Magnet R&D (J. Strait)
- Accelerator Theory, Simulation and the Student Program (M. Syphers)
- University Perspective (C. White)
- Prototype Recommendations (S. Geer)

THERE WILL BE NO DIRECTOR'S COFFEE BREAK TODAY

THERE WILL BE NO ACCELERATOR PHYSICS AND TECHNOLOGY SEMINAR TODAY

Wednesday, November 19

3:30 p.m. DIRECTOR'S COFFEE BREAK - 2nd Flr X-Over

4:00 p.m. Fermilab Colloquium - 1 West

Speaker: C. de Duve, Rockefeller University/ Christian de Duve Institute, Brussels

Title: Singularities in the Origin and Evolution of Life

Cafeteria

Proton Committee Report Now Available Online

On October 26, Fermilab's Proton Committee reported to Fermilab Director Mike Witherell their advice on the use of protons at Fermilab through the end of the decade. Witherell formed the 11-member committee in February.

Dave Finley

Dave Finley, chair of the committee, noted "The committee is important because it brought together the providers of protons and the major users of protons, and tried to come up with a reasonably achievable projection of what can be done." The complete report is available online.

Conclusions include:

1) The reliance of the Linac on a single vendor for power tubes represents a significant vulnerability.

2) MiniBooNE and NuMI can run at the same time given a few sensible modifications to the Booster.

3) The Beams Division should prepare to use the Main Injector to support Run II, NuMI and Fixed Target at once.

4) The Beams Division needs a clear plan for providing the multiple batches to the Main Injector required for NuMI without creating large losses in the Booster.

5) The lab has to figure out how to collaborate with the largely untapped resources represented by the university groups.

Director's Corner

Good Morning!

Mike Witherell

On Friday we are holding a party for the entire Fermilab community to celebrate 20 years of physics with the Tevatron in addition to the many accomplishments of the last year. We are restarting accelerator operations after a shutdown in which a remarkable amount of carefully planned work on the accelerator complex was completed. CDF and D0 reported their new physics results at the Lepton-Photon Symposium in August, which was another notable success. The NuMI, LHC, and CMS projects advanced right on schedule. Finally, we had the best safety record in the history of the laboratory during fiscal year 2003.

We have great prospects for new physics in the year ahead, from CDF and D0, MiniBooNE, CDMS, Auger, and Sloan. Come help us celebrate and look forward to the year ahead.

Announcements

Virtual Ask-a-Scientist Tonight!

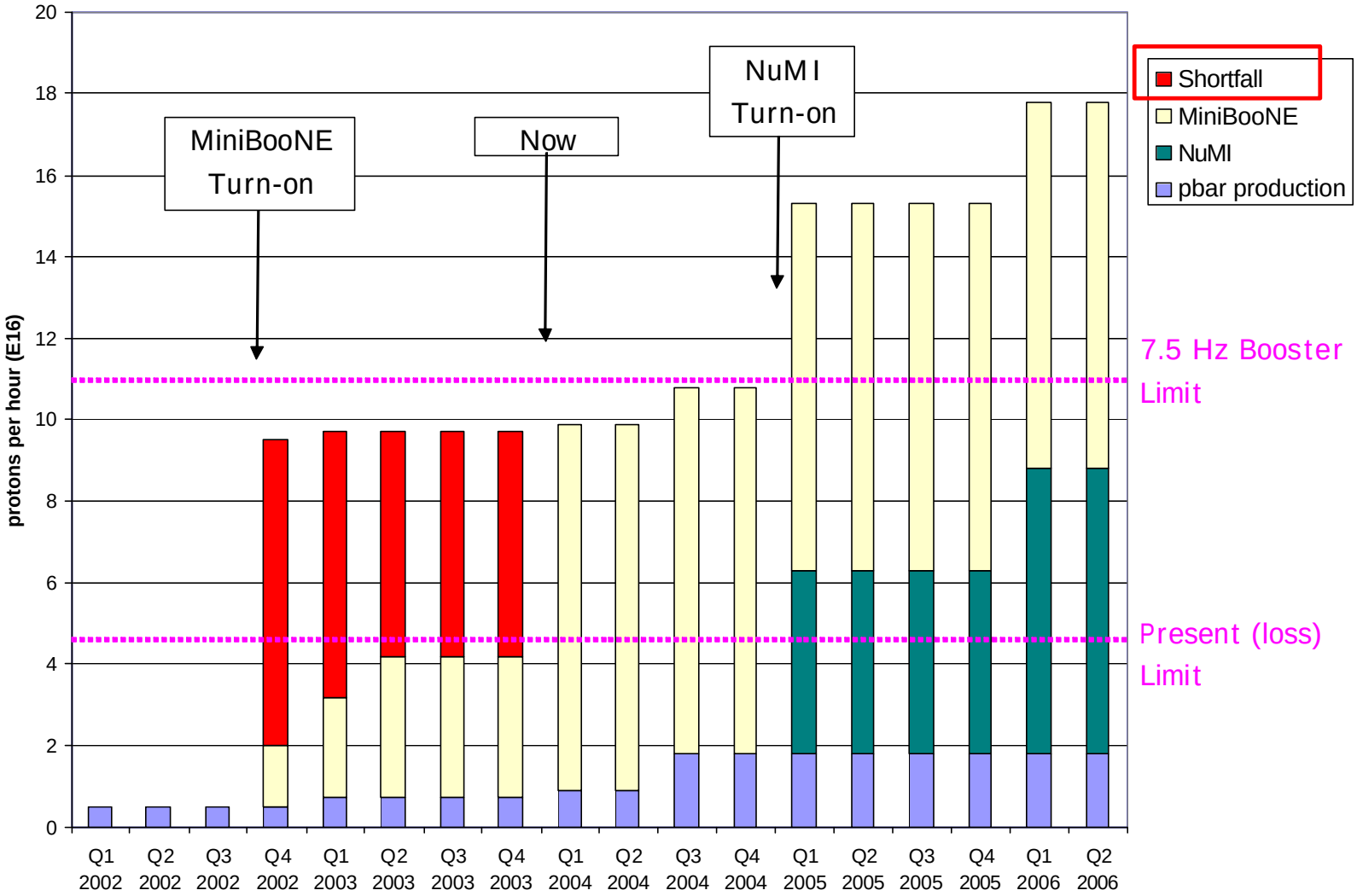
DZero's Greg Davis and Harald Fox will be the feature scientists tonight on Virtual Ask-a-Scientist. The online chat session will take place from 7:00 to 9:00 p.m. Central Time. Participants can log on to

Highlights of The Proton Team Report

- Conclusions include:
  - 1) The reliance of the Linac on a single vendor for power tubes represents a significant vulnerability.
  - 2) MiniBooNE and NuMI can run at the same time given a few sensible modifications to the Booster.
  - 3) The Beams Division* should prepare to use the Main Injector to support Run II, NuMI and Fixed Target at once.
  - 4) The Beams Division* needs a clear plan for providing the multiple batches to the Main Injector required for NuMI without creating large losses in the Booster. [and for Run II Stacking]
  - 5) The lab has to figure out how to collaborate with the largely untapped resources represented by the university groups.

* Now (once again) known as the "Accelerator" Division

Proton Demand
(Lifted from Eric Prebys' PAC talk yesterday)



Modifications

- Top of the List for addressing
  - Booster losses and Main Injector intensity

Booster Collimators ← Control Loses

Booster Dog Leg Rearrangement ← Reduce Losses

Booster Installation of Two Wider Aperture RF Cavities

Main Injector Damper Systems

Main Injector Slip Stacking ← Need high intensity implementation

Booster Cogging for Multibatch Transfers into the Main Injector

Booster Notch Creation Improvements

Need high intensity concept / implementation

Modifications

- Next on the List (in need of a planning process)

Booster Monitoring Software

Booster Radiation Protection

Booster to Main Injector 8 GeV Line Aperture Increase

Booster Upgraded Loss Monitors

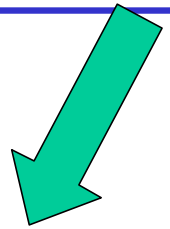
Main Injector Beam Loading Compensation

Main Injector Upgraded BPM System

Main Injector Lattice Changes for NuMI Extraction

Main Injector Operation of NuMI and Antiproton Stacking In The Same Cycle

This has become an almost unconscious assumption



Modifications

- Also on the List (need more information before proceeding)

Linac Low Energy Replacement ← A Big Deal …

Booster Dog Leg Replacement — Coordinate with LRP

Booster Replacement of Remaining RF Cavities

Booster Replacement of High Power RF System ← ~$10M

Main Injector Aperture Increase

Main Injector Mixed Mode E907 and Antiproton Stacking

Main Injector Radiation Protection

Main Injector Beam Loss Control

Main Injector Fast Proton Stacking

Modifications

- For the Mid Term or later

Main Injector Beam Permit For NuMI ← This could limit NuMI

Booster Dampers

Booster Gamma-t Jump Recommissioning

- Later in the Mid Term or for the Long Term

Main Injector Debunched Resonant Extraction

Booster Repetition Rate in Excess of 7.5 Hz

Faster Main Injector Ramp ← This is more than $10M

(A New Proton Driver is not a “modification for a few $10M’s”)

Summary of Technical 1of 9

1. First, the committee notes that the reliance of the Linac on a single vendor for the 5MW 7835 power tubes represents a significant vulnerability that may result in no protons at all for Fermilab for an unacceptably long period, and the Lab obviously has to mitigate this vulnerability.

Summary of Technical 2 of 9

2. The committee recommends the following be done as soon as possible.

In the Booster to reduce or control losses:

Install the collimators and make them operational.

Rearrange the Long 3 extraction region.

Install two wider aperture RF cavities.

Develop and implement notching and cogging for multibatch transfers.

In the Main Injector to increase intensity and control beam quality:

Fully develop the damper system.

Implement slip stacking.

Summary of Technical 3 of 9

3. Insufficient control of radiation in the Booster is expected to continue to be the primary limitation on its performance, and control of radiation in the Main Injector is expected to become a limitation with or without a new Proton Driver. Either the Beams Division arranges to overcome these radiation limitations, or better understands the actual limitations and consequently redefines what is acceptable, or those parts of the physics program demanding more and more protons will continue to be limited.

Summary of Technical 4 of 9

4. Run II, NuMI, Meson120 and MiniBooNE can run at the same time assuming the Booster losses are reduced or controlled by a combined factor of almost three better than today. However, if the Booster remains limited to 7.5 Hz operation (including 2 prepulses), and Run II and NuMI receive their demands of 1 Hz and 2.5 Hz respectively in a combined 2 second Main Injector cycle time, then MiniBooNE will be limited to receiving beam at a rate of 3 Hz instead of its maximum of 5 Hz. For a Main Injector cycle time of 3 seconds, MiniBooNE would be limited to 4.5 Hz.

Summary of Technical 5 of 9

5. Proton stacking in the Main Injector is required for Run II and the later stages of MINOS. Slip stacking appears to be the best hope for meeting the Run II proton intensity demand for antiproton stacking of 8E12 protons per pulse. Fast stacking of some kind appears to be the best hope for meeting the MINOS proton intensity demands beyond the initial value of 2.5E13 protons per pulse. The present performance of slip stacking is about a factor of six too low for Run II, and fast stacking has not yet been attempted. Either sufficient time must be given to develop proton stacking into an operational technique, or Run II will continue to be limited by the Booster intensity level to about 5.5E12 protons per pulse for antiproton stacking, and MINOS will be limited to its initial demand.

Summary of Technical 6 of 9

6. Multibatch transfers between the Booster and the Main Injector are demanded both by Run II (two batches starting in 2004) and NuMI (five batches starting in 2005). At present the Booster extracts a single batch with acceptable losses by creating a beam-free notch at 400 MeV that is then used for the extraction kicker at 8 GeV. At present there is a concept for how to transfer multiple Booster batches to the Main Injector by creating a notch, cogging it in the Booster to where the Main Injector requires it, and extracting it. This has been done for low intensity beam in which uncorrected pulse-to-pulse variations in the arrival of the notch of up to two Booster turns can be accommodated by controlling the radial position. However, correcting these variations with high intensity beam is very likely not possible without unacceptable beam losses. If notching cannot be made operational for multibatch transfers, or the source of the variations are not found and eliminated, then the losses will have to be controlled in some other manner, or the number of protons delivered to the Main Injector will not even approach the Mid Term needs.

Summary of Technical 7 of 9

7. Proton intensity in the Main Injector will continue to be limited by the ability to implement operational control of instabilities. In the past, the Main Injector has consistently provided about 1.5E13 during operation, but the Mid Term demands are more than a factor of two larger, 3.3E13 (8E12 for Antiproton Stacking plus 2.5E13 for MINOS), and the requirements on the NuMI beam emittances are more stringent than in the past. Although on paper the total intensity limitation in the Main Injector exceeds 5E13, progress will require sufficient beam study time as well as priority in assigning people to make modifications.

Summary of Technical 8 and 9 of 9

8. The continually increasing proton demands of the neutrino program will require modifications, but it is not clear at this point which ones are the most feasible. These include increasing the Booster batch intensity, some form of fast stacking in the Main Injector, and shortening the Main Injector cycle time. Determining which ones of these to pursue should start as soon as possible.

9. The committee anticipates the neutrino program will eventually demand more protons than reasonable upgrades of the present Linac and Booster can accommodate. At that point it would be prudent to have a new Proton Driver available.

Summary of Organization and Collaboration 1 of 3

1. Several organization changes should be made to help assure the maximum utilization of available resources. These changes should be integrated into the overall operation and organization of the Lab, and not considered as a "Protons Only" enterprise. An individual should be made responsible and given the authority to develop and implement a plan for delivering the protons demanded by the upcoming physics programs. This plan would likely include some incarnation of a PMG-style enterprise. It is most important that a group be formed to technically evaluate ideas for improving all the accelerators, perhaps incorporating some techniques that are more common in detector collaborations. And another group should be formed to nurture and develop ideas as well as to facilitate the intellectual involvement of physicists in accelerator physics.

Summary of Organization and Collaboration 2 and 3 of 3

2. For collaboration between the Beams Division and non-Fermilab institutions to succeed better than it has so far, the Beams Division or the Directorate must provide a high level point of contact with sufficient clout to wisely guide the department heads and group leaders along the path of success. The same point of contact could also make cooperative efforts between the Beams Division and other Divisions within the Lab work much better.

3. Program Planning will have to determine just how to timeshare the Main Injector between cycles using slow resonant extraction for Meson120 fixed target experiments, and cycles using fast, single turn extraction for antiproton stacking and MINOS.

Formulating a Plan
(Lifted from Eric Prebys' PAC talk yesterday)

- The lab has recognized that the proton demands of the experimental program are significant, if not daunting, and will require substantial efforts to meet.
- As the financial burden of Run II begins to ease, it's envisioned that financial resources on the order of $20M will be diverted to these efforts over the next few years.
- We are in the process of putting together a plan with the maximum likelihood of reaching these goals.
- Ultimate goal is to generate a project similar to Run II
- However, because the future (MiniBooNE) is already here, such a plan will necessarily have near and long term components.

University and Accelerator Collaboration

- Some specific examples from Janet Conrad (Columbia University / MiniBooNE) and Doug Michael (CalTech / MINOS) … who were on the Proton Team.
  - Calculation and study of Booster losses
    - R. Johnson, U Cincinnati professor; L. Coney, Columbia post doc / P. Kasper
  - Development of a code to monitor Booster ramped devices
    - L. Coney, Columbia post doc; C. Jacobs, Columbia undergraduate, / P. Kasper
  - Development of electronics for Booster dipole correctors
    - J. Monroe, Columbia grad student; M. Wascko, Louisiana State University post doc / W. Pellico

University and Accelerator Collaboration

- More specific examples from MiniBooNE and MINOS
  - Machining of wider aperture Booster RF cavities
    - Tufts, CalTech, UT Austin, Columbia, Indiana, Princeton / Many Fermilab
    - Total cost closer to $10K rather than ~ $150K
  - Booster Cogging needed for NuMI and Run II Stacking
    - Bob X, UT Austin grad student / W. Pellico
  - Barrier Bucket fast stacking in Main Injector
    - Hai Zheng, CalTech post doc / D. Wildman and W. Chou
  - And Loans …
    - Columbia and Indiana (and others) to keep things like the collimator and other shutdown work on an aggressive schedule

So What's Next?

- Invite Eric Prebys to give the next briefing
  - Appointed by Roger Dixon to devise a plan and carry it out implementing elements of the Proton Team Report

- Eventually invite a briefing on a Proton Driver
  - Probably await the official outcome of the Fermilab Long Range Planning Committee process.
    - (Bob Kephart is the chair of the Proton Driver Subcommittee of the FLRPC.)

Summary
(Lifted from Eric Prebys' PAC talk yesterday)

- We have a good understanding of the proton demands over the next few years in the context of the limitations of the Fermilab accelerator complex.
- We have made remarkable progress toward meeting these demands, but are still falling well short.
- We are pursuing an ambitious plan to attempt to meet these demands, but cannot yet guarantee its success.
- The next few months will be very important.