

# Working Group on Protons for MINOS

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Jan. 5, 2002

# Why

- At the current time, it is possible to accelerate only a relatively small fraction of the total protons needed by MINOS.
- **Everyone agrees that work needs to be done to deliver the necessary protons:**
  - But currently there is little to no manpower to work on issues of direct importance to MINOS!
  - Manpower will clearly remain very tight.
  - We should identify improvements which have the best chance of providing the biggest increase in the number of protons available for MINOS.
- We need people working directly on MINOS issues and advocating for our needs in the accelerator complex.

# What

- We have time to act, but now is the time to be getting started on improvements.
- Two stages:
  - First define a path/program
    - Needs input on the current issues and performance
      - Start doing machine tests to better define the status
    - Needs input from accelerator experts
      - Establish contacts and raise awareness on MINOS issues
    - Needs evaluation of improvements and manpower
    - Define a clear program of work which can/will be endorsed by Fermilab leadership (Directors and Beams Division leaders).
  - Second: Carry out a program of improvements.
- A committee has been established with input from both MINOS leadership and Fermilab leadership to get started on the first stage of this process.

# The NuMI/MINOS Proton Working Group

- An initial, relatively small working group has been established to get the process started:
  - Phil Martin (co-chair) Beams Div.
  - Doug Michael (co-chair) MINOS
  - Eric Prebys Proton Source
  - Stan Pruss Main Injector
  - Peter Lucas MINOS
  - Tom Fields MINOS
  - Alberto Marchionni MINOS/Beams

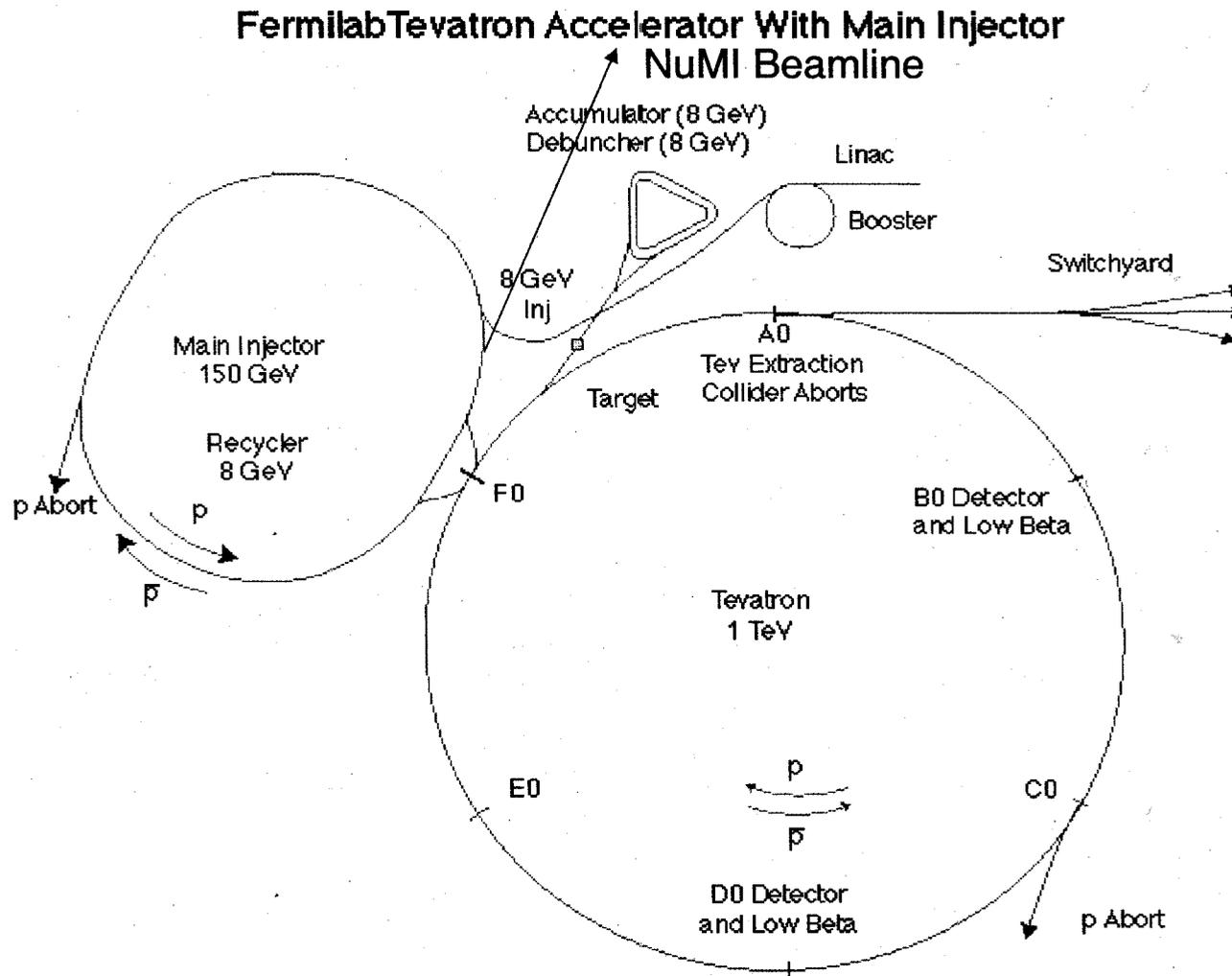
# Charge to the Proton Working Group

- Charge
- The working group is charged with advising the Directorate and the MINOS spokesperson on the number of protons per year that the MINOS experiment can expect to have targeted and actions which can be taken to help maximize the total number of protons delivered in a three-year running period.
- This advice should be based upon the following:
  - Document the present capability of the accelerator complex with respect to protons per cycle that can be accelerated to 120 GeV in the Main Injector in the mixed-mode expected for joint NuMI + pbar production operation. Document the beam emittance, both transverse and longitudinal, at 120 GeV, and the Booster losses per proton relative to the trip point of the interlocked detectors. The emittances and the losses are functions of intensity, so the above measurements need to be done over a range of intensities.
  - Document the number of protons per hour that can be accelerated in the Booster for the above operating cycle while staying within the safety envelope.
  - Document the number of hours per week that beam can be expected to be available from the Main Injector.
- Based on the above measurements, develop a plan of improvements, ordered in priority to the extent possible, that appear most attractive towards increasing the projected proton intensity per year. Assuming these improvements are implemented, what is the expected gain? Although it should not be taken as a limit, the working group should specifically identify a list of improvements which appear to have the best chance of delivering a total of  $12e20$  protons on target for MINOS over a three year period starting in April 2005.
- Where possible, the working group should identify specific manpower needs, from both inside and outside of Fermilab, in order to meet the suggested improvement goals.
- A final report should be submitted by April 15, 2002. The working group should report at each MINOS collaboration meeting and NuMI PMG meeting until then.

# Some Issues

- Proton Source
  - Improvements in the ion source?
  - Improved simulation of Booster
    - Better acceptance of beam from Linac?
    - Better control against beam losses (radiation)?
    - Better ability to collimate beam (radiation control)
    - Better phase-space control for better MI beam at high intensity
  - Better matching between Linac and Booster?
  - Cogging for multi-bunch MI operation at high intensity
- Main Injector
  - (Re)-establish multi-bunch operation
  - Beam stability at high intensity operation (phase-space and proton losses)
  - Tuning of Main Injector for high intensity
  - Options for increasing the number of batches accepted by the Main Injector (>6?)
    - Slip stacking
    - RF Barrier stacking
  - New control software and hardware for high intensity operation?
  - New collimation systems to avoid beam losses in NuMI transfer line?
  - New control software for NuMI beam permit system?
  - Faster repetition rates (needs new hardware) under various operating scenarios?
- Overall
  - Reliability and uptime of the accelerator complex
  - Personnel to focus on MINOS issues
  - Laboratory resources necessary to accomplish MINOS objectives
  - MINOS collaborators in the accelerator groups
  - Participation of non-Fermilab personnel in accelerator complex improvements

# The Fermilab Accelerator Complex



# The Return of Multi-Batch Operation

Phil Martin recently re-established multi-batch operation of the Main Injector.

See Figures.

This is a good start!

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NuMI Beamline E-log 11:06:46 Fri Dec 14 2001  
-- First Entry in NuMI Beamline Elog --

Studiers: Wally

Start of Studies Notes: Any questions, let me know. - Wally Kissel

08:49:17- Another round of studies was attempted on Friday, Dec. 14. In this period, we got beam partially operational on the NuMI cycle, but only for the \$14 Booster reset...beam for pbar production. Basically, we (I was assisted by Dave Capista, Stan Pruss and Alberto Marchionni) set the curves for rf, tune and chromaticity to be the same on the \$23 as on the \$29. However, the transmission on the \$23 was not quite as good as on the \$29, even accounting for the longer 8 GeV dwell time. I looked at the BLMON (bunch length monitor) signal right at injection, and it clearly looks like there is something different between the two cycles. The \$29 cycle had a narrow envelop for the BLMON signal for the first few hundred msec (all I was looking at) while the \$23 showed both a lot of pulse to pulse variation and a much large oscillation on any given pulse. like there might be some feedback on the \$29 but not on the \$23. I talked to Brian Chase later during the Christmas party, and he said he could take a look at it today. - Phil Martin

15:56:29- This note summarizes some of the details regarding the NuMI beam studies. The NuMI cycle is Main Injector Tclock event \$23; for "mixed Mode", in which one Booster batch goes to the pbar target, and the remaining batches are for NuMI, the Booster event for pbar is \$14, and the batches for NuMI are event \$19. A TLG (Time Line Generator) module has been defined which has the above events. This is module number 222. At the present time, there is no event \$80 in this module...that is the event that is also required to ramp the P1, P2 and AP1 beamlines to extract the beam to the pbar target...the beam now goes to the MI abort for the \$23 cycle. The MI ramp for \$23 has a 0.5 sec front porch for injecting the six batches, and an overall length of 1.85 sec. There are two Booster prepulses in addition to the Booster beam pulses (just as there are for essentially all Booster scenarios). The timing relationship of the prepulses and the event \$14 are in the same relationship to the MI event, for both the \$29 and the \$23...i.e. the beam will appear in the MI at the same time on both cycles. For the time being, it is not possible to get beam on the event \$19. This is because the Beam Switch Sum Box (BSSB, affectionately known as the hemorrhoid box) is not configured with the same logic for the NuMI beam as for pbar and Tevatron. For those machines, beam is present, for example, if the Tevatron permit is made up and all the beam switches are set to ON, but beam may also be accelerated in the Linac, Booster and Main Injector IF both the TeV permit is down and a beam switch is OFF...then whether beam is accelerated or not is determined by the MI beam switch. To get beam on the event \$19, we will have to either change the BSSB logic, or get the NuMI beam permit jumpered. I have gotten authorization to jumper the permit, and will work to getting that done for studies this week. - Phil Martin

Tue Dec 18 10:10:07- Starting studies again, trying to get the beam permit jumpered. Beam on the \$14 looks reasonable. - Phil Martin

Tue Dec 18 10:11:38-

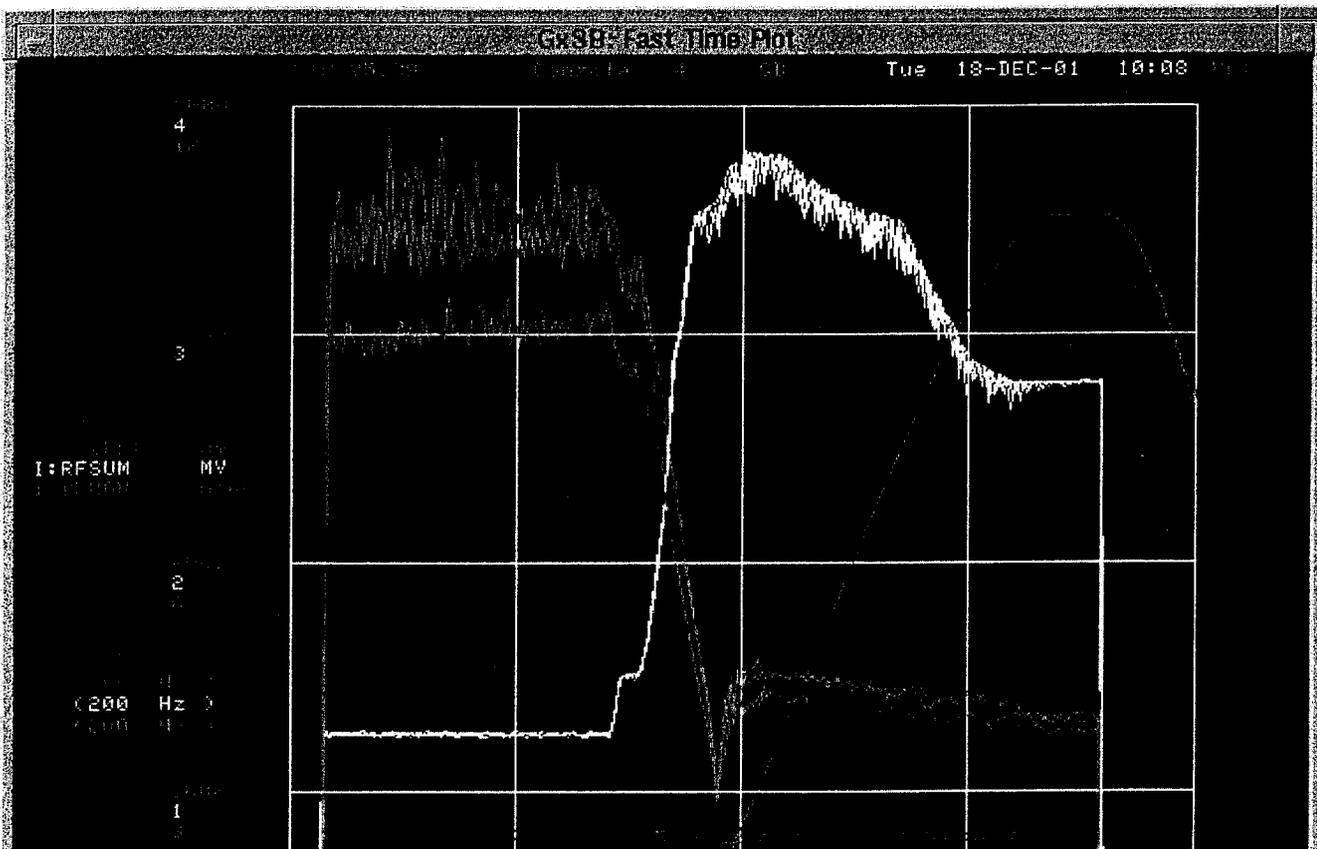
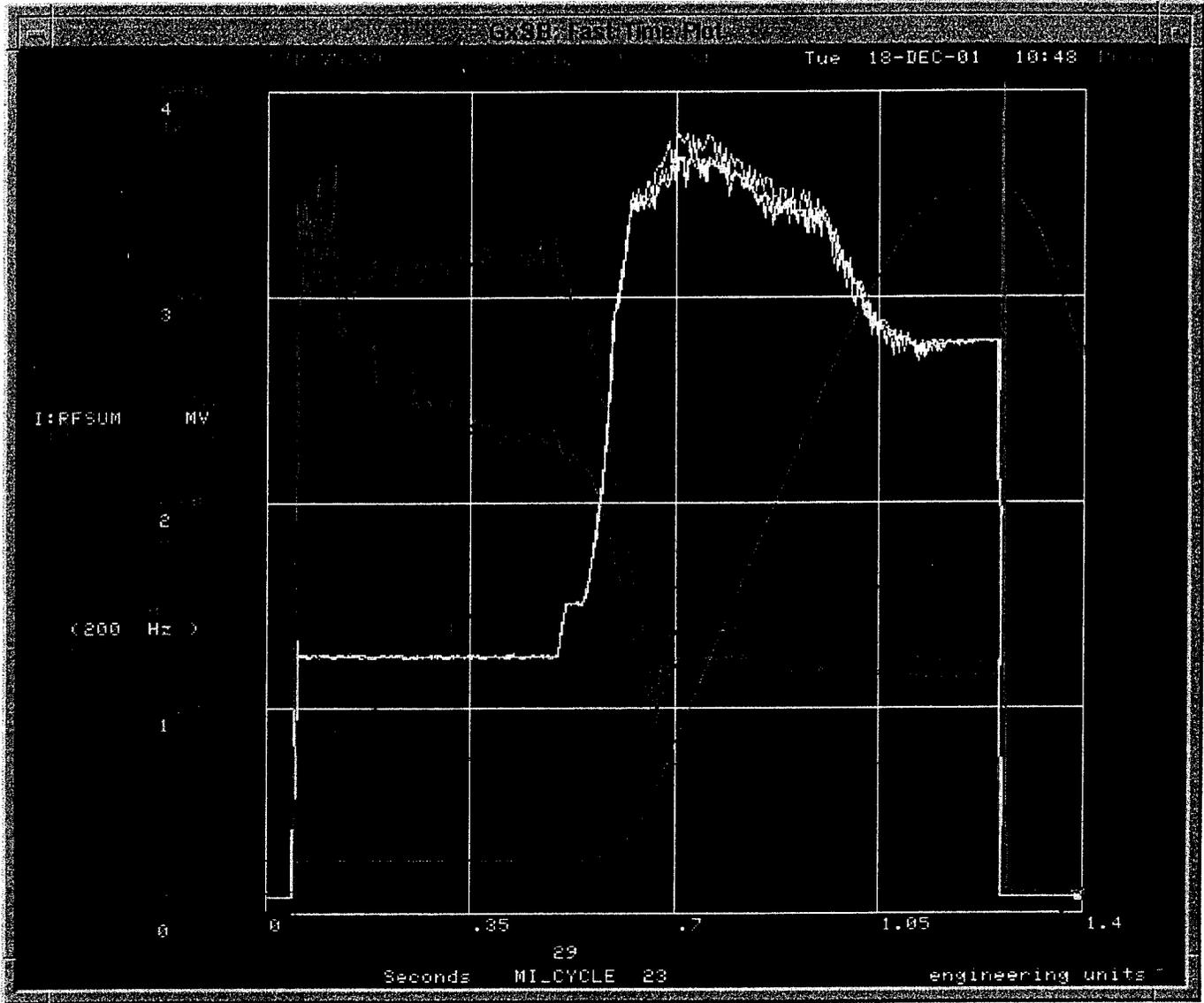
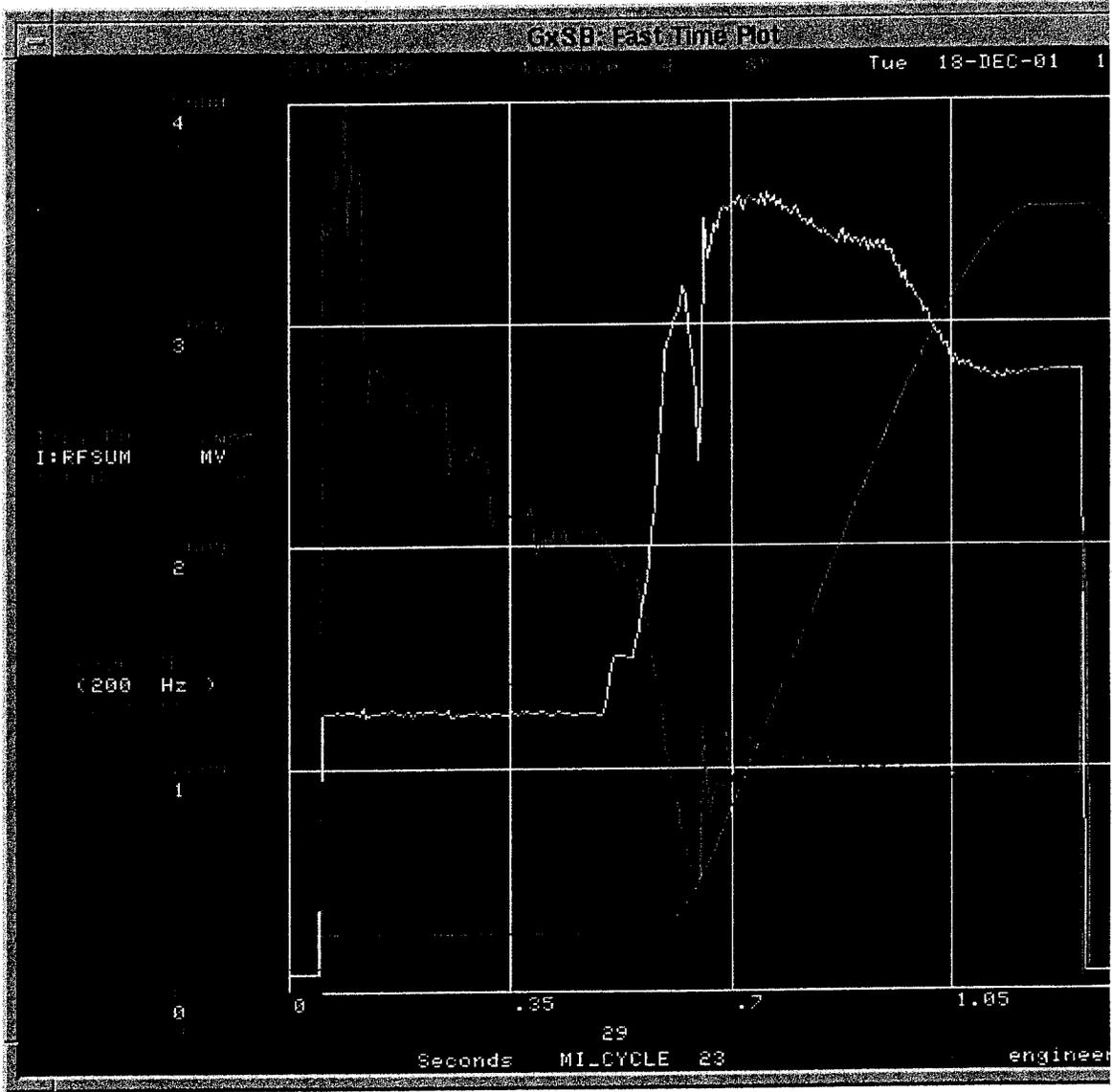


fig. at the start



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# Anticipating the Next Stage

- In general, manpower to work on issues of direct relevance to MINOS appears to be the main impediment to accomplishing the necessary work:
  - Accelerator personnel continue to be very busy with activities related to collider operation.
  - There is only modest overlap between work needed to make the collider program a success and work needed for MINOS.
  - Within the accelerator groups, the continuing priority remains very, very strongly the collider. This is re-enforced by beams division leadership. We need to establish a clear presence in these groups working on MINOS as well as exert pressure on laboratory management.
- Although increasing Fermilab personnel focus on MINOS issues is an important goal, we will need extra help:
  - There is too much work to be done to optimize protons for MINOS given the demands for work for the collider program.
  - Personnel working on MINOS on accelerator issues will help to get further resources from the accelerator groups by making our issues known and interesting.
- We will need non-Fermilab MINOS collaborators help!