Proton Source Workshop

Afternoon Session Minutes, December 7, 2010

Compiled by Elliott McCrory

December 9, 2010

# Agenda

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| --- | --- | --- | --- | --- | --- | --- | --- |
| **07 Dec 2010, 13:00** | | [**Operational and Accelerator Physics Issues**](https://beamdocs.fnal.gov/AD-private/DocDB/DisplayMeeting?sessionid=72) | | | **Users Center**  **Piano Room** | | |
| **Start** | **Title** | | **Author(s)** | **Topic(s)** | **File(s)** | **Length** |
| ***13:00*** | [*Linac-Booster Beam Interface*](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3733) | | [*Valeri A Lebedev*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=98) | [*Beam Dynamics*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=114)[*Beam Dynamics*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=129) | [*.pdf*](https://beamdocs.fnal.gov/AD/DocDB/0037/003733/001/LinacToBoosterTrLine.pdf) | *00:30* |
| ***13:30*** | [*Linac and Booster Beam Diagnostics*](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3730) | | [*Craig C Drennan*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=364) | [*Beam Instrumentation*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=130) | [*PDF version*](https://beamdocs.fnal.gov/AD/DocDB/0037/003730/003/Beam%20Diagnostics%20Presentation%20--%20Current%20101207.pdf)[*Power Point File*](https://beamdocs.fnal.gov/AD/DocDB/0037/003730/003/Beam%20Diagnostics%20Presentation%20--%20Current%20101207.pptx) | *00:30* |
| **14:00** | [BOOSTER COLLIMATION AND SHIELDING](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3734) | | [Nikolai Mokhov](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=159) | [Energy Deposition](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=165) [Upgrades](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=138) | [Beams-doc-3734...pdf](https://beamdocs.fnal.gov/AD/DocDB/0037/003734/002/Beams-doc-3734-Booster-120710-mokhov.pdf) [Beams-doc-3734...ppt](https://beamdocs.fnal.gov/AD/DocDB/0037/003734/002/Beams-doc-3734-Booster-120710-mokhov.ppt) | 00:30 |
| ***14:30*** | [*Booster Acceptance, Apertures, and Alignment*](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3727) | | [*Kiyomi Seiya*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=269) | [*Alignment*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=150) | [*PSWorkshop.pptx*](https://beamdocs.fnal.gov/AD/DocDB/0037/003727/002/PSWorkshop.pptx) | *00:30* |
| **15:00** | Break | | | | | 00:30 |
| ***15:30*** | [*Booster Optics Measurements & Correction*](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3743) | | [*Yuri Alexahin*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=102) | [*Proton Plan*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=174)[*Beam Dynamics*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=129) | [*Booster Optics...ppt*](https://beamdocs.fnal.gov/AD/DocDB/0037/003743/001/Booster%20Optics%20Measurements%20%26%20Correction.ppt) | *00:30* |
| ***16:00*** | [*Summary of Booster Dampers*](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3742) | | [*Dave McGinnis*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=163) | [*Booster*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=11) | [*PPTx file*](https://beamdocs.fnal.gov/AD/DocDB/0037/003742/001/BoosterDampersSystems.pptx) | *00:15* |
| ***16:15*** | [*Transverse Instabilities*](https://beamdocs.fnal.gov/AD-private/DocDB/ShowDocument?docid=3736) | | [*Valeri A Lebedev*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?authorid=98) | [*Beam Dynamics*](https://beamdocs.fnal.gov/AD-private/DocDB/ListBy?topicid=129) | [*.pdf*](https://beamdocs.fnal.gov/AD/DocDB/0037/003736/001/TransvInstabilities.pdf) | *00:15* |

# Notes on the Discussion

## Lebedev: Linac-Booster Beam Interface

Vladimir Lebedev (VL) reports here on work that was done, but not fully completed, in 2005. A differential orbit was conducted on the 400 MeV line, and the optics of the line, in addition to the output Twiss parameters of the Linac beam, were determined. This required “fudging” the fields on the elements in the line by a small amount. He said that the RMS emittance of the Linac beam was 2.5 mm mrad (15 mm mrad at 95%). Milorad Popovic (MP) thought that this was a factor of two too large. VL claims that the acceptance to the booster is 25 mm mrad. Thus, he concludes, painting is not possible with the present Linac beam. We can either reduce the emittance of the Linac beam, or we can scrape the beam down to a suitably small emittance.

VL says that the foil causes an increase in the emittance of 0.6 mm mrad (20 passes through the foil). Bill Pellico (WP) says that they have not seen this effect with the real Booster beam. VL comments that this may be because the effect is too small.

VL says that we can think about painting the Linac beam at injection into the Booster if the RFQ upgrade project successfully reduces the emittances, as planned. He cautions that paining in this way can affect the tune negatively.

VL observes that the 400 MeV line will have to be understood better to gain from the improvements expected from the RFQ upgrade.

VL states that an RMS emittance of 1 mm mrad will be needed to effectively utilize painting at injection into Booster.

WP states that we should not be scraping on the RF cavities in Booster. VL concurs, stating that there must be some misalignment. WP states that everything is misaligned in Booster.

Several people (including Chuck Ankenbrandt (CA) and Rick Tesarek (RT)) comment on the fact that the magnet aperture is rectangular and the RF cavity aperture is circular. The circular aperture inscribes the rectangular aperture, which may be leading to scraping in the corners of the RF cavity aperture. MP comments that he thinks a larger circular aperture for the cavities will help with the losses.

Dave McGinnis (DM) asks about the change in the position of the Linac beam during the pulse (“slew”). This is an effect, he says, that has been a problem in the past. WP says that they are also concerned about the energy slew.

DM also points out that the Booster beam is strongly coupled—the skew quad circuits are running strong. He also comments, in response to MP, that changing the cavities is a non-starter—it will take too long.

WP refers to the Task Force Report (TFR) by saying that the Booster needs more total voltage out of the RF system. VL agrees.

Ray Tomlin (RT) asks if space charge forces affect the modeling. VL replies that space charge is an important issue for the Booster at injection (the space-charge tune shift), but a minor issue in 400 MeV line calculations. Space charge is necessary to consider in the 400 MeV line modeling, but only to adjust the specifics of the line match.

## Drennan: Linac and Booster Beam Diagnostics

Craig Drennan (CD) presents a compilation of the beam diagnostics in the Linac and in the Booster. He observes that almost every system has obsolete components, but this might not be a problem since these components have not failed. He presents tables of the devices in these machines.

DM asks about automatic beam steering in the Linac. Fernanda Garcia (FG) says that this has not been implemented.

Emittance measurements in the Booster are addressed. WP says that the ion profile monitors (IPM) in the Booster have needed attention for at least ten years. It seems to be a delicate instrument. Jim Lackey (JL) observes that the IPM is the only instrument capable of seeing beam properties at injection.

There exists a plan for a profile monitor in the 400 MeV line that uses lasers, as has been done for the SNS beam. Of course, this can only be used on the H-Minus beam.

It was stated that more precision in the Booster BPM’s would be useful. WP says that the log amps in these BPM’s need to be changed as they are quite old and have probably drifted some.

CD says that new hardware for the Beam Loss Monitors (BLM’s) was created three years ago. Controls is working on implementing fast time plots for the BLM’s that can store several cycles of data.

Ralph Pasquinelli (RP) asks if any of the diagnostics are orphaned. In other words, are there people assigned to all of the diagnostics systems. WP says that this was addressed in the TFR, and that there is, in fact, a person (or people) assigned to all of these systems.

Eric Prebys (EP) says that the analysis tools for the Booster beam diagnostics are limited and antiquated. It would be nice, he says, to have a tool like SDA for the Booster. And analysis framework is needed.

Elmie People-Evans (EPE) asks if we really need anything *new* in diagnostics. Maybe a Linac BPM upgrade, fashioned after the MTA BPM’s.

WP adds that there is an ongoing effort to understand the scanning emittance probes, and the data they produce, at the extraction to the high-voltage columns at the upstream end of the Linac.

RP says that we need priorities in these diagnostics systems. WP says that these priorities are all in the TFR.

DM says we need more and better software to make these diagnostics more useful. WP says that is has recently received a lot of attention. There are two people in AD/Controls who spend a significant fraction of their time on Proton Source software. In particular, the tune measurements in the Booster have been enhanced through software. RT asks, what about chromaticity? WP responds, hardware and software are under development now. This led to a detailed discussion of the difficulty of measuring the chromaticity in the Booster.

## Mokhov: Booster Collimation and Shielding

Nikolai Mokhov (NM) begins by saying that the loss per meter in the Booster is 10 to 100 times better than it would be without the collimation system, installed 10 years ago. The goal of this talk is to assess the requirements for the collimation and shielding in order to get to 2E17 protons per hour in the Booster.

Many observed that the collimation system does not work as designed. Part of the problem is that we now do cogging in the Booster, and this severely restricts where we can put the beam during the cycle. WP says that we move away from the collimators after injection because of cogging.

NM then outlines the criteria that are necessary to consider in a shielding study for 2E17 pph operation. These criteria are:

* Prompt dose equivalent: 10 mrem accident to a member of the public or an untrained worker, and < 5 mrem/hr (operational, 2001) at peak, 13.5 ft of dirt above tunnel
* Sump water activation < S >gravel < 4000 cm−3 s−1
* Residual dose rate P < 100 mrem/hr (= 1 mSv/hr) at 1 ft in tunnel (30 days/1 day) hands-on maintenance
* Accumulated absorbed dose in magnets, cables, motors, instrumentation lifetime
* Energy deposition in collimators: jaw in

With regard to the residual dose rate of 100 mrem/hr at 1 ft, WP says that we have never seen the levels this low. We see numbers more like 1200 mrem/hr at 1 ft after a one-hour cool-down. NM says that his calculations are for a 24-hour cool-down. WP says that even that period is not enough to cool down to that level. NM wants to get these data from the Booster people so he can try to figure out what is going on. RT observes that the Tevatron never got the loss pattern right, and he suggests that improving the diagnostics would help this.

CA reiterated that the circular RF cavities, with respect to the rectangular aperture of the collimators, are a problem. NM said that this can be modeled, and that it is conceivable that the collimators could be upgraded to account for this issue. Of course, these devices are very hot now, so it will be a lot easier to model it than to actually change it!

There is a shielding problem above ground, in the Booster West Tower, so that at least one of the offices and the stairwell (the ones closest to the street between the two Booster “Towers”) are close to being not occupiable. These areas can be declared to be minimal occupancy. But it is necessary to consider more shielding. This is an Action Item.

## Seigya: Booster Acceptance, Apertures and Alignment

Kyiomi Seigya (KS) presented data on the lattice measurements and magnet moves that have happened in the last 16 years.

WP summarizes his perspective on this issue by saying that there is considerable work ongoing to determine the accurate machine lattice for the Booster, and to state this lattice in the MAD format, and to get this lattice online. We are verifying this now. We only want to make magnet moves if we believe it will actually improve things. We have stronger correctors now, so we should have more leeway in making these moves.

DM observes that moving combined-function magnets is very difficult, compared to other accelerators that have separated function magnets.

EP reminds us that Meghan McAteer (UT Austin) has made excellent measurements of the lattice in the Booster, especially the coupling. WP says that they are trying to consolidate these efforts. DM suggests that one-bumps be utilized to measure the Booster lattice, but cautions that coupling makes this really hard. Also, RPOS makes it even harder.

Bob Webber (RW) reminds us that there are severe mechanical issues with moving the Booster magnets. JL says that the girders are relatively easy to move, but individual magnets are very hard to move safely. One issue is that the “candy canes” are very brittle. A previous effort requested that an individual magnet be un-rolled, and this operation took three days.

## Alexahin: Booster Optics Measurements and Corrections

Yuri Alexahin (YA) outlines the goals for optics measurements in the Booster:

* Move Qx closer to Qy
* Perform corrections to the optics
* Chromaticity Control

An overriding problem in these measurements is the degree of X/Y coupling in the Booster. This, in particular, makes the chromaticity measurements more difficult. He has had some success out to 20 milliseconds into the cycle. There is a problem with the BPM’s when a ping is done. It looks like there is a problem with the gating of some BPM’s. WP says that the ping duration is about half of the ring—40 bunches. VL asks why not the whole ring. Kent Triplett (KT) says that the shorter ping produces more stable results. WP says that they have been working very hard to get these timing issues resolved. Additionally, they are working on the calibration of the skew quad circuits. He says that we previously obtained one-third of the expected effect from these magnets. WP presents this list of actions the group is doing now:

* Fix timing of the BPM’s
* Preserve the gating of the BPM’s
* Skew quad calibration
* Chromaticity measurements and sextupole calibrations (when they understand coupling)
* General Optics tuning
* Linear sum resonance compensation

Bruce Brown (BB) asks if space charge is all that important at 26 milliseconds. YA replies that it changes the spectra.

## McGinnis: Summary of the Booster Damper Systems

DM points out how hard it is to build broad-band dampers for the Booster. Thus, narrow-band dampers are built as the need arises. These dampers really only work after transition. He also observes that there has to be a big change in the chromaticity after transition. Nathan Eddy (NE) says that they cannot anti-damp horizontally now. This is being addressed. This could be a chromaticity problem, or they could have the wrong filter coefficients.

DM says that there is a need for new and better Spectrum Analyzer software.

NE says that we really need to go after the head-tail instability. DM warns that this will need a lot of bandwidth.

## Lebedev: Transverse Instabilities

VL presented this talk with very little comment.

DM reminds us that the chromaticity after transition is very different than before transition.

# Appendix 1: Abbreviations

The people in this document are identified by their initials, as follows.

|  |  |
| --- | --- |
| Alexahin, Yuri | YA |
| Ankenbrandt, Chuck | CA |
| Brown, Bruce | BB |
| Drennan, Craig | CD |
| Eddy, Nathan | NE |
| Garcia, Fernanda | FG |
| Lackey, Jim | JL |
| Lebedev, Vladimir | VL |
| Mokhov, Nikolai | NM |
| Pasquinelli, Ralph | RP |
| Pellico, William | WP |
| Peoples-Evans, Elmie | EPE |
| Popovic, Milorad | MP |
| Prebys, Eric | EP |
| Seigya, Kyiomi | KS |
| Tesarek, Rick | RT |
| Triplett, Kent | KT |
| Webber, Robert | RW |

These abbreviations are utilized:

|  |  |
| --- | --- |
| Beam Loss Monitor | BLM |
| Beam Position Monitor | BPM |
| Ion Profile Monitor | IPM |
| Methodical Accelerator Design (a modeling program) | MAD |
| MuCool Test Area | MTA |
| Protons per hour | pph |
| Sequenced Data Acquisition | SDA |
| Task Force Report | TFR |