NSLS-II TRANSPORT LINE PROGRESS*

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Abstract

The National Synchrotron Light Source II (NSLS-II) is a state-of-the-art 3-GeV third generation light source currently under construction at Brookhaven National Laboratory. The NSLS-II injection system consists of a 200 MeV linac, a 3-GeV booster synchrotron and associated transfer lines. The first part of the Linac to Booster Transport (LBT) line has been installed for linac commissioning. This part includes all components necessary to commission the NSLS-II linac. The second part of this transport line is undergoing installation. Initial results of hardware commissioning will be discussed. The Booster to Storage Ring (BSR) transport line underwent a design review. The first part of the BSR transport line, consisting of all components necessary to commission the booster will be installed in 2012 for booster commissioning. We report on the final design of the BSR line along with the plan to commission the booster.

INTRODUCTION

The National Synchrotron Light Source II (NSLS-II) is a state-of-the-art 3-GeV third generation light source currently under construction at Brookhaven National Laboratory. The transport line for NSLS-II are broken down into four parts, Linac to Booster Transport Line (LtB) parts I and II, and Booster to Storage Ring (BtS) Transport Line parts I and II. In this paper we discuss the status of the transport lines, initial performance with beam for the diagnostics and future plans.

LINAC TO BOOSTER PART I

The linac to booster transport line installation was finished in January 2012. It includes all of the necessary diagnostics and equipment to successfully commission the linac, and some components necessary for transport into the booster. Figure 1 shows a picture of the installed transport line.

The LtB part I line has two beam dump lines. The straight line is for initial tuning of the beam and for emittance measurements. The second beam dump is located after the dipole magnet and is used for energy and energy spread measurements.

All transport line magnets, with the exception of the BtS dipole correctors are being produced by Stangenes Industries. One of each type of magnet was measured via a hall probe (dipole and corrector) or rotating coil (quadrupoles). All magnets received thus far are within specifications.

Figure 1: LtB part I installation. Spectrometer beamline shown. Energy Slit in the foreground, beam dumps in the background.

The available diagnostics include an integrating current transformer, fast current transformer, six beam flags, two beam position monitors, an energy slit and two faraday cups incorporated into the beam dumps. All diagnostics are being used for beam commissioning.[1] In an effort to simplify the design of the transport lines, the same diagnostics components will be used in both transport lines. This allows us to use linac commissioning to commission the diagnostics controls needed for commissioning of the booster.

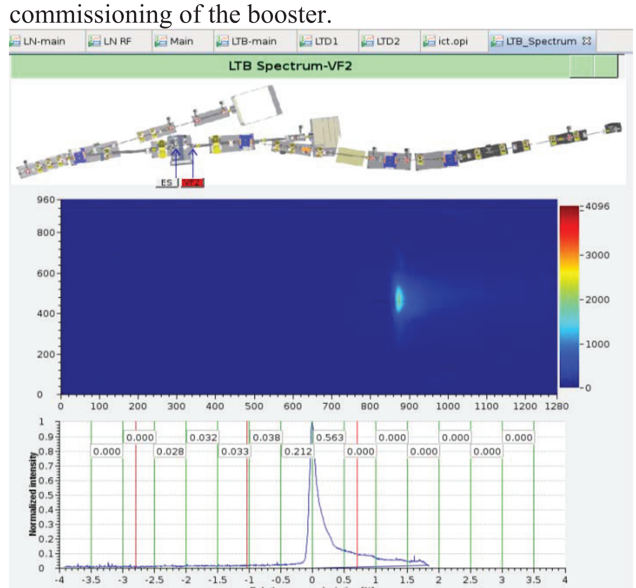

Figure 2: Screenshot of beam on the YAG screen at LB-VF2 in the spectrometer arm.

* This manuscript has been authored by Brookhaven Science Associates, LLC under Contract No. DE-AC02-98CH10886 with the U.S. Department of Energy.
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Figure 2 shows a typical screen shot of a flag in the spectrometer arm of the transport line. The horizontal beam size at this flag is dominated by dispersion and is 13mm. The dispersion is 860mm at the flag so we can conclude that the energy spread is 0.15%.

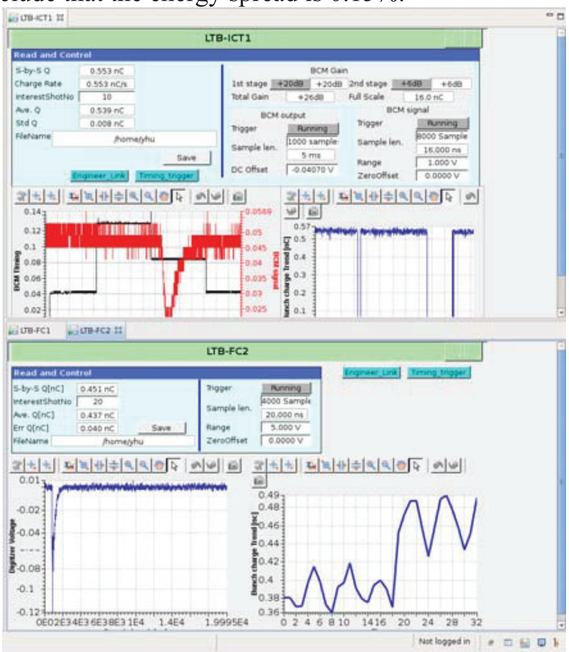

Figure 3: Comparison of the integrating current transformer and a beam dump faraday cup in the transport line.

Each beam dump is configured to act as a Faraday Cup. As the cups are not impedance matched, they can only provide information of the total bunch train charge. Figure 3 shows a typical comparison of the Faraday cup in the spectrometer line (FC2) with the integrating current transformer at the linac output. The ICT shows that 0.553 nC are exiting the linac with 0.451 nC getting to the beam dump in the spectrometer arm. We expect some beam loss after the spectrometer as not all of the beam that exists the linac is captured in an RF bucket, and is therefore of the wrong energy. The faraday cup in the straight beam dumps typically shows close to 100% transmission. These numbers also compare well with the diagnostics in the linac, therefore we have good confidence that our charge diagnostics are functioning properly.

The identical beam dump will be used in the booster to storage ring transfer line as well.

TRANSPORT LINES FOR BOOSTER COMMISSIONING

The LtB part II and BtS part I are required for booster commissioning. LtB part II completes the installation of the transport line to the booster injection septum. Figure 4 shows the second part of the LtB line.

LtB part II includes all of the necessary diagnostics to ensure high efficiency injection into the booster, including three flags and three beam position monitors to measure the beam position and envelope. There are sufficient quadrupoles in the beamline to match the beam optics from the linac into the booster under a variety of conditions.

Installation of the LtB part II line is scheduled to start later this summer after booster installation is complete.

BtS part I installation includes all components of the transport line in the booster vault. This provides all of the components for booster commissioning, and many of the components necessary for injection into the storage ring. Figure 5 shows BtS part I layout.

The BtS part I line contains all of the diagnostics needed to commission the booster. The beam optics in the beam dump line are such that the beta function and dispersion contribution to the horizontal beam size are comparable. In order to measure the beam emittance and energy spread of the booster beam, a series of beam profiles must be taken for a variety of magnet settings.

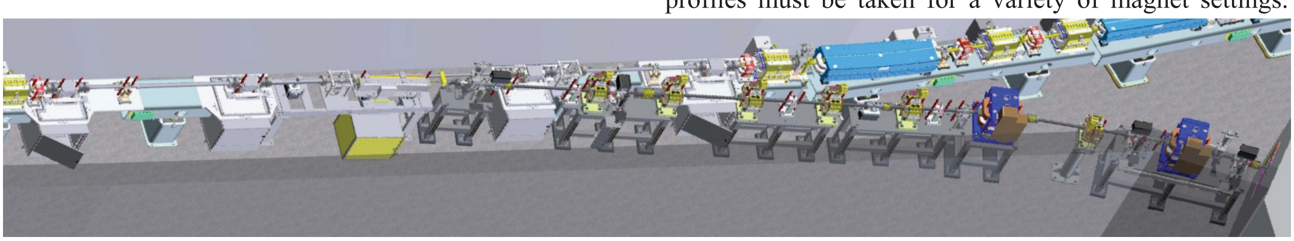

Figure 4: Linac to Booster Transport Line

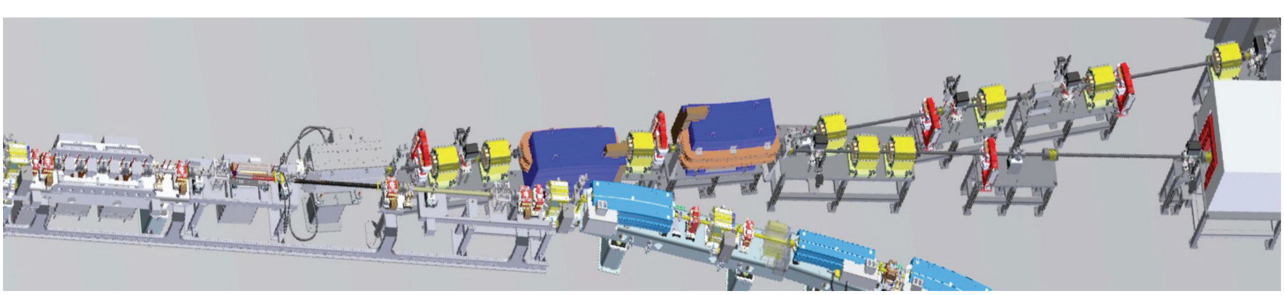

Figure 5: Booster to Storage Ring Transport Line Part I, showing booster extraction, the beam dump line and the injection path to the storage ring.

ISBN 978-3-95450-115-1

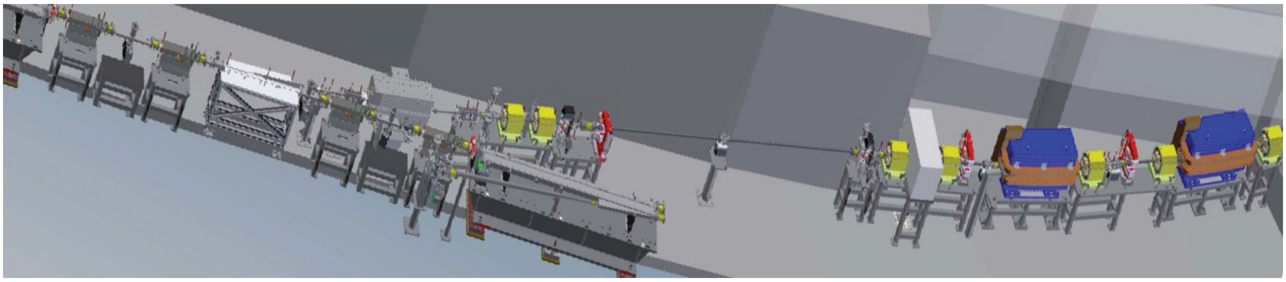

Figure 6: Booster to Storage Ring Transport Line Part II, showing injection to the storage ring.

These will allow us to disentangle the emittance and energy spread.[2]

As mentioned above, all components for the BtS line are being provided by the same vendors as the LtB line, and most diagnostics are already in hand. Quadrupole and dipole magnets are due to arrive in this summer.

Installation of the BTS part I line is scheduled to occur in this summer.

BOOSTER TO STORAGE RING PART II

Installation of the BtS part II line is scheduled to occur in late fall. Figure 6 shows this section of transport line.

BtS part II allows for injection into the storage ring while maintaining the beam emittance from the booster. This section also contains an energy selection slit to limit the energy acceptance of the transport line. The optics of the transport line allow for matching of the beam via the quadrupoles and flags in the straight section penetrating through the wall. Figure 7 shows the optics for the beamline for the anticipated optics of the booster and storage ring.

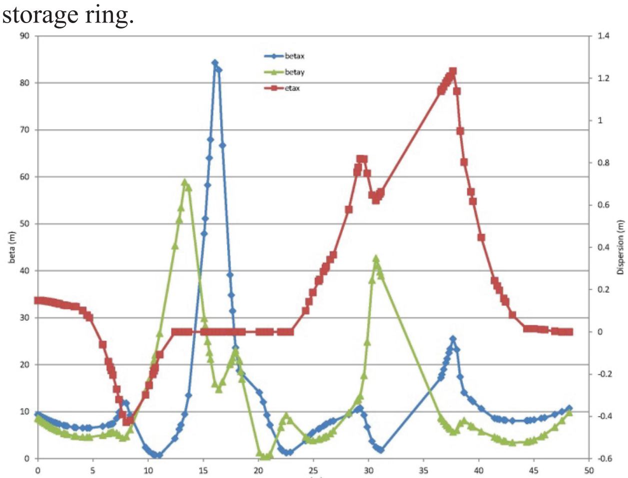

Figure 7: Beta and Dispersion functions of the Booster to Storage Ring Transfer line for Storage Ring injection.

CONCLUSION

The NSLS-II transport line installation and commissioning is underway. The LtB part I installation and commissioning is complete. All components are functioning as expected. The remaining transport lines will be ready in time for installation with the current schedule.

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[1] Guimei Wang, Raymond Patrick Fliller, George Ganetis, Hsiao-Chaun Hseuh, Yong Hu, Danny Padrazo, Sergei Seletskiy, Timur Shaftan, Om Singh, Yuke Tian, Huijuan Xu. "Preparation for NSLS II Linac to Booster Transport Line Commissioning". These Proceedings, MOPPR094.

[2] Guimei Wang, Raymond Patrick Fliller, Igor Pinayev, Timur Shaftan, "Double Quads Scan for Beam Parameters and Flag Resolution Measuremeent", These Proceedings, MOPPR092.