

PREPARATION FOR NSLS II LINAC TO BOOSTER TRANSPORT LINE COMMISSIONING*

G.M. Wang[#], M. Davidsaver, R. Fliller, G. Ganetis, H. Hseuh, Y. Hu, D. Padrazo, G. Shen, O. Singh, Y. Tian, H. Xu, L. Yang, T. Shaftan. Photon Sciences, BNL, Upton, NY, 11973, U.S.A

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 first part of the Linac to Booster Transport (LBT) line was installed and starts commissioning in March 2012 along with linac. This part will be used for the linac acceptance test. In the paper, we describe the status of the LBT and the control system for high level applications.

INTRODUCTION

The NSLS-II [1] is a state of the art 3 GeV synchrotron light source under construction at Brookhaven National Laboratory. The injection system consists of a 200 MeV linac and a 3 GeV booster synchrotron.

The linac [2] is a turn-key project, provided by Research Instruments GmbH. The installation started in Oct. 2011 and was finished in Feb. 2012. It operates in two modes. The first mode is long pulse mode where the linac will produce 15 nC in 80-150 bunches separated by 2ns. In the second mode the linac will produce a small number of bunches, each with 0.5nC. The geometric emittance of the beam is specified to be $4\sigma_x\sigma_x=150$ nm, with 0.5% energy spread.

The linac to booster (LTB) transfer line is equipped with sufficient diagnostics to commission along with linac to measure the linac beam parameters. In this paper we

discuss status of the transport line and the control system for high level applications.

LTB PHASE I TRANSPORT LINE

Figure 1 shows the LTB [3] line phase I layout in linac tunnel. It includes two diagnostic beamlines for linac commissioning, troubleshooting and beam studies. The first dump beamline (dump1) is the straight line after linac and can be used for emittance measurements. The second dump beamline (dump2) has large dispersion and can be used for energy and energy spread measurements. These two dump beamlines allow the linac to operate while maintenance activities are ongoing in the booster vault. The installation of two dump lines in the linac tunnel was finished in January 2012 and starts commissioning in March 2012.

Table I shows the diagnostics in the transport lines to measure the linac beam parameters.

The bunch charge coming from the linac can be measured with the integrating current transformer (ICT, located at the exit of the linac) and faraday cup in each dump. There is one fast current transformer (FCT), located after the energy slit to measure the bunch fill pattern and charge uniformity.

There are three flags in the first dump beam line, measuring the emittance of the linac via three screens measurement method. Along with upstream quads, they can also measure the beam emittance with quads scan method.

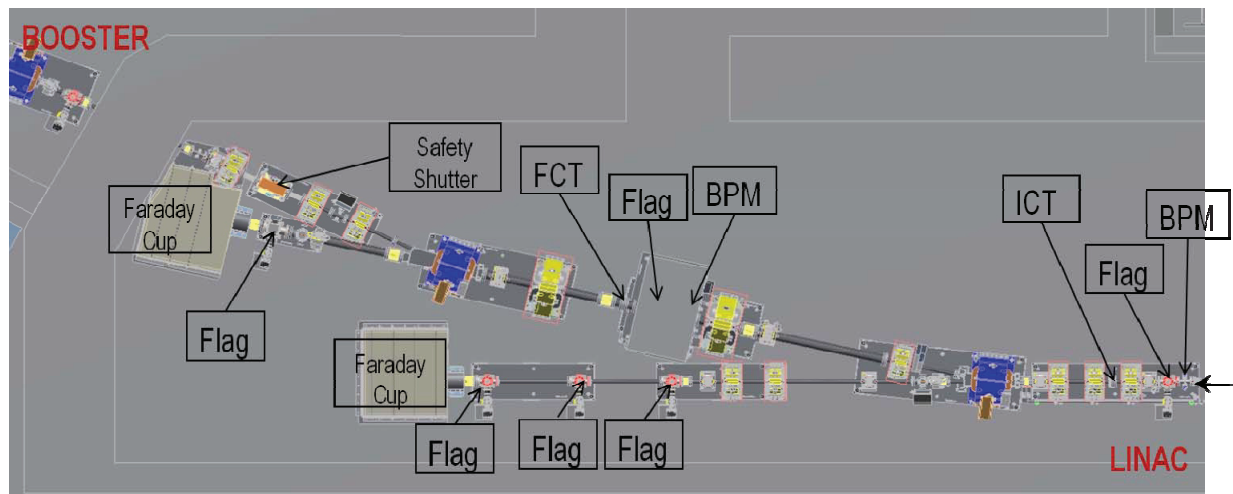


Figure 1: Linac to Booster Transport Line Part I in Linac tunnel.

In the second dump beamline, there are two flags at

* This manuscript has been authored by Brookhaven Science Associates, LLC under Contract No. DE-AC02-98CH10886 with the U.S. Department of Energy.

[#]gwang@bnl.gov

large dispersion location. They can measure the beam energy and energy spread. There is an energy slit in large dispersion location to limit the energy acceptance. Its blades were coated with scintillator and a camera can

image the scraped beam. When the blades are closed, it can be used as a spectrum to measure the beam energy and energy spread. After energy slit, there is a special BPM. By splitting its signal, it outputs two signals, the bunch train location as a regular BPM and the pulse to pulse location as a fast BPM. The regular BPM can measure the beam energy with dipole. The fast BPM signal can monitor the pulse to pulse energy jitter and be used for beam loading compensation feed forward system in linac.

Table I: Diagnostics in Linac to Dump Line

Parameters	Specifications	Diagnostics	TL
Geometric emittance	<155 nm-rad@200MeV	Flags	Dump1
Energy	200 MeV	Dipole, BPM/Flags	Dump2
Pulse to pulse energy jitter	<0.2%	BPM	Dump2
Energy spread	<0.5%	Flag	Dump2
Useful charge for SPM	>0.5 nC/bunch	ICT, FC	Dump1 Dump2
Useful charge for LPM	>15 nC/bunch train	ICT, FC	Dump1 Dump2
Charge non-uniformity	<10%	FCT	Dump2
Filling pattern	Bunch number and separation	FCT	Dump2

INJECTOR CONTROL SYSTEM

NSLS II uses the EPICS [4] control system to monitor and control all accelerator hardware. The high level control system includes two parts, complex accelerator physics application for beam study and simply display/control for hardware. Mainly, we use cothread [5] to machine process variables (PVs) with Python script for complex accelerator physics applications and the CSS (BOY) [6] panel for simple tasks such as monitor, display and set of PVs. Besides that, MATLAB is also available for programming and EDM panel is used for Linac control system due to the commercial product. In the future, CSS will be the main tool for the operation panel. The file system is organized with Mercurial [7].

The NSLS II operation panel includes the user panel and the expert panel. It is to display the device status and parameters (set point and read back) and show the device performance history. The user panel shows only information that user needs, such as the magnet current setpoint and readback. The expert panel shows all the information that expert can fully control the device or diagnose devices, such as power supply operation mode and magnet temperature.

A screenshot of Linac to Booster transfer line operation panel main page is shown in Figure 2. It shows the transport line status, subsystem link to operate the device, beam parameter and beam study link.

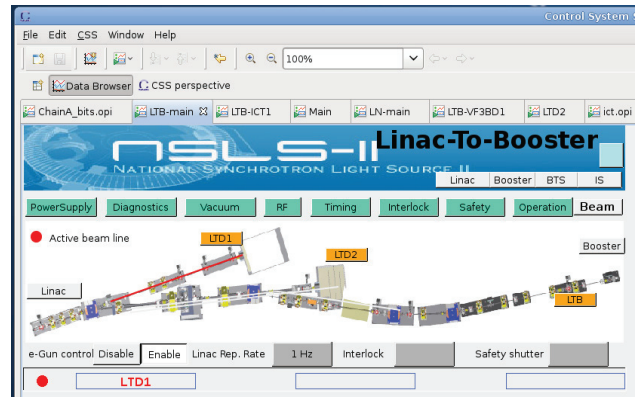


Figure 2: Linac to Booster Transport line operation panel.

Besides the devices status and control, we also develop the high level applications to realize the accelerator physics application tools. It is to translate the raw/processed data from PV to physics parameters, such as from beam size read in flag to beam emittance, beam energy measurement. The code was programmed with Python, initially tested and debugged in our virtual accelerator. Although we program the high level applications with Python, their GUIs are based on CSS so that the user has a consistent interface environment. Code runs either in continuous mode or button pressing call mode. The user can input parameters and monitor the progress in GUI as regular device PV set and monitor. This process is realized through soft IOCs.

There are advantages of using soft IOCs. Firstly, users do not need to know how to run code. Second, users share the same information through PVs. Third, it avoids the code execution path dependence. CSS or user does not need to know where and what code is.

But it also has disadvantages, including that the code depends on the soft IOC status and CSS has limited plot function feature.

Currently, we developed applications for magnets cycling; ICT, FCT, FC and WCM current save function; BPM position and button voltage save function; flag multi-image save function; 3-flags for emittance measurement; Quads scan; Response matrix measurement; Trajectory correction; energy and energy spread measurement.

A screenshot of beam energy and energy spread measurement with flag VF2 is shown in Figure 3. It runs in continuous mode, which means whenever the beam image updates, the beam energy and energy spread is updated correspondingly. It shows the beam image, horizontal beam profile, beam energy, beam energy spread, and the charge ratio in every 0.5% energy deviation.

A screenshot of quads scan to measure the beam emittance is shown in Figure 4. It runs in user call mode. It needs user to input parameters first, then click run. The input parameters include select quads, flag, target type (YAG/OTR), set the quads scan steps, scan low and high current limit, beam energy and number of images for beam size average. The result includes beam twiss

parameters and emittance. The plot shows beam size change along with quads scan current. The scan result is saved in certain folder. The code execute progress is shown in the monitor PV info. All the data are globally shared through PVs. It avoids multi users execute the same code at the same time.

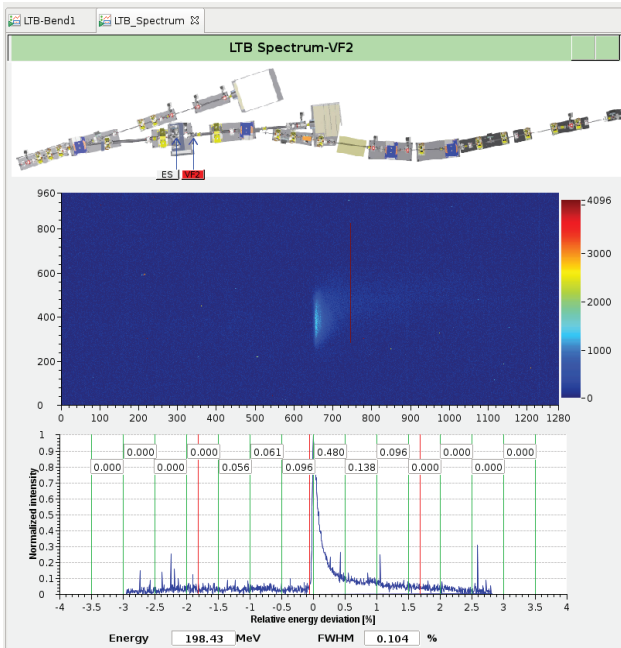


Figure 3: Screenshot of beam energy and energy spread measurement with flag VF2 in LTB transport line.

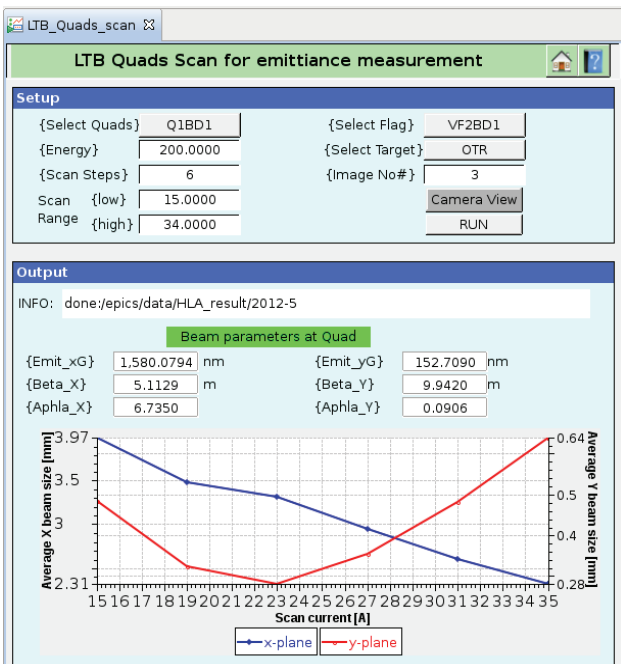


Figure 4: Screenshot of beam emittance measurement with quads scan method in LTB transport line.

The Machine Snapshot and Retrieve service (MASAR) is one importance function used during commissioning. It is developed by our controls group for save/compare/restore function. The user creates a list of

PVs that are important for the system as a configure file and MASAR saves the configure. Based on the configure, MASAR can save current machine PVs' value, compares the current machine with the saved data and sets the machine back with the saved data by the restore function.

CONCLUSION

The NSLS-II transport line installation and commissioning is underway. The LtB part I installation and commissioning is complete. The user operation panel and high level application interface are based the CSS. They are updated through the tool of mercurial. The high level applications are developed with Python (Matlab). With soft IOC, it realizes the information global share.

REFERENCES

- [1] F.J. Willeke, "Status of the NSLS-II Project", PAC2011, p732 (2011).
- [2] K. Dunkel, "BNL 200 MeV Linac", Research Instruments Gmbh. 3200-BP-8530-B_FDR_TP_20101026.pdf
- [3] R. Fliller, et al., "NSLS-II Transport Line Progress", this conference MOPPR051.
- [4] L. R. Dalesio, et. al., "EPICS Architecture," Proc. of ICALEPCS'91, KEK Proceedings 92-15, pp 278-282 (1992).
- [5] <http://controls.diamond.ac.uk/downloads/python/cothre> ad/
- [6] <http://cs-studio.sourceforge.net/>
- [7] <http://mercurial.selenic.com/wiki/Tutorial>

Copyright © 2012 by IEEF - cc Creative Commons Attribution 3.0 (CC BY 3.0) — cc Creative Commons Attribution 3.0 (CC BY 3.0)