NSLS-II INJECTION STRAIGHT DIAGNOSTICS*

I. Pinayev#, A. Blednykh, M. Ferreira, R. Fliller, B. Kosciuk, T.V. Shaftan, G. Wang
BNL, Upton, NY 11973, U.S.A.

Abstract

The ultra-bright light source being developed by the NSLS-II project will utilize top-up injection and fine tuning of the injection process is mandatory. In this paper we present the diagnostics installed in the injection straight. Its use for commissioning and tuning of the injection cycle is also described.

INTRODUCTION

The NSLS-II storage ring will utilize a 9.3 meter long injection straight section shown in Fig. 1. Injection will be preformed with two septa (one pulsed, one DC) and four kickers [1]. The stored beam will be shifted towards the pulsed septum up to 15 mm and the nominal distance between centers of the injected and the bumped beam is 9.5 mm.

The NSLS-II beam position monitors will have turn-by-turn and first-turn capabilities [2] and will be used for the commissioning and tuning the injection process. There are three additional BPMs and two beam intercepting OTR screens (flags) installed in the injection straight.

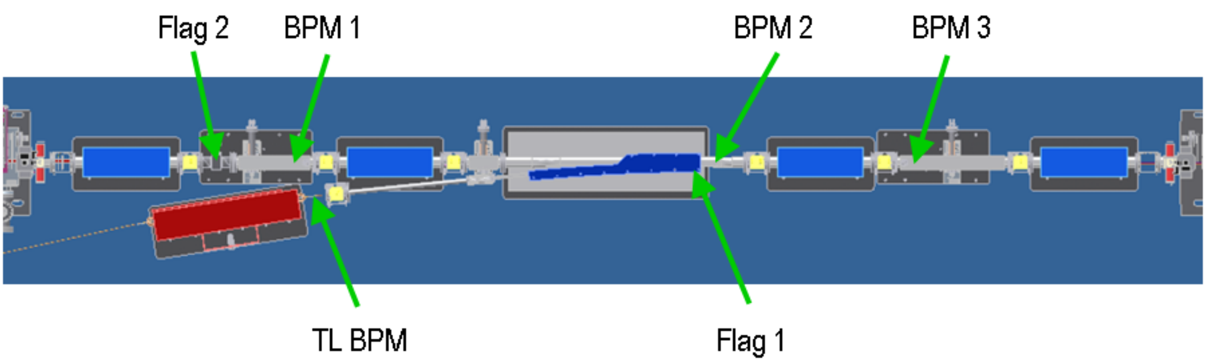

Figure 1: Layout of the injection straight.

FLAGS

The Flag 1 is placed at the exit of the pulsed septum and serves to view the injected beam. The OTR screen will be inserted into the slot of the septum taper (see Fig. 2). Such design provides a shield for the flag from the wake fields induced by the circulating beam and reduces impedance of the assembly. Prosilica GC1290 GigE camera will provide 17×7 mm field of view with 50 microns resolution. The distance from the screen to the camera is 0.6 meters. The final design will be done after the type of the pulsed septum is established (in-vacuum or out of vacuum).

The Flag 2 is inserted between the kickers 1 and 2 and serves to monitor shape and position of the injected beam after the one turn. The OTR screen will be inserted sideways into the vacuum chamber with the rectangular profile (see Fig. 3). The 19 mm diameter field of view can be extended by a scan of the screen position. The screen to the camera distance and resolution is the same.

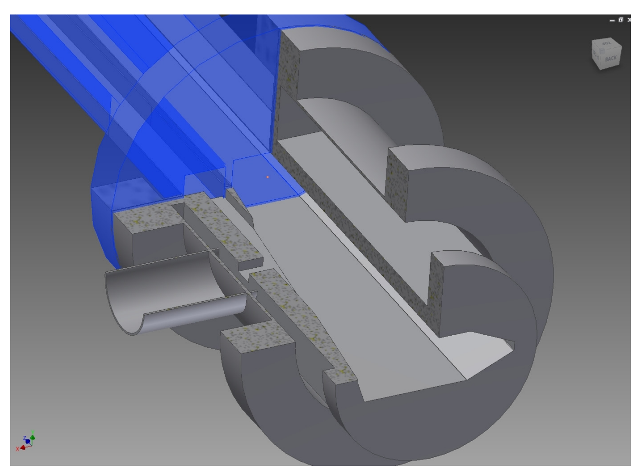

Figure 2: Cross section of the vacuum chamber for the Flag 1. The screen is inserted into the slot of the taper with a hollow tube to extract beam image.

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

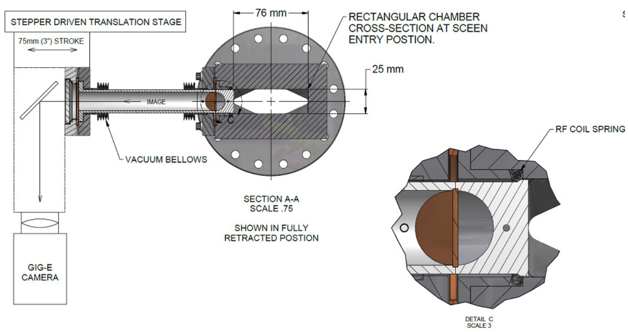

Figure 3: Design of the vacuum chamber for the Flag 2.

BEAM POSITION MONITORS

The BPM1 and BPM3 are installed on the vacuum chamber with a profile matching the multipole vacuum chambers, which have an octagonal shape. The pick-up buttons are identical to the regular BPMs described in [3]. The sensitivity to the beam motion is S_x=0.089 mm^{-1} and is shown in Fig. 4.

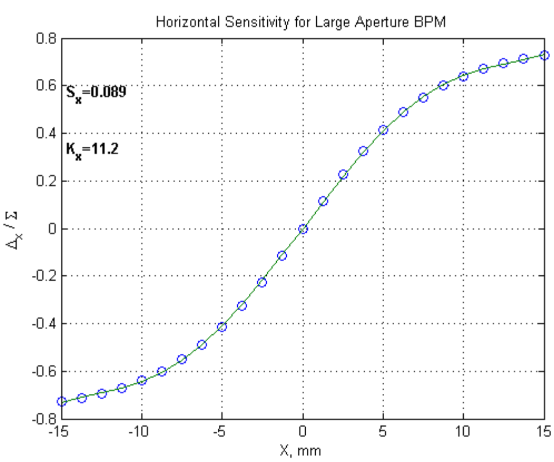

Figure 4: Sensitivity to the horizontal motion of BPM1 and BPM3. Zero position corresponds to the nominal position of the stored beam.

These BPMs will be used for monitoring of the circulating beam and calibration of the kickers. The maximum deviation of the bumped beam is approximately 9 mm, which is inside of the BPM range. A polynomial fit will be required for accurate calculation of beam position with large deviation. The accuracy of the fit can be verified by gradually increasing the kicker strength.

The injected beam enters the storage ring at nominal distance of 25 mm from the center of the vacuum chamber. Such large displacement is beyond the range of the regular BPM. Therefore, the BPM2, located after the pulsed septum, is shifted inwards by 17.5 mm. The vacuum chamber profile is modified to accommodate the shift and the corresponding geometry is shown in Fig. 5.

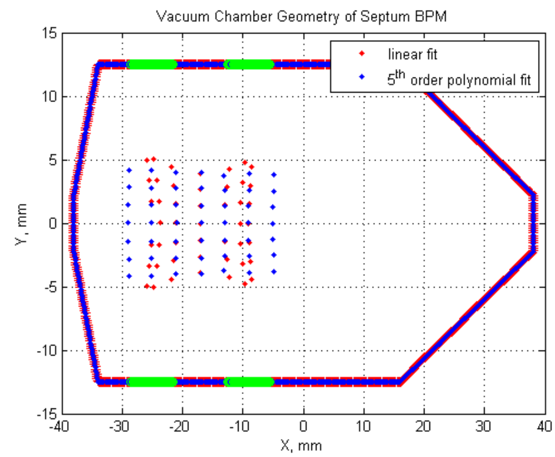

Figure 5: Geometrical profile of the BPM2 vacuum chamber placed after the pulsed septum. The vacuum is shown in magenta and buttons are shown in green. Zero position indicates the nominal position of the circulating beam. The red dots correspond to the calculated beam position with linear approximation and the blue dots correspond to the fifth order polynomial fit.

The sensitivity to the beam displacement of the BPM2 is shown in Fig. 6. This BPM will be capable of measuring the position of the fully bumped beam and of the injected beam (provided there is no circulating current).

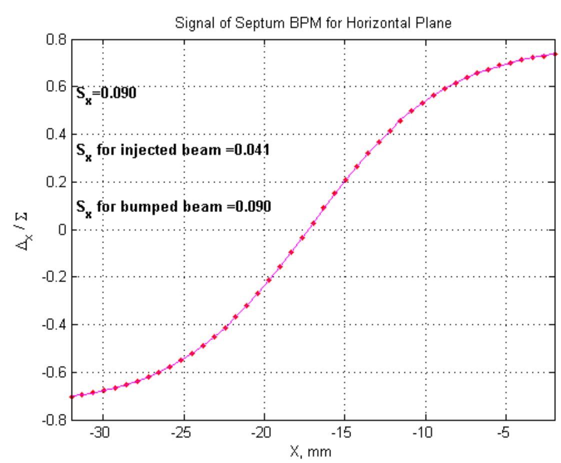

Figure 6: Sensitivity to the horizontal motion of the second BPMs.

The BPM pick-up electrodes are placed on the transfer line after the DC septum. The electrodes are mounted on the round vacuum chamber with 40 mm diameter. The detailed description of the BPM assembly can be found in [4].

TUNING

The flags will be calibrated using the engraved fiducial marks. The second flag will have an encoder for the readback of its position.

Quadrupole centering of the regular BPMs (not in the injection straight) will provide data for the beam position in the vacuum chamber. The sensitivity of the BPM1 and BPM3 will be calibrated from the turn-by-turn data. The accuracy of the polynomial fit will be verified with the circulating beam by variation of the kicker strengths as it was mentioned before.

CONCLUSIONS

The diagnostics equipment installed in the injection straight in combination with other diagnostic will provide sufficient means for commissioning, troubleshooting and health monitoring of the injection system.

REFERENCES

[1] T.V. Shaftan et al., "Progress with NSLS-II Injection Straight Section Design," NAPAC'11, New York, 2011, THP216; http://www.JACoW.org.

[2] K. Vetter et al., "NSLS-II RF Beam Position Monitor," NAPAC'11, New York, 2011, MOP211; http://www.JACoW.org.

[3] P. Cameron, et al., "BPM Button Optimization to Minimize Distortion due to Trapped Mode Heating", PAC'09, Vancouver, Canada, May 2009, TH5RFP011; http://www.JACoW.org.

[4] D. Padrazzo, "NSLS-II Injector System Diagnostics", BIW10, Santa Fe NM, TUPSM098; http://www.JACoW.org.