PS-Booster Ejection Correction Dipoles

Goal

Attempt to reproduce the results in http://wwwpsco.cern.ch/private/gm/gmdescrip/LINC-Note.pdf

- Used the latest configuration files for **Ring 3** from Vivien for the ring
- **Matched the optics in MADX (32 bits)** to get the tunes
- After add a horizontal or vertical kick from one of the correction dipoles
- Extract the geometrical relations between the kicks at the entry point and at the center of the ejection Septum, SMH15L1
- Trying different tunes and configurations

Head-to-head Comparison

- Configuration 1: **Expected from Note**
  - center of DHZ,DVT 4L1 at=1.327-0.426 m = 0.901 m
  - center DHZ,DVT 11L1 at=1.327-0.950 m = 0.377 m
  - entrance of SMH15L1 4L1 at=1.327-0.800 m = 0.527 m
- Configuration 2: **2014 Corrected using Tobias' measurements**
  - center of DHZ,DVT 4L1 at=1.3355(original)-0.4255(correction) m = 0.910 m
  - center DHZ,DVT 11L1 at=0.296(original) +0.0720(correction) m = 0.368 m
  - entrance of SMH15L1 4L1 at=.909892(center)-0.508706(center→beginning blade) m = 0.401186 m

With the entrance of the septum we understood the beginning of the SMH15L1 septum blade. From the drawing (thanks to M. Houricane), the blade does not appear to be centered simmetrically w.r.t. the tank, but slightly shifted upstream, see sketch in Figure 1. We Labeled **A** the distance between the beginning of the tank and the beginning of the blade, **B** the blade length, **C** the distance between the end of the blade and the end of the tank and **X** the distance between the beginning of the blade and the center of the tank. With some simple math one can deduct that:

$$X = \frac{B + C - A}{2} \tag{1}$$

Using the values from drawing PS.CA.98411.1 of A=121.03 mm, B=1000.24 mm and C=138.21 mm, one obtains X=508.706 mm. Thus if in the configuration expected from the note one sets the SMH15L1 entrance to be at 0.527 m, this means the center of SM15L1 is at (0.507+0.508706) m = 1.015706 m.

The results of using these values and a kick of 1 mrad are summarized in Table 1.

From Figure 2 to 5 we report the horizontal and vertical distortions along the machine circumference resulting from a 1 mrad kick in the dipoles BE3.DHZ4L1, BE3.DHZ11L1, BE3.DVT4L1 and BE3.DVT11L1, respectively.

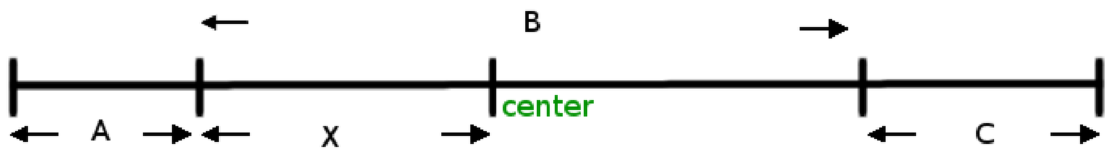


Figure 1: simplified drawing of SMH15L1. **A** is the distance between the beginning of the tank and the beginning of the blade. **B** is the blade length. **C** is the distance between the end of the blade and the end of the tank.

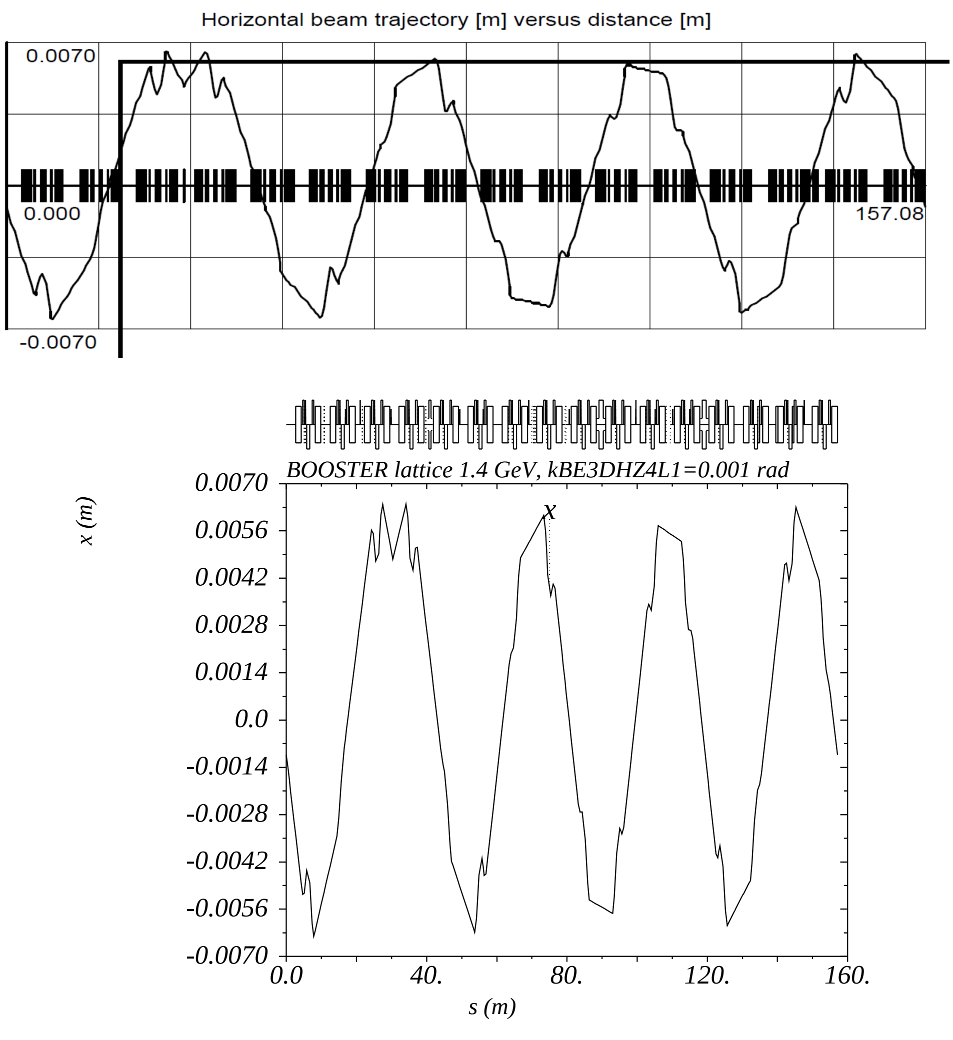


Figure 2: Closed Orbit comparison for a kick of 1 mrad for BE3.DHZ4L1. Top: Configuration 1, using the tunes $Q_H = 4.17$ and $Q_V = 5.23$. Bottom: Configuration 2, using the tunes $Q_H = 4.17$ and $Q_V = 4.23$

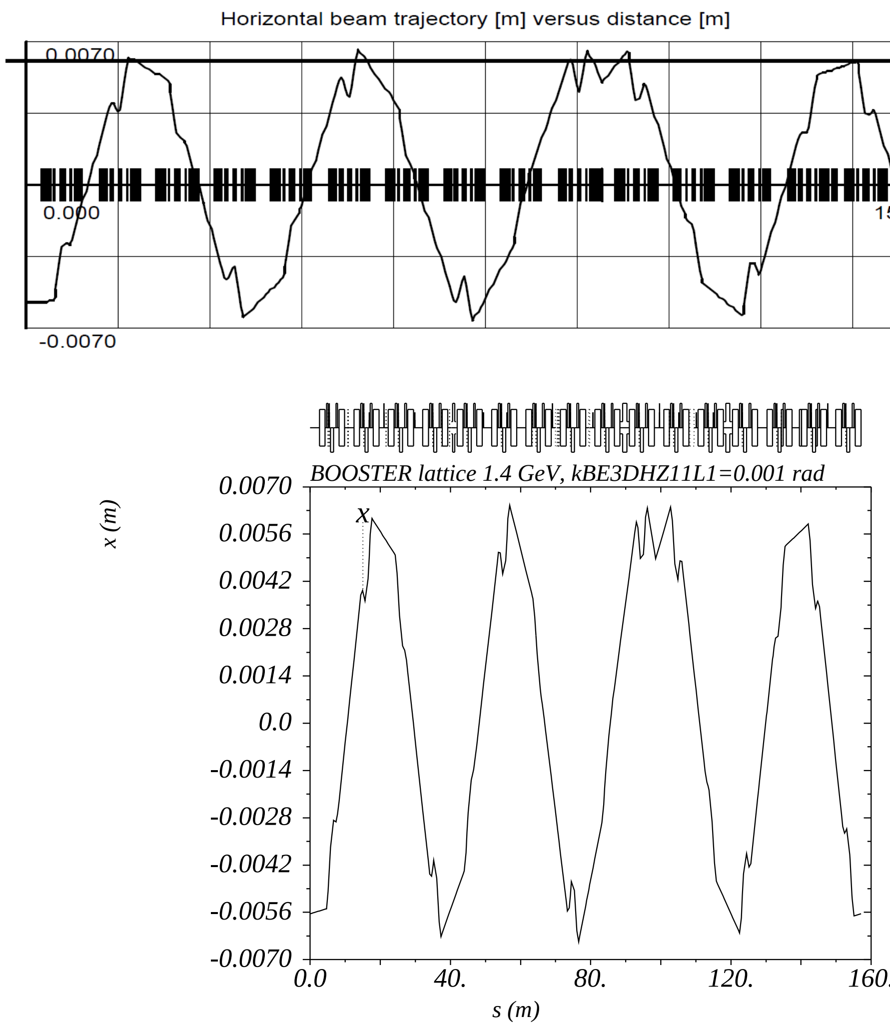
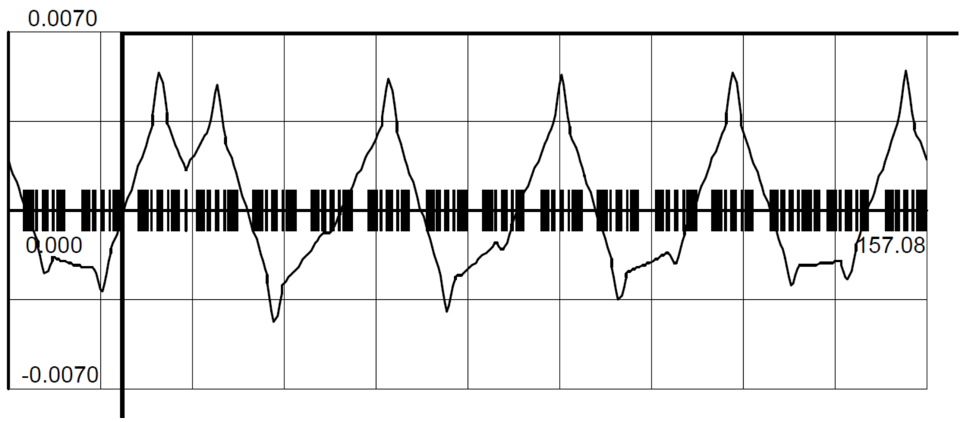


Figure 3: Closed Orbit comparison for a kick of 1 mrad for BE3.DHZ11L1. Top: Configuration 1, using the tunes $Q_H = 4.17$ and $Q_V = 5.23$. Bottom: Configuration 2, using the tunes $Q_H = 4.17$ and $Q_V = 4.23$



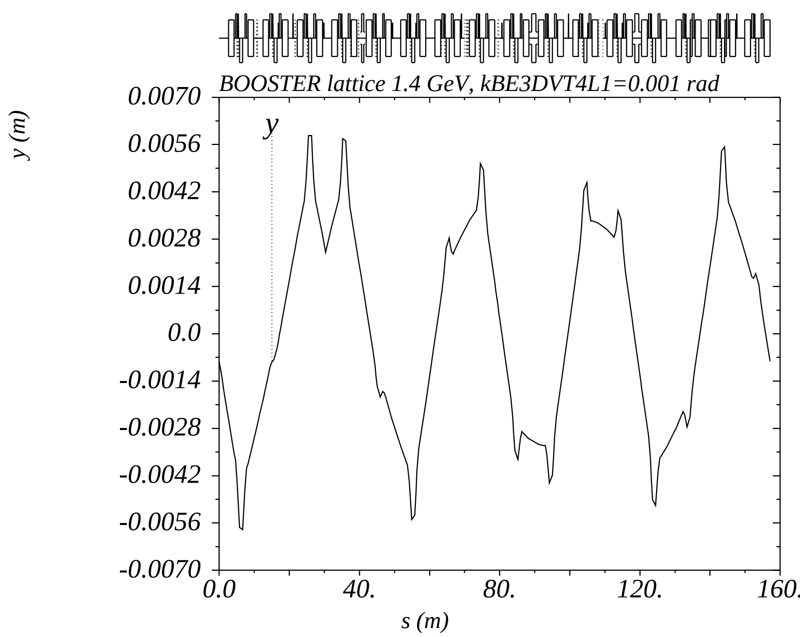
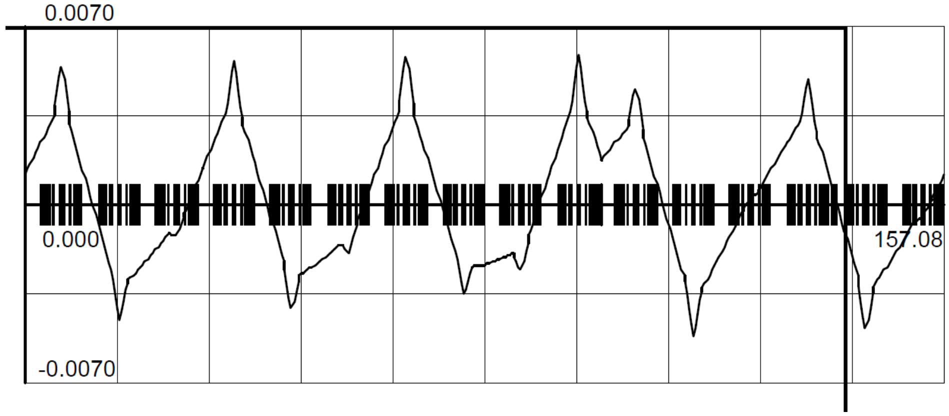


Figure 4: Closed Orbit comparison for a kick of 1 mrad for BE3.DVT4L1. Top: Configuration 1, using the tunes $Q_H = 4.17$ and $Q_V = 5.23$. Bottom: Configuration 2, using the tunes $Q_H = 4.17$ and $Q_V = 4.23$



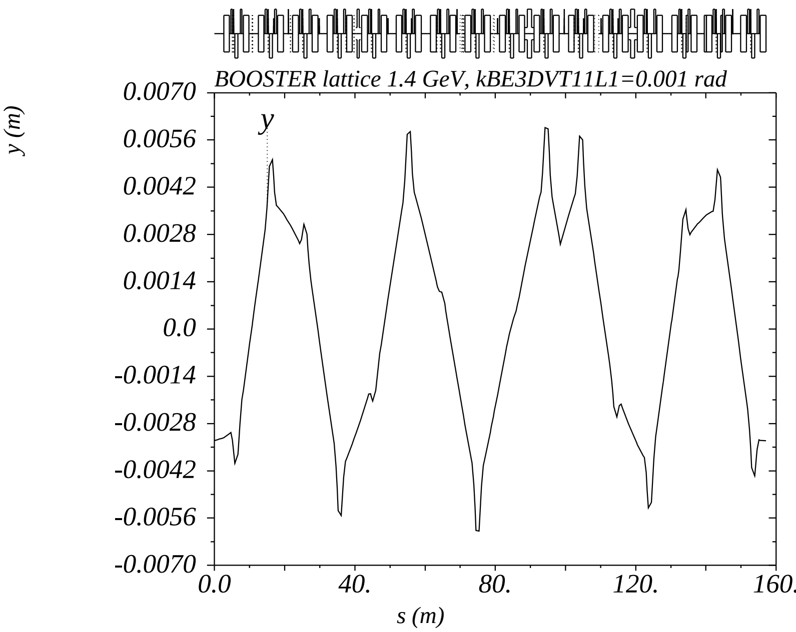


Figure 5: Closed Orbit comparison for a kick of 1 mrad for BE3.DVT11L1. Top: Configuration 1, using the tunes $Q_H = 4.17$ and $Q_V = 5.23$. Bottom: Configuration 2, using the tunes $Q_H = 4.17$ and $Q_V = 4.23$

Table 1: Comparison for the geometrical relation between the kicks in the different PSB sections at the entrance of SMH15L1

Kicker	Note Value	Config. 1	Config. 1	Config. 2
	Q_H=4.172,Q_V=5.230	Q_H=4.172,Q_V=5.230	Q_H=4.172,Q_V=4.230	Q_H=4.172,Q_V=4.230
	entrance of SMH15L1	**Beginning Blade**	**Beginning Blade**	**Beginning Blade**
BE3.DHZ4L1	ΔX_{ES}[mm] = 0.760 · DHZ4L1 [mrad]	0.786	0.768	0.641
	$\Delta X'_{ES}$[mm] = 0.947 · DHZ4L1 [mrad]	0.938	0.937	0.938
BE3.DHZ11L1	ΔX_{ES}[mm] = 5.615 · DHZ11L1 [mrad]	5.572	5.487	5.478
	$\Delta X'_{ES}$[mm] = 0.104 · DHZ11L1 [mrad]	0.105	0.103	0.101
BE3.DVT4L1	ΔY_{ES}[mm] = -2.122 · DVT4L1 [mrad]	-2.143	0.596	0.500
	$\Delta Y'_{ES}$[mm] = 0.021 · DVT4L1 [mrad]	0.023	0.708	0.709
BE3.DVT11L1	ΔY_{ES}[mm] = 0.669 · DVT11L1 [mrad]	0.710	3.147	3.137
	$\Delta Y'_{ES}$[mm] = -0.793 · DVT11L1 [mrad]	-0.798	0.108	0.107

The control power supplies and also for the acquisition need the deflection of each dipole magnet to be expressed in term of its current. The deflection-per-current factors for a beam energy of 1.4 GeV is measured to be:

$$\frac{\text{Deflection}}{\text{Current}} = 0.113 \frac{\text{mrad}}{\text{A}} \tag{2}$$

Using this scale factor the newly evaluated geometrical relation can be written as

$$\begin{pmatrix} \Delta X_{ES}[\text{mm}] \\ \Delta X'_{ES}[\text{mrad}] \end{pmatrix} = \begin{pmatrix} 0.0724 & 0.6190 \\ 0.1059 & 0.0114 \end{pmatrix} \times \begin{pmatrix} \text{DHZ4L1 [A]} \\ \text{DHZ11L1 [A]} \end{pmatrix} \tag{3}$$

$$\begin{pmatrix} \Delta Y_{ES}[\text{mm}] \\ \Delta Y'_{ES}[\text{mrad}] \end{pmatrix} = \begin{pmatrix} 0.0565 & 0.3544 \\ 0.0801 & 0.0120 \end{pmatrix} \times \begin{pmatrix} \text{DVT4L1 [A]} \\ \text{DVT11L1 [A]} \end{pmatrix} \tag{4}$$