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Note: **O-2**

Closed Orbit Bumps

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Introduction

In SESAME we plan to use correctors embedded in the sextupoles (horizontal correctors in SF's, vertical in SD's). In this note we evaluate the strength needed for these correctors in order to realize an angular/displacement closed bump in the middle of the straight sections adopting a 4-corrector scheme. An example of orbit bump using higher number of correctors like an 8-corrector one is mentioned. The evaluation is carried out on both SESAME working points [1].

1 - 1st order 4-corrector closed orbit bump in a Symmetry Point

The middle of all the straight sections (*LONG* and *SHORT*) is a symmetry point, therefore it is convenient to make closed orbit bump with a 4-corrector scheme. In the following, we derive the general relations that the 4-correctors must satisfy, in order to obtain such a bump. Let us call **A** the (2x2) transfer matrix from D1 to D2 (SF/2 to SF/2) for the horizontal plane, (SD/2 to SD/2) for the vertical plane, and **B** the transfer matrix from D2 to L/2 (middle of the long or short section).The effect of the first kicker at the second kicker position is given by:

$$\begin{pmatrix} x_2 \\ \theta_2 \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} * \begin{pmatrix} 0 \\ \delta_1 \end{pmatrix} = \begin{pmatrix} a_{12}\delta_1 \\ a_{22}\delta_1 \end{pmatrix}$$

Therefore the condition to have in the middle of a straight section a bump (x_0,θ_0) can be written as:

$$\begin{pmatrix} x_0 \\ \theta_0 \end{pmatrix} = \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} * \begin{pmatrix} a_{12}\delta_1 + 0 \\ a_{22}\delta_1 + \delta_2 \end{pmatrix}$$

From the above relation we have the system of the 2 equations:

$$x_0 = (a_{12}\, b_{11} + a_{22}\, b_{12})\, \delta_1 + b_{12}\, \delta_2$$
$$\theta_0 = (a_{12}\, b_{21} + a_{22}\, b_{22})\, \delta_1 + b_{22}\, \delta_2$$

This system of 2 equations can be used for any bump, displacement or angle, keeping in mind that a pure displacement is symmetric:

$$(+\delta_1 \quad +\delta_2 \quad +\delta_2 \quad +\delta_1)$$

While an angular bump is antisymmetric:

$$(+\delta_1 \quad -\delta_2 \quad +\delta_2 \quad -\delta_1)$$

In Tab. 1 are reported the strengths of the correctors for all the possible cases while Fig. 1 shows different orbit bumps in the Long s.s. for the working point ($Q_x = 7.23 - Q_z = 5.19$).

TABLE 1. Kicker strengths for 4-corrector scheme.

$Q_x = 7.23 - Q_z = 5.19$					
Section	**Plane**	**Δx (mm)**	**$\Delta x'$(mrad)**	**δ_1 (mrad)**	**δ_2 (mrad)**
Long	H	1	0	+0.145	+0.132
Short	H	1	0	+0.145	+0.132
Long	H	0	-1	+0.330	- 0.770
Short	H	0	-1	+0.180	-0.836
Long	V	1	0	+0.760	-0.548
Short	V	1	0	+0.760	-0.548
Long	V	0	-1	+ 2.330	- 2.433
Short	V	0	-1	+1.548	-1.869
$Q_x = 7.23 - Q_z = 6.19$					
Long	H	1	0	+0.137	+0.126
Short	H	1	0	+0.137	+0.126
Long	H	0	-1	+0.312	-0.715
Short	H	0	-1	+0.170	-0.844
Long	V	1	0	+0.766	-0.505
Short	V	1	0	+0.766	-0.505
Long	V	0	-1	+2.342	-2.292
Short	V	0	-1	+1.55	-1.77

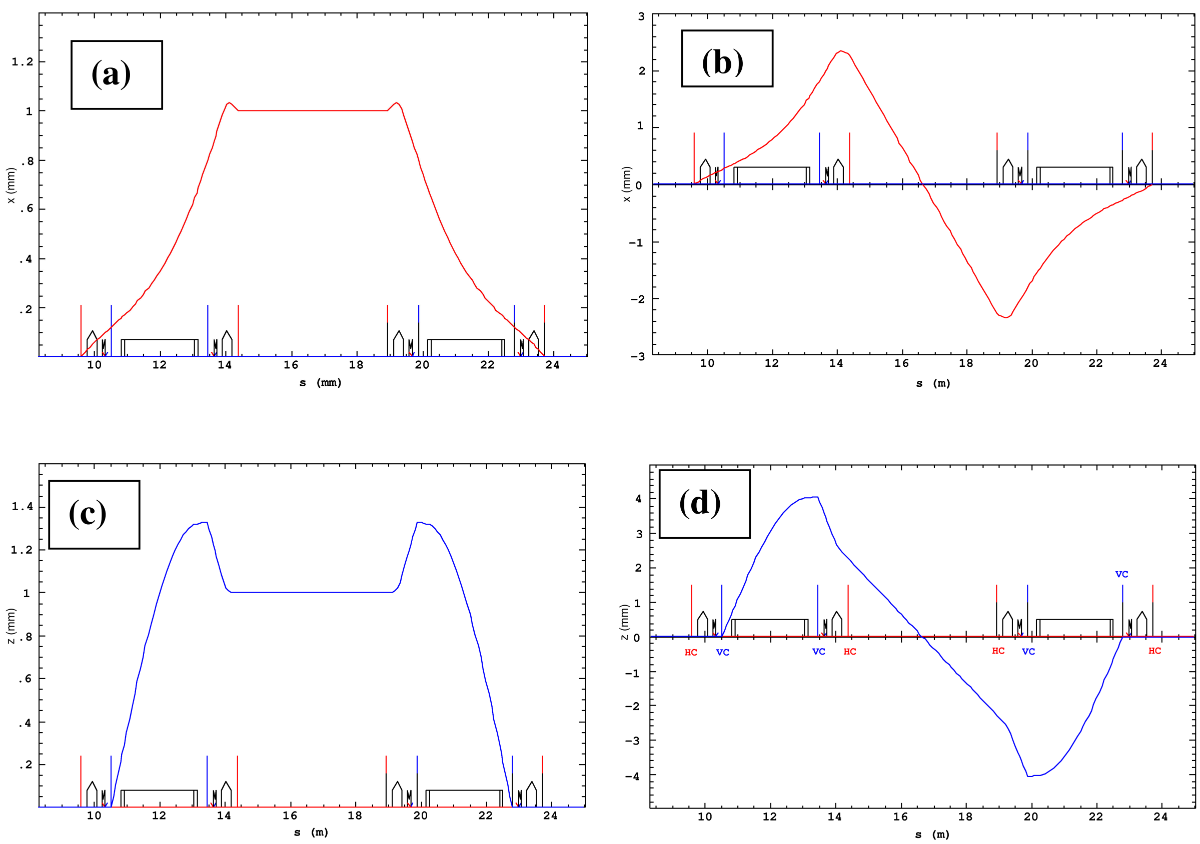

Figure 1: (a) and (b) show the horizontal (position and angular) bumps, while (c) and (d) are the vertical ones.

The strengths of the correctors can be obviously reduced by bumping with more than 4 correctors. As an example, a symmetric 8-corrector bump scheme, with horizontal and vertical correctors embedded in all the 8 sextupoles of the unit cell, will require the following strengths:

$$\delta_1 = \mathbf{0.264976mrad},\ \delta_2 = \mathbf{0.257388mrad},\ \delta_3 = \mathbf{-0.019216mrad}\ \&\ \delta_4 = \mathbf{-0.309553mrad}$$

for 1mm vertical displacement and :

$$\delta_1 = \mathbf{0.87063mrad},\ \delta_2 = \mathbf{0.76799mrad},\ \delta_3 = \mathbf{-0.87155mrad}\ \&\ \delta_4 = \mathbf{-0.86991mrad}$$

for -1mrad vertical angular bump.

REFERENCES

[1] G. Vignola, M. Attal - SESAME Technical Note **O-1**, December 2004