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Note: **O-6**

Closed Orbit distortion and Correction

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Introduction

In this note we reevaluate the closed orbit distortion due to magnets errors and misalignment, for the working point Q_x = 7.23, Q_z = 6.19, in order to assess the adequacy of the maximum design corrector strength [1].

The closed orbit distortion is caused by dipole kicks coming from bending field error, quadrupole misalignment and, to 2^{nd} order, from sextupole misalignment. The distortion is function of the value of the β function at the kick and at observation point and of the fractional part of the tunes. In SESAME the bending magnets have vertical gradient: this makes their misalignment an additional source of orbit distortion. Moreover, the relatively high β_z (see Fig. 2) in the bending amplifies the consequent vertical orbit distortion and makes the bending center a place of highest vertical orbit distortion in the ring.

Closed Orbit Distortion

Different types of expected misalignments and field errors were introduced in the SESAME lattice in order to study their individual and total effects on the closed orbit. The individual effect of each type of error gives us an indication about the optical disturbance importance of each error. Care should be taken to minimize the most harmful errors. Tab. 1 displays the error types and the impact of each one represented by the rms orbit distortion in the sextupoles for 100 probable error distribution in the magnets, according to BETA code [2].

Table 1

	BENDING MAGNET						QUADRUPOLE		SEXTUPOLE	
1rms Error	$\Delta B/B$ 5e-4	dx 0.2mm	dz 0.2mm	$d\varphi_s$ 0.2mrad	$d\varphi_z$ 0.2mrad	$d\varphi_x$ 0.2mrad	dx 0.2mm	dz 0.2mm	dx 0.2mm	dz 0.2mm
Sextupoles 1rms orbit distortion	Horizontal 0.94mm	Horiz. 0.64mm	Vertical 4.44mm Horiz. 0.17mm	Vertical 1.8mm Horiz. 0.028mm	Horiz. 0.45mm	Vertical 0.094mm	Horiz. 2.84mm	Vertical 2.05mm	Horiz. 0.16mm	Vertical 0.15mm

We see that the most harmful misalignment is the vertical displacement of the bending magnets due to the high β_z, followed by the positioning errors of the quadrupoles. Rotation of the bendings around s-axis has noticeable vertical orbit distortion too.

To see the overall effect, all the errors were introduced and 100samples (probable error distribution) were tracked. The resulting 1-rms orbit distortions in the sextupoles were 3.29mm in the horizontal plane and 4.82mmin the vertical one. Fig. 1 shows this orbit distortion.

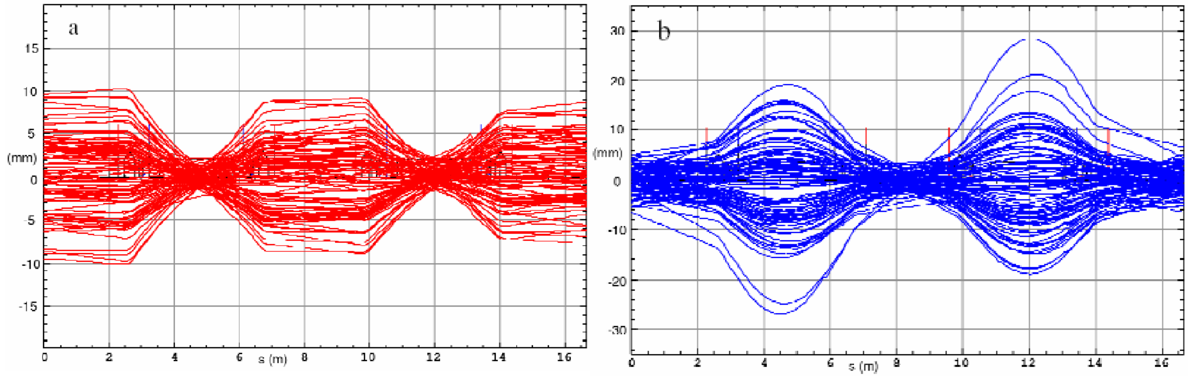

Figure 1: a) Horizontal orbit distortion and b) vertical orbit distortion, due to all the above errors, along one period.

Closed Orbit Correction

In SESAME there are 32 beam position monitors (BPMs) distributed all over the ring in a such a way to minimize the residual vertical orbit distortion in the bending magnets and the horizontal one in the straights.

The correctors are 64, half of them correct the horizontal orbit distortion and are placed as additional coils in the focusing sextupoles while the other half works in the vertical plane and are placed in the defocusing sextupoles (see Fig. 2).

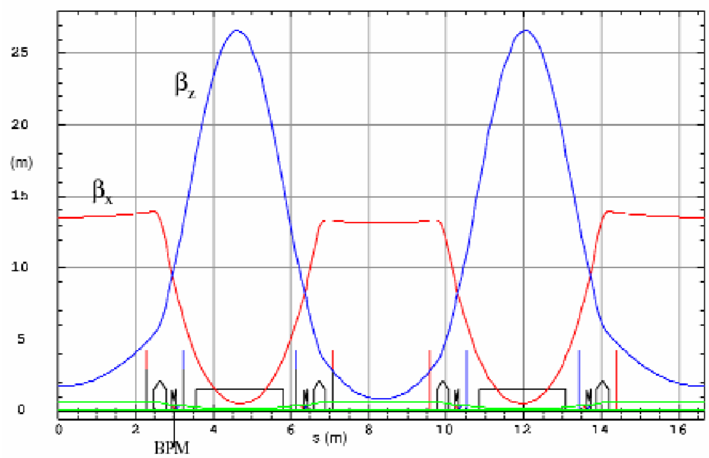

Figure 2: BPMs are situated near to defocusing quadrupoles. The horizontal correctors (red) are in the focusing sextupoles while the vertical ones (blue) are in the defocusing sextupoles.

Closed Orbit Correction

In the correction scheme all the correctors were used. 100samples of corrected orbits were tracked twice and the maximum corrector strengths have been considered. The 1rms residual closed orbit distortion in sextupoles was approximately the same in both cases. The maximum needed correction kicks were $\delta_{x,\ max}$ = 0.4306mrad for the horizontal correctors and $\delta_{z,\ max}$ = 0.3995mrad for the vertical ones. They have been calculated by taking the rms of the rms of each corrector kicks in the 100samples and multiplied by 3. These corrector strengths are within the range of the maximum kicks that can be achieved by SESAME correctors at 2.5GeV (0.5mrad). Taking into account that the first orbit correction will be done at the injection energy of 0.8GeV, the design strength of the correctors seem adequate.

The corrected orbits, using all correctors, are shown in Fig. 3.

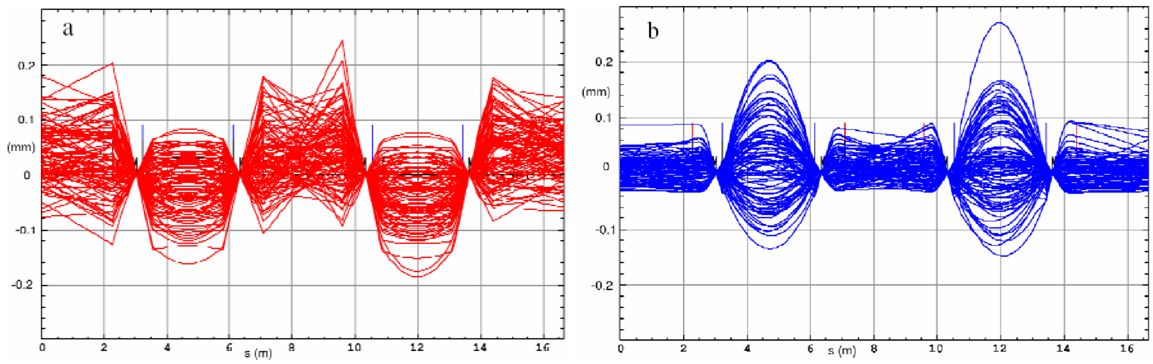

Figure 3: Horizontal (a) and vertical (b) residual orbit distortions after correction.

Minimizing the number of correctors used in the correction scheme will increase the residual orbit distortion for negligible decrease in the corrector strengths.

References

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

[2] J. Payet et al., BETA code LNS version.