Technical Note

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Note: **O-3**

WIGGLERS AND SUPERBEND IN SESAME

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Introduction

Since SESAME has a non zero dispersion in the straight sections, the insertion of a wiggler will produce, in addition to a mismatching in the optical functions, an increase in the emittance that depends on wiggler length and magnetic field intensity. There is no problem to *locally* compensate the optical functions also with wiggler field intensity up to 7 Tesla, but the emittance increase will became appreciable if we exceed a field of ~ 2 Tesla.

Since there has been a proposal [1] to use in SESAME a 7-Tesla S.C. wiggler we will evaluate the effect of the insertion of such a wiggler but also we present in a preliminary way, from the optics point of view, the possibility to use a 7-Tesla SUPERBEND, which in perspective can be considered as an alternative to the use of a 7-Tesla wiggler.

All the evaluation will be made for the SESAME working point Q_x =7.23 and Q_z = 6.19 [2].

The 2.1-Tesla Wiggler

Let us consider a 23-period wiggler with a wavelength of 16 cm and a field of 2.1 Tesla inserted in a *Long Straight*: this wiggler will produce a mismatching in the optical functions and a tune shift.

We correct the mismatching and the tune shift *locally*, by changing the strengths of the quadrupoles at each side of the wiggler as well as the strengths of all the other quadrupoles, going from 2 families of quadrupoles to 4 families. The matched optical functions are plotted in Fig. 1, while the corresponding strengths of the quadrupoles and tune shift are listed Tab. 1.

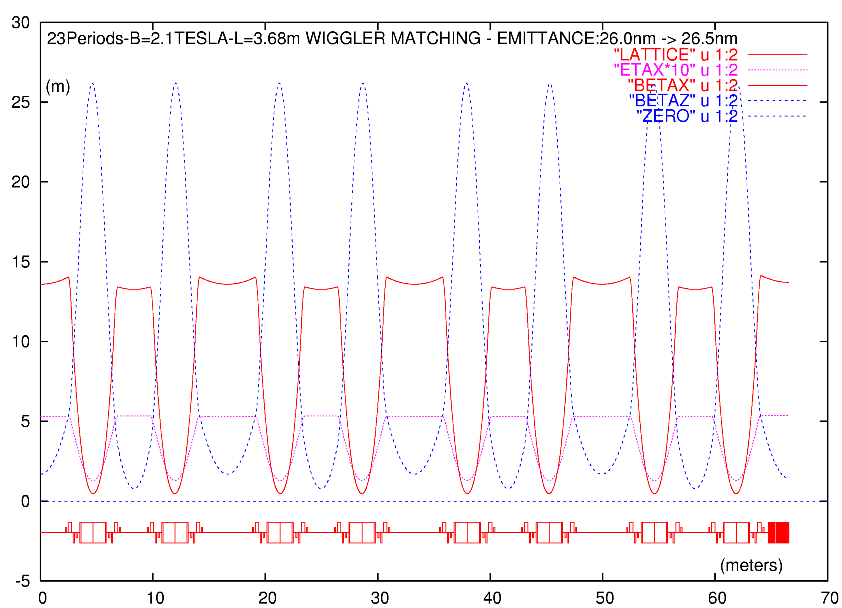

Figure 1: Half ring optical functions: the wiggler (1/2) is the last element of the lattice.

Table 1: Quadrupoles normalized gradient (m^{-2}) and tune shifts.

	NO MATCHING	MATCHING
QF	2.03217	2.02686
QD	1.22628	1.20025
QD_w	1.22628	1.32530
QF_w	2.03217	2.05148
ΔQ_x	0.0014	0.0
ΔQ_z	0.0211	0.0

There is also an increase in the emittance that goes from 26.0nm to 26.53nm. This increase in emittance is fully proportional to the number of wiggler periods as one can see from Fig. 2.

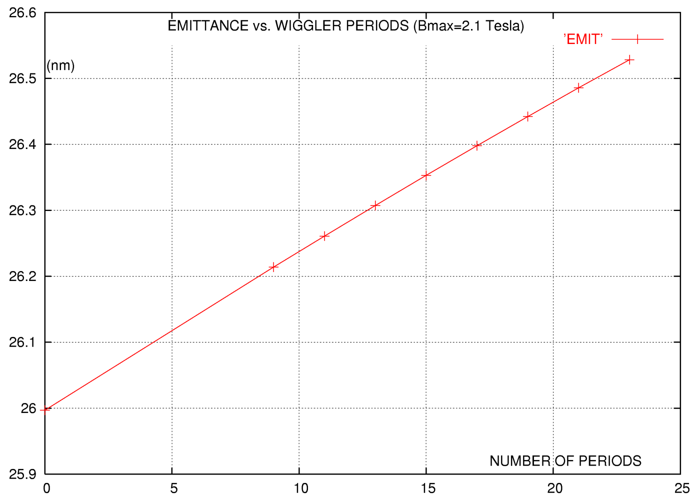

Figure 2: Emittance vs. the number of wiggler periods.

Instead, the emittance increase vs. the number of 23-period wigglers, as shown in Fig. 3, is slightly non linear.

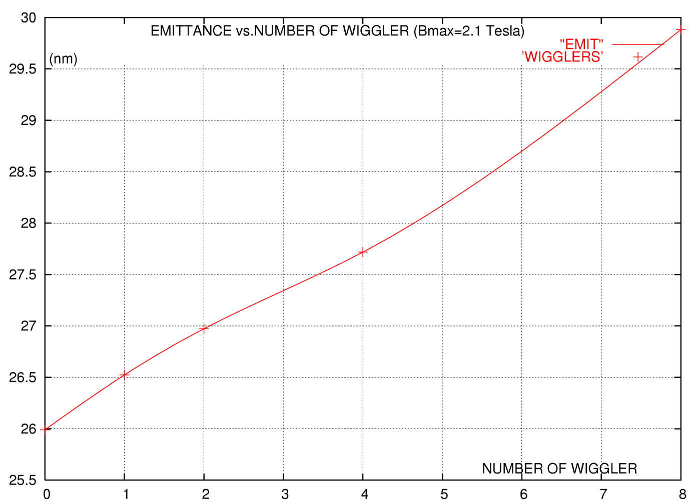

Figure 3: Emittance vs. the number of 23-period wigglers (the max number is obviously 8).

The 7-Tesla Wiggler

The proposed 7-Tesla wiggler has the following parameters:

λ	14.8 cm
B_{max}	7 Tesla
N	7 periods

Also in this case there is no problem in compensating *locally* the mismatching and the tune shift. We plot in Fig. 4 the optical functions, while the corresponding strengths of the quadrupoles and tune shift are listed Tab. 2.

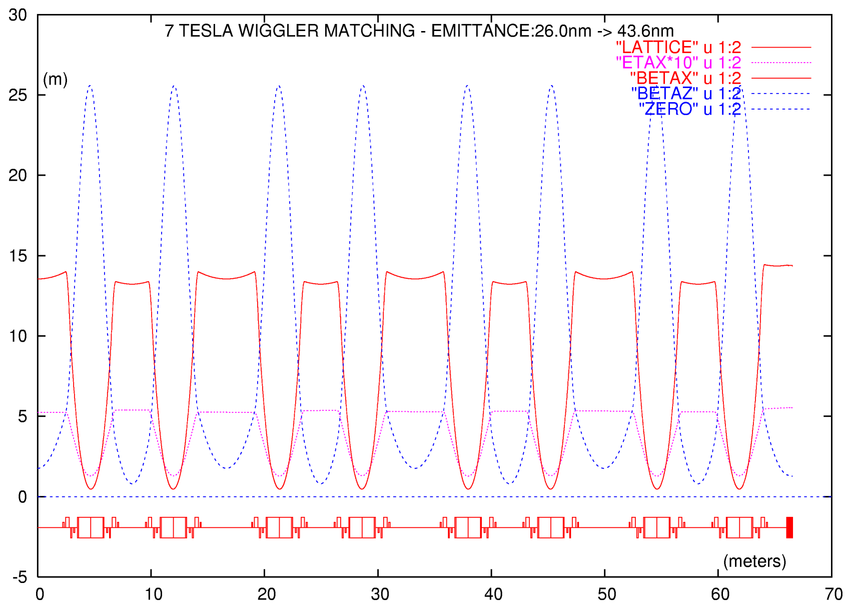

Figure 4: Half ring optical functions: the wiggler (1/2) is the last element of the lattice.

Table 2: Quadrupoles normalized gradient (m^{-2}) and tune shifts.

	NO MATCHING	MATCHING
QF	2.03217	2.0165
QD	1.22628	1.1557
QD_w	1.22628	1.6682
QF_w	2.03217	2.1040
ΔQ_x	0.0144	0.0
ΔQ_z	0.0434	0.0

The only problem, from the optics point of view, independently from RF power consideration (U_0 goes from 589.7 keV to 790.5 keV) is the emittance increase that goes from 26nm to 43.6nm. This increase of emittance calls, eventually, for dedicated SESAME operation.

Superbend

In order to find an alternative to the 7-Tesla wiggler, we have checked if the SESAME optics is capable to accommodate a 7 Tesla Superbend which replaces a normal dipole. The dipole of SESAME is 2.25 m long, while a 7 Tesla Superbend is only ~ 46.8 cm long. This shrinking in length leaves enough space to insert 2 additional quadrupoles (QF2 & QD2) on each side of the Superbend, as shown in Fig. 5.

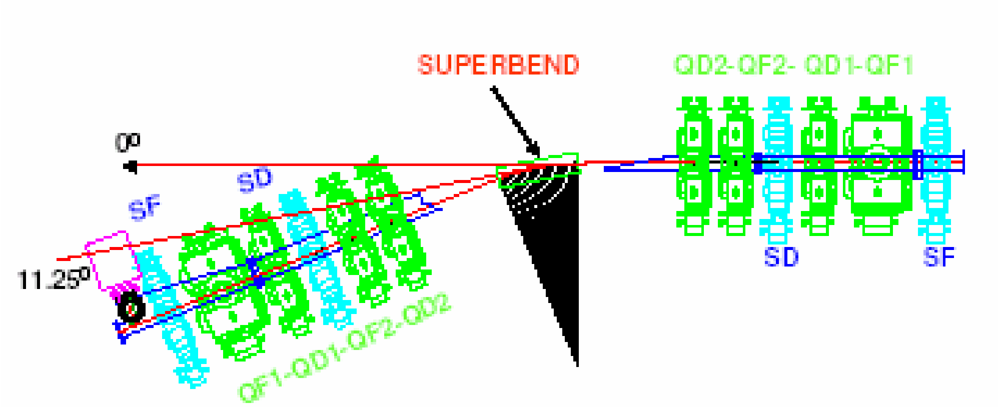

Figure 5: Layout of SUPERBEND solution in SESAME

The optical functions for SESAME lattice with one SUPERBEND are shown in Fig. 5, while the strengths of the quadrupoles are listed in Tab. 3.

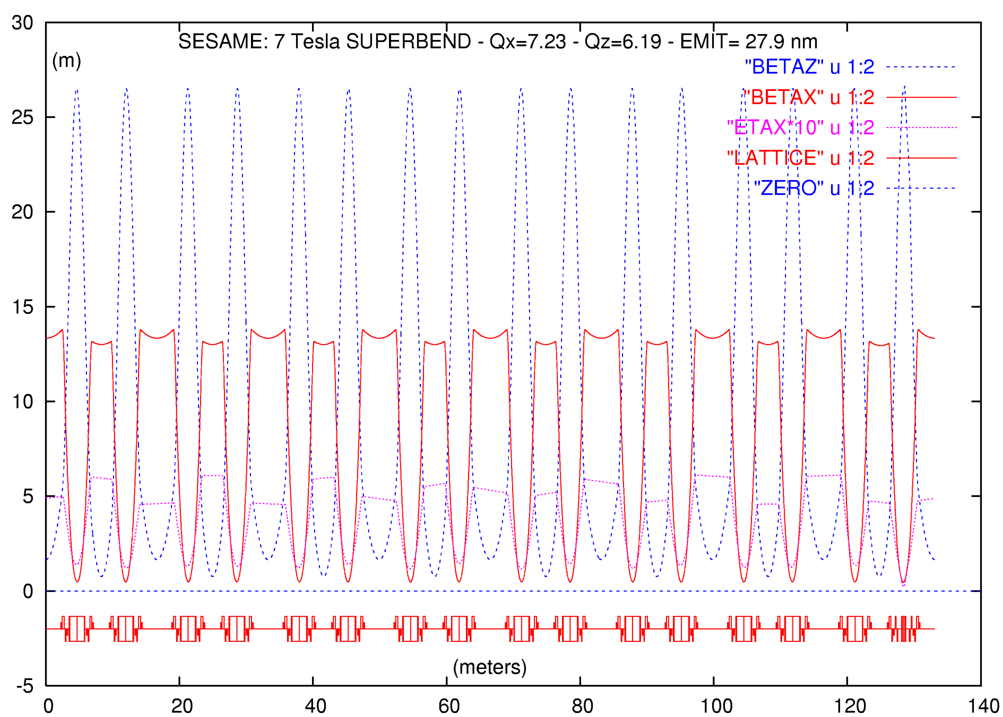

Figure 5: SESAME full ring optical function for the SUPERBEND solution.

Table 3: Quadrupoles normalized gradient (m^{-2}).

	NORMAL LATTICE	SUPERBEND
QF (L=30cm)	2.03217	2.02886
QD (L=10cm)	1.22628	1.22056
QF1(L=30cm)	2.03217	2.03733
QD1(L=10cm)	1.22628	1.23461
QF2 (L=10cm)	---------	0.52987
QD2(L=18cm)	---------	1.57452

Let us summarize the most relevant features of the SUPERBEND solution:

a) The emittance goes up from 26.0nm to 27.9nm;
b) Beam sizes in the middle of the SUPERBEND: $\sigma_x \times \sigma_z = 112 \times 83\ \mu m^2$;
c) U_o goes from 589.7 keV to 653.9 keV;
d) Quadrupole families needed : 6;
e) Sextupole families remain 2.

Finally, for completeness, we plot in Fig 6 and Fig.7 the Spectral Brightness vs. the Photon Energy for the 7 Tesla Wiggler and the SUPERBEND, respectively.

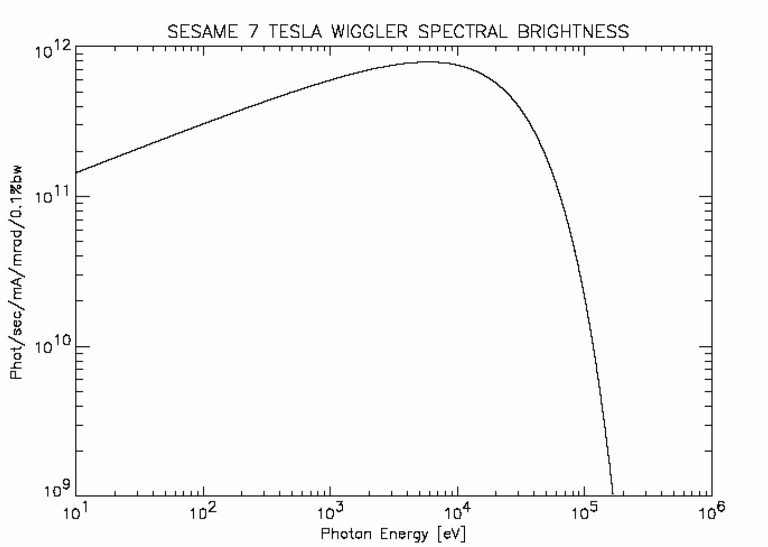

Figure 6: 7T-Wiggler Spectral Brightness.

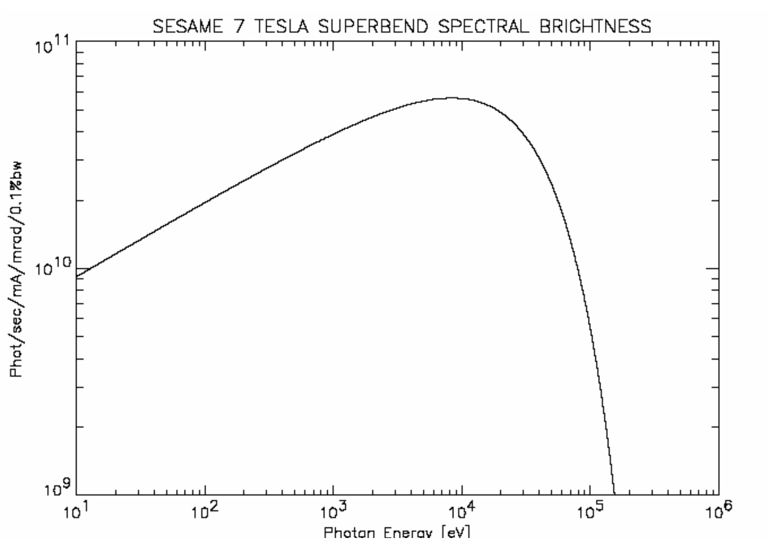

Figure 7: SUPERBEND Spectral Brightness.

References

[1] Antalya 3rd SESAMe User Meeting proceedings – October 2004
[2] G. Vignola, M Attal – SESAME Technical Note **O-1** – Dec. 2004