Amman, April 15, 2005
Note: **I-1**

SESAME INJECTION SYSTEMS AND LAYOUT

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Introduction

In this note we describe in some more details the full energy option for the actual SESAME design [1]; subsequently we redesign and reposition the 800MeV injection scheme [2], in order to make the transition between the two systems as smooth as possible.

1 - Full Energy Injection System

1.1 - Booster

The Booster and the Main Ring are located in the same tunnel; the booster is attached to the inner shielding wall, following the idea of SLS [3]. The lattice is similar to the Diamond booster [4] with some modifications; it is a 4-fold FODO with missing dipole and a Circumference whose ratio respect to the main ring circumference is (198/222).
The Booster main parameters are listed in Tab. 1, while the optical functions are shown in Fig. 1.

Table 1: Booster Parameter list.

PARAMETER	VALUE
Circumference (m)	118.7286486
Maximum energy (GeV)	2.5
Natural emittance (nm.rad)	184
Tunes: Q_x - Q_z	6.23 / 3.19
Natural chromaticity: ξ_x / ξ_z	-7.08 / -5
Number of long straights	8
Number of dipoles	32
Magnetic flux in the dipole (T)	0.8
Number of focusing/defocusing quads	20/20
Momentum compaction factor	0.03335
RF frequency	499.954
h	198

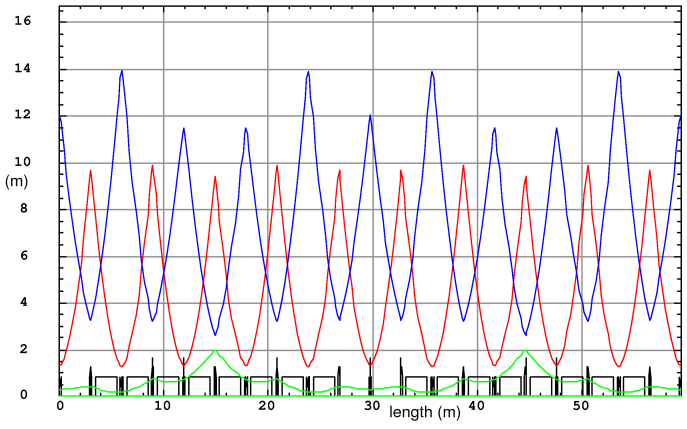

Figure 1: Half-booster optical functions: β_x is in red, β_z is in blue while the dispersion is in green.

1.2 - Injection bump

A 4-kicker bump is adopted for the injection in the main ring. To be sure that there is enough space available we use the same mechanical design of SLS for kickers and thin septum.

The *Long* section (# 1) will host the septum and two kickers while the other two kickers are located in the *Short* sections # 2 and # 16 (the straight sections are numbered clockwise, starting from the Injection straight). The arrangement of the injection magnets in the main ring is shown in Fig. 2, while

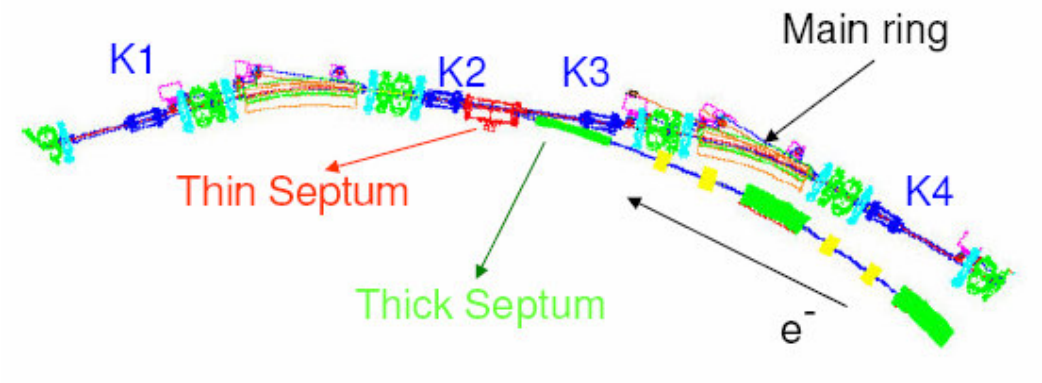

Figure 2: Injection layout

shape of the closed bump is plotted in Fig. 3. Finally in Tab. 2 are listed the strengths of the 4 Kickers

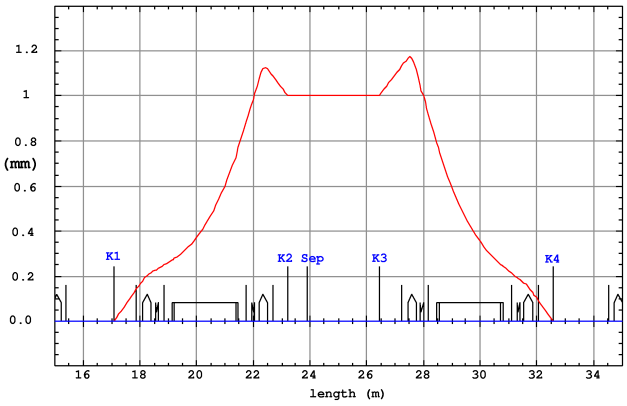

Figure 3: The injection closed orbit bump of 1mm in the long injection section (due to the crotch absorbers and pumping ports in the left hand side of the bending magnets, which prevents to position the kickers K1, K4 and K2, K3 symmetrically respect to the middle of the straight section, the orbit bump is slightly asymmetric).

Table 2: Kickers strength per mm of displacement.

KICKER	K4	K3	K2	K1
Strength (mrad/mm)	+0.17664	+0.16455	-0.17664	-0.16331

Since the amplitude of the closed bump is less than 24 mm, the maximum required strength of the Kickers is within the operating values of the SLS Kickers.

1.3 - Full energy transfer line

To make a *realistic* design of the full energy transfer line we use, as we already mentioned, the same extraction/injection septa of SLS, which have a bending angle, scaled to the SESAME energy, of 4.785°. It consists of 7 quadrupoles (4 defocusing and 3 focusing) necessary to control the six parameters β_x, β_z, α_x, α_z, η_x, η'_x and to have more flexibility. Moreover, two bending magnets and a thick septum are used for the *geometrical* matching.

The matched optical function are plotted in Fig. 4, while the complete sequence of all the elements of the transfer line, with the relative strengths, is listed in Tab. 3.

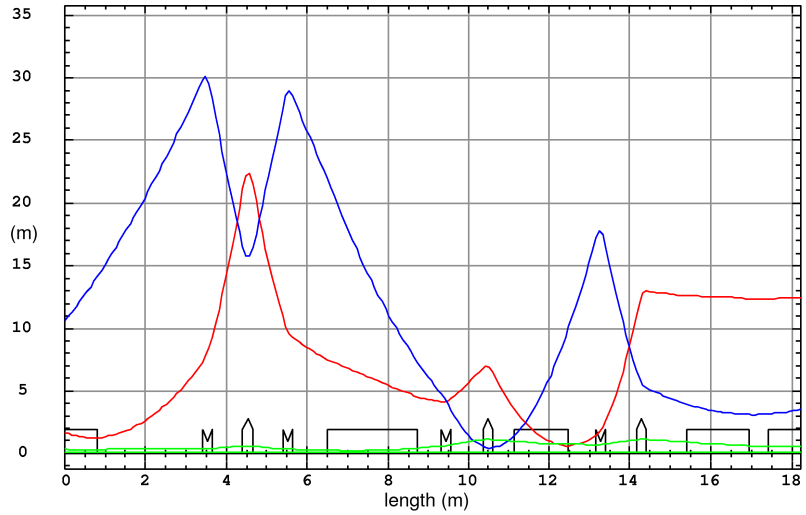

Figure 4: Booster- main ring transfer line optical functions for full energy injection: β_x is in red, β_z is in blue while the dispersion is in green.

Table 3: Full energy transfer line elements sequence.

ELEMENT TYPE	θ (°)	ρ (m)	LENGTH (m)	K (m^{-2})
Extraction septum	4.782	9.58506	0.8	
D			2.6	
QD			0.25	-1.74733
D			0.74	
QF			0.25	3.31595
D			0.74	
QD			0.25	-1.78352
D			0.86316	
BEND1	23.12	5.55941	2.243	
D			0.567927	
QD			0.25	-1.45374
D			0.78	
QF			0.25	3.0065
D			0.537927	
BEND2	14.03	5.55941	1.361	
D			0.66405	
QD			0.25	-3.32195
D			0.75	
QF			0.25	2.71311
D			1.00577	
Thick septum	9.542	9.26568	1.543	
D			0.4625	
Injection septum	4.782	9.58506	0.8	
TOTAL LENGTH			18.20833	

Finally, the overall layout of Main Ring, 2.5GeV Booster, Transfer line and inner shielding wall is shown in Fig. 5.

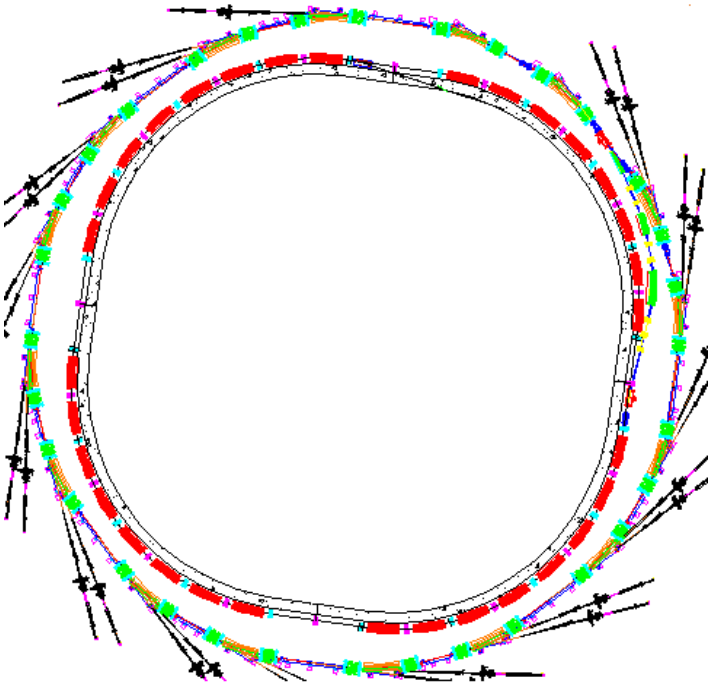

Figure 5: The layout of the full energy injector inside the Main Ring.

2 – 800MeV Injection System

The initial operation of SESAME will start with the 800 MeV booster synchrotron of BESSY I [2]. We have redesigned the transfer line in order to inject in the straight #1 and repositioned the booster inside the inner wall.

The 800 MeV transfer line make use of all the magnetic elements of BESSY I transfer line, with the exception of the injection septum (in BESSY I the injection septum was operating in the vertical plane and it will be very difficult to modify). We need also 2 new kickers to complete the injection orbit bump, since BESSY I injection was with 2 kickers only.

Fig. 6 shows the 800MeV transfer line optical functions that match SESAME ring parameters while in Tab. 4 the complete sequence of all the elements is listed.

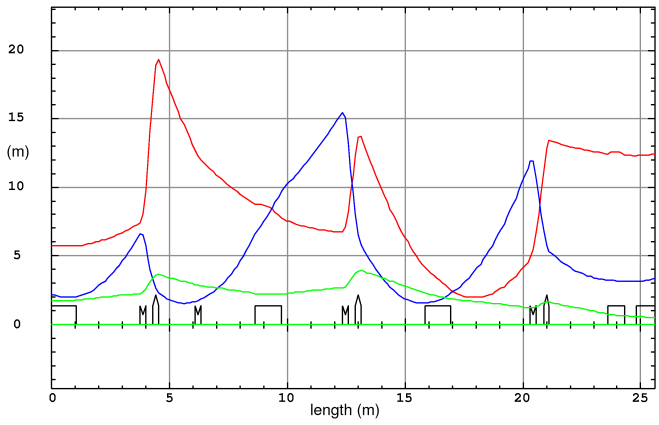

Figure 6: 800MeV transfer line matched optical functions: β_x is in red, β_z in blue while in green is the dispersion function.

Finally, the overall layout of Main Ring, 800MeV Booster and Transfer line is shown in Fig. 7.

Table 4: 800 MeV Transfer Line.

ELEMENT TYPE	θ (^{O})	ρ (m)	LENGTH (m)	K (m^{-2})
Extraction septum	10	5.874	1.0252	
D			2.7	
QD			0.25	-4.05504
D			0.3	
QF			0.25	3.41288
D			1.55	
QD			0.25	-0.298889
D			2.29739	
BEND1	23.5	2.66852	1.0945	
D			2.6	
QD			0.25	-3.16618
D			0.3	
QF			0.25	3.08025
D			2.71615	
BEND2	23.5	2.66852	1.0945	
D			3.37259	
QD			0.25	-3.34807
D			0.3	
QF			0.25	2.96678
D			2.5	
Thick septum	15	2.66852	0.69862	
D			0.4625	
Injection septum	4.782	9.58506	0.8	

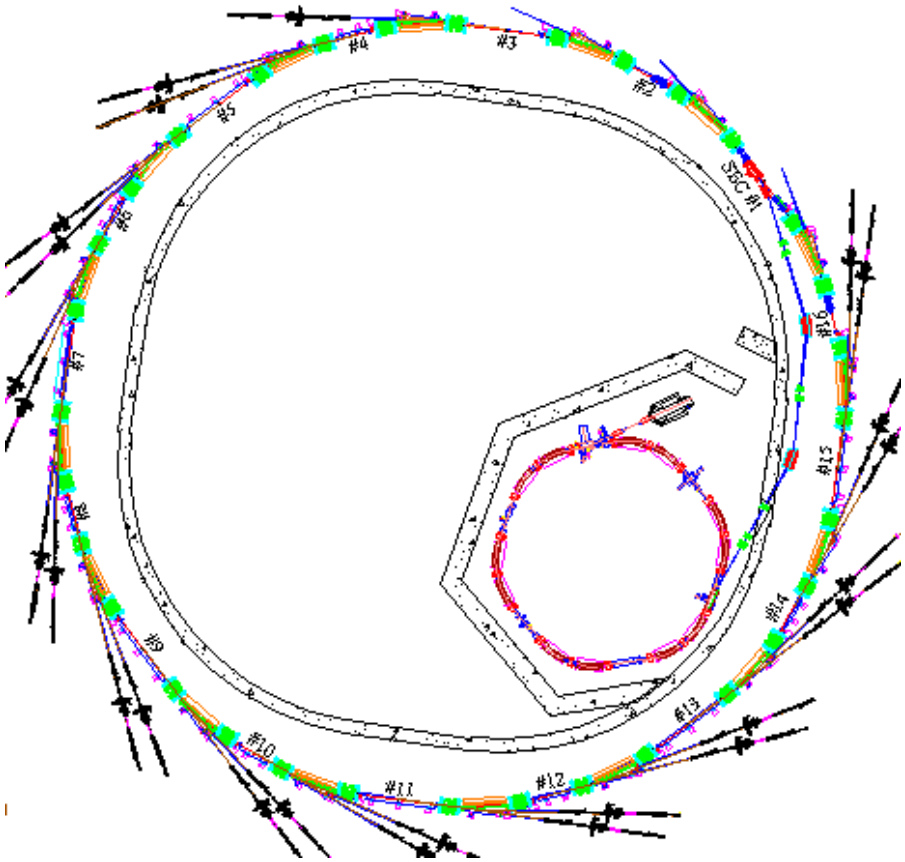

Figure 7: The layout of the 800 MeV injection system.

Final remarks

We have not evaluated the injector for the booster that could be a 100MeV Linac. The location of the Linac need to be decided; the best position, at the moment could be the one that inject the beam in the section of the booster parallel to section # 7 of the main ring, specially if we decide to use the section # 3 to install the RF cavities.

The kickers and thin septum arrangement in the main ring is the same for full energy and 800MeV injection, so one should consider, if there is enough money, to install these magnet for the full energy case since from the beginning.

References

[1] SESAME Tech. Note **O-1**, December 2004
[2] SESAME Yellow Book - www.sesame.org.jo
[3] SLS handbook, hb3_4.doc
[4] DIAMOND documents, F.3.Booster synchrotron.