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Note: **O-1**

SESAME LATTICE

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Introduction

In this note, we summarize the main parameters of SESAME lattice on which the detailed engineering design will be carried out.

The optics is basically derived by the one described in [1] with a circumference of 133.12 m instead of 129 m. The difference in length is mainly due to an increase of the *Short straight* section from 2.02 m to 2.38 m and to an increase of 5 cm in the separation between the dipole and the 2 adjacent sextupoles. To partially compensate the increase in the circumference the *Long straight* section has been reduced by 4 cm.

This lattice has 2 potential β-working points (Q_x=7.23 – Q_z=5.19) and (Q_x=7.23 – Q_z=6.19).

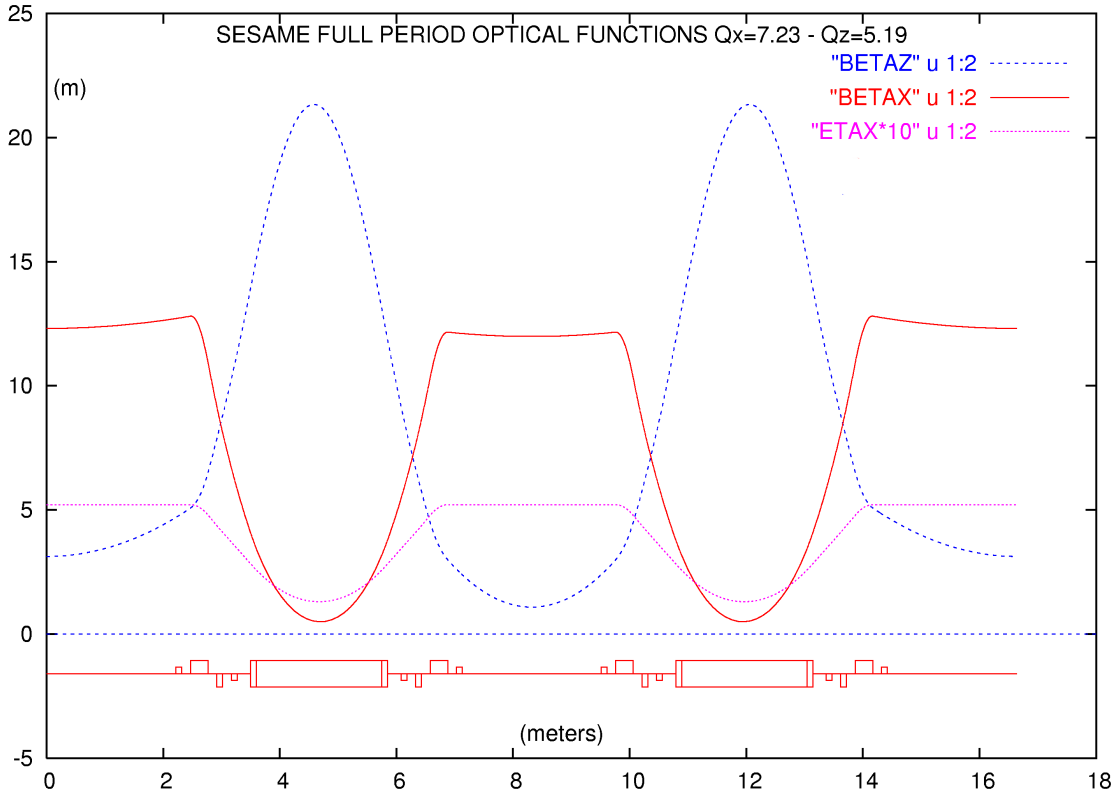
SESAME Lattice main features

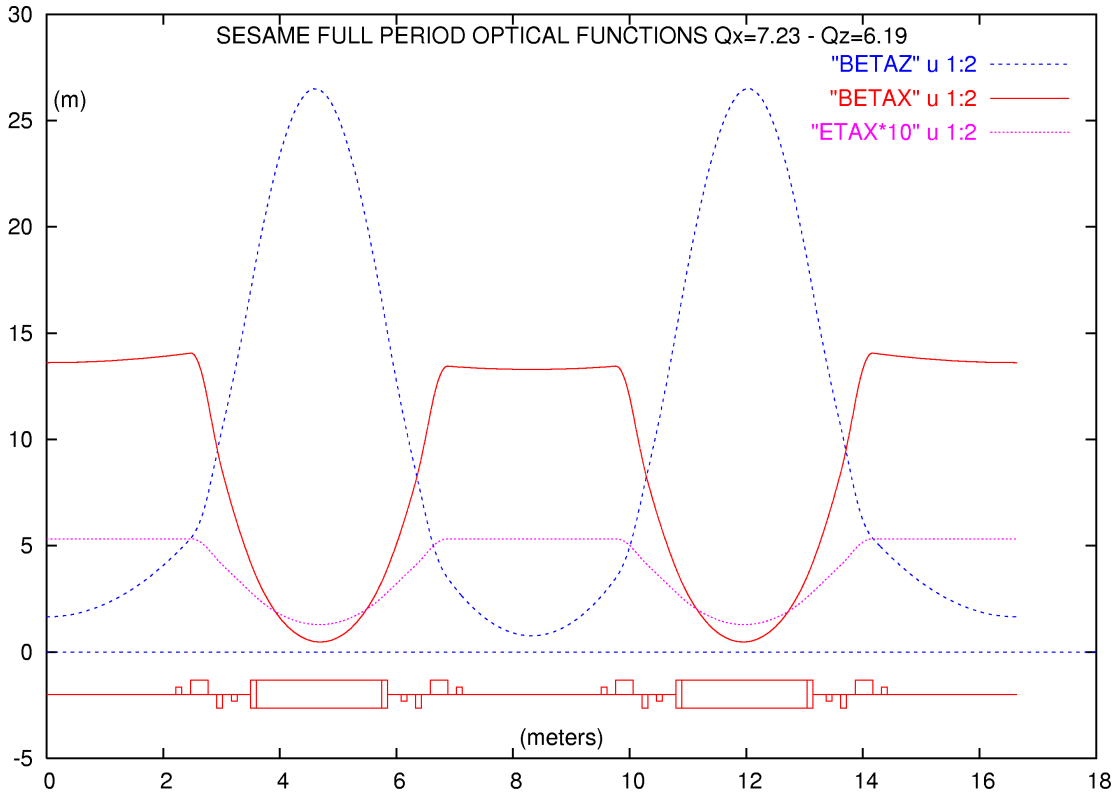
Tab. 1 shows the main lattice parameters that we assume from now on as the design ones.

Table 1: SESAME Design Parameters.

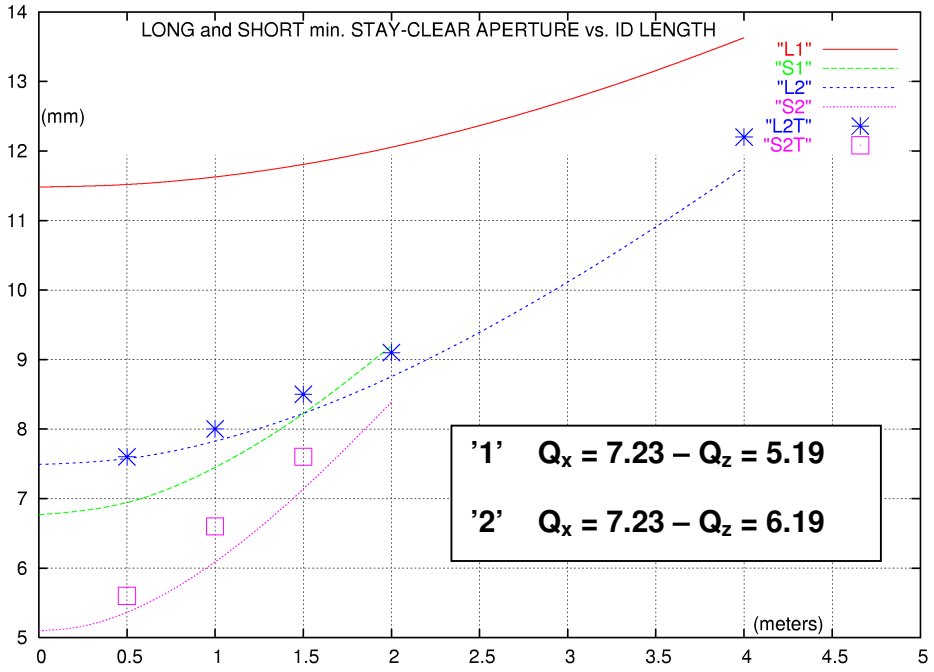
		Q_x=7.23-Q_z=5.19	Q_x=7.23-Q_z=6.19
GENERAL PARAMETERS	**UNIT**	**VALUE**	**VALUE**
Energy	GeV	2.5	
Circumference	m	133.12	
Number of periods		8	
Bending Dipole field	T	1.45545	
Bending radius	m	5.72958	
Field index n		11	
Betatron tunes H/V		7.23, 5.19	7.23, 6.19
Natural Chromaticity H/V		-14.0 / -13.8	-15.5 / -19.0
Momentum compaction		0.00833	0.00829
Energy loss / turn	keV	589.7	
Damping times (τ_E / τ_x / τ_z)	msec	2.81/ 2.27/ 3.77	2.80/ 2.28/ 3.77
RMS energy spread (σ_E)	%	0.1087	0.1086
Natural emittances (ε_x / ε_z)	nm-rad	25.24 / 0.2524	25.74 / 0.2574
Betatron coupling	%	1	
RF Parameters			
Frequency	MHz	499.954	
Harmonic Number		222	
Peak Voltage	MV	2.4	
RF acceptance (ε_{RF})	%	1.459	1.463
Synchrotron frequency (ν_s)	KHz	37.28	37.18
Natural bunch length (σ_L)	cm	1.16	1.15
Max. current (200 bunch)	mA	400	
(1/e) Lifetime	hrs	18.2	16.9
Horizontal full stay-clear aperture	mm	60	
Vertical full stay-clear aperture	mm	30	

In the following two figures the optical functions for a full period (1/8) of SESAME are shown for the two β-working points (Q_x=7.23 – Q_z=5.19) and (Q_x=7.23 – Q_z=6.19).


SESAME FULL PERIOD OPTICAL FUNCTIONS Qx=7.23 - Qz=5.19
"BETAZ" u 1:2
"BETAX" u 1:2
"ETAX*10" u 1:2
(m)
(meters)
25
20
15
10
5
0
-5
0
2
4
6
8
10
12
14
16
18


SESAME FULL PERIOD OPTICAL FUNCTIONS Qx=7.23 - Qz=6.19
"BETAZ" u 1:2
"BETAX" u 1:2
"ETAX*10" u 1:2
(m)
(meters)
30
25
20
15
10
5
0
-5
0
2
4
6
8
10
12
14
16
18

In the next figure we plot the minimum beam stay-clear vertical apertures, scaled from 30 mm full aperture @ β_z^{MAX}, vs. the ID length for the 2 β-working points in the *Long* and *Short* straight sections. The stars and boxes are instead the results from tracking for the working point "2" for the *Long* and *Short* straights respectively: these points indicate that, by taking into account the sextupoles non linearities, the stay clear apertures must be increased of ~ 0.5 ÷1.0 mm.



In Tab. 2 are listed the beam parameters relevant for the experiments, while in Tab.3 the sequence

Table 2: Main beam parameters

		Q_X=7.23- Q_Z=5.19	Q_X=7.23 – Q_Z=6.19
	UNIT	**VALUE**	**VALUE**
Optical Functions [middle of Long/Short (**) straights and @ dipole port (6.5°)]			
Horizontal Beta:			
Long straight/Short straight/Dipole	m	12.31/11.99/1.00	13.61/13.30/1.00
Vertical Beta:			
Long straight/Short straight/Dipole	m	3.13/1.09/19.74	1.65/0.77/24.50
Horizontal Dispersion:			
Long straight/Short straight/Dipole	m	0.52/0.52/0.154	0.53/0.53/0.154
Beam Sizes and Angular Divergences			
Horizontal beam size (σ_x):			
Long straight/Short straight/Dipole	μm	794.8/789.7/232.0	827.8/822.8/231.1
Vertical beam size (σ_z):			
Long straight/Short straight/Dipole	μm	28.1/16.6/71.5	20.6/14.0/79.5
Horizontal divergence (σ_x'):			
Long straight/Short straight/Dipole	μrad	45.3/45.9/260.9	43.5/44.0/267.1
Vertical divergence (σ_z'):			
Long straight/Short straight/Dipole	μrad	9.0/15.2/12.1	12.5/18.3/13.3

of the elements for a full period are reported (the correctors are embedded in the sextupoles with a target value of ~ 0.5 mrad @ 2.5 GeV).

Table 3: Element sequence in one Superperiod.

SESAME								
Half period lattice (reflected symmetry) – 8 Periods – E=2.5 GeV (Bρ=8.3391 Tm)								
					Qx=7.23 - Qz=5.19		Qx=7.23 - Qz=6.19	
#	Element	Length(m)	θ(rad)	n	$K_4(m^{-2})$	$K_6(m^{-3})$	$K_4(m^{-2})$	$K_6(m^{-3})$
1	1/2 *Long* s.	2.220						
2	SF/Hcorr	0.100	$5x10^{-4}$			17.98 *		16.99 *
3	D1	0.150						
4	QF	0.300			1.83222		2.03217	
5	D1	0.150						
6	QD	0.100			0.35834		1.22628	
7	D1	0.150						
8	SD/Vcorr	0.100	$5x10^{-4}$			26.57 *		26.32 *
9	D2	0.280						
10	BM	2.250	π / 8	11	0.33508		0.33508	
11	D2	0.280						
12	SD/Vcorr	0.100	$5x10^{-4}$			26.57 *		26.32 *
13	D1	0.150						
14	QD	0.100			0.35834		1.22628	
15	D1	0.150						
16	QF	0.300			1.83222		2.03217	
17	D1	0.150						
18	SF/Hcorr	0.100	$5x10^{-4}$			17.98 *		16.99 *
19	1/2 Short s.	1.190						
-------	Tot. Length	8.320						

(*) For chromaticities corrected @ +1 in both planes.

Magnetic relations

Dipole Radius (**R**) **= [L / θ] =** 5.729578 m
Max Dipole field (T) **= [Bρ** (Tm)/ **R** (m)**] =** 1.45545 T
Dipole gradient (T/m) **= [Bρ** (Tm) x **n** / **R^2] = [Bρ** (Tm) x **$K_4(m^{-2})$]**
4-pole gradient (T/m) **= [Bρ** (Tm) x **$K_4(m^{-2})$]**
6-pole diff. grad. (T/m^2) **= [Bρ** (Tm) x **$K_6(m^{-3})$]**

Note:

Optics calculations are performed by substituting the sequence D2-BM-D2 of Tab. 3 with the following one:

					Qx=7.23 - Qz=5.19		Qx=7.23 - Qz=5.19	
#	Element	Length(m)	R(m)	n	$K_4(m^{-2})$	$K_6(m^{-3})$	$K_4(m^{-2})$	$K_6(m^{-3})$
9	D2	0.230						
10	B1	0.100	11.459156	11	0.08377		0.08377	
11	BM	2.150	5.729578	11	0.33508		0.33508	
12	B1	0.100	11.459156	11	0.08377		0.08377	
13	D2	0.230						

where the dipoles have parallel ends.
Let us also point out that with this quite realistic dipole modeling the energy loss/turn decreases by ~ 2.23%.

References

[1] M. Attal et al.: An update on SESAME light source – EPAC 2004 Proceedings – pg. 2323