The New Upgrade of SESAME

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Abstract

Developed under the auspices of UNESCO, SESAME (Synchrotron light for Experimental Science and Application in the Middle East) will be a major international research centre in the Middle East / Mediterranean region. Most of the applications require hard x-rays up to 20 keV photons. SESAME will be a 2GeV 3rd Generation Ligth Source with an emittance of 17 nmrad and 13 places for the installation of insertion devices with a length around 3 meter. The circumference of the machine will be 120m. As injector the 800 MeV Booster Synchrotron will be used with small changes. Furthermore also the BESSY I quadrupoles and sextupoles can be used. In a later stage these new ones will be replaced in order to increase the length of the straight sections and to introduce mini beta sections for the reduction of the beam cross section. At SESAME around 35 % of the circumference can be used for the installation of insertion devices.

1. Introduction

According to the workshops held in the Middle East Region the scientific case for SESAME includes structural molecular biology, molecular environmental science, surface and interface science, micro mechanical devices, x-ray imaging, archaeological microanalysis, material characterization, and medical applications. Most of these applications require hard x-rays up to 20 keV photons. Within the "Green Book"-design [1] this 20 keV can be reached by upgrading BESSY I from 0.8 to 1 GeV and use 7.5 T super conducting wigglers. In order to increase the number of hard X-ray beam lines it was decided to upgrade the SESAME to 2 GeV and to optimize the design for a higher brilliance and a larger number of straight sections, In this paper we present the "New upgrade of SESAME"

2. New Lattice

For the new lattice a so called "TME-Optic" [2] was chosen, which gives the smallest emittance and it should give the highest percentage of the circumference, dedicated to the installation of the insertion devices. The basic elements of the lattice are a combined function bending magnets, with a set of quadrupoles and sextupoles on each side. The vertical focusing is performed by the combined bending magnet and the horizontal by the quadrupoles. The machine functions of one unit cell are given in figure 1. and the main parameters of the ring are summarised in table 1.

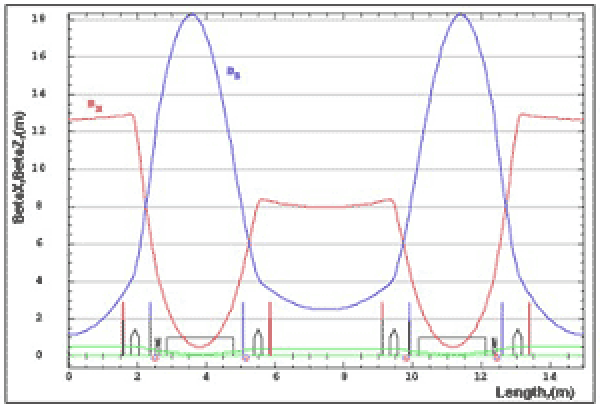

Figure 1: Optical functions of SESAME lattice, The green line represents dispersion. Horizontal and vertical correctors are represented by red and blue respectively.

In order to have the possibility for the vertical tuning of the bending magnets, a small vertical focusing quadrupole is placed. To reach a sufficient dynamic aperture and a energy acceptance of 4%, chromatic and harmonic sextupoles have to be used. The arrangements of the magnets within one cell are given in figure 2 and the layout of the whole storage ring is given in figure 3.

Table 1: Main parameters of the new SESAME upgrade

Parameter	Unit	Value
General Parameters		
Energy	GeV	2
Beam current	mA	400
Circumference	m	120
Natural emittance	nmrad	16.8
Coupling	%	2
Horizontal emittance	nmrad	16.5
Vertical emittance	nmrad	0.33
Momentum compaction factor		0.0079
Relative energy spread		0.090
Chromaticity(horizontal)		13.26
Chromaticity(vertical)		14.9
Machine functions		
Horizontal beta functions		
Wiggler/bending/undulator	m/rad	7.94/0.482/12.7
Vertical beta functions		
Wiggler/bending/undulator	m/rad	2.47/17.9/1.14
Dispersion function		
Wiggler/bending/undulator	m	0.4/0.112/0.52
Beam sizes and cross sections		

Horizontal beam size		
Wiggler/bending/undulator	µm	510/134/656
Vertical beam size		
Wiggler/bending/undulator	µm	28.5/70.9/19.4
Cross section		
Wiggler/bending/undulator	mm^2	0.91/0.060/0.080
RF-System		
Energy loss(bending)per turn	keV	286.4
Energy loss (per wiggler)per turn	keV	25.7
RF-frequency	MHz	499.654
Harmonic number		200
RF-power	kW	250
Number of cavities		2
Beam power (2 wigglers)	kW	135.1
Shunt impedance per cavity	MΩ/m	3.4
RF-cavity voltage	kV	553
Overvoltage factor		3.3
Energy acceptance		1.2
Bunch length	mm	12

3. Layout of the Machine

The layout of one cell is given in figure 2. The main elements are the 22.5 degrees vertical focusing bending magnets with the quadrupoles and sextupoles are located around it. The lengths of the straight sections are 3 meter It is foreseen to extract from each bending magnet one-beam line.

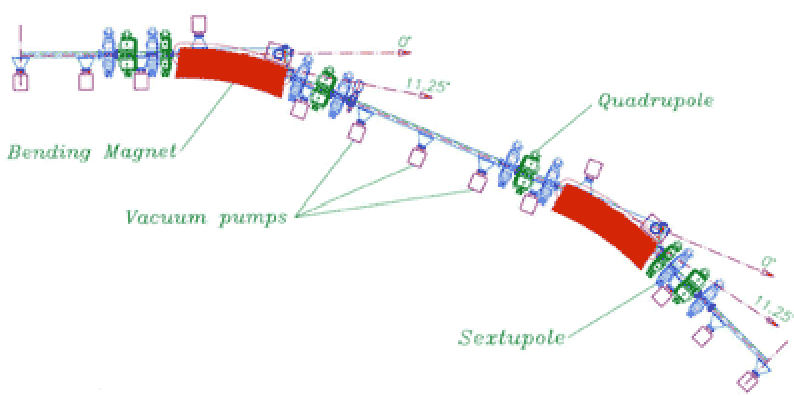

Figure 2: Arrangements of magnets within one unit cell of the storage ring SESAME.

These beam lines should be positioned at 11.25 degrees in order to use the smallest cross section of the beam. The layout of the whole storage ring with the 800 MeV BESSY I injector is shown in figure 3.

4. Components of the Machine

The original BESSY I injector will be used with some modifications. Instead of the 10 Hz white circuits, 1 to 3 Hz fast power supplies will be used. Perhaps in a later stage the 20 MeV Microtron as preinjector will be replace by a 50 MeV linac.

According to the upgrading of 2 GeV, the bending magnets with a flux of 1.35 Tesla and a gradient of 2.84 T/m must be new. The lattice allows to use in the first stage all the quadrupoles and sextupoles from BESSY I because they have been designed for the 6 GeV PETRA storage ring. In an upgrading process they will be replaced by smaller ones in order to increase the length of the straight sections.

With the changes of the circumference from 64 to 120(m) the vacuum system must be new. It will be an antechamber system like SLS or the CLS. All photons will be stopped at lump absorbers. For longer beam lifetimes the pumping speed must allow to reach an average pressure of 1 nTorr.

The rf-system will be build up in steps too, which are determined by the donations of other laboratories. DESY will donate to the project some 250 kW klystrons and ELETTRA a cavity and the low level electronics. The layout of the rf-system will be the same as for ANKA.

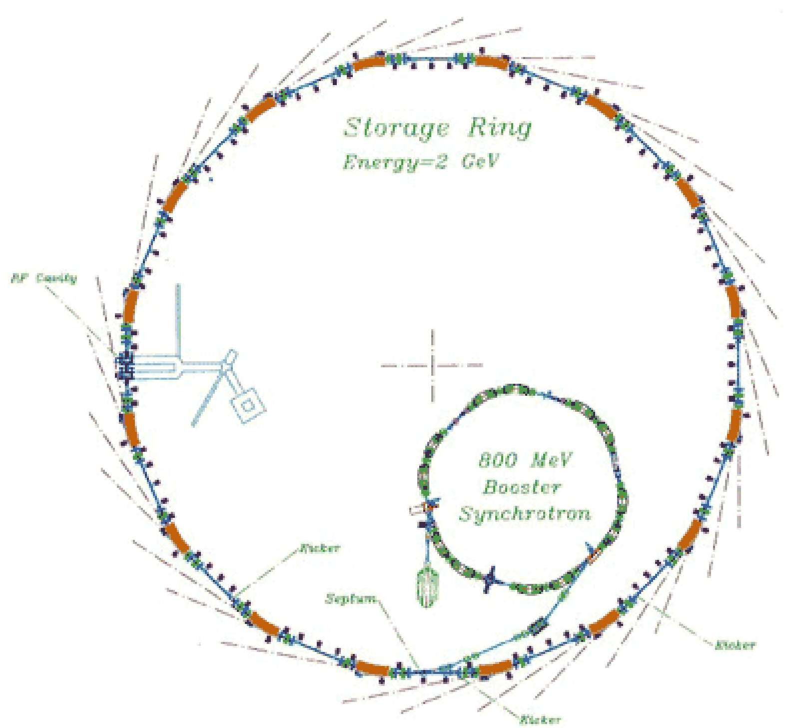

Figure: Arrangement of the storage ring of SESAME machine

All the power supplies for the project will be build in collaboration between SESAME and the Yerevan Physics Institute (Yerphi). The intention is to use the higher power parts of the old power supplies and replace the electronics.

For the control system we expect some donations from the Swiss Light Source. The concept is based upon EPICS but for graphical user interface we take the ANKA approach. The same control system will be used for both, the machine and the beam lines.

The whole diagnostics system for the SESAME storage ring will be new.

5. Flux and Brilliance

The flux and the brilliance of the emitted radiation from the stored beam in the bending (1.35 Tesla) and the wiggler (N_w=30, B=2.25Tesla, ?$_w$=8cm) for a beam current of 400mA are presented in figure 4 and 5.

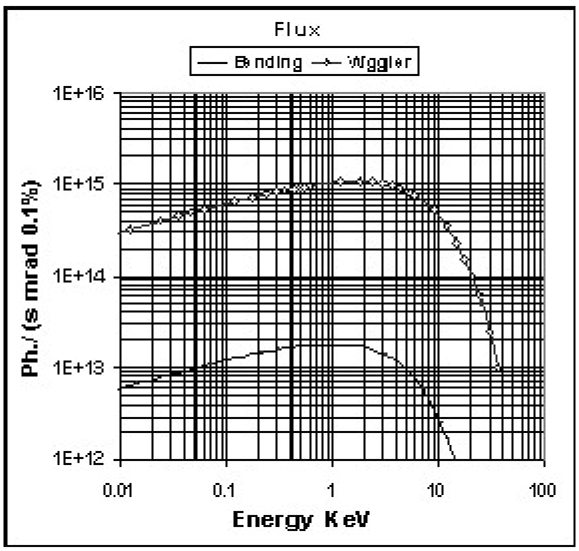

Figure 4: Flux of the synchrotron radiation emitted from the stored beam in the bending and wigglers.

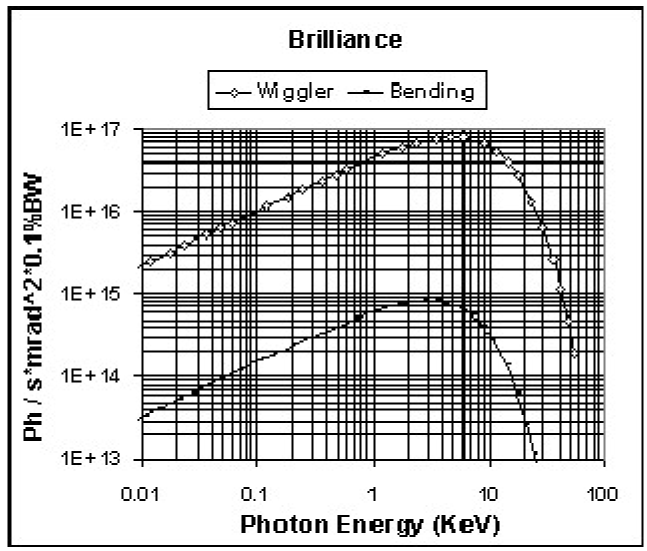

Figure 5: Brilliance of the synchrotron radiation emitted from the stored beam in the bending and wigglers.

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7. References

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