SESAME, A 3rd Generation Synchrotron Light Source for the Middle East

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Abstract. Developed under the auspices of UNESCO, SESAME (***S***ynchrotron-light for ***E***xperimental ***S***cience and ***A***pplications in the ***M***iddle ***E***ast) will be a major international research centre in the Middle East and Mediterranean region. On 6th of January 2003, the official foundation of SESAME took place. The facility is located in Allan, Jordan, 30 km North-West of Amman. As of August 2003 the Founding Members are Bahrain, Egypt, Iran, Israel, Jordan, Pakistan, Palestine, Turkey and United Arabic Emirates, representing a population of over 300 million. SESAME will be a 2.5 GeV 3rd Generation light source (emittance 24.6 nm.rad, circumference ~125m). About 40% of the circumference is available for insertion devices (average length 2.75m) in 13 straight sections. Beam lines are up to 36m. The site and a building are provided by Jordan. Construction started in August 2003. The scientific program will start with up to 6 beam lines: MAD Protein Crystallography, SAXS and WAXS for polymers and proteins, Powder Diffraction for material science, UV/VUV/SXR Photoelectron Spectroscopy and Photoabsorption Spectroscopy, IR Spectroscopy, and EXAFS.

INTRODUCTION

The SESAME scientific program includes structural molecular biology, molecular environmental science, surface and interface science, x-ray imaging, archaeological microanalysis, material characterization, and medical applications. Most of these applications require hard x-rays. In the "Green Book" design [1, 2], x-rays up to 20 keV are reached by upgrading BESSY I from 0.8 to 1 GeV and using 7.5 T super conducting wigglers. In order to a) increase the number of hard x-ray beam lines, b) minimize the influence of the 7.5 T wigglers on the beam behavior and c) reach the selenium K-edge with in-vacuum undulators, it was decided to upgrade SESAME to 2.5 GeV and to optimize it for a higher brilliance and a larger number of straight sections [3-6]. Given the constraints of the building now in construction, the maximum circumference of the storage ring is about 125 m.

The Layout of the Building and Machine

The ground floor of the building (figure 1) contains the storage ring, beam lines, workshops and laboratories. The main experimental area is 60m*60m (with crane coverage) with extensions at each side of 7.5m*30m. Offices for staff and users, plus other rooms (library, seminar and meeting rooms, control room, etc.), are located on the first floor. Space is available for a full-energy injector inside the storage ring as a future option.

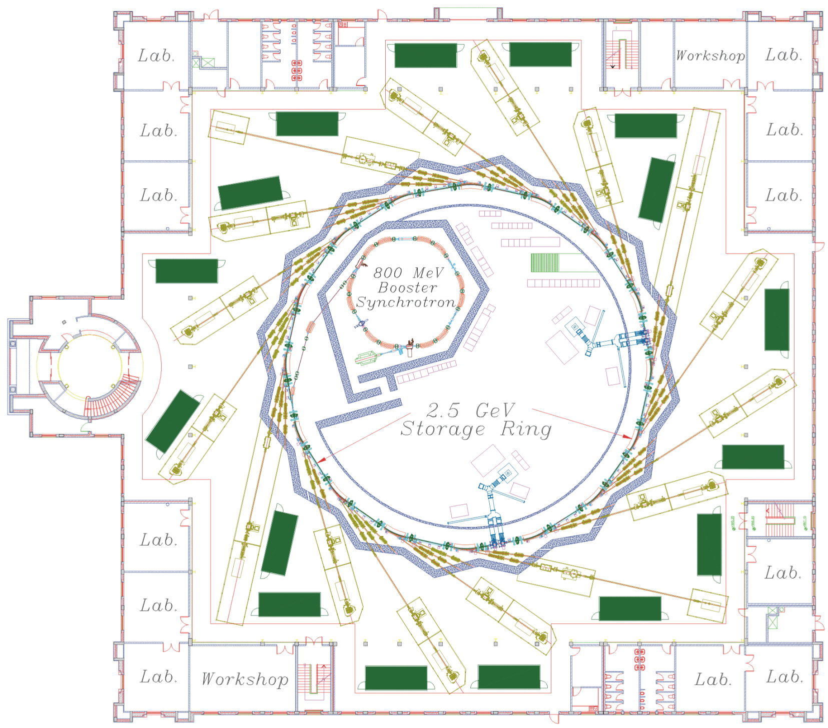

FIGURE 1. The ground floor of SESAME with the 0.8 GeV BESSY I injector, 2.5 GeV storage ring, experimental hall, beam lines, workshops and laboratories.

Thirteen straight sections are available for insertion devices with lengths up to 2.75 m. The natural emittance is 24.9 nm.rad, leading to beam cross-sections in the straight section of $\sigma(x) = 734$ μm, $\sigma(y) = 22$ μm, with 2% coupling. With lumped absorbers and installation of 32,000 l/s of pumping speed, it should be possible to reach an average pressure of 10^{-9} mbar after conditioning, leading to a lifetime of ~15 hours. The main parameters of SESAME are summarized in table 1.

TABLE 1. The Main Parameters of SESAME

Energy	2.5
Maximum Beam Current (mA)	400
Bending Flux Density (T)	1.4
Circumference (m)	124.8
Emmittance (nm.rad)	24.6
Length of the Insertion Devices (m)	2.70
Beam Cross Section within Straight Section (μm)	730*22
Available Straight Sections (m)	13

The lattice [5], a “TME-Optic” [7], gives the smallest emittance and the highest percentage of the circumference for insertion devices. The symmetry is 8, with 2*22.5 degree bending magnets in each unit cell (see figure 2). The lattice has combined function bending magnets, with quadrupoles and sextupoles on each side. The bending magnets with pole face windings perform the deflection and vertical focusing. Quadrupoles provide the horizontal focusing. In order to get more flexibility than provided by the pole face windings, investigations are underway to increase the circumference of the machine and introduce another set of quadrupoles.

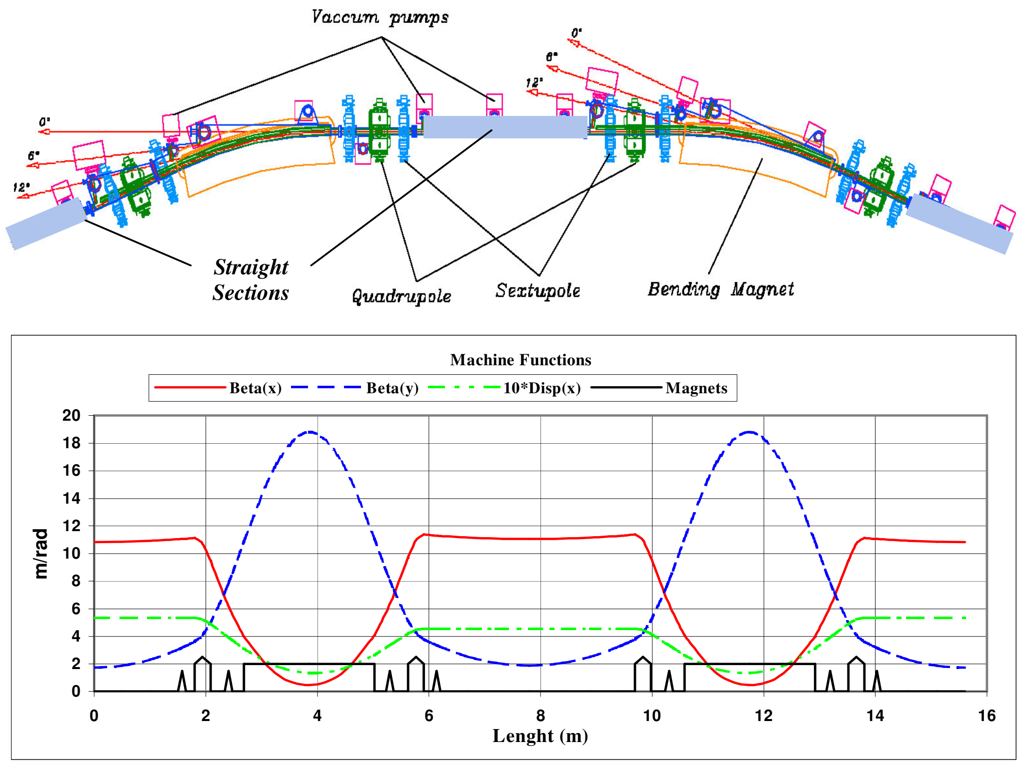

FIGURE 2. The arrangements of the magnets and the machine functions within the unit cell of SESAME.

Characteristics of Synchrotron Radiation and First Beam Lines

The flux and the brightness of the emitted radiation of a 400 mA stored beam from the different sources are presented in figure 3. The flux for the bending magnet and the wigglers are calculated for a horizontal angle of 1 mrad. Through extensive consultation, including scientific workshops and the first SESAME Users' meeting (see reports on the web site www.sesame.org.jo), six beam lines are being planed for the first phase (see table 2).

TABLE 2. The First Set of Beam Lines at SESAME

Number	Description of Beam Lines	Energy range
1	MAD protein crystallography (undulator)	7.5 – 15 keV
2	Small angle X-ray scattering (undulator or wiggler)	5.0 – 15 keV
3	Spectroscopy of gases and solids (undulator)	0.05 – 2 keV
4	EXAFS (2.5 Tesla multipole wiggler)	3 – 25 keV
5	Powder diffraction (2.5 Tesla multipole wiggler)	3 – 25 keV
6	Infrared spectroscopy	0.01 – 1 eV

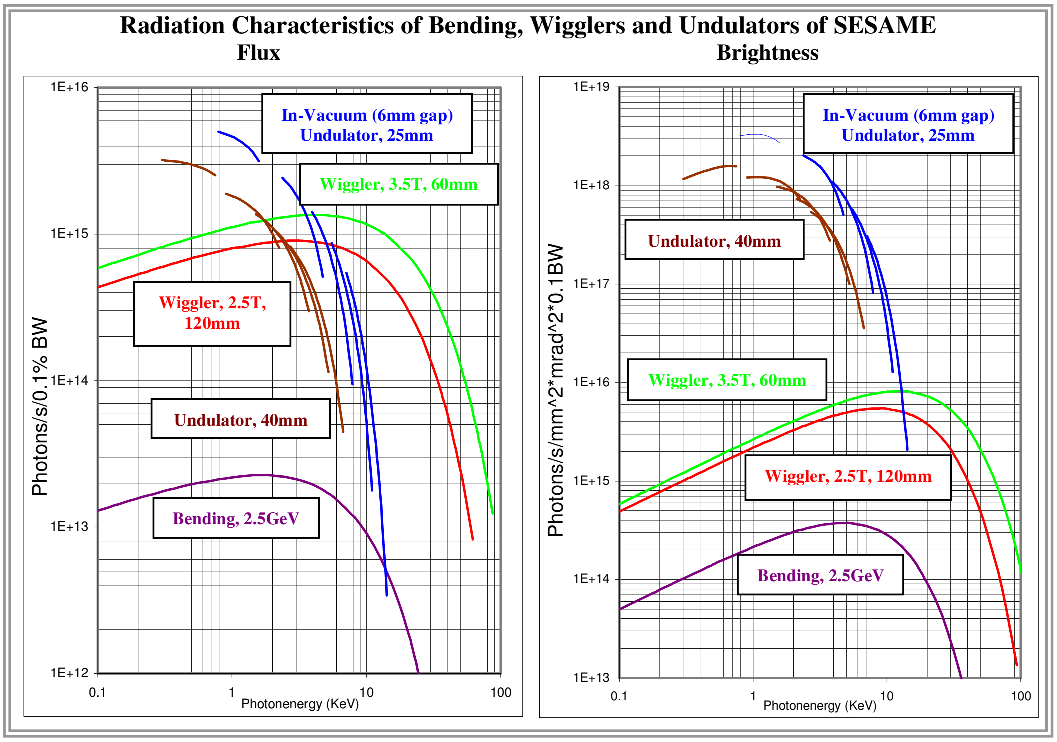

FIGURE 3. Flux and Brilliance of the synchrotron radiation emitted from the stored beam in the bending, wigglers and undulators.

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