THE BEAM DIAGNOSTICS FOR SESAME

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SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East) is an Independent Intergovernmental Organization developed and officially established under the auspices of UNESCO. It involves at present the following Member States: Bahrain, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, Turkey and UAE. SESAME will become a major international research center in the Middle East, located in Allan, Jordan. The machine design is based on a 2.5 GeV 3rd generation Light Source with an emittance of 26 nm.rad and 12 straights for insertion devices. The conceptual design of the accelerator complex has been frozen and the engineering design is started. The completion of the accelerators complex construction is scheduled for the end of 2009. In the following an overview of the electron beam diagnostic system is presented, with special emphasis on the beam position monitoring system and the synchrotron light monitor.

At SESAME the electrons are injected from a 20 MeV microtron, accelerated to the maximum of 800 MeV with a repetition rate of 1 Hz in the booster-synchrotron. The bunches of electrons then are transported through the transfer line to the storage ring where they are accelerated to 2.5 GeV. Through the path from microtron to and within storage ring both destructive and non-destructive monitoring of beam are performed, consisting of Faraday cup, fluorescent screen, current transformer, strip line, scraper, beam loss monitor, synchrotron light monitor and beam position monitor pick ups.

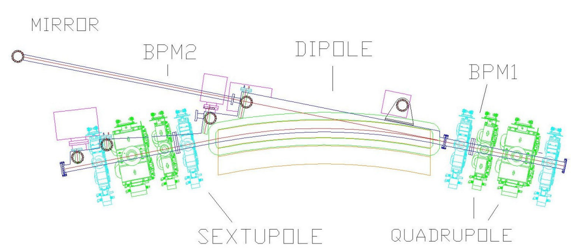

Figure 1 : Arrangements of BPM and light monitor within half cell of the storage ring SESAME.

Table 1: SESAME storage ring parameters relevant to beam diagnostics and their normal values.

Energy (GeV)	2.5
RF frequency (MHz)	499.564
Natural emittance $\varepsilon_x/\varepsilon_y$ (nm.rad)	25.24/0.2524
Injection energy (MeV)	800
Max. Average current(mA)	400
Harmonic number	222
Revolution period(ns)	444
Bunch length (cm)	1.16
Horizontal beam size (µm) LS/SS/Dipole	794.8/789.7/232
Vertical beam size (µm) LS/SS/Dipole	28.1/16.6/71.5
Horizontal divergence(µm) LS/SS/Dipole	45.3/45.9/260.9
Vertical divergence(µm) LS/SS/Dipole	9/15.2/12.1

BEAM POSITION MONITORS

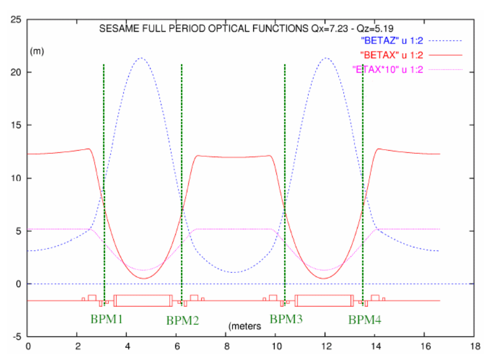

Figure 2: Optical function of SESAME and the BPM arrangements.

Overall there are 32 BPM sets, four BPMs in each cell of the storage ring. They will be placed between sextupoles and quadrupoles to measure the closed orbit distortion all around the ring.

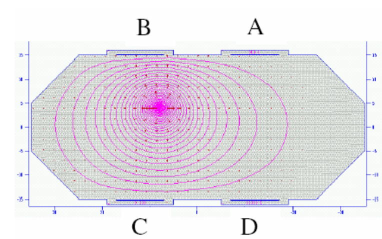

Figure 3: Cross section of the SESAME vacuum chamber, pick up buttons with a non-centered beam.

The electrical beam position in the x-direction is given by X, likewise the electrical beam position in the y-direction is given by Y as follows:

$$X = \frac{(Q_A + Q_D) - (Q_B + Q_C)}{(Q_A + Q_B + Q_C + Q_D)}$$

$$Y = \frac{(Q_A + Q_B) - (Q_C + Q_D)}{(Q_A + Q_B + Q_C + Q_D)}$$

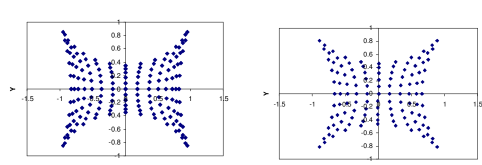

Figure 4: Position map with 30 mm (left) and 24 mm (right) H distance. distance between dots is 2mm.

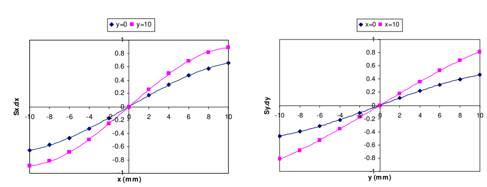

Figure 5: bpm sensitivity curves for x-direction (left) and y-direction (right).

The coefficients of the polynomial fitted to the calculated points in x and y direction are as follows:

$x = 11.73X+2.63X^3-19.66XY^3+12.35X^5+26.24X^3Y^2-2.03XY^4-13.77X^7-38.02X^5Y^2+32.07X^9$

$y = 17.64Y-21.17X^2Y+9.89Y^3+16.76X^4Y-25.29X^2Y^3+48.57Y^5-14.91X^4Y^3-48.55Y^7+33.94Y^9$

The sensitivity at the center of the beam pipe is 8.5% per mm for the x-direction and 5.6% per mm for the y-direction.

SYNCHROTRON LIGHT MONITOR

The 2.5GeV electron beam emitting synchrotron light in the 1.455T dipole magnet. It consists of visible light spectrum from 300 nm to 700 nm with a vertical opening angle of 2.3-3.1 mrad. The electron beam sizes in the horizontal and vertical planes are σ_x=232µm and σ_y=71.5µm respectively for 1% emittance coupling.

Transmission outside the ring

The light is reflected out from the first mirror that is positioned 45^0 vertically and 4.2m far from the source point into the 1m tube under atmospheric conditions. The second plane mirror brings the visible light into a horizontal (normal to gravity) plane, and into the other side of the SR ring through the 80cm thick concrete shielding wall. All the optical components and tables will be in the other side of shielding wall.

Vertical opening angle of light, λ= 500 nm	2.75 mrad FWHM
Slit angular aperture	1mrad horizontal, 7 mrad vertical
Visible light power	2.9 mW (300nm-700nm)
Depth of field error	21.49 µm
Diffraction error	105 µm
Curvature error	2.87 µm
Distance from source point to first mirror	4.2 m
Lattice function values at source point	β_x= 1m , β_y= 19.74m , η_x=0.154m
Bending radius at beam point	5.7296m
Peak power density on the mirror	4.95 W/mm^2
Linear power density on the mirror	6.5 W/mm

Table 2: parameters list at 2.5 GeV