

**TABLE OF CONTENTS**

		<b>Page No.</b>
<b>SESAME Project Planning</b>		
<b>1.</b>	<b>INTRODUCTION</b>	<b>1-1</b>
<b>2.</b>	<b>CHARACTERISTICS OF SYNCHROTRON RADIATION</b>	<b>2-1</b>
	2.1 Introduction	2-1
	2.2 Radiation from a Bending Magnet	2-2
	2.3 Radiation from a Wiggler	2-5
	2.4 Radiation of an Undulator	2-10
<b>3.</b>	<b>UPGRADING OF BESSY I</b>	<b>3-1</b>
	3.1 Introduction	3-1
	3.2 Performance of a Synchrotron Light Source	3-1
	3.2.1 Spectral Range of the Synchrotron Radiation	3-1
	3.2.2 Brilliance of the Radiation	3-2
	3.2.3 Number of Experimental Stations	3-2
	3.3 Upgrading Versions of BESSY I	3-2
	3.3.1 Green Book (GB) Proposal for Upgrading SESAME to 1 GeV	3-2
	3.3.2 White-Book (WB) Proposal for Upgrading SESAME to 2 GeV	3-4
	3.3.3 Yellow-Book (YB) Proposal for Upgrading SESAME to 2.5 GeV	3-6
	3.4 Comparison of the Different Versions	3-8
	3.4.1 Magnets	3-8
	3.4.2 Performance of the Different Upgrading Versions	3-8
	References	3-9
<b>4.</b>	<b>BEAM OPTICS</b>	<b>4-1</b>
	4.1 Introduction	4-1
	4.2 The Lattice	4-1
	4.2.1 The Unit Cell	4-1
	4.2.2 The Lattice Optimisation	4-4
	4.2.2.1 Choice of Working Point	4-5
	4.2.2.2 The Tune Shift with Amplitude	4-8
	4.2.2.3 The Dynamic Aperture	4-8
	4.2.2.4 The Off-momentum Dynamics	4-10
	4.2.3 The Machine Acceptance	4-14
	4.3 Effect of Insertion Devices on SESAME Optics	4-17
	4.3.1 Choosing the Optimum Optics	4-17
	4.3.2 The Compensation for the Undesirable Effects	4-21
	4.4 Closed Orbit Distortion and Correction	4-26

---

---

## *SESAME*

---

---

4.5	The Coupling	4-29
4.6	Specifications of the Magnets	4-29
4.6.1	The Bending Magnets	4-30
4.6.2	The Quadrupole Magnets	4-30
4.6.3	The Sextupole Magnets	4-30
4.6.4	The Corrector Magnets	4-30
4.7	The Beam Lifetime	4-31
4.7.1	The Gas Scattering Lifetime	4-31
4.7.1.1	Elastic Nucleus-Scattering Lifetime ( $\tau_{\text{coul}}$ )	4-31
4.7.1.2	Elastic Shelf Electron-Scattering Lifetime ( $\tau_{\text{coul}}(e)$ )	4-31
4.7.1.3	Inelastic Nucleus-Scattering Lifetime ( $\tau_{\text{brem}}$ )	4-32
4.7.1.4	Inelastic Shelf Electron-Scattering Lifetime ( $\tau_{\text{brem}}(e)$ )	4-32
4.7.1.5	The Total Gas Scattering Lifetime	4-32
4.7.2	Touschek Scattering Lifetime	4-32
4.7.3	The Total Beam Lifetime	4-33
	References	4-34
<b>5.</b>	<b>LAYOUT OF THE STORAGE RING</b>	<b>5-1</b>
5.1	Introduction	5-1
5.2	Description of the SESAME Storage Ring	5-1
5.3	Choice of Material	5-7
5.4	Pre-Dipole Vacuum Chamber	5-7
5.5	Dipole Vacuum Chambers	5-9
5.6	Straight Sections	5-10
5.7	Bellows and Gate Valves	5-12
5.8	Synchrotron Radiation and Absorbers	5-14
	References	5-19
<b>6.</b>	<b>MAGNETS</b>	<b>6-1</b>
6.1	Introduction	6-1
6.2	Bending Magnet	6-2
6.3	Quadrupole	6-7
6.4	Sextupole	6-9
6.5	Correctors	6-11
6.6	Girder System	6-11
<b>7.</b>	<b>VACUUM SYSTEM</b>	<b>7-1</b>
7.1	Introduction	7-1
7.2	SESAME Parameters	7-1
7.3	Requirements	7-1
7.4	General Layout	7-2
7.5	Materials for the Vacuum Chamber	7-4
7.5.1	Proprieties	7-4
7.5.1.1	Vacuum Performance	7-4
7.5.1.2	Mechanical Properties	7-4

---

---

## *SESAME*

---

---

7.5.2	Flanges and Gaskets	7-5
7.6	Vacuum Chamber Design	7-5
7.7	Pumps Selection	7-6
7.7.1	Rough Pumping	7-6
7.7.2	UHV Pumps	7-7
7.8	Vacuum Instrumentation	7-8
7.8.1	Total Pressure Gauges	7-8
7.8.2	Partial Pressure Gauges	7-9
7.9	Cleaning, Bakeout of Infrastructure	7-11
7.10	Assembly	7-12
7.11	Pressure Profile Calculations	7-12
7.11.1	Gas Load Generation and Desorption Processes	7-13
7.11.1.1	Thermal Desorption	7-13
7.11.1.2	Photon Stimulated Desorption (PSD)	7-13
7.11.2	Photon Flux from the Dipole	7-14
7.11.3	Photon Stimulated Desorption Yield for SESAME (PSD)	7-16
7.11.4	Desorption Flux	7-17
7.11.5	The Achromat Pressure Profile	7-18
7.11.5.1	Pumps Pumping Speed and the Average Dynamic Pressure	7-18
7.11.5.2	Changes of the Pumps Pumping Speed and the Average Dynamic Pressure Achieved.	7-20
7.11.5.3	Average Dynamic Pressure of the Achromat During Commissioning and Operation of the Machine.	7-20
7.12	SESAME Microtron Vacuum System	7-22
	References	7-22
<b>8.</b>	<b>RADIO FREQUENCY SYSTEM</b>	
8.1	Introduction	8-1
8.2	Components of the RF-System	8-2
8.2.1	Cavities	8-2
8.2.2	Klystron	8-4
8.2.3	Waveguide System	8-4
8.2.4	Low level Electronics	8-5
8.2.5	Principle of Operation	8-5
8.3	RF System Parameters	8-6
8.3.1	Parameters of the Stored Beam	8-6
8.3.2	Parameters of the Power System	8-9
8.4	Low level Electronics	8-11
8.4.1	Amplitude Loop	8-11
8.4.2	Phase Loop	8-12
8.4.3	Tuning Loop	8-13
<b>9.</b>	<b>POWER SUPPLIES</b>	<b>9-1</b>
9.1	Introduction	9-1
9.2	Storage Ring Power Supplies	9-1

---

---

## *SESAME*

---

---

9.2.1	Specifications of the Existing Power Supplies	9-1
9.2.2	Specifications of the New Power Supplies	9-3
9.2.3	Power Converter Topologies	9-3
9.2.3.1	Linear Power Converter	9-3
9.2.3.2	Line Commutated Thyristor Power Converter	9-4
9.2.3.3	Switched-Mode Power Converter	9-6
9.2.3.3.1	Chopped DC Regulator	9-7
9.2.3.3.2	Resonant Converter	9-8
9.2.4	Power Converter Selection for SESAME	9-9
9.2.4.1	Dipole Power Converter	9-9
9.2.4.2	Quadrupole and Sextupole Power Converters	9-10
9.2.5	Pole Face Winding Power Supplies	9-10
9.3	Booster Power Supplies	9-10
9.3.1	Discussion about the Waveforms	9-11
9.3.2	Specifications of the Booster Power Supplies	9-12
9.3.3	Dipole Magnet Power Supply	9-13
9.4	Correction Power Supplies	9-13
9.4.1	Correction Power Supplies of the Storage Ring	9-13
9.4.2	Correction Power Supplies of the Booster	9-14
9.5	Power Supplies of the Transfer Lines	9-14
9.6	Disturbances to the Mains	9-15
9.7	Electronics of the Power Supplies	9-15
9.7.1	Introduction	9-15
9.7.2	Conventional Analog Electronic	9-15
9.7.3	Modern Digital electronics	9-17
9.7.4	Recommendations for SESAME	9-18
9.8	Magnet Cables	9-18
9.8.1	Cable Conductors and Sizes	9-18
9.8.2	Cable Losses	9-18
9.8.3	Connection of the Magnets	9-19
9.8.4	Cable Trays	9-21
9.9	Location of the Power Supplies	9-21
	References	9-22
<b>10.</b>	<b>DIAGNOSTICS</b>	10-1
10.1	Introduction	10-1
10.2	Instrumentation	10-1
10.3	Measurement Procedures	10-2
10.3.1	Beam Intensity and Time Structure	10-2
10.3.2	Beam Position	10-2
10.3.3	Transverse and Longitudinal Particle Distribution	10-3
10.3.4	Lattice Functions, Tune and Dynamic Aperture	10-3
10.3.5	Measurement of Other Accelerator Parameters	10-3
10.4	Diagnostic System of SESAME	10-3
10.4.1	Fluorescent Screens	10-5

---

---

## *SESAME*

---

---

10.4.2	Beam Current Monitors	10-5
10.4.3	Current Transformer	10-6
10.4.4	Strip Lines	10-6
10.4.5	Scrapers	10-6
10.4.6	Beam Position Monitors	10-7
10.4.7	Beam Loss Monitor	10-9
10.4.8	Synchrotron Light Monitors	10-9
10.4.9	Other Instrumentation	10-9
	References	10-9
<b>11.</b>	<b>INJECTOR</b>	<b>11-1</b>
11.1	Introduction	11-1
11.2	Microtron	11-1
11.3	Booster Synchrotron	11-3
11.4	Transfer Line	11-6
11.4.1	Lattice of the Transfer Line	11-6
11.4.2	Instrumentation of the Transfer Line	11-11
11.5	Injection of the Storage Ring	11-11
11.5.1	Optimization of the Placement of the Kickers	11-13
11.5.2	Injection Efficiency Studies and Simulation of Injection Process.	11-13
	References	11-15
<b>12.</b>	<b>CONTROL SYSTEM</b>	<b>12-1</b>
12.1	Executive Summary	12-1
12.2	Introduction	12-2
12.3	Scopes of the Controls	12-3
12.4	General Requirements	12-3
12.4.1	User Requirements	12-3
12.4.2	System Requirements	12-4
12.4.2.1	Architecture	12-4
12.4.2.2	Hardware Layer	12-6
12.4.2.3	Software Layer	12-6
12.4.2.4	Applications with Graphical User Interface	12-6
12.4.2.5	The Databases	12-9
12.5	Subsystems	12-11
12.5.1	Timing System	12-11
12.5.1.1	Architecture	12-11
12.5.2	Diagnostics	12-11
12.5.3	Beam Line Controls	12-12
12.6	The Control System for the Pre-injector (Microtron)	12-16
12.6.1	Power Supplies (PS)	12-17
12.6.1.1	Digital PS with Fibre-Optics Bus Approach	12-17
12.6.1.2	CAN Approach	12-18
12.6.1.3	Ethernet Approach	12-18

---

---

## *SESAME*

---

---

12.6.2	Radio Frequency System	12-19
12.6.3	Vacuum Controls	12-19
12.6.4	Diagnostics	12-19
12.6.5	The Timing System	12-20
12.6.6	Other Controls	12-20
12.7	Estimated I/O	12-20
12.8	Control Room	12-21
12.9	Network	12-21
	References	12-21
<b>13.</b>	<b>SITE, BUILDING AND INFRASTRUCTURE</b>	<b>13-1</b>
13.1	Introduction	13-1
13.2	Site Investigation and Geotechnical Evaluation	13-4
13.3	Design of Building Foundation	13-4
13.4	The SESAME Building	13-5
13.5	Infrastructure	13-13
13.4	Cooling System	13-19
13.4.1	Capacity for the Cooling System	13-21
<b>14.</b>	<b>RADIATION SHIELDING</b>	<b>14-1</b>
14.1	Introduction	14-1
14.2	Safety and Dosage Limit	14-1
14.3	Shielding Design	14-1
14.3.1	Ionising Radiation	14-1
14.3.2	Shielding Calculations	14-2
14.3.2.1	Lateral Shielding	14-3
14.3.2.2	Perpendicular Shielding	14-4
14.3.2.3	Shielding for Sky-Shine	14-5
14.4	Considerations for BeamLines Shielding and Induced Activity	14-6
14.5	Radiation Monitoring and Personnel Protection System	14-6
14.6	Conclusions	14-6
	References	14-7