Chapter 1

INTRODUCTION

1. Introduction

Use of synchrotron radiation for fundamental science and applied technologies has experienced an explosive growth over the last twenty years. The growing importance of this new tool in such diverse fields as:

- Molecular environmental science.
- Medical imaging.
- Pharmaceutical R&D.
- Micro fabrication.
- and others.

Cannot be overlooked and is beginning to also have an economic impact. About 45 synchrotron radiation sources are in operation worldwide and more are under construction. Although synchrotron radiation sources became available in the meanwhile in several threshold countries including Brazil, China, India, Korea, Thailand and Taiwan, there are still many regions, including the Middle East, where such instruments are not available.

It is anticipated that a synchrotron light source would have a major impact on the development of science and technology in the Middle East region, with particular relevance to health and environmental issues, as well as benefits to industrial development, student training and the general economy of the region. As a cooperative venture by several countries in the Middle East region it also serves to promote understanding and peace in the region.

The decision to build the 3rd generation light source BESSY II in Berlin was already made in 1993. This machine has been commissioned in 1998 and routine operation has started in January 1999. Because of limited funds, the German Ministry of Education and Research (BMBF) and the Senate of Berlin, decided in 1997 to shut down BESSY I at the end of 1999 in order to concentrate the available funds on the operation of BESSY II.

Since the fall of 1997 extensive discussions (initiated by Prof. Voss and Prof. Winick) have taken place to see whether BESSY I could be offered as a gift by Germany and, in an upgraded form, brought to a suitable new place in the Middle East to serve as a seed for a new research centre. These discussions included scientists and administrators in many Muslim countries and Israel, German government officials and other scientists from the US, Europe and Japan. Some of the discussions took place at the UNESCO Headquarters (Paris) and a meeting in Uppsala/Sweden in April 1998 of the CERN-based Middle East Scientist Cooperation (MESC-group).

A meeting at UNESCO in Paris in June 1999 led to the formation of Interim Council and four Committees (Scientific, Technical, Training and Financial) to follow up this idea and prepare the next steps. About 12 countries from the Middle East participated in this first meeting and in 8 subsequent meetings of the Interim Council. Several countries from outside the Middle East also participated as Observers. Reports on all meetings of the Interim Council are posted on the SESAME web site [www.sesame.org.jo]. During the first meeting of the Scientific and Technical Committee in August 1999 in Berlin, the scientific case and the technical concept of the project were reviewed in detail, and the name SESAME was adopted for the project:

SESAME

Synchrotron-Light for Experimental Science and Applications in the Middle East

For the location of SESAME seven governments proposed 18 possible sites. At the 3rd Meeting of the Interim Council the decision was made, that the SESAME facility will be located in Jordan at the Allan site, which is 25 km northwest of Amman.

The initial proposal (Green Book) for SESAME has been issued in October 1999. The idea was not only to move BESSY I to the Middle East Region but to modify to make it a high-performance machine that would cover a broad spectral range, including hard X-rays. The layout of this proposal (BESSY IA) is given in the October 1999 “Green Book”. This design uses the BESSY I injector and many of the components of the 800 MeV storage ring.

In the Green Book, BESSY I is changed to six-fold symmetry by changing the magnetic optics from a TBA- to a DBA- structure. Furthermore the circumference was enlarged from 64 to 100 meters. With the modification of the bending magnets the energy was increased to 1 GeV. With six straight sections, the new ring could accommodate four insertion devices, compared with only two in the original BESSY I ring.

To reach hard X-rays the intention was to introduce 2 13-pole super conducting wigglers in so-called mini beta sections. With a magnetic field of 7.5 T these wigglers provide a spectrum with a critical energy of 5 keV and useful flux up to about 20 keV. Each wiggler could serve at least 3 experimental stations. However, the usage of these wigglers has some disadvantages: 1) They are costly 2) need a special knowledge for running and 3) have an influence on beam behaviour.

In the years 2000 and 2001 the Scientific Committee organized workshops for the usage of synchrotron radiation with participants from the Middle East region to get a better understanding of the scientific case at SESAME. Reports of these workshops are posted on the SESAME web site. A result of these workshops was, that most users require hard X-rays and the synchrotron light source SESAME should have more beam lines in this spectral range. The simplest way of doing this is by getting hard X-rays from the bending magnets. This is possible by increasing the energy to 2 GeV. The Interim Council of SESAME made in December 2001 the decision to upgrade SESAME to 2 GeV.

Jordan will provide the building and the decision was made to copy more or less the design of building of the synchrotron light source ANKA (60m*60m, covered with a crane), which houses a 2.5 GeV storage ring with a circumference of 110 meters. With a required 30 meters length of the beam lines the largest circumference of a machine in this “ANKA-building” is 124 meter. With this boundary a new concept for the synchrotron light source SESAME has been worked out within 2001 and 2002. It is an 8-fold symmetry machine with energy of 2 GeV. By using gradient bending magnets it is possible to have 12 for the installation of insertion devices and furthermore a reduction of the natural emittance down to 18 nmrad. This is really a state of the art synchrotron light source. The conceptual design of this machine (White Book) was presented at the 8th meeting of the Interim Council (15-16 July, 2002) and approved.

To establish the staff for the erection as well as the running of the machine, a training program has been started. Within this training program up to 16 trainees have worked at the different European Accelerator Laboratories: DESY, ESRF, ANKA, SLS, LURE, MAX-LAB, ELETTRA and Daresbury. The description of the new layout of the machine in the following “first draft version” of the conceptual design report has been made by these trainees with the help of the colleagues at the host laboratories and under the overall direction of the SESAME Technical Director.

In May 2000 the UNESCO General Conference and Executive Board approved SESAME under the auspices of UNESCO as an independent laboratory. UNESCO is the depository of the Statutes of SESAME. Within the Executive Board SESAME received enthusiastic and unanimous support and it was expressed that it could be a model project for other regions. The Executive Board called SESAME “a quintessential UNESCO project combining capacity building with vital peace building through science”.

For the erection of the machine an application for funds has been made at the European Union. Accordingly the European Union established a committee for the evaluation of the project with the conclusion: ”All the experts are very supportive of the overall concept behind the SESAME project and envisage that it would effectively stimulate scientific activity and cooperation in the Middle East as well as helping to alleviate political tension and promote peace in the region. The proviso is, indeed, that it is really opened to all qualified scientists in the region and elsewhere, without any racial or religious discrimination, and that equal opportunity is given to males and females. Hence the experts encourage the EC to support the project”. The Evaluation Panel suggested that consideration be given to increasing the energy of SESAME to 2.5 GeV. To enhance the hard X-ray capability and to be more in line with recently funded projects around the world.

On October 19-28 the JASS’02-Workshop about Synchrotron Radiation Science took place in Amman. This workshop was financed by the Japanese Society for the Promotion of Science (JSPS). The objective was to invite potential users of SESAME, give them an overview of the project, and introduce the synchrotron radiation science that could be done at SESAME. Overall 50 participants from the region attended this workshop and it turned out that it was the first SESAME User Meeting. A proposal for the scientific case and the first beam lines was outlined.

In a joint meeting of the “Beam Line- and Scientific Advisory Committee” at CCLRC Daresbury Laboratory, United Kingdom, in late December 2002, the decision was made about the “Potential First Phase Beam Lines” at SESAME.

The recommendation for these first beam lines was:

- MAD Protein Crystallography.
- Small Angle X-ray Scattering.
- Spectroscopy of Gases and Solids.
- EXAFS.
- Powder Diffraction.
- Infra Red Spectroscopy.

Both committees recommended exploring the option of a 2.5 GeV machine, with 2 in-vacuum undulators, and of running a 2.5 GeV machine at 2 GeV, if that is needed for Ultra-high resolution VUV- and SXR experiments. In the following report (Yellow-Book) the conceptual report of a 2.5 GeV 3rd generation synchrotron light source SESAME is presented.