SYNCHROTRON LIGHT IN THE MIDDLE EAST

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Abstract

It has been proposed to set up an international synchrotron light laboratory SESAME in the Middle East, based on an upgraded version of the BESSY I synchrotron light source till now in operation in Berlin. The background to this proposal is outlined. An overview is given of the light source itself and the use that can be made of it. It is argued that this international laboratory is likely to play an important role for the development of science and industrial technology in the Middle East and thereby also contribute to the peace process in the region.

1 Introduction

It has been proposed to create an international center SESAME for synchrotron radiation research in Middle East. Such a center would bring international and regional cooperation in one of the leading fields of science into a region that has a history of political and cultural conflict but where there is now hope for peace. The base-line of this proposal is that Germany would offer the synchrotron light source BESSY I used since 1982 in Berlin and recently (November 1999) shut down as a consequence of the startup in Berlin in January 1999 of a new synchrotron facility BESSY II.

According to the proposal BESSY I would be upgraded to reach higher performance, in particular higher energy. The new SESAME center will thereby provide first class research facilities to a broad range of research programs in molecular biology, molecular environmental studies, microelectronics and micro mechanical technologies, material science, atomic, molecular and solid state physics, chemistry and geology. The experimental methods to be used are protein crystallography, powder diffraction, X-ray absorption spectroscopy, X-ray photoelectron spectroscopy, X-ray fluorescence, X-ray microscopy, X-ray lithography and others. Front-line research in these areas will stimulate the development of modern industry and economical growth in the Middle East and provide many opportunities for close scientific cooperation between the countries of the region.

2 Background to the SESAME proposal

The idea to stimulate scientific collaboration in the Middle East with the aim of promoting prosperity and peace in the region was first proposed by Sergio Fubini (CERN/Torino University) and co-workers who organized in November 1995 a "Sinai Meeting on High Energy, Condensed Matter and Environmental Physics" i Dahab, Egypt. On the invitation of Fubini, Tord Ekelöf (Uppsala University) and co-workers organized in November 1997 a one-week "Seminar on Experimental Techniques in High Energy and Synchrotron Radiation Physics" in Torino, Italy. It was not possible to organize the second meeting in the Middle East owing to the deterioration of the political situation there at the time. However, both the meeting in Dahab and that in Torino were organized with a large participation of researchers from the Middle East. Following these seminars a committee for Middle East Scientific Collaboration, MESC, was set up with Herwig Schopper (CERN) as chairman to organize the continued work.

At the Torino meeting, Gustaf-Adolf Voss (DESY) brought up the proposal, originally made by Herman Winick (SLAC), to transfer and set up in the Middle East an upgraded version of BESSY I . This proposal was further discussed in Uppsala in April 1998 at a MESC meeting between scientists from several Middle Eastern and European countries and the USA.

In June 1999 UNESCO hosted a Consultative Meeting in its headquarters in Paris under the chairmanship of Herwig Schopper to consider the SESAME (Synchrotron Light for Experimental Science and applications in the Middle East) proposal with scientific and governmental representatives from 11 Middle Eastern countries, several European countries and the USA [1]. At this meeting a SESAME International (Interim) Council was set up together with four committees to work on the technical, scientific, training and financial aspects, respectively, of the project. A technical and scientific proposal with cost estimates for SESAME was published in October 1999 [2].

In December 1999 a second SESAME UNESCO meeting was held in Paris. At this meeting commitments were collected from the participating countries and UNESCO itself to cover the costs for the demounting and storage of the BESSY I machine (which had by that time stopped operation in Berlin) in view of the later transfer to the Middle East. There were qualified offers presented by several Middle Eastern countries to host the SESAME international laboratory. A proposal for statutes of the future international SESAME organization as an international laboratory were presented and discussed. The proposed statutes were in several respects similar to the statutes of the CERN organization.

3 The BESSY Ia machine and the SESAME laboratory

The original BESSY I machine is a second generation synchrotron light source. It consists of a 20 MeV microtron preinjector, a fast cycling 800 MeV booster synchrotron injector and a 800 MeV storage ring of 62.4 m circumference with four straight sections, two of which are used for injection and acceleration, respectively. The synchrotron radiation is created in the 1.5 T magnetic field of the machine dipole magnets. The critical energy is 0.64 keV implying that the spectrum of useful synchrotron radiation stretches up to about 3 keV. There are two permanent magnet undulators, one in each free straight section, providing photon beams of high brilliance.

The upgrade of BESSY I to BESSY Ia for SESAME comprises an increase in the field of the storage ring dipole magnets to 1.85 T and an increase in the number of storage ring straight sections to six (BESSY Ia will thus have four free straight sections as compared to two for BESSY I) and of the storage ring circumference to 100 m. The higher dipole magnetic field will provide an increased critical energy of 1.25 keV, resulting in a spectrum of useful synchrotron radiation stretching up to 5–6 keV. In two of the four straight sections will be installed 1 m long superconducting multipole wigglers with a magnetic field strength of 7.5 T, providing radiation with a critical energy of 5 keV. In the remaining two straight sections there will be undulators for high brilliance beams.

The main technical modifications required for this upgrade of BESSY I are to modify the gap of the existing dipole magnets to produce the higher magnetic field, to upgrade the radiofrequency system to provide more power, to construct a new vacuum chamber for the storage ring, to provide a new control system and beam monitoring system, to upgrade the energy of the injector synchrotron to 1 GeV and to replace the microtron injector by a new and more reliable linear accelerator injector. The cost for these modifications, assuming that the BESSY I machine is put at disposal by Germany free of charge, is estimated to be 6 MUSD.

In addition to the upgraded machine itself the build-up of the SESAME International Laboratory, located at a site in the Middle East still to be decided, will require the construction of experimental halls, laboratory and office buildings, computer rooms, workshops, electrical distribution, cooling facilities and other infrastructure at an estimated cost of 14 MUSD.

Furthermore, funds will be required to construct the SESAME beam lines and associated experimental equipment. According to the plans two superconducting-wiggler beam-lines with five experimental branch-lines will be build during the first five years. The branch-lines are; a diffraction branch-line, a protein crystallography branch-line and a X-ray absorption (EXAFS)/fluorescence branch-line in the first beam-line and an X-ray lithography (LIGA) station and an X-ray microscopy branch-line in the second. During the same period five bending-magnet beam-lines with various monochromator equipments will be set up. For this build-up of instrumentation an investment of about 17 MUSD will be required during the period. The operation of the laboratory will require an estimated 3.5 MUSD/year for spare parts, electric power, general maintenance, improvements etc. and a crew of scientists, engineers and technicians growing from about 30 to about 70 over the five first years.

4 Concluding remarks

In the whole world there are presently some 45 storage rings operated as synchrotron radiation sources. The basic and applied research performed at these sources provide continuously new information and stimulus that is of fundamental importance for the technological development of modern industry. There is today no such radiation source located in the Middle East. The potential of the SESAME project for the development of modern industry in this region of the world is very large.

The cost for SESAME is considerable and, in view of the economical situation in the Middle East, a significant part of this cost needs to be covered from outside the region. There is already a program in operation in the industrialized world to provide financial support to the region. This program presently focuses, to a large extent, on the development of facilities to provide water, food, roads and other basic needs. Although the funds required for SESAME are significant, they represent only a small fraction, on the percent level, of the total foreign aid provided to the Middle East.

Even if it may be more urgent, in a short time perspective, to help with the basic needs, it is the development of high technology industry in the Middle East that will, in a longer time perspective, make this region prosperous and self sustained. To achieve the latter goal there is now a real need, of fundamental importance, to promote basic and applied research in the Middle East. This need would motivate the deviation of a smaller fraction of the funding of the present aid program towards the development of such research. The SESAME project has been proposed as a facility optimized for this purpose.

Finally, basic scientific research has shown to be, more than most other activities, independent of political, religious and cultural differences. Collaboration on basic science projects have been possible even during times of deep political conflict, like e.g. during the Cold War between the East and the West. One example of this is the scientific collaboration at CERN between USA, Europe and the Soviet Union that persisted throughout the Cold War. Collaboration of this kind stimulates mutual understanding between the parties involved. Such understanding is, in a wider perspective, one of the prerequisites for the durable peace that is now so much hoped for in the Middle East.

References

[1] T. Feder; German Synchrotron Light Source May Find New Home Somewhere in Middle East, Physics Today, August 1999, p. 54

[2] M. Abo-Bakr et al; SESAME, A Proposal for a Synchrotron Radiation Source in the Middle East, October 1999

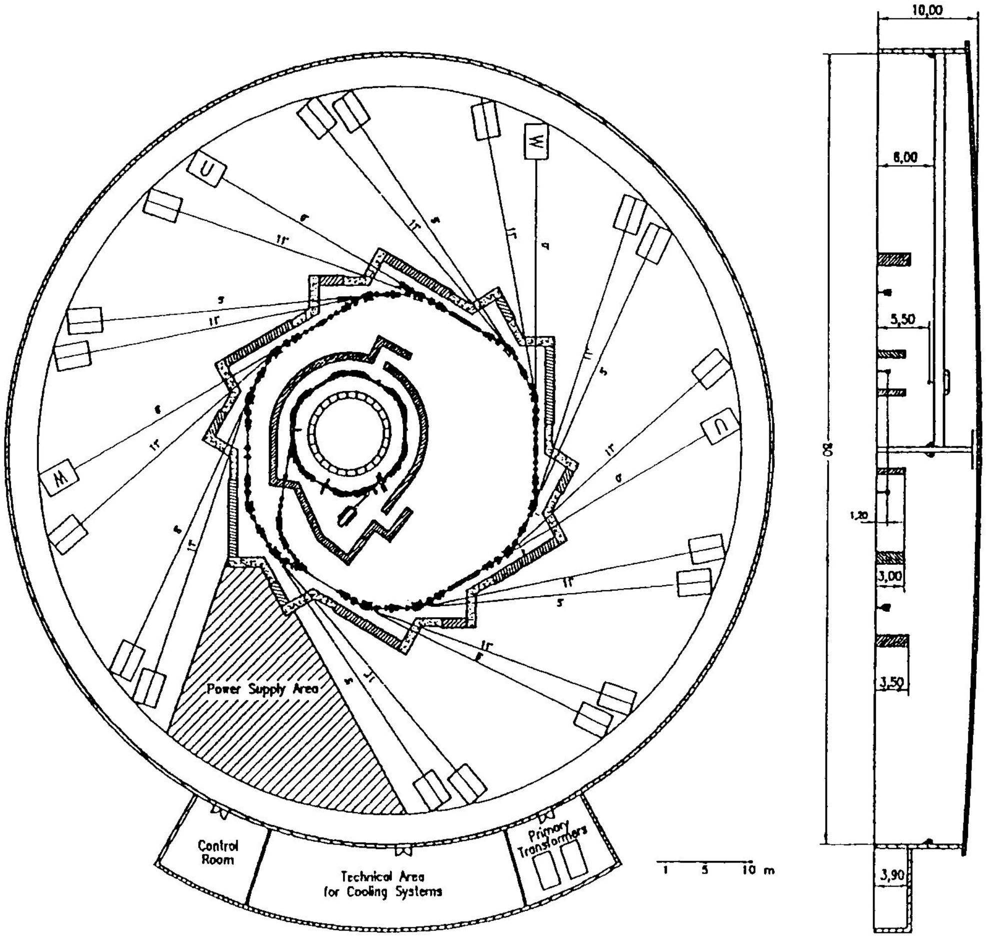

Figure 1: Lay-out of the BESSY Ia machine and its beam-lines at the future SESAME International Laboratory. The figure shows the 1 GeV storage ring with its six straight sections and the injector synchrotron mounted inside. Radiation shielding walls are mounted around the storage ring. The beam lines, emerging tangentially from the storage ring through this shield, are surrounded by a circular building housing the whole facility (from ref. [2]).