Privileges, Benefits and Obligations of Members of SESAME

I. Background

1. What is a Synchrotron Light Source?

Synchrotron light – or synchrotron radiation – sources produce very intense pulses of light/X-rays, with wave lengths and intensities that allow detailed studies of objects ranging in size from human cells, through viruses down to atoms, with a precision that is not possible by other means. Synchrotron light sources therefore enable a very wide range of important applied sciences, from biology and medical sciences (imaging and therapy) through pharmaceuticals, physics, chemistry and materials science to archaeology, and can be used to improve manufacturing techniques, provide forensic evidence, and address environmental issues.

The heart of a synchrotron light source is a ring of magnets (133m in circumference in the case of SESAME) in which electrons are stored after being accelerated to high energy. They are therefore relatively expensive devices which are frequently built by international collaborations. Working in collaboration has the important benefit that it disseminates the highest scientific and technical standards through the participating countries, which helps foster the development of a wide range of basic and applied science and industrial activities.

Synchrotron light sources are generally 'user facilities'. Scientists from universities and research institutes typically visit synchrotron laboratories for a few days, two or three times a year, to carry out experiments, frequently in collaboration with scientists from other centres/countries, and then return home to analyse the data they have obtained. These scientists bring back scientific expertise and knowledge, which they share with their colleagues and students.

Information on the status and aims of SESAME, and future plans may be found on the web site of SESAME (www.sesame.org.jo).

2. Rationale for a Synchrotron Light Source in the Middle East

Synchrotron light is nowadays considered an essential way of promoting many modern technologies and fostering interdisciplinary activities and this has resulted in over 50 storage-ring-based synchrotron light sources being set up in the world (including in Brazil, Republic of Korea, Singapore, Taiwan and Thailand). No such facility exists in the Middle East, although a need for this had been recognised by eminent scientists such as the Nobel laureate Professor Abdus Salam (Pakistan), founder of the International Centre for Theoretical Physics (ICTP) in Trieste (which fosters advanced studies and research, especially in developing countries) in the early eighties already. This need promoted the CERN (European Organization for Nuclear Research) and Middle-East based MESC (Middle East Scientific Cooperation) group to take concrete action in the late nineties to establish the SESAME light source.

While SESAME is located in the Middle East, the membership (which includes, for example, Pakistan) is broader, and SESAME has always been open to all countries that wish to join forces in exploiting the scientific possibilities that it offers.

SESAME will foster the development of a very wide range of applied and basic science and technology, and motivate leading scientists and technologists to stay in the region, or to return if they have moved elsewhere.

3. The SESAME Centre

SESAME is an intergovernmental scientific centre established under the auspices of UNESCO along the model of CERN, although it has very different scientific goals. It is 'owned' by its Members which have full control over its development, exploitation and financial matters. It is located in Allan some 35km north-west of Amman in Jordan in a building specially constructed for it by the Jordanian Authorities, which was officially inaugurated in November 2008. The host state has additional obligations, such as providing diplomatic privileges, tax exemptions, necessary facilities to allow the Centre to function properly, etc.

A Guest House to accommodate users while conducting experiments at SESAME will be constructed on the premises of SESAME.

The current Members of SESAME are Bahrain, Cyprus, Egypt, Iran (Islamic Republic of), Israel, Jordan, Pakistan, Palestinian Authority and Turkey. Observers countries are: Brazil, China, the European Union, France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russian Federation, Spain, Sweden, Switzerland, U.K. and U.S.A.

4. The SESAME Machine and Beamlines

SESAME will be a competitive "third generation" light source. The energy of the electrons will be 2.5 GeV and the circumference of the storage ring will be 133m.

SESAME will be exploited in experiments at up to 25 beamlines, which will focus the synchrotron light on samples of materials. In the first phase, there will be seven beamlines. These beamlines, which have been selected on the basis of requests from scientists in the region, are the following:

- IR (infrared spectromicroscopy) beamline;
- XAFS/XRF (X-ray absorption fine structure/X-ray fluorescence spectroscopy) beamline;
- MS (materials science) beamline;
- MX (Macromolecular Crystallography) beamline;
- EUV (extreme ultraviolet spectroscopy) beamline;
- SAXS/WAXS (small angle and wide angle X-ray scattering) beamline; and
- VUV (soft X-ray vacuum ultraviolet) beamline.

It is expected that the two first beamlines listed above (IR and XASF/XRF) will be available from 'day-one' of operation of the light source, to be followed six and twelve months later by the MS and MX beamlines respectively The three other beamlines will be added after this.

The microtron, which accelerates the beam to 20 MeV, is fully operational, as is the booster synchrotron, which in September 2014 successfully accelerated a beam to the design energy of 800 MeV, making it the highest energy accelerator in the Middle East (the microton and booster are based on components from the decommissioned Berlin Synchrotron - BESSY 1, generously donated by the German Government). The booster will inject electrons into a completely new 2.5 GeV storage ring. The magnets of the main ring were constructed under the leadership of CERN, in collaboration with SESAME, with funding from the European Commission. The first of the 16 cells of the new storage ring was assembled and successfully tested at CERN in March 2015 - at the time of updating of this paper (April 2016), 12 cells had been installed and aligned at SESAME. Commissioning of the whole facility – initially with two beamlines, and two of the four accelerating cavities – is expected to begin during the autumn of 2016.

Two of the first four beamlines (IR and MX) will be completely new. The XAFS/XRF and MS beamlines will incorporate components of beamlines previously in use at ESRF and the Swiss light-source. A Fourier Transform Interferometer (FTIR) microscope, which will be used with the IR beamline, has already been purchased and has been in use, producing science, with a conventional IR source since 2014.

Every year, SESAME publishes a Three-Year Budget Plan (TYBP) which summarises the investments already made, the investments and operational funding that will be needed for the next three years, and the capital funding that is available. The capital funding that is needed to bring SESAME into operation, initially with two beamlines, is now available, thanks to voluntary contributions being provided by the Members (Iran (Islamic Republic of), Israel, Jordan and Turkey), the European Union through CERN, and Italy through the INFN (Istituto Nazionale di Fisica Nucleare). More will however be needed, and is being sought, to complete the full suite of seven Phase I beamlines, construct the planned Conference Centre, etc.

5. Returns for investment in SESAME

Because SESAME groups the efforts of a number of countries, is located on land provided by the Jordanian Authorities in a building they funded, and has benefited from important external contributions in cash and in kind, it offers an extraordinarily cost-effective way to access excellent wide-ranging research opportunities.

The extensive SESAME training programme has been playing an important role in strengthening scientific and technical capacity for over a decade, while scientists from the Members have been able to carry out research with the FTIR at SESAME since 2014. The full benefits of Membership will however only become available after the start-up in late 2016 or early 2017. These benefits are spelled out in detail in the next section. Briefly they include:

- Access to wide-ranging research opportunities;
- Opportunities to collaborate with scientists from the other SESAME Members and beyond, including scientists from Europe, the USA and other countries who are expected to be involved in experiments at SESAME;
- Experience in up-to-date experimental techniques, which will open up opportunities for collaboration at other synchrotron-light sources around the world;
- Valuable experience for any countries that may in due course wish to build their own light source;
- On-going opportunities for training through workshops, Users' meetings, visits to other light-sources, etc. that SESAME organises;
- A voice in the governance of SESAME, including in the choice of future beamlines and the scientific strategy behind the programme;
- Opportunities for appointments at SESAME;
- Opportunities to obtain SESAME contracts, which is an effective way to transfer technical capabilities;

- Exposure to international standards through collaboration and international peer review, which in the case of other international organisations (such as CERN) has contributed to raising standards in the Members' national universities and organisations.

It is hoped that the possibility of working at SESAME while remaining based in national universities and research institutes will help to prevent or reverse the brain drain.

II. Privileges of Members and Benefits for Them

1. Governance

Through the Council, which is the governing body of SESAME, Members participate in decisions on:

- the Centre's policy in scientific, technical and administrative matters;
- the Centre's financial regulations and staff rules;
- the establishment of staff posts at the Centre;
- the installation, operation and upgrading of the Centre's facilities,
- the scientific programme of the Centre;
- the training programme of the Centre;
- the election of the President of the Council, and appointment of the Directors of the laboratory, and chairpersons and members of the advisory committees;
- all financial issues, including adoption of the yearly budget, review and approval of expenditures, etc.

2. Scientific and Technical Activities

Scientists from the Members of SESAME will have full access, free-of-charge, to all facilities in the laboratory, including existing beamlines and instruments. They will be able to propose to design and conduct experiments according to their specific interests/needs, without being limited to what is offered under routine operational conditions at synchrotron radiation user facilities.

SESAME will provide its Members a unique environment for training in a field that is at the frontiers of science. Young scientists will not only be able to benefit from the training fellowships provided through SESAME, but they will also have greater opportunities for hands-on training through more generous beam-time allocations than would be available elsewhere. Furthermore, through international cooperation enabled by SESAME, scientists and technicians from the Members of the Centre will be brought to world-level standards and will become equal partners in the world scientific community.

National universities of the Members will also stand to benefit. The international synchrotron radiation community's enthusiastic response to SESAME opens the way for international collaborations and student exchanges, which will help to enlarge local pools of know-how. Moreover, since most of the experiments will be carried out in international collaborations by scientists from universities in the Members of SESAME and beyond, this will enable universities to compare their standards with those of internationally-renowned universities which, in turn, will contribute to raise the level of their competence. Universities will also benefit from various spin-offs. For example, with the help of SESAME, the infrastructure of internet connections will be developed to enable intensive exchange of electronic messages and scientific data produced by the SESAME beamlines. Furthermore, local high-technology capacity, in areas such as ultrahigh vacuum, high-specification electromagnet production, and electronics, will develop to support experiments that will be conducted at SESAME, and also preliminary or complementary experiments that SESAME users may wish to conduct in their home country. One example is the EU-funded LinkSCEEM project which has not only helped to define the computing needs of SESAME, but has also provided a user base for the supercomputing facility at the Cyprus Institute which has made the project more competitive at an international level.

In the same way that the intense scientific activity of CERN in Switzerland led to the creation of other European scientific organisations, e.g. EMBL (European Molecular Biology Laboratory) in Germany, SESAME's activity may in the long term lay the seed for the establishment of other collaborative laboratories in the region, which in turn will bring greater prosperity to the participating countries.

3. Training

To date, some US$4 million has been invested in training (almost all provided by outside supporters), and some 300 potential SESAME users have already benefited from the programme. The training programme has two main elements:

(a) Workshops, users' meetings and schools. The users' meetings provide a forum for formulating SESAME's scientific strategy, and are fostering the formation of international collaborations which will carry out experiments at SESAME. So far, twelve users' meetings have been held and more are being organised (for details see www.sesame.org.jo). The workshops focus on specific topics, while the schools provide basic training in carrying out experiments at synchrotrons. Support for these activities is provided *inter alia* by the International Atomic Energy Agency (IAEA), the Abdus Salam International Centre for Theoretical Physics (ICTP), the American, British, German, Italian and European physical societies, the American Chemical Society, and the International Union of Pure and Applied Physics.

(b) Individual training, through visits to leading laboratories around the world. Numerous fellowships have been established which support extended visits by young scientists and engineers from the SESAME Members. These fellowships are being financed by sponsors such as the IAEA, which has provided more than US$1 million for SESAME's training programme and is providing a further €757,461, ICTP, synchrotron laboratories in different parts of the world and small charities.

It should be pointed out that the engineers who received training in European laboratories on how to install and later operate a synchrotron radiation source in the early years of the SESAME project received this tuition thanks to the SESAME training programme and the generosity of their European hosts. A number of these engineers are now staff members of SESAME. A similar mechanism has been established for scientists to learn how to install and operate beamlines, and how to carry out tests using synchrotron radiation techniques.

How much a Member benefits from SESAME's training programme depends on how active a Member is in proposing candidates. This training is not only useful for the exploitation of SESAME, but also has benefits for the Member's universities, and even industry - some of the people trained by SESAME have moved to high-tech jobs in the Member countries.

4. Staff and Contracts for Equipment/Services

Although no definite quotas are foreseen, applicants from the Members are given priority when international staff are hired at SESAME.

Moreover, for contracts placed by SESAME preference is given to national companies from the Members (provided their bids are not more than 8% higher than any bids from non-Members), which have been awarded a number of contracts for components of the SESAME machine. Such contracts are not only interesting from a financial point of view, but in many cases are important tools for technology transfer. The flow of contracts is expected to continue as further beamlines are built, other facilities are added, and (in due course) SESAME is upgraded, as happens periodically at all light-sources.

III. Obligations of Members

1. Intellectual and Other Obligations

Members are to ensure that they are represented on the Council of SESAME by persons having the required experience and authority. Each Member may have up to two delegates on the Council. Ideally, one should be a scientist and the second a person entrusted with decision-making powers. They may be accompanied to Council meetings by up to two advisers.

The delegates to Council should make known the Council decisions to their respective national authorities. They should be pro-active in responding to the Council's calls for representation on its advisory committees, candidates for training and vacant SESAME staff posts, bids for components that are to be purchased for the SESAME beamlines, etc. They should bring SESAME's activities to the attention of their national scientific institutions and universities so that their country may benefit to the full from the opportunities offered by SESAME.

2. Financial Obligations

The operational costs of SESAME (staff costs and materials for operating the machine and running the Centre) are to be covered by the Members of the Centre.

In 2015, the yearly budget of SESAME is US$3.54 million. It is expected to increase to some US$6,4 million in 2017 when SESAME is operational, and then stabilize at around this amount. It is hoped that eventually the number of Members will increase to more than a dozen with the consequence that the contribution of any single Member will be rather modest.

The total yearly budget is distributed among the various Members based on a system inspired from the principles of the UN scales. The total yearly budget and its distribution among the various Members are presented to the Council every year and require unanimous approval by the Council.

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