

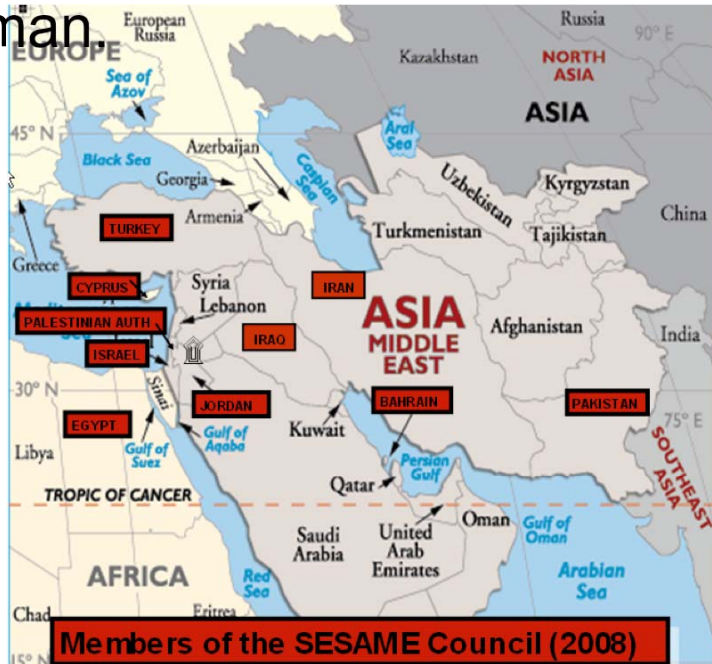
SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East)

Chris Lewellyn Smith

President SESAME Council



SESAME = **S**ynchrotron-light for **E**xperimental **S**cience and **A**pplications in the **M**iddle **E**ast (2.5 GeV light source). A major facility, under construction near Amman



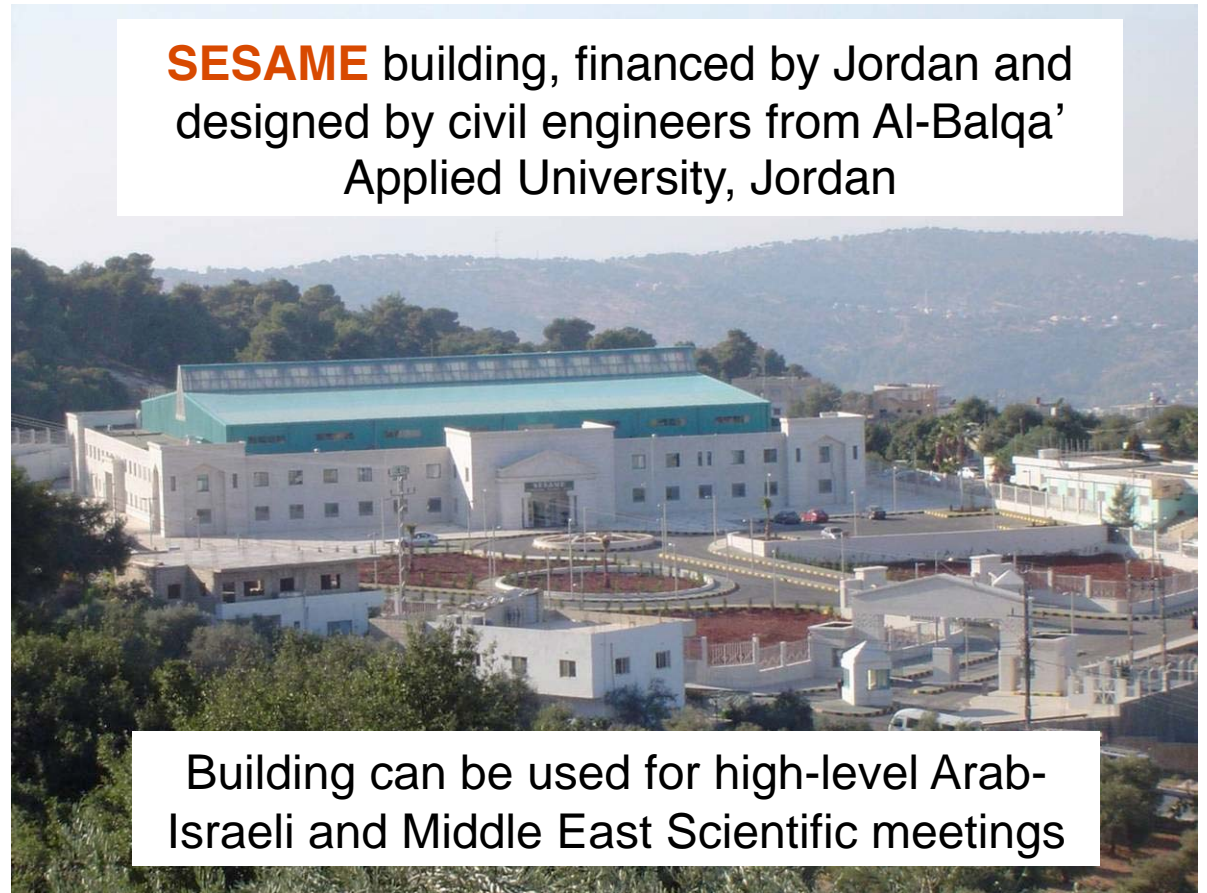
Members: Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestinian Authority, Turkey

Observers: France, Germany, Greece, Italy, Japan, Kuwait, Russian Federation, Sweden, UK and USA. Pending: Switzerland

Purpose: Foster excellent science and technology in the Middle East, and prevent or reverse the brain drain, by enabling world-class research in subjects ranging from biology and medical sciences through materials science and physics to archaeology

+ Build bridges between diverse societies and contribute to a culture of peace through international cooperation in science.

Synchrotrons are large, expensive, facilities. Richer countries can afford their own; there are ~ 60 in developed countries, but only a few in developing countries – none in the Middle East.



International collaboration is the obvious way for countries with limited science budgets to build synchrotron light sources, which are ideal facilities for scientific capacity building

Synchrotron-light Sources

- The 'heart' is a circular electron accelerator (133m circumference at SESAME).
The circulating electron beam emits very intense pulses of light/X-rays which are used to study matter on a scale from cells, through viruses to atoms. This enables a wide range of applied science, ranging from biology and medical sciences (imaging and therapy) through pharmaceuticals, materials science physics and chemistry to archaeology, and can be used to improve manufacturing techniques, provide forensic evidence, and address environmental issues.
- SESAME (like all other synchrotrons) will be a user facility: scientists from universities and other institutes will typically come to SESAME two or three times a year for a week or two to carry out experiments, generally in collaboration with scientists from other institutions/countries.

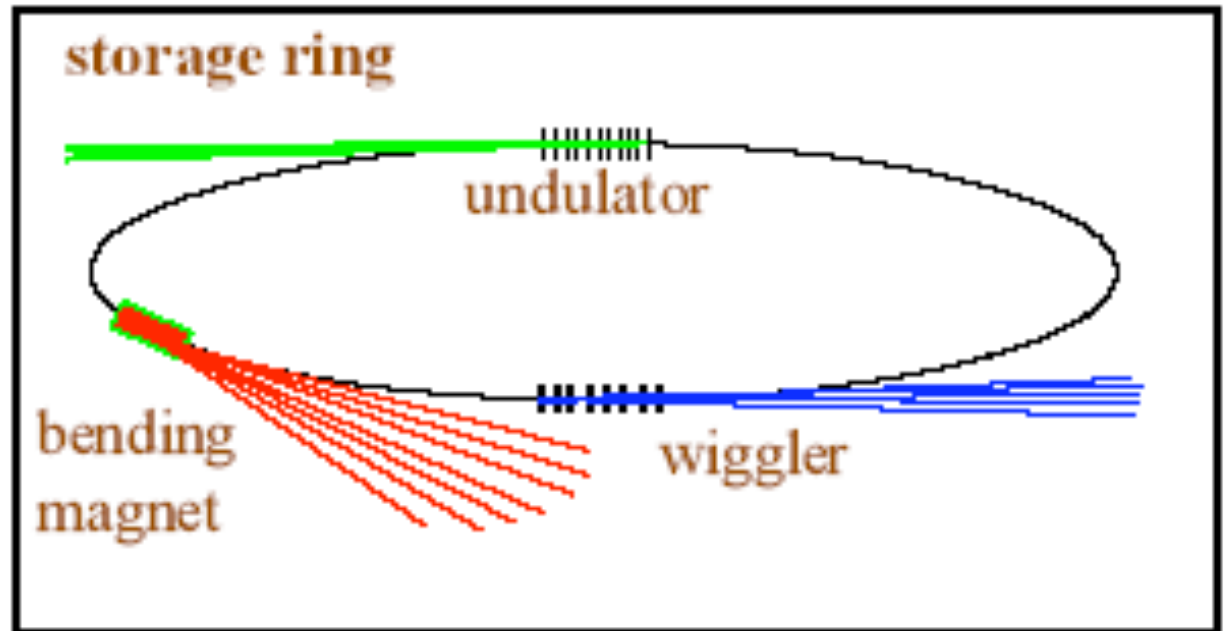
Synchrotron Radiation is emitted by

- Bending magnets (light in a 0.012° cone at SESAME)

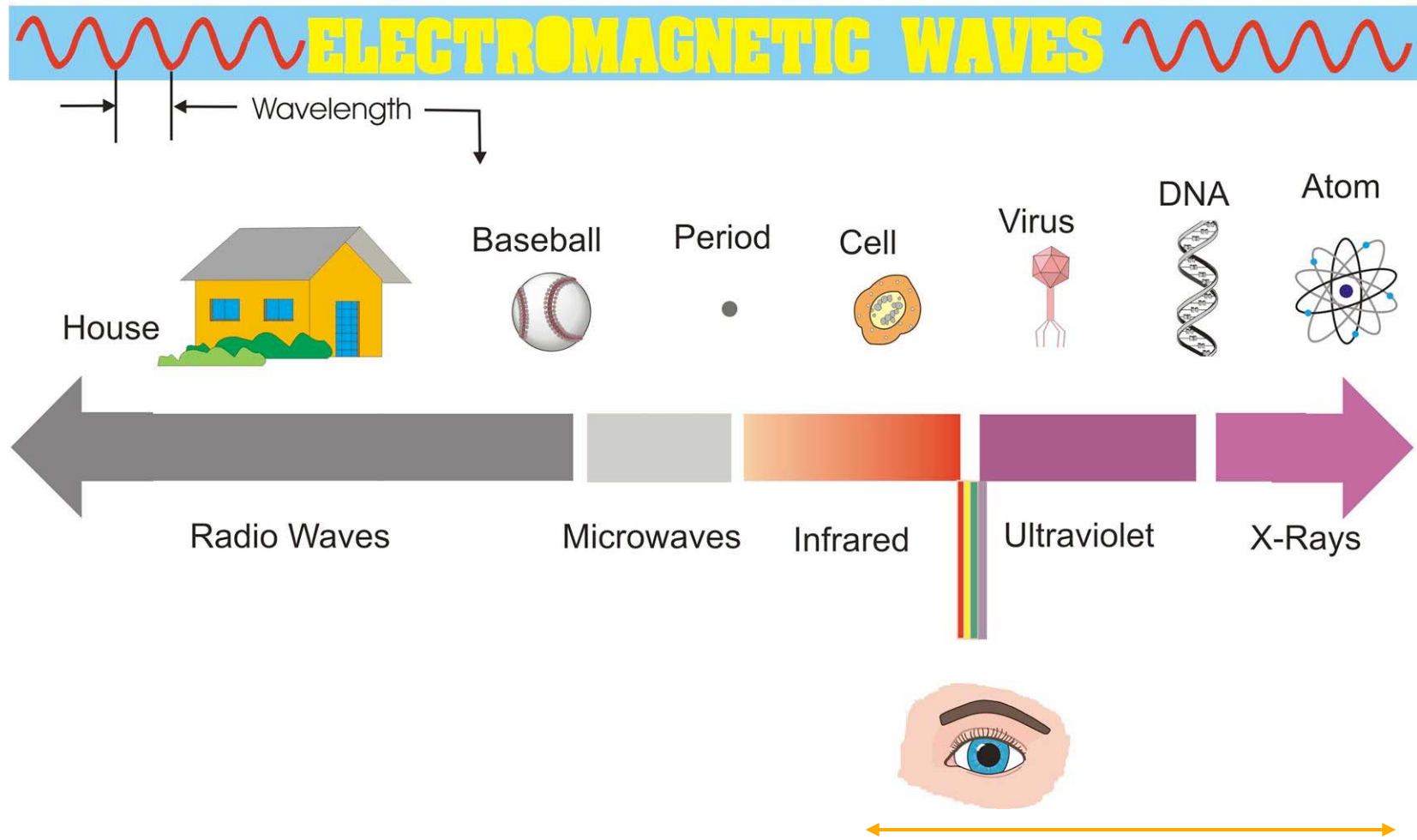
- Wigglers

- Undulators

in electron storage ring accelerators




Synchrotron radiation is an intense source of electromagnetic radiation (infra-red and ultraviolet light and X-rays)



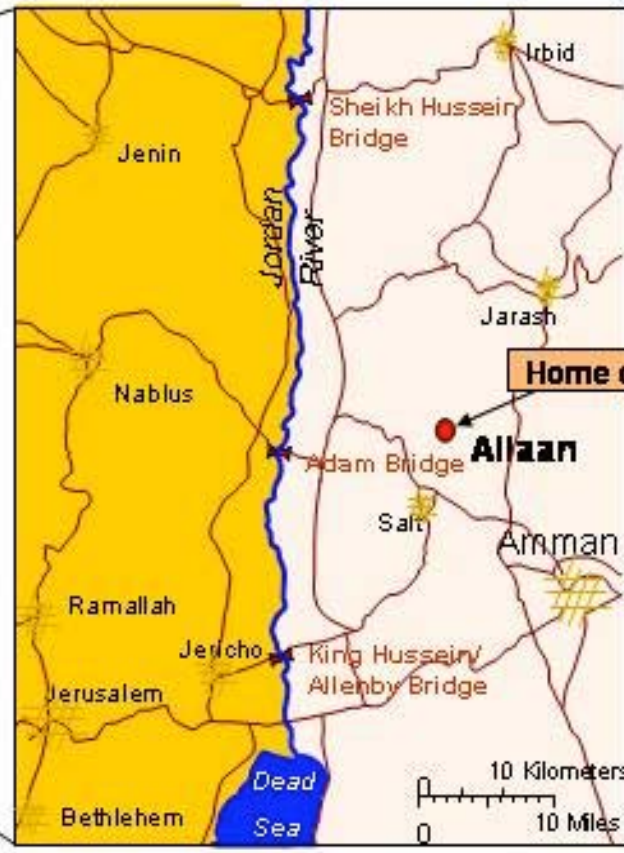
Synchrotron radiation is used for experiments typically over this region

Very Brief History of SESAME

- Original idea (1997): rebuild & upgrade the old 0.8 GeV Berlin Synchrotron (BESSY 1) in the Middle East, as basis for a new international organisation, modelled on CERN, under umbrella of UNESCO
- **2002: decision to build a new 2.5 GeV ring (BESSY 1 as injector)**
  ***competitive 3rd generation device, as needed to make a serious contribution to scientific capacity building (synchrotron-light ideal)***
 + provide firm scientific foundations, essential for building political bridges
- Ground breaking (2003); **completion of building (2008)**

BESSY 1 partially installed; much of initial suite of donated beamlines (from Daresbury UK...) available

- **Vigorous training programme and growing potential user community**
- **First experiments expected 2014, *assuming* funding for main ring and adapting/upgrading beamlines can be found**



SESAME GROUND BREAKING CEREMONY - 6 JANUARY 2003





Zehra Sayers

Heman Winick

Dincer Ulku

Javad Rahigi

3rd SESAME User Meeting
October 11-13, 2004, Antalya, Turkey
8th Users' meeting in Amman November 2009



Visit to SESAME site by IAEA D-G Mohamed ElBaradei, April 14, 2007



SESAME Accelerator Group, August 14, 2007

First row left to right: Yara Zreikat, Mechanical Designer (Jordan), Adel Amro, Vacuum Assistant Engineer (Jordan), Adli Hamad, Radiation Officer (Jordan)

Second row Left to Right: Darweesh Foudeh, RF Engineer (Jordan), Firas Makahleh, Mechanical Engineer (Jordan), Mohammad Alnajdawi, Mechanical Designer (Jordan), Maher Shehab, Mechanical Engineer (Jordan), Hamed Tarawneh, Accelerator Physicist (Jordan), Maher Attal, Accelerator Physicist (Palestine), Ahed Aladwan, Control Engineer (Jordan), Arash Kaftoosian, RF Engineer (Iran) Seadat Varnasseri, Diagnostics Engineer (Iran)

Opening of the SESAME Building by the DG of UNESCO and his Royal Highness Prince Ghazi Ben Mohammad, 3 November 2008



Microtron Installed at SESAME

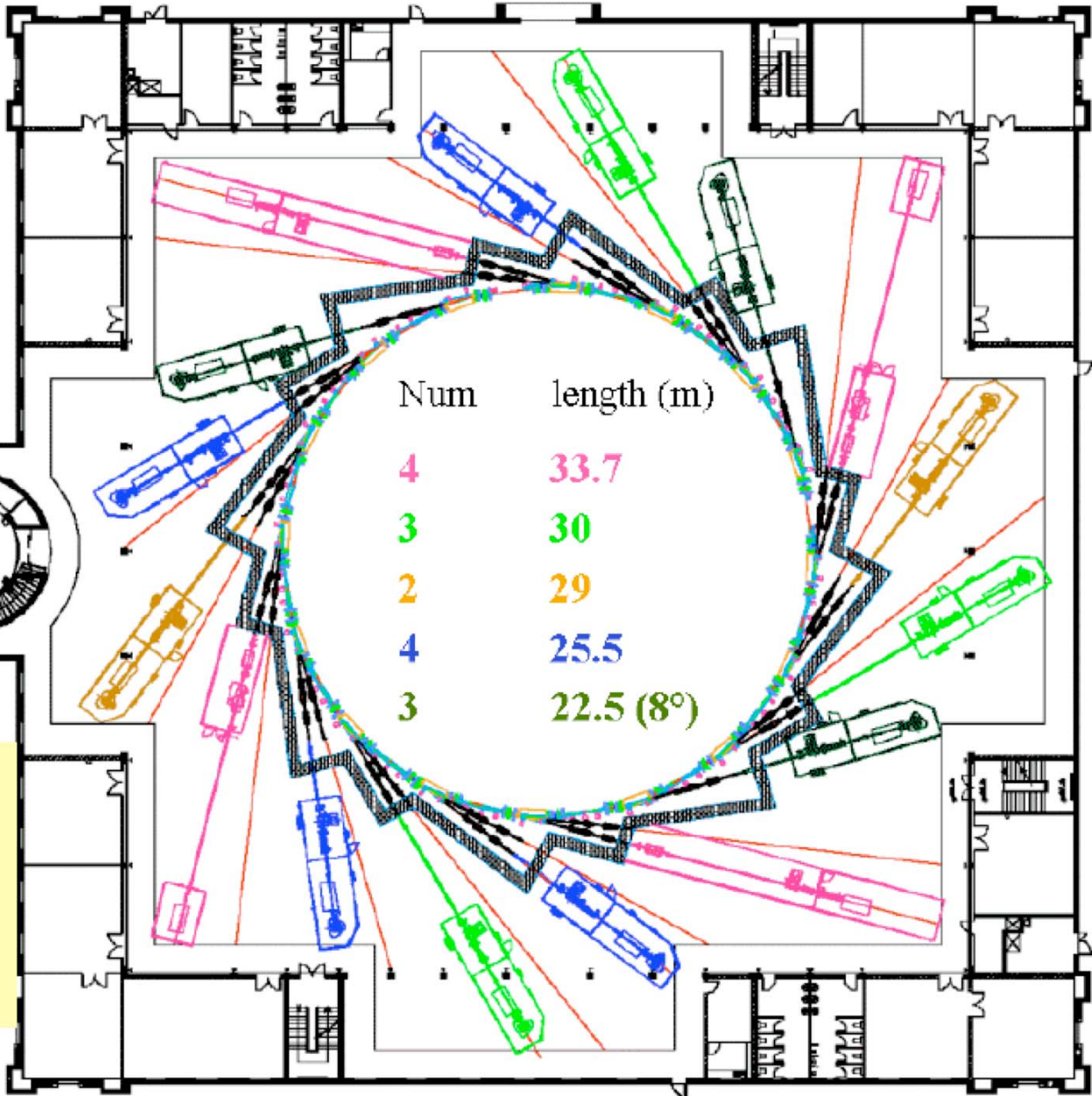
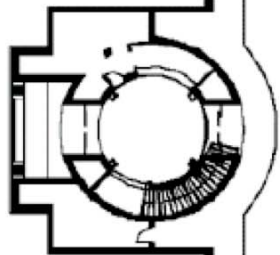


Components of BESSY 1 installed to form (part of) the SESAME Booster November 2008





Beam Lines



Num	length (m)
4	33.7
3	30
2	29
4	25.5
3	22.5 (8°)

First beamlines:

- Protein Crystallography
- Infra Red Spectroscopy
- Powder Diffraction
- Photoelectron spectroscopy
- Small Angle X-ray scattering
- EXAFS
- Zero (Atomic, molecular, optics)



Initial Scientific Programme of SESAME

- Structural Molecular Biology
- Atomic and Molecular Sciences
- Surface and Interface Science
- Environmental Science
- Material Science
- Archaeological Science
- Medical Applications (demanded by the users community at the 3rd Users Meeting)

Funding

Capital cost: Jordan (land, building and cash), donations (BESSY 1, beamlines etc.), EU (€1.2M already provided + €2M not yet spent)

New main ring not foreseen initially, and not budgeted by Members. Funding being sought for this and for adapting/upgrading the beamlines

- see below for analysis of missing funding and possible sources

Operational cost - provided by Members:

2009 - \$1.25, 2010 - \$1.75M...\$(5.7-8.5)M in 2014 when SESAME will come into operation (funding permitting)

Paying the subscription is a problem for many countries

New members would help and would be **very welcome**

Extensive Training Programme – funded by outside donors (see below) – over \$3M already spent and/or committed

Donated Equipment

- **From LURE, France**
 - Beamline, undulator, ...
- **From SLS, Switzerland**
 - Beamline, wiggler
- **From Daresbury Lab & University of Liverpool, UK**
 - Five beamlines, value if new over €20M
- **From SLAC, Stanford University, USA**
 - Undulator,...
- **From ALS, Bekeley, USA**
 - Wiggler
- **From LBNL, USA**
 - Wiggler
- **From Elettra, Italy**
 - Cavities

Training Programme

One of the essential objectives of SESAME

- **So far \$2.84M**, from a variety of national and international sources, **has been spent on training:**
 - \$760k - Fellowships for accelerator experts
 - \$1.17M (including \$500k from the IAEA) - Fellowships for beamline experts and users
 - \$250k - workshops and schools
 - \$580k - users' meetings (8 so far)
 - \$80k - grants for attending meetings and visits to laboratories
- Once recently offered Fellowships are filled, **the value of the training programme will be ~ \$900k p.a.:** approaching **£800k for Fellowships + over £100k for meetings and visits.**

This will ensure that SESAME is fully exploited from the start by scientists from across the region.
- **Funding from:**

IAEA, UNESCO, ESRF + external national organisations & synchrotron labs in: Brazil, France, Germany, Italy, Japan, Spain, Sweden, Switzerland, Taiwan, UK, USA + organisations in Members: Egypt, Iran, Israel, Jordan, Turkey + scientific bodies: APS + EPS + IOP + DPG, IUCr + Companies: Gentech, Ox Diffraction, PANanalytical + Canon Foundation + Link SCEEM project

Training and Development of User Community

Users Meetings:

Focus on applications using synchrotron radiation
and development of beamlines
Encourage development of collaborative projects
Enhance communication and familiarity among
scientists from the region; building trust
Establishing a SESAME community

Workshops:

Narrow focus; concentrate on a particular
application of synchrotron radiation and provide specific training

Individual training:

Training of accelerator and machine staff
Training of beamline scientists
Extensive training for specialization

Funding Needed 2010-14

See Strategic Plan 2010-14

- **To complete accelerator: \$30.5M**
Certain non-essential items will be added later
- **To provide three day-one beamlines** (two using components donated by Daresbury + one new) **+ computing: \$6.1M**
Four more Phase 1 beamlines will be added later (three based on donated components; one new)
- **Ancilliary buildings and security: \$1.2M**
Would like to add conference centre and other buildings later

Total Capital funding needed 2010-14: \$37.8 M

- **Operational funding needed 2010-14: \$(21-24)M** – to be provided by Members
- **Value of donated equipments to be used In this period + contributions already made and spent:~ \$50M**

Thus the total cost of bringing SESAME into operation, with three day-one beamlines, starting from a green field, will be ~ \$110M
– in line with the cost of other recently constructed light-sources

Possible Sources of Funding

- **Members** – must pay **operational/personnel costs** + hoping will provide at least half of missing **capital funding**: Israel has recently offered substantial funds *provided* at least four other SESAME Members do the same; planning ‘summit’ to discuss in April
- More from **EU** (€2M ~ \$3M in-hand)
- **US** - 5 Congressmen have written to Secretary Clinton proposing a contribution of \$5M over 2 years; encouragement from Obama’s Cairo speech, which is strong on science – waiting for first report from Clinton’s three science envoys to the Muslim world
- Preparing bid for **FP7/Euromed** funding
- Preparing bid (UNESCO, UNOPS, IAEA) to **UN HSTF**
- Will approach more **Foundations**
- **European Investment Bank** prepared in principle to make a **loan**, but this would be a last resort



There are challenges

- Stable financial support
- Increasing the number of member countries in the Gulf as well as in the Mahgreb
- Compensating the differences in the human and financial resources of the member countries
- Solutions to some practical problems involving travel restrictions in the region
- Funding for main ring and adaptation/upgrading of beamlines

But the outlook is good with commissioning possible in 2014

thanks especially to HM King Abdullah II, Director Toukan, UNESCO, IAEA, and those who have donated equipment, especially BESSY 1 and Daresbury

ANOTHER WORLD?

“As a string theorist, I work on parallel universes. I was always curious about what a parallel universe was like, and now I know. I’m living in one when I go to *SESAME* meetings”

Eliezer Rabinovici; Hebrew University and Israeli representative to the SESAME Council



S ESAME

- A competitive synchrotron radiation laboratory
- Providing non-discriminating scientific environment for working together
- Interdisciplinary research; an environment for collaborations as well as individual development
- Exploiting local advantages
- An advanced facility for training
- A place to which expatriate scientists can return
- Contribute to development of local economy

Back-up Slides

Further details of:

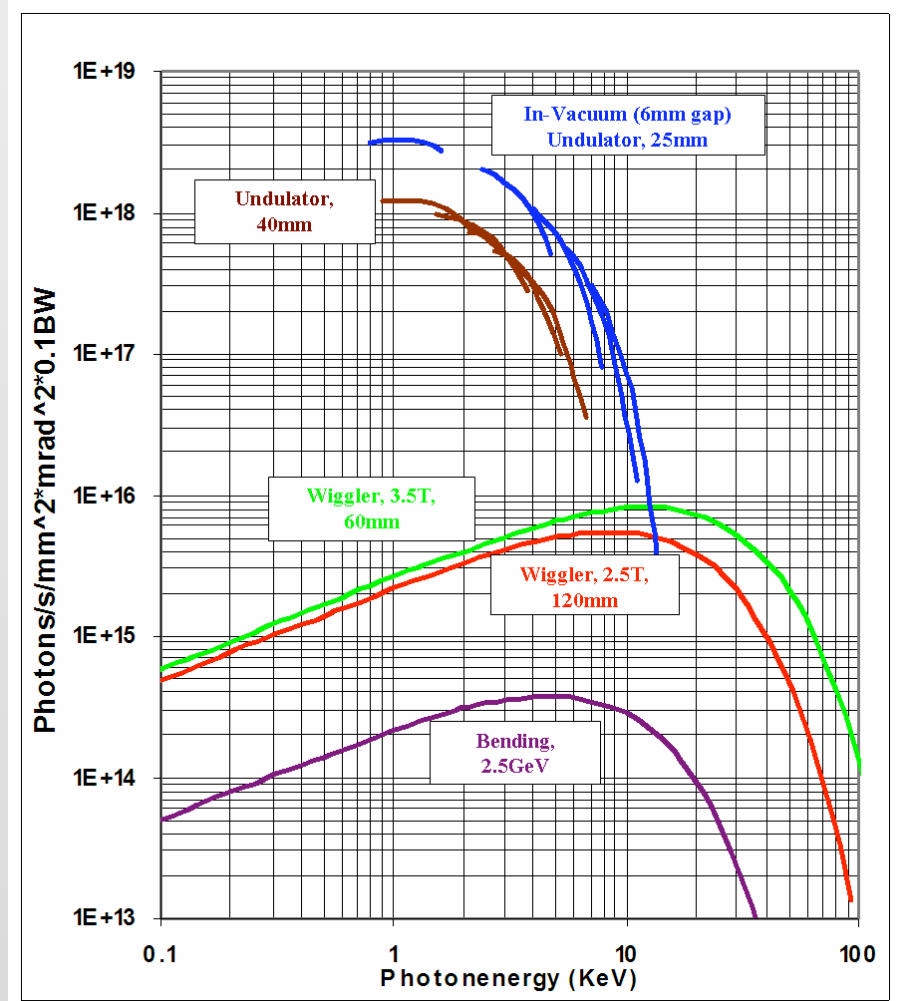
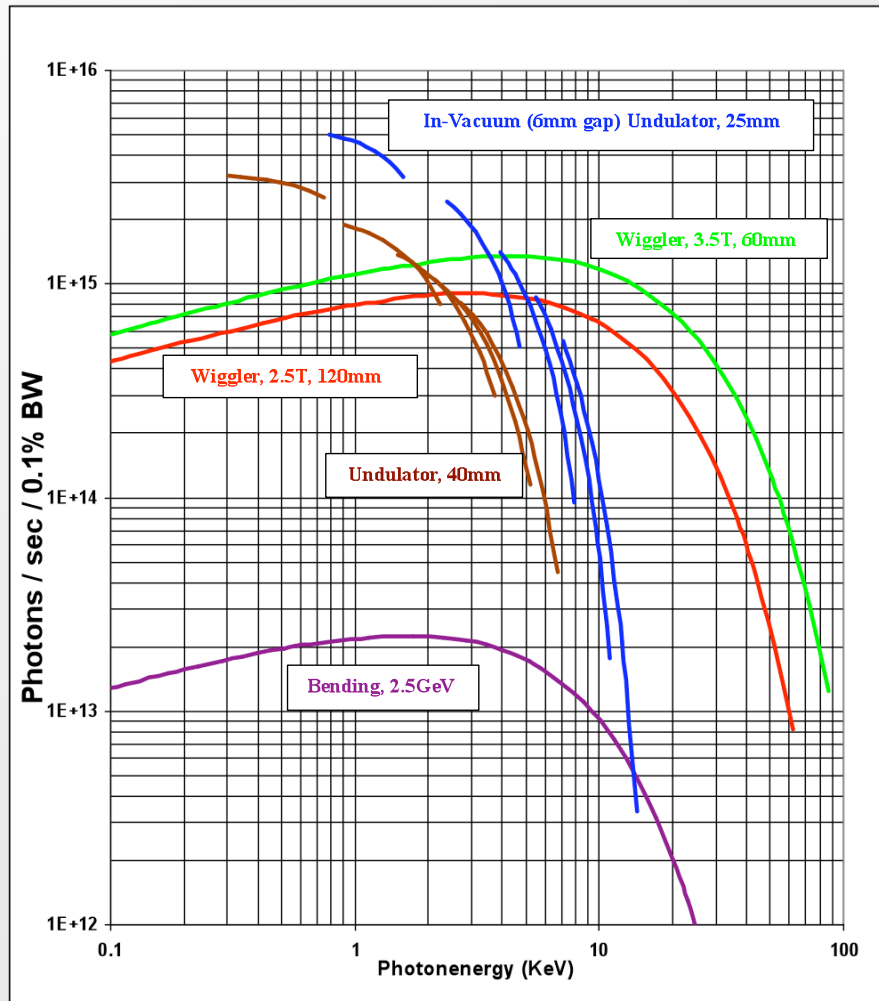
- Synchrotron-light spectrum
- Experimental programme
- Management and Governance



Radiation from Bending Magnets, Wigglers and Undulators of SESAME at 2.5 GeV

Flux

Brightness





SESAME Phase I Beamlines

No.	Beamline	Energy	Source	Research
1	Multi-wavelength Anomalous Dispersion (MAD) Protein Crystallography	4- 14 keV	Wiggler	Structural Molecular Biology (SMB)
2	X-ray Fluorescence XRF/X-ray Absorption Fine Structure XAFS	3 - 30 keV	Bending magnet	Materials Science, Environment
3	Infra Red Spectro-microscopy	0.01 - 1 eV	Bending Magnet	Environment, Materials, Archaeology
4	Powder Diffraction	3 - 25 keV	Multi-pole Wiggler	Materials Science,
5	Small and Wide Angle X-ray scattering (SAXS/WAXS)	8-12 keV	Bending magnet	SMB, Materials Science
6.	Extreme Ultra Violet (EUV)	10-200 eV	Bending Magnet	Atomic & Molecular Physics
7	Soft X ray, Vacuum ultra-violet	0.05 - 2 keV	Elliptically polarised undulator	Atomic., Molecular & Condensed Matter Physics

Plans for Phase I Beamlines

Before re-optimisation of in late beamlines 2009

Soft-X-ray beamline led by scientists from Pakistan

Champions : Z. Hussain and H. Hoorani

EXAFS/XRF beamline led by scientists from Jordan

Champions: A. Hallak

SAX beamline led by scientists from Turkey, Jordan and Israel

Champions: Z. Sayers. I. Sagi and M. Al-Hussain

Zero beamline led by SESAME staff Scientists

Champions: to be recruited

MAD PX beamline project led by scientists from Egypt, Israel, UK

Champions: M. Yousef, G. Shahom and S. Hasnain

Infrared Beamline led by scientists from Jordan

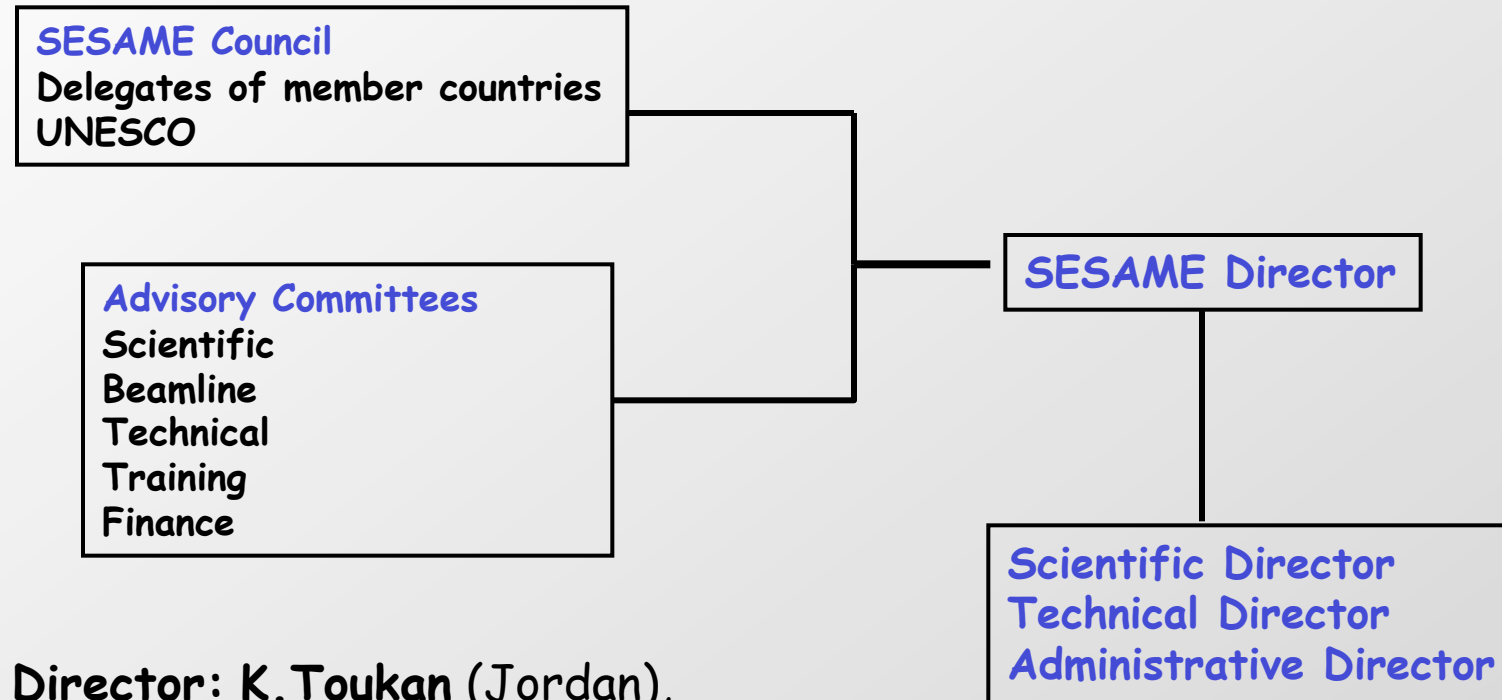
Champion: Z. El-Bayyari

Powder Diffraction beamline led by scientists from Turkey

Champion: Engin Ozdas



Organizational Structure of SESAME



Director: K. Toukan (Jordan),

Scientific Director: H. Hoorani (Pakistan),

Technical Director: A. Nadji (France-Algeria),

Administrative Director: M. Y. Khalil (Egypt)

Scientists: M. Gharaibeh, W. Saleh

Technical Staff: T. Abu-Hanieh, A. Amro, A. Aladwan, M. Alnajdawi, M. Attal, D. Foudeh, A. Hamad, A. Kaftoosian, T. Kahn, F. Makahleh, S. Matalgah, R. Sarraf, M. Shehab, H. Tarawneh, S. Varnasseri



Members of SESAME Council

BAHRAIN, KINGDOM OF, Dr. Huda AL-AWADI, Curricula Expert, Ministry of Education.

CYPRUS, REPUBLIC OF, Professor C Victor JONGENEEL, Vice President for Research, Cyprus Institute. **Ms Niki SANTAMA**, Senior Planning Officer, Planning Bureau.

EGYPT, ARAB REPUBLIC OF, Professor Mohamed Taha EL-KOLALY, Vice-President, Egyptian Atomic Energy Authority (EAEA). **Professor Mohamed Tarek HUSSEIN**, President, Academy of Scientific Research and Technology (ASRT).

IRAN, ISLAMIC REPUBLIC OF, Dr Javad RAHIGHI, Head, Accelerator Physics Laboratory, Atomic Energy Organization of Iran (AEOI).

ISRAEL, STATE OF, Professor Moshe PAZ-PASTERNAK, School of Physics and Astronomy, Tel Aviv University. **Professor Eliezer RABINOVICI**, Racah Institute of Physics, Hebrew University.

JORDAN, THE HASHEMITE KINGDOM OF, Dr Kamal ARAJ, Commissioner for International Cooperation, Jordan Atomic Energy Commission (JAEC). **Professor Abdul-Halim WRIEKAT**, Department of Physics, Faculty of Science, University of Jordan.

PAKISTAN, ISLAMIC REPUBLIC OF, Dr Shoaib AHMAD, Member Physical Sciences, Pakistan Atomic Energy Commission (PAEC).

PALESTINIAN AUTHORITY, Professor Said A. ASSAF, Director-General, Arab Scientific Institute for Research and Transfer of Technology (ASIR). **Professor Salman M. SALMAN**, Professor of Physics, Physics Department, An-Najah National University.

TURKEY, Professor Dincer ULKU, Co-Vice President of the Council of SESAME, Department of Engineering Physics, Hacettepe University.



Advisory Committees

Scientific Committee

Chair : Z. Sayers (Turkey)

Members: M. Al-Sherbiny (Egypt), A. El-Nadi (Egypt), A. Hoummada (Morocco), S. Mahmood (Jordan), I. Sagi (Israel), M. Sowwan (Palestinian Authority)

Beamlines Committee

Chair: Z. Hussain (Pakistan, USA)

Members: J. Bordas (Spain), S. Hasnain (Pakistan, UK), C.-C., Kao (USA), E. Ozdas (Turkey), J. Sussman (Israel), S. Wakatsuki (Japan), H. Winick (USA)

Technical Committee

Chair: A. Wrulich (Switzerland)

Members: A. A. Adli (Egypt), E.E. Alp (USA/Turkey), C. J. Bochetta (Slovenia), D. Einfeld (Germany/Spain), J. M. Filhol (France), S. M. Salman (Palestinian Authority), L. Schulz (Switzerland), M. Serio (Italy), E. Weihreter (Germany).

Training Committee

Chair: J. Rahigi (Iran)

Members: R. M. A. Abdul-Karim (Egypt), D. E. Arafah (Jordan), S. A. Assaf (Palestinian Authority), S. I. Kuokawa (Japan).