

The Impact of the SESAME Project on Science & Society in the Middle East

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American Physical Society, St. Louis, MO; April 13, 2008
Impact of Major Accelerator Projects on the Development of
Emergent Countries

SESAME

Synchrotron-light

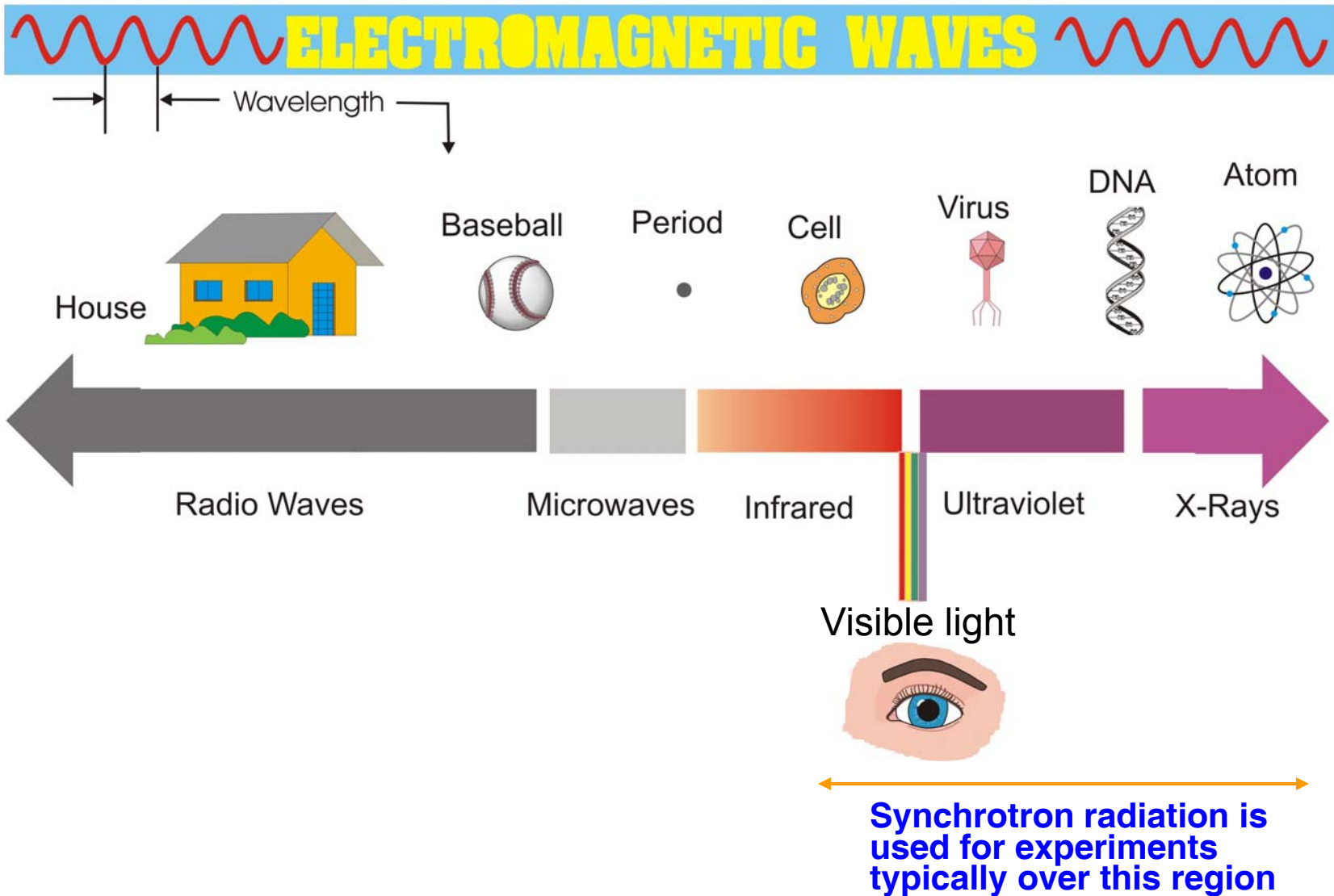
for Experimental Science & Applications

in the Middle East

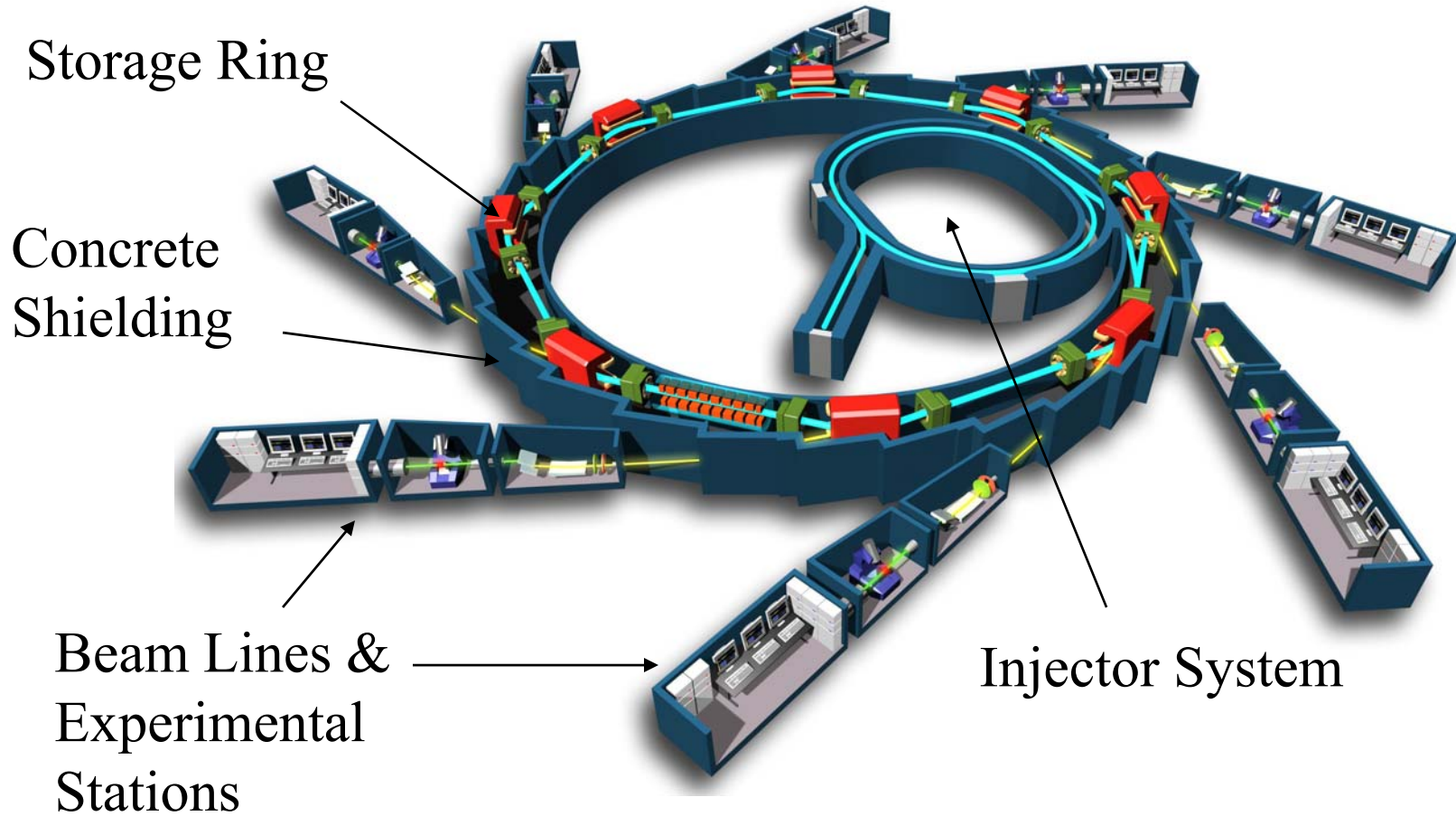
WWW.SESAME.ORG.JO

The Electromagnetic Spectrum

How It Relates to the World We Know



Synchrotrons produce high intensity X-ray beams



X-rays Have Enabled Seminal Scientific Discoveries

19 Nobel Prizes Based on X-ray Work

Chemistry

1936: **PETER DEBYE**

1962: **MAX PERUTZ** and **SIR JOHN KENDREW**

1964: **DOROTHY HODGKIN**

1976: **WILLIAM LIPSCOMB**

1985: **HERBERT HAUPTMAN** and **JEROME KARLE**

1988: **JOHANN DEISENHOFER**,
ROBERT HUBER and **HARTMUT MICHEL**

1997: **PAUL D. BOYER** and **JOHN E. WALKER***

2003: **PETER AGRE**, and **RODERICK MACKINNON***

2006: **ROGER KORNBERG***

**** Required synchrotron radiation***

Physics

1901: **WILHELM RÖNTGEN**

1914: **MAX VON LAUE**

1915: **SIR WILLIAM HENRY BRAGG**
and **SIR WILLIAM LAWRENCE BRAGG**

1917: **CHARLES BARKLA**

1924: **KARL MANNE SIEGBAHN**

1927: **ARTHUR COMPTON**

1981: **KAI SIEGBAHN**

Medicine

1946: **HERMANN JOSEPH MULLER**

1962: **FRANCIS CRICK**, **JAMES WATSON**
and **MAURICE WILKINS**

1979: **ALAN M. CORMACK** and
SIR GODFREY N. HOUNSFIELD

Synchrotron Radiation Facilities **Around the World**

- **>50 in operation in 19 countries used by more than 30,000 scientists**

In many technologically advanced countries plus

Brazil, China, India, Korea, Taiwan, Thailand

- **9 recently completed or in construction**

Armenia, Australia, Canada, China, France, Jordan, Russia, Spain, UK, US

- **More in design/planning**

For a list of SR facilities around the world see **www.lightsources.org**

The Four Largest US Light Sources – supported by the Dept. of Energy (DOE)



**Advanced Light Source (ALS),
Lawrence Berkeley National Laboratory (1993)**



**Advanced Photon Source (APS),
Argonne National Laboratory (1996)**



**National Synchrotron Light Source (NSLS),
Brookhaven National Laboratory (1982)**



**Stanford Synchrotron Radiation Laboratory (SSRL),
Stanford Linear Accelerator Center (1974)**

Objectives of an SR facility in the developing world

- Create a world-class interdisciplinary research laboratory
- Promote basic & applied research & technology
- Address regional biomedical & environmental issues/concerns
- Provide an environment for collaborations & individual development
- Train graduate students who will no longer have to go abroad
- Attract scientists working abroad to return (*reversing the brain drain*)
- Promote international scientific collaborations
- Promote development of high-tech industry (*capacity building*)

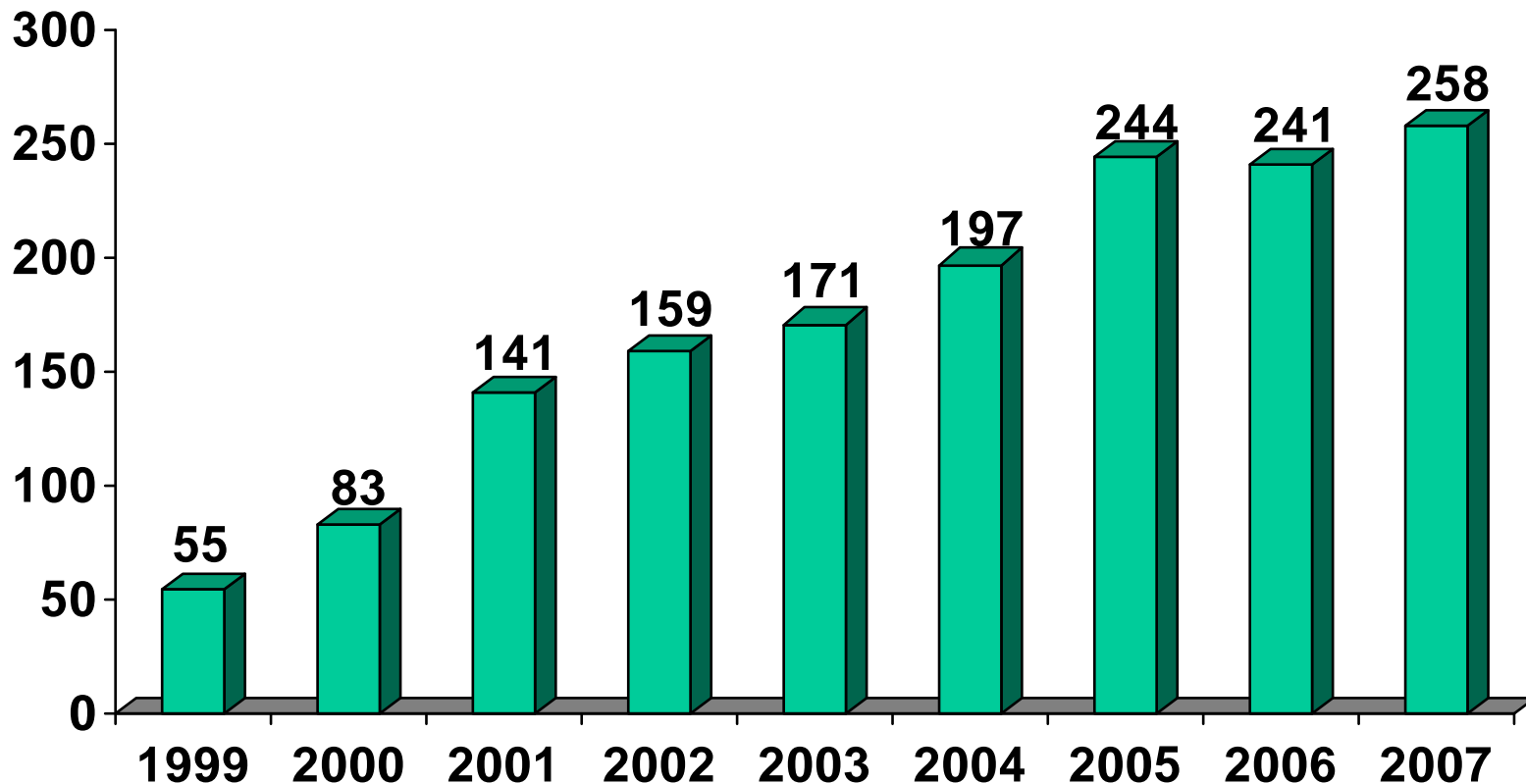
Use scientific cooperation to promote peace & understanding between people from different traditions, religions, races, & political systems.

STUDENT INVOLVEMENT WITH KOREAN LIGHT SOURCE

	<u>2004</u>	<u>2007</u>
Undergraduate students	25	98
Graduate Students (master degree)	492	970
Graduate Students (doctoral degree)	662	1047
Total	1179	2115

Brazilian Light Source

Publications from 1999 to 2007



* Data from March 6th, 2008.

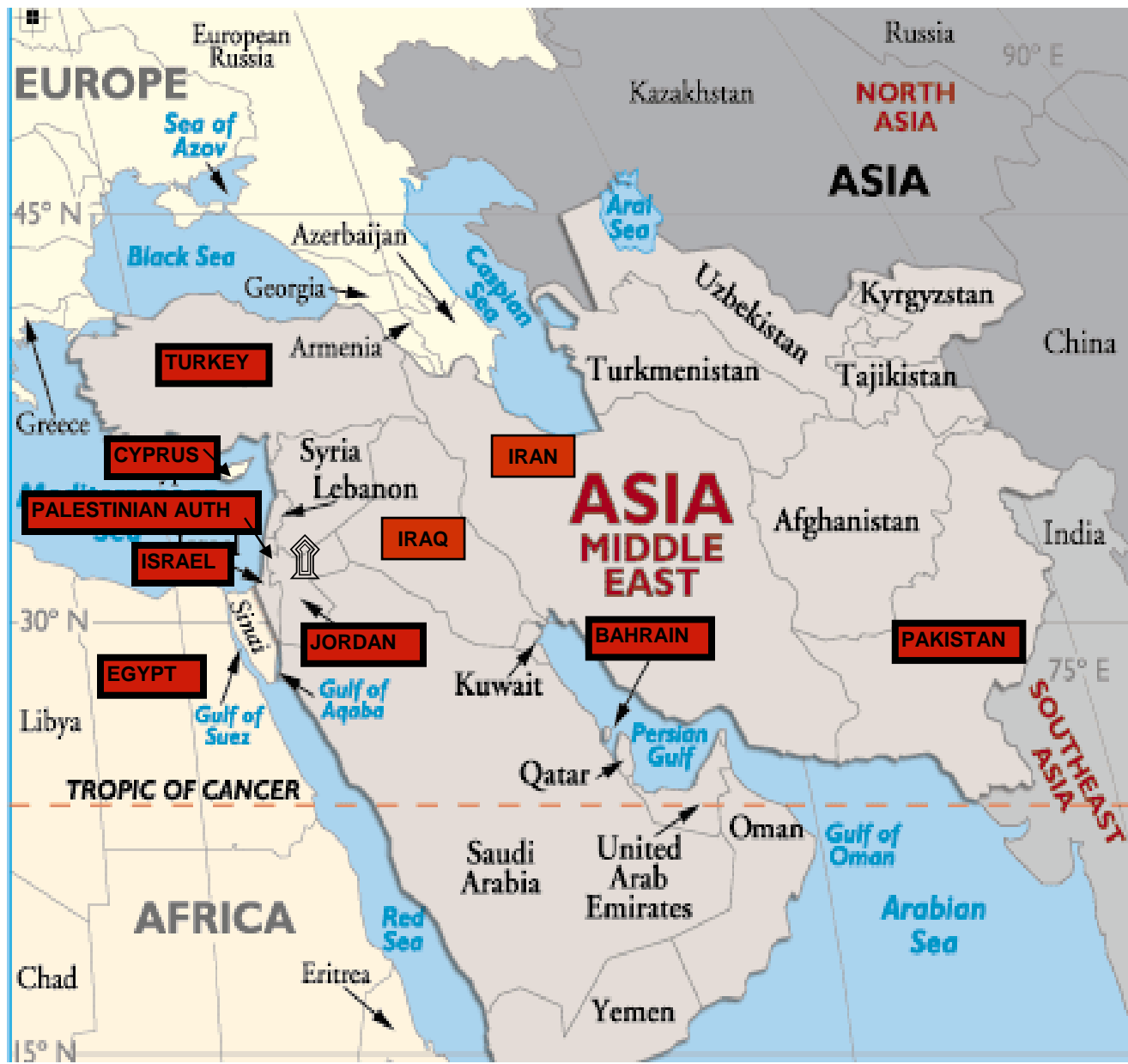


Synchrotron-Light for *Experimental Science*
and
Applications in the Middle East

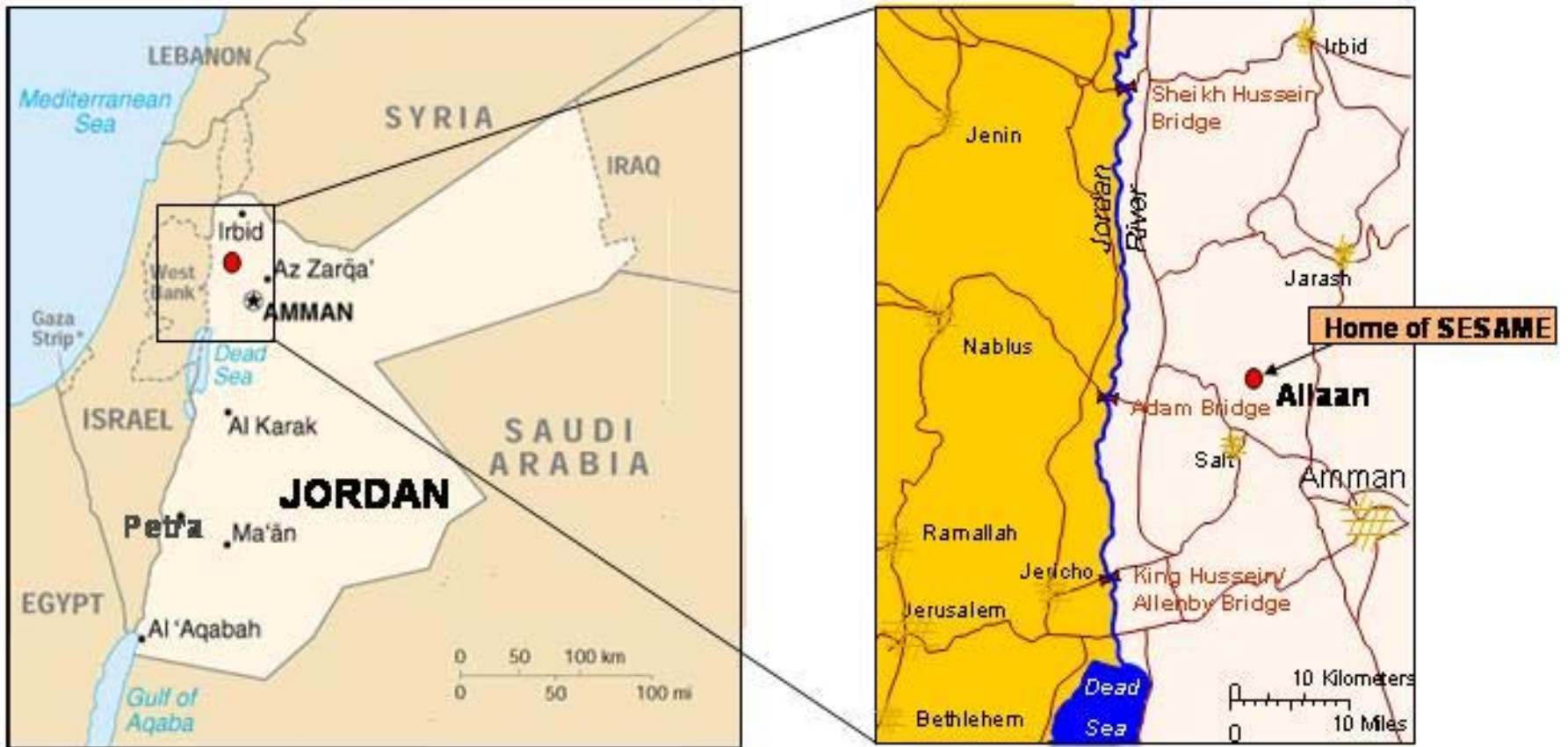
SESAME

A 3rd Generation Synchrotron Light Source for the Middle East

- A UNESCO sponsored project
- Initiated by a gift from Germany of the 0.8 GeV BESSY I facility
- 10 Members of SESAME Council; **Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Pakistan, Palestinian Authority, Turkey**
- Observer Countries: **Armenia, France, Germany, Greece, Italy, Japan, Kuwait, Libya, Portugal, Russia, Sweden, UK, United Arab Emirates, US**
- Jordan is host country; selected from 7 competitors
- Jordan provided the site & funds for the building just completed
Capital funds sought from other sources (EU, Japan, US...)
- First operation expected in 2010-2011
- ***Open to qualified scientists from everywhere***



Members of the SESAME Council (2008)



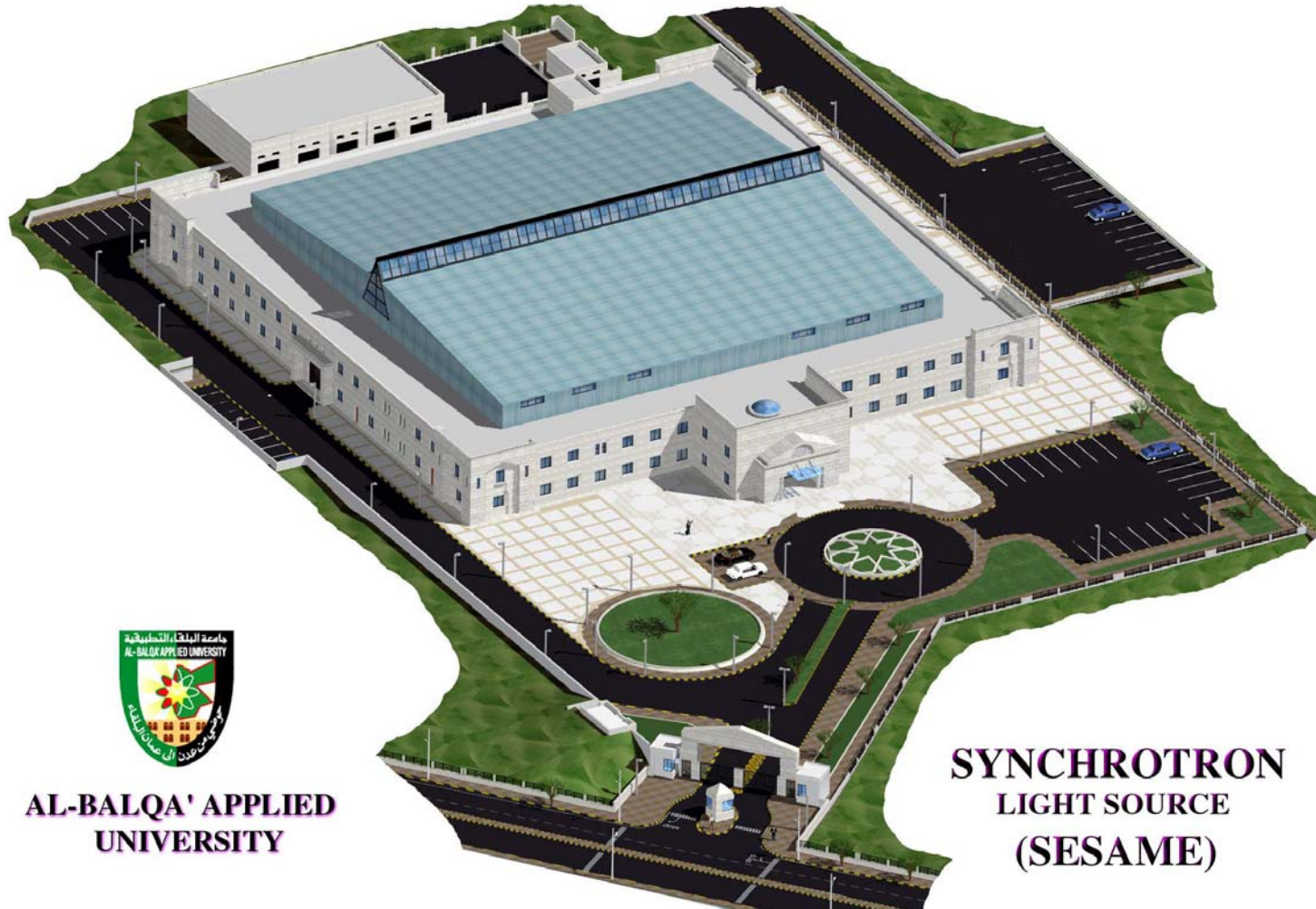
SESAME location in Allaan, Jordan



SESAME site in Allaan, Jordan
Before start of SESAME construction

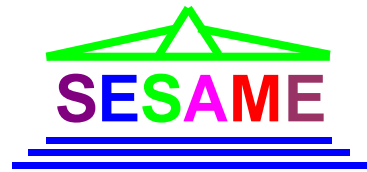


**Synchrotron-Light for *Experimental Science*
and
*Applications in the Middle East***



**AL-BALQA' APPLIED
UNIVERSITY**

**SYNCHROTRON
LIGHT SOURCE
(SESAME)**



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

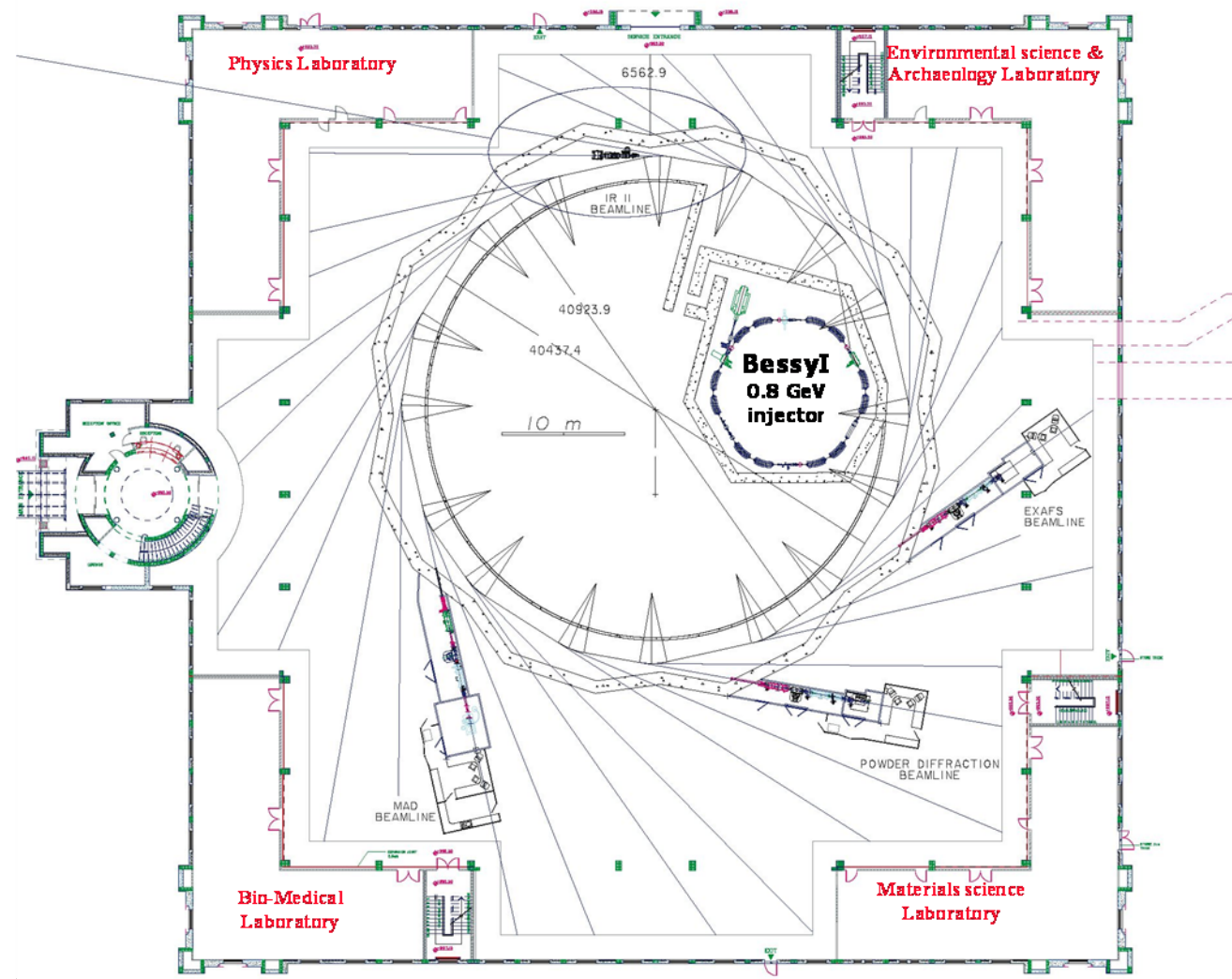


DESIGNED BY: **SAAD & PARTNERS**
ARCHITECTS & ENGINEERS
CONSULTANTS





R. Sarraf 10-5-2007



Energy; 2.5 GeV
Circumference; 133m
Emittance; 26 nm-rad
Space for 12
Insertion Devices

SESAME; in construction in Jordan

www.sesame.org.jo



King Abdullah II (Jordan) & Koïchiro Matsuura (Director-General of UNESCO) at SESAME Ground Breaking Ceremony on January 6, 2003



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



Herwig Schopper (SESAME Council President) receiving Al Istiklal medal from **King Abdullah II** at Jan. 6, '03 ground breaking ceremony

IAEA Director-General

ElBaradei visit to
SESAME

April 14, 2007





10th Meeting of SESAME Council; IAEA, Vienna, July 31-Aug 1, 2007

Chris Llewellyn-Smith, President of SESAME Council in late 2008

Khaled Toukan, Director of SESAME

Ana Maria Cetto, Deputy Director-General IAEA

Maciej Nalecz, Secretary to SESAME Council, UNESCO Division Director

Herwig Schopper, President of the SESAME Council

Amor Nadji, Technical Director of SESAME

SESAME Workshops and Schools (2000-2001)

1st Workshop on Structural Molecular Biology (SMB); Univ. of Athens, 6-7 April, 2000;
Sponsors; UNESCO & Univ. of Athens; **20 Middle East scientists**

Workshop/School on Accelerator Science & Technology
Al-Balqa' Applied Univ. Al-Salt, Jordan, 9-19 Sept, 2000.
Sponsors; UNESCO, IAEA, ICTP (Trieste) & Al-Balqa' Applied Univ.
50 Middle East scientists & engineers

Workshop on Materials Science; Hacettepe Univ, Ankara, 21-22 Sept, 2000.
Sponsors; UNESCO & Hacettepe Univ; **20 Middle East scientists**

2nd Workshop on Structural Molecular Biology (SMB)
Univ. of Cyprus, 6-7 December, 2000. Sponsors; Univ. of Cyprus, Cyprus Inst. of Neurology
& Genetics, Cyprus Planning Bureau & UNESCO. **20 Middle East scientists**

Workshop on Bioinformatics & Structural Modeling; Istanbul, Turkey,
3-8 Sept, 2001; Sponsors; Sabanci Univ. & UNESCO. **20 Middle East scientists**

Opportunities for training as beam line scientists and other SESAME staff

See web site; www.sesame.org.jo

ANNUAL SESAME USERS' MEETINGS SINCE 2002

1st Meeting 19-28 Oct. 2002, Al-Balqa' Applied University, Al Salt, Jordan. **50 Middle East scientists**

2nd Meeting 29 Nov.-1 Dec. 2003, Esfahan, Iran
60 Middle East Scientists

3rd Meeting 11-13 Oct. 2004, Antalya, Turkey
100 Middle East Scientists

4th Meeting 6-8 Dec. 2005, Dead Sea, Jordan
140 Middle East Scientists

5th Meeting 27-29 Nov. 2006, Cairo, Egypt
150 Middle East Scientists

6th Meeting 17-19 Nov. 2007, Amman, Jordan
200 Middle East Scientists



Three SESAME Trainees, Taiwan Light Source Directors C. T. Chen and Keng Liang, plus other NSRRC staff

Seated Left to Right; Tasaddaq Ali Khan (Quaid-i-Azam University; Islamabad, Pakistan); C. T. Chen; Fatemeh Elmi (Tarbiat Modarres University; Tehran, Iran); Ozen Ozgen (Hacettepe University; Ankara, Turkey). Keng Liang is standing, second from the right.



Israeli-Arab students from Ben-Gurion University at NSLS (Brookhaven Lab) for one month, summer 2005. Funded by the US Department of Energy

Lisa Miller, Vivian Stojanoff, Zhong Zhong, Avraham Dilmanian, *Mahmoud Simri*, Herman Winick, Brenda Laster, *Ebrahim Mahajna*, *Sami Khoury-Salameh*

SESAME Accelerator Staff (April, 2008)

AMRO, Adel Vacuum Assistant Engineer
ALADWAN, Ahed Computing and Control
ALNAJDAWI, Mohammad Mechanical Designer
ATTAL, Maher Accelerator Physicist
KHAN, Tasaddaq Control System Engineer
FOUDEH, Darweesh Radio Frequency Engineer
ABU-HANIEH, Thaer Survey and Alignment Engineer
HAMAD, Adli Safety Officer
KAFTOOSIAN, Arash Radio Frequency Engineer
MAKAHLEH, Firas Fluid and Mechanical Systems Engineer
MATALGAH, Salman Computing and Network Administrator
SHEHAB, Maher Head, Mechanical engineering
TARAWNEH, Hamed Accelerator Physicist
VARNASSERI, Seadat Beam Diagnostic Engineer

Plus 4 more by September, 2008 and more next year.

Scientific Directions & Perspectives

- ✓ Biological and Medical Sciences
- ✓ Environmental Sciences
- ✓ Archaeology
- ✓ Material Science/Physics/Chemistry
- ✓ Industrial Applications

More than 70 proposals received from:

United Arab Emirates, Oman, Jordan,
Turkey, Egypt, Israel, Iran, Saudi
Arabia, USA, Canada

*Several are collaborations between scientists
from two or more countries*

Human Histone Deacetylases are flexible enzymes: insights from solution structural analysis of human apo-histone deacetylase 8 (HDAC8)

Authors:

Tzvia Selzer¹, Brian Vash², Said Ali³, Rotem Sertchook¹,
Guenter Grossmann⁴, Peter Atadja², Travis Stams²,
Dalia Cohen², and Irit Sagi¹ *

1. *Dept of Structural Biology, the Weizmann Inst. of Science, **Rehovot, Israel.***
2. *Novartis Institutes for Biomedical Research, **Cambridge, MA USA.***
3. *Department of Biophysics, **Cairo University, Giza, Egypt.***
4. *Molecular Biophysics Group, CCLRC **Daresbury Lab, Warrington, UK***

**Corresponding author*

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irit.sagi@weizmann.ac.il

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

SESAME is Happening!!

www.sesame.org.jo

End of Presentation

Thank you

Projects:

Biological & Medical Sciences

- ✓ Pathogen structure
- ✓ Genetic diversity; plants & microorganisms
- ✓ Metalloenzymes & Metalloproteinases
- ✓ Biosensors
- ✓ Biominerals & Biomineralization

Techniques: Crystallography, XAS, EXAFS, SAX, IR

Projects:

Material Science/Physics/Chemistry

- ✓ Ceramics
- ✓ Glasses
- ✓ Magnetic Materials
- ✓ Polymers
- ✓ Thin Films
- ✓ Superconductors

Techniques: X-ray diffraction, XAS, EXAFS,
Crystallography, IR

Projects: Environmental Science

- ✓ Clay minerals
- ✓ Mineral analysis of rocks
- ✓ Soil contaminants
- ✓ Agriculture & bioremediation

Techniques: X-ray diffraction, XAS, EXAFS,
Crystallography, IR

Industrial Applications

- ✓ Polymer characterisation
- ✓ Synthesis and characterisation of novel materials
- ✓ Chemical analysis
- ✓ Screening for drug design

Techniques: X-ray diffraction, XAS, EXAFS, Crystallography, IR

Clinical Medical Research

Proposals received for

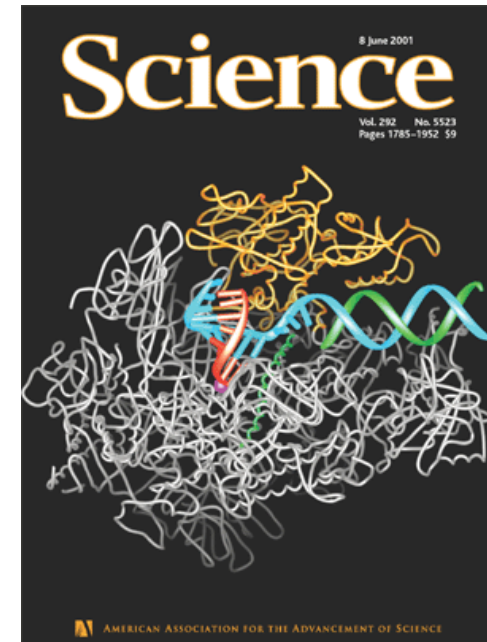
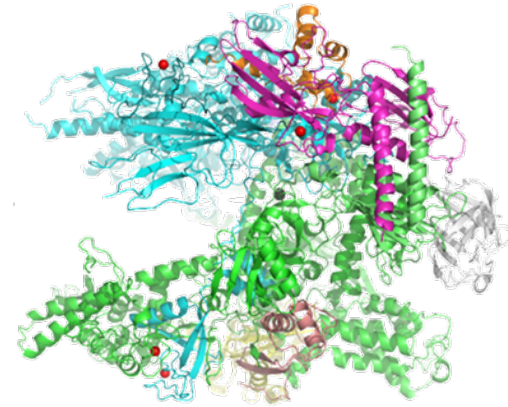
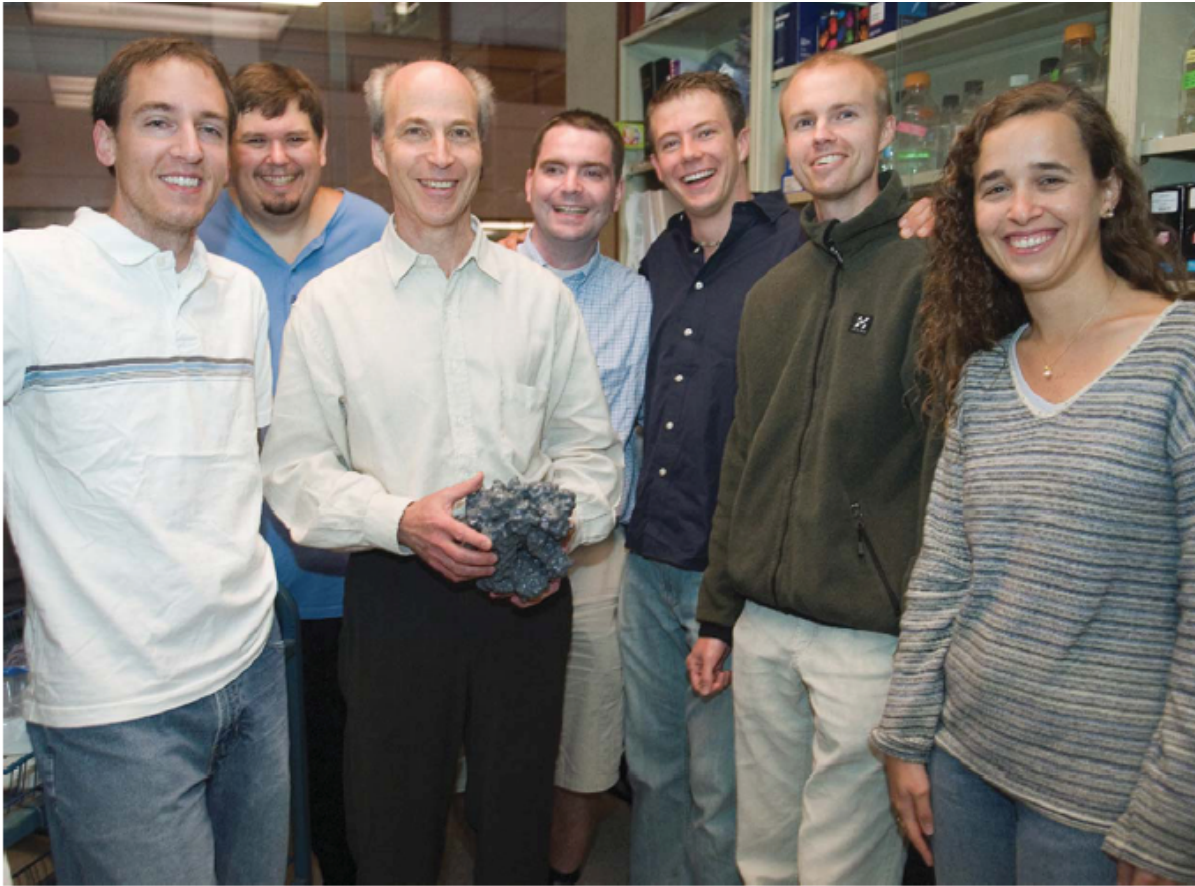
- Diffraction Enhanced Imaging
- Microbeam Therapy
- Photon Activation Therapy

A 7 Tesla superbend or wiggler magnet would provide a spectrum with a critical energy of 29 keV.

Iran says it will build a medical beam line

J. Synchrotron Radiation (2006) 13, 494-495.

Third Nobel Prize for synchrotron work: Stanford celebrates



Roger Kornberg with his team after receiving the news. From left to right, Craig Kaplan, David Bushnell, Roger Kornberg, Karl-Magnus Larsson, Andy Ehrensberger, Henrik Spahr and Maia Azube. (Photograph credit: Linda A. Cicero.)

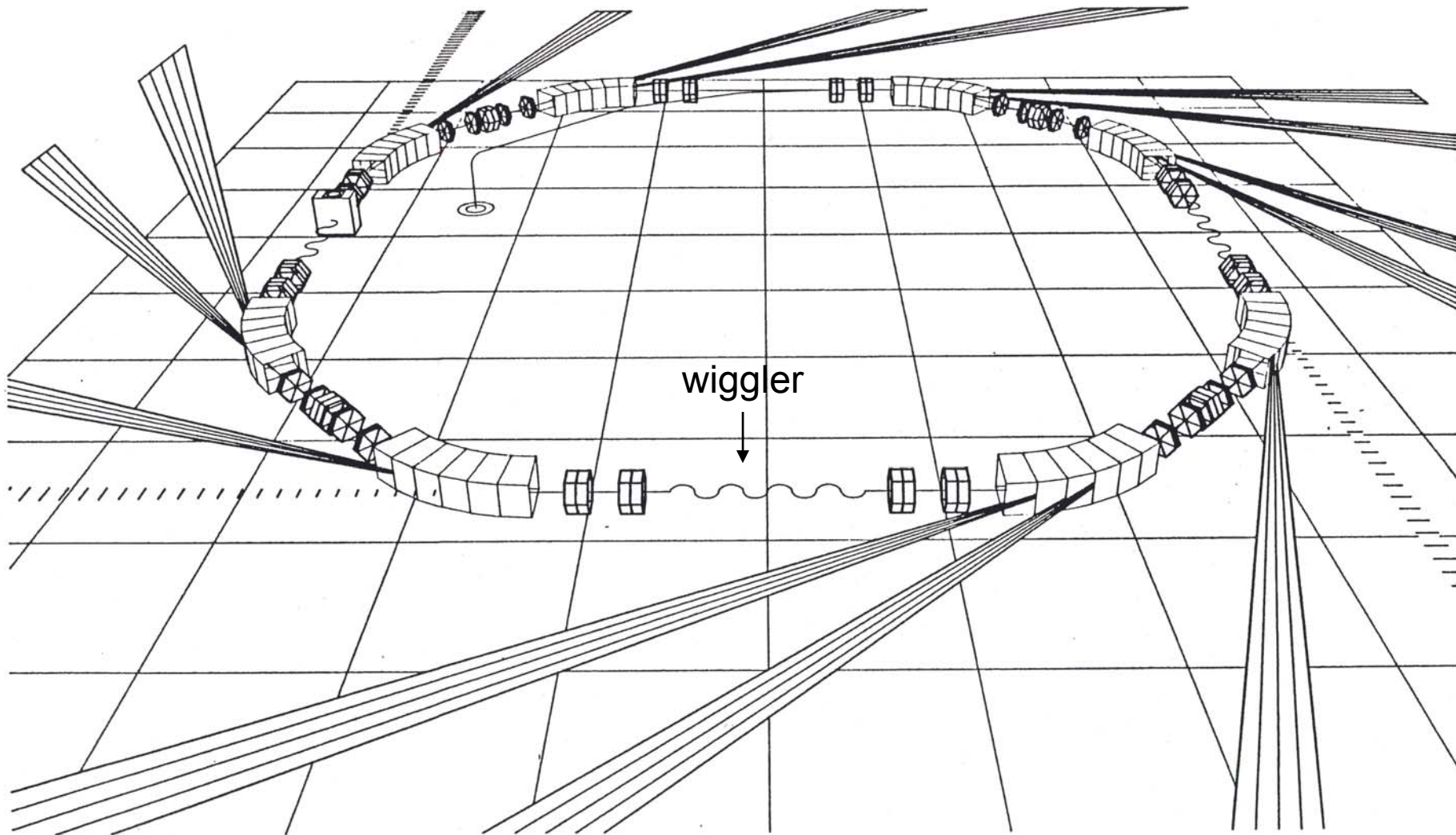


Gus Voss (DESY) watching the boat leave Hamburg harbor on its way to Aqaba, Jordan with BESSY I on board; June 7, 2002

Other Relevant Activities

- **Schools on synchrotron radiation by ICTP**
- **Beam time at Elettra (Trieste) & other facilities**
- **US Department of Energy (DOE) Cooperative Research Program for SESAME**
- **\$50K/year DOE annual grants to UNESCO for SESAME for 4 years**
- **Equipment transfers from other light sources**
 - Complete beam lines from France, UK*
 - Insertion devices/monochromators from US*
- **Fellowships to SR labs around the world**

A small storage ring at Louisiana State University



The SESAME Council

President: **Herwig Schopper** (*former Director-General of CERN*)

(replaced by Chris Llewellyn-Smith in late 2008)

Vice President: **Dinçer Ülkü** (*Hacettepe Univ. Ankara*)

2 delegates from each of the Members (Bahrain, Cyprus, Egypt, Israel, Iran, Iraq, Jordan, Pakistan, Palestinian Authority, Turkey)

The SESAME Directorate

Director: **Khaled Toukan** (*Minister of Education, Jordan*)

Technical Director: **Amor Nadji** (*France & Algeria*)

Administrative Officer: **Yasser Elshayeb** (*Cairo Univ.*)

Scientific Director: **Hafeez Hoorani** (*Pakistan, CERN*)

ADVISORY COMMITTEES TO THE SESAME COUNCIL

Scientific Committee

Chair: Z. Sayers (Turkey)

M.N. Comsan (Egypt),
J.P. Connerade (Pres. Euroscience)
A. Hoummada (Morocco)
S. Mahmoud (Jordan)
I. Sagi (Israel)
M. Vlassi (Greece)

Beam-Lines Committee

Chair: Z. Hussain (Pakistan, LBNL)

J. Bordas (Spain)
N. Hamdan (UEA/Palestine)
S. Hasnain (Pakistan/Daresbury)
E. Ozdas (Turkey)
J. Sussman (Israel)
S. Wakatsuki (Japan, Photon Factory)
H. Winick (USA, SSRL)

Technical Committee

Chair: A. Wrulich (SLS, Switzerland)

F. Asfour (Egypt)
C. Bocchetta (Italy, ELLETRA)
M. Eriksson (Sweden, MAX)
M. Hadizadeh Yazdi (Iran)
A. Nadji (Algeria, LURE)
S. Salman (Palestinian Authority)
E. Weihreter (Germany, BESSY)

Training Committee

Chair: J. Rahighi (Iran)

T. El-Khalafawy (Egypt)
S. Kurokawa (Japan, KEK)
I. Khubeis (Jordan)
R. Mansouri (Jordan)
A. Shoaib (Pakistan)
S. Assaf (Palestine)

UNESCO has played a key role in the development of SESAME (as it has in the creation of CERN)

- Financial support
- Experienced staff and leadership
- A neutral umbrella under which scientists can work cooperatively in spite of tensions among governments, cultural and religious differences, etc.

The UNESCO Executive Board & General Assembly referred to SESAME as

“a model project for other regions” and

“a quintessential UNESCO project combining capacity building with vital peace-building through science”

Key UNESCO staff; Walter Erdelen, Maciej Nalecz, Clarissa Formosa-Gauci

The SESAME concept is attracting attention around the world

*Report of the Synch. Rad. Light Source Working Group
of the Basic Energy Sciences Advisory Comm. of the US
Department of Energy- Oct. 8-9, 1998*

R. Birgeneau (MIT) - Chairman

Z.-X. Shen (Stanford) - Vice-Chairman

from the Executive Summary:

“The most straightforward and most important conclusion of this study is that over the past 20 years in the United States synchrotron radiation research has evolved from an esoteric endeavor practiced by a small number of scientists primarily from the fields of solid state physics and surface science to a mainstream activity which provides essential information in the materials and chemical sciences, the life sciences, molecular environmental science, the geosciences, nascent technology and defense-related research among other fields.”



*Users' meeting site
visit. Nov. 18, 2007*



Hafeez Hoorani
Scientific Director

Amor Nadji
Technical Director



Zehra Sayers
Scientific Comm.

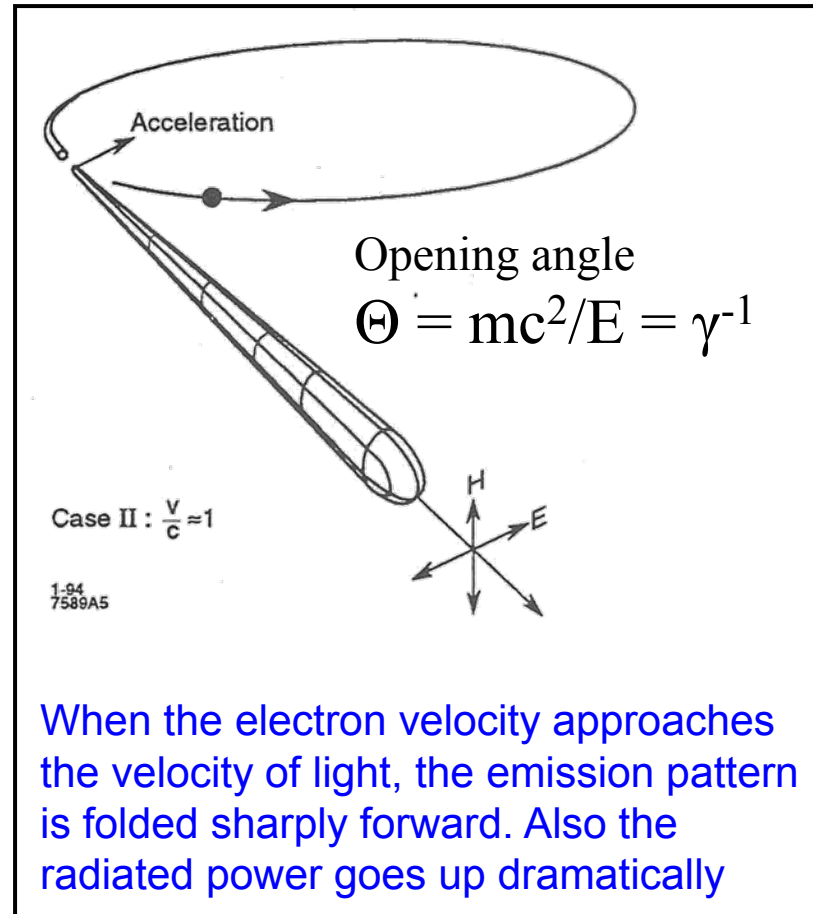
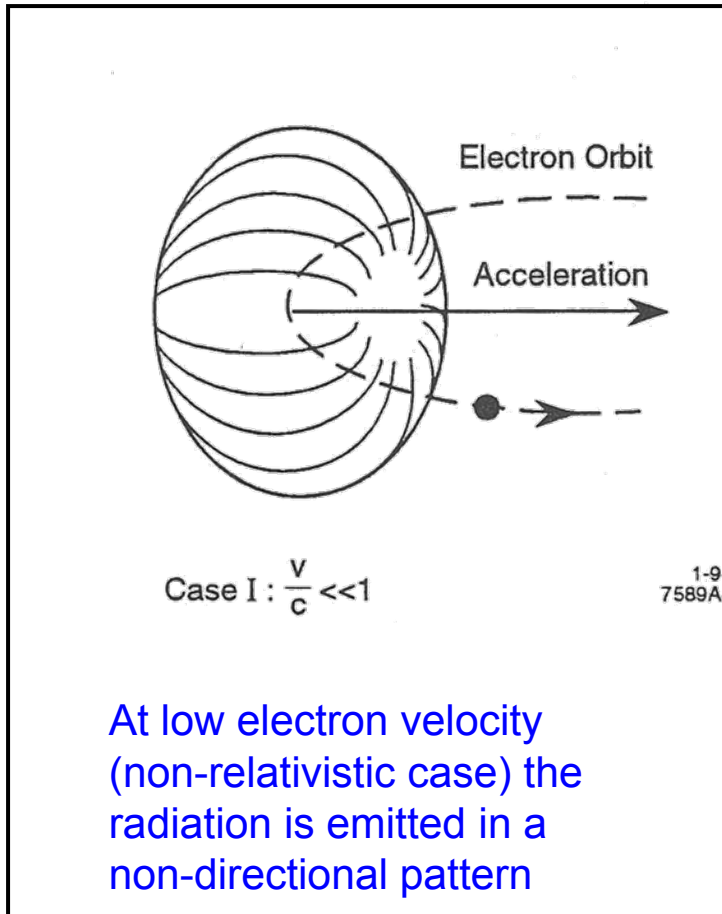
Zahid Hussain
Beamline Comm.



R. Sarraf 10-5-2007

Radiation Fundamentals

- When electrons are accelerated (e.g. linear acceleration in a radio transmitter antenna) they emit electromagnetic radiation (i.e., radio waves) in a rather non-directional pattern
- Electrons in circular motion are also undergoing acceleration (centripetal)



SYNCHROTRON RADIATION

BASIC PROPERTIES

1. **HIGH FLUX, BRIGHTNESS, STABILITY**
2. **BROAD SPECTRAL RANGE - Tunability**
3. **POLARIZATION (linear, elliptical, circular)**
4. **PULSED TIME STRUCTURE (0.01 – 0.1 nsec)**
5. **SMALL SOURCE SIZE (\leq mm)**
6. **PARTIAL COHERENCE**
7. **HIGH VACUUM ENVIRONMENT**

Flux = No. of Photons at given λ within a given $\Delta\lambda/\lambda$
s, mrad Θ

Brightness = No. of Photons at given λ within a given $\Delta\lambda/\lambda$
s, mrad Θ , mrad φ , mm²

(a measure of the concentration of the radiation)



***Signing of
agreement for IAEA
to provide funds for
training of SESAME
scientists &
engineers:
December 7, 2006,
Petra, Jordan***

Ana-Maria Cetto (Deputy D-G, IAEA), ***Herwig Schopper***
(President of SESAME Council), ***Khaled Toukan***
(Director of SESAME & Minister of Education, Higher
Education & Scientific Research of Jordan)



Ground Breaking Ceremony; Allaan Jordan, January 6, 2003