The SESAME Project and the Impact of Synchrotron Radiation in Science and Society in Developing Countries

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Ghana; July 28, 2012

July 28; 0430 am

OUTLINE

- **What is synchrotron radiation (SR)?**
- **Applications** *(biology, chemistry, material science, environment, medicine, industry,…)*
- **SR facilities around the world** *(more than 60)*
- **Impact on developing countries**
- **SESAME;** *an example of a regional international light source in the developing world*
- **A similar project for Africa;** *(with help from UNESCO, IAEA, EU, Japan, China, US… Initiative from Africa)*

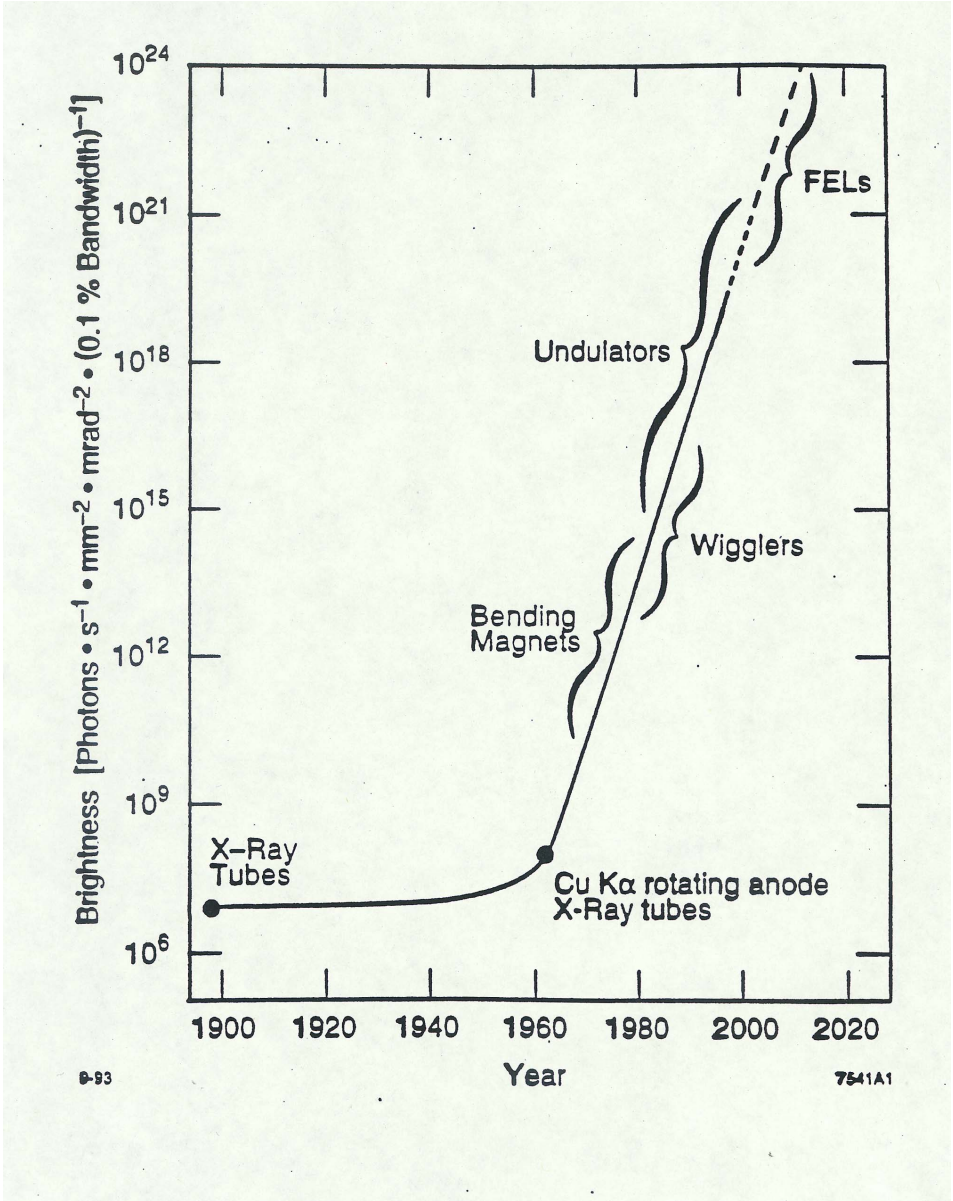
Physics Today, October 2003; page 32

Alexander Animalu, past president of the Nigerian Academy of Science and chairman of the Institute for Basic Research in Abuja, Nigeria,

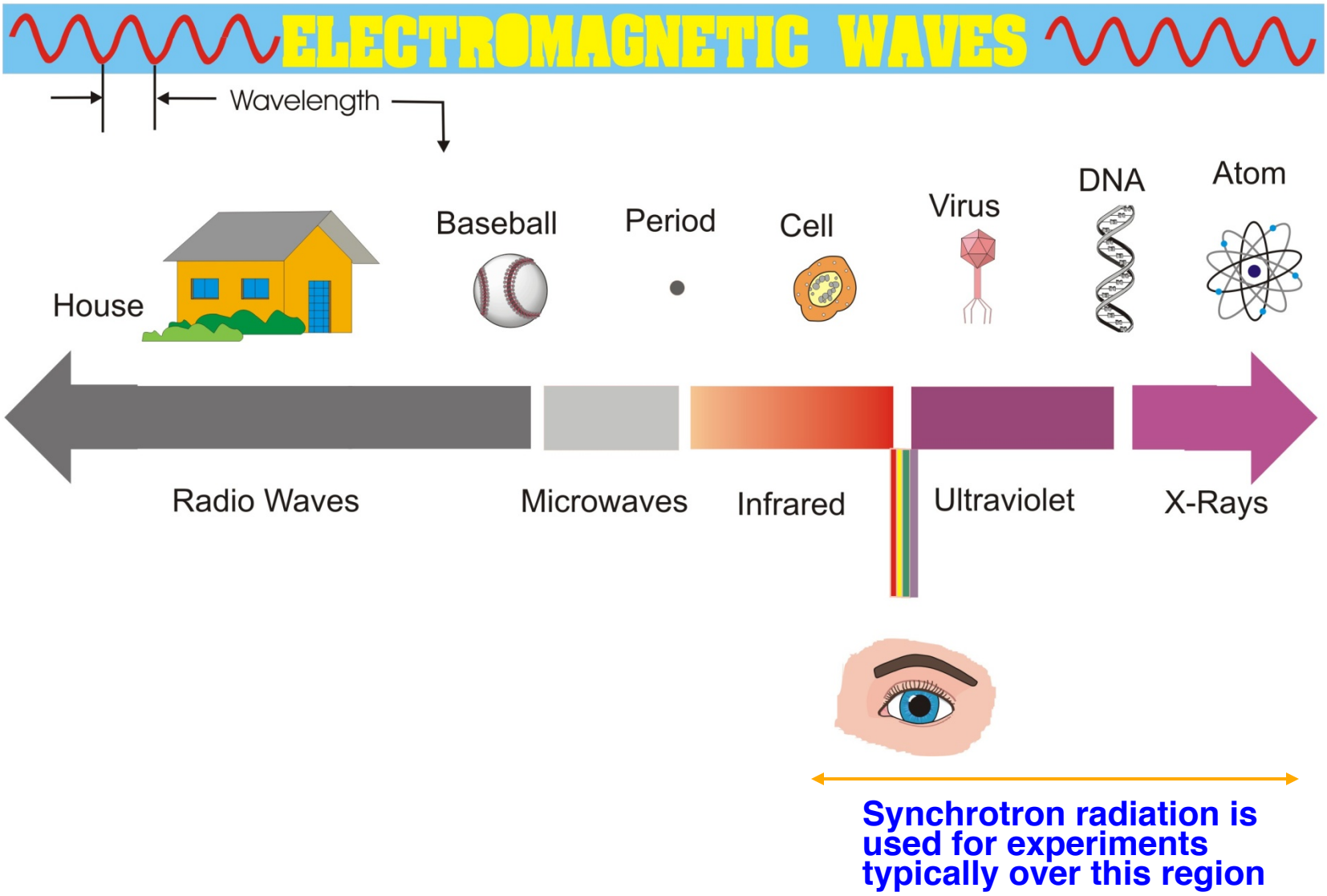
"Given Nigeria's bloated foreign debt, high rate of inflation, mass unemployment, fuel crisis, collapse of the health and educational sectors, deterioration of the infrastructure of roads, epileptic electric power supply, religious riots, ethnic militia, and insecurity of life and property, the only hope of tackling this myriad of problems is by focusing on science- and technology-driven socioeconomic initiatives."

An African Synchrotron Light Source Research Facility

X-ray brightness as a function of time

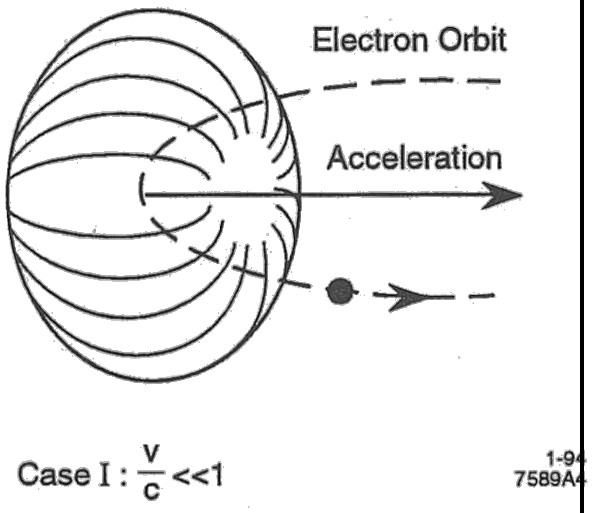


Electromagnetic Radiation - How It Relates to the World We Know

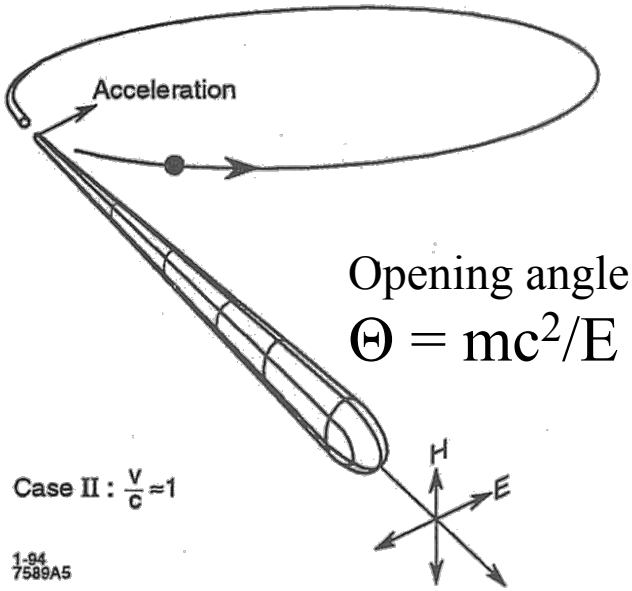


Radiation Fundamentals

- 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)



At low electron velocity (non-relativistic case) the radiation is emitted in a non-directional pattern



When the electron velocity approaches the velocity of light, the emission pattern is folded sharply forward. Also the radiated power goes up dramatically

X-rays Have Enabled Seminal Scientific Discoveries

20 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

2009: VENTKATRAMAN RAMAKRISHNAN,
THOMAS STEITZ, ADA YONATH

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 (SR) Facilities Around the World

- **>60 in operation; 20 countries; >30,000 Users**

  In many technologically advanced countries plus

  Brazil, Korea, Taiwan, Thailand…

- **Recently completed or in construction**

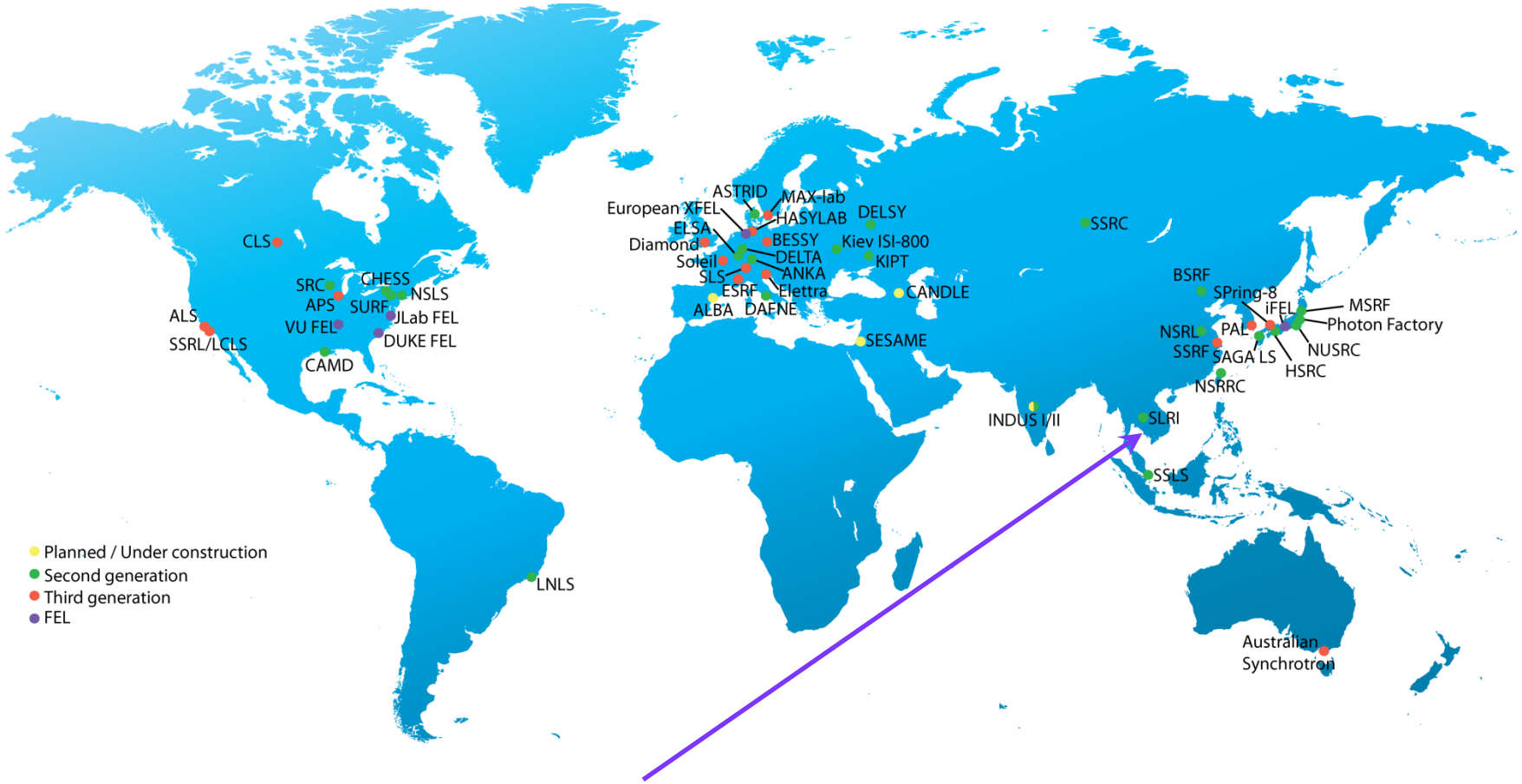
  Armenia, Australia, Brazil, China, France, Japan, Jordan, Korea, Poland, Russia, Spain, Sweden, Taiwan, UK, US

- **More in design/planning**

For links to SR facilities around the world and information on SR see

www.lightsources.org

Synchrotron sources around the world



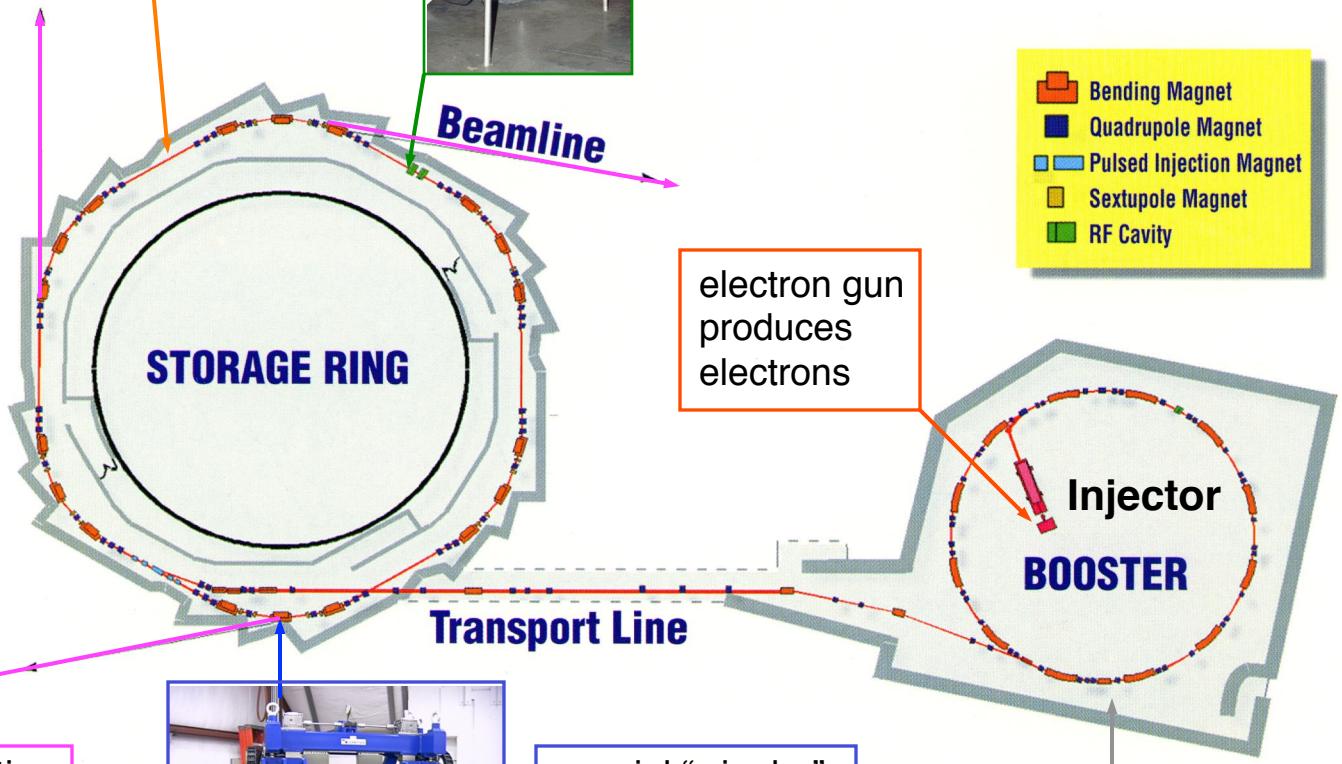
SLRI (Synchrotron Light Research Institute) is located in **Nakhon Ratchasima, Thailand**

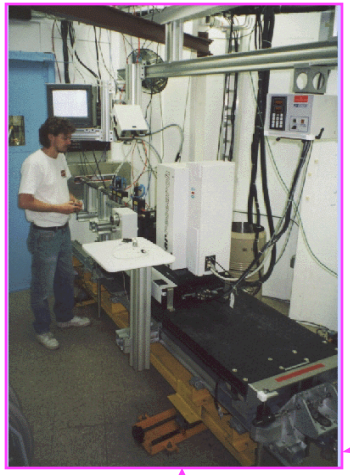
สถาบันวิจัยแสงซินโครตรอน (องค์การมหาชน)
Synchrotron Light Research Institute (Public Organization)

Synchrotron Radiation - How is it Practically Produced and Used for Research?

the storage ring circulates electrons and where they are bent - synchrotron radiation is produced

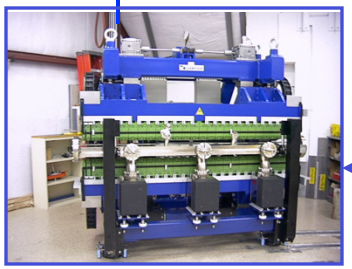
klystrons generate high power radiowaves to sustain electron acceleration, replenishing energy lost to synchrotron radiation





electron gun produces electrons

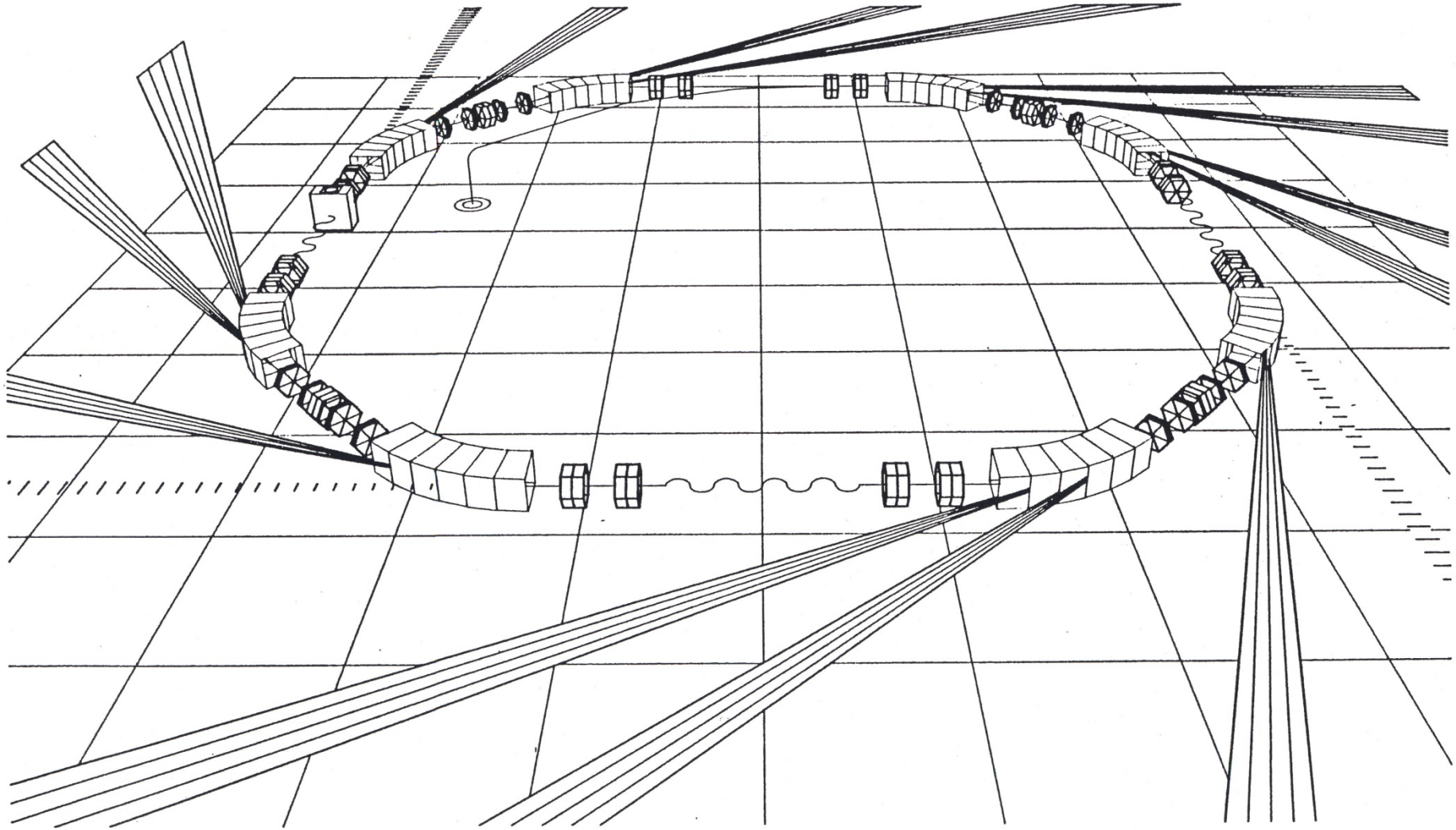
beam lines transport radiation into “hutches” where instrumentation is available for experiments



special “wiggler” insertion devices used to generate x-rays

linear accelerator/booster accelerate e^- which are transported to storage ring

CAMD – Louisiana State Univ. 1.2 GeV



Why a Synchrotron Radiation Facility in the Developing World?

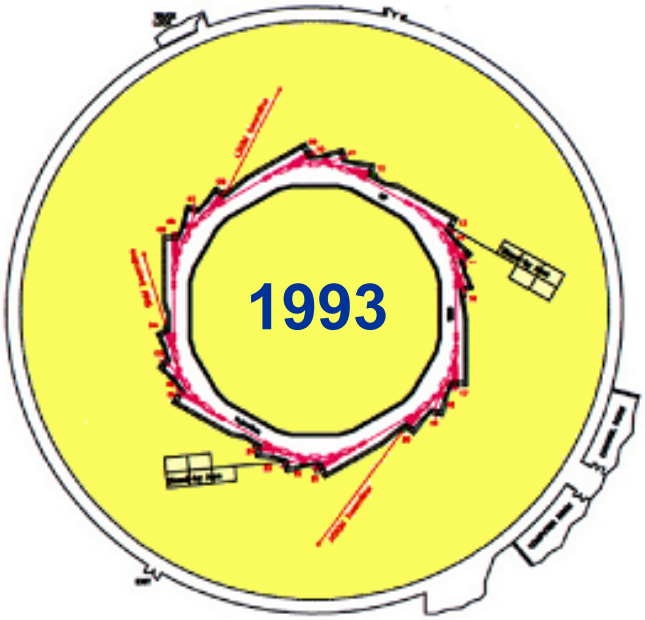
- **World-class basic & applied research**
- **Train graduate students who will no longer have to go abroad**
- **Attract scientists working abroad to return (*reverse the brain drain*)**
- **Address regional biomedical & environmental issues/concerns**
- **Promote development of high-tech industry (*capacity building*)**
- **Use scientific cooperation to promote peace & understanding between people from different traditions, religions, races, & political systems.**

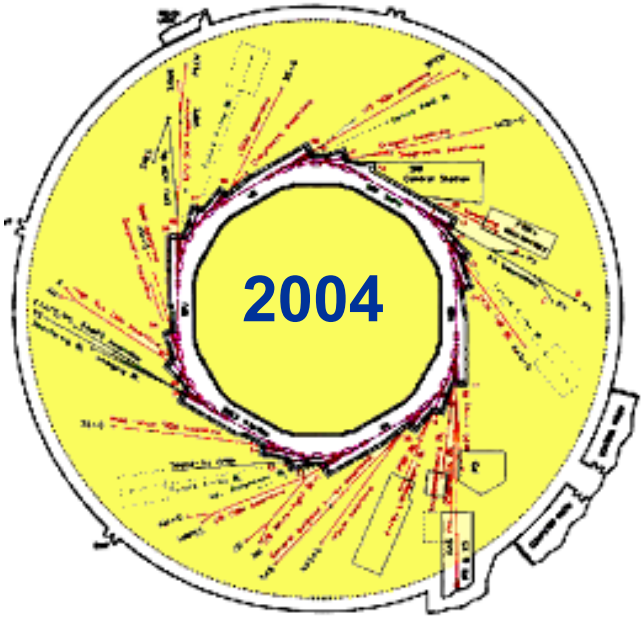
Experience at Synchrotron Radiation Laboratories which Started in Developing Countries in the 1980's

Consider particular examples;
China, Brazil, Korea, Taiwan

Each started with a low energy second generation facility. Based on the experience with ~15 years of operation, each has built, or is building, a higher performance third generation facility costing ~$200m or more.

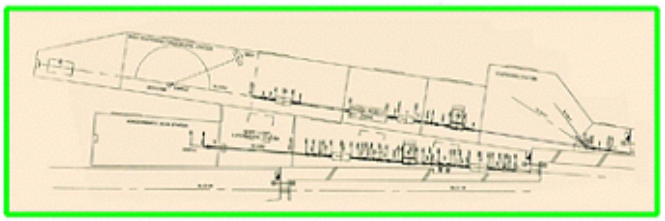
Taiwan Light Source (TLS) Facility Development





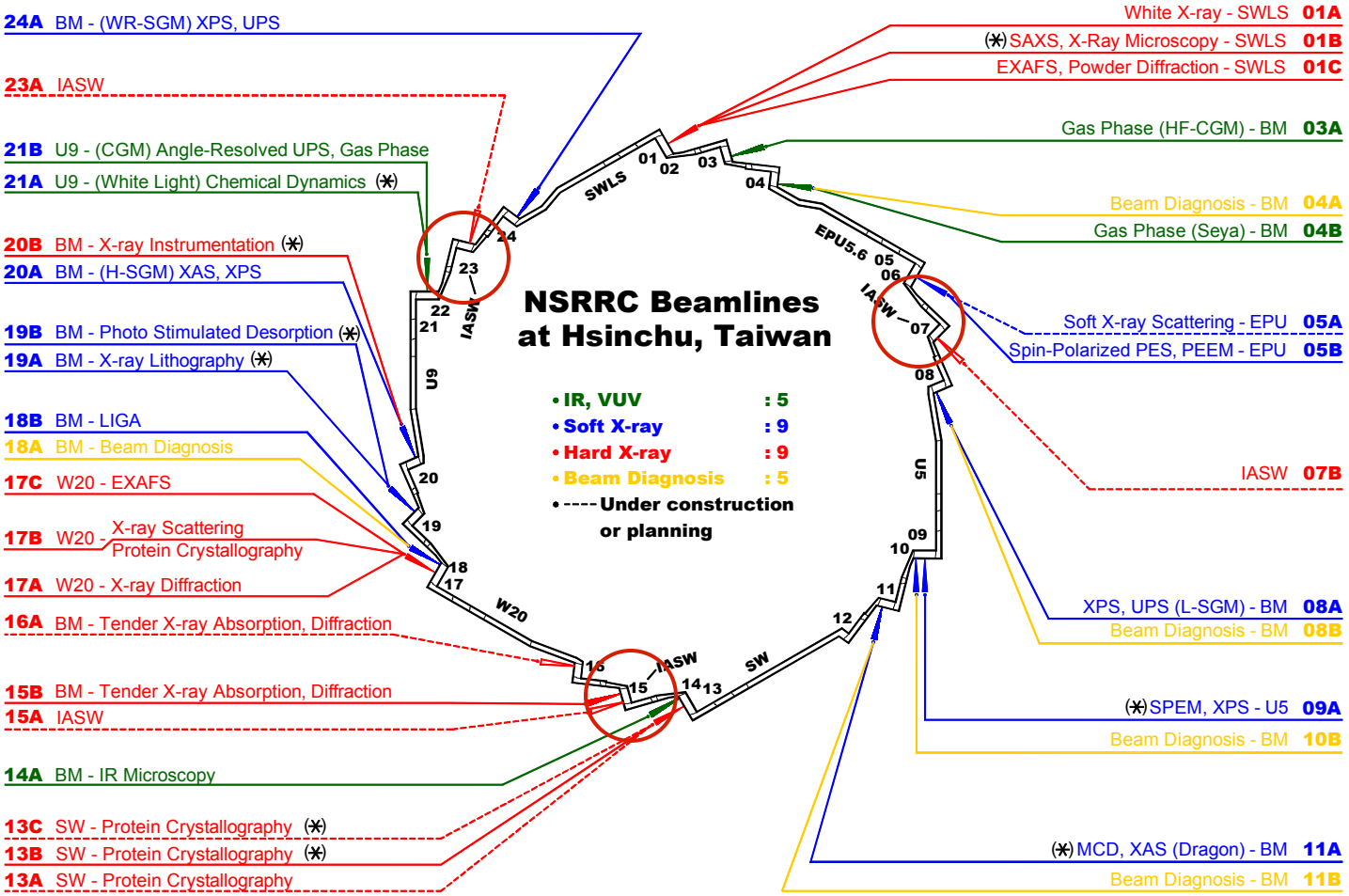
+

- Light Source: 1.3 → 1.5 GeV
- Insertion Devices: 0 → 8
- Beamlines: 3 → 23
- End Stations: 3 → 35



Taiwan Contract Beamlines at SPring-8, Japan

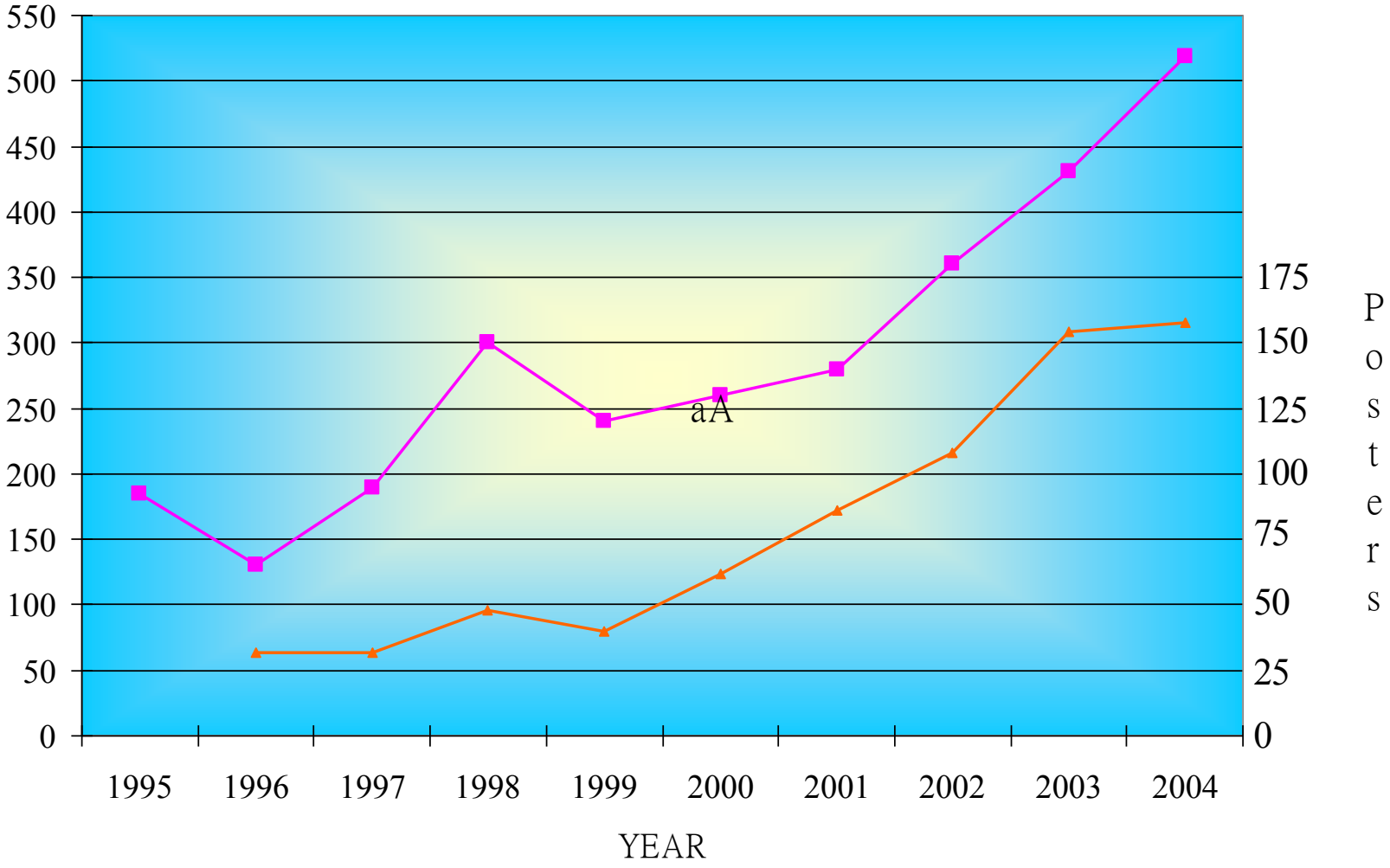
NSRRC Beamline Map



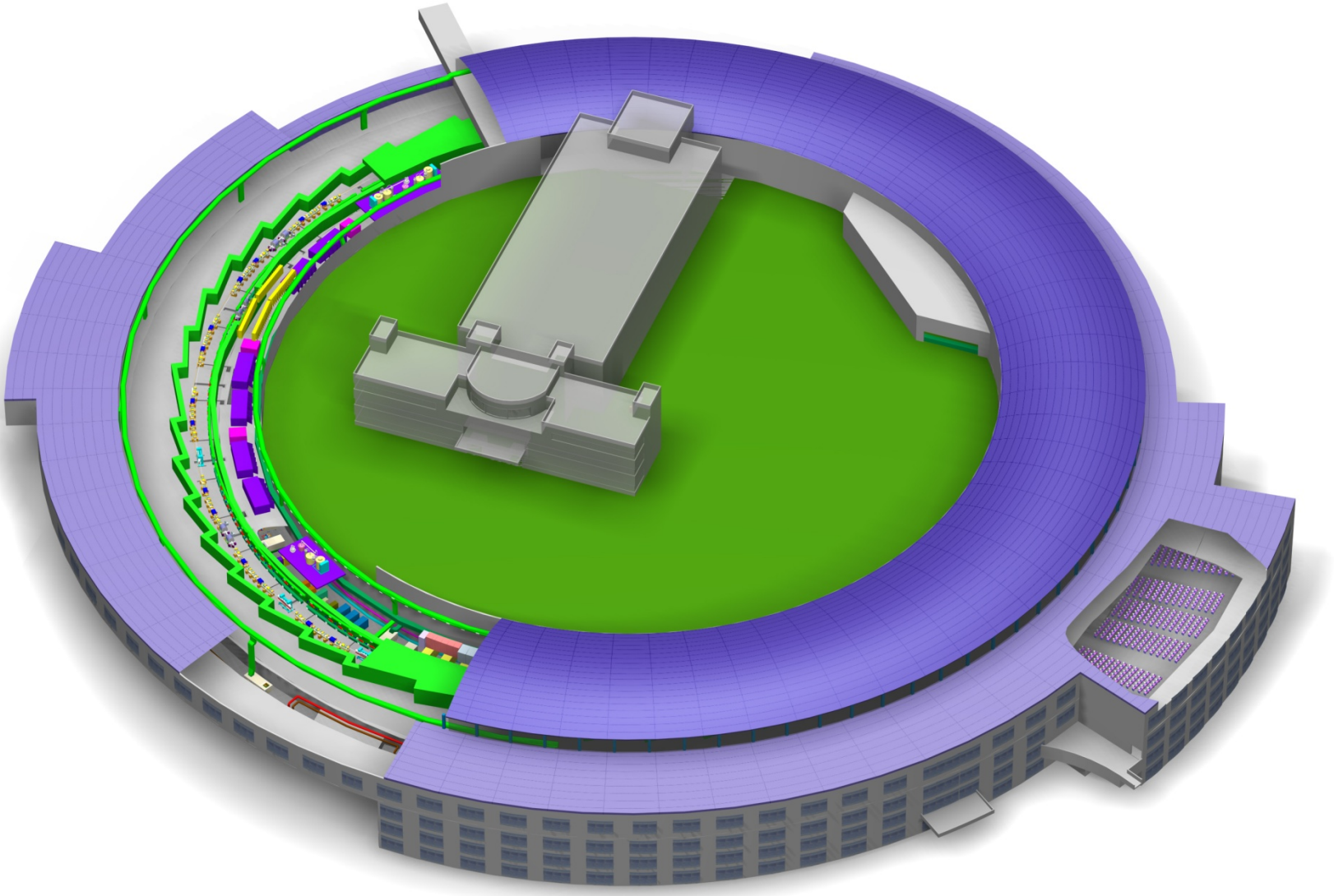
- Insertion Devices
  - EPU5.6: Elliptically Polarized Undulator (5.6 cm , 66 Periods)
  - IASW: In Archomatic Superconducting Wiggler (3.5 T, 15 Poles)
  - SW: Superconducting Wiggler (3.2 T, 32 Poles)
  - SWLS: Superconducting Wavelength Shifter (6 T)
  - U5: Undulator (5 cm, 76 Periods)
  - U9: Undulator (9 cm, 48 Periods)
  - W20: Wiggler (1.8 T, 27 Poles)
- (⚹) : Participating Research Group
- NSRRC website: www.nsrrc.org.tw

June 2004

Attendance at Annual Users Meeting




財團法人國家同步輻射研究中心
成立暨揭牌典禮
國家同步輻射研究中心



One of the Brightest Synchrotron X-ray Sources in the World; in Construction in Taiwan

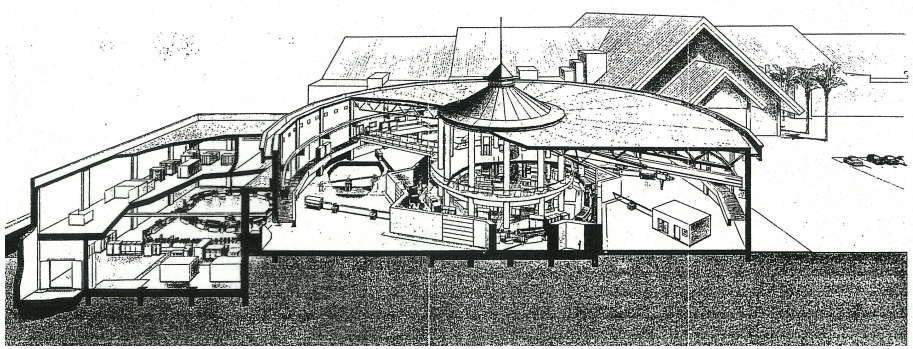
TPS Machine Advisory Committee, 2011

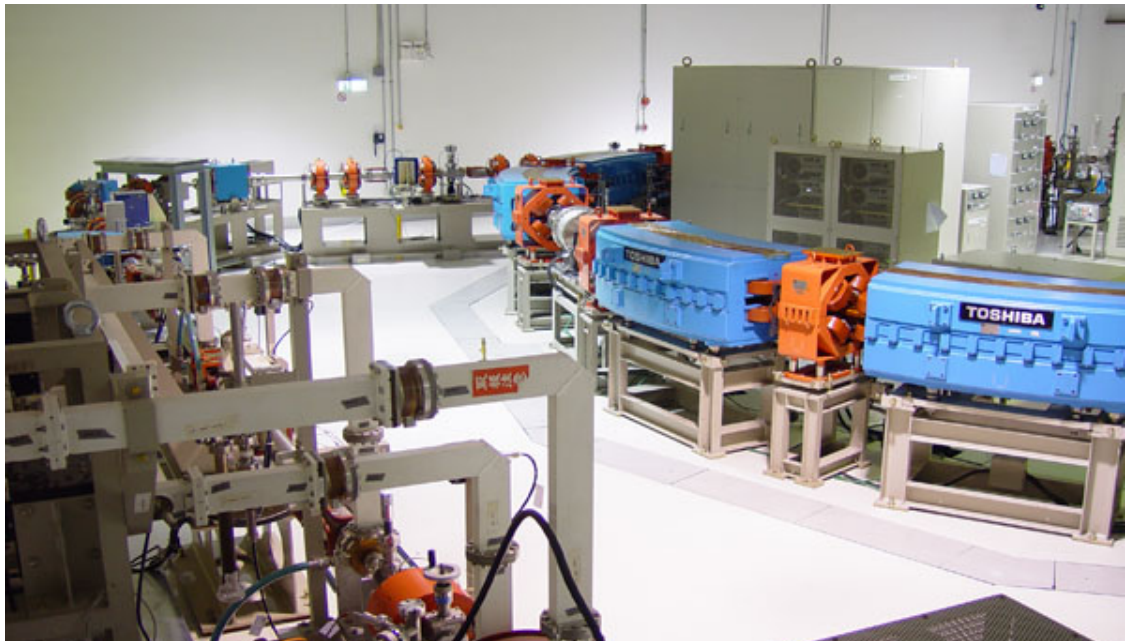
International Review Committee for first Taiwan Light Source (TLS); 1984-94

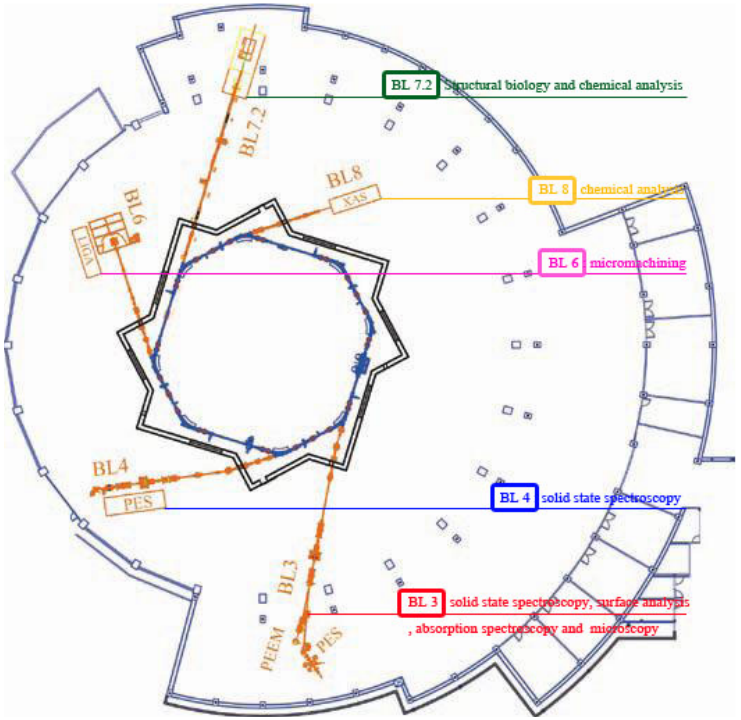
Siam Photon Source

Prapong Klysubun
Synchrotron Light Research Institute (SLRI)

Synchrotron light in Thailand
SIAM facility; gift by Japan of 1 GeV SOR-Tech facility
An initiative by Takehiko Ishii





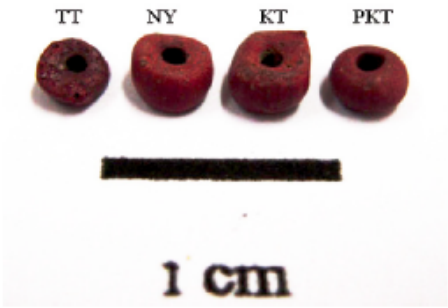


National Synchrotron Research Center (NSRC); Thailand

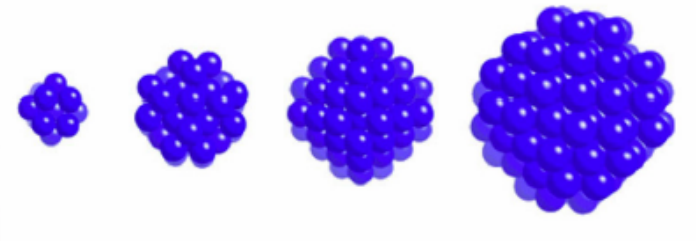
Researches at SLRI

Synchrotron light and archaeology

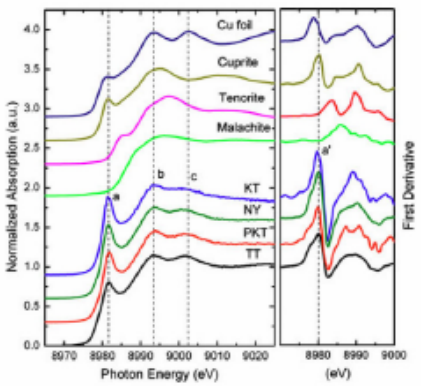
Origin of red color in ancient glass beads



Ancient glass beads



Metallic copper cluster



X-ray absorption spectra

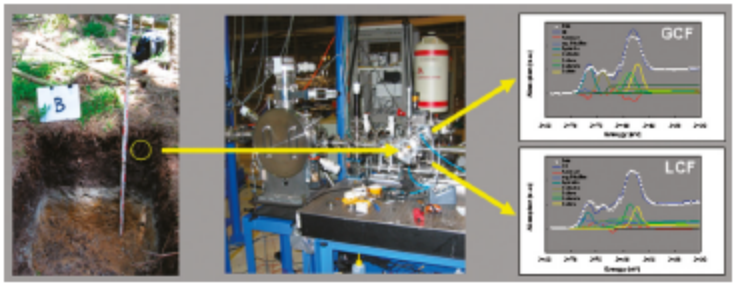
Scientists used synchrotron x-rays at SLRI BL8 to reveal the origin of red coloration in Thailand's ancient glass beads. These glass beads were collected from archeological sites in three southern provinces of Thailand: Krabi, Ranong, and Pang-Nga, dated back to 10 – 710 AD. It was found from this study that the red color in the glass beads comes from the red colorant mixture of copper and iron very similar to the mixture invented in Europe around 1400 BC, suggesting that in the past there might have been a transfer of glass-making techniques between the two continents. This research also reveals that there are two forms of copper in the glass beads, that is, about half of the copper ions present in the glass beads are bonded to oxygen and another half are in the form of metallic copper. By using computational calculation, the team of scientists was able to conclude that the metallic copper clusters in the glass beads are responsible for the beads' red color.

[XAS study on copper red in ancient glass beads from Thailand, Klysubun W. et al, Anal Bioanal Chem 399, 3033 (2011)]

Researches at SLRI

Synchrotron light and environment

Speciation of sulfur in soil



Soil measurement at BL8

Environmental samples such as soil usually contain a large variety of electronic oxidation states, or 'forms', of sulfur. As each of these forms behaves differently regarding its biological, chemical, geological, and physical reactions, it is desirable for environmental scientists to be able to accurately determine the form of sulfur in soils. The ability to do so is invaluable for the investigation of soil pollution and contamination.

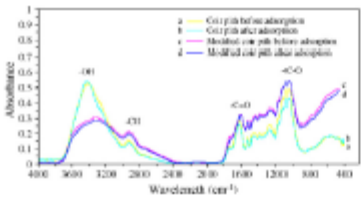
A group of researchers from Technische Universität München, Germany, together with SLRI BL8 team, have looked into the method of identify the form of sulfur in soil samples. The scientists found that with suitable measurement setup such as SLRI BL8 together with appropriate data analytical methods, they can accurately identify quantitatively the forms of sulfur in soil to within ±5 to 10%.

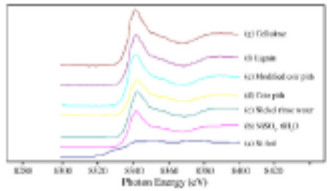
[Sulfur speciation in soil by S K-edge XANES spectroscopy: comparison of spectral deconvolution and linear combination fitting, Prietzel, J. et al, Environ. Sci. Technol. 45, 2878 (2011)]

Synchrotron light and environment

Coir pith: potential substance for treating metal-contaminated wastewater

Coir pith and coir fiber from a coconut





Measured spectrum of modified coir pith

Coir pith, also known as coco peat, is the spongy material found inside a coconut between the outer husk and the inner hard shell. We can find this coir pith as a by-product from mattress factories, left after the coir fiber is extracted for use as padding. Scientists found that it contains a high amount of lignin (36%) and cellulose (44%), and has potential for treatment of polluted water, more specifically, to remove both chromium and nickel from electroplating wastewater. At SLRI BL8, a team of researchers from King Mongkut's University of Technology Thonburi found that most of the chromium bound on the coir pith was changed from a previously toxic to a non-toxic form, and the lignin structure in coir pith may be involved in the mechanism of chromium adsorption. Later, the team modified the coir pith with sodium hydroxide (caustic soda) and was able to significantly increase its nickel adsorption ability.

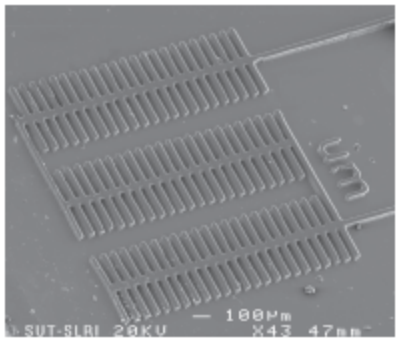
[Comparison of nickel adsorption from electroplating rinse water by coir pith and modified coir pith, Ewacharoen, A. et al, Chemical Engineering Journal 137.2, 181 (2008). Chromium removal from electroplating wastewater by coir pith, Suksabye, P. et al, Journal of Hazardous Materials 141.3, 637 (2007).]

Researches at SLRI

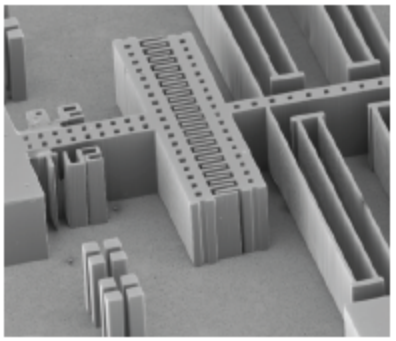
Synchrotron light and industry

Fabricating microstructures and devices

Deep x-ray lithography (DXL) is a fabrication technique that utilizes synchrotron x-rays for making a very small three dimensional structures. These microstructures can be used to make micro-mold inserts for subsequent mass production of micro-parts. At SLRI BL6, DXL technique is utilized to make a wide variety of microdevices that can be applied for uses in different types of industrial applications. For example, humidity sensors that were made can be used in agricultural industry such as in poultry farms. Acceleration sensors, which had also been fabricated at SLRI BL6, can be used as shock sensors for automotive air bag activation system as well as for harddisk shock protection system.



Humidity sensor



Microactuator

Microscale emblem

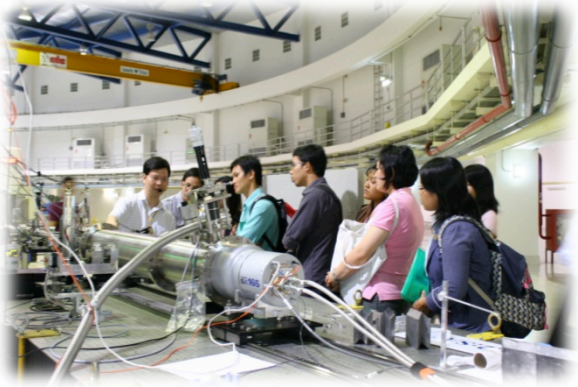
ASEAN Science Camp

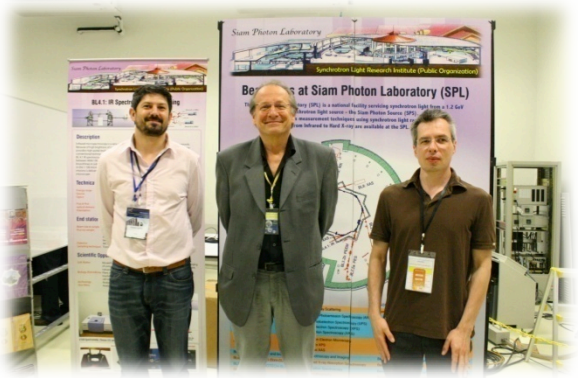
The Summer Science Camp is arranged annually. Now it is in its 9th year and it has just been expanded from previously accepting only Thai student participants to include students from all the ASEAN countries.

High School Physics Teacher Training

The High School Physics Teacher Training is also arranged annually. Now it is in its 3rd year.

ASEAN Workshop on Infrared Spectroscopy and Imaging (AWIR)





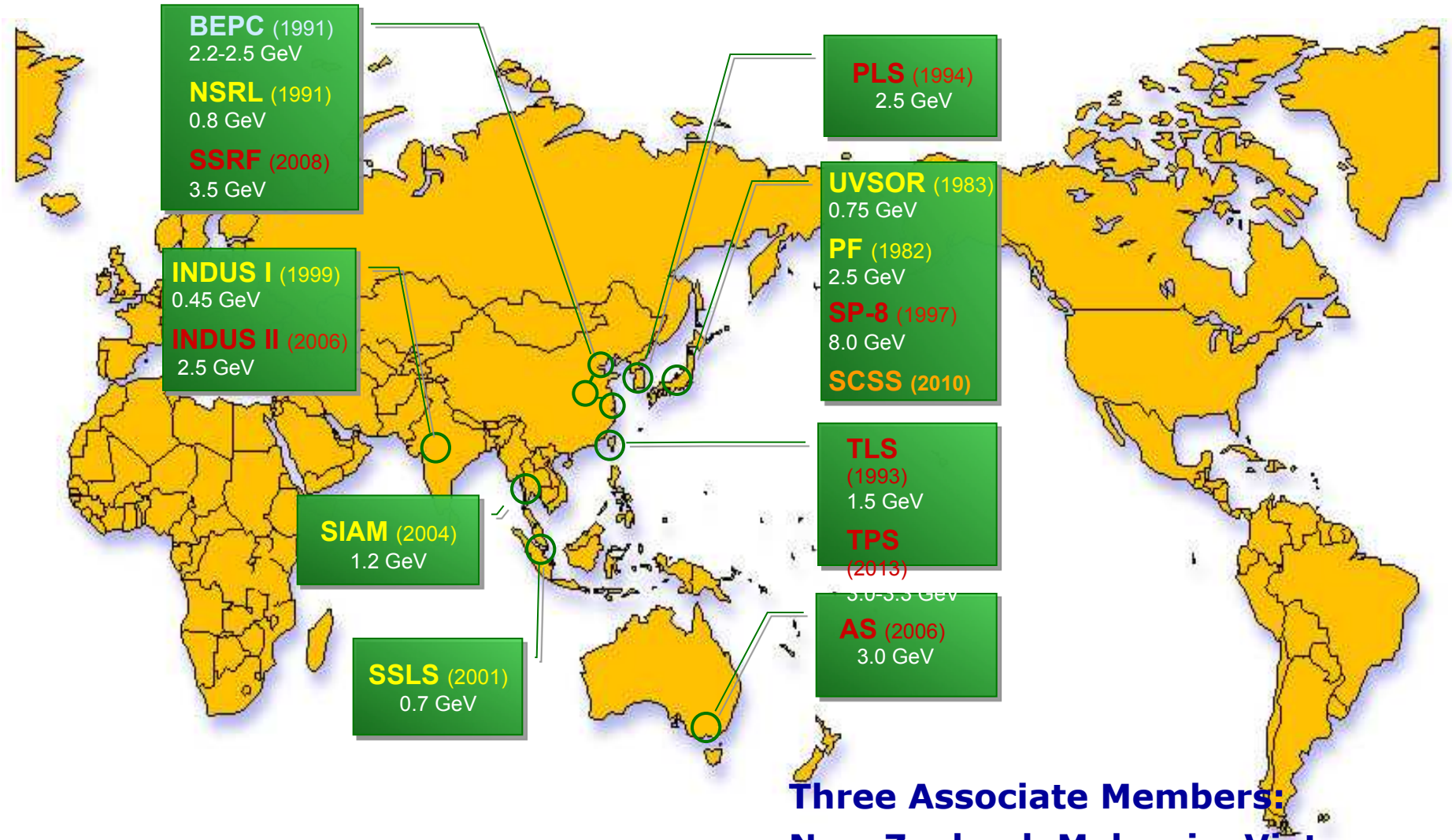
ASEAN Protein Crystallography Workshop

สถาบันวิจัยแสงซินโครตรอน (องค์การมหาชน)
Synchrotron Light Research Institute (Public Organization)

ASEAN Workshop on Photoemission Electron Spectroscopy and Microscopy (APESM)

ASEAN Workshop on Small Angle X-ray Scattering (AWSAXS)

Asia Oceania Forum of SR Research



Three Associate Members:
New Zealand, Malaysia, Vietnam

Asia/Oceania Forum for Synchrotron Radiation Research

AOFSRR Objectives

To encourage regional collaboration, and to promote the advancement of, synchrotron radiation research and related subjects in Asia and Oceania.

Specific Activities:

(1) Organization of scientific collaboration meetings
(2) Exchange of information of facilities and user groups
(3) Provide a framework for cooperative activities

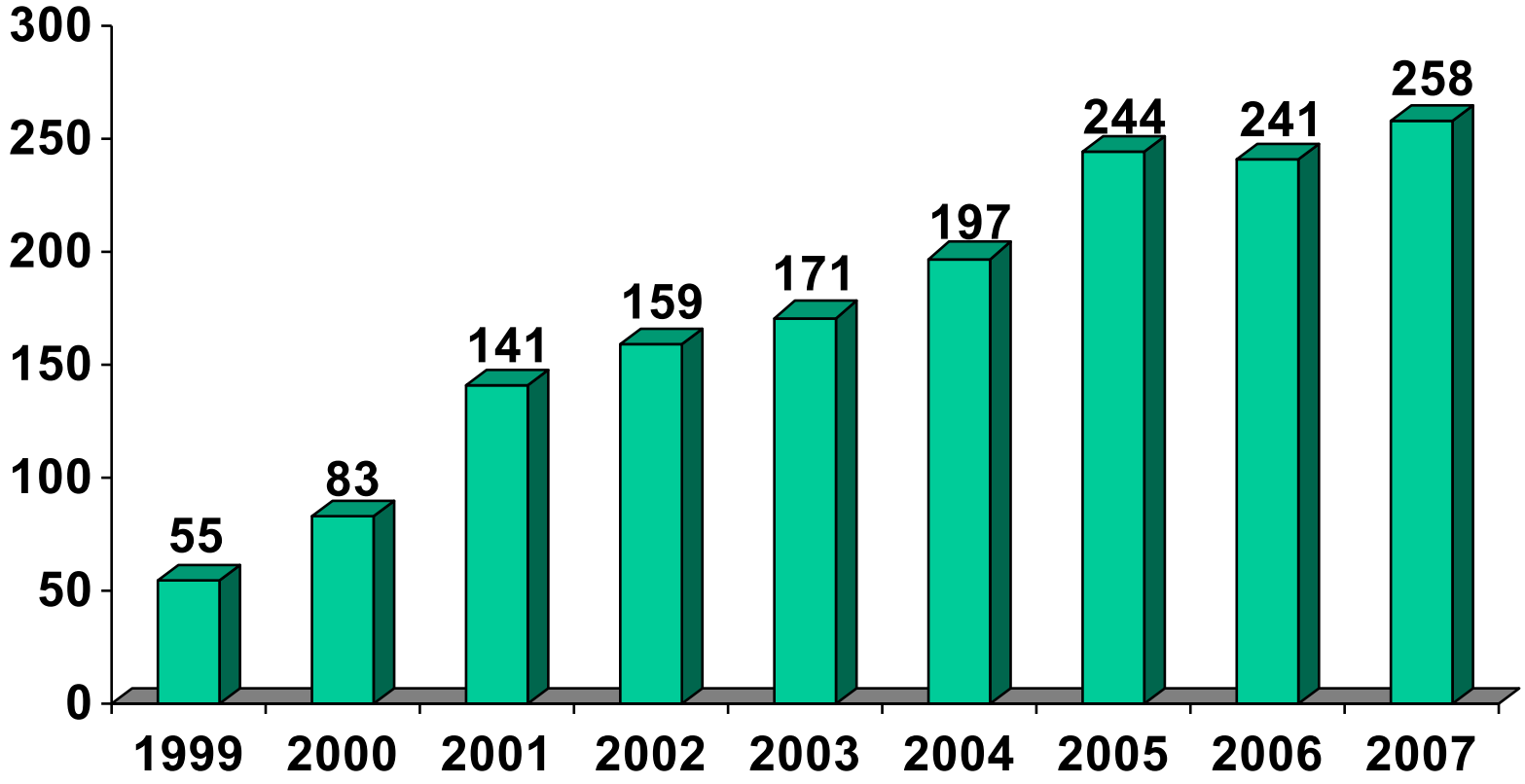
Benefits of Light Sources to Developing Countries

STUDENT INVOLVEMENT WITH KOREAN LIGHT SOURCE

	2004	**2007**
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

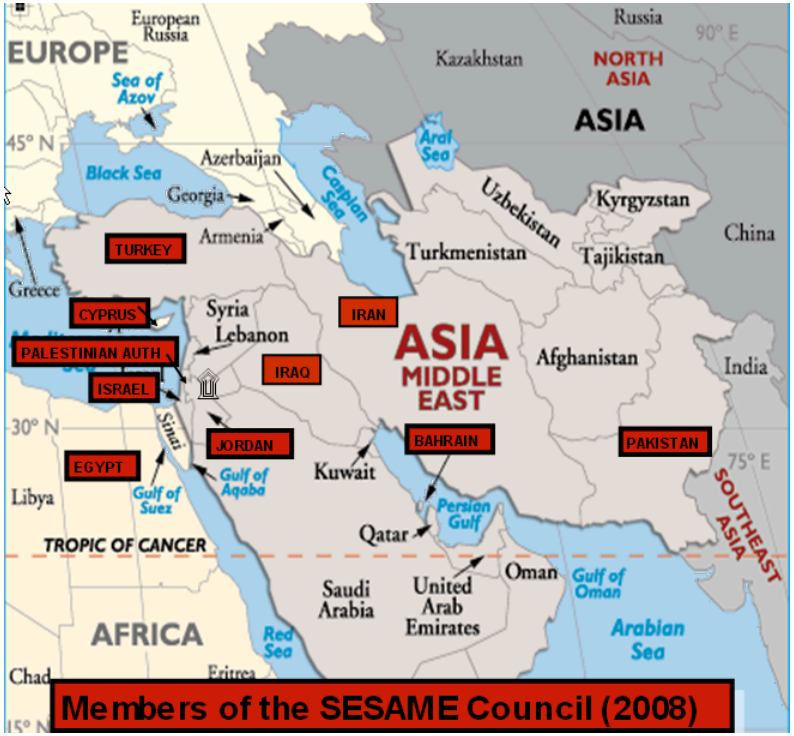


* Data from March 6th, 2008.

SESAME = *S*ynchrotron-light for *E*xperimental *S*cience and *A*pplications in the *M*iddle *E*ast

A 2.5 GeV light source facility, under construction near Amman, Jordan

Under UNESCO Auspices, Modelled on CERN



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

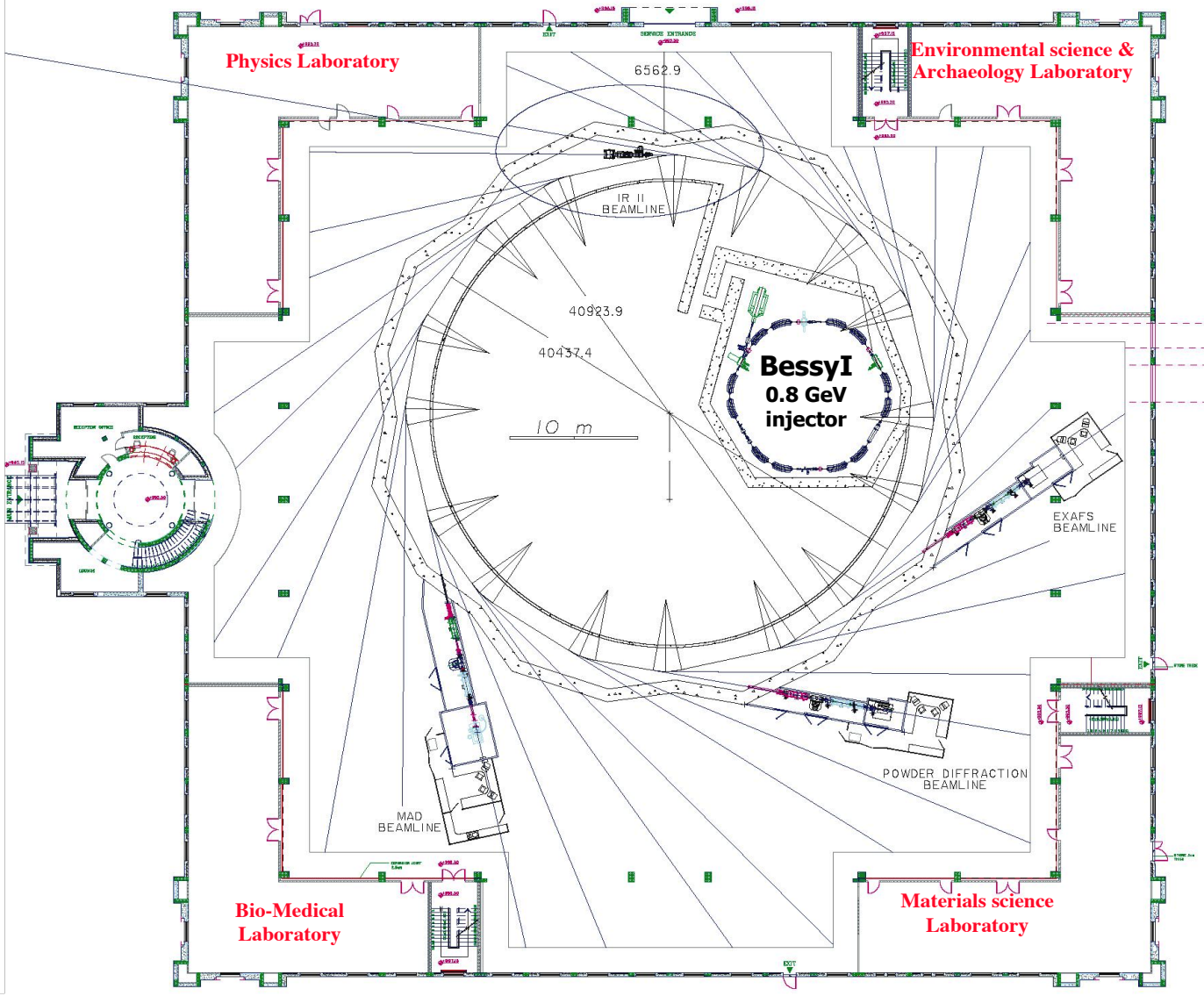
Observers: France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russia, Sweden, Switzerland, UK and USA.

Purpose: Foster excellent science and technology in the Middle East (and prevent or reverse the brain drain)

\+ Build bridges between diverse societies

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

SESAME; *in construction in Jordan*
www.sesame.org.jo



2.5 Gev

400 mA

C = 133 m

Emitt; 26 nm

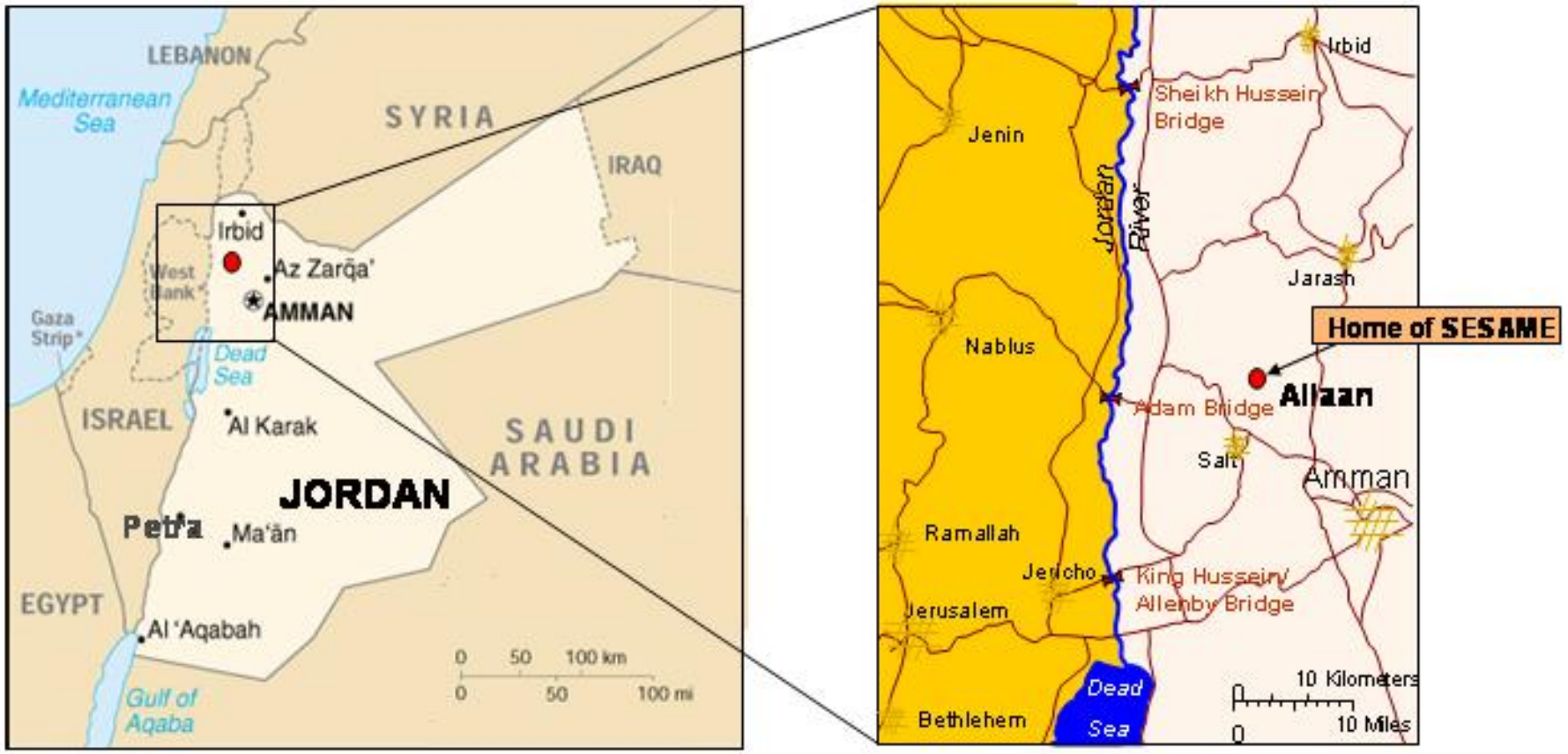
12 spaces for wigglers or undulators

16 bend magnet lines

Beam lines up to 36 m long

Operational in 2013-14

The SESAME Members



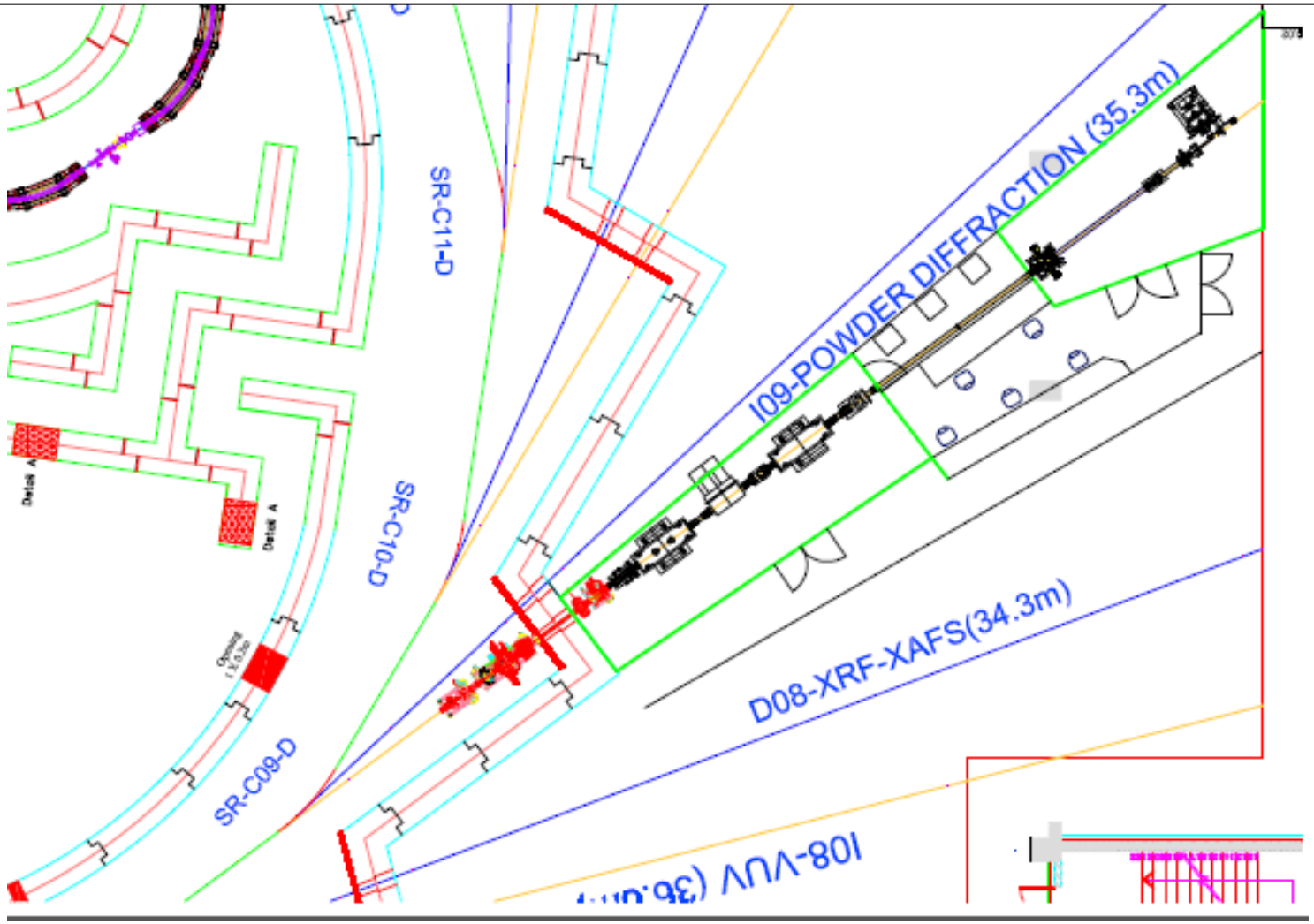
SESAME location in Allaan, Jordan

SESAME Building in Allan, Jordan

Shielding Completed, May 2011

Design of Powder Diffraction Beamline

Made by a team for scientists & engineers from Turkey
+ SESAME staff



Tests of the MICROTRON Subsystems

Donated Equipment

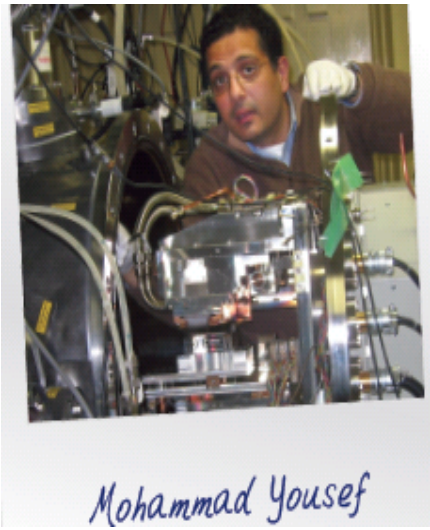
- **From Germany**
  - BESSY 1
- **From LURE, France**
  - Beamline, undulator, …
- **From SLS, Switzerland**
  - Beamline, wiggler
- **From Daresbury Lab & University of Liverpool, UK**
  - Five beamlines, value if new over €20M
- **From SLAC, Stanford University, USA**
  - Undulator,…
- **From ALS, Berkeley, USA**
  - Wiggler
- **From Elettra, Italy**
  - Cavities
- **From ESRF/Helmholtz (Germany)**
  - Rossendorf beamline

3rd SESAME User Meeting

October 11-13, 2004, Antalya, Turkey

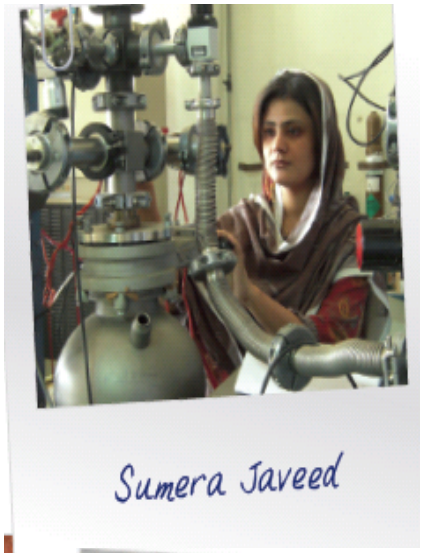
9th Users' meeting in Amman November 2011

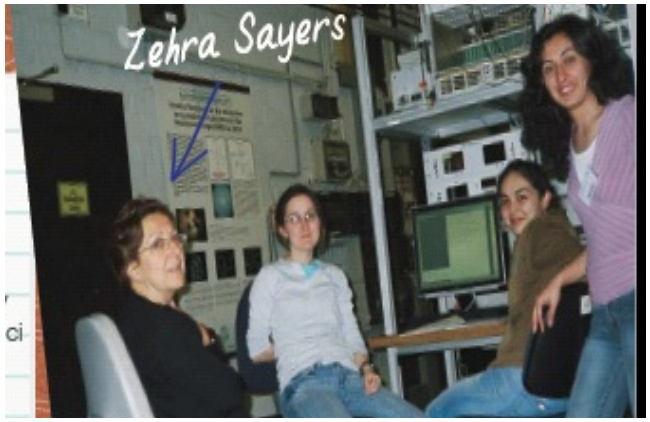
Some SESAME People, including Users of Day One Beamlines



← Egypt

Pakistan →

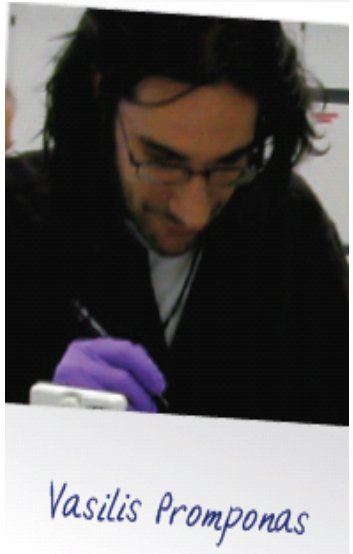




Turkey

Palestinian Authority

Israel



Cyprus

Palestinian Authority

SESAME

SESAME

JSPS-Sabanci School

March 1 – 5, 2010

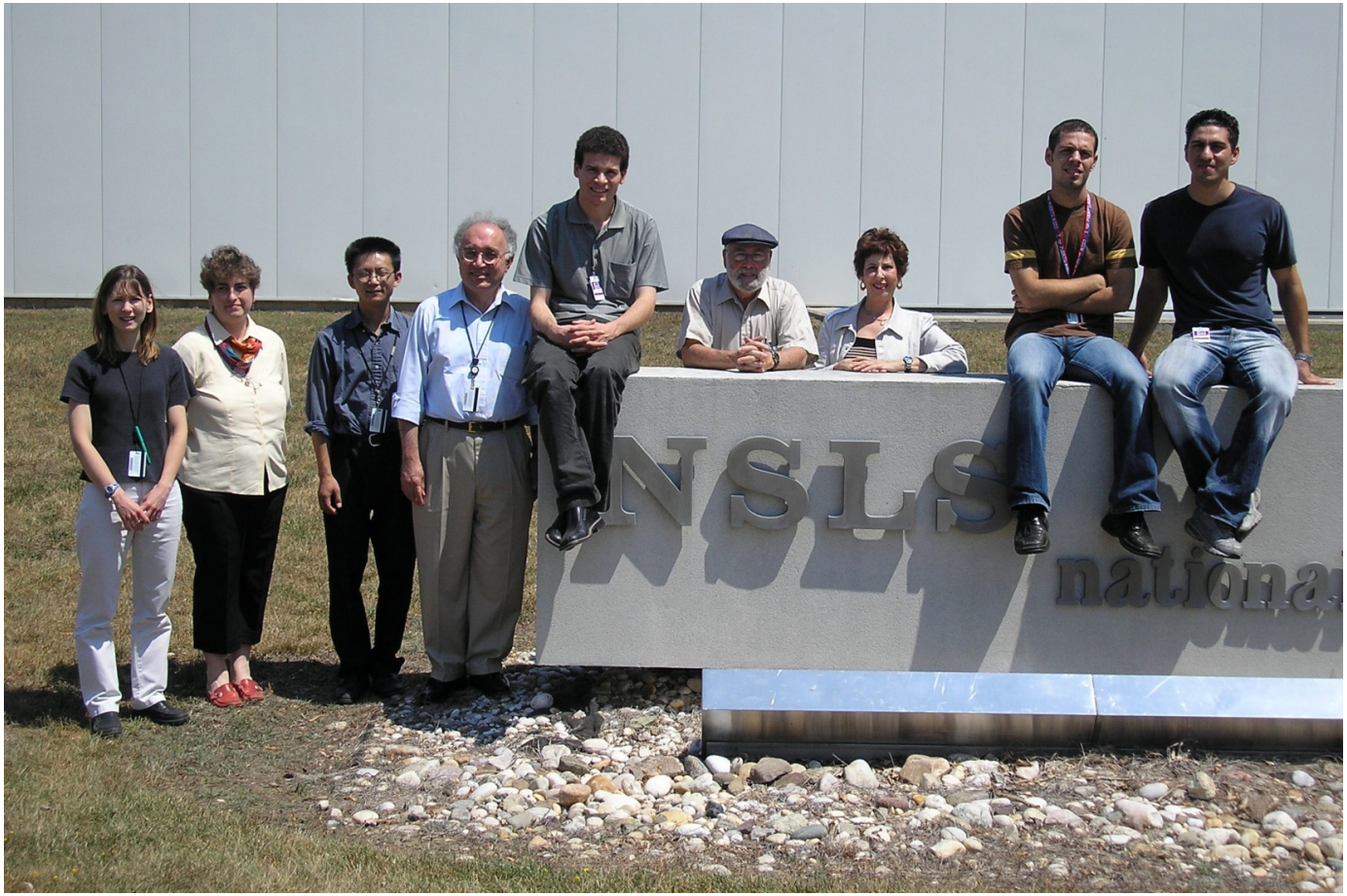
Antalya, Turkey

JSPS-SESAME-Sabanci Univ. SCHOOL; Turkey, March 1-5, 2010

Hands-on Session at *SESAME-JSPS* School for Synchrotron Sciences; Cairo, Egypt; Nov. 17-23, 2008

DOE Cooperative Research Program for SESAME

More than 25 students and scientists from the Middle East supported at US synchrotron radiation facilities since 2001



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*

Training Programme

One of the essential objectives of SESAME

- **Users meetings, Workshops, Individual training (Visits, Fellowships..)**
- **Funding from**

  International organisations: **IAEA, UNESCO, ICTP, ESRF**

  External National organisations & synchrotron labs in: **Brazil, France, Germany, Italy, Japan, Portugal, Spain, Sweden, Switzerland, Taiwan, UK, USA (DoE)**

  Organisations in Members: **Cyprus, Egypt, Iran, Israel, Jordan, Turkey**

  Scientific bodies: **APS + EPS + IOP + DPG + ACS**

  Companies: **Gentech, Ox Diffraction, PANanalytical, Jordanian Phosphate Mining co.**

  Foundations: **Canon, Lounsbery**

  LinkSCEEM project (Cyprus): ***high performance computing (HPC) eco-system in the Eastern Mediterranean region***

Topics include: ***accelerator technology, beamlines, scientific applications***

SESAME Scientific Collaborations

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

Authors:

Tzvia Selzer[1], Brian Vash[2], Said Ali[3], Rotem Sertchook[1], Guenter Grossmann[4], Peter Atadja[2], Travis Stams[2], Dalia Cohen[2], and Irit Sagi[1*]

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*
Ph: 972 8 9342130 Fax: 972 8 9344154 irit.sagi@weizmann.ac.il

Photodynamic Therapy of Human Melanoma Cells by Indocyanine Green Induced Rapid Apoptosis through Activation of Caspases & Cytochrome C & Inhibition of Histone Deacetylases & NF-KB P65

Amira M. Gamal–Eldeen (a), Meghan E. Ruppel (b), Randy J. Smith (c), Thomas Tsang (d), Lisa M. Miller (b,c), and Abdel-Megid Mamoon (e)

(a) Cancer Biology Laboratory, Center of Excellence for Advanced Sciences, National Research Center, Dokki 12622, Cairo, Egypt
(b) Department of Biomedical Engineering, Stony Brook University, Stony Brook, NY 11794 USA
(c) National Synchrotron Light Source, Brookhaven National Laboratory, Upton NY, 11973 USA
(d) Instrumentation Division, Brookhaven National Laboratory, Upton NY, 11973 USA
(e) Egyptian Atomic Energy Authority, Nasr City, Cairo, Egypt

Endorsements of SESAME

UNESCO Executive Board 164th session, May 2002

"a quintessential UNESCO project combining capacity building with vital peace-building through science" and "a model project for other regions"

Nobel Laureates: 45 Nobel laureates signed a joint statement in June 2008

"SESAME, as well as producing educational and economic benefits, will serve as a beacon, demonstrating how shared scientific initiatives can help light the way towards peace."

IUPAP (International Union for Pure and Applied Physics) October 2008 resolution

"The IUPAP strongly endorses SESAME and urges its national committees and Commissions to identify opportunities for continued and expanded assistance to the project, including identifying opportunities for broadening participation by scientists from the region, and raising the visibility of its "science for peace" objectives throughout scientific and policy-making communities."

US Liaison Committee of IUPAP 12 June 2009 resolution

"*We enthusiastically welcome the new international S&T initiatives announced by President Barack Obama in his address in Cairo on 4 June 2009. As noted by the President, the economic, diplomatic and health drivers for these initiatives are compelling. Africa, the Middle East and Southeast Asia will provide fertile ground for establishing scientific centers to meet the stated goal, and the U.S.A. should play a significant role in establishing such centers. We cite the SESAME project as an initiative that is designed to build bridges between diverse societies and to contribute to the culture of peace through international scientific cooperation."*

Chief Executive IOP (Institute of Physics, U.K.) 27 August 2009 letter of support

"I am writing to express the strong support of the Institute of Physics for the SESEAME project. We share the perspective of the US Liaison Committee of IUPAP and of IUPAP itself, that this is an excellent example of an initiative that should build bridges between diverse societies and contribute to the welfare of people through international scientific co-operation."

IUBMB (International Union of Biochemistry and Molecular Biology) September 2009 resolution

"The IUMBM strongly endorses SESAME and urges its National Committees and Commissions to identify opportunities for continued and expanded assistance to the project, including identifying mechanisms for increased participation by scientists from the region, and raising the visibility of its "science for peace" objectives at the level of scientific and policy-making communities."

Nobel Laureates visit SESAME site in June, 2008

45 Laureates endorse SESAME *"as a beacon, demonstrating how shared scientific initiatives can help light the way towards peace"*.

Further information about SESAME and potential SESAME Users can be found at

http://mag.digitalpc.co.uk/fvx/iop/esrf/sesamebrochure/

and

http://mag.digitalpc.co.uk/fvx/iop/esrf/sesamepeople/

These can be downloaded from the SESAME website

www.sesame.org.jo

Conclusions

There are challenges

Stable financial support; attracting new members from the Gulf and the Mahgreb **(new members very welcome)**; compensating differences in the human and financial resources of the members; solving problems involving travel restrictions; remaining funding for main ring and adaptation/upgrading of beamlines

***But an enormous amount has been achieved** **

** *thanks especially to HM King Abdullah II, Director Toukan, UNESCO, IAEA, those who have donated equipment,…*

SESAME is working politically and technically, and the training programme is building capacity in the region

The voluntary contributions** (shortly to be formally agreed) **constitute a major step forward and make it possible for SESAME to come into operation in 2015

International Science

Anton Chekov:

"There is no national science, just as there is no national multiplication table. Science that is national is not science."

End of Presentation

Thank you

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

International Science, *SESAME, CERN*, and Human Rights

Anton Chekov:

"There is no national science, just as there is no national multiplication table. Science that is national is not science."

International connections make scientists aware of human rights abuses

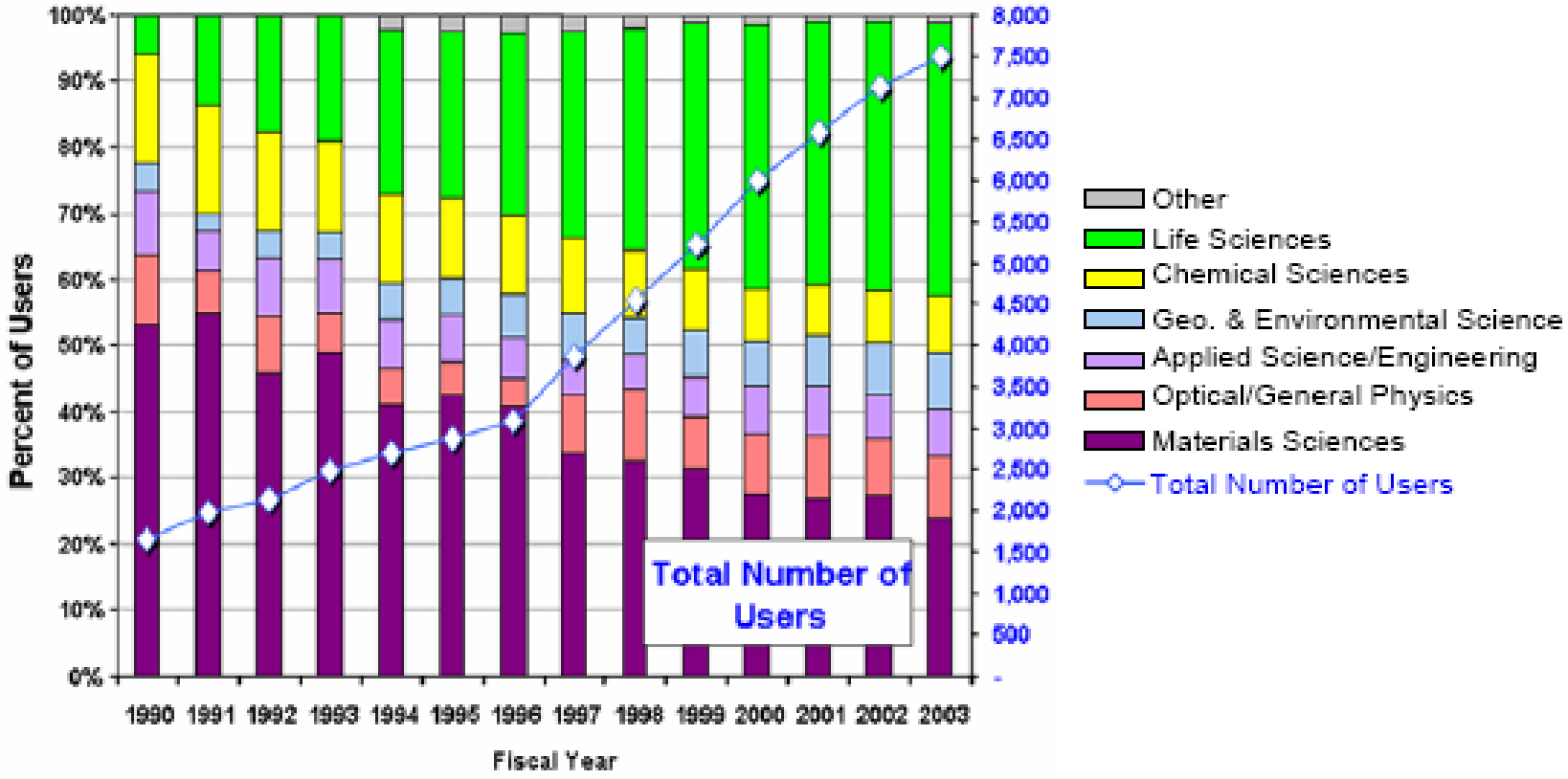


Figure 1.3.1 *User profile by discipline of experiments and total number of users for the four DOE synchrotrons (ALS, APS, NSLS, SSRL). This shows the strong increase in the percentage of users in the life sciences as well as the dramatic growth in total number of users. Current projections are that the total number of users will grow to ~ 11,000 annually in coming years.*

Applications

Materials Research

Basic understanding of semiconductors, metals, superconductors, alloys, elementary excitations, electronic structure, phase equilibrium, actinide chemistry, . . .

Photoelectron Spectroscopy, EXAFS,
Small angle scattering, powder diffraction, . . .

Surface Science

Structure of clean surfaces, ultra-thin films, chemisorption complexes, interfacial junctions, dynamic and kinetic properties of surfaces, growth modes of thin films, . . .

UV Photoemission Spectroscopy (UPS) (Angle-resolved, spin resolved)

Polymers

Structure-property relationships
Small Angle Scattering (SAS)

Applications (continued)

Atomic, Optical, Molecular Physics and Chemistry

Vibration/rotation spectroscopy
Infrared microspectroscopy
Chemical dynamics

Molecular Environmental Science

Study of environmental contaminants

- molecular structure, composition, oxidation state, reaction mechanisms
- stability, toxicity, mobility, bioavailability, ***SPECIATION***

Geosciences

Mineral interfaces, compositional variations and coordination chemistry of materials at high temperature and pressure in the earth's crust, amorphous geological materials, mineral phases and phase transitions at high temperature and pressure, . . .

EXAFS, XANES, IR Spectroscopy; Laser-heated diamond anvil cells

Microscopy

IR, Soft x-ray, Hard x-ray

Applications (continued)

Structural Molecular Biology (Macromolecular crystallography)

- Determination of the 3-dimensional structure of proteins
- Elucidating biological pathways
- Drug design

MAD technique makes use of tunability of synchrotron radiation

Sequencing of the human genome has led to the need to understand the structure and function of tens of thousands of proteins

Industrial Utilization - Enabling Basic and Applied Research

- **SSRL serves the industrial research community for basic** and **applied research** (currently **41 U.S. companies)**
  - **11 % of all users on active proposals are from industry**
  - **15% of all active proposals involve an industry collaborator**
- **Simple user agreement and provisions for proprietary research**
- **Examples of technological areas and companies:**

Semiconductor Processes and Fabrication

AMD, Applied Materials, Balazs, DEC/Compac, Hewlett-Packard, Intel, Motorola, National Semiconductor

Catalysis

Air Products, Chevron, Exxon, The EXAFS Company,
Union Carbide

Pharmaceuticals and Drug Discovery

Agouron Pharmaceuticals, Berlex Biosciences, Bristol-Myers Squibb, Genencor, Genentech

Materials Properties

Dupont, Exxon, Edge Analytical, IBM

Detector and Instrumentation Development

Adelphi Technology, Hirsch Scientific, Ovonics

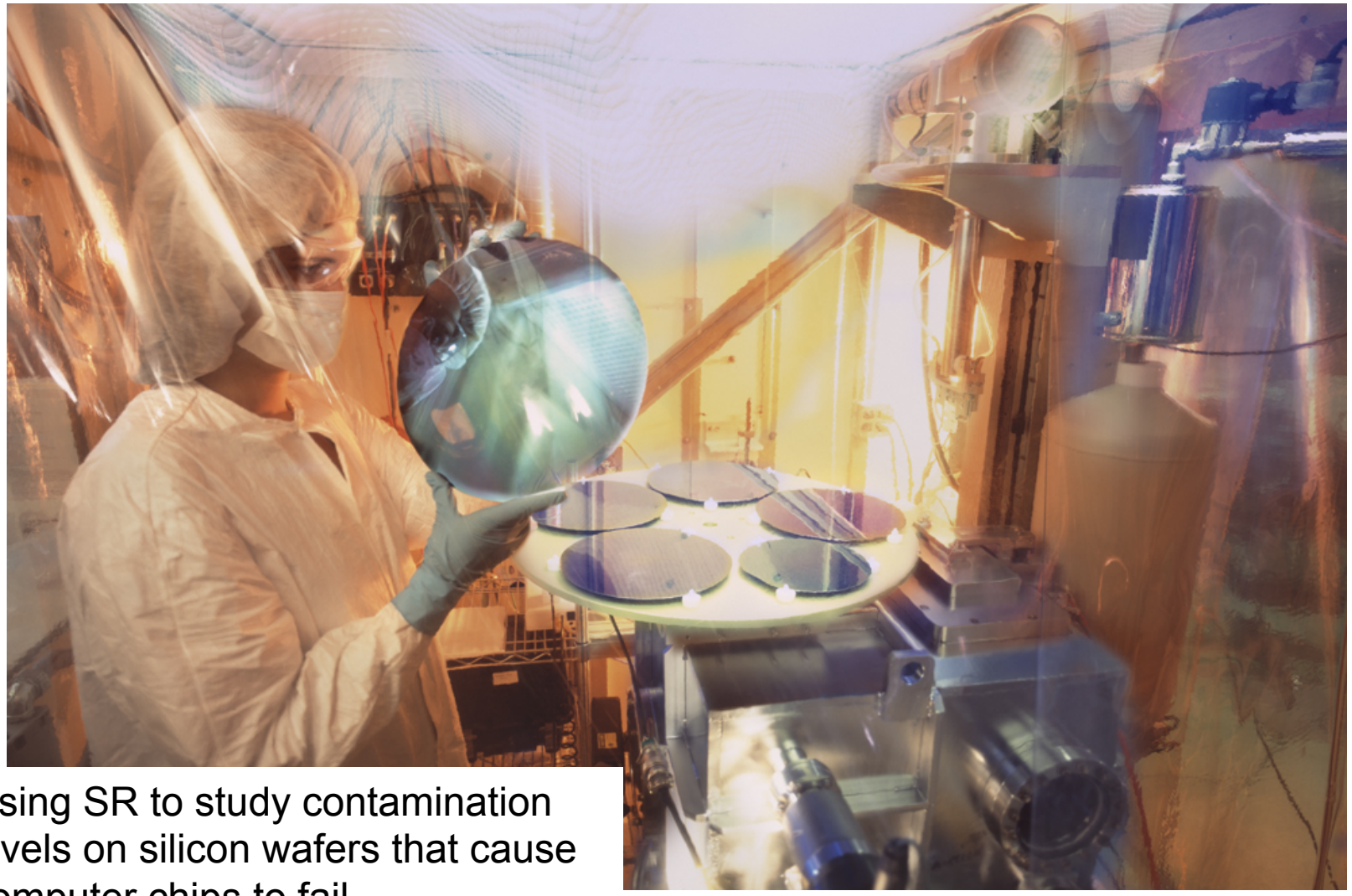
Environmental Sciences

Boeing, Babcock & Wilcox (Hanford)

Medical Applications

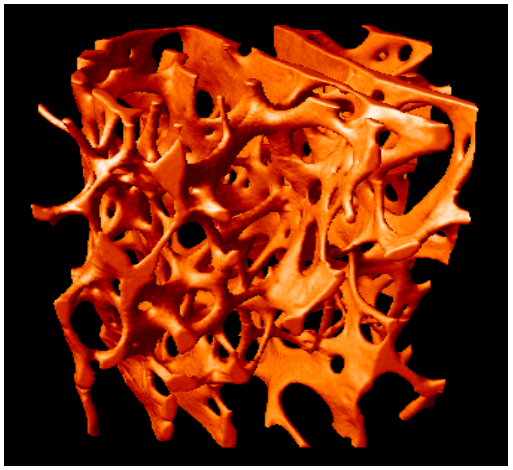
Orthologics, X-ray Instrumentation Associates

Materials Science



Using SR to study contamination levels on silicon wafers that cause computer chips to fail

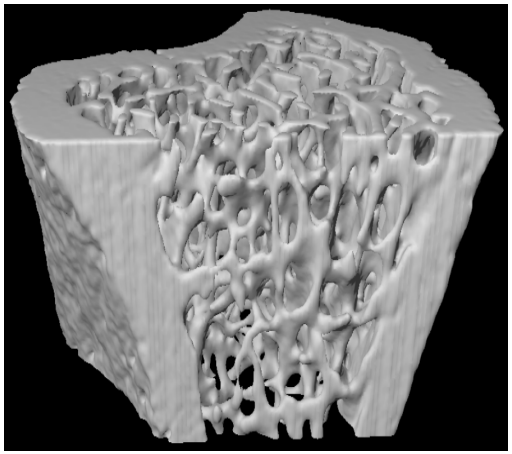
Osteoporosis Research - Understanding Loss of Bone Mass



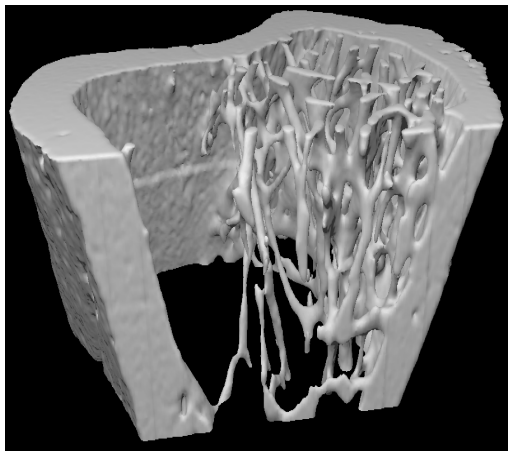
X-ray tomograph of trabecular bone in the human femoral neck taken with synchrotron radiation by LLNL scientists using synchrotron radiation at ***SSRL***

Osteoporosis is a major public health problem

- **1.3 million osteoporotic fractures each year**
- **50% of women over 70 have had at least one fracture**
- **a disease which strikes without warning**
- **responsible for more deaths than breast cancer**



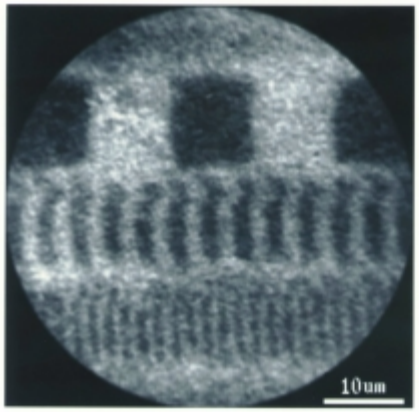
before estrogen loss



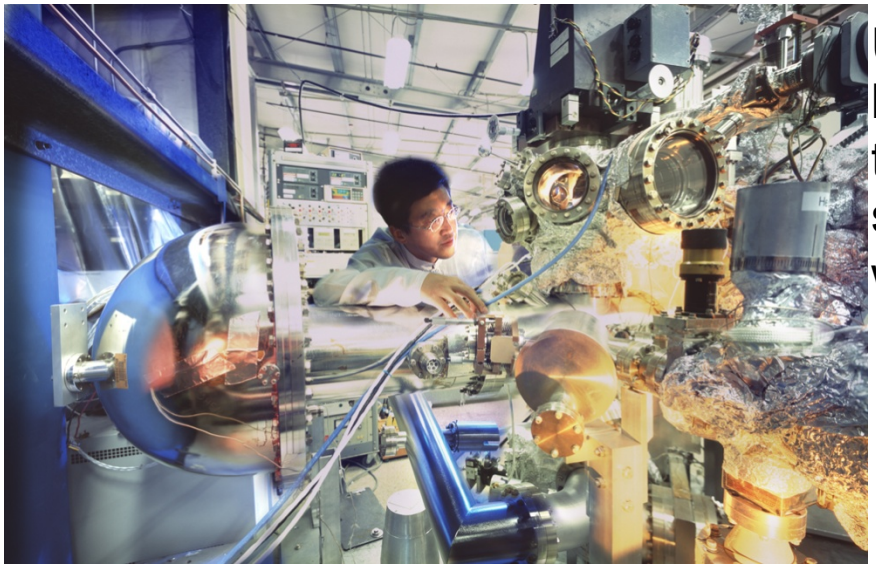
after estrogen loss

Estrogen deficiency induces rapid bone loss and altered architecture. This can be visualized in living beings using non-invasive x-ray synchrotron tomography imaging. The image above is from a rat taken under sedation.

Materials Science

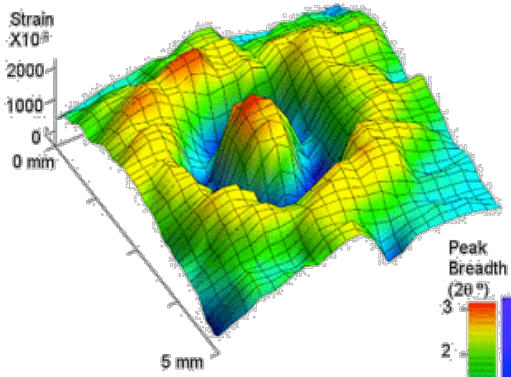


Visualizing magnetic bits on a computer hard drive

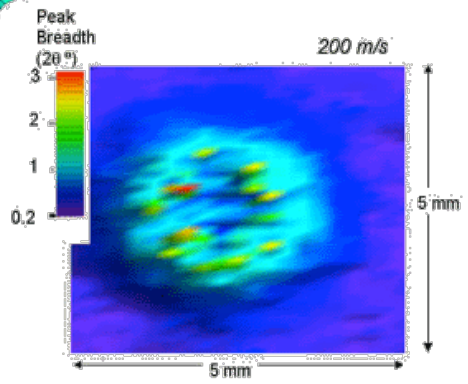


Using SR to learn how high temperature superconductors work

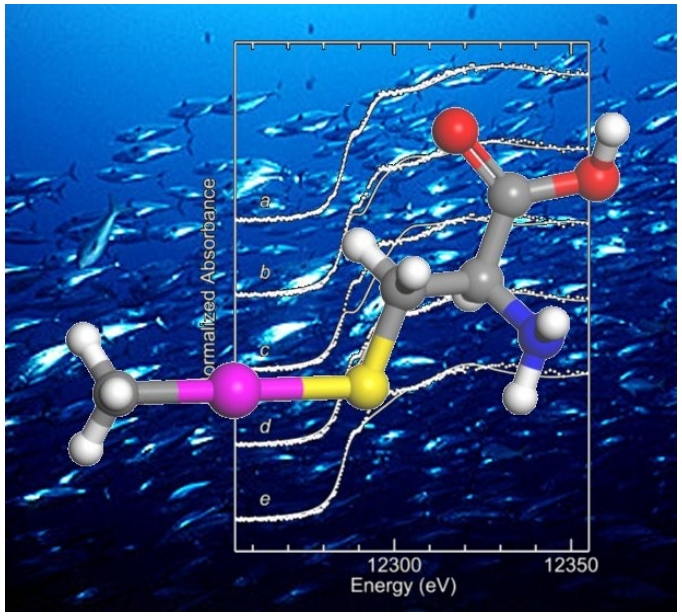
Using SR to make miniature mechanical and electromechanical devices



Understanding how debris causes damage to aircraft turbines

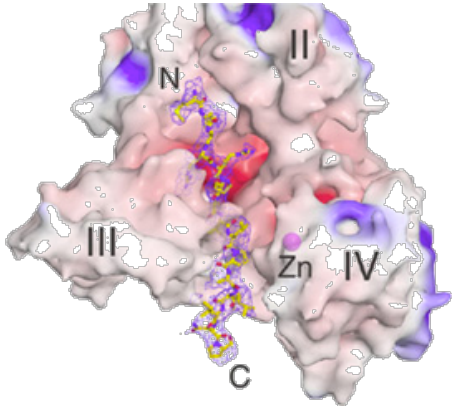


Chemistry and Biology

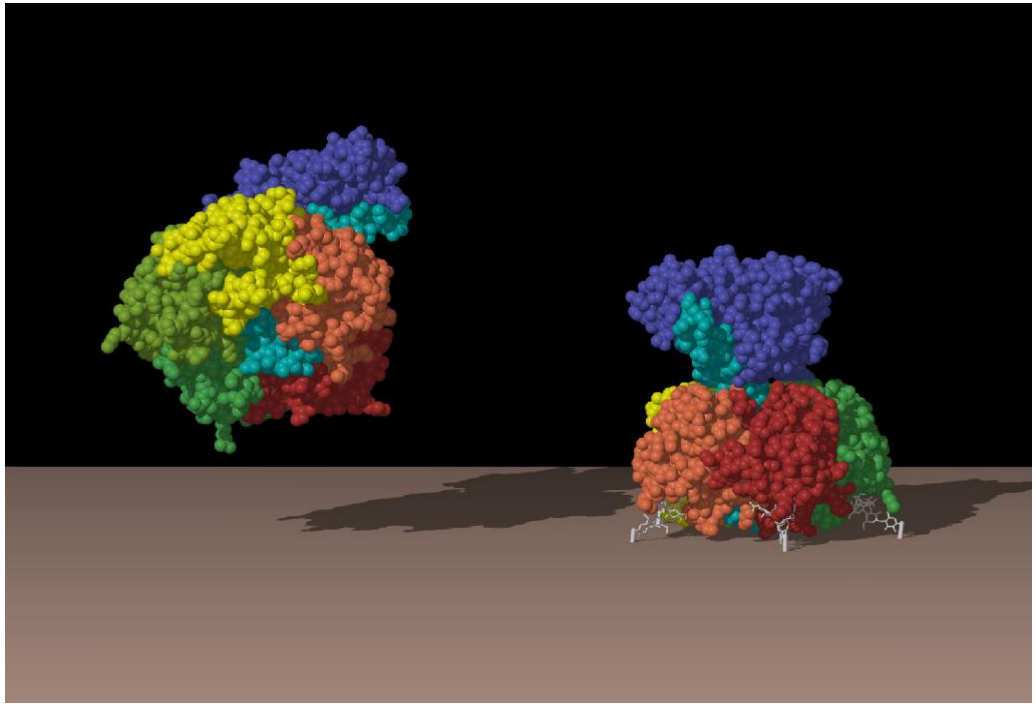


Measuring very low levels of mercury in fish and determining its chemical form

Studying Anthrax Toxin components to develop treatment in the advanced stages of infection

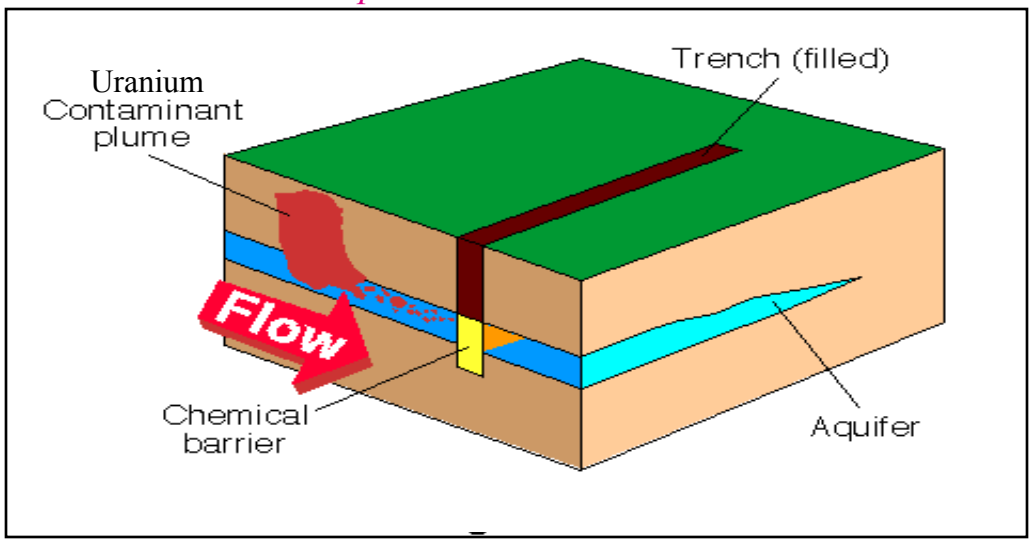


Cholera toxin attacking a gut cell



Geoscience & Environmental Science

Reactive Barrier Concept - bone ash



Scientific understanding leads to strategies for containment of toxic & radioactive waste that threatens water supplies

Concept studied at SSRL

A giant underground filter is removing uranium contamination in an aquifer in Utah

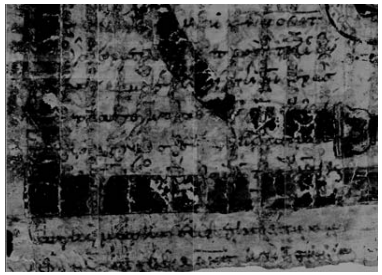
Examples of Synchrotron Science:
X-Rays Illuminate Ancient Secrets

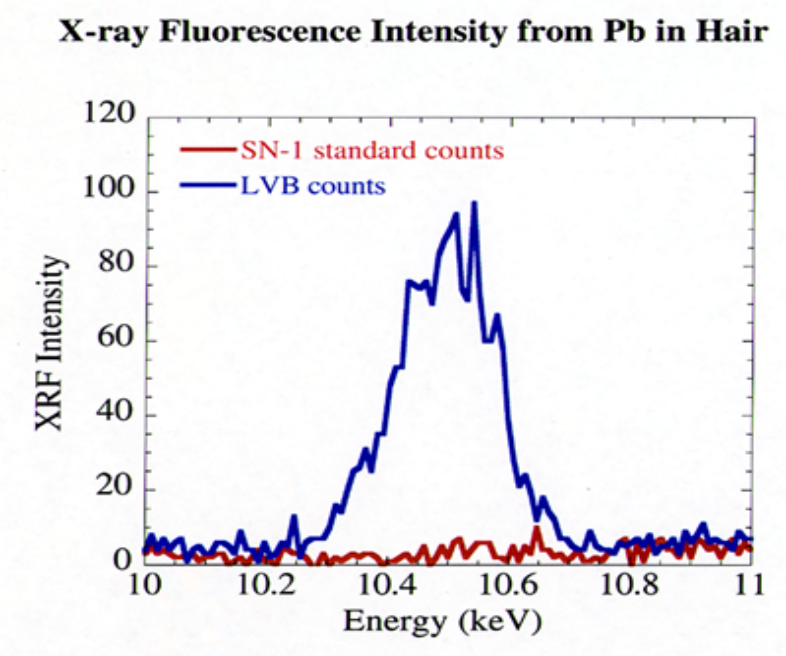
Archimedes' exceptionally advanced ideas have been lost and found several times throughout the ages. Now scientists are employing modern technology, including x-ray fluorescence, to completely read the Archimedes Palimpsest, the only source for at least two previously unknown treatises.

(Images provided by Will Noel, The Walters Art Museum)

A photograph of one page of the Archimedes Palimpsest. Visible and UV light cannot see Archimedes' text under the gold painting done by a 20th Century forger.

X-ray fluorescence imaging revealed the hidden text. This x-ray image shows the lower left corner of the page.





Intensity of Pb x-ray fluorescence from a standard hair (SN-1) with 6 ppm of lead compared to that of a hair from Beethoven (LVB) as determined at APS.

Synchrotron studies at the Advanced Photon Source reveal massive amounts of lead in bone fragments from skull of Beethoven.

These findings confirm studies of Beethoven hair samples.

Researchers believe this confirms lead poisoning as cause of composer's chronic illness.

150 Million Year Old Fossil of *Arhaeopteryx* (dinosaur/ bird?) Studied at SSRL by X-ray flourscence

Feathered dinosaurs of China

Recent discoveries in China demonstrate that birds evolved from small, meat-eating dinosaurs called theropods.

Skeletons of several kinds of small dinosaurs & primitive birds were found by farmers since 1994 in the north-eastern Chinese province of Liaoning. These dinosaurs are the first to be found covered with feathers. The bird-like dinosaurs and dinosaur-like birds were found near the villages of Jianshangou & Sihetun, in rocks aged between 120 & 145 million years old.

The fossils show several different stages in the evolution of feathers & flight, revealing how grasping arms transformed into flying wings.

Rapid Assessment of Resource Partitioning in Algae with IR Microspectroscopy

Z. El-Bayyari (1,2,3), M. J. Nasse (2,3), A. Norici (4), S. Ratti (4), C. Hirschmugl (2), and M. Giordano (4)

1 Dept of Basic Sciences, Philadelphia Univ, Amman, Jordan.
2 Department of Physics, Univ of Wisconsin–Milwaukee,USA.
3 Synchrotron Radiation Center, Univ of Wisconsin–Madison, USA.
4 Dipartimento Scienze del Mare, Universitá Politecnica delle Marche, Ancona, 60131 Italy.

We use an IR synchrotron based microscope to address a central problem in cell biology: the strategies adopted by cells (in this case algal cells) to allocate and partition their resources in response to changes in environmental availability. Using FTIR spectroscopy for this scientific problem facilitates an understanding of the related physiological responses in an unperturbed cell environment.

Funding Needed 2010-14

- **To complete storage ring etc: $27.5M**
  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
- **Ancillary buildings and security: $1.2M**
  Would like to add conference centre and other buildings later
  Total Capital funding needed 2011-14: $34.8 M
- **Operational funding needed 2011-14: $(21-24)M** – to be provided by Members

  [With investments so far + donations (~ $55M) → total cost to bring SESAME into operation, with three day-one beamlines, starting from a green field ~ $110M
  - in line with the cost of other recently constructed light-sources]

Possible Sources of Funding

- **Members** – must pay **operational/personnel costs** + make a substantial contribution to the **capital funding:**

  - Last year **Israel** offered $1M a year over five years *provided* at least four other Members do the same

  - **Jordan, Iran and Turkey** are prepared to match this offer

  + as we hope will Egypt, and perhaps Cyprus, while Pakistan and the Palestinian Authority are prepared to make an in-kind contributions of up to $5M and $(1.5-2.0)M respectively

  *This initiative t**his should provide $25M** which will enable SESAME to proceed optimistically, although more is needed, e.g. from:*

- **EU** (already contributed ~ $4M)
- **US**
- **FP7/Euromed (p**reparing bid)
- **Foundations**
- **European Investment Bank**, which is prepared in principle to make a loan **-** this would be a last resort

Speech by President Obama at Cairo University; June 4, 2009

"On science and technology, we will launch a new fund to support technological development in Muslim-majority countries, and to help transfer ideas to the marketplace so they can create jobs. *We will open centers of scientific excellence in Africa, the Middle East and Southeast Asia,* and appoint new Science Envoys to collaborate on programs that develop new sources of energy, create green jobs, digitize records, clean water, and grow new crops. And today I am announcing a new global effort with the Organization of the Islamic Conference to eradicate polio. And we will also expand partnerships with Muslim communities to promote child and maternal health."

13 NOVEMBER 2009 VOL 326 SCIENCE

U.S. Takes Steps to Use Science To Improve Ties to Muslim World

In a surprise announcement, U.S. Secretary of State Hillary Clinton last week named three prominent scientists as special envoys to assess the potential for scientific partnerships with Muslim-majority countries. The move is the first concrete step in a broader U.S. effort to expand the role of science in diplomacy.

Speaking in Morocco on 3 November, Clinton said the new envoys will help "to fulfill President Obama's mandate to foster scientific and technological collaboration" and to "develop the capacity to meet economic, social, and ecological challenges." She announced the selection of Egyptian-born *Ahmed H. Zewail*, a chemistry Nobelist at the California Institute of Technology in Pasadena; Algerian-born *Elias Zerhouni*, a radiologist who stepped down last fall as director of the National Institutes of Health
(NIH); and biochemist *Bruce Alberts*, former president of the U.S. National Academy of Sciences (NAS) and current editor-in-chief of *Science.* Clinton said that the State Department is also bolstering its scientific and environmental expertise at embassies around the world.

April 9, 2007 Volume 85, Number 15 p. 11 Embargo Fallout

ACS is forced to drop Iranian members because of U.S. regulations

William Schulz

The American Chemical Society has confirmed that, in January, it was forced to drop 36 members of the society who live in Iran because of the terms of a U.S. embargo against Iran and other nations. ACS officials say they came to the decision after careful legal review indicated that the society was running afoul of the regulations, which are administered by the Treasury Department.

May 14, 2007

Society reinstates 14 people who were dropped from the rolls owing to federal regulation

The American Chemical Society has sent letters reinstating 14 Iranian members who had previously been dropped from the rolls (C&EN, April 9, page 11). The society's board of directors decided to take this action after conducting further review of its legal options and after contact with the Department of Treasury's Office of Foreign Assets Control (OFAC). In addition, the board received a number of letters from concerned ACS members who wanted their Iranian colleagues reinstated.

The New York Times

British Academics' Union Endorses Israel Boycott; *May 31, 2007*

To Sally Hunt,
General Secretary, University & College Union (UCU) June, 8, 2007
Dear Ms. Hunt,

Let me express my sincere opposition to the boycott of Israeli academics that is being considered by the University and College Union. As a scientist living in the Middle East, I appreciate the move of UCU to express its unhappiness about the restrictions being made by Israeli forces to the Palestinian students and academics. However, the decision made by UCU is violating the same principles one is trying to defend. It is hard to accept that the Israeli academia are proponents of such restrictions.

Reza Mansouri
Prof. of Physics,
Sharif University of Technology,
& Chair, School of Astronomy and Astrophysics, IPM,
Tehran, Iran

SESAME GROUND BREAKING CEREMONY - 6 JANUARY 2003

There are ~ 60 synchrotrons in world

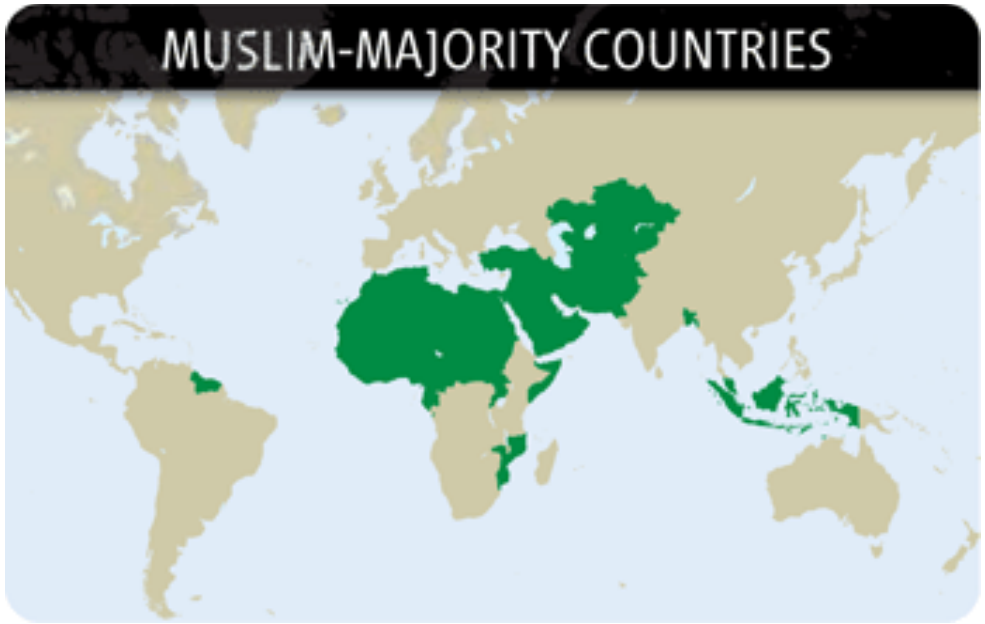
None in the Middle East

SESAME building, financed by Jordan and designed by civil engineers from Al-Balqa' Applied University, Jordan

Building can be used for high-level Arab-Israeli and Middle East Scientific meetings

- International collaboration is obvious way for countries with limited science budgets to build synchrotron-light sources
- Broad programme makes synchrotron ideal facilities for building scientific capacity
- SESAME will be a user facility: scientists will typically go to SESAME two or three times a year for a week or two to carry out experiments, in collaboration with scientists from other institutions/countries

Hadi Hadizadeh, Herman Winick, Zafra Lerman
At the Soft Inauguration of SESAME; November 2008



U.S. Takes Steps to Use Science To Improve Ties to Muslim World

Clinton in Morocco, Nov. 3, 2009

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

Science; 30 March 2007, Vol 315. no. 5820, p 177
NEWS OF THE WEEK

PROFESSIONAL SOCIETIES:
ACS Drops Iranian Members, Citing Embargo
Yudhijit Bhattacharjee

The American Chemical Society (ACS) has reluctantly rescinded the membership of some 36 Iranian scientists after the society determined that having members in Iran violates U.S. law. The society hopes to reinstate them after obtaining a government license, a step that could set a precedent for other U.S. societies with Iranian members.

"Even the old German Chemical Society waited for a formal demand that it expel the Jews" Paul Walter

In 2007 the University and College Union (UCU) of the UK passed a motion endorsing a boycott of Israeli academics.

June, 8, 2007
To Sally Hunt, General Secretary, University & College Union (UCU)

Dear Ms. Hunt,
Let me express my sincere opposition to the boycott of Israeli academics that is being considered by the University and College Union. As a scientist living in the Middle East, I appreciate the move of UCU to express its unhappiness about the restrictions being made by Isreali forces to the Palestinian students and academics. However, the decision made by UCU is violating the same principles one is trying to defend. It is hard to accept that the Isreali academia are proponents of such restrictions.
Reza Mansouri, Prof. of Physics,
Sharif University of Technology,
Chair, School of Astronomy & Astrophysics, IPM,
Tehran, Iran

“The real voyage of discovery consists not in seeking new lands, but in seeing with new eyes.”

Marcel Proust

A La Recherche du Temps Perdu

Examples of Bridge Building Through Scientific Collaboration

- CERN
- Some cases considered in *Scientific Co-operation, State Conflict – The Roles of Scientists in Mitigating International Discord,* New York Academy of Sciences, 1998

Note: "Diplomatic Science" does not work. Excellent science must be a major driving force and is a necessary condition for building sound bridges.

CERN

Conceived late 1940s (formally born 1954) when two ideas came together

- **Physicists realised that no single European country could compete with the US in constructing large accelerators – collaborating therefore necessary for participation**

- **A far sighted group of diplomats and scientific administrators conceived the idea of a joint European Laboratory as a contribution to rebuilding bridges between nations recently at war**

It worked scientifically. What about bridge building?

Bridge building through CERN

Participation in pluri-national collaborations at CERN enriches the scientists and engineers involved, especially students - many of whom move to other careers, taking an enhanced knowledge of other cultures and other societies, and excellent international networks of contacts. Generally CERN has done much more than science (and inventing www):

- First inter-Governmental organisation to which Germany was admitted (as an experiment) after the war
- Other European Scientific organisations modelled on CERN – EMBL, ESRF, ESO, . . .
- First post-war contacts between German and Israeli scientists (outside International Conferences) on the neutral territory of CERN
- Kept open scientific relations with Russia and other East block countries during the Cold War (not only Russians coming to CERN, but in the late 1960s – early 1970s CERN physicists working at Protvino)
- Joint Russian CERN summer school started 1970, continues today
- Russian particle physicists did not join the Diaspora after the end of communism, knowing they could work at CERN while based in Russia
- CERN closely involved with INTAS and ISTC
- Spread international standards across Europe

Examples from the NY Academy Conference/book

- Government-initiated activities: nuclear arms control negotiations; US-Soviet cooperation in space (launched with rhetoric concerning cooperation as a means of increasing mutual understanding, promoting global security and diminishing conflict); International Institute for Applied Systems Analysis; South American Nuclear Cooperation; . .

- Scientists initiated activities: scientific cooperation between the USA and China (started by individuals 1964; institutionalised 1973); Pugwash movement (especially conception and promotion of the International Treaty on Chemical and Biological Weapons); unofficial Palestinian and Israeli academic contacts that preceded the Oslo Agreement; role of scientific cooperation in normalising Israeli-Egyptian relations (built on congressional initiative that provided funding: marine sciences, medicine and agriculture – only the latter judged exceptionally successful politically as well as scientifically)

Zafra Lerman, Louise Oliver (US Ambassador to UNESCO), Herman Winick


R.Sarraf

Congressman Bill Foster and his wife Aesook Byon visiting SESAME in 2009

Synchrotrons are large, expensive, facilities. Richer countries can afford their own (there are more than 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

Under the auspices of UNESCO and modeled on CERN

Members

- BAHRAIN
- Cyprus
- EGYPT
- Iran
- ISRAEL
- JORDAN
- PAKISTAN
- PALESTINIAN AUTHORITY
- TURKEY

Observers

France
Germany
Greece
Italy
Japan
Kuwait
Portugal
Russia
Sweden
Switzerland
UK
USA

Governing Body

Council

Each Member one vote

Two delegates

Members of Interim Council

SESAME

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

A. Hamad (Radiation officer) M. Attal (Accelerator Physicist)
F. Makahleh (Mechanical engineer-cooling system)

BESSY I 0.8 GeV Booster Synchrotron set up in SESAME building for “soft” inauguration on November 3, 2008

Mayor of Salt, Mr. Salameh, and Herman Winick

Day-one Beamlines

1. Protein crystallography beamline (photon energy range: 4-14 keV) for structural molecular biology, aimed at elucidating the mechanisms of proteins at the atomic level and providing guidelines for developing new drugs (as done by pharmaceutical companies and biotech companies). Such studies have led to four Nobel Prizes since 1997.

2. X-ray absorption fine structure and X-ray fluorescence spectroscopy beamline (3-30 keV) for applications in basic materials science and environmental science on the micrometer scale, including designing new materials and improving catalysts (e.g. for the petrochemical industries), and identification of the chemical composition of fossils and of valuable paintings in a non-invasive manner.

3. Infra-red beamline (0.01-1 eV) for molecular biology, environmental studies, materials, and archaeological sciences. Infra-red spectromicroscopy is very powerful in studying cells and tissues without the need for chemical fixing. Since infra-red light is non-ionizing, there is a promising future for time-resolved imaging of living cells.

Other Phase-1 Beamlines

4. Powder diffraction beamline (3-25 keV) to be used mainly for materials science. This technique is particularly powerful for studying disordered/amorphous material on the atomic scale and the evolution of nano-scale structures and materials in extreme conditions of pressure and temperature, and has become a core technique for developing and characterizing new smart materials.

5. Small and wide angle X-ray scattering beamline (8-12 keV) for structural molecular biology and materials science, including studying molecular properties of synthetic and biological polymers and determining parameters (e.g. strength) that improve the quality of a polymer for a particular purpose, studying large macromolecular assemblies and providing information on protein-protein complexes.

6. Extreme ultraviolet beamline (10-200 eV) for atomic and molecular physics. Photoabsorption and photoionization techniques used in this spectral range provide fundamental information on the behaviour of atmospheric gases. Photoemission studies in this spectral range can also be used to characterize the electrical and mechanical properties of materials, surfaces and interfaces.

7. Soft X-ray vacuum ultraviolet beamline (50-2000 eV) for atomic, molecular and condensed matter physics. This multi-purpose beamline will be used for a variety of applications, including surface science, one example being studies of the behaviour of catalysts and how they can be improved.

A training program has been underway since 2000

- accelerator technology
- beamlines
- scientific applications

funded by

- International Atomic Energy Agency (IAEA)
- Abdus Salam International Centre for Theoretical Physics (ICTP)
- Japanese Society for the Promotion of Science (JSPS)
- Portuguese Foundation for Science & Technology (FCT)
- US Department of Energy (DOE)

Plus fellowships by synchrotron radiation laboratories around the world.

To date over 1000 scientists from the region have benefited from SESAME training activities.

12th Meeting of SESAME Council; Uppsala Sweden, June 9-10, 2008

Dinçer Ülkü; Vice President of the SESAME Council

Chris Llewellyn-Smith; Council President starting in November, 2008

Yasser Khalil; Administrative Director

Khaled Toukan; Sesame Director

Herwig Schopper; Council President 1999-2008

Hafeez Hoorani; Scientific Director

Amor Nadji; Technical Director

Albin Wrulich; Chair of SESAME Technical Advisory Comm.

Missing; *Zahid Hussain* (Chair, Beamlines Comm.) *Zehra Sayers* (Chair, Scientific Comm.) *Javad Rahighi* (Chair, Training Comm.)

Ground Breaking Ceremony; Allaan Jordan, January 6, 2003

Synchrotron Radiation in Art & Archaeology
Metropolitan Museum of Art, New York City
May 5-9, 2012

SESAME – A Third Generation Light Source for the Middle East

Claudio Tuniz[1], Herman Winick[2]
1 International Centre for Theoretical Physics (ICTP), Trieste
2 SLAC National Accelerator Laboratory

Developed under the auspices of UNESCO & modeled on CERN, SESAME (*S*ynchrotron-light for *E*xperimental *S*cience and *A*pplications in the *M*iddle *E*ast) is an international research centre in construction in Jordan, enabling world-class research while promoting peace through scientific cooperation. Based on presentations and interest at nine Users' meetings and several workshops and schools, as well as preliminary proposals, it is expected that SESAME will support many studies relating to art and archaeology when it comes into operation in 2015.

The Middle East is at the crossroads of human migrations during the last hundred thousand years. A vast range of materials were left by the passage of hundreds of generations from the first modern humans 'out of Africa' to the Romans, from the Neanderthal of the Kebara cave to the Nabateans of Petra. Some of these materials are in museums or still buried underground, or at the bottom of the sea. Composition and structure of fossil bones, archaeological artifacts, works of art and other cultural heritage finds can be analyzed down to the sub-micrometer scale using a portfolio of spectro-microscopy techniques. In particular, SESAME will promote long-term cross-disciplinary programs based on the use of X-ray fluorescence, x-ray absorption spectroscopy and x-ray micro-tomography for imaging non-invasively the structure and composition of precious objects and materials.

SESAME's centerpiece will be a new 2.5 GeV 3rd Generation Electron Storage Ring (26nm-rad emittance with 12 places for insertion devices) which will provide intense light from infra-red to hard X-rays. The Members (Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, and Turkey) are currently finalizing arrangements to fund the final stage of construction. The 800 MeV booster, which is based on the BESSY 1 booster donated by Germany and now upgraded, is on track for commissioning at the end of this year, while the 22 MeV microtron pre-injector has already been operated. A training program supported by synchrotron-light sources and agencies around the world, with a value of some $1 million/year, has been underway since 2000. SESAME and its user community are on-track to start operation with four day-one beam lines in 2015. See: www.sesame.org.jo

Anton Chekov:

"There is no national science, just as there is no national multiplication table. Science that is national is not science."

Endorsements of SESAME

UNESCO Executive Board 164th session, May 2002

"a quintessential UNESCO project combining capacity building with vital peace-building through science" and "a model project for other regions"

Nobel Laureates: 45 Nobel laureates signed a joint statement in June 2008

"SESAME, as well as producing educational and economic benefits, will serve as a beacon, demonstrating how shared scientific initiatives can help light the way towards peace."

IUPAP (International Union for Pure and Applied Physics) October 2008 resolution

"The IUPAP strongly endorses SESAME and urges its national committees and Commissions to identify opportunities for continued and expanded assistance to the project, including identifying opportunities for broadening participation by scientists from the region, and raising the visibility of its "science for peace" objectives throughout scientific and policy-making communities."

US Liaison Committee of IUPAP 12 June 2009 resolution

"We enthusiastically welcome the new international S&T initiatives announced by President Barack Obama in his address in Cairo on 4 June 2009. As noted by the President, the economic, diplomatic and health drivers for these initiatives are compelling. Africa, the Middle East and Southeast Asia will provide fertile ground for establishing scientific centers to meet the stated goal, and the U.S.A. should play a significant role in establishing such centers. We cite the SESAME project as an initiative that is designed to build bridges between diverse societies and to contribute to the culture of peace through international scientific cooperation."

Chief Executive IOP (Institute of Physics, U.K.) 27 August 2009 letter of support

"I am writing to express the strong support of the Institute of Physics for the SESEAME project. We share the perspective of the US Liaison Committee of IUPAP and of IUPAP itself, that this is an excellent example of an initiative that should build bridges between diverse societies and contribute to the welfare of people through international scientific co-operation."

IUBMB (International Union of Biochemistry and Molecular Biology) September 2009 resolution

"The IUMBM strongly endorses SESAME and urges its National Committees and Commissions to identify opportunities for continued and expanded assistance to the project, including identifying mechanisms for increased participation by scientists from the region, and raising the visibility of its "science for peace" objectives at the level of scientific and policy-making communities."

Conclusions

There are challenges

Stable financial support; attracting new members from the Gulf and the Mahgreb **(new members very welcome)**; compensating differences in the human and financial resources of the members; solving problems involving travel restrictions; remaining funding for main ring and adaptation/upgrading of beamlines

But an enormous amount has been achieved *

* *thanks especially to HM King Abdullah II, Director Toukan, UNESCO, IAEA, those who have donated equipment,…*

SESAME is working politically and technically, and the training programme is building capacity in the region

The voluntary contributions *(shortly to be formally agreed)* ***constitute a major step forward and make it possible for SESAME to come into operation in 2015***

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

Further information about SESAME and potential SESAME Users can be found at

http://mag.digitalpc.co.uk/fvx/iop/esrf/sesamebrochure/

and

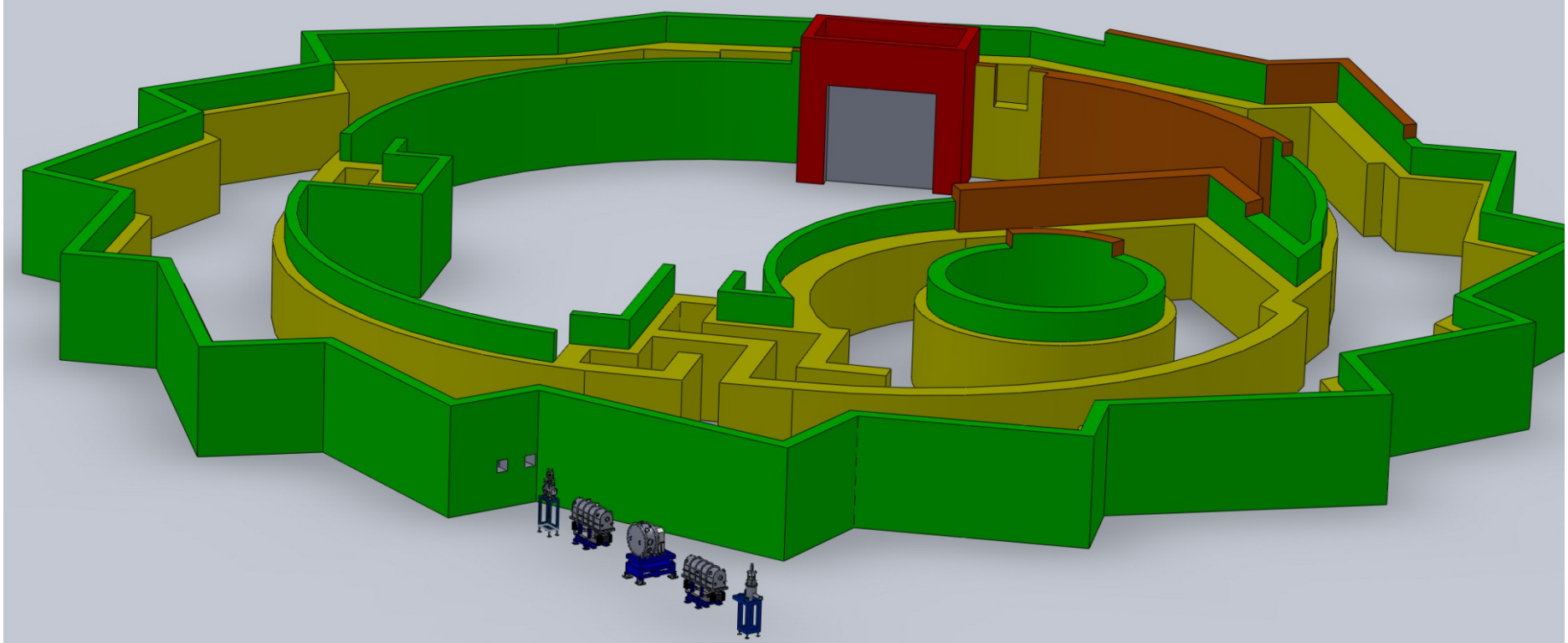
http://mag.digitalpc.co.uk/fvx/iop/esrf/sesamepeople/

These can be downloaded from the SESAME website

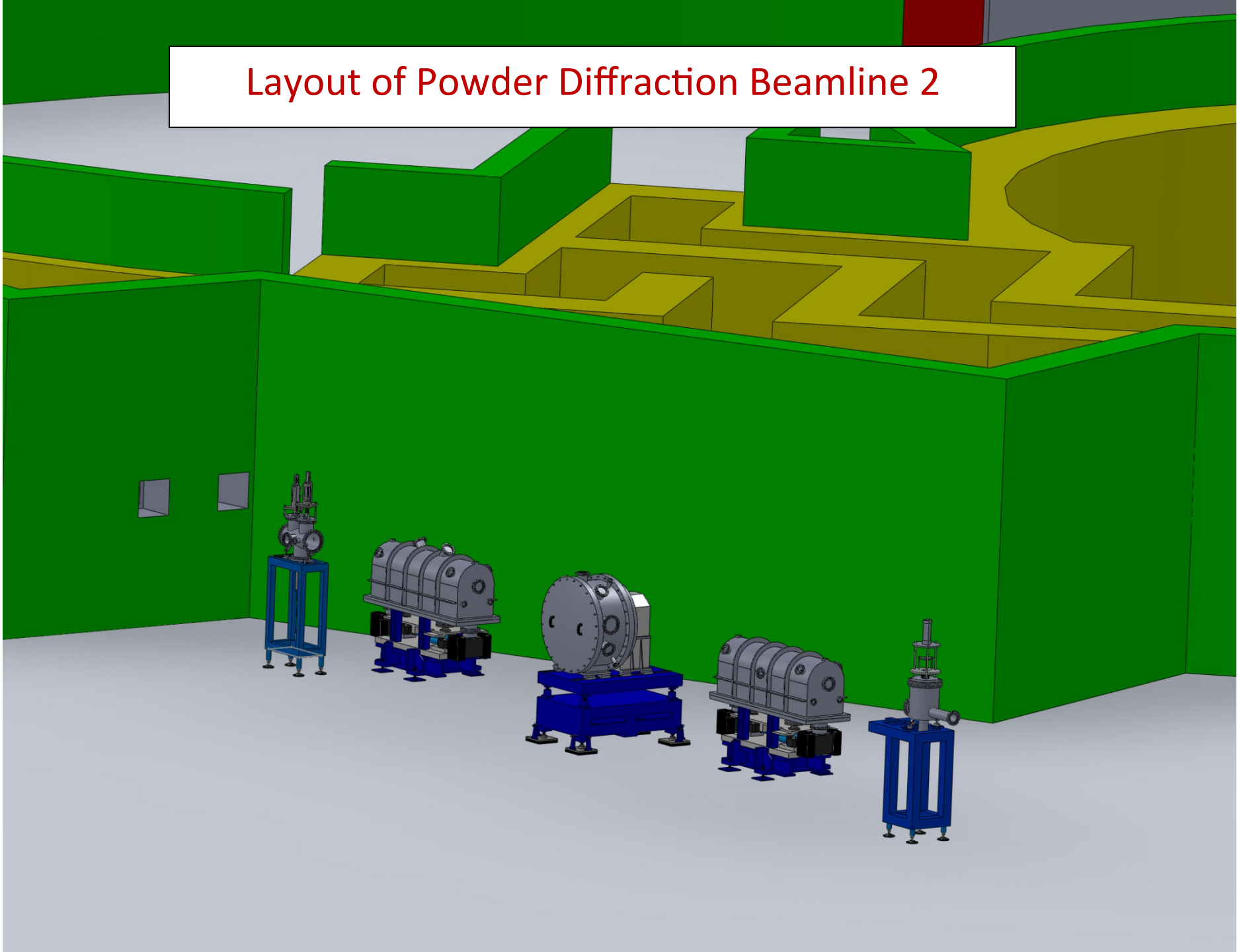
www.sesame.org.jo

Microtron installed in final position
+ ring in which booster is being installed
May 2011

Layout of Powder Diffraction Beamline 1



Layout of Powder Diffraction Beamline 2



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

Islamic outreach. U.S. Secretary of State Hillary Clinton unveiled a new science initiative to the 57 Muslim-majority countries (*below*) during a trip to Morocco.

DIPLOMACY

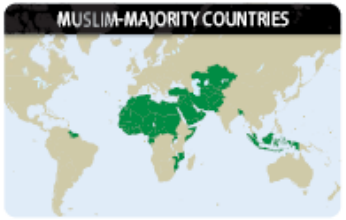
U.S. Takes Steps to Use Science To Improve Ties to Muslim World

In a surprise announcement, U.S. Secretary of State Hillary Clinton last week named three prominent scientists as special envoys to assess the potential for scientific partnerships with Muslim-majority countries. The move is the first concrete step in a broader U.S. effort to expand the role of science in diplomacy.

Speaking in Morocco on 3 November, Clinton said the new envoys will help "to fulfill President Obama's mandate to foster scientific and technological collaboration" and to "develop the capacity to meet economic, social, and ecological challenges." She announced the selection of Egyptian-born Ahmed H. Zewail, a chemistry Nobelist at the California Institute of Technology in Pasadena; Algerian-born Elias Zerhouni, a radiologist who stepped down last fall as director of the National Institutes of Health (NIH); and biochemist Bruce Alberts, former president of the U.S. National Academy of Sciences (NAS) and current editor-in-chief of *Science*. Clinton said that the State Department is also bolstering its scientific and environmental expertise at embassies around the world.

Clinton's speech to the Forum for the Future, a group that fosters dialogue between countries in the region and industrialized nations, builds upon Obama's highly publicized 4 June speech at Cairo University that called for a "new beginning" in relations with the Muslim world. Within the scientific realm, the president also promised to establish at least three technology "centers of excellence" in the Middle East, North Africa, and Muslim-majority regions in Asia, an idea now under discussion by an interagency group.

While these initiatives are aimed at the 57 Muslim-majority countries, officials at both



the State Department and the White House told *Science* that the goal is to bolster the department's science capacity across the board. Assistant Secretary of State Kerri-Ann Jones, who directs the Bureau of Oceans and International Environmental and Scientific Affairs, says the department wants "to better engage science as part of our diplomacy."

Pradeep Ramamurthy, senior director for global engagement at the National Security Council, says the envoys program and the expansion of science diplomats "reflects a broader, long-term commitment by this Administration to the role of S&T in global engagement." A bill (S.838) to create such envoys cleared the Senate Foreign Relations Committee this spring, and its sponsor, Senator Richard Lugar (R–IN), praised the initial appointments and said that he "look[s] forward to more envoys that will be announced in the coming months."

The trio was selected from a list, drawn up by the White House Office of Science and Technology Policy and the State Department, of "illustrious scientists who have shown global leadership and the ability to build partnerships with excellent research institutes abroad," Jones said. The National Academies helped winnow down the list, she said, and the final selection was made by Jones, White House science adviser John Holdren, and State Department science adviser Nina Fedoroff.

Zewail, who earned his initial degrees at Egypt's Alexandria University, plans to travel to the Middle East next month to ask government officials and scientists "to help come up with a visionary road map of how to create new partnerships." He has called for "scientopolitical" initiatives (*Science*, 12 September 2008, p. 1417) that focus on education and science to advance political and social goals.

Zerhouni, a graduate of the University of Algiers Medical School, says, "We want to open doors that others cannot." A senior adviser to the Johns Hopkins University School of Medicine and a senior fellow at the Bill and Melinda Gates Foundation, Zerhouni notes that "we've made great strides in 'health diplomacy' worldwide, and we hope to extend that success to science diplomacy."

As NAS president, Alberts helped create and co-chaired the InterAcademy Council in Amsterdam, an international organization of science academies that produces reports on major science, technological, and health issues. A strong advocate for increased international science cooperation, he has also been

CREDITS (TOP TO BOTTOM): JEAN BLONDIN (REUTERS/LANDOV) (SOURCE); ORGANIZATION OF THE ISLAMIC CONFERENCE

Obama address in Cairo June 4, 2009

"On science and technology, we will launch a new fund to support technological development in Muslim-majority countries, and to help transfer ideas to the marketplace so they can create jobs. *We will open centers of scientific excellence in Africa, the Middle East and Southeast Asia, and appoint new Science Envoys to collaborate on programs that develop new sources of energy, create green jobs, digitize records, clean water, and grow new crops."*

Science envoys
Bruce Alberts, Elias Zerhouni, Ahmed Zewail,
Rita Colwell, Gebisa Ejeta, Alice Gast

Brief History of SESAME

• 1997 – Original idea *(Voss, Winick)*; rebuild 0.8 GeV BESSY 1 in the Middle East, as centerpice for a new international research center. Voss presents the concept to a *MESC* meeting in Turino. Positive response from Middle East scientists.

• 1998 – Voss presents concept to *MESC* meeting in Uppsala. *MESC* endorses SESAME

• 1999 - 1st meeting at UNESCO; (Interim) Council established – *Herwig Schopper, President;* form international advisory committees

• 2000 – Begin workshops, schools; Growing community interest

• 2002 - Decision to build a *new 2.5 GeV ring* (*still using BESSY injector*)

• 2003 - Ground breaking for building; completion in 2008

• 2008 – Chris Llewellyn-Smith takes over as Council President

Vigorous training programme and growing potential user community

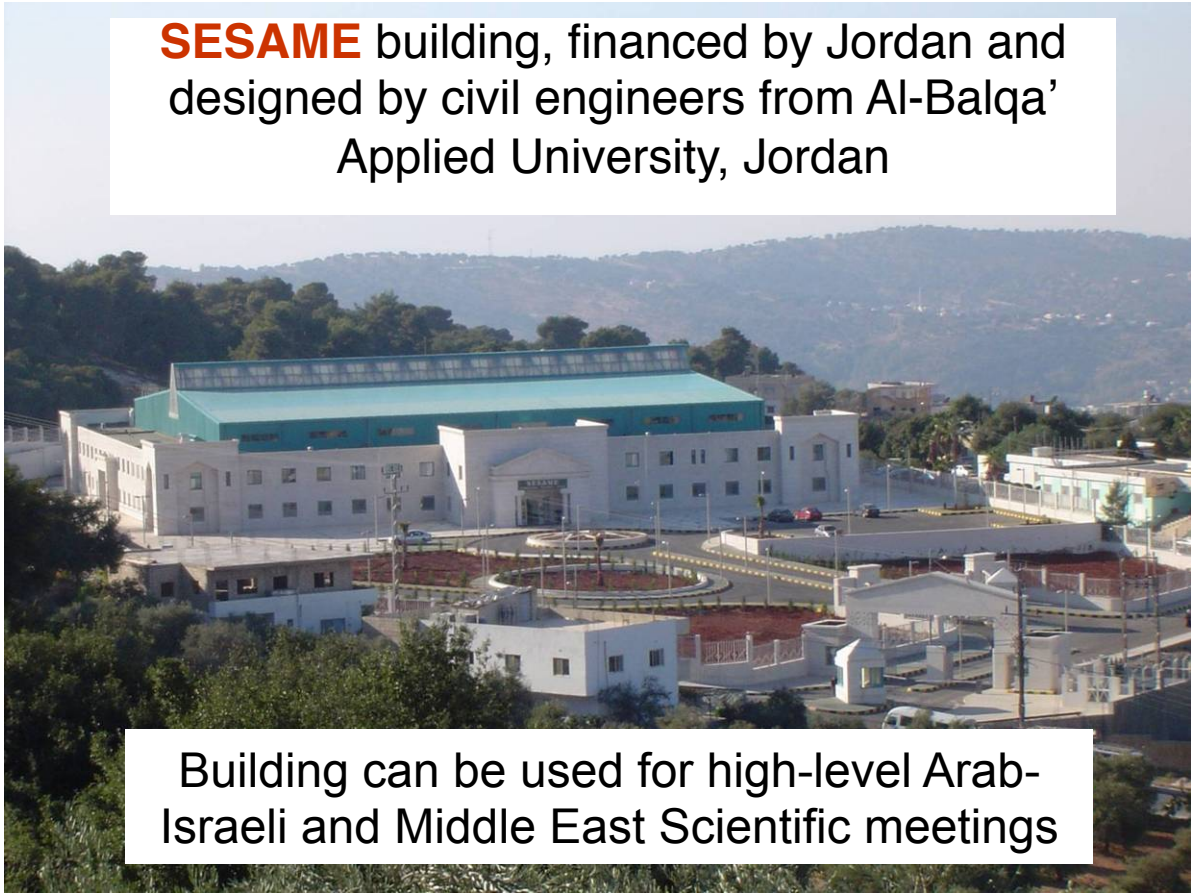
First experiments in 2015, *assuming* funding for main ring + building and adapting/upgrading beamlines is secured.

SESAME PARAMETERS

- Electron energy 1 GeV
- Injection energy 1 GeV
- Stored electron current 700 mA
- Initial lifetime ~8 hours
- Horizontal emittance 50 nm-radians
- Bending magnet field 1.875 T
- Field in 13 pole SC wiggler 7.5 T
- Circumference 100.8 m
- No. of straight sections 6
- No. available for IDs 4
- Free space high beta SS (Undulators) 6 m
- low beta SS (Wigglers) 2.5 m
- Critical energy bend magnet 1.25 keV
- 7.5 T, 13 pole wiggler 5.0 keV
- Source size (1 sigma H/V)
- bend magnet .26/.16 mm
- 7.5 T 13 pole wiggler .44/.02 mm
- undulator .76/.09 mm

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

SESAME building, financed by Jordan and designed by civil engineers from Al-Balqa' Applied University, Jordan



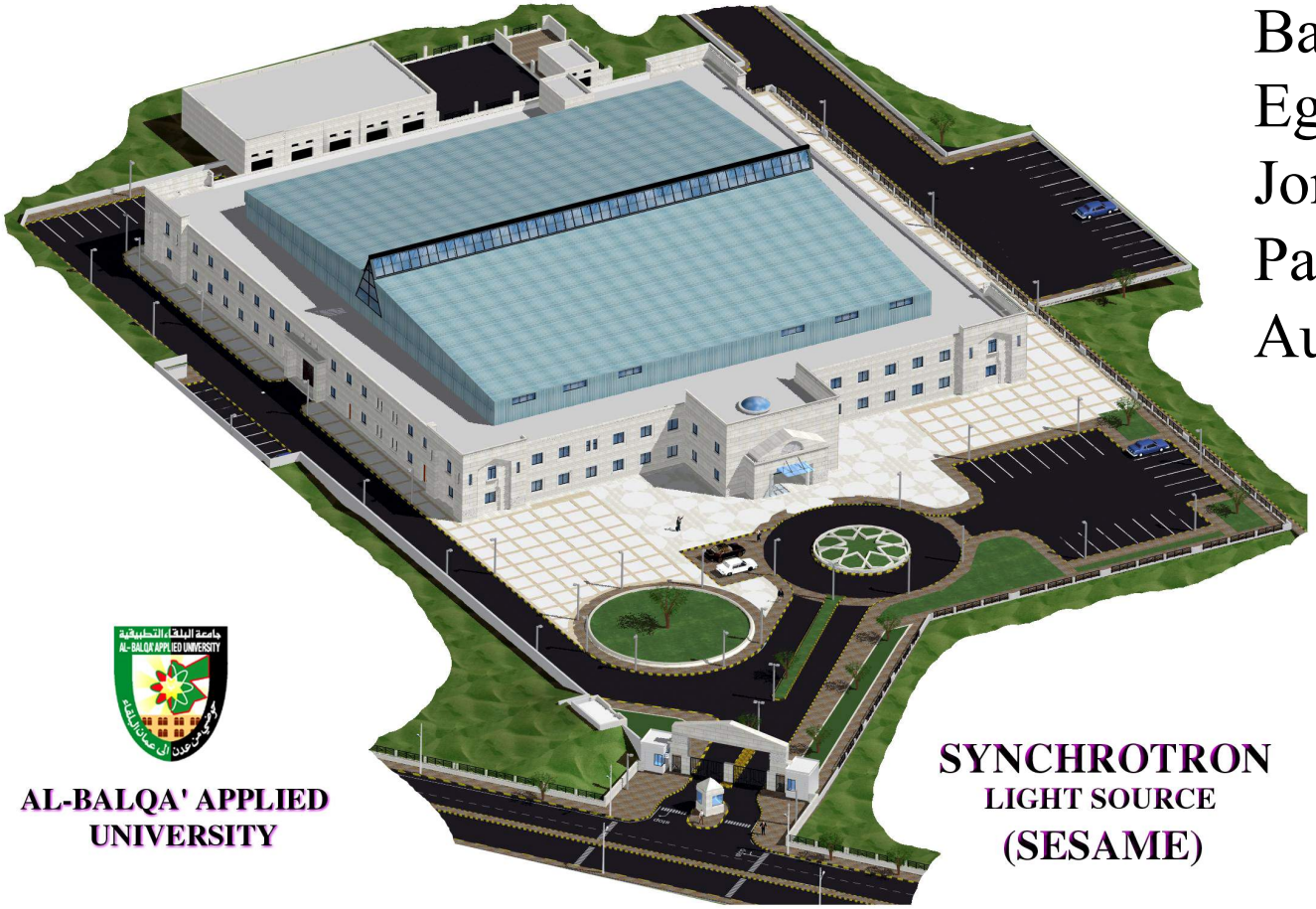
Building can be used for high-level Arab-Israeli and Middle East Scientific meetings

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

Under the auspices of UNESCO and modeled on CERN

SESAME

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



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

AL-BALQA' APPLIED UNIVERSITY

SYNCHROTRON LIGHT SOURCE (SESAME)

www.sesame.org.jo

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

SESAME Technical Committee meeting of Nov. 19, 2004

Albin Wrulich (SLS, Chair), members include Carlo Bocchetta (Elettra), Mikael Eriksson (MAXLAB), Amor Nadji (Soleil), Ernst Weihreter (BESSY)

Accelerator Trainees at the following Laboratories, usually for 2 years

ANKA (Germany)	**Control system**
DESY (Germany)	**Injector + Power supplies**
ELETTRA (Italy)	**Beam Diagnostics**
LURE (France)	**Optics+Vacuum**
Max II (Sweden)	**Optic**
SRS (England)	**Vacuum, Power supplies**
SLS (Switzerland)	**Control system**


R.Sarraf

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

Presentation of Einstein Gold Medal to Herwig Schopper by Koïchiro Matsuura, Director-General of UNESCO; April 15, 2004

SESAME

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

12th Meeting of SESAME Council; Uppsala Sweden, June 9-10, 2008

***Dinçer Ülkü*; Vice President of the SESAME Council**

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***Yasser Khalil*; Administrative Director**

***Khaled Toukan*; Sesame Director**

***Herwig Schopper*; Council President 1999-2008**

***Hafeez Hoorani*; Scientific Director**

***Amor Nadji*; Technical Director**

***Albin Wrulich*; Chair of SESAME Technical Advisory Comm.**

<u>Missing</u>; *Zahid Hussain* (Chair, Beamlines Comm.) *Zehra Sayers* (Chair, Scientific Comm.) *Javad Rahighi* (Chair, Training Comm.)

"As the region's first major international research centre, SESAME will contribute to regional scientific, technical and economic development at a crucial stage in the history of the Middle East. It will be a focal point for regional scientific collaboration and for cross-border networking,"

said Her Royal Highness **Princess Sumaya Bint El Hassan,** President of the El Hassan Science City in Amman (Jordan), when she welcomed the delegates of the SESAME Council.

Members

- BAHRAIN
- Cyprus
- EGYPT
- Iran
- ISRAEL
- JORDAN
- PAKISTAN
- PALESTINIAN AUTHORITY
- TURKEY

Observers

France
Germany
Greece
Italy
Japan
Kuwait
Portugal
Russia
Sweden
Switzerland
UK
USA

Governing Body

Council

Each Member one vote

Two delegates

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

Ground Breaking Ceremony; Allaan Jordan, January 6, 2003

Nobel Laureates visit SESAME site in June, 2008

45 Laureates endorse SESAME "as a beacon, demonstrating how shared scientific initiatives can help light the way towards peace".

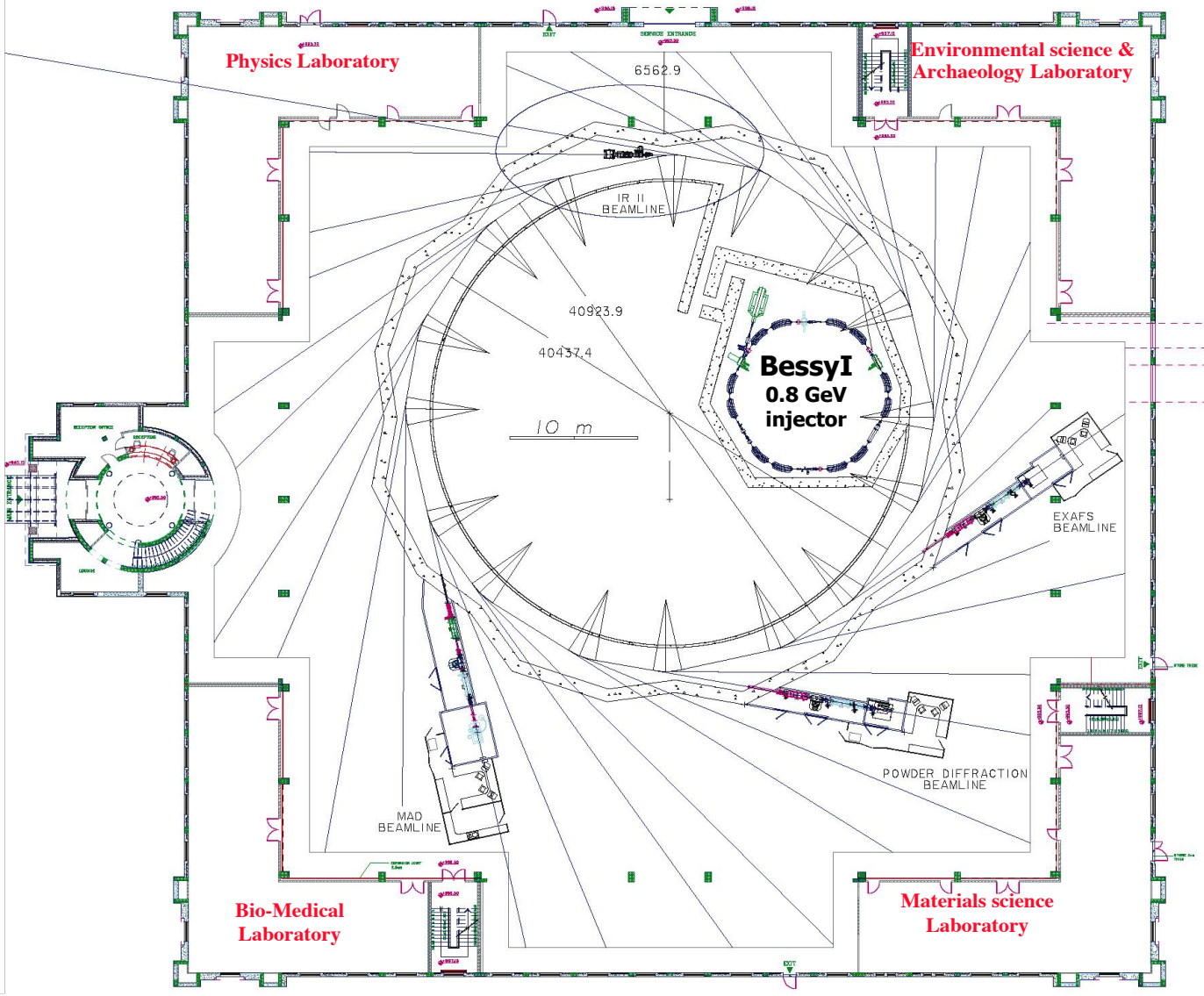
US Congressman Bill Foster and his wife Aesook Byon visiting SESAME in 2009

Inside the SESAME building; May 2008

BESSY I 0.8 GeV Booster Synchrotron set up in SESAME building for “soft” inauguration on November 3, 2008

Mayor of Salt, Mr. Salameh, and Herman Winick

SESAME; *in construction in Jordan*
www.sesame.org.jo



2.5 Gev

400 mA

C = 133 m

Emitt; 26 nm

12 spaces for wigglers or undulators

16 bend magnet lines

Beam lines up to 36 m long

Operational in 2013-14

3rd SESAME User Meeting
October 11-13, 2004, Antalya, Turkey
9th Users' meeting in Amman November 2009

***JSPS-SESAME-Sabanci Univ. SCHOOL*; Turkey, March 1-5, 2010**

Hands-on Session at *SESAME-JSPS* School for Synchrotron Sciences; Cairo, Egypt; Nov. 17-23, 2008

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)**

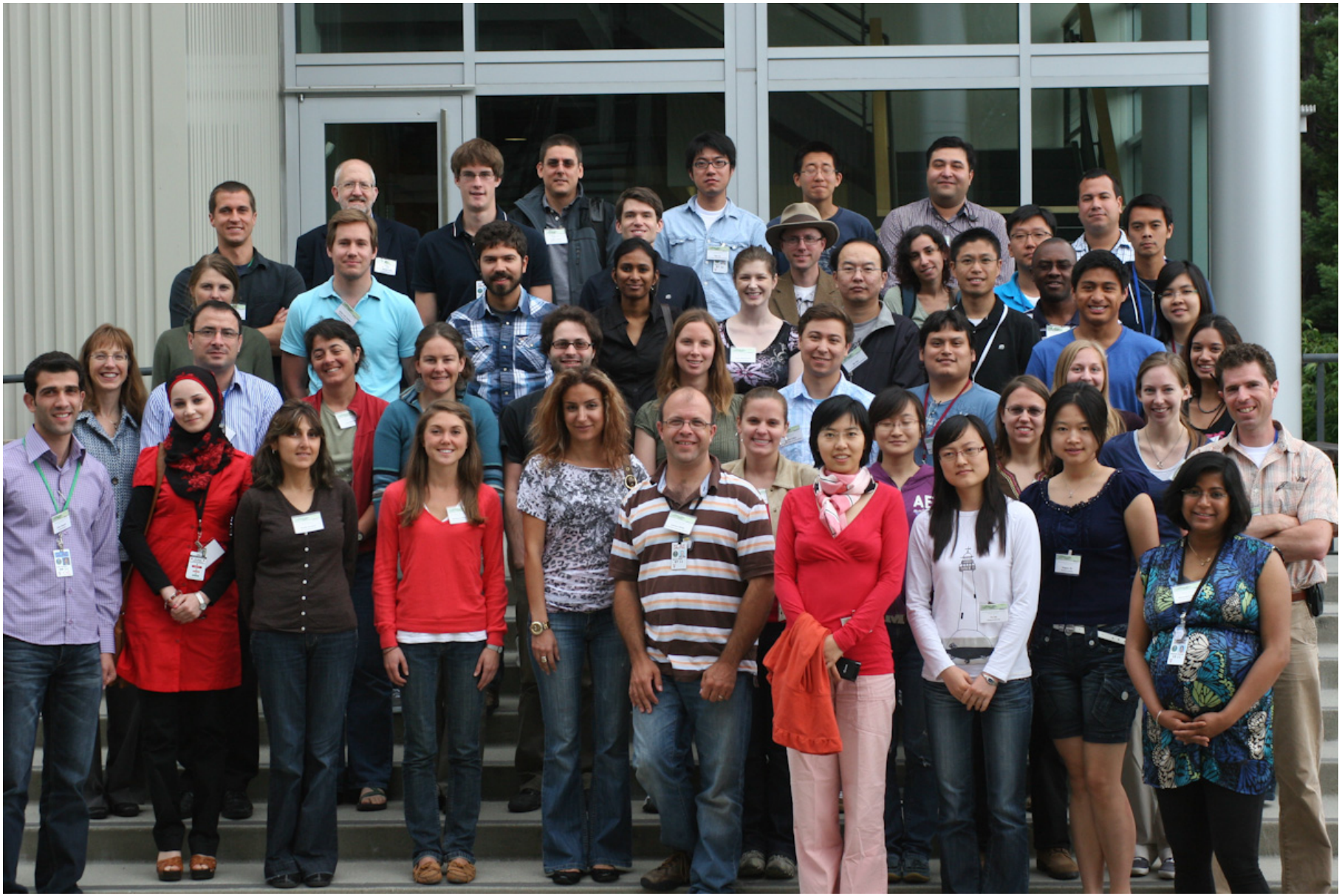
Second row Left to Right; **Darweesh Foudeh, RF Engineer (Jordan), Firas Makahleh, Mechanical Engineer (Jordan), Mohammad Alnajdawi, Mechanical Designer (Jordan), Maher Shehab, Mechanical Engineer (Jordan), Hamed Tarawneh, Accelerator Physicist (Jordan), Maher Attal, Accelerator Physicist (Palestine),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

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

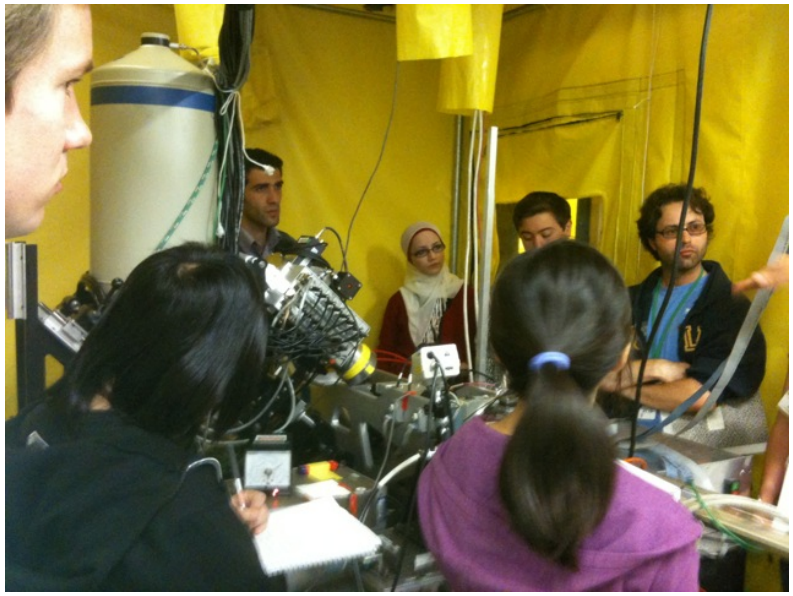
Seated Left to Right; Tasaddaq Ali Khan (Quaid-i-Azam University; Islamabad, Pakistan); C. T. Chen; Fatemeh Elmi (Tarbiat Modarres University; Tehran, Iran); Ozen Ozgen (Hacettepe University; Ankara, Turkey). Keng Liang is standing, second from the right.

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*



2011 SSRL-XAS Summer School Class Photo by Natalie Cramar



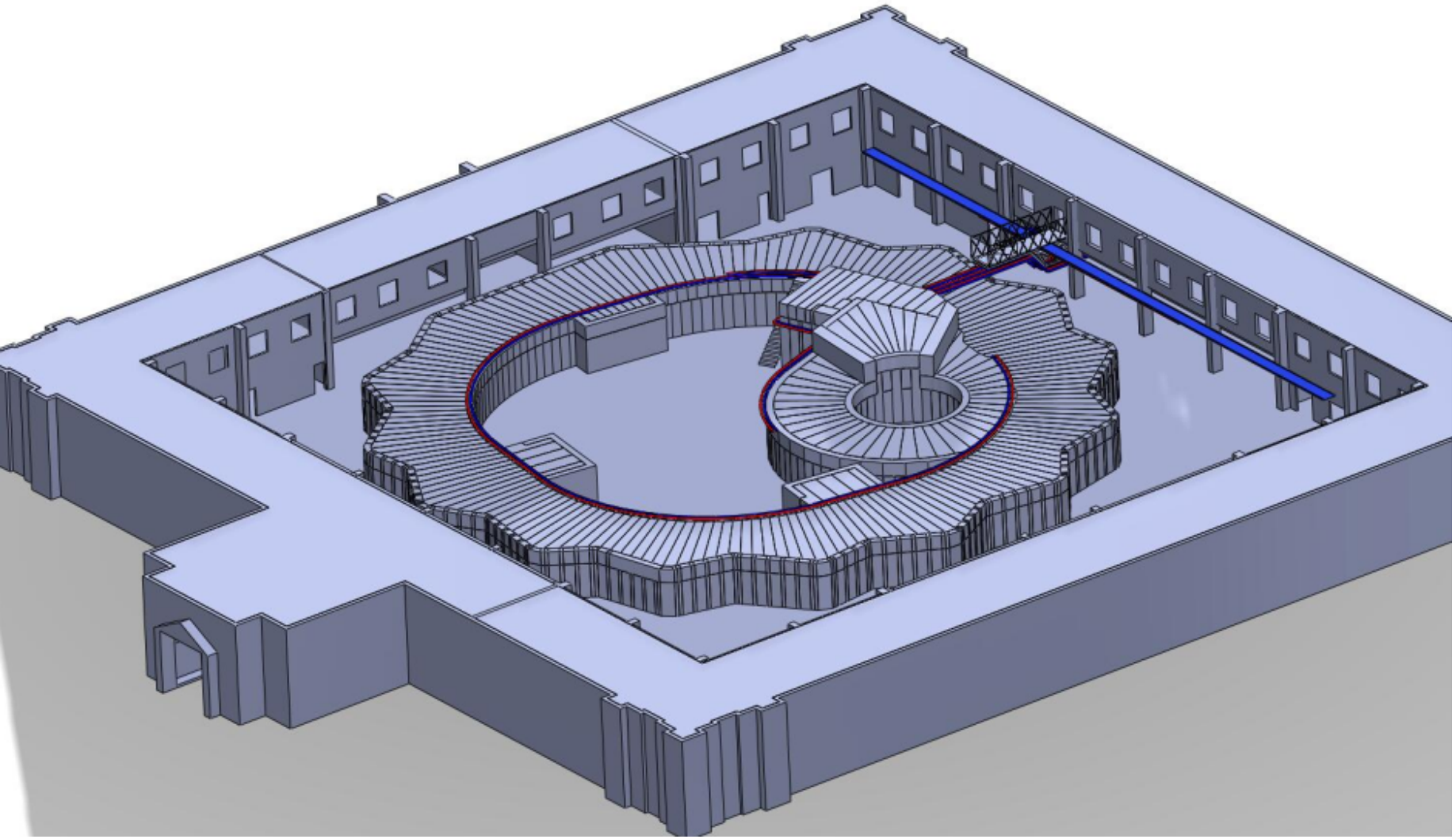

BL 2-1

Tests of the MICROTRON Subsystems

Microtron PreInjector at SESAME

Accelerated beam, April 2009

3D View of the New Shielding



K. Toukan The Royal Swedish Academy of Sciences, Stockholm, Sweden, June 10° ,2008

Shielding complete for SESAME injector and storage ring; May 2011

SESAME Scientific Collaborations

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

Authors:

Tzvia Selzer[1], Brian Vash[2], Said Ali[3], Rotem Sertchook[1], Guenter Grossmann[4], Peter Atadja[2], Travis Stams[2], Dalia Cohen[2], and Irit Sagi[1*]

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*
Ph: 972 8 9342130 Fax: 972 8 9344154 *irit.sagi@weizmann.ac.il*

Photodynamic Therapy of Human Melanoma Cells by Indocyanine Green Induced Rapid Apoptosis through Activation of Caspases & Cytochrome C & Inhibition of Histone Deacetylases & NF-KB P65

Amira M. Gamal–Eldeen (a), Meghan E. Ruppel (b), Randy J. Smith (c), Thomas Tsang (d), Lisa M. Miller (b,c), and Abdel-Megid Mamoon (e)

(a) Cancer Biology Laboratory, Center of Excellence for Advanced Sciences, **National Research Center, Dokki 12622, Cairo, Egypt**
(b) Department of Biomedical Engineering, **Stony Brook University, Stony Brook, NY 11794 USA**
(c) National Synchrotron Light Source, **Brookhaven National Laboratory, Upton NY, 11973 USA**
(d) Instrumentation Division, **Brookhaven National Laboratory, Upton NY, 11973 USA**
(e) **Egyptian Atomic Energy Authority, Nasr City, Cairo, Egypt**

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

THE IMPACT OF SYNCHROTRON LIGHT SOURCES ON SCIENCE AND SOCIETY IN DEVELOPING COUNTRIES

Herman Winick
SSRL/SLAC/Stanford University
winick@slac.stanford.edu
April 28, 2007

BRAZIL

1. Laboratório Nacional de Luz Síncrotron (LNLS); Campinas, Brazil (ref. 1)
http://www.lnls.br/index.asp?idioma=2&opcaoesq

A 1.35 GeV light source has been in operation in Campinas since1997. In 2004 there were more than one thousand external users. Demand for beam time exceeds available time by a factor of two. Twelve beam lines are in operation.
Since 2000 more than 29 PhD theses and 21 Masters Dissertations have been completed based on work done at LNLS. Almost all of the technical components of the facility were built in Brazil, largely by LNLS, which now has skills unique in Brazil in certain technical areas (ultra-high vacuum, magnets design and construction, controls, rf, etc). For example, as a result of the experience gained in constructing the storage ring, LNLS now supplies UHV equipment at cost to universities in Brazil. Of sixteen staff scientists four returned to Brazil after their postdoctoral research abroad.
LNLS plays an important role in the Latin-American scientific community (15% of LNLS users come from outside Brazil, including 9-10% from Argentina). Others come from Africa, Europe, and the USA.
LNLS has made significant contributions to industrial development in Brazil. One company got its start by building flanges for LNLS. In a permanent program to train industrial scientists, about 15 students work each year at LNLS for 6 months before taking industry jobs. Seven joint projects with industry are underway (e.g. catalysis). LNLS develops special instrumentation to meet the needs of industrial users. Seven LNLS staff are dedicated to service to industry.
LNLS has introduced the concept of a national research facility, equipped with world-class equipment and open to all.

Hefei, China

3. National Synchrotron Radiation Laboratory (NSRL); Hefei, China (ref. 3)

http://en.nsrl.ustc.edu.cn/

An 0.8 GeV light source has been in operation since 1991. A major Phase II upgrade was carried out from 1999 to 2004. NSRL now operates 14 photon beamlines and experimental stations, three of them from a 6 Tesla superconducting wave length shifter (SLS) and one from a 29-period permanent magnet undulator. The facility operates for 4,800 hours per year and serves 400 users.58 PhD and 53 Masters Degrees have been produced by the University of Science and Technology of China alone. This now continues at the yearly rate of 20 PhD and 20 Masters Degrees per year. A total of about 150 graduate students are now involved. Several senior scientists have returned to NSRL from abroad, including Chen Gao from LBNL, now Vice-Director of NSRL.

KOREA

4. Pohang Accelerator Laboratory (PAL); Pohang, Korea (ref. 4)
http://pal.postech.ac.kr/eng/index.html

A 2.5 GeV light source has been in operation since 1994. Twenty seven beam lines, including six from insertion devices, are in operation, serving 1500-2000 users each year. About 500 papers are published each year based on work at the light source.
Ten scientists returned to Korea to join the laboratory. Four became directors. Thirty professors who returned to the Pohang University of Science and Technology (Postech) are now users of the light source. Many others returned to become faculty at other Korean Universities and are now as users at PLS. At least 40 PhDs have already been completed at Postech using the light source. About 100 PhDs have been completed at other universities in Korea using the light source.
Many parts of PLS have been built in Korea (magnets, power supplies, vacuum chambers, ion pumps, klystrons, modulators, beam position monitors, etc.). The 2.5 GeV linac injector was designed and constructed in collaboration with China, although China & Korea did not have diplomatic relations until 2 years after this collaboration started. Collaborations with other countries included France, Italy, Japan, the UK, and the US.

Several new companies were formed as a direct result of the light source project. These include Geumryong (magnets), VMT (ion pumps), a controls company, and an alignment company. Samsung & LG studied defects in LSI chips & LCDs for cellular phones.
A comment by a former director: “As a result of the success of the PLS project, ordinary Koreans and the Korean government trust Korean scientists since they spent a large amount of money and achieved, and even exceeded, project goals. Initially there was some doubt that this could be done.”

TAIWAN

5. National Synchrotron Radiation Research Center (NSRRC)

Hsinchu,Taiwan (ref. 5) http://www.nsrrc.org.tw/

A 1.5 GeV light source has been in operation since 1993. A total of 28 beamlines, 45 end stations, and 8 insertion device magnets are in operation. These serve about 1000 users on 660 experimental proposals in 2005. Also two hard x-ray beam lines (one from a bending magnet and one from an undulator) have been constructed at Spring 8 in Japan for use by scientists from Taiwan. These have been in operation since 2001.

So far more than 140 students have received the PhD based on work done at the light source. More than 25 overseas Taiwanese scientists returned to NSRRC, universities, and national research institutes in Taiwan due at least in part to the light source.

There has been significant benefit to companies in Taiwan which have collaborated with the light source to develop capabilities to design, fabricate, and measure many technical components. This includes magnets, insertion devices (including superconducting devices), ultra-high vacuum chambers and other components, survey and alignment technology, beam line components, x-ray energy analyzers, cryogenics technology, radio frequency components, digital electronics, and brazing technology.

As part of the international synchrotron radiation community, the light source has had many interactions with other facilities, including Spring 8, ANKA, ALS, SSRL, CHESS, the Australian light source, and SESAME. The Taiwan light source has provided full support for three fellowships for scientists from the Middle East who worked at NSRRC for one year. Three more have been offered.

A new 3-3.3 GeV third generation light source is proposed at the same site. This proposal is currently under evaluation by the National Science Council of Taiwan.

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***

Other Relevant Activities

- **Schools on synchrotron radiation by ICTP/ Trieste**
- **Beam time at other facilities (e.g. Italy)**
- **US Department of Energy (DOE) Cooperative Research Program for SESAME ($300K)**
- **$50K/year DOE annual grants to UNESCO for SESAME for past 4 years**
- **Equipment transfers from other light sources**
- **Fellowships to SR labs in operation or construction**
- **Support by Int. Atomic Energy Agency (IAEA)**

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 recently 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 plans to build a medical beam line

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.

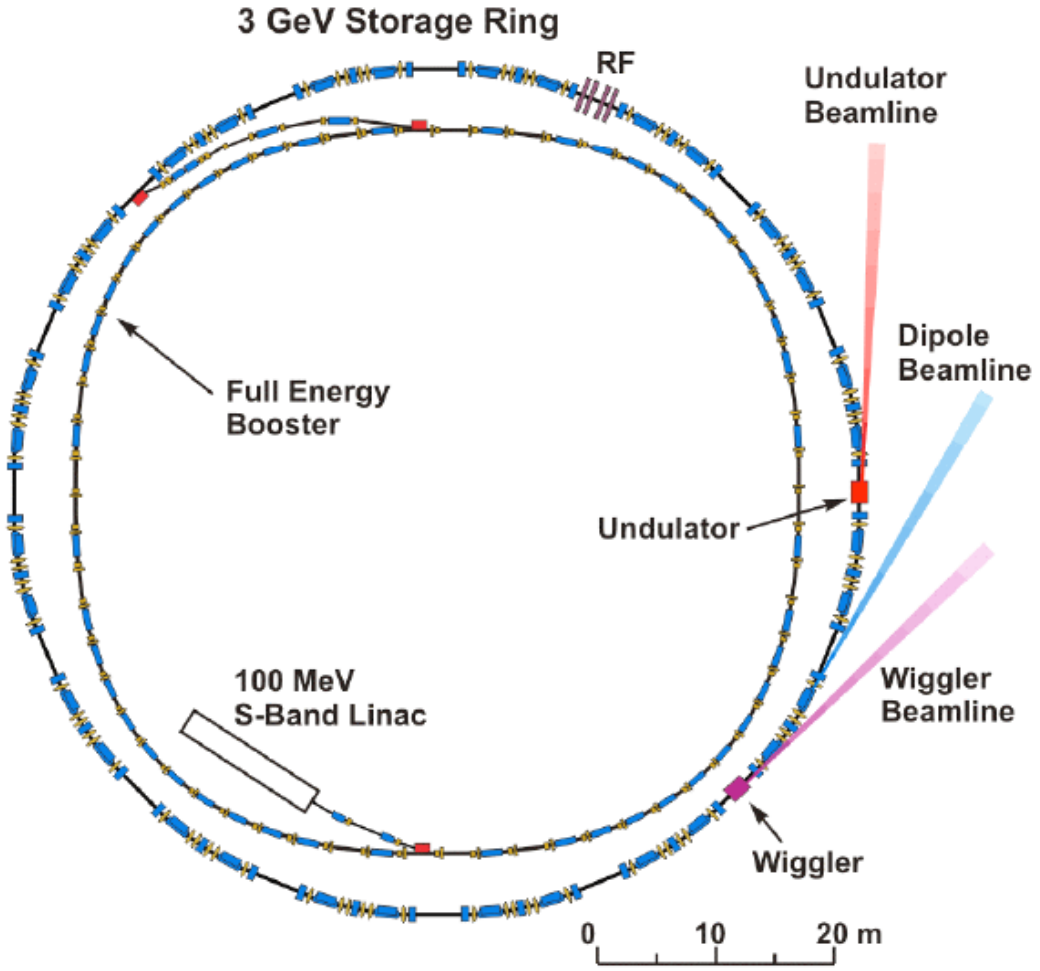


Fig. 2.3.1 The general layout of CANDLE facility.

Storage Ring. The analysis of the synchrotron radiation user statistics lead us to the 3 GeV energy machine with the nominal beam current in the storage ring of 350 mA. The storage ring has been optimized to have the beam emittance of 8.4 nm-rad that is accomplished by having the 16 Double Bend Achromatic type lattices, the small 0.18m dispersion in the straight section and the combined function dipole magnets with vertical focusing gradient of 3.3 T/m. These provide the characteristic photon energy of 8.1 keV emitted in the 1.354 T magnetic field dipoles and the spectral brightness of the order of 10^{16} ph/mm^{2}mrad^2 in 0.1% energy band wide.

CANDLE

Armenia

3 GeV

Training Accelerator Physicists and Engineers for SESAME

As is well known to readers of *SRN*, the SESAME Project aims to develop a synchrotron radiation research center in the Middle East based on an upgrade of the BESSY I facility, which is being offered as a gift by Germany. Because there is little experience with accelerators in the Middle East, for this project to succeed it is necessary to create a team of scientists and engineers with expertise in accelerator technology. The SESAME Training Committee, co-chaired by Reza Mansouri (Iran) and Miguel Virasoro (Italy), is charged with the developing programs to train scientists and engineers in all aspects of the SESAME project, including accelerator technology, beam lines, and research applications of synchrotron radiation. As a first step in the area of accelerator technology, a workshop/school sponsored by the SESAME Training Committee was held at Al-Balqa' Applied University, Al-Salt, Jordan from September 9-18, 2000, with financial support from Al-Balqa' Applied University, the International Atomic Energy Agency, ICTP-Trieste and UNESCO.

The main driving force behind the workshop was Gus Voss (DESY), co-chair of the SESAME Technical Committee. Together with Kamal Araj (then at Al-Balqa' Applied University and presently with the IAEA) and Ernst Weihreter (BESSY), Voss developed the agenda and chose the following instructors: A. Gamp / DESY (RF-transmitters, acceleration systems); C. Herveaux / LURE (vacuum systems); N. Holtkamp / Fermilab (magnet design, power supplies); H. Martirosyan / YerPhi (White circuits, power supplies); A. Nadji / LURE (beam optics, beam dynamics); M. Plesko / Jozef Stefan Institute (control systems); E. Weihreter / BESSY (synchrotron radiation, injection); H. Zyngier / LURE (beam diagnostics and instrumentation). Since only 50 participants could be accommodated from about 100 final applications (winnowed from an original 200 applications), a selection committee con-

SESAME Machine Workshop participants gathered in Jordan.

A dip in the Dead Sea by some of the workshop lecturers. Shown (from left to right) are Norbert Holtkamp, Alexander Gamp, Ernst Weihreter and Gus Voss.

Why is a synchrotron radiation facility relevant to a developing country?

A synchrotron light source in a developing country provides a means to:

- **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**
- **Promote international scientific collaborations**
- **Promote development of high-tech industry (capacity building)**

The UNESCO-sponsored SESAME Project in Jordan (www.sesame.org.jo), has an additional objective:

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

In Summary

• X-rays and VUV/soft x-rays have been an important probe of materials for basic and applied research for 100 years

•Synchrotron radiation from storage rings provides extremely intense x-rays, soft x-ray, and VUV beams - “big scale machines” enabling a large quantity of “individual investigator science”

•New Concepts (FELs, ERLs) offer major performance extensions

• We are living through a revolution in science & technology due to this immense increase in x-ray source performance

The future looks very “bright” indeed

The Evolution of SESAME

1980's: Nobel Laureate *Abdus Salam* suggests a light source for the Middle East

1990's: Individuals and groups promote scientific cooperation between Israel and Arab countries.
In particular, *Middle East Scientific Cooperation (MESC)* group, based at CERN *(Sergio Fubini, Eliezer Rabinovici, Herwig Schopper, Tord Ekelof…)*

My own involvement; BESSY II Machine Advisory Committee meeting, *September 1997*

I asked, "What will become of BESSY I?"

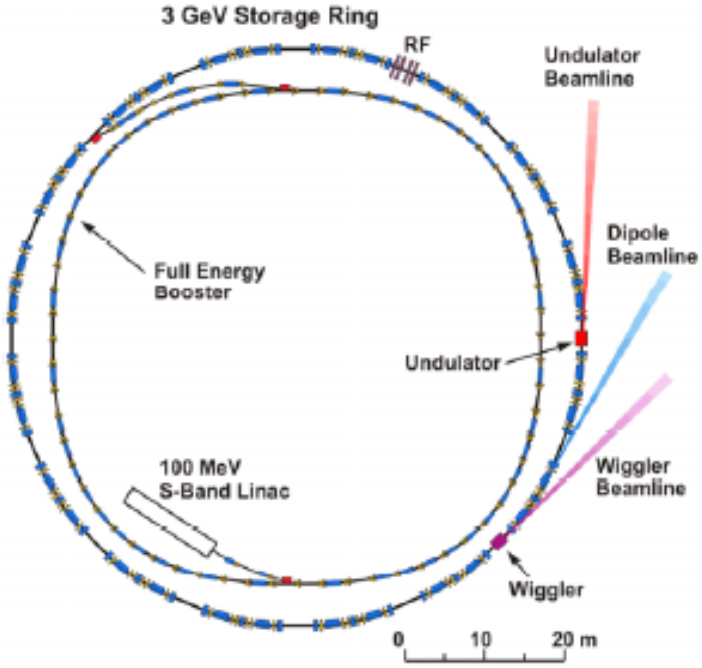


Figure1: The general layout of CANDLE facility.

Table1. Main parameters.

Energy E (GeV)	3
Circumference (m)	216
Current I (mA)	350
Number of lattice periods	16
Horiz. emittance (nm-rad)	8.4
Beam lifetime (hours)	18.4

The CANDLE facility in Yerevan, Armenia; in design

There are ~ 60 synchrotrons in world

None in the Middle East

SESAME building, financed by Jordan and designed by civil engineers from Al-Balqa' Applied University, Jordan

Building can be used for high-level Arab-Israeli and Middle East Scientific meetings

- International collaboration is obvious way for countries with limited science budgets to build synchrotron-light sources
- Broad programme makes synchrotron ideal facilities for building scientific capacity
- SESAME will be a user facility: scientists will typically go to SESAME two or three times a year for a week or two to carry out experiments, in collaboration with scientists from other institutions/countries

Training Programme

One of the essential objectives of SESAME

- **Users meetings, Workshops, Individual training (visits, Fellowships, …)**
- **Funding from**

  International organisations:

  IAEA, **UNESCO**, ICTP, ESRF

  External National organisations & synchrotron labs in: Brazil, France, Germany, Italy, Japan, Portugal, Spain, Sweden, Switzerland, Taiwan, UK, USA (DoE)

  Organisations in Members: Cyprus, Egypt, Iran, Israel, Jordan, Turkey

  Scientific bodies: APS + EPS + IOP + DPG + ACS

  Companies: Gentech, Ox Diffraction, PANanalytical, Jordanian Phosphate Mining co.

  Foundations: Canon, Lounsbery

  Link SCEEM project

SESAME Accelerator School
September 9-18, 2000

In Jordan; Organized by Gus Voss, DESY

Lecturers

A. Gamp / DESY (RF-transmitters, acceleration systems)

C. Herveaux / Lure (vacuum systems)

N. Holtkamp / Fermilab (magnet design, power supplies)

H. Martirosyan / YerPhi (White circuits, power supplies)

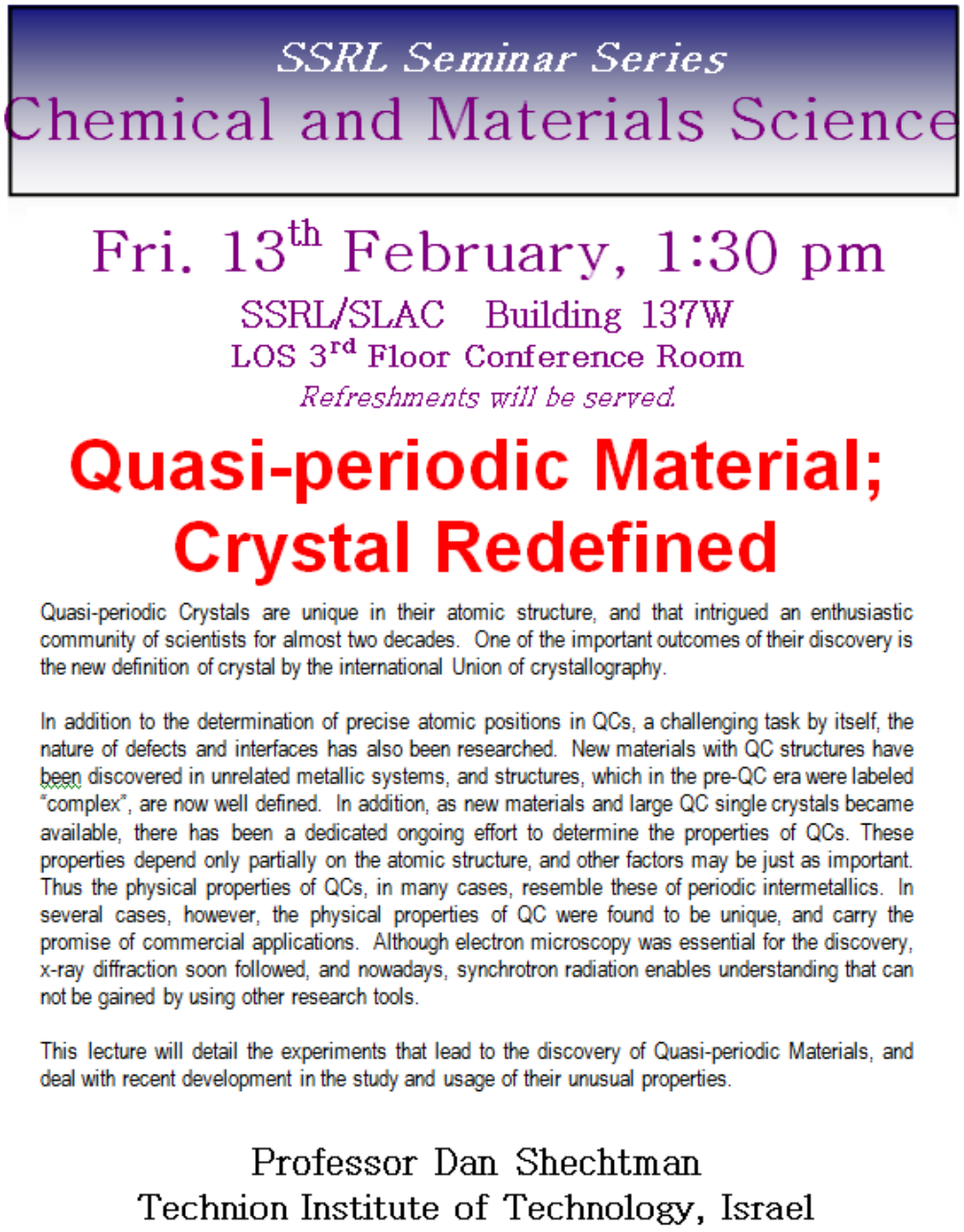
A. Nadji / Lure (beam optics, beam dynamics)

M. Plesko / Jozef Stefan Institute (control systems)

E. Weihreter / BESSY (synchrotron radiation, injection)

H. Winick/SLAC (Overview of SR)

H. Zyngier / LURE (beam diagnostics and instrumentation)



SSRL Seminar Series

Chemical and Materials Science

Fri. 13th February, 1:30 pm

SSRL/SLAC Building 137W

LOS 3rd Floor Conference Room

Refreshments will be served.

Quasi-periodic Material; Crystal Redefined

Quasi-periodic Crystals are unique in their atomic structure, and that intrigued an enthusiastic community of scientists for almost two decades. One of the important outcomes of their discovery is the new definition of crystal by the international Union of crystallography.

In addition to the determination of precise atomic positions in QCs, a challenging task by itself, the nature of defects and interfaces has also been researched. New materials with QC structures have been discovered in unrelated metallic systems, and structures, which in the pre-QC era were labeled "complex", are now well defined. In addition, as new materials and large QC single crystals became available, there has been a dedicated ongoing effort to determine the properties of QCs. These properties depend only partially on the atomic structure, and other factors may be just as important. Thus the physical properties of QCs, in many cases, resemble these of periodic intermetallics. In several cases, however, the physical properties of QC were found to be unique, and carry the promise of commercial applications. Although electron microscopy was essential for the discovery, x-ray diffraction soon followed, and nowadays, synchrotron radiation enables understanding that can not be gained by using other research tools.

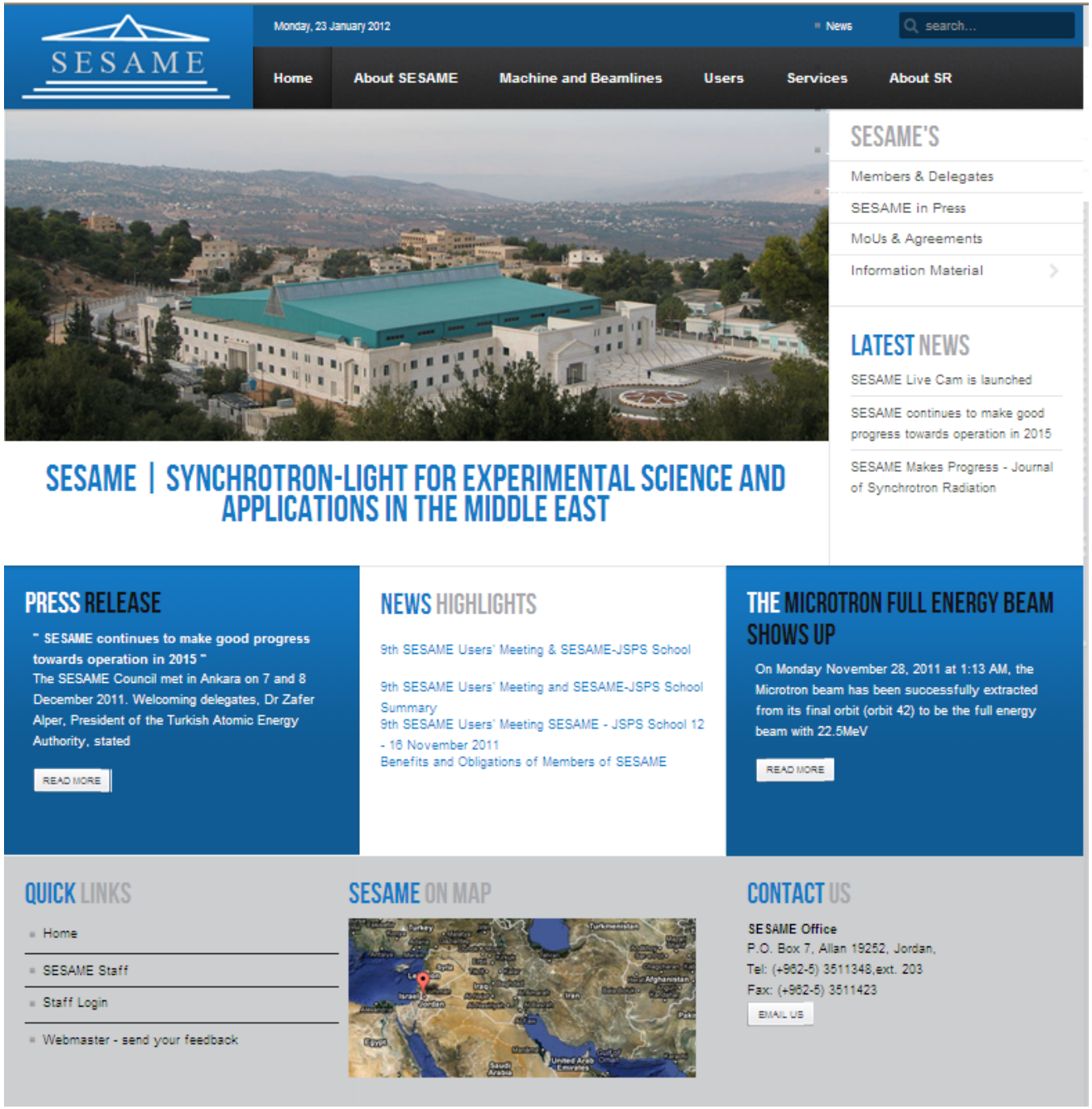
This lecture will detail the experiments that lead to the discovery of Quasi-periodic Materials, and deal with recent development in the study and usage of their unusual properties.

Professor Dan Shechtman

Technion Institute of Technology, Israel

SSRL seminar in 2004 by *Dan Shechtman,* Nobel Prize in Chemistry, 2011

Support provided by DOE Cooperative Research Program for SESAME



www.sesame.org.jo

RESOLUTIONS/ENDORSEMENTS IN SUPPORT OF SESAME 1

UNESCO Executive Board, 2002:

"a quintessential UNESCO project combining capacity building with vital peace-building through science" and "a model project for other regions"

Nobel Laureates: joint statement by 45 laureates, 2008:

"SESAME, as well as producing educational and economic benefits, will serve as a beacon, demonstrating how shared scientific initiatives can help light the way towards peace."

IUPAP 2008, *see next page but one*

US Liaison Committee of IUPAP 2009, *welcomed the new international S&T initiatives announced by President Barack Obama in his address in Cairo on 4 June 2009, citing the SESAME project as an initiative that is designed to build bridges between diverse societies and to contribute to the culture of peace through international scientific cooperation."*

Chief Executive IOP 2009, *wrote to express the strong support of the Institute of Physics for the SESEAME project, sharing the perspective of the US Liaison Committee of IUPAP and of IUPAP*

RESOLUTIONS/ENDORSEMENTS IN SUPPORT OF SESAME 2

IUBMB 2009 resolution

"The IUMBM strongly endorses SESAME and urges its National Committees and Commissions to identify opportunities for continued and expanded assistance to the project, including identifying mechanisms for increased participation by scientists from the region, and raising the visibility of its "science for peace" objectives at the level of scientific and policy-making communities."

U.S. National Commission for UNESCO 2010 statement:

*"We enthusiastically welcome the international science and technology initiatives announced by President Barack Obama in Cairo, June 4, 2009. We wish to recognize the **S**ynchrotron-light for **E**xperimental **S**cience and **A**pplications in the **M**iddle **E**ast (SESAME) as a scientific initiative that supports the diplomatic interests of the United States. The U.S. National Commission (USNC) for UNESCO strongly endorses SESAME. As the SESAME Project serves UNESCO's cross-cutting educational, scientific and cultural goals, the USNC urges UNESCO to work with its Member States to identify opportunities for continued support for SESAME and to highlight world-wide SESAME's objectives of 'science for diplomacy'."*

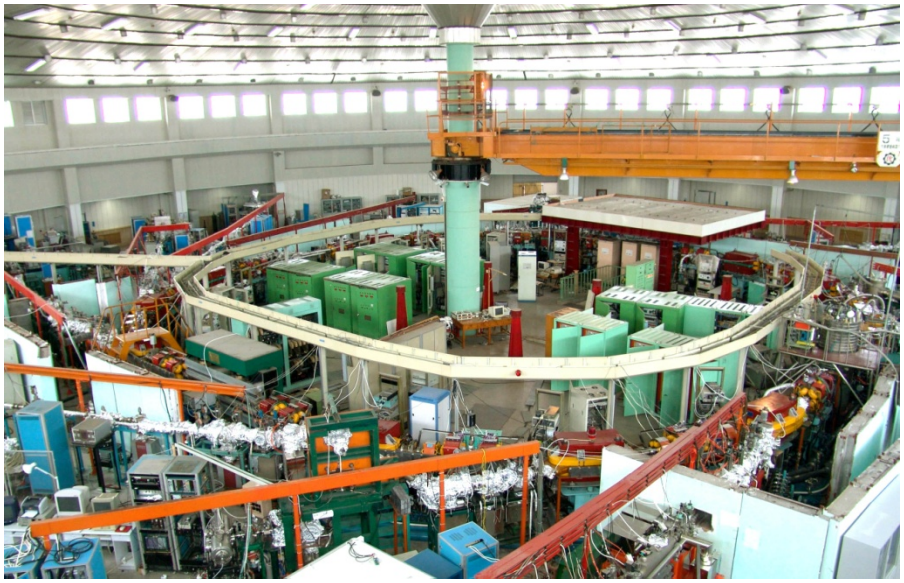
IUPAP 16th General Assembly, Tsukuba, Japan, 14-18 October 2008

Resolution Endorsing SESAME

(Presented by the United States Liaison Committee to IUPAP)

- Recognizing the importance of science and technology for modern society and for improving the human condition
- Recognizing that frontier scientific facilities provide training of regional scientists without their having to leave their region, and enable them to address biomedical, environmental, and other regional issues
- Recognizing the value of international scientific cooperation to promote peace & understanding
- Recognizing that SESAME addresses all of the above in a regional, frontier research facility

The IUPAP strongly endorses SESAME and urges its national committees and Commissions to identify opportunities for continued and expanded assistance to the project, including identifying opportunities for broadening participation by scientists from the region, and raising the visibility of its “science for peace” objectives throughout scientific and policy-making communities.



NSRL, Hefei, PRC

Abstract Glass has been used in ornaments and decorations in Thailand for thousands of years, being discovered in several archeological sites and preserved in museums throughout the country. To date only a few of them have been examined by conventional methods for their compositions and colorations. In this work we report for the first time an advanced structural analysis of Thai ancient glass beads using synchrotron X-ray absorption spectroscopy (XAS) and energy-dispersive X-ray (EDX) spectrometry. Four samples of ancient glass beads were selected from four different archeological sites in three southern provinces (Ranong, Krabi and Pang-nga) of Thailand. Archaeological dating indicated that they were made more than 1,300 years ago. A historically known method for obtaining a red color is to add compounds containing transition elements such as gold, copper, and chromium. For our samples, EDX spectrometry data revealed existing fractions of iron, copper, zinc, and chromium in ascending order. Thus, copper was selectively studied by XAS as being potentially responsible for the red color in the glass beads. K-shell X-ray absorption near-edge structure (XANES) and extended X-ray absorption fine structure (EXAFS) of copper were recorded in fluorescence mode using an advanced 13-element germanium detector. Comparisons with XANES spectra of reference compounds identified two major forms of copper, monovalent copper and a metallic cluster, dispersed in the glass matrix. The cluster dimension was approximated on the basis of structural modeling and a theoretical XANES calculation. As a complement, EXAFS spectra were analyzed to determine the first-shell coordination around copper. XAS was proven to be an outstanding, advanced technique that can be applied to study nondestructively archaeological objects to understand their characteristics and how they were produced in ancient times.

Keywords Copper red · Ancient Thai glass bead · X-ray absorption near-edge structure · Extended X-ray absorption fine structure

Published in the special issue *Analytical Chemistry for Cultural Heritage* with Guest Editors Rocco Mazzeo, Silvia Prati, and Aldo Roda.

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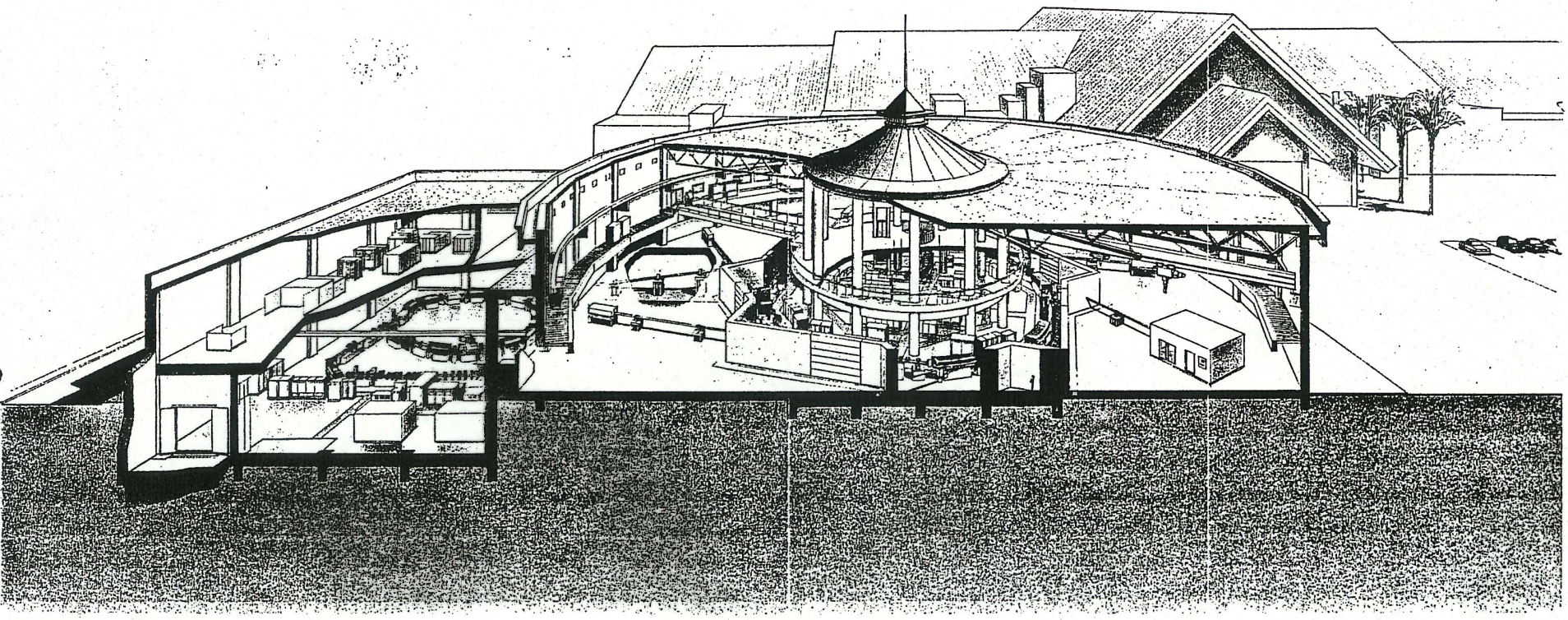
Introduction

Glass beads comprise the majority of glass objects found in South and Southeast Asia since 1000 BC, following the

Synchrotron light in Thailand

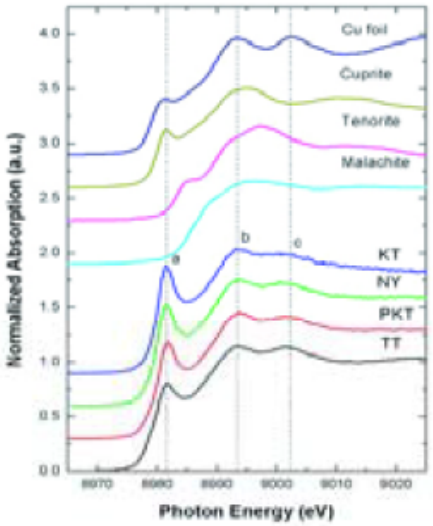


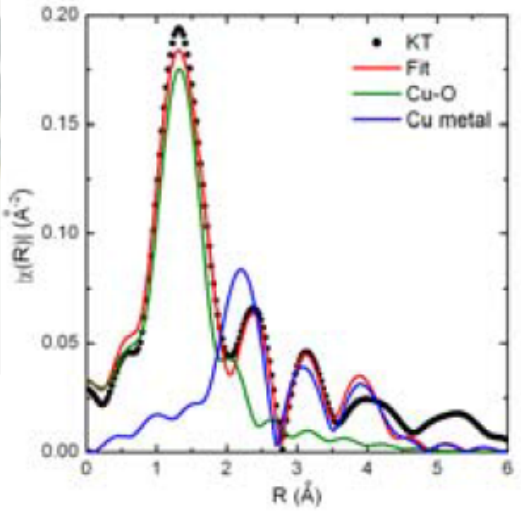
INTERIOR VIEW

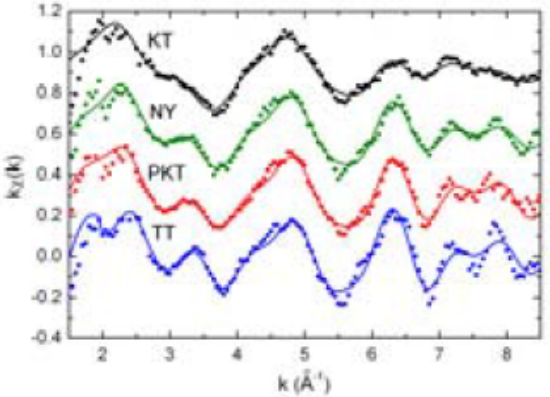
NATIONAL SYNCHROTRON RESEARCH CENTER
SIAM PHOTON LABORATORY

NIKKEN SEKKEI
planners | architects | engineers

XAS analysis on traced copper in Thai ancient beads







W. Klysubun *et al.*, XAS study on copper red in ancient glass beads from Thailand, Anal. Bioanal. Chem. 399 (2011), 3033-3040.

Anal Bioanal Chem (2011) 399:3033–3040
DOI 10.1007/s00216-010-4219-1

ORIGINAL PAPER

XAS study on copper red in ancient glass beads from Thailand

Wantana Klysubun · Yatima Thongkam · Sorapong Pongkrapan · Krit Won-in · Jiraroj T-Thienprasert · Pisutti Dararutana

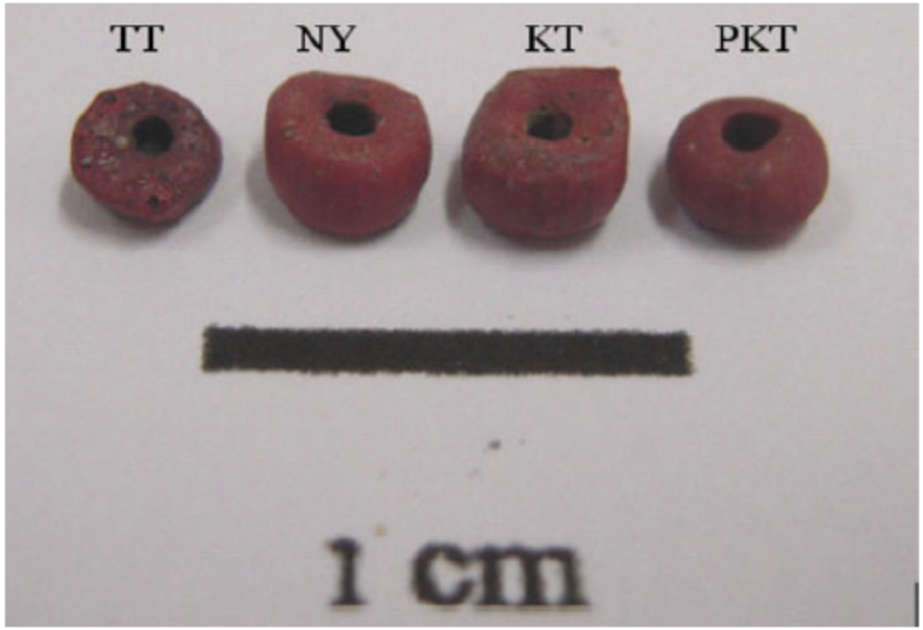


Fig. 1 Photograph of the ancient glass beads. *NY* Nang Yon, *TT* Thung Thuk, *KT* Khlong Thom, *PKT* Phu Khao Thong

Brief History of SESAME

• 1997 – Original idea *(Voss, Winick)*; Upgrade/rebuild BESSY 1(0.8 GeV) in the Middle East, as centerpice for a new international research center. Voss presents the concept to a *MESC* meeting in Turino organized by Tord Ekelof. Very positive response from Middle East scientists.

• 1998 – Voss presents concept to *MESC* meeting in Uppsala. *MESC* endorses SESAME

• 1999 - 1st meeting at UNESCO; (Interim) Council established – *Herwig Schopper, President; form international advisory committees*

• 2000 – Begin workshops, schools; *Growing community interest*

• 2002 - Decision to build a *new 2.5 GeV ring* (*still using BESSY injector*)

• 2003 - Ground breaking for building; completion in 2008

• 2008 – Chris Llewellyn-Smith takes over as Council President

Vigorous training programme and growing potential user community

First experiments in 2015, *assuming* funding for main ring & beamlines is secured. *(new beamlines plus adapting/upgrading donated beamlines)*

Wilhelm Röntgen
Universität Würzburg
Dec. 1895

Michael Pupin
Columbia University/New York
Feb. 1896

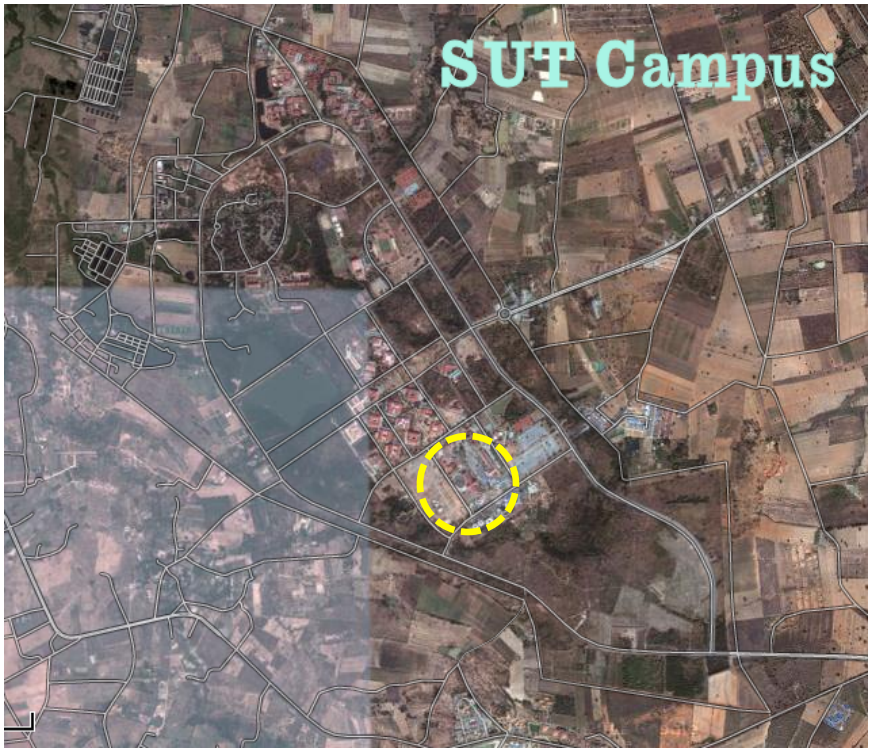
"This is of the hand of a gentleman resident in New York, who, while on a hunting trip in England a few months ago, was so unfortunate as to discharge his gun into his right hand, no less than forty shot lodging in the palm and fingers. The hand has since healed completely; but the shot remain in it, the doctors being unable to remove them, because unable to determine their exact location. The result is that the hand is almost useless, and often painful." - Cleveland Moffett, McClure's Magazine, April 1896

Wilhelm Conrad Roentgen 1845-1923

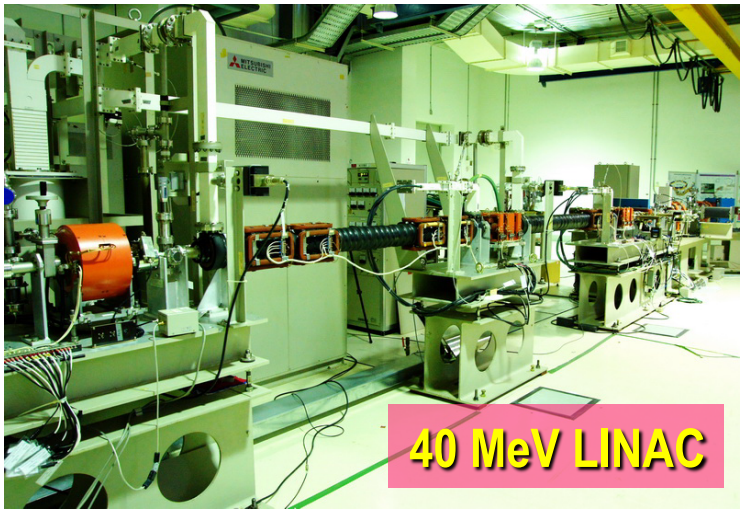
Siam Photon Source (SPS)

Siam Photon Source (SPS) is a dedicated 1.2-GeV synchrotron light source operated by the Synchrotron Light Research Institute (SLRI), and is located in Nakhon Ratchasima (~ 250 km northeast of Bangkok), Thailand.

Siam Photon Source (SPS)
Nakhon Ratchasima



SPS accelerator complex

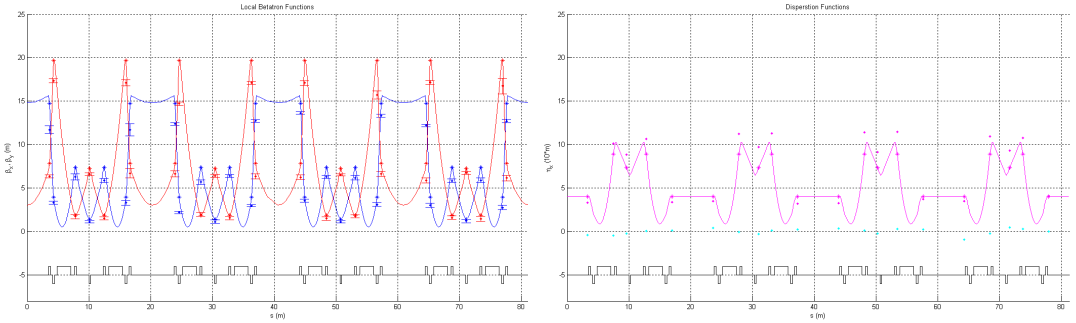


SPS machine parameters

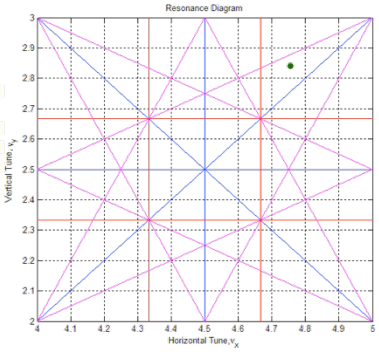
Siam Photon Source (SPS) parameters

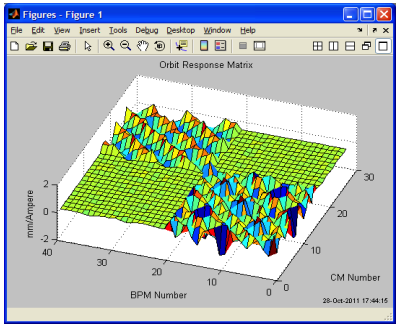
Table 1: SPS machine parameters

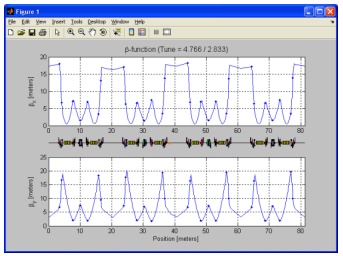
Electron beam energy [GeV]	1.2
Beam current [mA]	150
Lattice	DBA
Number of superperiods	4
Horizontal emittance [nm·rad]	41
Coupling [%]	0.8
Circumference [m]	81.3
Orbital period [ns]	271
Number of straight sections	4 (7 m)
Betatron tunes ν_x, ν_y	4.75, 2.82
Synchrotron tune ν_s	2.33×10^{-3}
Natural chromaticities ξ_x, ξ_y	-9.40, -6.61
Momentum compaction factor α_c	0.0170
Betatron functions β_x, β_y [m/rad]	
Bending magnets	1.79, 5.48
Straight sections	17.12, 3.21
Maximum values	17.83, 19.13
Dispersion function η [m]	
Bending magnets	0.28
Straight sections	0.81
Beam size σ_x, σ_y [mm]	
Bending magnets	0.32, 0.15
Straight sections	0.97, 0.12
Radio frequency [MHz]	118
Harmonic number	32
RF voltage [kV]	100
RF power [kW]	14
Number of RF cavity	1
Damping times τ_x, τ_y, τ_s [ms]	5.36, 4.93, 2.37
Energy loss per turn [keV]	65.94
Injection beam energy [GeV]	1.0

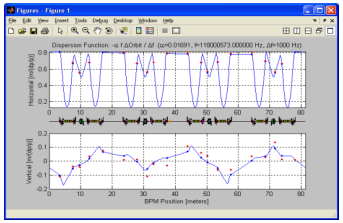


Storage ring optics





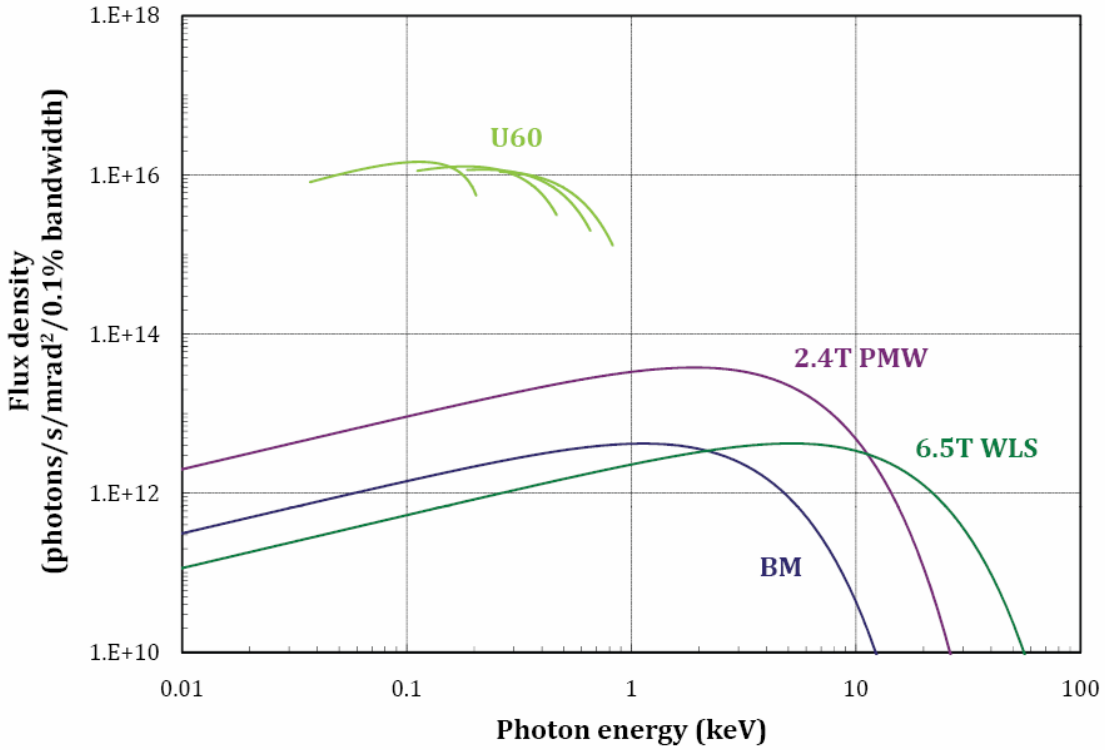




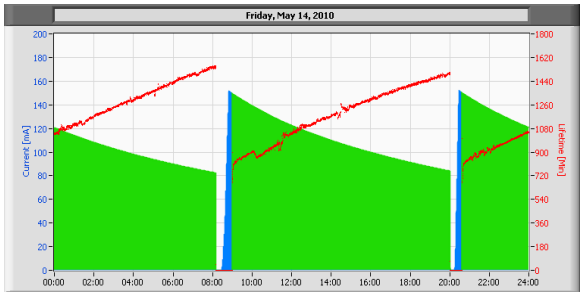
$(\nu_x, \nu_y) = (4.756, 2.837)$

$(4.755, 2.838)$

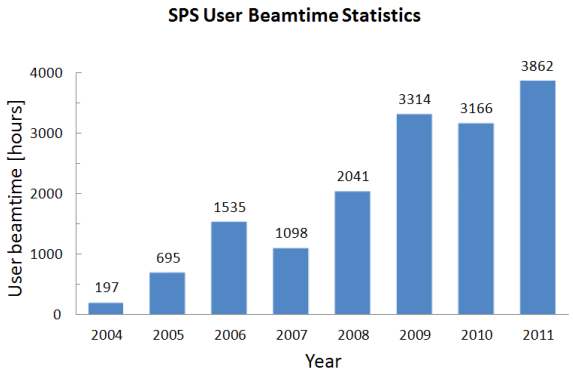
SPS spectrum & operation



SPS spectrum



24H SPS operation

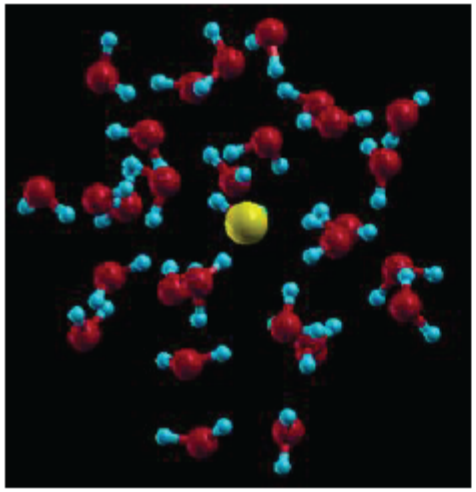


2004 – 2011 user beamtime statistics

The Siam Photon Source provides synchrotron light for users 23 hours/day, 7 days a week. At present, beam lifetime is ~ 11 hours at 100 mA.

Synchrotron light and chemistry

Synchrotron light reveals the structure of aqueous ionic solution



Computer simulation of water molecules around an ion

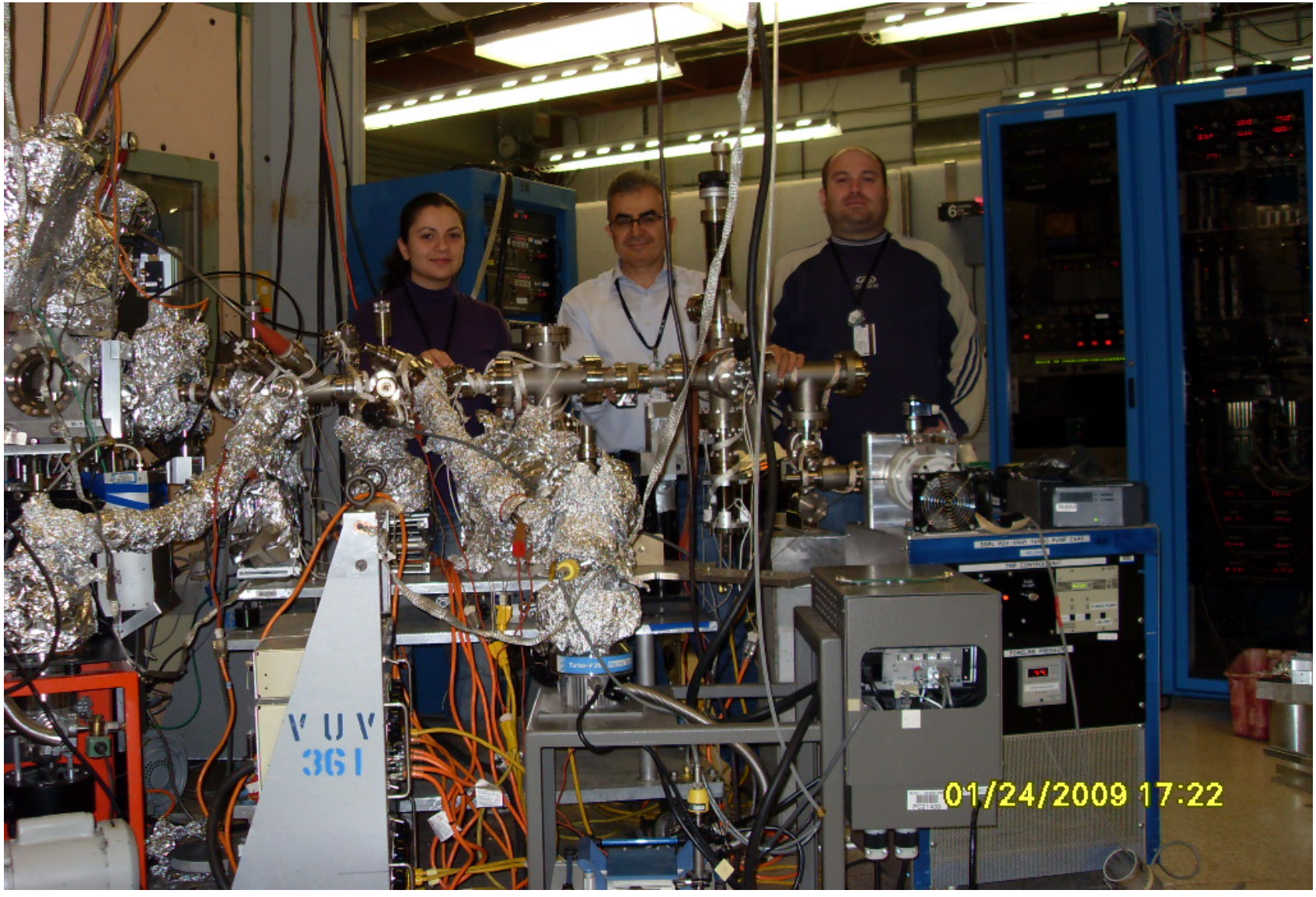
The characteristics of ions solvated in water have long been an interesting topic for scientists. Both experimental and theoretical methods of study have been applied to these types of systems. However even comparison between different experiments give rise to discrepancies in structural solution. It is not difficult for us to imagine that it must be an extremely arduous and complicated task to determine the structure that involves a huge amount of atoms of different types, all moving around one another.

Nevertheless, a group of scientists came to utilize x-ray absorption measurement at SLRI BL8 in order to determine the structure of their solution of interest, a calcium chloride solution. By analyzing the measurement results together with carrying out molecular simulation called quantum mechanical/ molecular mechanical molecular dynamic (QM/MM MD) technique, the research team succeeded in solving this very complex aqueous structure.

[Tongraar et al., Phys Chem Chem Phys 12, 10876(2010).]

At an SSRL Beamline

Prof. Yuksel Ufuktepe from the University of Cukurova in AdanaTurkey with his two PhD students Guvenc Akgul and Funda Aksoy



Sabancı Üniversitesi

Day-One Beamlines

SESAME

No	Beamline	Energy Range	Source Type	Comments
1.	Protein Crystallography	4-14 keV	Wiggler (ALS) (?)	·Daresbury 14.1/2 ·New Double Crystal Mono, liq N2 cooled ·New Hutch
2.	X-ray Absorption Fine Structure/X-ray Fluorescence (XAFS/XRF)	3-30 keV	Bending Magnet	·Helmholtz-Zentrum Dresden-Rossendorf/ ESRF ·New focussing optics ·New Hutch
3.	Infrared Spectro-microscopy	0.01-1 eV	Bending Magnet	·Mod to storage vacuum chamber ·New beamline

Sabancı Üniversitesi

Remaining Phase I Beamlines

SESAME

No	Beamline	Energy Range	Source Type	Comments
4	Soft X-rays	0.05-2 keV	Elliptically Polarizing Undulator	New BL
5	Small- and Wide-Angle X-ray Scattering SAXS/ WAXS	8-12 keV	Bending Magnet	Daresbury 14.2
6	Powder Diffraction	3-25 keV	2.1 Tesla MPW (SLS)	SLS X04SA
7	Extreme Ultraviolet	10-200 eV	Bending Magnet	Daresbury 4.1 & Lure

Beamlines chosen by the users community.

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 - 1 nsec)**
5. **SMALL SOURCE SIZE (≤ mm)**
6. **PARTIAL COHERENCE**
7. **HIGH VACUUM ENVIRONMENT**

Flux = $\frac{\text{No. of Photons at given } \lambda \text{ within a given } \Delta\lambda/\lambda}{\text{s, mrad } \Theta}$

Brightness = $\frac{\text{No. of Photons at given } \lambda \text{ within a given } \Delta\lambda/\lambda}{\text{s, mrad } \Theta, \text{ mrad } \varphi, \text{ mm}^2}$

(a measure of the concentration of the radiation)

The Four DOE-BES Light Sources

Two US 3rd Generation facilities - among the world's first

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)

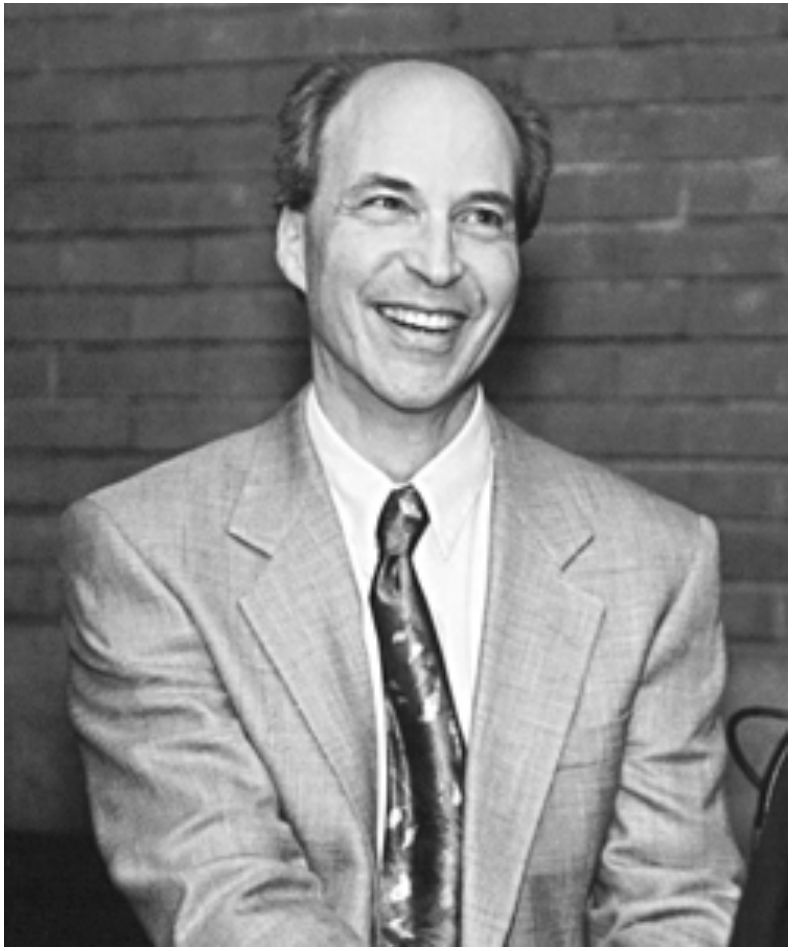
First US 2nd Generation facility

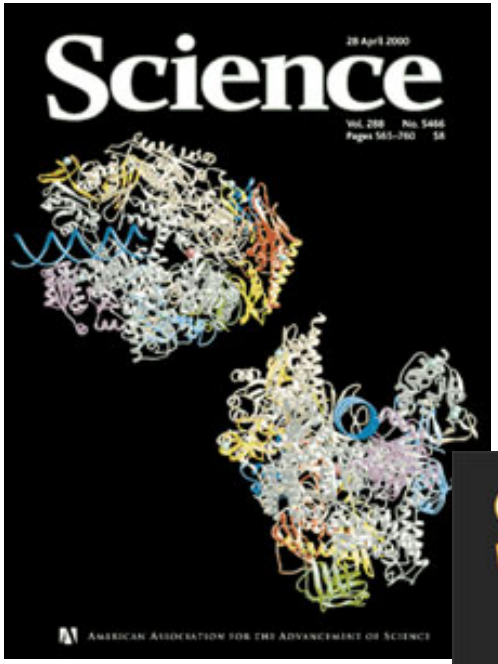
Stanford Synchrotron Radiation Laboratory (SSRL), Stanford Linear Accelerator Center (1974)

World's first SR storage ring x-ray user facility

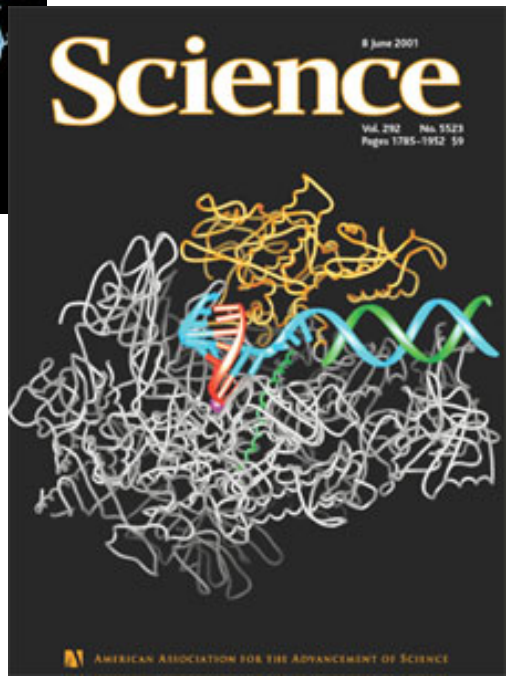
Roger Kornberg, Stanford University

Nobel Prize in Chemistry, 2006

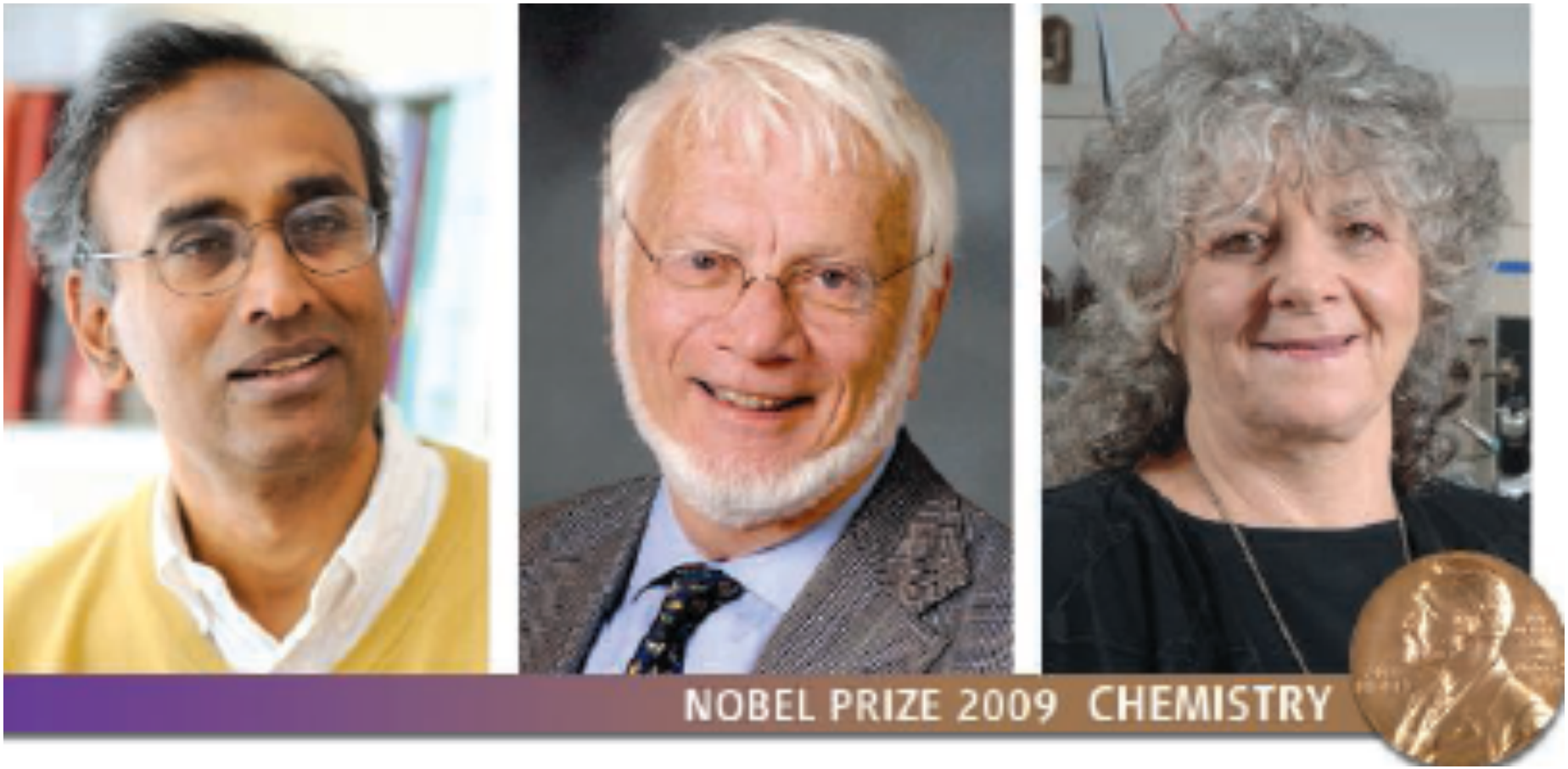




RNA Polymerase

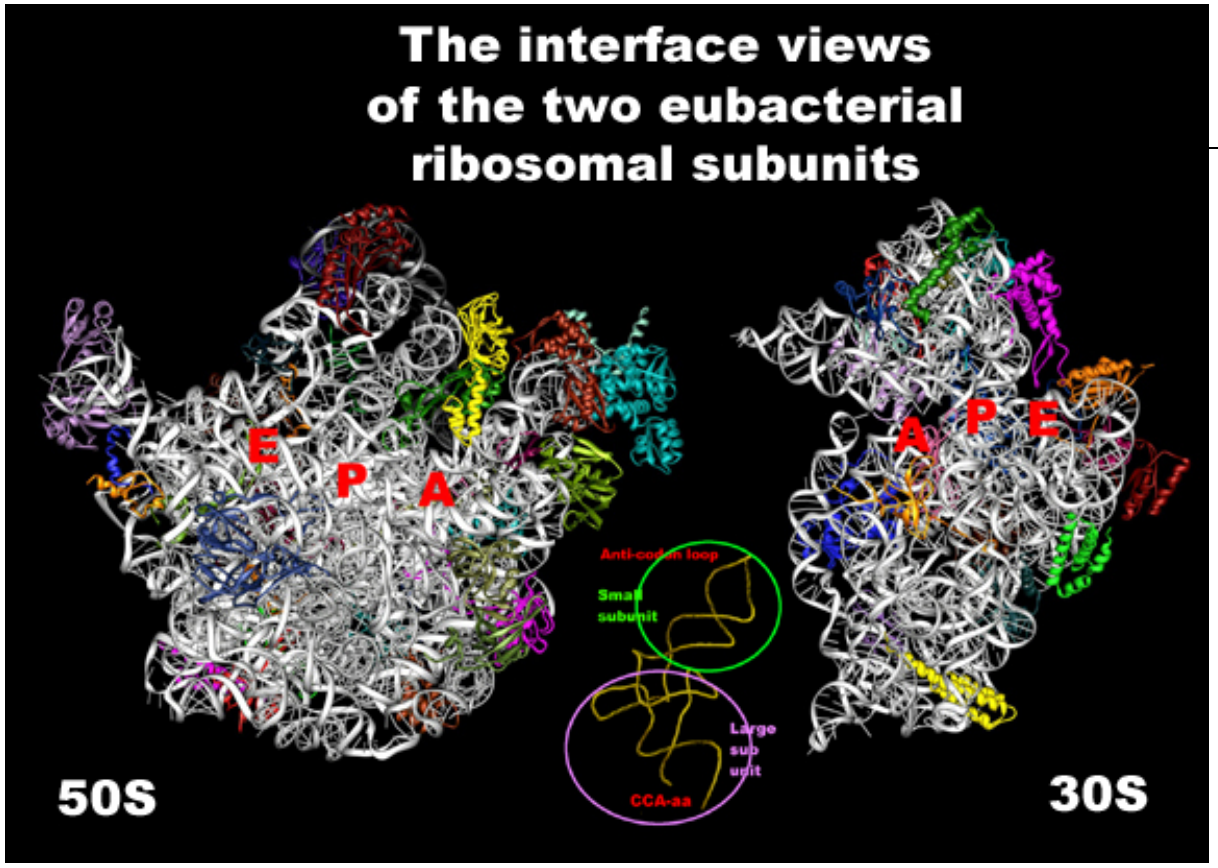


Required Synchrotron Radiation



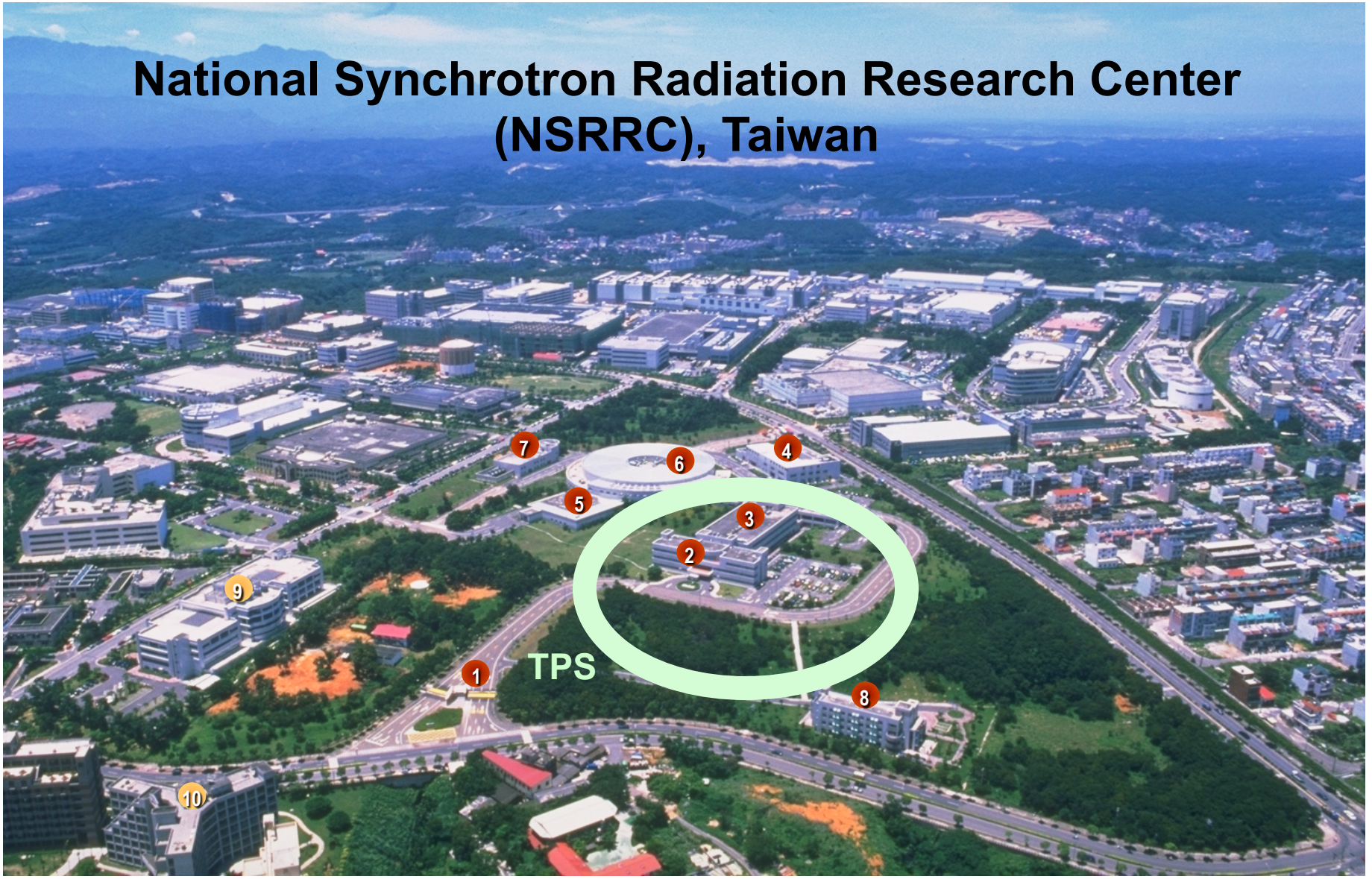
Ventkatraman Ramakrishnan **Thomas Steitz** **Ada Yonath**

The 2009 Nobel Prize in Chemistry was shared by **Venkatraman Ramakrishnan**, **Thomas A. Steitz** and **Ada E. Yonath** for showing what the ribosome looks like and how it functions at the atomic level. They used ***synchrotron radiation*** X-rays to map the position for each and every one of the hundreds of thousands of atoms that make up the ribosome.



For detailed explanation, figures, movies see:

http://www.weizmann.ac.il/sb/faculty_pages/Yonath/home.html



New 3rd GenerationTaiwan Photon Source in Construction

Prospects

- ***To become one of the world's brightest synchrotron x-ray sources***
- ***To develop cutting-edge experimental facility and new areas of scientific research***
- ***To help high-tech industry conduct product R&D and process optimization***
- ***To attract more international scientists to perform experiments or build dedicated beamlines at NSRRC***
- ***To recruit worldwide outstanding scientists to establish long-term leading-edge research in Taiwan***
- ***To attract young generation to advanced scientific research and plant the seeds for great future scientific discoveries***

C.T. Chen; April 2005

Siam Photon Source II (SPS-II)

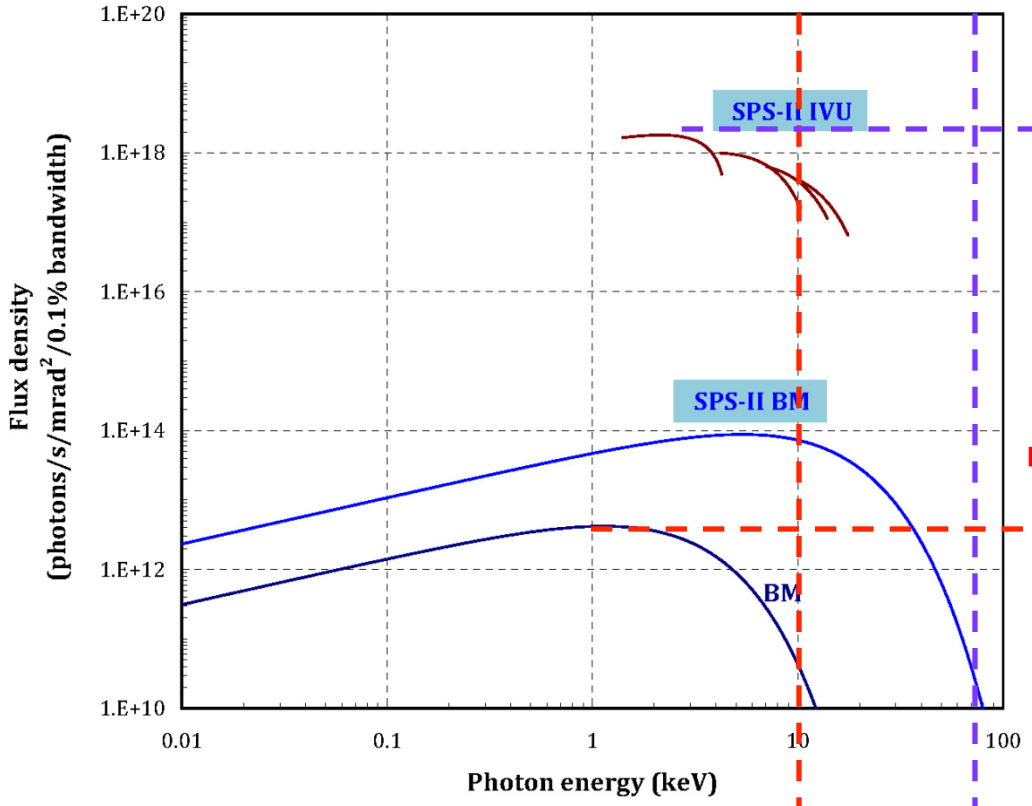
3 GeV STR

Beam energy [GeV]	3.0
Beam current [mA]	500
Circumference [m]	320
Horizontal emittance [nm.rad]	2
Main radio frequency [MHz]	100
Harmonic number	106
Number of achromats	12
Length of achromat [m]	26.5
Length of long straight sections [m]	5
Number of long straight sections available for IDs	11
Beam lifetime [hr]	> 10
Energy loss per turn [keV]	360 (690)
Beam power [kW]	180 (345)
Total accelerating voltage [MV]	1.2
Energy acceptance [%]	4.5 - 6.8
Number of cavities	4
Operation mode	Top-up

3 GeV linac

Operating energy (GeV)	3
Total length (m)	300
Repetition rate (Hz)	10 (100)
Frequency (MHz)	2,856
No. of klystron stations	17
Klystron power (MW)	35
No. of linac structures/klystron	2
Structure length (m)	5
Energy gain/station (MeV)	200

SPS-I and PS-II spectrum



2×10^{18} phs/s/mrad^2/0.1%BW

Up to 500,000x INTENSITY

4×10^{12} phs/s/mrad^2/0.1%BW

SPS-I

SPS-II

SPS-I

10 keV limit

SPS-II

8x ENERGY

~ 80 keV available

Comment by a director of the Pohang Light Source in Korea

The most important (from my personal point of view) contribution to Korea by the success of PLS project is that ordinary Koreans and Korean government have a strong trust to Korean scientists in terms of using or spending huge amount of budget and bringing the achievement of project goals. There was a big speculation whether PLS and peoples involved in this project could success the construction of PLS in time and within the budget and could bring the design goals by completing its commissioning as planned. To everyone's surprise, PLS finished within budget and time, and its performances are well over its design values. One more factor is that key components were fabricated with domestic or in-house technology. Thus, we can minimize the trouble shooting time and repair time for PLS operations.

The success of PLS brought another big science projects rather easily. From 1997, Korean government started ambitious tokamak project named KSTAR which is the first tokamak with all superconducting coils. This project costs about 350 MUSD and will be finished by 2007. KSTAR will play a prototype of ITER (International Thermonuclear Experimental Reactor) by Korean involvement of ITER collaboration in 2003.

Since there are 1500~2000 users every year and about 500 papers produced by them, it is widely accepted that PLS project is the best example of success story sponsored by the government. SAMSUNG and LG gets a great benefit by investigating defects in their LSI chip production and LCDs for cellular phone with the help of X-ray tomography

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

SESAME building, financed by Jordan and designed by civil engineers from Al-Balqa' Applied University, Jordan

Building can be used for high-level Arab-Israeli and Middle East Scientific meetings

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

Under the auspices of UNESCO and modeled on CERN

Components of BESSY 1, which will form the booster accelerator that injects electrons into SESAME, temporarily 'installed' for the opening ceremony, November 2008

SESAME GROUND BREAKING CEREMONY - 6 JANUARY 2003

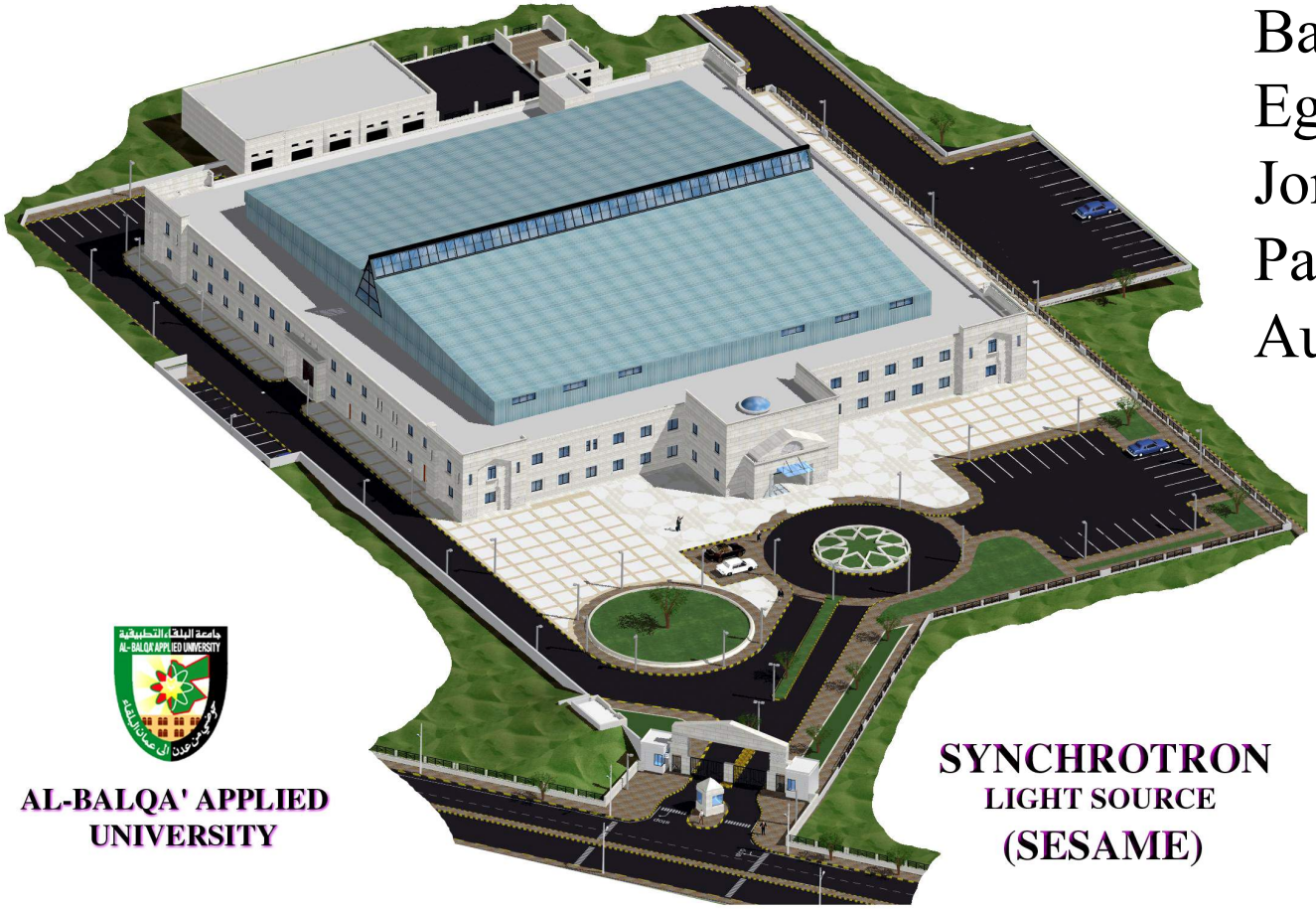
Visit to SESAME site by IAEA D-G Mohamed ElBaradei, April 14, 2007

BESSY I 0.8 GeV Booster Synchrotron set up in SESAME building for “soft” inauguration on November 3, 2008

Mayor of Salt, Mr. Salameh, and Herman Winick

SESAME

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



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

AL-BALQA' APPLIED UNIVERSITY

SYNCHROTRON LIGHT SOURCE (SESAME)

www.sesame.org.jo

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)

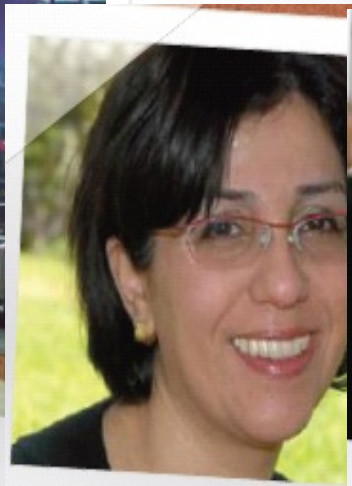
Some SESAME People, including Users of Day One Beamlines

Mohammad Yousef

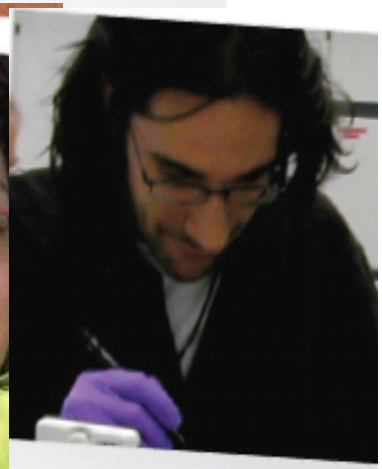
Sumera Javeed

Mukhles Sowwan

Maher Attal



Irit Sagi



Vasilis Promponas

SOME FACTS ABOUT THE TAIWAN SYNCHROTRON RADIATION PROJECT

•The first Director of NSRRC, *Chien-Te Chen*, was born in Taiwan. He was the leader of a major Bell Labs research group which used synchrotron radiation to study the electronic properties of materials by the photoemission technique. Under his leadership, Bell Labs built a beam line for these studies at the National Synchrotron Light Source (NSLS) at Brookhaven National Laboratory. In the 1990's he returned to Taiwan as Director of the NSRRC. As part of the deal to bring him back to Taiwan, the government paid to have his beam line at NSLS sent to Taiwan where it was installed at the NSRRC.

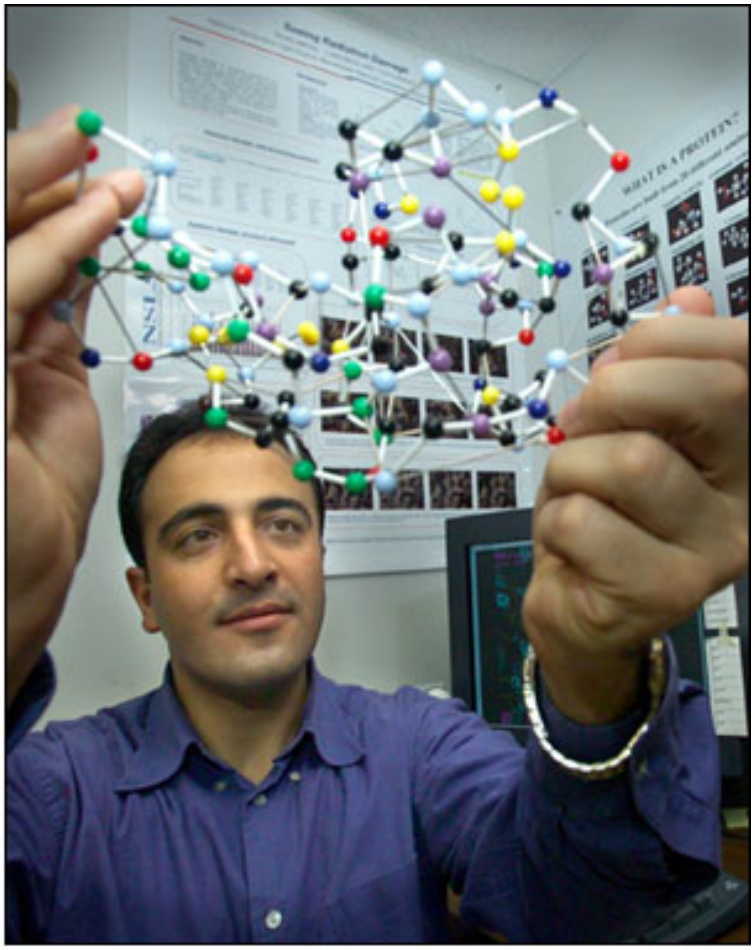
•The second Director (Jan. 1, 06) of NSRRC, *Keng Liang*, was born in Taiwan, received a PhD at Stanford University in the 1960's after which he worked for the EXXON corporation for about 30 years. His main research activity was the use of synchrotron radiation for studies relevant to the interests of EXXON (materials, catalysis, etc.). In the 1990's he returned to Taiwan to become Deputy Director of the NSRRC.

•So far NSRRC has produced more than *100 PhDs*. About 20 Taiwanese students got PhD degrees abroad and returned to Taiwan. *(from Keng Liang)*

September 3, 2004 NSLS Newsletter

NSLS Visiting Scientist Mehmet Aslantas Wins Prestigious Lecturer Award

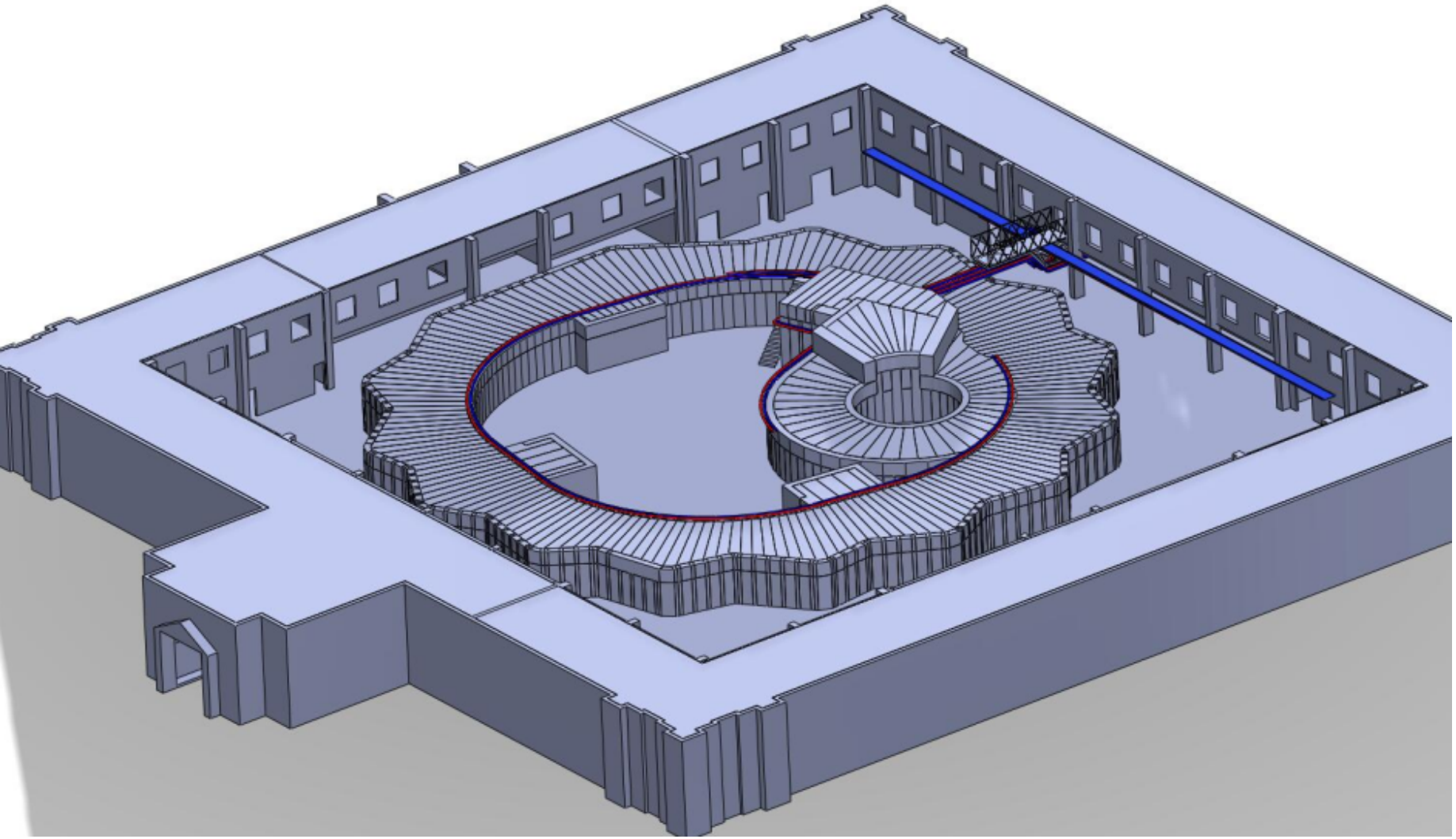
Aslantas, who initially came to the NSLS for six months through a U.S. Department of Energy Cooperative Research program, received an extension that allowed him to stay for over a year. “The NSLS is a great place to work, and I couldn’t have completed my research or won this award without the research extension I received,” said Aslantas. “I would like to thank the NSLS Chairman, Steve Dierker, the Associate Chair for User Science, Chi-Chang Kao, Vivian Stojanoff, and the User Administration office for their support.”



Mehmet Aslantas holds a ball-and-stick model of the test protein he used in his research.

Inside the SESAME building; May 2008

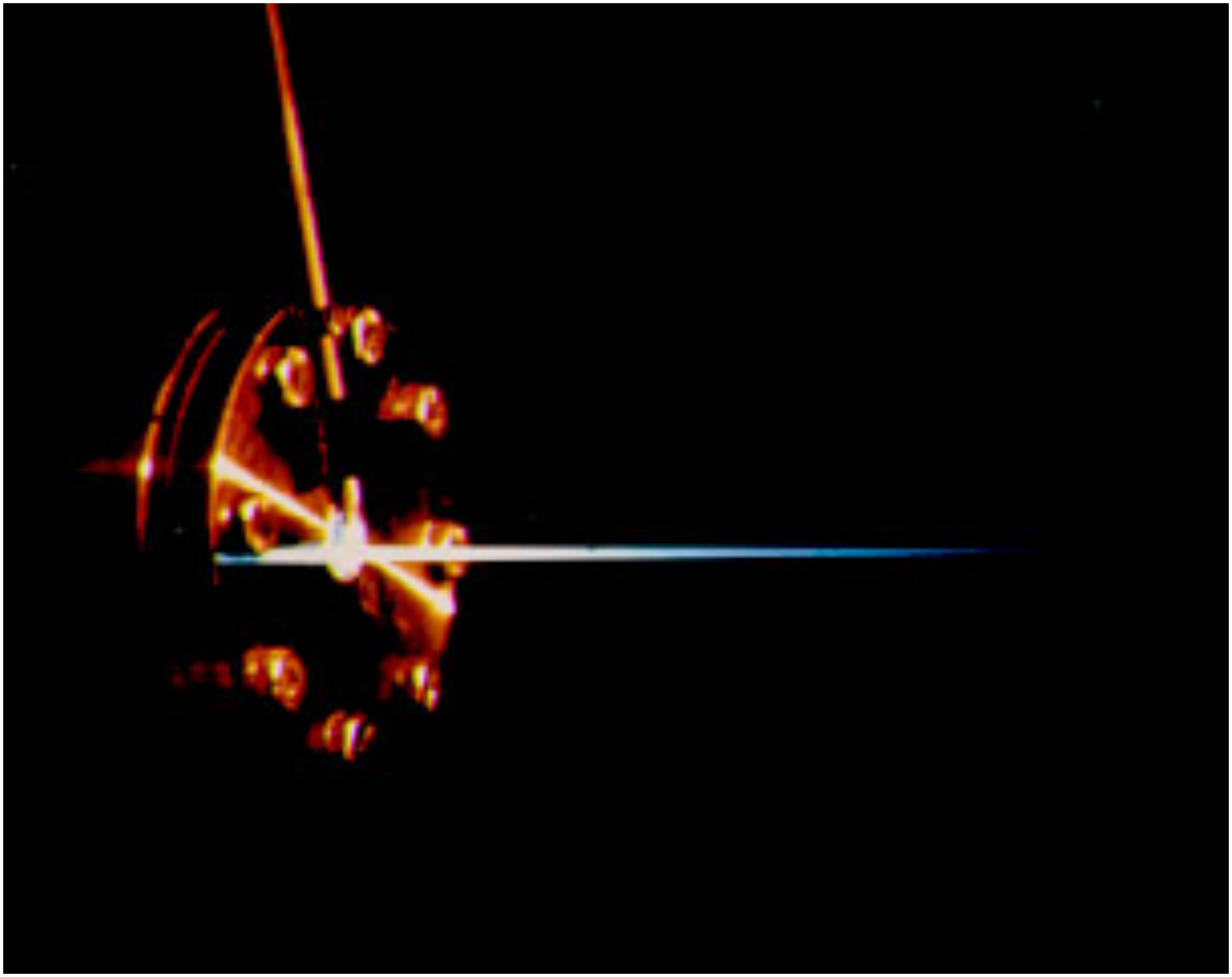
3D View of the New Shielding



K. Toukan The Royal Swedish Academy of Sciences, Stockholm, Sweden, June 10° ,2008

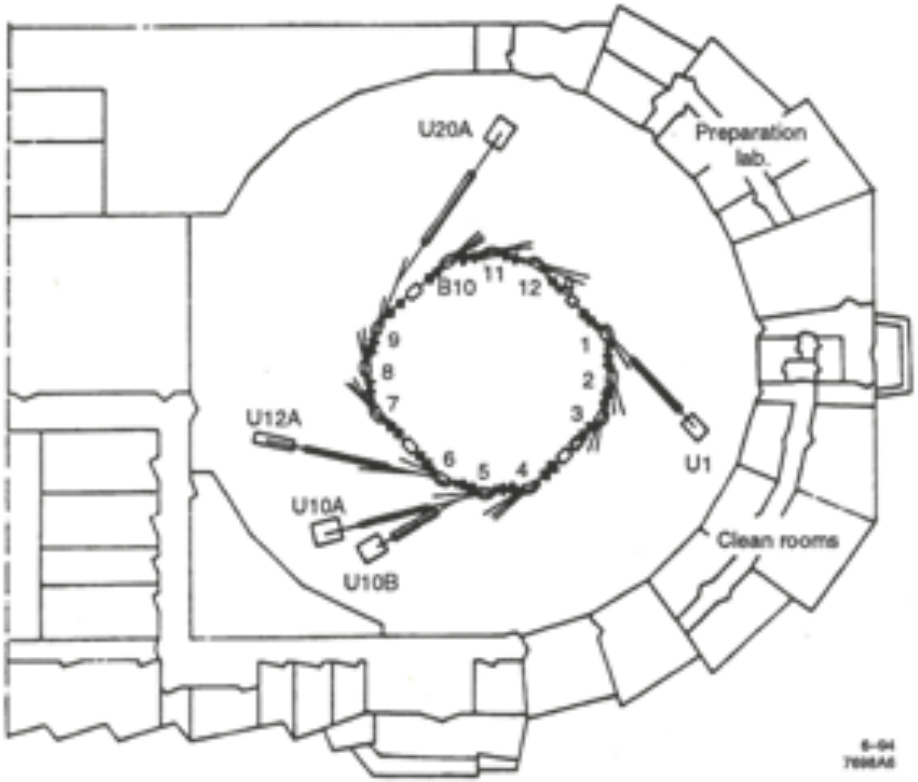
Shielding under construction November 2010

Focused x-ray beam from the Cambridge Electron Accelerator – 1972 (Paul Horowitz, Harvard University)



Microtron (injector to BESSY 1) at SESAME, November 2008

NSRL, Hefei, PRC (from Prof. Zupin Liu; Vice-Director)



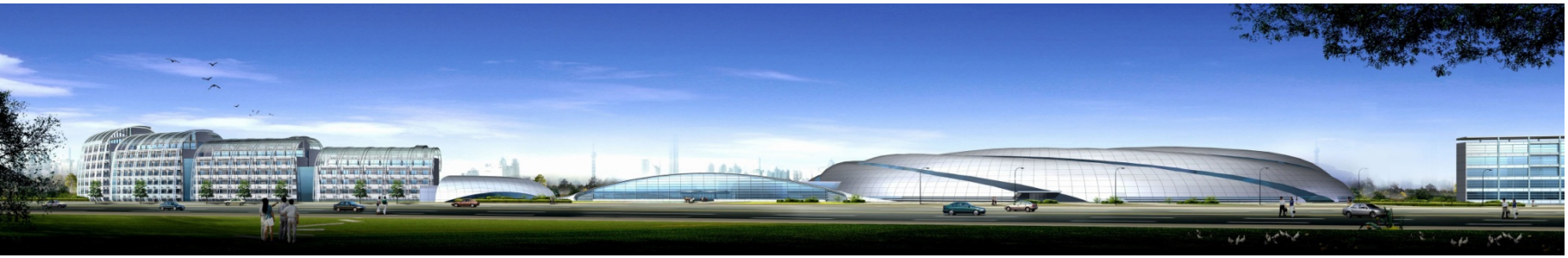
800 MeV light source in Hefei, China

Project first proposed in '77; began operation around 1990. Phase II Upgrade started in '99; completed in '04

- **Data as of 2004**
- **Now have 14 experimental stations, three from a 6T superconducting WLS & one from a 29-period perm magnet undulator**
- **Emittance now 133 nm; working on low emittance optics (~20-40 nm)**
- **800 MeV; 250 mA; less than 5% down time; 400 Users/yr; 4800 hrs/yr**
- **Plan to emphasize IR, VUV, Soft x-ray as Shanghai machine comes on line. One IR station in operation. Plan 2nd IR station & 2nd undulator.**
- **58 PhD, 53 Masters produced from USTC alone; Now 20 PhD + 20 Masters/yr. 150 graduate students now involved.**
- **Several senior scientists have returned to NSRL from abroad, including Chen Gao from LBNL, now Vice-Director of NSRL**

National Synchrotron Radiation Laboratory, Hefei; 0.8 GeV, 66.13 meters

Shanghai light source; 3.5 GeV, 432m, 3 nm-rad



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.

SESAME staff members Hussein Al-Mohammad and Zai Al-Haq Qazi working on control system and beam diagnostics at Shanghai Light Source