SESAME

Synchrotronlight for
Experimental
Science and
Application in the
Middle
East

An International Research Center
for the Middle East and the Mediterranean Basin

Created under the auspices of UNESCO according to CERN model

The first international research organization in Muslim countries

Herwig Schopper, Islamabad, 26 March 2007

Objectives

- **Promote science and technology in the region**
- **Help to improve mutual understanding and building trust among people from different traditions, religions and races**

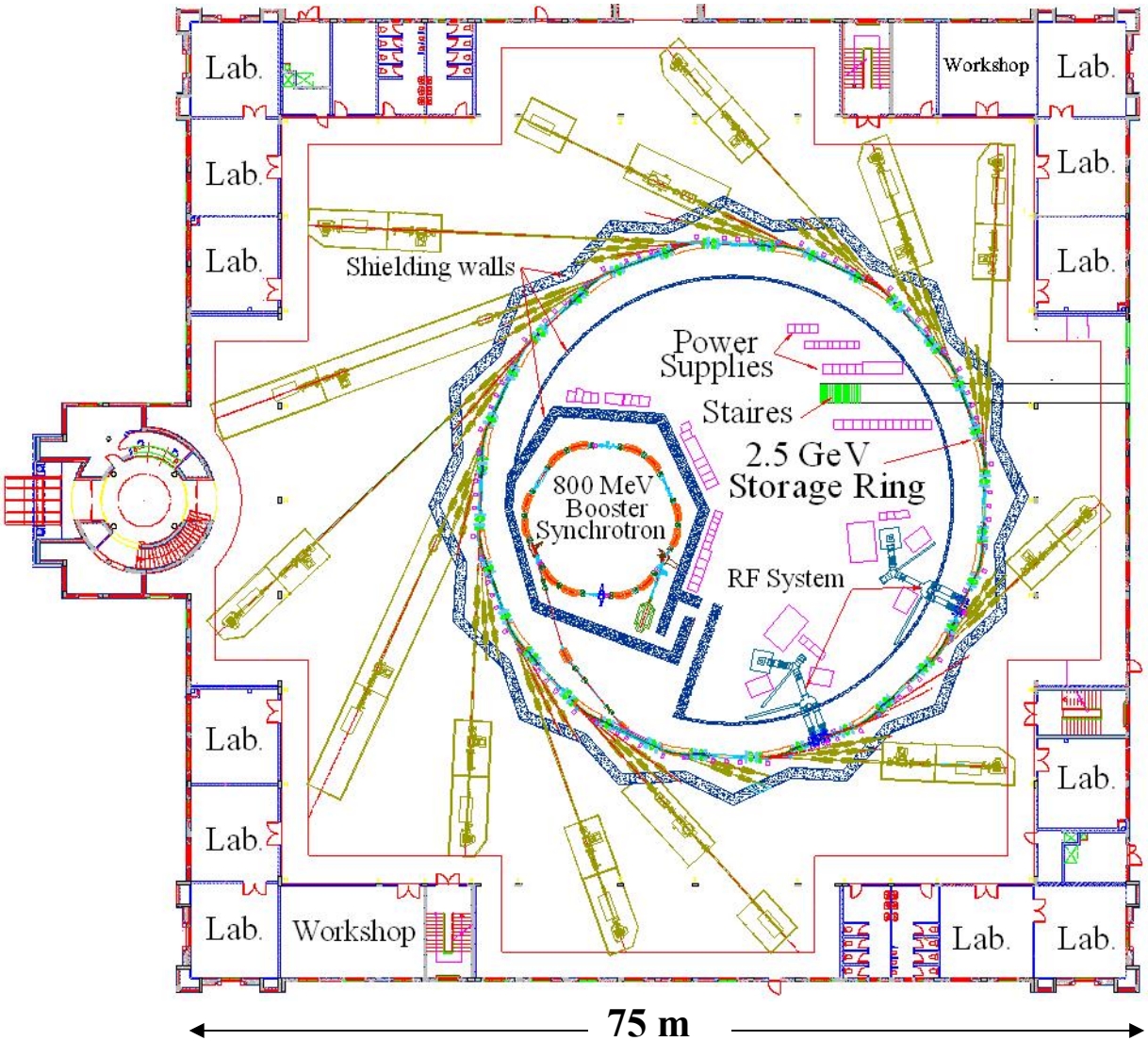
UNESCO "Science for Peace"

How to do it ?

- **Create a centre of excellence for interdisciplinary research with competitive research facilities**
- **Promote international cooperation, main principle: scientific excellence**
- **Training of scientists, students and technicians (and even administrators)**
- **Attract scientists from the region working abroad, reverse brain drain**
- **Promote the development of applications and high-tech industry**

What is the SESAME Facility ?

- **Extremely strong light source**
- **A synchrotron which produces intense light from the infrared region to X-rays.**
- **Apart from high intensities, light has special properties (very short pulses, polarized)**
- **Individual beams for specific research domains**



Energy	2.5 GeV
Current	400 mA
Circumference	128.4m
Emittance (horiz)	26.4 nm-rad
Possible IDs	13
ID Length	2.75 m

e^- Beam Size in Straight Sections

σ_x/σ_y	700μm/35μm
Critical Energy	5.9 KeV
e^- Energy Spread	0.1%
Bending Mag. Field	1.425 T

Outlay of SESAME

Parameters: 2.5 GeV ring with 13 possible insertion device beam lines. Beam lines can also come from the 16 bend magnets.

Why a synchrotron radiation source for the region?

❖ **SR sources have became ubiquitous tools for research in many domains and for interdisciplinary research**

~ 60 sources are in operation worldwide with ~20.000 users
including Brazil, China, India, Korea, Taiwan, Thailand
in Japan about a dozen sources, in Germany 4 SR sources

❖ **Cheaper and less complicated than neutron source (research reactors, spallation sources), more versatile as lasers**

❖ **Smaller facilities than supermachines are competitive can do about 90 % of research**

❖ **No source in Middle East !! SESAME will be the first!!**

❖ **But not the last and only one !!**

Large Members of SESAME (Pakistan, Egypt, Turkey, Iran) will learn how to build facility, establish beamlines, train people

Is SESAME really needed in the region?

Abdus Salam dreamed of several centres in the Middle East.

- ***At 1983 Symposium held at Bahrain University on the Future Outlook of the Arabian Gulf :***

Salam proposed *SR Lab for Jeddah, Bahrain,*
did not happen

- ***H.Schopper proposed SR Lab for Saudi Arabia about 10 years ago,***

did not happen

SESAME will change the situation!

Scientific Programme

- **Research in the domains :**
  - **Physics (mainly condensed matter)**
  - **Material science**
  - **Nanotechnology**
  - **Molecular biology**
  - **Archaeology**
  - **Environmental studies**
  - **Medical research**

Phase One Beamlines

No.	Beamline	Energy Range	Source type	Science Area (traditional disciplines indicated)	Possible Champion & committee advisers
1	MAD Protein Crystallogphy	**4 – 14 keV**	**In-vacuum undulator (6mm gap, 1.5m)**	Structural Molecular Biology (Biomedical)	**Shoham, Salman, Yousef , Hasnain & Wakatsuki**
2	Photoemission/ Photoabsorption spectroscopy soft X rays	**50-2000 eV**	**Elliptically polarising undulator (λ_u=50 mm, k_{max}= 5.5, ID $_{length}$= 2.6 m)**	Atomic, Molecular & condensed matter physics (Physics, Chemistry, Materials)	**Hamdan, Shoaib Ahmed, (Zahid Hussain)**
3	SMALL/WIDE ANGLE X ray Scattering SAXS/WAXS	**8-12 keV**	**Undulator**	SMB & Material Sc (Biomedical, Physics, Chemistry, Materials engineers)	**Changizi, Semra Ide, Zehra Sayers, M. Al-Hussein, Irit Sagi**
4	X-ray Absorption Fine Structure/ Fluorescence Microprobe XAFS/XRF	**3-30 keV**	**2.0 Tesla MPWiggler**	SMB, MS, Environmental Sc., Archaeological	**Sagi, Mahmood, F. Afaneh, Rami Ali, Hallak (Hamdan & Hasnain)**
5	Powder Diffraction	**3-25 keV**	**2.4 Tesla MPWiggler**	MS, EnvironmentalSc., Archaeological	**Engin Ozdas, and Shoaib Akhtar**
6	IR Spectro-microscopy	**0.01-1 eV**	**Large Aperture Bending magnet**	SMB, MS, Environmental Sc., Archaeological	**El Bayyari & Sagi**
0	Soft X-Ray/UVU Spectroscopy	**5 - 250 eV**	**Bending magnet**	Start and learn	**SESAME complete beam from LURE**

A short history of SESAME

1997: H.Winick and G.-A.Voss propose to use components of BESSY I (to be closed down) at Berlin

during a workshop for **Middle East Scientific Cooperation**
organised by **S.Fubini** of CERN

Winick and Voss try to convince countries, no success

S.Fubini et H.Schopper write to DG UNESCO to establish international laboratory according CERN model

June 1999: F.Mayor, DG UNESCO, invites all governments of the region to a meeting at Paris

Positive decision taken, Interim Council created with 12 members and 6 Observers

H.Schopper elected President

History of SESAME Parameters

Original Concept: Upgrading of BESSY I ***(Green Book)***

Energy 1 GeV, circumference 100,8 m, (from 0.8 Gev, circumf. 80 m)

BESSY I was still very actively used

Energy 2 GeV, ***(White Book)***

higher energy, mainly requested by biologists

circumference 116 m, quadratic building ('copy' of ANKA)

Energy 2.5 GeV ***(Yellow Book)***

circumference of ring 133 m, length of beamlines about 30 m

16 straight sections (8 long),

spectrum from bending magnets up to 12 keV, wiggler up to 24 keV

Energy increase demanded by potential users

Approved by Council in July 2003

SESAME very competitive

supermachines cover remaining ~10 %

2000: Germany makes gift – components of BESSY I

Condition: orderly dismantling is financed by SESAME and UNESCO
$ 600.000

After clarification of legal problems with help of UNESCO equipment shipped to Jordan in June 2002

Boat leaving Hamburg harbor on its way to Aqaba in Jordan with BESSY I on board; June 7, 2002

Booster Synchrotron at BESSYI in Berlin

Microtron 20 MeV

Injector System of BESSY I

will be used unchanged for SESAME

Worth several million $

Formal establishment of SESAME by UNESCO as autonomous international laboratory

UNESCO General Assembly (about150 countries)

October 2001

- asks Director General, K.Matsuura, to elaborate feasibility study and propose Statutes

- authorises Executive Committee to decide definitely

Mai 2002: unanimous Authorisation by Executive Committee (about 50 countries) (including approval of Statutes)

Procedure takes normally more than 3 years!!

"...model project for other regions....

Quintessential UNESCO project combining capacity building with vital peace-building through science."

Suggestion: ‚seed money' for similar projects (South Africa interested)

SESAME Council

Governing body, each Member one vote,
two delegates (ideally government representativ + scientist)

President: H.Schopper (Germany)
Vice Presidents: F. Elrefai (Egypt), D. Ülkü (Turkey)

- **BAHRAIN** **JORDAN**
- **Cyprus** **PAKISTAN**
- **EGYPT** **PALESTINIAN AUTHORITY**
- **ISRAEL** **TURKEY**
- **Pending Memberships (Member of Interim Council) :**
  Iran, Kuwait, Oman, Morocco, UAE,
- **Interested countries: Libya, Yemen, Iraq asked to become Member**

15 April 2004 :
Ratification of adhesion, official birth date of SESAME

Observers

France	**Portugal**
Germany	**Russia**
Greece	**Sweden**
Italy	**UK**
Japan *	**USA**

To become Members: **Kuwait, United Arab Emirates**

Formal legal procedure still under way for *

Site Selection

7 Members proposed 12 sites

Criteria:

a. Accessible to all scientists from world
b. Central geographical location
c. Political commitment by authorities
d. Special contribution by host country (diplomatic privileges)
e. Technical infrastructure (water, electricity, soil, airport)

10/11 April 2000, CERN **Decision by secrete vote**

Allan site (Salt) of Al-Balqa Applied University, Jordan (20 km from Amman, centrally located)

Strong support by H.M.Abdullah II

Jordan provides site and funds for building

Lesson in international cooperation

Location does not imply ownership

needs new mentality in the region

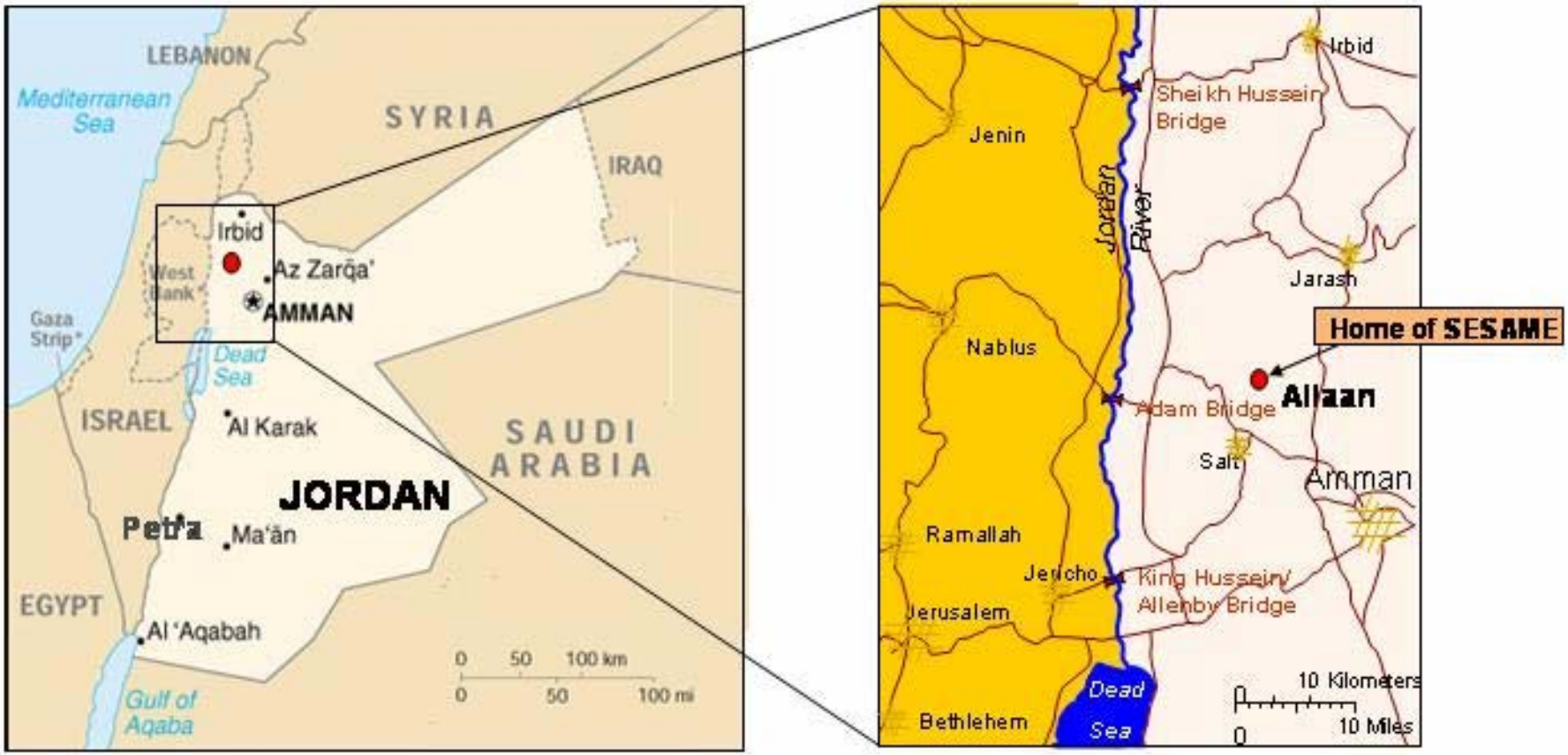
Every Member has equal rights in :

decision taking,
exploitation,
staff members,
industrial contracts

Host country has special obligations

How much a Member benefits depends on its initiative

CERN is not „owned“ by CH or F



SESAME location in Allaan, Jordan

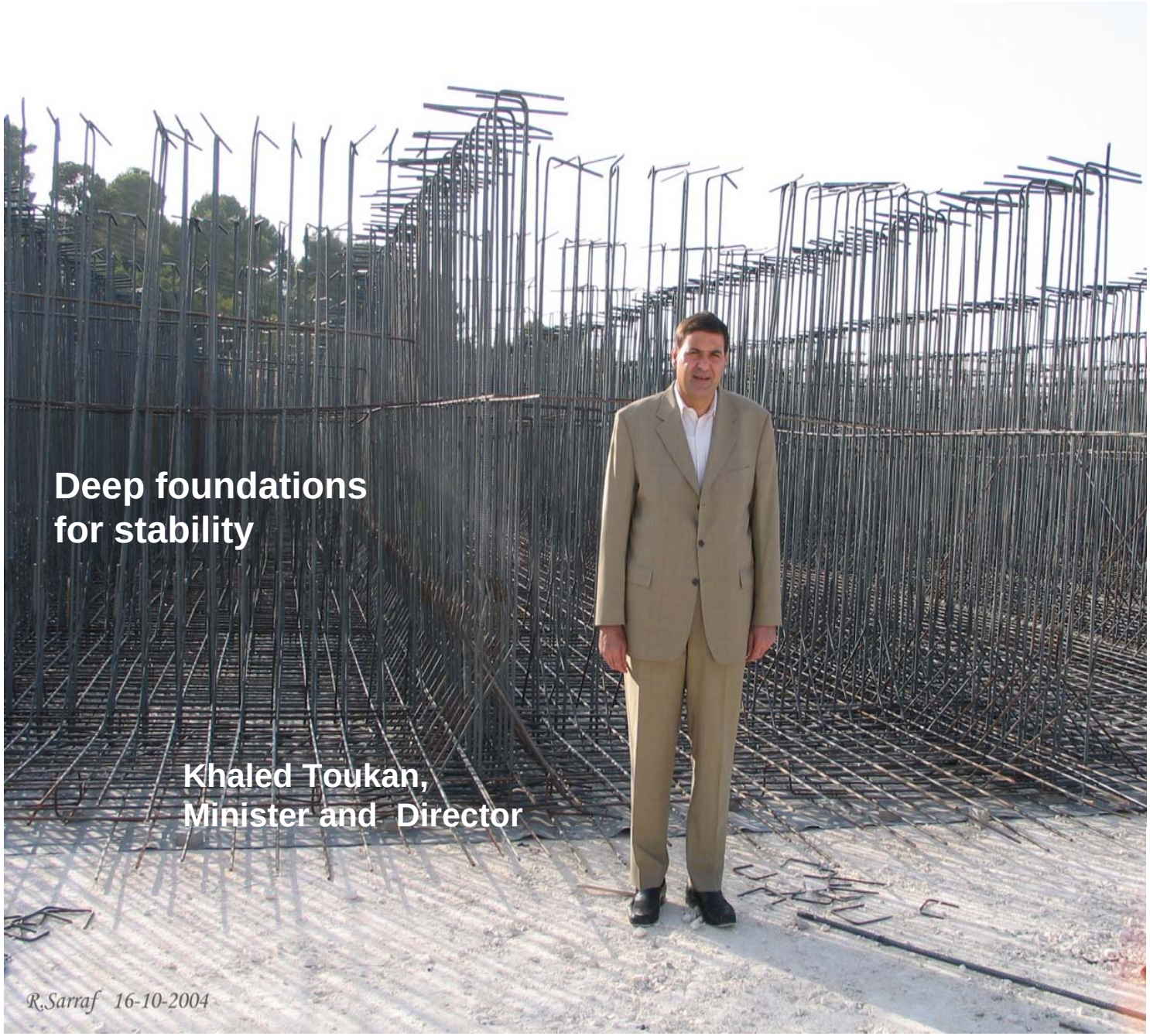
H.M.King Abdullah II and UNESCO DG Matsuura unveiling marble plate, Groundbreaking 6. January 2003

Herwig Schopper, Islamabad, 26 March 2007

Opening of IC meeting with H.M. King Abdullah II and DG Matsuura

SESAME site before construction


Photo: R. Sarraf


Deep foundations
for stability
Khaled Toukan,
Minister and Director
R.Sarraf 16-10-2004

Girder spanning the machine hall (about 60 m) without additional supports


R.Sarraf 28-2-2007

Herwig Schopper, Islamabad, 26 March 2007

Building

- **Authorization for construction extremely fast**
- **Possession of site and access thereto** **July 2003**
  commencement of construction **August 2003**
- **Building finished** **end 2006**
- **Girls college will be given to SESAME for offices etc**

All this was achieved in incredible short time!

In spite of some problems: quality of ground, roof

Most encouraging achievement

Building up of staff at Amman

Director: Minister Khaled Toukan (Jordan)
Administrative Director: Vacant, *Minister Hany Helal (Egypt)*
Technical Director: Gaetano Vignola (Italy),
Deputy H.Tarawneh
Scientific Director: Hafeez Hoorani (Pakistan),
following Aslam Baig

Technical Staff: A. Amro, M. Attal, H.Azizi, A. Kaftoosian, F. Makahleh, M. Shehab, H. Tarawneh, S. Varnasseri
Administrative staff: Yasser Elshayeb, Sonia Faques

**Preliminary location at local UNESCO Office,
will move into SESAME building in summer 2007**

Open positions: look at WEB site: www.sesame.org.jo

International Advisory Committees

Beamlines Committee:

Chair: **Zahid Hussain (USA/Pakistan)**

define beamlines, help to set up collaborations, later evaluating proposals

Scientific Committee:

Chair: **Zehra Sayers (Turkey)**

advice on long term policy, energy and upgrading of machine

Technical Committee:

Chair: **Albin F. Wrulich (Germany)**

advice on machine design, technical solutions, cost estimates

Training Committee:

Chair: **Javad Rahighi (Iran)**

help in organizing training programme, selection of candidates

Finance Committee

Chair: **Minister Hany Helal (Egypt)**

prepares budget, distribution of contributions among Members

Training Programme

One of the essential objectives of SESAME

- **Training of machine experts (supported by IAEA)**
  20 fellows, finished in 2004, some became staff
- **Training of beamline experts**
  starts now about a dozen fellows, can become later staff
- **General training of potential users**
  fellowships, workshops, users' meetings
  supported by Japan, USA, others, opportunities are there!
- **Special fellowships**
  Brazil, 3 long-term fellows, (no candidates found!)
  Taiwan, 3 long-term fellows, (very successful, repeated)
  European Scientific Institute, accelerator school
  in France near Geneva, 9 students in 2005, >6 in 2006

New phase with IAEA: MoU signed in December 2006
Funds for training of $ 750 000 for 4 years

SESAME Workshops and Schools (2000-2005)

1st Workshop on Structural Molecular Biology (SMB);
Univ. of Athens, 6-7 April, 2000;
Workshop/School on Accelerator Science & Technology
Al-Balqa' Applied Univ. Al-Salt, Jordan, 9-19 Sept, 2000.
Workshop on Materials Science;
Hacettepe Univ, Ankara, 21-22 Sept, 2000.
2nd Workshop on Structural Molecular Biology (SMB)
Univ. of Cyprus, 6-7 December, 2000.
Workshop Bioinformatics & Structural Modeling;
Istanbul, Turkey, 3-8 Sept, 2001;
JSPS Asian Science Seminar,
19-28 October, 2002 at Al-Balqa' Applied University, Al Salt, Jordan..
The 1st SESAME Users' Meeting
2nd SESAME Users' Meeting
29 Nov.-1 Dec. 2003, Esfahan, Iran.
3rd SESAME User Meeting
October 6-8, 2004, Antalya, Turkey
4th SESAME User Meeting
December 6-8 2005, Dead Sea, Jordan
5th SESAME Users' meeting and workshop
Nov27-Dec2, 2006, Cairo, Egypt

Breakdown of SESAME Investment

Item	Paid by	Cost Million
Building, Technical infrastructure, land,roads	Jordan	$ > 8.0 $ ~ 100
Injector chain	Germany	$ ~ 6.5
Main Ring	Third Party (EU)	€~ 16 *
Beam Lines (6 ?) In kind	Member States, other? SLAC,LURE, Diamond	$ 15.0 ?? $ 2 to 4

*** New Estimate for main ring (offers by European firms)**
but labs to build components cheaper (CERN Model)

EU: Request made several years ago. After evaluation and long discussions on which program to use (bilateral or regional)
€ 1 million approved for 2006/7 ***in October 2006*** **(within bilateral program of Jordan)**
SESAME recognized by EU as valuable activity

After 'green light' from EU now US and Japan will be contacted

Operation cost
provided by Members, proving their engagement

Starting with a practically constant budget	
2000-2003 during the Interim Council period	**$ 300k - $ 400k**
2004-2009 slowly increasing (in 2007 $ 900k)	**$ 600k - $2500k**
2010 initial operation	**$ 3000k**
>2012 full operation	**$ 4500k**

Finance Committee has agreed 2006
that total budget will rise during the coming years

At present unanimous decision required for:
Total budget and distribution among Members
'Magic formula' being investigated,
wait until final Members are known

Upper (lower) limits for individual contributions:
2007 increased from $100 k ($ 50 k) to $125 k ($62.5 k)

Time Schedule

- **Raw Building finished** **December 2006**
- **Installation Microtron and booster synchrotron**
  Summer 2007– 2008
- **Tendering, production, Installation of main ring**
  Spring 2007 – September2010
- **Commissioning of main ring** **October - November 2010**
- **Operation of beamlines**
  end 2010
- **About 1 year delay because negotiations with EU**
  Schedule subject to availability of funds
- **Jordan provides funds not to delay further**

10 years from first idea to operation, not bad!!

SESAME

- **All countries of the region are invited to participate**

Lessons learned from SESAME -some observations concerning the region-

my experiences from having been involved in SESAME for many years.

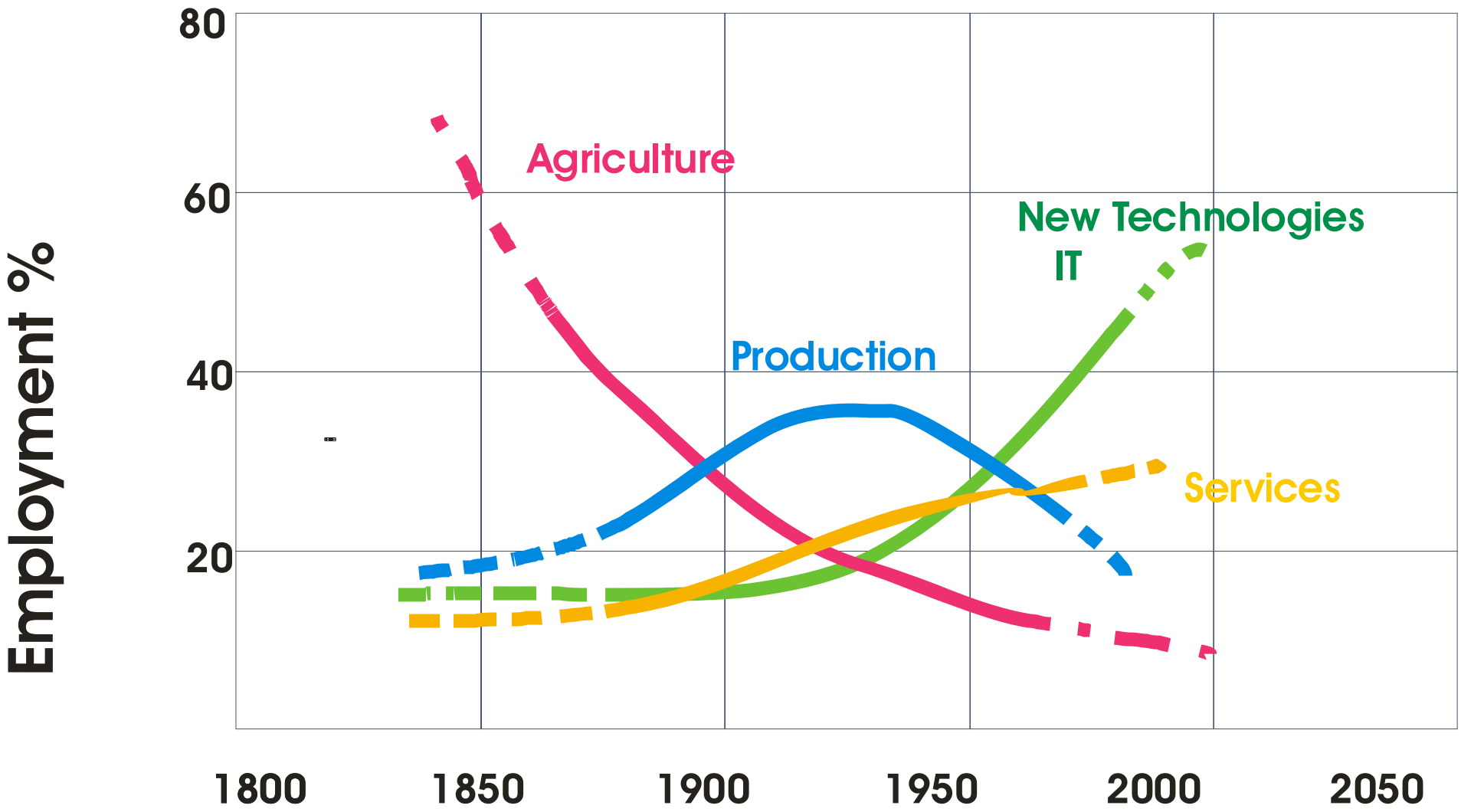
Herwig Schopper, Islamabad, 26 March 2007

Science and Technology are important and necessary for any society and its welfare.

Improve awareness of this fact among political leaders

Many reasons: just a few examples
- long term employment conditions
- manufacturing
- environment

Employment in Germany



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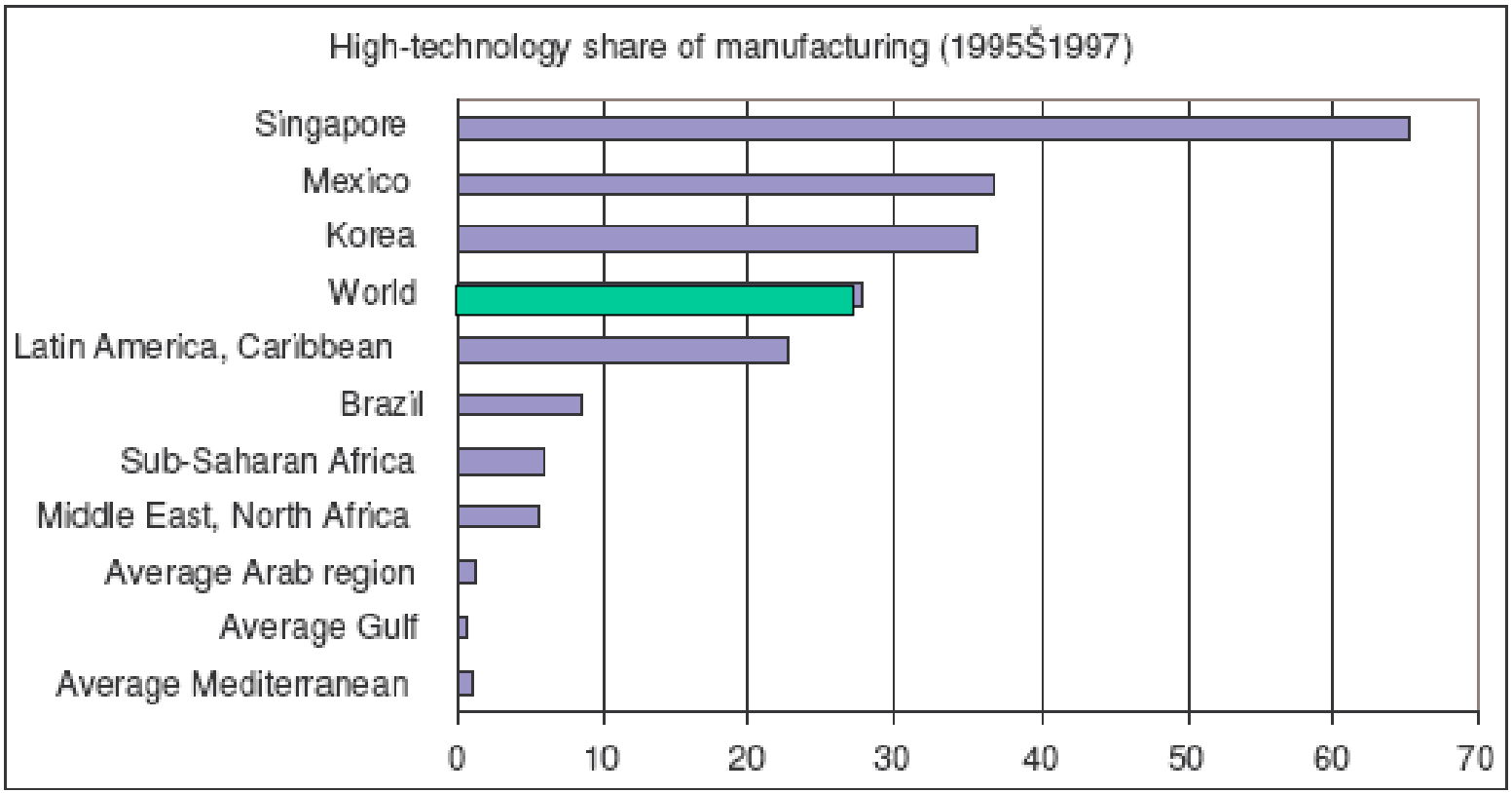
Proportion of high-technology manufactured goods



Source: Adapted from Haddad (2002) and Lall (1999). Computations based on UN COMTRADE data 2000 and 1996 respectively.

Developing Countries

need most advanced technologies for

- Power stations
- Mobility (cars, airplanes)
- TV, IT (for professions and entertainment)
- Environment

Total GDP in Arab countries

- **GDP of all Islamic countries ≈ US $ 1,200 billion**
  (in 2002)
  compare: < 1/4 GDP Japan, about GDP of Germany.
- **GDP per capita of all Muslim countries**
  slightly more than that of Spain,
  Spanish population about 15 percent of the Arab world.
- **Muslim population is more than 1/5 of the world population**
  (larger than USA, Europe and Japan combined)
  dire situation!
- **total GDP is small compared to developed countries**
  (in spite of the oil richness.)
  why?

What should be done ?

Necessary measures:

1. **Improve finances**
2. **Establish strategy for research**
3. **Decide on national priorities**
4. **Intensify international cooperation**
5. **Provide leadership**

Not exhaustive list!

1. Financial situation of R&D

•Annual spending on R&D as fraction of GDP in the Islamic world is an order of magnitude below global averages.

no Arab country spends more than 0.2% of GDP
world average 1.4% of GDP
industrialized countries 2.5 % to > 3% GDP
(Denmark, France, Germany, Japan, Switzerland, the USA and Finland)

in 1995 even Cuba spent 1.26% of its GDP.

(United Nations' Development Program and the Kuwait-based Arab Fund for Social and Economic Development, study 2003)

Increase spending for science and technology

Many Efforts – results poor

Several leaders in the Arab world are well aware of the precarious situation and make a big effort to improve it, but sometimes with little success. Many examples

- **President Pervez Musharraf of Pakistan in 2002 at a meeting of the Standing Committee on Scientific and Technological Cooperation of the Organisation of Islamic Countries in Islamabad, called to create a multi-billion dollar fund providing at least US$1 million annually**

  During a recent visit to CERN the President reconfirmed his engagement for science and education.

- **Atta-Ur-Rahman (Minister of Education and Science in Pakistan) tried to persuade representatives of the Organisation of the Islamic Conference in 2003 to set aside more of their GDP for research programmes. He urged that Muslim nations 'must spend more on science'.**

Arab Region Roundtable on Harnessing Science, Technology and Innovation for Sustainability (April 2005 at Dubai) :

"Arab governments are urged to spend at least 1% of their GDP on science and technology (a five-fold increase over average expenditures today) and to launch a number of capacity-building programmes in science and technology, including transforming existing research institutions into centres of excellence (or building new centres if this is not possible)".

- **Summit meeting of the Arab League (22 nations) in Khartoum, Sudan, in March 2006**
  Omar Hassan al-Bashir, president of Sudan, suggested that the increasing revenues from oil production should be used to fund science and technology development.

Many more examples

2. Establish strategy for research

poor funding is not the only reason
for the bad situation of sciences

- **Unclear priorities for institutional support**
- **Science and technological know-how cannot be bought (even with lot of oil money). Science is not a commodity that can be separated from the thought processes. For science and technology to flourish it needs a cultural base which can only be acquired by science education and doing research.**

3. National Science Priorities

❖**Learn how to establish priorities** and develop flexibility in redirecting funds, introduce evaluation.

Lack of priority for research infrastructure,
mechanisms for decision taking and priority setting are missing

❖**Lack of cooperation inside individual countries**

encourage establishment of national networks

❖**Priority is given to short-term problems**

(infrastructure, roads, water)

mercantile mentality prevails in some countries,
promoting activities with short return (tourisms)

❖ ***spend a very small amount of available funds***
for basic research, i.e.long term development

4. International Cooperation

❖**little experience in international scientific collaboration**

countries think in terms of national or at best bilateral projects

(e.g. with international organisations EU, IAEA, UNESCO, TWAS)

excellence can only be achieved in international cooperation

❖**lack of experience in management of international cooperation, how to deal with international bureaucracy**

Teach administrators how to apply for (international) funds

❖**Political problems are often only pretext for other issues**

some countries agree to separate scientific cooperation from politics, others use it as political weapon

Discourage the latter attitude, use scientific cooperation for building trust "Science for Peace"

Strengthen international cooperation

5. Leadership

Great achievements require outstanding persons

- **Role of individual political leaders is crucial**

(**During Golden Time of Muslim Countries:** Princes and ministers found pleasure or reputation in supporting sciences)

In some countries they exist:

Pakistan (President Pervez Musharraf , Atta-ur Rahman, Riazuddin,…),

Jordan (HM Abdullah II, Toukan)

- **Educate future scientific leaders (Career planning),**

  give younger scientists responsibilities

- **Scientists in Diaspora are willing to return**

  provided they get research facilities,

Great differences between Muslim countries regarding the interest in science and giving support to it

Different approaches to improve the situation

- some countries are well advanced **and make effort (Pakistan)**
- some are aware of the problem and take action **(Egypt, Jordan)**
- others show very little interest to revive golden epoch of science, **(Emirates, Oman, Kuwait,….)**

- **'Poor countries' much more open to education and research than oil-rich countries**

Many good intentions and suggestions

– but actions have to follow

Help from outside the region cannot be expected if own effort is not stronger

Pakistan is going in the right direction:

1. The importance of R&D is recognised
2. Leadership exists and younger scientists are getting involved
3. Finances for science and technology are increasing
4. National priorities and programme is being discussed and decided upon
   New facilities!
5. International cooperation is intensified (CERN, SESAME)

Best wishes for your continuation!

Thank you