



**The Abdus Salam
International Centre for Theoretical Physics**



2139-13

**School on Synchrotron and Free-Electron-Laser Sources and their
Multidisciplinary Applications**

26 April - 7 May, 2010

**Light Sources in Developing Member States
SESAME Project**

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Austria*

Light Sources in Developing Member States

SESAME Project

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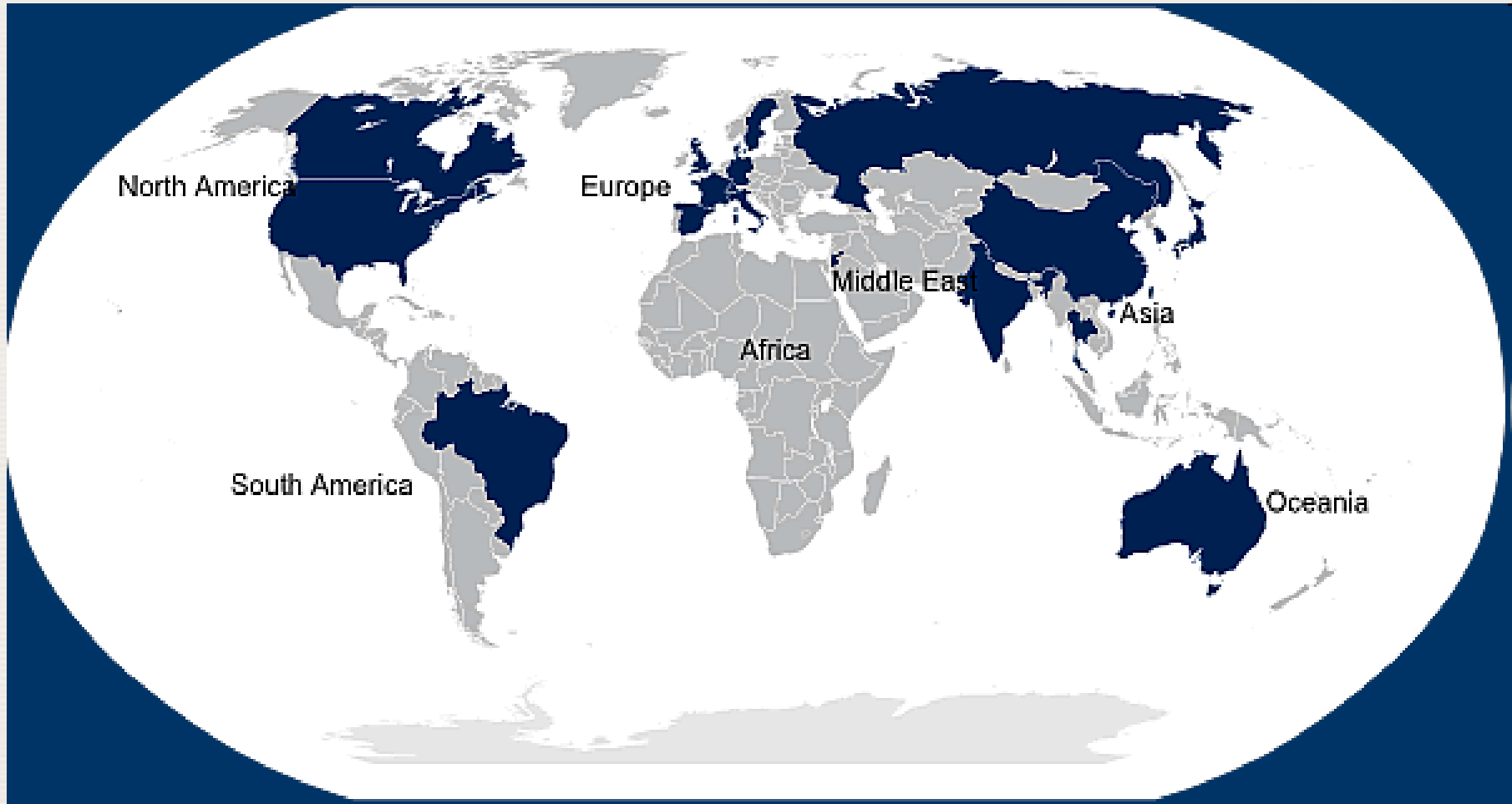
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IAEA

International Atomic Energy Agency

38 Lightsources over 20 Member States



North America

Canada	Canadian Light Source (CLS)	Saskatoon
USA	Advanced Light Source (ALS)	Berkeley, California
	Advanced Photon Source (APS)	Argonne, Illinois
	Center for Advanced Microstructures and Devices (CAMD)	Baton Rouge
	Cornell High Energy Synchrotron Source (CHESS)	Ithaca, New York
	National Synchrotron Light Source (NSLS)	Brookhaven, New York
	Stanford Synchrotron Radiation Laboratory (SSRL)	Menlo Park, California
	Synchrotron Radiation Center (SRC)	Madison, Wisconsin
	Synchrotron Ultraviolet Radiation Facility (SURF III), NIST	Gaithersburg, Maryland

Europe

Denmark	Institute for Storage Ring Facilities (ISA, ASTRID)	Aarhus
England	Diamond, Rutherford Appleton Laboratory	Didcot
France	European Synchrotron Radiation Facility (ESRF)	Grenoble
France	SOLEIL Synchrotron	Saint-Aubin
Germany	ANKA Synchrotron Strahlungsquelle	Karlsruhe
Germany	BESSY	Berlin
Germany	Dortmund Electron Test Accelerator (DELTA)	Dortmund
Germany	(HASYLAB) at DESY	Hamburg
Italy	Elettra Synchrotron Light Source	Trieste
Italy	Daphne Light Laboratory	Frascati
Spain	ALBA Synchrotron Light Facility	Vallés
Sweden	MAX-lab	Lund
Switzerland	Swiss Light Source (SLS)	Villigen

Asia

China	Beijing Synchrotron Radiation Facility (BSRF)	Beijing
China	National Synchrotron Radiation Laboratory (NSRL)	Hefei
China	National Synchrotron Radiation Research Centre (NSRRC)	Hsinchu
China	Shanghai Synchrotron Radiation Facility, (SSRF)	Shanghai
India	INDUS-1 and INDUS-2	Indore
Korea South	Pohang Accelerator Laboratory (PAL)	Kyungbuk
Russia	Siberian Synchrotron Radiation Centre (SSRC)	Novosibirsk
Singapore	Singapore Synchrotron Light Source (SSLS)	Singapore

Australia and Japan

Australia	Australian Synchrotron	Melbourne
Japan	Photon Factory (PF) at KEK	Tsukuba
Japan	Super Photon Ring - 8 GeV (SPring8)	Nishi-Harima
Japan	UVSOR Facility	Okazaki
Japan	SX Light Source	Kashiwa

Other Developing Member States

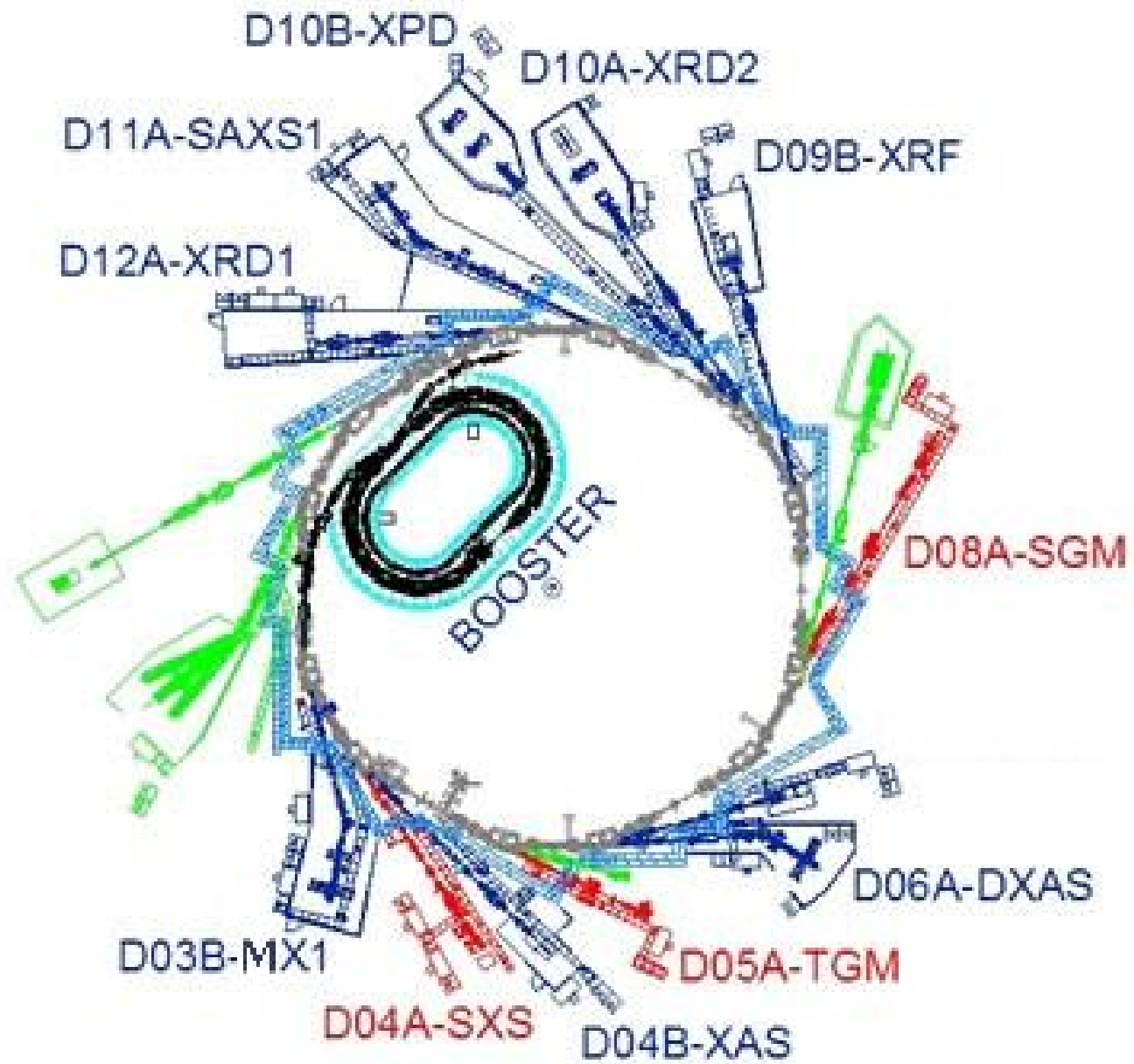
Brazil	Laboratório Nacional de Luz Síncrotron (LNLS)	São Paulo
Thailand	Siam Photon Source (SPS)	Nakhon Ratchasima
Jordan	SESAME	Allan

Brazilian Synchrotron Light Laboratory: LNLS



Laboratorio Nacional de Luz Síncrotron

- Facility with a 1.37 GeV synchrotron and a molecular and structural biology centre.
- Open to the international community.
- Relatively low energy synchrotron machine.
- Most of the beamlines (10) operate in the 'hard' x-ray region (~ 10 keV), reflecting the demands of the Latin American community.
- 14 operating bending magnet beamlines.



Laboratorio Nacional de Luz Síncrotron

- There are also four straight sections for insertion devices.
 - The first one: conventional wiggler for a MAD beamline dedicated to protein crystallography, which is now available to external users.
 - The second one: a home-made undulator, optimizing the flux in the soft x-ray region, the beamline for which is under construction.
 - The third one will be a superconducting wiggler for materials science applications (under construction).
 - The fourth and final device is under debate.

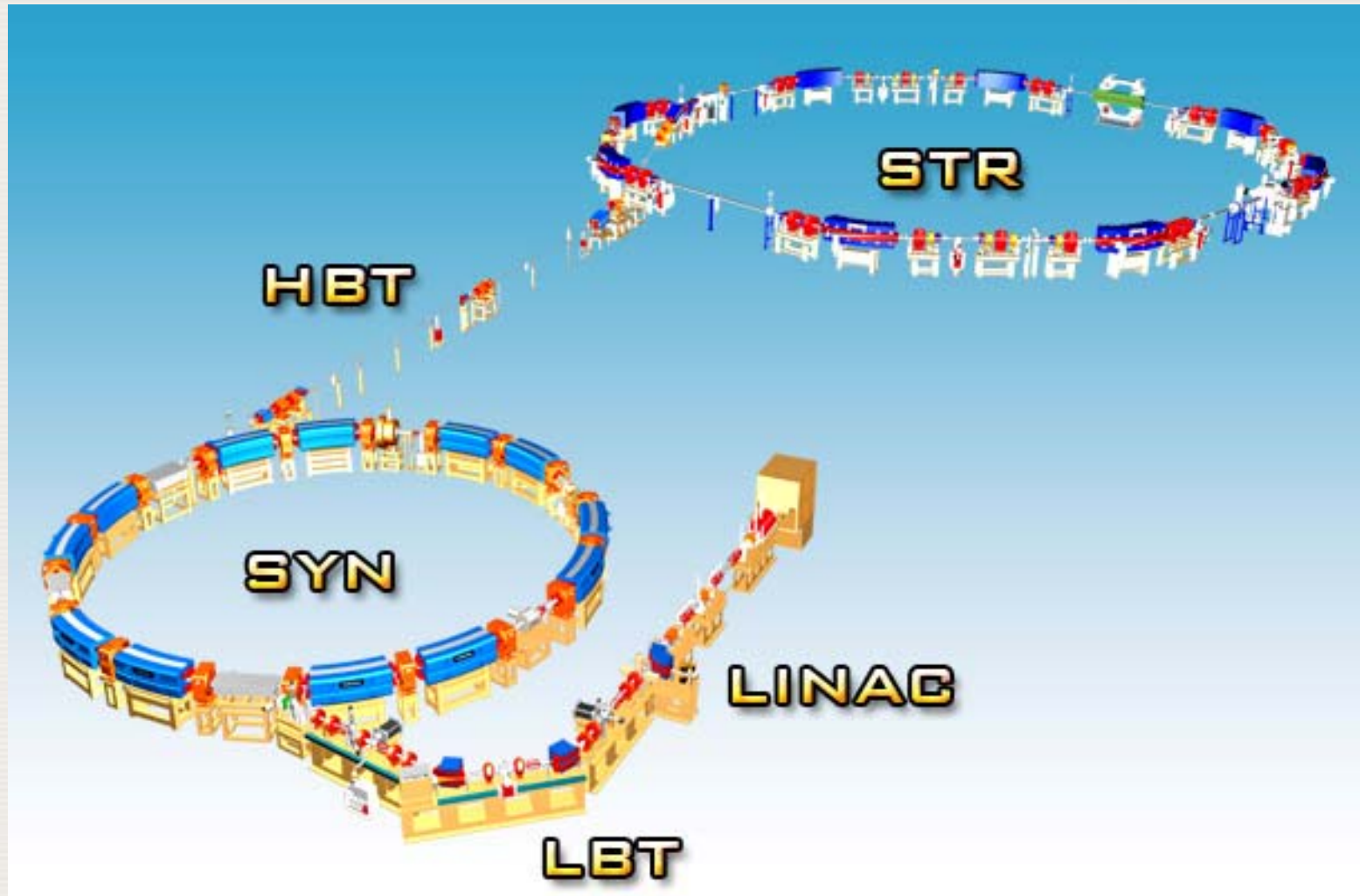
Laboratorio Nacional de Luz Síncrotron

- Space saturation is approaching and is expected to be achieved in the next few years.
- Continuous qualitative and quantitative expansion of the synchrotron beamlines since the first year of operation (1997), the user community is growing rapidly, not only in Brazil but in the whole Latin America, which may push the demand for the construction of a new, higher energy machine in the next decade.
- LNLS is presently experiencing severe limitations on budget and human resources, which limits the expansion of the capabilities.

Siam Photon Source (SPS)



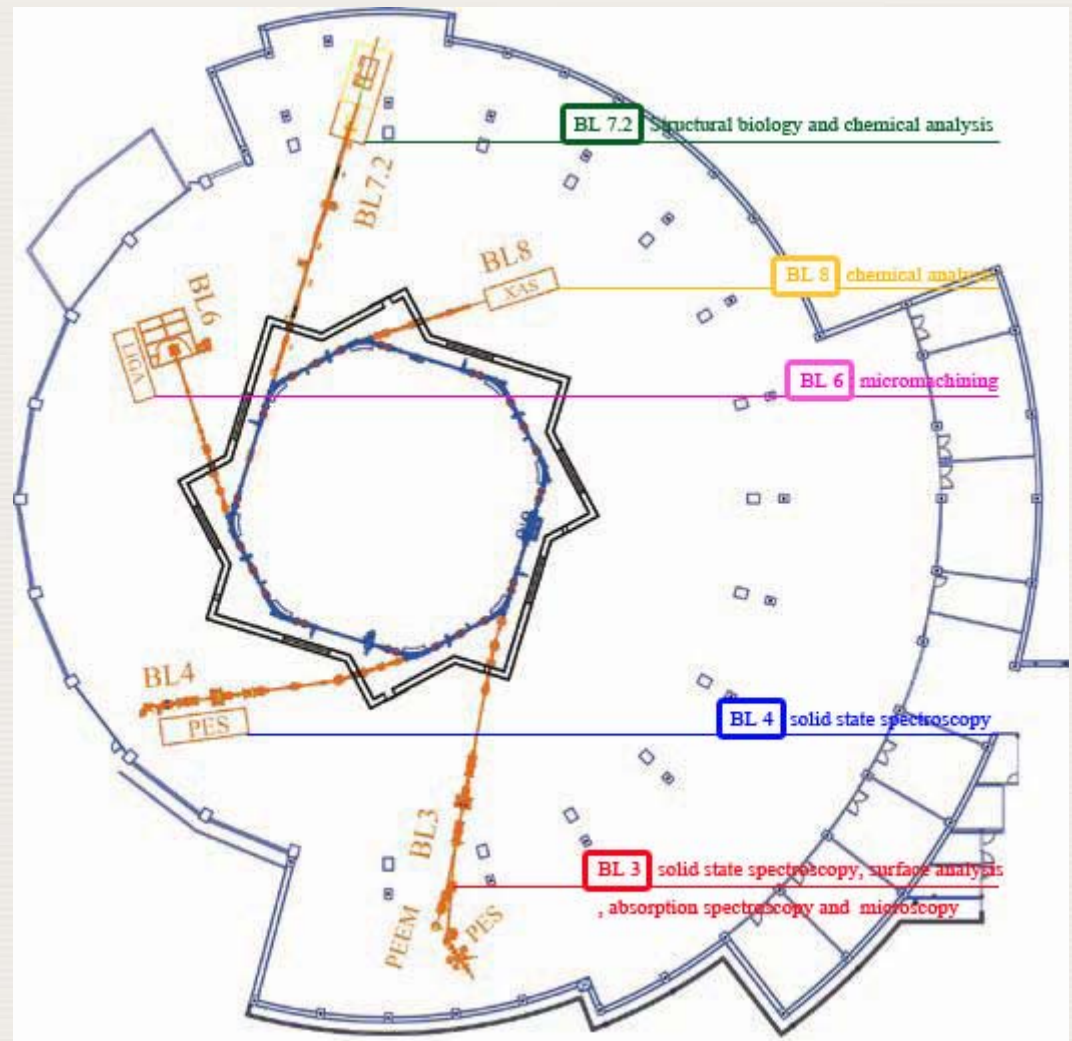
Siam Photon Source (SPS)



Synchrotron Light Research Institute

1.2 GeV synchrotron light source

- 3 beamlines completed and opened for users.
- 3 more beamlines are under construction, and a few more are planned.



Machine & Beamlines



Machine & Beamlines

Name	Source	Energy	Techniques
Beamlines in operation			
BL4	BM	20-240 eV	Photo Emission Spectro.
BL6	BM	White light	SR irradiation
BL8	BM	1.8-8 keV	XAS
Beamlines under construction			
BL3	Undulator	40-800 eV	PES, PEEM, XAS, TXM
BL7.2	WLS	5–15 keV	PX, XAS, SAXS, WAXS

Concept and Mission

1. to build up the Siam Photon Source Laboratories
2. to provide synchrotron radiation for government and private individuals and educational institutes of many countries to do research
3. to carry out research and technological development related to Synchrotron radiation and to promote cooperation between government and private sectors for application of related technology
4. to develop manpower in science and technology
5. to promote technology transfer associated with synchrotron radiation



*Synchrotron light for
Experimental
Science and
Applications in the
Middle
East*

International Center for Research and
Advanced Technology

R. Sarraf 28-2-2007

- Work presented here is mostly taken from SESAME directors:
 - Professor Sir Chris Llewellyn Smith, Council President
 - Dr. K. Toukan, Director
 - Dr. H. Hoorani, Scientific Director
 - Dr. A. Nadji, Technical Director
 - as well as other members of the SESAME beamline coordination meeting
- IAEA is only involved in providing training and expert missions

A Brief Early History of SESAME

1997: Proposal to use components of BESSY I as basis for new facility in the Middle East

June 1999: DG UNESCO (“Science for Peace”), invited all governments of the region to a meeting at Paris. Interim Council created with 12 members and 6 Observers; H. Schopper elected President

2000

- Site choice (candidates in Armenia, Egypt, Iran, Jordan, Oman, Palestinian Authority, Turkey)
- 18 scientists chosen to be trained at ANKA, Daresbury, Elettra, ESRF, LURE, MAXLAB, SLAC

2002

- Formal endorsement by UNESCO
- Decision that BESSY should be injector to new 2.5 GeV ring

6 January 2003 Ground breaking by King Abdullah II and DG of UNESCO

15 April 2004 Statutes ratified: official birth of SESAME

3 November 2008 Building opened by DG of UNESCO and Prince Ghazi Ben Mohammad. C Llewellyn Smith took over as President of Council



Winick - Schopper - Llewellyn Smith – Toukan



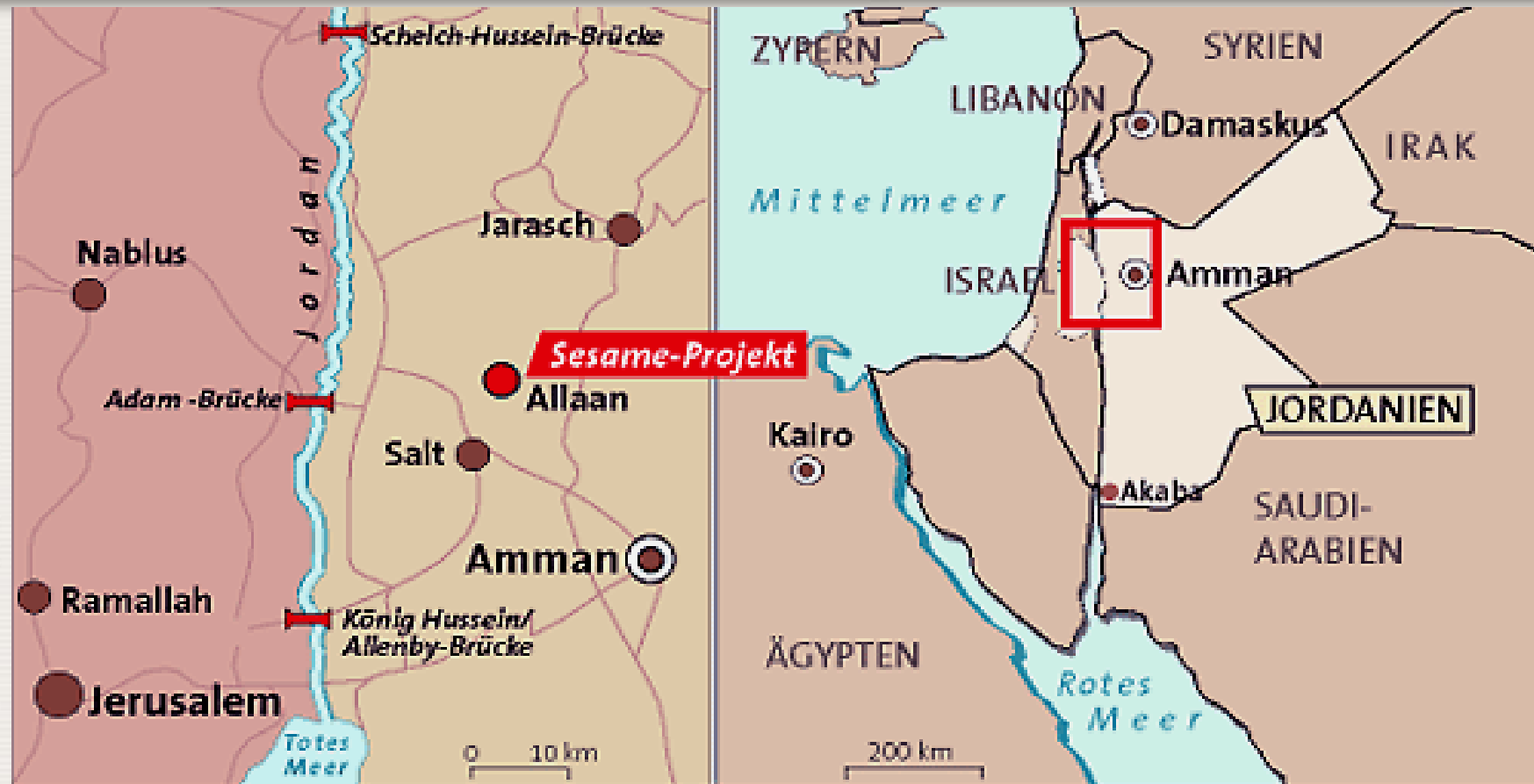
SESAME

www.sesame.org.jo

- ✓ **World class synchrotron radiation laboratory of 3rd. generation for the region**
- ✓ **Interdisciplinary research**
- ✓ **Providing environment for collaborations as well as individual development**
- ✓ **Applications**
- ✓ **Technology**
- ✓ **An advanced facility for training**
- ✓ **Bringing nations together**

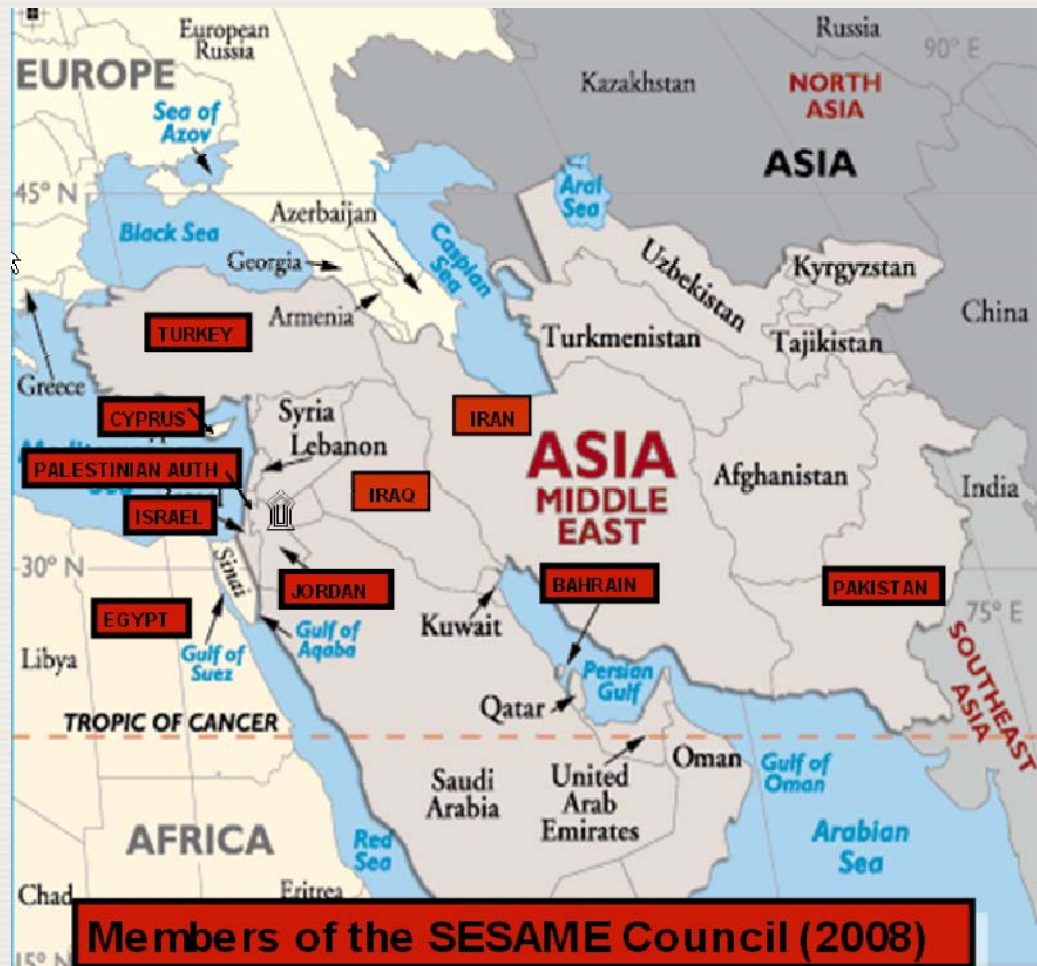


Location of SESAME



Within easy reach of Jordan, Israel, Palestinian Authority, Egypt.
Samples/equipment/people can in principle be transported by car.

Member Countries



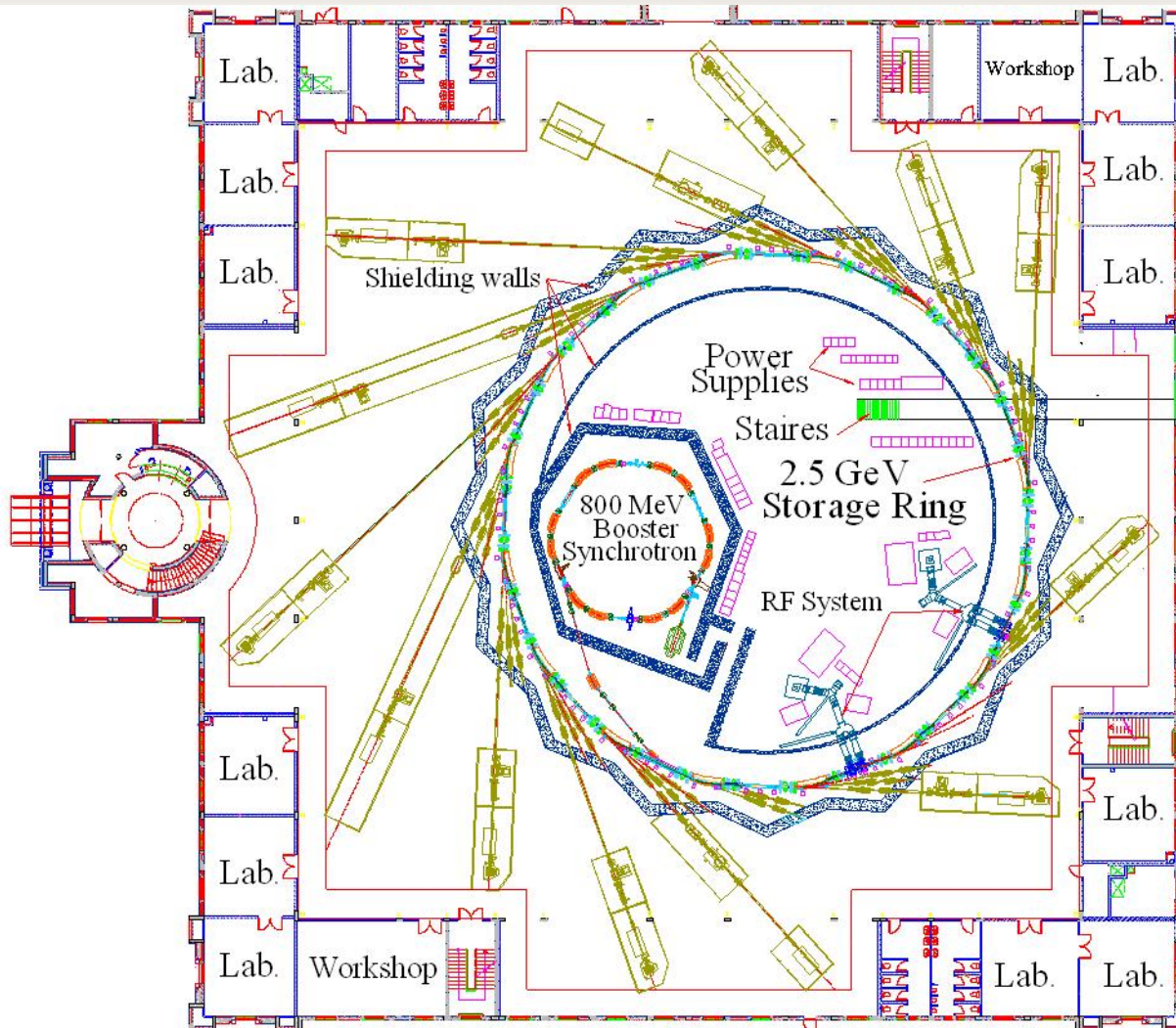
- Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestinian Authority, Turkey

Observer Countries

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

Outlay

Parameters: 2.5 GeV ring with 12 possible insertion device beam lines. Beam lines can also come from the 16 bend magnets.



Energy	2.5 GeV
Current	400 mA
Circumference	128.4m
Emittance (horiz)	26.4 nm-rad
Possible IDs	12
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

MICROTRON Parameters



Extractable energy	5.3 - 22.5MeV
Magnetic field	0.112T
Magnet diameter	2.22m
Pole diameter	1.8m
Gap	0.11m
Magnet Weight	11Tons
Microwave frequency	3GHz
Microwave peak power	2MW
Pulse duration	2 μ s

Emittance for 100% of the beam

At 21MeV:

Horizontal 3.8 π mm.mrad

Vertical 12.8 π mm.mrad

Installed MICROTRON System

at BESSY (1998)

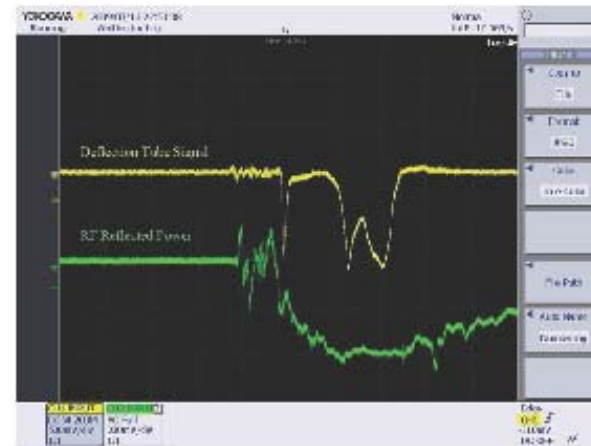
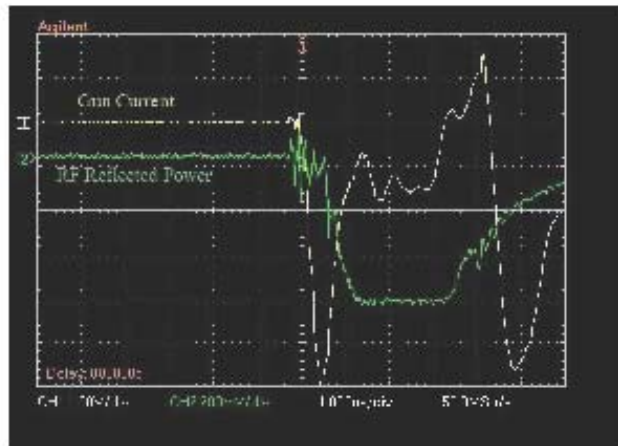


at SESAME (2008)



First Microtron Beam

JULY, 14th, 2009 (00:35): FIRST SESAME MICROTRON BEAM



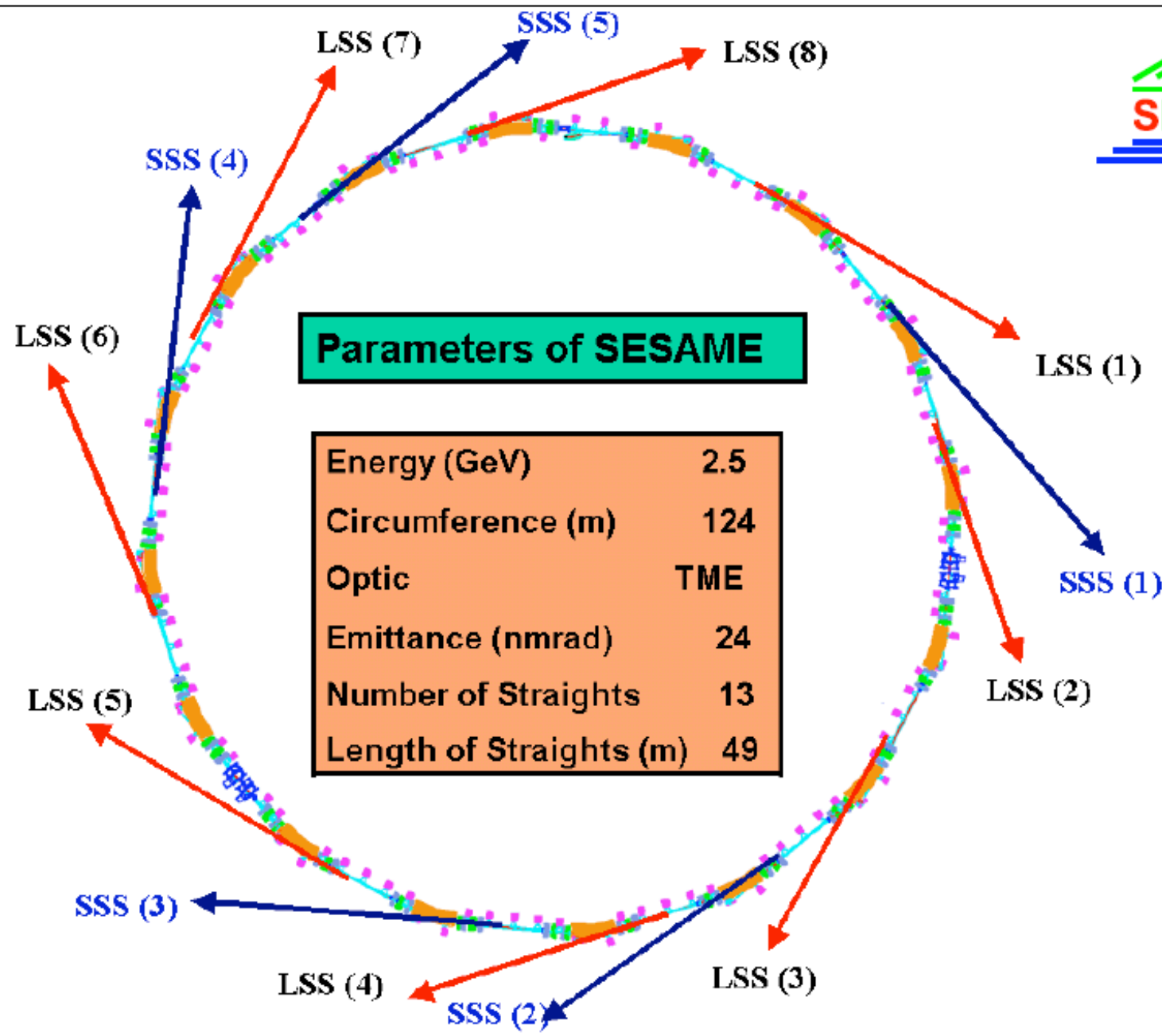
A. Nadji, 14th Council meeting, Istanbul, 20 – 21 July 2009

Components of BESSY1 installed



SESAME Beamlines

- SESAME has the capacity for ~28 beamlines:
Straight Sections = 16 (8 long 4.44 m, 8 short 2.38 m):
Beamline Length 21 - 36.7 m
Photon energies from IR to soft x-rays to hard x-rays
- Mission for beamline development is to ensure appropriate capabilities to:
 - meet needs of very diverse user community (novice to experienced in many different areas of science),
 - develop state-of-the-art user-friendly capabilities,
 - provide user support for carrying out outstanding science,
 - has clear and transparent policy that provide equal opportunities for access of beam times



Parameters of SESAME

Energy (GeV)	2.5
Circumference (m)	124
Optic	TME
Emittance (nmrad)	24
Number of Straights	13
Length of Straights (m)	49

Phase I Beamlines

No.	Beamline	Energy Range	Source Type	Research Area
1.	Mad Protein Crystallography	4 - 14 keV	In-vacuum Undulator	Biology
2.	Soft X-ray - VUV	0.05 - 2 keV	Elliptically Polarizing	Atomic Molecular
3.	SAXS/WAXS	8 - 12 keV	Undulator	Material Science
4.	XAFS/XRF	3 - 30 keV	2.0 Tesla MPW	Material, Arch.
5.	Powder Diffraction	3 - 25 keV	2.1 Tesla MPW	Material, Arch., Env.
6.	IR Spectro-microscopy	0.01 - 1 eV	Bending Magnet	Material, Arch., Env.
7.	VuV Spectroscopy	5 - 250 eV	Bending Magnet	Atomic Molecular

Phase I Beamlines at SESAME & Other

SESAME: Phase I

- 1) PX (und)
- 2) Soft x-ray (EPU)
- 3) SAXS/WAXS
- 4) EXAFS/XRF (Wiggler)
- 5) Powder Diff (Wiggler)
- 6) IR (BM)
- 7) AMO (und)

NSLS-II

- 1) Inelastic
- 2) Nanoprobe
- 3) Soft Coherent
- 4) Hard Coherent
- 5) EXAFS
- 6) Powder

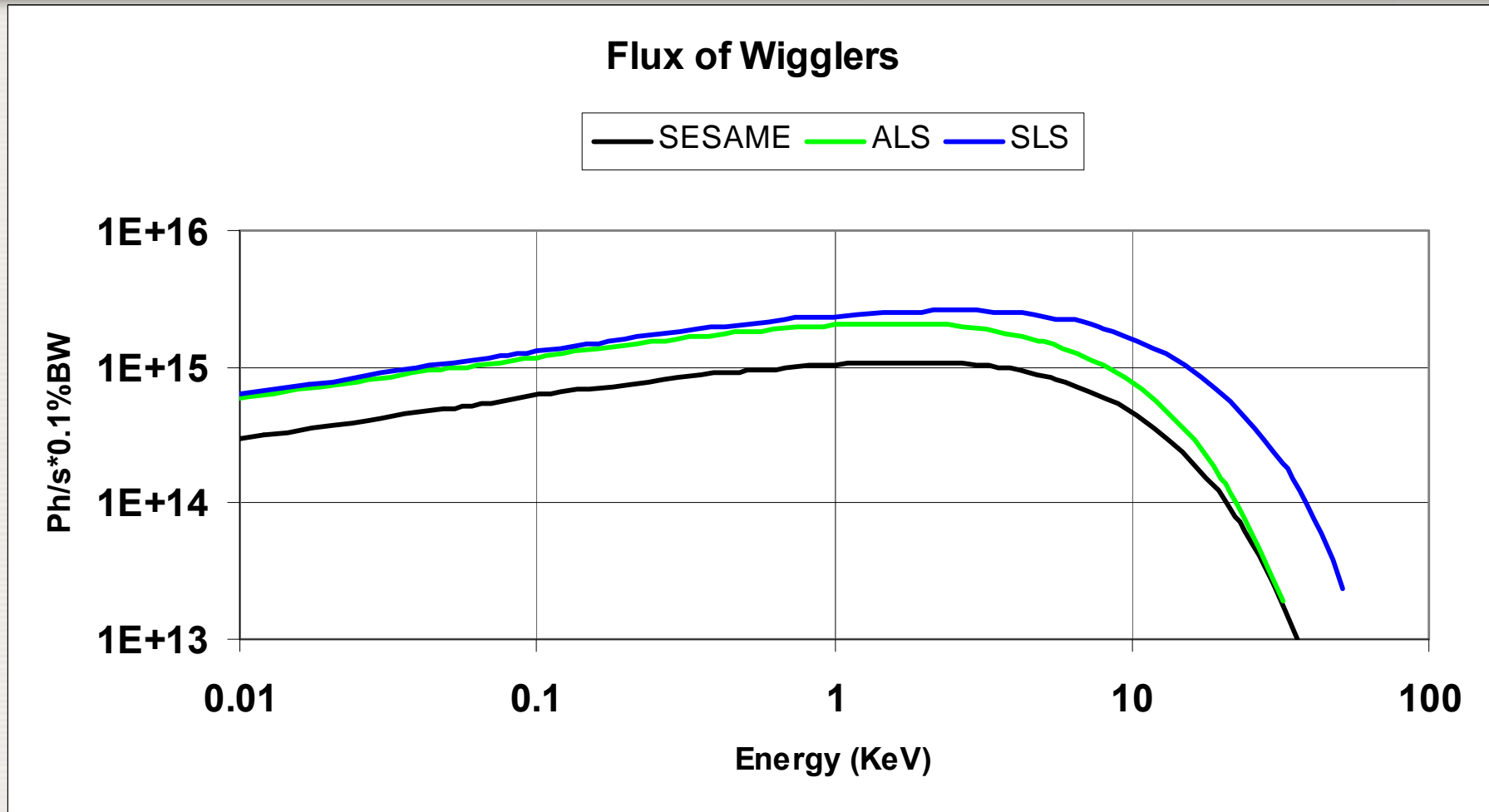
A(ustralian)SP

- 1) IR
- 2) PX (BM)
- 3) Soft (undulator)
- 4) EXAFS (wiggler)
- 5) Powder (BM)

C(anadian)LS

- 1) far-IR
- 2) UV (PEEM+XAS)
- 3) Soft (STXM)
- 4) Soft (PEEM+XAS)
- 5) EXAFS

Comparison of SR from wigglers of SESAME, ALS and SLS



Thus at 10keV there is little difference between ALS and SESAME

Collaboration or “Parentage”

- SESAME will be assisted by international laboratories who have built 3rd generation synchrotron radiation sources
- Signing of agreement with **SOLEIL**: Since 2007
Pulsed Magnets, Power Supplies, Building Infrastructure, Alignment, ...
- Approval by **ESRF** Directorate for
Calculation of the Shielding, Radiation Monitors
Distribution, PSS
- Collaboration with **ALBA** is being arranged
Bending Magnet Measurement, IOTs and LLE-RF,
Personnel Exchange
- Collaboration with **SLS** is in progress
Vacuum and Control Systems

Technical Team



Scientific Programme

- **Research in the domains:**
 - **Atomic and Molecular Physics**
 - **Material science**
 - **Nanotechnology**
 - **Molecular biology**
 - **Archaeology**
 - **Environmental studies**
 - **Medical research**

SESAME is a model project in Middle East

- SESAME will help:
 - Capacity Building in the region
 - State-of-the art research in various science disciplines
 - Act as catalyst for several such projects at the national level in the region
 - Generate understanding between various groups
- SESAME is truly “Science for Peace”



IAEA activities towards SESAME

- 4 x 6 months Beamline scientist fellowships per year. IAEA Technical Officer participates to evaluation panel. **Restricted to IAEA & SESAME Member States fellows**
- 4 x 1 months technical trainings per year. **Restricted to SESAME staff**
- Expert missions
- Lecturers at users' meetings

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www.Lightsources.org



Thank you