The Abdus Salam
International Centre for Theoretical Physics

United Nations
Educational, Scientific and
Cultural Organization

IAEA
International Atomic Energy Agency

2332-21

School on Synchrotron and FEL Based Methods and their Multi-Disciplinary Applications

19 - 30 March 2012

Light Sources in Developing Member States SESAME Project

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Light Sources in Developing Member States

SESAME Project

Ralf Kaiser & Françoise Mulhauser

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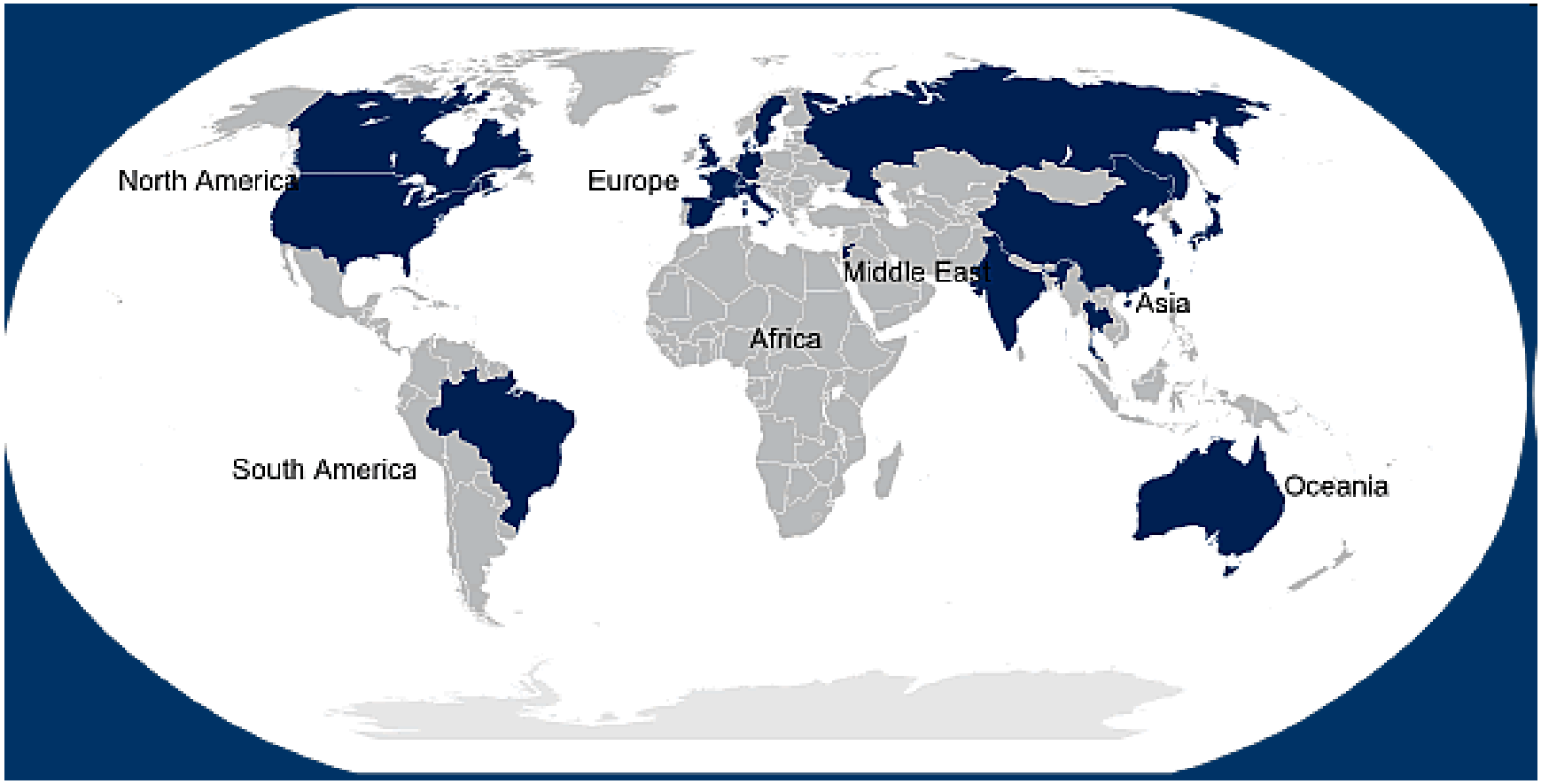
72 Lightsources in 27 Member States



Listing/details: www.lightsources.org

Developing Member States

Brazil	Laboratório Nacional de Luz Síncrotron (LNLS) **Self made**	São Paulo
Thailand	Siam Photon Source (SPS) **Donation from Japan** **Self development**	Nakhon Ratchasima
Jordan	SESAME **Donation from Germany** **International support**	Allan

Brazilian Synchrotron Light Laboratory: LNLS

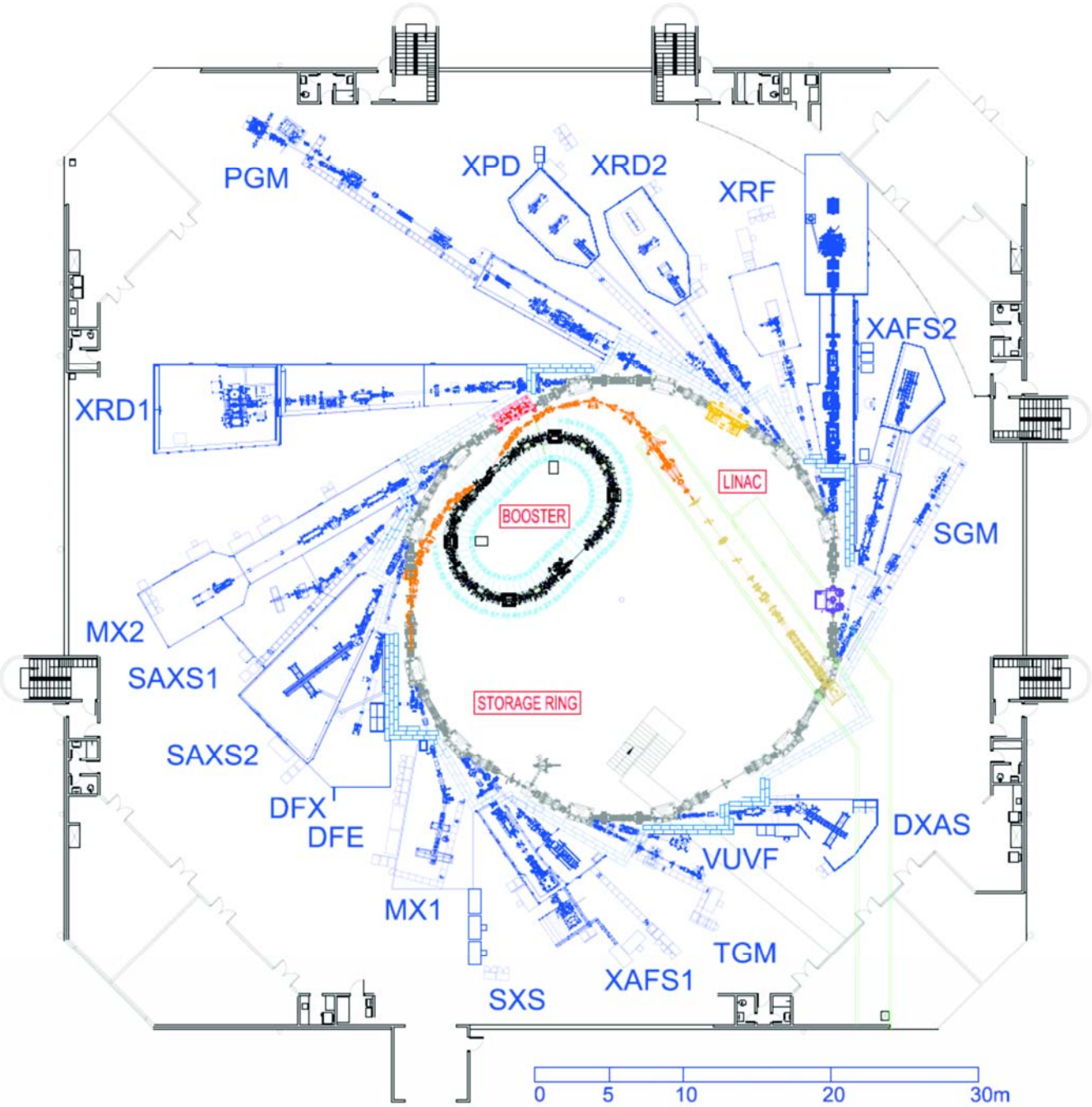
LNLS

Laboratório Nacional
de Luz Síncrotron

www.lnls.br

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.
- 15 operating bending magnet beamlines.


PGM
XPD
XRD2
XRF
XAFS2
XRD1
LINAC
BOOSTER
SGM
MX2
SAXS1
STORAGE RING
SAXS2
DFX
DFE
DXAS
VUVF
MX1
TGM
XAFS1
SXS
0
5
10
20
30m

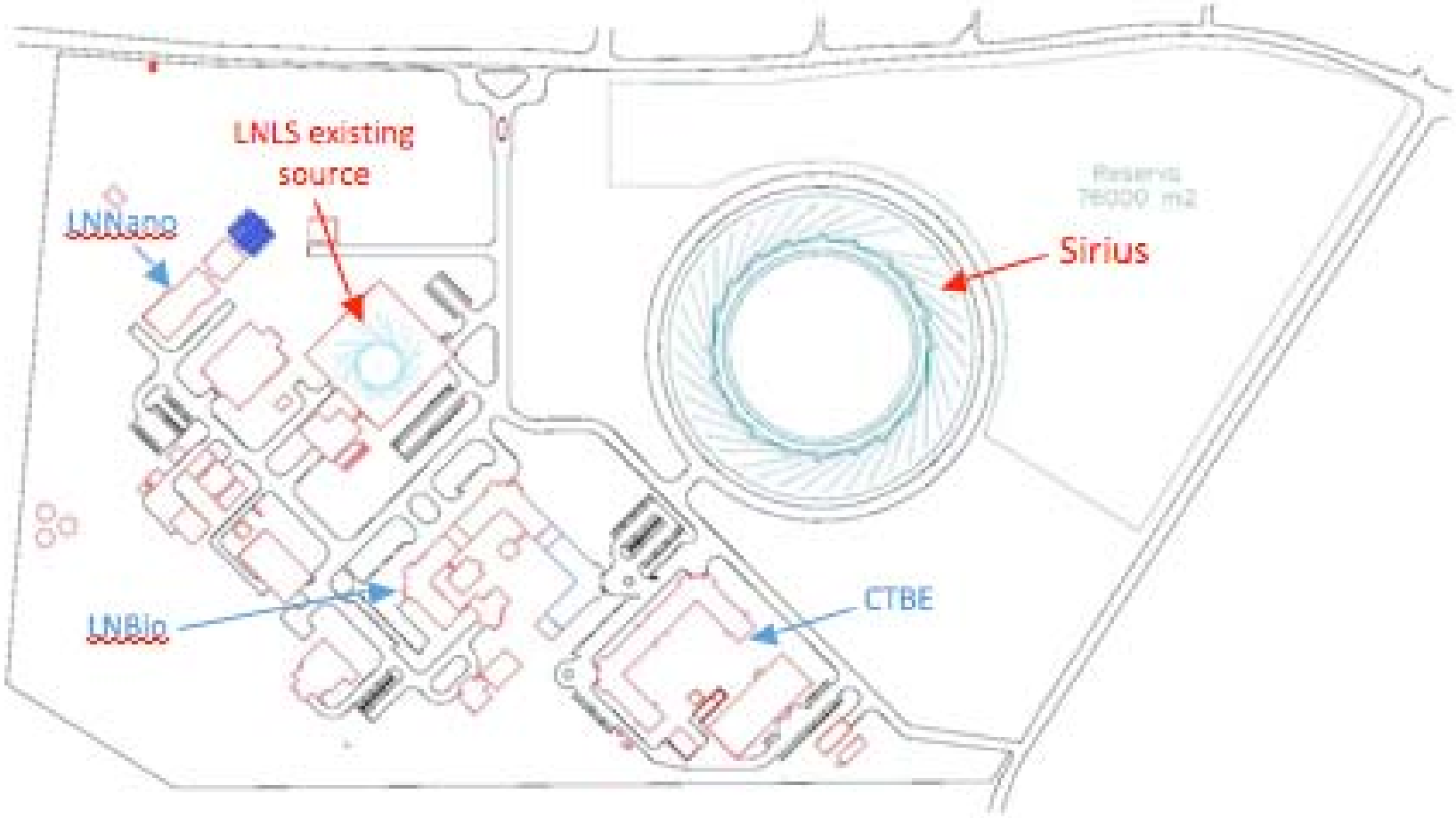
Laboratorio Nacional de Luz Síncrotron

- 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.

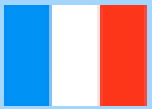
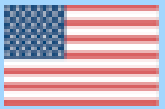
Laboratorio Nacional de Luz Síncrotron

- 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)
- Rapidly growing user community, not only in Brazil but in the whole of Latin America, which pushes 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.

LNLS Future Facility: Sirius

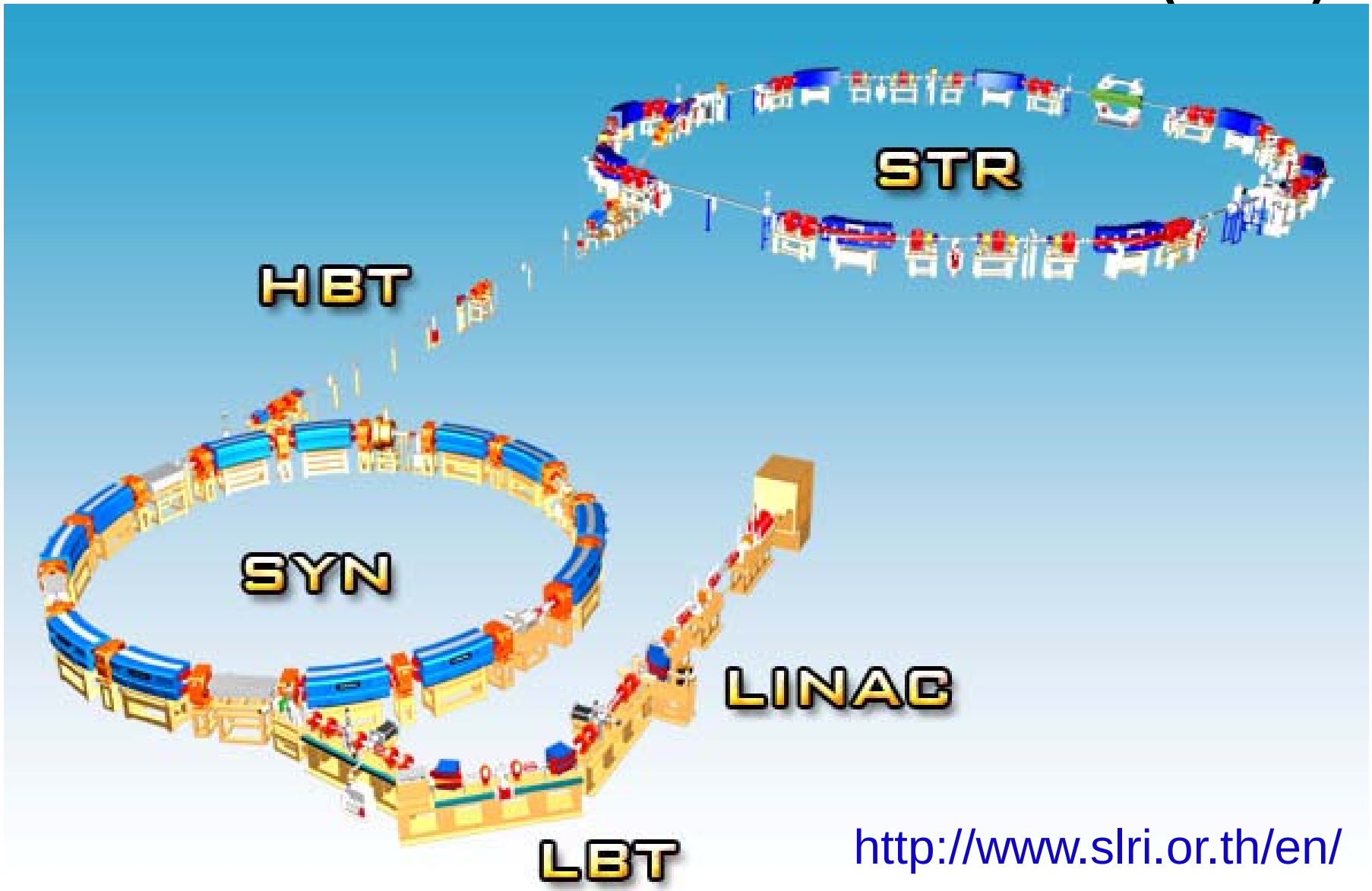


LNLS Future Facility: Sirius

	 LNLS UVX[1]	 LNLS Sirius[2]	 Soleil[1]	 Diamond[1]	 Shanghai[1]	 NSLS II[3]
Energy (GeV)	1,37	3,0	2,75	3,0	3,5	3,0
Average diameter (m)	30	153	113	179	137	252
Brightness from dipoles @ 10 keV *	1	5600	1560	3600	2200	370
Brightness from dipoles @ 50 keV *	1	25.10^9	$1,9.10^9$	$4,4.10^9$	$5,8.10^9$	2700[4]
Emittance (irrespective of insertion devices)[nm.rad]	100	1,8	3,7	2,7	3,9	2,1

Notes: [1] in operation; [2] in design; [3] in construction; [4] the design does not envisage dipole beamlines.
*related to the LNLS source

Thailand: Siam Photon Source (SPS)

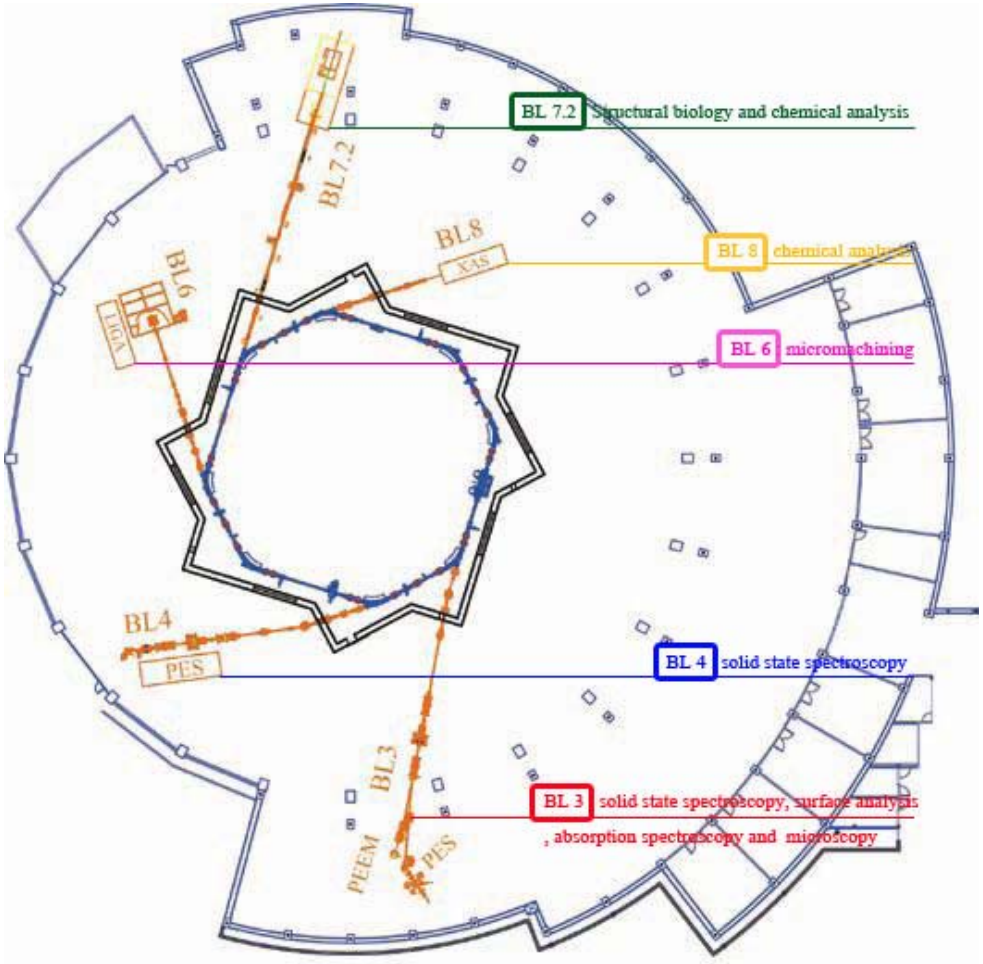


http://www.slri.or.th/en/

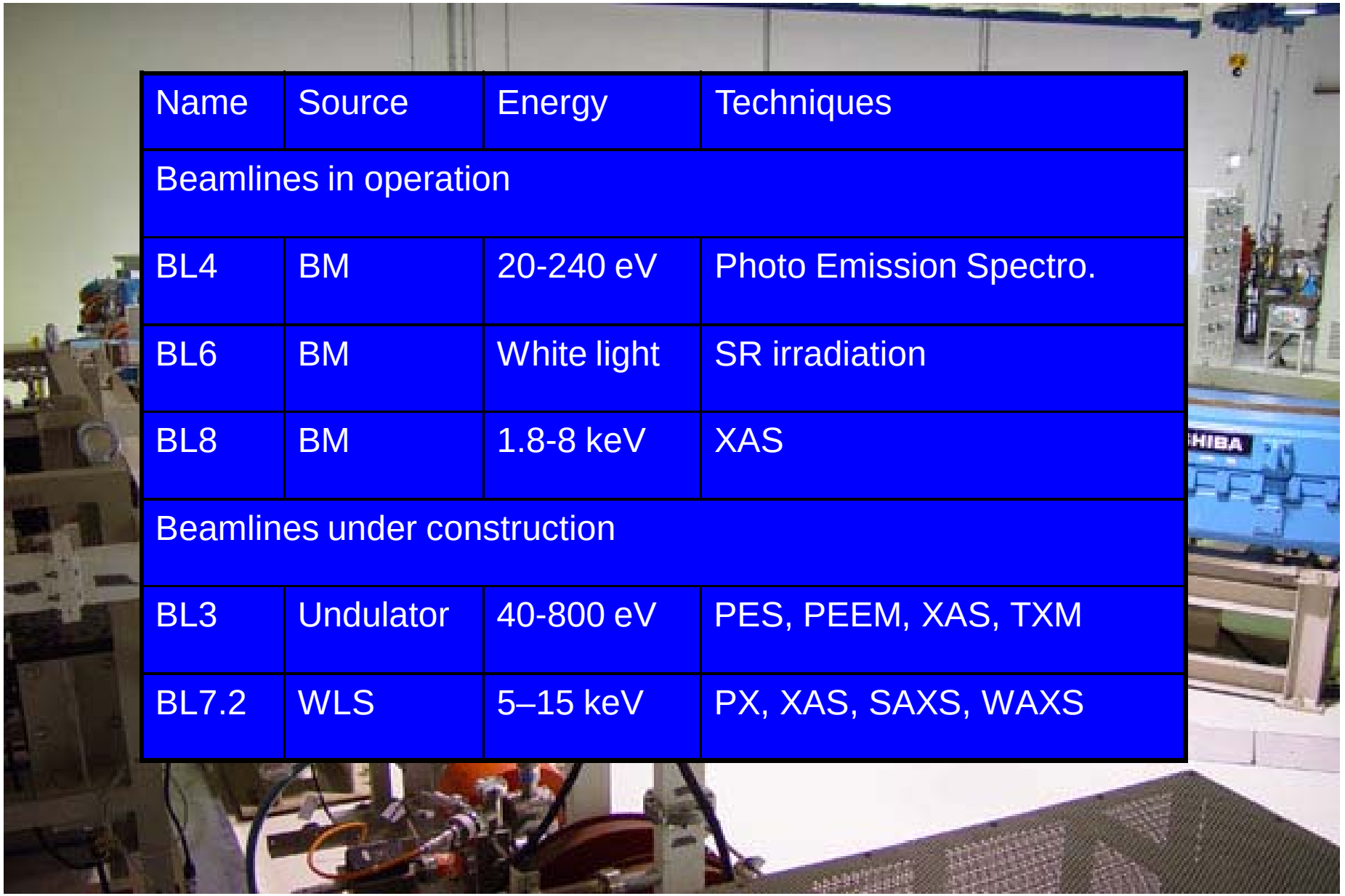
Synchrotron Light Research Institute

Siam Photon

- 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



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


SESAME
Synchrotron light for Experimental Science and Applications in the Middle East
International Center for Research and Advanced Technology
R.Sarraf

- 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

http://www.sesame.org.jo/

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

A Proposal for a Synchrotron Radiation Source in the Middle East

Members of the Study Group

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[5]LURE, Orsay, France

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[16]AEOI, Tehran, Iran

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[20]Cairo University, Giza, Egypt

[21]Cornell University, Ithaca, U.S.A.

[22] Tokyo University, Tokyo, Japan

[23]Annaja University, Naja, P.A.

[24]Lawrence Berkeley Lab, Berkeley, U.S.A.

[25]Synchrotron Radiation Center, Stoughton, U.S.A.

[26]APS, Argonne Nat. Lab, Argonne, U.S.A..

[27]Fermi Nat. Lab, Chicago, U.S.A.

[28]FZK Karlsruhe, Germany

[29]Freie Universität Berlin, Germany

October 1999

SESAME

Synchrotron Light for Experimental Science and Applications in the Middle East

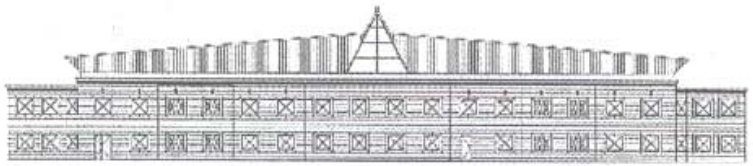
NORTH ELEVATION

Conceptual Design

for the

Upgrading of SESAME to 2GeV

April 2002



WEST ELEVATION

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Acknowledgements:

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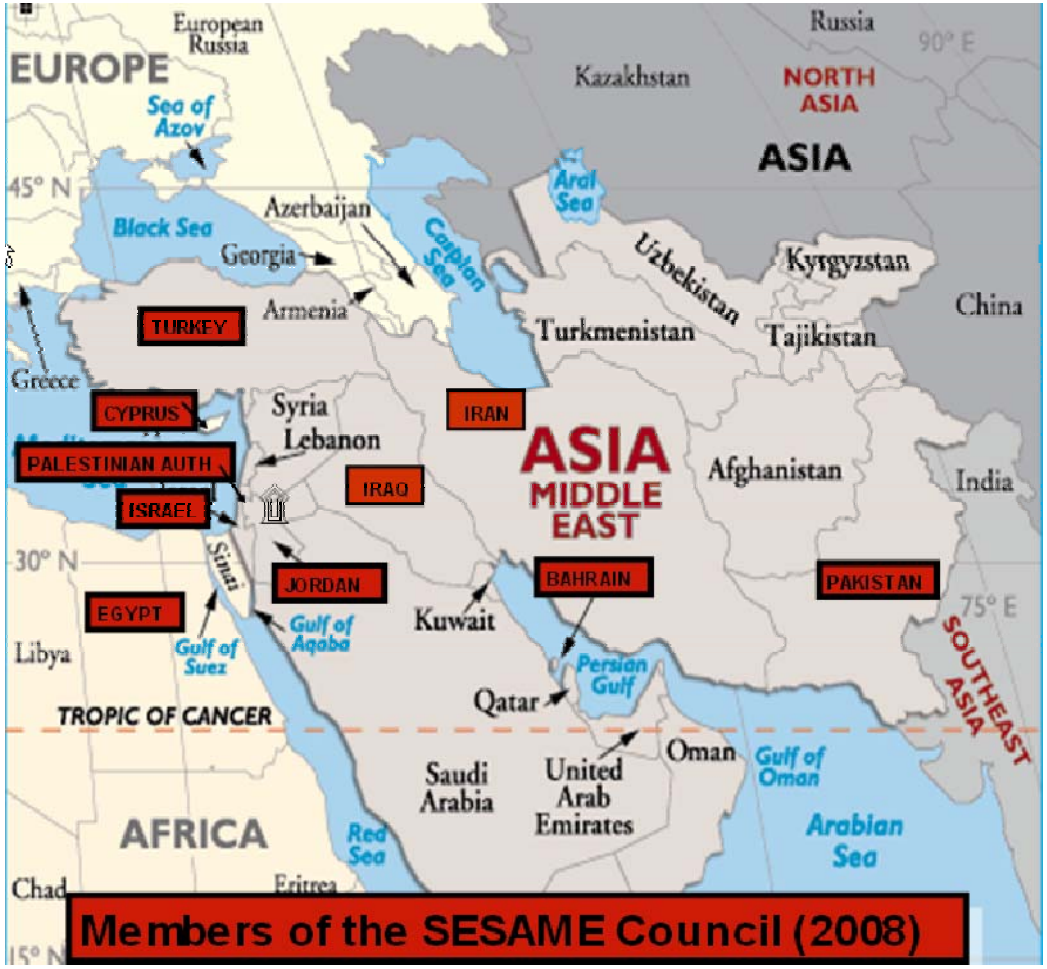
SESAME *www.sesame.org.jo*

- ✓ **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



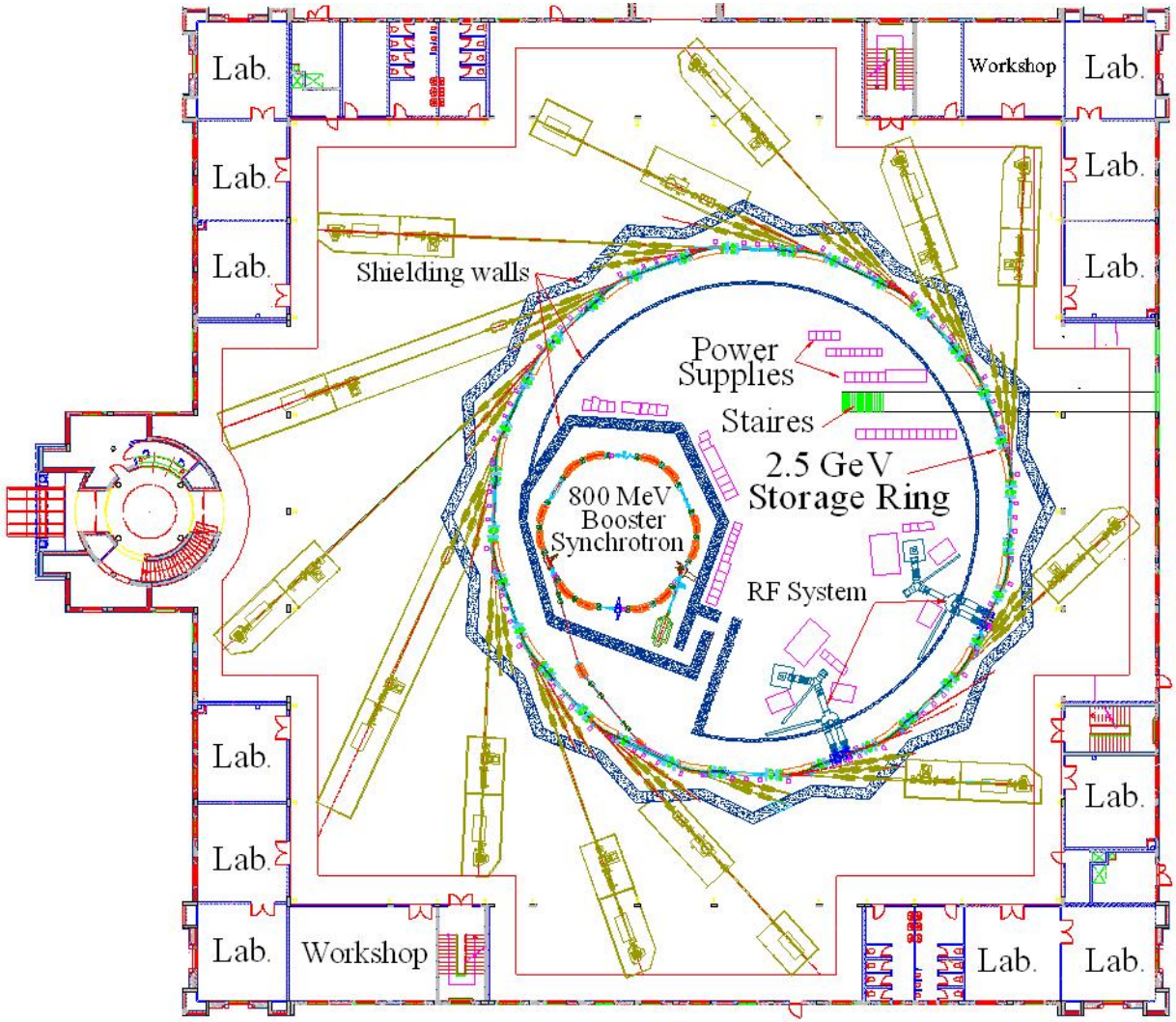
- Bahrain, Cyprus, Egypt, Israel, Iran, Jordan, Pakistan, Palestinian Authority, Turkey

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	2μs

Emittance for 100% of the beam
At 21MeV:

Horizontal	3.8π mm.mrad
Vertical	12.8π mm.mrad

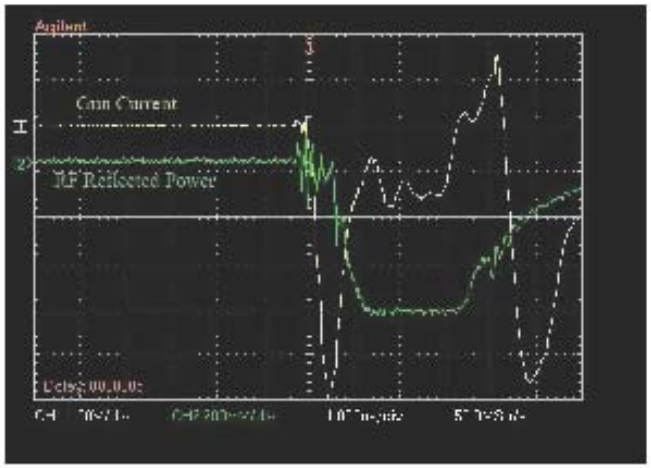
Installed MICROTRON System

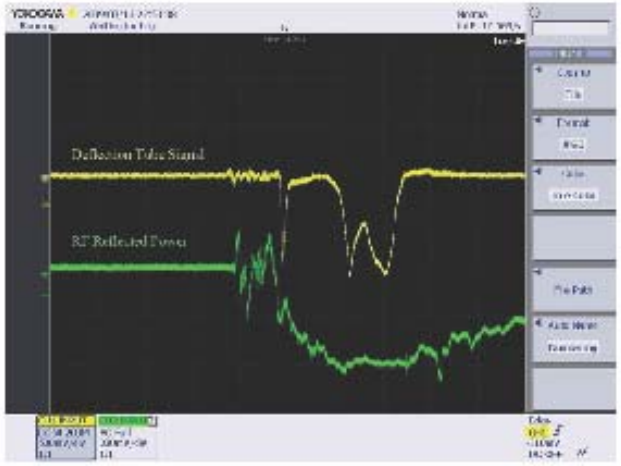
at BESSY (1998)

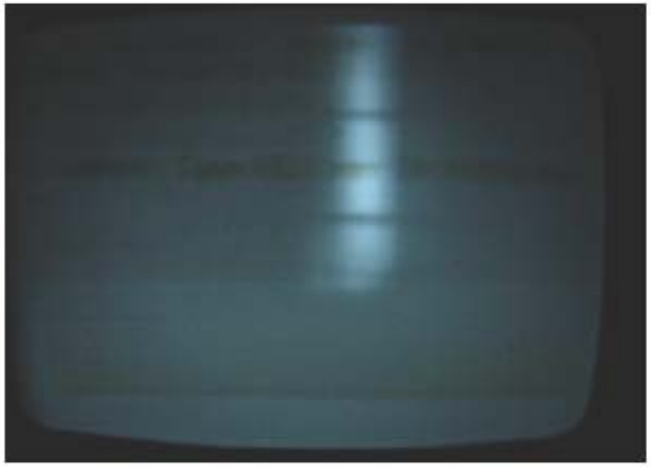
at SESAME (2008)

First Microtron Beam

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

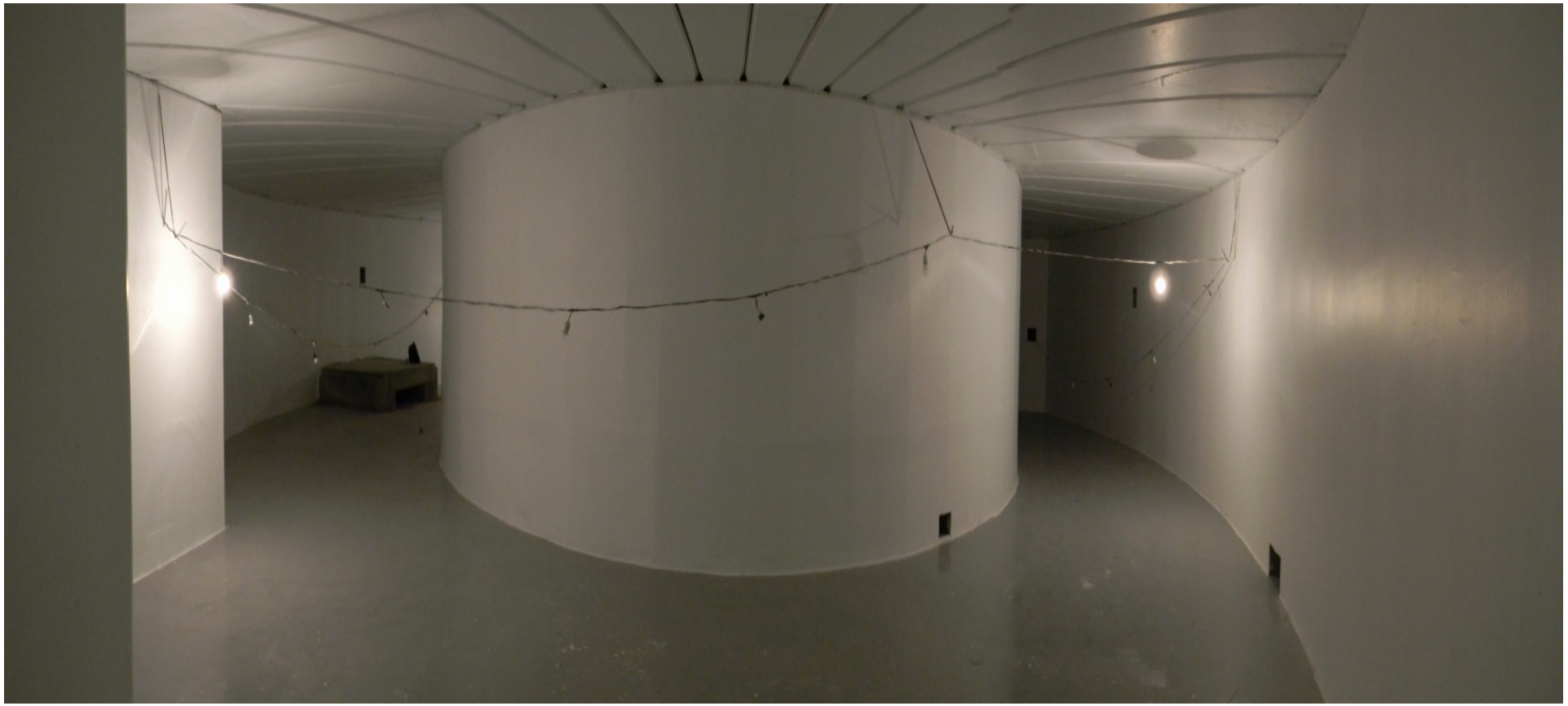






The Shielding Wall is Complete!

The Painting of the Shielding Wall is Complete!



Example：BOOSTER TUNNEL

Components of BESSY1 installed

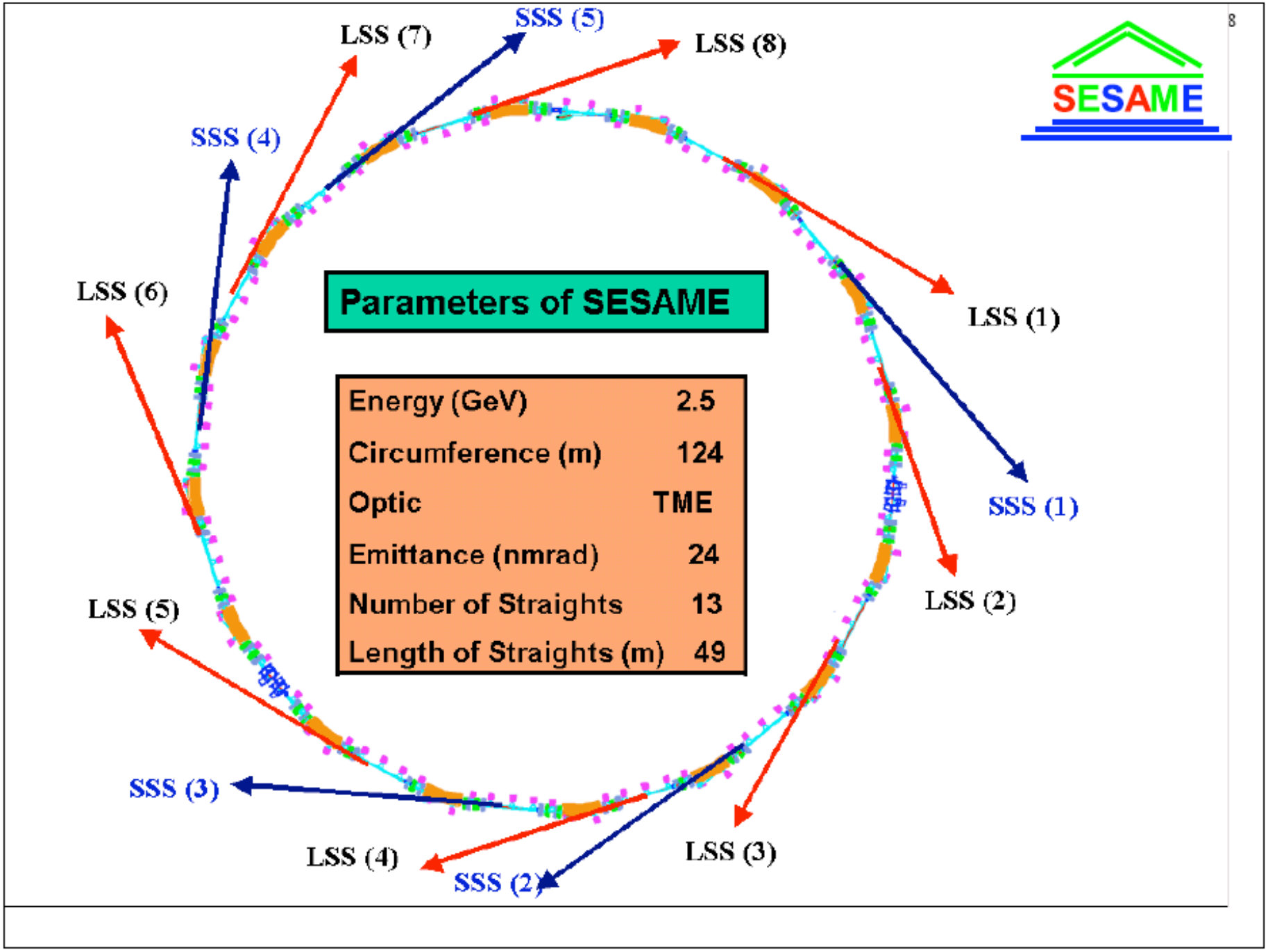
SESAME Beamlines

- 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



SESAME

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

Beamline	Energy Range	Expected Science
PX	4 – 14 keV	Structural Molecular Biology
XAFS/XRF	3 – 30 keV	Materials Science, Environment
IR	0.01 – 1 eV	Environmental, Materials, Archaeological Science
PDB	3 – 25 keV	Materials Science
Soft X-ray, VUV	0.05 – 2 keV	Atomic, Molecular and Condensed Matter Physics
SAXS/WAXS	8 – 12 keV	Structural Molecular Biology, Materials Science
EUV	10 – 200 eV	Atomic and Molecular Physics

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

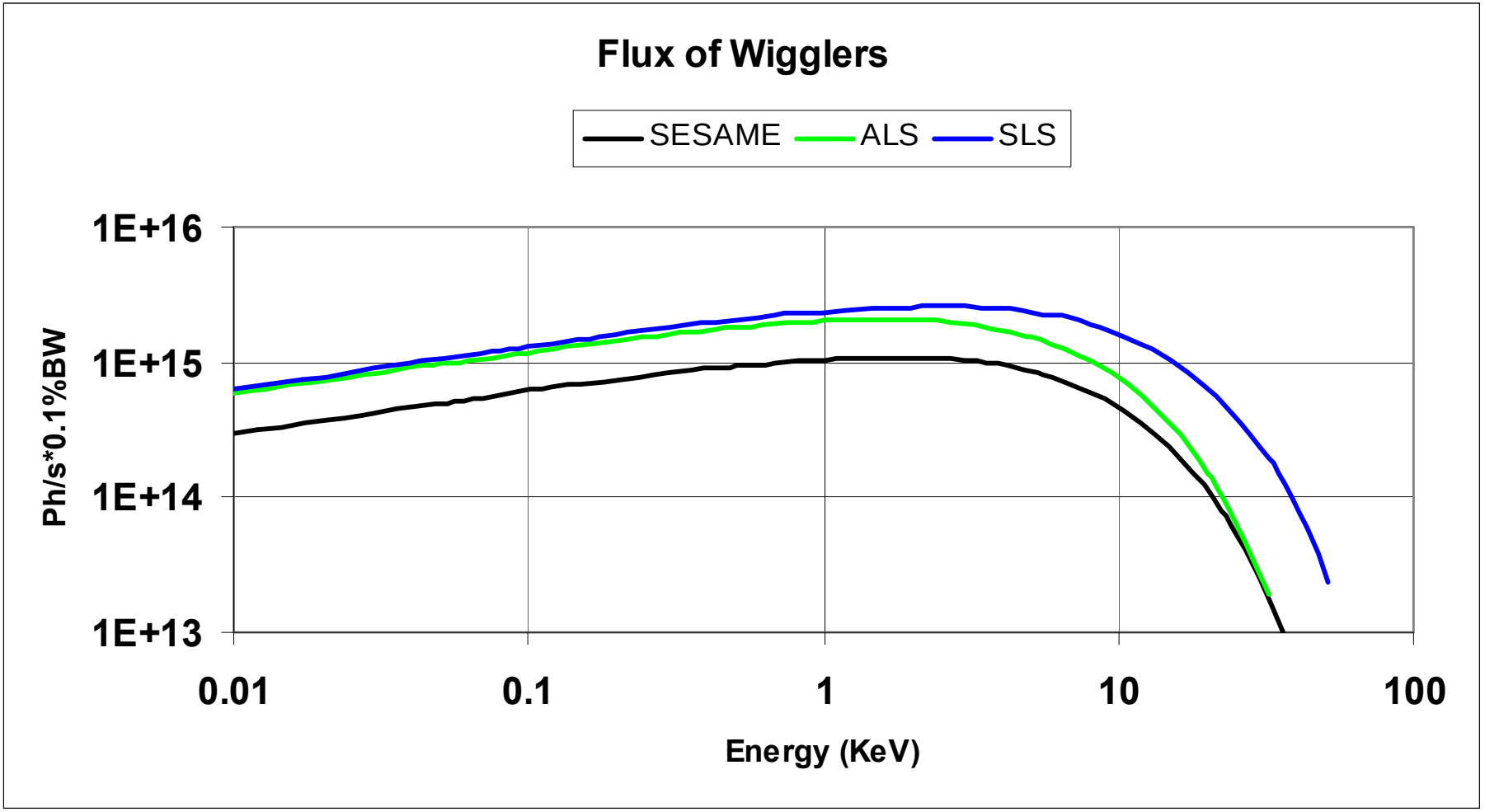
A(ustralian)SP

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

Tentative Agenda

Program	2010				2011				2012				2013				2014				2015			
	T 1	T 2	T 3	T 4	T 1	T 2	T 3	T 4	T 1	T 2	T 3	T 4	T 1	T 2	T 3	T 4	T 1	T 2	T 3	T 4	T 1	T 2	T 3	T 4
Completion of the Shielding																								
Installation + Test of the Booster Subsystems																								
Commissioning of the Microtron at 22.5 MeV																								
Commissioning of the Booster																								
Storage Ring call for Tender + Manufacturing																								
Installation + Tests																								
Commissioning of the Storage Ring																								

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

- Beamline scientist fellowships
  - IAEA Technical Officer participates to evaluation panel. Restricted to IAEA & SESAME Member States fellows
- Staff technical training
  - Restricted to SESAME staff
- Expert missions
- Lecturers at users' meetings

Latest News from SESAME

- 13.3.2012 : SESAME announces agreement by Jordan, Turkey, Israel and Iran to contribute US$ 5 Million each towards the construction.
- Another US$ 15 Million are required to complete the first 4 beamlines by 2015.

Lightsources around the world

www.lightsources.org


Thank you