SESAME - A 3rd Generation Synchrotron Light Source for the Middle East

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IAEA F1-TM-34708
IAEA, Vienna, Austria
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Evolution of Synchrotron Radiation

Yesterday’s Synchrotrons
- Circular electron motion
- Continuous circular trajectory
- Photons

Third-Generation Synchrotrons
- Many straight sections containing periodic magnetic structures
- Tightly controlled electron beam

Bend Magnet Radiation
- X-ray light bulb
- Photons flux vs. Photon energy

Undulator Radiation
- Laser-like
- Tunable
- Photons/s vs. Photon energy

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The ALS mostly produces ultraviolet light and soft X rays which have just the right energies to explore many of the atomic properties of matter.
What Properties Make Synchrotron Radiation (SR) so Useful?

• **High brightness and stability:** SR is extremely intense (hundreds of thousands of times higher than conventional X-ray tubes)

• **Wide energy spectrum:** SR is emitted with a wide range of energies

• **Highly polarized and short pulses:** SR is emitted in very short pulses, typically less than a nano-second (a billionth of a second)

• **SMALL SOURCE SIZE (≤ mm).**

• **PARTIAL COHERENCE.**

• **HIGH VACUUM ENVIRONMENT.**
Photons - a Unique Tool in Studying Structure and Properties of Matter - X-rays as an Example

Seeing the Invisible

X-rays can “see” smaller things - down to the size of molecules and individual atoms
These Techniques Provide Very Valuable Information

Imaging - Seeing the Invisible

Atomic and Molecular Structure
- where are the atoms -

Electronic Structure and Bonding
- where are the electrons -

Magnetic Structure and Properties
- where are the spins -
• Birth of a new radiology

Synchrotron light is revolutionizing radiology. The superior characteristics of synchrotron light open the way to very effective radiological diagnosis using a much reduced dose of x-rays. Furthermore, microscopic details can be detected with incredible precision, enhancing the diagnostic capabilities.

• A powerful “microscope” for basic research and industry

Synchrotron light explores the microscopic world in many different ways and with unprecedented effectiveness. One domain stands out for its present explosive growth: macromolecular crystallography. New synchrotron-based crystallography techniques such as "MAD" find the positions of thousands of atoms in huge biological molecules, most notably proteins.
• Microchemical analysis

Novel synchrotron-based techniques analyze the chemical and physical properties of materials and biological systems with very high sensitivity and accuracy “chemical composition and the bonding state of elements on a scale of a few millionths of a millimeter”. Microchemical analysis is a powerful and non-destructive tool to analyze specimens of archaeological and historical interest. Synchrotron spectromicroscopy investigates medical problems such as the chemical aspects of new therapies for the fight against cancer.

• Microfabrication towards a new industrial revolution

Synchrotron-emitted x-rays are used not only for scientific studies, but also for industrial fabrication of ultraminiaturized products. Photolithographic techniques based on short-wavelength ultraviolet light are the key to extreme miniaturization in today's microelectronics industry -- which led to the greatest industrial revolution in history. Synchrotron x-rays have even shorter wavelengths than ultraviolet light, and can push the miniaturization even further (nanotechnology).
SESAME COUNCIL

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PENDING OBSERVER STATUS
· JAPAN
### SESAME Storage Ring Main Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Energy (GeV)</td>
<td>2.5</td>
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<tr>
<td>Maximum Beam Curr. (mA)</td>
<td>400</td>
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<tr>
<td>Bending Flux Density (T)</td>
<td>1.4554</td>
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<tr>
<td>Circumference (m)</td>
<td>133.2</td>
</tr>
<tr>
<td>Emittance (nm.rad)</td>
<td>26</td>
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<tr>
<td>Maximum ID Length (m)</td>
<td>3.9</td>
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<tr>
<td>Long Straights Beam Cross Section ($\sigma_x\sigma_z$) ((\mu m))</td>
<td>828 x 21</td>
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<tr>
<td>Available Straight Sections for Insertion Devices</td>
<td>12</td>
</tr>
</tbody>
</table>
3D View of the New Shielding

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• The Modulator has reached its maximum value of 9 kV

• The Maximum magnetic field has been reached:
Collaboration
Have visited SESAME for a technical work:

- Michael Hartrott (20 - 25/1/08, BESSY), funded by SESAME: Microtron
- Pierre Lebasque (2 – 7/3/08, SOLEIL), funded by IAEA: Pulsed magnet system and Microtron
- Alain Lestrade (8 – 12/3/08, SOLEIL), funded by IAEA: Surveying and alignment

Signature of collaboration with ALBA (Spain) and APS (USA).

Collaboration signatures with ELETTRA and SLS are also foreseen.
Vacuum Chamber, Magnets and Girder Assembly, Design Progress
<table>
<thead>
<tr>
<th>No</th>
<th>Beamline</th>
<th>Coordinator</th>
<th>Expert</th>
<th>Donation</th>
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<tr>
<td>1</td>
<td>Mad Protein Crystallography</td>
<td>S. Hasnain, M. Yousef</td>
<td>Samar Hasnain</td>
<td>DL – 14.1 &amp; 14.2</td>
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<td>2</td>
<td>Soft X-ray - VUV</td>
<td>B. Suleman, Aslam Baig</td>
<td>Zahid Hussain</td>
<td>DL – 4.1 &amp; 4.2</td>
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<td>3</td>
<td>SAXS/WAXS</td>
<td>M. Al-Hussein, Zehra Seyers</td>
<td>Wim Bras</td>
<td>DL – 16.1</td>
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<td>4</td>
<td>XAFS/XRF</td>
<td>Awni Hallak, Abu Samak</td>
<td>A. Simionovici</td>
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<td>5</td>
<td>Powder Diffraction</td>
<td>E. Ozdas</td>
<td>Fabia Gozzo</td>
<td>SLS</td>
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<tr>
<td>6</td>
<td>IR Spectro-microscopy</td>
<td>Z. El Bayyari, I. Sagi</td>
<td>Paul Dumas</td>
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<tr>
<td>7</td>
<td>Zero beamline</td>
<td>M. Gharaibeh, Rami Ali</td>
<td>---</td>
<td>LURE</td>
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</tbody>
</table>
DONATION FROM Daresbury

5 BEAMLINES

- 16.1 SAX/WAXS beamline (also expect to receive an appropriate front end)
- 14.1 Fixed wavelength high resolution PX
- 14.2 Tunable Se MAD with a robot for high throughput screening
- It is expected that the above two will be provided with a front end and also possibly a high field MPW. Thus, both beamlines can be instantly commissioned on SESAME.
- 4.1 VUV Spectroscopy (14-60, 50-140 and 100-170 eV)
- 4.2 NEXAFS/XAS (1.8-10keV)
- The above two will be provided with a front end so the beamlines can be instantly integrated onto a BM of SESAME.
Synchrotron Light For Experimental Science And Applications In The Middle East

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What Do We Have

• Wiggler from ALS & Undulator and Double Crystal Monochromator from SSRL (*USA*).
• Optical Parts, Hutches and Undulator from LURE (*France*).
• 5 SRS – DL beamlines (*UK*).
• 1 SLS – PDB beamline (*Sweden*).
**SESAME TEAM**

*Directorate*: K. Toukan (Director/Jordan), H. Hoorani (Scientific Director/Pakistan), A. Nadji (Technical Director/France-Algeria), M.Y. Khalil (Administrative Director/Egypt), A. Hallak (Assistant to Director/Jordan) H.Tarawneh (Deputy Technical Director/Jordan), S. Al-Faques (Administrative Assistant/Jordan).


*Scientific Staff*: M. F. Gharaibeh, W. Salah.

*Advisory Committee Chairs*:  
- **Technical**: A. Wruhlich (PSI, Switzerland)  
- **Scientific**: Z. Sayers (Sabanci Univ., Turkey)  
- **Beam Lines**: Z. Hussain (ALS-US/Pakistan)  
- **Training**: J. Rahighi (Iran).
http://www.sesame.org.jo