9th International Platform on Integrating Arab e-Infrastructure in a Global Environment, e-AGE19”
Abu Dhabi, UAE, 11-12 December 2019

Professor Walid Zidan
Administrative Director of SESAME
Synchrotron Light for Experimental Science and Applications in the Middle East (SESAME)
SESAME Location
Brief History of SESAME

- Convergence of two ideas: build a light source in the Middle East (Abdus Salam) + foster projects that cross divides (MESC Group) (Sergio Fubini, Eliezer Rabinovici, Herwig Schopper, Tord Ekelof).

- Original proposal (1997- Dahab - Sinai) (Rabinovici, Vince Guda,...) rebuild old 0.8 GeV Berlin Synchrotron (BESSY 1) in the Middle East modelled on CERN (Guss Voss, Herman Winik).

- 1999 - (Interim) Council established: followed by international advisory committees.

- 2002 - decision to build a new 2.5 GeV ring (still using BESSY booster) competitive 3rd generation facility.


- Commissioning late 2016.
Why Build a Synchrotron Facility?

- International collaboration is obvious way for countries with relatively small scientific communities and/or limited science budgets to build a synchrotron-light source.
- Broad programs make synchrotron-light sources 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.
SESAME as a Project

SESAME is a cooperative venture by scientists and governments of the region set up on the model of CERN (European Organization for Nuclear Research) although it has very different scientific aims.

It was developed under the auspices of UNESCO (United Nations Educational, Scientific and Cultural Organization) following the formal approval given for this by the Organization's Executive Board (164th session, May 2002).
SESAME Members and Observers

Palestine
**SESAME storage ring parameters**

- **Energy (GeV)**: 2.5
- **Current (mA)**: 200
- **Circumference (m)**: 133.2
- **Natural emittance (nmrad)**: 26

**Synchrotron light** is emitted by the circulating electrons as their trajectories are distorted. It can be used to carry out research in fields ranging from medicine and biology, through materials science, physics and chemistry to healthcare, the environment and archeology.

**Bending magnets**: deviate the electron beam, keeping it inside the storage ring's doughnut shaped vacuum chamber.

**Radiofrequency cavities**: restore energy lost by the circulating electrons as they emit synchrotron light.

**Focusing and defocusing magnets**: control the characteristics of the circulating electron beam.

**Beamlines**: collect the synchrotron light and convey it to experimental chambers. Beamlines operate in parallel, simultaneously serving tens of user groups.

**Microtron**: generates and pre-accelerates the electrons.

**Booster synchrotron**: accelerates the electrons and transfers the beam to the storage ring.

**Storage ring**: stores an electron beam. The beam circulates for many hours.

**SAXS/WAXS**: Small Angle and Wide Angle X-ray Scattering Beamline

**MS**: Materials Science Beamline

**XAFS/XRF**: X-ray Absorption Fine Structure / X-ray Fluorescence Spectroscopy Beamline

**MX**: Macromolecular Crystallography Beamline

**IR**: Infrared Beamline

**Soft X-ray Beamline**: HESEB
Phase I Beamlines

In the first phase, there will be six beamlines. These beamlines, which have been selected on the basis of requests from scientists in the region, are the following:

1. The (XAFS/XRF) X-ray Absorption Fine Structure/ X-ray Fluorescence Spectroscopy
   - Active

2. The IR (Infrared Spectra Microscopy)

3. The MS (Materials Science)

4. MX (Macromolecular Crystallography)

5. Soft X-ray Beamline (HESEB)

6. Tomography Beamline (BEATS)

Future
1. XAFS/XRF

The XAFS/XRF beamline is the first operational beamline at SESAME, and it has been open for **external users** since **July 2018**.

- Ozensoy’s team during a beamtime campaign (group of PhD students) from Bilkent University
- Dr. Murat Osman Ozkendir and his MSc. student from Mersin University while changing samples

**Beamtime** has resulted in the first two papers published in highly ranked journals
First Scientific Paper Published in June, 2019

in a High Impact Factor Journal (11.6)

Exceptionally active and stable catalysts for CO₂ reforming of glycerol to syngas

Selin Bac, Zafer Say, Yusuf Kocak, Kerem E. Ercan, Messaoud Harfouche, Emrah Ozensoy, Ahmet K. Avci

Department of Chemical Engineering, Bogazici University, Bebek, 34342, Istanbul, Turkey
Bilkent University, Department of Chemistry, 06800, Ankara, Turkey
Department of Physics, Chalmers University of Technology, 412 96, Göteborg, Sweden
Synchrotron-Light for Experimental Science and Applications in the Middle East (SESAME), 19252, Allan, Jordan
UNAM-National Nanotechnology Center, Bilkent University, 06800, Ankara, Turkey
2. IR

SESAME’s First Fully Designed Beamline
in collaboration with the French Synchrotron, SOLEIL

2016: Design Validation

2017: Fabrication (France)

2018: Installation

2018: Experimental Hutch

2018: Optical Alignment

2018: SR-Commissioning

2017: Fabrication (France)

FIRST RESULTS (April, 2018)

DAY-1 Beamline

BEAMLINE SERVING SESAME USERS:
NOVEMBER 2018
Call for Proposals 2018_IR-BL

43 Proposals Submitted, 22 Scheduled
39 Experiments Already Performed in 2019:

<table>
<thead>
<tr>
<th>Experiments</th>
<th>IR</th>
<th>XAFS/XRF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>19</td>
<td>20</td>
<td>39</td>
</tr>
</tbody>
</table>

...and 6 More Before the End of 2019:

<table>
<thead>
<tr>
<th>Experiments</th>
<th>IR</th>
<th>XAFS/XRF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>3</td>
<td>3</td>
<td>6</td>
</tr>
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</table>
Speaking of industry and commercial applications, MS beamline is the first to come to mind. This beamline aims to use X-ray diffraction techniques for investigating materials atomic structure.
4. Macromolecular Crystallography

- The first macromolecular crystallography beamline in the Middle East to facilitate experiments in the medical and pharmaceutical fields in the region as well as in Asia-Pacific.

- Currently a proposal has been submitted to construct the beamline through IAEA/SESAME intergovernmental project based on cost sharing approach.
On 25th of October 2018, SESAME hosted a delegation from the Helmholtz Association of German Research Centers consisting of 43 persons. It was headed by Professor Otmar Wiestler, President of the Association.

During the visit, Otmar Wiestler informed SESAME that five research centers of the Helmholtz Association will be taking part in construction of a soft X-ray beamline for SESAME under the leadership of DESY (Deutsches Elektronen-Synchrotron). This is another one of SESAME’s Phase I beamlines.

The five research centers are:
- DESY (Deutsches Elektronen-Synchrotron)
- FZJ (Forschungszentrum Jülich)
- HZB (Helmholtz-Zentrum Berlin)
- HZDR (Helmholtz-Zentrum Dresden-Rossendorf)
- KIT (Karlsruher Institut für Technologie)

A complete undulator beamline with monochromator and refocusing optics and a small chamber to conduct absorption and fluorescence yield experiments. The capital value of this work would be of the order of €3.5 million
6. Beamline for Tomography at SESAME (BEATS)

- The project is an H2020-EU funded project of €6. million to pave the way for an efficient and sustainable operation of SESAME.

- Led by the ESRF, the European synchrotron (France), BEATS involves leading research facilities in the Middle East (SESAME and the Cyprus Institute), and European synchrotron radiation facilities ALBA-CELLS (Spain), DESY (Germany), the ESRF (France), Elettra (Italy), INFN (Italy), PSI (Switzerland), SESAME (Jordan) and SOLARIS (Poland).

- Aimed at serving user communities in the region, in particular the cultural heritage and archaeology communities. It is an obvious advantage for these communities to be able to access a state-of-the-art beamline close to the source of samples or remains to be analyzed.
SESAME Guest-House is funded by the Italian Ministry of Education, Universities and Research through INFN (total of 1.75 M Euro). The Guest-House includes a canteen, large meeting room and 48 Guestrooms.
## Project Information

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<table>
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<tr>
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<tr>
<td><strong>Funded by</strong></td>
<td>Italian Ministry of Education, Universities and Research through INFN</td>
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<tr>
<td><strong>Donation</strong></td>
<td>1.75 million Euro</td>
</tr>
<tr>
<td><strong>Actual Cost</strong></td>
<td>2.095 million Euro</td>
</tr>
<tr>
<td><strong>Consultants</strong></td>
<td>Integra A.E.S Roma-Italy&lt;br&gt;Consolidated Consultants Group (CC) Amman – Jordan</td>
</tr>
<tr>
<td><strong>Construction Completion</strong></td>
<td>15-5-2019</td>
</tr>
<tr>
<td><strong>Testing &amp; Commissioning</strong></td>
<td>1-7-2019</td>
</tr>
<tr>
<td><strong>Operator Selection</strong></td>
<td>Tender documents under preparation and Request for Proposal (RFP) will be posted soon on the website</td>
</tr>
</tbody>
</table>

*The actual cost is excluding furniture, and the additional cost beyond the donation was incurred by SESAME (=345K Euro)*
First Accelerator in the World Powered by Renewable Energy

Thanks to the European Union’s fund of 7.143 million USD, all of SESAME’s energy needs are now being met by the solar power plant, and this has allowed it to become a signatory of the UN Climate Neutral Now initiative.
## Financial Impact

<table>
<thead>
<tr>
<th>Start Date of Operation</th>
<th>February 28th, 2019</th>
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<tr>
<td>Total Initial Investment</td>
<td>7,143,938 USD</td>
</tr>
<tr>
<td>Lifetime of the PV System</td>
<td>20 years</td>
</tr>
<tr>
<td>Peak Monthly Bill Prior to Solar Plant (July 2018)</td>
<td>266,583 USD</td>
</tr>
<tr>
<td>Average Monthly Bill (including wheeling) – Present</td>
<td>12,000 USD</td>
</tr>
<tr>
<td>Pay Back Period</td>
<td>2 years</td>
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</table>
Computing Services to the community

- Computing infrastructure for Machine, Beamlines and Offices
- SESAME Users Office portal (Call for proposals CFP, Beam-time)
  - [https://sup.sesame.org.io](https://sup.sesame.org.io) (next deadline: Jan 27, 2020 13:00 Jordan time)
- SESAME Experimental Data (SED) management
- HPC clusters (CPU/GPU)
  - Tesla K20 GPU \ Xeon CPUs
- Data acquisition systems, data transfer, high-end storage and remote access
  - Private cloud, SSL tunneling, X2Go/NX, ssh gateway, remote experiments
  - Web services for R&D

Availability for 7+ years uptime

SESAME Datacentre is Powered by many open-source software apps
Why data connectivity is essential for SESAME?

ASREN/ GÉANT as a potential service provider

- Allow user communities worldwide to submit their proposals via the open CFP on SESAME Users Portal (SUP) portal
  [https://sup.sesame.org.jo](https://sup.sesame.org.jo)
- Enable fast file transfer using an *uncommercial* reliable data connectivity to carry out the expected massive data generation from SESAME beamlines i.e. µ-tomography beamline (~2 TB for each experiment)
- Enhance the communication platform between SESAME and the world class research labs.
- Current potential and related projects:
  - OpenSESAME
  - BEATS, BEAmline for Tomography at SESAME
  - Helmholtz/SESAME soft X-ray beamline
- Avoid any bottleneck to access HPC clusters for data analysis purposes.

- High speed connectivity for cloud computing apps.

**Nowadays: International Access to Education & Research Networks**

GÉANT (pan-European data network for the research and education) via ASREN.

Connectivity service contract:
- STM-1: 155 Mbps circuit over fiber connectivity
- 100 Mbps Internet bandwidth
- **Operational since July 2016**
Success Stories of SESAME / Jordan

- Remote access to SESAME computational resources [Regional]
  - Jordan university of science and technology, JUST, Jordan
  - The University of Jordan, Jordan
  - Jerash University, Jordan
  - National Academy of Sciences of the Republic of Armenia, NAS RA, Armenia
  - The Cyprus Institute, CyI, Cyprus
  - International Centre for Theoretical Physics, ICTP, Italy
  - Supreme Council of Universities-Egypt, Egypt
  - University of Laghouat, Algeria

- Recent scientific computing research @SESAME
  - Computational optimization using CUDA, encryption/decryption, big data and life sciences
  - Research outcomes and publications has been announced – see next slide--.
Acknowledgements

The authors would like to acknowledge the support of National Science Foundation (CNS-0953447 and CNS-1718033) and Jordan University of Science and Technology for both providing the financial support to complete this work. The authors would like also to thank the computing center of Synchrotron Light for Experimental Science and Applications in the Middle East (SESAME) for providing the GPU platform resources for our simulations. Sincere thanks are given to Computing Engineers Mustafa A. Alzu’bi and Salman Matalgah for their continuous help in maintaining the GPU resources at the center and providing us with unrestricted access.
SESAME’s Message

- SESAME has become a reality
- SESAME is a unique large scientific infrastructure in the Middle east and neighboring regions
- SESAME is now operational and performing well
- SESAME has started to produce world class science
Thank You