

SESAME* - Science and Diplomacy in the Middle East

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

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The SESAME Building



The SESAME Members:



'Science for Peace'

Two organisations created under the umbrella of UNESCO:

CERN

Conceived late 1940s - two aims:

- Enable construction of a facility beyond means of individual members
- Foster cooperation between peoples recently in conflict



SESAME

Conceived late 1990s with the same aims:

Members: Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, Turkey

It will work politically ***provided*** science is first class



Examples of bridges between peoples built by CERN:

- 1st intergovernmental organisation that Germany joined after WW II (on probation!)
- 1st post WW II meetings between German and Israeli physicists at CERN
- Collaboration between CERN & Russia at the height of Cold War kept doors open & established trust, and was model for later USA-Russian collaboration
- In the late 1970s, when China was closed, scientific contacts between Europe and China were pioneered in work at DESY (in Hamburg) and later at CERN - Nobel Laureate Sam Ting from MIT got backing of Deng Xiaoping
- In 1985, when USSR-USA arms negotiations in Geneva were stalled, the US delegation asked the DG to arrange a dinner at CERN for Russian and American scientific advisors - which facilitated a subsequent breakthrough
- CERN had an open door policy for E European countries during the cold war, this allowed them quickly to join CERN (as a an expression of their European identity) following the fall of the Berlin wall
- Experience of CERN: even if they are initially very suspicious, scientists and engineers with very different political & religious views and cultures, develop technical respect when they work together, which leads to greater mutual tolerance and understanding (after that their relations are like those with anyone else). **Hope/expect this will happen at SESAME – it is starting.**

SESAME is a 3rd generation light-source ('extremely bright flash lamp → very powerful microscope') **near Amman – starting to operate**

SESAME will foster

- science and technology in the Middle East and neighbouring countries (from biology and medical sciences through materials science, chemistry, and physics to archaeology)
- cooperation across political divides

Members:

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

Others welcome



Observers: Brazil, Canada, China, EU, France, Germany, Greece, Italy, Japan, Kuwait, Portugal, Russian Federation, Spain, Sweden, Switzerland, UK, USA

There are some 60 light sources in the world None in the Middle East

- Broad programmes make synchrotron-light sources ideal facilities for building scientific capacity
- International collaboration is the obvious way for countries with relatively small scientific communities and/or limited science budgets to build a synchrotron-light source
- SESAME will be a user facility: scientists will typically go to SESAME two or three times a year for a few days to carry out experiments, in collaboration with scientists from other institutions/countries



Buildings can be used for high-quality Middle East Scientific meetings

Very Brief History of SESAME

- **Convergence of two ideas** – build a light source in the Middle East (Abdus Salam – early 1980s) + foster scientific projects that cross divides
- **Original proposal (1997)** - rebuild old 0.8 GeV Berlin Synchrotron (BESSY 1) in the Middle East, as basis for a new international organisation, modelled on CERN
- **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*
- **Ground breaking (2003); completion of building (2008)**
- **Vigorous training programme and growing potential user community**
- **First beam circulated in January 2017**

Status of SESAME

- SESAME has faced many difficulties, almost all financial, but the accelerator complex is now complete and beams have been stored and accelerated to the design energy
- Vigorous training programme, building scientific capacity in the region and growing potential user community
- The scientific programme (in molecular biology, environmental studies, materials sciences archaeology ,...) will begin in this summer, with initially just two beamlines and minimal supporting infrastructure
- Opening by HM King Abdullah II on 16 May 2017
- Will discuss on-going challenges later. Now: photographic history of SESAME, outline what it will do and how it is supported

SESAME GROUND BREAKING CEREMONY - 6 JANUARY 2003



In 2007 I was asked to succeed Herwig Schopper (also a former DG of CERN) as President, which I did in November 2008. Two things that helped convince me:



SESAME Accelerator Group, August 2007 – young people trained in Europe with funding obtained by SESAME who returned to the Middle East to build SESAME

Eliezer Rabinovici: As a string theorist, I work on parallel universes. I was always curious about what a parallel universe was like, and now I know. I'm living in one when I go to SESAME meetings working hand in hand with our neighbours on a common goal, bringing advanced knowledge to our region.

Experimental Hall in May 2012



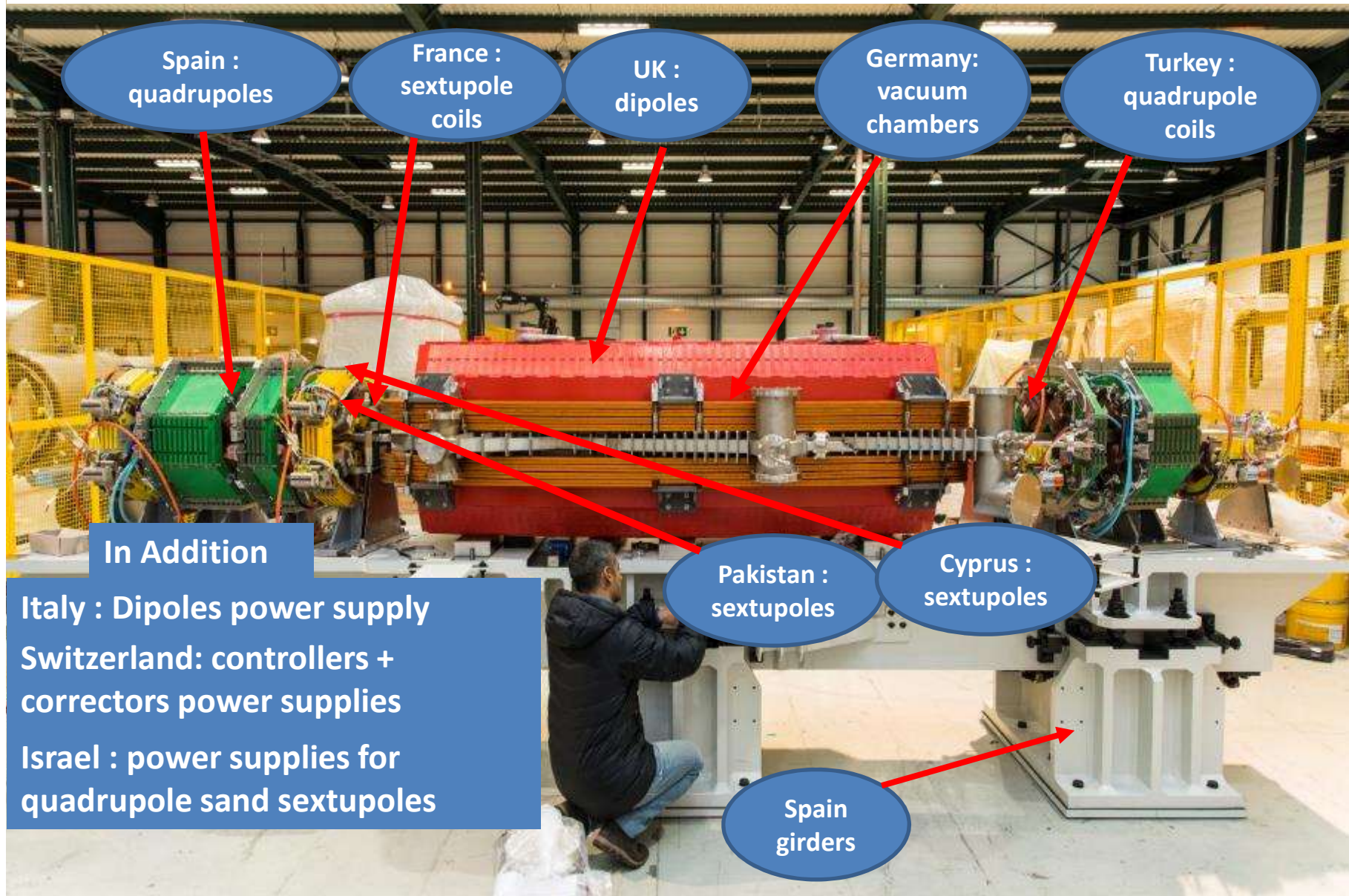
**Booster in
November 2013**

Beam stored &
brought to full energy
(800 MeV) in
September 2014

Then the highest
energy accelerator in
the Middle East

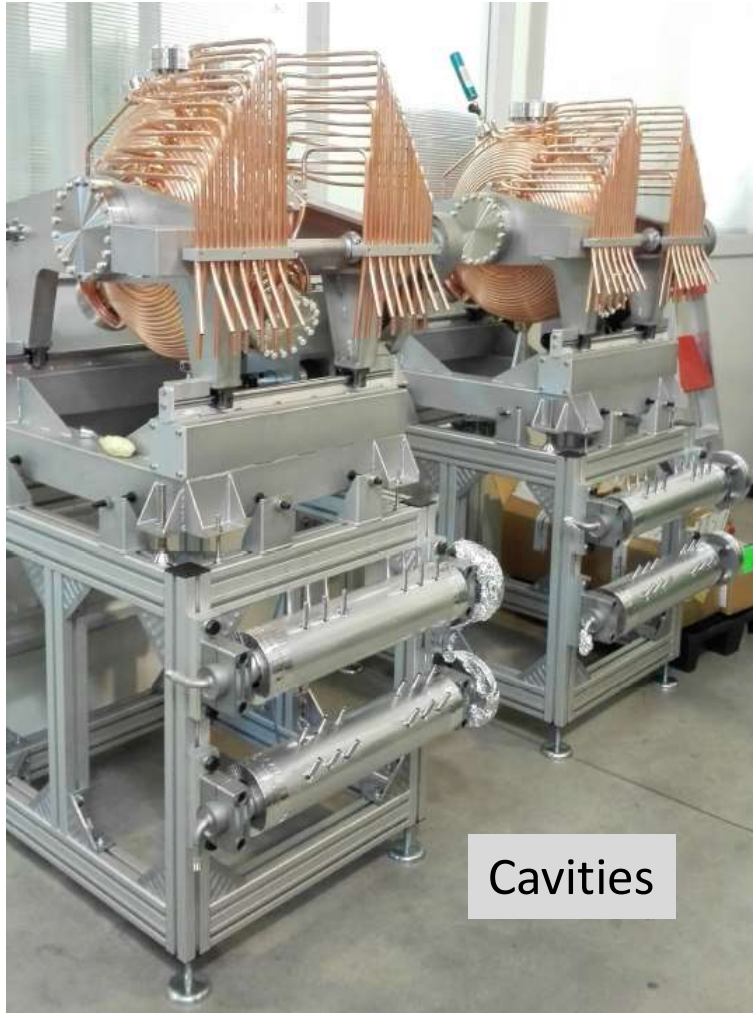
First of 16 sectors of the main storage ring at CERN 31 March 2015

Collaboration between CERN, SESAME Members and Observers – funded by EU

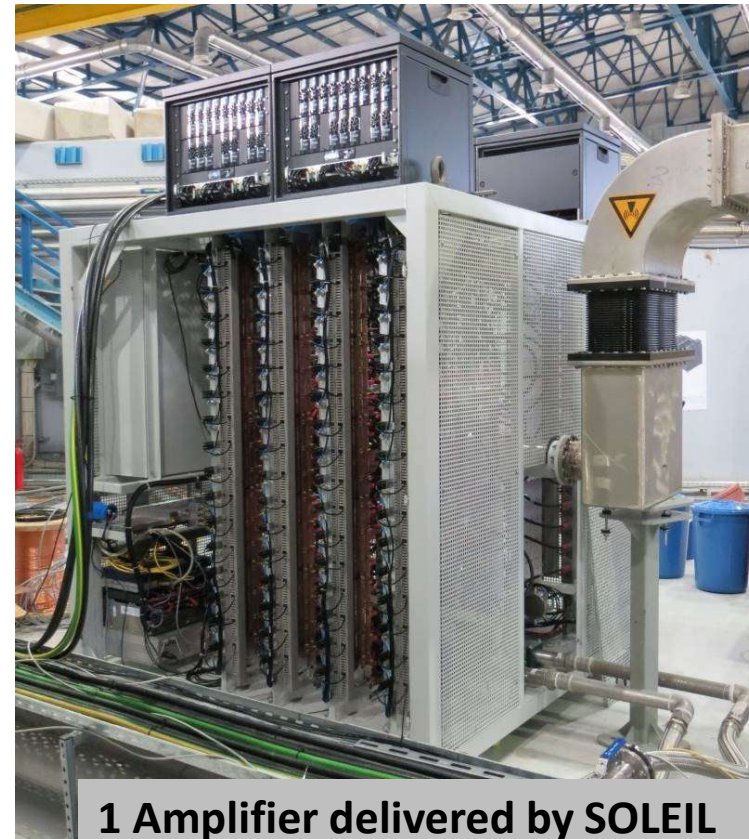




RF-Cavities – donated by Italy



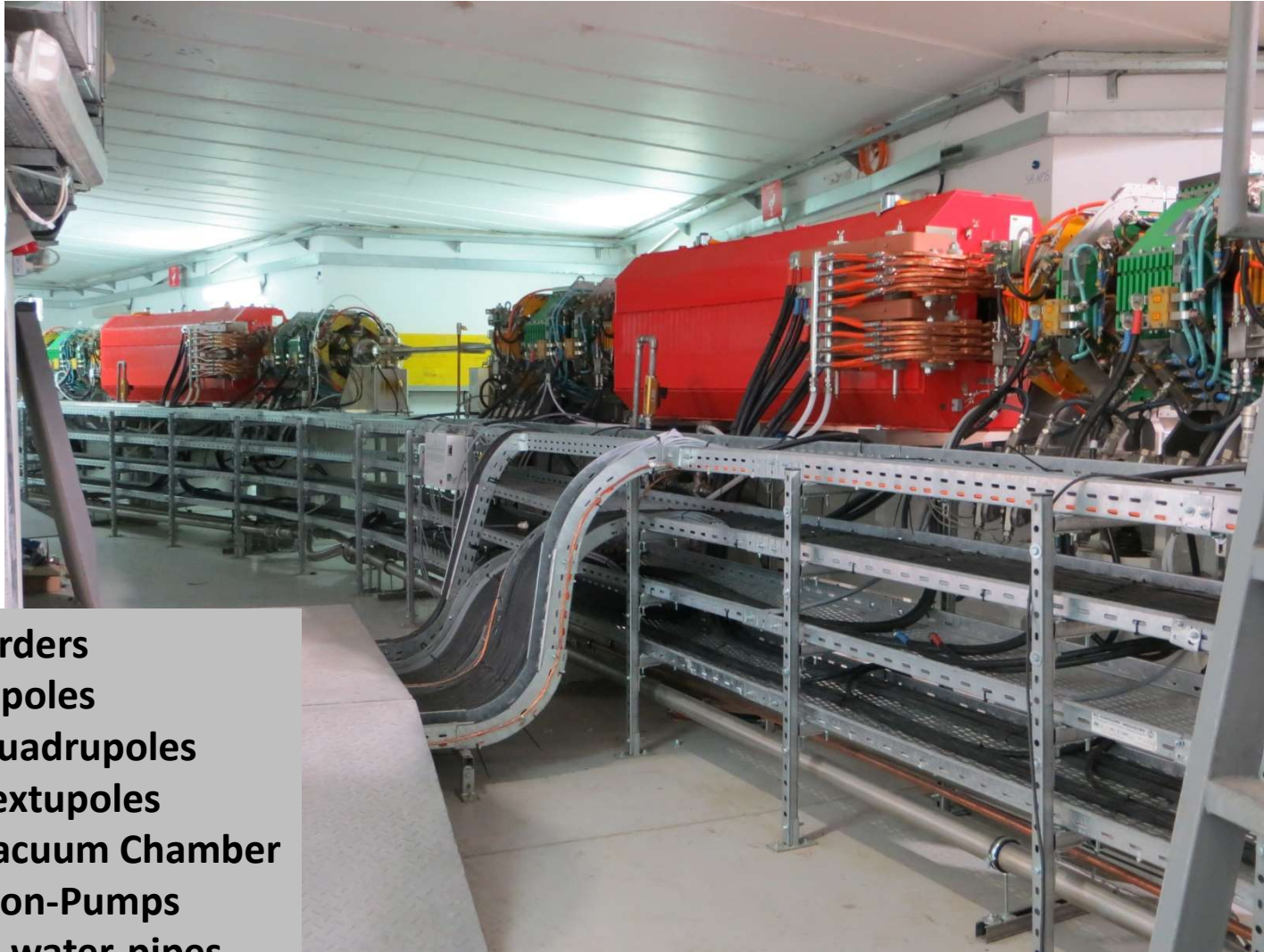
Cavities



**1 Amplifier delivered by SOLEIL
2 Amplifier delivered by SIGMA-PHI
2 out of 3 in operation, enough for
commissioning
Final delivery, installation Jan 2017**



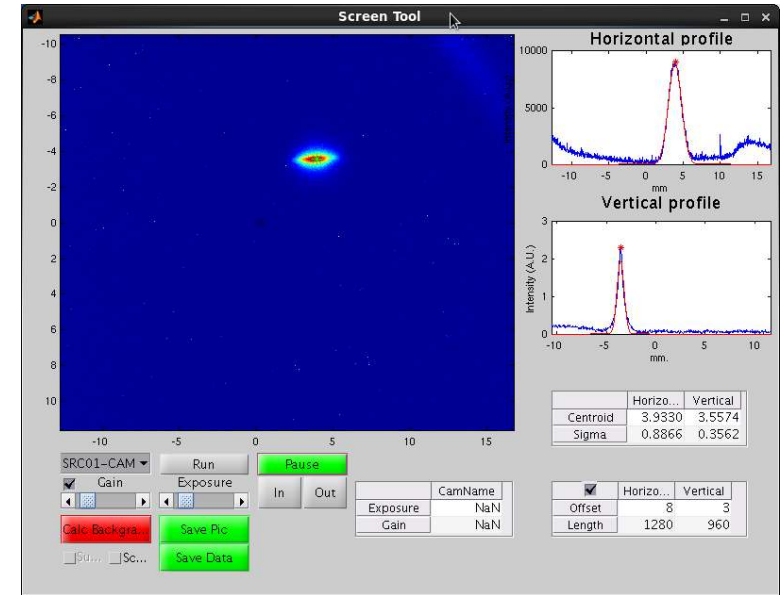
Installation Completed Nov 2016



16 girders
16 dipoles
64 Quadrupoles
64 Sextupoles
32 Vacuum Chamber
110 Ion-Pumps
1 km water-pipes
12 km cables

Success

The bright red spot on the display shows the passage of the first beam to circulate in the SESAME main ring, at 18:12 (UTC+2) 11 January



Some members of the SESAME beam commissioning team led by Technical Director Erhard Huttel (centre) after successfully circulating SESAME's first beam

Scientific Programme

Synchrotron light source are equipped with 'beamlines' which focus the light on samples that scientists wish to study. Each beamline can support several experiments in series and in parallel

- **Initially two**

BASEMA (Beamline for Absorption Spectroscopy for Environment and Material Applications) - a smile in Arabic

EMIRA (ElectroMagnetic Infrared RAdiation) – Princess.

- **Two more in next two years**

Materials Science SUSAM (SESAME USers Application for Materials Science) – SESAME in Turkish, for studying disordered/amorphous material on the atomic scale and the evolution of nano-scale structures and materials in extreme conditions of pressure and temperature – 2018

Macromolecular Crystallography combined with a protein expression/crystallization facility for structural molecular biology, aimed at elucidating the mechanisms of proteins at the atomic level and providing guidelines for developing new drugs – 2019

- **Three more when funds permit**

XAFS/XRF Beamline “BASEMA”

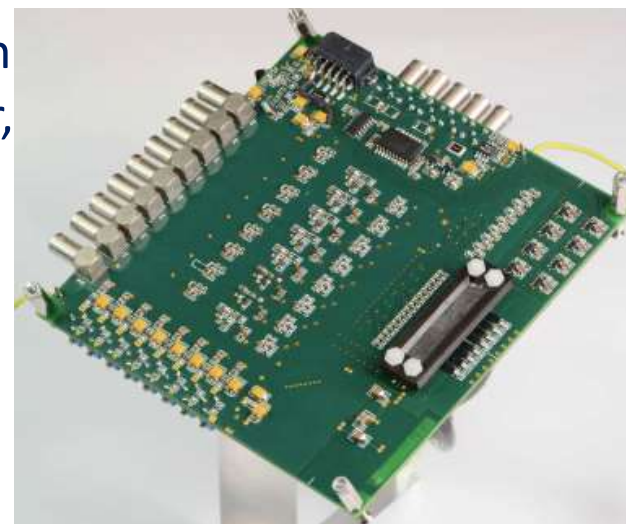
Components (from ESRF) in
final position in the hutch:

Applications: in basic materials
science, life sciences and
environmental science on the nano-
and micro-meter scale

Examples: designing new
materials and improving
catalysts/ e.g. for the
petrochemical industries,
determining bonding
structure and identification
of the chemical composition
of fossils and of valuable
paintings in a non-invasive
manner



Will be equipped with
an advanced detector,
contributed by Italy -
sensitivity at least 50
times higher than
existing technology +
unprecedented
dynamic range:

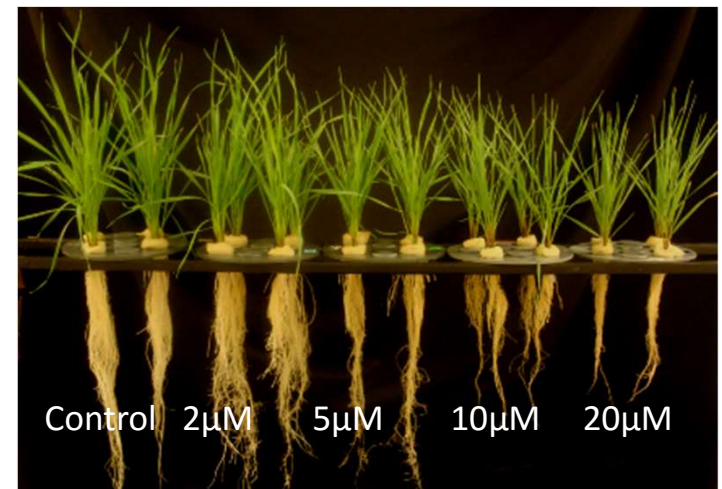


Examples of work at other synchrotrons that is expected continue at BASEMA:

- Absorption and mobility of heavy metals in soils in the vicinity of Jordan and Yarmouk rivers (SESAME and Jordan)



- Tracking Pollution (Air/Soil) in Some Arab Regions (SESAME, Egypt, Jordan)
- Metal storage and balance in wheat

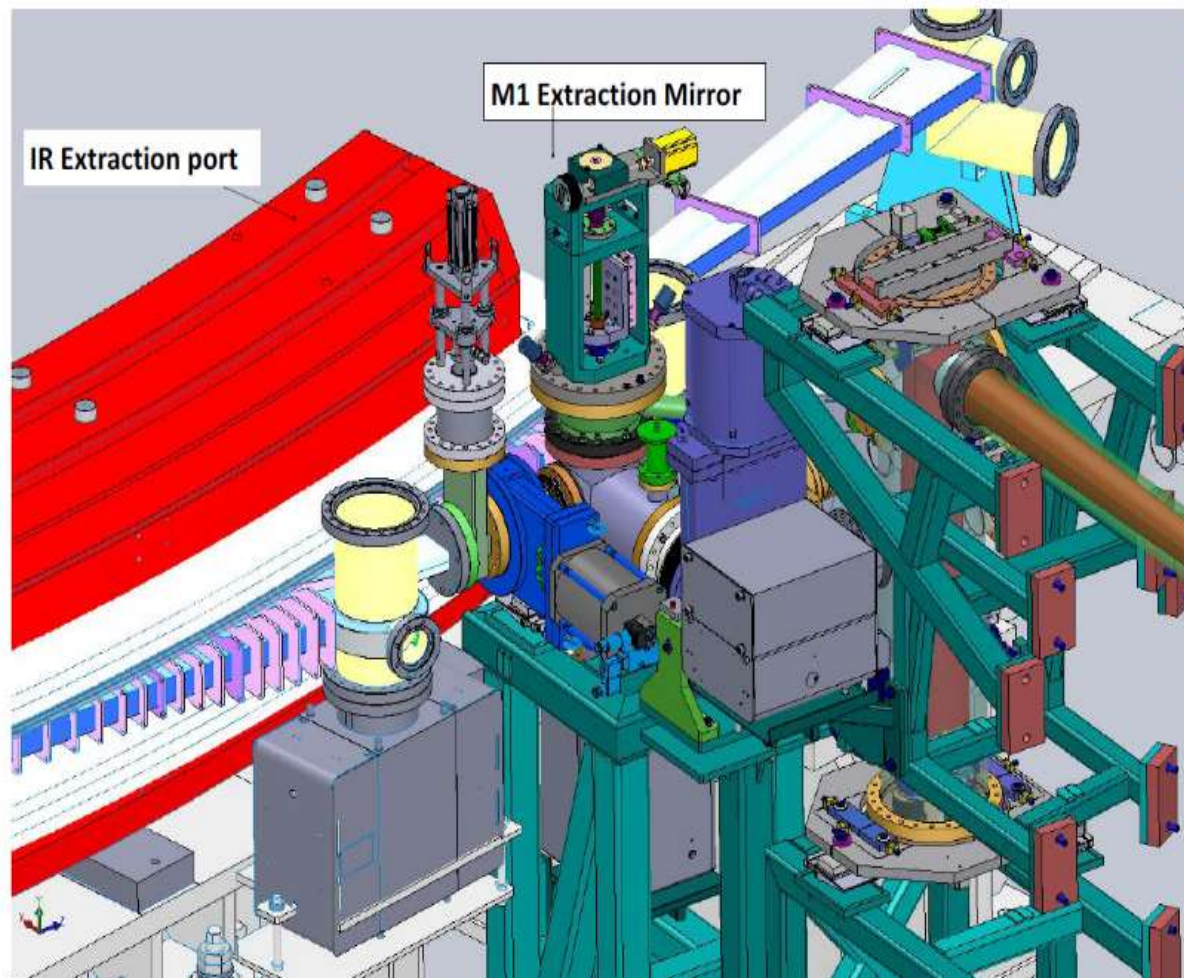


Seeds exposed to increasing Cd concentrations

Infra Red Beamline

EMIRA ElectroMagnetic Infrared Radiation

Applications include surface and materials science, biochemistry, microanalysis, archaeology, geology, cell biology, biomedical diagnostics, environmental science, etc



Science began in 2014 with an Infra-Red Microscope using a thermal source, to be replaced by synchrotron-radiation in 2017

**17 proposals
approved**

e.g. **Study of breast cancer**
(now published) by **Fatemeh Elmi**, Assistant Professor,
University of Mazandaran,
North Iran, shown here with
Randa Mansour, PhD
student in the Faculty of
Pharmacy, University of who
used the FTIR microscope to
study the effect of a
medicinal oil



Further medical work expected to include study of a
hepatitis C genotype that is prevalent in the Middle East

Training Programme (thanks to external support listed later)

Users' Meetings, Schools, Workshops, Fellowships, visits to operating light-sources,... are building technical and scientific capacity in the region

1st Users' Meeting Amman 2002



SESAME-JSPS School Cairo 2008

10th Users' Meeting Amman 2012

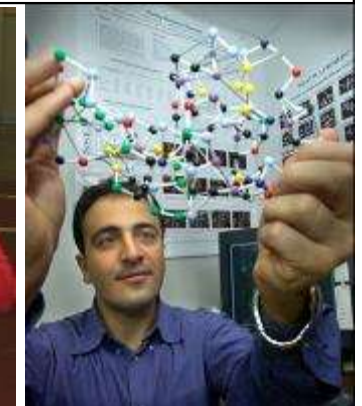


Began training accelerator experts who returned to the Middle East



Members of SESAME Accelerator Group, 2007

Now Training Scientists
Left @ Advanced Light Source
Users' Meeting, Right @ NSLS



Support from: SESAME Members

- **Provide operating budget** – manpower, consumables, electricity...
- **Capital funding** – special contributions from Israel, Jordan, Turkey – hoping others will join
- **Jordan** – provided land and building + cash from Royal Court, Jordan Scientific Research Support Fund

External:

- **Advice** – from members of Advisory Committees; visits
- **Equipment** – many donations of equipment surplus to requirements
- **Training** – support from Brazil, China, France, Germany, Italy, Japan, Portugal, Spain, Sweden, Switzerland, UK, USA, EU, IAEA, UNESCO

Plus

- **Cash** – from the European Union, Italy,



SESAME benefits from the advice of leading scientists from around the world who serve on the Scientific & Beamlines Advisory Committee (seen here in November 2010) and the Technical Advisory Committee

1- SESAME (Jordan) 2- CLS (Canada) 3- Stanford Univ. (USA) 4- ALBA (Spain) 5- Soleil (France) 6- Sabanci Univ. (Turkey) 7- Elettra (Italy) 8- ALS (USA) 9- Soleil (France) 10- SESAME (Jordan) 11- Oxford Univ. (UK) 12- CERN (Switzerland) 13- Al-Quds Univ. (Palestinian Authority) 14- LBNL (USA) 15- PSI (Switzerland) 16- Hacettepe Univ. (Turkey)



Nobel Laureates visit SESAME site in June 2008

**45 Laureates have endorsed SESAME “as a beacon,
*demonstrating how shared scientific initiatives can help light
the way towards peace*”**

Powering SESAME

- When fully operational (5000 h/year) SESAME will use 10 GWh/year. SESAME is paying \$375/MWh.
- Solar Power Plant is vital for sustainability of the project. The conditions near Amman are good.
- Agreement to provide power for SESAME from SPP reached with grid and site made available by JAEC.
- Government of Jordan has agreed to provide funding, using EU funds for carbon emissions reduction in neighborhood countries

SESAME will be the world's first accelerator powered entirely by renewable energy

OUTLOOK & CONCLUSIONS

- **There are on-going challenges** - solving problems involving travel restrictions, sanctions on Iran, political uncertainties,.....
 - **funding** full suite of Phase 1 beamlines, supporting infrastructure (laboratories, workshops, conference centre, ...), payment of annual contributions
 - **attracting new Members**. Hope that successful operation of SESAME will reinforce support from the Members and help attract new Members

But **SESAME** is a working example of Arab-Israeli-Iranian-Turkish-Cypriot-Pakistani collaboration

- Senior scientists and administrators **from the region** are working together to govern SESAME through the Council, with input from scientists **from around the world** through its Advisory Committees
- Young and senior scientists **from the region** are collaborating in preparing the scientific programme (Users' Meetings, Workshops) and will soon be collaborating in experiments at SESAME, some focussed on local issues
55 proposals received in January-March to use 1st two beamlines

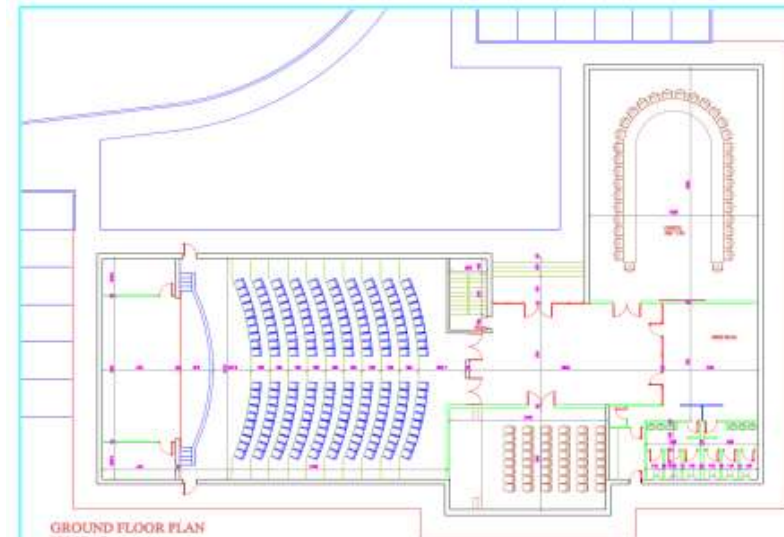
Beyond SESAME?

SESAME is about to build a guest house (funded by Italy) which will be available in 2018 (already have small temporary guest house):



This will be followed by a Conference Centre:

When SESAME is not in operation, SESAME will be able to house meetings on other topics (food, water, archaeology, ...) in secure/easily accessible surroundings



Dream:

this will lead to other joint facilities & collaborations

The construction of SESAME has been a victory of



and hope over scepticism and realism

Last word from the users of SESAME, interviewed by David Shukman of the BBC in 2012

<http://www.bbc.co.uk/news/science-environment-20447422>

For further information see www.sesame.org.jo and CERN Courier July 2015