Report of the 1st Workshop on Materials Science Research with SESAME

Hacettepe University,
Ankara, Turkey,

September 21-22, 2000

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Report on the 1st meeting of the Workshop on Materials Research with SESAME

SESAME Scientific Committee
Hacettepe University, Ankara, Turkey, September 21-22, 2000

The Ankara workshop was the second such workshop to focus on a particular area of research at SESAME. It was organized to develop the plans for materials research in the region using SESAME and to begin the detailed planning of materials science beamlines, user-support facilities and staff, and the associated scientific program at SESAME. The first such workshop was held at the University of Athens on April 6-7, 2000 on Structural Molecular Biology. The report of the Athens workshop is posted on the SESAME web site [www.sesame.org.jo]. This report will also be posted.

Twenty-five scientists from 8 SESAME member countries (Armenia, Egypt, Greece, Iran, Israel, Jordan, Oman and Turkey) met at Hacettepe University in Ankara Turkey on September 21-22, 2000. Financial support for the workshop was provided by Hacettepe University and UNESCO, the umbrella organization for the SESAME (Synchrotron-light for Experimental Science and Applications in the Middle East) Project. Participants from Middle East countries provided their own airfare. The workshop was organized by the SESAME Scientific Committee [cochairs Ercan Alp (APS/Argonne) and Herman Winick (SSRL/SLAC)] and was cochaired by Ercan Alp and Engin Ozdas (Hacettepe University).

1. EXECUTIVE SUMMARY

After a warm welcome by Hacettepe University President Tuncalp Ozgen, and a report by H. Winick on the status of the SESAME Project and the performance of the ring as a light source with a spectral range from IR to hard x-rays, participants form each of the SESAME member countries presented materials, which addressed the first objective. The result is that, integrated over all SESAME member countries, it is anticipated that several hundred materials scientists will use the facility a few years after it starts operation, presently projected for 2003.

The workshop benefited greatly from the participation by experienced synchrotron radiation scientists from outside the Middle East region who gave tutorial talks on the various aspects of materials research. These included; Ronald Frahm (Duesseldorf) on XAFS, Giorgio Margaritondo (EPFL-Lausanne) on Photoemission Spectroscopy, Franz-Joseph Pantenburg (Karlsruhe) on LIGA and Peter Stephens (SUNY Stony Brook) on Powder Diffraction. Contributions to the discussions and working groups were also made by Ercan Alp, Bob Batterman, and Herman Winick, as well as the many participants from SESAME member countries. The Ankara workshop was focused on four specific synchrotron radiation techniques pertinent to Materials Science applications; ***i.*** x-ray powder diffraction (XPD), ***ii.*** x-ray absorption spectroscopy (XAFS), ***iii.*** Photoemission spectroscopy (PE), and ***iv.*** micro manufacturing methods (LIGA). The participants emphasized the need for standard materials preparation and characterization support laboratories, in addition to specialized clean rooms and a processing laboratory for LIGA.

An important outcome of this workshop was a discussion on source requirements for LIGA and other techniques, and beamline sharing. It was agreed that 3 branch lines could be built on a wiggler line. The two side stations could be used for XAFS, XPD, and LIGA. The center branch could be used for microfocusing, as well as for protein crystallography, using focusing optics to exploit the small source size (one standard deviation horizontal/vertical of 440/30 microns) at these wiggler locations. Franz-Joseph Pantenburg pointed out that LIGA requires intensity uniformity at the sample of ± 4% over 100 mm. Subsequent ray tracing by Tom Rabedeau of SSRL showed that side stations on either of the two 13 pole, 7.5 T SESAME superconducting wigglers can easily provide such uniformity and very high intensity at x-ray energies up to around 10-15 KeV in an unfocused beam (details in Appendix E).

Since microfocusing was not part of this workshop, details of the XPD and XAFS were discussed. It was concluded that a white beam collimating mirror, followed by a double crystal monochromator (with the second crystal used as a sagittal bender for horizontal focusing) and finally a vertical focusing mirror, represents a state-of-the-art beamline. For x-ray absorption, a QUICK-EXAFS type fast-scanning monochromator design was considered advantageous. There was a detailed discussion on standard and state-of-the-art high resolution alternatives for photoemission spectroscopy. Total cost estimates range from 7.5 to 9.2 M US $, including the support facilities.

Finally, the needs of a functioning LIGA facility were discussed along with the level of support facilities. It was clear that a minimum level of support is necessary to characterize the samples and handle them for the experiments. The LIGA effort would need substantial support facility. The expected total cost of these support facilities is around 1.8 million US dollars.

It is anticipated that the SESAME Scientific Committee will conduct additional workshops in 2001, with sponsorship by UNESCO. A follow-up workshop on Materials Research, primarily to cover microscopy and imaging with applications in soil, geological, and environmental sciences. The techniques will include x-ray fluorescence, small angle scattering, and if necessary, a review of XAFS and white beam powder diffraction. Archeological applications can be incorporated into this workshop. The location and time of this workshop are not yet determined.

2. DESCRIPTION of MATERIALS SCIENCE ACTIVITIES in the REGION

2.1 Armenia:

Materials Science Activity Using Synchrotron Radiation in Republic of Armenia
(X-ray Diffraction, X-ray Imaging, EXAFS, Luminescence)
by Grant Yeritsyan (Yerevan Physics Institute)
and Arshak Grigoryan (Yerevan State University)

The short summary of the experimental results obtained at the synchrotron radiation beamlines of Yerevan 6 GeV accelerator is given. The activity of the main research groups from Yerevan Physics Institute and Yerevan State University that can be a certain interest for SESAME program in materials science is presented.

After the running of the 6 GeV Electron Synchrotron ARUS in Yerevan Physics Institute in 1967, the activity on the use of Synchrotron Radiation (SR) in materials science get new impulse that led to construction and use of three SR beamlines. Since 1974 the intensive experimental research study have been conducted on these beamlines in various area of material science. An important consequence of these study was the formation of the different research user groups in Yerevan Physics Institute in close collaboration with Yerevan State University. This report is the short summary of the works done by the different research groups using the SR of the ARUS synchrotron.

2.1.1. User Groups from Yerevan Physics Institute

Solid State Radiation Physics Lab. (Hrant Yeritsyan): The effect of impurity and structural defects on the optical, physical properties of GaP Y-garnet (YAG) and corundum single crystals has been studied using synchrotron radiation (SR) in wide spectral range. Reflectivity, luminescence, absorption, EXAFS spectra were measured taking into account also the polarization of SR beam. The luminescence spectra of corundum (a-Al2O3) and Y-garnet single crystals with different defect structure have been investigated at temperatures 90K and 300K. The kinetics of luminescence decay showed two time-resolved components in the luminescence spectrum: "fast" and "slow" which have different characters. An EXAFS measurements of GaAsP epitaxy grown substrates were carried out at the SR spectral interval from 10 KeV to 14keV including Ga and As K-edges. It is suggested to carry out experiments to elucidate the possibility of subthreshold structural defect formation in solids via electronic subsystem excitation mechanism or "radiation shaking" of the crystal lattice.

On the reflection spectra of irradiated GaP single crystals new two bands at 140 eV and 146 eV were observed, which were attributed to AsM 2,3 core transition. The physical nature of these bands and low concentration impurity control are essential for A3B5 semiconductor devices. The AC magnetic and electro physical properties of doped and irradiated Y-and Bi -based High T_c superconductors were investigated; both increasing and decreasing behavior of transition temperature T_c was obtained. It is of great interest to establish relation of these changes with the structural ones, particularly in the case of orientation dependent thin layers taking into account the SR polarization.

Laboratory of Radiation Biophysics and Biosensors (Valery Arakelian): In the Laboratory of Radiation Biophysics and Biosensors at the Yerevan Physics Institute in Armenia, there is much experience in SR implementation for structural and radiobiological investigations of biological objects using the 4 GeV synchrotron ARUS since 1974. Investigations of different biological objects such as enzymes, amino acids with the use of EXAFS, EPR, and X-Ray structural analysis methods, have been conducted. The atomic short-range order of Copper-Albumin protein complexes in the freeze-dried form has been investigated by EPR and EXAFS spectroscopy using SR. The superhyperfine structure of EPR spectra of these complexes testifies to the fact that the copper atom is surrounded by four ligand atoms of nitrogen.

2.1.2. User Groups from Yerevan State University

Department of Solid State Physic: *Group leader K. Trouni:* Theoretical and experimental investigations on dynamic focusing to create X-ray lenses have been carried out. At present, these studies are in process in collaboration with the Institute of Physical Science (IPS), University of Ancona, Italy, European Synchrotron Radiation Facilities (ISRF), Grenoble, France, within the frames of the project Intas 99-0469 on the following topic “Advanced X-ray techniques for materials study based on the new generation of focusing devices”. *Group leader A. Grigoryan:* Universal goniometric system on SR have been developed for the investigation of materials through the high resolution diffractometry method. The following studies are realized on these diffractometer: High precision and express methods have been developed based on X-ray diffraction diagnosis of imperfection in massive monocrystals and crystal plates (white beam topography). Piezoceramic resonance systems have been studied by the method of energy-dispersion diffractometry (EDD). The peculiarities of parameters of formed beam in consistent diffraction in crossed geometry were studied**.** *Group leader E.Abovyan:* New method of investigation of powder materials on white spectrum of SR is developed. Express method of investigation of the structure of textured materials with the use of white spectrum SR was developed. Highly precision determination of the parameters of misorientation of bulk crystals was developed. Structural investigation of magnetic multicomponent solid solutions was performed. Roentgenography of micro structural peculiarities of high temperature heating elements, powder fast cutting steel, thin layers and alloying metallic coats, termobimetals, concrete, minerals and other composite materials. Within the frames of international grant CRDF (Civilian Research and Development Foundation, USA), project award #AE1-103 the following investigation on the topic “X-ray Diffraction Investigation of the Microstructure of the Transition Zone in Concrete” was performed in collaboration with the University of California, Berkeley**.** *Group leader K. Avetyan:* A monitoring system of structural defects of X-ray topographical images is developed. The system is constructed to work with SR and with mean power laboratory x-ray producer. The system applies for a grade control and for a fabrication grown crystals calibration and for study of the structural defects. A screen-converter of X-ray images to optical ones with high space resolution (100 pair pin/mm) and high degree effective transformation of X-rays is developed. This system may be applied for SR.

Department of General Physics: *Group leader M. Navasardyan:* For the first time, the phenomenon of the "Controllable complete reflection" of x-rays has been observed. The double-modulations of x-rays, as well as the transmission and reception of audio information by the use of x-ray beams have been realized. The modulation of x-rays and synchrotron radiation beams has been conducted by the single crystals. The investigations based on the organic single crystals are currently under proceeding with simultaneously improvement of the running device for modulation and reception of the signals**.** *Group leader R. Gabrielyan:* The investigations were carried out to study the phenomena concerning the problems of X-ray multi-beam scattering by the single crystals (Borrman’s effect in the multi-beam case, Renninger’s double diffraction effects, Umeno’s effect etc.), as well as to study the influence of the external factors on these phenomena. Based on the X-ray multi-beam scattering phenomena the various monochromators, interferometers, resonators and other X-ray optical devices were developed in the laboratory. The nearest plan of the group is the application of the X-ray multi-beam scattering in the field of diagnostics of the crystal lattice structure as a high sensitive and informative tool. To provide the high efficiency of the investigations, the application of the coplanar multi-beam scattering geometry based on the synchrotron radiation is under consideration.

2.2. Egypt - *Adel El-Nadi*

Material research is very wide-spread in Egyptian universities, research centers and Industrial sites. Faculties of Engineering (mainly Material and chemical Engineering Depts), Science (mainly Physics, Chemistry, Geology and Biophysics Depts), Pharmacy and Agriculture, among others, have many active groups with interest in x-ray studies. There are more than 32 powder diffractometers available with the main thrust being in material characterization. A CAD-4 diffractometer has been recently acquired at the National Research Center. Besides, Egypt has active crystallography groups at the National Research Center and in many Universities such as Cairo , Ein Shams, Helwan, Tanta and Suez Canal Universities.

The presence of a nearby (within driving distance) synchrotron laboratory can influence and enhance present activities in such a way as to allow more scientific contributions .

2.3. Greece – *Alexos Lappas*

Materials Science research activities in Greece are based in various universities and National Research Centers;

2.3.1. Research Programmes at Institute of Materials Science, National Center for Scientific Research "DEMOKRITOS", *Director: K. Prassides, Deputy Director: K. Papastaikoudis*

<u>Nanostructured Materials:</u> Dr. A. Dimoulas, Dr. E. Moshopoulou, Dr. D. Niarchos, Dr. G. Papavassiliou, Dr. M. Pissas, Dr. K. Prassides: The main research projects of Nanostructured Materials Group are bulk permanent magnetic materials; thin films, multilayers and nanoparticles; collosal magneto resistance (CMR) oxides; high-Tc superconductors (single crystals and powders) and oxide physics and chemistry; carbon based materials (fullerenes and nanotubes); protonic glasses; incommensurate structures.

<u>Ceramic Composite Materials:</u> Dr. P. Aloupogiannis, Dr. G. Kordas, Dr. C. Trapalis, Dr. A. Travlos, Dr. G. Vekinis with research interests covering quasi-two-dimensional metallic systems, quasicrystals, high strength alloys, sol-gel processing, ceramic matrix composites, self propagating high-temperature synthesis.

<u>Archeometry:</u> Dr. Y. Bassiakos, Dr. V. Kilikoglu, Dr. Y. Maniatis, Dr. C. Michael. The main research projects of Archeometry Group are dating, ancient technologies and characterization and

<u>Bio-inorganic Catalytic Materials:</u> Dr. D. Petridis, Dr. V. Petrouleas, Dr. V. Psychairs, Dr. A. Terzis. The main research projects are molecular magnets, organic-inorganic hybrid systems, radiopharmaceutical complexes, photosystem II, nano-and mesopous materials.

<u>Computational Physics:</u> Dr. S. Thanos, Dr. A. Theofillou, Dr. K. Trohidou. Computational Physics Group is studying electronic structure and magnetic and transport properties of nanostructured and disordered materials and thermodynamic behavior of magnetic systems.

<u>Technological Applications & Services:</u> Plasma and surface cleaning and radiography sections are composed under this division.

Experimental facilities at "DEMOKRITOS": The research groups of "DEMOKRITOS" have their own facilities including, SEM, HRTEM, MFM, NMR / NQR spectroscopy, Mossbauer spectroscopy, EPR, FT-EPR, ENDOR, molecular beam epitaxy (MBE), FT-IR, resistivity, dc/ac susceptibility, (magneto) resistivity, SQUID susceptometry, mechanical properties measurements, radio carbon dating, thermoluminescene, single crystal and powder x-ray diffractometer and also they are current users of DESY, Elletra, Daresbury and ESRF.

2.3.2. Institute of Electronic Structure and Laser, Foundation for Research and Technology (FO.R.T.H.), *Director: Dr. K Fotakis*

Materials Science Group, Solid State Chemistry Laboratory: Dr. Alexandros Lappas, Grigoris Beis and Eirini Mastoraki, Magnetism of low-dimensional quantum spin systems and new solid inorganic-organic nanocomposite materials are the currently research projects. The sample preparation facilities; inert atmosphere glove box, high vacuum system, various kinds of furnaces and materials characterization facilities; 12 kW powder-thin film diffractometer and DSC are available. The group is also current user of Daresbury, ISIS, RAL and Paul Scherrer Institute. *Possible opportunities at SESAME:* Precise structural characterization at a high brilliance, high-energy, stable and focused source. To study the electron density in new materials wit pressure, extending the research capacity to include amorphous systems, defect and particle size effects.

Materials Science Group, Superconducting and Magnetic Materials Laboratory: Dr. John Giapintzakis, Yiannis Androulakis, Zacharias Viskadourakis, Vasilis Alexandrakis. Synthesis, structural-chemical characterization and investigation of electrical, magnetic and thermal properties of thermoelectric, magnetic and superconducting materials are the main research interests. 1.4 to 400K cryostat with 7 T superconducting magnet for electrical transport, ac susceptibility and dc-extraction measurements; SQUID magnetometer with 2 to 400 K cryostat and 5 T superconducting magnet for dc magnetization and helium liquefier are the available experimental facilities.

Materials Science group, Photonic and Electronic Materials: Dr. George Kiriakidis, Dr. Nikos Katsarakis, Dr. Marcus Bender. Modeling, fabrication and characterization of photonic band-gap crystals is the research interests and dc magnetron sputtering and FT-IR spectrometer are the available facilities.

2.3.3. Department of Physics, University of IOANNINA

Dr. Vasillis Papaefthymiou, Dr. Thomas Bakas, Dr. Aliki Moukarika, Dr. Michalis A. Karakassides, Dr. Dimitris Gournis: Synthesis, structural characterization and study of properties of composite materials, molecular models, glasses, magnetic materials, magnetic oxides, mesoporous materials, clays, pillared clays and nanophase materials are the main research interests. Three variable temperature Mossbauer spectrometers (20 – 600 K), X-ray powder diffraction, vibrating sample magnetometer, FT-IR, UV-Vis and SEM systems are experimental facilities.

2.3.4. Department of Physics and Physics Division of Tech., Aristotle University

Dr. G. A. Kourouklis, Dr. S. Ves, Dr. D. Christifilos, Dr. S. Assimopoulos, Y. Arvanitidis, K Papagellis, I Tsilika: Study of fullerenes C60, C70, C84, pressure and temperature induced phase transitions and chemical modifications; fullerene molecular complexes, charge transfer; intercalated fullerenes; fullerene hydrides, semiconductors, laser host crystals are the main research interests. The group is equipped to carry out experimental studies on optical spectroscopy (emission, absorption Raman), optical spectroscopy under high hydrostatic pressure (0-100 GPa range), and optical spectroscopy under variable temperature within 10 – 370 K range. *Materials Analysis and Synthesis Group:* Dr. Th. Karakostas, Dr. J. G. Antonopoulos, Dr. Ph. Komninou, Dr. E. Paloura, Dr. Th. Kehagias, Dr. G. P. Dimitrakopulos, Dr. V. Papaioannou, Dr. M. Katsikini, P. Kavouras, Ch. Tzivanakis, J. Kioseoglou, I. Sarigiannidou, L. Tsiakiris, G. Kaimakamis: Compound epitaxial semicon-ductors, with emphasis on GaN, metals and alloys – interfacial structure and material properties (physical, mechanical), multilayered and magnetic materials – structural characterization, interfacial crystallography and interfacial connectivity, nanocrystalline and amorphous materials – synthesis by powder methods, characterization of structure and properties, solid waste management – neutralization by vitrification, processing of low cost materials for microelectronics, synchrotron based materials characterization, plasma passivation of defects are the currently held research projects. Transmission electron microscope JEM2000 FX and JEM120 CX, scanning electron microscope JSM840 equipped with an EDS micro analysis system, Tapometrix AFM, ion beam milling, electrochemical polishing dimler systems are available for experimental studies.

2.3.4. Physics Laboratory, Electrical Eng. Department of Democritus University

Dr. Panagiotis Kotsanidis, Dr. Chiristina Routsi, Dr. Ioulia Semitelou: Crystal and magnetic structures of binary and ternary compounds with rare earth transition metals are the current research activities. The group is equipped to carry out experimental studies such as x-ray diffraction, SQUID magnetometry (laboratory equipped with helium liquefier) and synthesis is carried out by arc – melting methods.

2.4. Iran – *Azam Irajizad (revised 1,1,2001)*

In this report, some of the research centers and universities that considered as potential users of the SESAME in the field of materials science are introduced. Most of the information is obtained from the database that is supplied by interested people and from their institution web sites and brochure.

2.4.1. Research Centers

Research Center for Radiation Processing (RPC) at Yazd: This facility is a rhodotron type electron accelerator with two beamlines working with energy of 5 to 10 MeV at 10 mA of beam current. Polymer modification, sterilization, food preservation is the main research applications and having collaboration with Physics Department of Yazd University.

Nuclear Research Center for Agriculture & Medicine (NRC) at Tehran: Director: Dr. A. S. Hosseni. A cyclon 30 type 30 MeV accelerator with 4 beamlines. Beam current is composed of 500μA proton and 150μA deuteron. Radiopharmaceutical production of TI201, Ga67, In111, Kr81m, FDG sre the main applications and research, development and training programs are held as well.

Material and Energy Research Center (MERC) at Tehran: Departments: Ceramics, Semiconductors and Energy. Equipment: STA, DTA, TG, XRD, XRF, TEM, EPMA, AFM, SEM, PSA, SAA, MP, Hall Effect, GC, IR, LS, UV-VIS spectrophotometers, HPLC. Activities: Research, development and training. Contact: MERC88@DCI.iran.com

Research Institute of Petroleum Industry (RIPI) at Tehran: *Exploration and Production:* Geochemistry Research Department, geophysics, reservoir fluids, modeling and numerical simulation, core analysis. *Petroleum Refining:* Catalyst Research Department, chemical analyses, physical, microactivity evaluation section, quality control, Lubrication Research Department, gaseous hydrocarbons, analytical group, Chemical- Physical and Standard Analytical Instrumental Analysis Department. *Chemical and Petrochemistry, Polymers Science and Technology:* Polymer Chemistry Research Department, polymer analysis, polymer technology and polymeric material. *Industrial and Environmental Protection:* Corrosion and Material Research Department, air pollution, fuel and combustion, microbiology water and wastewater. *Engineering Development of Chemical Processes, Research Services, Planning and Production, Gas.*

Iran Polymer Institute: Info:http://www.iranpolymerinstitute.org. Rubber, plastic, composite and paint, adhesive and resin, polymer science, special polymers and biomaterials.

Iranian Research Organization for Scientific and Technical (IROST): Info: http://www.mche.or.ir. *Activities:* Research and development, human resource science and technology, transfer of technology. *Institutes:* Chemical Engineering, Chemistry, Material and Metallurgy Engineering and Biotechnology.

2.4.2. Universities

University of Tehran (UT): Info: http://www.ut.ac.ir. Physics department: Crystallography, Dr. E. Arzi. Electrical and Computer Engineering Department: Thin film research laboratory, semiconductor devices, Dr. Solymani. Biochemistry and Biophysics Research Center: Dr.Goliaei, goliaei@ibe.ut.ac.ir . Material Science Engineering Department: Surface engineering.

Iranian University of Science &Technology (IUST): Info: http://www.iust.ac.ir. Department of Physics: Material Science and Metallurgical Engineering: SEM Laboratory, Material Research Laboratory: Electronic Research Center: Semiconductors Laboratory, Dr. S. A. Mohaes Kassai, http://erc.iust.ac.ir. Chemical Engineering department: X-ray Laboratory, Analysis & Materials Identification and Catalysis Laboratory.

Ferdosi University of Mashhad: Info: http://www.um.ac.ir. Physics Department: X-ray diffraction, Dr. Tajabor, n-tajabor@science1.um.ac.ir, Thin films, Dr. Keshmiri. Geology: Crystallography, Dr. Razmara , Razmara@science2.um.ac.ir.

Tabriz University (TU): Info: www.tabrizu.ac.ir. Applied physics institute: Solar cell, semiconductors, optical properties, Dr. Kalafi, Dr. Tajaali, Dr. Salehi

Sharif University of Technology (SUT): Info: http://www.sharif.ac.ir. Physics department: Surface and thin films, Photoelectron spectroscopy (XPS & AES), film deposition, characterization & physical properties, High T_c superconductors and magnetism, Dr. A. Iraji zad, iraji@sina.sharif.ac.ir, Dr. Moshfegh, moshfegh@sina.sharif.ac.ir, Dr. M. Vesaghi vesaghi@sina.sharif.ac.ir, Dr. M. Akavan, akavan@sina.sharif.ac.ir, Materials Science and Engineering Department: Materials Research Laboratory, STEM Laboratory, Dr. Nategh, nategh@sina.sharif.ac.ir. Chemistry department: Surface chemistry and polymer, Dr. Gobal, gobal@sina.sharif.ac.ir, Dr. Pourjavadi, pourjavadi@sina.sharif.ac.ir.

2.4.3. Potential SESAME users in Iran

At the present more than 1.3 million students attend government and private universities and colleges. The number of teaching faculties in the universities and research centers are about 40000. By considering related subjects to SESAME project activities, we approximate the number of interested researcher are 200. In addition out of 11500 graduate student (MSc and PhD) in the related fields, about 500 can become potential user of SESAME.

2.5. Israel - ***Dan Shechtman (revised 4,1,2001)***

Israel has seven research universities. These are: Technion (Haifa), The Hebrew University (Jerusalem), the Weizmann institute of Science (Rehovot), Tel-Aviv University, Bar-Ilan University (Ramat-Gan), The Haifa University and Ben-Gurion University in the Negev (Be'er-Sheva). In all but the Haifa University there are groups that study materials and use x-rays for diffraction, EXAFS and more. In addition, there are many research groups in the private sector and in government laboratories. Materials research is conducted in departments of Physics, Solid State Physics, Chemistry, Materials Science and Engineering, Electrical Engineering and Chemical Engineering. X-ray equipment available to these groups varies from modest to elaborate and modern. A good number of rotating anode sources function in several universities. These groups are potential users for SESAME.

Israel is a member of the ESRF in Grenoble and several studies are being conducted there. In edition, Israeli scientists, usually in a collaborative mode with local researchers, are using other Synchrotrons around the world.

Following is a partial list of current Synchrotron users in fields related to materials. In particular, the rather large community of Structural Biology synchrotron users is not included.

Emil Zolotoyabko, Materials Engineering, Technion. (Time resolved x-ray diffraction. topography and imaging).
Dov Sherman, Materials Engineering, Technion (Microstructure of Materials)
Yachin Cohen, Chemical Engineering, Technion (Interfaces, Polymers with other materials)
David Cahen, Weizmann (Semiconductor surfaces and thin films)
Mair Lahav, and L. Laiserowitz (Weizmann) (Langmuir films)
Jacob Sagiv, Weizmann (Self-assembly of multilayers)
Moshe Deutsch, Bar-Ilan U. (Liquid metals, Spectroscopy, Perfect crystals, X-ray optics, Tomography).
Aaron Lewis, Applied Physics, The Hebrew U.
Yizhak Yacoby, Physics, the Hebrew U (Develops techniques for studying thin films and overlayers on substrates, EXAFS)
M. Paz-Pasternak, Tel-Aviv U. (Phase transitions).
Aharon Gedanken, Chemistry, Bar-Ilan U. (UV, EXAFS, Diffraction of nanoparticles)
Israel Goldberg, Chemistry, Tel Aviv U. (Crystallography)
Yoram Shapira, Electrical Engineering, Tel Aviv U. (Semiconductors, Surfaces, Thin films)
Chava Lifshitz, Physical Chemistry, Hebrew U., (VUV photoionization, Clusters)
Reuven Shuker, Physics, Ben Gurion U. (Spectroscopy, synchrotron radiation, Free electron lasers)
Dan Davidov, Physics, Hebrew U. (Thin films, Liquid crystals, Conjugated polymers, HTSC)
Aaron Lewis, Applied Physics, Hebrew U. (Nanochemistry and nanophysics, non-linear optics, photoreception)
Ellen Wachtel, Chemical Services, Weizmann (Crystallography, Diffraction)

The web page addresses of the Israeli universities:
http://www.technion.ac.il, http://www.weizmann.ac.il, http://www.bgu.ac.il, http://www.huji.ac.il, http://www.biu.ac.il, http://www.tau.ac.il

The number of potential Israeli users of Synchrotron radiation is large. Today, there is practically no limitation on time using sources in Europe and the US. Some of these studies and many new ones may be diverted to SESAME if it works properly, hosts potent resident professionals and is user friendly.

2.6. Jordan – *Abdul Raouf El Ali*

This report includes the available information on the web pages of Jordan universities.

Department of Chemistry, Mu'tah University: Dr. Hassan Al-Salah, Dr. Samir Al-Taweel, Dr. Mohamad Qtaitat, Dr. Helmi Hussain, Dr. Abdullah El-Alali , Dr. Ali Mahsneh, Dr. Hamazh Omari, Dr. Arab El-Qisairi, Dr. Hanan El-Qisairi, Dr. Muhammad Ashram. *Research Topics:* The Department is equipped with instruments like: FT-NMR, FT-IR, UV, HPLC, GLC, Atom's Absorption, Thermal Analyzer, and more, which are available for both undergraduate and graduate use. The Department is also assisted by a laboratory, which is used for instruction and research. *Facilities:* Current research interests include: polymer, analytical, organic, inorganic, and physical chemistry. Research areas also include environmental studies on soil, air pollution, and water sources.

Department of Physics, Mu'tah University: Dr. Marwan Suleiman Mousa, Dr. Mohamad Zaal Abadi, Dr. Ismaeel Ahmad Garaibeh, Dr. Mahdi Salem Lataifeh, Dr. Ali Mohamed Qudah, Dr. Abdellatif Mahmoud Al-Sharif, Dr. Mansour Al-Haj. *Research Topics:* The Department of Physics has an ongoing research in both theoretical and experimental physics. On the theoretical side, research includes Mathematical Physics and Astrophysics. Research activities in experimental physics include the study of polymers, superconductors, molecular spectroscopy and electrical and optical properties of thin films, surface physics, and magnetism. *Facilities:* Laboratories have been established to accommodate the experimental interests of the Department with additional research laboratories to be established in the near future. In the research laboratories we have the flowing instruments: Scanning electron microscope, Transmission electron microscope, Differential scanning calorimeter, U.V. spectrophotometer, FT/IR Spectrophotometer, Vibrating sample magnetometer, Thermal evaporator, Mossbauer, Surface Science Lab, Nuclear Lab, RF Sputtering.

Department of Chemistry, University of Jordan: Dr. Musa Nazer, Synthesis of Organic Compounds, Stereochemistry, Chemical Education. Dr. Mustafa El-Abadelah, Synthesis of Heterocyclic Compounds. Dr. Marwan Kamal, Chemistry of polymers, Syntheses of heterocyclic Compounds. Dr. Salim Sabri, Synthesis and Spectroscopic studies of Heterocyclic Compounds and Natural Products. Dr. Kamal Abu-Dari, Metal poisoning, Coordination Compounds of Transition Metals. X-Ray Crystallography, Coordination Compounds. Dr. Hamadallah Hodali, Organometallic and Coordination Compounds. Dr. Afif Seyam, Synthesis and characterization of organometallics, Complexes, Catalysis, Mechanisms and Spectroscopy. Dr. Muhammad Zughul, Mechanisms Underlying Stability of Molecular Complexes of Compounds of Pharmuceutical Interest, Photochemistry and Reaction Dynamics, Photochemical Stability of Bioactive Compounds. Dr. Leila Hanaineh - Abdelnour, Heterocyclic Synthetic, Analysis of Organic Compounds in Biological Material. Dr. Bassam Sweileh, Polymer Chemistry.

Department of Physics, University of Jordan: Dr. Isa Khubeis, Rutherford Backscattering, Channeling, High Temperature Super-Conductor thin films, Ion Implantation into Metals and Insulators. Dr. Awwad Zihlif, Mechanical, Electrical, Optical; Structural Properties of Solids as Metals; Polymers; Single Crystals; Minerals, and Rocks. Dr. Nasr Saleh, Nuclear spectroscopy of X-Ray Accelerator-Based Solid-Particle Interactions: Particle-Induced X-Ray Emission, IM (Ion Mixing) Studies Using RBS and Electrical Resistivity Measurements. Dr. Mohammad Ahmad, Magnetic, Electrical, Thermal and Mechanical Properties of Solids. Dr. Kamal Al-Saleh, X-Ray Spectroscopy and Applications, Ion Mixing in Thin Film Layers Using Rutherford Backscattering Spectrometry and Resistance Measurements. Dr. Ma'rouf Abdallah, Molecular Spectroscopy, Nuclear Reactions, Electrical Characteristics of Semiconductor and Composite Materials. Dr. Jamil Khalifeh, Electronic and Elastic Interactions in Solids, Magnetic Structure of Transition Metal

Ovelayers, Surfaces and Interfaces. Dr. Abdul-Jawad Abu El-Haija, Electrical Optical Properties of Thin Films, Multilayers and Superlattices. Dr. Mousa Abdul-Gader Jafar, Solid State Physics involving: Electrical, Dielectric and Optical Properties, Thermally Stimulated Current (Depolarisation) and Metal-Insulator Transition in Semiconductors and insulators. Dr. Yahya Al-Ramadin, Polymer Science; Electrical Proprieties, Refractive Indices. Dr. Tayel Abu Khajil, Liquid Metals, Liquid Transition Metals, and Alloys, Semiconductors, The Magnetism of Surfaces and Interfaces, Quantum well and Quantum Dot Semiconductors. Dr. Laila Abu-Hassan, Optical Effects of Ion Beam Irradiations of Alkali Halides, Oxides and Thin Films; Thermoluminescence, Metalic Thin Film, Optical, Electrical and Structural Characteristics of Porous Silicon.

Department of Chemistry, Jordan University of Science and Technology: Mousa AL-Smadi, Polymer chemistry, Heterocyclic chemistry, organometallic chemistry. Mohammed Walid M. Mulqi, Picolinamides, Reactions with Transition Metals, Utilization of Raw Materials Present in Jordan. Mazin Y. Shatnawi, Heterogeneous and Hamogeneous Catalysis, Inorgenic Chemistry, Environmental Aspects of Chemistry.

Department of Physics, Jordan University of Science and Technology: Dr. Akrama Rousan, Thermal Properties of Cementations Material, Thin Films, Magneto-Optics, Solar Energy. Khaled M. Abu El-Rub, Solid State, Physics of Semiconductors. Ali H. Al-Akras, Photobiology, Radiation Biology, Molecular Mechanisms in Photo medicine. Imaddin A. Al-Omari, Solid State Physics, Structural and Magnetic Properties of Materials, Mossbauer Spectroscopy, Superconductivity. Mohammad-Kahair A. Hasan (Qaseer), Solid State Physics, Magnetism and Superconductivity, Biophysics & Medical Physics, Nabil B. Malhi, In the field of Ion-Atom collision and x-Ray excitation of Inner shell. Khalaf A. Azez Klaeif, Liquid Metal, and Liquid Alloys, Metallic Glasses, Superconductors and Properties of Materials. Borhan Aldeen Aibiss, High temperature superconductivity, Irradiation effects on solids, Electromagnetic Properties of solids, Radiation Physics.

2.7. Oman – *Carlo Carboni*

There are several active groups in the College of Sciences at Sultan Qaboos University carrying out research in materials science.

Department of Physics: *The group of Dr. Khalid Bouziane* is involved in the study, fabrication and characterization of magnetic thin films and multiplayer. Metallic multiplayer (Fe/Cu, Fe/Cr, Co/Cu, Co/Cr…) displaying Gigantic Magneto Resistance as well as oxides thin films (thermochromics, ITO, LaCaMnO perovskites) are investigated. *Dr. Azouz Sellai* investigates three areas in semiconductor devices. Modeling of transport characteristics in heterojunction based devices, Surface plasmons for probing optical properties of materials and resonant tunneling devices, SPICE simulated HF and logic circuits. *The Mossbauer group* is the largest group in the physics department. Six members of staff in this group are involved in a wide range of research activities in basic as well as applied sciences. The fundamental research activity utilizes theoretical and experimental techniques to study the magnetic and electronic structure of 3d - and rare earth transition metal alloys, compounds and metalloids. The applied research includes characterization and study of soils, Omani traditional medicine, kidney and bladder stones, Oman archaeological specimens and environmental pollutants. *The liquid Crystal group* has several programs investigating ferro, ferri and antiferro electric materials. One of the areas of research is the mechanism involved in the switching of di-mesogenic molecules in the smectic phase. This research requires time resolved small-angle synchrotron radiation x-rays scattering. *The polymer group* is working on dynamics of polymers.

Department of Chemistry: The group of Dr. Musa Shongwe is interested in protein crystallography. Dr Shongwe's research group is concentrating its efforts on the preparation and characterization of derivatives of the transferring family of proteins. Detailed structural analysis of the co-ordination spheres of the metal ions is essential to understand the structure-function relationships of these life-sustaining proteins. *The group of Dr. A Pillay* is engaged in the investigation of a variety of materials containing rare-earth elements. The type of materials studied includes semi-conductors, alloys, environmental and archaeological specimens, and organometallic complexes. X-ray fluorescence is an essential tool for the characterization of these materials.

All the groups are particularly interested in performing EXAF or XAF experiments at the SESAME radiation source and express the desire to be involved in the design of this beam line. Some of the groups are also interested in X-ray fluorescence and X-ray microscopy.

2.8. Palestinian Authority – *Najeh Jisrawi (revised 6,1,2001)*

Facilities for Research: Laboratory equipment for experimental science: Most Palestinian colleges started with adequate experimental equipment for teaching, however, the infrastructure for experimental research remains modest. Equipment for physics and material science is lacking in general. Some form of network access exists in most institutions, even though attempts to build a national academic network did not succeed. This is in spite the fact that the justification for this network remains very strong given the political and geographical conditions of the Palestinian territories.

The Scientific community: A Palestinian Physical Society was created about six years ago with an initial membership of about 150 (Bachelors degree and higher) but has since gone inactive except for a bi-annual conference on physics education. The third such conference was supposed to be held in Mid-October 2000 but has since been postponed.

Government and Science Policy: Efforts are underway to outline a national policy for scientific research and create a national research council. Even though there is a ministry for higher education, this ministry does not handle issues related to research and development. It should be noted that regional expenditure for Arab countries on R&D is also quite meager (less than .015%) but the Palestinian authority has yet to have this as a legitimate expenditure item. We are unaware of any body or person that advises government on science issues. Some external resources exist for funding scientific research in Palestine. European national and international funds are the most substantial. Many researchers turn to these funds for support. External funding, however, is usually earmarked for certain areas and for most of the categories of material research very little resources are available. People doing research in the environmental sciences have been the luckiest.

Materials Research: A lot of the work done in physics and chemistry departments can easily be classified under material science. Each of the eight universities (six in the West Bank and 2 in the Gaza strip with a total student population of 60,000 and a combined faculty of less than 2000) has physics and chemistry departments. The size of a typical physics department is about 8 faculty members. Chemistry departments are usually larger and may average as many as 12 faculty members of all ranks. In our assessment and based on specialties at Birzeit's chemistry and physics departments, about half of these people (or 80 people altogether) may eventually be doing something that can be related to materials properties and characteristics.

Here is a breakdown of some of the known research in this area.

Bethlehem University: At least one faculty member does work on semiconductor properties.

Al-Najah University: This University has physics and chemistry faculty members who do work on semiconductors and also some electrochemistry of surfaces. Theoretical work including band structure calculations and molecular dynamics simulations are also done here.

Birzeit University: At least one faculty member is doing work on "hydrogen in metal films and nanoclusters " and another faculty member is doing research solar cells.

Al-Quds University: Several faculty members are working on lasers and related materials.

Gaza AlAzhar and Islamic Universities: Researchers in these two universities is concentrated on environmental issues and the applications of physical and chemical techniques in this important area.

This summary illustrates that a large percentage of the appropriate faculty members in Palestinian colleges can become interested in Materials research at the synchrotron. We know for sure that some members of the engineering faculty are doing work for which x-ray diffraction and other synchrotron analysis may be shown to be useful.

The creation of a world-class facility for x-ray and UV radiation in the region is bound to create unlimited opportunities for researchers in this field. With the advent of SESAME, Palestinian institutions can have a leap into the future of materials research by creating at least one center of excellence, which focuses on materials research. Such a center will provide unique opportunities for Palestinian universities by providing access to world-class science in the region, providing employment opportunities for young scientists and engineers in machine and accelerator science at the cutting edge of technology, and providing spin-off benefits for researchers in many other fields. Engineering and chemistry researchers stand to benefit tremendously. If the Palestinian academic institutions are to benefit from their proximity to the proposed world-class laboratory, then they ought to institute some changes to their research infrastructure and to the conditions under which researchers find themselves.

2.9. Turkey – *Servet Turan & Engin Ozdas*

This report is a brief summary of the materials research activities in Physics, Chemistry, Chemical Engineering, Ceramics Engineering, Metallurgy and Materials Science Departments of 27 universities and their research institutes in Turkey. More than 750 materials scientists publish experimental scientific articles about 1000, annually, in various field of materials science.

2.8.1. Materials science research activities in the universities

The major subjects of research interest in some universities and some research groups is listed below:

Afyon Kocatepe University: Advanced ceramics, traditional ceramics and composites
Anadolu University: Advanced ceramics, electronic ceramics, bio-ceramics, glass and glass ceramics, traditional ceramics, inorganic pigments for ceramic industry, commercial ceramic cutting tools.
Dumlupinar University: Raw materials, refractories and porous ceramics
Hacettepe University: Advanced ceramics, high T_c superconductors, ferroelectrics and piezoelectric materials, carbon clusters and negative thermal expansion ceramics.
Istanbul University: Bioceramics, electroceramics, non-ferrous metals, powder synthesis

Istanbul Technical University: Advanced Ceramics, sol-gel processing, refractories, powder metallurgy, non-ferrous metals, iron-steel casting, intermetallics, alloys, amorphous alloys, composites, coatings on thin films, wear, fatigue-creep, recycling
Kocaeli University: Thin film, alloys and PVD processing
Middle East Technical University: Advanced Ceramics, electronic ceramics, sol-gel processing, refractories, powder metallurgy, shape memory alloys, ferroelectrics and piezoelectric materials, joining, non-ferrous metals, iron-steel casting, intermetallics, alloys, amorphous alloys, composites, coatings on thin films, wear and fatigue.
Sabanci University: polymers and ceramics
Sakarya University: Electroceramics, glass ceramics, refractories, non-ferrous metals and tribology
Tübitak Marmara Research Center: Advanced ceramics and composites, electroceramics
Yıldız Technical University: Ceramics, refractories, casting, iron and steel, fatigue-creep.

Dincer Ülku and Engin Kendi, Physics Department, Hacettepe University: Crystal and molecular structures and structure property relations of Hoffmann clathrates and pyridine complexes, monomeric, dimeric, trimeric, tetrameric and polimeric metal organic complexes. Biologically active molecules, identification of archeological, mineralogical, industrial samples, kidney and urinary stones. *Annual Output*: 30 - 40 papers in refereed international journals. *Facilities:* 5kW GE-XRD-700 x-ray diffraction unit. Manual SPG-2 diffractometer for single and polycrystal measurements. Four-axis single crystal diffractometer Enraf-Nonius CAD4 (since 1992).

Engin Ozdas, AMRL, Physics Department, Hacettepe University: Synthetic metals, carbon clusters, metal intercalated fullerides, negative thermal expansion materials, high T_c superconductor thin films and bulk materials, x-ray optics, instrumentation, molecular simulations and Rietveld refinement packages and workstations. *Facilities:* 12 kW rotating anode, 4-circle high resolution powder and thin film diffractometer, Huber G670 image foil, the low and high temperature attachments; cooling head 12-300 K, heater device up to 900 °C**.** Facilities for synthetic materials synthesis: Glove box, grinders and furnaces. *Expectations From SESAME*: High resolution powder diffraction under pressure and as a function of the temperature to study phase transition at a high brilliance source.

Meral Kizilyalli, Chemistry Department, Middle East Technical University: Inorganic Chemistry, Solid State Chemistry and Inorganic Materials, Structural Inorganic Chemistry, X-Ray Crystallography, Structure of Rare Earth, Alkaline and Alkaline Earth Condense Phosphates and Borophosphates, Synthesis of Sulfides by Solid-Gas Reactions and Conducting Properties, Synthesis of Silicon Oxynitrides, Solid State Synthesis of Sodium Dichromate and Chromates, Solid-State Synthesis of Ferrites. *Facilities:* 400 MHz solid-liquid NMR, PNMR, E-12 ESR, Balzers 311 and Finnigan 3000 Mass spectrometer, Powder diffractometer.

Macit Özenbas, Materials Science Engineering, Middle East Technical University: Surfaces and Interfaces, Thin Films, Ferroelectric Thin Films, Diamond Thin Films, Superconducting Thin Films. *Facilities:* SEM, TEM, and X-Ray Diffraction Laboratory.

*Servet Turan, Ceramics Engineering Department, Anadolu University***:** Interfaces, liquid phase sintering, advanced ceramics, ceramic cutting tools, inorganic pigments, joining ceramics and ceramics to metals, composites, frits and glazes. *Facilities:* SEM, x-ray powder diffractometer, TG-DTA, TG-DSC, special furnaces.

Sefik Suzer, Chemistry Department, Bilkent University: Synchrotron X-ray Photoemission Studies of Siloxanes on Metals, Deposition and Stability of Metal Ions on Oxidized Surfaces, XPS Investigation of X-ray Induced Reduction of Metal ions, Reductive Deposition of Au^{+3} on Oxidized Surfaces, XPS Characterization of Au, Bi and Mn collected on Atom Trapping Silica for

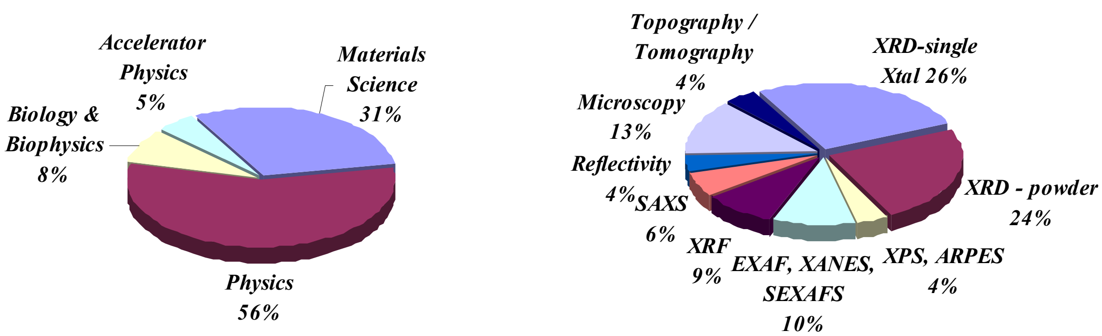
AAS. *Expectations From SESAME:* Similar studies are planned to be carried out within the SESAME context.

*Yalc□n Elerman, Physics Department, Ankara University***:** Synthesis, Crystal Structure and Magnetic Properties of organometallic, inorganic, organic complex, RT_2X_2 intermetallic alloys, giant magnetoresistive materials and molecular simulations. *Facilities:* Single crystal and powder diffractometer.

*Yüksel Ufuktepe, Physics Department, Cukurova University***:** Characterization of Situ-Fabricated or Clever Samples Using SR Photoemission and Other Spectroscopy Techniques, Electronic Photoemission Studies of Organic Salts Using Photoelectron Spectromicroscopy, Resonant Photoelectron Study of Thulium Monochalcogenides around the Tm 4d Threshold, Many-Body Effects, Electronic Properties of Solids, Elementary Excitations, Rare and Transition Metal Systems. *Expectations From SESAME:* Suitable beamlines and beamtimes for investigator proposals. Basic experimental chamber must be provided to SESAME users, which is not available at their home institution.

High T_C Superconductivity Research Groups: Tezer Firat, Hacettepe University; Mustafa Altunbas and Ekrem Yanmaz, Karadeniz Technical University; Eyup Yakinci, Inönü University.

2.8.2. Potential synchrotron users in Turkey



(a) (b)

Figure 1. The distribution of potential Turkish SESAME users by main research areas (a) and their experimental expectations from SESAME (b).

A database is built on September 1999 for the potential Turkish SESAME users and includes the personal information, research activities and the needed experimental techniques of 101 potential Turkish users (http://www.imal.hacettepe.edu.tr/syn).

3. WORKING GROUP DISCUSSIONS

The focus of the workshop was to define the materials science community needs of the SESAME member countries, and two working groups met separately to discuss potential beamlines for the following techniques:

1. Powder diffraction (E. Ozdas, A. Lappas, reporters)
2. X-Ray Absorption Spectroscopy (R. Frahm, E. Alp, reporters)
3. Photemission and spectromicroscopy (G. Margaritondo, reporter)
4. LIGA (A. El Nadi, F.J. Pantenburg, reporters)

The Group Chairpersons reported back in the next session.

During the discussions the question arose about the properties of the off-axis beams from the multipole superconducting wigglers. In particular, would they meet the uniformity requirement for LIGA which is to have ±4% uniformity of intensity across a 100 mm field.

After the workshop a study of this was carried out by Tom Rabedeau of SSRL. He concludes that this requirement is easily met in an unfocused side station beam. His note describing the properties of this beam is included in Appendix E of this report. In addition he has calculated the properties of a focused side station beam from the wiggler. In this case there is some structure in the focal spot, particularly for off-axis viewing angles greater than about 10 milliradians. His note on this is also included in Appendix E.

4. WORKING GROUP REPORTS

4.1. X-ray Powder Diffraction – *E. Ozdas, A. Lappos, P.Stephens, K. Prassides*

Powder Diffraction Beamlines at SESAME will have a huge load for the high resolution powder diffraction experiments required by the materials scientist in the region, because powder diffraction is one of the most widely used materials characterization methods. Therefore, the Diffraction Scientific Subgroup proposed two diffraction beamlines at SESAME; a parallel optic beamline and a focusing optic beamline to serve a wide range of user requests including high pressure and small molecule single crystal measurements. Also, beamlines should be provided with equipment such as the new detector foil system, cryogenic system (1.5 to 273 K), induction furnace (20 to 1800 ºC) and high pressure attachments (600 kbars and up). In addition to structure-refinement from powders, low/high temperature phase transition and high pressure studies, the parallel optic beamline may also be used for reflectivity and surface/depth analysis with a small hardware modification.

X-ray optics: The beamline should be situated about 22 m tangentially from the 7 T multipole wiggler where x-ray wavelengths of 0.5-4 Å will be available (Figure 1). Incident beams are monochromatized by a channel cut, double crystal Si (111) monochromator scattering in the vertical plane for a parallel beam geometry. The main optics of a focusing beamline contains two mirrors and a double crystal monochromator (Figure 2). In the energy range of 3-25 keV, to obtain a high resolution with a high photon flux, the x-ray beam is vertically collimated by the first mirror before the monochromator. The second monochromator crystal and the second mirror will focus the beam at the sample position in the horizontal and vertical plane, respectively. The beam size at the sample will be sub-millimeter square. Due to the double mirror reflection, the higher harmonics will be reduced to less than 10^{-5}. To achieve thermal stability, the temperature of the monochromator is constantly maintained at constant temperature using a closed-cycle water refrigerator. The user can choose the diffraction plane among Si (111), (311) and (511) depending on the most suitable energy and resolution. The tuning assembly of the monochromator should be housed in a chamber that is under vacuum or in a He atmosphere.

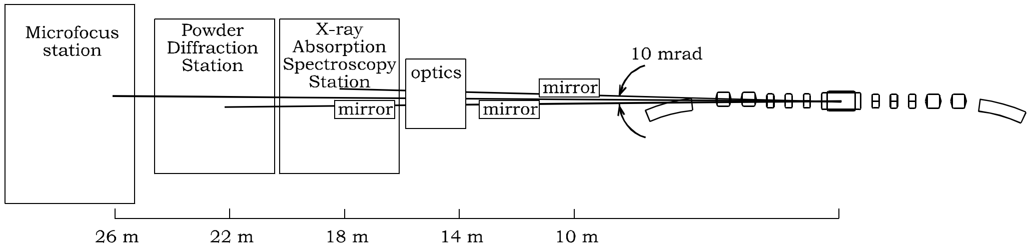


Figure 1. Layout of 7T-wiggler beamlines.

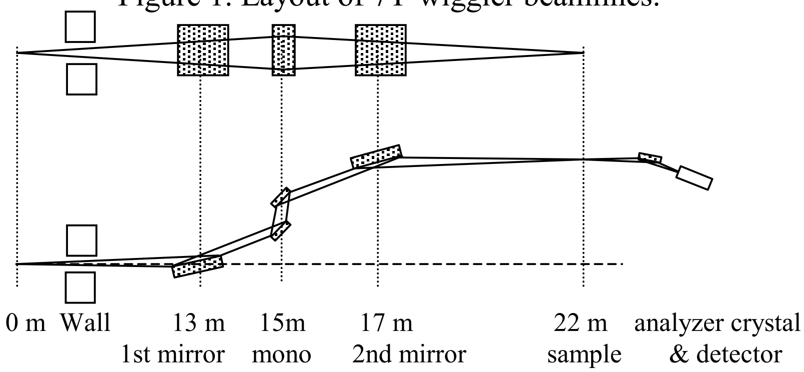


Figure 2. Optical layout of the focusing powder diffraction beamline

The analyzer crystal geometry gives the instrument a very fine angular resolution, on the order of 0.01° full width at half maximum (FWHM) at small Bragg angles 2θ. The x-rays diffracting from the sample pass another set of adjustable slits and strike the analyzer crystal, typically Ge (111) or Ge (220). This diffracts the beam into a commercial NaI scintillation counter. The diffraction peaks become sharper at shorter wavelengths, so that the overall δ d/d resolution is roughly independent of wavelength. It is a rare sample that produces instrumental resolution limited peaks in this configuration. This resolution is very useful for separating closely spaced diffraction peaks, and often provides a much better signal to background ratio than a conventional laboratory powder diffractometer. Also, the analyzer crystal discriminates against x-ray fluorescence from the sample (although it can contribute its own fluorescence when operated above the Ge edge at 11.1 keV).

Goniometer at Parallel Optic Beam Line: A two+two circle goniometer; two main axes for the sample, θ and detector arm, 2θ which has two other axes, one for the analyzer crystal and the other axis for detector. Another 2θ arm can be add to the goniometer for a high speed scanning mode with a soller slit –detector combination. Some good examples of this configurations have been constructed at NSLS-X3B1, SSRL-2.1 (Appendix F) and SRS-2.3.

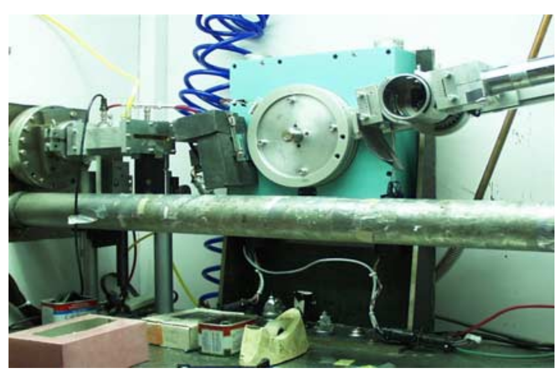
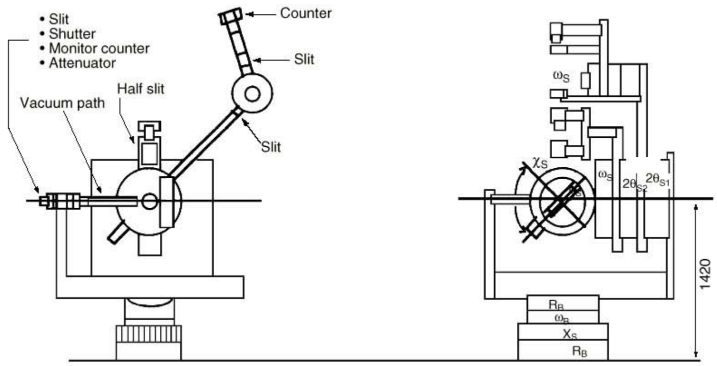


Figure 3. Huber 424, 2-circle goniometer at NSLS-X3B1



Schematic drawing of the seven-axes diffractometer with the basement table

Figure 4. A seven-circle diffractometer at Spring8-BL02B1 Beamline

Goniometer at Focusing Optic Beam Line: A six-circle goniometer; four main circles and two circles for the analyzer housing. With a six-circle goniometer, thin film and single crystal measurements become available at the beamline. A typical application with an extra circle at Spring8 is shown in Figure 4. The two sets of 2θ axis are designed in such a manner that one set is used for the precision scanning while the other is for the high speed scanning depending upon the purpose of the experiment.

Image foil detector: A large area detector will make it possible to measure high quality powder diffraction data of polycrystalline materials at low/high temperatures and pressures. The diffraction experiments will be performed by transmission geometry.

Specification of X-rays at the sample:

Energy Range	:	3-25 keV
Energy Resolution	:	$\Delta E/E=10^{-4}$
Photon Flux	:	10^{10}-10^{12} ph/s

Facilities at Beamlines:	Estimated Cost (kUSD)
Collimating mirror (white beam, water cooled, UHV)	400
Vertically focussing mirror (monochromatic, HV)	300
Monochromator (double crystal, tunable)	450
Measurement	
• Gas flow type ion chambers (two) including gas supply system for ion-chambers	10
• CCD video cameras and monitors for beam monitoring	15
• Scintillation counters	20
• Image foil camera and its electronics	120
• Detector electronics: HVPS and current amplifiers for ion chambers, NIM bin electronics for scintillation detector, MCA, etc.	60
Sample	
• 6-circle Goniometer + optical table	210
• Cryostat for phase transition studies with semispherical Be window, temperature range: 1.5 – 300K	40
• Electric furnace up to 1100 K.	20
• Induction furnace, temperature range: 20-1800 ºC.	50

• Diamond anvil-type high pressure cells (3).	30
• Polarize microscope	50
• Spark Eroder	20
• Ruby Luminescence Spectrometer	40
• Sample spinners for capillary and flat specimen.	30
Control & Analysis	
• Motor control (24 axis)	36
• Data acqusition (VME crate + modules)	40
• Workstations for control	10
• Workstations for data analysis	15
• Rietveld refinement and visualization packages	10
Others	
Exchangable fixed slits, motorized half slit (up/down, right/left),	10
shutter for incident beam	10
TOTAL	1,996 K US$

Manpower

typically 2 beam line scientists
dedicated technician
2 post-doc's

4.2. X-ray Absorption Spectroscopy – *E.E.Alp*

The modern approach to x-ray absorption spectroscopy is to combine space and time resolved experiments from small samples to address diverse needs of the materials science, chemistry, soil science, and environmental science communities. Therefore, the preferred approach is to adopt a quick-scanning monochromator on a multipole wiggler source.

The energy range should be between 3-25 keV, although, with some modifications, it may be possible/desirable to extend the lower energy range to 1 keV. This might require a combination of ultra high vacuum (UHV, $P<10^{-9}$ torr) and high vacuum (HV, $P<10^{-6}$ torr) components (see, for example, R. Frahm, et al, J. Synchrotron Radiation, vol 6 (1999) p. 172).

To reach the necessary energy resolution in the soft x-ray range (1-4 keV) crystals with large lattice spacing like YB66, or artificial multilayers are required. For the energy range of 4-10 keV, Si (111) and for higher energies Si (311) can be used. In addition, a vertically collimating white beam mirror should precede the water cooled, piezo-motor driven, double crystal monochromator. The second crystal of this monochromator can be the sagitally focusing type to reduce the horizontal size of the beam. Finally, a vertically focusing mirror brings a small, energy tunable beam into the station. The mirrors, and the off-set between the two crystals should be sufficient for higher harmonic rejection.

With such an arrangement, a 2 mrad swath of the side branch of the wiggler source can be utilized. A ray tracing for this particular case is provided in the Appendix E. A discussion was held about the possibility of using an asymmetric wiggler to produce circularly polarized x-rays. The benefits and disadvantages of this approach are related to net flux loss on the linearly polarized, on-axis photons. The group did not adopt a particular view, given the fact that this wiggler is also a source to two other branches: powder diffraction, and LIGA. This may have an impact on circular dichroism experiments, which are important in magnetism of rare-earth elements. On the other hand, some of the most impressive work on circular dichroism is being carried out on the soft x-ray range between 0.5-1 keV, and it might be appropriate to consider this activity separately.

Finally, there was a discussion on how to combine this branch with the other two branches. A proposed scheme was further discussed in the joint session, and a tentative solution is presented in Figure 1. According to this scheme, the XAS line will be placed on the side branch, and will take the 2 mrad swath of the radiation, centered about 5 mrad off the central branch.

Facilities at Beamlines:	Estimated Cost (kUSD)
Monochromator (double crystal, tunable)	450
Collimating mirror (white beam, water cooled, UHV)	400
Vertically focussing mirror (monochromatic, HV)	300
Measurement	
• Gas flow type ion chambers (four) including gas supply system for ion-chambers	12
• Fluoresence detectors (multi element solid state detector)	75
• CCD video cameras and monitors for beam monitoring	4
• Detector electronics: HVPS and current amplifiers for ion chambers, NIM bin electronics for scintillation detector, MCA, and PHA boards.	75
Sample	
• Optical table with six degrees of freedom	75
• 6-circle Goniometer + optical table (for reflection geometry)	210
• Cryostat for phase transition studies with semispherical Be window, temperature range: 1.5 – 300K	40
• Sample holders and stages	60
• Microfocussing mirrors	100
Control & Analysis	
• Motor control (24 axis)	36
• Data acqusition (VME crate + modules)	40
• Workstations for control	10
• Workstations for data analysis	15
TOTAL	1,902 K US$

Manpower

typically 2 beam line scientists, dedicated technician, 2 post-doc's

4.3. Photoemission Spectroscopy – *Giorgio Margaritondo*

Experiments based on the photoelectric effect have been for the past three decades a leading application of synchrotron sources [1]. An important role of SESAME in this field can be projected with reasonable confidence, based on two facts: (1) the parent source BESSY I has been used for many years very extensively in this domain, becoming one of its most important centers in the world; (2) in the Middle East research spectrum, many groups in different areas are, or potentially are, interested in photoemission.

One important point, however, is that photoemission-based techniques are widespread. We cannot, therefore, envision a “generic” use of an excellent source like SESAME in this domain. The technical and scientific choices must reflect the worldwide trends, and reserve the SESAME instrumentation for truly advanced experiments (to be complemented in many cases by preparation work done elsewhere).

Along these lines, we can identify several subdomains that are particularly active and advanced at the present time. The discussions among the interested scientists were eventually focused on two leading directions: (1) experiments emphasizing the energy and k-vector resolution and (2) spectromicroscopy experiments, coupling the spectroscopic capabilities of synchrotron photoemission with high lateral resolution [2]. These choices are primarily based on science and technology arguments.

4.3.1. High Energy resolution

Experiments performed at low energies and with energy resolution levels better than 20-30 meV are able to reveal a variety of novel and exciting phenomena [3]. In essence, natural and artificial system with low dimensionality systematically exhibit instabilities that manifest themselves on the scale from a fraction of an meV to several tens of meV -- and are in many cases detectable with high-resolution photoemission. Such phenomena include leading themes of today's research: superconductivity, charge density waves, spin density waves, magnetic transitions, non-Fermi-liquids.

Three examples can give an idea of the level of the research. In superconductivity, high-resolution photoemission is universally considered as the leading probe of the electronic structure near the Fermi level. Experiments of this type removed once and forever [4] all uncertainties about the d-wave nature of high-temperature superconductivity, and clarified a series of other issues. In the case of Peierls insulators, high-resolution experiments were recently able to elucidate, for the first time, the relative role of the crystal periodicity and of the super-periodicity in the electronic structure [5].

More fundamentally, high-resolution experiments increasingly raise the issue of the limit of validity of the fundamental framework of solid-state physics, which is based on the Fermi liquid. Clear deviations from Fermi-liquid behavior have been observed, and hints of non-electronic quasi-particles are accumulating.

One should note that such experiments have at the same time fundamental interest but also a high technological interest. The components of nanotechnology devices are primarily low-dimensional systems. High-resolution experiments clearly reveal that our knowledge of the electronic structure of such a system is limited. This will limit the impact of nanotechnology, unless the situation changes drastically -- with the specific help of high-resolution photoemission experiments.

4.3.2. Spectromicroscopy

Born a little more than 10 years ago, these techniques [2] are already considered a fundamental tool for both materials science and the life sciences. The instrumentation was developed along two different lines: (1) systems based on photon beam focusing and scanning, and (2) instruments based on electron optics. In both cases, a series of breakthroughs were able to bring advanced photoemission techniques down to a microscopic scale ranging from 20 - 100 nm.

The primary beneficiary of this evolution is life-science research. As soon as a photoemission probe can focus on areas smaller than a cell, it becomes a very interesting microchemistry probe for a variety of life-science problems. Experiments of this kind [6] were able to clarify microchemical aspects of brain cell contamination by simulated environmental problems, as well as the local chemical issues of brain cancer therapy.

On the other hand, spectromicroscopy has an equally important impact on materials science. Outstanding progress was made possible by spectromicroscopy in the field of polymers [7]. Applied to semiconductor interfaces, spectromicroscopy techniques revealed [8] unexpected fluctuations in the interface barriers that raise fundamental questions about the current modeling of microelectronics devices.

The most advanced instruments of this kind open up an array of new and exciting opportunities. For example, focusing-scanning experiments were used to study the microchemistry of surface chemical waves [9] and of a variety of oxidation phenomena. Coupled to the high lateral coherence of a synchrotron source, spectromicroscopy can reveal diffraction patterns [10] showing promise of extending interferometric techniques to the microscopic scale.

4.3.3. Possible strategies

The discussion among the interested scientists narrowed down, both for spectromicroscopy and for high-resolution experiments, to two possible philosophies. The first philosophy ("Top") would develop on SESAME the best possible instrumentation systems, targeting front-line performance. The consequence would be a substantially higher cost than the second philosophy. Furthermore, the success of this approach requires the full-time commitment of one or more regional groups, willing to make such an endeavor the focus of their activities.

The second philosophy ("Medium-advanced") would take instead the existing instrumentation transferred from Bessy I and make the best use of it (after upgrading) to reach advanced (but not top) performance levels. Such an approach would not prevent SESAME from producing front-line science, since both spectromicroscopy and high-resolution photoemission still are in their infancy. The instruments so developed would serve a wide user community with effectiveness and flexibility.

These are the main elements of the two philosophies for each technique:

4.3.3.1. High Energy resolution: "Top" Philosophy -- the objective would be an energy resolution better than 4 meV for a solid-state Fermi edge. This would require the use of a low-energy undulator working in the 8-20 eV photon energy range, possibly shared with a "spectromicroscopy station or with another instrument. To avoid heat-load problems, we should probably consider an aperiodic Fibonacci undulator design. The beamline should be designed for high flux and a resolving power in excess of $2x10^4$. The spectroscopic instrumentation would be of the class of a Scienta 300 or of an advanced VG analyzer ***[Solution 1A]***. "Medium-advanced" Philosophy -- the objective would be an energy resolution better than 20-30 meV. The corresponding instrumentation would be again of the class of a Scienta 300 or an advanced VG analyzer. The beamline could be the TGM beamline transferred from Bessy I, after the planned upgrades. ***[Solution 1B]***

4.3.3.2. Spectromicroscopy: The general choice here is in favor of "electron-optics" instruments of the class of a PEEM (Photoemission Electron Microscope), whose spectroscopic capabilities are primarily based on x-ray absorption and photon energy scanning. In fact, such instruments are more flexible than their focusing-scanning counterparts, more suitable for a wide user community and specifically for life-science applications. "Top" Philosophy -- the objective would be a lateral resolution better than 10-20 nm, with the capability of electron energy analysis in addition to photon energy scanning. The spectromicroscope could be semi-commercial, i.e., based on the upgrade of a commercial instrument. The source should be a low or medium-energy undulator, possibly shared with other applications. The reference instruments are the SPLEEM beamline by Bauer et al. on Elettra [10] and the new advanced PEEM-class beamline at Bessy II. ***[Solution 2A]*** "Medium-advanced" Philosophy -- the objective would be a lateral resolution better than 100 nm. The spectromicroscope could be a commercial instrument (e.g., by Omicron). The beamline could be either the SX-700 beamline provided by the upgrade of one of the lines transferred from Bessy II (or - as a limit case - the transferred TGM beamline shared with a high-resolution photoemission system). ***[Solution 2B]***

4.3.4. Preliminary cost estimation

Solution 1A: Spectrometer 0.65 M$, Temperature Control 0.25 M$, Undulator 1 M$, Beamline 1 M$, Sample Preparation Chamber with Depth Profiling etc. (optional) 0.6 M$, Miscellaneous 0.2 M$.
TOTAL: 3.7 M$ (0.6 M$ optional).
***Solution 1B**:* Spectrometer 0.65 M$, Temperature Control 0.25 M$, Sample Preparation Chamber (optional) 0.6 M$, Miscellaneous 0.2 M$.
TOTAL: 1.7 M$ (0.6 M$ optional).
Solution 2A: PEEM 1 M$, Undulator 1 M$, Beamline 1 M$, Miscellaneous 0.2 M$.
TOTAL: 3.2 M$.
Solution 2B: PEEM 0.22 M$, miscellaneous 0.15 M$.
TOTAL: 0.37 M$.

Personnel (FTE = full time equivalent):
***Solution 1A**:* 2 scientists, 3 postdocs, 3 technicians.
***Solution 1B**:* 1 scientists, 2 postdocs, 2 technicians.
***Solution 2A**:* 2 scientists, 3 postdocs, 3 technicians.
***Solution 2B**:* 1 scientists, 2 postdocs, 1 technicians.

4.3.5. Concluding Remarks

The final decision between "top" solutions (1A and 2A) and medium-advanced solutions (1B and 2B) must be primarily based on the capability to identify one or more regional groups willing to take the leading responsibility. Without such groups, solutions 1B and 2B should be selected.

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4.4. LIGA (Lithographic-Galvanik-Abformung)

LIGA is an acronym which stands for the main steps of the deep x-ray lithography process as developed by the Karlsruhe group; lithography, electroplating and plastic molding. Beginning with a suitable substrate, this process is used to produce intricate structures with heights of up to few mm with a lateral resolution of the order of a fraction of a micron. The technique is based on exposing a photoresist material to synchrotron radiation x-rays through a properly designed mask. The highly penetrating, intense and directional radiation produces smooth and parallel walls. The process allows the production of either an individual three-dimensional structure, or the metallic mold which can then be used for repeated casting when mass production is desired. A wide range of materials can be used for the microstructures, such as polymers, metals, glass and ceramics. The fully-assembled system may include microelectronic components. Cost-effective fabrication technology is necessary and is being continuously improved.

LIGA is a convenient process for the production of:

1- MicroElectroMechanical Systems (MEMS).

2- Positioning structures and switching components for optical fiber communication.

3- Miniature motors, gears, pumps and heat exchangers.

4- Micro-optical components.

5- Microsurgical tools.

In general MEMS are mechanical microstructures, microsensors, microactuators and electronics integrated in the same environment (i.e. on a silicon chip). Miniaturization of mechanical systems promises unique opportunities for new scientific and technological directions. MEMS are not only about miniaturization of mechanical systems; they are also a new paradigm for designing such devices and systems. Microfabrication technology enables production of large arrays of devices, which individually perform simple tasks but in combination can accomplish complicated functions. The biggest advantage is not necessarily that the system can be miniaturised, but rather that the lithographic techniques that now mass produce thousands of complex microchips simultaneously can also be used to manufacture mechanical sensors and actuators. As component price is reduced to nearly zero, as has happened for microprocessors, they can be deployed pervasively, revolutionizing future society possibly to a greater extent than even the microprocessor.

At the August 19-21, 1999 meeting of the SESAME Scientific Committee in Berlin, the use of a side branch of one of the two superconducting multipole wigglers was proposed for LIGA. This would provide intense radiation in the 3-25 keV range, which covers the occasional LIGA applications at very high energy, as well as the large majority of applications which use radiation below ~15 keV. A LIGA beam line is rather simple compared to beam lines for other applications. No monochromator is needed. A wide fan of several milliradians is desirable, particularly for quantity production.

In support of a full-scale LIGA program the following equipment and off-line facilities are needed.

1- A clean room with means for micropositioning, electroplating, coating and etching.
2- Monitoring tools such as SEM and ellipsometry equipment.
3- Equipment for the final precision assembly (such as laser welding).
4- A mirror to scan the exposure area at the required rate together with suitable masks.
5- An exposure shutter for proper timing.
6- Means to control the spectral range of the radiation (e.g., windows, mirrors, filters).
7- Commercially available electrolyte and photoresist materials.

SESAME could also support a "print-shop" service, as is done at other synchrotron radiation facilities. In this case LIGA exposures are made at the site and the exposed material is sent elsewhere for processing.

Facilities at Beamlines:			Estimated Cost (kUSD)
Lab I	Laminar Flow box		145
	• Structure	25	
	• Oven	40	
	• UV aligner (copying)	50	
	• Spin coating and baking	30	
Lab II	Wetlab		415
	• Gold plating	25	
	• Reactive ion etching	100	
	• Chemicals and equipments	100	
	• Ni bath	40	
	• Sputtering device	150	
LabIII	Support lab		400
	• Optical microscope	100	
	• SEM	200	
	• Profilometer	100	
Beamline			50
X-ray scanner (including tilt) for adjustable wiggler			600
TOTAL			1,610 K US$

Manpower

typically 2 beam line scientists
dedicated technician,
2 post-doc's

4.5. Materials Science Facilities at SESAME

A sample handling laboratory with optical microscope, glove box, diamond cutter, small press, oven and furnace, sensitive balance and standard laboratory equipments would be the minimum requirement. A detailed discussion regarding on the exact nature of the support facilities would be possible with participation of other materials science groups involving x-ray microscopy , x-ray fluorescence and other potential participants in the next workshop.

The participants in this workshop did not feel the need to have a scanning electron microscope, or other major characterization facility as a must have facility. On the other hand, the needs of the LIGA effort are quite extensive, and they are discussed separately. The organizers feel that this issue will come up in the next workshop, and therefore, a definitive cost estimate would be premature at this time.

The estimated cost of the materials Science Support facilities are in the range of 200,000 US dollars.

Appendix A – List of Participants

Participants in First Materials Science Workshop at SESAME,
Hacettepe University, Ankara, Turkey, September 21-22, 2000.

(1) Azam Irajizad (2) Bob Batterman (3) Ronald Frahm (4) Florian Weissbach (5) Abdul Raouf El Ali (6) E. Ercan Alp (7) Takehio Ishii (8) Herman Winick (9) Giorgio Margaritondo (10) Servet Turan (11) Peter Stephens (12) Tufan Gungoren (13) Semra Ide (14) Elif Sarikaya (15) Nurettin Efe (16) Ahmed Dhofar Al Rawas (17) Yuksel Ufuktepe (18) Adel El-Nadi (19) Dan Shechtman (20) Marut Navasardyan (21) Mohammad-Ali Vesaghi (22) Pervin Arikan (23) Onur Hosten (24) Engin Ozdas (25) Alexandros Lappas (26) Kosmas Prassides (27) Omer Yavas (28) Ridvan Kirmaz (29) Mehmet Kaplan (30) Franz-Joseph Pantenburg (31) Carlo Carboni (32) Yakup Kalayci

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Appendix B – Agenda

Agenda of First Workshop on Materials Research at SESAME

R-Hall, Conference Center, Hacettepe University, Sihhiye Campus, Ankara, Turkey

Thursday, September 21, 2000

Session Chairman : Peter Stephens (State Univ. of New York, Stony Brook)
09:00-09:10 Welcome remarks: Tuncalp Ozgen (President, Hacettepe University)
09:10-09:50 SESAME Source Performance: Herman Winick
(Cochair, SESAME Sci. Comm. & SSRL/Stanford Univ.)
09:50-10:00 Introduction of the participants
10:00-10:15 The Role of UNESCO: Florian Weissbach
10:15-10:30 Charge to the workshop: Ercan Alp
10:30-11:15 Coffee break

10 minute talks (+5 minutes for discussion) by representatives of Middle East Countries on the status of materials science research in their country and potential use of SESAME by scientists from their countries.

Session Chairman: Ercan Alp (APS, Chicago)

11:15-11:30	Armenia	Marut Navasardyan (Yerevan State Univ.)
11:30-11:45	Egypt	Adel El-Nadi (Cairo Univ.)
11:45-12:00	Greece	Kosmas Prasides (Univ. of Sussex) & Alekos Lappas, (I.E.S.L.)
12:00-12:15	Iran	Mohammad-Ali Vesaghi & Azam Irajizad (Sharif Univ. of Tech.)
12:15-12:30	Israel	Dan Shechtman (Technion)

12:30-14:00 Lunch break

Session Chairman: Herman Winick (SLAC/SSRL,Stanford)

14:00-14:15	Jordan	Abdul Raouf El Ali (Yarmouk University)
14:15-14:30	Oman	Ahmed Dhofar Al-Rawas & Carlo Carboni (Sultan Qaboos Univ.)
14:30-14:45	Turkey	Servet Kara (Anadolu University) & Engin Ozdas (Hacettepe Univ.)
15:15-15:45	Coffee break	

Session Chairman: Boris Batterman (CHESS, Cornell Univ.)
Synchrotron radiation techniques in materials research:

16:00-16:45 Powder diffraction, Peter Stephens (State Univ. of New York, Stony Brook)
16:45-17:30 EXAFS spectroscopy, Ronald Frahm (Univ. of Wuppertal)
17:30-18:15 Photoemission spectroscopy, Giorgio Margaritondo (EPFL Switzerland)

19:00 Reception

Friday, September 22, 2000

Session Chairman: Takehiko Ishii (SIAM Project, Thailand)

09:00-9:30	Joint session to define the strategy for parallel sessions	
09:30-10:30	Parallel sessions on	
	Diffraction & Absorption	R-hall
	Photoemission spectroscopy & LIGA/Lithography	S-hall
10:30-11:00	coffee break	
11:00-12:30	Parallel sessions continue	
12:30-14:00	Lunch break	

Session Chairman: Ercan Alp (APS, Chicago)

14:00-17:00 Joint session

Discussion of recommendations for the SESAME;
- Materials Research Program
- Beam lines
- User support facilities
- Scientific/technical staff requirements
- Visitors

Follow up work;
- Responsibilities for workshop report
- Second workshop on Materials Research
- Imaging & Environmental Sciences & Archaeology

17:00 Meeting adjourns

19:00 Gala Dinner

Appendix C – Role of UNESCO at SESAME

by Florian Weissbach, UNESCO

It is a pleasure and a great honor for me to be able to address you today on behalf of UNESCO. Let me take the opportunity to thank Professor Ercan Alp, Professor Engin Ozdas, and Professor Herman Winick for organizing and preparing this important meeting. Let me also say that I am sure that the warm welcome here at Hacettepe University creates an ideal atmosphere for a successful outcome of the workshop, which is so essential to the SESAME project. I would also like to thank you, the participants from the SESAME members, for coming here to Ankara. We are all looking forward to you presentations.

UNESCO, the United Nations Educational, Scientific, and Cultural Organization, regards this project with highest interest and considers it an outstandingly fine example of regional collaboration, enhancing research and education in the ME.

Let us take a quick look at UNESCO's foundation and at its principles to highlight the Organization's role for the project.

UNESCO's role for the SESAME project

The Constitution of UNESCO was signed in London on 16 November 1945 by 37 countries and came into force a year later following ratification by 20 of its signatories. The governments declared: "Since wars begin in the minds of men, it is in the minds of men that the defenses of peace must be constructed."

This is how the UNESCO Constitution begins. Also in its Preamble we find the following statement:

> "… they [the member states] do hereby create the United Nations Educational, Scientific, and Cultural Organization for the purpose of advancing, through the educational and scientific and cultural relations of the peoples in the world, the objectives of international peace and the common welfare of mankind."

And some paragraphs later in more detail:

> "The purpose of the Organization is to contribute to peace and security by promoting collaboration among the nations through education, science and culture in order to further universal respect for justice, for the rule of law and for the human rights and fundamental freedoms which are affirmed for the peoples of the world, without distinction of race, sex, language or religion, by the Charter of the United Nations."

So rather than a funding organization UNESCO is an intellectual organization. Today it has 188 member states. (By the way, the United States left the Organization in 1985, but we have every hope that they will rejoin UNESCO. If this should happen it would also be a success of the American scientists who are working on the SESAME project.) Every two years the member states meet at the General Conference in Paris at UNESCO headquarters to determine the policies of the Organization and to approve its programme and budget. Every six years the GC appoints the Director-General upon recommendation of the Executive Board. The Executive Board is composed of 58 Members and meets twice a year. It is responsible for the execution of the programme adopted by the General Conference.

The UNESCO Secretariat is subdivided into several sectors. On this transparency you can see a very textured landscape of little boxes representing the Organization's different sectors. The one important for SESAME is the Science Sector (SC). It is again subdivided into these [transparency] divisions. And the Division of Basic Sciences then harbors the disciplines Mathematics, Physics and Chemistry (MPC). This division has focused on assisting developing countries and countries in transition in building up national and regional research and training capacities in mathematics, physics and chemistry through cooperation with competent international and regional networks and centers, and national specialized scientific bodies and institutions. For instance UNESCO was the Godfather of CERN, the first European research agency. And in a way one can say that CERN laid the foundation for a more comprehensive European collaboration, namely the European Coal and Steel Community ECSC, predecessor of the EU. In cooperation with the IAEA UNESCO established the ICTP, an international center for theoretical physics in Trieste, Italy. ICTP is a research and in particular an advanced training center for scientists from developing countries. The number of attendants of ICTP courses and schools is of the order of 3000 per year.

But what is now UNESCO's particular role for our project?

Is UNESCO the "Open, Sesame!" the password at which the door of the robbers' cave flew open in the tale of Ali Baba and the 40 thieves? In a way this is indeed the case. There actually is a parallel between UNESCO and the beautiful tale from the ARABIAN NIGHTS. "Open, Sesame!" is the marvelous means of securing access to what would usually be inaccessible.

SESAME will be an international research center, providing the whole ME region with a world-class research facility. Also it will serve as an outstanding training capacity. A large number of MSc and PhD students is envisaged to study at SESAME, being educated for life and enabled to address the challenges facing the ME region. We will hear from the experts from the SESAME members just now how many potential users are expected to benefit from the synchrotron source. These users would mostly come from the region, but access for scientists from all over the world will be guaranteed. So SESAME already today enhances international collaboration. Also the SESAME statutes are a fine example of an international agreement as mentioned in the UNESCO Constitution. It promotes cooperation and the free flow of ideas. It will broaden the mutual knowledge of peoples and lay a foundation for a fruitful scientific exchange in the ME region. The statutes reflect UNESCO's main principles. Thus SESAME nearly uniquely matches the principles verbalized in the UNESCO Constitution. Without UNESCO, SESAME would not be the same project. May be there would not even be a SESAME project at all without UNESCO.

There are many ways in which SESAME benefits from UNESCO:

First of all UNESCO is a catalyst for projects of the order of magnitude of SESAME. UNESCO provides a forum for interaction between scientists and government officials from various countries. The Organization is the international framework for SESAME.
Moreover UNESCO is very experienced in firmly escorting but also motivating and stretching all project partners.

Apart from that UNESCO is very firm on legal grounds. UNESCO will be able to establish a contract with the German Federal Government on the disassembly of BESSY 1 in Berlin. Also the SESAME statutes and all structural questions will be clarified, the last small wrinkles will be ironed out very soon. And last but not least UNESCO was successful in raising funds for this and other meetings of the scientific subgroups of SESAME and will be able to do so hopefully for SESAME itself.

So as a conclusion one could say that UNESCO is sort of a midwife for SESAME.

So from UNESCO's point of view, how will the project go on and what are the necessary steps to be undertaken?

The answer is actually very easy. As you all know, clearly fund raising remains the activity with the highest priority and the SESAME statutes have to be adopted. Once the financial situation is clarified, SESAME will be presented to UNESCO's governing bodies for consideration and approval.

Ladies and Gentlemen, it is now extremely important to preserve and to even increase the momentum that brought us here. So we as physicists have to get used to a concept of increase of momentum rather than just conservation of momentum, which we are all very familiar with. All parties are highly committed to SESAME, and we have a once-in-your-lifetime opportunity to set up a world class research facility in the ME, open to scientists from the region and from all over the world, boosting the local education and research capacities, as well as the economy, and promoting cooperation within the ME scientific community.

Thank you very much for your attention.

Appendix D – An Indicator of X-ray Related Current Research Activities in the Middle East

Middle East Countries	# of the articles[1]	Host Countries	# of the articles[1]
Armenia	11	Brazil	398
Cyprus	3	Canada	809
Egypt	130	China	2110
Greece	174	France	2392
Iran	25	Germany	3253
Israel	222	India	950
Jordan	11	Italy	1181
Lebanon	4	Japan	3932
Morocco	63	Russia	1169
Oman	3	South Korea	810
Palestinian Authority	-	Spain	976
Turkey	122	Taiwan	465
		UK	1952
		USA	5930

[1]Source: Web of science, keywords included all x-ray techniques.

The table shows the number of the scientific articles related experimental x-ray research published by the Middle East countries in 1999. The comparison of these numbers with the same kind of publications of the countries having the synchrotron facilities give an idea about how SESAME improves the x-ray related research in the region.

Appendix E – Properties of Off-Axis Beams from SESAME Wigglers

by Tom Rabedeau

Unfocussed Beams such as needed for LIGA

The effects that produce flux density variation with horizontal position on a LIGA sample could be classified;

1. The critical energy variation with fan horizontal angle. This produces flux density roll off with observation angle at higher energies. I calculate the following in plane flux densities per pole vs horizontal observation angle...

angle	photons/sec*0.1%bp*mrad^2*pole	
(mrad)	5keV	10keV
3	1.348 x10^{13}	9.036 x10^{12}
4	1.348 x10^{13}	9.016 x10^{12}
5	1.348 x10^{13}	8.998 x10^{12}
6	1.347 x10^{13}	8.976x10^{12}
7	1.347 x10^{13}	8.949 x10^{12}

Thus at 5keV the unfocused flux density variation across a 100mm wide sample 25m from the source (i.e., 4mrad occluded angle) is less than 0.1%. At 10keV the variation is more like 1%.

2. Horizontal viewing angle variations from pole to pole add a little more lateral flux density variation. However, for the Sesame 7.5T wiggler this effect is pretty small. For example, 25m from the source the down stream end pole observation angle is 5.19mrad when the center pole observation angle is 5.00mrad with orbit excursion included. Thus the pole to pole observation angle variations contribute very little additional flux density roll off.

The key to the beam uniformity here is that LIGA uses unfocused beam and the wiggler fan is rather broad even at 10keV. If the beam were focused one would image the individual source points and find a multi-lobed source image much like the two lobed source image seen on axis for the PX line.

Focused Beams

The problem I was having with SHADOW was attributable to pilot error. I looked at the focus for a SESAME wiggler off axis station using a simple 1:1 focusing toroid mirror system at three different off axis angles (5mrad like BL9-3, 10mrad, and 20mrad). The results are plotted below. The bottom line is that the focus isn't too lumpy at 5mrad but gets quite bad by the time one gets to 20mrad. The vertical focus could be improved by using a cylindrical mirror and a sagittal focusing mono, but the pole granularity effect on the focus is illustrated adequately using the simple toroid optics. Since the fan from the wiggler is huge, one could consider a fan distribution as follows:

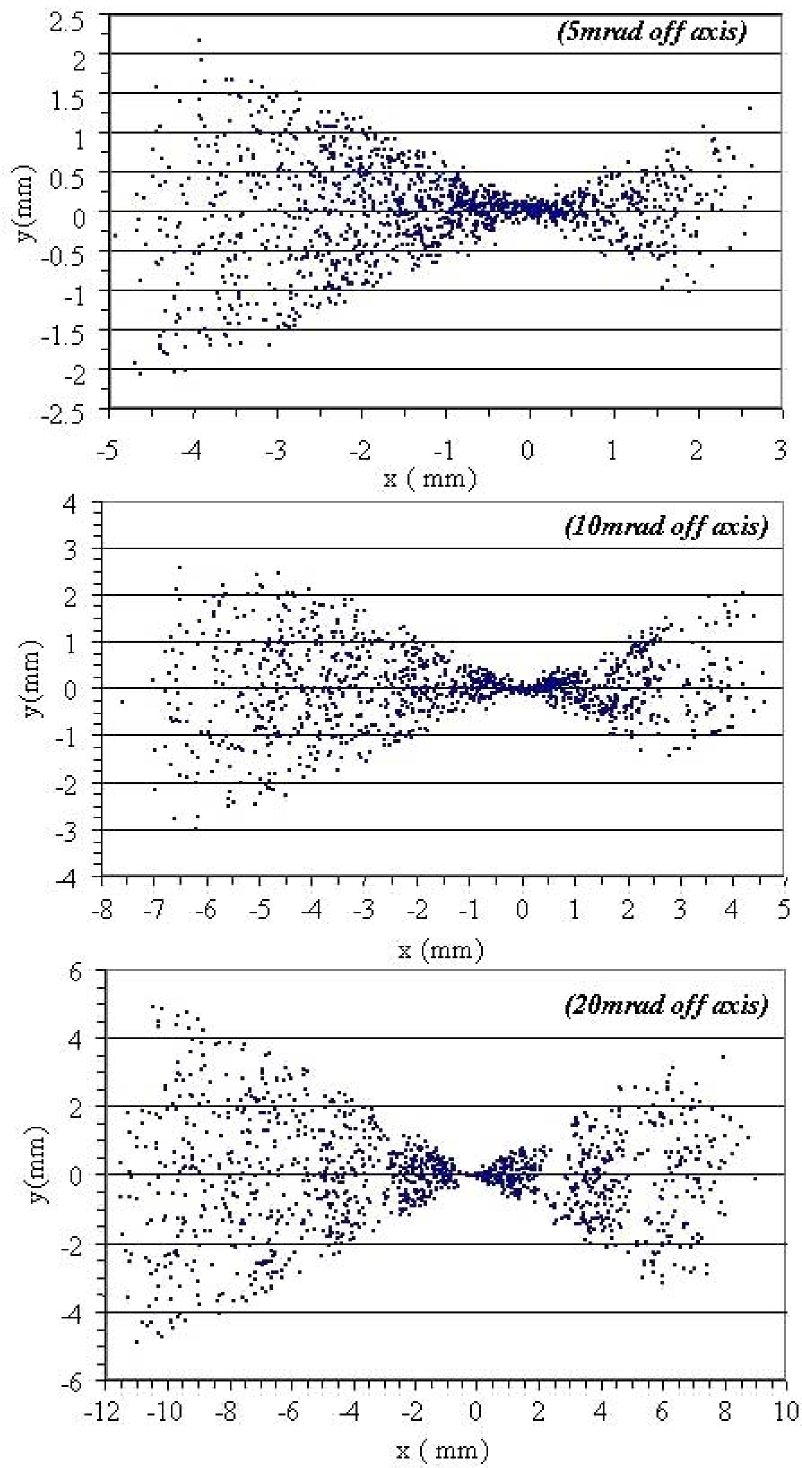
materials scattering (~line focus, side deflecting mono): -14 to -15mrad
XAS & anomalous scatt.(focused, double crystal mono & tandem hutch):-6 to -4 mrad
MAD PX (focused & double crystal mono): -0.75mrad to +0.75mrad
materials scattering or PX (focused, side deflecting mono): +4 to +6mrad
LIGA (white or pink downstream of mat scattering / PX station): +10 to +15mrad

Simulated configuration:

E_{ring} = 1GeV
emittance = 50nm-rad w/ 2% coupling

$\sigma_x = 0.438$mm
$\sigma_y = 0.022$mm
Sinusoidal wiggler with 7 each 140mm periods and B_{max}=7.5T
2mrad fan acceptance centered at 5, 10, and 20mrad off wiggler axis
1200mm toroid mirror with alpha=4.0mrad and z=12m
focus at 24m (1:1 optics)
10keV photons
mirror yaw set such that mirror axis points to x=0 (i.e., one lobe of source)

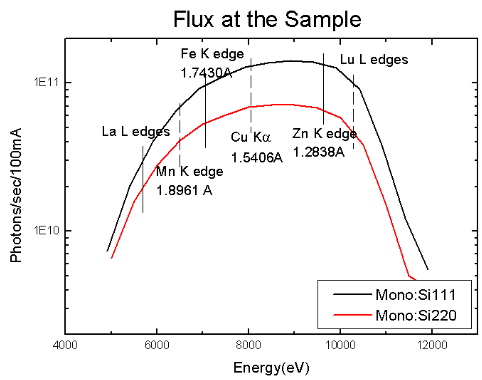
Sesame Wiggler Focus

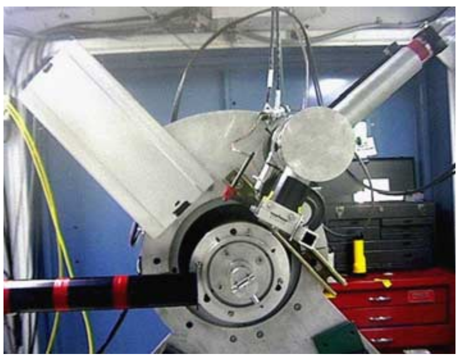


Appendix F– Example Beamline: Powder Diffraction Beamline 2-1 at SSRL

by Apurva Mehta

The dedicated powder diffractometer is built at one of the focused bending magnet beamlines. The size of the focused beam is 2x1 mm. Approximately 10^{11} photons/sec are incident on the sample at the energies between Fe K edge (7111 eV) to Zn K edge (9659 eV).





a Si111 analyzer

a Si111 analyzer and a soller slit

The powder diffractometer at SSRL is designed around two large concentric Huber goniometers. The 2-theta circle accommodates two detector systems. Either detector can cover a full range of scattering angles (0 to 150; 2θ), or the detectors can be used simultaneously to speed data collection. One detector is based on a perfect crystal analyzer (usually Si111). The second detector arm accommodates either a 1 mrad Soller slit, an energy-resolving Ge or diode detector, or a linear position sensitive detector. With the appropriate choice of detector and the monochromator a powder diffraction pattern can be collected with ultrahigh to medium angular resolution.

The most intense (110) peak of a standard LaB_6 flat plate has 10K counts/sec in the ultrahigh resolution configuration whereas the same peak can have more than 300K counts/sec in the moderate resolution configuration.

Samples can be either 25mm wide flat plates, mounted into a cavity in one of the available Si zero background flat plate, or loaded into a 0.3 - 0.5 mm glass/quartz capillary. SSRL is developing sample stages to cover the temperature range from 2 to 1500 K, which will be available users on request.