The African Light Source Manifesto

The first meeting of the African Light Source Conference and Workshop was held from 16-20 November at the ESRF in Grenoble. This was the first in a series of conferences, leading ultimately to the establishment of a Light Source in Africa. This manifesto presents the African Light Source Conference Resolutions as well as the draft African Light Source Roadmap.

Introduction

Light sources (LSs), based at either Synchrotron or Free-Electron laser facilities, are currently the most transformative state-of-the-art research instruments for application to a broad spectrum of disciplines. They embrace essentially all spectroscopy, scattering and imaging techniques, utilising radiation from the infrared (IR), to the visible, ultra-violet (UV), X-ray, and even to the soft gamma ray portion of the electromagnetic spectrum. They are orders of magnitude brighter than traditional lasers, which for decades have transformed science and technology. Though costly, LSs have become clear leaders for research outputs, graduate student training, and drivers of technological innovation. Thus, they benefit nations far more than they cost. Among scientific instruments, their usage produces the most *Nature* and *Science* (considered to be among the most prestigious scientific journals) papers per project, and supports the highest density of researchers from the widest range of disciplines. These researchers all work in close proximity, since as many as fifty (50) or more beamlines can operate simultaneously, with some beamlines supporting more than one experiment. LSs are not used solely by academic researchers, as an increasing number of industrial entities purchase beamtime at many such facilities.

The extremely high photon brightness and flux provided by LSs have allowed significant advances to be made in numerous applications for the benefit of society, including drug development and better understanding of diseases, based upon the deciphering of protein, bacterial and viral structures; and advances in data storage through studies of electronic structure and magnetism in selected materials. LSs show tremendous promise in direct medical applications, allowing innovative imaging techniques of such organs as the heart, lungs, brain and breast, leading to exciting new diagnostic techniques and therapies. More recently, LSs have been used in palaeontology and cultural heritage studies. For example, three-dimensional tomographic images have been made of fossils, rock art, and other artefacts. The use of LSs in palaeontology in South Africa has been one of the big success stories of synchrotron science, especially as regards the recent spectacular results on *Australopithecus sediba*, leading to a revolution in the field.

The figure below depicts the location of operating LSs worldwide. Several facilities operate more than one storage ring, so that more than 47 storage rings are in operation. As seen prominently in the figure, Africa is presently the only habitable continent without a LS. Dozens of scientists from African countries now perform experiments at facilities in Europe and elsewhere. Their numbers are limited mostly by distance and travel costs. A LS in Africa would enable thousands of African scientists, engineers and students to gain access to this superb scientific and technological tool. Indeed, in order to be competitive socially, politically and economically in the years to come, access to a nearby LS will be an absolute necessity.

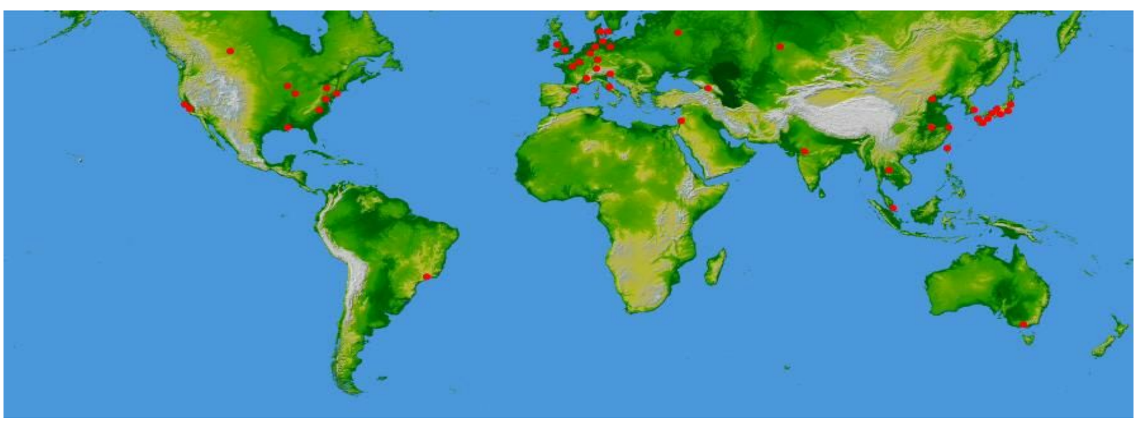

Figure: Locations of Synchrotron Light Sources[1]

[1] Source: lightsources.org/cms.

Grenoble Resolutions towards the African Light Source

1. Advanced light sources are the most transformative scientific instruments similar to the invention of conventional lasers and computers.

2. Advanced light sources are revolutionizing a myriad of fundamental and applied sciences, including agriculture, biology, biomedicine, chemistry, climate and environmental eco-systems science, cultural heritage studies, energy, engineering, geology, materials science, nanotechnology, palaeontology, pharmaceutical discoveries, physics, with an accompanying impact on sustainable industry.

3. The community of researchers around the world are striving collaboratively to construct ever more intense sources of electromagnetic radiation, specifically derived from synchrotron light sources and X-ray free-electron lasers (XFELs), to address the most challenging questions in living and condensed matter sciences.

4. The African Light Source is expected to contribute significantly to the African Science Renaissance, the return of the African Science Diaspora, the enhancement of University Education, the training of a new generation of young researchers, the growth of competitive African industries, and the advancement of research that addresses issues, challenges and concerns relevant to Africa.

5. For African countries to take control of their destinies and become major players in the international community, it is inevitable that a light source must begin construction somewhere on the African continent in the near future, which will promote peace and collaborations among African nations and the wider global community.

Vision

For Africa to construct, operate, maintain and continuously enhance a world class light source facility on the African soil for the benefit of the scientific community of the member states and of the scientific community at large in order to stimulate and support the development and growth of knowledge-based socio-economic systems to improve the quality of human life and sustainable environment.

Mission

To support and facilitate the development and growth of light source based science in Africa, thereby contributing to excellence in science, innovation, social and industrial development, via the following:

a. Driving the implementation of the Roadmap towards the African Light source
b. Developing human capital, including enhancing education, attracting world class talent to Africa, attracting back the African scientific Diaspora (brain gain), thereby mitigating the brain drain of young Africans who have recognised this as a key research tool for their career development
c. Developing key and/or strategic international collaborations
d. Ensuring financial support for Africans to access international light source facilities
e. Promoting awareness and use of light source science and its capacity to enable the exploration of new frontiers of science and technology.

Roadmap Summary for an African Light Source

In order to make its vision a reality and fulfil its mission, the AfLS Steering Committee decided upon the following short-, medium-, and long-term goals:

a. ***Short-term (0-3 years)***

The short term goals focus on the following issues: building awareness of the benefits of light source based research; enhancing education; developing human capacity; developing international collaborations, linkages and partnerships related to light sources; promoting mobility and access to current light sources; developing local infrastructural capacity to support access to light sources; and building formal structures and procedures in support of the Roadmap.

i. Promote human capacity development in Africa by doing the following:
    1. Encouraging and training large numbers of scientists, engineers, technicians, students in fundamental, as well as applied, light source science.
    2. Developing and expanding the LS user community.
    3. Growing and enhnacing the relevant engineering technical expertise.

ii. Encourage and commit to light source radiation studies at existing international facilities.

iii. Form focused formal relationships/memberships with existing LSs.

iv. Promote the involvement of industry via the appointment of Liaison(s) between the AfLS Steering Committee and the business sector.

v. Establish a viable communication structure for the African light source science community.

vi. Promote outreach and communication around light source based science.

vii. Establish and enhance the current and needed critical feeder infrastructure that empowers light source science, which ultimately allows for the generation of successful proposals to LSs and the training of students.

viii. Study the feasibility of constructing African multinational beamlines at existing LSs, perhaps with partners from other regions of the world.

ix. Develop a Strategic Plan for submission to African Ministries.

x. Convene a Meeting to present the African Light Source Strategic Plan, launching the establishment of the Pre-Conceptual Design Report (Pre-CDR, non-site specific, candidate sites only) which specifies the scientific case and the characteristics of the future light source, including accelerator complex specifications, experimental beamlines and ancilliary facilities, and in parallel developing a detailed Business Plan. Those attending should include African Ministers of Science, Technology, Health, Education, Culture, Agriculture, Energy and Natural Resources; representatives from the African research community; and other international stakeholders and interested parties.

b. Medium-term (0-5 years)

i. Continue all the activities towards the Short-Term Goals as required.
ii. Evolve the Steering Committee to become a mandated AfLS Task Team.
iii. Conduct a feasibility study, including costs, for an African fourth generation LS, with requisite infrastructure (including such items as information technology and guest housing).
iv. Develop a detailed Business Plan.
v. Develp a Governance Model.

c. Long-term (0-beyond 5 years)

i. Continue all the activities towards the Short- and Medium-Term Goals as required.
ii. Complete the Technical Design Report (TDR). This includes the site selection and the establishment of the AfLS as a legal entity. When approved by a sufficient number of African governments, begin the construction of an African fourth generation LS, with requisite infrastructure.

Conclusion

LSs have been of tremendous benefit to many countries' socio-economic development. In particular, Brazil and Taiwan began planning the construction of LSs more than twenty (20) years ago when they were considerably less developed than they are now. Despite those countries' limited experience with accelerators, limited funds, and small initial light source science user communities, they enthusiastically endorsed the construction of LS facilities. A major benefit of the LSs that they built is that many mid-career scientists and engineers have returned home, thus reversing the brain drain. An AfLS would surely lead to a similar brain gain in Africa.

Finally, a LS called Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME) is now under construction in Jordan as a collaboration of nine Middle East governments, namely Bahrain, Cyprus, Egypt, Iran, Israel, Jordan, Pakistan, Palestinian Authority, and Turkey. SESAME is closely modeled after CERN, is being developed under the auspices of UNESCO, and is scheduled to start research in 2016. Indeed, Africa should consider adopting the CERN/SESAME model.