Building a brighter future for Africa with the African Light Source

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Africa is the only habitable continent that is not yet host to a light source — an important tool across disciplines. Scientists from the Executive Committee of the African Light Source Foundation discuss work towards building an advanced light source in Africa, and what remains to be done.

Africa has a population of over 1 billion that is projected to outpace the rest of the world in the next 100 years. Likewise, there is a growing need for innovation to address the challenges that impact the lives of many Africans today[1]. Meeting these challenges calls for investment in science, technology and innovation, including large-scale research infrastructure. To help answer this need, the African Light Source (AfLS) Foundation, along with its partner organizations, is working to establish the first advanced light source on the African continent[2].

An advanced light source is a source of electromagnetic radiation that can generate exceptionally intense beams of X-rays, ultraviolet and infrared light. Advanced light sources derived from either synchrotron or free-electron laser sources underpin innovation in topics including condensed-matter physics, biological processes, advanced materials, soft matter, drug design, catalysts, electronic devices, structural engineering and heritage science[3–5]. Light sources are important for studying viruses and have played a pivotal role in understanding the SARS-CoV-2 virus[6]; the current pandemic has highlighted the importance of each continent having facilities for developing medical interventions.

Among large-scale scientific infrastructures, light sources support one of the widest and most diverse set of researchers, numbering over 30,000 in Europe alone and many thousands of accesses to each facility every year. Light sources have the additional value of facilitating retention of talented early- and mid-career scientists for whom they are a key research tool for their development. Having an African light source would challenge the current dependence of African scientists on the use of existing light sources on other continents.

Large-scale infrastructure such as an advanced light source can also benefit the entire African continent, not just the host country. The socio-economic impact of building an advanced light source include human capacity development, the development of local and regional infrastructure that is capable of both excellent research and able to act as feeder infrastructure for the advanced light source, a competitive industry advantage that accrues from involvement in the light source, big data analytics capacity, innovation and other benefits that create wealth in its widest terms for all of Africa.

There is certainly appreciation in Africa for large-scale research infrastructure and the benefits that it brings. Such appetite can be seen in the SKA (Square Kilometre Array) project, with substantial African funding, as well as the strong and growing African participation in a variety of international large-scale infrastructures, such as CERN, Joint Institute for Nuclear Research (JINR), astronomical observatories and, of course, synchrotron facilities including European Synchrotron Radiation Facility (ESRF) and Synchrotron-light for Experimental Science and Applications in the Middle East (SESAME).

Inclusive approach for an African light source

The key enabling principle that is uniquely African is the Ubuntu approach, which is best described as the embodiment of the ethical harmony of a person's identity with their community or natural environment. It is centred around the values of inclusivity, fairness, tolerance, democracy, honesty, equity, consultation and empathy. This principle is a unifying force at the heart of AfLS, primarily because the AfLS project represents an important step towards a more equitable African participation in global science accompanied by technological skills for innovation and growth. This view is shared by the majority of Pan-African organizations and was affirmed during the first African Higher Education Summit[7].

In practice, the AfLS governance structure consists of an International Advisory Committee and an Executive Committee that collectively fulfil the AfLS mission as outlined in the AfLS Roadmap[8]. There are several implementation committees for specific areas of the Roadmap. The Roadmap has community-driven components, such as capacity building, conferences and workshops, deep training through extended working visits to partner international synchrotrons, the growth of the African user base and also establishing the necessary research networks. There are also programmes that develop the local and regional research infrastructure and its access

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more broadly. The AfLS is also engaged in high-level conversations with African governments, pan-African organizations, science academies and national and pan-African professional bodies for each relevant discipline. The AfLS has representation and support from countries and regions including Egypt, Ethiopia, Ghana, Nigeria, Rwanda, Senegal, South Africa, Zimbabwe, the Caribbean, Europe, Japan, UK and USA. Their development is crucial to fostering discussions and decisions between African countries on key points such as site selection, funding and members' rights and obligations.

The AfLS has received expressions of support from and has collaborated with several science professional associations and science academies including the African Physical Society, Federation of African Societies of Chemistry, African Materials Research Society, Federation of African Societies of Biochemistry and Molecular Biology, Biostruct Africa, Federation of African Immunological Societies, Federation of African Medical Physics Organizations, the newly launched African Crystallographic Association, and several others including the East African Association for Palaeoanthropology and Palaeontology, and the Network of African Academies of Science. The President of Ghana, His Excellency Nana Akufo-Addo, has committed to be a champion of the African light source project, not only in his own government, but also in the Economic Community of West African States and the African Union. The AfLS works with these organizations in this common goal. An important aspect is that the dominant funding for an African light source should be derived from full participation of African governments. As is the case for any large scientific investment, it will take time to develop this level of understanding and commitment from African governments. The interim roadmap towards the African light source however will benefit from external contributions to ensure continued momentum and progress.

Progress towards the goal

A milestone on the AfLS roadmap is the completion of the Conceptual Design Report (CDR) and Technical Design Report (TDR), documents that articulate the need and potential designs for the light source. The audience for the CDR includes policymakers, politicians, academics, engineers, technicians, business persons, industrialists, financiers, strategic thinkers, potential stakeholder organizations and the general public. The CDR is currently in preparation by the international writing team as appointed by the AfLS Executive Committee and is scheduled for publication later in 2022. It is accompanied by widespread inclusive solicitation of input and participation from Africa and any interested person abroad. Completion of the CDR will facilitate concrete dialogue with the African Union, African governments, Pan-African organizations, and relevant national and international organizations regarding the choice of design and potential location of the advanced light source facility. As the CDR sets the preconditions that must be in place for consideration to construct an African light source, a site selection process will occur after completion of the CDR but sometime before the TDR. Site selection for large-scale scientific infrastructures normally proceeds via a competitive bidding process similar to the approaches used for the ITER and SKA projects where African countries will submit bids to host the advanced light source from which the most favourable is selected.

Progress toward an African light source will also benefit from significant investment in local and regional infrastructure with a bolstered and upskilled workforce to build the human and infrastructure capacity in Africa so that an African light source is well supported by a local userbase. This will help to reverse the trend of African scientists drawn away to employment outside of Africa. Continuity of training programmes, such as START[9], LAAAMP Africa and the participation of African nations in existing facilities such as the SA-ESRF Scientific Associateship, the African partnership with SESAME light source through the AfLS, the IUCr OpenLABS project and other programmes to develop the next generation of synchrotron users are also important means to develop the local userbase.

Greater utilization of existing overseas national light source facilities by African scientists in the form of dedicated African beamlines or remote access beamtime would enable scientific, engineering and technical skills development in synchrotron science, accelerator science and instrumentation. In addition, 50/50 jointly funded sandwich programmes for African students and sabbatical visits for African staff to synchrotron facilities and build deep skills will encourage embedding of synchrotron skills in Africa. Regional and pan-African participation as full members in the respective governing bodies of national light source facilities will develop governance experience and raise awareness of the African light source. Such experience will springboard coherent join funding applications to international funding streams, to develop local and regional feeder facilities.

There has been excellent progress towards the realization of an African light source. Working in the spirit of Ubuntu in Africa and with Africa's friends and partners, a large-scale advanced light source has all the potential of being built and operated in Africa, by Africa and for Africa in the very near future.

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Competing interests
The authors declare no competing interests.