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Member, Executive Committee, AfLS Foundation
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November 16, 2022
World Map of advanced Light Sources

More than 50 advanced light sources are in operation, construction or planning. The map shows most of them.

As the map shows, there are none in the entire continent of Africa, and only one in Latin America.
Ghana to champion African Light Source – Akufo-Addo

Ghana will champion the African Light Source (AfLS) to make it an official project of the African Union (AU) and ECOWAS, President Nana Addo Dankwa Akufo-Addo, has said.

President Akufo-Addo made the disclosure on Tuesday, in a speech read on his behalf at the opening of the conference on ‘Towards a Lightsource for the African Continent’ held at the West African Science Service Organization and Alliance for deltas (WASOD) in Accra.
Bottom Up Training

https://laaamp.iucr.org/
Bottom Up Training  X-Tech Lab, Benin (https://www.xtechlab.co/)

Pan-African Students, 2 weeks, 2 x /yr

Crystallography, X-ray Diffract, Tomography, Math Engineering
Bottom Up

Capacity in Africa

START is a collaborative project that seeks to foster the development of Synchrotron Techniques for African Research and Technology.

Two lines of scientific investigation:
1. New energy materials (e.g., solar cells, novel catalysts)
2. Structural biology studying diseases and develop drug targets.

Jump-start Africa’s entry into synchrotron based bioscience. SA, Lesotho, Ethiopia participation so far ......
Bottom up  African Laser Centre Founders, Johannesburg, 2003
# ALC Founding Nodes

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<th>Facility</th>
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<td>National Laser Centre</td>
<td>Pretoria, South Africa</td>
<td>Manufacturing, Machining, and Materials Processing</td>
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<tr>
<td>University of Cheikh Anta Diop</td>
<td>Dakar, Senegal</td>
<td>Atomic and Molecular Physics and Laser Spectroscopy and Processing</td>
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<tr>
<td>Laser and Fibre Optics Centre</td>
<td>Cape Coast, Ghana</td>
<td>Agricultural and Environmental Science</td>
</tr>
<tr>
<td>National Institute of Laser Enhanced Science</td>
<td>Cairo, Egypt</td>
<td>Medical and Biological Applications of Lasers</td>
</tr>
<tr>
<td>Tunis el Manar University</td>
<td>Tunis, Tunisia</td>
<td>Plant and Environmental Science and Molecular Spectroscopy</td>
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<tr>
<td>Advanced Technologies Development Centre</td>
<td>Algiers, Algeria</td>
<td>Laser Spectroscopy and Surface Studies</td>
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Conceptual Design Report

Motivation for an African Light Source
# The Africa Light Source Foundation
Towards a Lightsource for the African Continent

## Editorial Staff

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The Africa Light Source Foundation
Towards a Lightsource for the African Continent

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Chapter 1: Overview and Description of an Advanced Light Source

The Electromagnetic Spectrum

EM spectrum compared to well-known objects and sources of radiation
(Figure courtesy of Lawrence Berkeley National Laboratory, USA)
Chapter 2: Scientific Benefits

2.1 Structural Biology

2.1.3 Role of Synchrotron Light Sources in Studying Infectious Diseases Prevalent in Africa

2.2 Materials for Energy Applications

2.2.2 Solar Energy
2.2.3 Rechargeable Batteries

2.3 Geoscience

2.4 Environmental Science

2.5 Plant and Soil Science

2.6 Palaeontology and Archaeology
Distribution of African Earth science sample materials that have been investigated utilising synchrotrons  
(Figure from Bjorn von der Heyden)
Chapter 3: Social and Economic Benefits

Justifications for large-scale Research Infrastructures RIs

- Expectations & Arguments have changed over time

RIs need major long-term investments

- "Grand challenges" of "S&T driven"
  - Scientific benefits
  - Curiosity-driven
  - Diffusion of Technology

- "Big science"
  - top-down agendas related to national security and national ambitions:
    - e.g. U.S. Manhattan Project, the French Nuclear Program, the Apollo Program
  - also big labs, e.g. CERN

- History of Big Science Infrastructures
  (Figure Courtesy of DESY)

- "grand societal challenges":
  - climate crisis
  - health
  - aging society
  - SDGs

- also industrial requirements must be addressed

Time:
- 1940s/50s/60s
- 1970s/80s/90s
- 2000/2010+
Social and Economic Benefits (cont’d)

3.1.1 Disease Prevention and Cure

3.1.2 Food Security

*Improvements in food and packaging characterisation; structure determination of products, including chocolate, oils and fats; and determining the oxidation states of products used for agriculture.*

3.1.3 Clean Energy

*AfLS would prove to be a powerful tool for developing materials and processes, including batteries, fuel cells, catalysts and catalytic processes.*

*AfLS would characterise sources of ecological damage, such as CO$_2$ and asbestos, and develop catalysts and materials to convert them to less harmful products.*

3.2 Economic Benefits

*According to Andrew Harrison, Former CEO, Diamond Light Source*

“For every English pound put into the facility, 3.5 pounds come back into the economy.”
Chapter 4: History of the African Light Source

- 1990: First publications from Egypt then SA
- 1995: Letter to SA-NRF
- 2000: SA Synchrotron Initiative
- 2005: 1st formal Pan-African call. AfLS is in the ALC launch docs
- 2010: Global conversations about the AfLS
- 2015: Formation of AfLS Interim Steering Committee

First African HE Summit: AfLS in the Declaration

- AU: STC-EST, AAS call to support AfLS as a Pan African initiative
- AU: Exec Council call to support AfLS as a Pan African initiative
- Ghana Govt support

AfLS Foundation Legal Entity

Many AfLS Roadmap related activities
The Africa Light Source Foundation
Towards a Lightsource for the African Continent

Group Photo of the 1st African Light Source Conference and Workshop
ESRF, Grenoble, France, 2015
Why is an AfLS essential?

The Grenoble resolutions

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

- Advanced light sources are revolutionising a myriad of fundamental and applied sciences, with an accompanying impact on sustainable industry.

- 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.

- 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.

- 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 collaboration among African nations and the wider global community.
Papers Published by AfLS Participants
Chapter 5: Local Technical Infrastructures and Human Capacity Building

5.1 African Laser Centre (ALC, https://africanlasercenter.org/)
   
   To Transform the Laser Community in Africa

5.2 Atomic, Molecular and Optical Sciences Network (LAM Network)

   To Develop Optics and Photonics in Africa (https://lamoptinet.org/)

5.3 Lightsources for Africa, the Americas, Asia, Middle East and Pacific (LAAAMP, https://laaamp.iucr.org/)

   To Enhance the Utilisation of Crystallography and Advanced Light Sources in the Developing World

5.4 X-TechLab (https://www.xtechlab.co/)

   To Transform Crystallography Research and Training in Africa
Local Technical Infrastructures and Human Capacity Building (cont’d)

5.6 ICTP School on Synchrotron Light Sources and their Applications
   [https://indico.ictp.it/event/10057/](https://indico.ictp.it/event/10057/) 23 Jan – 3 Feb 2023 (Free Virtual School)

5.9 African Crystallographic Association
   (AfCA, [https://www.iucr.org/outreach/africa/afca/](https://www.iucr.org/outreach/africa/afca/))
   To advance science on the African continent via crystallography

5.10 BioStruct-Africa ([https://www.biostructafrica.org/](https://www.biostructafrica.org/))
   To build capacity in the field of structural biology for Africa-based scientists.

5.11 Synchrotron Techniques for African Research and Technology
   (START, [https://start-project.org/](https://start-project.org/))
   Seeks to foster the development of synchrotron techniques for African research and technology, with initial emphasis on structural biology and energy materials.
Continued Support from the African Physical Society

Inaugural AfLS Council, Dakar, Senegal, January 2010
**Chapter 7: Proposed Statutes of the African Light Source**

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Chapter 8  4th Generation Synchrotron Light Source Accelerator

Explain why 4th Generation Multi-Bend Achromat (MBA) lattices improve electron beam emittances compared to 3rd Gen.

Describe a prototype 3 GeV, ~500 meter, ~100 psec horizontal emittance storage ring.

Describe Ancillary Requirements

  Offices
  Food Services
  Guest Housing
  Water
  Waste Disposal

Describe Electrical Power Plant

  Provide schematic for a nominal 10 MW Solar Power Plant à la SESAME.
Chapter 9: Integrated Science and Technology Park

The bigger picture – the Harwell Campus

Facilities
Support Labs
Challenge-focussed institutes
Over 100 companies co-located and growing
Chapter 10: Recent Beamline Experiments Sponsored by LAAAMP

10.1 Study of Diagenesis in Ancient Egyptian Bones
Ahmed El-Hussein and Mostafa Zeidan (Student)
National Institute of Laser Enhanced Sciences, Cairo University, Egypt
Research Conducted at the ALBA Advanced Light Source, Barcelona, Spain

10.2 Study of Materials for Possible Energy Applications
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Research Conducted at the ESRF, Grenoble, France

10.3 Study of Nano-Crystalline WC-Co Films
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Research Conducted at the Synchrotron Light Research Institute
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Recent Beamline Experiments Sponsored by LAAAMP (cont’d)

10.4 Determining the Spectra and STXM Images of HAp, TiO$_2$ and the Composite HAp/TiO$_2$

Maria Josefina Robles Águila and Ana Karen Sánchez Hernández (Student)
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Research Conducted at the Canadian Light Source

10.5 Applications of XAS to Studies of ZnS Sphalerite Material and Cameroon Volcanic Ashes

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Chapter 11: Summary

To be extracted from

The Concept of Ubuntu and African Identity in the Development of Initiatives in Africa

by

Gihan Kamel, Oumar Ka, and Prosper Ngabonziza
THANKS FOR YOUR KIND ATTENTION!

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