

Nuclear Physics in Africa – Education, Research and Challenges

Iyabo Usman

Leader: Nuclear Structure Research Group

School of Physics

University of the Witwatersrand, Johannesburg

South Africa

<https://www.wits.ac.za/physics/research-areas/nuclear-and-radiation-physics/>

Outline

- Nuclear Physics Research Facilities in Africa
- Roles of African Government Policies towards the advancement of science, technology, and innovation
- Focus on Nuclear Physics Education, Training and Research in South Africa

Nuclear Physics Research Facilities in Africa

Accelerators and Cyclotrons

- Accelerator-Based Neutron Sources: Blue (146 with **3** in Africa)
- Boron Neutron Capture Therapy (BNCT) facilities: Orange (29 with **0** in Africa)
- Electrostatic Accelerators: Red (322 with **7** in Africa)
- Synchrotron Light Sources: Light Blue (60 with **0** in Africa)
- X-ray Free Electron Laser Sources: Yellow (14 with **0** in Africa)

<https://nucleus.iaea.org/sites/accelerators/Pages/Interactive-Map-of-Accelerators.aspx>



Country	Facility	Category	Incident Particle	Target	CW Operation	Pulse Operation	Max. Neutron Energy (MeV)	Max. Source Strength (n/s)	Max. Current (A)	Max. Exp. Neutron Flux (n/s/cm ²)
South Africa	RFQ	CANS	d	D		Yes	5		0.03	1.00e+04
	SSC	CANS	p	Be, Li		Yes	200	1.00e+04	3e-07	
	van de Graaff	CANS	p, d		Yes		3.8		0.0001	

Nuclear Physics Research Facilities in Africa

Research reactors

- Heavy Water: ES-SALAM in Algeria
- Pool: ETRR-2 in Egypt
- MNSR: GHARR-1 in Ghana and NIRR-1 in Nigeria
- Critical Assembly: TNRC Critical Facility in Libya
- TRIGA MARK-II: MA-R1 in Morocco
- Tank in Pool: SAFARI-1 in South Africa

ES	ES-SALAM Type: HEAVY WATER	Algeria City: Djelfa	Operational
NI	NIRR-1 Type: MNSR	Nigeria City: Zaria	Operational
TC	TNRC Critical Facility Type: CRIT ASSEMBLY	Libya City: Tajoura	Operational
MA	MA-R1 Type: TRIGA MARK II	Morocco City: Rabat	Operational
GH	GHARR-1 Type: MNSR	Ghana City: Accra	Operational
SA	SAFARI-1 Type: TANK IN POOL	South Africa City: Pretoria	Operational
ET	ETRR-2 Type: POOL	Egypt City: Cairo	Operational

Out of 220 Operational Research Reactors in the world, 7 in Africa

Nuclear Physics Research Facilities in Africa

Neutron Beam Instrument

- Neutron Scattering Instrument: **4** in Africa Out of 370 worldwide
- Neutron Imaging Instruments: **4** in Africa out of 55 worldwide
- Cold neutron Source: **0** in Africa out of 26 worldwide
- Neutron Activation Analysis Facilities:

Industrial Irradiation Facilities

- Gamma Irradiators: **5** in Africa out of 184 worldwide
- E-Beam Irradiators: **1** in Africa out of 110 worldwide

Fusion Devices

- Out of 96 operating worldwide
- LIBTOR: Libya
- EGYPTOR Tokamak: Egypt

Roles of African Government Science Policies

- Government supports and funding towards Nuclear Education, Training and Research- From Policy Management to Implementation
- Human capacity developments in science, technology and innovation
- Role of IAEA, AFCONE, AFRA-NEST, etc
- Outreach and Community Engagements/Interventions
- Enabling environment for research and development
- Research to Innovation supports

Nuclear Physics Education and Training in South Africa- Current Status

- Universities with Nuclear related program
 - University of the Witwatersrand
 - University of Cape Town
 - Stellenbosch University
 - University of Western Cape
 - University of Johannesburg
 - University of Pretoria
 - North-West University
 - University of Zululand
 - Rhodes University
 - University of South Africa
- Nuclear infrastructure for Research and Training
 - iThemba LABS (Cape Town and Johannesburg)
 - National Metrological Institute South Africa (NMISA)
 - Nuclear Energy Corporation of South Africa (NECSA)
- Nuclear Energy Infrastructure
 - Koeberg Nuclear Power Plant

Nuclear Physics Research Area in South Africa

- **Experimental Nuclear Structure:** Light-ion induced medium-energy reactions with investigations ranging from Nuclear structure, Nuclear reactions, Nuclear cluster and Nuclear astrophysics using K600 Magnetic Spectrometer, Nuclear Chirality and superdeformation using AFRODITE, Electron Spectrometer, GAMKA Detectors, and High-energy Neutron experimental Facility at iThemba LABS SSC Cape Town and TANDEM Accelerator iThemba LABS Gauteng.
- **Accelerator Mass Spectrometer (AMS) at iThemba LABS Gauteng**
- **Theoretical Nuclear Physics:** Nuclear Few-Body system
- **Applied Nuclear Physics:** Environmental Radiation in collaboration with Centre for Nuclear Safety and Security (CNSS) at NNR, Nuclear Forensics, Medical Physics and Nuclear Medicine.
- **Reactor Physics:** Reactor Safety Analysis using MCNP, SCALE-VI, OSCAR5, GEANT4, Reactor Thermal-hydraulic Analysis using RELAP5
- Nuclear Material Research using SAFARI-1 Reactor Neutron Activation Analysis (NAA) at Necsa, **South African Isotope Facility (SAIF) Project:**

South African Fact Sheet 2020

Human Capacity Developments

<https://physics.aps.org/articles/v13/176>

SOUTH AFRICAN RESEARCH FACTSHEET

R&D spending in 2017

\$2.8 billion, or 0.83% of GDP
(US: \$476 billion, or 2.7% of GDP)

Source: UNESCO

Researchers per million inhabitants

518 (US: 4217)

Source: NACI 2020 STI indicators

Number of physicists

500–600

Source: South African Institute of Physics

Number of physics PhDs per year

39 in 2015

Source: Government scientometric report

Recent Developments and Conferences in South Africa

The IAEA and South Africa's Laboratory for Accelerator Based Sciences, NRF-[iThemba LABS](#), have signed a major agreement to collaborate on achieving major goals regarding accelerator-based sciences and training. The press release can be found here: <https://www.miragenews.com/iaea-south-africas-ithemba-labs-to-work-671783/>



The 28th International Nuclear Physics Conference (INPC2022) will be held at the Cape Town International Convention Centre in Cape Town, South Africa from 11 to 16 September, 2022.

<https://196.24.234.38/event/110/program>

Advanced Nuclear Science and Technology Techniques (ANSTT4) Workshop

9-13 May 2022
Auditorium
Africa/Johannesburg timezone

Overview

Thematic Programme

Sponsors

Photo Gallery

Support

anstt2020@tlabs.ac.za

Thematic Programme

Accelerator Mass Spectrometry

Metrology and Applications

Environmental Measurements

2nd African Nuclear Physics Conference (ANPC2021)



African Physics Newsletter

Produced by and for African Physicists, APS publishes the [African Physics Newsletter](#) to facilitate communication among physicists across Africa and highlight physics news and research from the continent to a broader international community.



Future Energy Sources?

- Small Modular Reactors
- Clean Hydrogen

