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**Event: Symposium on Science at the Paarl Africa
Underground Laboratory (PAUL)**

Date: 15 January 2024

**Venue: Du Kloof Lodge, Du Toitskloof Mountains,
South Africa**



- ❖ A few words about Botswana.
- ❖ Brief introduction to the Botswana International University of Science and Technology (BIUST).
- ❖ Envisioning the Botswana Institute for Nuclear Science and Technology (BINST).
- ❖ Proposed Accelerator Facilities.
- ❖ Proposed Laboratories and Supporting Facilities.
- ❖ New Educational Programmes in Nuclear Science and Technology.
- ❖ Human Capital Development in Nuclear Science and Technology.
- ❖ Participation in Projects at the Paarl Africa Underground Laboratory (PAUL).



Botswana





- ❖ Gained independence from Britain on 30 September 1966.
- ❖ ~2.6 million people; same size as France (581,730 km², 45.6% zoned for agricultural production); middle-income country.
- ❖ Landlocked country; topographically flat, with approximately 70% of its territory being the Kalahari Desert.
- ❖ Known for political stability and good governance.
- ❖ World's biggest producer of diamonds by value.
- ❖ The Okavango Delta is the world's largest inland river delta, flooding over 15,000 km² on a seasonal basis.
- ❖ Largest elephant concentration in Africa (~131,900).
- ❖ Economy dominated by mining, beef, and tourism.
- ❖ Vision 2036 defines Botswana's aspirations to transform from upper middle-income country to high-income country by 2036.
- ❖ Botswana is one of 8 African countries partnering with South Africa to host Square Kilometre Array (SKA) radio-astronomy project.



- ❖ Government university located in Palapye:
 - Entrepreneurial, research-intensive university focusing on science, engineering and technology;
 - 2,500 hectare campus;
 - Graduated 1st cohort of students in 2017;
 - Celebrated 10th anniversary in September 2023.
 - ~ 2,000 students (aim to reach 6,000);
 - All lecturing staff have a PhD degree.
- ❖ BIUST is (or will be) hosting the following national projects:
 - Botswana's first satellite (launch in October 2024);
 - Africa Very-Long Baseline Network (AVN) and SKA radio-astronomy projects;
 - Coal beneficiation project;
 - Medical drones project;
 - Botswana Institute for Nuclear Science and Technology (BINST);
 - First Noble Gas Analysis Facility in Africa for analysis and managment of groundwater resources on the continent.



Envisioning the Botswana Institute for Nuclear Science and Technology (BINST)

- ❖ We recognize that the societal benefits of deploying non-energy nuclear radiation technologies are tremendous.
- ❖ Nuclear Science and Technology (NST) holds great development potential to meet the objectives of the African Union’s Agenda 2063 and the Sustainable Development Goals (SDGs) of the United Nations on the continent.
- ❖ NST has the potential to support socio-economic development in diverse sectors (such as health, food and agriculture, security, mining) and to contribute towards a building a knowledge-based economy in alignment with Botswana’s Vision 2036, the National Mindset Change Campaign, and the National RESET Agenda.
- ❖ Botswana intends to capitalize on the deployment of nuclear technologies for contributing to the national development goals by establishing the Botswana Institute for Nuclear Science and Technology (BINST).



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BIUST TO ESTABLISH BOTSWANA INSTITUTE FOR NUCLEAR SCIENCE & TECHNOLOGY

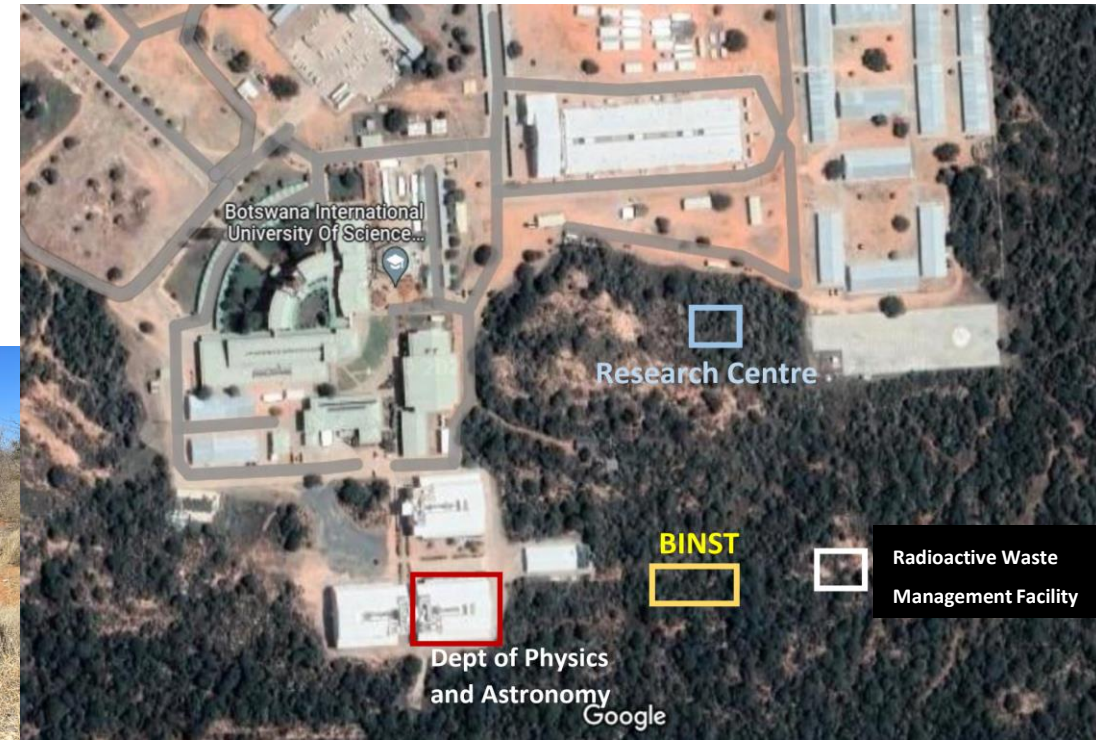
The institution is working closely with the International Atomic Energy Agency as Botswana takes a grand leap into the world of nuclear science and technology.





Envisioning the Botswana Institute for Nuclear Science and Technology (BINST)

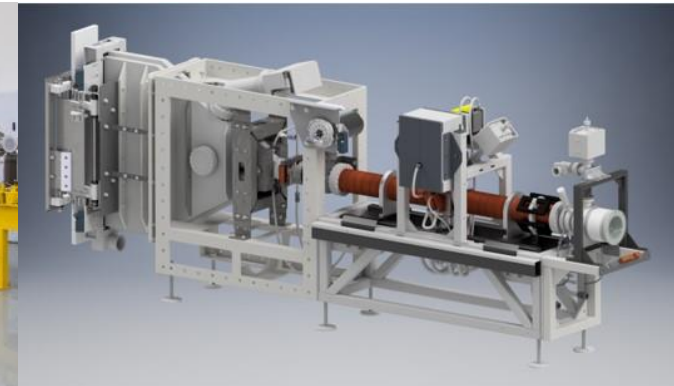
- ❖ The Botswana Institute for Nuclear Science and Technology (BINST) will consist of accelerator facilities and state-of-the-art laboratories that will be operated and used by specialized human capital, focusing on undertaking locally relevant and globally competitive, multidisciplinary, research and education in Nuclear Science and Technology to support Botswana's social and economic development needs in several sectors, including: health, agriculture, manufacturing, mining, water resources management and sanitation.
- ❖ BIUST is working closely with the International Atomic Energy Agency (IAEA) through National Project BOT1001 to develop: a costed business plan, human capital, and educational programmes in nuclear science and technology.
- ❖ Site for BINST and a radioactive waste management facility have been identified on the BIUST campus and included in the campus masterplan.





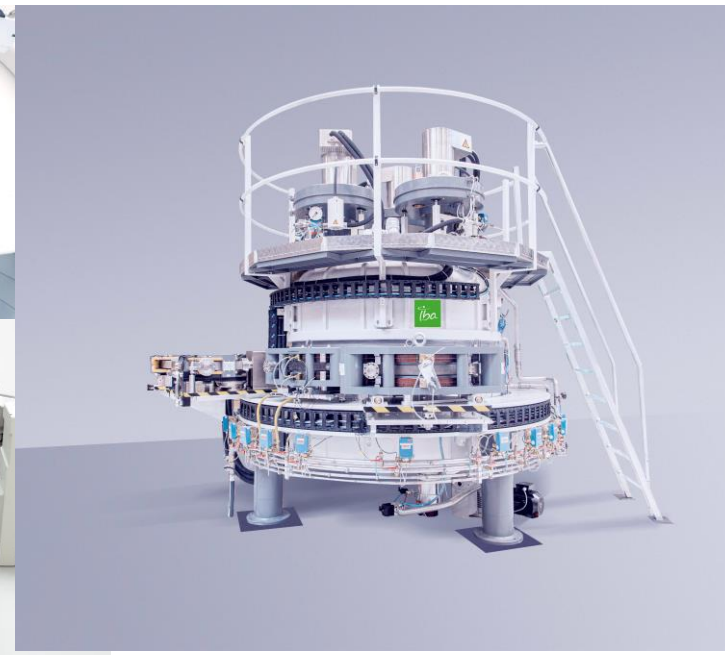
National Accelerator Facilities

- ❖ 3 MV tandem particle accelerator
- ❖ 5 - 10 MV electron accelerator and X-ray facility
(Feasibility studies currently undertaken by IAEA and USA Department of Energy; interested investor)



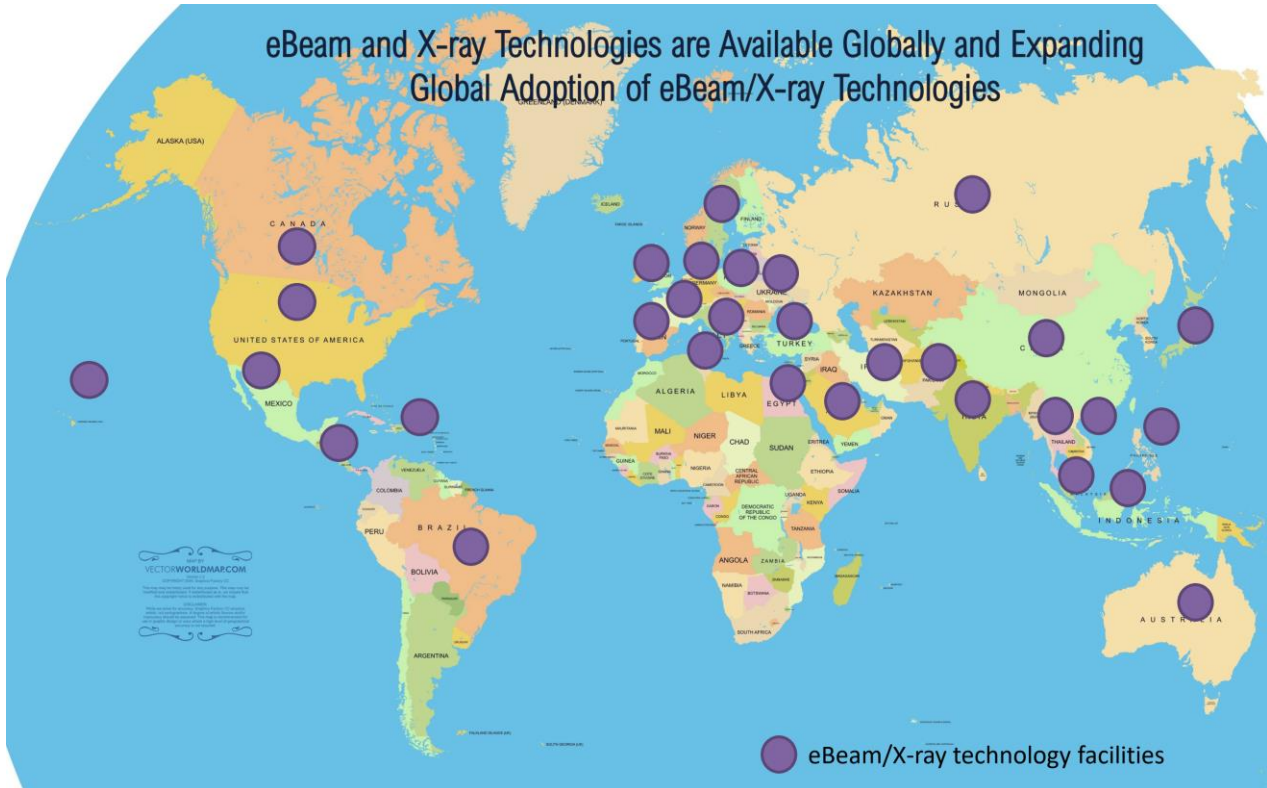
National Facilities for Cancer Therapy and Production of Radiopharmaceuticals

- ❖ 18 MeV compact proton accelerator
(production of PET isotopes; interested investor)
- ❖ 230 MeV proton cyclotron (proton therapy)





Severe Shortage of Accelerator Facilities in Africa



Industrial Electron Beam and X-ray Facilities



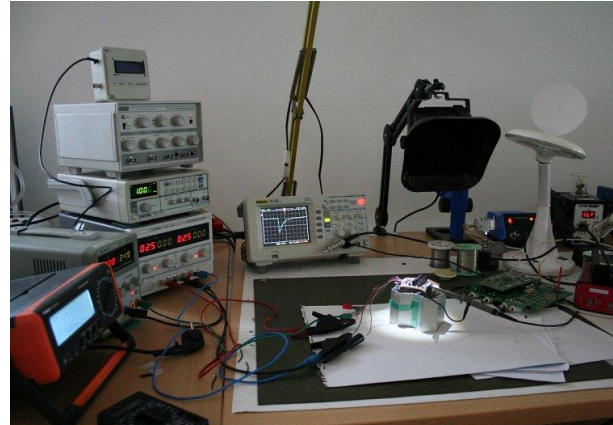
Electrostatic Accelerators

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



Proposed Laboratories and Supporting Facilities

- ❖ Multidisciplinary NST teaching labs
- ❖ Environmental nuclear metrology lab
- ❖ Laboratory for sterile insect technique
- ❖ Gamma radiation research lab
- ❖ Neutron generator facility (for coal characterization lab)
- ❖ Radioactive waste management facility
(Environmental Impact Assessment study)
- ❖ Isotope hydrology lab (including Noble Gas Analysis Facility)
- ❖ Secondary standard dosimetry lab
- ❖ Radiobiology lab
- ❖ Food pasteurization facility
- ❖ Radiochemistry lab
- ❖ Detector development lab
- ❖ Digital electronics and nuclear instrumentation lab
- ❖ Mechanical workshop



- ❖ From August 2024, the Department of Physics and Astronomy at BIUST will be offering the following newly accredited (by the Botswana Qualifications Authority) learning programmes:
 - BSc in Applied Physics with modules in Applied Nuclear Physics and Technology;
 - BSc (Honours) in Applied Physics with a specialization track in Applied Nuclear Physics and Technology;
 - Taught MSc in Physics with a specialization track Applied Nuclear Physics and Technology;
 - PhD (by research) in Physics, including Applied Nuclear Physics and Technology.

- ❖ Through IAEA expert assistance, we are currently developing new national Honours and taught Masters learning programmes in:
 - Applied Nuclear Physics and Technology (IAEA Expert visit in September 2023);
 - Radiochemistry (IAEA Expert visit in September 2023);
 - Radiobiology (IAEA Expert visit scheduled for April 2024).

- ❖ The above programmes will be jointly offered by all three public institutions in Botswana (BIUST, UB, BUAN).

- ❖ We have procured lab equipment through the IAEA to the value of 130,000 Euros (~2.6 million ZAR) for NST lab: delivery is expected in February 2024.



❖ We have access to access research facilities through partnerships with:

- The Botswana Radiation Protection Inspectorate;
- iThemba LABS (South Africa);
- The University of Witwatersrand (South Africa);
- The University of York (UK);
- Ruder Boskovic Institute (Croatia);
- Jožef Stefan Institute (Slovenia);
- King Saud University, Saudi Arabia;
- Institute of Nuclear Chemistry and Technology, Poland;
- Joint Institute for Nuclear Research, Russia.

❖ Postgraduate students:

- 6 MSc graduated (1st in 2018);
- 1 PhD graduated (2023);
- 5 MSc (3 awarded IAEA Marie Skłodowska-Curie Fellowships);
- 8 PhD (3 awarded IAEA PhD Sandwich Fellowships).

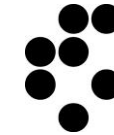
❖ Challenge: Botswana does not have national research funding agency.



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**iThemba
LABS**
Laboratory for Accelerator
Based Sciences



**Jožef Stefan Institute
Ljubljana, Slovenia**



- ❖ Through participation in the Paarl Africa Underground Laboratory (PAUL), BINST will be able develop human capacity in Nuclear Science and Technology for Botswana, the SADC region, and the rest of Africa by:
 - Establishing robust collaborative partnerships and projects;
 - Securing joint funding for research and prestigious postgraduate scholarships;
 - Joint training of MSc students, through accredited, taught learning programmes that involve hands-on activities (modelling, simulations, detection, data analysis) ;
 - Joint supervision of MSc and PhD students;
 - Attracting top undergraduate students through involvement with undergraduate research projects.
- ❖ We need to establish a strong and sustainable collaboration with PAUL to train postgraduate students through shared facilities.
- ❖ Once again, I want to thank the organizers for inviting me to this important symposium. I look forward to interacting with all participants.

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