Advanced Nuclear Science and Technology Techniques Workshop (ANSTT 6)

Report of Contributions

Contribution ID: **1** Type: **Oral**

Level-lifetime measurements as a probe of shapes and symmetries in nuclei.

The measurement of lifetimes of excited nuclear levels is an important technique for probing the details of internal nuclear structure. The electromagnetic transition rates extracted can be linked to the composition of the wavefunctions of the initial and final states involved, and also to nuclear shape (via $\beta_2$deformation), thereby allowing stringent tests of nuclear models. In recent years, arrays of LaBr3(Ce) detectors with sub-nanosecond timing capabilities have enabled precision electromagnetic transition rate determinations in some of the most exotic radionuclides. This talk will describe some recent measurements in A~100 nuclei and discuss the physics insights that have been obtained from interpreting the results.

Primary author: BRUCE, Alison (University of Brighton)

Presenter: BRUCE, Alison (University of Brighton)

Track Classification: Nuclear Structure Studies

Contribution ID: **2** Type: **Oral**

LEVERAGING CLIMATE DATA ANALYTICS FOR SUSTAINABLE ENVIROMENTAL SOLUTIONS IN KENYA AND BEYOND

Exploring Climate Variability and Environmental Trends and in Kenya and beyond Using an Interactive Data Dashboard

1Brown Kirsten Wekesa; 1Julian Ogondo
1Maseno University,
Private Bag
Maseno, Kenya
Email:kirstenbrown571@gamil.com;
jaogondo@gmail.com, jogondo@maseno.ac.ke

Kenya's climate system is characterized by strong spatial and temporal variability driven by interactions between topography, regional circulation systems, and broader global climate processes. These variations significantly influence agriculture, water resources, ecosystem stability, and overall environmental sustainability. Understanding these patterns requires analytical tools that can process large climate datasets while presenting findings in an accessible and scientifically meaningful format. This project analyzes historical climate variability in Kenya through the development of an interactive, data-driven dashboard designed to transform raw climate data into clear visual and analytical insights. Open-access climate datasets were used to examine key environmental variables, particularly surface temperature and precipitation trends across different regions and time scales. Data processing and statistical exploration were conducted using Python, while visualization and user interaction were implemented through a Streamlit-based web application framework. The analysis indicates a consistent warming trend across multiple regions of Kenya, alongside increasing variability in precipitation patterns. Observed shifts in seasonal rainfall distribution suggest growing uncertainty in water availability and agricultural planning cycles. Regional contrasts in climate behavior further highlight the need for localized analysis when assessing environmental risk and adaptation strategies. By converting complex datasets into an interactive and user-friendly interface, the dashboard bridges the gap between climate data and practical environmental understanding. The platform supports research, education, and informed decision-making by improving transparency and accessibility of climate information. This work demonstrates how interactive data systems can strengthen climate and environmental research capacity in Africa and contribute to evidence-based discussions on climate change adaptation and environmental management.

The link to this captivating project is:https://climate-dashboard-by-brown-awqze9mmv7pszcnvbl3pdy.streamlit.app/

Primary author: WEKESA, BROWN (STUDENT MASENO UNIVERSITY)

Presenter: WEKESA, BROWN (STUDENT MASENO UNIVERSITY)

Track Classification: Environmental Physics & Applications

Contribution ID: **3** Type: **Oral**

Electric monopole (E0) studies at iThemba LABS

Electric monopole (E0) transition studies focus on nuclear transitions between states of the same spin and parity (typically $0^+ \rightarrow 0^+$), which are critical for probing nuclear structure, shape coexistence, and deformation. The E0 strengths ($\rho^2(E0)$) are key parameters to understanding nuclear shape mixing and isomerism in various nuclei, including light, odd-A, and shape-coexistence in nuclei.
Because single-photon emission is forbidden, these transitions are measured via internal conversion electrons (ICE) or electron-positron pair formation (IPF), serving as a sensitive indicator of changes in the mean-squared charge radius.
As such, high-precision electron spectrometers (e.g., Si(Li) detectors) and detector arrays consisting of HPGe and LaBr3:Ce detectors are used to measure internal conversion coefficients (ICC) to identify E0 components.
iThemba LABS has, in the last 5 to 10 years, been developing spectrometers suited for E0 transition studies. This talk will focus on the in-house refurbishment of the existing solenoid magnetic lens into an electron and internal-pairs spectrometer, the in-beam experiment involving 30 MeV proton beam on a ^{50}Ti target aimed at investigating the excited 0_2^+ state in ^{50}Ti, as well as future experimental possibilities, for example when this facility will be used in conjunction with other existing spectrometers like the K600.

Primary author: CHISAPI, Maluba Vernon J. (iThemba LABS/Stellenbosch University)

Co-authors: JONES, Pete (iThemba LABS); AVAA, Abraham (iThemba/Wits)

Presenter: CHISAPI, Maluba Vernon J. (iThemba LABS/Stellenbosch University)

Track Classification: Nuclear Structure Studies

Contribution ID: **4** Type: **Oral**

Radiological Health Risk Assessment of Agricultural Soils Around Selected Quarry Sites in Selected States, Nigeria

Soil samples in the agricultural farmland surrounding selected quarry sites in Ondo and Ekiti states was assessed to measure the concentration of 238U, 232Th, 40K using NaI (TI) detector and estimating radiological parameters in order to determine the possible radiation effects to the farmers and member of the public consuming the farm products. Analysis of the result revealed that the average contents of the measured radioelements were 15.19, 31.92 and 1354.15, 16.55, 38.60 and 1185.44, 24.66, 34.25, 1385.89 and 18.10, 37.66, 1242.67 Bq/kg for Iyin, Ita ogbolu, Aaye and Ikere quarry sites, accordingly. The absorbed dose rate in the soil samples ranges from 64.91 nGy/h in Iyin quarry site to 146.88 nGy/h in Aaye quarry site with the mean value of 86.06 nGy/h for the four study locations. The concentration of 40K, the absorbed dose rate, the indoor and outdoor annual effective dose and the excess lifetime cancer risk were higher than the world limit in the study area, predisposing the member of the public in these locations to hazard of radiation exposure. There is the need for constant monitoring of the quarry sites, provision of radiation protective shield for workers mining at the sites, awareness of radiation risks to the farmers and members of the public around the quarry sites.

Primary authors: Prof. USIKALU, Mojisola; Dr MORAKINYO, Ruth Omoseeke

Presenter: Prof. USIKALU, Mojisola

Track Classification: Radiation and Health Physics

Contribution ID: **5** Type: **Poster**

African Nuclear Security Landscape and Non-Proliferation

Background:
Africa has developed a dense legal and institutional architecture for nuclear non-proliferation and nuclear security, centred on the Treaty of Pelindaba, the Treaty on the Non-Proliferation of Nuclear Weapons (NPT), and emerging continental bodies such as the African Commission on Nuclear Energy (AFCONE). Despite this,
implementation remains uneven, and long-term sustainability of nuclear security programs is threatened by capacity and funding constraints.[1–3]
Objectives:
To provide a narrative synthesis of: (1) the current African nuclear security and non-proliferation landscape, (2)
key enablers and barriers to strengthening nuclear security, and (3) funding models capable of sustaining longterm nuclearsecurity programs in Africa.
Methods:
A narrative review of policy reports, institutional statements, and analytical papers from international organizations (IAEA, AU/AFCONE), regional initiatives (AFRA, FNRBA), and specialized think tanks was undertaken, focusing on governance, capacity building, and financing of nuclear security in Africa. Sources
were selected for relevance to African institutions, legal frameworks, and concrete programs or funding initiatives. [1,2,4]
Results:
Africa benefits from strong formal commitments to non-proliferation and disarmament through near-universal NPT membership and the African Nuclear-Weapon-Free Zone (Treaty of Pelindaba), which together prohibit nuclear weapons, mandate IAEA safeguards, and oblige implementation of the Amended Convention on the Physical Protection of Nuclear Material (A/CPPNM). Key enablers include a robust normative framework; the emergence of AFCONE, AFRA, and the Forum of Nuclear Regulatory Bodies in Africa (FNRBA); and growing regional capacity-building and regulatory-harmonization initiatives. Barriers include gaps in treaty adherence and domestic implementation, under-resourced regulators and continental bodies, and pressure from expanding nuclear energy ambitions and uranium production. Sustainable funding models point toward a mix of national budget lines, AU-anchored regional funds, predictable donor and IAEA support, and innovative initiatives such as the African Nuclear Energy Funding Initiative (ANEFI) that link back-end fuel-cycle revenues to governance and security. [1,2,4–10]
Conclusions:
Africa's nuclear security regime rests on comparatively advanced legal norms, but durable progress depends on strengthening implementation capacity and designing funding architectures that move from project-based assistance to African-owned, multi-decade financing arrangements. Leveraging Pelindaba, AFCONE, and emerging financing partnerships can position Africa as both a beneficiary and shaper of global nuclear security and non-proliferation norms. [3,11,12]

Primary authors: KOFI, Mostafa (Prince Sultan Military Medical City, Riyadh, Saudi Arabia); Mr MBOYO„ H. E. Gaspard Liyoko (African Commisssion on Nuclear Energy); Dr OMONDI, , Collins (AF-

CON); Prof. FIALA , Lamiaa (Professor of Public Health, FHE-UK, Princess Noura Bent Abdelrahman University, Riyadh, Saudi Arabia); Prof. HARIS , Jasson T. (Professor, School of Health Sciences, Associate Dean for Graduate Programs and Online Education, Director for the Center for Radiological and Nuclear Security (CRANS), Teaching Academy Fellow, Purdue University, United States of America)

Presenter: KOFI, Mostafa (Prince Sultan Military Medical City, Riyadh, Saudi Arabia)

Track Classification: Nuclear Safety, Security and Nuclear Energy

Contribution ID: **7** Type: **Oral**

Training Needs Assessment for Transitioning from Cesium-137 to X-ray Blood Irradiators in African Countries

Abstract
Background
The transition from Cesium-137 (
Cs) gamma irradiators to non-isotopic X-ray
technology is a global security imperative to mitigate the risk of radiological terrorism[1][15]. In the African context, this transition faces unique operational challenges, including inconsistent electrical power supply, extreme climatic conditions, and limited access to specialized technical support[3][6]. The prevention of TransfusionAssociated Graft-Versus-Host
Disease
(TA-GvHD)
depends
critically on the
effective
and

uniform
irradiation of
blood
products.
Historically,
137
137
Cs irradiators have been the
standard due to their operational simplicity and independence from electrical infrastructure. However, international security initiatives—including the Global Cesium Security Initiative (GCSI)—now advocate for the replacement of high-activity radioactive sources with alternative technologies such as X-ray irradiators to reduce security vulnerabilities[1][15].
Objective
This study presents a comprehensive Training Needs Assessment (TNA) framework designed to facilitate sustainable adoption of X-ray blood irradiators within African blood banking facilities and healthcare systems.
Methods
A multi-layered TNA approach is proposed, targeting three distinct professional cohorts: clinical laboratory operators, biomedical engineers and medical physicists, and radiation protection officers with regulatory responsibilities[3][12]. The assessment framework evaluates critical gaps across four domains: technical operation, infrastructure management, clinical dosimetry, and radiation safety protocols. Data collection instruments include quantitative skill-gap surveys, infrastructure audits, and semistructured qualitative
interviews.
Results
Preliminary analysis reveals that while X-ray technology effectively reduces the security

burden associated with radioactive sources, it simultaneously increases technical requirements for stable electrical infrastructure, specialized preventive maintenance protocols, and enhanced cooling system management[1][2]. Training curricula must transition from "static source management" principles to "dynamic electrical system troubleshooting" competencies[2][15].

Conclusion

Successful technology transition requires a fundamental shift from vendor-dependent maintenance models to locally sustainable capacity building within African healthcare systems[6][12]. This TNA framework serves as a strategic roadmap for ministries of health and international development partners to ensure continuous availability of safe, appropriately irradiated blood components in low-resource settings.

Primary authors: KOFI, Mostafa (Prince Sultan Military Medical City, Riyadh, Saudi Arabia); Mr MBOYO,, H. E. Gaspard Liyoko (African Commisssion on Nuclear Energy); Dr OMONDI, , Collins (AFCON); Prof. FIALA , Lamiaa (Professor of Public Health, FHE-UK, Princess Noura Bent Abdelrahman University, Riyadh, Saudi Arabia); Prof. HARIS , Jasson T. (Professor, School of Health Sciences, Associate Dean for Graduate Programs and Online Education, Director for the Center for Radiological and Nuclear Security (CRANS), Teaching Academy Fellow, Purdue University, United States of America)

Presenter: KOFI, Mostafa (Prince Sultan Military Medical City, Riyadh, Saudi Arabia)

Track Classification: Radiation and Health Physics

Contribution ID: **9** Type: **Oral**

Organ-Specific Dosimetric Assessment of Radon Exposure via Drinking Water in a Selected Population

This study evaluated organ-specific annual effective doses and excess lifetime cancer risk (ELCR) from radon exposure through 20 groundwater samples in a selected population. The experiment was analysised using Liquid Scintillation Counter (LSC). Radon concentrations ranged from 10.6 to 43.1 Bq/L, with over 90% of samples exceeding the U.S. EPA limit of 11.1 Bq/L, though remaining below the WHO limit of 100 Bq/L. Total annual effective doses ranged from 34.4 to 140.1 μSv/year, with the lungs receiving the highest organ-specific dose (up to 13.0 μSv/year), followed by the stomach. Estimated ELCR values (1.21×10^{-4} to 4.90×10^{-4}) exceeded the EPA's acceptable threshold of 1.00×10^{-4} in most samples, suggesting a notable radiological health risk. Inhalation was the dominant exposure pathway. These findings underscore the need for regular monitoring, public awareness, and mitigation measures in areas with elevated groundwater radon levels.

Primary authors: BELLO, Ibrahim Ayodeji (Kabba College of Agriculture, Ahmadu Bello University); Dr VATSA, , Vatsa, M.A. (Ahmadu Bello University Zaria); Ms TIJJANI , F. S. (Ahmadu Bello University Nigeria); Dr MOMOH, A. H. (Department of Physics, Confluence University of Science and Technology, Osara, Nigeria)

Presenter: BELLO, Ibrahim Ayodeji (Kabba College of Agriculture, Ahmadu Bello University)

Track Classification: Environmental Measurements

Contribution ID: **10** Type: **Poster**

Computer-Aided Diagnosis of Breast Cancer via Mammography

Advanced Nuclear Science and Technology Techniques (ANSTT6) Workshop

18–22 May 2026 — iThemba LABS, Cape Town

Computer-Aided Diagnosis of Breast Cancer via Mammography

Andrew Lucio Mbewe and Dr. Maluba Vernon Chisapi
University of Zambia, School of Natural and Applied Sciences, Lusaka, Zambia

Abstract

Zambia faces a critical shortage of radiologists and limited mammography infrastructure. This has resulted in significant diagnostic delays and in turn to high mortality rates due to late-stage breast cancer presentation [1]. This study aimed to develop and validate a computer-aided diagnosis (CAD) system utilizing the YOLOv11 deep learning architecture to automate the detection and classification of breast cancer lesions in mammograms [2]. A quantitative research design was employed, using a dataset of 4,060 anonymized mammograms collected from Maina Soko Hospital in Lusaka, Zambia. The model was developed using a progressive training strategy, incorporating curriculum learning [3] and utilized both manual and model-assisted annotation to identify masses, calcifications, and architectural distortions. The CAD system achieved robust performance results, reaching an accuracy of **71.4%**, precision of **72.2%**, recall of **70.8%**, and an F1-score of **71.1%**. While the progressive training strategy successfully improved detection of underrepresented lesions like architectural distortions, the model faced challenges with small lesions and false positive results. These findings demonstrate that deep learning-based CAD systems can enhance radiological workflows in resource-limited environments through fast, automated screening.

Keywords: Breast Cancer, YOLOv11, Computer-Aided Diagnosis (CAD), Mammography, Zambia.
Category: Radiation and Health Physics

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2. T. Abd El-Hafeez, M. A. Shams, and N. E. Farrag, "Optimizing YOLOv11 for automated classification of breast cancer histopathology images," *Scientific Reports*, vol. 15, p. 1234, 2025.

3. Y. Bengio, J. Louradour, R. Collobert, and J. Weston, "Curriculum learning," in *Proc. of the 26th Annual Int. Conf. on Machine Learning*, pp. 41–48, 2009.

Primary author: MBEWE, Andrew Lucio (Researcher)

Presenter: MBEWE, Andrew Lucio (Researcher)

Track Classification: Radiation and Health Physics

Contribution ID: **11** Type: **Oral**

Estimation of Annual Effective Dose and Excess Lifetime Cancer Risk from Background Ionizing Radiation at Udege Mbeki Abandoned Excavated Mining Site, Nasarawa State, Nigeria

This study evaluates the radiological health implications of human exposure to background ionising radiation (BIR) at the mining site, with particular emphasis on the Annual Effective Dose Equivalent (AEDE) and Excess Lifetime Cancer Risk (ELCR). Soil samples were collected from four distinct zones; dumps, farmland, surface soil and the processing site, and analyzed using a gamma-ray spectrometer to determine the activity concentrations of naturally occurring radionuclides 40K, 226Ra, and 232Th. Radiological hazard indices, including absorbed dose rate, AEDE, and ELCR were subsequently computed. At the processing site, mean activity concentrations of 40K, 226Ra, and 232Th were 218.58 Bq kg^{-1}, 114.35 Bq kg^{-1}, and 420.06 Bq kg^{-1}, respectively. These elevated radionuclide levels resulted in a mean absorbed dose rate of 315.66 ± 9.72 nGy h^{-1}, corresponding to a mean AEDE of 161.30 ± 4.97 mSv y^{-1} and a mean ELCR of 564.56 × 10^{-3}. The highest values were recorded at sample point P7, with AEDE and ELCR reaching 387.03 mSv y^{-1} and 1354.59 × 10^{-3}, respectively. In the dumps, mean AEDE and ELCR were 148.81 ± 4.49 mSv y^{-1} and 520.83 × 10^{-3}, respectively, while farmland soils showed comparatively lower values with mean AEDE of 67.12 ± 2.67 mSv y^{-1} and ELCR of 234.92 × 10^{-3}. Surface soils exhibited intermediate radiological characteristics, with mean AEDE and ELCR of 121.49 ± 3.48 mSv y^{-1} and 425.22 × 10^{-3}, respectively. Overall, the estimated AEDE and ELCR values across the studied locations exceeded internationally recommended safety limits for public exposure, indicating significant radiological risk, particularly within the processing and dump sites. The elevated ELCR values suggest an increased probability of cancer development over a lifetime of exposure. These findings underscore the need for continuous environmental monitoring, restriction of prolonged human activities within high-exposure zones of the mined area to mitigate long-term health risks and enforcement of land reclamation agreement to restore excavated mining sites into usable land for agriculture or residential purposes.

Primary author: EGHAGHE, Stephen (Bingham University)

Co-author: Prof. ADELEYE, Michael (Bingham University, Nigeria)

Presenters: EGHAGHE, Stephen (Bingham University); Prof. ADELEYE, Michael (Bingham University, Nigeria)

Track Classification: Environmental Measurements

Contribution ID: **13** Type: **Oral**

Integrating Localized Carbon Capture, Accelerator-Based Isotope Analysis, and Climate Modeling for Carbon Cycle Monitoring and Sequestration Research

Atmospheric carbon dioxide (CO_2) levels have surpassed 420 ppm, with transportation emissions contributing approximately 24% of global energy-related CO_2 output. Mitigating these emissions requires integrated experimental frameworks that combine capture, measurement, and long-term carbon stabilization. This submission presents a conceptual research proposal developed and extensively tested theoretically by the author, which integrates localized carbon capture, accelerator-based isotope analysis, and climate modeling to investigate traceable carbon management pathways. The goal is to transition from theoretical modeling to practical experimental validation with access to advanced laboratory facilities and expert collaboration.
The framework begins with localized capture of CO_2 from mobile combustion sources, which are then redirected into controlled laboratory systems. Using accelerator-based analytical techniques such as mass spectrometry and ion-beam analysis, the captured carbon can be precisely characterized in terms of ^{12}C, ^{13}C, and ^{14}C isotopic composition, enabling detailed tracking of carbon origin, transformation, and retention across experimental systems. Following isotopic characterization, carbon streams are proposed to enter experimental carbon conversion and sequestration platforms, including:
Microalgae photobioreactors, converting CO_2 into biomass with high efficiency.
Mineralization processes, forming stable carbonates for long-term storage.
Thermochemical conversion systems, producing biochar and engineered carbon materials for durable carbon storage.
The inclusion of the author-developed climate model allows simulation of localized carbon flows, prediction of system impact on broader atmospheric carbon levels, and optimization of carbon conversion pathways. Integrating modeling with laboratory experiments enables a feedback system where real-world data informs predictive simulations and scenario analysis, strengthening the scientific rigor of the project.
Research Objectives:
Develop a practical experimental setup for capturing CO_2 from localized mobile emissions and channeling it into controlled laboratory systems.
Quantify carbon transformation, movement, and long-term sequestration potential using accelerator-based isotope analysis, with a focus on verifying ^{12}C, ^{13}C, and ^{14}C dynamics.
Evaluate and compare multiple carbon conversion pathways, including biological, mineral, and thermochemical approaches, to determine efficiency and storage stability.
Integrate experimental findings with the climate model to assess potential system impact on atmospheric CO_2 and refine predictive capabilities for broader carbon management strategies.
This research concept is presented as the original idea of the submitting author, fully developed theoretically, and now positioned for practical experimentation. The author seeks laboratory access, expert mentorship, and interdisciplinary collaboration to realize this framework. The long-term aim is to establish a scientifically verifiable carbon-management research platform that combines localized carbon capture, isotope-based tracing, and predictive climate modeling, contributing to innovative strategies for reducing global CO_2 emissions.
Keywords: carbon capture, isotope analysis, accelerator mass spectrometry, carbon sequestration, climate modeling, emission monitoring, experimental carbon management, carbon tracing.

through this link one can access the visual sketch work of this project that needs implementation;
https://co2-capture-pilot-6uckdu8jqswmnydumaphwc.streamlit.app/

Primary author: Mr WEKESA, BROWN (STUDENT MASENO UNIVERSITY)

Presenter: Mr WEKESA, BROWN (STUDENT MASENO UNIVERSITY)

Track Classification: Environmental Physics & Applications

Contribution ID: **14** Type: **Oral**

Estimation of radiation exposure to family members of patients treated with I-131 in Tanzania

Abstract
Radiation therapy using Iodine-131 (I-131) is a widely employed treatment for thyroid disorders; however, it poses potential radiation exposure risks to patient caregivers due to gamma emissions from treated patients. This study estimates the radiation doses received by family members of patients undergoing I-131 therapy in Tanzania, where cultural practices and living conditions complicate adherence to international safety guidelines. Using the Particle and Heavy Ions Transport-code System (PHITS), exposure scenarios during hospitalization and post-discharge phases were modelled, accounting for proximity, activity levels, and caregiver-patient interactions. These models were utilized to estimate the radiation exposure to family members of patients treated with I-131 in Tanzania. Results indicate that family members assisting dependent patients during hospitalization received doses of 1.53, 2.33, and 2.99 mSv for 3700, 5550, and 7400 MBq, respectively. These doses are below the 5 mSv/episode limit but exceed the 1 mSv/year public dose limit. Post-hospitalization, the doses decreased significantly, with the highest exposure caused by close-contact activities. Meanwhile, transportation scenarios showed the exposure to be less than 1 mSv/year for short durations. Nevertheless, strict adherence to maintaining a one-meter distance and minimizing the duration of close contact is emphasized. These findings provide critical insights for maintaining public health while ensuring effective thyroid cancer treatment.
Keywords: Caregiver safety, family members, Iodine-131 therapy, PHITS simulation, radiation exposure, Tanzania, thyroid cancer.

Primary authors: Ms MBAGO, Penina (University of Dar es Salaam); Dr LUGENDO, Innocent (University of Dar es Salaam)

Presenters: Ms MBAGO, Penina (University of Dar es Salaam); Dr LUGENDO, Innocent (University of Dar es Salaam)

Track Classification: Radiation and Health Physics

Contribution ID: **15** Type: **Oral**

Quantitative Determination of Uranium in a Certified Uranium Ore Concentrate Reference Material Using ICP-MS

Accurate determination of uranium concentration in uranium ore concentrates is essential for nuclear safeguards, material accountability, and nuclear forensic investigations. Reliable analytical techniques supported by certified reference materials are therefore required to ensure measurement accuracy and traceability. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is widely used for quantitative determination of uranium due to its high sensitivity, low detection limits, and capability for multi-element analysis. In this study, the uranium content of a Canadian Certified Reference Material (CRM) uranium ore concentrate was quantitatively determined using ICP-MS following acid digestion and dilution procedures. The solid CRM sample was digested using nitric acids under controlled laboratory conditions to ensure complete dissolution of the sample matrix. The resulting solution was analysed using a NexION 2000 ICP-MS, and the measured uranium concentration was converted into weight percent uranium through appropriate dilution and mass balance calculations.

The analytical results indicated a uranium concentration of approximately 76.55 wt.% U, corresponding to 90.27 wt.% U_3O_8 equivalent, which is consistent with the expected composition range for high-grade uranium ore concentrates. The use of a certified reference material provided confidence in the accuracy and reliability of the analytical methodology. These findings demonstrate the effectiveness of ICP-MS for quantitative uranium analysis in uranium ore concentrates and highlight the importance of validated analytical techniques for nuclear safeguards, nuclear forensics, and material verification. The development and application of such analytical capabilities contribute to strengthening nuclear security frameworks and support ongoing efforts to establish nuclear forensic databases and analytical capacity within Africa.

Primary author: Dr KUPI, Tebogo Gilbert (North-West University)

Co-authors: Ms JONAS, Khumoetsile (North-West University); Mr SEERANE, Valid (North-West University); Mr MONYE, Gabriel (North-West University); Ms KUNENE, Ntaoleng (North-West University); Dr JOHN, Samuel Odumu Ogana (North-West University)

Presenter: Dr KUPI, Tebogo Gilbert (North-West University)

Track Classification: Nuclear Safety, Security and Nuclear Energy

Contribution ID: **16** Type: **Oral**

Numerical Simulation of Discrepancies Between Measured and Estimated Half-Life of Strontium Sr-90

Abstract
Reliable half-life data are fundamental to many areas of nuclear science, including reactor physics calculations, environmental radioactivity studies, and the long-term management of radioactive waste. Strontium-90 (Sr-90), one of the most significant fission products produced in nuclear reactors, plays an important role in environmental monitoring and radiological safety because of its relatively long half-life and biological mobility. The currently recommended half-life for Sr-90 is 28.79 ± 0.05 years, as adopted by the international Decay Data Evaluation Project. In practice, however, experimentally determined half-life values often show small but noticeable deviations from this reference value. Such discrepancies may originate from detector efficiency variations, background radiation fluctuations, counting statistics, and other experimental conditions that influence measured decay curves.
This study investigates the potential sources of these discrepancies through a numerical simulation approach focused on Sr-90 decay measurements. A computational framework was developed to reproduce realistic experimental conditions by combining exponential decay modelling with Monte Carlo–based uncertainty propagation. Synthetic decay datasets were generated using the standard decay equation. The simulations incorporate typical measurement effects such as detector efficiency drift of approximately 1%, background radiation variability of about 3 counts min^{-1}, and Poisson counting noise. A total of 100,000 Monte Carlo iterations were performed to evaluate how these factors influence the extracted half-life.
The simulation results produced an effective half-life estimate of 28.80 ± 0.04 years, which remains consistent with the recommended value but reveals potential deviations of roughly 0.2–0.3% depending on measurement conditions. Sensitivity analysis indicates that detector efficiency instability contributes the largest portion of the bias, followed by counting statistics and background radiation fluctuations.
The findings highlight how realistic experimental conditions can influence half-life estimation and demonstrate the usefulness of numerical simulation for interpreting radionuclide decay measurements. The developed framework provides a practical computational tool for evaluating Sr-90 half-life measurements and may support improved detector calibration procedures and measurement corrections in radionuclide metrology. Ultimately, this approach contributes to more reliable application of nuclear decay data in environmental monitoring and nuclear safety assessments.

Primary author: Mr SHITU, Mohammed (Aliko Dangode University of Science and Technology Wudil Kano, Nigeria)

Co-author: Prof. BICHI, Tijjani Sale (Aliko Dangode University of Science and Technology Wudil Kano, Nigeria)

Presenters: Mr SHITU, Mohammed (Aliko Dangode University of Science and Technology Wudil Kano, Nigeria); Mr INUWA, Ibrahim Abdullahi (Aliko Dangode University of Science and Technology Wudil Kano, Nigeria)

Track Classification: Nuclear Experimental Techniques and Data Analysis

Contribution ID: **18** Type: **Oral**

Investigating radiological risk due to solid-phase 'black powder' from the Secunda Gas Pipeline

The extraction and transport of natural gas leads to the accumulation of black powder, a hazardous byproduct composed of corrosion species, microorganisms and Naturally Occurring Radioactive Materials (NORM) within gas pipelines. These NORM contaminants tend to concentrate within dust filters and during periodic 'pigging' operations, posing a potential radiological threat to workers and the environment. The study evaluated the radiological assessment of black powder collected at the Secunda gas pipeline by determining the activity concentrations of naturally occurring radionuclides 226Ra, 232Th and 40K using gamma spectrometry. Results show that the average activity concentrations for black powder obtained from pigging operations were 2.53 ± 0.18 (range: 1.87 - 2.94), 4.23 ± 0.32 (range: 2.78 - 5.00) and 27.17 ± 1.75 (range: 23.59 - 29.76) Bq/kg for 226Ra, 232Th and 40K respectively. Similarly, the average activity concentrations for black powder obtained from dust filters during normal operations resulted in 1.82 ± 0.21 (range: 1.34 - 2.24), 1.67 ± 0.26 (range: 1.27 - 2.21), 25.98 ± 1.73 (range: 18.36 - 2.71) Bq/kg for 226Ra, 232Th and 40K respectively. Radiological hazard indices were also determined by calculating the Raeq, D, Hex, Hin, AEDE and ELCR. Average values for these indices for black powder samples from pigging operations were 10.68 Bq/kg, 4.86 nGy/h, 0.03,0.04, 5.96 × 10-3 mSv/yr and 2.0 × 10-5 respectively. For black powder samples from dust filters, the corresponding average values were 5.13 Bq/kg, 2.47 nGy/h, 0.01, 0.02, 3.03× 10-3 mSv/yr and 1.06 × 10-5, respectively. All calculated radiological hazard indices were significantly below the recommended regulatory safety limits, indicating negligible radiological risks to maintenance workers during pigging and filter replacement operations.

Primary author: Ms MOKGELE, Tsholofelo (North-West University)

Presenter: Ms MOKGELE, Tsholofelo (North-West University)

Track Classification: Environmental Physics & Applications

Contribution ID: **20** Type: **Oral**

Estimation of the composition of the primary cosmic ray particles by measurements of the cosmic ray muon component

The primary cosmic ray particles constitute 85% protons, 12% helium, 3% iron, and heavier elements. They interact with the Earth's atmosphere, producing secondary particles known as Extensive Air Showers (EAS). Among the particles produced in EAS are pions and kaons, which subsequently decay into muons. Cosmic ray muons form the main part of cosmic ray particles that reach on the earth's surface. The lateral distribution of cosmic ray muon coincidences is often used to model and understand the development of the EAS in the earth's atmosphere. In this work, the lateral distribution of cosmic ray muons was investigated using two-fold coincidences. Four detectors were positioned at two-fold coincidence separated at regular intervals. The coincidence rate was between these detector stations was measured. The measured data was compared with Monte Carlo (MC) simulations of EAS. The EPOS and GHEISHA models were used for high and low-energy particle interactions respectively. The analyses indicate the following composition of primary cosmic ray: protons (81±0.01) %, helium (10±0.04) %, and iron and heavier elements (9±5.88) %. The knowledge gained from the lateral distribution of cosmic ray muons is essential for the understanding of the interaction of cosmic ray particles and the development of extensive air showers. Furthermore, this information enhances our understanding of the chemical composition of primary cosmic ray particles.

Primary authors: Ms KIHAGI, Veronicah (Kenyatta University); Prof. HASHIM, Nadir (Kenyatta University); Dr KIMANI, Naftali (Kenyatta University); Mr CHEGE, Samwuel (Kenyatta University); Dr OCHILO, Livingstone (Jaramogi Oginga Odinga University of Science and Technology.)

Presenter: Ms KIHAGI, Veronicah (Kenyatta University)

Track Classification: Cosmic Ray and Muon Physics and Applications

Contribution ID: **21** Type: **Poster**

Comparison of tangential-intensity modulated radiotherapy (t-IMRT) and volumetric modulated arc therapy (VMAT) for different sizes of left breast cancer

Background: Radiotherapy is an essential part of the management of left-sided breast cancer, and this requires an optimal balance in target volume coverage and organs at risk, such as the ipsilateral lung and the heart. Advanced techniques such as tangential-intensity modulated radiotherapy (t-IMRT) and volumetric modulated arc therapy (VMAT) are commonly used. However, the dosimetric performance of t-IMRT and VMAT for varying breast sizes has been poorly characterized.
Aim: To compare the effectiveness of tangential-IMRT and VMAT for hypo-fractionated left-sided breast cancers across small, medium, and large breast sizes.
Materials & Methods: A total of 30 CT datasets from female patients with left-sided breast cancer, acquired between 2020 and 2025, were analyzed. Patients were divided into groups based on breast volume, with a mean volume of 781.00 cc. For each patient, two treatment plans were designed using the Monaco treatment planning system, which uses the Monte Carlo method. A dose of 26 Gy in 5 fractions was prescribed according to the FAST-Forward hypo-fractionated protocol. Evaluation of the dosimetric parameters included the Planning Target Volume (PTV) coverage indices D2%, D5%, D95%, Homogeneity Index (HI), Conformity Index (CI), and doses to the heart (V7 and V1.5 Gy), as well as the ipsilateral lung volume receiving V8 Gy. A two-way ANOVA was performed, with a significance ($p < 0.05$).
Results: VMAT showed superior target coverage, conformity, and dose homogeneity compared to t-IMRT across all breast sizes ($p < 0.05$). PTV D95% coverage with the VMAT plans was 99.8%, 98.3%, and 97.0% for small, medium, and large breasts, respectively, whereas the t-IMRT plans failed to achieve the required coverage of ≥95% and resulted in 89.2-90.0% coverage across all the breast sizes. Also, the homogeneity and conformity indices were improved with the VMAT plan. Both plans satisfied the PTV hotspot constraints of D2% < 107% and D5% < 105%. Although the t-IMRT plans resulted in lower hotspot doses for small and medium breasts, the VMAT plans resulted in slightly better hotspot dose control for large breasts. However, the differences were not clinically significant, as they were within 1%. However, the t-IMRT plans resulted in superior OAR sparing, with lower ipsilateral lung V8 Gy and lower high-dose cardiac exposure (Heart V1.5 Gy: 0.9 - 1.1 Gy), compared to the VMAT plans, which resulted in higher high-dose cardiac exposure (2.9 - 3.3 Gy), exceeding the tolerance limit, though the VMAT plans resulted in lower low-dose cardiac exposure (Heart V7 Gy).
Conclusion: VMAT provided superior target coverage, conformity, and homogeneity across all breasts compared to t-IMRT, achieving the required PTV D95% ≥ 95% in all cases. Both techniques were able to meet the PTV hotspot requirements, with slightly improved control for larger breasts with VMAT, while this may not have a clinically significant impact. However, t-IMRT showed superior sparing of OARs, particularly the ipsilateral lung and high-dose cardiac areas. In contrast, VMAT showed increased dose to high-dose cardiac areas and decreased dose to low-dose cardiac areas.
Keywords: VMAT, Tangential-IMRT, Left-sided Breast radiotherapy, Breast sizes, UK FSAT-Forward protocol.

Primary author: AHMED, Abuobaida (North-West University)

Co-authors: Dr NTOMBELA, Lethukuthula (University of Pretoria); Prof. MATHUTHU, Manny (North-West University)

Presenter: AHMED, Abuobaida (North-West University)

Track Classification: Radiation and Health Physics

Contribution ID: **22** Type: **Oral**

Cosmic rays – origin, composition, interactions and applications

This presentation highlights the origin of cosmic radiation, their interactions in the earth's atmosphere, their measurements and their applications. The work by Theodore Wulf and Victor Hess showed increased rates ionization with height above the ground. This observation led to the conclusion that the source of ionization is not from the earth but from space. That marked the discovery of cosmic radiation. Over the years, there has been extensive research work carried out in order to understand cosmic radiation. It is now known that the primary cosmic ray particles comprise of about 85% protons, 12% helium, 3% iron and other heavier elements. These primary cosmic ray particles interact with nuclei in the earth's atmosphere to produce secondary particles such as kaons, pions, neutrons. The kaons and pions decay into muons which further decay into electrons. Neutrinos are produced in these decay processes. Experimental data shows that the all-particle cosmic ray energy spectrum follows a simple power law with a spectral index of about 2.7. However, the value of the spectral index changes at cosmic ray energies of about 10^6 GeV – known as the "knee" region and 10^9 GeV known as the "ankle" region. The bending of the spectrum at the knee region is attributed to the varied energy loses due to the difference in masses of the cosmic ray particles at those energies. Cosmic ray particles with energies beyond 10^9 GeV have been observed by several experiments. These are known as Ultra-High-Energy-Cosmic-Ray (UHECR) particles. The UHECR particles are thought to be of extra-galactic origin. These particles lose a large fraction of their energies when they interact with photons from the Cosmic Microwave Background Radiation (CMBR). This leads to a drastic cut-off on the cosmic ray energy spectrum – known as the Greisen-Zatsepin-Kuzmin (GZK) cut-off. The earth's magnetic field acts as a shield for charged cosmic ray particles. Exposure to cosmic radiation is therefore not only dependent on the altitude but also on the latitude on the earth surface. The dose due to cosmic radiation is minimum around the equator and increases as one moves away from the equator. On the earth surface, cosmic radiation comprises mostly of cosmic ray muons. These cosmic ray muons are useful in imaging large structures like volcanos and pyramids on the earth. They are also useful in security applications and in the nuclear industry. In the field of agricultural science, the flux of cosmic ray neutrons on the earth surface provides a reliable and efficient means of monitoring the moisture content of the soil. The knowledge of cosmic radiation in our earth's atmosphere and on the earth has applications in diverse fields of science and technology in support of our development goals at the national, regional and global levels.

Primary authors: Prof. HASHIM, Nadir (Kenyatta University); Prof. GRUPEN, Claus (Siegen University)

Presenter: Prof. HASHIM, Nadir (Kenyatta University)

Track Classification: Cosmic Ray and Muon Physics and Applications

Contribution ID: **23** Type: **Poster**

Categorization and characterization of uranium-bearing materials for nuclear forensic attribution using ICP-MS

The increasing risk of illicit trafficking and misuse of nuclear and radioactive materials has highlighted the importance of nuclear forensics in supporting radiological crime scene investigations and nuclear security. This study focuses on the categorization and characterization of uranium-bearing materials to support nuclear forensic attribution and investigative processes. Uranium materials originating from different stages of the nuclear fuel cycle were analyzed using advanced analytical techniques to determine their physical, chemical and isotopic signatures. Samples including Uranium ore and triuranium octoxide were prepared through crushing,pulverization and microwave digestion prior to analysis. Elemental and isotopic measurements were performed using Inductively Coupled Plasma Mass Spectrometry. These techniques enabled the determination of trace elements concentrations, rare-earth elements (REE) patterns, uranium isotopic ratios and lead isotopic ratios that serve as distinctive nuclear forensic signatures.

The results demonstrate that uranium-bearing materials possess measurable elemental and isotopic characteristics that can be used to distinguish materials originating from different geological sources and processing stages. Rare-earth element distributions, uranium and lead isotopic compositions provided valuable geochemical fingerprints that support source attribution. Overall, the study highlights the importance of combining elemental and isotopic analysis for reliable categorization and characterization of uranium-bearing materials. These signatures provide critical information for nuclear forensic investigations and may contribute to the development of a national nuclear forensic library to assist law enforcement and regulatory authorities in identifying the origin and history of intercepted nuclear materials.

Primary author: Ms JONAS, Khumoetsile (North-west university)

Co-authors: Dr KUPI , Tebogo (North-west university); Dr OLUKOTUN, Stephen (North-west university)

Presenter: Ms JONAS, Khumoetsile (North-west university)

Track Classification: Nuclear Safety, Security and Nuclear Energy

Contribution ID: **24** Type: **Oral**

Why the Need for Environmental Measurement?

Environmental measurement is essential for evaluating environmental quality, detecting contamination, and protecting human health. Increasing industrial, agricultural, and urban activities have led to the release of chemical and radiological pollutants into environmental systems. Accurate measurement of these parameters is therefore critical for monitoring environmental media such as air, water, and soil. This lecture highlights the importance of environmental measurement in pollution detection, environmental risk assessment, and regulatory compliance. Particular emphasis is placed on environmental radioactivity monitoring and the application of radiation detection techniques in assessing naturally occurring and anthropogenic radionuclides. Strengthening environmental monitoring capacity remains vital for effective environmental management and sustainable development.

Primary author: Dr BASHIR, Munirat (Ibrahim Badamasi Babangida University Lapai, Nigeria)

Presenter: Dr BASHIR, Munirat (Ibrahim Badamasi Babangida University Lapai, Nigeria)

Track Classification: Environmental Measurements

Contribution ID: **25** Type: **Oral**

Monte Carlo-Based Optimization of Occupational Radiation Protection in a Diagnostic Radiology Facility at Kitui County Level V Hospital, Kenya

Accurate occupational dose estimation is essential for optimizing radiation safety and ensuring compliance with regulatory guidelines. The spatial distribution of scatter radiation in the radiography room was characterized using Monte Carlo simulations based on Geant4. A diagnostic X-ray system was accurately modeled and validated using experimental measurements to evaluate the magnitude and distribution of scattered radiation. Simulated and measured dose rates showed good agreement within ±10%, with a root mean square error of 0.08 μSv h^{-1}, indicating strong model reliability. Scatter dose exhibited a general decrease with distance from the source, approximately following the Inverse Square Law, although deviations were observed due to distributed scatter sources and attenuation in air. The scatter dose decreased from 1.51 μSv h^{-1} at 0.25 m to 0.36 μSv h^{-1} at 2.0 m from the source, representing approximately a 76% reduction. Increasing the field size from 10 × 10 cm^2 to 20 × 20 cm^2 and 30 × 30 cm^2 significantly increased scatter dose even at far-field positions. The combined use of lead protective clothing and 0.5 mm mobile lead shielding reduced scatter dose by approximately 90–96%. Overall, the estimated occupational dose levels were within internationally recommended limits. The observed distribution and variability of scatter radiation highlight the importance of continuous radiation protection optimization. The study therefore recommends routine indoor radiation monitoring, particularly for staff working in radiology departments. Strict implementation of the ALARA principle through appropriate positioning and effective shielding using lead aprons is strongly recommended.

Keywords: Occupational dose, Monte Carlo simulation, X-ray dosimetry, Scatter Dose, radiation safety.

Primary authors: MATSITSI, Muthama (South Eastern Kenya University); Dr MUGAMBI, James (South Eastern Kenya University); Dr KEBWARO, Jeremiah (Karatina University); Dr FELIX, Wanjala (International Atomic Energy Agency)

Presenter: MATSITSI, Muthama (South Eastern Kenya University)

Track Classification: Radiation and Health Physics

Contribution ID: **26** Type: **Oral**

Measurement of angular correlations in gamma-gamma cascades using coincidence detection and Monte Carlo simulation

Coincidence counting techniques are widely used to determine correlated γ-ray emissions from nuclear decays. Measured singles and coincidence rates share common factors - i.e. absolute efficiency - that can be divided out in analysis. However, standard formulations often assume perfect isotropic correlation between emitted quanta, neglecting possible decay chain losses, and ignore angular correlations. In this work, we use coincidence-based absolute activity measurements to show that the angular correlation function, $W(\theta)$, modulates the detection probability of cascade pairs. Using 60Co and 22Na as benchmark sources with differing cascade and correlation properties, we demonstrate that the true coincidence rate reflects detector efficiencies and angular correlations, which can be extracted from the observed measurands.
A custom FLUKA Monte Carlo source routine was developed to implement angular distributions in $\gamma - \gamma$ correlations to support these observations. A Python proof-of-concept generated the normalised cumulative distribution functions of $W(\theta)$, which were incorporated into FLUKA for multi-detector simulations. The Monte Carlo results successfully reproduce the experimentally observed angular modulation, confirming that coincidence counting combined with a tailored simulation framework can probe angular correlations.
Our approach forms the groundwork for future studies of more complex decay schemes with non-trivial cascade probabilities and for developing multi-detector techniques for angular-correlation metrology.

Primary authors: CHAPLIN, Mikayla; Mr LEADBEATER, Tom; Ms HUTTON, Tanya

Presenter: CHAPLIN, Mikayla

Track Classification: Nuclear Experimental Techniques and Data Analysis

Contribution ID: **27** Type: **Oral**

Portable African Neutron-Gamma Laboratory for Innovative Nuclear Science

The Portable African Neutron-Gamma Laboratory for Innovative Nuclear Science (PANGoLINS) [1] project aims to investigate measurements of both gamma rays and neutrons which forms an important component part on site or in transit and the detection of both fissile material for the use in decarbonised energy sources or disposal thereof. A core component of the project is to miniaturize the weight of the gamma ray detection device and associated infrastructure so that it can be loaded on an unmanned aerial vehicle to enable access to and enhance performance of radiation monitoring measurements at remote sites leading to autonomous operations.

PANGoLINS incorporates commercial detector assemblies of LaBr3(Ce), SrI2(Eu) and/or CLYC(Ce) for spectroscopy. In addition, the project encompasses the instrumentation of other scintillation detectors with silicon photomultiplier technologies. The coupling of these to readout devices such as high-density ADC readout are planned for applications for nuclear science, medical imaging [2] or astronomy.

An overview of the project, its progress and potential outcomes will be presented.

References

[1] Jones, P. et al., IEEE Nuclear Science Symposium (2025) DOI: 10.1109/NSS/MIC/RTSD57106.2025.11286641
[2] Hart, S. et al., IEEE Nuclear Science Symposium (2025) DOI: 10.1109/NSS/MIC/RTSD57106.2025.11287197

Primary authors: JONES, Pete (iThemba LABS); HART, Shanyn (iThemba LABS); Mr TAYLOR, Glen (SARAO); VAN TUBBERGH, Christo (iThemba Labs); Mr VANKER, Ahmen (SARAO)

Presenter: JONES, Pete (iThemba LABS)

Track Classification: Environmental Measurements

Contribution ID: **28** Type: **Oral**

Compact scintillator-based neutron spectrometers for use in aviation and space applications

Cosmic radiation, composed of Galactic Cosmic Rays (GCRs), Solar Energetic Particles (SEPs), and their associated secondary particles, represents a recognized radiation risk to space missions, satellites, and air travel. To improve risk assessment models in these contexts, it is essential to measure the various components of the radiation environment at the specific location of interest, particularly during unexpected high-energy space weather events. Secondary neutrons, with characteristic spectral features around 1 MeV and 100 MeV, are produced by cosmic ray interactions with matter and contribute substantially to overall radiation exposure at flight altitudes and in space. Neutrons pose a particular hazard to biological tissue because they interact directly with atomic nuclei, producing energetic, densely ionizing recoil particles that induce DNA damage. Continuous monitoring of radiation environments aboard aircraft and spacecraft using active radiation detectors would provide key data for improved risk assessment.

Current neutron spectrometry technologies, such as Bonner sphere systems or liquid organic scintillators coupled to photomultiplier tubes, are not well suited for use outside the laboratory. This work aims to develop a compact detector system based on plastic scintillators and silicon photomultipliers that is robust, portable, and suitable for non-expert use. A prototype spectrometer has been constructed for operation in high-energy neutron fields. Accurate spectrometry using unfolding techniques relies on well-characterized detector response functions covering the full energy range of interest. The high-energy neutron facility at iThemba LABS in Cape Town, South Africa, provides a unique opportunity to directly measure detector response functions up to 200 MeV.

We present progress toward the development of a novel detector system for high-energy neutron spectrometry in aviation and space environments, as well as in accelerator facilities such as proton therapy centres. Detector design, calibration methodology, and planned field testing are discussed.

Primary authors: KIDSON, Miles (University of Cape Town); BUFFLER, Andy (UCT); HUTTON, Tanya (University of Cape Town); Dr TROMPIER, Francois (ASNR)

Presenter: KIDSON, Miles (University of Cape Town)

Track Classification: Nuclear Experimental Techniques and Data Analysis

Contribution ID: **29** Type: **Oral**

Measurement of Azimuthal Bremsstrahlung Photon Emission from a 28-GHz ECR Ion Source Using NaI(Tl) Detectors

The emission of high-energy bremsstrahlung photons beyond the expected critical energy during electron cyclotron resonance (ECR) heating has attracted significant attention, and its underlying mechanism remains not fully understood. In this study, we measured the azimuthal angular distribution of bremsstrahlung photons produced in a 28 GHz ECR ion source at the Busan Center of the Korea Basic Science Institute (KBSI). Three round-type NaI(Tl) scintillation detectors were used to simultaneously measure bremsstrahlung photons emitted radially from the plasma chamber. An additional NaI(Tl) detector was positioned downstream of the ECR ion source to monitor the overall photon intensity. The ion source was operated at an RF power of 1 kW to extract an 16O ion beam, with dominant charge states of O^{3+} and O^{4+}. Bremsstrahlung photon energy spectra were recorded at nine azimuthal angles on the extraction side of the ion source. To evaluate possible systematic uncertainties arising from differences among the three detectors, measurements were repeated by alternating the detector positions. Geant4 Monte Carlo simulations were performed to account for geometrical acceptance and energy-dependent detection efficiency caused by non-uniformities in the material budget. The true bremsstrahlung spectra were then reconstructed using an inverse-matrix unfolding method. The extracted end-point energies of the bremsstrahlung spectra were (2.040 ± 0.045) MeV at 150°, (1.650 ± 0.040) MeV at 330°, and (1.610 ± 0.040) MeV at 330° for detectors D1, D2, and D3, respectively. These values exceed the maximum electron kinetic energy of approximately 1.330 MeV expected from standard ECRIS operating parameters. The higher end-point energy observed near 150° appears to correlate with the structural configuration of the ion source and the the shape of the ECR plasma. However, the secondary maximum near 330°, located roughly 180° opposite to 150◦ which is among the maximum angles, cannot be explained solely by the shape of the ECR plasma. We interpret these observations as evidence of unconfined high-energy electrons reaching the chamber wall and producing bremsstrahlung radiation. These escaping electrons likely arise from imperfect magnetic confinement within the ECR plasma. The results provide new insight into the mechanisms of high-energy bremsstrahlung production in ECR ion sources and suggest that improved magnetic confinement design could reduce electron losses and associated high-energy photon emission.

Primary author: JOHN KUMWENDA, Mwingereza (University of Dar es Salaam)

Presenter: JOHN KUMWENDA, Mwingereza (University of Dar es Salaam)

Track Classification: Nuclear Experimental Techniques and Data Analysis

Contribution ID: **30** Type: **Poster**

EXPERIMENTAL AND DATA ANALYSIS TECHNIQUES FOR COSMIC RADY AND RADIATION MEASUREMENT

Advances in nuclear science and technology continue to expand the role of radiation and particle detection in areas ranging from fundamental physics to environmental monitoring and nuclear safety. Accurate measurement and interpretation of radiation and cosmic ray events require improved experimental techniques combined with sophisticated data analysis approaches. This work presents a study of modern experimental and computational methods used for the detection and analysis of cosmic rays and ionizing radiation in laboratory and environmental conditions.
The study focuses on detector-based measurement systems designed to record high-energy particle interactions and radiation events. Emphasis is placed on signal processing, background noise reduction, and statistical analysis methods that enhance the reliability and precision of experimental results. In addition, computational tools and data analysis frameworks are applied to identify patterns within large datasets generated by radiation detection systems. These approaches allow for improved characterization of cosmic ray interactions and environmental radiation levels.
The results demonstrate how integrated experimental and analytical techniques can significantly improve measurement accuracy, detection sensitivity, and data interpretation in nuclear science research. Such advancements contribute to broader applications in nuclear safety, environmental radiation monitoring, and health physics, while also supporting the development of future experimental programmes in nuclear and particle physics.
This work highlights the importance of interdisciplinary collaboration between experimental physics, data science, and nuclear technology in addressing emestrong textrging challenges in radiation detection and nuclear research infrastructures.

Primary author: MWANGI, Nickson (student)

Presenter: MWANGI, Nickson (student)

Track Classification: Cosmic Ray and Muon Physics and Applications

Contribution ID: **31** Type: **Poster**

Activation of p53 pathway in combination with photon irradiation for treatment of cancer

Medulloblastoma (MB) and glioblastoma (GB) are highly aggressive brain tumours that exhibit substantial resistance to radiotherapy, largely due to impaired DNA damage repair mechanisms. The cellular response to radiation-induced DNA double-strand breaks (DSBs) is a critical determinant of radiosensitivity. This study investigated the effects of the MDM2 inhibitor AMG232 in combination with photon irradiation on DNA damage signalling in MB and GB cell lines using γH2AX foci analysis. Photon irradiation induced a clear dose-dependent increase in γH2AX foci across all cell lines, confirming effective DSB formation. Treatment with AMG232 resulted in prolonged persistence of γH2AX foci, particularly in MB cell lines, indicating delayed or compromised DNA repair. Residual foci detected at later time points suggest increased reliance on error-prone repair pathways, notably non-homologous end joining (NHEJ), especially in G0/G1-arrested cells. In contrast, GB cell lines exhibited sustained γH2AX foci levels irrespective of AMG232 treatment, consistent with intrinsic radioresistance. These findings demonstrate that AMG232 enhances radiosensitivity primarily by extending DNA damage signalling rather than increasing initial DNA damage, highlighting impaired repair kinetics as a key mechanism influencing treatment response in aggressive brain tumours.

Primary author: MALULEKA, Musa

Co-authors: Dr NEMANGWELE, Fhulufhelo (University of Venda); Dr ENGELBRECHT, Monique (iThemba LABS and UWC); Dr FISHER, Randall (Division of Radiation Biophysics, NRF iThemba LABS)

Presenter: MALULEKA, Musa

Track Classification: Radiation and Health Physics

Contribution ID: **32** Type: **Oral**

Development and Optimisation of a Two-Stage SiPM-Based Compton Camera

This work investigates the development of a two-stage Compton camera for environmental radiation monitoring, with a focus on energy resolution, detection efficiency, fast timing, and optimal geometrical configuration. While significant advances have been made in radiation imaging technologies, challenges remain in achieving high sensitivity and accurate source localisation in complex environments.

A prototype Compton camera is studied using compact, low-voltage 14 × 14 × 25.4 mm $LaBr_3$:Ce scintillation detectors coupled to SiPM readout, with the aim of leveraging the advantages of modern SiPM technology. These detectors, manufactured by CapeScint (MA, USA), demonstrate excellent energy resolution (3.4% at 662 keV) and fast timing performance. Scatter event tracking is modelled using the TOPAS Monte Carlo toolkit to determine optimal detector geometry and timing characteristics, complemented by experimental measurements with standard gamma-ray sources.

In addition, two Cs_2LiYCl_6 (CLYC-6) SiPM-readout detectors of the same geometry have been commissioned to exploit their neutron sensitivity. Pulse shape discrimination is used to distinguish neutron and gamma-ray interactions, enabling simultaneous gamma–neutron detection for comprehensive environmental radiation assessment.

The development of this system has the potential to improve radiation source localisation, contamination mapping, and situational awareness in environmental and nuclear safety applications. Its compact design and fast-timing capabilities make it well suited for field deployment in scenarios such as nuclear facility monitoring, waste management, and emergency response. Preliminary results from simulation and experimental studies will be presented.

Primary authors: HART, Shanyn (iThemba LABS); PELLEGRI, Luna (University of the Witwatersrand and iThemba LABS); Dr JONES, Pete (iThemba LABS); VAN TUBBERGH, Christo (iThemba Labs); PETERSON, Steve (University of Cape Town)

Presenter: HART, Shanyn (iThemba LABS)

Track Classification: Environmental Measurements

Contribution ID: **33** Type: **Oral**

RISK ASSESSMENT OF RADON PROGENY IN AFRICAN DWELLINGS

Radon is a radioactive noble gas. Of all radon isotopes only two, radon-222 (radon) and radon-220 (thoron) occur in significant amounts indoors. The state of equilibrium of thoron and the decay products is very low and varies a lot due to the short half-life of thoron. That of radon and progeny is relatively high and stable due to the relatively longer half-life. As a result, the equilibrium equivalent radon concentration, EERC, can be used to determine the level of radon progeny in indoor air. Exposure to radon and radon progeny is the dominating source of exposure to ionizing radiation in most countries. The radon levels vary between dwellings, and depend on inflow of soil gas and the type of building materials. In indoor air, the degree of radioactive equilibrium between radon and its short-lived progeny depends on the aerosol concentration and its size distribution and the air exchange rate. The degree of equilibrium is expressed in terms of the equilibrium factor which is used in determining the dose to the lungs from radon progeny. The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) and the International Commission on Radiological Protection (ICRP) have adopted a worldwide factor of 0.4 for indoor air. Measurement of radon gas is therefore considered to be a good alternate for approximating the concentrations of the radon decay products. To make a reliable estimate of the radon risk, a long-term (three months to a year) measurements of radon are required. The most important route of exposure to radon and its decay products is inhalation. It is the inhalation and deposition in the airways of radon progeny that give rise to irradiation by alpha particles of sensitive cells in the lung tissue. The radiation dose delivered to the lung from inhaled radon progeny is dominated by the alpha particles emitted by the short-lived radon decay products. These alpha particles have very short ranges in tissue hence they deliver a high density of DNA damage to cells in these short distances. This paper discusses the radon progeny levels and the doses received by residents in Africa estimated from radon concentrations levels reported by different researchers in the continent and as measured using continuous and passive monitoring techniques.

Key words: Radon progeny, EERC, Cancer risk, lung cancer, equilibrium factor.

Primary author: Dr NYAMBURA, Catherine (University of Embu)

Co-authors: Dr MUTHEE, Dorah (University of Embu); Dr CHEGE, Margaret (Kenyatta University); Dr ERASTUS, Millien (University of Embu)

Presenters: Dr NYAMBURA, Catherine (University of Embu); Dr MUTHEE, Dorah (University of Embu); Dr CHEGE, Margaret (Kenyatta University); Dr ERASTUS, Millien (University of Embu)

Track Classification: Environmental Physics & Applications

Contribution ID: **34** Type: **Oral**

New High-spin states in W-182

This work presents a detailed investigation of high-spin states in ^{182}W, populated through a deep-inelastic reaction using an 840 MeV ^{136}Xe beam on a thick ^{186}W target and studied using coincidence γ-ray spectroscopy. Out-of-beam data were used to extend the known level scheme, confirming the K^{π} = 16^{+} rotational band up to the 19^{+} state and identifying new levels feeding this structure. The study is motivated by the need to understand how nuclear structure evolves at high angular momentum. Several new intrinsic states have been observed up to 6549 keV, including an isomeric state with a lifetime of 148(9) ns. Spin and parity assignments were derived from transition multipolarities using internal conversion coefficients, angular correlation and mixing ratios, with most states firmly characterized, including the 6549 keV state assigned K^{π} = 24^{-}.

No new rotational bands were observed, indicating a dominance of intrinsic configurations at high spin. Configuration assignments, supported by multi-quasiparticle calculations, led to the identification of several six-quasiparticle states with transition strengths consistent with neighboring nuclei in the A $\approx$ 180 region. At high K-values, weak transitions intensities limited the full characterization of some states, however, the long lifetime of the K^{π} = 24^{-} isomer is suggested to arise from configuration changes rather than K-forbidden decay, while K^{π} = 20^{+} isomer shows behavior consistent with K-isomerism. Overall, this work provides insight into the increasing dominance of intrinsic structure over collective motion at high-spin in ^{182}W.

Primary author: MAPHAGE, Lefika (iThemba LABS/UCT)

Presenter: MAPHAGE, Lefika (iThemba LABS/UCT)

Track Classification: Nuclear Structure Studies

Contribution ID: **35** Type: **Oral**

Use of Environmental Measurements as a Tool to Understand Factors Influencing Radionuclides Concentrations

Radon (Rn-222) is a radioactive gas that originates from uranium (U-238) and is ranked as a major source of natural ionising radiation and identified among the leading causes of lung cancer. It is therefore essential for its occurrence and concentration levels present in the environment to be well understood, quantified and assessed. This study characterised indoor radon levels regionally in the gold mining sites of Gauteng Province and coal mining sites in the Mpumalanga Province using the solid-state nuclear track detectors, which were deployed predominantly during summer and winter months. Moreover, radon parent nuclides were determined in mine tailing residues, soils, rocks and water to help in the understanding of the primary sources and controls of radon.

The study aimed to evaluate the extent to which the local conditions such as the underlying lithology, content of the parent radioisotopes in primary sources, mining activities, seasonal variations and building characteristics affect indoor radon. It was found that the gold tailings residues and coal related operations have no drastic effect on indoor radon concentrations measured in the dwellings studied, other than at a localized location where contamination resulting from tailings materials was observed. The major contributing factors were the uranium content in geological formations and soil, which depicted a positive correlation with indoor radon concentrations at $R^2 = 0.7827$ for rocks and $R^2 = 0.5302$ for soil. The uranium content in the ground surface was proven to be a good first indicator of indoor radon. Contributions from water to indoor radon were found to be negligible. Variations in meteorological conditions with seasons, ventilation rate of the house and the rooms where measurements are conducted, the age of the dwelling and type of building materials were found as additional contributors and controls to indoor radon concentrations.

Primary author: Mrs MARAKALLA, Paballo (National Nuclear Regulator (CNSS))

Co-authors: Prof. ABIYE, Tamiru (University of the Witwatersrand); Dr KORIR, Ian (National Nuclear Regulator (CNSS)); Dr NHLEKO, Sifiso (National Nuclear Regulator (CNSS))

Presenter: Mrs MARAKALLA, Paballo (National Nuclear Regulator (CNSS))

Track Classification: Environmental Measurements

Contribution ID: **36** Type: **Oral**

K600 magnetic spectrometer and the NUMEN project

The NUMEN (NUclear Matrix Elements for Neutrinoless double-beta decay) project aims to obtain the nuclear matrix elements (NME) to be used as inputs in models to determine the lifetime of neutrinoless double-beta ($0\nu\beta\beta$) decay, which is related to the absolute mass of the neutrino [1]. This will be achieved by conducting heavy-ion double charge-exchange (DCE) reactions and measuring the cross sections of these reactions for all isotopes that have been identified to undergo $0\nu\beta\beta$ decay [1]. The occurrence of the $0\nu\beta\beta$ decay will imply that the lepton number is violated [2]. It is, therefore, very important to determine the NMEs as they will assist in elucidating Physics beyond the Standard Model [2]. The transition operators of the $0\nu\beta\beta$ decay and DCE reactions have a similar mathematical structure with a combination of short $0\nu\beta\beta$ decay range Fermi, Gamow-Teller, and rank-2 tensor components [3]. The weights of such components are different, being controlled by the axial and vector coupling constants in the weak sector and by the energy-dependent isospin, spin-isospin, and tensor coupling strengths for the strong interaction [3]. Therefore, more experimental data are required from a range of incident beam energies for DCE measurements. Additionally, to explore the candidate nuclei of $0\nu\beta\beta$ decay in a systematic way, more experimental data are required. Previous experiments for the NUMEN project at Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali del Sud (INFN-LNS) have suffered from high signal rate due to the interaction of the target and projectile, which greatly outnumber any potential DCE events. Additionally, the limited energy resolution of the MAGNEX spectrometer for DCE measurements makes it a cumbersome task to decouple transitions of interest relevant to the NUMEN project. Particle-γ coincidence measurements are a plausible attempt at a solution for this problem. Thus, a high-resolution magnetic spectrometer like the K600 at the iThemba Laboratory for Accelerator Based Sciences (iThemba LABS), which is already used for coincidence measurements, is a perfect candidate for baseline measurements especially given that the LNS facility is still under upgrade. However, in its current design, the existing K600 detection system is limited in the detection of heavy ions (e.g. ^{6}Li,^{12} C,^{18} O,^{18} Ne) at moderate kinetic energies ($\approx$ 10~MeV/u) and light ions at low energies ($\approx$ 5~MeV/u)[4]. The development of a new low-pressure detection system for the K600 is currently underway to expand the spectrometer research program [4]. Thus, an already existing detection system from the MAGNEX large-acceptance spectrometer at INFN-LNS has been coupled to the K600 to provide a baseline as to how the K600 will operate with a low-pressure detection system. The coupling of the MAGNEX focal-plane detection system with the K600 is also beneficial for other nuclear-structure studies to be conducted with the K600 spectrometer.

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Primary authors: Dr KHUMALO, Thuthukile (iThemba LABS); Prof. PELLEGRI, Luna (University of the Witwatersrand and iThemba LABS); Dr NEVELING, Retief (iThemba LABS); Dr BRUMMER, Johann Wiggert (iThemba LABS); Dr DONALDSON, Lindsay (iThemba Laboratory for Accelerator Based Sciences)

Presenter: Dr KHUMALO, Thuthukile (iThemba LABS)

Track Classification: Nuclear Structure Studies

Contribution ID: **37** Type: **Oral**

An Integrated Baseline Environmental Radioactivity Assessment Across Various Exposure Pathways

Monitoring natural radionuclides in the environment is important for establishing baseline radioactivity levels that support the evaluation of public exposure. The study presents baseline environmental radioactivity levels measured in collected soil, external gamma, water and indoor radon samples to assess resultant public doses through external, inhalation and ingestion exposure pathways.

The soil media comprised six (6) beach sand samples, seven (7) sediments, and twenty-two (22) surface soils. Water samples included twelve (12) surface water, five (5) seawater, and sixteen (16) groundwater samples, which were analysed for natural radionuclides originating from the Uranium-238, Uranium-235 and Thorium-232 decay series. External gamma radiation measurements were conducted at fifty-three (53) locations, and indoor radon concentrations were measured in fifteen (15) dwellings. The water and soil samples were analysed using calibrated gamma spectrometry and alpha spectrometry. External gamma radiation was measured in situ using a calibrated portable gamma survey meter (RS-230) to determine ambient dose rates. Passive solid-state nuclear track detectors were deployed in dwellings for a period of three (3) months to measure indoor radon (Radon-222) concentrations.

The radioactivity levels measured in soil samples were found to be significantly lower than the reported worldwide average values of 420 Bq/kg for Potassium-40, 32 Bq/kg for Radium-226, and 45 Bq/kg for Thorium-232. The calculated radiological hazard indices, including radium equivalent activity and external hazard index, were also below internationally recommended safety limits. Similarly, radioactivity levels in water samples were below the World Health Organisation's (WHO) recommended drinking water reference levels, corresponding to an annual committed effective dose of less than 0.1 mSv/year. The measured external gamma dose in the study area due to natural background radiation was below the reference level of 1 mSv/year, which is the public dose limit for planned exposure situations. Indoor radon concentrations were generally below the 100 Bq/m³ reference level recommended by the World Health Organisation, except for one measurement (117 Bq/m³), which was nonetheless below the 300 Bq/m³ action level recommended by the International Atomic Energy Agency (IAEA). Further investigations indicated that the elevated level was unlikely to be attributed to underlying geology but may instead be attributed to factors such as building characteristics or ventilation.

The results of this study provide integrated baseline data of environmental radioactivity levels, which are relevant for environmental monitoring and assessment of public exposure. These findings support radiation protection and safety initiatives.

Primary author: Ms MOLOKWE, Thato (Centre for Nuclear Safety and Security)

Co-authors: Ms MARAKALLA, Paballo (Centre for Nuclear Safety and Security); Dr OCWELWANG, Atsile (Centre for Nuclear Safety and Security); Dr NHLEKO, Sifiso (Centre for Nuclear Safety and Security); Dr KORIR, Ian (Centre for Nuclear Safety and Security)

Presenter: Ms MOLOKWE, Thato (Centre for Nuclear Safety and Security)

Track Classification: Environmental Measurements

Contribution ID: **38** Type: **Oral**

Shape coexistence in neutron deficient nuclei

Across the nuclear chart, many interesting and diverse phenomena arise through the interplay of single-particle motion, nucleon pairing and collectivity. One such phenomenon, known as shape coexistence, is defined as the presence of distinct nuclear shapes within the same nucleus and at similar energy [1]. Significant theoretical and experimental effort is taking place to explore this phenomenon in different mass regions, while it is suggested that it could manifest in most, if not all nuclei [2].

One of the more prominent regions where shape coexistence has been observed, is in neutron-deficient nuclei close to the neutron mid-shell at N=104 and the Z=82 magic number. A broad range of experimental approaches including laser spectroscopy, α-decay fine structure measurements, in-beam γ-ray and conversion electron spectroscopy, lifetime measurements and Coulomb excitation experiments have been employed to study this phenomenon in detail.

In this presentation, we will explore some of these techniques, focusing primarily on simultaneous in-beam γ-ray and conversion electron spectroscopy [3], that has been instrumental in recent years in the study of shape coexistence in lead nuclei [4-8]. To demonstrate its effectiveness we will discuss some of the latest findings in particular in even-even lead isotopes.

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Primary author: PAPADAKIS, Philippos (STFC Daresbury Laboratory)

Presenter: PAPADAKIS, Philippos (STFC Daresbury Laboratory)

Track Classification: Nuclear Structure Studies

Contribution ID: **39** Type: **Oral**

Establishment of Local Diagnostic Reference Levels for Adult and Pediatric Patients in Intraoral Radiography at South African Oral Health Care Center

This work contributes to the Radiation and Health Physics theme through the application of dose quantification and optimization methodologies in intraoral radiography. By establishing locally relevant Diagnostic Reference Levels (DRLs) for both adult and pediatric populations, the study addresses a key gap in South African radiological protection practice. The findings support standardization efforts and provide a framework for future national DRL development and optimization strategies in medical imaging.

Primary author: Mr MASHININI, Sello

Co-authors: Prof. NYATHI, Mpumelelo; Dr RAJBARAN-SINGH, Sandeepa

Presenter: Mr MASHININI, Sello

Track Classification: Radiation and Health Physics

Contribution ID: **40** Type: **Oral**

Extreme Energy Events Project: A National Network of MRPC Muon Telescopes for Cosmic-Ray Physics and Science in Schools

The Extreme Energy Events (EEE) Project is an innovative cosmic-ray experiment that combines frontier astroparticle physics with a large-scale educational mission. EEE is built around a network of muon telescopes based on Multigap Resistive Plate Chambers, distributed across Italy and hosted primarily in high schools. One of the defining features of the experiment is the direct involvement of students and teachers in many stages of the scientific process, from detector construction and commissioning to monitoring, data taking, and analysis.

EEE addresses several key topics in cosmic-ray physics, including measurements of the secondary muon flux at ground level, the observation of extensive air showers, and the study of correlations between distant events through synchronized observations over a wide geographical area. The distributed nature of the array, together with centralized reconstruction and analysis, makes EEE an effective observatory for investigating both local and large-scale features of cosmic radiation.
In 2018, the EEE scientific program was further extended through the PolarquEEEst initiative, which introduced compact scintillator-based detectors to perform cosmic-ray measurements at very high geomagnetic latitudes. The first campaign explored the latitude dependence of the secondary cosmic-ray flux up to the Svalbard archipelago, and in 2019 three detectors were installed at Ny-Ålesund (Svabard) enabling long-term monitoring of muons in an extreme environment. This extension broadened the scientific reach of EEE toward high-latitude studies, with potential connections to atmospheric and environmental phenomena, while preserving the project's emphasis on compact instrumentation and distributed measurements.

The talk will provide an overview of the EEE scientific program, the detector and network architecture, and selected physics results, while also discussing the broader impact of the project as a model of research-driven education. EEE demonstrates that a school-based infrastructure can produce meaningful scientific results while at the same time fostering scientific culture, hands-on training, and long-term collaborative communities in experimental physics.

Primary author: Dr GARBINI, Marco (Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi", Roma)

Presenter: Dr GARBINI, Marco (Museo Storico della Fisica e Centro Studi e Ricerche "Enrico Fermi", Roma)

Track Classification: Cosmic Ray and Muon Physics and Applications

Contribution ID: **41** Type: **Oral**

Gamma and radon measurements in the Huguenot tunnel for the PAUL project

The PAUL project has made significant progress toward planning and designing an underground laboratory to be constructed during the upgrade of the Huguenot Road Tunnel near Paarl in the Western Cape, South Africa. Measurements of muon-flux suppression in the tunnel—critical to demonstrating reduced cosmic-ray backgrounds—will be presented in a separate contribution to this conference. Here, we report on measurements of the gamma-ray background and radon concentrations, which are also crucial for assessing the site's suitability for low-background experiments.

This presentation summarizes radon monitoring results, gamma-ray spectra measured in the tunnel, and the concentrations of naturally occurring radionuclides in the surrounding rock. Measurement methods and results will be described, with emphasis on implications for background mitigation and for the design of the planned underground laboratory.

Primary author: LINDSAY, Robbie (UWC)

Co-authors: Mr MNGONYAMA, Sifiso (University of the Western Cape); NGWADLA, Xolisani Enkosi (student); ELHAG, Elmughera (University of the western cape); Mr NQEKETO, Ntuthuzelo (University of the Western Cape)

Presenter: LINDSAY, Robbie (UWC)

Track Classification: Environmental Measurements

Contribution ID: **42** Type: **Oral**

GATE Monte Carlo Simulation for FDG-18 Image Quality Evaluation of the Siemens Biograph mCT 64S – 3R PET-CT scanner at ORCI

Image quality in Fluoro-2-deoxyglucose-18 (FDG-18) positron emission tomography–computed tomography (PET-CT) is a critical determinant of diagnostic accuracy, as lesion detectability and quantitative reliability depend directly on image contrast and noise characteristics. In FDG-18 PET-CT imaging, administered radiotracer activity governs photon statistics, thereby influencing key image quality metrics including contrast-to-noise ratio (CNR), contrast recovery coefficient (CRC), and background variability (BV). Since the relationship between FDG-18 activity and image quality is non-linear and constrained by competing physical and clinical factors. Therefore, studying the influence of FDG-18 activity is essential to achieving high-quality images while maintaining clinical feasibility at the Ocean Road Cancer Institute (ORCI).

This study evaluated the influence of FDG-18 activity on PET-CT image quality using the Geant4 Application for Tomographic Emission (GATE) Monte Carlo simulation framework and a NEMA image quality phantom. FDG-18 activity was varied from 4.0 to 5.0 MBq/kg, and image quality was quantified using CNR, CRC, and BV. Results demonstrated that increasing FDG-18 activity from 4.0 to 5.0 MBq/kg improved CNR by approximately 18–25%, with small lesion CNR increasing from 4.2 to 5.3, exceeding the Rose criterion threshold of 5 required for reliable lesion detectability. CRC improved by 10–15% for lesions ≤17 mm, indicating enhanced recovery of true FDG-18 uptake, particularly in small structures affected by partial volume effects. Concurrently, BV decreased from 12% to 8%, reflecting improved image uniformity and reduced noise.

An optimal FDG-18 activity of approximately 5.0 MBq/kg was identified, where CNR ≥5, CRC was maximized, and BV minimized. Thus, this study establishes a quantitative framework for establishing FDG-18 PET-CT image quality protocols at ORCI, supporting improved diagnostic reliability in Tanzania.

Primary author: Ms MUNIR, Fatima (University of Dar es Salaam)

Co-authors: Dr LUGENDO, Innocent (University of Dar es Salaam); Dr MWINGEREZA, Kumwenda (University of Dar es Salaam); Ms RAMADHAN, Rehema (Kilimanjaro Christian Medical Center); Dr NKUBA, Leonid (Tanzania Atomic Energy Commission)

Presenter: Ms MUNIR, Fatima (University of Dar es Salaam)

Track Classification: Radiation and Health Physics

Contribution ID: **43** Type: **Oral**

Bridging Reaction Physics and Nuclear Structure: γ-Ray Spectroscopy and Cross-Section Systematics for Nucleon-Induced Reactions

We present here a a comprehensive and systematic study of nuclear γ-ray production cross-sections induced by proton reactions on a series of key nuclei, specifically 24,25,26Mg, 28,29,30Si, 40Ca, and 56Fe [1,2]. These investigations are conducted within the framework of an Algeria-France-South Africa collaboration at the iThemba LABS facility, utilizing the high-resolution AFRODITE gamma-ray spectrometer. The primary objective is to provide high-precision experimental data in a proton energy range of 30-200 MeV [1,3] where existing data are often scarce or inconsistent, yet crucial for multiple scientific domains.
The measured cross-sections serve as a cornerstone for several applications. In medical physics, they are essential for optimizing radioisotope production and improving dose calculations in proton therapy. In nuclear astrophysics, these data are employed to simulate γ-ray line emissions resulting from the interaction of galactic cosmic rays (GCRs) with abundant elements in the interstellar medium (ISM) and solar flares. By comparing laboratory measurements with satellite observations (such as those from INTEGRAL or COMPTEL), we can better determine the chemical composition and understand the energetic processes of the cosmos.
A central technical aspect of this work involves the adjustment of optical model potential (OMP) parameters for nucleon-nucleus interactions. Beyond the primary gamma-ray line analyses following inelastic scattering on target nuclei, our analysis allows for the measurement of production cross-sections for a wide range of residual nuclei. Indeed, the complex interaction mechanisms lead to the observation of various isotopes resulting from nucleon or alpha emission, such as 21,22Ne, 22,23Na, and 24,25,26Al from magnesium and silicon targets, as well as 38,39K, 36,38Ar, 54,55Fe, and 52Cr for heavier targets. To ensure the highest accuracy, the analysis of the γ-ray spectra is complemented, whenever necessary and possible, by a lineshape calculation to account for Doppler effects and peak broadening.
This process is a fundamental approach to better understand the physics of reactions and the complex interactions between the candidates (incident particles and target nuclei). By systematically adjusting the OMP parameters, we can adjust the nuclear level coupling and determine the nuclear deformation parameters (β2 and β4). While the analysis of the 40Ca data is currently in progress-focusing on the optimization of nucleon-induced reactions and their implications for residual Argon nuclei-future objectives aim to extend this methodology to α-particle induced reactions as they are rather scarce. Ultimately, this hierarchical approach - moving from fundamental interaction physics to the adjustment of theoretical models - is needed for improving the predictive accuracy of global nuclear reaction codes such as TALYS.
The experimental and theoretical results obtained and compiled will be presented and discussed.

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Primary author: YAHIA CHERIF, Walid (Nuclear research center of Algiers (CRNA))

Co-authors: Prof. OUICHAOUI, Saad (USTHB); Dr LAWRIE, Elena (iThemba LABS); Dr KIENER, Jurgen (IJC Lab); Dr LAWRIE, Kobus; Dr JONES, Pete (iThemba LABS); Dr BELHOUT, Amel (USTHB); Dr MOUSSA, Djamel (USTHB); Dr DELONCLE, Isabelle (IJC Lab); Mr DEBABI, Mohamed (USTHB); Dr HAMMACHE, Fairouz (IJC Lab); Dr DE SEREVILLE, Nicolas (IJC Lab); Dr TATISCHEFF, Vincent (CNRS); Dr WIEDEKING, Mathis (LBNL); Dr MAJOLA, S. N. T. (iThemba LABS); Dr CHAFA, Azzedine (USTHB)

Presenter: YAHIA CHERIF, Walid (Nuclear research center of Algiers (CRNA))

Track Classification: Nuclear Experimental Techniques and Data Analysis

Contribution ID: **44** Type: **Oral**

Revisiting Radiocesium Retention in Japanese Cedar: Implications for Post-Accident Forest Recovery

The long-term management of contaminated forest landscapes depends not only on declining environmental inventories of radiocesium (137Cs), but also on how this radionuclide is retained within commercially important tree species. Japanese cedar (Cryptomeria japonica), which underpins much of Japan's plantation forestry, exhibits an unusual internal distribution of 137Cs within wood (stem), marked by preferential accumulation in heartwood rather than sapwood. This pattern challenges conventional assumptions about radionuclide behavior in woody tissues and raises questions about the processes controlling internal redistribution and retention. This study synthesizes current knowledge and ongoing works on radial radiocesium dynamics in Japanese cedar, focusing on anatomical, physiological, and environmental factors that may drive these observations. Key uncertainties are identified, and directions for future research are outlined to improve predictive capability and inform risk-based decisions on the utilization of forest timber in post-accident environments.

Keywords: Japanese cedar, Radiocesium, Forest ecosystems, Fukushima.

Primary author: Prof. OROSUN, Muyiwa (Institute of Environmental Radioactivity, Fukushima University)

Co-authors: YOSCHENKO, Vasyl (Institute of Environmental Radioactivity, Fukushima University); NANBA, Kenji (Institute of Environmental Radioactivity, Fukushima University)

Presenter: Prof. OROSUN, Muyiwa (Institute of Environmental Radioactivity, Fukushima University)

Track Classification: Environmental Measurements

Contribution ID: **45** Type: **Oral**

Nuclear structure studies relevant for 136Xe neutrinoless double beta decay

The search for neutrinoless double beta ($0\nu\beta\beta$) decay provides a unique probe of the Majorana nature of neutrinos, i.e whether neutrinos are their own antiparticles. The observation of this process would imply the violation of lepton number conservation and signal new physics, beyond the Standard Model. However, the interpretation of $0\nu\beta\beta$ experimental searches relies critically on nuclear matrix element (NME) calculations, which are sensitive to nuclear structure inputs and remain a significant source of uncertainty. In this talk, I will discuss nuclear structure properties relevant to the 136Xe $0\nu\beta\beta$ decay, investigated via the 137Ba(d,3He)136Cs single-nucleon transfer reaction. The results provide experimental constraints on single-proton occupancies and contribute to reducing uncertainties in NME calculations.

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Primary author: NZOBADILA ONDZE, Jespere Calderone (University of the Western Cape)

Presenter: NZOBADILA ONDZE, Jespere Calderone (University of the Western Cape)

Track Classification: Nuclear Structure Studies

Contribution ID: **46** Type: **Oral**

Extraction of Giant Monopole Resonance strength with Multipole Decomposition Analysis

It has been established that inelastic alpha scattering at a few hundreds MeV, particularly at very forward scattering angles including 0◦, is effective for probing the Isoscalar Giant Monopole Resonance (ISGMR) strength distribution (E0) in atomic nuclei. Two previous studies on the evolution of the ISGMR in the even-even 40,42,44,48Ca isotopes were conducted at two different facilities: the Research Center for Nuclear Physics (RCNP) and the Texas A&M University Cyclotron Institute (TAMU). These studies produced conflicting results regarding the systematic trend of nuclear incompressibility across the calcium isotopic chain under investigation.

In response, the iThemba LABS group conducted an independent study of the same isotopes to investigate the potential origins of these discrepancies. Measurements were carried out at 0◦ and 4◦ scattering angles, and an energy-dependent version of the difference-of-spectra (DoS) method was initially employed. While this method offers high energy resolution, it relies on the strength contributions of all L ≥ 0 multipolarity components published in the literature, thereby compromising the independence of our results. To address this, Multipole Decomposition Analysis (MDA) was applied to extract the E0 strength distributions. Although the limited angular range may reduce the precision for higher multipolarity strengths, it does allow for the accurate extraction of the E0 component independently of other studies.

Two MDA methods were used in the analysis: the emcee Python code, which employs the sophisticated Markov Chain Monte Carlo (MCMC) sampling algorithm, and a second MDA method is based on the MINUIT algorithm, implemented within the ROOT data analysis framework. Selected results obtained using both methods will be presented at the workshop.

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Primary authors: JAFTA, Lesedi (iThemba LABS); NEVELING, Retief (iThemba LABS); DONALDSON, Lindsay (iThemba Laboratory for Accelerator Based Sciences); TRIAMBAK, Smarajit (University of Western Cape); KHUMALO, thuthukile (iThemba LABS); PELLEGRI, Luna (University of the Witwatersrand and iThemba LABS); USMAN, Iyabo (University of the Witwatersrand); BAHINI, Armand (University of Caen Normandie / Laboratoire de Physique Corpusculaire Caen (LPC Caen)); BRUMMER, Johann Wiggert (iThemba LABS); JIVAN, Harshna (University of the Witwatersrand); JONES, Pete (iThemba LABS); JONGILE, SANDILE (UNIVERSITY OF ZULULAND); LI, Kevin (Stellenbosch Postgraduate Student); SMIT, Ricky (iThemba LABS); STEYN, Deon (iThemba LABS)

Presenter: JAFTA, Lesedi (iThemba LABS)

Track Classification: Nuclear Structure Studies

Contribution ID: **47** Type: **Oral**

Assessment of Radiation Exposure and Radiological Security Risks in Scrap Metal Facilities and Waste Dumpsites in Dar es Salaam, Tanzania

Background: The increasing presence of radioactive materials in non-nuclear facilities such as scrap metal stores and waste dumpsites poses significant radiological safety and security threats to
workers, the public, and the environment. In urban settings like Dar es Salaam, Tanzania, scrap metal yards and dumpsites are often located in close proximity to residential and commercial areas, raising concerns about uncontrolled radiation exposure and potential illicit trafficking of radioactive materials.

Objective: This study aimed to assess radiological safety and radiological security risks in selected scrap metal stores and dumpsites in Dar es Salaam.
Methods: The study was performed by evaluating the radiation exposure levels and radon exhalation rates in five scrap metal stores and three dumpsites in Dar es Salaam respectively. The radiation exposure rates were measured using an Ionization Chamber Survey Meter (ICSM) and a Gamma Scout Detector (GSD) while the radon (^{222}Rn) exhalation rates were measured using an AlphaGUARD radon monitor. Annual effective dose equivalent (AEDE) and excess lifetime cancer risk (ELCR) were calculated.

Results: The average radiation exposure rates ranged from 0.15 ± 0.03 μSv/h to 1.02 ± 0.18 μSv/h. Store S_1 recorded the highest exposure (1.41 μSv/h at chest level), exceeding the ICRP public exposure limit of 0.57 μSv/h. Calculated AEDE values ranged from 1.76 ± 0.57 mSv/y to 9.55 ± 1.22 mSv/y, all above the ICRP public limit of 1.0 mSv/y but below the occupational limit of 20 mSv/y. ELCR values ranged from (5.79 ± 1.56) × 10^{-3} to (31.42 ± 4.01) × 10^{-3}, significantly higher than the global average of 0.29 × 10^{-3}. Meanwhile, the mean radon exhalation rates at dumpsites ranged from 123.0 ± 10.0 mBq m^{-2} h^{-1} (Pugu-Kinyamwezi) to 216.0 ± 40.0 mBq m^{-2} h^{-1} (Tabata). Yet, all radon concentrations remained below ICRP (300 Bq m^{-3}) and WHO (100 Bq m^{-3}) safety limits.

Conclusion: The findings reveal significant radiological safety and security concerns at scrap metal stores, where workers are exposed to radiation doses exceeding public limits, with elevated lifetime cancer risks. While radon levels at dumpsites remain within international safety thresholds, continuous monitoring is necessary to maintain these levels. Urgent regulatory interventions are recommended, including mandatory radiation screening protocols for scrap metal shipments, provision of personal dosimeters for workers, radiological safety training, and establishment of a centralized national database to track radioactive sources. These measures are essential to mitigate health risks, prevent illicit trafficking of nuclear materials, and enhance overall radiological security in Tanzania.

Keywords: Radiological safety, radiological security, radiation exposure, scrap metal, dumpsites, radon exhalation, annual effective dose equivalent, excess lifetime cancer risk, Dar es Salaam.

Primary author: LUGENDO, Innocent Jimmy (University of Dar es Salaam)

Presenter: LUGENDO, Innocent Jimmy (University of Dar es Salaam)

Track Classification: Environmental Measurements

Contribution ID: **48** Type: **Oral**

Applications of Accelerator Mass Spectrometry in southern Africa

The AMS facility at iThemba LABS is the only one of its kind on the African continent. It operates with NRF support to achieve a threefold mandate: to provide a technology platform for users, to train future science leaders, and to do research. In meeting this mandate the AMS facility operates in a partnership with the user base in the provision of know-how to run analyses on science agendas set by the users, and in leading in-house research that accommodates academic partners and post-graduate student training. While the AMS facility is framed securely in the particle physics domain, the greatest impact is found in applied disciplines. The greatest demand is from the traditional heritage market, and the "recent archaeology" of southern Africa is almost entirely dependent on AMS radiocarbon dating to provide a chronological framework. Other important applications include testing climate change forecasts, dating groundwater recharge, assessing global phenomenon such as magnetic field fluctuations over the last 50 000 years, and assessing the mechanisms of coastal erosion. The essence of the AMS program is to use particle physics for the benefit of the people of South Africa, and Africa, and this depends on attracting innovative young scientists into the field.

Primary author: WOODBORNE, Stephan

Presenter: WOODBORNE, Stephan

Track Classification: Environmental Physics & Applications

Contribution ID: **49** Type: **Oral**

Title: Review of Environmental Radioactivity in Mkuju, Manyoni, and Bahi Uranium Deposits in Tanzania

Uranium deposits in Tanzania, particularly at Mkuju, Bahi, and Manyoni, have attracted increasing attention due to their economic potential and environmental implications. Over the past two decades, numerous studies have investigated activity concentrations of naturally occurring radionuclides, including uranium-238, thorium-232, and potassium-40, as well as associated radiological hazards. However, these studies remain scattered, limiting a spatial pattern, methodological consistency, potential environmental and public health implications. This paper aims to systematically review and synthesize published studies on natural radioactivity in the Mkuju, Bahi, and Manyoni uranium deposits. The findings reveal that activity concentrations in soil for 238U (21 to 846 Bq/kg), 232Th (12 to 107 Bq/kg) and 40K (38 to 791 Bq/kg) in Manyoni indicating moderate to high variability depending on sampling location. In contrast, Mkuju exhibits the highest radioactivity levels, particularly within concession areas where 226Ra reaches extremely elevated values of 2430 – 4200 Bq/kg, accompanied by increased 232Th (130 – 220 Bq/kg) and 40K (up to ~1466 Bq/kg). Bahi deposit shows comparatively lower to moderate 226Ra concentrations (9.19 – 69.38 Bq/kg), but relatively high 40Klevels, reaching up to 1384.75 Bq/kg. Despite these observations, inconsistencies in sampling strategies and limited longitudinal studies hinder reliable comparisons and comprehensive trend analysis. This review emphasizes the need for standardized methodologies, long-term environmental monitoring, GIS-based mapping, geochemical fingerprinting and expanded studies on radionuclide transfer through environmental pathways. This review provides a comprehensive perspective on radioactivity measurements in Tanzanian uranium deposits and serves as a benchmark for future investigations in radiation safety and sustainable uranium exploitation in Tanzania.

Primary author: Dr MAZUNGA, Mohamed (University of Dar es Salaam)

Presenter: Dr MAZUNGA, Mohamed (University of Dar es Salaam)

Track Classification: Environmental Measurements

Contribution ID: **50** Type: **Oral**

The Rhisotope Project - A novel use of radiation to deter poaching

The rate of poaching of rhinos in South Africa shows little sign of slowing. The numbers are down but there are less animals to be poached. South Africa is custodian of the majority of the world's black and white rhino populations. The conventional methods of anti poaching are proving barely adequate whilst at the same time risking the lives of antipoaching patrols. The Rhisotope Project utilises nuclear science in a novel manner to protect these megaherbivores and give them the chance to survive and thrive once again.

Primary author: LARKIN, james (University of Witwatersrand)

Presenter: LARKIN, james (University of Witwatersrand)

Track Classification: Environmental Physics & Applications

Contribution ID: **51** Type: **Oral**

Collimator-Free Non-Collinear Cascade Gamma Coincidence Imaging: A GATE-Based Study Achieving Sub-Millimeter Resolution and High Sensitivity

This study presents the GATE-based Monte Carlo model and performance evaluation of a non-time-of-flight, collimator-free tomographic medical imaging system based on non-collinear cascade gamma-ray Coincidence (CGC) imaging. A CGC imaging model was developed to reconstruct three-dimensional decay vertices from valid coincidence events. A custom geometric back-projection reconstruction algorithm was implemented to generate tomographic images in transverse, coronal, and sagittal views, enabling quantitative assessment of spatial resolution, sensitivity, and coincidence detection efficiency (CDE). The results show, with 111In-ion point source at the center of field of view (FoV), the modeled imaging system achieved sub-millimeter isotropic spatial resolution of approximately 0.477 mm (FWHM) along all axes and demonstrated resolving capability between 1.5-2.0 mm for closely spaced point sources. The CGC imager achieved a coincidence efficiency of 1.50588×10^{-2} and sensitivity of 15,058.8 cps/MBq for a 111In source at the center of the FoV in air, their corresponding values for source in PMMA phantom were 1.25279 × 10-2 and 12,527.9 cps/MBq, respectively. These values were significantly higher than those reported for conventional parallel-hole, focused, and hybrid collimator-based systems, representing improvements of several orders of magnitude. For positional reconstruction, the analysis confirmed the reconstructed source position within ±16 mm transaxially and ±17 mm axially resembles to simulated position. To evaluate the impact of radionuclide decay characteristics on imaging performance, four cascade gamma emitters (43K, 73Se, 111In and 177Lu) were simulated under identical conditions. 111In and 73Se exhibit the highest CDEs, followed by 177Lu, while 43K shows the lowest due to its extremely short intermediate-state half-life of 46 ps, which is below the detector timing resolution (~0.549 ns), leading to missed valid coincidence events. The higher CDE for 111In is partly from random coincidences caused by its longer half-life and wider timing window. These results emphasize that detector timing resolution, isotope selection, and coincidence window design are critical for optimizing cascade gamma imaging performance. On the other hand, spatial resolution remained the same (~0.477 mm FWHM) across radionuclides. This finding confirms that system resolution is governed by detector geometry and reconstruction parameters rather than decay properties. The findings demonstrate that non-collinear CGC imaging enables the simultaneous achievement of both high sensitivity and sub-millimeter spatial resolution. However, experimental testing of the system should be conducted to assess its practical performance.

Primary authors: JUNIOR, Innocent (Dar es Salaam University College of Education); MWITA, Enock Mtatiro (University of Dar es Salaam); Dr NKUBA, Leonid (Tanzania Atomic Energy Comission); MOHAMMED, Najat (University of Dar es Salaam); LUGENDO, Innocent Jimmy (University of Dar es Salaam)

Presenter: MWITA, Enock Mtatiro (University of Dar es Salaam)

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Characterization of an I-125 seed using the AAPM TG-43 dosimetry protocol

Introduction:
I-125 seeds are often used in temporary or permanent radiotherapy implants. The American Association of Physicists in Medicine (AAPM) formed Task Group (TG) 43 to propose a dosimetry protocol for such cylindrically symmetric seeds. The protocol calculates the dose rate at a particular point by taking into account the air kerma strength, dose rate constant, geometry function, radial dose function, and anisotropy function.

Methods and Materials:
OncoSeed 6711 I-125 seed dimensions of 20 seeds were confirmed with a Vernier caliper. These dimensions were then used to obtain the geometry function, which provides an inverse square correction based on the activity distribution in the source. Air kerma strength was confirmed using a calibrated PTW Sourcecheck 4π chamber. The anisotropy and radial dose functions were measured in specially designed solid water phantoms using thermoluminescent dosimeters (TLDs). Gafchromic film was also used for these measurements. The dose rate constant was determined using the ratio of the measured dose rate at 1 cm and the air kerma strength. Spectral measurements were made with a Silicon Drift Detector. These results were used to determine the average seed energy, as well as the dose rate constant by taking into account each peak's individual contribution.

Results:
The active length of the seeds was measured to be 2.85 mm ± 0.99 %, while the nominal seed length was given as 3.0 mm. The difference in the geometry function was less than 1 % at 0.5 cm, and less than 0.06 % at distances of 2 cm and larger. The average ratio of stated and measured air kerma strengths was 0.999 ± 0.031 for 175 seeds measured from 7 different batches of seeds. The anisotropy and radial dose function matched published data to within one standard deviation. The measured dose rate constant using TLDs was Λ = 0.96 ± 0.2 cGy h-1 U-1, while the calculated one using the spectrum was Λ = 0.978 cGy h-1 U-1. The average energy of the I-125 seed excluding the titanium characteristic X-rays of the seed housing was 27.44 keV, in good agreement with published data.

Conclusion:
All seed parameters matched published data very well, allowing accurate and precise dose calculations for radiotherapy treatment planning.

Primary author: Dr TRAUERNICHT, Christoph (Tygerberg Hospital and Stellenbosch University)

Presenter: Dr TRAUERNICHT, Christoph (Tygerberg Hospital and Stellenbosch University)

Track Classification: Radiation and Health Physics