PANGOLINS

PORTABLE AFRICAN NEUTRON-GAMMA LABORATORY FOR INNOVATIVE NUCLEAR SCIENCE

Pete Jones
Separated Sector Cyclotron Laboratory
iThemba LABS, South Africa

ANSTT Workshop, iThemba LABS
18-22 May 2026

Application of accelerator based instrumentation and techniques for environmental applications and societal benefit

Nuclear Inst. and Methods in Physics Research, A 1026 (2022) 166195

Contents lists available at ScienceDirect

Nuclear Inst. and Methods in Physics Research, A

journal homepage: www.elsevier.com/locate/nima

A fast-timing array of 2" x 2" $LaBr_3$:Ce detectors for lifetime measurements of excited nuclear states

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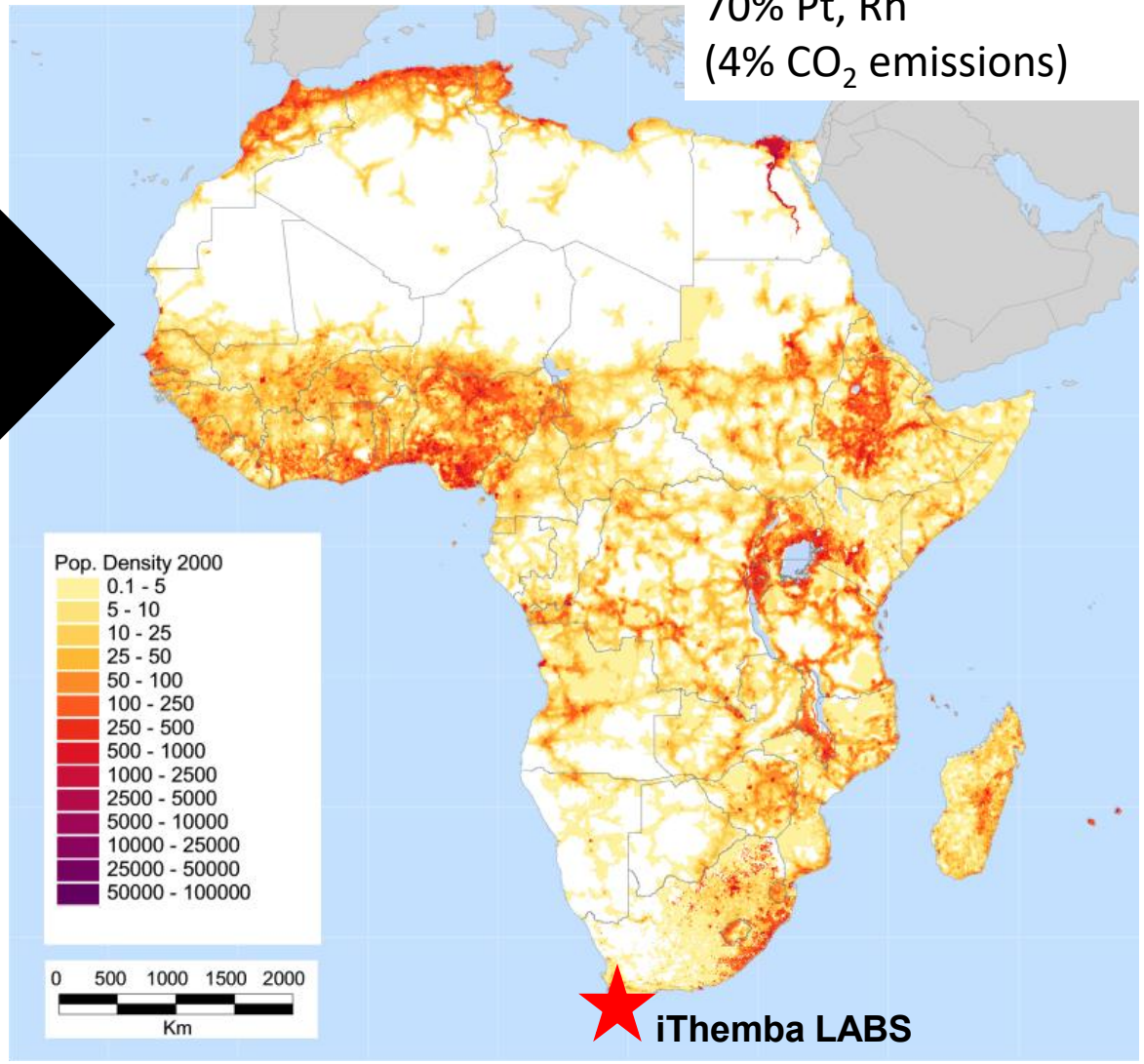
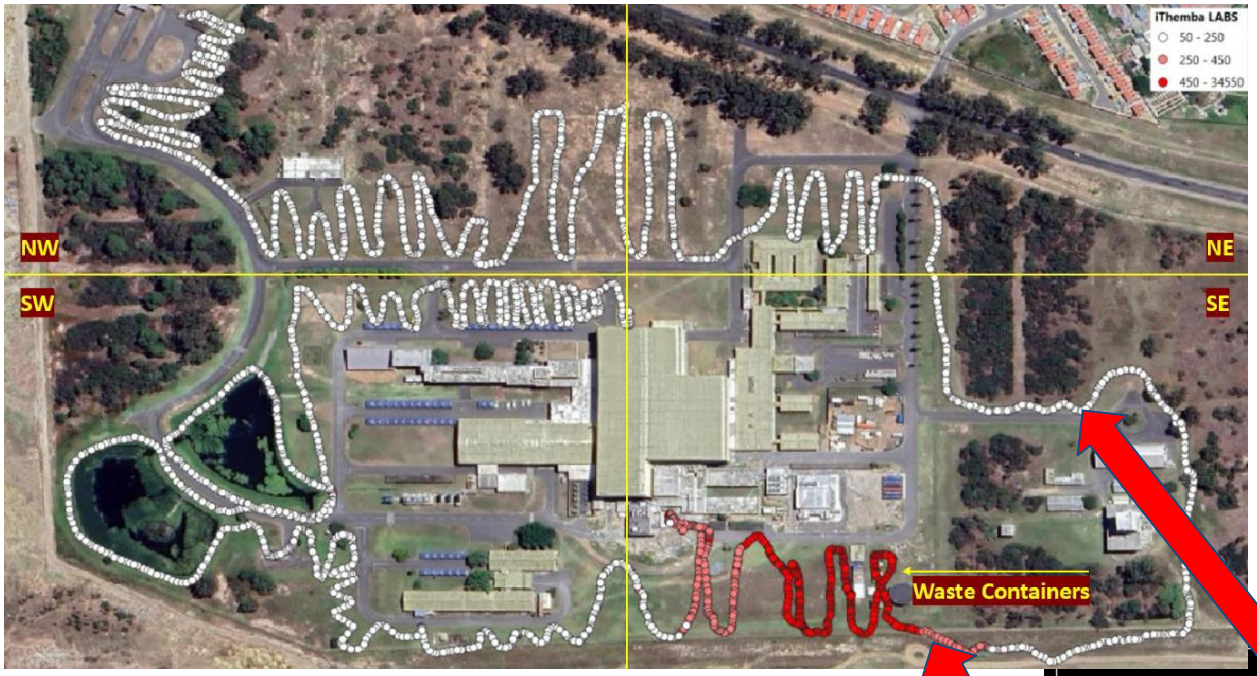
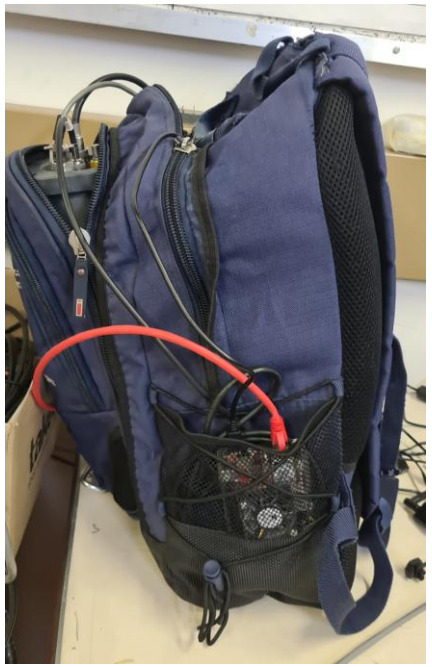
Taking science impact from the LAB to the FIELD

30% Natural Resources
50% Au, Cr
70% Pt, Rh
(4% CO_2 emissions)

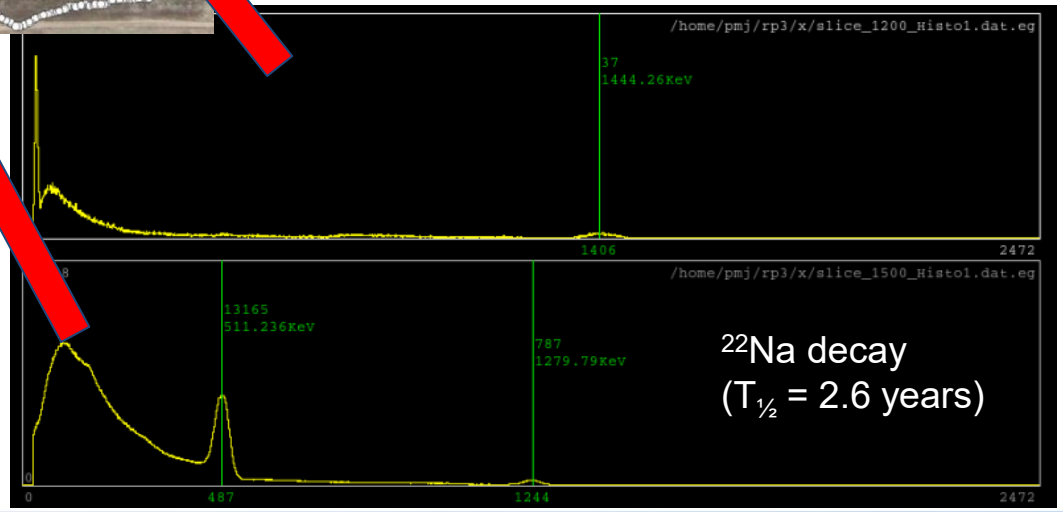


Mobile Radiation Detection Unit Measuremen





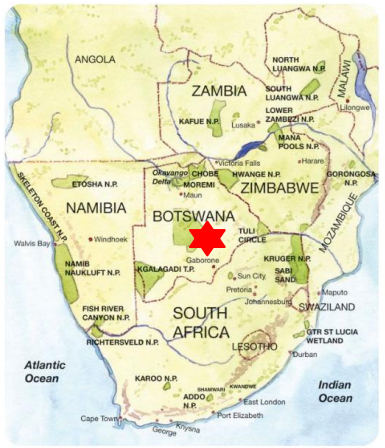
Ph.D. Candidate
F. van Niekerk (SU/TUT/iTL)



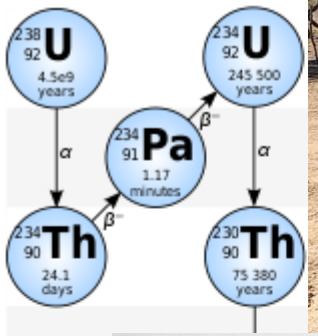
^{22}Na decay
($T_{½}$ = 2.6 years)

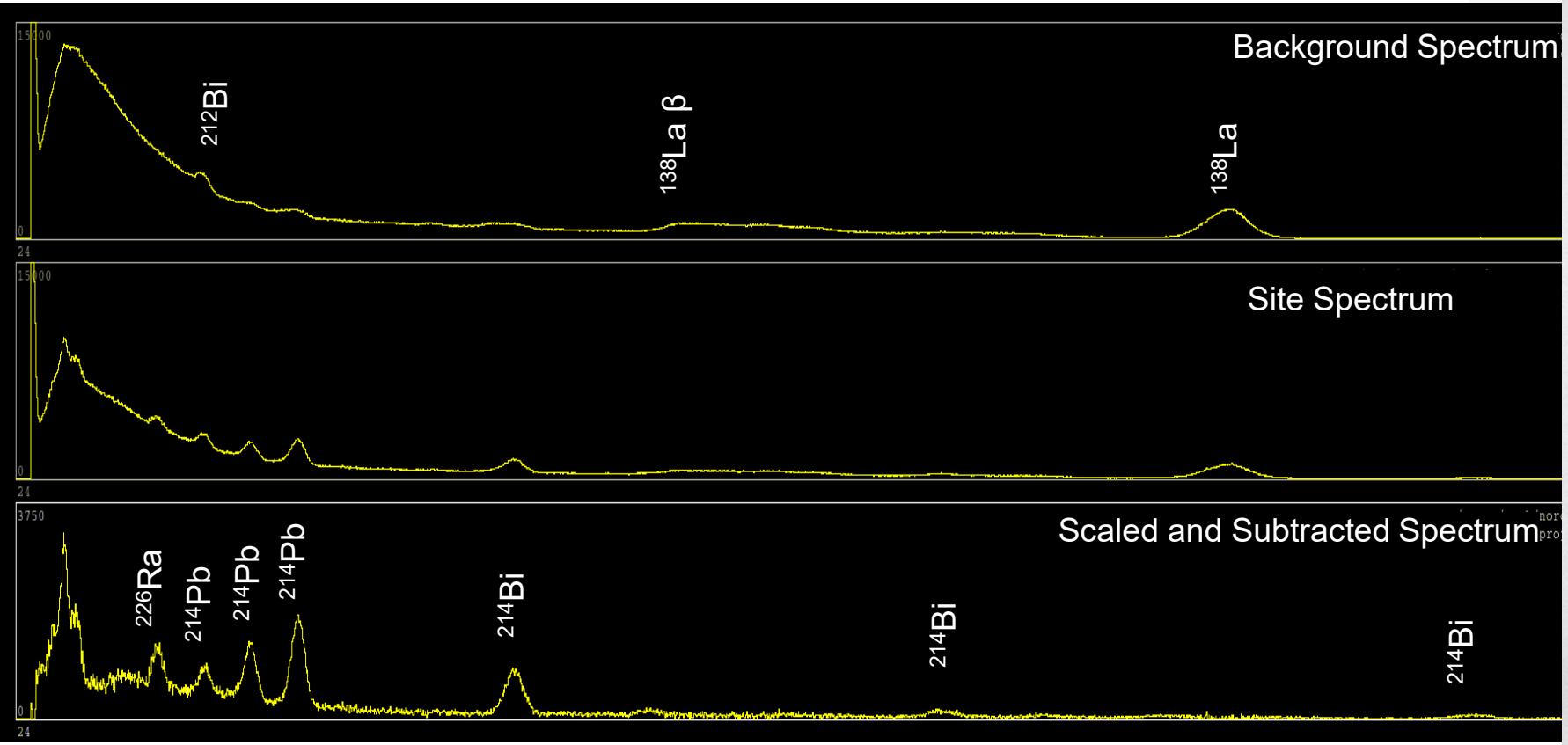
$LaBr_3$ Detector
125MHz digitiser
Raspberry Pi readout
Cloud based
Low Power system

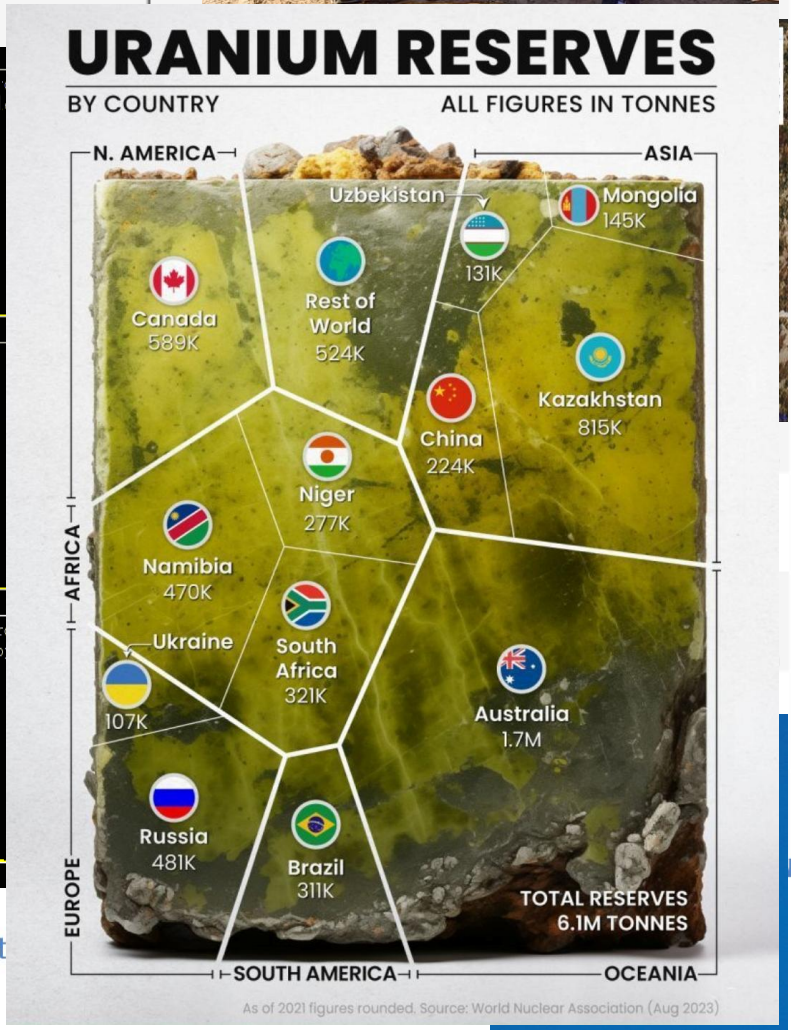
iThemba LABS' Mobile Radiation Detection Unit



Preliminary in situ Measurements: Serule, Botswana







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Milestones

- Reduce the footprint of the Mobile Radiation Detection Unit
- Introduce newer and smaller detectors – $LaBr_3$, SrI_2, Cs_2LiYCl_6
- Introduce neutron sensitivity for detection (and gamma discrimination)
- Replace photomultiplier technology to silicon avalanche photomultipliers
- Replace the high voltage with low voltage (and stabilities)
- Characterise and deploy a next generation of measurements
- Continue in-situ measurements on foot and though uncrewed aerial vehicles (drones)

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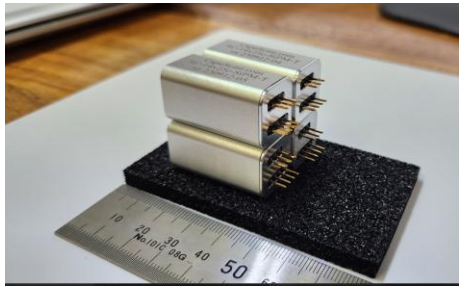
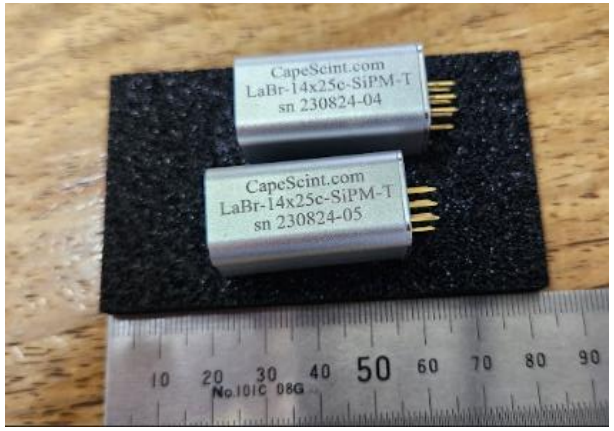
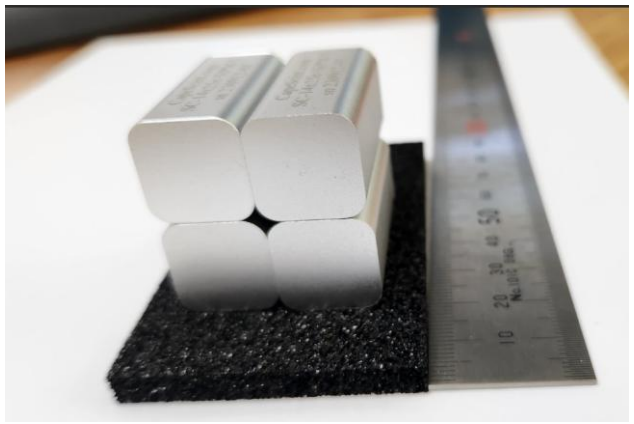
Technologies

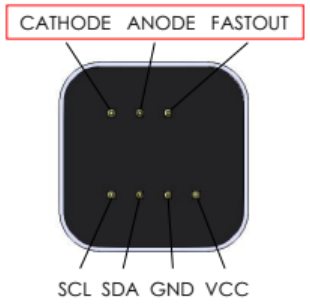
$LaBr_3$ 1.5 x 1.5 cm x 2.5 cm
SiPM coupled

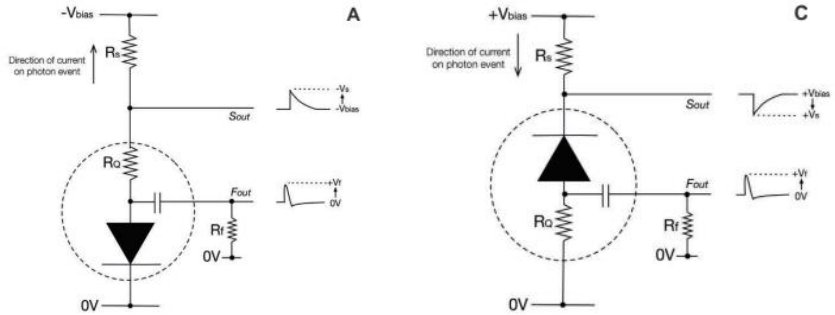


SrI_2
Cs_2LiYCl_6:Ce (CLYC) – n sensitive









Need for new instrumentation, LV (~30 V) couplings, rather than High Voltages (~1000 V)

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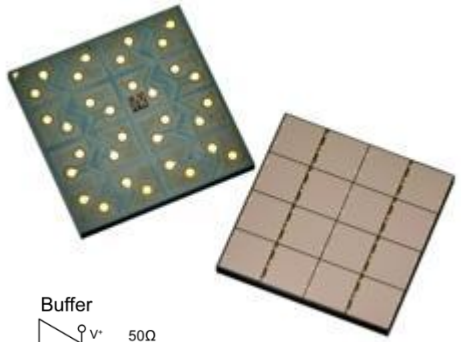
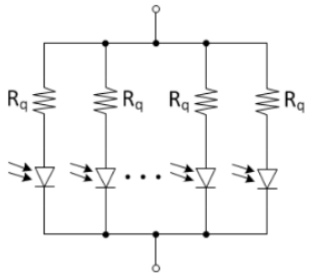
Technologies

Standard or specialized detectors
Silicon Photomultiplier Array

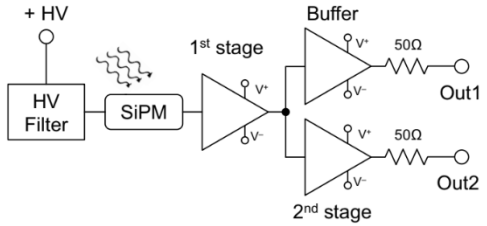
4x4 array – 16mm^2

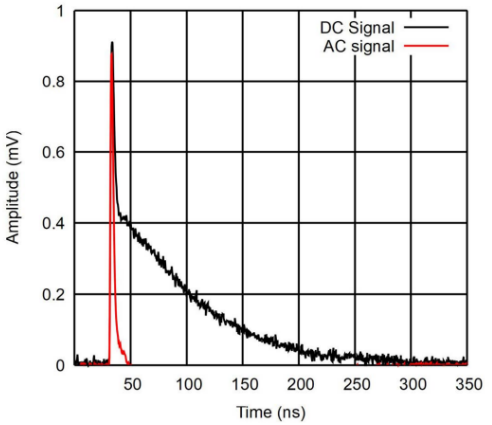
AFBR-S4N44P164M
4×4 NUV-MT Silicon Photo Multiplier Array

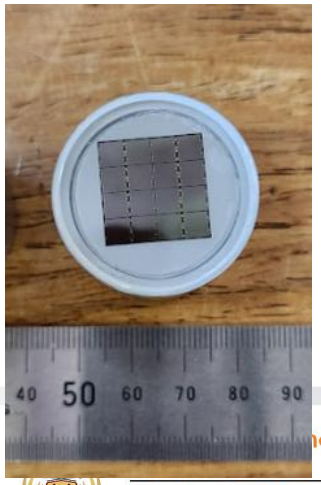


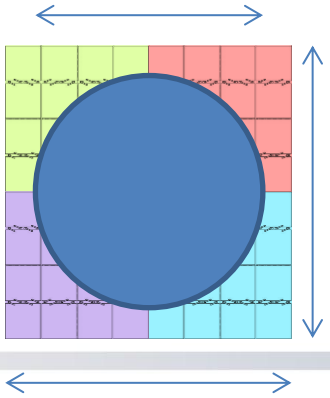


Block Element









1” $LaBr_3$ crystal needs many SiPM’s to collect all the light
or some kind of light guide – matching (bias / gain) important

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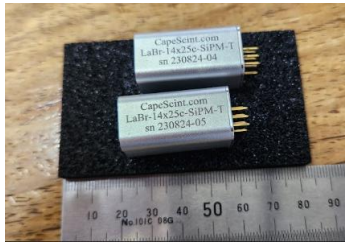
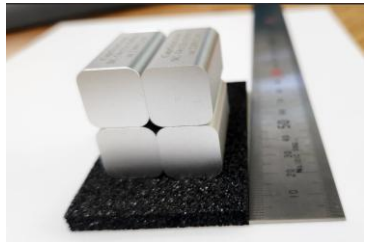
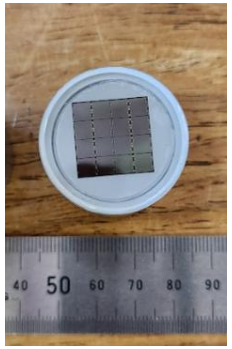
Deployments





Detector Developments



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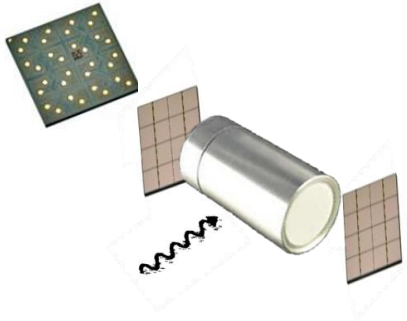

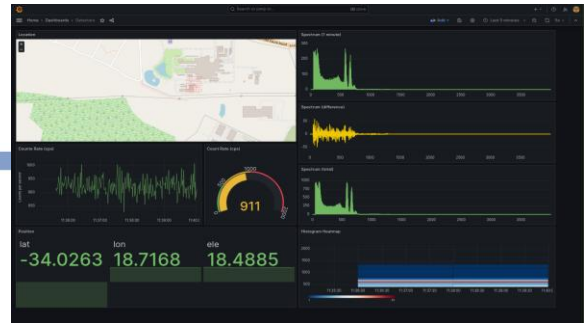

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Use case scenarios with *IMPACT*

LOTUS RESOURCES

Assessing the Influence of Excavation Practices on Background Radiation Levels: A Case Study of the A-Cap Uranium Mining Lease Area in Botswana

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[2]iThemba LABS, Separated Sector Cyclotron Laboratory, P. O. Box 722, Somerset West 7130, South Africa

Mertech Marine

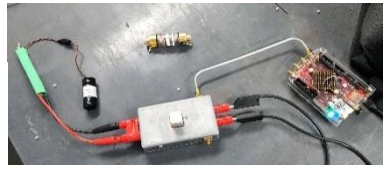
Development of a mobile gamma-ray $LaBr_3$:Ce detector unit for in-situ radionuclide analysis at TENORM contamination sites

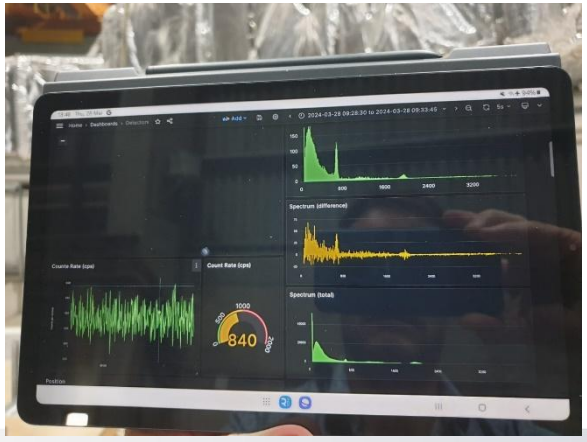
by

Ferdinand van Niekerk

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

University of Cape Town





Building a Hybrid Compton Camera System for Improving Proton Therapy Imaging

NRF National Research Foundation

iThemba LABS Laboratory for Accelerator Based Sciences

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nspiring a n

SiPM Research

Maahir Rahman & Glen Taylor, SARAO

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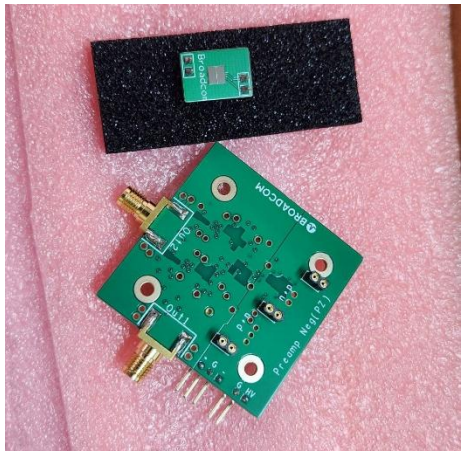
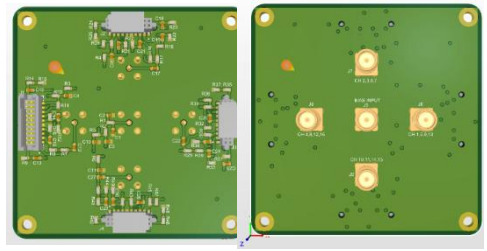
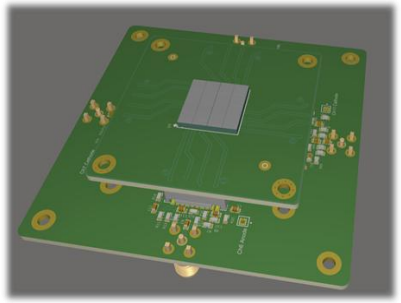
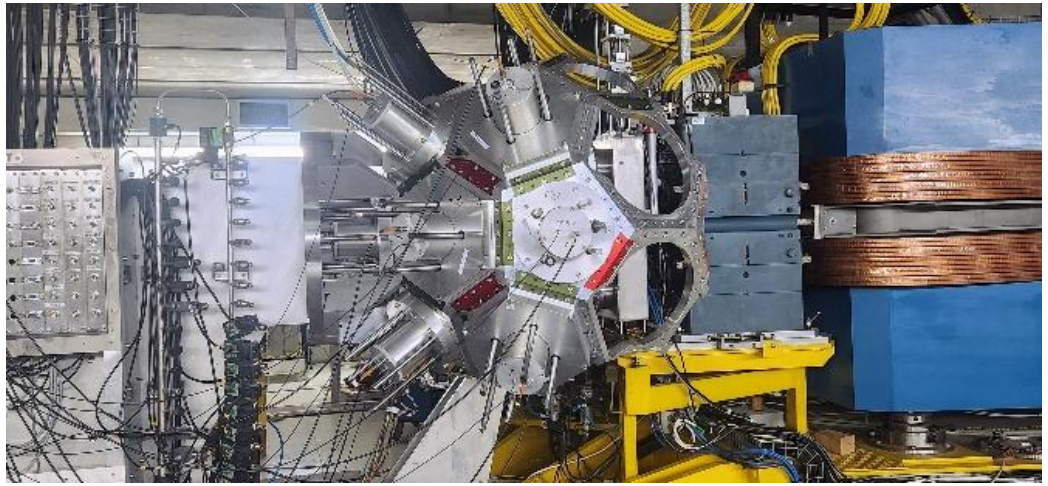




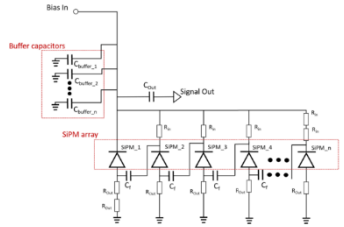


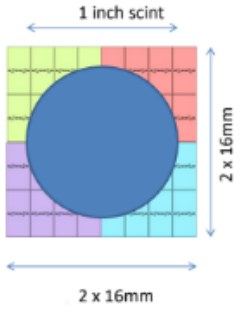


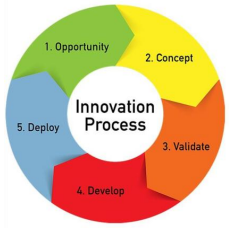
ALBA Array at iThemba LABS (21 of 8” x 3.5” $LaBr_3$)

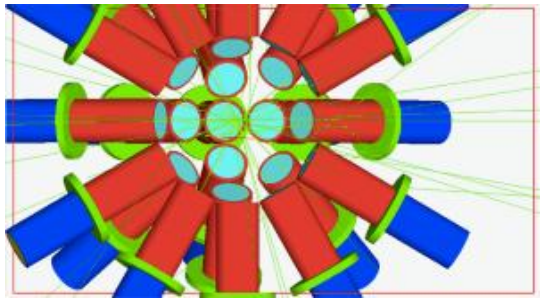
Figure 5 illustrates a basic schematic of the hybrid-ganging method.

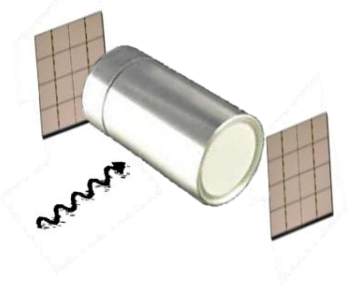
Figure 5: Illustrative Sketch of the Hybrid-Ganging Method for the Summation of Analog SiPM Signals

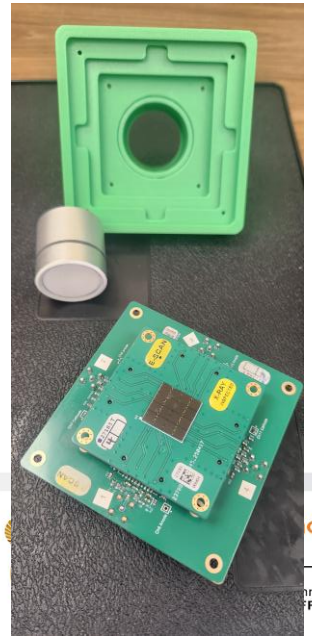


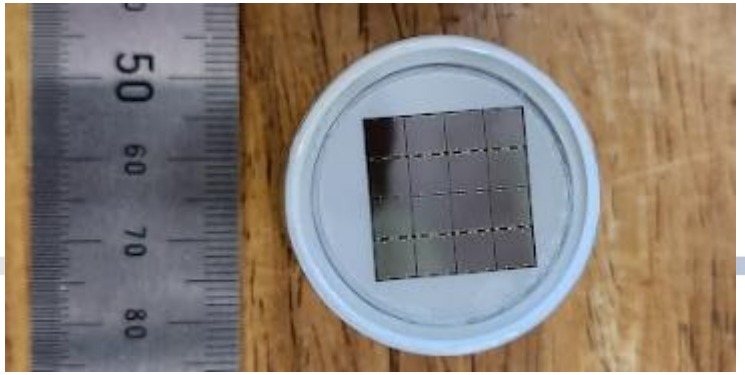


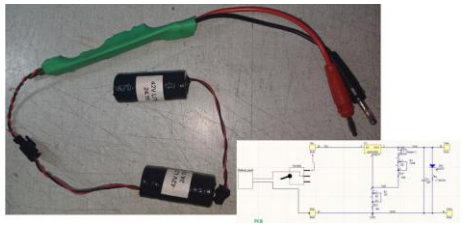












Bias Supply
Christo van Tubbergh, iTL

New laboratory space at
Technology Innovation Platform, iThemba LABS

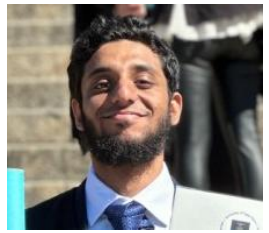
Team *PANGoLINS*

- Mr Etienne Bauermeister, SARAO
- Dr Shanyn Hart, iThemba LABS
- Mr Mark Johnson, SARAO
- Dr Pete Jones, iThemba LABS
- Mr Matlou Mabokano, SARAO
- Mr Omer Mahgoub, SARAO
- Mr Steyn Meyer, SARAO
- Dr Ferdinand van Niekerk, Tshwane University of Technology
- Prof Luna Pellegri, iThemba LABS, University of the Witwatersrand
- Mr Maahir Rahman, SARAO
- Mr Nieldane Stodart, iThemba LABS
- Mr Glen Taylor, SARAO
- Mr Christo van Tubbergh, iThemba LABS
- Dr Stephan Woodborne, iThemba LABS / University of Pretoria
- Mr Donovan Wyngaard, iThemba LABS
- Mr Ahmed Vanker, SARAO














Off the press…

Journal of Environmental Radioactivity 289 (2025) 107767

Contents lists available at ScienceDirect

Journal of Environmental Radioactivity

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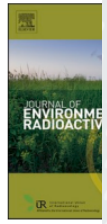

DOI: 10.1016/j.jenvrad.2025.107767

A mobile gamma-ray $LaBr_3(Ce)$ detector unit for in-situ radionuclide analysis at TENORM contamination sites

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Highlights

- Industrial sectors have radioactive by-products with radiation levels above natural background.
- Scintillator detectors such as NaI(Tl) and semiconductor detectors such as HPGe are used to measure gamma ray emissions.
- $LaBr_3(Ce)$ was investigated as an alternative and employed as a mobile detector.
- Real-time spatial and activity data were collected using the MRDU.
- Activity concentrations were compared to chemical concentrations to evaluate the presence of chemical disequilibrium.

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Mail & Guardian August 2025

INNOVATION in Nuclear Science and Technology for Societal Benefit

Radioactive decay is responsible for roughly 50% of the heat generated by our planet. The radioactive decay series depicts the process through which radioactive elements are spontaneously transformed into stable elements by emitting radiation in the form of particles and/or waves. The detection of the radiation emanating from these radioactive sources allows for the unravelling of the unique signature of the parent elements, like a fingerprint.

The need to drive sustainable development necessitates a balancing act between people, planet, and profit. This requires not only environmental impact studies in the planning of new mining or industrialization activities but also monitoring of the efficacy of remediation practices at sites with increased radiation levels. The prioritisation of profit over planet and people can negatively impact the health of animals and humans living around mining sites through habitat disruption, water contamination, air pollution, and poor management of radioactive waste. This destruction is even more severe in areas prone to artisanal mining operations.

NRF-iThemba LABS, a national research facility of the National Research Foundation (NRF), is known as the largest particle accelerator facility on the African continent. It has expertise in radiation detection and safety, data-analysis, and the utilisation of technology for the betterment of society. For example, it investigated the possible radiation pollution of the Olifants River in December 2013/January 2014 after spillage of polluted process water from the Bosveld Phosphates mine adjacent to the Kruger National Park.

NRF-iThemba LABS is ideally positioned to conduct impactful research in the area of radiation detection provided that the following challenges can be addressed, namely:

- Planning for remote data collection;
- Rough terrain and the elements;
- Access to the data in real-time for analysis and decision-making;
- The incorporation of location- and time-stamps in the data-sets; and
- Improvement of data collection methodologies and optimisation techniques through the use of AI and machine learning.

The PANGoLINS Project

The Portable African Neutron-Gamma Laboratory for Innovative Nuclear Science (PANGoLINS) project is the brainchild of Dr Pete Jones, a senior research scientist at NRF-iThemba LABS who was inspired by the pangolin, a mammal found in tropical Asia and Africa. PANGoLINS brings together expertise from engineering (mechanical, electronic, software), instrumentation science, drone pilots, and data analysts to drive innovation that creates a safer and better tomorrow.

The mobile radiation detection unit (MRDU), pioneered by NRF-iThemba LABS in 2022, allows a user to operate in the field and chart the location, strength and energy of gamma radiation. The system uses a sensitive scintillation detector integrated into a backpack and incorporates a fast 125 MHz digitiser for readout and a GPS enabled Raspberry Pi microprocessor system which allows *in situ* measurements of radiation, with collected data streamed to the cloud and analysed offline.

The PANGoLINS project utilises cuboid MacroPixel scintillators in a compact geometry, complete with silicon photomultiplier and integrated
th 1 000V in standard detectors), and both
types of scintillator were studied, namely
the latter providing sensitivity to neutrons.
ultipliers, and their integration into existing,

urrent regulators. Prototype modules power
d payload, with a total mass of 1.1kg, was
tes to facilitate access to rough terrains.

ced radiation fields that are essential for

Innovation, the process of finding new ways of doing, is key as the world turns to a more decarbonised future, and the impact of global climate change on food security is felt across the African continent. Access to reliable data sets to inform our decision-making will be crucial as we navigate among planet, societal benefit, and profit. NRF-iThemba LABS is committed to become the meeting place for scientists, engineers, and civil society as we look after our radioactive earth as the enabler of industrial and societal transformation.

meeting place for scientists, engineers, and civil society as we look after our radioactive earth as the enabler of industrial and societal transformation.

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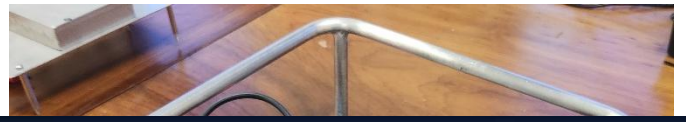
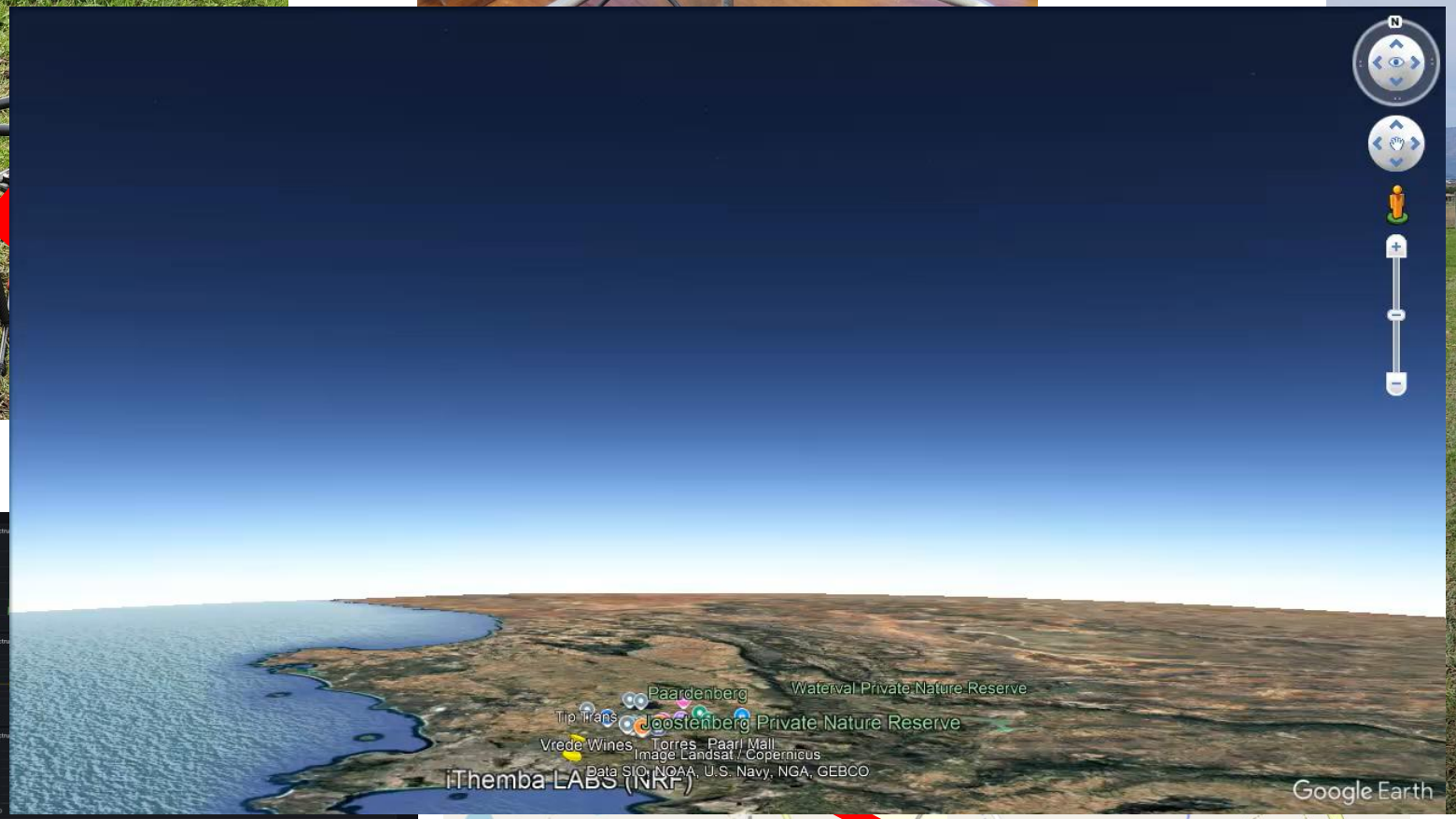
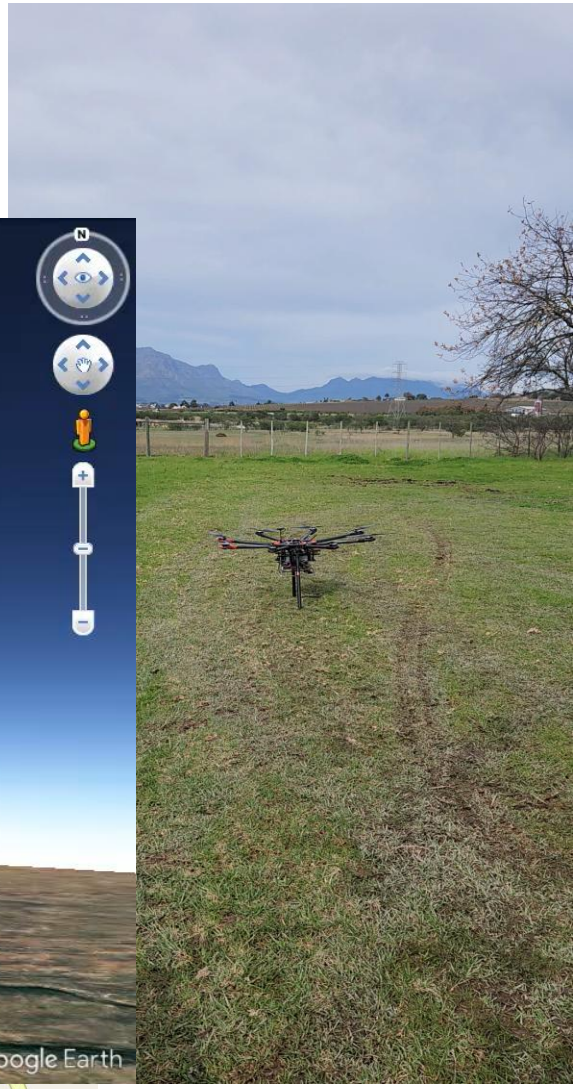
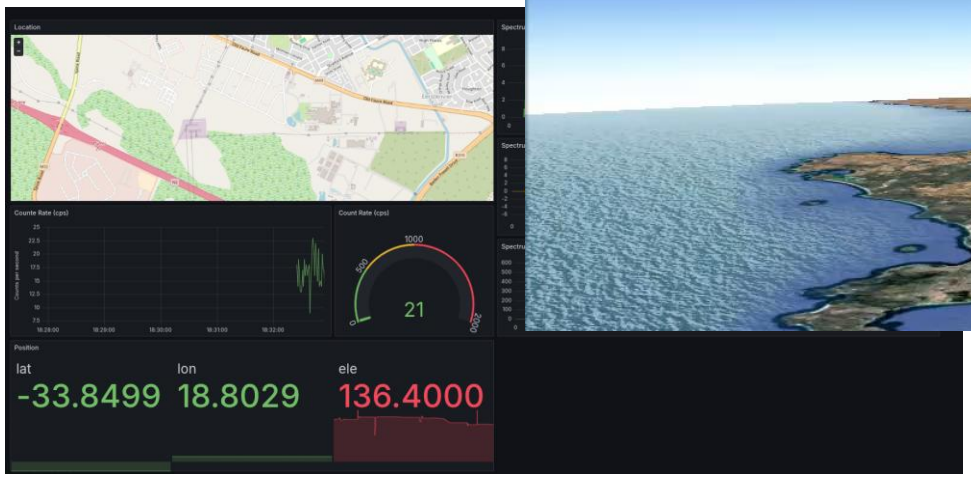
NRF National Research Foundation | iThemba LABS Laboratory for Accelerator Based Sciences

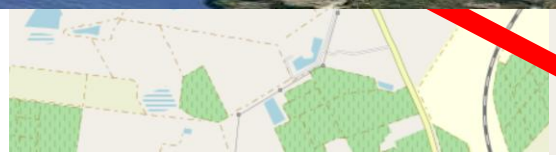
Latest flights July 2025 with integrated payloads







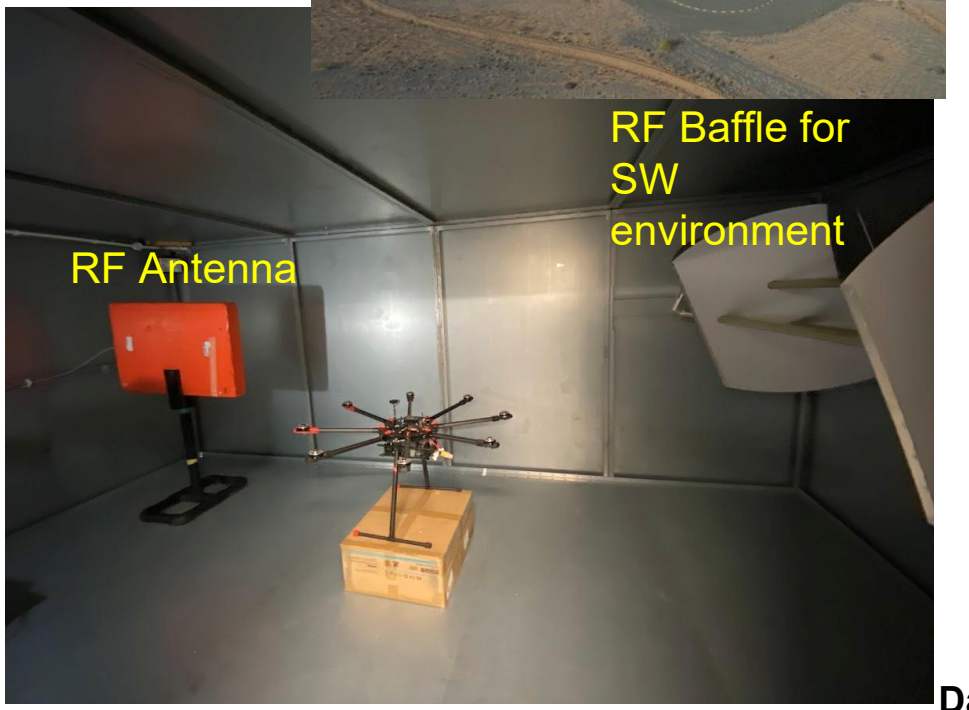




UAV Research

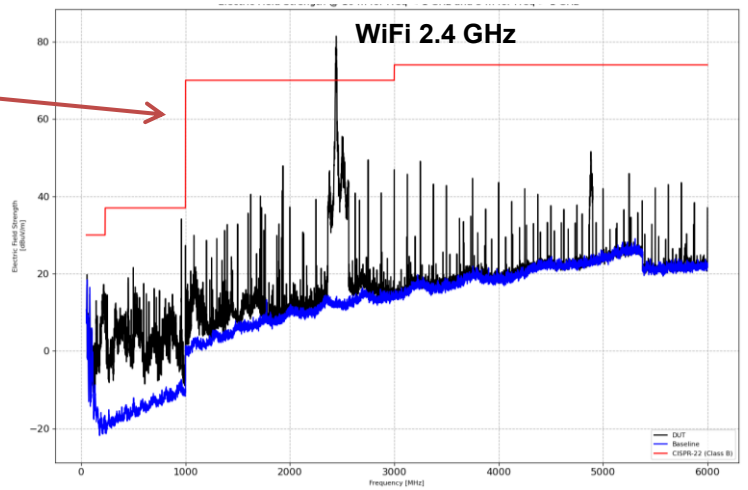
Tests of RF spectrum for UAV and its payload especially for high speed digitiser
(50 MHz – 6 GHz)

RFI Chamber at SARAO, Cape Town

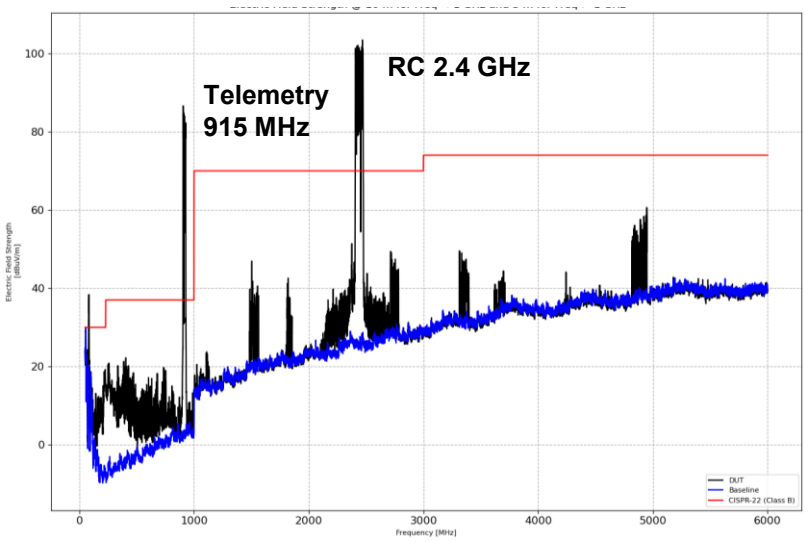


RFI Limit

Payload only – WiFi, Data Processing



Drone rotors 100% - Radio Control

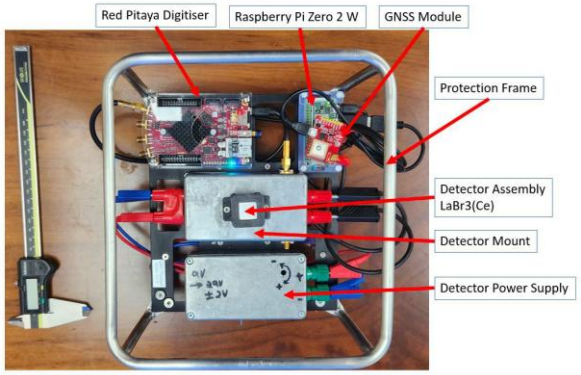


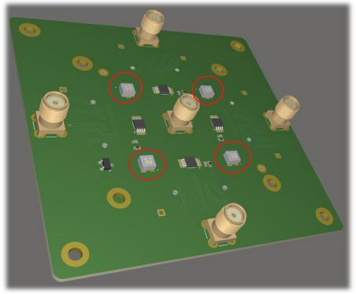
Data Courtesy of Aneshka Bothma, RFI-SARAO

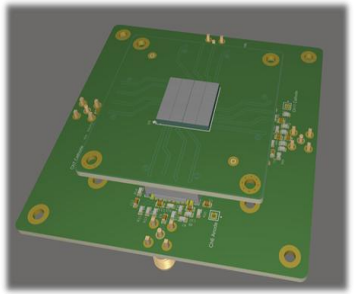
PANGoLINS 2023-2025

New laboratory space at Technology Innovation Platform

NRF INSIGHTS
Unveiling the trends to shape tomorrow



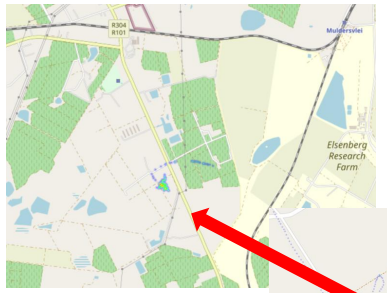


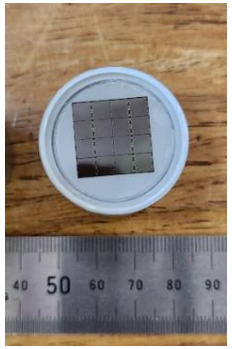


Compton Camera imaging

RPC Training

Field Measurements with UAV

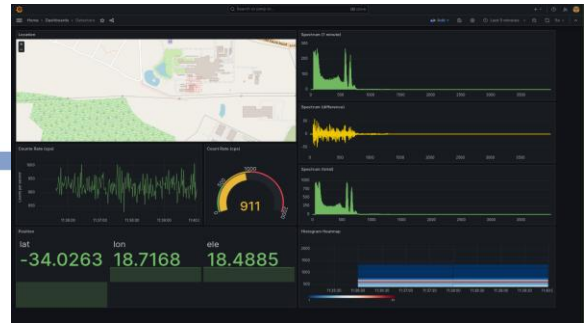




technology innovation AGENCY
Innovating Tomorrow Together

SiPM development collaboration with SARAO

AFRICA2MOON



Supported 2023-24 under Grant number 14606/01

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Advancing knowledge. Transforming lives. Inspiring a nation.

Collaborations

technology innovation AGENCY
Innovating Tomorrow Together

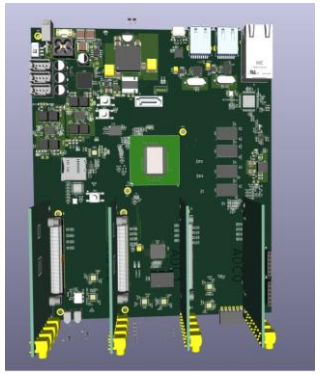
Supported 2023-24 under Grant number 14606/01
Grants: R 1.6 M

NRF National Research Foundation | SARAO South African Radio Astronomy Observatory

UKRI Science and Technology Facilities Council

DASSIE
Digital Acquisition Signal System for Innovative Experimentation

GOV.UK Development Tracker



ANSTT 18-22 May 2026

Status IMPLEMENTATION

The current stage of the Programme, consistent with the International Aid Transparency Initiative's (IATI) classifications.

Actual Start
01 Dec 2024

Planned End
31 Mar 2027

Progress by time
53.11%

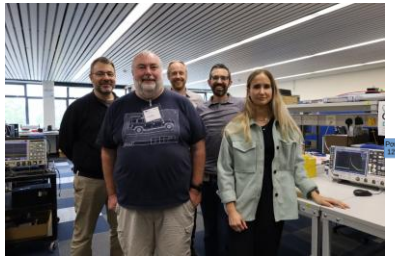
Programme Spend

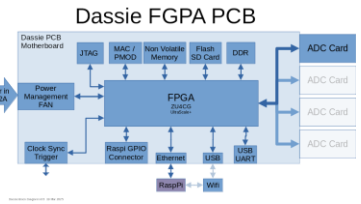
Programme budget and spend to date, as per the amounts loaded in financial system(s), and for which procurement has been finalised.

Programme budget
£329,898

Spend to date
£128,049 (38.81%)

https://devtracker.fcdo.gov.uk/countries/ZA/projects





Total full economic costs (fEC)
£663,110

Total contribution from applying organisation(s)
£132,622.00

Total funding applied for
£530,488.00

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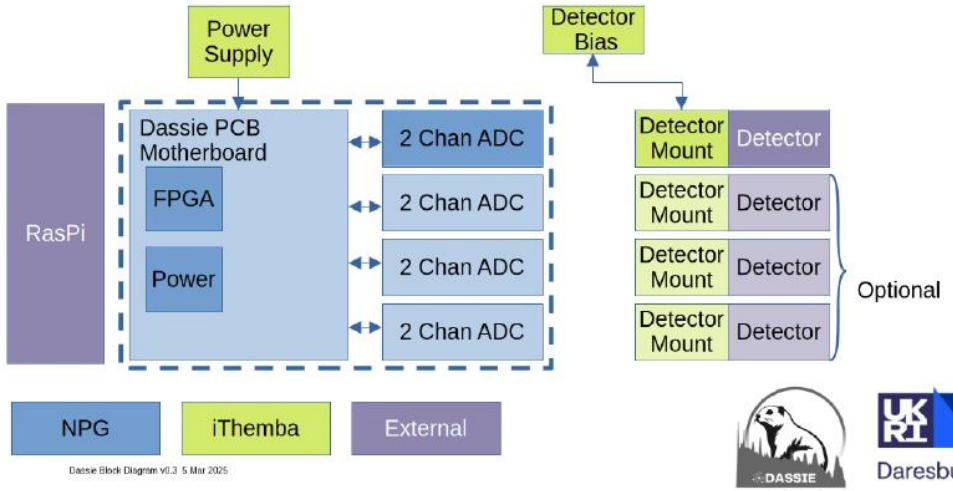
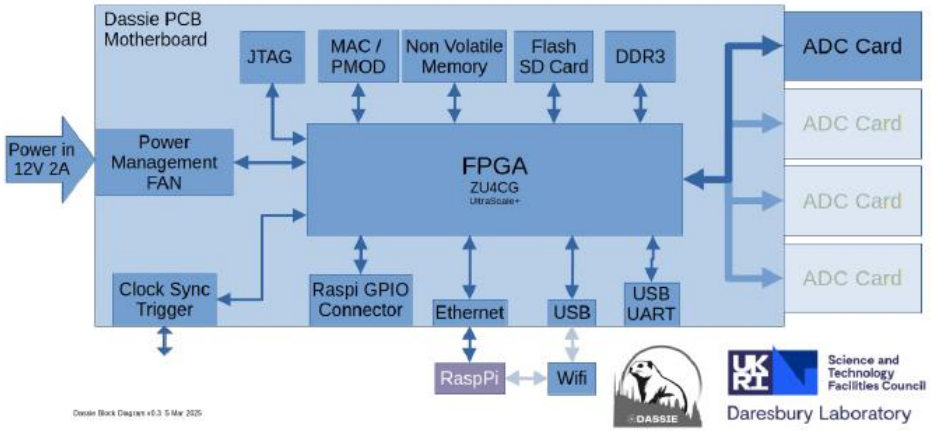
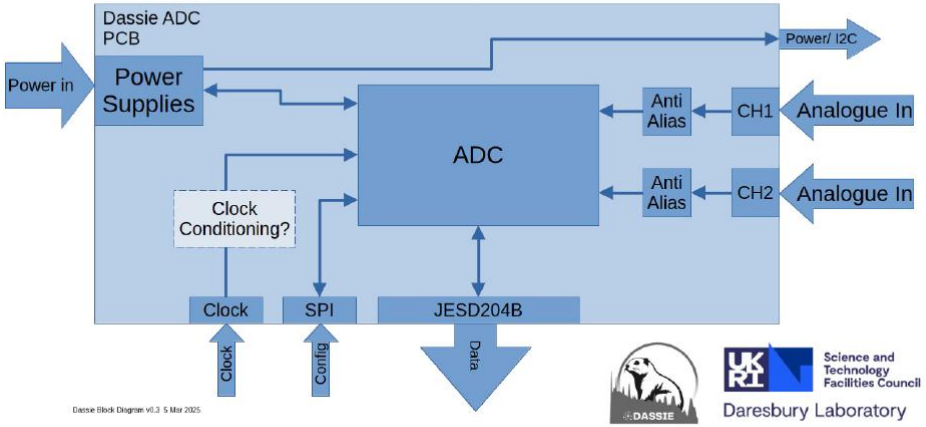
Dassie Block Diagram



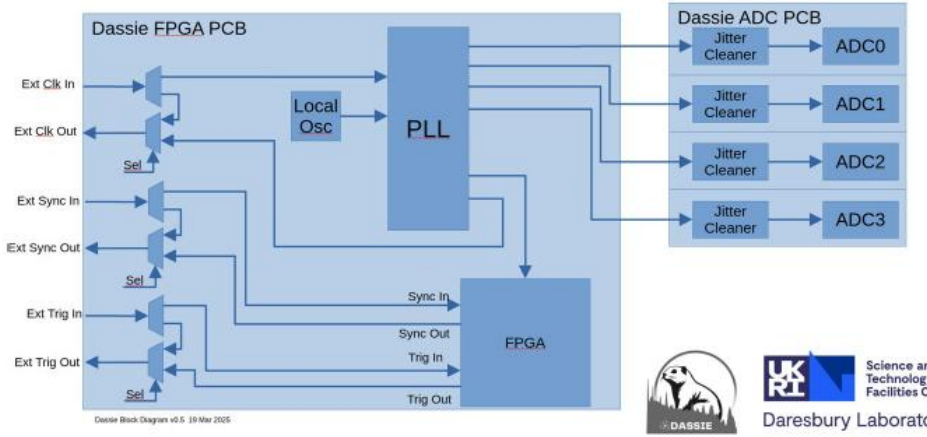
Dassie FGPA PCB



Dassie ADC PCB



Dassie Clock Distribution



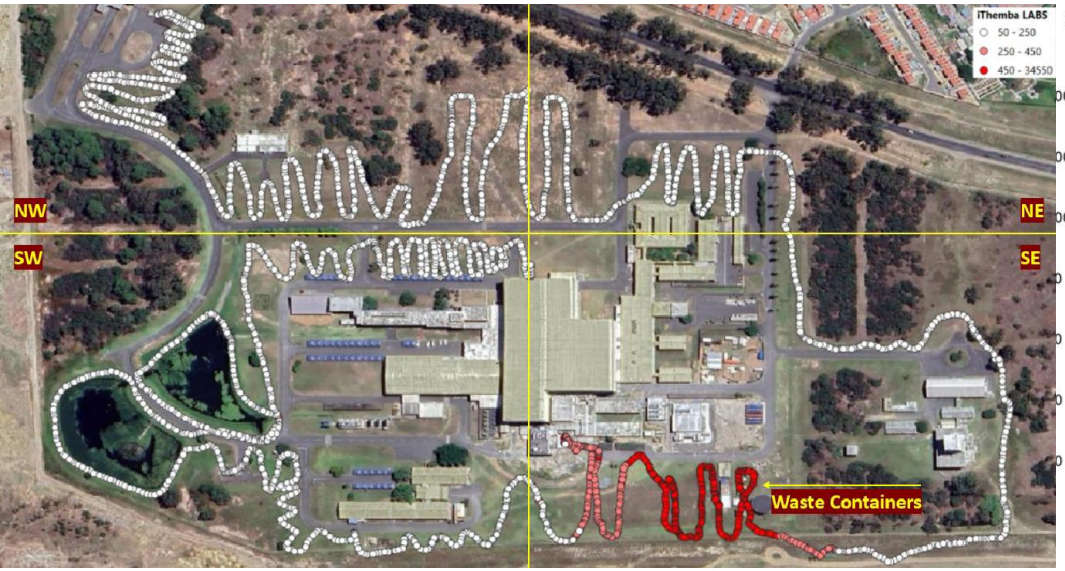
Specification completed early 2026, design ongoing review with SARAO (Ettienne)

Streaming Radiation Mapping using Window Models, Gaussian Processes, and Delayed-Acceptance MCMC

Ravikanth Tadikonda, STFC, UK

Science and Technology Facilities Council

Hartree Centre



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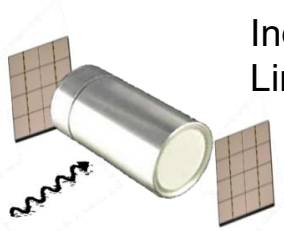
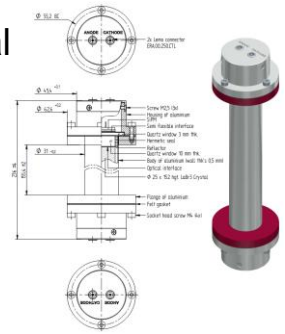
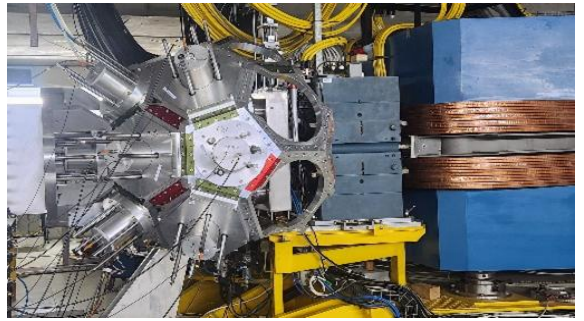
Instrumentation for applications and beyond: bespoke digital detectors through ***advanced manufacturing***

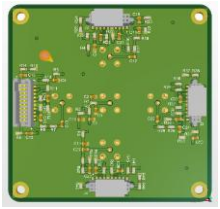


Industrial Linkage

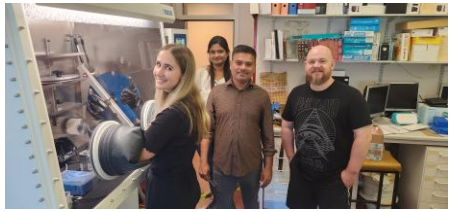




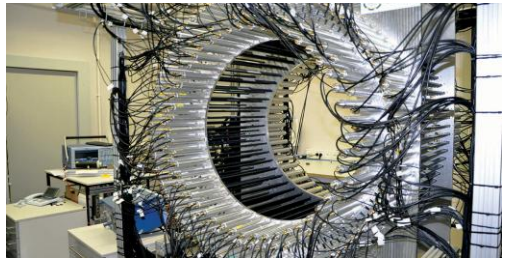
Nuclear Physics Instrumentation



Technology Localisation

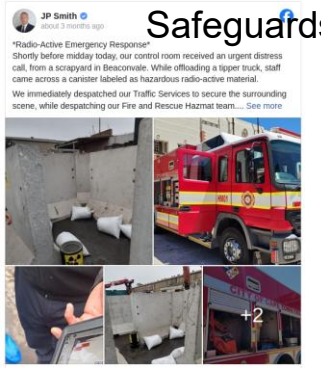


In house expertise
#OneNRF

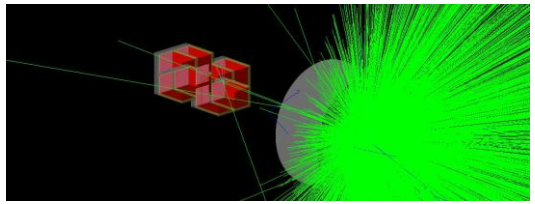


Next Generation PET Scanners

Tailored Industrial Applications

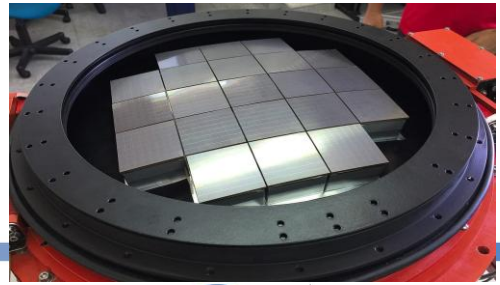


Safeguards



Simulation, Digital Twins, AI

?



Astronomy and Astrophysics

THANK YOU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