

Portable African Neutron-Gamma Laboratory for Innovative Nuclear Science (PANGoLINS)



Pete Jones
Separated Sector Cyclotron Laboratory,
iThemba LABS, South Africa



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

30% Natural Resources
50% Au, Cr
70% Pt, Rh
(4% CO₂ emissions)

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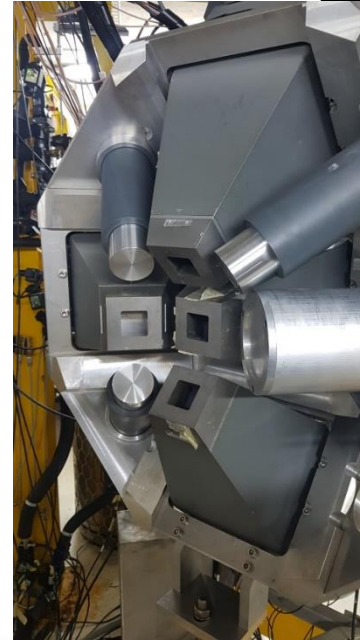
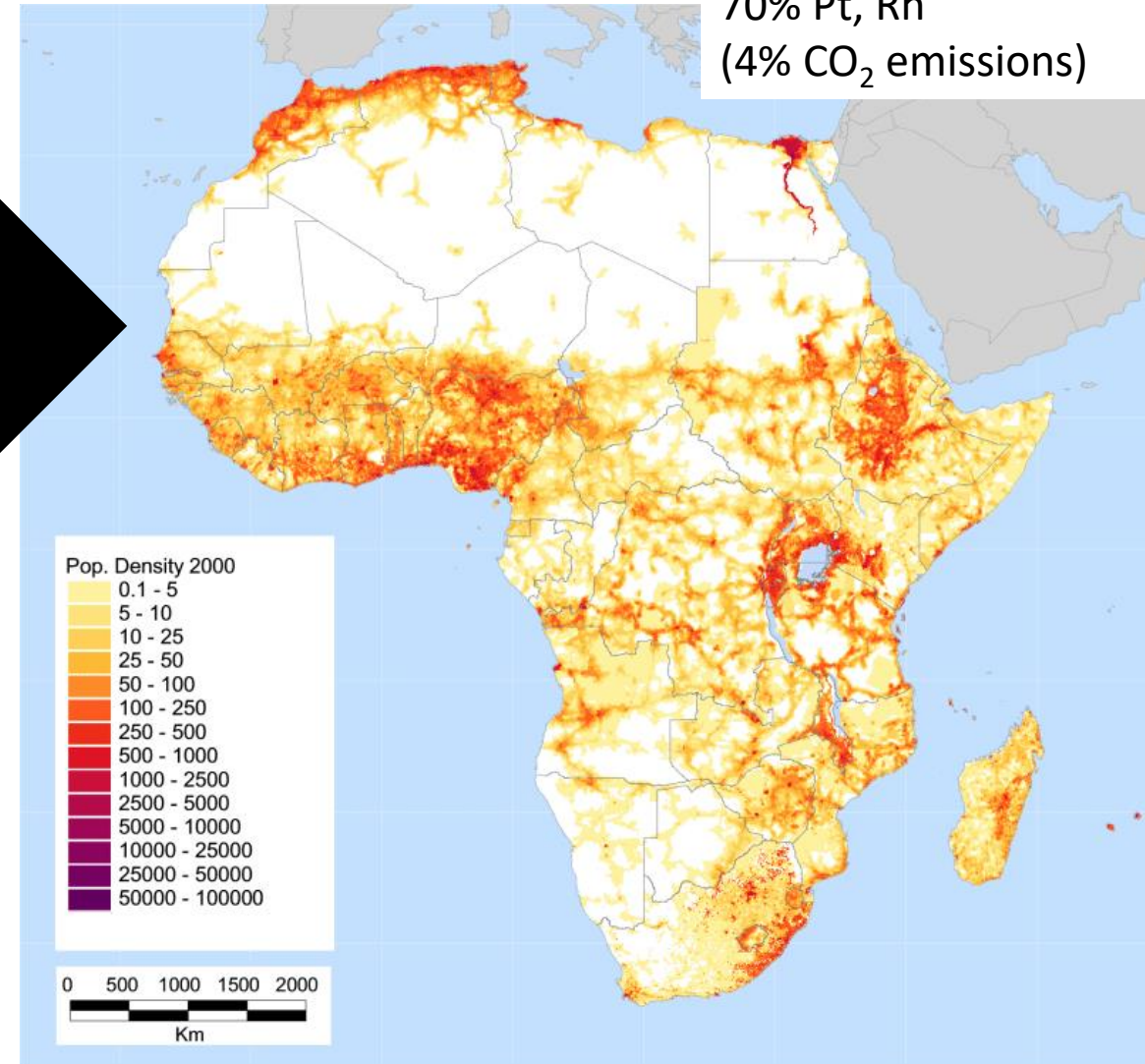


A fast-timing array of 2" x 2" LaBr₃:Ce detectors for lifetime measurements of excited nuclear states

L. Msebi^{a,b}, V.W. Ingeberg^c, P. Jones^b, J.F. Sharpey-Schafer^f, A.A. Avaa^{b,e}, T.D. Bucher^a, C.P. Brits^{b,d}, M.V. Chisapi^{b,d}, D.J.C. Kenfack^{b,d}, E.A. Lawrie^b, K.L. Malatji^{b,d}, B. Maqabuka^{a,b}, L. Makhathini^b, S.P. Noncolela^{a,b}, J. Ndayishimye^b, A. Netshiya^b, O. Shrinada^g, M. Wiedeking^{b,e}, B.R. Zikhali^{a,b}



Taking science impact from the LAB to the FIELD



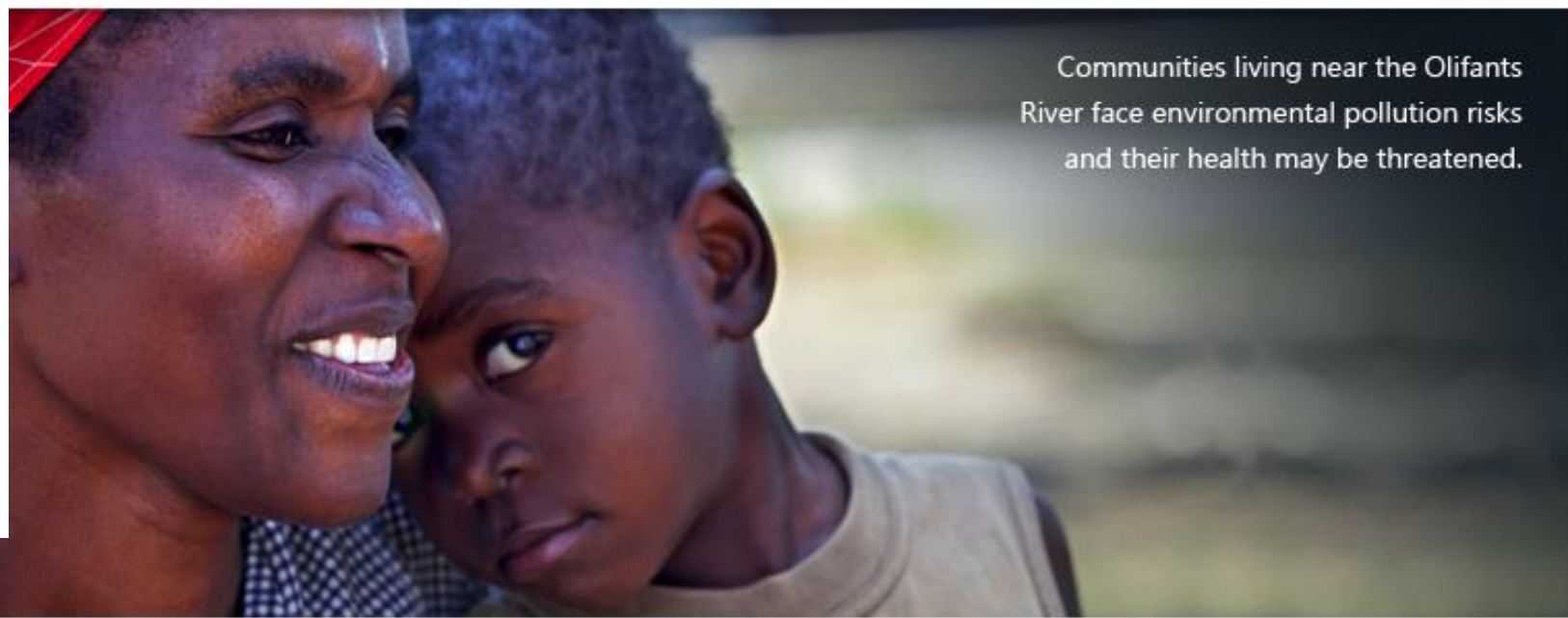
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Wildlife deaths in parts of the Olifants River Catchment Management Area alerted scientists to possible serious pollution problems.



Communities living near the Olifants River face environmental pollution risks and their health may be threatened.

ARTICLE / 10 MARCH 2014

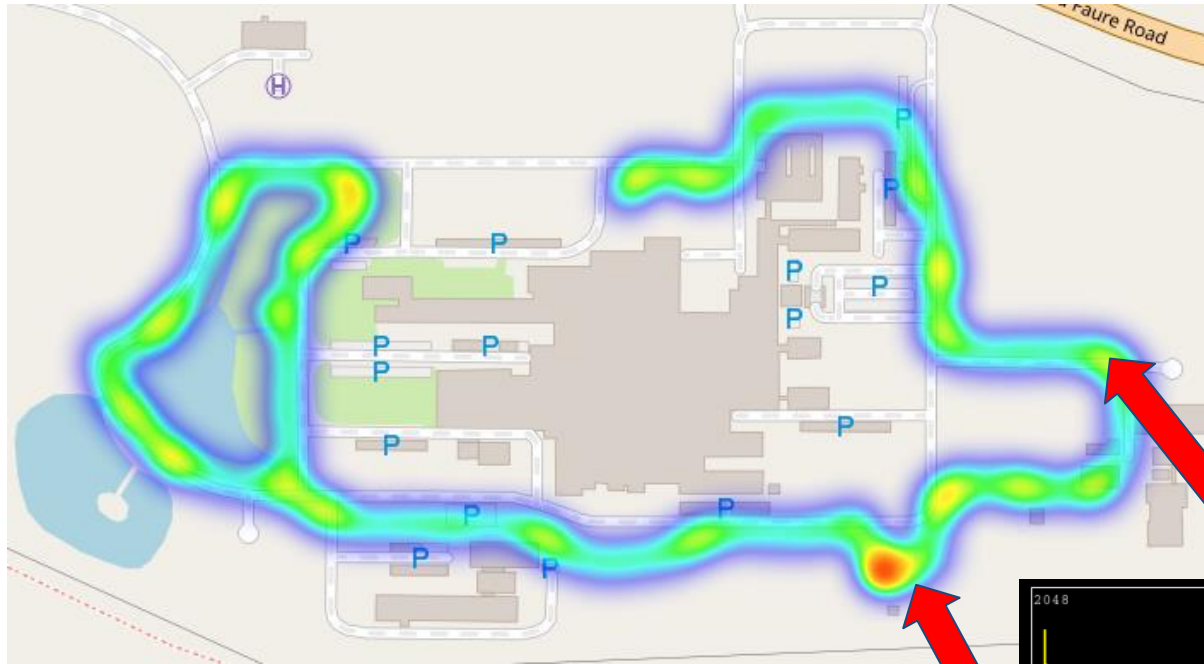
Bosveld Phosphates pollutes Kruger rivers, again

By Siphso Kings



A leak at the Bosveld Phosphates's plant in Phalaborwa, adjacent to the Kruger National Park in Limpopo, has spilled polluted water into rivers that run into the reserve. The plant, which used to be owned by Sasol, produces phosphoric acid, which is used in fertiliser.

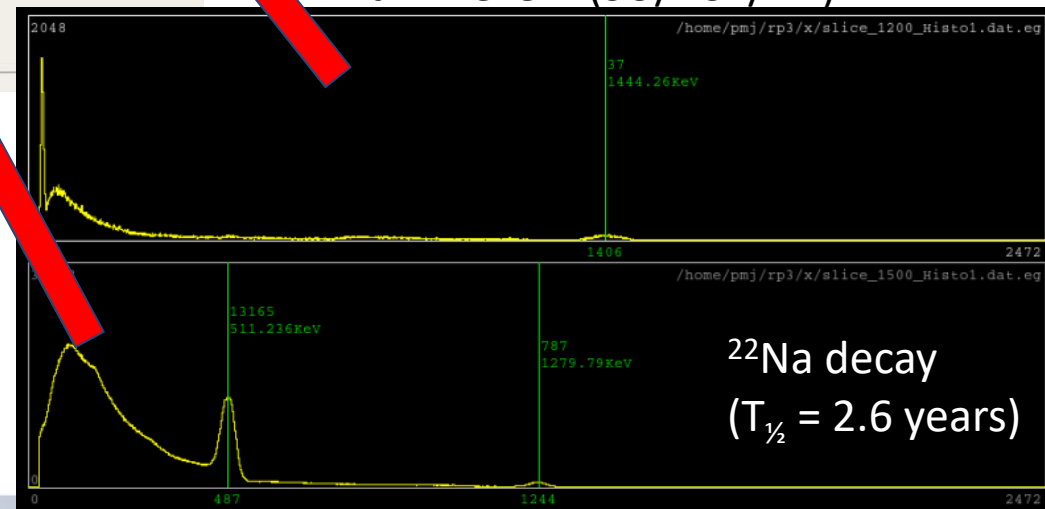
Mobile Radiation Detection Unit Measurements



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



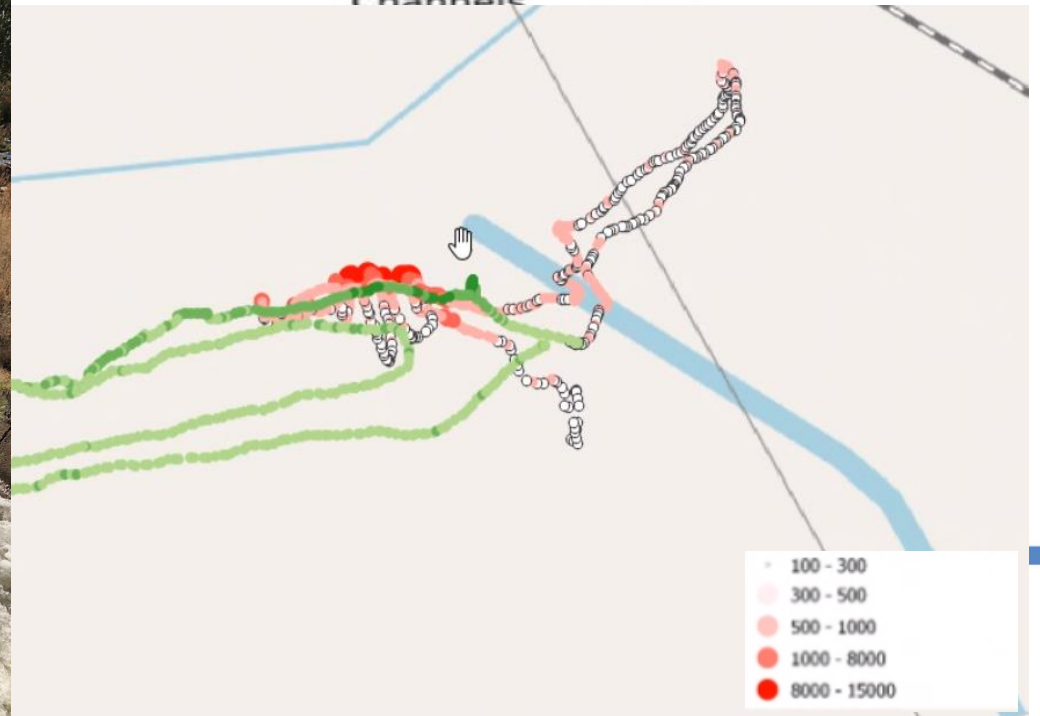
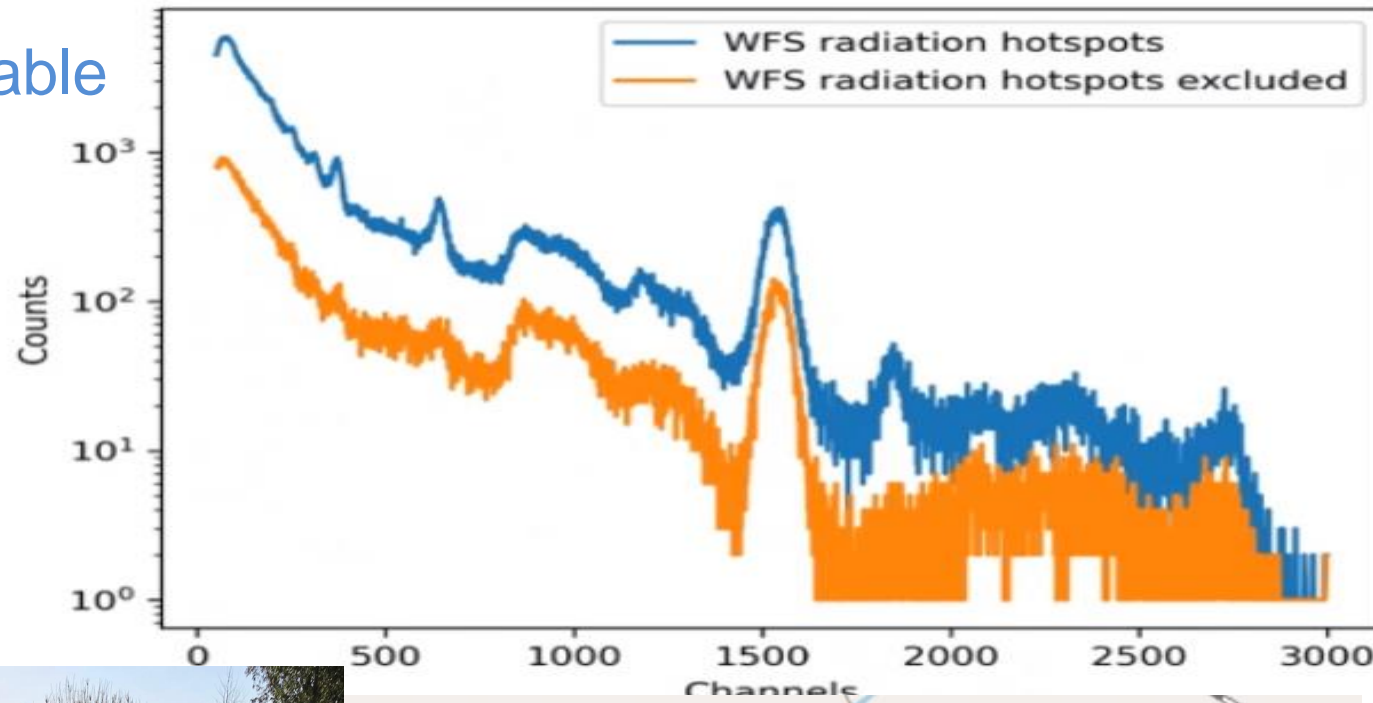
- LaBr₃ Detector
- 125MHz digitiser
- Raspberry Pi readout
- Cloud based
- Low Power system



Bosveld spill site measurements



Sometimes measurements are inhospitable



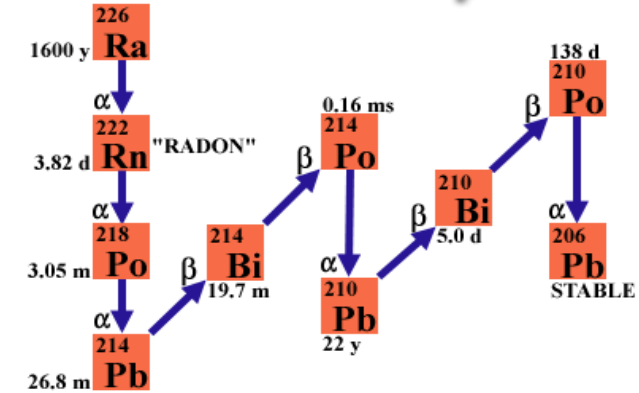
Sometimes measurements can only be done in situ...

Orphan ^{226}Ra source at iThemba LABS (< Ci) - ***-\$70k / gram***



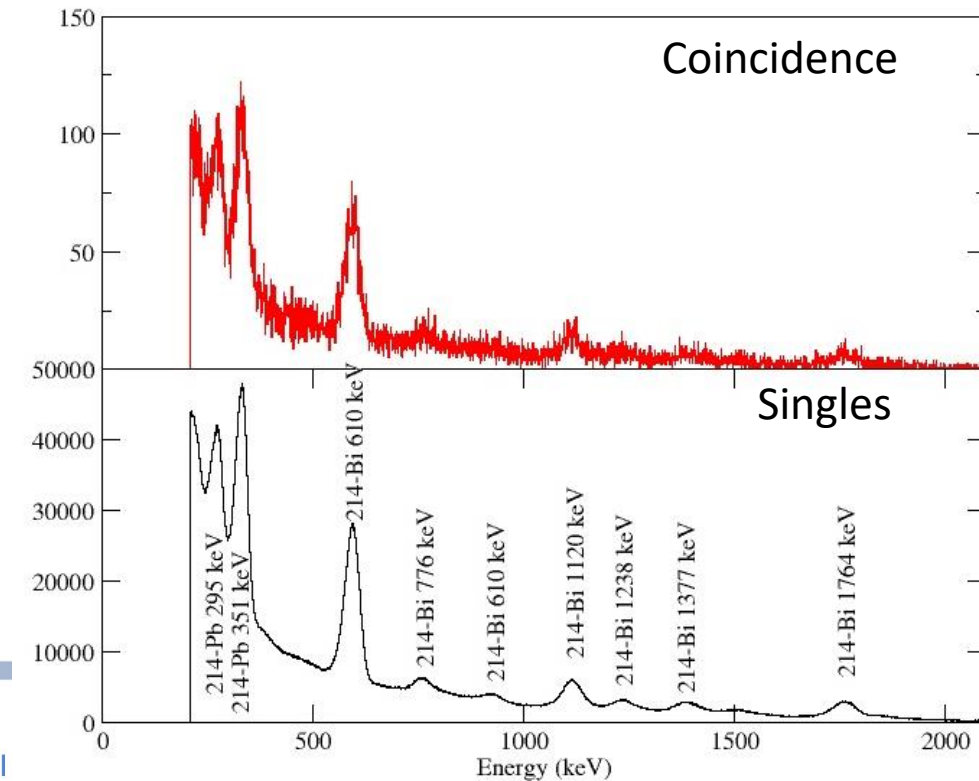
Decay	Gamma-ray Energy (keV)	Yield	Photopeak Counts (900 s) x 10 ²	Corrected Activity (MBq)	Estimated Activity (mCi)
Bi-214	609	46.1%	13221(61)	157(0.7)	106(0.5)
Bi-214	1120	15.1%	2796(6)	331(0.7)	224(0.5)

Radium-226 Decay Chain

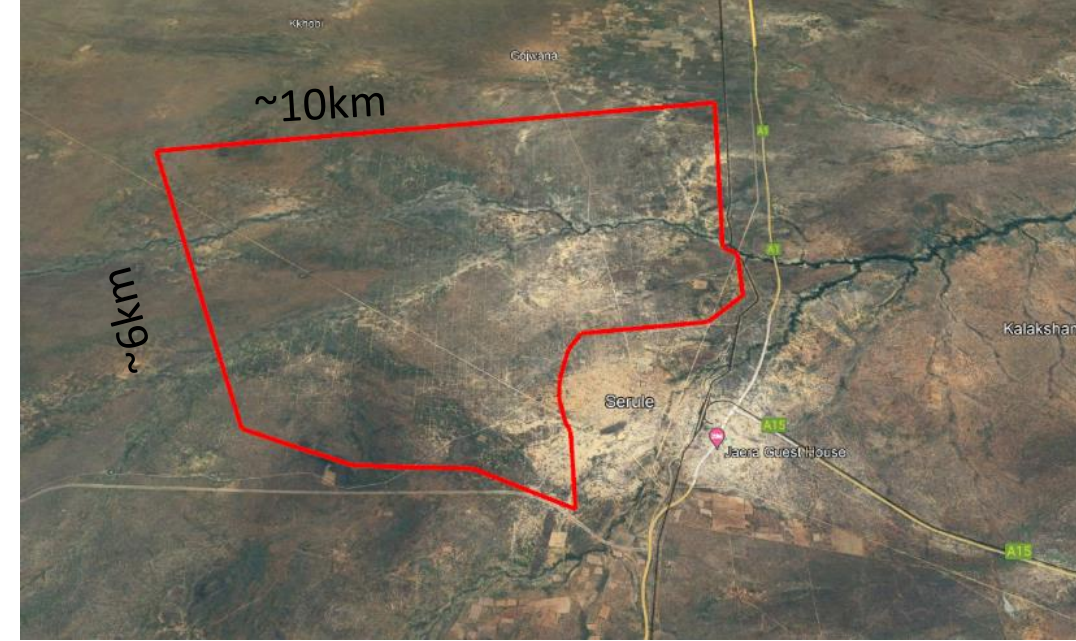


2 LaBr₃:Ce detectors at 90cm (15kHz per detector)

Measurements for 15 minutes



Sometimes measurements are just too large...



ACAP
Energy

URANIUM
Lethakane Uranium Project

Three uranium mines open in the US

The mines are based in Arizona and Utah.

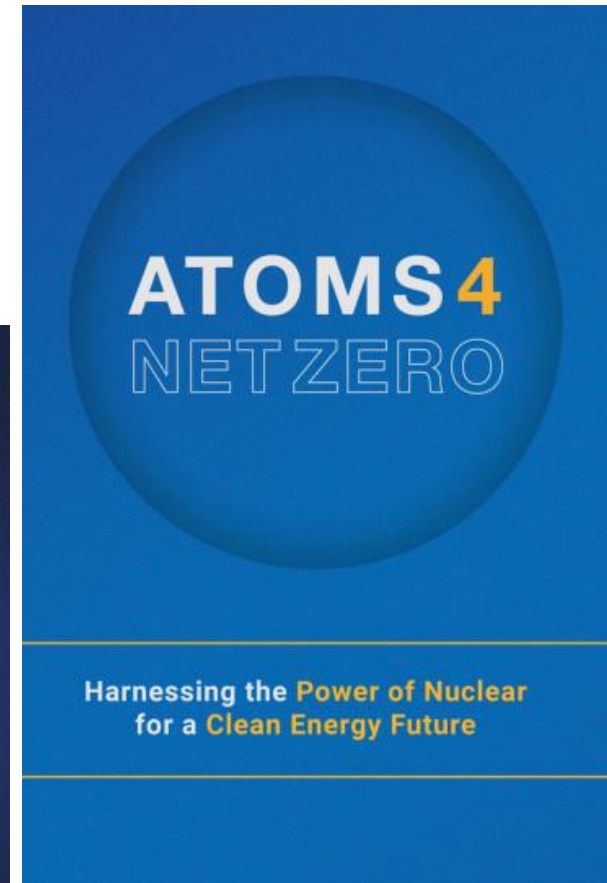
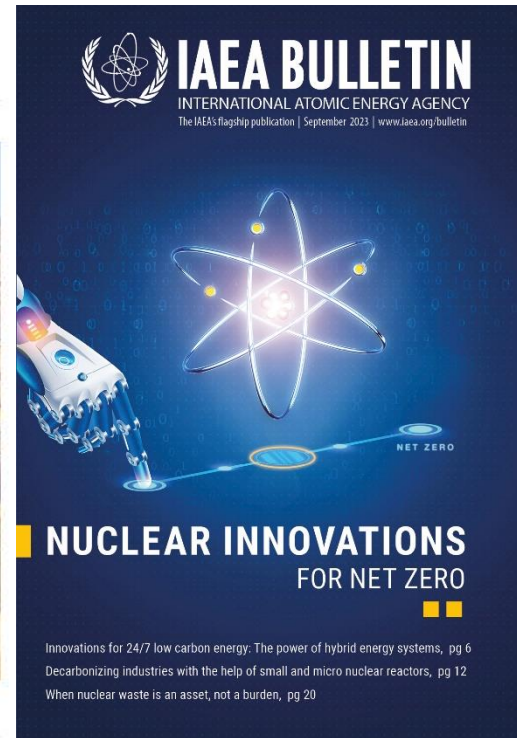
Alfie Shaw | January 2, 2024

Share this article <



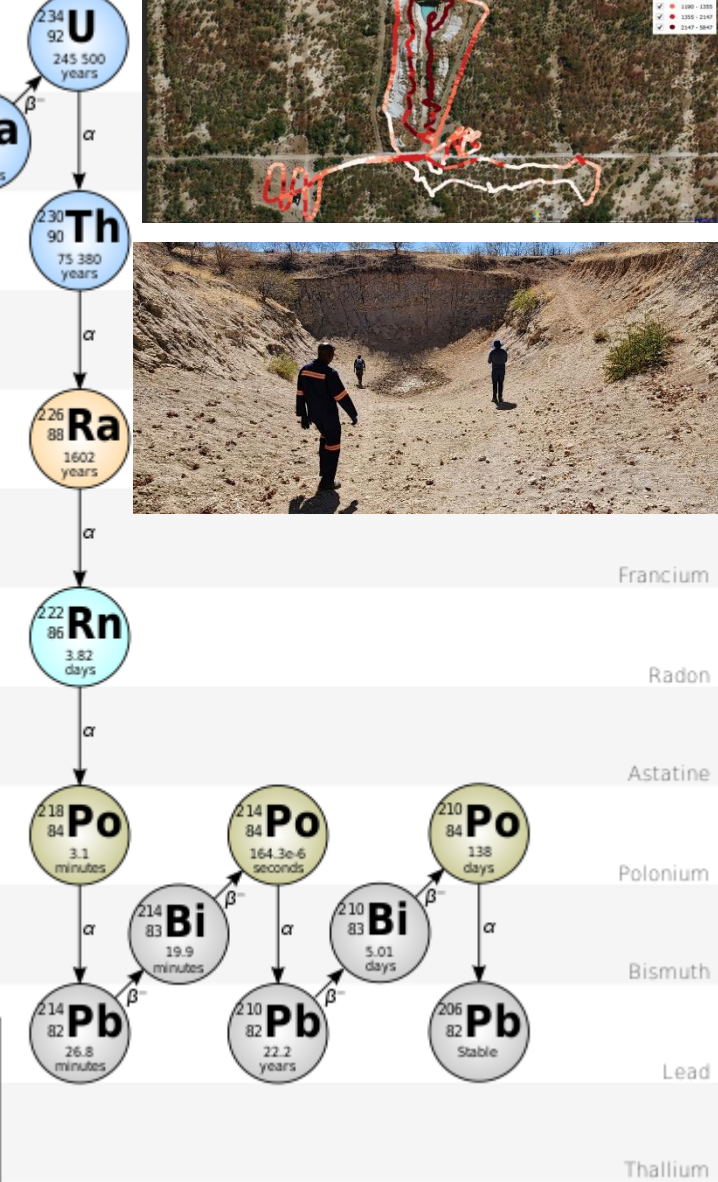
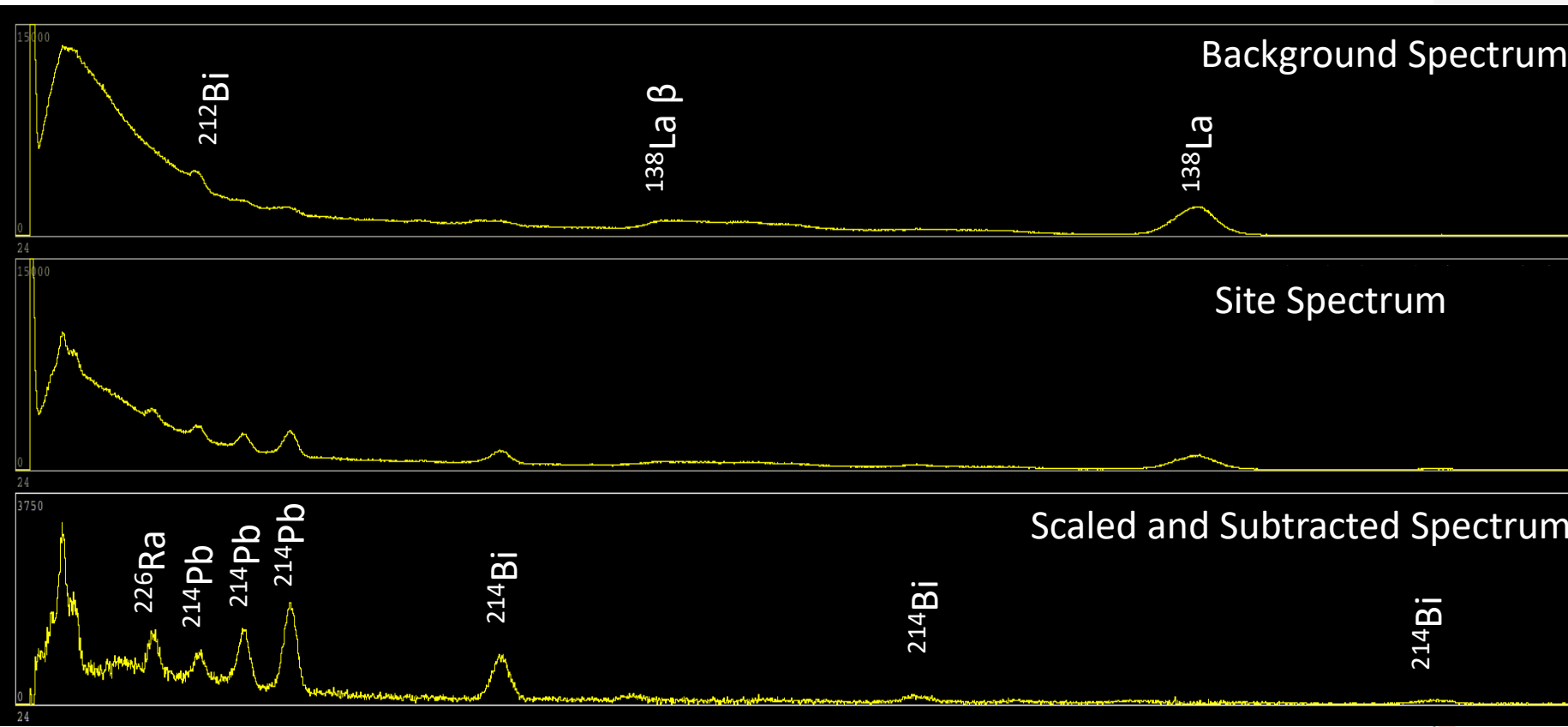
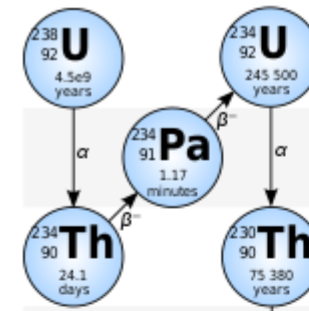
Energy Fuels is seeking to increase its uranium production off the back of strong market conditions. Credit: S. Hermann / F. Richter from Pixabay.

Three new uranium mines in the US began production at the end of last year. US mining company [Energy Fuels](#) opened the mines in Arizona and Utah in response to strong market conditions.

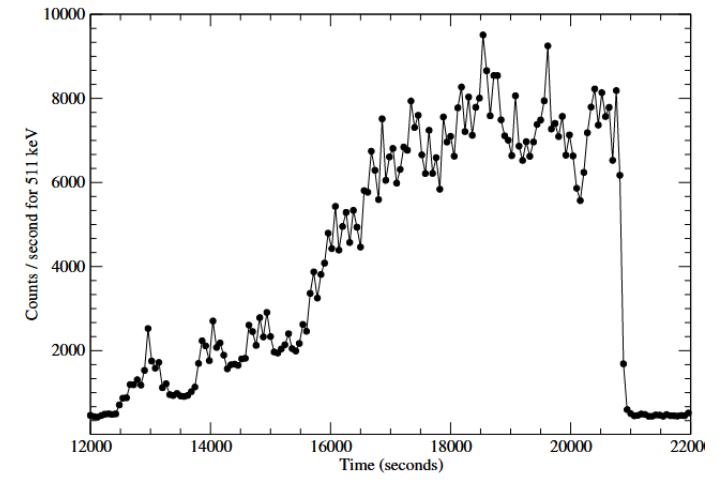
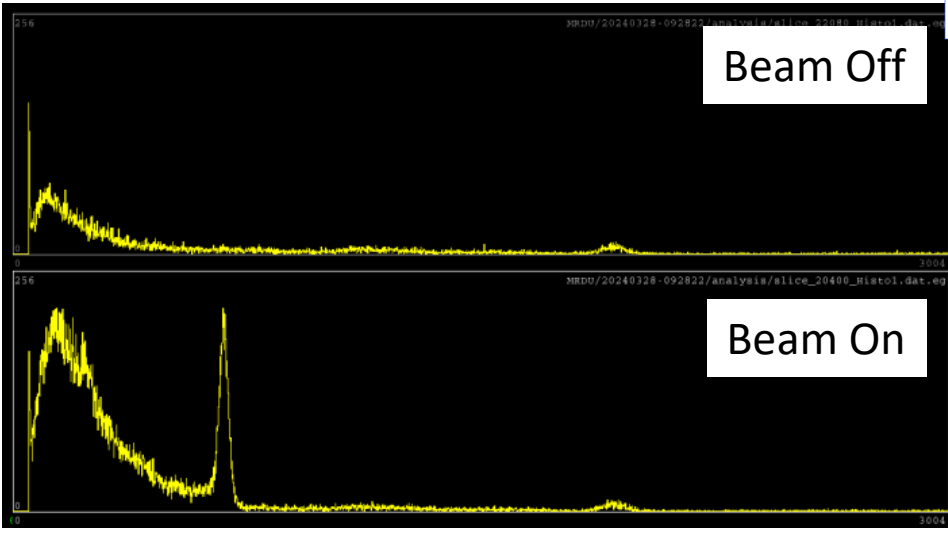
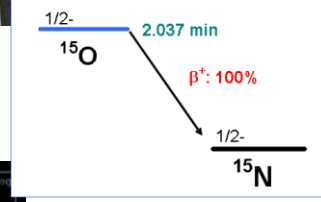
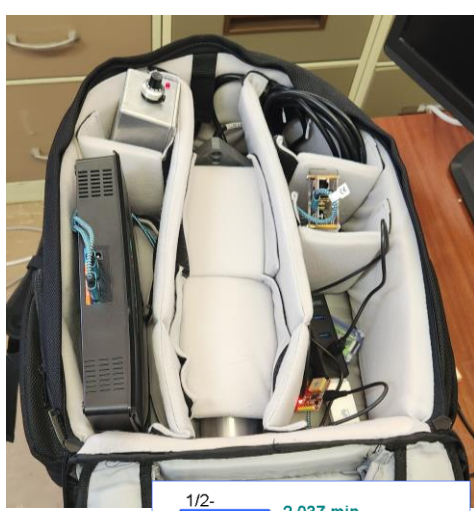
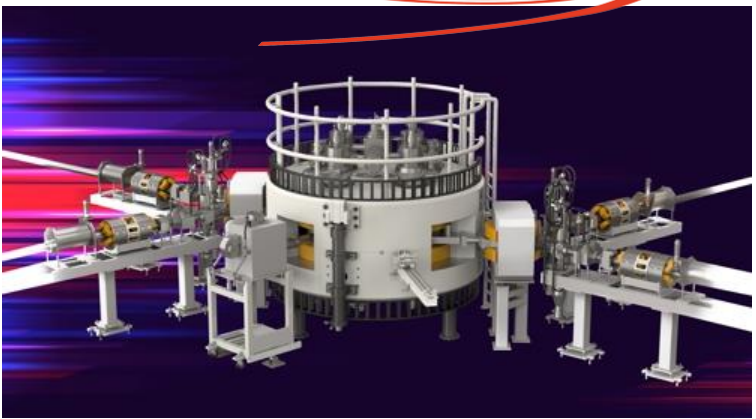




Preliminary in situ measurements at Serule, Botswana

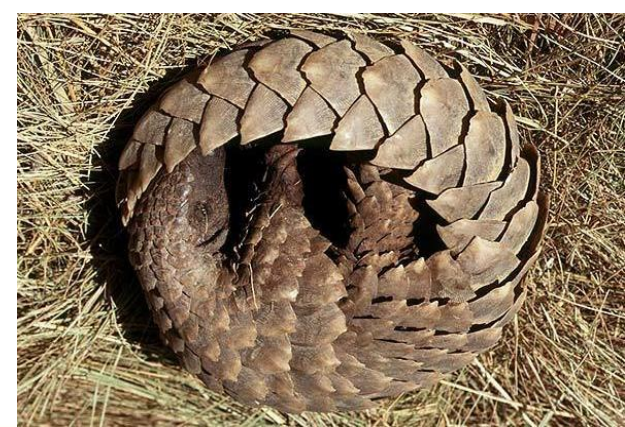


New system integration with lower power and < 1kg and more applications...



Data courtesy of iThemba LABS RP

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Milestones

- Reduce the footprint of the Mobile Radiation Detection Unit
- Introduce newer and smaller detectors – LaBr_3 , SrI_2 , $\text{Cs}_2\text{LiYCl}_6$
- 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 through unmanned aerial vehicles (drones)

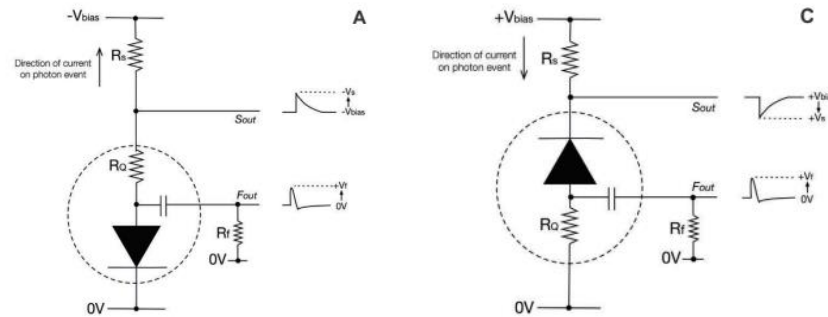
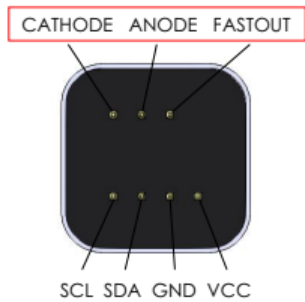
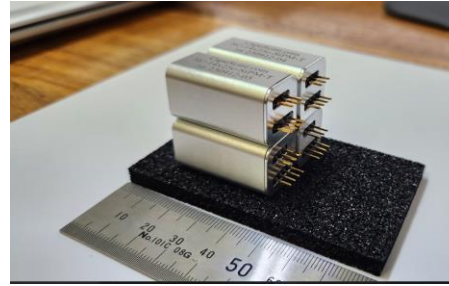


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Technologies

LaBr₃ 1.5 x 1.5 cm x 2.5 cm
SiPM coupled

SrI₂
Cs₂LiYCl₆:Ce (CLYC) – n sensitive

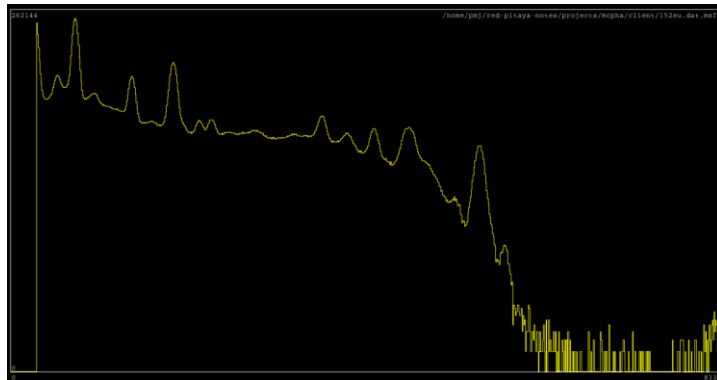
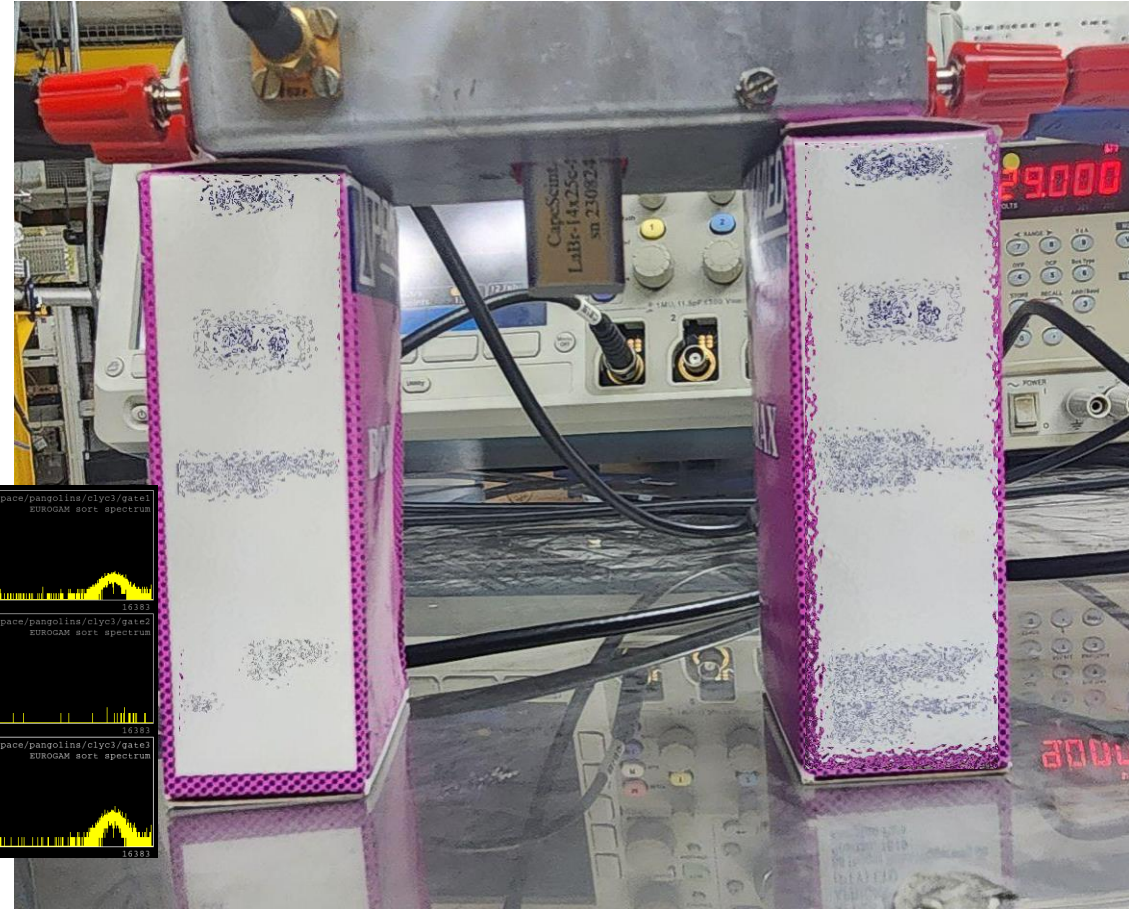
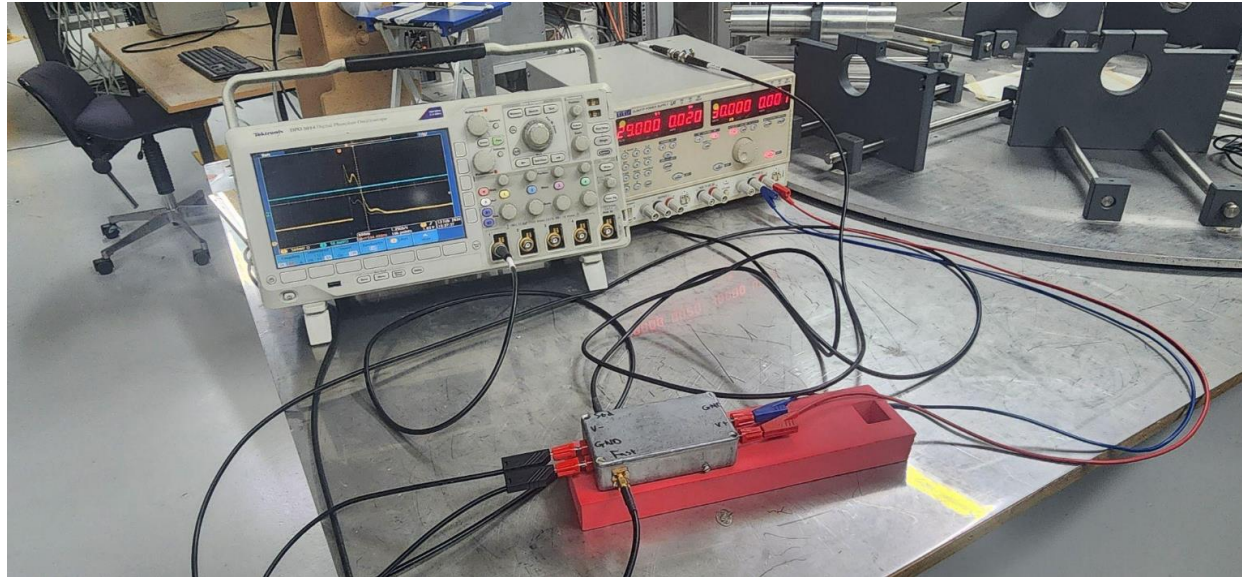


Need for new instrumentation, LV (~30 V) couplings, rather than High Voltages (~1000 V)

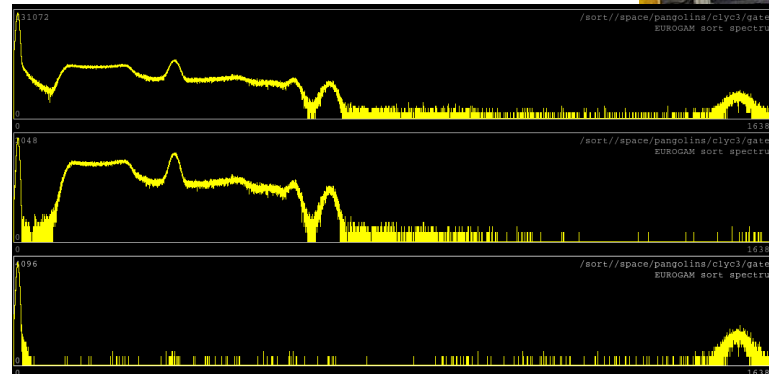
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See Presentation Shanyin-Dee Hart
Thursday 10:25

Detector Assemblies



LaBr₃(Ce)



Cs₂LiYCl₆:Ce (CLYC)



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4x4 array – 16mm²

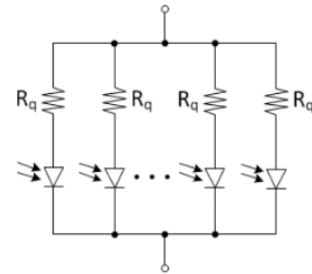
Technologies

Standard or specialized detectors

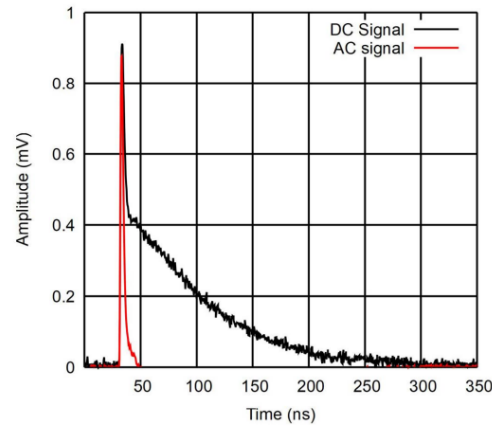
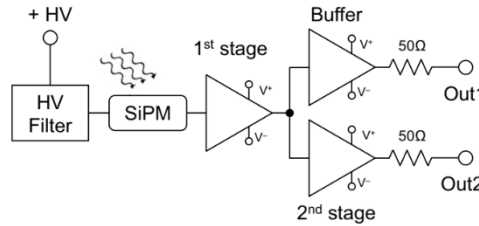
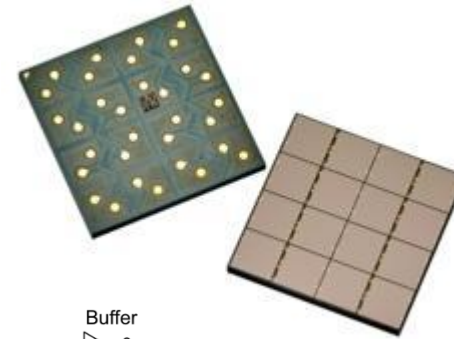
Silicon Photomultiplier Array

AFBR-S4N44P164M

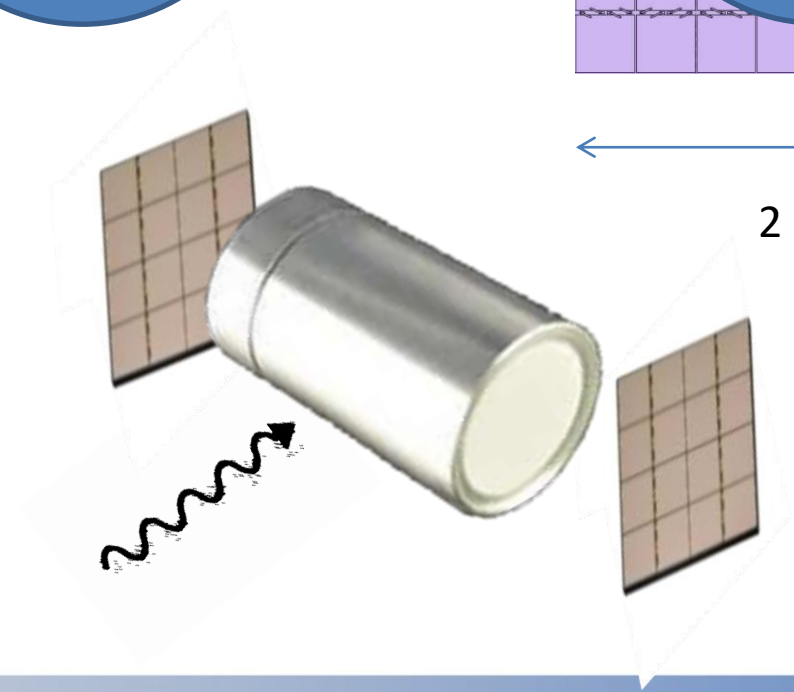
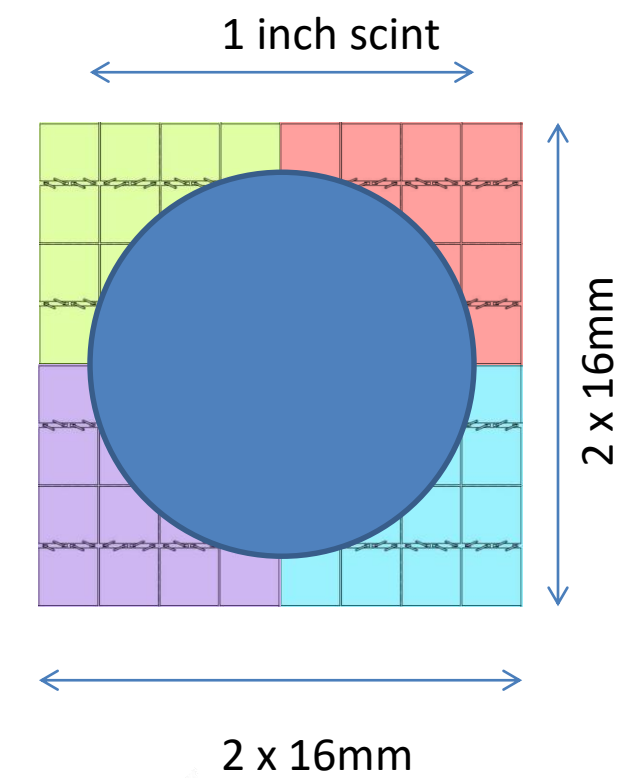
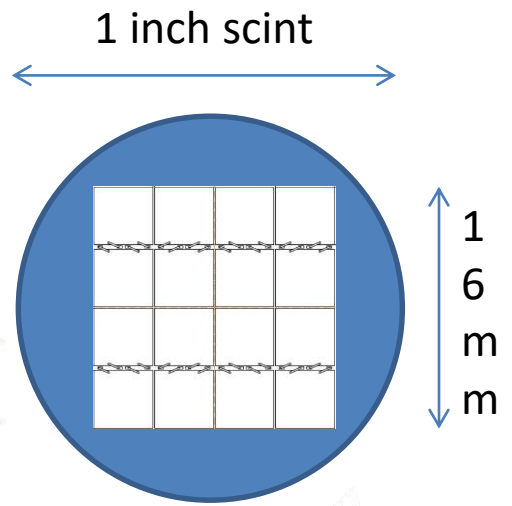
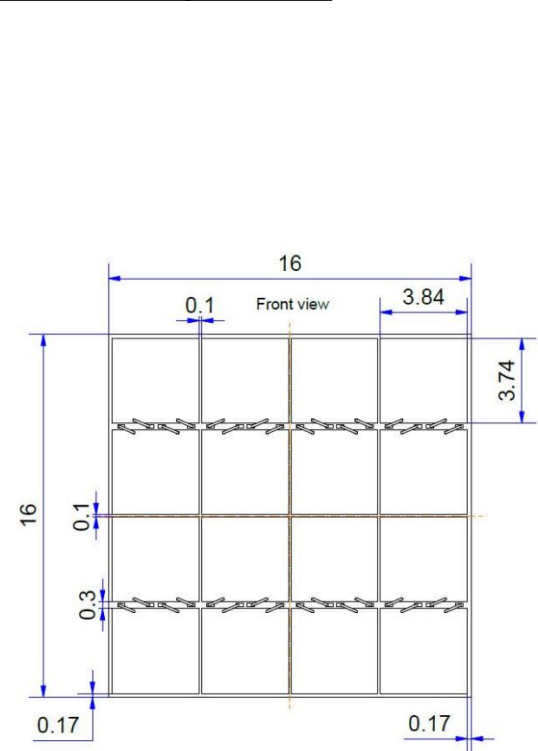
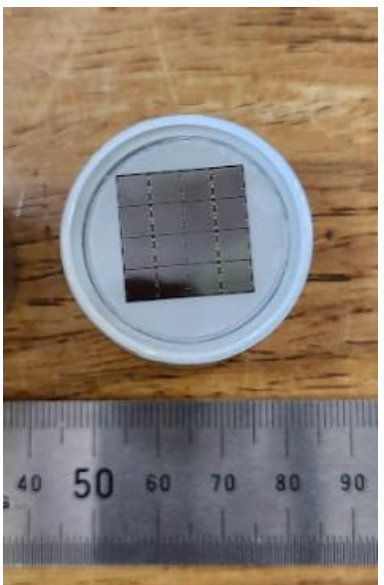
4x4 NUV-MT Silicon Photo Multiplier Array



Block Element



SiPM Innovations for Detector Developments



1" LaBr₃ crystal needs many SiPM's to collect all the light or some kind of light guide – matching important

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Detectors

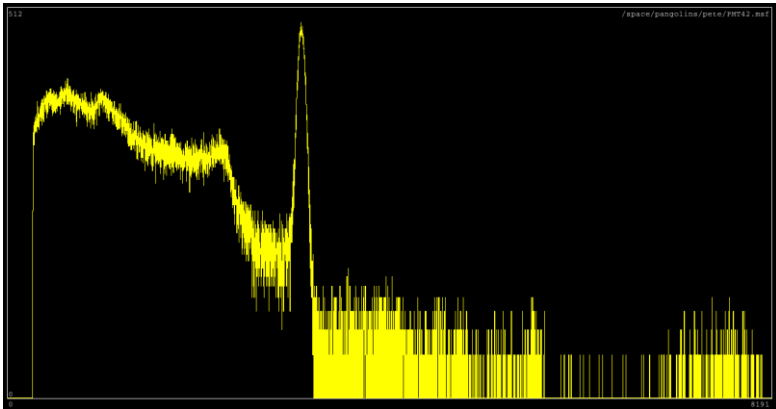
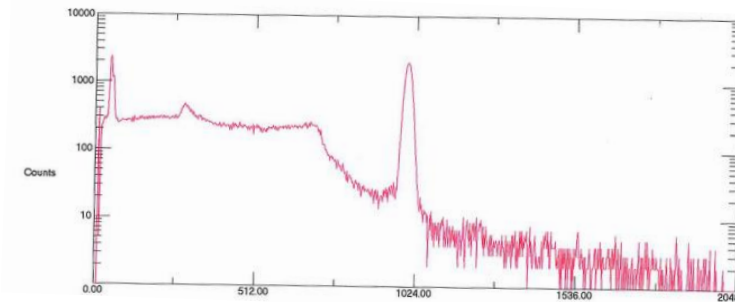
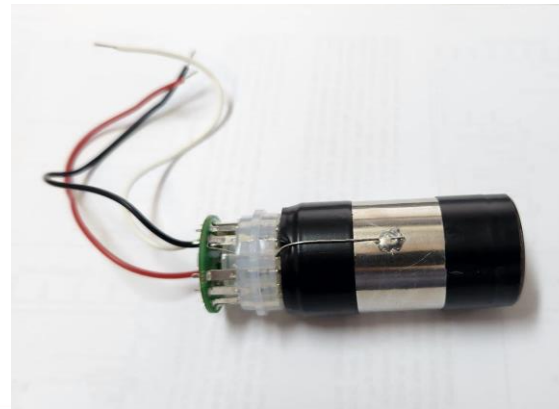


2 x 1" LaBr₃ Crystals



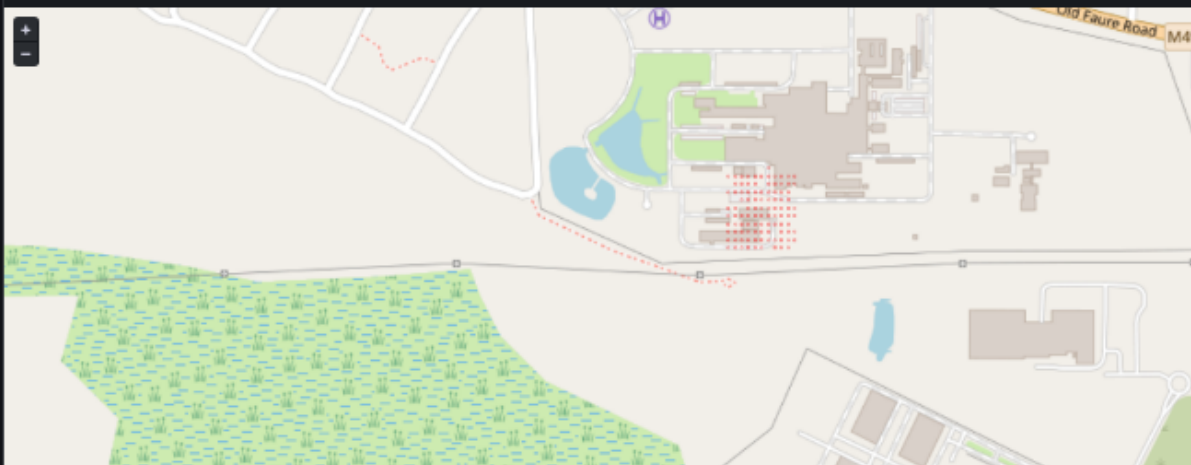
DETECTOR	S/N	COMPONENTS #	ER%
enLaBR-25x25	230929-03	enLaBr Q3_23	2.23% at 662 keV

1" Photomultiplier Tube to Characterise





Location



Spectrum (1 minute)



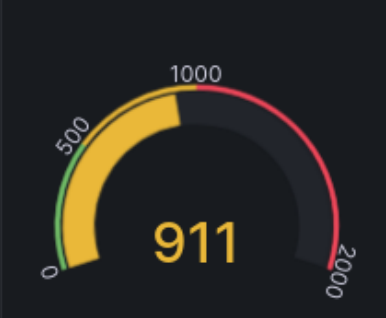
Spectrum (difference)



Count Rate (cps)



Count Rate (cps)



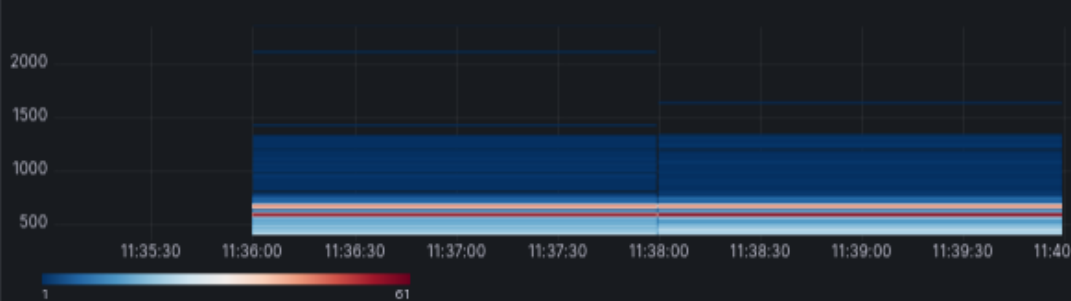
Spectrum (total)



Position

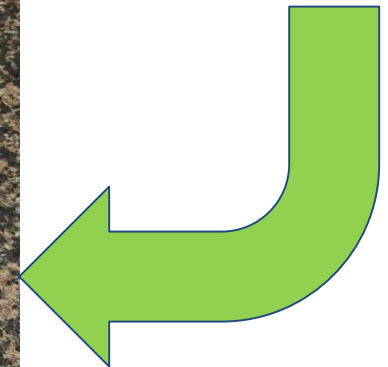
lat **-34.0263** lon **18.7168** ele **18.4885**

Histogram Heatmap



PANGoLINS

Deployments



Buy in kit form
Flight time, payloads, configurations,
swarms to cover large areas



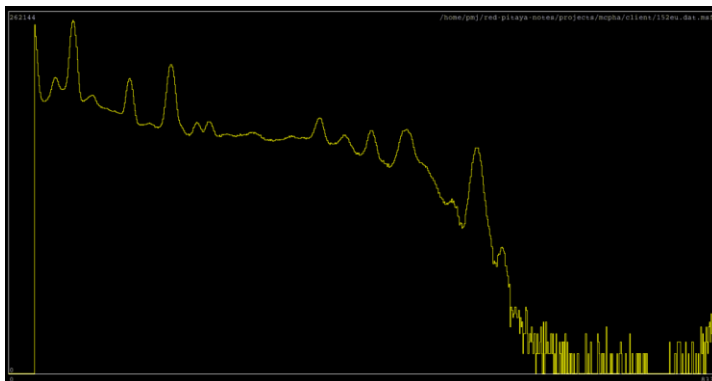
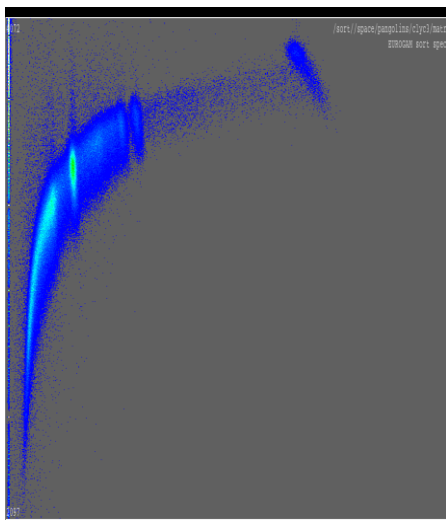
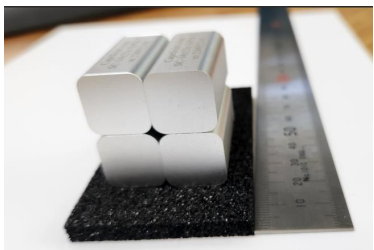
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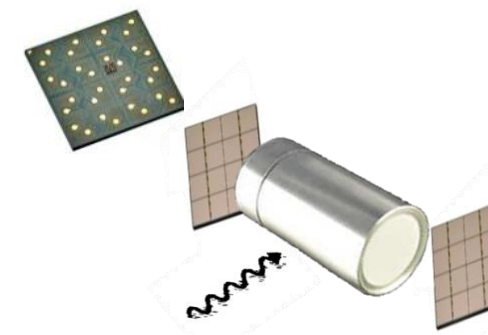
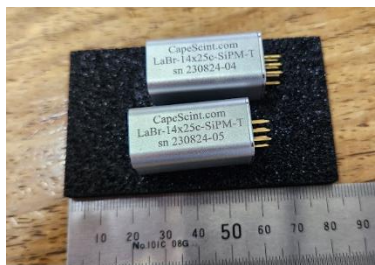
Deployment of detector technologies in challenging environments requiring low power, versatility and adaptive solutions



First spectrum from detector assembly (^{152}Eu) (Jan 2024)

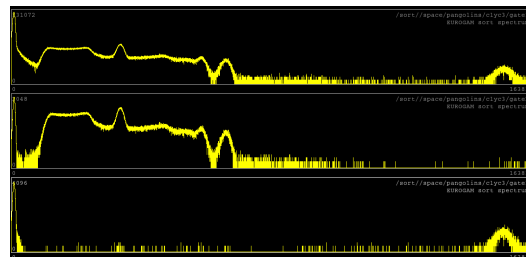
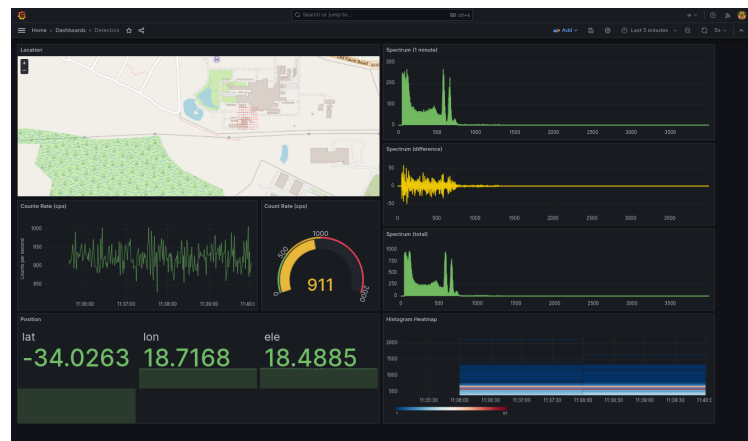


Tarot X8 TL8X000 8 axle octocopter
First Flight February 2024



“Spin off” – application of SiPM for novel detectors

Latest detector assembly ready as payload (Mar 2024)

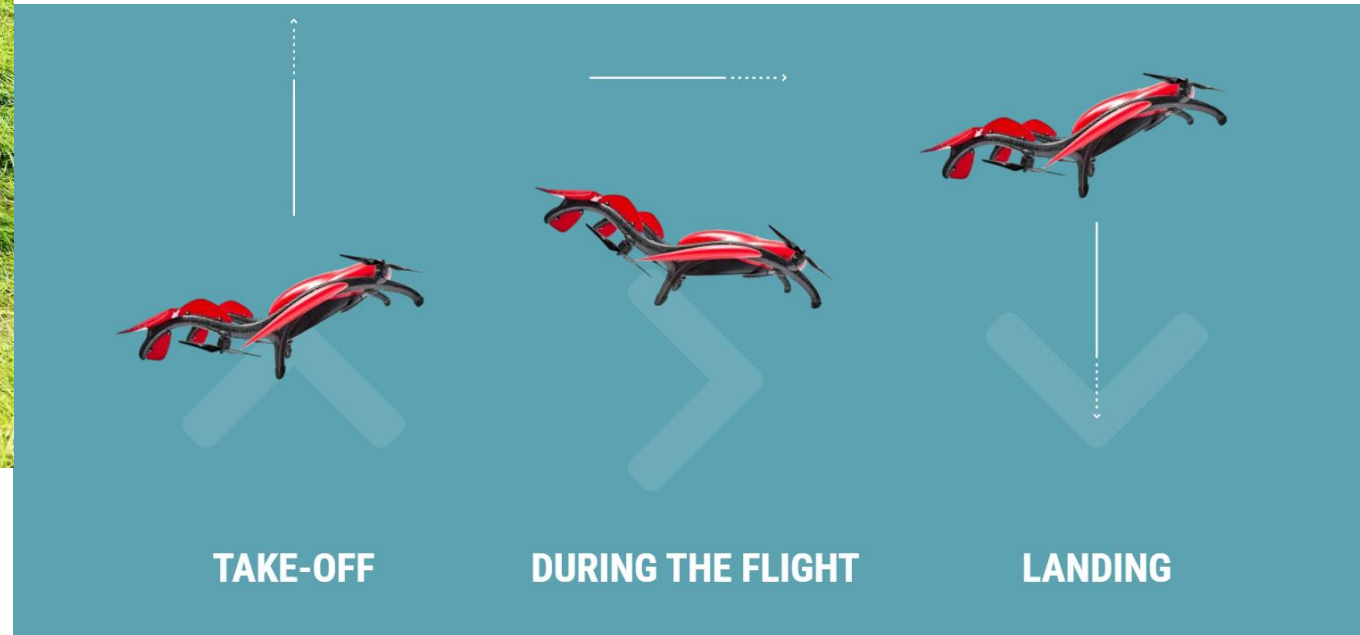
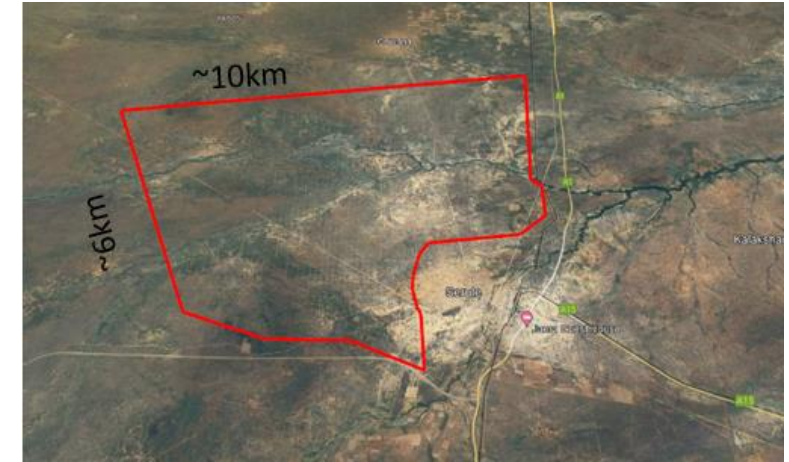


Neutron Discriminated Spectrum (Mar 2024)



technology innovation
AGENCY
Innovating Tomorrow Together

BIUST COMMERCIAL DRONES REACH NEW HEIGHTS



Summary

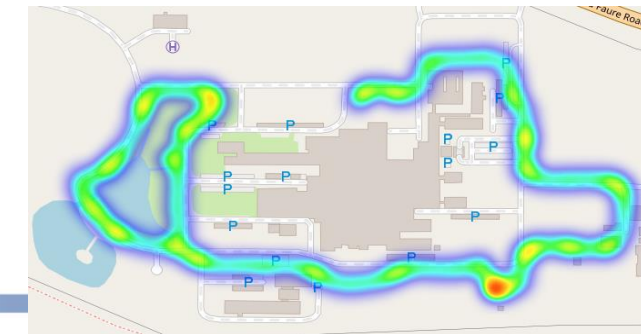
- Taking accelerator based techniques into the innovation field
- Measurements in situ are important, need quantification always
- Next generation of detection systems progressing well
- Airborne measurements over large areas the next challenge
- Training and networking with industries (mines, communities..)
- Exciting challenges and innovations ahead



Wildlife deaths in parts of the Olifants River Catchment Management Area alerted scientists to possible serious pollution problems.



Communities living near the Olifants River face environmental pollution risks and their health may be threatened.



❖ This work is based on the research supported wholly by National Research Foundation of South Africa (90741, 99037, 127116) and iThemba LABS .

❖ Supported by the Technology Innovation Agency 2023-24 under Grant number 14606/01



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