



NGET TECHNIQUE FOR NDA IN RADIOACTIVE WASTE MANAGEMENT

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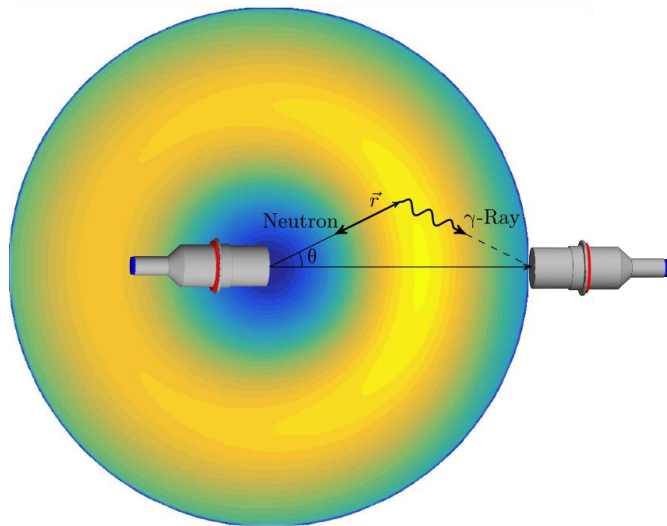


VINNOVA

Neutron-Gamma Emission Tomography

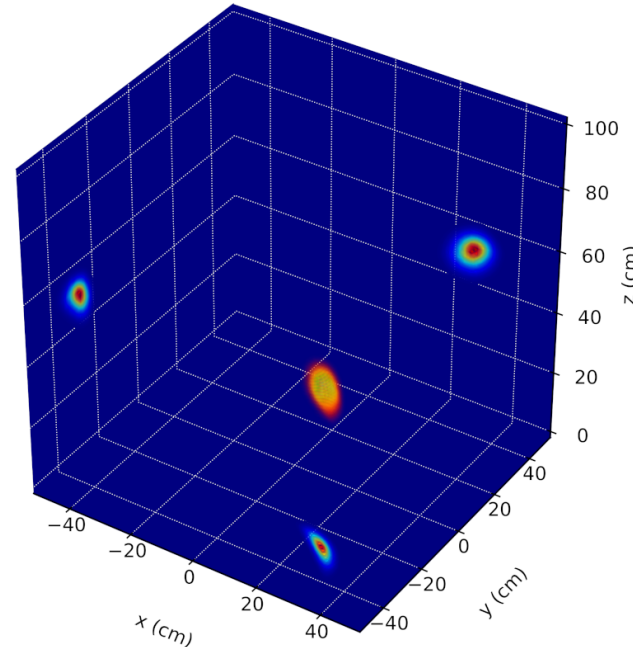
Rapid 3D localization of SNM – lab measurements

Schematic illustration of NGET* event mapping following the detection of a correlated gamma-neutron pair from one fission event.



Weak ^{252}Cf source (5400 n/s, 27% of ANSI N42.35-2016). Shielded by 1.6 cm Pb cylinder. The developed algorithm uses Bayesian inference. Typical PDF after 10 s measurement time.

Source position: $(x,y,z) = (30,-30,52)$ cm



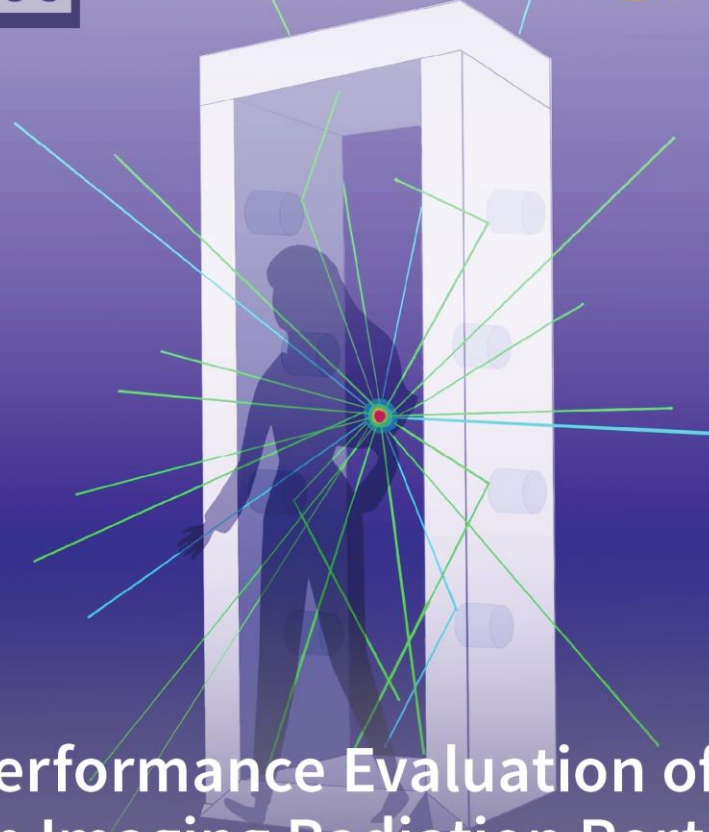
*Jana Petrović, Alf Göök, and Bo Cederwall, "Rapid imaging of special nuclear materials for nuclear non-proliferation and terrorism prevention", Science Advances 7, eabg3032 (2021)



applied sciences

IMPACT
FACTOR
2.838

CITESCORE
3.7



Performance Evaluation of an Imaging Radiation Portal Monitor System

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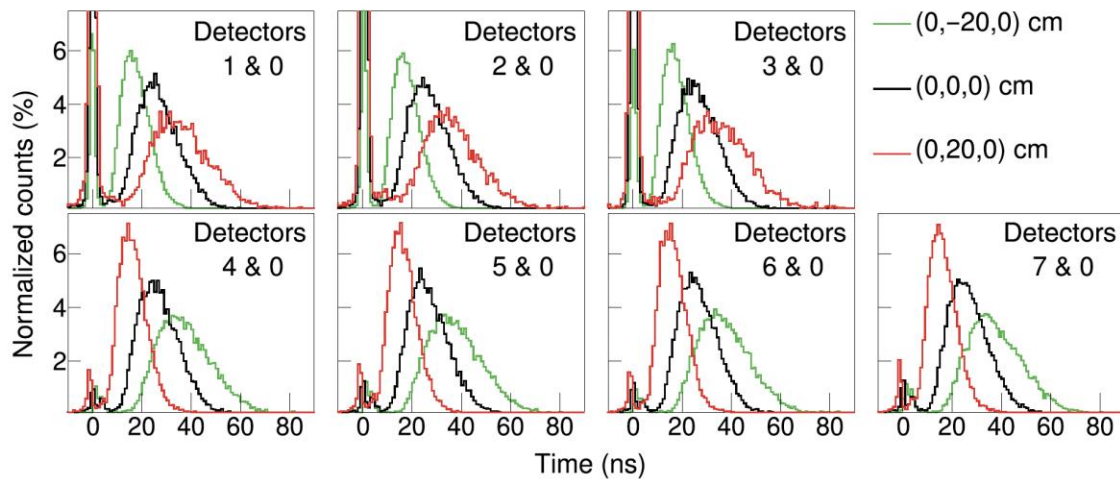


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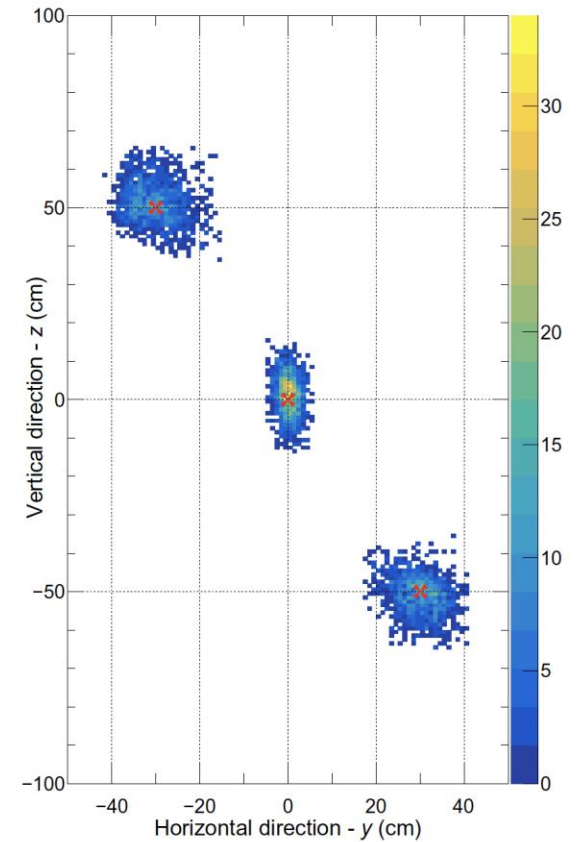
COVER STORY

*Vasiljević J, Cederwall B. Performance Evaluation of an Imaging Radiation Portal Monitor System. *Applied Sciences*. 2022; 12(18):9001.
<https://doi.org/10.3390/app12189001>

Cumulative NGET approach based on Machine Learning

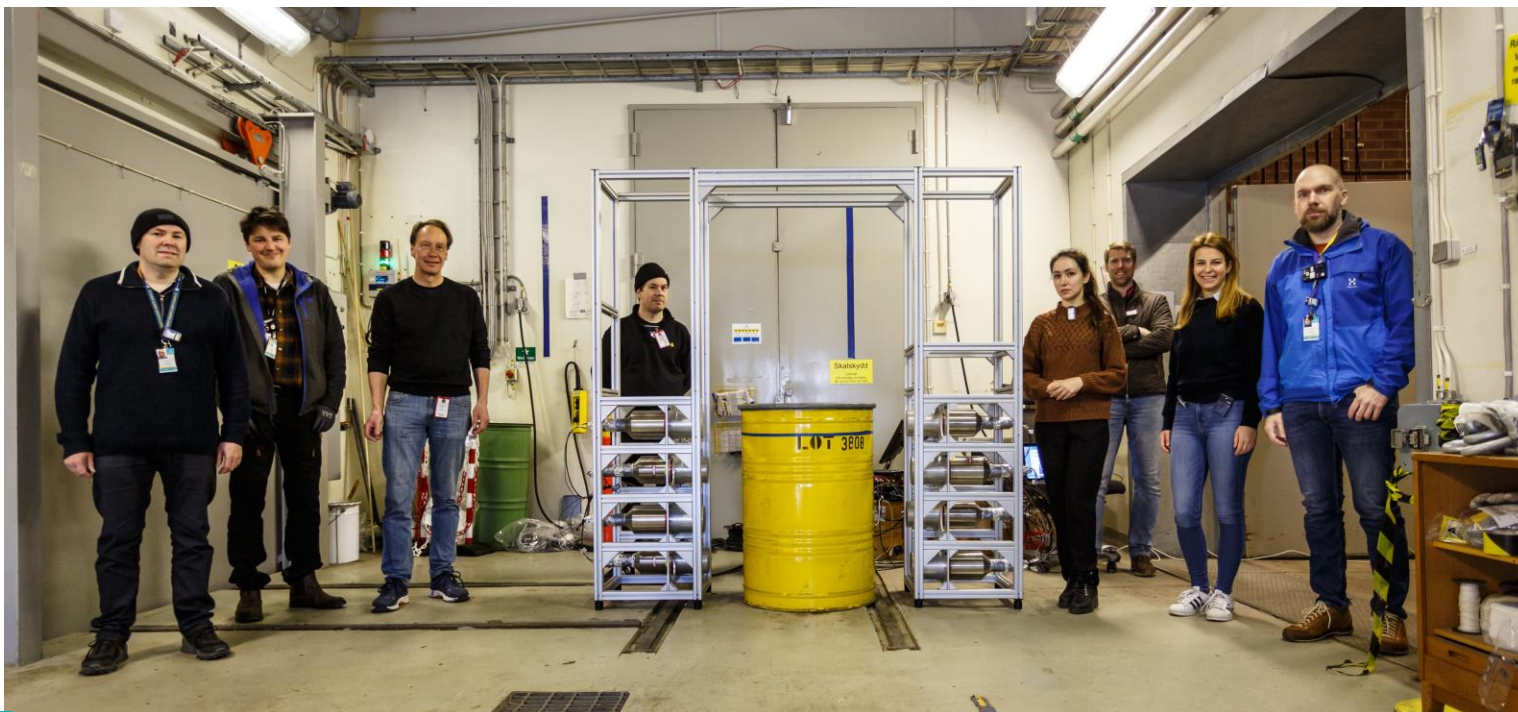


ANN



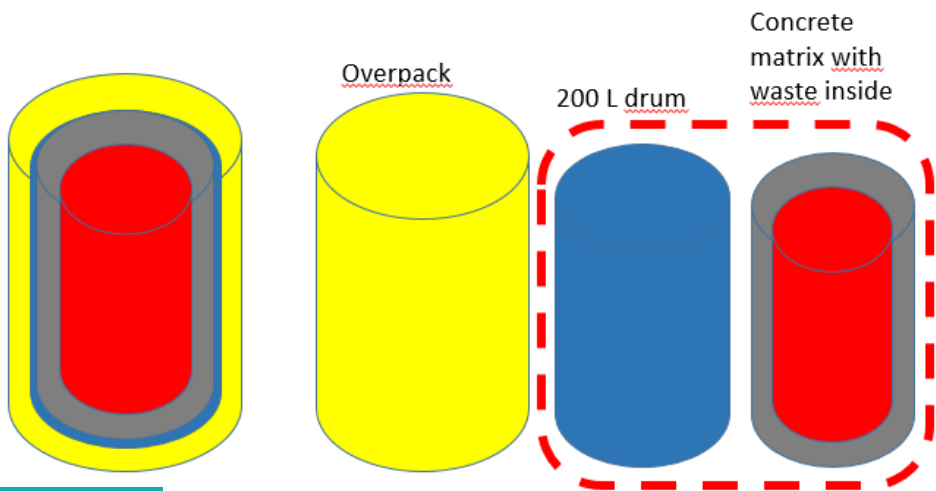
3D-scanning of legacy waste drums, AB SVAFO, Studsvik nuclear decommissioning site

“AB SVAFOs task is decommissioning nuclear facilities in a safe and environmentally responsible manner and taking care of nuclear waste from early Swedish nuclear research.”



Tests with legacy waste (at SVAFO, Sweden, May 2021)

- Mixed waste in drums produced from 1960s to about 1991, around 8000 units
- Legacy waste: different origins, limited documentation, no or uncertain data
- Multi origin waste in a steel drum (100 l), with around 5 cm concrete shielding placed in a steel drum (200 l) and grouted, repackaged in 280 l drums. 200 l drums partly severely corroded.

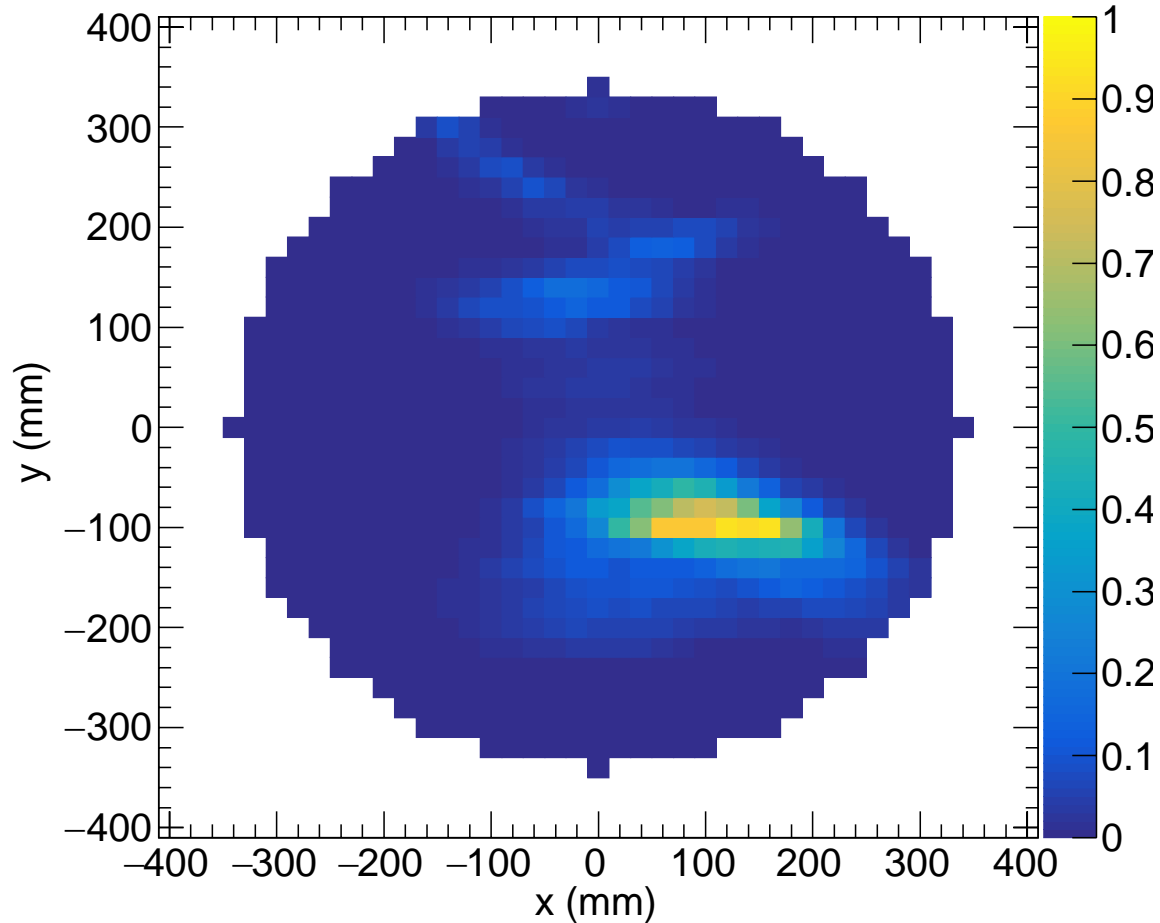


Tests with legacy waste (at SVAFO, Sweden, May 2021)



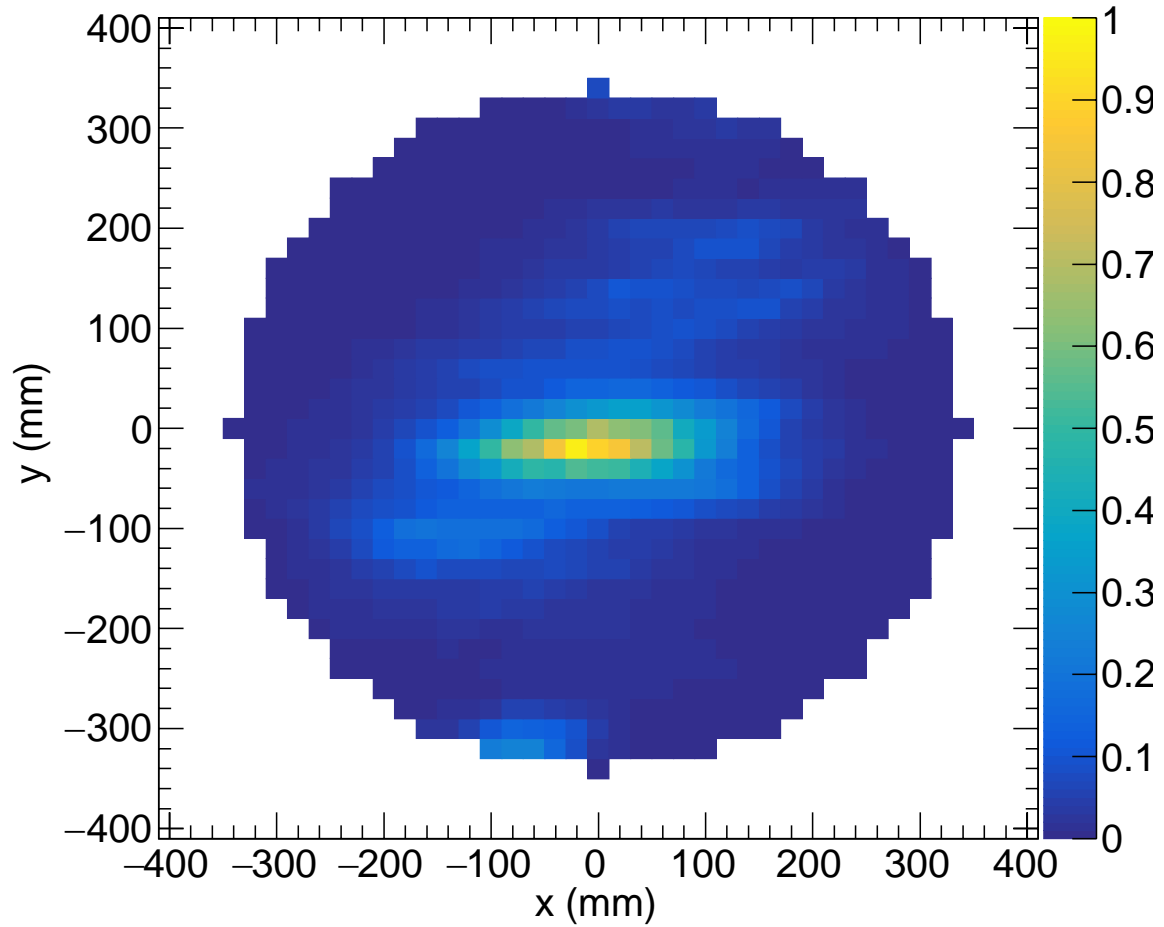
Results of 3D-scanning of legacy waste drums, AB SVAFO, Studsvik nuclear decommissioning site

$z = [600, 620]$ mm



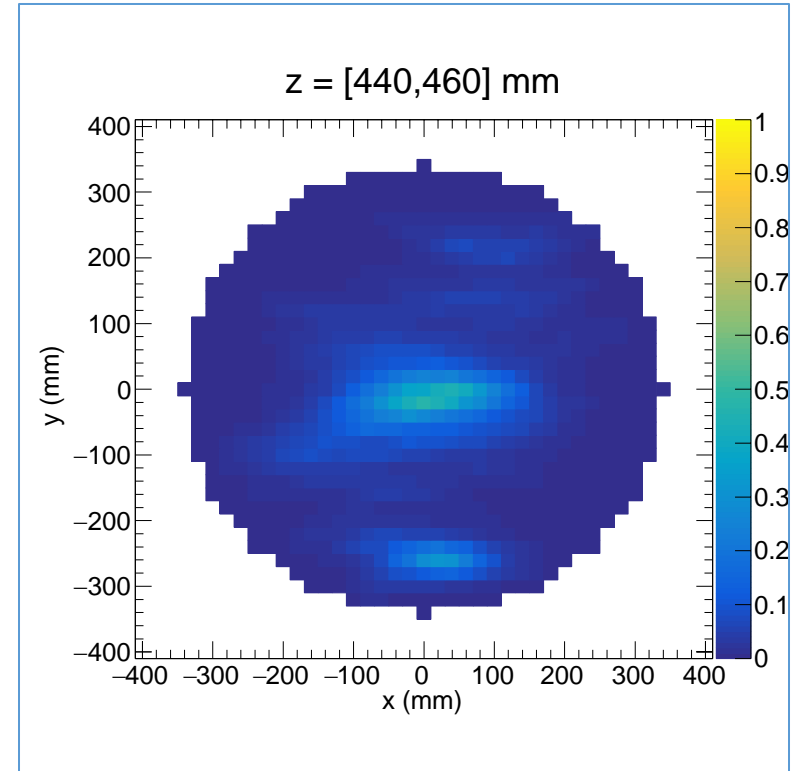
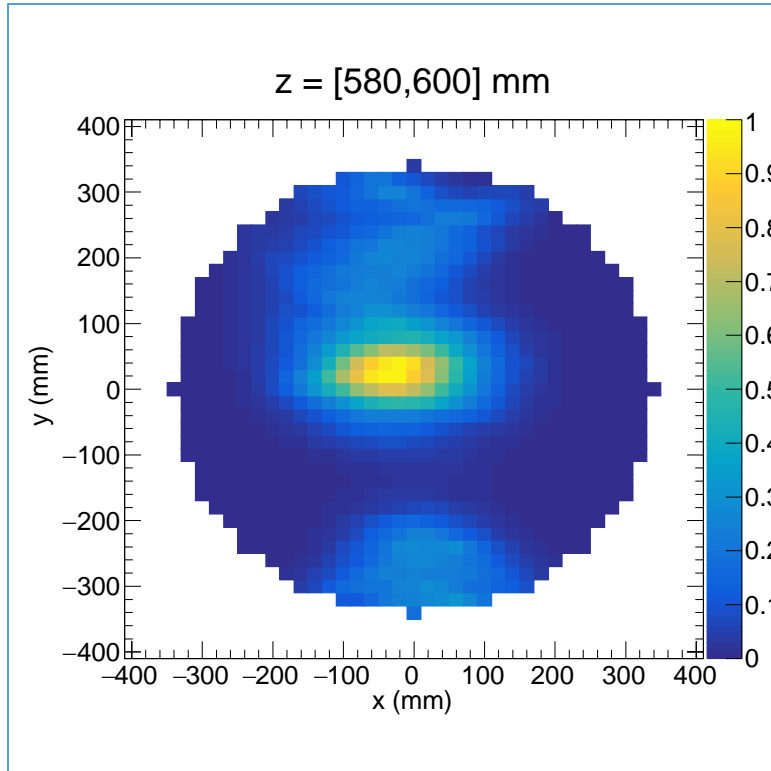
Results of 3D-scanning of legacy waste drums, AB SVAFO, Studsvik nuclear decommissioning site

$z = [340, 360]$ mm

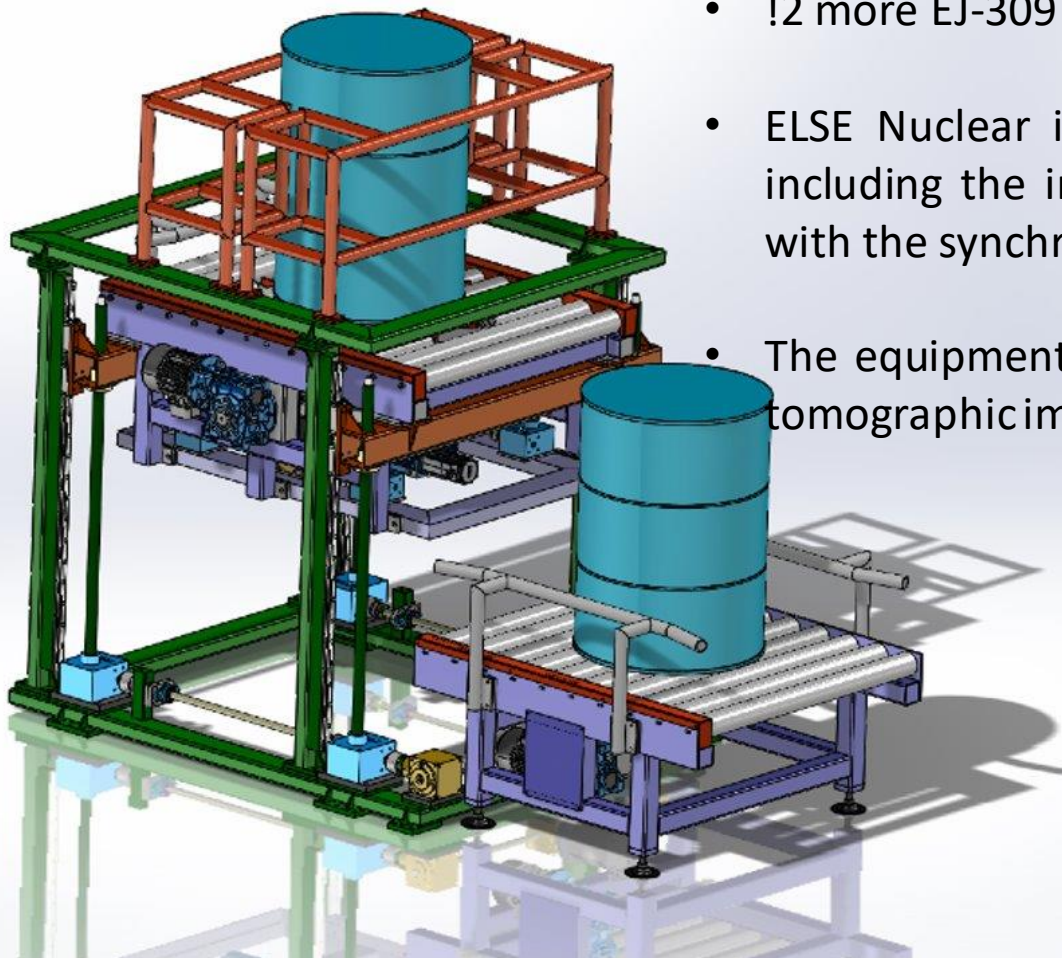


Results of 3D-scanning of legacy waste drums, AB SVAFO, Studsvik nuclear decommissioning site

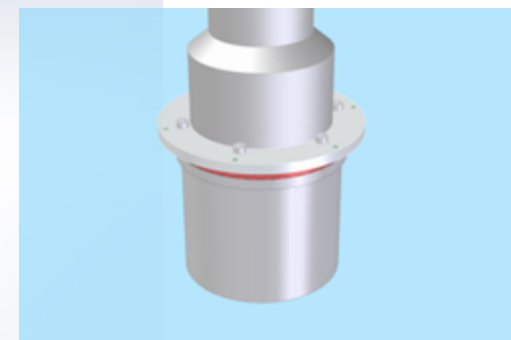
- ***Good agreement with existing documentation, x-ray and γ -ray spectroscopy results***



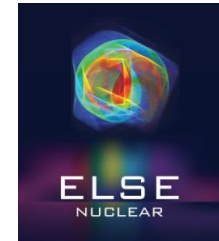
Future development



- !2 more EJ-309 detectors, smaller detection volume
- ELSE Nuclear is developing a drum scanning system including the integration of rotational & axial motion with the synchronized multi array detector output.
- The equipment will be made with capability to add γ -tomographic imaging technique.



Technology and IP status



Technology Status

- Localization of SNM in realistic conditions (legacy waste) achieved
- Quantitative Estimates < 1g Pu (based on MC simulations)
- Enhanced QE in combination with HPGe measurements
- Prototype development in collaboration with AB SVAFO, Studsvik nuclear decommissioning center, Sweden and ELSE Nuclear, Milano, Italy

IPR

- Patent application on the core technology filed in EU, USA, China (IPR owned by KTH Holding).
- Awarded EURATOM Nuclear Innovation Prize (1st prize) 2022



Summary

- Fast neutron – γ correlations are applied as a novel, sensitive tool for detecting and locating SNMs for applications in Nuclear Security (RPMs), and for passive and active interrogation NDA scenarios related to Nuclear Safeguards and Radioactive Waste Management.
- The approach is inspired by techniques used in fundamental nuclear physics experiments using arrays of organic scintillation detectors and high-speed digital pulse processing.
- Uses spatial, time and energy correlations between particles emitted in fission (spontaneous/induced)
- "Rapid" and accurate SNM localization applied to Radioactive Waste Management.
- Prototype development for high-throughput scanning of waste drums in collaboration with AB SVAFO, Studsvik nuclear decommissioning site and ELSE Nuclear, Milano, Italy



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Thank you!

