Radwaste online monitoring: opportunities from new technologies

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University
- Theoretical / experimental
- nuclear and subnuclear physics

Industry
- Medicine
- Cultural heritage
- Computer science
- Electronics
- ENERGY: strategic project

≈ 30 Sections
+ 4 National Laboratories

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- ENERGY: strategic project
protection of nuclear material and nuclear facilities

what
why
how
what
storage

handling

transport

inspection

check

security & safety issues:
maintaining the continuity of knowledge (e.g. legacy waste)
checking package integrity
why
why monitoring? why new tools?

nuclear material lasting hundreds of thousands years ➔ geological repository

but... predisposal & preclosure?

handling, transportation, interim, legacy waste... ➔ inspecting? monitoring?

need to prevent, detect and respond to theft, sabotage, unauthorized access and illegal transfer or other malicious acts

conventional methods

new technologies?
To have a complete and detailed record of the history of each cask

What would be the goal?

individual and continuous online monitoring of casks

to improve safety, security, transparency

why monitoring?

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Why monitoring?

WIPP
Waste Isolation Pilot Plant
14-Feb-2014 New Mexico

Could individual online monitoring have prevented or limited the accident?

Drum 68660

R16:C4

R17:C5

R15:C5

68660

R16:C4
Why (online) monitoring?

- minimizing direct human intervention (accidents, mistakes, malicious acts)
- monitoring in place and/or during transportation
- detecting possible diversion from casks
- preventing illicit trafficking
how
low-cost thermal neutron counter

low-cost linear gamma ray counter

Muon Scattering Tomography system

miniature low-cost gamma ray spectrometer / dosimeter
nuclear material | data acquisition and control | • local wireless and LAN
• global WAN

in place | counters | wireless | LAN

in place | counters | local Data Base

transport | counters | remote Data Base

IAEA
organizations
control authorities
low-cost linear gamma ray counter

- low voltage (30V)
- high gain
- radiation hard
- flexible
- robust
- reliable
- easily handled
- low cost

developed with the support of Ansaldo Nucleare
low-cost linear gamma ray counter

tested with ILW at decreasing distances

tested with LLW for three months

tested in collaboration with SOGIN
miniature low-cost gamma ray spectrometer / dosimeter

developed by Wisnam under INFN license

IAEA CN-254 - Vienna - 13-17 Nov 2017 - Radwaste online monitoring: opportunities from new technologies (ORA-117)
low-cost thermal neutron counter

this sample 3cm x 3cm also available 5cm x 5cm

solid state (Silicon + $^6$LiF)
low cost technology, cheaper than $^3$He
low voltage (25 V)
compact, robust, manageable
good detection efficiency ($5 \div 10\%$)
optimum gamma discrimination ($<10^{-8}$)

tested and in use at neutron beam facilities nTOF at CERN and ISIS at RAL

partly supported by JRC Ispra
Muon Scattering Tomography system

- non-invasive inspection technique
- provides the 3D density distribution
- inspection of legacy unknown radwaste
- can detect missing fuel rods

Presented at the Consultancy Meeting on Recent Developments in Muon Radiography 25-29 September 2017, IAEA, Vienna
radiation fingerprint, similar to CRC Control Code for computer data

radiological characterization

neutrons and gamma rays convey information from the inside

an unexpected change in counting rate is an indication of anomaly

how

muon tomography

storage & monitoring via a sensor network = fingerprinting

transport

neutrons and gamma rays convey information from the inside

an unexpected change in counting rate is an indication of anomaly
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Nuclear Power Plant → Temporarily Storage → Interim Storage → Processing → Disposal

- Nuclear fuel
- Recycled nuclear fuel
- Wet storage
- Dry storage
- Direct disposal
- Deep geological disposal
- Treatment
- Intermediate depth disposal
- Partitioning (and transmutation)

Spent Fuel Management Cycle
- Transport monitoring
- In-place monitoring
Conclusion

The deployment of many compact low-cost radiation sensors for in-place and transport monitoring of nuclear material along with muon tomography devices for non-invasive inspection can improve trust, reliability, safety, public acceptance, accident prevention, and security.

And help preventing and detecting theft, sabotage, unauthorized access and illegal transfer or other malicious acts.

New technologies provide viable solutions for full continuity of knowledge.
Thank you Catania and the Etna volcano

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