Radwaste online monitoring: opportunities from new technologies

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INFN

National Institute of Nuclear Physics

≈ 30 Sections

+ 4 National Laboratories

University

Theoretical / experimental
nuclear and subnuclear physics

INFN

Industry

Medicine

Cultural heritage

Computer science

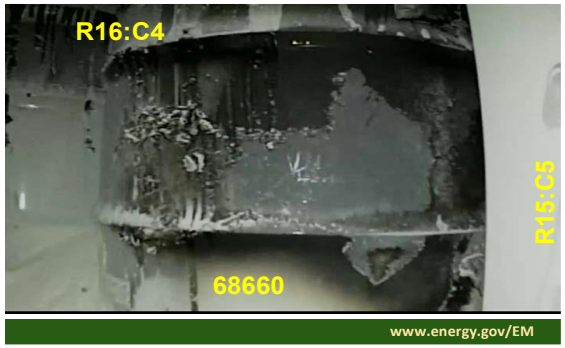
Electronics

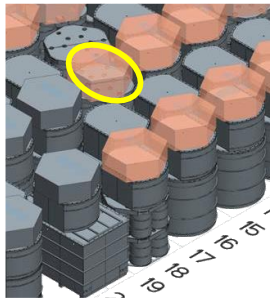
ENERGY: strategic project

INFN-E

protection of nuclear material  and nuclear facilities

what **why** **how**






what

what

storage

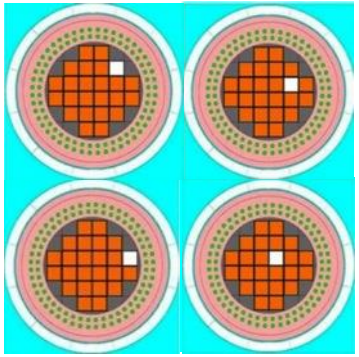
handling

transport

inspection

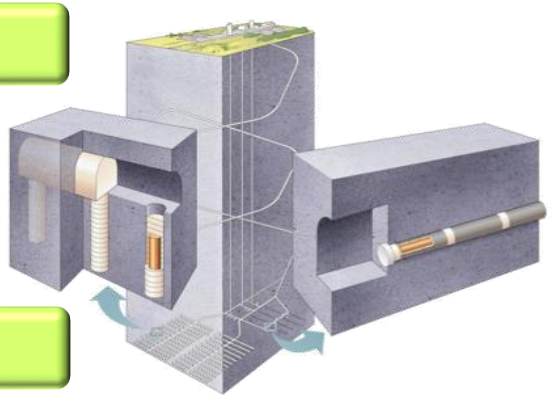
security & safety issues:
maintaining the continuity of knowledge (e.g. legacy waste)
checking package integrity

check




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?

why monitoring?

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

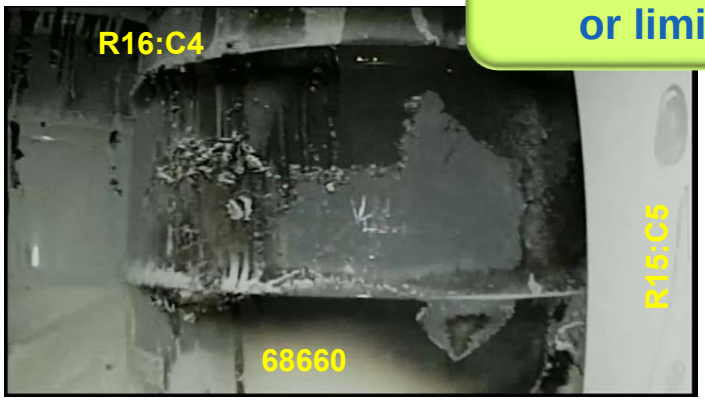
to improve safety, security, transparency

Why monitoring?

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

OFFICE OF ENVIRONMENTAL MANAGEMENT

Drum 68660

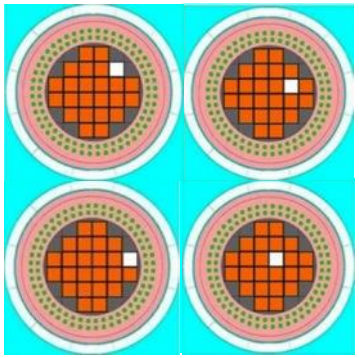


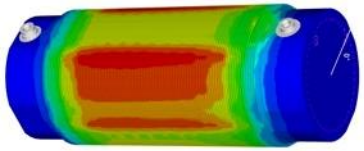
Could individual online monitoring have prevented or limited the accident?

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

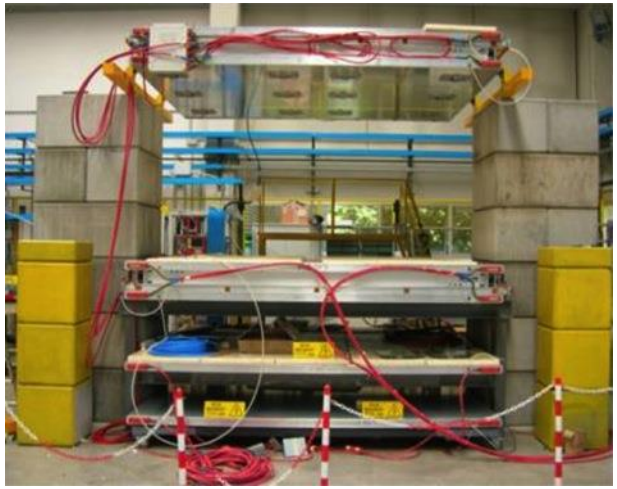
how

how

low-cost thermal neutron counter

low-cost linear gamma ray counter

Muon Scattering Tomography system



miniature low-cost gamma ray spectrometer / dosimeter

how

in place

in place

transport

counters

counters

counters

LAN

wireless

local Data Base

remote Data Base

IAEA

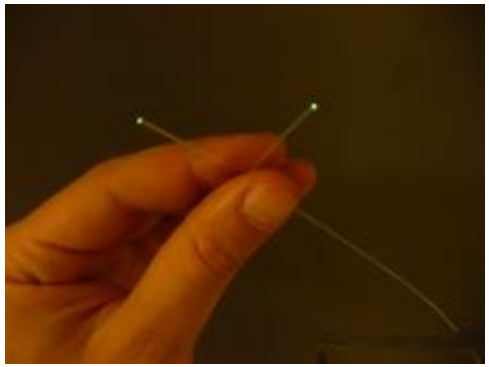
control authorities

organizations

nuclear material	data acquisition and control	• local wireless and LAN • global WAN

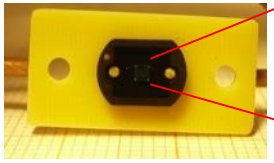
how

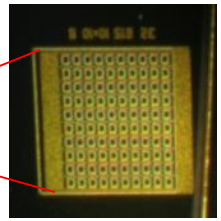
low-cost linear gamma ray counter



scintillating fiber + 2 SiPM

SiPM





low voltage (30V)
high gain

1 mm

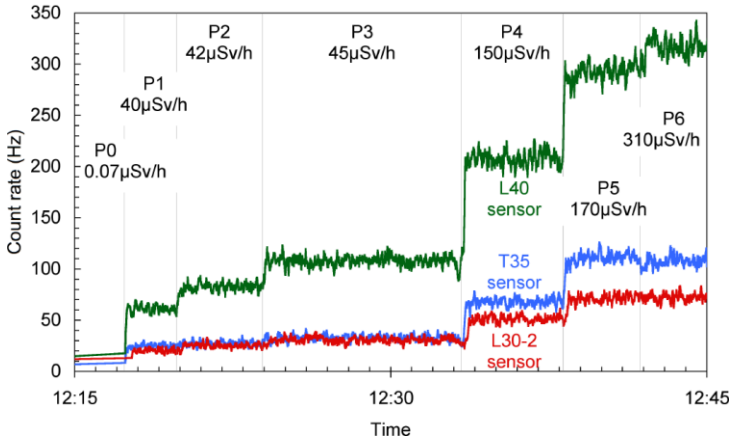
1÷2m long

- radiation hard
- flexible
- robust
- reliabile
- easily handled
- low cost

developed with the support of
Ansaldo Nucleare

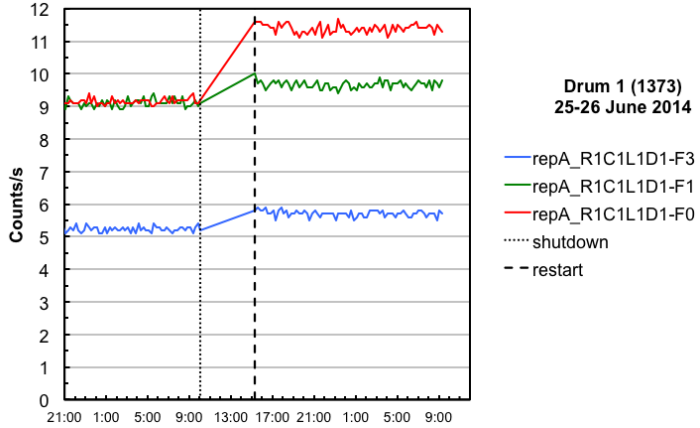
how

low-cost linear gamma ray counter



tested with ILW at decreasing distances

tested in collaboration with SOGIN

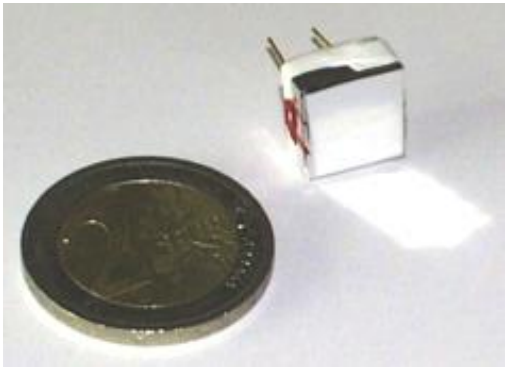


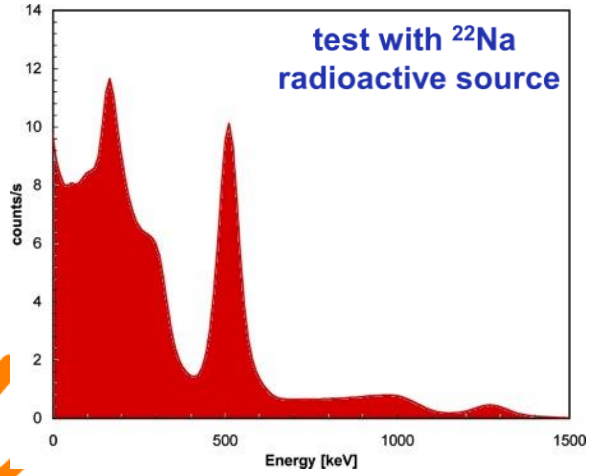
tested with LLW for three months

how

miniature low-cost gamma ray spectrometer / dosimeter

equipped with GPS





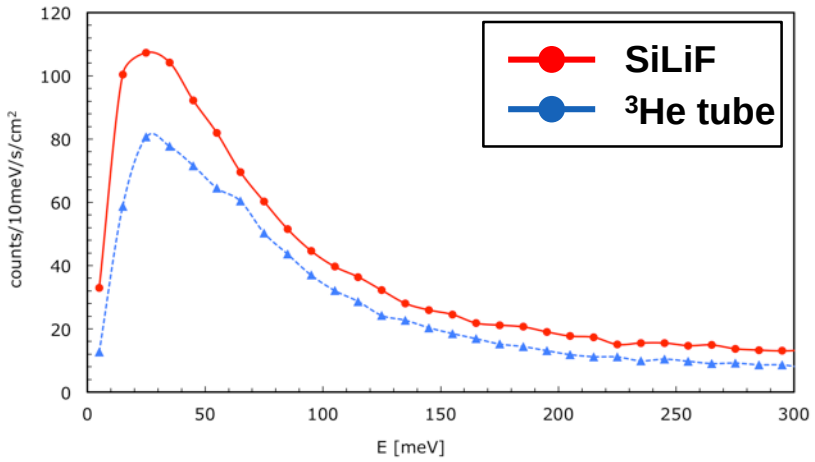
developed by Wisnam
under INFN license

WISNAM
SENSING EVERYTHING EVERYWHERE

how

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 ÷ 10%)
- optimum gamma discrimination (<10^{-8})

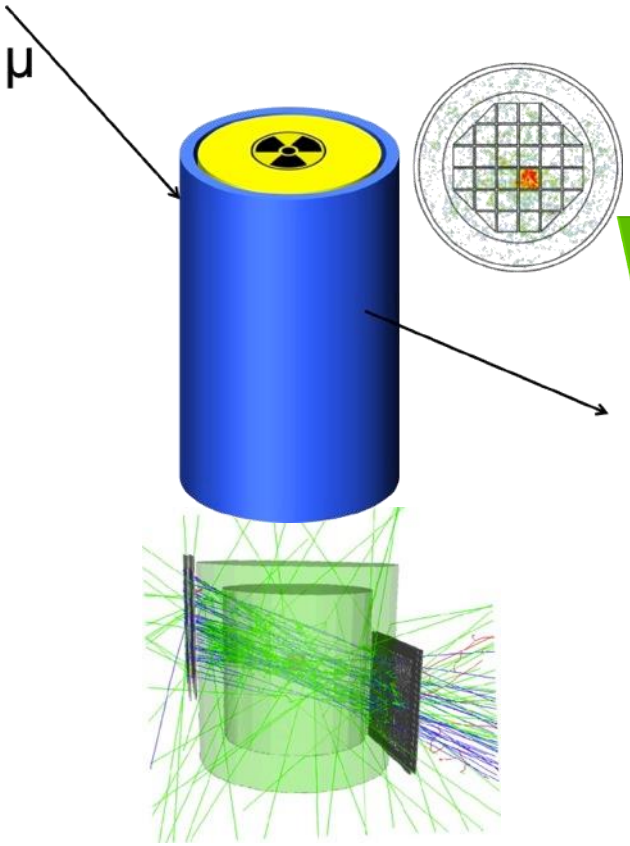
tested and in use at neutron beam facilities
nTOF at CERN and ISIS at RAL

partly supported by JRC Ispra

JRC EUROPEAN COMMISSION

how

Muon Scattering Tomography system



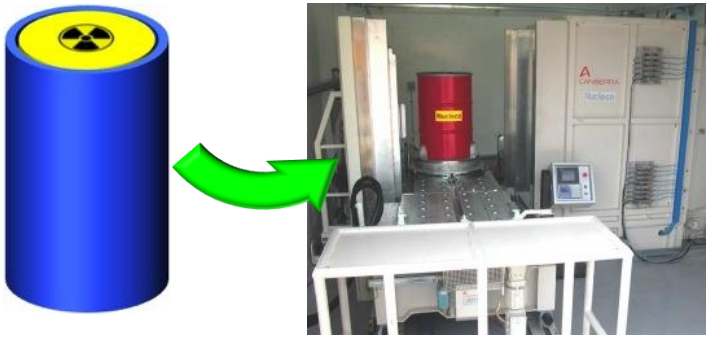
- non-invasive inspection technique
- provides the 3D density distribution
- inspection of legacy unknown radwaste
- can detect missing fuel rods

presented at the Consultancy Meeting on
Recent Developments in Muon Radiography
25-29 September 2017, IAEA, Vienna

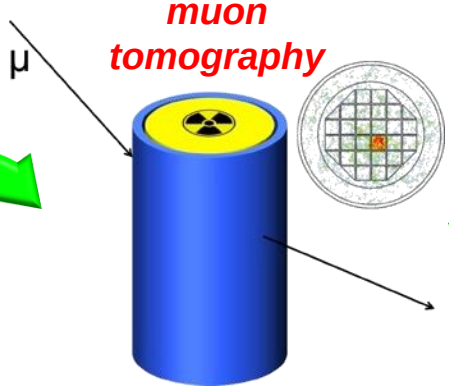
how

radiation fingerprint, similar to CRC Control Code for computer data

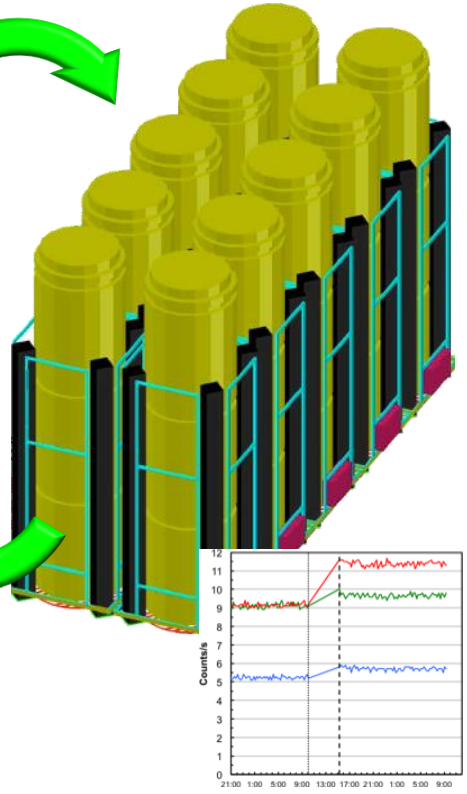
radiological characterization



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

Temporary Storage

Interim Storage

Processing

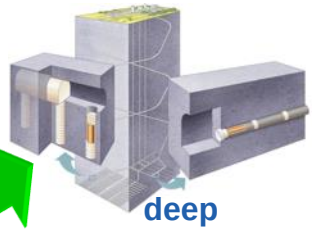
Disposal

nuclear fuel

recycled nuclear fuel

wet storage

direct disposal



deep geological disposal

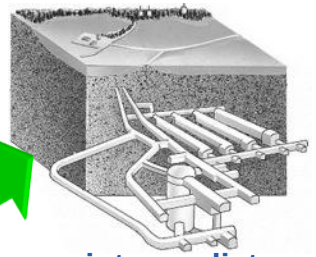
temporary storage

dry storage

treatment

reactor

partitioning (& transmutation)



intermediate depth disposal

Spent Fuel Management Cycle

transport monitoring

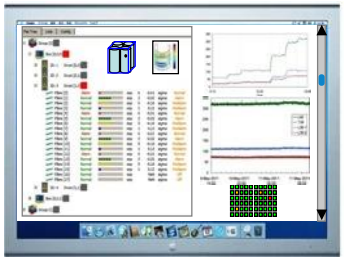
in place monitoring

Conclusion

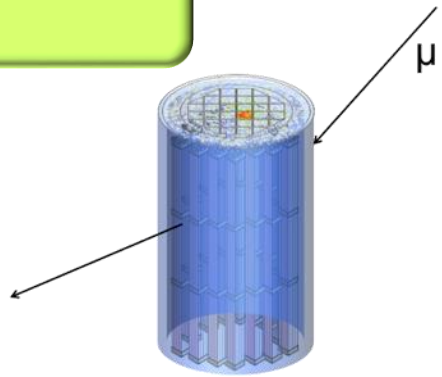
the deployment of many compact low-cost radiation sensors for in-place and transport monitoring of nuclear material along with muon tomography devices for non-invasive inspection can improve

- trust
- public acceptance
- reliability
- accident prevention
- safety
- 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

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Catania and the Etna volcano