PREDEC 2016

International Symposium on PREparation for DECommissioning

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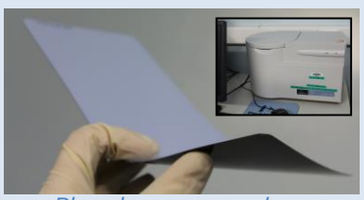
Preliminary identification of α and β contaminations through Digital Autoradiography

Introduction

Digital Autoradiography is :

- A radioactivity-imaging technique (phosphor type)
- Performed through the in-situ exposure of 2-D screens
- Non-destructive (no wastes ; reusable screens)
- Sensitive to all types of radioactivity (α, β incl. ^{3}H, γ/X)
- Sensitive to both labile and fixed radioactivity
- Semi-quantitative (activity in Bq/cm²) after calibration
- Recently applied to α/β radiological mapping, and to the preliminary characterization of various samples (drilled cores, pieces of furniture, tank blocks, rubble, dust, wastes…)

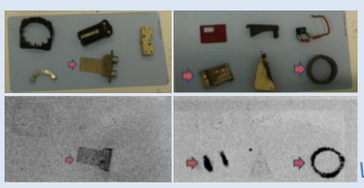


Phosphor screen and scanner

Concrete floor mapping

Previous abilities for contamination detection :

- accurate location
- shape and structure
- inhomogeneity (hot points)



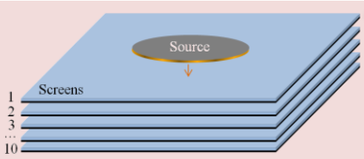
Wastes preliminary discrimination

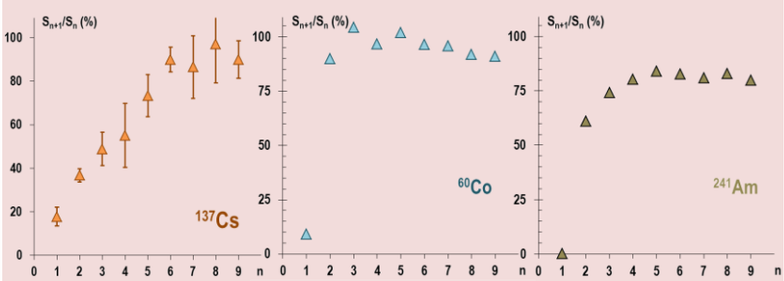
Targeted additional ability :

Radioactivity type **identification** to preliminary evaluate activity without destructive analysis

Screen stacking method

Signal transmission sequences for radionuclides commonly met in dismantling (S_n = signal measured on screen n)

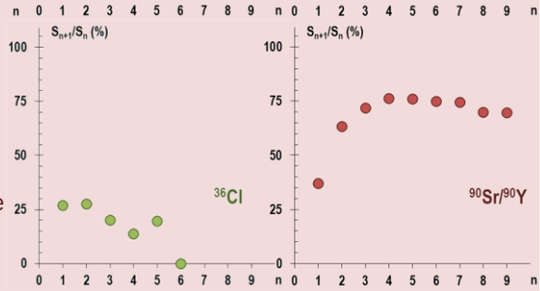




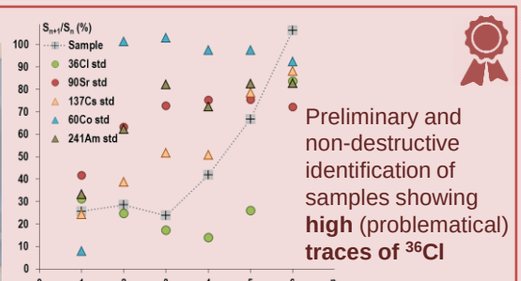
Specific signatures, independent on :

- activity
- exposure time

Very small variations from source to source for S_2/S_1 and S_3/S_2



Steel block from a tank

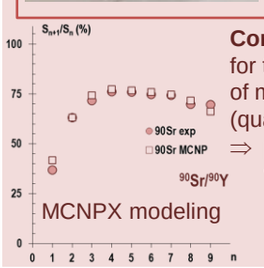


Preliminary and non-destructive identification of samples showing **high** (problematical) **traces of ^{36}Cl**

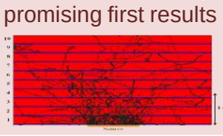
Contribution of modeling

for the elucidation of mixtures of radionuclides (quantitative evaluation)

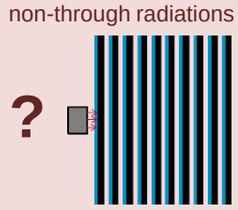
⇒ promising first results



MCNPX modeling

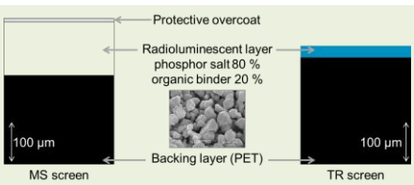


Dealing with the case of non-through radiations

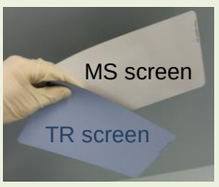


MS/TR comparison method

Ratios of the signals obtained with two different types of screen in identical exposure conditions for radionuclides commonly met in dismantling



Rad. nucl.	Emission (mean energy)	MS/TR
^{3}H	β (5 keV)	0.001
^{233}U	α (4.8 MeV)	0.39
^{239}Pu	α (5.1 MeV)	0.46
^{241}Am	α (5.5 MeV)	0.49
^{244}Cm	α (5.8 MeV)	0.55
^{14}C	β (50 keV)	1.0-1.6
^{55}Fe	X-ray (5 keV)	2.0
^{60}Co	β (100 keV) + γ (1.25 MeV)	3.0
^{137}Cs	β (200 keV) + γ (0.66 MeV)	4.7
^{204}Tl	β (240 keV)	5.0
^{36}Cl	β (320 keV)	6.1
$^{90}Sr/^{90}Y$	β (560 keV)	6.5
^{40}K	β (510 keV) + γ (1.5 MeV)	7.4



Specific ratios, independent on :

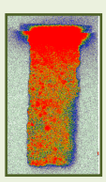
- activity
- exposure time

Very small variations from source to source (excepted ^{14}C)

Concrete drilled core

Stacking : ● ($S_{n>1}$=0)

=> MS/TR comparison



MS

TR

Evaluation of :
Contamination depth
Relative contamination profile
Hot spots location

MS/TR = 1.6

⇒ Contamination **mainly due to ^{14}C**

⇒ Reaching activity profile in Bq/cm²

Identification of contaminating radionuclide and, in turn, **evaluation of contamination activity**, through non-destructive **Digital Autoradiography only**, subject to certain conditions.

Limits to overcome :

- Contamination with complex mixtures of radionuclides
- Influence of matrix effects (self-attenuation)

Tuesday 16th ▪ Thursday 18th February 2016

Lyon Convention Centre ▪ France

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