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. 3H, 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…)

**Screen stacking method**
Signal transmission sequences for radionuclides commonly met in dismantling ($S_n = $ signal measured on screen $n$)

**Steel block from a tank**

**MCNPX modeling**

**Preliminary and non-destructive identification of samples showing high (problematical) traces of $^{35}$Cl**

**Contribution of modeling for the elucidation of mixtures of radionuclides (quantitative evaluation)** ➔ promising first results

**Dealing with the case of non-through radiations**

**Previous abilities for contamination detection:**
- accurate location
- shape and structure
- inhomogeneity (hot points)

**Targeted additional ability:**
Radioactivity type identification to preliminary evaluate activity without destructive analysis

**Wastes preliminary discrimination**

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

**Evaluation of:**
- Contamination depth
- Relative contamination profile
- Hot spots location

**MS/TR = 1.6**

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

**Concrete drilled core**
Stacking : $S_{n+1}$ (S_n > 0) ➔ MS/TR comparison

<table>
<thead>
<tr>
<th>Rad. nucl.</th>
<th>Emission (mean energy)</th>
<th>MS/TR</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^3$H</td>
<td>β (5 keV)</td>
<td>0.001</td>
</tr>
<tr>
<td>$^{233}$U</td>
<td>α (4.8 MeV)</td>
<td>0.39</td>
</tr>
<tr>
<td>$^{239}$Pu</td>
<td>α (5.1 MeV)</td>
<td>0.46</td>
</tr>
<tr>
<td>$^{241}$Am</td>
<td>α (5.5 MeV)</td>
<td>0.49</td>
</tr>
<tr>
<td>$^{244}$Cm</td>
<td>α (5.8 MeV)</td>
<td>0.55</td>
</tr>
<tr>
<td>$^{56}$Fe</td>
<td>β (50 keV)</td>
<td>1.0-1.6</td>
</tr>
<tr>
<td>$^{56}$Co</td>
<td>β (100 keV) + γ (1.25 MeV)</td>
<td>3.0</td>
</tr>
<tr>
<td>$^{56}$Ti</td>
<td>β (200 keV) + γ (0.66 MeV)</td>
<td>4.7</td>
</tr>
<tr>
<td>$^{35}$Cl</td>
<td>β (240 keV)</td>
<td>5.0</td>
</tr>
<tr>
<td>$^{85}$Sr</td>
<td>β (320 keV)</td>
<td>6.1</td>
</tr>
<tr>
<td>$^{40}$K</td>
<td>β (510 keV) + γ (1.5 MeV)</td>
<td>7.4</td>
</tr>
</tbody>
</table>

**Concrete floor mapping**

**MS/PH screen and scanner**

**Concrete drilled core**
Stacking : $S_{n+1}$ (S_n > 0) ➔ MS/TR comparison

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**Reaching activity profile in Bq/cm²**

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