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## Custom radioactive standards to assess detector performance

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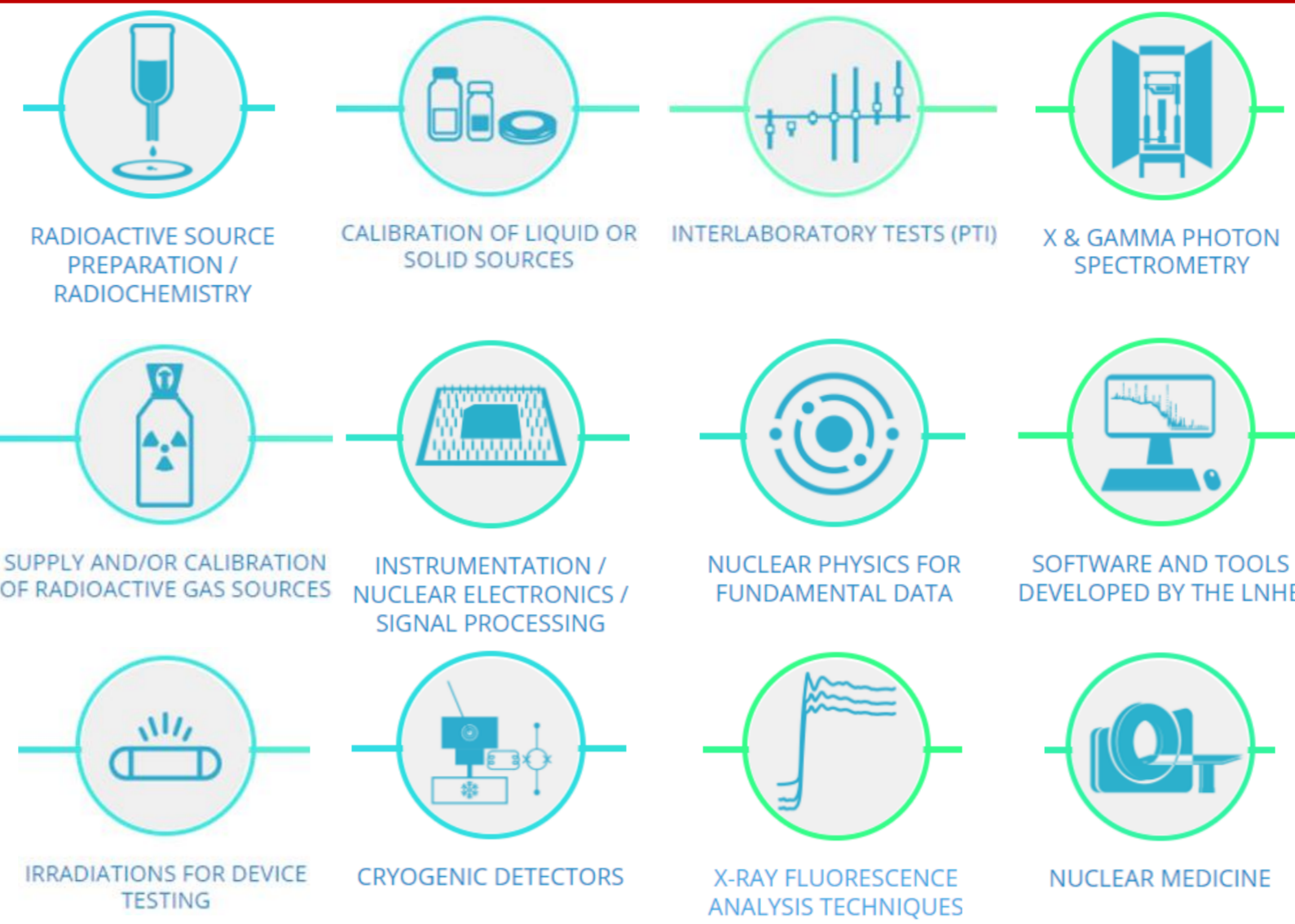
# Custom radioactive sources to assess detector performance



## Our job: metrology



- The Laboratoire National Henri Becquerel is the French **metrology laboratory** for ionizing radiation. We implement 3 units (Bq, Gy, Sv) of the International System of Units (SI).
- We can manufacture custom radioactive standards, traceable according to ISO 17025.
- We also evaluate and publish nuclear and atomic data associated with the decay of radionuclides (half-lives, energies and emission intensities, decay schemes...).  
<http://www.lnhb.fr/nuclear-data/module-lara/> and  
<http://www.lnhb.fr/nuclear-data/nuclear-data-table/>.

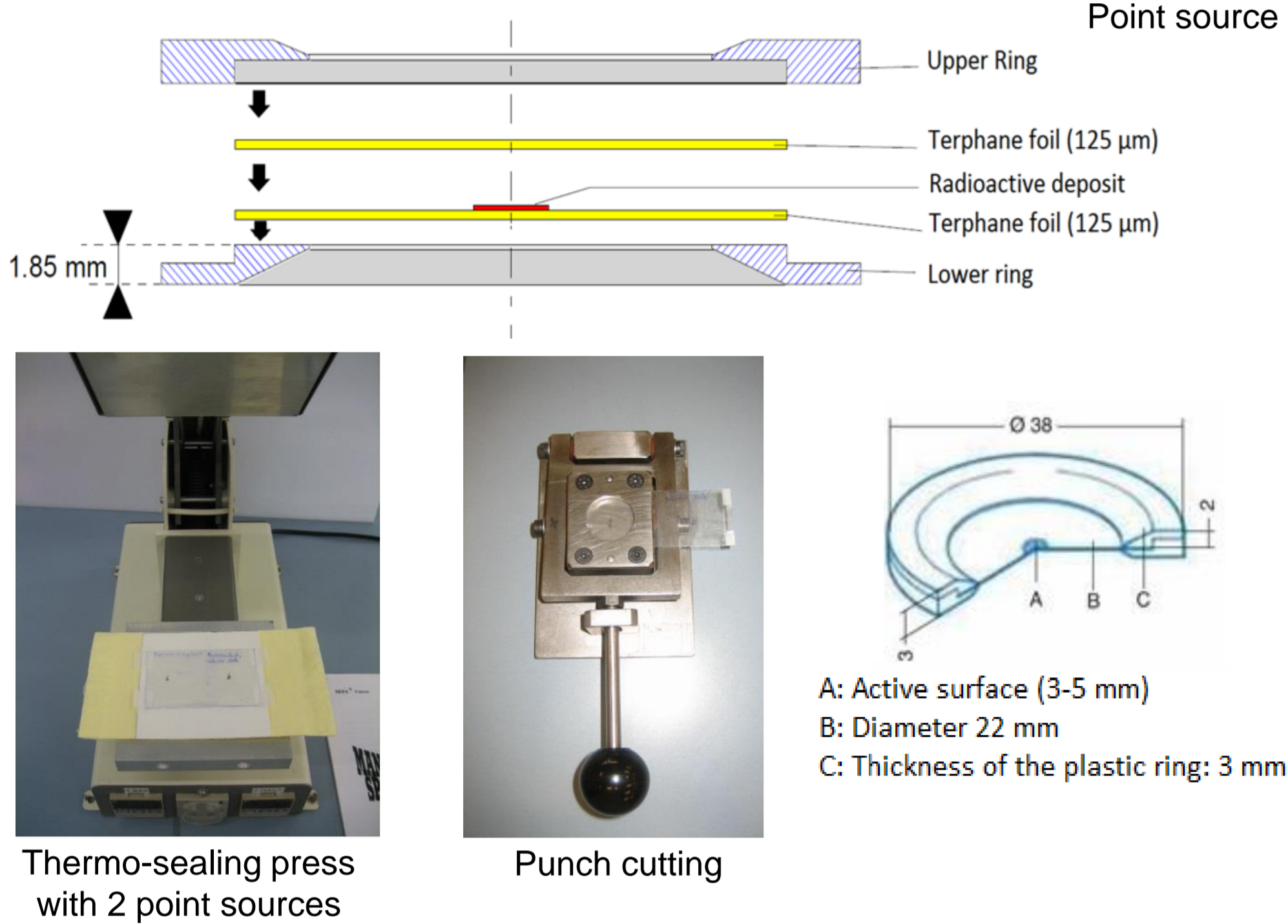


- Our **calibration certificates are recognized** by our homologues, such as NIST (<https://www.bipm.org/fr/cipm-mra/>).
- The LNHB technical platforms include the means of preparing radioactive sources and measurements adapted to the diversity of radionuclides (physical form, half-life, decay scheme). We also have radiation sources adapted to radiotherapy, radiodiagnostics, radiation protection and industrial irradiation.



## Detector performance

### NANTISTA: Neuromorphic Architecture for Nuclear Threat Identification for Security Applications



Our sources have been successfully used to test an original signal processing strategy based on artificial spiking neural networks to enable fast radionuclide identification at low count rate for radiological threats (International Conference on Radionuclide Metrology and its application 2015: Real-time radionuclide identification in  $\gamma$ -emitter mixtures based on spiking neural network. C. Bobin, O. Bichler, V. Lourenço, C. Thiam, M. Thévenin).

Calibration of a  $\gamma$ -camera in terms of dose-rate ( $\mu\text{Sv/h}$ ) at several energies ( $^{57}\text{Co}$ ,  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$  and  $^{241}\text{Am}$ )

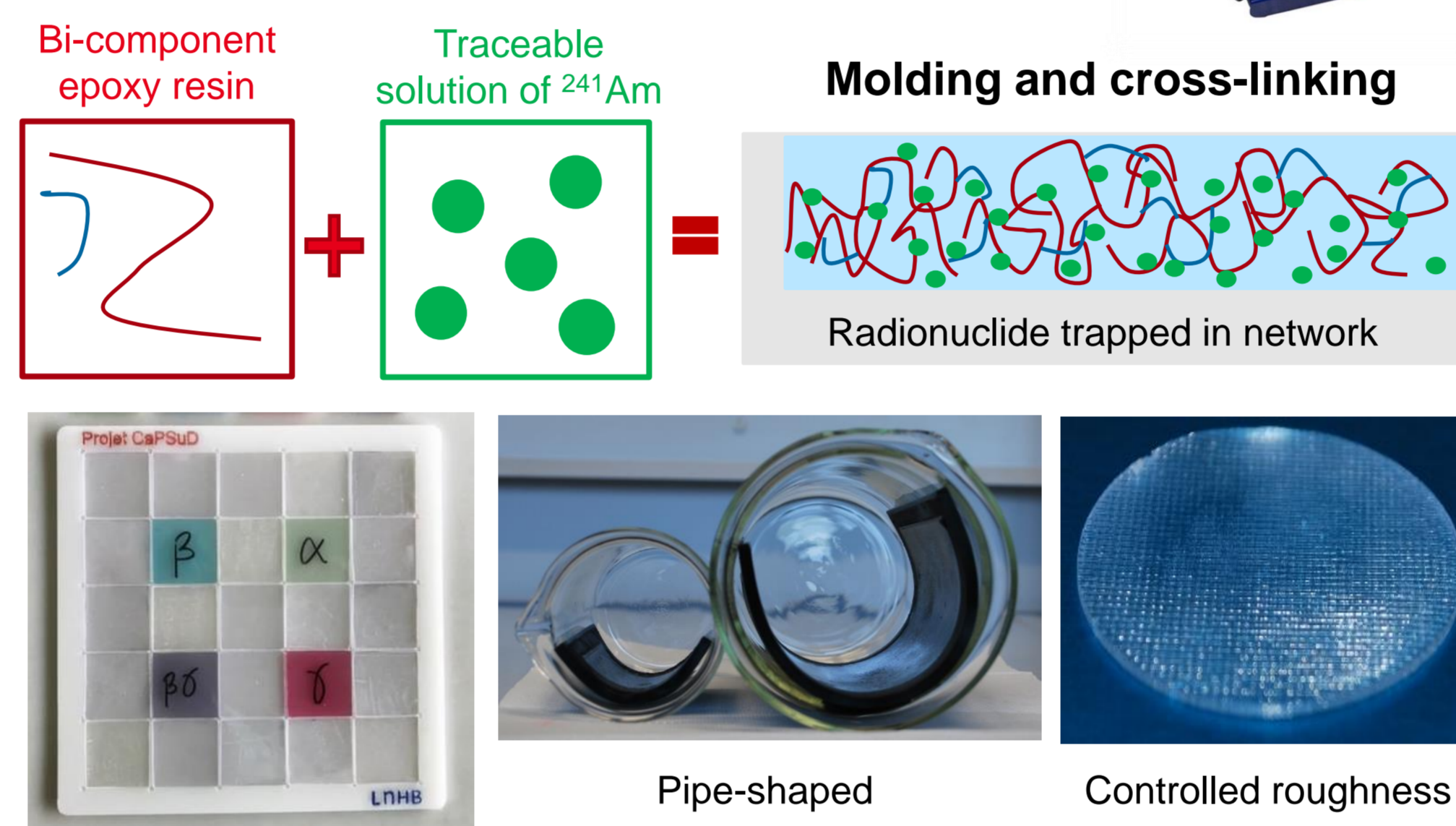
12 point sources prepared:  $^{57}\text{Co}$ ,  $^{60}\text{Co}$ ,  $^{137}\text{Cs}$  and  $^{241}\text{Am}$

Flexible surface source uniformity assessment using autoradiography

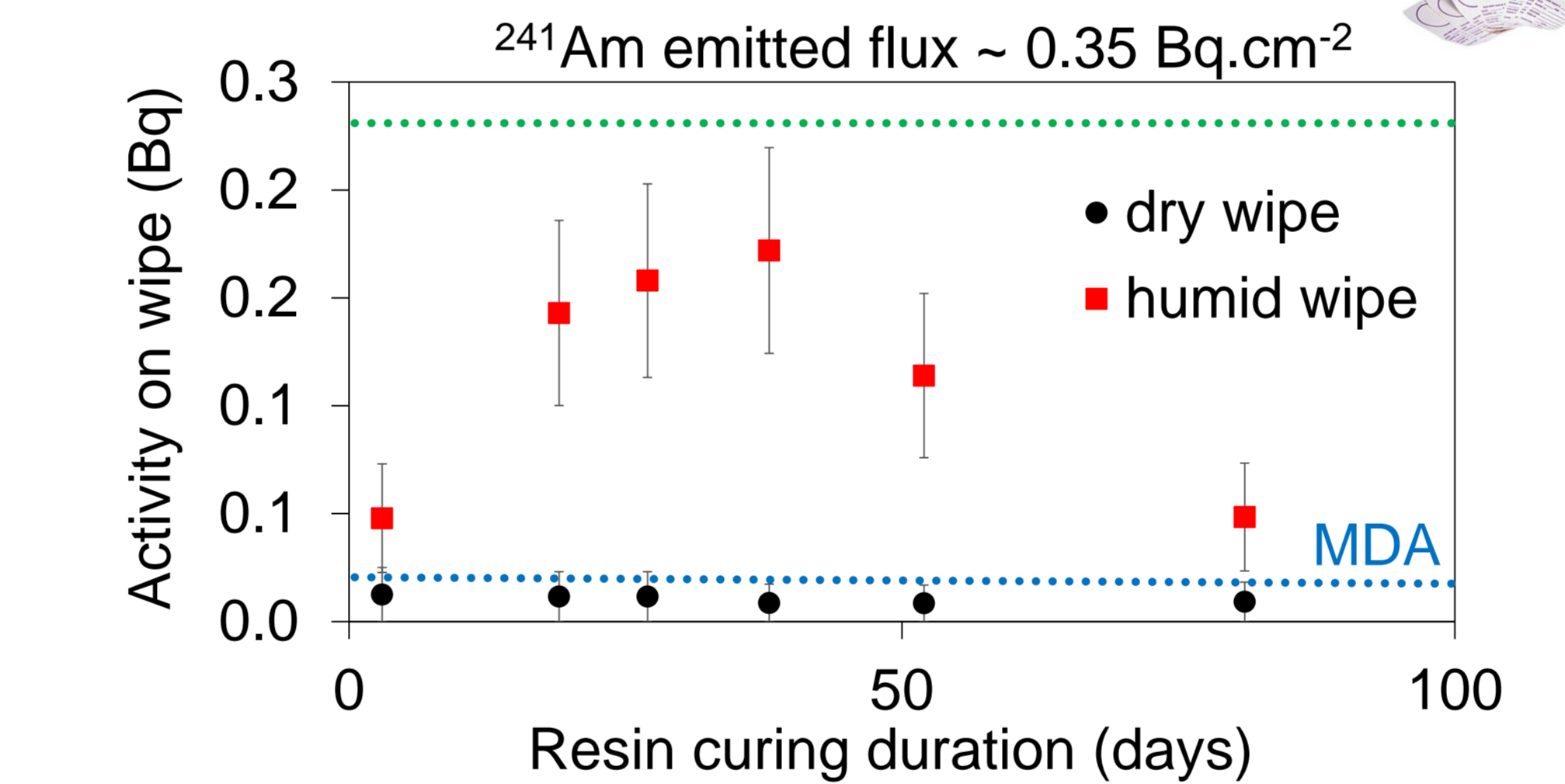
Detection of a flexible source, placed inside a pipe, using a  $\gamma$ -camera (courtesy of LCAE)

## Custom surface sources

In the decommissioning field, it is necessary to discriminate between non-contaminated surfaces/slightly contaminated surfaces, to minimize waste, save money and time. There's a need for representative, traceable surface sources (shapes, roughness).



### Non-contaminating? Wipe tests (NF 9978)



- Advantages**
- Simple protocol
  - All soluble radionuclides
  - Reproducible
- Limitations**
- Low  $\alpha$  emission efficiency
  - Limited total emitted flux

### Improvement strategy: functionalization

Existing sources: radionuclide dried + protected

- Thin emitting layer
- Limited self-absorption
- Strong surface-ligand-radionuclide interactions
- No need for cover layer

## Traceable volumic sources

Liquid samples for LNHB proficiency tests from 1 mL to 3 L

Variety of tests: mixture of multi- $\gamma$  emitting radionuclides (activation and/or fission products), tritium, spiked filters or gases, with activities ranging from  $\text{mBq}\cdot\text{g}^{-1}$  to  $\text{kBq}\cdot\text{g}^{-1}$ . Specific tests can be provided on demand.

Criteria	In agreement	Questionable	Discrepant
$e_p$	$\leq 15\%$	$15\% < e_p \leq 20\%$	$> 20\%$
$E_{n,p}$	$\leq 1$	$1 < E_{n,p} \leq 1.3$	$> 1.3$
$Z_p$	$\leq 2$	$2 < Z_p < 3$	$\geq 3$

Participating in LNHB Proficiency Tests enables a laboratory:

- to prove its measurement capabilities,
- to detect any possible measurement problem.

## Reference materials

Lourenço et al. (2014) ARI  
<https://dx.doi.org/10.1016/j.apradiso.2013.11.034>

Grass material drying in the test chamber with forced convection

Open knife grinder with 0.25 mm sieve

Dried material after sieving

Rotary evaporator: spiking/drying

Gamma spectrometry measurement of a 50  $\text{cm}^3$  subsample (left) and a 500  $\text{cm}^3$  sample (right)

Disk mill

Jar crusher

Set of sieves

Fraction distributor

## Primary sources

VYNS: vinyl acetate + chloride.

Absolute ethanol + crystallizing agent + wetting agent

Glass capillary + constantan electrode

Diaphragm VYNS ( $45 \mu\text{g}/\text{cm}^2$ ) Stainless steel ring

## Emanation sources

MetroRadon: emanation sources for traceable calibration of  $^{222}\text{Rn}$  measurement devices. Manufacturing of a porous polymer by co-precipitation with  $^{226}\text{Ra}$ .

$\text{BaCl}_2 + \text{Na-stearate}$  Büchner filtration

## $^{222}\text{Rn}$ on the Moon

The DORN instrument will be embarked on the Chinese mission Chang'E6 in 2023-2024 to measure for the first time on the surface of the Moon, the quantity of  $^{222}\text{Rn}$  which escapes from the lunar ground, to better understand what governs lunar outgassing with this ideal tracer. The LNHB is providing electroplated  $^{209}\text{Po}$  sources to calibrate the alpha spectrometry system of the DORN device and we will also be able to measure  $^{222}\text{Rn}$  in lunar samples.

4  $\text{mm}^2$   $^{209}\text{Po}$  source  $\sim 20 \text{ Bq}$

Detection of Outgassing Radon  
月球氡气探测

## Applications

Our custom radioactive sources enable you to:

- calibrate/assess the performance of (new) detectors,
- reproduce interferences of *in-situ* measurements with no access constraints.

## Contact

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