

# FST-51200.50.19.13 (FY 2019-2021):

## Integrating Nuclear Techniques to Enhance Detection of Opioids

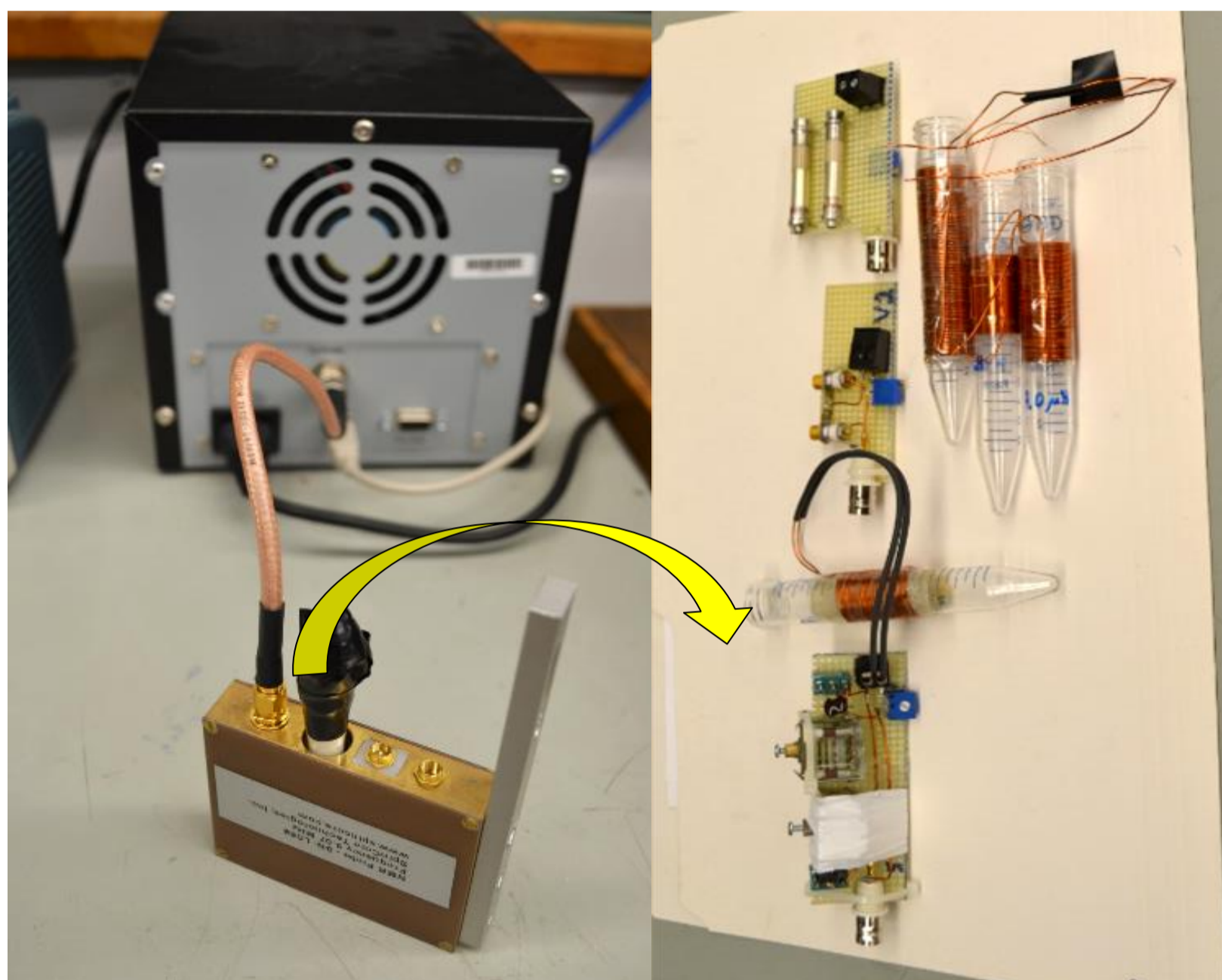
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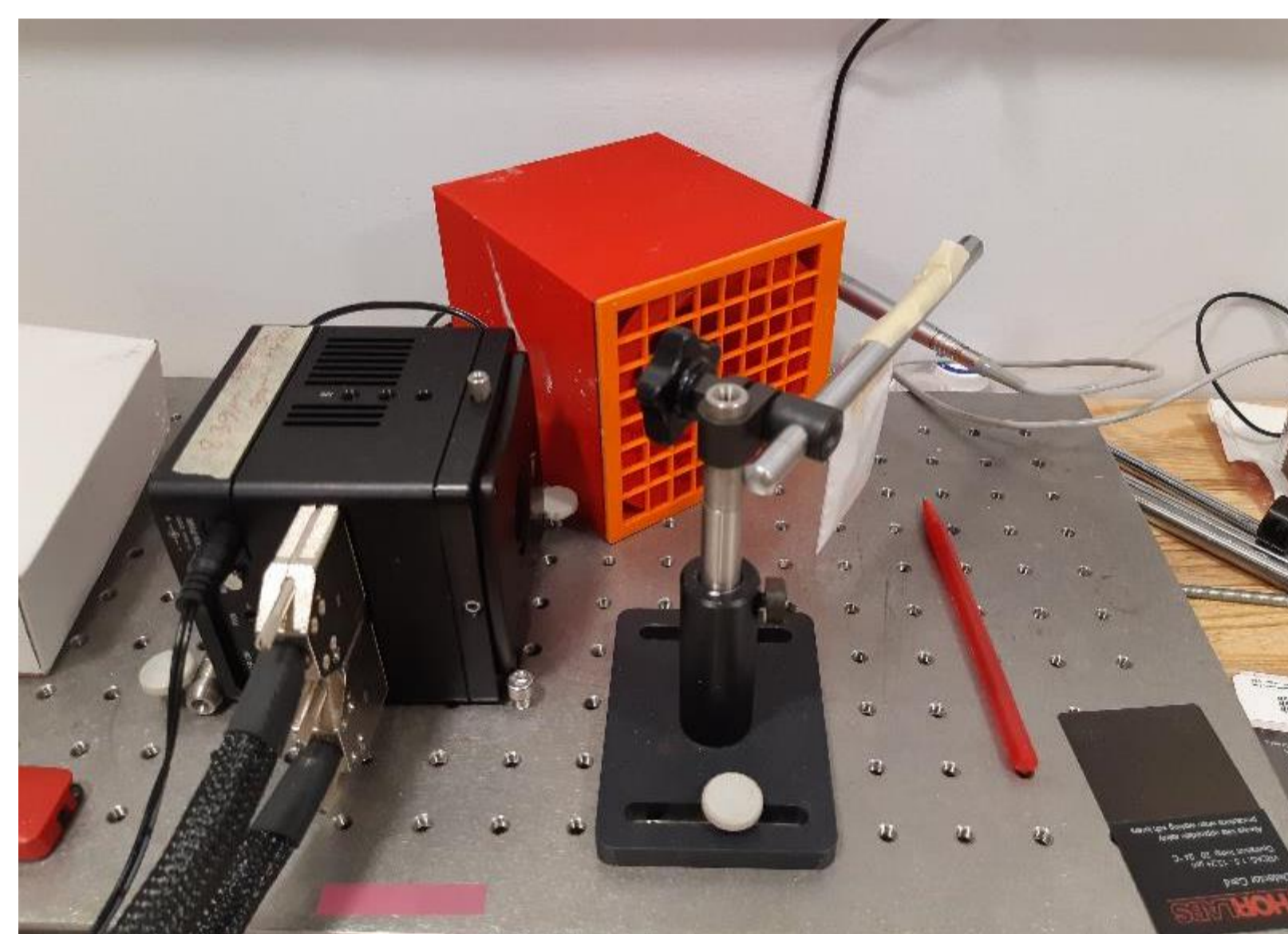
**Objective:** Develop and integrate complementary nuclear techniques to enhance detection of opioids in packages passing through mail rooms, airports and other sensitive areas.

### Results/Achievements Thus Far:

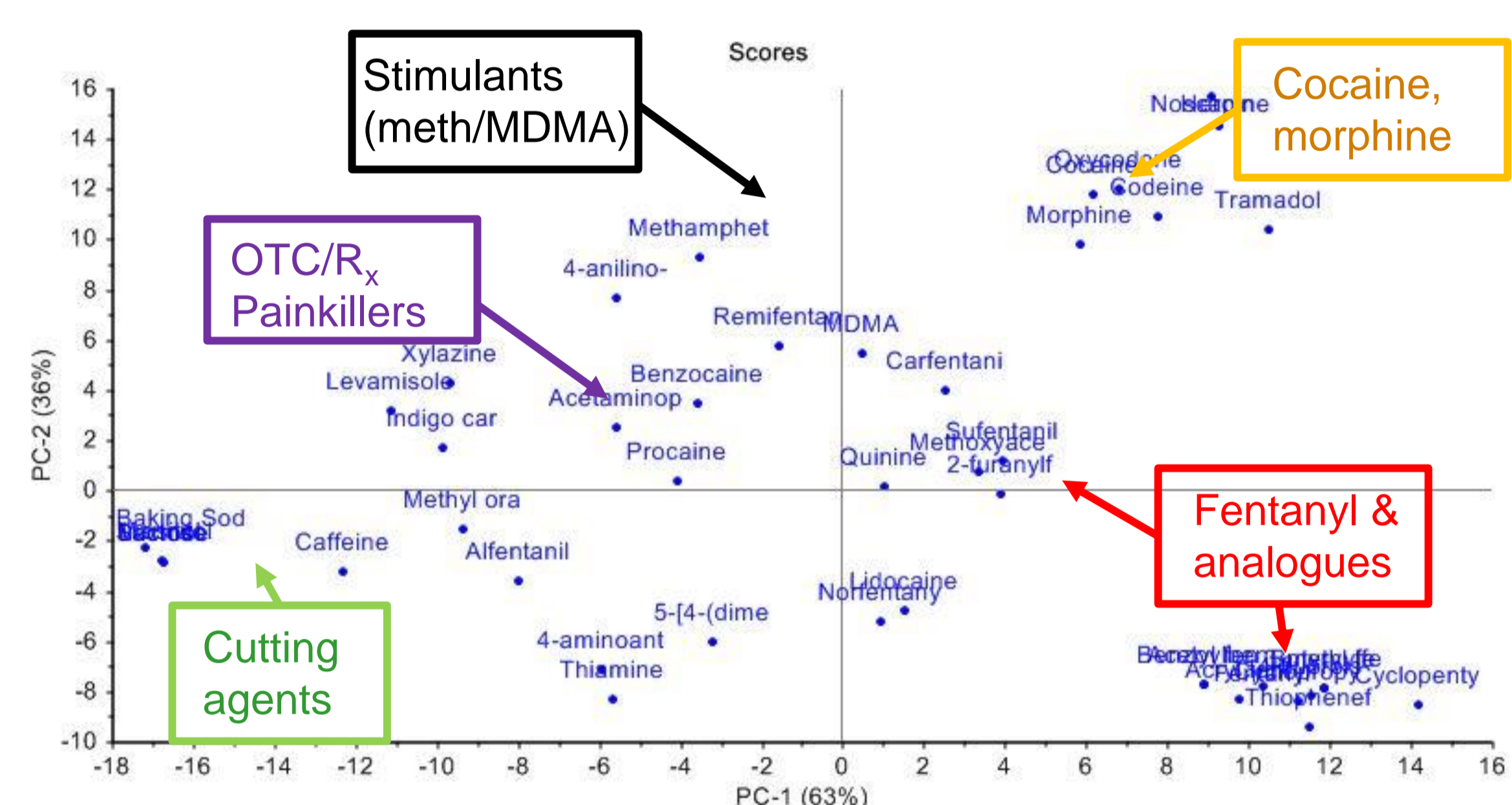
- Built and commissioned Nuclear Quadrupole Resonance Spectrometer (NQR) (Figure 1).
- Built and commissioned first-generation photoacoustic system, with 3D-printed acoustic horn detection (Figure 2).
- Completed preliminary round-robin testing of surrogate packages using non-nuclear and nuclear (neutron and x-ray) techniques. Limitations of non-nuclear techniques (non-penetrating) confirmed.
- Initial chemometric model shows excellent ability to distinguish various classes of narcotics from each other and cutting agents (Figure 3).



**Figure 1:** Custom-built NQR system for detection of nitrogen-containing compounds (e.g., drugs, explosives). Yellow arrow indicates sample probe.



**Figure 2:** Custom-built photoacoustic system for detection of drugs and explosives. Source (black box), sample (stand, hanging), detector (orange box).



**Figure 3:** Principal Component Analysis (PCA) plot of illicit and prescription drugs and most common cutting agents based upon a model of atomic ratios of the molecules in pure form.

### Collaborations/Leveraging:

Stakeholders: CBSA, RCMP, DRDC, CSC, AECL

This work follows from a preliminary study investigating the use of nuclear techniques for the detection of opioids and explosives (FST-51200.50.18.14) and current Canadian Safety and Security Program project CSSP-2018-CP-2338 "Advanced Nuclear Techniques for Toxic and Explosive Chemical Detection".

**Future Work: (1)** Continue developing NQR, photoacoustic, x-ray and neutron-based detection.  
**(2)** Further testing of multiple narcotic surrogates in different packaging (paper, foil, mixed).  
**(3)** Further development of chemometric models (individual and collective detection).  
**(4)** Test real substances with support from RCMP and CBSA.

### Expected Outcomes:

- Demonstrated effectiveness of nuclear techniques for detection of opioids, showing need for these techniques in the real world.
- Chemometric model integrating multiple techniques to enhance detection and classification.

