Development of a Smart Sniffer Device for the Detection of Illicit Drugs, Homemade Explosives, and their Precursor Chemicals

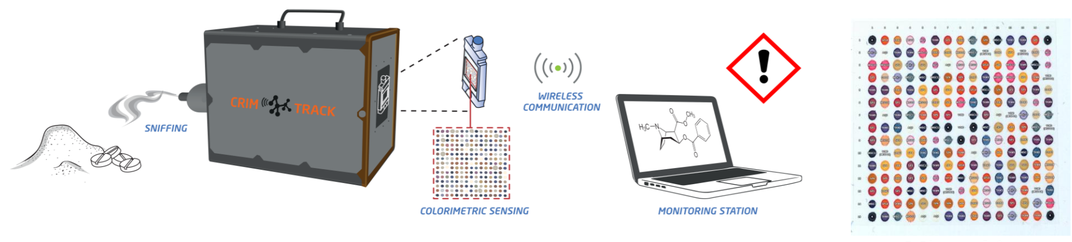
Background

The **controlled drug market** in the UK (worth £9.4 billion a year) is used to finance other crimes, including **terrorism**, with enormous **social-economical costs**. The threat continues to change and exploitation of the latest **scientific and technical advances** for an early detection of terrorist and criminal activities, is at the core of **Law Enforcement Agencies (LEAs)** operational requirements.

Among the technologies for the **detection of illicit substances** currently used/explored by UK and International markets there is the **CRIM-TRACK sniffer**, a portable detection device that detects the **vapours** of illicit substances, in a non-destructive, **non-intrusive and near real time manner.**

The CRIM-TRACK sniffer was developed by Cranfield and Danish Technical University (EU FP7 project) is currently at TRL 4.

CRIM-TRACK

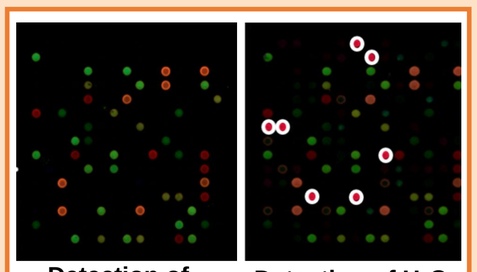


Schematic representation of CRIM-TRACK sniffer device.

Microchip

The **CRIM-TRACK** sniffer device includes an air sampling system, colorimetric sensor system, monitoring station and wireless communication between sniffer and monitoring station.

The **colourimetric detection technology** uses a microchip containing a number of chromic substances (**Dyes**) to detect vapour traces of explosives, controlled drugs, and their precursor chemicals (**Analytes**).



Detection of pure water

Detection of H_2O_2 in pure water

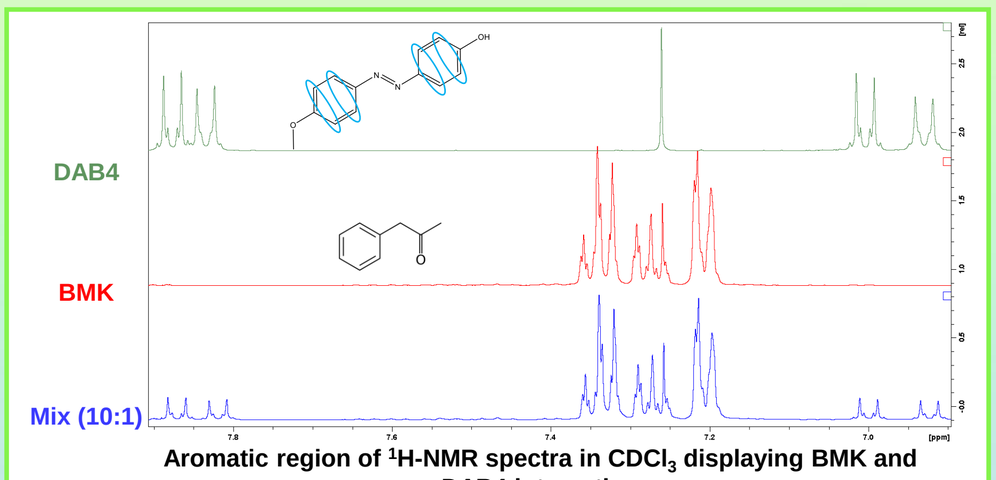
Aim

- Further develop the CRIM-TRACK **colourimetric sensor** system by investigation of dyes/analytes interactions and selection of dyes
- Perform **detection experiments** with targeted analytes and populate the detection database.

Results and Discussion

This PhD research is primarily focused on the investigation of dye/analytes interactions

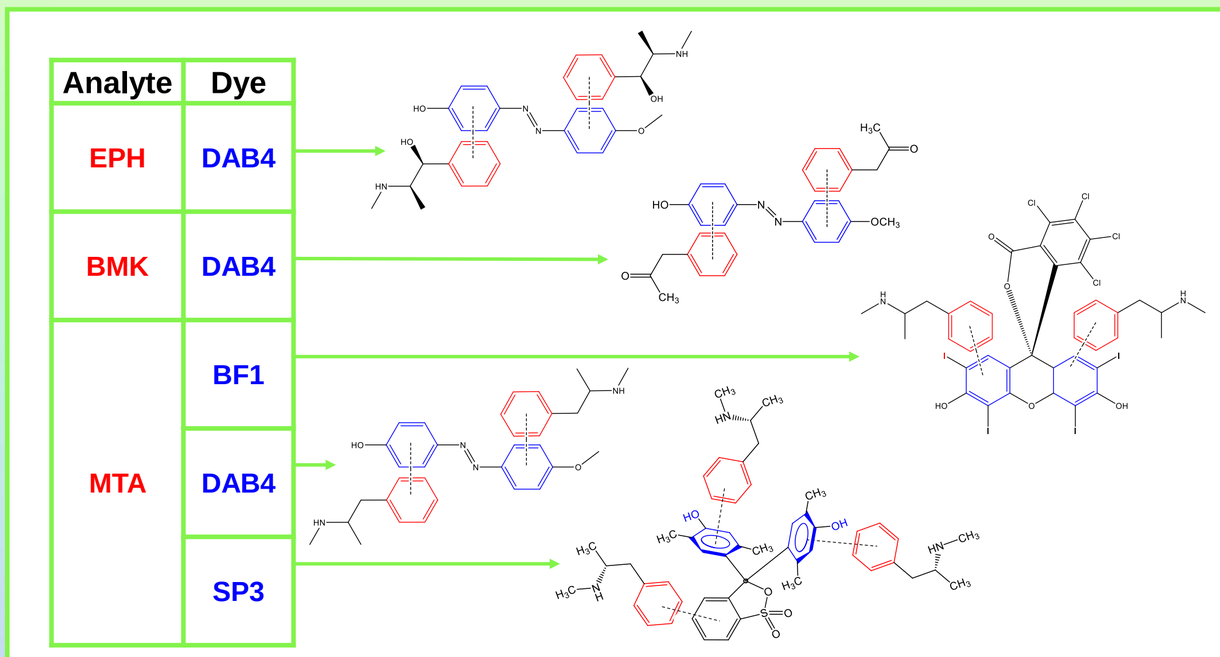
- ^{1}H-NMR experiments in $CDCl_3$ and DMSO-d_6,according to the solubility of the chemicals
- The spectra of **4-methoxy-4'-hydroxyazobenzene (DAB4), bengal rose B (BF1)** and **xylenol blue (SP3)** (dyes) and **benzyl methyl ketone (BMK), ephedrine (EPH)** and **methamphetamine hydrochloride (MTA)** (analytes), were compared to their analyte:dye 10:1, 5:1 and 2:1 mol/mol mixtures
- Any variation of the chemical shifts were associated to physical interaction or chemical reaction between the components of the mixture.



Aromatic region of ^{1}H-NMR spectra in $CDCl_3$ displaying BMK and DAB4 interaction

When molecules of BMK, approach the aromatic rings of DAB4, their electron density is affected causing significant chemical shifts of the aromatic protons.
This effect is increased with higher concentrations.

Analyte	Dye
EPH	DAB4
BMK	DAB4
MTA	BF1
	DAB4
	SP3



Proposed dye/analyte interactions

Conclusions

- Selected dyes and analytes have been characterised chemically using NMR spectroscopy
- NMR has been determined as a valid method for observing interactions/reactions between illicit substances and dyes in solution
- Previous results from detection experiments have been validated
- The higher the concentration of dye, the larger the effect on chemical shift.

Future Work

- Investigate further dye/analyte interactions using NMR and TGA/DSC
- Design and synthesise alternative chromic dyes
- Perform detection experiments with other controlled substances in collaboration with the Danish Technical University.

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