

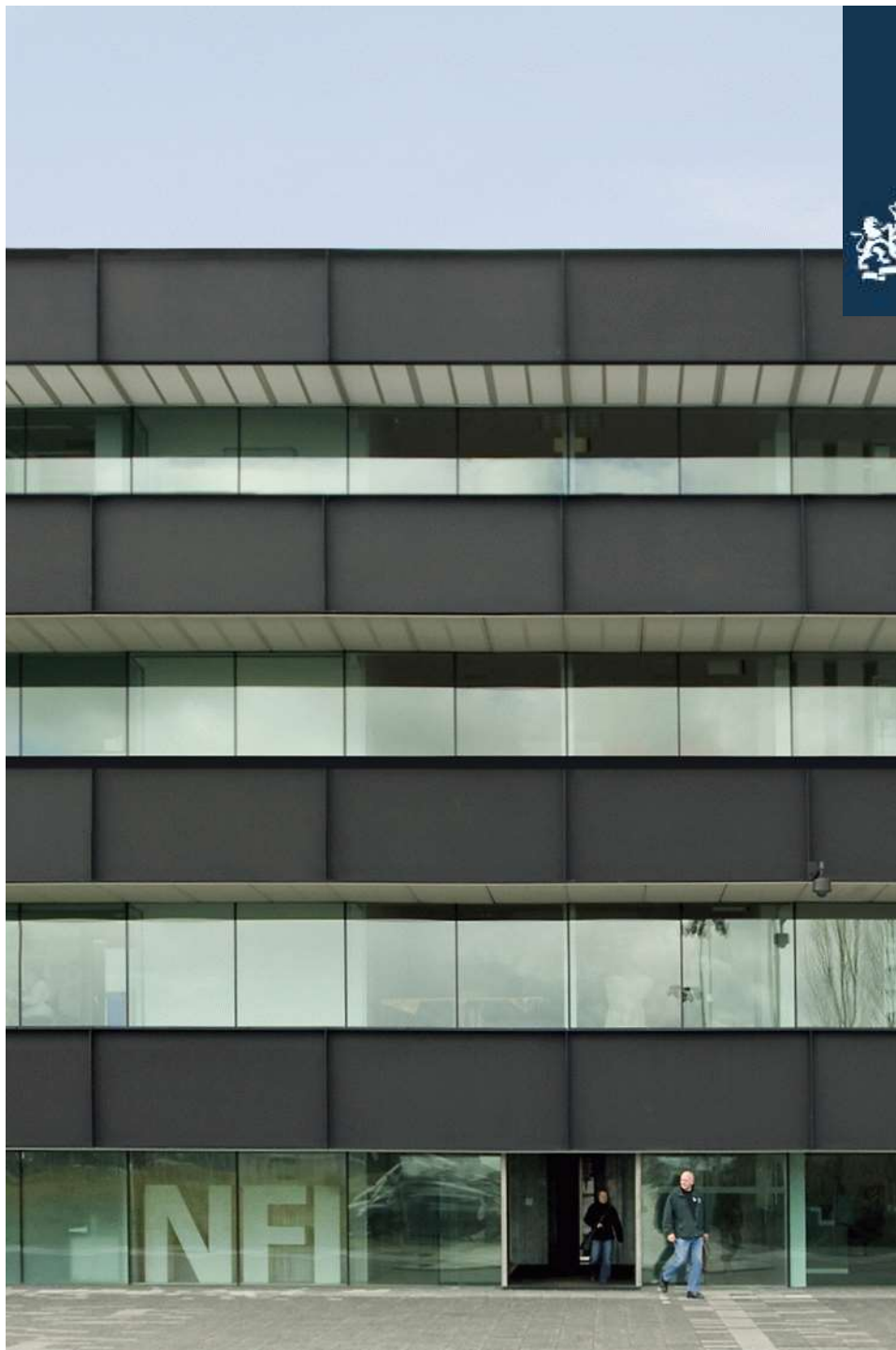


Netherlands Forensic Institute  
*Ministry of Security and Justice*

# CBRN Forensics, a challenge?

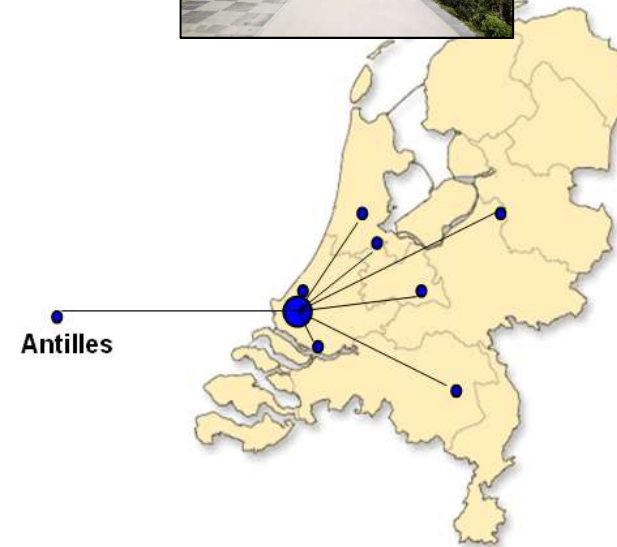
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## Locard's Exchange Principle

***Every contact leaves a trace***

Wherever he steps,  
    whatever he touches,  
        whatever he leaves,  
            even unconsciously,  
will serve as a silent witness against him.



Physical evidence cannot be wrong,  
                                it cannot perjure itself,  
                                it cannot be wholly absent.

Dr. Edmond Locard (13 December 1877 – 4 May 1966)



## What is attribution?

- In Judicial proceedings attribution is relating materials to their possible source (persons, materials, processes, locations ....)
- Attribution as a conclusion is generally done in Court by the judge and/or jury and not by technical experts.
- Technical experts deliver evidence in Court and the only conclusion they can deliver is an exclusion.
- Attribution should cover a narrative of the incident answering questions like





## The experts role in attribution?

The expert performs:

- Analysis of the materials with standardised methods typical for these materials;
- These analysis can give information of e.g. DNA profile, chemicals, precursors, artifacts in materials, ....
- The signature or profile of the unknown material (A) is tested against a known material with a possible source (B) and their composition can be compared.

For attribution purposes additional work needs to be done:

- Build a database/library of similar materials from different sources, production methods etc. to test the uniqueness of the signature or profile;
- The signature is then tested in the database on hypothesis  $A = B$  and  $A \neq B$ , both hypothesis will give an answer with a likelihood ratio which is reported.



## CBRN Forensics

- **CBRN Forensics** is a sub-discipline of forensic science that examines Chemical, Biological, Nuclear or other Radioactive materials and/or exhibits that are contaminated with CBRN material in the context of the law
- **CBRN Forensics** supports national security and criminal investigations by:
  - identifying materials out of regulatory control and confirming legitimacy of possession
  - reconstructing their process history from their origin to the point of seizure
  - connecting illicit material to individuals and events



## Additional scope CBRN forensics

Recent casework showed that the CBRN scope has to be broadened

- Autopsy of bodies contaminated with cyanide, phosphine
- Unknown white powders to be investigated (fentanyl derivatives, synthetic drugs, anabolic steroids, anthrax, ...)
- Recent cases with Ricin in Germany
- Cases that have been presented by earlier speakers at this conference

# Crime Scene



first responders

fire brigade

medical assistance

how about  
forensics?

-collaboration  
-forensic awareness

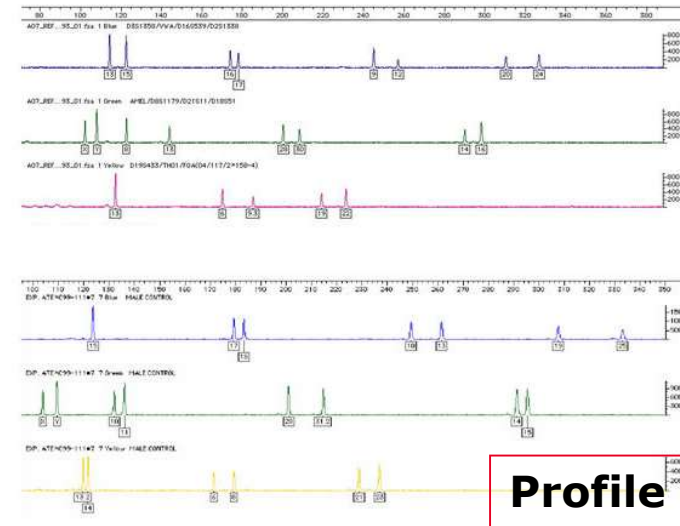
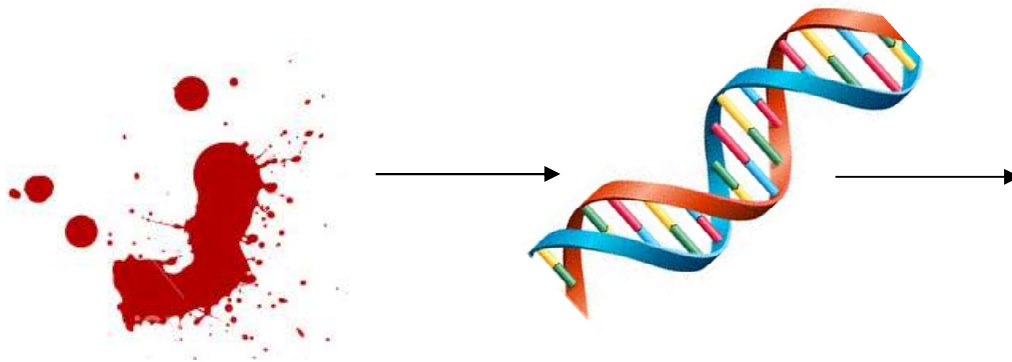




# Traditional forensics



- Decontamination of exhibits
- DNA-analysis
  - latent fingerprints
  - digital data carriers
  - toolmarks
- ...
- Disaster Victim Identification



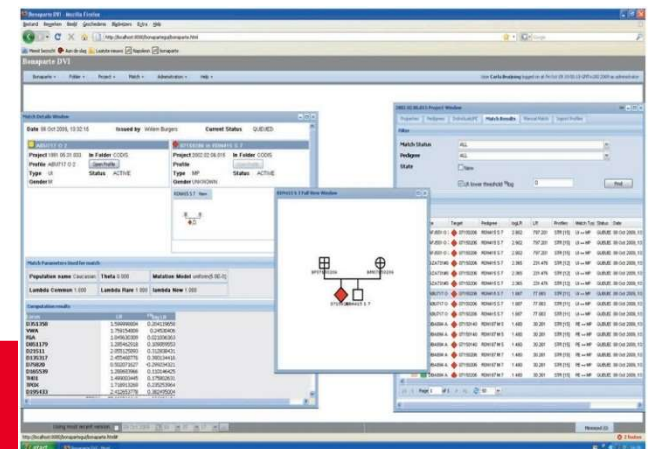
# DVI



## MH-17

Identification method for 500 victims

- DNA-analysis
- Anthropological methods.
- use of pedigrees



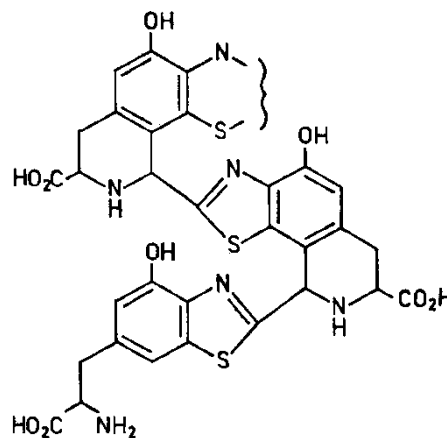


## Chemical agents

- Chemical Warfare agents
- Toxic Industrial Chemicals
- Explosives

Matrices:

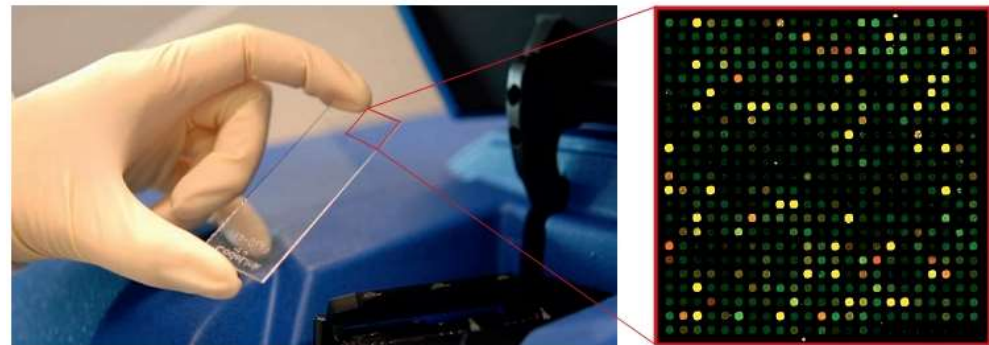
- Human tissue and blood
- Environmental samples
- chemicals





## Biological agents

- Micro array screening
- DNA sequencing
- Bio moleculen (MS)





Is the forensic investigator prepared for that?

## Yes and No

Yes, protocols and methods are available and applicable from CBRN case work and developments

No, crime scene investigators and laboratory technicians are not always aware of the presence of hazardous materials



## How to approach these “new” hazards

Within the CBRN forensics community

- Protocols
- On-site detection equipment
- Risk assessment tools
- Use of PPE
- Investigation approach
- Decontamination of materials and traces
- Sampling and packaging methods
- Analytical methods

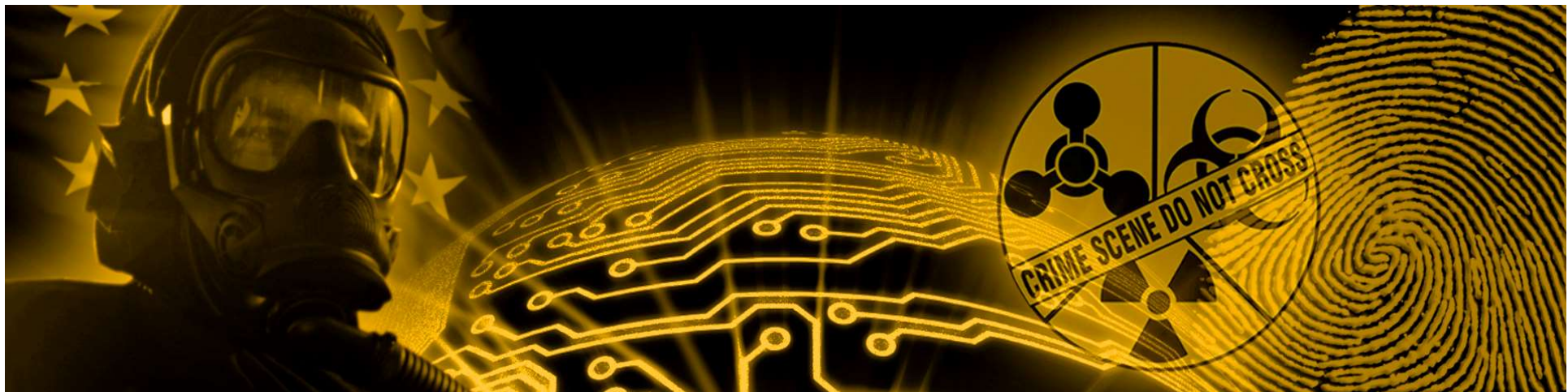


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## Which methods are already accessible

Within the EU FP7 GIFT project  
(**G**eneric **I**ntegrated **F**orensic **T**oolbox)

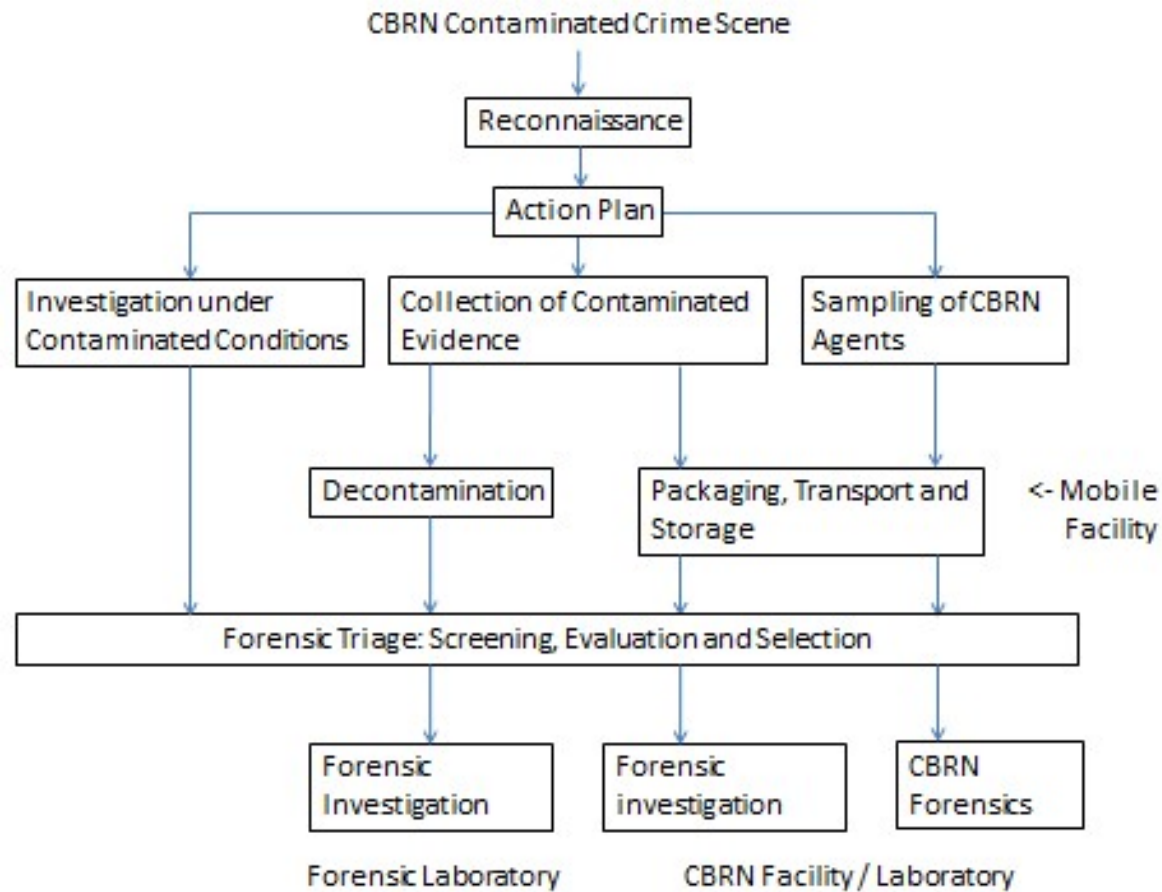
tools have been developed that can be applied by the forensic  
investigators for their work at the crime scene and the  
examination in the laboratory





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# Crime Scene Investigation (1)

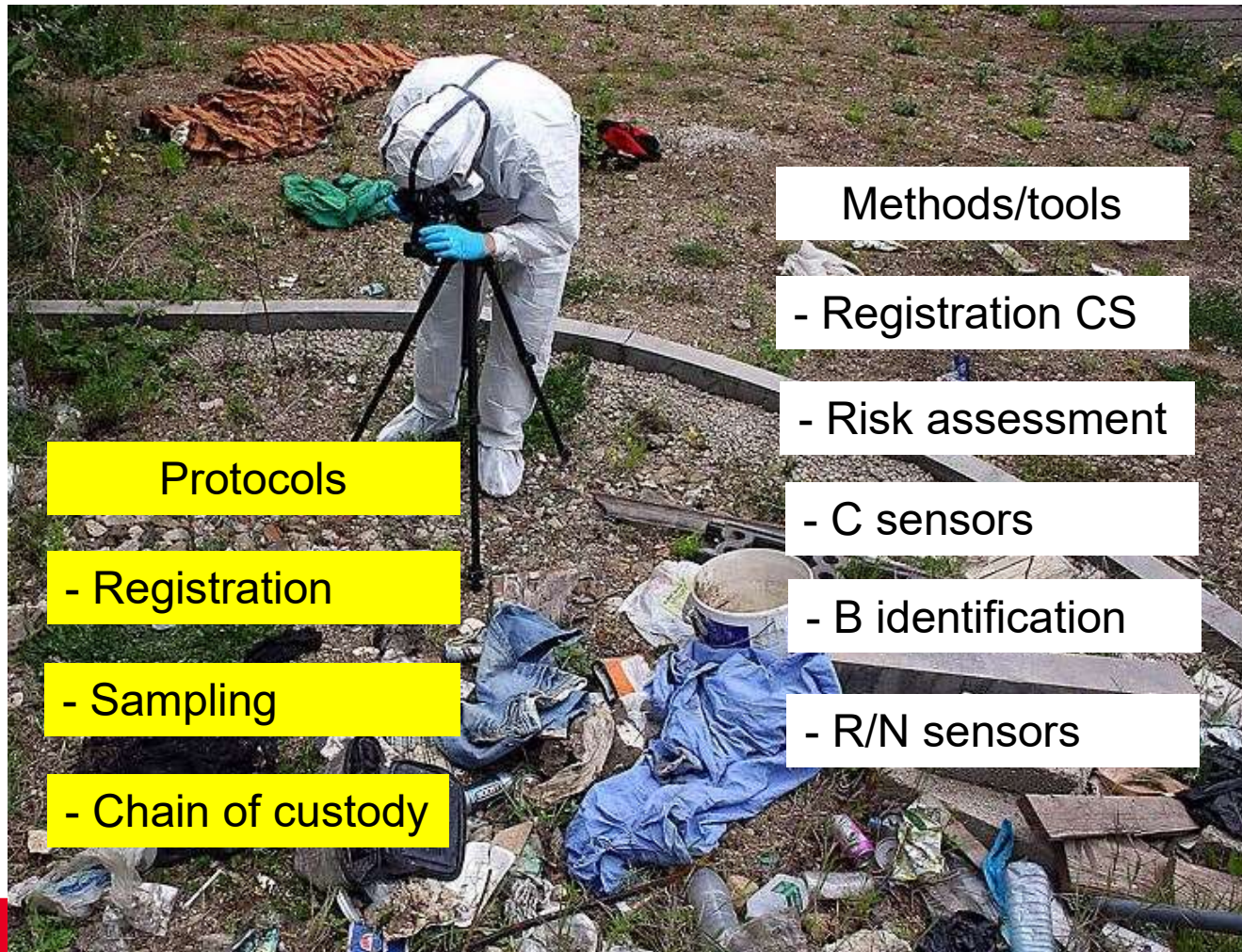






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## Crime Scene Investigation (2)



### Protocols

- Registration

- Sampling

- Chain of custody

### Methods/tools

- Registration CS

- Risk assessment

- C sensors

- B identification

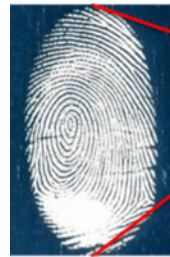
- R/N sensors

# Crime Scene Investigation



## *Visualization of fingerprints:*

Feasibility study instrument for remote detection of fingerprints and characterization of chemical composition



## *Detection of Bio agents*

- A portable bio-detection module is developed
- Identification of selected bio-agents on site
- Successfully tested in B-exercise

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# Crime Scene Investigation



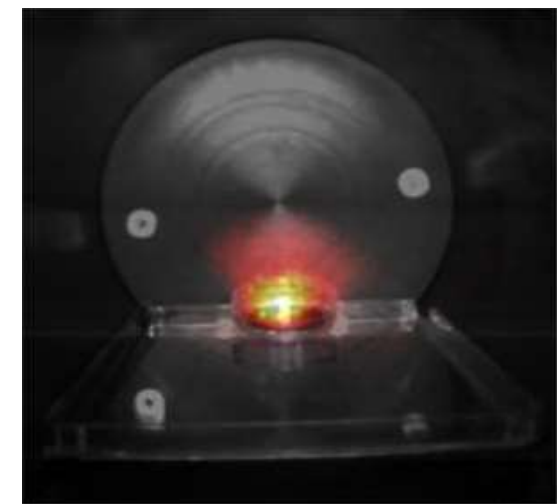
## *Determination of alpha radiation sources*

- Alpha radiation sources difficult to detect
- Interaction with nitrogen molecules in air
- Nitrogen molecules emit ultra violet light
- The detector developed detects the emitted ultra violet light



## *Identification and localisation of RN materials*

- Hand-held gamma direction finder
- Fully functional prototype is designed
- Commercial available



# Crime Scene Investigation



## *Detection of chemical agents*

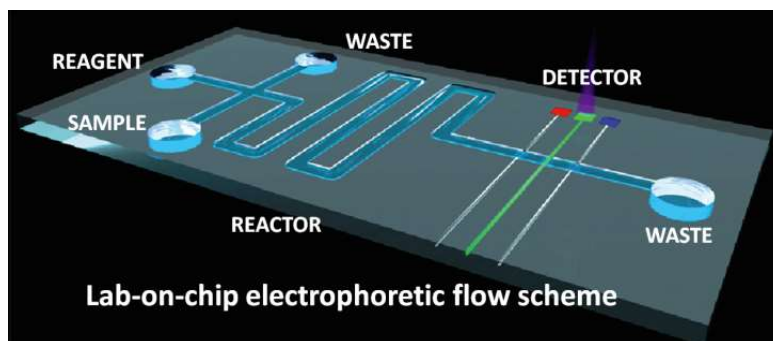
### **HRIMS**

On-site analytical methods to identify volatile organic chemical agents



### **μTAS**

To enable preliminary testing at the crime scene a lab on a chip for on-site detection of Nerve Agents is developed





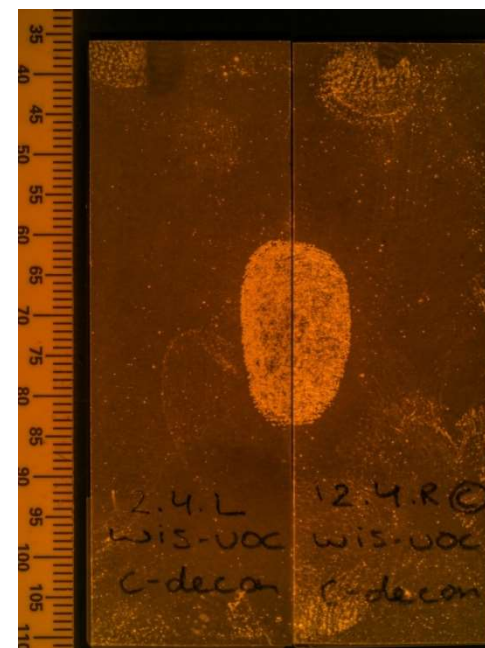
## Decontamination

### Impact on forensics

- Fingerprints,

VHP: negligible loss of ridge detail, enhancement OK,

VDC: no loss of ridge detail, enhancement OK.



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## Decontamination

### Impact on forensics

- Fingerprints,  
VHP: negligible loss of ridge detail, enhancement OK,  
VDC: no loss of ridge detail, enhancement OK.
- DNA:  
VHP: loss of DNA material, but full profiles,  
VDC: no loss of DNA material and full profiles.
- Flash Memory Systems:  
All methods: No effect of decontamination.



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## Decontamination

### Decontamination Efficiency

VHP: **residuals for C, B and RN contamination,**

GDS 2000: **residuals for C** (in concurrence with earlier work done by TNO),

DeconGel/Dekoneutral: **residuals for RN.**

VDC: **residuals for C,**

BDS 2000: **residuals for B.**



## CBRN Forensic Tools in a Laboratory Environment

### Forensic investigation of electronic devices in glove box

Interface developed for glove box

Tests with USB, SIM and mobile phones for USB 2.0, 3.1 and RJ45 interface together with NFI

Data transfer successful





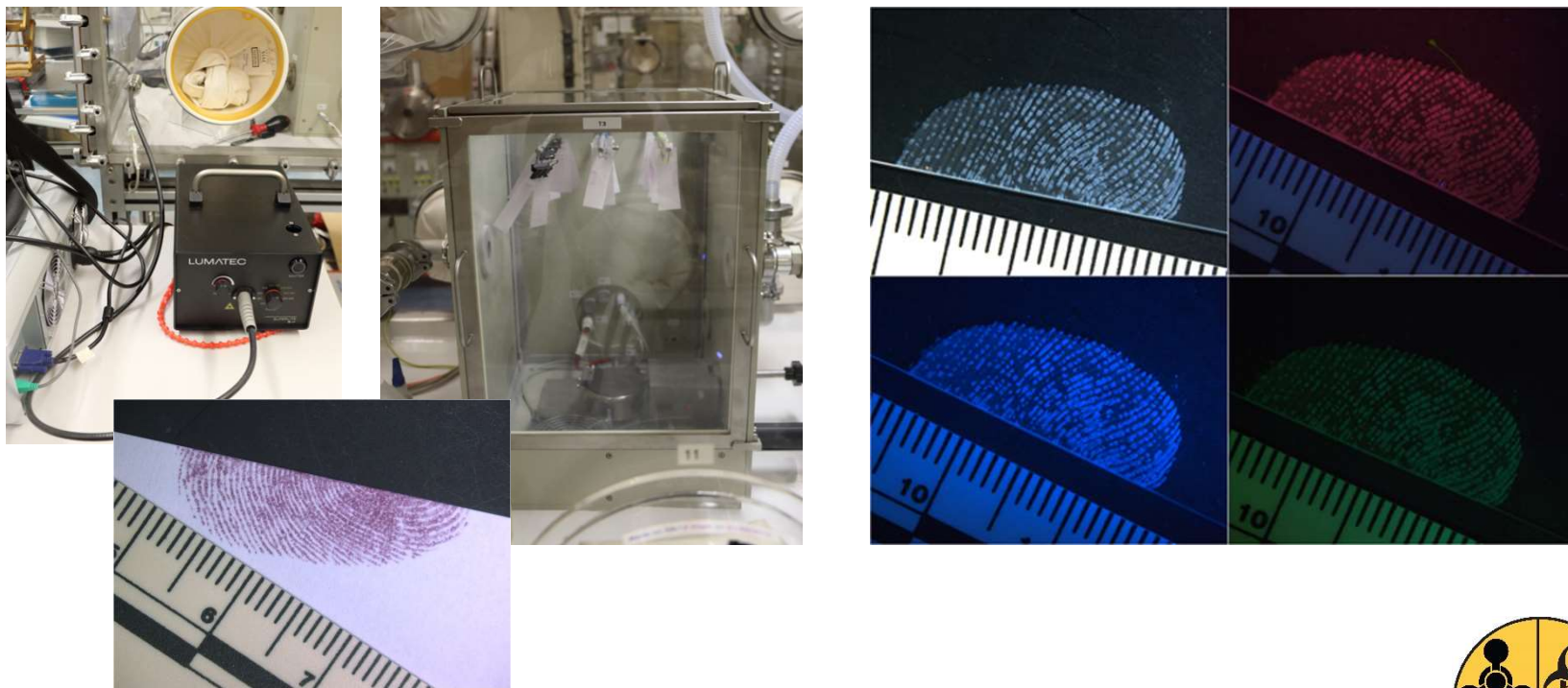


# CBRN Forensic Tools in a Laboratory Environment

## Forensic investigation of fingerprints

Interface for Lumatec Superlite S 04 developed and installed in glove box

New Ninhydrine and Lumicyano method successfully implemented

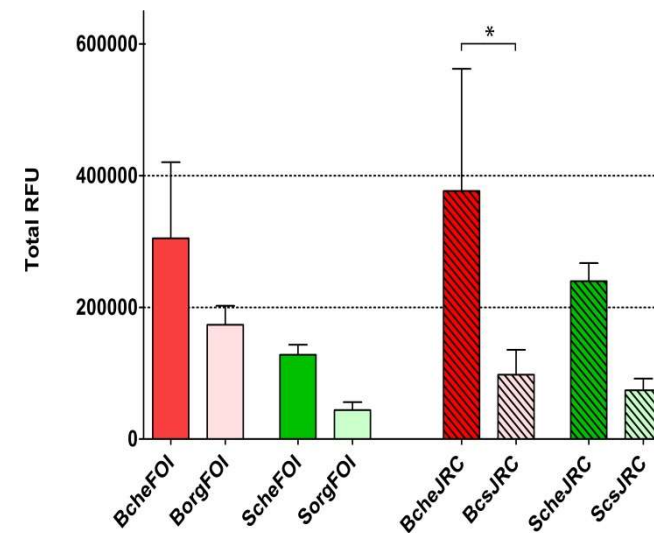
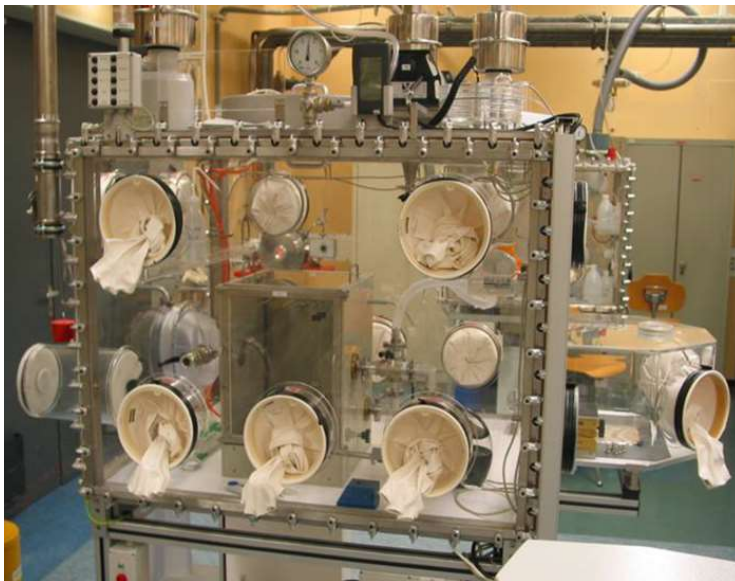


# CBRN Forensic Tools in a Laboratory Environment

## Forensic investigation of DNA

ChargeSwitch<sup>®</sup> extraction successfully implemented in glove-box

Extracted samples analysed, full profiles could be obtained



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## Chemical Threat Agents

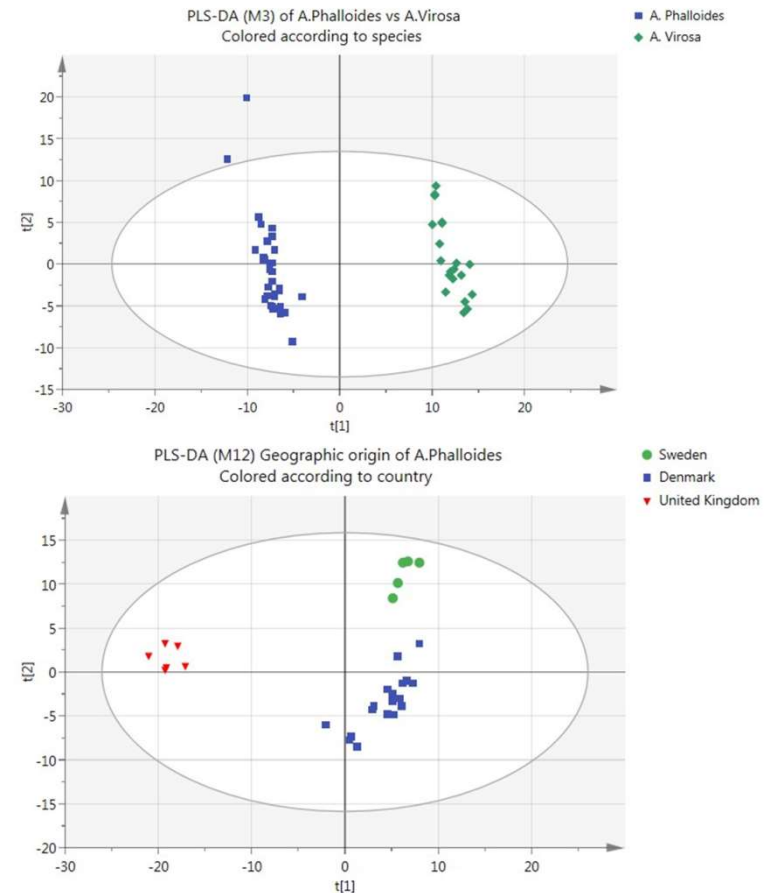
- The aim of the subtask was to develop analytical procedures that provide information about the C-agent itself and secondly to identify the “Chemical Attribution Signatures” of the agents that may provide sufficient information to relate it to any possible source, perpetrator or vendor
- Three distinct subjects were identified
  - Generic screening analysis of environmental samples
  - Generic screening analysis of biomedical samples
  - Chemical attribution signatures
- It was decided to work with 3 model compounds (phorate, acrylonitrile, fentanyl) as representatives for 3 different classes of compounds (nerve agents, toxic industrial chemicals, opiates)
- Our approach is unique, because we aim at *harmonization* of the various analytical approaches for the 3 subjects as much as possible



# Toxins

## Results

- A high resolution LC-MS screening method has been developed for screening of model toxins, spiked to different sample matrices.
- Attribution profiling of toxin samples with genetic and chemical analytical tools
  - Toxic *Amanita* mushroom species used as model
  - Species specific toxin profiles
  - Geopositioning of source organisms.

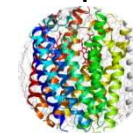




## DNA preparation – in Bio agents

### Protocol to obtain a non-infectious DNA-extract

- *Lactobacillus casei* (non-pathogenic bacteria)
- Protocol to obtain a non-infectious DNA extract starting with :
  1. DNA-extraction (hand held bead beater) followed by
  2. Centrifugal filtration
  3. Additionally the use of HDP as a biological disinfectant was proposed. The tested HDP showed bactericidal activity and PCR amplifiable DNA was obtained after a DNA purification step.
- Methods 1 and 2 were efficient in killing or removal of *L. casei* cells in solutions up to  $10^8$  CFU ml<sup>-1</sup> and yielded PCR amplifiable DNA.

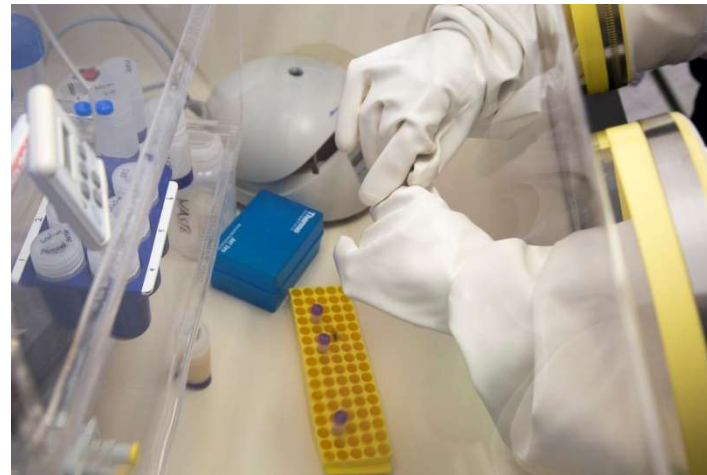


GENERIC  
INTEGRATED  
FORENSIC  
TOOLBOX

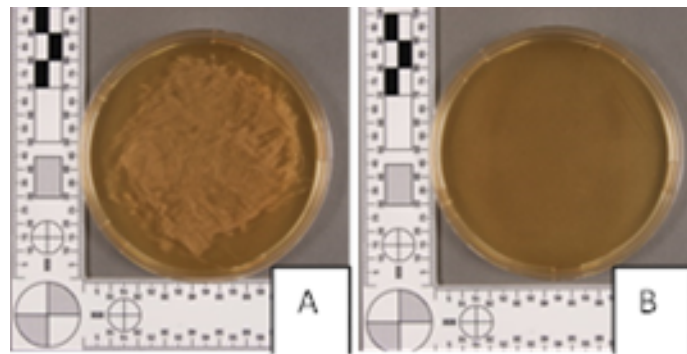
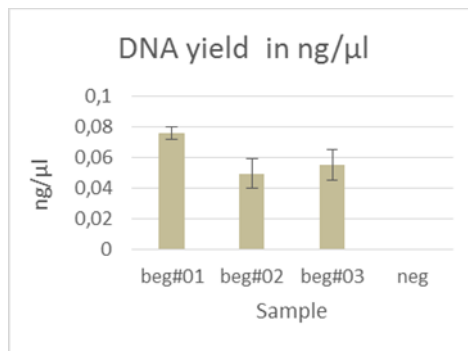


# DNA preparation – in Bio agents

Proof of principle in during B-exercise in the Netherlands



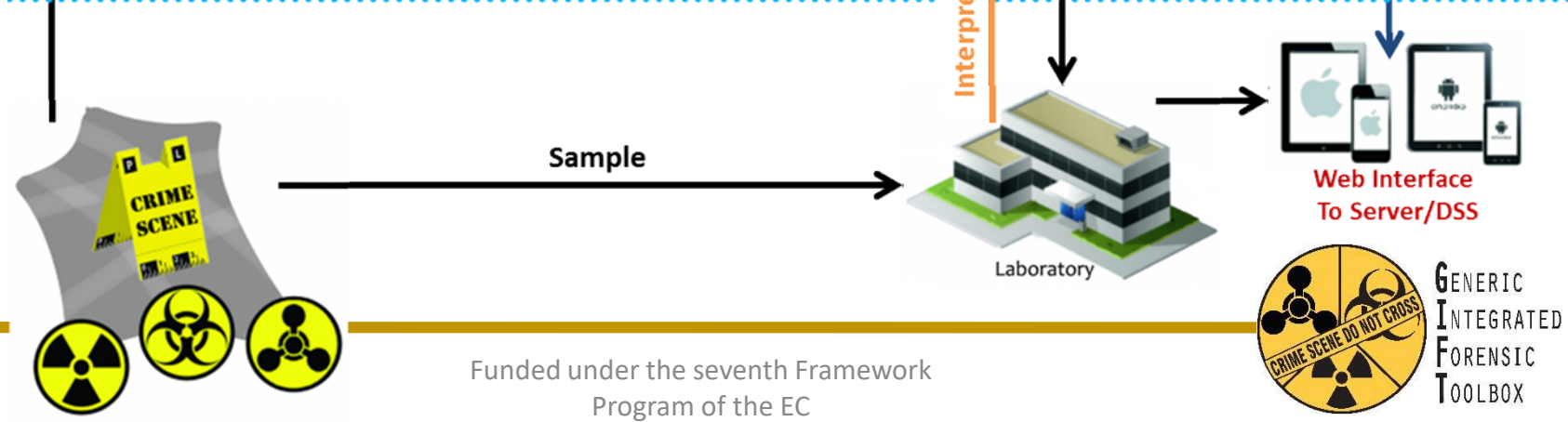
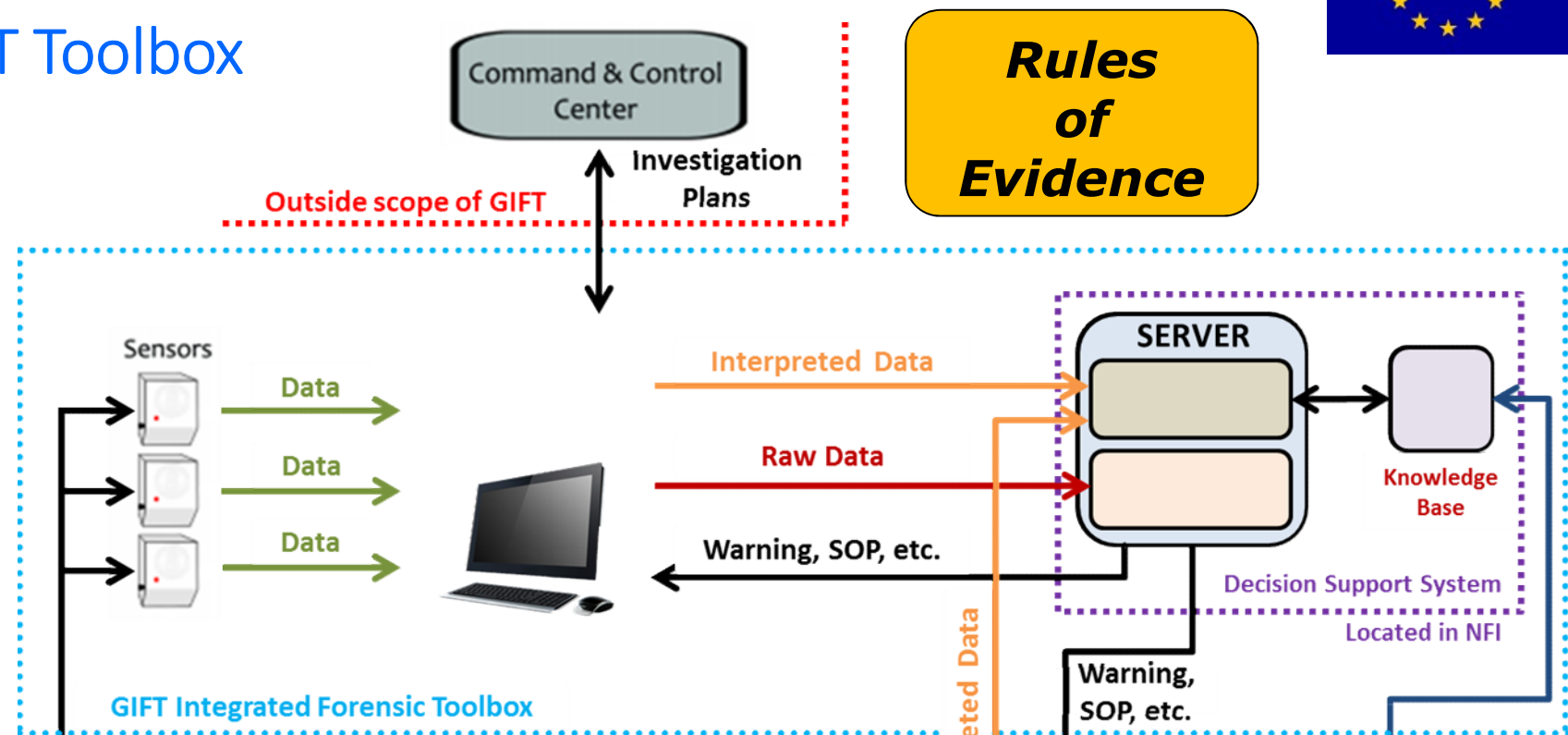
Amplifiable non-infectious DNA was obtained, the protocol works



A: Control, 50 μl Yakult  
B: obtained DNA -extract(s)



# GIFT Toolbox



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## Education and Training

Developing protocols, detection devices and laboratory methods is one,

Implementing is second and of utmost importance.

Education and training of staff with a “fit for purpose” curriculum is important

Within the GIFT project a method is developed how to determine the target groups for training and their training needs





## Conclusion and challenge

Protocols, detection devices, sampling methods and laboratories methods are available and applicable

but

**Education and training is of paramount importance**

when dealing with CBRN Forensics



## Questions?





## *Sharing Knowledge*

for information see  
[www.forensicinstitute.nl](http://www.forensicinstitute.nl)  
or contact  
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