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Network of Testing Facilities for CBRNE detection equipment

State of the art and specifics of instrument testing **Chemical Threats**

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State of the art in C-detection testing

René Olivier, TNO

- **Technologies in C-detectors**
- **Agents used for testing**
- **Conditions of testing**
- **Reference equipment**
- **Standards and protocols**

Technologies in C-detectors

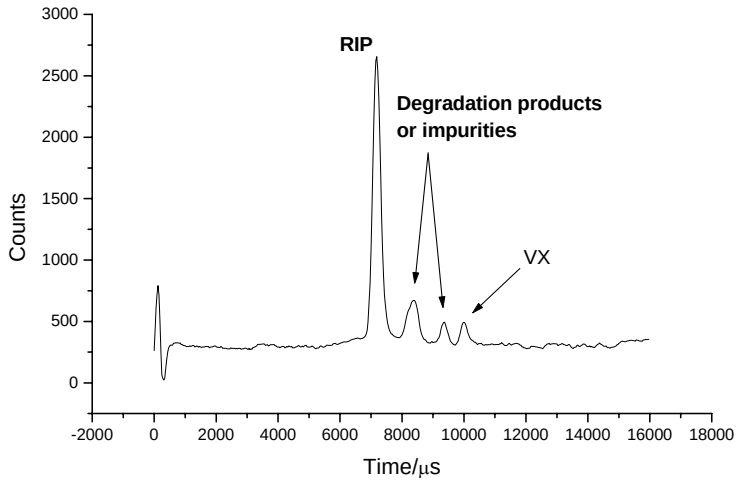
- Technology may differ based on operational use of C-detection, e.g.
  - Warning
  - Confirmation
  - Identification
  - Monitoring
  - Survey
  - Point detection / Stand off detection

Technologies in C-detectors

- Several technologies are in use, examples:
  - Ion mobility spectrometry (IMS, FAIMS, DIMS)
  - Colorimetric technology (colorimetric tubes, tapes)
  - Micro sensors (SAW, BAW, MEMS)
  - Electrochemical (EC) technology
  - Gas chromatography-Mass Spectrometry (GC-MS)
  - LIDAR stand off detection
- Consequences for test setup and protocols

Agents used for testing

- Preferably live agents (classical chemical warfare agents)
  - Requires special facilities, safety measures, OPCW designation
- Purity of agents
  - Sensitivity of detectors towards impurities
  - False alarm rate
- Interfering compounds
  - False alarm rate, false positives or false negatives
  - Vehicle exhaust, perfumes, smokes, plant aromas



Conditions of testing

- Concentration of test agents (Extremely low, ppb and sub-ppb)
- Reproducibility & Accuracy
- Humidity of air and agent gas flow (0 – 95% RH)
- Temperature (- 25º – 50º C)
- Purity of the laboratory air used for testing

Conditions of testing

- Example of a vapour generation system

Reference equipment

- Verification of agent concentration and purity
- Verification of reference equipment
- Types of reference equipment used (e.g. GC-MS)

Standards and protocols

- NATO requirements (classified information!)
- Military protocols and in house developed protocols are used for testing
- No civilian standards exist

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State of the art and specifics of instrument testing **Biological Threats (B)**

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Resources for B-test & evaluation

- Facilities
  - Aerosol chamber
  - Wind tunnel/duct
  - Field Trial Area
  - Semi-closed chamber
- Reference instruments
  - Air-to-agar slit sampler
  - Particle counter/sizer
  - Anderson impactor
  - Met stations (field trial)
- Aerosol generation
  - From slurry
  - From powder
- Simili agents
  - Bacteria spores
  - Bacteria cells
  - Virus
  - Protein

Air-to-Agar Slit Samplers

- Calibrated and controlled flow rate
- Controlled incubation (colonies of right size)
- Colony counting
  - Good resolution (pixels/concentration/rev rate)
  - Good contrast in the image

Aerosol generation

- Generate aerosol from wet and dry material
- Control aerosol concentration
- Control aerosol size distribution
- Control viability

Example: Determination of LOD

- Considerations prior to experiments
  - Select relevant test substance (detector/requirements/rules and regulations)
  - Select aerosol concentration/size range (reference system/detector/requirements)
  - Select suitable test facility (rules and regulations/cost/requirements/detector)
  - Etc.

Fig. 1: Plot of signal from a tested instrument and reference system *versus* time.

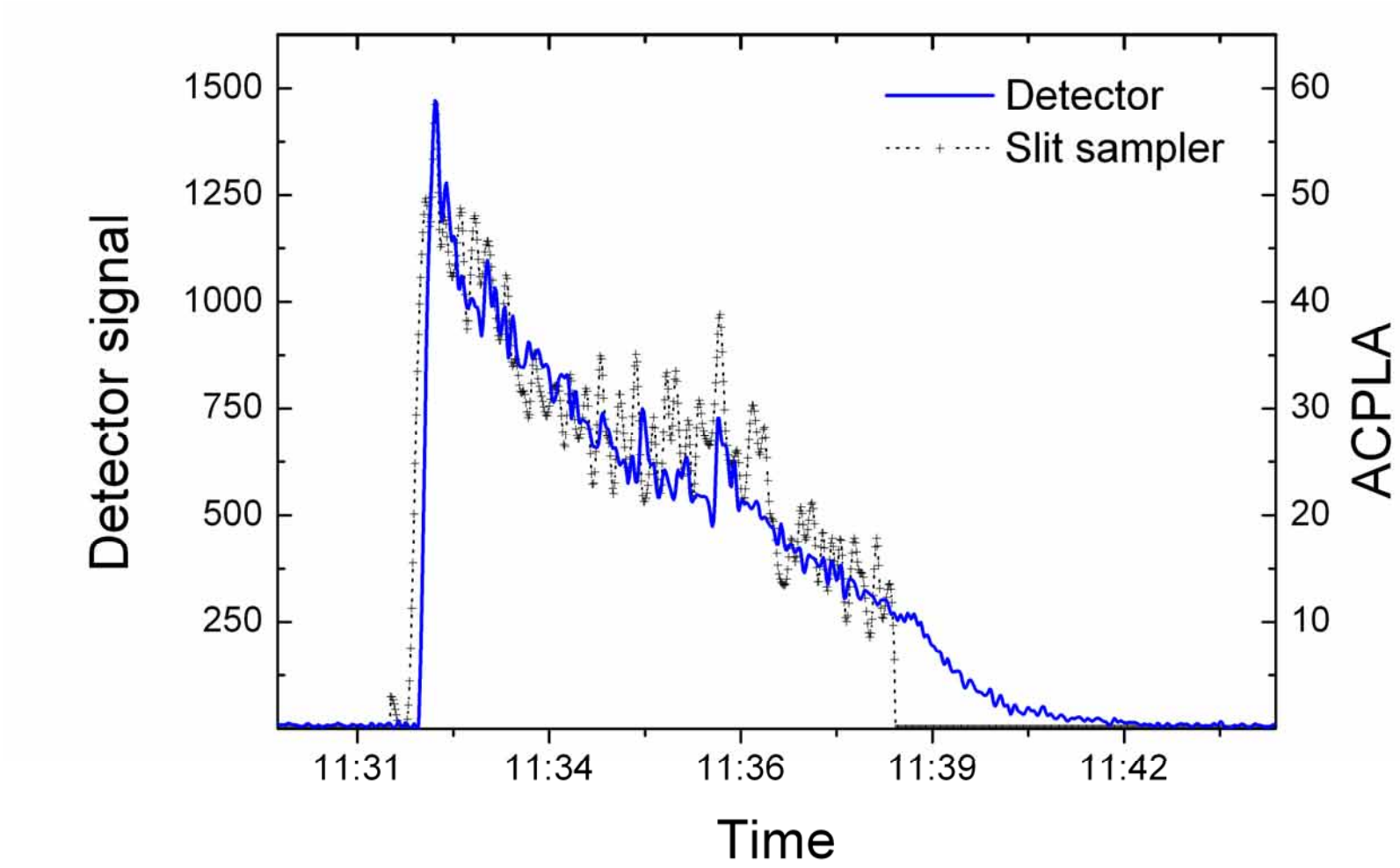
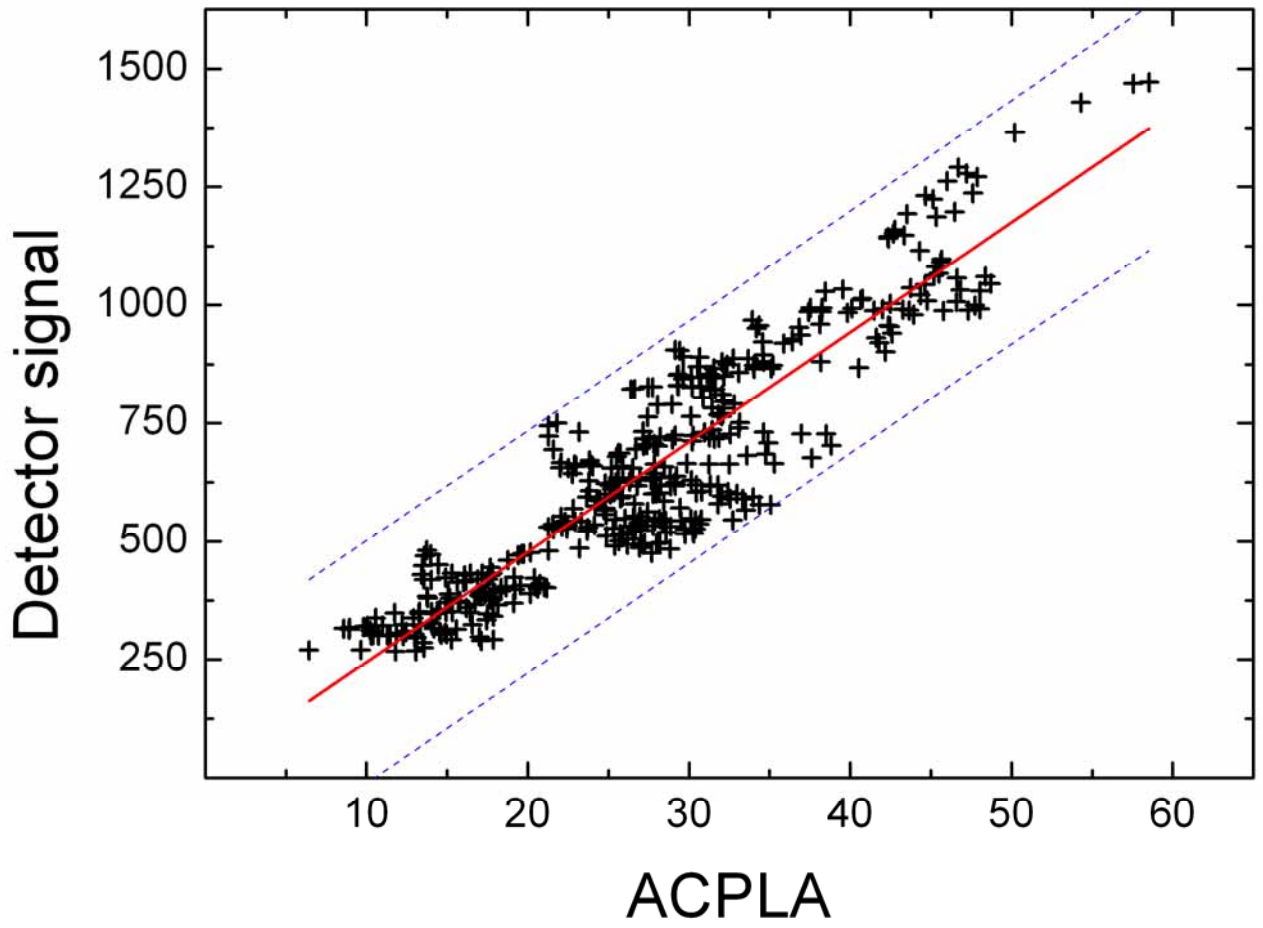


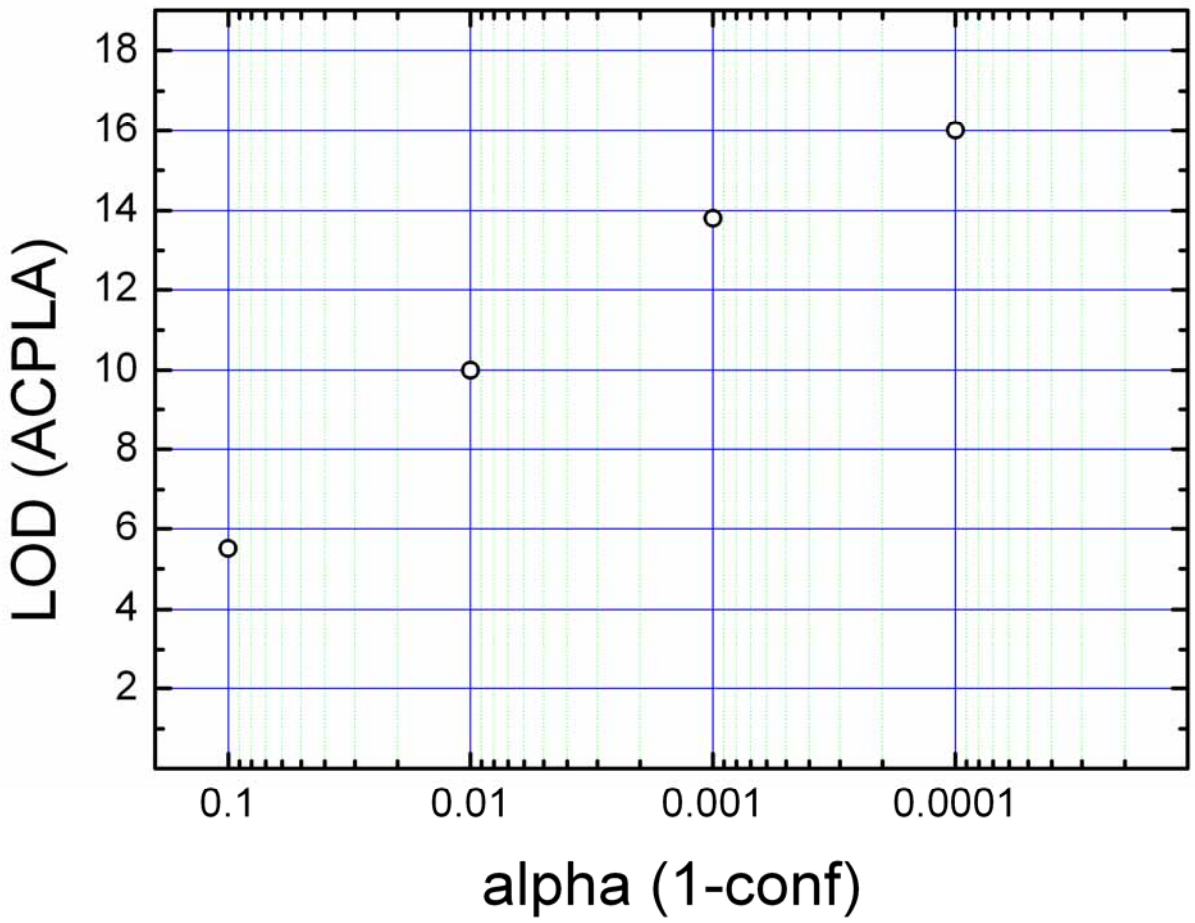
Fig. 2: Signal *versus* ACPLA.

The LOD was 10 ACPLA, calculated at a prediction limit of 99% (Lee and McAllister 1996; Mocak et al. 1997) .



Lee, K. and McAllister, P. *DRUG DEVELOPMENT AND INDUSTRIAL PHARMACY* **22** (1996) 891-908.
Mocak, J., Bond, A., Mitchell, S. and Scollary, G. *PURE AND APPLIED CHEMISTRY* **69** (1997) 297-328.

Fig. 3. Plot of the limit of detection at different confidence limits.



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State of the art and specifics of instrument testing **Radiation & Nuclear Threats (RN)**

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Content

- **Available Detection Technologies**
- **Instrument Testing Today**
- **Test Protocols & Standards**
- **Testing Problems & Challenges**

Available Detection Technologies

- **type of radiation**
  - **alpha** (short range – only internal exposition)
  - **beta** (medium range – external & internal exposition)
  - **gamma** (penetrating – external exposition)
  - **neutron** (indicative for nuclear material)

- **type of detector**
  - **gas counter** (cheap, ruggedized)
  - **scintillation** (good value for money ➔ most popular)
  - **semiconductor** (expansive, very sensitive, delicate to handle)

Identification ➔ Thread Analysis

- **radionuclide**
  - **type of radiation** (alpha, beta, gamma, neutron)
  - **half life** (hours - millions of years)
- **source type**
  - **sealed ➔** external exposition
  - **open ➔** incorporation, contamination
- **physical & chemical form**
  - **solid / powder / aerosol**
  - **soluble (in water)**
  - **bioavailability**

Instrument Testing – Past, Today, Future

- **first tests** started in Europe
  (ITRAP campaign - 10 year ago)
- **now most testing in US,** Europe starts to catch up
  (based rather on test protocols than on standards)
- **standards** and **test procedures** available
- should become **mandatory ?**

Standards and Test Procedures
– **nuclear security** (excl. radiation protection)

- **IAEA**
  - **Nuclear Security Series 1:**
    "Technical and functional specification for border monitoring equipment", 1st revision
- **ANSI**
  - **N42.xx:** 10 available, 6 under preparation
- **IEC**
  - **SC45B/WG15:** 3 available, 4 under preparation
- **CENELEC**
  - currently no European standards available
  - adoption of IEC **in progress**

Testing Problems & Challenges

- **Radiation- & physical protection**
  - **expansive facilities** (set up & licenses)
  - **monitoring of staff** (radiation exposed personal)
  - **sources** (short half life, special nuclear material)
- **Simulation of operational conditions**
  - **static & dynamic testing** (safety & reproducibility)
  - **temperature** (range, different rate of change)
  - **human factor** (handling, usability,)