

# **Lab-on-a-chip- based instrumentation for rapid detection of biological weapons: from pure science to level 8 of technology readiness**

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A concept of transportable container-type laboratory for fast detection and recognition of several bacterial and viral pathogens has been a matter of discussion between officials of European Defense Agency and NATO for several years. The decision to build such mobile system for Polish Army was overtaken in 2010. The base concept is to transport fully-equipped laboratory, placed inside 52" standard container near red-zone, collect polluted sample by ground or air UAVs, and to proceed a completed genetic analyzing of samples in less than 30 minutes. Limited available capacity of the container and critical collect-to-analyze time interval turned us toward lab-on-chip solutions.

Three portable, instruments have been designed, manufactured and tested. The first one is micro-robot for extraction and purifying of DNA samples delivered by UAVs. The second instrument is 9-hole lab-on-a-chip for PCR DNA real time analyzer, Finally, the third device is lab-chip gel capillary electrophoresis DNA analyzer. All of them are placed inside NATO-norms compatible transport cases. The instruments (circa 20 kg each) are dust, water, shock proof and can be transported by any kind of media, including military air transport.

Instruments are operated automatically, steered and controlled by proper software. Results of analysis are given in numerical or graphical forms, can be stored or send by electronic way. PCR and electrophoretic lab-chips used in the instruments are made of glass. Laser-induced fixed-wavelength fluorometric detection of signals is applied.

PCR-DNA real time analyzer detects up to 52 types of pathogens, including Anthrax, Plague, Tularemia, Brucellosis, Glanders, Melioidosis, Q-fever, Cholera, E. Coli, Smallpox, CCHF, Hantaviruses, Ricin and Influenza. Sensitivity of detection (3.6÷36 copies of RNA virus copies and 1÷10 pg/□l of bacteria DNA) meets AEP-10 STANAG 4359 norms. Lab-chip gel-electrophoresis analyzer sensitivity allows to recognize kinds of pathogens, including pathogenic and non-pathogenic bird-flu viruses (for the first time ever, Fig 1 d). Instruments have been tested according to level 8 conditions, they meet class 3 biological threats expectations. Their parameters are at least comparable to NATO standards.

We believe, that the success of development road-map of micro engineered lab-chip based microfluidic instruments for military application clearly shows future of civilian oriented applications as well.