German Aerospace Center

# How DLR laser systems will detect hazardous substances to protect the population

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Emergency response mission after a gas attack (mock exercise situation).

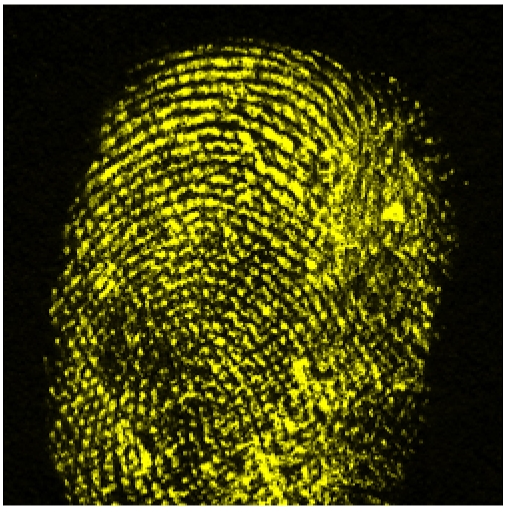
Image: picture-alliance/dpa

Whether deliberate or unintentional, any release of hazardous chemical, biological, radioactive, nuclear, or explosive substances (CBRNE) may have devastating consequences. The DLR Institute of Technical Physics is developing innovative methods for tracking down and identifying such substances in time. Called standoff detection, these laser-based systems are designed to mitigate threats to the population in cases of crisis.

As part of its security research programme, DLR is developing innovative methods to detect hazardous substances. The concrete objective is to obtain a compact and mobile detection system that can be easily deployed and effectively used in a crisis. Such a system will obviously be based on the latest laser technology.

At the Institute of Technical Physics in Stuttgart, DLR scientists are working on laser-based standoff detection. Its crucial advantage is that it permits examining dubious substances from a relatively great distance. By contrast, most of the detection methods available today will work only in direct contact with a hazardous substance or within a radius of a few metres around the danger point. In either case, it is difficult to assess a situation early, and it involves a certain danger to the people entrusted with the investigation. An ideal detection method, therefore, should work at greater distances and be capable of analysing potential hazardous-substance categories quickly and discreetly.

**Researchers are confronted by great challenges**



Explosives leave traces on surfaces, for instance in the form of fingerprints.

Image: DLR.

The sheer variety of hazardous substances presents a great challenge to any detection system. Additional difficulties are raised by the wide range of dispersal, contamination, and incubation pathways. Chemical substances, such as the nerve poison Sarin, are normally dispersed through the air in gaseous form. Bacteria and viruses may adhere to objects or spread as aerosols into the air where they can survive for several days and even weeks. Explosives, on the other hand, leave traces in the form of fingerprints on surfaces, or as particles adhering to textiles.

Laser-based standoff detection is able to meet all these challenges. It takes advantage of various mechanisms of interaction between light and matter: laser light is partly scattered, absorbed, and re-emitted by the object under scrutiny. The reflected light will then be examined for intensity, polarisation, and spectral distribution. The results reveal not only the properties of a substance but also, and unambiguously, its identity. In this way, a large number of hazardous substances can be detected - in different forms, discreetly and quickly, even from kilometres away.

**Suitability for use in public places in a crisis**

But not every laser may be used to detect hazardous substances: depending on the substance category involved, they need to comply with specific requirements in terms of wavelength, energy, and pulse duration. Further restrictions apply because these systems will be used in places accessible to the general public, indoors and outdoors. Therefore, the wavelength of the laser must be confined to a range where human eyesight is not threatened, i.e. below 400 nanometres in the ultraviolet (UV) and above 1,400 nanometres in the infrared (IR). In the open air, interference can also come from weather conditions, dust, changes in the radiation background, or traces of matter resembling hazardous substances, additional factors which the DLR researchers need to take into account.

Under the open sky: experiment with a laser-based standoff detection system at DLR's open-air laser test range in Lampoldshausen

Image: DLR.

Suitable laser sources whose frequency is to a great extent tunable are being developed at the DLR Institute of Technical Physics in Stuttgart. Once they have been installed in standoff systems, they will be conveyed for testing to the DLR open-air laser test range in Lampoldshausen where they will be examined under realistic conditions, evaluated, and finally optimised. One thing is certain: future laser-based standoff detection methods will be able not only to distinguish between different hazardous substances, they will also be weather-independent and not dangerous to human eyes so that they can be deployed anywhere and at any time. After all, there are human lives at stake.

Scientists from one of DLR's main research areas, aeronautics, is involved in this project, which at the same time forms part of DLR´s security research, a cross departmental programme under which defence- and security-related research and development activities are being planned and controlled.

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