



Federal Ministry  
of Education  
and Research

# Research for Civil Security

Detection of Hazardous Substances



**HIGH-TECH STRATEGY**

**Igniting ideas!**

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Federal Ministry  
of Education  
and Research

# Research for Civil Security

**Detection of Hazardous Substances**

## Forewords

The success of our export-oriented industry would not be feasible without the free movement of information, persons and goods. Secure energy and transport networks, Internet and telecommunications, food and healthcare provision are vital nerves of our highly networked society. However, Germany's high population density and sophisticated technological infrastructure mean that it is facing increasing new threats. The security risks have changed. Despite robust technologies, our supply networks are vulnerable to even just small disruptions: Global mobility allows danger to spread more easily and makes it more difficult to combat. Natural disasters and technological accidents, but also terrorism, crime and sabotage can cause serious damage in a closer knit world.

The Federal Ministry of Education and Research (BMBF) will be investing approximately € 123 million in security research in the period up to 2010 under its Research Programme for Civil Security, which is part of the High-Tech Strategy for Germany. The aim is to develop innovations which will provide more security without at the same time encroaching on Germany's culture of freedom. It is the task of stakeholders in the research projects to take up the best ideas from science and research and integrate them in innovative security solutions. It is decisive to involve the entire innovation chain from research to industry and end users in public authorities and private industry.

Innovation in this context does not only mean new technological processes, but also includes innovative organizational concepts and strategies. Interdisciplinary projects involving the humanities and the social sciences, the transfer of knowledge to the public, accompanying research on critical issues and transparency are important preconditions for the success of security research.



The individual projects in the programme will be presented within the framework of a new series of publications. This first brochure provides an overview of research into the detection of chemical, biological, radiological, nuclear and explosive hazardous substances. The research results contained therein form the basis for improving security standards in our country for the benefit of our people.

A handwritten signature in blue ink that reads "Annette Schavan". The signature is written in a cursive, flowing style.

**Dr. Annette Schavan, MP**  
**Federal Minister of Education and Research**

Chemical, biological, radiological, nuclear and explosive substances have an extremely high risk potential, as has been shown in particular by the numerous explosives attacks worldwide. Therefore, security research programmes throughout the world are focussing on the detection of hazardous substances from explosives to nuclear material. Given this wide range of hazards, different technologies must be developed and optimized for use in early warning systems or emergency locations.

Especially in the sphere of chemical, biological and explosive material, of which even minute quantities can be extremely hazardous, we are frequently confronted with hitherto unknown types of substances which may entail risks that are difficult to assess. Research activities are therefore urgently needed. On the one hand, this means that tried and tested detection technologies must be adapted for broader application through the use of new sensors. On the other hand, new potential hazards require new, innovative solutions such as terahertz technology. The manifold applications of this technology, e. g. for the detection of liquid explosives, must be examined more closely.

Central fields for research are sampling and the immediate on-the-spot analysis of the biological and chemical hazards as these activities still take much time and effort. The development of multi-sensor, mobile detection systems that can be automated is therefore a major, overarching goal. Such systems can be designed for various applications ranging from airport security to safe goods transport to the protection of public events. The Scientific Programme Board particularly appreciates that, while aiming for optimum technological solutions, the research projects presented here are also placing major emphasis on societal issues.



The broad range of ideas and innovations for increasing security which are presented here also illustrate how the necessary development of new detection systems can be inspired by the needs of end users while at the same time aiming to open up new markets. Against the background of the European Security Research Programme, further efforts must be made to enhance research and technology development in Germany and to strengthen Germany's position in the area of civil security research.

A handwritten signature in blue ink that reads "K. Thoma". The signature is written in a cursive, slightly slanted style.

**Prof. Dr. Klaus Thoma**  
**Fraunhofer-Gesellschaft / Head of Ernst-Mach-**  
**Institut, Chairman of the Scientific Programme**  
**Board Security Research**



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# Innovations for civil security: The detection of hazardous substances

Substances like explosives, toxins or pathogens may be extremely hazardous, even in small amounts. Their release and dissemination can become a serious threat for any civil society. This includes major accidents in chemical companies and the resulting release of toxic chemicals as well as the danger posed by terrorist attacks. Quick and precise detection of the released hazardous substances using appropriate techniques and processes allows rescue operations to be started immediately on the spot and can save human lives in a crisis.

Hazardous substances with great damage potential for people and the environment include chemical and biological, radiological and nuclear as well as explosive substances. Particularly the three categories of chemical, biological and explosive substances involve a high security risk as they can in many cases be produced easily. Hazardous chemical substances in this context are chemical toxins or agents that can be used in chemical warfare. Hazardous biological substances are agents such as viruses, fungi or microorganisms which can be noxious for humans, plants or animals. The hazards posed by explosives result both from the dissemination of conventional explosives and from the increasing availability of non-conventional or liquid explosives.

## Relevance of the research topic

Modern chemical and biological analysis already allows the reliable identification of many substances. However, further research is needed as today's global communication enables people to find ample information on the Internet on how to produce explosives with simple means. Smuggled into airports or railway stations or into means of transport, they can have devastating consequences as was shown by the terrorist attacks in recent years. Beside wilful acts, accidents can also pose a serious risk which should not be underrated. The global networking of transport routes and still increasing international travel moreover facilitate the abuse of hazardous substances and explosives and the spreading of pathogens across national or even continental borders.

The truth is: Quicker detection of hazardous substances – for example at airports, in drinking

water or in foodstuffs – means better protection of people against such threats. While the detection of hazardous substances is supported by the methods currently available, these methods are often time-consuming and expensive and in most cases not suited for mobile use on the spot. For this reason, the German Federal Ministry of Education and Research (BMBF) is providing €34 million in funding for the development of new and innovative detection systems and technologies, which are necessary for enhancing civil security. This brochure on “Research for Civil Security – Detection of Hazardous Substances” for the first time presents all 19 projects supported under this priority, as well as the players involved.

## Detection of hazardous substances under the Research Programme for Civil Security

The projects on the detection of hazardous substances are being funded under the Research Programme for Civil Security, which was adopted by the Federal Government on 24 January 2007 as part of the High-Tech Strategy for Germany. The Security Research Programme focuses on the improvement of protection for people. The aim is to counter societal threats posed by terrorism, organized crime, natural disasters and major technical accidents. A characteristic feature of the programme is the application-related work in the projects involving the entire innovation chain from research to industry and up to the end users. Research on the detection of hazardous substances includes not only government authorities and organizations but also airport operating companies, fire brigades, the Federal Agency for Technical Relief and municipal water works.

But security cannot be achieved by the development and use of technologies alone. Acceptance of these technologies by emergency staff is crucial in the development, testing and use of new systems and methods for the detection of hazardous substances. The collaborative projects therefore address numerous social science issues. In particular, they deal with the implementation and acceptance of new detection technologies. Research activities include the consideration of requirements with regard to emergency staff training and the

preparation of decision-making aids for authorities and rescue staff. Further priorities of the projects are risk assessment with regard to pathogens that may be used in agroterrorism, as well as biological and chemical hazardous substances and the spreading of animal diseases and related scenarios.



The described threats are not a national but a global problem and must therefore be considered in an international context. For example, the detection of hazardous substances and objects in air traffic requires increasingly close cooperation between all member states of the European Union as well as with non-EU countries. The European Security Research Programme therefore also includes the funding priority for the detection of hazardous substances and biological agents. Furthermore, the involvement of foreign partners in international research alliances is to ensure that the needs of global markets are taken into account in the development of security solutions.

In addition to using international research know-how, efforts are focused on global markets. Support for innovations in the detection of hazardous substances provides German companies with an opportunity to improve their competitiveness and participate in an expanding market. It is estimated that the German market for civil security technologies alone currently accounts for more than € 10 billion. The US market for detectors that screen people for all relevant hazardous substances is expected to account for roughly US\$10 billion by 2010.

## Major research topics related to the detection of hazardous substances and objects

Clear objectives have been set for the future detection of hazardous substances: Detection is to become quicker, more reliable and increasingly mobile. The projects presented in this brochure deal mainly with the detection of biological and chemical agents and explosives and with the identification of hidden objects using terahertz radiation. Some of the research priorities are described in the following:

### Miniaturization and mobile application

An important development approach is miniaturization. Biological samples must be cleaned and processed before they can be analysed. This takes time and can only be done in specially equipped laboratories. Consequently, it may be necessary to transport potentially dangerous samples over long distances, which poses an additional security risk and means that results will only be available after prolonged waiting periods.

Lab-on-a-chip systems could improve the situation. These miniaturized devices can perform all the steps of sample processing which usually require an entire laboratory. The samples can be analysed on the spot within a very short time. So, when a biological pathogen or hazardous chemical has been detected, the necessary measures can be taken at once. It is important to ensure that such a system can be operated by local emergency staff so that they need not wait for specialists. It is therefore necessary to study the user-friendliness and manageability of such systems.

### Detection of animal diseases

Animal diseases, whether caused by naturally occurring pathogens or by intentionally disseminated infectious agents, are a serious problem in modern agriculture. Not only the disease-related loss of animals but in particular the culling of infected herds to prevent spreading of the disease may cause considerable damage. In order to respond to this

risk, we must develop new techniques which enable us to determine on the spot whether animals have been infected. Possible solutions are spectroscopic detection methods or the polymerase chain reaction (PCR).

The PCR method can detect even the tiniest amounts of pathogens. It is already a standard method used in biological laboratories but is very time-consuming. The challenge is to develop technologies which enable clearly quicker analysis and mobile use of this method. On-site analysis ensures the immediate availability of the data needed for taking countermeasures in the event of infection.

### **Detection of hazardous substances in drinking water and in the air**

Clean drinking water is vital for the civil society. It is therefore important to quickly detect any contamination in order to warn people, decontaminate the water or offer alternative supplies. Targeted measures can only be initiated if the type of hazard is determined and the hazardous substance identified.

A possible approach is the development of quick, mobile, low-cost detection systems working with microorganisms. These microorganisms act as indicators of changes in water quality. Their behaviour is different if the water contains toxic substances: they move more slowly or stop moving altogether. Research addresses the continuous recording of change with a camera and computerized analysis of the results. As microorganisms also respond to harmless changes such as temperature variations, such interferences must be identified and corrected.



The air can be contaminated by poison gas attacks but also by fires or unintentional release of hazardous substances from laboratories. The resulting clouds of smoke are spread by the wind, which makes air sampling on the affected site impossible. Special spectrometers which can analyse air from large distances may be able to solve the problem. These systems provide improved data about the existing hazard so that more specific remedial measures can be taken much more quickly. Emergency and rescue staff can initially respond from a distance. Evacuation can be limited to the actually affected areas.

### **Detection of hazardous objects with terahertz radiation**

The detection of hazardous objects is necessary in various contexts. The best-known example is checks on persons and luggage at airports. But relevant situations also include security checks at the entrance to public buildings, underground train stations or football stadiums. Currently used methods, such as X-ray screening, metal detectors and manual pat-down searches, are well established but have a number of disadvantages. They are time-consuming and staff-intensive and have deficiencies particularly with regard to the detection of non-metallic objects and explosives. This gap can be closed by using terahertz systems.

A special feature of terahertz radiation is its high capacity to penetrate opaque, that is, non-transparent matter such as textiles. It is therefore suited for detecting body-worn objects hidden under clothing. Furthermore, an analysis of the radiation spectrum can provide hints regarding the material of the detected object. Another asset of terahertz radiation is the fact that it is not harmful to people.

Research is needed to develop better sources and detectors for terahertz radiation. Their intensity and sensitivity must be improved. Also, the source and the detector must be combined and designed to meet the special requirements of use in security checks.

Particularly the detection of hazardous objects on persons raises a number of questions regarding the ethical and legal consequences. Checks on bags or persons always mean interference with

the right to privacy. The same goes for screening with terahertz radiation. Both methods may upset people and may even prevent them – unintentionally – from going to specific places or entering an aircraft. It is therefore necessary to consider to what extent new security measures affect the personal privacy of passengers undergoing security checks. Acceptance of the different security measures must be studied and compared with the requirements formulated by security authorities when new detection and screening systems are to be implemented.

**References:**

Research for Civil Security – Programme of the German Federal Government. Federal Ministry of Education and Research, Public Relations Division, 2007.

Call for proposals “Detection systems for chemical, biological, radiological, nuclear and explosive hazardous substances (CBRNE hazards)”, Federal Ministry of Education and Research, 2007.

People Screening Weapon and Explosives Detection Market Report 2003–2010, Homeland Security Research Corporation, 2002.

The fight against bioterrorism. Communication from the European Commission, 2003 (<http://europa.eu/scadplus/leg/en/cha/c11576.htm>).



## Collaboration projects and actors at a glance

All the collaboration projects presented in this brochure focus on the development of detection systems for biological or chemical and explosive substances and the potential uses of Terahertz technology in detecting weapons and hazardous substances. The research topics range from the early recognition of biological pathogens and other contaminants which are dangerous to health, for example in drinking water supply systems, to the detection of traces of explosives, for example within the framework of luggage screening at airports. Particular attention is focused on the development of practical and portable systems for detecting toxic or explosive substances and improved on-the-spot analysis methods for examining suspicious objects and detecting biological or chemical warfare agents. The projects will also study ethical, psychological and organizational issues relating to the use of these new detection technologies.

The following pages give all the actors involved an opportunity to present brief profiles of their research priorities, describing their motivation, goals and the potential applications of the new methods of detecting hazardous materials developed in the course of their projects.



# AquaBioTox

Online-capable system for monitoring drinking water with a biological broadband sensor including automatic image recognition

## Motivation

Water networks are exposed to deliberate or accidental contamination. This is why drinking water regulations provide for routine examination. But today's analytical techniques are time-consuming and their application spectrum is limited. Early identification of contaminants in drinking water requires an online-capable broadband sensor system. Its features: it responds quickly and reliably, is robust against false alarm, easy to handle and operates economically.

## Project description and goals

The project aims to develop and realize such a system. Its operating principle is as follows: Highly sensitive biological microorganisms are exposed to drinking water taken from the main water current, their reaction is continuously recorded by a camera and the data is automatically analysed in an online procedure. Any characteristic changes compared with microorganisms in pure water, for example regarding their vitality, movement, colouring or glowing, are automatically indicated.

## Innovations and applications

The system should be properly combined with other sensors available on the market in order to ensure maximum diagnosis reliability and robustness against false alarm in online diagnosis. This combined broadband sensor concept can be used not only to diagnose contamination with hazardous substances but also in more general quality and safety checks on water supply facilities.

### Project title

Online-capable system for monitoring drinking water with a biological broadband sensor including automatic image recognition (AquaBioTox)

### Duration

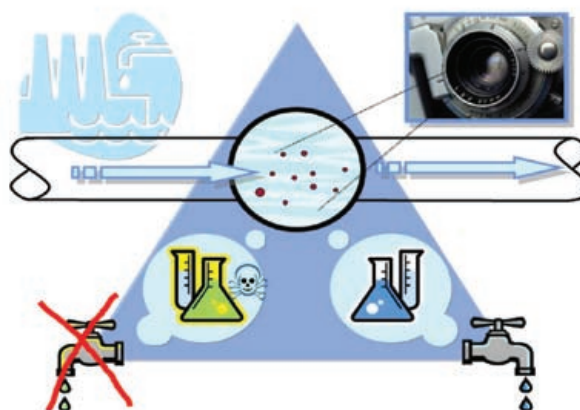
1 December 2007 – 30 November 2010

### Project partners

- Berliner Wasserbetriebe BWB, Berlin Berlin Waterworks BWB, Berlin
- bbe Moldaenke GmbH, Kronshagen
- Fraunhofer Institute for Interfacial Engineering and Biotechnology (IGB), Stuttgart
- Fraunhofer Institute for Information and Data Processing (IITB), Karlsruhe

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The AquaBioTox sensor concept (source: AquaBioTox)

# ATLAS

## Chip-based system for the detection of animal diseases

### Motivation

Agriculture forms part of critical supply-related infrastructures which are particularly affected by biological hazards. Animal diseases can have severe economic consequences and may considerably upset the general public. Efficient protective and remedial measures as well as damage control depend on the quick identification of potential biological agents. However, the detection of hazardous substances on the spot is only possible to a limited extent so far.

### Project description and goals

For this reason, a new system is to be developed which enables the detection of different animal diseases on the spot. The approach includes three main modules: The first and most important module is on-site sample processing. The second is a PCR chip which allows the detection of highly sensitive pathogens without requiring much space or energy. The third module is a DNA chip which enables pathogens to be identified and differentiated on the spot.

### Innovations and applications

Such an innovative miniaturized lab-on-a-chip system will ensure a quick and flexible response to potential hazards caused by epizootic pathogens. The above modules are generally designed for the detection of hazardous biological material. The chip-based electrical detection system may also be used for detecting hazardous chemical substances.

### Further information

[www.fli.bund.de](http://www.fli.bund.de)



Field application of the portable lab (source: photo Jan-Peter Kasper, dpa; photomontage Wolfram Maginot, FLI)

### Project title

Autonomous animal disease lab-on-a-chip system (ATLAS)

### Duration

1 November 2007 – 31 October 2010

### Project partners

- Friedrich Loeffler Institute (FLI), Federal Research Institute for Animal Health, Jena
  - National Reference Laboratory for Foot and Mouth-Disease
  - National Reference Laboratory for Contagious Bovine Pleuropneumonia
  - National Reference Laboratory of Blackleg
  - Institut of Epidemiology
- Friedrich Schiller University of Jena, Jena BioChip Initiative, Jena
- Institute of Photonic Technology, Microfluidics Department, Jena
- Analytik Jena AG, Jena
- Tecart GmbH, Erfurt

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# BiGRUDI

## Biological hazards: risk assessment, ultra high-speed detection and identification of bioterrorist agents

### Motivation

Following the anthrax attacks in the USA in October 2001, similar attacks have frequently been simulated in recent years. Offenders claimed to have sent such hazardous material by post. As a result, roughly 5,000 samples had to be examined in Germany alone, and as many as 120,000 in the USA. Such examinations require much time and effort because the agents that can be misused include various bacteria, viruses and toxins which cannot be easily detected. Special laboratories are needed to identify individual agents.

### Project description and goals

A quick and easy-to-use diagnostic platform is to be developed for the first time using selected model agents in order to enable the assessment of bioterrorism risks entailed by suspicious material samples. For this purpose, innovative and highly specific detection reagents will be generated which, when combined with spectroscopic detection methods in a mobile system, will enable on-site diagnosis. This multiplexable system should operate quickly and preferably enable the simultaneous detection of bacteria, viruses and toxins. At the same time, the system should be highly user-friendly so that it can be operated by non-expert staff. Any action required as a result of the diagnosis can thus be initiated right on the spot.

### Innovations and applications

These innovative technological developments should not only serve to improve the detection of biological hazardous material but should also be applicable in clinical diagnosis: Results would then be available shortly after sampling directly at the bedside or in doctors' practices. In addition to entering the health market, the envisaged diagnostic systems might also be used in process control in the food industry. In this way, faulty batches and the resulting corporate losses could be avoided.

### Project title

Biological hazards: risk assessment, ultra high-speed detection and identification of bioterrorist agents (BiGRUDI)

### Duration

1 February 2008 – 31 January 2011

### Project partners

- Federal Office of Civil Protection and Disaster Assistance (BBK), Bonn
- Federal Criminal Police Office (BKA), Wiesbaden
- Public health office of Land Baden-Württemberg (LGA), Stuttgart
- Jenoptik Instruments GmbH, Jena
- Scienion AG, Berlin
- GenExpress, Berlin
- Charité/Central Institute for Laboratory Medicine and Pathobiochemistry, Berlin
- FZMB GmbH, Bad Langensalza
- Freie Universität Berlin, Institute for Chemistry and Biochemistry, Berlin
- Charité/Institute for Pharmacology, Berlin
- Technische Fachhochschule Wildau (TFHW), Biosystems Engineering, Wildau
- Robert Koch Institute (RKI), Berlin

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# BioPROB

Detection of biological hazardous substances such as toxic proteins, pathogens and viruses with an automated B-detector based on an electrical biochip

## Motivation

Improved protection against threats related to the use of biological hazardous substances is becoming increasingly important in the societal context. Safety from biological contaminants and pathogens can only be guaranteed on the basis of reliable analyses and data. Currently, the generation of such data is, in many cases, only possible in the lab using complex methods. Portable and automated systems with integrated sample processing are not available on the market. Sample processing is a particular challenge.

## Project description and goals

A portable system would pave the way towards robust on-site identification of biological hazardous substances. The collaboration will therefore provide the scientific and technological basis for a complete and universal B-detection system for on-site analysis. The aim is to develop an automated portable system which allows the detection of both biological poisons and pathogenic germs (e. g. smallpox).

## Innovations and applications

The system will integrate all previous laboratory steps. It will for the first time enable the detection of different substances in a closed system, which can be operated by emergency staff. Furthermore, an online procedure will provide for detail control and evaluation of results by experts from a distance. The system could, for example, be used for checks on drinking water for aircraft and ships as well as in ponds and swimming pools. Potential germs can quickly be detected.

## Further information

[www.analytik-jena.de](http://www.analytik-jena.de)  
[www.ebiochip.de](http://www.ebiochip.de)  
[www.bdal.de](http://www.bdal.de)  
[www.isit.fraunhofer.de](http://www.isit.fraunhofer.de)

## Project title

Fully automated detection of biological hazardous substances with integrated sample purification for on-site use (BioPROB)

## Duration

1 May 2008 – 30 April 2010

## Project partners

- Analytik Jena AG, Jena
- AJeBiochip GmbH, Itzehoe
- Bruker Daltonik GmbH, Leipzig
- Fraunhofer Institute for Silicon Technology (ISIT), Itzehoe

## Collaboration coordinator

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# ChipFlussPCR

Chip-based flow-through PCR system for complete mobile nucleic acid analysis of biological hazardous substances

## Motivation

The terrorist attacks using biological agents in the USA in October 2001 and the appearance of avian flu in Asia and Europe in recent years demonstrated the limited capabilities of the various national inspection authorities. An adequate response to major incidents requires quick, safe and mobile analytical techniques that can be used for diagnosing infections or contamination of people, animals, food-stuffs or sensitive infrastructures.

## Project description and goals

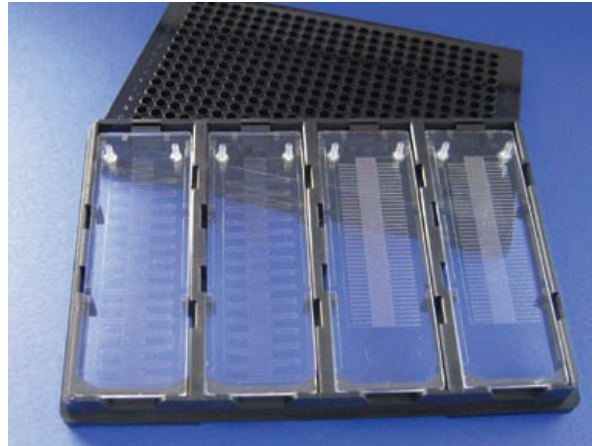
The aim is a portable, fully fledged analytical lab for rapid and unequivocal detection of potential pathogens which can be misused for bioterrorist attacks. Such a miniaturized, credit card-sized lab-on-a-chip allows the entire range of detection steps to be effected: from the collection of bacteria from potentially contaminated material such as soil samples or food to the identification of the bacteria. The main component of the lab-on-a-chip is a special form of the PCR (polymerase chain reaction) method for bacteria detection.

## Innovations and applications

The applied method enables the unequivocal identification of DNA and thus the detection of bacteria in three steps: separation of the DNA, its replication and finally its identification. A special feature is the integration of this method into a portable, extremely small system, which can replace large equipment and entire labs and is suited for on-site use. Gaining a few extra minutes is vital for taking effective measures quickly in the event of bioterrorist attacks or animal disease.

## Further information

[www.microfluidic-ChipShop.com](http://www.microfluidic-ChipShop.com)



Small is beautiful: a credit card-sized portable lab. Lab-on-a-chip systems for ultra highspeed PCR (source: microfluidic ChipShop GmbH)

### Project title

Chip-based flow-through PCR system for complete mobile nucleic acid analysis of biological hazardous substances (ChipFlussPCR)

### Duration

1 December 2007 – 30 November 2010

### Project partners

- microfluidic ChipShop GmbH, Jena
- Clemens GmbH, Waldbüttelbrunn
- TIBMOLBIOL Syntheselabor GmbH, Berlin
- Bundeswehr Institute of Microbiology, Munich
- Bavarian State Office for Health and Food Safety, State Institute for Health and Nutrition, Oberschleißheim
- Sensovation AG, Stockach

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# PathoSafe

## Raman spectroscopy to detect security level 3 agroterrorist pathogens

### Motivation

An increasing number of terrorist attacks on public life is to be expected due to current developments in world politics. The possibility of attacks on food-producing agricultural production and processing companies (agroterrorism) has been less in the focus of public attention so far. The abuse of pathogens which are hazardous both to humans and animals would have far-reaching repercussions on health and the economy.

### Project description and goals

A rapid detection and identification of bacterial contamination is therefore necessary for an early hazard control. A special method, the Raman spectroscopy, is therefore established to identify pathogens under different threat scenarios. The goal is to develop a portable device which can be used on site in a threatened area and can be operated by relief personnel such as Technisches Hilfswerk (Federal Agency for Technical Relief), police, fire brigade or health and veterinary offices. These newly developed epidemiological tools are to facilitate practical use of the device in the future.

### Innovations and applications

The entire device concept will be integrated into an automatic and mobile Raman apparatus to be newly designed. This mobile approach enables on-site application and thus avoids long transport routes and the resulting loss of time. Furthermore, the threat of disease dissemination is minimized. The device is particularly interesting for protection against epidemics and for the food industry, where the technology could be used for quality controls of food.

### Further information

[www.fli.bund.de](http://www.fli.bund.de)

### Project title

Raman spectroscopy to detect security level 3 agroterrorist pathogens (PathoSafe)

### Duration

1 January 2008 – 31 December 2010

### Project partners

- Friedrich Loeffler Institute (FLI), Federal Research Institute for Animal Health, Jena
- rap.ID particle systems GmbH, Berlin
- Friedrich Schiller University, Institute for Physical Chemistry, Jena
- Federal Institute for Risk Assessment, Berlin
- University of Hamburg, Centre for Science and Peace Research, Hamburg

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# S.O.N.D.E.

## Scenario-based emergency diagnostics system for field use

### Motivation

The risk posed by pathogens to the world's population has increased considerably over the last thirty years. The reasons for this include the world-wide increase in population density, the development of mega cities and increasing mobility. International terror networks can take advantage of both the fear of lethal infectious diseases and the fatal effects of using biological warfare agents (category B agents).

### Project description and goals

The aim of this research project is to develop mobile, integrated, diagnostics systems using microsystems. This equipment will serve to demonstrate the presence of (new) pathogens and potential B-agents. The current project aims to develop a point-of-care diagnostics system for field use using disposable cartridges. The cartridges will be inserted in a portable device on the spot. This will process and analyse the sample fully automatically without intervention by the user.

### Innovations and applications

The interdisciplinary integration of Applied Molecular Microbiology and Microsystems Technology (MST) is completely new. It opens up entirely new prospects for the development of diagnostic agents, i.e. substances used to examine the organism and provide a diagnosis. The device will also be able to identify toxins and pathogens such as Ebola or Lassa virus. It will enable electronic and thermal, optical and/or electrochemical readings. This will cut the time and energy currently involved in achieving results – several hours, large pieces of equipment, specially trained staff.

### Project title

Scenario-based emergency diagnostics system for field use (S.O.N.D.E.)

### Duration

1 September 2008 – 31 August 2011

### Project partners

- Freiburg University, Department of Microsystems Engineering (IMTEK), Freiburg
- University Medical Center Göttingen, Institute for Virology, Göttingen
- University Medical Centre Freiburg, Institute of Molecular Medicine and Cell Research, Freiburg
- Freiburg University, Centre for Applied Biosciences, Freiburg
- ESE Embedded System Engineering GmbH, Stockach
- HSG-IMIT Institute for Micro and Information Technology, Villingen-Schwenningen
- Robert Koch Institute, Centre for Biological Safety (ZBS), Berlin

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# ChipSenSiTek

Fibre-optical micro-sensors for the real-time detection of explosives

## Motivation

State-of-the-art sensors need ten or more seconds for the sampling and/or processing and analysis of potentially hazardous substances. In addition, most sensor systems are limited to the detection of just a few explosives and are often insensitive to fluid explosives. The development of special sensors could facilitate a touch-free short-term identification and classification of explosives in particular for baggage and passenger controls, for example at airports.

## Project description and goals

The aim of the project is to study a novel miniaturized sensor principle. The concept is a special coating of the sensors, so that the selective and highly sensitive detection of different classes of explosive becomes possible. These sensors are suitable for installation in a sluice gate with an integrated airstream, so that contaminations on clothes, for example, can be carried by the airstream. They are thus directed towards the sensors, which detect the hazard. Traditional sampling and processing will no longer be necessary and time and costs will be considerably reduced.

## Innovations and applications

Miniaturized systems based on special sensors provide security technology with totally new possibilities of real-time analysis of hazardous substances. Due to an unproblematic integration, the newly developed system will be used in two model applications, i.e. in a person sluice gate as well as in a robot-controlled baggage control system, and will be tested under real-life conditions. Besides application in person and baggage controls, the system is also suited for industrial process control and food monitoring. A handheld sensor, for example, can be used for routine vehicle controls.

## Further information

[www.pe.tu-clausthal.de/AGSchade](http://www.pe.tu-clausthal.de/AGSchade)

## Project title

Fibre-optical micro-sensors for the real-time detection of explosives (ChipSenSiTek)

## Duration

1 October 2007 – 30 September 2010

## Project partners

- Clausthal Technical University, LaserApplicationCentre (LAC), Goslar
- Diehl BGT Defence GmbH, Überlingen
- KABA Gallenschütz GmbH, Bühl
- Ingenieurbüro Wanner GmbH (IBW), Potsdam
- CryLaS GmbH, Berlin
- Flug- und Industriesicherheit Service- und Beratungs-GmbH (FIS), Kelsterbach

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These new sensors are suitable for installation in a person sluice gate (source: KABA)

# DACHS

## Detector array with a gas chromatograph for the identification of toxic substances

### Motivation

Chemical substances may be released deliberately or by accident, for example during transportation, and thus become a hazard for the population, for mission staff during rescue operations or for the environment. Especially gaseous substances require quick action at the emergency site because they can spread rapidly in the air and pose a special threat to emergency staff and the population. It is important that information about the hazardous substance and its spreading is immediately available so that quick action can be taken.

### Project description and goals

The research project promises quick on-site analysis of toxic industrial chemicals and chemical warfare agents. The aim is to develop a portable measuring system which can detect and identify such hazardous substances. The device should be easy to operate and ensure the reliable interpretation of results. The new system will enable the automatic routine concentration of gas samples and the separation of individual components using special techniques (chromatography).

### Innovations and applications

After concentration and separation of hazardous substances by means of gas chromatography, different sensors will be used for their identification. The combination of special sensors and detectors facilitates complete, error-free analysis. An example of such a device is a special ionic spectrometer, which can detect and analyse chemical compounds in the air. The results will be analysed online using statistical methods. Quick sample processing and direct analysis are a new feature which provides for almost universal use of this measuring device for the identification of hazardous substances.

### Further information

[www.airsense.com](http://www.airsense.com)



Derailement of freight train near Hamburg releasing chloroacetic acid (source: DACHS)

#### Project title

Detector array with a gas chromatograph for the identification of toxic substances (DACHS)

#### Duration

1 December 2007 – 31 November 2010

#### Project partners

- Federal Office of Civil Protection and Disaster Assistance (BBK), Bonn
- Hamburg University of Technology, TUHH, Hamburg
- Airsense Analytics GmbH, Schwerin

#### Collaboration coordinator

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# EXAKT

## Near real time trace analysis of airborne chemical warfare agents and explosives

### Motivation

In view of the threats posed by potential terrorist attacks with explosives or chemical warfare agents, we need to develop new, quick and reliable techniques for detecting such substance groups. Traditional quick tests are not designed for identifying the rapidly increasing number of new, hitherto unknown and potentially hazardous substances.

### Project description and goals

A new flight time mass spectrometer is to be used for the near real time analysis of highly toxic or hazardous substances in the air. The mass spectrometer is linked to a new thermodesorption system which is based on the principle of continuous ingestion and concentration of air samples. The resulting mixture is then directly supplied to the mass spectrometer for analysis without time-consuming substance separation. Hazardous substances are identified immediately and results are produced in a fully automated process.

### Innovations and applications

The measuring system can be optimized for different classes of hazardous substances, e. g. chemical warfare agents or explosives, and is thus multifunctional. Owing to the direct combination of different methods, this measuring system can operate quickly without measuring errors and needs clearly less time for sample analysis. The new technique enables near real time measurement and thus contributes substantially to the early identification of hazardous substances.

### Further information

[www.odourvector.de](http://www.odourvector.de)

#### Project title

Near real time trace analysis of airborne chemical warfare agents and explosives (EXAKT)

#### Duration

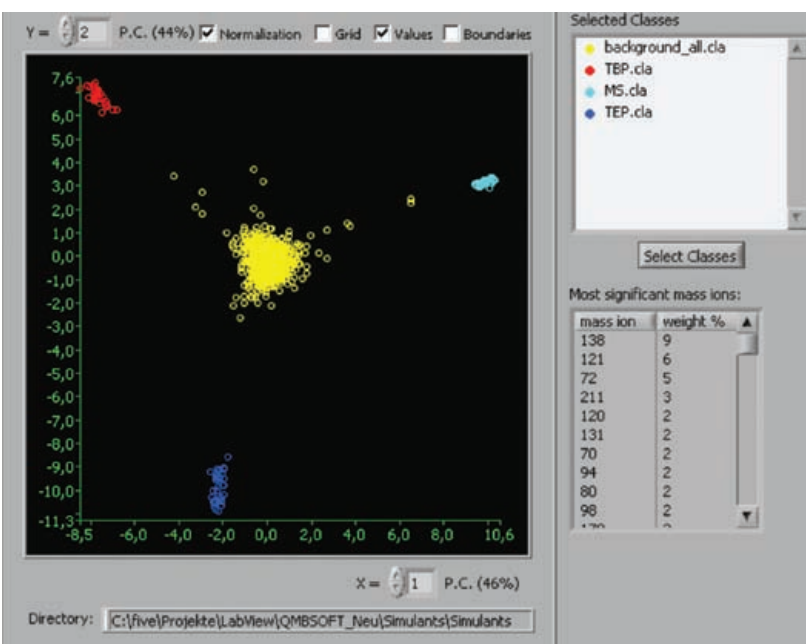
1 January 2008 – 31 December 2010

#### Project partners

- five technologies GmbH, Munich
- Bundeswehr Research Institute for Protective Technologies and NBC Protection (WIS), Munster
- Bonn University, IFL Sensors Section, Bonn
- Fraunhofer Institute for Chemical Technology (ICT), Pfinztal
- SECURETEC Detektionssysteme AG, Brunnthal / Munich

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Identification of three warfare agents in an air mixture using chemometric analysis techniques (source: EXAKT)

# HYGAS

Hyperspectral sensor for quick automatic remote detection of hazardous substances

## Motivation

Though considerable improvements have been achieved in technical security arrangements over the past decades, accidents during the production, transport and processing of chemicals frequently release hazardous material in the form of a cloud. Furthermore, hazardous substances have in the past been released as a result of war operations or terrorist attacks. Hazard assessment by local emergency staff requires quick availability of information about the released material and the regions affected.

## Project description and goals

Traditional analytical techniques involve sampling. This process can, however, be dangerous for mission staff. Remote sensing with an infrared spectrometer enables hazardous clouds to be identified from a great and thus safe distance. This project will develop a hyperspectral sensor, i.e., an imaging remote sensing system. This special sensor can be used for automatic detection of hazardous material from a distance and its visualization for exact locating.

## Innovations and applications

The image of the hazardous cloud is to be superimposed on a video image using appropriate technology. This combination is important for timely and proper action. The remote sensing system is designed for use by mission staff in monitoring airports, railway stations and major events as well as for on-site analysis in response to major chemical accidents, large fires or terrorist attacks.

### Project title

Hyperspectral sensor for quick automatic remote detection of hazardous substances (HYGAS)

### Duration

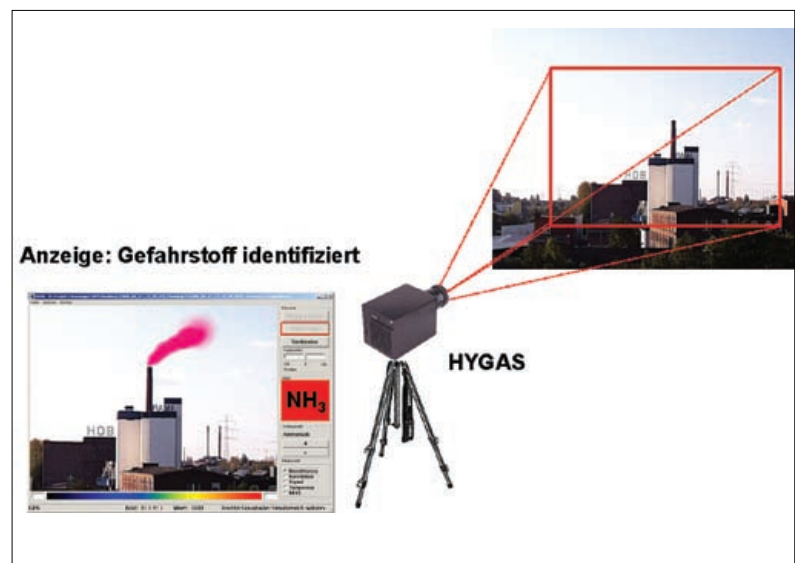
1 February 2008 – 31 January 2011

### Project partners

- Bruker Optik GmbH, Ettlingen
- Hamburg Fire Brigade, Hamburg
- Federal Office of Civil Protection and Disaster Assistance (BBK), Bonn
- Hamburg University of Technology (TUHH), Institute of Measurement Technology, Hamburg

### Collaboration coordinator

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 harig@tuhh.de



Visualization of an identified hazardous cloud (source: HYGAS)

# IRLDEX

## Infrared laser-assisted imaging detection of explosive materials

### Motivation

So far researchers have not managed to solve the technological challenge of developing a short and long-distance, non-contact process for detecting explosive materials. The development of such a process is vital in the fight against chemical, biological, radiological, nuclear and explosive hazards. Finding a solution to this problem is becoming all the more important against the background of the increasing threat of terrorism world-wide. A non-contact detection process which is not based on taking surface samples or use in a gas room is needed for testing objects which are suspected of being an IED (Improved Explosive Device), for example.



Image of an inhomogeneous surface coating with TNT taken using the IRLDEX process (source: IRLDEX)

### Project description and goals

The work of the collaboration partners focuses on the analysis of relevant explosives and scenarios, the construction of an active multispectral sensor and the development of image-processing algorithms for detecting explosives. The equipment is to be able to detect commercially available explosives such as TNT as well as so-called home-made peroxide-based explosives such as TATP (Triacetone triperoxide). The sensor is based on a combination of a compact adjustable medium infrared (MIR) semi-conductor laser and an MIR camera with downstream image processing capability. The object which is to be examined is illuminated in a spectrally selective manner and the infrared images which are registered are analysed. The multispectral sensor is suitable for the localized spectroscopic detection of explosive materials in the gaseous phase and particularly on

### Project title

Infrared laser-assisted imaging detection of explosive materials (IRLDEX)

### Duration

1 January 2008 – 31 December 2010

### Project partners

- Fraunhofer Institute for Applied Solid State Physics (IAF), Freiburg
- Fraunhofer Institute for Chemical Technology (ICT), Pfintztal
- Fraunhofer Institute for Physical Measurement Techniques (IPM), Freiburg
- Federal Criminal Police Office (BKA), Wiesbaden
- Diehl BGT Defence GmbH & Co. KG, Überlingen
- Thermosensorik GmbH, Erlangen

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surfaces. In the future, this procedure can be enhanced for use in individual devices or in complex multi-sensor platforms.

### Innovations and applications

The availability of this kind of detection procedure for explosives will improve measures to counter a large number of potential risks and threats in the future. Apart from enhancing security for members of the emergency services dealing with possible terrorist attacks, other potential uses are controls on persons and objects in high security areas (airports) and at checkpoints as well as security surveillance at large events. It is possible that the detection process will be developed in future to include other critical substances such as drugs or chemical hazardous substances or warfare agents.

# SAFE INSIDE

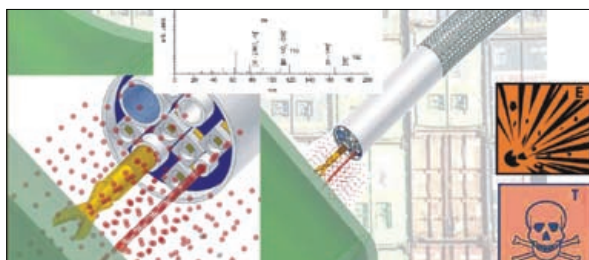
Detection of security-relevant substances in places which are difficult to access

## Motivation

Growing demands are being placed on detection systems: Multimodal trace detection systems for the on-the-spot analysis of dangerous substances are needed for dealing with various classes of substances and in various fields of application. These include the ability to quickly detect dangerous substances in indoor air to help to protect emergency service personnel, for example police or fire brigade task forces at crime scenes and during operations. The equipment should also be able to detect traces of explosive materials as well as pre-substances of drugs or toxic agents when uncovering illegal laboratories. A corresponding system is also needed for searching hiding places, cavities or suspicious objects.

## Project description and goals

The detection system will involve a combination of a mobile, highly selective and sensitive mass spectrometer as its central component and an infrared spectrometer. It will be able to search cavities which are difficult to access, containers and in particular different types of surfaces for traces of substances which are relevant to security interests. The equipment will be used in conjunction with various innovative sampling and enrichment techniques, including micro-invasive techniques.



Detection of hazardous substances by means of endoscopic sampling and verification using SPI-MS (source: Optimare GmbH)

These techniques are associated with less invasive operations or so-called “key-hole surgery”. As far as detecting hazardous substances is concerned, this involves, for example, using an endoscope to search the inside of spaces or containers for traces of relevant substances. The system also makes it possible to conduct on-the-spot sampling using a special enrichment technique called solid phase micro-extraction which enables an analysis of volatile substances.

## Project title

Detection of security-relevant substances in places which are difficult to access (SAFE INSIDE)

## Duration

1 January 2008 – 31 December 2010

## Project partners

- Airsense Analytics GmbH, Schwerin
- Federal Criminal Police Office (BKA), Departments KT 34 and KT 16, Wiesbaden
- Coherent GmbH, Munich
- Helmholtz Center Munich – German Research Centre for Environmental Health, Neuherberg
- Optimare GmbH, Wilhelmshaven
- Schindler Endoskopie Technologie GmbH, Gutach-Bleibach
- Smiths Heimann GmbH, Wiesbaden
- Technical University Munich, Physics Department E12, Garching
- University of Rostock, Department of Chemistry, Rostock

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## Innovations and applications

The combination of various separate detection methods and the use of micro-invasive technologies are highly innovative and open up new potential applications. The equipment’s ability to provide an extremely precise on-the-spot analysis enables emergency personnel to assess a given situation quickly and reliably. This type of mobile, multimodal trace detection system is not only suitable for use in the event of a crisis, but also for the surveillance of technical facilities and industrial plants.

# HANDHELD

## Handheld THz spectrometer for the detection of explosive hazardous liquids

### Motivation

Fortunately the planned attacks on aircraft in London in 2007 were foiled. However, they revealed significant gaps in passenger and luggage screening. In the past it has been easy to smuggle explosive hazardous materials through airport security systems disguised as apparently harmless liquids in normal shampoo or drinks bottles. Just a tiny amount of these liquid explosives is sufficient to cause horrendous damage in an aircraft.

### Project description and goals

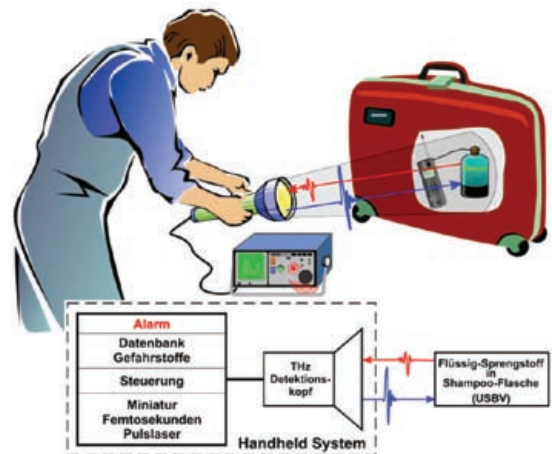
Mobile detection processes are called for which are non-destructive, non-contact, safe and sensitive to traces of very varied hazardous substances. Terahertz (THz) spectroscopy promises solutions in this field. Apart from fulfilling all the above criteria, this technology is not harmful to humans and easily penetrates clothing and packaging materials. The aim of the project is to develop a prototype of the world's first mobile handheld THz-spectrometer. This will be able to locate liquid explosives even in closed bottles.

### Innovations and applications

The THz technology is still in its infancy and current THz spectrometers are expensive, large and sensitive pieces of laboratory equipment. The new handheld system will consist of two components: of a detection head the size of a torch and of a compact steering module. Apart from its proposed use in the field of security technology, further applications for the handheld device are also feasible: for example, in controlling production processes. Aircraft building and car production are two fields that are making increasing use of plastics which are virtually transparent for THz waves.

### Further information

[www.menlosystems.com](http://www.menlosystems.com)



Handheld THz spectrometer for the detection of explosive hazardous liquids in closed containers (source: HANDHELD)

### Project title

Handheld THz spectrometer for the detection of explosive hazardous liquids (HANDHELD)

### Duration

1 January 2008 – 31 December 2010

### Project partners

- Menlo Systems GmbH, Martinsried
- Federal Institute for Materials Research and Testing (BAM), Berlin
- Technical University, Institute for High-Frequency Technology, Braunschweig
- Fraunhofer Institute for Telecommunications (Heinrich Hertz Institute – HHI), Berlin
- TEM Messtechnik GmbH, Hannover

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# TEKZAS

THz real-time camera (two-dimensional) for application in security technology

## Motivation

A growing terrorism threat in all its new variants and the resulting necessary legal regulations require additional and new security measures also in the field of transportation, above all in air traffic. Airlines, as well as airports, depend on efficient processes in all matters in order to be internationally competitive. These increased security requirements are met under this project with flexible and effective combined technology process solutions for security controls.

## Project description and goals

The overarching objective of the project is to study and implement a multi-sensor system for the remote detection of hidden chemical, biological and explosive (CBE) hazardous substances carried directly on the body. Persons carrying such substances are moving in real time. The system to be developed will be based on terahertz (THz) technologies and include a surveillance camera and a two-dimensional camera in the THz spectral range. In addition, a novel THz source with a high peak performance is to be studied which will make it possible to make two-dimensional pictures in real-time by means of a special detection method.

## Innovations and applications

Both the THz source as well as the corresponding detection technique are innovative and have not been implemented in this form to date. The research project aims at developing a demonstrator as a starting point for a marketable system in the airport sector. Furthermore, technical innovations in the field of THz technology are expected which might be suitable for the surveillance of critical infrastructures, such as industrial facilities, stadiums and public institutions.

### Project title

THz real-time camera (two-dimensional) for application in security technology (TEKZAS)

### Duration

1 October 2007 – 30 September 2010

### Project partners

- Hübner GmbH, Kassel
- Robert Bosch GmbH, Stuttgart
- Xiton Photonics GmbH, Kaiserslautern
- FIS Flug- und Industriesicherheit Service- und Beratungs-GmbH, Kelsterbach
- Fraunhofer Institute for Physical Measurement Techniques (IPM), Freiburg
- Fraunhofer Institute for Industrial Mathematics (ITWM), Kaiserslautern
- Technical University, Kaiserslautern
- Max Planck Institute for Solid State Research, Stuttgart
- University Frankfurt/Main, Frankfurt/Main
- Institute for Economy + Prevention, Munich
- ILB Internationale Luftfahrt- und Verkehrsberatung GmbH, Berlin

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# TERAcam

Active, fully electronic, room-temperature, real-time THz camera for security applications

## Motivation

Security controls at airports, football stadiums or in government buildings are difficult and it is not easy to increase security levels. In particular, there is growing demand for reliable and secure passenger screening at airports. Increased controls mean tedious, long waiting periods for passengers and a steep increase in costs for airport operators. Faster, smaller and cheaper measures are to be introduced to counter these effects.

## Project description and goals

One important application in this context is the development of an active, fully electronic, room-temperature THz camera. The aim is to develop and test a camera using THz technologies which enables real-time images, for example of objects hidden under clothing. Two laboratory camera systems will be developed in the course of the project: One system is to be suitable for long-distance early recognition enabling images at a distance of up to 20 metres. The second system will involve lower production costs but will only be usable for close-up images.

## Innovations and applications

The aim is to provide a compact, portable prototype for a field test. It is to be suitable for various different applications. Apart from screening passengers at airports, the device may also be used in public and non-public areas (heavily frequented places such as banks, stadiums and museums or less frequented places such as government buildings, embassies, police stations, R&D centres).

## Further information

[www.ge.com/researcheurope/](http://www.ge.com/researcheurope/)  
[www.radiometer-physics.de](http://www.radiometer-physics.de)

## Project title

Active, fully electronic, room-temperature, real-time THz camera for security applications (TERAcam)

## Duration

1 June 2007 – 31 May 2010

## Project partners

- Johann Wolfgang Goethe University Frankfurt, Institute of Physics (IP), Frankfurt
- Siegen University, Institute for High Frequency Technology and Quantum Electronics (HOE), Siegen
- Institute of Photonic Technology (IPT), Jena
- Radiometer Physics GmbH (RPG), Meckenheim
- General Electric (GE), Global Research, Munich

## Collaboration coordinator

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Checkpoint scenario and experimental THz image made within ten seconds of a weapon hidden under clothing (source: GE (left); Uni-FFm / RPG)

# TeraTom

## High-resolution THz tomography for security applications

### Motivation

The increased threat of terrorist activities in recent years means that it is important to improve security controls. The focus is on screening people for explosives, weapons and other dangerous items. It is important that screening measures discover dangerous objects which could be hidden in shoes, headgear or medical bandages, for example, with high precision and with only a short measuring period.

### Project description and goals

Additional equipment based on microwave imaging technology is to be used to support the screening of people in areas of enhanced security, at airports for example. The aim is to develop a prototype for close-range screening which enables high-resolution searches of small items, for example a shoe. New methods are called for in this area as it is forbidden to X-ray people for non-medical purposes, and taking off one's shoes so that they can be X-rayed takes up too much time.

### Innovations and applications

The prototype which is to be developed should demonstrate the feasibility and suitability of modern integration technologies for security applications. The aim is to develop a virtually real-time 3D image-generating system which is specially designed for measuring compact objects with a complex structure. One vision is the development of a handheld device which enables persons to be screened anywhere and, in particular, without involving body contact. The advantages would be the visual depiction of metallic and non-metallic objects (weapons, explosives) and higher acceptance compared with being searched by hand.



Design study: Checkpoint with follow-up check zones (source: TeraTom)

#### Project title

High-resolution THz tomography for security applications (TeraTom)

#### Duration

1 October 2007 – 30 September 2010

#### Project partners

- Rohde & Schwarz GmbH & Co. KG, Munich
- Smiths Heimann GmbH, Wiesbaden
- University Friedrich-Alexander Erlangen-Nuremberg, Chair for Microwave Engineering and High Frequency Technology, Erlangen

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# THEBEN

## Terahertz detection systems: Ethical support, evaluation and standardization

### Motivation

In many places, moral conflicts do not emerge until technical options leave the enclosed space of research labs and enter public awareness as visions for the future. What the public may consider to be problematical was developed in the lab in many small and unspectacular steps and decisions. Direct involvement of the ethical community in the process of technology development ensures that the small steps and decisions are considered and justified so that potential conflicts between researchers in the lab and the general public can be perceived and addressed.

### Project description and goals

THEBEN supports a number of projects in the development of Terahertz detection systems. Where such systems are used on people (producing images of the 'naked' human body), this project provides for critical reflection, designs and evaluates implementation scenarios and drafts recommendations for application. In addition, societal security concepts are analysed and evaluated in the context of security technologies, and advice is offered for the political and research communities.

### Innovations and applications

Security is a complex issue seen from the ethical perspective: Security is a precious good whose provision and preservation is an ethical must. At the same time, (technology-based) provision of (objective or subjective) 'security' often entails restrictions in other areas: for example the classic conflict between different basic values and rights such as security, freedom, justice and privacy.

Activities focus on the innovative, fundamental and application-related development of a security ethics approach to identify problems and find solutions by engaging in a dialogue with technology developers while focusing on responsibility in complex processes as well as on social values and human dignity.

### Further information

[www.izew.uni-tuebingen.de/kultur/theben.html](http://www.izew.uni-tuebingen.de/kultur/theben.html)

### Project title

Terahertz detection systems: Ethical support, evaluation and standardization (THEBEN)

### Duration

1 October 2007 – 30 September 2010

### Project management

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[theben@izew.uni-tuebingen.de](mailto:theben@izew.uni-tuebingen.de)

# THz-Videocam

Passive THz video camera for security applications to detect hidden objects at great distances

## Motivation

The detection and identification of hidden objects and substances on people is most important for security in public transport. Checks on persons are currently restricted to the complex and time-consuming detection of metallic objects. The quick X-ray screening technology used, for example, in checking luggage cannot be used here because persons would be exposed to an inadmissibly high dose of X-rays. A possible solution is Terahertz (THz) radiation, which can be used in imaging the human body surface without causing health hazards. This enables the detection and identification of hidden objects on people.

## Project description and goals

The project develops a passive video camera which takes real-time pictures of moving objects at great distances in the THz spectrum. The camera shows hidden metallic and ceramic objects as well as chemical substances which cannot be visualized with existing optical techniques operating in the visible or infrared spectrum. A main characteristic of the presented solution is that it does not require the objects or persons to be directly exposed to radiation but records the objects' natural THz radiation.

## Innovations and applications

The primary application of the proposed THz camera is the field of civil security technology. If adequately modified, it can furthermore be used in industrial inspection, in analytical processes and in sensors as well as in medical imaging. Research activities focus on sensitive detectors and quick measuring techniques as well as the reliability of THz images.

### Project title

Passive THz video camera for security applications (THz-Videocam)

### Duration

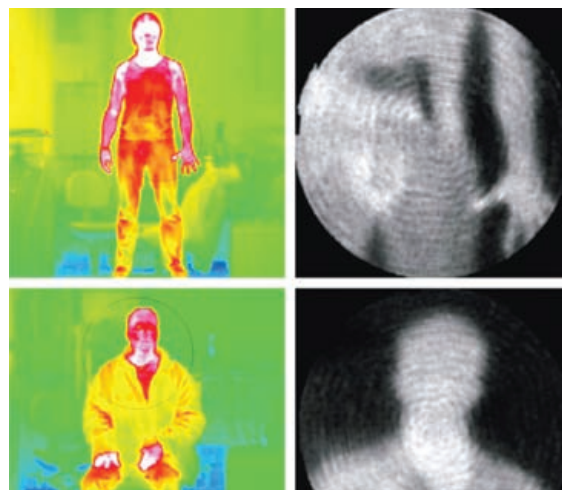
1 August 2007 – 31 July 2010

### Project partners

- Universität Karlsruhe (TH), Laboratory of Micro- and Nanoelectronic Systems (IMS), Karlsruhe
- German Aerospace Centre (DLR), Berlin
- Institute of Planetary Research, Berlin
- Institute of Photonic Technology (IPHT), Jena
- Jena-Optronik GmbH, Jena
- Supracon AG, Jena
- Diehl BGT Defence GmbH (DBD), Röthenbach

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Comparison of infrared (left) and THz images (right) from a distance of five metres: THz imaging takes a mere two seconds (source: THz-Videocam)

# Glossary

<b>Agents</b>	General term for a chemical substance which produces a specific effect.
<b>Agroterrorism</b>	Type of terrorism which mainly uses biological agents; the affected sectors are agricultural production and the food industry.
<b>Anthrax</b>	Infectious disease which mainly affects cloven-hoofed animals; anthrax spores can also be used as a biological weapon.
<b>Biochip</b>	A small device with miniaturized test sites (microarrays) arranged on a solid substrate that permits large numbers of biological or biochemical tests to be performed at the same time.
<b>Bioterrorism</b>	Type of terrorism which uses biological weapons in attacks.
<b>Ion mobility spectrometer</b>	Device for chemical analysis which is capable of identifying very low concentrations of chemicals at short reaction times and can be used to detect different classes of chemicals at ambient pressure.
<b>Lab-on-a-chip</b>	Microfluidic system that enables all the functions of a large laboratory for analysing chemical or biochemical substances to be housed on a synthetic substrate the size of a credit card.
<b>Microwave imaging technique</b>	A method for producing images using microwave radiation.
<b>Polymerase chain reaction (PCR)</b>	A technique for replicating DNA without using a living organism. Possible applications include the diagnosis of hereditary diseases and virus infections and the identification of genetic fingerprints.
<b>Pathogene</b>	Bacteria and viruses are called pathogens when they cause disease. Such disease is not necessarily lethal.
<b>Point of care diagnostic</b>	Samples are analysed on the spot and need not be transported to a laboratory.
<b>Raman spectroscopy</b>	Spectroscopic technique similar to infrared spectroscopy.
<b>Spectroscopy</b>	A method using electromagnetic radiation for studying objects and materials.
<b>TATP (triacetone triperoxide)</b>	Liquid explosive with the impact sensitivity of a primary explosive.
<b>Terahertz</b>	Electromagnetic radiation at a frequency range between microwave and infrared radiation which can be used for imaging objects through barriers such as paper or textiles.
<b>Toxin</b>	A term used for poisonous substances, specifically substances released by bacteria.



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