Competence in Security and Environment

- Company Profile -

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1. Who we are

The Company

SARAD is a German company working in the field of sensor- and security technology. Since about 20 years SARAD develops innovative equipment detecting hazards caused by radioactive aerosols.

Complete environment monitoring systems were delivered worldwide to monitor geothermal fields, forecasting earthquakes or to detect and analyse atmospheric contaminations in industrial areas. Correspondingly the list of customers contains famous adresses all over the world.

The innovative power and potential of our Company was appreciated by the President of the Federal Republic of Germany and the official German institutions such as the Government of Saxony for several times.

On the picture right you can see President of SARAD Group **Prof. Dr. Thomas Streil** in the governmental delegation during a visit of German Chancellor **Angela Merkel** in 2008 and on the picture below with the president of Germany **Joachim Gauck** in Latin America in 2013.

Today SARAD is involved into several German and European competence networks established to increase the security of "critical infrastructures" like airports, harbours, railway systems or chemical plants. To achieve the ambitious security goals SARAD is cooperating within several networks of forward-looking companies, research institutes and organisations. All customers of SARAD will benefit from the competence which is available in these networks.

Today our Company offers:

- Development and manufacturing of sensor systems detecting radioactive alpha, beta and gamma radiation
- Development and manufacturing of self-configurationg sensor networks for mobile area monitoring and protection of first responders.
- Development and manufacturing of comprehensive environment monitoring systems with application in environment protection and survilance of climatic changes
- System engineering and manufacturing monitoring vehicles for security applications
- "RiskProtect"-software to understand and control complex risky situations in the field of terrorism, organized criminality or in disaster management typical situations occur, which are not foreseeable. Such scenarios are subject to a large number of factors influencing each other. This together with their temporal behaviour generates a very high complexity. Without computers ineffective or faulty decisions in many cases are the consequence. Sometimes measures cause the oposite of their intention.

Based on experiences in airport and railway protection SARAD develops systemic modells of the security processes and analyses the behaviour of the system in different situations. The computer modells consider numerical data (generated for example by sensor networks as well as non-numerical data (for example delivered by news services).

In international cooperation’s leading staff of SARAD give lectures in measurement technology and innovation management.

We can look back on a number of successful research and development projects which have increased our competitiveness as a result 88% of our products we export in more than 100 countries. Our products are certified in many European countries. Our quality system meets **ISO 9001-2008** Standard

ZERTIFIKAT ■ CERTIFICATE ■ 認證證書 ■ СЕРТИФИКАТ ■ CERTIFICADO ■ CERTIFICAT

Management Service

CERTIFICATE

The Certification Body
of TÜV SÜD Management Service GmbH
certifies that

SARAD GmbH
Wiesbadener Str. 10
01159 Dresden
Germany

has established and applies
a Quality Management System for

Development, production, distribution and service of environmental instruments, including software products.

An audit was performed, Report No. **707016053**.
Proof has been furnished that the requirements according to

ISO 9001:2008

are fulfilled.
The certificate is valid from **2016-10-07** until **2018-09-14**.
Certificate Registration No.: **12 100 46380 TMS**.

Product Compliance Management
Munich, 2016-09-27

TÜV SÜD Management Service GmbH • Zertifizierungsstelle • Ridlerstraße 65 • 80339 München • Germany
www.tuev-sued.de/certificate-validity-check

MS/01-07/2004

General information

Foundation year: 1993

Main location: Dresden, Germany

Offices in Russia, Kazakhstan, South Africa, Latin America and China

Office & production area (Germany only): more than 1500 m2

Personnel, total (End of 2013): 30 (plus about 25 in other offices worldwide)

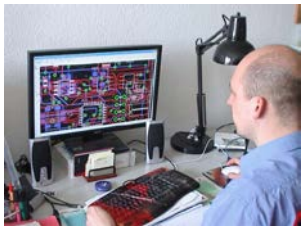
Personnel

Administrative personnel: 8

Educational background: *university-level, higher school*

Production personnel: 12 specialists with wide-range experience in engineering and manufacturing of measuring technique for radon and its daughter products and radiation aerosol monitors and systems as well.

Educational background: *technical / engineering education*



R&D personnel: 10 specialists with wide-range experience in science, research and development, engineering and manufacturing of measuring technique for radon and its daughter products and radiation aerosol monitors as well.

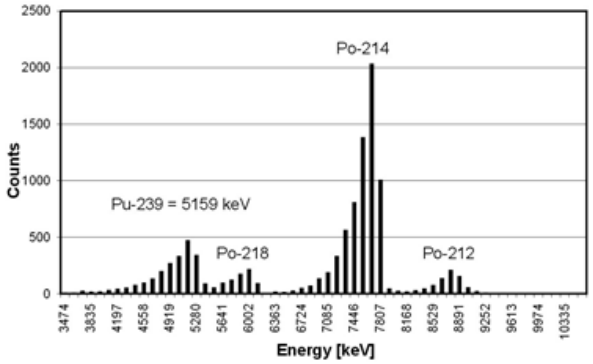
Educational background: *one is Professor, 2 people have MSc (PhD), other have technical / engineering / electronic / physical university or higher school education.*

In other our offices most our employee have university degree, one of them is a member of Academy, three are Professors.

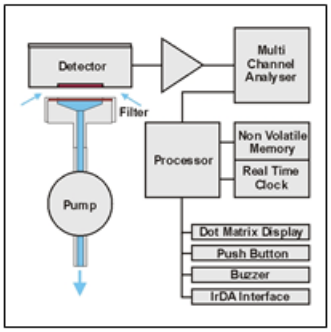
2. Our Products & Detection of Radioactivity

2002 on the basis of the new developed DOSEman device (on the picture below) the first online PU-Monitor for the Nuclear Facility Los Alamos was developed. This development was the Basis for the Personal air sampler MyRIAM that you can see on the picture above. In this device an external 3 l/min Pump and 4 cm² light tight Silicon detector was used.

Spectrum with LLRD and Rn-daughters



MyRIAM - THEORY OF OPERATION



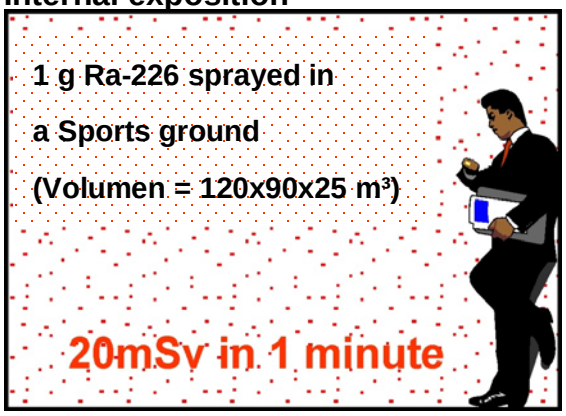
- Aerosol collection at the surface of a filter
- Detection of Alpha & Beta particles using a semiconductor detector
- Separation of long living Alpha Nuclides from Radon daughters by alpha-spectroscopy
- Beta gross counting and natural background subtraction
- Online calculation of non natural Alpha & Beta exposure

Why Aerosols are dangerous

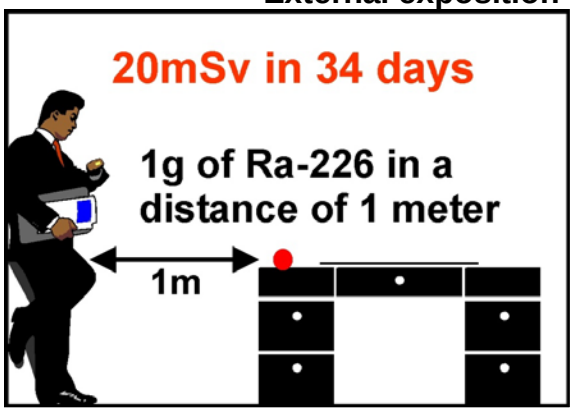
In case of inhalation of radioactive gases or aerosols radioactive sources will be incorporated into the body. This means: the sources are immediately near sensitive biological cells. There is no attenuation of radiation intensity caused by air or human skin.

Very (!) small amounts of radioactive material produce a strong exposition if the source is incorporated. The relationship between internal and external exposition is shown in the following images. Serious preventive measures for personnel protection avoiding inhalation are absolutely necessary.

Internal exposition



External exposition



Personal Inhalation Dosimeter

Two types of personnel detectors are offered: The "Doseman" detects the radioactivity dose caused by incorporable radioactive aerosols.

The "MyRiam" is able to identify typical radiation sources of alpha and beta radiation.

α radiation: Pu-238/239; Am-241; Ra-226

β radiation: Sr-90; J-131; Cs-137

These substances are typical candidates for usage in "Dirty bombs"

Special dangers which require the usage of a personal dosimeter (MyRiam) are:

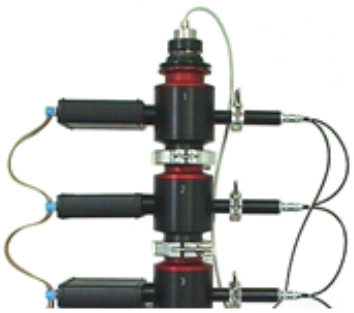
- Military operations
- Nuclear weapon blast (fall out),
- evaporated uranium ammunition
- Terrorist attacks
- „dirty bombs“ easy aerosol generators
- Spray of radioactive solutions
- Accidents in nuclear-technical arrangements (Chernobyl)
- Leakages in nuclear power plants, reactor accidents, fire in the facilities using radioactive materials (hospitals, research, establishments, industry etc.)

Therefore typical customers are:

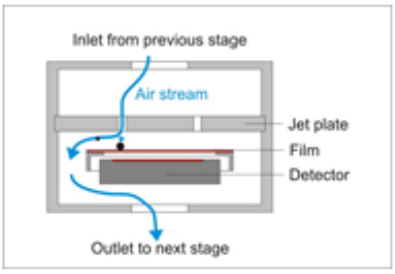
- Fire Fighters,
- Armed Forces
- Nuclear Industry
- Security Personal
- VIP's

For stationary installation in buildings or vehicles several types of detectors are available fulfilling distinct customer requirements.

Separation of size fractions

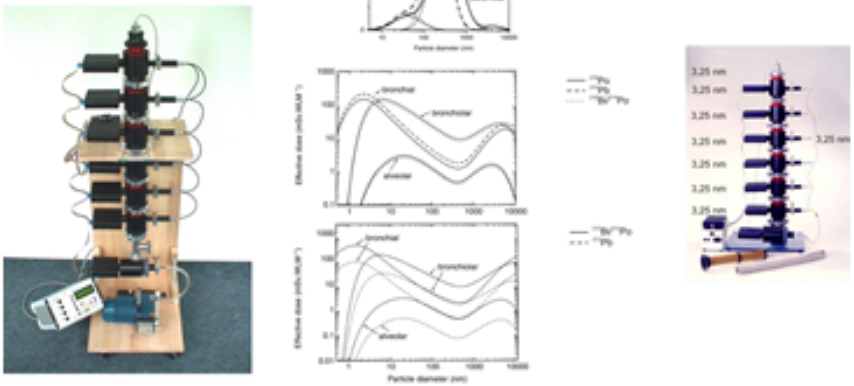


Cascade Impactor



Number of fractions
dependent on stage count

Scientific equipment to verify the simulations for the aerosol and radio nuclide transport…



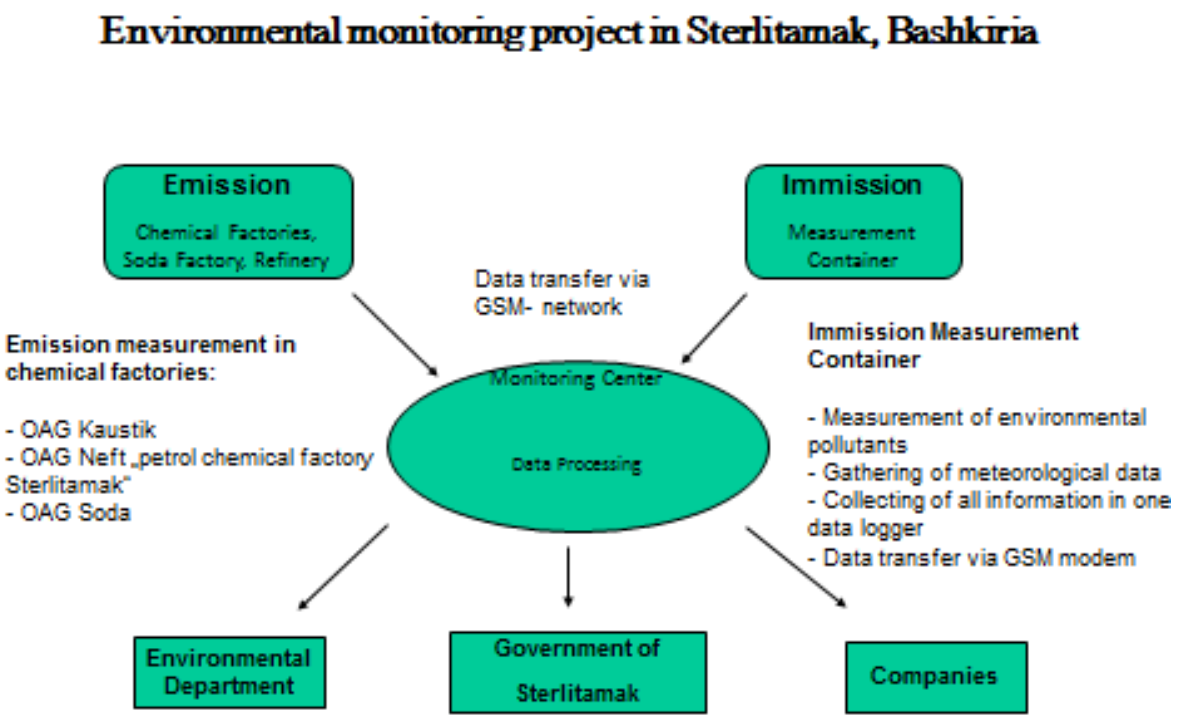
Activity size distribution analyser

Aer 5200 - High Volume on-line air sampler for measurement of LLRD and Radon progenies.

Online - continuous radioactive Aerosol und Radon/ Thoron Monitor in Tomsk, Russia

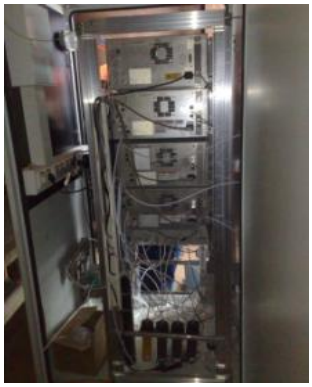
monitor is designed for outdoor operation at the temperatures from -50 C to +60 C and has temperature stabilization. IP68.

Area Monitoring Systems



The figure above shows an integrated system measuring the quality of air.

The next pictures show an installed and now working integrated measurement system of the quality of air. Five such full autonomous air monitoring stations was produced and installed in Sterlitamak city on different locations in Bashkiria, Russia.



Typical applications are

- within the center of big cities,
- near chemical plants
- near catastrophic areas (accidents of large fire)

If mobility is required the container could be installed on a vehicle. The special design depends on individual customer requirements regarding the expected threat, emissions or the chemical substances produced in an industrial plant.

Environmental Monitoring System with Emission Measurement Station at soda production facility in Sterlitamak, Bashkiria





Oil refinery industry




The following substances were measured:

Immission		Emission	
Name	**Chemical formula**	**Name**	**Chemical formula**
Phenol	C_6H_6O	OAG Neft	
Benzene	C_6H_6		
Toluol	C_7H_8	Dimethylamine	C_2H_7Cl
Xylene	C_8H_{10}	Methanol	CH_3OH
Alpha Methylstyrol	C_9H_{10}		
Vinyl chloride	C_2H_3Cl		
Methyl-2-butene	C_5H_{10}		
Trichloromethane	$CHCl_3$		
Dimethylamine	C_2H_7Cl		
Pentane	C_5H_{12}		
Dichhloroethane	$C_2H_4Cl_2$		
Methanol	CH_3OH		
Carbon monoxide	CO	OAG Kaustik	
Nitrous gases	NO		

• Sulfur dioxide	• SO_2	• Dichhloroethane	• $C_2H_4Cl_2$
• Nitrogen dioxide	• NO_2	• Vinyl chloride	• C_2H_3Cl
• Hydrogen Sulfide	• H_2S	•	•
• Ozone	• O_3	• OAG Soda	•
• dust	• Staub	•	•
• Ammonia	• NH_3	• Carbon monoxide	• CO
• Chlorine	• Cl_2	• Ammonia	• NH_3
• Hydrogen Chloride	• HCl	• Hydrogen Sulfide	• H_2S

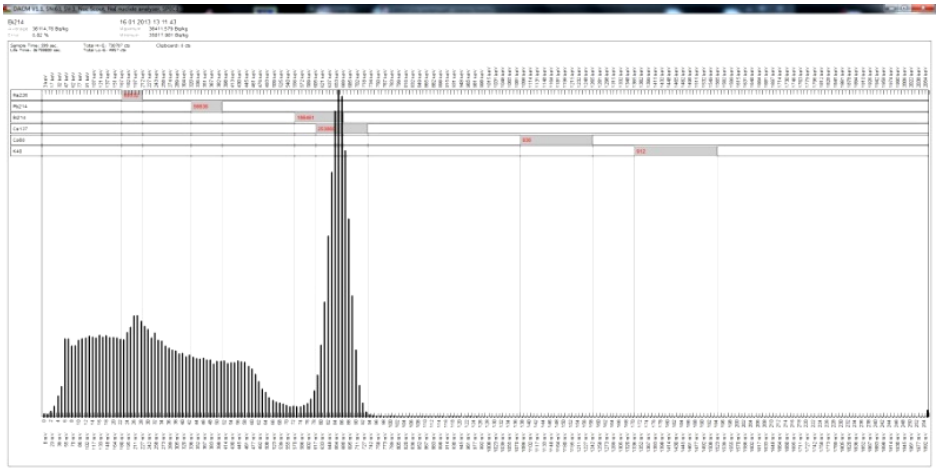
Detection of Gamma Radiation

The reactor accident of Chernobyl has shown that a permanently monitoring of the concentration of radioactivity in air and waters is undisposable.

The very sensitive detectors of Gamma-Radiation & Identifiers are shown in the right figures. The shown detectors are designed for installation in buildings or vehicles (i.g. the reconnaissance vehicle) as well as for mobile applications.

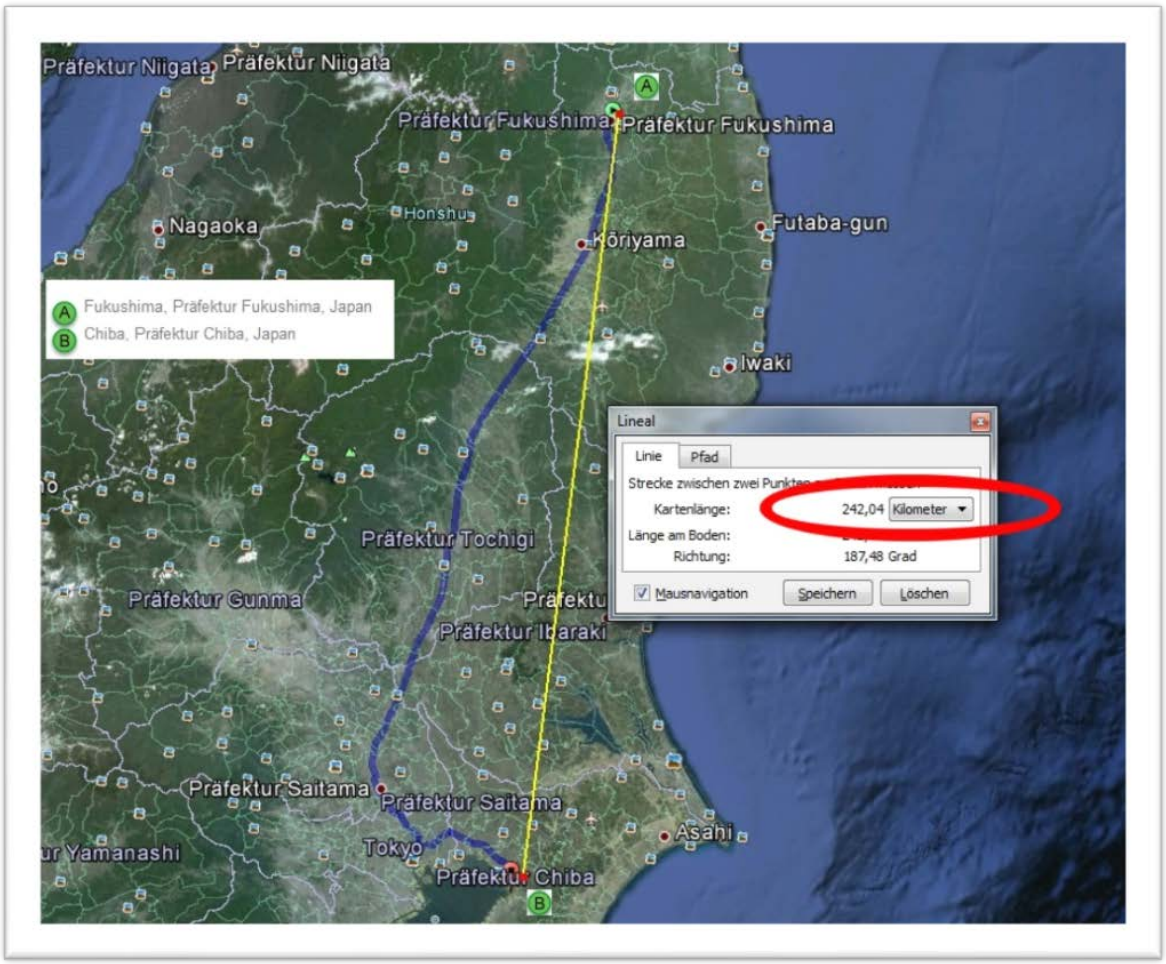
Searching and nuclide identification with map based visualization of area distribution of contamination at Wismut in Königstein Halbe

Leopoldishain, Germany



Comparison case study of BioScout in respect of the HPGe detector

• PARAM / DEVICE	• Standard HPGe	• Bio Scout
• **Weight**	• > 500 kg (with shield)	• 6 kg (no shield required)
• **Dimension**	• > 1,5x0,5x0,5	• = 0,5x0,25x0,25
• **Portability**	• No (stationary only)	• Yes (mobile)
• **Price**	• > 100k€	• ~5k€



Measurement data:

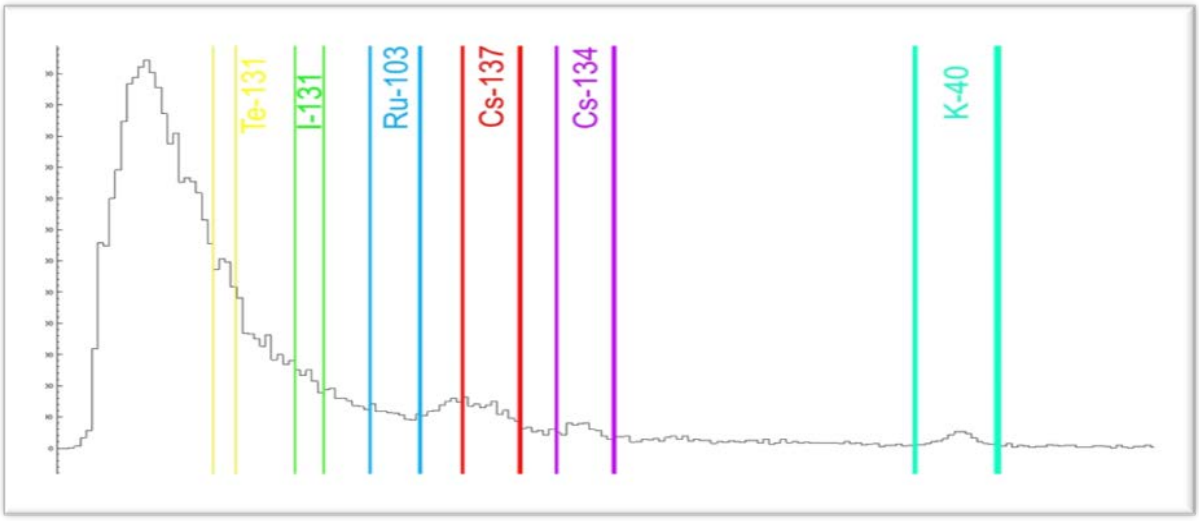
HPGe (High-purity germanium detector)				
Sample name: NIRS-soil-wet, Location: Chiba				
Measurement parameters	Weight [kg]	0,078	Interval [sec]	7000
Nuclide [Bq/kg]	Cs-134	±Δ[%]	Cs-137	±Δ[%]
4.	153	2	259	2

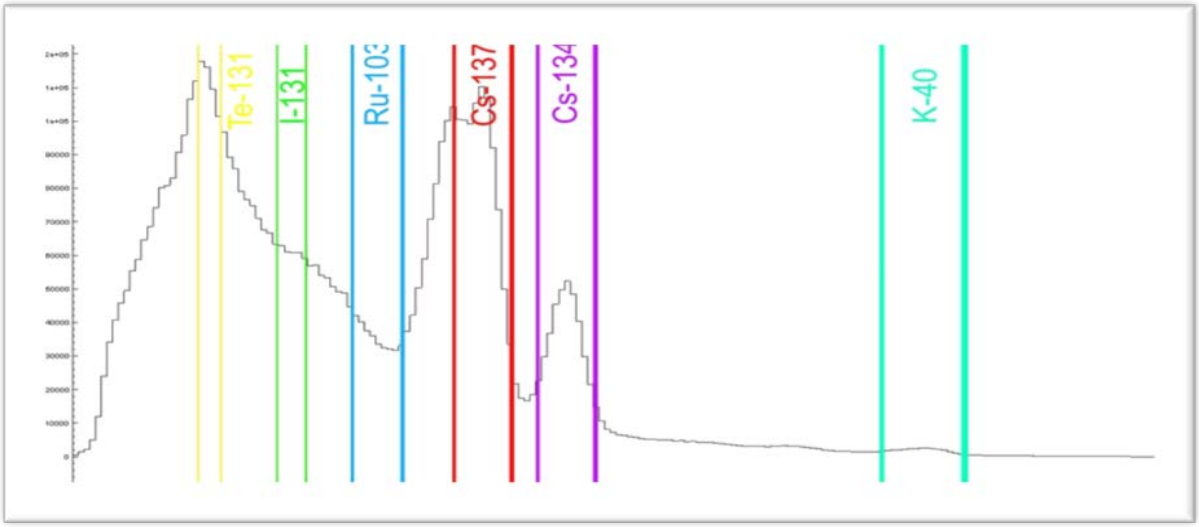
SARAD Bio Scout				
Sample name: NIRS-soil-wet, Location: Chiba				
Measurement parameters	Weight [kg]	0,94	Interval [sec]	206
Nuclide [Bq/kg]	Cs-134	±Δ[%]	Cs-137	±Δ[%]
1.	150	25	230	25

HPGe (High-purity germanium detector)				
Sample name: NIRS-soil-wet, Location: Chiba				
Measurement parameters	Weight [kg]	0,078	Interval [sec]	600
Nuclide [Bq/kg]	Cs-134	±Δ[%]	Cs-137	±Δ[%]
3.	145	9	279	6

SARAD Bio Scout				
Sample name: NIRS-soil-wet, Location: Chiba				
Measurement parameters	Weight [kg]	0,94	Interval [sec]	210
Nuclide [Bq/kg]	Cs-134	±Δ[%]	Cs-137	±Δ[%]
2.	155	27	276	21

Acquired Spectra





3. Our Projects

Public Projects

- **OGU-SARAD Julich 241003** - Real time monitoring of hydrological and geochemical parameters as precursory of earthquake in Eskisehir region, Turkey
- **DEG (KfW) PPPE3122 Philippines** - Continuous Measurement of Geo gases for effective geothermal reservoir management and earthquake prediction
- **Protect Rail (EUFp7)** – Integrated protection of rail transportation Monitoring of radioactivity and radioactivity aerosols
- **RUS 10/B05 (BMBF)** - development of a portable Alpha detector for surface contamination analyses
- **IW060218 (BMWI)** - development of Radon detector system for geological applications
- **MONACO (BMBF)** - development of a CO2 flux measurement system and conception of a remote data transfer for several CO2 instruments
- **KF2476602ABO (BMWI)** - development of a uranium measurement system based on nano particles and biochemical reactions
- **100092504 (IPMS)** - development of self-organized sensor networks for the acquisition of hazardous materials
- **BRA068/98(DLR/BMBF)** - Environmental management in Brazilian mining regions
- **MEX001/97 (DLR/BMBF)** - Geo hazard research in Mexico

Project BRA068/98(DLR/BMBF) – Dose management in Brazilian mining industry

The pictures below show the use of the personal Radon dosimeter DOSEman to protect personnel from exposure at mines in Brazil.
Professor Dr. Thomas Streil was personally present at acceptance of the equipment and has trained personnel how to use this instrument.

Large area Radon online monitoring system for ALDI food discounter, Germany

Our company committed recently a complex Radon monitoring system for a newly established logistic center of the German food discounter ALDI.

22 Indoor Air Sensors have been installed within a warehouse with the dimensions of about 300m x 250m. Each sensor is equipped by a SARAD Net-Monitors wireless interface (ZigBee).

All Sensors are linked to a Server PC which is located in the security center of the warehouse. Recent sensor readings are displayed and stored into a data base by the SARAD Tracking Online Monitoring and Alert System (TOMAS).

All data is stored additionally by the Indoor Air Sensors to ensure a gapless documentation even if the signal quality varies over the time (e.g. heavy Wi-Fi traffic by transport cars and scanners).

If a sensor reports a concentration above the alert threshold, a local alert will be generated an Emails will be automatically sent to responsible

persons. The internet connection is realized by an UMTS router. Therefore, there is no need to access ALDIs local network.

The structure of TOMAS allows the usage of the monitoring and alert functions simultaneously at any PC with internet access.

DEG (KfW) PPPE3122 Philippines - Continuous Measurement of Geo gases for effective geothermal reservoir management

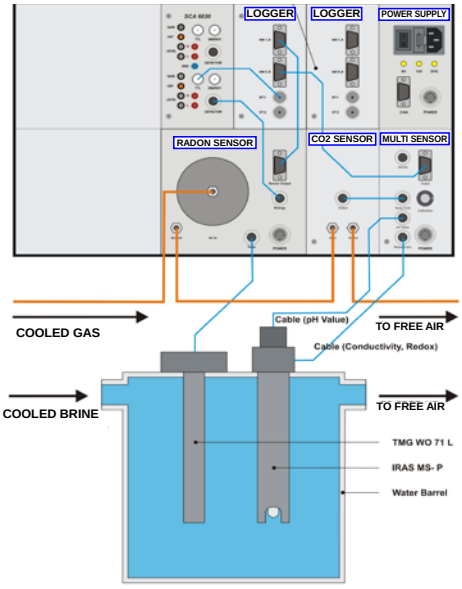
The aim of this project was to get information about the transport mechanism of re-injected water for the hot steam production using Radon gas as tracer. The second point of interest was to investigate the growing of radioactive scales on the inner walls of the production pipes.

Four stations at different production wells have been installed. The high pressured hot steam was de-compressed by water separators and water and air were cooled down to temperatures which are suitable for sensors.

The measurement of Radon/Thoron tracers and other geogenic gases was carried out in the gas as well as in the liquid phase. Gamma detectors were installed belong the pipes. All stations were linked by a wired CAN bus system into an operators office with internet connectivity.

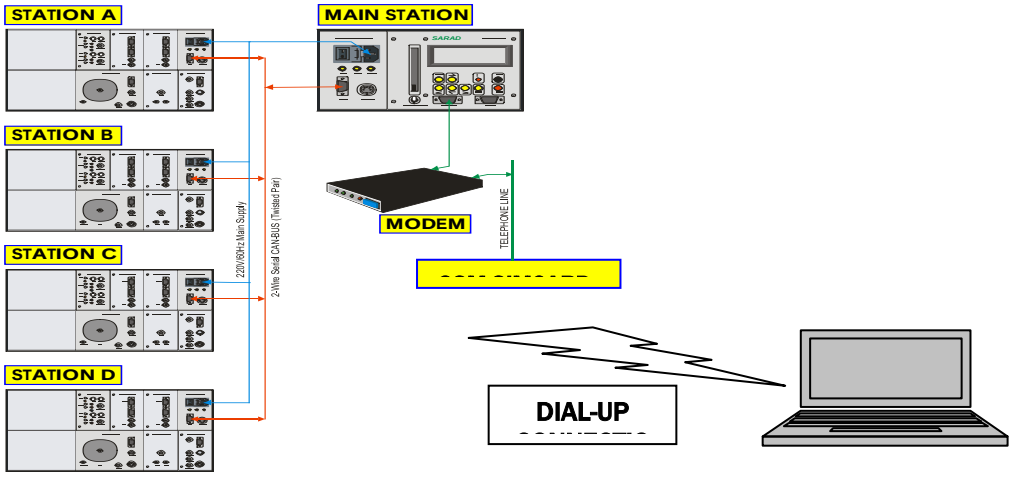
The figures as example show the application of pipeline monitoring on the Philippines.

Leakage of the pipelines as well as geological changes of the ground could be detected at an early state.



Parameters monitored in each substation.

	PARAMETERS
GAS Stream	Radon CO_2 Gas Flow Gas Temperature Gas Relative Humidity
WATER Stream	pH Chloride Redox Potential Conductivity Water Temperature



Schematics of remote data acquisition for the MEDAS

MEX001/97 (DLR/BMBF) - Geo hazard research in Mexico

The station is located in the tropical rainforest nearby a natural hot spring. There is no infrastructure on site available. The power is provided by a solar panel, the communication is realized by satellite phone link.

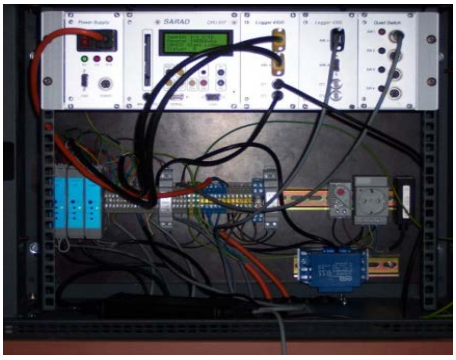
The ambient conditions are very harsh because of the high temperatures and humidity (30°C/95%). The spring generates a corrosive environment by mineralization and high water temperature.

A big number of geochemical, geophysical and radiation sensors are directly exposed to the hot water and soil gas.

OGU-SARAD Jülich 241003 - Real time monitoring of hydrological and geochemical parameters as precursory of earthquake in Eskisehir region, Turkey

A system of 10 complex monitoring stations have been installed belong the central Anatolien fault zone.

The local conditions were very different and did require a flexible fitting of the equipment. In some cases ground water pumps were used to provide the soil fluids for the sensors.



The system is based on the MEDAS system which was the base of our DACM technology. All stations are linked by GSM network to a central monitoring office.

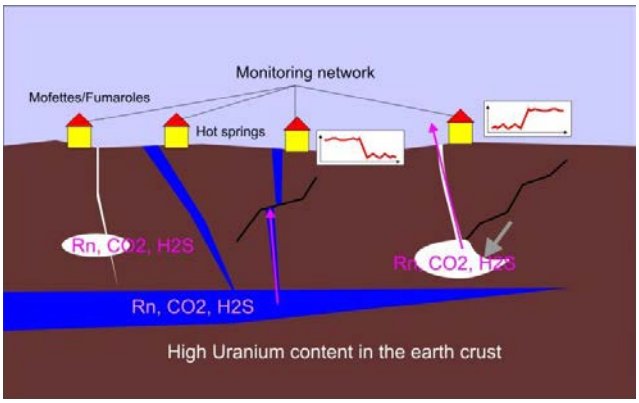
The stations working under rough environmental conditions like strong temperature variations between day/night and summer/winter. The stations were equipped by air conditioning systems and special protection systems for sensors and detectors.

A big number of sensors, including Radon/Thoron, pH, Redox, Conductivity, CO2, Methane etc. are operated by the stations.

MEDAS / GEO-RTM 2100
Installation related to continuous monitoring of Radon in water and physicochemical water parameters

Earthquake Prediction & Volcano Research

Geophysical changes could be caused by Earth quakes or man-made seismicity caused by oil production or mine activities.



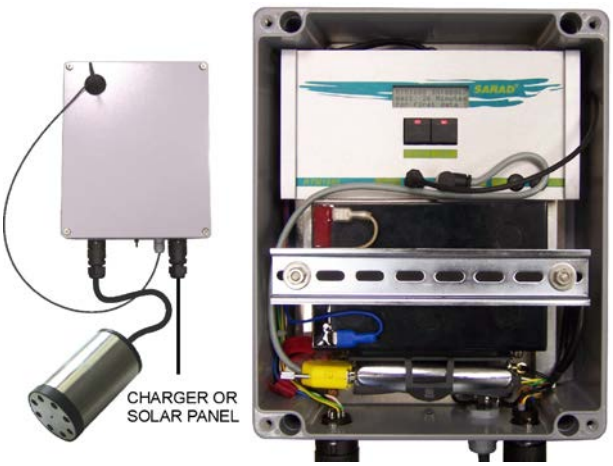
For example, the Earthquake on 6. April 2009 in L'Aquila produced more than 300 deaths, about 1600 injuries and more than 65000 homeless people.

These catastrophe shows that a reliable early warning system is indispensable.

It is well known that radon detection is suitable to build up an earth quake early warning system because radon gas is coming up through micro cracks in the soil before the real earthquake.

The SARAD Radon ground detector is sensitive to register the radon gas. The same is valid for man-made seismicity caused by oil production and mine activities.

The figure right shows a soil probe which detects (radioactive) radon emerging at the surface of ground. The soil probe is connected with the water proofed analyzing system.



The soil gas probe was developed especially for geophysical applications. The compact and rough cover made from stainless steel allows the usage of the probe inside bore holes from three inch (76.2 mm) up.

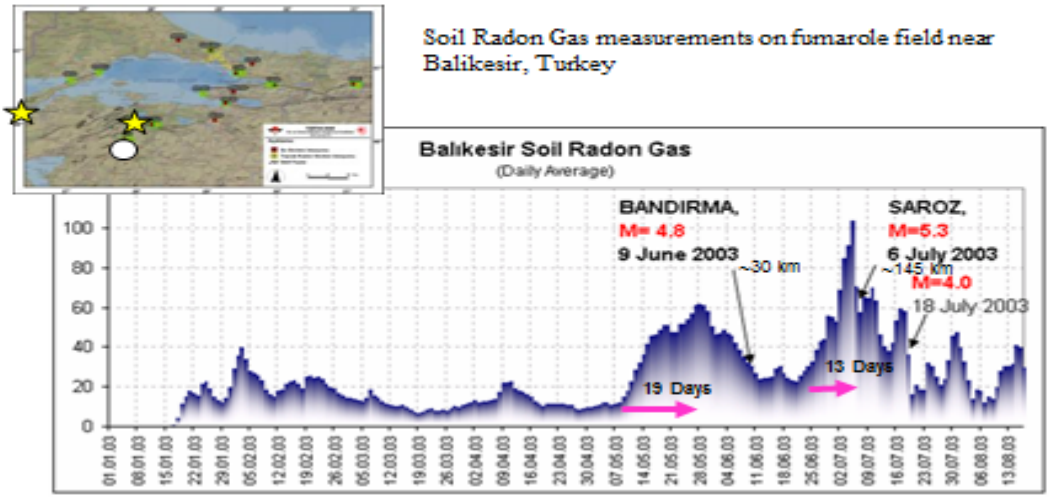
The electronic as well as the detector are protected by a special Urethane coating to ensure long operation times even under extreme conditions as expected in seismic and volcanic active areas (e.g. H2S).

A large area Silicon diffusion membrane causes a short response time.

Sensors for temperature and humidity are integrated in addition to the Radon chamber.

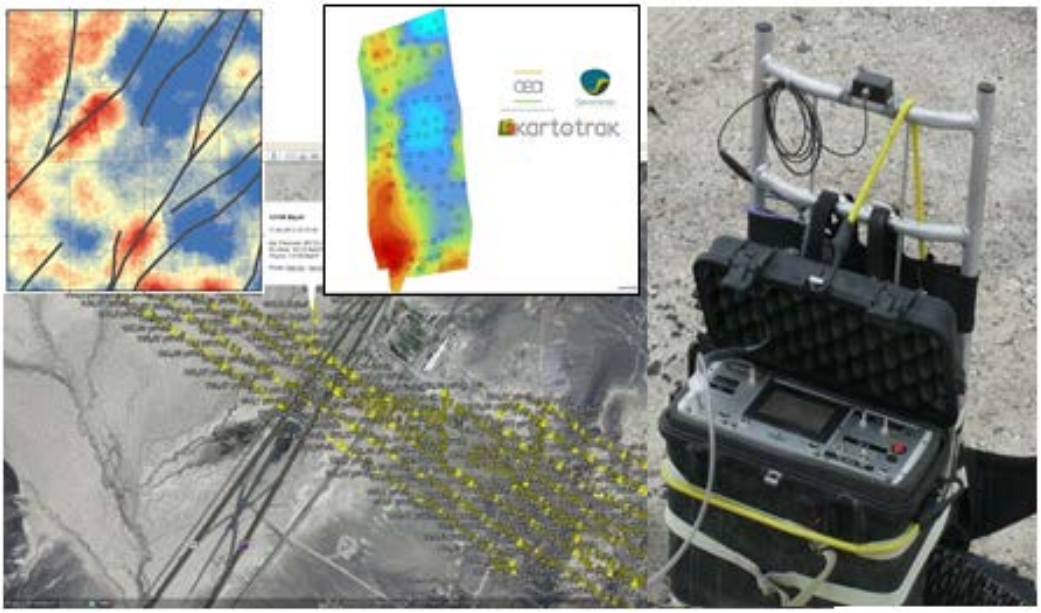
The images below shows as well as soil probe connected with the analyzing system and direct measurement process on a fumarole field near Taipei, Taiwan

Earthquake Prediction & Volcano Research

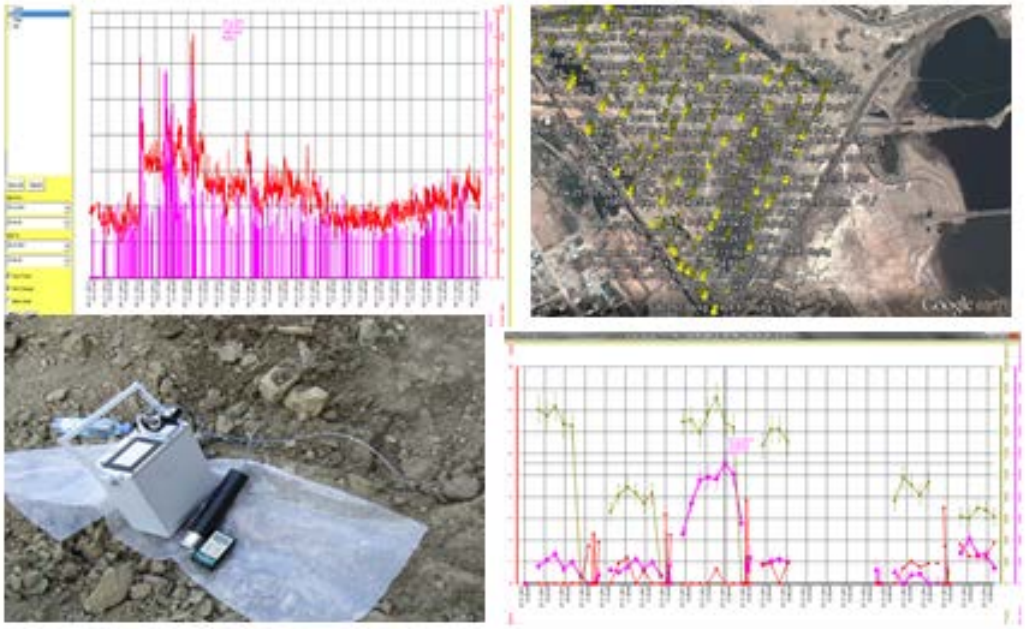


Soil Radon Gas measurements on fumarole field near Balikesir, Turkey

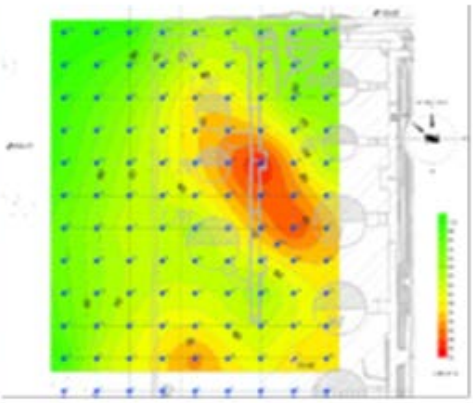
Mobile Monitoring of Radioactivity and Radon gas in the Desert of Nevada, USA



Measuring the Radon / Thoron soil gas activity and the local Gamma activity in Environmental remediation project from Norm material in Azerbaijan



Detection of Legacy Oil Sites by Radon Measurements



GICON

Protect Rail (EUFp7) – Integrated protection of rail transportation monitoring of radioactivity and radioactivity aerosols

The European Community project (running under the "Seventh Framework Program") for railway security improvement has been finished successfully after three years with a two weeks demonstration in Zmigrod/Poland. A consortium of European companies where SARAD worked together with industrial giants like Alstom and Bombardier demonstrated the today available solutions for prevention against terrorism and vandalism, and to increase transportation safety.

One key issue was the introduction of a decentralized and standardized communication system which is able to receive various events (generated by video systems, sensors, messages) from independent sources. Then, the events become categorized by a network broker and will be forwarded to potential users with respect to their competence profile. A parallel communication path allows the control of data sources and operators on site following the procedure which is foreseen after a specific event occurs (e.g. video tracking, parallel sampling)

Our company was involved in fife work packages and four demo-scenarios:

- Detection of radioactive sources inside luggage on the platform
- Continuous monitoring of freight containers regarding explosive and toxic gases
- Sniffing radioactive aerosols and toxic/combustible gases in wagons
- Inspection of freight containers
- Wireless communication via ZigBee network on train and platform
- Interface to ProtectRail communication network (event generation and access to available detector resources)

The various realistic scenarios have been carried out successfully several times under the critical eyes of the European Commission and stakeholders of the European railway industry. We are glad to get this pleasant confirmation of our development work during the last years.

You will find many of the demonstrated solutions already in our new products. For further information visit the website www.protectrail.eu.

4. NRC Reconnaissance Vehicle

Threats by Chemical Material

Chemical Plants

Chemical plant safety

New Jersey chemical plant vulnerable

Chemical plants must submit a report to the Environmental Protection Agency (EPA) detailing what they -- the plants -- consider a "worst case disaster scenario"; Kuehne Chemical said that for its South Kearny, New Jersey, chemical facility the worst that could happen would be the catastrophic release of one 90-ton rail car of chlorine gas which would put 12 million people at risk within a 14-mile radius of the plant in the New York-New Jersey region; trouble is, the company keeps more than one chlorine-filled rail car on the site, in addition to on-site storage of 2 million pounds of chlorine gas, so a worst-case disaster at the site could be far worse than the company's scenario.

Fertilzer Bombs

The Canadian Association of Agri-Retailers wants a comprehensive plan of action to prevent agricultural supplies such as fertilizers from becoming tools of terrorists; the association calls for an "integrated crop input security protocol" for Canada's 1,500 agri-retail sites; this plan would include perimeter fencing, surveillance and alarm devices, lighting, locks, software, and staff training in various security techniques, at retail outlets; estimated cost: $100 million.

=> http:www.fssc.ca

Industrial accidents or terrorist attacks can contaminate large areas or buildings by hazardous substances, industrial chemicals or radioactive material. The NRC Reconnaissance Vehicle contains all detectors and personal

protection equipment necessary to check whether areas are decontaminated and to estimate the type of contamination.

Based on requirements of the German civil protection SARAD produces customer-specific measuring container integrable into previously selected vehicles.

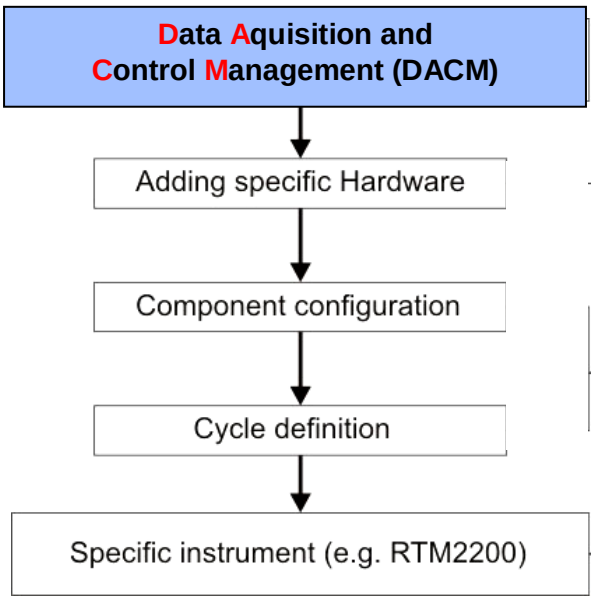
The following list contains some features of a possible configuration:

- Identification of chemical substances
- Detection of alpha, beta and gamma radiation; nuclide identification
- Detection of radioactive aerosols; inhalation dosimetry
- Container for suspicious biological samples
- Radio link (data and video channels)
- 360° Video-Zoom Monitoring and Storage
- GPS (time dependent position documentation)
- Illumination units
- Computer with video and data displays
- Personnel protection equipage.

5. Platform for Multi-Sensor Systems

The design of customer specific measuring systems is an expensive task. The advanced systems are based on a "Data Acquisition and Control Management" System consisting of hardware together with software.

The system uses standard procedures to integrate large number of (different) sensors into a single measuring system. Data visualisation and evaluation is also standardized using software.



The platform is quit suitable to build-up environment monitoring systems individually designed to customer requirements.

The platform contains interfaces to analogue and digital sensors. Build-in controlling elements allows the control of several actors with respect to actual input signals.

The platform is also equipped with interfaces to transmit measured data to an external guidance system via cable or radio link. A mass storage is installed too, if required the platform is usable as data logger for multi-sensor measuring tasks. Of course each measured value of each sensor is provided with a time stamp.

Multi-Sensor-System for Remote Data Acquisition via Radio Link:

6. SARAD's Software "RiskProtekt" as tool to handle Complex Risk Situations

In the field of terrorism, organized criminality or in disaster management typical situations occur, which are not foreseeable. Such scenarios are subject to a large number of factors influencing each other. This together with their temporal behaviour generates a very high complexity. Without computers ineffective or faulty decisions in many cases are the consequence. Sometimes measures cause the opposite of their intention.

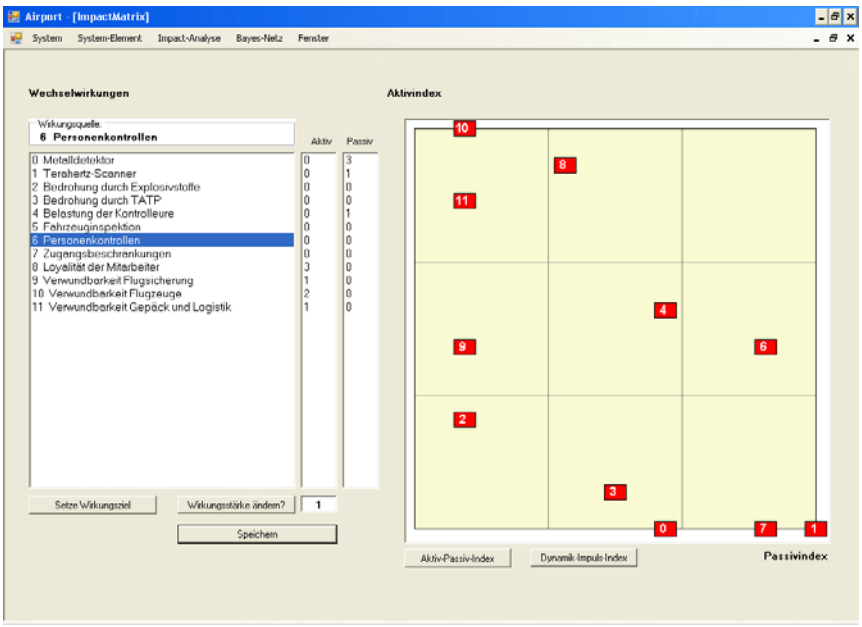
Decision Support with "RiskProtect"

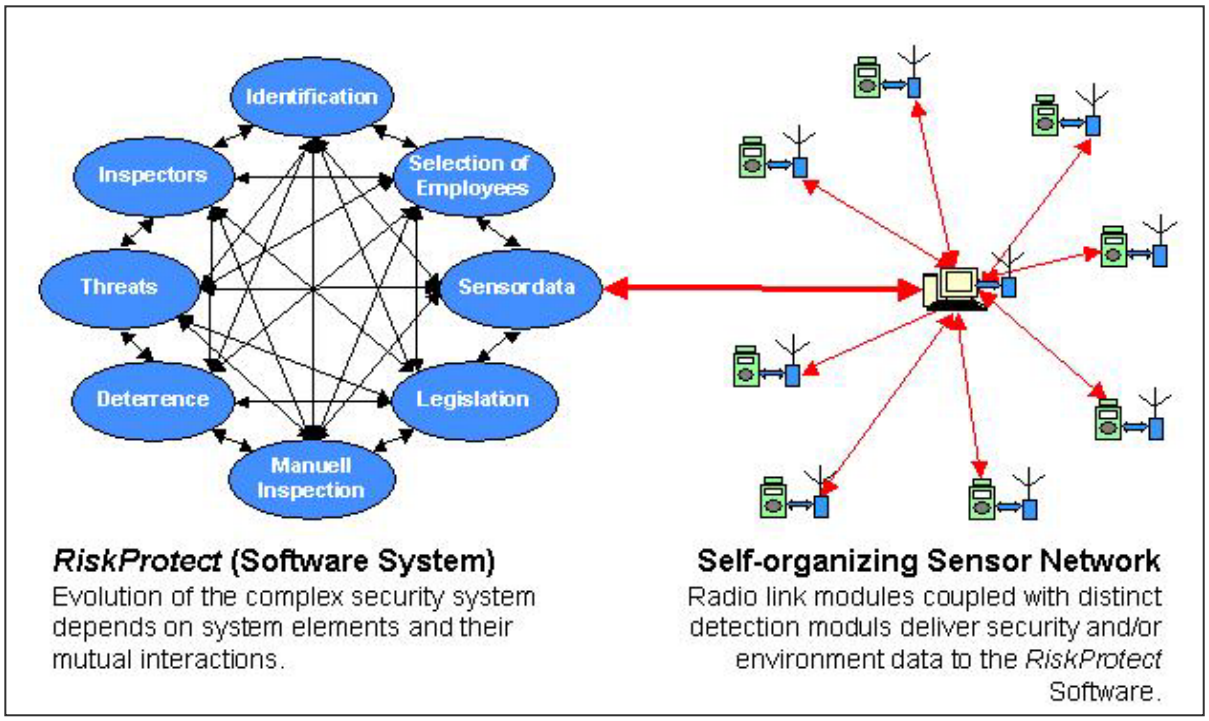
Based on experiences in airport and railway protection SARAD develops systemic models of the security processes and analyses the behaviour of the system in different situations. The computer models consider numerical data (generated for example by sensor networks as well as non-numerical data (for example delivered by news services).

Random events will be also considered.

The methods will be supported by the SARAD-secusys software "RiskProtect", developed by SARAD. Planer and decision maker get the possibility to early recognize consequences and impacts of their decisions.

Relation between the power of active and passive reactions in a security system





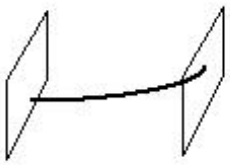
Relations between hard- and software components delivering numerical and non-numerical information used in* RISKPROTECT *as risk evaluation and decision support system.

Fig. shows the relationship between the security or environment system model as combination of a number of influence factors (the left side, most described by non-numerical data), and the sensor network delivering numerical data (right side).

To understand the behaviour of the complex security or environment system requires a detailed analysis of the mutual interactions between each couple of influence factors (system elements). Very important for this analysis is how far the concept of causality is applicable to these interactions. In our research project we distinguish four different concepts of causality:

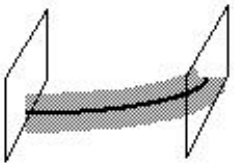
1. Weak Causality

   This is the case if equal causes create equal consequences. Mathematical equations and idealised physical laws are examples of weak causality.



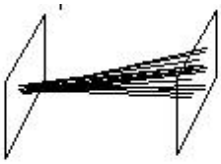
2. Strong Causality

   Causality is called as strong, if similar causes create similar consequences. Linear Systems are such of strong causality.



3. Deterministic Chaos

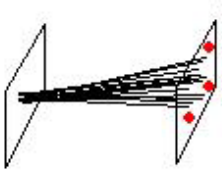
   Similar causes create unsimilar consequences. This is the case in non-linear systems as well as in random systems. In deterministic chaos the weak causality is valid but strong causality is unvalid. For example a cloud is not a clock because of the unknown initial conditions a cloud is a highly random system.



4. Non-Deterministic Chaos

   Non-deterministic chaos is characterized by the appearance of creativity and self-organization. In these cases both principles, weak causality as well as strong causality are invalid.

   The behaviour of non-deterministic chaotic systems is not predictable. Typical examples are social systems. Traditional methods of constructive engineering are not applicable to guide and control such systems. On contrary evolutionary methods of problem solving are required.



The different types of causality imply different degrees of uncertainty about the future evolution of the system. In most real systems all types of causality appear. This means based on the present state some interactions lead to well-known future states and some other are subject to high degree of uncertainty. In the first case the interactions could be described by mathematical functions to calculate the future state. In the second only rough estimations of future states are possible.

Therefore the *RISKPROTECT* software provides functions considering the uncertainty with respect to the interactions between the system elements. Three foresight techniques are implemented and could be used jointly to describe the very same system.

1. Scenario Technique

   In this case formal rules about the future development of the system elements are not known. The technique is based on knowledge and experience of experts.

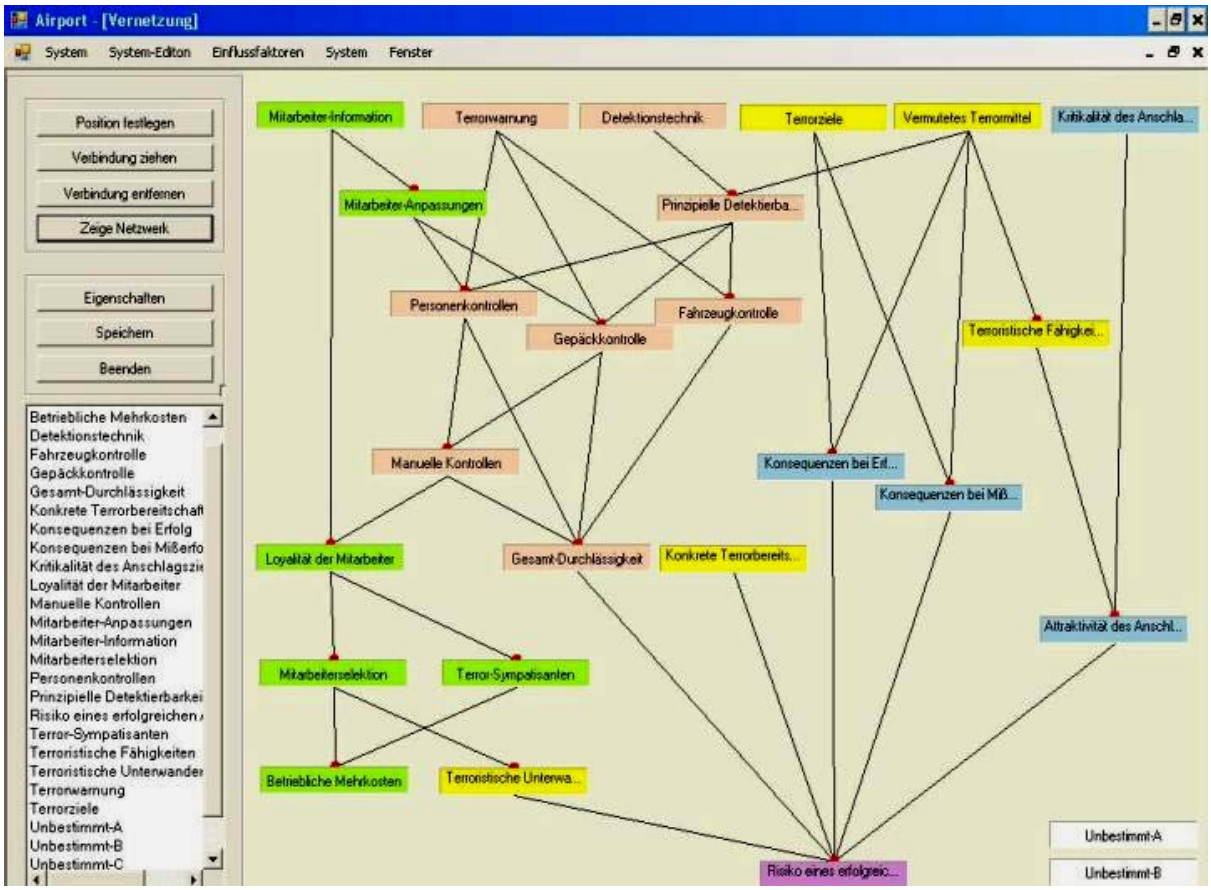
2. Bayes Networks

   If statistical values are known to calculate conditional probabilities these values could be used to calculate to probability of future states. In case of terror countering reliable statistical data are not available. In praxis instead of the probability values estimated values of "plausibility" will be used.

3. System Dynamics

   The future state of an influence factor could be calculated according to a mathematical function. For example if we double our security staff the new personal cost is twice of the old cost.

The following figure on the next page (sadly in German) shows a *RISKPROTECT* dialog window containing the interactions within a simple airport access control system. The various groups of influence factors are marked by different colours.



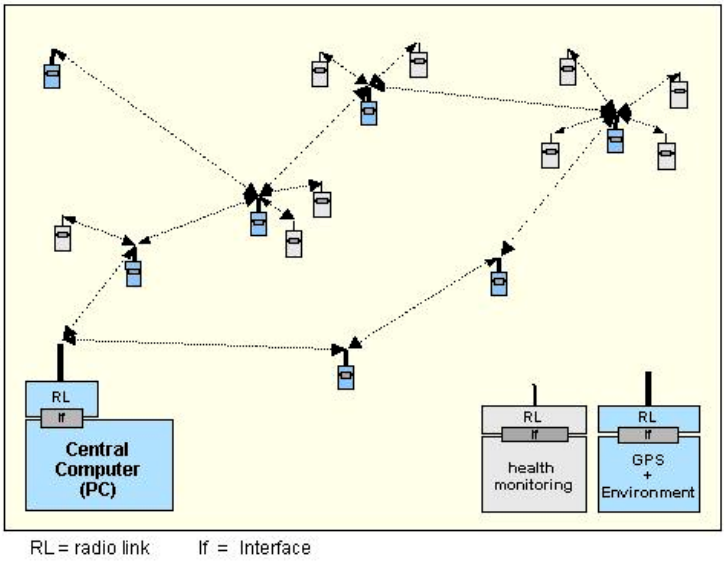
Dialog Window showing the relations between the system elements of a simple airport access

Access control at airports checks people and staff only at the entrance to the security area. Desirable is also security surveillance inside the area. Mobile sensors carried by security staff will provide a high degree of flexibility without any constraints.

The self-organizing sensor network as symbolized in Fig. provides the capability of area protection regarding various hazardous substances. Each sensor is equipped with a radio link to connect the sensor with other sensors and/or a central computer. The redundancy provided by the network makes it tolerant against disturbances and failures.

By combination of the network with specialised sensors opens a wide range of applications. Examples of suitable sensors are:

- Alarm switches
- Explosive Gases (methane)
- Radioactive Aerosole
- Radioactive Radiation
- Health monitoring of first responders
- GPS geographical location
- Pipeline monitoring (pressure loss, thefts)



Symbolized wireless network of mobile security

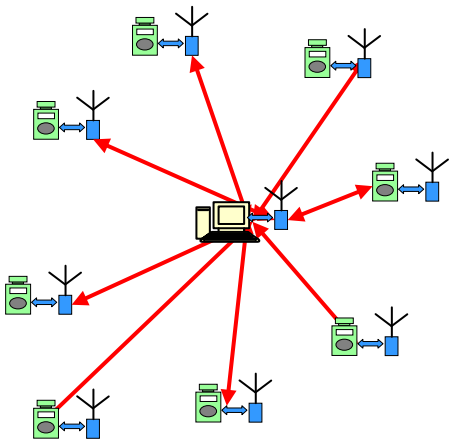
Freight Inspection System

Independent from the sensor network detection technology a freight inspection system will be developed on basis of an ion mobility spectrometer and an integrated system detecting radioactive aerosols and radioactive radiation (development in cooperation with Moscow Engineering Physics Institute (MIFI).

The freight inspection system will be designed as tunnel system similar to those for X-ray luggage investigation ndt protection or disaster management.

7. Self-organizing Sensor Networks

The self-organizing sensor network as symbolized in the right figure provides the capability of area protection regarding various hazardous substances. Each sensor is equipped with a radio link to connect the sensor with other sensors and/or with a central computer. The redundance provided by the network makes it tolerant against disturbances and failures.



Self configurating sensor network for area monitoring.

The radio-link doesn't use the GSM system because in case of terrorist attacks sometimes it is reasonable to disable terrorist communication by switching off the GSM system.

Inserting specialised sensors into the network opens a wide range of applications. Examples of suitable sensors are:

- Alarm switches
- Explosive Gases (methane)
- Radioactive Aerosole
- Radiation
- Health monitoring of first responders
- GPS geografical location
- Pipeline monitoring (pressure loss, thefts)

8. Systems Engineering and Training

In the field of terrorism, organized criminality or in disaster management typical situations occur, which are not foreseeable. Responders should be prepared on a wide range of possible alternative outcomes of the disaster evolution. Based on models of the systemic behaviour of complex systems SARAD delivers recommendations for the design of sustainable security systems.

The recommendations consider:

- the vulnerability of critical assets (e.g. Transport systems, Airports, Seaports, ships, energy plants, oil- and gas supply or similar)
- the capability of terrorist (know-how to produce or handle the weapons, technical and financial resources),
- the "attractivity" of an attack in view of terrorist.
- the capability to overcome barriers established by the security system against terrorists (e.g. access control, vehicle inspection, perimeter protection)
- the consequences of a successful or unsuccessful attack,
- the consequences of the preventions.

9. Competencies and Experiences

Worldwide SARAD is one of the leading developer and manufacturer of nuclear radiation detectors, especially of the detection of radioactive aerosols.

Further its environment monitoring systems are working not only in Germany but also for example in Russia, Philippines and Mexico.

It systemic network approach has let to leading participation in German and European research projects to increase security of transport systems (airports, railways, harbours)

Beyond their business the leading personal of SARAD have scientific reputation as lecturers in Germany and Russia. Prof. Dr. Thomas Streil (managing director of SARAD) is Member of the Academy of Sciences of the Russian Republic of Tatarstan, Dr. Karl-Dieter Wien gave lectures in innovation and quality management to students as well as to Russian and Chinese Managers.

SARAD organized the International Conference on "Hazard - Detection and Management" which was held in Dresden from Sept. 20th until Sept. 24th in 2010. SARAD will also act as member of the scientific committee. Conference topics are (among others):

- Detection Methods
- Sensors on different Platforms
- Monitoring of natural and man-made Risks
- Forewarning.

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