The NATO Science for Peace and Security Programme

Special Edition

NATO SPS Science Day in Kyiv, Ukraine, 27 May 2016

NATO Emerging Security Challenges Division

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— SPS Cooperation with Ukraine —

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Science for Peace and Security Cooperation with Ukraine

The NATO Science for Peace and Security (SPS) Programme is a partnership tool that promotes security-related practical cooperation between experts and scientists from NATO and Partner countries. Active engagement between Ukraine and the SPS Programme dates back to 1991 and has been deepening ever since. In response to the crisis in Ukraine and following the political guidance provided by NATO Foreign Ministers in April 2014, practical cooperation with Ukraine in the field of science and technology has been further enhanced.

In September 2015, the NATO-Ukraine Joint Working Group on Scientific and Environmental Cooperation (JWGSEC) met at NATO HQ in Brussels. The high-level Ukrainian Delegation was led by the Deputy Minister of Education, Mr. Maxim Strikha. During the meeting, the Ukrainian representatives provided an overview of the impact of the current security crisis in Ukraine on scientific infrastructure and education institutes in the country. In this regard, the SPS Programme plays an important role by engaging Allied and Ukrainian scientists and experts in meaningful, practical cooperation, forging networks and supporting capacity building in the country.

SPS activities in Ukraine address a wide variety of emerging security challenges such as counter-terrorism, energy security, and defence against chemical, biological, radiological, nuclear (CBRN) agents. Many of the SPS activities currently ongoing help Ukraine to deal with the effects of the crisis. New flagship projects in Ukraine's priority areas of cooperation have been developed and launched, and further ideas for potential cooperation are being explored. In 2015 alone, 16 new SPS activities with Ukraine were approved by Allies, making it the largest beneficiary of the SPS Programme.

One particularly important SPS top-down flagship project is supporting the efforts of State Emergency Service of Ukraine (SESU) in the area of humanitarian demining in Ukraine. Initiatives like this not only benefit the security community but also positively impact the local populations by enabling them to safely return to their homes. Ukraine also recently joined a major SPS project to develop a multinational telemedicine system for emergency situations. Once completed, this system will allow medical personnel to assist in major disasters and incidents, of military or civilian nature, that require specified medical expertise in remotely-located areas. Other suc-

NATO Assistant Secretary General for Emerging Security Challenges, Ambassador Sorin Ducaru, and the Ambassador of Ukraine to NATO, Ihor Dolhov speak about practical cooperation at a joint interview in December 2014.

The NATO Science for Peace and Security Programme

The SPS Programme is a major NATO partnership initiative. Created in 1958, it is a brand for the Alliance and today provides opportunities for practical cooperation in partner countries through multi-year projects, training courses and research workshops. SPS activities promote collaboration based on security-related civil science, technology, innovation and beyond and are guided by a set of key priorities aligned with NATO's strategic objectives to:

- address emerging security challenges, such as cyber defence, counter-terrorism, energy security, or defence against CBRN agents;
- support NATO-led missions and operations;
- support the development of security-related advanced technology;
- address human and social aspects of security;
- address any other security-related domain that is in line with NATO's strategic objectives.

cessful joint activities address important issues such as Women, Peace and Security, Border Security or CBRN Defence.

By bringing together high-level scientists, collaboration through the SPS Programme benefits not only Ukraine, but the global scientific community and creates networks and synergies with practical results. Over the last years, dozens of young scientists from Ukraine got the opportunity to pursue research with international experts in their field, and received stipends through SPS-funded projects, helping them to kick-start their academic career. Each project director has to clearly identify end-users, manly government institutions, in order to ensure the sustainability of their projects. The equipment and the money provided throughout the life-cycle of the multi-year projects will be used for the benefit of the local populations.

Many SPS activities, in particular in partner countries receive a high-level of recognition both in the national and in the local media. The SPS Programme continues to enhance its public diplomacy efforts in order to promote its activities and to raise its visibility. Next to the SPS website (www.nato.int/science), social media channels such as Twitter (@NATO_SPS) are actively used to update SPS stakeholders and the wider public on its current activities. The Programme also directly engages SPS project directors in public diplomacy efforts by involving them in SPS Information Days and offering them the opportunity to publish the results of their research in the NATO Science Series under IOS Press and Springer.

This booklet provides an overview of the status of cooperation between NATO and Ukraine in the framework of the SPS Programme as well as a summary of selected ongoing activities as of May 2016. It is a special edition that has been compiled for the occasion of the SPS Information Day in Kyiv on 27 May 2016.

The SPS Programme would like to thank the Ukrainian Mission to NATO, the Ministry of Science of Education of Ukraine and the National Academy of Science of Ukraine for their excellent cooperation and support in organizing this Information Day. The event is yet another manifestation of the strong commitment of both NATO and Ukraine to strengthen their cooperation through the SPS Programme.

PROJECT HIGHLIGHTS

A MULTINATIONAL TELEMEDICINE SYSTEM

Leading nations: **Ukraine, Romania, United States, Finland and the Republic of Moldova**

Medical specialist using telemedicine system

This multi-year flagship project enables telemedicine to cross national borders allowing medical specialists to engage in major disasters or incidents that require specialized expertise or that are in need of first response humanitarian aid.

Once fully developed, it will have a dual-use for both civilian and military application. Portable medical kits will allow first responders to connect to the system to receive advice from medical specialists in case of an emergency, even in remote areas. Through the use of modern communications technologies, an international network of medical specialists will be able to assess patients, diagnose them and provide real-time recommendations. This will allow the right aid and care to reach those who need it most quickly, with the potential to save many in disasters. The NATO Communication and Information Agency (NCIA) is providing expert support on communication technologies.

The system was successfully live-tested during the consequence management field exercise **Ukraine 2015** that took place in September 2015. The exercise scenario was based on a mine collapse and subsequent chemical and radiological incidents, as well as transportation accidents, compounded by complex hazards affecting critical infrastructures in the area of Lviv, Ukraine. The overall aim of the exercise was to practice cooperation and contribute to enhancing national capabilities of NATO Allies and partners in the area of civil emergency planning.

NATO Secretary General Jens Stoltenberg and President of Ukraine Petro Poroshenko in the telemedicine tent during the September 2015 exercise

It was the first time that independent national telemedicine systems interacted to provide medical support in a disaster scenario. NATO Secretary General Jens Stoltenberg and the President of Ukraine Petro Poroshenko attended the exercise and a demonstration of the telemedicine system.

Ukrainian experts recently visited their counterparts in Romania in order to identify best practices in the field of telemedicine and emergency response. The visit was the first stepping stone to establish a national emergency response training centre in Ukraine [ref. G4748].

SPS SUPPORT TO UKRAINIAN DEMINING ACTIVITIES

The SPS Programme provides valuable support to Ukraine to build capacity in the domain of demining. In 2015, two multi-year projects with Ukraine were launched in this area.

SUPPORT TO HUMANITARIAN DEMINING IN UKRAINE

Executing Agency: **NATO Support and Procurement Agency (NSPA)**

SESU EOD teams undertaking demining operation

This multi-year project provides Ukraine with assistance in the area of humanitarian demining by enhancing the capacity of the State Emergency Service of Ukraine (SESU) in undertaking demining operations in Eastern Ukraine. The overall aim is to significantly contribute to safeguarding the civilian population within areas affected by the conflict and allow the return of displaced persons.

The project is based on two areas of activity that are mutually supporting and are providing the demining teams of the SESU with an initial operational capability, through equipment and training. The SESU teams will be introduced to and equipped with modern technologies of detection and clearance. The NATO Explosive Ordnance Disposal (EOD) Centre of Excellence in Slovakia will carry out specialist training to familiarize the trainees with the new equipment. Further reconnaissance training will be provided, which includes the investigation, detection, and reporting of explosive ordnance so that the SESU can cope with the additional challenges brought about in a high threat environment [ref. G5024].

HOLOGRAPHIC AND IMPULSE SUBSURFACE RADAR FOR LANDMINE AND IED DETECTION

Leading nations: **Italy, Ukraine and the United States**


Project Kick-Off meeting – October 2015

Detecting buried explosives is a vital security issue. Therefore, development of techniques that enable rapid detection with a low number of false alarms is crucial. This SPS project is developing a remotely-operable, robotic, multi-sensor device for enhanced detection of unexploded ordnance (UXO), mines, and improvised explosive devices (IEDs) and to diminish the number of false alarms by means of new techniques combining holographic and acoustic methods. The enhanced radar will enable the demining of larger areas of land in a safe and efficient manner, open new possibilities in demining in a range of soil conditions, eventually helping to diminish the number of casualties among demining personnel and civilians while reducing the overall cost of demining. Scientists from the University of Florence, the National Academy of Sciences of Ukraine and the Franklin & Marshall College in the United States are working together to create this prototype [ref. G5014].

REMEDIATION OF FUEL POLLUTED MILITARY SITE IN UKRAINE

Leading nations: **France and Ukraine**

A bird's eye view on the polluted military sight near Kyiv

Sand and carbon filters

A military base established in 1975 serves as a fuel deposit whose role is to supply fuel to other military bases in the vicinity. Nearly 12,000 tons of oil per year are provided by this base. However, located in the residential areas of Kyiv, it causes significant groundwater pollution and soil contamination in the area.

The main goal of this multi-year research project is to research and develop more efficient technologies to eliminate the pollution. The measurement of the geological and hydrogeological context will enable the development of a remediation model and the design of appropriate devices. The results of this project will enable the Ukrainian team to acquire all the know-how and skills necessary to master these increasingly complex technologies and to expand these competences to other sites.

This capacity building project exemplifies the strong partnership relations between NATO and Ukraine. It is a joint cooperation between the Bureau de Recherches Géologiques et Minières (BRGM) in France, the Ukrainian Ministry of Defence and the Institute of the Geologic Sciences of Ukraine. The collaboration between these institutions will enable a generation of young scientists to develop expertise in a critical security domain. It will build the capabilities of future generations to better protect the environment and populations.

The training of Ukrainian scientists by experts from the BRGM began in 2014. In 2015, modern equipment was provided by NATO and the remediation of the polluted site started [ref. G4585].

DEVELOPMENT OF AN ADVANCED X-RAY GENERATOR

Leading nations: **Ukraine, the Netherlands and Germany**

Scientist working on the x-ray generator

The scientists in this project are building a unique machine that produces high energy X-rays needed for high resolution image detection systems, which can be used across the world in fields as diverse as medicine, illicit trafficking, explosion detection, forensic detection and environmental security. Launched in 2003 and nearing completion, this is one of the longest running projects under the SPS Programme.

The machine uses state-of-the-art laser and storage ring technology and operates in two parts. The first part accelerates electrons to a very high speed. In the second part, a laser beam interacts with the accelerated electrons to produce high-energy X-rays. While building such X-ray generators can be very expensive, the unique technology used to build this machine as part of the SPS project, enables it to be developed at only a fraction of the cost without compromising range or energy level.


Storage ring

Located at the National Science Centre's Kharkiv Institute of Physics and Technology in Ukraine, the X-ray generator is only 15 meters in circumference and thus takes up significantly less space, allowing it to be placed in the basement of smaller buildings.

This project also plays an important role in building scientific capacity in Ukraine. The National Science Centre in Kharkiv contains many nuclear physicists who are given the possibility of working in their field of expertise. A team of 42, of which 18 are young scientists, is working on the development of the X-ray machine, thus contributing to the formation of the next generation of scientists in Ukraine [ref. G7982].

EXAMPLES OF ONGOING PROJECTS WITH UKRAINE ACCORDING TO SPS KEY PRIORITIES

Many of the SPS projects have a tangible, lasting impact on the international scientific community, local populations and governments in partner countries in addressing a variety of security concerns. The 40 ongoing activities with Ukraine support essential capacity-building, help to build scientific networks, bring about tangible benefits for the end-users, and train many young scientists. These recent initiatives build on a strong history of scientific cooperation with Ukraine. This section outlines a selection of ongoing activities led by scientists and experts from Ukraine and NATO countries under the framework of the SPS Programme.

COUNTER-TERRORISM

Terrorism poses a direct threat to the security of the citizens of NATO countries, and to international stability and prosperity. As a key priority for both the SPS Programme and Ukraine, several projects have been launched in this domain that primarily focus on research towards the development of counter-terrorism capabilities including new technologies

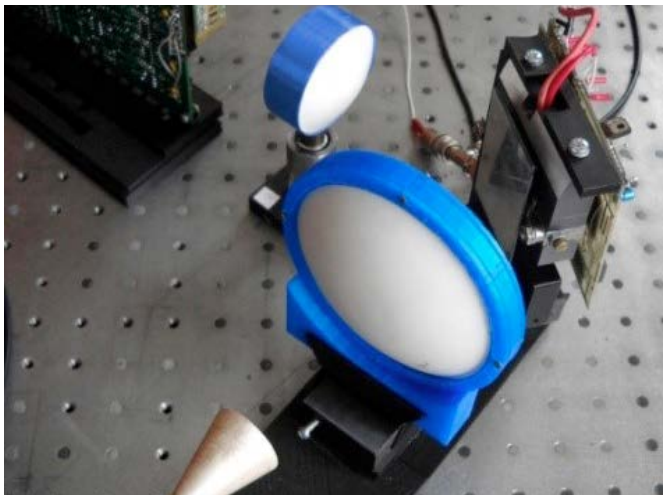
LONG-RANGE STAND-OFF MICROWAVE RADAR FOR PERSONNEL PROTECTION

Leading nations: **Canada and Ukraine**

The detection of threats concealed under clothing is a clear challenge in a variety of civilian and military security environments. Technological advances are needed to allow military and law enforcement personnel to neutralize threats in moving crowds in order to stop an attack before it can affect the targeted infrastructure. This multi-year project aims to develop a portable warning system of on-body concealed weapons (IEDs, knives, handguns and grenades) at distances up to 20 meters. A unique feature of this detector is its ability to "learn" from and adapt to specific environments, allowing it to differentiate threats and 'clutter' from the moment it is deployed. This new, compact technology will enhance military and security personnel to react effectively in highly unpredictable environments [ref. G4992].

UNCOOLED TERAHERTZ ARRAYS FOR IMAGING EXPLOSIVES

Leading nations: **Spain, Ukraine, United States**



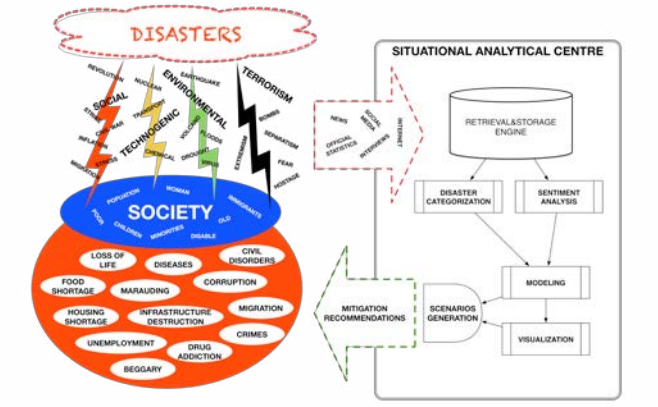
THz active optical system with aspheric lenses and scanning mirror for obtaining THz images

In the last few years, interest in using Terahertz (THz) technologies for security applications increased significantly. The fact that non-ionizing THz radiation can detect concealed weapons, and that several examples of drugs and explosives have THz radiation characteristics suggest that THz technology offers an impressively adept tool for the next generation of security applications. But, at the same time, there is a notable lack of real-time THz active imaging instruments that are essential to promptly detecting and revealing concealed weapons, explosives, and drugs. This project is investigating a new technology for fabricating THz sensitive films with

arrays of integrated micro-antennas. Once developed, these THz sensitive arrays will be incorporated into a prototype high-efficiency uncooled THz imager based on the newly developed arrays. Such an imager could help improve the detection of concealed threats with imaging times acceptable for a wider range of screening applications [ref. G4544].

MODELING AND MITIGATION OF PUBLIC RESPONSE TO CATASTROPHES AND TERRORISM

Leading nations: **Romania, Ukraine and the Republic of Moldova**



Developing of Situational Analytical Centre for modeling and mitigation of public response to catastrophes and terrorism.

During and in the aftermath of crises information on the public reaction is widely available through traditional media reports as well as social media. Harnessing this public information would allow incident managers to transform the public into an asset in crisis response. Towards this goal, this project initiated in 2014 is developing analytical tools to help predict, manage and analyse public reactions to provide response teams with real-time, public-sourced intelligence to better understand the situation on the ground and enhance the effectiveness of their response [ref. G4877].

MAGNETIC RESONANCE & MICROWAVE DETECTION OF IMPROVISED EXPLOSIVE AND ILLICIT MATERIALS

Leading nations: **Turkey and Ukraine**

The detection of explosive and illicit materials as well as concealed weapons is an issue of extreme importance for modern civilization. Hence, the main objective of this project is to develop an effective and fast technique for the identification of explosive and illicit substances. This is done by combining two complimentary methods of explosive detection: 1) magnetic resonance detection based on the application of nuclear magnetic resonance technique; 2) Microwave & sub-Terahertz dielectric spectroscopy. An important outcome of the project is the development of a device prototype for the detection of liquid explosives and liquid precursor components which can be used in the fabrication of improvised explosive devices (IEDs). Besides energetic or explosive substances, the device will detect illicit substances, first of all flammable liquids that are banned from transportation in airships or other kinds of transport [ref. G5005].

HAND-HELD GAMMA DETECTOR BASED ON HIGH-PRESSURE XENON GAS

Leading nations: **United States and Ukraine**

The primary goal of this project is the design and construction of a prototype hand-held gamma detector based on high-pressure xenon for the detection, identification and characterization of radioactive materials. This detector with spectrometric capability will be used in security applications and border protection to detect whether radioactive materials are being transported in the normal stream of commerce. In order to accomplish this goal, a complex cryogenic installation for Xenon purification and for filling the detector chamber is being developed and manufactured [ref. G4655].

ENERGY SECURITY

Energy security is a critical component for the national security of any country and the world at large. As a critical domain, it is a key priority for Ukraine and NATO member states. Several projects have been launched within the SPS framework with Ukraine.

NANOSTRUCTURED METAL-SEMICONDUCTOR THIN FILMS FOR EFFICIENT SOLAR HARVESTING

Leading nations: **United States and Ukraine**

Up to a third of the load carried by dismounted soldiers on patrol consists of batteries. This project aims to reduce this burden by developing new materials to allow the production of high-efficiency and low cost solar cells which could be deployed as energy solutions for both fixed and person-borne military applications. Developing new types of coatings capable of absorbing light will allow the absorbed energy to be transferred into a variety of solar cell technologies. By providing a platform for increased absorptivity, and thus increased power generation, this project has the potential to benefit militaries and defence contractors greatly. It will contribute to developing and maintaining robust, mobile and deployable conventional forces [ref. G4617].

DEVELOPMENT OF NOVEL METHODS FOR IMPROVED SAFETY ASSESSMENT OF GAS PIPELINES

Leading nations: **Italy and Ukraine**

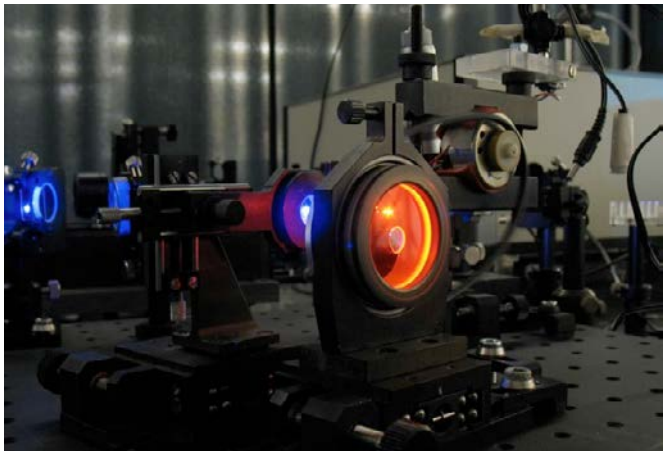
The project is addressing a common technical problem with aging gas pipelines that are risking disruptions of flow: hydrogen-induced pipeline degradation. The presence of hydrogen in the natural gas mix encourages corrosion and brittle fracture, which could lead to crack propagation and ultimately pipeline failure. The research teams will develop a novel non-destructive method to diagnose impending infrastructure failures earlier, faster and more precisely based on indentation tests performed on the external surfaces of pipe segments without the need of extracting material specimen for laboratory testing. Such a tool will help prevent pipeline disruptions and their potentially negative security ramifications. The cooperation with experts from Italy and the funding by the SPS Programme is helping Ukraine to build capabilities for a quick and reliable diagnosis of its national gas pipelines. The Ukrainian public gas transit company Ukrtransgaz will implement the novel methods [ref. G5055].

DEFENCE AGAINST CHEMICAL, BIOLOGICAL, RADIOLOGICAL AND NUCLEAR (CBRN) AGENTS

The central objective of SPS activities in the fight against CBRN agents is to improve the ability of NATO and partner countries to protect their populations and forces from such threats. The activities with Ukraine include research towards the development of CBRN defence capabilities, training courses and workshops.

MULTI-SENSOR SYSTEM FOR RAPID DETECTION OF DANGEROUS AND HAZARDOUS AGENTS

Leading nations: **Italy, Ukraine and Finland**



In light of the rising danger posed by different chemical agents, the need for reliable, quick-acting, low-cost detectors seems evident. The objective of this project is therefore to develop an affordable system for fast warning against hazardous chemicals. This will be achieved by creating a multi-sensor system, which employs a combined methodology based on metal oxide nanowires and signal processing methods. The system's own user friendly interface, in form of a touch screen, and advanced control functions enable a self-calibration capacity and reliable drift compensation features; reduced influence of temperature and humidity; as well as an improved reliability of chemical agent identification [ref. G5043].

A NEW METHOD OF DETECTION OF FAST NEUTRONS TO CONTROL ILLEGAL TRANSPORT OF NUCLEAR MATERIALS

Leading nations: **France, Ukraine and the United States**

This project will greatly contribute to the improvement of current nuclear safety systems. The neutron detector that will be developed in this research will provide significantly increased sensitivity while minimising the burden of false alarms, favouring the prevention of nuclear terrorism. This will be achieved through the measurement of inelastic scattering within scintillator detector materials that contain heavy atomic components. This approach offers the potential for greatly increased efficiency of detection in neutron detector systems that will be more compact than present systems. The project will provide enhanced security by enabling the improved efficiency and sensitivity in the detection of fissionable nuclear materials to aid the prevention of illegal transport of these materials [ref. G4605].

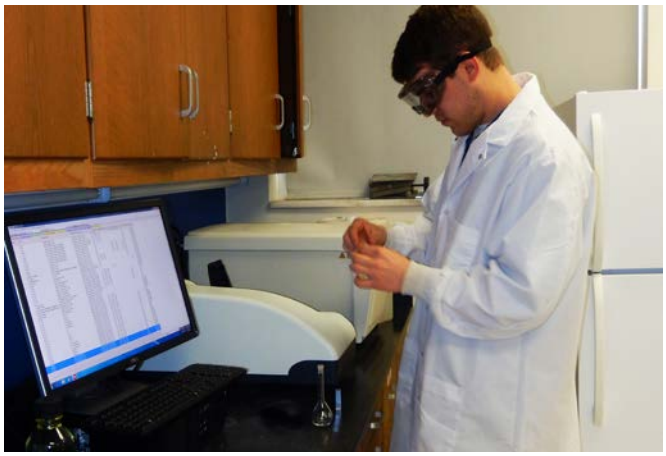
DEVELOPMENT OF OPTICAL BIO-SENSORS FOR DETECTION OF BIO-TOXINS

Leading nations: **Hungary, Ukraine, Israel, France and the United Kingdom**

The main focus of this project is the development of a new portable, hand-held device for highly sensitive detection of bio-toxins in low concentrations. For this purpose, research and development of optical bio-sensors is conducted. Through their high sensitivity and low power consumption, optical technologies provide great opportunities for scaling down devices as well as for operating in different environments such as liquid and gas. Portable bio-sensor devices will prove useful in military as well as civilian applications as they have the potential to help in early warning on the presence of toxins in water, drinks, food and even the atmosphere [ref. G4637].

DEVELOPMENT OF A SUPERSELECTIVE ADSORBENT AGAINST CBRN AGENTS

Leading nations: **United States and Ukraine**



In order to reduce radioactive contamination after CBRN incidents, this multi-year projects aims to develop a novel composite material for the selective adsorption and extraction of hazardous radiological materials. Radioactive isotopes of cesium are among the most hazardous CBRN agents that can be released into the environment and thus the thorough examination of its composite materials and its adsorption on obtained materials is all the more relevant. The selective adsorbent developed in this project will enable decontamination of the areas affected by a CBRN incident and reduce the risk of dangerous consequences on human health and environmental pollution [ref. G4639].

NEW DOSIMETRY FOR THE TRIAGE OF RADIATION EXPOSURE

Leading nations: **Turkey, Ukraine, Israel and the United States**

Physicists, radiologists, radiation chemists and researchers have recognized the harm that energetic radiation can cause when exposure is uncontrolled and have worked diligently to further understand biological effects of radiation. The objective of this multi-year project is to manage the consequences of an unexpected, large-scale release of radioactivity into the environment. By identifying new dosimetric materials and developing dosimetry methods, affected populations can be identified and public movement controlled through selection. The research will also enable the evaluation of the approximate dose of radiation people have been subject to in order to determine a medical course of action [ref. G4649].

METAL NANOCRYSTALS FOR HIGHLY SENSITIVE DETECTION OF BIOCHEMICAL AGENTS

Leading nations: **Estonia, Ukraine and France**

Early and sensitive detection of hazardous chemical or biological agents is one of the principal priorities of CBRN defence. Therefore, this project aims at the elaboration of modern refined technology for rapid and specific revelation of such agents which will create the basis for improving the defence system against biological and chemical terrorism. Specifically, it will develop low-cost and effective Surface Enhanced Infrared Absorption and Surface Enhanced Raman Spectroscopy nanostructured surfaces on the base of gold naoprisms to detect minute quantities of chemical and biological hazardous substances as well as bacteria, viruses and other infectious agents. The adaptability for the detection of both toxic contaminants and germs which bear specific biochemical markers and are the source of these toxins, is a unique feature of the method designed in this project [ref. G4702].

NEW SENSOR MATERIALS AND DETECTORS FOR IONIZING RADIATION DETECTION

Leading nations: **United States, France and Ukraine**

Scintillator crystals of alkali earth halide family

Detection methods against explosives and other illicit materials must be continuously upgraded in view of rapid changing technology. By developing a new generation of radiation detectors to enhance radiation safety, this project is directly addressing these emerging needs. This is to be achieved through improved performance materials based on scintillator crystals of alkali earth halide family. Currently, only laboratory methods for obtaining the crystals have been developed. In order to fabricate such detectors at reasonable cost and to accelerate their practical application, the existing laboratory methods of crystal fabrication will be upgraded to obtain large-size crystals and detectors. The detectors may eventually be used for counter-terrorism purposes, border and port security, diagnosing of CBRN agents and other radiation detection applications [ref. G4958].

RELIABLE NUCLEAR MATERIALS IDENTIFICATION TECHNOLOGY FROM SPECTROMETRY DATA

Leading nations: **United States and Ukraine**

Currently, one of the most important problems of nuclear safety is the control and monitoring of facilities which contain radioactive materials (RM). In order to ensure the reliability of the control over RMs and to prevent their unauthorized spread, it is important to improve currently available instruments and protocols for RM control and detection. This multi-year project aims to construct a near real-time RM detection system that can detect and identify hidden sources of radiation. The system will be capable of preventing illicit shipment of radioactive materials, increase security at facilities that contain radioactive materials such as nuclear power plants, industry, medical instruments, etc. For this, low-cost neutron/gamma-ray detection systems for the monitoring of radiological and nuclear threats are developed. It includes the development of new algorithms for treating full spectra signals and developing new scintillator detectors [ref. G5094].

NOVEL ELECTROCHEMICAL NANO-SENSORS FOR TOXIC ION DETECTION

Leading nations: **France, Ukraine, Morocco, Tunisia, Egypt and the United States.**

Target molecules often have to be specifically and selectively analysed in samples of very complex compositions, such as biological fluids and tissues, food or waste water. This can only be achieved by using very expensive, laborious and time consuming methods. Thus, the development of reliable analytical methods that are easy to use and cheap to produce is necessary for many fields of human activity, such as for diagnostics of diseases. The main objective of this project is to develop smart, robust, reliable, selective, and sensitive biological and chemical sensors and analytical kits for the detection of key toxic ions. This will be achieved by using novel synthetic ion-recognizing molecules (ionophores), very effective natural ion-binding compounds (as siderophores) and novel genetically constructed bio-molecules (his-cluster-tagged proteins) [ref. G4173].

SECURITY-RELATED ADVANCED TECHNOLOGY

Ukrainian and Allied scientists are working closely together to develop cutting-edge technologies with defence and security applications. They develop innovative solutions that contribute not only to force protection but also have applications in the civilian domain.

ICING MITIGATION STUDIES AND TECHNOLOGY WITH APPLICATIONS TO SECURITY SYSTEMS

Leading nations: **Canada, Ukraine and Belgium**

This multi-year project aims to achieve tangible benefits in terms of technology development for combating icing issues in applications of interest to the military, such as Unmanned Aerial Vehicles (UAVs), communication antennas and dishes as well as operating vessels on high sea. Ice build-up can deteriorate their performance or even have hazardous effects on such systems as it can cause UAVs and aircraft to malfunction and in extreme cases, crash. This project is developing advanced coating materials to mitigate icing issues. Energy efficient strategies will also be explored, including anti-icing systems based on electrical heating [ref. G4957].

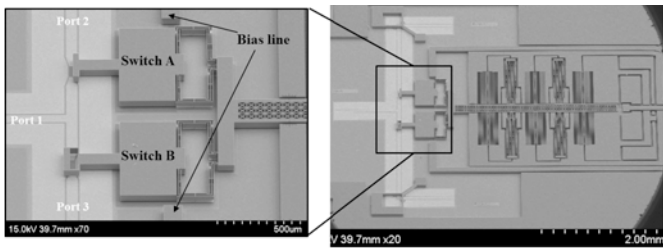
REMOTE SENSING IN THE NEAR-SHORE ZONE FOR IMPROVED SECURITY

Leading nations: **United State and Ukraine**

Coastlines are of strategic and economic importance. They offer a point of entry to diverse groups such as military troops, organizations providing humanitarian relief supplies as well as smugglers and illegal immigrants. Hence, monitoring such coastlines is a key strategic activity. Detecting moving targets, such as boats, in this highly clutter-filled environment is, however, very challenging. The aim of this multi-year project is to advance the technological capability of unmanned aerial vehicle-borne radars to efficiently monitor the nearshore zone. This is achieved by using an airborne miniaturized interferometric synthetic aperture radar, which provides high-resolution measurements of the backscattered radar signal and surface motion that can be used in moving target detection and geophysical parameter estimation algorithms [ref. G4684].

COMPACT SENSOR SYSTEMS FOR UNMANNED AERIAL VEHICLES

Leading nations: **Spain, the Republic of Korea and Ukraine**

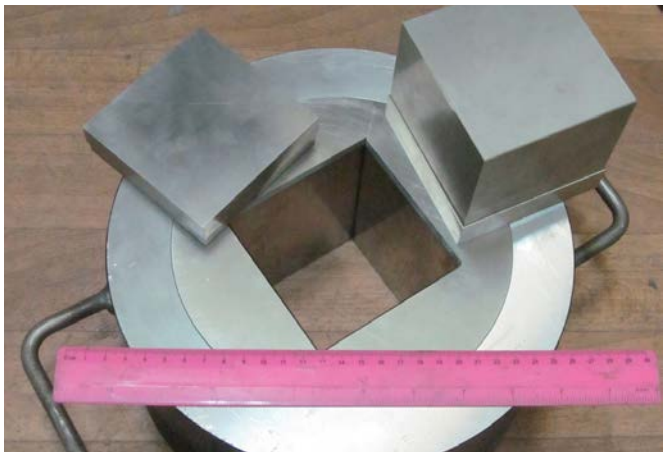


Microelectromechanical switch produced during the execution of the project

This multi-year project aims to develop a sensor for Unmanned Arial Vehicles (UAVs) which is able to provide knowledge about an enemy outpost location. The sensor will be capable of intercepting signals on the battlefield, identifying the direction and location of their transmitting source and thus creating a frequency map. Its small size, low weight and reduced power consumption will make it a key prototype for strategic planning [ref. G4809].

TITANIUM ARMOUR WITH GRADIENT STRUCTURE: ADVANCED TECHNOLOGY FOR FABRICATION

Leading nations: **United States and Ukraine**



Ballistic threats are among the most common dangers for military personnel in theater. Launched in 2015, this project aims to develop advanced technology for the fabrication of high-strength and lightweight titanium-based armour materials that offer protection against ballistic threats. The technology is based on a combination of Blended Elemental Powder Metallurgy and Surface Rapid Heat Treatment approaches. This research will improve the state-of-the-art in technology for lower-cost titanium fabrication, eventually allowing wider deployment of lightweight titanium-based armour [ref. G5030].

INFRARED TRANSPARENT CERAMIC WINDOWS FOR HIGH-SPEED VEHICLES

Leading nations: **Germany and Ukraine**

Young scientist working on ceramics in the clean room

Aircraft, satellite and missiles carry sensitive infrared devices for guidance, Intelligence, Surveillance and Reconnaissance (ISR) and other functions. These devices require optimal access to the outside through windows which, while transparent, can withstand the forces involved in high-speed flights. The new technology developed in this project will allow the creation of large shaped infrared-transparent ceramic windows able to withstand such flights. As a result of the high durability, improved performance and lower cost sensors for guidance, ISR, and other uses on satellites, aircraft and missiles will be developed. The fabricated windows will be tested to ensure sufficient strength, wear resistance, optical transparency at room and elevated temperature conditions [ref. G5120].

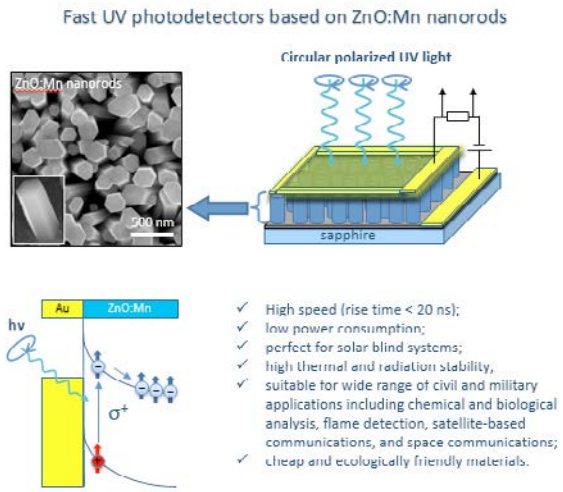
ULTRA-FAST ADAPTIVE OPTICAL ELEMENTS

Leading nations: **United States, Ukraine and Israel**

Active optical elements such as variable-focus lenses, beam shapers, and gratings are one of the key elements in modern military optics for applications such as guidance and tracking of missiles and UAVs. This multi-year project is developing a new technology for electronically-controlled optics for military applications, including lenses and beam shapers. This technology will allow high-speed control of optical characteristics for use in such applications as projectile tracking, night vision, military communications, and so on. Many current active optical elements are based on liquid crystal (LC) technology which allows electrical signals to be converted into optical changes. The principal problem of existing LC optical elements is their slow response to changes in the electrical signal. The materials and devices to be developed in this project incorporate a novel class of LCs which should increase switching speed significantly and open a host of high-speed applications to LC optics [ref. G4856].

NOVEL NANOSTRUCTURES FOR SECURITY APPLICATIONS

Leading nations: **France, Ukraine, Sweden and Austria**



This project aims to develop a fundamental new technology to enhance electronics and computing, which have a profound impact on defence and security. Spintronics are a new type of electronics where information is carried by electron spin rather than by charge. Spintronic devices hold the promise for faster computation at reduced power for a variety of applications, including defence and security. Current sprintronic devices are based on magnetic metals which are not compatible with conventional semiconductor electronics. This project aims to develop the technology required for all-semiconductor spintronic devices including, for example, high-speed UV detectors which could eventually form part of defence hardware such as launch detection systems [ref. G4735].

NEW SHOCK-RESISTING BORON-BASED CERAMICS: COMPUTER MODELING, PRODUCTION, TESTING

Leading nations: **United State and Ukraine**

Ceramics are widely used in impact protection with applications from personal body armour to bomb-resistant tools and devices for explosive ordnance disposal (EOD). This multi-year project aims to develop a new class of ultra-hard, impact-resistant high-boron content ceramics. Through design, modelling fabrication, and testing the co-directors of this project aim to develop, optimize, and demonstrate these novel materials. This new class of ceramics should improve the state-of-the-art blast resistance by up to 20 percent, increasing both personal and collective protection. These materials will eventually be made available for industrial production at suitable cost. Companies producing security and non-security related shock-resistant products will greatly benefit from this cutting-edge technology [ref. G5070].

IMPACT ASSESSMENT OF SELECTED SPS PROJECTS WITH UKRAINE COMPLETED IN 2015

By connecting scientists, experts, government representatives and civil society on key issues of security, the SPS Programme is able to make a significant positive impact upon society. Practical cooperation between the SPS Programme and Ukraine helped to forge strong networks between the scientific communities. Ukraine and the SPS Programme are involved in a number of large-scale projects, many of which have left tangible and lasting results such as in the development of cutting-edge technology, the creation of patents and several scientific publications.

In 2015, five SPS projects with Ukraine were completed. SPS projects not only offer equipment for research, but also provide training for young scientists and experts who are the end-users. The following projects are selected examples of recently completed projects.

THERMOELECTRIC MATERIALS AND DEVICES FOR ENERGY SAVING AND IMPROVED SECURITY

Leading nations: **Turkey and Ukraine**

Young scientist prepares thermoelectric samples

This project developed new thermoelectric materials with higher efficiency which are able to generate electricity from heat or, operating in reverse, cool without refrigerants. Such materials have several military applications, for example, for the mobile generation of electricity from a campfire or from waste heat from a vehicle exhaust. This power-generating technology could be included into devices that can recharge the batteries of a unit in the field from the energy of their campfire. It could also enable robust refrigerant-free cooling of medical applications in the field or personal cooling for military personnel in warm climates [ref. G4536].

HANDS ON CYBER DEFENCE TRAINING COURSE FOR SYSTEM/NETWORK ADMINISTRATORS OF UKRAINE

Leading nations: **Turkey, Canada, Georgia and Ukraine**

Ukraine has experienced a surge in cyber-attacks – even the presidential website was rendered inaccessible for several hours in 2014 as a result. To help strengthen Ukraine's capabilities, a tailored hands-on cyber defence training course for system and network administrators was developed together with the Security Service of Ukraine. The course curriculum includes fundamental cyber security protocols, services and technologies and offers an ability to identify system vulnerabilities and monitor network traffic. This complements work being carried out under the new NATO Cyber Security Trust Fund for Ukraine [ref. G4967].

REMOVAL OF HEAVY METALS AND RADIONUCLIDES FROM WATER USING CERAMIC MEMBRANES

Leading nations: **Slovenia, Ukraine and the Czech Republic**

With the rapid development of industries such as metal planting facilities or mining operations, heavy metal wastewaters are directly or indirectly discharged into the environment. Consequently, water pollution with heavy metals and radionuclides has become a serious environmental problem. This project developed a family of advanced adsorptive membranes which are capable of selective binding of heavy metals and uranium from waste waters and thus minimize environmental exposure to hazardous substances [ref. G4398].

MICROWAVE TUNABLE MATERIALS, COMPOSITES, AND DEVICES

Leading nations: **Slovenia, Ukraine and the United Kingdom**

The main issue assessed in this project was the increase in the frequency-agility and reliability of modern wireless communications through the use of new efficient materials and composite structures with significantly enhanced characteristics. This research developed new prototypes of tunable devices for modern communication systems that will make an impact on the information security level by enabling both safer and more reliable wireless data transmission. The implementation of the developed materials and devices will allow a substantial enhancement of the frequency agility of currently available communication systems, and have an impact on further development of new sophisticated designs of microwave equipment including phased array antennas, tunable phase shifters for local radars and GPS receivers or mobile satellite communications and broadcasting [ref. G4091].

NOVEL NANOCOMPOSITE MATERIALS BASED ON LOW DIMENSIONAL CARBON SYSTEMS FOR ELECTROMAGNETIC SHIELDING

Leading nations: **Germany, Ukraine, Israel and France**

Electronic equipment can be damaged by the powerful impulse of electromagnetic (EM) radiation. Such radiation may induce voltage and current overloads that initiate degradation, breakdown and melting of semiconductor elements and, hence, lead to the failure of electronic equipment including switched off devices. Consequently, the development of protective systems against EM radiation becomes all the more relevant. This multi-year project developed nanocarbon-polymer composite materials as effective protective screens against EM irradiation. It also established the conformities of behavior of the electrical static and dynamic characteristics of the materials depending on the structure, phase composition, injected metals, concentration of the nanocarbon filler modified by transition metals or their compounds, and types of polymer matrices. The use of such fillers that possess special physicochemical properties in polymer composites allows to create composites with extremely low content nanocarbon fillers for effective broadband EM shielding. It further enables EM shielding with controllable frequency range, polarization selection and attenuation [ref. G4243].

OVERVIEW OF ONGOING SPS ACTIVITIES WITH UKRAINE

as of May 2016

Project Number	Mechanism	Title	Countries	Institutions
G4173	Multi-Year Project	Novel Electrochemical Nano-Sensors for Toxic Ions Detection	France, Ukraine	University Claude Bernard Lyon 1 Institute of Cell Biology
G4440	Multi-Year Project	A Model to Predict and Prevent Possible Disastrous Effects of Toxic Pollution in the Tisza River Watershed	Romania, Ukraine	BACIU, Babes-Bolyai University Institute of Environmental Geochemistry
G4481	Multi-Year Project	Nanostructured Materials for the Catalytic Abatement of Chemical Warfare Agents	Italy, Ukraine	Institute of Molecular Sciences and Technology, National Research Council (CNR) National University of Life and Environmental Sciences of Ukraine (Crimean State Medical University) (Nano-SISTEMI Interdisciplinary Centre, University of Eastern Piedmont “A. Avogadro”)
G4544	Multi-Year Project	Uncooled Terahertz Arrays for Imaging Explosives	Spain, Ukraine	Universidad Autonoma de Madrid Ukrainian Academy of Sciences (Brookhaven National Laboratory)
G4585	Multi-Year Project	Remediation of Hydrocarbon Polluted Military Site in Ukraine	France, Ukraine	Bureau de Recherches Géologiques et Minières (BRGM) Ukraine Ministry of Defence, Ecological Unit Institute of the Geologic Sciences of Ukraine
G4605	Multi-Year Project	A New Method of Detection of Fast Neutrons to Control Illegal Transport of Nuclear Materials	France, Ukraine, US	DETEC-Europe Institute of Scintillation Materials (ISMA) at the National Academy of Sciences of Ukraine US Naval Postgraduate School
G4617	Multi-Year Project	Nanostructured Metal-Semiconductor Thin films for Efficient Solar Harvesting	US, Ukraine	University of Colorado at Colorado Springs National Academy of Sciences of Ukraine Taras Shevchenko National University of Kyiv

G4637	Multi-Year Project	Development of Optical Bio-Sensors for Detection of Bio-Toxins	Hungary, Ukraine, Israel, France, UK	Central Environmental and Food Science Research Institute (CFRI) National University of Life and Environmental Sciences of Ukraine (NULES) Weizmann Institute of Science, Department of Materials and Interfaces (WI DMI) Université de Perpignan Laboratoire IMAgES (UP IMAgES)
G4639	Multi-Year Project	Development of a Superselective Adsorbent against CBRN Agents	US, Ukraine	East Tennessee State University Institute of Bioorganic Chemistry and Petrochemistry (Institute for Safety Problems of Nuclear Power Plants)
G4649	Multi-Year Project	New Dosimetry for the Triage of Radiation Exposure	Turkey, Israel, Ukraine	Cukurova University Lviv Polytechnic National University Sheba Medical Centre
G4655	Multi-Year Project	Hand-Held Gamma Detector Based on High-Pressure Xenon Gas	US, Ukraine	Brookhaven National Laboratory Kharkov Institute of Physics and Technology
G4684	Multi-Year Project	Remote Sensing in the Nearshore Zone for Improved Homeland Security	US, Ukraine	University of Washington Kharkiv National Academy of Sciences of Ukraine
G4687	Multi-Year Project	New Phytotechnology for Cleaning Contaminated Military Sites	US, Ukraine, Slovenia, Belarus, Kazakhstan	Kansas State University Kansas Agricultural Experimental Station National University of Life and Environmental Science Faculty of Natural Science, Matej Bel University Vitebsk State Academy of Veterinary Medicine Institute of Plant Biology and Biotechnology
G4702	Multi-Year Project	Metal Nanocrystals for Highly Sensitive Detection of Biochemical Agents	Estonia, Ukraine, France	Institute of Physics University of Tartu (IPUT) Institute of Physics of NAS of Ukraine (IP-NASU) Institute of National Sciences and Applications (INSA de Lyon), France Ovcharenko Institute of Biocolloidal Chemistry, National Academy of Sciences of Ukraine Kavetsky Institute of Experimental Pathology, Oncology and Radiobiology, National Academy of Sciences of Ukraine, Kyiv

G4705	Multi-Year Project	A Sensor Network for the Localization and Identification of Radiation Sources	Greece, Ukraine, Japan, Bulgaria	Hellenic Army Academy (HAA) V.E. Lashkaryov Institute of Semiconductor Physics of the National Academy of Sciences of Ukraine (ISP-NASU) Greek Atomic Energy Comission (GAEC) Yuriy Fedkovych Chernivtsi National University (YFCNU) Institute of Nuclear and Particle Physics (INPP), NCSR Demokritos Research Institute of Electronic, Shizuoka University (RIE) National Center of Radiobiology and Radiation Protection (NCRRP)
G4735	Multi-Year Project	Novel Nanostructures for Security Applications	France, Ukraine, Sweden	ESPCI Lashkaryov Institute of Semiconductor Physics (Marseille University) (Linkoping University) (Johannes Kepler University)
G4748	Multi-Year Project	Developing a Multinational Telemedicine System for Emergency Situations	Finland, Romania, Republic of Moldova, Ukraine	Ministry of Internal Affairs (Romania) Ministry of Social Affairs and Health (Finland) Public Health Emergency Management Centre (Moldova) Ukrainian Parliament
G4809	Multi-Year Project	Compact Sensor Systems for Unmanned Aerial Vehicles	Spain, Republic of Korea, Ukraine	Centre Tecnològic de Telecomunicacions de Catalunya Chonbuk National University National Academy of Sciences
G4834	Multi-Year Project	Fighting Maritime Corrosion and Biofouling with Task-specific Ionic Compounds	Belgium, Ukraine	Antwerp Maritime Academy Inst. of Molecular Biology and Genetics, National Academy of Sciences of Ukraine
G4856	Multi-Year Project	Ultra-Fast Adaptive Optical Elements	US, Ukraine, Israel	University of Colorado at Colorado Springs National Academy of Sciences Jerusalem College of Technology

G4877	Multi-Year Project	Modelling and Mitigation of Social Disasters Caused by Catastrophes and Terrorism	Romania, Ukraine, Republic of Moldova	Romanian Academy of Science National Technical University of Ukraine Academy of Sciences of Moldova
G4886	Advanced Research Workshop	A Framework for a Military Cyber Defence Strategy	Turkey, Ukraine	Old Dominion University Taras Shevchenko National University of Kyiv Swedish Defence College
G4906	Multi-Year Project	Redefined Chernobyl Confinement Model – Assisting Ukraine in Managing the Radioactive Dust Disturbances and Leaks and Protecting their Workers	Germany, Ukraine	Gesellschaft für Anlagen und Reaktorsicherheit (GRS) mbH Institute of Engineering Thermophysics (IETP), NAS of Ukraine
G4910	Advanced Research Workshop	Nanomaterials for Security	Slovenia, Ukraine	J. Stefan Institute Bogolyubov Institute of Theoretical Physics
G4918	Advanced Research Workshop	Best Practices and Lessons Learned in Conflict Management: NATO, OSCE, EU and Civil Society	Slovakia, Ukraine	Research Centre of the Slovak Foreign Policy Association Foreign Policy Research Institute, Ukraine
G4957	Multi-Year Project	Icing Mitigation Studies and Technology with Applications to Security Systems	Canada, Ukraine, Belgium	York University Odessa I.I. Mechnikov National University Vladimir Martynovskiy Institute of Refrigeration, Cryotechnology and Ecoenergetics Universite Libre de Bruxelles
G4958	Multi-Year Project	New Sensor Materials and Detectors for Ionizing Radiation Detection	Ukraine, France	Institute for Scintillation Materials NAS of Ukraine Institute of Light and Matter, UMR5306 CNRS, University Claude Bernard Lyon 1
G4992	Multi-Year Project	Long-Range Stand-Off Microwaves Radar for Personnel Protection	Canada, Ukraine	McMaster University Kiev Polytechnic Institute (KPI)
G5005	Multi-Year Project	Magnetic Resonance & Microwave Detection of Improvised Explosive and Illicit Materials	Turkey, Ukraine	Gebze Technical University O.Ya. Usikov Institute for Radio-physics and Electronics (IRE) TÜBİTAK, Marmara Research Center, Institute of Materials State Research Center “Iceberg”

G5014	Multi-Year Project	Holographic and Impulse Subsurface Radar for Landmine and IED Detection	Italy, Ukraine, US	University of Florence Usikov Institute for Radiophysics and Electronics Franklin & Marshall College
G5015	Advanced Research Workshop	Border Security Challenges in Eastern Europe: Lessons for Allies and Partners	Poland, Moldova, Ukraine	German Marshall Fund of the United States Foreign Policy Association Institute of World Policy
G5024	Multi-Year Project	Support to Humanitarian Demining in Ukraine	NSPA, Ukraine	NATO Support Agency State Emergency Service of Ukraine (SESU)
G5030	Multi-Year Project	Titanium Armour with Gradient Structure: Advanced Technology for Fabrication	US, Ukraine	University of California Los Angeles G.V. Kurdyumov Institute for Metal Physics NAS of Ukraine
G5043	Multi-Year Project	Multi-Sensor System for Rapid Detection of Hazardous Agents	Italy, Ukraine, Finland	National Research Council - National Institute of Optics South-Ukrainian National Univ. Tampere Univ. of Technology
G5055	Multi-Year Project	Development of Novel Methods for the Prevention of Pipeline Failures with Security Implications	Italy, Ukraine	Department of Civil and Environmental Engineering, Politecnico di Milano Karpenko Physico-Mechanical Institute of the National Academy of Sciences of Ukraine
G5066	Advanced Research Workshop	The Military Conflict in Ukraine and UN Security Council Resolution 1325	Italy, Ukraine	Instituto Affari Internazionali (IAI) Democracy Development Centre
G5070	Multi-Year Project	New Shock-Resisting Boron-Based Ceramics: Computer Modeling, Fabrication, Testing	US, Ukraine	Center for Ceramic Research Department of Material Science and Engineering Rutgers University Frantsevich Institute for Problems of Materials Science of the National Academy of Sciences of Ukraine V. Bakul Institute for Superhard Materials of the National Academy of Sciences of Ukraine
G5094	Multi-Year Project	Reliable Nuclear Materials Identification Technology from Spectrometry Data	US, Ukraine	Clemson University Taras Shevchenko National University of Kyiv Institute for Safety Problems of Nuclear Power Plants of National Academy of Sciences of Ukraine State Institution “Institute of Environmental Geochemistry of National Academy of Sciences of Ukraine

G5120	Multi-Year Project	Infrared Transparent Ceramic Windows for High-speed Vehicles	Germany, Ukraine	Fraunhofer Institute of Ceramic Technologies and Systems (IKTS) National Technical University of Ukraine (KPI)
G7982	Multi-Year Project	Development of an Advanced X-ray Generator	Netherlands, Ukraine, Germany	Technische Universiteit Eindhoven, Department of Applied Physics Kharkiv Institute of Physics and Technology, National Science Centre

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