

NOKTOWIZOR

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R+D PLANS FOR 2019

SCIENTIFIC COOPERATION

EUROPEAN DEFENCE FUND

DIFFRACTIVE LENSES



IV. KONFERENCJA
OPTOELEKTRONICZNA

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INTRODUCTION

FOREWORD FROM THE PRESIDENT OF THE PCO S.A.



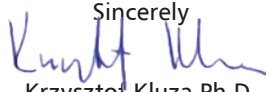
The beginning of a new year is always the time for making summaries and plans for the future. This is why the first issue of "Noktowizor" this year focuses on the Company's plans and prospects for future growth. In this issue you will find interviews with PCO S.A.'s senior management concerning the Company's current situation and prospective development in 2019.

Next, investments in manufacturing infrastructure planned for 2019 are presented. We also encourage you to learn about the Company's scientific cooperation in 2018 and its results. Introducing the European Defence Fund, we lay down the broad lines of its work and opportunities for PCO S.A.'s cooperation with the Fund.

In the "Technologies" section, you will find information on diffractive lens machining and modernization of equipment in the Laboratory for Thin Layers, Photochemistry and Measurement that make it possible to improve the coating process of optical elements.

This issue also provides information on activities related to the Company's management policy. Last but not least, you will find a summary of the most important events which took place in the late 2018 and some recent press reports on PCO S.A.

We are pleased to provide you with this issue, hoping that it will prove a useful source of valuable information on our Company.

Sincerely

 Krzysztof Kluza Ph.D.
 President of the Board at PCO S.A.

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THE COMPANY'S PLANS FOR 2019

PCO S.A. is considered as one of the innovative companies representing Poland's defence industry. Recently, the Company has greatly improved its thermal imaging technologies. The main plans for the future include further development of thermal imaging and building

a competence centre focused on manufacture of laser devices. The Company also opts for developing human resources, improving research and development base and manufacturing footprint, and cooperating with domestic and foreign centres.

KRZYSZTOF KLUZA, PRESIDENT OF PCO S.A., SUMMARIZES THE IMPLEMENTATION OF 2018 PLANS AND ACTIVITIES PLANNED FOR 2019

What were PCO S.A.'s major achievements in 2018? Was it a good year for the Company?

The year 2018 was certainly a good one for PCO S.A. We have added new systems and products used in Technical Modernization Programmes for the Polish Armed Forces to our portfolio. KLW-1E and KDN-1T thermal cameras, used to modernize Leopard 2 tanks, were awarded the "Defender" Prize at last year's edition of the International Defence Industry Exhibition (MSPO) in Kielce. There are new prospects of increasing exports as a letter of intent was signed with Indonesian concern PT Pindad at the Indo Defence show in November. We have also managed to broaden our product portfolio. One of R&D achievements was developing the MU-3MS night vision monocular, being a new version of the MU-3M monocular, with smaller weight and dimensions. This has shown that we can respond to feedback from users of our equipment and their demand for modifications of optoelectronic devices.

The Company was also awarded the "Leader of the State's Security" Prize as "an Innovative Company for State Security" in a contest organized by the Association of Suppliers for Uniformed Services. Then, the modernization of the Laboratory of Thin Layers, Photochemistry and Measurement was recognized by the Polish Federation of Engineering Associations (FSNT-NOT). The Company was awarded the honourable mention in the Laurel of Innovation competition.

PCO S.A. has focused on developing products used in Technical Modernization Programmes for the Polish Armed Forces. What new products were designed?

We improved our competencies in manufacturing thermal imaging equipment. One of the products we currently manufacture is an thermal camera modernisation kit for PT-91 tanks, comprising of thermal camera, adapter, and a gunner's display. There is also the PCT-72 Periscopic Thermal Vision Sight for T-72 tanks in our portfolio. It can replace the TPN-1-23-11 night sight that has been used to date. We also offer an upgrade of the POD commander's observation system, consisting in replacing the night vision circuitry with the latest



generation thermal imaging technology based on an uncooled detector.

Irrespective of whether the Ministry of National Defence chooses a broad or narrow scope of the project of modernizing the T-72 tanks, we can supply optoelectronic devices provided for in the project.

Our product range includes also KDN-1 day-and-night cameras, which increase situational awareness of vehicle drivers. They were designed in response to the Polish Army's requests for such devices, for instance for crews of Rosomak wheeled armoured vehicles.

Key products within this segment are, however, designed for Leopard 2 tanks. These include the KLW-1E infrared camera and the KDN-1T day-and-night camera for the vehicle driver. The latter combines television and thermal imaging technologies, and is not based on the classic concept of a periscope night-vision device. PCO S.A. offers the set of cameras as part of the Technical Modernization Programme of Leopard 2 tanks used by the Polish Army.

GOC and GOD biaxially stabilized observation and aiming systems in our portfolio are designed to work with the Fire Control System. Each head is equipped with a cooled thermal camera (GOD – long wave, GOC – medium-wave), a laser rangefinder, and a television camera.

We are ready to provide full polonization of fire control systems used in Polish Army's tanks.

PCO S.A. also supplies a set of cameras for the Poprad programme and participates in the Pilica programme currently under way, for which an optoelectronic module for a short-range missile and artillery set was manufactured. This biaxially stabilized head is equipped with a set of cameras: a television camera working in the 3–5 band and a day television camera, and a high-repetition-frequency laser rangefinder. We have also designed and are supplying a thermal weapon sight for man portable missile launchers.

What are the Company's plans for 2019?

This year we will continue to broaden PCO S.A.'s product portfolio, including both small night-vision devices and equipment featuring infrared imaging technology. We are planning further investments. Last year the Company bought some new equipment for facilities such as the laboratory of thin layers, photochemistry and measurement. In this way, we are better equipped to manufacture infrared imaging devices and aspherical optical elements that enable equipment downsizing. We are planning to buy equipment that will shorten the manufacturing process and enable troubleshooting as early as at the first step of assembly.

Due to the modular structure of our thermal imaging devices, it is easier to develop new types of equipment. The KLW-1 family of cameras can be developed to include new types adapted to certain vehicles used by the Polish Army. We participate in all technical modernization programmes of armoured and mechanised forces. We place high hopes on projects such as delivering KLW-1E thermal cameras and KDN-1T day-and-night cameras for the Polish Army's Leopard tanks, including the 2 A5 version. Irrespective of whether the Ministry of National Defence chooses a broad or narrow scope of the modernization of T-72 tanks, we are able to supply state-of-the-art optoelectronic devices for these vehicles.

This year, we are also planning to develop the range of optoelectronic modules for systems such as air defence systems, ZSSW, NPBWP Borsuk, and unmanned aerial vehicles. Product portfolio diversification will remain one of our goals. We will promote the MU-3MS night vision monocular, being an upgraded version of the MU-3M monocular, with smaller weight and dimensions. Work related to the equipment of the Future Soldier will also be continued.

We will implement our plans in cooperation with the companies of Polska Grupa Zbrojeniowa and other entities of the Polish defence industry.

DIRECTOR PAWEŁ GLICA TALKS ABOUT KEY ACHIEVEMENTS IN 2018 AND PLANS FOR 2019

What were PCO S.A.'s major achievements in 2018 in terms of sales?

In 2018 we were strongly focused on securing new contacts in Poland and abroad. One important event was signing a multiannual contract for delivering optoelectronic equipment as part of the "Regina" squadron-level fire module. Vehicles in which our equipment will be provided include KRAB gun howitzers and accompanying vehicles. The contract is essential for PCO due to significant amount of equipment and its time span, as the supplies will be delivered until 2024.

We have also managed to complete formalities and secure multiannual deliveries of our set of infrared cameras for Leopard 2A4 tanks which are modernized up to the 2PL standard. At present, PCO is already providing a series of deliveries of cameras for German partners.

Another project worth mentioning is delivering a set of commander's and gunner's heads for the Borsuk combat vehicle, expected to be a successor of legacy BWP-1 vehicles.

In 2018, PCO S.A. also continued to strengthen its position on European and Asian markets. The Company has recently signed a collaborative agreement (MoU) with an Indonesian state-owned armament manufacturer PT. Pindad (Persero). The agreement concerns using

PCO S.A.'s optoelectronic equipment in combat vehicles produced in Indonesia. During the recent Indo Defence 2018 show in Jakarta, the SSP-1 OBRA-3 vehicle self-shielding system was demonstrated on a new Indonesian medium-weight tank Harimau (Tiger), manufactured by PT. Pindad (Persero). It is also worth noting that the vehicle will be marketed by its manufacturer not only in Indonesia but across Southeast Asia, which increases the chances of PCO's deliveries to new markets.



In 2018, we also made further efforts to certify our devices, and performed analytical studies on establishing a centre supporting our equipment in the Ukraine that would make it possible to respond faster to user needs.

What are the Company's major objectives in 2019 in terms of sales policy?

As in recent years, the Ministry of National Defence will remain the main buyer. We will seek new orders for individual optoelectronic equipment for soldiers, which

remains a key item in PCO S.A.'s portfolio. We are also planning to introduce new products that extend soldiers' observation capabilities, such as thermal imaging binoculars.

Cooperation with PT. Pindad provides us with broad opportunities, since our products have already been known in Southeast Asian markets. Since production of new tanks for the Indonesian Army is planned, our optoelectronic devices could be mounted on them. We are also strongly engaged in some projects concerning prospective export markets, where PCO S.A. has not yet delivered its products. These projects are currently at various phases but we hope to be able to disclose more details in the near future.

At the beginning of 2018, the Company announced to extend its portfolio by including civilian customers.

Was this goal achieved?

Yes, we have prepared a product portfolio for civilian use. In 2018, we launched PNL-3M aviator's night vision goggles, certified by the European Aviation Safety Agency (EASA) for use in the European airspace.

We sold the first batches of PNL-3M aviator's night vision goggles for civilian use to foreign customers. These were bought by Czech and Norwegian training centres for helicopter crews. We expect new orders from emergency services and the police.

The goggles were also demonstrated at the HAI Heli Expo show, held between 27.02.2018 and 01.03.2018 in Las Vegas. They attracted much interest, which is likely to translate into orders. We are also working to have PNL-3M certified according to the requirements of the American Federal Aviation Administration (FAA).

RESEARCH AND DEVELOPMENT PLANS FOR 2019

PCO S.A.'s R&D plans for 2019 are based mainly on the following assumptions:

1. The assessment of results of projects carried out in 2018, including justification of continuing them in 2019.
2. Ensuring that the Company's strategic goals will be met, i.e. completing the tasks under the ZISW TYTAN and ZSSW programmes as regards observation and sighting instruments GOC-1/GOD-1/CAD.
3. Implementation of sales plans for 2019 and subsequent years.
4. Completing the contracts concluded so far.

In the current year, R&D activities will be pursued in three main areas: soldier's optoelectronic equipment, optoelectronic equipment for combat platforms, and new technologies, i.e. optoelectronic modules.

For soldier's optoelectronic equipment, development of the TYTAN Advanced Individual Battle System, carried out by a consortium led by PCO S.A., will continue.

Apart from that, in the area of soldier's optoelectronic equipment, works on a modular night vision set and a portable observation and measurement instrument (multisensory binoculars), initiated by the Company, will be under way in 2019. These works will be financed entirely from the Company's own funds.

The key tasks for the optoelectronic equipment for combat platforms will be works on observation and sighting instruments for the Remotely Operated Turret System (ZSSW), developed by a consortium of HSW S.A. and WB Electronics S.A., namely the GOD-1 and GOC-1 heads. 2019 will see the continuation of tests of these instruments on ZSSW and preparation for starting series production of these products.

There are plans to start working on the GO-35 Integrated Vision Module and to adapt the 35 mm cal. anti-aircraft gun to the fire control system.

Works on the SOD-2 (modular) On-Board Observation System for military vehicles will be also carried out.

In the area of new technologies, i.e. optoelectronic modules, the following products will be developed: the DL-11 impulse laser rangefinder, an infrared (IR) camera zoom lens, a SWIR camera and a thermal imaging module based on a 1024x768 matrix.

The Company participates in a consortium developing laser directed-energy weapon systems and laser non-lethal weapon systems, such as: laser directed-energy weapon systems, laser non-lethal weapon systems, a laser radiation warning system, and a laser system for jamming IR guided rockets.

In the area of new technologies, projects under way will include:

- The CIROP infrared Earth observation system, developed under the contract concluded with the European Space Agency (ESA) as part of the Polish Industry Incentive Scheme.
- The HANEDA holographic colour near-eye display, developed under the contract with the Foundation for Polish Science (FNP) as part of the TEAM TECH programme (competition 3/2016). The project is carried out by a consortium joined by the Faculty of Physics of the Warsaw University of Technology.
- Tunable hyperbolic metamaterials, developed under the contract with the National Centre for Research and Development (NCBR) as part of the TECHMASTRATEG competition. To complete the project, a consortium will be established, including: Warsaw University of

Technology (PW) as the leader, the National Institute of Telecommunications, Military University of Technology, Institute of Physics of the Polish Academy of Sciences, and PCO S.A.

In addition, we are starting to work on a driver's thermal imaging assistance system and a miniature missile guiding system.

TRADE FAIRS AND EXHIBITIONS PLANNED IN 2019*



* The plan can be changed.

SCIENTIFIC COOPERATION

Cooperation with universities and research institutes is an essential aspect of PCO S.A.'s activity. This provides us with an opportunity to leverage the results of R&D projects, cooperate as a member of consortia, and establish contacts as part of the network of optoelectronic industry entities. In regard to cooperation with universities, PCO S.A. keeps long-term contacts with their authorities and participates in scientific conferences, seminars, and meetings with students. Since 2015, PCO S.A. has co-organized the Optoelectronic Conference, designed to promote cooperation between representatives of science, industry, and end-users. The event provides an excellent opportunity to establish contacts, share experiences, and expand knowledge in the field of optoelectronics, which is currently an extremely important field of science.

PCO S.A. has cooperated on an on-going basis with the Institute of Optoelectronics in the Military University of Technology, Warsaw University of Technology, Air Force Institute of Technology, the Military Institute of Armament Technology, the Military Institute for Armoured and Vehicle Technology, Maksymilian Pluta Institute of Applied Optics, the Institute of Electronic Material Technologies, numerous companies from the armaments industry, and other domestic and foreign entities. As far as space technologies are concerned, the Company cooperates with the European Space Agency, the Space Research Centre of the Polish Academy of Sciences, and the European Commission.

EUROPEAN DEFENCE INDUSTRY SUMMIT

On 6th December 2018, the European Defence Industry Summit was held. The conference focused on the key role of the industry in strengthening the defence cooperation within the EU. It was attended by representatives of the European Commission, the European Defence Agency,

NATO, and the Polish defence industry, including PCO S.A. Cooperation under the EU defence policy, including funds for research and innovation in the field of defence, was discussed. Other topics included cooperation between the EU and NATO, and cybersecurity.

3RD PGZ INNOVATION AND TECHNOLOGICAL DEVELOPMENT FORUM

On 29–30 November 2018, the 3rd Innovation and Technological Development Forum of Polska Grupa Zbrojeniowa S.A. was held. Topics discussed during the Forum included information exchange on R&D projects carried out by Companies in the PGZ Group of Companies, information concerning sources of finance for R&D (both domestic and foreign), and challenges faced by the Companies in this area. The goal of the Forum is to strengthen cooperation between the industry and the government, intensify relations with universities and research institutes, and use the didactic and research potential of universities by Polska Grupa Zbrojeniowa S.A. companies.

The meeting was attended by representatives of PGZ Group of Companies, the Ministry of National Defence, the Ministry of Foreign Affairs, and the research sector.

Cyclical meetings of the Innovation and Technological Development Forum are organized by the Department of Innovation and Technological Development (DIRT) of Polska Grupa Zbrojeniowa S.A. The Forum focuses on R&D issues and is dedicated to R&D professionals and experts in the PGZ Group of Companies.



4TH OPTOELECTRONIC CONFERENCE

On 14–15 November 2018, the 4th Optoelectronic Conference, “Photonics as the leading technology of the 21st century”, was held in Jachranka. The two-day conference was filled with lectures and discussions on photonics, being the leading technology of the 21st century. Experts shared their knowledge and conclusions on the current state and development of photonics, particularly in the context of state security.

The theme of the first day of the conference was “Photonics and the challenges of the modern battlefield”. During the day, photonics technologies, used in defence systems, especially in reconnaissance and fire control systems, were discussed. Speakers demonstrated that state-of-the-art optoelectronic devices are decisive in the battlefield, so if one fails to develop them, combat equipment will not meet current requirements. At present, optoelectronics is a key technology in guided weapons systems and so-called directed-energy weapon systems.

The theme of the second day was „Photonics and the challenges of the 21st century”. Lectures focused on new technologies, while panels related to issues such as flight and space reconnaissance, photonics in cybersecurity and telecommunications, and photonics in imaging systems and sensors. During the conference, start-ups leveraging the photonics potential were also presented, which helped establish contacts between industry representatives and innovative companies.

The increasing role of photonics in the defence industry stems from the fast pace of advancement of various types of observation and transfer devices as well as sighting systems, used in all kinds of forces. Proliferation of drones and other unmanned platforms has resulted in a vast demand for observation and machine vision systems. Optoelectronic devices are also becoming widely used in non-military applications. Photonics can more often be found in communication systems, material manufacture



and machining systems, and in security and safety systems.

Despite good prospects for development, there are still many barriers to implementing photonics solutions in Poland. Experts concluded that Poland lacks large companies that would stimulate developing state-of-the-art photonics technologies in the country, and intermediate-level system integrators. Although detectors and materials for manufacturing optoelectronic components are produced in Poland, there are not enough companies to manufacture subassemblies that are necessary to produce advanced optoelectronic devices. The result is that the Polish industry and science are vulnerable to processes abroad, and sometimes these sectors are not able to develop their equipment and carry out research on their own.

Poland is also short of manufacturers of highly integrated optoelectronics, e.g. optoelectronic chips which can form the basis for future devices.

What the photonics industry strongly requires is also human capital, namely qualified engineers, who are already hard to find on the Polish market. Therefore, universities, the industry, SMEs, and state and regional bodies need to cooperate to educate prospective photonics professionals in Poland.

One idea to support the advances in optoelectronics is to establish a scientific and industrial entity that would serve as a technological accelerator and a liaison between science, SMEs, and end-users.

The conference has actively contributed to the dissemination of knowledge about optoelectronics applications in everyday life and to improving cooperation between science, the army, and the industry. The discussions held mark the direction of photonics development and enable aligning to demands of the ever changing market.

WARSAW DAYS OF TECHNOLOGY

On 19 October 2018, PCO S.A.'s headquarters hosted participants of the Warsaw Days of Technology, organized by the Polish Federation of Engineering Associations (FSNT-NOT) and the Warsaw branch of the Association of Polish Engineers and Mechanical Technicians (SIMP).



Guests listened to lectures on night vision, infrared imaging, and laser technologies, and then visited manufacturing departments. Night vision and infrared imaging equipment was also demonstrated. The Warsaw Days of Technology are organized by the Polish Federation of Engineering Associations (FSNT-NOT) and the Warsaw branch of the Association of Polish Engineers and Mechanical Technicians (SIMP).

LASER TECHNOLOGY SYMPOSIUM

On 25–27 September 2018, the Laser Technology Symposium was organized in Jastarnia by the Military University of Technology, Warsaw University of Technology, Wrocław University of Technology, and Warsaw University. The event was sponsored by PCO S.A. One of the speakers at the symposium was PCO S.A.'s representative, Business Development Director, Mariusz

Krawczak, who presented military applications of laser systems. The systems discussed included devices produced by PCO S.A.: various types of indicators, illuminators, laser blinders, and rangefinders implemented in devices such as night vision goggles and integrated optoelectronic modules.

INTERNATIONAL ARMS CONFERENCE

Between 17 and 20 September 2018, the 12th International Arms Conference entitled: "Scientific Aspects of Arms and Security Technology" was held. The event was organised by the Institute of Armament Technology in the Faculty of Mechatronics and Aviation of the Military University of Technology together with the Military Institute of Armament Technology. It was held under the auspices of the President of the Republic of Poland and the Ministry of Science and Higher Education. Mariusz Krawczak, Business Development Director at PCO S.A., was one of the speakers and summarized the Company's achievements. Unique competences regarding optoelectronic equipment design and manufacture capabilities were emphasized. At the Company's portfolio presentation, the latest implementations of individual soldier equipment and thermal imaging devices installed on combat vehicles were pointed out.

During the conference, products offered by the Polish defence industry companies, including PCO S.A., were presented.



NEW TECHNOLOGIES

EUROPEAN DEFENCE FUND (EDF)

AUTHOR: MARIUSZ KRAWCZAK, BUSINESS DEVELOPMENT DIRECTOR

On 31 November 2016, the European Commission announced the European Defence Action Plan (EDAP) which sets out directions of EU financial activities for establishing new technical and defence capabilities of member states and providing new capacities of EU defence industry. The European Defence Fund (EDF) is European Commission's decision-making and financial body.

The main ground for Commission's activities is optimisation of funds assigned to defence by EU member states.

There are strong economic arguments for strengthening cooperation regarding defence spending in EU states. The costs of the lack of cooperation between member states in this area are estimated to be between 25 and 100 billion euro annually. As much as 80% of public contracts and over 90% of research and technological projects are carried out on the national level. By combining contracts, up to 30% of annual defence spending could be saved.

The Permanent Structured Cooperation (PESCO) on security and defence of Member States was also established, joined by 25 EU member states. The states united under PESCO will be awarded a 10% bonus as an additional financing from the EU funds at the stage of developing new armament systems.

FINANCING

The first research projects under the Preparatory Action on Defence Research (PADR) were awarded 90 million euros in 2017–2019. Funds for developing new military capacities will be awarded under the European Defence Industrial Development Programme (EDIDP), with a budget of 500 million euros for 2019–2020. In 2021–2027, funds available from EDF will amount to 13 billion euros. The European Defence Fund will provide financial support only to new industrial projects resulting in creating a prototype, engaging at least three companies from at least three member states.

ELIGIBILITY CRITERIA

The fund will provide separate financing for research projects on new capacities (a so-called Research Window) and for prototype development for a specific new armament system (a so-called Capacity Window).



The EU financial support amounts to 20–30% (30% is guaranteed in projects defined under PESCO) in the Capacity Window, and 100% in the Research Window. The European Commission will not directly support defence budgets of Member States, so it stops financial support at the stage of prototyping. Then, the industrialization and purchase of serialized armament systems will be financed by the states which entered into contracts.

The procedure of assessment and awarding the funds will start in the second half of the next year. The Ministry of National Defence listed the following topics of interest to Poland, in which PCO S.A. could participate:

- A next-generation tank.
- Combating unmanned aerial vehicles from the air.
- 23 and 35 mm cal. programmable ammunition.
- A static aerostat for reconnaissance systems.
- Marine unmanned anti-mine devices.
- Supervision and protection of port and coastal waters.
- European artillery support systems.

The new European Commission's programme is both an opportunity and a threat to PCO S.A. Participation in this programme will help receive substantial additional funds for development. Additionally, funds for a project will be awarded provided that at least two other member states declare to purchase the newly developed products. This will allow long-term planning of sustainable company's expansion. It has to be noted, however, that a considerable part of funding for the projects will come directly from ministries of defence of each country. Hence, no funds for development will be available under national programmes (which is the goal of the European Commission). The market will consolidate by strengthening stronger players and eliminating weaker ones.

Given these circumstances, we shall do our best to be one of the companies supported by the European Defence Fund.

THE HANEDA PROJECT

AUTHORS: EMPLOYEES AT THE BUSINESS DEVELOPMENT DEPARTMENT: DR INŻ. TOMASZ MIROŚŁAW [PH.D. ENG.], HEAD OF THE “HANEDA – HOLOGRAPHIC NEAR-EYE DISPLAY” PROJECT, AND JOLANTA DYBEK, PROJECT COORDINATOR; PROJECT SUPPORT

The “HANEDA – Holographic Near-Eye Display” project was assessed by the Foundation for Polish Science together with an international group of experts as a very innovative and prospective one. Since the request was given an almost maximum rating, the consortium initiating the project, made up by PCO S.A. and the Faculty of Physics of the Warsaw University of Technology, received the maximum possible funding, amounting to 65% of the project value.

The goal of the project is to develop a prototype of goggles for generating virtual 3D images using the holographic technology.

Virtual reality (VR) goggles are shown as a tool used in applications such as education systems to show images in front of real objects. The images displayed include additional information that is not normally seen by the user, for instance, the view inside a machine housing. In this way, extended reality (XR) objects are introduced.

Analytical studies on an XR device have been carried out for several years by a team of PCO S.A.’s and Warsaw University of Technology’s employees who successfully anticipated trends in display systems development.

Following the feasibility study, additional financing was sought for the project whose goal is to build a prototype of XR holographic goggles and to gather science and industry professionals to implement VR systems, particularly using holographic techniques. The goggles to be prototyped will generate colour 3D image using the holographic technique.

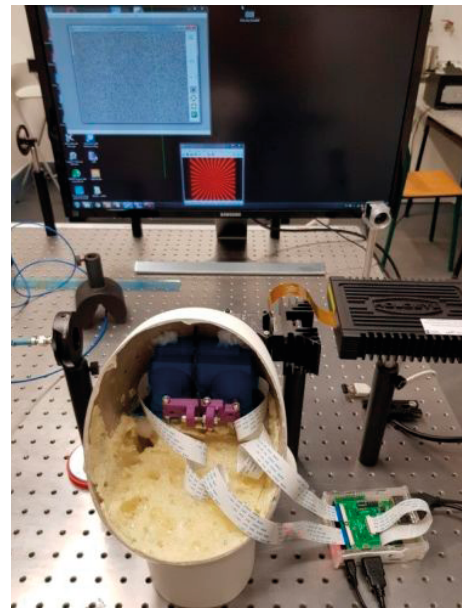
The advantage of the project over commercially available solutions consists in that the latter provide the three-dimensional effect in a number of ways, for instance, by using LED displays of 2D images with an angular displacement for each eye. In some solutions the image is displayed on the goggle glasses such that the user has to refocus his or her eyes, switching between the real view and the image on the display. In another solution, the goggle glasses are used as a screen on which images are projected by a lamp or lamps focused on infinity. Each of these solutions has its drawbacks, the most important one being discomfort after a longer use, since the techniques used affect brain activity. Another disadvantage is a significant intolerance of misalignment between the goggles and the eyes.

Under the HANEDA project, PCO S.A., working as part of a consortium with the Faculty of Physics of the Warsaw University of Technology together with the ophthalmology department of the Military Institute of Aviation Medicine, develops a new solution that would satisfy the requirements of ergonomics and optical biophysics.

The concept involves generating images through holography which allows displaying objects at apparent lengths, that is to say, next to objects rather than in front of them.

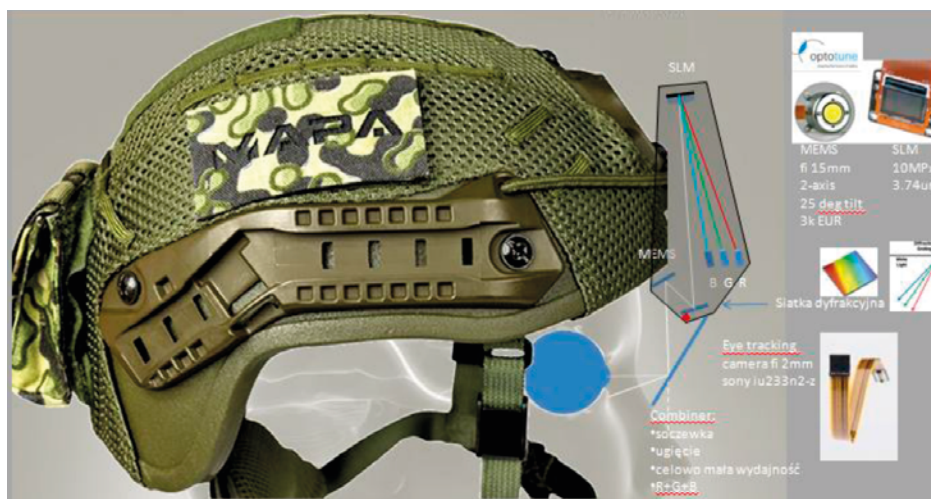
In holography, a spatial light modulator (SLM) is a source of image, displaying the Fourier transform of the image instead of the target image, i.e. phase data instead of amplitude data. This makes it possible to see various pieces of the image display at various lengths. Hence, the eye is not forced to accommodate when a person looks in a different direction.

This means that when a user switches from a real nearby object to a distant one, thus changing the range of visual acuity, he or she will see virtual objects at a changed range of visual acuity. The image generation technique considered will follow the way the brain works rather than deceive it. It is expected to help reduce eye fatigue and eliminate balance issues, allowing the user to behave more naturally.



Testing stand of the technology demonstrator

Foundations of holography were devised almost a hundred years ago by Mieczysław Wolfke, a professor at Warsaw University of Technology. In 1920 he developed theoretical principles and divided the process of image generation or acquisition by recording the amplitude and phase of coherent light. He also described the possible use of light interference to write and read information. Following Wolfke’s death in 1947, Denis Gabor, a British scientist born in Hungary, carried out first experiments involving image recording and displaying by the application of the holographic method using beta-rays. For works on holography he was awarded the Nobel prize in 1971.



Visualisation of the goggle concept in a military application

The present stage of development of the laser technology and phase modulators enables using this technique to generate dynamic images of spatial objects.

According to designers, the holographic goggles for displaying XR images will be used as a key component of:

- battlefield observation and visualization systems,
- drone operator interface systems,
- emergency services systems,
- training systems.

In civilian applications, apart from entertainment, they can be used as a tool for sight diagnostics and rehabilitation.

As part of the project, PCO S.A. is responsible for the mechanical structure of the goggles, image generation technique, and system verification methodology.

We hope to be able to demonstrate the device prototype at the 100th anniversary of the beginning of holography in Poland.

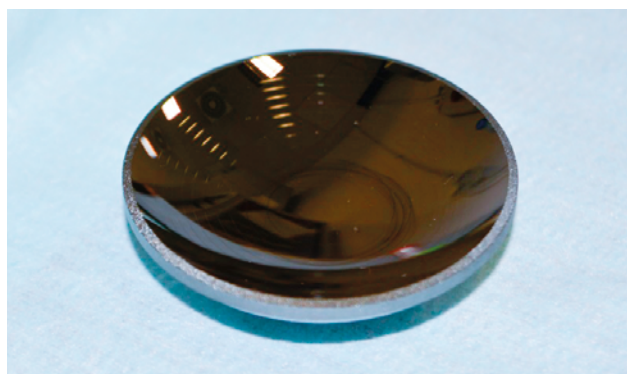
DIFFRACTIVE LENSES

AUTHOR: MAREK SZLENDAK, OPTICS TECHNOLOGIES DEPARTMENT

In 2016, PCO S.A. introduced the Single-Point Diamond Turning (SPDT) technology that enables ultra-precise machining. By applying the SPDT technology, details can be produced with the roughness grade Ra better than 1 nanometre.

The new technology is used mainly in the manufacture of spherical and aspherical lenses, a key component of products based on thermal imaging technology. These include the SCT Rubín thermal weapon sight, NPL-1T thermal imaging binoculars, and KLW-1E and KLW-1 Asteria infrared cameras.

In 2018, using the ultra-precise machining method, PCO S.A. started producing diffractive lenses (Diffractive Optical Element, DOE). The lenses feature special diffractive structures in the form of adjacent zones which were transferred on the optical surface. The final image depends mainly on their number, shape, and depth. The DOE lens manufacturing method requires the use of a cutting tool with a tip made of a monocrystalline diamond. The shape of the cutting edge of the tool is defined with an accuracy between 50 and 100 nanometres. The ability to program the tool position very precisely and the active anti-vibration system allow producing submicrometre-scale structures.



Diffractive lens

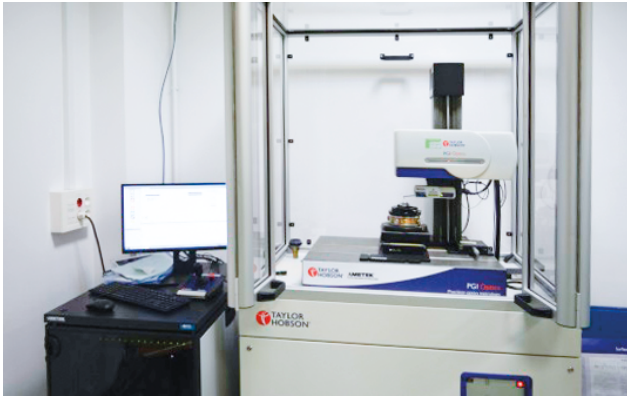
Due to their unique properties, diffractive lenses can be used to build optical instruments with better characteristics than spherical and aspherical systems. For instance, athermal (insensitive to temperature changes) lenses were designed for the LWIR band. Due to the use of DOE lenses, the athermal lenses have no movable lenses to compensate for temperature changes. Such a lens is smaller, lighter, and, first and foremost, more reliable.

Before the production started, a number of R&D studies were carried out concerning the manufacture of various

types of diffractive and diffractive aspherical lenses. The studies examined various materials, including the following crystals: germanium, ZnS, silicon, ZnSe, and halide glasses. Work intended to produce components of various geometries was undertaken to eliminate typical defects of optical systems, such as astigmatism. Parameters of the manufacturing process were also optimised.

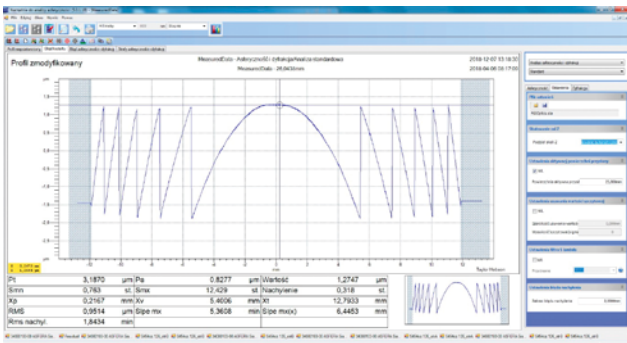
Test bench

In addition, to control the quality of diffractive lenses, PCO S.A. implemented necessary measurement technologies using microscopes, advanced interferometers, and



Test bench

profilometers. A high-performance profilometer with a very precise feeler is used to control the diffractive surface. The measurement is carried out using the tracer method. Since the components have to be made with high precision, the profilometer is calibrated on a daily basis.



The measured profile of the diffraction structure on the lens

A new machine

In the first quarter of 2019, the PCM production department will start manufacturing mechanical components with DMG MORI's NTX 1000 integrated turning and milling centre. The centre is equipped with dynamic linear drives, two spindles (the main spindle and the counter spindle), a tool revolver, and a hinged milling and turning head.



NTX 1000 integrated turning and milling centre

The additional equipment of NTX 1000 includes control of low and high clamping pressure of the main and counter spindle, and an out-feed conveyor to transport finished workpieces outside the machining area without stopping the machine (a so-called programmable robot).

The machine structure is very rigid, which makes it possible to produce components with consistently high accuracy. The centre combines turning and milling operations and its specifications enable concentration of processes with a single clamping of a workpiece. This helps reduce the time of machine-cutting by 50% and eliminates tool changing and the need to use other clamping tools. The centre accuracy enables machine-cutting complex workpieces with a maximum turning diameter of 430 mm and a maximum turning length of 800 mm.

This model of the machine is equipped with the CELOS user interface. CELOS applications allow the user to manage, document, and visualise orders, processes, and machine data using a multi-touch screen. In addition, CELOS provides unique connections of the machine with upper-level company structures to make the production computer-based and create a paperless environment.

“The machine tool was delivered with a technology for manufacturing one of the most labour-intensive components. Following the optimisation of the manufacturing process, a workpiece that earlier required eight operations on several machine tools could be produced in just one operation on this machine tool.”

INTRODUCING INNOVATIVE TECHNOLOGIES FOR MANUFACTURING THIN-FILM COATINGS FOR PRECISION OPTICAL COMPONENTS USED IN OPTOELECTRONIC EQUIPMENT

AUTHORS: MGR BOLESŁAW PYCZAK [MA], MGR INŻ. MACIEJ LEŚKIEWICZ [MSC ENG.],
LABORATORY FOR THIN LAYERS, PHOTOCHEMISTRY AND MEASUREMENT

Due to PCO S.A.'s participation in implementing the Technical Modernization Programme for the Polish Armed Forces, a comprehensive upgrade concept of the Laboratory for Thin Layers, Photochemistry and Measurement was implemented in three independent areas:

1. Improving air quality by building and providing infrastructure for closed spaces with higher purity class according to ISO 14644-1, meeting the following requirements:

- cl. 8 in rooms;
- cl. 5 in laminar cabinets;
- rated air humidity: 45% +/- 15%;
- rated temperature: 22°C +/- 2°C.

The following zones were demarcated in the rooms: vacuum coating zones; process preparation zones: application stations with laminar cabinets and laboratory equipment; a special preparation zone; and separate technological protection zones.

2. Implementation of a special technology for preparing optical elements to vacuum coating, using LUA 1000 automated supersonic washing line for precision optical components.

3. A new design of thin-film coatings with improved optical specifications and improved mechanical, chemical, and environmental resistance, using SYRUSpro 1110 IR high vacuum equipment operated under PIAD system.

Since new innovative thin-film coating production technologies were implemented, it is possible to apply coating on optical elements made of next-generation optical materials that are currently used in thermal imaging and

night vision equipment. PCO S.A. has also extended the range of optical elements in terms of quality, as it is now possible to coat aspherical surfaces and ones with a small radius of curvature.

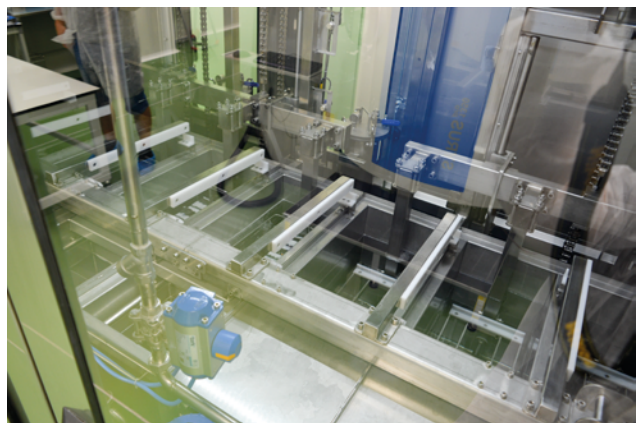
Technologically advanced thin-film coatings have been developed and implemented, with much higher optical and resistance specifications than standard requirements of military consumers and special services, which underlines the quality and competitiveness of PCO S.A.'s products on foreign markets.

Since optical elements are prepared for coating in improved purity conditions, using a state-of-the-art supersonic washing line, the quality of current manufacturing processes has greatly improved, the throughput has increased, costs have been reduced, and technically advanced R&D studies can now be supported.

In addition, the level of environmental protection was improved by reducing volatile compound emissions and using biodegradable components.

To sum up, the modernization of the Laboratory, including the cleanroom technology, the new high vacuum equipment, and the supersonic washing line, has greatly improved the quality and innovation of optoelectronic devices offered by PCO S.A. on domestic and foreign markets.

The modernization of the Laboratory of Thin Layers, Photochemistry and Measurement was awarded the honourable mention in 2018 in the Laurel of Innovation competition organized by the Polish Federation of Engineering Associations (FSNT-NOT).



MANAGEMENT POLICY

CORPORATE SOCIAL RESPONSIBILITY AT PCO S.A.

AUTHOR: ALEKSANDRA CELER, HEAD OF COMMUNICATIONS AND PR DEPARTMENT

Corporate Social Responsibility is a quite new term in marketing. Until recently, it was linked with politics and economy, since it was the economic situation of many countries that gave rise to the development of a new model of activity of state-owned and, in subsequent years, private companies.

In line with the CSR concept, companies do business taking into account social interests, environmental aspects, or relations with various groups of stakeholders. Social responsibility means investing in human resources, environmental protection, and external relations of the company and sharing information on such activities.

At PCO S.A., CSR guidelines were developed under the Communications Strategy. The guidelines set out three main areas of activities: partnering with customers, suppliers, and business partners; cooperation with science and research community; and cooperation with universities and secondary schools, including supporting aca-

demical initiatives. The Company supports recurring events organised by universities, such as the International Day of Light, Engineering Job Fair, and JOBICON Job Fair. Seeking young talents, PCO S.A. offers internships and apprenticeships for students.

Furthermore, the Company participates in and supports patriotic initiatives, charities, and public benefit organizations. Due to the nature of its business, PCO S.A. supports soldiers injured during military missions and war veterans. The Company participates in and supports industry events, such as the International Armaments Conference, the International Science and Technology Conference, the Krynica Economic Forum, and the Laser Technology Symposium. Once a year, during the annual picnic for PCO S.A.'s employees and their families, funds are raised to support employees' children who are under the foundation's care. The Company supports and promotes interesting projects launched by employees.

PCO AS AN EMPLOYER

AUTHOR: EWA TOWERSKA, MANAGER FOR PROFESSIONAL DEVELOPMENT AND RECRUITMENT

PCO S.A. takes care to be regarded as a good employer by offering stable employment, satisfactory earnings, and a focused career development. The Company pursues various activities on the job market to promote its business and encourage electronics, mechatronics, physics, and IT specialists to cooperate. PCO S.A. regularly participates in stationary job fairs organized by technical universities and engages in their initiatives by providing topic-oriented lectures, presentations, and meetings with students. During open days, students of technical secondary schools and technical universities are invited to the Company premises to learn about our activities.

The Company also offers internships and apprenticeships in R&D, Production, and Quality Control departments for students attending both technical universities and secondary schools.

Classes have been provided for two years for students attending 2nd and 3rd classes of the Secondary School of Mechatronics, willing to become optician technicians. The Company's experienced employees take the role of teachers, and through this activity PCO S.A. participates in a so-called dual curriculum, where the profession is taught by an employer based on theoretical and practical training.

The Company is open to candidates who are creative, challenge-oriented, seriously planning their career development, and seeking a motivating and ambitious job.

To obtain and keep employees, we focus on consistent and long-term activities, engage employees in R&D projects, and recognize their intellectual contribution to developing our products.

PCO S.A. actively prepares new employees to their jobs by offering internal training to familiarize them with current business areas. Integration and development meetings are also provided for employees and managers. Future project and team leaders develop their expert and interpersonal capabilities.

One of the Company's key HR policy priorities is promoting innovative activities and team work, and developing industry know-how, which results in efficient R&D works and achieving strategic goals.

At our Company, managers' task is not only to make decisions, but also to inspire, motivate, and engage others to work.

OVERVIEW OF PCO S.A. EVENTS

SEPTEMBER 2018 – DECEMBER 2018

EVENTS OVERVIEW

COLLABORATIVE AGREEMENT WITH PINDAD

On 8 November 2018, at the Indo Defence 2018 show in Jakarta, Indonesia, PCO S.A. signed a letter of intent with Pindad (Persero). The document concerns developing cooperation in the area of optoelectronic systems dedicated to armoured vehicles manufactured by PT. Pindad. The document was signed by PT. Pindad (Persero) CEO, Abraham Mose and PCO S.A. Sales Director, Marcin Janiszewski. The ceremony of signing was also attended by Deputy Head of the Armament Policy Department at the Ministry of National Defence, Mateusz Sarosiek and Defence Attaché of the Republic of Poland in Indonesia, Col. Leszek Słomka.



Bandung, West Java-based PT Pindad (Persero) specializes in manufacturing a number of military vehicles, fire-arms, and ammunition used by armed forces of Indonesia

and other countries in the region. One of major projects currently carried out by PT. Pindad is a new Indonesian Modern Medium Weight Tank (MMWT).

COLLABORATIVE AGREEMENT WITH ELBIT SYSTEMS

On 6 September, during the third day of the International Defence Industry Exhibition MSPO in Kielce, PCO S.A. signed a collaborative agreement with Elbit Systems ISTAR Division.



The cooperation was established in the area of marketing, service and manufacture of SPECTRO XR optoelectronic module systems and the MINI MUSIC DIRCM aircraft protection system. The SPECTRO XR optoelectronic module is a multispectral day-and-night optical system for long-range reconnaissance. Directional Infrared Counter Measures (DIRCM) systems are designed to protect aircraft from thermally guided ground-to-air missiles.

THE BORDERS CONFERENCE, HELITECH, ARMS SECURITY

On 24–25 October 2018, the city of Lublin hosted the Borders Conference dedicated to border security and uniformed services equipment. Among the products shown by PCO S.A. were the NPL-1T thermal imaging binoculars, which were presented at the Conference. MU-3M night vision goggles and the SCT thermal weapon sight were also exhibited at the Company's stand. On 16–18 October in Amsterdam, the Helitech conference and trade fair

were held, being the biggest helicopter technology event in Europe. PCO S.A. participated in the fair, demonstrating PNL-3M aviator's night vision goggles for civilian use. PNL-3M aviator's night vision goggles and the MU-3MS night vision monocular were also included in the Company's portfolio presented during Arms & Security armaments fair in Kiev on 9–12 October.

VISIT OF REGIONAL MILITARY REPRESENTATIONS

On 19 October 2018, representatives of Regional Military Representations (RPW) from across Poland were taken on a tour of the PCO S.A. headquarters. The Representations are responsible for accepting goods supplied by defence

industry Companies, before these are delivered to military recipients. The guests were given a presentation on the Company's business and had an opportunity to visit production departments.

AWARDS FOR PCO S.A.

Last year, PCO S.A. was awarded a number of industry awards, including: the Leader of the State's Security award in two categories (the Innovative Company for State Security and for the NPL-1T thermal imaging binoculars); the honourable mention by the Quality Certification Center for special achievements in implementation of the quality management system; the Defender prize for outstanding technologies for the state defence and security (for the optoelectronic upgrade kit for the Leopard 2A4 tank, comprising KDN-1T driver's thermal camera and KLV-1E gunner's thermal camera); and Targi Gdańskie S.A.'s Special Prize for PNL-4 night vision goggles, awarded at the 15th Balt Military Expo fair. At the end of the year, PCO S.A. was awarded the Laurel of Innovation for introducing innovative technologies for manufacturing thin-film coatings for precision optical components used in optoelectronic equipment. The prize is awarded by the Polish Federation of Engineering Associations (FSNT-NOT).



MEDIA ABOUT US

SEPTEMBER 2018 – JANUARY 2019



PCO S.A.'s plans for 2019

16.01.2019 *Portal Mundurowy*, Altair.com.pl

The article presents PCO S.A.'s plans for 2019. The Company plans to take on further infrastructure investments, extend optoelectronic product portfolio, participate in modernization programmes of the Polish Armed Forces, and extend and upgrade R&D base. PCO S.A.'s plans for the current year will be implemented in cooperation with Polska Grupa Zbrojeniowa's companies and other entities of the Polish defence industry.



PCO's ambitious plans: Investments, exports, army modernization

17.01.2019, WNP.pl

The publication covers the main plans for the current year, including further development of thermal imaging, and building a competence centre focused on manufacture of laser devices. The Company also opts for developing human resources, improving research and development base and manufacturing footprint, and cooperating with domestic and foreign centres.

Defence24

Bezpieczeństwo Wojsko Przemysł

Thermal imaging, laser devices, and modernization of combat vehicles

16.01.2019, Defence24.pl

The article relates to PCO S.A.'s plans for 2019. The key areas listed include further infrastructure investments, extending optoelectronic product portfolio, participation in modernization programmes of the Polish Armed Forces, and extending and upgrading R&D base.

Defence24

Bezpieczeństwo Wojsko Przemysł

PCO's President: standardization should be one of decision-making criteria

13.12.2018, Defence24.pl

Author: Jędrzej Graf

Interview with PCO S.A.'s President Krzysztof Kluza on the completion of multiannual contracts and plans for 2019. The main theme of the interview is the postulate of standardization as a key criterion for making decisions concerning orders placed by the Polish Armed Forces. In this regard, PCO S.A. suggests that KLW-1 cameras should be mounted on Leopard 2A4, 2A5, Rosomak, PT-91, the upgraded T-72, and potentially on other combat vehicles.



PCO's large backlog of orders

10.12.2018, *Wirtualny Nowy Przemysł*

Author: Włodek Kaleta

The article describes PCO S.A.'s plans for 2019, focused on extending product portfolio, also for civilian use, and developing entire systems for combat platforms. Prospects for future growth can be seen mainly in supplying systems for upgrading Leopard 2 tanks used by the Polish Armed Forces. The Company's strategic objective is to participate, as a supplier of optoelectronic devices and systems, in all operational programmes under the Technical Modernization Programme for the Polish Armed Forces.

Defence24

Bezpieczeństwo Wojsko Przemysł

Polish thermal imaging technologies for PT-91 Twardy tanks

21.11.2018, Defence24.pl

A press release on the contract concluded between PCO S.A. and the 2nd Regional Logistics Base, providing for delivering another batch of Modification Kits for Thermal Imaging Cameras (ZMKT) to the Base. The KLW-1 infrared camera, manufactured by PCO S.A., is the main component of ZMKT kits and is designed for PT-91 Twardy tanks equipped with SKO-1T (DRAWA-T) fire control systems as the gunner's sight.



Turkish-Indonesian "Anders" tanks to be manufactured

20.11.2018, Defence24.pl

Author: Marek Dąbrowski

The author describes a new fire support vehicle Kaplan MT (Harimau Hitam), designed as a result of cooperation between Turkish company FNSS and Indonesian company PT Pindad (Persero). One component of the tank is the SSP-1 OBRA-3 laser radiation warning system produced by PCO S.A.

Missile electro-optics and the return of Polish laser devices. Industry challenges as the main theme of the Optoelectronics Conference

17.11.2018, Defence24.pl

Participants of the 4th Optoelectronics Conference discussed key needs regarding photonics in defence applications, as well as major industry needs and corresponding corrective actions. The issues addressed included the need to provide conditions for pursuing R&D activities for the army based on equal rights, re-establish domestic manufacture of laser devices, and increase the share of Polish manufacturers in special-purpose projects funded by the European Defence Agency. The current demand and status of related work under Wisła and Narew programmes were also discussed.

**PCO S.A. and PT. Pindad signed a collaborative agreement during Indo Defence 2018**

12.11.2018, Special-Ops

The press note informs that PCO S.A. was present at the Indo Defence 2018 show in Jakarta, hosted by the Ministry of Defence of the Republic of Indonesia. This major Asian defence industry event was held on 7 November 2018. The show hosted over 850 exhibitors from 55 countries, including Polska Grupa Zbrojeniowa's companies, which exhibited their portfolio at a joint stand of the Ministry of Defence of the Republic of Poland and PGZ S.A.

At the show, PCO S.A. signed a memorandum of understanding (MoU) with Indonesian armaments manufacturer PT. Pindad (Persero). The document concerns developing cooperation of the companies in the area of optoelectronic systems dedicated to armoured vehicles manufactured by PT. Pindad.

**Optoelectronic equipment for Leopard tanks**

09.10.2018, InfoWire.pl

The article relates to the on-going modernization of Leopard 2A4 tanks used by the Polish Army. PCO developed three cameras for the purpose of modernizing the Leopard 2A4 tanks up to the 2PL version: KLW-1E for the EMES gunner's sight, KLW-1P for the PERI R17 commander's instrument, and KDN-1T driver's camera.

**PCO S.A.'s new cooperation and another Defender following MSPO 2018**

11.09.2018, InfoWire.pl

The press release about awarding PCO S.A. another Defender prize at the International Defence Industry Exhibition (MSPO) in Kielce. At the fair, the Company also signed a collaborative agreement with Elbit Systems, which will allow PCO S.A. to actually transfer advanced technologies to the company and to extend its product portfolio.

**PCO's ambitious plans: investments, exports, army modernization**10.09.2018, *Wirtualny Nowy Przemysł*

Author: Bartosz Dyląg

PCO S.A.'s President of the Board's statement on future PCO S.A.'s priorities, including an increase in investments, exports, and funds for R&D activities, further participation in modernization programmes of the Polish Army, and developing individual soldier equipment.

**Collaborative agreement between PCO S.A. and Elbit Systems**

09.09.2018, Special Ops

Information about signing, on 6 September 2018, a collaborative agreement between PCO S.A. and Elbit Systems at the 26th MSPO fair. The cooperation was established in the area of marketing, service, and manufacture of SPECTRO XR optoelectronic module systems and the Mini MUSIC DIRCM aircraft protection system.

„Civilian” Orlik night vision goggles to be exported

06.09.2018, Defence24.pl

Author: Maksymilian Dura

The author describes the civilian version of PCO S.A.'s PNL-3M air night vision goggles. Since the device had been certified by the European Aviation Safety Agency (EASA), it has already been purchased on the commercial market by consumers from the Czech Republic and Norway, to name just a few. Training centres and dealers of civilian aviation equipment are the main consumers. The military version of PNL-3M is used in Polish and Ukrainian armed forces.

MSPO 2018: a new version of PCO S.A.'s miniature night-vision device

04.09.2018, Defence24.pl

Author: Maksymilian Dura

The article relates to the MU-3MS night-vision universal monocular, manufactured by PCO S.A., demonstrated at the International Defence Industry Exhibition MSPO 2018 in Kielce. The device is an upgraded version of the MU-3M monocular used by the Polish armed forces and other uniformed services. It is designed for night observation by a single user.

PCO S.A.'s new products shown at MSPO 2018

29.08.2018 Portal Mundurowy

At the 26th MSPO trade fair in Kielce, PCO S.A. exhibited a number of new products, including the MU-3MS Miniature Universal Monocular, being the latest night-vision device manufactured at PCO S.A. and designed for night observation by a single user. At present, it is one of the lightest and smallest night-vision devices in the world. Another new product in PCO S.A.'s portfolio is the ZMO-3 Integrated Optoelectronic Module, designed for a remote-controlled weapon module (ZSMU) which is mounted on a light armoured reconnaissance vehicle LOTR. DCM-1, a new version of the modular day sight, was also introduced. The DCM-1 Modular Day Sight is designed for aiming and observing of the battlefield under normal daylight conditions.

The launch of MU-3MS

04.09.2018 E-Raport MSPO 1/2018

Author: Maksymilian Dura

The author describes the civilian version of PNL-3M air night vision goggles produced by PCO S.A. Since the device had been certified by the European Aviation Safety Agency (EASA), it has already been purchased on the commercial market by consumers from the Czech Republic and Norway, to name just a few. The PNL-3M ultra-light-weight stereoscopic air night vision goggles are designed for use for area surveillance and target detection during night flights by pilots and aircraft crews. They are successors to the PNL-3 system, widely used by the Polish Armed Forces and uniformed services: the Police and the Border Guard.

MSPO 2018: PCO's new products

03.09.2018, Milmag

Information about new PCO S.A.'s products which were demonstrated by the Company during the 26th International Defence Industry Exhibition in Kielce: the MU-3MS Miniature Universal Monocular, the ZMO-3 Integrated Optoelectronic Module, and a new version of the DCM-1 modular day sight.





PCO S.A.

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