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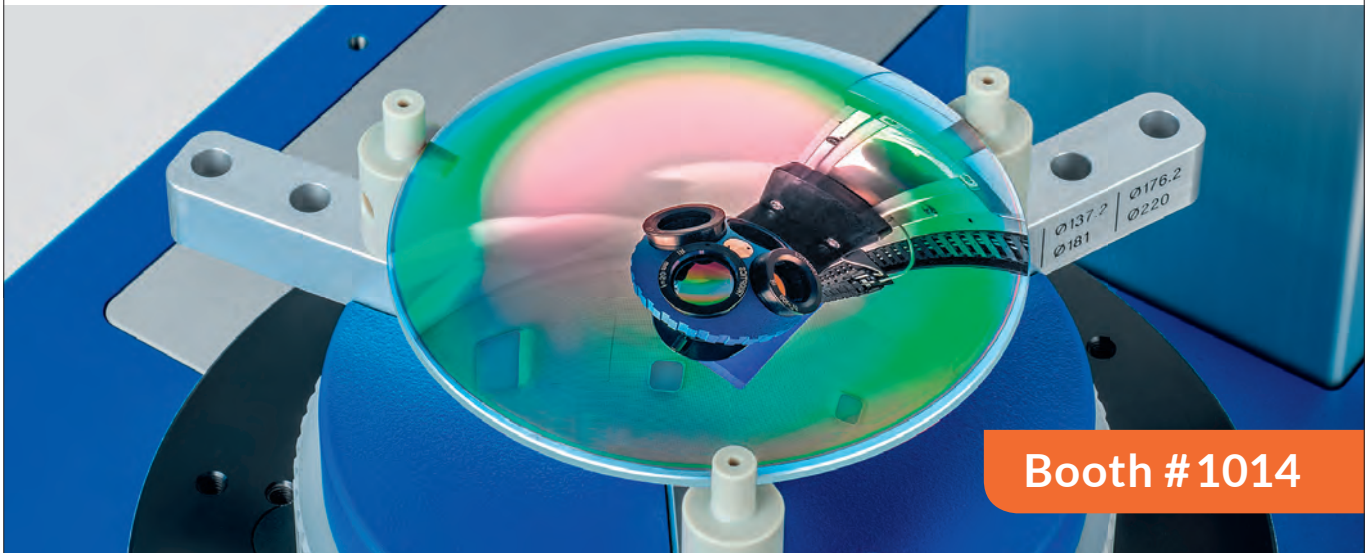


## product focus

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# Leonardo laser target designators selected for Australian Defence Force...

...while Northrop Grumman contracted to equip US Marine Corps with handheld targeting devices.

Defense technologies developer Leonardo Australia has signed an agreement with Collins Aerospace Australia to supply Type 163 Laser Target Designators (LTDs) to the Australian Defence Force (ADF). The order will be fulfilled in the second quarter of 2022. This order follows an earlier order by the ADF.

More than 800 units of Leonardo's Type 163 LTDs have already been delivered to 27 countries, including the the US, UK, Canada, and New Zealand, as well as NATO members such as Italy, France, Belgium, Denmark, Netherlands and, most recently, Germany and Norway.

Developed by Leonardo engineers in Edinburgh, UK, the Type 163 Laser LTD is a lightweight, high-energy laser system designed for use by ground forces. The Type 163 is specified to meet the mission requirements of special and conventional force Joint Terminal Attack Controllers and Joint Fires Observers. These include marking and terminally controlling semi-active air-to-ground weapons accurately onto the target at ranges up to 10km.

The Type 163 LTD exploits Leonardo's experience in providing targeting lasers for aircraft such as the F-35 and Apache



Credit: Leonardo.

Leonardo's Type 163 LTDs are deployed in 27 countries.

helicopter, where space, weight and power are at a premium. This means that the resulting product is able to deliver market-leading laser-designation and range finding capabilities in a compact package weighing just 2.3kg.

The product produces a high-energy laser with a narrow beam divergence and its feature set, developed with a focus on JTAC and JFO missions, includes immediate firing from switch-on and a continuous lasing capability.

## Northrop Grumman supplies US Marine Corps with targeter

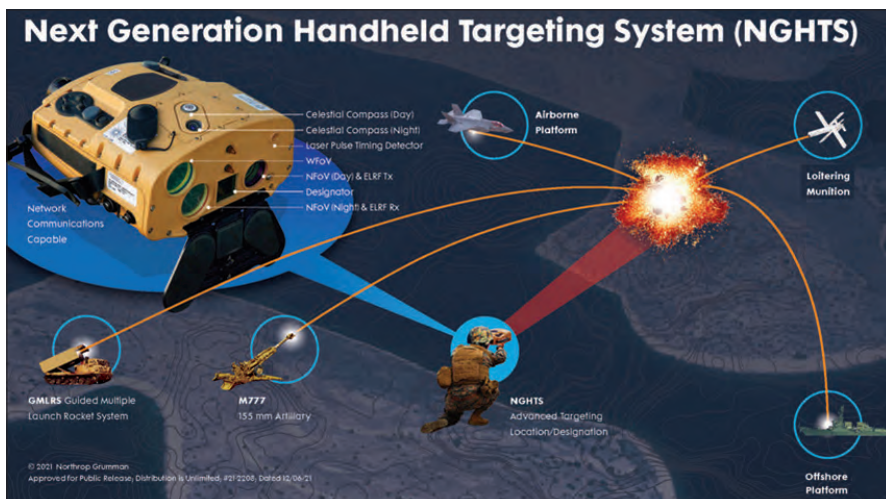
Northrop Grumman is to provide the US Marine Corps with its Next Generation Handheld Targeting System (NGHTS). This compact targeting device offers precision targeting and can operate in GPS-denied environments.

"NGHTS will significantly enhance the ability of Marines to identify ground targets under a wide range of conditions," commented Bob Gough, VP, Navigation, Targeting and Survivability.

"Connected to military networks, NGHTS provides superior situational awareness and accurate coordinates for delivery of effects beyond the line of sight."

NGHTS is capable of performing rapid target acquisition, laser terminal guidance operation and laser spot imaging functions. Its high-definition infrared sensors provide accuracy and grid capability over extended ranges. Additional features include a high-definition color display and day/night celestial compasses.

Credit: Northrop Grumman.



Northrop Grumman's Next Generation Handheld Targeting System.

<https://optics.org/news/13/2/39>

# Teledyne Flir Defense wins \$100 million contract with Danish Defense Forces

To provide medium- and long-range surveillance systems for imaging and sensing over next seven years.

Teledyne Flir Defense, part of Teledyne Technologies, together with its Denmark-based partner Precision Technic Defence Group, have signed a seven-year framework agreement with the Danish Defense Acquisition and Logistics Organization to provide a variety of medium- and long-range surveillance systems for land, maritime and airborne applications.

DALO also has awarded the companies a service and maintenance contract. The potential contract value is estimated to exceed \$100 million over the period of performance.

Teledyne Flir has offered its SeaFLIR/TacFLIR 280-HDEP and SeaFLIR/TacFLIR 380 HLD-X advanced day/night, all-

weather imaging systems. The contract allows DALO to procure versions of these products for the Danish Defense Mobile Sensor Systems program, which supports the surveillance needs of its Army, Air Force and Navy users.

## Investment in technology

JihFen Lei, executive vice president and general manager of Teledyne Flir Defense, commented, "We've invested heavily in technology upgrades across our lineup, including edge processing and AI capabilities that reduce the cognitive load on operators and improve situational awareness.

"As a trusted industry and regional partner, we look forward to supplying imaging platforms, service and support to Danish

defense forces for many years to come."

Designed for full-time, all-weather maritime duty, SeaFLIR 280-HDEP provides long-range target detection, identification, and tracking for a broad range of mission support, such as intelligence, surveillance and reconnaissance; maritime search and rescue; interdiction; covert operations; and disaster recovery.

TacFlir 280-HDEP is a land-based version of the system used for ground vehicle surveillance and fixed installations, featuring a laser designator.

The SeaFlir/TacFLIR 380 HLD-X provides HD multi-spectral imaging, ultra long-range imaging performance, superior image stabilization, and true metadata embedded in digital video, complete with laser designation and rangefinder.

## Latest trading by parent Teledyne Technologies

On January 27, 2022, Teledyne Technologies reported its latest quarter's (Q4) trading results, the highlights of which are as follows:

- Record quarterly sales of \$1,375.7 million, an increase of 70.0% compared with last year.
- Fourth quarter GAAP diluted earnings per share of \$3.39 and non-GAAP diluted earnings per share of \$4.56.
- Fourth quarter GAAP operating margin of 14.2% and non-GAAP operating margin of 21.5%.
- Record annual sales of \$4,614.3 million, an increase of 49.5% compared with last year.
- Full year GAAP diluted earnings per share of \$10.05 and non-GAAP diluted earnings per share of \$16.86.
- Full year GAAP operating margin of 13.5% and non-GAAP operating margin of 21.3%.
- Record quarterly and annual cash flow from operations.
- Year-end Consolidated Leverage Ratio declined to 2.9x from 3.8x in May 2021.
- Issuing full year 2022 GAAP diluted earnings outlook of \$14.10 to \$14.55 per share and full year 2022 non-GAAP earnings outlook of \$17.60 to \$18.00 per share.



Credit: Teledyne Flir Defense.

Teledyne Flir Defense offers a range of surveillance systems for defense applications.

<https://optics.org/news/13/2/3>

# Intevac sells photonics division to rifle scope maker Eotech

Deal sees Eotech pay at least \$70 million to acquire Intevac Photonics and its night-vision technology used by the US military.

Intevac has sold its photonics division, which specializes in sensors and imaging technology mostly used in defense applications, to fellow US firm Eotech.

Michigan-based Eotech agreed to buy Intevac Photonics with an up-front cash payment of \$70 million, alongside an earn-out agreement that could push the total value of the deal to \$100 million.

Primarily a maker of holographic optics for rifle scopes and similar military applications, Eotech was carved out of the major US defense contractor L3Harris in March 2020, when it was sold to American HoloOptics, a subsidiary of private equity firm Koucar Management.

## Strategic review

Intevac CEO Wendell Blonigan said in a release from the two firms: "Intevac Photonics, as envisioned by our late founder Norman Pond, pioneered the night vision technologies that have become the standard for most advanced digital night vision programs for the US military, as well as many foreign nations."

Matt Van Haaren, the CEO at Eotech, added: "Intevac Photonics has built an impressive portfolio of digital night vision technologies that set the standard for advanced military avionics platforms. We are excited to continue to build this business as it develops the next generation of digital night vision for the dismounted soldier."

The switch in ownership follows a strategic review initiated by Intevac in the past year, with its chairman David Dury commenting: "We have always believed in the long-term growth potential of [our photonics division], however with any significant new photonics product revenue ramp still at least a



Image: Intevac.

Based on a combination of III-V and silicon semiconductor components, digital night vision goggles from Intevac Photonics provide state-of-the-art awareness in low-light conditions.

couple of years away, and the complexity of achieving maximum shareholder value from two substantially different businesses within one company, the board of directors determined that this transaction was in the best interest of maximizing stockholder value."

In a conference call discussing the sale of the photonics business, Blonigan told investors: "Over the last 30 years, Intevac Photonics became the gold standard for sensors and cameras for practically every digital night vision program for the US military."

## Digital night vision

According to Intevac's most recent financial results, its photonics division posted sales of \$6.8 million for the three months ending October 2 - down from \$12.2 million for the same period in 2020.

Those figures were issued shortly after the Santa Clara firm revealed that it had signed

a new five-year, \$16 million contract to provide night-vision cameras to be used by pilots flying the US Army's Apache helicopters.

Timothy Justyn, executive vice president and general manager of Intevac Photonics, said at the time: "Intevac finished deliveries outfitting the US Apache fleet, spares and initial FMS (foreign military sales) customer orders in September of 2020. We are excited to be delivering additional cameras to support our warfighters' effort."

Intevac's "electronic image intensification" technology, used in those night vision cameras, is based on its patented active pixel digital imaging sensor for extreme low-light-level detection.

However, the roll-out of digital night vision technology across the US military - and any subsequent ramp in sales for Intevac - has suffered delays in recent months, partly explaining the firm's decision to sell the photonics division and focus on its thin-film equipment business.

The additional \$30 million of potential earn-out payments will be dependent on the extent to which existing development programs involving the US military are converted into significant sales deals for Eotech through 2025.

<https://optics.org/news/13/1/5>

# US Navy fires laser weapon in Gulf of Aden

Capability of high-power demonstrator system tested on static target in Middle Eastern waters.

A US Navy ship has carried out the latest test firing of a high-power laser weapon, in a demonstration of the technology in the Gulf of Aden.

Installed on board the USS Portland - an amphibious transport dock ship - the "Solid State Laser - Technology Maturation Laser Weapons System Demonstrator (LWSD) Mark 2 MOD 0" was fired at a "static surface training target", stated a US Navy release.

That is the same system that was used to shoot down an unmanned aerial vehicle (UAV) in May last year, while the USS Portland was in the Pacific Ocean.

'High-precision defensive approach' Built by the Office of Naval Research, the LWSD appears to rely on solid-state laser technology initially developed at defense contractor Northrop Grumman.

Back in 2015 the US firm signed a contract worth up to \$91 million to deliver a core laser module for LWSD with 100-150 kW output power, at a Technology Readiness Level (TRL) of 6.

Guy Renard, director and program manager of directed energy at Northrop Grumman's Aerospace Systems division, said at the time of that contract award:

"For about the price of a gallon of diesel fuel per shot, we're offering the Navy a high-precision defensive approach that will protect not only its sailors, but also its wallet."

The system has been designed with a view to future installation aboard "DDG 51" class destroyers, with minimal modifications, and it is hoped that such lasers will eventually protect a wide array of naval platforms from advanced

surface and air threats.

According to the US Navy, the USS Portland is part of the Essex Amphibious Ready Group that departed San Diego in August and began operating in what

is known as the 5th Fleet region in September.

"The region's geography, climate, and strategic importance offer a unique environment for technology innovation," it added in a brief statement about the laser firing.

The 5th Fleet's area of operations includes the world's largest standing maritime partnership, Arabian Gulf, Red Sea, Gulf of Aden, Gulf of Oman and parts of the Indian Ocean.

<https://optics.org/news/12/12/26>

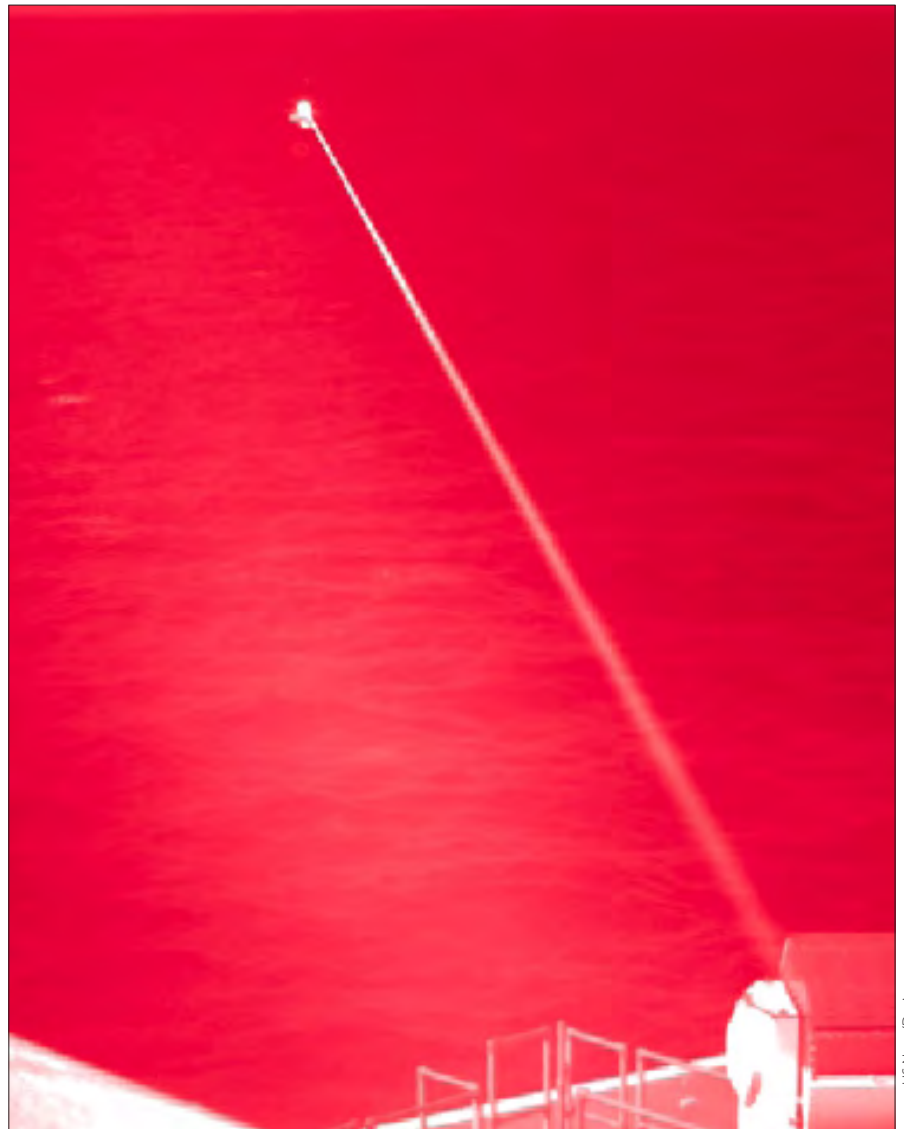


Image: US Navy/Devlin

Amphibious transport dock ship USS Portland conducts a high-energy laser weapon system demonstration on a static surface training target, while sailing in the Gulf of Aden on December 14. The US Navy says that during the demonstration, the "LWSD" successfully engaged the training target. This image was captured through a short wave infrared (SWIR) lens and optical filter.



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# Revision launches new laser eye protection glasses to counter strikes on aviators

Co-developed with AFRL, CALI-C lenses protect against laser hazards in a cockpit environment.

In response to the dramatic increase of laser strikes reported by the FAA and the desire to protect the vision of pilots and ensure the safety of their passengers, Revision, a developer of ballistic and laser protective eyewear systems, has launched new laser eye protection solutions “that are optimized for aviator protection and awareness.”

Developed with the US Air Force Research Laboratory (AFRL), Revision’s CALI-C lens formulation offers eye protection that protects against common handheld laser hazards without compromising a pilot’s ability to see instrumentation.

In February, 2022, the US Federal Aviation Administration (FAA) reported a large increase in laser strikes against aircraft in the United States – 9,723 reports in 2021 alone – a 40% increase over 2020.

Despite the FAA threatening civil and criminal penalties plus \$11,000 fines for people that shine lasers at aircraft, the number of incidents isn’t dropping. In fact, there’s reason to believe the amount of laser strikes is underreported because pilots don’t want to risk getting medically grounded as a safety precaution after reporting an in-flight laser incident.

## Higher rate of strikes

“Each year the FAA reports a higher rate of laser strikes against aircraft, putting aviators and passengers at risk,” said Revision CEO Amy Coyne. “Over the past decade, Revision has been partnered with AFRL on laser eye protection solutions for the military. This CALI-C formulation represents a real solution that gives aviators peace of mind while operating in low-altitude operations, keeping them safe and reducing the impact of laser hazards on their mission.”

Revision research scientists look to design formulations that consider the specific end-user environment and needs. Both rotary- and fixed-wing aircraft have the benefit of altitude, which means a reduction in the rate of



AFRL courtesy photo

*Flight Officer Cameron Iverson of the Washington State Patrol tested CALI laser protective lenses formulated at Air Force Research Laboratory’s Materials and Manufacturing Directorate.*

eye damage, but a heightened threat of distraction, disorientation, and flash blindness as laser light can fill a cockpit with bright light in an instant.

The CALI-C formulation takes this into account by offering a wide band of protection without compromising light transmission – a critical point given most aviation laser incidents happen at night.

## Specs’ specs

The ideal cockpit laser eye protection solution offers the following: a wide range of protection given the variety of laser hazards; lenses that do not interfere with the cockpit instrument panel, yet transmit enough light to be worn at night when most laser incidents occur; and are easy to don and doff, featuring

frames that integrate with cockpit head borne equipment such as headsets and helmets.

Therefore, a set of laser protective eyewear designed for a ground-to-ground laser hazard isn’t ideal for the cockpit. The CALI-C solution was developed to maximize aviator protection and situational awareness – solving the challenges of laser eye protection in a cockpit environment.

The CALI (Commercial Aviation Low Intensity) solution was developed by AFRL in collaboration with Revision Military and successfully tested and evaluated by Washington State Patrol pilots. The Personnel Protection Team at AFRL’s Materials and Manufacturing Directorate is headed by Dr. Matthew Lange, who says “Simply put, the lenses maximize protection while minimizing the impact to the cockpit.”

CALI-C is being offered in two configurations tailored for either fixed-wing or rotary-wing environments: The Aviator SF-2 frame offers a lightweight metal frame with dual lenses – low profile and ideal for a fixed-wing cockpit. The StingerHawk frame offers a single wrap-around lens for maximum coverage, ballistic protection, and anti-fog performance for rotary-wing cockpits.

<https://optics.org/news/13/3/2>



Image: Revision.

*CALI-C is available in two configurations tailored for either fixed-wing or rotary-wing environments.*



# UK's DSTL researching materials to better protect optical sensors against laser attack

**Trials conducted to assess novel protection filters on military system cameras against high-intensity lasers.**

The UK's military research facility the Defence Science and Technology Laboratory is researching new materials to improve protection for optical sensors within digital cameras against attacks by lasers.

Mounted on a variety of different platforms such as vehicles, ships or aircraft, cameras capture crucial intelligence, surveillance and reconnaissance (ISR) data to help commanders gather information and manage their forces. Disrupting these cameras and restricting the flow of imagery provides adversaries with a strategic advantage.

Sensors within digital cameras are extremely sensitive to light, which is why camera manufacturers advise never to point a camera at the sun, for instance. Lasers are powerful and bright

projections of light which, directed at the lens of a camera, could dazzle or damage the sensor.

## Novel protection filters

The Defence Science and Technology Laboratory (Dstl) conducted a trial to assess novel protection filters on cameras and demonstrate hardening to high intensity lasers. Several devices tested on the trial demonstrated protection across a wide range of laser intensities, even when exposed to laser engagements many times.

The Dstl trial was attended by 3 international collaborating organisations and identified extensive follow-on work to allow sensors to continue operating in contested environments.

Data from the trial is being reviewed, following which expressions of interest will be invited from industrial suppliers to accelerate the development of the technology.

Chris Westgate, Dstl's technical authority for the trial, commented, "Dstl researches new technologies to help keep UK forces and their equipment safe from harm. We protect assets not just from conventional threats, such as bullets and explosives, but from novel and unconventional threats such as cyber, radio frequency and other attacks.

"By improving the resilience and durability of equipment we will help UK forces retain freedom of action against current and future threats," added Westgate.



Image: DSTL

Scimitar reconnaissance vehicle illuminated by a green laser.

<https://optics.org/news/13/2/12>

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Camino de Hormigueras 124-4

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## First Light Imaging

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More information: <https://www.first-light-imaging.com/product/c-red-2-extended-range-2/>



#### Contact Details

First Light Imaging

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[www.first-light-imaging.com](http://www.first-light-imaging.com)

[contact@first-light.fr](mailto:contact@first-light.fr)

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# Elbit Systems to build deep-UV space telescope

**\$16M contract with the Weizmann Institute of Science under Israel's Ultraviolet Transient Astronomy Satellite program.**

Israeli defense firm Elbit Systems has won a \$16 million contract to provide an ultraviolet space telescope for the Weizmann Institute of Science.

Procured under Israel's Ultraviolet Transient Astronomy Satellite (ULTRASAT) program, which is jointly managed and funded by Weizmann and the Israeli Space Agency - in association with Germany's DESY research center - the contract covers a period of two years.

"Elbit Systems will develop, manufacture and integrate a highly sensitive, wide field of view (200 square degrees) ultraviolet space telescope that is intended to help scientists in understanding the creation of heavy elements, black holes, and gravitational waves and discover astronomical phenomena such as supernovae," announced the Haifa-headquartered firm.

## 220-280 nm wavelength range

While better known for its military systems activities, Elbit has a record of providing space cameras, satellites, and other electronic instruments to space programs in Israel, the US, Europe, South Korea, and Brazil.

According to the Weizmann Institute's overview of the ULTRASAT mission, a miniature satellite will carry the telescope into a geostationary orbit, from where it will observe deep-ultraviolet light in the 220-280 nm wavelength range.

"ULTRASAT will revolutionize our understanding of the hot transient universe," states Weizmann in its description of the program, which was expected to have a total cost of around \$70 million when details were revealed in August 2019.

The telescope is expected to have a broad scientific impact across the fields including the study of gravitational wave sources, supernovae, variable and flare stars, active galactic nuclei, tidal disruption events, compact objects, and galaxies.

All ULTRASAT data will be transmitted to the ground in real-time, with transient alerts distributed to the community in less than 15 minutes.

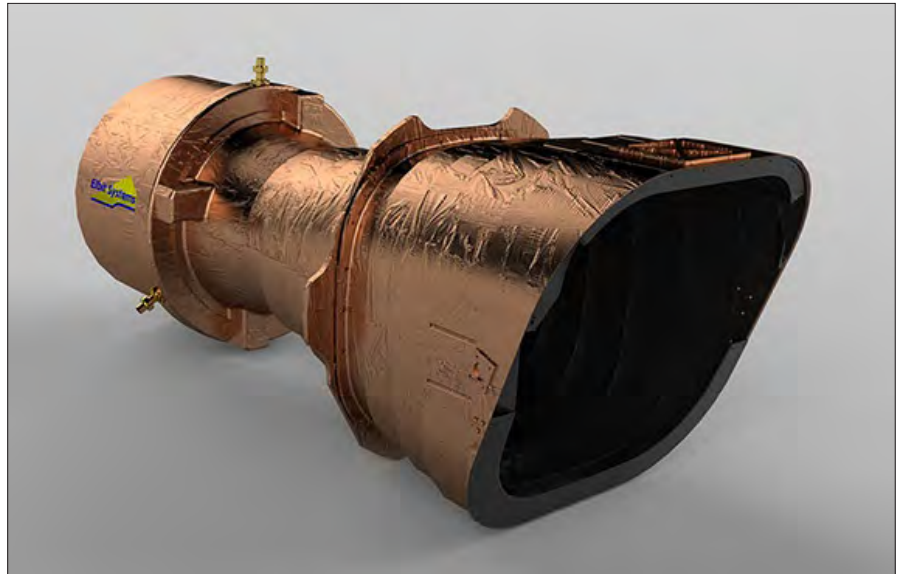


Image: Elbit Systems.

*With rapid slewing capability and a wide field of view, the deep-UV detecting "ULTRASAT" telescope should be able to pinpoint electromagnetic radiation generated shortly after cosmic collisions that cause gravitational waves to be felt by giant interferometers on Earth. Astronomers will then be able to follow-up these so-called "hot transient" events with ground-based telescopes operating in the optical and infrared spectral regions.*

One of the key science goals is to detect electromagnetic radiation associated with gravitational wave events, for example caused by the distant collisions of black holes and neutron stars.

"Such detections will be the key to using these events for addressing fundamental physics questions, such as the origin of the heaviest elements and the expansion rate of the universe," states the Weizmann team.

## Rapid slewing

ULTRASAT will be able to slew across more than half of the sky within minutes of such events being sensed, and with a wide field of view it should be able to cover the areas of the sky where gravitational-wave events are thought to have originated.

Because of the nature of gravitational wave detection, and the small number of interferometer detectors currently operating, it is not always possible to pinpoint the exact location of the collisions that caused the cosmic "ripples".

However in 2017, astronomers were able to make the first observation of both gravitational waves and electromagnetic radiation from the same source - a merger of two neutron stars - that caused a gamma-ray burst and associated light signals across the spectrum.

On that occasion a minute-long gravitational wave signal was quickly followed by a gamma-ray burst, and within 24 hours several large optical and infrared telescopes were able to observe a new bright-blue "kilonova" in the night sky, before it turned red and rapidly faded from view.

From spectroscopic observations made at the time, astrophysicists were able to confirm the formation of large amounts of gold and platinum from the collision - in the process solving the long-standing mystery of how such heavy elements are formed.

As well as making it easier to spot any deep-UV radiation produced by such collisions, ULTRASAT should be able to alert astronomers on Earth very quickly, so that they can carry out follow-up spectroscopy and monitoring of any optical and infrared emission that arises after the gravitational ripples are first felt.

If all goes according to plan, ULTRASAT is planned to have a three-year operational life in its geostationary orbit.

"ULTRASAT is groundbreaking both in terms of science and in terms of implementation," states the Weizmann Institute. "If successful, we will demonstrate that breakthrough science can be achieved by small satellites at an affordable cost [in the region of \$100 million including launch], leading the way to future similar missions."

<https://optics.org/news/13/1/40>

# NIST upgrades instruments to calibrate US scales for light measurement

Precision devices measure properties of reflected and transmitted light, as references for U.S. metrology sector.

The U.S. National Institute of Standards and Technology (NIST) has completed significant upgrades to two key instruments serving what the agency calls “critical national needs”. The devices measure the properties of light as it is reflected from a surface or transmitted through a sample material.

Together they are at the core of NIST’s ability to set and maintain official U.S. scales. They allow operators of reflectance and transmittance instruments to calibrate their equipment by comparing their measurements against an authoritative source – to ensure that different devices produce comparable data.

NIST maintains the national scales in the near ultraviolet (UV, wavelengths above about 250 nm, visible (400 to 700 nm), and the near- and short-wave infrared (IR, up to about 2400 nm) spectral regions. Dissemination of those scales — along with improvement in metrology traceable to the SI, support of U.S. defense labs, and coordination with national metrology institutes worldwide — are major aims.

## ROSI reflections

NIST is a world leader in measuring these effects through the science of reflectometry. One important example is the newly upgraded, state-of-the-art Robotic Optical Scattering Instrument (ROSI) in NIST’s Physical Measurement Laboratory, in Gaithersburg, MD. Its capabilities are described in detail in Applied Optics.

ROSI can measure reflection from both specular (mirror-like) and diffuse (rough surfaces that spread out reflected light) samples. It has an angular range of 0 to 80deg for both illumination and viewing. One exceptional feature of ROSI is its ability to measure at out-of-plane viewing angles.

“Along with commercial interests, ROSI’s customers are national and international government laboratories,” commented PML scientist Heather Patrick. For example, Earth-monitoring satellites use measurements of different wavelength bands of reflected light to determine ocean temperature, chlorophyll concentration, sea-surface height, currents and other parameters of interest to climate scientists.

“One of our longest-running customer relationships,” said Patrick, “is with NASA’s Diffuser Calibration Laboratory. Earth-observing satellites for applications like climate monitoring use a diffuse reflector called a solar diffuser to help calibrate the response of their cameras to different colors reflected by scenes in images of the Earth.



NIST physicist Heather Patrick with ROSI.

“NASA relies on ROSI calibrations to ensure the accuracy of the reflectance values assigned to the solar diffusers. It has been estimated that a conventional weather satellite can cost between \$3 billion and \$5 billion to develop and launch, so accurate measurements of all the satellite components are critical.”

Patrick added, “In the commercial realm, manufacturers of color measuring instruments rely on standards measured by ROSI to ensure accuracy and reproducibility of color measurements. A measurement on ROSI of a white sample, where the variation in reflectance from wavelength to wavelength is minimal, provides a known top-of-scale that instrument manufacturers can use to calibrate spectral response and enable reproducible color measurements.”

ROSI has been in continuous development and improvement since 2013, taking over many of the measurement tasks formerly accomplished by NIST’s aging STARR instrument—still in use for hemispherical reflectance measurements. A shorter-wavelength light source has been added to ROSI. The original source could provide tunable light to a sample down to about 430 nm (visible deep violet). The new source extends the range to 250 nm in the UV. One reason is the need for reflectometry of UV sources used in germicidal applications.

## Gains in UV transmittance calibrations

NIST researchers have also improved their ultraviolet light transmittance calibration service. Thanks to a lab upgrade, they have achieved a 70% reduction in uncertainty, as well as halving the measurement times.

“These upgrades have made it possible to make more customer measurements on our reference instrument,” said NIST’s Catherine Cooksey, referring to the main apparatus that NIST scientists built which makes measurements that are traceable to the SI, the international system of units used as the world standard.

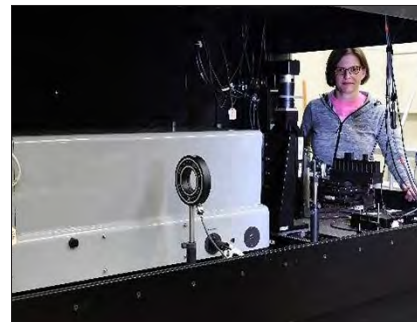
“Before, the time required for performing measurements on the reference instrument was

very long, so we used a commercial instrument instead. But the reference instrument is now operating so well, and with such ease, that I can turn it on at any time and make a customer measurement directly.”

NIST transmittance calibrations, which assess the amount of light of different wavelengths passing through an object, are performed for customers who work with materials that filter light. These include glass manufacturers trying to optimize coatings for windows, or people building remote sensing instruments who rely on light filters, as well as pharmaceutical companies and military standards laboratories.

Indirectly, these measurements support myriad uses on a consumer level. For example, police officers might use a commercial transmittance sensor—traceable to NIST or another national metrology lab – to test how much light is passing through a tinted car window, to determine if the window is in compliance with local laws.

So what did Cooksey and her colleagues change about their set-up to allow them to improve their UV measurements? To calibrate a sample,



Catherine Cooksey with the upgraded transmittance calibration system.

NIST staff use a UV source that is “broadband,” meaning it produces many wavelengths of light. That light then goes through a monochromator, a series of gratings and mirrors that allows NIST staff to select a single frequency. The light then travels through the customer’s sample before hitting a detector that tells the scientists what passed through the glass.

One issue with the old UV calibration system was that it used a deuterium lamp as its source. The deuterium lamp produced a fairly weak UV beam, which reduced the size of the signal the researchers could achieve. So Cooksey and colleagues replaced it with a more intense source, a laser-driven light source (LDLS), which uses a high-power laser to induce a gas-filled bulb to emit broadband light.

But the LDLS, though it gave the team more light to work with, was unstable: The amount of UV light fluctuated over the course of just a couple of minutes. Scientists solved this problem by adding a monitor line that could measure the light coming out of the monochromator in real time. A change in measurement protocol also allowed the team to complete these calibrations twice as fast.

<https://optics.org/news/13/1/13>

# Lidar firms burn through cash in race to commercialization

## Velodyne, Luminar, Aeva, Aurora, and Ouster report latest financial results.

Several of the lidar companies recently listed on the stock market in the US have reported their financial results for 2021, revealing the rates at which they are burning through cash.

in November 2021 following a period of boardroom wrangling, pointed to record shipments of nearly 5000 sensors in the latest quarter as early evidence of a turnaround in fortunes.



Photo: Luminar Technologies.

Austin Russell, Luminar's founder and CEO, pictured on the left here with Markus Schäfer, CTO responsible for development and procurement at Mercedes-Benz' Sindelfingen plant in Germany.

Luminar, Aeva, Aurora, and Ouster all posted sharp rises in sales but hefty operating losses, as they work to develop and commercialize technology aimed mostly at emerging applications in advanced driver assistance systems (ADAS) and autonomous vehicles.

Meanwhile Velodyne, the oldest of those companies - and the first to complete its listing via a special purpose acquisitions company (SPAC) agreement in mid-2020 - confirmed a 35 per cent fall in annual sales to \$61.9 million in 2021.

### Velodyne

For the closing quarter of 2021, Velodyne's revenues of \$17.5 million were down only slightly on the equivalent period of 2020, but the San Jose firm also burned through \$30 million in cash.

CEO Ted Tewksbury, who was appointed

"Lidar is going to transform virtually every industry as we know it, creating a safer, more efficient, and sustainable world," he said. "Velodyne Lidar is well positioned to capitalize on this opportunity."

Unlike many of its rivals, who are wholly focused on automotive applications, Velodyne is also targeting deployments in industrial automation and robotics, where Tewksbury anticipates the "first wave" of lidar commercialization.

"By supplying high-performance lidar at scale into these early autonomous markets, Velodyne expects to expand our technologies and further our leadership in low-cost, high-quality, volume manufacturing," the CEO added.

"This will enhance our advantage in the second wave of lidar growth - autonomous vehicles and ADAS."

Speaking during an investor conference call discussing the latest results, Tewksbury also said that around 30 per cent of current sales were destined for automotive applications.

Looking ahead, the Velodyne executive team predicted that sales in the opening quarter of 2022 would be somewhere between \$10 million and \$12 million.

### Luminar

Reporting on the same day as Velodyne, Luminar Technologies CEO Austin Russell described his firm's first full year as a public company as a "blowout success", with all critical milestones met.

"2022 will be our biggest year yet as we prepare for our breakthrough series production launch at year-end," he added.

In terms of sales revenues, Luminar posted \$12.3 million for the closing quarter of 2021, and \$31.9 million for the full year respectively - both figures rising sharply on the 2020 totals, with Volvo and Mercedes-Benz owner Daimler representing the firm's top two customers.

And despite its operating activities using up nearly \$150 million in cash during 2021 - double the amount in 2020 - Luminar's successful SPAC listing means that it still has nearly \$800 million in liquid assets on its balance sheet.

Looking ahead, Russell and his colleagues are expecting sales to top \$40 million in 2022, while by the end of the year the company also aims to ready its "Iris" lidar product and core software for series production.

Speaking with investors, Russell said that 2021 saw Luminar partner with key supply chain manufacturing and vehicle integration partners including Celestica and Fabrinet, as well as ink a deal with automotive giant Mercedes-Benz.

"One special aspect of this deal also relates to data," highlighted the CEO. "We will be able to access the data from both the development vehicles as well as the production vehicles for continuous improvement and updates, such that our technology will only get better and better over time. That's hugely significant."

### Aeva

Aeva, located close to Velodyne in Silicon Valley, said its 2021 revenues almost

*continued on next page*

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## Lidar firms burn through cash in race to commercialization

doubled on the 2020 figure, reaching \$9.3 million. Reporting a few days before its neighbor, it gobbled up just over \$80 million of its cash reserves - although, like Luminar, Aeva still has plenty of liquid assets on its balance sheet.

CEO and co-founder Soroush Salehian said: "Aeva delivered on all of our objectives in 2021 - from product and commercial to financial - enabling us to accelerate our path to commercialization."

The company, which is one of only a few lidar firms to have developed frequency modulated continuous wave (FMCW) lidar technology, has just released its "Aeries II" product, claiming it to be "the world's first commercially available 4D lidar that offers automotive grade reliability".

It is also targeting industrial automation

in a metrology-focused collaboration with Japanese technology giant Nikon, and, like Luminar, has aligned with Fabrinet as a manufacturing partner.

Fabrinet is set to manufacture Aeva's silicon photonics lidar chip module, Salehian told an investor conference call, with the new production line already automotive industry qualified and plans to scale to mass production volumes.

Deliveries to customers are expected to begin by the middle of this year, with deployments for future applications in trucks starting in late 2022.

"We are encouraged by the growing interest for Aeva's FMCW approach, and we expect to build on our commercial momentum as additional customers begin testing and development with Aeries II," said the CEO.

### Aurora and Ouster

Reporting their results in mid-February, Aurora and Ouster followed the same pattern, with Aurora - which is developing a full autonomous driving system based around its internal FMCW lidar - posting an annual operating loss of \$731 million

on "collaboration revenues" of \$83 million.

However, the company raised a colossal \$1.8 billion on completing its SPAC listing in November, with its balance sheet showing \$1.6 billion in cash and equivalent liquid assets as of December 31.

Aurora has also signed a deal with trucking firm US Express, which joins Volvo and PACCAR as one of its key collaborators.

Finally Ouster, which completed its SPAC almost exactly a year ago, and has since acquired Sense Photonics, reported \$33.6 million in annual sales revenues for 2021, accompanied by a cash burn of \$70.6 million.

The San Francisco company's CEO Angus Pacala described the past year as a "turning point", and predicted that sales will rise to between \$65 million and \$85 million in 2022.

<https://optics.org/news/11/1/63>

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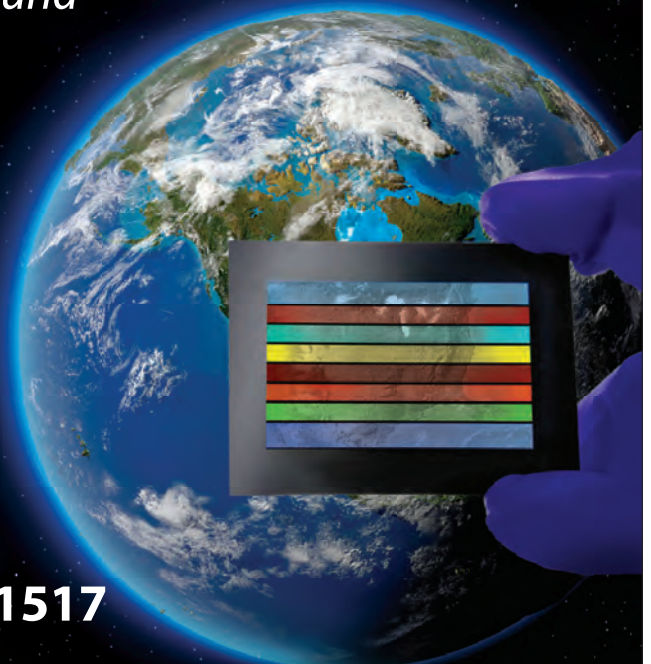
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# TriEye's SWIR driving sensor under evaluation by Hitachi

Israeli startup has developed CMOS-based short-wave infrared imager for use in low-light and adverse weather conditions.

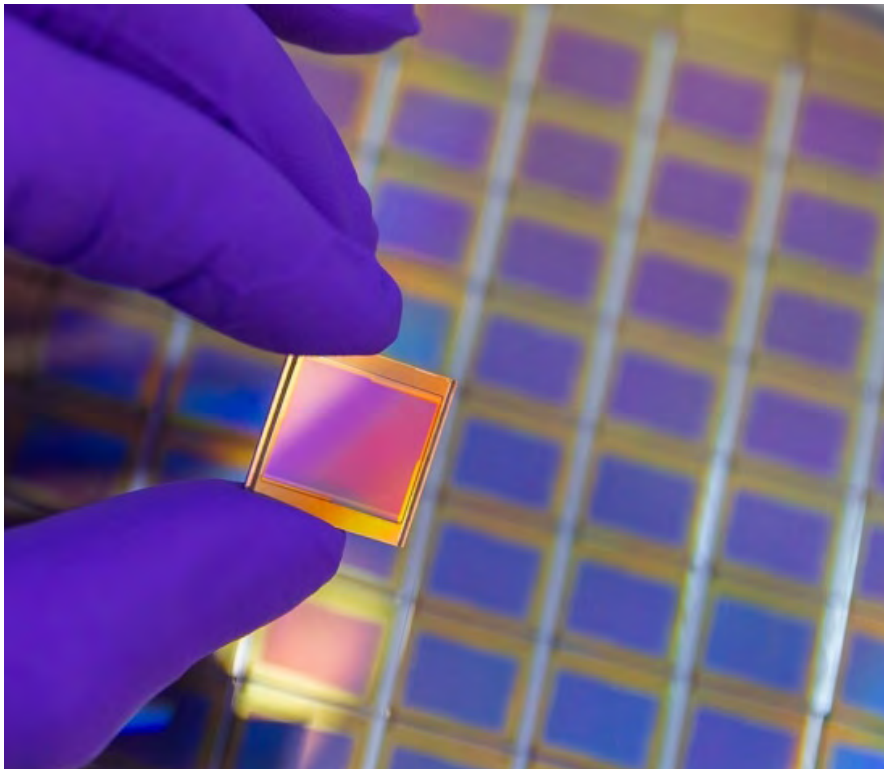


Image: TriEye.

TriEye says that its CMOS-based technology for SWIR sensing is the result of a decade of nanophotonics research by its CTO and co-founder, Professor Uriel Levy, that will enable mass production and therefore much lower cost than InGaAs alternatives.

The Israeli firm, founded in 2017, recently raised \$74 million in venture support from the likes of Intel, Samsung, and Porsche, to help commercialize a short-wave infrared (SWIR) device that can be manufactured using conventional CMOS semiconductor processes - and should therefore much cheaper than indium gallium arsenide (InGaAs) equivalents. The agreement with Hitachi Astemo will see the two companies work together to further enhance the capabilities of ADAS in adverse weather and low-light conditions.

## 'SEDAR' vs lidar

TriEye's technology is also compatible with a technique it calls "spectrum-enhanced detection and ranging" (SEDAR), claimed to be the automotive industry's first affordable and complete

solution capable of producing both high-definition image data and a detailed depth-map.

"The SEDAR was designed to meet the automotive market's requirements and redefine safety standards by enabling perception in all visibility conditions," stated TriEye, which calls the sensor "Raven" and says that SEDAR is ten times cheaper than current lidar technologies.

Hitachi Astemo, a direct subsidiary of the Japanese industrial giant whose name is an abbreviation of "advanced sustainable technologies for mobility", will evaluate SEDAR and validate whether it can be easily integrated into its existing ADAS solution to provide 2D and 3D depth information under low-visibility conditions.

John Nunneley, senior VP of design

engineering within Hitachi Astemo Americas, said in a joint release:

"Our goal is to continue to work towards improving vehicle safety. And we believe that TriEye's SEDAR can provide autonomous vehicles with ranging and accurate detection capabilities that are needed to increase the safety and operability under all visibility conditions."

TriEye demonstrated the SEDAR technology at the Consumer Electronics Show (CES) event in Las Vegas earlier this month, where it also claimed an innovation award.

Ziv Livne, chief business officer at TriEye, said: "Together with Hitachi Astemo's expertise in building and deploying complex ADAS systems, we can create a clear and focused path towards vehicle integration, saving lives on the road."

## 1350 nm VCSEL integration

Co-founded by CEO Avi Bakal, CTO Uriel Levy, and VP of research and development Omer Kapach, TriEye has previously signed similar collaborations with automation expert Trimble, and Continental Engineering Services.

Speaking in November last year, when the company revealed its \$74 million venture funding round, Bakal said: "We are proud to be the first to offer the advantages of SWIR sensing technology to multiple industries at a highly disruptive price point.

"Indeed, we believe SEDAR will change the automotive perception market as we know it today. And this is just the beginning.

"Thanks to the support of our new and existing investors, TriEye is accelerating its growth as we look to become a critical player in smart, safe, reliable, and cost-effective automated vision systems."

TriEye says that its CMOS-based SWIR sensor technology is the result of more than a decade of nanophotonics research by CTO Levy and colleagues at Hebrew University in Jerusalem.

In December, TriEye added that its SWIR device could also be integrated with 1350 nm vertical-cavity surface-emitting lasers (VCSELs) for short-range sensing applications such as biometrics and industrial automation.

<https://optics.org/news/13/1/33>

# Hamamatsu Photonics develops 'world's first' terahertz image intensifier

Enables real-time non-destructive imaging; suited to inspection of food products, body scanning, and other research.

Hamamatsu Photonics has developed what it calls "the world's first terahertz image intensifier". Capable of real-time non-destructive imaging, the device could have applications in the foreign matter inspection of food products and in (human) body scanning.

The image intensifier "THz-I.I." is based on Hamamatsu's imaging technology developed over many years. The company states that THz-I.I. has high resolution and a fast response, which allows for real-time imaging of terahertz wave pulses transmitted through or reflected from target objects.

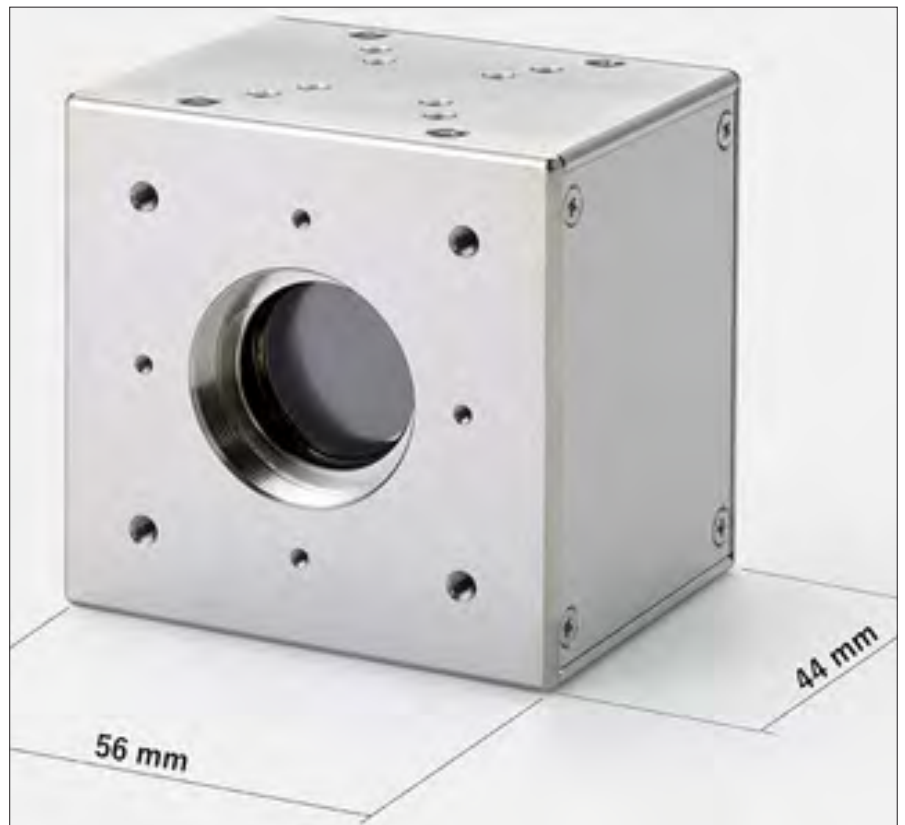
The THz-I.I. will be unveiled at the 69th Japan Society of Applied Physics Spring Meeting (JSAP) to be held at Aoyama Gakuin University in Sagamihara City, Japan from Tuesday, March 22 through Saturday, March 26.

## Overview of THz-I.I.

An image intensifier is an image enhancement tube primarily developed for night vision under starlight. A typical image intensifier consists of a photocathode to convert the incoming light into electrons, a microchannel plate to amplify the electrons, and a phosphor screen to return the electrons to light, all sealed in a vacuum tube.

By selecting the photocathode material, the incoming light including visible and invisible light can be converted into electrons, which are then multiplied in a vacuum. This enables high-speed, high-resolution and high-sensitivity imaging of luminescent phenomena.

Hamamatsu Photonics has been undertaking collaborative research with Technical University of Denmark



Terahertz image intensifier "THz-I.I."

to develop photoelectric conversion technology utilizing small metamaterial antennas that convert terahertz waves into electrons.

This photoelectric conversion technology is applied to Hamamatsu's imaging technology to form a metamaterial antenna on the inner surface of the I.I. input window. Hamamatsu also redesigned the antenna structure to increase the efficiency of converting terahertz waves into electrons – which are effectively multiplied in the vacuum.

Hamamatsu commented, "We have succeeded in developing a fast-response, high-resolution THz-I.I. capable of real-time

imaging of terahertz waves transmitted through or reflected from target objects. This terahertz image intensifier also allows imaging of terahertz waves in any frequency band by changing the antenna design to match the required application."

The intensifier is expected to expand the range of applications of non-destructive inspection. For example, rapid in-line inspection of nails and thin films in food production; contaminants are normally difficult to detect using conventional X-ray inspection techniques.

Since terahertz waves are harmless to the

human body, the THz-I.I. is also promising for body scanners that capture real-time images of terahertz waves reflected from the target object. This will prove highly effective when making walk-through security checks at train ticket gates and entrances to event venues.

In research, the THz-I.I. will serve as a tool to acquire the beam profile of terahertz waves or to adjust the terahertz optical system. As a future goal, Hamamatsu said, "we will be pushing ahead with developing a THz-I.I. with higher sensitivity for actual use and aim to start shipping product samples within one year."

<https://optics.org/news/13/3/33>

Credit: Hamamatsu Photonics

# Rockley posts hefty losses amid push to accelerate commercialization

Silicon photonics firm re-deploys datacom engineers to biosensing projects as it targets healthcare applications.

Rockley Photonics, the developer of photonic integrated circuits (PICs) for applications in optical biosensing and communications, says it is taking steps to preserve capital after posting huge losses in its latest financial year.

The California-headquartered company, which has its roots in the UK but listed on the New York Stock Exchange via a special-purpose acquisitions company (SPAC) merger last August, reported an operating loss of \$116 million in 2021.

Full-year sales slumped from \$22.3 million in 2020 to \$8.2 million last year, as the company pivoted away from its traditional area of datacom applications to focus on biosensing in wearable technologies - what Rockley refers to as its "clinic-on-a-wrist" technology.

Having boosted its balance sheet with \$168 million via its SPAC listing, the company went on to post an operating loss of \$23.2 million on sales of \$2.4 million in the final quarter of the year.

## Customer engagement

Commenting on those results, CEO and founder Andrew Rickman focused on the firm's efforts to penetrate both the medical and consumable wearables markets, saying:

"The recently released results from our core body temperature and blood pressure studies suggest that our approach will allow continuous insight into a person's individual health and wellness.

"We believe that the use of our platform could have a profound impact on the lives of individuals, patients, seniors, first responders, and more. [It] has the potential to help the current system evolve from 'sick-care' to preventative healthcare, by empowering individuals and by providing better tools for professional healthcare."

Rockley pointed to agreements with six global consumer electronics firms, plus engagements with 12 more - said to include six of the top ten largest makers of smart watches and wristbands - as evidence of the progress it is making.

Those prospective clients are being offered Rockley's "VitalSpex" chipsets and modules, while potential customers in the medical industry started to receive engineering samples of the photonics firm's "Bioptx" sensing platform in January - claimed to be two years ahead of schedule.

Commercial versions of the Bioptx sensors for medical technology customers are expected by the end of 2022, with Rockley planning to generate revenues from sales of cloud software and subscriptions while it seeks certifications for healthcare uses from the US Food and Drug Administration (FDA) and other regulatory bodies.

## Industry convergence

During an investor conference call discussing the latest results, Rickman outlined the rationale behind Rockley's pivot to healthcare and "wellness" applications, saying that the convergence of the medical technology and consumer electronics sectors was creating an opportunity for disruption.

"Governments are acutely aware of the need to empower people, to detect diseases early, and even to prevent them," he said. "[We] need to look for ways to not only treat but to prevent disease."

Rockley is developing two versions of the technology, known as "Baseline" and "Pro". The Baseline version is set to add blood pressure, core body temperature and hydration monitoring, with the Pro additionally offering blood lactate, alcohol, and glucose sensing.



This year Rockley plans to carry out further studies of the sensing technology's ability to probe biomarkers for cardiovascular health, with shipments for the medical technology industry expected to precede those for consumer electronics customers.

But in the meantime - and following the US Department of Commerce ruling that means Rockley is now looking for an alternative buyer for its datacoms joint venture - the company is taking steps to control its spending, with some engineers shifting their focus.

CFO Mahesh Karanth said: "We implemented programs to help us to preserve capital and improve our cash efficiency, correlating expenditures to initiatives tied to accelerating the commercialization of our consumer wearables and medtech products.

"We are in the process of redeploying datacom engineers to biosensing projects."

<https://optics.org/news/13/3/20>



# PreAct and Espros Photonics working on new lidar solutions

Partners plan to develop “flash lidar” for automotive, trucking, industrial automation and robotics sectors.

PreAct Technologies, an Oregon-based developer of near-field flash lidar technology and Espros Photonics, Sargans, Switzerland, a firm producing time-of-flight chips and 3D cameras, have announced a collaboration agreement to develop new flash lidar technologies for specific use cases in automotive, trucking, industrial automation and robotics.

The collaboration combines the dynamic abilities of PreAct’s software-definable flash lidar and the “ultra-ambient-light-robust time-of-flight technology” from Espros with the aim of creating what the partners call “next-generation near-field sensing solutions”.

Paul Drysch, CEO and co-founder of PreAct Technologies, commented, “Our

goal is to provide high performance, software-definable sensors to meet the needs of customers across various industries. Looking to the future, vehicles across all industries will be software-defined, and our flash lidar solutions are built to support that infrastructure from the beginning.”

‘Need for high performance sensors is paramount’

The automotive and trucking industries continue to rapidly integrate ADAS and self-driving capabilities into vehicles, and as the US NHTSA has just announced the requirement for human controls in fully automated vehicles, the need for ultra-precise, high performance sensors is paramount to ensuring safe autonomous driving.

The sensors created by PreAct and Espros are expected to address significant ADAS and self-driving features – such as traffic sign recognition, curb detection, night vision and pedestrian detection – with the highest frame rates and resolution of any sensor on the market, the partners state.

## Rise of the robots

In addition to providing solutions for automotive and trucking, the partnership will also address the expanding robotics industry. According to a market report published by Allied Market Research, the global industrial robotics market size is expected to reach \$116.8 billion by 2030.

The flash lidar technologies solutions will also enable a wide range of robotics and automation applications including QR code scanning, obstacle avoidance and gesture recognition.

Beat DeCoi, President and CEO of Espros, commented, “We have plans to demonstrate the capabilities of our 3D chipsets with PreAct’s hardware and software. By combining our best in class TOF chips with PreAct’s innovation and drive, we will see great results with clients benefiting from this partnership.”

<https://optics.org/news/13/3/41>



Image courtesy of Reuters / Stephen Lam.

*Self drive: An attendee takes a selfie inside a Cruise Origin autonomous vehicle, a Honda and General Motors self-driving car partnership, during its unveiling in San Francisco, California, U.S. January 21, 2020.*

# Photonics-enabled mining startup earns \$18M venture backing

Australian company Plotlogic harnesses lidar and hyperspectral imaging to optimize metal ore extraction.

Plotlogic, a startup company in Brisbane, Australia, says it has closed an \$18 million round of series A venture funding that will help further commercialize its photonics-based ore characterization techniques.

Founded by CEO Andrew Job in 2018, the firm's "OreSense" technology uses a combination of lidar and hyperspectral imaging alongside machine learning to provide automated analysis of ores - helping to improve extraction efficiency and reduce waste.

## Blue-chip customers

With customers already said to include global mining giants BHP, Glencore, and Anglo American, Plotlogic has now attracted backing from Innovation Endeavors - the Silicon Valley venture fund set up by former Google CEO Eric Schmidt whose portfolio companies include Uber and Planet Labs, among many others.

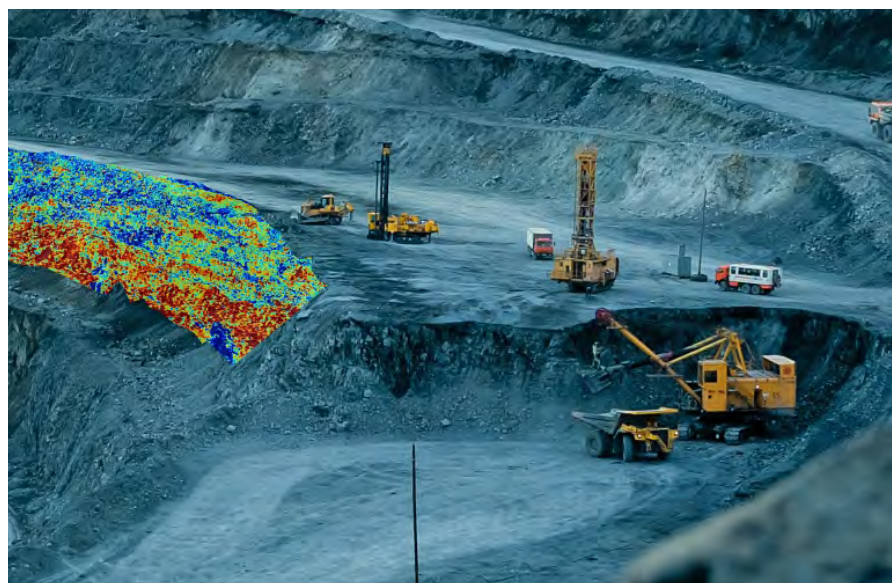
"The mining sector is hungry for solutions that improve safety, decrease greenhouse gas emissions, and improve profitability. And that's exactly what Plotlogic delivers



The Plotlogic equipment being used to characterize ore material extracted from the mine.

with our innovative technology," stated Plotlogic CEO Job.

Sam Smith-Eppsteiner, a partner at Innovation Endeavors, said that the company was "ready to revolutionize" the mining industry with its photonics technology, adding:



Plotlogic's combination of lidar and hyperspectral imaging is able to map the material in this mine, indicating where to find higher-grade metal ore, and which areas contain more waste material like clay.

"By bringing a new data modality to bear, Plotlogic generates precise, real-time, and predictive ore body knowledge. Early customer relationships underscore the value of such improved understanding: optimized operations, reduced carbon emissions and waste."

If widely implemented, it is hoped that the Plotlogic approach will increase access to minerals from which nickel, copper and manganese are extracted - metals regarded as critical for the transition to cleaner energy, for applications like electric vehicle batteries.

## Case study

According to a case study produced by Plotlogic, one customer in Western Australia used the technology to improve its extraction of high-grade iron ore that commands higher prices - and therefore makes the company's mine economically viable.

"The challenge for mining operators is to identify [the] type and grade of ore, and waste materials on the mine wall to improve the processing of ore and scheduling of the removal of ore and waste," explains the startup firm in its study.

It adds that the 'OreSense' system is capable of acquiring, processing, and classifying hyperspectral data in the field in real time, mapped to terrain and geo-referenced for integration with mine maps, and enabling precise grade control.

"In addition to this the other significant advantage is that it makes mining safer and healthier, as it reduces exposure of personnel to the active mine areas and can detect the presence of hazardous fibrous materials," claims the firm.

After a four-week deployment to identify and quantify levels of hematite, goethite, and limonite ores, as well as various clays that represent waste materials, the system was able to highlight the boundaries between different grades of ore and clay, and to map the absolute abundance of aluminum oxide on the mine wall.

Plotlogic says that it plans to use the proceeds of the venture capital round to invest in additional research and development, and to bolster commercialization efforts.

<https://optics.org/news/13/3/37>

# Telops introduces the Hyper-Cam Mini xLW: A compact hyperspectral imaging system for ground applications

The renowned Telops Hyper-Cam has been optimized to meet the requirements of modern remote sensing with transportability and lower power consumption in mind. With its small Size, Weight and Power (SWaP), the new Hyper-Cam Mini xLW – LW standing for Long Wave – can be utilized in harsh conditions and hard-to-reach locations to facilitate high-quality infrared spectral imaging measurements and ground-breaking science. Remote field work just became a lot less difficult!

The combination of the low-weight sensor head (8.2 kg) and the compact control and processing box (3.8 kg) makes the Hyper-Cam xLW easy to transport and deploy. Its low power consumption supports field use with an optional hot-swappable battery

pack, enabling reliable and sustainable operation over long-duration test campaigns without access to reliable shore power. The sensor command and control software can be operated by a remote laptop computer via Wi-Fi interface, allowing for safe operation during potentially hazardous experiments.

The Hyper-Cam Mini xLW is sensitive over an expanded spectral range extending from 7.4 to 12.5 microns, allowing for the measurement of important gas and mineral targets that were previously out of reach. "The wide spectral range of the new Hyper-Cam Mini xLW enables the measurement of several different types of targets that previously had undetectable signatures in the infrared due to the limited waveband of the regular Hyper-Cams," explains Philippe

Lagueux, Scientific Product Line Manager at Telops. Many environmentally-relevant gases can now be measured using a single sensor platform including methane, NOx, SOx, and more.

Innovation is more than a buzzword at Telops; it's something that guides the everyday operations of the entire company. "Developing a smaller, lighter and more efficient system that enables even more applications is a really exciting landmark in the history of Telops. It took years to miniaturize our flagship product to reach such a compact system with no compromise to the performance," says Lagueux.

The original Hyper-Cam bequeaths an outstanding legacy; its capabilities and performances in a large number of scientific settings over the last 20 years have repeatedly established Telops expertise in hyperspectral detection and identification. The Hyper-Cam Mini xLW now promises a true revolution in the commercial availability of performance infrared imaging spectroradiometry, enabling the scientific community to make the most challenging measurements to address the most important problems of our time.

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optics.org

e: [rob.fisher@optics.org](mailto:rob.fisher@optics.org)

t: +44 (0)117 905 5330

f: +44 (0)117 905 5331

