the business of photonics
optics.org
celebrating 20 YEARS online excellence
August 2016

VISION focus

Delivering the latest news from the Imaging and Machine Vision markets

Suspended multispectral system monitors crops

pco.

on the cutting edge

pco.edge family
now with advanced sCMOS
image sensor

up to
82%
quantum
efficiency

1.1
GByte/s
image data
bandwidth

small
form factor

www.pco.de
www.pco-tech.com

Eyes in and on the sky

Welcome to the latest issue of VISION Focus, the quarterly digital magazine that covers all aspects of vision and imaging, produced by the team that brings you optics.org: the business of photonics.

Our latest issue includes a look at a new multispectral approach for monitoring crops – and for a change it does not involves drones. Instead, a team in Zurich, Switzerland, has come up with a mobile machine vision system that travels above crops suspended on wires. The system is keeping an eye on hundreds of small plots of different varieties: including wheat, soy, maize, buckwheat and forage grasses.

Now if that kind of approach sounds familiar then you're right: the system is said to have been inspired by the "spider cams" now used widely in sports including American football, soccer and cricket.

In another sport – golf – a surprising connection with imaging has emerged. Before he won last month's US PGA championship, not many people knew about Jimmy Walker's talent for astrophotography. But among those who did were NASA, who have published some of the golfer's stunning images on their web site, and the University of Arizona's Steward Laboratory, where mirrors for many of the world's very largest telescopes are made. Walker has been sponsored by a telescope maker and has even been known to attend technical astro-imaging conferences, although he's probably busy preparing for the forthcoming Ryder Cup right now.

Sticking with the astro theme, we cover e2v's development of a new camera subsystem featuring a giant 1.2 gigapixel sensor that will aid the study of mysterious dark energy from a telescope being built in Spain. A major theme under discussion in astronomical imaging circles at the moment is the need to streamline projects to keep costs under control, and the increased involvement of the private sector looks likely to be a critical factor here.

Medicine promises to be another major growth area for optical imaging technologies, and on page 18 you can read about one of the very newest techniques under development. It promises to improve early diagnosis of cancer by focusing on the growth of blood vessels, known as angiogenesis, that tends to accompany the onset of the disease. Our interviewee Sarah Bohndiek, from the University of Cambridge, is at the very forefront of this exciting new field.

This Issue

Publication and Editorial Schedule 2016/17

October/November Issue 2016

- Bonus Distribution: **Vision, Stuttgart**
- **Editorial Focus:** machine vision applications, production line management and quality control, associated products and developments.
- Published in advance of VISION Stuttgart, 8th – 10th Nov

February/March Issue 2017

- Bonus Distribution **SPIE BiOS + Photonics West**
- **Editorial Focus:** industrial applications, sensing, biomedical analysis and treatments.
- Published in advance of BiOS, 28th Jan – 2nd Feb 2017 and Photonics West, 31st Jan – 2nd Feb 2017

April/May Issue 2017

- Bonus Distribution **SPIE DCS/DSS**
- **Editorial Focus:** aerospace and defense applications, associated research and development
- Published in advance of DCS *(Defence & Commercial Sensing)*, 11th – 13th April 2017

Suspended multispectral system monitors crops

A Swiss agricultural research station is pioneering the use of a versatile vision system to better understand the performance of different crop varieties ("phenotypes").

Plant scientists at ETH Zurich, (the Swiss Federal Institute of Technology in Zurich), are claiming a world first at the institute's Research Station for Plant Sciences in Lindau-Eschikon: the launch of the ETH Field Phenotyping Platform (FIP), a new type of crop phenotyping system, which is based on a mobile, suspended vision system that scans over the test site. The FIP is said to give crop researchers "an incredibly accurate tool for measuring and monitoring the health and performance of field crops".

At the research station in the village of Lindau-Eschikon, about 20 km outside of Zurich, there is a fenced-off agricultural plot of about 2 ha. Furthermore, plants can be raised in glasshouses throughout the whole year. The new camera system allows the scientists to study the crops in high detail virtually through the entire year. Their mission is to discover the differences between the individual plant varieties and to determine how long they need to flower, or to discover the exact link between their growth and the ambient temperature and soil moisture.

Spectral data collected from the plots, including a range of different crops are extracted and correlated with physiological plant properties. Different spectral indices are observed and measured within the visible spectrum; these indices can be related to factors such as leaf nitrogen, chlorophyll content, pigment concentration, canopy cover and leaf "greenness". For each of the mentioned traits good to very good correlations were identified.

Agricultural research group Gamaya, based in Lausanne, has previously worked at this site to establish that imagery data collected using hyperspectral sensors can be very accurately correlated with crop properties and translated into actionable information for farmers, such as nitrogen fertilization rates. Based on this information, the farmers can then decide to treat, irrigate and fertilize at variable rates.

Photo credit: Peter Rüegg / ETH Zurich.

Sensor head of the FIP: RGB and NDVI DSLR camera, laser scanning device, thermal camera, spectrometers and operational camera can take data of the field automatically.

The ETH researchers are currently studying hundreds of small plots of different varieties of wheat, soy, maize, buckwheat and forage grasses. The monitoring system also allows the scientists to investigate whether – and how – fungal diseases develop on the crops, or to monitor weed cover on the ground. "In the long run, our system is a valuable tool for crop cultivation and precision farming", commented Achim Walter, Professor of Crop Science at ETH Zurich.

Professor Walter originally came up with the idea of building a phenotyping system for crop research in the field. He was inspired by the "spider cams" suspended above football stadia, such as were recently used in the broadcasts of the Euro 2016 matches. These cameras provide a "birds eye" view.

Motion and vision system

The phenotyping system is based on the same principle as the spider cams: four masts, each one 24m high, are positioned at the four corners of a trial plot measuring 100 x 130m. Between them run double-braided aramid cables carrying the moving sensor

continued on next page

continued from previous page

Suspended multispectral system monitors crops

head, which hovers up to 7m above the ground. Electric cable-winches at the foot of the masts adjust the lengths of cable between the sensor head and the masts, allowing the sensor to be accurately positioned anywhere above the plot without touching the ground or disturbing the crops.

The sensor head is equipped with a laser measuring device, multispectral cameras, an infrared camera and two spectrometers. The current version includes visible-, near infrared and thermal cameras, multispectral point sensors and a laser scanner. A novel algorithm enables an automatic positioning of the sensors on an area of approximately one hectare.

The phenotyping system is already a device commonly used in the field, supplying data that can also be used to calibrate images from drones. Professor Walter said he is hoping to be able not only to gather a wealth of valuable trial data, but also to discover more about the limitations and potential applications of different sensors suitable for use in farming in future, for example on tractors, drones or smartphones.

"In ten years' time," he said, "the experienced eye of the farmer and grower will be supported by a broad range of digital tools capable of identifying diseases and providing information on the potential use of crop agents, for example. This system enables us to find out sooner and more accurately exactly what challenges we need to tackle in future. What type of advice do we want? Which tasks can we delegate to algorithms and machines, and how much can we depend on them?"

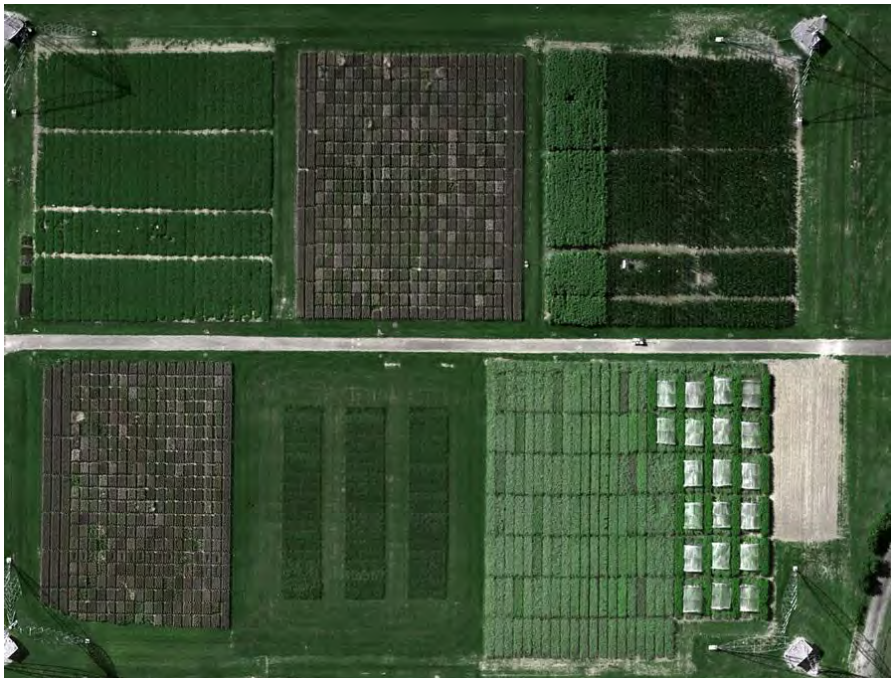


Photo credit: Peter Rüegg / ETH Zurich.

Tiled image of FIP field site with soybean, winter wheat, sunflower, maize, clover and buckwheat acquired by UAV.

Phenotyping research milestones

The Field Phenotyping Platform at the Eschikon Field Station of ETH Zurich was first installed in August 2014. Since then, more than one thousand individual plots, planted with wheat, ryegrass, buckwheat, soybean and maize, had been continuously monitored in the test phase of the system. Depending on the research question, crop- or genotype specific changes in growth and development throughout the day have been monitored at critical developmental stages and throughout the whole season. The changes have been related to their causal environmental factors such as fluctuating solar radiation, temperature and precipitation.

Photo credit: Peter Rüegg / ETH Zurich.

The poles are on massive pillars anchored 3.5 meters deep in the ground.

Photo credit: Peter Rüegg / ETH Zurich.

The sensor head only takes a few seconds to capture a wheat plot.

One major aim is to map quantitative trait loci *(QTLs)* related to environmental responses using association and QTL mapping panels and to develop new methodologies to assist breeder's selection in the field. Moreover, precision agriculture approaches will be refined utilizing the capacities of the FIP.

Further information: https://www.ethz.ch

Matthew Peach, Contributing Editor

Photo credit: Peter Rüegg / ETH Zurich.

Overview of the FIP area of about 1 ha covered by the system. Three of the poles which carry deflector roles on top and the winch houses at their base are visible.

Intel gets into machine vision software

Chip giant has eye firmly on autonomous vehicle revolution with 'Itseez' acquisition.

Logic chip maker Intel has acquired Itseez, a machine vision software firm started up by Russian entrepreneurs, as part of its long-term strategy to support the emerging Internet of Things and the development of autonomous vehicles.

Headquartered in downtown San Francisco, Itseez was founded in 2005 by Victor Erukhimov, Sergey Molinov, and Alexander Bovyrin. CTO Bovyrin also teaches at Nizhny Novgorod State University, while Erukhimov and Molinov both worked as researchers at Intel previously.

Itseez already sells algorithms for advanced driver assistance systems used in the automotive industry, for functions such as traffic sign recognition, lane departure warning, and spotting pedestrians – with the likes of Toyota among its customers.

Photo: Itzeez.

Started up in 2005, Itseez already had strong connections with Intel before the chip maker decided to acquire the business. The company has developed machine vision algorithms and software used in advanced driver assistance system (ADAS) applications, technology that could become ubiquitous in future autonomous vehicles.

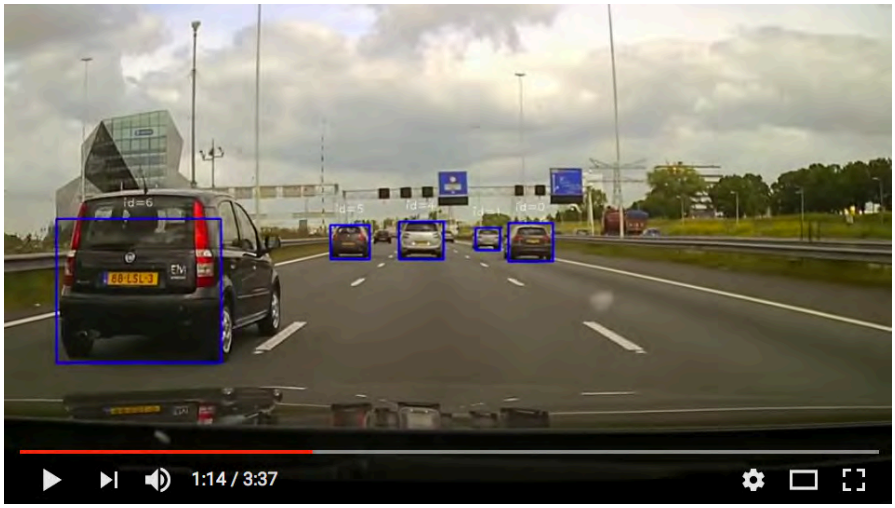
Connected future

Although Intel revealed nothing about the terms of the deal, in a blog post its senior VP with responsibility for Internet of Things, Doug Davis, highlighted the challenges facing the development of autonomous vehicles:

"While the possibilities are exciting, the reality requires solving a myriad of technology challenges," he wrote. "Solutions will need to seamlessly deliver a combination of compute, connectivity, security, machine learning, human machine interfaces and functional safety.

"Another key requirement for self-driving cars is the ability to see and accurately interpret surroundings. One of the technologies necessary to support this capability is computer vision."

Davis sees autonomous vehicles as just one of the technologies grouped under the IoT umbrella, of which machine vision technology is quickly becoming a critical part.



Video: Itzeez.

Itseez video: forward collision warning system. https://www.youtube.com/watch?v=8_ek2YJW-Co

While the first stage of IoT development is already under way and involves relatively simple concepts like "smart" toothbrushes featuring pressure sensors and Bluetooth connectivity, Davis says that the future heralds "constant connectivity" that will demand the intelligence to make real-time decisions based on an object's surroundings.

"This is the 'autonomous era', and machine learning and computer vision will become critical for all kinds of machines – cars among them," he wrote.

Among the products under development at Itseez are algorithms for face-recognition software, as well as a mobile application said to be capable of turning handset devices into powerful 3D scanners. Called Itseez3D, it works with Intel's "RealSense" 3D camera technology that mimics human vision.

http://optics.org/news/7/5/45

This is the final image of the Jovian planetary system, showing Jupiter and its four largest moons, taken by the JunoCam imager before it was switched off in advance of insertion into orbit around the giant planet. The craft's instruments are currently being powered back up, ahead of the first close-up fly-by in late August.

Image: NASA.

ON Semi boosts near-infrared sensitivity of its CCDs

Deeper pixel well in 8 megapixel sensor said to double quantum efficiency at 820nm.

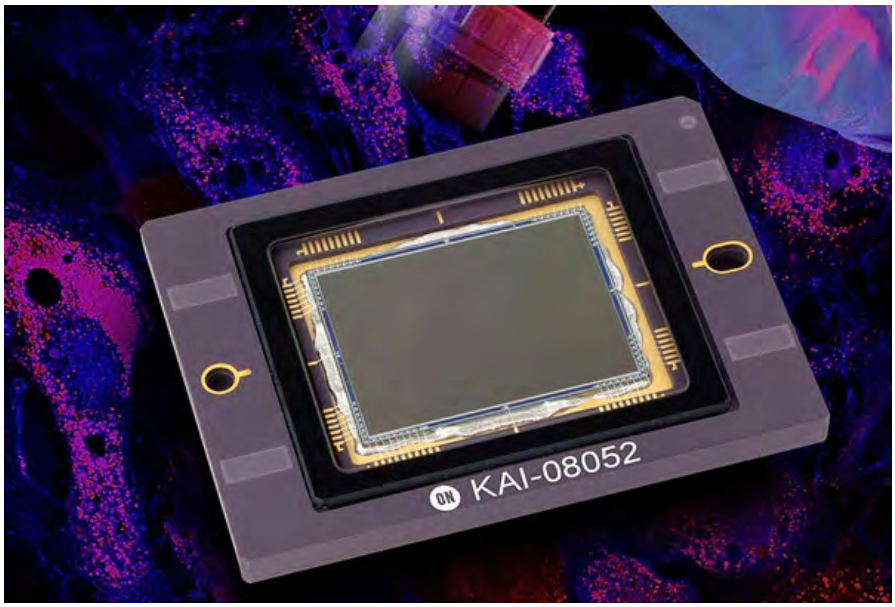


Image: ON Semiconductor.

On Semiconductor's latest CCD sensor is said to offer double the usual sensitivity at 820 nm in the near-IR region, something that ought to prove useful in medical and scientific imaging, and industrial applications like reading licence plates.

Chip manufacturer ON Semiconductor says that its latest CCD image sensor has double the usual quantum efficiency in the near-infrared region, boosting its sensitivity for target applications in medicine and industry.

The Phoenix, Arizona, firm, spun off from Motorola in 1999, says the 8 megapixel device features a design that extends the electron capture region deeper into the silicon structure. That improves the capture of electrons generated by longer-wavelength photons – effectively doubling the typical CCD sensitivity at 820 nm.

ON Semiconductor also stresses that good isolation between the photodiodes means that there is no trade-off in terms of image sharpness alongside the doubled sensitivity.

continued on next page

continued from previous page

ON Semi boosts near-infrared sensitivity of its CCDs

Herb Erhardt, who manages the company's image sensor group, said that camera makers and other end users wanted access to both CCD and CMOS technologies for industrial applications like machine vision, as well as for scientific and medical imaging.

One typical application could be number-plate recognition, where near-infrared illumination is often used. In scientific and medical imaging, the sensors could be particularly useful for detecting near-infrared fluorescence.

According to ON Semiconductor, the new KAI-08052 image sensor is available in an 8 megapixel, 4/3-inch optical format that provides a higher quantum efficiency than members of its standard 5.5µm family.

"The sensor shares the same broad dynamic range, excellent imaging performance, and flexible readout architecture as other members of the 5.5 µm pixel family," announced the firm. "But quantum efficiency at 820 nm has been approximately doubled compared to existing devices, enabling enhanced sensitivity without a corresponding decrease in modulation transfer function *(MTF)*."

Jupiter: ready for a close-up

Meanwhile a predecessor of ON Semiconductor's latest CCD has just arrived in the orbit of Jupiter on board NASA's Juno spacecraft, ready to capture images showing details of the Jovian atmosphere with unprecedented resolution.

After a five-year, 2.8 billion kilometer journey towards the gas giant, the JunoCam instrument will soon be sending back color images of Jupiter's cloud tops captured by one of the Phonenix firm's "KAI-2020" CCDs.

ON Semiconductor points out that the imaging challenges for Juno are complicated by its highly elliptical orbit. That will vary the craft's distance to the Jupiter cloud tops from a maximum 2.7 million kilometers to just 5,000 kilometers, with the planet only filling the JunoCam's field of view at its closest approach.

"In addition, the orbiter (and the camera) will be rotating at about two revolutions per minute, so that the sensor will be operated using time delay integration to keep images from being blurred," points out the CCD maker.

Even so, the new views of Jupiter are expected to be extraordinary. JunoCam is set to capture light in four wavelength bands – three in the visible region and another in the near-infrared to observe the absorption of methane gas at 889 nm.

At its closest approach, the sensor will deliver a resolution of 3 kilometers – an order of magnitude improvement on the familiar images captured by the earlier Voyager, Galileo and Cassini probes.

The raw data captured by JunoCam during the craft's planned 32 orbits of Jupiter is also being made available for free download, allowing anybody to process and share the images. The first scientific data and imagery is expected in early September, shortly after Juno makes its next close approach to the planet on August 27.

http://optics.org/news/7/7/14

Horiba hooks up with QuantIC on fluorescence imaging

Strathclyde's David Birch leading industry collaboration also involving the University of Edinburgh.

Horiba Jobin Yvon IBH, the Glasgow-based subsidiary of the Japan-headquartered Horiba Group, has entered into a development partnership with quantum technology researchers at two Scottish universities.

They are working together as part of the imaging-focused QuantIC research effort, one of the four dedicated research hubs that make up the UK's wider quantum technology network.

Under the leadership of University of Strathclyde professor David Birch, they are set to work on a multiplexed, time-correlated single-photon timing fluorescence system. University of Edinburgh researchers are also taking part.

Birch leads the photophysics group at Strathclyde, which has particular expertise in fluorescence lifetime techniques used in biomedical applications. In fact, Birch was one of the co-founders of IBH before it was acquired by the Horiba group in 2003. Originally known as IBH Consultants, it was one of the first technology spin-outs from a Scottish university.

Pioneer

In the four decades since the spin-off was founded, the company has pioneered advances in time-correlated single-photon correlation *(TCSPC)* technology, for example developing picosecond-scale diode light sources suitable for the ultrafast timescale on which fluorescence takes place, and deep-ultraviolet LEDs for protein analysis.

While that has expanded the application range of TCSPC well beyond the specialist laboratory, the aim of the new research project will be to develop a multiplexed version of the technology capable of capturing the full "signature" of a molecular fluorescence signal.

That signature includes excitation and emission wavelengths, fluorescence intensity, decay time, polarization, position and the yield, or efficiency, of the absorption and re-emission of light.

The team points out that, at present, even the most advanced commercially available fluorescence instrumentation can access only a small fraction of this information at a time. As a result, many sequential measurements over a long period are needed to build up a complete molecular fluorescence signature.

"QuantIC's researchers at the University of Strathclyde and University of Edinburgh will assess the feasibility of adding multiplexed *(imaging)* detection systems to Horiba's range of instruments in order to speed up measurements, which will open up new applications, for example in the study of transient species," they announced.

Quantum buzz

The UK's £270 million backing of quantum technology development has generated considerable interest and excitement among university researchers and industrial partners, with the European Commission now planning to establish a flagship research effort on the same topic.

http://optics.org/news/7/6/3

e2v camera subsystem ready for dark energy study

1.2 gigapixel 'CryoCam' from UK developer passes factory acceptance tests for 2.5 meter telescope in Spain.

Photo: e2v technologies.

e2v's 'CryoCam' camera sub-system features 14 large CCD sensors and will be used to survey the red-shift of millions of galaxies in the northern sky - giving astrophysicists a greater insight into the nature and whereabouts of co-called 'dark energy'.

CCD and CMOS sensor developer e2v Technologies says that its "CryoCam" 1.2 gigapixel camera subsystem has passed a critical milestone in advance of integration with a major telescope project in Spain.

The Javalambre Physics of the Accelerating Universe Astrophysical Survey (J-PAS) project, a collaboration between Brazilian and Spanish scientists, has completed a factory acceptance test on the camera, which is now set for delivery.

Once installed on the 2.5 meter-diameter telescope in the Aragon region of Spain, the CryoCam will be used in a five-year survey of an anticipated 14 million galaxies across the northern sky. Astrophysicists will use the data collected on red-shifted light from those galaxies to build a high-fidelity 3D map of the universe and a detailed study of so-called "dark energy".

Flat focal plane

UK-headquartered e2v says that one of the key features of the giant CCD array is its exceptionally flat focal plane. The full array comprises 14 individual sensors, each comprising 9000 x 9000 pixels.

According to Mark Robbins from the company, who gave a presentation about CryoCam's development at the SPIE Astronomical Telescopes and Instrumentation conference in Edinburgh earlier this week, the 27 µm peak-to-valley flatness far exceeded expectations, with the telescope consortium's representatives "delighted" at the characterization result.

continued on next page

continued from previous page

e2v camera subsystem ready for dark energy study

Robbins also highlighted excellent test results confirming low noise and cross-talk. That is critical because the wide-field J-PAS telescope, which boasts a 3° field of view, will detect light across an unprecedented 56 narrow-band filters in the optical region.

In a release from e2v Renato Dupke, principal investigator for the Brazilian side of J-PAS at the Observatório Nacional, said: "We are very happy with the development of e2v's 1.2 gigapixel cryogenic CCD camera for the J-PAS project. The subsystem is already achieving in-factory performances significantly beyond our original expectations.

"Tests are already suggesting an equivalent performance when the subsystem is fully integrated at the telescope. This will have a giant impact on a wide variety of fields in astronomy, in particular on the nature of dark energy."

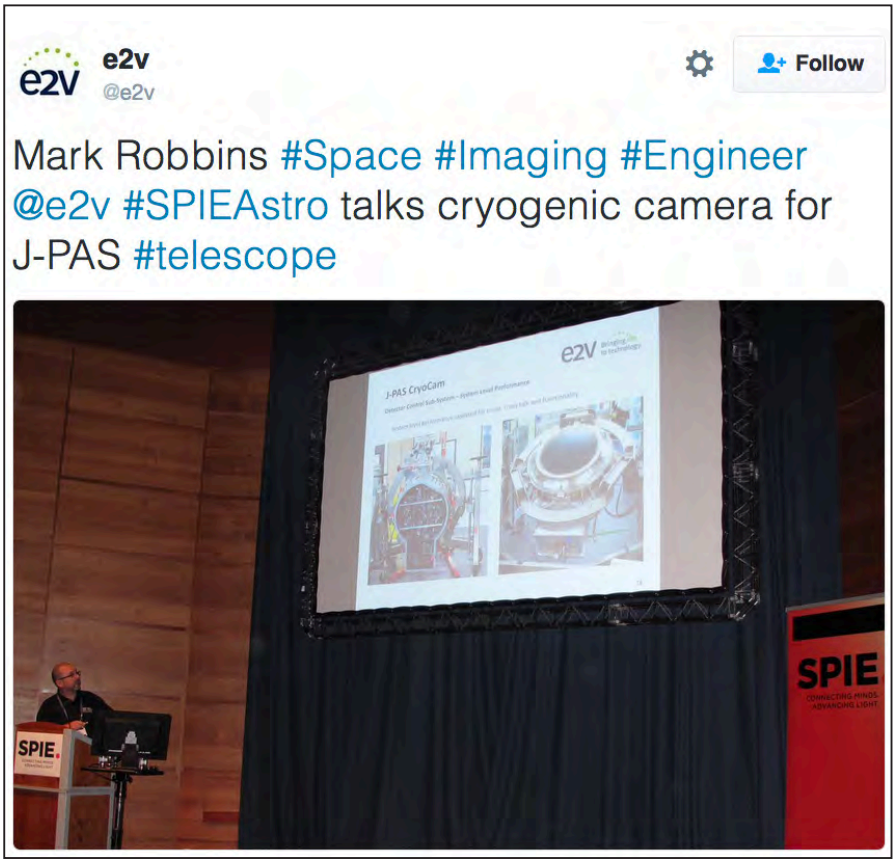
Robbins also pointed out at the end of his presentation that the project had demonstrated that a commercial partner could take on the development of a high-performance camera sub-system for a large telescope.

That appears significant at a time when many working in the field of large ground- and space-based telescopes are looking to the private sector to provide more of the key technologies required.

"Turning the battleship"

Also speaking in Edinburgh, Charlie Atkinson from Northrop Grumman Aerospace Systems *(NGAS)* told delegates that the current "paradigm" in large space telescope development was unsustainable, likening the need for a new way of thinking about such missions to "turning a battleship".

Using calculations developed by NASA, Atkinson – who was deputizing for Jon Arenberg, chief systems engineer for the James Webb Space Telescope *(JWST)* – said that a next-generation follow-up to the $8.7 billion JWST would likely cost half as much again and take nearly 25 years to complete.



https://twitter.com/e2v/status/748056041380782080/photo/1?ref_src=twsrc%5Etfw

Those calculations rely heavily on the size of the telescope's primary mirror, the wavelengths being detected and the operating temperature, and Atkinson pointed out that a subsequent step-up would require more than five times the JWST budget, and take some 87 years to build.

Part of the reason is that despite the undoubtedly cutting-edge nature of the technology involved, large telescope development is essentially an artisanal process – demanding bespoke components and systems, with little to no re-use of hardware or personnel.

System first; telescope design second?

One key issue is that, at present, systems must conform to individual telescope designs. One significant change that could make future development more sustainable would be to reverse that approach and start out with a system design, into which a new telescope would have to fit.

But another part of the solution could be the greater adoption of industrialized technologies that have been developed by the likes of e2v for multiple applications, as well as providing for a greater element of post-launch service - at the expense of the currently very extensive but costly pre-launch testing regime.

Atkinson pointed out that the potential for this more "evolutionary" approach to space systems was evidenced in the Hubble Space Telescope mission, where it proved possible to correct errors in HST's original optics with a subsequent service mission.

Giuseppe Borghi, e2v's VP of business development for space imaging, highlighted the service element in the CryoCam development for J-PAS:

"We plan to provide long-term post-delivery services throughout the camera's entire life such as optimisation, maintenance and high-priority support," he said. "We are looking forward to seeing outstanding scientific discoveries enabled by J-PAS and the e2v team."

The company says that it will deliver the CryoCam to J-PAS this summer, with integration in the autumn. The telescope should then be fully operational by early 2017. "This is a big achievement for e2v, as we're now offering a complete detection subsystem," the firm added.

http://optics.org/news/7/6/52

SPIE DCS 2016:
FLIR's Boson takes a bow

Thermal imaging giant launches tiny infrared uncooled camera core at Baltimore exhibition.

by Ford Burkhart in Baltimore

FLIR made a big splash on the industry events stage at SPIE's Defense and Commercial Sensing *(DCS)* gathering on the first day of the event's industry exhibition in Baltimore: it launched its latest innovative IR camera, and by far its smallest.

The firm's tiny "Boson" is named for the category of sub-atomic particles that, appropriately enough, includes the photon as a member.

Pierre Boulanger, FLIR's Santa Barbara-based CTO, described the tiny imager, barely bigger than a thumbnail, as a long-wave, uncooled IR camera core for recording thermal radiation.

The core, which features a 12-micron pixel pitch detector, is designed to be integrated into OEM products such as personal thermal vision systems.

"It is a successor, in a long line of FLIR camera cores," he said. "This one is four times smaller than the previous generation, which was the Tau camera core, and which FLIR is still selling. The Boson is smaller, lighter, lower cost, and lower power. And it provides a lot more functionality, by an order of magnitude."

Many interfaces are available, Boulanger said. To create a PVS *(personal vision system)* product, with many interfaces, "you need only the Boson core, and power circuits."

FLIR will sell the Boson as a component, for example in a system using infrared imaging to look at moisture inside a house, or to mount on a small UAV *(unmanned aerial vehicle)* to fly over a house to seek if it is leaking heat. The Boson would be ideal, Boulanger said, because it only weighs 10 grams.

Photo: FLIR Systems.

FLIR's Boson core weighs only 10 grams and features a high-sensitivity 12-micron pixel pitch detector for high-resolution thermal imaging. The thermal imaging giant launched the tiny device at SPIE's DCS 2016 exhibition.

Intelligent imaging

Designers might also place the Boson in a web-connected surveillance and security device. "Inside the core," Boulanger said, "there is so much calculation power, you can embed video analytics to find a person in a crowd, during surveillance; or to photograph persons approaching a high value asset, or your doorway. If someone crosses a line, it will find them and track them."

The Boson would perform in many security and maritime applications, for example finding an object floating in water, or in a search for animals, or birds. "It's a very intelligent imager," Boulanger said.

The device, measuring 21 x 21 x 11 mm and offered in 320 x 256 and 640 x 512 resolution formats with 15 field-of-view options, will be fabricated at FLIR's Santa Barbara facility.

On the product stage in Baltimore, FLIR also showed off its new camera that can *"freeze"* a speeding bullet. It was announced at Photonics West in San Francisco in February.

FLIR's Chris Bainter, director of business development for R&D Science Solutions, based in Pasadena, California, presented the camera system, saying that it can photograph objects at a very high speed with high resolution, delivering clarity beyond earlier methods.

For example, it could photograph tests of airbags when a dangerous piece of metal might be flying out, to analyze safety issues, or record fire or a brief puff of smoke during product testing.

About the Author
Ford Burkhart is a writer based in Tucson, Arizona.

http://optics.org/news/7/4/29

Astrophotographer Jimmy Walker wins US PGA

Photo: prnewswire.com

Professional golfer and astronomical imaging enthusiast bags first major title.

It's not often *(though not unprecedented)* that golf features in the pages of optics.org, but we'll make an exception for the astrophotographer Jimmy Walker, winner of the 2016 US PGA championship just played at Baltusrol Golf Club in New Jersey.

Walker, whose composed par-five score at the final hole saw off a fast-finishing Jason Day – also defending champion and currently ranked the world's number-one golfer – has published dozens of spectacular images of the cosmos, many captured using his own 16-inch reflecting telescope.

The new world number-fifteen golfer was swiftly congratulated on his first "major" tournament victory by UK-headquartered imaging specialist Andor Technology, which says that Walker is a customer of its Californian CCD camera subsidiary Apogee Imaging.

"It's not every day an #Apogee camera customer wins the US @PGAcom. Well done @JimmyWalkerPGA! pic.twitter.com/lhyyl1jBw3"
Andor Technology (@AndorTechnology) August 1, 2016

The golfer's passion for astronomy was the subject of a 2014 article by Helen Ross at www.pgatour.com, who wrote that Walker's childhood interest in observing planets and stars was rekindled in recent years, after wife Erin bought him a telescope as a Christmas present.

That same article even featured Walker taking a tour of the University of Arizona's Steward Observatory Mirror Laboratory, where the seven huge (8.4 meter diameter) mirrors that will eventually make up the Giant Magellan Telescope (GMT) are being manufactured.

The state-of-the-art mirror lab has since been renamed in honor of local high-tech businessman Richard Caris, a long-time supporter who donated $20 million to support the GMT work. Ground breaking at the GMT's 8000-ft mountaintop site in Chile took place last November, with excavation and concreting scheduled in 2017 ahead of a planned first light in 2022.

Jimmy Walker discussing astrophotography: https://www.youtube.com/watch?v=kkefSeXNXFc

Telescope sponsor

A pro golfer's time is spent largely on the road and in 2014 Walker signed a sponsorship deal with telescope maker Celestron that allowed him access to the firm's observatory-grade astronomical equipment installed at a high-altitude dark-sky site in New Mexico.

"The Celestron CGE Pro 1400 HD telescope is placed at a remote location that Walker can access via the Internet," said the telescope firm. "Whether he's at home in Dallas or at a tour event, Walker can control his telescope and conduct imaging sessions."

In the Celestron release, Walker said: "As a kid, I remember having a telescope and looking at the Moon, Saturn and Jupiter. My fascination started with looking up. From there, it evolved to attaching a camera and taking long exposures."

• A selection of Walker's stunning astrophotography images of galaxies, nebulae, comets and more can be viewed at www.darkskywalker.com.

http://optics.org/news/7/8/1

Optical imaging reveals vital details of cancer growth

Sarah Bohndiek leads a team studying new ways to monitor tumor development.

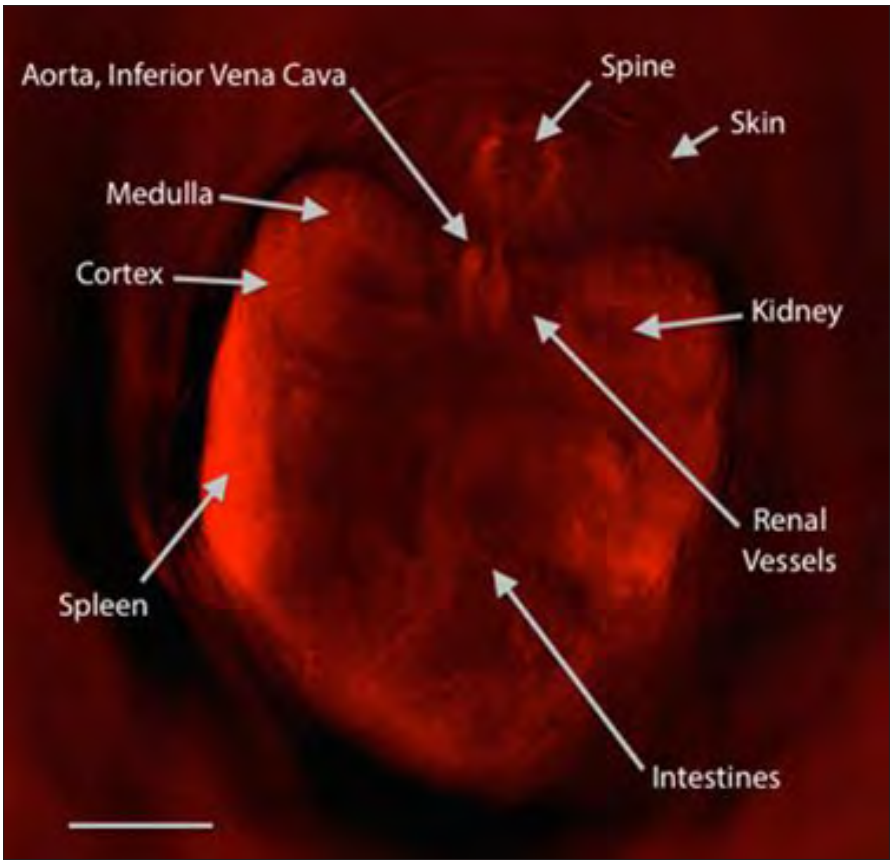
A growing tumor needs access to oxygen and nutrients from the blood, making the development of new blood vessels into the tumor a fundamental aspect of cancer behavior - and one that could be targeted for more effective treatment.

Sarah Bohndiek at the University of Cambridge leads an international team using bioimaging techniques to better understand the topic, giving her a broad perspective on the potential for novel photonics technologies to tackle this key question in cancer studies.

"A developing tumor stimulates the growth of new blood vessels to support itself, called angiogenesis," commented Dr Bohndiek. "But that supply can initially be relatively poor, leading to some areas of the tumor suffering from hypoxia - insufficient levels of oxygen."

At the same time, other areas of the tumor can experience oxidative stress, when the proliferation of cancer cells in an environment of sufficient oxygen generates an excess of free radicals, which are themselves damaging to the cell's DNA.

"Both of these stresses are known to be linked with poor clinical outcomes," said Bohndiek. "Hypoxic stress in hormone-sensitive cancers such as breast, prostate or ovarian cancer tends to make clinical prognosis worse. So imaging modalities able to study how oxygen is delivered and utilized in a tumor could be very valuable. In particular, directly probing the absorption properties of hemoglobin allows us to determine how much blood is present in the tumor, and how well oxygenated it is."



Blood hemoglobin oxygenation image acquired using multi-spectral optoacoustic tomography (MSOT), an emerging tool for clinical imaging that is low cost and does not require injected contrast. Scale bar = 5 mm.

Credit: Sarah Bohndiek/Vision Laboratory (unpublished data).

Bohndiek's team is studying a number of modalities that might contribute to this understanding, predominantly using visible or near-infrared light. A key avenue of interest is multi-spectral optoacoustic tomography (MSOT), a variant of the optoacoustic technique performed at multiple wavelengths, using the differential absorption of oxy- and deoxy-hemoglobin to assess oxygenation in tissue.

"Our work on MSOT sits close to the clinic, in that we have a series of experiments under way to validate the technique and determine just how reliable and quantitative the resulting images are," Bohndiek commented "We are also working to see how the MSOT data relates to the physical changes in blood vasculature within a tumor, and how to connect the results with vascular function in a meaningful way."

Another topic of research is hyperspectral imaging (HSI), able to produce both spectral and structural information about a tumor simultaneously. One goal here involves integrating monolithic hyperspectral sensors into robust fluorescence HSI systems, and applying the multiplexed imaging of reflectance, autofluorescence and fluorescent contrast agents. These experiments are currently being performed in pre-clinical cancer models.

continued on next page

continued from previous page

Optical imaging reveals vital details of cancer growth

Successful translation

A third angle of attack exploits current advances in endoscopy, both as a means to improve early cancer detection and potentially for therapeutic purposes too.

surveillance of high-risk patients in the coming years."

Moving techniques like these into clinical use will inevitably need control of the costs involved, a challenge that can be lessened when researchers work as closely as possible with clinicians during the development process.

As an example, Bohndiek points to her group's collaboration with Rebecca Fitzgerald, also of the University of Cambridge and developer of the Cytosponge - a "pill on a string." When

Credit: Image supplied by Sarah Bohndiek from Cambridge News.

Sarah Bohndiek (right) and Rebecca Fitzgerald (left), co-leaders of the Early Detection Programme at Cancer Research UK.

"Endoscopy is helpful in assessing high-risk patients, such as those with a predisposition to esophageal or colorectal cancer, but finding early, curable, lesions is challenging" Bohndiek noted. "Having advanced optical imaging capabilities incorporated into the endoscope - perhaps including hyperspectral imaging, near-infrared fluorescence or optical coherence tomography – could provide significant advances in endoscopic

swallowed, the device dissolves to reveal a sponge able to scrape off cells as it is withdrawn up through the gullet, collecting cells from along the length that can be analyzed to identify high risk patients.

"We are looking at partnering that type of test with an endoscopic imaging technique that looks directly at the lesions, to try to diagnose very early changes in the gullet that are not yet strictly cancerous but which indicate an increasing likelihood of progressing to cancer," she said. "That kind of partnership is where I can see optical techniques having a really strong role in clinics."

Interdisciplinary strengths

Translation also requires an understanding of exactly where an optics-based procedure might fit into the diagnostic pipeline and general clinical practices, which may well vary between geographic regions. In the UK, patients are highly likely to first see a local GP and then be referred to a specialist - such as a dermatologist for a skin lesion - where the more advanced technologies are usually brought to bear.

"Adoption depends on whether a technology solves a clinical need and can fit readily within the existing clinical paradigm, and this is where optical imaging modalities can often run into problems," noted Bohndiek. "If you look at the suite of clinically approved optical imaging methods, very few are actually used routinely in clinics. They need to pervade downwards and outwards from the hospital environment, and into a more local GP setting, to impact patient management. "

This in turn requires the new techniques to be incorporated into robust medical devices, able to withstand the realistic wear and tear of clinical environments - another hurdle where optical devices can sometimes fall short. Developers run the risk of investing too much at the early stages of product development, and overlooking how it can be packaged so as to survive life in the real world.

"A multidisciplinary approach is crucial in tackling these questions, and in the UK I am happy to say that we have been focused on driving interdisciplinary research forward in recent years," concluded Bohndiek. "Exactly how these programs develop in the future is still being discussed, but there is a strong interest in bringing more physical scientists from a broader range of backgrounds into biomedical studies. That's one reason why now is definitely a good time to be doing this kind of research."

About the Author
Tim Hayes is a contributor to optics.org.

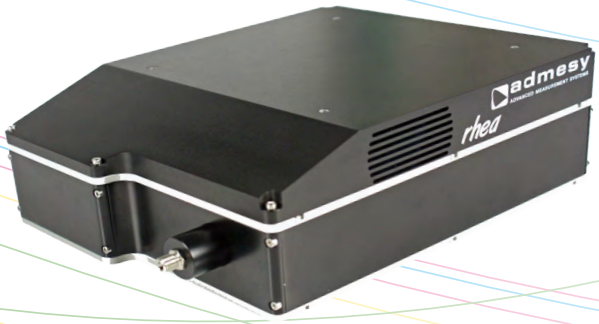
http://optics.org/news/7/6/9

The ultimate high-end spectrometer

Ultra high sensitivity
High dynamic range
High linearity
Highly configurable

RHEA SPECTROMETER SERIES

- High-end cooled 2D CCD sensor
- Dark current compensated, virtually zero over entire integration range
- All calculations done inside
- ND filter wheel for large dynamic range (incl. shutter)
- USB, RS232, Ethernet, ext. in/out trigger interfaces



THE ONLY THING LOW ABOUT THE RHEA IS THE PRICE

admesy
ADVANCED MEASUREMENT SYSTEMS

www.admesy.com