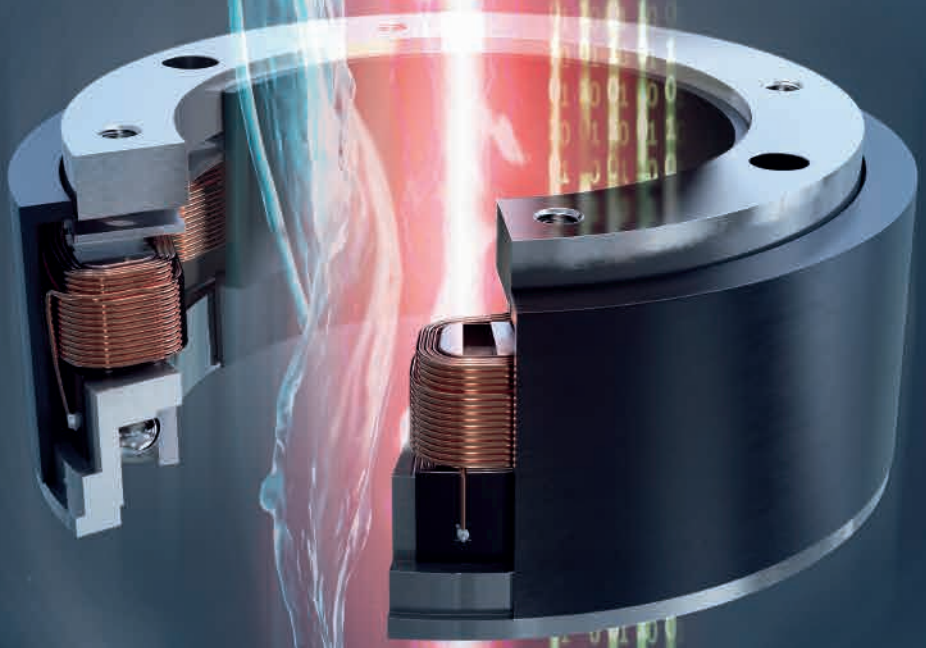
FAULHABER

# motion

02.2020

THE MAGAZINE WITH DRIVE



## APPLICATIONS? STEP INTO THE RING.






# Dear Readers,

The corona pandemic has clearly demonstrated to the whole world just what a highly contagious virus can do. Tourists and travellers have unintentionally contributed to the spread of the disease. Detecting infected persons on arrival at airports or train stations is key in preventing a potential chain of infection. Thermal imaging cameras make a decisive contribution here. Drives from FAULHABER help these cameras deliver precise images and measurement values in a fraction of a second.

The tests also play a prominent role. Now, during the winter season, there is a need for certainty in knowing whether, in the case of similar symptoms, the cause is the flu or a COVID-19 infection. Learn more about the use of FAULHABER drive systems in medical diagnostics in large-scale, automated laboratories or at the point of care in the immediate vicinity of the patient.

In this issue, you will also learn how to make a car rim glow without melting the tire. The light revolution of British photographer Patrick Llewelyn-Davies makes this possible. In his Light Revolution System, a precision drive from FAULHABER helps to create unusual images of everyday objects by illuminating them from a complete circular path.

With the new FAULHABER DM66200H hollow shaft drive, we present to you an expansion of our stepper motor portfolio. With a diameter of 40 millimetres, it features an especially large opening and is ideal if light, electrical signals, liquids or other parts of the application need to be guided through the motor.

Read more about these and other exciting topics in this issue of FAULHABER motion – the magazine with drive.

I hope you enjoy reading this issue!

Sincerely

Dr. Thomas Bertolini
Managing Director

IMPRINT

**Issue 02.2020**

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# AWARD: FAULHABER IS FIRST
## "PREFERRED TECHNOLOGY PARTNER" OF HEIDELBERGER DRUCKMASCHINEN AG


Heidelberger Druckmaschinen AG has been a reliable partner with great innovative strength for the global printing industry. The company's mission is to shape the digital future of the sector. For the extraordinary technological achievements and innovative support on the way to achieving this goal, Heidelberger has now designated FAULHABER as "Preferred Technology Partner."

FAULHABER is especially happy about this sign of recognition as it is the first time that Heidelberger Druckmaschinen AG has granted a distinction of this type to a supplier. In explaining its reasoning, Heidelberger emphasized the exceptional technological know-how and the modern production processes at FAULHABER which together lead to well thought-out solutions for complex technical issues. The award is also the new high-point in a long series, as FAULHABER has already been honored by Heidelberger in the past four years with the title "Preferred Supplier" within

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the "Electric Drives" product group. Various performance indicators play a role in the evaluation of this category. These include the zero-error rate in product and process quality, continuous improvement, a cooperative partnership and reliability with regard to logistics. "FAULHABER was able to convince us in all of these aspects," commented Helmut Braun, head of Quality Assurance/Electronics Procurement at Heidelberger.

**Sebastian Huber, Senior Manager Purchasing:** "FAULHABER has already in the past proven its outstanding performance in the collaboration with Heidelberger which, in each of the last four years, was honored with the "Preferred Supplier" certificate. We value FAULHABER as a reliable partner and are therefore very pleased to present FAULHABER with the Preferred Technology Partner award due to the contribution in the area of technical innovations and cost optimizations."

**Kai Albrecht, Senior Manager R&D:** "FAULHABER is a strong partner in the realization of technologically complex issues. Our high requirements in the area of drive technology are taken into account by FAULHABER and implemented with customized solutions. We value the cooperative partnership as well as the efficient development of appropriate solutions for our company."


# **DELICATE TOUCH** AND INTEGRATED REFERENCING

In combination with brushless DC servo motors, the new magnetic AEMT-12/16 L absolute encoder delivers absolute angle information with a preset multiturn resolution of 16bits (65536 revolutions) and a singleturn resolution of 12bits (4096 steps) for commutation, speed control and motion control.

This position data can be queried by an SSI Interface with BiSS-C Protocol, which is designed for industrial applications in which high transmission speed, flexibility and minimal implementation effort are required. The interface is designed differentially with a line driver. As a result, the motor/encoder unit can be positioned up to five meters away from the controller. With AEMT, sine commutation is possible as is very efficient operation of the motor with minimal torque ripple.

An additional backup battery allows the encoder to detect motor revolutions even if the main power supply is switched off and to increment or decrement the multiturn count accordingly. This way, when switching on the main supply again, the count is still valid. A new reference run is not necessary. The multiturn count can be reset via an additional interface pin during start-up.

The encoder is connected with a ribbon cable; suitable connectors are available. Different filter modules and adapters for connecting to FAULHABER Speed and Motion Controllers are also available.

### Advantages at a glance:

- Cable length of up to 5 meters
- Efficient operation with low torque ripple
- No reference run after after switch on is necessary

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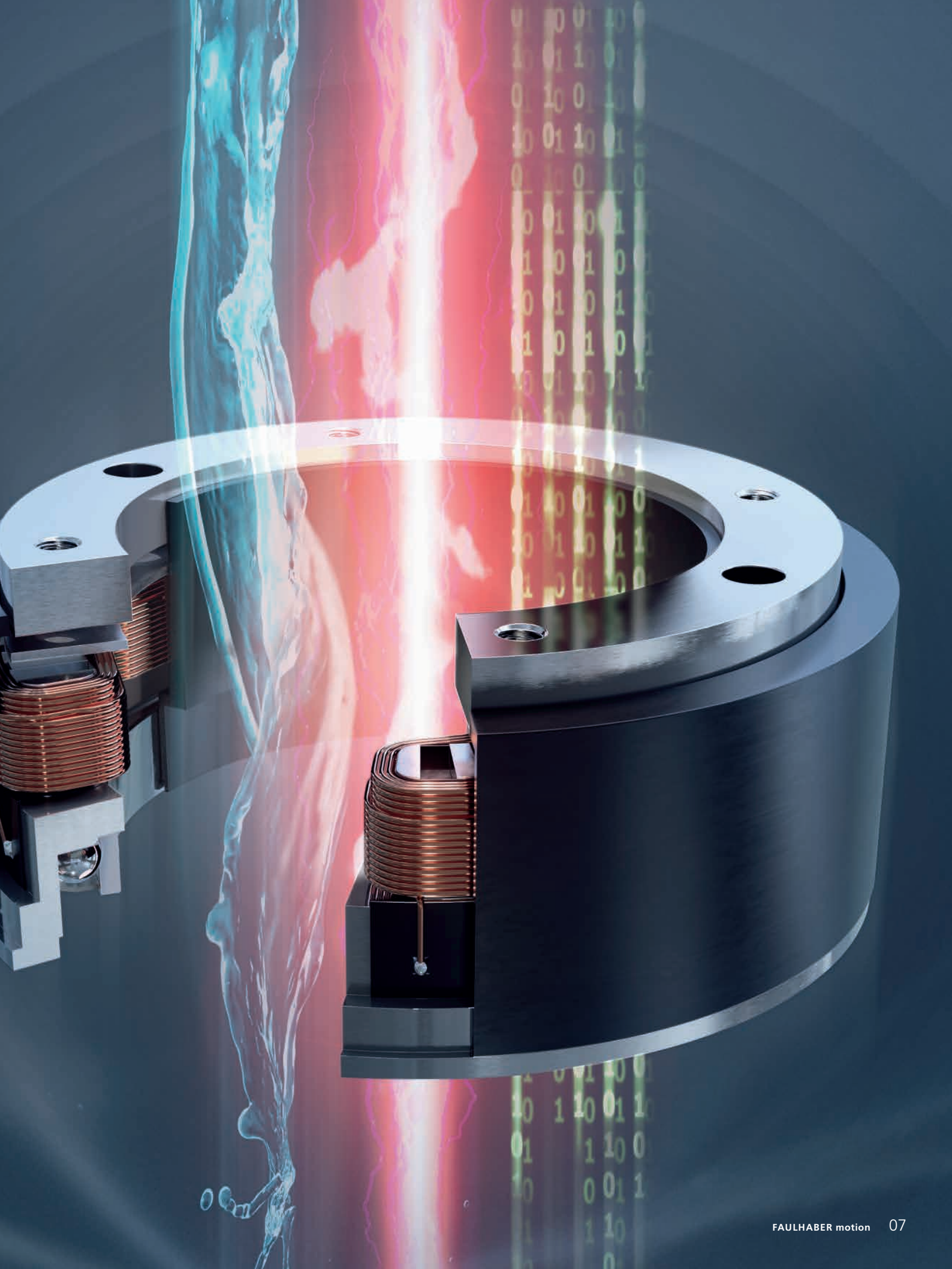
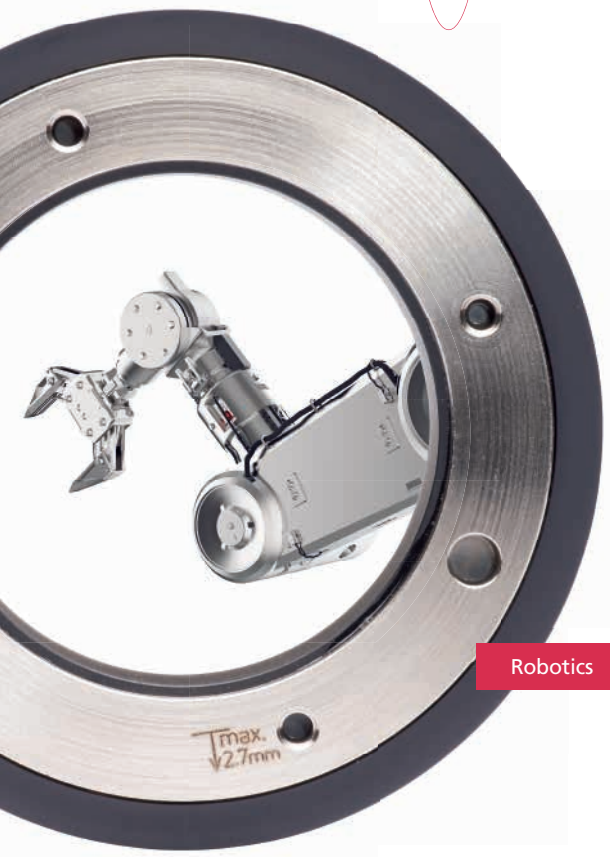
# APPLICATIONS? STEP INTO THE RING.

Many applications require drive solutions that have a central opening through which, e.g., light, cables or parts of the application can be guided. Examples of this can be found in optics and photonics for laser steering systems or in automation and robotics for semiconductor handling systems. Until now, conventional systems always resulted in compromises here. The apertures of the hollow shafts were often quite small, the drives slow, heavy or the mechanical integration required a great deal of work. But now, a new direct drive offers a promising alternative, a better solution. Its large opening has a diameter of 40 mm and, thanks to stepper motor technology, achieves a balanced combination of speed and torque with low weight and volume.

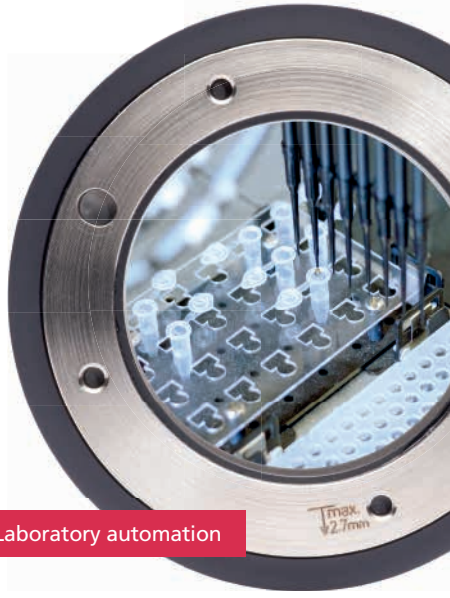


# APPLICATIONS? STEP INTO THE RING.

Laser beam control




Robotics

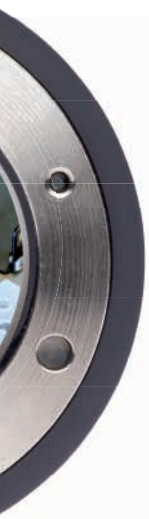



Laboratory automation

There are many drive technologies and solutions available that are generally suitable in cases where a central opening is needed. In practical use, however, each has its own disadvantages. With classically constructed motors, for example, the diameter of the hollow shaft is usually limited to approximately 10 to 12 mm on account of the necessary copper filling factor or magnet yoke. Due to their multi-pole design, torque motors do permit larger openings, but cannot achieve high speeds due to their large moving mass. In addition, they are relatively expensive and often difficult to integrate.

Many applications therefore use rotary tables with a central opening that are driven by a "common" motor. Such solutions require transmission and complex mechanics, however. The resulting inevitable backlash needs to be compensated by means of elaborate measures before this type of motor can be used in high-precision applications. This complicates system integration considerably. Furthermore, numerous wear parts are involved, which leads to high maintenance requirements. Hybrid stepper motors, i.e., the combination of reluctance and stepper motor in a hollow shaft design are likewise often the tool of choice, but have a large volume and are heavy when higher performance values are called for. Finding a practical solution when the application requires an opening has, thus, not necessarily been easy until now.

Originally designed for optics and photonics applications, the new hollow shaft direct drive also opening new possiblities in many other areas, such as wheel drives in cases where the drive shafts are guided through the motor for space reasons or in prosthetics with artificial knees or shoulders. In principle, it can be used wherever cables need to be guided through the opening or in cases where gases, fluids or light signals are to pass through the opening. Apart from the field of optics – e.g. for microscope stages, apertures, zoom lenses, laser beam controls, etc. – it can thus be used for a wide range of control and positioning tasks. Typical applications also include turntables, antenna mounts as well as air and gas vents.



## New approach – new possibilities

For the new DM66200H stepper motor series, FAULHABER has developed an entirely new drive solution, specially designed for applications requiring a large central opening. With a total diameter of 66 mm, it offers a very large hollow shaft inner diameter of 40 mm. And it is only 24 mm thick and weighs just 218 g. As a result, the compact drive is easy to mount and requires very little installation space. The rotor directly drives the mechanics, which are arranged around the opening and does so without transmission. As a result, there is no mechanical backlash that needs to be compensated for.

## High performance values in optimum combination

The direct drive is based on the proven stepper motor technology from FAULHABER. The multi-pole, two-phase motor with permanent magnets delivers 200 steps per revolution. With a high resolution of 1.8° in full-step mode, it can execute positioning tasks precisely in open loop operation. It achieves a dynamic torque of up to 200 mNm and can move correspondingly large loads. The maximum static torque is 307 mNm, and even 581 mNm when boosted. Brakes are thus unnecessary. Speeds of up to 2,000 revolutions per minute can be achieved. For many applications, the compact direct drive thereby offers a perfect balance of speed and torque. It enables maintenance-free continuous operation, as only on the ball bearing is there minimal wear. Application-specific modifications are possible on request, for example, specific lubricants, customer-specific windings, special cables and connectors as well as mounting flanges.

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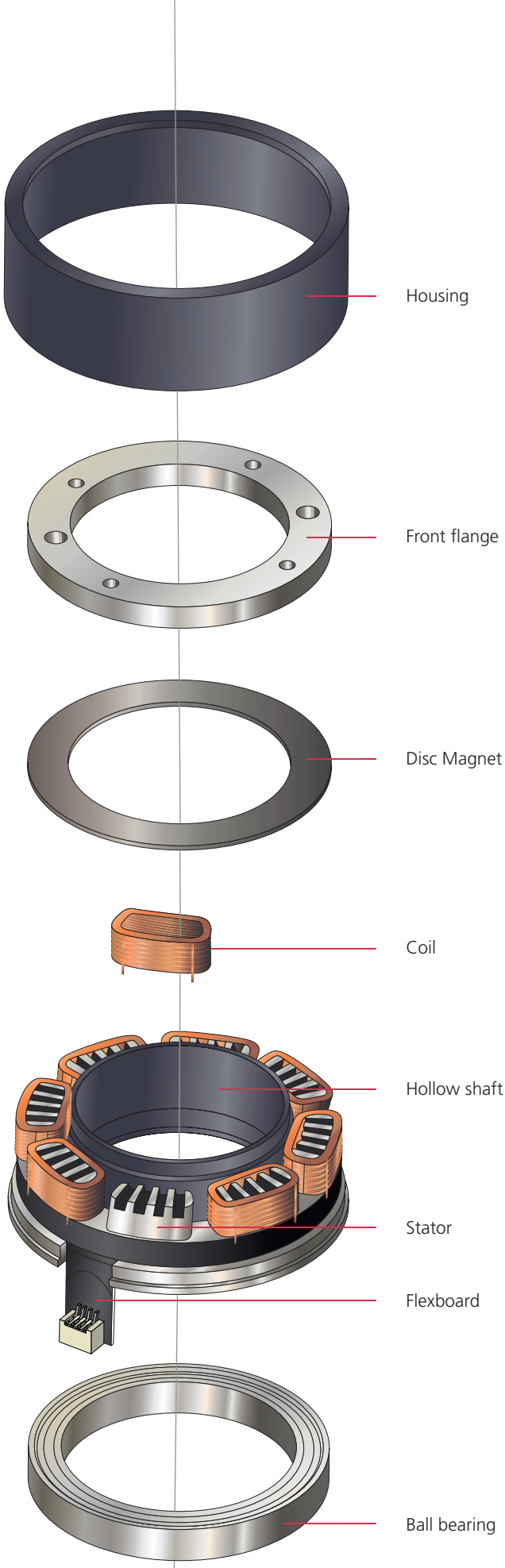
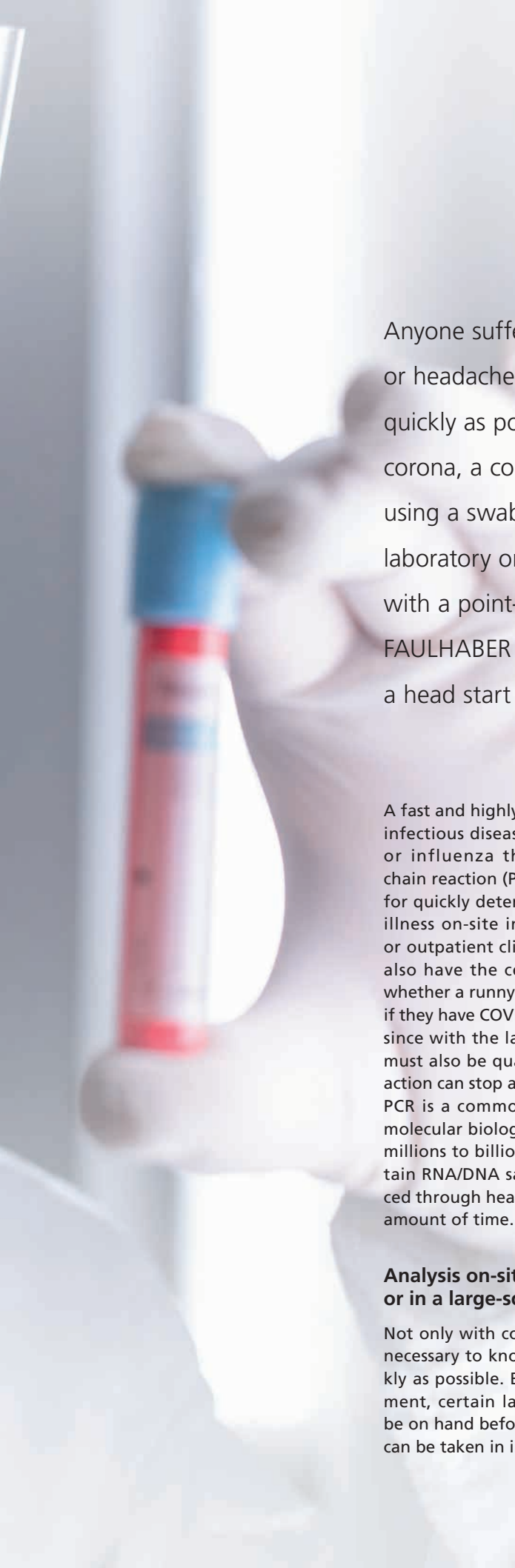


# A HEAD START SAVES LIVES



Anyone suffering from symptoms such as a cough, fever or headaches and muscle pains today tries to ascertain as quickly as possible whether they've been infected with corona, a cold or the flu. This is performed most easily using a swab. The sample can then be sent to a large-scale laboratory or – for even faster results – analyzed on-site with a point-of-care (PoC) system. In both scenarios, FAULHABER drives guarantee reliable analyses and ensure a head start in diagnostics.

A fast and highly specific diagnosis of infectious diseases such as COVID-19 or influenza through polymerase chain reaction (PCR) is the first choice for quickly determining the patient's illness on-site in a doctor's practice or outpatient clinic. Patients thereby also have the certainty of knowing whether a runny nose is just the flu or if they have COVID-19. That is decisive, since with the latter contact persons must also be quarantined, and quick action can stop any further spreading. PCR is a commonly used method in molecular biology by means of which millions to billions of copies of a certain RNA/DNA sample can be produced through heat cycles in just a short amount of time.

## Analysis on-site or in a large-scale laboratory?

Not only with corona tests is it often necessary to know the result as quickly as possible. Before starting treatment, certain lab values must often be on hand before the right measures can be taken in intensive care units, in outpatient departments or in doctors' practices. Here, point-of-care (PoC) analysis devices can make full use of their advantages: they are mobile and light, can be used flexibly and – above all – are fast. A result can be available in less than 15 minutes. The name reflects the most meaningful place of use of a PoC system: in the immediate vicinity of the patient and his or her treatment (point of care).

Compared to a central laboratory automation solution with pre- and post-analyzers, a PoC solution is more cost-effective, simpler, considerably faster and delivers relatively reliable results. There is also very little training required for personnel. Because just one sample can be analyzed at a time with PoC, the overall throughput is limited and is considerably lower than what is possible in a large-scale laboratory.

When it comes to performing a very large number of standardized tests, such as in the case of a mass test for COVID-19, there is no avoiding large-scale, automated laboratories.

## On-site analysis

Prior to a surgical procedure or a drug therapy, a PoC analysis device is used to determine important parameters such as blood values, coagulation, blood gas values and electrolytes or check patients for infectious diseases such as influenza. Various technologies are used for the analyses, including fluorescence detection, polymerase chain reaction (PCR) and microfluidics. They play an important role in the fight against COVID-19 as well. The most reliable test for detecting a coronavirus infection is the PCR test.

Analysis devices for PoC use are nearly fully automated and, through the use of test strips or test kits, require only very few actions by the user. Depending on the function of the analysis process, miniature drive systems are used for the disposition of samples, for mixing with reagents, rotating or shaking. At the same time, the PoC systems must be compact and easy to transport and must occupy very little space on-site. In the case of battery-powered systems, a highly efficient drive solution is necessary for enabling a long operating time.

Drives for these applications must therefore be as compact and as fast as possible. FAULHABER micro DC motors with graphite or precious-metal commutation or stepper motors are a good choice as they are compact in size, are highly efficient and offer a high power/weight ratio. In addition, they satisfy the requirements for high reliability, long service life, expanded product life cycle and low maintenance.


## Analysis in a large-scale laboratory

The advantages of automation are obvious: it enables more reliable results with a much higher throughput than would be possible with PoC systems – and does so with low susceptibility to errors and minimal personnel costs. Automated solutions have therefore been indispensable for many years in in-vitro diagnostics (IVD), i.e. the analysis of medical samples such as blood, urine and tissue. But automated processes in laboratories are also increasingly used in chemistry and in food technology. This can mean both performing individual processes in stand-alone devices but also in complex systems with a completely automated sample analysis.

Here, automation begins already when preparing the samples in color-coded sample collection tubes. A scanner is used to detect which analyses are to be performed for the given sample. Depending on the requirement, the sample can also be separated into its constituent parts with a centrifuge. Then the samples are transported on a conveyor belt or in sample taxis in small carts with wheel drive to the individual analysis stations. With these carts, which can only transport one sample at a time but also have several hundred other samples in the system, the appropriate analysis sequence can be performed fully automatically and yet be individually tailored to each sample.

## Numerous drive tasks

The drives used in the lab must perform a number of different drive tasks. Smooth operation is only possible if the individual steps occur with high dynamics and precision. For example, each sample must first be clearly identified with a bar code, the stopper unscrewed and it must be ensured that only a part of the sample is used for the analysis. Especially for tests for COVID-19 or vaccine development, it is important that part of the sample be resealed and archived for any subsequent retesting and for archiving purposes. Needed during the preparation of the samples are, above all, small servo drives that, as part of a mobile component, perform changes in longitudinal or rotational position of the samples. Conveyor belts that transport samples in racks, on the other hand, require large, powerful drives.

In the process sequence that follows – the transfer to a reaction vessel, such as a Petri dish or a test plate – the demands placed on the drive technology increase, as a range of different movements are required for pipetting, mixing, stirring and the handling of liquids. Repeated start-stop movements require a highly dynamic system in which extremely precise positioning is just as important as the speed of the pick-and-place or pipetting processes. Because the drive for the up and down movement of a gripper arm or pipetting head is usually located in the mobile component, this drive must additionally be especially light and compact.
micro DC motors of the 1524...SR and 2224...SR series are very well suited for this task. They have no iron armature and are lighter and smaller than other drives with comparable performance. Their high dynamics can usually be fully optimized in combination with an encoder of the IEH2 series, as this extends the overall length of the drive unit by only two millimeters.

**FAULHABER SR**
MICRO DC MOTORS WITH
PRECIOUS-METAL COMMUTATION

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medical-laboratory-equipment/

# HOTSPOT

The corona pandemic has clearly demonstrated to the whole world just what a highly contagious virus can do. Tourists and travellers have unintentionally contributed to the spread of the disease. Detecting infected persons on arrival at airports is key in preventing a potential chain of infection. Here, thermal imaging cameras can make a decisive contribution. Motors from FAULHABER help these cameras capture precise images and measurement values in a fraction of a second.

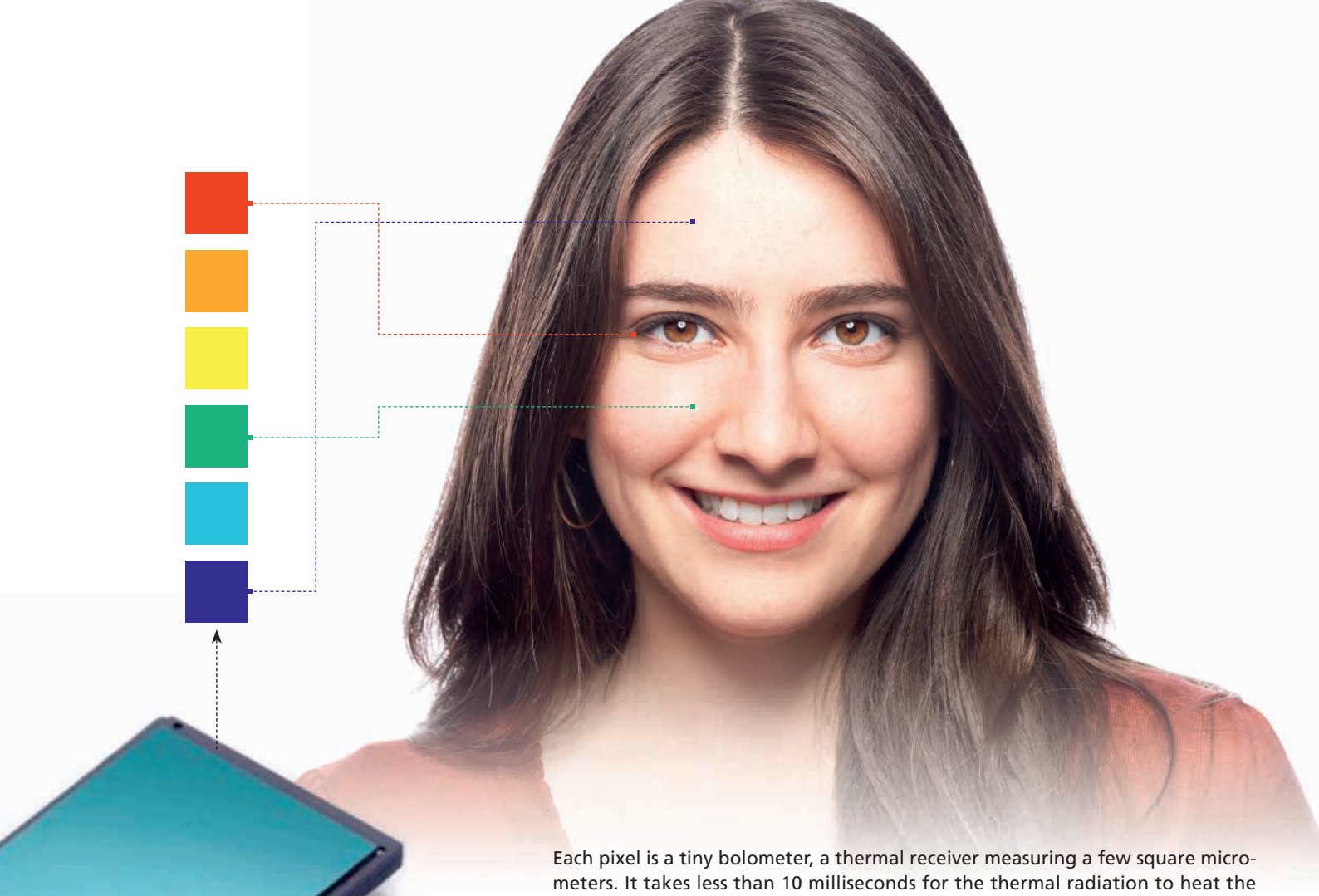

The idea of mass temperature monitoring is nothing new. Its introduction and increased use was prompted by the localized epidemics caused by the SARS, MERS and Ebola viruses. In view of the acute health risks that these viruses pose, some countries already began using thermal scans at airports and other points of arrival a number of years ago in order to at least hinder the spread of the diseases. As a result of COVID-19, this method is now increasingly being used all over the world.

Fever is usually a symptom of an infectious disease. Even if the increased temperature is not necessarily caused by the coronavirus, it is an indication that closer examination is required. If a traveller is found to have a high temperature, targeted tests can then be carried out and further immediate measures taken.

## Fast and contact-free

A major advantage of temperature measurement using thermal imaging cameras is its suitability for mass monitoring. The procedure is contact-free, takes just a few seconds and can be automated. This means it can be used at airports, at border controls or in other "bottleneck" situations without freedom of movement being significantly restricted or large numbers of people having to undergo cumbersome procedures.

The inner corner of the eyelid is the most suitable spot on a person's face for fast and relatively reliable temperature measurement. Unlike the forehead, for example, which can cool down significantly as a result of perspiration, the temperature at the corner of the eye is extremely constant. It can be determined using the infrared radiation emitted by the body's surface. Most thermal imaging cameras capture this radiation in a similar way to normal digital cameras using an image sensor with up to one million pixels.



Each pixel is a tiny bolometer, a thermal receiver measuring a few square micrometers. It takes less than 10 milliseconds for the thermal radiation to heat the bolometer, which is just 150 nanometers thin, by approximately one fifth of the temperature difference between the object temperature and the bolometer's own temperature. The sum of these values is used to calculate the temperature profile on the captured surface. Represented visually, this produces a thermal image with the familiar color shading – the brighter the color, the higher the temperature.

## Thermal pixels and quantum well

Apart from the bolometer, there are other methods of measuring temperature contact-free and optically. For example, certain sensor types detect the wavelength of the radiation and use it to determine the temperature. Bolometers and wavelength detection are not only used for clinical temperature measurement in humans. Another familiar application is searching for temperature leaks in the insulation of buildings. The colored thermal image immediately indicates where heat – or cold in the case of air-conditioned buildings – is being lost.

A less well known but widespread application for thermography is quality control. Whether metal, plastic or glass – a precisely set temperature during thermal processing steps is often a decisive factor in the quality of a product. This is why processes such as hot-rolling, lamination or glass hardening are frequently monitored using thermal imaging cameras. In the case of solar cells, thermography reveals structural damage by detecting energy-inefficient "hot spots". Thermography also plays a key role in safety technology. A thermal scan can, for example, make overheated components visible long before they reach a critical condition.
In atmospheric and space research, a completely different method is used: the quantum well infrared photo-

detector (QWIP). It consists of alternate layers of extremely thin semiconductor material and utilizes a quantum effect. The layers limit the quantum-mechanical states that a particle can assume there. Incoming infrared waves influence the state and from this it is possible to obtain meaningful images. These images are characterized by extremely high-resolution colors. There are also devices that do not use the available thermal radiation, but instead make use of active illumination. An infrared light source illuminates the observed scene in the same way as a standard photographic lamp – the thermal imaging camera becomes a night-vision device. This method is used in, for example, anti-terror operations in dark rooms. The infrared light remains invisible to the targeted individuals.

## Optics in motorized motion

No matter which method is used, electromagnetic waves must always be collected, bundled and guided for measurement and imaging. This is essentially done in the same way as for conventional photography in visible light. The same optical elements are used: Lenses are moved for focusing and zooming; apertures are adjusted, filters brought into position and shutters operated. In the case of the widely used bolometers, the thermal pixels must additionally be recalibrated at short intervals so that points with the same temperature have the same brightness in the image. For this purpose, most devices have a black shutter which is automatically moved in front of the sensor in order to calibrate all pixels to the same value. The quicker the shutter moves, the shorter the time during which measurement cannot performed.

To enable focusing and zooming, optical devices are often equipped with precious-metal commutated micro DC motors of the 1524 ... SR series. They achieve extremely high performance values with minimal space requirements. Motors measuring 8-10 mm in diameter are used in cases where drives need to fit inside minute microlenses. For example, stepper motors of type DM 0620 in combination with an integrated lead screw are ideal for moving filters and shutters. FAULHABER also offers an extensive range of motors as well as matching gearheads, encoders and other accessories. They provide the optimum solution for almost every application. The drive components can be found in many conventional optical devices where they have been successfully tried and tested for many years. This also applies to the automatic, motorized alignment of the cameras on pan-tilt mounts. The FAULHABER compact and low-vibration stepper motors in particular are predestined for such applications.

**FAULHABER STEPPER MOTORS**
2 PHASES PERMANENT MAGNET TECHNOLOGY

**FAULHABER SR**
MICRO DC MOTORS WITH PRECIOUS-METAL COMMUTATION

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# SURFING BACK TO EARTH

*A capsule full of material samples on its way back to Earth. Exposed to centrifugal forces of up to 12 G and temperatures from -270 to 5,000 degrees Celsius at its shell. The capsule has to brave it all to bring back an answer to an existential question: What is the origin of life on our planet? Scientists are using space probes to look for clues on, for example, asteroids and comets. That's because there are some indications that these celestial bodies played an important role in the genesis of life. Of course, it's pivotal that the capsule (and its precious cargo) survives re-entry into the atmosphere, and sticks the landing without damages. And that is what the HADES project at the Swiss University of Applied Sciences in Geneva, sponsored by FAULHABER, is all about. For the dynamic stabilization of the capsule's flight attitude, the HADES team will be relying on linear motors from FAULHABER in the future.*


*In 1969 Neil Armstrong and Buzz Aldrin were the first people to step foot on the moon. Their lunar landing mission was the first space mission during which samples were collected on a celestial body and brought back to Earth. Even today, scientists continue to evaluate and make new discoveries from the material. Manned space travel is, however, too expensive and complicated for collecting cosmic rocks. Since Apollo 11, it has above all been unmanned probes that have collected substances from celestial bodies.*

## Stardust by the gramme

While the famous astronauts brought back moon rock by the hundredweight, the unmanned missions generally make do with just a few grams of the cosmic material. Thanks to modern analysis methods, even the smallest quantities are sufficient for in-depth research. It helps the scientists to better understand the processes that occurred during the formation of our solar system. Moreover, the amino acid glycine was also detected in such samples. It follows that this protein building block landed on Earth with meteorites and probably contributed to the origin of life on our planet.

Before the samples can be examined, they must, of course, first be returned to Earth. To accomplish this, return capsules are used on the unmanned missions. They are released from the space probe at a precisely calculated moment and sent on their way with a small push. The Earth's gravitational pull eventually forces them to land in what is a precalculated area.

Like all objects that enter the Earth's atmosphere from space, the capsule becomes extremely hot in contact with the atmosphere (fig. 1). To counter this reaction, it is effectively protected by its round-oval shape and a heat shield. An especially critical phase of the


return begins a brief time later after it has already been significantly slowed down by the air resistance and moves at "only" subsonic speed.

## Danger from aerodynamics

During this part of its flight, the capsule is already exposed to the terrestrial aerodynamics. Every air eddy affects its trajectory and its orientation. Without wings and flaps, there is no way to stabilize from the outside. There is a risk that the capsule could begin to spin. This occurred, for example, with the return capsule of NASA's Genesis Mission in 2004. During this phase of the flight, it lost its intended orientation and it could not release the parachute and crashed unchecked into the ground.

"We want to prevent this scenario by stabilizing the orientation of the capsule during its flight through the atmosphere," explains Aurélien Walpen from the University of Applied Sciences Western Switzerland (HES-SO), which has campuses in Geneva and Fribourg. He was involved with the HADES project there as a master's student. "One of our professors is very active in the area of space travel and confronted us with the problem of the return capsule. We played through various concepts but soon returned to our initial idea: stabilization though center-of-gravity displacement." The capsule should, in principle, do the same thing as a surfer when he holds onto his board while riding a wave: He compensates for the effect of his dynamic "ground" by using his bodyweight to constantly adjust his center of gravity. "Translated into the language of mechanics, the compensating movement takes place on the x and y axis. By shifting a weight back and forth on both of these axes, it is possible to compensate for external destabilizing forces."

**Peak values with components**

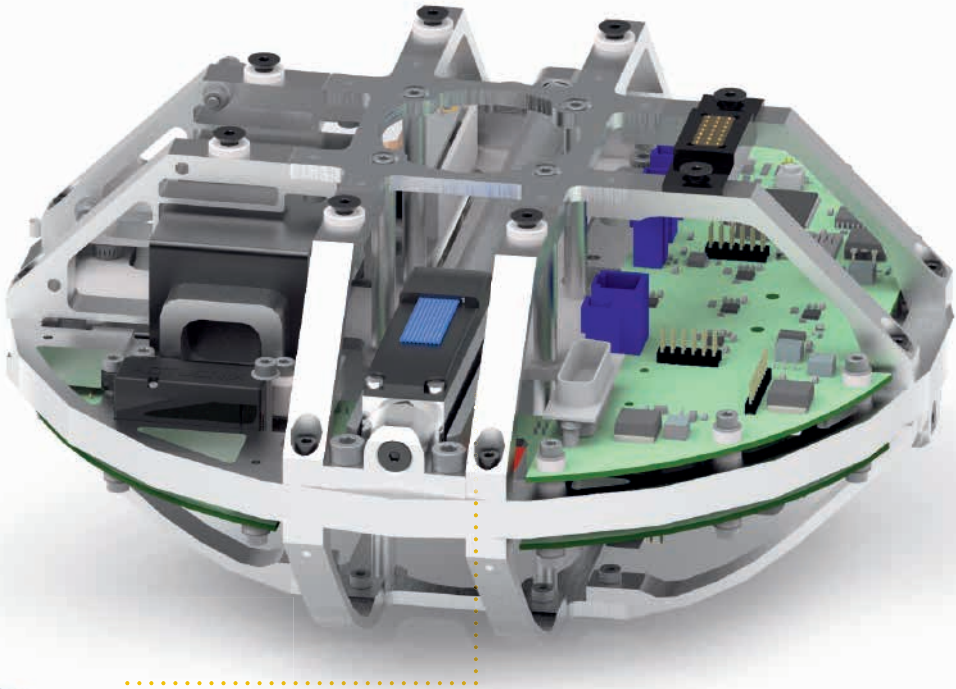
The small size of the rocket permits only a limited payload. All components must therefore be optimized with respect to size and weight for the limited available space in the rocket nosecone.

## Motors with double function

It made sense to use linear DC servo motors inside the capsule to move the two weights. Conveniently, the motor mass is sufficient in this case to function as a counterweight: The stabilizing effect is achieved by the two motors darting back and forth along their axes. Adding additional dead weight is not necessary. While searching for reliable solutions with linear motors for this task, experts from ESA and HADES turned to the solutions offered by FAULHABER. They were able to find a suitable drive in the portfolio based on the physical requirements for the unusual task. These are considerable. First, they must be relatively robust to withstand the enormous forces during rocket launch and upon re-entry into the atmosphere. Especially during the latter, it becomes very hot in the capsule – this after having been exposed to the extremely low temperatures in space and the vacuum present there.

All of this must not prevent the motors from performing their tasks reliably and quickly. They must be able to move back and forth along their axis of motion up to four times per second. To do this, they need a very high torque, as they must be able to work against significant braking and centrifugal forces. At the same time, the space within the capsule – as is always the case in space travel – is a very scarce commodity. The motor must supply maximum performance with the smallest of dimensions.

"We tried various types here as well, only to ultimately return to our first choice," explains Aurélien Walpen. "The LM 2070-12 linear DC servo motors from FAULHABER achieved the best values in all important points and proved itself to be the most reliable drive. It was also important that the motor control can be very easily programmed and integrated in the complete system." The entire system was tested in climatic and vacuum chambers as well as in the wind tunnel at the university in Geneva. There, the reaction of the capsule to the air resistance during the flight through the atmosphere was simulated. During the tests, the linear motors reliably stabilized the orientation of the capsule. The field test with actual return from space that was planned for March 2020 had to be postponed. Now it is scheduled to take place in spring 2021. The capsule will be launched by a REXUS rocket from the Esrange Space Centre in the northern Swedish town of Kiruna. After accelerating to 20 G and reaching a top speed of 4,300 kilometers per hour it will travel to an altitude of 100 kilometres above the Earth's surface from where the capsule will be dropped and thanks to FAULHABER it will return safely.



Inside of the HADES capsule showing one of the FAULHABER Linear Servomotor used to stabilize the capsule

**LINEAR DC-SERVOMOTORS**

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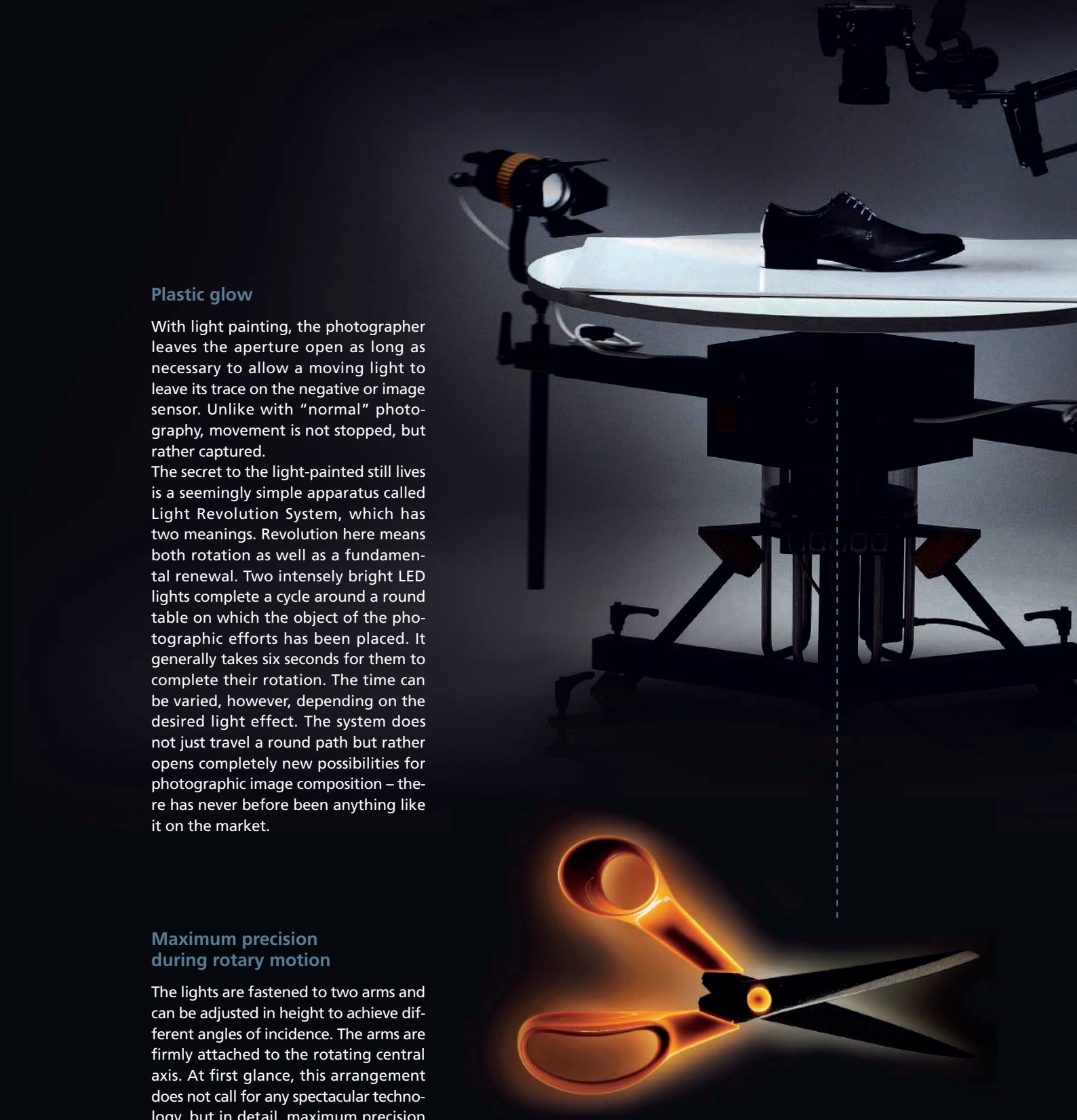
# *LightRevolution*
## TURNING THE TABLES IN PHOTOGRAPHY


„Making the ordinary extraordinary". The motto of British photographer Patrick Llewelyn-Davies puts it in a nutshell. In his photographs, he casts daily objects under a new light, giving them a very special aura. His secret is the innovative exposure technique that he uses to create a bridge from moving light painting to still life.


How do you make a car rim glow without melting the tire? Patrick Llewelyn-Davies does it with light, and thereby creates an unusually enlightening picture of this everyday object. His Light Revolution System redefines the contrast of light and shadow, as it uniformly irradiates the object from a complete circular path. A precision motor from FAULHABER ensures the uniform movement of the lamps and exact adherence to 360 degrees.

In his images, the resting object is at the center, and he uses the moving light like a pen for coloring in. Only that he adds no additional color to his images. Instead, he causes the objects to glow and illuminate. His use of light also allows for the creation of new and sometimes X-ray-like glimpses into the photographed objects. They take on a quasi three dimensional plasticity even though they never optically leave the 2D world.



## Plastic glow

With light painting, the photographer leaves the aperture open as long as necessary to allow a moving light to leave its trace on the negative or image sensor. Unlike with "normal" photography, movement is not stopped, but rather captured.

The secret to the light-painted still lives is a seemingly simple apparatus called Light Revolution System, which has two meanings. Revolution here means both rotation as well as a fundamental renewal. Two intensely bright LED lights complete a cycle around a round table on which the object of the photographic efforts has been placed. It generally takes six seconds for them to complete their rotation. The time can be varied, however, depending on the desired light effect. The system does not just travel a round path but rather opens completely new possibilities for photographic image composition – there has never before been anything like it on the market.

## Maximum precision during rotary motion

The lights are fastened to two arms and can be adjusted in height to achieve different angles of incidence. The arms are firmly attached to the rotating central axis. At first glance, this arrangement does not call for any spectacular technology, but in detail, maximum precision and extremely smooth operation are decisive. "Any pause or jerk in the rotation, regardless of how short, would result in uneven illumination," explains Patrick Llewelyn-Davies. "There would be brighter and darker patches that would affect or destroy the intended effect. The same applies for travelling the complete circle. The arms must not move one degree more or less than 360 degrees. And they should accomplish this in precisely the specified amount of time."

The inventor/photographer reports of earlier attempts with simpler components that were not able to meet these requirements. The greatest challenge was in moving the central axis of the system both very precisely as well as jerk-free. At the same time, the portable device needed to be as light as possible. When making the selection of the right drive, the experts of the British FAULHABER sales partner EMS provided assistance. "The support from EMS was great," explains Patrick Llewelyn-Davies.


"They provided the necessary technical expertise for the drive and the controller. It is decisive for the high quality of the product. Moreover, motors from FAULHABER have proven themselves in highly critical areas such as aerospace. That's how I knew that they would have the accuracy and reliability required by the Light Revolution System."
The experts from EMS identified the brushless motors of the BX4 series as the optimum solution. They were able to ensure the desired precision and repeatability of the sequence. "Once we selected a motor family, we could try different sizes without intervening in the programming", explains Dave Walsha, Commercial Development Officer at EMS, with regard to the joint development work. "As a result, we were able to respond very flexibly to changes to the system." Thanks to the compact and lightweight design of the BX4 motors, the ideal weight was also maintained.

## Detailed 3D models of museum objects

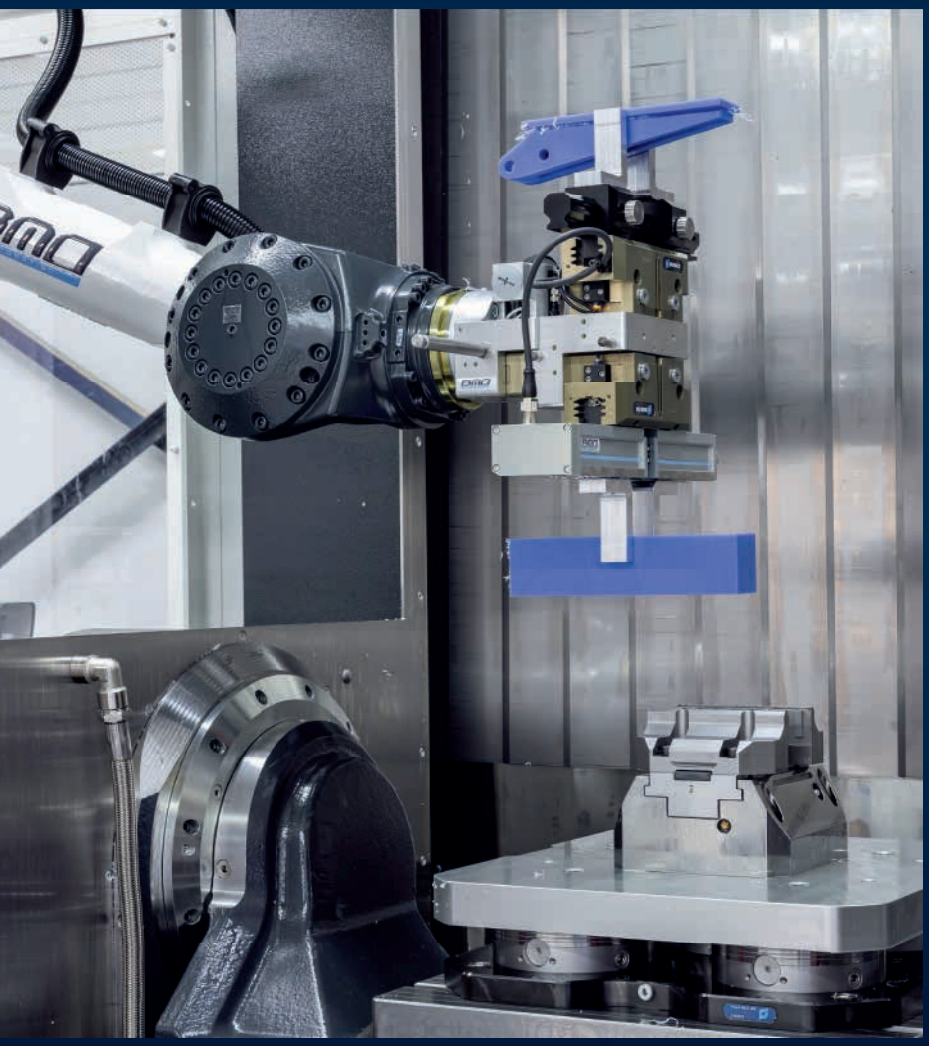
Of course, the photographer thoroughly tested his Light Revolution System himself. In his online gallery, you can admire examples of the unique light effects that he has achieved with his system. The glow that he elicits from unassuming everyday objects like a chicken egg or a fishhook is created by placing the circling LED lamps very low above the table. Because part of the light is laterally reflected by the objects onto the base, a glowing aura is created that appears to emanate from within the objects.
The system is currently being tested in various application areas. Instead of the lights, a camera can also be attached to one of the arms. If it is attached to an arc-shaped arm, the object can be photographed at a uniform distance from various angles. This method is used, e.g., by museums to calculate high-resolution 3D models of their valuable objects from image data. Researchers can then exchange this data worldwide and use it for their studies. Furthermore, precise replicas can be created using 3D printing. "Up to now, a considerable amount of hand work was associated with the creation of such images," says Patrick Llewelyn-Davies. "With the Light Revolution System, the process can be largely automated and greatly accelerated."

faulhaber.com/en/markets/optics-photonics/
light-revolution.com/

PREVIEW

# HIGH MIX & HIGH VOLUME

## CNC LATHES AND MILLING MACHINES



In the next issue of motion, learn how to achieve both high variances as well as high volumes when using CNC lathes and milling machines in the metal- and plastic-processing industries. A solution from the Netherlands does this by combining the advantages of pallet automation with the option of also being able to load individual workpieces fully automatically. From the principle "high mix – low volume" thus becomes "high mix & high volume". This is made possible by, among other things, servo-controlled gripper jaws whose precision and reliability are guaranteed by FAULHABER drives.

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