

motion

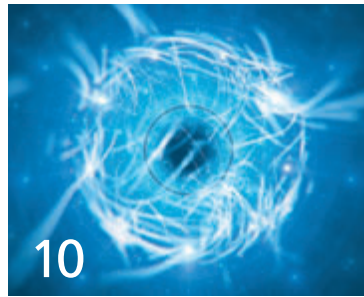
01.2019

THE MAGAZINE WITH DRIVE



**FACTORY
OF THE YEAR**

Winner 2018 in the category:
Excellent Small Series Assembly



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Enormous acceleration with disc magnet technology

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Dear readers,

The value of clothing sold worldwide in 2017 exceeded 1.4 trillion dollars. Can you imagine the amount of yarn contained in this mountain of clothing? Neither can we – but it must have been millions of miles. All of this yarn was wound and unwound multiple times during processing. This is just one process step in the textile industry in which the compact and long-lasting drives from FAULHABER prove themselves daily.

FAULHABER also proved itself in the "Factory of the Year" competition and claimed the top prize in the "Excellent Small Series Assembly" category. I am tremendously pleased with this honour for our company. Together – and that is very important to me personally – we have succeeded in bringing FAULHABER to the the forefront in terms of production as well. With our constant pursuit to improve processes, our synchronisation across locations and the high level of automation, we were able to convince the jury of the most traditional and most competitive benchmark competition.

Let's take a look at the stars: what's happening in the Milky Way? We know surprisingly little about this, because we literally have a hard time seeing the wood for the trees. But the MOONS project initiated by British astronomers aims to change this. Technology from FAULHABER will play an important role.

Learn 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

Issue 01.2019

Publisher / Editor:

DR. FRITZ FAULHABER
GMBH & CO. KG
Schönaich · Germany
Phone: +49 (0)70 31/638-0
Fax: +49 (0)70 31/638-100
Email: info@faulhaber.de
www.faulhaber.com

Layout:

Werbeagentur Regelmann
Pforzheim · Germany
www.regelmann.de

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Publication frequency & subscription:

FAULHABER motion is published twice a year and is delivered to customers, interested parties and employees of FAULHABER free of charge.

FAULHABER motion is also available as an app.



www.faulhaber.com/motion

CERTIFIED ECO POWER AT FAULHABER

Environmental protection is one of the core values of Dr. Fritz Faulhaber GmbH & Co. KG. This is why the company from Schönaich is using environmentally friendly technologies that help save raw materials, energy and water. In addition to a combined heat and power unit, a photovoltaic system is used which has been producing about 336 megawatt hours of electricity since its commissioning in 2015/2017 and has thus saved over 201 tonnes of CO₂. Any additional power that we need is also derived from 100% regenerative sources: FAULHABER uses "regio natur", a green electricity product from the Tübingen public utility company, certified by TÜV NORD as "certified green electricity".



FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/environmental-policy/en

FAULHABER WITH OWN SALES COMPANY IN ITALY



Since 1 January 2019, FAULHABER Italia S.r.l. is responsible for the sales and service of FAULHABER products in Italy. The wholly-owned subsidiary, located in Lomazzo north of Milan, has taken over the sales and service of FAULHABER products from its long-standing distributor, Servotecnica S.p.A. "Italy is a significant market for us, one in which we would like to be present throughout," emphasises Marcus Rimmel, General Sales Manager at FAULHABER Drive Systems and Managing Director of FAULHABER Italia S.r.l. "There are many very interesting companies in the country, in, among others, the areas of

hand tools as well as medical and automation technology, some of which are already our customers. And we'd like to win over the others." With the new subsidiary, customers profit from FAULHABER know-how even more than before. "For example, direct contact can offer great advantages, particularly when selecting the optimum drive for a specific use or for the customer-specific development of applications." FAULHABER Italia will also be present at trade fairs. For example, at sps ipc drives Italia in Hall 5, Booth A051. The FAULHABER team is looking forward to seeing you!

FURTHER INFORMATION

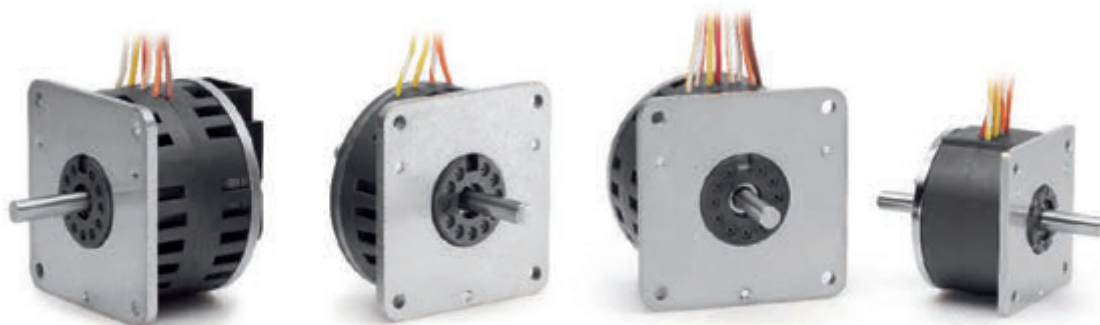
FAULHABER
www.faulhaber.com/m/opening-fit/en

NEW

ENORMOUS ACCELERATION WITH DISC MAGNET TECHNOLOGY

Schönaich/La Chaux-de-Fonds – Following the acquisition of Dimatech, a Swiss manufacturer of high-performance stepper motors, FAULHABER now also offers this motor type with higher power and greater dynamics. The primary difference between disc magnet motors and conventional motors is the disc magnet motor's extremely light rotor. It consists of a multi-pole magnet in the sha-

pe of a disc mounted on the motor shaft. Its low weight minimises the rotor inertia and enables an acceleration that is unattainable for these dimensions by any other technology. With their specific properties, these stepper motors are particularly suitable for applications in which the speed or direction change frequently and quickly and in which small loads have to be moved flexibly.



FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/dimatech/en

NEW

1645 SERIES – THE SHORT VERSION OF THE BHX SERIES



With respect to installation space and weight, the brushless DC-servomotors of the BHx series deliver high speed with low noise, vibration and heat development – inconceivable values until recently. The drives of this series are thereby predestined for medical handpieces, electrical grippers and robotic systems with high power requirements in applications with limited installation space. The new 1645 ... BHS series expands the product family by an even more compact ver-

sion which is only 45 mm long. At 100.000 min⁻¹, it reaches a significantly higher speed compared to similar-size motors on the market. It also achieves top values at maximum radial load (18 N), power density (58.5 W) and torque (8 mNm). In combination with a suitable planetary gearhead, the motor is capable of delivering a very high torque of 800 nNm at just 12.000 min⁻¹. At 90% efficiency and minimal heat development and vibration, the motor is very energy efficient.

FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/1645bhx/en

Factory OF THE YEAR

In the "Factory of the Year" competition, FAULHABER claimed the top prize in the "Excellent Small Series Assembly" category for 2018. The jury was convinced above all by the continuous quest to improve processes, the strong automation and the synchronisation across all production locations. The festive awards ceremony took place on 21 March 2019 during the 27th "Factory of the Year" conference in Ludwigsburg/Germany.



With the "Factory of the Year" conference, held from 21 to 22 March 2019 by SV Veranstaltungen GmbH together with the consulting firm A.T. Kearney and trade publication Produktion, the 27th round of the annual benchmark competition came to its conclusion. During the two-day event, the directors of the winning plants presented their solutions. For FAULHABER, Head of Production Hubert Renner discussed the topic "Production on demand – order-based production in the context of location-synchronised production and high variant diversity." Emotional highlight of the two days in Ludwigsburg was the festive awards ceremony on the evening of 21 March 2019.

Outstanding small-batch production

In the competition audit, A.T. Kearney certified that FAULHABER has a commendable process-oriented organisation structure in which the synchronisation and automation are operative value drivers of the plant. This also impressed the jury of experts, which awarded FAULHABER the Factory of the Year in the Excellent Small Series Assembly category.

Production manager Hubert Renner accepted the award on behalf of the whole company. In addition to the "Excellent Small Series Assembly", FAULHABER's social commitment was also appreciated on stage. "Your support of Schönaich's voluntary

fire brigade by letting employees leave their workplace to answer a call is a great service to the public. Outstanding! Please express our gratitude for this service to the rest of your team."

For FAULHABER, the category win is confirmation of the special production capability with respect to the complexity and wide variety of customer orders and the corresponding necessary volume flexibility in production. "It is our philosophy to always be technologically ahead by a nose length. We are pioneers, we design drive solutions that are unique with regard to their precision and reliability in the smallest spaces and move us to the limits of what is micromechanically possible," emphasises CEO Dr. Thomas Bertolini, "and to do so on a customer-specific basis with a batch size as small as 1."

Competition rich in tradition

"Factory of the Year is the toughest competition and hardest benchmark for manufacturing companies," said Dr. Martin Eisenhut, Partner and Managing Director A.T. Kearney Central Europe prior to the award ceremony on March 21, 2019 in Ludwigsburg (State of Baden-Wuerttemberg, Germany). "The companies awarded today should be an example and incentive for others to think about innovations in their field. Innovations are crucial to increase the overall competitiveness of Germany's economy."



FACTORY OF THE YEAR



Ten to twelve new products daily

For the optimum drive solution comprising motor, gearhead, encoder, electronics and accessories, customers have more than 25 million possible variations available with FAULHABER. "Ten to twelve new products that have never been produced in their given form are created every day," says Hubert Renner, Head of Production. Nevertheless, all orders are handled with the goal of shipping within two weeks. "For this to happen, we employ a site-synchronous production method in which the drive components are manufactured for specific orders in parallel at five different locations in Germany, Hungary, Romania and Switzerland and then mounted," reveals Production Manager Jan Patrick Schindler.

Production capability and innovative strength

In addition, nearly all employees are involved in the continuous improvement process: more than 2,000 improvement suggestions made by staff are implemented every year. "We first set goals that appear to be unachievable and work hard to determine how we can realise them," explains Hubert Renner. The production capability verified by the award meets a great innovative strength, which is reflected not least of all by again being named a "TOP 100 Innovator". The headquarters in Schönaich can, for the third time, again count itself among the innovative elite of small and mid-size German enterprises. In the independent selection process under the direction of Prof. Dr. Nikolaus Franke, the company convinced the jury, in particular, in the "Innovation success" category.



"Amazonizing of the world"

In a discussion following the award ceremony, Hubert Renner, Head of Production at FAULHABER, explained exactly how FAULHABER, motivated by the two awards, will continue to focus on the active involvement of staff, the optimization of procedures, processes and structures as well as on customer satisfaction in the future.

What does the award mean for FAULHABER?

The "Factory of the Year" competition is the toughest benchmark for manufacturing companies. For FAULHABER, the victory in the "Excellent Small Series Assembly" category is confirmation of our previous activities and motivation for what we are planning.

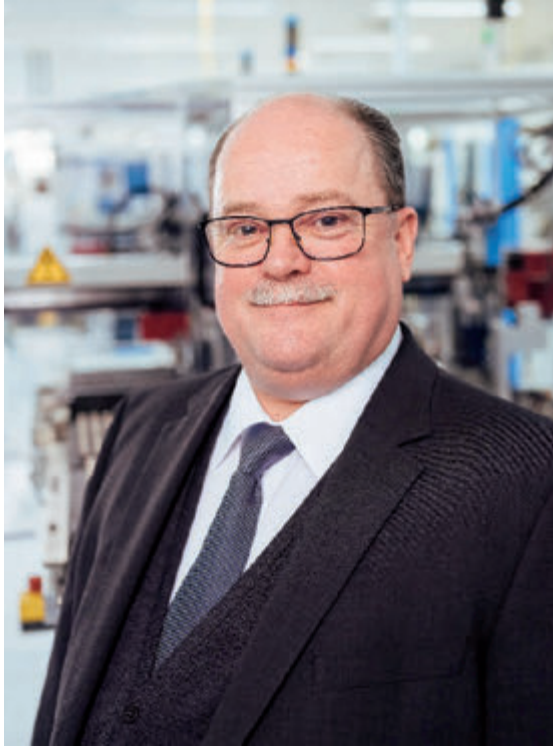
Why is FAULHABER distinguished in this category in particular?

Production at FAULHABER is characterized by a high variance. 25 million variants are possible; every day we produce up to 10 products that were never

before built in a given form. Because we produce all orders in the quantity ordered by the customer (production on demand), our batch sizes are also becoming smaller and smaller. On top of this is the fact that we realize >80% of sales with products that contain components from multiple locations. Given this complexity, we have – with location-synchronized production and with a very high level of automation at FAULHABER in Schönaich – succeeded in significantly reducing delivery times for the combinations.

How important are successes such as the Top 100 and Factory of the Year for FAULHABER?

These awards are an important form of feedback with regard to our performance. It allows us to see exactly where we stand on the market compared to the competition. These benchmarks provide a basis for reviewing our strategy. Communicating these awards with the staff sends an internal signal of appreciation and motivation. Externally, the communication provides a valuable impulse for the marketing of our products.



Hubert Renner, Head of Production at FAULHABER

What do you take from the competition into day-to-day work?

The detailed feedback report from A.T. Kearney provides us a number of thought-provoking ideas on our performance. It shows us, for example, where we lie above – as well as below – the average of industrial companies. The report provides us with information on potential improvements and is, thus, important for reviewing our strategy.

What expectations do you have on the competition – with respect to the external effect as a winning factory?

We feel that the high level of awareness of the "Factory of the Year" benchmark and the high significance of having won one of the first places will strengthen the trust of our customers in FAULHABER. The placing shows that we are on the right path.

What challenges do you foresee?

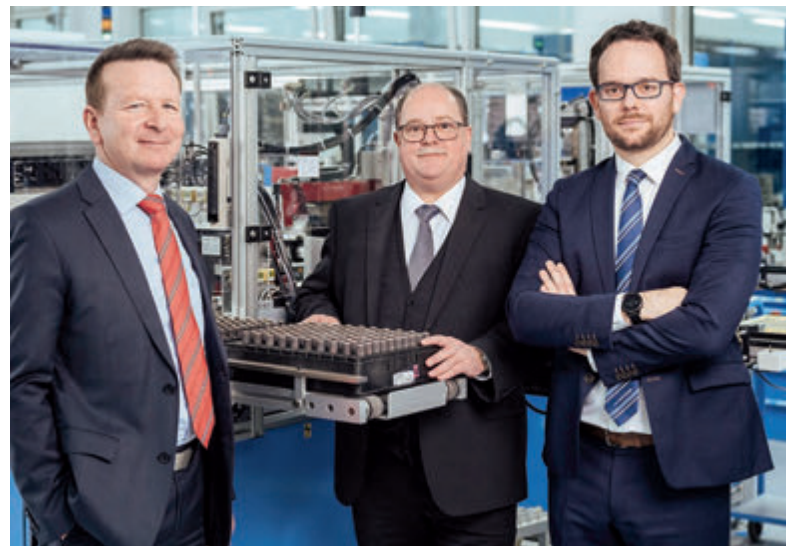
The greatest challenges for FAULHABER are the increasing complexity through the customer-specific drive technology as well as the handling of the decreasing batch sizes in production. Future business success is dependent not only on the price of a product but increasingly on the shortest delivery times. "Amazonizing of the world" is diffusing into all areas and consequently results in production on demand.

What are you planning in order to remain a step ahead?

At FAULHABER, nearly all production employees have for years been included in the continuous improvement process (CIP). We are grateful for this and would like to further increase this involvement. In order processing, we are working on leveraging valuable potential. We want to continue to use the location-synchronised production network to achieve a competitive cost structure. We aim to remain true to the path that was now confirmed with the 2018 Factory of the Year award – first place in the "Excellent Small Series Assembly" category.

What measures is FAULHABER taking to remain at the forefront of innovation?

We were able to implement an increased frequency in the development capacity of new products. What will remain essential for us in the future in this regard is the absolute focus on the satisfaction of our customers. We want to optimise production processes to the point that we can realise the shortest delivery time for our customers. We will continue to set goals for ourselves in the future that may appear unrealistic to us at first glance and then systematically work on implementing them.



Dr. Thomas Bertolini, Hubert Renner and Jan-Patrick Schindler

FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/factory-of-the-year/en



THROUGH A
STORM OF IONS
IN THE SERVICE OF MEDICINE

The more one knows about a tumour, the better it can be fought. With positron-emission tomography (PET), it is possible to very accurately distinguish cancer cells from the surrounding tissue. The highly detailed images are created with the help of low-level radioactive isotopes, which are produced in particle accelerators. In the GENtrace cyclotrons from GE Healthcare, drives from PiezoMotor help. The inhospitable conditions in such machines do not affect them at all.



Finding the head of a pin

"Discovering the mother tumor is normally quite easy and possible through many techniques. But to discover all the metastases, where many are the size of a pinhead, is very difficult," explains Dr. Martin Pärnaste, head engineer in the Cyclotron Systems division of GE Healthcare in the Swedish city of Uppsala. PET helps to detect such metastases. This can be of decisive importance for subsequent therapy.

Like X-ray and computer tomography (CT), PET generates its images with the help of a small dose of radioactive radiation. The radiation is not emitted by a device that directs it at the body from the outside in this case, however. Instead, it comes from radioactive particles that are previously administered to the patient. They are generally mixed with glucose in a so-called radiodiagnostic agent or "tracer" and injected into the bloodstream.

Short half-life

Relatively harmless, low-radiation substances are used for the PET diagnostic agent. They decay rapidly and leave no critical residues. In about 90% of cases, isotope 18F of the halogen Fluorine is used. It has short half-life of approximately 110 minutes, which means that it has lost nearly all of its radioactivity after one day. Other isotopes with a similarly short half-life are used as well.

Because the PET tracers decay so quickly, they cannot be kept in supply like other materials. They must be produced fresh in a particle accelerator – the cyclotron – shortly before they are used. This must not be located too far away from the place of use as every minute counts, even during transport.

Particle race on a spiral path

The first cyclotrons were constructed back in the 1930s by pioneers in particle physics. Their functional principle has since then been modified and further developed numerous times – including the world's largest particle accelerator, CERN, located in Geneva. The technology has also proven itself in medical technology as well, however. To produce isotopes for PET, negatively charged hydrogen ions are accelerated in a vacuum chamber located within the cyclotron. The ions are accelerated by electric fields and kept on a spiral path by a strong magnetic field.

At the end of this path, they fly through a thin graphite foil, thereby losing their electrons and becoming positively charged protons. As a result of this charge reversal, their trajectory changes from the

previous spiral movement to a straight line. The orientation of the foil determines the direction of the proton beam. It is directed towards a reaction chamber, the so-called target, in which the source material for the isotope is located. There, the proton beam triggers a nuclear reaction and produces the required isotopes from the target content.

A number of years ago, Dr. Pärnaste and his team were assigned the task of further improving the reaction as well as developing a machine that is as small and economical as possible. It was to contribute to making clinical access to PET isotopes simpler and this imaging technique more widely available. The result of the development was named GENtrace and was launched in 2017 with great success.

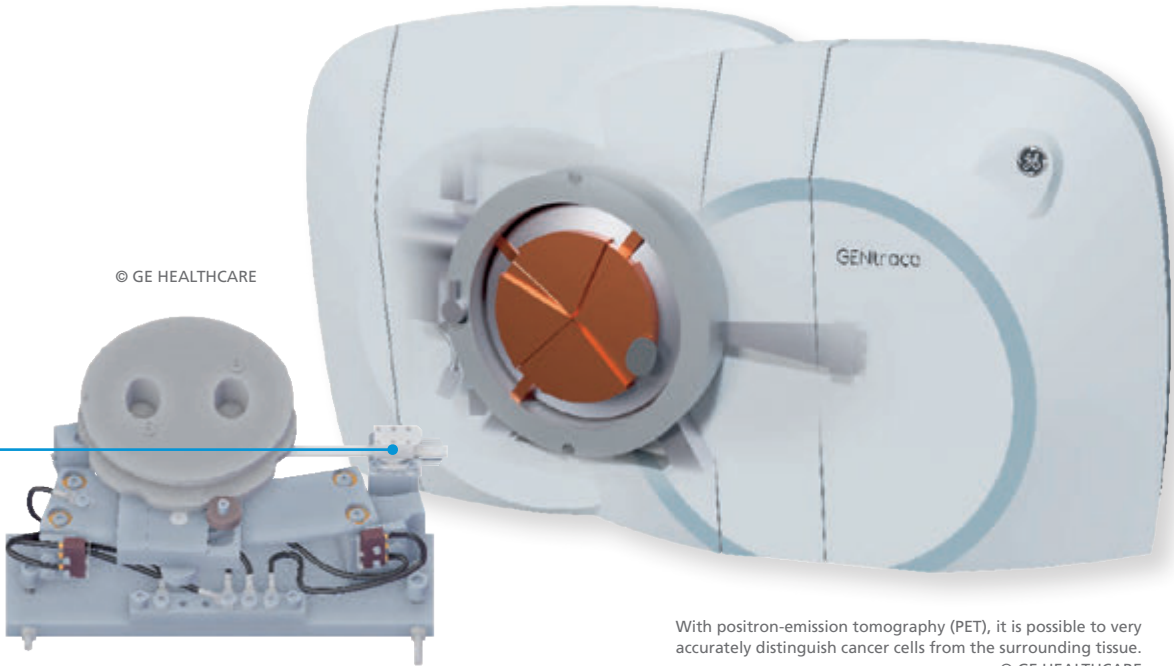
Magnet-free drive technology

To produce the largest possible quantity of isotopes or isotopes from various elements in a single pass, the new cyclotron has three targets. The orientation of the beam must thus be variable so that it can strike all three targets. To achieve this, the carrier on which the graphite foil is affixed is moved using motor power.

Inside of a cyclotron, however, are conditions with which standard electric motors can hardly cope: magnetic fields, vacuum, electric fields and radiation interfere with their function or make them outright impossible. The motor for directing the beam is therefore normally located outside of the actual cyclotron. Its movement is then transferred to the foil carrier by means of a complex mechanical construction. This has considerable disadvantages, including the mechanical play and the extensive sealing that is required where moving parts pass through the wall of the vacuum chamber.

These disadvantages disappear when using a piezo motor. Its functional principle makes it immune to the inhospitable conditions in the cyclotron. Because, unlike a classic electric motor, it requires neither magnetic components nor rotating parts to convert electric current into movement. Its operating principle is based on the fact that the shape of a piezoceramic element changes when a voltage is applied to it.

© GE HEALTHCARE



With positron-emission tomography (PET), it is possible to very accurately distinguish cancer cells from the surrounding tissue.
© GE HEALTHCARE

For these reasons, the piezo motor can be located directly at the deflection point as neither the fields nor the radiation or the vacuum affect its function. Accommodation only needs to be made to allow the cables for the power supply and the control to enter the vacuum chamber. Because they do not move, sealing is simple in this case.

Technology from the neighbour

The experts from GE Healthcare became aware of the technology from PiezoMotor through an article in a technical journal. Conveniently, it then turned out that both companies are based in Uppsala. "After testing several micromotors and motion solutions, we finally had a breakthrough in the development. In the final

design, we use two drives from PiezoMotor – a 20N linear motor to move the proton beam, and a non-magnetic rotary motor with 50 mNm torque to adjust the ion extraction," concludes Dr. Pärnaste.

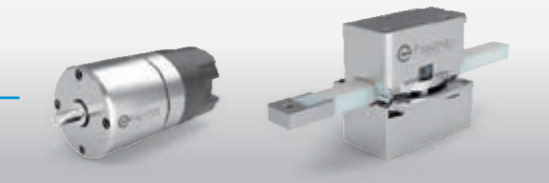
This second drive located within the cyclotron is responsible for positioning the ion source. To extract as many ions as possible with the help of an electrode, the relative position of source and electrode must be repeatedly adjusted. Thanks to the piezo motor, this is now possible during running operation, which also significantly shortens the maintenance time for calibrating the system.

"PiezoMotor offers a broad product range and modular design. We have found many options for both linear and rotating motors with different features from which we can select the appropriate models," Dr. Pärnaste explains. "Furthermore, PiezoMotor has a highly competent team of engineers and they contributed a lot during our product development process."

PIEZO MOTORS

Rotary Motors
Ø 23 mm, 50 mNm

Linear Motors
22 x 21 x 17.5 mm (L x H x D)



FURTHER INFORMATION

GE HEALTHCARE
www3.gehealthcare.se

PIEZOMOTOR
www.piezomotor.com

FAULHABER
www.faulhaber.com/m/cyclotron/en



HIGHTECH **IN** THE **STARRING** ROLE

The value of clothing sold worldwide in 2017 exceeded 1.4 trillion dollars. Can you imagine the amount of yarn contained in this mountain of clothing? Neither can we – but it must have been millions of miles. All of this yarn was wound and unwound multiple times during processing. This is just one process step in the textile industry in which the compact and long-lasting drives from FAULHABER prove themselves daily.



Machine tradition

The industrial revolution did not begin with the steam engine, as many believe. This was first used only to drain coal mines. It was not until the steam power was used for the mechanical weaving loom that the first mechanical production process was created, thereby marking the start of modern mass production. Textile machines thus benefit from a tradition that spans more than two hundred years.

During this time, they have developed into enormously complex and often extremely large machines that supply the fabric for the seemingly endless selection of clothing from which we today select our outfits online and in chain stores. The dimension of the machines forms a striking contrast to the delicate

material that they process: feather-light fibres that are first spun to yarn, sometimes as thin as a hair. This is used to weave textiles – from the Latin *textilis* = to weave – by the square mile. Countless rolls of yarn are consumed during the process.

Preliminary product on rolls

The rolls must, of course, first be wound. This is performed in a spinning mill, where the yarn is created from the raw fibres. There, this preliminary product is wound onto large reels.

But these are too large for the weaving machine, as many and often various reels of yarn are needed

The yarn is therefore usually rewound onto a smaller reel. Already during yarn production, individual fibres are often twisted together to form a twisted yarn to give it added volume and stability. The yarn is unwound and rewound during nearly every process step prior to its final processing. This also contributes to a higher quality of the intermediate results.

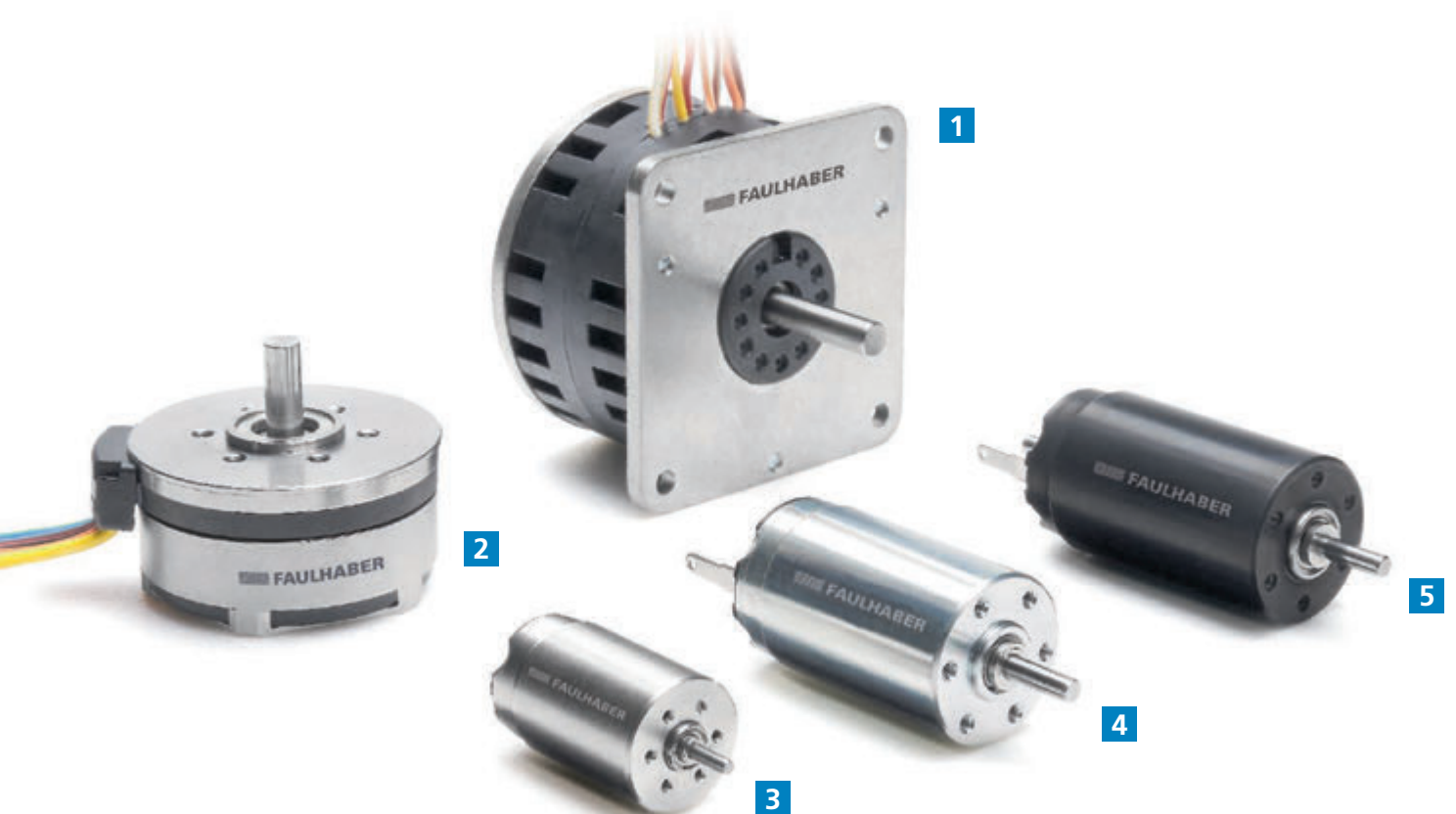
Anyone who has sewed on a button or repaired a seam is familiar with the regular squares that the thread forms on a spool. The reels of yarn in the textile industry are similar only larger, but other winding patterns are possible as well. The mostly diamond-shaped surface forms because the yarn is wound on the reel using a highly precise pattern, usually at an angle. It generally runs from one end to the other and back again. This ensures a uniform distribution of the thread and allows it to be unwound later without problem.

Rapid oscillation

Mechanical winding is performed extremely fast. During this process, the thread must be moved both constantly as well as very quickly between the two ends of the reel. There must be no delay when changing direction. This is a technical feat, as the guide eyelet moves back and forth about 400 times per minute, thereby processing some 1500 metres of yarn. There are also passive-mechanical guides, but the motorised yarn guide is far superior to this method. It is the standard in modern yarn winding machines.

The motor that is responsible for the rapid oscillation must above all be able to handle the quick change of direction without delay while maintaining the same speed and work trouble free for as long as possible. Disc magnet motors, such as the DM52, have proven to be an ideal solution for this task.

The rotor of this drive consists of a thin rare-earth magnet disc, which was magnetised with 25 pole pairs. This disc runs between two stators with the correspondingly arranged windings. Because it is extremely light, the rotor inertia is very close to the attainable minimum. This allows the motor to change direction in about five milliseconds at full speed, thereby making the lightning fast back-and-forth movement possible during yarn guiding.





Motorised little finger

Also used for yarn infeed is the so-called feeder, through which the thread runs into a knitting machine. It is not responsible for the uniform winding, however, but rather the constant tension of the yarn. In the mechanical knitting mill, the feeder performs the function of the left little finger when knitting by hand. It is attached a short distance in front of the knitting systems of the knitting machine. A small amount of yarn is wound on its roller, which serves as the buffer. Its mechanics respond to fluctuations in the yarn tension and compensate for them by various motorised movements.

Movements do not need to be performed here as fast as with the yarn winding. Important instead is the rapid reaction of the drive and the fine dosing of the motor power. The available space is, however, also very limited and, of course, the motors must not determine the maintenance cycles – like all machines, longevity has top priority here as well. Depending on the user, various motors from FAULHABER are used for this task, such as the DC motors with graphite commutation.

Knitting technology

Incidentally, modern knitting machines do more than knit just socks and sweaters, they are also used to produce technical fabrics. The new 3D knitting technology can even be used to create three-dimensional structures. It is used to produce, e.g., technical components from fine metal wires or ceramic fibres. Critical here is the proper thread tension, as it is a determining factor in the dimensions and quality of the products.

This manufacturing technology can also be used for rapid prototyping. It uses the material very sparingly with as much yarn as actually required. Different from most other prototyping methods, there are no cuttings or other material waste. How this fits with the overall topic is unclear.

There are numerous other applications in the various processes performed in the textile industry in which the high-quality micromotors are used. These

include, e.g., machines for sewing on buttons as well as material testing devices for examining the quality of yarns. FAULHABER's extensive range of products offers an optimum drive solution for all of these applications.

1 STEPPER MOTORS, TWO PHASES WITH DISC MAGNET

DM52100N series
 Ø 52 mm, length 32.6 mm
 Torque 200 mNm

2 FAULHABER BXT BRUSHLESS FLAT DC-SERVOMOTORS

4221 ... BXT R series
 Ø 42 mm, length 21.2 mm
 Torque 134 mNm

3 FAULHABER CXR DC-MICROMOTORS

1727 ... CXR series
 Ø 17 mm, length 27.2 mm
 Torque 4.9 mNm

4 FAULHABER CXR DC-MICROMOTORS

2237 ... CXR series
 Ø 22 mm, length 37 mm
 Torque 12 mNm

5 FAULHABER CR DC-MICROMOTORS

2342 ... CR series
 Ø 23 mm, length 42 mm
 Torque 19 mNm

FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/yarn-winding-machine/en

GPS FOR THE MILKY WAY

What is going on in the neighbourhood? We all want to know, whether we admit it or not. Applied to the whole of humanity and Earth, the question is: What is going on in the Milky Way? We know surprisingly little about this, because we literally have a hard time seeing the wood for the trees. But the MOONS project initiated by British astronomers aims to change this. Technology from FAULHABER will play an important role.



Galactic lack of knowledge

When it comes to exploring our own disc-shaped spiral galaxy, astronomers have a fundamental problem: While Earth is not right in the midst of it, it is still located on the disc of the Milky Way. So if they want to look at the centre from this vantage point, or even beyond it to the other side, the view is obstructed by countless stars. And from our terrestrial perspective it is very difficult or even impossible to determine where on our mutual disc they are located. One of the regions we know very little about – of all things – is the dense part in the centre of the galaxy, where countless stars and gas clouds cluster around a presumed black hole.

But a major astronomy project is about to close many knowledge gaps. Eight institutes from several countries are involved in this undertaking. The project was commissioned by the European Southern Observatory (ESO). This scientific organization is operating some of the world's most powerful telescopes in the Chilean Atacama Desert. This includes the Very Large Telescope (VLT) at the Paranal Observatory with a mirror diameter of 8.2 metres.

The goal of the project is to equip the VLT with a new instrument to capture the optical signals from space. The instrument in question is a spectrograph, which is capable of simultaneously capturing a large



number of cosmic objects in the visible and infrared part of the spectrum. Its abbreviated designation gives the project its name: Multi-Object Optical and Near-infrared Spectrograph, MOONS. It is coordinated by the United Kingdom Astronomy Technology Centre (UK ATC) in the Scottish capital of Edinburgh.

Spectrum instead of photo

"With a high-quality photo camera you can change the lens. But with an astronomy telescope it is the opposite – the VLT has an outstanding lens, and we will simply replace the currently connected 'camera'

with our MOONS," explains Dr William Taylor, scientist at the UK ATC. With its new technology, MOONS opens up entirely new possibilities in observing space, even though it does not produce large-sized images in the traditional sense. Instead, it captures minute details.

This is how it works: The huge lens and mirror of the VLT are pointed at the part of space that is to be observed, similar to before. Now, the ends of exactly 1001 optical fibres in MOONS are aligned to individual objects within this cosmic region. Instead of capturing the entire selected area like a camera, the new instrument focuses the fibres on certain points

in the Universe. And even these points are not just photographed, but instead their light is separated by prisms into the individual components, i.e. different wavelengths.

"Scientifically speaking, this method yields much more information than an image," explains Dr Taylor. "For example, we can learn about the chemical composition of the object. Furthermore, this allows us to calculate its dynamics, i.e. the velocity and direction of movement. Because MOONS captures the near-infrared spectrum, we can precisely analyse the redshift that the light from distant objects travelling to us is subjected to." When a star moves away from Earth, the wavelength of its light becomes longer. This is how part of the visible light shifts to the invisible infrared range, which is still close to the visible spectrum.

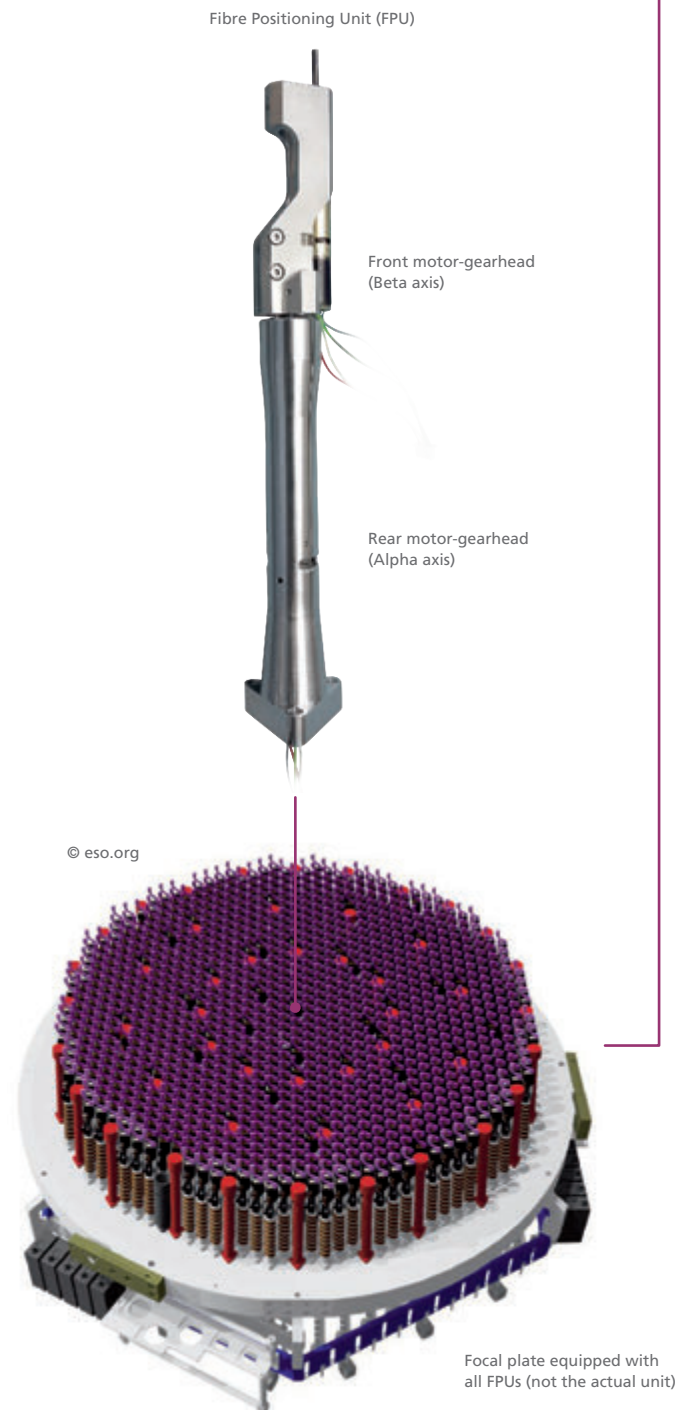
Thousands of objects in view

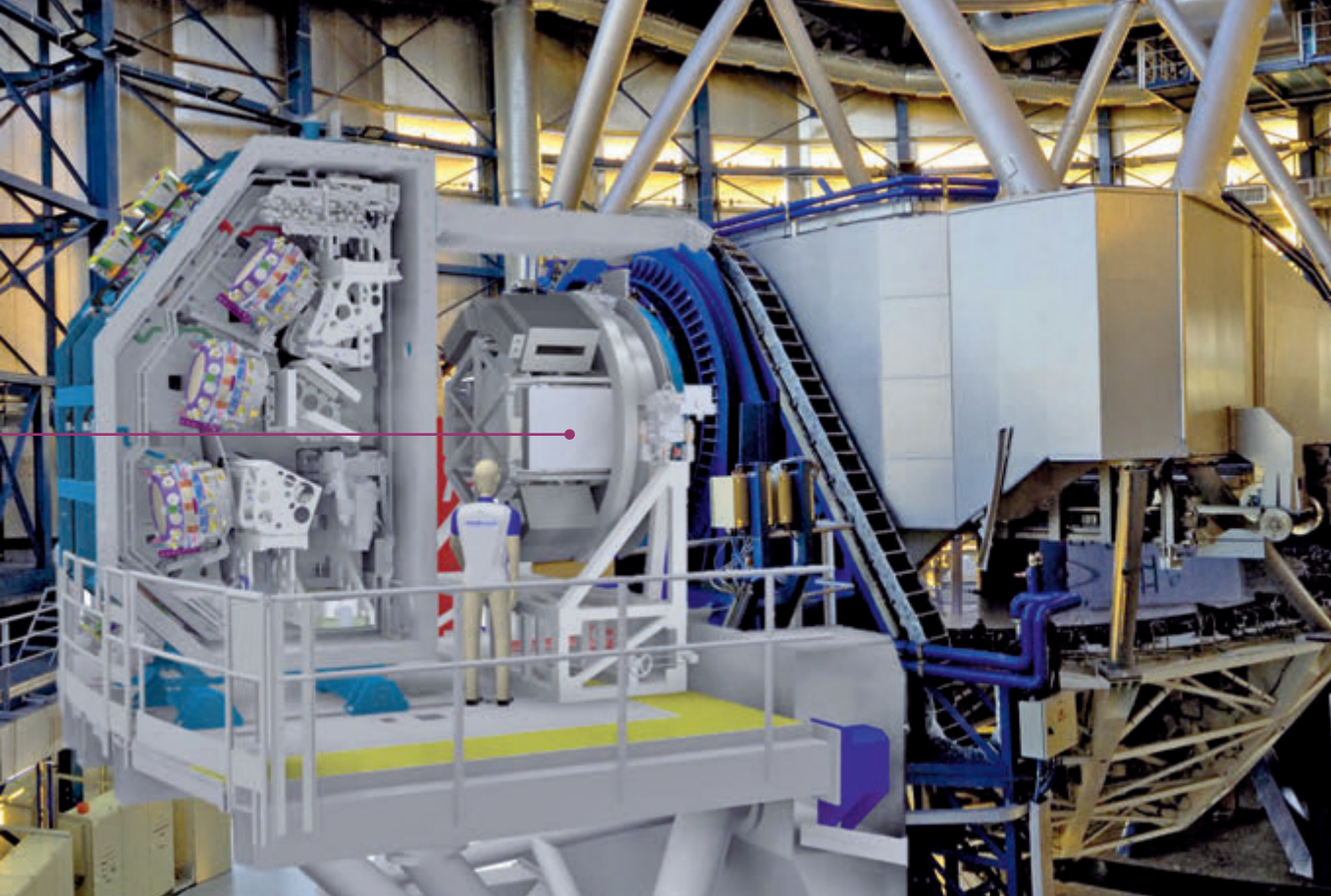
Prior technology allowed for a maximum of about one hundred objects to be observed individually, and only in the range of visible light. MOONS not only multiplies this number by ten, but the depth of information also increases manifold. Within the Milky Way, this will enable us to look much more precisely between the trees and get a much clearer picture of the entire proverbial forest.

"One of the objectives of the project is to create a 3D map of the Milky Way, which would allow some sort of GPS navigation throughout our galaxy. The MOONS technology with its unprecedented resolution also enables us to look very far, and thus also very far back in time. We will be able to approximate the Big Bang to within a few hundred million years." This will give scientists insights into the Universe's infancy. And while this is already possible today to some degree, MOONS will give us a much clearer and detailed picture, according to Dr Taylor. "We will be able to map the Universe to an unprecedented depth."

The astronomers aim to target several million objects over a period of about five years. To reach that aim, the 1001 optical fibres of the spectrograph have to be pointed at the cosmic targets quickly and mostly automatically. This is achieved with an equal number of fibre positioning units (FPUs). Each FPU has two stepper motor drive units fitted to reduced-backlash spur gearheads. The one in the back moves the central axis (Alpha) of the FPU. Eccentrically mounted on this, the front motor-gearhead drive unit (Beta) simultaneously moves the fibre tip. The combination of the two axial movements allows each FPU to cover a circular area, within which the fibre can be randomly aligned. This area partially overlaps the areas of adjacent FPUs. That means that every point within the capture zone can be controlled. To meet the challenging requirements in terms of positional repeatability, which is a must to avoid collisions

between FPU end tips, the drive system solution has to be extremely precise. To ensure the required precision and to avoid collisions between the FPU tips, the systems must operate with high repeatability. The high-quality stepper motors come from FAULHABER PRECISTEP; the zero backlash gearheads from FAULHABER Minimotor contribute to the positioning accuracy. FAULHABER subsidiary mps handles the mechanical design of the modules.





MOONS after installation in the VLT (not the actual unit)

© eso.org

Tailor-made aiming device

"We received very valuable input from all three participating companies of the FAULHABER Group," reports Dr Steve Watson, who is responsible for the FPU development at UK ATC. "Without their unique know-how, it would have been impossible for us to develop this core module in this form, and above all in the kind of numbers we needed. In addition to the alignment speed of the optical fibres, they must also be highly precise. We achieve an accuracy of 0.2 degrees and a reproducibility of the position down to 20 microns. Given the length of the FPU and the modular design, these are excellent numbers. And the units stay properly aligned to the focal plate on which the modules are arranged throughout all positions."

The high precision and extreme reliability of the components allows the control to be kept simple, which is another requirement to operate the spectrograph flawlessly. Complex electronics and control logics would severely impede the quick and simultaneous control of 1001 units. Thanks to the high quality of the components, precise alignment is achieved by means of simple open loop control. The technology must also be very sturdy and virtually maintenance-free in order to perform its tasks without interruption over the planned ten-year service life of the system.

Project manager Dr Alasdair Fairley is already looking beyond such technical concerns: "We are making good progress with the MOONS. We expect to be able

to install the spectrograph in summer 2021. Commissioning will take about half a year, so that we can probably start mapping at the beginning of 2022. We are confident that the FPU will remain fully operational for ten years without maintenance."

STEPPER MOTORS

Series AM0820
 Ø 8 mm, length 13,8 mm
 Torque 0.65 mNm



FURTHER INFORMATION

MOONS
<https://vl moons.org>

European Southern Observatory
www.eso.org/public/germany/teles-instr/elt

FAULHABER
www.faulhaber.com/m/spectrograph/en

E-Motion

ON THE

BIKE

It goes without saying that the bicycle is a part of locomotion culture in Germany. 97 percent of people in Germany can ride a bike. They use bicycles not only for bike tours in their free time but also on a daily basis for shopping or commuting to work. Due to rising petrol costs and the constantly congested roads at peak times, residents of large cities in particular see the bicycle as a true alternative to the automobile. FAULHABER drives are installed here in various components.



Bike sharing gains ground.

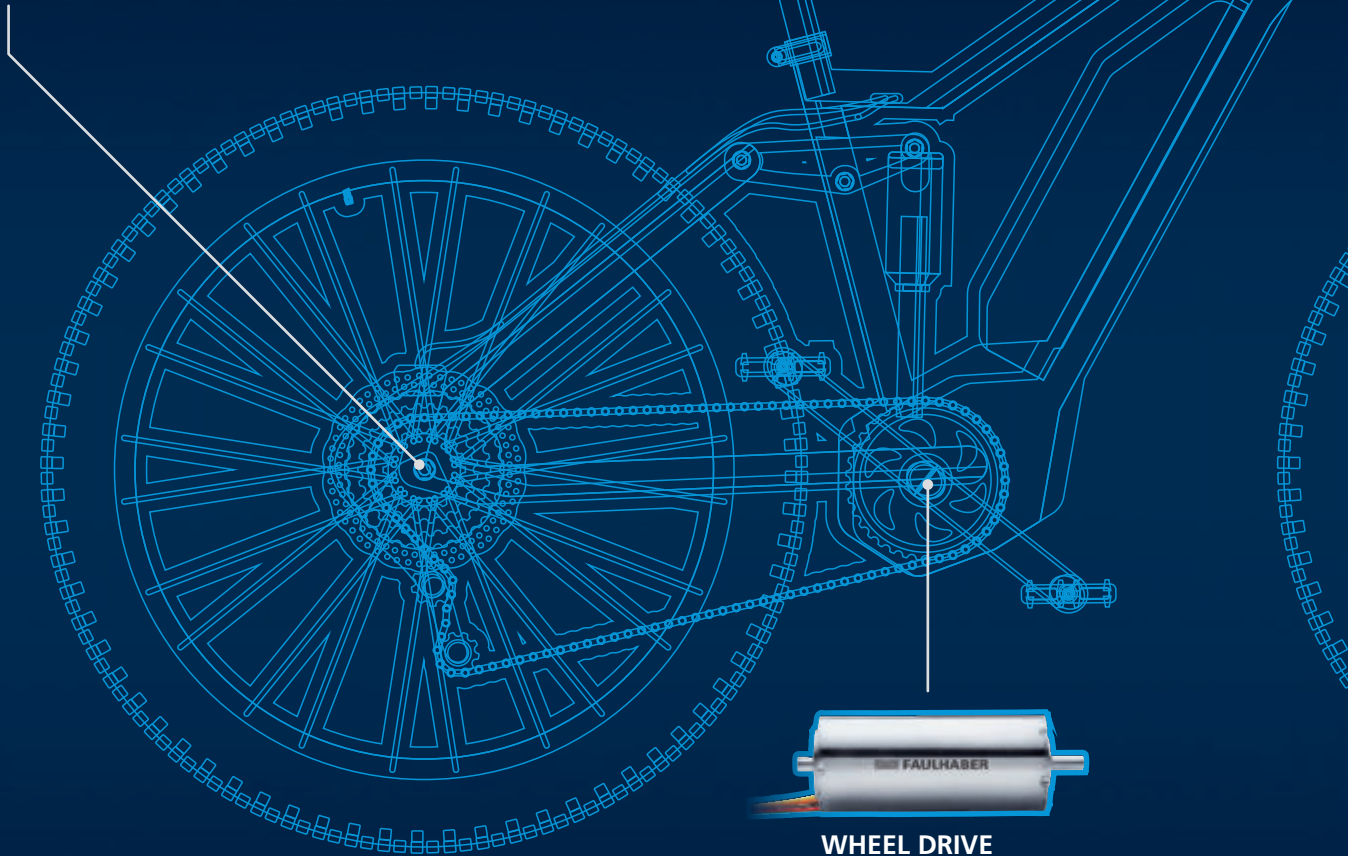
One doesn't need to have a bike of his or her own in order to use one. Especially in cities, a bicycle can today be hired quickly and easily. This saves the cost of purchasing and maintaining a bike and minimises the risk of theft. The rider also enjoys health benefits and helps to reduce CO₂ emissions. Sustainability is another advantage of bike sharing worth mentioning: the rate of use is approximately four times higher than an individually used bike.





ELECTRONIC POWER SHIFT DC-MICROMOTORS

1724 ... SR series
Ø 17 mm, length 24 mm
Torque 4.5 mNm



WHEEL DRIVE BRUSHLESS DC-SERVMOTORS

3274 ... BP4 series
Ø 32 mm, length 74 mm
Torque 162 mNm

Locking systems by FAULHABER.

To organise the use of hire bikes, bike sharing providers rely on drives from FAULHABER. For the locking systems of hire bikes, small FAULHABER gear motors are installed in the front fork. Depending on the usage system, the bike sharers can then hire a bicycle at fixed hire stations or even without a station using a smartphone app. There are now various bike hire companies that offer bicycles as well as pedelecs at their stations.

Riding with a tailwind.

A pedelec (pedal electric cycle) assists its riders with an electric motor. The degree of assistance can be set individually and is dependent on the pedal force or cadence of the rider. A bicycle with electric assist is legally equivalent to a regular bicycle. Riders therefore require neither a license plate nor a driving license. The pedelec market has grown significantly in Europe since 2008: in 2016, 1.6 million such bicycles were sold here. Germany leads the market in this sector.



LOCKING SYSTEM DC-MICROMOTORS

1624 ... S series
Ø 16 mm, length 23.8 mm
Torque 2 mNm

Bicycle drive systems from Schönaich.

Basically, a pedelec functions like so: a sensor registers that the rider is pedalling and passes this information on to the controller. As a control unit, the controller regulates the battery and ensures that it sends the required current to the motor. As soon as current flows, the pedal assistance of the pedelec engages.

Used as the bicycle drive system for pedelecs, FAULHABER motors ensure the optimum drive. Because the motors from Schönaich are very small in spite of their high performance, they can be installed so cleverly that the pedelec cannot even be recognised as such from the outside. The 3274 ... BP4 brushless DC-servomotor in combination with a plan-

etary gearhead is integrated in the frame and the corresponding battery "disguised" as a water bottle. This variant of an electrically assisted bicycle achieves a peak of 330 watts for a duration of approximately five minutes at a time.

Getting into gear.

DC-micromotors of the 1524/1724SR series also ensure the right drive when shifting gears on the bicycle – both with standard bicycles as well as with pedelecs. Electronic shifting systems guarantee efficient riding and increase comfort and safety. At the same time, they reduce wear on the shifting components. Gear shifting is performed with the help of the small servomotors.

Outlook.

The future of the bicycle remains exciting, as further electronic components will change cycling. What direction that could take is demonstrated, for example, by the SmartFaraday Pedal project, developed by a team of students in the Faculty of Engineering at the University of Freiburg. The intelligent bicycle pedal offers a number of functions that help cyclists track their journeys – from performance and route tracking to theft reporting and even an interface for Internet and smartphone. The students won the Cosima competition with this project in 2017. One of their main sponsors is the FAULHABER company.

FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/bike/en

SPONSORING



ELISABETH BRANDAU

FROM SCHÖNAICH FOR TOKIO 2020

Elisabeth Brandau is a standout in the world of cycling. And that's not just because of the orange team colours or the bright white jersey she will be wearing during the 2019 season as the incumbent German Champion. The cyclo-cross and mountain bike specialist from Schönaich has been doing things her way from the very beginning. Such as sleeping on the beach in a throw tent from the supermarket the night before the race. And then winning the race. 2020 will be a special year for the mother of two: she will be going to Tokyo to participate in the Olympics. FAULHABER will be right there with her.



Passion, motivation, technology – even cycling needs the right kind of drive. While hobbyists and leisure cyclists are increasingly enjoying electric bicycles – which require compact and powerful drives – they are completely off limits for professionals like Elisabeth Brandau. But the two-time German Cyclo-cross Champion also has to find the right balance between technology, fitness, talent and driving style for every

race. "Cycling is only about a third of it, the rest is planning as well as physical and mental fitness."

When she was a junior, Elisabeth Brandau was a successful road cyclist, German mountain race champion, and took part in the Junior World Championships in Canada. Eventually she put an end to this pursuit to have more time for her refrigeration plant engineer training and master craftsman certificate.

She only cycled for fun at that time. Her first mountain bike was bought in 2006, she became German Hobby Champion in the marathon category in 2007 and German Champion in the professional category and subsequently joined the national squad for the first time in 2008. In 2012 she became German Marathon and German Mountain Bike Sprint Champion.

In 2013 she founded her own team, the Radon Elisabeth Brandau Energie Racing Team (Radon-EBE-Racing), for which she still rides today despite offers from other teams. "If I'm not 100% committed mentally, then it's completely futile. So I'd rather do things my way." Such was the case in a race in Spain. "My budget was pretty tight, and I didn't want to strain it any more by staying at a hotel." She found a cheap throw tent at the supermarket, borrowed a blanket and slept on the beach of the camping grounds. High-maintenance is not her thing, she prefers to keep it down to earth. She won the race the next day. "I compete against Olympians and World Cup participants in these races. Many have no idea that I'm a mother of two, and they are quite surprised when they find out," Elisabeth Brandau grins.

Only very few active riders at the top level are also mothers. Training camps with the national team are almost like a vacation for her. "Good sleep for a couple of nights and regeneration, I love it." But when in doubt, Elisabeth Brandau would rather forego a training session if it means that she is separated from her family again after a competition. Now that the children are at daycare and in kindergarten, she makes a conscious effort to train in the morning. Then she picks up the children at noon, cooks, takes care of the household, organises the next few races, talks to her sponsors, holds lectures and much more.

Obviously, her Radon-EBE-Racing team has to take more direct responsibility as a result. The team consists of top athletes, junior athletes and amateurs and competes in national and international races such as World Cups, European and World Championships. In the end it was the team who convinced the mother of two to have her comeback after her maternity leave in 2017. "After my second son was born, I was completely out of touch with cycling. I probably would have quit cycling if it wouldn't have been for the team meetings. They got me back in the saddle and got me excited about the sport again. I told myself: you gave birth to two children, you can do this too. And I owed it to my team."

The year of her comeback, 2018, became the most successful year of her career with two German championship titles, the silver medal at the World Championships with the relay and the qualification for Olympia 2020 in Tokyo. At one point, she made it all the way to 8th place in the world ranking from 275th. On the side she was also completing her training as a naturopath.

Elisabeth Brandau also does it her way when she is racing. At the World Cup in Albstadt 2018 she was the only one to consistently ride the B-line. "It was very slippery and everyone but one rider slipped. I wanted to avoid that, I'd rather lose 4 seconds and stay on a safe line. I have two kids who also want to be picked up and held the day after the race." In Albstadt she made it onto the podium of a World Cup race for the first time. She aims to repeat this accomplishment in 2020. In addition to being successful at the Olympics. Starting in 2019, Elisabeth Brandau and her entire team will be sponsored by FAULHABER.



Elisabeth Brandau

born 1985, married, mother of two

German Champion

- 2001 Road Cup (junior class)
- 2002, 2003 Road/mountain (juniors)
- 2007 Mountain bike marathon (amateurs)
- 2008, 2011, 2012 Mountain bike marathon (elite)
- 2012 Mountain bike sprint
- 2016, 2018, 2019 Cyclo-cross
- 2018 Cross Country Olympic Mountain bike

Runner-up world champion

- 2018 Cross Country Olympic Mountain bike (relay)

FURTHER INFORMATION

FAULHABER
www.faulhaber.com/m/eberacingteam/en

Evolution IN MEDICINE



Maximum precision and speed as well as untiring stamina: there are good reasons why medical robotics is already used today in minimally invasive surgery, in orthopaedic operations or in trauma surgery. It also has great potential for other specialised areas of use. Experts see the use of medical robotics as the next evolution in the treatment of patients. In the next issue of motion, read how medical robotics applications can benefit from FAULHABER drive solutions.

Further information:



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