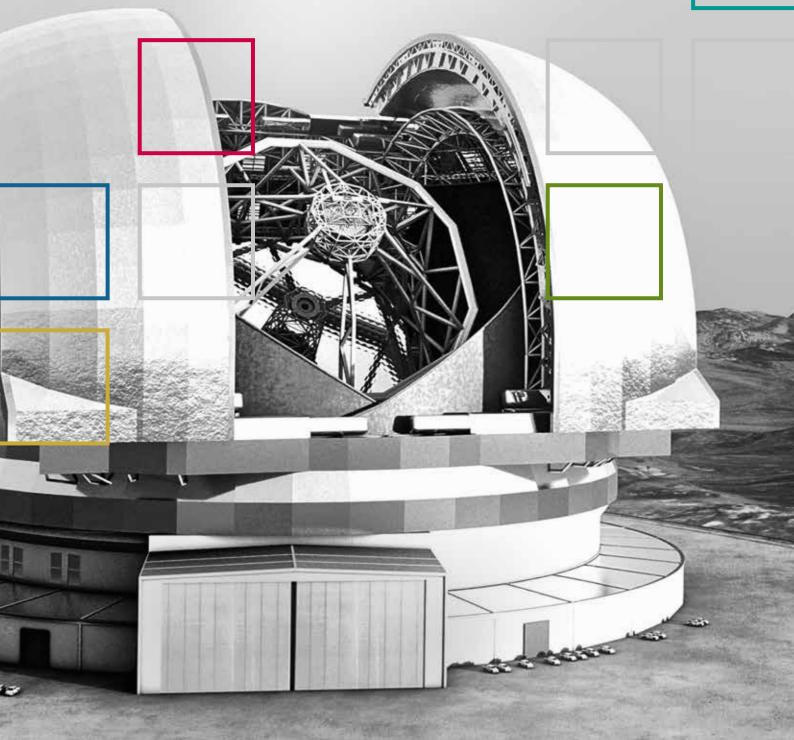


OPTICAL ENGINEERING



FROM NICHE KNOWLEDGE TO KEY TECHNOLOGY

When traditional skilled trade and German engineering expertise join forces to create a vision for the future, something special is born: a key technology with enormous innovative strength that influences almost

all industry sectors. We are talking about 'Optical Engineering' from Central Hessen. This region attracts worldwide attention for its unique industry profile, including optics, electronics and mechanics. This is where global brands like Leica Camera AG, Leica Microsystems, Zeiss, Bosch, and Pfeiffer Vacuum are headquartered, and where new products and ground-breaking partnerships are formed.

ENORMOUS POTENTIAL FOR GROWTH

Optical engineering has become indispensable in the modern industrial world. It has an enormous leverage

effect on other industry sectors. Optical technologies pave the way for ground-breaking developments – whether in the area of autonomous driving, sensor technology, mobile communication, or materials and production technology. New products and processes are created, which change the value chains of entire sectors. Experts say that this sector could grow by 25 percent over the next five years. This development is unexpected.

CENTRAL HESSEN IN FIGURESImage: State of the state

Not long ago, optical technology was still an industrial niche sector. Interdisciplinary links have substantially contributed to the rise of optical technology to one of Germany's most successful sectors. Annual turnover across Germany is 50 billion Euros, according to industry association Spektaris. The heart of the Central Hessian optics sector consists of 93 companies with at least 50 employees each. The annual

turnover of companies in Central Hessen is 4.2 billion Euros. There are approximately 22.275 employees in this sector. What's more, over 250 companies in the electronics and mechanics sector based in Central Hessen are closely associated with the optics industry and form a joint cluster. The export ratio of commercial enterprises in Central Hessen is at 42 percent, and hereby impressively exceeds Germany's overall export ratio of 32 percent.

IDEAL CONDITIONS FOR INVESTORS

Central Hessen has created ideal conditions for local players and foreign investors alike.

The unique collaboration of businesses from the optics, electronics, and mechanics sectors, is the key to success. The interdisciplinary teams from Central Hessen prove themselves as drivers of innovation and create integrat-





ed, trans-technological solutions, which establish themselves on the market. Central Hessen can draw from an abundance of resources here: sound entrepreneurship meets know-how developed over centuries, and a unique academic basis. This is where businesses find new talent. The region has the highest density of students in Germany. All three universities - Philipps University in Marburg, Justus Liebig University in Giessen and the Technical University of Central Hessen (THM) - have chairs for physics and chemistry. Essential players from industry and science have teamed up to create an optics centre for the region. This allows for research and development activities of the companies to be further concentrated and expanded. For this purpose, the optics centre will be equipped with cutting-edge technology, and is expected to explore new fields of research. This also includes the development of a unique degree program in 'Optical Technology' in Germany. The aim is to further promote the knowledge transfer between business and science - a think tank that will sustainably secure the significance of the location as an excellence cluster for optical technologies. An approach that experts agree on. Precision, effectiveness, and the necessary degree of flexibility reflect the aspirations of the region and pave the way for foreign investors.

OPTICAL TECHNOLOGIES – A DEFINITION

Optical technologies define the essence of physical, chemical, and biological natural laws, and of technologies for the generation, shaping, transfer, measurement, and utilisation of light.





DR ANDREAS KAUFMANN: MISSION RED DOT

Life still writes the best stories. This is also true in business, and in Central Hessen. The protagonists of our story are the global brand Leica and a teacher, anthroposophist, and amateur photographer, who was then unknown in the business world. In 2003, Dr Andreas Kaufmann bought his first, second-hand Leica camera in a gallery in Vienna. The Mannheim native was fascinated by the legend of the brand, a passion shared by many Leica fans around the world. It was clear to him that there was much more to the company than the ailing figures suggested. The luxury brand had missed the boat of digital photography and was almost bankrupt at the time. In 2004, Kaufmann bought his first shares of Leica Camera (27.2 percent) and in 2007 he became the sole owner. He turned the company around, put millions into research and development, and focused on its target groups. Kaufmann is considered an enthusiast and visionary who also takes unusual paths. As a young man, he travelled around with famous artist Joseph Beuys and was one of the founders of the German Greens. As a staunch market economist, he left the party after a short time. "Capital represents an obligation to create something lasting", says Kauf-mann, who now lives in Salzburg with his family. He was able to prove this credo in a convincing manner with Leica Camera: today, the brand is once again a symbol of European industrial know-how, a flagship brand. The brand with the red dot has long since managed the turnaround and is making a profit. Kaufmann re-invests this capital, on the company's path to becoming a global brand. The future is where the action is. This is also why Kaufmann moved the Leica headquarters back to Wetzlar in Central Hessen.



E CENTRE Central Hessen - the centre of the centre. This region is located in the heart of Europe, in the centre of Germany and the state of Hessen. Short distances are standard here, which

Satisfaction of companies in their location

Germany not including the Central Hessen region

2.3

2.1 The region of **Central Hessen**

VERY SATISFIED

LONDON 01:25

01:20

MADRID 02:50

Investors are very satisfied with their location in Central Hessen and give it top marks, above the German average.

offers unique opportuni-

ties for a sustainable market entry in Europe.

Source: WIK [2014] Corporate questionnaire in Germany (n=119)

Location decisions of internationally operating companies depend on important economic factors today: central location, existing infrastructure, and access to the European Single Market are priorities for decision-makers. The German state of Hessen and the region of Central Hessen can shine in these regards, and convince with 'hard facts'. 163 international companies invested in Hessen in 2016 alone. The number of annual investments has more than doubled since 2012. This is also an indication of the successful economic policy of the state and of the measures implemented for economic development.

VERY DISSATISFIED

The region of Central Hessen will play an important role in future direct investments. It is one of the leading locations in Germany for optical engineering and has a high innovative capacity. The Wetzlar Network is a significant leader in this field. This top-level cluster is based on intelligent economic policy, a development based on specialised networks that integrate business and science, and economic development that has been optimally adapted to market needs. "The positive development regarding the relocation of international companies to Hessen in recent years is the result of both the excellent location conditions, and the unique

cooperation with the regional management of Central Hessen, political decision-makers, and the economic players on site", summarises Dr Rainer Waldschmidt, Chief Executive Officer of the economic development organisation Hessen Trade & Invest (HTAI).

TARGET-ORIENTED COOPERATION

Central Hessen offers the freedom businesses require, and hereby creates room for visions. Unique networks like the Wetzlar Network generate a sense of belonging across company borders, which adds a shared value. "All relevant stakeholders work together in Central Hessen, and create a close dialogue between business, science, politics and administration", says Jens Ihle, managing director of the regional management of Central Hessen. According to Ihle, the target-oriented collaborative atmosphere is also the foundation of the well-established culture of welcoming newcomers, a benefit for all involved. Which is why companies that are already settled here give the location top marks. Location satisfaction is high, with German average values exceeded (see illustration).

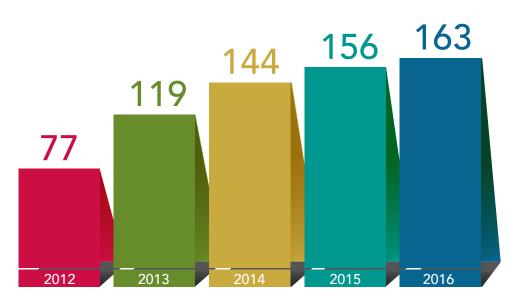








More and more international companies are coming to Hessen



"A unique and very successful collaboration!" Innovation and Business promoter Dr. Rainer Waldschmidt (CEO HTAI, right) with his Managing Director colleague Jens Ihle (Regionalmanagement Mittelhessen)

Hessen has a global pull. The number of foreign direct investments has more than doubled since 2012. For the first time, the majority of investors came from China in 2016 (44, ahead of the USA with 34 and the United Kingdom with 20).

Source: Hessen Trade & Invest GmbH

Central Hessen's regional management has been working on the further pooling of resources, supporting cooperation and the development of potential since 2003. Having started out as an association, a total of 19 partners founded 'Regionalmanagement Mittelhessen GmbH' in 2013. The participants are the administrative districts of Giessen, Lahn-Dill, Limburg-Weilburg, Marburg-Biedenkopf and Vogelsbergkreis, the cities of Giessen, Marburg, Wetzlar and Limburg, the four local Chambers of Industry and Commerce, the two Chambers of Trade in the region, the three universities in Central Hessen, and the Association of Central Hessen. The regional management supports all interested parties in relocation projects. It cares for and establishes contacts to important players, and helps investors with all relevant questions right up to the search for a location. The regional management also supports and coordinates further activities from business development parties in Hessen and coordinates all measures with HTAI.

CENTRAL HESSEN – EASY ACCESS TO THE EUROPEAN MARKET



Frankfurt Airport, one of the largest airports in Europe and an international hub, can be reached within one hour



With a well-developed railway network, it takes 25 minutes from the ICE train station Limburg Süd to Frankfurt



Excellent connection to the European highway network

Well-developed industrial parks and development of new commercial areas

FOCUSING ON INTERNATIONAL GROWTH

Central Hessen has long enjoyed an excellent reputation as a technology location. The top cluster Optical Engineering, which started as a regional network, is now attracting investors from around the world. No wonder, considering that Central Hessen leads the way to advance the sector profile, and is consistently expanding on the strengths of the region. A highly regarded networking trade fair, a unique welcoming culture, international cooperation, and strengthening support for scientific facilities are all characteristics of a lively and prospering location that inspires its residents and visitors with its high quality of life.

Success has many fathers, as English national economist Richard Cobden already knew in the 19th Century. Central Hessen has re-interpreted this observation and turned it into a positive motto. This is not about vanity but real cooperation. Central Hessen has long campaigned for business collaboration, regardless of company size and across disciplines. The goal is to utilise competence and innovative potential even better. One of the catalysts for this process is the industry network 'Wetzlar Network', which is supported by the business development unit of the state of Hessen, the regional

management of Central Hessen, the City of Wetzlar, local facilities and businesses, and the regional universities. As facilitators, communicators, and multipliers, responsible parties ensure that the unique sector profile of the optics, electronics and mechanical industry continues to gain international visibility and recognition.

HIDDEN CHAMPIONS AT THE W3+FAIR

With its network trade fair 'W3+ FAIR' for optics, electronics and mechanics, Central Hessen has a well-established forum for cutting-edge technology, now in its fourth year. With outstanding results: both numbers and international character of exhibitors and visitors have increased steadily since the first event. More than 3,000 guests came in 2017. 186 companies, partners, and sponsors exhibited at the Rittal Arena in Wetzlar. These included 56 new exhibitors - an increase of 18 percent from the year before. Major players and numerous 'hidden champions' make use of the trade fair as a forum for information, innovation, and contacts across disciplines. 34 percent of exhibitors came from the optics sector, 20 percent from electronics, 28 percent from mechanics, and 24 percent offered

other products from these sectors. Initially, most of the companies at W3+ FAIR came from the region, this has now changed: Almost one third of exhibitors are headquartered abroad. Overall, companies and organisations from ten different countries were represented at the trade fair. Wetzlar Network provided the name and ideas for W3+ FAIR, and is its nucleus and developer. Additional competence networks and industry partners, such as Brainport Industries, Optence, Spectaris, SPIE, and the VDI (Association of German Engineers) actively promote the trade fair and hereby expert exchange and networking.

APPLICATION OF THE LATEST LASER TECHNOLOGY

The Wetzlar Network is part of the funding programme for the "internationalisation of top clusters" of the German Federal Ministry for Education and Research (BMBF). The programme aims to assist regional medium-sized companies to build successful international research and development collaborations. lt promotes cooperation with the Czech laser research centre ELI (Extreme Light Infrastructure) in Prague. The focus here is on the development of the latest laser technology for scientific and in-





The specialist trade fair W3+ FAIR is growing every year and has become an internationally recognised meeting point for the sector. Visitors appreciate the easy networking opportunities and the new business potential with key contacts from the German and international optics cluster.

dustrial applications. Network manager Ralf Niggemann is convinced: "Both centres will benefit from this intensive cooperation. Central Hessen gains access to high-tech laser physics unavailable in Germany. Prague, on the other hand, can benefit from the short distances to industry businesses in our region, and tap into new areas of application, such as bio- and medical technology." The project has already started in January, with an 18-month concept phase. It will be followed by three R&D projects, which will be implemented within three years.

OPTICS INDUSTRY IN FIGURES

Annual turnover in Germany: 50 billion Euros

Annual turnover in Central Hessen: 4.2 billion Euros



Workforce: 22,275 employees



The core of the optics industry in Central Hessen: 93 companies (> 50 employees), including major players like Leica Microsystems, Carl Zeiss, Pfeiffer Vacuum, Opto Tech, Satisloh, and Schneider Optikmaschinen, and numerous 'hidden champions'

253 companies from the electronics and mechanics sectors form a joint cluster with the optics industry



Export ratio: 42 percent (Central Hessen); 32 percent (Germany)





RALF A. NIGGEMANN: MR NETWORK

Ideas and visions need people who realise them. It takes facilitators, communicators and multipliers. In Ralf A. Niggemann, Central Hessen has found a network manager who combines all these traits. Niggemann knows his way around the industry and is an optics professional par excellence: for 20 years, Niggemann was the Corporate Identity Manager for the Leica Microsystems brand.

The role introduced him to challenges on an international level. Photography is more than a passion for him: Niggemann, who graduated in Communications in Munich, with a major in photography, has been connected to the arts scene from the beginning. Together with Reinhart Wolf, Duane Michals, Mary Ellen Mark, and Eimu Arino, he was one of the founders of the '1st Munich Photo Symposium' in the venue 'Lenbachhaus'. He still organises exhibitions for contemporary photographers in the Viseum in Wetzlar today. His current home town commissioned Niggemann as a communication consultant, to strengthen the position of the optics, electronics, and precision mechanics industry in Central Hessen.

The tasks of the network manager cover the creation of networks and the initiation of business opportunities between the companies, as well as location marketing and recruiting. 'His' Wetzlar Network is now one of the most active and successful industry networks in the state. Ralf Niggemann is the first chairman of the business association Optikparcours and head of Viseum Wetzlar, the 'House of Optics and Precision Mechanics' – a science museum with more than 80 exhibits.



More than 90 percent of the future data traffic will consist of images and videos. This is a message that is welcomed in Central Hessen, as the region is well ahead in terms of quality optical engineering. The world is watching Wetzlar and trusts in German expertise, in the innovative strength of Central Hessian companies, and in reliable partnerships between equals. The high-profile collaboration between Huawei and Leica Camera, which began in February 2016 and is currently expanded, is such an example. Both partners are reinforcing their strategic cooperation with the establishment of a joint research and innovation centre, the Max Berek Innovation Lab. A role model for the industry.

JOINT RESEARCH CENTRE

In race terms, the speed of Huawei's and Leica's technology partnership would have to be a lightning start. This is, however, neither a race, nor a short-distance sprint. This is a technology partnership designed for the long-haul, with benefits for both sides. This already becomes apparent with their first joint products: the Huawei smartphones P9 (only 5 months after the start) and P10. With high praise from experts and subject to various awards, these mobile phones were able to assert themselves on the market: ten million P9 units alone have already been sold, a great success. Huawei talks of a 'new era of smartphone photography' and is now ideally positioned as a premium brand in the fiercely contested mobile phone sector. Leica, on the other hand, has again been able to prove its leading expertise – within a completely new and so far untapped segment. Now they are taking the next step, seven months after the partnership was announced in the optical engineering sector. The joint research centre, based at Leica headquarters in Wetzlar, will be dedicated to the further development of optical systems and software-based technologies for the improvement of image quality in the range of applications relevant to photography and mobile devices. The focus is also on the development of future technologies in the areas of computational imaging, augmented reality, and virtual reality. Development teams from both companies will cooperate with German and international universities in this regard. The vision





and implementation of this future project is based on the personal initiative of Dr Andreas Kaufmann, majority shareholder and Chairman of the Leica Camera AG Supervisory Board, and Ren Zhengfei, the founder of Huawei. It is evident that real partnership is based on mutual trust.

"What Huawei and Leica have in common, is their great innovative strength, their many years of research expertise, and particularly their commitment to the highest quality standards. The Max Berek Innovation Lab offers us the historical opportunity to advance future-oriented technology with joint forces and the pooled know-how of both companies", says Markus Limberger, Chief Operating Officer (COO) and managing director of Max Berek Innovation Lab. The name of the joint research and innovation centre comes from Max Berek (1886– 1949), German pioneer of microscopy and creator of the first Leica lenses, who calculated more than 20 lenses for the legendary 35 mm camera, conceived and constructed by Oskar Barnack.





Leitz-Park offers exciting insights into the world of Leica. Complementing production and assembly at the new company headquarters, an exhibition showcases historic cameras and lenses.





Dr Andreas Kaufmann: "Huawei and Leica Camera AG are extending their successful strategic partnership with the establishment of the Max Berek Innovation Lab, and are laying the foundation for joint research into and development of ground-breaking future technology in the imaging sector."



Huawei founder Ren Zhengfei: "With the Max Berek Innovation Lab we are able to further expand on our partnership with Leica, and to achieve continuous improvements in the image and video quality of our products. As a result, we will deliver the most progressive innovations in the sector of smartphone cameras, and will achieve even more added value for our customers."

9 0

THE WETZLAR LEITZ-PARK

The Wetzlar Leitz-Park was created as a unique area where production and science, culture and life come together. In 2014, the global Leica brand returned to its original home in Wetzlar. The park is currently expanding in its third development stage. A high-tech centre, open to guests from all around the world, is under construction. The Leica 'world of experience' will have its own building at Leitz-Park III. The future arcona Living Ernst Leitz Hotel will offer 129 rooms and suites as well as a restaurant with a spacious banquet area. This will be complemented by a corporate building for CW Sonderoptic GmbH. The future is everywhere you look.

HESSEN: 100 PERCENT MARKET SHARE MARKET SHARE ON PLANET MARS

Central Hessen stands for a unique dual training system, for bright minds, ambitious pioneers, and entrepreneurs. The Hessen Champions create exciting, globally renowned products. Precision, functionality, efficiency – knowledge creates value. In Central Hessen this is an aspiration with tradition: pioneers, researchers, and entrepreneurs have been working hand in hand here for centuries. Leitz (since 1849) and Hensoldt (since 1861) laid the groundwork for their global rise to the forefront of the global industry in Central Hessen. Innovation is still the driving force in the region today, a unique success story. Products from Central Hessen serve Nobel Prize winners, explore other planets, or attract attention in Hollywood. The know-how comes from many 'hidden champions', and investors benefit from it.

LAHNAU – RENDEZVOUS WITH THE RED PLANET.

Sensitec GmbH in Lahnau has catapulted itself ahead of the rest of the world with sensor solutions for industrial and automotive serial applications. The company from Central Hessen is also active on Mars: Sensitec technology is on board the Mars

rovers 'Spirit', 'Opportunity' and 'Curiosity'. The sensors register the angles and positions of all moving parts and deliver the signals to the control unit. They are also extremely robust. They easily withstand temperature variations of more than 160 degrees Celsius. Mars rover 'Opportunity' alone covered more than 41.7 kilometres in twelve years. That

hicle has ever travelled on another planet. Dr Rolf Slatter, CEO of Sensitec GmbH, tells us: "These advantages are not only of interest for space applications but also on Earth". On Mars, however, Sensitec has no competitors – market share: 100 percent!

is more than any other robotic ve-



GLASSES? FRONHAUSEN!

They have set the bar high. Schneider GmbH & Co. KG based in Fronhausen, Germany, has established itself on the global market as a leading manufacturer in the eyeglasses and precision optics industry. Whether freeform lenses, grinding and polishing of pre-



HTAI CEO Dr. Rainer Waldschmidt with Roland and Thomas Mandler

cision aspherical lenses, or measuring technology are concerned - the Hessen Champion has trailblazing standards in sight. Around the globe, the owner-managed company produces customer-oriented solutions for which it has been honoured as a "Top Innovator" by renowned science journalist Ranga Yogeshwar at the German SME Summit. OptoTech Optikmaschi- onen GmbH from Wettenberg was the cream of the crop in this year's Innovation category. The company offers machinery and equipment in the field of precision and spectacle optics. Recognised expertise, which has also prevailed on the global market.

ELI & CENTRAL HESSEN – A SPOT-LIGHT ON NEW TECHNOLOGIES.

In Central Hessen, tradition and experience are supplemented with innovation and the courage to pursue new ideas. Internationally shared ideas. Particularly in basic research. Companies from Central Hessen also make a significant contribution in the field of laser optics. The largest laser for civilian use is currently under construction in Prague. The Wetzlar Network is involved and is actively cooperating on the ELI Project.

WORTHY OF A NOBEL PRIZE – MARBURG AND GÖTTINGEN

Sha State

Emil von Behring received the first Nobel Prize for medicine in 1901 for the development of a new vaccine. He used optics technology from Wetzlar for it. The Marburg university professor hereby laid the foundation for a pharmaceuticals location, where global players such as CSL Behring and GlaxoSmithKline operate today. Another professor from the region, Stefan Hell from the Max Planck Institute in Göttingen, was awarded the Nobel Prize for chemistry in 2014. He also placed his trust in optics from the region – a confocal microscope from Leica Microsystems.

ACTIONI WETZLAR IN HOLLYWOOD

The developers of CW Sonderoptic GmbH have been honoured with the highest award in the film industry for technical products and innovations, the Scientific and Engineering Award of the Academy of Motion Picture Arts and Sciences – for their Leica Summilux-C (Cine) lenses. With the development of these lenses, a long-held dream of many cameramen and cinematographers came true in 2010: to translate Leica's unique image quality from still photography to film. Hollywood stars such as Michael Bay, Wim Wenders and Michael Ballhaus have been using this 'look'. And Oscar-win-

ning actors and actresses such as Meryl Streep, Ben Affleck and Tommy Lee Jones have already been filmed using these lenses.





LISA MAYER: GLOBAL ZOOM ON WETZLAR

Strength and the will to win – the essence of sports, in all its aesthetics and expressiveness. In one image. Sport becomes art in Wetzlar, the art of the moment.

Lisa Mayer is portrayed here, a firmly established name in the world of German athletics. The young runner gave a stunning performance at the Olympics in Rio and won gold at the World Relays on the Bahamas in 2017.

The entire region supports her and many companies sponsor her. Lisa has stayed loyal to her home in Hessen – she is a member of the Wetzlar sprint team and a student of German Studies and Geography in Frankfurt am Main. She followed sports photographer Oliver Vogler to the LEICA academy for the shoot. Vogler, who started his career in local sports journalism at Giessener Allgemeine Zeitung, has established himself as a well-known international sports photographer and covers both the Champions League and the German National Football Team.

In 2009, Vogler joined Leica Camera AG. His career path at Leica went from the customer care department's information service, to product management for the medium format camera Leica S in 2013, to Leica Academy, where he has since worked as a consultant. Lisa Mayer and Oliver Vogler are two Central Hessian perfectionists with a vision.

COVER IMAGE:

The world's largest optical telescope is currently being built in the Atacama Desert in Chile – with technology from Central Hessen. The heart of the system will be the enormous and highly complex adaptive M4 mirror. An optical machine from OptoTech in Wettenberg was specifically constructed for this project and is the foundation for the production of 1,000 individual adaptive parts, which together form the 'retina' of the main mirror. It can grind, polish, and measure components of up to two metres in size. This makes it the largest optical machine of its type in the world.



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IMAGE CREDITS: Title image ESO/L. Calçada for ESOshop: Mounted image 191: Artist's impression of the ELT, P. 2 and reverse Optical Engineering W3+ Wetzlar Network Edition 01, P. 3 Michael Agel/Leica Camera AG for Wetzlar Network, P. 4 capitanoseye -, Buntoon Rodseng -, P. 10 and 11 NASA images – shutterstock, P. 5 Tilman Lochmüller for Regionalmanagement Mittelhessen GmbH, P. 6 and 7 top Thomas X. Stoll/TXS.PICTURES for w3+ FAIR, P. 7 top right Yvonne Schudy/NIGGEMANN KOMMUNIKATION for NIGGEMANN KOMMUNIKATION, P. 8 bottom Michael Kisselbach/kiframes for Leitz-Park GmbH, P. 8 and 9 Photographie Dr Carsten Ott, The new corporate building of Leica Camera AG at Leitz Park Wetzlar, P. 9 top © Jörg Theimer for LEICA Camera AG Museum, P. 9 bottom ©Leica Camera AG, P. 10 bottom Jon Fauer for Oscars, P. 10 bottom left Rose Bahmani/RCC for Hessen Trade & Invest GmbH, P. 10 centre Sabrina Feige, P. 11 top Oliver Vogler for Leica Camera AG.





