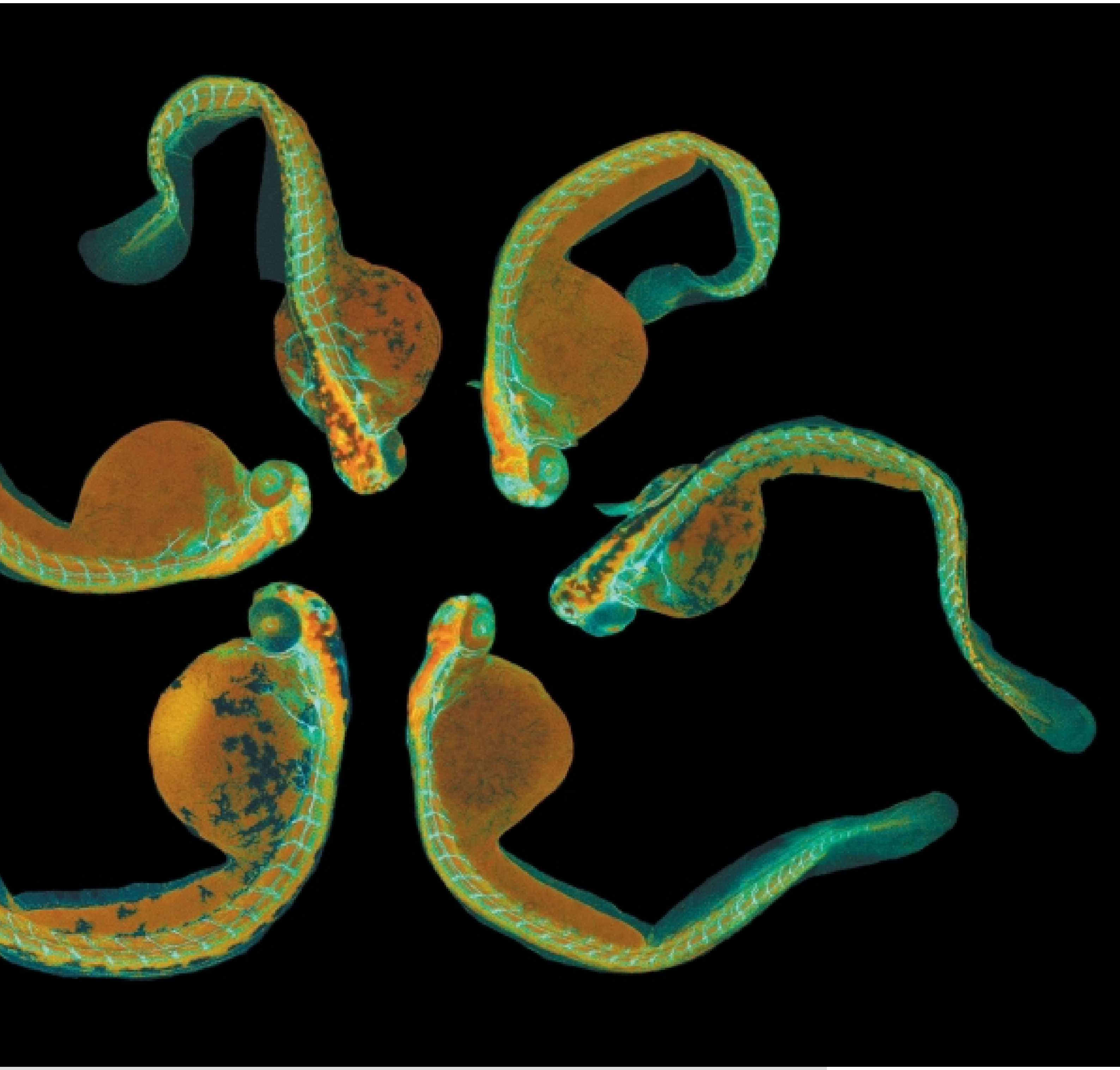
The Magazine from Carl Zeiss

Innovation

ISSN 1431-8040

14



- The Key Technology in the Life Sciences: FluoresScience
- Modern Surgical Microscopes and Methods
- Eye Care in Focus

Optics in All Areas of Modern Life

At the beginning of the third millennium, now the beginning of the 21st century, there are very few walks of life not affected by technology that uses light as information and for communication. It is not without reason that this is becoming the century of the photon. We run into optics at every turn – whether we realize it or not. Even processes that generally would not be associated with optics often become possible by using them: without optical systems, the chip industry would not be possible. Many articles in this issue provide perfect examples of this interaction.

Fluorescence techniques track down molecular interactions

Scientists have always been looking for the answer to questions on the structure and functionality of organs and tissues, on single cells and cell components. There are many ways of reaching this goal. Fluorescence-enhanced microscope images make structures and functions visible. Fluorescence microscopy has long been used to examine more than just bacteria and viruses. It is one of the most important tools available for research in the natural sciences today and for the future. Fluorescence techniques are the foundation of many modern methods in life sciences. State-of-the-art microscope systems recognize the faintest fluorescence signals, separate overlapping fluorescence spectrums and document dynamic processes with maximum speed and precision. Carl Zeiss – a trendsetter in the development of fluorescence microscopy from the beginning – delivers the world's leading fluorescence technology. We have given a name to our focus on the key methods: FluoresScience from Carl Zeiss.

Optics in medicine

Carl Zeiss surgical microscopes have contributed to the success of surgical procedures around the world for more than 50 years. The demands placed on surgical microscopes by surgeons have evolved over time – from a traditional magnifying device to an information and communication center. Testimonials from a large number of users convey an extremely positive reaction to surgical microscope designs from Carl Zeiss.

Optics as a platform for virtual reality

Modern life and efficient work processes necessitate ever faster and more comprehensive information. Data glasses, among others, make this possible. They augment the real environment with virtual objects and displays. Auto mechanics of the future will see both the repair instructions and the real engine.

Modern optical techniques for works of art

Optical inspection methods, microscopy for example, enable detailed examinations of works of art before scheduled restoration. Such inspection methods have always played their part in determining the merits of the restoration method selected. Exactly 500 years ago, Michelangelo presented his world-famous statue of David. His marble statue depicts David shortly before his encounter with Goliath. Restoration is now complete following extensive testing of various methods.

Optics for passionate photographers

It is not without reason that the name of the first camera from Carl Zeiss recalls the heyday of the German photo industry. Behind the name is an advanced camera system constructed with the goal of redefining range-finding cameras. The unique design indicates that Carl Zeiss succeeded. However, it is the ease of use and the many technical aspects of the camera, as well as the performance of the lenses, that this ambitious goal has been achieved.

December 2004

Dr. Dieter Brocksch

The Fluorescence Phenomenon

Fig. 1:
Glial cell culture from the optic nerves (visual nerve) of a goldfish. Astrocytes were identified with a GFAP (glial fibrillary acidic protein) antiserum, an intermediate filament (green fluorescence). Oligodendrocytes express myelin-specific gangliosides on their surface that have been detected using a monoclonal antibody (red fluorescence). All cell nuclei are stained blue with DAPI.

Micrograph:
Martin Bastmeyer, Friedrich Schiller University, Jena

Biologists and physicians have always searched for answers to the following questions: How is the cell structured? Which cell modules are responsible for which processes? How does the individual cell function? How does the cell act in tissues?

In addition to many other examination techniques, fluorescence microscopy also provides answers to these questions. Fluorescence micrographs help researchers understand the structure of cells and their components, as well as the mechanisms within them. Fluorescence microscopy has long been one of the most important research tools in medicine and natural sciences, allowing more than just the examination of bacteria and viruses. Today, fluorescence forms the basis of many modern techniques in the life sciences.

Luminescence effects

Luminescence (Latin word lumen = light) is a body's ability to emit light when illuminated by a light source. Scientifically speaking, luminescence is the optical radiation of a physical system produced during the transfer from an excited condition to a basic condition. Light emission is triggered by excitation in the UV, IR or visible light range.

Phosphorescence and fluorescence

Luminescence can be divided into two phenomenons: phosphorescence and fluorescence. In phosphorescence, the body continues to light up even if it is no longer illuminated. Fluorescence is the ability of certain chemical substances to absorb shortwave light energy and reflect it seemingly simultaneously as longwave light: for example, invisible, short-wave, high-energy daylight portions (e.g. UV light or X-rays), are absorbed first and then stored for a more or less long period of time; they then excite electrons for quantum leaps into a higher energy level and finally emit light of less energy and greater wavelength in the visible range when these electrons return to their previous, lower energy level. Luminescence and illumination are closely related: if the body is no longer illuminated, luminescence will disappear.

Autofluorescence, primary and secondary fluorescence are variations of fluorescence. Fluorescence is sometimes called photoluminescence.

When a chemical reaction releases energy, it can also appear as light: in other words, chemoluminescence or chemical light. One familiar example of this is luminol, used by police departments, that lights up bluish green in the presence of blood. One particular type of chemoluminescence is bioluminescence, i. e. the ability of living creatures to produce light either on their own or with the help of symbionts.

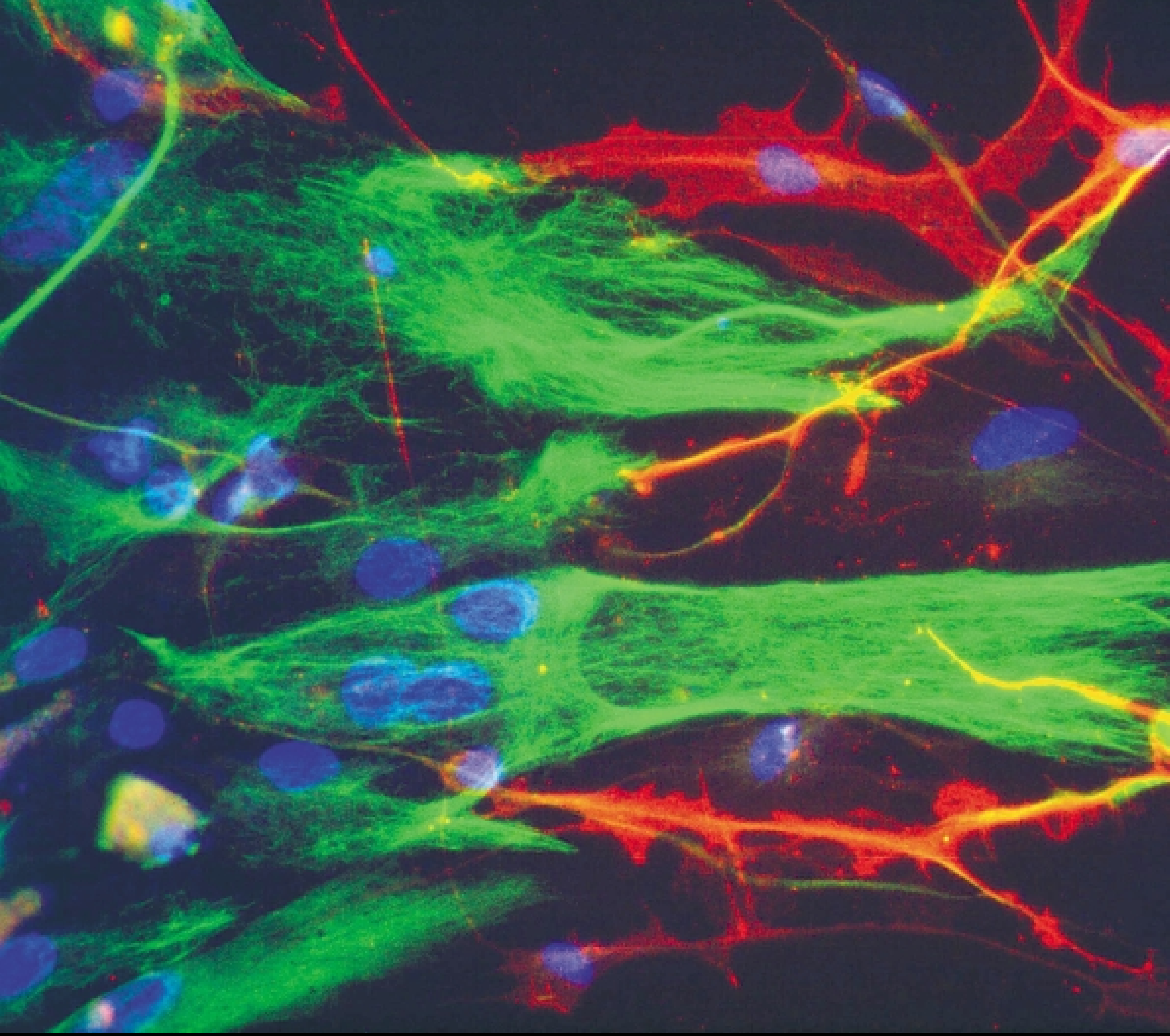
Brief history of fluorescence

The fluorescence phenomenon has been observed for thousands of years. However, it was not until today that we understand this phenomenon and have been able to control and make use of the process. Phenomenons now known as fluorescence and phosphorescence were mentioned in Chinese books as far back as 1500 BC.

Nicolás Monardes

1493–1588

Many centuries later, Nicolás Monardes (1493-1588) observed luminescence for the first time in 1565 in an extract of Lignum nephriticum – a drug recommended at the time for the treatment of kidney diseases.



In his book „Ars Magna Lucis et Umbrae“, Athanasius Kircher *(1602-1680) describes the effect of a wood extract (lignum nephriticum) in water and discussed the application of fireflies to illuminate houses.*

Athanasius Kircher

1602 – 1680

While experimenting with silver chloride at Jena University, Johann Wilhelm Ritter *(1776-1810) discovered the ultraviolet end of the spectrum in 1801.*

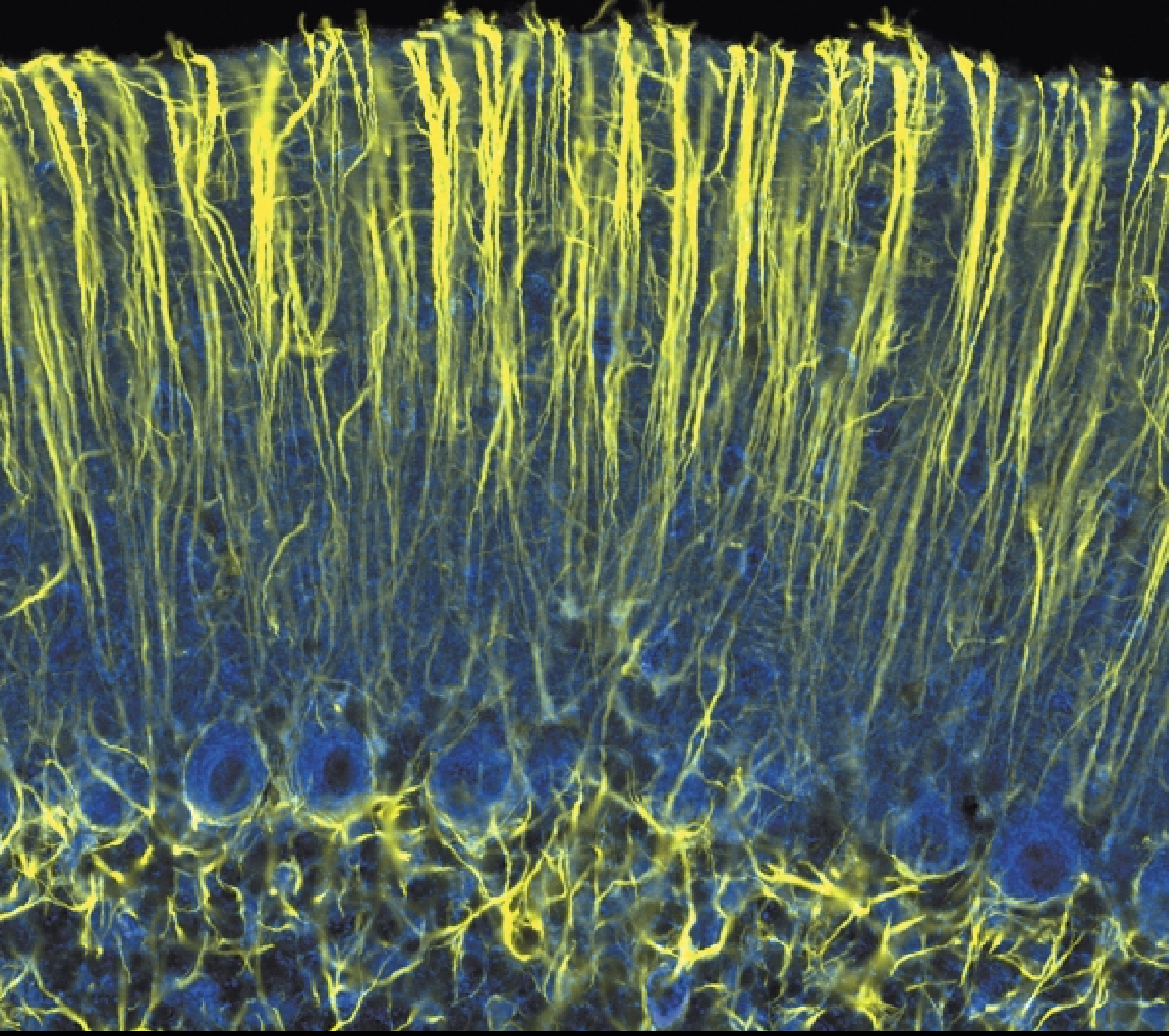
Johann Wilhelm Ritter

1776 – 1810

In his "Theory of Colors", Johann Wolfgang von Goethe *(1749-1832) also describes fluorescent light phenomenons. He asks his readers to "… dip a fresh piece of horse chestnut bark into a glass of water, which will then turn sky-blue immediately".*

Johann Wolfgang v. Goethe

1749 – 1832



Sir David Brewster *(1781-1868), the inventor of the kaleidoscope, described the red radiation of chlorophyll in 1833.*

Sir David Brewster

1781 – 1868

In 1845, Sir John Frederick William Herschel *(1792-1871) discovered the phenomenon of fluorescence in a quinine solution.*

Sir John Frederick William Herschel

1792 – 1871

In 1842, Sir George Gabriel Stokes *(1819-1903) described the luminescence observed in the fluorspar mineral (calcium fluoride) as fluorescence.*

Sir George Gabriel Stokes

1819 – 1903

Bioluminescence therefore is a special type of luminescence that performs various functions in flora and fauna, including the luring of prey and also of partners. Further functions are warning, threat and communication signals. Nature also uses bioluminescence for deterrence and camouflage. Familiar phenomena include marine luminescence, caused by plankton, such as dinoflagellate noctiluca, that react to current changes by emitting light. Fireflies, krills and fish use bioluminescence for various functions. Bioluminescent bacteria are also known for this phenomenon. The Vibrio Fischeri bacterium reproduces on dead saltwater fish, for example, and its growth can be easily observed on a dead salted herring. In bioluminescence, energy is frequently released in the form of light resulting from the oxidation of luciferin with the help of the luciferase enzyme.

The aequorea victoria jellyfish and the renilla reniformis coral produce light slightly differently, namely by using photoproteins. Aequorea victoria uses aequorine, a Ca^{2+} dependent primary photoprotein. Unlike luciferin, it is not chemically transferred in the course of the reaction, but returns to its original condition after the emission of light, enabling it to be reused again and again. The green luminescence of these jellyfish is generated by the combination of GFP (Green Fluorescent Protein) and aequorine.

GFP variants modified by genetic engineering play a major role in current research in the natural sciences. As early as 1994, it was demonstrated that GFP can be coupled with other proteins without loss of the fluorescent features of GFP or the functions of the GFP-coupled proteins.

Further types of luminescence include electro and carthodoluminescence. In electroluminescence, excitation is achieved through an electrical current, such as in the case of light-emitting diodes. In carthodoluminescence, excitation is achieved through electron bombardment (example: TV screen).

special

FluoresScience from Carl Zeiss

Fluorescence microscopy – the key technology for many modern methods in the life sciences enabling life functions to be made visible. Increasingly differentiated fluorescence applications have enabled science to track down molecular interactions within cells image by image.

Carl Zeiss has pioneered the development of fluorescence microscopy right from the start. Today, new optical systems visualize weakest fluorescence signals, separate overlapping fluorescence spectra and document dynamic life processes at highest recording speed. Complex applications are made accessible to a wide variety of users.

The growing demands made on optical systems can be easily implemented with **LSM 5 *LIVE*** and **Axio Imager**. Our focus on key techniques for the research of life has now been given a name: FluoresScience from Carl Zeiss.

Fig. 2:
Cerebellum (rat), superoxide dismutase (blue), Glial Fibrillary Acidic Protein (yellow)
Institute for Medical Neurobiology, Magdeburg, Germany.

In 1911, Max Haitinger *(1868-1946), who is considered the founder of modern fluorescence microscopy and the fluorochroming technique, coined the term "fluorochrome".*

Max Haitinger

1868–1946

In 1935, Alexander Jablonski *(1898-1980) presented his diagram to explain fluorescence: a fluorochrome features different energy states, the so-called singlets (S0, S1, S2...).*

Alexander Jablonski

1898–1980

Beginning in 1950, Albert Hewett Coons *(1912-1978) and* Melvin Kaplan *developed the immunofluorescence technique that led to sensational results in cell research, an area of natural sciences.*

Albert Hewett Coons

1912–1978

Fig. 3:
Endothelial cells, nucleus (blue: DAPI), F-actin (green: BODIPY FL), Mitochondria (red: mitotracker red).

Fluorescence is the basis of many modern methods in the life sciences. Fluorescent proteins in particular have become the key method in the search for the secrets of life in the early 1990s. Today, an increasing number of new, more differentiated fluorescence applications such as FRET, FRAP or FlAsH allow tracking of molecular interrelations inside the cell.

In the beginning, fluorescence microscopy was performed as transmitted-light fluorescence microscopy. The far more efficient epi-fluorescence microscopy then replaced the transmitted-light technique almost completely.

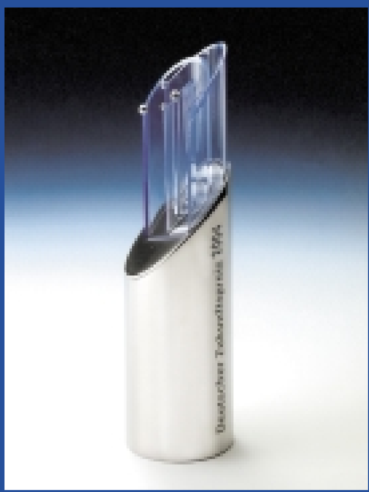
The modern reflected-light technique has one major optical benefit: the objective also acts as a condenser, thus ensuring optimum alignment of the light beam.

[*www.zeiss.de*
www.deutscher-zukunftspreis.de
www2.uni-jena.de/biologie/zoologie]

details

Nominated for German Future Prize

The development team around *Dr. Ulrich Simon, Dr. Bernhard Zimmermann* and *Ralf Wolleschensky* from the Microscopy Group was nominated for the 2004 German Future Prize for the market-ready development of the **LSM 510 META** laser scanning microscope.



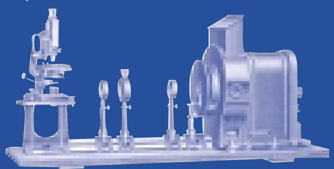
The German Future Prize, awarded by the German Federal President, is an annual award honoring outstanding innovations in technology, engineering and natural sciences within Germany. It is not possible to apply for the prize. The right to make recommendations for the German Future Prize lies with leading German establishments in science and industry. The "**LSM 510 META**" project was nominated by the Federal Association of German Industry (BDI).

Deutscher Zukunftspreis

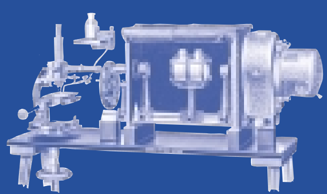
Fluorescence-optical instruments from Ca

1904
August Köhler published his study reports about the ultraviolet microscope.

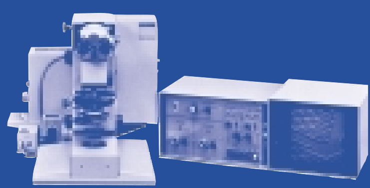
1913
Beginning in 1913, H. Lehmann and Stanislaus von Prowazek promoted development of the first apparatus allowing visualization and also measurement of fluorescence. The first optical instrument – still called a luminescence microscope – was introduced by Carl Zeiss as early as 1913.

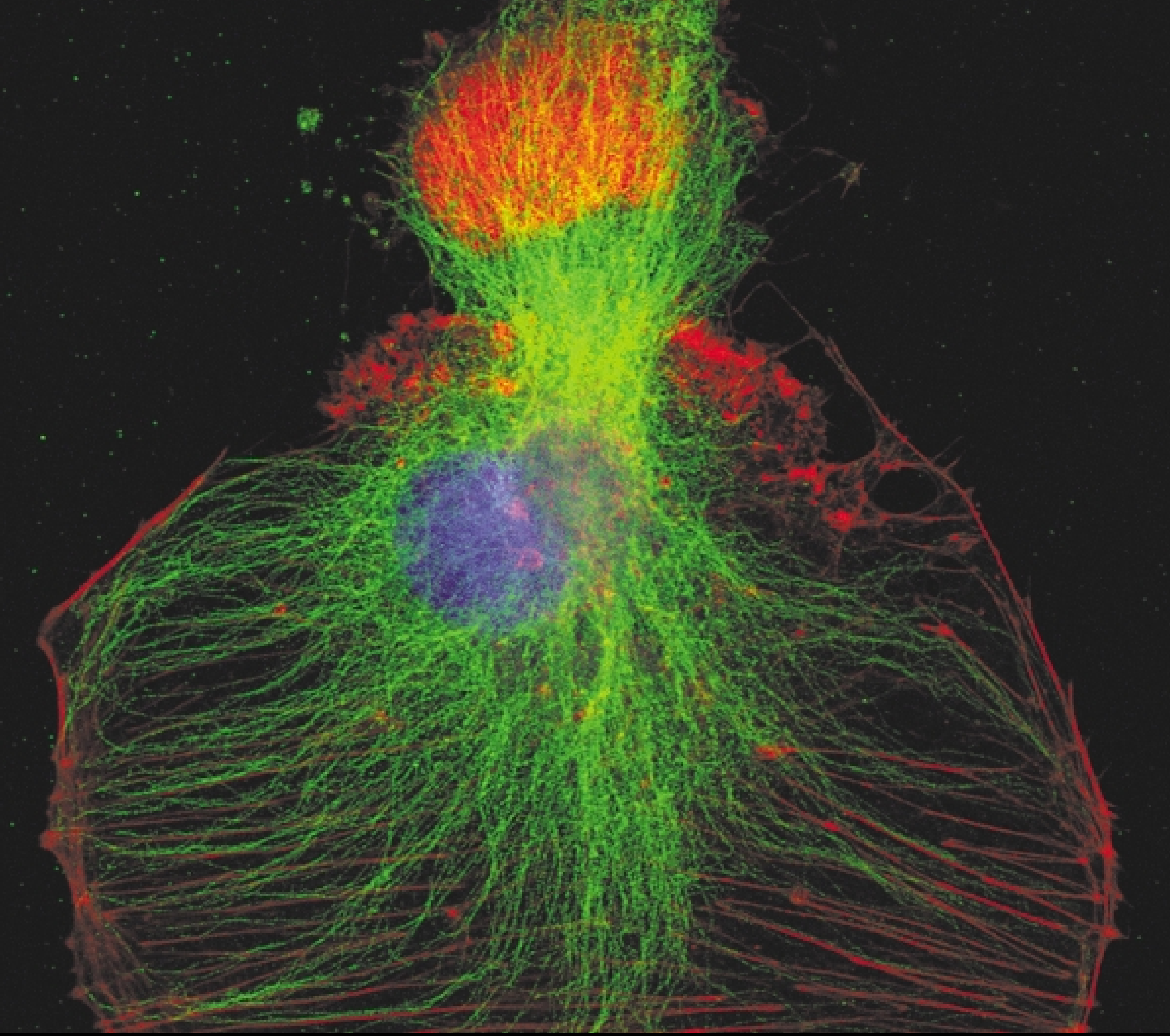


1935
The Ellinger-Hirt luminescence microscope was mainly used for intravital microscopy.



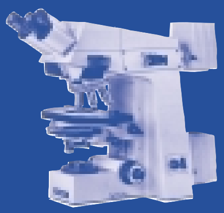
1982
The development of the first laser scanning microscope by Carl Zeiss laid the foundations for today's ultramodern three-dimensional reconstruction of cell structures in fluorescence microscopy.





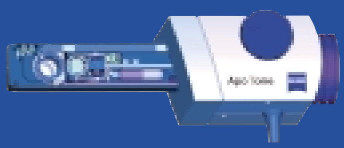
rl Zeiss

1986
Carl Zeiss made another major contribution to the further development of fluorescence microscopy with its microscopes in the Axio series featuring ICS optics.



2001
The **LSM 510 META** ideally implements the confocal principle like no other system. It permits the recording of multifluorescence without making any concessions on resolution and efficiency.

2002
In traditional microscopy, **ApoTome** enables very fast, high-quality optical sections through fluorescence-labeled specimens – e.g. for the 3-dimensional display of nerve cells.



2004
One hundred years after Köhler's invention of the "ultraviolet microscope", Carl Zeiss set a further milestone in fluorescence microscopy with the new **Axio Imager** microscope.

Light on New Paths – Moving Moments in Confocal Microscopy

Biologists and physicians are increasingly probing into the microcosm. Innovative optical microscope systems help them to better understand processes in cells and to gain precise insights into cellular interaction mechanisms.

The new optical design from Carl Zeiss now has the potential of addressing the question of speed dynamics of life processes – something that was previously assumed rather than precisely described. For the first time, major issues from the focal points of life sciences, such as cellular and developmental biology, immunology, virology or oncology, can now be analyzed with emphasis on dynamics. Systematically tailored to biomedical applications, the new design permits unique, high-resolution image series – both in space and time. Carl Zeiss thus launches a new era for confocal microscopy.

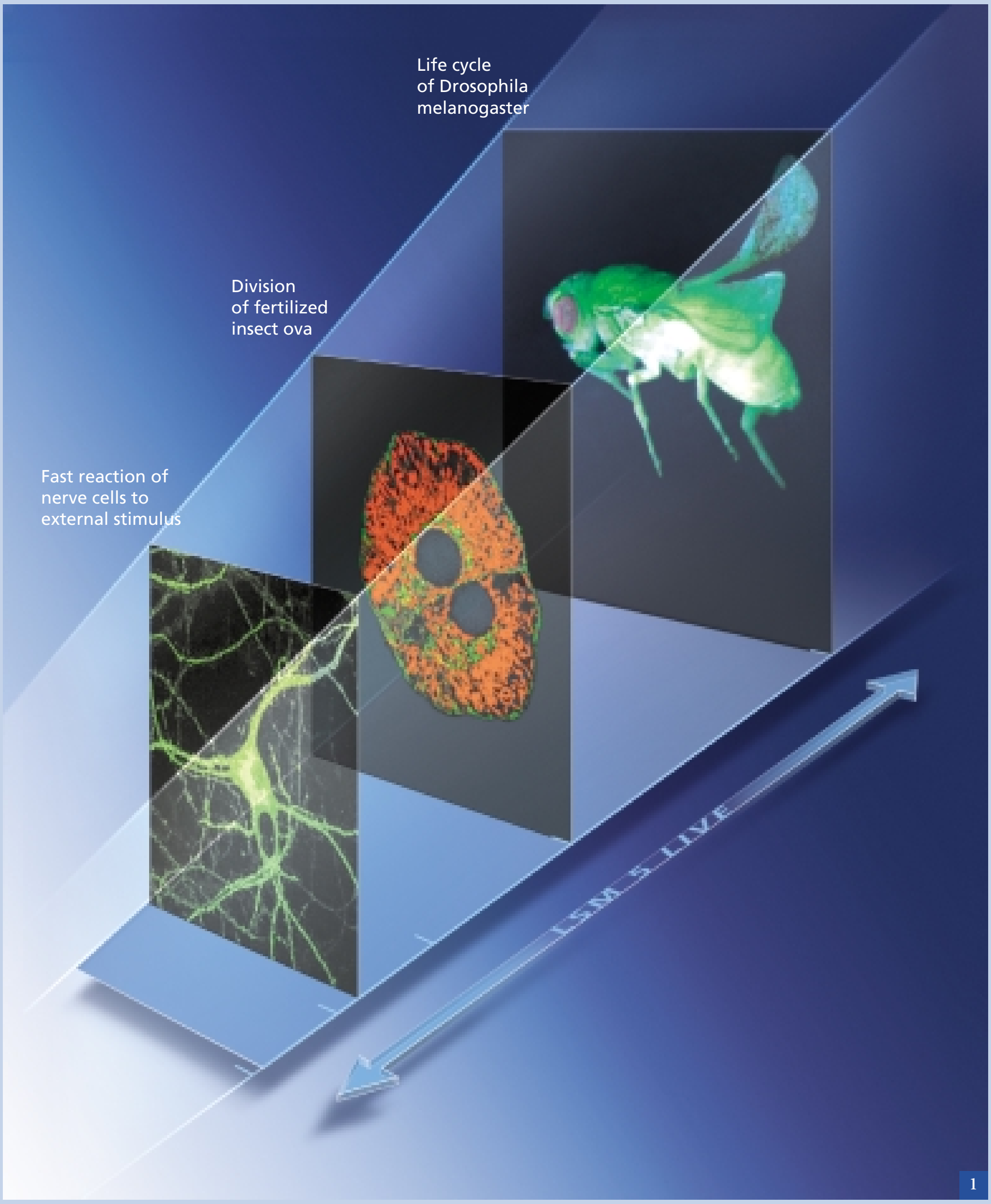


Fig. 1:
Time constants of selected cellular processes.

Life in motion

Living cells communicate at lightning speed using electrochemical transport mechanisms, for instance at neuronal switches in the brain. These processes direct our senses, allow us to learn, determine our creative potential, and form our memories. Cellular metabolic processes control breathing and digestion, and cellular mobility permits complex, coordinated movement and development processes.

Many of these fundamental processes and interactions between cells, but also the processes within a cell, have so far only been documented in "snapshots". Many individual "snapshots" sequentially arranged give an idea of the motion. However, full documentation of dynamic procedures actually taking place in living cells – i.e. the "high-speed film" – remains largely hidden.

Structures in motion

High spatial resolution is always absolutely necessary when tracking and analyzing communication and interaction processes of cell structures, cells and organisms in detail – for instance, when a large number of very small organisms or cellular particles are moving very rapidly. The size of many bacteria and, in particular, of viruses lies close to or below the resolution limit of light microscopes (bacteria: 500 nm – 2 µm, viruses: 20 nm – 200 nm). This means that these organisms, or particles, can in fact be localized in light microscopes as "light dots" or single pixels, but are characterized neither in shape nor structure.

However, not only these very small structures are being tracked. Confocal microscopes are particularly impressive in their ability to produce 3D images of objects by recording 3D image stacks from many optical sections. All organisms are three-dimensional in nature and often constructed of thousands of cells. Living model organisms like the thread-worm (Caenorhabditis elegans) or the fruit fly (Drosphila melanogaster) are preferred subjects of investigation for biologists because of their short life cycle.

Therefore, results are obtained quickly and do not require too much effort. However, developmental biologists have also researched the development phases of more differentiated models such as zebrafish or mice for many years.

Creating 3D images of these models and dynamically recording changes over time in their spatial complexity with high recording frequency and sensitivity is a benchmark for any fluorescence imaging system.

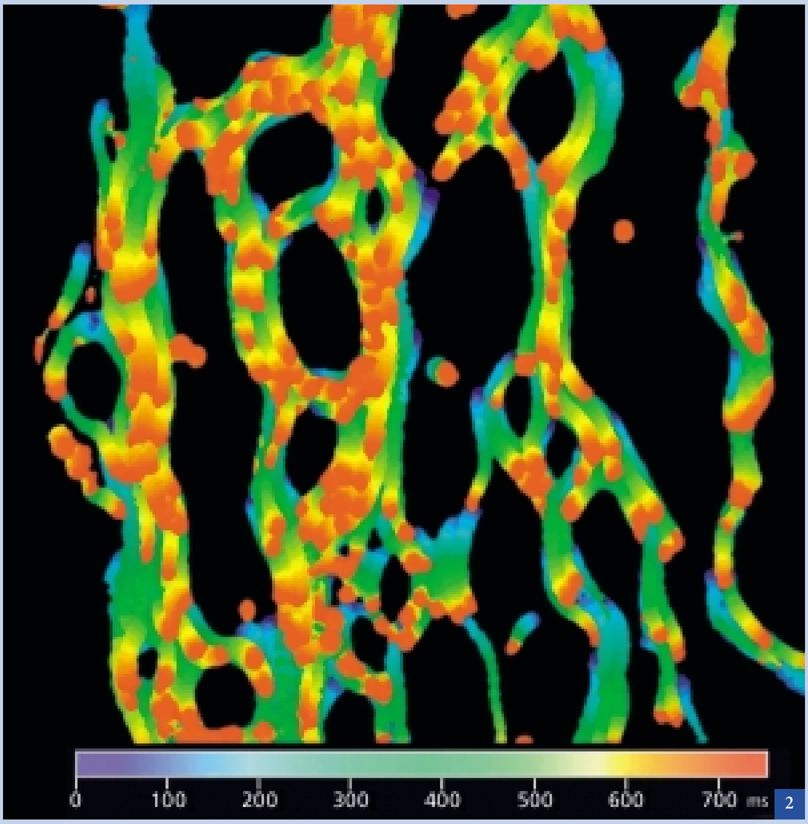


Fig. 2:
Motion of erythroblasts during a heart beat cycle in an 8-day old living mouse embryo. GFP expression, color-coded projection over time, recorded at 88 images per second.
Specimen: Dr. Mary Dickinson, Biological Imaging Center, Caltech Pasadena, CA, USA.

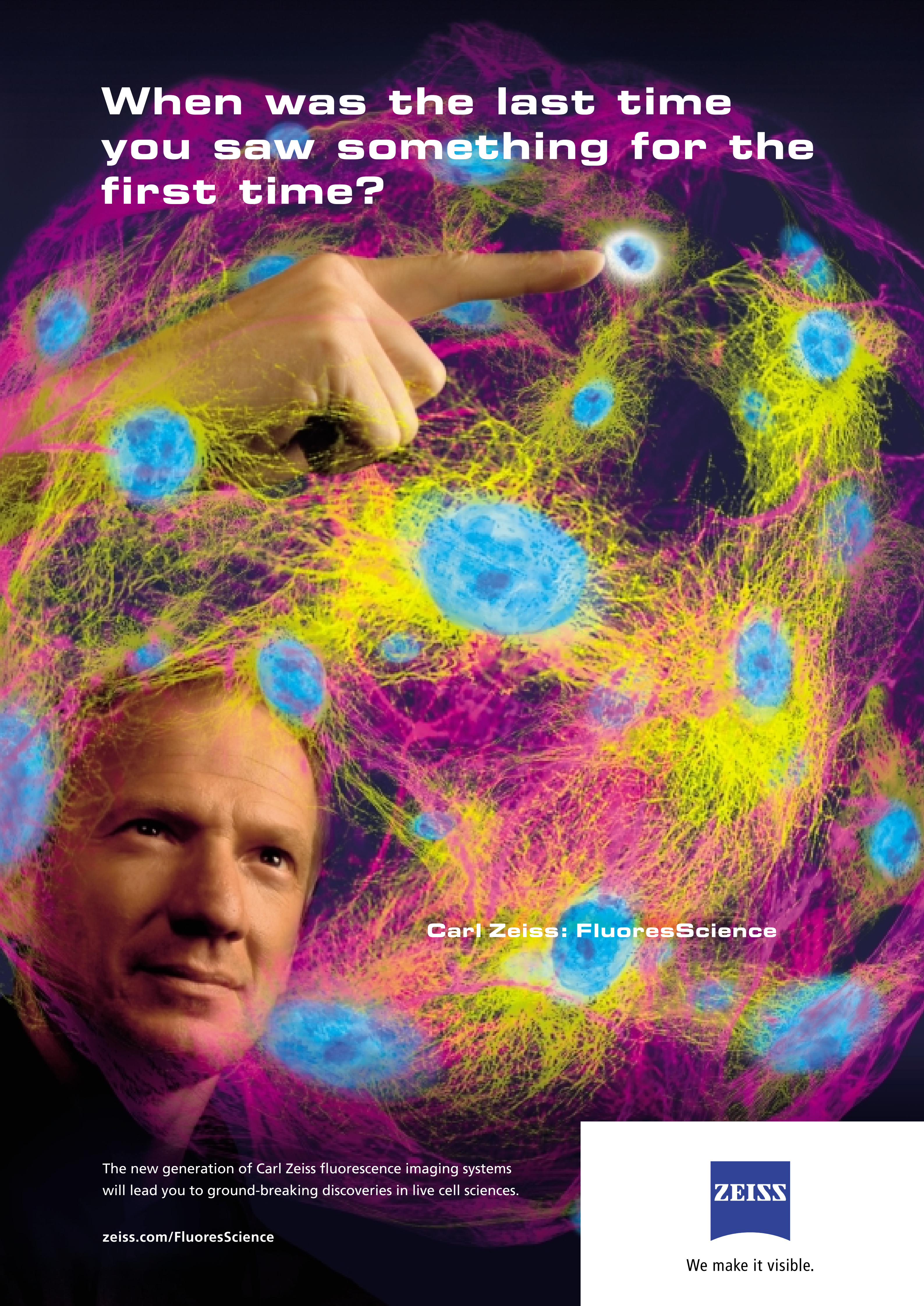
Microscopy in motion

"Fundamental processes in living cells are optimally studied and understood while in motion." This thought was at the heart of the new, ground-breaking design of a confocal analysis instrument from Carl Zeiss: the **LSM 5** ***LIVE***. With up to 120 confocal images per second, about 20 times more than before, the new confocal system "films moving moments" with outstanding sensitivity and excellent image quality of 512 x 512 pixels. This exceptional scanning rate now permits complete tracking of the motion paths of cell organelles, bacteria and viruses.

Reduced image formats (e.g. 512 x 50 pixels) now permit confocal images to be recorded in millisecond cycles, and confocal "line scans" even in microsecond cycles. Thus, even the fastest "flashes of inspiration and thought" in neuronal structures no longer remain in the dark.

The new optical design of the **LSM 5** ***LIVE*** permits the building blocks of nature to be studied in more detail and faster than ever before: microscopic image series that finally take into account the spatial complexity and time dynamics of these living creatures. Where one high-resolution, two-dimensional image per second was usually taken in the past in confocal microscopy, it is now possible to image the examination object 3-dimensionally in the same time period. These fast 4D image stack series now enable scientists to take a look behind the scenes of life: more brilliantly and more informatively than ever before.

Dr. Gerald Kunath-Fandrei, Carl Zeiss, AIM-PM, *www.zeiss.de*. Further examples and information on the **LSM 5** ***LIVE*** is available at *www.movingmoments.de.*


When was the last time you saw something for the first time?
Carl Zeiss: FluoresScience
The new generation of Carl Zeiss fluorescence imaging systems will lead you to ground-breaking discoveries in live cell sciences.
zeiss.com/FluoresScience
ZEISS
We make it visible.

(Living) Cells Made Visible

1

2


3

Microscopes are among the oldest scientific instruments used to visualize the structures of life. Without them, modern biosciences would be unimaginable. However, one of the major problems in microscopy is the poor contrast of biological specimens. Structures can only be visualized if contrast is available or if contrast-enhancing agents, such as selective dyes, are available. The so-called brightfield of simple light microscopes only permits optimum observation of dyed specimens. In the past, scientists therefore had to prepare and dye their specimens accordingly. Transparent as living cells are, they could not be adequately observed, documented and analyzed in the early days of microscopy. Only with the help of additional optical components could cell structures be examined in more detail under a light microscope: living cells became visible.

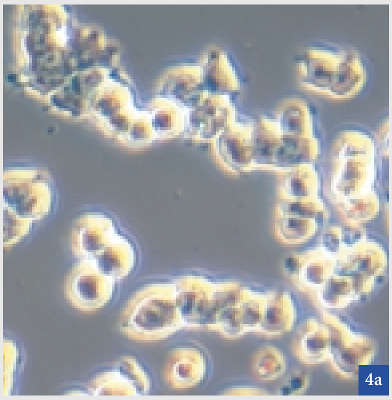
Fig. 1:
Axiovert 200
inverted microscope.

Fig. 2:
Cells in phase contrast (Ph).

Fig. 3:
Cells in differential interference contrast (DIC).

Fig. 4a:
PC12 cells in phase contrast.

Fig. 4b:
PC12 cells contrasted with PlasDIC.


4a


4b

Cells – or cellulae in Latin – was the term coined by English physicist Robert Hooke in 1667 to describe the structures he discovered while examining sections of cork under a magnifier. Despite advances made in microscope technology in the 18th and 19th centuries, it was not possible to recognize much when observing cells. With very few exceptions, cells are transparent bodies: without suitable optical aids, they are more or less structureless lumps. Bacteriologist *Robert Koch* was one of the pioneers in microscopy. He discovered the pathogens of tuberculosis, cholera and anthrax. Koch was the first to use the immersion objective developed by Ernst Abbe. It was not until the mid-1930s that a useful optical technique was developed: phase contrast microscopy. The electron microscope developed by Ernst Ruska in the middle of the 20th century then opened the door into the microcosm, a world reduced in size by the factor 1000. Even single subunits of protein molecules can be visualized with the electron microscope.

At that time, light microscopy seemed obsolete. However, the electron microscope only allows viewing of dead matter, requiring protracted, complex preparation. With the light microscope, however, researchers can witness growth, division and movement of living cells – a major benefit for natural sciences in the 21st century.

details

Cells are the smallest functional units of the body. Different cell types have different tasks – and each cell type has a very specific job. Depending on their function, body tissues are made up of cells of one or different types. Tissues enable the various body parts to perform their specific function. Tissues of similar and supplementary functions form organs. Organs form system groups, while system groups finally form the body.

The bodies of living creatures on earth, and the human body in particular, are a fascinating, fine work of art featuring outstanding complexity. Through constant interactions, the various body systems and their components permit the functions that make up our life. Individual organs must communicate with each other and be connected to each other directly or indirectly to allow this interaction to run smoothly – much the same as a machine. This interrelation is the result of a long evolutionary process resulting in the current “design” which meets the needs of its environment.

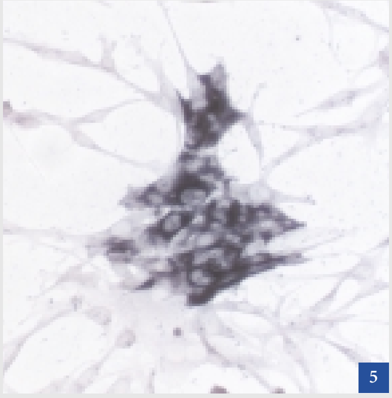
Both simple cell cultures and, increasingly, complex, 3-dimensional cell systems are used for what is known as *tissue engineering*. Modern cell and tissue cultures are indispensable in today's natural sciences, and have become established in all scientific institutions as an alternative to animal experiments. Dealing with manifold scientific issues requires defined cell populations or single cells that can only be obtained, observed and analyzed in cultures. Structural and functional results obtained from cell and tissue cultures have found their way into basic research.

Fig. 5:
Cells dyed with ink, brightfield.

Fig. 6:
Myocard cells contrasted with **VAREL.**

Fig. 7a:
Human egg cells (ICSI technique, prior to injection), contrasted with **PlasDIC.**

Fig. 7b:
Human embryos contrasted with **PlasDIC.**



5

6

Inclined illumination

Inclined illumination was used for the visualization of specimens right from the beginning of microscopy. Various techniques can be used to implement inclined illumination. The easiest method is the partially closed condenser stop or laterally offsetting the image of the light source.

In 1953, Zernike was awarded the Nobel Prize in Physics for the phase contrast technique he described, and particularly for his invention of the phase contrast microscope.

Frits Zernike, Dutch physicist

In the 1950s, Nomarski developed the DIC system that is now used most frequently worldwide.

Georges Jerzy Nomarski, Polish physicist and optics theorist

Phase contrast

The phase contrast technique was the first optical method to have a lasting influence on biological research. Around 1935, Dutch physicist *Frits Zernike* developed the optical principle of the phase contrast microscope, for which he was awarded the Nobel Prize in 1953. He sold his patent to Carl Zeiss, and the first phase contrast instruments were then launched in early 1940. This invention enabled scientists to take a big step forward: living cells could now be observed while they were dividing. In 1943, *Kurt Michel*, a developer at Carl Zeiss in Jena, made the first film of mitotic cell division. From the middle of the 20^{th} century, phase contrast equipment supplemented light microscopes, permitting reproducible image results under defined optical conditions. The phase contrast technique is the most commonly used method for optical contrasting of transparent specimens.

Differential interference contrast

Development of the second method for the visualization of unstained specimens – now used worldwide – started in the 1940s and 1950s. The development of **DIC** (Differential Interference Contrast) is based on examinations made at Reichert in Vienna. Initially, *Francis Smith* and *Maurice Françon* modified a polarization microscope in 1955. *Georges Nomarski*, however, gave the major impetus: he changed the position of the Wollaston prism in the beam path. The interference contrast microscope provides relief-type images. Today, this type of microscope is an integral part of standard imaging techniques.

Microscopes with differential interference contrast based on *Nomarski*'s method were launched by Carl Zeiss in 1965.

7a

7b

details

Most modern high-tech microscopes, electron microscopes and scanning probe microscopes do in fact offer fascinating insights into nano worlds, but are not suitable for the examination of living cells. This is still reserved for light microscopy.

Hoffman modulation contrast

Hoffman modulation contrast is a type of inclined illumination implemented using optical components from polarization microscopy. This contrasting technique was one of the first optical methods for the relief-like visualization of cell cultures growing in plastic dishes. This method was very successful when used with micromanipulation techniques in reproductive medicine.

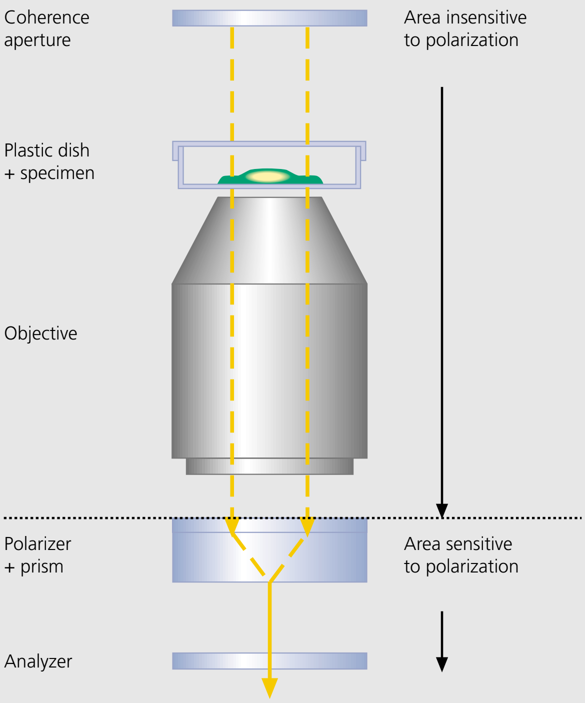
VAREL contrast

The Variable Relief Contrast, in which phase contrast and inclined unilateral illumination are mixed, was developed to examine tissues and living cells in culture vessels. The movement of an additional stop from the outside to the inside in a radial direction sets unilateral darkfield, **VAREL contrast** as superimposition of phase contrast and inclined brightfield, and, finally, inclined brightfield one after the other.

PlasDIC

Microscopy of thick, living objects is often fraught with problems in routine microscopic procedures. Thick object areas are critical in phase contrast, and the well-known halo effect distorts and falsifies the image information from thick specimens. Usually, differential interference contrast is then used in such cases, although it is ideal only if glass slides are used.

PlasDIC is a new polarization-optical transmitted-light differential interference contrast technique that produces linearly polarized light behind the objective – unlike traditional Smith or Nomarski **DIC**. The development of the **PlasDIC** contrasting technique enabled differential interference contrast microscopy with cells in plastic dishes for the first time: the new patent-pending arrangement of the optical components permits the use of birefringent vessels without any restrictions.



[www.zeiss.de/mikro]

OPMI® Pentero™ – The Surgical Microscope of the Future

Fig. 1:
AutoBalance.

Fig. 2 (center):
OPMI Pentero
surgical microscope.

Fig. 3:
Balanced at the push
of a button (touchscreen).

Fig. 4:
User-friendly solutions
for OR personnel.

Surgeons around the world have been using surgical microscopes from Carl Zeiss for more than half a century. The demands placed on a surgical microscope by neurosurgeons have evolved over time – from a traditional magnification aid to an information and communication center. The new *OPMI Pentero* for neurosurgery and spine surgery uniquely combines solutions for basic requirements with a variety of additional benefits: intra-operative diagnostics, integration of an entire video chain, integration of the surgical microscope into the hospital's information and communication infrastructure and user-friendly solutions for OR staff. Users can best describe just how good this design really is.


1

The best of the basics

Daniel L. Barrow M. D., Atlanta, Georgia, USA
"The basic functions of any operating microscope include optics, magnification and illumination. The Pentero enhances and combines these basic functions into an innovative and creative design that is very user-friendly not only for the surgeon but for the entire operating room team."

Dr. Andreas Raabe, Frankfurt, Germany
"The Pentero is another major step forward for the neurosurgeon. It is the unique combination of features which makes this microscope so valuable for any microsurgical operation. It is very compact, it has a great reach, and it has a great overhead clearance. I like the high-speed autofocus, the laser focusing aid for the manual focusing and robotic movements, which allows fine and precise adjustment during surgery without releasing the brakes."

Simply unique, uniquely simple

During a procedure, **OPMI Pentero** must meet various demands, i. e. quickly and precisely fulfill the task at hand.

Prof. Dr. Volker Seifert, Frankfurt, Germany
"Historically, balancing of the microscope has always been a little bit time-consuming. And now, the new auto balance system of the ZEISS microscope really speeds up the preparation time and it is a considerable help, especially for the assistant who usually has the task of balancing the microscope."

Robert F. Spetzler, M.D., Phoenix, Arizona, USA
"When the scope is draped, instead of having a bulky drape that constantly gets in the way of the nurse and the surgeon, there is a vacuum system attached to the drape so that it snugly hugs the contour of the scope itself."

3


4

5

Fig. 5:
Intraoperative diagnostics – first surgical microscope to offer completely integrated support for fluorescence-based angiography and tumor resection.

Fig. 6:
Integration of the surgical microscope into the hospital's information and communication infrastructure.

Figs 7 and 8:
A completely integrated digital video chain in a surgical microscope.

Integrated digital visualization

The digital age has entered the operating room. Electronically archiving patient data and videos for presentations is becoming ever more important to surgeons.

Robert F. Spetzler, M. D., Phoenix, Arizona, USA
"As a surgeon that spends a lot of time talking to other surgeons, being able to record operations and techniques is a critical component. This new digital interface really allows this to be done at a new level. It can be integrated with the hospital system so that I can actually observe the digital images in my office. I have the ability to edit them online and therefore the recording and the distribution of this information is made very easy."

Hospital workflow integration

Integration of the **OPMI Pentero** into the hospital's information and communication infrastructure is becoming ever more important. This includes a request for pre-op findings, storing important data from the

6

operation or exchanging information during the operation with colleagues at other locations. The communication interfaces on OPMI Pentero enable complete management of this data.

Prof. Dr. Volker Seifert, Frankfurt, Germany
"Neuronavigation has become an absolutely indispensable tool in neurosurgery. In this regard, the new ZEISS microscope has made a big step forward in allowing the integration of all sorts of neuro-navigational data in the colored fashion in both eyepieces of the neurosurgeon."

Intraoperative diagnostic solutions

OPMI Pentero offers the possibility of an innovative fluorescence procedure with which tumors and vessel diseases can be displayed and recorded during an operation.

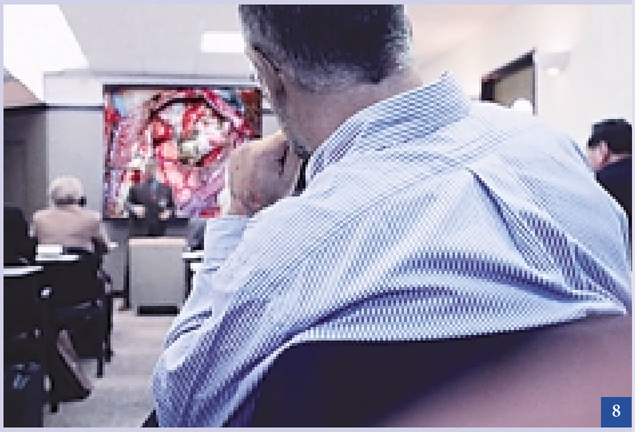
Prof. Dr. Volker Seifert, Frankfurt, Germany
"Radicality of tumor resection, especially in patients with glioblastoma, clearly defines the outcome of this patient group. In this regard, the new integrated support of fluorescence-based tumor resection is a unique and very helpful tool of the neuro ZEISS microscope."

Robert F. Spetzler, M.D., Phoenix, Arizona, USA
"The opportunity of easily performing an angiogram allows you to manipulate the vessels or the aneurysm while you are performing it, is something that is incredibly exciting to neurosurgeons."

Conclusion

Daniel L. Barrow M.D., Atlanta, Georgia, USA
"The Pentero is an operating microscope designed by surgeons for surgeons. It incorporates cutting edge technology in a compact, innovative and brilliant design. Carl Zeiss has combined efficiency, efficacy and ergonomics to create a microscope that brings neurosurgery and spinal surgery to an exciting new level."

7



8

www.zeiss.com/unique

Innovative Dental Microscopy in Japan
Patient Communications Becoming More

1

Fig. 1:
OPMI®PROergo
dental microscope.

Fig. 2:
Dr. Mitsuhashi at the dental microscope, patient with head mounted display (HMD).

Japan is the one country where the latest technology goes hand in hand with tradition and culture. Examples can be found in all walks of life: from women in traditional kimonos listening to MP3 players up to the latest electronic gadgets. Where else can you find flat screen televisions offered in the "in" colors of the season, or the newest mobile phone with integrated two megapixel digital camera?

The interest shown by the Japanese in innovative technologies is increasingly spreading to medicine. 3CCD video cameras are already a standard documentation accessory for surgical microscopes in Japan.

With around 85,000 dentists and almost 70,000 dental practices for its 127,790,000 residents, Japan has one of the world's highest density rates. Documentation has been increasingly moving into the limelight since the introduction of the surgical microscope to dentistry. Documentation possibilities, along with improved vision and increased working comfort for the dentist, are an important factor when a dentist purchases a dental microscope.

Dental care in Japan

In April 2004, Japan's national health insurance system (NHI) was overhauled to stem the cost explosion. Since then, patients have had to pay 30% of treatment costs while also paying higher monthly insurance premiums. Furthermore, the government also plans on reducing payments to doctors.

While the majority of dentists in Japan offer cost-effective care within the NHI, a second group has formed, which utilizes highly innovative technologies to offer high-quality dental

and More Important

2

details

Three conditions in Japan are prompting dentists to document their high-quality treatments and make them visible to patients:

- Communication and information

  At all times, dentists can show their patients where potential problems lie and how best to treat them.

- Invoicing and payment

  As a result of healthcare reform in Japan, dentists must convince their patients of the necessity of certain treatments that are no longer covered by the national health insurance. Patients must pay these costs themselves.

- Safety and responsibility

  If complications arise during or after an operation, dentists can retrace the procedure to search for possible causes and remedies.

treatments that go well beyond standard care. Dental microscopes also benefit from this trend: the use of microscopes in dental treatments is not reimbursed by the NHI even though using a microscope often improves the end results. Therefore, dentists must convince their patients of the advantages gained with a dental microscope.

For this reason, the latest dental microscopes from Carl Zeiss are equipped with co-observation possibilities for patients. For example, dentists are able to show patients the condition of their magnified teeth on a monitor and then discuss the necessary treatment as well as present them with specific oral hygiene directions.

One of these innovative dentists is Dr. Mitsuhashi. He has developed a documentation procedure that has been very well received by his patients: "Most people only look at their face once a day, and generally in the morning when they are still tired or unshaven. They wash their face and make sure they are quickly finished and ready for work. But how often do they look at their back? Even if you twist your neck or use a mirror, it is difficult to view your own back. Can we see the birth mark or mole? In fact, we can't see if anything is wrong with our back.

How about our mouths? The problem is not so much the front teeth. We can see if they are becoming yellow or if the gums are receding. How about the back side of our front teeth, or the deeper regions of the mouth? Most patients don't even know what exactly is wrong with their teeth because they can't see them properly.

It goes without saying that the quality of dental treatment is greatly affected by how well dentists can see. A dental microscope can dramatically increase the quality of

Fig. 3:
Dr. Mitsuhashi at the dental microscope, patient with head mounted display (HMD).

Fig. 4:
Dr. Mitsuhashi in his practice.

treatment in comparison to treatment with the naked eye."

To illustrate the condition of their teeth and the advantages of microscopes, Dr. Mitsuhashi allows his patients to wear a head mounted display (HMD) while they are lying in the treatment chair. When an HMD is connected to a dental microscope with an integrated CCD camera, the magnified image of the teeth is displayed on the monitor of the HMD. This combination enables patients to follow the examination in real time. Patients see the same picture as the dentist, enabling him or her to explain the required treatment and to receive a reaction immediately.

"Patients clearly see that the quality of treatment improves when a microscope is used. Another benefit is that patients have a better, more secure feeling during all steps of the procedure. In this way, it is much easier to convince patients of their own responsibility for the health of their teeth. Furthermore, an HMD also has a certain entertainment value and helps most patients get over their fear of dentists. Dental treatment should not be scary but enjoyable," explains Dr. Mitsuhashi.

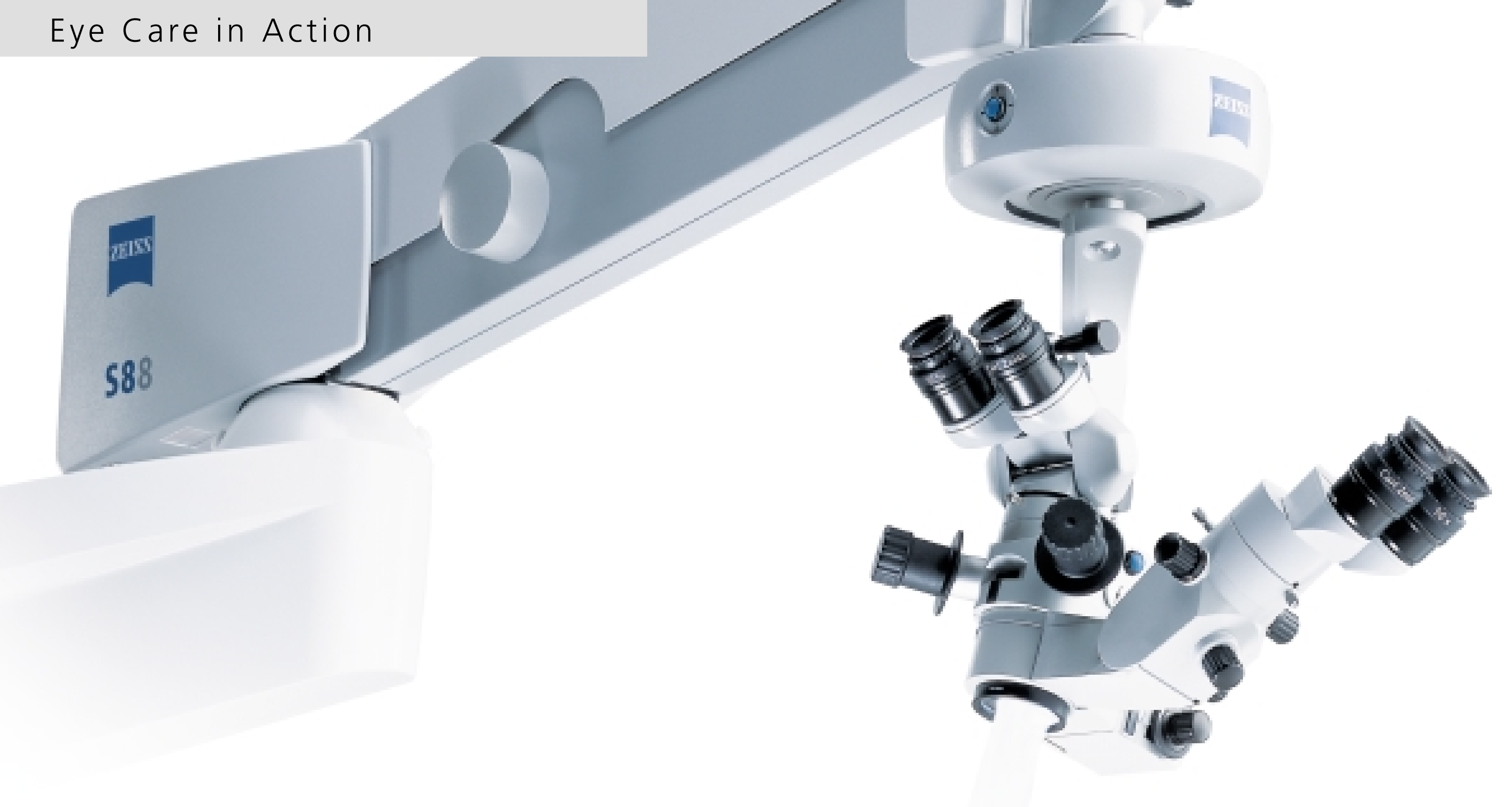
Dr. Jun Mitsuhashi, Dental Mitsuhashi, Tokyo

All clear with LotuTec™.

The eyeglass lens coating with the lotus effect.

Opt for LotuTec™,
the eyeglass lens coating
for safe, reliable vision.

We make it visible.



Ophthalmology, Vision 2020

VISION 2020: The Right to Sight is a worldwide initiative from the International Agency for the Prevention of Blindness (IAPB) and the World Health Organization (WHO) along with international, non-governmental organizations.

VISION 2020 celebrated its 5th birthday in 2004, shortly before World Vision Day on October 14, 2004. As one of the original companies involved, Carl Zeiss actively supports this initiative. The goal and mission of VISION 2020 is to eliminate preventable blindness throughout the world and give everyone the right to sight.

In the USA, 20/20 is the designation for perfect vision. At the same time, it also stands for the year 2020. The declared goal of VISON 2020 is to reduce preventable blindness as much as possible by the year 2020.

The goal of VISION 2020 is to reduce preventable blindness to 20 million cases by the year 2020. What exactly is preventable blindness?

Preventable blindness is any form of blindness that can be eliminated through good public health approaches by the appropriate healthcare measures or by currently available treatment methods. This includes vitamin A deficiency, trachoma, river blindness and cataract. Cataract and trachoma are the two most common preventable ailments.

How does blindness affect a person and his family in developing countries?

Blindness is actually the largest contributor to loss of productivity, and is not only confined to the particular individual concerned. It also affects the entire family because everybody in the family has to take care of that blind person. Consequently, it makes everybody in the family less productive, which in turn leads to a loss of productivity in the community. As you can see, blindness affects at many levels. As many families in developing countries live from one day to the next, the inability to earn any money for a couple of days, or even one day, can have devastating effects.

What's the average age of a blind person in developing countries?

I don't think there is such a thing as an average age. Children and the elderly are probably the two age groups that are most at risk. The elderly because they are most likely to be affected with cataract, and the children who suffer from vitamin A deficiency. In some African countries and other countries around the world, trachoma is a major cause of blindness affecting children.

In the western world, cataract generally affects people in their 70s. How is it in India?

In India, cataract usually occurs a decade earlier. This is due to a variety of reasons – genetics, nutrition,

VISION 2020

THE RIGHT TO SIGHT

Fig. 1:
Eye examination in a developing country.

exposure to UV light, debilitating dehydration, and the oil that is commonly used in cooking. All these factors have been associated with an increased risk of cataract in India.

How are people in developing countries treated for cataract today? Is it an expensive procedure?

In a country like India, we can do the procedure for about $ 30. The technique is removal of the cataract and insertion of an intraocular lens.

Dr. Rao, according to the literature, there are 45 million blind people worldwide, a figure that is predicted to rise to 75 million in the next few decades if nothing is done. What must be done to reverse this trend?

The strategies suggested in VISION 2020 provide a starting point. Disease control is the first step. This entails focusing on the diseases that cause blindness. It also requires good coordination among the different agencies. The 2nd step is to develop the human resources needed to make disease control possible. Finally, these human resources need an adequate infrastructure if they are to function properly. The combination of these three will make it happen; it is just a matter of time and resolve. We also need good global coordination and must better utilize our resources.

Compared to many other developing countries, India has had great success in fighting blindness. What has been the key to India's success?

There are 4 or 5 factors. The first factor is recognition of the problem by the Indian government and eye care professionals in India. The second key factor is the proactive stance of the government, unlike in many countries. A good example of this occurred about 15 years ago. India approached the World Bank seeking support in the fight against cataract blindness. The third factor is the presence of a private sector and a very strong, voluntary, non-profit

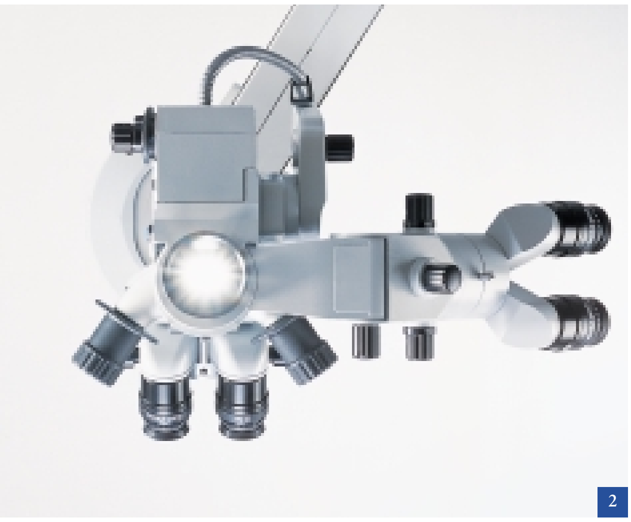
facts

Facts about blindness

Approximately 45–50 million people suffer from blindness around the world. 90 percent of them live in developing countries. At least five million people lose their sight each year. People living in developing countries are ten times more at risk of going blind than those in industrial countries. 80 percent of blindness on this planet is preventable. 90 percent of all blind children do not go to school. 80 percent of blind adults are unemployed due to a lack of educational opportunities. In Africa, an ophthalmologist must care for one million people (statistically), compared with 12,000 for a doctor in Germany. India currently has the world's largest blind population (10 million).

Dr. Gullapalli N. Rao

On September 27, 2003, VISION 2020 was introduced in the Andhra Pradesh region of India. It is one of the first steps in India to fight preventable blindness. The program is also supported by Dr. Gullapalli N. Rao, director of the L.V. Prasad Eye Institute (LVPEI) in Hyderabad, which was founded in 1986.



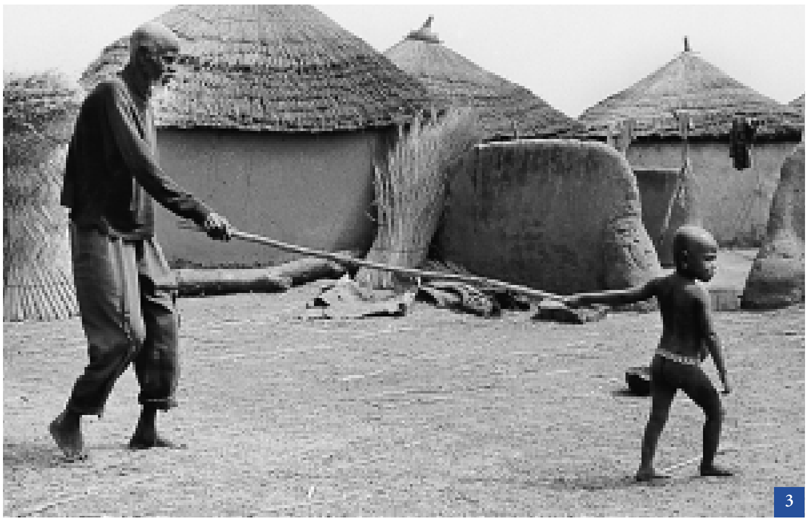


Fig. 2:
OPMI® VISU 210.

Fig. 3:
Helping the blind.

sector for eye care in India. The fourth factor is the degree of coordination between the public and private sectors. Finally, there has been significant improvement in the availability of affordable eye care services to all Indians. As you can see, many factors contributed to our success.

Can you give us an example of the cooperation between the private sector and the public sector?

When the World Bank grant arrived, the government established district blindness control societies which decentralized the system and delegated authority to a district unit which consists of about two million people on average. The funds are directed to the districts where the action actually occurs. The district society has the support of the federal government, the voluntary sector and the private sector. Everyone involved is given a kind of reimbursement if they perform cataract surgery. Another good example is the cooperation between the different groups at all levels of government. There is a blindness control group where everyone is represented.

Can you tell us more about the role of VISION 2020 in reducing preventable blindness?

Essentially, VISION 2020 is expanding the fight against blindness to a larger arena. There are three aspects to this campaign. The first is advocacy, advocacy with the 3 Ps – professionals, policymakers and the public. Professionals need to be aware of the big problem of blindness. They often focus only on their own small practice and may not be conscious of the bigger picture. Policymakers have to be convinced about how effective and cost effective eye care is among all public health problems. It is an effective and cost-efficient means of addressing this problem. Public awareness is the final key in eliminating preventable blindness. If the public is aware of the causes, they can do more to avoid unnecessary risks. The second step is to identify and mobilize financial and human resources to make VISION 2020 happen. These resources must be distributed to where the needs are; where the programs have to be developed. Finally, the groups involved in the prevention of blindness and eye care delivery throughout the world must be better coordinated, leading to partnerships, which in turn would provide much more effective eye care.

Can you tell us more about the role of the medical industry?

There are several things the medical industry can do. First, they can provide the technology required for eye care. If the technology is available at an affordable price, it opens up access to more people in developing countries. The industry could also provide more resources in terms of advice and expertise, which would lead to more availability and much more effective treatments in the drive to prevent blindness. Financial contributions are also needed. The medical industry must realize that although they may not have much of a market where care is most desperately need-

ed, they open up new markets by providing the necessary resources. Medical companies have to see it as a long-term investment. As the quality of care increases, so too will the demand for their products. It is a win-win situation for everyone.

Can you give us examples of this type of cooperation?

Carl Zeiss has agreed to provide affordable surgical microscopes and slit lamps for VISION 2020. If we can teach more and more ophthalmologists, optometrists and other eye care professionals how to conduct a proper examination, they will be able to detect and diagnose the symptoms at an earlier stage, thus preventing many cases of blindness. The availability of a proper microscope will enable eye care professionals to perform procedures properly, avoiding the complications that have arisen in the past during cataract surgery in the developing world. Newer techniques and proper technology will reduce morbidity in all types of surgery. Another example of the medical industry's willingness to help is Pfizer's donation of 135 million units of erythromycin about six months ago. It is a very effective drug in the fight against trachoma. Pfizer basically said take as much as you need as long as it takes. Merck has also donated medicine in the past. And now, Carl Zeiss and Bausch & Lomb have become corporate sponsors of VISION 2020, which allows us to set up programs around the world. This is the type of cooperation that can make VISION 2020 successful. Another example is our VISION 2020 workshops. They allow us to distribute the proper tools to countries around the globe, particularly developing countries, which will enable them to establish their own national programs to control blindness. Once you have a good plan, it is easy to identify the need for resources, find those resources and get things moving.

Dr. Rao, thank you very much for an interesting and informative discussion.

www.zeiss.com/eye
www.v2020.org
www.lvpei.org

Fig. 4:
Patient visiting an eye care professional.

Fig. 5:
Eye with cataract.

Fig. 6:
Eyeglass fitting.

Multimedia Eye Care Consultation

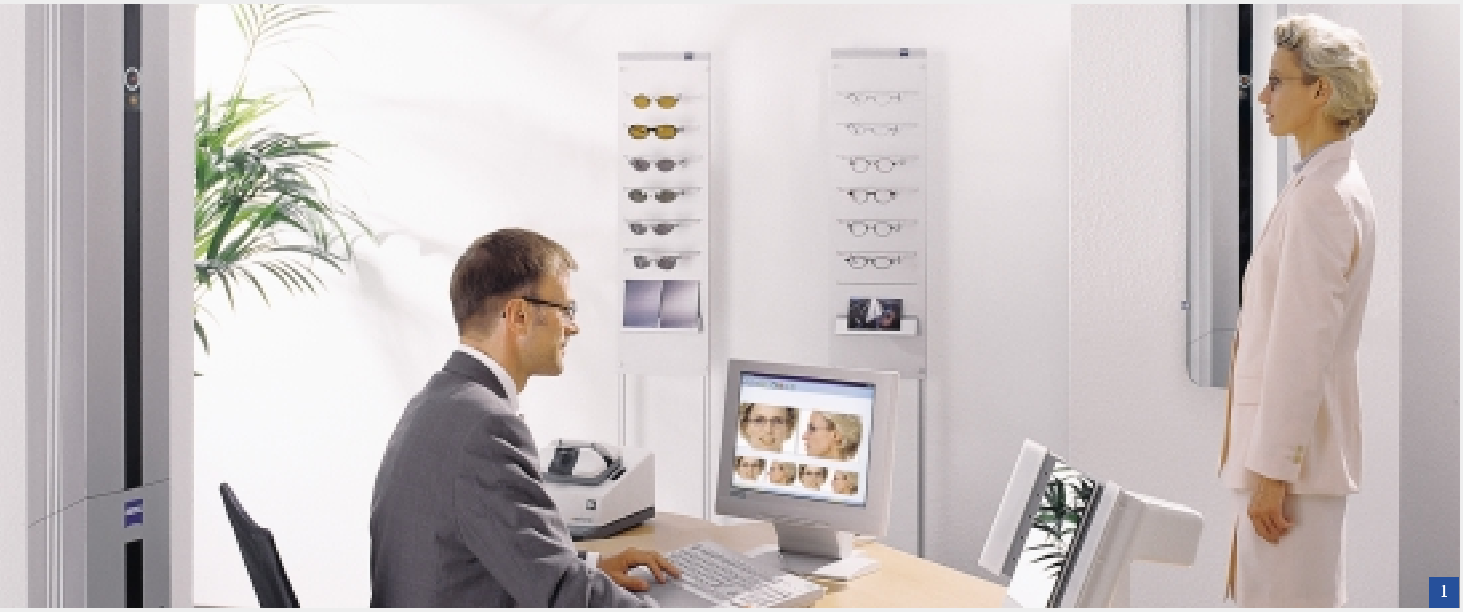


Fig. 1:
Modern eye care consultation.

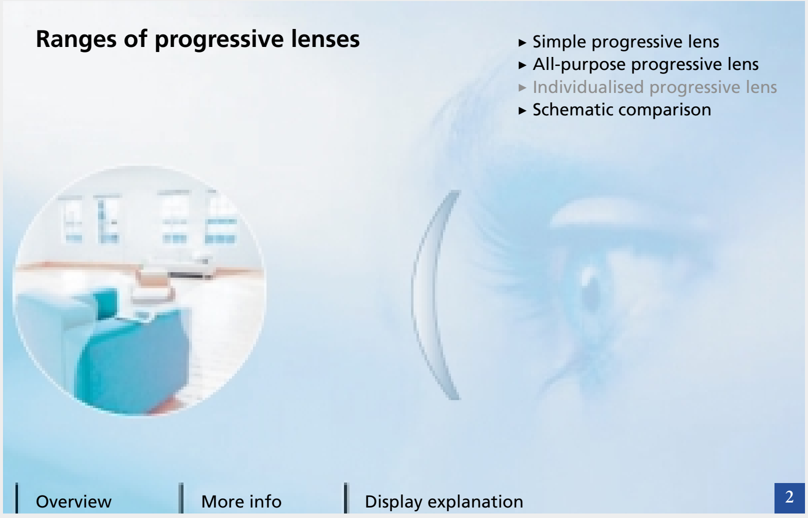
Fig. 2:
The animation "Ranges of progressive lenses" shows the different visual ranges offered by various progressive lens types.

Choosing an eyeglass frame is primarily a "matter of taste". When selecting the right lens, technical and cosmetic aspects also play an important role. Clear, easy-to-understand advice during eye care consultations helps eyeglass wearers to make their decision more easily and quickly. Carl Zeiss offers the NetFral® online consultation program with multimedia animations precisely for this purpose.

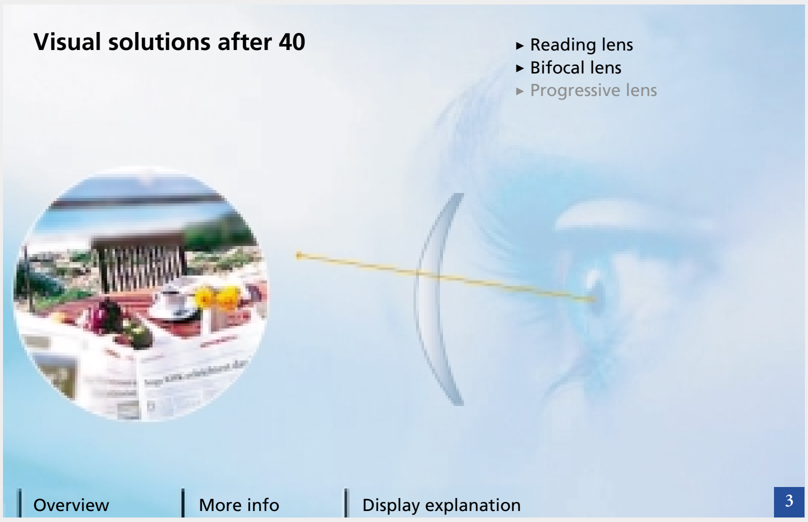
At first glance, the range of lenses on the market is just as enormous and confusing as that of frames. A broad spectrum of lenses is available: different lens types, different lens materials and numerous extras and coatings do not always make it easy to choose the right lens. Wearers are uncertain as to what lens is the best solution for their visual problem.

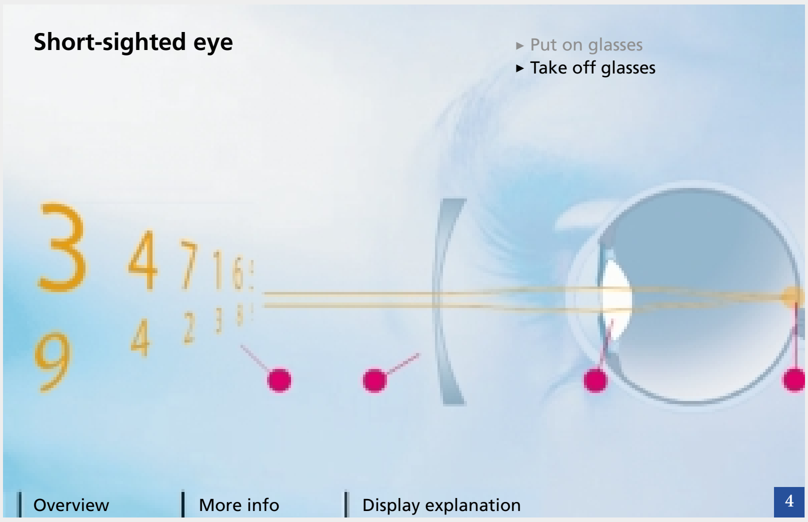
Buying eyeglasses is now a modern and informative visual experience: state-of-the-art, computer-assisted consultation systems make the diversity of lenses comprehensible and help in the decision-making process.

Eye-catching, multimedia animations make eye care consultations more understandable and effectively assist wearers in selecting the right lens for their personal needs. What wearers see through a particular lens is impressively simulated, providing them with a virtual but realistic impression of what their future vision could be like.



With **NetFral®**, the constantly updated, online lens consultation system, the eye care provider can effectively help patients to reach a decision. New visualization functions allow the patient to be actively involved in the consultation and decision. In the current **NetFral®** consultation mask, relevant or unclear terms and background material can be presented and explained in the course of the consultation. Via the keyword "Lens data", for example, the subject area "Eye & Vision" is reached, where the effects of defective vision or "ametropia" are explained in a readily understandable way using animated illustrations.





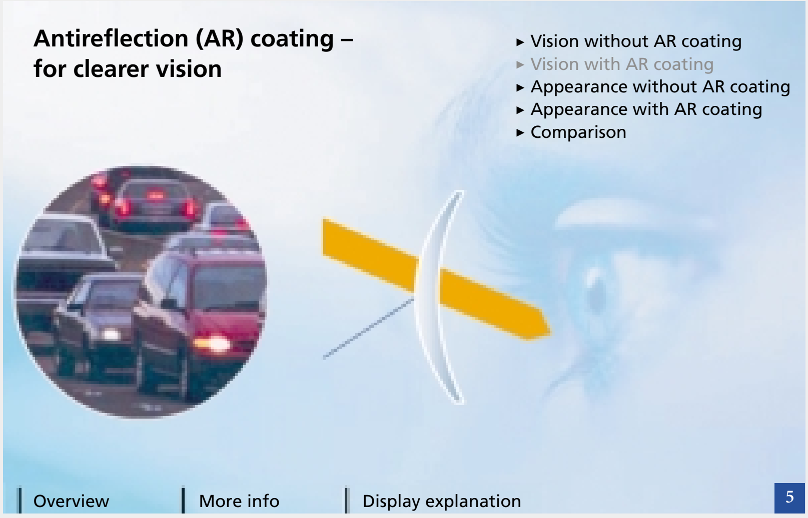


Fig. 3:
"Visual solutions after 40" demonstrate the visual image obtained with the respective solution.

Fig. 4:
The animation for the "Short-sighted eye" shows the vision of an uncorrected and a corrected short-sighted eye.

Fig. 5:
"Antireflective coating – for clearer vision" simulates both the vision and the appearance obtained with lenses featuring an antireflective coating.

What does a shortsighted eye and what does a corrected eye see? How does vision change after the age of forty? Questions that can now be visualized during consultations for a better understanding.

The leading **NetFral®** consultation system in the Carl Zeiss Partner Network has extended its proven lens consultation program by a totally new, innovative function: "Vision demos". The animations which **NetFral®** now provides with "Vision demos" in its consultation program allow a clear comparison of different correction possibilities and show how the wearer would personally see through various lenses.

The "Vision demos" function in the **NetFral®** system optimizes eye care consultations and offers benefits for both parties: it facilitates the decision-making process for the patient and underlines the professional expertise of the eye care specialist.

optics@zeiss.de
www.zeiss.de/kompendium

Round, Rectangular, Plastic, Metal, Colored

Finding a new pair of glasses is like finding a needle in a haystack. Not only does every pair of eyeglasses change your appearance, but you also literally see yourselves with different eyes. After filtering out a few favorites from a large number of models, the final decision is always a difficult one to make – after all, your new glasses will be our constant companion for a long time to come. They will ensure that you see well and look good in the many different situations experienced in everyday life. Furthermore, it is difficult, if not impossible, to assess what your finished glasses will look like if you cannot actually see them with the fitted lenses in place.

Round or rectangular lenses, a metal or plastic frame, or even colorful, extravagantly styled frames – you can now take your pick in the comfort of your own home: the Zeiss Try On software helps you preselect the models you prefer according to the motto "What type of glasses suits me best?" – and all before you visit your eyecare specialist. The procedure couldn't be easier: with the aid of a digital portrait photo, you simply follow the detailed instructions given by the program and examine the various options available. To ensure that the display is as realistic as possible, you enter the distance between your pupils at the mere click of a mouse – and the virtual fitting process can begin. In addition to different colors and shapes, various materials and tints are available. "Try On" is easy to access at www.zeiss.de/tryon.

details

Try On – Instructions

1 **Load portrait**
An ideal image has, for example, 400x600 pixels, and your head should fill practically the whole photo.

2 **Enter PD**
Enter the distance between the centers of your pupils when you are looking into the distance.

3 **Set pupils**
Click on "Set pupils" and then on your pupil centers. Red crosses appear that mark the position.

4 **Edit image**
To change the image settings (contrast and brightness), you can click on "Edit image".

5 **Select frame**
Choose your desired frame.
You can activate various possibilities here.

6 **Select tint**
After you have "put on a frame", you can select various tints and antireflective coatings.

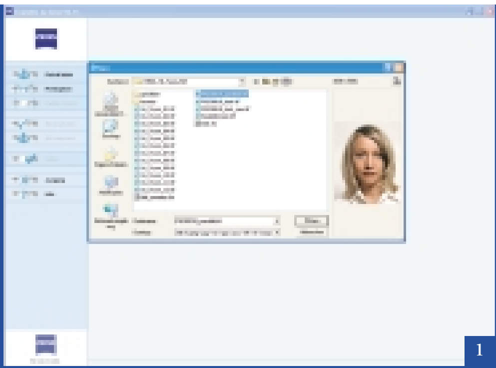
Activate the tint first, then the antireflective coating.

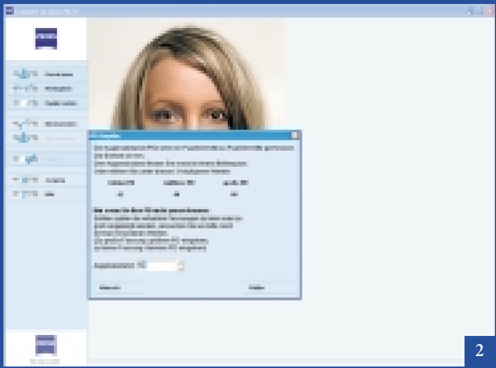
7 **Gallery**
You can use this button to get to the gallery. Here, you can compare various photos with each other and re-process them again later.

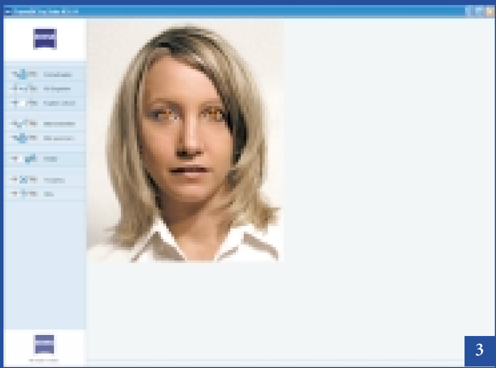
8 **Save photo**
You can save your portrait photo with frame. This photo can be opened again with standard graphic programs.

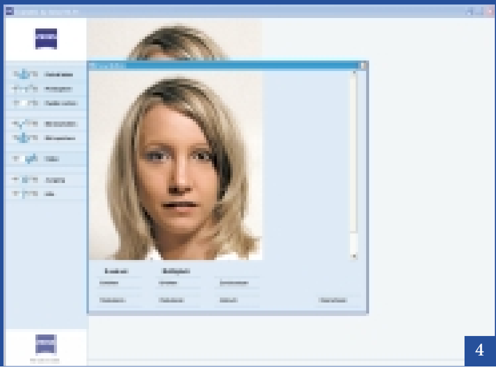
[*m.gold@zeiss.de*]

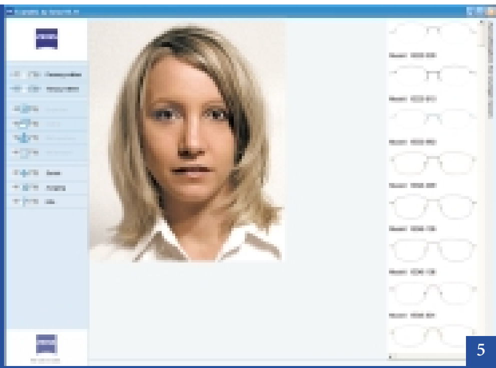
... What Glasses Suit Me Best?

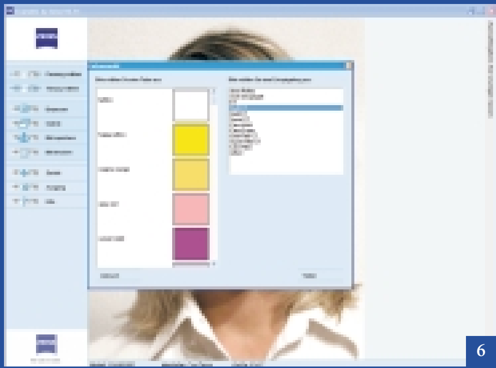

1

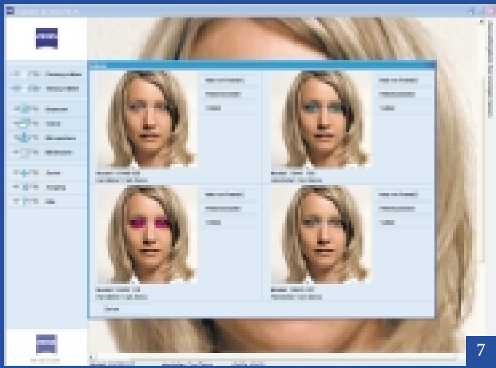

2

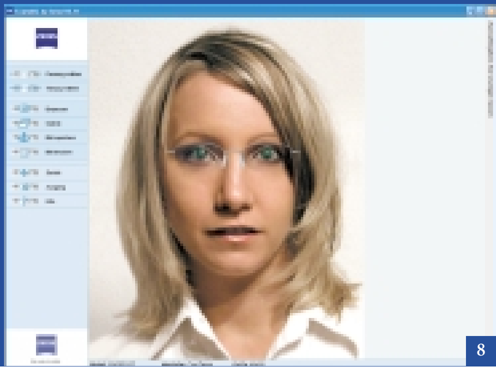

3


4


5


6


7


8

When Two Worlds Collide

Modern living and efficient work processes are linked to the challenge of receiving and sending information ever faster and more comprehensively. Innovative technology that expands and supplements the real world is known as augmented reality. Data glasses that project virtual objects and information onto the real world are one approach to making all information available in an ever more complex reality. Wearers of data glasses not only see their current environment, but also receive 3D information appropriate to their current field of view.

Augmented reality in a garage

What is now commonplace in Sci-Fi movies will become reality in the near future for service technicians thanks to BMW engineers. As cars become more complex, so too do diagnostics and maintenance. Injection of virtual data into the real world will make it easier for mechanics to find problems and eliminate them.

When repairing an engine, a mechanic will see both the real motor through the data glasses and virtual, animated tools, components, markings and instructions. The superimposed information directs mechanics from one step to the next throughout the entire repair job. The data is actually located on a computer that is wirelessly connected to the data glasses. Repair instructions incorporating augmented reality considerably simplify explanations of the various steps. Data glasses recognize the current environment by comparing corresponding markings on real components. After each step, virtual notes on the current environment are projected into the observer's visual field. Voice controls make interaction with the system even easier. Users can easily access the required virtual information via the data glasses.

Information transfer with augmented reality delivers decisive advantages in the service sector – a particular plus considering the increasing number of car models on the road.

- All information can be accessed at any time directly at a vehicle or component.
- Accessing almost textless information during a repair saves a great deal of time.
- The mechanic's hands remain free to complete the task.
- All-in-all, augmented reality technology increases the quality of the repair.

Field test: from the research lab to a real garage

Along with their partners from research and commerce, the *BMW Group* has dedicated itself toward the development of augmented reality. The *BMW Group* plays a leading role in the automobile service sector. Field tests are currently underway in several workshops to gather new knowledge and experience for the possible widespread use of augmented reality. The possible range of applications stretches across the entire service sector: from troubleshooting to repairs. Repair instructions provide detailed information on disassembling parts and components up to instructions on how to install new parts.

in short

virtual: something that exists only as an electronic image, but has no physical characteristics (Jaron Lanier).
Virtual reality (VR): specific technological development enabling people to dive into a digitally created world by using a special device.

Service technicians wear a type of headband with an integrated camera and a Head Mounted Display. When they look at the engine, for example, they see the real image along with additional information and instructions from the computer projected onto a small monitor in front of one eye. The camera recognizes certain markings from the current environment. The software runs on the computer which is wirelessly connected to the service technician. The computer not only shows the technician each step, but also indicates which tools are required and how much torque is required for a certain screw.

The next step in the development of augmented reality involves the identification of the surroundings in the observer's visual field without the aid of specific markers and codes. The camera will be able to reliably recognize the environment without requiring markings on all components beforehand.

Furthermore, the current, small monitor will be replaced by transparent data glasses that display a larger virtual object without impairing the view of reality.

www.zeiss.de
www.bmwgroup.com

details

Augmented reality projects

The ARVIKA Project 1999-2003

Research and implementation of user-oriented and application-driven augmented reality technologies (AR) to support work processes in development, production and service for complex technical products and systems is currently underway in the ARVIKA project sponsored by the German Ministry for Education and Research (BMBF) and supervised by the German Aerospace Center (DLR).

Ideas for the project are implemented in application fields relevant to German industry: automobile and aircraft construction, machine and system construction.

The improved diagnostics and maintenance know-how associated with augmented reality enables mid-sized companies to work more flexibly and efficiently, thereby increasing their competitiveness on the global market.

BMW is considered a technological leader in the interaction between the real and virtual worlds.

www.arvika.de

The ARTESAS Project 2004-2006

ARTESAS targets the exploration and evaluation of augmented reality base technologies for applications in industrial service environments. The project is based on the results of the ARVIKA project sponsored by the German Ministry of Education and Research. ARTESAS is funded by the German Ministry for Education and Research and supervised by the German Aerospace Center (DLR).

The project has three key focal points.
Markerless tracking procedures for rough industrial environments: position and orientation of users must be precisely determined in order to project virtual information about the real environment into the user's visual field. The project aims to create a universal reference system to combine the advantages of different processes appropriate to an application.
User-friendly AR devices proven under technical and ergonomic aspects: testing and assessment of newly developed instruments; availability and evaluation of an integrated solution of data glasses designed for AR with adequate portable components.
Implementation and evaluation in selected industrial application fields: service for cars, on aircraft and for automation systems.

www.artesas.de

ARVIKA

ARTESAS

New Perspectives: HMDs from Carl Zeiss

Fig. 1:
HMD design study
(Thomas Ehrig, Munich).

Fig. 2:
HMD research prototype
from Carl Zeiss.

Fig. 3:
HMD basic principle.

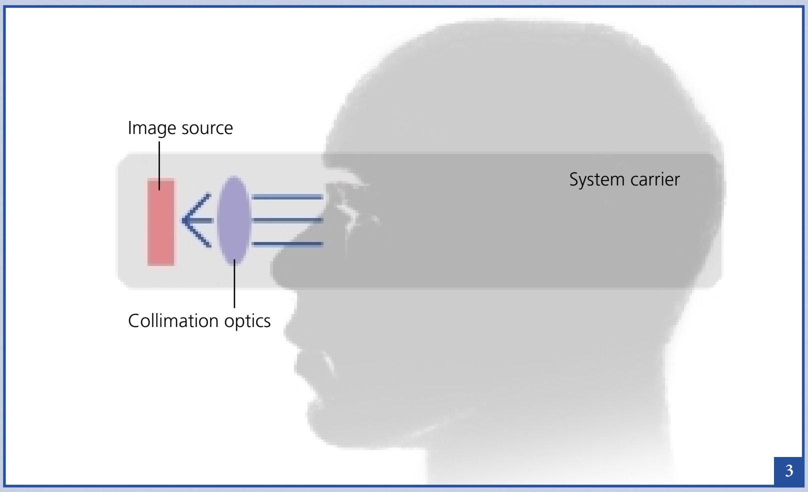
Moviegoers have long been familiar with Head Mounted Displays (HMDs). Two were shown in the James Bond film "Die Another Day", for example. The first HMDs were used by the military in the 1970s. Current designs are intended for comfortable, hands-free use – something mechanics and surgeons will greatly benefit from.

Researchers at Carl Zeiss have already developed a low-weight HMD prototype. The virtual image displays outstanding optical qualities and appears to float in front of the observer. It is the equivalent of the picture on a 21 inch monitor at a standard working distance. ARTESAS project partners can attest to the ease of use and have generally given positive feedback.

Another development stage will be completed in early 2005: an HMD prototype with a "see through design". A semi-transparent projection surface enables augmented reality, a system in which image content is added to the wearer's surroundings. The eyeglass design promises more wearing comfort resulting from the improved weight distribution.

Dr. Martin Edelmann, Optics Research
m.edelmann@zeiss.de
www.zeiss.de

2



3

The Reader Survey

We would like to thank all readers who have returned the questionnaire. Even though the survey was completed two years ago, the results should not be withheld. The return rate for a free magazine was particularly pleasing. The various suggestions showed us that the magazine is well received.

Resonance

One aspect thrilled us: the magazine is regularly read by 85% of our readers. The variety of subjects also received positive marks. We are particularly proud of the fact that 50 % of readers collect the magazine for reference purposes. Overall, ¾ of our readers want the magazine to stay as it is. This will also remain our duty in the future. The numerous comments about large or even small points and on general subject selection and design will help us to gradually alter the magazine to meet the wishes of our readers – a process that will develop from issue to issue.

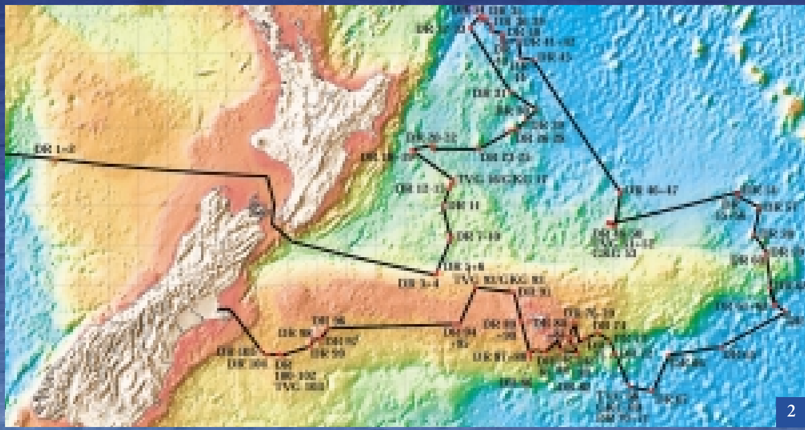
Comprehensive information offering

Additionally, many readers requested more in-depth information on applications and technologies. We will increase our efforts to include additional information and contacts for each contribution. On this note, we would also like to point out the various information available on the Carl Zeiss website – www.zeiss.de. There you can find extensive information on the company and its locations around the world, on the history of Carl Zeiss, economic figures, products and services, applications, innovative developments and current events. You can find current, worldwide addresses under "contact". You can also order brochures from all areas of the company. It is also very easy to establish contact with a sales or service organization.

You can also order sample copies of Innovation. All in all, we provide an extensive offering of information.

www.zeiss.de
magazin-innovation@zeiss.de

Fig:
Carl Zeiss International homepage.



News from the South –

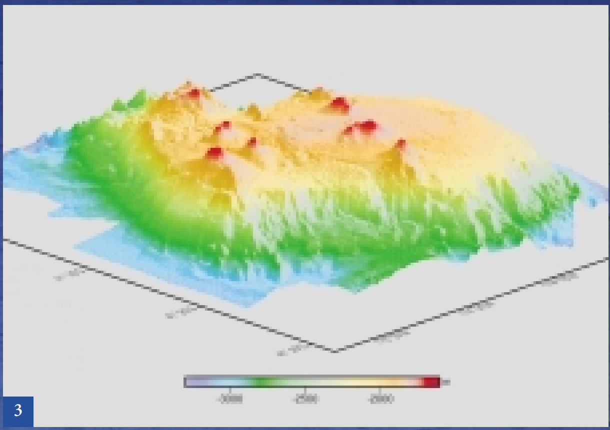
Fig. 1:
Research ship F.S. SONNE underway to new sampling areas. Provided by shipping company.

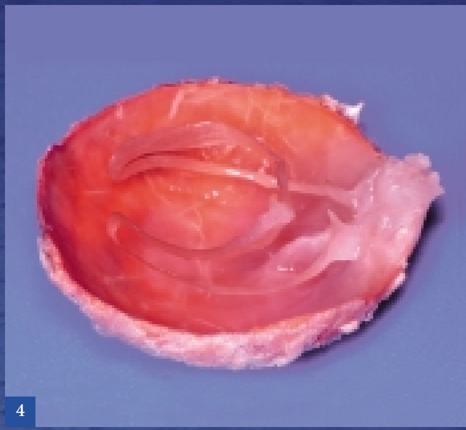
Fig. 2:
Route of the deep-sea expedition SO 168 ZEALANDIA.

Although oceans with a depth of more than 1000 m cover approx. 60% of the earth's surface, little is known about the composition of species and the distribution of animals living on the ocean floor at these depths. During the European winter of 2002/03, a group of 15 geologists and 3 biologists from Germany and New Zealand cruised on board the German research vessel F. S. SONNE near New Zealand to explore the origins of the Hikurangi Plateau, a huge tectonic plate, and its inhabitation by ocean-dwelling organisms.

In particular, samples were to be taken from long-extinct submarine volcanoes, also called seamounts. It was the 168th cruise of the F. S. SONNE. The members of the biological team were *Dr. Birger Neuhaus, Dr. Carsten Lüter* and student *Jana Hoffmann* from the Berlin Museum of Natural History.

We left Germany on December 7 to ensure arrival before the F. S. SONNE (Fig. 1) departed. By that time, the luggage for our expedition packed in a container had already been on its way to Sydney for 6 weeks. Our berth was a dream come true, located on Circular Quay below the Harbor Bridge directly in the city center. December 10: we departed from Sydney and sailed past the world-famous opera house with its bold, curved roof resembling nautilus shells, but which was supposedly modeled on the slices of a cut orange. Brilliant sunshine and a few rain clouds lingered in the background ready to stem the bush fires that had been raging for weeks. Just as we left the protective harbor, we got a first impression of what “Roaring Forties” means when referring to latitude. With swells more than 6 meters high, hardly any of us escaped seasickness. Only after another 4 days after we traversed the Cook Straits separating the northern and





Deep-sea Fauna near New Zealand

southern islands of New Zealand did the seas and our stomachs calm down. Over the next 5 weeks we saw neither land nor ship, only the vast expanse of the Pacific Ocean.

We used a satellite map (Fig. 2) to prepare for the collection of samples. They are based on satellite measurements of the sea level. The ocean surface reflects the topography and composition of the ocean bed. Deep ocean trenches, for example, cause "dents" of up to 60 m relative to mean sea level. To be on the safe side, however, we remapped the selected sample sites using our on-board SIMRAD multi-beam echo sounder. This allowed us to image the topography of the ocean bed at a depth of 2000 m across a width of approx. 20 km with height resolution of up to 10 m. The 3D map (Fig. 3) shows a seamount where we took samples. The flat plateau indicates that the former volcano used to reach the water surface where it eroded before the ocean bed with the seamount subsided or the sea level rose.

The biological growth on the volcanic rock of seamounts is gathered using a geological dredge. It is a thick, steel, toothed frame with a chain-mail back that is dragged over the seabed. Not all animals survive this less than gentle procedure unharmed. However, we still managed to capture an amazing number of live specimens: colorful yellow, red and green sponges up to 30 cm in diameter, ophiuroids, bristle worms, crabs, deep-sea corals and stone corals. *Carsten Lüter* found his favorite animal right away – a brachiopod (Fig. 4).

It got really exciting at the biologic specimen station. After finding a flat surface with the help of the SIMRAD echo sounder, we lowered the clamshell with integrated TV camera into the water at 1 m per second (Fig. 5). In principle, the dredge is a large shovel equipped with a color and a black/white video camera and also contains an illumination system.

All scientists who were not sleeping were sitting in front of monitors and feverishly following the progress of the dredger. Plankton flew across the monitor. 500 meters below the surface we saw the pink symphony of light created by the tiny creatures that disappear during the day. At night we witnessed the spectacular scene on the surface again. Each of these colonies consisting of thousands of the single organisms creates a closed pipe with a thick wall and can reach a length of up to 40 cm. Each individual animal filters the seawater for its food as it rushes in one end of the tube and out the other. The opening works similar to a jet with the water flow providing a motor for the colony. The dredge was now 2327 m deep; it should have been very close to the sea bed by now. The hoist controller stopped the dredge just above the ocean floor. He concentrated on his work. Everything depended on his experience if the

Fig. 3:
3D reconstruction of a seamount using the SIMRAD echo sounder.

Fig. 4:
Brachiopod Neothris lenticularis with skeleton. The soft body is missing.

Fig. 5:
The dredge with one color and one black/white video camera is lowered into the water.

Fig. 6:
Density gradient centrifugation is used to remove the tiny creatures from the deep-sea sediment.

Fig. 7:
The first animals are sorted out in the zoology lab.

exact spot chosen by scientists looking at a monitor will be probed or not. Fluctuations in the cable length caused by currents were well compensated for by the sophisticated technology on the hoist. The F. S. SONNE slowly moved 200 m. Many floor-dwelling fish remained unfazed by the suddenly appearing gray light. The spot lights make sea cucumbers, ophiuroids and other interesting creatures visible for a few moments. Not every station was as exciting – the mud does not have very much texture and we wouldn't see its inhabitants until we looked through the sediment on board the ship. The scientists were suddenly horrified at one station as the sediment turned into a lava field and then sediment again. We couldn't use a box grabber. Without an appropriate camera setup, it could not be very accurately positioned in a sediment field.

The TV dredge is back on board. We combed through the sediment looking for macrofauna and immediately preserved a portion of the mud in formalin. The laborious work began the next day. The sediment was placed in a large centrifuge (Fig. 6) which removed the meiofauna, or small animals up to 1 mm in size, and caught them in a sieve that has pores of only 0.04 mm. It worked as planned, even underway. The rocking ship quickly turned the subsequent sorting (Fig. 7) under a stereomicroscope into a test of how resistant biologists are to seasickness. Birger Neuhaus was ecstatic at the number of Kinorhyncha (spiny worms) (Fig. 8), tardigrades (water bears) (Fig. 9) and loricifera. The loricifera were a particularly spectacular find. Only a handful of scientists had ever seen them since they were first described in 1983. There were a significant number of them in our sample.

The shortcomings of technology became evident with many of the seamounts depicted on the satellite charts. They could not be found by the SIMRAD echo sounder and therefore do not exist. They can most likely be traced to weight anomalies on the surface of the ocean floor that falsified the satellite measurements. Our sample taking there was a washout. Surprisingly, our echo sounder system crashed whenever we crossed the 180 degree meridian, or the International Date Line. Only one thing helped. We mapped both sides of the 180 degree meridian and turned the echo sounder off when we crossed over. Very simple, but very effective.

We worked around the clock on the ship. We biologists alternated the night shift - no one really liked it. Christmas and New Year's day were the only days when almost nothing happened. The table tennis table had to make room for tables and chairs, and the room was appropriately decorated for a few days. The four-course Christmas dinner was only a small consolation for the thought of spending the holidays so many thousands of kilometers from any human


7


8


9


10

settlement. After a nice dinner together, we sang Christmas songs, exchanged gifts and celebrated – the biologists and crew together. On New Year's Eve, we fired our expired signal flares, a fitting replacement for the standard fireworks. We kept in contact with our families during the entire trip via email.

At night, hundreds of albatross sat on the water around the bright stern of the research ship. The scientists thought they were at the movies – only they were the actors and the birds the audience. Every night was similar. Chart the sample locations, lower the dredge, lay out the cable, hours of retrieving the cable, bring the dredge on deck and examine the stones and ocean inhabitants. I wondered if the birds had us mixed up with a fishing trawler.

At the end of the trip, we had a good 60 kg of sediment, more than 10,000 meiofauna organisms and 2,000 specimens of macrofauna. While still on board the F. S. SONNE, it was clear that we had already discovered new species. How many would only be determined in the next two years during the evaluation at the Museum of Natural History. Three biologists and specialists for certain animal groups, both from Germany and from abroad, will support us as we identify and describe any new animal species. A picture of the variety of floor-dwelling creatures, and the mechanisms that influence their distribution will become clear only after additional deep-sea expeditions to different oceans.

Dr. Birger Neuhaus and Dr. Carsten Lüter, Jana Hoffmann, Museum of Natural History, Central Institute of the Humboldt University in Berlin, Institute for Systematic Zoology
www.museum.hu-berlin.de

Fig. 8:
Kinorhyncha (spiny worms) propel themselves forwards using their spiny head. The head on this male Camplyoderes cf. vanhoeffeni (body length ca. 0.37mm) is almost completely retracted.

Fig. 9:
An adult Loricifera, body length ca. 0.5 mm), an undescribed species is about to hatch.

Fig. 10:
Stones found east of New Zealand at depths of 300-500 m are often overgrown with sedentary animals (sponges, bryozoans, muscles, tube-building bristle worms).

Mudpack for David

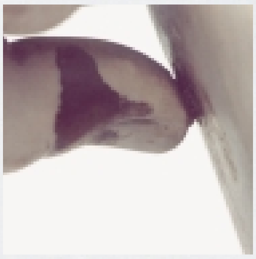
Fig. 1:
David's head.
One of the precise digital pictures taken during the Michelangelo Project conducted by the University of Stanford in California. It was taken while work was being done on the statue between 1999 and 2000.

Fig. 2:
Removal of dirt from the head of the statue.

Michelangelo's David – one of the antique world's symbols of youthful beauty and athletic perfection. He is the embodiment of a beautiful young man. The sculpture shows David holding a stone on his shoulder while taking aim at Goliath. His hip cocked, his shoulder lowered, his arms waiting for the fight, his view focused on the distance, it is a mixture of physical relaxation and extreme mental concentration.

"I am not dead,
I am only changing rooms.
I live in you
and walk through your dreams."

Michelangelo Buonarroti – Michelagniolo di Ludovico di Buonarroti Simoni
Sculptor, painter, builder and poet.
Master of the Italian high and late Renaissance.
Born March 6, 1475, in Caprese (today, Caprese Michelangelo) in Casentino near Arezzo
Died February 18, 1564 in Rome;
buried in Santa Croce, Florence



Middle finger on the right hand with traces of dirt.

Plaster filling on leg with a small silicate implant.

Plaster filling on stomach with several silicate implants.

Working for the city of Florence, Michelagniolo di Ludovico di Buonarroti Simoni, Michelangelo for short, completed his statue of David in 1504. It is a masterpiece from the short period known as the High Renaissance and a symbol of republican pride. Closely associated with the spirit of the Italian city-states of the time, David represented the glory of the citizens of Florence and a warning to opponents of freedom.

500 years in Florence

Michelangelo, 27 years old, multi-talented star of the Renaissance, began his work on September 13, 1501. The city granted him an advance payment of 400 ducats. Three years later, on September 8, 1504, he presented his mythical hero in the legendary relaxed pose.

David was carved from a single block of marble. He is 5.16 m tall, weighs 5.5 tons and was on display more than 500 years ago at the Piazza della Signoria. Despite being struck by lightning, a broken arm and toes, he remained there until his move to the Galleria Dell'Accademia 1873. A more weatherproof copy replaced him in front of the Palazzo Vecchio. In addition to the weather and the natural erosion process, David was most endangered by mankind: in 1527, his left arm was broken off during an uprising against the Medici clan. He lost toes in 1813, 1851 and finally in 1991. During the last century, restorers acid-washed and polished him.

Mudpack out of pulp and clay

Following a bitter dispute over the cleansing procedure, the Italian government authorized restoration of David in 2003. The famous statue was "dusted" in a very time-consuming and expensive process. David remained on display to the public during the eight-month procedure which did not use chemicals as originally planned, but only distilled water and paper towels. He was then completely measured and his ankles x-rayed. Result: the ankles with the slight cracks will hold until the next earthquake. The areas to be cleaned are covered with a piece of rice paper which is then moistened with distilled water. A mudpack consisting of pulp and clay is then placed over the area. The pulp remains on the statue for approximately 15 minutes and soaks up any dirt. The piece of paper prevents anything other than water from adhering to the marble.

David's now flawless surface has been freed from the dirt and dust that has been building up for almost 500 years. He will be dusted every six weeks by the restorers in the future.

Left arm, visible crack on lower arm filled with light-colored plaster.

Stump on the back of the statue with chalk filling.

Joint on the back of the pedestal with plaster filling and silicon implant.

Pictures: Fabio Fratini, Istituto per la conservazione e la valorizzazione dei beni culturali, Florence, Italy; http://server.icvbc.cnr.it/

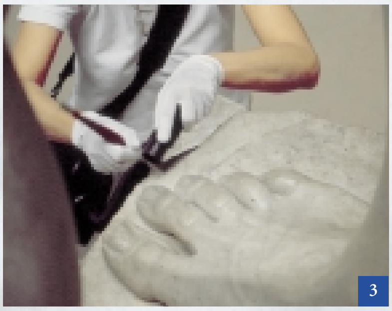


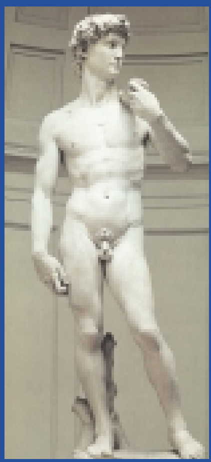
Fig. 3:
Careful cleaning on the statue's pedestal.

Fig. 4:
Mudpack on the left shoulder. The areas to be cleaned are covered with a piece of rice paper which is then moistened with distilled water. A mudpack consisting of pulp and clay is then placed over the area. The pulp remains on the statue for approximately 15 minutes and soaks up any dirt. The piece of paper prevents anything other than water from adhering to the marble.

http://www.sbas.firenze.it/accademia/
http://server.icvbc.cnr.it/
http://graphics.stanford.edu/projects/mich/

details

David, Israeli king around 1000 B. C., defeated the Philistines and is closely connected to the saga of David and Goliath. Goliath was a Philistine warrior known for his size. David slew him with a slingshot. David's biblical victory (1 Samuel 16) over Goliath was the symbol of political independence for the citizens of Florence during the Renaissance.



Identifying Pigments

1

An important step towards our understanding of works of art and their history is the composition of the pigments used by the artists. Knowledge of their main elements, such as the pigments and bonding agents used, is vital for the preservation of paintings, frescos and murals, in particular. Examinations of such compounds are usually done with destructive techniques in which a sample or microsample is required. Due to the uniqueness of the artwork, samples for external studies can only be taken with the utmost caution and only when they are vital for gathering additional information for the preservation of the piece. As a result, the need for the development of non-invasive techniques to identify pigments is growing.

Fiber-optic Reflectance Spectroscopy (FORS) in the ultraviolet (UV), visible (VIS) and infrared (IR) range has become a powerful tool used to capture spectroscopic data. This method requires no sample of the material, eliminating the limitations and problems associated with sample taking. Furthermore, non-contact measurements using lightweight and compact measuring devices can also be taken directly on site on objects that can not be removed from their location (murals, large paintings, etc.). This method is already being used to identify pigments, to test for the presence of products of change processes, and to analyze colors and color changes in paintings as the measured area (spot) can be remeasured later.

This allows measurement of the entire surface of the painting across a large number of spectrums and can be used as a basis for comprehensive data material for subsequent statistical analysis.

"Il ritratto della figliastra" by Giovanni Fattori

Scientists Mauro Bacci, Costanza Cucci, Marcello Picoll and Bruni Radicati from the Nello Carrara Institute for Applied Physics in Florence, Italy, used FORS technology while restoring Giovanni Cucci's 1889 painting "Il ritratto della figliastra". The painting is among the collection at the Gallery of Modern Art in the Palazzo Pitti in Florence. With permission from Carlo Sisi, director of the museum, and the support of Muriel Vervat, it was possible to identify the white pigments used by the painter (Fig. 1). One of Giovanni Fattori's most representative works, "Portrait of a Stepdaughter", is considered throughout the world as the leading example of the Macchiaioli movement.

details

2

Giovanni Fattori (1825-1908) is considered one of the most important representatives of the Macchiaioli movement. "Macchiaioli" is derived from the Italian word "macchia" and means spot or blot. It is one of a small group of painting techniques developed by Italian artists. The "daubers" are stylistically related to the impressionists but with more nationally-oriented content.

The Macchiaioli congregated around Giovanni Fattori in the Maremma region. They rejected academicism and campaigned for realism. They fought against the strict academic view of art and broke with traditional allegoric subjects that were so beloved in the first half of the 19th century.

For their motifs, they concentrated on nature and everyday life of the simple folk. They carefully observed the interaction between light and shadow on real objects and painted outdoors with portable easels and paint boxes. The spotted colored surfaces with strong contrast between light and dark areas are typical of their works. Integral elements of the image composition, such as people, animals, trees, etc. are starkly contrasted with the background. Figures are schematized and details are reduced to the essentials.

3

Fig. 1:
Giovanni Fattori:
"Il ritratto della figliastra" (Portrait of a Stepdaughter).

Fig. 2:
Giovanni Fattori:
Self portrait.

Fig. 3:
Giovanni Fattori:
"Gotine rosse" (Red Cheeks).

details

Fiber-Optic Reflectance Spectroscopy (FORS)

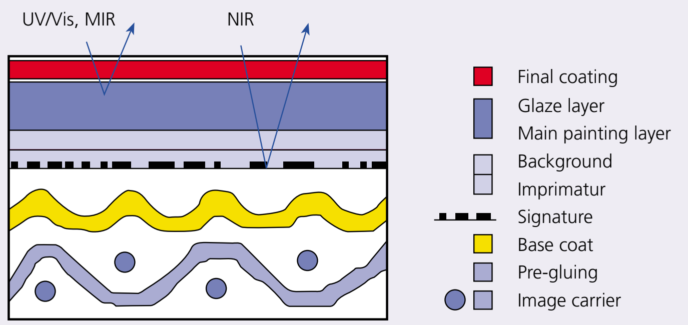
MCS 501 UV-NIR/CLH/F

Reflectance spectroscopy is a technique that is ideal for gathering information regarding the reflectance and absorptance behavior of surfaces in the spectral range between 300 nm (UV) and 1000 nm (near IR).

The word reflectance (from Latin reflectere: return, bend, twist) describes the fraction of radiant energy that is reflected from a surface.

Absorptance (Latin: absorptio or absorbere = draw off, soak up) generally describes the ratio of absorbed to incident radiation.

Optical sensors can determine artists' pigments without touching the painting.



UV/VIS: Ultraviolet/VISible light | MIR: Middle InfraRed light | NIR: Near InfraRed light

Non-invasive analysis

Reflectance spectrums of small areas with a diameter of approx. 5 mm were recorded in the 350-1000 nm wavelength range using an **MCS 501 spectrometer** from Carl Zeiss. The spectrometer was equipped with a self-built reflectance probe head and two optical fiber bundles. A 99% Spectralon® was used as a diffuse reflectance standard for calibration.

There are three aperture diaphragms located on the ball head of the 3 cm, dark, semi-spherical probe head. The two symmetrically attached aperture diaphragms at 45° relative to the vertical axis of the sphere head are used to beam light into the area of the sample to be examined. The third diaphragm on top of the ball head is used to receive the light emitted by the specimen. Selection of a 45°/0°/45° probe configuration enabled working with diffuse reflectance in which the reflected light is measured at an angle of 45° relative to the incident light. This permitted avoidance of specular, reflected light.

The areas to be examined were marked with a transparent Mylar film which also facilitated identification of the spots after a given timeframe. Circular holes corresponding to the selected measurement areas were cut into the Mylar film after several reference markings were added to the film and which corresponded to clear and distinctly contoured areas on the painting.

The results on "Il ritratto della figliastra"

A number of reflectance spectrums from white pigment lab samples were recorded for use as a reference library for pigment identification. Lead white [$2PbCO_3Pb(OH)_2$], zinc white [ZnO] and titanium white [Rutil, TiO_2] were selected as reference substances. They are the most likely substances to be used in modern oil paintings.

Approximately 50 areas on the painting were then analyzed. The majority of measurements were made on white or very light areas of the painting. Three spectrums were recorded for each analyzed area, and each spectrum represented an average of three single measurements.

The most distinct marker for the spectroscopic identification of these substances was the spectral behavior in the 350-450 nm range. The rise of the spectral curve allows clear distinction between the three pigments. This became clearer in the first derivation of the reflectance spectrums of the three white pigments. Measuring peaks of approx. 385 nm or 408 nm were recognized in the first derivative curves for zinc white and titanium white, while the first derivative curve from lead white in this spectral range displayed no characteristic peaks. The spectrums of a white spot on the dress (point A) and a spot on the white part of the neck band (point B) were recorded. The use of zinc white was clearly seen in the latter spectrum, while the spectrum of the white spot on the arm displayed a steady rise with a reflectance signal of approximately 30% in the measured UV range (350-380 nm), corresponding to the expected values of white lead. This result was confirmed by the first derivative curves calculated from the reflectance spectrums. The first derivative curve for point B indicated a distinct maximum of approx. 382 nm, i.e. near the value of the measuring peak of the zinc white reference sample. Furthermore, the derivative curve calculated from the reflectance spectrum for point A contained no peaks and displayed the same gradient as the first derivative curve of the lead white reference sample. There were no indications of the presence of titanium white, which can be seen as evidence of the assumed integrity of the original painting that has enabled no additional retouching since 1930-1940.

Marcello Picollo,
Institute of Applied Physics, Florence, Italy
www.ifac.cnr.it
www.zeiss.de

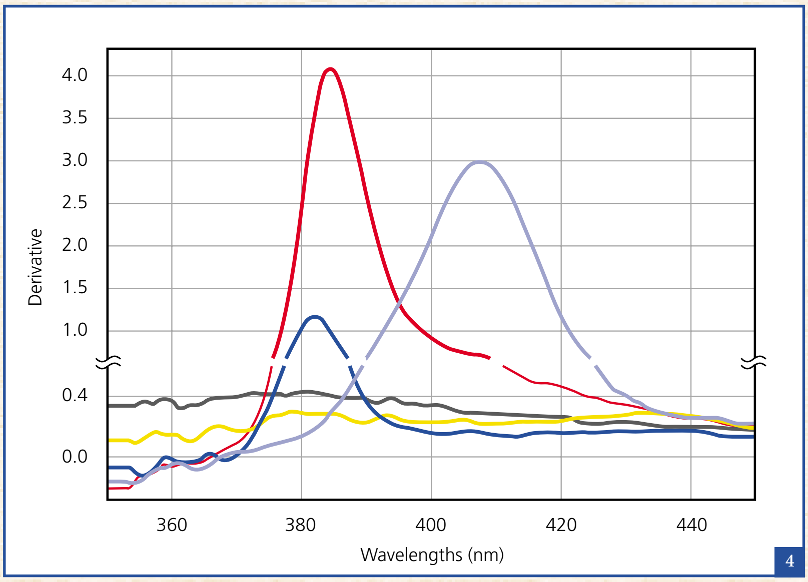


Fig. 4:
Reflectance spectrum of the reference pigments: lead white (black), zinc white (red) and titanium white (light blue).
Reflectance spectrum of the measuring points in the painting: point A (yellow), point B (dark blue).

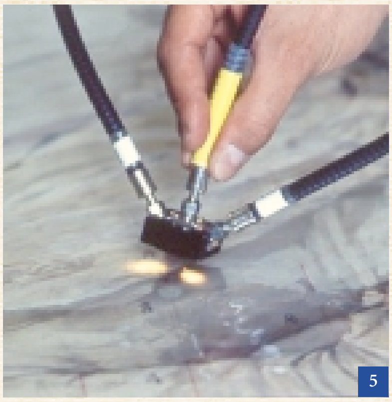
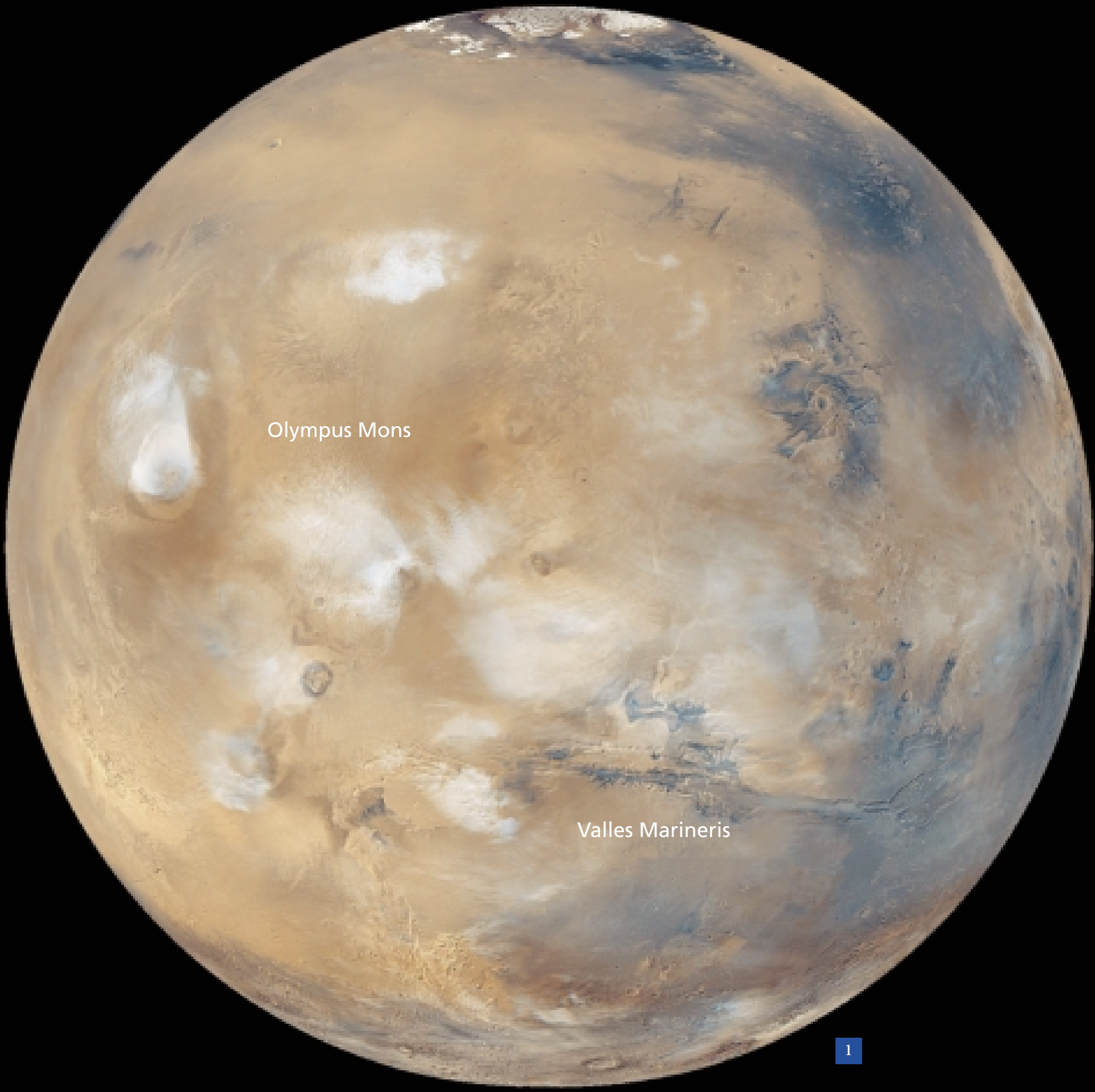
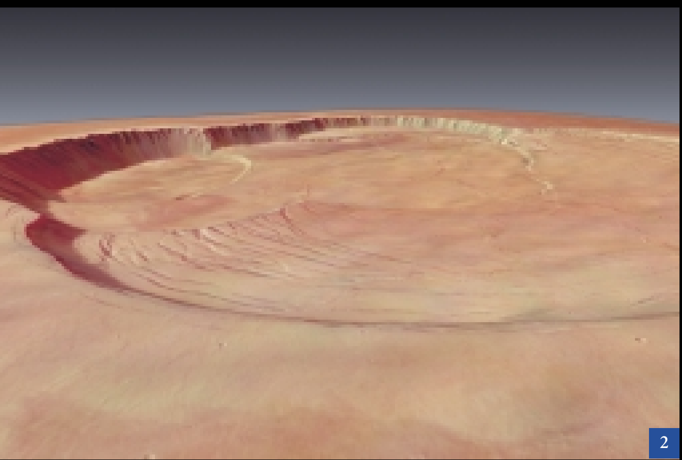


Fig. 5:
Measuring head.

Fig. 6:
Measurements on "Il ritratto della figliastra".



Express Mission to Mars



The European Space Agency ESA has launched its first planetary probe – Mars Express – on its journey to explore our red neighboring planet. The Mars Express spacecraft lifted off on June 2, 2003 from the Russian Baikonur Cosmodrome in Kazakhstan aboard a Soyuz Fregat booster. Mars Express is the most recent in a series of missions to Mars and opens up a new era of intensive research on the red planet.

Scientists expect to obtain important new data on the planet's geology, mineralogy and atmosphere. The greatest and most ambitious challenge is the search for traces of earlier life on Mars.

Equipped with high-precision scientific instruments, the spacecraft will explore the planet's atmosphere, surface and sub-surface layers. Its primary task, however, is the high-resolution 3D color mapping of the Martian surface.

A special camera will be used for the first time on a space mission to systematically map a planet's surface using high-resolution, 3D, color images. The HRSC (high resolution stereo camera) developed and operated by the Institute for Planetary Research at the German Aerospace Center in Berlin-Adlershof uses a stereo camera head to capture details on the planet's surface no larger than a one-family house from a distance of approx. 270 kilometers. The second camera head featuring an extremely high-resolution ZEISS lens from Jena identifies objects such as boulders the size of a garage or layers in sedimentary rock. Similar to a magnifier, the SRC (super resolution channel) lens is designed to capture areas of special interest on the Martian surface with a resolution of 2 to 5 meters per pixel.

Mars Express is comprised of two units: the Beagle 2 lander and the orbiter. Beagle 2 detached from the orbiter on December 19, 2003 for a soft touchdown on Mars in order to search the planet for traces of life. However, all attempts by ESA to establish radio contact with the lander have since failed, and Beagle 2 was abandoned as lost. The orbiter has continued to circle Mars since December 25, 2003 to fulfill its mission of using the HRSC camera to map the Martian surface in 3D and color with unprecedented accuracy. The heart of the camera is an outstandingly precise mirror lens manufactured by Carl Zeiss for Jenaoptronik GmbH.

The HRSC camera – a high-resolution stereo color camera – was developed under German direction for the Mars 96 Mission. Weighing only 20 kg, the HRSC features two camera heads: the high-resolution stereo head consisting of 9 CCD line sensors located in a parallel arrangement behind a lens objective, and the SRC head comprising a mirror tele lens and a CCD array sensor.

The first picture of Mars (Fig. 1) was captured with the high-resolution Zeiss tele lens from a distance of 5.5 million kilometers. The color information was provided by the HRSC and combined with the high-resolution picture. The ice cap covering the planet's south pole is clearly discernible.

[*www.zeiss.de*
www.esa.int/SPECIALS/Mars_Express/]

details

The HRSC camera (High-Resolution Stereoscopic Camera) is a high-resolution stereo color camera developed under German direction for the Mars 96 Mission. Weighing only 20 kg, the HRSC features two camera heads: the high-resolution stereo head consisting of 9 CCD line sensors located in a parallel arrangement behind a lens objective, and the SRC head comprising a mirror tele lens and a CCD array sensor.

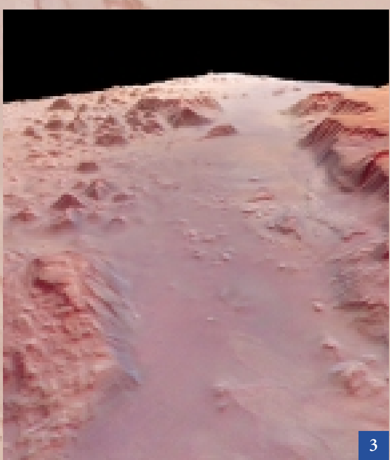
Fig. 1:
Mars.

Fig. 2:
Caldera Olympus Mons.

Fig. 3:
Valles Marineris.

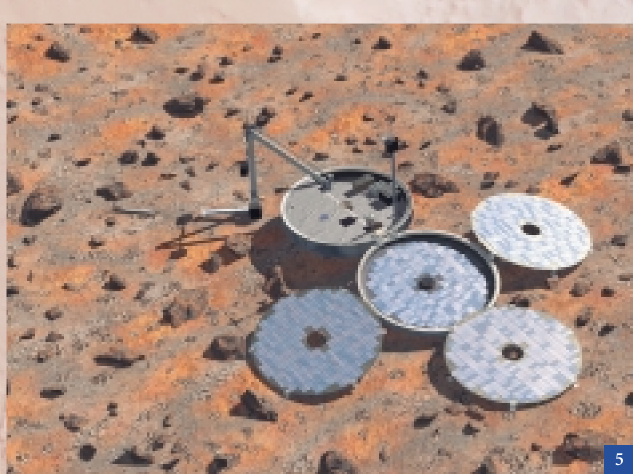
Fig. 4:
Mars.

Fig. 5:
Beagle 2 lander.

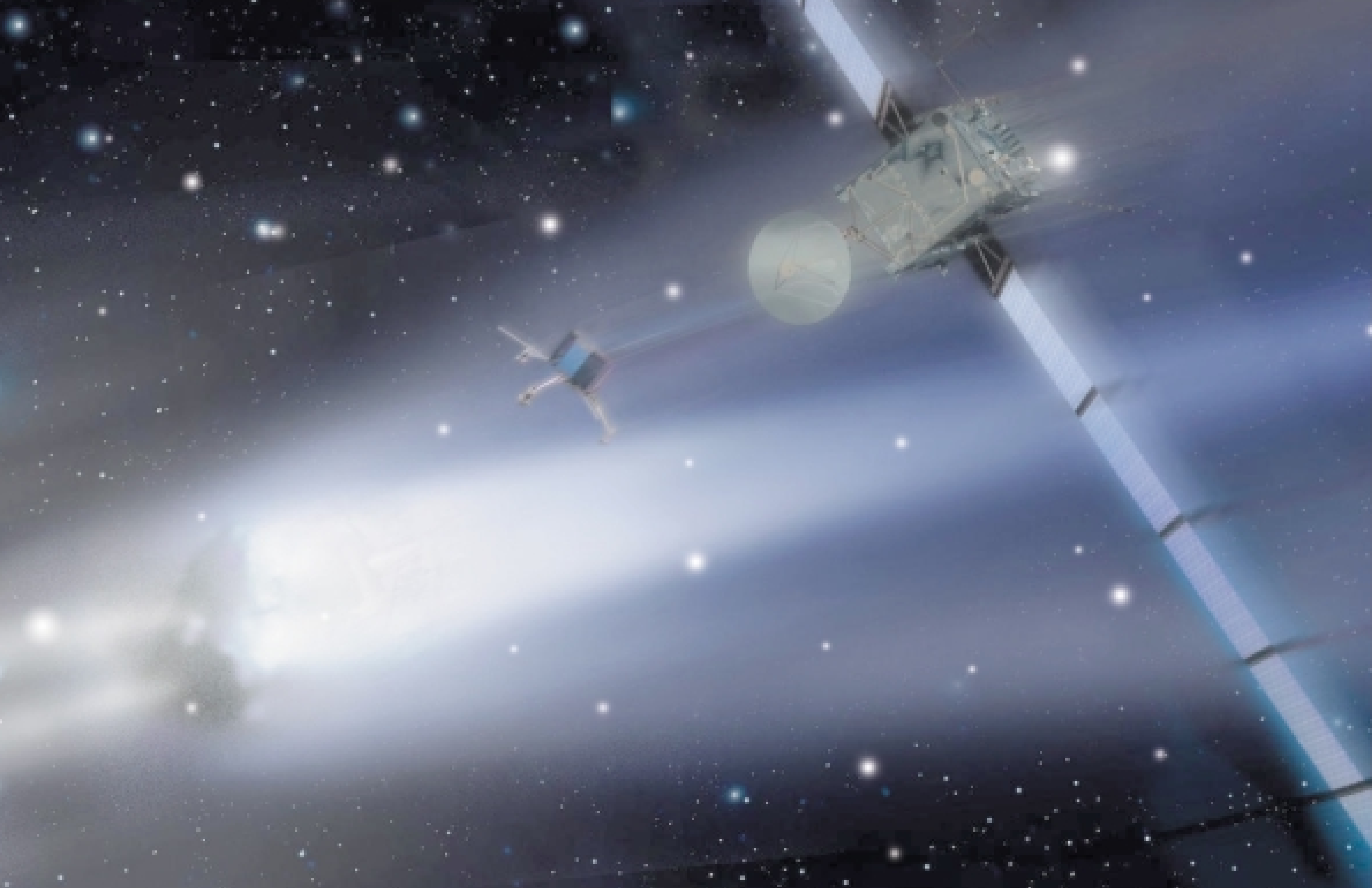


3

4



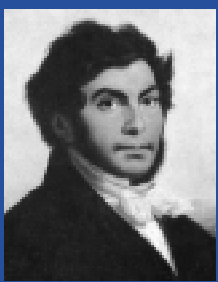
5



Carl Zeiss Chases after Comet Churyumov-Gerasimenko

French Guyana: the Rosetta mission successfully launched from the European space station in Kourou on its 10-year comet-chasing expedition. Approximately two hours after its launch on March 2, 2004, on an Ariane 5 rocket, the Rosetta spacecraft settled into its flight path to catch comet "Chury". The journey will lead back to the origins of life: the goal is to find new information permitting us to decipher the evolution of our solar system. Spectroscopy is one of the investigation methods used in the ambitious project.

Comets are giant, dirty snowballs. Their solid nucleus measuring only a few kilometers is surrounded by ice and a variety of frozen gases mixed with dust-like particles. Driven by the solar wind, a comet's visible tail is composed of gas and dust, the material lost by the comet as it heats up on its flight past the sun. Comets may be seen as the "index fossils" of our solar system. They were born 4.5 billion years ago, like the sun and planets. However, they have not undergone any major changes since then. From time to time, a chunk of a comet is propelled towards the sun, offering us the opportunity to visit it in a relatively short time, and to gather further information about the origins of our solar system 4.5 billion years ago.



French scientist Champollion succeeded in deciphering the hieroglyphs on the Rosetta Stone in 1822. This was a crucial breakthrough in unraveling the secrets of ancient Egyptian civilization.

Jean-Francois Champollion,
French egyptologist, 1790-1832.


1

Fig. 1:
Work on the Rosetta lander.

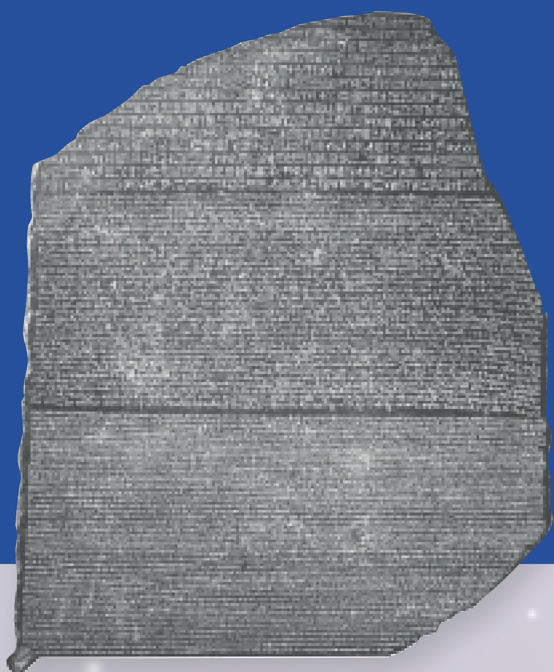
details

The Rosetta Stone

The Rosetta Stone is a slab of black granite with inscriptions carved in three different scripts which helped to decipher the Egyptian hieroglyphs.
The stone has been in the British Museum in London since 1802.

The dimensions of the Rosetta Stone are impressive: 114 cm high, 72 cm wide and approx. 28 cm thick. It weighs 762 kilograms. The inscriptions on the Rosetta Stone are in two languages, Egyptian and Greek, with the Egyptian text written in hieroglyphs and Demotic.

Unfortunately, only the last 14 lines of the hieroglyphic text remain, corresponding to the last 28 lines of the Greek text. However, most of the missing lines of the hieroglyphic inscription have been restored using a copy of a decree on an obelisk discovered near Damanhur in 1898. A further version of the text on the Rosetta Stone was found on the walls of Isis' birthplace on the island of Philae.



The Rosetta mission and the Philae lander

The mission's name was derived from the Rosetta Stone found in 1797 in the village of Rashid (Rosetta, Rosette) in the Nile delta while Egypt was occupied by *Napoleon*. The inscriptions on the stone date back to 196 B.C. and show the text of a decree in three different scripts: hieroglyphs, Demotic and Greek. French scientist *Jean-Francois Champollion* succeeded in deciphering the hieroglyphs on the stone in 1822.

This was a crucial breakthrough in unraveling the secrets of ancient Egyptian civilization. An obelisk from the island of Philae on the Nile also played a key role in deciphering hieroglyphs. It shows bilingual hieroglyphic inscriptions including the names of Cleopatra and Ptolemy.

The spacecraft is due to reach *Churyumov-Gerasimenko* in 2014 and establish orbit. The lander named after *Philae* will then separate and attempt to land on the comet. The 10-year journey is extremely demanding on the technology: all systems must function perfectly when *Rosetta* reaches its destination. To ensure this, the spacecraft will go into "hibernation" for a period of two and a half years during the journey. All systems including the scientific payload will be shut down. Only the on-board computer will continue to operate.

The box-shaped spacecraft measures 2.0 x 2.1 x 2.8 meters and weighed approx. 3 tons at its launch, with the propellant accounting for as much as 1670 kg and the lander for a mere 100 kg.

Most of the energy required for the long journey will be supplied by two solar panels with a total surface of 64 square meters. The spacecraft will circle the sun, with three flybys of the earth and one fly-by of Mars until 2009. Only then will it head for comet *Churyumow-Gerasimenko* where it is due to arrive in 2014. Touchdown is scheduled for November 2014. Approximately one year later, in December 2015, the **Rosetta mission** will be completed.

Fig. 2:
Instrument on the Rosetta lander undergoing function testing.

Spectroscopy using components from Carl Zeiss

Initially, the **VIRTIS** (visible and infrared thermal imaging spectrometer) experiment will be conducted to map the comet's surface, find a suitable landing site for the lander and, subsequently, to spectroscopically analyze the comet's tail. Two different spectrometer systems, **VIRTIS-H** with high resolution in the infrared range and **VIRTIS-M** with medium resolution in the UV to IR range, will be used for the spectral analysis of the light. The diffraction gratings needed for spectral analysis were developed and manufactured by Carl Zeiss in Oberkochen and by Galileo Avionica in Florence, Italy, for the French DESPA Institute in Paris Meudon.

Due to the high spectral resolution and high diffraction intensity required, the structure of the diffraction gratings had to be engineered with nanometer accuracy. This was achieved by using holographic lithography and the Zeiss **GTM6** high-precision grating ruling machine. Testing was performed by atomic force microscopy. The newly developed ion etching technology for constant variation of the groove shape across the grating surface meets all requirements with respect to the compensation of the detectors' spectral sensitivity curves and the distribution of incident light intensity. One of the gratings is the result of a three-year development and manufacturing project and is probably the most complex grating ever made.

Comet Linear (C/2002 T7) which reached its perihelion in late April provided an excellent first test object for the scientific payload on board the Rosetta spacecraft. The camera and three further measuring instruments were prematurely activated to benefit from the favorable position of the comet. Almost simultaneously, the spacecraft supplied spectra of the object, ranging from the UV to the microwave range, whose evaluation is expected to take some more time. The presence of water vapor detected by the instruments in the comet's coma confirms the measuring results of the European Solar and Heliospheric Observatory (SOHO) obtained last December when frozen water was released by the comet's nucleus.

[*www.zeiss.de*
http://www.esa.int/SPECIALS/Rosetta/]

Zeiss Asteroids in the Universe

On January 1, 1801, while scanning the constellation Taurus in the telescope of the observatory in Palermo, Sicily, astronomer and theologian *Giuseppe Piazzi* saw a faint star not recorded on any star map. Piazzi had discovered the first asteroid. He baptized the celestial body Ceres Ferdinandea. The Roman goddess Ceres is the patron saint of the island of Sicily. The second name allocated by Piazzi was intended to honor King Ferdinand IV who ruled Italy and Sicily at the time.

Approximately 220,000 asteroids are known to date, but their actual number is likely to total over one million. Only a tiny minority of them, however, boast a diameter of more than 100 km. The small, planet-like objects circle the sun on Keplerian orbits. Formerly called asteroids (star-like objects), these celestial bodies are now termed small planets or planetoids by astronomers.

The designations of planetoids are composed of a number followed by a name. The number indicates the chronological sequence of the celestial body's discovery. It is only assigned if the discovery of the planetoid has actually been confirmed.

In addition, the discoverer has the right to suggest a name for his discovery. *Piazzi*'s suggestion **Ferdinandea** for the first planetoid ever observed did not meet with the approval of the international astronomical community, and Ferdinandea was simply omitted. This means that the planetoid's official name is **Ceres**.

Planetoids

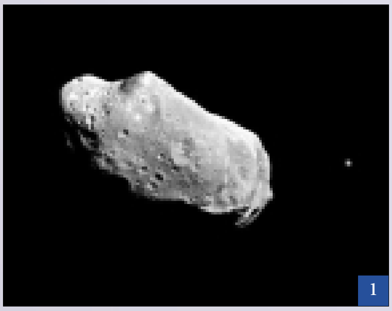
(526) Jena, (851) Zeissia,
(1553) Bauersfelda, (5224) Abbe,
(5489) Oberkochen

The planetoid which today bears the name of Jena was probably discovered in 1904 by the Heidelberg astronomer *Maximilian Franz Joseph Cornelius Wolf*. *Sergei Ivanovich Beljawsky* discovered a planetoid at the Simeis Observatory in Ukraine on April 2, 1916 and named it **Zeissia** in honor of Carl Zeiss. *Karl Wilhelm Reinmuth* who worked at the Königstuhl Observatory in Heidelberg named a planetoid discovered on January 13, 1940 **Bauersfelda** to honor the inventor of the planetarium, *Walther Bauersfeld*.

Abbe was the name assigned by *F. Borngen* to a planetoid detected on February 21, 1982 at the Thuringian Karl Schwarzschild State Observatory in Tautenburg. Planetoid **Oberkochen** was discovered on January 17, 1993 by *Y. Kushida* and *O. Muramatsu* at the Yatsugatake Observatory.

Ceres remained the largest known planetoid until a few years ago. It then yielded its rank to larger objects found in the Kuiper Belt: **Varuna** with a diameter of 900 km, **Quaoar** (planetoid 2002 LM60) with a diameter of 1280 km and planetoid **2004 DW** (discovered on February 17, 2004, no name assigned yet) with a diameter of 1800 km. Beyond the Kuiper Belt, asteroid 2003 VB12 (preliminary name **Sedna**) with a size of some 1500 km was discovered in late 2003.

[*www.zeiss.de*]



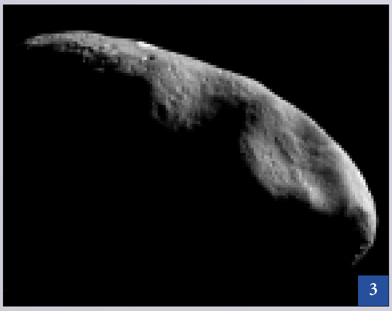
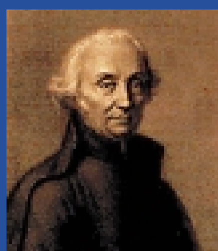


Fig. 1:
Planetoids Ida and Dactyl.

Fig. 2:
Planetoid Gaspra.

Fig. 3:
Planetoid Eros.



Giuseppe Piazzi detected a faint star not recorded on any star map while scanning the constellation Taurus. *Piazzi* had discovered the first asteroid, which he baptized Ceres Ferdinandea

Giuseppe Piazzi, astronomer and theologian

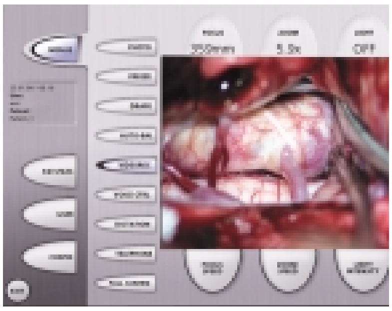
reddot Design Award

The reddot design award is considered an international seal of design quality and is a much-coveted trophy. There is more to reddot than just the competition. reddot stands for membership in the design and business elite. With more than 4,000 entries from a total of 40 countries, the reddot design award is among the world's largest design competitions. The competition is broken down into two areas that are announced and judged independently of each other: product design and communication design.

http://de.red-dot.org

OPMI® Pentero™

Carl Zeiss received the 2004 reddot design award for a modern, innovative product design for the **OPMI Pentero** surgical microscope. It is a highly-integrated total system that easily meets users' demands for simplification by delivering additional, innovative methods in a simple, elegant design which conveys a sense of lightness. It provides a sophisticated and intuitive user guidance system via the integrated touchscreen that ensures transparency in both handling and functionality. Furthermore, **OPMI Pentero** is equipped with a unique control system. It is now possible to inject diagnostic data into the eyepiece, much like a modern cockpit. OR personnel were also considered during the design phase. The system is equipped with auto balance and auto drape functions which require only the push of a button. In addition to these basic functions, **OPMI Pentero** offers many unique innovations: intraoperative diagnostics, inclusion of a complete video chain and integration of the surgical microscope into the hospital's information and communication infrastructure. The open system architecture can be retrofitted with future technologies.



Photonics Circle of Excellence Award and

The Photonics Spectra journal that has been in print since 1967 provides its readers with extensive information on technical solutions from the opto-electronics industry. The magazine annually honors the 25 best products with the Photonics Circle of Excellence Award.

www.photonics.com/spectra

ApoTome

The **ApoTome** microscope system from the Microscopy Group received two honors. The system received the R&D 100 Award in 2003, and the 2004 Photonics Circle of Excellence Award.

Optical sections through fluorescence-marked biological specimens. **ApoTome** creates optical sections of biological fluorescence specimens in an easy and elegant manner. The opto-electronic inserts for the Axiovert 200 and Axioplan 2 imaging fluorescence microscopes employs the structured illumination technique to display only those fluorescent structures optimally laying in the focal plane. Light outside the focal plane is suppressed. The result is a clear, crisp, detailed image of the biological structure. Pictures are taken using a state-of the-art technique with the cooled **AxioCam** digital camera and **AxioVision** imaging software.

Creating optical sections also means displaying 3D images of biological specimens quickly and with maximum precision. For thicker specimens in particular, **ApoTome** delivers unparalleled image quality characterized by crisp focus and high contrast.

R&D 100 Award

PlasDIC

The Microscopy Group won the R&D 100 Award for the third consecutive year with the **PlasDIC** procedure. It follows wins by the LSM 510 META laser scanning microscope in 2002 and the ApoTome fluorescence microscope in 2003. This is the 12th R&D 100 Award for Carl Zeiss.

An outstanding contrasting procedure in light microscopy.
As a new contrasting procedure in light microscopy, **PlasDIC** delivers images with outstanding quality. PlasDIC (patent pending) is the first polarization-optical, differential interference contrasting procedure independent of unwanted optical anisotropies (e.g. caused by strain-related or natural birefringence) of the condenser, specimen holder, object and objective. This enables, for example, the use of plastic Petri dishes that allow better growth of cells. **PlasDIC** permits greater depth of field than traditional differential interference contrast according to *Nomarski*. Both thin and thick specimens can be easily viewed at first glance – particularly important for in vitro fertilization.

PlasDIC innovative relief contrast is cost-effective and easy to use, making it ideal for routine microscope observations of living cells or for micromanipulation of cells on the microscope, e.g. intra-cytoplasmatic sperm injection. **PlasDIC** is typically used in cell biology labs or molecular biology labs in universities, pharmaceutical companies, hospitals or institutes for reproductive medicine.

The procedure is very simple and eliminates unintentionally incorrect settings on the microscope. Neither a special condenser nor a condenser-side prism is required. Furthermore, standard objectives can be used. A coherence stop for the condenser, LD A-plan objectives, a "**PlasDIC** slider" and an analyzer are all that is needed to work with **PlasDIC**.

R&D Magazine has been presenting awards for outstanding product developments since 1962. Originally published as Industrial Research in 1959, the magazine highlights the latest technologies and products to scientists, researchers, developers and engineers.
It has a monthly circulation of 90,000 and is the leading US magazine for research and development. The magazine honors 100 technologically significant products from around the world each year with the R&D 100 Award.

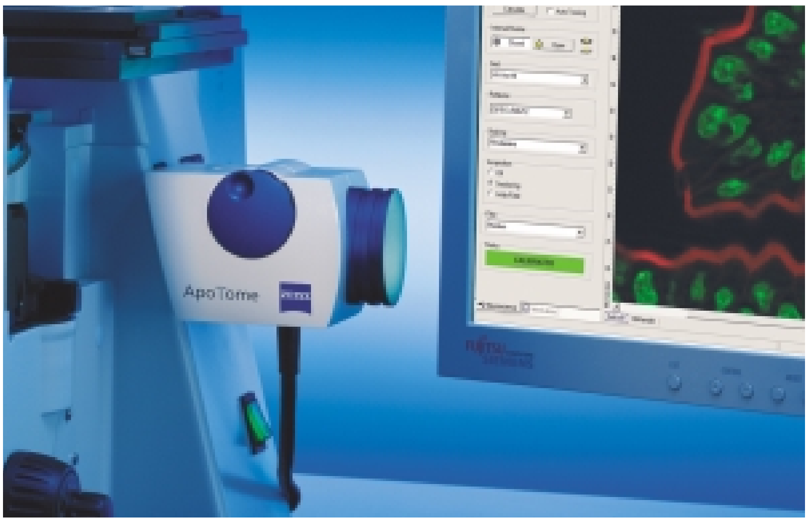
www.rdmag.com

[*www.zeiss.de*]

R&D 100 Award

ApoTome produces high-quality microscope images while reducing costs and the instrumentation required. Exact and reliable results that were previously limited to highly-specialized research centers are now available to a broader circle of users in bio-medical research.

[*www.zeiss.de*]



Zeiss Ikon rangefinder camera for great photography.

For Passionate Photographers: Zeiss Ikon

The newly designed camera from Carl Zeiss is a film-based rangefinder camera with the widest rangefinder base, the most accurate coupling mechanics, a rugged, full-metal focal plane vertical shutter and the brightest viewfinder on the market. Its goes by the name **Zeiss Ikon**, a name synonymous for precision cameras with outstanding optical performance. It is not without reason that the name of the first camera from Carl Zeiss recalls the heyday of the German photo industry. Behind the name is an advanced camera system constructed with the goal of redefining range-finding cameras. The unique design indicates that Carl Zeiss succeeded. The ease of use and the many technical aspects of the camera, as well as the performance of the lens, emphasize this claim.

The new **Zeiss Ikon** camera is a versatile, creative tool and combines a classic design with ease of use. Features and controls are designed to make practical photography comfortable and free from unpleasant surprises caused by the camera. Manual or auto TTL exposure metering as well as an AE-lock function give you complete control of the exposure situation, enabling you to make best use of the entire system – from the film to the lens. It's a highly versatile creative tool that won't let you down. Unlike 35 mm SLR camera viewfinders, for example, that can only show a little more than 90 % of what will be recorded on film, the **Zeiss Ikon** viewfinder lets you see the area surrounding the actual image, giving you greater possibilities and confidence as you compose each image. Furthermore, the triangulation rangefinder combined with the widest viewfinder base on the market means you can expect extreme accuracy and wide-angle focusing precision. All of this and more, enabling you to feed your passion: creating great images.

T* ZM Bayonet Lens

Passionate 35 mm photographers have been using rangefinder cameras with **M Bayonet** lenses for more than 50 years. The rangefinder camera offers optical designers a unique advantage over the single lens reflex (SLR) camera: more space. There is no hinged mirror and no mirror drive mechanism. This enables a shorter distance between the objective back lens and the film plane, permitting the use of superior lens design concepts and enabling wide-angle lenses with outstanding performance.

A whole new range of M-Bayonet lenses was created with a passion for perfect optics. They provide the highest protection against stray light possible today and deliver razor-sharp pictures with high brilliance. They are practically distortion free, enabling them to correctly reproduce geometric shapes. **Carl Zeiss T* ZM bayonet** lenses are specifically designed to minimize the unwanted focus shift which occurs with aperture changes – an important new feature which improves accuracy when setting the distance via the rangefinder. The precise diaphragm with 10 blades and 1/3 step click stops simplifies exact exposure. To ensure continuous peak performance, **Carl Zeiss T* ZM bayonet** lenses are equipped with a rangefinder coupling with unique precision and wear-resistant filter mounts.

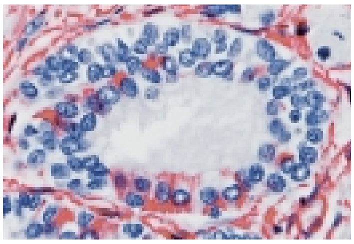
Carl Zeiss **T* ZM Bayonet** Lenses.

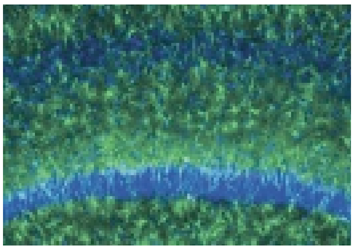
Victory 32 T* FL (left), **Victory 42 T* FL** (right)

Zeiss Victory FL – A New Dimension in Binoculars

A new generation of innovative binoculars stands out with its image brilliance and comfort. The "**FL**" in the name already indicates something new. The *fluoride* lenses with abnormal partial dispersion deliver outstanding new features in the recalculated optical system: minimum color fringes and high edge definition set new standards in resolution, contrast and color fidelity. **FL** lenses have already been successfully used in Carl Zeiss spotting scopes.

The new design with magnesium elements makes the powerful binoculars extremely light, compact and rugged. Five models are available: **7x42 T* FL, 8x 42 T* FL, 10x42 T* FL, 8x32 T* FL and 10x32 T* FL**. The compact, lightweight, all-round binoculars which fit perfectly in your hands meet even the highest standards – for nature observation, hunting, birdwatching, expeditions and research trips, or simply to see more of the world.





Axio Imager

A New Era in Digitial Fluorescence Microscopy: Axio Imager

With **Axio Imager**, Carl Zeiss delivers an innovative, modular microscope platform to fluorescence microscopy, offering more instrument technologies than traditional imaging systems. The optics guarantee optimum image quality and maximum contrast in all techniques thanks to the new **IC²S** (Infinity Contrast & Color Corrected System) principle. The apochromatic fluorescence beam path ensures optimum color correction over the entire wavelength range. For the first time, fluorescence filters with a clearly improved signal-to-noise ratio are available, reducing exposure times by up to 50% thanks to their excitation intensity which can be up to 70 % higher than normal. Visibly higher contrast is achieved by active stray light minimization. Fast, motorized reflector turrets, either for six or ten filter modules, enable high-speed fluorescence examinations. The convenient, self-aligning HBO lamp for homogeneous illumination, and **LCI Plan-Neofluar** objectives for live cell imaging are additional features specifically tailored to fluorescence applications. The complex software is integrated into the "intelligent" stand. Standard interfaces permit direct internal or external communication via USB and TCP/IP. The **Axio Imager** system can be integrated into a network and remotely controlled. The software automatically recognizes components such as filter wheels and objectives, and the "contrast manager" ensures fast and easy change between contrasting techniques.
The stand architecture also sets new standards in microscope technology. The modularly expandable stands can be flexibly motorized up to the maximum level of automation. The stable **"Imaging Cell"**, isolated from the stand for vibration-free observation, ensures precision never achieved before.

SteREO Lumar.V12

The New Dimension in Fluorescence Stereomicroscopy

With **SteREO Lumar.V12** fluorescence stereomicroscopy enters an entirely new dimension. A new, patented optics design provides not only optimum resolution, but also extremely bright fluorescence in ideal contrast – and all that with an unparalleled high-contrast 3D image.
Markedly more information is obtained from the micrographs, particularly in examinations in cellular, molecular and developmental biology or molecular genetic engineering.
In forensic investigations, in particular, the new **NeoLumar S** objectives, which feature an extremely high level of UV transmission, now permit quick and easy detection of human cells and trace amounts of bodily fluids in forensic material, which can be used for DNA analyses.
SyCoP – an entirely new **S**ystem **Co**ntrol **P**anel conveniently designed as a computer mouse – combines all the major functions of a stereomicroscope, such as zoom, focusing, contrast and illumination. It also provides the latest data on object field, resolution and depth of field.
However, that isn't everything. The new **SteREO Lumar.V12** has more to offer. Automatic recognition of the fluorescence filters **(AFR)**, individually adjustable zoom optics for the excitation beam path **(HiLite)**, new LED illumination and contrast systems, Ergo-phototube, specimen protection, light and focus speed manager, and a self-aligning HBO lamp are available for many more innovative solutions from Carl Zeiss for stereofluorescence microscopy.

Masthead

Innovation, the Magazine from Carl Zeiss
No. 14, December 2004

Publisher:
Carl Zeiss AG, Oberkochen
Corporate Communications
Marc Cyrus Vogel.

Editors:
Dr. Dieter Brocksch, Carl Zeiss
73446 Oberkochen, Germany
Phone (+73 64) 20 34 08
Fax (+73 64) 20 33 70
Email: brocksch@zeiss.de

Gudrun Vogel, Carl Zeiss Jena GmbH
07740 Jena, Germany
Phone (+36 41) 64 27 70
Fax (+36 41) 64 29 41
Email: g.vogel@zeiss.de

Authors at Carl Zeiss:
info@zeiss.de
www.zeiss.de

Other authors: If no information is given to the contrary, other authors can be contacted via the editors.

If readers have any inquiries about how the magazine can be obtained or if they wish to change their address (the customer number should be indicated, if applicable), we would kindly ask them to contact the editors.

Photos on pages 44 and 45:
Su concessione del Ministerio dei Beni e le Attività Culturali

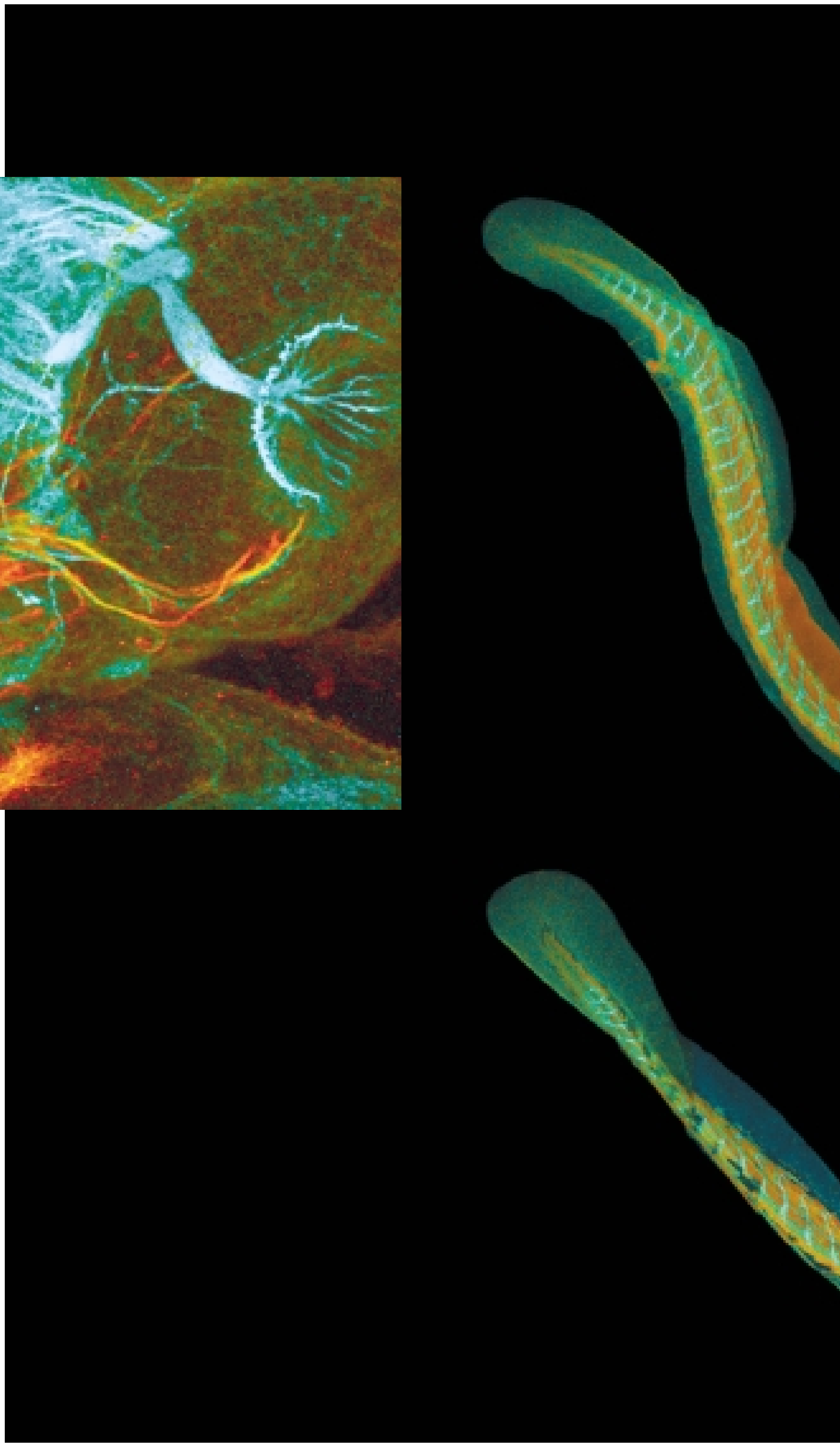
Photos on pages 50 and 51:
Courtesy of ESA.
www.esa.de

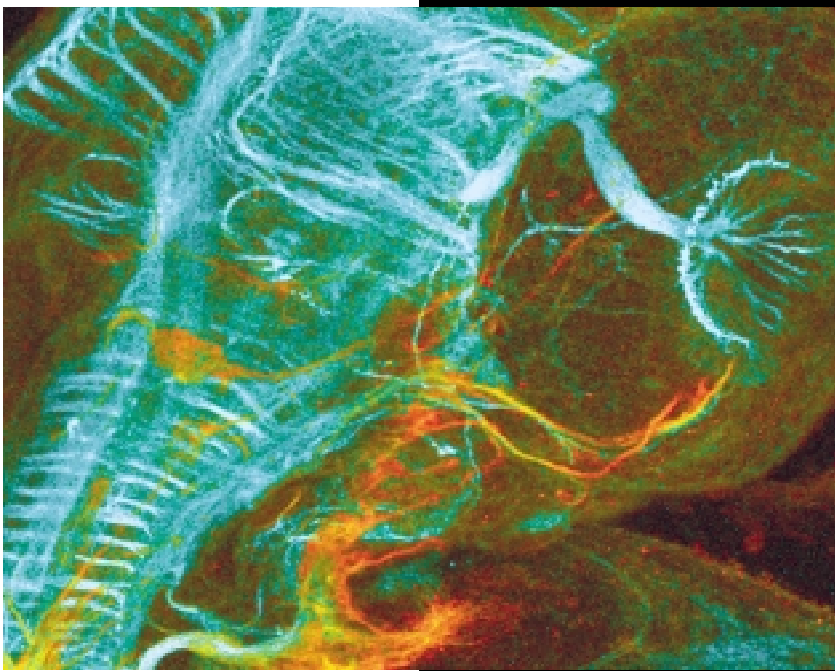
Design: Corporate Design,
Carl Zeiss, 73446 Oberkochen, Germany.
Layout and setting:
MSW, 73431 Aalen, Germany.
Printed in Germany by:
C. Maurer, Druck und Verlag,
73312 Geislingen a. d. Steige.

ISSN 1431-8040

The Magazine from Carl Zeiss
Innovation

The zebrafish is one of the model systems for vertebrate development. It is easy to keep, transparent, its genome is known, and it develops into a fish larva capable of swimming within three days.





Cover photo:
Six two-day-old embryos dyed with two antibodies to neuronal surface components by means of indirect immunofluorescence. Nerve cells of the brain are visible in orange, and parts of the peripheral nerve system in blue. The large yolk sac exhibits brown autofluorescence.

Dr. Monika Marx,
Friedrich Schiller University, Jena, Germany

Back cover:
Lateral view of the head of a two-day-old zebrafish embryo. The nerve system was made visible by indirect immunofluorescence with antibodies to different neuronal membrane components. The light blue dye shows all the axons of the central nerve system, while some of the peripheral nerves are shown in red.

Prof. Dr. Martin Bastmeyer,
Friedrich Schiller University, Jena, Germany