The Magazine from Carl Zeiss

ISSN 1431-8059

# Innovation 8


## What's New, Mr. Galileo?

- Porsche and Zeiss – A Winning Team
- Online Diagnosis – Certainty Within Minutes
- The Beauty of Black-and-White Photography

ZEISS

# Optical Technologies of the 21st Century

Andreas Tünnermann

Prof. Dr. Andreas Tünnermann is Director of the Institute of Allied Physics of the Friedrich Schiller University in Jena, Max-Wien-Platz 1, 07743 Jena, Germany.

**Photo:**
As a representative of industry, Carl Zeiss is a member of the steering committee of the German Agenda "Optical Technologies for the 21st Century". One example of the company's leading role in this field is the optical systems – consisting of highly complex objective lenses in addition to spectral and polarizing filters – which the European Space Agency (ESA) is using to test optical satellite communication.

Optical technologies already found their way into people's everyday lives thousands of years ago: mirrors are known to have been used in pre-Christian times. Optical instruments have made a decisive contribution to our understanding of the world. About 400 years ago, for instance, *Galileo Galilei* used a lens telescope for his observations of the sky, and in 1683 *Antony van Leeuwenhoek* discovered bacteria with the aid of a simple microscope.

Today, optical techniques and methods are influencing our lives in a way that no one would have thought possible even a few decades ago. Paradoxically, this influence often remains "invisible", as the use of optical technologies is now frequently taken for granted in many areas. The optical systems used in photocopiers and infrared remote control devices are two prime examples.

The importance of light in our everyday lives will continue to increase in the years ahead. Glass fiber networks will support novel forms of information and communication technology, and an increasing number of minimally invasive techniques will make inroads into the field of medical therapy. Harnessing light in all its many properties – from its generation and delivery to its spatial and temporal forming – will be of crucial importance for the technologies of the century that has just begun. Even now, in the year 2000, the 21st century is already being termed as the "century of light". However, numerous questions still have to be answered on the subject of light.

One example is the reliable and efficient generation of laser radiation with emission wavelengths in the red (630 nm), green (540 nm) and blue (450 nm) regions of the spectrum for digital projection and photographic technology. Although the first laser was created more than 40 years ago, the solutions implemented to date are generally inefficient and extremely complex, making them unsuitable for reliable long-term operation. After four decades of laser research, however, surprising implementations of the laser concept are still emerging. For example, new approaches on the basis of frequency-converted ultrashort pulse lasers or what are known as up-conversion lasers display the potential to meet the future requirements of users.

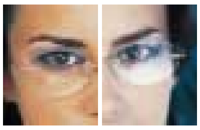
A further focus of development work is centered on materials with new optical properties, with the aim of controlling the propagation of light and its interaction with the material.

One example of this is glass optical fibers which today have already revolutionized communications by permitting the propagation of light over tens of thousands of kilometers and are nevertheless a subject of research.

The implementation of artificial optical material properties would now also appear to be feasible. Potential new applications result from the knowledge that photons can behave in special materials – so-called photonic crystals – in the same way as electrons in crystal lattices. The production of such photonic crystals which occur as one-, two- or three-dimensional geometries is extremely complicated and requires the use of such advanced technologies as those utilized in semiconductor electronics. Both in the form of miniaturized versions of known optical elements and by the implementation of totally new functions, such components will revolutionize optical technologies in the next few years.

## "Optics – the Science of Light"

Optical technologies have reached a similar technological and economic threshold to that experienced by conventional electronics in the mid-1960s when the step was made from discrete components toward microchips. The platform for this is provided by optical systems technology in which conventional optical functional units are integrated to form one system with overlapping or complete functionality, with functions currently implemented by volume optics being replaced by planar optics. The ability to master this systems technology will have far-reaching consequences for virtually all areas of modern national economies and can only be achieved by the interdisciplinary collaboration of a wide variety of specialist disciplines. The German agenda "Optical Technologies for the 21st Century" has brought together representatives from the fields of industry and science in the century of the photon. Their common interest lies in the formulation of a strategy to tap the economic potential of optics and laser technology.





**Cover photo:**
The XMM X-ray satellite of the European Space Agency (ESA) was launched on December 10, 1999. The tip of the ARIANE 5 carrier rocket bore the XMM mission logo, consisting of 14 award-winning pictures from a drawing competition. Carl Zeiss participated in the implementation of the mirror optics for the XMM satellite.
Please also see articles: What's New, Mr. Galileo?, page 11, and "Mission Impossible"-XMM-Newton Proves the Opposite, pages 12 to 14.
(Photos: ESA).

**Outside back cover:**
The ceiling design of the 40 m-high crossing tower in Canterbury Cathedral. High-resolution camera lenses from Carl Zeiss capture every detail with maximum brilliance and definition.
Photo: Lee Johnson, using a 100 mm **Makro-Planar®** f/2.8 lens.
Please also see article : The Beauty of Black and White Photography, pages 20 to 25.

Impressum

Innovation
The Magazine from Carl Zeiss
No. 8, June 2000

"Innovation" appears in German and English twice a year. It was formerly called "Zeiss Information with Jena Review" (1992 to 1996), previously "Zeiss Information" (1953 to 1991) and "Jena Review" (1956 to 1991).The issues of the magazine will be serially numbered, regardless of the year in question, beginning with No. 1/1996.

Publishers: Carl Zeiss, Oberkochen, and Carl Zeiss Jena GmbH, Corporate Communications, Hans-Hinrich Dölle.
Editors: Gudrun Vogel (editor-in-charge), Carl Zeiss Jena GmbH, D-07740 Jena, Phone: (+36 41) 64 27 70, Telefax (+36 41) 64 29 41, e-mail: g.vogel@zeiss.de and Dr. Hansjoachim Hinkelmann, Carl Zeiss, D-73446 Oberkochen, Phone: (+73 64) 20 34 08, Telefax (+73 64) 20 3370, e-mail: hinkelmann@zeiss.de, Germany.
Internet: http//www.zeiss.de

Layout: Marketingkommunikation Carl Zeiss, Oberkochen.
Layout: MSW Aalen, Germany.
Setting: Fotosatz Hermann, Schlat/Göpp., Germany.
Printed in Germany by C. Maurer, Druck und Verlag, D-73312 Geislingen a. d. Steige.

ISSN 1431-8059


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 editor.

Picture sources: Unless otherwise specified, all photographs were contributed by the authors or originate in the archives of Carl Zeiss.

Authors: If no information is given to the contrary, the authors of the articles are employees of Carl Zeiss and can be contacted via the editor.

# Porsche and Zeiss – a Winning Team

Uwe-A. Müller

Uwe-A. Müller is Head of Carbody Quality Management and is responsible for 3D metrology in the Research and Development Center of Dr. Ing. h.c. F. Porsche AG in Weissach near Stuttgart, Germany.

Photos on page 4:
Dr. Ing. h.c. F. Porsche AG.

*All over the world, the name Porsche is a byword for leading-edge accuracy and stylish, sporty design. Porsche's modern Research and Development Center in Weissach near Stuttgart is making sure that this will continue to be the case in the future, also thanks to coordinate measuring machines from Carl Zeiss.*

In the car industry, design has become a decisive competitive factor next to technical innovation and state-of-the-art manufacturing quality. This applies in particular to Porsche whose very characteristic styling is inextricably linked with its brand image. Porsche styling has become an award-winning, international hallmark of quality – also beyond the car industry.

## It all starts with the model

The first stage of turning designers' creative ideas into actual models is the production of a 1:1 scale car model. This is done quickly, reliably and flexibly using 3D coordinate measuring machines (CMM) from Carl Zeiss. The **SMM** horizontal-arm CMMs feature a very large measuring volume that easily accommodates entire vehicles or car-bodies. Horizontal arms project from the two columns on either side of the measuring field. These can be equipped with different measuring or machining heads.

An articulating milling head is used to produce the clay models. It cuts the new car shape from the soft modeling material with high accuracy and speed on the basis of the designer data. Models approved by the decision-making committees are then measured in detail to generate CAD data for the design department, prototype production and, later, high-volume production. This all happens on one and the same Zeiss 3D measuring machine, in this case equipped with the non-contacting **OTM** optical probe. A large variety of surface shapes has to be captured. The vast majority are free-form surfaces, in other words, surfaces of any shape which cannot be described by simple, standard geometries. This requires very experienced staff and the very special software supplied by Carl Zeiss in the form of **HOLOS**.

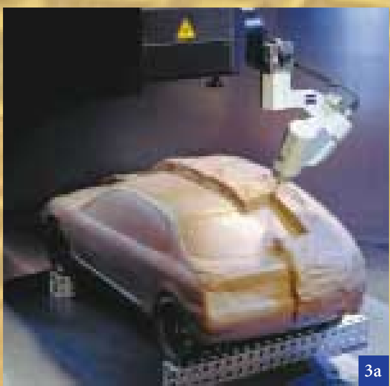
**Fig. 1:**
Porsche's ultramodern Research and Development Center in Weissach near Stuttgart. The background shows the test site.

## From design to production

The overall process from design to production is by no means a straightforward one. What is now known as "simultaneous engineering" circumscribes the fact that closed-loop data feedback is performed at an early stage to make early allowance for a large number of modifications and improvements. This means that the changed features have to be milled, modeled and measured again, with the digital operational data being transferred to the CAD design department.

Measuring machines are therefore not only used once in the process chain, but more or less constantly. Growing flexibility and shorter and shorter cycle times for some models result in an increasing demand for measuring capacity and highly skilled operators. As long ago as


**Fig. 2:**
Thanks to the large test-piece space, complete vehicles can be placed on the **SMM** horizontal-arm CMMs. The measuring or machining heads on their horizontal arms reach even poorly accessible parts for high-precision measurement or processing.





**Figs 3a and 3b:**
A variety of different measuring and machining heads makes Zeiss coordinate measuring machines incredibly flexible for versatile applications.
**3a:** The articulating milling head turns designer data into actual, highly accurate clay models in next to no time.
**3b:** Non-contact measurement using the **OTM** laser triangulation probe.

1986, Porsche purchased its first measuring machine especially for the design area. This was later replaced .by a modern Carl Zeiss **SMM** with a footprint of 24 m². In 1998, another **SMM** with a footprint of 36 m² was added, and in the coming year a third large measuring system from Zeiss will provide further support in this area.

## Every carbody is exclusive

In the Porsche Research and Development Center in Weissach, the coordinate measuring machines described are additionally used for quality assurance on finished carbodies. As a result of the extremely exacting quality standards, each individual carbody must be inspected to verify, for example, the dimensional integrity of function-related features in order to ensure the correct location of fitted components. The coordinates of many hundreds of bores and openings are verified at high speed and with extreme accuracy using the **DSE** articulating probe holder on the Zeiss **SMM** measuring machines. This extremely versatile probe can reach even poorly accessible areas in the carbody, and the specially designed **UMESS** software processes the captured information.

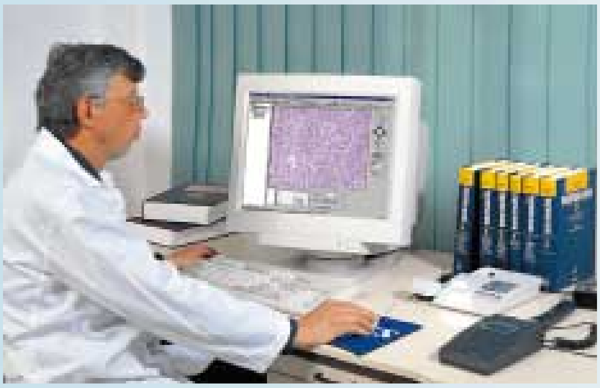
## Poised for the future

As innovative a company as Porsche never loses sight of the future. Ongoing expansion of the Research and Development Center in Weissach and constant upgrading of its machinery testify to the company's determination to always remain at the cutting edge of technology. Model throughput times, in other words the time in which a car model is measured on the CMM, will have to become shorter and shorter in the future. In this field, the recently launched **AutoScan** laser scanner from Carl Zeiss represents another major leap forward in quality. A specific wish voiced by Porsche is that the existing **SMM** horizontal-arm CMMs should be retrofitted with this new technology in the near future without any major complications. Optical and even photogrammetric methods will also be used in the future to enhance the potential for high-speed generation of a growing quantity of data.

**Figs 4a and b:**
The fascinating shapes of modern design consist mainly of free-form surfaces. These are surfaces which cannot be described by standard, simple geometries. The **HOLOS** measuring program was specifically designed for the measurement of these surfaces.

# Online Diagnosis – Certainty Within Minutes

*We all expect optimum medical care when we need it. This is particularly true when our lives are at risk or the quality of our lives is jeopardized. However, the necessary conditions are often not available directly where we live or at the nearest hospital. When a tumor has been diagnosed, the question whether it is benign or not can often only be answered during or after an operation. Therefore, it is necessary to obtain the advice of an expert while the patient is still anaesthetized to enable a decision to be made about the further course of action. However, a pathologist is not present on site to examine the tissue, e. g. in remote areas of Alaska, the sparsely populated Scandinavian countries, in localities with natural obstacles such as high mountains, or even in large cities. Modern communication technologies and remote-controlled microscopes make the specialists' competence available for the patient over long distances and at any time.*



**Figs 1 and 2:**
A digital, low-magnification microscope image of the dissected tissue section is transferred online from the laboratory to the pathologist's monitor.

## Network consultation

Today, the data network connecting institutes, diagnostic centers, hospitals and doctor's offices via state-of-the-art "data highways" and wide-band telephone cables make telework possible, also in microscopy. The fast exchange of data and micrographs makes it possible to bring experts together to increase the reliability of diagnosis. Cases of scientific interest can be discussed with other colleagues directly at the microscope. The network extends the "optical discussion bridge" from one institute to another. The highest demands on quality and availability are currently being made on telemicroscopy in what is known as online telepathology.

## Diagnosis half an hour earlier

The experience gained by the Elim hospital in Hamburg with telepathology has been very good. For frozen section diagnosis, the hospital cooperates with the Pathology Laboratory of the office-based pathologists *Prof. Niendorf* and *Prof. Hampe* which is about 10 minutes' drive away from the hospital. Until now it took approximately 40 minutes – not count-

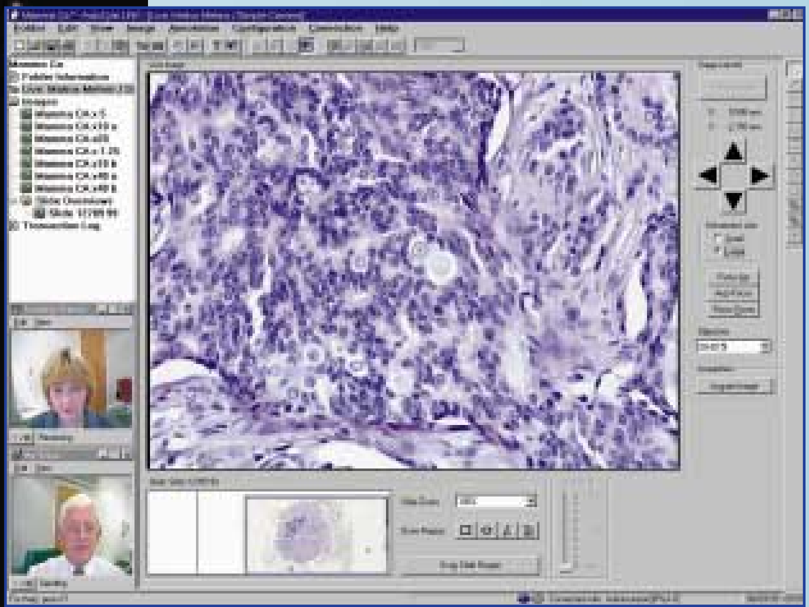


**Fig. 3:**
The **Axiopath** system offers a simple and clear user interface.

ing traffic jams – until the results were available in the gynecology department after the tissue collection – too long for *Dr. H. K. Pauli*, former senior physician of the obstetrics and gynecology department. "Thanks to telepathology we have succeeded in minimizing this time period. Now we need about 10–15 minutes until the frozen section result is available, i. e. we have achieved a status which is identical to that of the best institutes in our country. A microscope from Carl Zeiss automatically produces a razor-sharp image of the tissue on the monitor. The same image is transferred to a monitor in the Pathology Institute via ISDN cable. Using his "virtual microscope", the pathologist can display sections, set high and low magnifications, assess images and explain them to the surgeon in the operating room on the phone at the same time. This technique is highly beneficial and its quality is impressive. For us, telepathology has the following benefits: The examination result is available so soon as if the pathologist were present on site. Patient anesthesia times have been reduced to the absolute minimum. The surgeons involved receive very detailed information about the tissue and make use of this knowledge during the operation. The costs and all the imponderables of tissue transport can be omitted."

## From Friesach to Salzburg and back

The "Deutsch-Ordens-Spital" in Friesach is the first hospital in Austria to utilize the possibilities provided by telepathology. This means that the transport of tissue samples by car from Friesach to the pathology department of the Municipal Hospital in Klagenfurt required until now has become unnecessary. The medical manager and senior surgeon of the hospital in Friesach, *Primarius Dr. Georg Lexer*, highly appreciates the benefit of the new technique: "Telepathology is a further giant leap towards improved patient orientation. Normally, regional hospitals do not run their own pathology department, but have tissue samples taken to a distant central hospital and assessed there. Up to 50 minutes pass from the taking of the tissue sample to the availability of the findings. In most cases, the patient must bridge the waiting time under anesthesia." Now, the tissue findings become available in Friesach within only a few minutes, and the surgeon can determine the further course of

**Fig. 4:**
*H. K. Pauli*, former senior physician at the obstetrics and gynecology department of the Elim hospital in Hamburg, and colleagues at the telemicroscopy workstation.
(Photo: "Bild" newspaper, Beutner).

Fig. 5:
The Deutsch-Ordens-Spital in Friesach, Kärnten, which is the first hospital in Austria in which telepathology possibilities are available. (Photo: Fuss advertising agency, Klagenfurt/Austria).

action right away. At present, the new system connects the Ordens-Spital Friesach to the histology and cytology laboratory in Salzburg. As a pathologist, *Dr. Adolf Rickard Weger* highly values this modern technology: "I can view the images and operate the microscope, change magnifications and determine which tissue section is important for the diagnosis while sitting in my office in Salzburg." *Dr. Weger* considers the possibility of consulting another colleague in doubtful cases a further major benefit of the new technology. "It is always beneficial to obtain a second opinion, since this minimizes the risk of mistakes." Until now, this had to be done by mail, i. e. several days passed until arrival of the answer. Telepathology now makes it possible to consult another expert within only a few minutes, no matter whether he is in Stockholm or in New York".

## Far-sighted technology

Telepathology paves new ways for the use of a microscope in research and in the hospital. This new technology requires high-performance microscopes such as the **Axioplan® 2** imaging, and it must be possible to control all functions of these microscopes via a computer. In addition to viewing of the objects through the eyepieces, images can be acquired using an analog video camera or with a digital camera. If the computer itself is remote-controlled via the network (Client-Server principle), the microscope can also be remote-controlled at any time.

Depending on the requirements, various media are available for information transfer. The occasional transfer of histological and cytological images and accompanying texts is easy to perform via the Internet. This is also the ideal medium for scientific discussion forums where ideas can be exchanged. Today, telepathology, where huge data amounts are transferred, still requires reliable online image transfer such as that provided by the global network.

The microscope which – depending on the configuration – can be operated manually or fully motorized, the 3-CCD camera providing RGB image quality, specially developed software and convenient image archiving are combined into a flexible system tailored to meet the special requirements of pathologists and hospitals.

The modular **Axiopath** telemicroscopy system has made telepathology fast, efficient and convenient.

**Figs 6 and 7:**
Telepathology system from Carl Zeiss in the Deutsch-Ordens-Spital, Friesach.
**Fig. 6:** (from left) *Richard Kernbeiss*, Carl Zeiss Vienna, *Dr. Georg Lexer*, Spital Friesach, *Dr. Adolf R. Weger*, Pathology Laboratory in Salzburg, and *Ingrid Lexer* (medical assistant), Friesach. (Photos 6 and 7: E. Martins, Klagenfurt).

# Technology for Racing Images in Real Time

*Miniaturization is one of the magic words of our times. Not only chips with millions of storage and processor elements are becoming smaller and smaller and more densely packed at a breathtaking speed. Mechanical systems with their own dynamics are also increasingly being reduced to microdimensions. With such MEMS (MicroElectroMechanical systems), high-precision manufacturing alone is an extreme technological challenge. Furthermore, there remains the major question as to their functional behavior under realistic conditions of use, something which has remained in the dark until now.*

The procedure of minute ink drops being sprayed on paper by the tiny print heads of inkjet printers is well-known. However, many details of the procedure can only be guessed at even by experts, although it is precisely their knowledge which could result in an improvement of the overall system.

The same applies to microswitches which play a major part in relays. In the macro range, we are familiar with switches of all shapes and types. However, problems cannot be ruled out in an attempt to make these switches smaller and smaller, since material, shape and special solutions are often unsuitable for micro-dimensioning.

More details about these systems must be gradually obtained through experiments, in the same way as for many other microsystems. For this purpose, a prototype is built first, and a theoretical model of its expected behavior created. This enables its actual dynamics to be observed and permits improvements for a marketable product to be derived from comparisons with the model. Such an examination requires a powerful viewing and measuring instrument which can visualize minute structures and, at the same time, resolve very fast dynamic procedures.

## Tiny and fast as lightning

The department for measuring, control and microtechnology at Ulm University, Germany, has developed such a high-performance observation system which has already been used with great success. The centerpiece of this special configuration is an **Axioplan® 2** research microscope. The flexibility of the system, its high quality and magnifications of up to 1000x make this instrument ideal for the task. Since the dimensions involved with the samples to be examined lie in the range of 10 µm or even below, relatively high magnifications must often be used even in routine work.

In Ulm, a high-speed camera from DRS Hadland Ltd. has been connected to the optical port of the microscope which is normally used for TV or still cameras. In cooperation with the Ulm researchers, this camera was considerably modified by the British specialized manufacturer to allow the recording of sequences displaying an extremely high time resolution. The image, which is transferred from the microscope to the camera, is separated into eight identical images. These 8 channels are then activated one after another at extremely short intervals, and therefore supply image sequences with a currently unparalleled time resolution of 10 nanoseconds ($10^{-8}$ s).

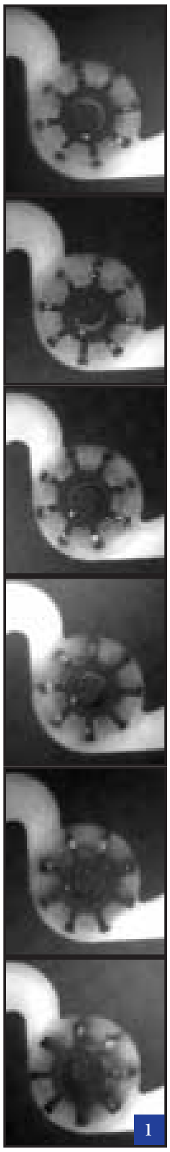


**Fig. 1:**
Image sequence of a turbine wheel rotating in an air current. Image intervals: 15 µs, recording time 500 ns, diameter of the turbine: 350 µm.

**Fig. 2:**
High-performance observation system for real-time cinematography on an **Axioplan®** 2 research microscope from Carl Zeiss.

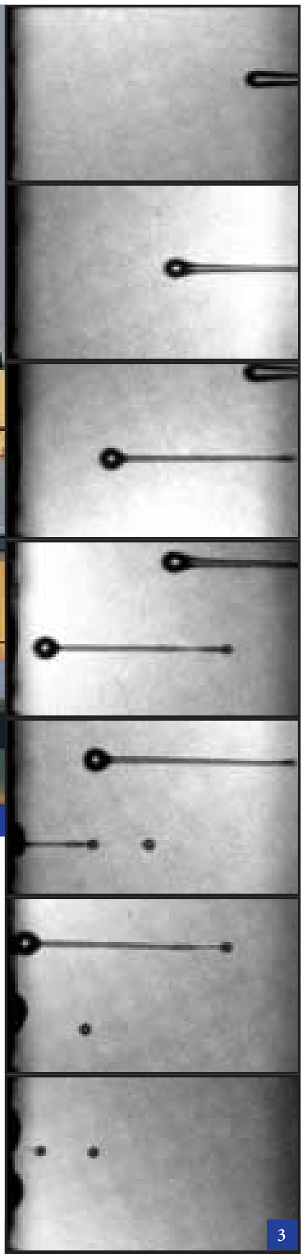


**Fig. 3:**
Image sequence of drops of an inkjet. Image intervals: 20 µs, recording time: 1 µs, distance between print head and paper: 500 µm.

The high-intensity light source has also been adapted to the special tasks of the microscope. By the appropriate modification of a xenon flashlight, sufficient energy is provided to illuminate the exposures successfully even at the required high magnifications and with the extremely short exposure times.

## Extreme experiments

The team at Ulm University utilizes this high-performance system for real-time cinematography for the microscopic observation of the dynamic behavior of many interesting microsystems. The behavior in realistic conditions of use is compared to model imaginations and calculations. This results in insights into how the parameters of such microelements can be optimized.

In the case of the inkjet printer, what is required is the details of the procedure providing the color drops. Furthermore, the drop formation and particularly the shape of the drops and their release is of major importance for fast and clean printing. Just imagine how fast the print head moves over the paper, and you will understand how short the times involved in this procedure must be.

During a further observation series, a tiny turbine wheel rotates in an air current with about 200,000 rotations per minute. This allows the problems and special phenomena occurring in the microrange and with the use of the respective materials to be clearly observed. In this specific case, the microscope's depth of focus was so good that even 3-dimensional "tumbling" of the wheel has been recognized. These observations have been followed by detailed evaluations aimed at improving the microsystem.

The same applies to a microrelay, where the vibration behavior of the contact has been observed. Here, material parameters have a major influence, so that concrete data about optimum materials for the special functional elements can be derived. Similar experience has been made with microswitch components for optical fibers.

Prizes have already been awarded for the development and testing of new techniques for model identification and high-speed cinematography for the fast and reliable quality inspection of microsystems. *Professor Dr. Eberhardt P. Hofer*, manager of the department for measuring, control and microtechnology at Ulm university, Germany, and his colleague, *Dr. Christian Rembe*, received the 1999 Baden-Württemberg research award for applied research in recognition of their work. *Claus Maier, Stefan aus der Wiesche* and *Hermann Brugger* are also members of this team.

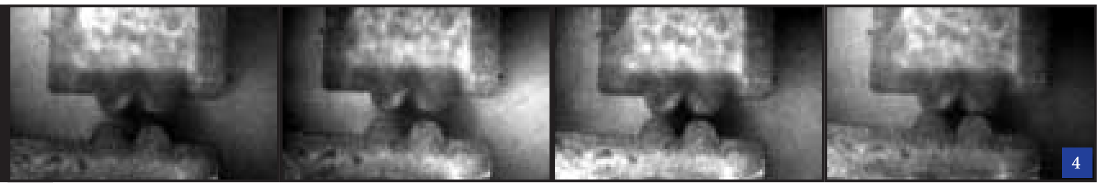



**Fig. 4:**
Image sequence of the switching procedure of a microrelay. Image intervals: 40 µs, recording time: 1 µs, distance of contacts with switch opened: 50 µm. (Micrographs: Ulm University, Germany).

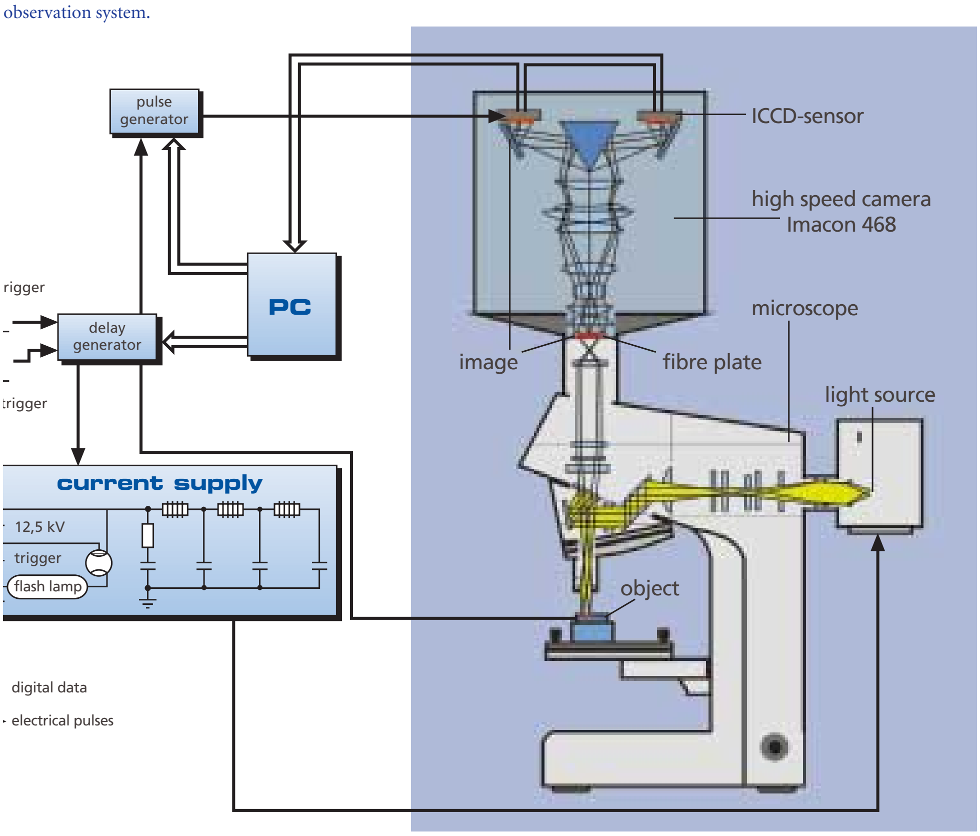



**Fig 5 :**
Diagram of the observation system.

# What's New, Mr. Galileo?

During the preparations for the XMM launch, the European Space Agency (ESA) advertised two competitions in its 14 member states: “Draw me a telescope” for 8- to 12-year-olds and “What's new, Mr. Galileo?” for pupils aged between 13 and 15. The enthusiastic participation of schools testified to the resounding success of the competition which was intended to arouse young people's interest in space.

In the drawing competition, children were encouraged to develop their own ideas on the subject of a telescope. The 14 winning entries were included in the XMM mission logo and traveled into space on the ARIANE 5 fairing.

The second competition challenged school classes to describe their vision of astronomy and its benefits for mankind in English – the language of ESA. The essays express young people's conviction that international cooperation in the field of space travel can make a major contribution to the understanding between nations and lead to a more peaceful life on earth. Questions, however, were also raised concerning vacations on the moon, the discovery of civilization in outer space and the possibility of living on distant planets – questions to which answers will perhaps be found by this generation. The winning essays can be read under http://sci.esa.int/xmm/competition/winners/essays/d. One school class from each member state were selected as winners and invited to Kourou to visit the Guiana Space Center and to witness the final XMM launch preparations on site.

A third competition named “Stargazing” was initiated for young people aged between 16 and 18 on the occasion of the first XMM image transmission. Assisted by XMM scientists, the participants have the opportunity to submit suggested observations, the best four of which will be selected and implemented by the XMM team.


**Photo:**
Winners of the ESA drawing competition in front of the XMM mission logo featuring the selected drawings.
(Photo: ESA).

# "Mission Impossible" – XMM-Newton Proves the Opposite

Wilhelm Egle

Wilhelm Egle was the manager responsible for the XMM development and fabrication programs at Carl Zeiss.

*The XMM X-ray satellite of the European Space Agency ESA was launched on December 10, 1999 from the European space center in Kourou (French Guyana) on board an ARIANE 5 carrier rocket and successfully placed in its planned orbit around the earth. Since the beginning of 2000, the XMM X-ray telescope has been supplying sensational images and spectra of hitherto unexplored, distant cosmic X-ray sources, e.g. quasars, neutron stars, active galaxies and such enigmatic objects as black holes.*

Thanks to its extensive experience in the development, manufacture and testing of leading-edge X-ray optics, e.g. for the ASTRO 8, ASTRO 4/2 and ROSAT projects, Carl Zeiss was able to make a major contribution to the implementation of the mirror optics for the XMM (X-ray Multi Mirror) telescope.


**Fig. 3a:** An XMM prototype mandrel after vacuum deposition of the gold coating (preparation for epoxy resin replication).

**Fig. 2:** The three XMM mirror modules.

## Ultra-light, ultra-smooth, ultra-precise

The opto-mechanical design of the three XMM mirror modules differs fundamentally from that of the German ROSAT X-ray satellite for which Carl Zeiss supplied the telescope more than 10 years ago.

Whereas the ROSAT mirror system used only a few – to be precise: four – thick-walled, concentrically arranged Zerodur® mirror shells with diameters from 500 to 800 mm to achieve maximum spatial resolution (<3 arc sec), the XMM design required maximum collecting power via a large number of extremely thin-walled mirror shells with diameters ranging from 306 mm to 700 mm and packed as densely as possible in a concentric configuration. The spatial resolution of a complete XMM mirror module comprising 58 integrated mirror shells was specified at better than 30 arc sec for X-ray photons in an energy range from 0.2 to 8.0 keV.

In addition, the total weight of the individual XMM mirror module (3 mirror modules together form the centerpiece of the XMM telescope) was specified at a maximum of 220 kg at the outset of the development work to permit the satellite to be launched into its highly eccentric 48-hour orbit on board the ARIANE 4 spacecraft.

In view of the stringent requirements made on the XMM mirror optics (Table 1) and the uncertainty as to whether and through what technology they could be met, ESA's scientists and project engineers nicknamed the XMM project "Mission Impossible". Nevertheless, the XMM mission has gotten off the ground and is promising to become a great success – with a not insignificant contribution from Carl Zeiss.

**Fig. 1:** Overall design of the XMM satellite. Behind the three large circular openings are the mirror modules, the centerpiece of the satellite.

## Specified properties – apparently unachievable in their entirety

In summer 1986, Carl Zeiss started an initial feasibility study on the fabrication of thin-walled light-weight mirror shells and complete mirror modules for the XMM telescope, which was commissioned by ESA and conducted in close cooperation with the Max Planck Institute of Extraterrestrial Physics in Garching *(Prof. J. Trümper, Dr. B. Aschenbach, Dr. H. Bräuninger)*. The result of this study was surprising and gratifying for all those involved: the XMM design was indeed feasible. First of all, however, a new technique had to be developed for the fabrication of the thin-walled, light-weight XMM shells, a method totally different from that used for ROSAT.

The aim was the replication of the mirror shape and surface on a suitable mirror substrate using a mandrel which represents the mirror's precise negative shape and whose surface


**Fig. 4a:**
An XMM FM mandrel during figuring (lapping/polishing process).

**Fig. 4b:**
Visual inspection of a medium-sized XMM mandrel during the final polishing process.



**Fig. 3b:**
A replicated CFRP shell is inspected after separation from the mandrel and packed. The shape and surface quality of the mandrel have been transferred to the inner surface of the CFRP carrier shell using a thin layer of epoxy resin.

roughness should, if possible, be better than that of the mirror to be replicated. Different replication methods were considered:

- epoxy resin replication on CFRP substrates or
- nickel electroforming technology.

In cooperation with Dornier, Carl Zeiss developed the epoxy resin/CFRP mirror technology (Figs 3a and 3b) while work was proceeding on the nickel electroforming technology in Italy at the same time.

The X-ray optical testing of the mirror shells was performed in the PANTER test facility of the Max Planck Institute of Extraterrestrial Physics in Munich/Neuried (MPE). The epoxy resin/CFRP mirror shells were fabricated with the specified shape accuracy and surface quality, and there was no doubt that they also met the extremely stringent weight requirements. After extensive X-ray tests, ESA finally opted for the nickel electroforming option as the basis technology for the fabrication of the XMM flight mirrors. The reason for deciding against Zeiss technology was that the epoxy resin/CFRP mirror shells did not display the necessary long-term stability in vacuum. This was due both to the shrinking of the matrix material of the CFRP mirror carriers which gives off water in vacuum, and to the rippling of the mirror surface at nanometer amplitudes. Due to the significantly greater weight of the nickel shells, however, ESA had to use the more powerful ARIANE 5 rocket for the launch of the XMM satellite.

After this decision, Carl Zeiss focused on the other XMM development and fabrication programs.

## Mirrors can only be as good as the mandrels

After developing and supplying the mandrels (a total of 10 prototype mandrels) for the XMM mirror development program, Carl Zeiss was also commissioned by ESA with the fabrication of the XMM flight model mandrels (Table 2) in early 1993. It took no longer than three and a half years to complete all of the 58 FM mandrels (Fig. 4a) to ESA's full satisfaction, and to deliver them to Italy (Media Lario) for the fabrication of the XMM flight mirrors.

The mirror shells fabricated there passed the X-ray tests in the MPE PANTER test facility with flying colors, which was an impressive demonstration not only of the high standard of the nickel electroforming technology, but also of the excellent quality of the Zeiss mandrels – true to the motto that a mirror shell can only be as good as the mandrel from which it was replicated.

As expected, the initially superb microroughness of the superpolished mandrel surfaces deteriorated in the repeated mirror replication processes (up to 10 times!). During the peak phase of the XMM flight mirror fabrication, many of the mandrels were reconditioned and repolished by Carl Zeiss.

**Table 1:**
**Requirements to be met by the XMM telescope and mirror optics.**

| | |
|---|---|
| **XMM telescope** | |
| Energy range of X-ray photons | *0.2 to 10 keV* |
| Optimized energy range | *2 to 8 keV* |
| Number of mirror modules | *3* |
| Effective collecting area at 2 / 8 keV | *4860/ 2070 cm²* |
| Total weight of 3 mirror modules | *<660 kg* |
| **XMM mirror modules** | |
| Mirror module design | *Wolter-1 type* |
| Specified total weight (target) | *220 (170) kg* |
| Specified resolution (target) | *<30 (<15 ) ″* |
| Effective collecting area (2 /8 keV) | *1620 / 690 mm²* |
| Image field diameter | *30 ′* |
| Focal length | *7500 mm* |
| Number of mirror shells | *58* |
| Diameter of mirror shells | *306 mm to 700 mm* |
| Length of mirror shells | *600 mm* |
| Wall thickness of mirror shells | *0.5 mm to 1.2 mm* |
| Radial distance of shells | *1.0 mm to 3.0 mm* |
| Reflective mirror coating | *gold* |
| Microroughness of mirror surface | *<0.5 nm (RMS)* |

**Table 2:
Main features of XMM
flight model mandrels.**

| | |
|---|---|
| Number of FM mandrels | *58* |
| Optical design | *monolithic Wolter-1 shape* |
| Focal length | *7500 mm* |
| Diameter of mandrels | *306 to 700 mm* |
| Length of mandrels | *600 mm* |
| **Material** | |
| Core | *AlMg alloy* |
| Surface layer | *chemical nickel* |
| Weight | *90 to 300 kg* |
| **Shape accuracy** | |
| Deviation from ideal Wolter 1 profile | *<1.8 ″* |
| Deviation from ideal roundness | *<1.5 µm* |
| 50 % energy concentration (in focus) | *<6.0 ″* |
| Surface quality: microroughness | *<0.4 nm (RMS)* |

## Unique measuring systems

The vital importance of reliable measurement for good optical quality also applies to the fabrication of the XMM mirror shells. Carl Zeiss designed, developed and manufactured several advanced measuring systems for ESA – some of them totally unique – and put them into operation on the premises of the Italian mirror manufacturer. The systems involved are:

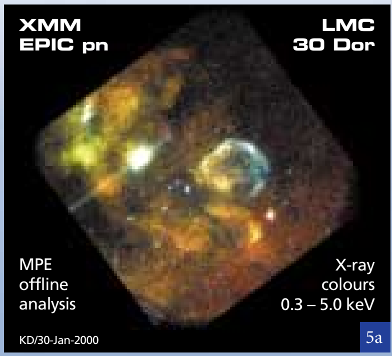
- an optical collimator with a 750 mm illumination diameter for the testing of the FM mirrors and for the integration of the mirror shells in the flight models of the mirror modules,
- a high-precision **UPMC 1200 C** 3D coordinate measuring machine equipped with an optical measuring system (Rodenstock RM 600) for no-contact measurement of the shape of the mirror shells,
- a **DIRECT 100**/Micromap Promap interferometer system for high-resolution measurement of the surface quality (ripple and microroughness) of the mirror shells,
- a high-resolution measuring system (Micromap Promap) for measuring the surface quality (microroughness) of the mandrels,
- a Nomarski microscope for quality inspection of the polished mandrel surfaces.

Carl Zeiss also developed and supplied the evaluation software required for the measured data analysis and the optical quality assessment. This equipment permitted the best mirror shells to be selected and integrated in the three XMM flight mirror modules.

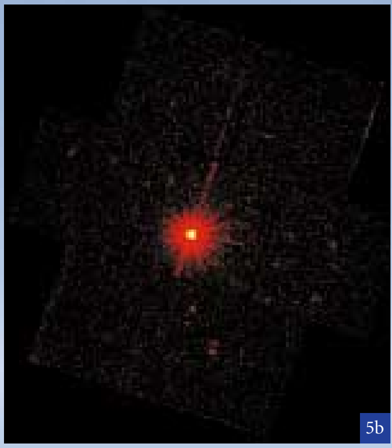
## Following in Newton's footsteps

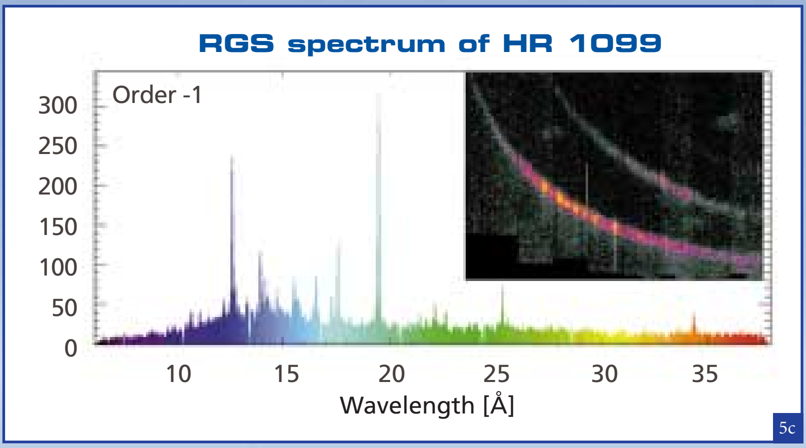
ESA named the XMM mission after *Isaac Newton* to honor the world's most famous scientist. The X-ray telescope is now called XMM-Newton Observatory. *Sir Isaac Newton* (1642 – 1727) who laid the foundations for modern science in the fields of mathematics, optics and physics, had a major influence on theoretical and practical astronomy. “We have chosen this name because *Sir Isaac Newton* was the man who invented spectroscopy, and XMM is a spectroscopy mission”, explained *Prof. Roger Bonnet*, ESA Director of Science. “The name *Newton* is associated with the falling apple which is the symbol of gravity, and with XMM I hope that we will find a large number of black hole candidates which are of course associated with the theory of gravity. There was no better choice of name for this mission.”

With its developments and products, Carl Zeiss made it possible to build the XMM mirror systems , thus helping to make “Mission Impossible” a reality. Official scientific observations will commence in June 2000 after calibration of the scientific instruments.



5a


5b



5c

**Figs 5a to 5c:**
In the start-up phase of the scientific instruments between January 19 and 25, 2000, XMM-Newton transmitted the first images, thus proving that it was functioning properly.
**5a:** Part of the Large Magellanic Cloud which has a diameter of more than 20,000 light years and is 160,000 light years away from the earth. The illustration shows X-ray sources of different temperatures: blue indicating the hottest regions and red the coldest regions. The white and blue arc-like formation at the center is a new object, only part of which was known until now.
**5b:** HR 1099 is a 6th magnitude star located more than 100 light years from the sun and only just visible with the naked eye. Its enormous brightness in X-ray light conceals the fact that this is actually a binary pair. The two stars whiz around each other in no more than three days whereas our sun takes 30 days for one rotation.
**5c:** The peaks of the spectrum recorded with the Reflecting Grating Spectrometer (RGS) can be used to deduce the presence of various elements in the stellar system.
(Photos 1, 2, 4b and 5a to 5c: ESA).


# Masks for Perfect Chips

Axel Zibold

*The ever growing demand for more information and faster data transmission is compelling the microelectronics industry to produce even more densely packed electronic components with increasingly smaller features. Storage media and processors, also termed chips, now display features with dimensions in the 100 nm range (one tenth of a micrometer) – a trend which has continued for many years and shows no signs of ending. This also represents a major challenge to quality assurance and process inspection.*

The industry uses optical lithography for the large-volume fabrication of chips. In this process, minute structures are imaged on a radiation-sensitive photoresist layer applied to the wafer. Using an electron beam writer, these structures are imprinted in masks which are exposed in wafer steppers. These mask structures are mostly 4 times larger than later on the chip. The complete structuring of a chip sometimes requires more than 20 different masks. Several hundred chips are located on one wafer. The individual masks can be used several thousand times in production.

## Better safe than sorry

Defects in the masks are transferred to the chips and result in faulty function. It is obvious what this means in terms of productivity and costs if such defects are not detected until after a few thousand chips have already been produced.

New complex masks such as phase masks allow even smaller dimensions to be generated on the chips. In masks of this type, however, the risk of defective structures occurring during fabrication increases, while the fabrication costs of the individual mask rise dramatically at the same time. This is why it is so critical to check the printability of the masks before they are used in large-volume fabrication.

## Realistic conditions

In combination with the AIMS™ aerial image measurement software, the MSM microlithography microscope system allows rapid and fast testing of masks under the same conditions as in the real wafer stepper. This requires appropriate high-resolution optics and the use of light of ever shorter and shorter wavelengths. The MSM 100 for the DUV (248 nm) and i-line (365 nm) wavelengths and the MSM 193 for the 193 nm wavelength are being used by mask shops and their laboratories in the semiconductor industry. The MSM is the only system which can prove the printability of mask structures without the use of mathematical simulation, thus providing direct, reliable and meaningful results.

## In-process inspection – the earlier, the better

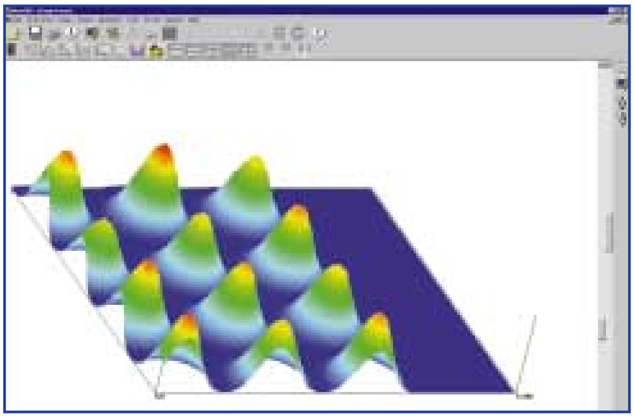
The current systems have mainly been designed for research and development tasks. The new AIMS™ fab microlithography simulation system is suitable for the quality inspection of masks at a very early stage in their manufacturing process. Due to the fully automatic parameter setting, throughput is very high. Regardless of the type of masks, either the DUV wavelength or the i-line can be used. In the event that a mask has to be repaired, previously determined defect coordinates can be input in the AIMS™ fab, enabling the automatic positioning of critical areas under the microscope. This allows the rapid and easy evaluation of image quality before and after the repair and ultimately the usability of the expensive mask. Another benefit of the new system is that the AIMS™ fab enables the operator either to set the process parameters such as wavelength, numerical aperture and degree of coherence of the light either as used in the wafer stepper, or to determine them in such a way that they are optimum for the fabrication of the chips. A series of highly magnified through-focus pictures taken with a highly sensitive UV camera yields a deep insight into the quality of the mask. The exposure-versus-defocus plot provides important information and enables the operator to determine the maximum process range admissible, i. e. the tolerance limits, without losing valuable wafer stepper time. For further analysis, the images recorded can be read into commercially available resist simulation software to allow a direct comparison of the measurements with the features lithographically generated on the wafer.

**Fig. 1:**
AIMS™ fab microlithography simulation microscope for inspection and repair checking in the production of masks and wafers.

**Background:**
Mask for wafer production under the inspection microscope.

Dr. Axel Zibold is Product Manager in the Microelectronic Systems Division of Carl Zeiss.

**Fig. 2:**
3D intensity graph of contact holes in a chip. Their shape determines the subsequent conductivity of the component.



# Cockpit for the Neurosurgeon

Frank Rudolph

Frank Rudolph is Product Manager in the business unit for Neurosurgical Instruments at Carl Zeiss.

*In microsurgery the surgical microscope is now increasingly becoming an integral part of the overall OR environment with all its interactions and networking facilities, including, of course, the surgeon him- or herself. This means that very special demands must be met by this very important aid for the operating physician.*


**Fig. 1:**
STN Surgical Tool Navigator navigation system from Carl Zeiss.

## More safety for the benefit of the patient

Neurosurgery is the branch of microsurgery that is most dominated by the use of state-of-the-art technologies and techniques – all to provide the surgeon with maximum ergonomic convenience, information and safety for his or her day-to-day work. Why is this so vital?

The key problem confronting neurosurgery is the need to safely and completely remove various types of tumors (primary tumors in the brain or metastases of other tumors sited elsewhere in the body). In difficult cases depending on the type, anatomical location and size of the tumor, this often constitutes a balancing act between the conservation of optimum brain functionality (to ensure an adequate quality of life) on the one hand, and the maximum possible resection of the tumor (to avoid subsequent surgery due to recurrences and to increase life expectancy) on the other. Here, on the basis of the pre-operative diagnosis, intraoperative communication with the pathologist and his own experience, the surgeon decides how much tissue can and may be removed.

## Navigated neurosurgery and neuroendoscopy

Prior to the commencement of each operation, the neurosurgeon has to familiarize himself with the current surgical situation confronting him (access to the tumor, position of the patient, the equipment and instrumentation required, etc.). In the past few years neurosurgeons have been supported in their demanding and difficult work by two new, extremely beneficial technical solutions.

The examinations to which the patient is subjected before surgery, e.g. computer tomography or magnetic resonance imaging (MRI), provide individual data which the surgeon can process using a powerful computer in such a way that, for example, the current position of the surgical instruments being used is displayed with millimeter accuracy in a 3D model of the patient's brain on the monitor during surgery. The system developed for this purpose by Carl Zeiss, the **STN Surgical Tool Navigator**, provides the surgeon with greater safety and reliability during the procedure (Fig. 1).

The importance of minimally invasive surgical methods has considerably increased, also in neurosurgery. The aim of special endoscopic procedures is to achieve better results in surgery and faster healing by reducing tissue traumatization. There are also cases, however, in which the simultaneous use of an endoscope and a surgical microscope is required, e.g. to clarify complicated anatomical situations, check the result of surgery or simply to "look around the corner" in order to visualize deeper-lying structures no longer visible with the surgical microscope (Fig. 2).


Both solutions have their respective benefits and offer the user important additional aids and information. However, they have two inherent and major drawbacks: extensive instrument technology, monitors and cables cause additional clutter in the increasingly cramped conditions of modern ORs, and the surgeon's

**Fig. 2:**
Neuromicrosurgery with a neuroendoscope. (Photo: Neurosurgical Clinic of the Johannes Gutenberg University, Mainz, Germany).

attention is diverted away from his concentrated work under the surgical microscope to look at the additional monitors. This can be critical during a difficult phase of surgery, as direct visual contact with the microsurgical field and the instruments used is lost.

## Data online in the surgeon's field of view

The goal of the ongoing enhancement of microsurgical systems is to avoid precisely the drawbacks described above. The surgeon should receive all important information "online" in much the same way as a pilot does from the various display instruments in the cockpit of his plane.

In the **OPMI® Neuro MultiVision/NC 4** system (Figs 3a and 3b), the microscope and the neurosurgical navigation system form one unit. With the integration of a monochrome display in the surgical microscope, additional information is projected into the neurosurgeon's field of view in the right-hand eyepiece of the microscope and superimposed on the surgical scene. This means that his field of view now always contains data which he was only able to receive in the past by the often distracting need to keep looking at monitors (Fig. 4).

In a further step, the video image of an endoscope camera has now been incorporated in the surgical microscope, hence functionally and ergonomically combining navigation and video in the **OPMI®**. This new functionality was made possible by a novel SVGA LC microdisplay (Fig. 5) which replaces the former monochrome CRT monitor in the **OPMI® Neuro MultiVision**.

Intelligent control electronics which are reliably and conveniently operated via the footswitch (handgrip) of the microscope allow the surgeon to switch easily between the microscopic anatomical image (with or without superimposed navigation data) and the video image of the simultaneously used endoscope camera which is projected with highly resolved color quality into the eyepiece. In the latter case, a synchronous shutter system simultaneously closes the optical beam path of the **OPMI® Neuro**, with the option of leaving the beam path in the left eyepiece open. This allows simultaneous viewing of the object with the left eye and of the video image of the endoscope camera.

For the very first time, the **OPMI® Neuro MultiVision/NC 4** system from Carl Zeiss provides the neurosurgeon with a fully integrated system that brings him considerably closer to achieving his goal of more effective and more reliable tumor removal. It helps him to heighten his concentration on the procedure being performed by reducing distractions, provides him with more information, and hence ultimately increases the safety of surgery for the patient.

Figs 3a and 3b:
OPMI® Neuro MultiVision/NC 4 System.

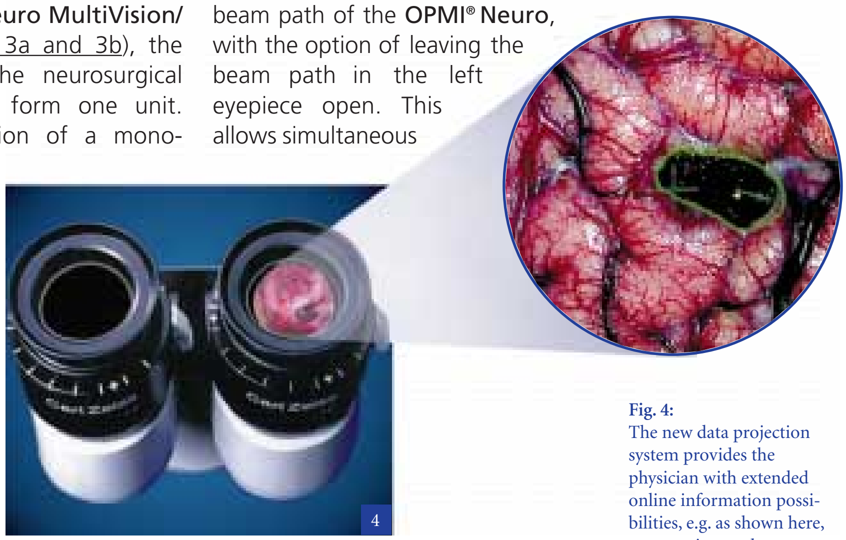



Fig. 4:
The new data projection system provides the physician with extended online information possibilities, e.g. as shown here, target points and contours (green) for navigation, the photo taken by an endoscope camera, and computer images of a navigation workstation.


Fig. 5:
Comparison of the SVGA LC microdisplay integrated in the microscope with a ballpoint pen.

# Insights Into Life

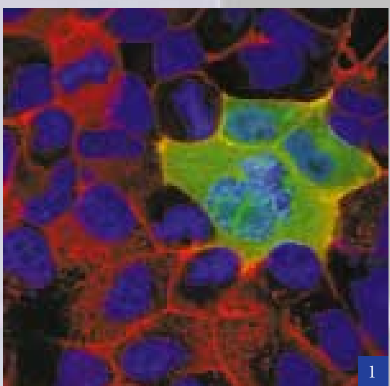
Ronald Wendenburg, Sebastian Tille

Dr. Ronald Wendenburg and Sebastian Tille are Product Managers for laser scanning microscopy at Carl Zeiss.

*A new member has been added to the family of laser scanning microscopes from Carl Zeiss. New variants of the* ***LSM 510*** *famous for its innovative and flexible scanning strategies provide even more benefits and possibilities for the examination of living objects. The little brother in the family, the* ***LSM 5 PASCAL****, is a low-price, entry-level instrument for high-quality confocal fluorescence microscopy.*

## Seeing proteins in their true colors

The diversity of fluorescent proteins (GFP, eGFP and mutants) used in biomedical research is increasing. To avoid losing track and to prevent cross talk (fluorescence overlay between different channels), the **LSM 510** uses a new method – multitracking (Fig. 1). It allows the clear allocation of colors in multi-



1

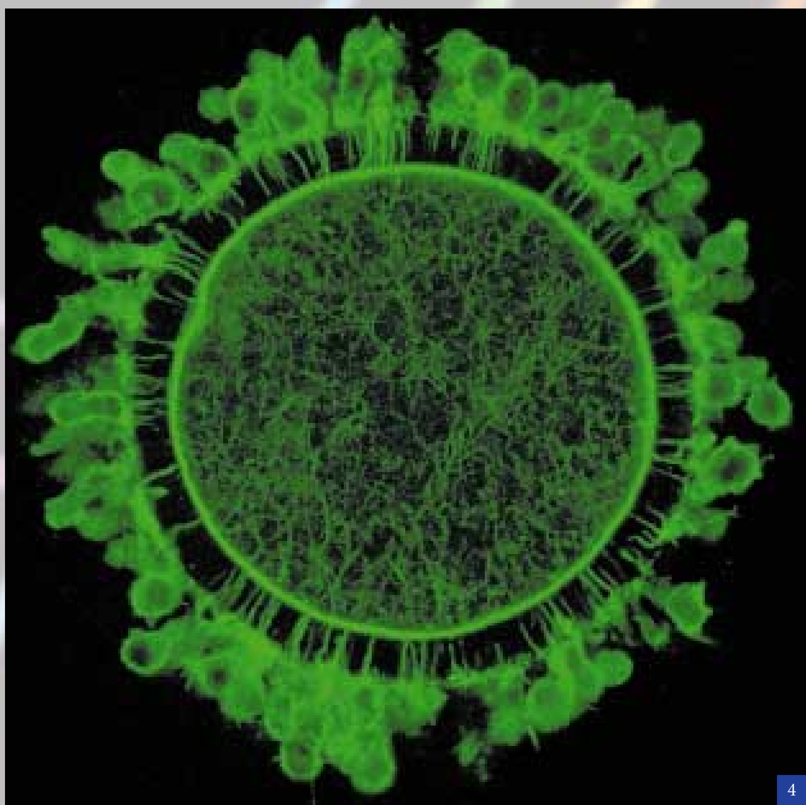
fluorescence applications. Dual and triple labeling with the recently introduced DsRed (red fluorescent protein) is extending our knowledge about protein-protein interactions, many metabolic processes and much more (Fig. 2). Multitracking provides brilliant images with a high information content even in cases of weak labeling, since the entire emission energy of fluorescence is used. To permit complete color spectra to be recorded in a defined cellular environment, a spectrometer is additionally available with the **LSM 510**. This allows conclusions to be made on the location of the dye and the precise environmental conditions as well as measurements of conditions in the cell.

## Dynamics in the cell

If transport processes in individual cells, protein interactions or the development of an embryo are to be monitored in all spatial dimensions, the new 4D Scan is the right choice. It allows entire image batches to be recorded over time and evaluated. Its high degree of automation facilitates observation.

2

3



4

**Fig. 1:**
Kidney cells (Opossum) with triple fluorescence labeling (multi-tracking of DAPI: DNA (blue), eGFP: PSD95 protein (green) and Alexa 543: Actin (red). Specimen: *Dr. Klöcker* and *Prof. Dr. J. Peter Ruppersberg*, Institute for Physiology of Eberhard Karls University in Tübingen / Germany.

**Fig. 2:**
Insulinoma cells of the rat. VIP receptor dyed with eGFP (green), cytoplasm with DsRed (red). Specimen/Micrograph: *Dr. Carsten Grötzinger*, Charité University Hospital, Humboldt University Berlin, Germany.

**Fig. 3:**
Double fluorescence (FITC/ Rhodamin) and DIC. Specimen / Micrograph: *Dr. Atomi*, University of Tokyo.

**Fig. 4:**
Bovine oocyte. Actin filaments dyed with Alexa 488. Multiphoton excitation 770 nm, confocal section at depth of 70 µm. Specimen: *Dr. Catherine Corolan*, Nat. Univ. of Ireland, Galways, Phys. Dept.

## High-precision hits

To be able to solve physiological problems, it is necessary in most cases to precisely select the target area which is to be observed. Up to 99 simultaneous ROIs (Regions of Interest) permit pixel-precise selection of regions of any shape. This allows image recording, quantitative analysis, spectra measurement or specimen manipulation by laser irradiation (uncaging, bleaching, FRAP) within exact limits and on precisely defined targets.

## Mild photons

Many living specimens do not tolerate irradiation with ultraviolet light without damage. They react with mutagenetic effects, serious cell mutations or death. The **LSM 510** ***NLO*** makes special allowance for such sensitive objects through multiphoton excitation of the fluorescence markers. Optimum specimen protection at maximum penetration depth, low phototoxicity, genuine three-dimensional selectivity, and minimized autofluorescence excitation are the outstanding features of the method (Fig. 4). Various short-pulse lasers in the infrared range are available.

## Speed is of the essence

Signal transfer to neurons is a major, if not the most important process in neurobiology. Calcium ion exchange between the cells plays a significant role here. These rapid processes must first be recorded if they are to be investigated. The combination of the **LSM 510** ***NLO*** with the "fixed stage" microscope stand **Axioskop® 2 FS MOT** permits simultaneous confocal imaging and electrophysiological derivations. The so-called Spline-Scan permits scanning along freehand lines of any required curvature, with the possibility of quantitative measurement of the calcium concentration and simultaneous online calculations.

## Laser scanning gets personal

The **LSM 5 PASCAL** (Fig. 6) is available for individual users and small workgroups involved in cell biology, development biology, neurobiology (Fig. 5), genetics or pathology who also want to use laser scanning microscopes. With the maximum of two fluorescence channels and an additional transmission channel (for the simultaneous recording of DIC contrast images, Fig. 3), it is a budget-priced alternative to the **LSM 510** for a wide variety of biomedical problems. Time-tested technology without any trade-offs in flexibility and providing simple operation and optimum image quality is available. The user can rely on high sensitivity and gentle treatment of the specimen, with multitracking again guaranteeing authentic visualization of processes in cells and tissue.

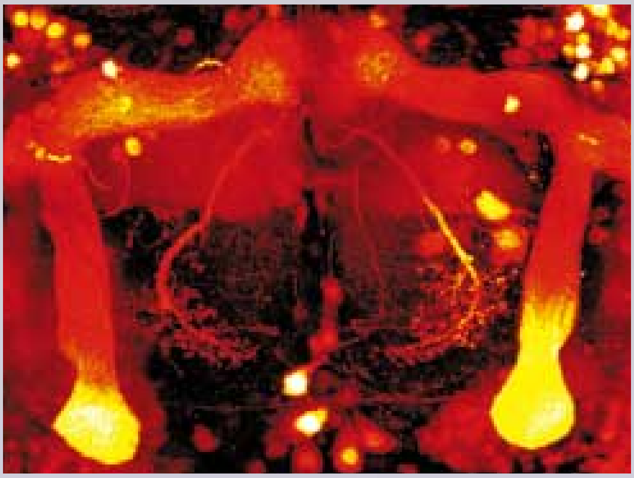


**Fig. 5:**
Neuronal network of a cockroach, labeled with GFP. Specimen/ Micrograph: Dr. Ito, National Institute of Basic Biology Lab, Okasaki.

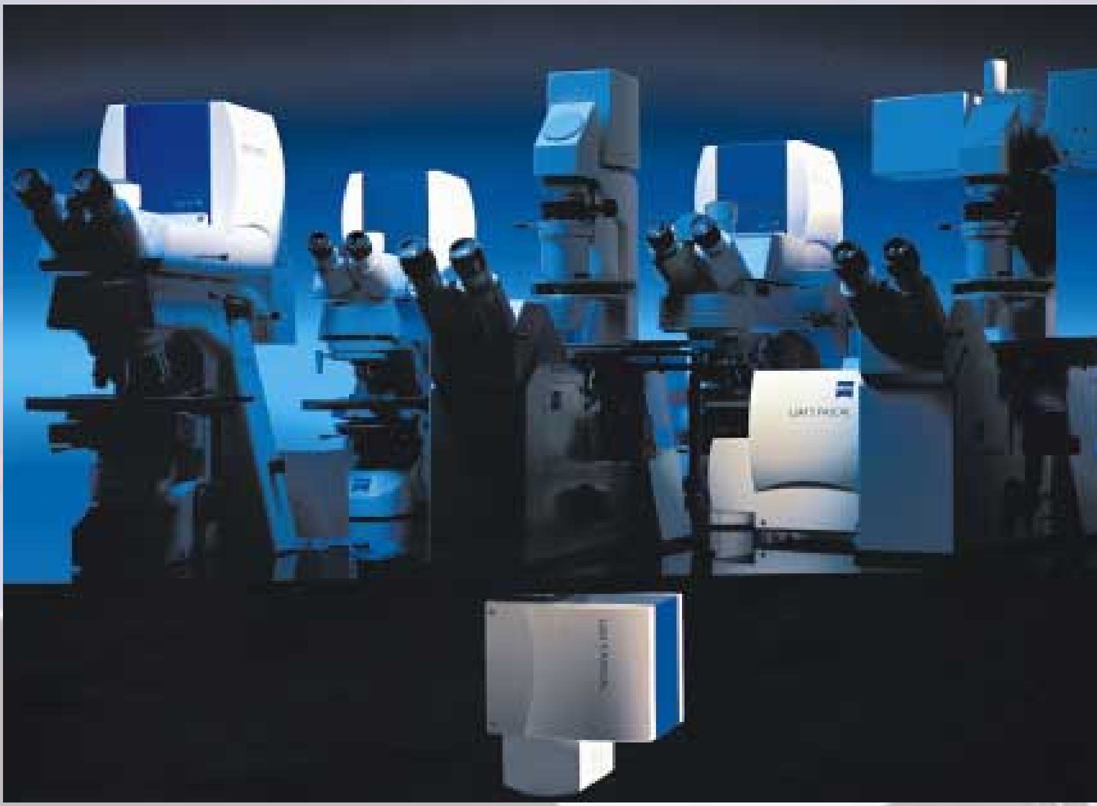


**Fig. 6:**
The LSM 5 PASCAL, the budget-priced, entry-level instrument for high-quality confocal fluorescence microscopy.

”Th

View from the Langdon Cliffs across the Straits of Dover toward Calais. After frequently sending inquiries to the Dover weather service for three years, the photographer chanced his luck and departed for the cliffs on September 2, 1997. His luck was indeed in for, according the local people, this was the clearest day since 1995. Even on sunny days you cannot see much owing to the dense haze present in the channel. Due to the combination of a deep red filter with a polarizing filter, the photo is even better than the visual impression obtained with a 7 x 42 binocular. The distance from Dover to Calais is approx. 40 km as the crow flies. (Photo: 200 mm **Tele-Tessar®** f/4.0, red and polarizing filters).


**"The more detail, the more valuable."**

The Greek orthodox Saint George monastery in Wadi Kelt (West Jordan) is approx. 1,500 years old. The valley is deeply cut into a plateau without any vegetation which resembles a landscape on the moon. Water can only be found at the bottom of the valley. If one moves away from the edge of the valley, the valley becomes invisible and one looks over it. The monastery dates back to the era before the great schisms when neither Catholicism nor Protestantism existed. At the time, the entire church was orthodox. (180 mm **Sonnar**® f/4 lens).

# The Beauty of Black-and-White Photography

One Tree Hill, fig tree in New Zealand. These trees can be found all over the South Pacific region and stand in almost all municipal parks. Often there is no normal trunk, but the roots turn into branches immediately above the ground (50 mm **Distagon**® f/4 lens).

The crossing tower of Canterbury Cathedral. View from the nave up into the approx. 40-meter-high tower. The impression of open space conveyed by this construction is even greater than in German cathedrals which do not have crossings which are open at the bottom. The photo took approx. 2 minutes during which several people walked through the scene. For instance, the whitish veil in the dark doorway is the trace of a female visitor in a bright dress. (15 mm **Distagon**® f/3.5, 25 ISO, f-stop 11).

Uncompromising
photography
by Lee Johnson

Lee Johnson, Provincial-
strasse 99, 53859 Mondorf
am Rhein, Germany,
works in the customer
support area of a
mechanical engineering
company.

The town of Namur is located in the French-speaking region of Belgium. Nothing has changed in the townscape during the past 70 years. The few new buildings have almost always been erected in a conventional style. Namur gives the impression of a classic European town which has escaped the architecture of the present day. (50 mm **Distagon**® f/4 lens)

The passionate photographer *Lee Johnson* uses 35 mm and medium-format cameras to take only black-and-white photographs, almost always using high-resolution film (25 ISO) and a tripod. His aim is uncompromising definition, maximum richness in detail and maximum information content. He says he has a pronounced aversion to "snapshots" and "action" photography. To him, the absolute culmination of photography was photography as it existed around the year 1900 with its large-format cameras and the time-consuming and painstaking method of working associated with these cameras. This age of photography produced valuable, detailed pictures documenting and chronicling an era long past.

*Lee Johnson* describes his basic attitude as follows: "To me, the technically perfect photo of a boring subject is more interesting than a technically imperfect photo of an interesting subject."

To achieve the desired technical perfection and great detail of his photographs without having to use cumbersome large-format cameras, *Lee Johnson* almost always uses high-resolution films of the 25 ISO speed category and lenses from Carl Zeiss. The popular films of 100 ISO with their 4 times higher speed are no longer suited for achieving the sharp definition he strives for. A particular advantage of black-and-white photography is that it allows the use of a combination of red and polarizing filters. This filter combination makes it possible to largely eliminate annoying haze which reduces contrast. The result is clear distance photographs with rich detail that would never be possible with color photography. The shutter speeds to be used with these photographs can be around 1/4 second – even in the brightest sunlight. For this reason, a reliable tripod is indispensable. To achieve maximum detail in the first place, the subjects are mostly stationary.

When mounted on 35 mm SLR cameras, the 16 mm **F-Distagon**® f/2.8 and 15 mm **Distagon**® f/3.5 wide-angle lenses which *Johnson* likes to use provided a resolution of 200 line pairs per millimeter on 25 ISO film at full aperture in application tests performed at Zeiss. A comparison: In standard snapshot photography, rarely more than 30 line pairs per millimeter are obtained.

For Johnson, photography fulfills two main functions:

- It records the photographer's past and his personal experiences for ever.
- A series of excellent photos of a subject also makes the photographer its owner to some degree. The more detail, the more valuable.

Additional information on the practical performance of Zeiss lenses is provided in "Camera Lens News" (CLN), an English brochure published by the Camera Lens Division and appearing at irregular intervals. CLN can be directly downloaded from the Zeiss internet pages www.zeiss.de/photo and is also available free of charge by subscription.

This view of Los Angeles (California, USA) from above was photographed through an aircraft window with poor optical quality (3x glazing with glass/plastic/plastic) using the full aperture of the lens. Despite this, the picture still displays good definition. (50 mm **Distagon®** f/4 lens).

This aircraft engine of the type “Wright” of the “Cyclone” model series in the Deutsches Museum in Munich is the most powerful radial engine ever built in large series: 2x9 cylinders, a constant power of 3,400 HP, a cubic capacity of 54.9 l and a weight of 1,580 kg. When the photo of the engine was shot, the engine was standing completely in the dark, flooded by intense backlight. Even in the viewfinder, the engine was difficult to see and focus on. For this reason, a lit flashlight was placed between the cylinders and the lens focused on it. (50 mm **Distagon®** f/4, shutter speed approx. 4 minutes at f-stop 11, with 18 fill-in flashes added).

# Coating on Prescription

Markus Kuhr, Matthias Schiller

Dr. Markus Kuhr is responsible for coating technology in Central Research and Technology Development at Schott Glas, Mainz.

Dr. Matthias Schiller heads the Coating Technology department at Carl Zeiss.

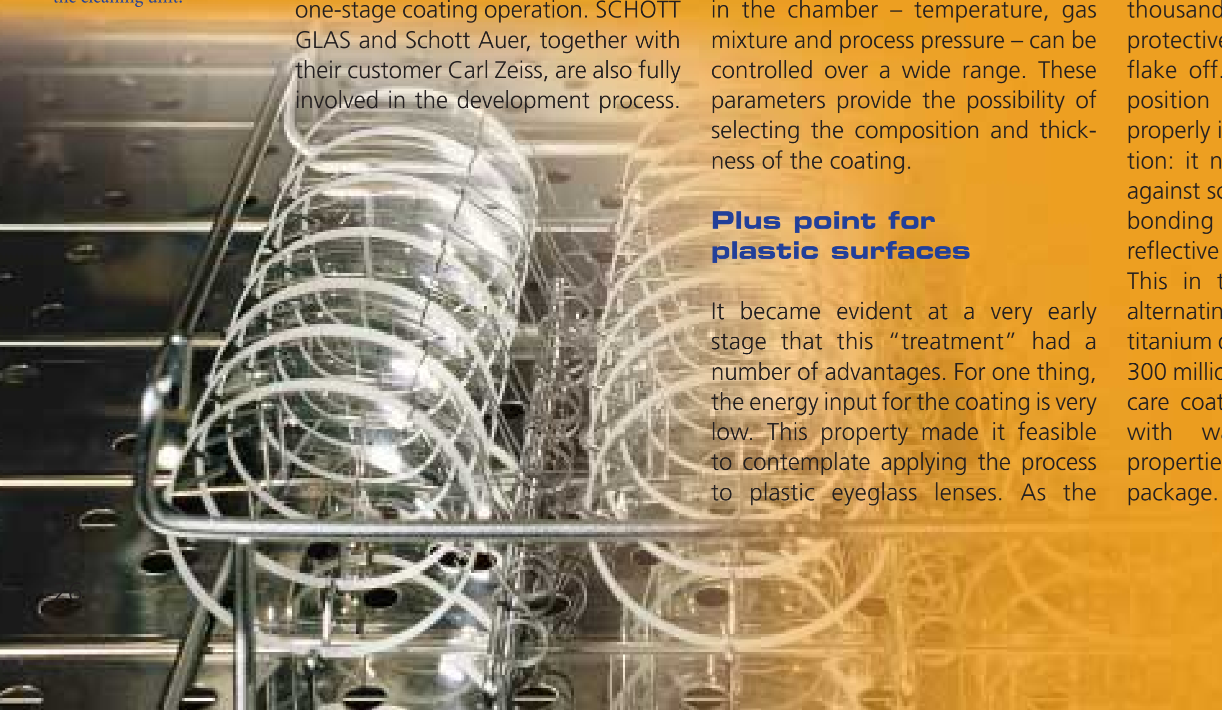


Fig. 1:
Substrates on their way to the cleaning unit.

*With the PICVD process developed by SCHOTT GLAS, Carl Zeiss is on the verge of a breakthrough in the coating of plastic lenses for eyeglasses. An antireflective coating, a hard coating and an easy care coating can be applied in a single operation. In addition, one-stage coating makes flexible production on prescription a possibility.*

Your eyecare professional prescribes a pair of glasses today, and tomorrow they're ready – and not just an ordinary pair of glasses but lightweight sports glasses with plastic lenses that are resistant to breakage, antireflective and scratch-resistant. Impossible? Far from it. With PICVD coating technology, Schott and Zeiss are well on the way to achieving a double objective: producing plastic lenses in a one-stage coating operation. SCHOTT GLAS and Schott Auer, together with their customer Carl Zeiss, are also fully involved in the development process.

## Scratch-resistant and antireflective

The PICVD process was originally developed by Schott for the manufacture of glass fibers and subsequently adapted for the coating of cold light reflectors for halogen lamps at Schott Auer in Bad Gandersheim. At an early stage, Carl Zeiss expressed an interest in using the process for eyeglass lenses as well. The aim was to apply a hard coating to make the lenses scratch-resistant and then add a further coating structure to make them antireflective. To do this, the coating materials are bombarded with short microwave pulses in a reaction chamber, breaking them down into components that are highly chemically reactive. The physical conditions in the chamber – temperature, gas mixture and process pressure – can be controlled over a wide range. These parameters provide the possibility of selecting the composition and thickness of the coating.

## Plus point for plastic surfaces

It became evident at a very early stage that this "treatment" had a number of advantages. For one thing, the energy input for the coating is very low. This property made it feasible to contemplate applying the process to plastic eyeglass lenses. As the substrates are only exposed to a comparatively low level of heat in the PICVD process, the plastic does not melt. Aspects such as weight saving, resistance to breakage and choice of color make plastic eyeglass lenses attractive compared to their glass counterparts.

On the other hand, plastic surfaces are very susceptible to scratching in contrast to glass lenses, and therefore need to have a hard protective coating. This consists mainly of silicon dioxide, which is applied in the PICVD plant. However, the difficulty lies – as always – in the detail. Pure silicon dioxide has a very different coefficient of expansion compared to the plastic substrate. Without the addition of various ingredients from organic chemistry, the approximately two thousandths of a millimeter thick protective layer would immediately flake off. However, when the composition of the coating is selected properly it even performs a dual function: it not only provides protection against scratching but also serves as a bonding interlayer for the antireflective coating to be applied too. This in turn consists of up to six alternating layers of silicon dioxide and titanium dioxide to a total thickness of 300 millionths of a millimeter. An easy care coating (known as Clean-Coat) with water and dirt repellent properties rounds off the coating package.

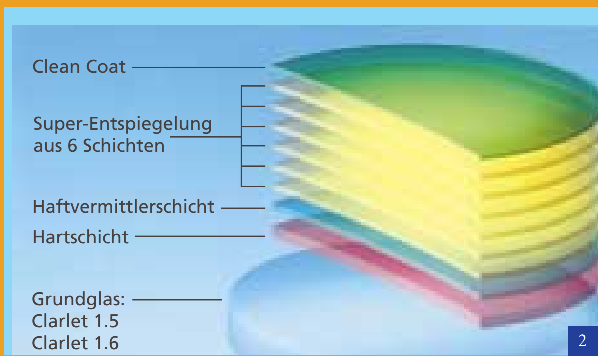



Fig. 2:
"CARAT®": high-tech coating system: layer for layer a top-of-the-line lens.

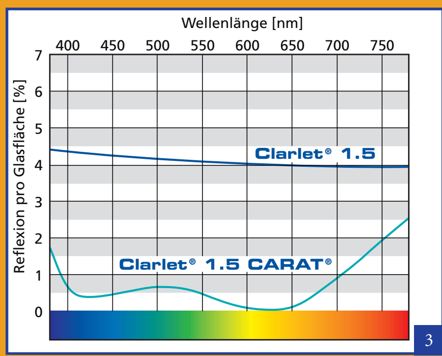



Fig. 3:
A "CARAT®"coating reduces reflectance per lens surface from about 4% to 0.6%.



**Figs 4a and 4b:**
Comparison of uncoated (**4a**) and coated (**4b**) plastic eyeglass lenses.

## Quick and flexible

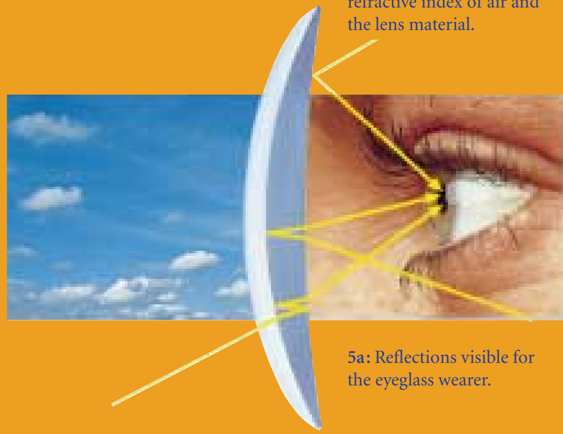
This demonstrates the decisive benefit of the PICVD process: the hard coating, the antireflective coating and the easy care coating are all applied in one and the same operation. The alternative, which is not necessary in this case, would to be to apply the hard coating first, harden it for several hours in a special oven, and then switch to another unit for antireflective coating. The highly attractive result: costs and time are saved since the whole procedure lasts only a few minutes.

These are all features that make a unit of this type an economical proposition compared to conventional production methods. In conjunction with the fact that each plastic lens is coated individually, rapid production on prescription is now a possibility. With previous antireflective coating processes, work could not start until a batch of 100 to 120 lenses had been assembled and the identical coating was applied to all of them in the same unit. They then had to be sorted according to their optical specifications, i.e. the prescriptions of the people who were going to wear them. By comparison, one-stage coating reduces this logistic outlay enormously and shortens the processing time to about one day at the most.

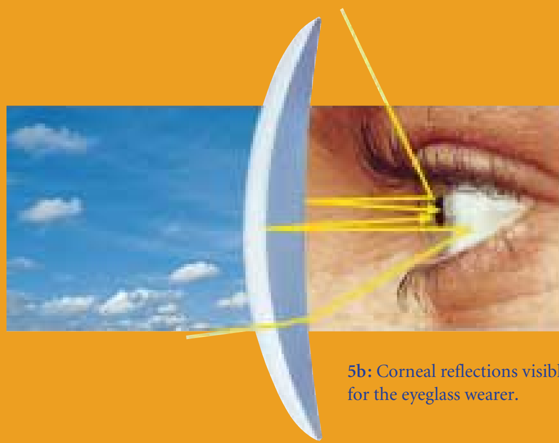
The pilot plant is finished, immediately providing Carl Zeiss eyeglass specialists with an instrument that will enable them to quickly adapt a flexible coating system to their prescription production. The exchange of information among the scientists at Schott and Zeiss has resulted in an extensive transfer of know-how and in a time saving that will further sharpen the company's competitive edge.

**Fig. 6:**
A microscope is used to measure reflections to check whether the required level of antireflective performance has been achieved.

**Figs 5a to 5c:**
The disadvantages of lenses without antireflective coating: reflections are caused by differences in the refractive index of air and the lens material.



**5a:** Reflections visible for the eyeglass wearer.



**5b:** Corneal reflections visible for the eyeglass wearer.

**5c:** Reflections visible for anyone looking at the eyeglass wearer.

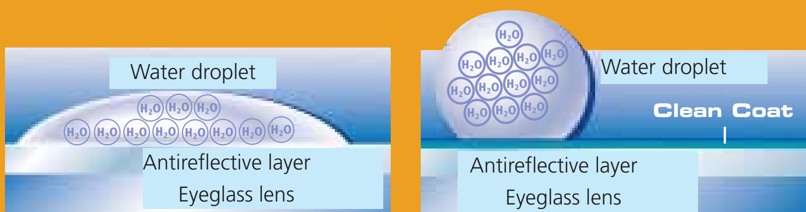


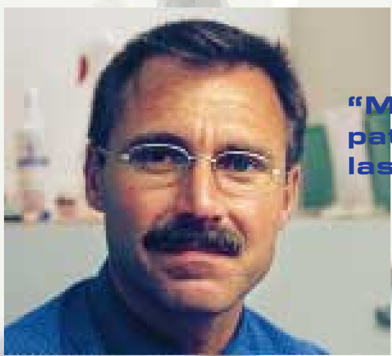

**Fig. 7:**
The principle behind the easy care Clean-Coat which repels water and dirt.

# Service Continues After Closing Time

How does an eyeglass frame get into a frame? This is usually the job of the eyecare professional who orders his lenses in an "uncut" state from the manufacturer. After receiving the lenses, he edges them until he obtains the shape of the selected eyeglass frame. This requires the utmost precision: every millimeter counts.

With the aid of modern technology and communication media, the eyecare professional can now have this intricate process done for him elsewhere. With what is known as a "tracer", a device that takes an exact measurement of the inner shape of the frame rim in just under one minute, the data required for the lens edging process is determined and sent to Carl Zeiss via remote data transmission. In a lab specially set up for this purpose in the Carl Zeiss eyeglass lens factory in Aalen, Germany, this data is used to shape or "edge" the ordered lens and subsequently send it to the eyecare professional. All he or she then needs to do is insert the lenses in the frame.

**Fig. 1 (below):**
*Thomas Stein*, one of the two managers of the ophthalmic outlet Optik Schmetterer in Prien, Germany.



**"More time for patients at long last!"**

The highly precise industrial grinding machines at Carl Zeiss perform this work at a considerably greater speed than the machines used by eyecare professionals and, particularly in the case of complicated lenses, often with better quality. For high dioptric powers, for instance, a neater lens bevel is obtained.

Since the beginning of the year 2000, Carl Zeiss has been offering this service to its eyecare clients in Germany within the framework of the Zeiss Partner Network. Other countries all over Europe will be linked to the system in the next few months. There are many reasons for our clients to use this facility, even if none of the participating eyecare professionals wants to totally dispense with their own edging machines. This work is too inextricably linked with their professional image. Nonetheless, the first clients to be connected to the system are impressed. *Maximilian Schmetterer*, manager of the ophthalmic outlet Optik Schmetterer in Prien, Germany, describes his first experiences with the system as follows: "What I really found impressive was the high quality of the edged lenses, right from the first delivery. Initially, we were skeptical, but today I must say that, particularly for more complex lenses, we ourselves cannot compete with the results we've been getting from Zeiss."

**"...no longer having to stand for hours on end in the lab after closing time..."**

**Figs 2 and 3:**
*Dirk Brune* (left) and *Dieter Gerking* (2nd from left and photo on top right), managers of Optic Brune & Gerking GmbH in Herford, Germany, seen here during their visit to the edging center in the Aalen eyeglass factory, are very satisfied with the results of the new service: "At long last, we no longer have to stand for long hours in the lab after closing time. We can now easily cope with peak order times and staff vacation or sickness by making use of this service. The decision to use the service was certainly an easy one for us to make."

# News from Italy

*Italy is a not only a popular tourist attraction because of its climate, cultural treasures and cuisine. Together with other major nations such as Germany, France and the United Kingdom, it plays a key role in the European Community and in the world economy.*

Products from Carl Zeiss had reached Italy long before the turn of the last century. One example is the famous Stazione Zoologica in Naples which had been equipped almost exclusively with Zeiss microscopes since its opening in 1873/74. Its founder and director of many years, *Anton Dohrn* (1840 – 1909), also purchased many instruments from Carl Zeiss and then resold them in Italy.

## From Milan to Arese

With the industrial expansion of the companies in the Carl-Zeiss-Stiftung one hundred years ago, the number of business connections between Italian customers and Zeiss increased. This soon made a permanent Zeiss presence in Italy an absolute must in the interest of customer proximity. The city of Milan proved to be the most favorable location for the new Zeiss office which was opened on the Piazza del Duomo in April 1911. After frequent switches to other representatives, a small, new branch opened its doors in Milan on June 22, 1948 and developed into a modern sales organization in the course of the next 50 years. Today, under the name Carl Zeiss S.p.A, this organization is responsible for the distribution and service of almost all products manufactured by the Carl Zeiss Group.

In modern buildings in Arese, on the north-west periphery of Mailan, a 140-strong workforce employed in the areas sales management, logistics, application technology and in general technical service ensures that all requirements of the company's Italian customers are met. They are supported by a dense network of expert sales staff working in the field who achieve an annual sales volume totaling almost 50 million euros. The strongest area of business is Consumer Optics with an annual sales figure of over one million eyeglass lenses, followed closely by Medical Systems and Microscopy. The past few years have also seen a rapid growth in Industrial Metrology business.

## From eyeglasses to Formula 1

Several thousand high-quality ophthalmic outlets offer Zeiss eyeglass and contact lenses. In Italy's large, modern hospitals such as the Ospedales San Raffaele in Milan, Gemelli in Rome or Cardarelli in Naples, highly renowned physicians work with diagnostic and surgical microscopes from Carl Zeiss. Companies in the automotive industry with such famous names as Fiat or Ferrari and also companies in the aviation industry such as Agusta measure and inspect their components successfully with Zeiss coordinate measuring machines. The stylish racing cars made by Ferrari in Modena are also measured with Zeiss precision.


**Fig. 1:**
"Progress is also a pair of glasses". This is how Italian eyecare professionals successfully advertise, and advertise with, Carl Zeiss eyeglass lenses.

**Fig. 2:**
Here on the Piazza del Duomo, Carl Zeiss opened its first office in Italy in 1911.

**Fig. 3:**
The current headquarters of Carl Zeiss S.p.A. in Arese near Milan.


**Fig. 4:**
Highly precise measurements with Carl Zeiss 3D measuring machines guarantee safety and speed for *Michael Schumacher's* red Formula 1 Ferrari.

# Brussels to Feel, Hear and Taste

Hugo Francq

Hugo Francq is a tourist guide in Brussels.

*In Belgium there are about 15,000 blind and very poor-sighted people. Numerous institutions and associations do a lot to help them, allowing many to actively participate in education, sport and cultural events. Many interesting initiatives also exist for these people in the field of tourism: the city of Bruges, for example, has a bronze model of the Belfort Tower with an explanation in Braille, permitting blind people to feel the exceptional beauty of the original. The Museum for the Blind in Brussels also organizes special exhibitions for the visually disabled, and other associations offer special trips within Belgium itself or abroad.*


**Fig. 1:**
Sweet delicacies have also helped to make Brussels famous.

## Getting a feeling for the city

A totally new and original possibility is a special guided tour through the center of Brussels city for visually impaired people. Encouraged by my 26-year-old daughter Liesbet who has been blind since the age of three, I worked out a tour that would appeal to all the senses and hence convey a real "feeling" of Brussels and its day-to-day life.

A lot of little stories on the history of the city, the important role played by guilds, the often dramatic ups and downs in the city's development and of the artists living there – *Peter Bruegel* is just one example – are elaborated and enhanced by noises and smells, by experiences of feeling and taste. It is very easy to get a very good idea of the products that have made Brussels famous all over the world, e. g. chocolates, "Gueze beer," "caricolles" and chestnuts by eating or drinking them. However, Brussels lace, Pompilio hats and, of course, "Manneken Pis" can only be experienced with the hands.

The center of Brussels has many places of interest all within a short distance of each other. The walk can therefore be kept relatively short and is therefore not too strenuous. It is no easy matter for blind tourists to keep their concentration right until the end of the tour, as the noise and the exhaust fumes of passing cars disturb the senses. Time and time again, interactive tasks on the tour awake the interest of the participants: for example, they have to use their hands to "read" a date on a wall or monument, guess the circumference of a column or the outline of a figure. They also have to remember brands of chocolate they taste during the tour.

## Experiencing what the sighted often miss

Needless to say, the guided tour cannot possibly cover everything: the restrictions of the visually handicapped are also our restrictions. Explanations concerning styles or architectures, for instance, are very difficult to convey. However, it does provide an extremely large number of opportunities for the participants to experience some beautiful aspects of our fascinating city that sighted people often pass by and fail to see. It goes without saying that the direct contact with people in cafés, chocolate and souvenir stores, in bakeries and restaurants, is an important part of the tour experience. With a lot of imagination and dedication, we repeatedly succeed in imparting to the natives and guests of the city a concrete sense of its uniqueness and history.

The tour finishes in a café where the participants discuss what they have experienced, a small quiz is held, and more questions are asked. And, of course, a typical Brussels Gueuze beer can help to seal many a new friendship!

## Carl Zeiss Academy

The tour, including tasting sessions and a light lunch, is free of charge for the visually disabled. Carl Zeiss Belgium is sponsoring this interesting experiment within the framework of its Carl Zeiss Academy.

Also as part of the Carl Zeiss Academy, tours are being organized for (sighted) practicing eyecare professionals and schoolchildren. With the use of special eyeglasses, they receive an impression of how blind or people with poor sight experience their surroundings.

A complete description of the tour is available in Braille and can be provided in large print for the visually impaired by the *Helen Keller* Atelier. This institution can also supply a map of Brussels' Grand Place in Braille. More information can be obtained from the author


- E-mail: Francq.hugo@mail.apb.be

or

- TenDoorn IIA,

1852 Grimbergen, Belgium,
Phone:+322 269 5329.


**Fig. 2:**
*Hugo Francq* with his daughter *Liesbet*.

**Background:**
Map of Brussels showing the route of the special tour for the visually handicapped, alongside a picture of the City Hall on the Grand Place, one of Brussels' many tourist attractions.

# New Landmark in New York

Volkmar Schorcht

*Volkmar Schorcht* works in the Planetariums business unit of Carl Zeiss.

*"Rising into view is the most advanced star projector in the world, capable of producing a perfect night sky as seen from Earth." With these words, Academy award-winner Tom Hanks officially opened the inaugural show in the new Hayden Planetarium of the Rose Center for Earth and Space at New York's American Museum of Natural History (AMNH). On February 19, 2000, after six years of preparation, the revolving doors of the USA's new leading center of science and education were opened to the public. With its five-story silver sphere that seems to hover in a gigantic glass cube, the unique architecture of the facility impressively signalizes to the world that a new, exciting millennium has begun.*

## Passport to the universe

In just 25 minutes, at speeds that would astound even the most imaginative science fiction writer, we leave Earth, fly through the solar system, reach the Orion nebula 1500 light years away and then leave the Milky Way, our home galaxy, to penetrate the depths of intergalactic space. We salute our neighboring galaxy, Andromeda, while advancing into the Virgo Supercluster, the largest three-dimensional structure in the universe to which our Earth belongs. Eerie, daunting almost, are our reactions to the honeycomb structure of the Superclusters consisting of thousands of galaxies grouped around gigantic cavities – the cosmic honeycombs – each galaxy consisting of billions of stars and maybe also planets...

So much show – but what we experienced was certainly no science fiction trip: the journey had a strict scientific basis. The artificial sky is accurate down to the last detail; the modeling of the universe is based on data obtained from NASA and from astrophysics research institutes. The objects we encounter are described by facts, photos and scientific analysis.

**Fig. 1:**
The over 15-ton Willamette meteorite in the Hall of the Universe.

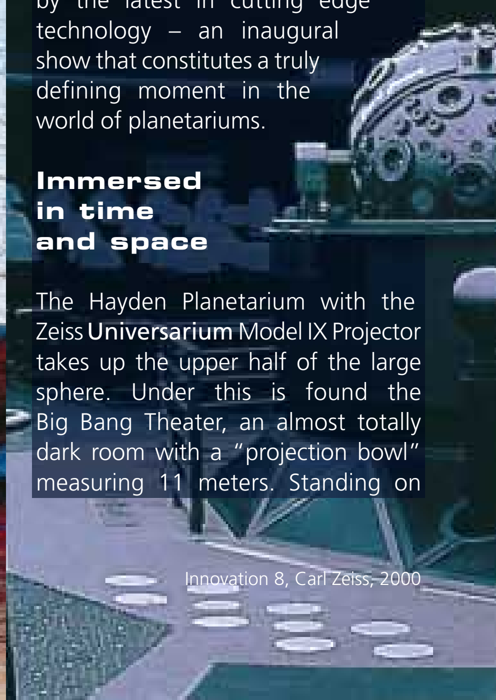


**Fig. 2 (background):**
Auditorium of the Hayden Planetarium showing the **Universarium Modell IX.**

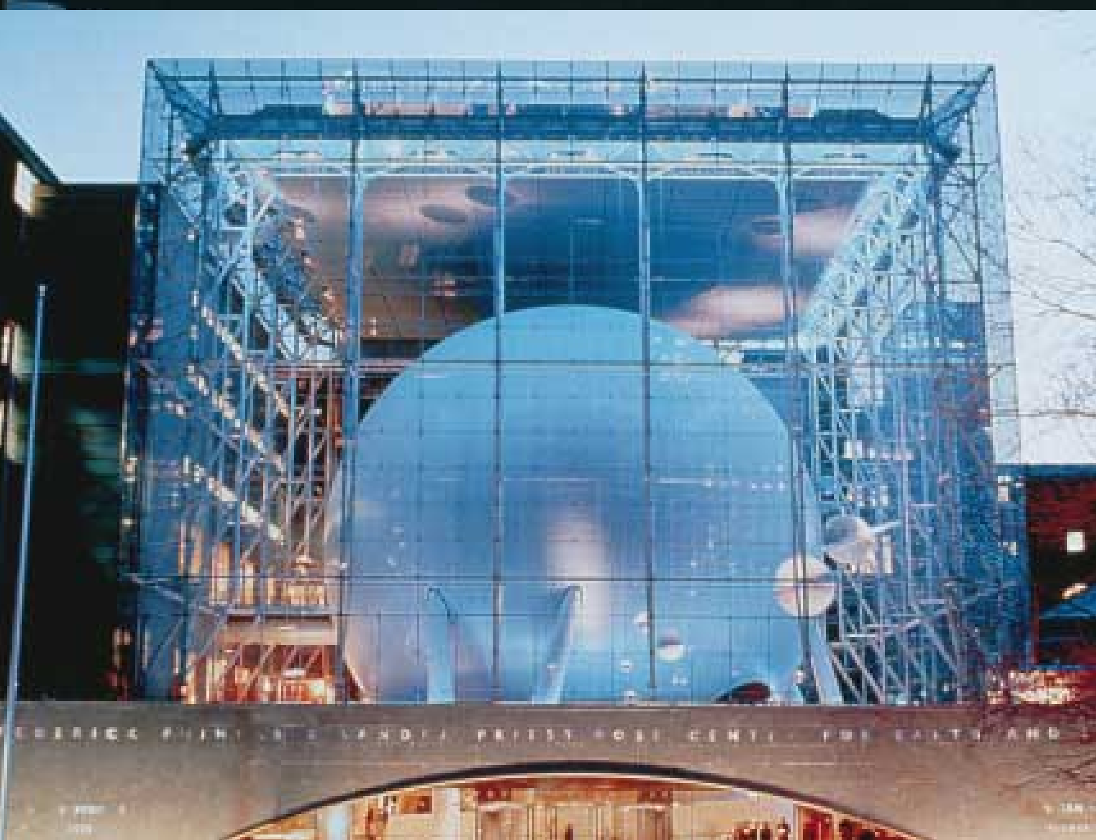



**Fig. 3:**
With its huge glass cube, the Rose Center for Earth and Space in New York accommodates the Hayden Planetarium.

Our "Passport to the Universe" launched us on an intriguing, multi-sensory journey, accompanied by the best from Hollywood and Harvard and by the latest in cutting edge technology – an inaugural show that constitutes a truly defining moment in the world of planetariums.

## Immersed in time and space

The Hayden Planetarium with the Zeiss **Universarium** Model IX Projector takes up the upper half of the large sphere. Under this is found the Big Bang Theater, an almost totally dark room with a "projection bowl" measuring 11 meters. Standing on

Plexiglas flooring and separated from the seemingly concealed projection surface by only a railing, we follow the first seconds of the creation of space presented with an OMNISCAN laser. Two-time Academy award-winner *Jodie Foster* dramatically narrates visual and audio effects that re-create how the universe began.

After leaving the theater, we proceed along the "Cosmic Pathway" to the present. The path leads us downward and forward in time on a gently sloping walkway. As if on a time beam, we can follow the stages of cosmic evolution: 13 billion years of development history are chronicled over a distance of 110 m. The first photos show the most distant objects which, due to the finite speed of light, are also the oldest ones visible to us. The evolutions of galaxies, the birth of stars and the formation of heavy elements are all stages on our downward path. Most of what is shown here by cosmic photos has only lately been discovered and still appears strange to us. We feel more at home in the last few meters where we experience a piece of the oldest rock on Earth, dating back billions of years, and then move on toward the present via fossils that are only (!) a few million years old and hence more within the realm of human comprehension. And then suddenly – a human hair. Astoundingly, civilization spans nothing more than the breadth of a human hair – the time between the first cave paintings and today. Is humanity only a flash of lightning in the thunderstorm of cosmic evolution?

"Scales of the Universe" is the name given to a walkway that hugs the glass curtain wall along the second level of the Rose Center. Here, models are shown that allow us to assess cosmic proportions. With its 26-meter diameter, the sphere of the Hayden Planetarium serves as a basis for comparison. The scale extends from the enormous expanse of our observable universe, galaxies and stars to Earth itself and then to the minuteness of a blood corpuscle and a virus, ultimately ending with tiny subatomic particles.

The "Hall of Universe" is a permanent exhibition hall on the lower level of the center. It is split up into four zones: the Universe zone, including a model of a "Black Hole" swallowing all matter, the Galaxies zone in which the collision of two swarms of stars is shown, the Stars zone which captivates visitors with fascinating information on supernovae and solar activity, and the Planets zone in which visitors can see and touch the large Willamette meteorite, a relic of our solar system and a piece of ancient cosmic debris. The latest discoveries, images from research telescopes and news from the world of astronomy are constantly displayed on a four-meter-high screen.

## Scintillating in every sense

Anyone who has visited the Hayden Planetarium knows that they have experienced the ultimate in cutting-edge technology.

The AMNH made very exacting demands on the planetarium projector. Before the decision was made in favor of the **Universarium**, Carl Zeiss had to show its willingness and ability to tailor the projector precisely to the needs of the new Hayden Planetarium. The projector is indeed unique – unique in its presentation capabilities, its projection quality and its accuracy.

The "starball" dominates the platform. It is simultaneously rotatable about three axes and carries all projectors required. The star-lit sky is ten times brighter than was ever possible with the former projector used in the Hayden Planetarium – thanks to the fiber projectors, an invention by Carl Zeiss. The artificial night sky is perfected by the extremely small radii of

**Fig. 4:**
*Ellen V. Futter*, Museum President, speaking at the press conference held to mark the opening of the Rose Center for Earth and Science, attended by over 200 journalists from all over the world.

Photos 1 and 4:
V. Schorcht,
2, 3, 5 and 8:
D. Finnin, AMNH,
6 and 7:
Digital Galaxy Project.

**Fig. 5 (background):**
Cosmic Pathway with the planets of the solar system; Jupiter in the foreground.

the stars. Together, the astounding brightness and the tiny diameters result in what can only be described as brilliance – in every sense of the word. And the capabilities of the fiber projector by no means end there: it can also simulate the scintillation or sparkling of the stars, and for the first time in a way that is totally true to nature. Visitors will also marvel at the realism of the Milky Way – all made possible by new, pioneering technologies.

In nature, galaxies, star clusters and nebulae can only be observed in very clear air. The new Hayden Planetarium wanted to show as many of these very faint objects as possible. Carl Zeiss met this requirement so successfully that the visitor can view them with a pair of binoculars – just as in nature.

The Hayden Planetarium has its own constellations, created by the New York graphic artist *Scott Ewalt* and technically implemented by Carl Zeiss.

In then Universarium eight single projectors generate the images of the sun, moon and planets whose motions are based on data which is supplied by software developed by Carl Zeiss for astronomical simulations. This means that all constellations are accurately callable within a time period of ±10,000 years.

The Hayden is the first planetarium to incorporate all planets of our solar system, i.e. also the most distant which are not visible with the naked eye from Earth. Even small planets, artificial space probes or fictitious objects can be projected and moved along astronomical pathways – truly an all-time first in the world of planetariums.
.

The digital drive technology of the **Universarium** makes it possible to "position" planets in a matter of seconds, allowing leaps into the distant past and future. And that is not all: the Earth is no longer the only vantage point.

The abundance of didactic lines, scales and markings is unique. Everything is included to help 500,000 school students to better understand the processes of the universe every year.

## New cosmic perspectives

The strength of the Zeiss projector lies in the brightness and excellent definition and brilliance of all projections. However, the second projection system in the Hayden auditorium has other merits.

Virtual space can be shown with the aid of digital projection. Seven video projectors on the dome periphery generate an invisibly composite image on the dome.

Here, once again, the AMNH is a pioneer in the field: the data used originates from scientific sources. The entire Milky Way galaxy with all its stars, nebulae and other interstellar objects is contained in a digital form in the computer. If no observation data is yet available, interpolations fill the gap. The digital dome projection transforms the Hayden Planetarium into the biggest scientific virtual reality simulator in the world.

Both systems ideally complement each other: the Zeiss projector transports visitors to any location in the solar system and projects a star-lit sky of incomparable quality. The digital projection system advances into the third dimension and provides cosmic perspectives of our solar system right to the very limits of the universe.

## New architectural icon for New York

The New York architect's office Polshek Partnership designed and executed the shell of the building as a metaphor of our understanding of the universe. As a symbol of all orders of magnitude from the microcosm to the macrocosm, the sphere is the centerpiece of the seven-story annex, embedded in a gleaming cube of glass with a transparency reminiscent of unclouded atmosphere. The entire facility rests on a granite base, whose arch-shaped entrance echoes the curvature of the inner sphere and conceals its supporting columns from the exterior. Whether in glaring sunlight or in the discreet blue of the artificial lighting, the sphere appears to hover gracefully in the air.

The glistening of the black terrazzo flooring in the entrance area – an effect produced by chips of Czech glass – fills visitors with a sense of anticipation, even cheerfulness. From the height of a balcony, they first see the complex structure of the exhibition hall under the sphere, then the supporting columns and the spiral walkway leading to the lower level emerge. Recognition and understanding are the principles underlying the architecture and the design. Radiant brightness, clear guidance, explanatory panels, graphic models, interactive and three-dimensional exhibits leave no doubt in the visitors' mind that they are in the midst of a living world of science.

## Taken by storm

Even in the first few days after its opening, the Rose Center for Earth and Space was literally taken by storm: 8000 visitors a day was the record. Overall, the AMNH anticipates an increase in visitors of one million a year, with the annual total rising to 4.5 million. New car-parking facilities, the rejuvenation of the neighboring park, a new entrance on Columbus Avenue, an additional museum shop and the reconstruction of the museum underground station – this has all been done to meet the demands of a growing number of visitors.

## Contacting the future

The AMNH combined its exacting demands on the planetarium's technology with an additional requirement: uniqueness. With the numerous extras, ranging from the metallic effect of the anthracite-colored projector, the 67 exclusive constellations, the additional celestial objects and astronomical coordinates to the operational capabilities which are totally beyond compare, the Hayden Planetarium has set pioneering new trends. Museum President, *Ellen V. Futter*, summarizes her expectations as follows: "The Rose Center takes our mission of sharing with the public how we fit into our planet, our galaxy, and the universe to new heights. With its extraordinary cutting-edge technology, the Rose Center enables us to bring today's developments in outer space and the possibilities of the future directly to our visitors. We are proud to have created architecture in the service of science and education, a place where people of all ages will enjoy a transporting and transforming educational experience, a place that embodies our role as a museum for the 21st century."

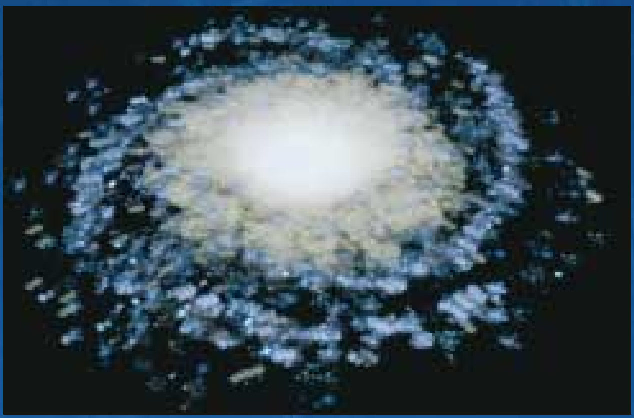


**Fig. 6:**
Digital projection of the Milky Way, as seen from the outside, on the planetarium dome.

**Fig. 7:**
Digital projection of the Orion nebula with star clusters onto the planetarium dome.

**Fig. 8:**
Cosmic Pathway with Saturn in the foreground.

# Carl Zeiss Research Award

*Professor Dr. Ursula Schmidt-Erfurth.*

**Background:**
Laser irradiation of the eye with 689 nm.
Source: CIBA Vision
**Below:**
Blue laser on GaN basis.

*Professor Dr. Shuji Nakamura.*

The winners of this year's Carl Zeiss Research Award were *Professor Dr. Ursula Schmidt-Erfurth* (Luebeck University Hospital, Ophthalmology Clinic, Germany) and *Professor Dr. Shuji Nakamura* (University of California, Materials Department, Santa Barbara, USA). The award, to which the total sum of DEM 50,000 was allocated, was presented during the annual convention of the German Society of Applied Optics (DGaO) in Jena, Germany, on June 16, 2000.

*Ursula Schmidt-Erfurth* was given the award for her development of the basic principles behind photodynamic therapy on the eye. This technique can be used to halt the impairment of vision caused by a condition known as wet, age-related macular degeneration, the principal cause of blindness in persons over 50 years of age. The study on the photodynamic therapy of a neovascular retinal disorder published in May 1998 by a international workgroup set up by the award-winner represented the first use of the method on the human eye anywhere in the world. The therapy is based on a photochemical effect induced by laser irradiation.

Together with CIBA Vision, Carl Zeiss has helped photodynamic therapy to achieve a breakthrough. The **VISULAS 690s** medical laser from Carl Zeiss provides a suitable system configuration for efficient treatment, while subjecting the patient to minimum strain.

*Shuji Nakamura* received the Carl Zeiss Research Award for the development of high-brightness blue light-emitting and laser diodes, permitting such applications as full-color displays and full-color indicators. The blue LEDs join previously developed red and green light-emitting diodes to complete the palette of primary colors, enabling long-lasting, energy-efficient LEDs to dominate such niche applications as sports stadium displays. In future, white LEDs, which combine red, blue and green LED structures in one device, could eventually make conventional light bulbs obsolete. The shorter wavelength of the laser allows, for example, a fourfold increase in resolution in CD players and CD-ROM drives over traditional equipment, where infrared lasers are used to read the signals. In 1994 *Nakamura* succeeded for the first time in producing a blue light-emitting diode with a brightness of over 1 cd, and later also of 2 cd and 10 cd. In 1995 *Nakamura* succeeded in fabricating a semiconductor laser diode with an emission wavelength in the range of 390–440 nm, and he successfully increased the lifetime to 35 hours at room temperature in 1996.

At the end of 1999, Nichia Chemical Industries Ltd. (Japan) started to market the blue laser diode with an output power of 5 mW and a lifetime of 10,000 hours.

The Carl Zeiss and Otto Schott Research Awards, each presented once every two years on an alternating basis, were created to motivate primarily young scientists in recognition of outstanding work in the fields of optics and glass technology. Both research awards are administered by the Donors' Association for the Promotion of Science in Germany and are advertised internationally in line with the global operations of both the Carl Zeiss and Schott Groups. Past winners therefore include not only German physicists and chemists, but also scientists from the USA, Japan and other European countries outside Germany.

# Carl Zeiss Lecture

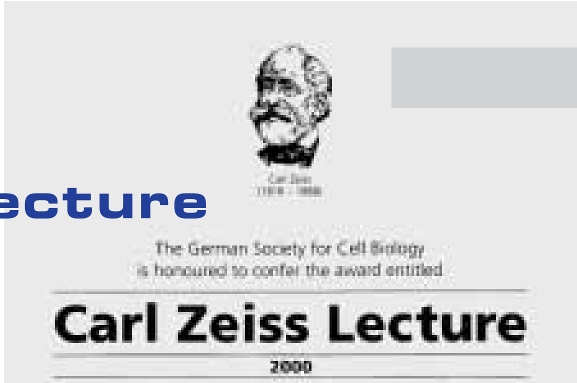



**Photo:**
The Carl Zeiss Lecturer 2000, *Professor Dr. Erwin Neher*, receiving the certificate from the President of DGZ, *Prof. Werner W. Franke*. Left: *Dr. Heinz Gundlach* from Carl Zeiss.

The annual meeting of the German Association of Cell Biology (DGZ) took place in Karlsruhe, Germany, in March 2000. Two coinciding anniversaries were on the agenda: 25 years of the DGZ, and, at the same time, 10 years of the Carl Zeiss Lecture.

The lecture opening the meeting was held this time by *Professor Dr. Erwin Neher,* Nobel Prize winner for Medicine in 1991 together with *Prof. Dr. Bert Sakmann* and Director of the Max Planck Institute of Biophysical Chemistry in Göttingen. *Neher* spoke to an audience of more than 600 people about the subject of "Nerve cells in the light of the modern microscope". During his examinations of living nerve cells, a light microscope is linked with the FCS (Fluorescence Correlation Spectroscopy) technology.

In modern microscopes, observation and imaging are only one aspect of what light is able to provide. Light is also used in quantitative analyses and influences important signal processes – mainly calcium signals in the central nervous system. The examinations of *Professor Neher* and his research team look at the role of the calcium signal as a messenger between electrical signal transduction of the nervous system and cellular functions, and at the submicroscopic structures of the calcium signal.

With this award, the DGZ and Carl Zeiss honored *Professor Neher's* outstanding achievements in the fields of cell biology and neurobiology.

# Award of Excellence

… and the winner is: Carl Zeiss Optical. The Zeiss team was proud to hear these magic words twice during the annual convention of the Optical Laboratories Association (O.L.A.) in Nashville/Tennessee in November 1999. Of the approximately 400 member labs in the O.L.A. in a total of nine categories for the Award of Excellence, Carl Zeiss was nominated no fewer than three times. The awards were presented in an Oscar-style ceremony. Carl Zeiss was the winner in the two categories "Coating Technologies for Eyeglass Lenses" and "Best Anti-reflective Coating for Eyeglass Lenses". An unexpected and therefore all the more appreciated triumph! Although Zeiss is currently cooperating with only 65 labs in the USA, most of the others are obviously convinced that Zeiss quality is unbeatable. After fewer than five years, the breakthrough has now been achieved. The US is export country No. 1 for the Ophthalmic Products area. The Zeiss market share in the US is still quite small, and the growth potential correspondingly high. Every seventh **Gradal®** progressive lens sold in the world is currently bought in North America.

The staff of Carl Zeiss Optical are delighted to receive the two O.L.A. awards.

# Fraunhofer Award

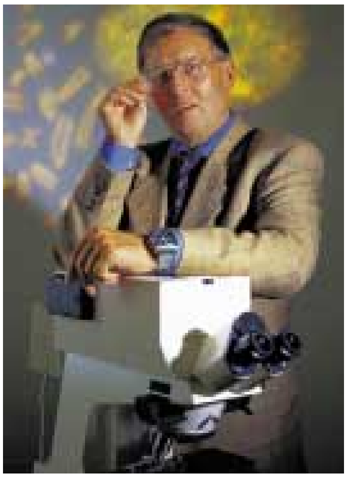
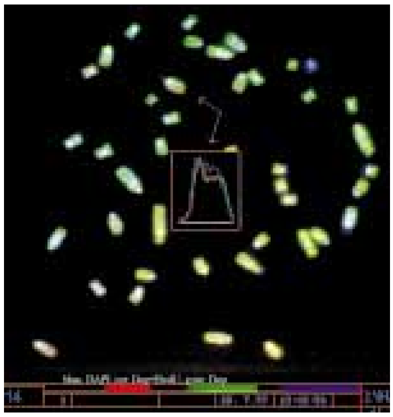


Fig. 1:
Fraunhofer award winner in 1999: *Professor Dr. Rudolf Fahrig* of the Fraunhofer ITA Institute for Toxicology and Aerosol Research in Hanover, Germany, at the **Axiophot® 2** photomicroscope. (Photo: Volker Steger).

Every year, approximately 330,000 people in Germany develop cancer. In addition to surgery and radiation therapy, chemotherapy is another possibility of fighting this disease. Here, chemicals are used which inhibit the growth of tumor cells. The aim of such cytostatics is to prevent cell division. However, chemotherapy has one drawback: the cancer cells can become resistant to these chemicals after a certain period of therapy. *Prof. Dr. Rudolf Fahrig* of the Fraunhofer ITA Institute of Toxicology and Aerosol Research in Hanover has found a way of preventing the chemicals from becoming ineffective. For this discovery, he has received the 1999 Fraunhofer Award.

All the resistant tumors examined so far have one thing in common: certain multiplied genes are present in them. In most cases, these are cancerogenic genes or Multi-Drug-Resistance (MDR) genes. The latter produce a protein that pumps foreign substances – such as cytostatics – out of the cell. If the genes are present in a multiple form, more of this protein is formed. The result: drugs are increasingly transported out of the cancer cell and are no longer effective. The tumor continues to grow undisturbed. "To prevent tumors from becoming resistant to chemotherapy, multiplication of cancerogenic and MDR genes must be inhibited", was how *Prof. Dr. Rudolf Fahrig* of ITA explained his research. He has found a substance which prevents the multiplication of the genes. If this substance is taken together with cytostatics, no resistance to chemotherapy will form. In a further step, the new approach to therapy will be examined in clinical studies. However, a number of years will be required until this combination therapy can be applied in cancer treatment. In late 2003 at the earliest, we will be able to say whether the therapy will be effective in humans.

Fig. 2:
Measuring the multiplication of rat chromosomes. (Photo: Dr. Harry Scherthan, Kaiserslautern University, Germany).



*Professor Fahrig* heads the Gene Toxicology department of ITA. For his research, for which he has received several awards, he uses various Zeiss microscopes, including the **Axiophot® 2** and **Axioskop® 2**.

# Zeiss on the Dot Every Time

Fig. 1 (on far right):
The diagnostic and therapy microscope **OPMI® pico** received the stamp of quality "Red Dot for Highest Design Quality".

The new surgical microscopes submitted by Carl Zeiss for the competition "Design Innovation 2000" have received much-coveted awards. In this international competition aimed at honoring innovative design, they were both awarded the "Red Dot". The two **OPMI®** were jointly developed and designed by Carl Zeiss and the firm Haseke, Porta Westfalica, Germany (**OPMI® pico**), and the firm busse design Ulm, Germany (**OPMI® VARIO**). With such renowned names as Audi, BMW, DaimlerChrysler, IKEA, Shimano and Sony among the other prize-winners, Carl Zeiss is certainly in very good company.

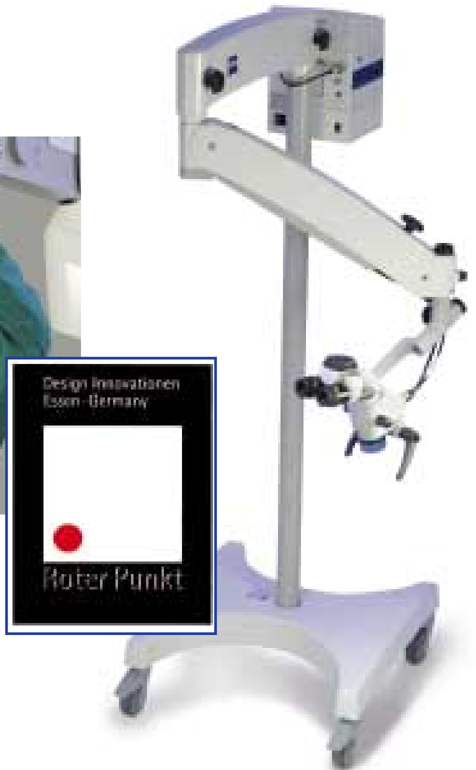



Fig. 2:
The **OPMI® VARIO** surgical microscope received the award "Red Dot for High Design Quality".

# Measuring Technology for Renault

Carl Zeiss has received a major order worth DEM 5.8m from the French car manufacturer Renault for the delivery of coordinate measuring machines. Carl Zeiss will supply the entire metrology equipment for a new engine company in Curitiba/Brazil. This comprises coordinate measuring machines of the **Prismo®**, **UPMC** and **Eclipse** series, including such services as maintenance, training and programming. The measuring machines will be used in flexible production lines for cylinder heads and engine blocks, in the central metrology room, and for the inspection of crankshafts.

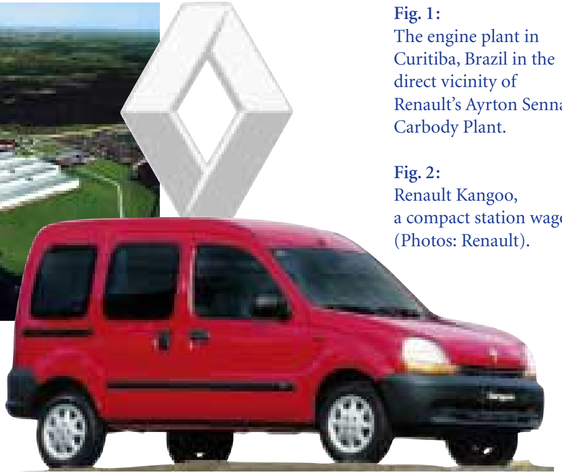


**Fig. 1:**
The engine plant in Curitiba, Brazil in the direct vicinity of Renault's Ayrton Senna Carbody Plant.

**Fig. 2:**
Renault Kangoo, a compact station wagon. (Photos: Renault).

# Highly Recommended

Carl Zeiss is supplying microscope systems for quality assurance in chip production in Singapore. A total of 27 units covers the entire requirements for inspection systems of the new chip factory of SSMC (Systems on Silicon Manufacturing Company Pte Ltd.).

One decisive factor for awarding the contract worth of DEM 10m to Carl Zeiss was a recommendation by Philips Electronics N.V., one of three joint venture partners of SSMC. Inspection systems from Carl Zeiss have been successfully used for more than four years in the MOS-4 chip factory of Philips Semiconductors in Nijmegen, Holland. They offer not only excellent technical performance, but also outstanding service.

# Brilliant Images for Professionals

The world's first laser projector equipped with leading-edge laser technology to permit high-resolution video and data projection with previously unknown quality comes from SCHNEIDER Rundfunkwerke AG, Türkheim, Germany. This laser projector projects incredibly crisp images onto surfaces of virtually any shape with maximum color brilliance and without any loss in definition The projection heads used for this purpose are manufactured by Carl Zeiss within the framework of a license agreement with SCHNEIDER.

The projector head is flexible and even allows moving images along projection surfaces within a room. This gives laser technology decisive advantages over traditional projection systems, especially in professional use, e.g. for planetariums, simulation technology, digital cinema, theater scenery systems and for major events.

**Photo below:**
Regardless of whether science fiction worlds like "Star Wars", "Starship Enterprise" or other effects are to be shown, the new laser display technology can be used to combine the star-lit sky in the planetarium with moving pictures, vector graphics and even laser beams.

# New Metrology Room Gets Starting Signal

The new VW plant in Shanghai is now manufacturing the Passat car, for which Carl Zeiss has delivered measuring technology to the tune of DEM 7m which is used in the stamping plant and in quality assurance for car-body production.

However, the actual installation of the measuring machines was only the beginning. Special software packages were needed to start up these modern systems. Carl Zeiss provided the customized CNC programs and conducted staff training courses on site. In December 1999, the acceptance report documenting the successful installation of the seven **SMC** and **SMM** horizontal-arm coordinate measuring machines was signed by VW Shanghai.

**Fig. 1:**
An **SMM-C/DSE** horizontal-arm CMM in the new metrology room of VW in Shanghai. The two measuring tables made of cast iron weight 36 tons without the foundations, and approx. 236 tons with the foundations. The foundations “float” on spring elements 50 mm above the foundation basin.

# Everything You Need for Precise Measurement

Since December 1999, the doors of the office and demo center for Industrial Measuring Technology of Carl Zeiss in Shanghai have been open to anyone interested. In the new exhibition rooms, horizontal-arm coordinate measuring machines such as **Carmet®** and **SMC**, bridge-type coordinate measuring machines such as **Contura®** and **Prismo®** and a **ScanMax®** articulated arm measuring machine are not only on show, but can also be tested with practical measuring applications. To provide quick, on-site support for customers, a spare part inventory was set up and specialized service and applications engineers were employed for hardware and software applications.

The first visitors included representatives of the Shanghai Volkswagen Group in whose VW plant Carl Zeiss metrology is being used. They were very impressed by the demo facilities, the high-quality service, training, and customer demonstrations in China.

**Figs 1 and 2:**
Demo center for industrial measuring technology from Carl Zeiss in Shanghai.

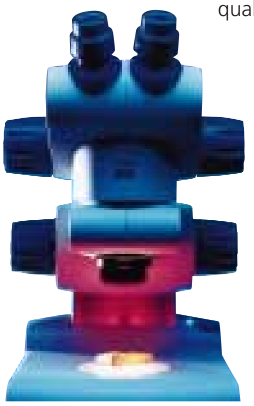
# Market Approval Granted

The ophthalmic **Visulas 690s** laser developed by Carl Zeiss in cooperation with CIBA Vision® allows a new approach to be taken in the treatment of wet age-related macular degeneration (AMD) using the drug Visudyne™. At the end of 1999, Switzerland was the first country to grant market approval to Visudyne™ under monitored release. A short time afterward, the U.S. Food and Drug Administration (FDA) approved the use of the **Visulas 690s** for the activation of the drug for the photodynamic treatment of AMD.

Currently, only 10 to 15 % of the estimated 500,000 patients who develop AMD are eligible for existing treatments. In 40 to 60 % of all cases, wet AMD causes predominantly classic lesions in the eye and typically destroys central vision which is necessary for reading, driving and recognizing faces.

## Light Microscopy

The **Stemi® DV 4** stereomicroscope sets new standards for low-cost and yet high-performance zoom stereomicroscopes. Its excellent optics have been designed around a new, patented zoom system which guarantees brilliant, razor-sharp, high-contrast images throughout the zoom range – from 8x overview to 32x detail magnification. This is unique for a stereomicroscope of this price category. With the new, compact C stand and an ingenious approach to illumination control – at the touch of a button, the user can select between reflected, transmitted and mixed light – the **Stemi® DV 4** sets new standards for the handling of modern stereomicroscopes which will be appreciated by students and trainees as well as by users in industrial assembly, testing and quality inspection departments.



Stemi® DV 4 stereomicroscope.

## Microelectronic Systems

The **CSM VIS-UV** confocal scanning module makes it possible to produce high-resolution, high-contrast light microscope images of structures as small as 0.16 µm in visible light and 0.100 µm in UV light. In the range only just below 0.16 µm, where even white-light confocal technology with the best optics reaches its limits, the **CSM VIS-UV** is now setting new standards. The shorter wavelength of the ultraviolet light is combined with a real-time confocal mode. The result: brilliant images. The contrast and resolution possible with this new unit far exceed those provided by the white light CSM. The new technology which allows the imaging of feature widths and spacing of 0.100 µm already meets the requirements of future wafer inspection.

Fully automatic **Axiosprint** wafer inspection station.

Wafer Inspection requires high throughput rates and a high degree of reliability for defect detection and classification. The fully automated **Axiosprint** Wafer Inspection Station provides all this at a high technological level without diverting the operator's attention away from his work. The **Axiosprint** can be used in class 10 cleanrooms and as SMIF model. It features a front-loading double-cassette system, vacuum grippers, optically controlled, contact-free – and therefore contamination-free – centering. A special feature permits even the back of 150 and 200 mm wafers to be displayed in a tilted form. A further benefit is the extremely high throughput rate of more than 400 wafers per hour. **Axiosprint** offers everything that is expected of a very modern wafer inspection station. In line with the motto of the semiconductor industry, it is faster, more flexible and smaller.

## Surgical Products

Unique in function and design is the **NC 4** ceiling mount featuring Contraves technology for the **OPMI® Neuro** surgical microscope. This Contraves technology (a suspension system using magnetic brakes and counterweights for balancing) is currently not available in a ceiling mount from any other manufacturer. It allows almost effortless movement of the surgical microscope including guidance of the microscope with one hand or by mouth. The wide radius of action ensures optimum ergonomic convenience when working with the microscope and when positioning the patient. Handling and balancing of the **NC 4** ceiling mount are extremely easy.

**OPMI® Neuro** surgical microscope on **NC 4** ceiling mount.

Hand grips are provided for the control of the **OPMI® Neuro** or for bringing it into its rest position. Another benefit of the **NC 4** ceiling mount with the **OPMI® Neuro** is its perfect integratability in image-guided systems for microscope navigation. With all leading manufacturers of surgical navigation systems, the **OPMI® Neuro** on the **NC 4** floor stand has become established as the system of choice.

The **OPMI® pico** dental microscope enables the dentist to perform the innovative diagnosis and therapy expected by informed patients, e. g. by using microdentistry – the integration of microscopic examination methods and microsurgical techniques performed using this microscope. Using the video camera integrated in the microscope body, the image of the patient's mouth is transmitted to a monitor, improving communication between the dentist and the patient. In addition, the dentist's team can participate live in therapy and assist the dentist with more foresight. The **OPMI® pico** dental microscope makes changes and even the finest detail in the tooth structure visible which could not be seen with the naked eye, resulting in diagnosis with unparalleled precision. Totally homogeneous illumination, widefield binocular tubes and high-eyepoint eyepieces provide a panorama view of the therapy site and visual comfort you would otherwise only associate with surgical microscopes. Even over extended periods of time, the dentist can work in a relaxed posture – the design and the ideal mobility of the **OPMI® pico** ensure optimum ergonomic convenience. An S100 wall mount, ceiling mount or floor stand can be chosen for optimum integration in the dentist's practice.

**OPMI® pico** dental microscope.

The **OPMI® VARIO** surgical microscope for plastic and reconstructive surgery, hand and accident surgery and maxillofacial surgery features Varioskop optics, allowing the working distance to be adjusted to the existing surgical situation without any need to change the position of the microscope or the optical module. Another benefit is the fast, reliable positioning of the **OPMI® VARIO** over a large distance in the XY directions. The high-intensity

**OPMI® VARIO** surgical microscope as a double microscope.

Superlux 180 W xenon light source provides extremely bright, high-contrast, daylight quality illumination. If the microscope illumination fails during surgery, the 180 W xenon backup lamp can be moved quickly into position. The spot illumination with its extremely small diameter of 13 mm focuses the light right where it is needed. In plastic and reconstructive surgery, two surgeons often operate in a face-to-face position. The symmetric stereo bridge makes the **OPMI® VARIO** the perfect double microscope. Special accessories for documentation and coobservation extend the range of applications of the **OPMI® VARIO**. This microscope is available with S8 suspension systems, innovative and flexible carrier systems with many individually adjustable memory functions and optimum mobility.

## Spectral Sensor Systems

**ZodiaC** is the name of the **Z**eiss **O**ptical **D**issolution **I**n-situ **A**nalysis and **C**ontrol System for determining dissolution rates in the pharmaceutical industry – without any need for extractive sampling and filtering. This allows faster and more accurate measurement of the time required to dissolve a specific agent of a drug. The basis of the system is a diode array spectrometer of the **MCS 500** series coupled with fiber optic probes from Hellma via an 8 channel multiplexer from DICON. In-situ analysis using fiber optic probes avoids the problems associated with extractive systems. These include the blockage of tubing and filters, the adsorption and precipitation on filters and in Teflon tubes which may lead to lower concentrations and therefore falsified results. The need for time-consuming calibration of the flow and pumps is totally eliminated by the

Zeiss Optical Dissolution In-situ Analysis and Control System **ZodiaC**.

use of the probes. Designed originally for sustained release products with dissolution profiles of 24–48 hours, the system can also be used for drugs with very short dissolution times. The stability and accuracy is ensured by the fact that the blank and the standard are measured during every cycle. Extremely short measuring times of less than 1 minute also allow the monitoring of fast release products.

## Optronic Systems

The **HDIR** (High Definition Infrared) thermal camera for detailed observation, correct assessment of the scene and precise recording of military and non-military targets displays an unprecedented range and resolution. **HDIR** offers the HDTV standard with a 9:16 format, providing a 33 % wider horizontal field of view than the usual CCIR standard. The generated image comprises 1152 lines with 1920 pixels

**HDIR** thermal camera and an infrared image recorded with the thermal camera.

each. **HDIR** can be either used as a standalone thermal camera or integrated in multisensor platforms. Upgrading by a tracker for automatic target tracking, laser rangefinders and laser target designators is possible at any time. When combined with an image processing system, the instrument forms an "intelligent" sensor for automatic panoramic search and object identification.

## Camera Lenses

The 35-70 mm **Vario-Sonnar®** T* f/3.5-5.6 lens is a compact and light standard zoom lens for the **Contax®** G 2 rangefinder camera. It is the world's first interchangeable lens with continuously adjustable focal length for a rangefinder camera. The rangefinder of the **Contax®** G 2 camera automatically adapts its frame continuously to the zoom setting of the 35-70 mm **Vario-Sonnar®** T* f/3.5-5.6 lens. The focal length range of 35 to 70 mm allows flexible use of the lens from the wide-angle focal length of 35 mm and the standard focal length of 50 mm for true-to-nature photos to the medium telephoto focal length of 70 mm which allows slightly longer distances to the object to be bridged without falsifying the natural perspective. These qualities make the 35-70 mm **Vario-Sonnar®** T* f/3.5-5.6 the lens of choice for travel photography within the range of the **Contax®** G System. Major photo magazines in Germany and the USA have confirmed the excellent image quality of the 35-70 mm **Vario-Sonnar®** T* f/3.5-5.6 lens.

35-70 mm Vario-Sonnar® T* f/3.5-5.6 lens for Contax® G 2.

The first DV Camcorder with an integrated editing computer from SONY is equipped with a Zeiss lens. The **Vario-Sonnar®** lens with an optical 10x zoom (digital: 40x zoom) functions precisely in the focal length range from 48 to 480 mm (10x zoom), with the Super Steady Shot anti-wobble system also allowing steady photography with long focal lengths. Focusing is performed either automatically (autofocus) or using the focusing ring on the lens.

SONY DV camcorder DCR-TRV20 with **Vario-Sonnar®**.

The CLA 35 HD Cine Lens Adapter is the first product launched by the co-operation venture set up between Angénieux, France, a manufacturer of zoom lenses for movie and TV cameras, and Carl Zeiss, a supplier of lenses for the movie industry. The new optics allow the use of 35 mm movie lenses with a PL bayonet on high-resolution ("High Definition") electronic 2/3" digital cameras. The CLA 35 HD is based on a very complex optical design which ensures that optimum image quality and chromatic properties are obtained with the new ULTRA PRIME lenses which Zeiss supplies for the Arriflex 35 mm movie cameras. A format converter has been integrated in the CLA 35 HD Cine Lens Adapter which images the full frame of the 35 mm format without loss on the 2/3" image sensor chip of the electronic camera. The field angle of the lens remains unchanged, the speed is even raised by more than one f-stop and the modulation transfer data (MTF) is also improved. The adapter is compatible with all electronic 2/3" cameras featuring a standard bayonet and, in particular, with the new high-resolution progressive scanning cameras ("24p"). The CLA 35 HD is distributed worldwide by Angénieux.

The CLA 35 HD cine lens adapter with an ULTRA PRIME lens and an electronic camera.

## Binoculars and Riflescopes

The Zeiss **Victory** 8 x 40 B T* and 10 x 40 B T* binoculars are the first in this price category to feature Abbe-Koenig prisms and four-element lenses of the Superachromat type, resulting in superior image quality and optimum twilight performance at an attractive price. They are shorter, lighter and provide high light transmission. This has been made possible by close cooperation between glass researchers at SCHOTT GLAS, Mainz/Germany and optical designers at Carl Zeiss.

Varipoint® 1.5 - 6 x 42 T* riflescope on a Blaser R93 rifle.

Victory 8 x 40 B T* (right) and Victory 8 x 56 B T* binoculars.

The new glass types which are free from arsenic and lead display the optical properties required for the AOS system (Advanced Optics System), providing high image quality along with markedly reduced weight. The unique optics of the **Victory** binoculars is matched by equally advanced mechanical systems.

The **Victory** 8 x 40 B T* is a compact multi-purpose binocular which is 710 g light and is ideally suited for travel, photo safaris, hiking and sporting events. It also provides the eyeglass wearer with an extremely wide field of view of 135 m at 1,000 m.

The **Victory** 10 x 40 B T* with its 10x magnification and a weight of 730 g make it the ideal binocular for watching animals in the wild and for birdwatching. It is a binocular which lets you recognize even the finest detail and most subtle shades of color. At 10x magnification, you can experience nature in close-up without disturbing it.

The **Victory** 8 x 56 B T* is suitable for observation at early dawn and late dusk. The classic binocular for hunters and zoologists is now provided with state-of-the-art optics and an unparalleled field of view of 132 m at 1,000 m. The flagship of the new range of Zeiss binoculars is the **Victory** 10 x 56 B T*. With its 10 % shorter length, it weighs approx. 17 % less than its predecessor. It remains a binocular which provides superlative twilight performance, image quality and detail recognition.

The **Varipoint**® VM/V 1.5 - 6 x 42 T* is a multi-purpose red dot scope for sitting game in daylight and twilight, for stalking and the occasional drive hunt. The scope is available with two reticle versions. The intensity of the red dot can be adjusted from a very high to a very low level – without glare. The second reticle type is a combination of the red dot with posts, with the dot lying in the second and the horizontal posts in the first image plane. While the size of the dot remains constant over the entire power range, the two horizontal posts and the opening between them are also magnified.

## Ophthalmic Products

**Gradal® Individual** is a new development from Carl Zeiss that not only optimizes progressive eyeglass lenses for every power, but also takes into account the personal parameters of each and every wearer. The data specified by the eyecare professional including interpupillary distance, corneal vertex distance, pantoscopic angle, the frame dimensions, the reading distance, and a lot more besides are incorporated in the mathematical computation of the free-form surface. This has all been made possible by a new, revolutionary technology in collaboration with the firm Schneider, Steffenberg, Germany. By the ingenious distribution of free-form surface and prescription surface, optimum optical and cosmetic properties are obtained for each wearer. In extreme cases, the new design can double the size of the usable fields of vision. Another new feature is the use of wave front sensor technology to measure the surface of the progressive lens. This highly precise technique uses the position of the lenses in front of the eyes as its basis.

**Gradal® Individual** progressive lens.

With four new models, the frame collection entitled **Zeiss. High End Eyewear.** now contains a total of 30 different models. With their various colors and shapes, they offer both male and female wearers a high quality, fashionable accessory.

Frames in the Zeiss. **High End Eyewear.** Collection: Model 1315 (left) and 1314 (right).

# The fascination of detail –

Captured with high-resolution camera lenses from Carl Zeiss