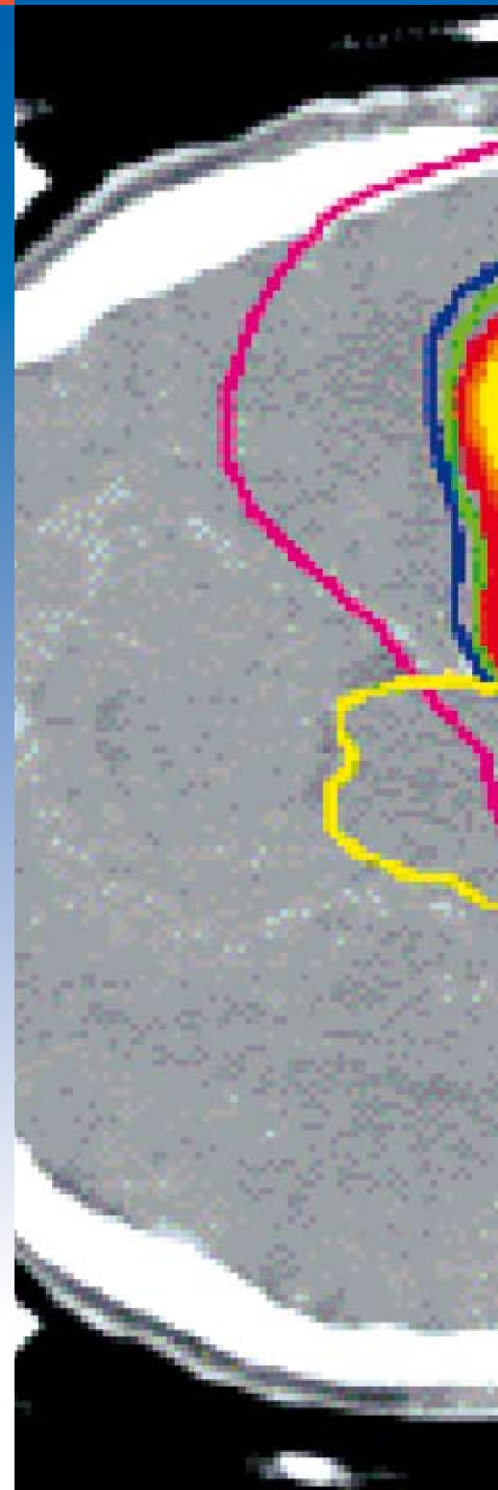
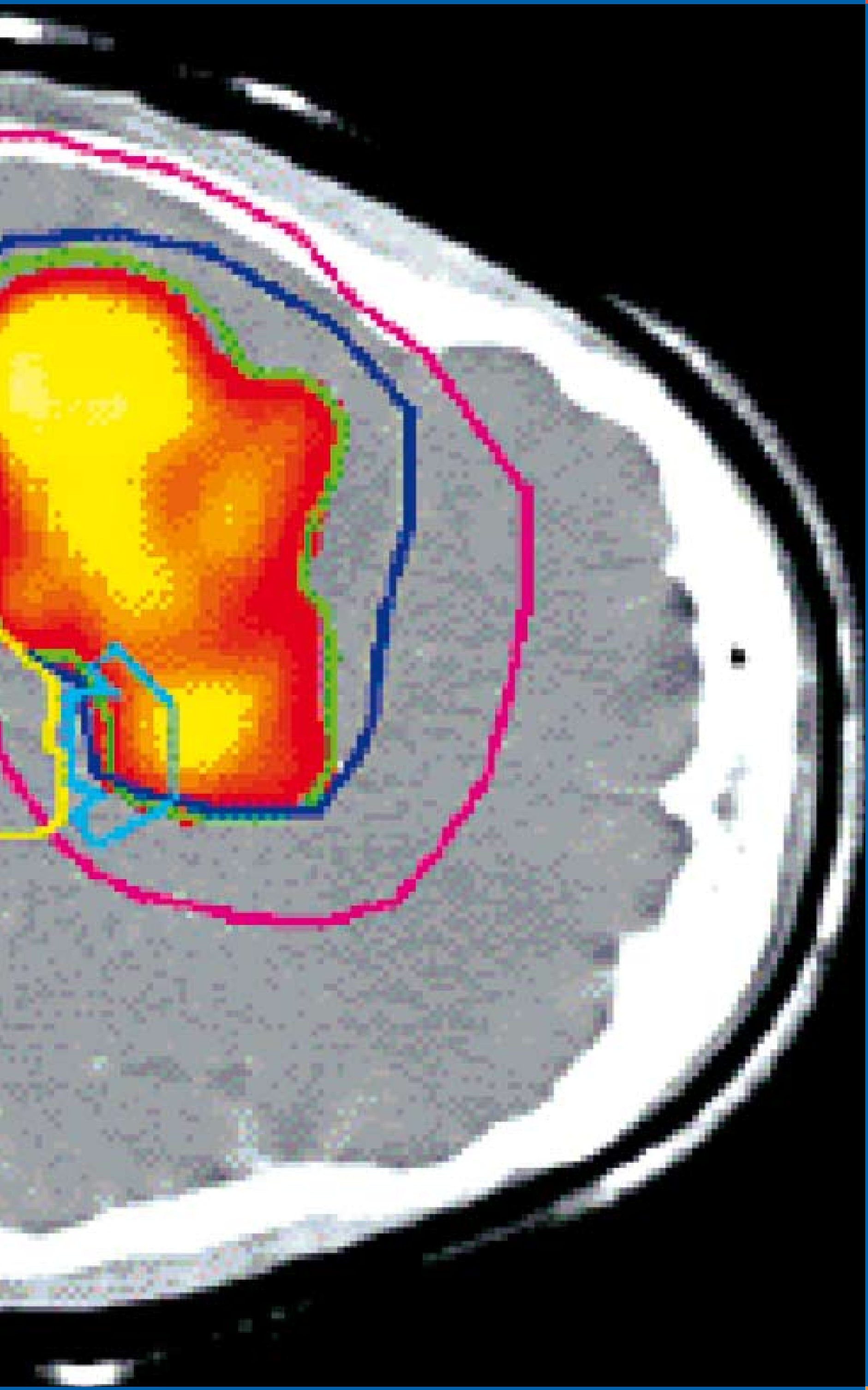


GERMAN
CANCER RESEARCH CENTER
IN THE HELMHOLTZ ASSOCIATION

SIEMENS



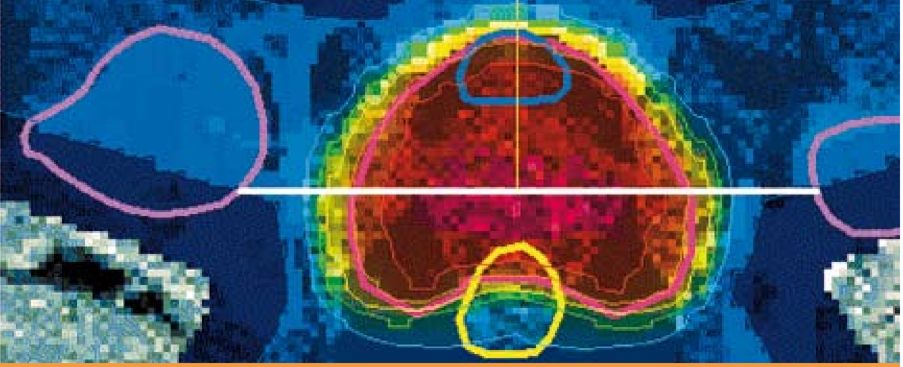
Strategic Alliance

German Cancer Research Center

Siemens

Contents

Front page:
Representation of a brain tumor with computer and positron-emission tomography. The coloured outlines are the basis for the planning of radiation therapy.



Compentency cluster in imaging and radiotherapy

The German Cancer Research Center (DKFZ) is among the world leaders in research into imaging and radiotherapy in oncology. Siemens Healthcare is a world-class manufacturer of medical equipment in this area. Having signed a Strategic Alliance agreement in January 2006, the two partners are now bundling their joint know-how in the field of radiooncology and intensifying the successful collaboration they have had for many years.

Siemens contributes state-of-the-art equipment, systems and development know-how to the Alliance, and the German Cancer Research Center its scientific expertise. Over the next six years, the two partners will each invest 20 million euros in this exemplary cooperation. By entering into this Strategic Alliance, the German Cancer Research Center and Siemens are breaking new ground in cooperation between a national research institute and an industrial company and are making a major contribution to strengthening Germany as a research base.

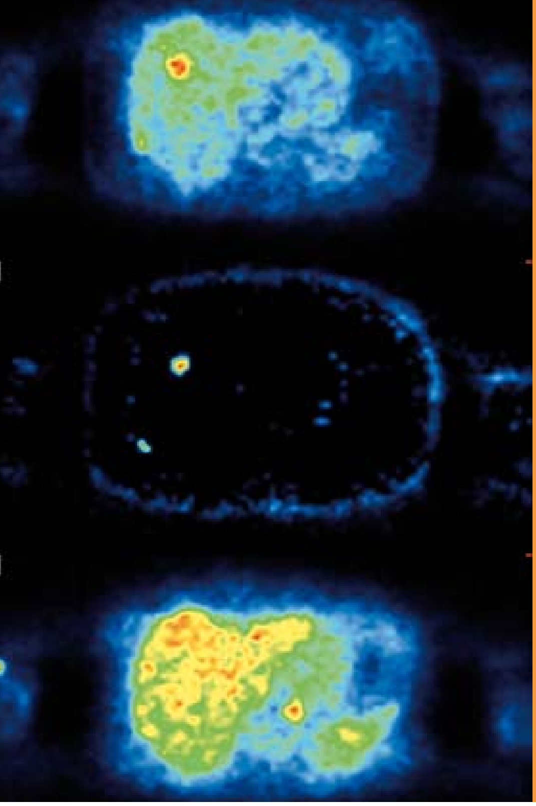
Under the Alliance, numerous, mostly interdisciplinary teams consisting of physicians, physicists, chemists, and IT specialists in the Research Program "Imaging and Radiooncology" at the German Cancer Research Center are working hand in hand with colleagues from Siemens Healthcare to improve the quality of care in oncology. One special focus of their work is coordinating the wide variety of diagnostic imaging methods and adapting them to the requirements of radiotherapists.

The world's only 7-Tesla high field scanner, which will be used exclusively for oncological investigations, along with fresh prospects in molecular imaging, will, it is hoped, provide research scientists with completely new information in tumor diagnostics. The Alliance researchers are also working on innovative concepts in radiotherapy, for instance on image-guided irradiation or the use of heavy ions in treatment.

Owing to the close cooperation with hospitals in Heidelberg and with the National Center for Tumor Diseases (NCT), the integrated diagnostic and therapeutic concepts developed within the Strategic Alliance can be tested in clinical trials as quickly as possible. After all, the top priority for all those working in the Alliance is to ensure that their progress benefits the patients.

Professor Dr. Otmar D. Wiestler
Chairman of the
Management Board
German Cancer Research Center

Dr. Bernd Montag
Chairman of the
Division Imaging & IT
Siemens AG



Strategic Alliance – the research areas

Research within the Strategic Alliance is divided into four core areas

The aim of the doctors and researchers working in the ***Integrated Diagnostic and Therapeutic Center (IDTC)*** under Dr. Christian Thieke is to develop an optimized and coordinated sequence of all processes in radiological diagnostics and radiation therapy. State-of-the-art methods that are not yet part of routine clinical practice are tested and integrated in new treatment concepts. In magnetic resonance imaging (MRI), this includes the visualization of dynamic processes such as perfusion or spectroscopic imaging. Another focal point is to exactly correlate the dose distribution with the vast array of image data obtained in order to improve radiotherapy planning and to analyze the therapy outcome more precisely. The clinical trials carried out in the IDTC (see pages 4 and 6) are aimed at creating new treatment standards that will benefit all cancer patients.

Faster, more precise, better: Researchers working in the Alliance will have access to the first ***7-Tesla high-field system*** for whole-body imaging in oncological diagnostics. The radiologists hope that the equipment's higher signal strength will provide significantly better images with shorter measurement times. The main aim of the 7-Tesla MRI project group headed by Dr. Michael Bock (see page 8) is to integrate this high-power system into diagnostic processes.

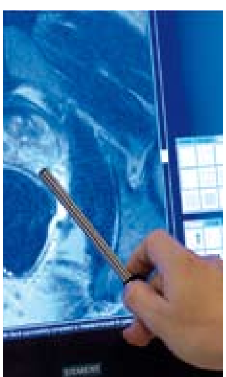
How much energy does a suspect tissue focus use? Do the cells in this area express surface proteins that are characteristic of cancer? In addition to the morphological data obtained from CT and MRI, ***Molecular Imaging*** contributes quantifiable information about molecular biological processes through positron emission tomography (PET). Under the leadership of Professor Ludwig Strauss (see page 10), physicists and nuclear medicine specialists are endeavoring to maximize the amount of tumor information obtained from PET signals.

In the field of radiotherapy, several innovations are on the verge of being used in clinical practice. "Adaptive" or "image-guided" therapy is being tested in an initial set of experimental investigations and it was for this form of treatment that the special device "ARTISTE" was developed. "ARTISTE", the fruit of cooperation between the DKFZ and Siemens Healthcare, is a linear accelerator with various integrated imaging options, which is designed to adjust the therapeutic beam to any movement of the tumor. One of the goals of the researchers in the ***Adaptive Cone Beam Therapy/ Particle Therapy*** unit under the leadership of Professor Uwe Oelfke is to further improve the quality of the images delivered by "ARTISTE" and to provide software that adjusts the therapeutic beam to the movement of the tumor inside the patient's body (see page 12).

As part of the Alliance, the researchers develop mathematical methods to speed up and optimize inverse therapy planning for radiation with protons and heavy ions. These calculations also take into account the biological properties of the tissue (see page 14).

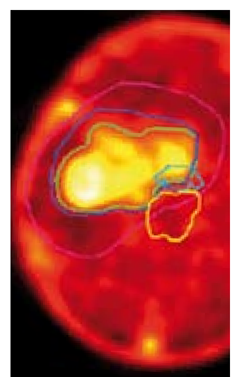
The research group ***Software Development for Integrated Diagnostics and Therapy***, under group leader Dr. Oliver Nix (see page 16) provides support for all of the Alliance's four core areas. Its researchers are developing software called DIROlab, which provides a common language for all diagnostic and therapeutic procedures. The program, being created in conjunction with MeVis gGmbH, is a key element in achieving the primary goal of the Strategic Alliance, which is to integrate diagnosis and therapy.

The articles on the following pages provide some examples of the work being done in these five areas.



Integrated Diagnostic and Therapeutic Center

7 Tesla-MRI



Molecular Imaging

Adaptive Cone Beam Therapy/ Particle Therapy

Software Development for Integrated Diagnostics and Therapy

Dr. Julien Dinkel

Lung cancer: a diagnostic mosaic for optimized therapy

"Nowadays, we can deliver radiation therapy with millimeter precision. But what good does that do if the tumor moves by as much as four centimeters with every breath the patient takes?" asks Dr. Julien Dinkel, pinpointing a frequent problem encountered in radiotherapy of lung cancer. Dinkel and his colleague Dr. Christian Hintze from the Department of Radiology are developing a method by which they can track the movement of the tumor as if on a video recording. The success of such real-time imaging depends on the magnetic resonance scanner being able to generate two complete 3D images per second of the entire thorax.

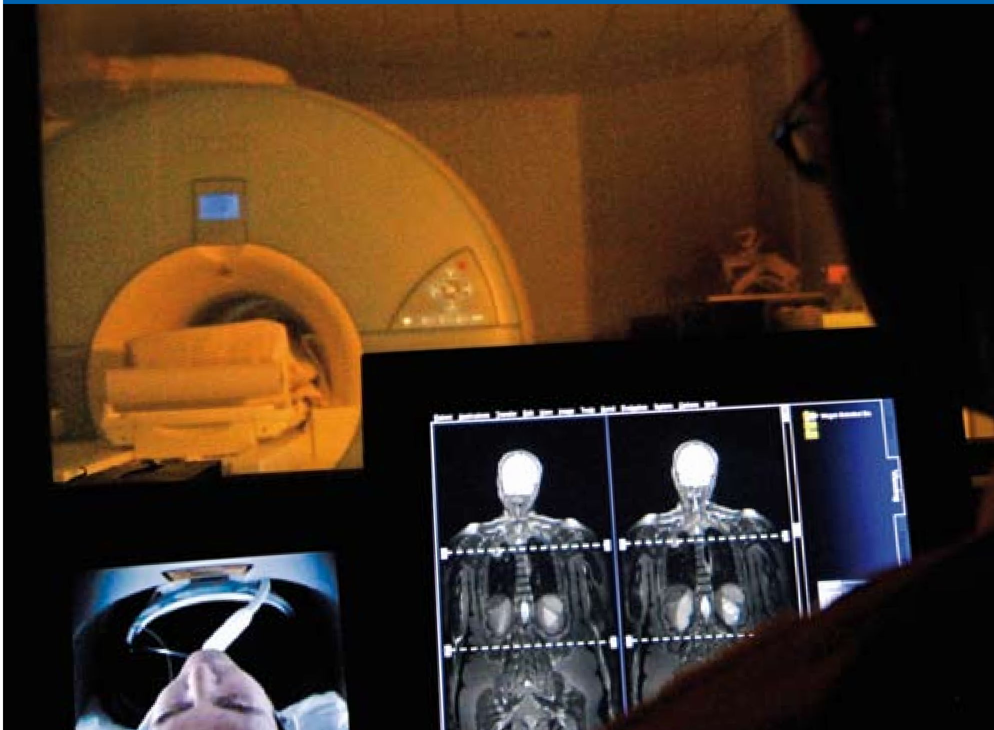
The MRI video of the thorax determines the likely location of the tumor, which helps the physicians making decisions about treatment. Radiotherapy methods are currently being developed (page 12) which will make it possible to actuate a beam only when respiratory movement puts the tumor exactly in the path of the beam. However, planning and executing such "four-dimensional radiation" is both costly and time-consuming. "And not every patient benefits from it," adds Dinkel. "A treatment must offer the greatest likelihood of success, but it should also make good economic sense." Small-sized tumors in the lower lobes of the lung near the diaphragm exhibit the largest movements.

In such cases, radiotherapy which is adjusted to respiratory movement can be of great assistance should the patient be inoperable for medical reasons.

By combining all the data obtained from the full panoply of imaging techniques, Dinkel and Hintze are able to maximize the information they collect about each patient's tumor. Besides employing MRI and computer tomography (CT) for planning treatment, the two radiologists gain further information from ultrasound or, in cooperation with nuclear medicine professionals (page 10), from PET. The patients studied in their trials come from the Heidelberg University Radiology Clinic or from the Heidelberg Thorax Clinic. Many of the diagnostic methods employed by Dinkel and Hintze were first tested for feasibility by means of a lung phantom and calibrated for reliable, reproducible values. The phantom, which was developed by Professor Jürgen Biederer, University of Kiel, is a plastic capsule containing pulmonary lobes from slaughterhouse animals. Respiration is simulated by means of a vacuum pump.

While multi-slice CT is currently the gold standard in pulmonary diagnosis, the method has shortcomings and leaves much to be desired. A frequent problem, for instance, is that a cancer focus in the bronchi compresses the surrounding lung tissue so severely that the pulmonary alveoli no longer contain any air. "This means that the CT can no longer distinguish between lung tissue and tumor tissue," says Hintze, "and it's not possible to plan treatment precisely." The problem can be dealt with by means of PET or MRI perfusion measurement, which shows the circulation of blood in the different tissue areas. The physicians are now conducting a trial to determine whether the additional diagnostic techniques should be recommened for the routine clinical examination of such borderline cases.

Hintze and Dinkel agree that "with all the different techniques that we use, we'd be lost without the work done by our software developers," and are full of praise for the quality of the cooperation within the Alliance: "The development of DIROlab as a single platform for the integration of all imaging techniques and radiation therapy (see page 16) is essential for us."

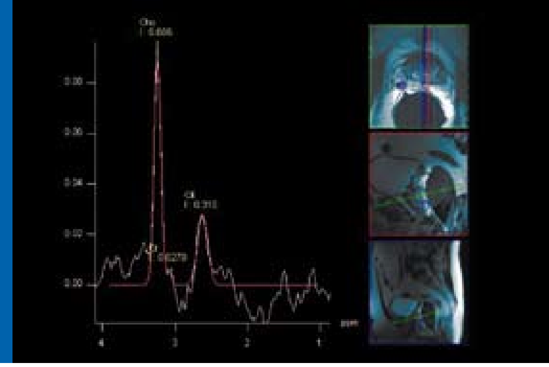


Dr. Christian Zechmann

Navigation tool for the biopsy needle

"Many of the patients referred to us have already run a real diagnostic marathon," says Dr. Christian Zechmann from the Radiology Division. "First, the usual palpation and ultrasound examinations, then two or three biopsies – invariably negative – and still the PSA count continues to climb. No wonder the men gradually lose patience." PSA, or prostate-specific antigen, is regarded as a biomarker for cancer of the prostate. If a steady rise in the protein is measured in the blood, urologists consider it very probable that the patient is suffering from cancer of the prostate gland. Before treatment is started, however, it is essential that the suspicion of cancer be confirmed by examining the prostate tissue; after all, the elevated PSA may indicate nothing more than a harmless inflammation. The problem is, though, that the fine biopsy needles often cannot find small tumors in a gland that is no bigger than a walnut. "It is for these cases that we are trying to give the doctor doing the biopsy a navigation tool of sorts," says Zechmann, explaining the aim of a study that he is conducting together with Dr. Patrik Zamecnik.

Zechmann and his colleagues combine three types of magnetic resonance diagnosis in this prostate study: imaging, dynamic measurement showing the blood supply to the tissue, and spectroscopy, which delivers information on the chemical composition of the tissue. None of these

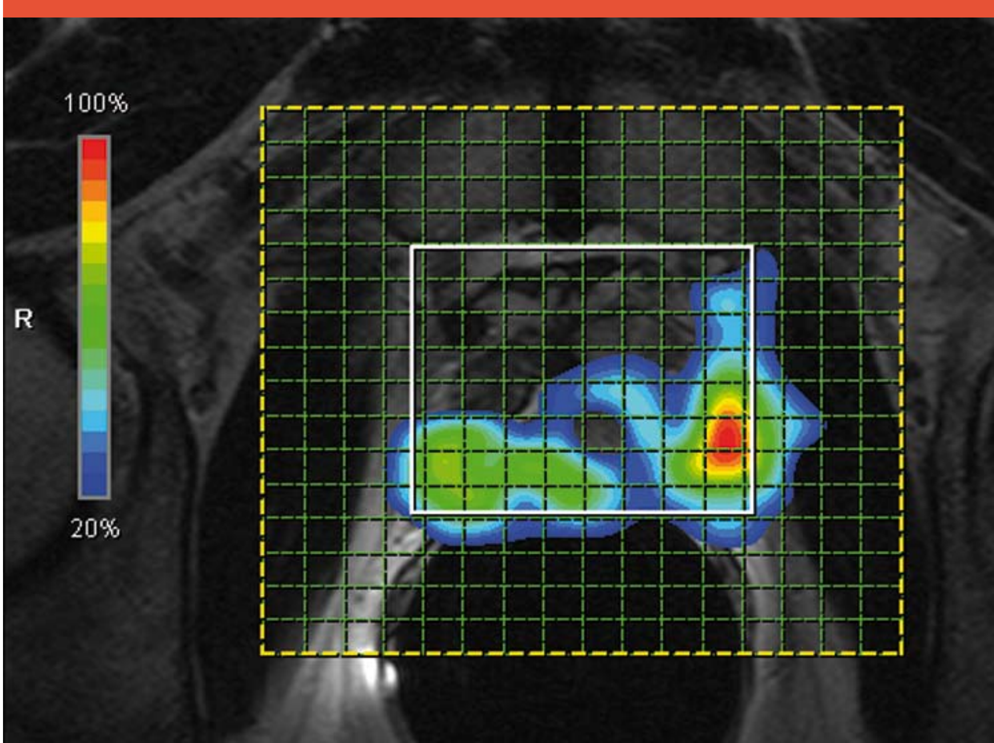


approaches alone conclusively demonstrates the presence of a carcinoma. The secret of success lies in combining the three methods.

The patients participating in the study are referred by Salem Hospital in Heidelberg, a cooperation partner. The radiologists from the DKFZ have already had some success at distinguishing between the tumor and healthy prostate tissue on the basis of measurements of blood vessel density and vessel permeability. To do this, they employed a mathematical method that shows the rate at which blood is exchanged between the vessel system and the interstitial space, i.e. the space between the cells.

MR spectroscopy, which visualizes the biochemical differences between the tumor and healthy tissue, is yet another information element. Growing tumor cells are constantly producing new cell membranes, meaning that higher concentrations of choline, a constituent of the cell membrane, can be measured spectroscopically. Working up the data from a spectroscopy analysis, however, is extremely time-consuming. In order to make this approach viable in clinical practice, Zechmann, together with medical IT specialists from Professor Fred Hamprecht's group at the University of Heidelberg, developed a mathematical model for the automatic analysis of spectroscopy data. The software, known as CLARET, produces a "probability map" to help locate a tumor in the prostate. Says Zechmann enthusiastically: "Compared with manual analysis, we save a good two hours' work for every patient."

"If we combine the information elements, we can put together a pretty exact picture of the tumor's morphology and malignancy," explains Zechmann. The radiologists are continuing their investigations using a 3-Tesla scanner to achieve an even finer distinction between the tumor and normal tissue. It is hoped that this approach will define especially aggressive areas of the tumor, which can then be treated with a higher radiation dose. "Making our research mesh with clinical practice –" says Zechmann, "that's exactly what the Integrated Diagnostic and Therapeutic Center is all about."

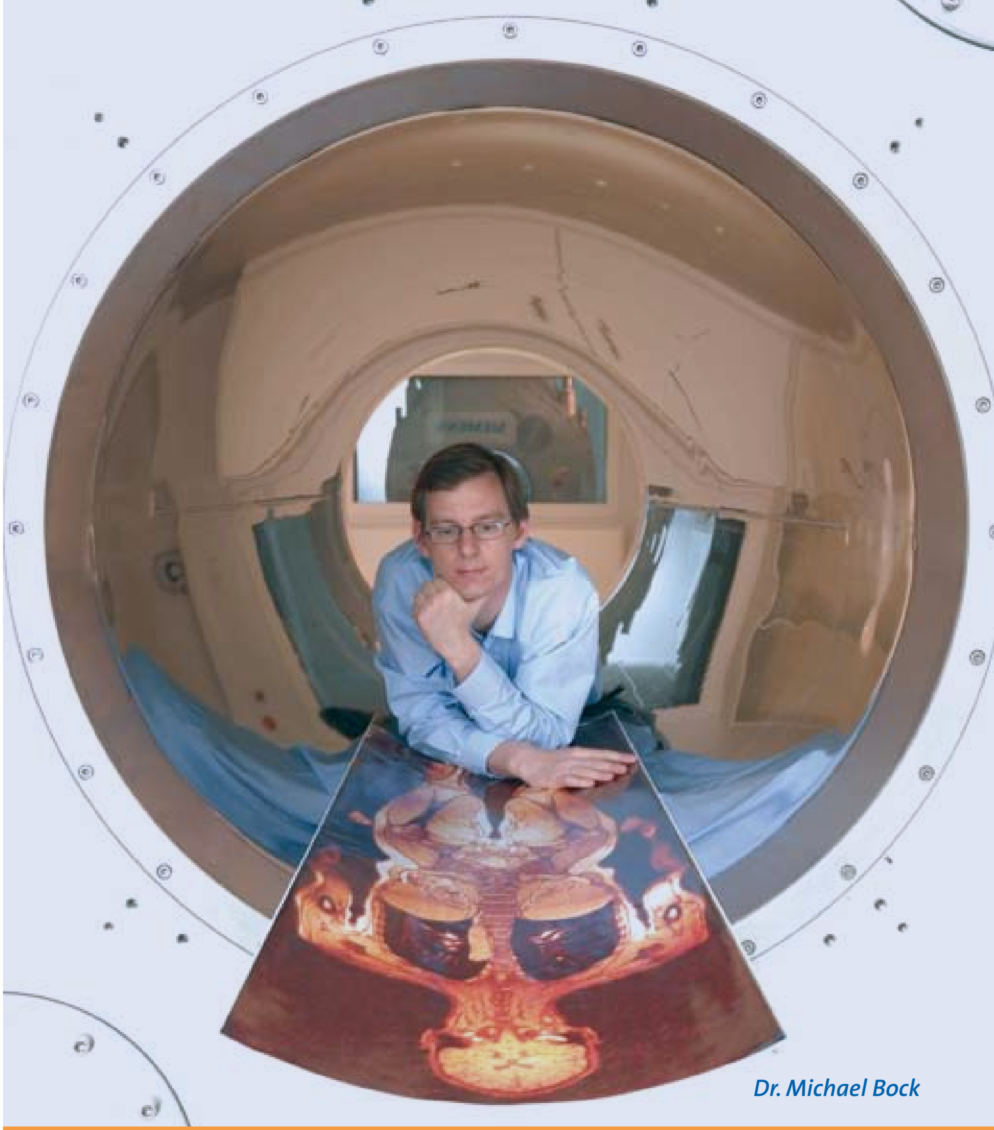


140,000 times the Earth's magnetic field for cancer research

„There are 230 tons of steel in there," says Dr. Michael Bock, pointing to the walls surrounding the new 7-Tesla high field MRI system. „That's to provide a shield against the enormous magnetic field." The system's magnet, which weighs some 32 tons, produces a magnetic field 140,000 times stronger than that of the Earth. Installation of this new diagnostic system should be completed by the summer of 2008. The most powerful device of its kind in Heidelberg to date, it will be dedicated exclusively to oncological investigations. Siemens is making the MRI system available on loan, while the German Cancer Research Center is responsible for infrastructure and maintenance.

In routine clinical practice, 1.5-Tesla or 3-Tesla systems are used for cancer diagnosis. But researchers expect this high field equipment to deliver significantly more information both for morphological imaging and for functional and spectroscopic investigations: the imaging of small structures right down to the sub-millimeter range, new tissue contrasts, the improved imaging of tissue functions such as blood circulation, and a more precise analysis of the chemical composition of the tissue. „And it's going to be faster," adds project manager Bock. „The first research projects with the 7-Tesla MRI system will revolve around brain tumors. One of our goals is to examine the entire brain in less than five minutes and with a resolution of half a millimeter."

However, Bock, a physicist, is clear about the timing: „No, we certainly won't be ready to examine the first patients this summer. We still have a lot of development work to do together with our research partners at the Universities of Heidelberg, Freiburg and Würzburg." The first step is to conduct comprehensive experimental measurements to ensure patients' safety in the powerful magnetic field. And there is still work to be done on other technical aspects such as the special antennas, known as high-frequency coils, with which the signals from inside the human body are received.


Dr. Michael Bock

The oncological research projects are to start at the same time. While the first investigations will focus on the diagnosis of brain tumors, they will later be extended to include prostate and breast cancer. What doctors will be looking at is heterogeneity within the tumor tissue – they want to be able to distinguish active areas from those areas in which the cancer tissue is already dying off, for example. High field MRI will permit images with less noise compared to others obtained with lower field strength, a shorter measurement time and improved contrast within the tumor tissue.

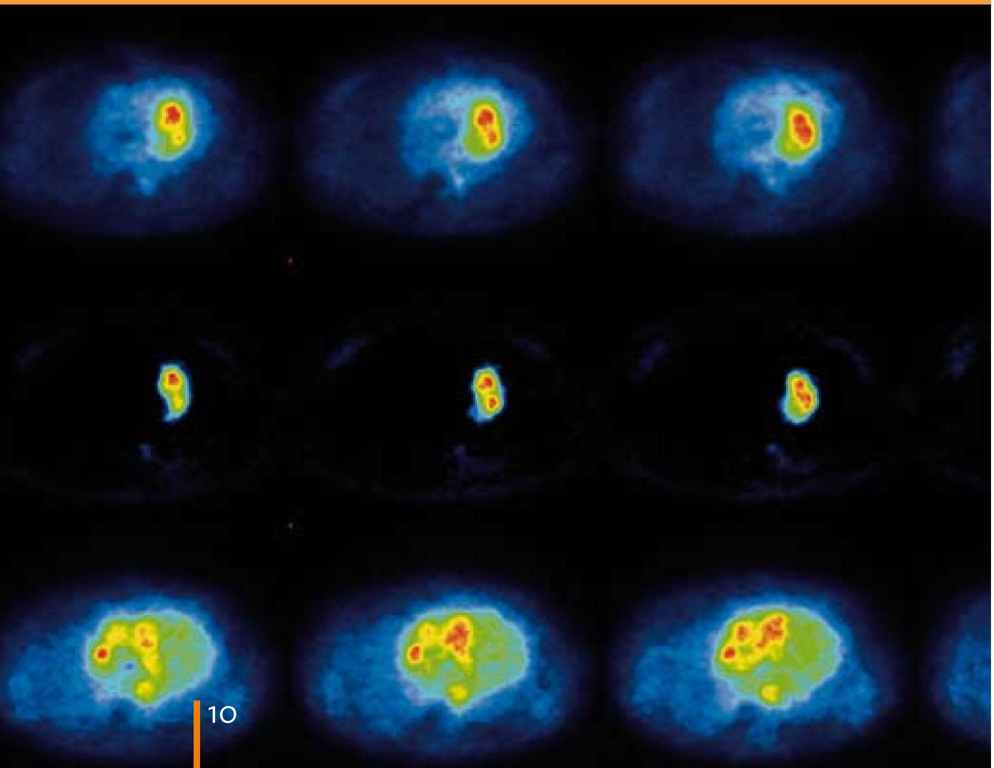
Studies on the supply of blood and oxygen to tumors are also planned. These will give physicians important pointers to tumor malignancy and allow them to monitor the patient's response to a given therapy. Another area in which scientists have high hopes of the powerful imaging capability of the 7-Tesla MRI system is the non-invasive investigation of the tumor's metabolic properties. Radiologists are already using less powerful equipment (see page 6) to search for tiny cancer foci in the prostate. The 7-Tesla system should be able to provide even clearer images of typical cancer molecules in tumor tissue, thus supplying important information in addition to the purely anatomical picture.

„Our long term goal," says Bock, summing up, "is to advance 7-Tesla high field MRI to the same technical level in clinical medicine as we have already achieved with 1.5-Tesla or 3-Tesla equipment." He and his colleagues are eagerly looking forward to putting the new system through its paces.

Multi-layered snapshots of body function

"PET enables us to observe a number of different physiological processes within the body at the same time," explains Professor Ludwig Strauss of the Nuclear Medicine Clinical Cooperation Unit. In molecular imaging with positron emission tomography, or PET, a radioactive tracer incorporated into a biologically active molecule is injected into the patient. The positrons emitted by the decay of the radioactive tracer (beta decay) can be traced by means of external detectors. This information tells the specialist in which tissues the radioactive molecule is becoming concentrated. The most commonly used tracer in nuclear medicine is a radiolabeled sugar, 18-fluorodeoxyglucose (FDG). This is used to image energy metabolism – an important indicator in cancer diagnosis since tumors as a rule have a higher energy metabolism than the surrounding tissue.

"What we measure in the PET scanner is at first only raw data," explains Strauss, "a combination of signals from all the physiological processes detected. Indeed, the typical black splotches of a PET image show those areas of the body where a good blood supply to the vessels transports a lot of sugar quickly. But they also indicate where large numbers of transport proteins carry the tracer through the cell membrane into the cell. And, furthermore, they show where the FDG transported into the cell is metabolized. But as Strauss points out: "That alone doesn't help doctors much. They need to be able to see the various information layers separately." He and his team are therefore developing mathematical methods which separate out these three superimposed information layers – vessel density, membrane transport and intracellular metabolism – at pixel level.

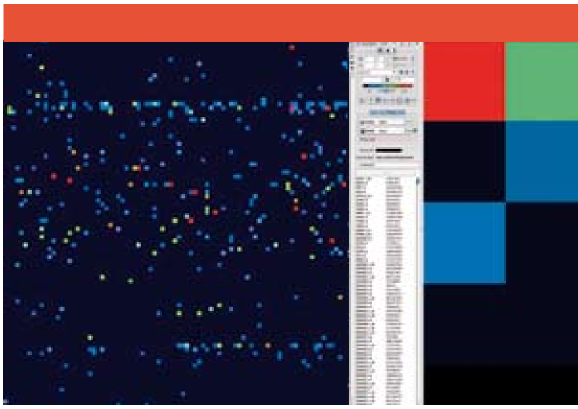


The three readings can then be individually quantified and individually imaged. As a result, a small tumor or a metastasis is often more clearly visible than in the much more diffuse image derived from the raw data. This separation technique, known as parametric imaging, not only improves the diagno-

Professor Ludwig Strauss,
Professor Antonia Dimitrakopoulou-Strauss

sis, but also often helps in making decisions about treatment, for instance about the use of angiogenesis inhibitors, which suppress the development of new blood vessels. The use of such drugs only makes sense if the PET signal clearly shows that the cancer is promoting the formation of new vessels. "We are using PET to contribute key diagnostic information for the lung cancer (see page 4) and brain tumor studies that are now being conducted as part of the Strategic Alliance," explains Strauss.

But PET does a great deal more than just measuring sugar metabolism. Crucial to the method's performance is the use of the right tracers, which must be highly specific for certain physiological processes or typical tumor molecules. Radiotherapists want to know in particular how well the tissue is supplied with oxygen, because it is on this that the tumor's susceptibility to radiation largely depends. One promising tracer molecule for this purpose is 18-fluoromisonidazole, which is taken up by the cells and then leaves them again – unless the tissue suffers from a lack of oxygen. In that case, the tracer will remain caught in the cell and can be detected by means of PET. "To be able to fine-tune cancer treatment to the individual patient, we are testing a number of PET tracers in clinical trials so that we can provide clinical practitioners with the maximum amount of information about the disease in question," says Strauss, summing up the research project.



Taking aim at moving targets

"Every patient who undergoes radiotherapy at the DKFZ now receives image-guided therapy," says Dr. Christian Thieke from the Clinical Cooperation Unit Radiation Oncology. "During radiation, which lasts several weeks, we monitor treatment once a week as a rule – even daily, if critical structures are located nearby. And sometimes the treatment plan does indeed have to be adjusted." 'Monitor' in this context means ascertaining by means of computer tomography whether the tumor is still in exactly the same position as when visualized at diagnosis, since the original radiation plan was based on this finding.

What can cause tumors to change their position? The reasons vary, depending on the disease. The patient may lose weight, the tumor may decrease in volume as a result of irradiation, or – typically in prostate cancer – the degree to which the bladder or bowel is filled may cause the tumor to move.

"We are conducting a number of studies on image-guided therapy, as well as on tumors near the spinal cord and cancer in the head and neck region," explains Thieke, who is both a medical doctor and a physicist. In treating these conditions, the beam has to be directed close to highly sensitive areas, making the utmost caution essential. The tumor might be very close to the spinal cord or

Dr. Simeon Nill

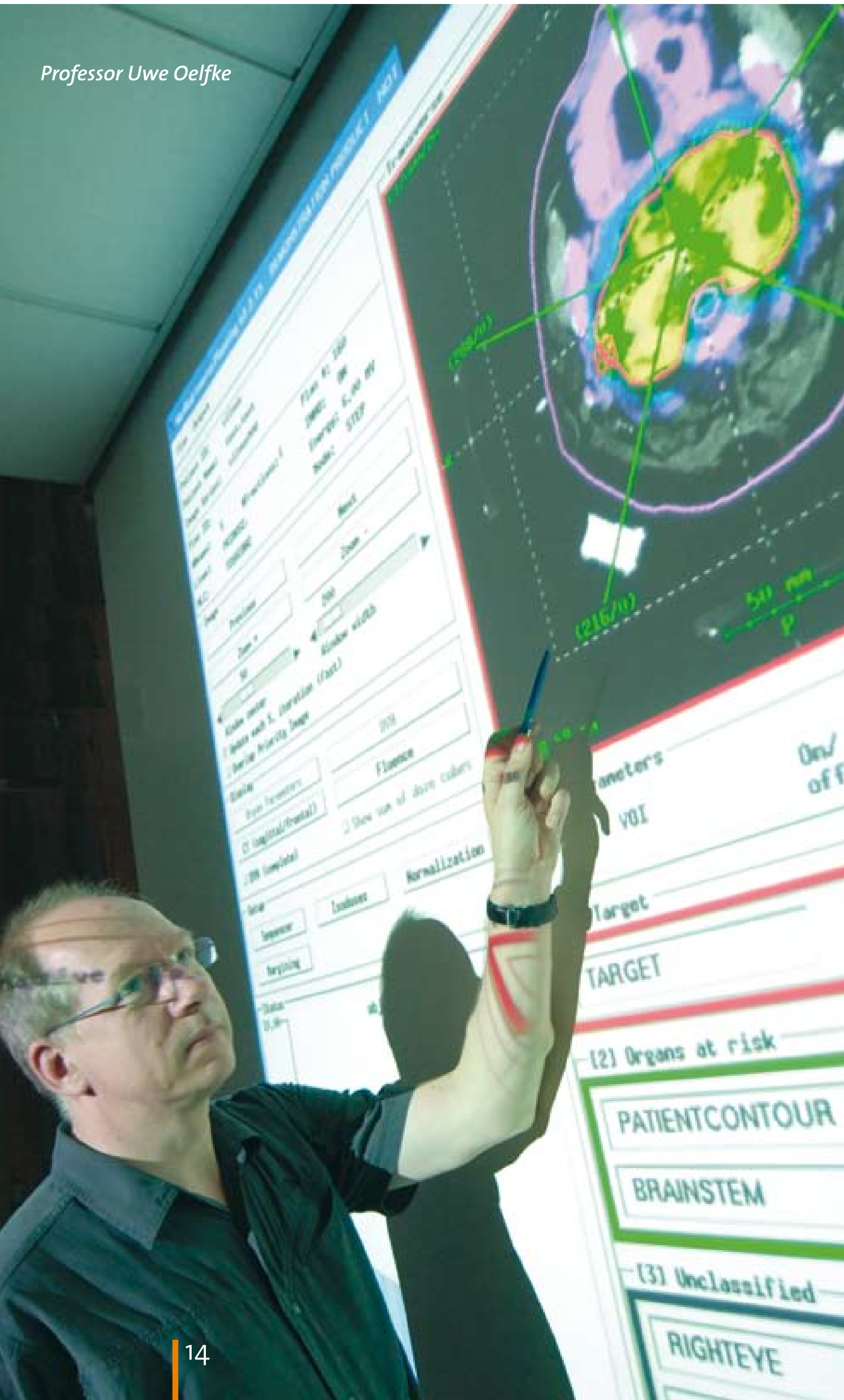
the salivary glands, for example, any impairment of which would be very serious for the patient. This makes it all the more important to ascertain even slight shifts in the position of the tumor prior to radiotherapy.

Dr. Simeon Nill, who works in Professor Uwe Oelfke's team, explains what radiotherapy should be able to accomplish in the future: "Our goal is to adjust the beam to the moving tumor, in other words to track it." Nill and Oelfke, both from the Division of Medical Physics in Radiology, were involved in developing "ARTISTE", a linear accelerator with various integrated imaging options, which was developed especially for image-guided therapy. With the help of image data, the beam is adjusted to the tumor's movement by means of a multileaf collimator, a deflector made of heavy-metal 'leaves'. The physicists are currently engaged in extensive measurements on phantoms to determine whether the calculated radiation dose is actually hitting its target, meaning the tumor.

One particular challenge for the researchers is that posed by rapid and large respiration-induced movements during the radiotherapy of lung tumors. Thanks to rapid X-ray imaging, it is now possible to follow the tumor movement live and immediately adjust the irradiated area. This requires enormous computing power, but is facilitated by the good contrast between the tumor and healthy lung tissue. The first experiments with a lung phantom, which simulates the physical properties of lung tissue, have now been successfully completed. "If we continue to get good results with the phantom," hopes Nill, "we'll be well on the way to genuine motion-adjusted therapy."

Dr. Dr. Christian Thieke, Annette Miltner

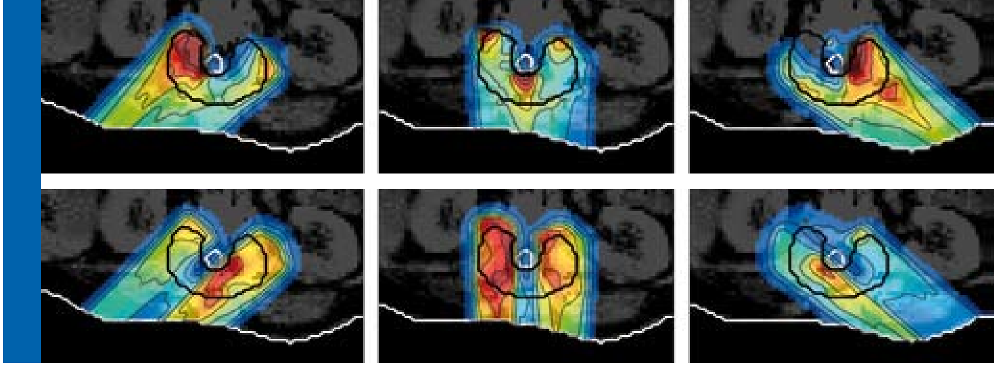
Faster planning for particle therapy



Professor Uwe Oelfke

"When planning particle therapy, the computing power needed is about fifty times higher than that for comparable treatment with conventional photon radiation. That can certainly upset the normal hospital routine," says Professor Uwe Oelfke, a physicist who heads up the Adaptive Therapy/Particle therapy Core Area in the Strategic Alliance.

In 'normal' radiotherapy with photons, high-energy X-rays, the area to be irradiated is broken down mathematically into small segments, and the radiation dose necessary for each of these areas calculated. Treatment with electrically charged particles, such as protons or carbon ions, proceeds differently and is so far available only at a few specialized centers. In this case, the tumor is treated layer for layer. Magnets direct the particle beam, which is about as large as a pencil in diameter, in such a way that it delivers its destructive energy point for point in each of these theoretical layers. "Whereas we have to calculate about 200 to 300 individual beams for photon radiotherapy, we require about 100,000 individual calculations for comparable particle therapy," explains Oelfke. For the physicists at the German Cancer Research Center, therefore, the paramount goal – after safety – when developing new planning algorithms is the speed at which a new procedure works.



The planning, which is in any case time-consuming, is further complicated by radiation biology. "Unfortunately, there is no simple equation saying that the higher the radiation dose, the more tumor cells will die. The correlation is not linear," points out Dr. Jan Wilkens, who is developing the planning algorithms together with Oelfke. "Relative biological effectiveness" also has to be calculated and this depends not only on the type of tissue treated and the radiation dose, but also on the depth to which the radiation penetrates the tissue.

The DKFZ physicists at first concentrated on programs for planning proton therapy. As part of a licensing and cooperation agreement, Siemens was granted exclusive rights to use these software systems. Another project involves the development of planning software for the treatment of tumors in the head region using carbon ions. To facilitate the planning of such particle therapies, the optimized calculations were integrated into "KonRad". This software, which is now used worldwide for radiation planning, was developed at the German Cancer Research Center for the calculation of intensity-modulated radiation therapy (IMRT) with photons, but now encompasses the planning of particle therapies as well. In the future, physicians should be able to allocate specific radiation doses to the tumor and adjacent structures at risk using what for them is a familiar user interface. The program then automatically takes over inverse treatment planning, i.e. the planning of the particle beam that is deduced from the target dose.

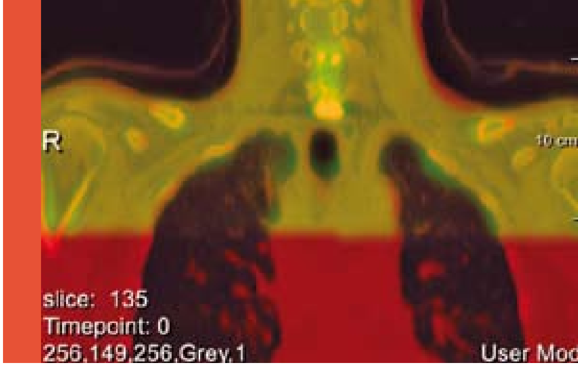
Oelfke and his colleagues feel certain that treatment planning will become even more complex in future years and the need for efficiency in this area ever greater. Tumors could be treated with a combination of different ions, for instance with helium and oxygen in addition to carbon ions. Or doctors may be able to prescribe photon therapy with an additional 'shot' of carbon ions to treat particularly aggressive areas of the tumor and so improve their patients' response.

Dr. Oliver Nix

DIROlab: Esperanto for imaging

"You can't expect doctors to have the kind of IT know-how that would enable them to extract all the important information from complex medical images," insists Dr. Oliver Nix, Head of the "Software Development for Integrated Diagnostics and Therapy" Task Force. Nix, who is a physicist, regards it as his job to provide an interface between the developers of new diagnostic procedures and the radiologists and radiotherapists who use these techniques. "Our goal is to create intuitive software with a single user interface which gives the physician access to all the diagnostic data for a particular patient: CT, MRI and PET images as well as the relevant analyses. In any plane and in 3D."

At the DKFZ, this common platform for all systems is known as DIROlab. "DIRO" stands for "Diagnostic Imaging and Radiooncology, which is the central research focus of the Strategic Alliance between Siemens and the DKFZ. Nix gives an example of what DIROlab is supposed to accomplish in practice: When planning treatment, physicians draw the contours of the tumor and of any adjacent organs at risk onto the CT scan on the screen. And it is this contour that must also be visible in the PET images taken of the patient. So far this has not been feasible because the different analysis programs speak a Babel of languages: The data produced by a CT are simply incompatible with those from a PET scan-



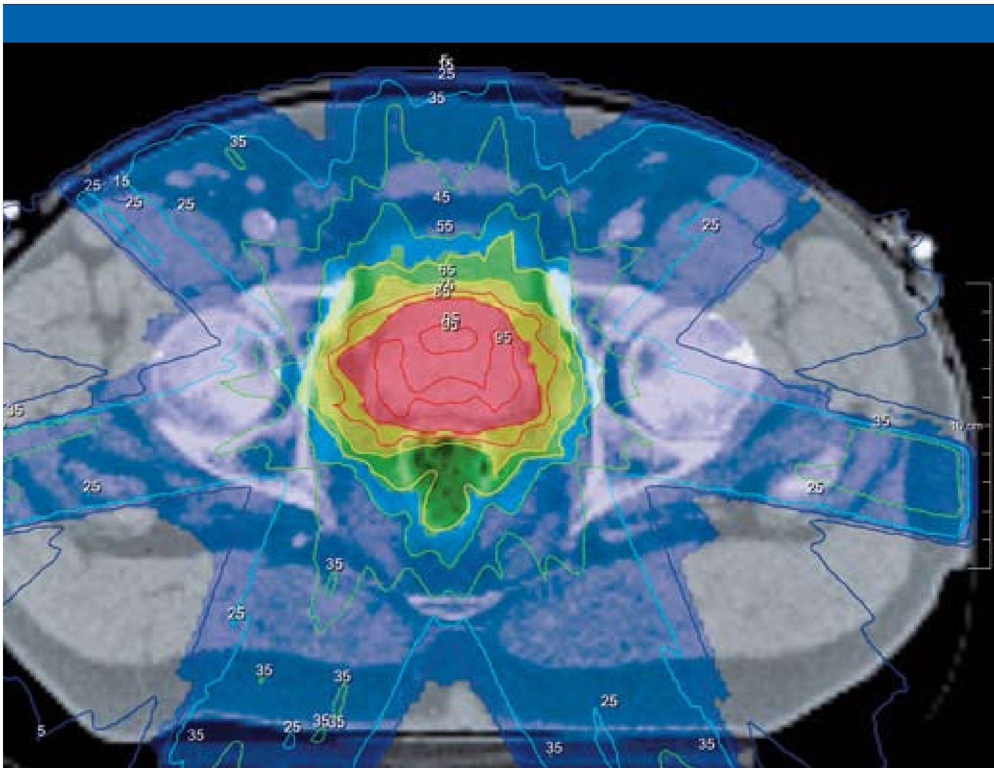
ner. The aim of DIROlab is to translate all this information into a single language – Esperanto for imaging, as it were.

DIROlab is based on MeVisLab, a software platform developed by MeVis gGmbH, a research institute in Bremen. The software features a simple modular structure and allows new ideas to be incorporated quickly. "Researchers at the DKFZ have already invested a lot of time and energy in developing programs for automated data analysis to answer specific diagnostic questions," explains Nix. "The trouble is, these programs are not used very much because except for the developers themselves no one is really able to handle the software." An example is CLARET, a program that analyzes the data from MR spectroscopy examinations of the prostate and so saves doctors a lot of drudgery (see page 6). CLARET has now been integrated into DIROlab, which means that all the physicians in the IDTC can use this helpful tool without additional training.

DIROlab's greatest strength comes into play in the research-intensive environment of the DKFZ, with its many clinical trials. Without this tool, it would be difficult to collect and compare the huge data sets for each patient generated by the various diagnostic procedures.

Another decisive factor is that DIROlab can communicate with other systems, for instance with PACS, the image archiving system of the Heidelberg University Radiology Clinic, with which IDTC research workers maintain close cooperation. Or with VIRTUOS, software developed by the DKFZ for treatment planning with which radiotherapists can visualize the calculated dose distribution in DIROlab and compare it with control studies of all kinds.

Nix feels that the IDTC is the perfect place for him to be: "The Strategic Alliance with Siemens puts us in an enviable position. Hardly anywhere in Germany is there such a wide variety of diagnostic imaging techniques in use as at the DKFZ. That's why our work here is instrumental in making life easier for physicians and research scientists."



Division of Radiology
Acting Head:
Professor Dr. Stefan Delorme

The goal of this division is to refine radiological methods of tumor imaging (CT, MRI and ultrasound) for the comprehensive biomedical analysis of diseases and of cancer in particular. Once the methods seem likely to prove useful in practice, they are offered to patients and evaluated in clinical trials.
An important task is the early detection and staging of tumors. Tumors and other tissue changes are characterized according to functional and

Division of Medical Physics in Radiology
Head:
Professor Dr. Dr. Wolfhard Semmler

The physicists and radiologists in this division work on improving existing methods and technologies of cancer diagnostics and establishing new ones. The aim is to make the diagnostic methods more informative in order to provide a foundation for individual tumor treatment and enhanced local tumor control. To this end, morphological, functional, and molecular data are collected using imaging technologies such as computer tomography, magnetic resonance imaging (MRI) and positron

Division of Radiopharmaceutical Chemistry
Head:
Professor Dr. Michael Eisenhut

This division seeks and develops new molcules that bind to or are taken up by tumor cells. These substances are labeled with radioactive isotopes and so act as molecular probes for positron-emission tomography (PET) and single photon emission computerized tomography (SPECT).
The radiopharmaceuticals manufactured with a cyclotron supply information on the functional and structural properties of organs and tumors, on pathological changes in tissues, on perfusion dynamics in

Division of Medical Physics in Radiation Oncology
Head:
Professor Dr. Wolfgang Schlegel

Radiation therapy is the second most successful and most frequently used cancer treatment after surgery. Today, over 50 percent of patients with malignant tumors receive radiation therapy.
The Division of Medical Physics in Radiation Oncology concentrates on optimizing conformation radiotherapy, which facilitates precise adjustment of dose distribution in the tissue to the shape of the tumor. The division's successful developments include three-dimensional radiother-

Clinical Cooperation Unit Radiation Oncology
Head:
Professor Dr. Dr. Peter Huber

This Clinical Cooperation Unit is a collaborative project of the German Cancer Research Center (DKFZ) and the Heidelberg University Radiology Clinic. The aim is to facilitate the swift transfer of the physical and biological methods developed at the DKFZ into radiotherapeutic practice for the benefit of patients. In this process, the central task is to assess the safety and reliability of newly developed treatment methods through phase I and phase II clinical trials.

Clinical Cooperation Unit Nuclear Medicine
Head:
Professor Dr. Uwe Haberkorn

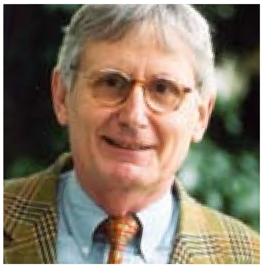
This Clinical Cooperation Unit is a collaborative project of the German Cancer Research Center (DKFZ) and the Heidelberg University Radiology Clinic. The unit's close cooperation with the University Clinic and with the Division of Radiochemistry and Radiopharmacology at the DKFZ provides an ideal platform for combining basic research methods with those of nuclear medicine.

The divisions of the DKFZ cooperate closely with the Department of Radiooncology (Professor Jürgen Debus) and the Department of Radiology (Professor Hans-Ulrich Kauczor) of the University of Heidelberg Hospitals.

biological parameters such as blood supply, cell metabolism, oxygen content, movement and molecular mechanisms. This knowledge enables doctors to better assess the individual cancer and to choose and plan the therapy accordingly. The techniques are also used to predict the disease course and evaluate the treatment results. In addition to clinically oriented projects, the division also conducts experimental and preclinical studies.

emission tomography (PET). These data are used for primary diagnosis, individual treatment planning and the evaluation of therapy results both during and following treatment. Two promising new research areas for this division are molecular diagnostics and interventional MRT.

diseased organs, on the local distribution and availability of drugs, and on the time course of various therapies.



apy planning, intensity-modulated radiation therapy (IMRT) with inverse therapy planning and planning optimization for therapy with protons and carbon ions.
In addition, the researchers are developing methods for recording and monitoring changes in the position of irradiated tissues during therapy.

The unit also investigates the effect of combining radiation therapy with new, targeted cancer drugs such as substances that inhibit the formation of new blood vessels.

One of the unit's central aims is the development and application of nuclear-medicine technologies for the diagnosis and treatment of malignant tumors. What it is searching for are tracers, which depending on the isotope employed can be used for both diagnosis and therapy.

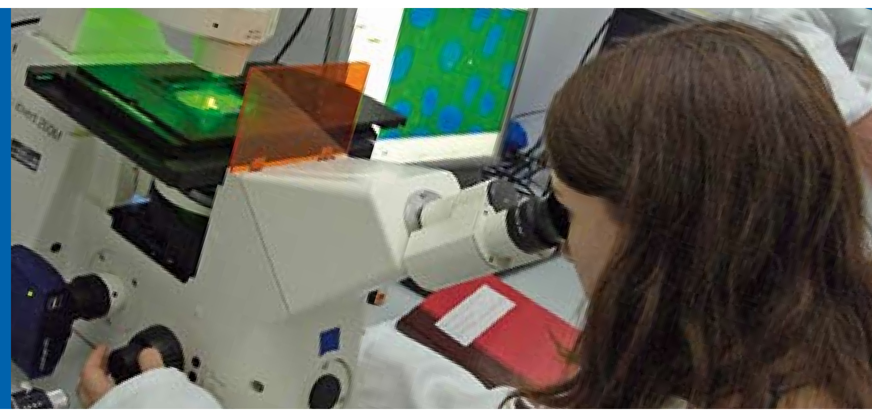
A joint R&D platform for imaging and radiation therapy has been set up at the National Center for Tumor Diseases (NCT) Heidelberg.

The partners in the Strategic Alliance

Everyone at the ***German Cancer Research Center*** has a common goal: to systematically investigate the mechanisms by which cancer develops and to ascertain the risk factors for cancer. It is expexted that the findings from this basic research will give rise to new approaches to the prevention, diagnosis and treatment of cancer. The German Cancer Research Center was founded in Heidelberg in 1964 as a public law foundation of the State of Baden-Württemberg. The Center currently has over 2,000 employees, of whom 970 are research scientists, including physicians, biologists, chemists, physicists, IT specialists, engineers and mathematicians working across disciplinary boundaries.

The Center's scientific divisions cover seven research programs: Cell and Tumor Biology, Functional and Structural Genomics, Cancer Risk Factors and Prevention, Tumor Immunology, Imaging and Radiooncology, Infection and Cancer, Translational Cancer Research.

The German Cancer Research Center is a member of the Helmholtz Association of German Research Centers and of the Deutsche Forschungsgemeinschaft (DFG – German Research Foundation). Ninety percent of the funding for the Center comes from the Federal Ministry of Education and Research and 10 percent from the Baden-Württemberg Ministry of Science, Research and the Arts.



Siemens Healthcare is one of the world's largest suppliers to the healthcare industry. The company is a renowned medical solutions provider with core competence and innovative strength in diagnostic and therapeutic technologies as well as in knowledge engineering, including information technology and system integration. With its laboratory diagnostics acquisitions, Siemens Healthcare is the first fully integrated diagnostics company, bringing together imaging and lab diagnostics, therapy, and healthcare information technology solutions, supplemented by consulting and support services.

Siemens Healthcare delivers solutions across the entire continuum of care – from prevention and early detection, to diagnosis, therapy and care. Additionally, Siemens is the global market leader in innovative hearing instruments. The company employs more than 49,000 people worldwide and operates in 130 countries. In the fiscal year 2007 (Sept. 30), Siemens Healthcare reported sales of 9.85 billion Euros, orders of 10.27 billion Euros, and group profit of 1.32 billion Euros. Further information can be found by visiting www.siemens.com/healthcare

in conjunction with:

From its beginning in 1995, the non-profit research center MeVis Research in Bremen, Germany, has chosen a disease-oriented approach for solving significant diagnostic and therapeutic problems. MeVis has especially focused on tumors affecting all the major organs and diseases of the cardiovascular system, liver, lungs and brain. MeVis Research develops workflow-oriented software assistants that allow efficient visualization and quantification of medical image data in cooperation with clinical and industrial partners worldwide. It has a team of some 40 researchers working on new solutions for the healthcare industry.

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