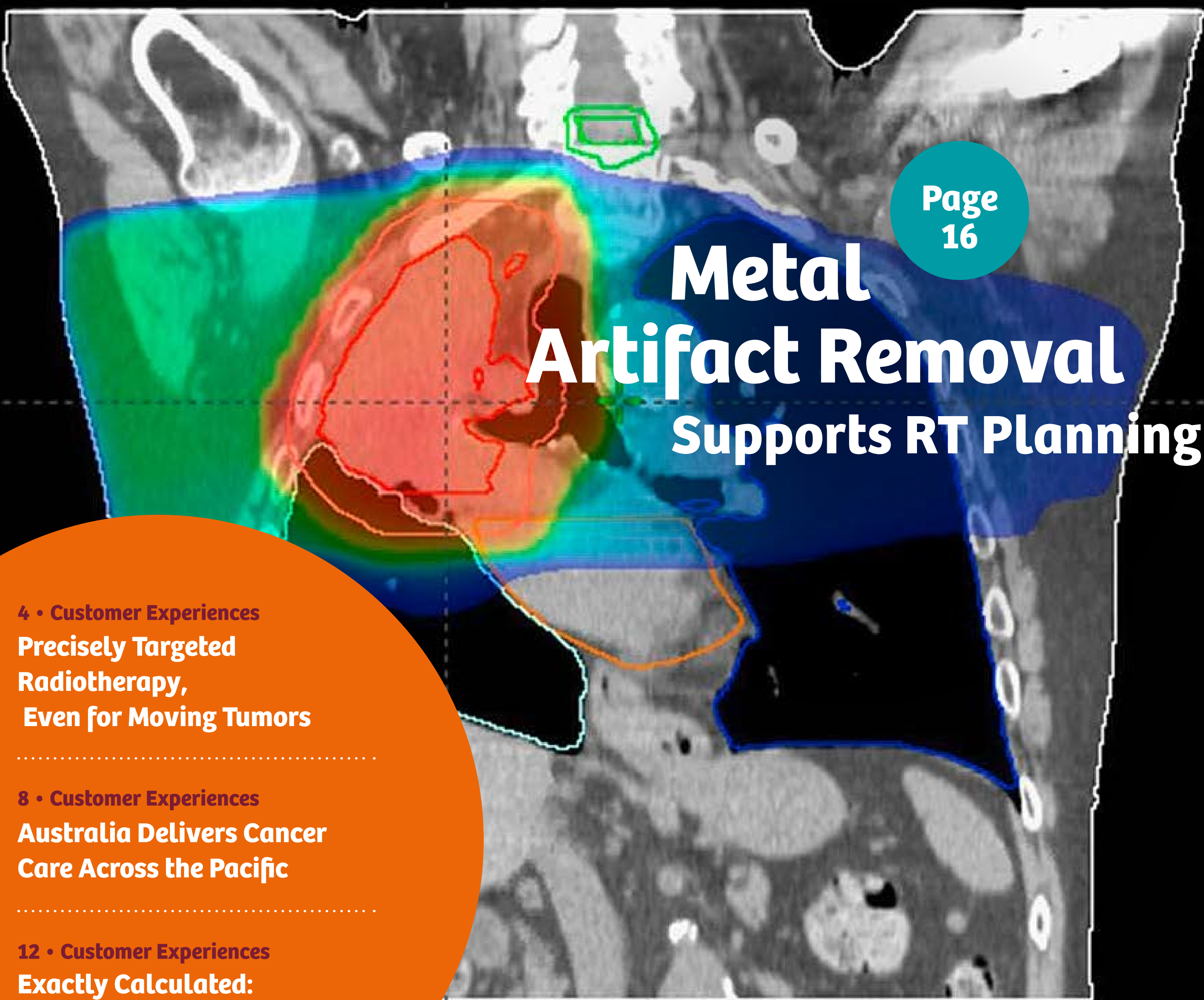
SOMATOM Sessions

Radiation Therapy Supplement



Page 16

Metal Artifact Removal Supports RT Planning

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Chief Editors:
Monika Demuth, PhD;
Christoph Bauer

Project Management:
Miriam Berner, Geraldine Roberts

Responsible for Contents:
Cécile Mohr, PhD

Editorial Board:
Christoph Bauer; Monika Demuth, PhD; Joel Parrish; Gerald Reinig

Author of this issue:
Kenton Thompson, Radiation Oncology Centres, North Lakes, Australia

Journalists:
Garry Barker, Philipp Braune, Matthias Manych

Photo Credits:
Christine Blei, Philip Gostelow, Tim Wegener

Production and PrePress:
Norbert Moser, Kerstin Putzer, Siemens Healthcare GmbH

Reinhold Weigert,
Typographie und mehr ...
Schornbaumstrasse 7, 91052 Erlangen

Proof-Reading and translation:
Sheila Regan, uni-works.org

Design and Editorial Consulting:
Independent Medien-Design, Munich, Germany
In cooperation with Primafila AG, Zurich, Switzerland

Managing Editor: Mathias Frisch

Photo Editor: Andrea Klee

Layout: Mathias Frisch

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SOMATOM Sessions on the Internet:
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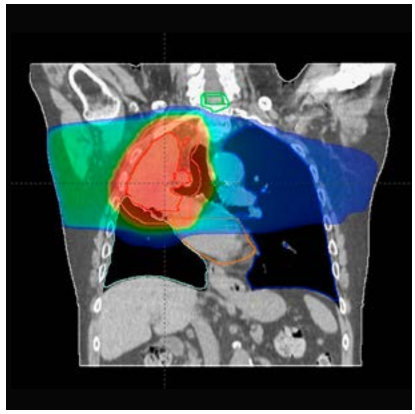
Cover



Metal Artifact Removal Supports RT Planning: Read about the benefits that metal artifact reduction brings to RT planning on page 16.
Courtesy of Radiation Oncology Centres, North Lakes, Australia

Contents

Dear reader,

The precise delivery of radiation therapy is critical in achieving the best outcome for oncology patients. New developments in CT are making the images for radiotherapy more precise and easier to use, providing opportunities to expand and enhance services. Our customers expect more information through imaging technology as they strive to improve the outcomes for the many and varied clinical cases.

In this edition of SOMATOM Sessions, customers share interesting perspectives on how they solve challenging problems within their clinical practice using the features of our newest CT scanner. We are also excited to observe how a leading academic partner is improving the precision of ion beam therapy through an innovative application of Dual Energy.

Proton and ion beam therapy are the most complex and advanced forms of radiation therapy. The physical characteristics of these particles offer unique opportunities to deliver the treatment dose to the target while minimizing the side effects to healthy tissue. To achieve this dose benefit requires exact treatment planning. Researchers from the German Cancer Research Center (DKFZ) in Heidelberg, Germany, describe how they use Dual Energy CT to improve treatment accuracy when planning for ion beam therapy. (Page 12)

CT is the modality of choice for radiotherapy treatment plans. But what can RT professionals expect from a modern CT scanner combined with the latest image-processing software? Read how physicians at the University Hospital in Heidelberg, Germany, describe what has changed for them since they started using the new SOMATOM Confidence® RT Pro. (Page 4).

Many of the technological advances in cancer treatment often remain at centralized academic institutions, which forces patients living in the suburbs or countryside to leave their home and family support base in order to receive state-of-the-art treatment. SOMATOM Sessions spoke with the Icon Group to learn about its network of comprehensive cancer centres situated outside large city centers in Australia. Working with Siemens Healthineers and Varian has enabled them to provide cutting-edge treatment consistently across the network. (Page 8)

Helping you deliver better outcomes at a lower cost is at the core of Siemens Healthineers' mission. For our dedicated Radiation Oncology team, this means pushing the boundaries of imaging beyond simulation and planning to include treatment follow-up.

At Siemens Healthineers we are listening to how imaging solutions can better support exciting new methods of treatment while creating platforms that make it simpler to bring the benefits of advanced radiation treatment to more patients.

Your cooperation drives our innovation, so we look forward to hearing about your ideas and experiences.

Kind regards

Gabriel Haras

Gabriel Haras, MD
Head of Radiation Oncology,
Advanced Therapies,
Siemens Healthineers,
Forchheim, Germany

Professor Jürgen Debus, Medical Director of the Department of Radiation Oncology and Radiotherapy, Heidelberg University Hospital, Germany.

Precisely Targeted Radiotherapy, Even for Moving Tumors

In radiotherapy, limiting the target volume within the treatment area has always been hugely important so as to give maximum protection to the healthy tissue surrounding a tumor. Moving tumors present a particular challenge in this regard. Professor Jürgen Debus, Medical Director of the Department of Radiation Oncology and Radiotherapy at Heidelberg University Hospital, tells us about how his department is using new technology to tackle this issue and to make some significant improvements.

Text: Philipp Braune | Photos: Christine Blei

Professor Debus, what improvements have been made in radiotherapy as a result of advances in computed tomography in recent years?
PROFESSOR JÜRGEN DEBUS: The key thing for us is to get an exact 3D picture of the patient's anatomy and the area around the tumor, so that we can target it precisely with radiation. Thanks to the huge advances that have taken place in computed tomography in recent years, we have been able to make significant progress in this area in terms of geometric precision, contrast resolution, and temporal resolution. With modern CT systems, we can now generate not just a 3D model of the patient, but a 4D one, taking into account movements within the patient. This means that we can match the treatment area even more closely to our target volume and provide even better protection for the tissue surrounding the tumor. In short, our aim is more accurate and we are able to hit the target better than with previous CT scanners.

Where do you use 4D CT imaging?
DEBUS: We find moving tumors in the lung, for example, but the pancreas also moves several centimeters back and forth. If 4D imaging can be used to offset this motion, treatment can be delivered in an extremely gentle way that protects the gut, for instance, which sits just above and below the pancreas. There are two procedures we use to do that. The first is gating, where we use the information from the 4D scan to ensure that the beam is on only when the tumor is in exactly the right position. The second approach involves precisely synchronizing the delivery of radiation with the patient's breathing.

How were moving tumors treated previously?
DEBUS: They could be irradiated, but we had to leave a safety margin around them. We would determine the maximum phases for inspiration and expiration, for instance. But this gave us only an approximate idea of the area in which the tumor was moving around. In fact, tumors don't just move back and forth – they can also tip over and twist backwards and forwards. With 4D CT, we can capture this

complex movement precisely on all three axes of rotation.

What are the advantages of modern CT technology for particle therapy?
DEBUS: To treat tumors with protons and carbon ions, we need to be able to predict the penetration characteristics of the tissue in question with a high degree of accuracy, so that we can determine how deeply the beam is able to penetrate. The new detectors on modern CT systems allow us to determine tissue characteristics much more accurately. That means that we can work out in advance exactly how the radiation will act when it is applied. This is helpful, by the way, not just in proton and carbon ion therapy but also in conventional radiotherapy.

Are there other features that are important for a CT system used for the radiotheray workflow, as compared with normal diagnosis?
DEBUS: There is one issue we haven't even mentioned yet. In radiotherapy, we have specific requirements as regards variability of patient positioning. We have to place patients in the same position for imaging as for their subsequent treatment – namely, in a prone position or with their arm or leg extended. For that reason, we need a particularly big gantry. In addition, the table must have a particularly high load-bearing capacity. Older CT systems were often designed with a weight limit of 135 kg. With the additional load of our specialist equipment, that meant that sometimes it wasn't possible to scan heavier patients.

To overcome those challenges, you installed one of the first SOMATOM Confidence® RT Pro systems in summer 2016. Does this scanner do everything that you require of a CT system?
DEBUS: Yes, it meets our needs perfectly. It is not just that it has an 80 cm gantry and a table that can take up to 250 kg. The main thing is that using this system we are able, in the specific conditions in which we operate, to achieve excellent image quality with low noise and high reproducibility. It also allows us to take extremely precise measurements for particle therapy modelling. Furthermore, it was important for us to be able to do image processing, especially 4D processing, as soon as possible after imaging – instead of having to postpone it until the treatment planning stage. The *syngo*.via RT Image Suite allows us to do just that.

You are now also using the new iMAR package for metal artifact suppression. How important is that for radiotherapy?
DEBUS: Many of our patients now have metal implants, which produce artifacts in the area that is being examined. These can be artificial joints, pacemakers, chemotherapy ports or simply dental implants. We therefore use iMAR with about 10% of patients. We have just used CT imaging on a patient with two artificial hip joints. Previously that would have been a guessing game, but with iMAR we can suppress the artifacts which may be beneficial in our RT workflow.

Was radiation dose also a factor for you when choosing your new CT system?
DEBUS: Radiation dose is actually a very important issue for us. We treat lots of children here and have chosen specifically to use proton beams in those cases on radiation safety grounds. It is therefore only logical that we should also use a scanner that minimizes radiation exposure. Our SOMATOM Confidence RT Pro CT system offers us a variety of ways to keep doses as low as possible – by using the CARE dose package, for example.

What feedback have you had from your staff on operating the new system?
DEBUS: Our staff love the machine. It is very easy to operate, which is particularly important, as our staff have to get to grips with the technical possibilities of the system, and to be able to harness them, to

The SOMATOM Confidence® RT Pro.

"The new SOMATOM Confidence® RT Pro CT system is ideal for the needs of radiotherapy."

Professor Jürgen Debus, Medical Director of the Department of Radiation Oncology and Radiotherapy, Heidelberg University Hospital, Heidelberg, Germany

achieve the result that best meets our complex needs. For example, if I want to capture density values for proton therapy with high precision, I can't work using the default setting.

How has your workflow changed?
DEBUS: In fact, scan time is no longer the limiting factor for us with a CT system. The thing that really holds us up is image processing. We have to segment normal tissues – for example, the entire lung or the spinal cord – for radiotherapy, and that is very time consuming. The *syngo*.via RT Image Suite, with its intelligent, automatic algorithms, is enormously helpful in that regard. Also, when using the 4D applications, we no longer have to segment the time series completely by hand. Segmentation in one breathing phase is enough – the program does the rest. That makes processing not just a good deal faster, but also more reliable, as it is less dependent on the person doing the examination.

Where do you see new approaches being developed in the future to optimize the synergy between CT imaging and radiotherapy?
DEBUS: There are sure to be some improvements around image processing – for instance, in the use of data from treatment carried out previously as a parameter set when delivering similar treatment to other patients. The same is true of follow-up examinations, so that if I am comparing images taken two years apart, for instance, the image processing system shows up the differences automatically. We are looking closely at those issues right now, and we think that the *syngo*.via RT Image Suite will enable us to bring that in.

Professor Debus, thank you for taking the time to talk with us. ●

The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there can be no guarantee that other customers will achieve the same results.

Australia Delivers Cancer Care Across the Pacific

Despite all the progress made in the detection, diagnosis, and treatment of cancer, the huge distances some Australian patients need to cover for treatment add to the burden of the disease. Enter Icon Group's network of comprehensive cancer centers outside the large cities.

Text: Garry Barker | Photos: Philip Gostelow

For many cancer patients in the sprawling cities of Australia, receiving treatment has until recently involved time-consuming travel because, while cancer care and treatment was centralized in city centers, it was usually scattered – the doctor here, radiation therapy there, and the pharmacy in yet another place. For folk outside metropolitan areas, Australia's huge distances just increase the problem. Melbourne, for example, is 1000 square kilometers bigger than Greater London. Someone living in an outer suburb could drive more than 100 kilometers just to see a cancer specialist. Journeys from country centers can cover hundreds of kilometers.

Australia's Icon Group seeks to alleviate the stress of travel by bringing all elements of diagnosis and treatment – medical oncology, hematology, radiation therapy, and pharmacy – together in its new and expanding network of comprehensive cancer centers. These centers are sited in satellite population locations outside the cities. For instance, the company's newest center, opened in July 2017, in Midland, 30 kilometers from the center of Perth in Western Australia. Another is under construction beside the Valley Hospital near Dandenong, a large and rapidly growing, largely migrant city of 160,000 inhabitants, 40 kilometers from the center of Melbourne.

The Midland centre has been built inside the historic Perth railway workshops constructed in 1921 as the western terminus of the 4500-kilometre line from Sydney and Melbourne to Perth. Locomotives and rolling stock on what is one of the longer rail lines in the world were serviced and repaired there and some of the old lines are still to be seen behind the new Icon center. Brooke Arnold, the Icon Site Manager at Midland quips: "Back then it repaired steam engines. Now we repair human engines."

Capability is key

Arnold says Icon set up in Midland, 30 kilometers north-west of Perth, because it has become a major population hub. Until the construction of St John of God Hospital Midland and now Icon's day hospital, he explained that all Perth's hospitals and medical services were in the CBD (central business district). "Before this center was built, cancer patients had to go all the way into Perth for treatment. Now they don't have to. It's a major

Convenience, technology, and human capability are the main pillars of Icon's structure.

Jim Frantzis is Icon Group's CEO of the Cancer Services division in Australia.

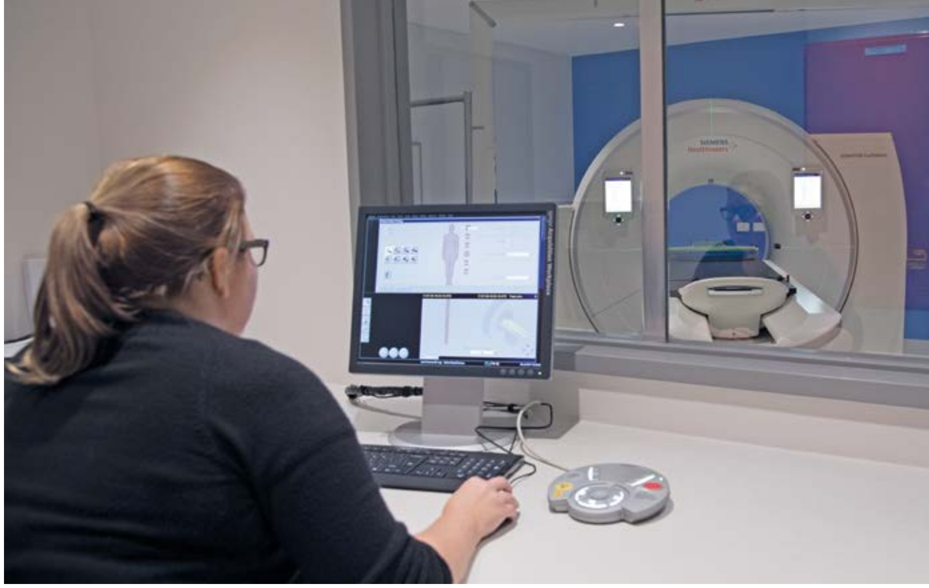
help to them." The same journey-saving concept is being applied at the second Icon center in Western Australia being built at Rockingham, 50 kilometers south of Perth.

Convenience for patients is a benefit, but the main pillar of Icon's structure is having the best technology and human skills readily available, side-by-side, in comprehensive centers. Dedicated onsite pharmacies dispense the chemotherapy ordered by specialist medical practitioners. Some also compound on-site. And the latest, most precise, Siemens Healthineers CT scanners and Varian linear accelerators control and administer the radiation treatment.

Icon's standard CT imaging platform is the SOMATOM Confidence® RT Pro – a dedicated CT scanner designed to support radiation therapy chosen by Icon because it provides optimized imaging functions, improved visualization, metal artifact reduction, and overall superior precision. Linear accelerators are predominantly Varian, ensuring seamless interfacing and connectivity with the Siemens Healthineers CT scanners.

"Using this machine and the tight integration with the Varian environment, we can work to submillimeter accuracy," says Clinical Implementation Manager, Claire Smith. "We can work on a tumor very close to important areas of a patient's body, such as the spine, without risking damage."

"A great example of our system is the seamless motion management, which was developed through a collaboration between Siemens Healthineers and Varian," says Icon Group's CEO of the Australian Cancer Services division, Jim Frantzis. "It's proven very effective and efficient in capturing and processing images. And that has reduced the time patients are required to be on the CT table for this specific imaging modality. The scanner is of wide-bore design allowing for clearance around the



With the SOMATOM Confidence® RT Pro, tightly integrated into the Varian environment, accurate treatment to submillimeter accuracy is possible, as Clinical Implementation Manager Claire Smith explains.

patient in even the most challenging of treatment positions."

Experienced cancer care consortium

Icon is a consortium formed in 2015 by four healthcare companies – Icon Cancer Care, Radiation Oncology Centers (ROC), Epic Pharmacy, and Slade. All have many years' experience in cancer care and have been pillars of the Australian healthcare community for decades. The group is the largest private day oncology provider in Australia and growth has been rapid. Icon now has 20 cancer centers spaced across Australia with another eight set to open over the next 14 months.

Expansion into China

Icon is growing rapidly in Australia with its innovative all-in-one cancer care centers, and like most successful Australian companies looks to keep on growing. A start has been made in Asia. China's prosperous and aspirant but aging middle class demands high-quality medical care. "Icon believes it can help and already has joint ventures in the market," Frantzis says.

Claire Smith says she has seen huge changes in China where millions of people can now afford quality healthcare, but they are careful. They are going to look at our capability and our equipment to see what we can offer."

Last year Icon signed agreements with a number of partners to provide radiation therapy services in China, with Icon's centralized remote dosimetry function forming the backbone of these agreements. Here, the treatment plan defining how the linear accelerator will target and deliver radiation to the tumor is created based on imaging and other data obtained during consultation with the patient.

Icon also has medical oncology clinics in Singapore, via the acquisition of Singapore Oncology Consultants, and a further deal has been signed to run a seven-bunker radiation therapy center co-located with an 800-bed private hospital in Guangzhou, a major industrial city in southern China. "Working with good partners who understand our business has been the backbone of our rapid expansion in Australia, and it will underpin our growth in Asia," CEO Jim Frantzis says. "Siemens Healthineers' knowledge of different international markets is vital to our expansion in Asia. Their relationships will assist us in transitioning into new markets seamlessly and successfully. The robustness of their machines, systems and maintenance approach, will also ensure we can deliver a high-quality remote service across Asia. Their innovative approach to healthcare delivery is the reason we use their CT technology across our Australian cancer care sites and they will be instrumental in paving the way for our international growth."

Stimulating training environment for staff

Plans as big as that mean the company pays great attention to staff and specialist training. "A major part of Icon's focus is on our people and their professional development," Frantzis says. "Education and training are the pathway to exceptional, contemporary, and evidence-based cancer care. "With over 200 clinicians now part of the Icon team, the opportunity for collaboration, peer review, and innovation is significant," according to Frantzis. "Many of Icon's medical specialists are international leaders and that provides a stimulating learning environment for all staff." The partnership with Siemens Healthineers completes that with ongoing training and maintenance: "Having experts available at all times is key. It helps us to deliver accurate, precise, and modern treatment approaches," says Frantzis.

Facing the challenges of the industry

Similarly, with high-end technology now vital in cancer care, Siemens Healthineers is synonymous with cutting-edge technology and innovation, he says. "Siemens Healthineers has a dedicated team that focuses on radiation therapy requirements. This ensures the workflows are current and the technologies support the evolving challenges of our industry. Their tailor-made imaging solutions help us achieve optimal outcomes for our patients and let our staff perform their duties to the highest possible standard."

Icon's specialist Australian workforce and robust software systems underpinned the partnership with Siemens Healthineers and Varian, he said, providing an ability to deliver a remote approach to radiation therapy planning globally. The team at the company's headquarters in Brisbane can deliver radiation to a tumor with pinpoint precision regardless of where the patient lives.

Icon's new comprehensive cancer centres represent a revolution in the care of cancer patients. Having everything easily available on one site has made changes in treatment. Opening centers close to new and fast-growing outer suburbs and regional areas has lifted the burden of often long and inconvenient travel. And, most importantly for patients' peace of mind, while the battle goes on against these life-threatening diseases, great care is taken to be sure they understand and are calm about each procedure.

Garry Barker specializes in business, technology, and healthcare. Previously Technology Editor of The Age, Melbourne's premier morning newspaper, he now writes and produces weekly global podcasts on those topics.

SOMATOM Confidence® RT Pro

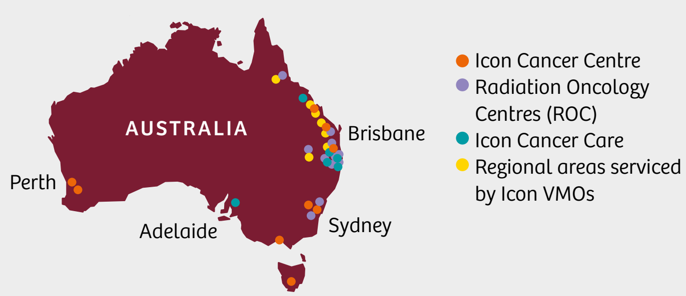
Medical imaging and radiation therapy technology have come a long way and are still improving, says Jim Frantzis, CEO of Icon's Cancer Services division. Technologies such as DirectDensity™[1] allow CT features to be fully realized when undertaking radiation oncology planning, giving a more personalized approach to the process. Iterative metal artifact reduction (iMAR) addresses implant-specific artifacts, producing improved datasets on which to contour and plan. Respiratory gating interfaces developed for the Varian RGSC device, apply across both CT and linacs. This has advanced the data acquired and its consistency in clinical use. "Together these technologies optimize the imaging data, enabling accurate delineation of tumor volumes and normal tissue that enhances the overall quality of care and patient outcomes," Frantzis says. And for patient comfort and confidence, the wide-bore design of the SOMATOM Confidence® RT Pro may help to reduce the claustrophobic effect of the CT experience, according to Frantzis.

[1] DirectDensity™ reconstruction is designed for use in Radiation Therapy Planning (RTP) only. DirectDensity™ reconstruction is not intended to be used for diagnostic imaging.

The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there can be no guarantee that other customers will achieve the same results.

Icon's expansion in Australia

Deliberately, the majority of Icon's 20 state-of-the-art cancer centers are not in major cities, but in larger suburban and regional centres. Cancer patients in Australia's hugely spread communities once had to commute, often for 100 kilometres or more, to get treatment. Now, for Icon's patients, in Australia and elsewhere in the region, it's a shorter journey. Icon is continuing to invest many millions of dollars in the world's best equipment, skilled medical and technical staff, onsite pharmacies, and access to allied health, combining them conveniently together which, Icon says, is now what patients are demanding.



Includes centres set to open in 2017/18

Exactly Calculated: Better Targeting for Ion Beam Therapy

To use the precision and effect of ion beam therapy consistently, it is crucial to calculate the range of the particle beam exactly. Thanks to the method developed by Steffen Greilich, PhD, and his team, a new level of accuracy is now possible. Siemens Healthineers paid a visit to the head of the research group "Ion Beam Therapy" at the German Cancer Research Center (DKFZ) in Heidelberg, Germany, to learn about the current status and clinical implementation of their development.

Text: Matthias Manych | Photos: Tim Wegner

The view from the eighth floor of the DKFZ building reveals the dimensions of the Heidelberg campus with its research institutes and university hospital. Here in the Neuenheimer Feld, scientific and medical competence is concentrated, with approximately 11,000 people contributing to it. "On the left you can see the so-called Heidelberger hospital ring. There is also the Department of Radiation Oncology, which is connected to the Heidelberg Ion Beam Therapy Centre (HIT) by underpass," Greilich explains. Research into the healing effects of radiation on cancer cells began here in 1906. As early as 1950, a center for radiotherapy was established and the potential of computed tomography (CT) for radiotherapy planning has been used and further developed since around 1980. Heidelberg is one of the world's most important sites for oncological radiotherapy, especially those with protons and carbon ions. The Heidelberg Institute of Radiooncology (HIRO) has been in existence since 2010 and the DKFZ is one of its sponsors. Together with OncoRay in Dresden, it forms the National Centre for Radiation Research in Oncology (NCRO). The scientists at both locations work intensively together on the further development of ion beam therapy based on Dual Energy CT (DECT) images. The algorithms developed by Greilich and his team increase the accuracy of therapy planning.

Ionisation at exactly the right place

Ion beams are particularly suitable for the treatment of certain radiation-resistant tumors, for hard-to-reach cancer sites, and for those in the immediate vicinity of risk organs. Greilich reports: “Ion therapy is the treatment of choice for skull base tumors. This is an established and frequent indication, the costs of which are also covered by health insurance funds in Germany.” Other tumors for which ion beam therapy is considered are salivary gland tumors, soft tissue sarcomas, and prostate carcinomas. According to estimates by the World Health Organization (WHO), about 60 percent of all cancer patients receive radiotherapy and about 10 percent could benefit from ion beam therapy. The reason why particles such as protons and carbon ions are particularly predestined for this is due to their physical behavior: They release the majority of their energy to the tissue at the end of their path and come to a standstill shortly afterwards. As a result, tissue lying in front of the target volume is only exposed to very little load and the tissue behind remains largely untouched by radiation. The concentrated energy of ionizing radiation almost exclusively hits the tumor. This also reduces the risk of undesirable effects later on. In conventional radiotherapy, on the other hand,

On the Heidelberg campus, scientific and medical competence is concentrated, with approximately 11,000 people contributing to it.

Thanks to the method developed by Steffen Greilich, PhD, and his team, a new level of accuracy for ion beam therapy is now possible.

The work of Steffen Greilich, PhD, and his team as well as their colleagues at OncoRay in Dresden is based on Dual Energy CT (DECT).

photons are used. “Actually, they are not so well suited for therapy,” explains Greilich. Photons release a considerable amount of their ionizing energy on the first few centimeters after entering the tissue, so that less energy reaches the tumor and a further portion leaves the body unused. By using sophisticated treatment techniques, the physical behavior of photons can, however, be partly compensated.

New algorithm versus old uncertainty

Steffen Greilich has been working on radiotherapy for almost ten years. He is particularly interested in the links between the smallest physical effects and biological changes. The scientist knows all too well that ion beam therapy can only turn the physical properties into therapeutic effects if the energetic particles stop precisely in the tumor and emphasizes: “If it is not known where protons and heavy ions stop in the body, the result of ion beam therapy is worse than with conventional photon therapy.” The problem regarding range has not yet been solved satisfactorily because clinically significant deviations can occur with the current calculation method. For example, protons directed at deep-seated tumors can penetrate tissue a few millimeters further than predicted. One focus of the Greilich research group was therefore to develop a more precise algorithm for predicting the range.

Important prerequisite: Dual Energy CT

The basis for treatment planning is a three-dimensional reconstruction of the tumor and surrounding tissue using CT imaging. The standard method for this is Single Energy CT (SECT). Decisive values for therapy planning are the attenuation of X-ray radiation in tissues (Hounsfield Units, HU) and electron density. However, the translation of the HU into the relative electron density of the target tissue for dose calculation using the so-called “HU look-up table” leads to inaccuracies. Greilich explains the disadvantages of SECT: “With the conventional Single Energy CT, the clear information on electron density is superimposed with that of the atomic composition of the tissues. The atomic composition of the tissues is assumed to be the same in all patients but in reality it varies. The result is an ambivalent image.” When converting the ambivalent CT contrast into electron density, all tissues would be treated the same, Greilich explains. The same Hounsfield units mean the same electron density, but this would only apply if all tissues had the same atomic composition. But that is not the case. Overall, SECT can limit the clinical possibilities for photon and proton therapy on several levels:

- less accurate dose calculation
- more difficult target contouring due to missing soft tissue contrasts without contrast agent
- unidentifiable or difficult to identify and quantify foreign material (e. g., implants)
- with contrast-enhanced images, a native CT scan is often also required for radiotherapy dose calculation.

The work of Greilich and his team as well as their colleagues at OncoRay in Dresden is based on Dual Energy CT (DECT). The aim was to use DECT in clinical application for ion beam therapy. By providing two images each at different energy levels, DECT can provide information on both the atomic tissue composition (or effective atomic number) and the electron density. These two values may help in determining an accurate estimation of the stopping power ratio of the tissue. This means that information is available for calculating the range of ion beams, which is not only much more precise but also patient-specific and personalized, so to speak. DECT provides Greilich with all the information he needs to increase the accuracy of radiotherapy planning enormously. “In tissue experiments, we have an uncertainty range for the ion of 10 micrometers,” he notes. His confidence in the range prediction with DECT is very high. Greilich is sure that the advantages of ion beam therapy will be confirmed in long-term investigations. At the same time, other disadvantages of SECT are also avoided: Radiation exposure and workload are reduced because the additional native scan is not necessary and foreign materials are clearly identified. Moreover, their composition can be taken into account during treatment planning.

Successful collaborations

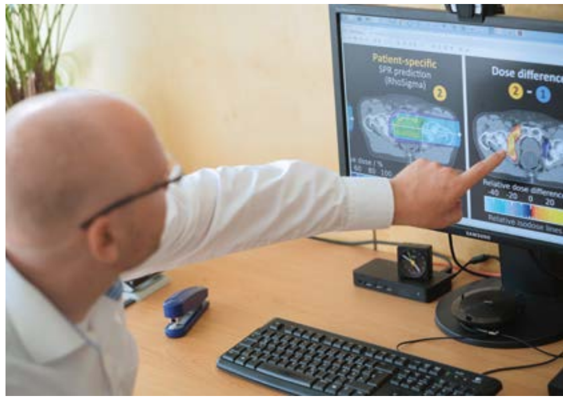
The joint work of the scientists in Heidelberg and Dresden began in 2014. Financial support for the DECT project was possible under the umbrella of the National Center for Radiation Research in Oncology. Once the algorithms of Greilich’s team had been understood and developed, the next major goal was to validate them. With a head phantom located in Dresden to mimic the complexity of biological tissue and geometric conditions found in humans, the approach was successfully tested. The stopping power ratio of the tissue can now be determined much more precisely. It has also been proven that the correction of the uncertainty with the algorithm actually works reliably in human tissue. “The tests of the algorithms on biological tissues, the implementation of the algorithms, this collaboration between us and our Dresden colleagues works very well,” concludes Greilich. Since July 2017, patients in Dresden have already been benefiting from more precise ion beam therapy with the new DECT possibilities.

Greilich sees the cooperation with Siemens Healthineers as another significant component of this successful development. On the one hand, Dual Energy CT was the only clinically established system of quality available in terms of both hardware and software, in Greilich’s experience. For the ion beam researcher, it turned out “that we work on the basis of perfect CT images.” On the other hand, it was crucial for him to understand, together with the developers at Siemens Healthineers, “that there is more to the software than just the calculation of electron density.”

Next steps

With the possible range prediction, the field is now ready for clinical applications outside of research centers such as Heidelberg or Dresden. As Greilich explains, a clinically certified software is a prerequisite for this: “The state-of-the-art software allows the algorithm to work very well.” The Heidelberg researcher does not doubt that DECT is also suitable for conventional photon therapy. He is surprised that the advantages of DECT are not yet being used here. “In terms of photon therapy everything is on the table, one could simply start,” assures Greilich.

The Heidelberg research group “Ion Beam Therapy” and its Dresden colleagues are already planning the next steps in the collaboration between HIRO and OncoRay. After the algorithms and their implementation, the focus is now on the clinical advantages and the reduction of the safety margins that are still common in radiotherapy. ●



The aim of the cooperation between Heidelberg and Dresden was to use DECT in clinical application for ion beam therapy.

Matthias Manych, a biologist, works as a freelance scientific journalist, editor, and author specializing in medicine. His texts appear primarily in specialized journals, but also in newspapers and online.

Metal Artifact Removal Supports RT Planning

By Kenton Thompson
Radiation Oncology Centres, North Lakes, Australia

History

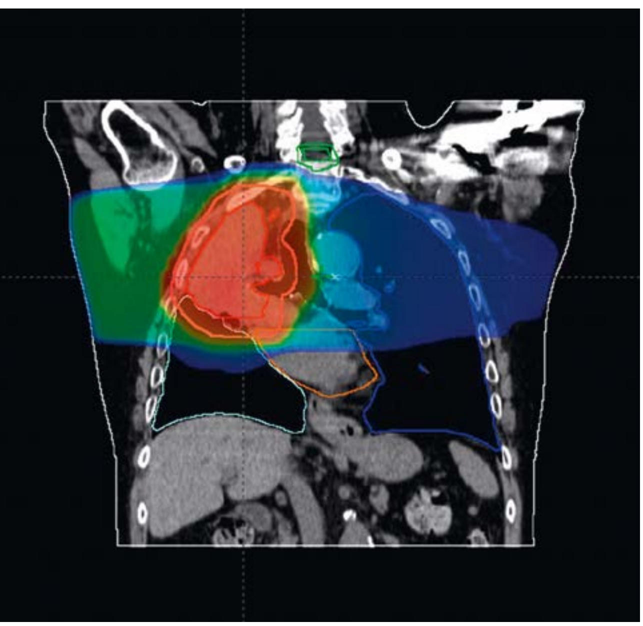
An 84-year-old male patient presented to the Radiation Oncology Centres with a right upper lobe (RUL) mass. Annual imaging including diagnostic CT scans had shown significant progression in his lung mass. At the same time, the patient started losing weight and experienced a worsening cough.

A core biopsy of the RUL mass revealed a histopathology that confirmed non-keratinising squamous cell carcinoma. The patient subsequently received 30 Gy in 10 fractions as a palliative treatment to help alleviate his symptoms.

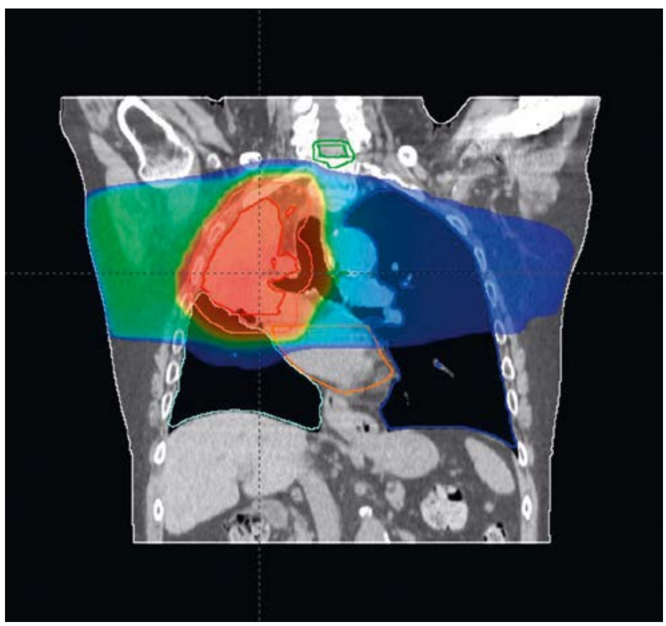
Comments

The patient has an extensive medical history including arthroplasty of the left shoulder. Metal artifacts from such implants can obscure the target area or make the beam setup difficult when planning radiation therapy. Although metal artifacts did not occur in the radiation fields for this patient, the side by side images show the clear benefit of using iMAR for patients with arthroplasty or showing metal implants in other forms.

1a

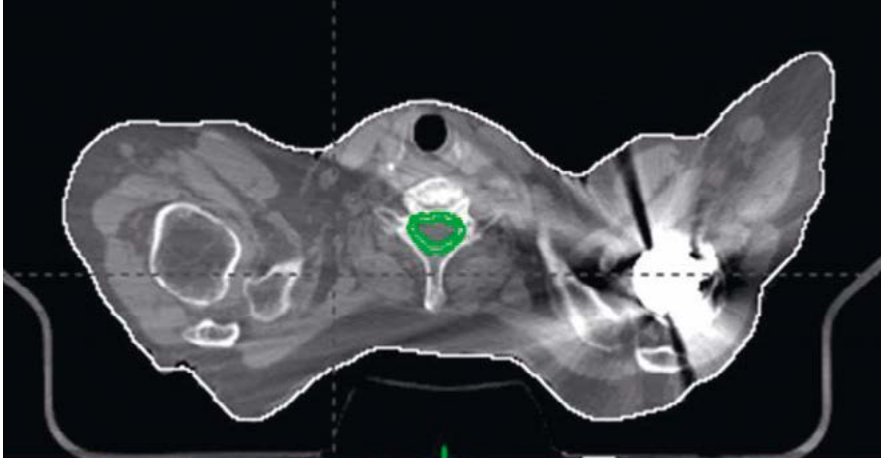


1b

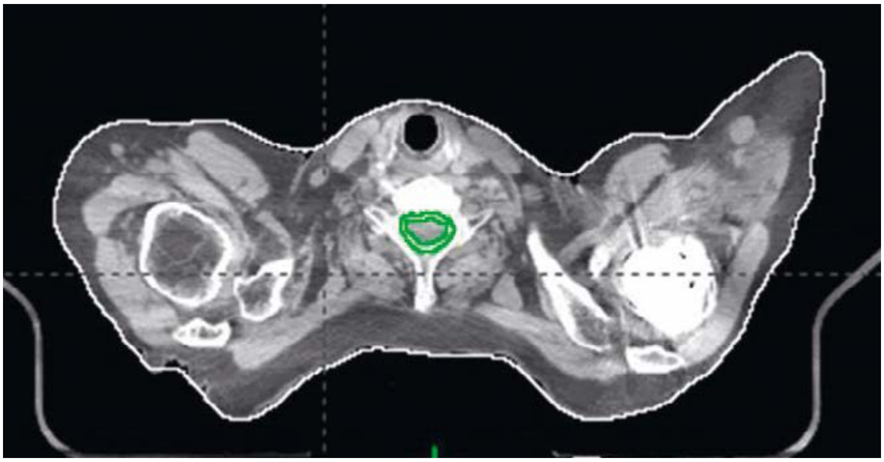


1 Metal artifacts caused by the arthroplasty (Fig. 1a) are removed with iMAR (Fig. 1b).

2a



2b



2 Metal artifacts caused by the arthroplasty (Fig. 2a) are removed with iMAR (Fig. 2b).

Examination Protocol

Scanner	SOMATOM Confidence® RT Pro		
Scan area	Chest	**DLP**	666.6 mGy cm
Scan length	334 mm	**Rotation time**	0.5 s
Scan direction	Caudo-cranial	**Pitch**	0.8
Tube voltage	120 kV	**Slice collimation**	64 × 0.6 mm
Tube current	250 mAs	**Slice width**	2.0 mm
Dose modulation	CARE Dose4D™	**Reconstruction increment**	2.0 mm
$CTDI_{vol}$	19.25 mGy	**Reconstruction kernel**	B31f

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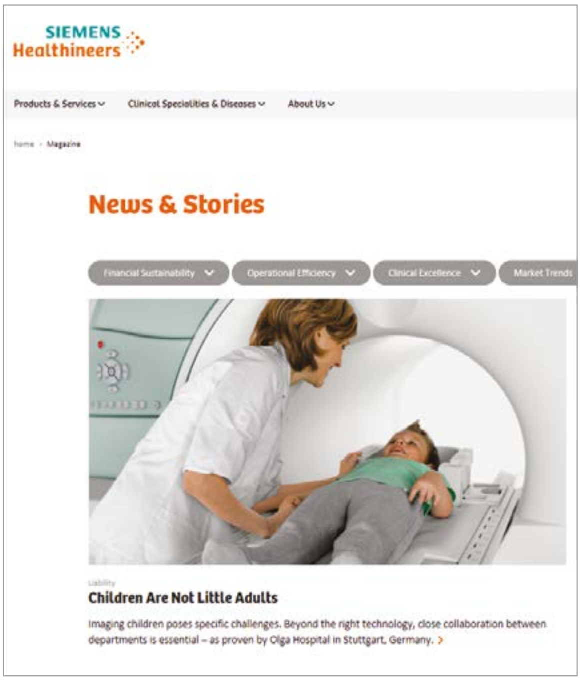

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Siemens Healthineers Headquarters
Siemens Healthcare GmbH
Henkestr. 127
91052 Erlangen, Germany
Phone: +49 9131 84-0
siemens-healthineers.com

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