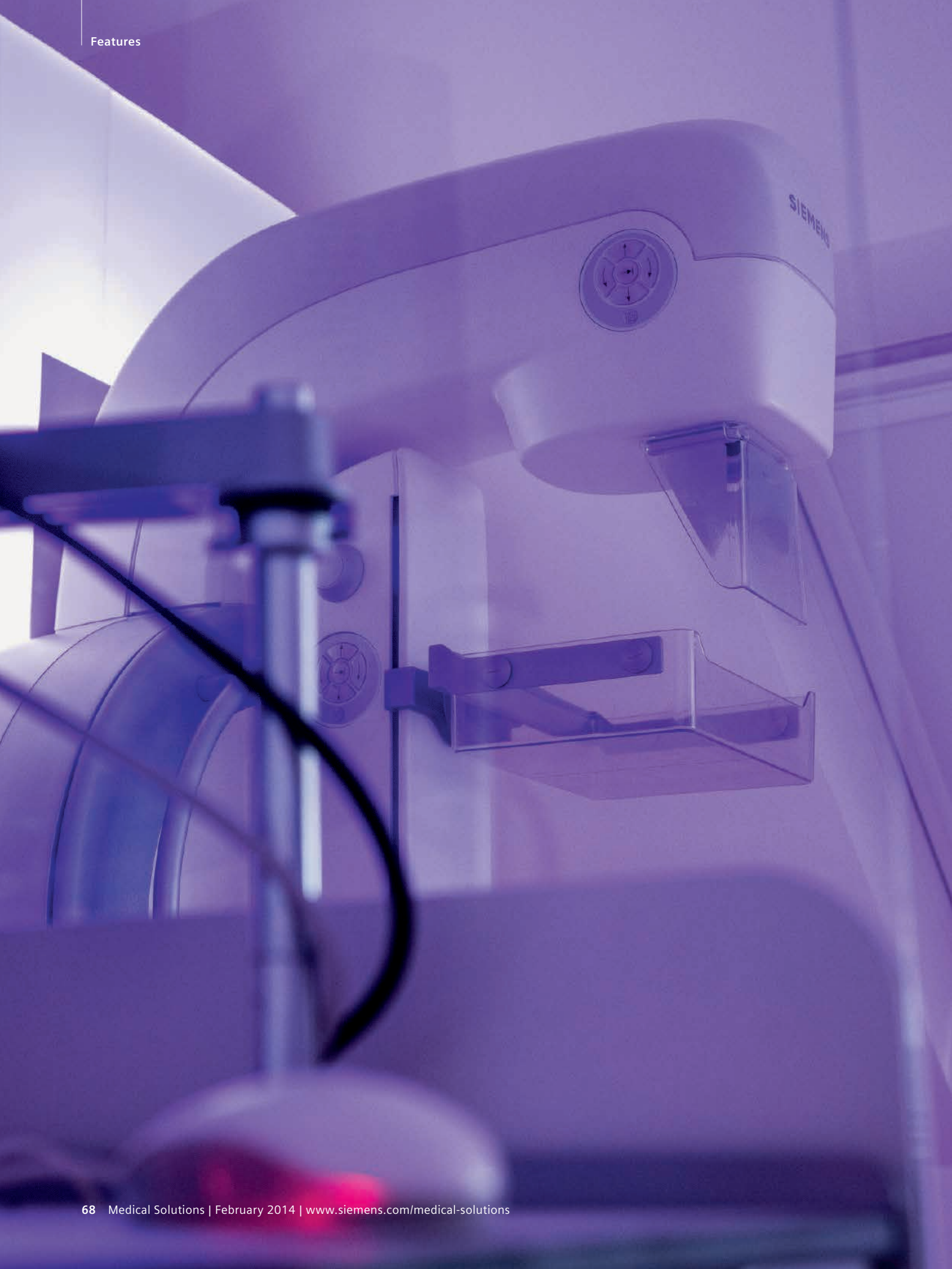

SIEMENS

A Winning Team

for Low Dose Digital Mammography

With Siemens as technical partner, clinician Professor Detlev Uhlenbrock, MD – who heads an Ambulatory Healthcare Center in Dortmund, Germany – found a way of reducing radiation dose in digital mammography by up to 30 percent, while still preserving image quality. *Medical Solutions* talked to both partners about this successful cooperation, which led to the creation of the MAMMOMAT Inspiration PRIME Edition.

Text: **Wiebke Kathmann, PhD** Photos: **Wolfram Schroll**

The MAMMOMAT® Inspiration has served radiologists and other clinicians involved in breast health and mammography screening in hospitals and clinics all over the world. With concern growing about radiation dose, especially in the screening of healthy women, there was, however, some room for improvement. Professor Uhlenbrock challenged the convention that an anti-scatter grid was an absolute necessity for obtaining high contrast images in digital mammography: "There had to be a way without a grid," he said during an interview looking back over his successful partnership with Siemens. "Even if we had to live with images with slightly less contrast, any resulting radiation dose reductions would make it worth the effort."

With Thomas Mertelmeier, PhD, Head of Technology& Concepts at Siemens' X-ray Product (XP) business unit, he found a partner who was just as eager as he was to find a solution.

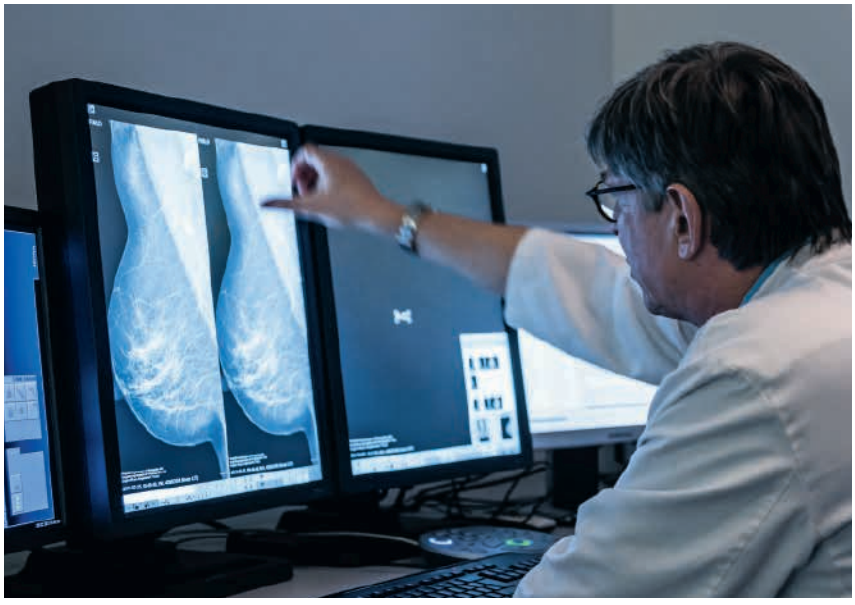
Taking Out the Grid

It all started in 2008, at the Ambulatory Healthcare Center in Dortmund. Uhlenbrock acquired a couple of experimental images without the grid: "We looked at the alterations and were impressed that the quality of the images was preserved quite well," he recalls. After these first measurements, the ball was again in the court of Siemens R&D. It was time for the Siemens physicists to generate an algorithm that corrected any image changes resulting from removal of the grid.

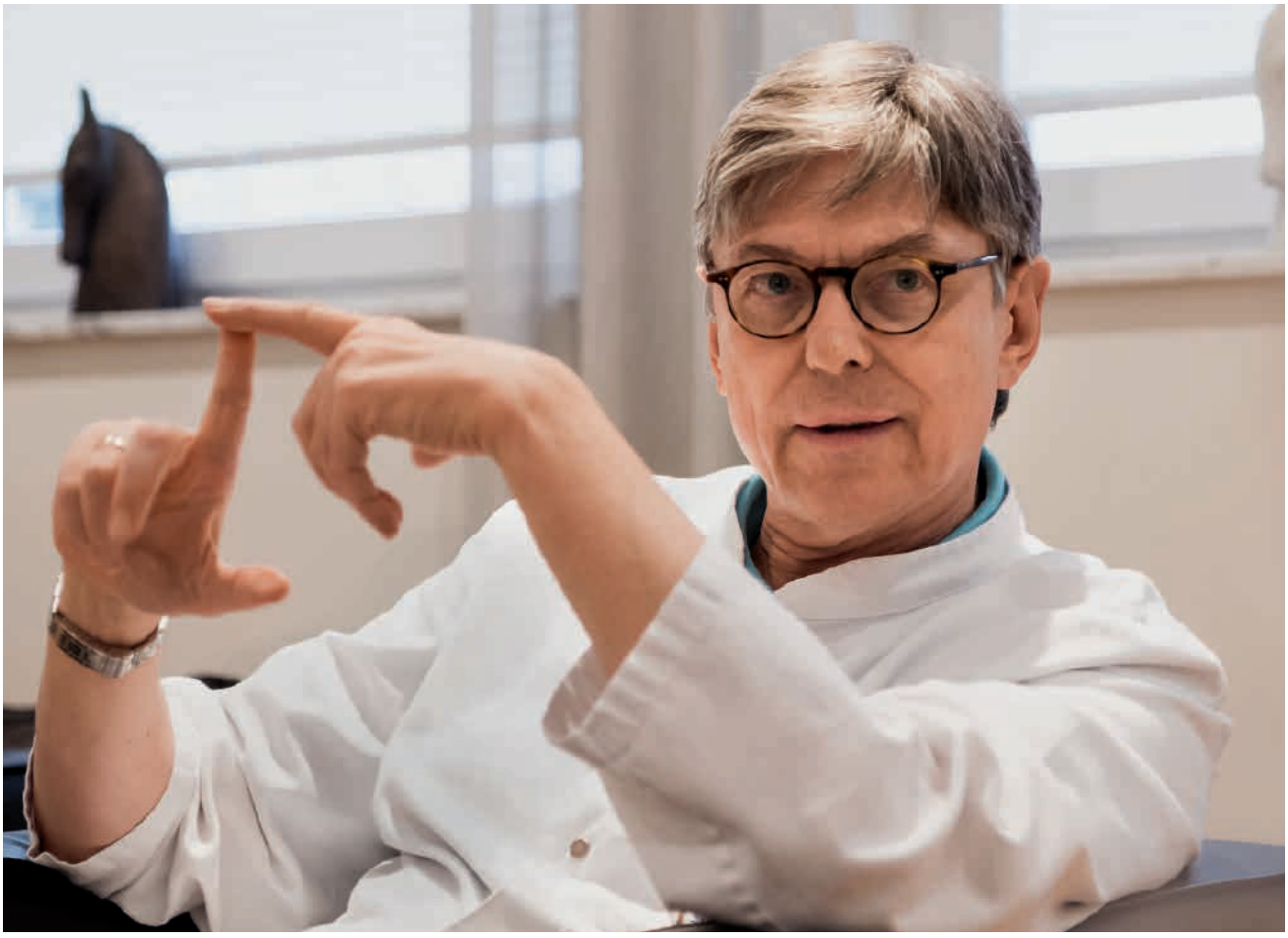
Working on a Software-based Scatter-correction

Developing the algorithm and testing it on phantoms took place at the Erlangen headquarters. Differing breast volumes and shapes had to be taken into account, which was achieved using acrylic glass plates of differing thickness during the measurements. The contrast-to-noise ratio needed to be calculated in order to determine the level by which radiation could be reduced – without lowering image quality, compared with those images produced with the grid. This meant repeatedly modifying the algorithm until it could fully compensate for the effects of the grid on image contrast.

"As expected from the theoretical analysis, the images taken of the phantom at reduced dose using the software-based scatter-correction came out with just as good contrast as with the grid," recalls Andreas Fieselmann, ▶



Images taken with PRIME technology had the same image quality as those taken using grid-technology – but with up to 30 percent less radiation.



Mammography expert Uhlenbrock teamed up with Siemens to find ways of further reducing radiation dose in mammography.

PhD, engineer in Mertelmeier's team at Siemens. Uhlenbrock agrees: "No difference in image quality was detectable."

According to Uhlenbrock, both partners had originally thought that taking out the grid would not be possible. In this regard as well, reality surpassed their expectations: Potential dose savings during phantom measurements were in the region of ten up to 30 percent – an encouraging result when it came to filing for a clinical study.

Even at this stage, it had become clear that women with smaller breasts would benefit most from the new software-based anti-scatter solution, or PRIME (Progressive Reconstruction Intelligently Minimizing Exposure) technology.

Clinical Study – Putting to the Test on Women

Planning for a clinical trial began in 2008. The objective was to prove that PRIME technology was not inferior to grid-technology; that the same image quality was possible using lower radiation dose. 75 women aged between 50 and 72 were enrolled. This covered the 50-69 age range, when women in Germany are invited for mammography screening every two years (see sidebar "The German Mammography Screening Program"). Participants were all diagnostic patients, called back after conspicuous features had been found during earlier mammograms. They were asked to give their written consent for two additional mammography exposures – one with the grid, one without – in addition to the medically indicated digital mammography images on two planes. Both sets of images were taken with the same compression to ensure that they were directly comparable.

"The whole process of getting the go-ahead from the authorities – Ethics Committee, Federal Office for Radiation Protection (BfS) and Patient Insurance – was laborious," Uhlenbrock recalls. "However, everyone was open to this new anti-scatter solution, and by the fall of 2011, all the necessary approvals from various authorities were in place."

With Uhlenbrock acting as a guarantor for the German mammography screening program, the recruitment process was very fast: "Around five million women are invited to breast-screenings every year; around 54 percent of these attend. This means that the German mammography screening program sees

The German Mammography Screening Program

Germany was a late bloomer when it came to mammography screening programs. The national scheme was established in 2002, with all women aged between 50 and 69 receiving an invitation every other year. The cost of screening is covered by the individual's health insurance. By 2008, 94 mammography screening units had been established: Each one was led by one or two executive directors/program guarantors, and covered an area home to between 800,000 and 1,000,000 people.

The true innovation in the German program is the function of a program guarantor. This individual covers all steps – from the first mammography, conferences, and recall imaging, to biopsies and therapy planning, if necessary. This feature not only ensures high quality standards; it also shortens waiting times for women and strengthens their trust, with one physician attending them throughout the entire process. The reliability of diagnostic clarification is very high on this program – partly because the teams receive regular training.

The issue of radiation dose still remains. The exposure of healthy women to radiation every other year has sparked a hot debate, which in turn has inspired clinicians and technologists to find solutions. The close partnership between the Ambulatory Health Care Center Prof. Dr. Uhlenbrock and Partners in Dortmund and the R&D Department at Siemens was a further step to tackle this challenge.

about 2.6 million women per year," he says, alluding to the huge potential for sourcing participants.

PRIME Technology: Surpassing All Expectations

When the image acquisition phase ended four months later, the evaluation of the images began: "The results of the study[1] clearly surpassed our expectations, even though they had been pretty high following the phantom measurements," Uhlenbrock notes. "But the results from the clinical setting were even better – especially with regard to their consistency."

Statistical analysis clearly showed that images taken with PRIME technology had the same image quality as those taken using grid-technology – but used up to 30 percent less radiation. They were non-inferior in all seven of the criteria examined. "This proves that with the right algorithm, one can eliminate all the drawbacks that gridless acquisition has on contrast," Uhlenbrock concludes.

Even though establishing the new technology as standard routine might take years, Uhlenbrock is going to use the PRIME technology from now on. "In two of our facilities, we are now changing to the software-based technology. This means we can offer women reduced-radiation mammographies. Their reactions are extremely positive when I tell them that I can now cut up to 30 percent of the usual dose. For me, the MAMMOMAT Inspiration PRIME Edition is the new standard in low-dose mammography." ■

Medical writer **Wiebke Kathmann** is a frequent contributor to German-language medical magazines aimed at physicians. She holds a Master's degree in biology and a PhD in theoretical medicine, and worked as an editor for many years prior to becoming a freelancer in 1999. She is based in Munich, Germany.

➔ **www.siemens.com/Prime-proof**

Management Summary

The challenge Uhlenbrock and Mertelmeier accepted was to minimize radiation dose while performing mammography scans on healthy women. It wasn't just a technical challenge: Coming up with a solution also meant challenging the long-held belief that grids were essential in suppressing scatter in digital mammography. Additionally, they had to find an alternative means of filtering out the scatter.

The solution they found was removing the grid and replacing it with a software-based scatter-correction that used PRIME (Progressive Reconstruction Intelligently Minimizing Exposure) technology.

The results were impressive:

- Same image quality as with the grid
- Up to 30 percent lower radiation dose
- Improved healthcare solution for women
- Creation of a marketable product, as a result of the close collaboration between customer and Siemens

[1] The results of the study were published in Physics of Medical Imaging, accessible under the link above: Fieselmann, A., Fischer, D., Hilal, G., Dennerlein, F., Mertelmeier, T., and Uhlenbrock, D., "Full-field digital mammography with grid-less acquisition and software-based scatter correction: investigation of dose saving and image quality," In: Proceedings of SPIE Medical Imaging 2013: Physics of Medical Imaging, Lake Buena Vista, FL, USA, vol. 8668, pp. 86685Y, (2013), doi:10.1117/12.2007490

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