# Phase contrast improves mammography

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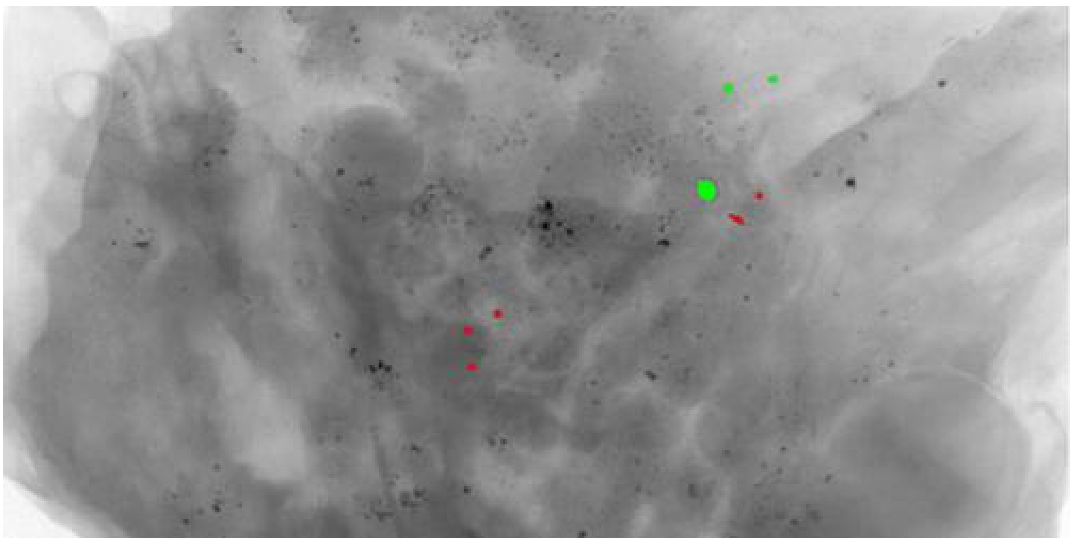

With the new method two types of microcalcifications in breast tissue can be distinguished. Credit: Z. Wang / ETH Zurich / PSI

Phase contrast X-ray imaging has enabled researchers at ETH Zurich, the Paul Scherrer Institute (PSI) and the Kantonsspital Baden to perform mammographic imaging that allows greater precision in the assessment of breast cancer and its precursors. The technique could improve biopsy diagnostics and follow-up.

The researchers have succeeded in advancing an emerging imaging technique for breast investigations: the X-ray phase-contrast mammography. The new developments enable distinguishing between the different types of microcalcifi-cations observed in breast tissue and help assigning them to malignant lesions. The study has just been published in *Nature Communications*.

One of the advantages of the phase contrast technique is its ability to provide images of high contrast. In the future, this technique can aid physicians to de-termine in a non-invasive way where premalignant and malignant breast lesions are most likely located. One goal of breast cancer screening is to detect (groups of) microcalcifications in the breast, because these may be associated with early stages of breast cancer since they often occur in connection with cancer cell death. Mammographic screening does not allow definite conclusions regarding the underlining conditions that cause calcifications. Only tissue biopsies that are examined under the microscope by pathologists can determine which lesions have caused the calcareous deposits.

## Clinical equipment could be used for phase contrast imaging

At the PSI, the use of phase contrast for medical X-ray imaging has been inves-tigated for several years. X-ray radiation as used in conventional mammography was long considered not suitable for phase contrast procedures because of its incoherence and mixture of multiple wavelengths. "The fact that we have now managed to use these X-ray sources for the phase contrast method in order to develop a new and improved imaging method is a considerable step towards application in daily clinical practice," says Marco Stampanoni, Professor at the Institute for Biomedical Engineering at ETH Zurich and Head of the X-ray To-mography Group at the PSI. He received an ERC Consolidator Grant in 2012 to advance the clinical use of X-ray phase contrast.

In X-ray phase contrast, the extent in which tissue absorbs x-rays is not the only quantity that is being measured but also how tissue deflects radiation laterally (refraction) and consequently how it influences the sequence of oscillation peaks and valleys of X-ray waves – the so-called phase. Depending on the tissue type, the overall scattering also varies. To be able to measure the phase shift, researchers use three very fine grids. The first one is located directly at the source. It ensures that the object is illuminated with the required coherence. Another grid is placed behind the object and generates an interference signal that is analysed by a third grid downstream. Using suitable algorithms, the re-searchers calculate the absorption, phase and scattering properties of the object from the interference signal. This information can be used to generate sharp and high-contrast images that show very detailed soft tissue properties. A discovery by Zhentian Wang, PostDoc in Prof. Stampanoni's team, initiated this development: "During my trials with the phase contrast method, I noticed that there are microcalcifications with different absorption and scattering signals. That indicated that the new method might identify different types of calcifications," he says. Wang subsequently reviewed through medical literature and found studies that showed that a certain type of calcification is more frequently associated with breast cancer precursors. "I was persuaded that my observation could be very interesting for breast cancer diagnosis, since it could distinguish between the different types of microcalcifications", says the researcher.

## Clinically relevant

The relevance of the new method was also confirmed by the physicians who participated in the study: "We are hopeful that the new technique, in comparison to standard mammography, will help to better indicate where a biopsy must be carried out in the breast," says Rahel Kubik, Head of the Institute of Radiology at the Kantonsspital Baden. "Still, it is not ready for clinical use as it needs to be validated in a larger number of cases", says the radiologist. "But it is very en-couraging that the new method enables a distinction between the different well-known microscopic types of calcifications," confirms Gad Singer, Head of the Institute of Pathology at the Kantonsspital Baden.

Whether the technology will make it to clinical use also depends on the radiation dose. "The aim will be to significantly improve quality, resolution and diagnosis with the same radiation dose as for a standard mammography so that breasts can be better examined" says Nik Hauser, Head of Gynaecology and of the In-terdisciplinary Breast Center at the Kantonsspital Baden. "If we can significantly improve imaging, this would enable better assessments of tumour extent prior to surgery. Then the new method will quickly become important," he is convinced. The foundation for a new imaging device has been laid, says Hauser. "We are optimistic that we soon will be able to present further results." To date, the re-searchers have worked with a prototype. They examined breast tissue samples, but no patients have been involved yet. "One of our next aims will be to develop a device for clinical use," says Marco Stampanoni.

**More information:** Wang Z, Hauser N, Singer G, Trippel M, Kubik-Huch RA, Schneider CW, Stampanoni M. Non-invasive classification of microcalcifications with phase-contrast X-ray mammography. *Nature Communications*, published online 15th May 2014. DOI: 10.1038/ncomms4797

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