

## **Advantages of Magnification in Digital Phase-Contrast Mammography Using a Practical X-ray Tube**

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Phase-contrast imaging for clinical use has been realized with a practical cone-beam X-ray tube in digital mammography using computed radiography (CR). To perform phase-contrast imaging, the X-ray detector must be distanced from an object so that the phase-contrast image achieves magnification; in a mammography unit dedicated to phase-contrast imaging, the magnification ratio is 1.75. When using an X-ray tube with a 0.1-mm focal spot, it is supposed that the penumbra in magnification blurs projected images and smears the phase-contrast, which generates an edge effect. However, where the sampling pitch of the CR plate is 43.75  $\mu\text{m}$ , the blur stretches the width of the phase-contrast so that unit-pixels in the detector can capture it. Note that the width of an ideal phase-contrast using an X-ray point source results in a phase-contrast too narrow for detection with the CR. In addition to the phase-contrast improving image quality, a re-scaling effect increases image sharpness in magnification. Further, image noise induced by magnification can be reduced during printing to dry-silver film by demagnifying the digital output image to the original size of the object. After the process of demagnification by  $1/1.75$  from 43.75 $\mu\text{m}$  in image acquisition, a 25- $\mu\text{m}$  pixel size of the output image is obtained so that spatial resolution matches that of conventional screen-film mammography. In this paper, such technical advantages of magnification in digital phase-contrast mammography are reviewed, and the image quality of phase-contrast images is discussed in light of diagnostic requirements in detecting breast cancer.

**KEYWORDS:** phase contrast, magnification, breast cancer, mammography, digital imaging