FACT SHEET

Synopsis of Publications from the UC Davis Breast Tomography Project

Introduction

This document summarizes a comprehensive collection of peer-reviewed publications from the UC Davis Breast Tomography Project, led by Dr. John M. Boone and colleagues. Spanning nearly two decades, the work conducted at UC Davis represents the foundational research and clinical evaluation of dedicated breast computed tomography (bCT). The studies included in this synopsis chronicle the technical innovation, system optimization, image processing advancements, and clinical feasibility of bCT as an emerging modality for breast cancer detection and diagnosis. By combining engineering, physics, radiology, and artificial intelligence, this body of work provides the scientific basis for a new standard in breast imaging, one that enables high-resolution, true 3D imaging without compression, and with promising diagnostic accuracy, particularly for women with dense breast tissue. The following summary distills the key findings and contributions from this extensive research program.

Summary of UC Davis Breast CT Publications

The UC Davis Breast Tomography Project's research contributions fall into several major domains: system development and performance optimization, image processing innovations, clinical validation studies, and exploratory applications such as radiation therapy and PET/CT integration. The earliest studies laid the groundwork for characterizing system geometry, scatter properties, spatial resolution, and optimal x-ray spectra. This includes the development of a geometric calibration method for cone-beam systems and quantitative modeling of spatial resolution degradation across the field of view. In parallel, investigators addressed key limitations such as x-ray scatter and cone-beam artifacts, leading to the development of optimized acquisition parameters, including higher tube voltages and filters, and the use of anthropomorphic breast phantoms for reproducible performance testing.

Advanced image processing techniques emerged as a critical focus. Deep learning and maximum likelihood polynomial fitting methods were developed to correct shading artifacts, enabling consistent adipose tissue segmentation and accurate Hounsfield unit representation. Other image enhancement strategies included temporal subtraction of contrast-enhanced datasets and radiomics-driven tumor classification based on shape and local curvature metrics. The group also explored CAD algorithms and segmentation accuracy, emphasizing how image quality directly influences diagnostic performance.

Clinically, early phase patient studies confirmed the advantages of breast CT in mass conspicuity, with higher diagnostic confidence compared to conventional mammography. Contrast-enhanced bCT (CE-bCT) demonstrated promising results in differentiating benign from malignant lesions based on enhancement kinetics, and CE-bCT's accuracy was shown to be comparable to MRI in dense breast tissue, with better spatial resolution and greater patient comfort. Studies also showed how bCT could improve tumor response assessment during neoadjuvant chemotherapy, potentially guiding surgical planning and treatment monitoring.

Finally, the team explored novel use cases such as bCT-guided radiation therapy and hybrid PET/bCT systems, suggesting the potential for bCT to serve as a multimodal imaging platform. A key theme throughout the work is patient-centered design, including the development of a non-compressive imaging experience, improved resolution without anatomical distortion, and radiation doses comparable to standard mammography.

Collectively, these publications represent the most robust and extensive body of research supporting the clinical viability of breast CT. The work conducted at UC Davis laid the scientific and technical foundation for commercial development of breast-dedicated CT systems, offering a compelling alternative to mammography and MRI, especially for women with dense breast tissue.

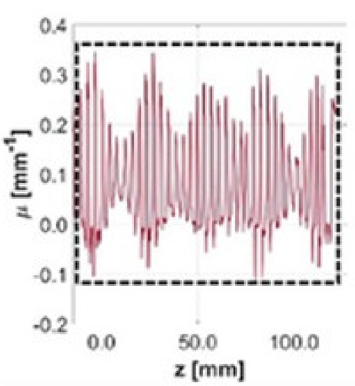
Note

Izotropic holds the exclusive global technology licensing rights to Breast CT from UC Davis, where the technology was founded and developed. Synopsis written by Dr. John Boone, Izotropic Founder & Director.

Technical Development or Performance Analysis of Breast CT

1. AE Becker, Am Hernandez, PR Schwoebel, JM Boone, Cone beam CT multisource configurations: evaluating image quality, scatter, and dose using phantom imaging and Monte Carlo simulations, PMB 65(23);235032 (2020)

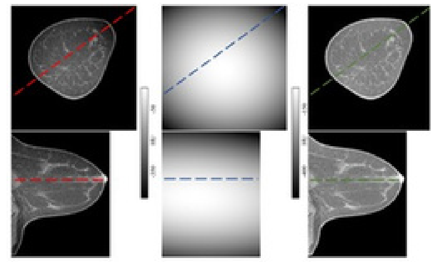
This paper describes a simulated 5 x-ray source breast CT system which would reduce cone beam artifacts and improve image quality. The fourth breast CT scanner at UC Davis, Doheny, was used to physically simulate and acquire the data sets using 5 x-ray source locations. The results demonstrated superior performance with the multisource x-ray system, and this has led to another line of funded research activity at UC Davis and other collaborating sites.



2. AM Hernandez, CK Abbey, P Ghazi, GW Burkett, JM Boone, Effects of kV, filtration, dose and object size on soft tissue and iodine contrast in dedicated breast CT, Medical Physics 2020; 47:2896-2880

This study sought to optimize the x-ray acquisition parameters used for breast CT in terms of image quality for both soft tissue contrast and iodine contrast. This research was performed with physical experiments on the Doheny breast CT scanner, with different x-ray filters, x-ray tube voltages, and for different breast sizes.

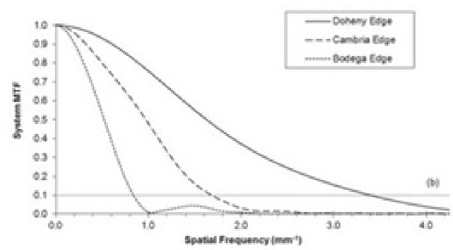
3. Ghazi P, Hernandez AM, Abbey C, Yang K, Boone JM. Shading artifact correction in breast CT using an interleaved deep learning segmentation and maximum likelihood polynomial fitting approach. Medical Physics 2019.



This study used a deep learning-based segmentation algorithm to segment adipose tissue from glandular tissue in breast CT data sets. Once the adipose tissue pixels were identified, the 3D second order polynomial was fit to the adipose tissues, and in the fit parameters were used to compute a smooth adipose background of the breast. This 3D background image was subtracted from the original reconstructed breast CT data, which removed any cooking artifact that may have been produced during image reconstruction. This sequence of algorithms proved to be quite useful in flattening the breast CT images. This procedure also would convert the average Hounsfield unit of adipose to zero, so spectral modeling was used to determine the most appropriate Hounsfield unit for adipose (-84 HU), and this was added to all voxels in the image to restore Hounsfield integrity.

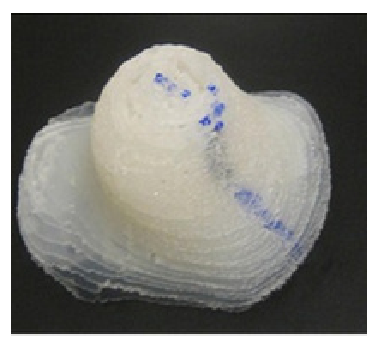
4. Gazi, Peymon M; Yang, Kai; Burkett Jr, George W; Aminololama-Shakeri, Shadi; Seibert, J Anthony; Boone, John M; Evolution of spatial resolution in breast CT at UC Davis. Med Phys 42(4): 1973-1981: 2015

This study used images from all four breast CT scanners designed and manufactured at UC Davis, and used pre-sampled MTF approach to compute the spatial resolution of these four breast CT scanners (Albion, Bodega, Cambria, and Doheny). The results demonstrate that the spatial resolution of this family of breast CT scanners improved markedly as the technology used in the scanners also improved.



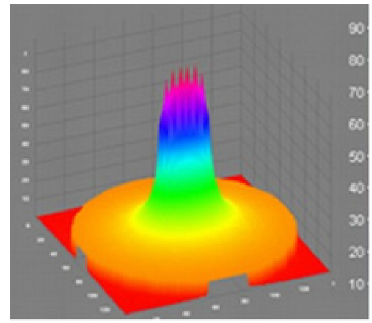
5. Prionas ND, Burkett GW, McKenney SE, Chen L, Stern RL, Boone JM. Development of a patient-specific two- compartment anthropomorphic breast phantom. Physics in Medicine and Biology. 2012;57(13):4293.

The development of the physical phantom which, when imaged on a breast CT scanner, produces realistic breast CT images is a challenge. Using the breast CT data set from a specific woman, computer-controlled machine commands were developed to produce such a phantom menace slice by slice manner. Polyethylene sheets with 0.53 mm thickness were cut using a waterjet device, and the sections of the breast corresponding to adipose tissue were cut out, leaving polyethylene sheets which can be stacked together-polyethylene is an excellent surrogate for adipose tissue in terms of x-ray contrast. The layers of this phantom work placed within a thermoplastic "skin", and the remaining air voids were filled with water-which has x-ray attenuation properties similar to glandular tissue in the breast. This phantom could be used to reproducibility generate realistic breast CT data sets, to test the performance (over time) of the breast CT systems.



6. Prionas ND, McKenney SE, Stern RL, Boone JM. Kilovoltage rotational external beam radiotherapy on a breast computed tomography platform: a feasibility study. International Journal of Radiation Oncology Biology Physics. 2012;84(2):533-9.

The prone-patient, pendant-breast geometry of breast CT may lend itself to developing a radiation therapy system which can treat breast cancer with rotational radiation therapy, which is known to yield highly conformal dose deposition. This study used both computer simulation and a physical phantom to demonstrate the potential of such a image guided radiation therapy system for rotational radiation therapy the breast.



7. Prionas ND, Huang S-Y, Boone JM. Experimentally determined spectral optimization for dedicated breast computed tomography. Medical Physics. 2011;38(2):646-55.

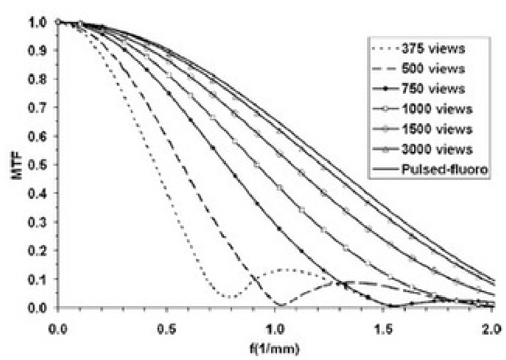
This was an earlier study which used a series of physical experiments using the bodega scanner with both adipose-glandular tissue and adipose/iodinated glandular tissue phantoms. The optimal x-ray technique factors (tube voltage and being filter, etc.) were developed for this breast CT system.

8. Boone JM, Yang K, Burkett GW, Packard NJ, Huang S-Y, Bowen S, et al. An x-ray computed tomography/positron emission tomography system designed specifically for breast imaging. Technology in Cancer Research & Treatment. 2010;9(1):29.

The Boone lab collaborated with UC Davis medical physicist specializing in positron emission tomography (PET) imaging to design, fabricate, and test a combined PET/CT system for dedicated breast imaging.

9. Wu Y, Bowen SL, Yang K, Packard N, Fu L, Burkett Jr G, et al. PET characteristics of a dedicated breast PET/CT scanner prototype. Physics in Medicine and Biology. 2009;54(13):4273.

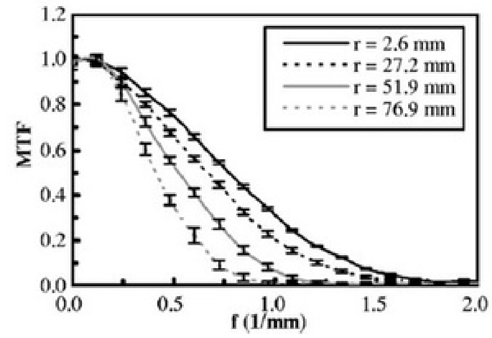
This study used physical experiments to measure the spatial resolution of all elements in the imaging chain of our breast CT scanner. These comprehensive studies then were used to model the spatial resolution of a breast CT scanner under different experimental systems (e.g. the number of projection image views acquired, shown in the figure). The study outlined some of the necessary design parameters required to produce high-quality breast CT scanner.



10. Yang K, Kwan AL, Boone JM. Computer modeling of the spatial resolution properties of a dedicated breast CT system. Medical Physics. 2007;34(6):2059-69.

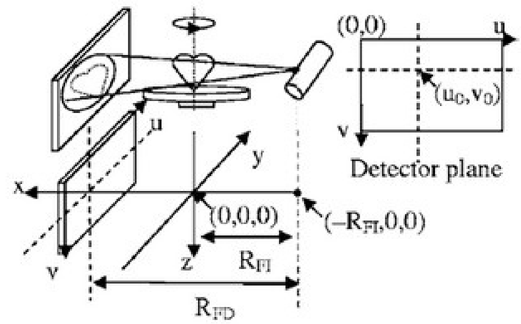
11. Kwan AL, Boone JM, Yang K, Huang S-Y. Evaluation of the spatial resolution characteristics of a cone-beam breast CT scanner. Medical Physics. 2007;34(1):275-81.

This study used physical measurements on the bodega scanner to measure spatial resolution at different radial distances from the scanner isocenter showing a degradation in the MTF towards the periphery of the field-of-view. This scanner used the continuous x-ray sources, and these measurements provided the necessary motivation to develop a pulsed x-ray system for breast CT.



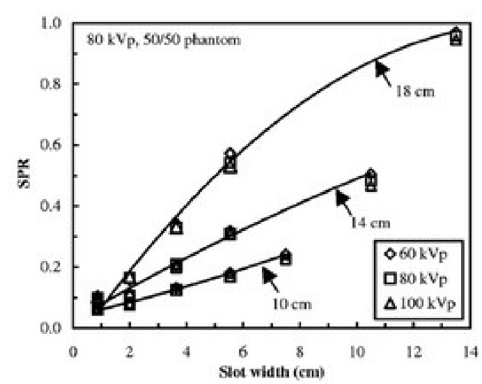
12. Yang K, Kwan AL, Miller DF, Boone JM. A geometric calibration method for cone beam CT systems. Medical Physics. 2006;33(6):1695-706.

The precise geometry of the breast CT hardware needs to exactly match the geometry of the reconstruction algorithm, and a calibration method was developed to measure a specific phantom, use associated analysis of that image data, and produce the exact relationship between the geometry of the scanner in the recon algorithm. This calibration leads to calibration file, used to reconstruct subsequent acquisitions accurately.



13. Kwan AL, Boone JM, Shah N. Evaluation of x-ray scatter properties in a dedicated cone-beam breast CT scanner. Medical Physics. 2005;32(9):2967-75.

This study used cylindrical phantoms of different diameters to evaluate the scatter to primary ratio (SPR) in the breast CT system, as a function of slot width, tube voltage, as well as other parameters. The results demonstrated expected performance, with a solid quantitative understanding of just how bad scattered radiation can be in the concise geometry of a breast CT scanner. The influence of the bow tie filter was also evaluated.



14. Boone JM, Kwan AL, Seibert JA, Shah N, Lindfors KK, Nelson TR. Technique factors and their relationship to radiation dose in pendant geometry breast CT. Medical Physics. 2005;32(12):3767-76.

This study was a computer simulation exercise which evaluated the x-ray technique factors necessary for imaging breasts of different size and glanularity. The key relationship between mammography compressed breast thickness and breast diameter in breast CT was determined. The data from this paper allowed comparisons of radiation dose between mammography and breast CT.

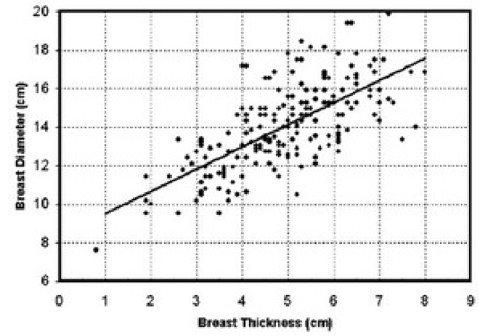
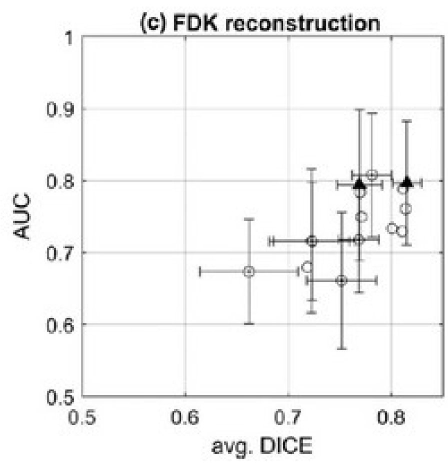


Image Processing in Breast CT

15. Lee J, Nishikawa RM, Reiser I, Boone JM. Neutrosophic segmentation of breast lesions for dedicated breast computed tomography. Journal of Medical Imaging. 2018;5(1):014505.

16. Lee J, Nishikawa RM, Reiser I, Boone JM. Relationship between computer segmentation performance and computer classification performance in breast CT: A simulation study using RGI segmentation and LDA classification. Medical Physics. 2018;45(8):3650-3656.

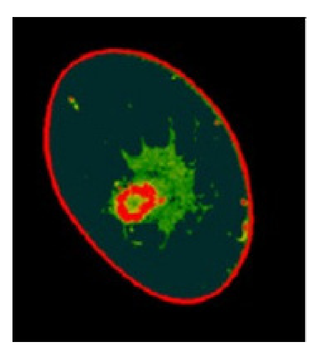
This study evaluated the segmentation performance of 85 lesions depending on the reconstruction method used. The AUC performance as a function of DICE coefficients (segmentation parameter) show a correlation, meaning that better segmentation is correlated with better detection (AUC) performance, for this study performed at University of Chicago. This study was part of our effort to study Computed Aided Diagnosis (CAD) with non-contrast breast CT. Chicago is the premier institution for breast CAD work.



17. Lee, J, Nishikawa, RM, Reiser, I, Boone, JM. Optimal reconstruction and quantitative image features for computer-aided diagnosis tools for breast CT. Medical Physics, 44(5): 1846-1856, 2017

18. Gazi, PM, Aminololama-Shakeri, S, Yang, K, Boone, JM. Temporal subtraction contrast-enhanced dedicated breast CT. Physics in Medicine and Biology, 61(17): 6322-46, 2016

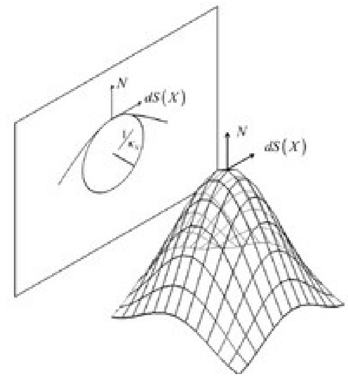
When both non-contrast and contrast enhanced breast CT images are acquired of the same breast, similar to the two-dimensional image subtraction used in digital subtraction angiography (DSA), the 3D breast CT data sets can be subtracted (contrast minus non- contrast) to reveal the lesion enhancement pattern. Given that several minutes of court between the non-contrast and contract imaging, patient motion needs to be corrected for proper subtraction. Here, we developed a deformable registration algorithm to accomplish this correction, with the subtracted image shown on the right.



18. Gazi, PM, Aminololama-Shakeri, S, Yang, K, Boone, JM. Temporal subtraction contrast-enhanced dedicated breast CT. Physics in Medicine and Biology, 61(17): 6322-46, 2016

19. Lee, Juhun; Nishikawa, Robert M; Reiser, Ingrid; Boone, John M; Lindfors, Karen K; Local curvature analysis for classifying breast tumors: Preliminary analysis in dedicated breast CT, Medical Physics 42(9):5479-5489; 2015

This study was related to computer aided diagnosis with colleagues from University of Chicago – the premier site for CAD in breast imaging. This paper showed how a normalized curvature measure contains useful information with respect to the benign / malignant status of a known lesion.



20. Kuo, Hsien-Chi; Giger, Maryellen L; Reiser, Ingrid; Drukker, Karen; Boone, John M; Lindfors, Karen K; Yang, Kai; Edwards, Alexandra; Impact of lesion segmentation metrics on computer-aided diagnosis/detection in breast computed tomography, Journal of Medical Imaging:1(3):031012-031012: 2014

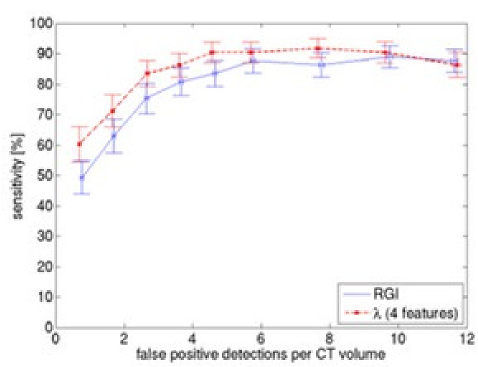
21. Yang, Kai; Burkett Jr, George; Boone, John M; A breast-specific, negligible-dose scatter correction technique for dedicated cone-beam breast CT: a physics-based approach to improve Hounsfield Unit accuracy, PMB 59(21); 6487: 2014

22. Kuo H-C, Giger ML, Reiser I, Drukker K, Boone JM, Lindfors KK, et al. Segmentation of breast masses on dedicated breast computed tomography and three-dimensional breast ultrasound images. Journal of Medical Imaging. 2014;1(1):014501-.

23. Kuo H-C, Giger ML, Reiser I, Boone JM, Lindfors KK, Yang K, et al. Level set segmentation of breast masses in contrast-enhanced dedicated breast CT and evaluation of stopping criteria. Journal of Digital Imaging. 2014;27(2):237-47.

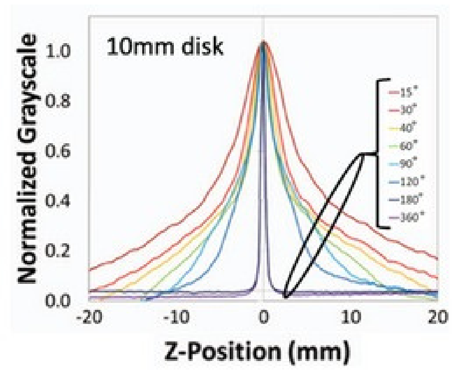
24. Reiser I, Nishikawa R, Giger M, Boone J, Lindfors K, Yang K. Automated detection of mass lesions in dedicated breast CT: A preliminary study. Medical Physics. 2012;39(2):866-73.

This paper evaluated the effectiveness of computer aided detection (CAD) algorithms for identifying suspicious breast lesions on breast CT images. A new metric called the radial gradient index (RGI) was compared to conventional features used in CAD, and the RGI was shown to improved detection performance.



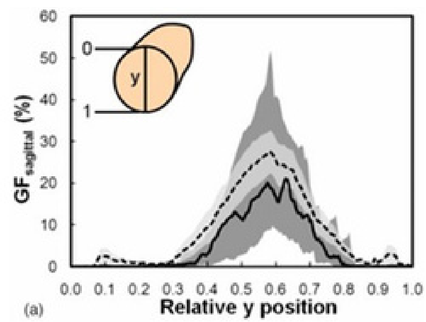
25. Nosratieh A, Yang K, Aminololama-Shakeri S, Boone JM. Comprehensive assessment of the slice sensitivity profiles in breast tomosynthesis and breast CT. Medical Physics. 2012;39(12):7254-61.

This study analyzed the slice thickness of tomosynthesis as a function of the tomographic angle, and showed that for standard tomosynthesis acquisitions of 15 degrees, that the slice thickness (determined as the FWHM) was about 8 mm –far thicker than that of breast CT (which has an acquisition angular range > 180 degrees. This explained in part why 'beta" was so high with tomosynthesis.



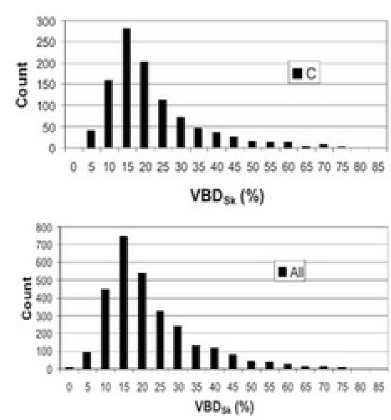
26. Huang S-Y, Boone JM, Yang K, Packard NJ, McKenney SE, Prionas ND, et al. The characterization of breast anatomical metrics using dedicated breast CT. Medical Physics. 2011;38(4):2180-91.

Breast CT images have provided insight on the 3D anatomy of the breast. In this study, the distribution of breast density in the breast was demonstrated quantitatively – showing quite dramatically that breast tissue is not a homogeneous mixture of adipose and glandular tissue, but rather glandular tissue is located more towards the center of the breast – consistent with the glandular structure and function of the breast.



27. Yaffe M, Boone J, Packard N, Alonzo-Proulx O, Huang S-Y, Peressotti C, et al. The myth of the 50-50 breast. Medical Physics. 2009;36(12):5437-43.

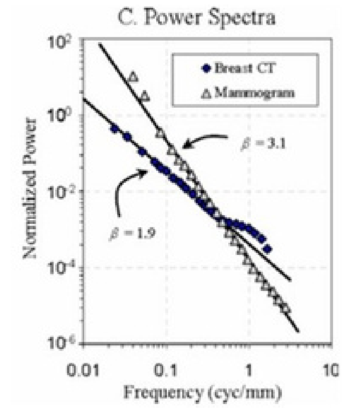
This study was in collaboration with Martin Yaffe's lab in Toronto, where breast CT data were used to validate their algorithm for breast density assessment on mammograms. This study showed that the median breast density was far lower than previously thought. Instead of the standard assumption of a median 50% glandular breast, this study showed that the median breast was 16% glandular. This has implications for breast dosimetry and this paper has led to the acceptance of a new assumption for breast density.



28. Nelson TR, Cerviño LI, Boone JM, Lindfors KK. Classification of breast computed tomography data. Medical Physics. 2008;35(3):1078-86.

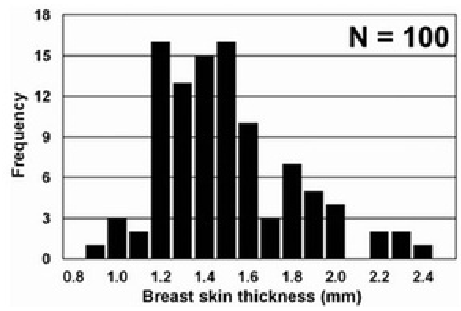
29. Metheany KG, Abbey CK, Packard N, Boone JM. Characterizing anatomical variability in breast CT images. Medical Physics. 2008;35(10):4685-94.

This study used the formulation of a power law for the noise power spectrum first developed by Burgess in his landmark paper. We evaluated the NPS on breast CT and corresponding mammogram images, and fit them to a function NPS(f) = alpha x exp(-beta x f). Beta becomes the slope of the curve when log scales are used, and we found beta ~ 3.1 for mammography, and beta ~ 1.9 for breast CT, where lower values of beta correspond to better lesion detectability.



30. Huang S-Y, Boone JM, Yang K, Kwan AL, Packard NJ. The effect of skin thickness determined using breast CT on mammographic dosimetry. Medical Physics. 2008;35(4):1199-206.

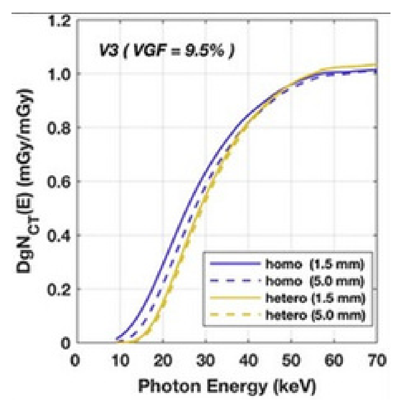
For two decades, Monte Carlo studies of radiation dose in breast imaging assumed that the skin was 4 or 5 mm thick. Breast CT images allowed direct visual assessment of skin thickness, not possible in mammography, and it was found that the average skin thickness was 1.5 mm, which changed dosimetry by about 20%.



Radiation Dosimetry

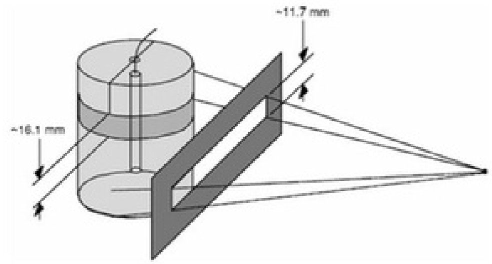
31. Hernandez AM, Becker AE, Boone JM. Updated breast CT dose coefficients (Dg NCT) using patient-derived breast shapes and heterogeneous fibroglandular distributions. Medical physics 2019;46:1455-1466.

Earlier evaluation of breast dosimetry assumed cylindrical breast shapes, but after the acquisition of 100's of breast CT data sets, the actual shape of the breast was used to compute radiation dose levels using Monte Carlo techniques for 5 different breast sizes. This study also used a new model (heterogenous versus homogeneous) for the distribution of anatomical tissue in the breast, also made possible with breast CT.



32. Boone J, Shah N, Nelson T. A comprehensive analysis of DgNCT coefficients for pendant-geometry cone-beam breast computed tomography. Medical Physics. 2004;31(2):226-35.

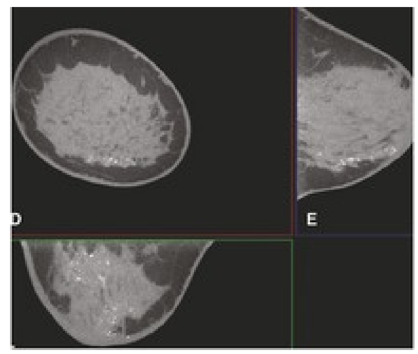
The radiation dosimetry for the geometry of pendent breast CT was never evaluated, and before patient studies could start we needed to estimate radiation dose. Monte Carlo studies assumed simple cylinders of various diameters (8-18 cm in diameter) were used to compute the newly defined DgNCT values for breast CT.



Clinical Studies

33. Dedicated breast CT: Getting ready for prime time, SA Shakeri and JM Boone, Journal of Breast Imaging 6:465-475 (2024)

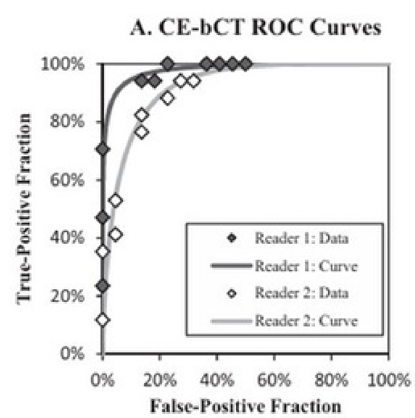
This was an invited paper from this journal which is focused on breast imaging. This was a radiologist's description to the radiologist audience of the characteristics of breast CT, in comparison to mammography and breast MRI. This paper also characterized the literature on breast CT studies and described the growing literature on the excellent performance of breast CT



34. Aminololama-Shakeri S, Abbey CK, López JE, et al. Conspicuity of suspicious breast lesions on contrast enhanced breast CT compared to digital breast tomosynthesis and mammography. The British journal of Radiology2019;92:20181034.

35. Aminololama-Shakeri, Shadi; Abbey, Craig K; Gazi, Peymon; Prionas, Nicolas D; Nosratieh, Anita; Li, Chin-Shang; Boone, John M; Lindfors, Karen K; Differentiation of ductal carcinoma in-situ from benign micro-calcifications by dedicated breast computed tomography, European Journal of Radiology 85(1): 297-303; 2016.

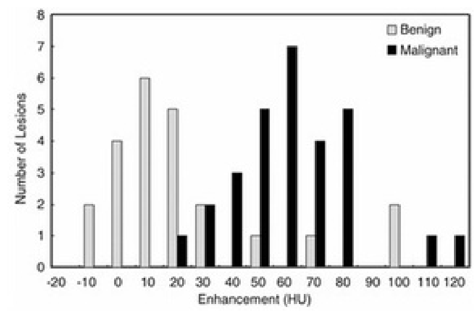
This paper focused on microcalcifications, and showed the important role of contrast enhancement for improving the diagnostic evaluate in breast CT for macrocalcifications. Two expert radiologist readers evaluated 39 lesions and their average reader performance was an area under the ROC curve (AUC) of 0.94, with some difference between each observer (as shown on the right). Contrast enhancement was key to delineating benign from malignant microcalcifications.



36. Prionas, ND; Aminololama-Shakeri, S; Yang, Ki; Martinez, SR; Lindfors, KK; Boone, JM, Contrast-enhanced dedicated breast CT detection of invasive breast cancer preceding mammographic diagnosis, Radiology Case Reports 10; 2015

37. Prionas ND, Lindfors KK, Ray S, Huang S-Y, Beckett LA, Monsky WL, et al. Contrast-enhanced Dedicated Breast CT: Initial Clinical Experience 1. Radiology. 2010;256(3):714-23.

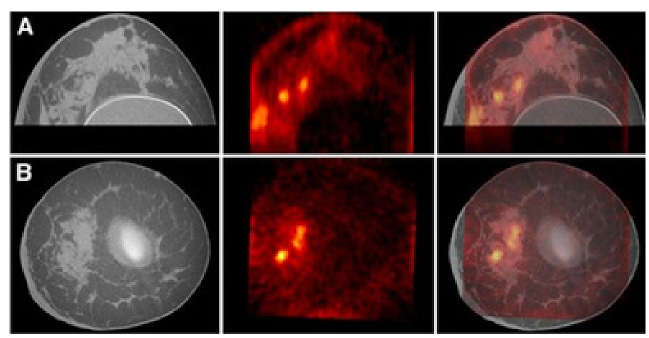
This key publication showed the diagnostic potential of “enhancement” of a lesion from the non-contrast setting to the contrast enhanced setting. The enhancement levels alone (see chart) led to an AUC of 0.87, even with no radiologist input. This study involved 54 lesions (25 benign, 29 malignant).



38. Lindfors KK, Boone JM, Newell MS, D'Orsi CJ. Dedicated breast computed tomography: the optimal cross- sectional imaging solution? Radiologic Clinics of North America. 2010;48(5):1043-54.

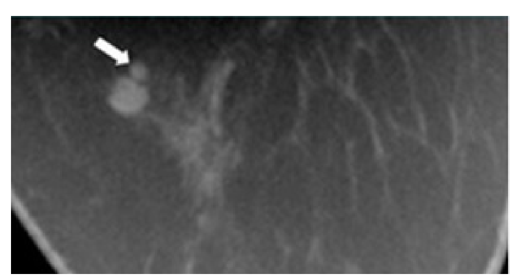
39. Bowen SL, Wu Y, Chaudhari AJ, Fu L, Packard NJ, Burkett GW, et al. Initial characterization of a dedicated breast PET/CT scanner during human imaging. Journal of Nuclear Medicine. 2009;50:1401-8.

This paper described the technology of the first dedicated breast PET/CT system built and used to image patients. The CT images and PET images were fiducially matched and the colorized PET images were overlayed onto the grey scale CT images, showing classic performance of PET/CT.



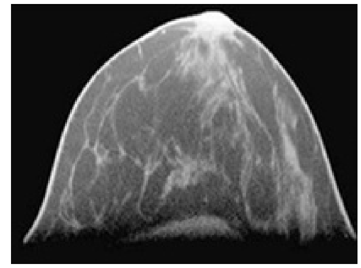
40. Lindfors KK, Boone JM, Nelson TR, Yang K, Kwan AL, Miller DF. Dedicated Breast CT: Initial Clinical Experience 1. Radiology. 2008;246(3):725-33.

This was our first clinical paper which described the performance of our dedicated breast CT system, after 79 women had been imaged on our first scanner (“Albion”).



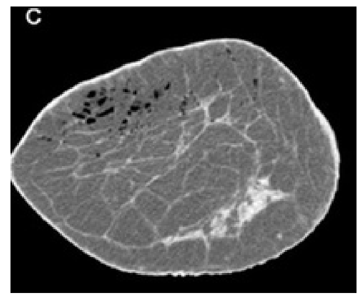
41. Boone JM, Kwan AL, Yang K, Burkett GW, Lindfors KK, Nelson TR. Computed tomography for imaging the breast. Journal of mammary gland biology and neoplasia. 2006;11(2):103-11.

This was an invited paper from this journal, where the imaging hardware, patient geometry and radiation dosimetry aspects of breast CT were introduced to the readers along with example breast CT images from patients.



42. Boone JM, Nelson TR, Lindfors KK, Seibert JA. Dedicated Breast CT: Radiation Dose and Image Quality Evaluation 1. Radiology. 2001;221(3):657-67.

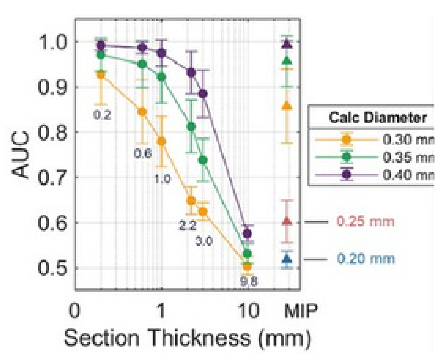
This was the first paper published in the peer-reviewed literature on the topic of cone-beam breast CT. In this paper, the image quality issues were addressed by scanning a cadaver breast in a clinical CT scanner, and radiation dose issue were evaluated to determine that breast CT could be performed at realistic radiation doses.



Model Observer Studies

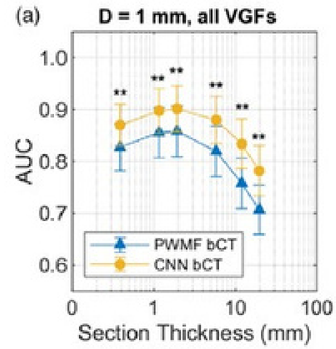
43. Lyu SH, Abbey CK, Hernandez AM, Boone JM. Microcalcification detectability in breast CT images using CNN observers. Med Phys. 51:933-945 (2024). https://doi.org/10.1002/mp.16922

This paper studied the role of a CNN computer observer in detecting microcalcifications of varying sizes (0.2 – 0.4 mm) in breast CT backgrounds. The AUC for various microcalcification diameters rapidly declined with breast section thickness, pointing to the superiority of breast CT over thicker images such as mammography. This paper also showed that the Maximum Intensity Projection (MIP) images performed on one image equivalent to a single thin slice CT image, which is not surprising.



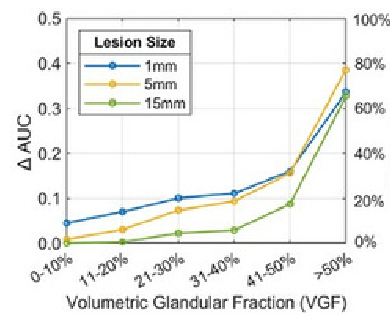
44. Lyu SH, Abbey CK, Hernandez AM, Boone JM. Pre-whitened matched filter and convolutional neural network- based model observer performance for mass lesion detection in non-contrast breast CT. Med Phys. 50:7558-7567 (2023) https://doi.org/10.1002/mp.16685

This paper demonstrated a comparison between two observer models: (1) a prewhitened matched filter (PWMF) and (2) a convolutional neural network (CNN), on the detectability of non-contrast mass lesions. The CNN significantly outperformed the PWMF for the 1 mm diameter lesions (see graph); performance peaked at about 2 mm slice thickness and then declined rapidly with further slice thickness (such as with mammography). The CNN outperformed the PWMF across other parameters such as breast density, and other lesion diameters.



45. SH Lyu, AM Hernandez, SA Shakeri, CK Abbey, JM Boone, Model Observer performance in contrast-enhanced breast CT: The influence of contrast concentration on lesion detectability, Med Phys 50;6748-6761 (2023)

We knew that contrast enhancement led to much better lesion conspicuity just from observing the W and WO breast CT images. This study used a prewhitened matched filter (PWMF) with modeled lesions to study the increase in AUC between non-con bCT and CE-bCT. CE-bCT produced an increase in AUC across all breast densities (see plot), but more so for denser breasts, and indeed for ≥5 mm lesions, the CE-bCT AUCs were essentially unity.

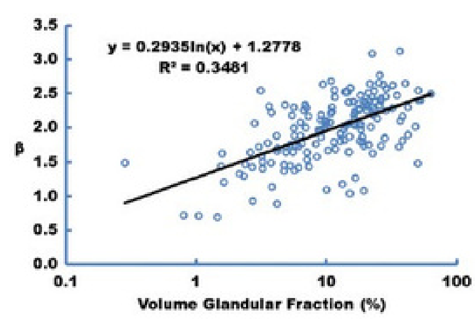


46. Chen, L; Boone, JM; Abbey, CK; Hargreaves, J; Bateni, C; Lindfors, KK; Yang, K; Nosratieh, A; Hernandez, A; Gazi, P; Simulated lesion, human observer performance comparison between thin-section dedicated breast CT images versus computed thick-section simulated projection images of the breast, Physics in medicine and biology 60(8): 3347: 2015

This study reported on human observer studies with simulated mass lesions (1-11 mm in diameter), where the average of 3 breast radiologist performance was AUC = 0.92 for thin section (breast CT) images and AUC = 0.67 for thicker images (43 mm). A gradual reduction in performance (AUC) was observed as the breast thickness increased. This study concluded that radiologists performed significantly better on thin section lesions compared to thicker breast images (“mammograms”).

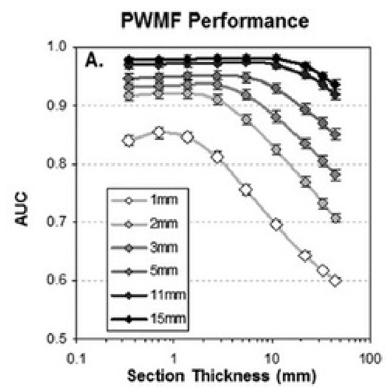
47. Chen L, Abbey CK, Boone JM. Association between power law coefficients of the anatomical noise power spectrum and lesion detectability in breast imaging modalities. Physics in Medicine and Biology. 2013;58(6):1663.

β is a metric which is the slope of the anatomical noise power spectrum. This paper showed the value of β are higher for projection images (“mammograms”) than for breast CT images, and lower values of β are known to be associated with higher detection rates. This paper also showed that dense breasts have higher β values, explaining why lesion detectability in dense breasts is low.



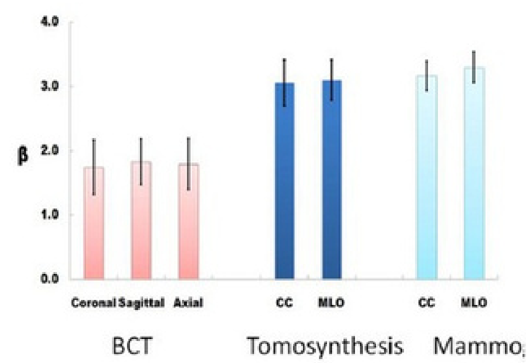
48. Packard NJ, Abbey CK, Yang K, Boone JM. Effect of slice thickness on detectability in breast CT using a prewhitened matched filter and simulated mass lesions. Medical Physics. 2012;39(4):1818-30.

This paper used 151 bilateral breast CT images with simulated spherical lesions placed into non-contrast breast CT background images, and developed a pre-whitened matched filter (PWMF) using 2000 lesions on each breast CT image and tested PWMF performance on 2000 different lesions (1000+, 1000- cases). Lesion diameters were 1, 2, 3, 5, 11 and 15 mm. Calculated AUC values were maximum for thin slice breast CT images, and were dramatically reduced for thicker breasts – especially for smaller lesions ≤5 mm



49. Chen L, Abbey CK, Nosratieh A, Lindfors KK, Boone JM. Anatomical complexity in breast parenchyma and its implications for optimal breast imaging strategies. Medical Physics. 2012;39(3):1435-41.

[Best paper of the year award]. This paper used the slope of the anatomical Noise Power Spectrum (β) and compared this metric across 23 women who underwent breast CT, mammography, and tomosynthesis imaging. The average β for breast CT was 1.79, while β for mammo was 3.17 and for tomo was 3.06, where lower values of β are known to correlate to better lesion detection performance.



Other Breast CT studies with other investigators outside of UC Davis

50. JJ Paultasso, M Caballo, M Mikerov, JM Boone, K Michielsen, et al, Deep learning for x-ray scatter correcion in dedicated breast CT, Medical Physics 50(4) (2023), Editor's Choice

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52. A Sarno, G Mettivier, K Bliznakova, AM Hernandez, JM Boone, P Russo, Comparisons of glandular breast does beween digital mammography, tomosynthesis, and breast CT based on anthropomorphic patient-derived breast phantoms, Physica Medica 2022:97, 50-58

53. M Caballa, AM Hernandez, SH Lyu, J Teuwen, RM Mann, B van Ginneken, JM Boone, I Sechopoulos, Computer-aided diagnosis of masses in breast computed tomography imaging: deep learning model with combined handcrafted and convolutional radiomic features, J Med Imaging 8(2): 24501 (2021)

54. A Sarno, G Mettivier, F de Franco, V Varallo, K Bliznakova, AM Hernandez, JM Boone, P Russo, Dataset of patient-derived digital breast phantoms for in-silico studies in breast computed tomography, digital breast tomosynthesis, and digital mammography, Medical Physics 48, 2021

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63. Kalender WA, Beister M, Boone JM, Kolditz D, Vollmar SV, Weigel MC. High-resolution spiral CT of the breast at very low dose: concept and feasibility considerations. European Radiology. 2012;22(1):1-8.

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66. Boone JM. Breast CT for Cancer Detection and Diagnosis. Australasian Physical & Engineering Sciences in Medicine. 2007;30(4):303.