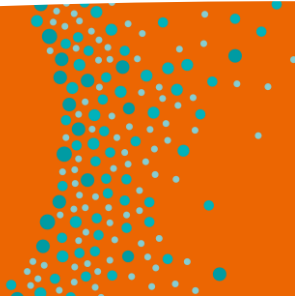


Siemens Digital Breast Tomosynthesis:

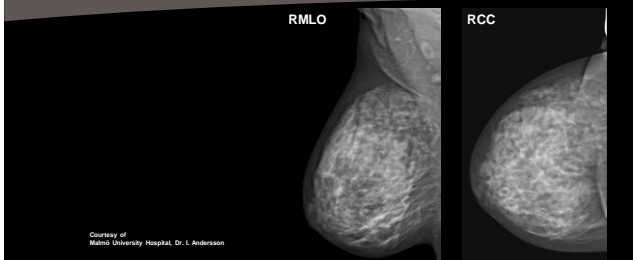
Design of a wide angle system & Quality Control



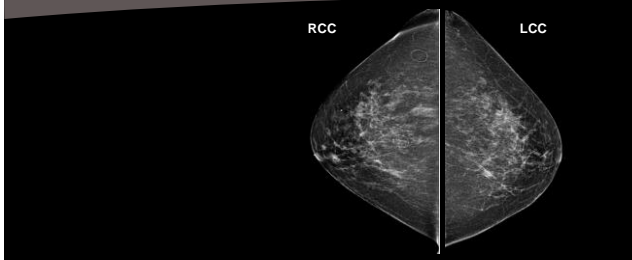
Mammography is not perfect

- **15-30% of cancers are missed at screening** (Bird 1992, Laming 2000)
- **Typical reasons**
 - Dense breast tissue - anatomical noise
 - Small or no attenuation difference – low or no contrast
 - Tumor growth pattern – diffuse cancer

FFDM limitations (where is the suspicious lesion?)



FFDM limitations (where is the suspicious lesion?)



Digital Breast Tomosynthesis: Why?

- Tomosynthesis reduces tissue overlap!
- Tomosynthesis reduces tissue overlap!
- Tomosynthesis reduces tissue overlap!
- Tomosynthesis reduces tissue overlap!

Digital Breast Tomosynthesis: How?

Multi-parameter problem

- > Angular range
- > Number of projections
- > X-ray spectrum optimization
- > Dose
- > Reconstruction method

Digital Breast Tomosynthesis: System Design Goal



Good compromise between

- Dose
- Noise
- Depth resolution
- Acquisition/compression time
- FoV (Field of View)

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Digital Breast Tomosynthesis: Prototype



- 2004 first prototype installed at Duke University



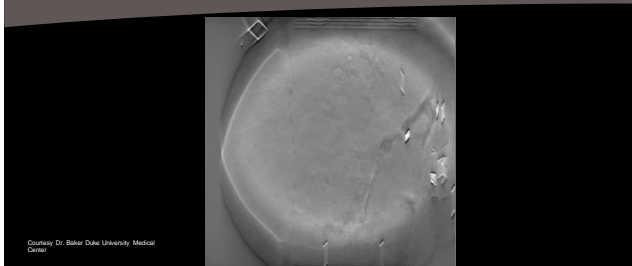
Proc. SPIE 5745, 529-540, 2005

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First Specimen slices



Courtesy Dr. Bahar Duke University Medical Center

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Digital Breast Tomosynthesis: System Design (angular range)



Large angular range...

- Increase depth resolution(z)
- Decrease slice thickness ("in focus")
- Reduces "out-of-plane" artifacts
- Improves contrast of low-frequency objects

but...

- Decreases FOV (stationary detector)
- Increase of acquisition/compression

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Digital Breast Tomosynthesis: System Design (Ball phantom angular range test)

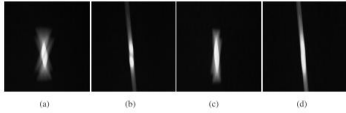


Fig. 2. Images of the two steel balls separated by 6 mm in x -direction. The scan direction is in y . (a) y -plane, $\pm 20^\circ$ angular range, (b) x -plane, $\pm 20^\circ$ angular range, (c) y -plane, $\pm 10^\circ$ angular range, (d) x -plane, $\pm 10^\circ$ angular range.

Optimization of Tomosynthesis Acquisition Parameters: Angular Range and Number of Projections
Thomas Kliewert et al. © 2016, SPIE, DOI: 10.1117/1.5461146, pp. 120-121, 2016
A 4-Page Paper, DOI: 10.1117/1.5461146, pp. 120-121, 2016
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Digital Breast Tomosynthesis: System Design (Number of projections)



More projections ...

- Decrease streak artifacts ("limited view artifacts")

but

- Reduces signal per projection (at constant total dose)
- Increases scan duration and therefore compression time

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Digital Breast Tomosynthesis: System Design (Clinical result of angular range/projections)

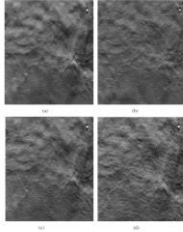
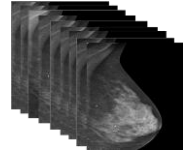


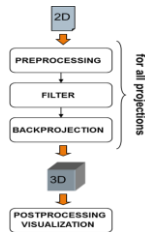
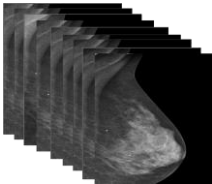
Fig. 6. Four views (ortho, cranio, medio, caudo) of a breast area, not 180° rotated. Fig. 7: 27 projections (90° step) of the same breast area, 180° rotated with an acquisition of 120°. (180° step) gives 9 projections with angle intervals of 120°.

Optimization of Tomosynthesis Acquisition Parameters: Angular Range and Number of Projections
Thomas Kliewert et al.
In: International Journal of Medical Physics and Clinical Oncology, pp. 220-231, 2008.
© Springer-Verlag Berlin Heidelberg 2008

Digital Breast Tomosynthesis: Development



Digital Breast Tomosynthesis: Development



Digital Breast Tomosynthesis Inspiration Clinically approved



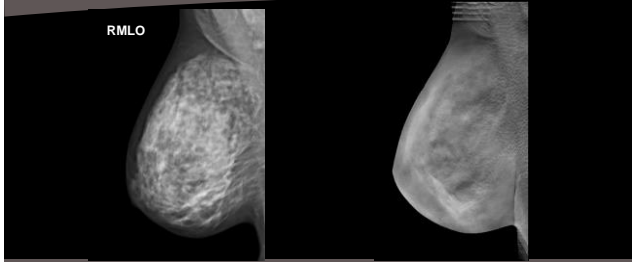
- > 50° sweep (continuous scan)
- > 25 projections
- > <25 seconds (scan time)
- > W/Rh only
- > Grid removed
- > a-Se detector (full resolution readout)
- > FBP reconstruction
- > 1mm slice separation

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FFDM limitations reduced with DBT

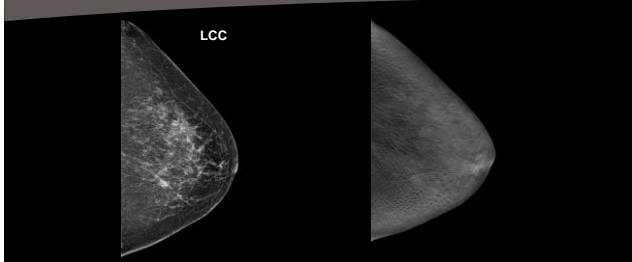


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FFDM limitations reduced with DBT



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DBT QUALITY CONTROL (QC)



Digital Breast Tomosynthesis: FDA Rules & Regulations

- Under MQSA, DBT is considered as three different modalities
- Per DMQS - 8 hours of training is required
<http://www.fda.gov/Radiation-EmittingProducts/MammographyQualityStandardsActandProgram/FacilityCertificationandInspection/ucm447869.htm>
- Facility must apply to FDA to have its certificate extended to include DBT. Also, it must already be an accredited facility.

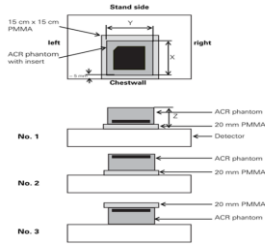
Digital Breast Tomosynthesis: QC manual

Current manual:

- VB30 or higher (v1)



Digital Breast Tomosynthesis: Test 2, Geometric accuracy and z-resolution

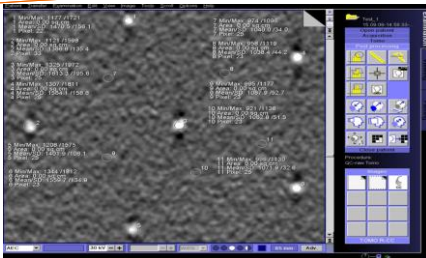


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Digital Breast Tomosynthesis: Test 2, Geometric accuracy and z-resolution (cont'd)



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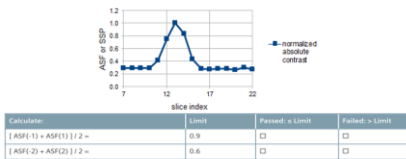
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Digital Breast Tomosynthesis: Test 2, Geometric accuracy and z-resolution (cont'd)



ASF-SSP for LMAM v2 without binning
low object position



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Digital Breast Tomosynthesis: Test 3, Radiation Field



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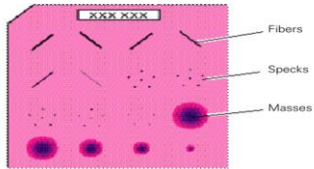
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Digital Breast Tomosynthesis: Test 4, Phantom Image Quality



- ≥ 4 Fibers
- ≥ 3 Specks
- ≥ 3 Masses



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Digital Breast Tomosynthesis: Test 5, Artifact Detection



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System Interface (GUI) tips



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Digital Breast Tomosynthesis: System interface (Precursor to DBT QC tests)

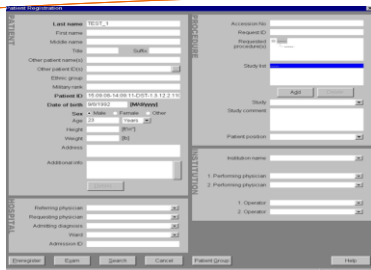


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Digital Breast Tomosynthesis: System interface (test registration)

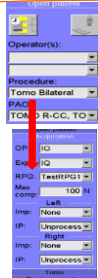


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Digital Breast Tomosynthesis: System interface (procedure/RPG) 



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Digital Breast Tomosynthesis: System interface (Acquisition settings) 



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Digital Breast Tomosynthesis: System interface (reconstruct/review) 



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