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
Digital Breast Tomosynthesis: Why?

- Digital Breast Tomosynthesis reduces tissue overlap!
- Digital Breast Tomosynthesis reduces tissue overlap!
- Digital Breast Tomosynthesis reduces tissue overlap!
- Digital Breast Tomosynthesis reduces tissue overlap!
- Digital Breast 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)

Digital Breast Tomosynthesis: Prototype

• 2004 first prototype installed at Duke University

First Specimen slices

Courtesy Dr. Baker Duke University Medical Center
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

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

More projections ...

- Decrease streak artifacts ("limited view artifacts")

but

- Reduces signal per projection (at constant total dose)
- Increases scan duration and therefore compression time
Digital Breast Tomosynthesis: System Design

Clinical result of angular range/projections

Digital Breast Tomosynthesis: Development

Optimization of Tomosynthesis Acquisition Parameters: Angular Range and Number of Projections

Thomas Mertelmeier et al.

© Springer-Verlag Berlin Heidelberg 2008
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

FFDM limitations reduced with DBT

FFDM limitations reduced with DBT
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: Calibration set

Digital Breast Tomosynthesis: QC Responsibility and Frequency

Only 5 tests for DBT

<table>
<thead>
<tr>
<th>Test</th>
<th>Annually</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Glandular dose</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>2. Sources and number of fields</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>3. Radiographic field</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>4. Phantom image quality</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>5. Artifact detection</td>
<td>NP</td>
<td>NP</td>
</tr>
<tr>
<td>NP</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>

T = Technologist

Digital Breast Tomosynthesis: Test 1, Average Glandular Dose (AGD)

![Diagram of test setup with detector and PMMA plate]

<table>
<thead>
<tr>
<th>Material/Portion of body</th>
<th>Test level (Overall ALR)</th>
<th>Average glandular dose (AGD) (Euk)}</th>
<th>Maximum Glandular Dose (Euk) (AGD)</th>
<th>ALR_{50.0}</th>
<th>Maximum value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAM</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>1.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Digital Breast Tomosynthesis: Test 2, Geometric accuracy and z-resolution

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

Digital Breast Tomosynthesis: Test 2, Geometric accuracy and z-resolution (cont’d)
Digital Breast Tomosynthesis: Test 3, Radiation Field

Digital Breast Tomosynthesis: Test 4, Phantom Image Quality
- ≥ 4 Fibers
- ≥ 3 Specks
- ≥ 3 Masses

Digital Breast Tomosynthesis: Test 5, Artifact Detection
System Interface (GUI) tips

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

Digital Breast Tomosynthesis: System interface (test registration)
Digital Breast Tomosynthesis: System interface (procedure/RPG)

Digital Breast Tomosynthesis: System interface (Acquisition settings)

Digital Breast Tomosynthesis: System interface (reconstruct/review)
Digital Breast Tomosynthesis: System interface (Closing exam)

Thank you!