

Stony Brook Medicine DEPARTMENT OF RADIOLOGY

## Assessing Image Quality

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Digital Radiological Imaging Laboratory

### Breast Tomosynthesis

- Limited angular range: 11~60°
- Slice thickness: 1mm
- Total Dose: ~1 - 2 times screening mammogram
- Screening/diagnosis
- Less compression
- Fast clinical transition

### Different DBT System Design

Company	System Design	View #	Detector	Recon
GE	±12.5°, step/shoot	9	CsI/a-Si, 100 μm	iterative
Planmed	±15°, continuous	15	CsI/a-Si, 83 μm	iterative
Fuji	±7.5°/±20°, continuous	15	a-Se, 68 μm hex	FBP
Hologic	±7.5, continuous	15	a-Se, 70 μm 2x2 binning	FBP
Siemens	±25°, continuous	25	a-Se, 85 μm	FBP
IMS Giotto	±20°, step/shoot	13	a-Se, 85 μm	iterative
Philips Microdose	±5.5°, continuous		Si counting, 21 slit, 50 μm	iterative

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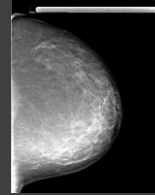
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### Factors Affecting Image Quality

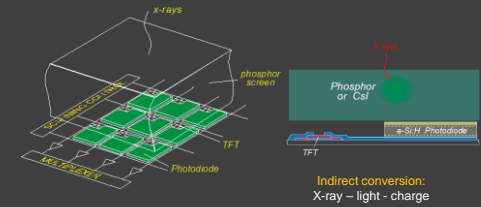
- **Detector performance**
  - DQE at low dose:  $1/N_{VIEW}$
  - Temporal performance: lag and ghosting
- **Imaging system design**
  - Focal spot blur: continuous tube travel
  - Geometric blur: Oblique entry of x-rays
  - Angular range, number of views
- **Reconstruction algorithm**
  - Analytical: FBP (filter design)
  - Iterative

### Projection Image Quality

- **Low dose:** (1/N views)
  - Electronic noise effect
- **Fast acquisition:**
  - Lag and ghosting: Image artifacts
  - Pixel binning (2x2)



### Detector physics: Flat panel detectors




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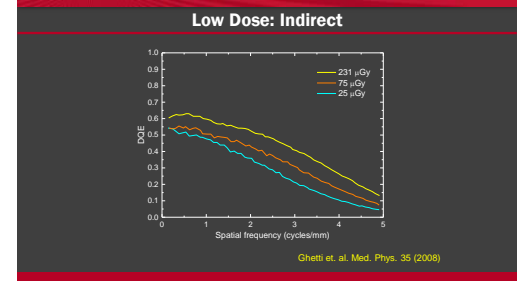
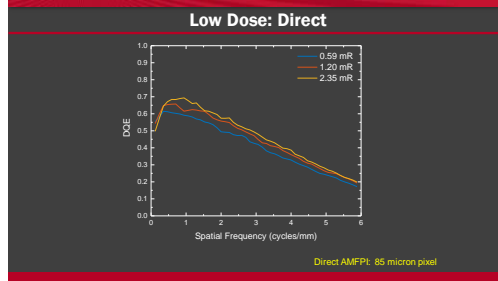
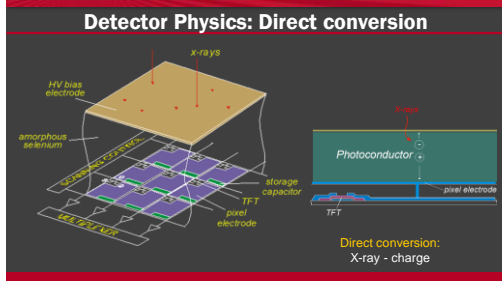
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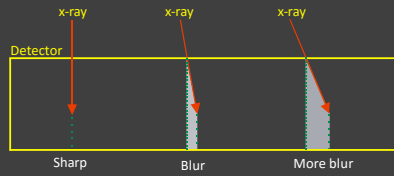
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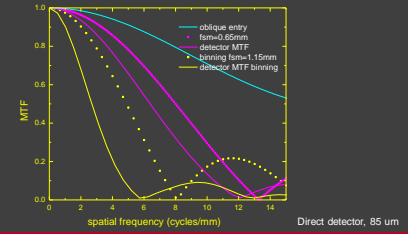
**Physics: Projection Images**

- Detector performance
- Tomo acquisition cause additional blur
  - Moving focal spot:
    - Continuous tube motion during exposure
    - Gantry speed, x-ray pulse width: motion ~1 mm
  - Oblique entry of x-rays

**Resolution: Oblique Entry of X-rays**



**2D: Projection Image Resolution**




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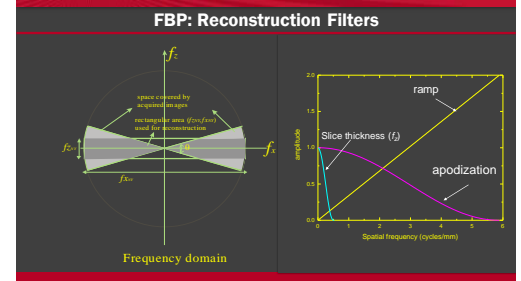
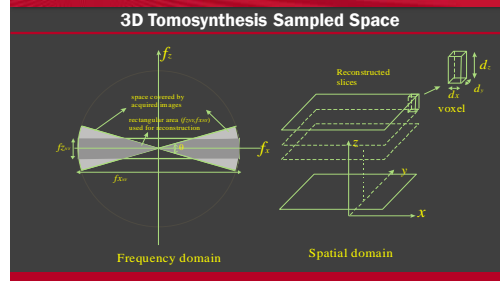
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**Image Quality: 3D tomo slices**

- Central slice theorem: 2D - 3D
- Angular range: Resolution, artifact
- Reconstruction algorithm: FBP, iterative




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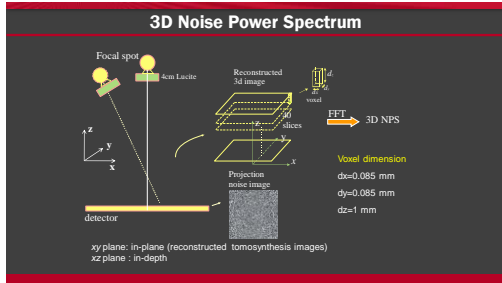
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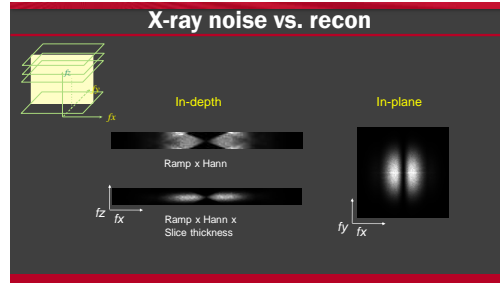
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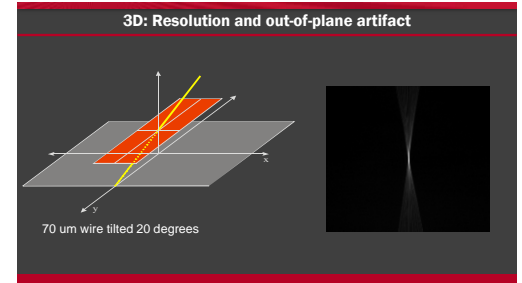
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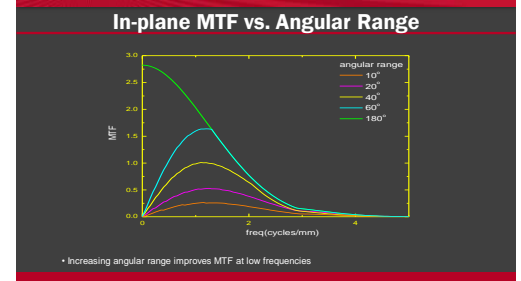
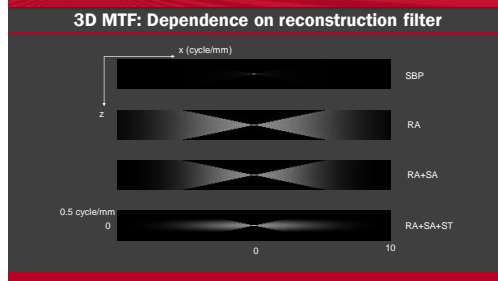
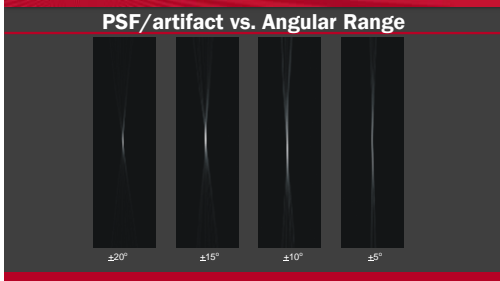
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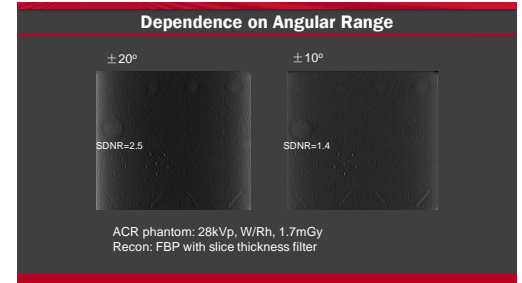
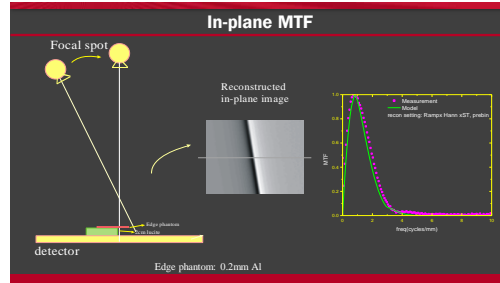
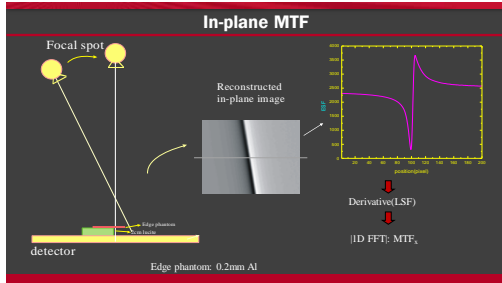
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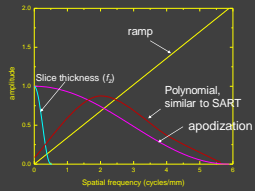
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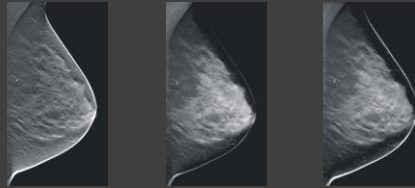
### Reconstruction filter designs

- **Ramp + limited angle:** loss of low frequency (breast density)
- **Modified filters:** recovers density, but increased out-of-plane blur
- **Iterative recon:** improvement at the cost of computation



J. Zhou et al. Med. Phys. 2007; Ludwig et al. IWDM2008; B. Ren et al. SPIE 2008

### Reconstruction filter comparison



Adapted from Ludwig et al. (IWDM 2008)

### Quality Control of DBT Systems

- Several QC protocols under development and testing
  - EUREF
  - TMIST
  - AAPM TG245
  - IEC
  - ACR
- Phantom design for image quality assessment in QC

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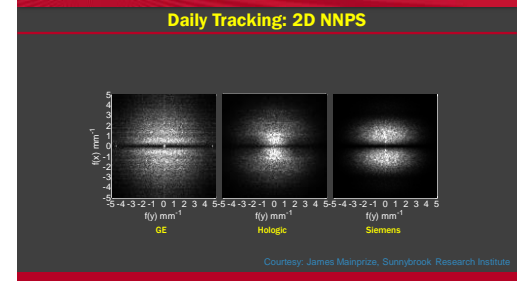
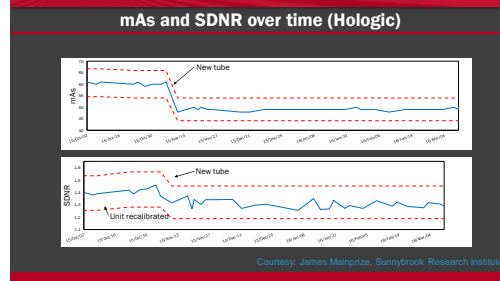
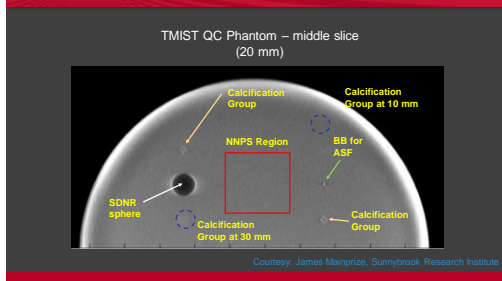
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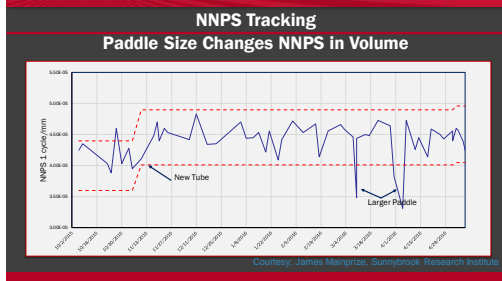
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


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### QC Phantoms tested by TG245

- PhantomLab TomoPhan
- CIRS DBT QC Phantom



Update of AAPM TG 245  
WE-DE-2078-S  
Wednesday at 10:55  
(Room 207B)



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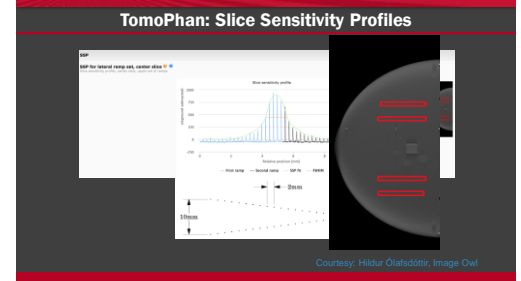
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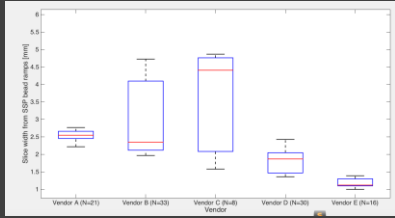
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### SSP versus System Design



Courtesy: Hilar Clascador, Image Owl

### Summary

- Assessing Image Quality: Projection to 3D
  - 2D projection images: low-dose performance
  - 3D reconstructed slices: resolution, artifact, noise
- Impact of Imaging geometry and reconstruction
  - Acquisition: angular range, focal spot motion
  - Reconstruction: filter design
- Quality control: Phantom design and features
  - Monitor image quality during daily operation

### Acknowledgements

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  - Bo Zhao, Y. Hu, David Scaduto, S. Burleson, H. Huang
- Funding sources:
  - Siemens Healthcare
  - NIH 1 R01 CA148053

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