Optimizing configuration parameters of a stationary digital breast tomosynthesis system based on carbon nanotube x-ray sources

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**Goal:**
Determine optimal configuration parameters of the stationary digital breast tomosynthesis (s-DBT) system

**Parameters:**
- Number of Projection Images
  - 29 or 15
- Total Angular Coverage
  - 28° or 14°
- Dose Distribution Across Projections
  - Uniform or Non-uniform
- Total Dose
  - 60 mAs, 80 mAs, 100 mAs or 120 mAs

**Methods:**
- Four groups of configurations were analyzed. In each group only one of the four different parameters was varied.
- Two phantoms were imaged: the ACR mammography accreditation phantom and a 0.05 micron diameter tungsten wire with a thickness of 2 mm.
- Each configuration was analyzed based on its Artifact Spread Function (ASF), Signal Difference to Noise Ratio (SdNR), Modulation Transfer Function (MTF), and overall Quality Factor (QF).

**MTF:**
- Using the reconstruction images of the line wire phantom, an oversized line spread function (LSF) was modeled.
- The Fourier Transform of the LSF was used as the MTF.
- The value of the MTF at 10% was used to evaluate the in-plane resolution of the configuration.

**ASF:**
- Using reconstructions of the ACR phantom the ASF was determined.
- The width of the ASF at 50% of the largest speck cluster (0.54 mm) was used to evaluate z-axis resolution.

**SdNR:**
- The SdNR of the largest mass in the ACR phantom (2 mm) was used to evaluate in-plane contrast.

**Results:**
Using a different number of projection images over the same total angular coverage, 28°, did not have a significant effect on the image reconstruction quality. A slightly higher QF was found for 15 projections compared to 29 projections.

From the plot above it can be seen that as the total angular coverage increased the width of the ASF decreased. Configurations with a larger angular coverage have a higher QF. Varying the dose distribution from an even distribution across all projections resulted in a slight decrease in SdNR.

As expected, a higher total dose resulted in an increased SdNR which in turn resulted in a higher QF. However, in order to reduce the amount absorbed radiation dose given to the patient, the total dose should depend on the tissue composition and the thickness of the object.

**Advantages of s-DBT over rotating DBT**
- No motion blurring of the focal spot
- Mechanical Stability
- Faster procedure times with increased angular range
- Capable of using higher radiographic magnification without a large loss in spatial resolution

**S-DBT Specifications**
- 31 x-ray generating focal spots
- 30 degree total angular span
- 45 mA maximum tube current
- 50 kVp maximum tube potential
- Tungsten anode
- 1 mm thick aluminum window
- X-ray spectrum which mimics the Hologic Selenia Dimensions
- Reconstruction is completed using a back-projection filtering method developed by Real Time Tomography LLC.

**Conclusions:**
- It was found that a configuration with a large angular span, an intermittent number of projection views, and an even dose distribution resulted in the best overall image quality.
- In the s-DBT system, the MTF is dominated by factors other than the configuration parameters.

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