Scanning-beam digital x-ray (SBDX) is an inverse geometry x-ray fluoroscopic system using a sequentially illuminated array of focal spot positions, CdTe photon-counting detector array, and real-time image reconstructor. The system design substantially improves the dose efficiency of fluoroscopy by minimizing image degrading x-ray scatter, maintaining high primary detection efficiency at high kVp, and increasing entrance field area. SBDX also has a unique real-time tomosynthesis capability that enables 3D catheter tracking, fiducial tracking, and 3D vessel dimension analysis during procedures. Recently, image intensity equalization via adaptive reduction of beam-on time in more transmissive patient regions has been investigated.

These advanced fluoroscopic capabilities stem from a radically different x-ray source design. SBDX has a large-area transmission-style tungsten target bonded to a water-cooled beryllium plate. A multihole collimator positioned beyond the target defines a series of narrow overlapping x-ray beams. As the focal spot is electronically deflected from one collimator hole to the next, detector images are simultaneously acquired. Images of the scanning field-of-view are reconstructed in real time at up to 30 Hz. Design challenges include achieving sufficient x-ray source output, fast readout rates in the detector, and the need for real-time image reconstruction.

This lecture will present the principles of the SBDX system and inverse geometry fluoroscopy. Applications of SBDX tomosynthesis and techniques used to increase signal-to-noise ratio and reduce heat loading in the x-ray source will be discussed.

This research was supported by NIH Grant R01 HL084022, NovaRay Medical, Inc., and Triple Ring Technologies, Inc.

Learning Objectives:

1. Understand how inverse geometry x-ray fluoroscopy design improves dose efficiency
2. Understand the operating principles of the scanning-beam digital x-ray system
3. Understand applications of real-time tomosynthesis in fluoroscopically-guided procedures