Purpose: Image guidance system such as the one used in Cyberknife or Brainlab ExacTrac, utilizes two x-ray sources underground, which generates a pair of 2D orthogonal images for target localization. This work investigates the feasibility of bringing 3D or 4D imaging into such environment.

Methods: The x-ray sources in a Cyberknife room are replaced with scanning x-ray tubes, in which an electron beam is electromagnetically scanned across a 25cm x 25cm transmission target located behind a collimator. The collimator restricts the emerging x-ray photons to those directed towards the detector. The system is simulated to generate a series of orthogonal 2D projections, and a fully 3D reconstruction algorithm is developed using the total variation (TV) technique. Parameters such as the source-to-axis distance, the source-to-detector distance, the electron beam scanning pitch, and the detector resolution are varied to study their impacts on the image quality.

Results: As the electron beam scanning across the transmission target, a moving x-ray source is formulated. With as few as 25 paired projections, a 3D image can be reconstructed. It is found that the image quality increases to a certain degree when finer scanning pitch is used. The image quality also increases as the distance between the x-ray source and the isocenter decreases, significantly, however the field of view (FOV) is reduced. The maximum FOV is about 16 cm under current setup. Using high detector resolution can also improve the image quality.

Conclusions: With scanning beam technology, it is possible to obtain volumetric images for fixed x-ray imaging systems (i.e. without gantry moving). The image quality is comparable to the current on-board cone-beam CT used in the treatment room, however the FOV is limited and the image reconstruction time is relatively long.