

**Purpose:** The image quality of cone beam CT (CBCT) is significantly inferior to that of diagnostic CT systems. The major problems of CBCT systems include excessive scatter, inferior detector performance, data truncation and approximate cone reconstruction. Its inferior image quality hinders the implementation of advanced IGRT treatment techniques, such as online and offline adaptive radiation treatment (ART). We are developing a novel tetrahedron beam computed tomography (TBCT) system which can significantly improve online image quality, thereby increasing the precision of radiation treatments.

**Method:** A multiple pixel x-ray source may allow novel imaging systems with improved image quality, reduced x-ray exposure and lower cost. With a single rotation, the volumes enclosed by a cone (pyramid) and tetrahedron are exactly the same. Hence a volumetric CT scan can also be achieved by rotating a tetrahedron, which is formed by a linear x-ray source array and a linear detector array orthogonal to each other. In TBCT, scatter photons are mostly rejected thanks to the fan beam geometry. Image quality is further improved by the use of a high quality solid-state CT detector. Approximate FDK cone reconstruction artifacts can be mitigated using iterative image reconstruction algorithms.

**Results:** A TBCT benchtop system has been developed using a 75 pixel x-ray tube and an in-house developed CT detector array. An iterative image reconstruction algorithm has been developed. The system produced excellent CT images which are superior to that of commercial CBCT scanners and close to that of diagnostic CT scanners.

**Conclusion:** TBCT is able to produce image quality close to that of diagnostic CT scanners. Clinical implementation of TBCT in IGRT can improve the precision of radiation treatments. Due to its superior image quality and compact geometry, c-arm TBCT can also possibly be used as low-cost, mobile diagnostic CT scanners.