

SUPER-RESOLUTION DENTAL TETRAHEDRON BEAM COMPUTED TOMOGRAPHY (TBCT) SYSTEM IMPROVES IMAGE QUALITY WITHOUT SACRIFICING SPEED FOR EXPANDED CLINICAL APPLICATIONS

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Current cone beam computed tomography (CBCT) systems lack concurrent high-resolution imaging and speed

With current digital CBCT imaging technology, x-ray tube power limitations mean high-resolution images can only be achieved by reducing imaging speeds. In dental applications, CBCT suffers from image degradation via excessive scattering, limited soft-tissue contrast, and dental artifact prominence. Low-resolution images are typical due to limitations of the x-ray focal spot, detector pixel size, and gantry motion blurring. There is a need for high-performance technology that removes these constraints to expand the use of CBCT in clinical applications for more efficient and effective dental care.

Tetrahedron beam computed tomography (TBCT) technology offers high-speed, super-resolution imaging for advanced dental treatment applications

This system introduces hardware and algorithm innovations to alleviate the limitations of CBCT. The result: an office-based, 3D imaging system capable of producing super-resolution images at high speed, while decreasing dental artifact presence and lowering radiation exposure. This will improve the quality of complex procedures in several fields of dentistry, such as prosthodontics, endodontics, periodontics, orthodontics, and pre-surgical planning. TBCT is a super-resolution micro-CT using a new, multi-pixel x-ray source and a time-delay-integration detector. It is capable of freezing source motion with a linear array wobbling microfocus x-ray (LAWMFX) source and detector motion via a time-delay-integration (TDI), both in unison with gantry motion. These techniques, along with an iterative image reconstruction algorithm, create the super-resolution images. Additionally, the linear array wobbling microfocus x-ray can diffuse heat on the target surface to allow for faster imaging.

Solution Advantages

- **Higher resolution:** The system's design synchronizes focal spot motion, freezes residual motion with a powerful time-delay detector, and uses an advanced iterative image reconstruction algorithm to produce a super-resolution image.
- **Faster:** The unique, heat-dissipating design of the LAWMFx allows faster projection measurements due to the x-ray source's sequential scanning process at each projection angle and reduction of the focal spot's travel distance.
- **Fewer artifacts:** Using new photon-counting detector technology, this system reduces metal

artifact appearance and allows CT image reconstruction free of beam hardening artifacts.

- **Lower radiation exposure:** This system uses compact fan beam geometry to prevent scattering along with a photon counting detector to reduce noise, leading to a reduction in radiation exposure.
- **Less expensive:** TBCT is projected to cost the same as CBCT yet offers significantly better performance.

Potential Applications

- Dental procedures in the fields of prosthodontics, endodontics, periodontics, orthodontics, and pre-surgical planning
- Study of bones, teeth, tissue/organs, composite materials, medical devices, batteries and other items that need to be evaluated at a very fine resolution.
- Aerospace and defense industries (e.g., industrial applications needing non-destructive imaging).
- Automotive industry
- Electronics industry
- Food industry (e.g., detecting foreign bodies at production facilities)

Patents

The following patent application has published: [US20230141925A1](https://www.uspto.gov/patents/apply/patent-application-number-US20230141925A1)