Arineta's Proprietary Cardiac CT Technology

Scope

This paper describes some of the Arineta Ltd. proprietary technologies developed for use in cardiac CT scanning.

The purpose of these technologies is to provide high performance, dose efficient and cost effective solutions for heart imaging.

Focused Field of View

Conventional medical CT scanners are designed to image from single organs to a whole body and cover field of view (FOV) of typically 450 to 500mm diameter. As a result, even if only a single organ such as the heart needs to be imaged, the whole thorax is irradiated. In comparison, a cardiac cath lab typically uses a small side detector (e.g. 20cmx20cm) and the imaging field is limited to the heart.

Fig. 1 is a schematic presentation of the FOV in conventional scanner compared to the desired FOV for cardiac scanning. In either case, the FOV is the cylindrical extent covered by the scanner and is defined by the x ray beam collimation and the space covered by the detector. The limited FOV in the right side of Fig. 1 is associated with lower radiation dose to the patient.

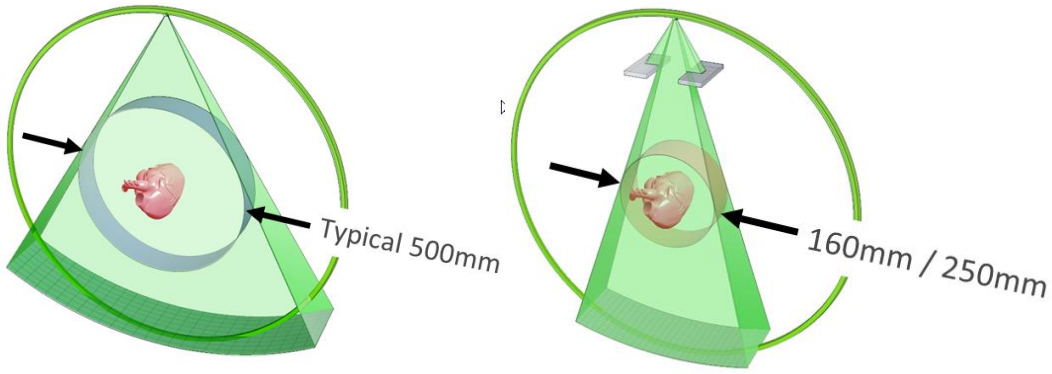

Fig. 1: Scan FOV in conventional CT (left) and desired FOV in cardiac CT (right)

However, unlike projection angiography imaging, in CT the body parts outside the FOV still affect the image in the center FOV. Therefore, simple beam truncation as shown in Fig. 1 (right) does not yield good results. This is resolved in the Arineta scanner by using full beam intensity in the FOV of interest and highly attenuated beam in the peripheral parts of the patient (Fig. 2). The patented configuration comprises two types of detector arrays: high resolution array in the focused FOV and peripheral detector arrays optimized for low intensity imaging at the wings. Special algorithms are used to reconstruct the images in the FOV at the center.

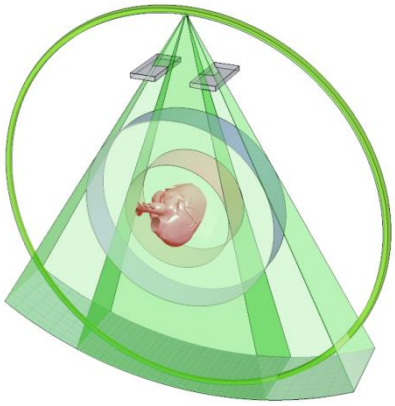

Fig. 2: Focused FOV with attenuated peripheral beams

The focused FOV design provides several advantages:

- Reduced radiation dose
- Image reading is focused on the organ of interest, e.g. heart
- Reduced cost

Twin Beam Technology

The heart perpetual motion presents a challenge in cardiac imaging. Best results are obtained by capturing the whole heart in a single phase of a single heartbeat. This is conventionally done by wide cone beam scanners with detector arrays sufficiently wide to cover the whole heart in a single shot (Fig. 3).

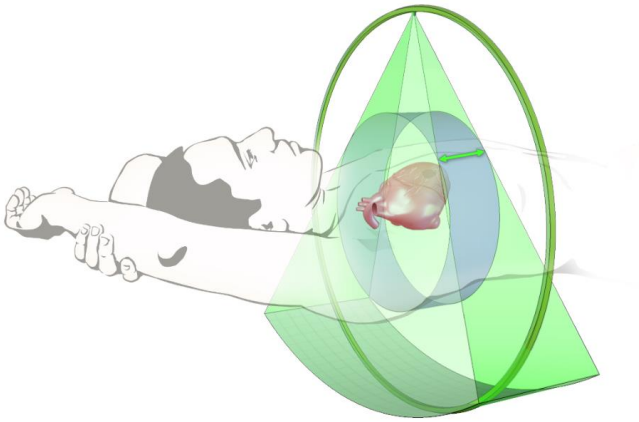

Fig. 3: Cone beam scanning of the heart

While this approach provides good results compared to scanners with narrower cone beams, it has certain disadvantages:

- Wide cone beam dose utility is less than optimal

- The wider the beam is, more cone beam image artifacts are present in the images
- The large area detector is expensive

Arineta has developed a unique Twin Beam technology involving two overlapping x ray beams irradiating the scanned volume and detected both by a single detector (Fig. 4). The technology involves unique X ray sources, ultra-fast beam switching technology and unique reconstruction algorithms that optimize image quality for this geometry.

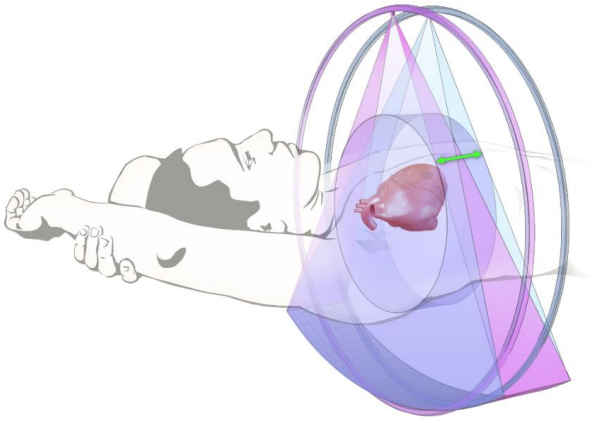

Fig. 4: Twin Beam heart scanning

The Twin Beam architecture has several advantages over single cone beam geometry:

- Better dose utility
- Eliminates cone beam artifacts
- For equal coverage, less wide and less expensive detector

The improved image quality is demonstrated in Fig. 5. Simulated phantom data are reconstructed to images in single cone beam and Twin Beam geometries. The cone beam artifacts present in the single cone beam image is eliminated with the Twin Beams.

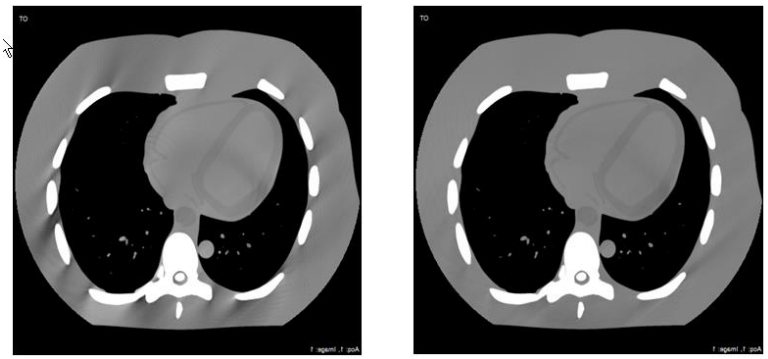

Fig. 5: Single cone beam (left) and Twin Beam (right) simulated phantom images.

Fig. 6 is a schematic presentation of the combined Focused FOV and Twin Beam technologies implemented in a single machine:

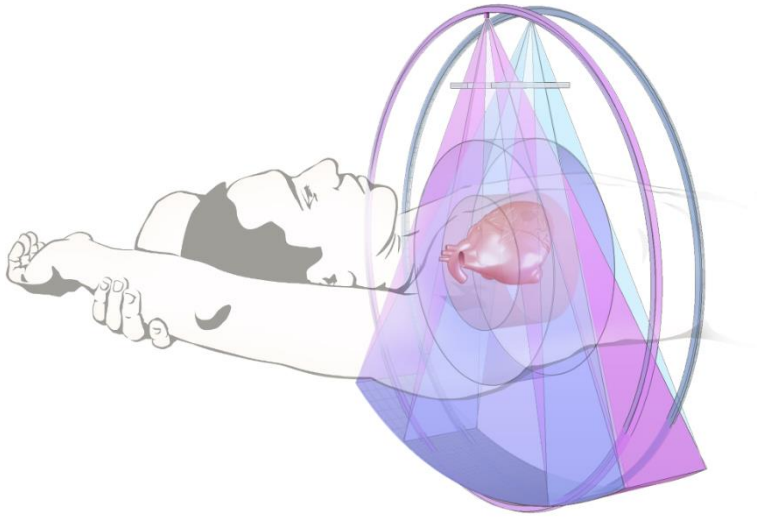

Fig. 6: Beam geometry in a cardiac dedicated CT

Ultra Short Geometry

Ultra Short Geometry refers to CT scanner architecture wherein the x ray source (twin sources in the present case) is substantially closer to the patient than in conventional CT design. This is enabled by proper design of the x ray source(s) and beam(s) collimation unit.

Ultra Short geometry presents several advantages:

- For a given generator power, the x ray photons flux at the patient increases by approximately 50%. Therefore, less power is needed to run the machine
- The overall machine size is smaller and it can fit in a smaller room
- The machine is easier to rotate fast, improving temporal resolution