Purpose:
Cone beam CT (CBCT) image quality and volumetric coverage are very important for patient treatments. LINAC -mounted CBCT (Varian Trilogy) has limited 17 cm longitudinal coverage, not enough for many clinical sites including head-neck. CBCT also suffers from poor image quality especially in the most superior and inferior slices. These problems hold back the usage of CBCT in many quantitative studies, including tumor response evaluation and daily dose computation. In this study, we evaluated a new idea of flexible X-ray source trajectory CBCT to overcome these limitations.

Methods:
The core concept is to combine gantry rotation with simultaneous couch motion during CBCT acquisition. Longitudinal coverage can therefore be extended without interruption. Image quality can be enhanced by improving the image reconstruction algorithms which supports the flexible imaging-trajectory utilizing all the projection data.
To test these new ideas, we implemented CBCT simulation software tools to compute the projection images of digital phantoms according to any flexible source trajectories. We improved the FDK algorithm to reconstruct images from the simulation projection data.

Results:
We studied a few different source trajectory models including double circle and helical. The initial results were encouraging. The longitudinal coverage was extended. Image quality has been improved even with simple FDK reconstruction algorithm, comparing to multiple individual scans with a couch shift in-between.

Conclusions:
We are still at the beginning of the project. It is quite clear that the new CBCT method has great potential. We are developing better reconstruction algorithms to fully take advantages of the new methods for image quality improvement. We are optimizing the source trajectory designs, mathematically and with simulation, to improve image quality, dose exposure and scan time. Anthropomorphic phantom studies with Varian TrueBeam, which could support this proposed CBCT method, are also planned.

Funding Support, Disclosures, and Conflict of Interest:

This projection is partially supported by a Varian MRA grant with Washington University in Saint Louis.