Purpose:
3D ultrasound (3DUS) can be used to provide soft-tissue visualization in both CT-sim and treatment rooms. Fused CT/3DUS datasets provide complementary information for contouring, and 3DUS-to-3DUS comparisons are used for soft-tissue based IGRT. To date, 2DUS probes have been used in combination with a position sensor to reconstruct images from a freehand sweep. In this work we describe the development of a mechanically sweeping autoscan probe for acquisition, with a focus on transperineal prostate imaging.

Methods:
A calibration algorithm was developed for reconstruction of 3D autoscan images in room coordinates. To ensure images are consistently centered, a Hall sensor was used to tag the central position of the sweep within the probe casing. The accuracy was measured by comparing 3DUS and CT images of the same phantom. Precision was measured by scanning a sphere within the phantom 32 times. The effect of treatment and CT radiation dose on probe homing was measured by delivering 8000 MU of 6 and 18 MV beams with the probe 1 cm outside of the field edge, as well as CT scans of the entire probe, between successive acquisitions. Preliminary patient images were acquired to show the feasibility of scanning prostates transperineally.

Results:
Accuracy of the system was found to be within 1 mm, and precision within 0.5 mm with 95% confidence. Neither CT nor treatment dose affected the spatial accuracy. Preliminary images showed feasibility of imaging the prostate and surrounding structures.

Conclusions:
A mechanically sweeping probe can reconstruct 3DUS images accurately and precisely in CT and treatment room coordinate systems and is not affected by radiation dose. Transperineal imaging of the prostate with the probe is shown to be feasible. Future work will enable continuous image acquisitions during treatment to track intrafractional motion of the prostate and critical structures.

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All authors except J. Wallace are employed by Elekta/Resonant Medical