

A New Approach to Ultrasound Guided Radio-Frequency Needle Placement

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Outline

- Introduction
- Related Work
- Methods
 - Device Calibration
 - Needle Placement
- Evaluation
- Results
- Conclusion

Introduction

- Tumor Ablation/Radio-Frequency Ablation (RFA)
 - Minimally invasive
 - Kill cancer cells in-situ
 - RFA requires accurate needle placement

- Ultrasonography (US)
 - Non-invasive
 - Highly available
 - Simple to use

Workflow

- Pre-operative
 - Diagnosis, based on MRI study using contrast agent.
 - Planning (Number of needles, time, power, and path)
- Intra-operative
 - **Locate lesion and path.**
 - **Insert needle into the center of the lesion.**
 - Apply RF.
 - Remove needles.
- Post-operative
 - Confirm ablation (PET).

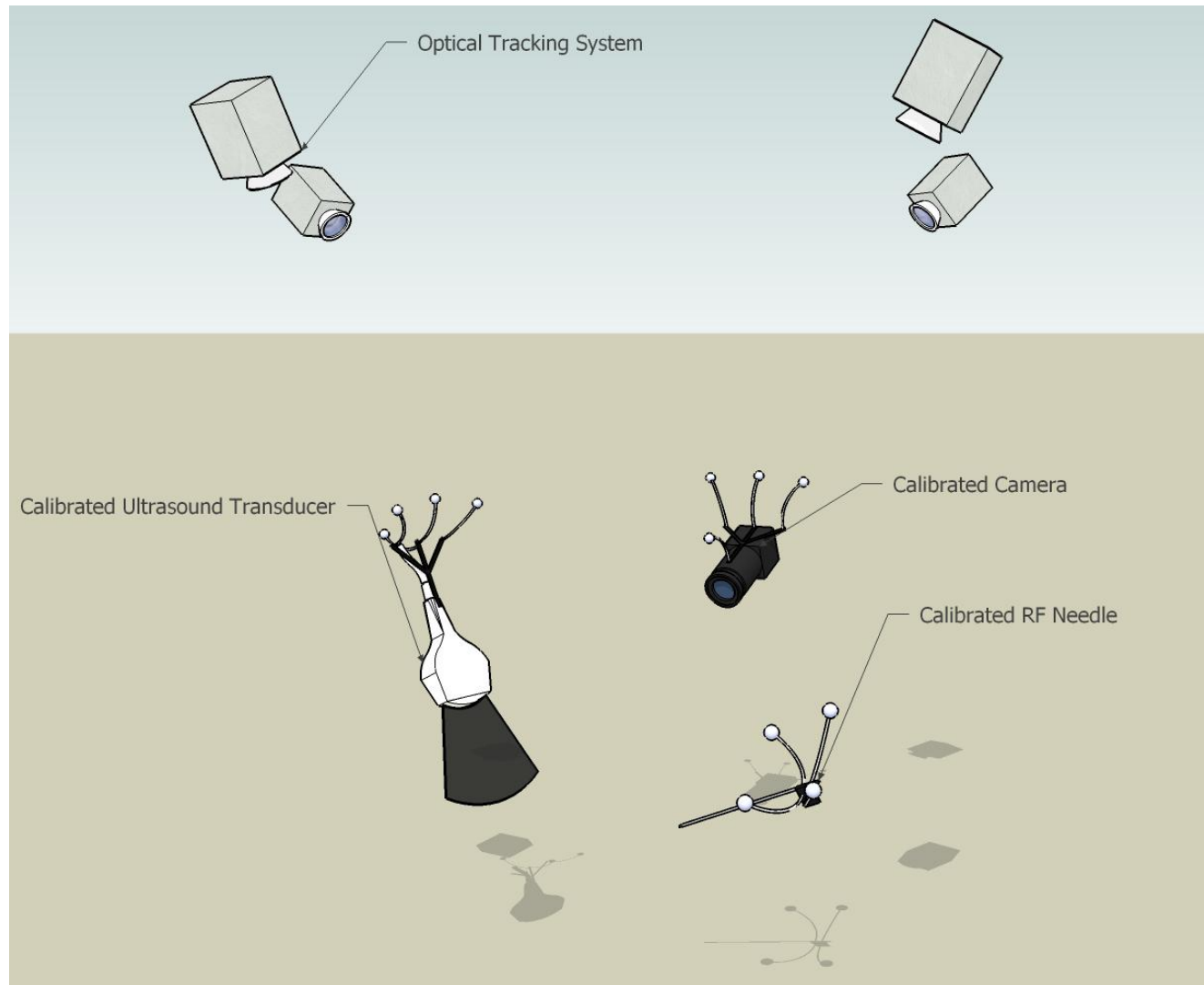
Related Work

- Ultraguide 1000
 - Electromagnetic tracking (distortions, cables, lower accuracy)

- BrainLAB
 - Preoperative 3D data (CT, MR, or PET)
 - Correct registration required

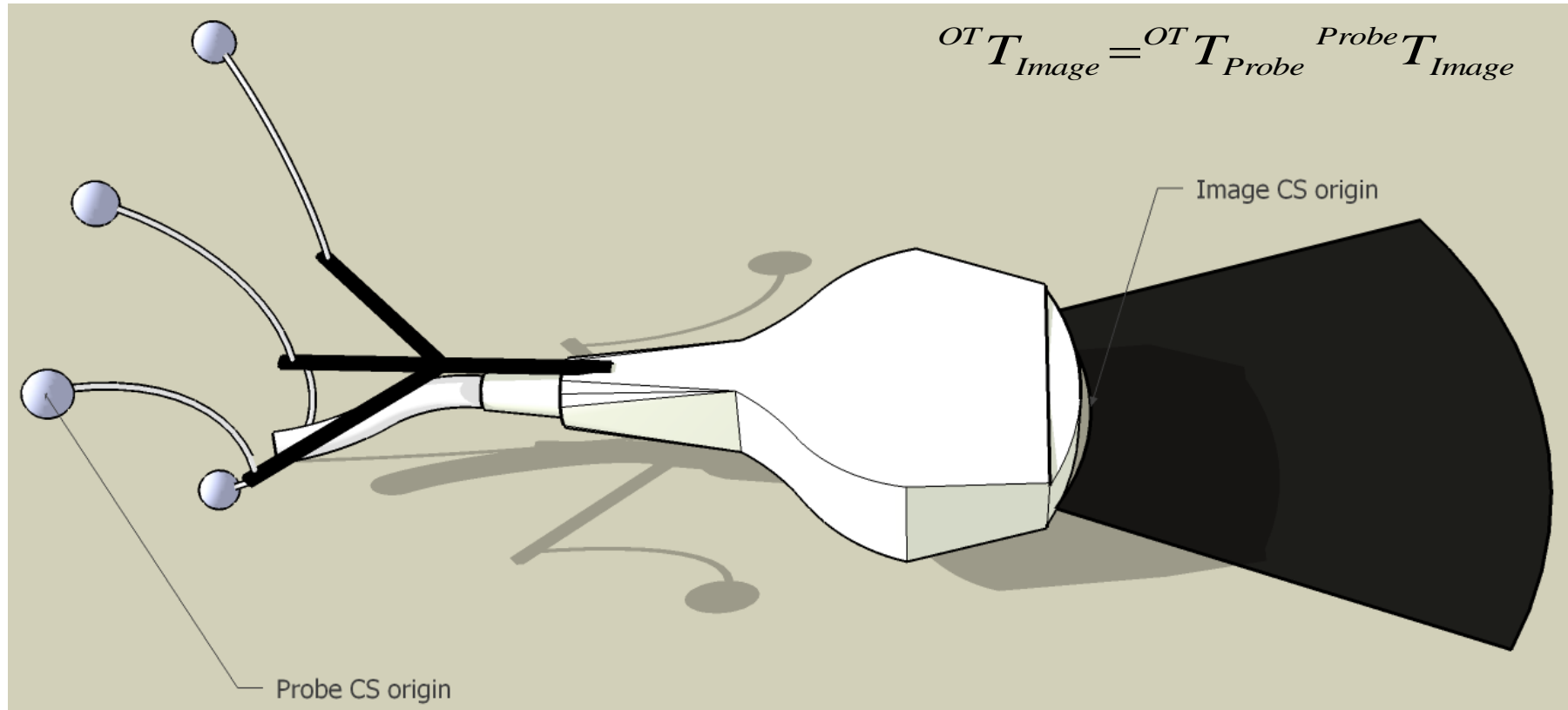
- Siemens Corporate Research
 - Expensive AR equipment (HMD)
 - In-situ US volume creation

Methods: Setup

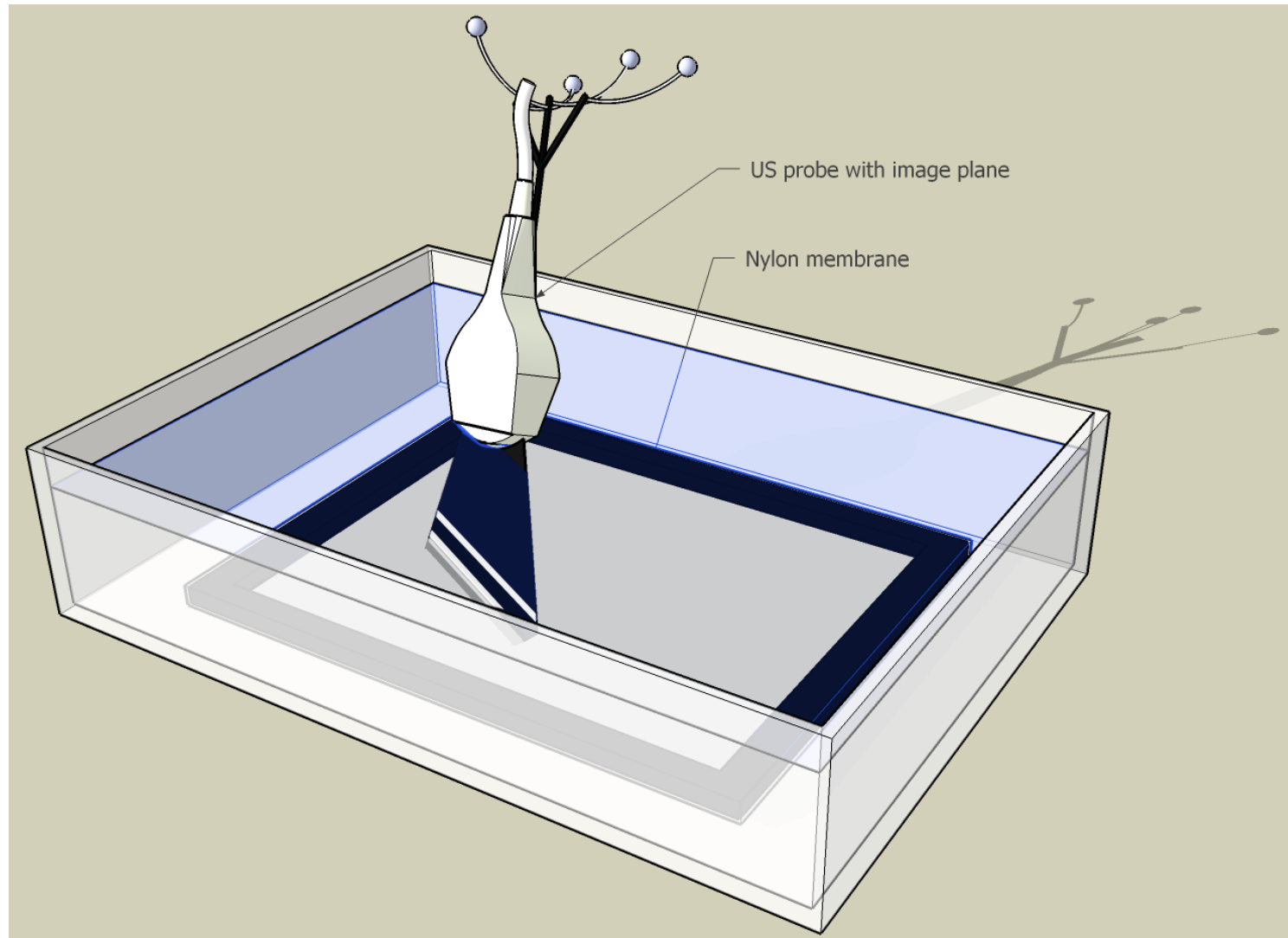


Methods: US Calibration

- Single Wall calibration with Langø's extension (incl. time & SOS)

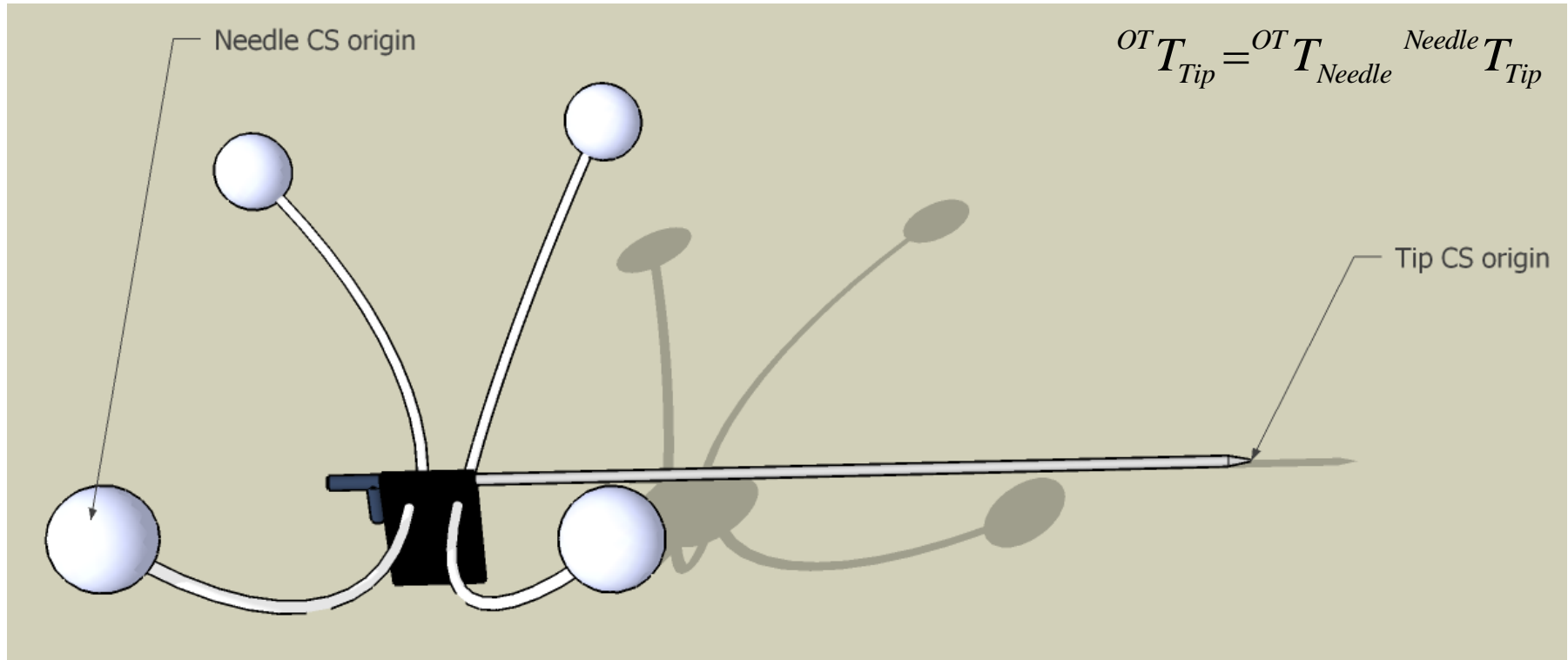


Methods: US Calibration

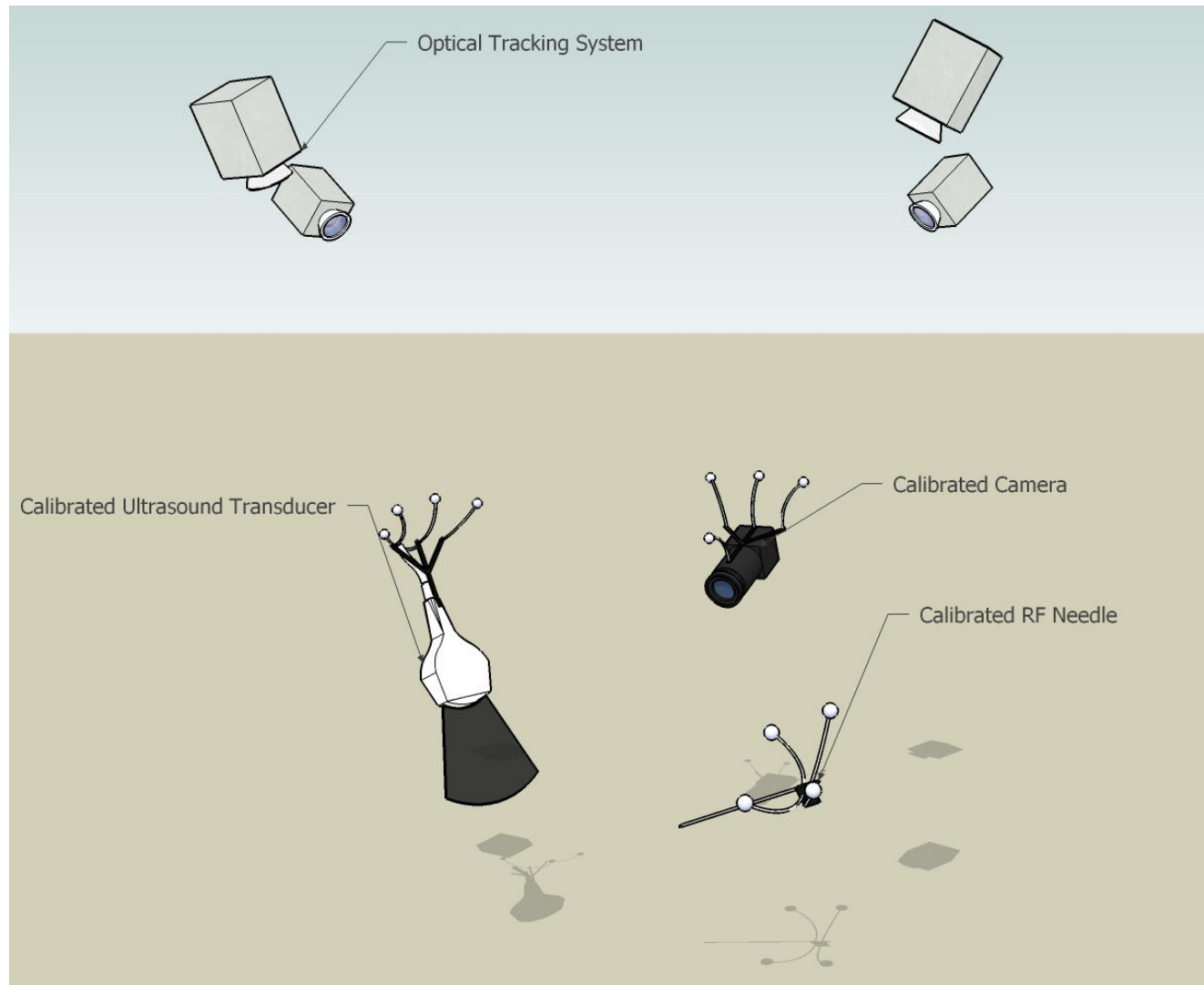


Methods: Needle Calibration

- Hot-Spot calibration for tip and base

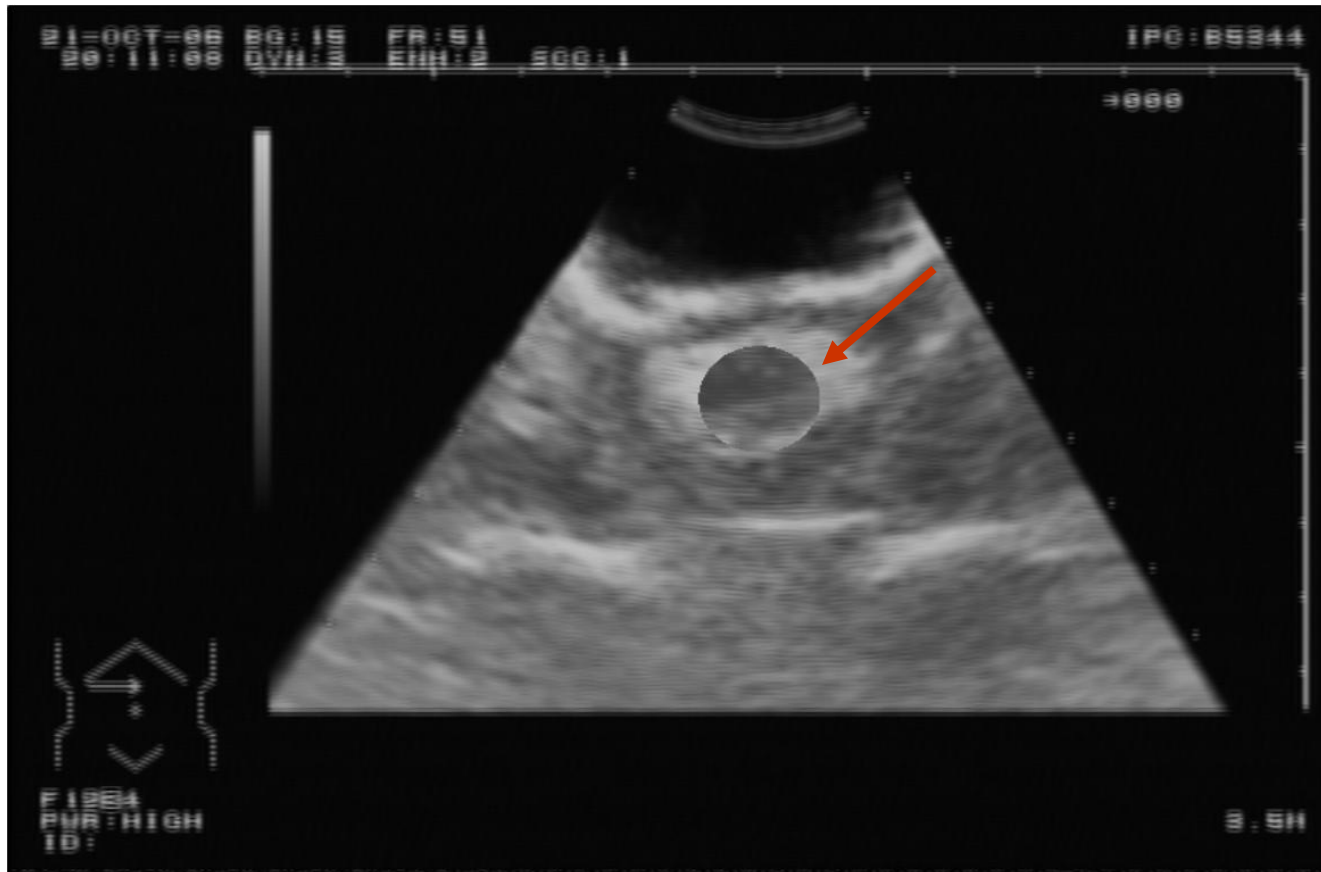


Methods: Setup



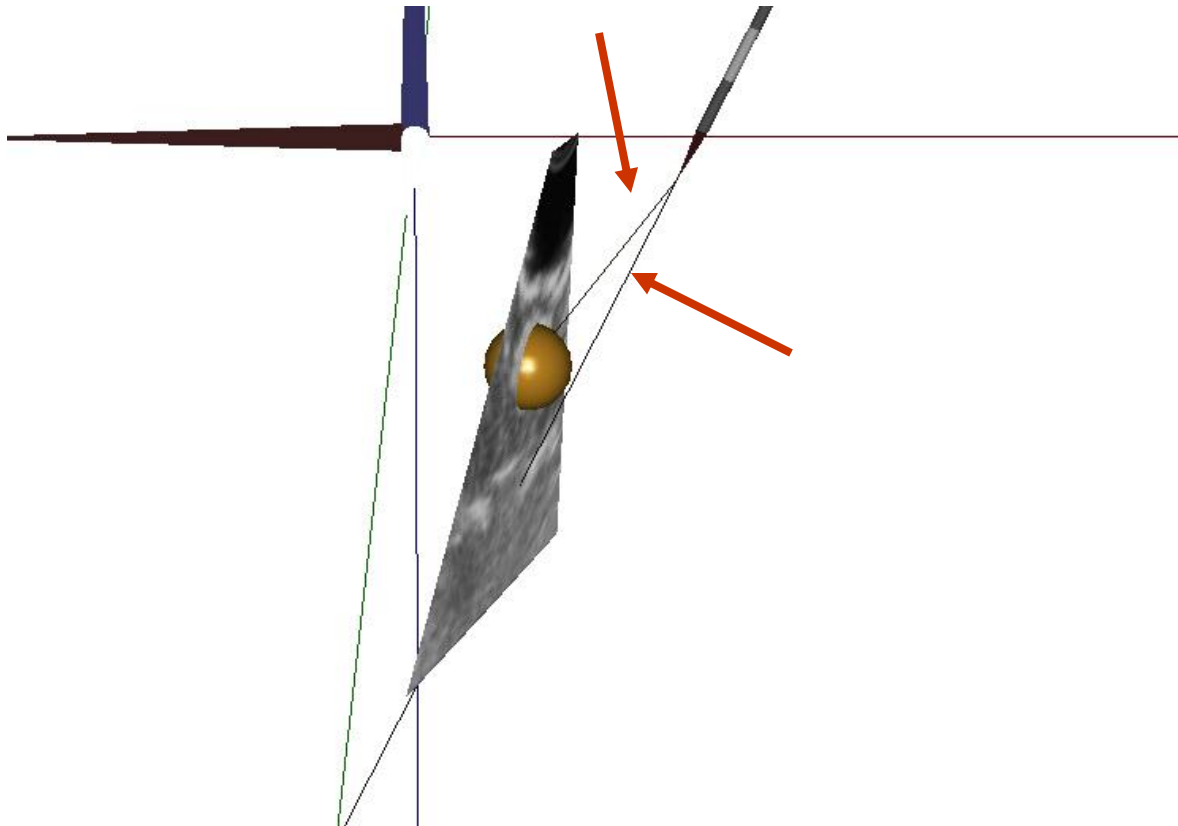
Methods: RF Needle Placement

- Surgeon selects target in the *US View* (live image or frozen)



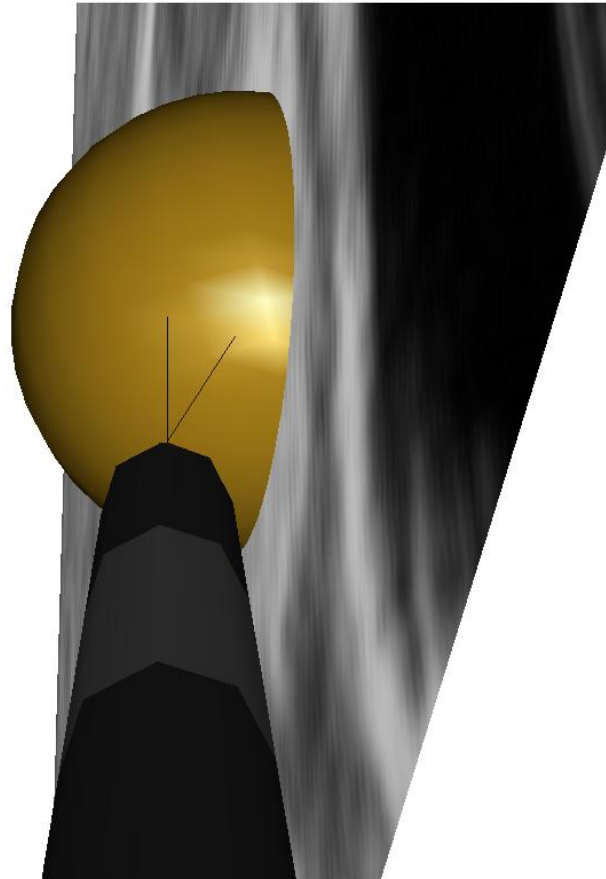
Methods: RF Needle Placement

- Surgeon aligns the guidance lines and inserts the needle in the *World View*



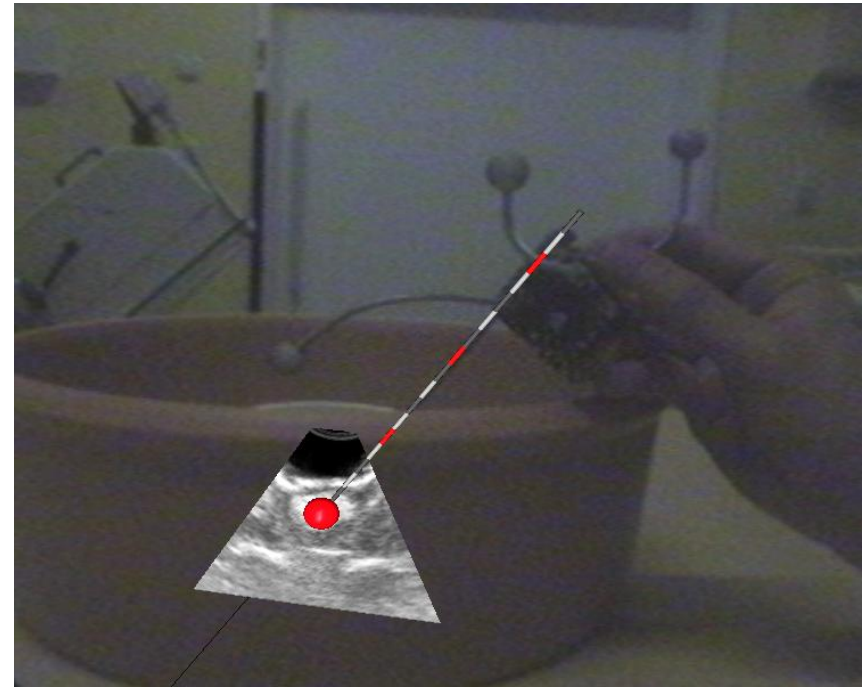
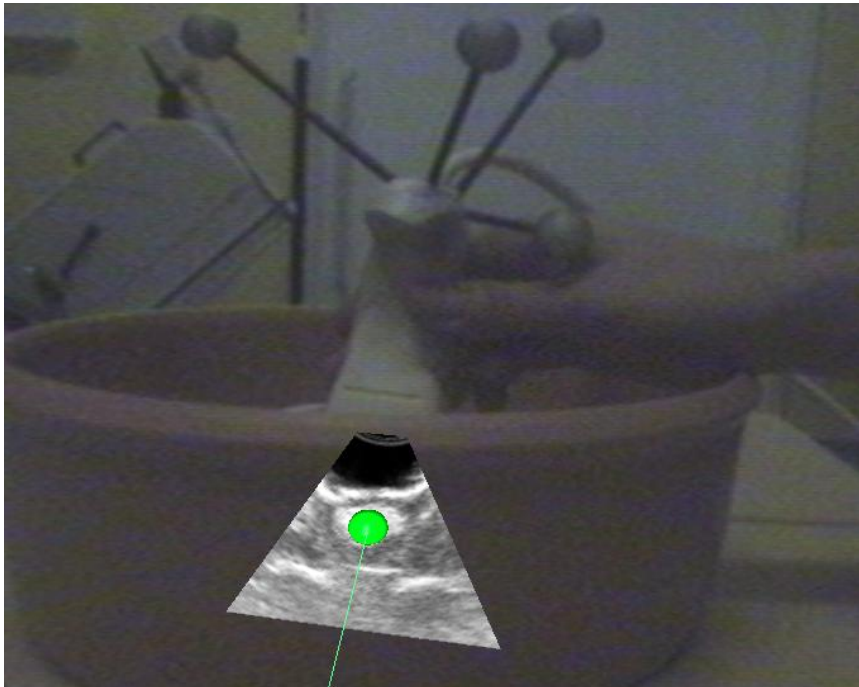
Methods: RF Needle Placement

- Alternative perspective: *Needle View*



Methods: RF Needle Placement

- Another perspective: *Augmented Reality View*

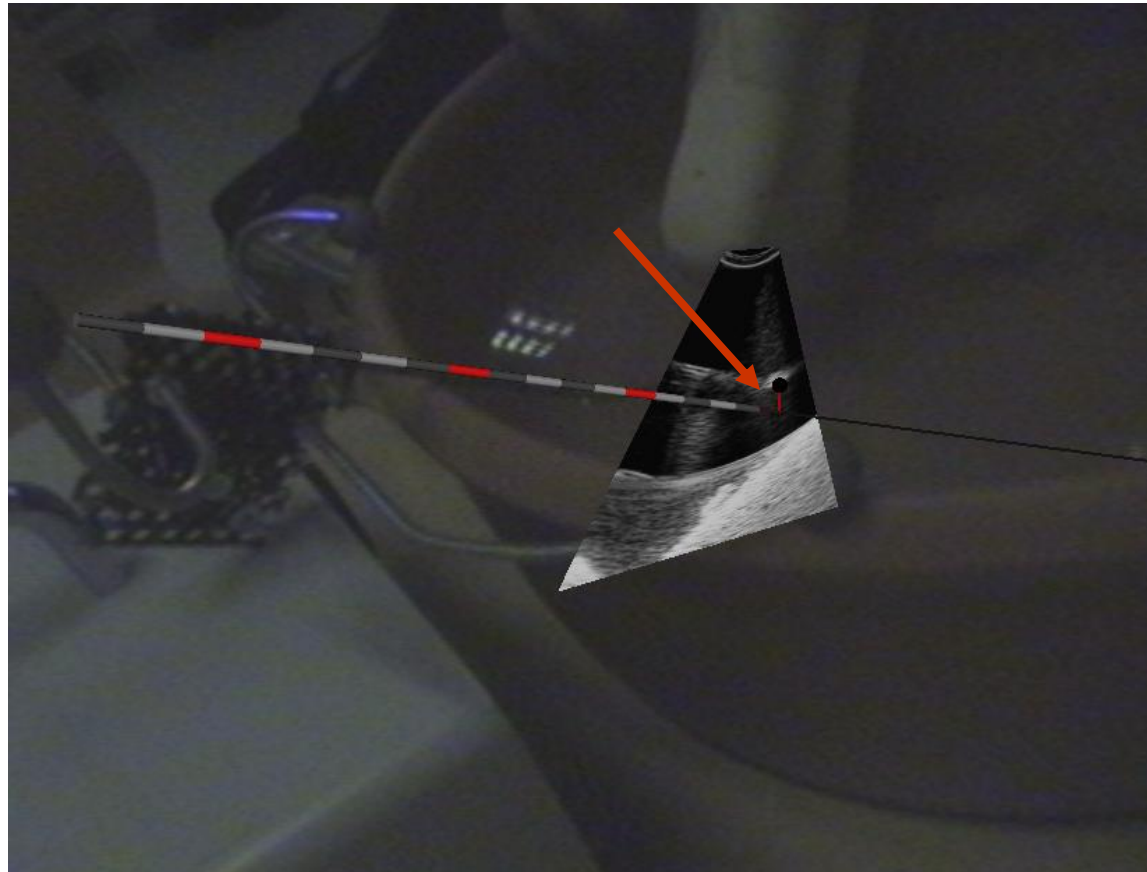


Methods: RF Needle Placement

- Distance to the target is color-coded.
- Guidance lines help the surgeons to align the needle correctly before the needle is visible in US.
- Support for pre-operative volumes.

Evaluation

- Euclidean distance from needle tip to segmented tip



Results

- Errors measured using a more recent system:
1.1 mm mean, 0.4 mm standard deviation, 1.17 mm RMS

Conclusion

- RFA divided into two consecutive tasks:
 - Surgeons only need to handle one device at a time.
 - The needle position can be shown relative to live, frozen, or past US measurements

- Possible improvements include:
 - Better lesion segmentation
 - More complex (deformable) models
 - Automated registration of pre-operative volumes
 - Planning and guidance along a safe path

Thanks for your attention!