Adjustable Sleeve Template Assembly Device for Joint MR/US-guided Diagnosis and Treatment of Prostate Cancer: Initial Design and Feasibility Evaluation

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Prostate Cancer (PCa)

- 30% incidence for men in their 50s, 80% for men in their 70s
  - 450,000 new cases in 2015
- Second most-common cause of cancer-related death in men
  - 1 of 10 men will die from prostate cancer
- Imaging: diagnosis, staging, treatment

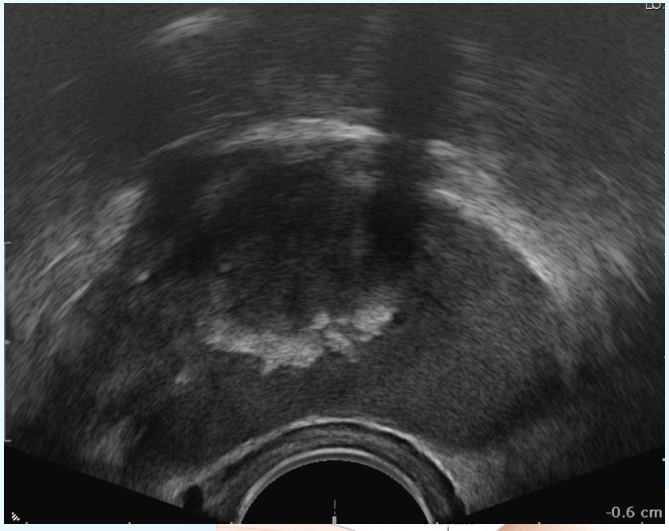
Challenges: early and accurate detection, choice of treatment, delivery of treatment, active surveillance

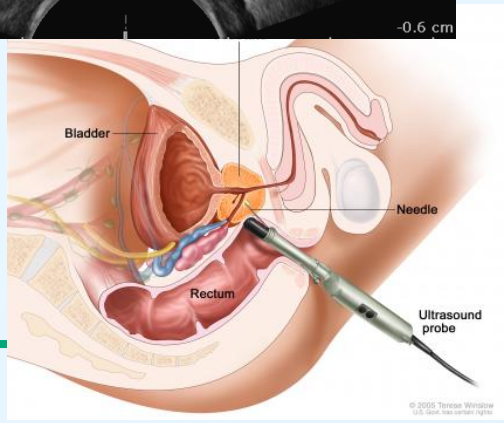
Transrectal Ultrasound (TRUS)

- Everyday modality for prostate imaging
  - Biopsy guidance (non-targeted)
  - Brachytherapy
- Typically not effective for cancer localization
  - 40% cancers are isoechoic
- Advanced modes of operation
  - B-mode
  - Doppler
  - Contrast-enhanced (research)
  - Elastography (research)
  - RF-mode for tissue typing (research)

http://www.cancer.umn.edu/cancerinfo/NCI/glossary/CDR322891.html

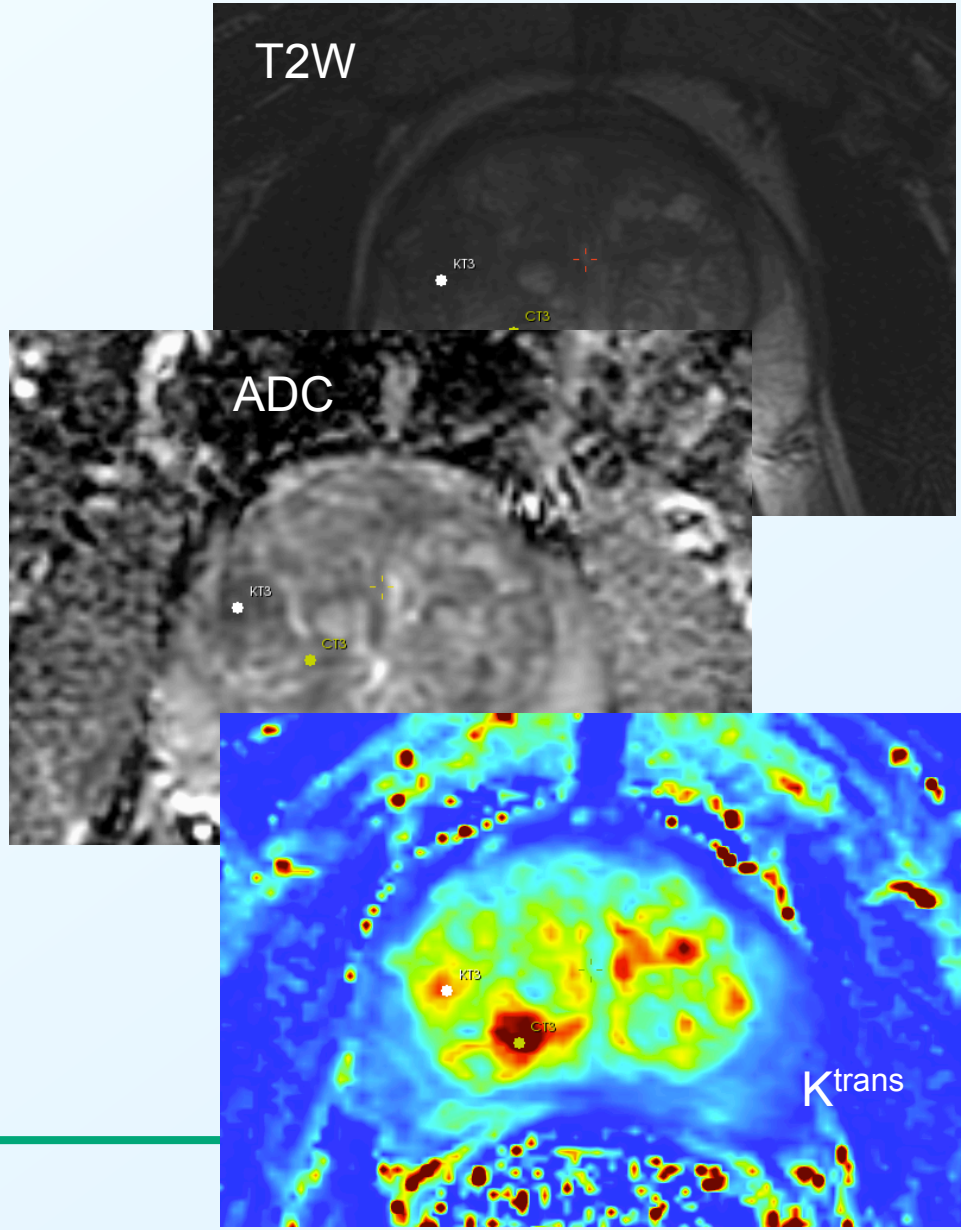
BK 8818 transrectal probe, http://bkmed.com



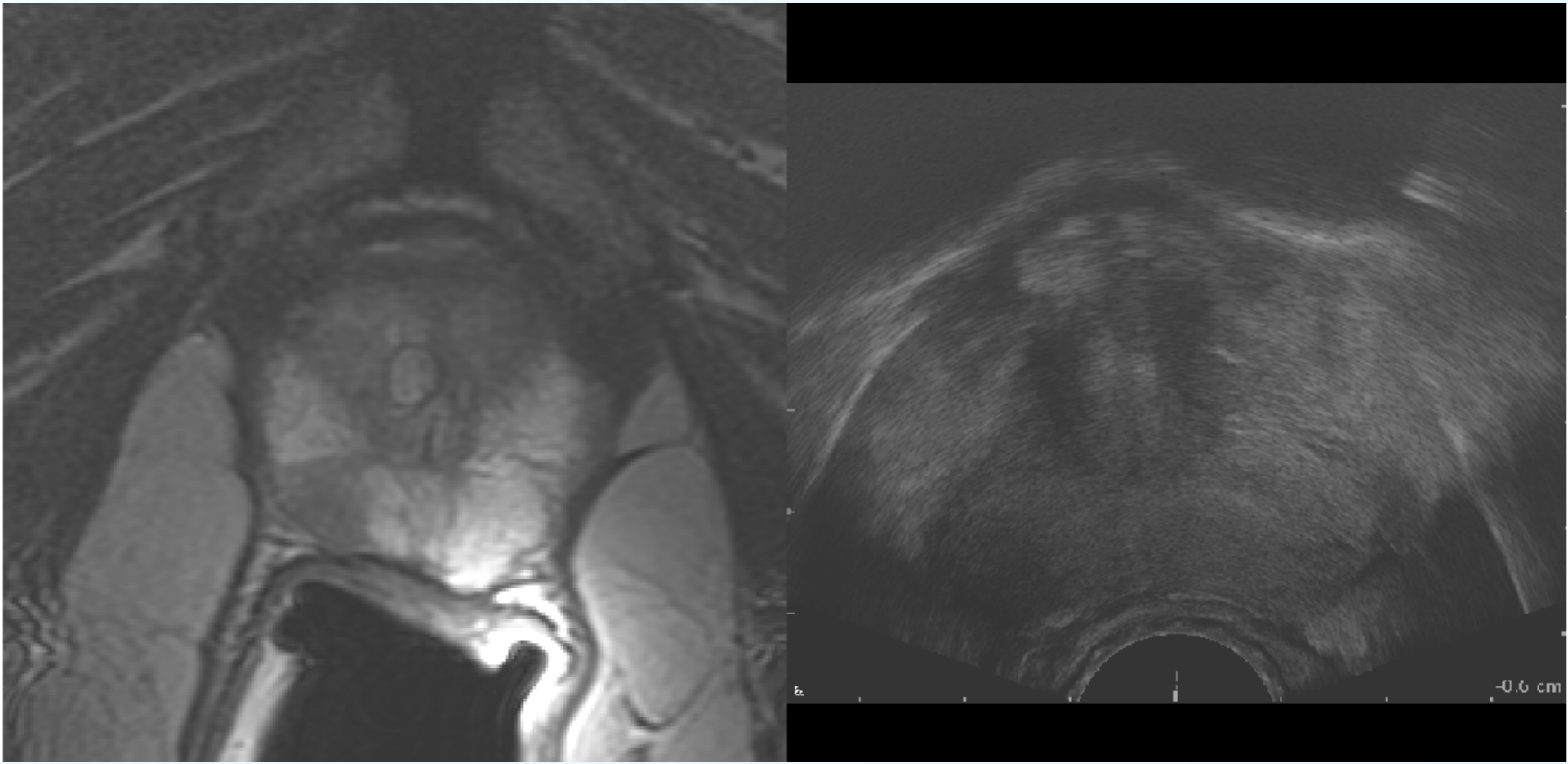


Magnetic Resonance Imaging

- State of the art:
  - Multi-parametric (T2W, DCE, DWI, spectroscopy)
  - 3 Tesla magnet
  - endorectal coil
- Most effective modality for detection, staging, monitoring of response, focal treatment
- IGT applications (clinical research):
  - Biopsy
  - Brachytherapy
  - Focal therapy (eg HIFU)



TRUS + MR



Adjustable Sleeve-Template Assembly

ASTA schematic drawing courtesy Wendy Plesniak

Adjustable Sleeve-Template Assembly

TRUS

BK Medical

MRI

HOLOGIC®

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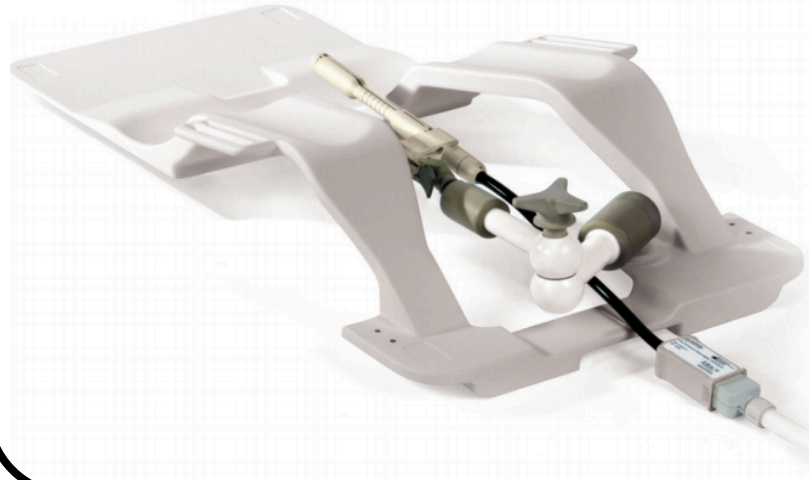
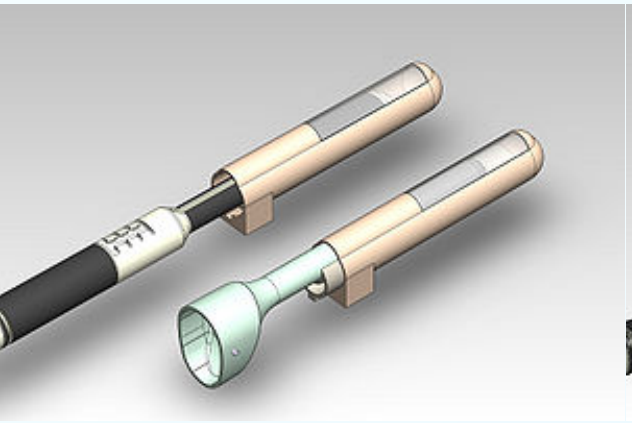
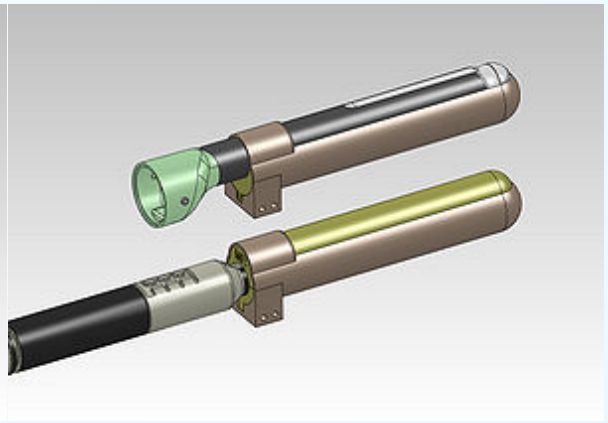


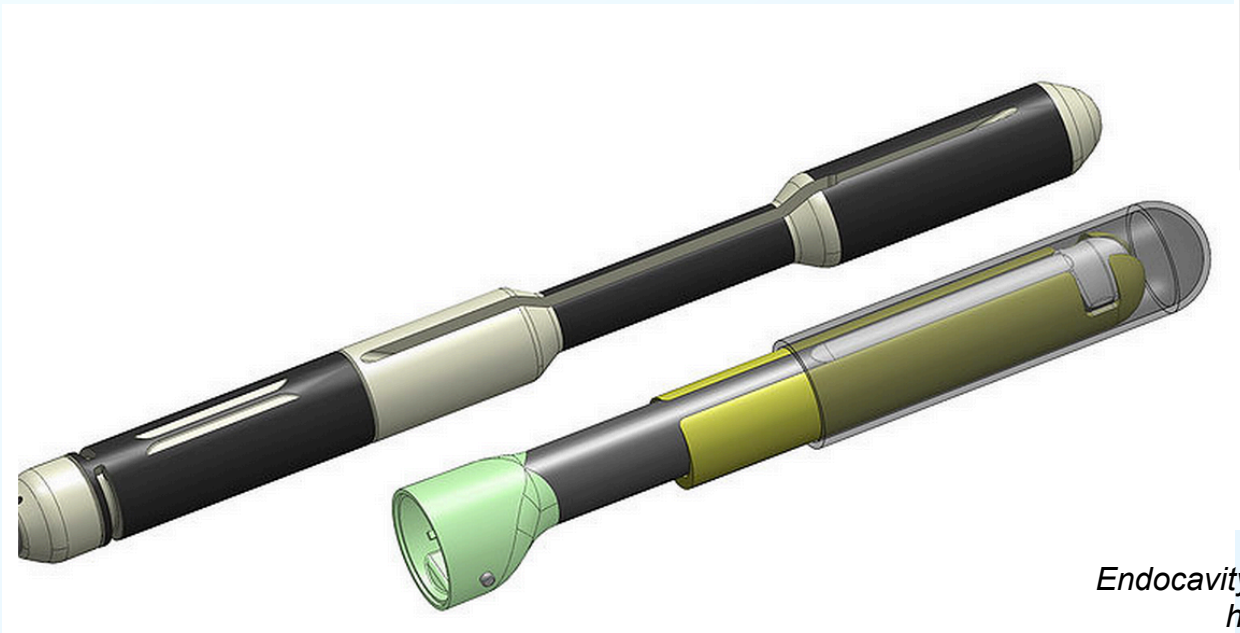
ASTA design considerations

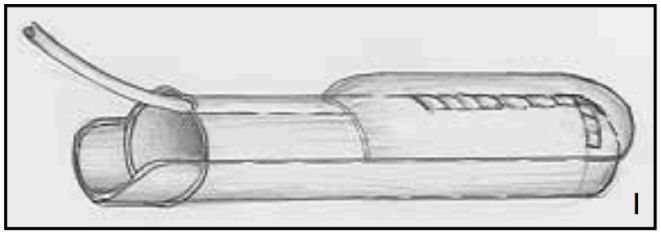
- Accommodate MR (D=26 mm) and US (D=20mm) probes
- Minimum device profile
- Diagnostic quality of the image
- No/minimal deformation of the surrounding tissue while exchanging probes
- Facilitate repeated imaging interchanging MR/US probes

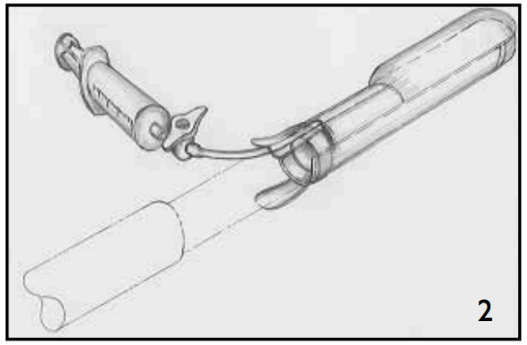
Design





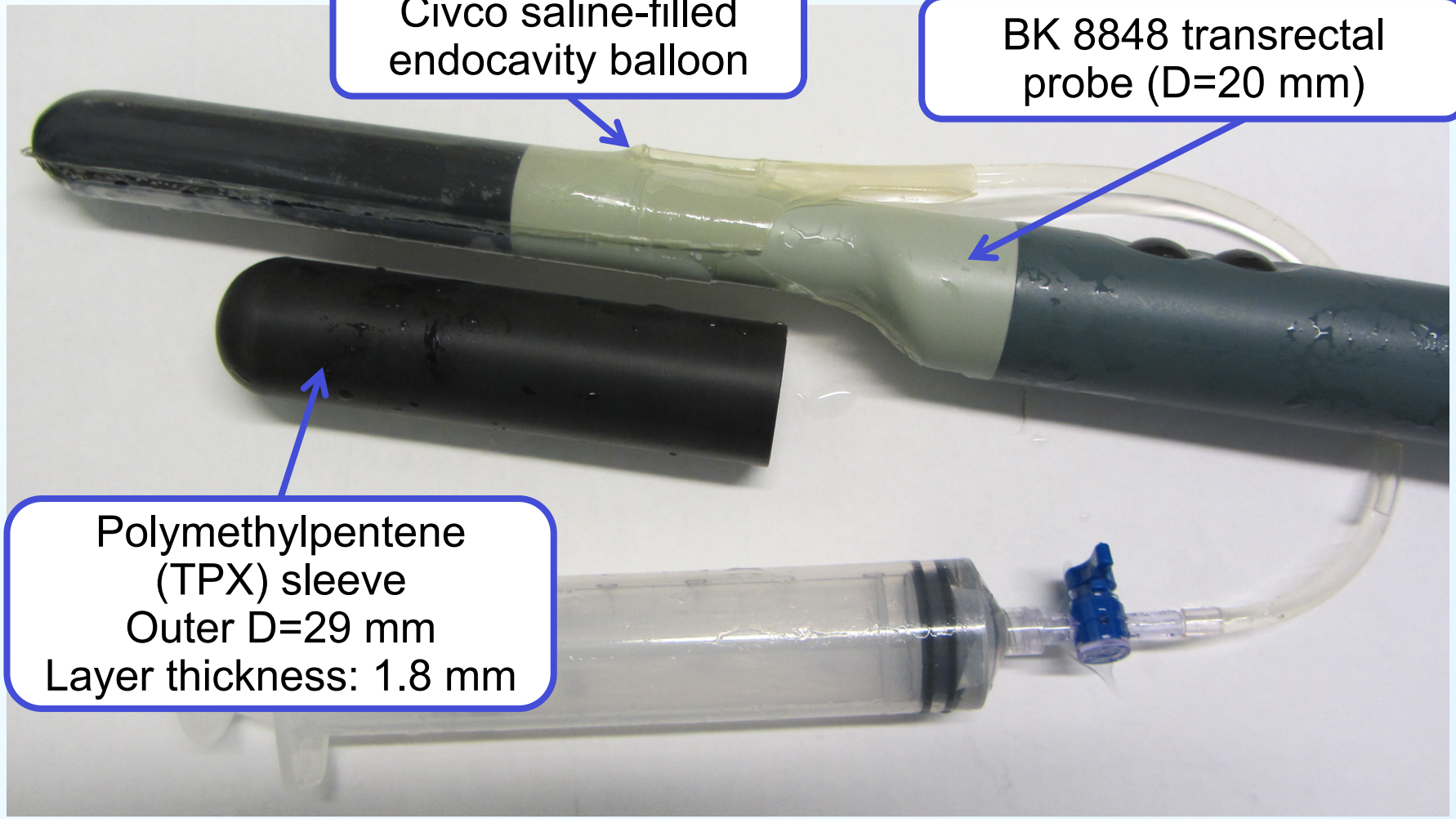






Endocavity balloon (Civco Medical Solutions,Kalona IA)
http://www.civco.com/docs/043592.pdf

Implementation



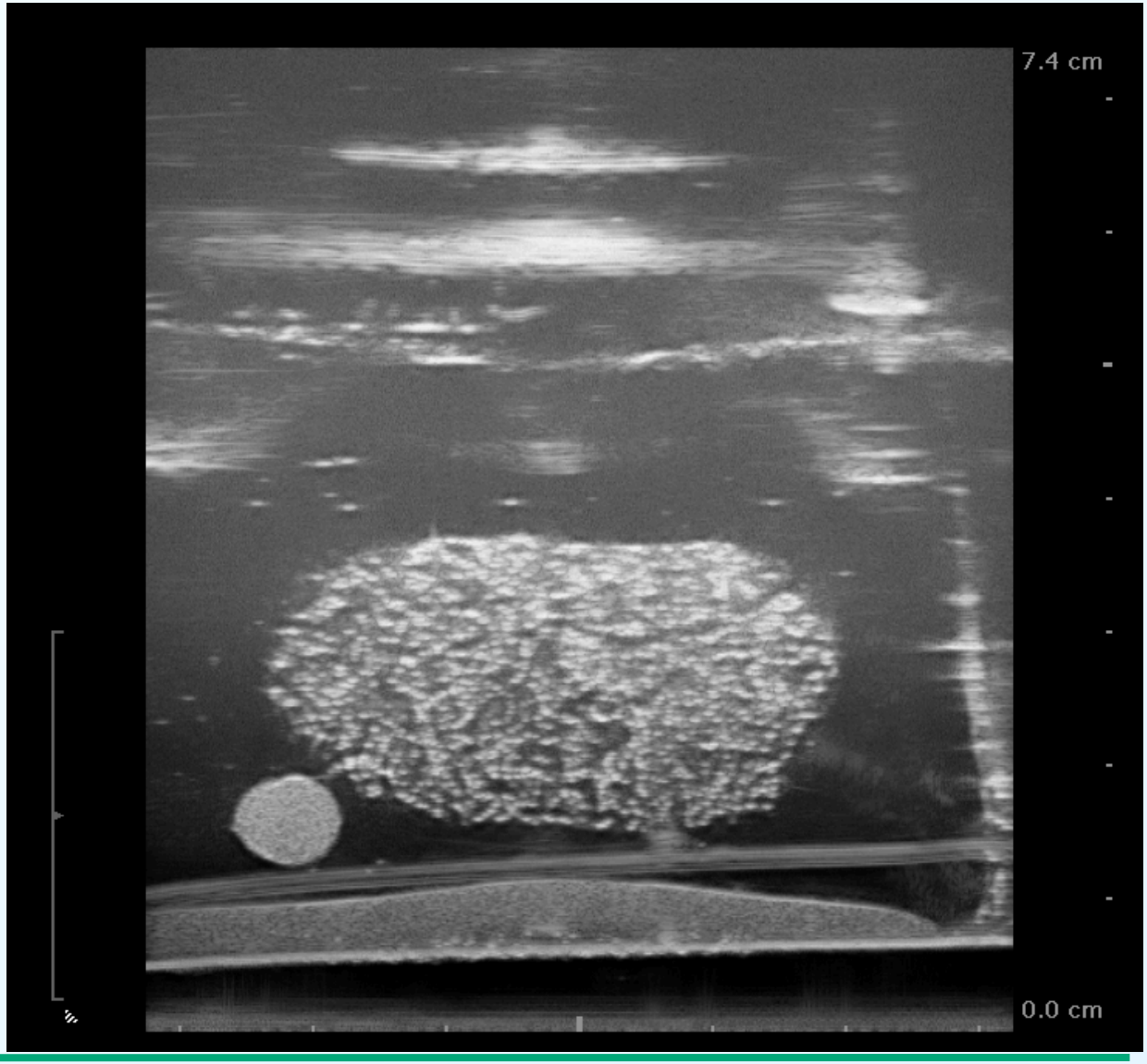
Preliminary evaluation

Phantom studies:

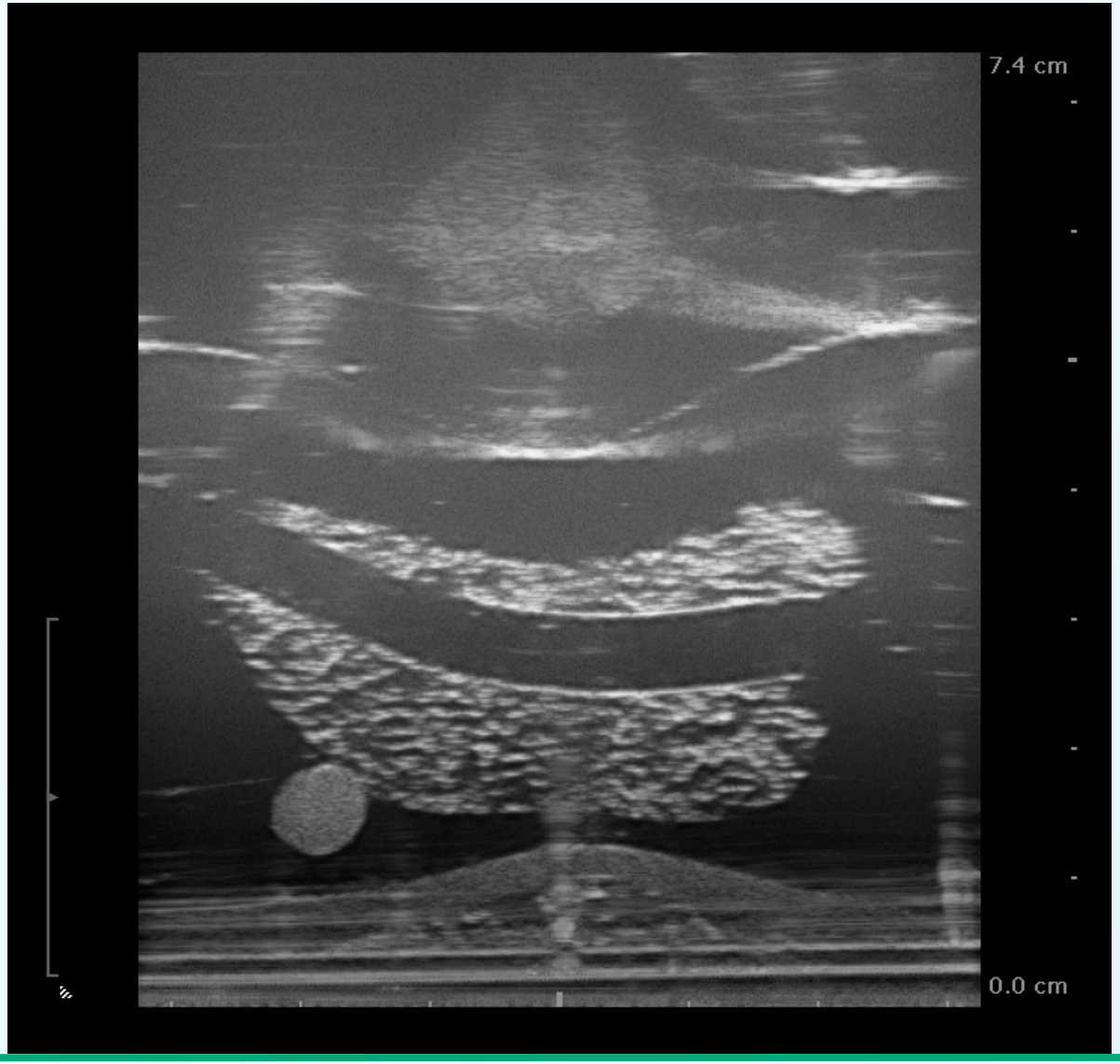
1. Confirm acoustic coupling and transparency
2. Evaluate the setup workflow
3. Confirm imaging quality upon reinsertion

Preliminary evaluation

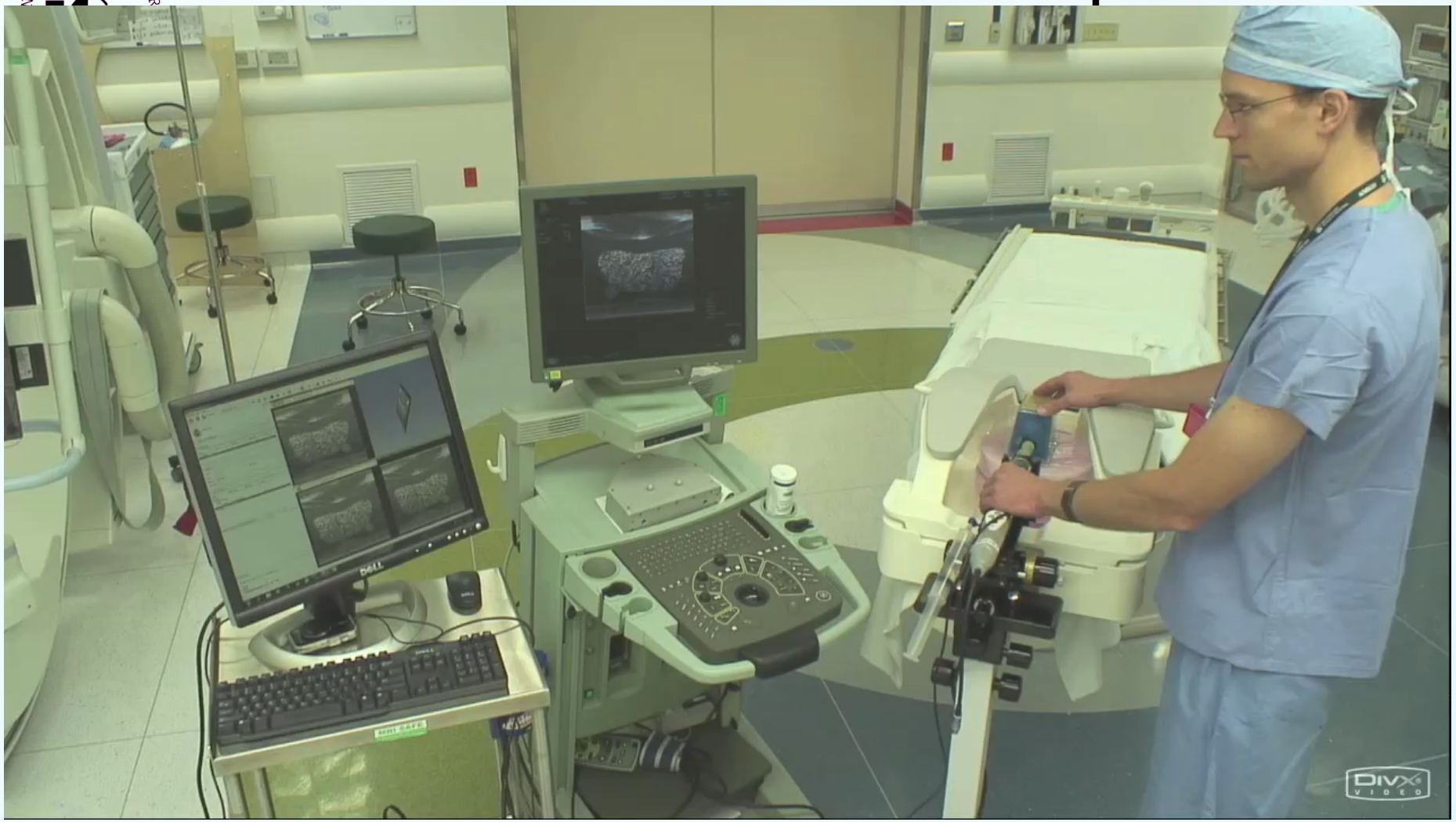
Preliminary evaluation



Preliminary evaluation



AMIGO Suite setup



Integration of the BK ProFocus US and orientation tracker with 3D Slicer enabled by Public software Library for UltraSound imaging research (PLUS) (PerkLab, Queens U.) and OpenIGTLink.

ASTA Research applications

- Improved MR-TRUS tissue/imaging correlation
  - Reduce or eliminate concerns of gland motion/ deformation
- Improved validation of the MR-TRUS registration
  - Diagnostic MR → Intraprocedural MR → TRUS

    vs
  - Diagnostic MR → TRUS

Next steps

- Testing of MR imaging with Hologic rigid coil (pending clearance for integration with Siemens magnet)
- Refinement of the prototype, integration with the Hologic tabletop
- Design of the patient studies protocols

Acknowledgments

- BWH Radiation Oncology: Paul Nguyen, Emily Neubauer
- PLUS team and especially Andras Lasso (PerkLab, Queens U.)
- NIH support:
  - R01 CA111288
  - P41 EB015898
  - P01 CA067165