TRUS QA Workshop

Introduction

- The goals of using TRUS in prostate brachytherapy
  - Visualize the prostate
    - Need the US to penetrate deeply enough
    - Need sufficient grey scale resolution to be able to visualize the prostate from background
    - Need to be able to accurately measure the volume and linear dimensions of the prostate
  - Visualize the needles
    - Need sufficient resolution to see the needle
    - Need to be able to see the needle in both AX and SAG
  - Visualize the template
    - Electronic grid must be aligned with both physical grid and TPS grid

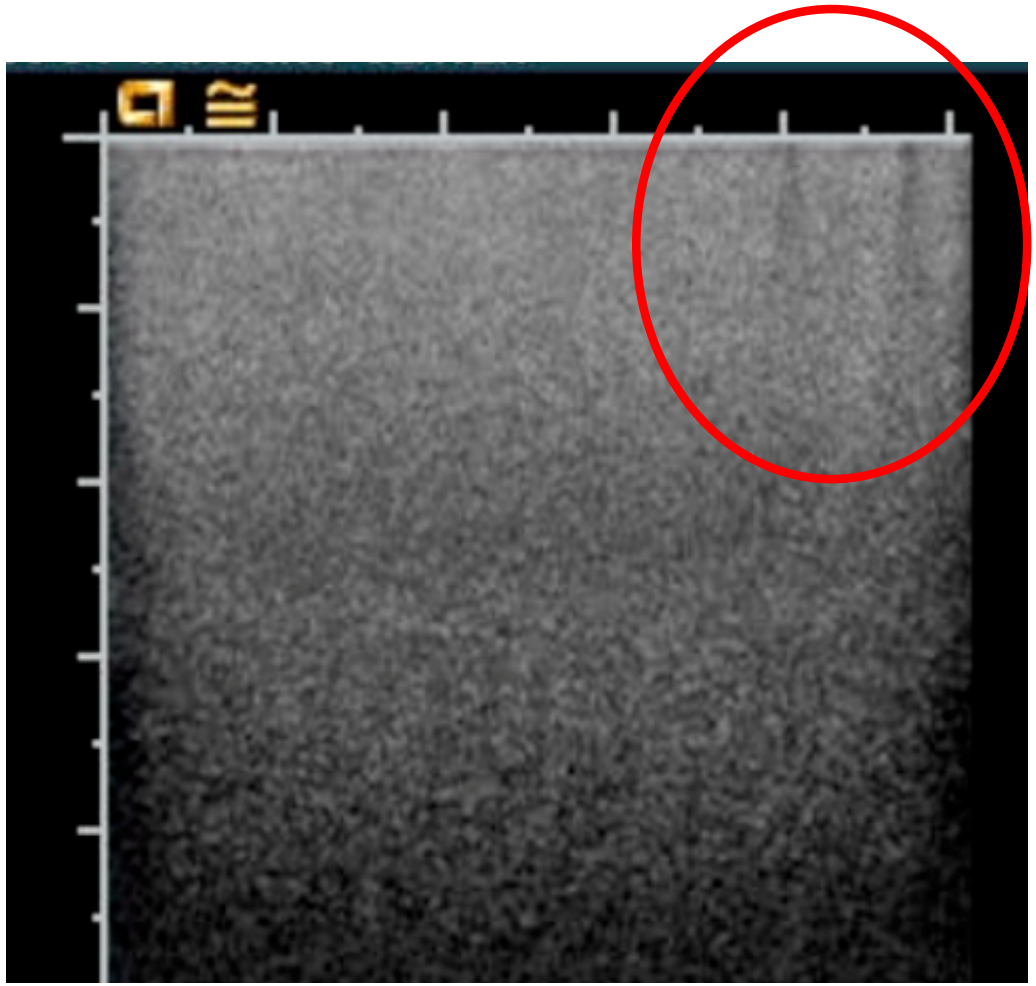
- The goal of TRUS QA is to ensure your system can do all of this accurately.

Equipment

- Ultrasound system
- TRUS probe
- Brachytherapy phantom (e.g. CIRS) (Check that phantom hasn't changed)
- Stepper and stabilizer
- Template
- Bucket of water (plus adjuncts to bring SOS closer to 1540 m/s)
- Needles
- Baseline data
- Time: ~ 90 minutes

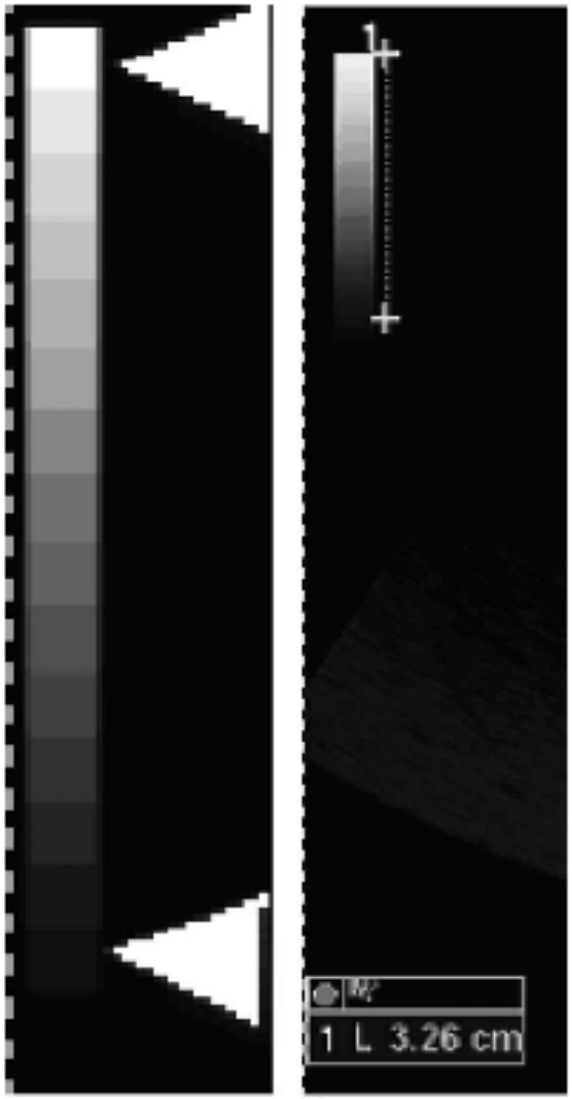
Tests – Element Drop-Out

- System turns on
- All crystals are functioning
  - Image a uniform phantom and look for non-uniformities
  - The figure illustrates element drop-out.
  - Further investigation warranted, requires service engineer.



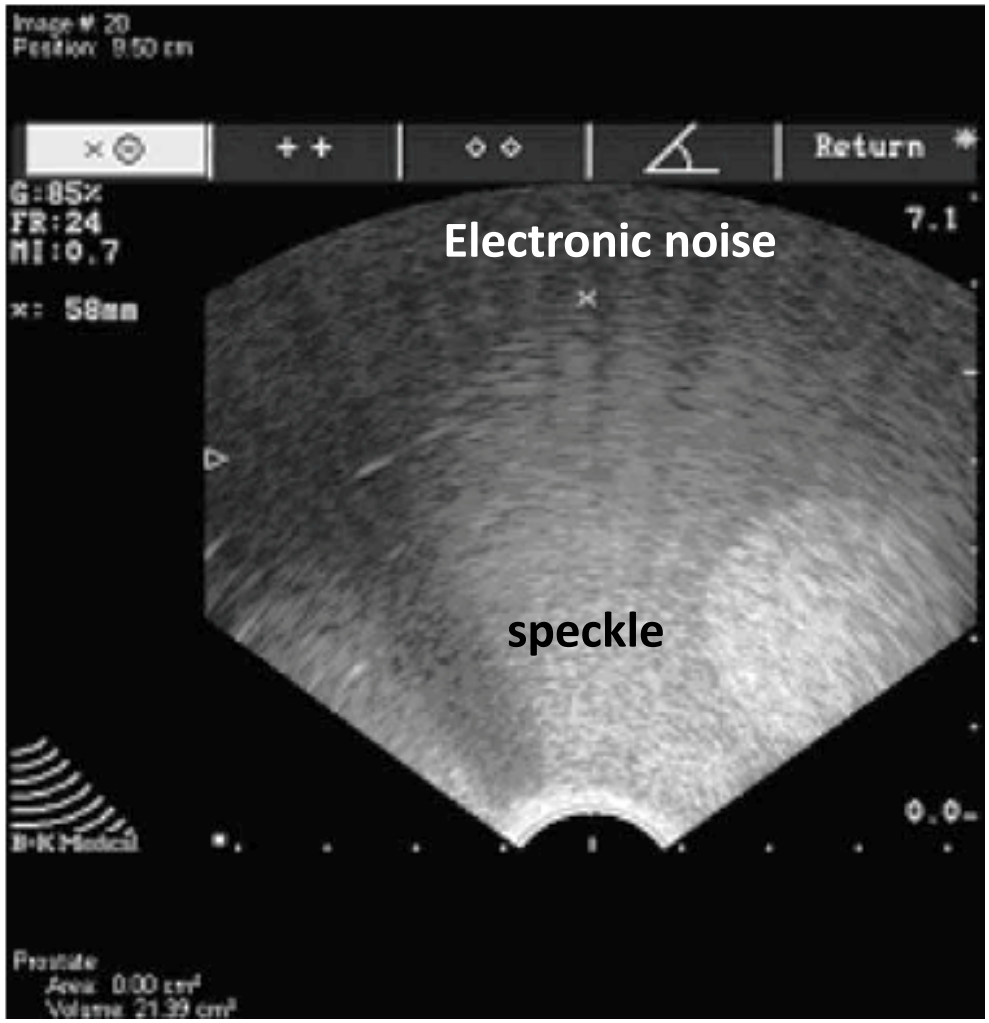
Tests – Greyscale Visibility

- **Frequency**: Annual
- **Tolerance**: 2 steps or 10% of baseline length
- **Correction**: Re-calibrate monitor
- **Test**:
  - Locate greyscale strip in image
  - If discrete steps (left), count the number of steps you can see
  - If gradient (right), use calipers to measure length of visible gradient.
  - Record # of steps or length



Tests – Depth of Penetration

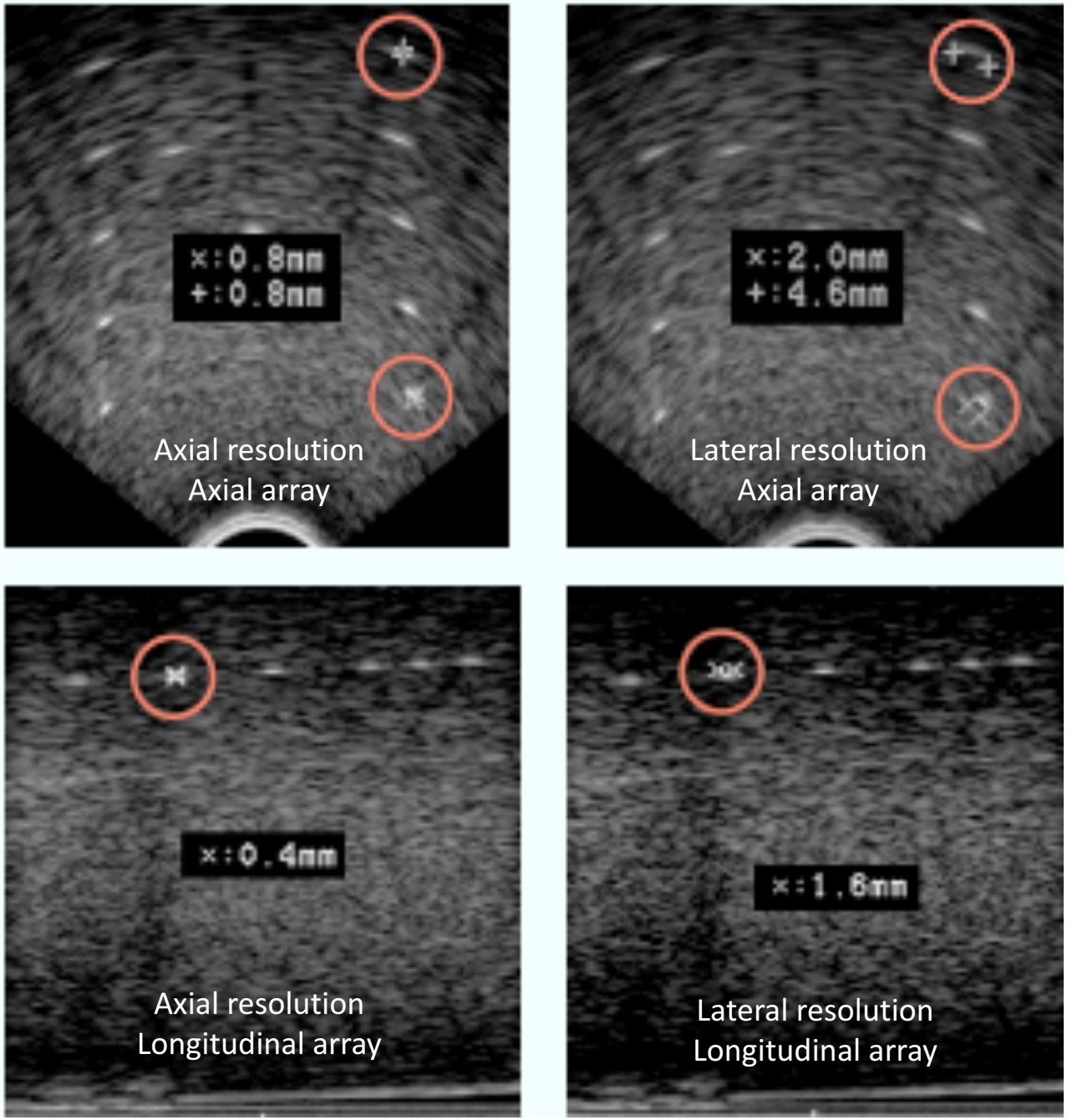
- **Frequency**: Annual
- **Tolerance**: change < 1cm from baseline
- **Test**:
  - Place probe on phantom
  - Image a relatively uniform region
  - Use usual frequency and consistent, high gain
  - Freeze image, record scan settings
  - Measure depth at which speckle is overwhelmed by electronic noise.
  - Repeat for orthogonal plane
  - Optional: repeat for other frequencies



Tests – Axial and Lateral Resolution

- Frequency: Annual
- Tolerance: change < 1mm from baseline
- Test:
  - Place probe on phantom
  - Image single filament targets at depth
  - Set focal depth to match depth at which measurement is to be taken
  - Set the gain to optimize visibility of targets
  - Freeze image, record scan settings
  - Measure the dimensions of the filament image in both axial and lateral planes
  - Repeat for orthogonal plane
  - Optional: repeat for other frequencies

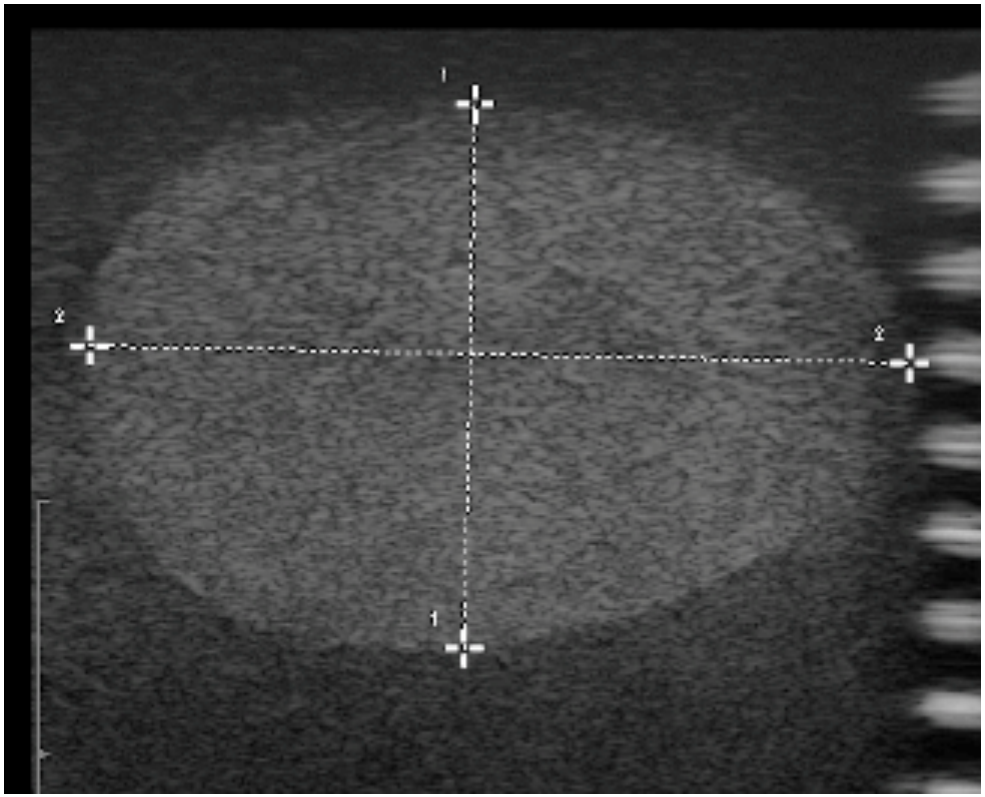
Tests – Axial and Lateral Resolution



Tests – Axial and Lateral Distance Measurement

- **Frequency**: Annual
- **Tolerance**:
  - **Axial**: error ≤ 2mm or 2% from baseline (whichever is larger)
  - **Lateral**: error ≤ 3mm or 3% from baseline (whichever is larger)
- **Test**:
  - Use typical clinical scan parameters
  - Record scan settings
  - **For axial test**: align a column of filament targets in the centre of the image. If this is not possible, ensure you use the same set-up each time.
  - **For lateral test:** Image a row of targets.
  - Freeze the image.
  - **For axial test:** Measure vertical distance between most proximal and most distal targets.
  - **For lateral test:** Measure horizontal distance between left-most and right-most targets. Repeat for both distal and proximal pairs.
  - Compute absolute and relative difference between baseline and measured values
  - Repeat for orthogonal plane
- If high-contrast filaments are not available, regularly shaped targets of known dimension may be used.

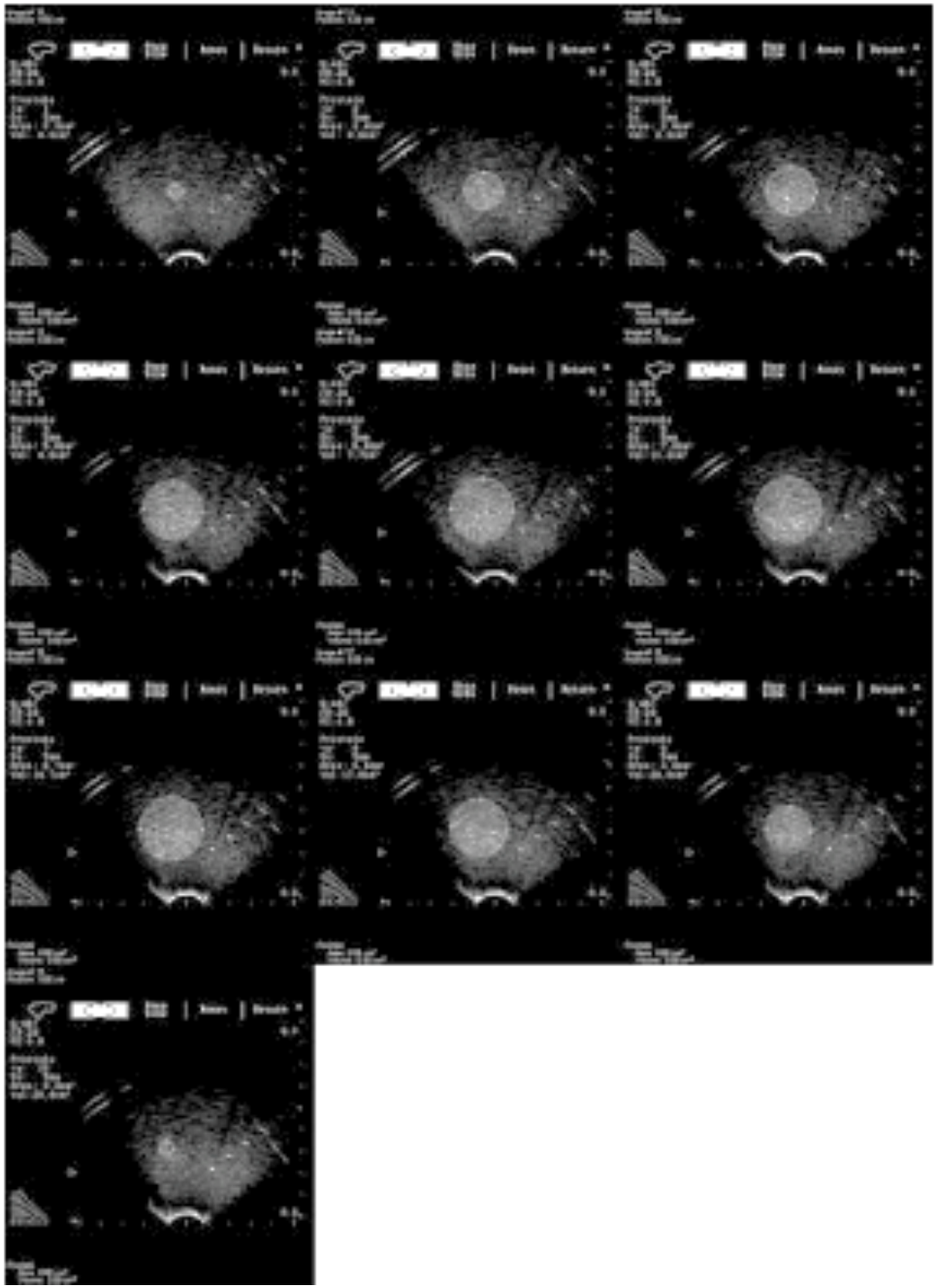
Tests – Axial and Lateral Distance Measurement



Tests – Area and Volume Measurement Accuracy

- **Frequency**: Annual
- **Tolerance**: within 5% of nominal Area or Volume
- **Test Area**:
  - Use typical clinical scan parameters
  - Record scan settings
  - Scan an object with circular cross section of known size.
  - Freeze image.
  - Using appropriate tools on the scanner, trace the boundary of the object.
  - Record area and calculate % difference.
- **Test Volume**
  - Set up the phantom so that the probe can maintain good contact as it is stepped across the volume
  - Use typical scan settings
  - Record scan settings
  - Scan an egg-shaped object in axial cross section.
  - Locate the equivalent of the base and apex and zero the stepper at the base
  - Using the typical clinical procedure, translate the probe contouring the target at each step throughout the target
  - Record calculated volume and calculate % difference

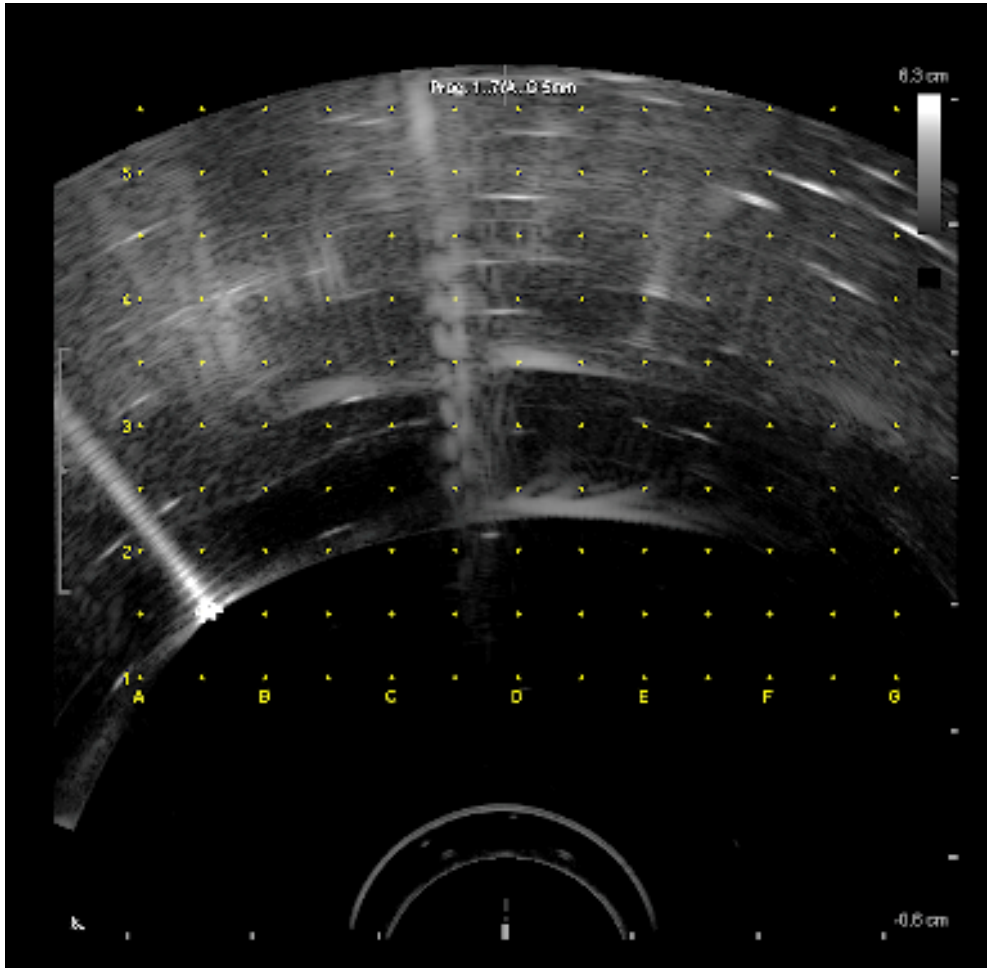
Tests – Area and Volume Measurement Accuracy

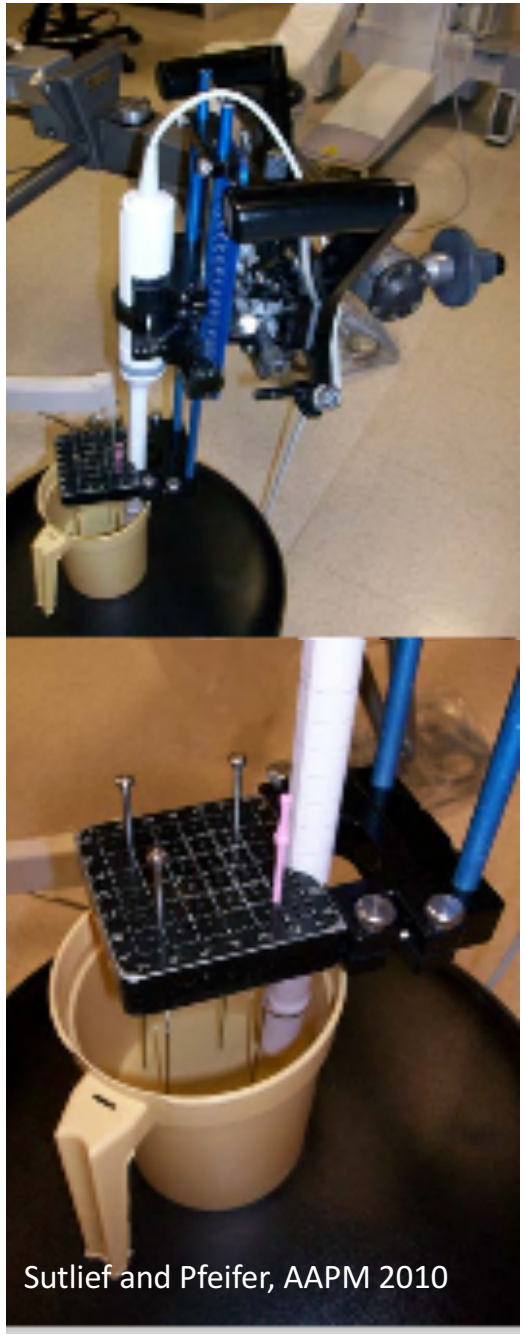


Tests – Template/Electronic Grid Alignment

- **Frequency**: Annual, a vendor's disposable templates should be checked periodically for consistency
- **Tolerance**: alignment should be within 3 mm
- **Test**:
  - Obtain a water container big enough to immerse the TRUS probe
  - Ensure water is room temperature and free of bubbles
  - Set the stepper with probe and needle template attached to be vertical and immerse the probe in the water.
  - Place needles at each corner of the template and one in the centre.
  - Verify that the location of the needle flashes in the image correspond to the physical location of the needles in the template
  - Adjust electronic grid as necessary
- **NOTE**: room temperature water has a SOS of 1480 m/s, which will introduce depth dependent distance errors. Adding 43 g of salt per litre of water will increase the SOS to ~1540 m/s. Consider using a probe cover in a saline solution.

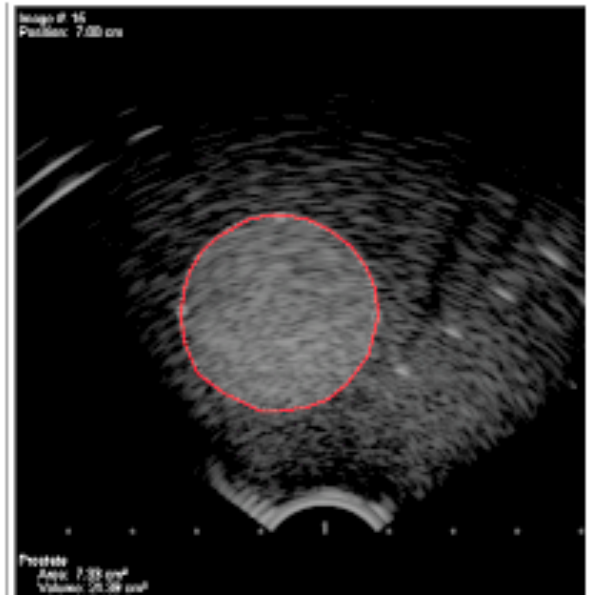
Tests – Template/Electronic Grid Alignment





Tests – Treatment Planning Computer

- **Frequency**: Annual,
- **Tolerance**: Ultrasound and TPS should agree within 5%
- **Test:**
  - Perform a volume study of a 3D object in the prostate phantom
  - Import the volume study into the TPS
  - Contour the object in the TPS
  - Compare US and TPS volumes



Sutlief and Pfeifer, AAPM 2010