For prostate radiation treatments, a non-ionizing imaging system is a better IGRT technology than an imaging system that uses ionizing radiation.

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- Elekta  
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- Varian Medical Systems  
- ViewRay

For teaching me new IGRT modalities and giving me images for this presentation.

Non-ionizing Radiation (NIR) Imaging Techniques

- EMF  
  - Optical  
  - Mm Wave  
  - Radiofrequency

- Ultrasound

- MRI  

- Surface Tracking  

- Organ Tracking with Beacon Transponder

- Soft Tissue Imaging
Organ Position Tracking
Do we need anything else?

Calypso
(Varian Medical Systems)

Requires transponders to be implanted by surgeon
Organs at risk (bladder, rectum are not tracked)

Prostate Only (Intra-Fraction)

Calypso  kV Fluoro

Adamson & Wu, Med Phy (2008)
Do we need soft tissue imaging? Do we need soft tissue imaging?

Prostate Seminal Vesicles CT Images

Clarity US Images

Clarity in Simulation Prostate

It is a hybrid system

Courtesy of Elekta

CT with Clarity contour

CT with Clarity

CT Images

CONE BEAM CT

MR

Do we need soft tissue imaging?

Courtesy of ViewRay
US Challenges
- RTTs require intensive training
- Isocenter calibration needs special phantom
- Image registration difficult
- Target delineation operator dependent
- Not quantitative
- QA intensive
- Continuous monitoring requires transducer on the perineum

MR Challenges
- Limits in Spatial Accuracy
  - Magnetic Field Inhomogeneity
  - Field Gradient Non-linearity
- Difficulties in Image Interpretation
  - Pulse Sequence
  - RF Coil
- Poor System Stability (RF, gradient subsystems)
- Not quantitative
- May require CT image for registration
- In-room MR incompatible with Linac
- Very costly if system is integrated with RT unit

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**Imaging Doses From Ionization System**

<table>
<thead>
<tr>
<th>Acquisition type</th>
<th>Number of fractions per treatment angle</th>
<th>Acquiring quality</th>
<th>Number of dose buildup 100% × 2.5</th>
<th>Number of dose buildup 100% × 1.9</th>
<th>Number of dose buildup 100% × 1.6</th>
<th>Max surface dose (cGy)</th>
<th>Mean surface dose (cGy)</th>
<th>Center dose (cGy)</th>
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<tbody>
<tr>
<td>RTS</td>
<td>5</td>
<td>2.6</td>
<td>2.2</td>
<td>1.6</td>
<td>3.2</td>
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<td></td>
<td></td>
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<tr>
<td>BRON</td>
<td>5</td>
<td>0.4</td>
<td>0.6</td>
<td>0.4</td>
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<tr>
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<td>1.6</td>
<td>1.0</td>
<td>1.3</td>
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<tr>
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<td>2.6</td>
<td>1.4</td>
<td>1.4</td>
<td></td>
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<tr>
<td>Gantry rotation</td>
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<td>0.5</td>
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<td>Yes</td>
<td>4.6</td>
<td>3.3</td>
<td>4.5</td>
<td>2.9</td>
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</tbody>
</table>

- If operated correctly and effectively, imaging dose
  - < 1% of prescription therapy dose
  - Comparable or less than standard weekly portal film dose
CONCLUSION

NO. For prostate radiation treatments, a non-ionizing imaging system is **NOT** a better IGRT technology than an imaging system that uses ionizing radiation.