

Credentialing for the Use of IGRT in Clinical Trials

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2007 AAPM Annual Meeting
Minneapolis, MN

RADIATION THERAPY ONCOLOGY GROUP - RTOG 0236

Phase II Trial of Stereotactic Body Radiation Therapy (SBRT) in the Treatment of Patients with Medically Inoperable Stage I/II Non-Small Cell Lung Cancer

Principal Investigator/Radiation Oncology

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Medical Physics Co-Chair

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Image-Guided Radiotherapy Co-Chair

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Prescription and Margins as Defined in RTOG 0236

- 20 Gy x 3 fractions = 60 Gy
- An additional 0.5 cm in the axial plane and 1.0 cm in the longitudinal plane (craniocaudal) will be added to the GTV to constitute the PTV

RADIATION THERAPY ONCOLOGY GROUP - RTOG 0618

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Other RTOG IGRT Protocols Under Development

- Lung SBRT (x2)
- Sarcoma
- Spine
- Head & Neck (x2)

Using IGRT in RTOG Protocols

- The RTOG has developed Guidelines for the use of IGRT in their protocols
- The Advanced Technology Consortium (ATC) is working on having a uniform set of guidelines for all cooperative groups using radiation in studies

Definition of IGRT

- Process extending from CT-simulation imaging through the step of imaging the patient on the treatment unit
 - Process includes the following steps:
 - Manual or automatic registration of the two datasets
 - Determination of a series of mechanical movements of the patient support system to correct for detected positioning errors

IGRT Techniques

- In-room diagnostic quality CT scanner
- MV and kV cone-beam CT attachments
- MV helical CT capabilities
- Stereoscopic 2D images obtained with kV x-rays

Internal Organ Motion Control (as defined in RTOG #0236)

- Acceptable maneuvers include reliable abdominal compression, accelerator beam gating with the respiratory cycle, tumor tracking, and active breath-holding techniques

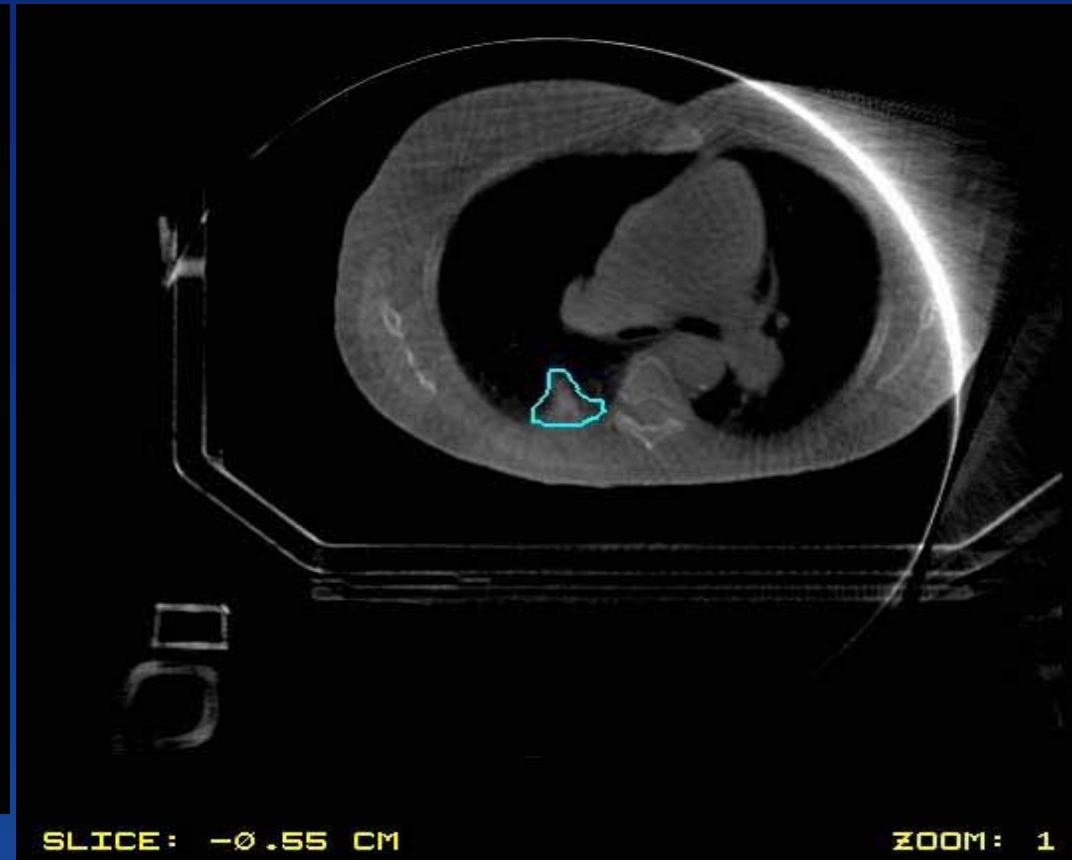
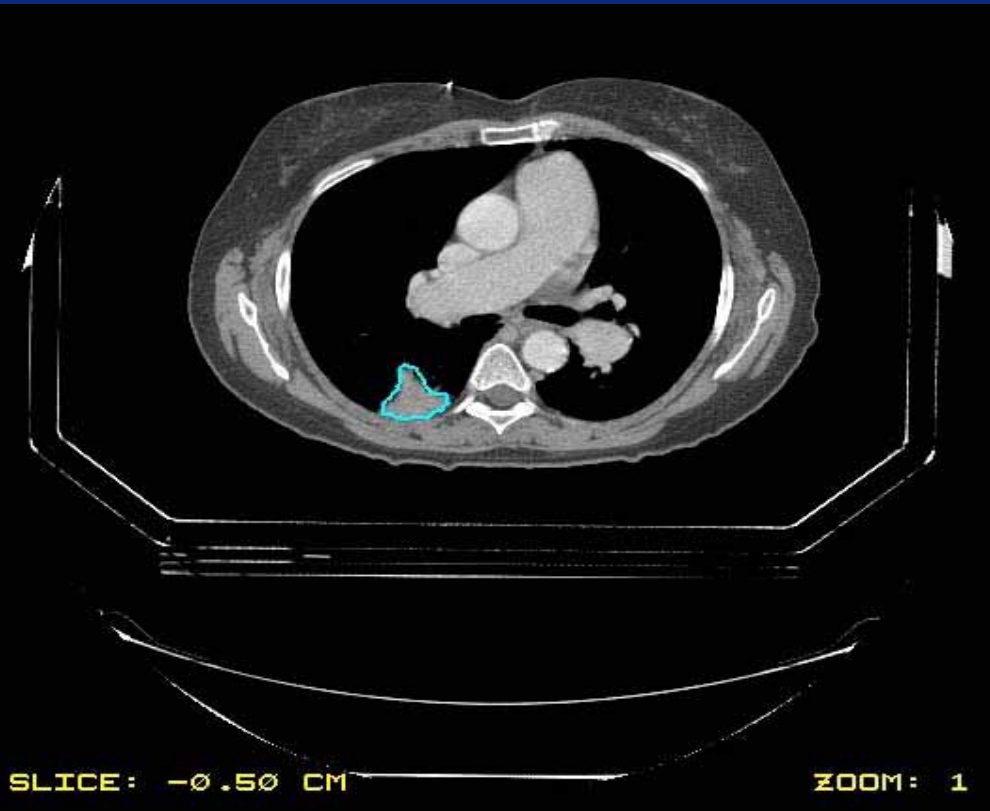
Many Different Approaches to IGRT

- There are many different ways of imaging the patient in the treatment room
- There are many different ways for registering the CT-sim and IGRT datasets
- There are many different ways for adjusting the patient's position based on registration information

Procedure for including IGRT in RTOG Protocols

- **Protocol must include:**
 - **IGRT Specifications**
 - **IGRT Questionnaire**
 - **Phantom Irradiation**
 - Treatment units that do not include a robotic couch
 - Test to evaluate the performance of robotic couches with pitch and roll capabilities
 - **Image Registration Software Tests**
 - Tests that use patient datasets

ITC Remote Review Tool



IGRT Methodologies Not Currently Included

- The guidelines presented here do not include IGRT techniques that use ultrasound or infrared systems that place fiducial markers on the patient's skin
- Deformable fusion techniques are not included at this time

Phantom Requirements

- **Phantom must work for IGRT technologies that use either dual radiographic imaging or volume imaging**
 - Both kV and MV imaging must be accommodated
 - All images must be artifact-free
- **Using the treatment beam, markers must be visible when using EPID, radiographic film, or radiochromic film**

Phantom Requirements (continued)

- Phantom must check both linear and rotational couch adjustments
- Phantom must work for collimators with a restricted field size (e.g., Novalis or Synergy S)
- Phantom must work for robotic systems like the CyberKnife unit

Design Features of TJU Phantom

- Simple cubic phantom made of acrylic
- Precision slide that holds three stainless steel balls (approx. 4 mm dia.)
 - Holes where ball markers are placed are used for artifact-free kV CT imaging
 - One ball is placed at the phantom center and the other two balls are shifted 4 cm from the center
- Phantom has extra base so that rotational errors of 3 degrees along a diagonal can be introduced at the treatment unit

Using Phantom to Check Performance of Robotic Couches



Using Phantom to Check Performance of Robotic Couches



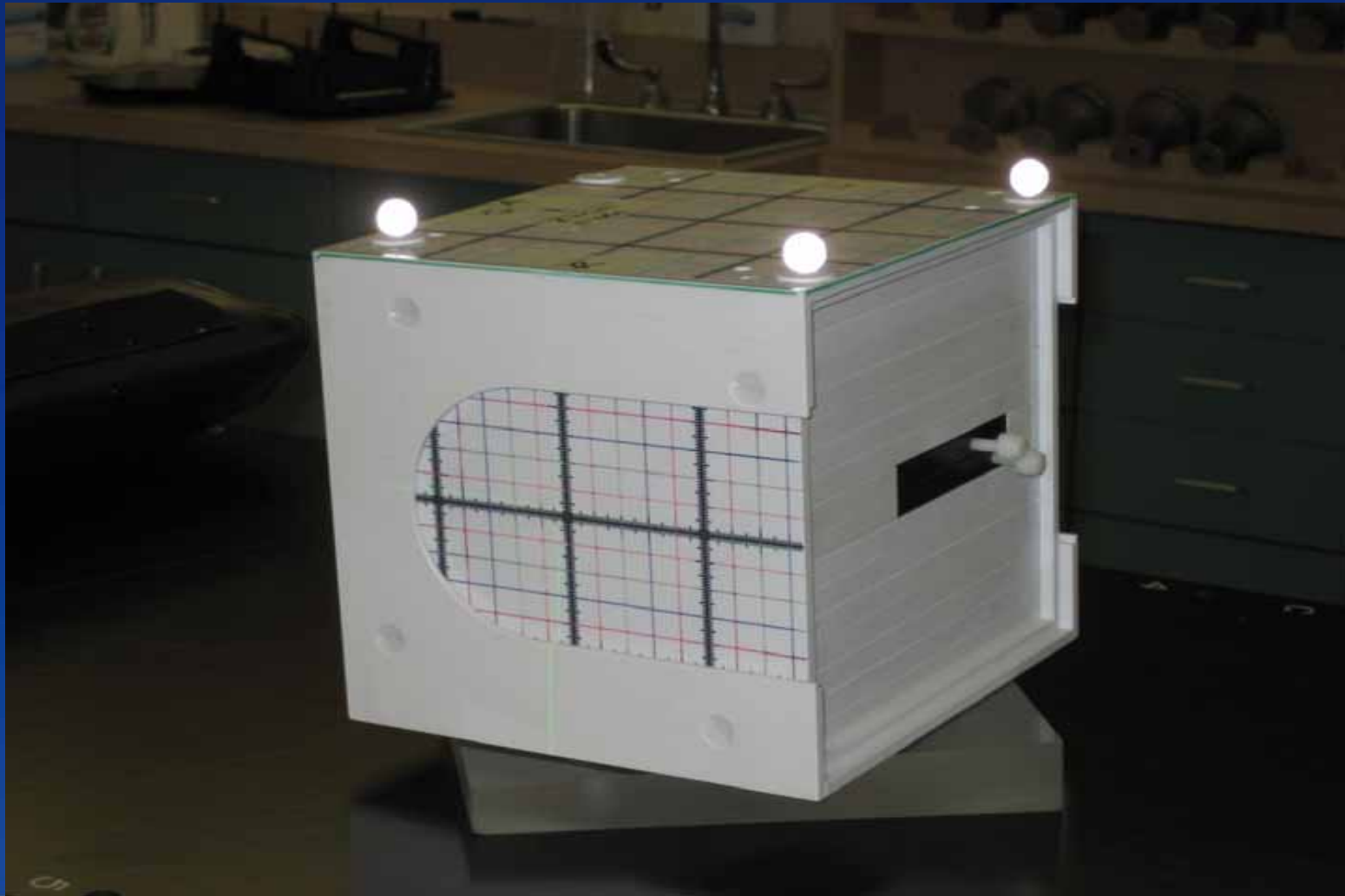
Using Phantom to Check Performance of Robotic Couches



Using Phantom to Check Performance of Robotic Couches



Phantom Design



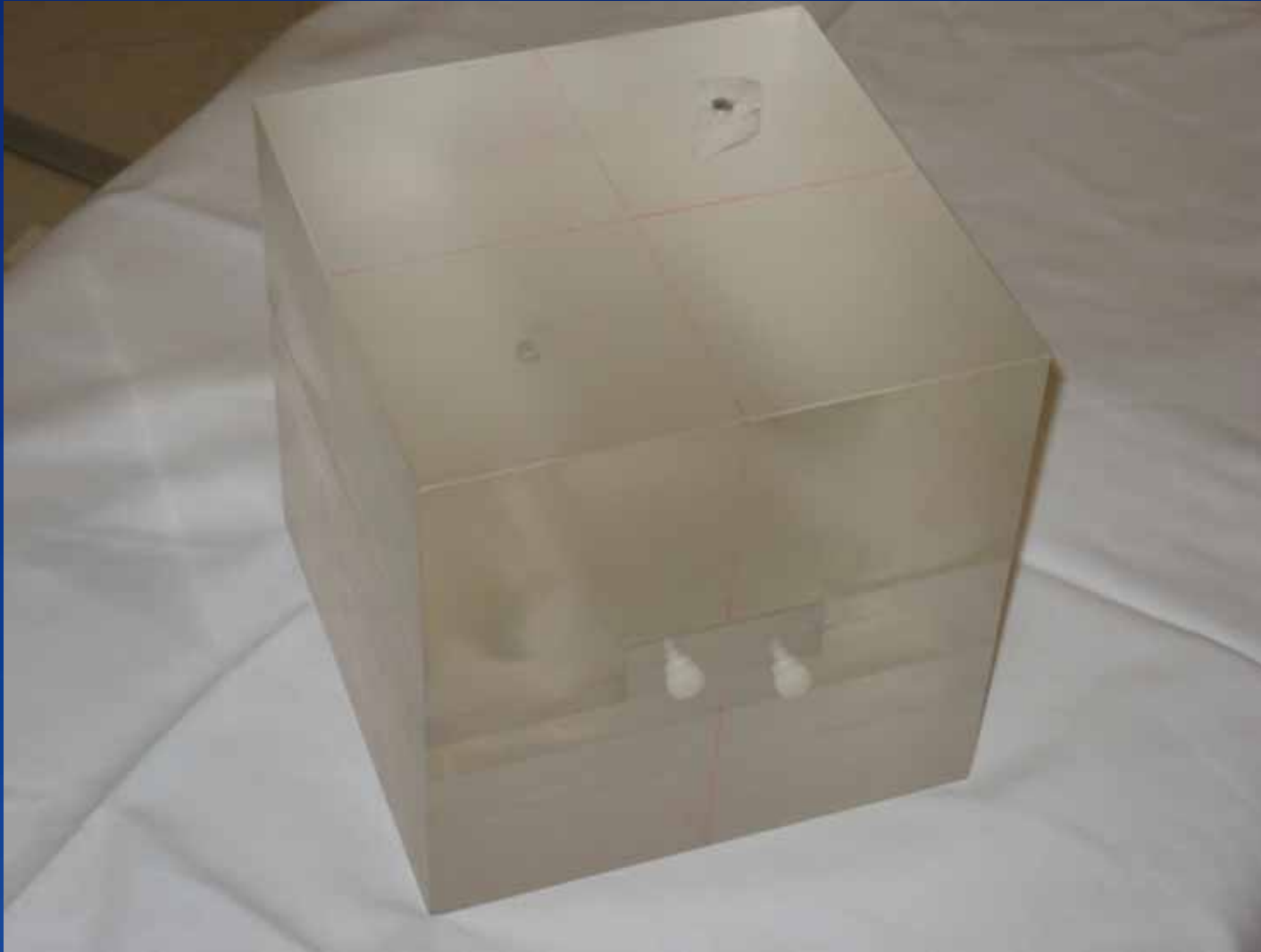
Phantom Design



Phantom Design



Phantom Design



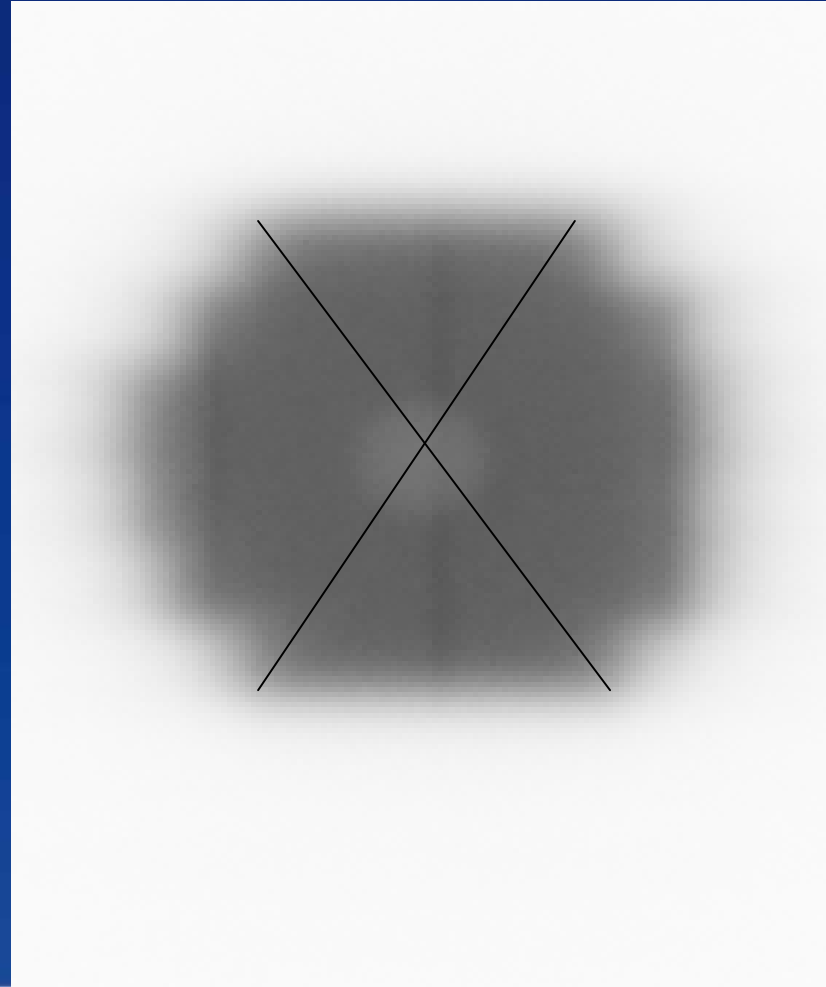
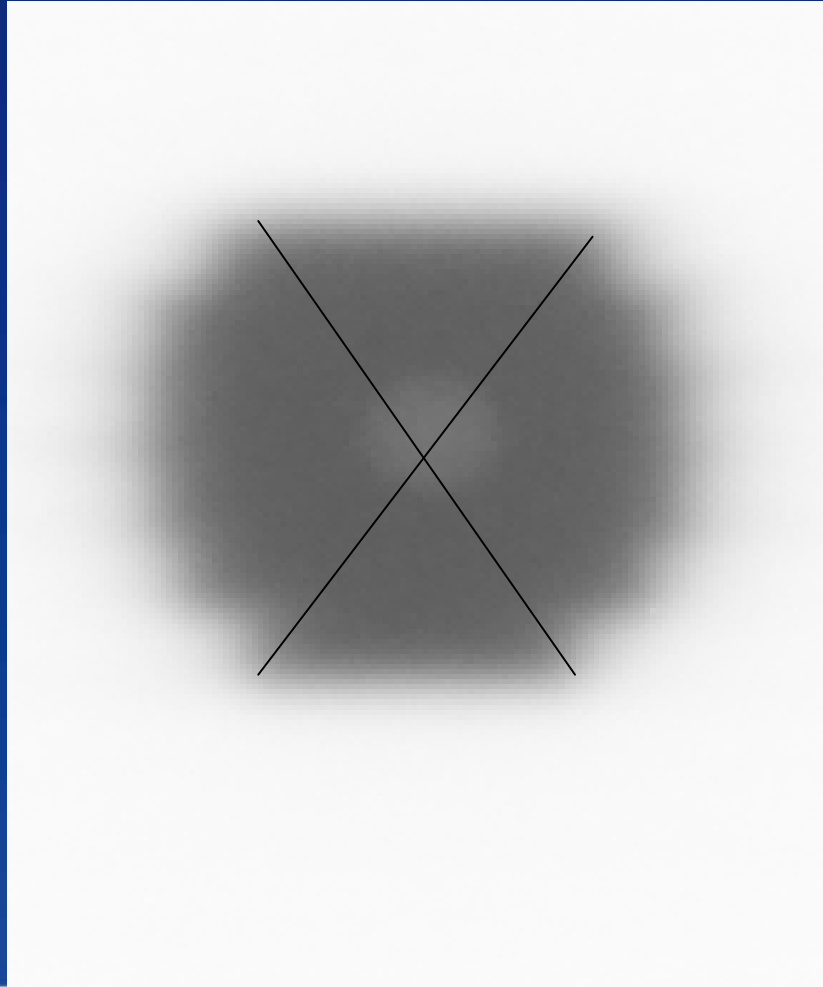
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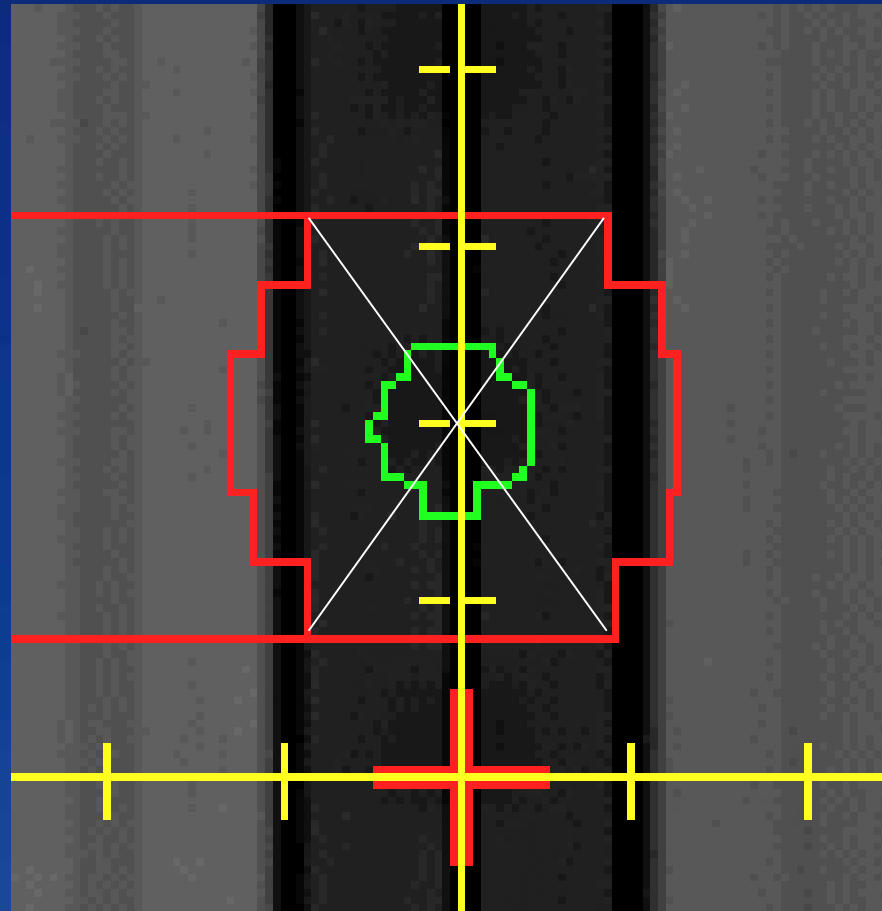
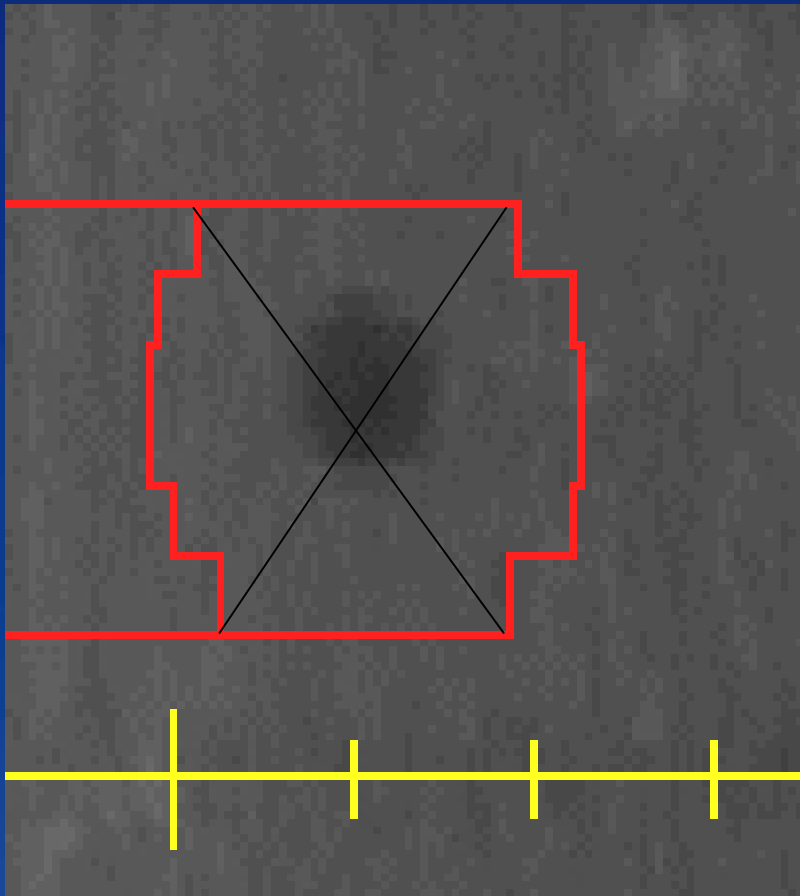
Phantom Design



Orthogonal Pair Shows Deviation Compared to DRR



DRRs



Conclusions

- **Image Guided Radiation is the Next QA Hurdle for Cooperative Groups**
- **The IMRT Model is a Reasonable Starting Point**
- **However, the Challenge is Significant**

