

# Safety Challenges in Motion Management

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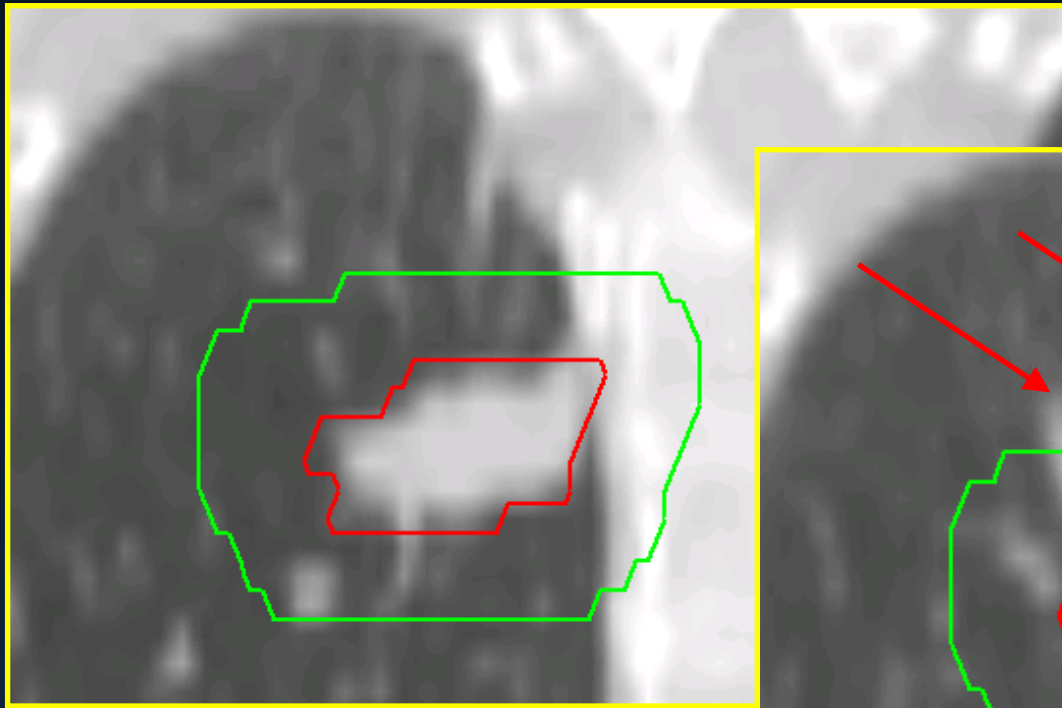
# Disclosures

# Learning objectives

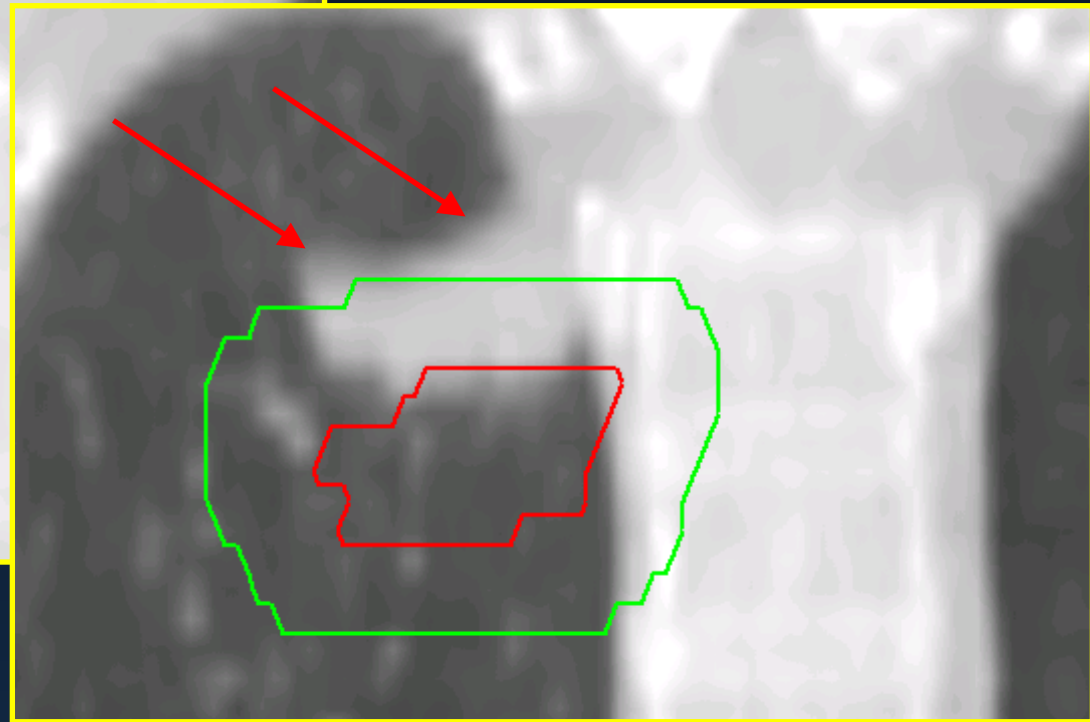
- Describe quality and safety challenges in motion management
- Raise awareness about safety issues in motion management at our home clinics

# Goals of Motion Management (MM)

- Keep the target in our sights  
1 cm margin



Free-Breathing CT

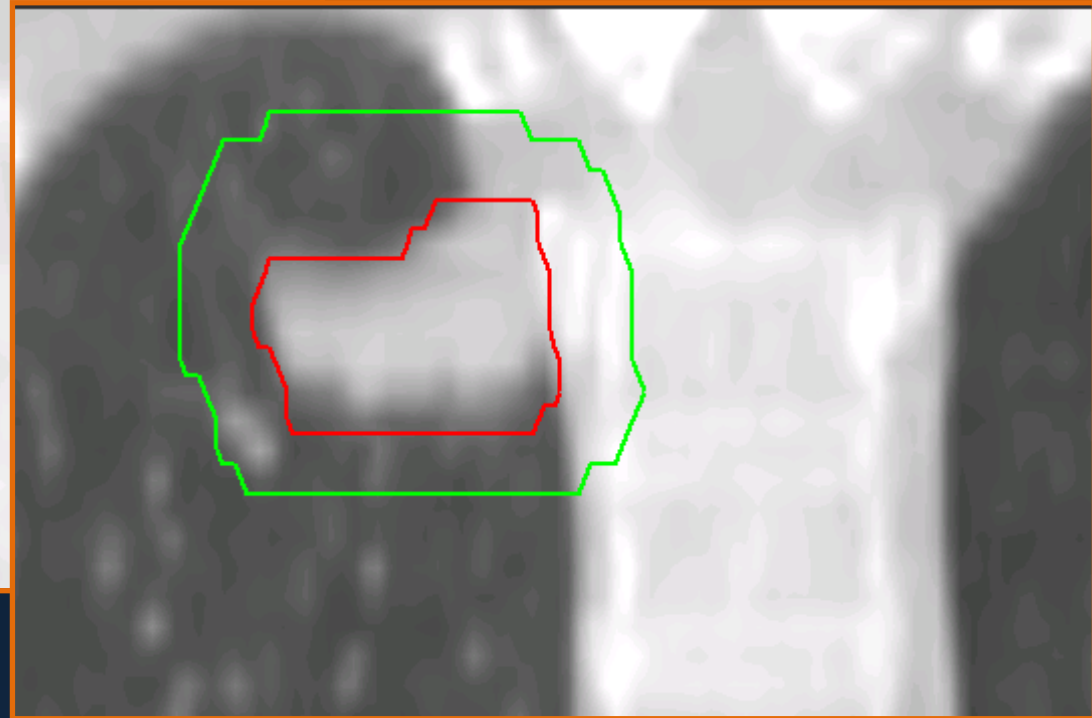
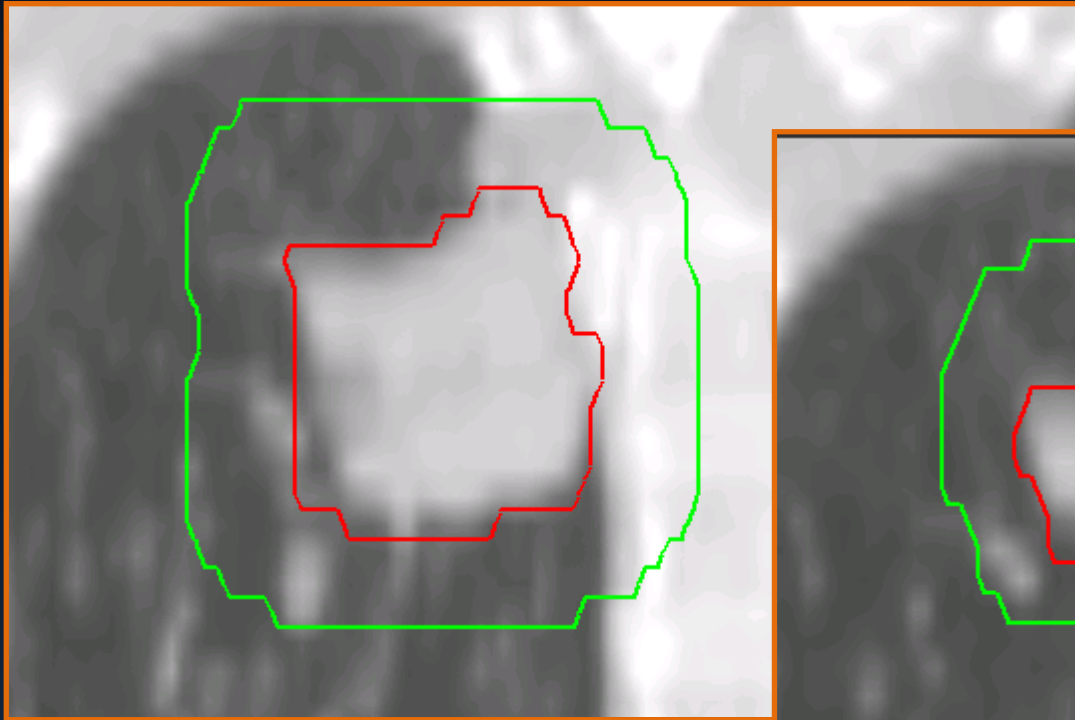


60% phase

# Goals of Motion Management (MM)

- Spare normal tissue

0.7 cm setup margin



MIP

PTV: 107.6 cm<sup>3</sup>

40-60% phase

PTV: 53.4 cm<sup>3</sup>

# Motion management techniques

- Motion-encompassing
- Respiratory gating
- Breath-hold
- Forced shallow breathing
- Real-time tracking

# Know thy enemy

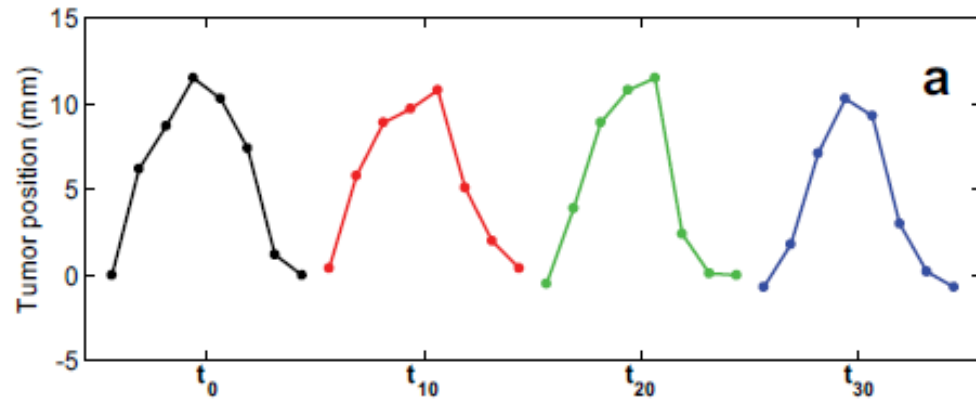
- Given that all other aspects of treatment are safe, what could possibly go wrong
  - Geometric miss
  - Marginal miss
  - Unnecessary normal tissue dose

Safety Challenges

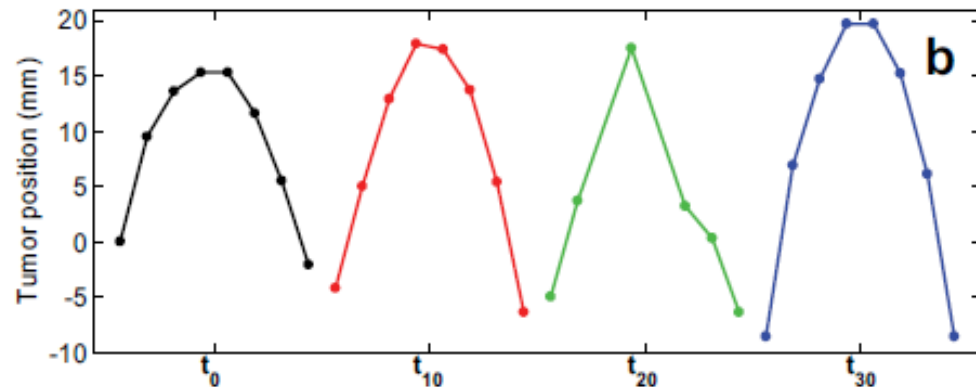
# Simulation



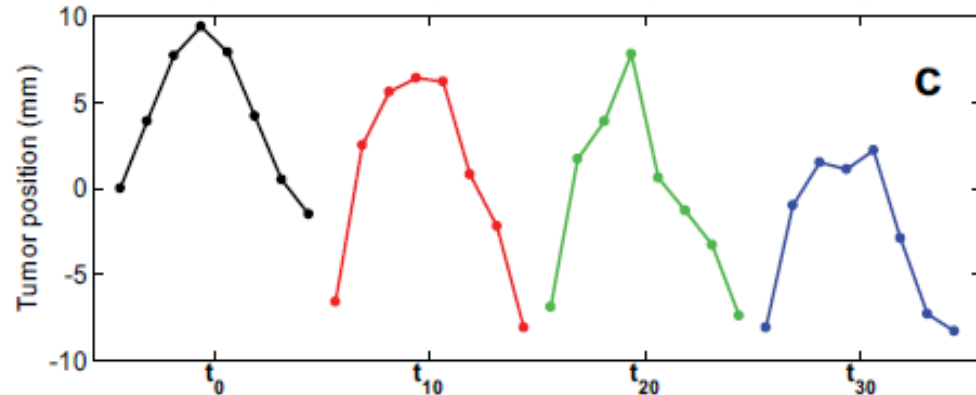
# 4DCT at simulation



← Stable



← Change in excursion



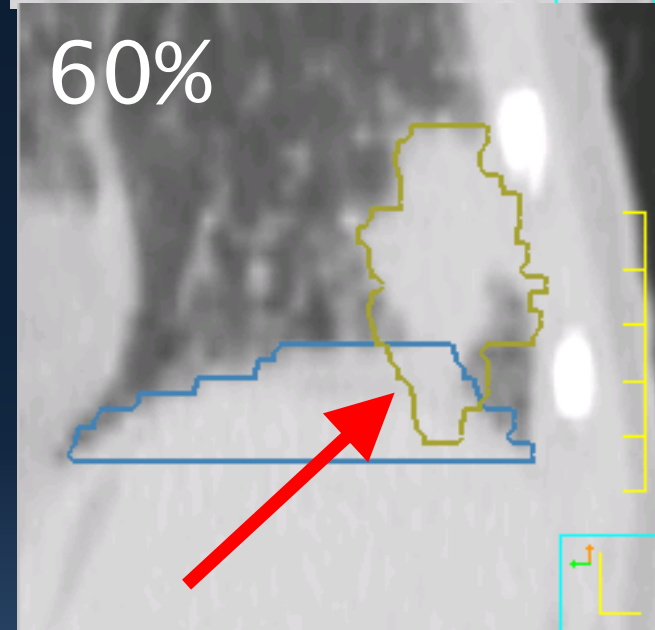
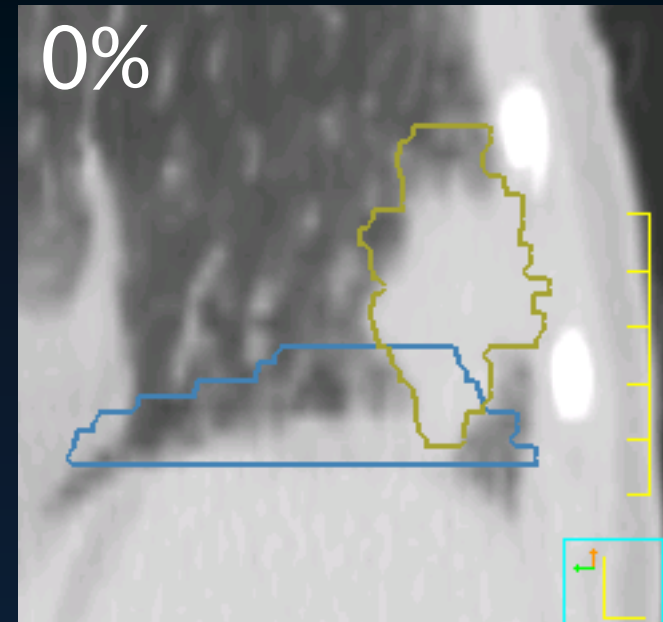
← Change in mean position

Safety Challenges

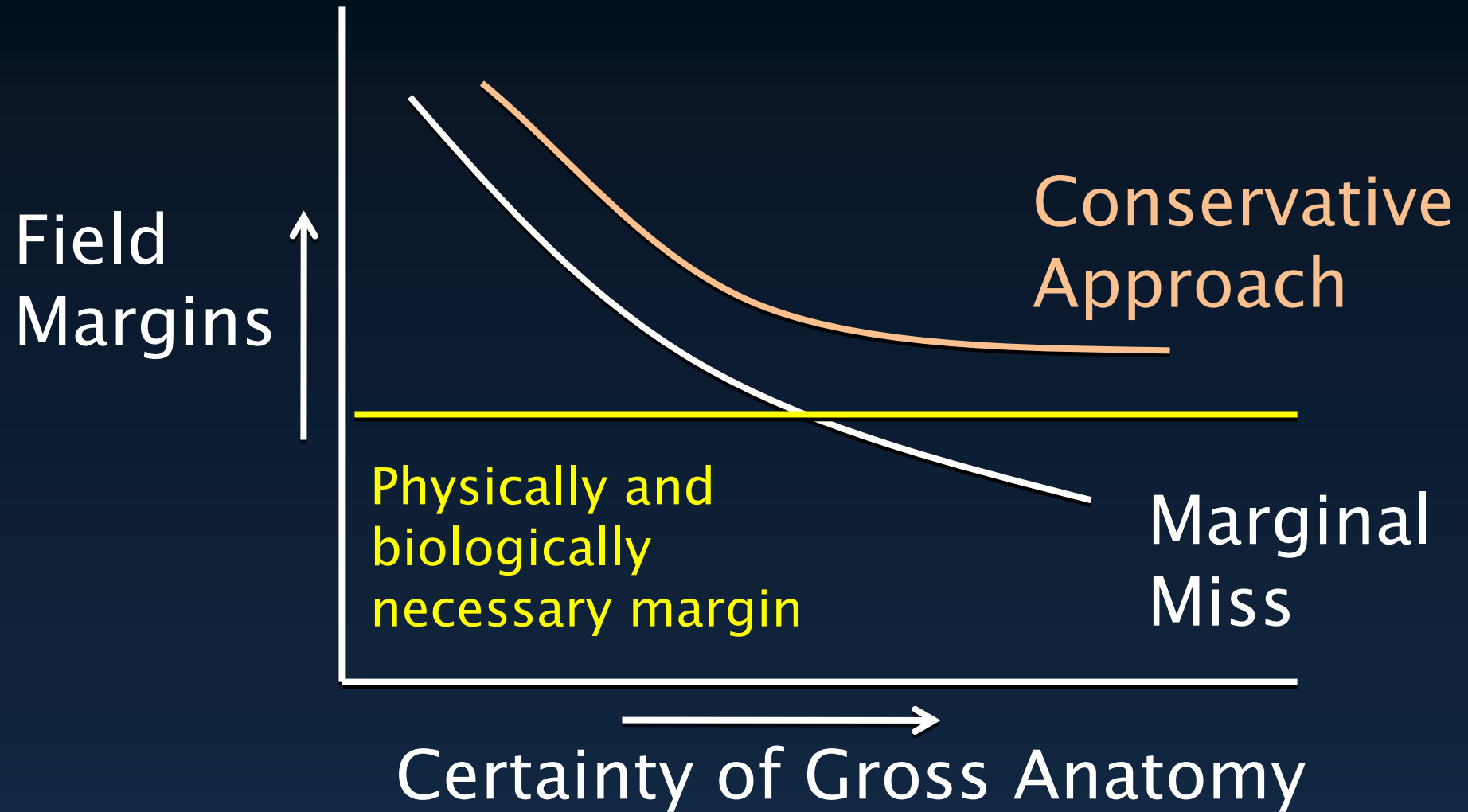
**Planning**

# Contour QA

- Watch for overlapping anatomy in MIP
  - Chest wall, hilum, diaphragm
  - 4DCT
- Who checks the M.D.?
  - QA the ITV contours

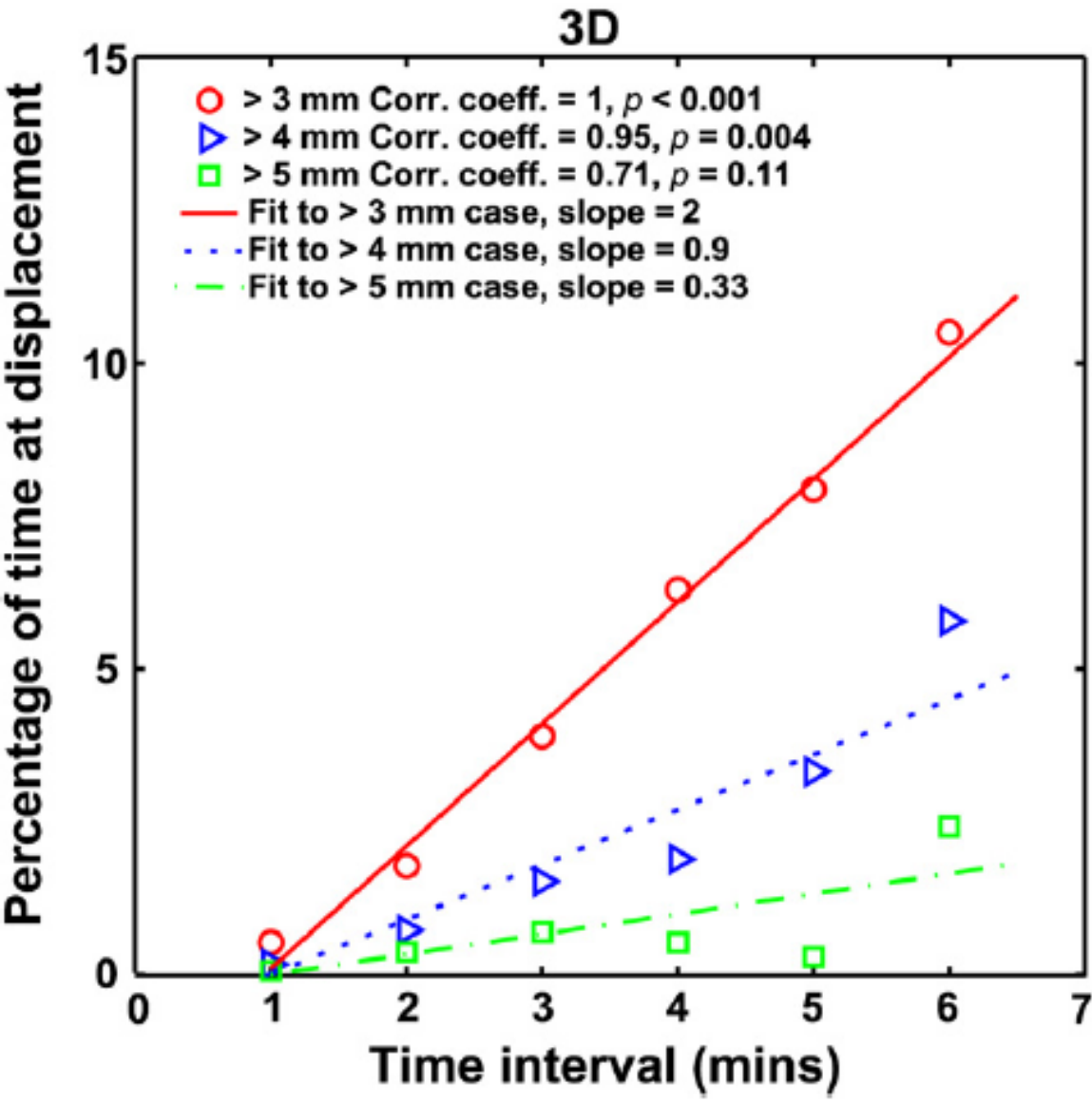


# Physical and Biological limits



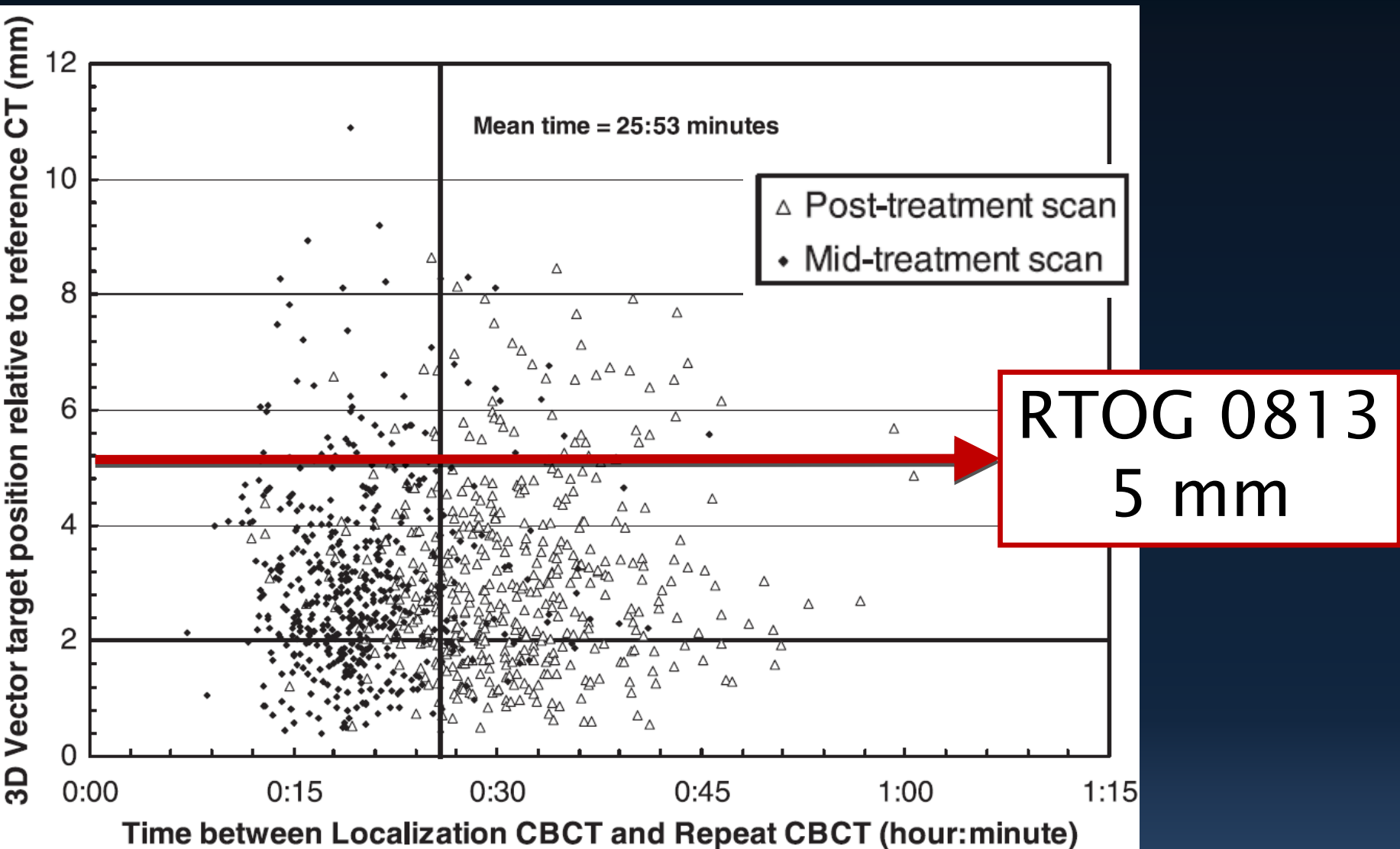
Safety Challenges

**Patient setup/localization**



Intra-fractional prostate motion increases with time, even in the presence of an endorectal balloon

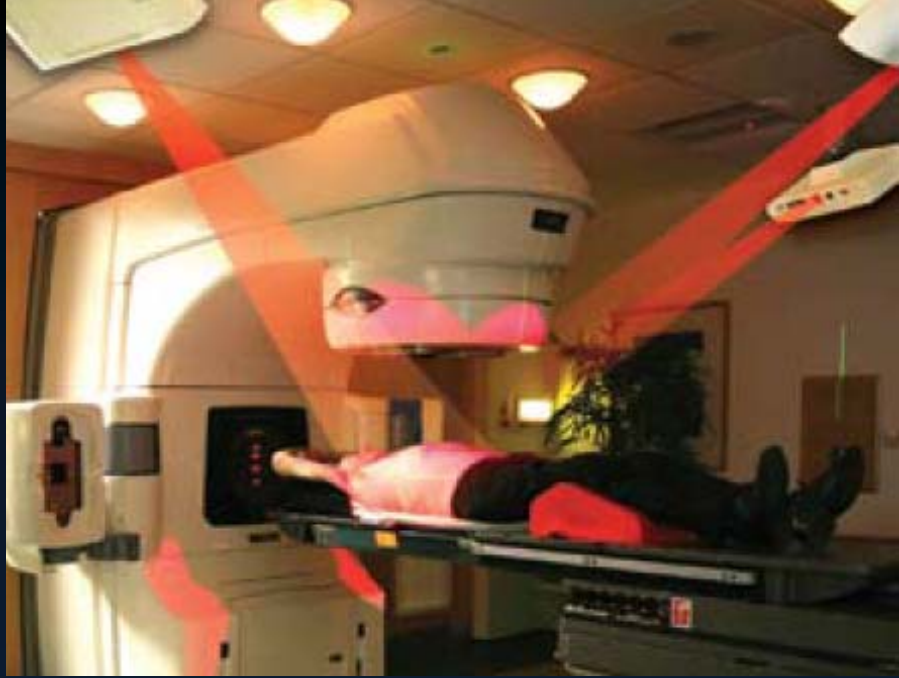
# Intra-fractional motion in lung not correlated to treatment time



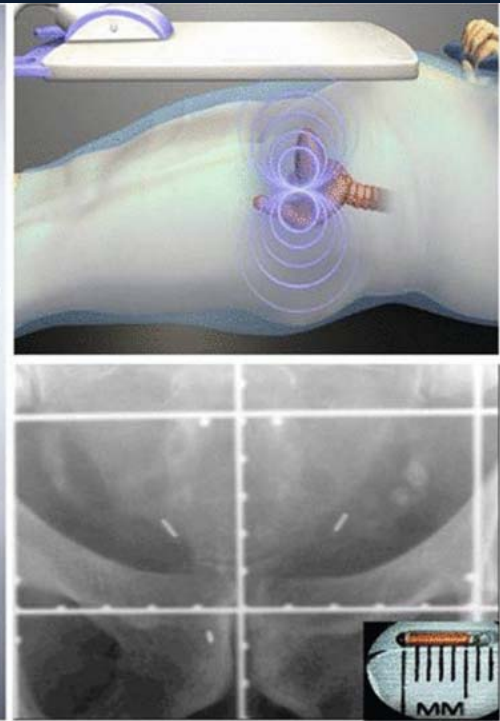
Safety Challenges

**Treatment**





# Real-time tracking

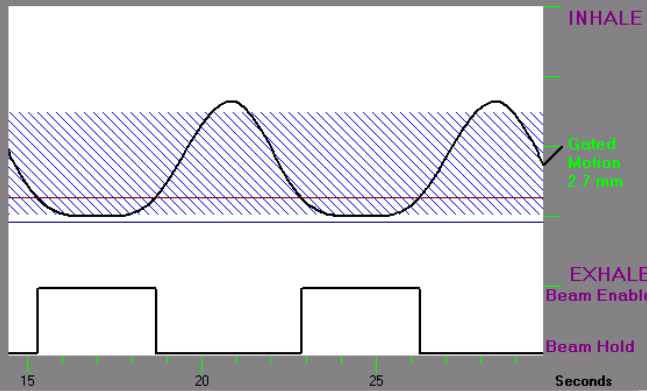
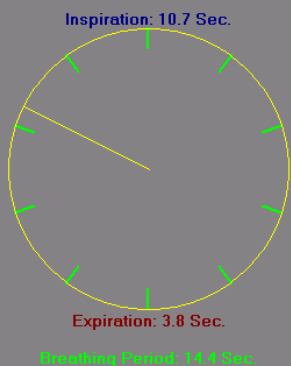


# Respiratory surrogates

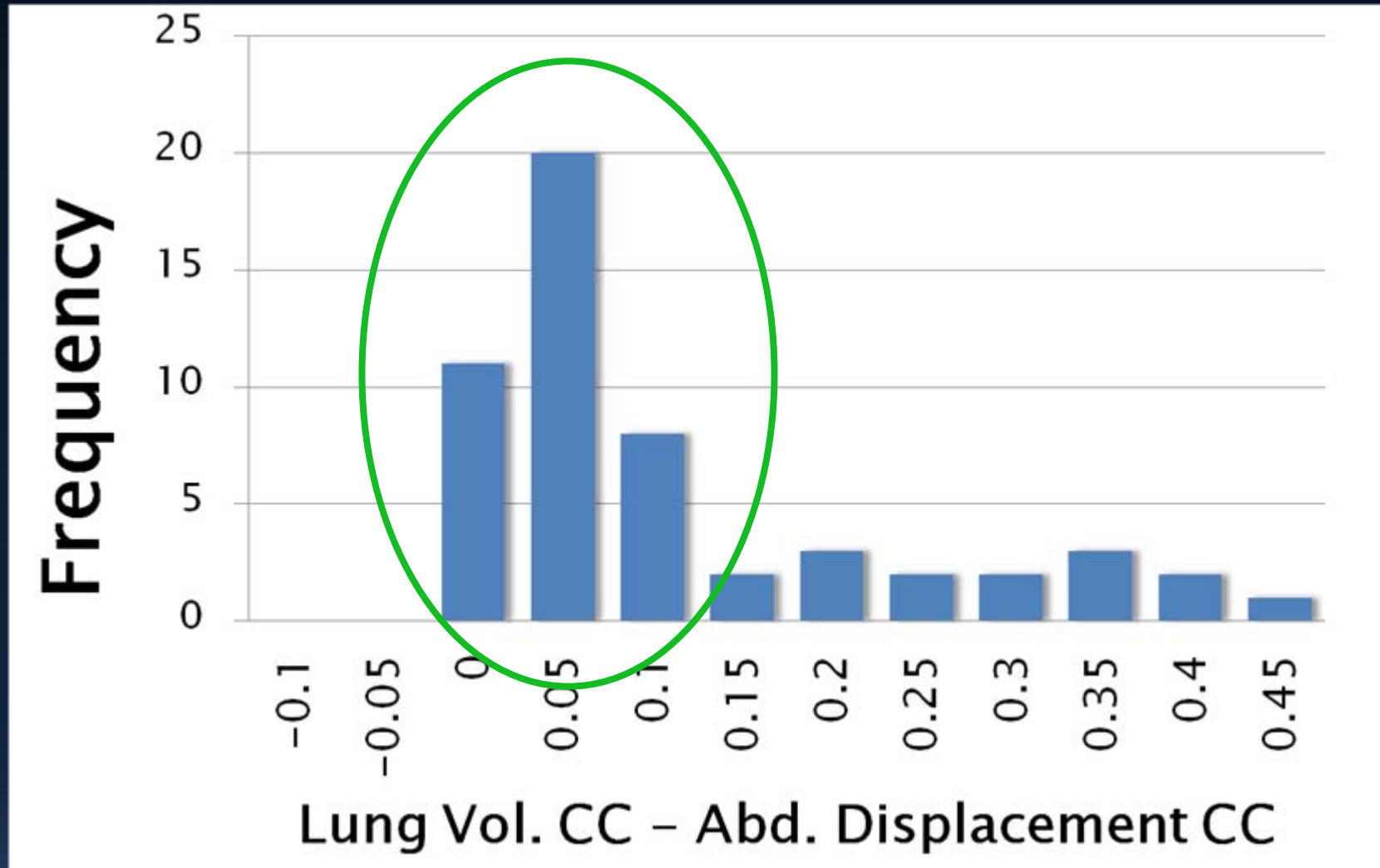
## Abdominal displacement



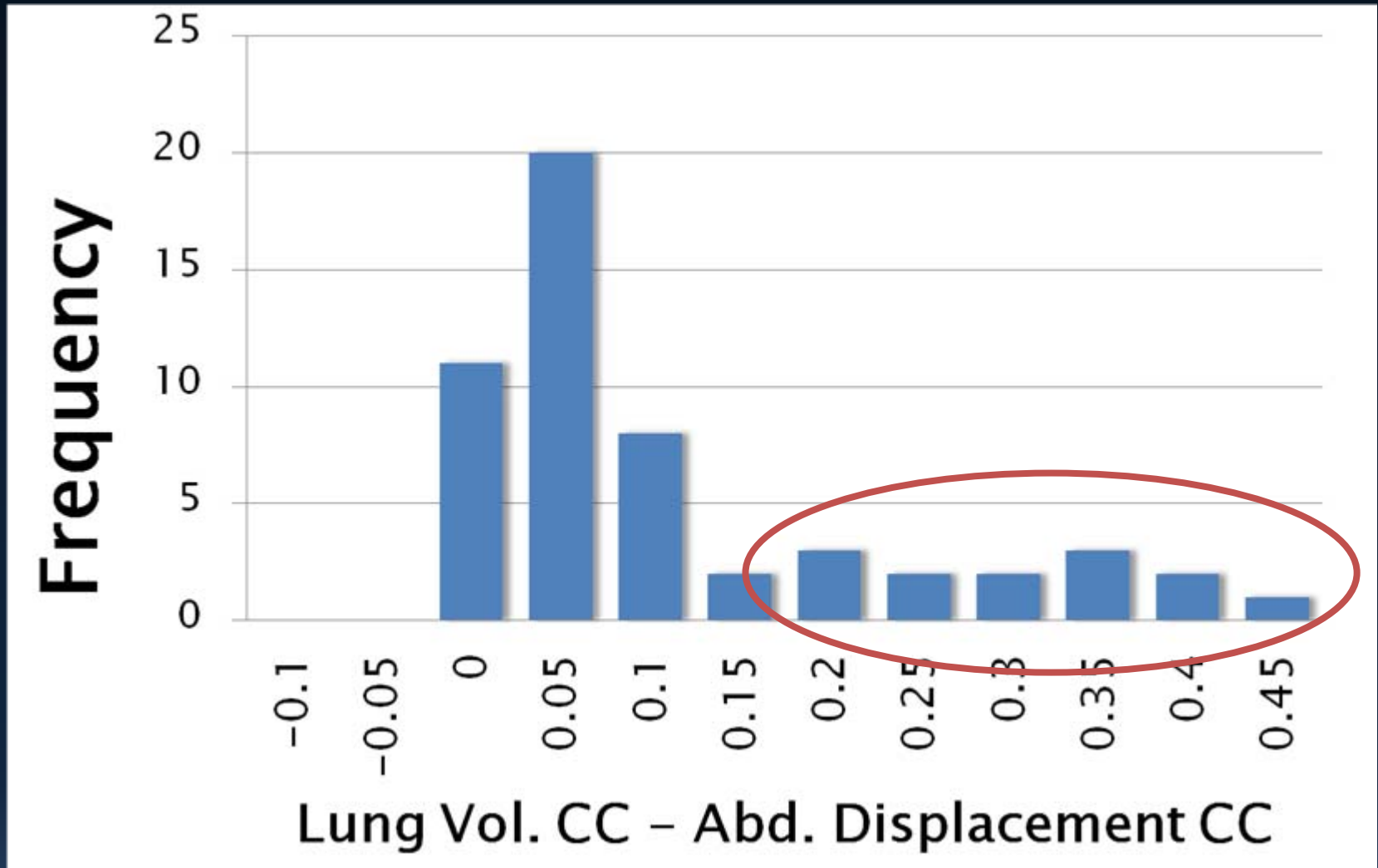
## Differential lung volume



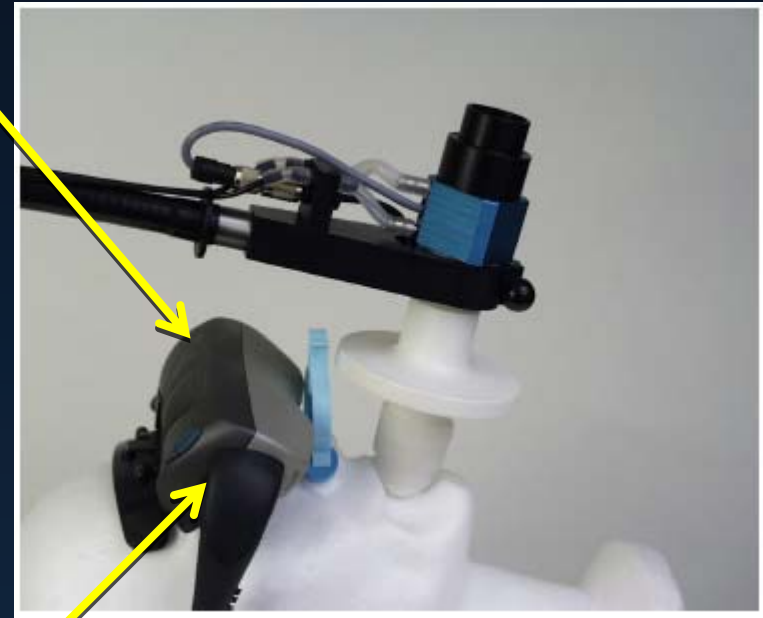
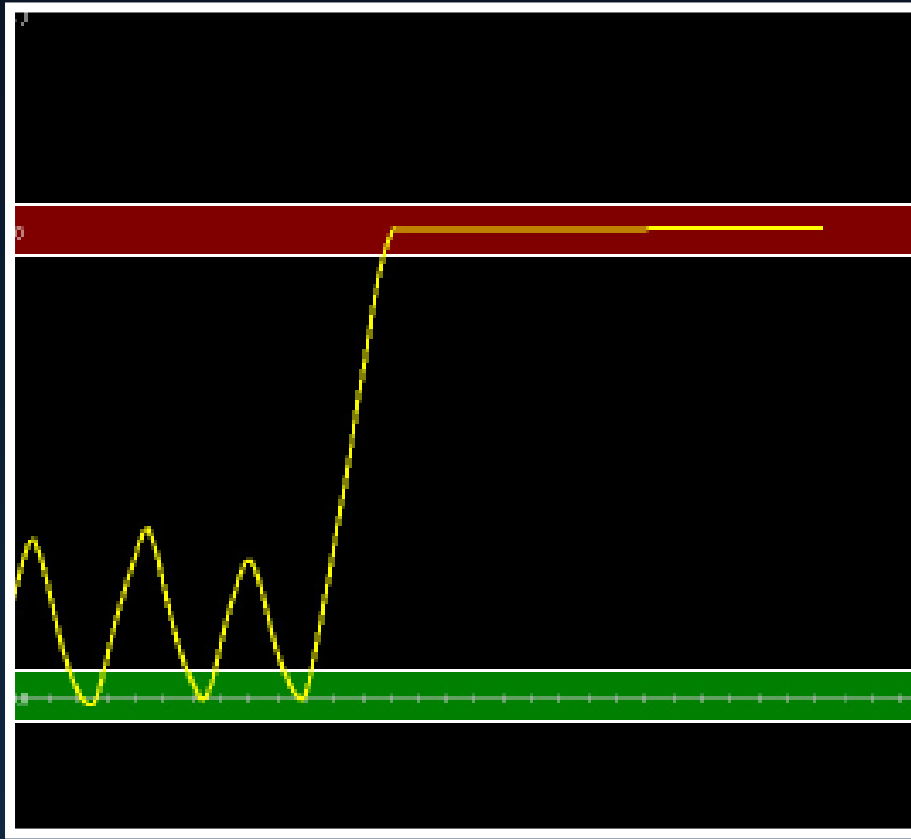
# Lung volume vs abdominal displacement often have similar CC



# When abdominal displacement correlates poorly, Lung volume CC remains high



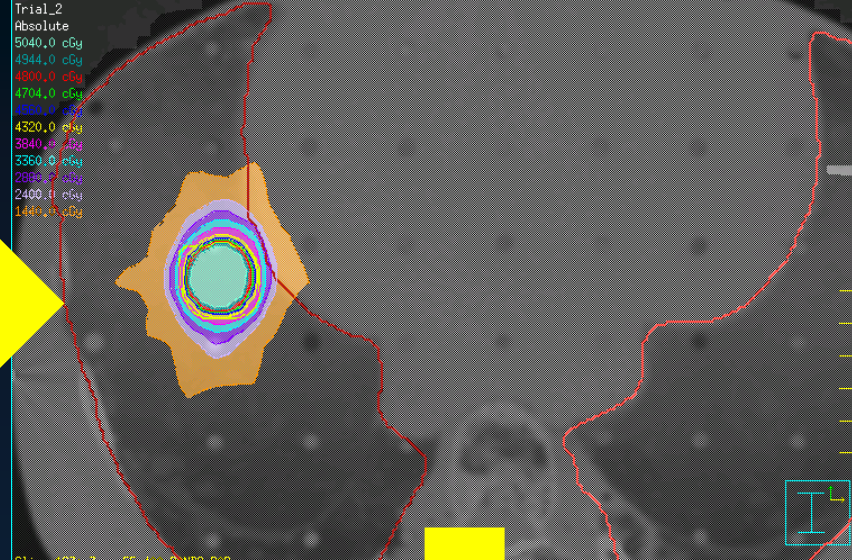
# Can patient-feedback improve correlation among surrogates and internal motion?



Safety Challenges

**Quality Assurance**

# Paradigm of the end-to-end test



?



# Summary of Key Challenges

- Understanding biological and physical requirements of margins
- Identification of misalignment in real-time
- Developing tools and techniques least susceptible to patient-related variability
- Expanding the QA paradigm to include the patient and physician