Introduction

Disclosures

- **Patents**: Awarded and pending
- **Licenses**: Nano-X, Respiratory Innovations, Standard Imaging, Varian
- **Grants**: Philips (Co-Investigator), Varian (Co-I)
- **Ownership**: Cancer Research Innovations, Nano-X, Respiratory Innovations

Real-Time Target Tracking Technologies

What is your real-time target tracking feature wish list?
What is your real-time target tracking feature wish list?

- Volumetric
- High spatial resolution
- High temporal resolution
- High fidelity
- Can transfer planning contour & dose information to & from
- Low latency
- No interference with delivery system
- Non-invasive
- No imaging dose
- Can optimize and compute dose on
- Reduces treatment time
- Cheap with low operational costs
- Low latency
- No interference with delivery system
- ...
Real-time Ultrasound Guidance:
Prostate tracking using Elekta Clarity

Elekta Clarity Autoscan™ Gating response interface received FDA Clearance Nov 2014

Courtesy Emma Harris & Tuathan O'Shea

Potential for robust tracking of liver tissue during therapy – O'Shea et al. MO-DE-210-5

Real-time Ultrasound Liver Guidance

Real-time markerless guidance (MV)

› Less contrast, challenges with beam modulation
› Cheapest, in BEV

Courtesy Ross Berbeco & Joerg Rottmann
Real-time markerless guidance (kV)

Class of algorithms w/without priors, including digital tomosynthesis

SI error (Mean ± SD)

0.0 ± 0.7 mm

Courtesy Andy Shieh

Real-time ‘4D’ fluoroscopy

Axial Tumor Position (mm)

Projection Angle (degrees)

Lewis PMB 2010

Real-Time Adaptation Technologies
What is your real-time adaptation wish list?

› Integrates all sources of imaging information
› Integrates all sources of uncertainty
› Optimizes in real-time using all available degrees of freedom
› Modifies delivery appropriately
› Responds instantaneously

Real-time Adaptation Systems

Robotic linac head
CyberKnife
Synchrony, Accuray
Clinical 2004

Gimbaled linac
Varo/Mitsubishi
Clinical 2011

MLC adaptation
Clinical 2013
Smallest
Lightest
6 DoF
Deformation

Robotic couch
Clinical ?
Clinical MLC tracking

Dose With and Without MLC Tracking

Red = PTV

Real-time adaption vs nothing (current standard of care)
Many real-time target tracking and adaptation technologies are available
Several barriers to widespread uptake
Tipping point will be availability on standard linacs → clinical routine

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