


Working On MRI Guided Machines (MRI-Linac/Co60) for Medical Physicists Who Are Not Trained in MRI

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all for one 

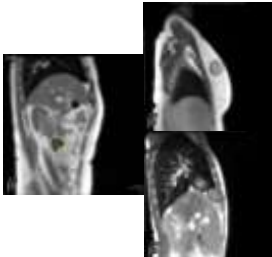
Disclosures

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 - Philips Healthcare
 - HFHS Internal Mentored Grant
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all for one 

Why MR-IGRT?

- Bring powerful soft-tissue contrast into the treatment room
- Enable real-time tracking, gating
- Monitoring
- Facilitate adaptive radiation therapy
 - Potential for per-fraction dose-escalation when anatomy is favorable
 - De-escalation if necessary



Clinical MR-guided RT Platforms



1.5T MRI
7 MV standing wave linac



Split bore 0.35T MRI
6XFFF magnetron powered linac or
Tri-Cobalt

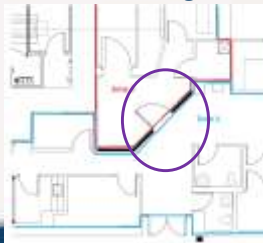
Vault & Room Construction

- Retrofitted a Varian 21EX Linac vault
- Shielding with concrete, reinforced with rebar
- Copper layers for RF insulation
- Run all electronics/cables through penetration panel (waveguides/filters) to limit RF interference



Lesson Learned: Following ACR MRI Safety Zoning Recommendations for Room Design

- Added badge-protected sliding door to partition Zone 3
 - Restricted area, controlled/supervised by MR personnel
 - Restricted from public access (key locks, badge swipe, etc.)
 - Follows our hospital MR Safety Policy
- Zone 4: MR scanner room



Routine QA for Hybrid MR-IGRT

- Simulator:
 - TG-66, CT-SIM QA
- IGRT System:
 - TG-142, couch repositioning, image quality, frequency
- Linac:
 - TG-142 recommendations, SBRT/SRS considerations, Gating
- MRI:
 - TG-1, MRI image quality checks
- Ultimately you need to devise tests to work in an environment unlike anything you have worked in before!

Example Daily QA Workflow

1. Align water-filled phantom to lasers
2. Verify couch height
3. Move to known offset of imaging iso, acquire A26 (0.015 cc) MR-compatible ion chamber MRI, verify image quality/spatial integrity



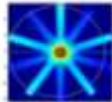
4. Register to baseline MRI at imaging isocenter
Verify couch shifts (1, 2, -2 cm), apply shifts
5. Verify output of 6XFFF beam against expected



New QA Approaches & Needs

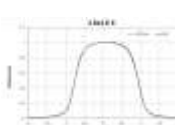
Gantry Isocentricity

- Gafchromic film in cylindrical water phantom to generate signal



Small Beam Profiles

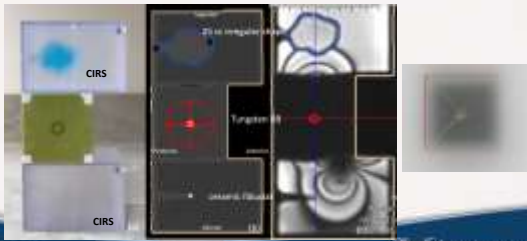
- 1D MedTech tank with A26 (0.015 cc) MR-compatible ion chamber, manually stepped couch



MR-Compatible Equipment List (what we purchased & use)

| Equipment | Use |
|---|--|
| • Exradin A26 MR-Compatible Chamber (0.015 cc) | • PSQA (SBRT), Daily QA |
| • Exradin A12 MR-Compatible Chamber (0.65 cc) | • Monthly output checks, TG-51 |
| • Gafchromic EBT Film + In-house software | • SBRT PSQA, Winston-Lutz, Picket fence test |
| • 1D Medtech mechanically driven water tank | • Monthly output checks |
| • SunNuclear MR-compatible Arc Check | • Commissioning: PDDs and small field profiles |
| • SunNuclear MR-compatible IC Profiler | • Conventional IMRT PSQA |
| • JM Specialty Parts Large MRI Phantom (ACR) | • Commissioning: large field profiles |
| • In-house large field of view distortion phantom | • Monthly flatness & symmetry |
| • MR-compatible programmable motion platform | • Monthly image quality QA |
| | • Commissioning: distortion evaluation |
| | • Monthly/Annual Gating QA |

In-house End-to-end/Winston Lutz



Coil/Immobilization Optimization for SNR



MR-guided RT Requires Creative Solutions!



Paul Jackson, RTT
Solution to bore geometry differences (85 cm vs. 70 cm):
NERF DARTS!



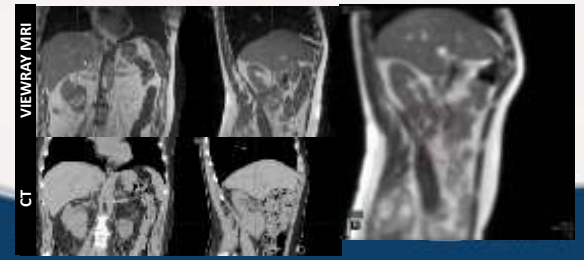
UW Madison trick:
Pool noodle to suspend coil from breast →
avoid deforming external anatomy

Brain/H&N Mockups: Trial #1,345,324

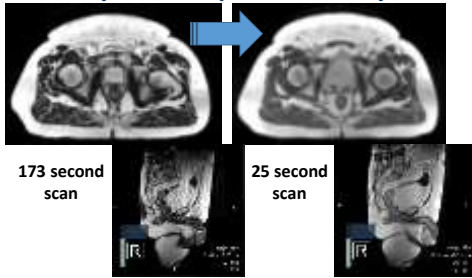


Earphones: Attenuating
Ear buds: Require
cutouts

Metastatic melanoma, inferior Rt kidney mass, gated SBRT, end-inhale, 3 mm tracking boundary



Physicists help with so many decisions!



Conclusions

- MR-IGRT hybrid systems present unique siting & QA needs
- RT Physicists will need to bring creative solutions into their programs and work with vendors to develop tools we need
- You will see amazing things—but then we need to decide how to act on all of this new information
