



Clinical Applications of MRI

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Outline

- What has limited MRI from wide applications?
- Applications in MR-based treatment planning
 - Current: CT-based planning with Image fusion

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|----|-----|--------------|-------------|-----------|
| CT | MRI | Registration | Delineation | Dose Plan |
|----|-----|--------------|-------------|-----------|
 - Future: MRI-based planning is almost ready
 - Two approaches: Synthetic CT and MRCAT

| | | |
|-----|-------------|-----------|
| MRI | Delineation | Dose Plan |
|-----|-------------|-----------|
- Applications in MR-guided treatment delivery
 - MRI-guided radiotherapy (and brachytherapy)



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Gaps to wide MRI Applications

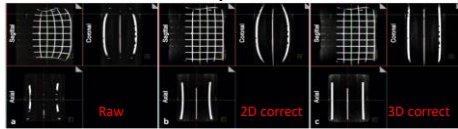
- Some gaps have been/will be filled with recent efforts
 - Lack of MRI expertise knowledge
 - Lack of quantitative measures of geometric distortion and correction methods
 - Other lacks...
 - Lack of billing code for clinical service reimbursement
 - Lack of dedicated MRI scanner for radiotherapy department
 - Lack of established MRI clinical workflow for simulation
- These suggest opportunities for improvement
 - More vendors have participated clinical implementations ...



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MRI Scanner QA

- Gradient-nonlinearity distortion & correction



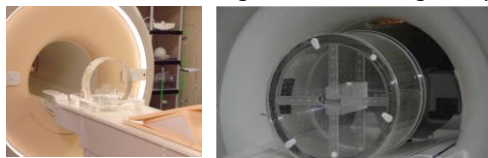
Siemens 3T scanner, Courtesy of Dr. Eric Paulson, Méd Phys, 42 28, (2015)

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MRI QA Phantoms

- Correction of MRI field gradient inhomogeneity



Philips $\Phi = 40\text{cm}$ QA phantom

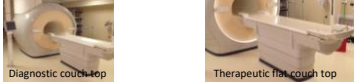
Quasar $\Phi = 40\text{cm}$ QA phantom with surface markers



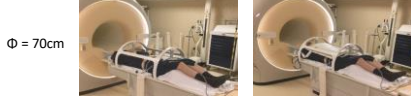
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Patient Simulation

- Couch top: from curved to flat for simulation



- Anterior coil setting for planning simulation



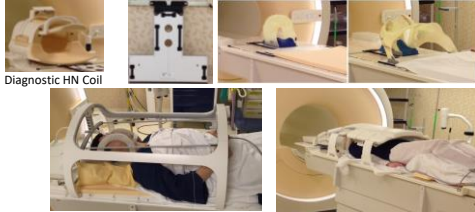
Φ = 70cm



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Patient Immobilization

- HN immobilization device setting



Diagnostic HN Coil

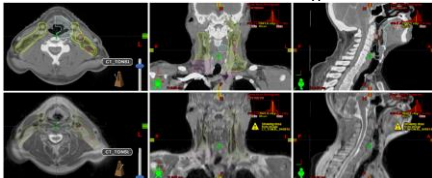


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Head and Neck

- Using a MRI-compatible immobilization device

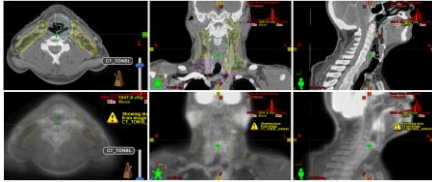
- Less tissue deformation and better target delineation



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PET/CT with MRI

- Multimodal images for better target delineation



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Lung MR Simulation

- Alpha cradle extending from the shoulder to the pelvis on a lung board with table index.
- Mold is modified to include ear plugs and head phones
- Arms up and knee support
- Use a MRI-compatible Bellows
- Anterior coil is placed on a bridge

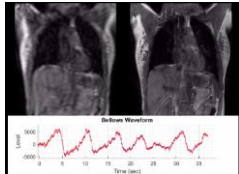
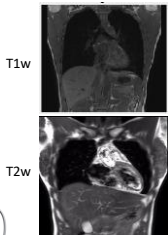


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Lung and Upper Abdomen

- 4DMRI for motion assessment



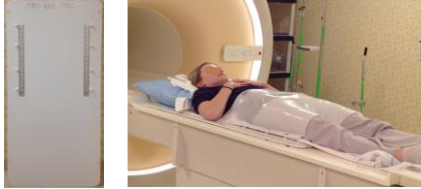
Time-resolved, super-resolution volumetric 4DMRI

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Pelvis MR Simulation

- MR coil can be placed on top of the mask

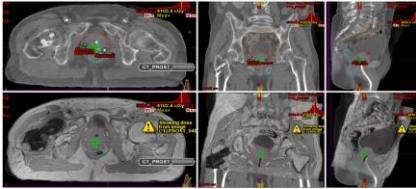


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Prostate MR example

- MR to CT image registration for treatment planning
 - Metal artifacts are shown due to femur metal implants

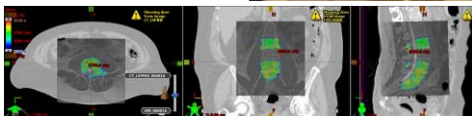


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Paraspinal Simulation

- Better cord delineation for paraspinal SBRT/SRS
- Use anterior/posterior coils
- Clinical MR/CT image fusion



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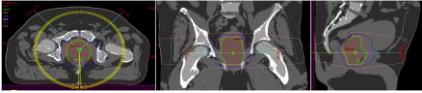


MRCAT for Prostate

- MRI-only treatment planning workflow



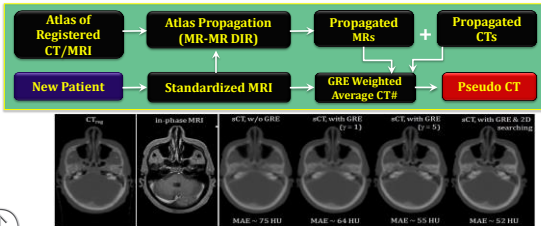
- MRCAT is a FDA-approved product to convert MRI image to CT image for pelvis/abdomen



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Synthetic CT for HN



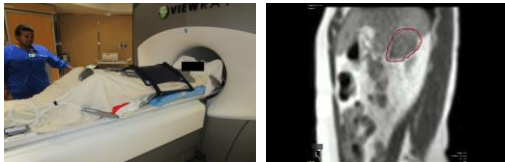
Courtesy of Drs. Reza Farjam and Joe Deasy at MSKCC for sharing this slice.

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MRgRT from ViewRay

- ViewRay patient setup
- Sagittal cine MR



Courtesy of Drs. Dan Low and James Lamb for sharing this slice.

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Summary

- Wide clinical MRI applications require efforts from ALL parties involved in Radiotherapy
- Majority of current clinical MR applications are image-fusion based
- Methods and workflow of MRI-based planning have been studied and ready for applications



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