

Impact of Gantry, MLC, and patient table power on an MRgRT system

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INTRODUCTION

High confidence in spatial integrity and imaging isocenter are paramount for patient positioning and adaptive radiotherapy planning. MRI guided radiotherapy (MRgRT) systems incorporating a moving LINAC within an MRI system are at risk of degradation in spatial integrity and movement of the imaging isocenter due to the ferromagnetic components of the LINAC moving and disrupting the magnetic field homogeneity.

AIM

To assess imaging spatial integrity and isocenter position at multiple gantry angles, MLC field sizes, and patient table power state, on the ViewRay MRIdian MR-LINAC system.

This work also investigates the change in these parameters pre- and post-system upgrade to the LINAC version 2.0 and software package 5.3.0.

METHOD

Phantoms:

- Spatial integrity (SI) phantom with internal grid markers
- Cylindrical daily QA (DQA) phantom with five post markers

Gantry position:

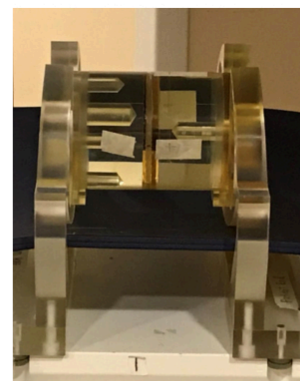
- Images acquired every 30° and compared to the home angle designated at installation (0° and 300° pre- and post-upgrade respectively)
- Assessed with the SI phantom in MR QA mode and the DQA phantom in clinical mode.

MLC

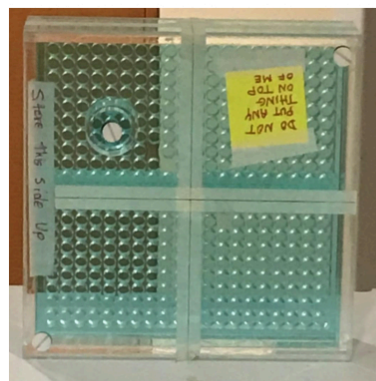
- The impact of MLC position was assessed for eight square fields and a fully open field
- Performed in MR QA mode using the SI phantom post-upgrade.

Table power state

- Table power was assessed with the SI phantom only post-upgrade.



DQA phantom in cradle

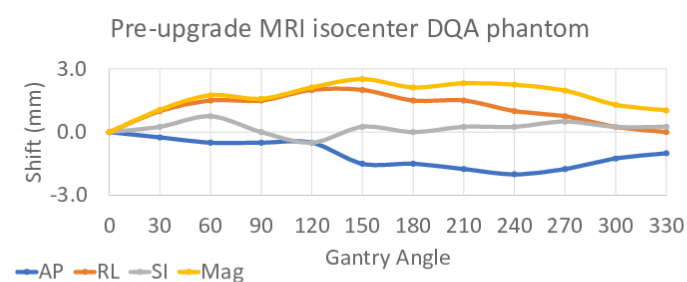
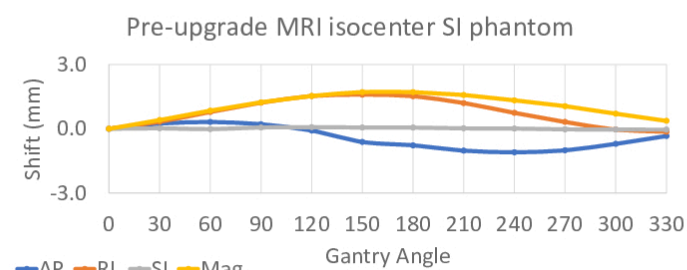


SI phantom on table

RESULTS: ISOCENTER SHIFT

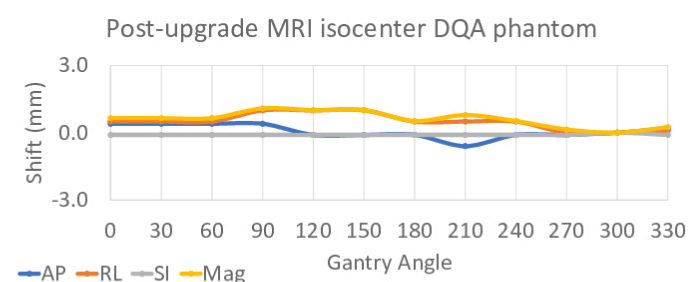
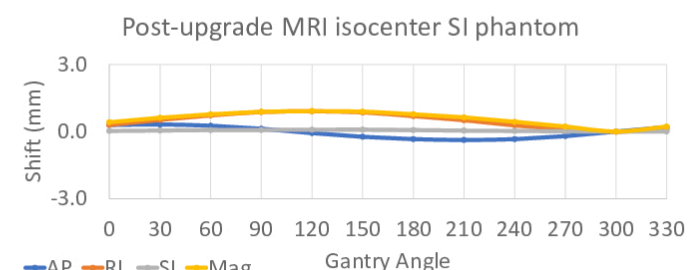
Pre-upgrade magnitude shift:

- 1.7mm with SI phantom
- 2.5mm with DQA phantom



Post-upgrade magnitude shift:

- 1.7mm with SI phantom
- 2.5mm with DQA phantom



RESULTS: SPATIAL INTEGRITY

Pre-upgrade Spatial integrity errors:

- Sagittal orientation: 0.5mm
- Coronal orientation: 0.5mm
- Axial orientation: 0.3mm

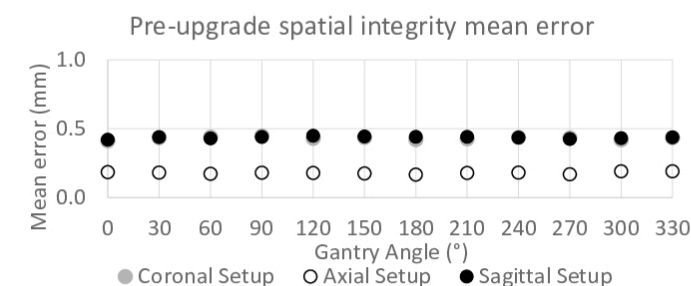
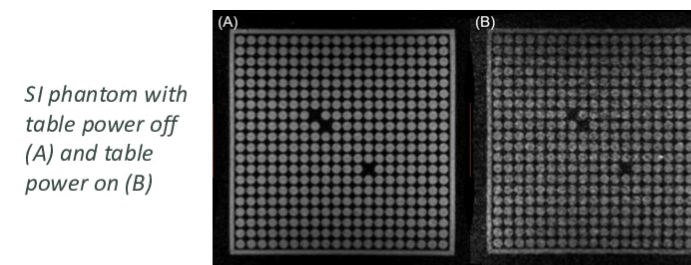


Table power Spatial integrity errors:

- Insignificant SI change
- SNR decrease from 19.4 to 9.0 with table on



SI phantom with table power off (A) and table power on (B)

Post-upgrade Spatial integrity errors:

- Sagittal orientation: 0.4mm
- Coronal orientation: 0.5mm
- Axial orientation: 0.3mm

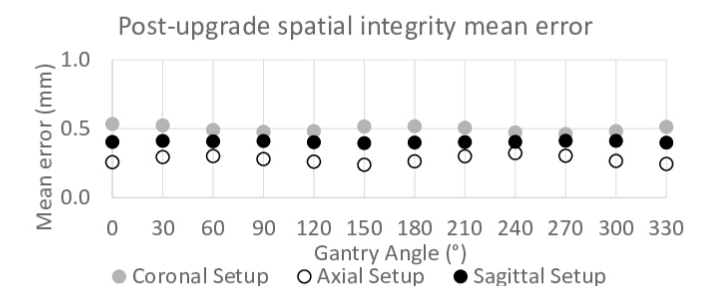
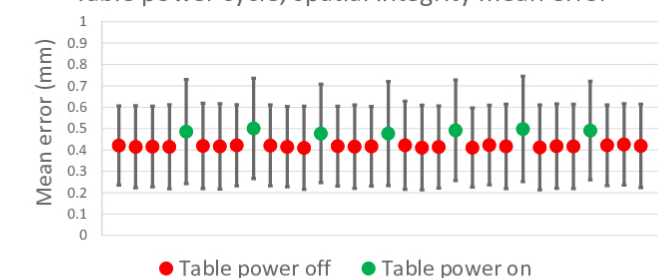


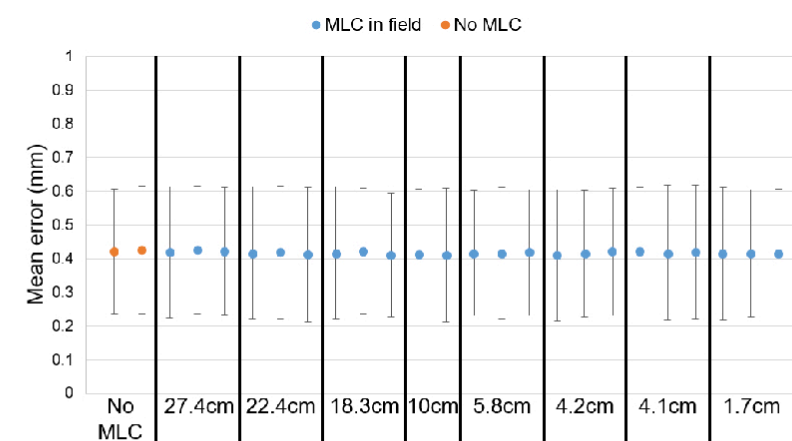
Table power cycle, spatial integrity mean error



RESULTS: MLC SPATIAL INTEGRITY

MLC Field Size spatial integrity errors:

- Insignificant SI change
- Open field to 1.7cm x 1.7cm square field



CONCLUSION

Imaging isocenter of the MR-LINAC system can be affected by imaging at gantry angles other than the home gantry position designated at installation

Imaging isocenter variation on this system was significantly reduced after the LINAC and software upgrades, however still had a magnitude shift of 1.7mm with the SI phantom and 2.5mm with the DQA phantom. This is a significant amount and emphasizes that images acquired at non-home gantry position may impact planning accuracy.

Spatial integrity variation was not significant across gantry angles and was smaller than acquisition voxel size due to up sampling intrinsic to the analysis software.

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