

Theme: Physics

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Abstract Title: Analysis of Inter-Fractional Displacement in Prostate Cancer Patients Receiving Carbon-Ion Radiotherapy Using Fiducial Markers on Digital Radiography

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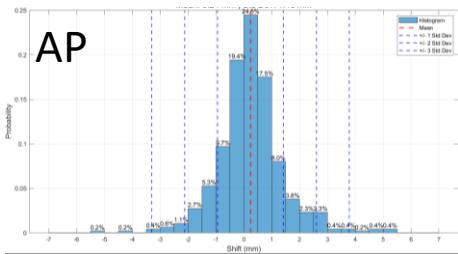
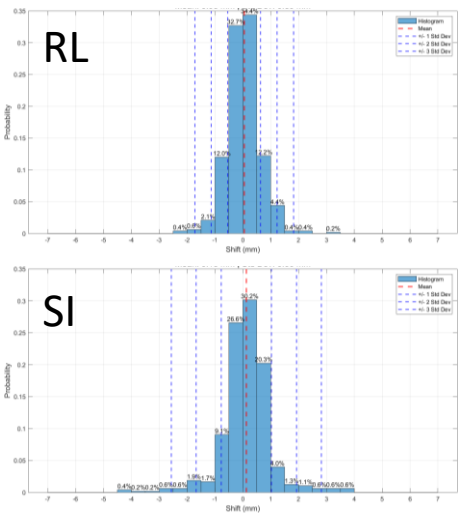
Background / Aims:

- This study aims to analyze inter-fractional positional variability of prostate cancer patients by quantifying the displacement of implanted fiducial markers observed on oblique digital radiography (DR) images across treatment sessions.

Subjects and Methods:

- Patients:** 20 prostate cancer cases who received carbon-ion radiotherapy between December 2023 and January 2025
- Image Acquisition and Analysis:**
 - ✓ Two oblique DR images acquired per fraction
 - ✓ Marker segmentation using region-growing + manual editing
 - ✓ Marker coordinates were extracted to reconstruct 3D positions using stereo geometry.
 - ✓ A total of 480 data points (20 patients X 12 fractions X 2 markers) were assessed for inter-fractional displacement in three orthogonal directions.

Results and Conclusions:



Direction	Mean (mm)	SD (mm)
Right-Left (RL)	0.05	0.59
Anterior-Posterior (AP)	0.24	1.18
Superior-Inferior (SI)	0.13	0.90

- Statistical analysis showed that inter-fractional displacement was most prominent in the anterior-posterior direction (0.24 ± 1.18 mm), mainly influenced by variations in bladder filling.
- All displacements remained within clinical tolerance (≤ 3 mm).
- This study demonstrates that fiducial marker-based analysis on DR images enables reliable quantification of prostate positional changes during carbon-ion therapy.
- The framework established here may contribute to refining clinical guidelines and improving the safety and precision of image-guided radiotherapy in prostate cancer patients.