MPHIL PHYSICS · THESIS DEFENSE

An Integrated Framework for Systematic Validation of TPS-Based Dose Calculation in Radiotherapy

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MOTIVATION & OBJECTIVES

A treatment plan is only as safe as the dose the TPS calculates

01

Compare TPS-calculated dose with measured dose

02

Validate point-dose, 3D and IMRT plans with the gamma index

03

Build one integrated, reproducible framework for safe delivery

Errors can enter at the beam model, the 3D calculation, or the delivery of modulated plans — single-level checks miss some of them.

METHODS

Three phases of increasing complexity

PHASE I

Point dose

Farmer chamber in water (TRS-398). 6 & 15 MV, open and 30°/45°/60° wedged fields.

PHASE II

3D dose

Octavius 4D phantom: AP, four-field box, five-field wedge and oblique plans.

PHASE III

Patient-specific QA

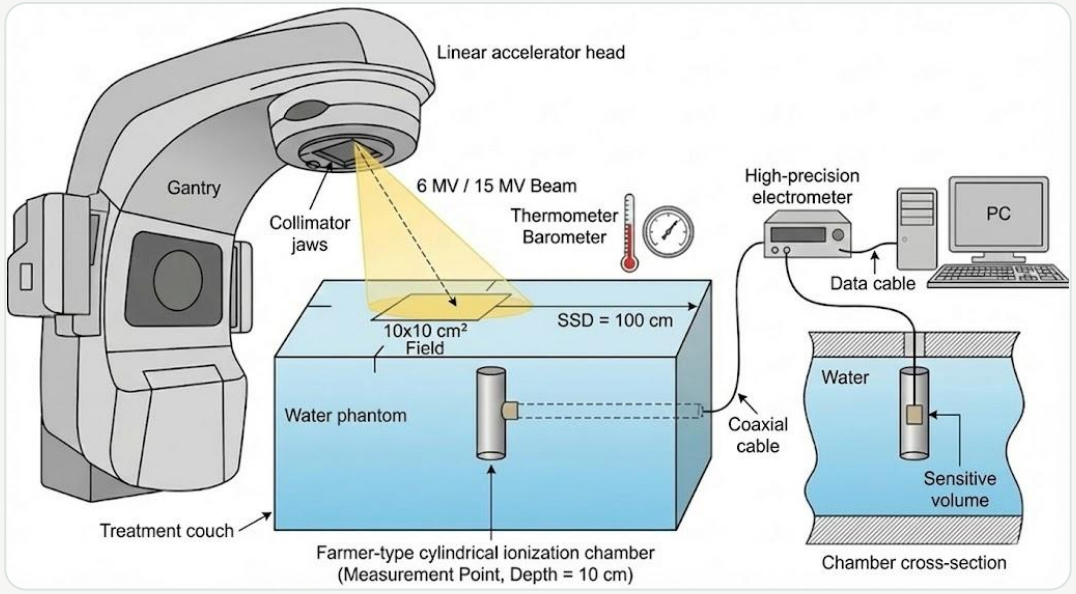
10 clinical IMRT plans: head-and-neck, prostate, thoracic, simplified.

Equipment: Varian linac · Eclipse TPS (AAA) · PTW UNIDOS electrometer · Octavius 4D + VeriSoft

Metrics: % dose difference · 3D gamma (3%/3 mm, 10% threshold) · measured-vs-calculated R^2

PHASE I · POINT DOSE

The beam model agrees closely with measurement

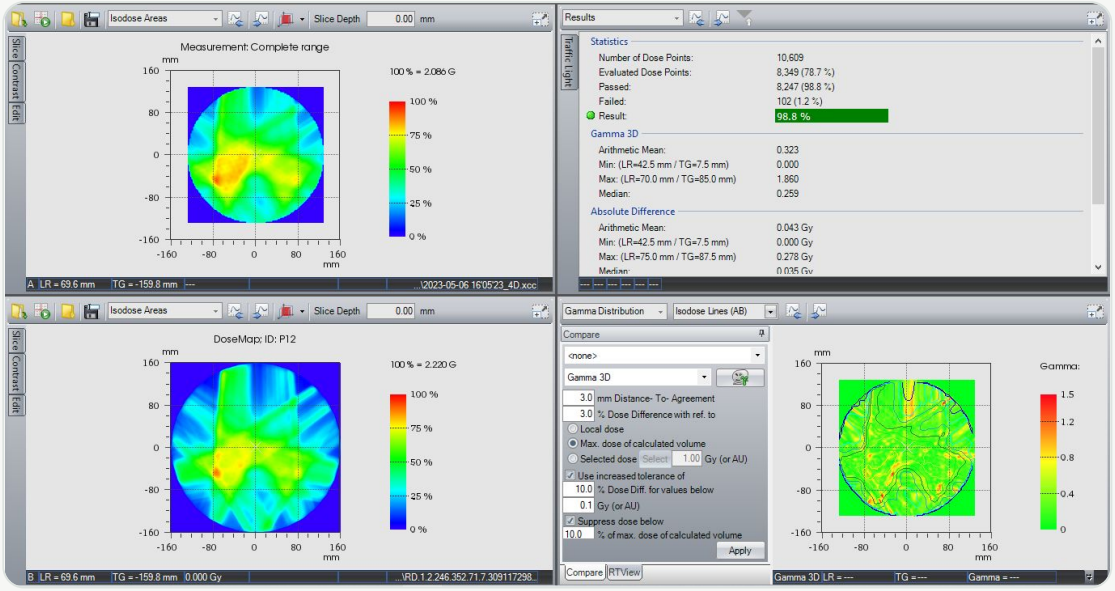


0.63%
mean absolute deviation (SD 0.79%)

96.2%
within the ±2% criterion

SSD 100 cm · 10 cm depth · 10×10 cm² · 100 cGy · wedges mostly <0.5% off

Full 3D distributions hold up in multi-field setups



Four-field box: 98.8% gamma pass, 102 of 8,349 points failed

1.34%
mean deviation (SD 0.95%)

92.3%
within ±2%; all within ±3.5%

>95%
gamma pass, 3%/3 mm

0.998
R^2, measured vs. calculated

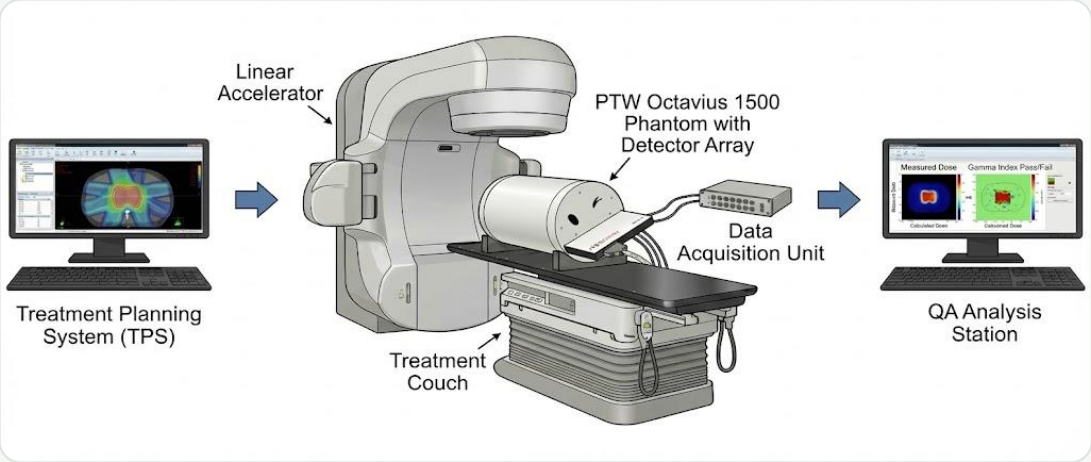
PHASE III · PATIENT-SPECIFIC IMRT QA

All ten clinical IMRT plans pass with margin

97.2% 6 MV gamma pass, 3%/3 mm range 93.4–99.6%

96.8% 15 MV gamma pass, 3%/3 mm range 92.7–99.1%

1.88% mean point-dose difference (SD 1.34%)

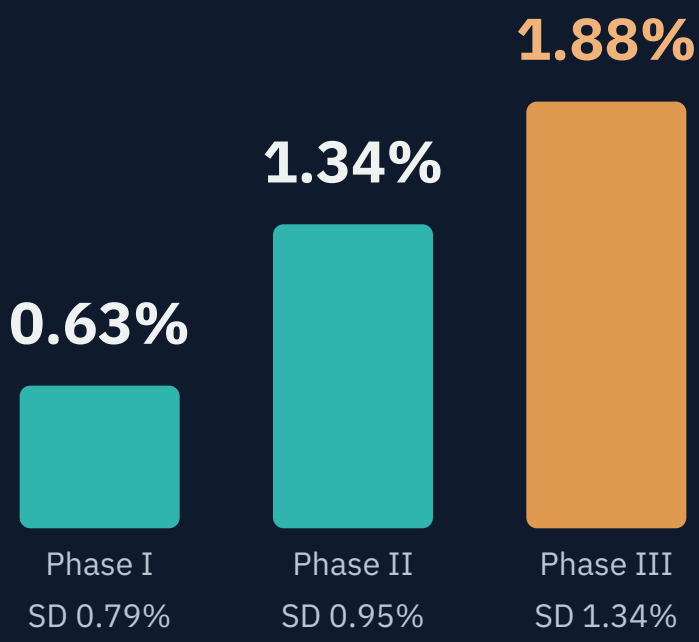


Action threshold: 90% · Stricter 2%/2 mm (6 MV): 91.8%

Sites: head-and-neck, prostate, thoracic, simplified

CONCLUSION

Deviation grows with complexity — and stays clinically acceptable



Mean dose deviation by phase · $R^2 > 0.995$ throughout

Each phase isolates a different error source: beam model, 3D geometry, delivery

Comprehensive and reproducible — strengthens confidence in TPS performance for safe clinical practice