Comparative Dosimetry of an Indigenous 6 MV Linac

HEELA prototype vs Varian IX clinical reference

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Introduction

50–60%

of cancer patients need radiotherapy

HEELA

indigenous 6 MV linac built at PINSTECH

No data

no published dosimetric comparison until now

Aim: benchmark the HEELA prototype against a clinical Varian IX using IAEA TRS-398 and AAPM TG-142 criteria.

Scope: beam quality, depth dose, and in-plane and cross-plane profiles (flatness, symmetry).

Materials and methods

Linacs and setup

Varian IX (reference)
IRNUM Peshawar, 6 MV, rotating gantry

HEELA prototype
PINSTECH, 6 MV, fixed gantry at 0°

10×10 cm² field, SSD 100 cm, 3D water phantom, depths 15, 50, 100 and 200 mm

Detectors

PTW 30010 Farmer chamber
Absolute dose, TPR20,10 and PDD (IAEA TRS-398)

PTW Semiflex 3D chamber
In-plane and cross-plane beam profiles



Acceptance (AAPM TG-142): flatness ≤ 3% | symmetry ≤ 2%

Experimental setup



Varian Clinac iX
Clinical reference linac



HEELA prototype
Indigenous linac, PINSTECH



DoseView 3D
Water phantom, Standard Imaging

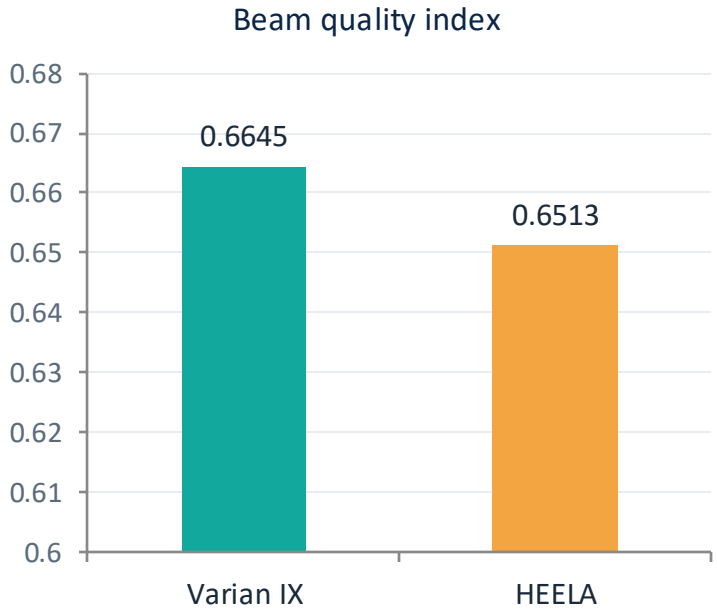
Beam quality: close, slightly softer

0.6645

TPR20,10
Varian IX (clinical)

0.6513

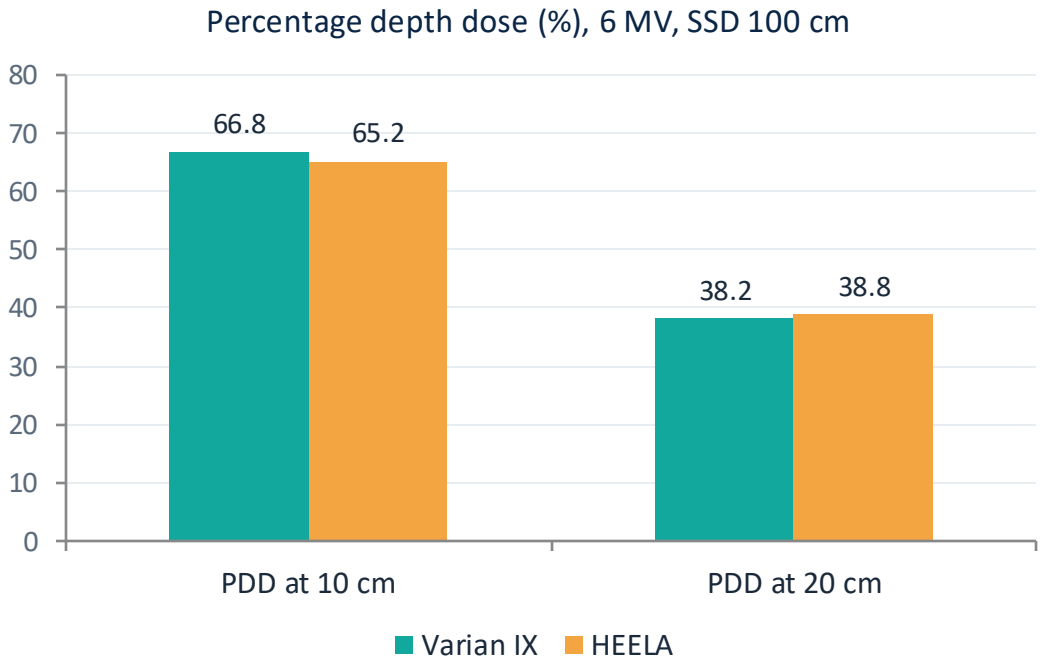
TPR20,10
HEELA prototype



dmax: 1.40 cm vs 1.39 cm

HEELA ≈ 5–6 MV: clinically usable energy

Depth dose: nearly overlapping



dmax

1.40 cm vs 1.39 cm

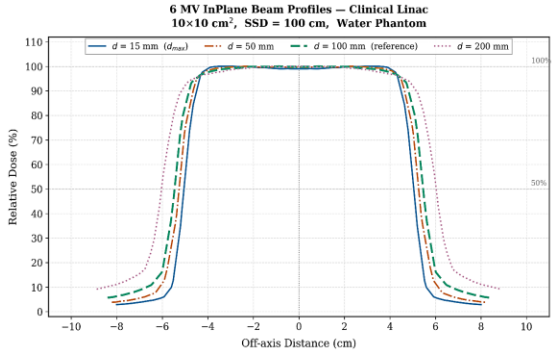
Build-up is virtually identical

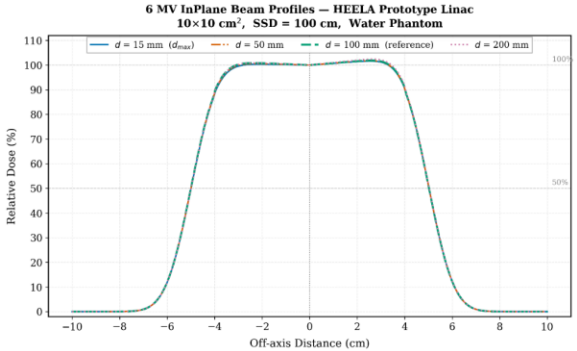
Difference

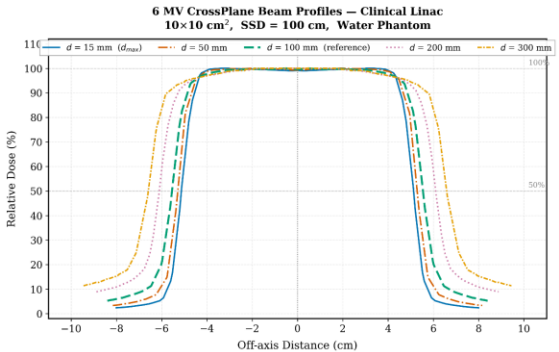
≤ 1.6% at both depths

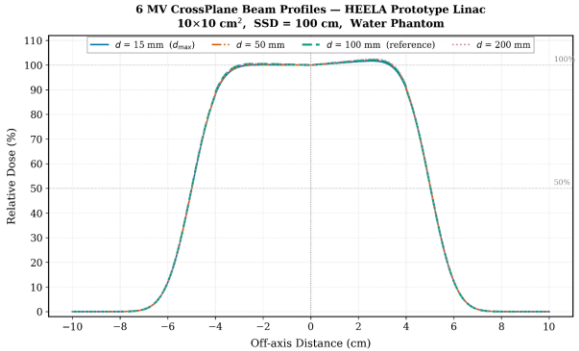
Comparable penetration

Measured beam profiles, 6 MV, 10×10 cm²







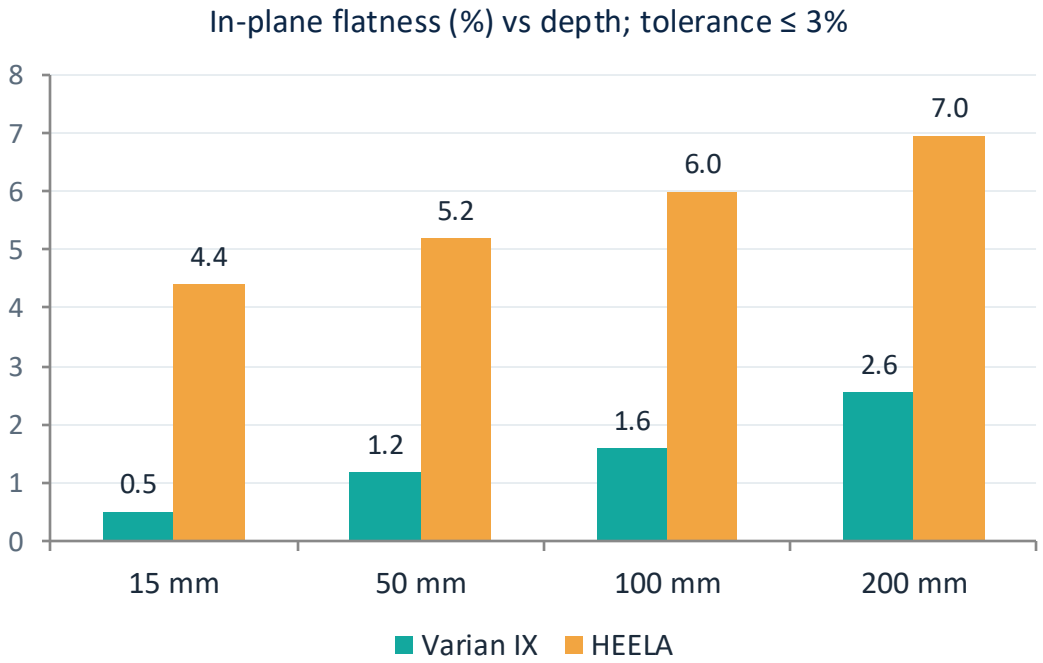


Varian IX
Flat plateau, sharp edges, symmetric

HEELA
Sloped, tilted plateau at all four depths

Top row: in-plane. Bottom row: cross-plane. Depths: 15, 50, 100, 200 mm (clinical cross-plane also 300 mm).

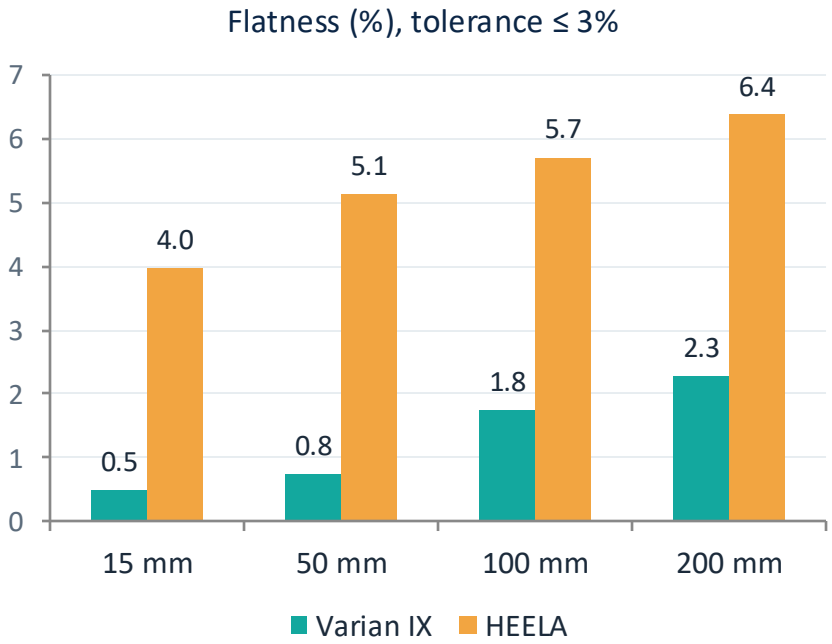
In-plane: uniformity falls short

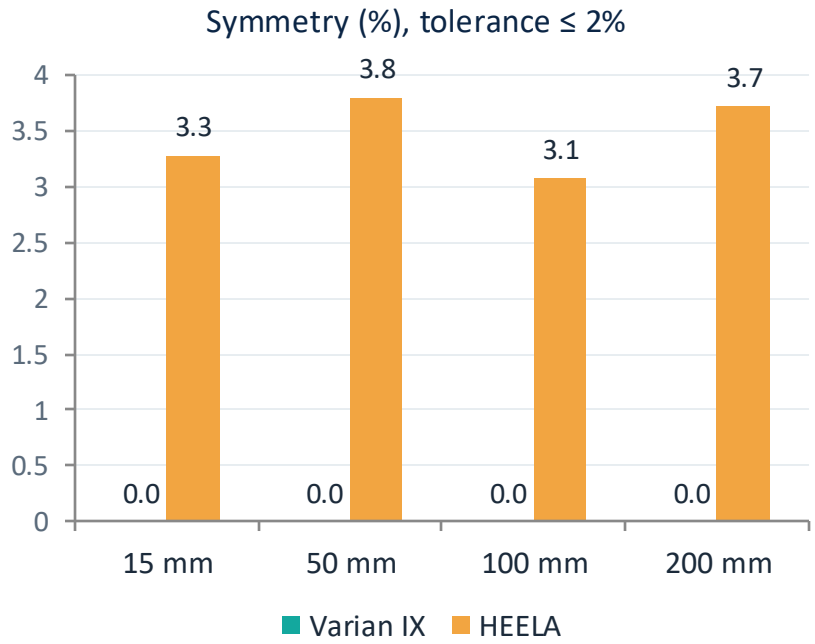


Clinical PASS
Flatness ≤ 2.55%
Symmetry 0.00%

HEELA ABOVE LIMIT
Flatness 4.40–6.96%
Symmetry 2.08–3.03%

Cross-plane shows the same pattern





Summary

Parameter	Varian IX	HEELA	Verdict
TPR20,10	0.6645	0.6513	Slightly lower
dmax	1.40 cm	1.39 cm	Match
PDD at 20 cm	38.2%	38.8%	Match
Flatness (≤ 3%)	0.50–2.55%	3.98–6.96%	Exceeds limit
Symmetry (≤ 2%)	0.00%	2.08–3.80%	Exceeds limit

Next: flattening filter redesign, steering optimisation, Monte Carlo modelling, full commissioning.

Sound accelerator physics, the beam head needs refinement. Thank you.