

Dosimetric comparison of static intensity-modulated radiation therapy (IMRT) and volumetric modulated arc therapy (VMAT) plans for the treatment of patients with the Left-sided Breast Cancer with Positive Nodes on Ring Delivery System and Conventional Linac

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PURPOSE/OBJECTIVES

To compare the dosimetry of static IMRT and VMAT techniques for patients with the left-sided breast cancer with positive nodes utilizing Halcyon and TrueBeam.

Twenty treatment plans (4 plans per patient, Rx=50Gy total, 6MV) were generated using both volumetric modulated arc therapy and static intensity modulated radiation therapy utilizing Halcyon and TrueBeam. Eclipse v.15.6 was used.

The patients were simulated in the supine position on breast board with both arms up and free breathing.

MDs contoured the planning target volumes for the left breast (PTVp) and nodes (PTVn) by expanding CTVp and CTVn (p = primary, n = nodes).

HA-VMAT/TB-VMAT: 4 arcs per plan.

HA-sIMRT / TB-sIMRT: 7-9 fields per plan.

The dose to the Organ at Risks (OARs) such as heart and ipsilateral lung were compared and analyzed using RTOG 1034 guidelines.

The objectives for PTVs and OARs coverage were as follows: Lt Breast $D_{95} \geq 95\%$ and SCLAV Nodes $D_{90-95} \geq 95\%$, Heart mean $\leq 5\text{Gy}$ and Lung L $V_{20} \leq 40\%$. The maximum dose PTVpn dose was kept below 120% in all plans.

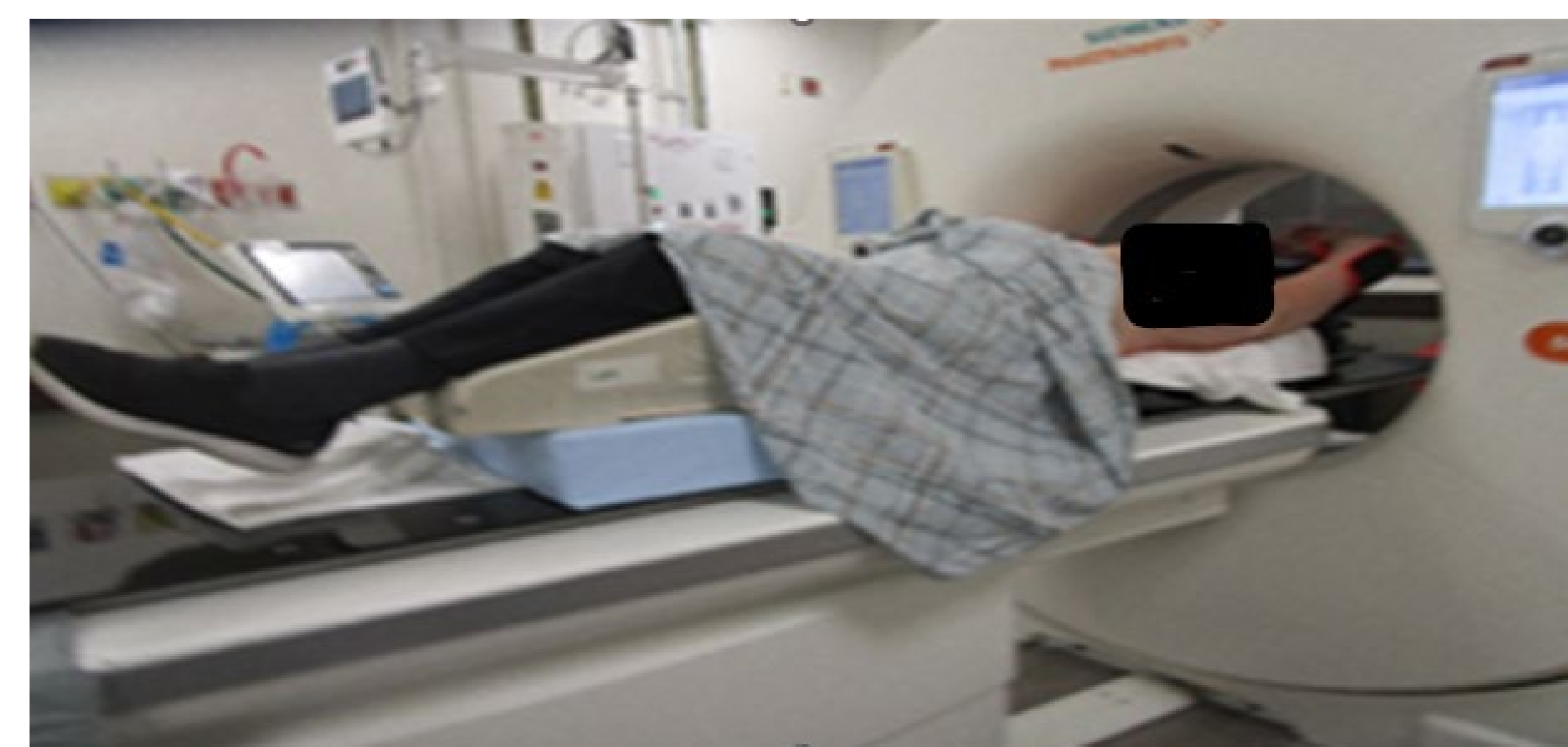


Figure 1 Patient setup



Figure 2 TrueBeam (www.varian.com)

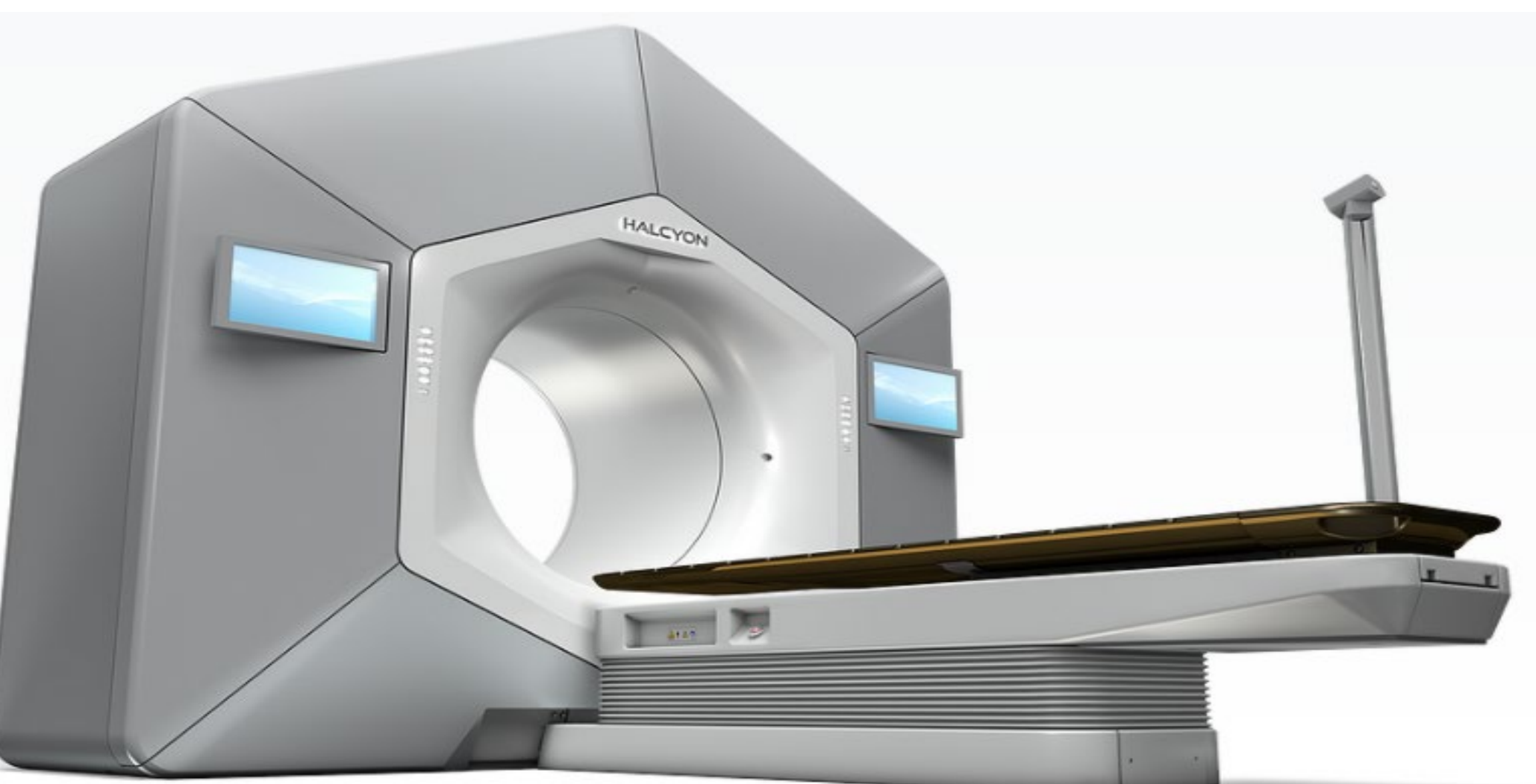
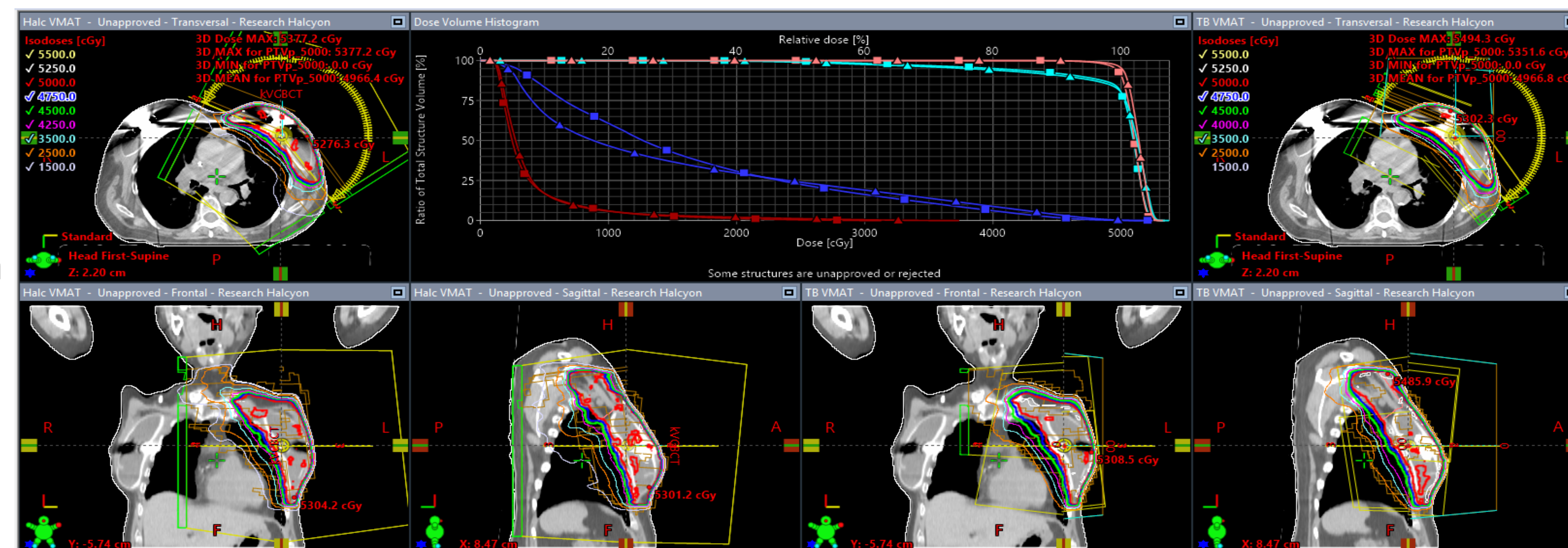


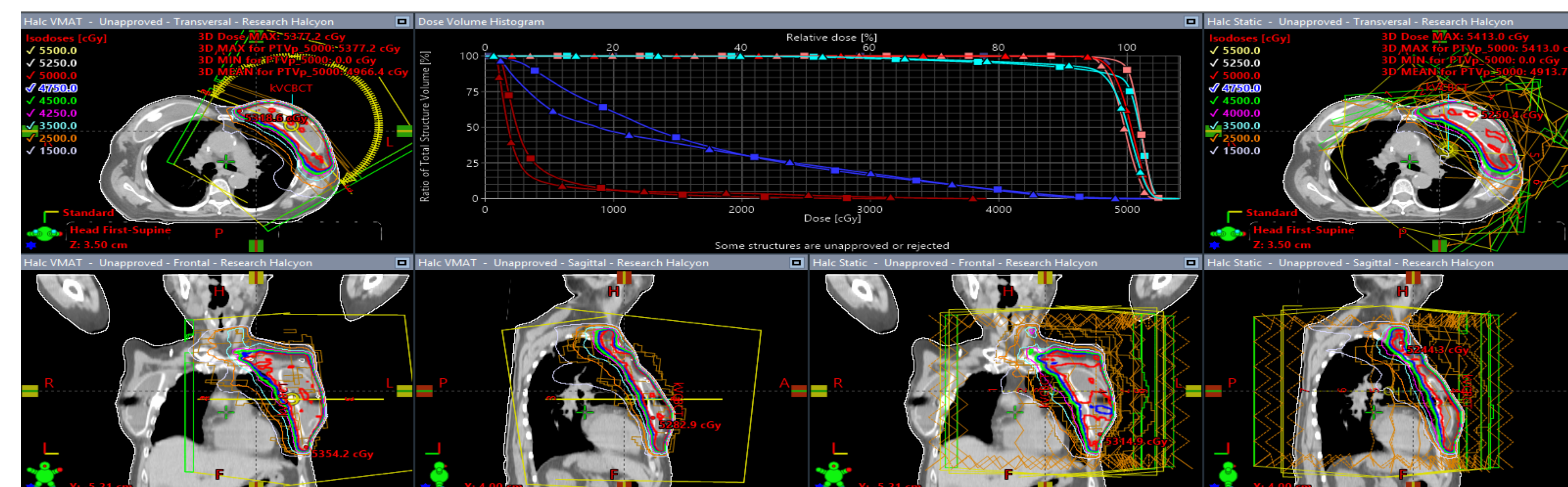
Figure 3 Halcyon (www.varian.com)

MATERIALS and METHODS

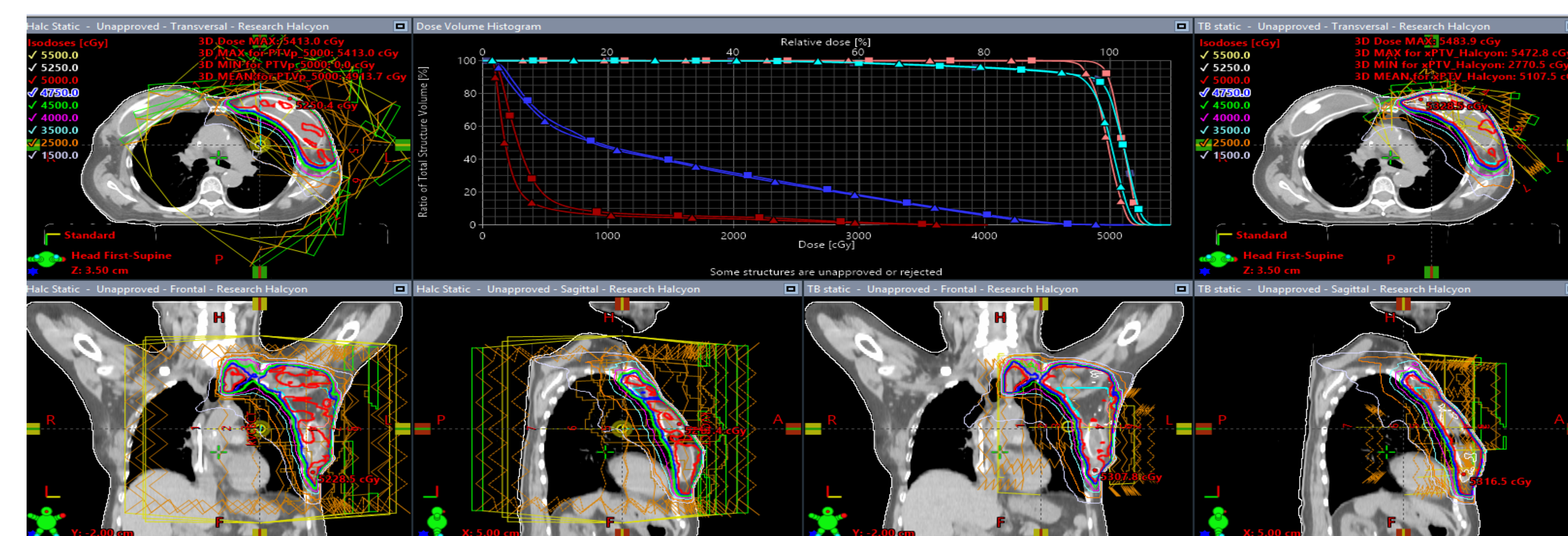
DVH: PTVp= Cyan; PTVn= Pink; Heart= Red; L Lung= Blue



HA-VMAT plan= squares, TB-VMAT plan= triangles



HA-VMAT plan= squares, HA-sIMRT plan= triangles



TB-sIMRT plan= squares, HA-sIMRT plan= triangles

Average Data						
OARs/PTVs	Lung Left	Heart	PTVpn	PTVp	PTVn	
Constraints	V20 (%)	Mean (Gy)	Max Dose	D90-95 (%)	D90-95 (%)	MUs
HA-VMAT	30.86	4.35	108.94	97.54	97.18	645.4
HA-sIMRT	30.34	3.76	109.4	97.36	96.46	1879.2
TB-VMAT	24.8	4.41	109.36	97.88	98.34	673.4
TB-sIMRT	31.92	4.59	109.12	98.72	99.14	1981.4

RESULTS

All treatment plans met PTVp and PTVn coverage requirements ($D_{95} \geq 95 \pm 2\%$). Amongst the VMAT plans, TB-VMAT provided a lower lung dose (V_{20} : range 17-30%) than HA-VMAT (V_{20} : range 29-33%), whereas HA-VMAT provided a lower dose to the heart (mean: range 3.6-4.9Gy) than TB-VMAT (mean: 4-4.76Gy).

HA-sIMRT plans yielded lower doses to both (heart mean: range 3.1-4.1Gy and lung V_{20} : range 28-33%) than TB-sIMRT plans for both (heart mean: range 4.05-4.95Gy and lung V_{20} , range 30-34%).

HA-VMAT MUs (average 646, range 545-783) and TB-VMAT MUs (average 673, range 502-848) were 3 times lower than HA-sIMRT MUs (average 1879, range 1571-2454) and TB-sIMRT MUs (average 1981, range 1325-2728).

In addition, Halcyon, HA-sIMRT delivered a lower dose to the heart (mean) and lung (V_{20}) than HA-VMAT.

CONCLUSION

Even though our plans met all RTOG constraints, there was a noticeable difference between Halcyon and TrueBeam in terms of the dose to OARs. One possible explanation for TrueBeam's low lung dose is the jaw tracking function which may minimize the spread of the low dose to the lung volume. However, due to the design of the Halcyon machine, treatment of patients with left-sided breast cancer with positive nodes was discovered to be three to four times faster. Thus, the treatment plans for Halcyon take advantage of faster dose delivery and can achieve the same dosimetry as TrueBeam. Future project is to evaluate 3D conventional plans with VMAT and static IMRT for Halcyon and Conventional LINAC.

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