

Fight the cancer. Protect the heart.

How we use AlignRT to help prevent
cardiac toxicity in left-breast radiotherapy

Joe Deister
Regional Sales Manager
Vision RT

Introducing AlignRT

AlignRT

Market leading solution for Surface Guided Radiation Therapy (SGRT)

Increases accuracy in treating left-breast cancer while helping to protect patients' hearts

The Hidden Danger in Treating Left-breast Cancer

Proximity

Proximity of the left breast to the heart leaves the heart vulnerable to radiation exposure.



Cardiac complications

Radiation exposure increases risk of serious long-term cardiac complications.

Clinical Investigation

Utility of Deep Inspiration Breath Hold for Left-Sided Breast Radiation Therapy in Preventing Early Cardiac Perfusion Defects: A Prospective Study

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Evidence of Perfusion Defects



Siemens single-photon emission computed tomography machine in operation.
Photograph courtesy of Y Trottier.

Single-photon emission computed tomography (**SPECT**) is used to predict short-term cardiac events³

Background

Purpose of Current Study:

- To evaluate radiation-induced cardiac toxicity after left breast/chest wall RT with DIBH

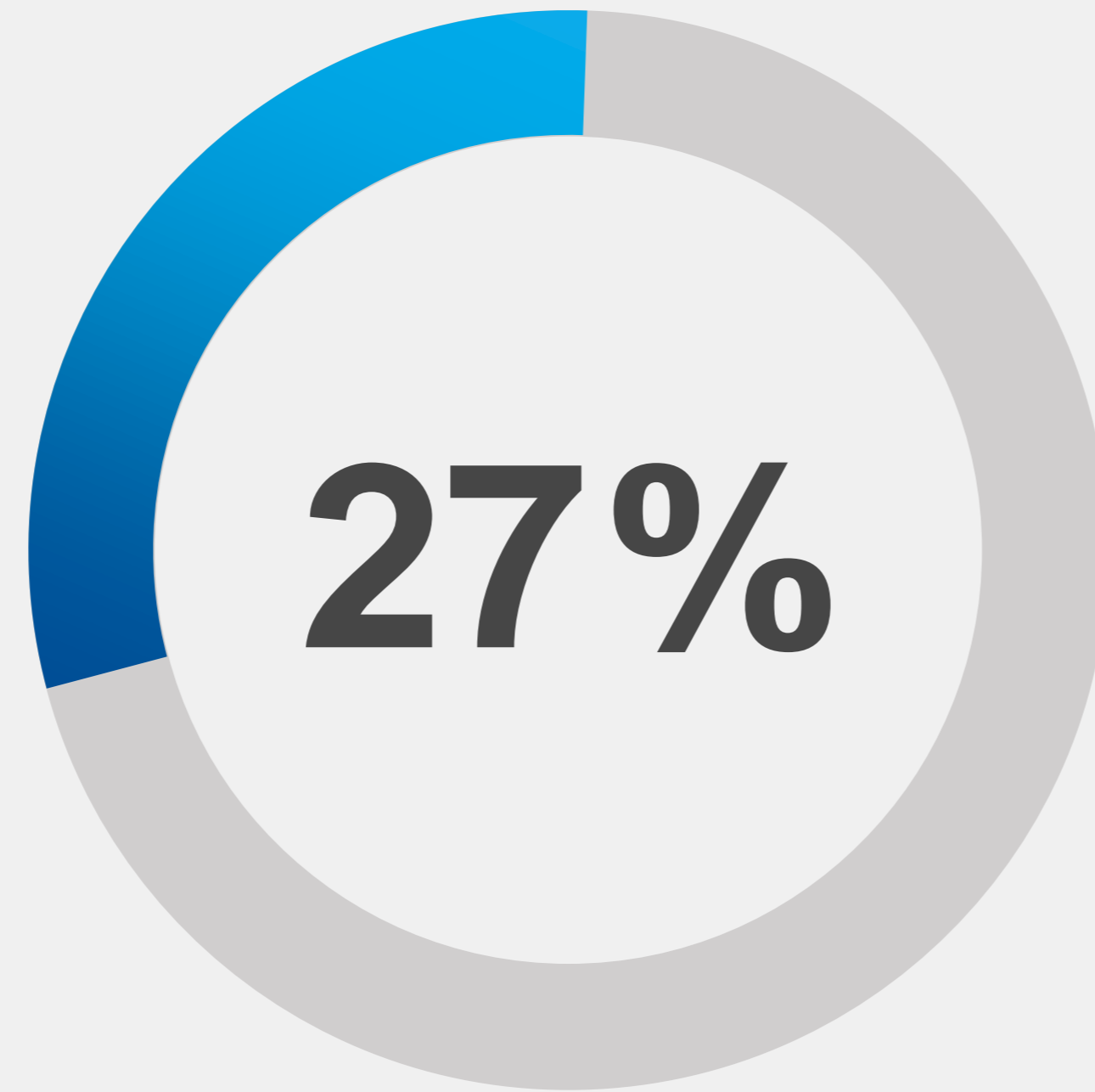
Existing Data – 2005 Study:

- Marks et al. studied the incidence of new perfusion defects post-RT (1998-2001) ¹
- 114 patients were treated in free-breath with no surface guidance
- Post-RT SPECT were compared with the pre-RT studies
- *Results:*
 - Incidence of new perfusion defects = 27% 6 months after RT (increasing to 42% after 24 months)
 - 12% to 40% of patients with perfusion defects also reported wall motion abnormalities (compared to 0% to 9% without perfusion defects)
- *Conclusions:*

“RT causes volume-dependent perfusion defects in ~40% of patients within 2 years”

¹ Marks, L. B. et al. The incidence and functional consequences of RT-associated cardiac perfusion defects. IJROBP 63, 214-223, doi:10.1016/j.ijrobp.2005.01.029 (2005).

Evidence of Perfusion Defects



In one study, **twenty-seven percent** of patients treated for left-breast cancer demonstrated SPECT volume-dependent cardiac perfusion defects within **6 months**.⁴

DIBH: Part of a Robust Solution



Deep Inspiration
Breath Hold (DIBH)



How DIBH Works

01

Patient breathes in

02

Heart moves down & away from chest wall

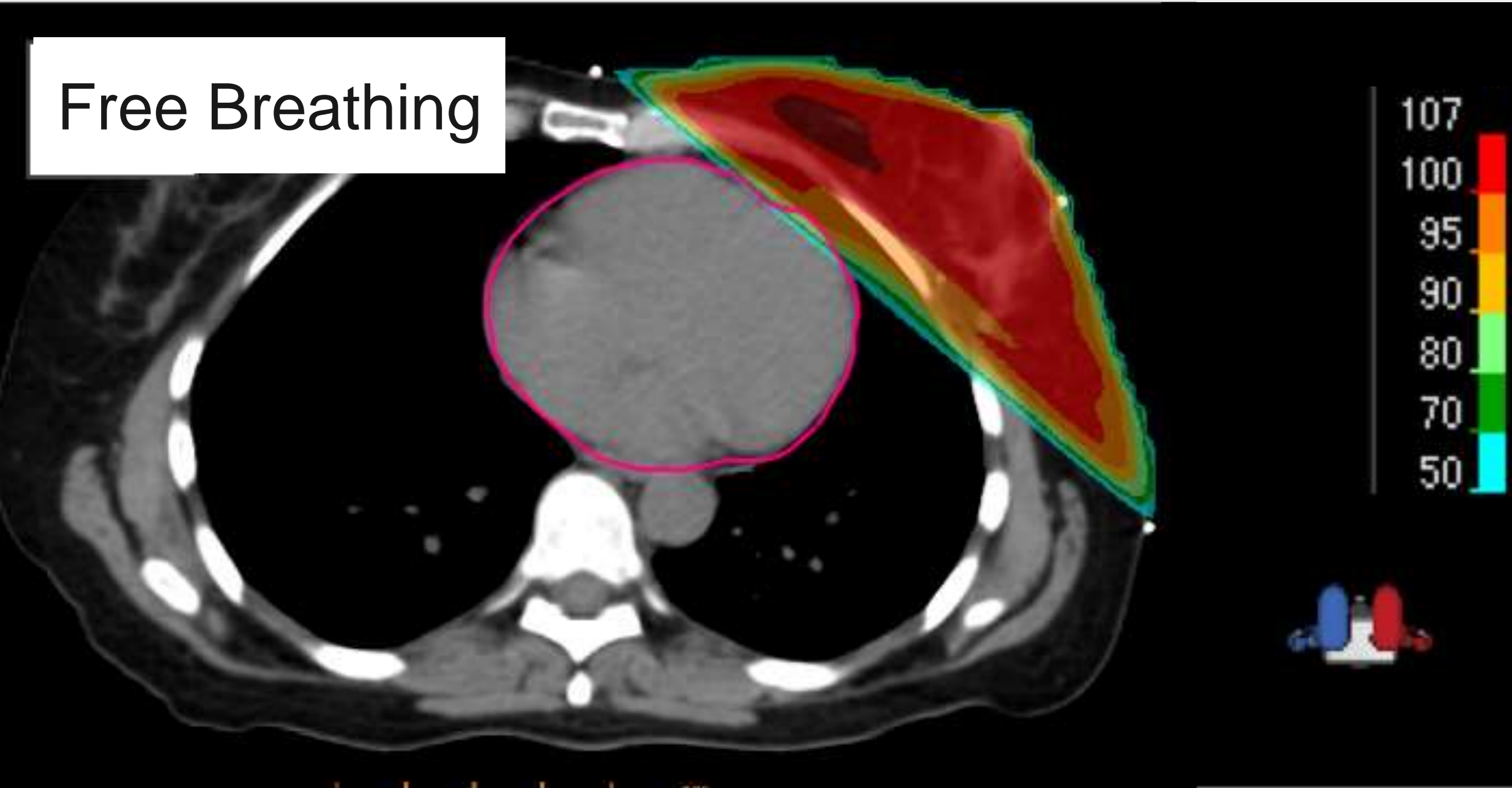
03

Patient holds breath (typical duration: 20s)

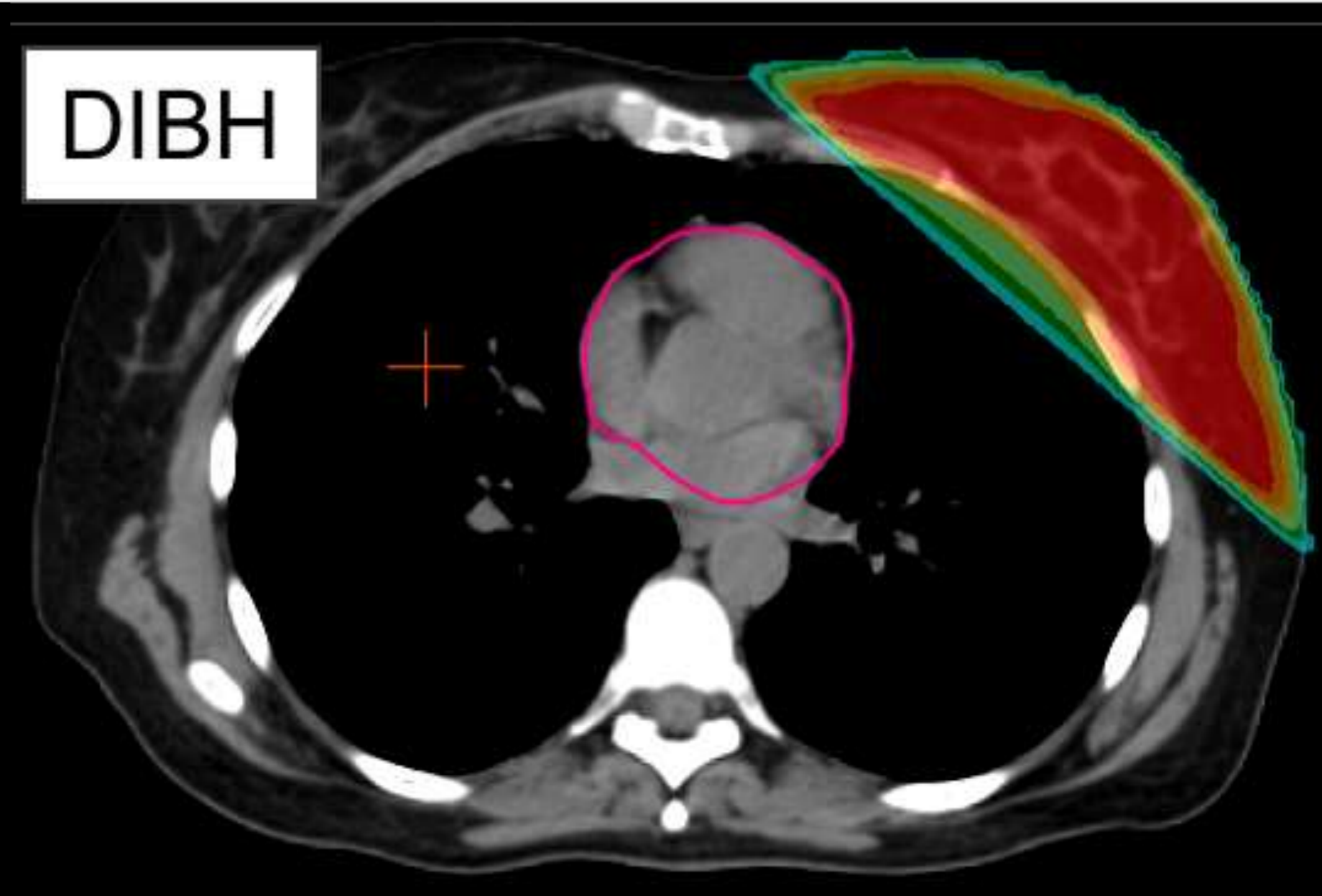
04

Radiation administered

Free Breathing



DIBH



Images courtesy of J Matney PhD

Traditional DIBH Techniques Also Have Their Limitations

Breath hold without guidance —

- Not necessarily reproducible⁶

Breathing control systems —

- Large positional variations can occur¹¹
- Invasive for the patient⁷

Box on chest —

- Tracks vertical displacement of box on xiphoid process:
Measures breath hold in one dimension only

DIBH, if not performed effectively, may not be enough to prevent heart damage.⁸

A robust solution

Deep Inspiration Breath Hold (DIBH) + AlignRT

CT Planning for DIBH

- Patient achieves optimal breath hold during planning
- Moves the heart away from the treatment site



Therapy with AlignRT

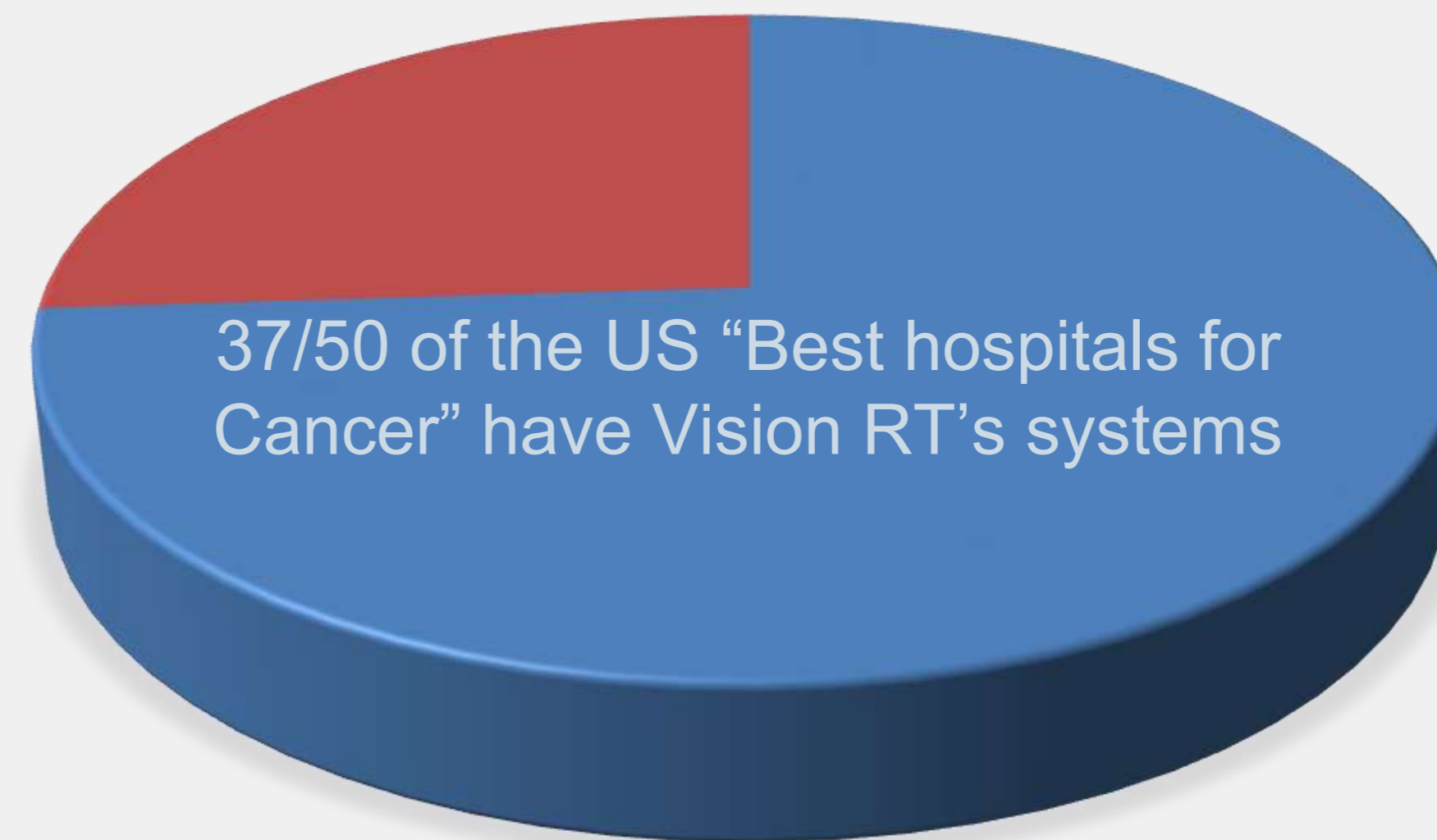
- Patient's position tracked with extreme accuracy to match planning position
- Helps ensure reproducibility and accuracy for every breath hold and every fraction

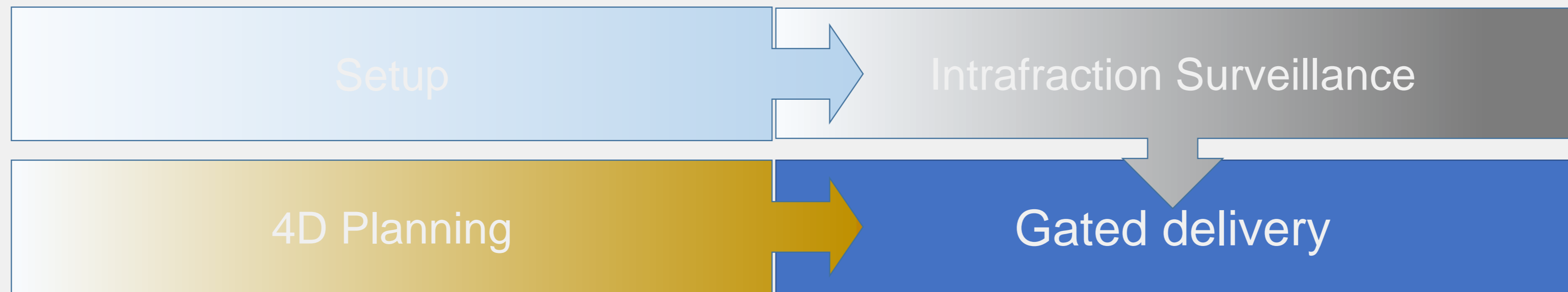
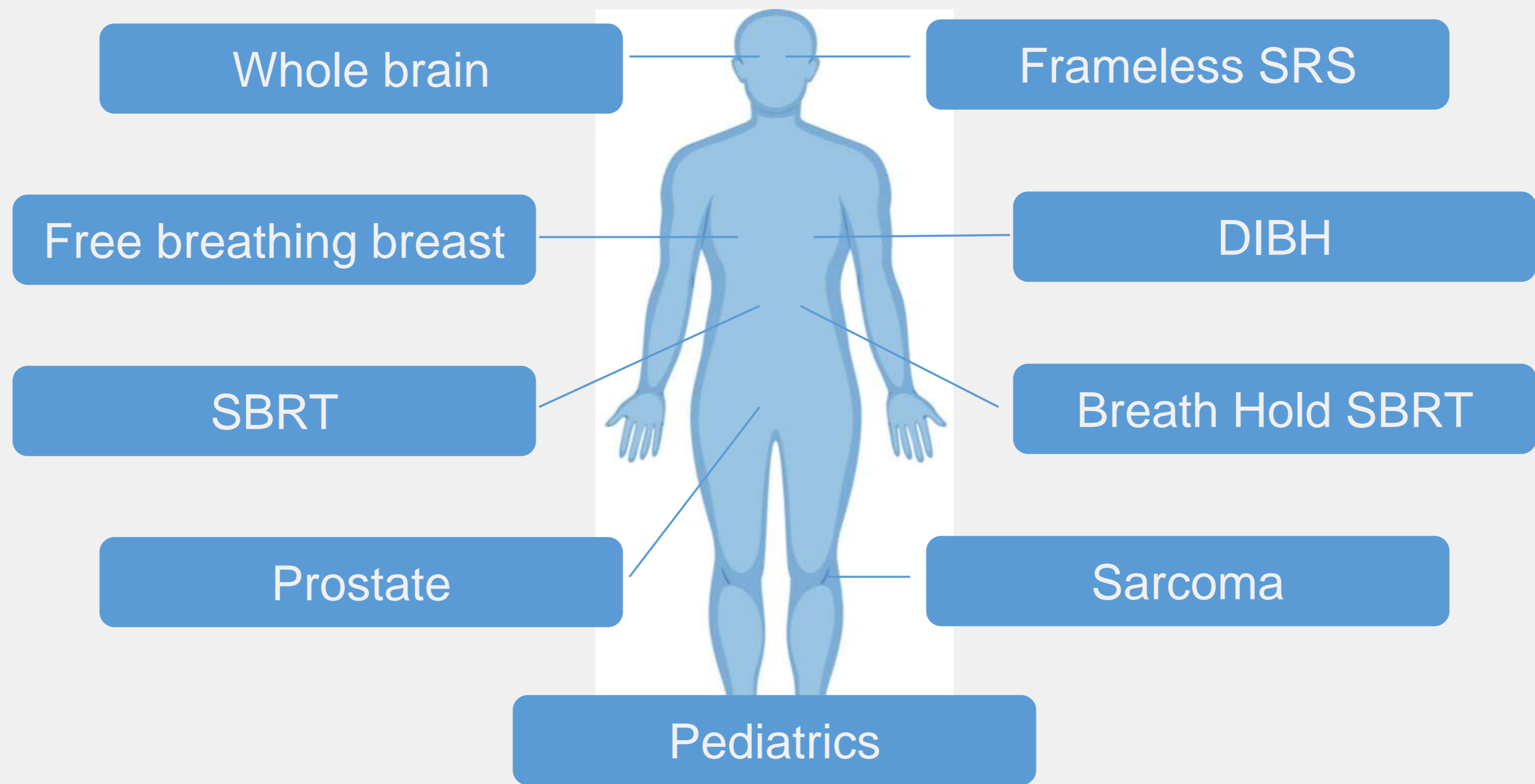
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Huntsman Cancer Hospital
Massachusetts General Hospital
Mayo Clinic, Rochester
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More than 700 installations worldwide, including:

- UK Heidelberg
- UK Dresden (x2)
- Klinikum Bayreuth (x3)
- UK Erlangen (x3)
- Bonn-Rhein-Sieg (x3)
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- Zürich University Hospital
- Biel (x2)
- Guy's and St Thomas' Hospital (4)
- Dublin Beacon Hospital
- Memorial Sloan Kettering Cancer Center (9)
- Massachusetts General Hospital (6)
- Mayo Clinic, Rochester (5)
- Cleveland Clinic
- Oslo University Hospital
- University of California (10) - San Diego,
UC Davis, San Francisco, Irvine, Los Angeles





Three stereo camera units measure the 3D patient surface

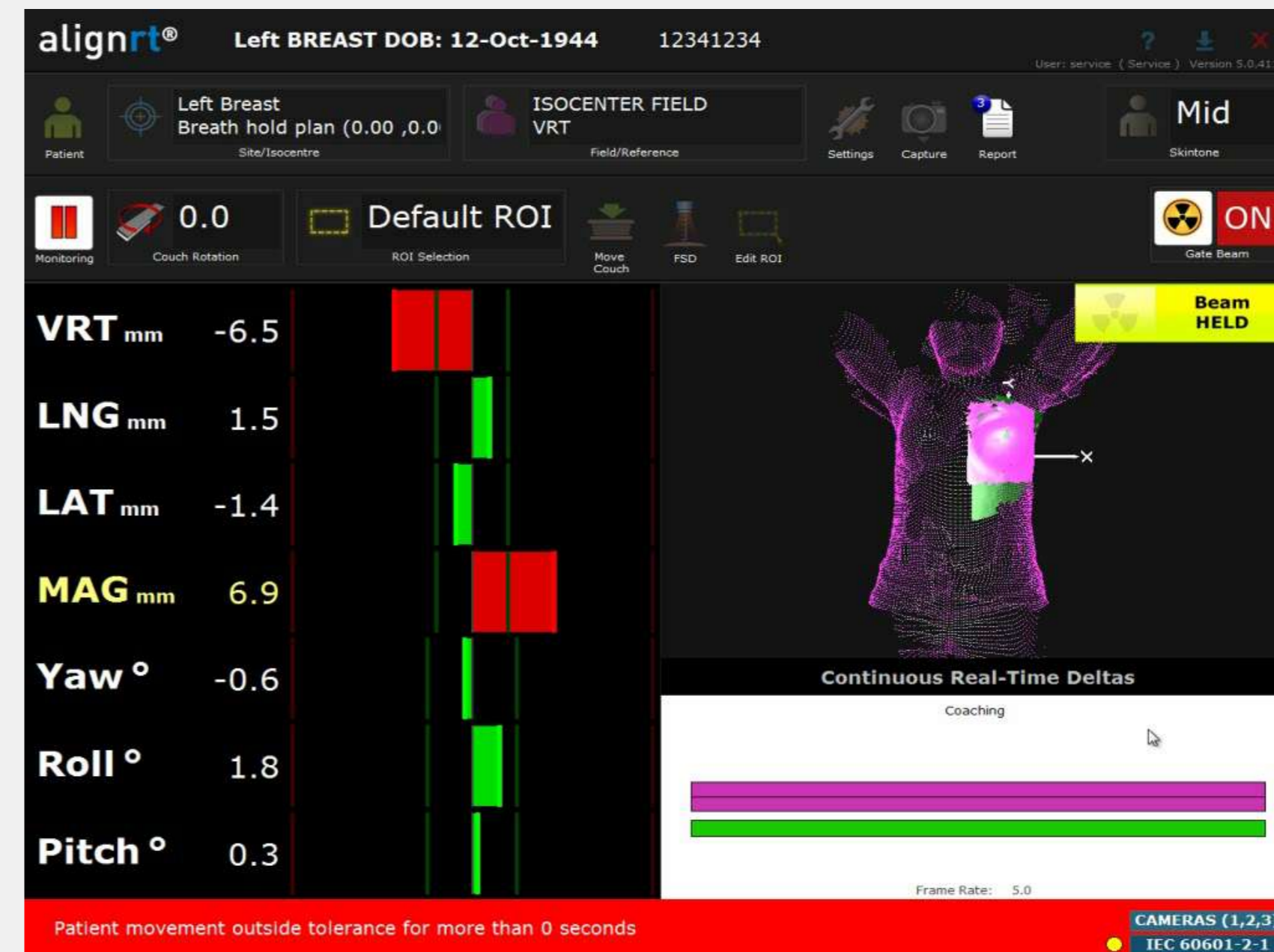
This is matched to the CT reference

Patient setup:

Gives XYZ translations and rotations $<1\text{mm}$, <1 degree accuracy

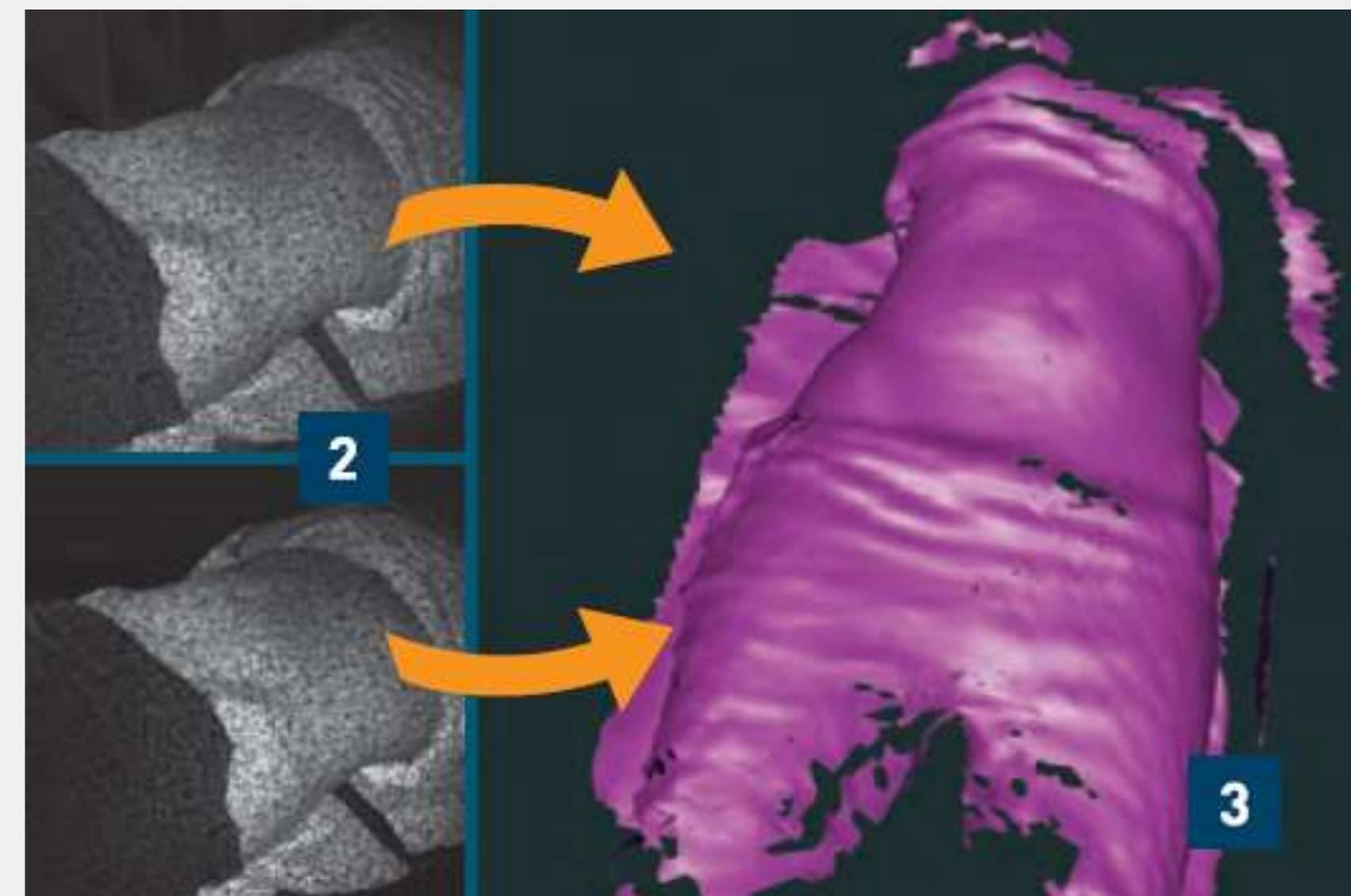
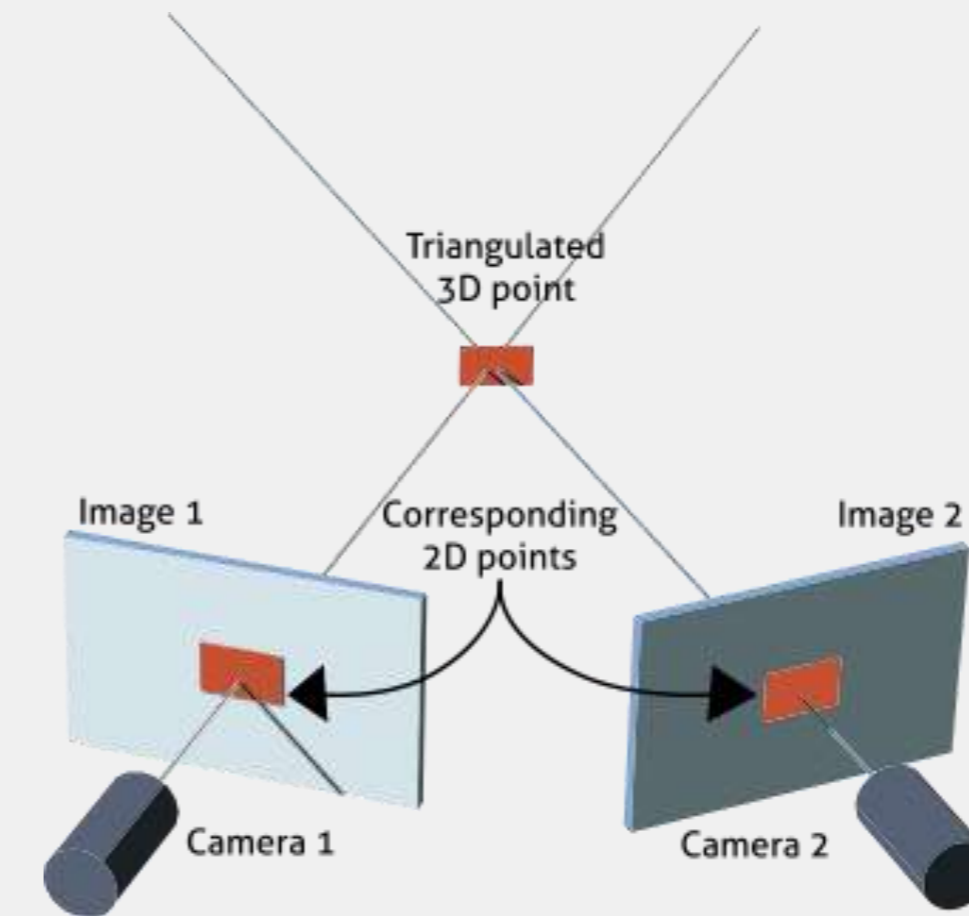
Treatment:

Holds beam if patient moves out of tolerance in any of **6 degrees** of freedom, **enables beam** when patient moves back into position



20s Video DIBH

- Near infrared light in pseudo random speckle pattern
- Map of ~20,000 points of patient's external anatomy
- Rigid registration algorithm computes deviation from reference surface
- Sub-millimetre accuracy in all 6 degrees of freedom
- **Holds beam** if patient moves out of tolerance in any of **6 degrees** of freedom, **enables beam** when patient moves back into position

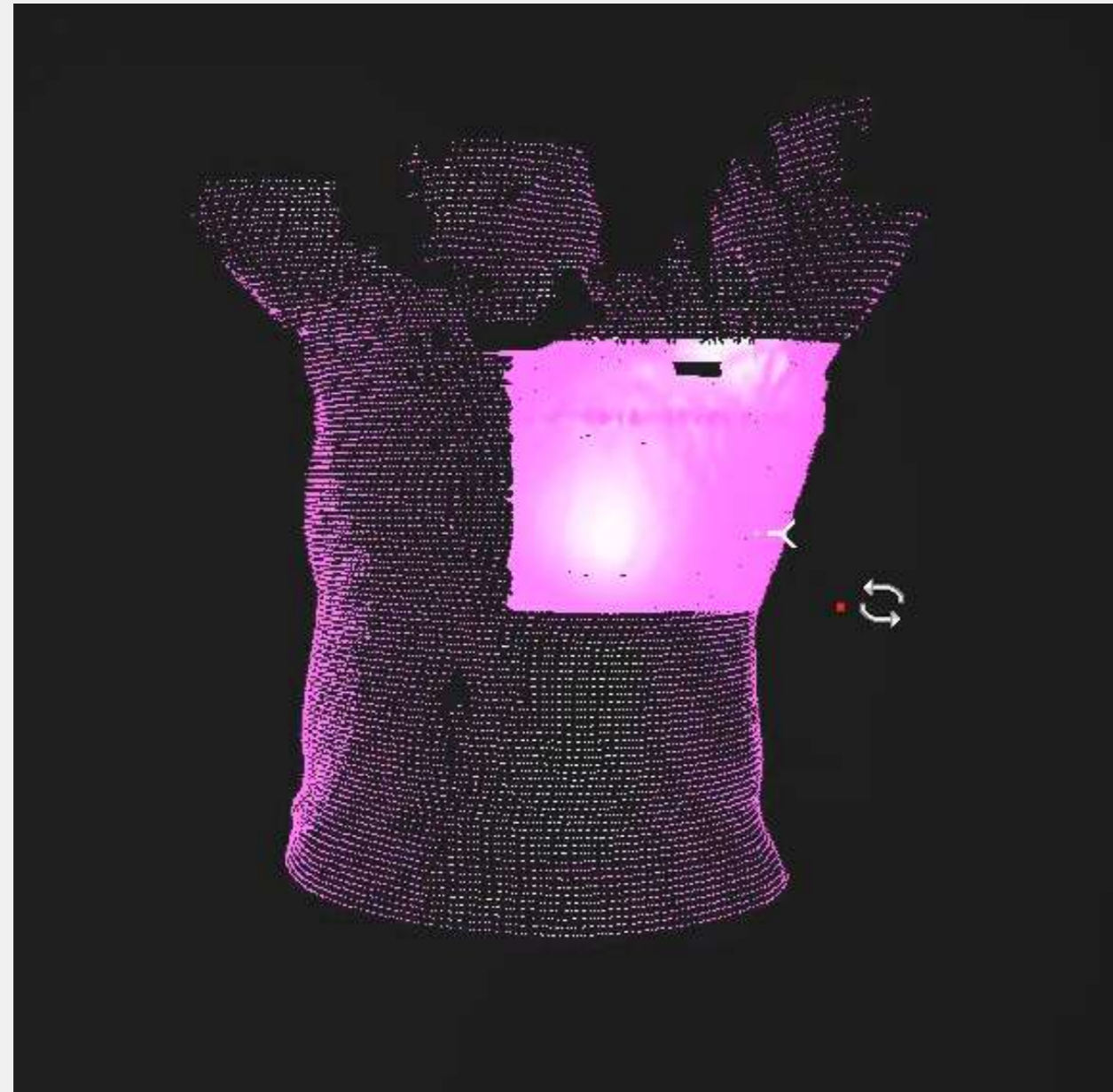


Back to main menu

How AlignRT Helps To Protect the Heart

01

DIBH CT scan is performed as normal and exported to AlignRT.



02

During treatment, patient motion is tracked by AlignRT.



How AlignRT Helps To Protect the Heart

Beam ENABLED

Left Breast
Breath hold plan (0.00 ,0.0)

Monitoring 0.0 Default ROI

Parameter	Value
VRT mm	-1.2
LNG mm	-1.7
LAT mm	-0.5
MAG mm	2.2
Yaw °	0.6
Roll °	0.5
Pitch °	0.7

Continuous Real-Time Deltas

03 Radiation beam is only activated when patient positioned as per CT.

Beam HELD

Left Breast
Breath hold plan (0.00 ,0.0)

Monitoring 0.0 Default ROI

Parameter	Value
VRT mm	-16.9
LNG mm	8.3
LAT mm	1.9
MAG mm	18.9
Yaw °	-3.2
Roll °	3.0
Pitch °	-2.2

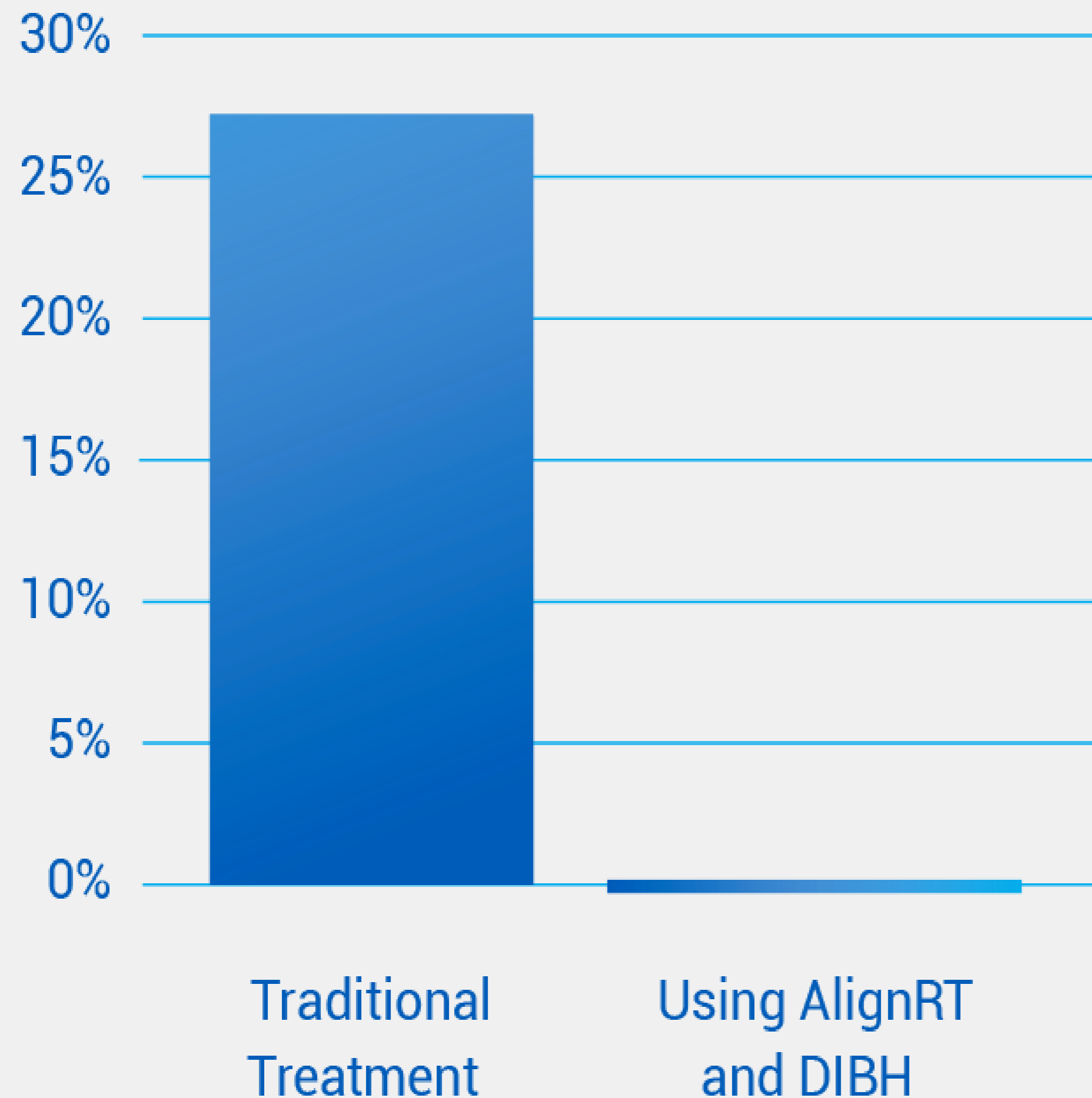
Continuous Real-Time Deltas

04 If patient moves out of intended position, radiation is automatically paused.





Cardiac perfusion defects at 6 months as measured using SPECT imaging



Various studies using older techniques of breast radiation have been studied, with varying rates of resultant heart damage^{4,9}.

In recently published study at the University of North Carolina, patients were treated using AlignRT for DIBH. **0% exhibited cardiac perfusion defects six months after treatment¹⁰.**

PTV was modified accordingly. Cosmesis was scored according to the Harvard scale at the 3 month follow up visit.

Results: Since February 2014, ten patients were enrolled on this prospective registry. Median age was 57.4 (range: 42 – 77). Mean PTV volume was 76.4 cc (range: 131 – 54.6 cc), representing a 64% reduction

among evaluable patients was 71% (20/28; 19 implants and 1 flap; 90% confidence interval, 54-85%). Of the 8 failures, 2 implants failed solely due to cosmetic scores, 2 had infections, 1 had significant capsular contracture (eventually revised to flap), 1 implant was revised to a flap, 1 flap required major revision, and 1 TE was removed due to pain and had no

in volume when compared to treatment room was and MR imaging. 1 evaluation. The mean (range: 99.1-100%). Mean inter-fraction coverage was less than PTV, and 95% pres MR during treatment. Maximum skin the ten patients had for breast cosmesis cosmetic results.

Conclusion: Delivered appropriate treated dose with favorable first series of minimal margins, and Efforts to collect to underway.

Author Disclosure: Roach: None. R. K. Mutic: Honoraria; penses; American Association of Physics Radiation Oncology M.A. Thomas: No

2026

Effects of Postmastectomy Expander and Acell
J.S. Wong,^{1,2} Y.H. C. J.M. Morcau,³ Y.S. Institute, Boston, M

Purpose/Objective: erred to an immediate increases the risk of co used with a TE to contracture. We hypo would lessen compli a prospective trial is **Materials/Methods:** tients with stage I-II TE-ADM reconstruction final reconstruction discretion. Patients minimum of 2 year plications (infectio requiring implant r prescribed chest wal with 0.5-cm bolus te was defined as 90% reconstruction, 2) ne or good cosmetic or **Results:** Thirty-two years: 1 left the cou Median follow up ti (range, 24-63). Med stage I disease, 72 received chemother struction. There we

Physics Contri

A Volun Left Bre Surface I

David P. Gie Daniel E. Se and Alphons

**Department of Massachusetts*

Received Mar 13, 2

Summary

This article des a surface imagi for daily setup tive real-time r breath-hold bre ments, resulting differences of 2 the treated and breath-hold pos

Reprint requests to Hospital, Department 02114. Tel: (617) 72 partners.org

Int J Radiation Oncol 0360-3016/\$ - see from http://dx.doi.org/10.1016/j.pro.2015.06.002

International Journal of Radiation Oncology biology • physics



Practical Radiation Oncology (2014) 4, e151-e158

Original Report

Clinical expe matching-ba left-sided br

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^aDepartment of Radiation ^bDepartment of Biostatistics ^cDepartment of Imaging P ^dDepartment of Radiation ^eDepartment of Radiation

Received 18 January 2013; n

Abstract

Purpose: Three-dimensional inspiration breath-hold (DIBH) exposure. We analyzed port (assess the practical workflow **Methods and materials:** The studied. AlignRT (London, U pericardial shadow as seen or on the digitally reconstructed quantitative measure of setup assessed. In a subset of 21 durations were analyzed to a **Results:** Considering all 50 p d_{BRH} was 0.20 cm (range, 0 –1.22 to 0.67 cm), and their was no significant change in treatment duration for the assessments, 15/21 had non-course of therapy. On interpu more experience with this tex

Supplementary material for Conflicts of interest: None. * Corresponding author. Dep E-mail address: xiaoli.tang@

1879-8500/\$ - see front matter http://dx.doi.org/10.1016/j.pro.2015.06.002

Practical Radiation Oncology (2015) 5, 358-365



Original Report

Prospective assessment of deep inspiration breath-hold using 3-dimensional surface tracking for irradiation of left-sided breast cancer

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Abstract

Purpose: Deep inspiration breath hold (DIBH) is used to decrease cardiac irradiation during radiation therapy (RT) for breast cancer. The patients most likely to benefit and the impact on treatment time remain largely unknown. We sought to identify predictors for the use of DIBH and to quantify differences in dosimetry and treatment time using a prospective registry. **Methods and materials:** A total of 150 patients with left breast cancer were enrolled. All patients were simulated with both free breathing (FB) and DIBH. RT was delivered by either modality. Alternate scans were planned with use of deformable registration to include identical RT volumes. DIBH patients were monitored by a real-time surface tracking system, AlignRT (Vision RT, Ltd, London, United Kingdom). Baseline characteristics and treatment times were compared by Fisher exact test and Wilcoxon rank sum test. Dosimetric endpoints were analyzed by Wilcoxon signed rank test, and linear regression identified predictors for change in mean heart dose (ΔMHD). **Results:** We treated 38 patients with FB and 110 with DIBH. FB patients were older, more likely to have heart and lung disease, and less likely to receive chemotherapy or immediate reconstruction (all $P < .05$). Treatment times were not significantly different, but DIBH patients had greater variability in times ($P = .0002$). Of 146 evaluable patients, DIBH resulted in >20 cGy improvement in MHD in 107 patients but a >20 cGy increase in MHD in 14. Both MHD and lung V20 were significantly lower in DIBH than in paired FB plans. On multivariate analysis, younger age (4.18 cGy per year; $P < .0001$), higher body mass index (6.06 cGy/kg/m²; $P = .0018$), and greater change in lung volumes (130 cGy/L; $P = .003$) were associated with greater ΔMHD.

This study was funded by a research grant from Kaye Family New Technologies. * Corresponding author. Dana-Farber Cancer Institute, 450 Brookline Ave, Boston, MA 02215. E-mail addresses: jbellon@roch.harvard.edu (J.R. Bellon), Ylyatskaya@roch.harvard.edu (Y. Lyatskaya).

http://dx.doi.org/10.1016/j.pro.2015.06.002 1879-8500/© 2015 American Society for Radiation Oncology. Published by Elsevier Inc. All rights reserved.

Proven

Why AlignRT is different

10 published papers in DIBH showing reproducibility of the technique / reduction in cardiac dose^{6,12-20}

- New study suggests prevention of cardiac perfusion defects for left breast patients at 6 month follow-up¹⁰
- Monitors patient surface throughout treatment in all 6 degrees of freedom
- Adds no time to procedure⁶
- Completely safe and non-invasive: no radiation exposure, non-contact
- Published papers also show value for AlignRT use in other indications including non-DIBH breast, brain, head and neck, sarcoma and other cancers²¹⁻³⁰

To review papers, visit VisionRT.com/heartstudies

Heart radiation damage is a widely acknowledged issue.

It can lead to **morbidity and mortality**.

DIBH can help avoid heart radiation exposure –
provided it is performed accurately and reproducibly.

AlignRT is a fast, non-invasive means to help ensure effective, **reproducible DIBH**.

A new study suggests that **AlignRT helps prevent cardiac perfusion defects** in left-breast radiation therapy patients.



Vielen Dank

Joe Deister

000-000-0000

www.GeneralCancerHospital.com/AlignRT

References

¹ Harris EE, et al Late cardiac mortality and morbidity in early-stage breast cancer patients after breast-conservation treatment. *J Clin Oncol.* 2006 Sep 1;24(25):4100-6.

² Darby et al. Risk of Ischemic Heart Disease in Women after Radiotherapy for Breast Cancer. *N Engl J Med* 2013; 368:987-998

³ Udelson et al. Radionuclide imaging in risk assessment after acute coronary syndromes. *Heart* Aug 2004; 90(Suppl 5): v16-v25

⁴ Marks, L. B. et al. The incidence and functional consequences of RT-associated cardiac perfusion defects. *Int. J. Radiat. Oncol. Biol. Phys.* 63, 214–223 (2005)

⁵ Bartlett et al. The UK HeartSpare Study (Stage IB): randomised comparison of a voluntary breath-hold technique and prone radiotherapy after breast conserving surgery. *Radiother Oncol.* 2015 Jan;114(1):66-72. doi:10.1016/j.radonc.2014.11.018

⁶ Gierga et al. A Voluntary Breath-Hold Treatment Technique for the Left Breast With Unfavorable Cardiac Anatomy Using Surface Imaging. *Int J Radiat Oncol Biol Phys.* 2012 Dec 1;84(5):e663-8

⁷ Bartlett et al. The UK HeartSpare Study: randomised evaluation of voluntary deep-inspiratory breath-hold in women undergoing breast radiotherapy. *Radiother Oncol.* 2013 Aug;108(2):242-7.

⁸ Zellars R et al. SPECT analysis of cardiac perfusion changes after whole-breast/chest wall radiation therapy with or without active breathing coordinator: results of a randomized phase 3 trial. *Int J Radiat Oncol Biol Phys.* 2014 Mar 15;88(4):778-85.

⁹ Prosnitz et al. Prospective assessment of radiotherapy-associated cardiac toxicity in breast cancer patients: analysis of data 3 to 6 years after treatment. *Cancer.* 2007 Oct 15;110(8):1840-50.

¹⁰ Zagar T, et al. Utility of Deep Inspiration Breath Hold for Left-Sided Breast Radiation Therapy in Preventing Early Cardiac Perfusion Defects: A Prospective Study. *Int J Radiat Oncol Biol Phys* 2017;97 (5):903-909.

¹¹ Mittauer et al. Monitoring ABC-assisted deep inspiration breath hold for left-sided breast radiotherapy with an optical tracking system. *Med Phys.* 2015 Jan;42(1):134-43.

¹² Cerviño et al. Using surface imaging and visual coaching to improve the reproducibility and stability of deep-inspiration breath hold for left-breast-cancer radiotherapy. *Phys Med Biol.* 2009 Nov 21;54(22):6853-65.

¹³ Chang et al. Video surface image guidance for external beam partial breast irradiation. *Pract Radiat Oncol.* 2012 Apr-Jun;2(2):97-105.

¹⁴ Padilla et al. Assessment of interfractional variation of the breast surface following conventional patient positioning for whole-breast radiotherapy. *J Appl Clin Med Phys.* 2014 Sep 8;15(5):4921.

¹⁵ Rochet et al. Deep inspiration breath-hold technique in left sided breast cancer radiation therapy: Evaluating cardiac contact distance as a predictor of cardiac exposure for patient selection. *Practical Radiation Oncology* (2015) 5, e127-e134.

¹⁶ Rong et al. Improving intra-fractional target position accuracy using a 3D surface surrogate for left breast irradiation using the respiratory-gated deep-inspiration breath-hold technique. *PLoS One.* 2014 May 22;9(5):e97933.

¹⁷ Shah et al. Clinical evaluation of interfractional variations for whole breast radiotherapy using 3-dimensional surface imaging. *Pract Radiat Oncol.* 2013 Jan-Mar;3(1):16-25.

¹⁸ Tang et al. Clinical experience with 3-dimensional surface matching-based deep inspiration breath hold for left-sided breast cancer radiation therapy. *Pract Radiat Oncol.* 2014 May-Jun;4(3):e151-8.

¹⁹ Tang et al. Dosimetric effect due to the motion during deep inspiration breath hold for left-sided breast cancer radiotherapy. *J Appl Clin Med Phys.* 2015 Jul 8;16(4):5358.

²⁰ Tanguturi et al. Prospective assessment of deep inspiration breath-hold using 3-dimensional surface tracking for irradiation of left-sided breast cancer. *Pract Radiat Oncol.* 2015 Nov-Dec;5(6):358-65.

²¹ Shah et al. Clinical evaluation of interfractional variations for whole breast radiotherapy using 3-dimensional surface imaging. *Pract Radiat Oncol.* 2013 Jan-Mar;3(1):16-25.

²² Wiant et al. The Accuracy of AlignRT Guided Set-Up for Whole Breast and Chestwall Irradiation, AAPM Abstract SU-D-213CD-2 2012

²³ O'Connor et al. A Review of the Magnitude of Patient Imaging Shifts in Relation to Departmental Policy Changes. AAPM Abstract SU-E-J-16 2014

²⁴ Padilla et al. Assessment of interfractional variation of the breast surface following conventional patient positioning for whole-breast radiotherapy. *J Appl Clin Med Phys.* 2014 Sep 8;15(5):4921

²⁵ Pan et al. Frameless, real-time, surface imaging-guided radiosurgery: clinical outcomes for brain metastases. *Neurosurgery.* 2012 Oct;71(4):844-51.

²⁶ Pham et al. Frameless, real-time, surface imaging-guided radiosurgery: update on clinical outcomes for brain metastases. *Trans. Cancer Res,* 3, 4, 351-357, August, 2014.

²⁷ Gopan O, Wu Q. Evaluation of the accuracy of a 3D surface imaging system for patient setup in head and neck cancer radiotherapy. *Int J Radiat Oncol Biol Phys.* 2012 Oct 1;84(2):547-52.

²⁸ Wiant et al. A prospective evaluation of open face masks for head and neck radiation therapy. *Pract Radiat Oncol.* 2016 Feb 13

²⁹ Gierga et al. Analysis of setup uncertainties for extremity sarcoma patients using surface imaging. *Pract Radiat Oncol.* 2014 Jul-Aug;4(4):261-6

³⁰ Apicella et al. Three-dimensional surface imaging for detection of intra-fraction setup variations during radiotherapy of pelvic tumors. *Radiol Med.* 2016 Oct;121(10):805-10.