

Radiation Therapy To The Left Breast Using Deep Inspiration
Breath-Hold with the aide of real-time 3D surface imaging.

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The image shows the exterior of a modern multi-story building with a large glass facade. The building has a prominent entrance area with a covered walkway supported by several thick columns. A few people are visible walking on the sidewalk in front of the building. The sky is clear and blue.

Chao Family Comprehensive Cancer Center

University of California-Irvine

A National Cancer Institute-Designated Comprehensive Cancer Center

Literature

- “Initial experience with breath-hold treatments for left breast cancer radiation therapy using real-time 3-dimensional surface tracking”
- S. Yu PhD, N. Hanna, MD, Sue Dietrich, CMD, V. Sehgal, PhD, P. Daroui, MD, J. Kuo, MD, N. Ramsinghani, MD, M.Al-Ghazi, PhD
- University of California, Irvine

- “Respiration Induced Heart Motion and Indications of Gated Delivery for the Left-Sided Breast Irradiation”
- X. Sharon Qi, PhD., *Angela Hu, PhD., *Kai Wang, M.D., Francis Newman, M.S., *Marcus Crosby, M.D., yBin Hu, M.S., yJulia White, M.D., X. Allen Li, PhD.
- *Department of Radiation Oncology, University of Colorado Denver, Aurora, CO
- yDepartment of Radiation Oncology, Medical College of Wisconsin, Milwaukee, WI

Introduction

- ▣ Radiation therapy has been widely used for breast cancer treatments. It has been shown to increase local control and overall survival. However, for left sided breast radiotherapy cardiac complication is of concern. There are several techniques that will help reduce the dose to the heart; traditional heart block (custom or MLC's), prone setup, and Deep Inspiration Breath-Hold (DIBH) with the aide of Real-Time 3D Imaging.

Background

- ▣ Breast conservation therapy has become the standard/preferred treatment for the majority of breast cancer patients with stage 0, 1, or II, resulting in more early-stage breast cancer patients receiving postoperative radiotherapy.
- ▣ Post-Op irradiation after a lumpectomy substantially reduce local and regional recurrence rates for early-stage and locally advanced breast cancers, and contributes to improvements in overall survival.

Background cont'd

- ▣ However, earlier studies did not show an increase in overall survival in breast cancer patients treated with RT because of the increase in non-breast cancer mortality.
- ▣ RT for breast cancer is associated with an increased risk for cardiovascular disease long after RT. Radiation-induced heart disease: pericarditis, ischemic heart disease, myocardial infarction, and in some cases fatal complications.

Background cont'd

- ▣ The greater the volume of the heart included in the radiation field the higher the chances of cardiac injury.
- ▣ Radiation-induced cardiac injury is a latent event, which means that long-term survivors are at higher risks of cardiac mortality.
- ▣ Cardiovascular mortality is higher in patients receiving RT to the left breast.

Technique

- ▣ Voluntary deep inspiration breath-hold (DIBH) technique can reduce cardiac dose by increasing the distance between the heart and the breast or chest wall. To perform accurate DIBH treatments, it is essential to ensure that patients are positioned, and take in breath-hold, consistently. And one way to do that is to actively monitor the patient's respiratory motion and the gating window for the treatment.

Materials and Methods

- ▣ Real-time 3-Dimensional surface tracking consists of three ceiling mounted stereo camera pods, two of the pods are located laterally to the treatment couch and the other is one is located centrally at the foot of the treatment couch.
- ▣ The real-time surface image can be registered with the planned surface contour and provides the patient's real-time positioning offsets. The real time offsets is utilized to align patients initially before treatment and monitor the patient during treatment.

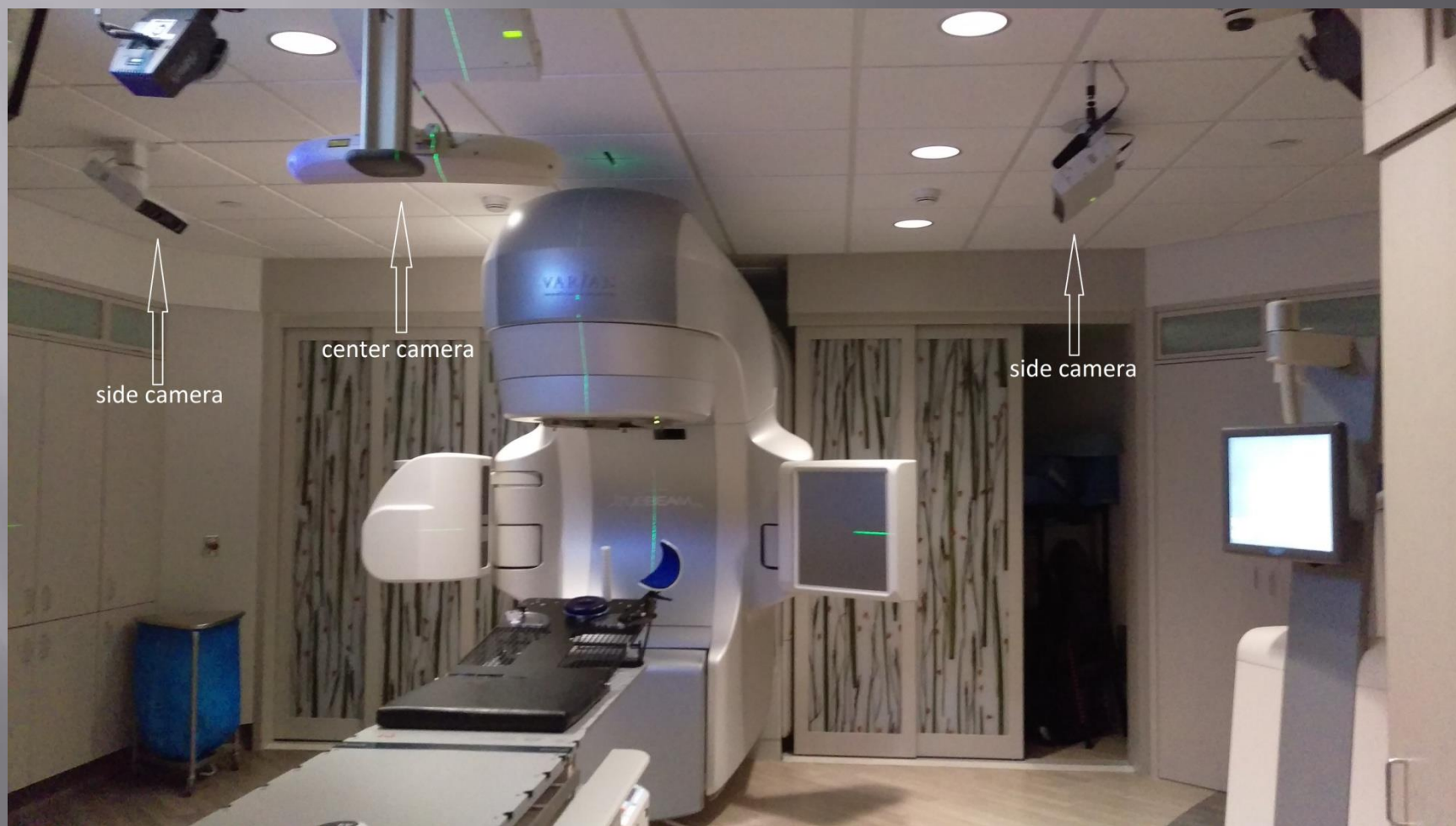
Breast Board



Breast board with vac-bag



Ceiling mounted real-time imaging cameras



Simulation

- ▣ Screening: We have the patient take in a deep breath and hold it for 25-30 seconds. If successful then the patient is an ideal candidate for DIBH treatments.
- ▣ Setup: The majority of our patients are set up on a standard breastboard. Occasionally we use vac-loc on the slant board (breastboard)
- ▣ Scans: We do two set of scans, one with normal free-breathing (FB), and one with DIBH. The FB scan is used to plan for the electron boost and for kv imaging during the isocheck. The DIBH scan is used to plan for treatment ports (mv imaging) and treatments.

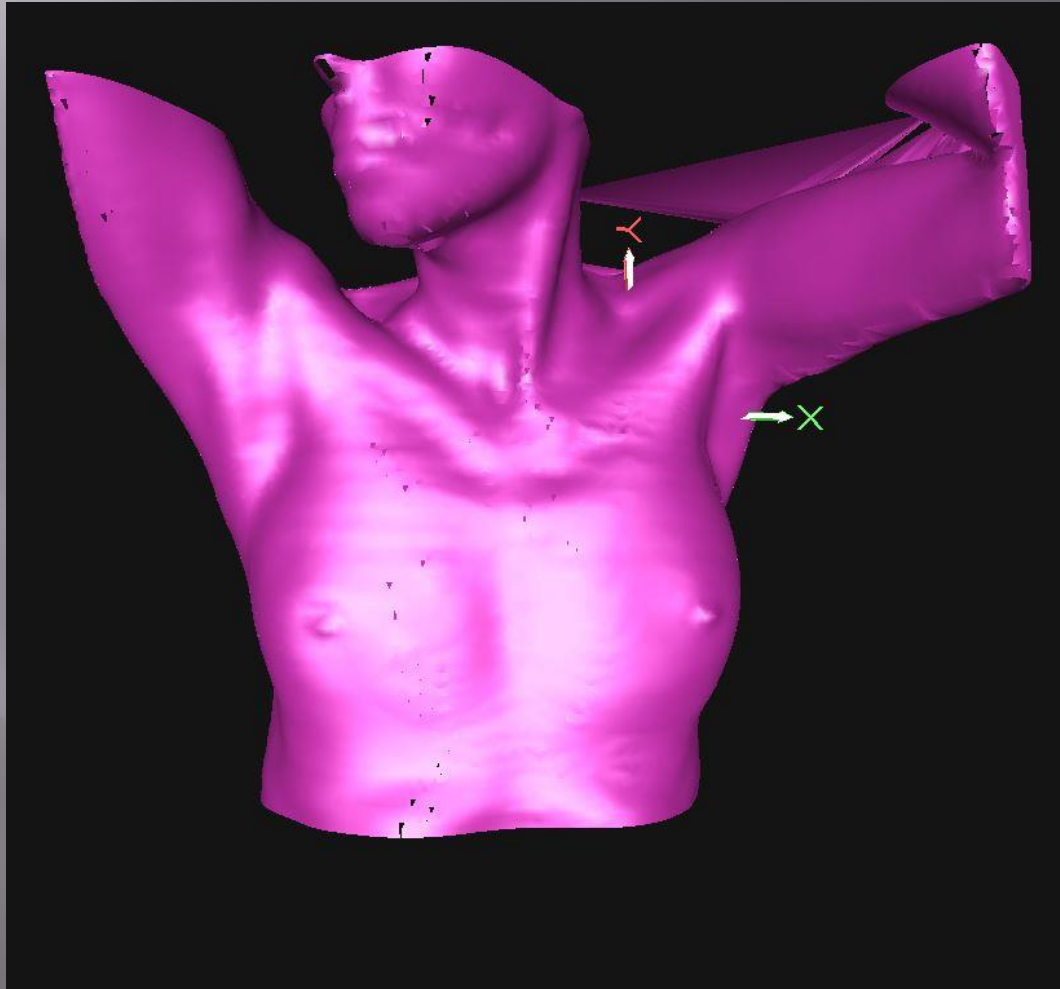
CT Simulation



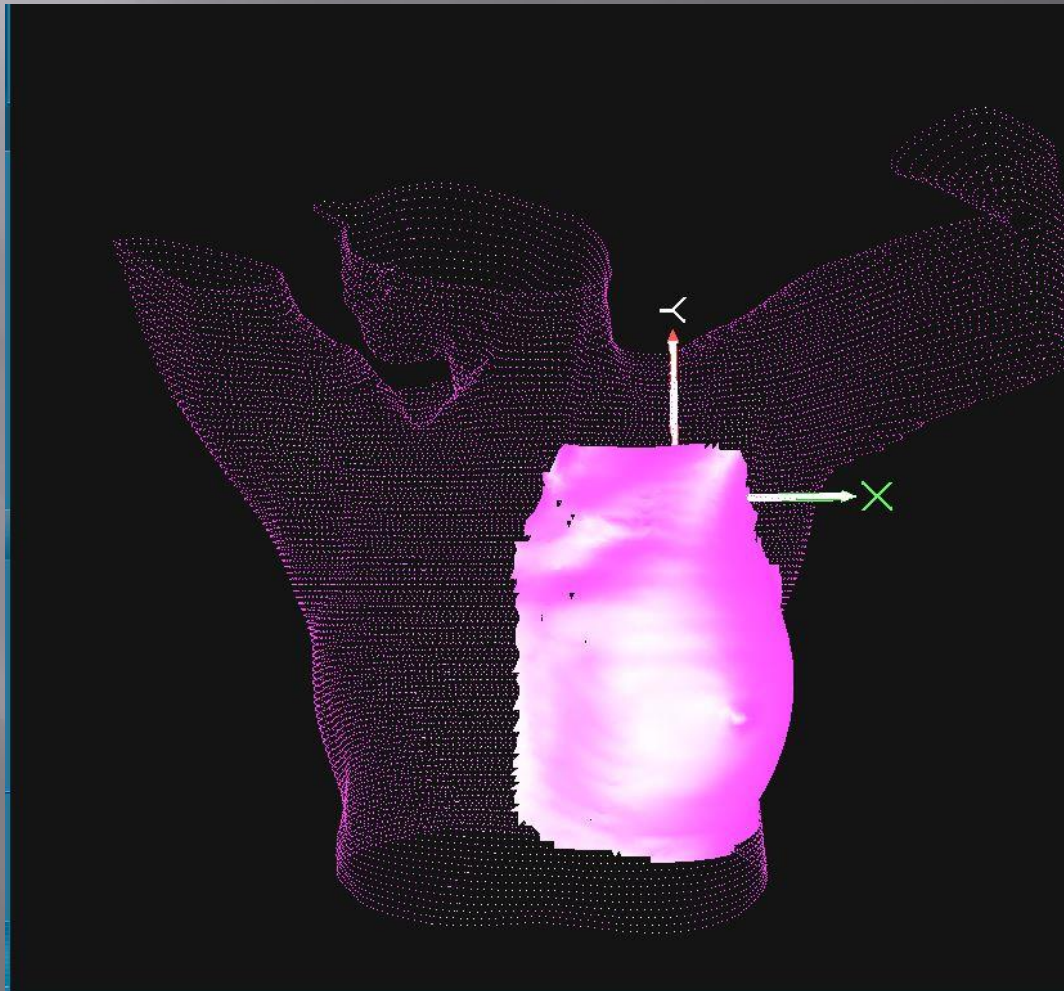
Surface Tracking



Body Contour



Region of Interest



Real-Time Delta: FB

The interface displays the following information:

- Patient:** Left Breast, Lt Breast BH (5.88 ,2.46 ,2, Site/Isocentre
- Field/Reference:** ISOCENTER FIELD VRT
- Skintone:** Fair
- Monitoring:** 0.0
- ROI Selection:** Default ROI
- Tools:** Move Couch, Surface Tools, Edit ROI
- Gate Beam:** OFF

Parameter	Value
VRT mm	-7.4
LNG mm	3.0
LAT mm	-0.6
MAG mm	7.9
Rtn °	-0.4
Roll °	-0.2
Pitch °	0.6

Beam ENABLED

Continuous Real-Time Deltas

Coaching

Frame Rate: 5.2

Real-Time Delta: DIBH

Left Breast
Lt Breast BH (5.88 ,2.46 ,2.46)

ISOCENTER FIELD
VRT

Patient Site/Isocentre Field/Reference Settings Capture Report Skintone Fair

Monitoring Couch Rotation 0.0 Default ROI ROI Selection Move Couch Surface Tools Edit ROI Gate Beam OFF

VRT mm	0.3
LNG mm	-1.3
LAT mm	-1.7
MAG mm	2.1
Rtn °	-0.7
Roll °	-0.1
Pitch °	0.7

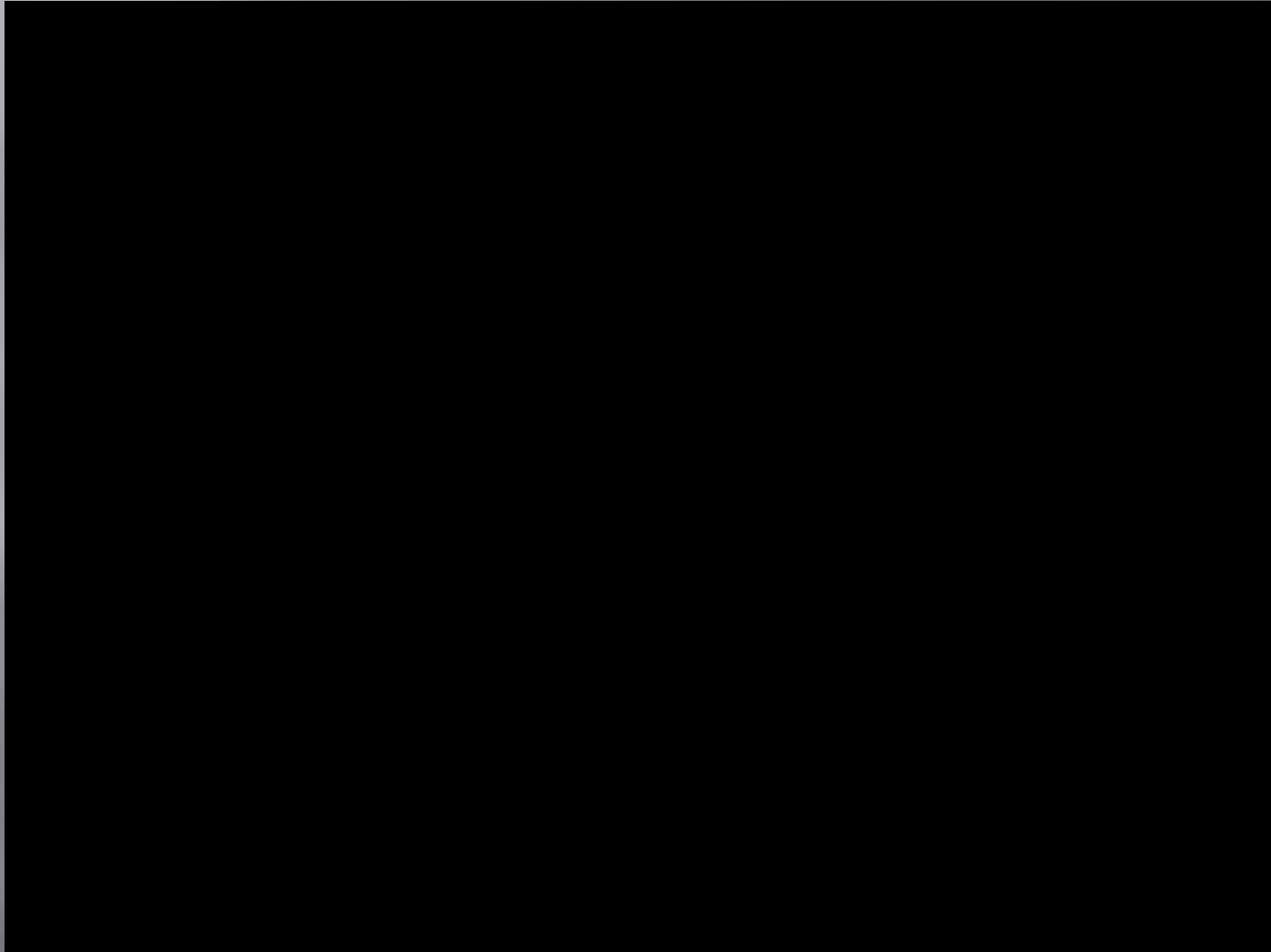
Beam ENABLED

Continuous Real-Time Deltas

Coaching

Frame Rate: 2.6

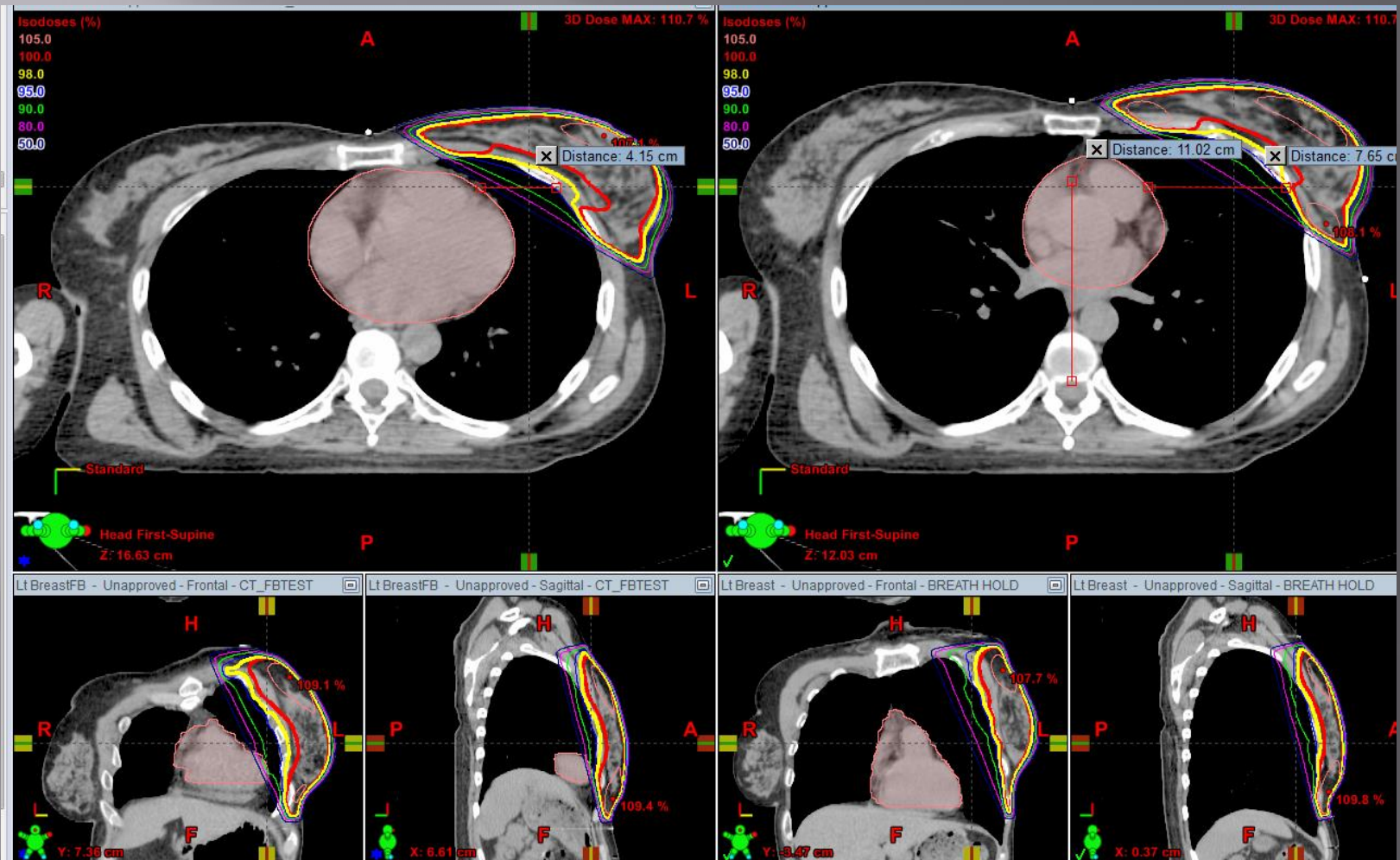
Real Time Imaging System



Treatments

- ▣ Treatments were prescribed 45-50.4 Gy in 25-28 fractions. Treatment plans were created on both freebreathing and DIBH scans to provide a dosimetric comparison of the dose to the heart. Opposing tangent fields with electronic compensator techniques (field-in-field) were used to improve dose homogeneity. The separation between the heart and the chest wall was measured at the 7th thoracic vertebrae and 11 cm anterior to the vertebral body on the two scans for each patient.

Dosimetric comparison



Anatomy and isodose comparisons for a left breast (Free-Breathing and Breath-hold). The separation between the heart and chest wall from 4.15 cm to 7.66 cm.

Results:

- ▣ The overall treatment time, including patient setup and alignment as well as beam on time, ranged from 15-25 minutes for each fraction. The average time for each treatment field is 11 seconds (ranged for 9.5-15 seconds).
- ▣ The separation between the heart and chest wall for DIBH scans is 6.4 cm (range 5.1-7.7cm). This is significantly larger than the separation in the FB scans, which is 2.74 cm (range 2-4.2 cm)
- ▣ The maximum dose to the heart is significantly lower for the DIBH scans than the FB scans, 11.1 Gy (range 6.8-21 Gy) vs 35.5 Gy (range 12.8-45.5 Gy). The mean dose to the heart is lower, 0.92 vs. 2.05 Gy

Dosimetric results of the heart dose for all patients

Patient number	Age (Y)	Separation between heart and CW (cm)		Heart maximum dose (Gy)		Heart mean dose (Gy)	
		FB	BH	FB	BH	FB	BH
		1	42	2.02	6.29	32	21.5
2	51	4.15	7.65	43.47	7.4	1.4	0.9
3	62	3	5.64	43.7	11.57	1.7	1.16
4	47	2.01	5.13	12.8	6.8	0.72	0.62
5	48	2.52	7.17	45.49	8.14	3.25	1.16
Mean	50	2.74	6.38	35.49	11.08	2.05	0.91

Challenges

- ▣ Pendulous breast: Utilization of the breast cup. It's quite a challenge to reproduce the treatment position on a daily basis; the breast has to be tucked in uniformly, and consistently.
- ▣ Bolus: Recapture the reference after placing bolus. And switching back to the reference without the bolus if s'clav is involved (3-fields breast).

Conclusion:

- DIBH can significantly benefit the left breast and chest wall patients by separating the heart from the radiation fields.
- DIBH is dosimetrically beneficial because the target is static.
- Daily real-time surfacing imaging facilitates patients setup and ensures accurate and reproducible positioning for DIBH treatments without additional radiation dose. Patient compliance was good, and treatment durations are clinically acceptable.
- Voluntary DIBH with real-time surface monitoring appears to be a viable option to potentially reduce heart dose for left breast cancers patients , and thus reduce potential long term complication.
- More patients and a substantial period of follow up are required to assess the clinical advantage of this technique.

Questions/Comments?

Thank You

