Clinic Experiences of DIBH-based Breast Treatment Using C-RAD System

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Roadmap

- ***Clinic Background on DIBH Treatment for Whole Breast RT***
- ***Clinical Options for DIBH***
  - ❑ ***Tidal Volume-based DIBH systems***
  - ❑ ***Surface-guided DIBH systems***
- ***DIBH workflow using C-RAD system***
  - ❑ ***CT simulation***
  - ❑ ***Planning***
  - ❑ ***Treatment***
- ***Conclusions***

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Background

- **Breast cancer is the most common cancer for female in U.S., about 29% of all sites** (Siegel R, et al. Cancer statistics, 2014. CA Cancer J Clin. 2014 Jan;64(1):9-29)

Estimated New Cases*

Males			Females		
Prostate	233,000	27%	Breast	232,670	29%
Lung & bronchus	116,000	14%	Lung & bronchus	108,210	13%
Colorectum	71,830	8%	Colorectum	65,000	8%
Urinary bladder	56,390	7%	Uterine corpus	52,630	6%
Melanoma of the skin	43,890	5%	Thyroid	47,790	6%
Kidney & renal pelvis	39,140	5%	Non-Hodgkin lymphoma	32,530	4%
Non-Hodgkin lymphoma	38,270	4%	Melanoma of the skin	32,210	4%
Oral cavity & pharynx	30,220	4%	Kidney & renal pelvis	24,780	3%
Leukemia	30,100	4%	Pancreas	22,890	3%
Liver & intrahepatic bile duct	24,600	3%	Leukemia	22,280	3%
All Sites	**855,220**	**100%**	**All Sites**	**810,320**	**100%**

Estimated Deaths

Males			Females		
Lung & bronchus	86,930	28%	Lung & bronchus	72,330	26%
Prostate	29,480	10%	Breast	40,000	15%
Colorectum	26,270	8%	Colorectum	24,040	9%
Pancreas	20,170	7%	Pancreas	19,420	7%
Liver & intrahepatic bile duct	15,870	5%	Ovary	14,270	5%
Leukemia	14,040	5%	Leukemia	10,050	4%
Esophagus	12,450	4%	Uterine corpus	8,590	3%
Urinary bladder	11,170	4%	Non-Hodgkin lymphoma	8,520	3%
Non-Hodgkin lymphoma	10,470	3%	Liver & intrahepatic bile duct	7,130	3%
Kidney & renal pelvis	8,900	3%	Brain & other nervous system	6,230	2%
All Sites	**310,010**	**100%**	**All Sites**	**275,710**	**100%**

- **Post-lumpectomy whole –breast RT has become the standard treatment option for early-stage breast cancer (**Fisher B, et al, N Engl J Med 2002: 347: 1233-1241)

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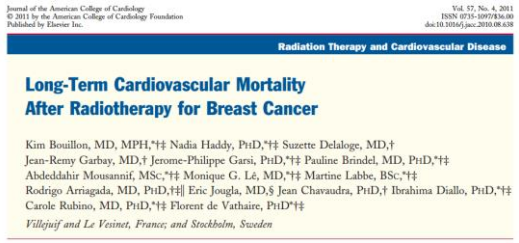
Background

Radiation Induced Toxicity

- Acute toxicity: skin discoloration
- Pneumonitis
- Lymphedema
- ***Cardiac toxicity***
  - ❑*Myocardial infarction, coronary revascularization, death from ischemic heart disease*
  - ❑*1.76 fold increase with Surgery + RT compare to Surgery alone*
  - ❑*1.56 fold increase for left V.S. right breast RT*
  - ❑*Rates of major coronary events increased linearly with mean dose to heart by 7.4%/Gy with no apparent threshold.*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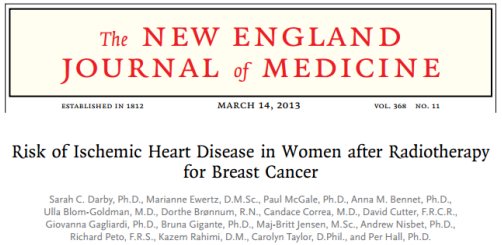
Radiation Therapy and Cardiovascular Disease

Long-Term Cardiovascular Mortality After Radiotherapy for Breast Cancer

Kim Bouillon, MD, MPH,*†‡ Nadia Haddy, PhD,*†‡ Suzette Delaloge, MD,† Jean-Remy Garbay, MD,† Jerome-Philippe Garsi, PhD,*†‡ Pauline Brindel, MD, PhD,*†‡ Abdeddahir Mousannif, MSc,*†‡ Monique G. Lê, MD,*†‡ Martine Labbe, BSc,*†‡ Rodrigo Arriagada, MD, PhD,†‡‖ Eric Jougla, MD,§ Jean Chavaudra, PhD,† Ibrahima Diallo, PhD,*†‡ Carole Rubino, MD, PhD,*†‡ Florent de Vathaire, PhD*†‡

Villejuif and Le Vesinet, France; and Stockholm, Sweden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Risk of Ischemic Heart Disease in Women after Radiotherapy for Breast Cancer

Sarah C. Darby, Ph.D., Marianne Ewertz, D.M.Sc., Paul McGale, Ph.D., Anna M. Bennet, Ph.D., Ulla Blom-Goldman, M.D., Dorthe Brønnum, R.N., Candace Correa, M.D., David Cutter, F.R.C.R., Giovanna Gagliardi, Ph.D., Bruna Gigante, Ph.D., Maj-Britt Jensen, M.Sc., Andrew Nisbet, Ph.D., Richard Peto, F.R.S., Kazem Rahimi, D.M., Carolyn Taylor, D.Phil., and Per Hall, Ph.D.

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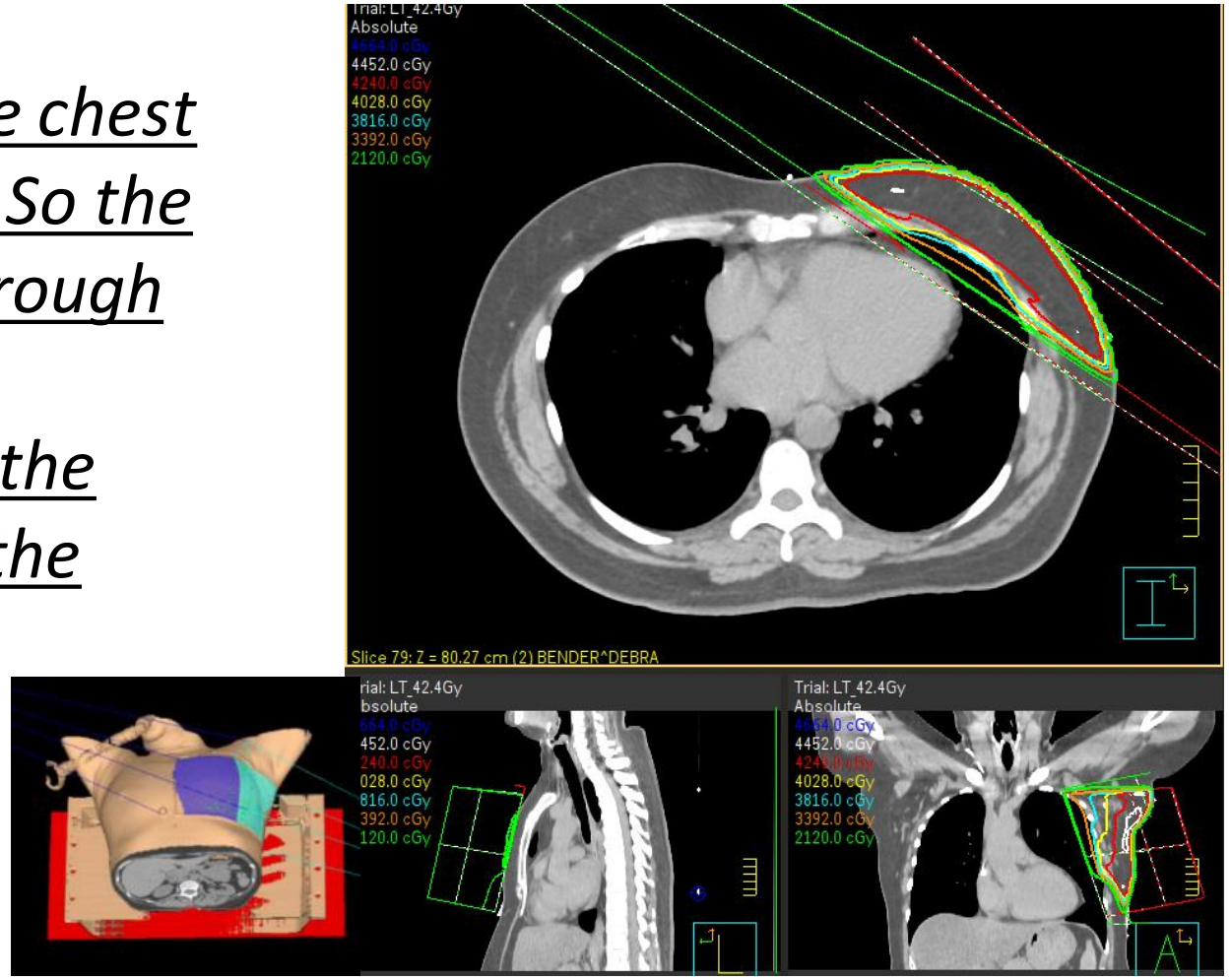
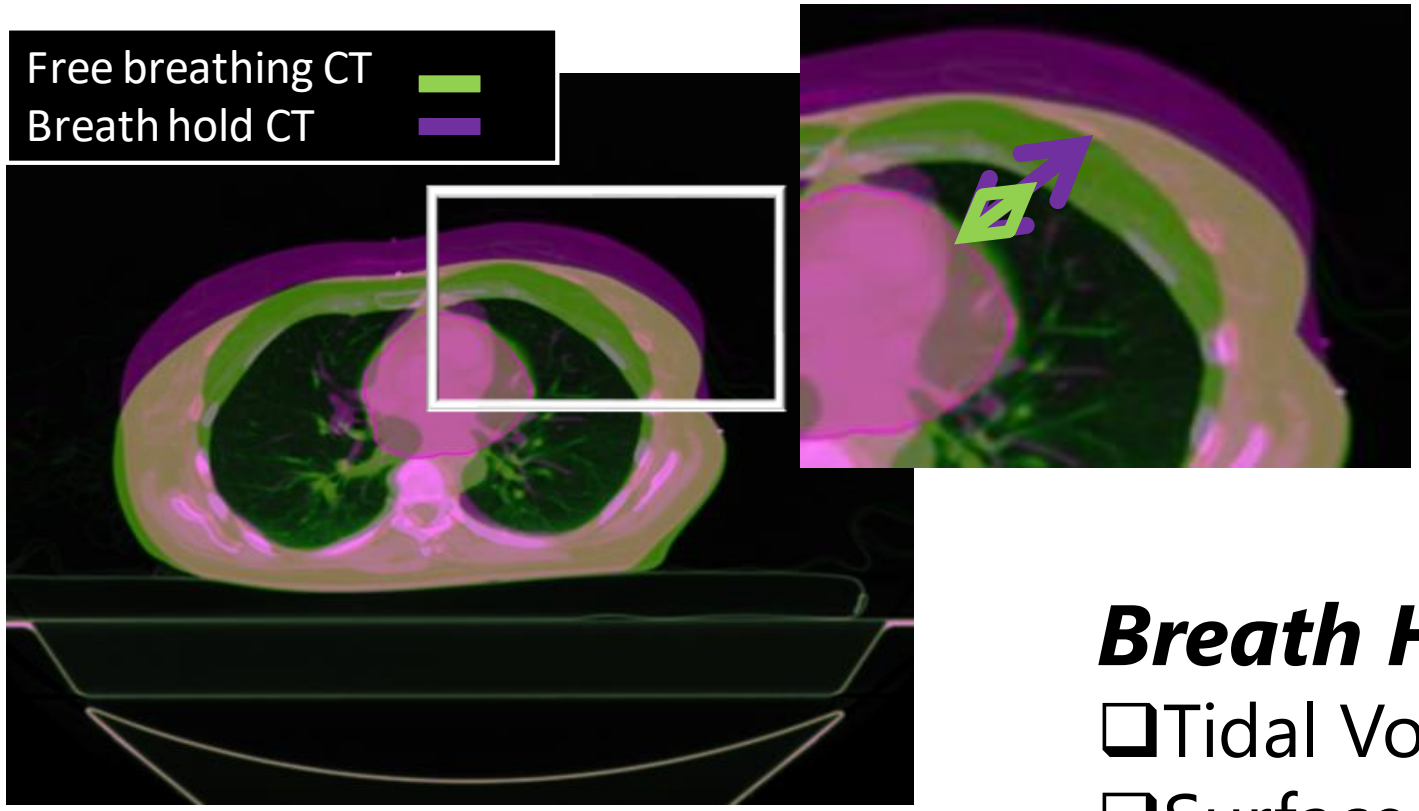
Background

The separation between the chest wall and the heart is small. So the tangent beams can pass through the heart. Even the beam geometry can barely spare the heart, the scatter doses to the heart are still significant.



Clinic Options



Breath Hold Techniques

- ❑Tidal Volume-based BH
- ❑Surface-Guided BH

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Clinic Options

Volume-based Deep-Inspirational Breath Hold

- **ABC (Active Breathing Coordinator)**
  - Control lung expansion at user-defined volume, usually 75% of max inspiration for at least 20 seconds
- **SDX**
  - Similar to ABC with addition of real-time feedback to patient through goggles and shorter breathing tube

Pros: *safe breath hold*
Cons: *patient comfort, no certain correlation between volume and chest position*

ABC (Elekta Oncology Systems, Crawley, UK)

SDX (Qfix, Avondale, PA)

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Clinic Options

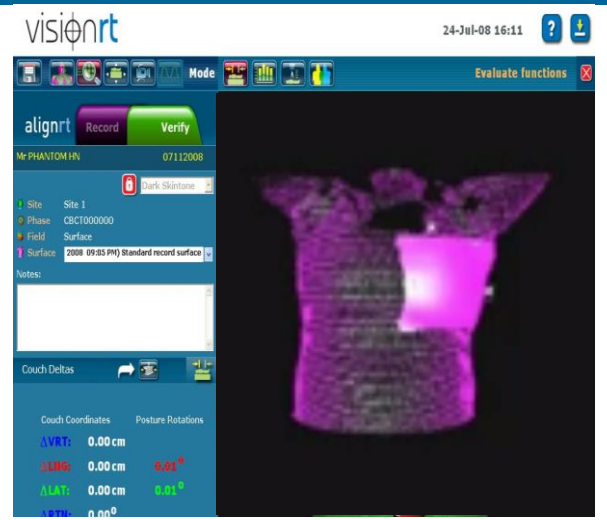
Surface-Guided Deep-Inspiration Breath Hold

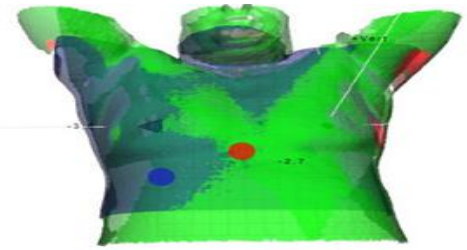
- **Vision RT**
  - Using stereo cameras to acquire the infrared light projected to patient's surface

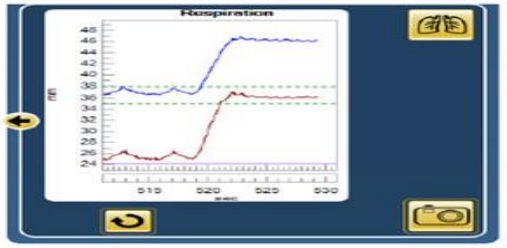
- **C-RAD**
  - Digital Light Processing(DLP) surface scanning system(Catalyst) and laser surface scanning(sentinel)

Both systems can provide accurate breast/chest wall position during DIBH

Workflow-wise, I personally prefer C-RAD system







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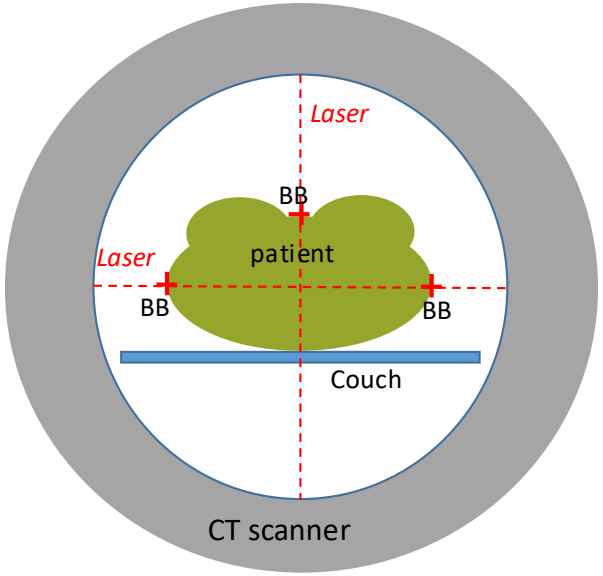
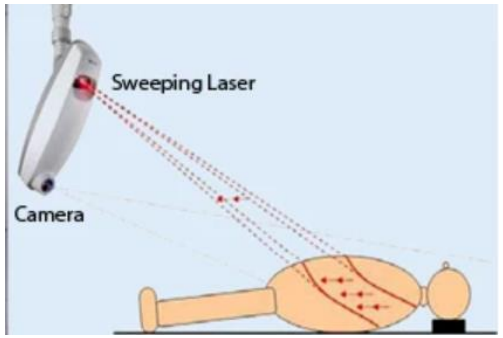
DIBH workflow using C-RAD system

CT Simulation

- Patient selection
  - ❑Can patient perform consistent breath hold?
  - ❑Can patient hold breath long enough?
- BB alignment and positioning



- surface imaging acquiring through Laser scanning



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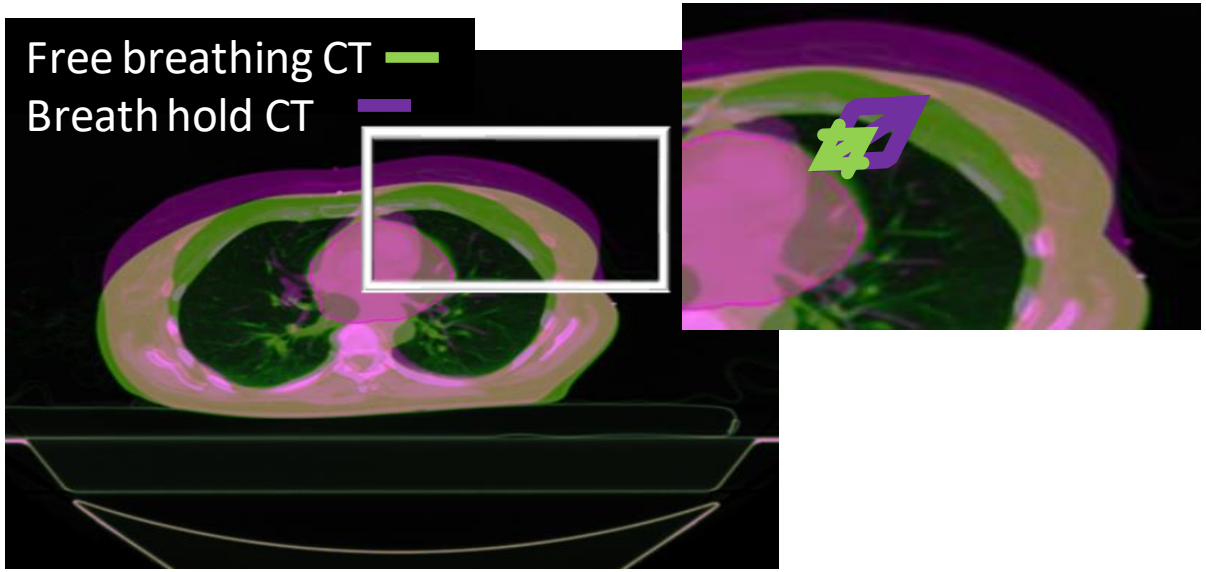
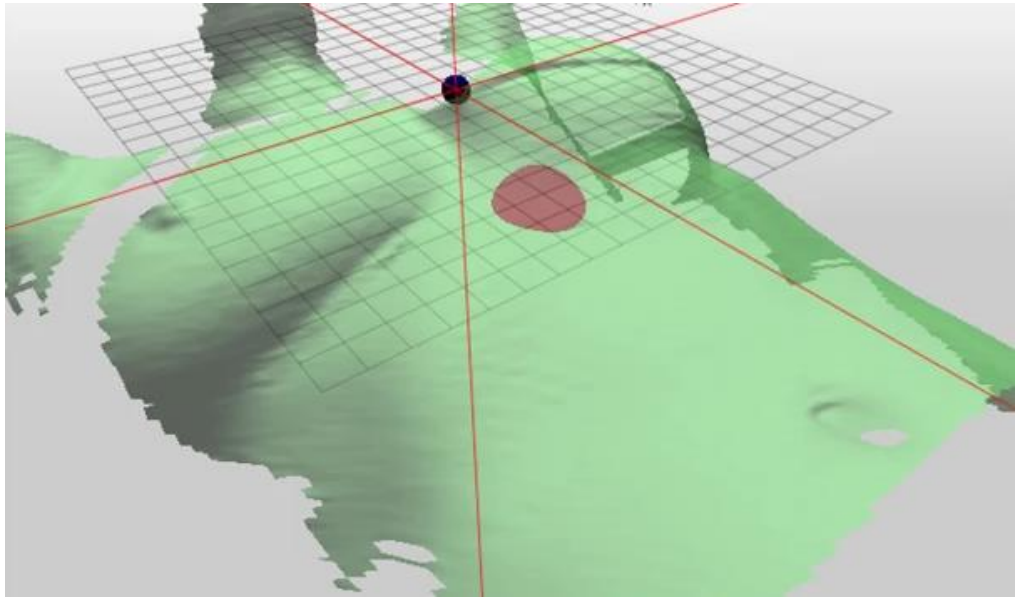
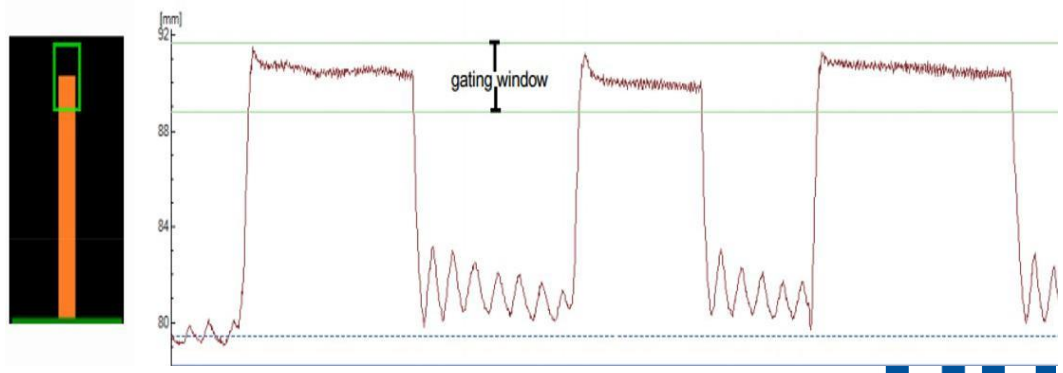
DIBH workflow using C-RAD system

CT Simulation (cont.)

- DIBH training
- Free breathing CT scan
- Breath Hold CT scan







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DIBH workflow using C-RAD system

Planning

- Ensure to use DIBH CT as the primary
- Define CT iso based on BB
- Design beams
- Dose Evaluation
  - ❑Mean dose to heart should be less than 500cGy
- Sent Plan information to CRAD system

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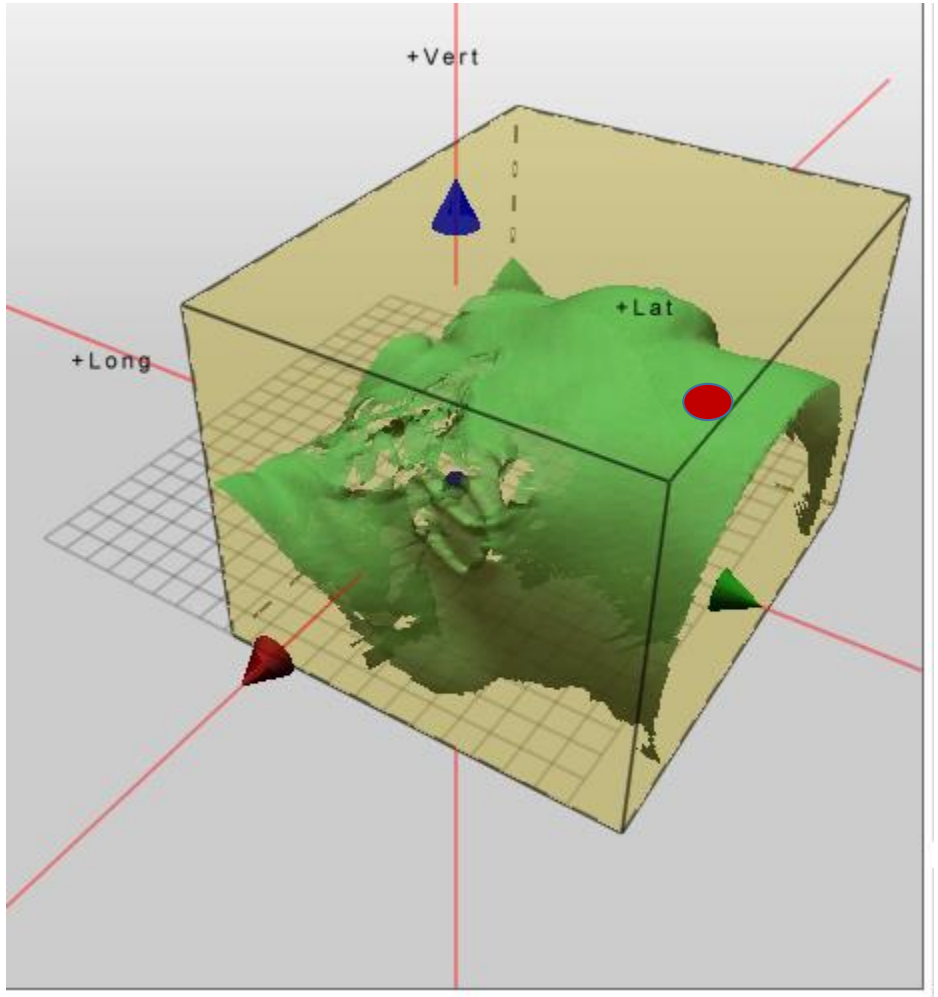
DIBH workflow using C-RAD system

Treatment

- Setup preparation
  - ❑Camera parameter setting
  - ❑Bounding box define
    - ✓From Neck to upper abdomen
    - ✓Including the tracing point
    - ✓Ensure the superior boarder high enough to be able to cover the contour during DIBH
  - ❑Motion control specs define
    - ✓cRespiration
    - ✓cMotion
    - ✓cPosition



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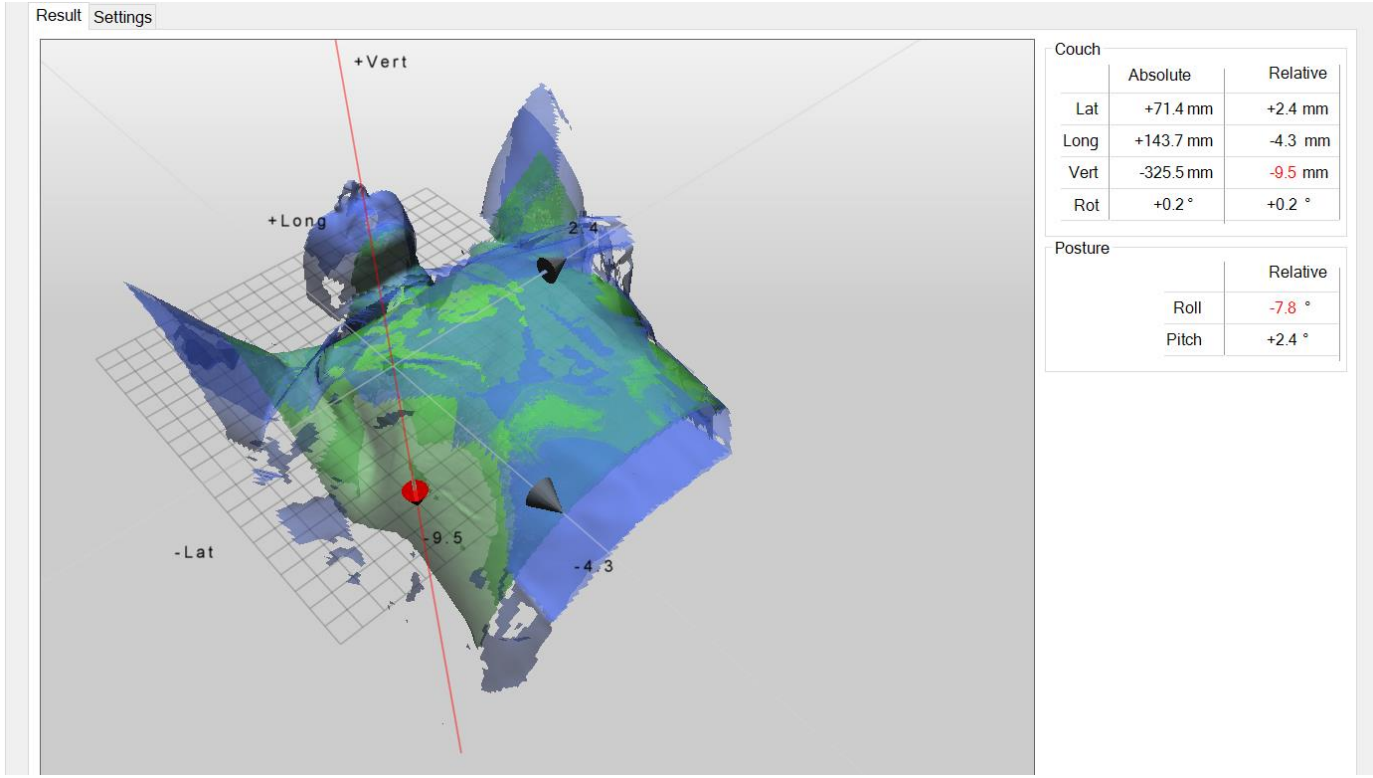
DIBH workflow using C-RAD system

Treatment (cont.)

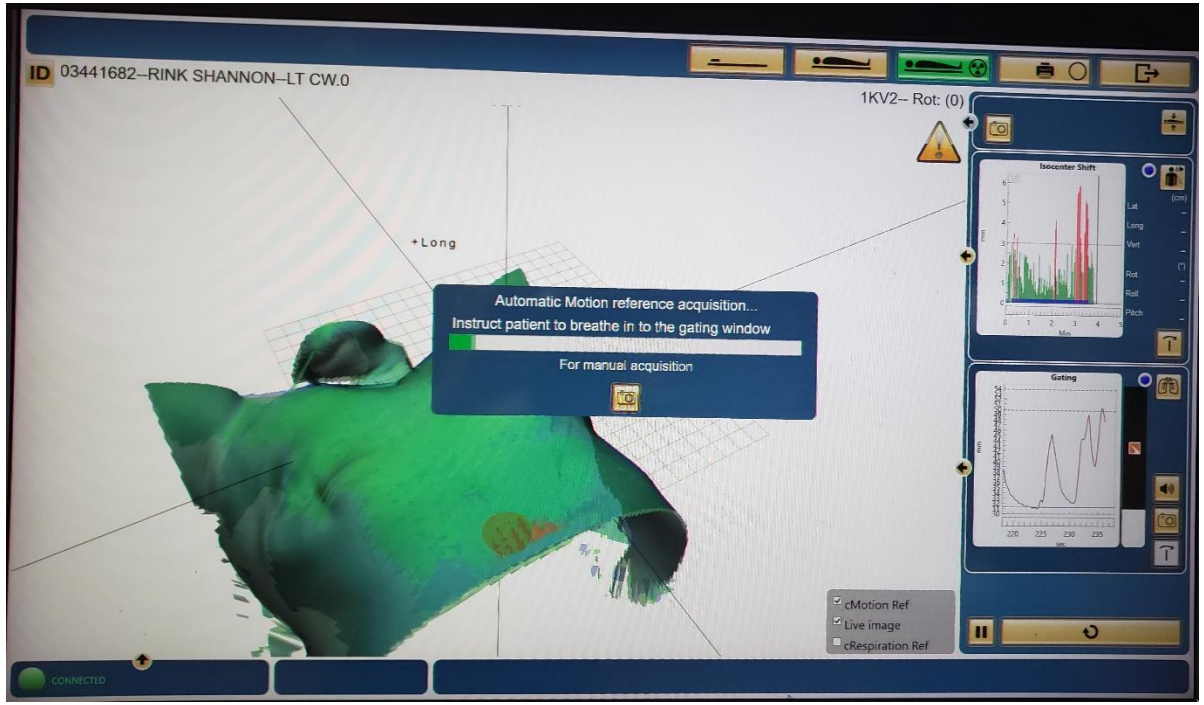
- Coarse alignment using Sentinel acquired images



DIBH workflow using C-RAD system

Treatment(cont.)

- Practice DIBH and acquire reference contour at 50% of breathing window



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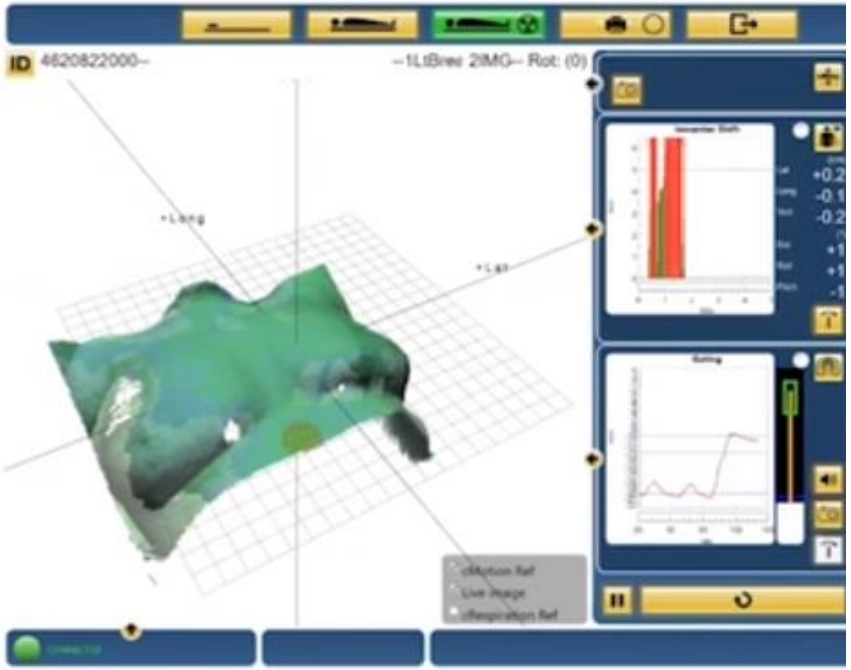
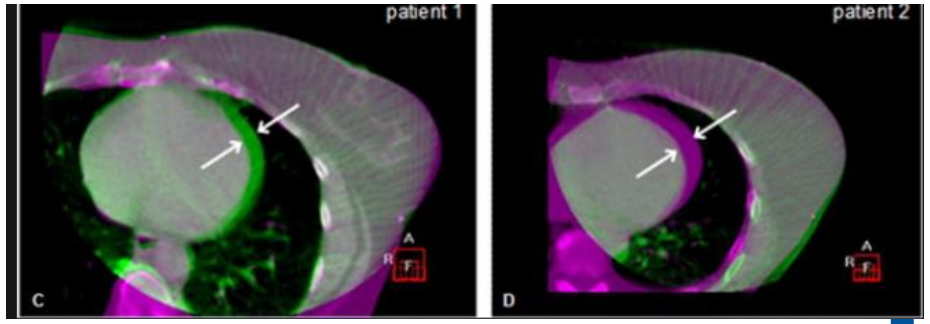
DIBH workflow using C-RAD system

Treatment(cont.)

- Performing DIBH-based CBCT and re-align the patient
  - ❑Short time scanning time
  - ❑Pause if breaks needed
  - ❑Start or resume scan when all three within specs
    - ✓cRespiration
    - ✓cMotion
    - ✓cPosition





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DIBH workflow using C-RAD system

Treatment(cont.)

- Perform treatment based on the guidance of CRAD
  - ❑Gated treatment through ELEKTA response box
  - ❑Provide enough rest time between BH
  - ❑Ensure the FB return to the baseline after each BH
  - ❑Most of the patient prefer verbal instruction than feed back system

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Conclusions

- **DIBH technique is effective for decreasing cardinal toxicity for whole breast RT**
- **SGRT-based DIBH treatment become more popular than Tidal-volume based treatment due to its patient comfort and position accuracy**
- **C-RAD system provide a clinic-friendly workflow for DIBH RT**

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Any Question?