Direct DIBH Workflow for Breast inBore SGRT in Varian ETHOS

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How story begin?

Varian Ethos was installed in April 2022

(1st in the country)

No CBCT based adaptive experience

AlignRT installed in September 2022

(with Ethos, 3rd in the world)

No SGRT experience

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Main reason: Motion Management

Ideal Patients for DIBH Treatments

- Cooperation is needed
- Trainning is needed
  - **Respiration monitoring and/or visual assistance** is important for both CT simulation and treatment
- At least 15-20 sec breath hold is needed
  - Stable
  - Repeatable

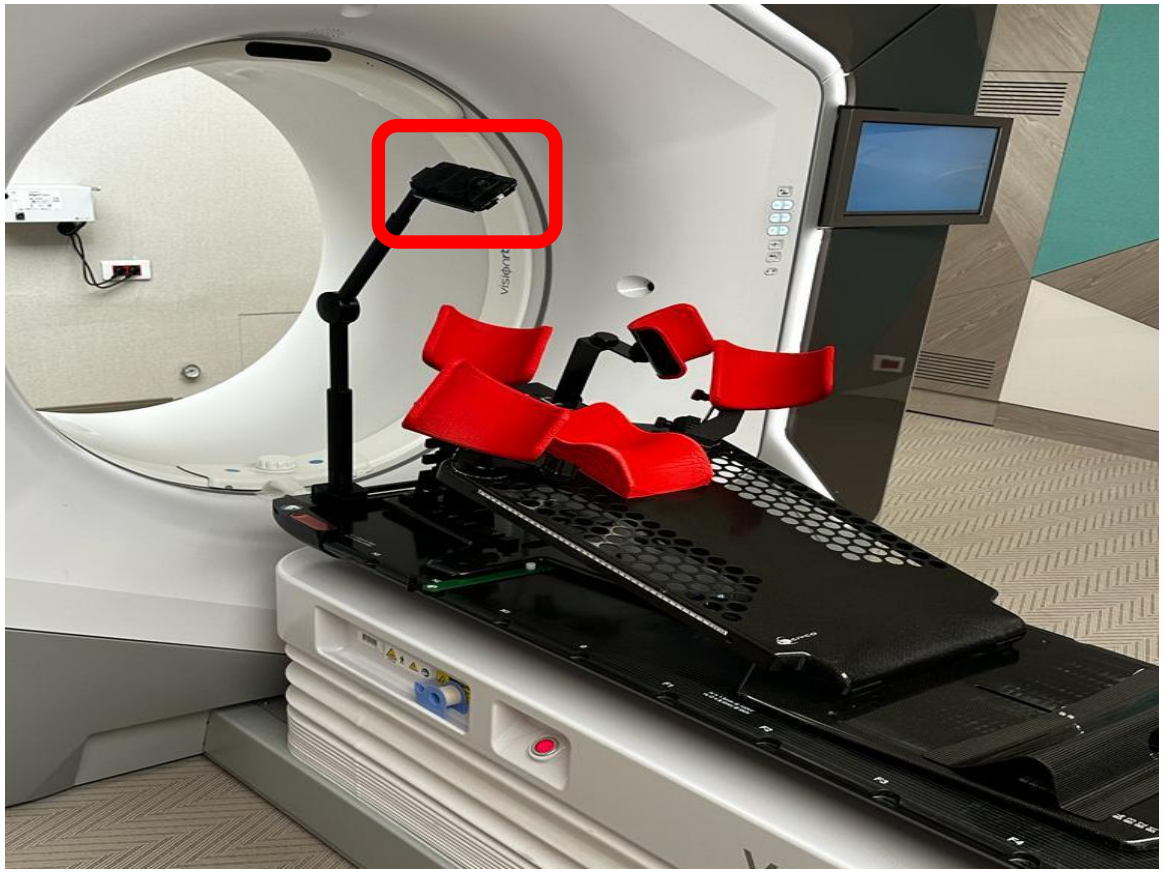
Monitoring - CT Simulation

No SGRT at CT

Varian RGSC (RPM) for Breath Hold or 4DCT imaging

No VCD (bore size!)

Visual Coaching - Treatment



SGRT easy to implement?

C Arm Linacs

- Machine iso = Plan iso
- Position with lasers, markers, SGRT at same location
- Positioning, imaging and treatment at same location
- SGRT is very useful for both positioning and tracking

AAPM SCIENTIFIC REPORT

MEDICAL PHYSICS

AAPM task group report 302: Surface-guided radiotherapy

Hania A. Al-Hallaq[1] | Laura Cerviño[2] | Alonso N. Gutierrez[3] | Amanda Havnen-Smith[4] | Susan A. Higgins[5] | Malin Kügele[6,7] | Laura Padilla[8] | Todd Pawlicki[8] | Nicholas Remmes[9] | Koren Smith[10] | Xiaoli Tang[11] | Wolfgang A. Tomé[12]

WORKFLOW FB / DIBH

FB / No Motion

CT Simulation:
- Create SGRT-friendly immobilization

Planning:
- Create accurat body contour (D COM)
- Export plan and SGRT system

Prepare data in SGRT system:
- Impo nd body contour
- Sele ROIs a d settings including thresholds

Positioning for Treatment:
- Initial positioning using SGRT
- X-ray based target localization (e.g., kV/MV ports) at least once per week to confirm position and for troubleshooting as needed

Treatment:
- SGRT monitoring of DICOM FB surface
- If motion exceeds tolerance, go back to "Positioning for Treatment"

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Treatment:
- SGRT monitoring of DICOM FB surface
- If motion exceeds tolerance, go back to "Positioning for Treatment"

DIBH

CT Simulation:
- Create SGRT-friendly immobilization
- Acquire scans at FB and DIBH

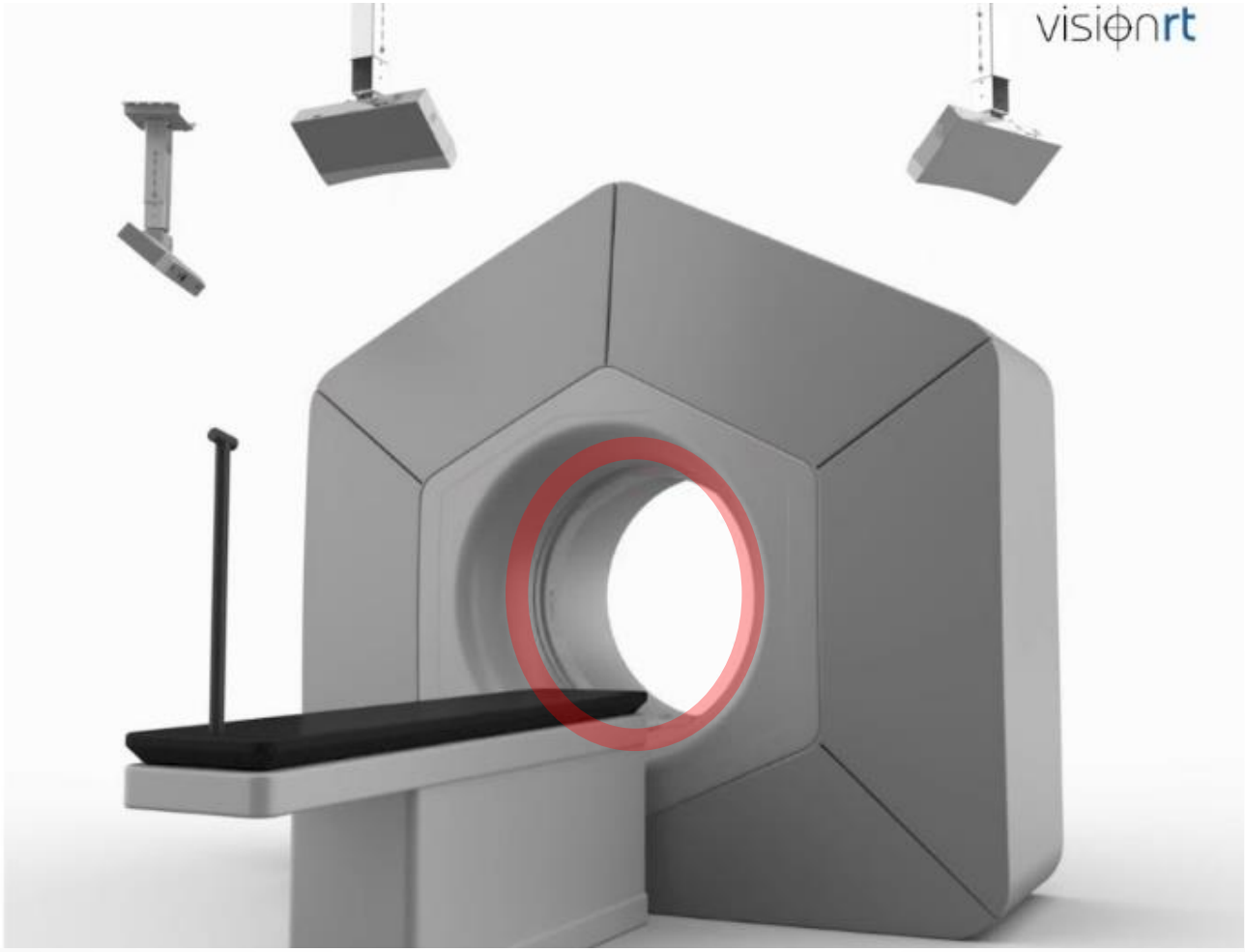
Planning:
- Create accurate FB & DIBH body contours (DICOM)
- Export plan and body contours (FB & DIBH) to SGRT system

Prepare data in SGRT system:
- Import plan and body contours (FB & DIBH)
- Select ROIs and settings including thresholds

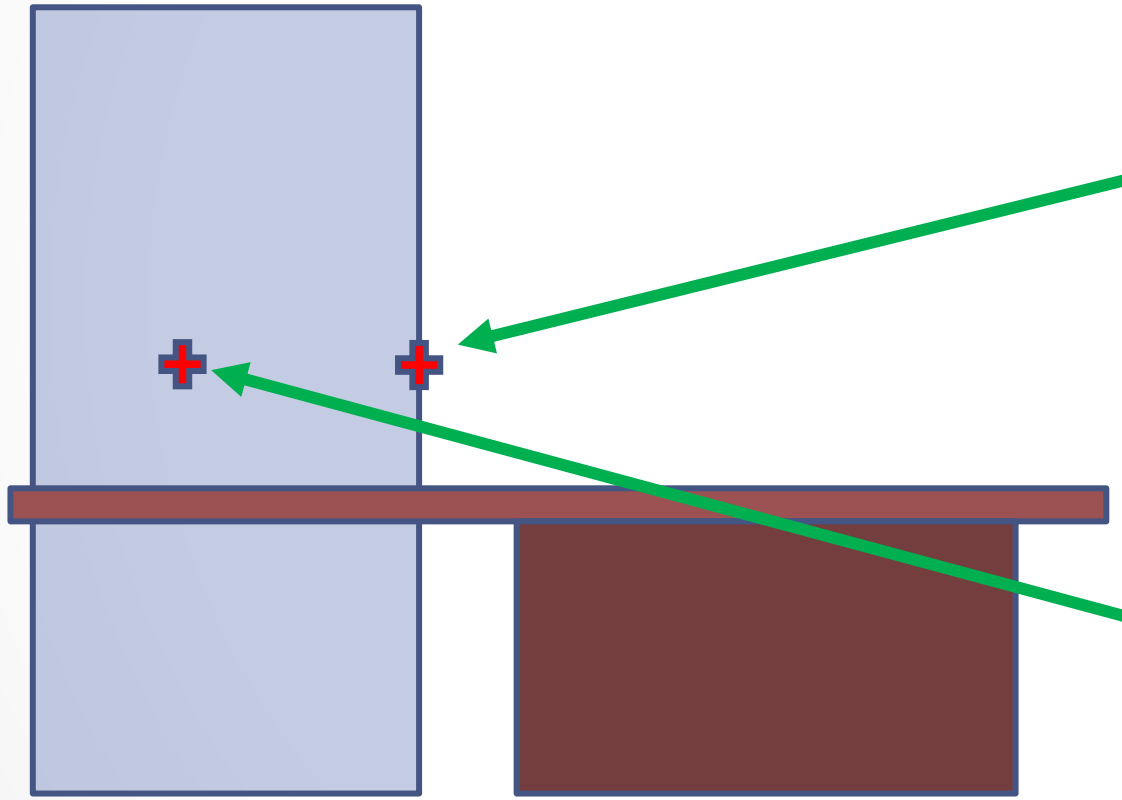
Positioning for Treatment:
- Initial positioning with SGRT at FB
- Fine-tune positioning with SGRT at DIBH
- X-ray based target localization (e.g., kV/MV ports) to confirm DIBH position at least once per week and for troubleshooting as needed

Treatment:
- SGRT monitoring of DICOM DIBH surface
- If motion exceeds tolerance, coach patient to DIBH
- If motion continues to exceed tolerance, return to "Positioning for Treatment"

O-Ring Linac with inBore SGRT (DIBH)



Differences: Varian Ethos



- Virtual İSO
  (Laser & Setup)
- Real İSO
  (IGRT & Treatment)

Differences: inBore SGRT

3 ceiling pod

2 inBore pod

Number of the cameras
ceiling = 6 > inBore = 4

Technology
Horizon (ceiling) > inBore

Surface generation
3 direction > 2 direction

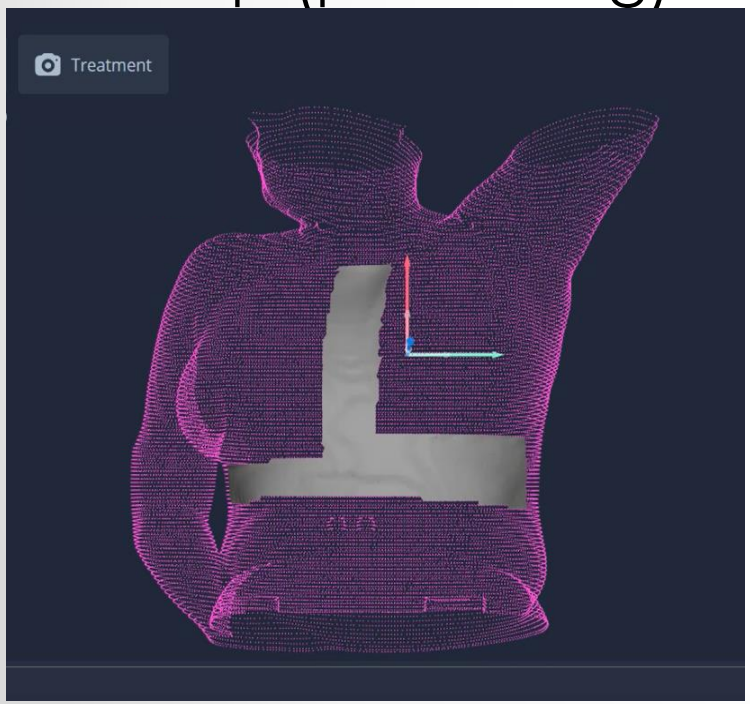
Needed different type of ROIs for different cam groups

Challenges: O-Ring Linac & inBore DIBH SGRT

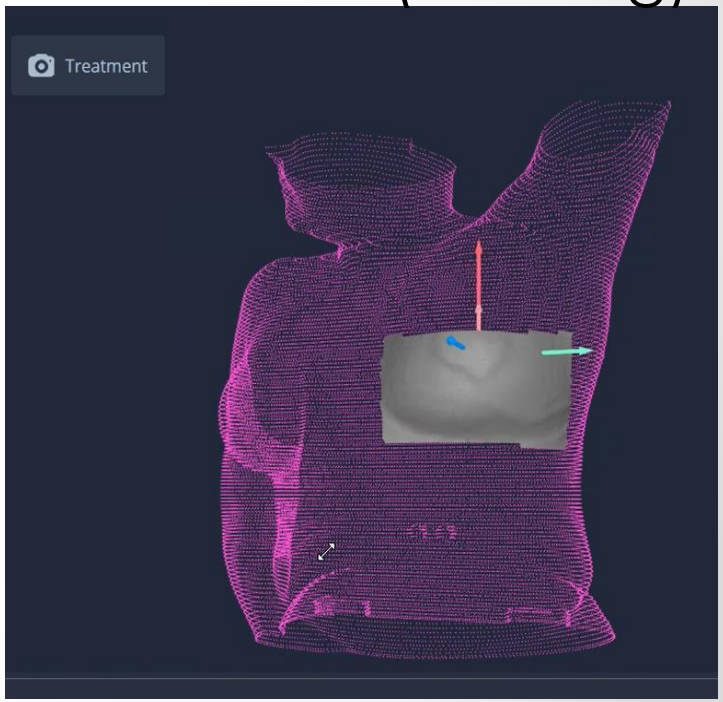
2 CT (simulation)	2 İsocenter (setup&treatment)	2 Set Camera (Body&ROI)
• Free breathing	• Position @ virtual iso	• Ceiling
• Breath hold	• İmage&treat @ real iso	• InBore

Challenges: O-Ring Linac & inBore DIBH SGRT

Virtual iso
FB
Ceiling cams
Setup (positioning)

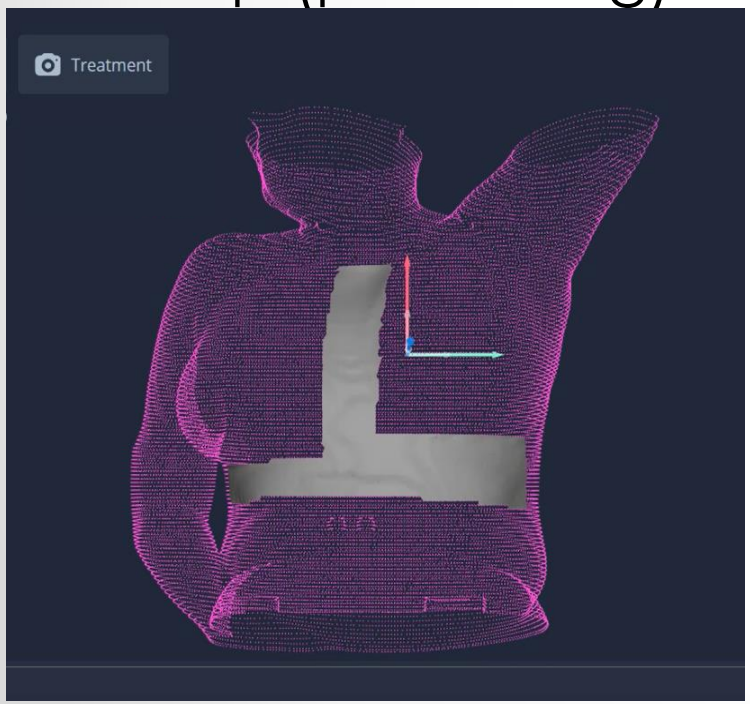


Real iso
DIBH
inBore cams
Treatment (tracking)



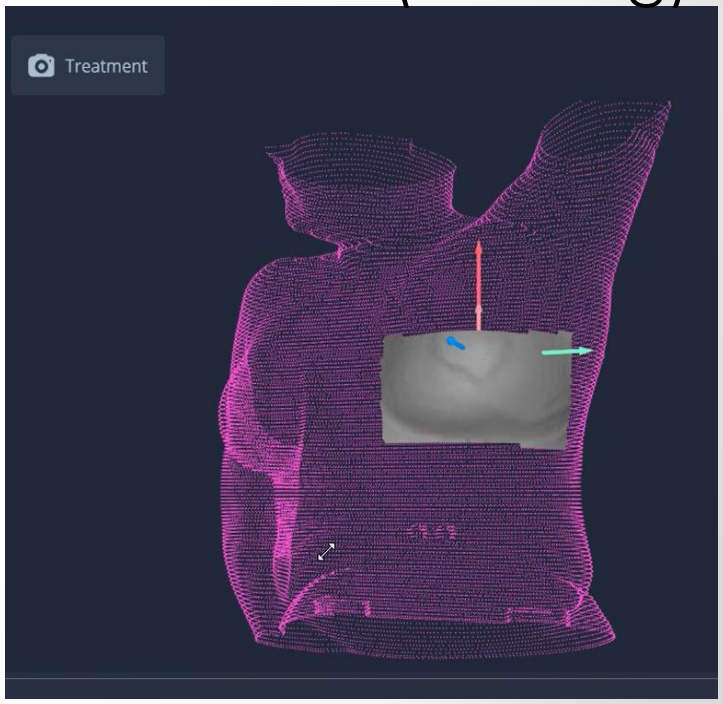
Challenges: O-Ring Linac & inBore DIBH SGRT

Virtual iso
FB
Ceiling cams
Setup (positioning)



ROI differences
Patient may move
FB uncertainity
Breath amplitude

Real iso
DIBH
inBore cams
Treatment (tracking)



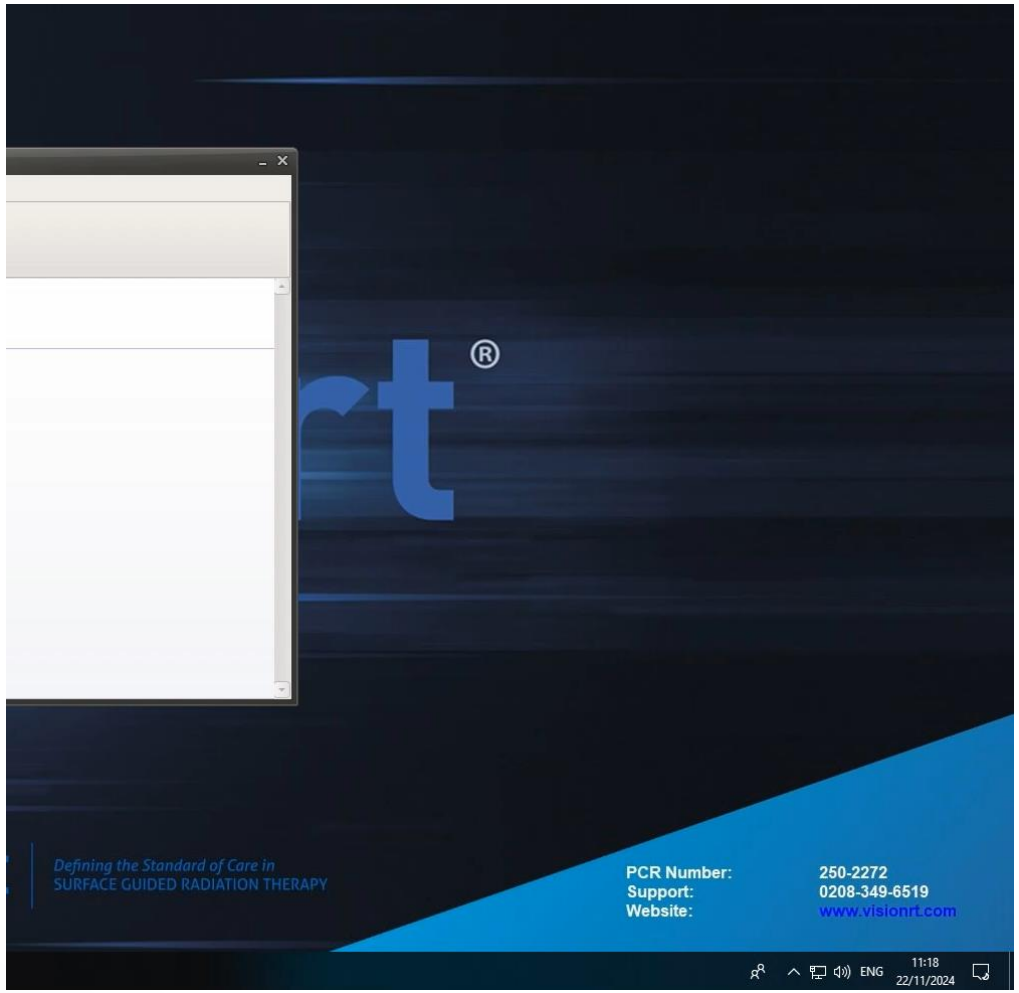
Challenges: O-Ring Linac & inBore DIBH SGRT

2 CT (simulation)	2 İsocenter (setup&treatment)	2 Set Camera (Body&ROI)
• Free breathing	• Position @ virtual iso	• Ceiling
• Breath hold	• İmage&treat @ real iso	• InBore

Not easy to implement

Also we were still at learning period of OART

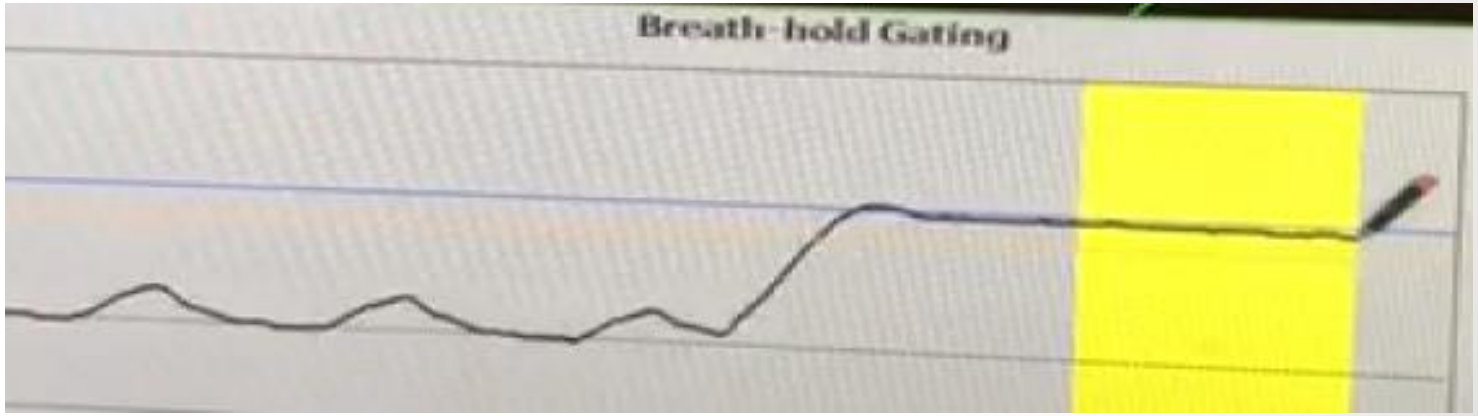
New WorkFlow



New WorkFlow

- **No FB reference for SGRT**
  Only for initial plan verification
- **DIBH only for every step**
- **1 SGRT Body**
- **1 SGRT ROI**
- **Skin markers on DIBH**

Extra effort (training/caution) for CT&setup

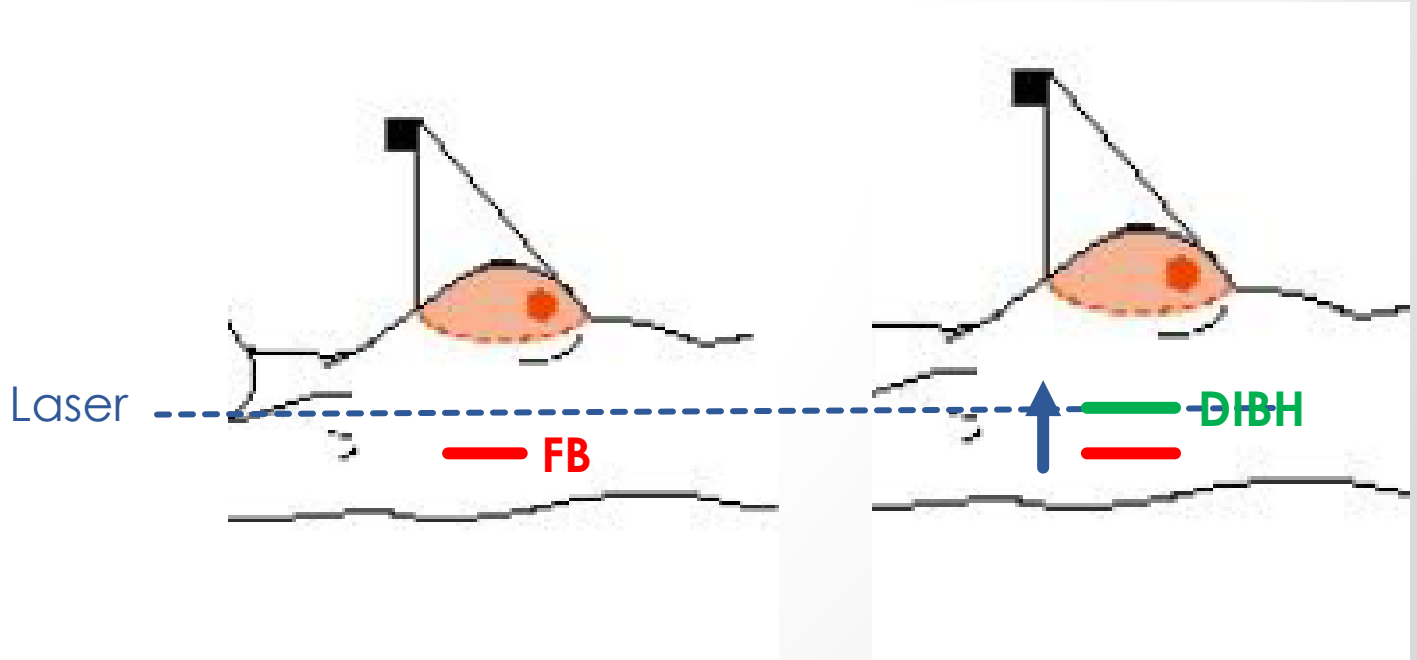


New WorkFlow

- **No FB reference for SGRT**
  Only for initial plan verification
- **DIBH only for every step**
- **1 SGRT Body**
- **1 SGRT ROI**
- **FB / DIBH marker on skin (at the beginning)**

Extra effort (training/caution) for CT&setup

Check markers with lasers between FB&DIBH repeatable and stable DIBH



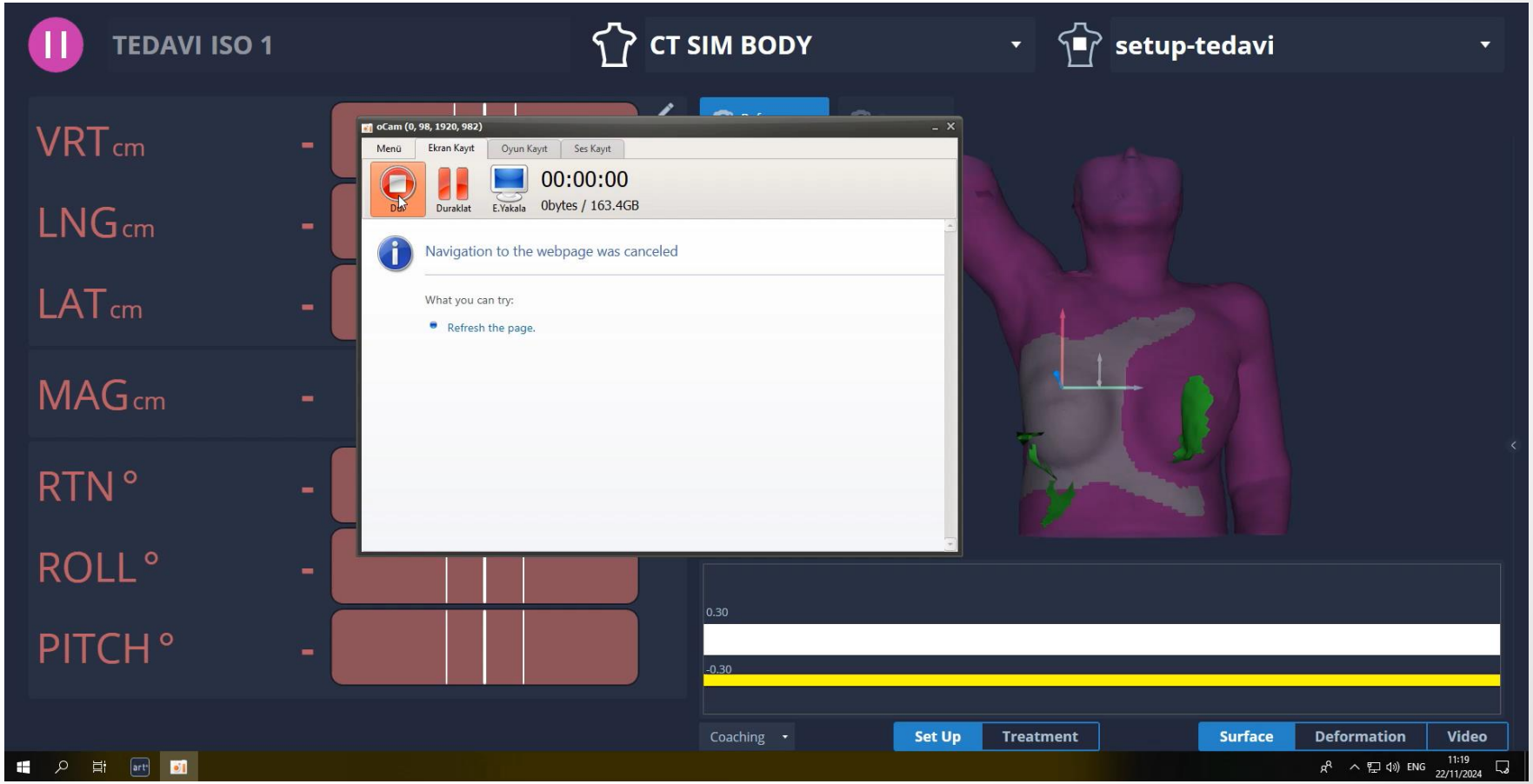
New Workflow

Setup & Couch shifts from virtual (laser) to real iso

Almost 5 sec

Keep DIBH, finish the shift and take SGRT ref with inBore cams

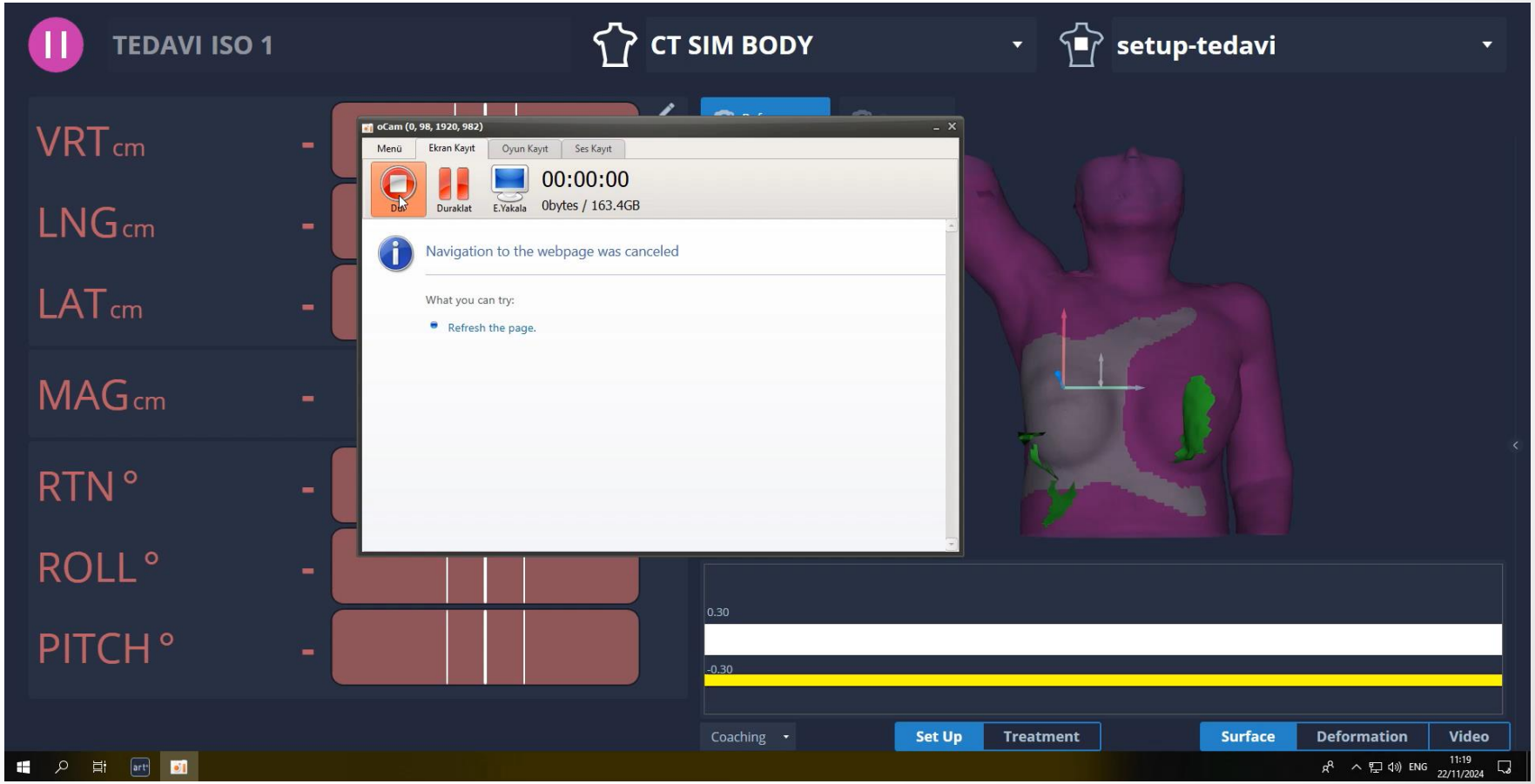
This is new reference for CBCT



New Workflow

IGRT Step

CBCT time 16 sec
(breast fast mode)

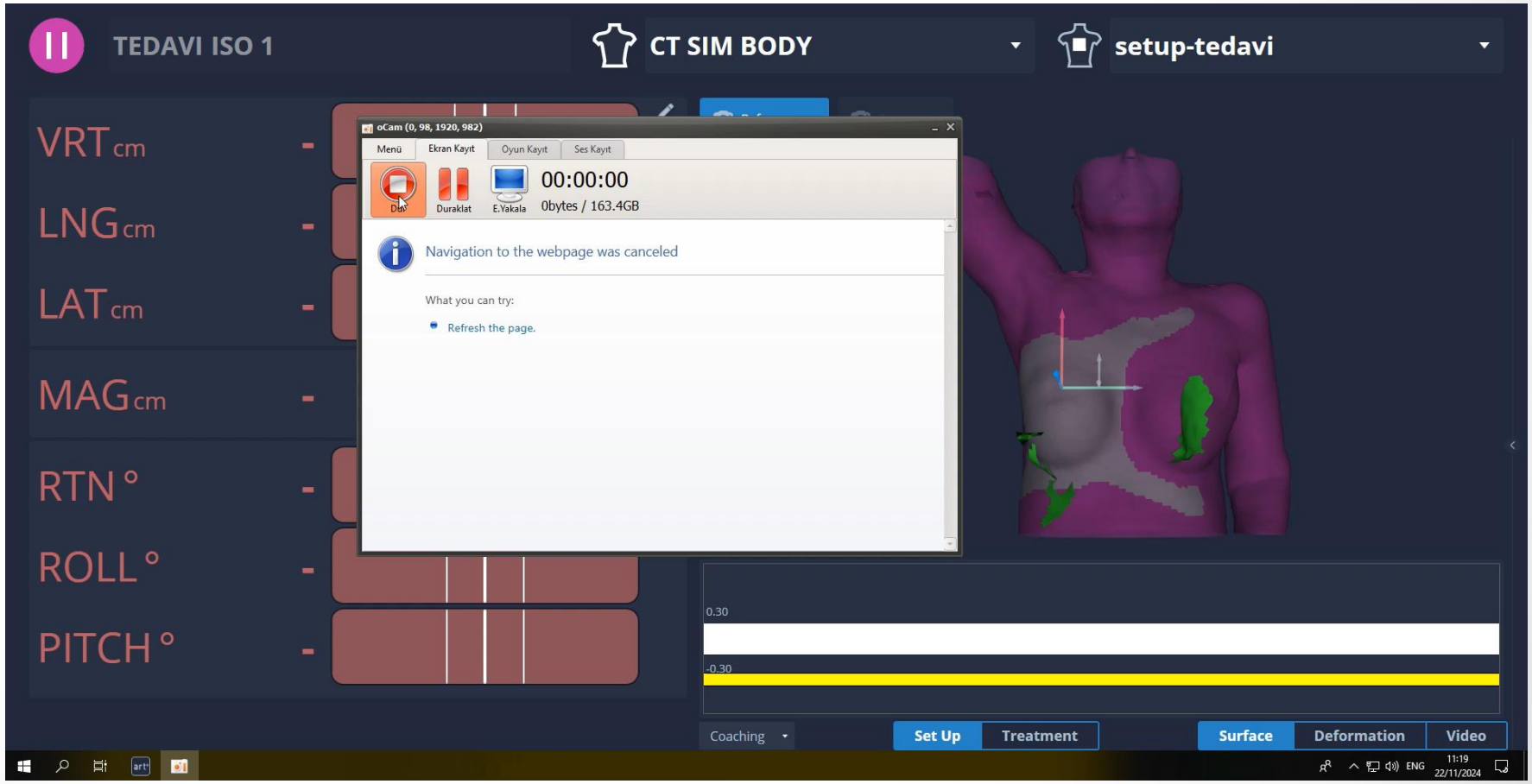


New Workflow

Couch shifts after IGRT

IGRT shift also with breath hold

inBore SGRT for tracking



SGRT vs IGRT

Possible technical reasons of calculated shift differences

- Only 3D couch shifts with IGRT
- SGRT includes rotations which may effect lat, long, vert values
- SGRT has surface based, CBCT has volumetric & anatomical info
- Shift calculation algorithms are different
- SGRT ROI may change results

Result

- **IGRT is still gold standard!**

  Prove that our new workflow is applicable
  Shifts are more related with initial SGRT setup
  İmplementation is more simple

- Both FB+DIBH and Direct DIBH workflows has

  similar, breathing amplitude and
  arm, chin positions or small body rotations uncertainities.

  RTT's are happier with Direct DIBH workflow

thank you…!