



Department of
Radiation Oncology

OPTIMIZING BREAST SETUPS IN PROTON THERAPY USING SGRT

IMPROVING SETUP PRECISION AND WORKFLOW EFFICIENCY IN
PROTON BREAST TREATMENTS

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SGRT Meeting
May 7, 2026 Orlando, Florida

LEARNING OBJECTIVES

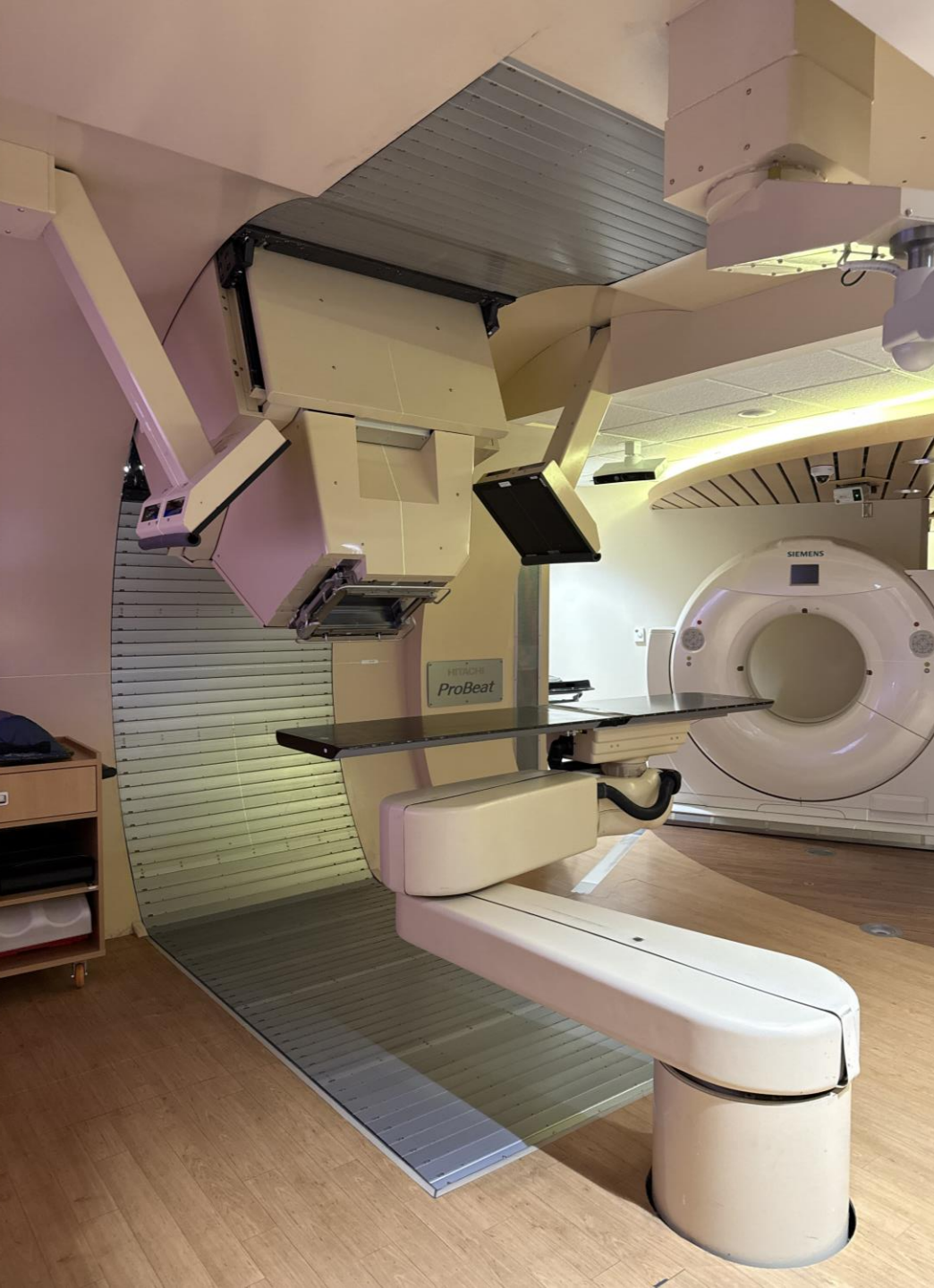
- **Overview of our proton therapy and its key capabilities**
- **Role of SGRT and its importance for accurate patient setups in proton therapy**
- **SGRT workflow for breast setups**
- **Challenges in SGRT-guided proton breast therapy and solutions**
- **Benefits of SGRT in breast treatments** (accuracy, reproducibility, patient experience)
- **Summarize**



Department of
Radiation Oncology

BACKGROUND INFORMATION

KEY TERMS AND KNOWLEDGE



PROTON TREATMENTS

- We have one synchrotron and four treatment rooms
- 180-degree Hitachi PROBEAT-V Gantries
- 6 degrees of freedom couch
- Treatment times can range from 30 – 90 minutes
 - Our standard breast treatments range from 30-45 minutes or 1 hour for bi-lateral breast treatments
- All of our breast patients have tattoos from CT SIM
 - These are UV which make them have a pink color and are less noticeable



PATIENT IMMOBILIZATION

- Standard breast patients are positioned on an indexed breast board, with a chin mask in place and a small Vac-Lok used for immobilization.
- The arm on the treated side is raised above their head, resting on the Vac-Lok, holding a handle, while the opposite arm rests on a slanted handle that is indexed to the table for consistent positioning.
- Bi-lateral breast patients are immobilized in a five-point mask with arms at their sides holding handles attached to the table

FRACTIONATION

Bi-lateral Breasts

- 15 fractions
- 300 cGy per fraction
 - Total dose of 4,500 cGy
- Five-Point Mask

Partial Breast Irradiation (PBI)

- 3-5 fractions
- 600 cGy per fraction
 - Total dose of 3,000 cGy
- No Patient Specific Immobilization

Breast CW with or without nodes

- 15 fractions
- Typically 320 cGy per fx
 - Total dose of 4,800 cGy

KEY TERMS

- **Setup 270:** This field is used to establish the patient's treatment position and alignment before delivering radiation.
 - 270 is referring to the table angle
 - Where the patient gets on the table, three point, shift to isocenter, and take x-rays for alignment
- **CT Sim (dicom) body only** is referring to the patient's external anatomy in the area that we are treating, this comes from the treatment planning CT scan.
- **ROI:** Region of Interest, this is created based off the body only and will encompass the treatment area.

WHEN SGRT IS USEFUL FOR PROTON THERAPY

- **Post–kV Setup Verification (e.g., Setup 270)**
 - Confirms patient remains aligned after x-ray–based couch corrections
- **During Couch Rotations**
 - Monitors patient position relative to isocenter at each treatment angle
 - Ensures rotations (e.g., T180°) maintain isocenter alignment within **±4 mm translational and 3° robotics**
- **Real-Time Motion Monitoring**
 - Infrared 3-camera system provides continuous surface tracking during treatment
 - Detects drift from isocenter instantly
- **Before Beam Delivery**
 - Verifies patient has not moved during longer beam wait times



F19BreastL ISO 1 ▾



CT SIM body_only ▾



f19 breast ▾



F1BreastL [Breast] ISO 1 [54.4, -284.1, -360.0]

F10BreastL [Breast] ISO 1 [60.3, -285.2, -303.7]

F19BreastL [Breast] ISO 1 [53.7, -285,4, -360.2] ✓

VRT_{cm}

LNG_{cm}

-

LAT_{cm}

-

MAG_{cm}

-

YAW[°]

-

ROLL[°]

-

PITCH[°]

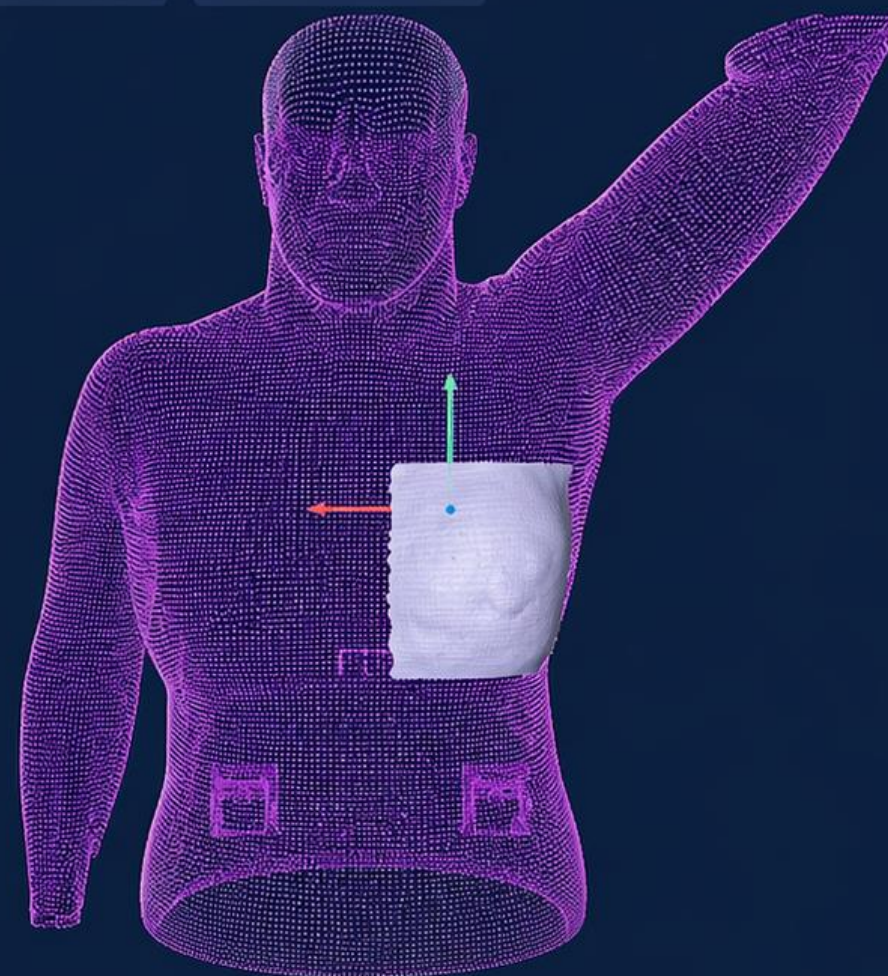
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Reference ▾

Treatment

Couch 270.0[°] ▾

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Surface

Deformation

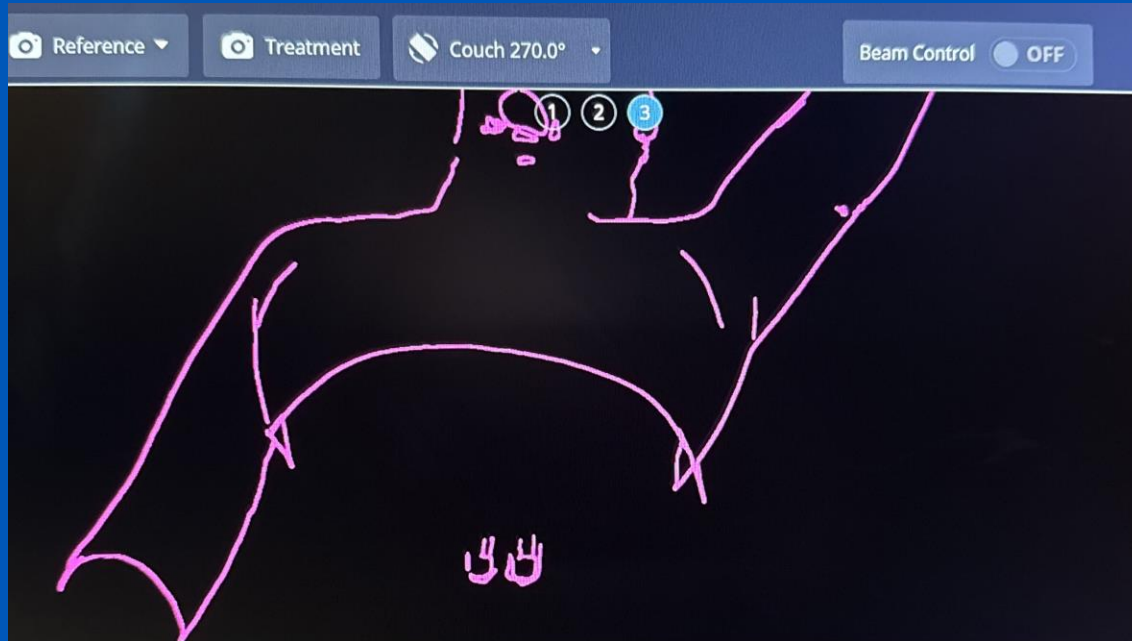
Video

HOW WE IMPLEMENT SGRT INTO OUR BREAST SOP

BEFORE X-RAY ALIGNMENT

- **Initial Setup**
 - Align patient using tattoos and room lasers
 - Shift couch to planned isocenter
- **SGRT Surface Capture**
 - Select ***Treatment***
 - Compare live surface to reference (CT Sim (dicom) body only)
- **Threshold Evaluation**
 - Translation tolerance: **± 4 mm**
 - Robotic tolerance: **$\pm 3^\circ$**
- **Apply Corrections**
 - Enter and apply shifts exceeding tolerance
 - Manually adjust patient for robotic deviations $>3^\circ$
- **Verification**
 - Select ***Treatment*** and reconfirm SGRT alignment within tolerance
- **Imaging**
 - Proceed to kV (x-ray) imaging for verification


POSTURAL VIDEO



- Provides real-time visual guidance to support accurate patient positioning
- Improves consistency in arm placement during setup
- Reduces setup time by minimizing the need for repositioning



POST-X-RAY BONY ALIGNMENT WORKFLOW

Process	Purpose
Auto-Select ROI	Ensure correct treatment plan is used for comparison
Enable “PLAY” 	Activate real-time surface tracking
Select Deformation	Define acceptable surface deviation tolerance (<i>0.5 cm / 0.3 cm PBI</i>)
Analyze Surface (Current vs CT SIM)	Compare live patient surface to reference dataset
Review Results	Identify magnitude and location of surface deviation
Report Screenshot	Automatically document and store deformation data for tracking
Evaluate for Replan	Physician can decide if deviations are consistent enough to justify replan



F19BreastL ISO 1



CT SIM body_only



f19 breast

VRT_{cm} 0.26



LNG_{cm} 0.35



LAT_{cm} 0.00



MAG_{cm} 0.39



YAW° 2.2



ROLL° 1.0



PITCH° 1.2



Reference

Treatment

Couch 270.0°

Beam Control OFF

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Surface Deformation

Current Position

Surface within tolerance: 99%

Average displacement: -0.1cm

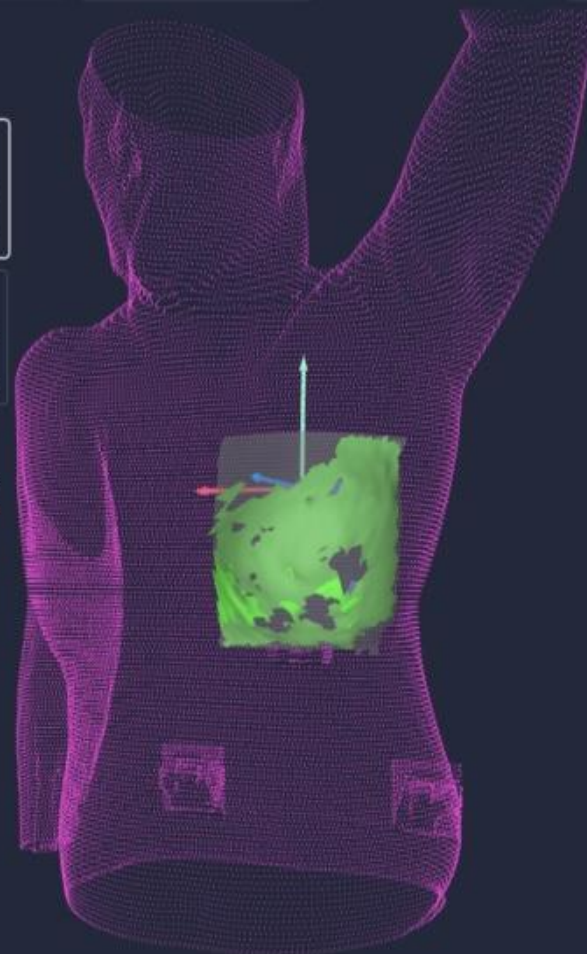
Corrected Position

Surface within tolerance: 100%

Average displacement: 0.0cm

Tolerance Limits

Below -0.5 cm Above +0.5 cm



Skin Tone

SSD

Report Screenshot

ROI Tools

Surface Display

Reset Surface

2D Plotter Off

Surface

Deformation

Video



F1BreastL ISO 1

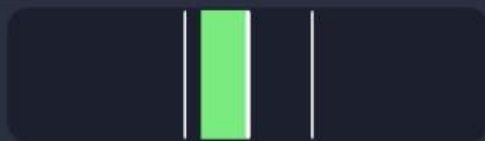


CT SIM body only



F1BreastL

VRT_{cm} -0.30



LNG_{cm} 0.09



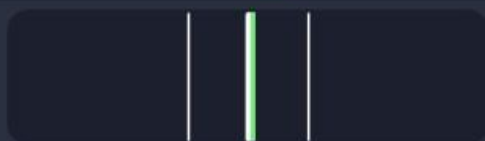
LAT_{cm} 0.10



MAG_{cm} 0.33



YAW° 0.4



ROLL° 0.3



PITCH° -0.8



Reference

Treatment

Couch 270.0°

Beam Control OFF

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Surface Deformation

Current Position

Surface within tolerance: 90%

Average displacement: 0.1cm

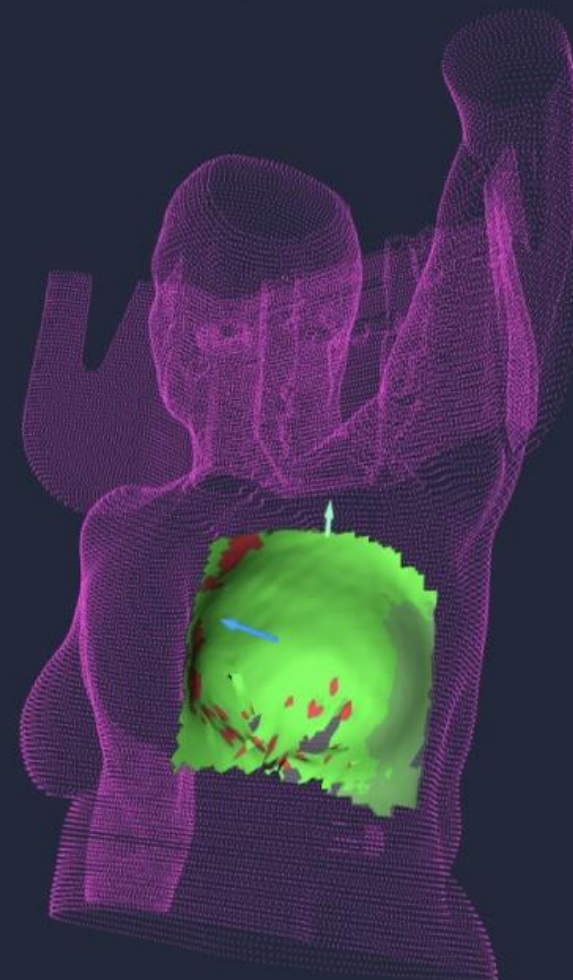
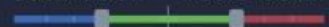
Corrected Position

Surface within tolerance: 99%

Average displacement: 0.0cm

Tolerance Limits

Below -0.3 cm Above +0.3 cm



Skin Tone

SSD

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Surface Display

Reset Surface

2D Plotter Off

Surface

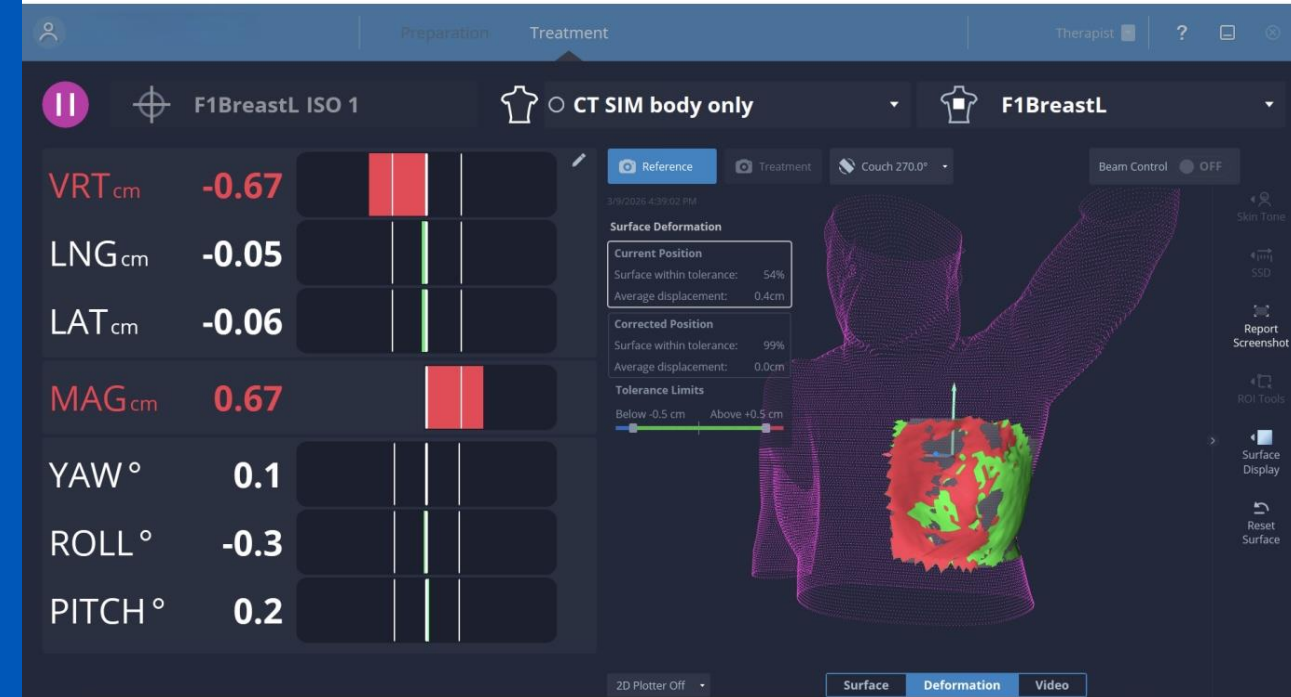
Deformation

Video

PROBLEM SOLVING

COLOR MAPPING

- Concerns or large areas of red or blue in the ROI that suggest the breast position is not the same
 - **Red** means too much tissue
 - **Blue** means a lack of tissue
- Striations can occur when analyzing deformation
 - Lightning bolt pattern of red and blue on the ROI
- Reasons may include
 - flipped magnet
 - breast position differing
 - patient movement
- This may require
 - additional imaging
 - Splitting x-ray boney alignment with soft tissue
 - resetting up the patient
 - additional verification scans



For percentages lower than 85%

- Take an additional x-ray
- Potentially call Physics for guidance
 - Physics would pull up the patient's plan on external beam and analyze the significance of discrepancies within the ROI

HOW SGRT IS BENEFICIAL FOR PATIENTS AND THERAPISTS

For Patients

No additional dose during setup

Improved positioning accuracy (surface vs CT SIM reference)

Better soft tissue alignment (not visible on x-ray)

More consistent arm and body positioning

Reduced risk of setup errors

For Therapists

Enables setup without relying solely on imaging dose

Real-time feedback on patient position

Enhances confidence beyond bony anatomy alignment

Visualizes patient from multiple angles simultaneously

Supports efficient and reproducible setups

SUMMARY

- SGRT is used **prior** to x-ray alignment using the 'Treatment' button which compares the patient's current position to the planning CT scan
- SGRT is used **post** x-ray alignment by pressing 'Play' and selecting deformation which will show a percentage
 - This is comparing the breast tissue to the planning CT scan
 - Acceptable percentages for treatment are 85% however, this is up to physics discrepancies
- SGRT is used **during** the patient's entire treatment to monitor movement
 - this is especially helpful due to long beam waits
- If the surface capture is out of the 4mm translational or 3° robotic tolerance, pause the beam and take an x-ray and re-align
 - If we re-align, capture a new reference and use that for the remainder of treatment

QUESTIONS & ANSWERS

