AdventHealth

The Use of SGRT for Sim, Plan, Treat, and Dose

Adi Robinson Ph.D., DABR
AdventHealth Celebration

Objectives

- Introduce Surface Guided Simulation, Planning, Treatment and Dose Verification.
- Review our implementation process and workflows.
- Discuss some clinical examples.

The Radiation Oncology Workflow

Simulation

- Patient Registration
- Patient Setup
  - Orientation
  - Accessories
  - Immobilization
- Scan Type
  - Free Breathing
  - DIBH
  - 4D
- Scan!

Planning

- Import CT DICOM
- Select Plan Type
  - 3D/IMRT
  - Static/Arc
  - Energy
- Calculate MUs
- Export Plan to Linac

Treatment

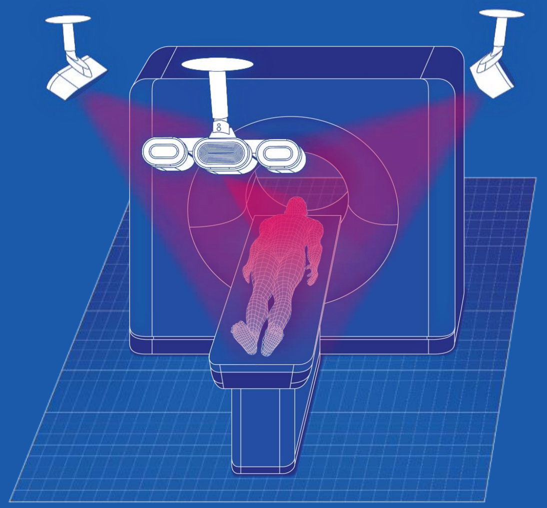
- ID the Patient
- Patient Setup
  - BBs or Tattoos
- IGRT Verification
  - Shifts (if need)
- Treat!

Verification

- IGRT
- Diodes/TLDs
- Visual Inspection

The SGRT Workflow

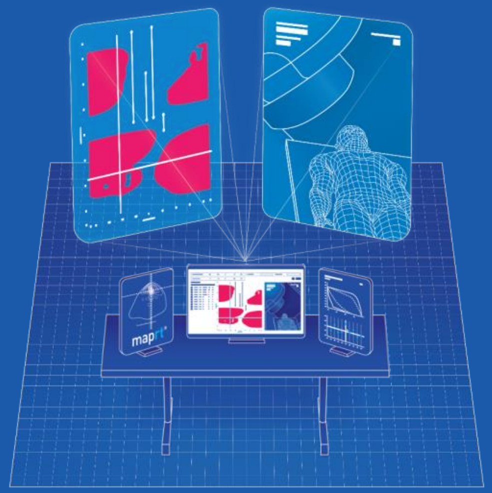
SIM



4D AND BREATH HOLD CT

simrt™

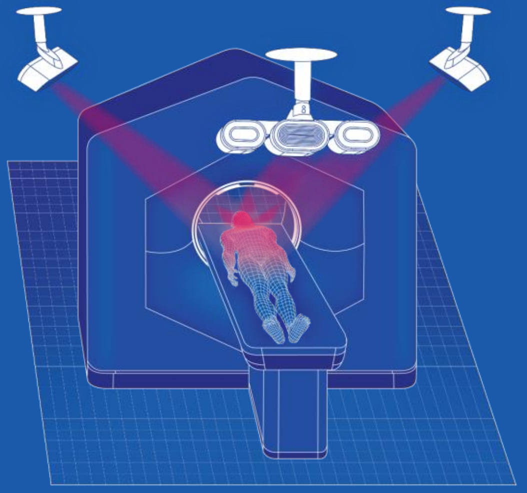
PLAN



CLEARANCE MAPPING

maprt®

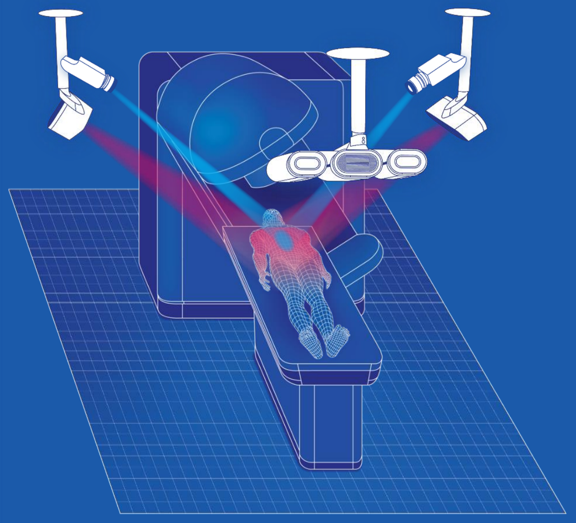
TREAT



MOTION MANAGEMENT

alignrt®

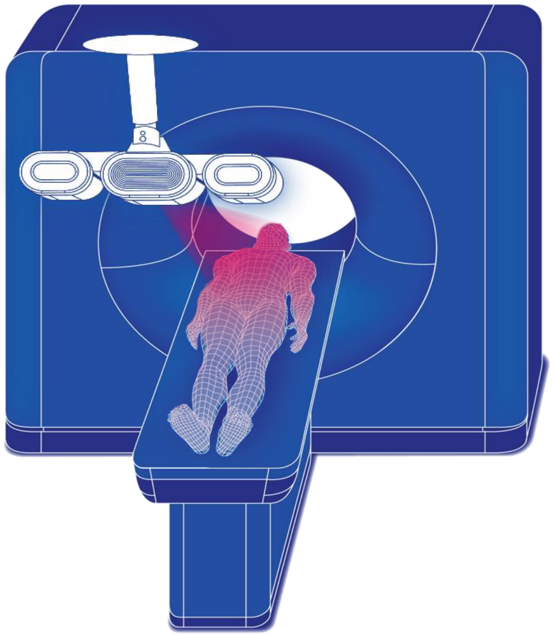
DOSE



DOSE VISUALIZATION

dosert™
Powered by BeamSite®

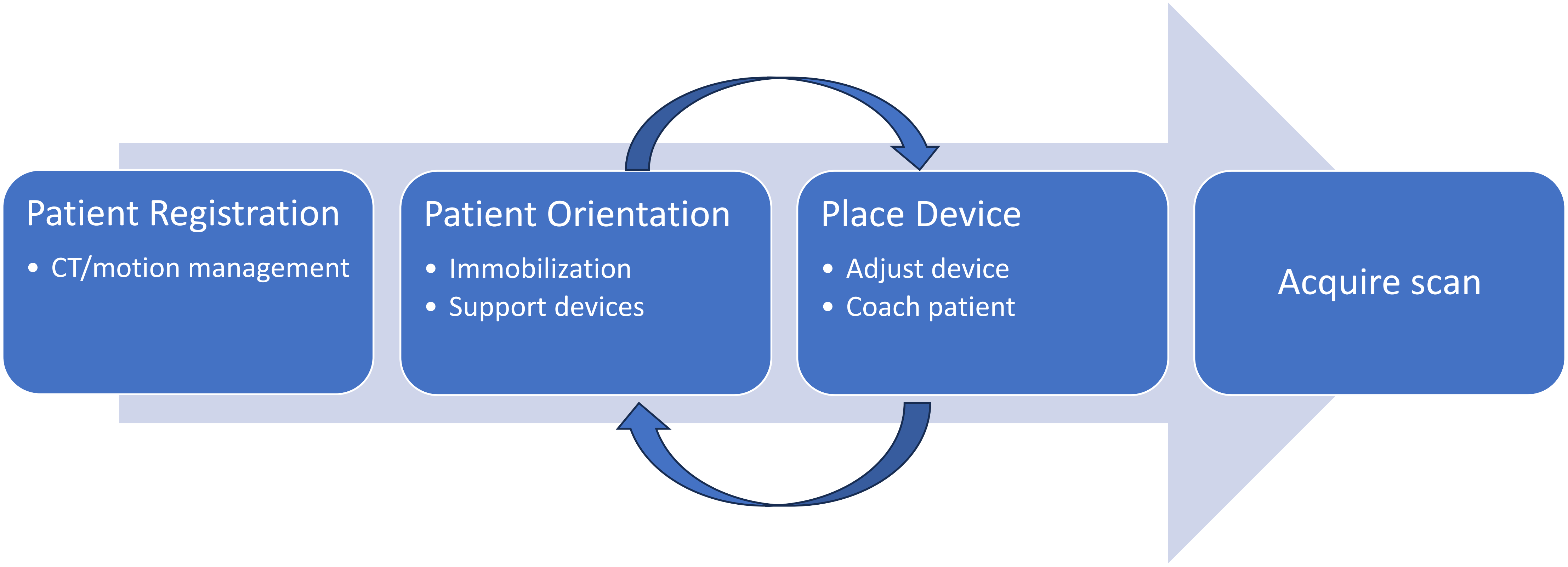
Surface Guided Simulation



The Ideal CT Simulation

- Should be able to accommodate different treatment positions and patient's anatomy
- Should be non-invasive and contactless
- Should not compromise the physician's treatment and immobilization strategy
- Easy to use and learn with simple workflows that are designed around clinical needs

The Simulation Loop



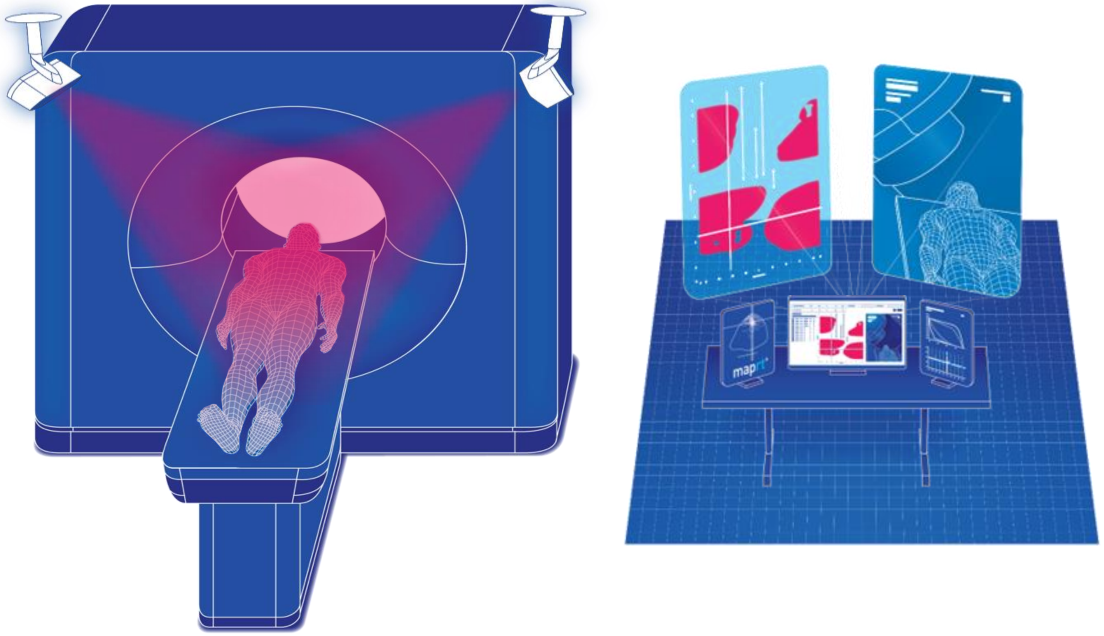
CT Simulation with SimRT

- SimRT is deviceless. A virtual tracking point is placed on the patient
- Quick and easy comparison between different tracking points to find the optimal position
- Workstation is available near the patient for visual feedback to both patient and therapist
- Appointment time is shortened to about 20 minutes

Surface Guided Simulation – DIBH Workflow

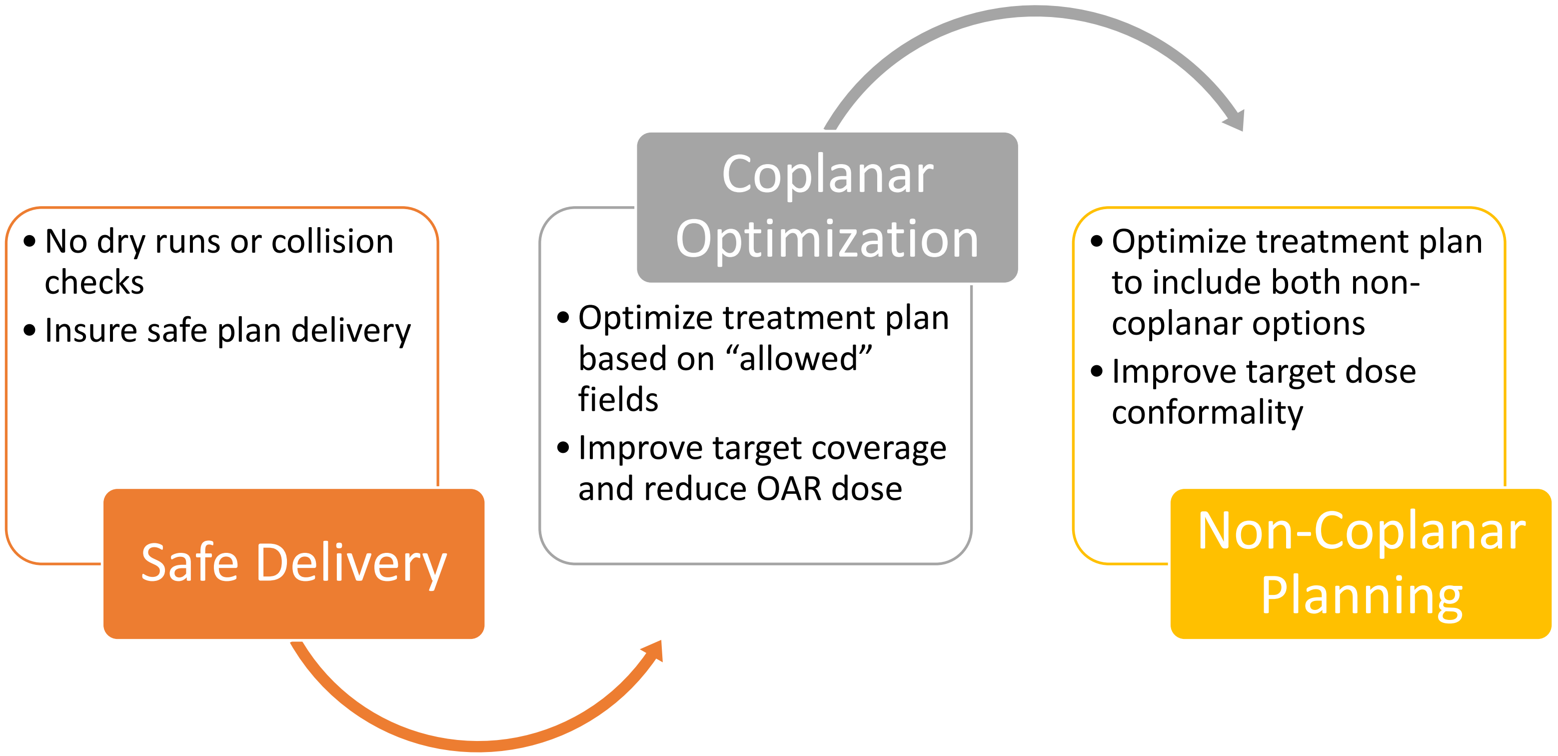
Surface Guided Simulation – 4D Workflow

Surface Guided Planning

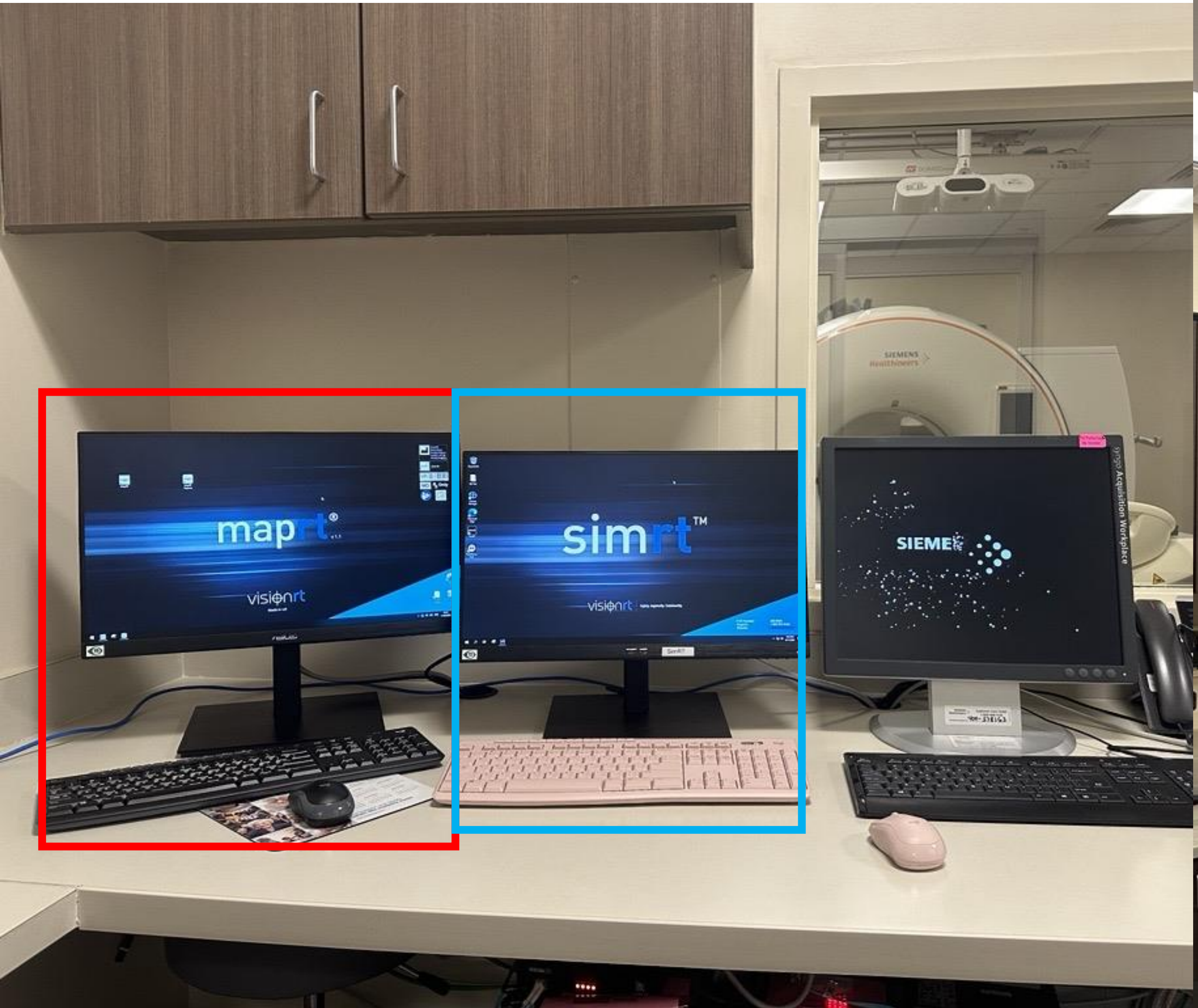


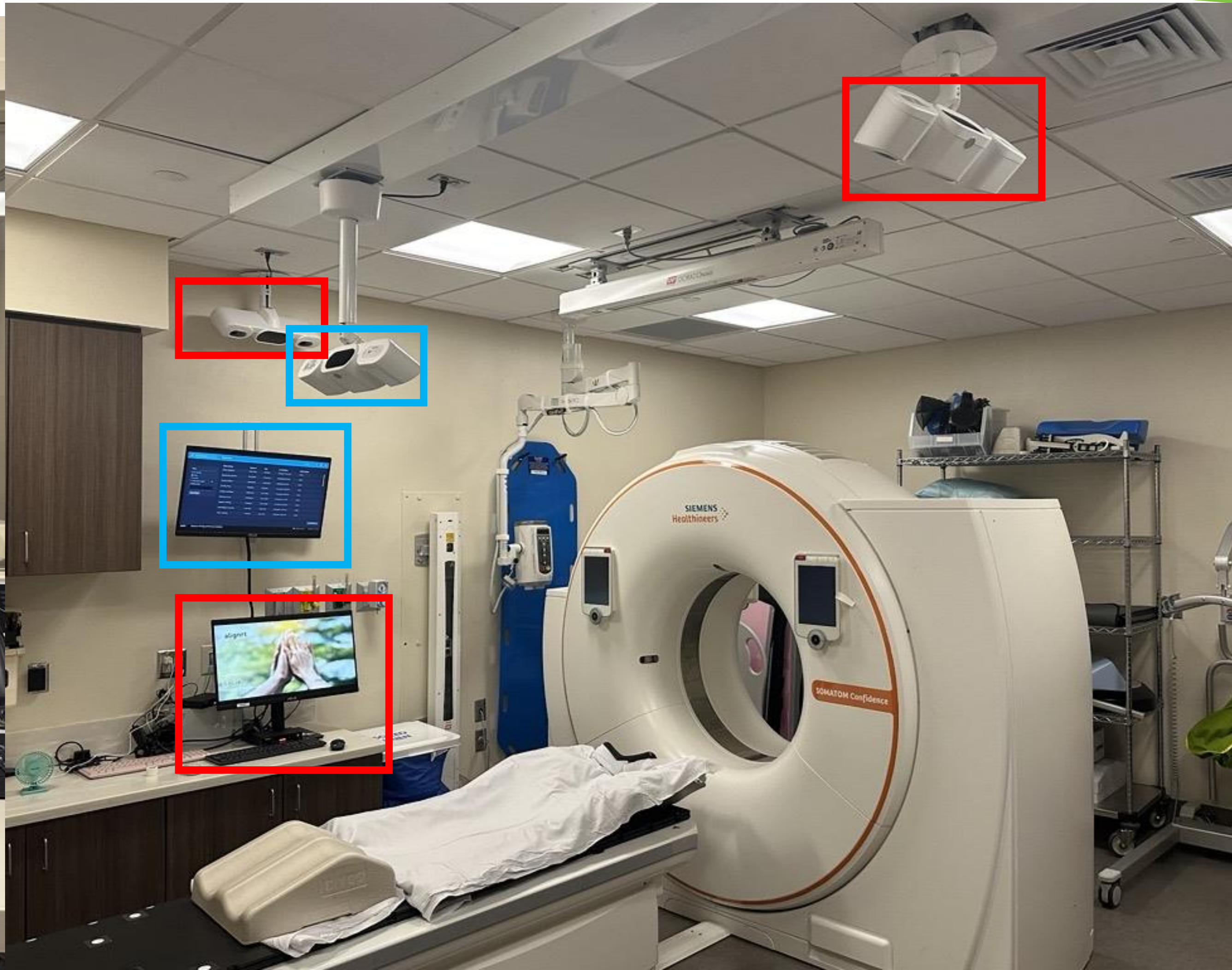
Surface guided Planning with Clearance Mapping

- Ensure safe plan delivery and reduce physical collision checks
- Introduce clearance-based plan optimization
  - Coplanar planning
  - Non-coplanar planning



The Simulation Room





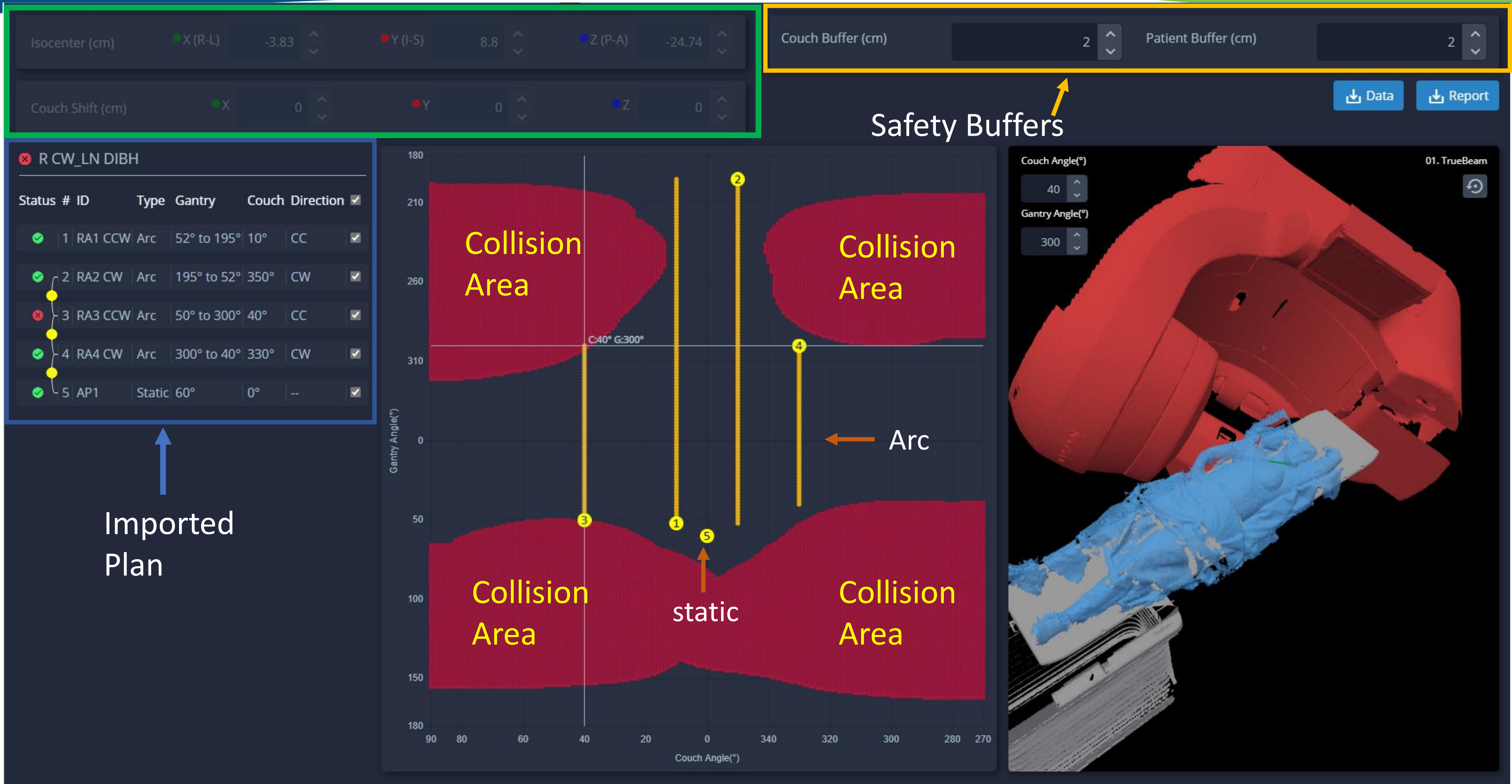
The Clearance Map

Iso location and couch shift

Passing Field

Colliding Field

Potential transition collision

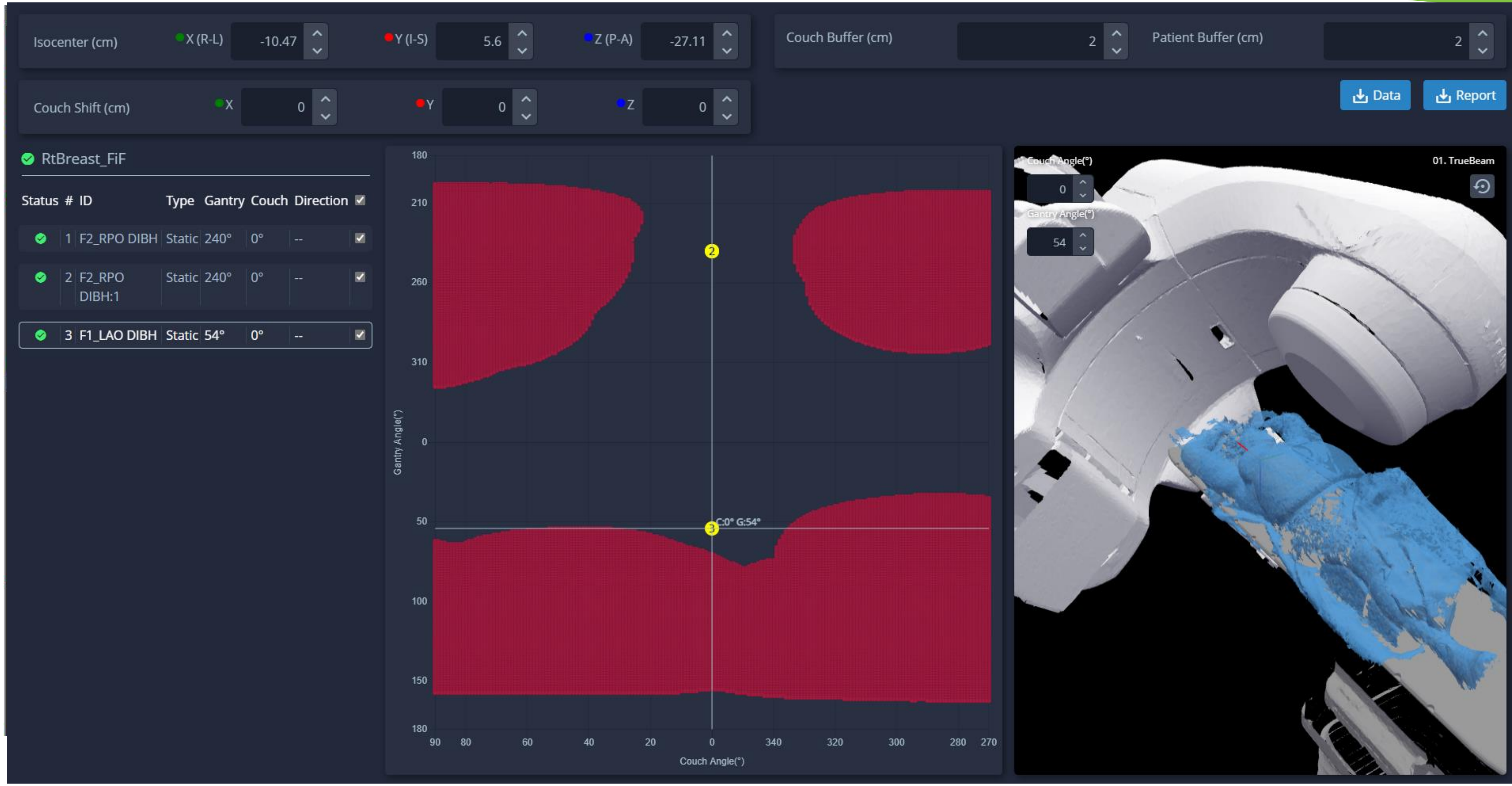


Surface Guided Planning Workflow

- In the CT sim room
  - Capture surface prior to CT sim
  - Check for collisions
  - Adjust patient position or immobilization device accordingly.
- Treatment Planning
  - Use clearance map to optimize the plan
- Treatment
  - Plan can be safely delivered

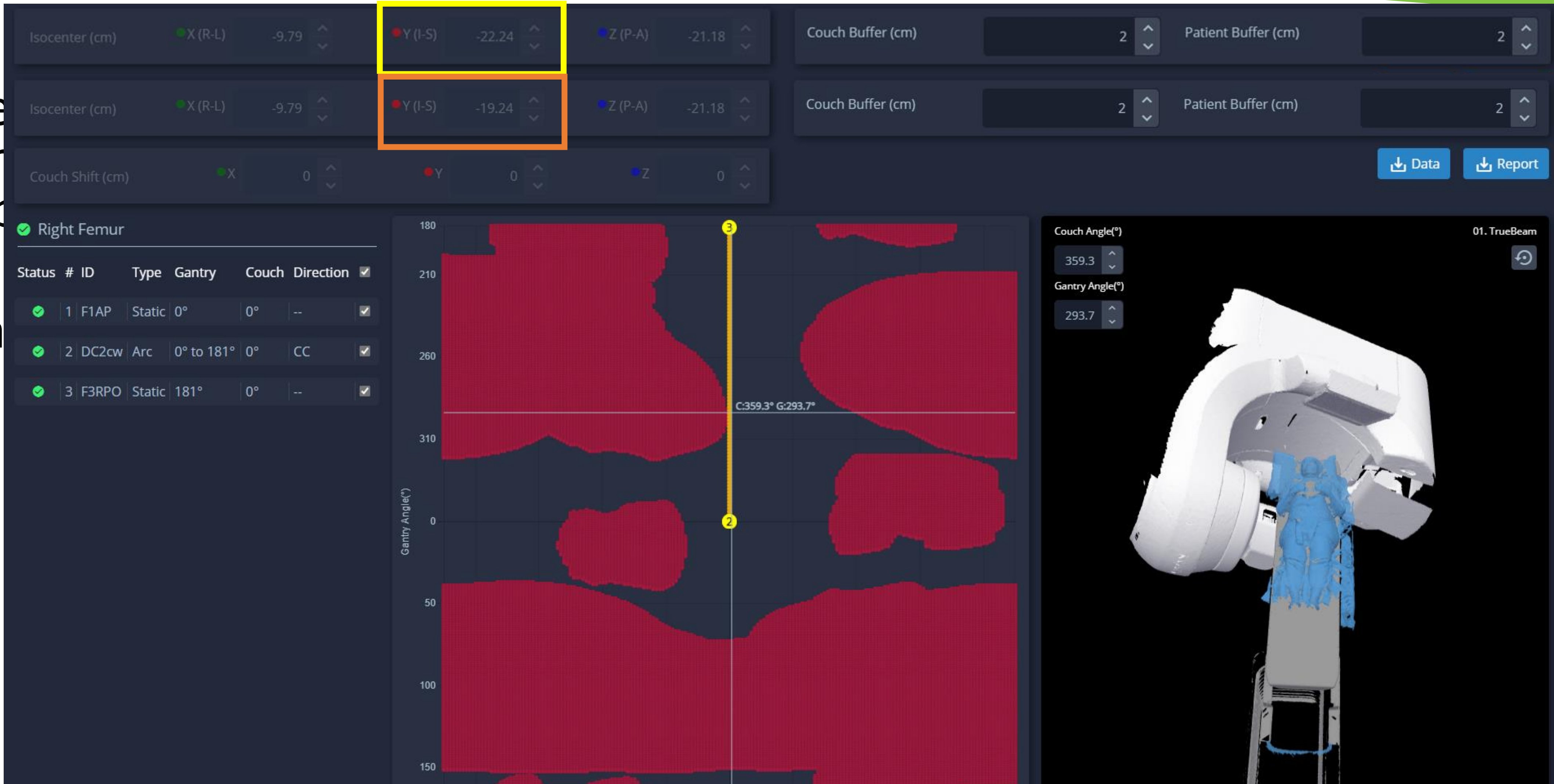
Safe Delivery – Rt Breast Plan

- 69 year old female with malignant neoplasm of the upper-inner quadrant of the right female breast
- Standard 3D tangent plan



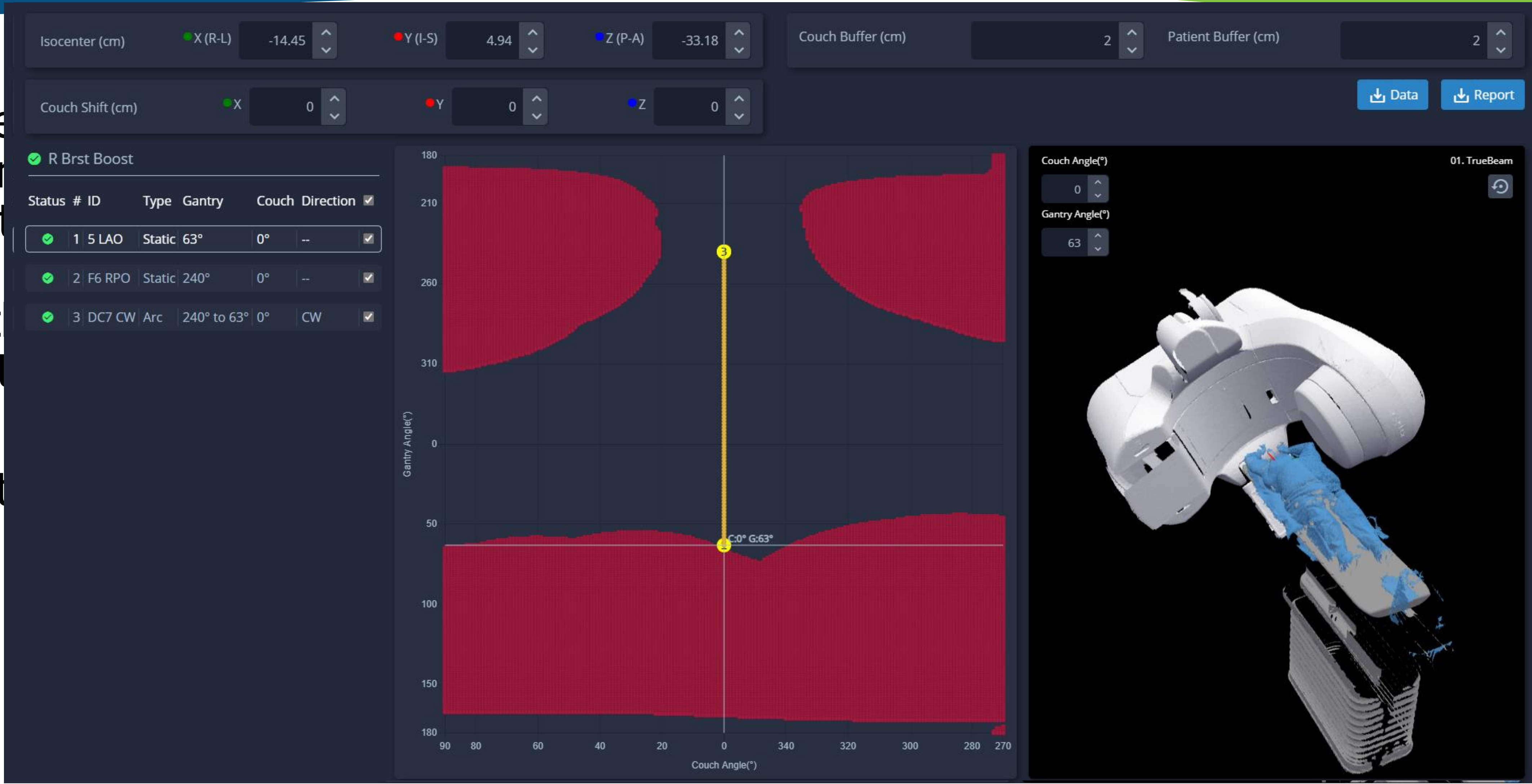
Safe Delivery With Accessories – Rt Femur

- 68 year old fe
with malignar
neoplasm of l
- Standard 3D
conformal pla
2 static fields
DCA



Coplanar Optimization – Rt Breast Boost

- 59 year old fe with malignar neoplasm of t upper-inner quadrant of t female breast
- Standard 3D conformal wit static fields a DCA

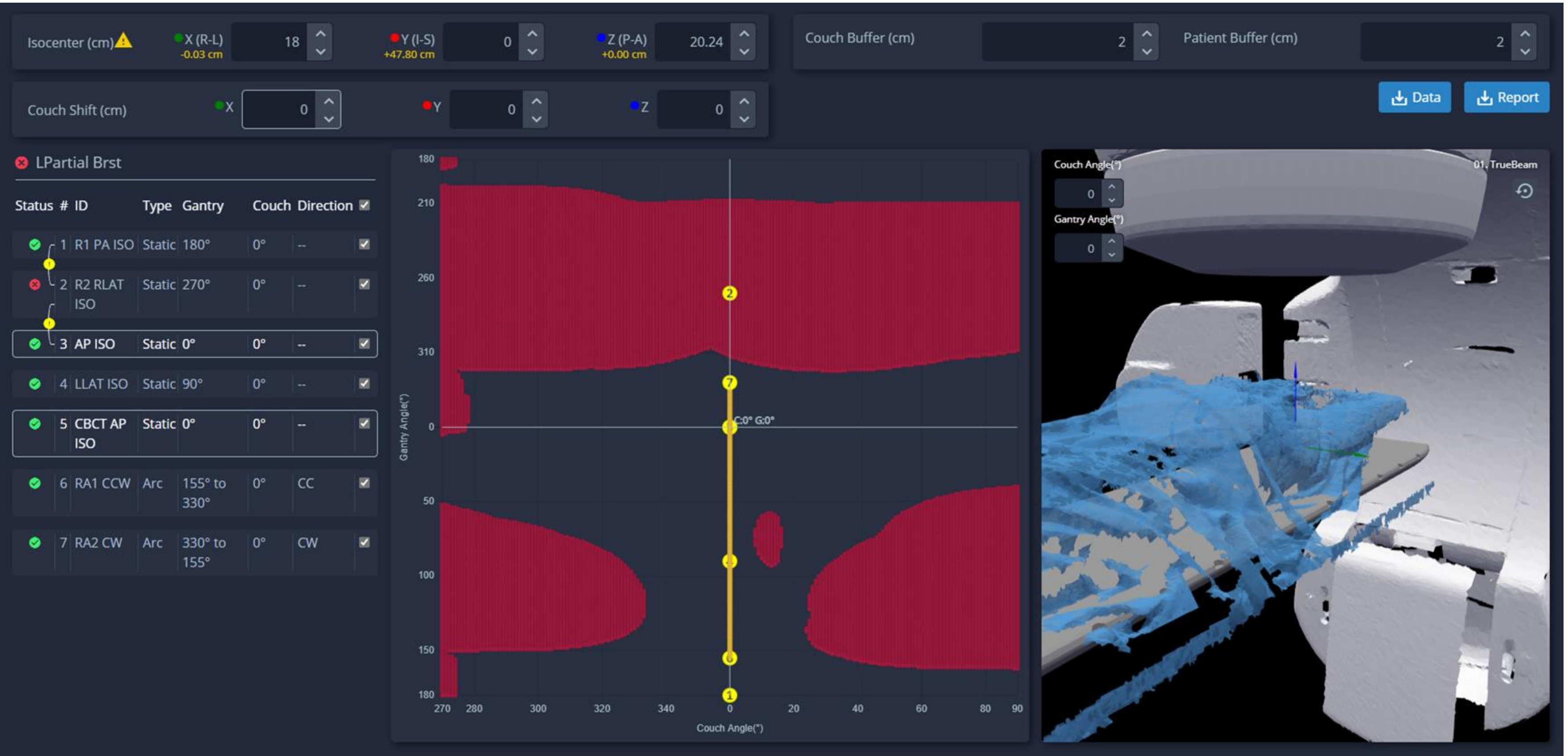


Surface Guided Planning – Lt APBI

- 75-year-old female with malignant neoplasm of the central portion of the left breast
- VMAT DIBH plan, 267cGy x 15 fractions

Standard Approach

- 2 Field VMAT DIBH
  - CCW G155-G330
  - CW G330-G155



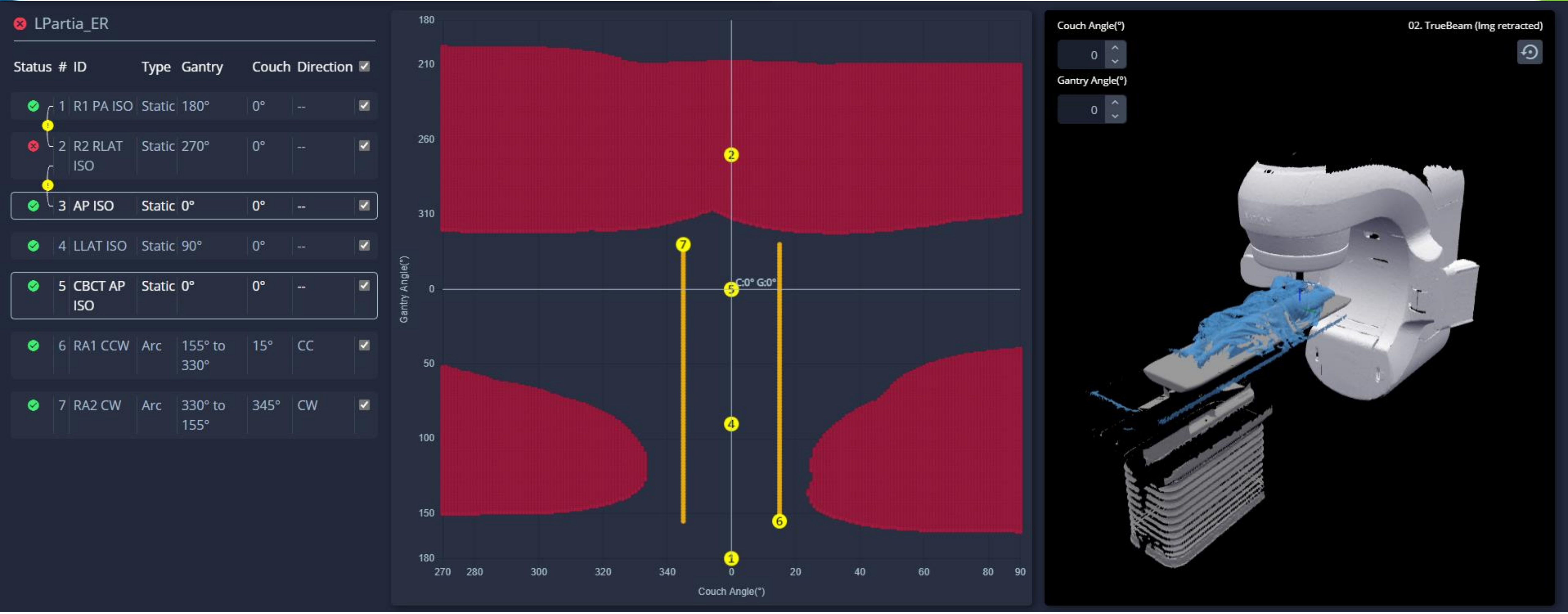
Structure	Constraint	Lt APBI CP
Lumpectomy_Lt	95% ≥ 95%	99.981%
Lumpectomy_Lt	V100% ≤ 93%	95%
Lumpectomy_Lt	Max ≤ 107%	105.619%
Heart	V1600cGy ≤ 5%	0%
Heart	Mean ≤ 200cGy	112cGy
Lung_L	V1750cGy ≤ 15%	0%
Lung_L	V880cGy ≤ 10%	0%
Lung_L	V144cGy ≤ 50%	11.972%
Breast_R	V144cGy ≤ 10%	0%
Lung_R	V440cGy ≤ 10%	0%

Non-coplanar Approach

- 2 Field VMAT DIBH with Non-Coplanar Fields
  - CCW G155-G330, **T345**
  - CW G330-G155, **T15**

Structure	Constraint	Lt APBI CP	Lt APBI NCP	Difference
Lumpectomy_Lt	95% ≥ 95%	99.981%	99.952%	0.029
Lumpectomy_Lt	V100% ≤ 93%	95%	95%	0
Lumpectomy_Lt	Max ≤ 107%	105.619%	104.427%	1.192
Heart	V1600cGy ≤ 5%	0%	0%	0
Heart	Mean ≤ 200cGy	112cGy	110cGy	2
Lung_L	V1750cGy ≤ 15%	0%	0%	0
Lung_L	V880cGy ≤ 10%	0%	0%	0
Lung_L	V144cGy ≤ 50%	11.972%	2.66%	9.312
Breast_R	V144cGy ≤ 10%	0%	0%	0
Lung_R	V440cGy ≤ 10%	0%	0%	0

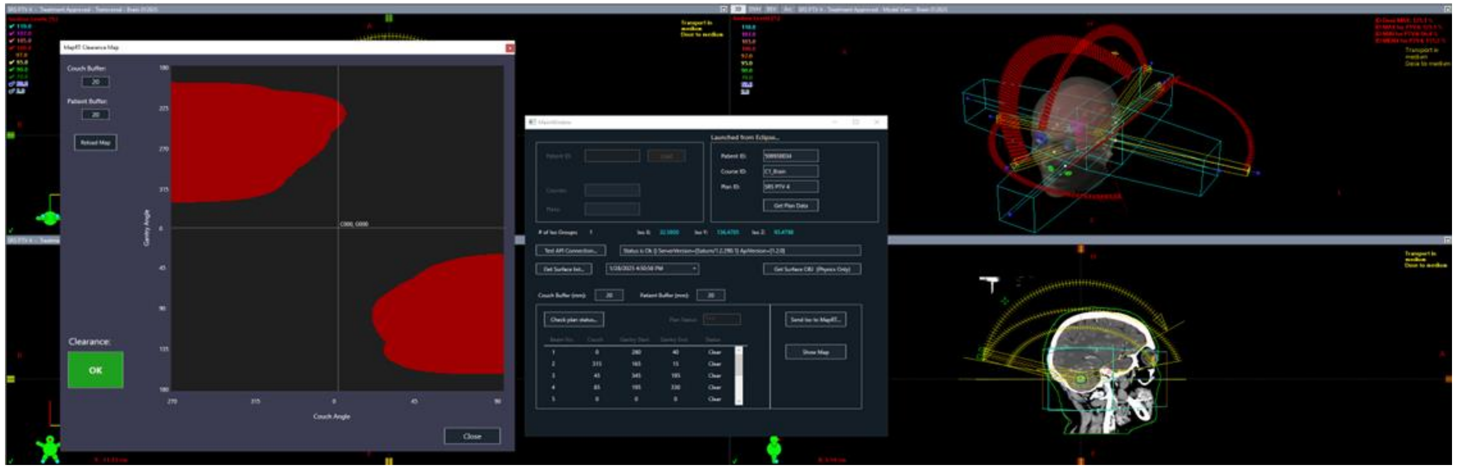
Non-coplanar Clearance Map: Lt APBI

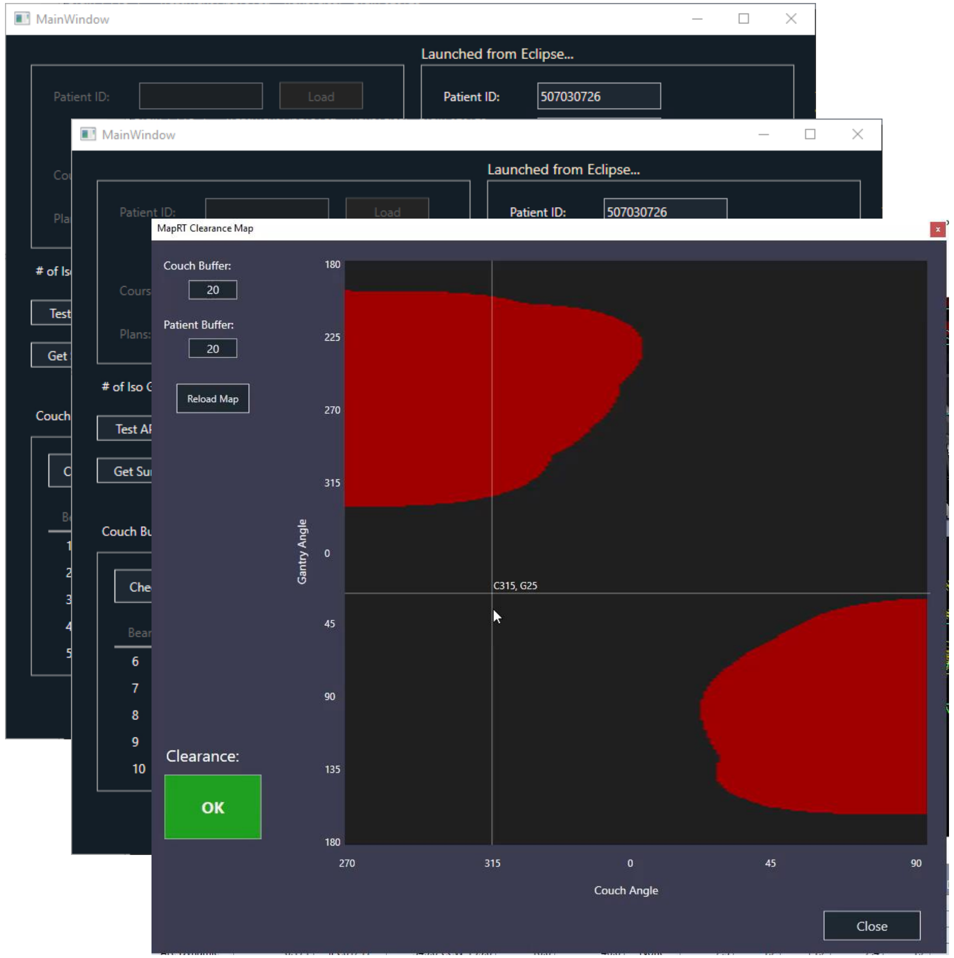


TPS Integration - Raystation

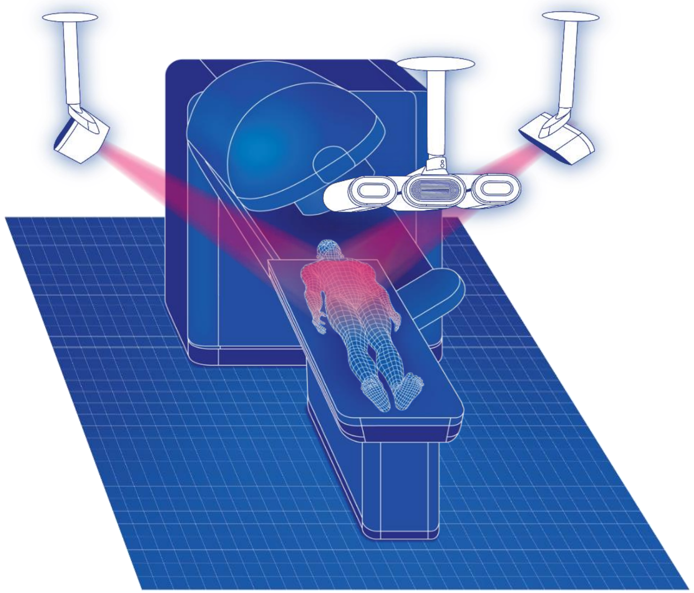
No.	Name	Description	Isocenter Name	R-L	I-S	P-A	SSD To surface	To skin	Energy [MV]	Gantry start [deg]	Gantry stop [deg]	Rotation	Coll. [deg]	Couch Rotation	Clearance check	No. of segm.	MU/fx	Del. time [sec]	Bolus	Jaw X1	Jaw X2
1	Nose_330_Couch_0		Nose li+iB	1.83	2.43	7.00	93.99	94.77	6	330.0	120.0	Clockwise	30.0	0.0		76	119.24	31	Bolus 0,5cm	-8.00	4.25
2	Nose_120_Couch_0		Nose li+iB	1.83	2.43	7.00	93.00	93.00	6	120.0	330.0	Counterclockwise	330.0	0.0		76	123.34	31	Bolus 0,5cm	-6.50	5.24
4	Nose_300_Couch_270		Nose li+iB	1.83	2.43	7.00	92.87	92.87	6	300.0	30.0	Clockwise	80.0	90.0		46	89.35	19	Bolus 0,5cm	-4.24	4.25
5	Nose_30_Couch_315		Nose li+iB	1.83	2.43	7.00	94.66	95.25	6	30.0	300.0	Counterclockwise	130.0	45.0		46	106.31	19	Bolus 0,5cm	-6.00	5.00

TPS Integration - Eclipse





Surface Guided Treatment



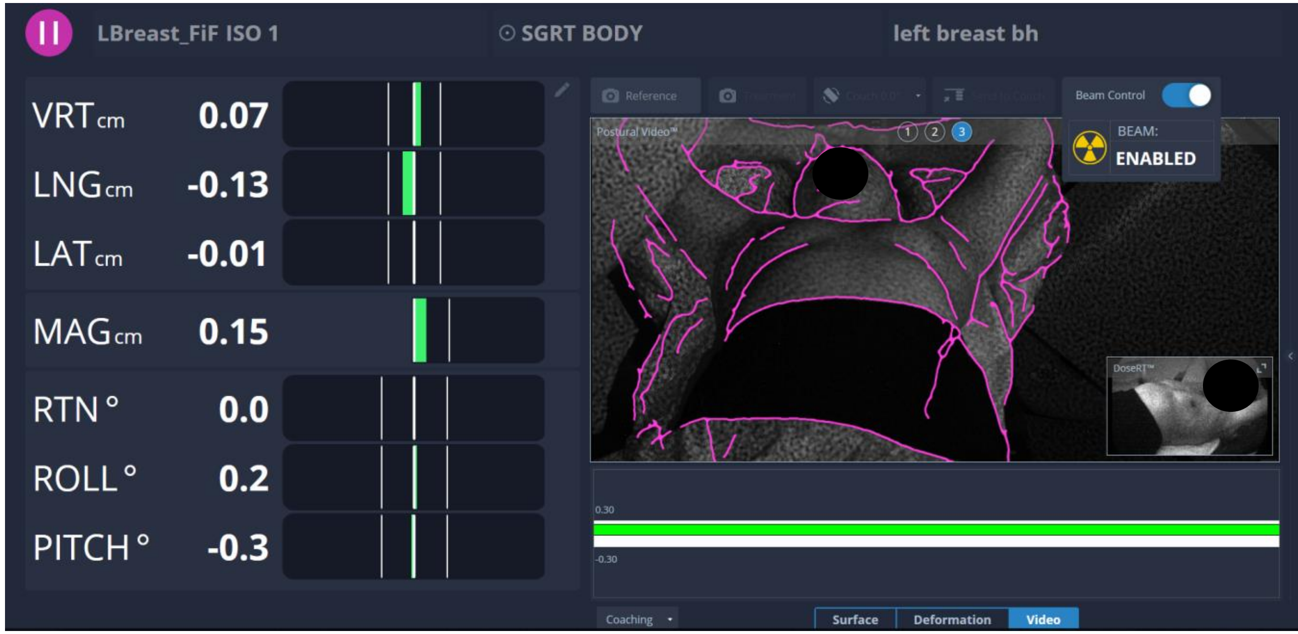
The AlignRT Advantage

- Biometric Patient Facial Recognition
- Patient Setup
  - Postural video – improves patient setup accuracy and efficiency
  - Markerless treatments – surface setup vs. 3 marks
  - Deformation view – quickly assess changes in patient's body habitus
- Motion Management
  - Respiratory management – DIBH with beam hold
  - Monitoring motion in real time throughout the treatment – less immobilization
- Submillimeter accuracy from head to toe

AlignRT in Action

Deformation View

Postural video



AlignRT with HN – Less Immobilization

- With Alig
  quickly a
- Natural
  immobili

Radiotherapy and Oncology 208 (2025) 110909

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Original Article

Goodbye face masks! Accurate head and neck radiotherapy using individual dorsal shells and surface guidance

Marion Essers *, Lennart Mesch, Maaike Beugeling, Eva de Wee, Robert Poorter, Richard Hamelink, Willy de Kruijf

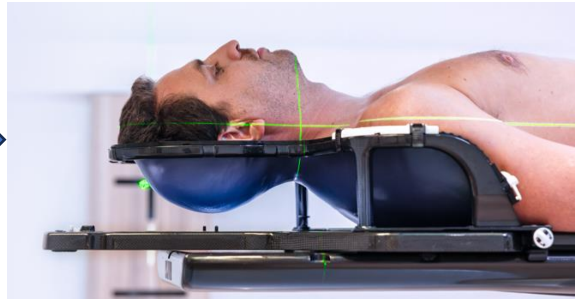
Institute Verbeeten, Radiation Oncology, PO Box 90120, 5000 LA Tilburg, the Netherlands

A R T I C L E I N F O

Keywords:
Surface-guided radiotherapy
Head and neck cancer
Patient positioning
Intrafraction motion monitoring
Dorsal shell
No face mask

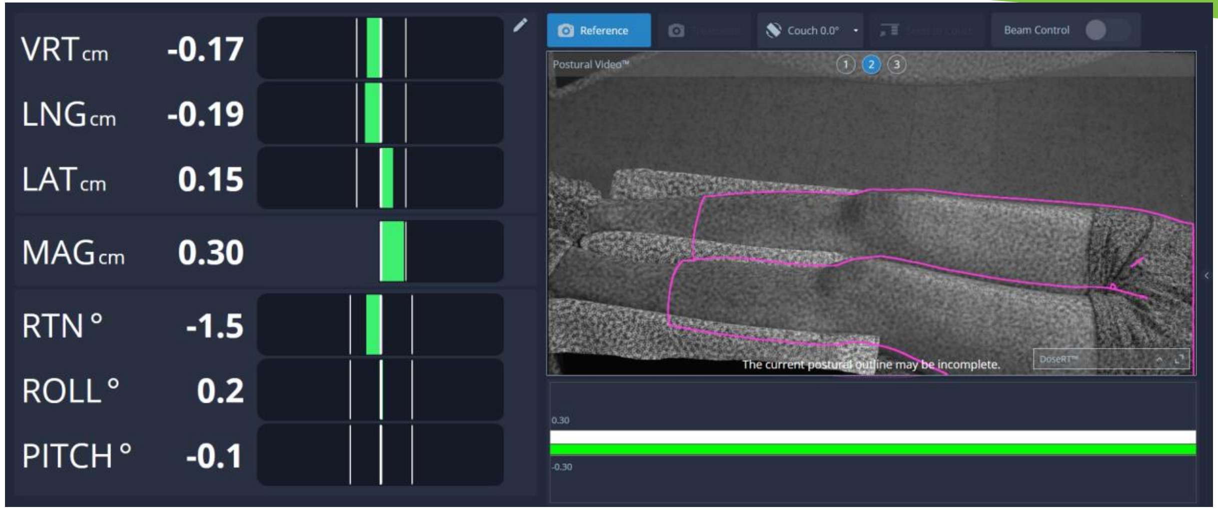
A B S T R A C T

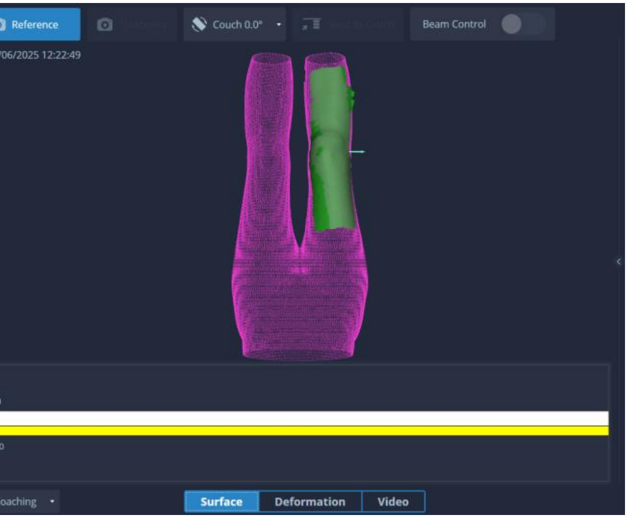
Background and purpose: Using surface guided radiotherapy (SGRT), head and neck (H&N) cancer patients may undergo radiotherapy without the discomfort and stress of a restricting face mask. In this study, the patient setup accuracy, number of necessary treatment interrupts, and intrafraction motion for H&N cancer patients positioned using an individual dorsal shell and monitored using SGRT was examined.
Material and methods: Twenty-six H&N cancer patients were positioned in a dorsal shell using SGRT. A cone-beam CT (CBCT) was used for online setup correction. SGRT was also used for intrafraction motion monitoring, and repositioning of the patient when an intrafraction motion threshold of 2 mm or 2° (th_2) was exceeded. Based on post-treatment CBCT's, the intrafraction motion and resulting CTV-PTV margin were determined.
Results: For 1.1 % of fractions, the patient had to be repositioned because of motion during/after the CBCT, and for 4.4 % of fractions because of inaccurate patient posture. For 3.5 % of fractions, treatment had to be interrupted for repositioning because intrafraction motion exceeded th_2. The CTV-PTV margin for intrafraction motion is 1.1 mm in all directions. A total CTV-PTV margin of 3 mm can be applied.
Conclusions: By replacing traditional face masks with SGRT and a dorsal shell, we can offer H&N cancer patients a more comfortable radiotherapy treatment experience without sacrificing the treatment accuracy.

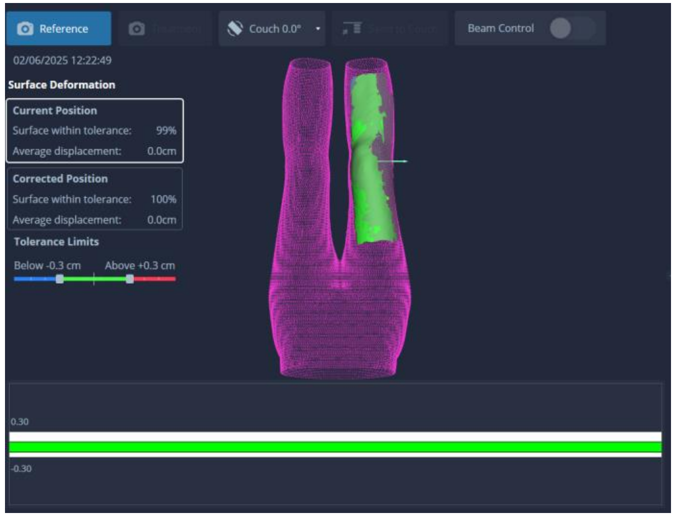


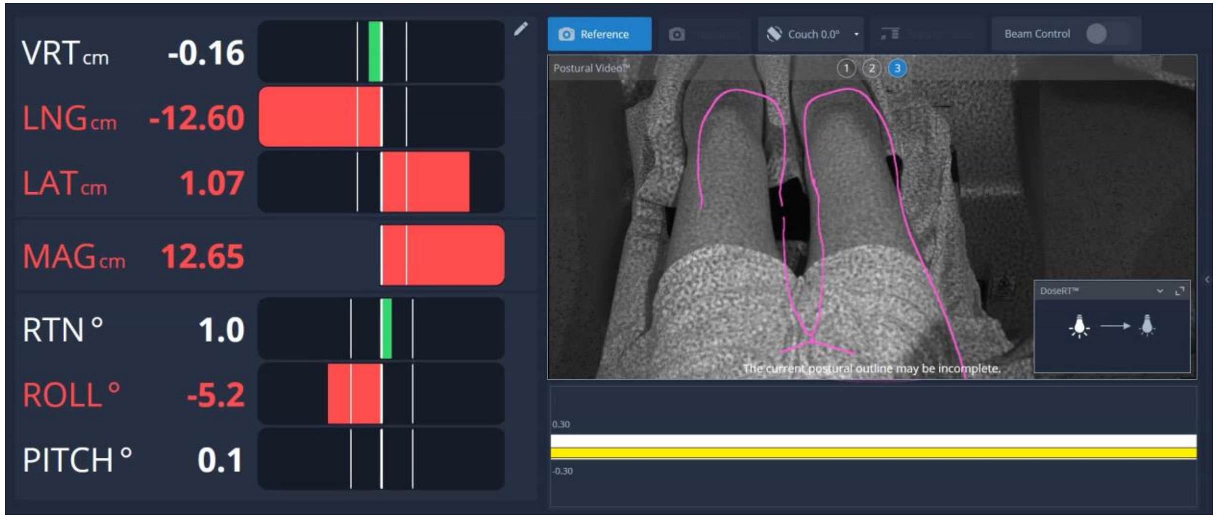
Extremity Positioning and Treatment

- Extremity positioning is made simple with Postural Video
- Changes in body habitus or gross positioning errors are visible in the surface deformation view



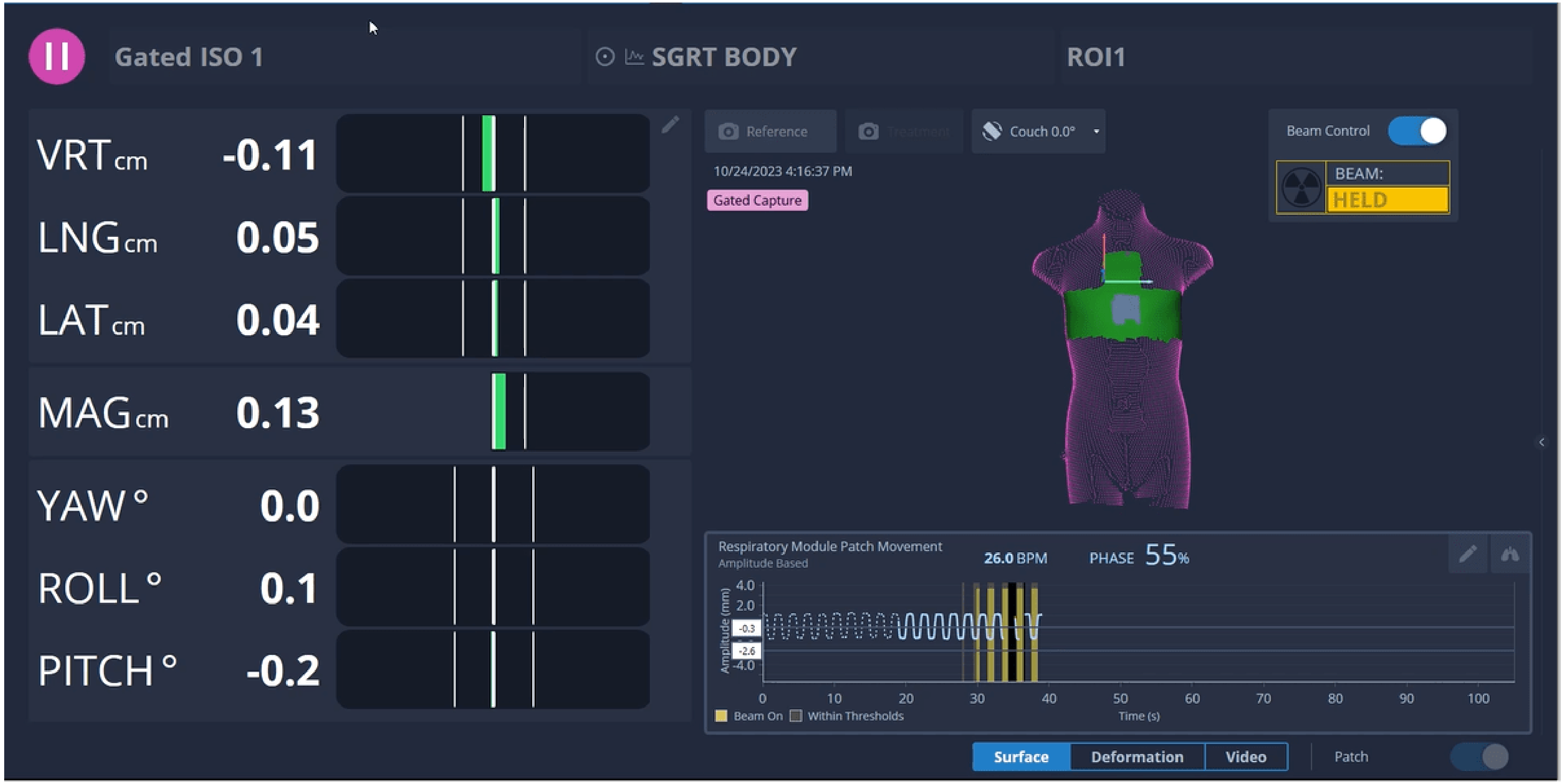




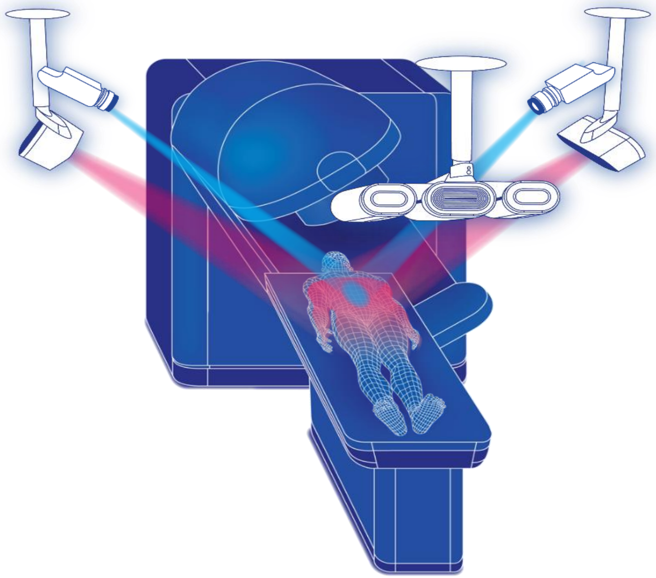


Respiratory Module

- Phase and Amplitude Gating
- AlignRT Integration
  - Continues monitoring in 6 DoF
- Deviceless Delivery



Surface Guided Dose Visualization

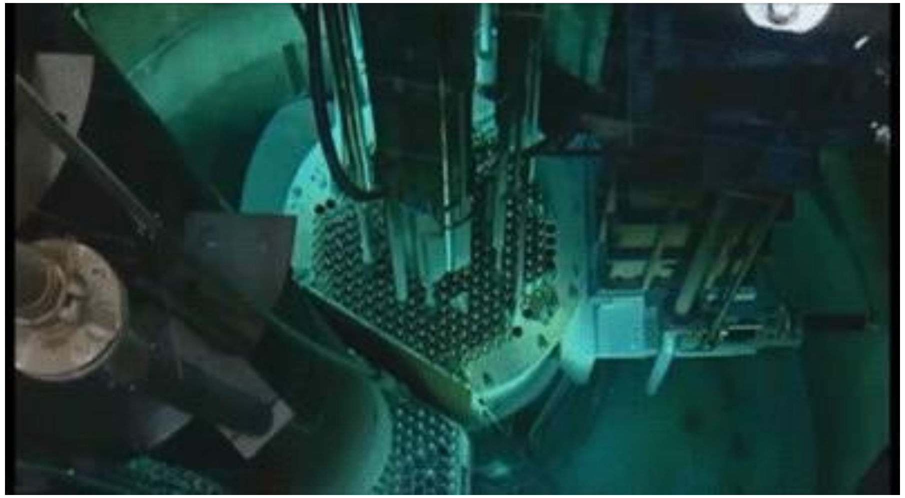


SGRT with Dose Visualization

- Simultaneous real time visualization of dose delivery and patient positioning.
- Can help prevent treatment errors in real time and improve clinical outcome

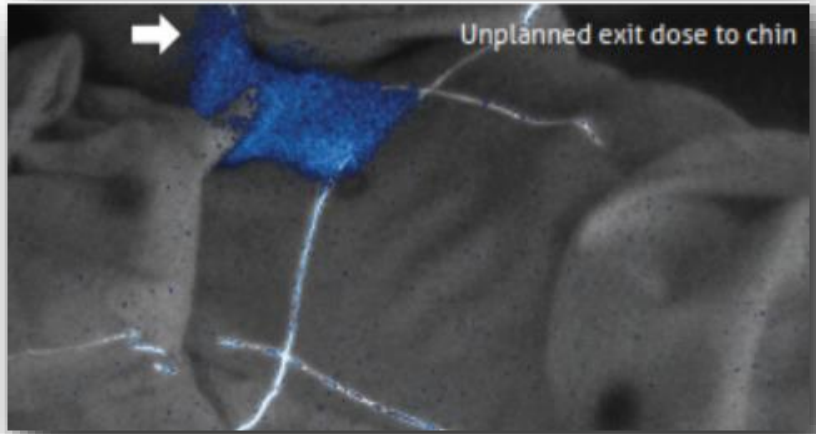
Cherenkov Radiation

- Cherenkov radiation is emitted when a charged particle moves through a medium faster than the phase velocity of light in that medium.
- First observed in 1934 by Pavel Cherenkov when he saw a bluish light around a radioactive source placed in water. Tamm and Frank developed the theory in 1937 and all 3 share the 1958 Nobel Prize.



Benefits of Cherenkov Imaging

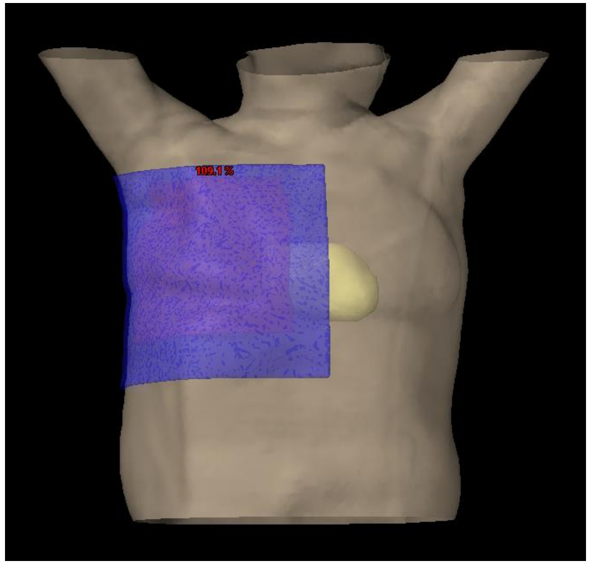
- Initial study out of Dartmouth suggests that about 10% of patients experience issues that could not be visualized without Cherenkov imaging. For example:
  - Chin irradiated during supraclavicular fields
  - Arm irradiated during tangential breast fields
  - Bolus misplacement
  - Open MLC leaves
- We can now detect these With DoseRT!

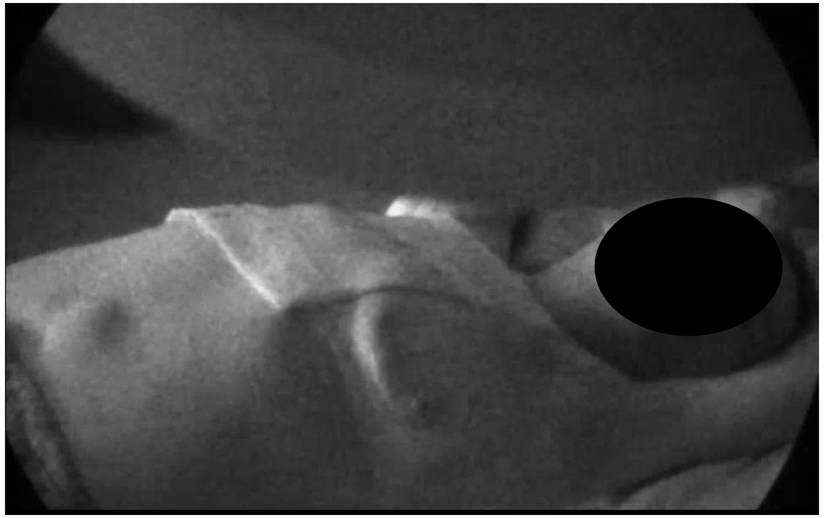


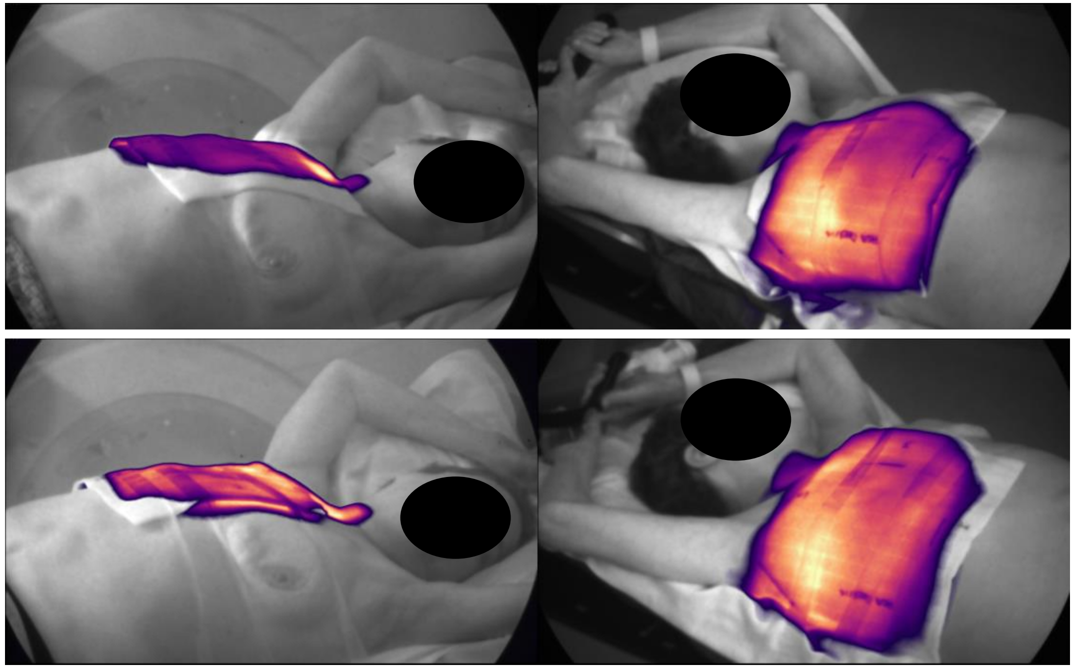
DoseRT Workflow

- We monitor every patient using both AlignRT and DoseRT
- If the therapists visualize something our of the ordinary, they can do one of the following:
  - Pause treatment and call physics for review
  - Finish the fraction and notify physics for offline review
- Adjustments to the plan, patient positioning or treatment thresholds will be done accordingly after case review

Case Study: Bolus Misplacement

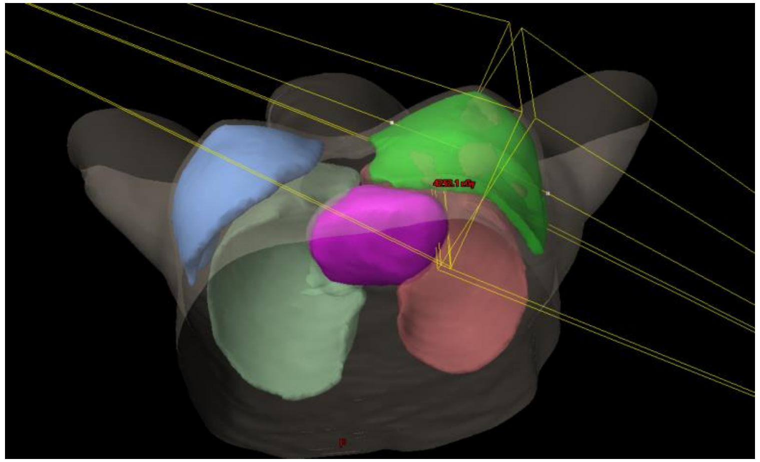


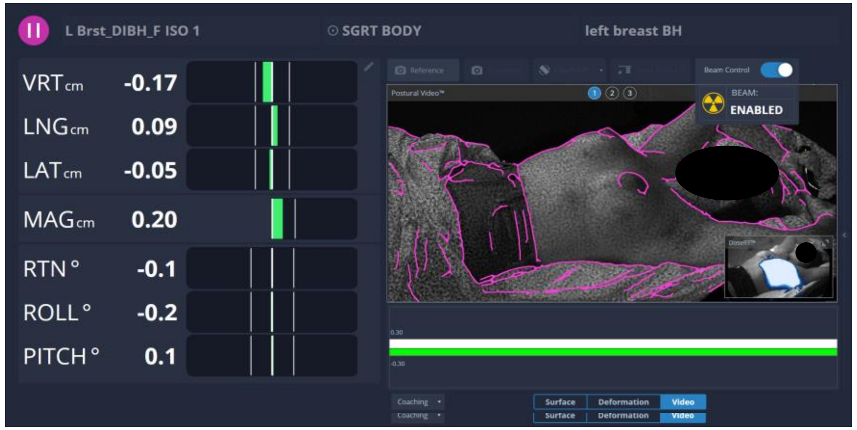


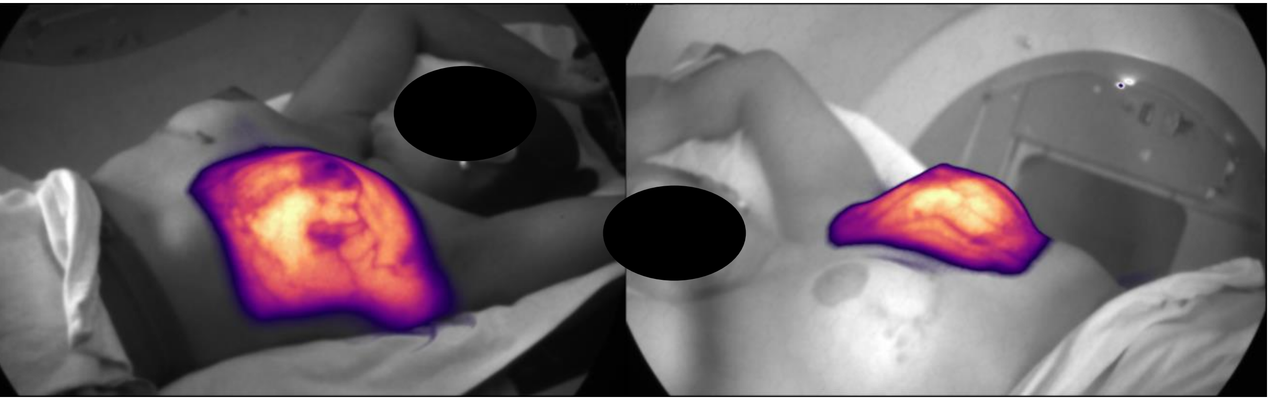


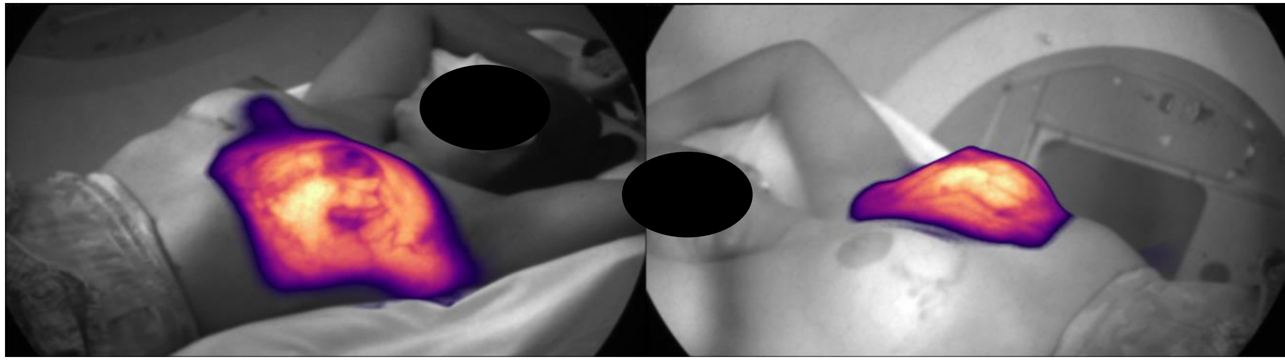
- 62-year-old female, whole right breast treatment.
- 13 with bolus, 12 fractions without.
- On fraction 8 her bolus was misplaced
- Corrected for the next fraction.

Case Study: Contralateral Breast Dose

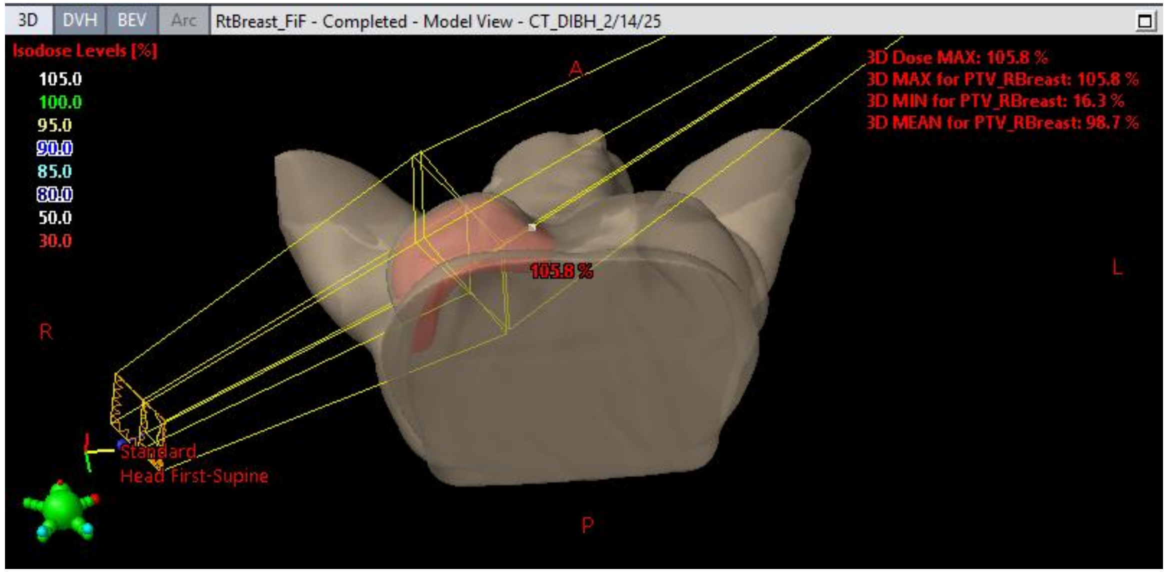


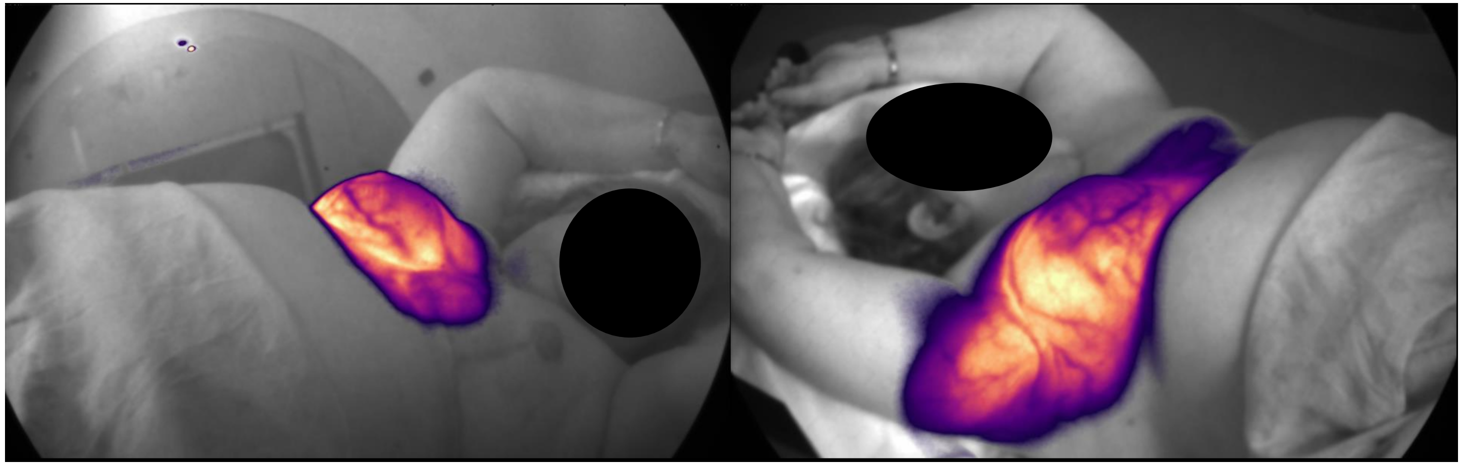






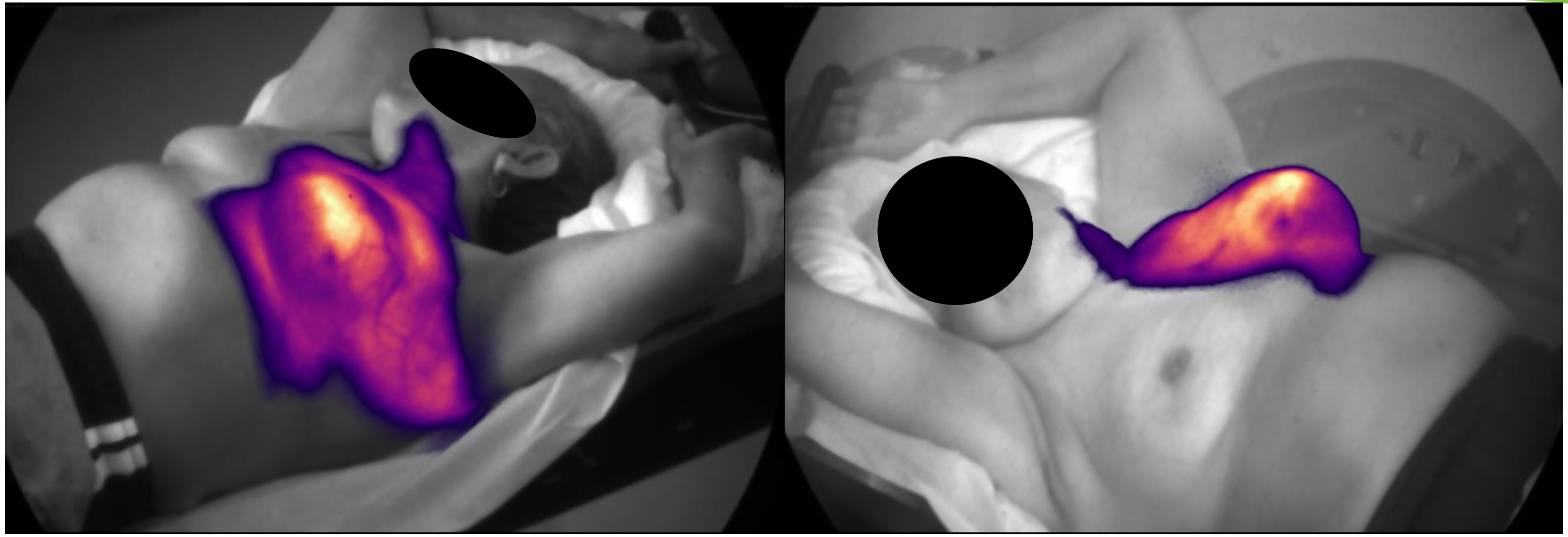
Case Study: Contralateral Breast Dose



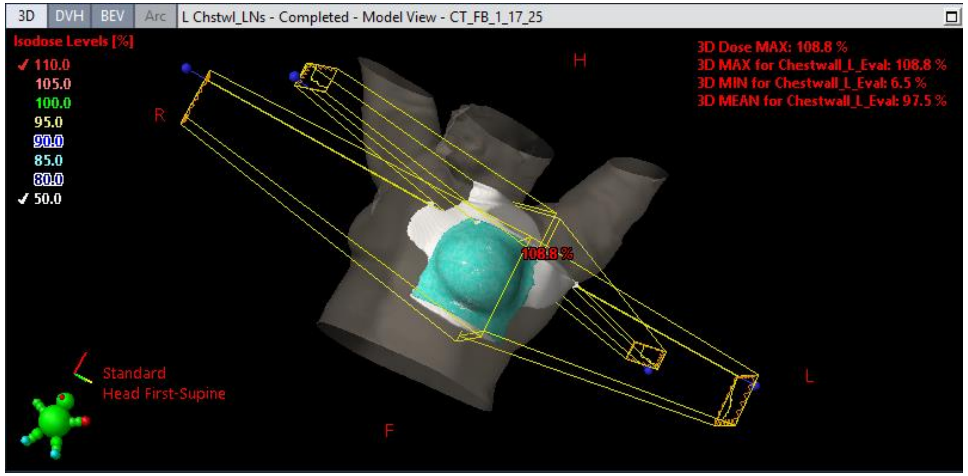


- 69-year-old female, whole right breast treatment.
- Dose to her left breast was visualized in the first fraction
- Corrected for the next treatment delivery

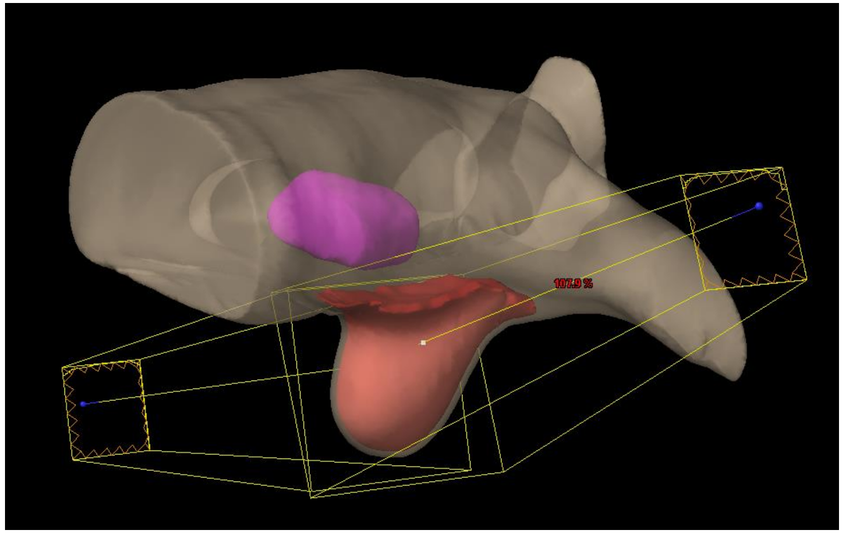
Case Study: Dose to the Chin

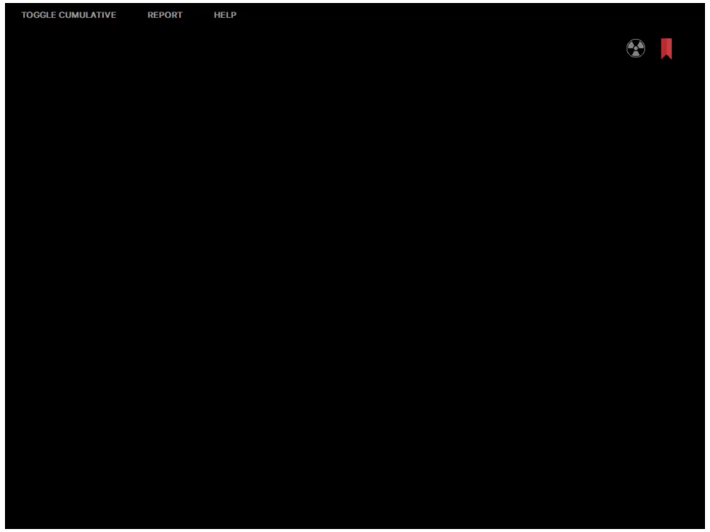


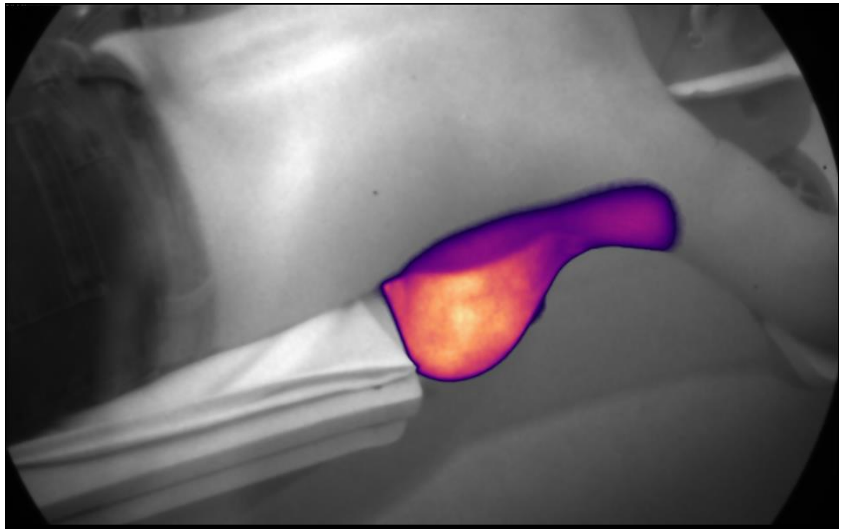
- 61-year-old female with malignant neoplasm of the left breast.
- During the treatment of her SCV lymph node, dose to the chin was visualized.
- Positioning of the patient was corrected for the next fraction



Prone Breast

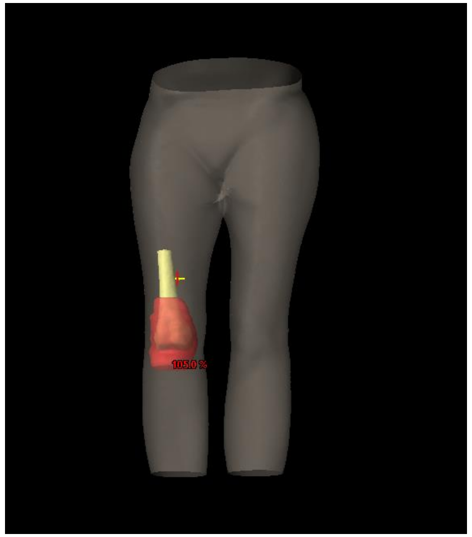


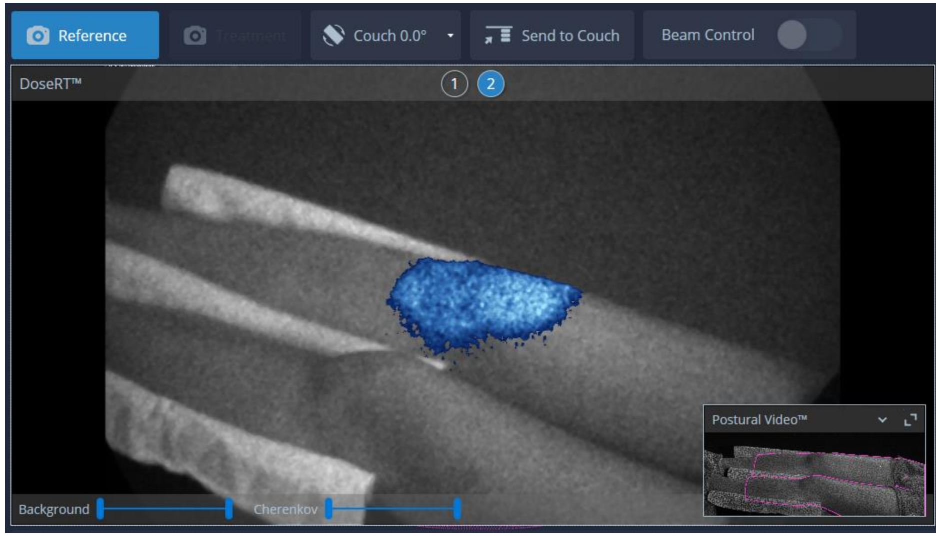


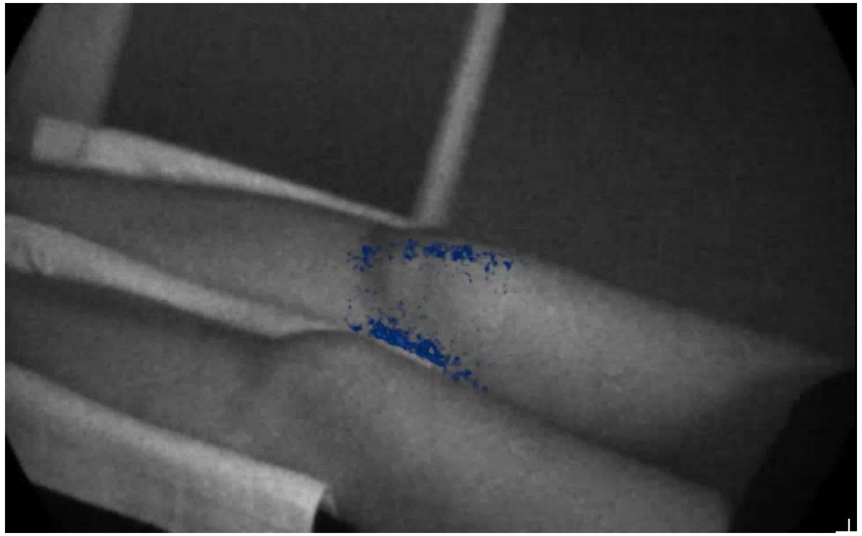


- 52 Year Old Female undergoing treatment to her right breast
- Patient was treated in the prone position
- Visual verification of treatment dose initiated from first day of treatment
- Verify no treatment through the table, dose to primary in the breast, and no contribution to the back or arm.

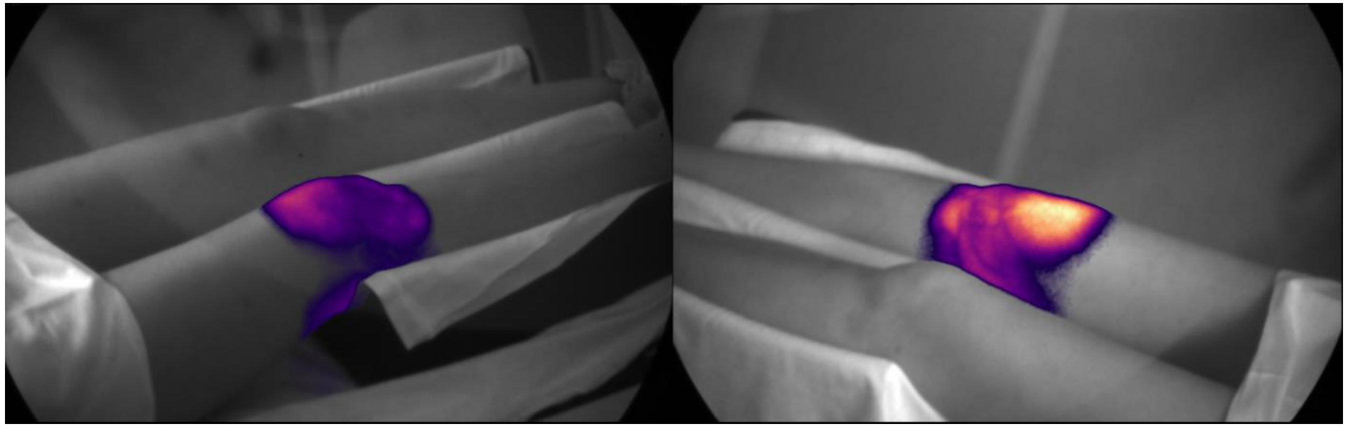
Case study: Extremity Treatment -Rt Knee



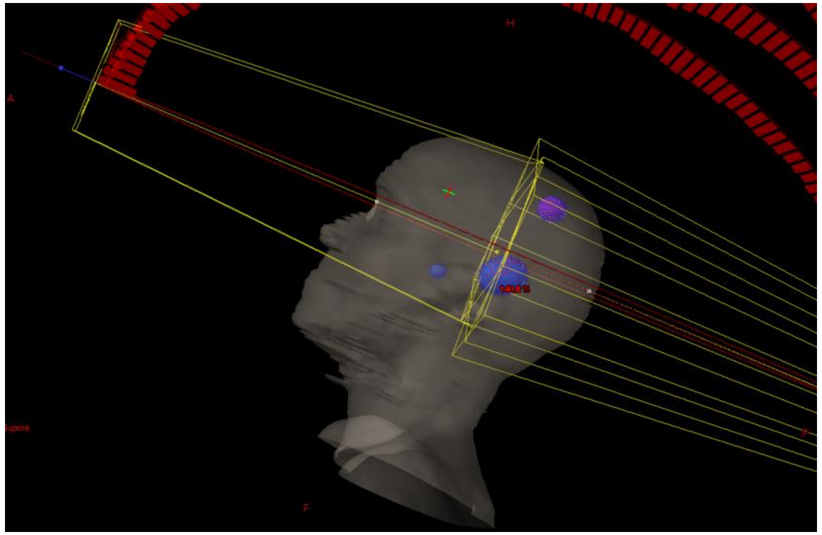


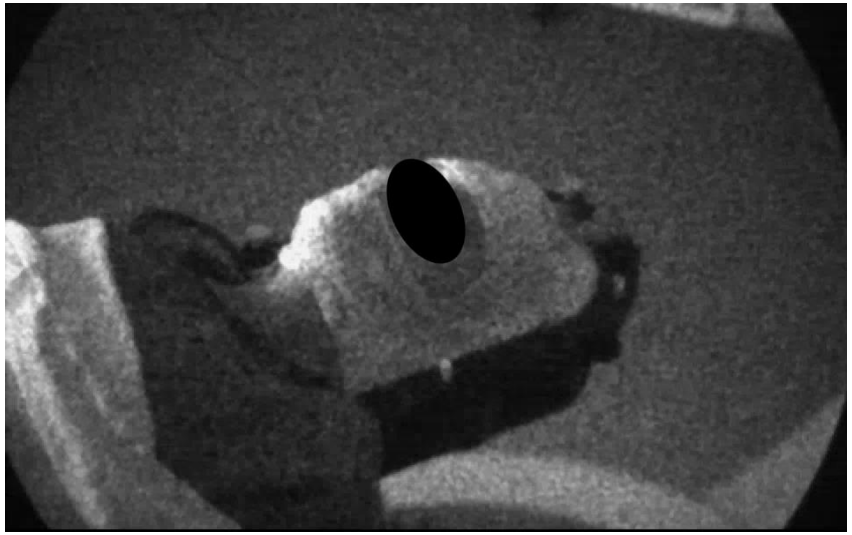


- 21 year old female with Villonodular Synovitis of the right knee (benign)
- 4 field 3D conformal plan

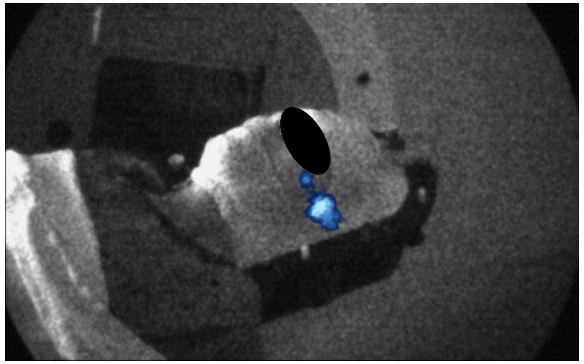


Case Study: SRS Treatment





- 53 year old female with malignant neoplasm of brain.
- 9 Gy x 3 to 3 lesions.
- 4 VMAT arcs in a non coplanar treatment.



Conclusion

- SimRT provides a quick and easy way to capture respiratory motion information during CT simulation. It is effective, non-invasive and simple to use.
- MapRT provides a clearance map that eliminates the need for collision checks and dry runs while assisting in improving the quality of the treatment plan
- AlignRT provides a marker-less patient positioning and monitoring. Greatly reduces the need for reposition and reimaging the patient.
- DoseRT provides dose visualization in real time. assists in improving the quality and safety of treatment delivery.

Thank you!
Questions?

Email: Adi.Robinson@adventhealth.com