AdventHealth

# Surface Guided Planning and Dose Visualization

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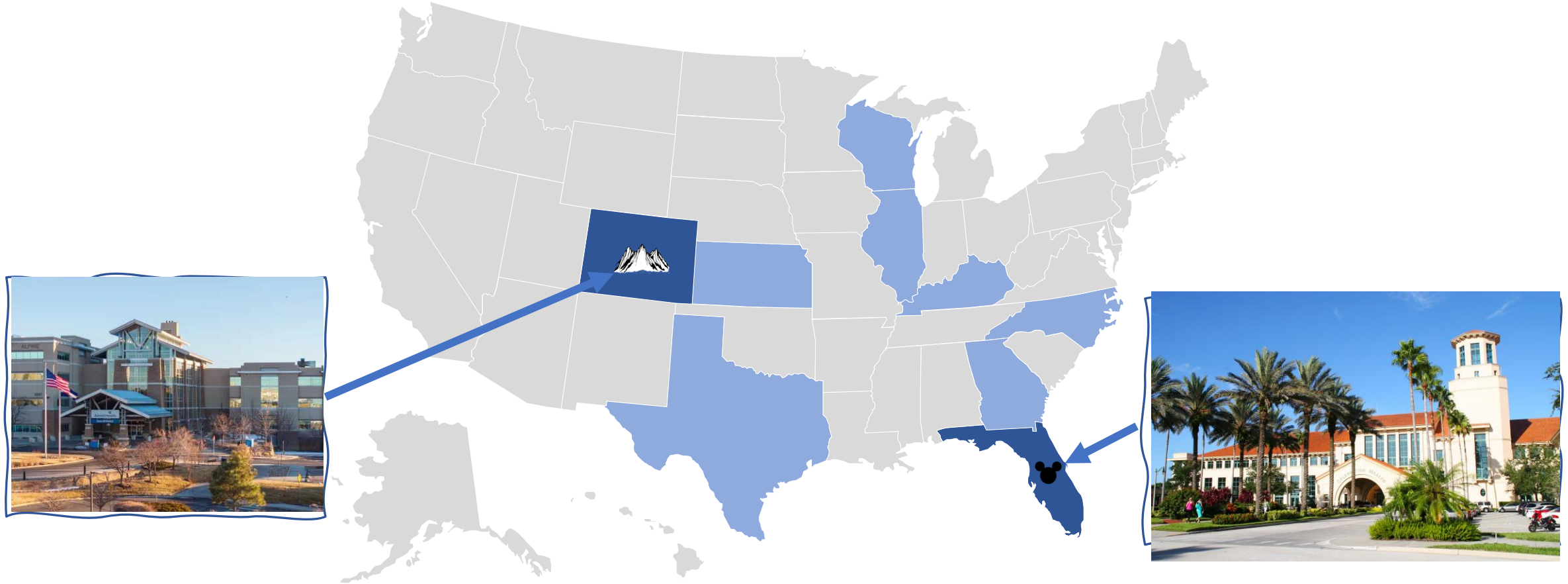
# Disclosures

- AdventHealth Celebration has a COE agreement with VisionRT
- AdventHealth Parker has a PSA agreement with VisionRT

# Objectives

- Discuss the clinical need for MapRT and DoseRT
- Explain current acceptance procedures and our implementation process
- Go over commissioning tests we performed prior to clinical use
- Give an overview of some clinical cases we observed

# AdventHealth Hospitals



# 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

# Why Did We Get MapRT

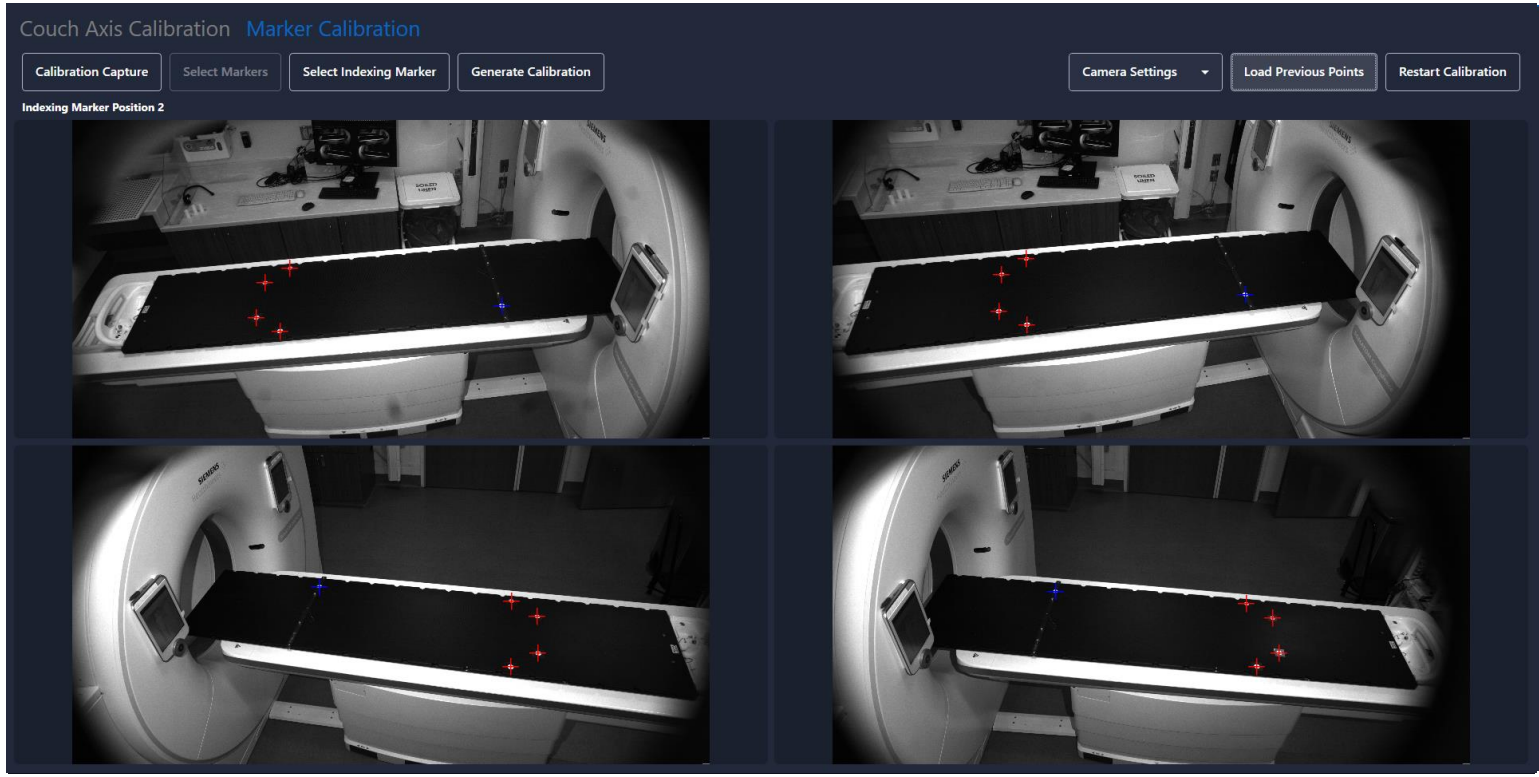
- Safety
  - Prevent close calls and near collisions
- Busy Clinic
  - 50% of patients are breast: tight clearance on elbows (supine) or back (prone)
  - Difficult setups with accessories and immobilization devices
- Time Savings
  - Time spent doing dry runs and collision checks before or on day 1
- SBRT/SRS
  - Opens up non coplanar possibilities

# MapRT Install and Setup - Surface Calibration

- During install and acceptance, a calibration is performed to link the CT DICOM origin with the reference position of the camera system.
- The calibration is performed using the vendor supplied calibration plate similar to AlignRT.
- This calibration is verified every day with daily QA.

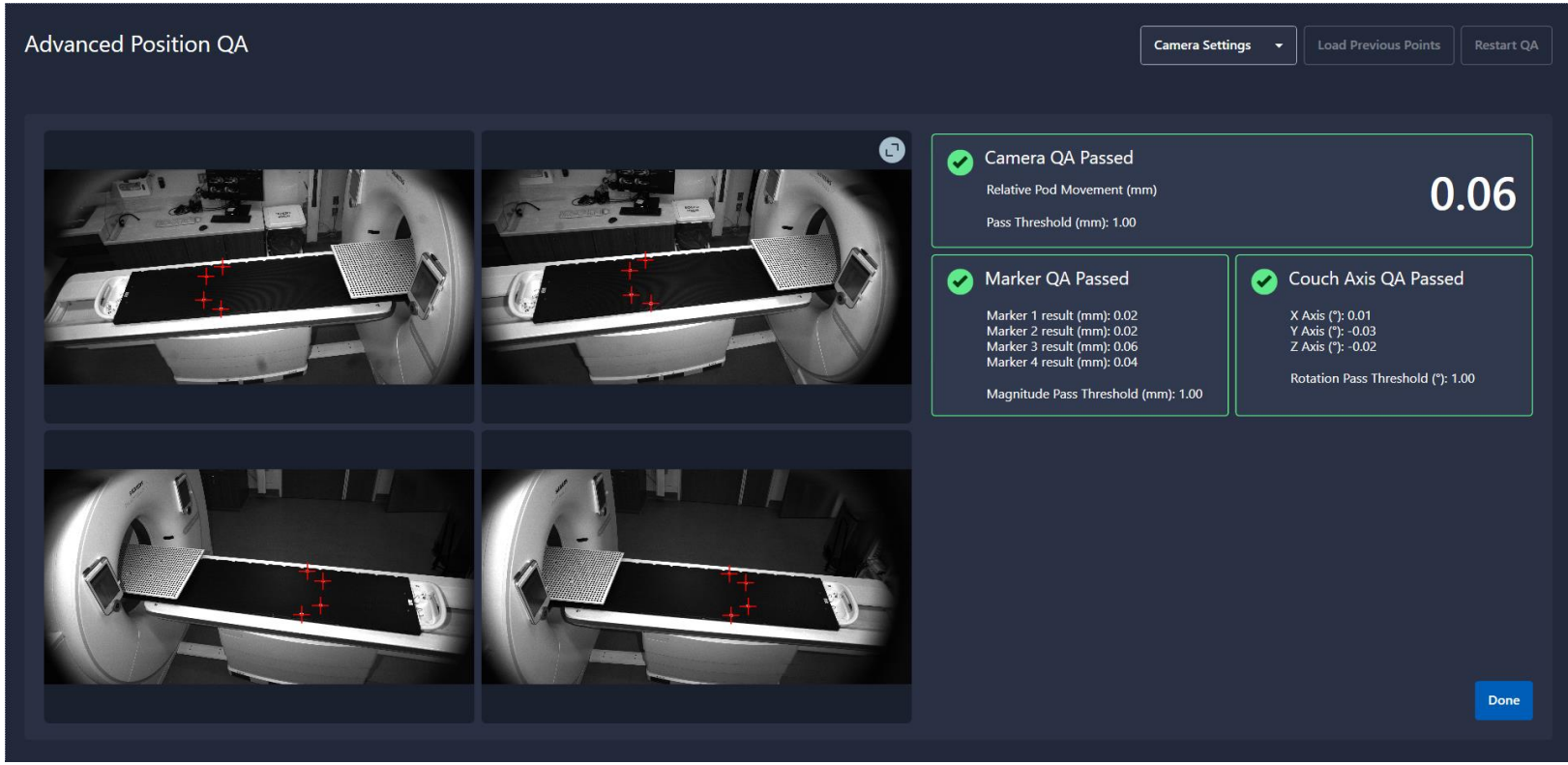
# The MapRT Calibration Process

- The CT table is placed at a fixed position with the calibration plate indexed at the end of the table.
- Table markers must be visible by all 4 camera sensors.
- The test is then repeated at a second position 250mm inside the CT bore.
- Another marker is placed on an index bar that can be flipped to identify the central ray of travel of the CT table.



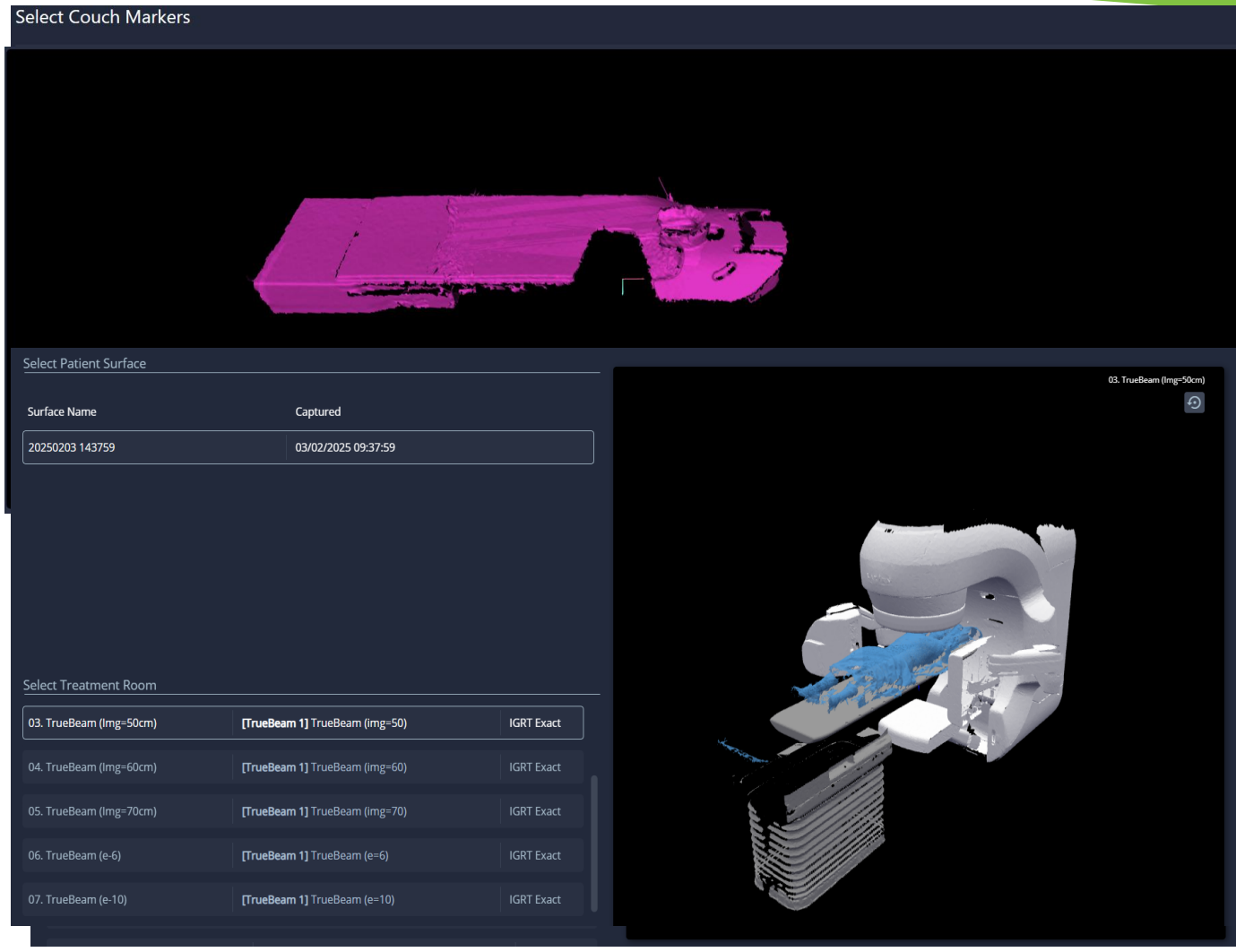
# MapRT Vendor Acceptance

- Vendor acceptance includes the following steps
  - Camera calibration
  - Capture surface of vendor reference phantom
    - Verify clearance map
    - Apply isocenter offsets
  - Select site appropriate safety buffers (patient and table)
  - Verify a collision point from the clearance map on the linac.

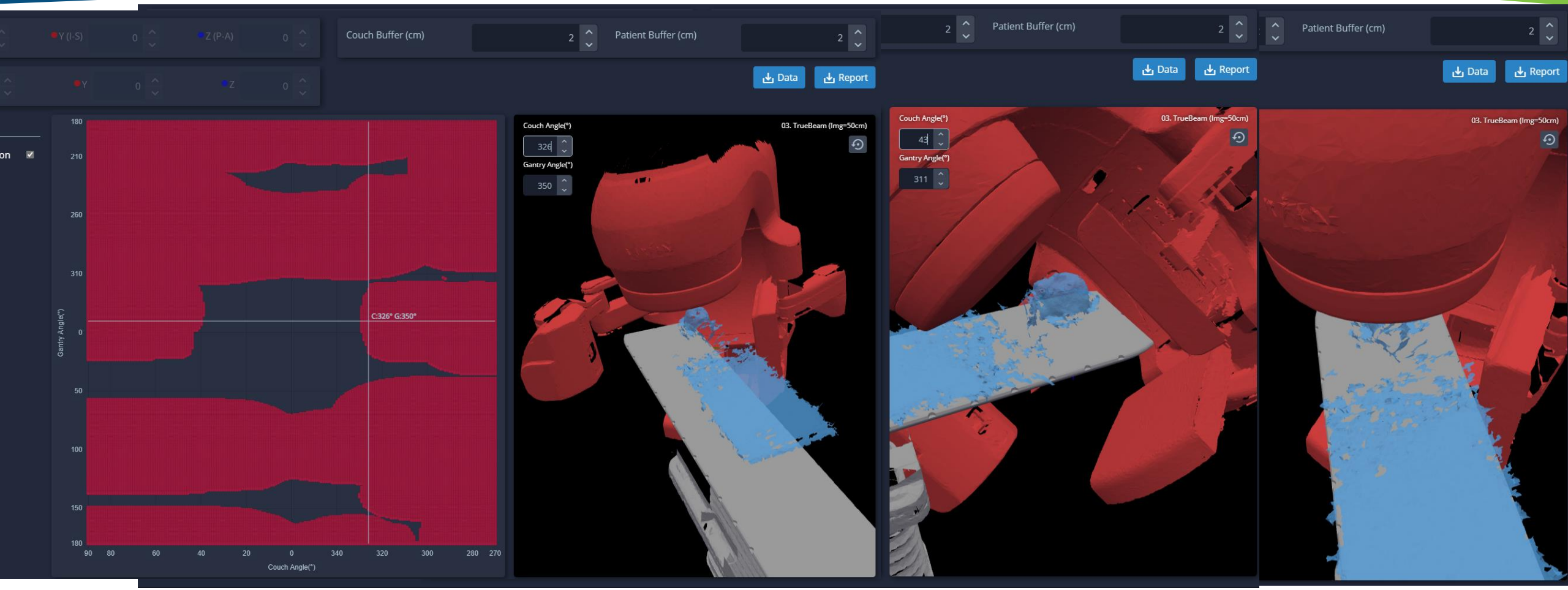


# Additional recommended Tests

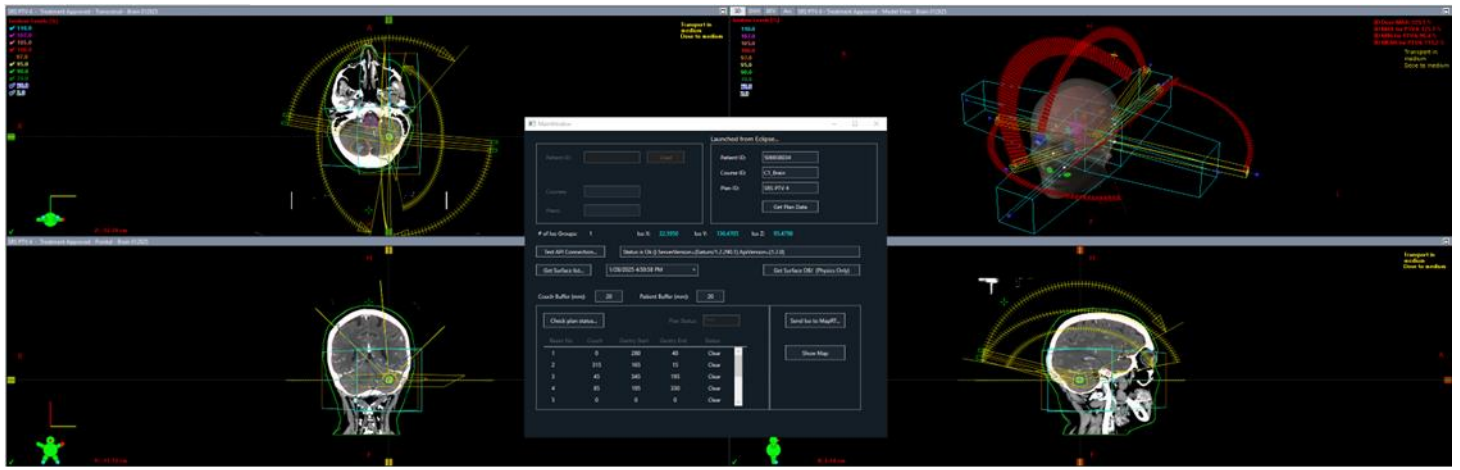
- Test the surface calibration with an end-to-end test that includes at least one currently used clinical workflow.
- Test surface captures with the various immobilization devices that are used clinically to ensure visibility of at least two table markers at every possible setup.
- Verify  and validate all appropriate machine models are available within MapRT
  - Couch tops
  - Electron cones
  - Imaging panels

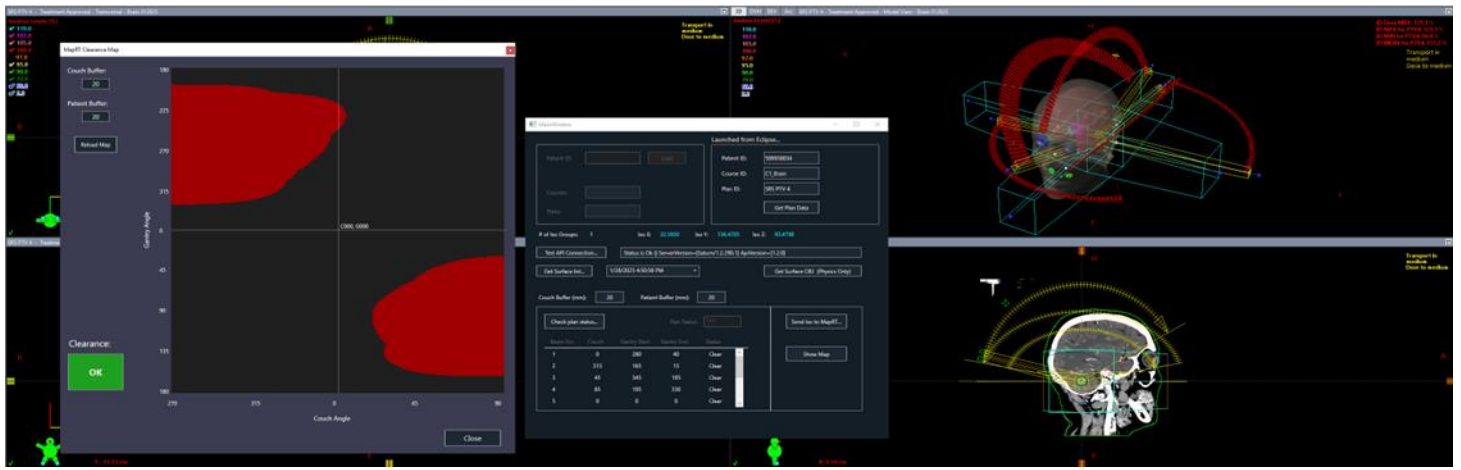


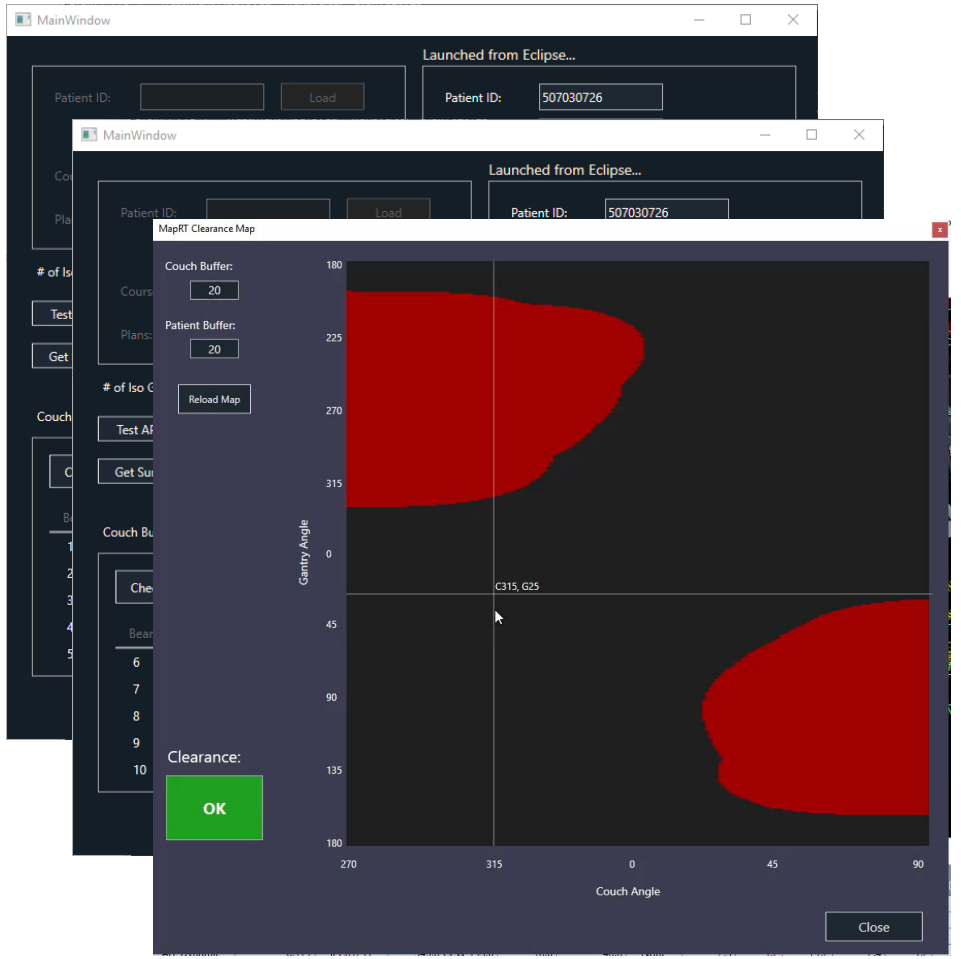
# MapRT Phantom Validations



# TPS Integration - Eclipse







# Surface guided Planning

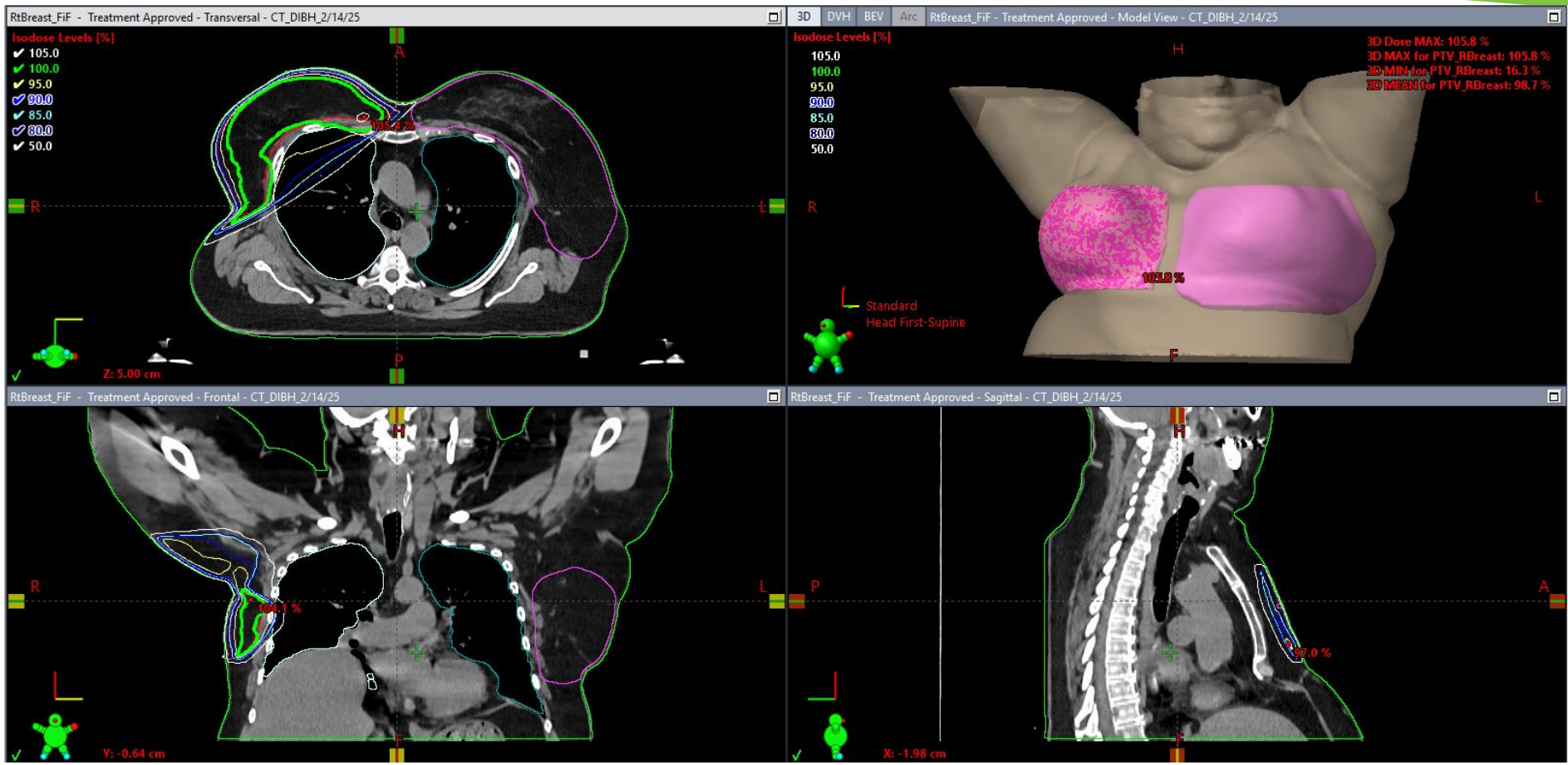
- Clearance map at time of simulation.
  - Patient and immobilization device collision check
- Planner can use the clearance map data to optimize planning
  - Plan with “allowed” fields
  - Non-coplanar treatment
- No need for dry run or collision check

# Surface Guided Planning Workflow

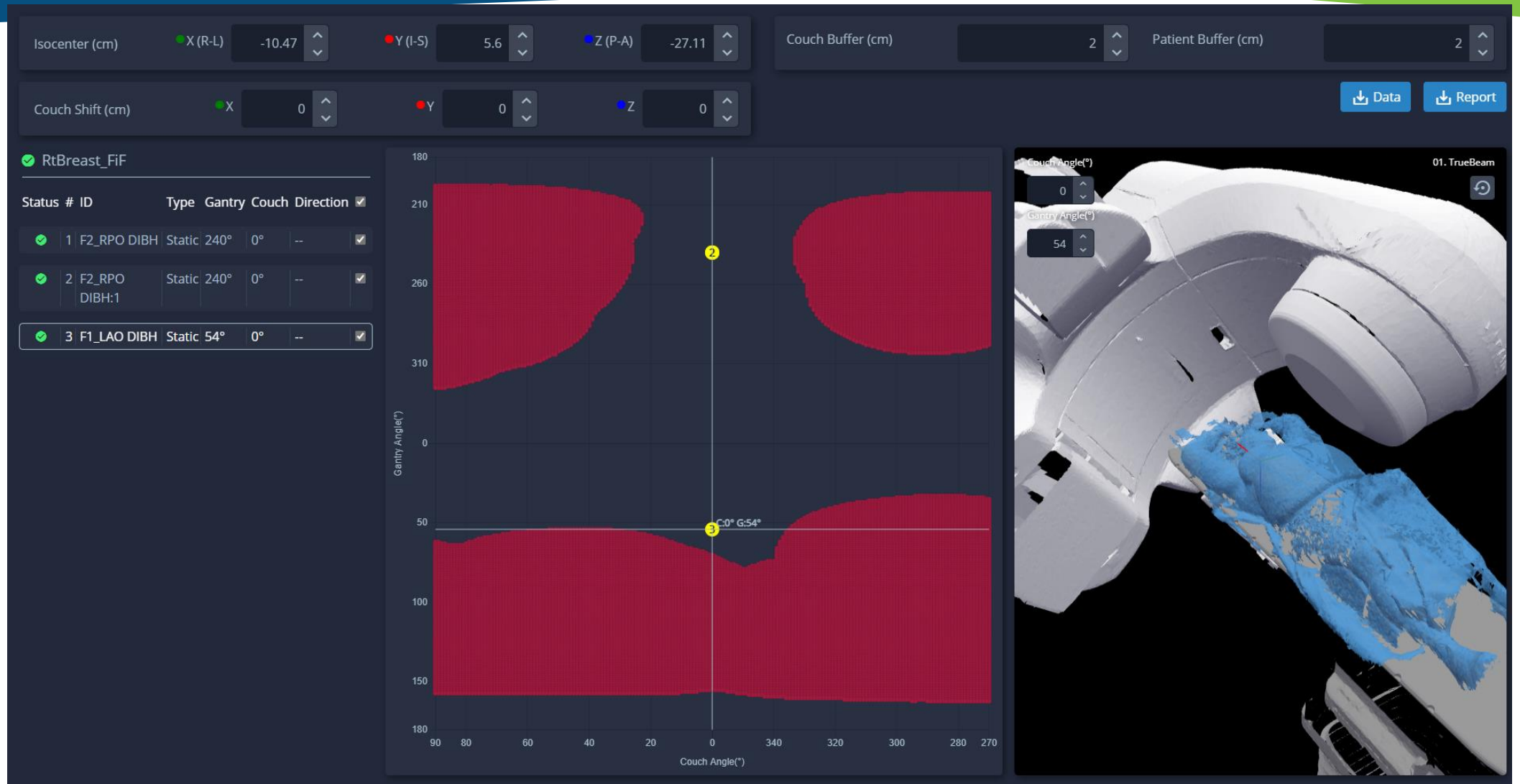
- In the CT sim room
  - Capture surface prior to CT sim
  - Check for collisions
  - Adjust patient position or immobilization device accordingly.
- Treatment Planning
  - Use clearance map to optimize the plan
- Treatment
  - Plan can be safely delivered

# Case Study: Rt Breast

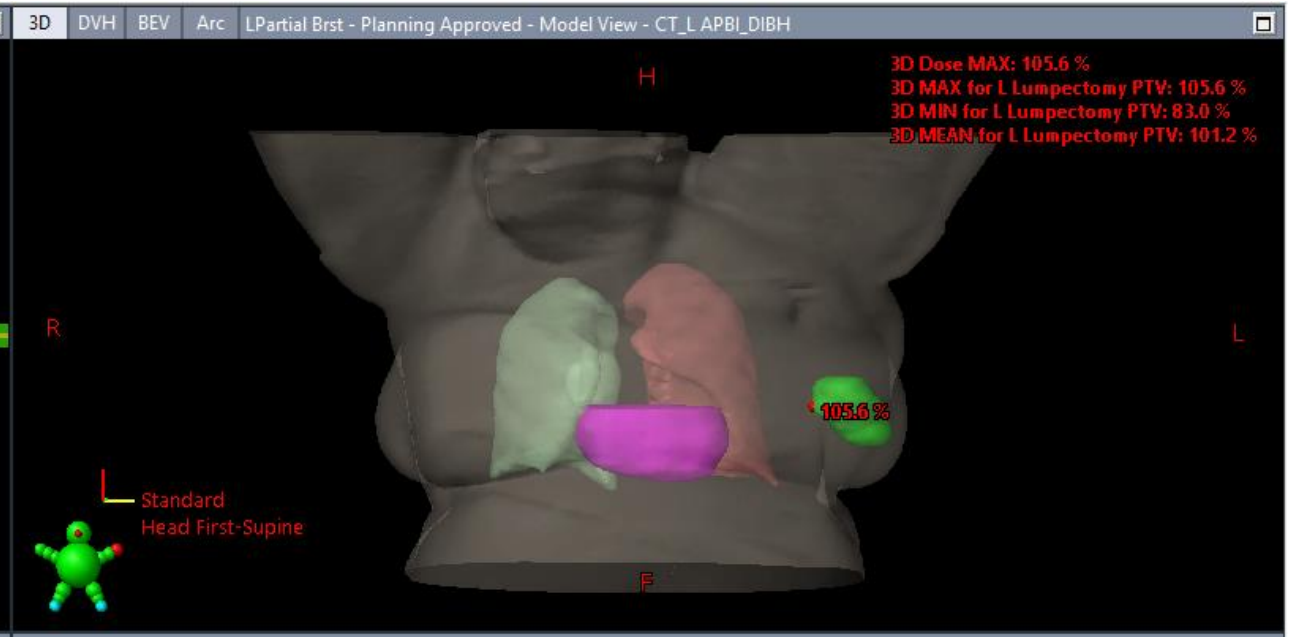
- 69 year old female with malignant neoplasm of the upper-inner quadrant of the right female breast



# Rt Breast Clearance Map



# Case Study: Lt APBI

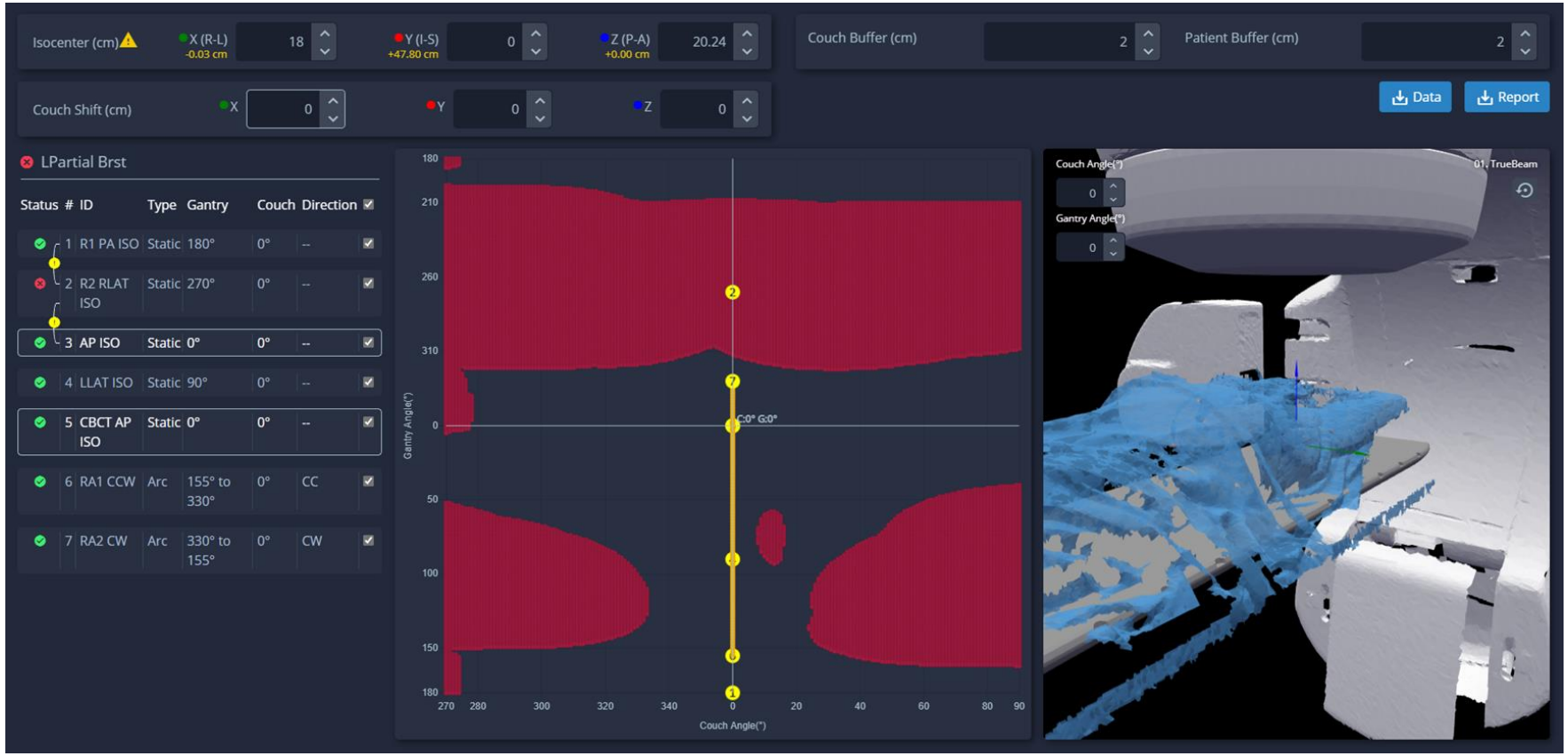




- 75-year-old female with malignant neoplasm of the central portion of the left breast
- VMAT DIBH plan, 267cGy x 15 fractions

# Standard Approach to APBI

- 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 Surface Guided Planning

- 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 |

# Lt APBI Non-coplanar Clearance Map

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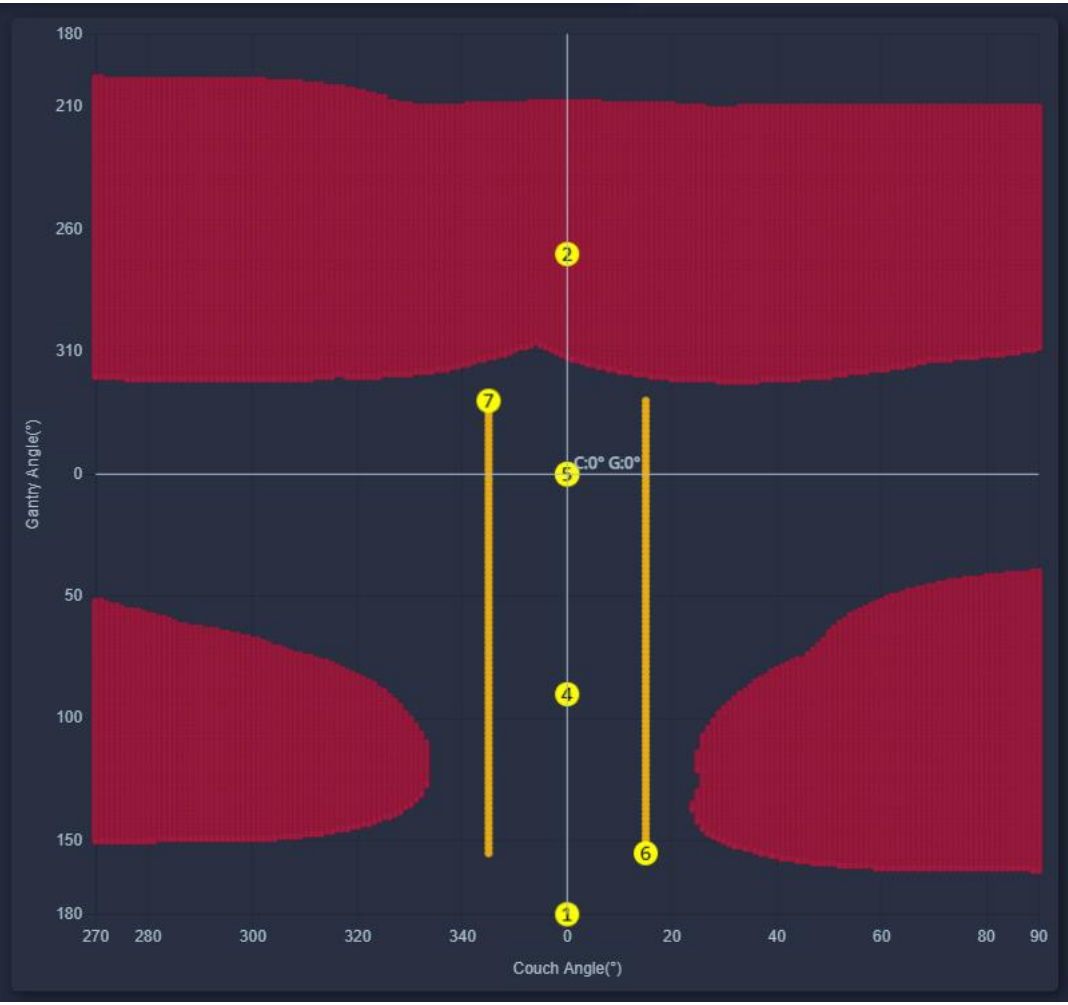
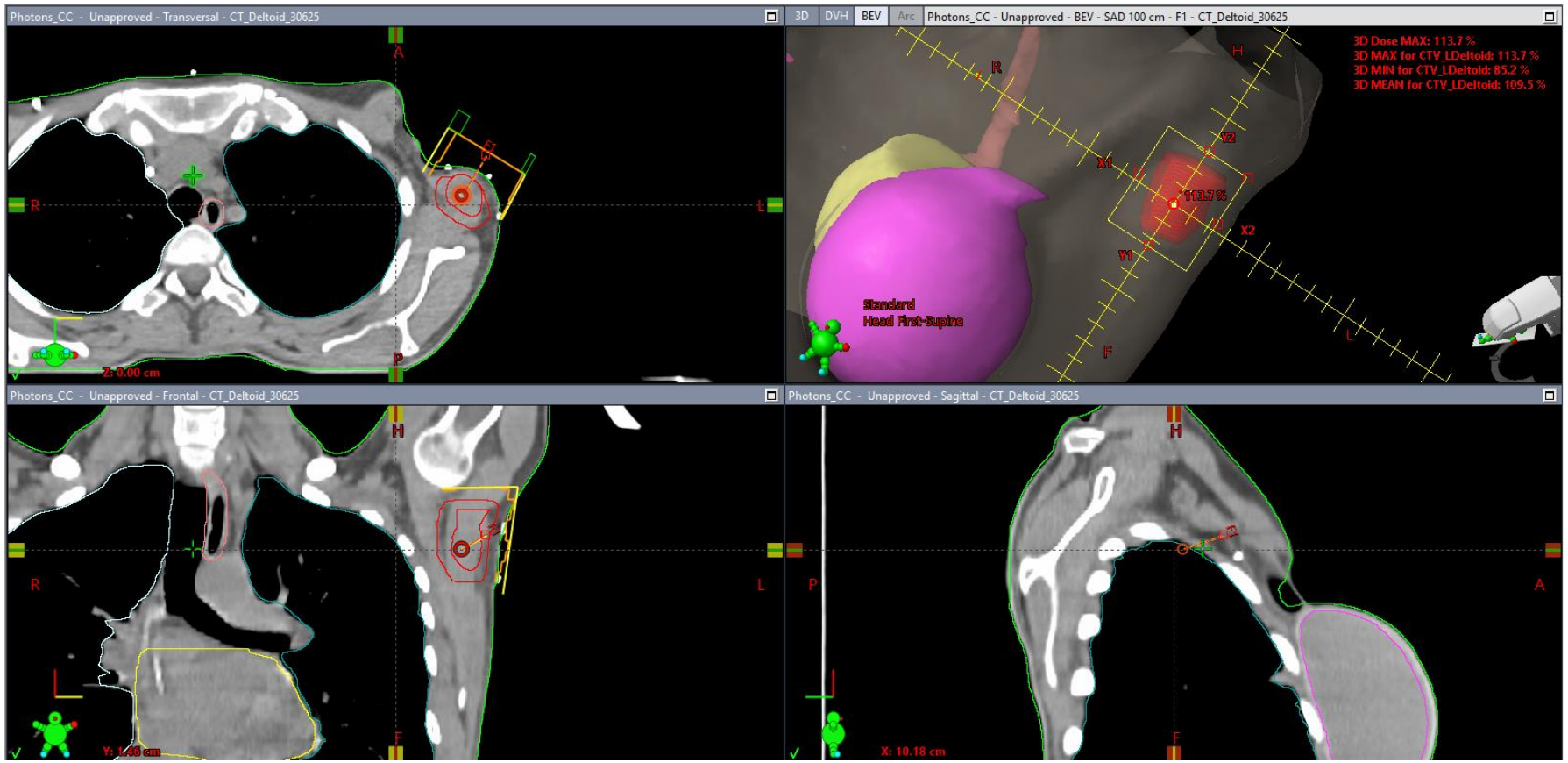
| Status | # | ID | Type | Gantry | Couch | Direction |
|---|---|---|---|---|---|---|
| ✓ | 1 | R1 PA ISO | Static | 180° | 0° | -- |
| ✗ | 2 | R2 RLAT ISO | Static | 270° | 0° | -- |
| ✓ | 3 | AP ISO | Static | 0° | 0° | -- |
| ✓ | 4 | LLAT ISO | Static | 90° | 0° | -- |
| ✓ | 5 | CBCT AP ISO | Static | 0° | 0° | -- |
| ✓ | 6 | RA1 CCW | Arc | 155° to 330° | 15° | CC |
| ✓ | 7 | RA2 CW | Arc | 330° to 155° | 345° | CW |




# Case Study: Lt Deltoid

- 41-year-old female with secondary malignant neoplasm of the left deltoid muscle
- Previous radiation to the left chest wall and lymph nodes

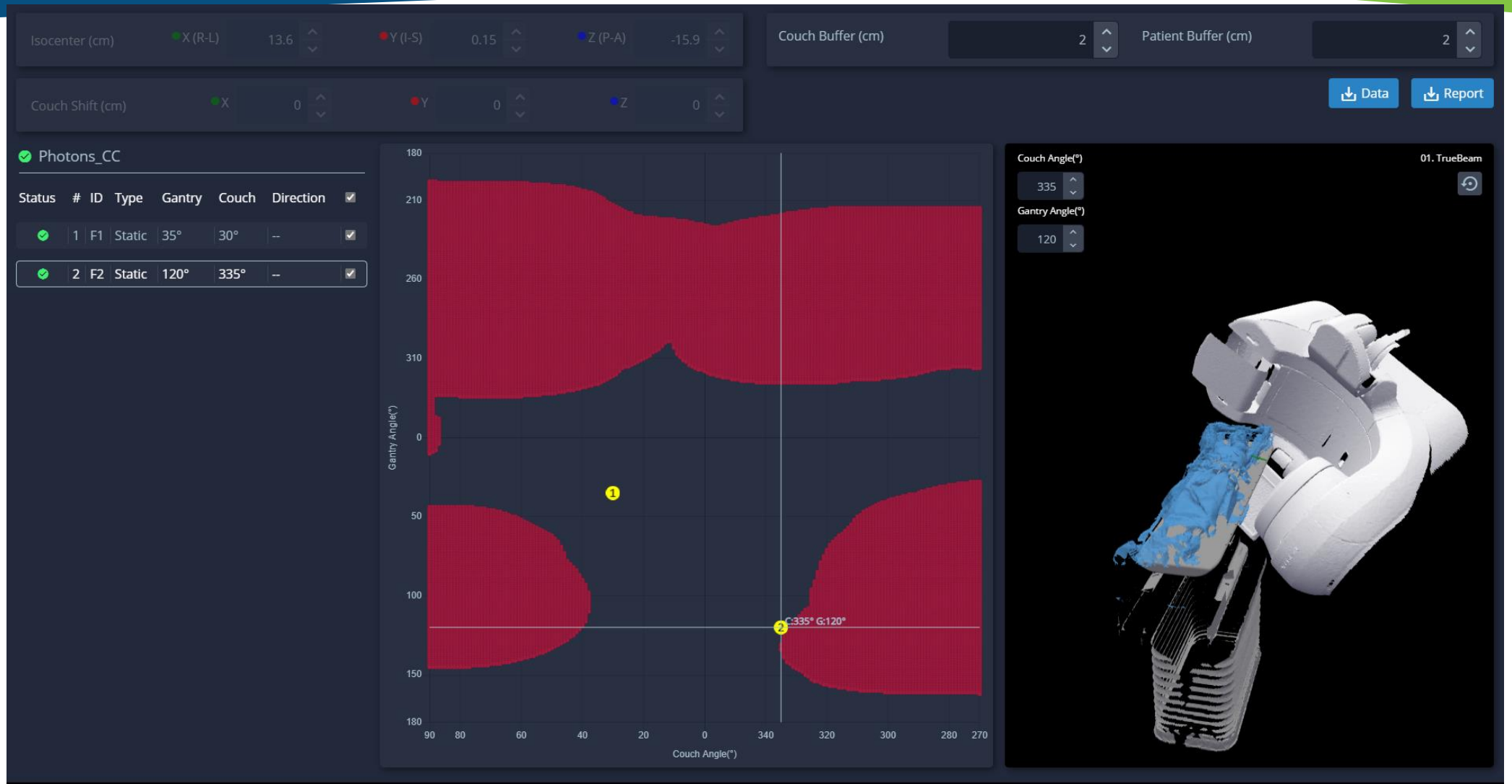


# Surface Guided Planning for Lt Deltoid

- Coplanar plan
  - LAO G35
  - LPO G120
- Noncoplanar Plan
  - LAO G35, **T30**
  - LPO G120, **T325**

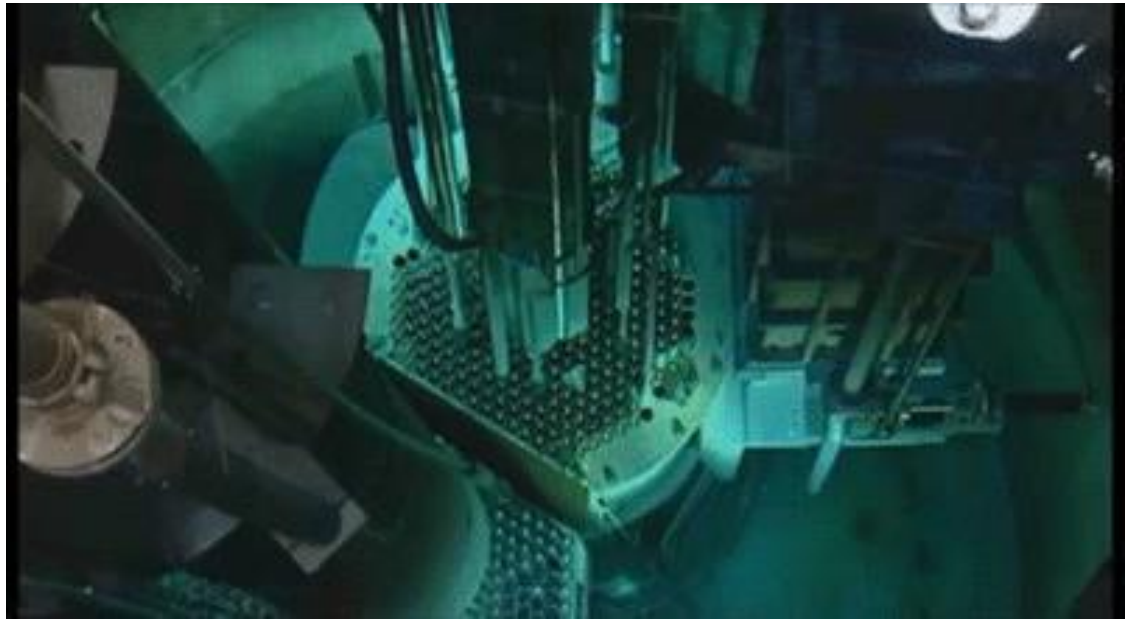
| Structure | Constraint | NCP | CP | Diff |
|---|---|---|---|---|
| Lt Deltoid | Max ≤ 110% | 109.71% | 111.56% | -1.85% |
| Lt Deltoid | V95% ≥ 95% | 99.56% | 99.31% | 0.25% |
| Breast_L | V300cGy ≤ 10% | 0% | 0.02% | -0.02% |
| Breast_L | Max ≤ 300cGy | 49.6cGy | 655.2cGy | -605.60 cGy |
| Heart | V2500cGy ≤ 10% | 0% | 0% | 0.00% |
| Heart | Mean ≤ 300cGy | 4cGy | 10cGy | -6.00 |
| Lung_L | V2000cGy ≤ 35% | 0% | 0% | 0.00% |
| Breast_R | V300cGy ≤ 10% | 0% | 0% | 0.00% |
| Breast_R | Max ≤ 300cGy | 1.5cGy | 1.8cGy | -0.30 cGy |
| Lung_R | V500cGy ≤ 10% | 0% | 0% | 0.00% |

# Lt Deltoid Clearance Map

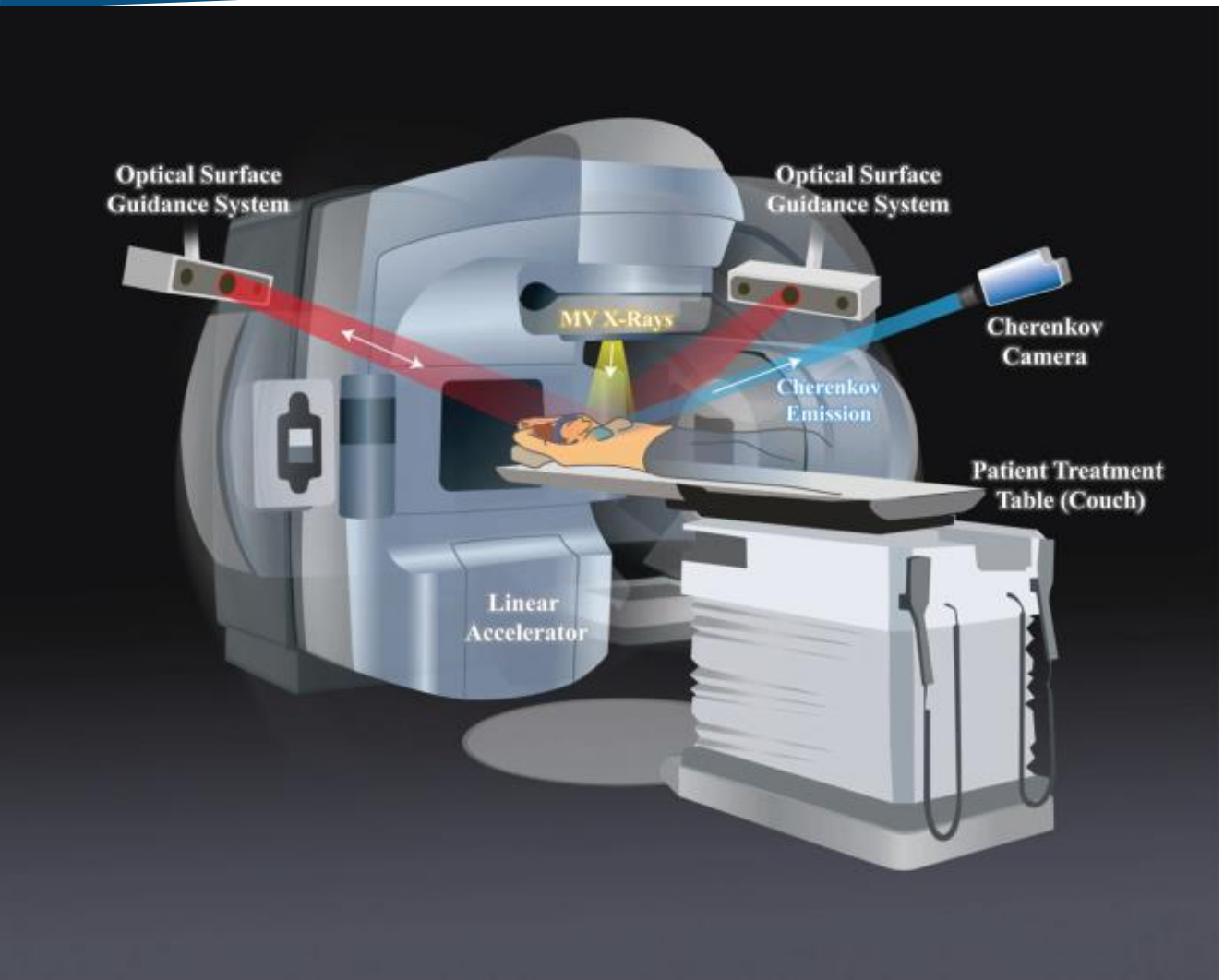


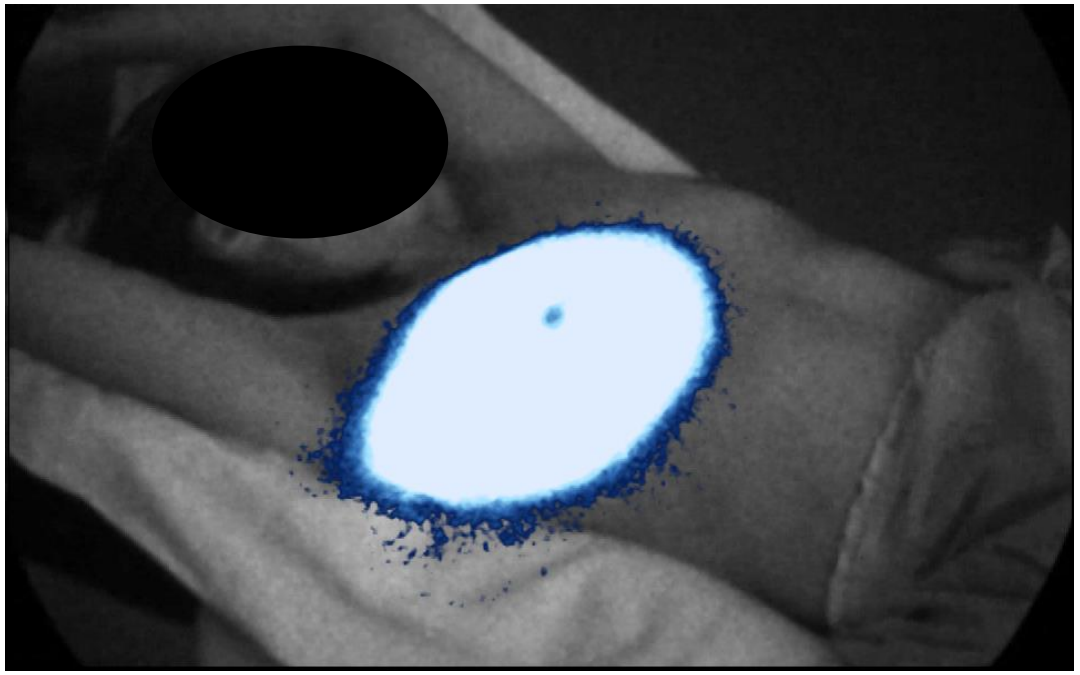
# Why Did We get DoseRT?

- Ability to visualize dose in real time
  - Verify setup
  - Verify fields
  - Verify patient position
- The cool factor
- Future application



# Cherenkov Imaging



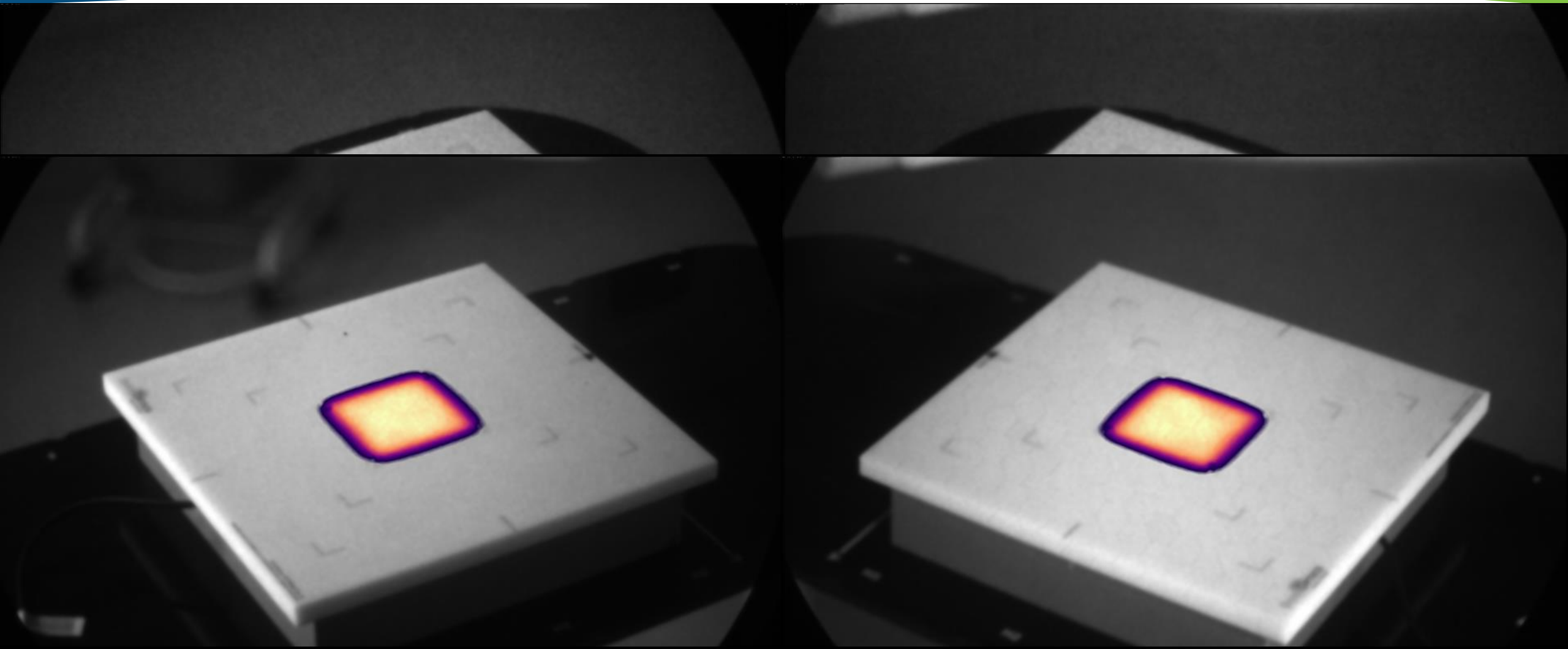
# Installation and Acceptance

- During installation, the following should be addressed:
  - Default ambient light in the vault
  - Positioning of the camera system
  - Calibration of the camera system
- Acceptance testing will confirm visualization of Cherenkov signal to verify proper installation.

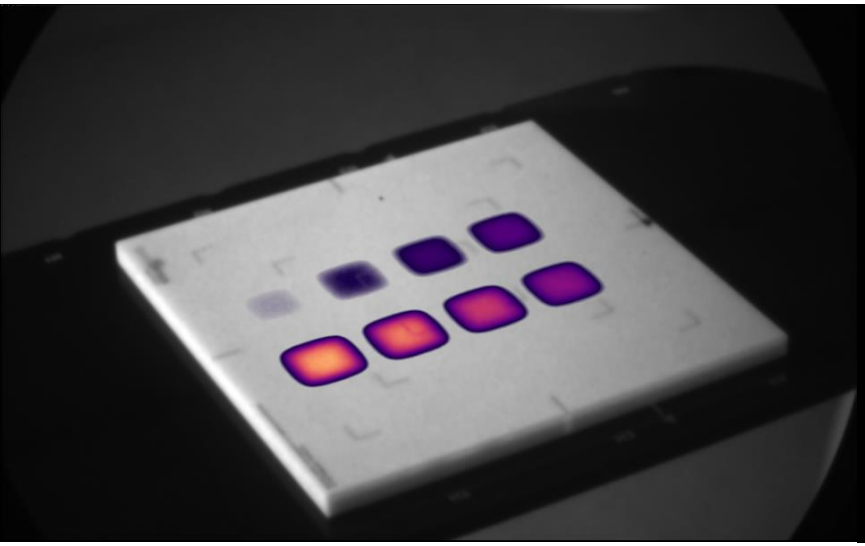
# Additional Tests and Validation

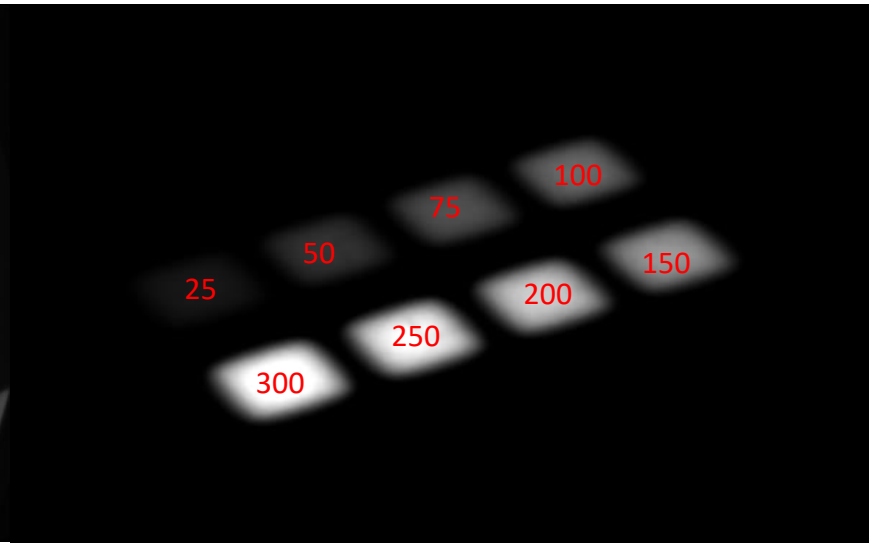
- DoseRT is currently used for qualitative visualization and analysis of treatment delivery.
- However, it is still important to check and validate the Cherenkov signal we are visualizing.
  - Linearity check
  - Singal constancy check
  - Field size constancy check
  - Signal vs. output check

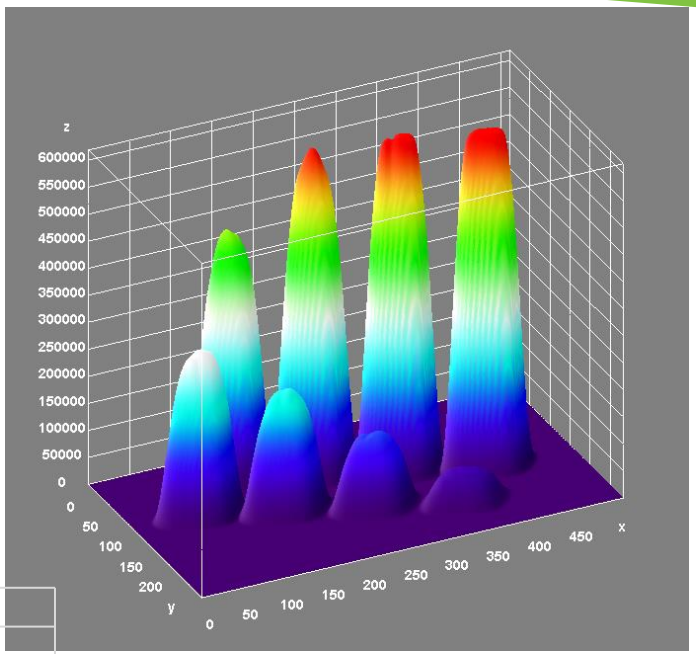
# Phantom Tests

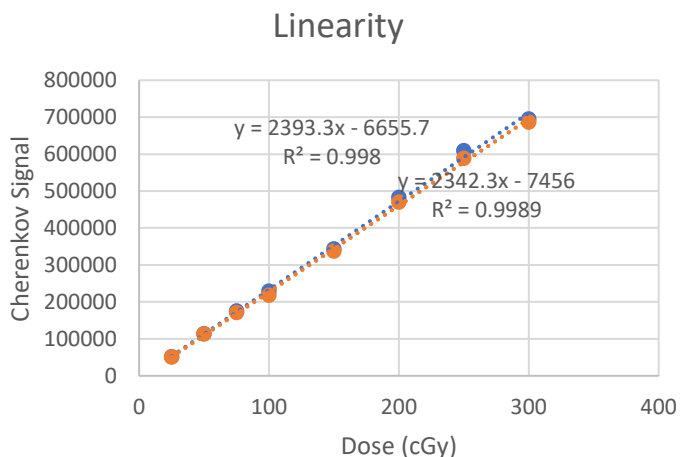


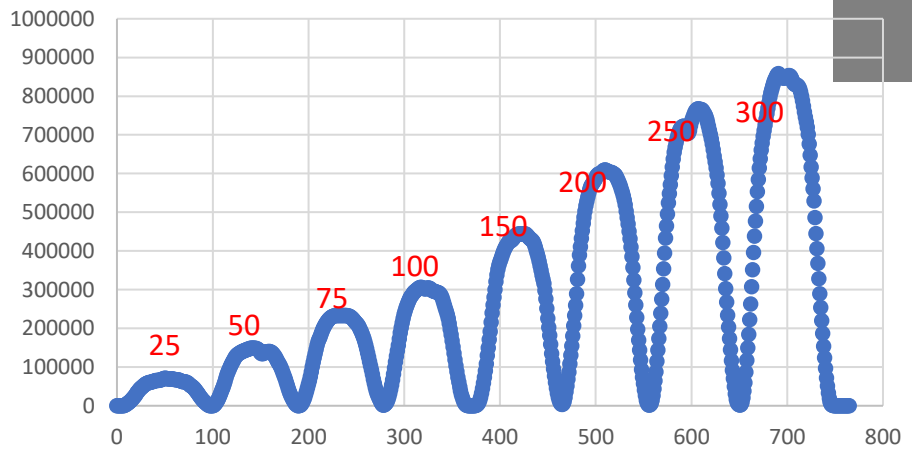
# Cherenkov Signal Linearity





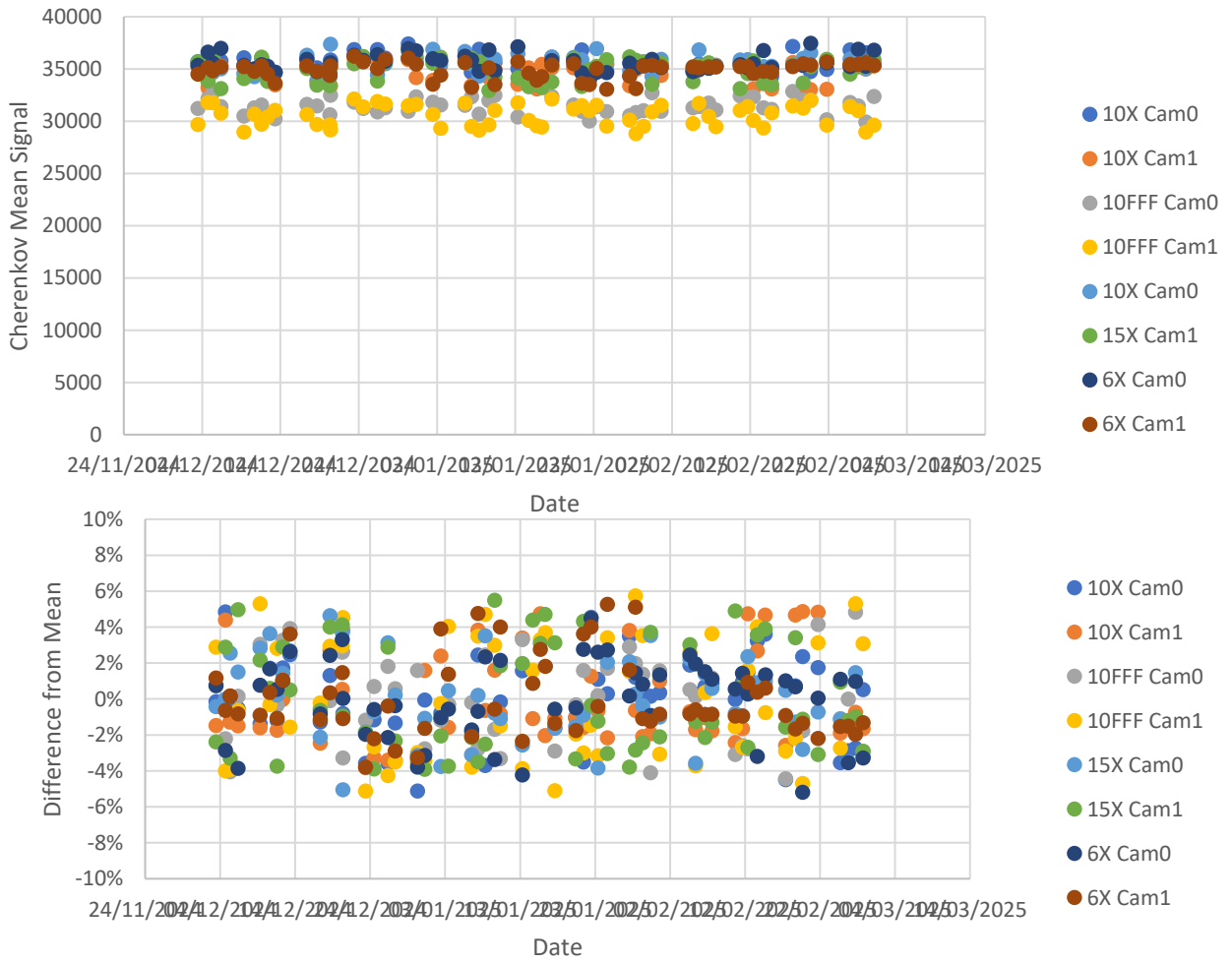



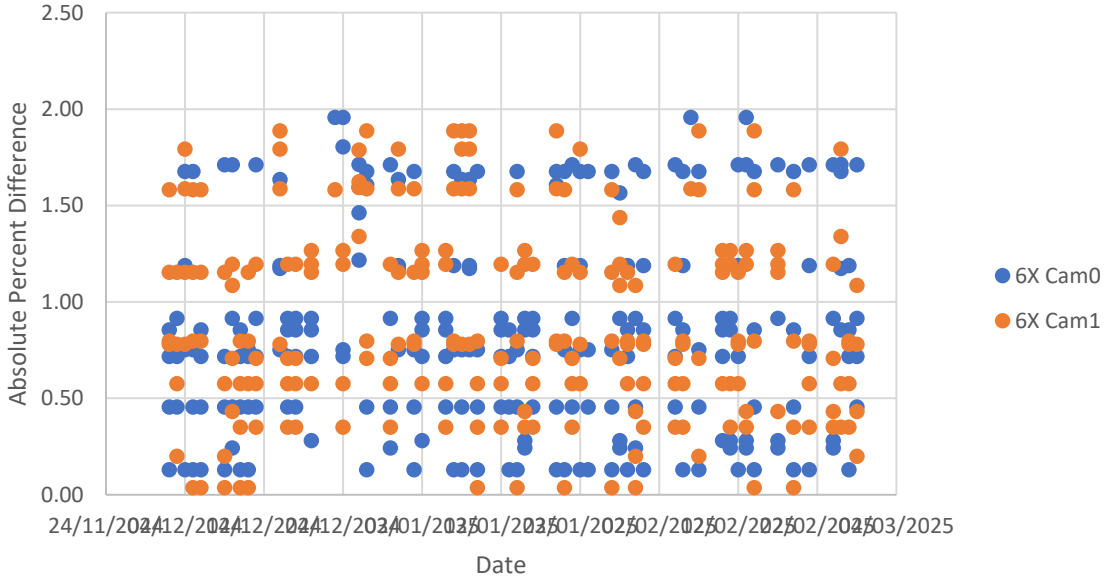



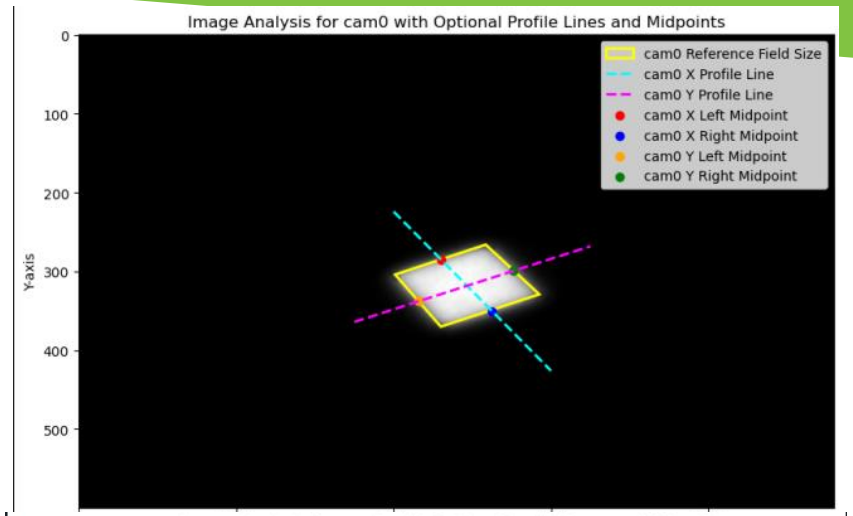
# Cherenkov Signal Linearity

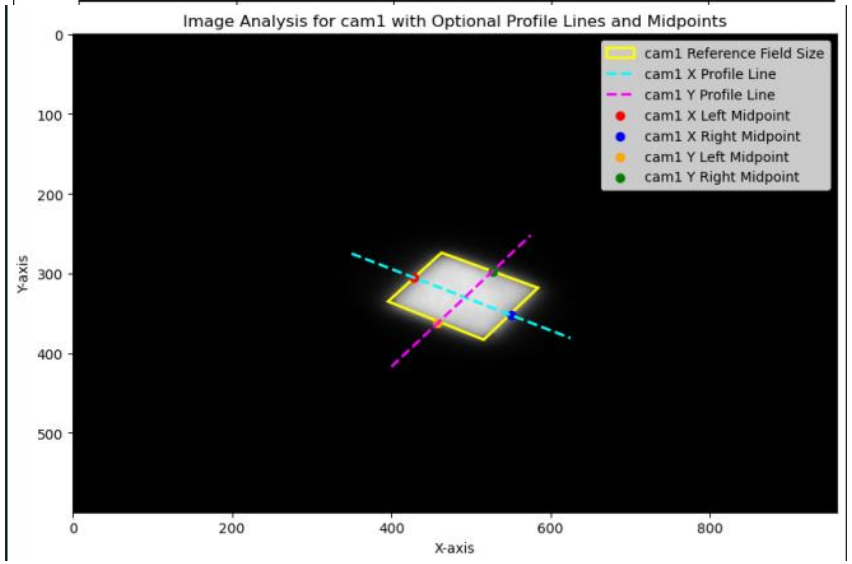
- Singal constancy check daily for 3 months.
- All photon energies (except 6FFF)
- Variation from mean does not exceed +/-6%



# Cherenkov Singal Shape Constancy

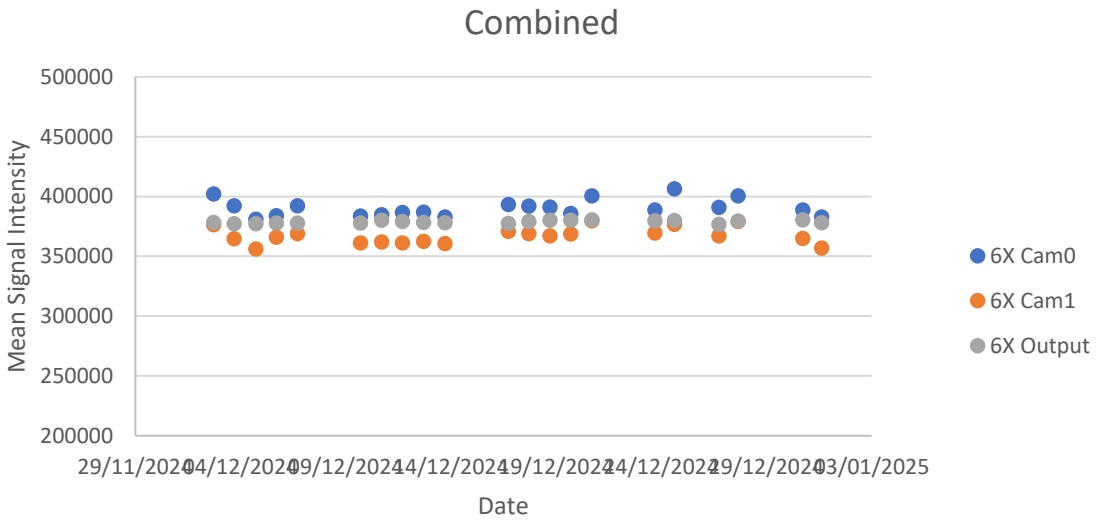


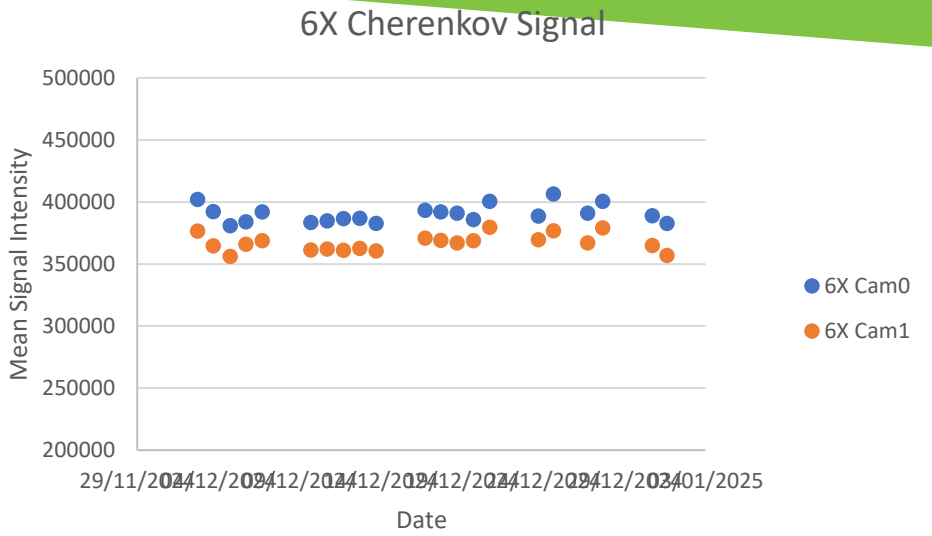



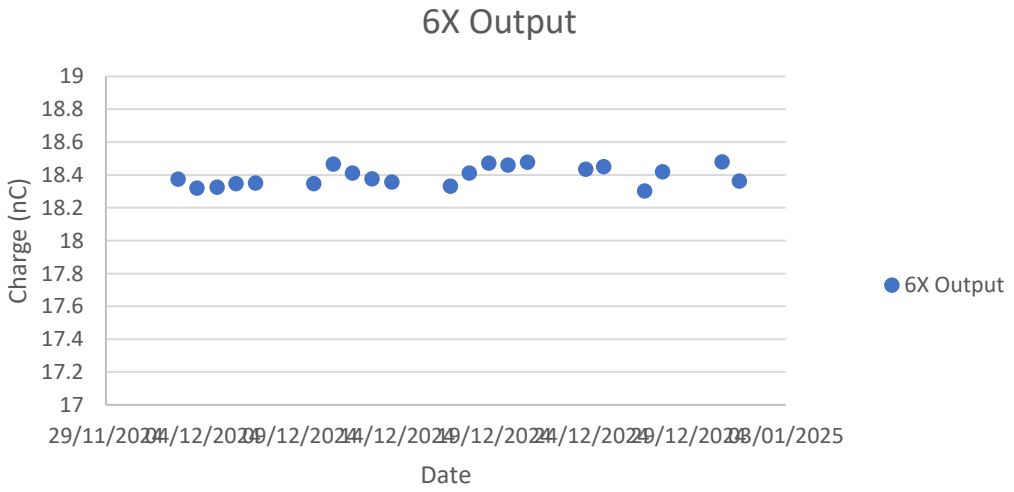




- Field size check for 3 months
- 6MV
- All measurements under 2% following TG-142.

# Cherenkov Signal vs. Output



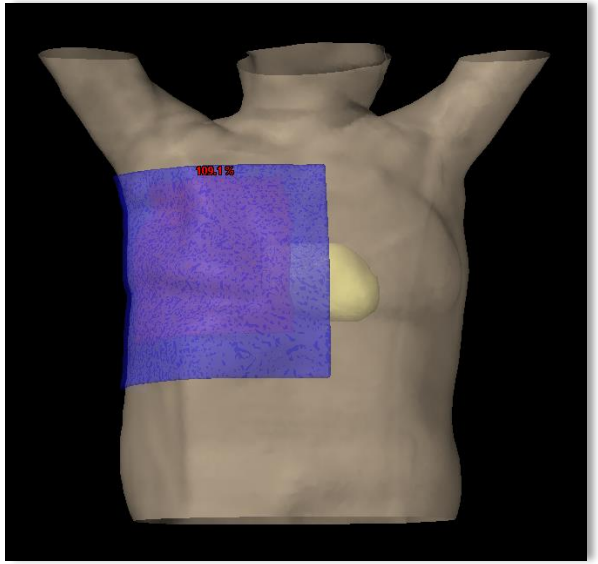



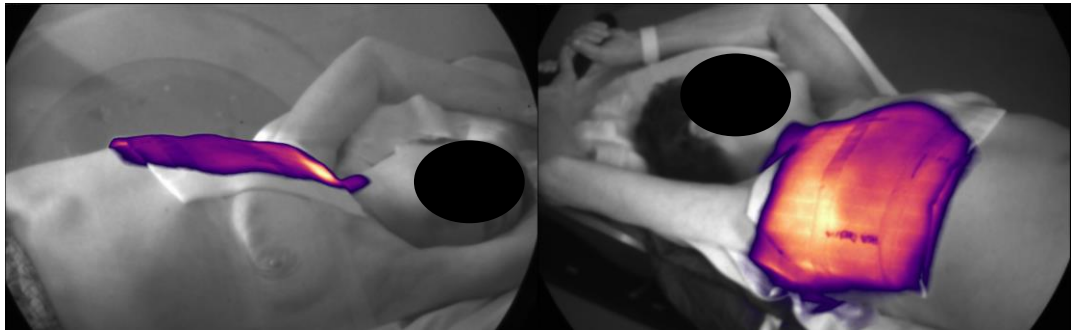

- Linac output was measured using ion chamber
- Cherenkov signal was measured at the same time
- Similarity was observed between the two

# DoseRT Workflow

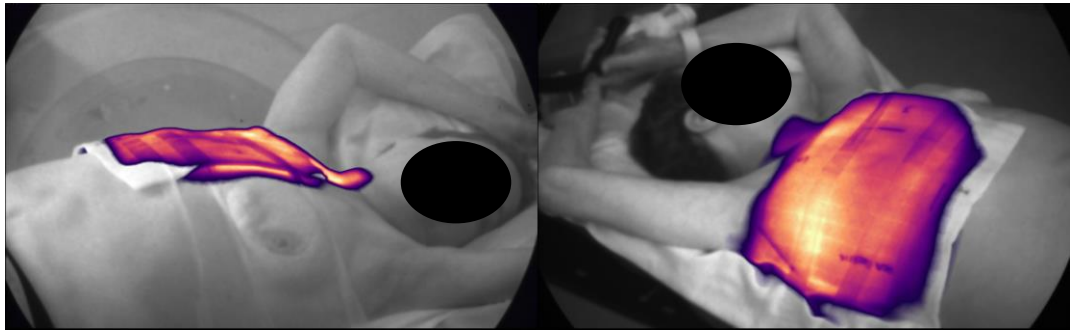
- We monitor every patient using both AlignRT and DoseRT
- If the therapists visualize something out of the ordinary, they can do one of the following:
  - Pause treatment and call physics for review
  - Finish the fraction and notify physics for offline review
- Adjustments to the plan, patient positioning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

# Case Study: Bolus Misplacement

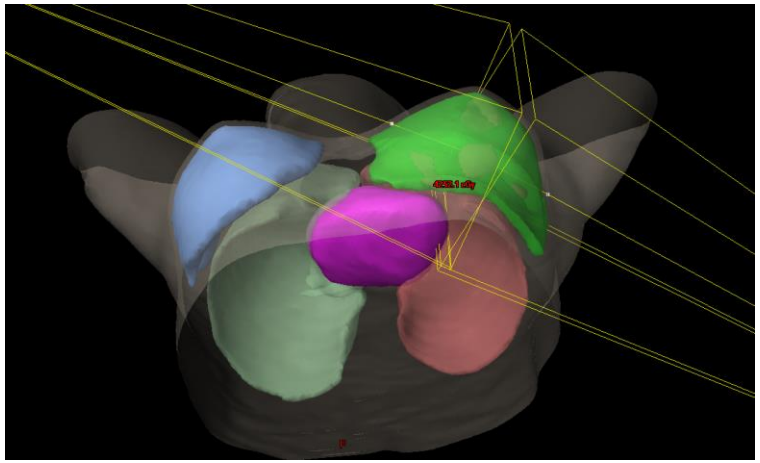


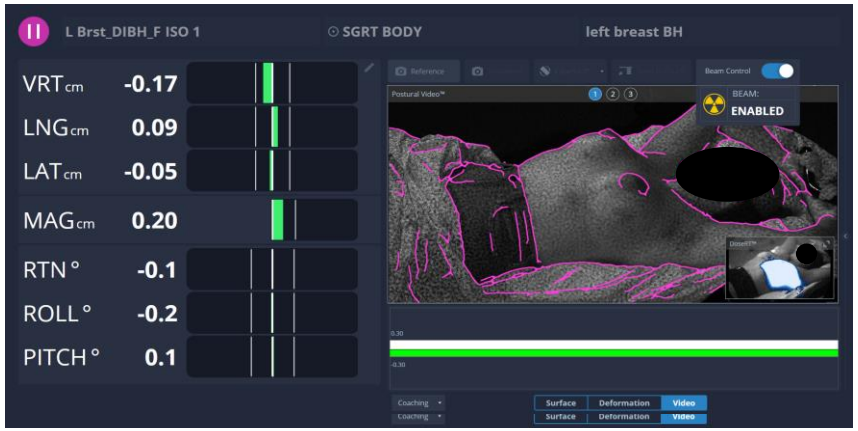


- 62-year-old female, whole right breast treatment.
- 13 with bolus, 12 fractions without.
- On fraction 8 her bolus was misplaced
- Corrected right away and closely monitored after.

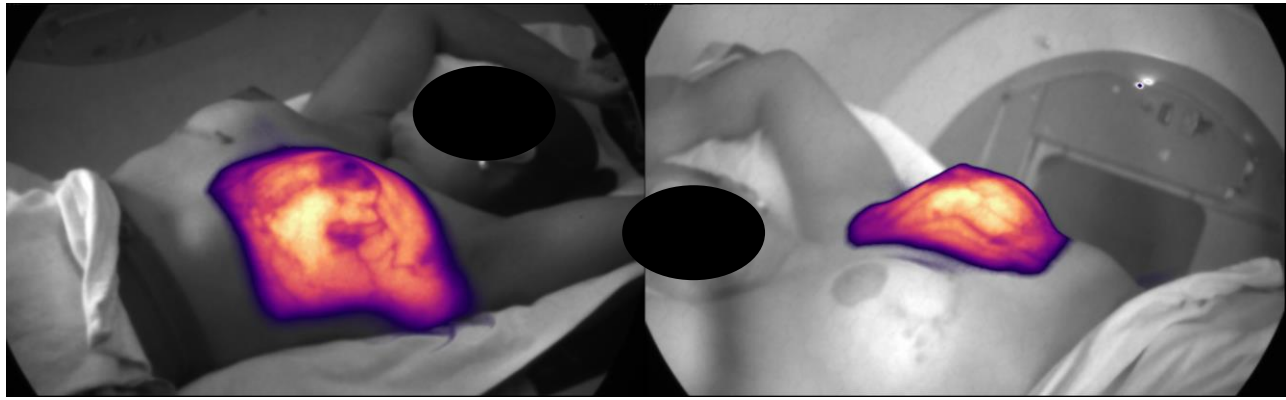


# Lt Breast with Contralateral Breast Dose

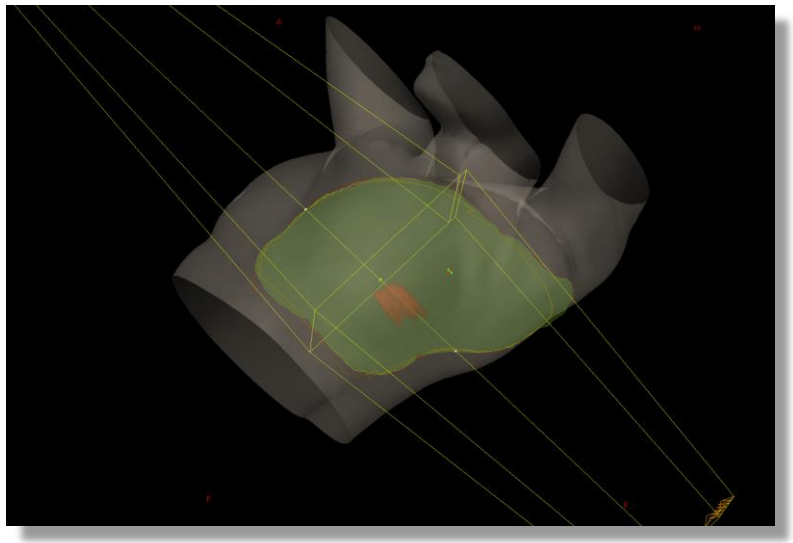


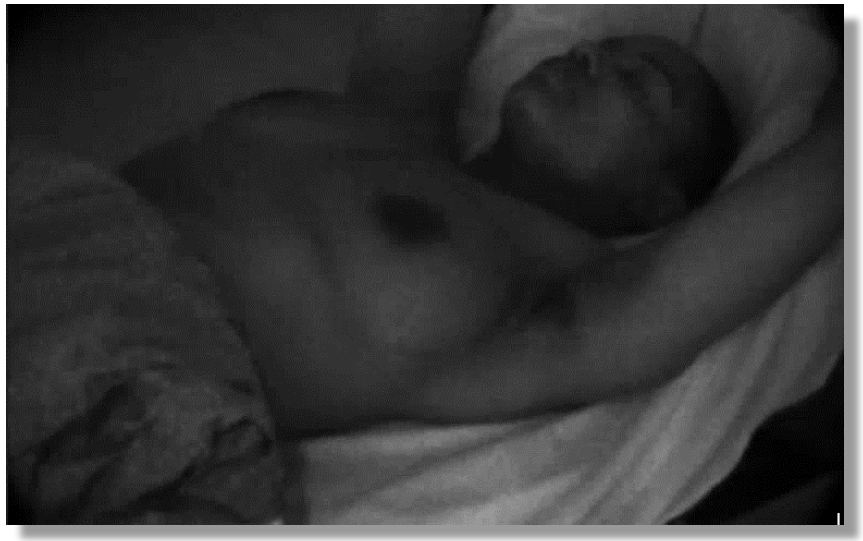


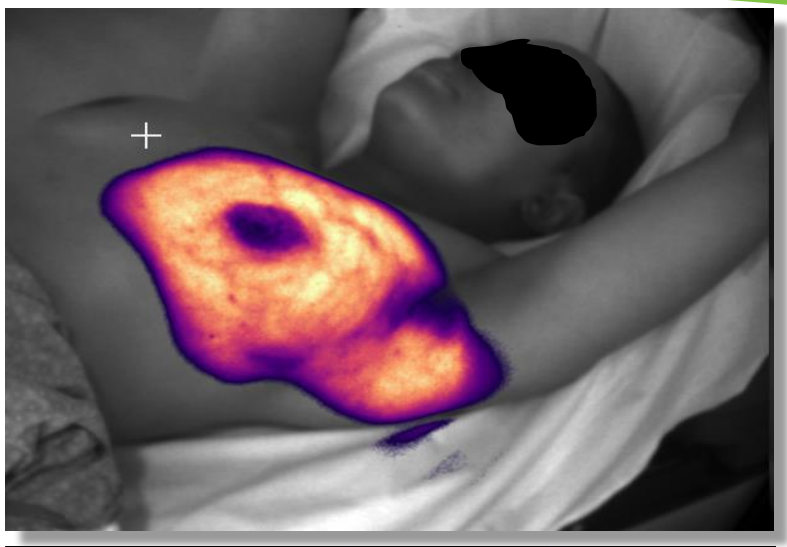

- 51 -year-old female, whole left breast treatment.
- Treated with DIBH
- On the 5th fraction, dose to the right breast was visualized
- AlignRT tolerances and positioning were adjusted
- On fraction 6, no dose to the right breast was seen,

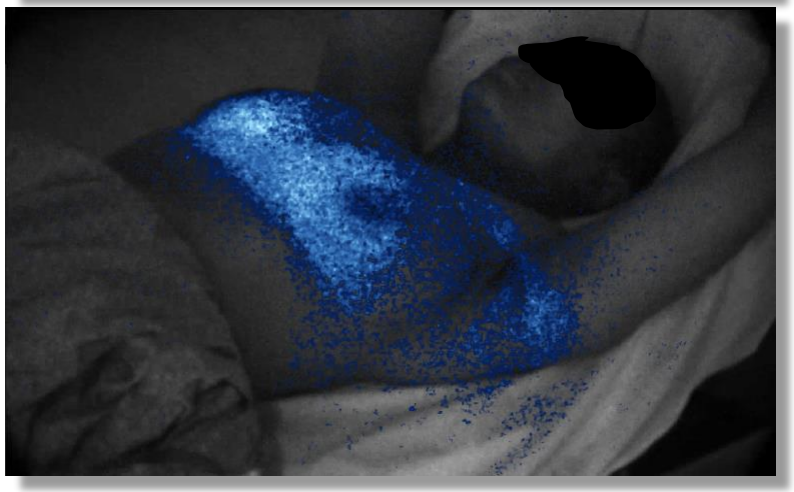


# Case Study: Improper Port Technique



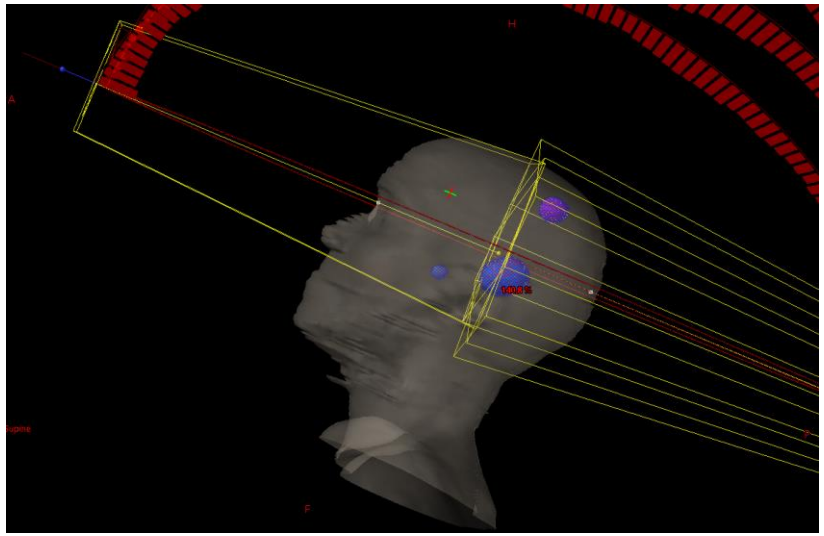


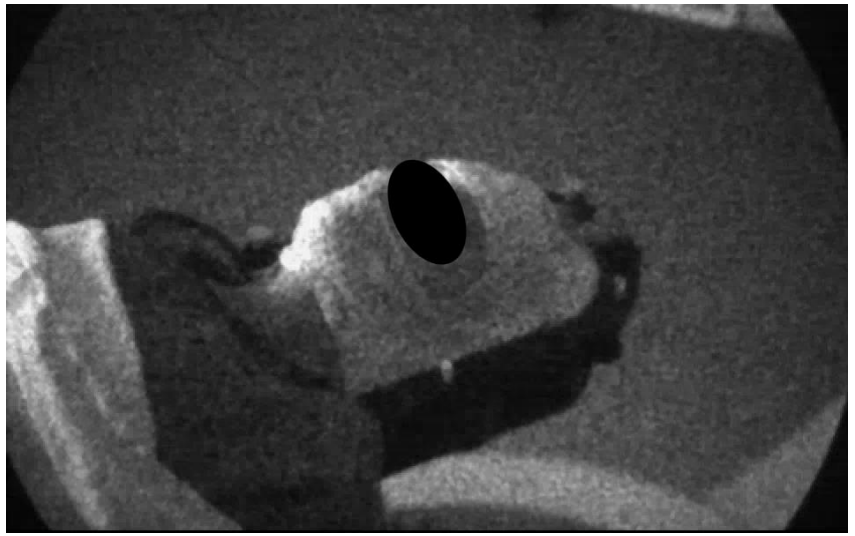




- 36 Year Old Female undergoing DIBH for left intact breast treatment
- Intended 3D surface dose rendering provided to treatment staff via the TPS
- Visual verification of treatment dose initiated from first day of treatment
- Identification of stray anomalous dose witnessed during video review of Fx1
- Incorrect port film technique found to have been assigned by staff
- Corrected for Fx2 and beyond

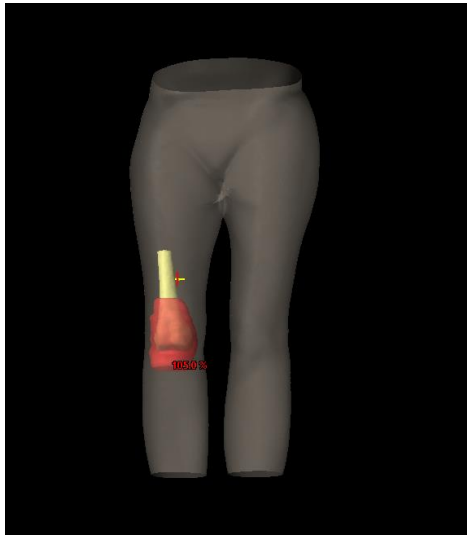
# SRS Brain

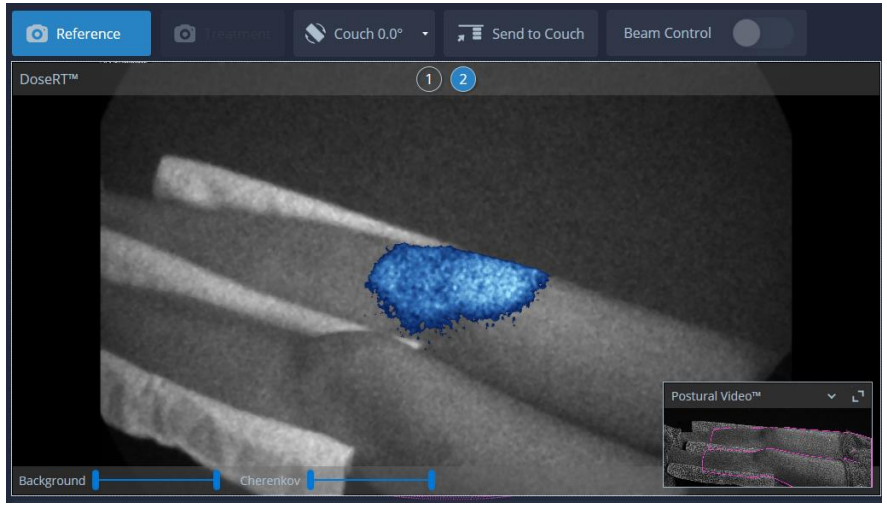


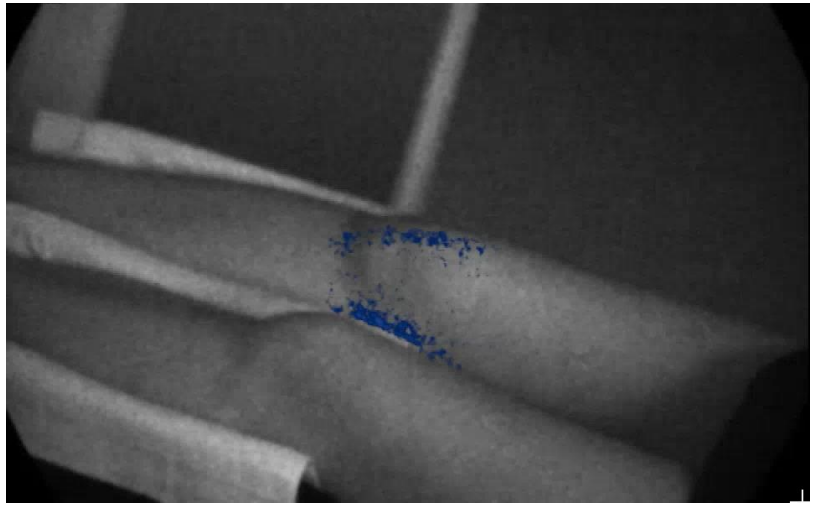


- 53 year old female with malignant neoplasm of brain.
- 9 Gy x 3 to 3 lesions.
- 4 VMAT arcs in a non coplanar treatment.

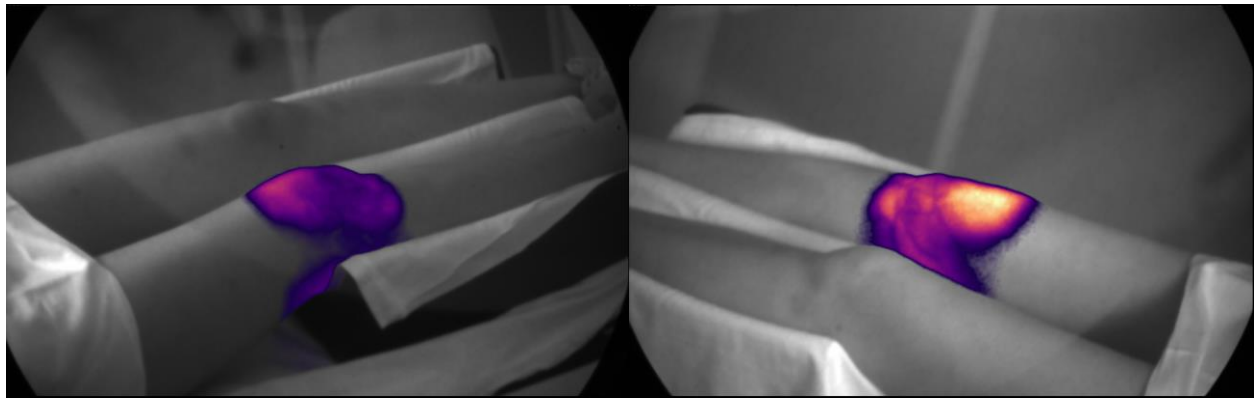
# Rt Knee





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



# Conclusion

- 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
- DoseRT provides dose visualization in real time. assists in improving the quality and safety of treatment delivery.


Thank you!
Questions?
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