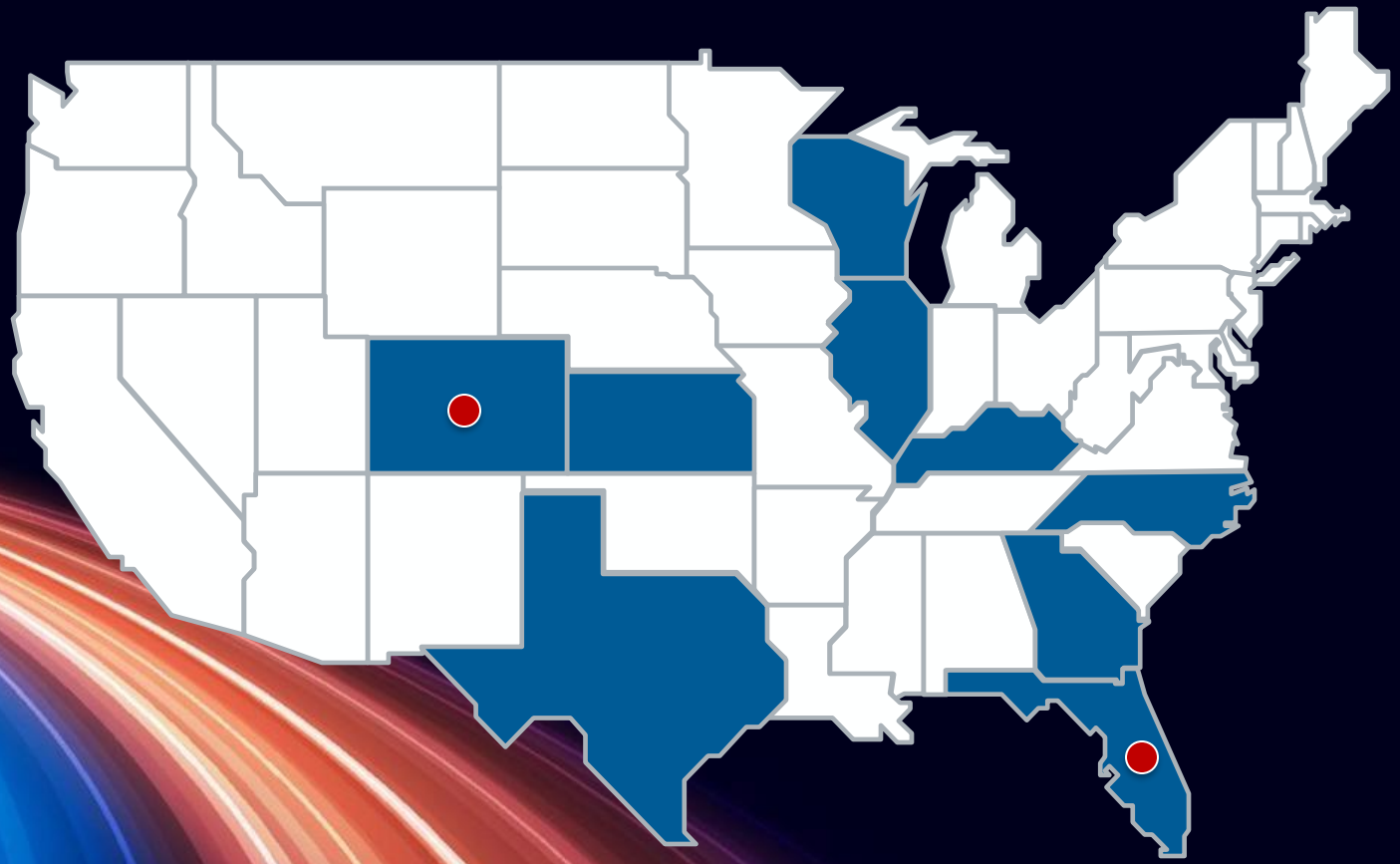
Maximizing the Value of SGRT with DoseRT

Discuss the early findings, value, and use cases for this new technology



Michael J Tallhamer MSc DABR
Chief of Radiation Physics
AdventHealth Rocky Mountain Region
Michael.Tallhamer@AdventHealth.com

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Disclosures

- AdventHealth – Parker has a PSA agreement with Vision RT.
- AdventHealth – Celebration has a COE agreement with Vision RT.
- I provide physics consultation services to the following vendors
  - Vision RT
  - Varian Medical Systems

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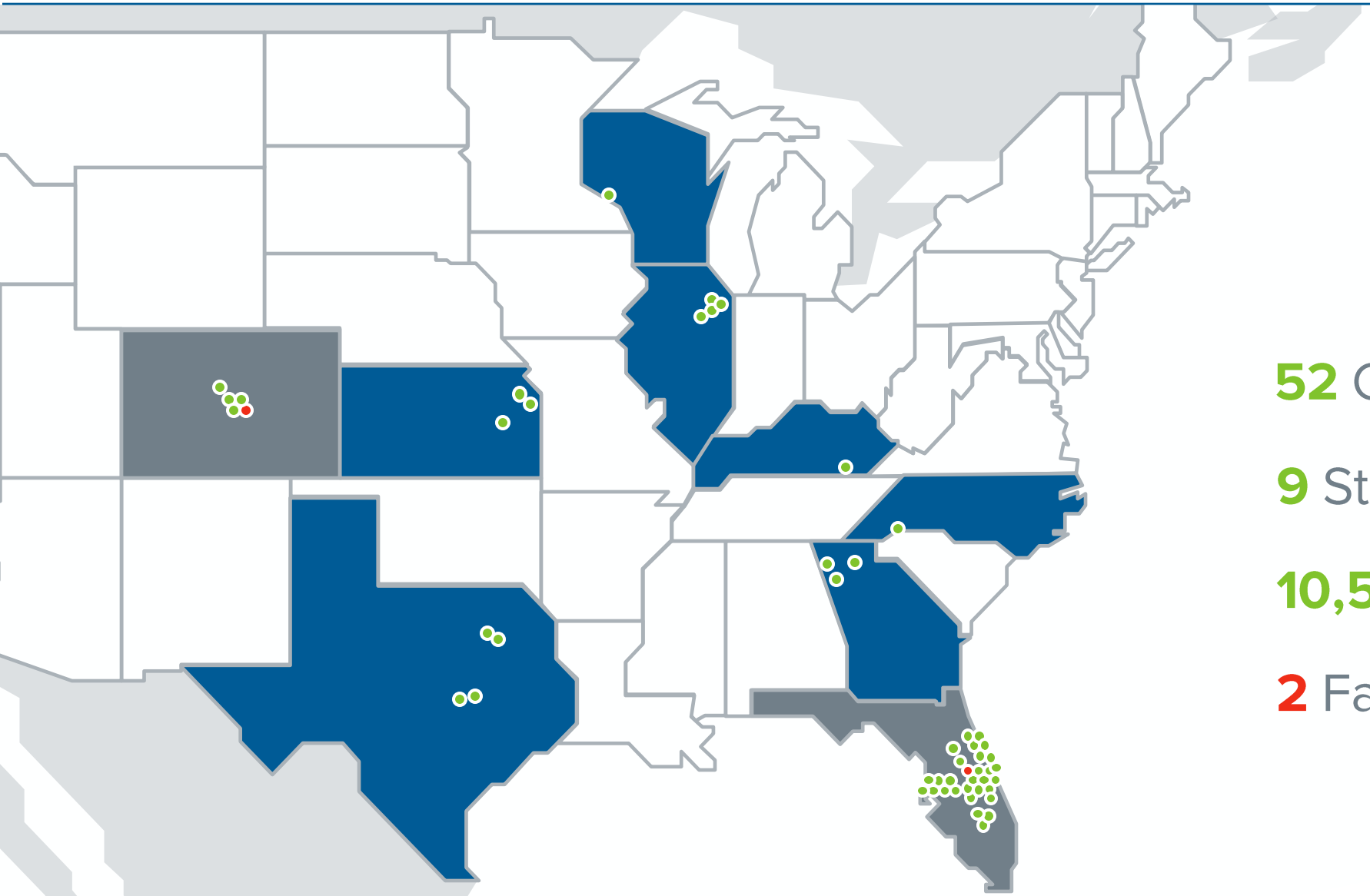
AdventHealth Hospitals



52 Campuses

9 States

10,500+ Licensed Beds

2 Facilities with DoseRT

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Umwelt

An organism's umwelt is its unique sensory world, which is dependent on what it can detect and interpret.

* Coined by German biologist Jakob von Uexküll (1864-1944).

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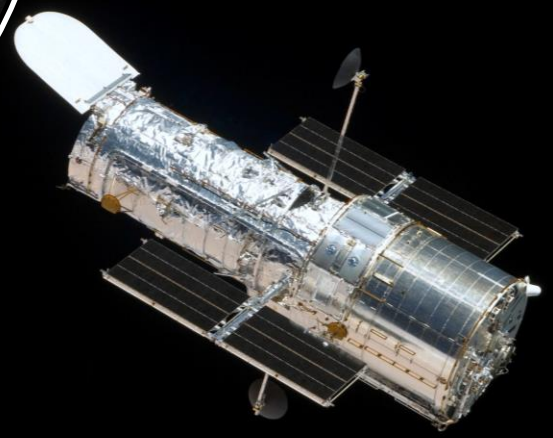
Expanding our SGRT Umwelt

Hubble Deep Field Experiment

September 24, 2003 - January 16, 2004 & August / September 2009

What in the world does this have to do SGRT?



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Goals

- Share examples of use cases for Cherenkov Imaging in a clinical setting focussing on the current software functionality.
  - Quality and Safety Applications.
  - Unexpected or Stray Dose Visualization
  - Plan Robustness Evaluation
- Illustrate the utility of Cherenkov Imaging in recomending and/or making clinical changes to a plan.
- Discuss the difference between data and insight and look at some of the challenges in interpreting the data provided by a new imaging system like this.

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Quality and Safety

Current Strengths of Cherenkov Imaging with DoseRT

Clinical case reports from the Cherenkov Consortium illustrating current utilization patterns

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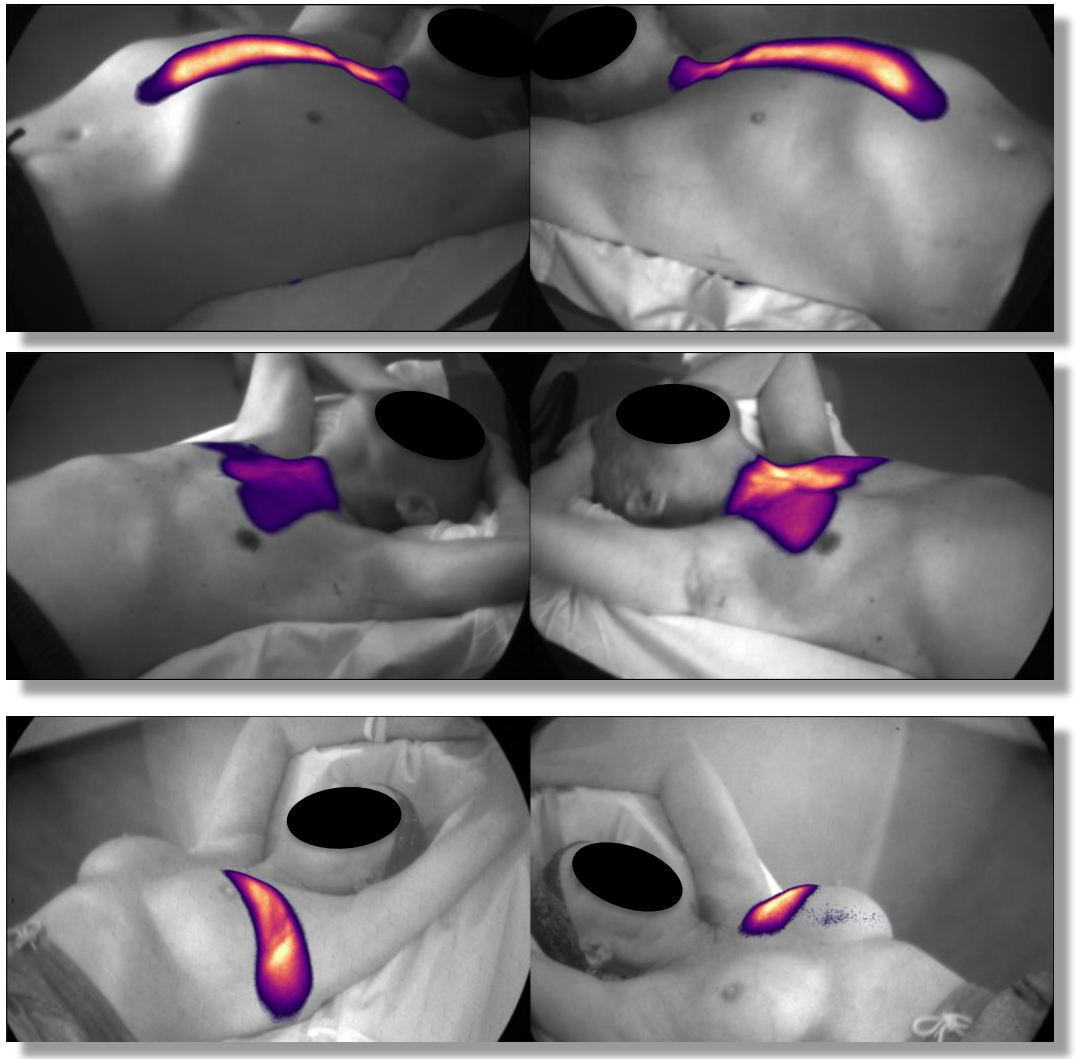
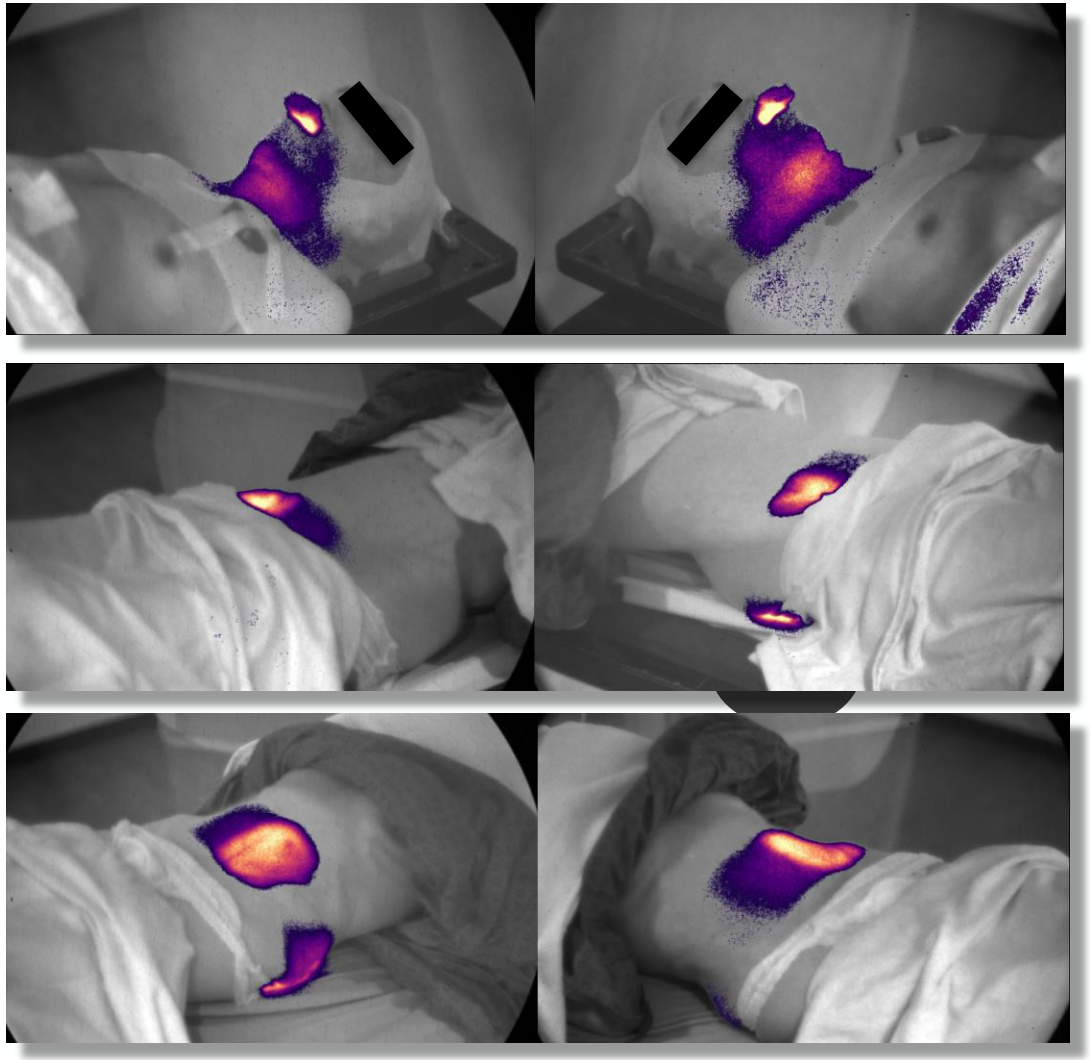
Basic Value Proposition: We Can See The Dose Delivery!

How cool is that!!





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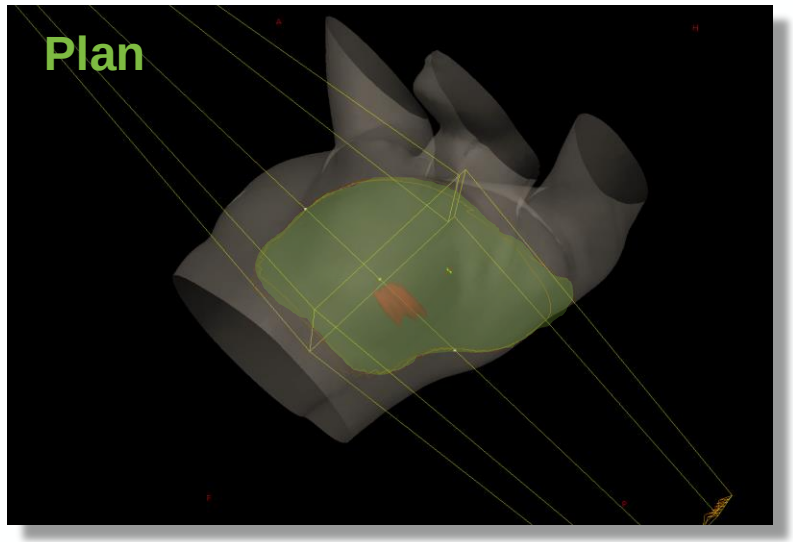
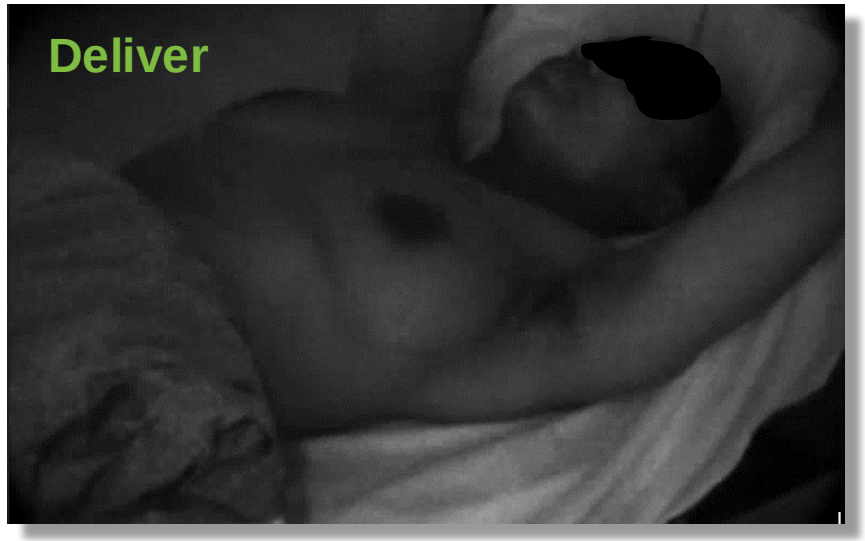
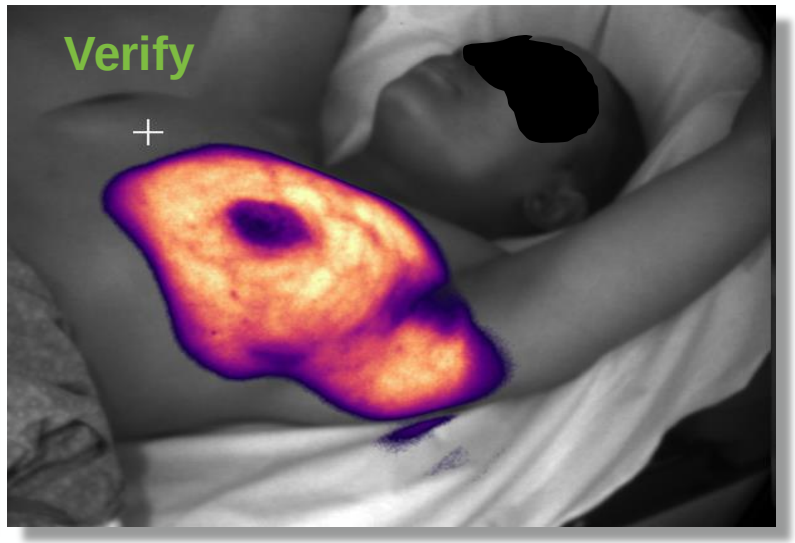
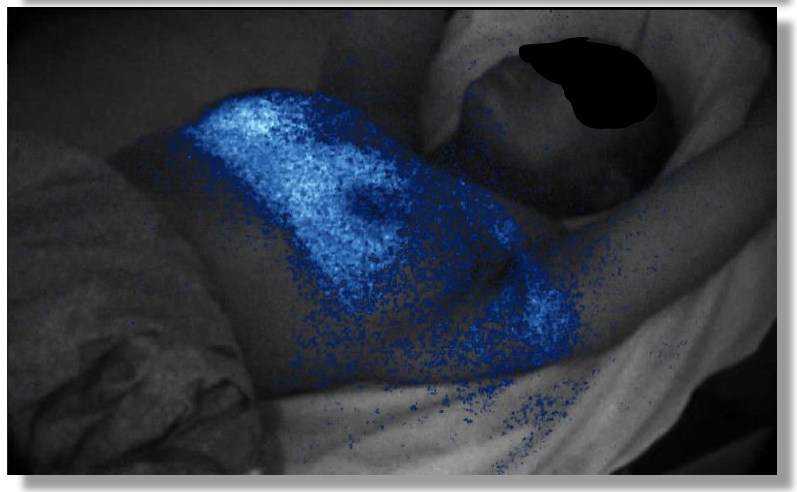
CASE STUDY: Inadequacy of Administrative Controls

Improper Portal Imaging Technique (**Human Error** and **Varian v4.1 Upgrade Errors**)…









- 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
- **Most common error due to manual process**
- **Error found in TrueBeam 4.1 in MV port settings manifesting in the same way**

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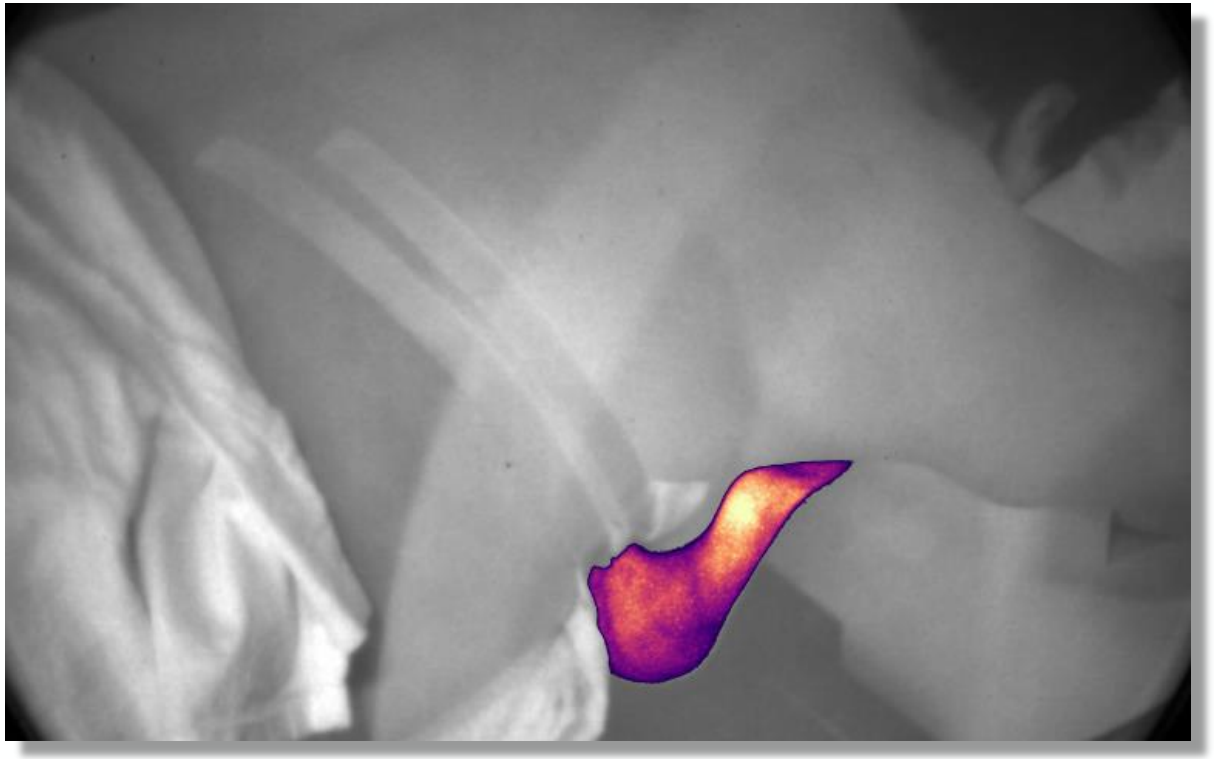
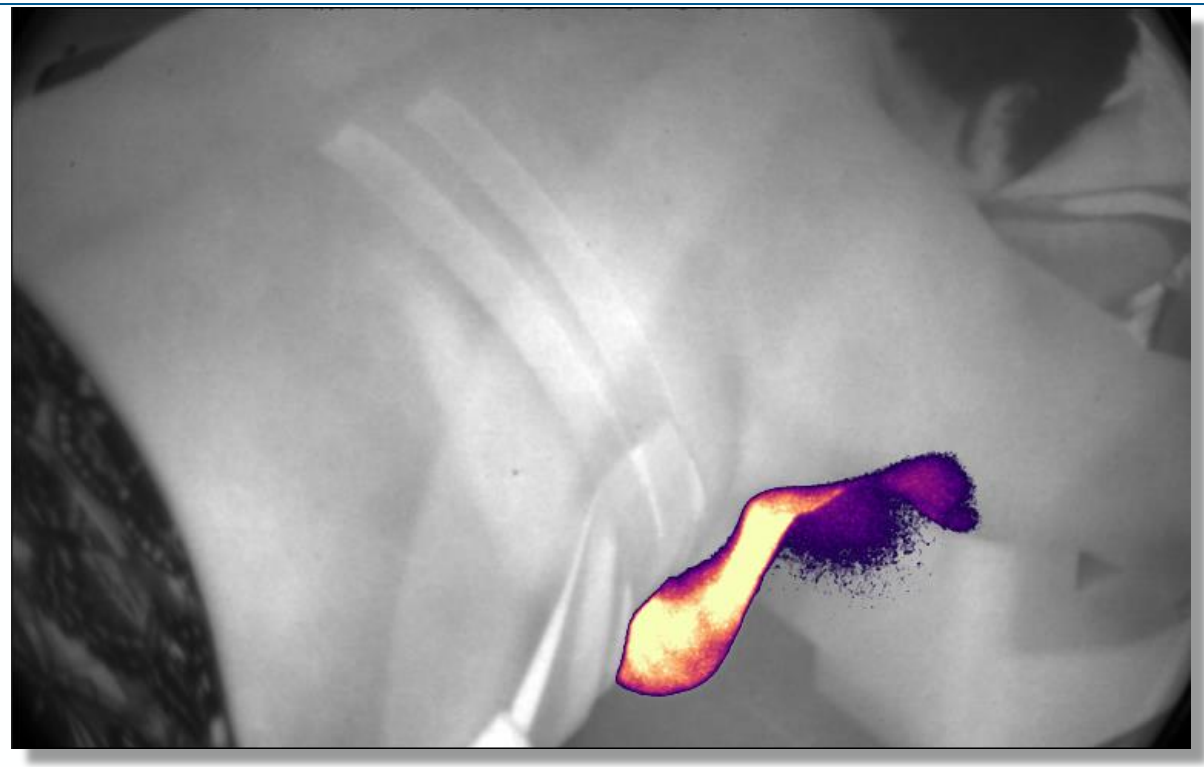
CASE STUDY: Identifying the Impact of Daily Positional Variance

Identify interfraction changes in both patient position and immobilization…





- 67 Year Old Female undergoing 3DCRT for Prone Breast
- Visual verification of treatment dose initiated from fraction 1 of treatment
- Fraction 3 - Exit dose through arm noted by physics team during daily review
  - Investigation showed prone pad indexing places slightly inferior resulting in wrong elbow position
  - Decreased arm extension resulted in beam exiting through upper arm.

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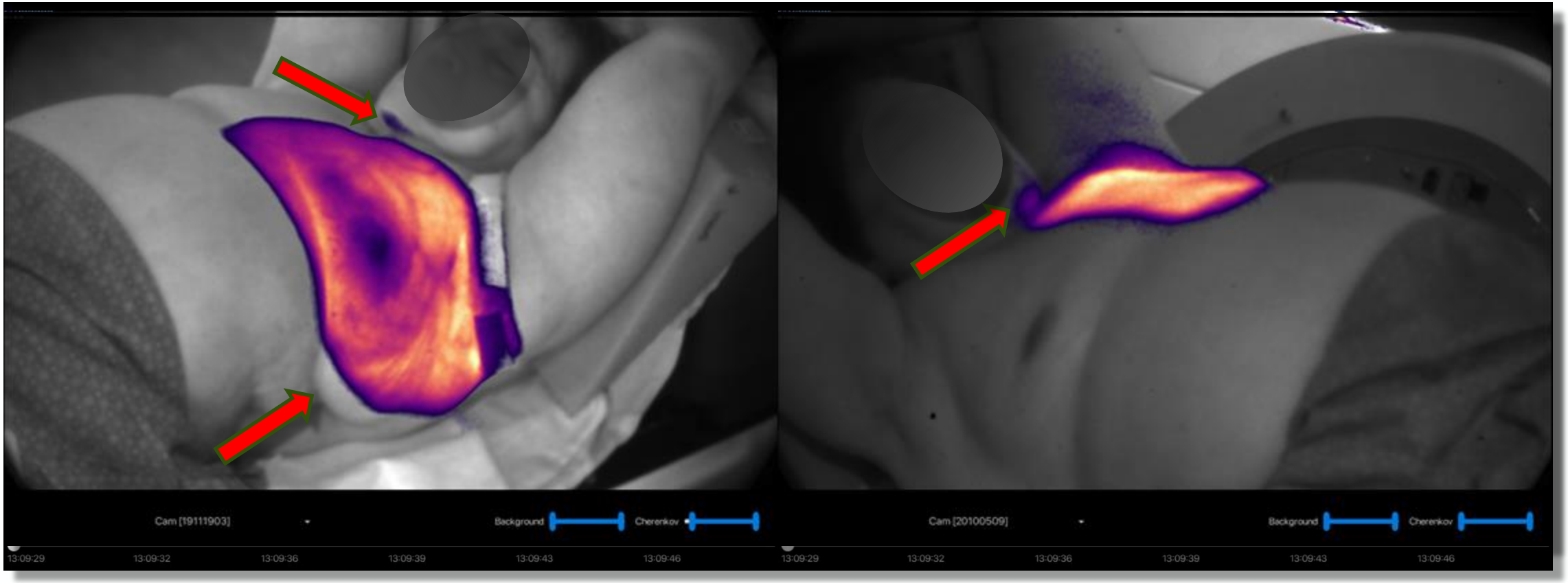
CASE STUDY: Impact of Daily Patient Compliance

* Sub-Optimal Treatment Delivery and Rapid Response to Identified Problems…



- 68 Year Old Female, Challenging body habitus
- Patient was noted as being very combative and non-compliant with simulation instructions (no DIBH)
- Patient refused to raise chin during Fx 1 resulting exposure to chin
- Fx 1 it was also noted during review that it looked like the plan had clipped some of the breast tissue

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Stray Dose Visualization

Current Strengths of Cherenkov Imaging with DoseRT

Clinical case reports from the Cherenkov Consortium illustrating current utilization patterns

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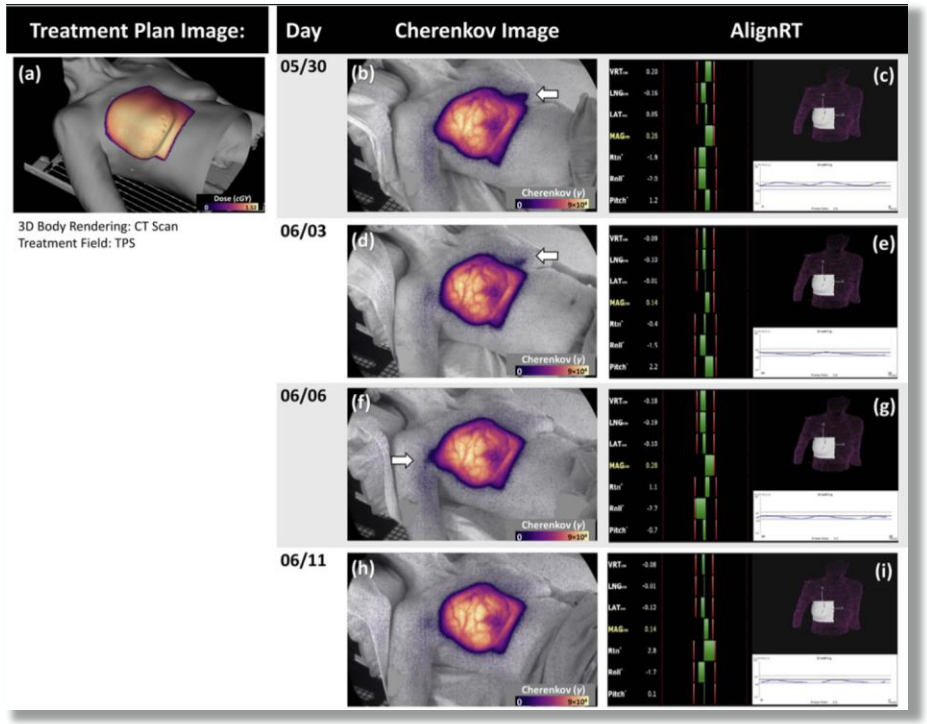
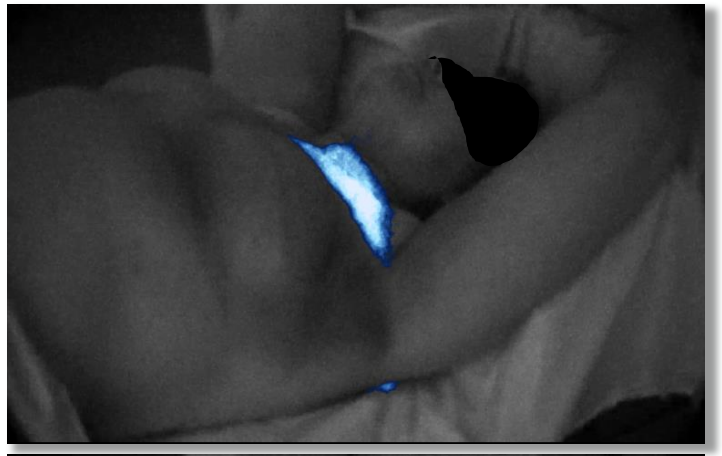
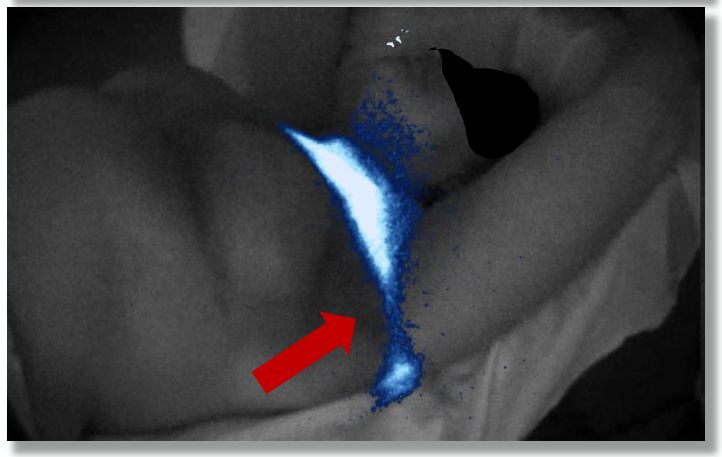
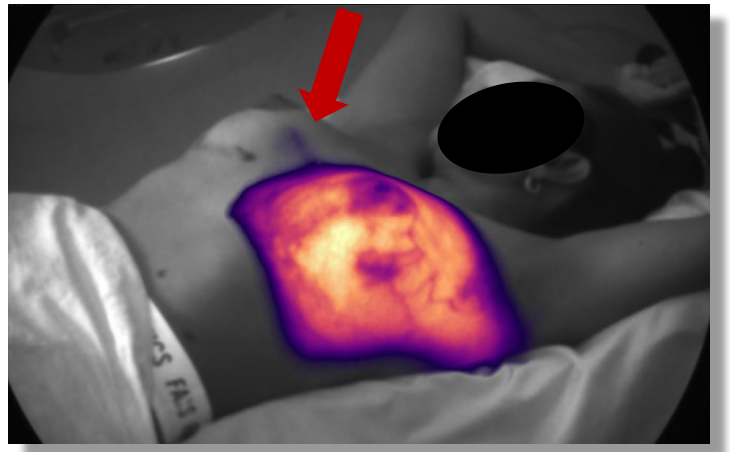
CASE STUDY: SGRT Tolerance Adequacy and Planning Technique

* Sub-Optimal Treatment Delivery and Rapid Detection / Correction…









Jarvis LA et al. Initial Clinical Experience of Cherenkov Imaging in External Beam Radiation Therapy Identifies Opportunities to Improve reatment Delivery. Int J Radiation Oncol Biol Phys. 2021 Apr 1;109(5):1627-1637

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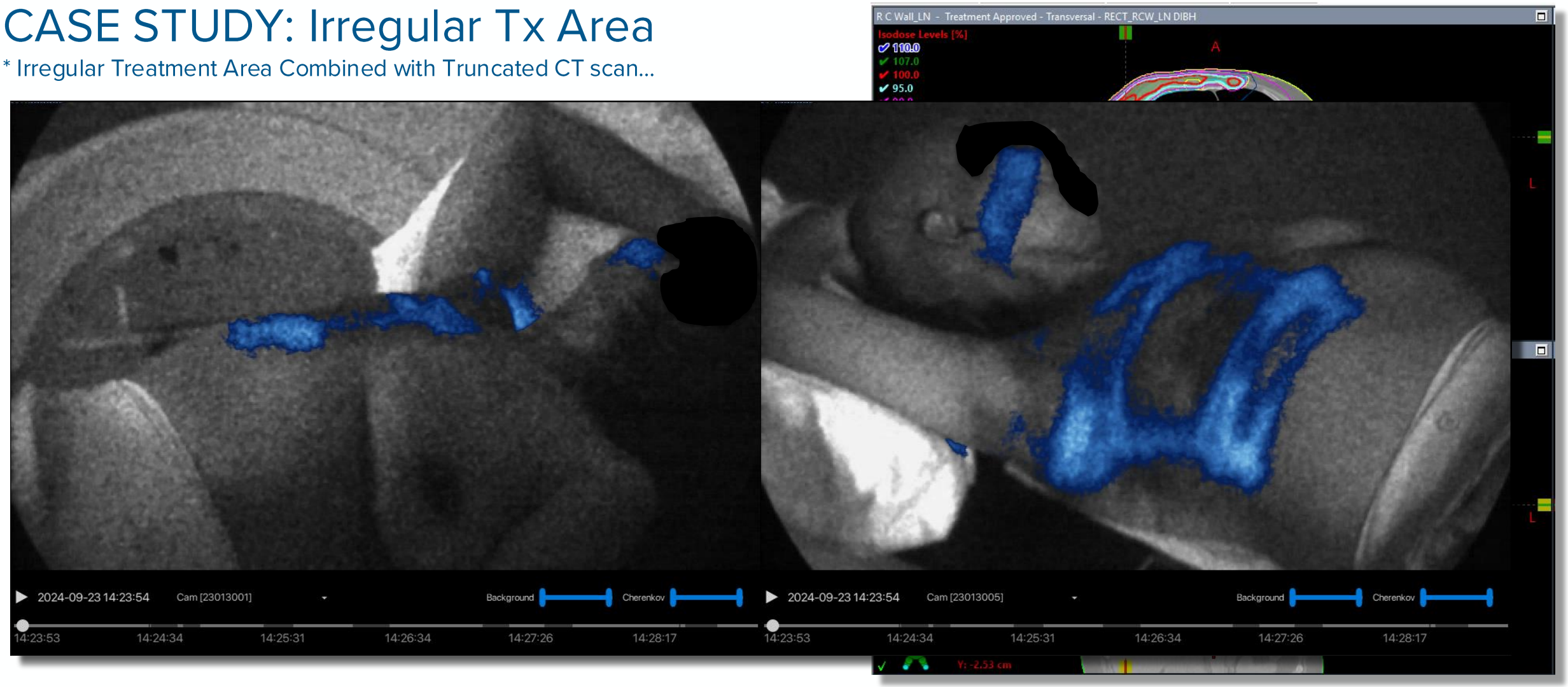
CASE STUDY: Irregular Tx Area

* Irregular Treatment Area Combined with Truncated CT scan…



- 73 year old woman with malignant neoplasm of overlapping sites of the right breast
- Treatment to the right chest wall, lymph nodes and extending up the right arm with one arm up and one arm down
- Standard scanning protocol stopped after chin in superior direction
- Fx 1 exit dose on face from high axillary nodes was noted (not in plan due to truncated scan)

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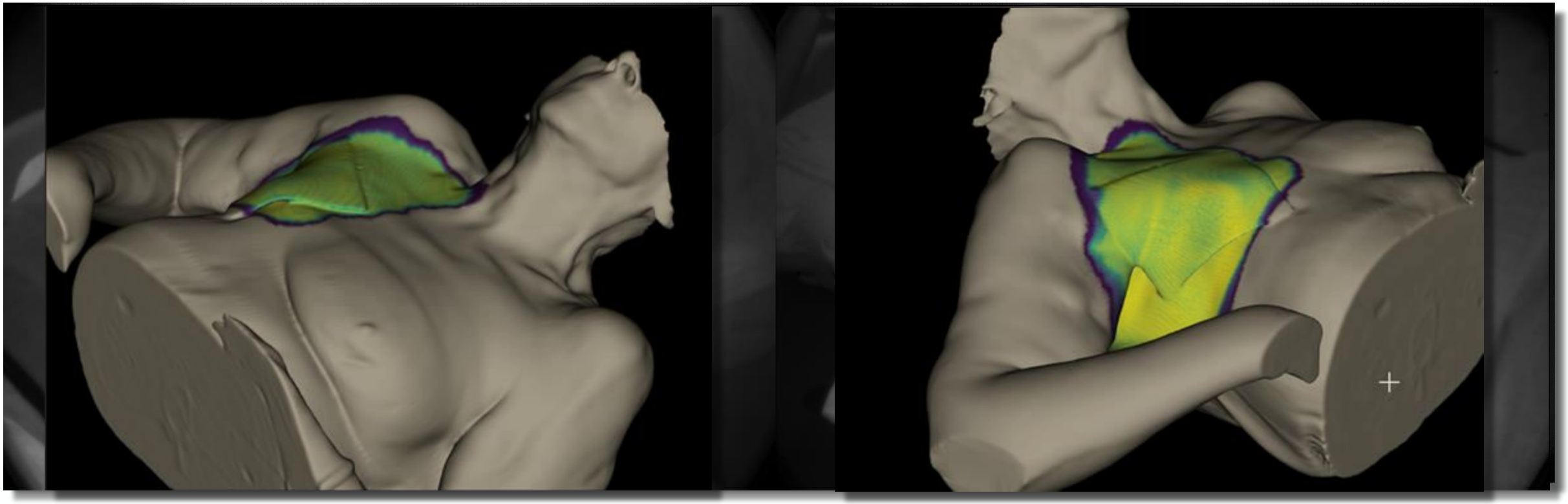
CASE STUDY: Confirmation of Ipsilateral Limb Sparing

See dose where you want it and not where you don't…



- 99 Year Old Female undergoing IMRT treatment for fungating mass in left intact breast / axilla
- Challenges from simulation
  - Partial bolus coverage of mass and involved skin margin
  - Bubble wrap spacer to address skin fold due to inability to raise ipsilateral arm
- Visual verification of treatment dose initiated from fraction 1 of treatment

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Plan Robustness

Current Strengths of Cherenkov Imaging with DoseRT

Clinical case reports from the Cherenkov Consortium illustrating current utilization patterns

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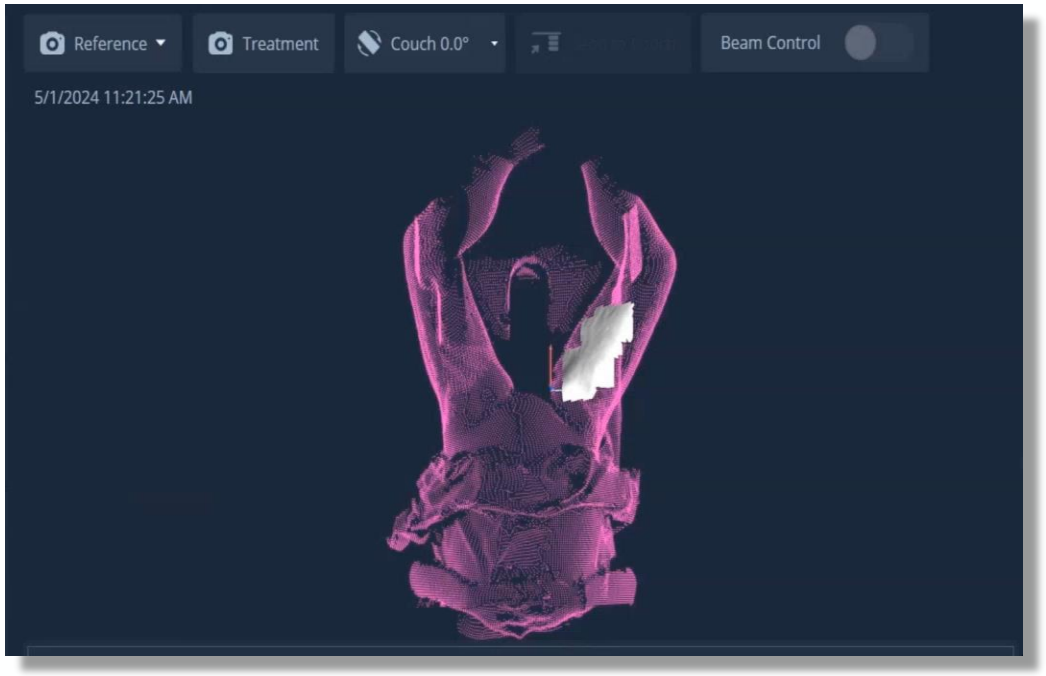
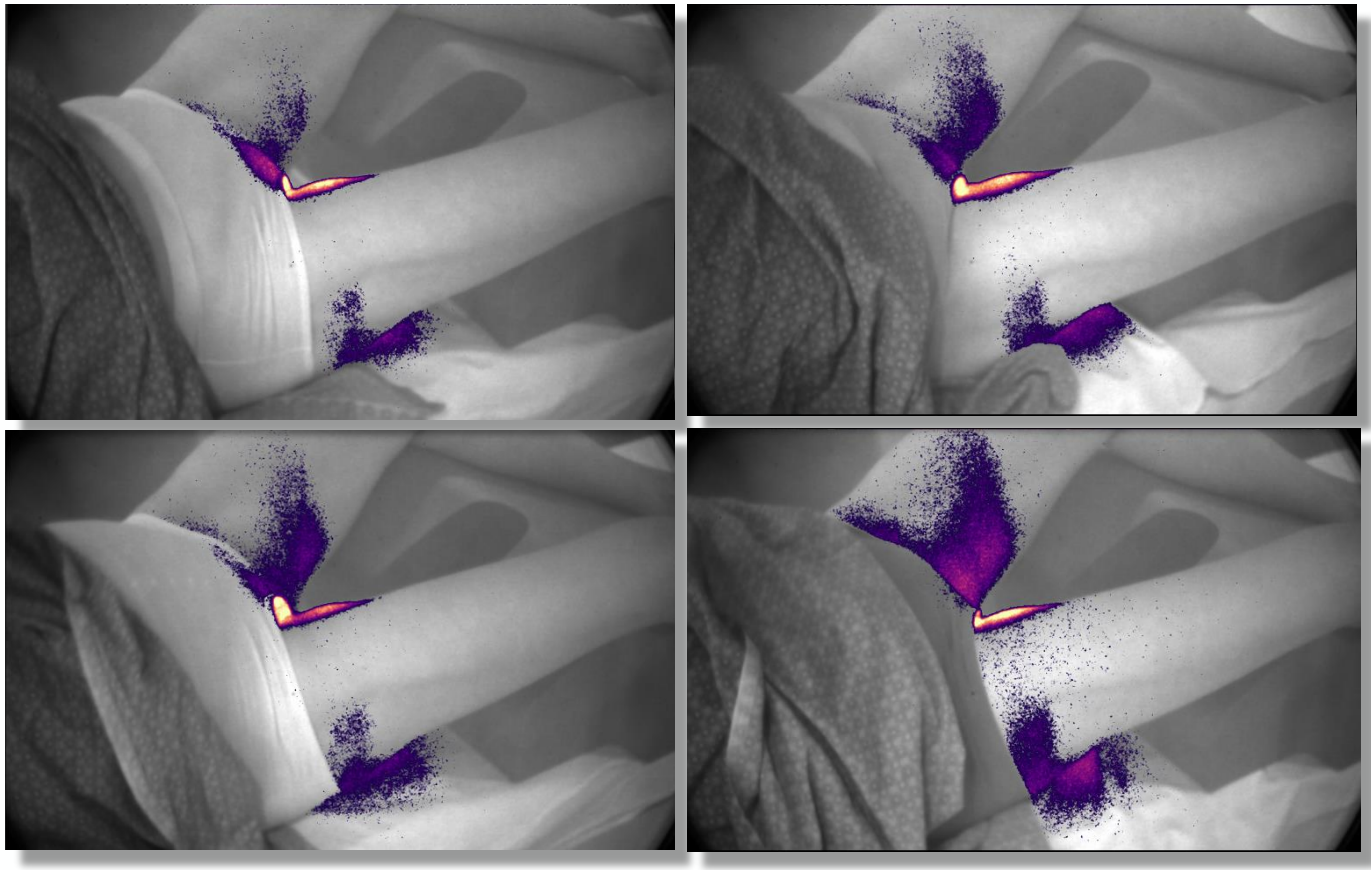
CASE STUDY: Contralateral Limb Sparing

Importance of Postural Video Setups in addressing complexity of planning techniques…

With heavy use of VMAT for delivery the use of avoidance sectors during optimization has become common place

DoseRT allows for confirmation during delivery of proper use and parameterization of planning techniques like **avoidance sectors** for VMAT





4 Fractions with contralateral leg dose noted

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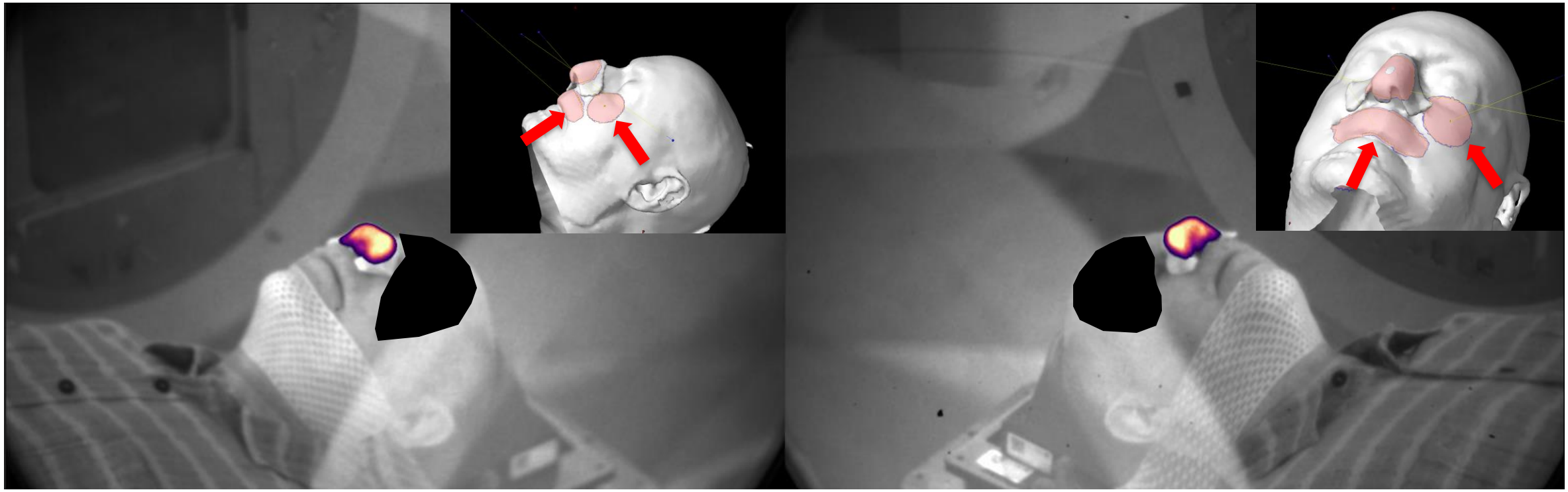
CASE STUDY: Avoiding Previously Treated Areas

See dose where you want it and not where you don't…



- 54 Year Old Male undergoing 3DCRT with small fields after previous radiation to surrounding area
- Challenges from simulation
  - Custom bolus coverage of mass and involved skin margin
  - Previous irradiation of upper lip and right cheek – desire to avoid overlap with previous areas of treatment and other sensitive structures
- Visual verification of treatment dose initiated from fraction 1 of treatment

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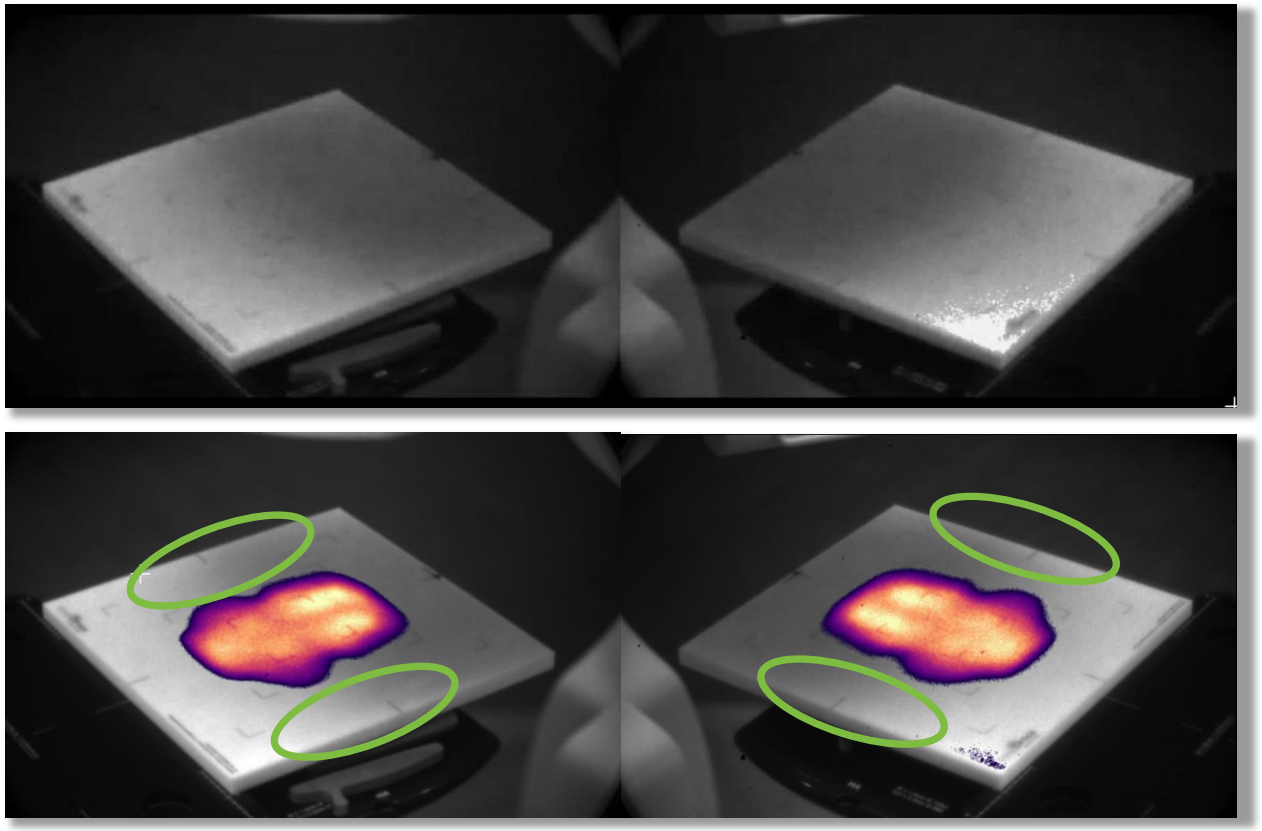
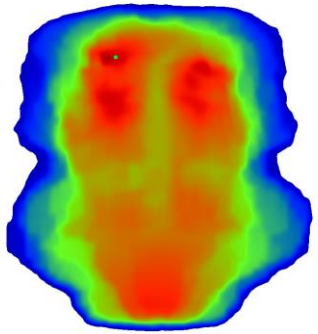
CASE STUDY: Plan Quality Assurance at All Stages

High modulation factor verification prior to treatment delivery and verification of desired avoidance sectors during treatment delivery…



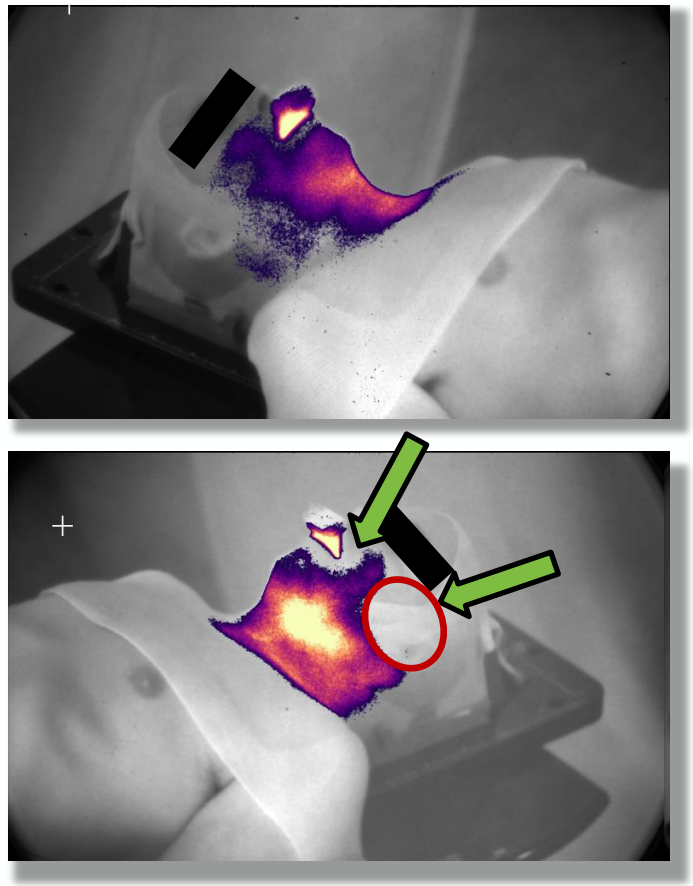
Visual Verification of Suspected Over Modulation of Plan

(Check can be performed in QA mode prior to plan finalization)



Perform Standard QA

(Pre Tx Verification)



Treatment Delivery

Confirmation during delivery of planning techniques like avoidance sectors for VMAT

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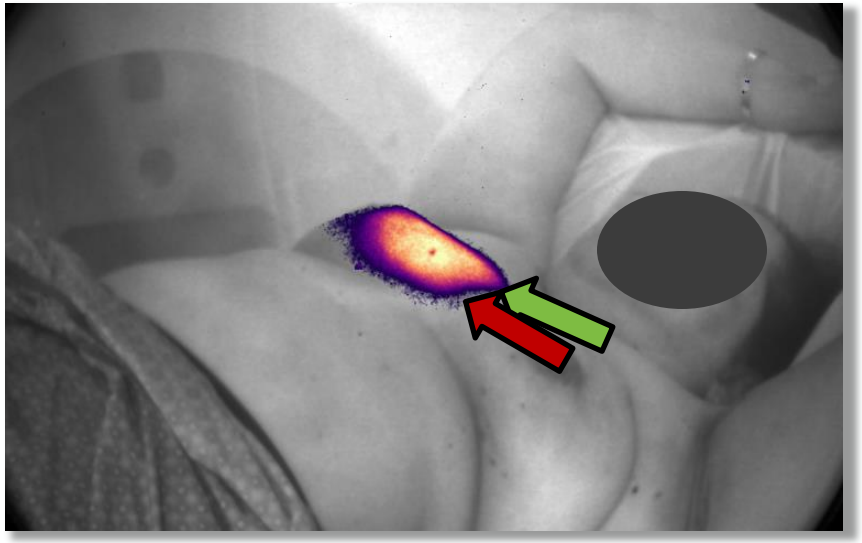
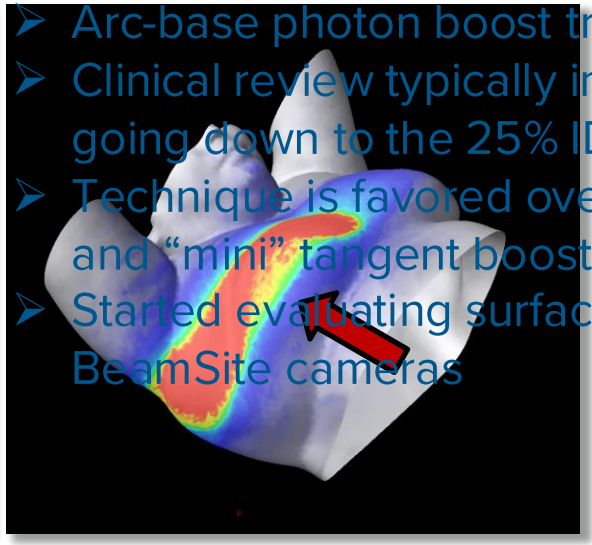
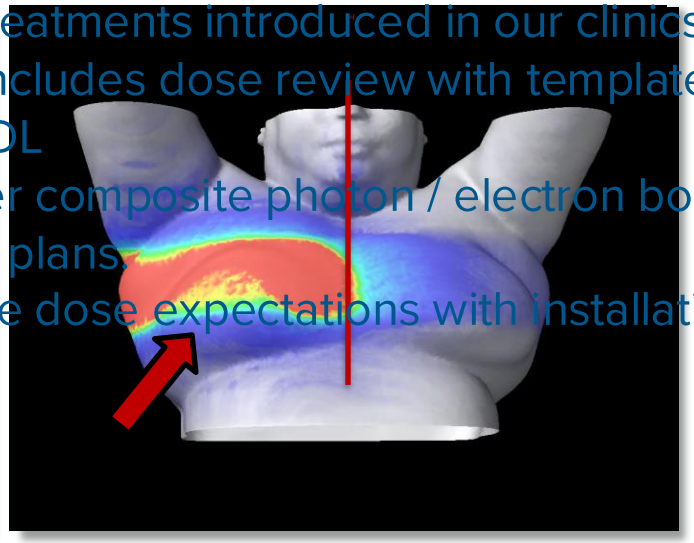
CASE STUDY: New Discoveries in Plan Evaluation Methods

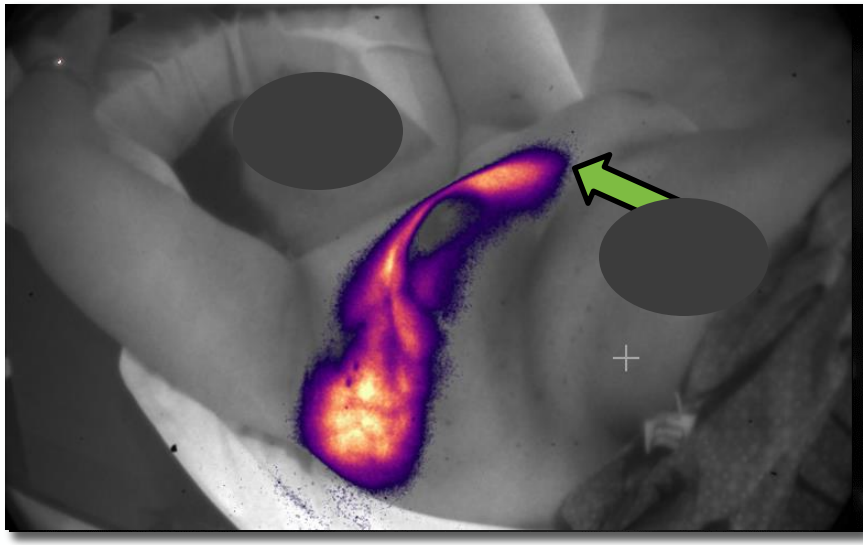
New Plan Evaluation Methods Highlight Missing Information: Seeing What They Don't Show You…

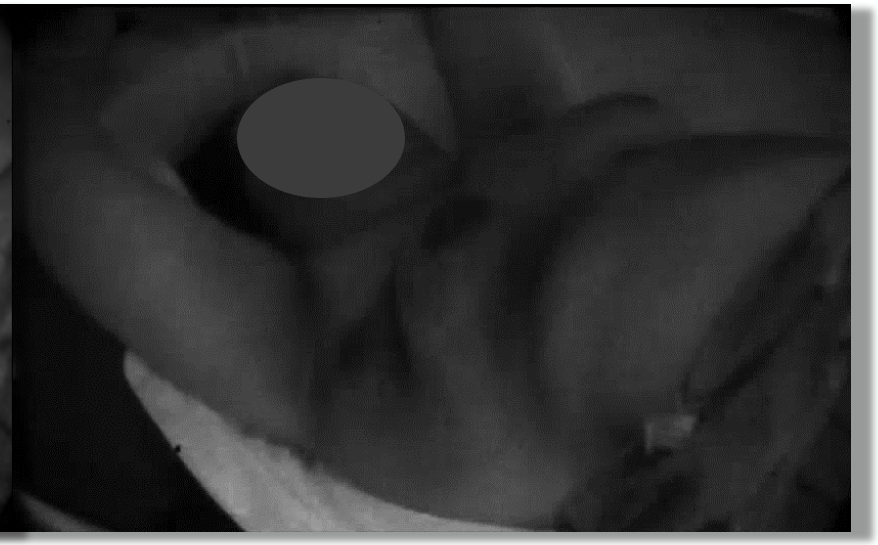


- Arc-base photon boost treatments introduced in our clinics
- Clinical review typically includes dose review with template going down to the 25% IDL
- Technique is favored over composite photon / electron boosts and "mini" tangent boost plans.
- Started evaluating surface dose expectations with installation of BeamSite cameras









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Data Interpretation

Current Strengths of Cherenkov Imaging with DoseRT

Clinical case reports from the Cherenkov Consortium illustrating current utilization patterns

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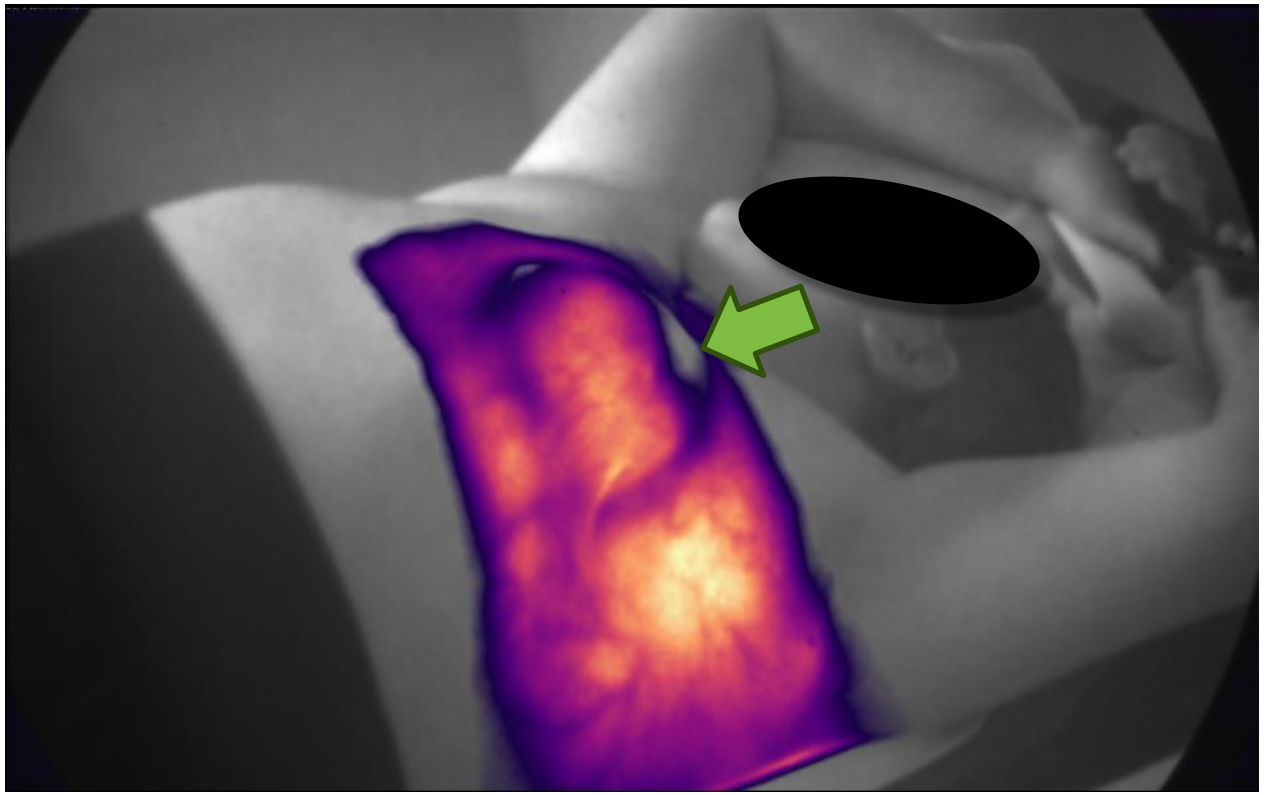
CASE STUDY: Challenges in Interpretation

Importance of interinstitutional collaboration when implementing new technology

- 45 Year Old Female undergoing VMAT DIBH breast treatment for malignant neoplasm of overlapping sites of the left breast
- Upon dose visualization an area with no Cherenkov signal was observed.
- The case was presented to the Cherenkov Consortium users for comment
- Consortium users suggested that the hole was a result of attenuation from the chest wall expander.
- Review of TPS data showed that the expander was not in the plane of the hole and therefore was probably not the source of the anomaly.
- Use of tighter SGRT margins appeared to reduce the size of the hole.
- Thresholding of the composite image in combination with a lower dose was expected as the root cause of the issue



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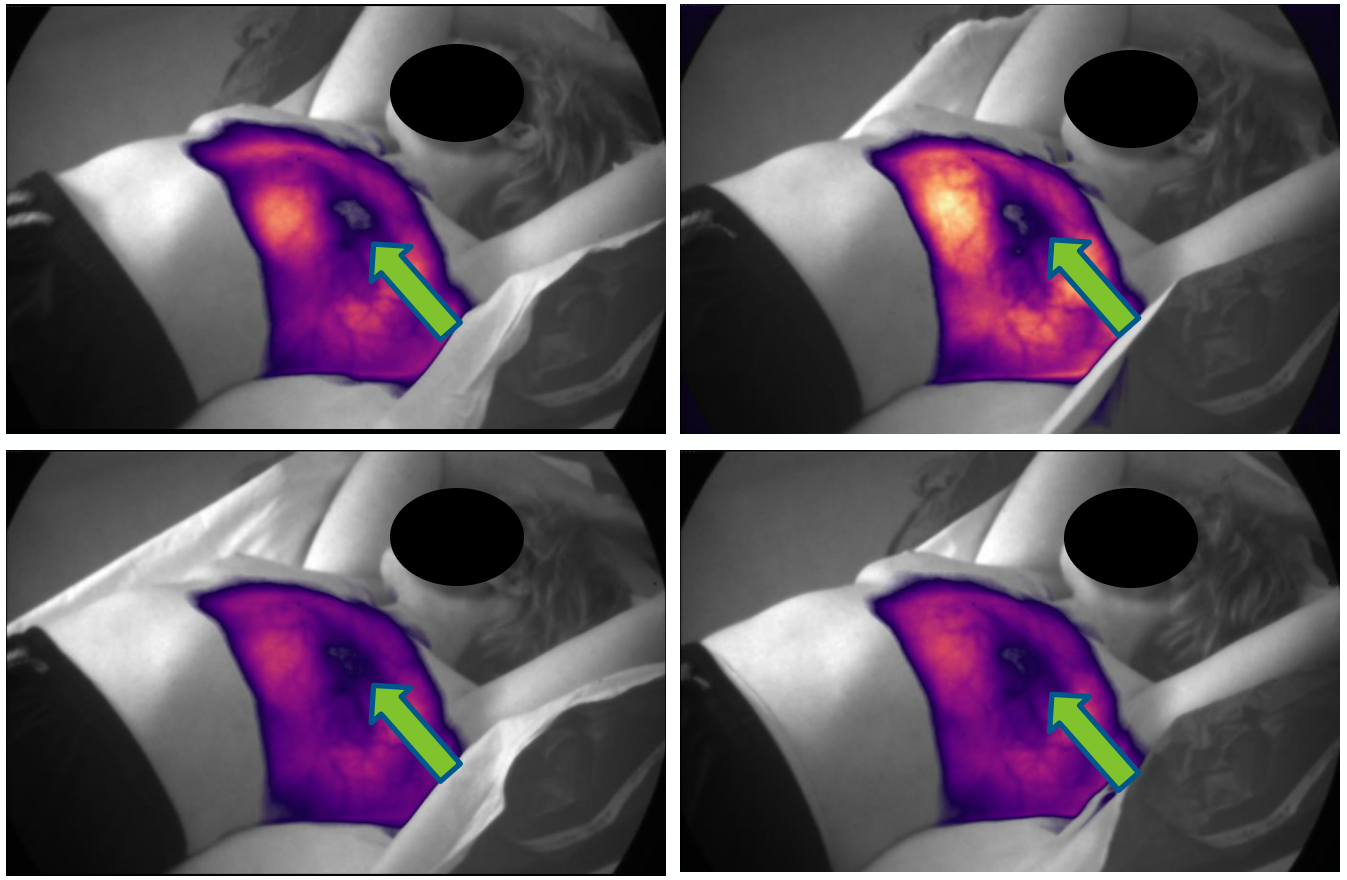
CASE STUDY: Mismatch between Plan and SGRT Tolerances

Do your SGRT Tolerances make sense for the plan pushed to the machine (VMAT vs Standard Forward Plan DIBH)…



- Another patient presents with an unexplained hole in the composite image
- This time the patient has no reconstruction or expander in the treatmetn area.
- Case is presented for review to secondary site
- DIBH Plan is reviewed and found to be VMAT with no flash allowance which was not a common technique at the secondary site.

4 Fractions with varying hole sizes noted

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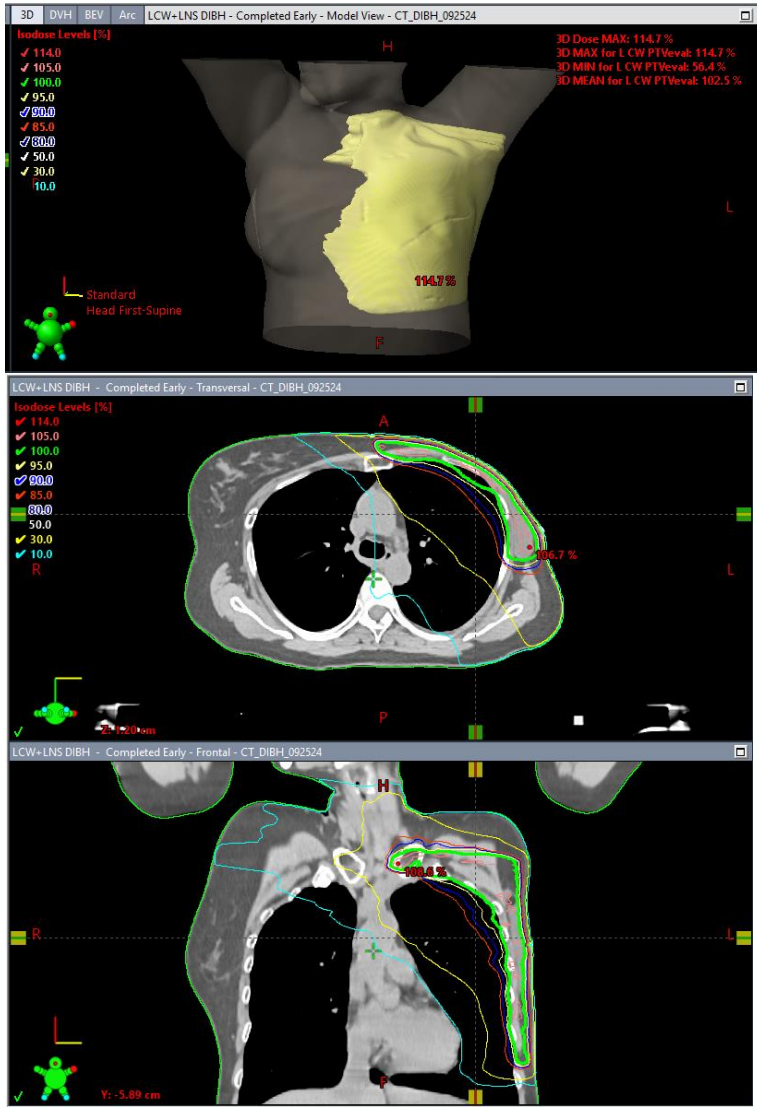
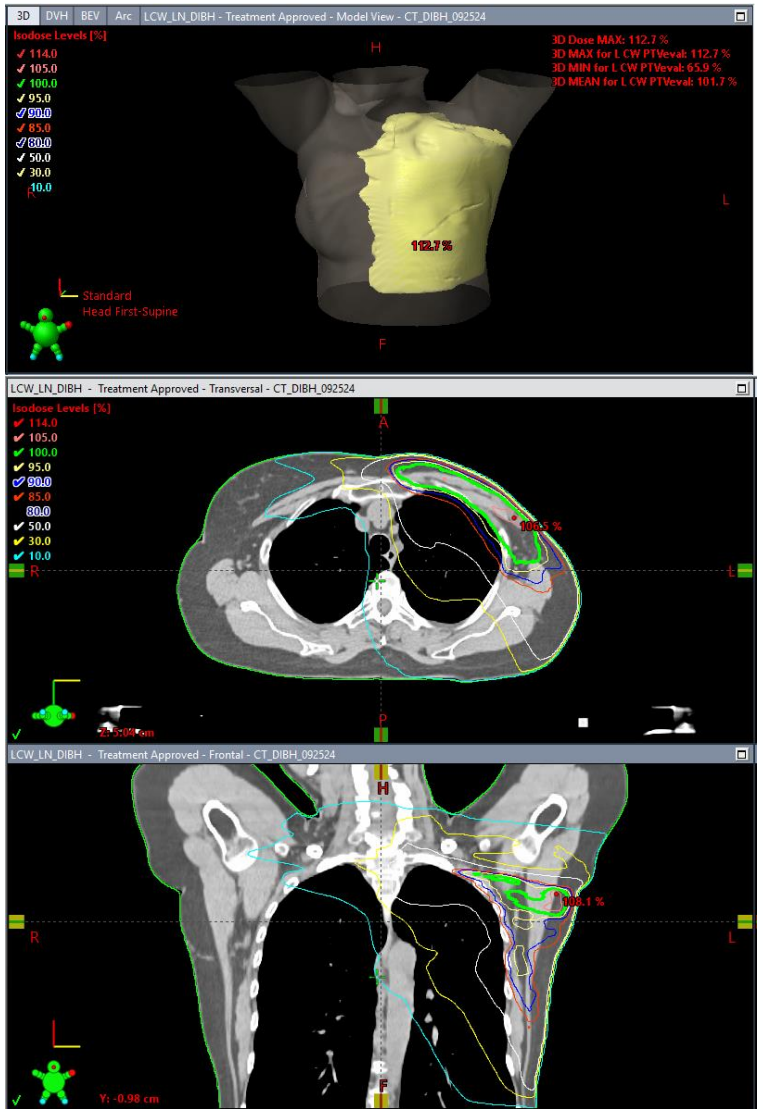
CASE STUDY: Mismatch between Plan and SGRT Tolerances

Do your SGRT Tolerances make sense for the plan pushed to the machine (VMAT vs Standard Forward Plan DIBH)…

Original Plan Without Flash



New Plan With Flash



- Determination was made to use TLDs from UW Madison to verify in vivo dose.
- While waiting on TLD results the patient was replanned using flash to mimic traditional breast flash.
- Patient was moved to the new DIBH plan and new TLDs were ordered to verify the dose in the region after plan change
- TLD results suggested a discrepancy of 30-43cGy per fraction or 7.5-11Gy for the full course (lower) in this region when comparing the with and without flash plans

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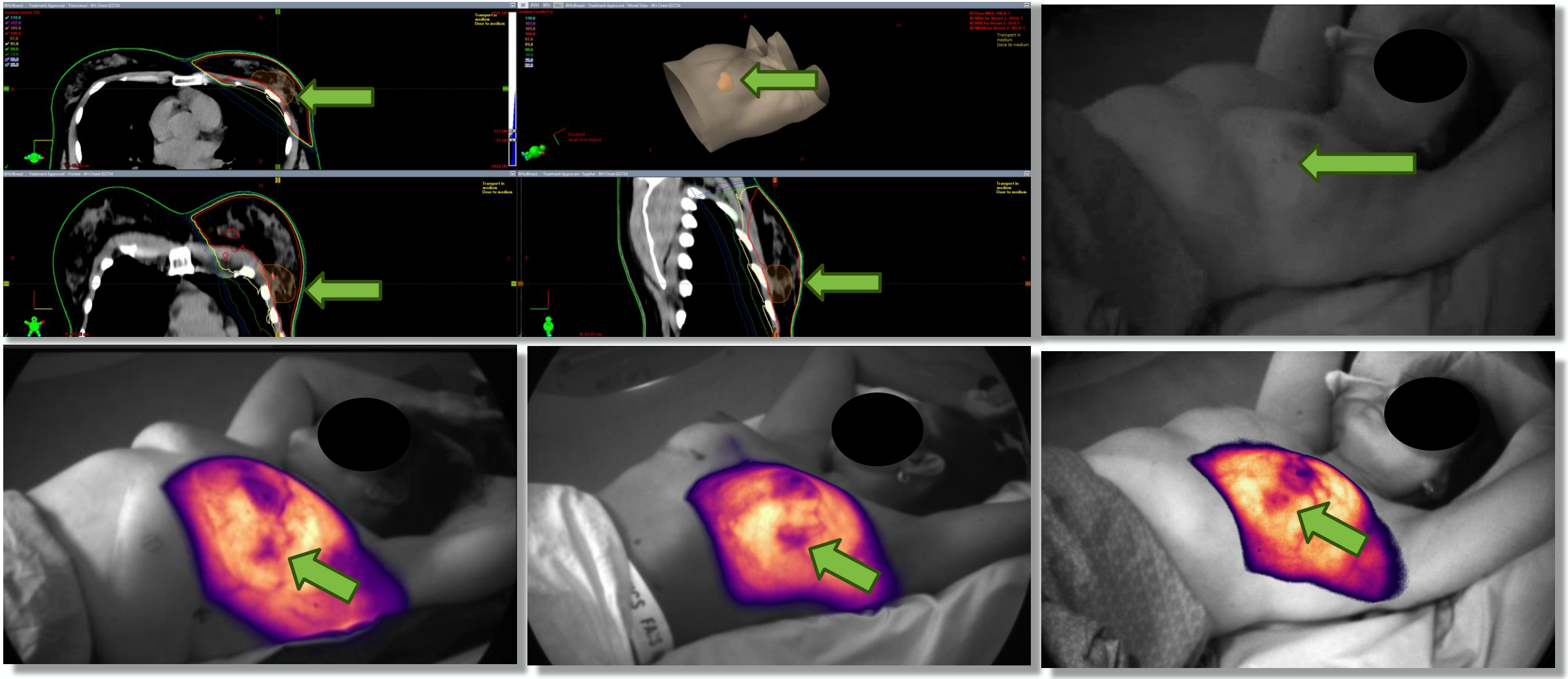
CASE STUDY: Target Coverage Visibility

* Resection Cavity: Visualization and Evaluation of Breast Target Changes…



- Potential evaluation of large seroma changes for replanning
- Cone down boost targeting

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Summary

- Cherenkov Imaging in addition to SGRT in a clinical setting improves
  - Quality and Safety during delivery.
  - Provides a way to detect Unexpected or Stray Dose both during and after delivery
  - Provides a way to evaluate Plan Robustness to things like patient body habitus and compliance issues
- Cherenkov Imaging can be used in recomending and aiding making treatment plan adjustments.
- Cherenkov Imaging provides a unique perspective on treatment that can improve the quality of treatment delivery however care must be taken when interpreting the data .

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Thank You!

- Special Thanks to the AdventHealth Physics team.

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feel whole®

Adi Robinson PhD
AdventHealth - Celebration

Extending the Healing Ministry of Christ