```python
from connect import *

# Connect to the treatment planning system
case = get_current("Case")
exam = case.PatientModel.StructureSets[0]
beamset = case.BeamSets[0]

# Create a surface from external and
# selected internal structures
body = exam.ExternalGeometry["External"]
targets = ["PTV_7000", "CTV_5600", "GTV"]
pts = body.GetSurfacePointCloud()
for s in targets:
    pts = np.vstack((pts, exam.StructureSets[0]
        .RoiGeometries[s].GetSurfacePointCloud()))

# Analyze surface
z = pts[:, 2]
z_norm = (z - z.min()) / (z.max() - z.min())

# Create analytics-driven parameter
metric = np.mean(z_norm)
beamset.Description = f"Mean Elevation: {metric:.2f}"
print(f"Mean Elevation: {metric:.2f}")
```

Scripting with MapRT

Michael J Tallhamer MSc DABR

Chief of Radiation Physics

AdventHealth Rocky Mountain Region

Michael.Tallhamer@AdventHealth.com

AdventHealth

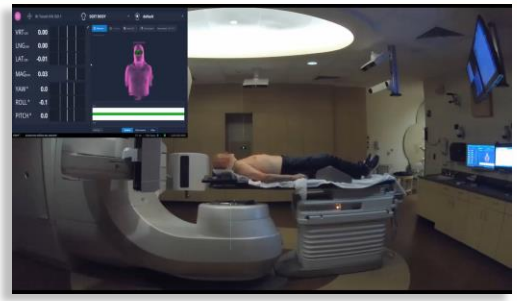
Disclosures

- AdventHealth – Parker has a PSA agreement with Vision RT.
- AdventHealth – Celebration has a COE agreement with Vision RT.

AdventHealth

AdventHealth's SGRT Radiation Oncology Therapy Workflow

Sim Plan Treat Dose

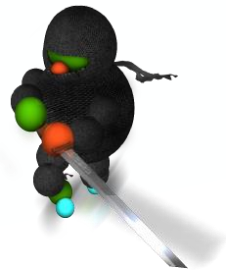


AdventHealth

Goals

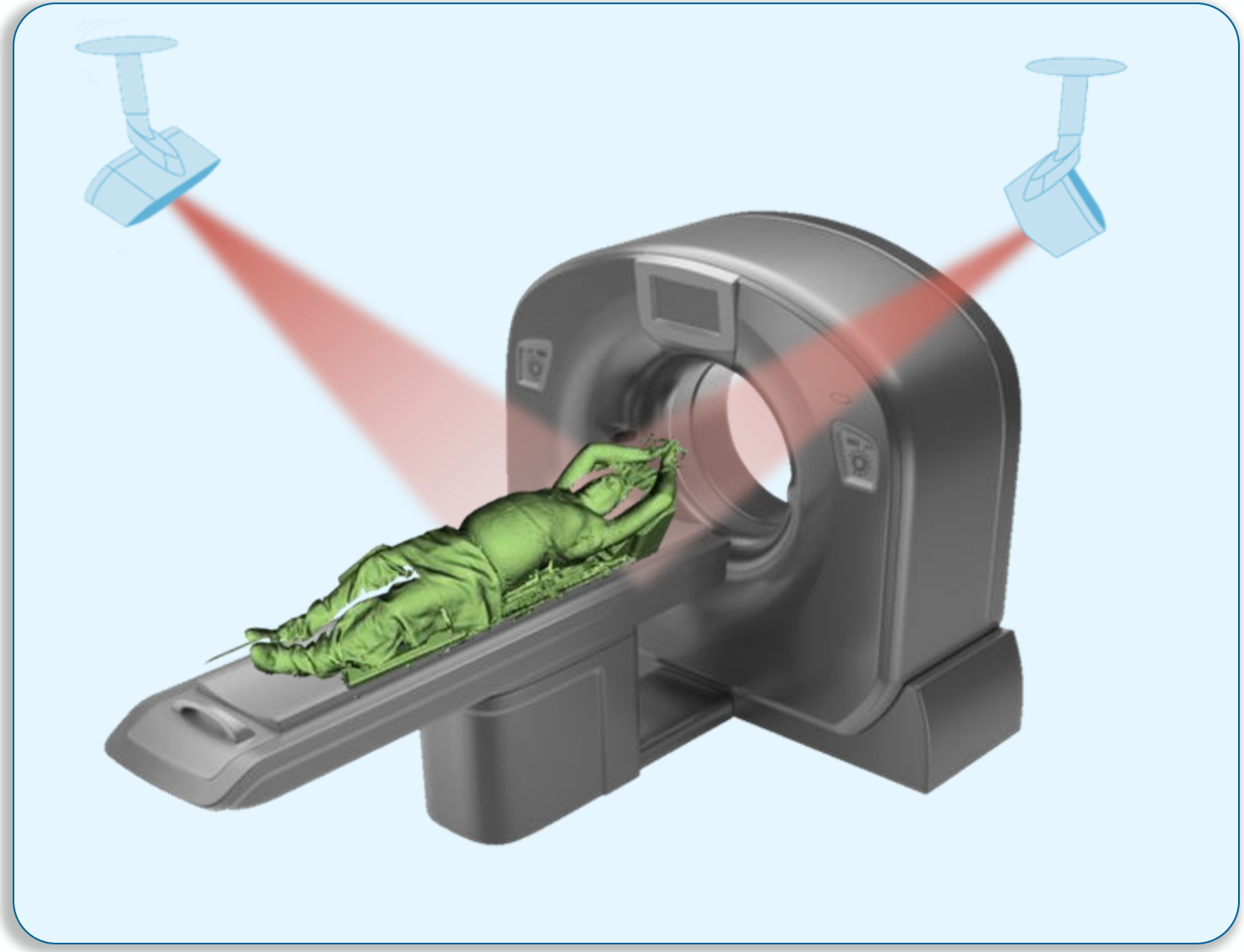
- Give a simple and basic introduction to MapRT
- Discuss the use of SGRT for surface guided planning and some of the benefits it brings to our patients
- Discuss case studies where scripting can address concerns within our workflows and/or validate changes to your process.
- Highligh how scripting can bring together currently isolated steps in the SGRT End-To-End workflow.
- Hopefully give a good overall perspective on what is possible with scripting and help others start exploring new possibilities and workflows.

python™ VTK PySide Python for Qt C#



AdventHealth

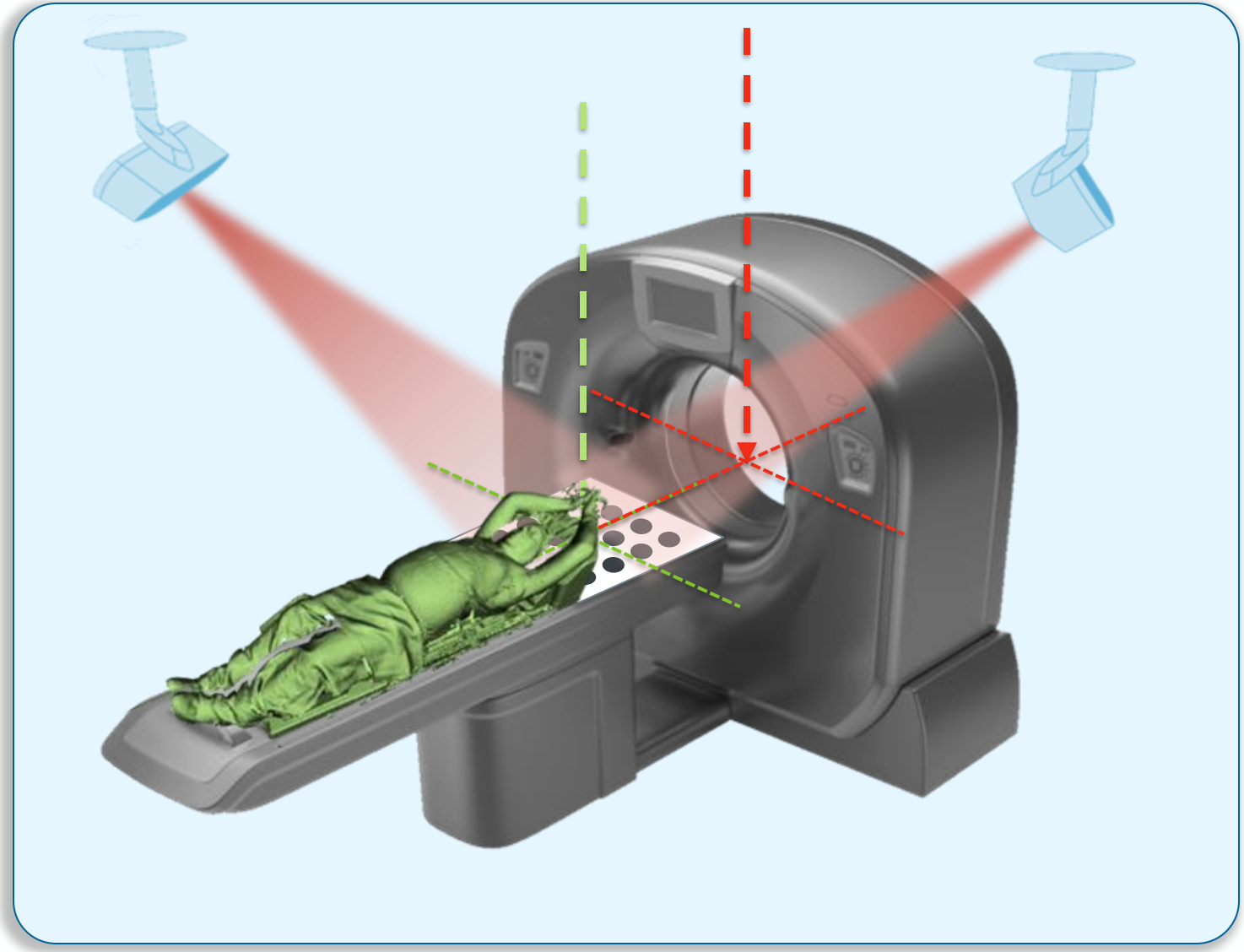
MapRT Basic System Description for Surface Base Planning



- Installation of 2 lateral cameras with unique large field of view
- Allows for surface capture over a large area encompasing both the patient and the immobilization devices on the CT couch at the time of simulation

AdventHealth

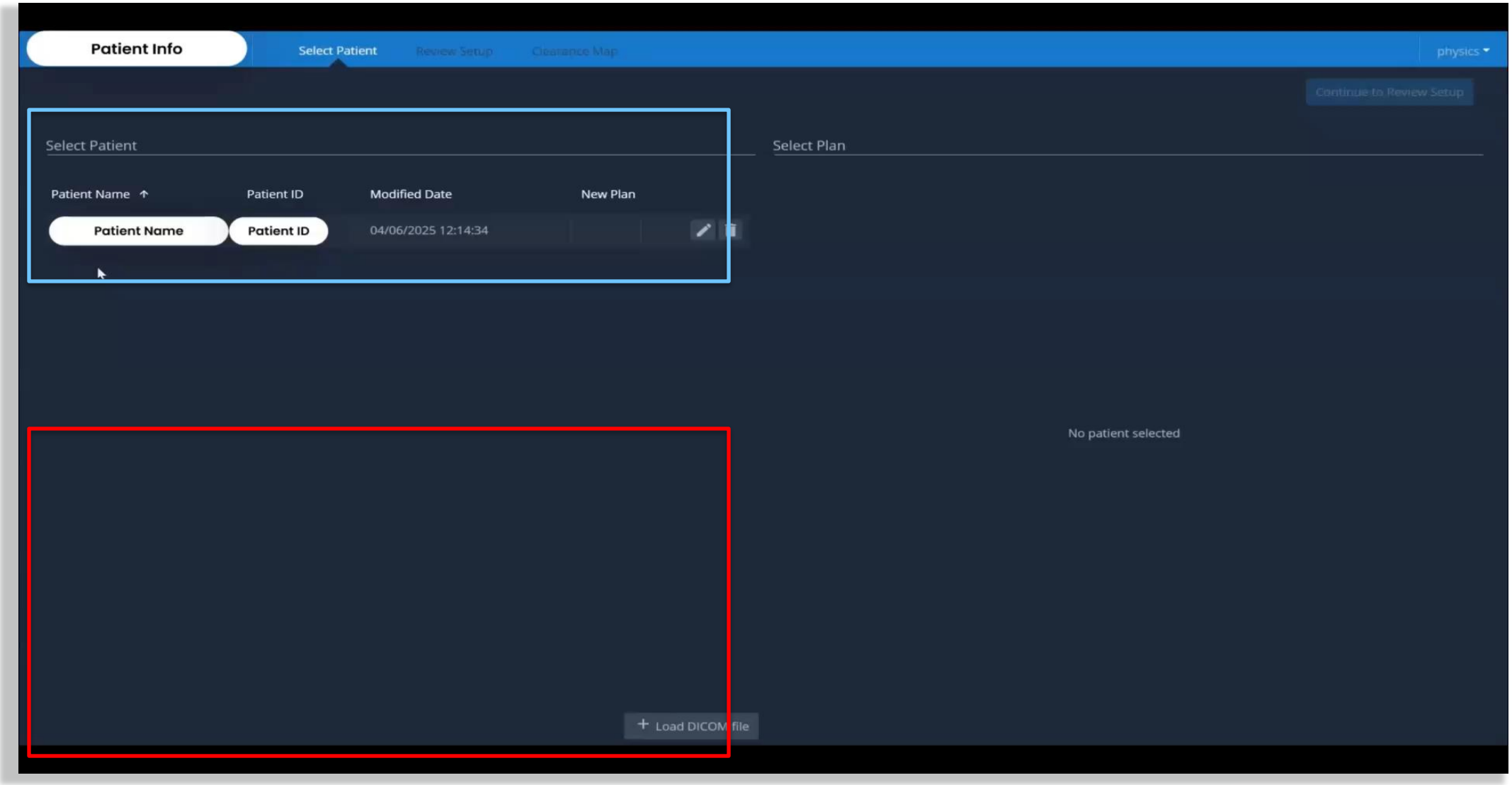
MapRT Registration of Camera and DICOM Coordinates



- The **reference position** can be registered with the DICOM frame of reference through the **DICOM origin** which is defined in a vendor specific transform.
- A least one couch marker must be visible in both sensors on the same camera pod to allow for merging of surface captures at different couch poisitions.
- This process allows for longer surface captures.

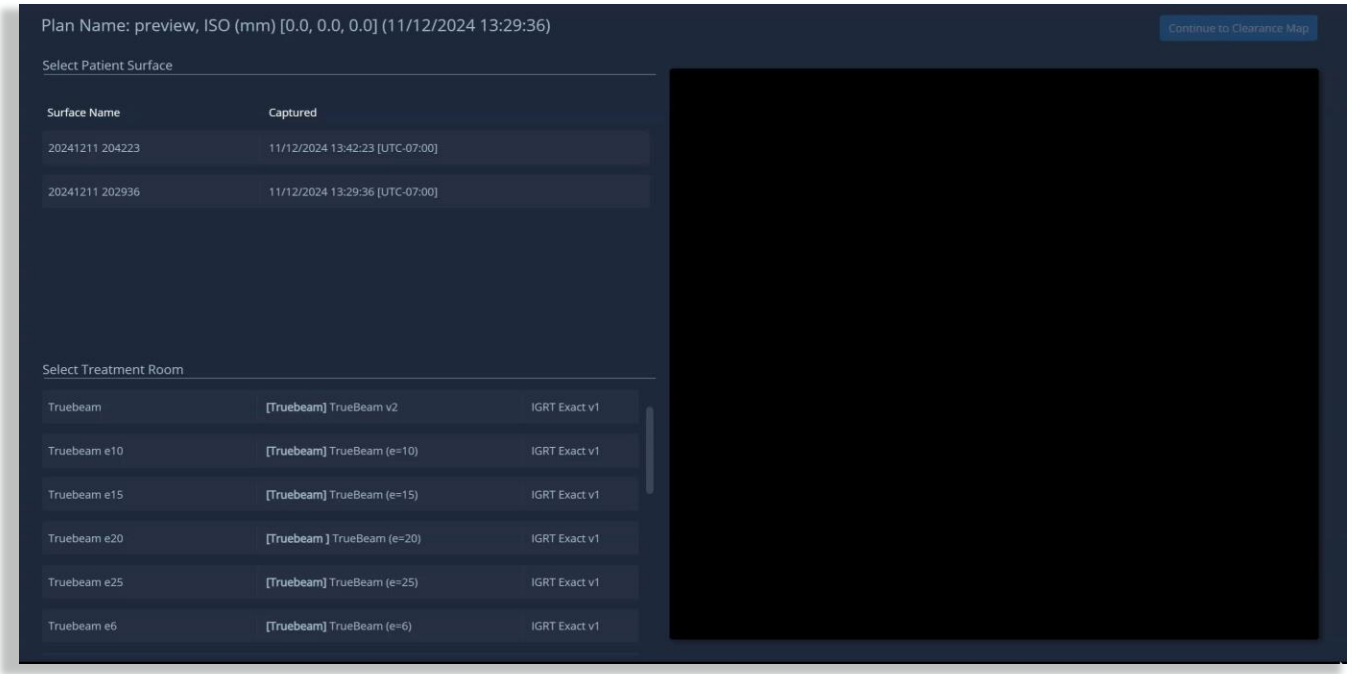
AdventHealth

Powerful Planning Insights

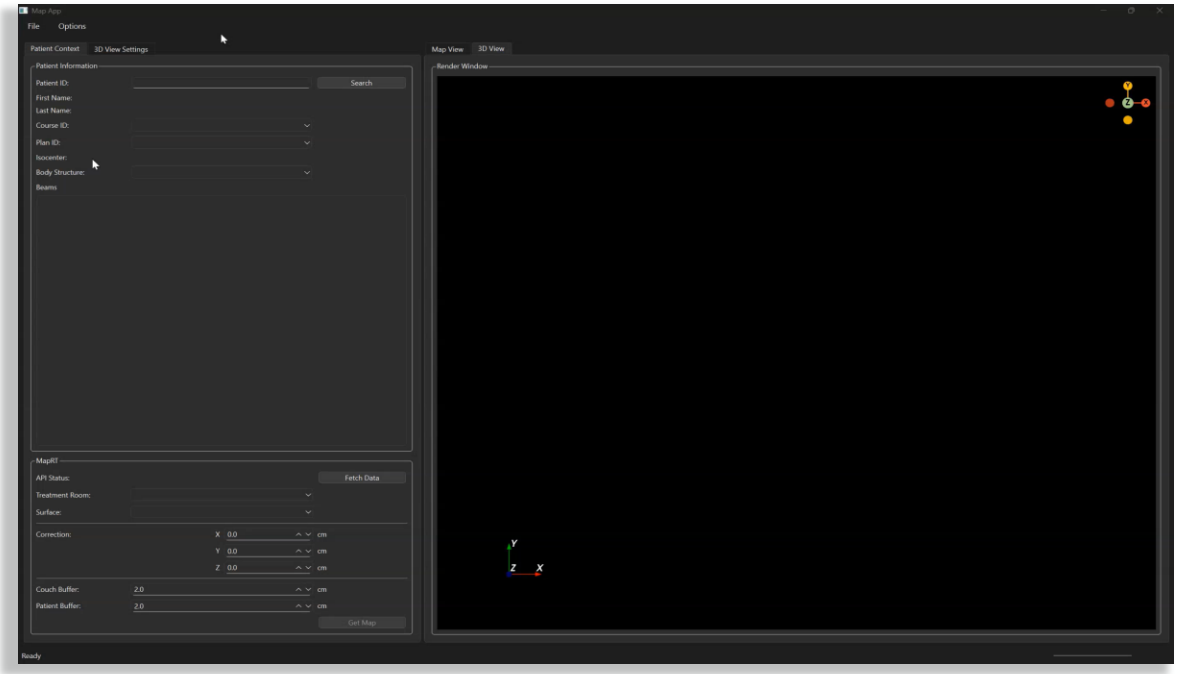


MapRT API in Development of More Familiar Workflows in CT Sim

MapRT Web Interface



MapRT API

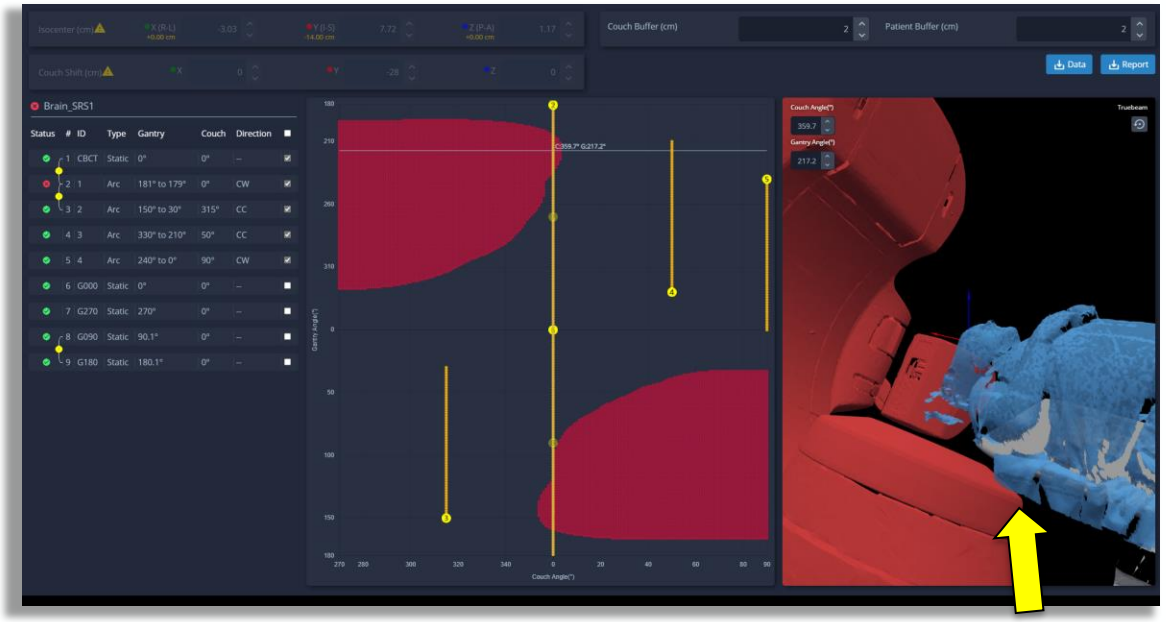


We can work with the therapy teams to

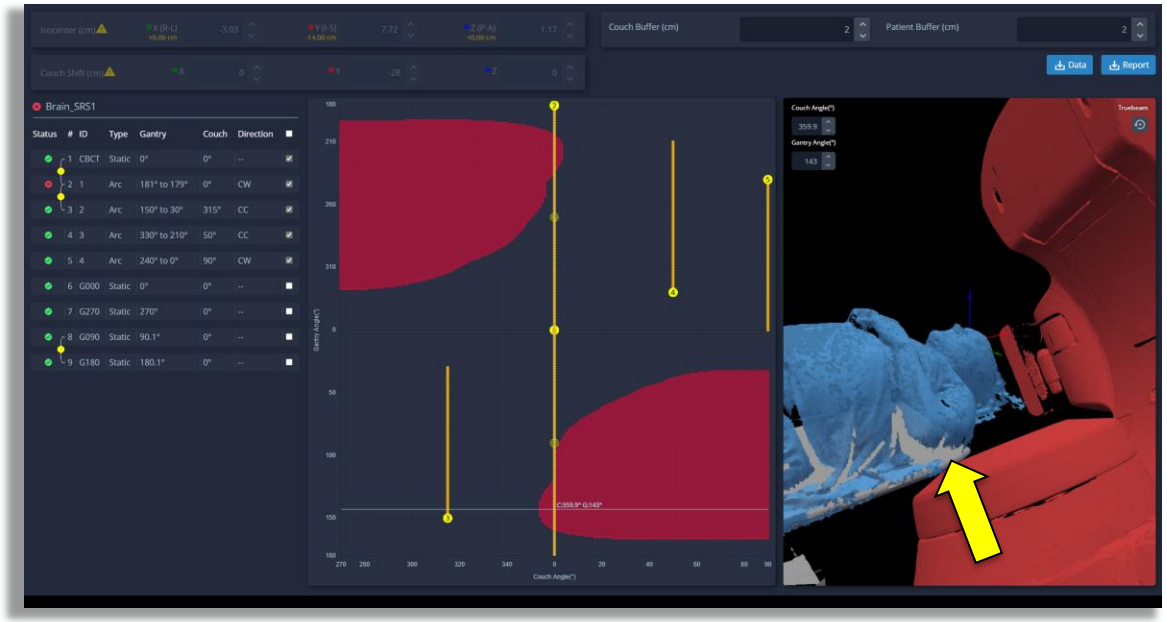
- Design workflow to take advantage of the process familiarity(e.g. lasers vs axis marker)
- Set isocenter once and compare multiple collision maps
- Cache maps to avoid recalculation with repeated changes

AdventHealth

Evaluation of a Very Simple “Standard” Case



False Positive on Sheet

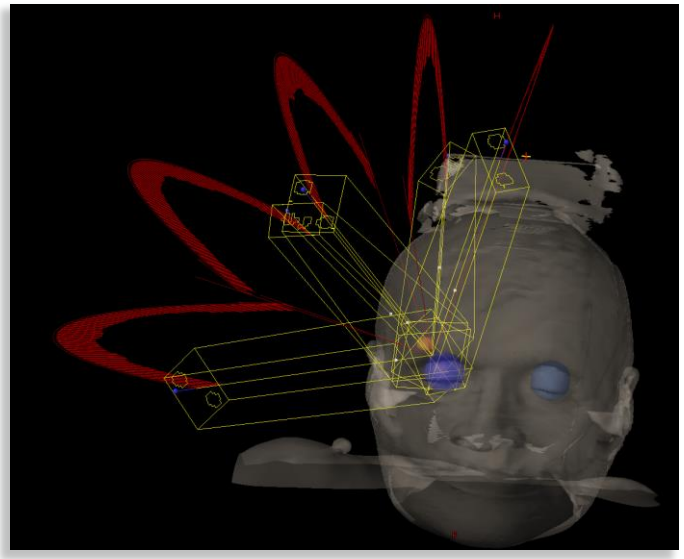


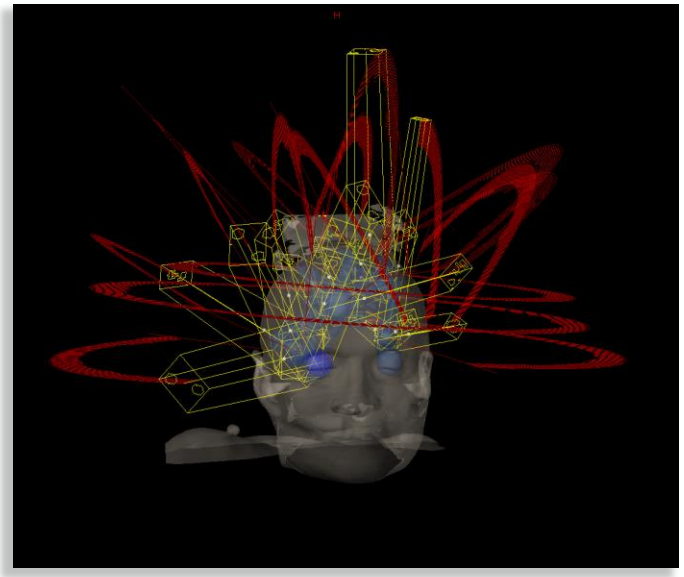
True Positive on Couch

- Review of very basic SRS plan by physics showing a false positive on ipsilateral side of the couch 0 arc due to sheet inclusion in the processed capture surface.
- True collision with table found on contralateral pass of the same arc confirming prior calculation due to a combination of factors that included patient physical size, head position, and target location.

AdventHealth

Efficient Exploration of Noncoplanar Solutions

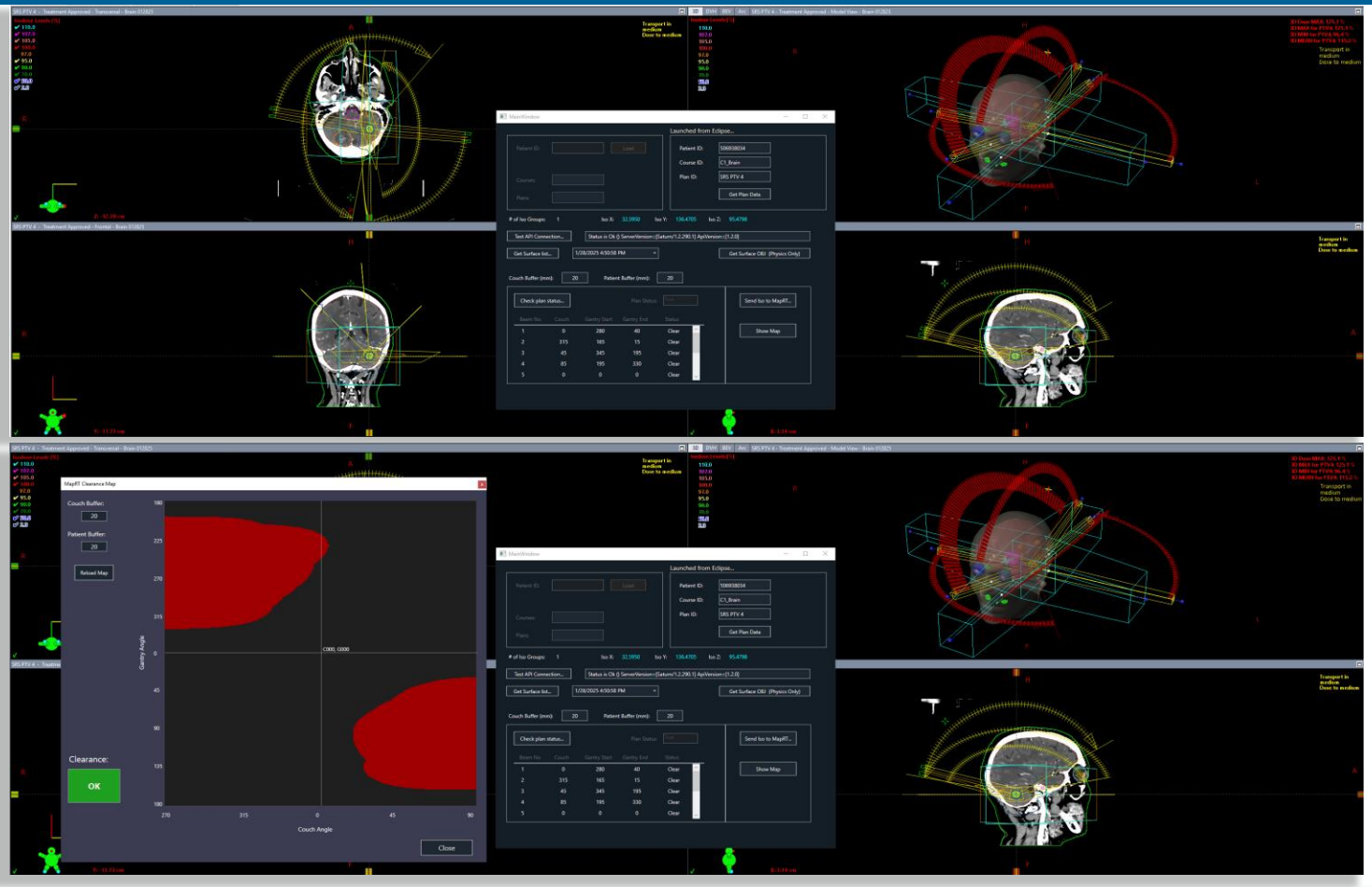


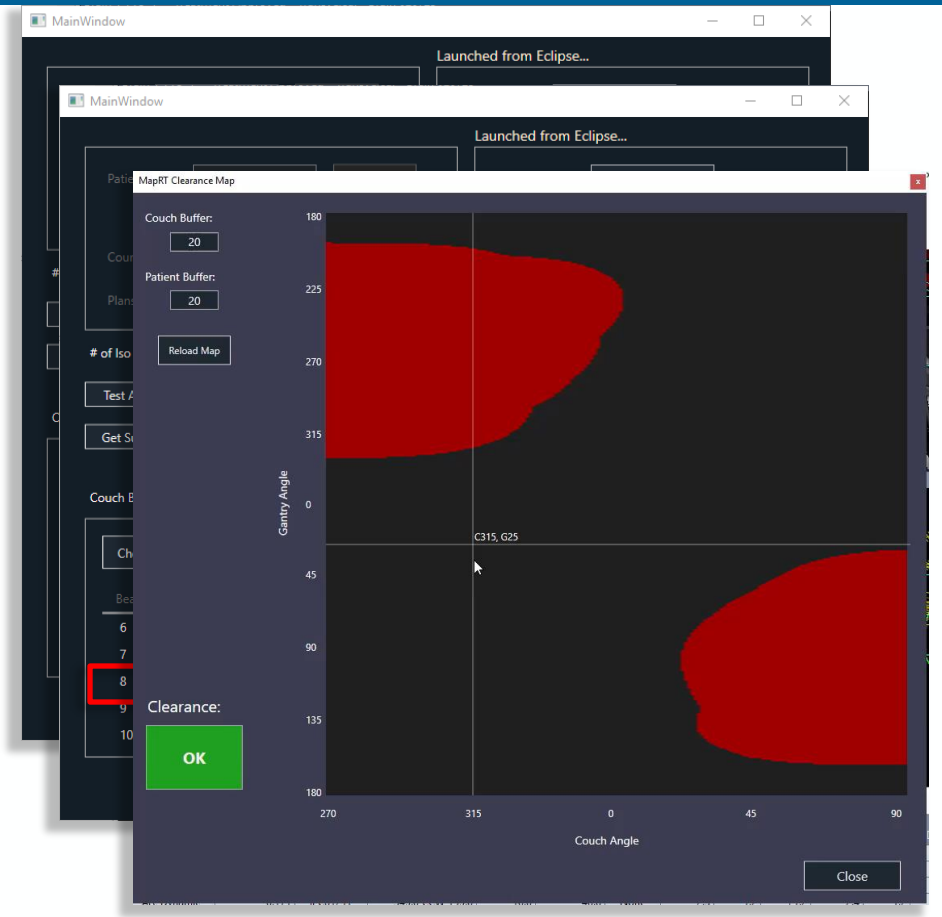


- Intracranial SRS is a high-precision, high-dose ablative treatment.
- At AdventHealth they are typically delivered in 4-6 non-coplanar arcs.
- While collision risk can be significant, technologies such as Varian's HyperArc help reduce that risk by artificially limiting the planning solution space to a given set of arc geometries and requiring a very specific and approved immobilization system.
- Surface-based planning allows planners to explore the full solution space with confidence, without restrictions on immobilization or beam geometries, facilitating highly complex multi-target SRS cases that must avoid previously irradiated areas.

AdventHealth

Using the API for Efficient Exploration of Noncoplanar Solutions

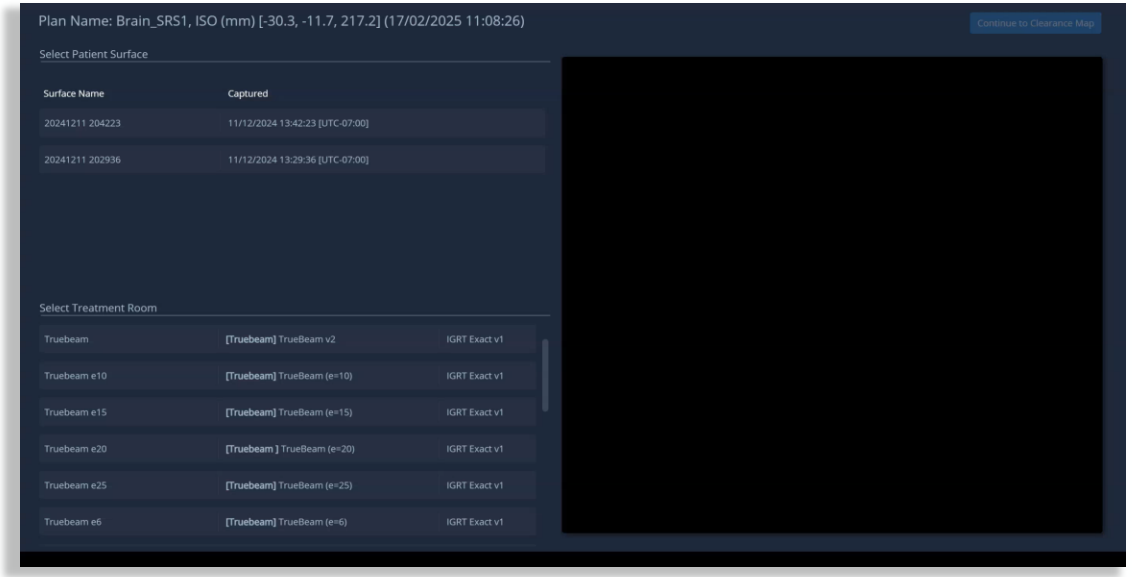


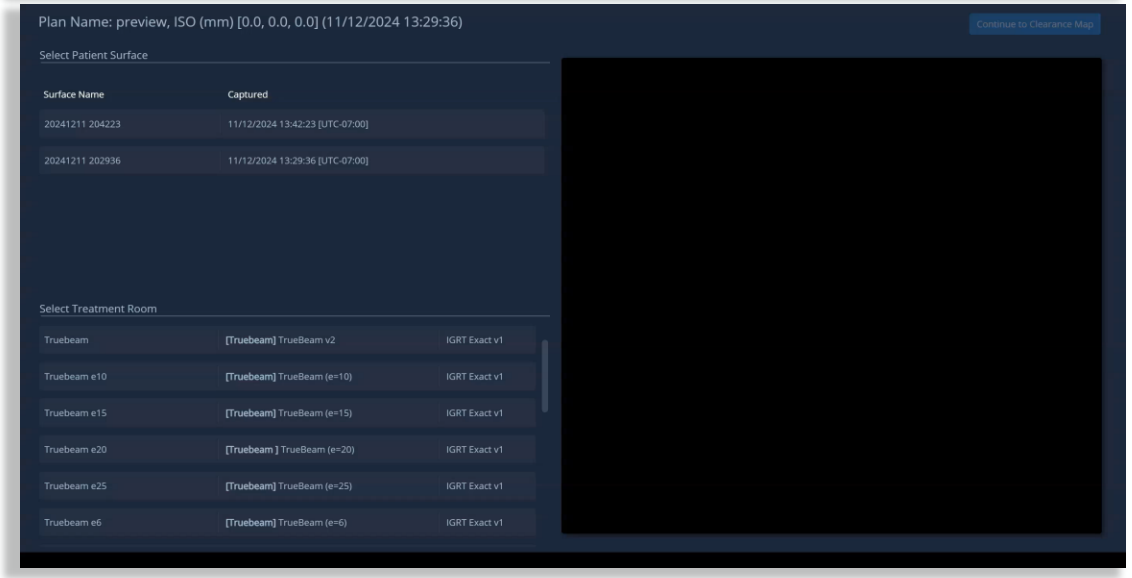


- Leveraging the API allows the user to rapidly evaluate the plan context being worked during planning.
- The API also allow the user to generate a clearance maps that can be dynamically explored for alternate solutions reducing planning time by more than 30 minutes.

AdventHealth

Workflow Dependent Errors: Clearance Map Validation



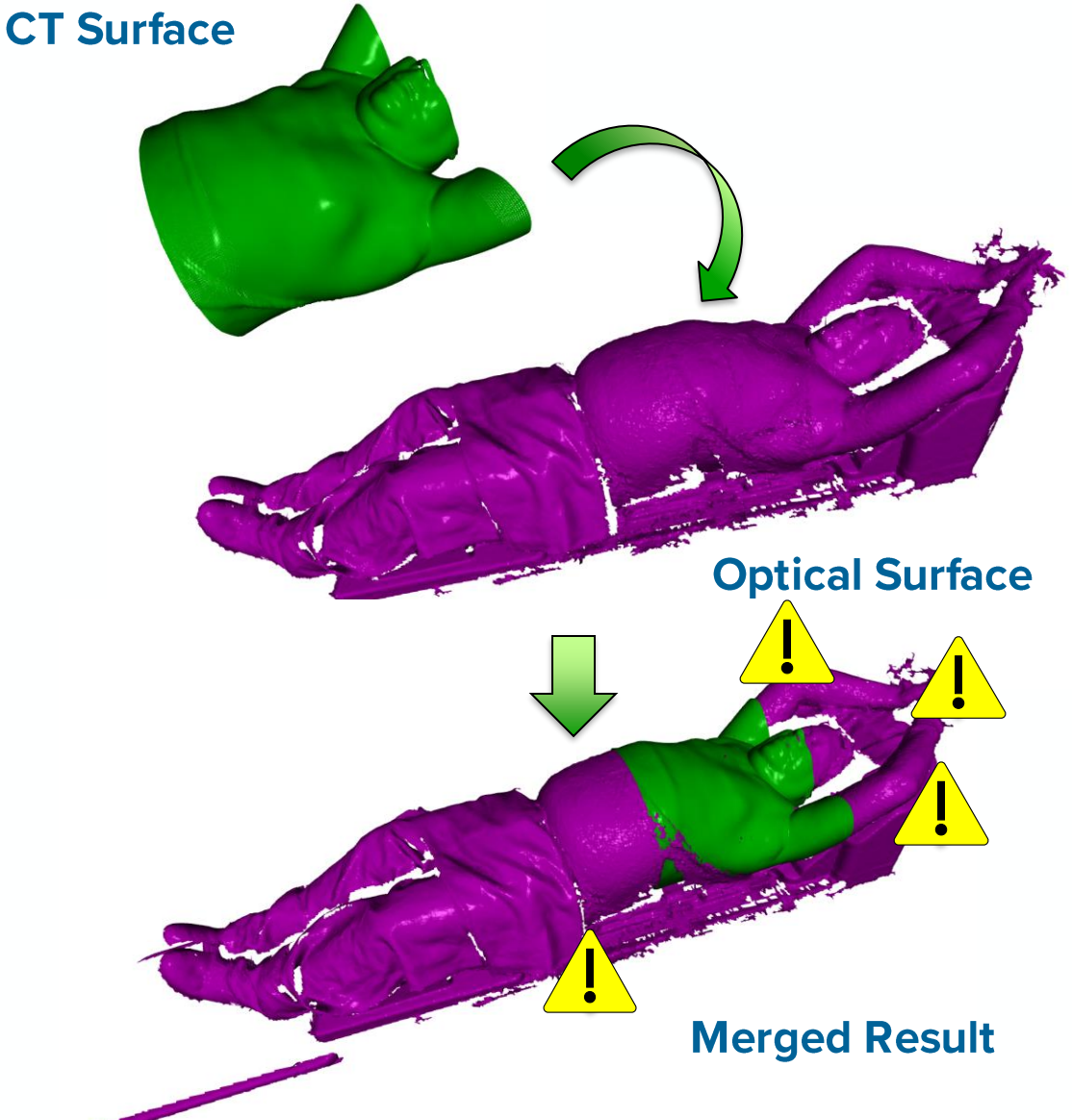


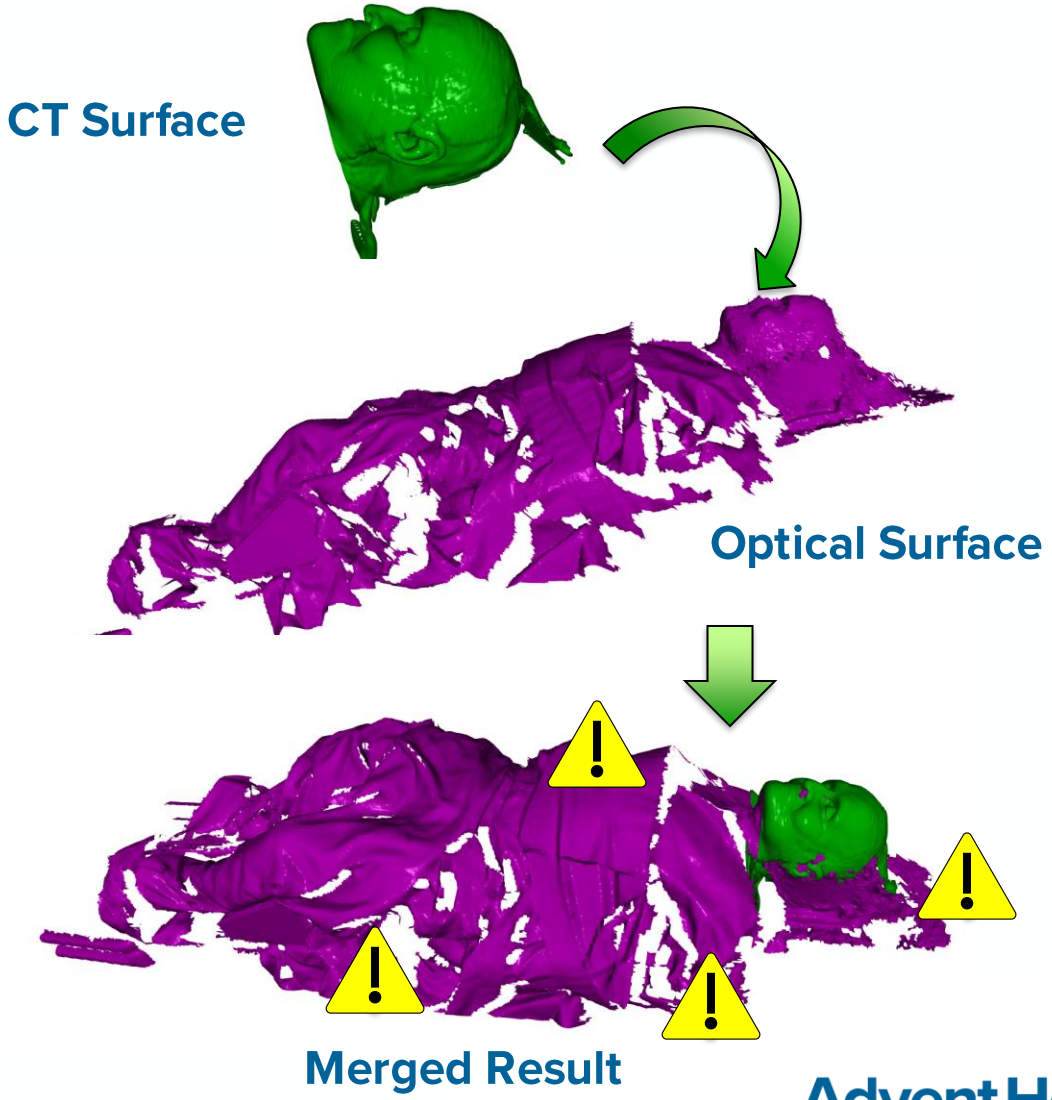
Promoting replacement of safety checks with new methods requires new safety checks

- We need to verification that the proper data is used for collision map calculation if collision maps are going to be used to help guide our planning
- Safety dictates that errors should be readily identifiable if the new check is to replace the old
- **Policies and Procedures** are the lowest level of the **Hierarchy of Effectiveness**

AdventHealth

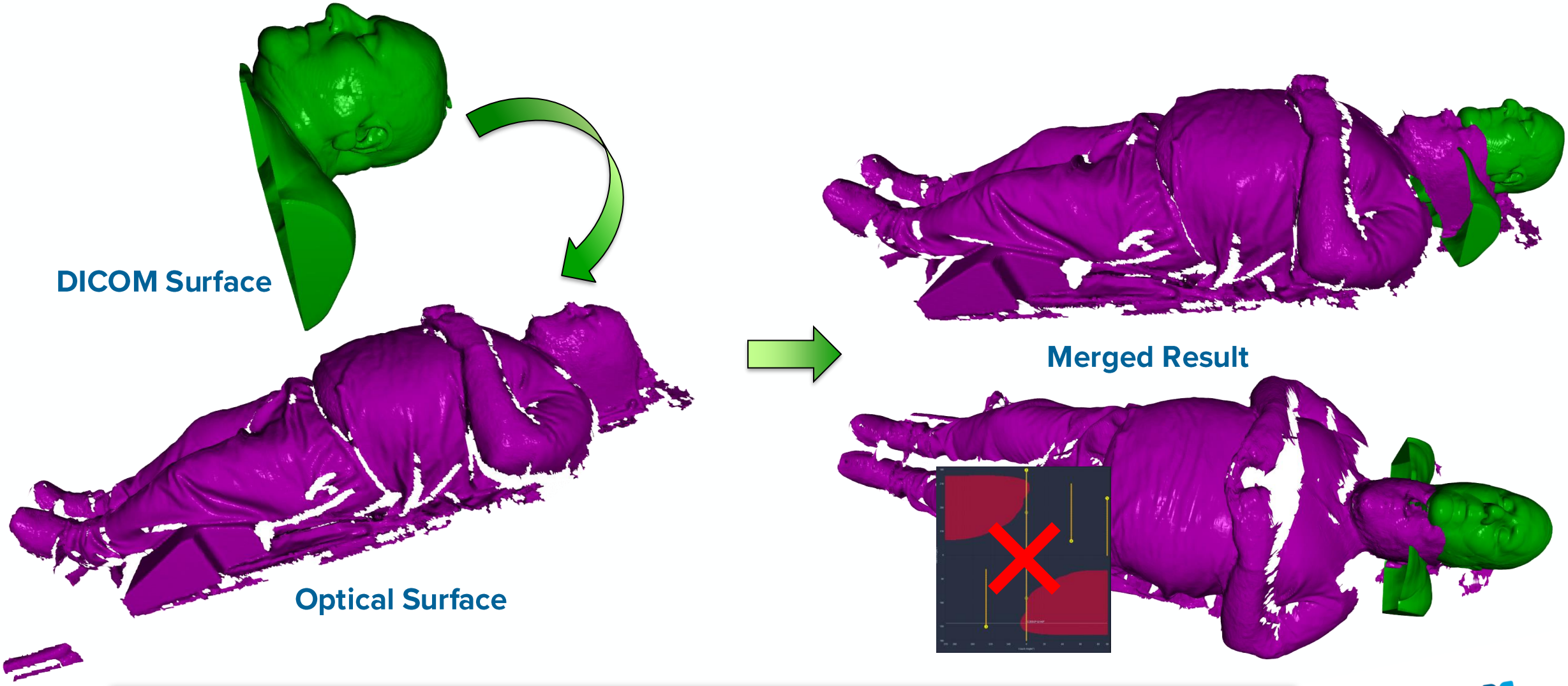
Combining 3D Volumetric and 3D Surface Information for Planning





AdventHealth

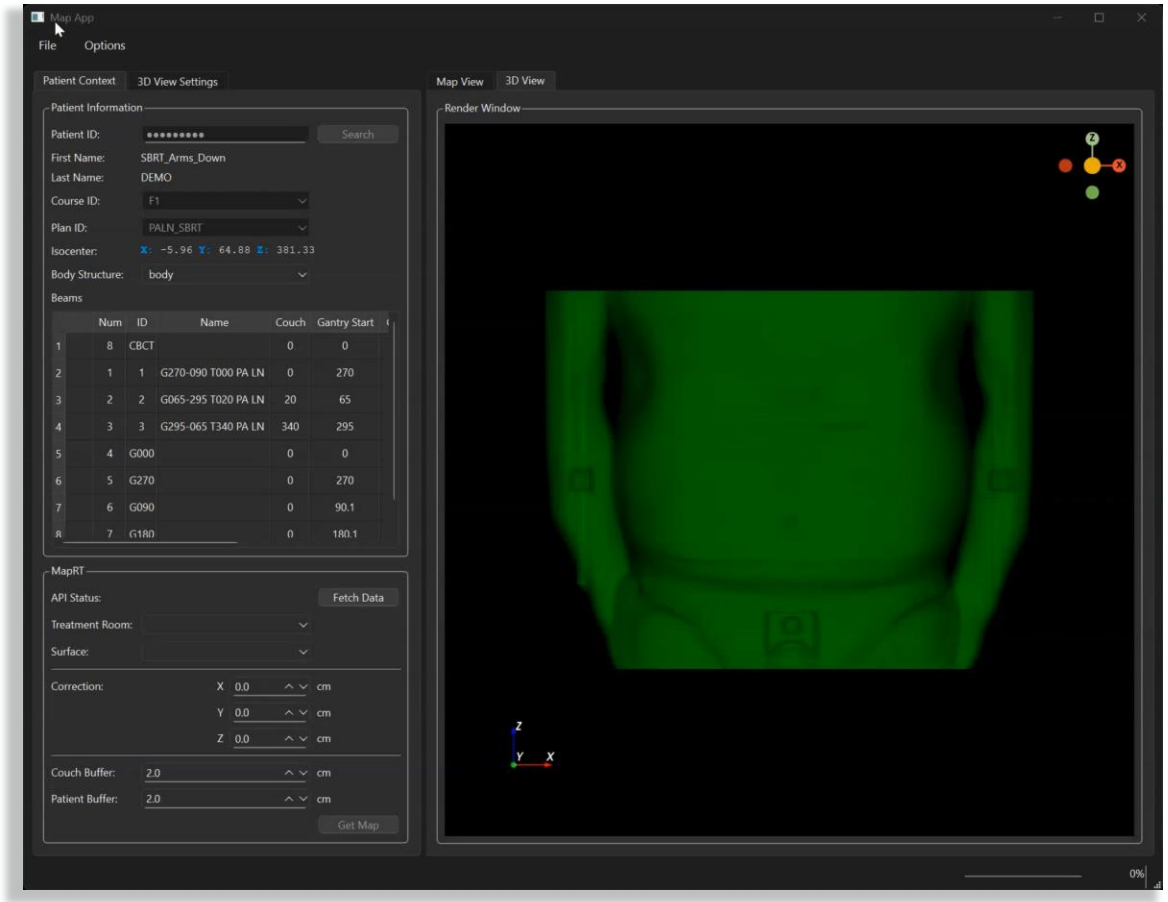
API Integration for Additional Isocenter Verification



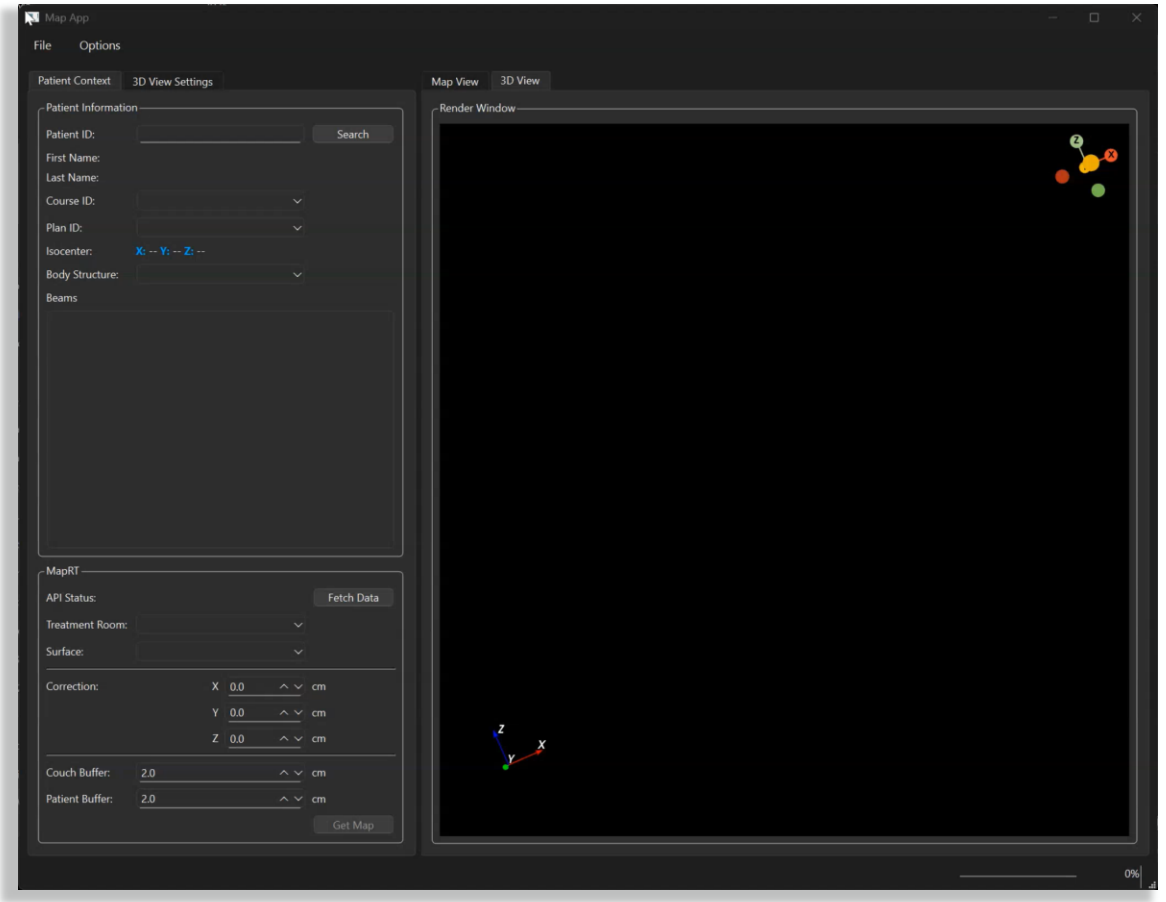
Incorrect captures can result in artifical clearance due to an offset in DICOM isocenter

AdventHealth

Two Improper Surface Capture Correction Workflows



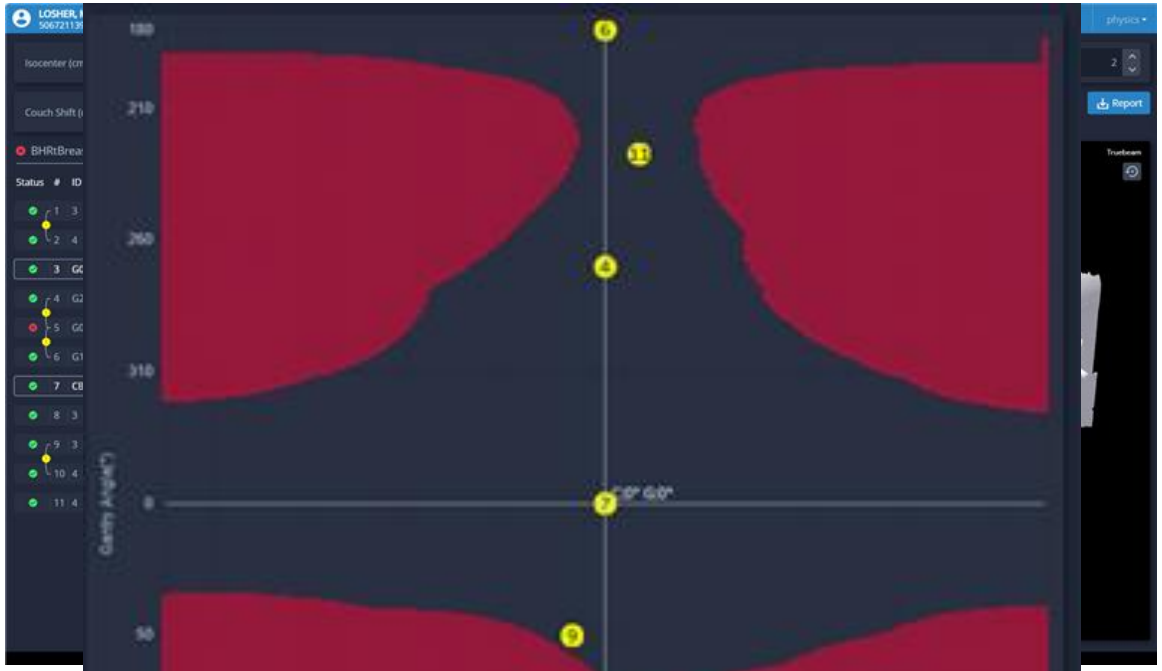
Validation of Correction During Simulation

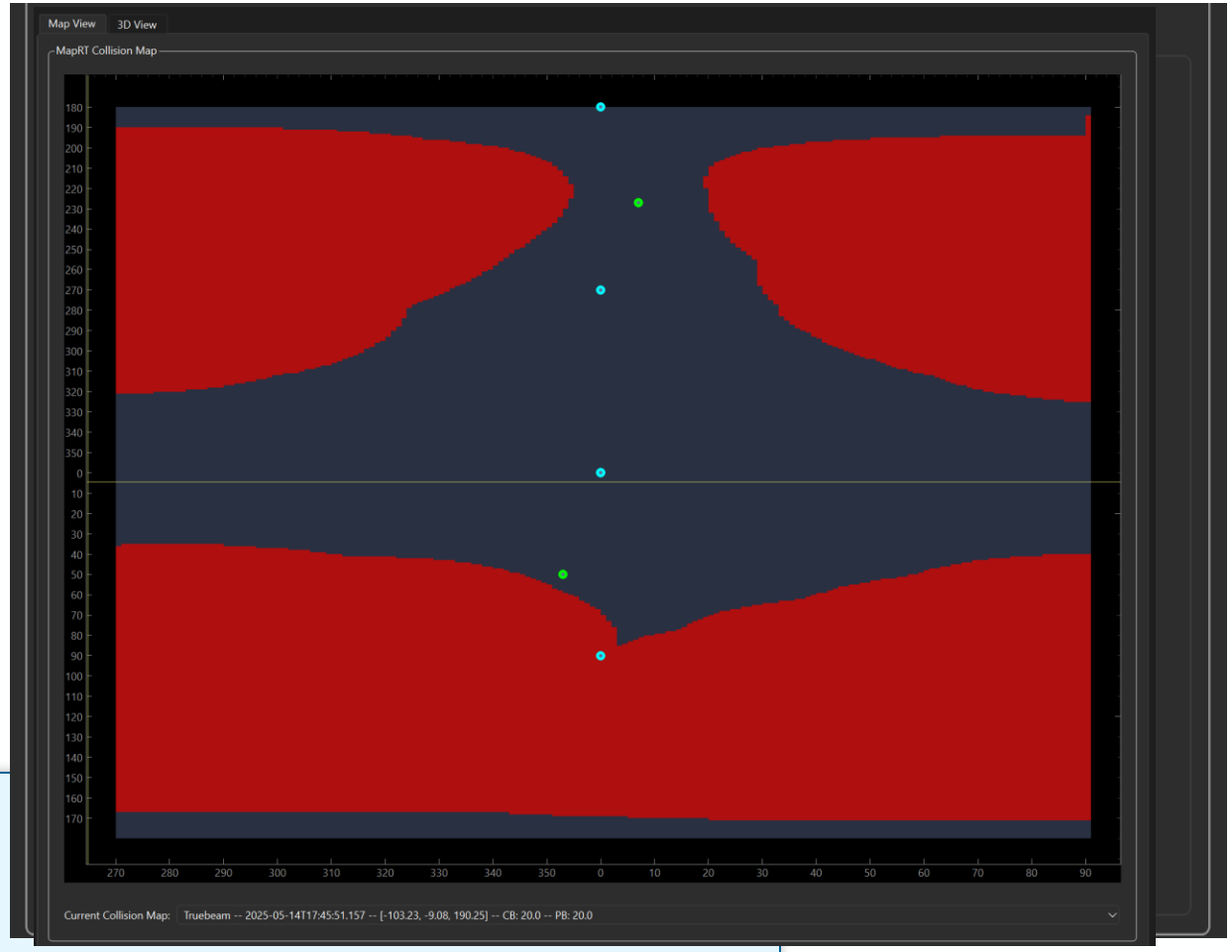


Correction During Treatmetn Planning

AdventHealth

MapRT API to Clean Up Information Display During Plan Evaluation

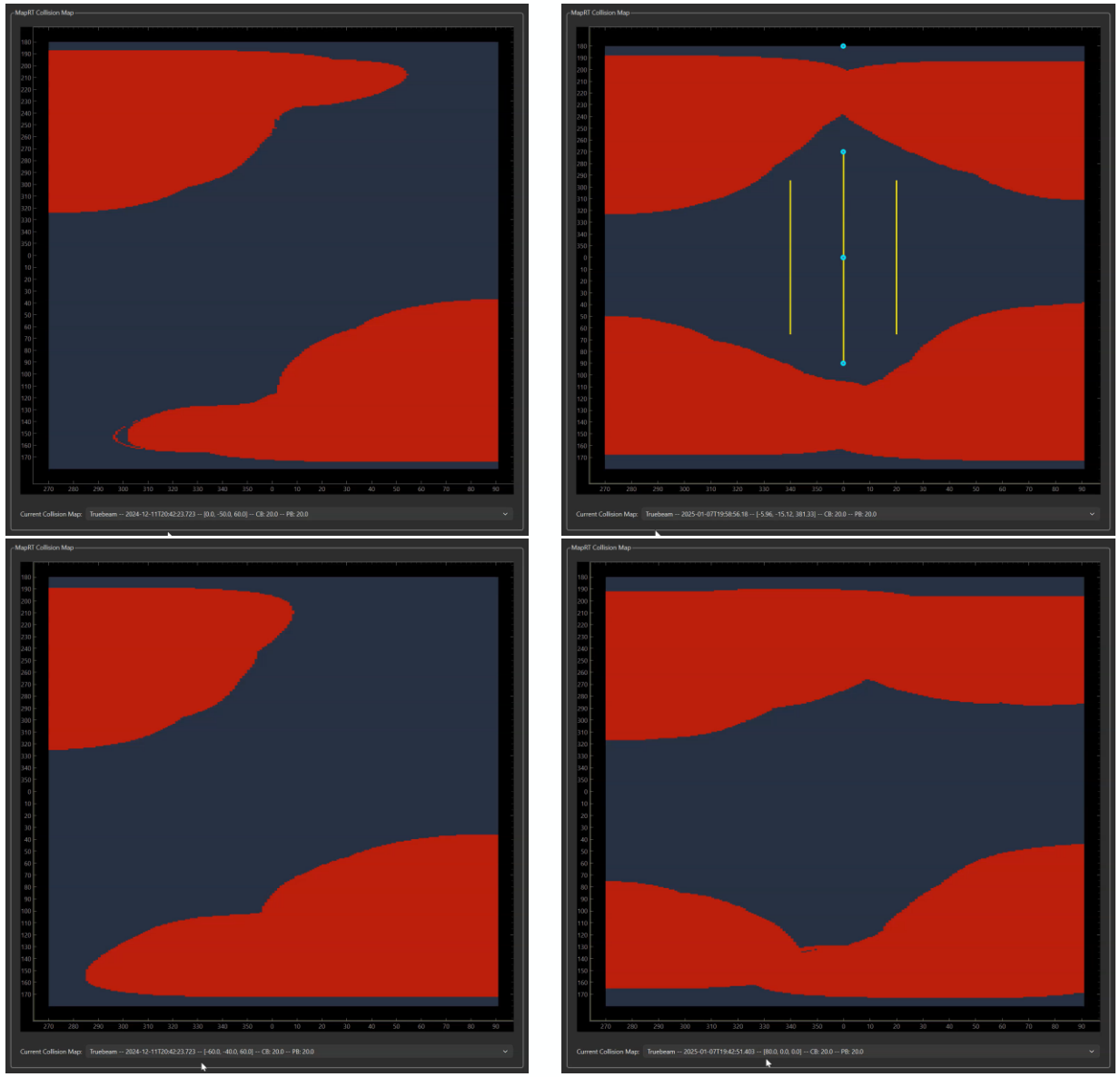




- W
- ➢ using
- ➢ sues from non-issues
- ➢ Simply make folks happy

AdventHealth

Async Protocols and Map Caching for Isocenter Placement



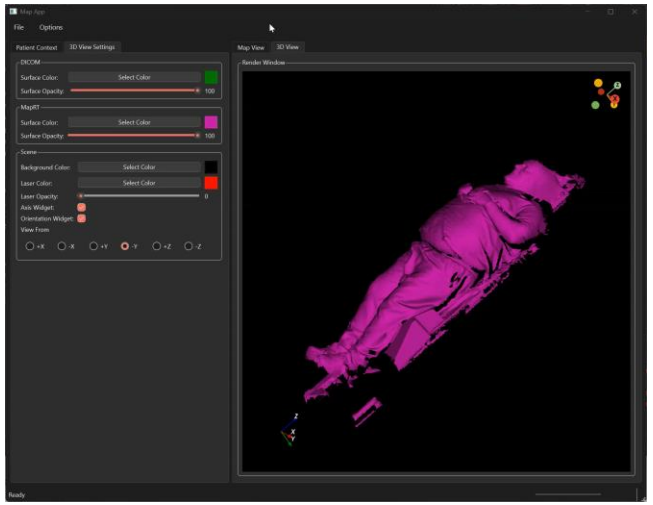
Leveraging Automation and Asynchronous API calls for Dynamic “5D” Exploration

- The web API allows for asynchronous calls
- Sorting clearance map calls by isocenter coordinates allows you to order the resulting clearance maps for dynamic exploration
- Combining the above with caching and call hooks allows the user to automate the construction of a search protocol around a plan isocenter.
- The resulting dataset can be explored dynamically to identify more advantageous isocenter positioning

AdventHealth

Advanced Surface Based Applications for Planning

API



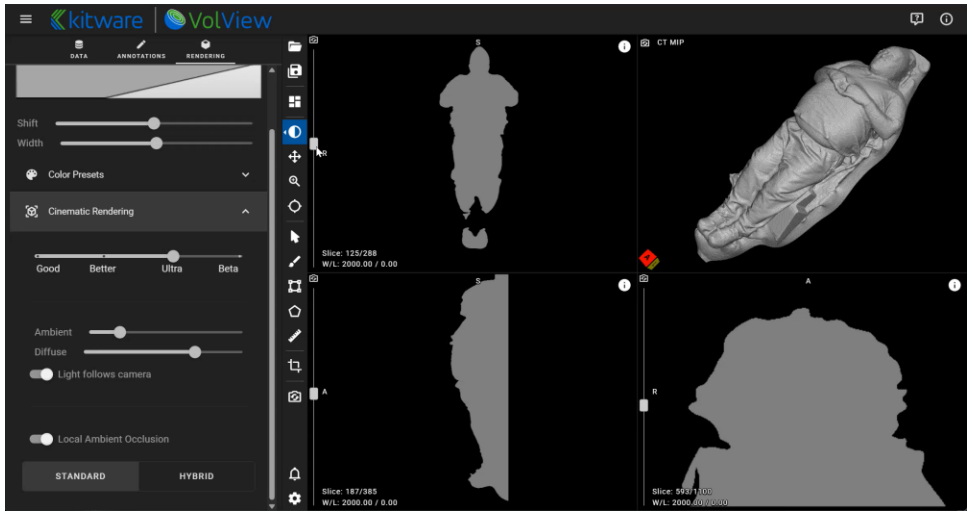
Extraction

Reconstruction

Isolation

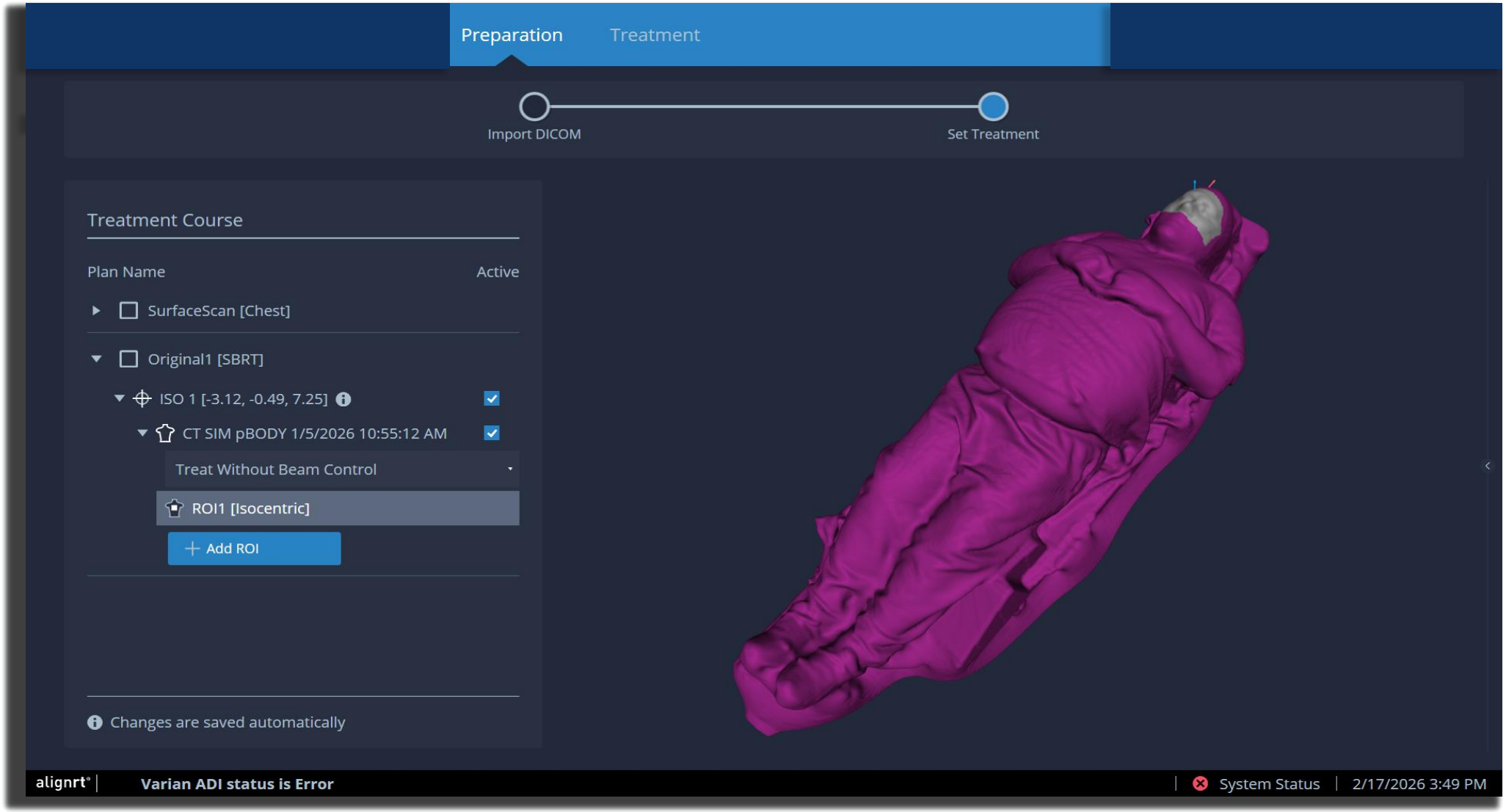
Normalization

Voxelization



AdventHealth

Advanced Surface Based Applications for Planning



AdventHealth

Summary

- We have had a basic introduction to MapRT and what it offers
- Discussed some of the benefits of surface guided planning and the benefits it can bring to your patients
- Seen some case studies where scripting can be used to increase safety and reliability of surface guided planning process..
- Highlighed how scripting can be used to leverage surface guided planning information to enhance other areas of the End-To-End SGRT workflow (**Sim**-**Plan**-**Treat**-Dose) .
- Hopefully gave you a good overall perspective on what is possible with scripting so that you can start exploring new possibilities and workflows.

AdventHealth

Thank You!

- Special Thanks to the AdventHealth Physics team.