

Changing Practice with MapRT

David Parsons

February 21, 2025

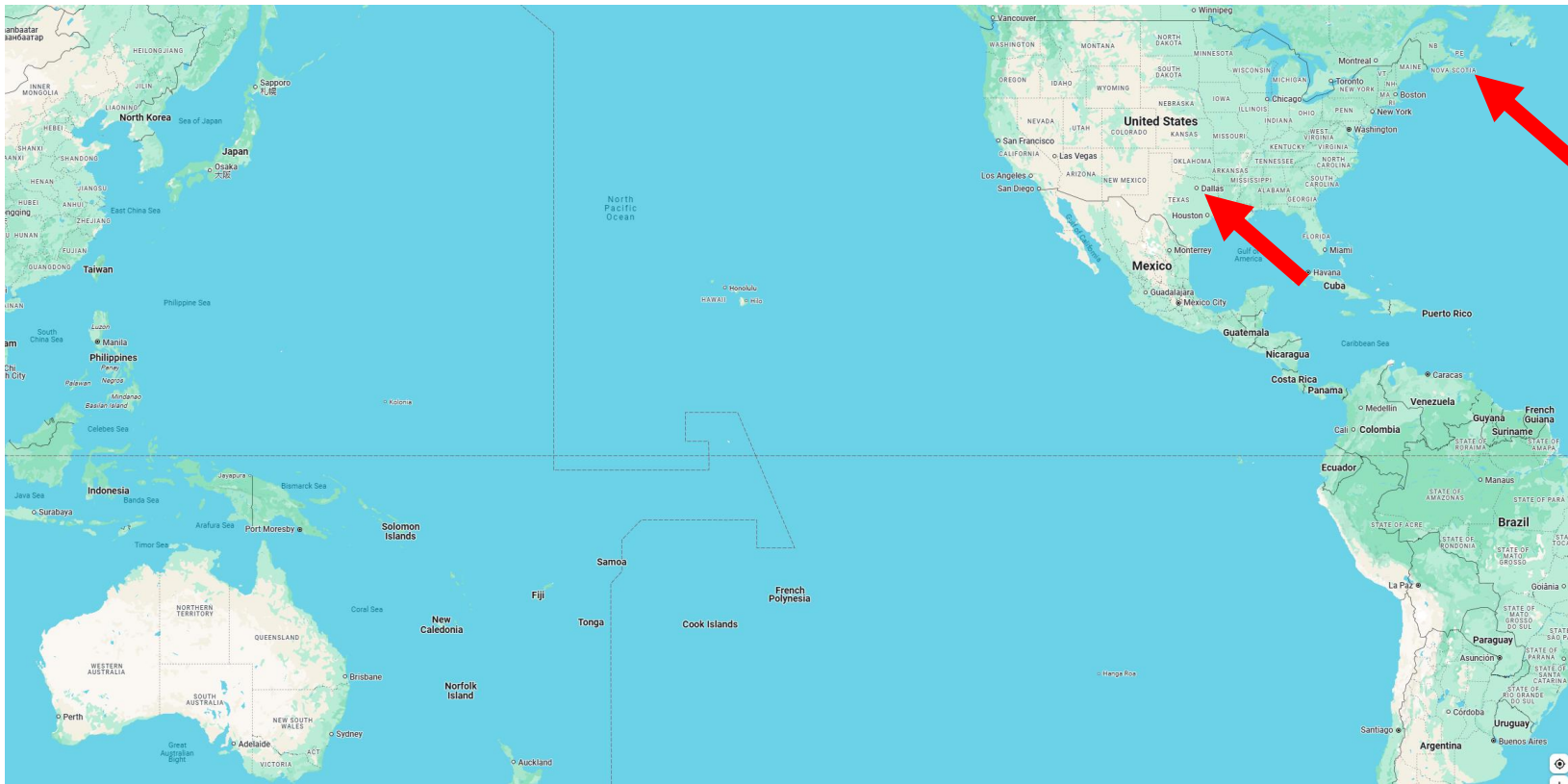
SGRT APAC 2025

Outline

- **About UT Southwestern Radiation Oncology**
- **Why non-coplanar (NCP) treatments are important**
- **How we did clearance checks**
- **MapRT our Clearance Check Saviour**
- **Initial implementation**
- **Case Examples**
- **Summary**

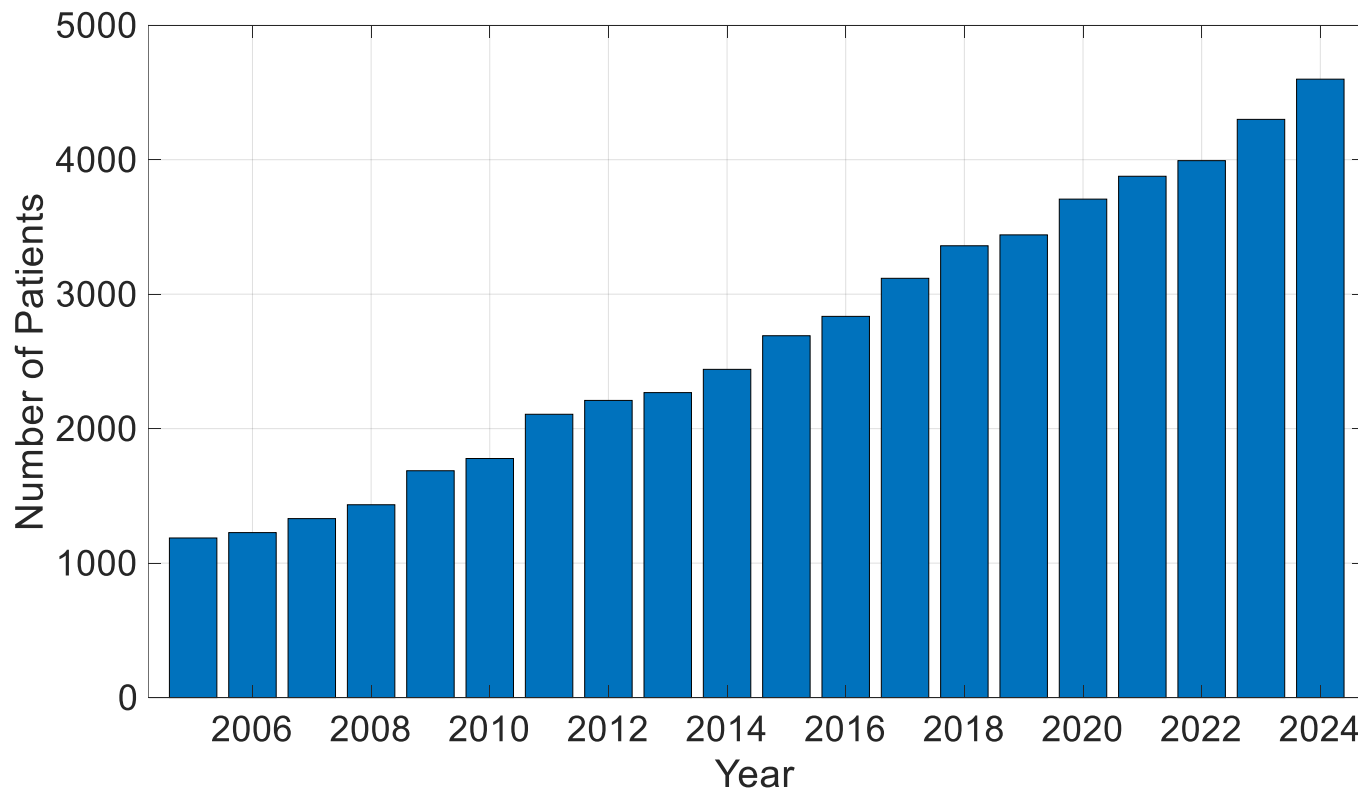
1. About UT Southwestern Radiation Oncology

UT Southwestern



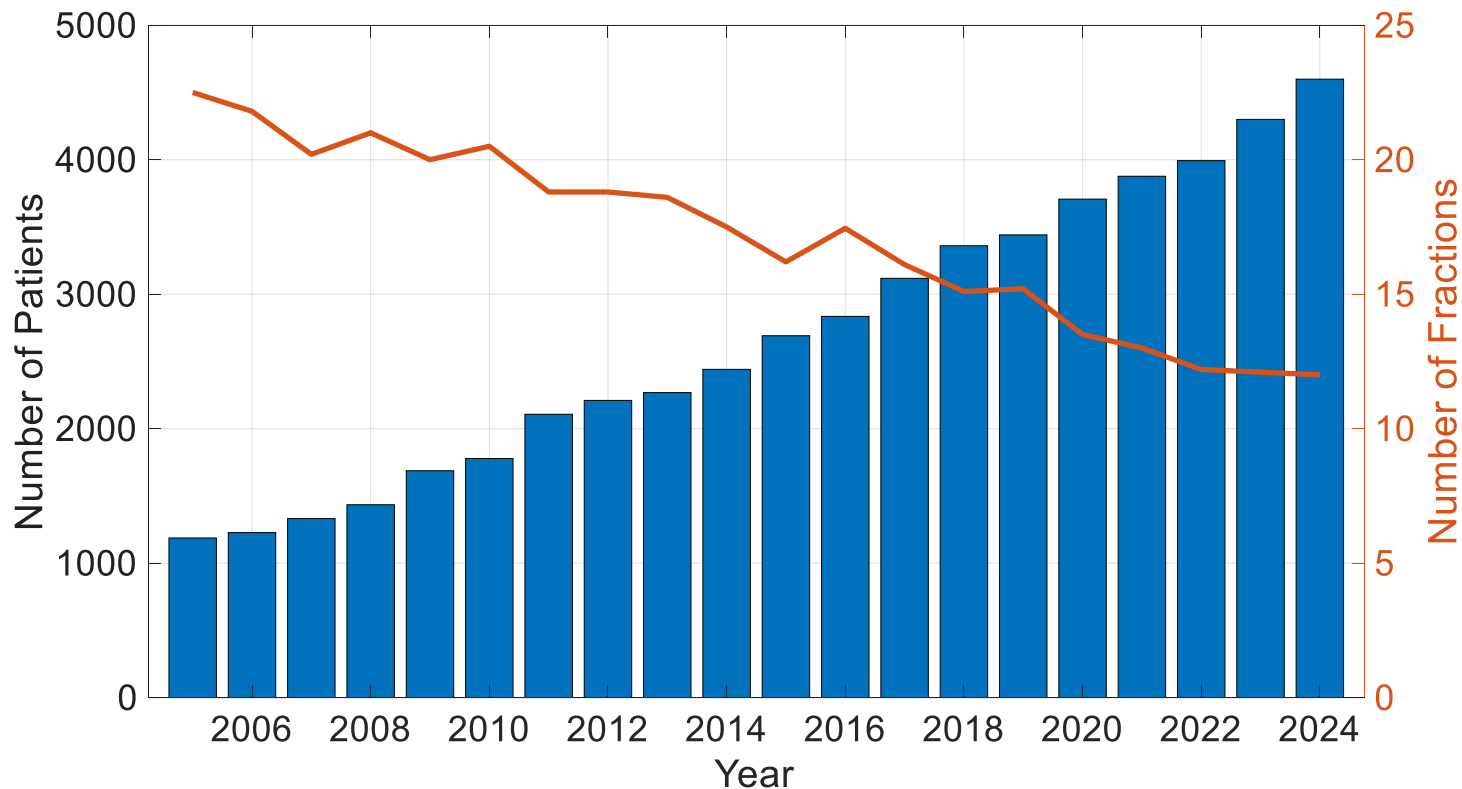
UT Southwestern Growth

- In 2024, we are treating ~4600 patients



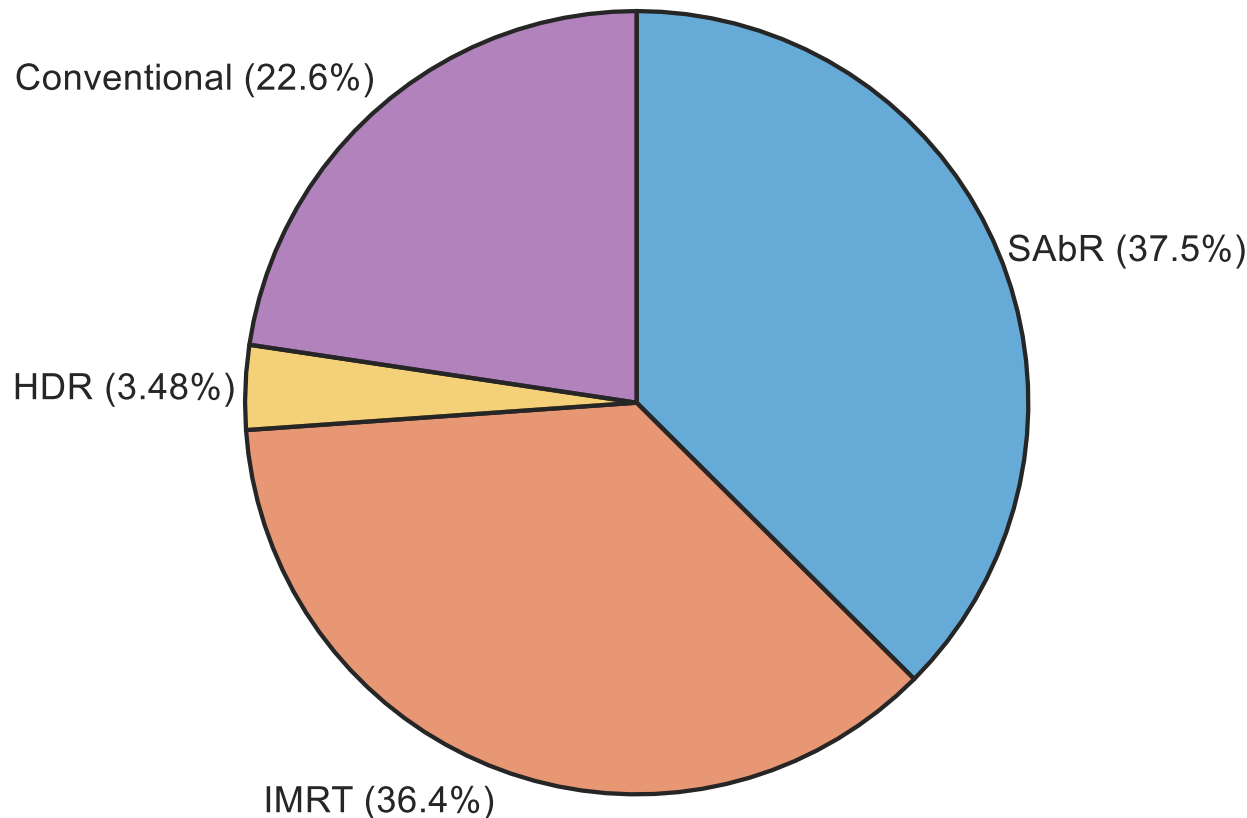
Drastic decrease in the number of fractions

- In 2024, we are treating ~4600 patients
- Average number of fractions is 12



Stereotactic treatments account for a large volume

- In 2024, we are treating ~4600 patients
- Average number of fractions is 12
- ~1700 are SAbR



2. Why non-coplanar treatments are important



Respect tumor coverage and “Dose Compactness” constraints

- These characterize (define) SAbR
- High dose conformality, d2cm, low gradient index (GI)
- Designed to require **many beams, many angles**, spread out entrance dose, etc...
- Effectively, **isotropic dose falloff**

SAbR Planning: Priorities



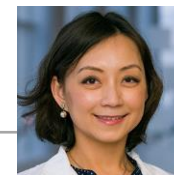
d2cm is the max dose 2 cm away from the PTV in any direction

Gradient Index is:

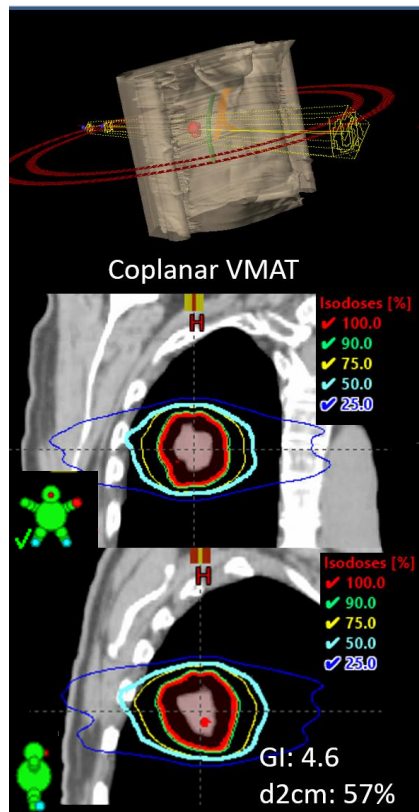
$$GI = \frac{V_{50\%Rx}}{V_{100\%Rx}}$$

PTV Volume (cc)	Ratio of Prescription Isodose Volume to the PTV Volume		Ratio of 50% Prescription Isodose Volume to the PTV Volume, R _{50%}		Maximum Dose (in % of dose prescribed) @ 2 cm from PTV in Any Direction, D _{2cm} (Gy)		Percent of Lung Receiving 20 Gy Total or More, V ₂₀ (%)	
	Deviation		Deviation		Deviation		Deviation	
	None	Minor	None	Minor	None	Minor	None	Minor
1.8	<1.2	<1.5	<5.9	<7.5	<50.0	<57.0	<10	<15
3.8	<1.2	<1.5	<5.5	<6.5	<50.0	<57.0	<10	<15
7.4	<1.2	<1.5	<5.1	<6.0	<50.0	<58.0	<10	<15
13.2	<1.2	<1.5	<4.7	<5.8	<50.0	<58.0	<10	<15
22.0	<1.2	<1.5	<4.5	<5.5	<54.0	<63.0	<10	<15
34.0	<1.2	<1.5	<4.3	<5.3	<58.0	<68.0	<10	<15
50.0	<1.2	<1.5	<4.0	<5.0	<62.0	<77.0	<10	<15
70.0	<1.2	<1.5	<3.5	<4.8	<66.0	<86.0	<10	<15
95.0	<1.2	<1.5	<3.3	<4.4	<70.0	<89.0	<10	<15
126.0	<1.2	<1.5	<3.1	<4.0	<73.0	>91.0	<10	<15
163.0	<1.2	<1.5	<2.9	<3.7	<77.0	>94.0	<10	<15

SAbR Planning: Lung Beam Orientation



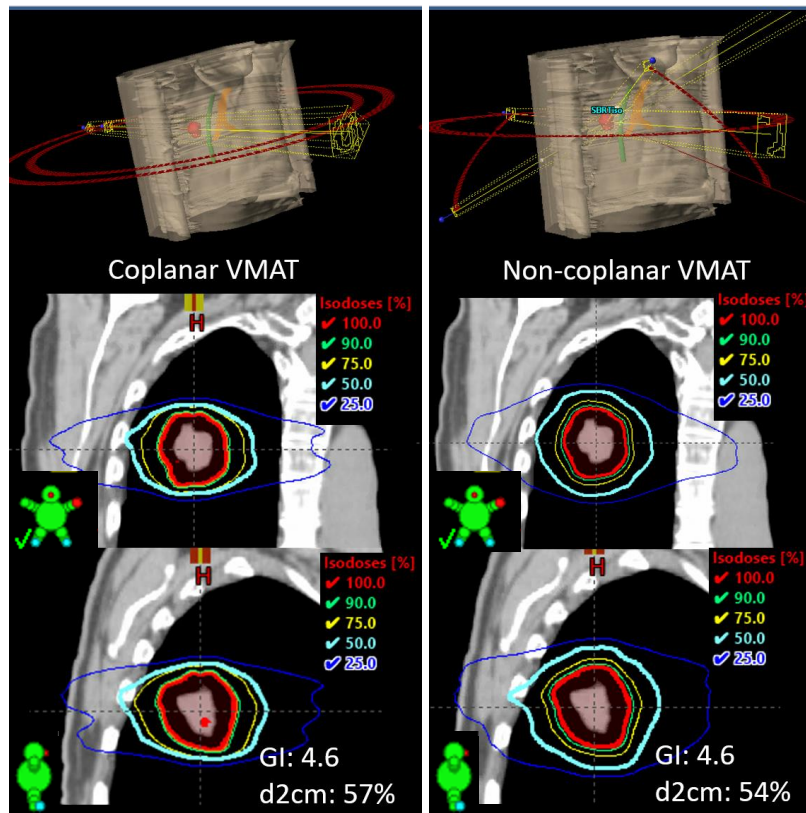
Mu-Han Lin, Ph.D.
Medical Physicist



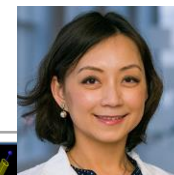
SAbR Planning: Lung Beam Orientation



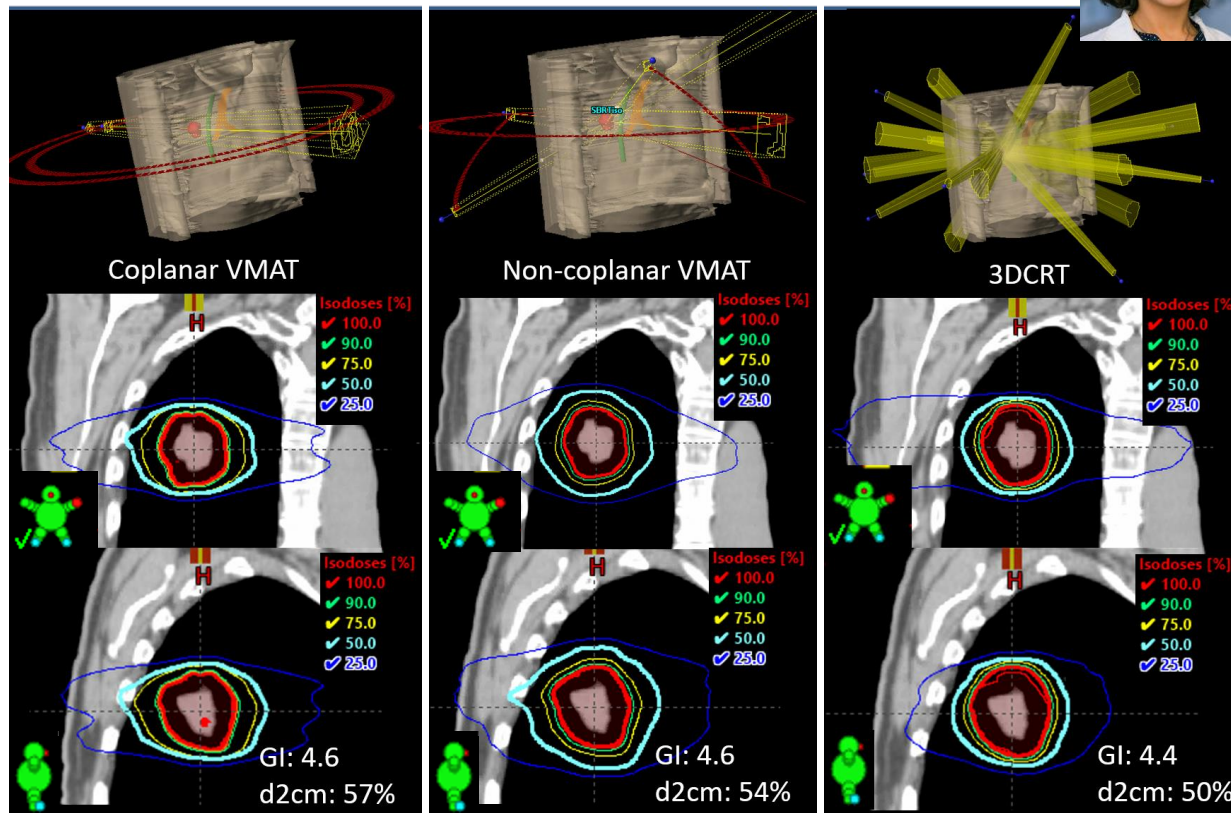
Mu-Han Lin, Ph.D.
Medical Physicist



SAbR Planning: Lung Beam Orientation



Mu-Han Lin, Ph.D.
Medical Physicist



3. How we did clearance checks

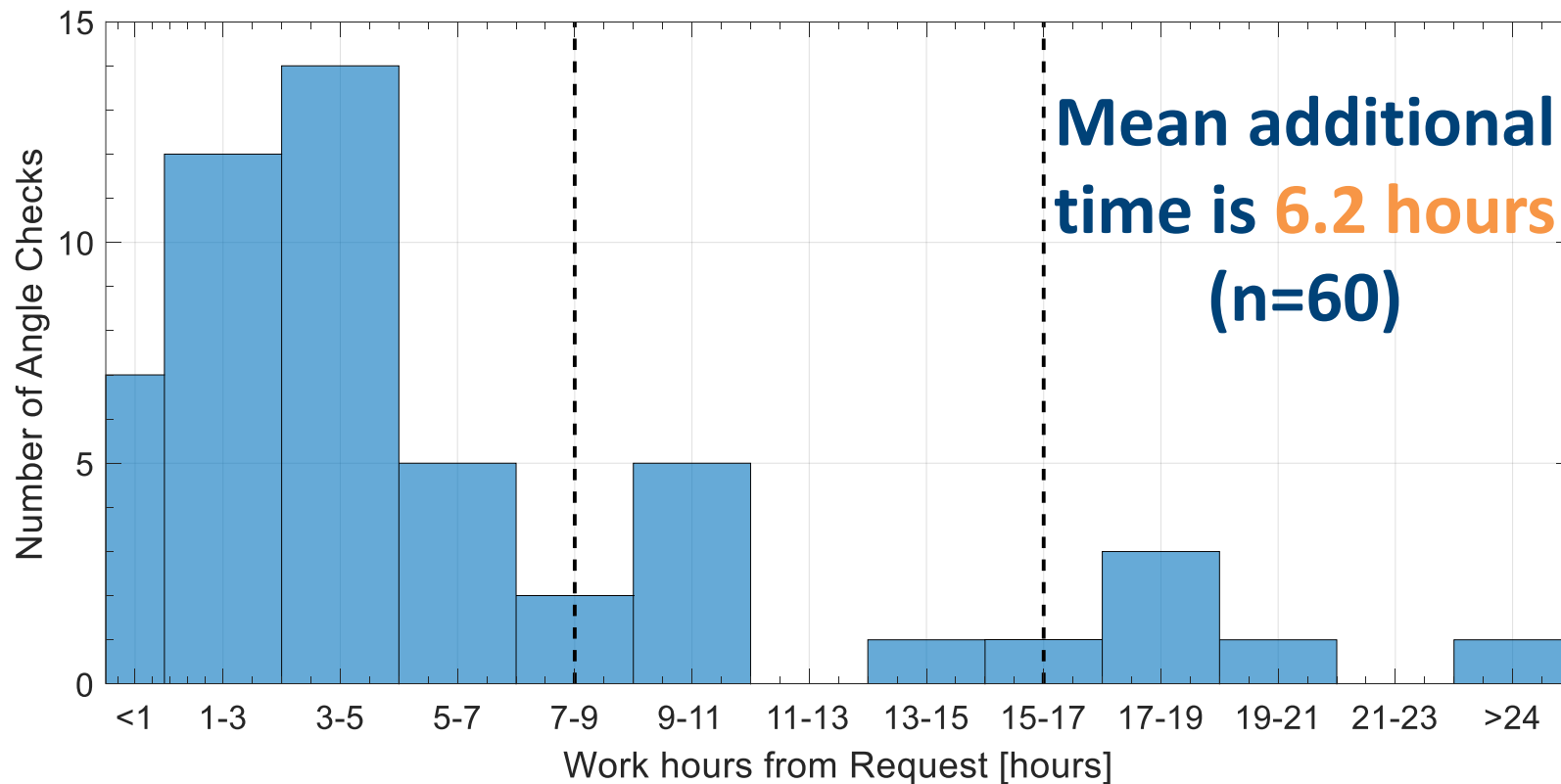
Currently this is mostly a manual process



Fields

ID - Name	Technique	FieldSize X1/X2 (cm)	FieldSize Y1/Y2 (cm)	Isocenter (cm)	Gantry (deg)	Collimator (deg)	Couch (deg)
1 - <input type="checkbox"/> Pass <input type="checkbox"/> Fail	SRS STATIC-Static	1.9 / 1.8	2.3 / 2.3	0.00, 0.00, 0.00	180.1 <input type="text"/>	0.0 <input type="text"/>	0.0 <input type="text"/>
2 - <input type="checkbox"/> Pass <input type="checkbox"/> Fail	SRS STATIC-Static	2.8 / 1.1	2.4 / 2.4	0.00, 0.00, 0.00	230.0 <input type="text"/>	0.0 <input type="text"/>	10.0 <input type="text"/>
3 - <input type="checkbox"/> Pass <input type="checkbox"/> Fail	SRS STATIC-Static	3.1 / 0.6	2.5 / 2.3	0.00, 0.00, 0.00	270.0 <input type="text"/>	0.0 <input type="text"/>	345.0 <input type="text"/>
4 - <input type="checkbox"/> Pass <input checked="" type="checkbox"/> Fail	SRS STATIC-Static	3.1 / 0.6	2.4 / 2.5	0.00, 0.00, 0.00	270.0 <input type="text"/>	0.0 <input type="text"/>	15.0 10 <input type="text"/>
5 - <input type="checkbox"/> Pass <input type="checkbox"/> Fail	SRS STATIC-Static	2.6 / 1.3	2.3 / 2.2	0.00, 0.00, 0.00	315.0 <input type="text"/>	0.0 <input type="text"/>	0.0 <input type="text"/>
6 - <input type="checkbox"/> Pass <input type="checkbox"/> Fail	SRS STATIC-Static	1.9 / 1.8	2.7 / 2.1	0.00, 0.00, 0.00	15.0 <input type="text"/>	90.0 <input type="text"/>	90.0 <input type="text"/>

Manual clearance checks adds to planning time



Trouble!!!!

Angle Check Request

Patient: [REDACTED] MRN: [REDACTED]
Initiated By: Francisco, Jeric
Initiated Date: September 21st, 2022 - 10:09am GMT -05:00
Attn. Phys: Westover, M.D., Ph. D., Kenneth D

Planning

Plan Name
LungR

Machine

TrueBeam2 - EROC

Status

- ☒ Initial Check
☐ Re-Check

Start Date

September 23rd, 2022

Planning Comments

Failed - change Y to 120 for CBCT clearance. Center couch only changes lat. (Coll 175 for CBCT)

Angle
Verification

Table Vertical

Table Lateral

Table Longitudinal

Angle Verification Comments

G180 change to 180.1, G30/couch90 change to G15/couch90, G40/couch 345 change to G35/couch345.

- CBCT won't clear iso too posterior
- Collides with the immobilization
- 2 couch/gantry combinations
- Collides with the immobilization



Not every risk can be evaluated



UT Southwestern Medical Center

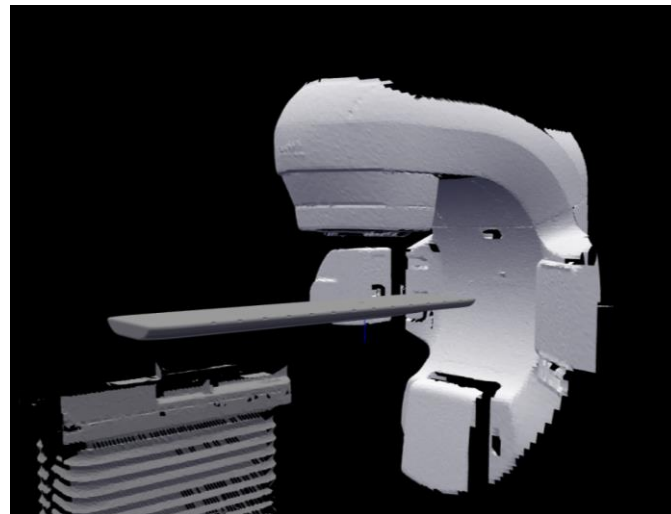
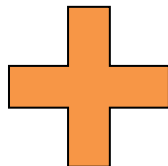
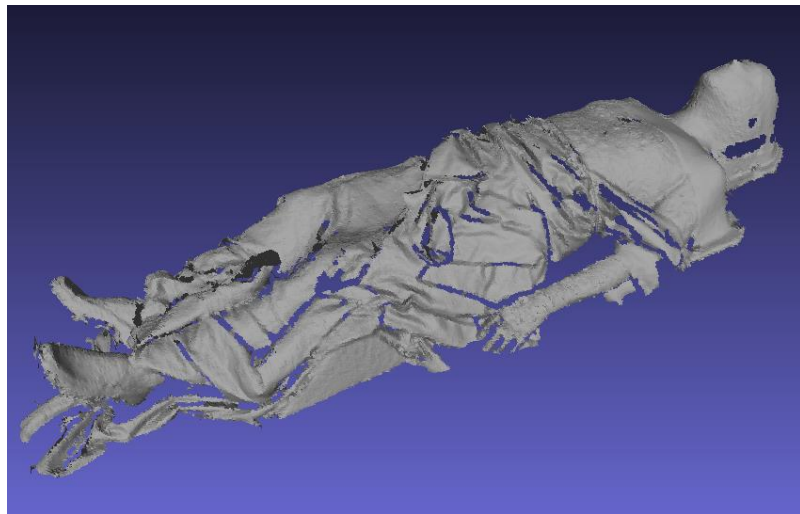
Angle Check Request

Patient: [REDACTED]	MRN: [REDACTED]
Initiated By: Mai, Trinh	Initiated Date: September 21st, 2022 - 4:59pm GMT -05:00
Attn. Phys: Westover, M.D., Ph. D., Kenneth D	
Planning	
Plan Name LungR	Machine TrueBeam2 - EROC
Status	
<input type="checkbox"/> Initial Check	
<input checked="" type="checkbox"/> Re-Check	
Start Date September 23rd, 2022	
Planning Comments new doc with new suggested iso & gantry are in mosaic	
Angle Verification	
Table Vertical 13.8	
Table Lateral 0	
Table Longitudinal 118.62	
Angle Verification Comments all clear, watch L elbow - wg	

4. MapRT our Clearance Check Saviour

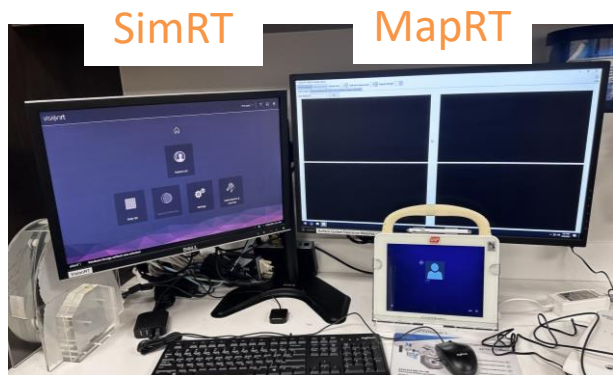
MapRT

- MapRT is a SGRT virtual clearance mapping software



MapRT

- MapRT is a SGRT virtual clearance mapping software
- Consists of 2 Horizon cameras in the CT vault



Plan Name: Larynx 4250, ISO (mm) [0.1, 37.3, 18.0] (24/03/2023 13:40:28)

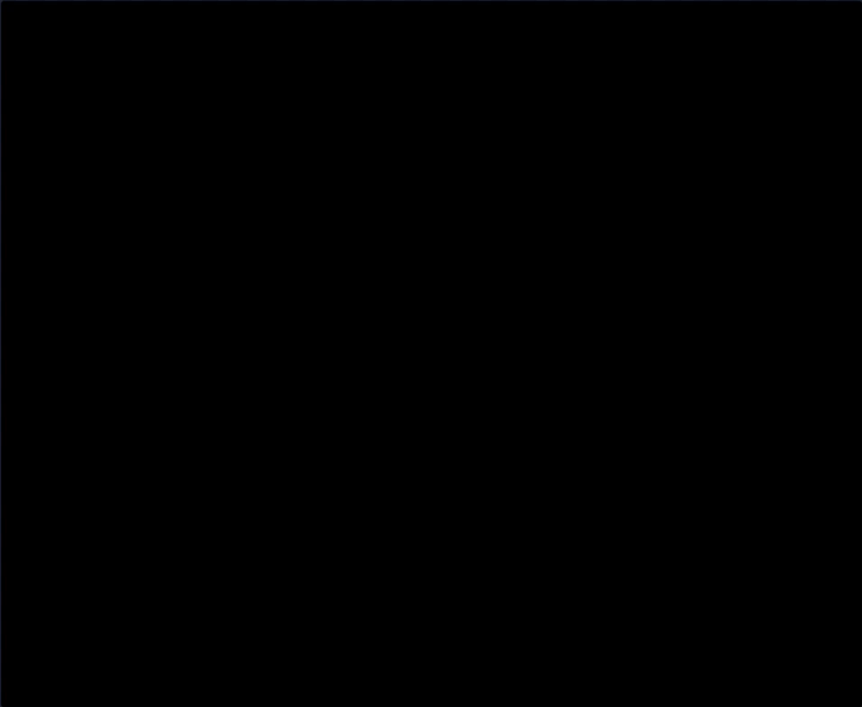
[Continue to Collision Map](#)

Select Patient Surface

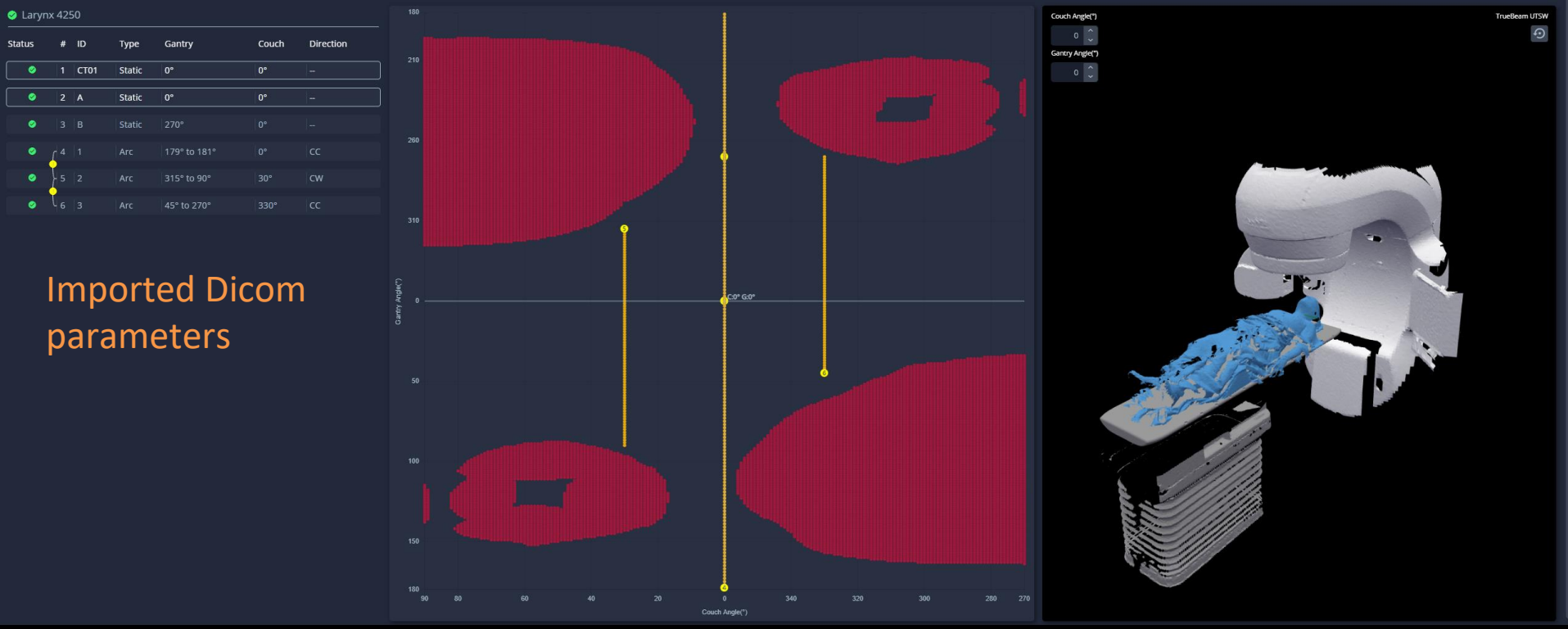
Surface Name	Captured
20230321 091322	21/03/2023 16:02:44

Select Treatment Room

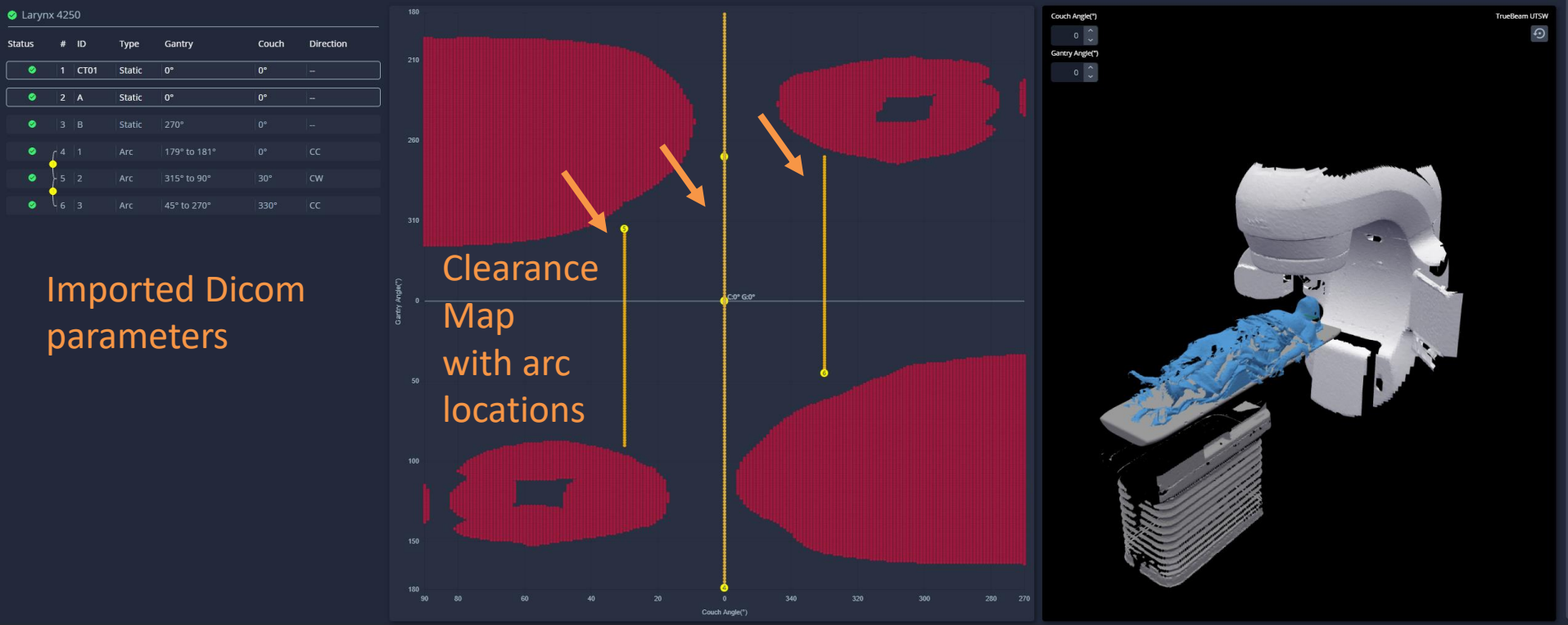
Room Name	Treatment Machine	Couch
TrueBeam UTSW	TrueBeam LIDAR	TrueBeam LIDAR
Versa HD UTSW	Versa HD	Elekta Couch



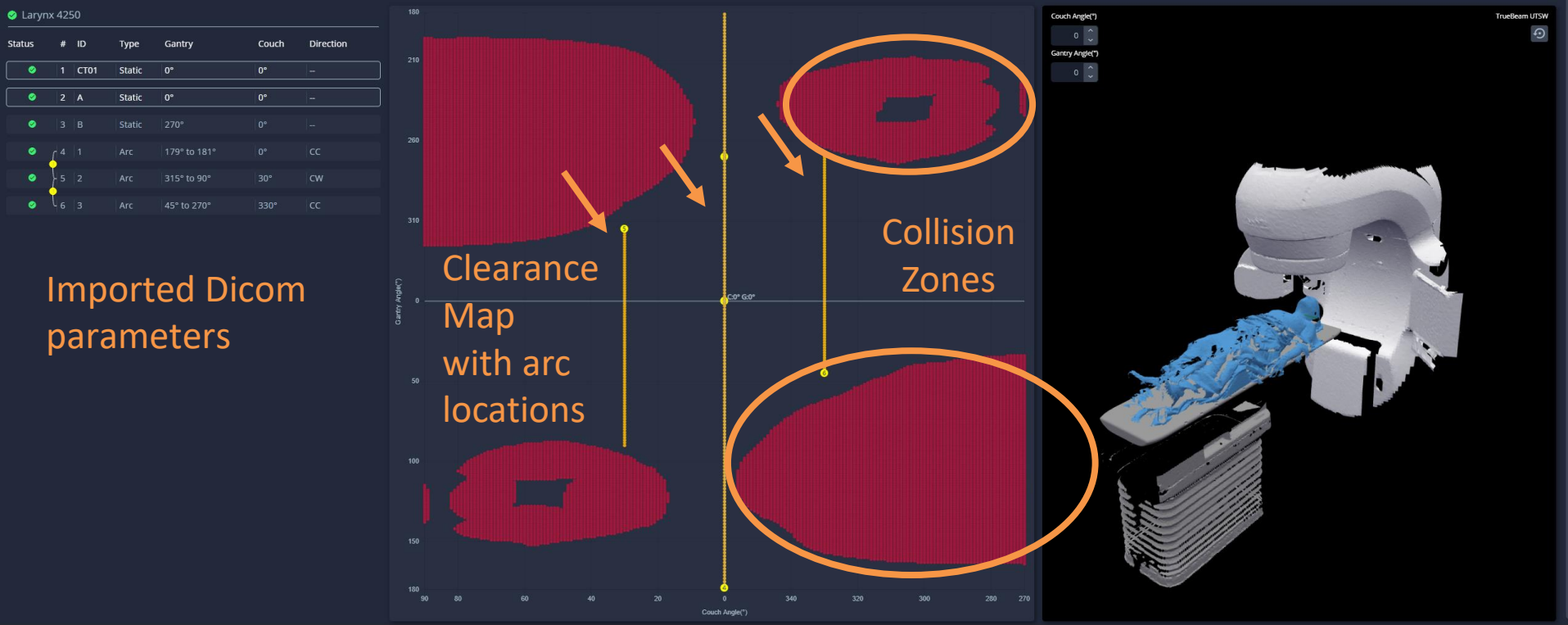
MapRT



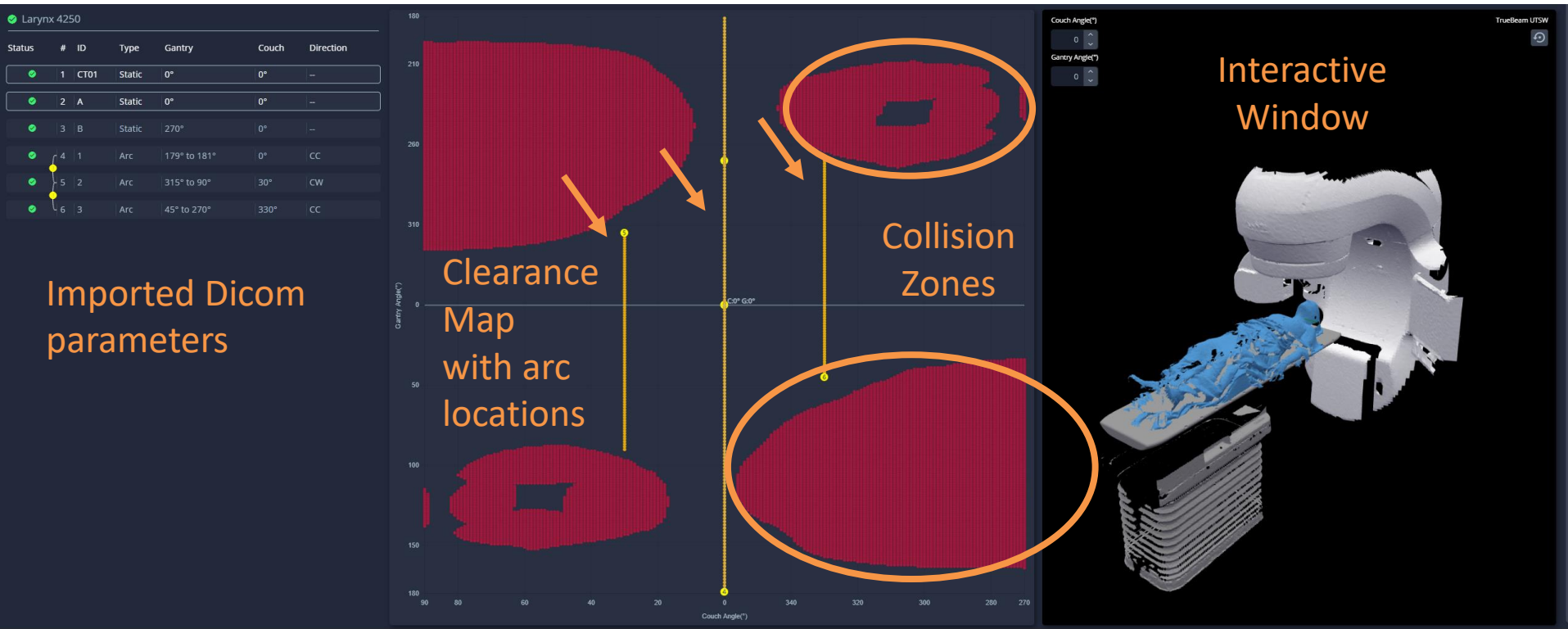
MapRT



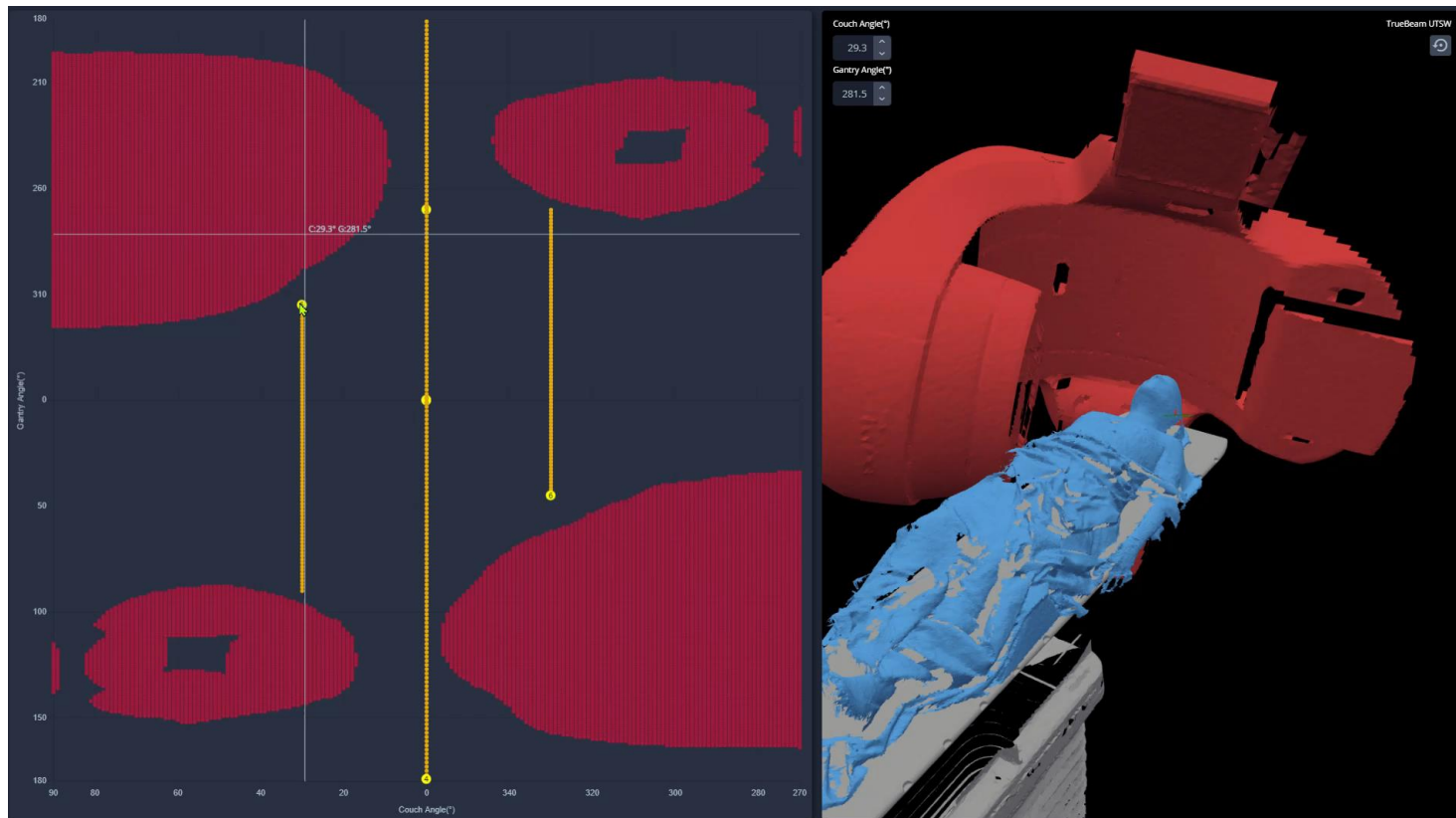
MapRT



MapRT



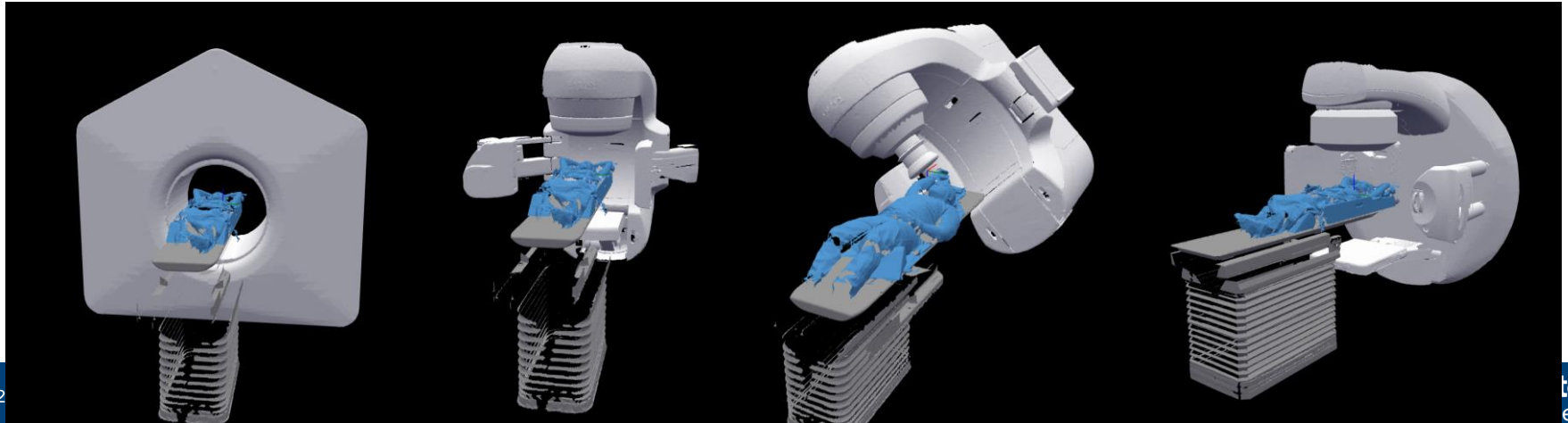
MapRT



5. Implementation

Implementation Timeline

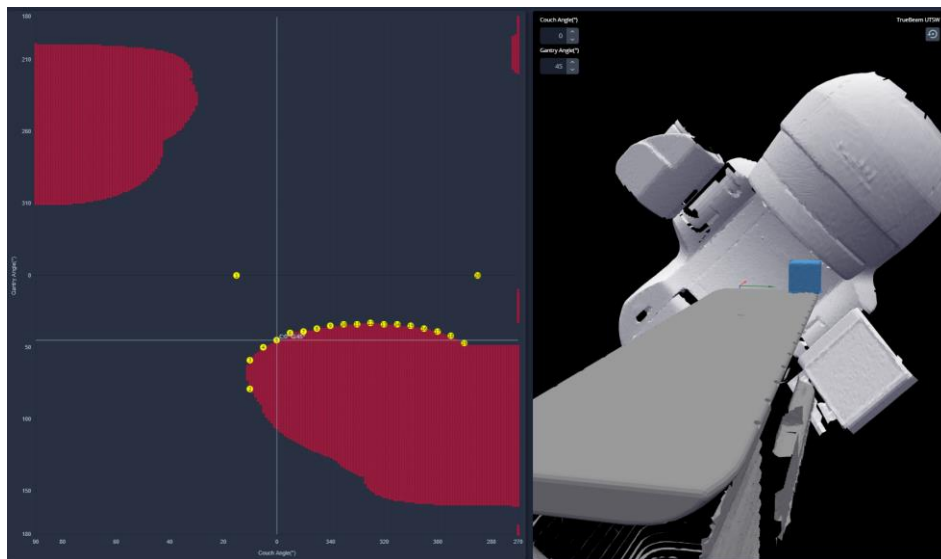
- Research version installed 08/2022
- Validation / iteration updates over the next year
- Clinically live 10/2023
- 2nd system installed 01/2024 – more linac models added
- 3rd system installed 01/2025 (first system on a PET/CT)



What is the accuracy?



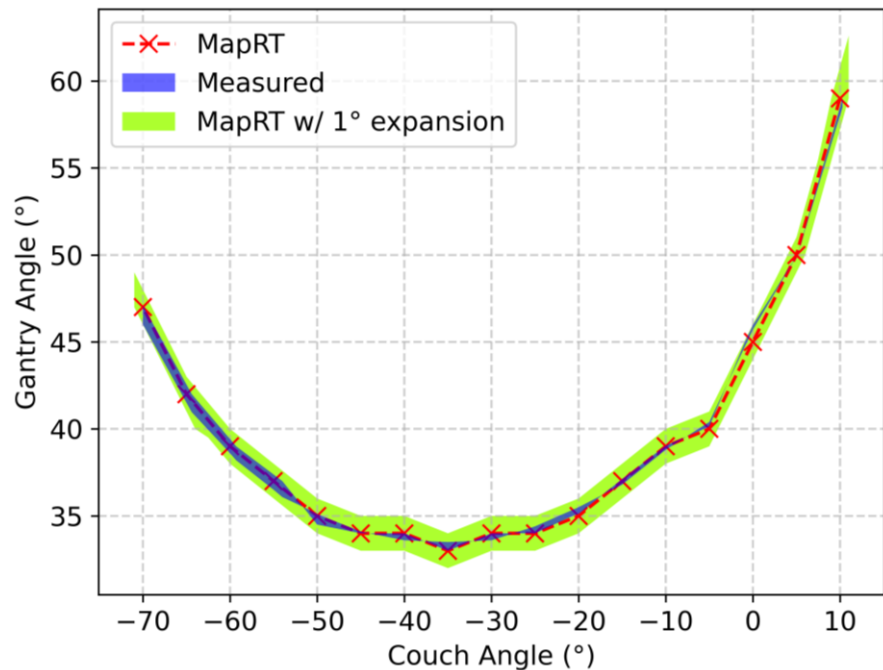
Siqui Wang, Ph.D.
Medical Physicist



Clearance accuracy is within $\pm 1^\circ$



Siqui Wang, Ph.D.
Medical Physicist



How does it compare to manual checks?



Siqu Wang, Ph.D.
Medical Physicist

60 SAbR and non-coplanar brain patients at UTSW

Method	Clearance Agreed	Clearance Disagreed	Success Ratio
Physical Angle Check	55	5	91.7%
MapRT			

How does it compare to manual checks?

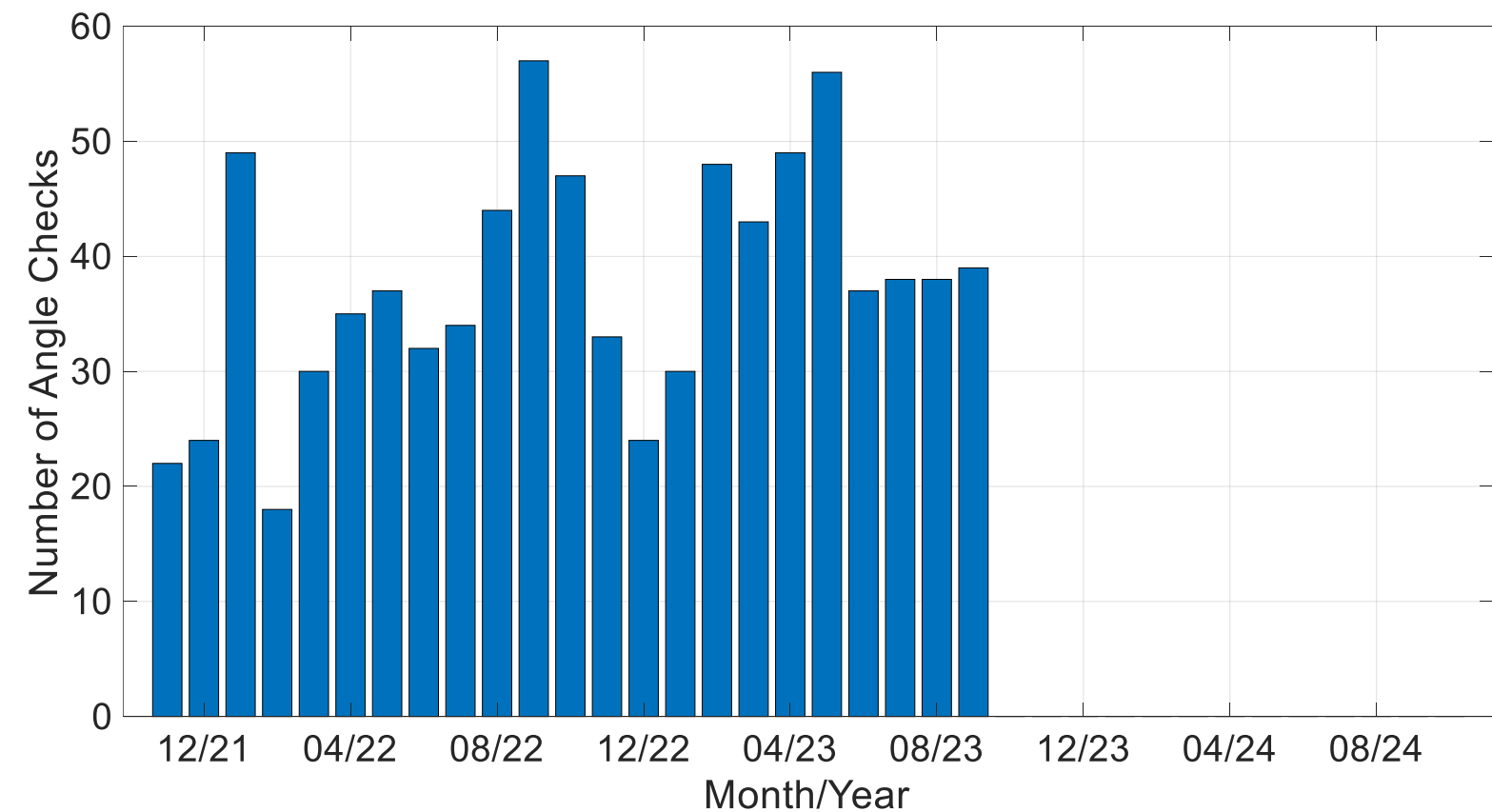


Siqu Wang, Ph.D.
Medical Physicist

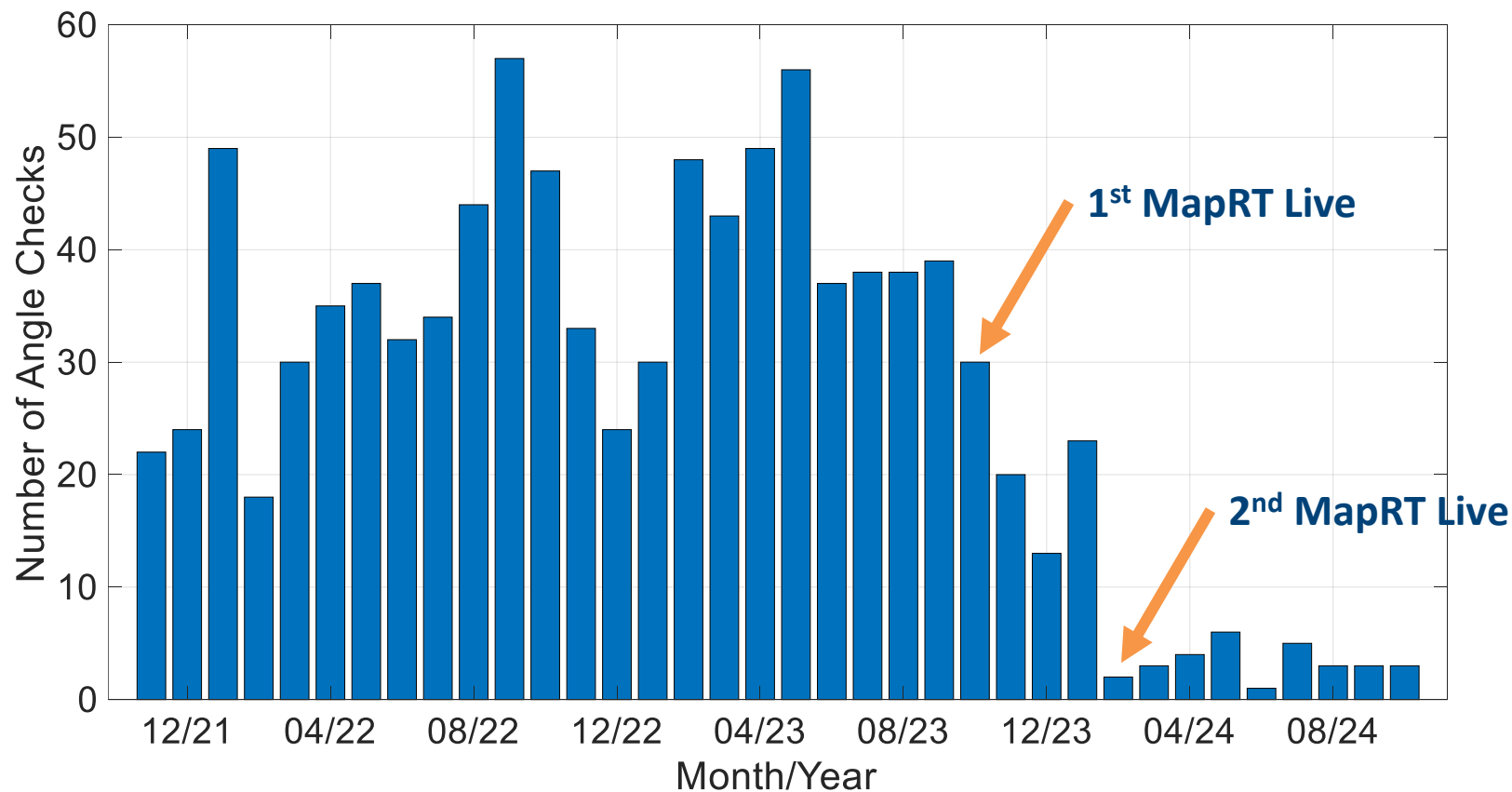
60 SAbR and non-coplanar brain patients at UTSW

Method	Clearance Agreed	Clearance Disagreed	Success Ratio
Physical Angle Check	55	5	91.7%
MapRT	60	0	100%

Manual Angle Checks for our Varian Linacs



Manual Angle Checks for our Varian Linacs



Residual Checks – Devices that cover markers



- MR-Linac – we've shifted the Marker location further down the couch
- CyberKnife – the therapists tuck under the patient's legs for capture

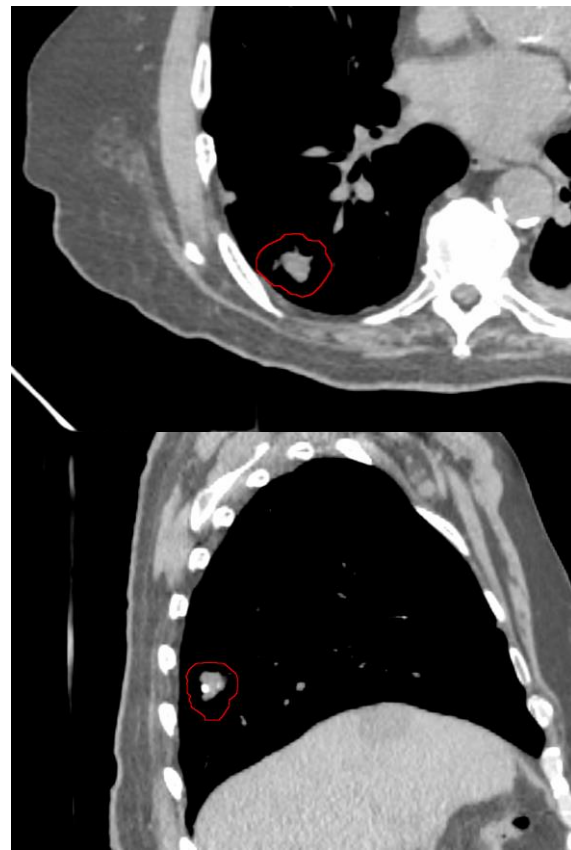
Estimated Time Savings for our Varian Linacs

- Prior to MapRT, on average there were **38** manual angle checks per month
 - ~9.5 hours of in-vault time
 - ~9.8 days of dosimetry waiting to start plans
- After MapRT, on average there were **3** manual angle checks per month
 - ~0.7 hours of in-vault time
 - ~0.8 days of dosimetry waiting to start plans

6. Case Examples

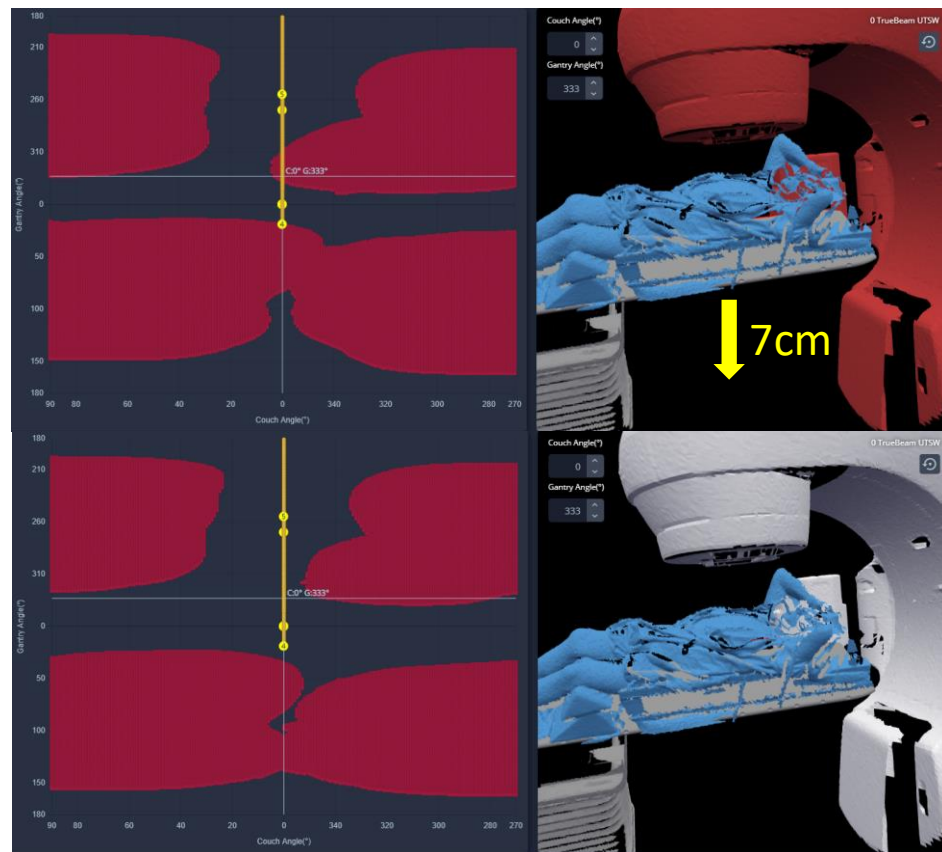
How this is done in practice

- 74-year-old female
- 17.6 cm³ right lung lesion
- SAbR candidate with 60Gy in 5Fx
- 2 arc treatment was chosen

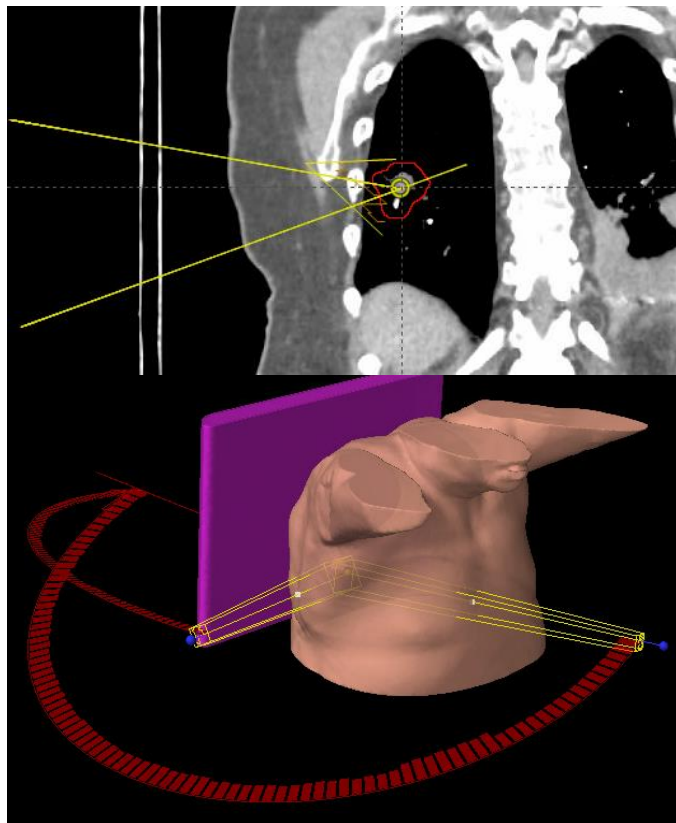


How this is done in practice

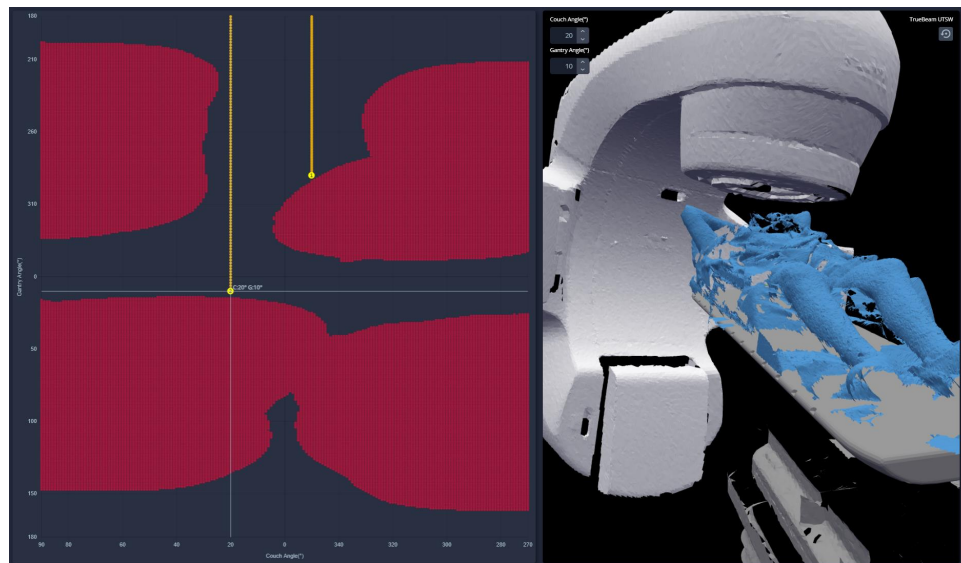
- 74-year-old female
- 17.6 cm³ right lung lesion
- SAbR candidate with 60Gy in 5Fx
- 2 arc treatment was chosen
- MapRT wasn't used
- Patient collision was identified on Fraction 1



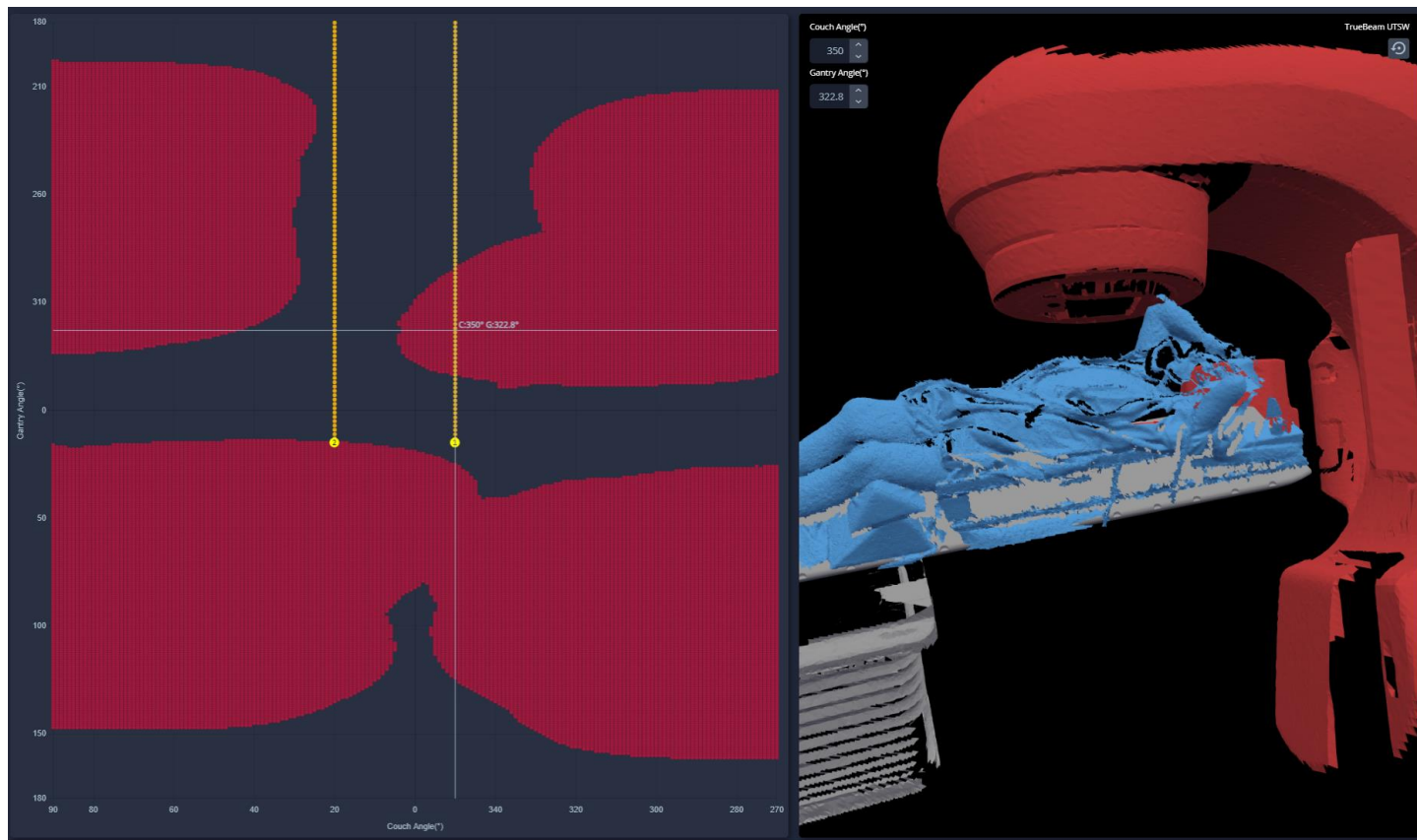
Leveraging MapRT for NCP Planning



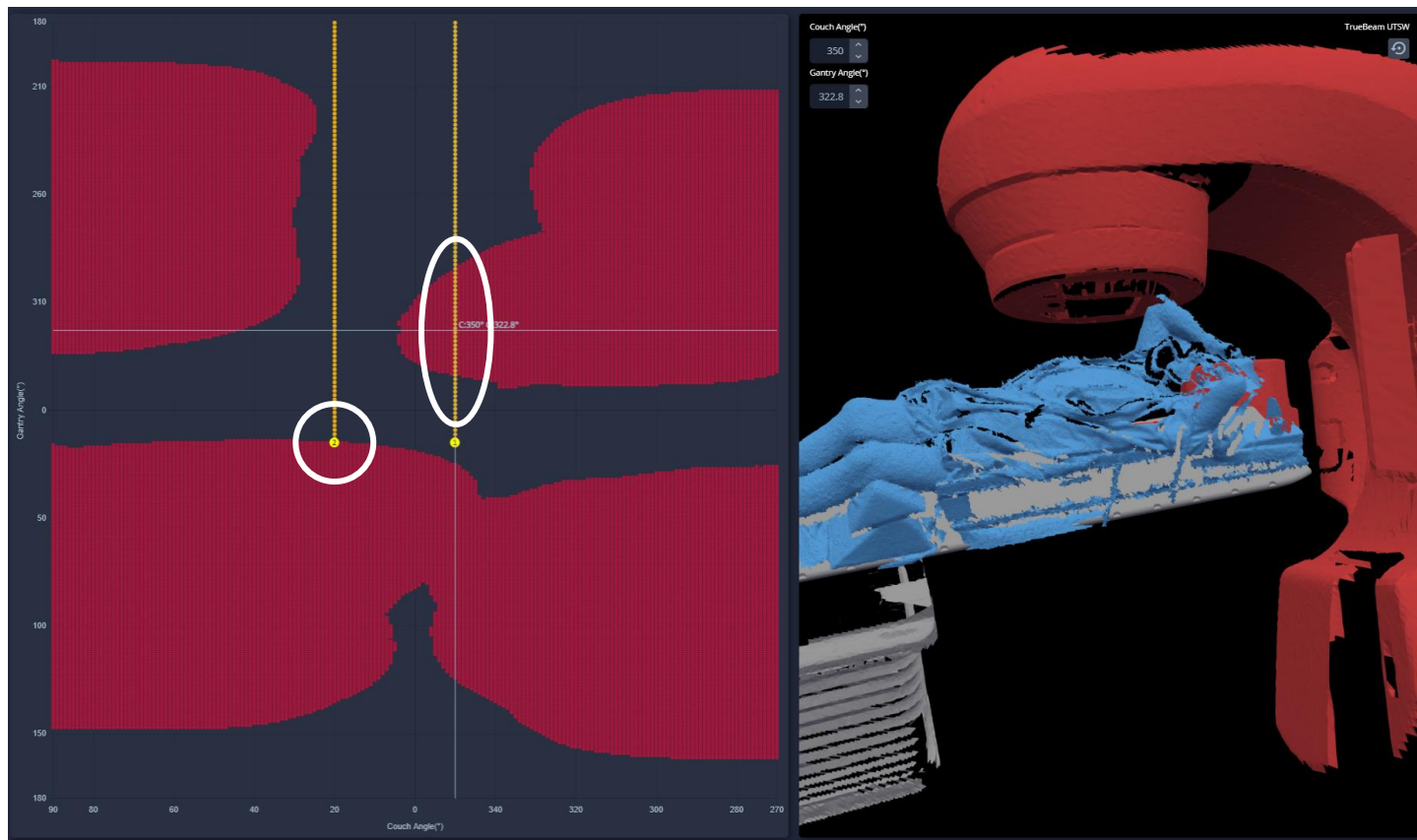
- Spread out the entrance and exit doses



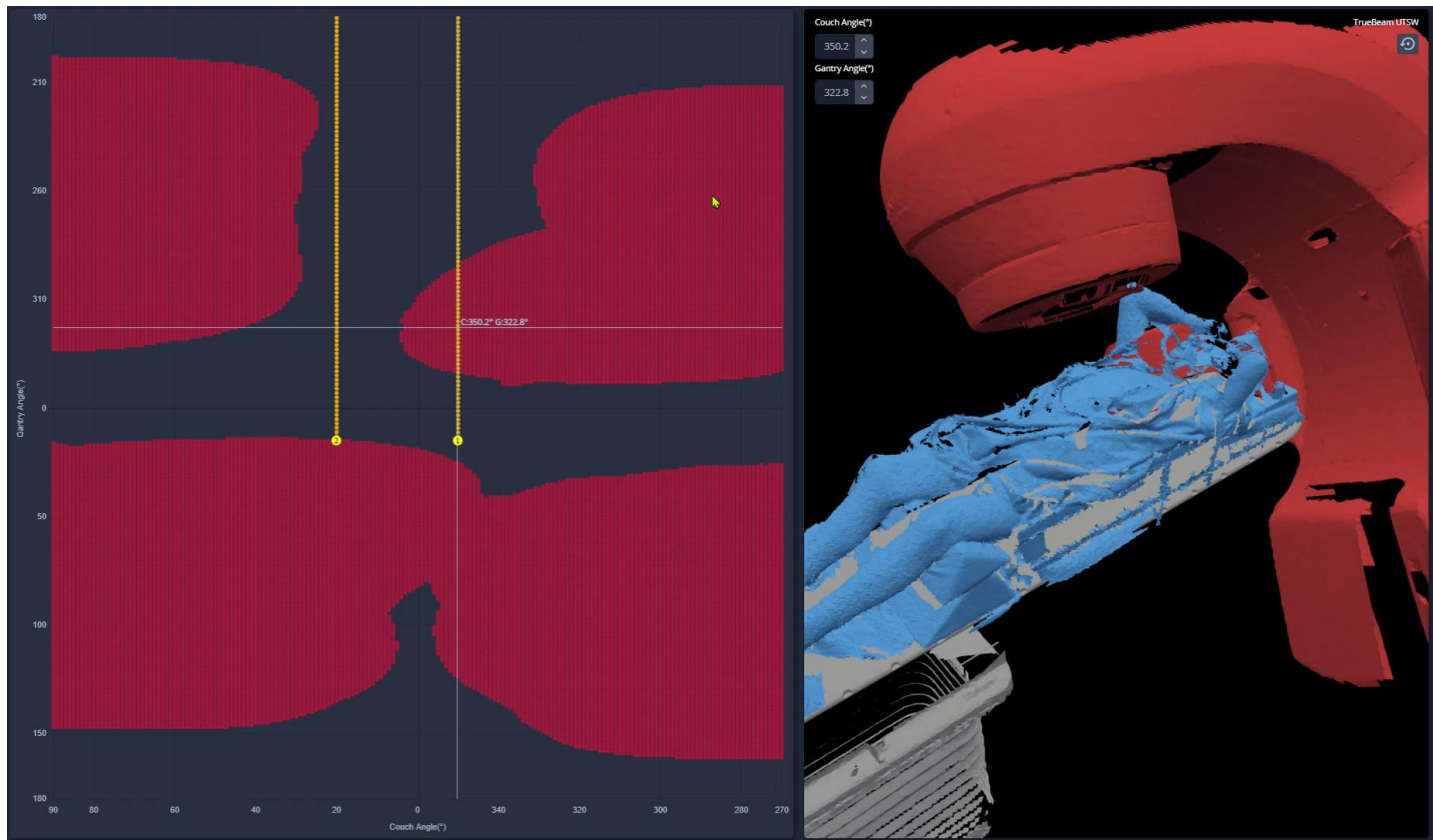
Enter MapRT



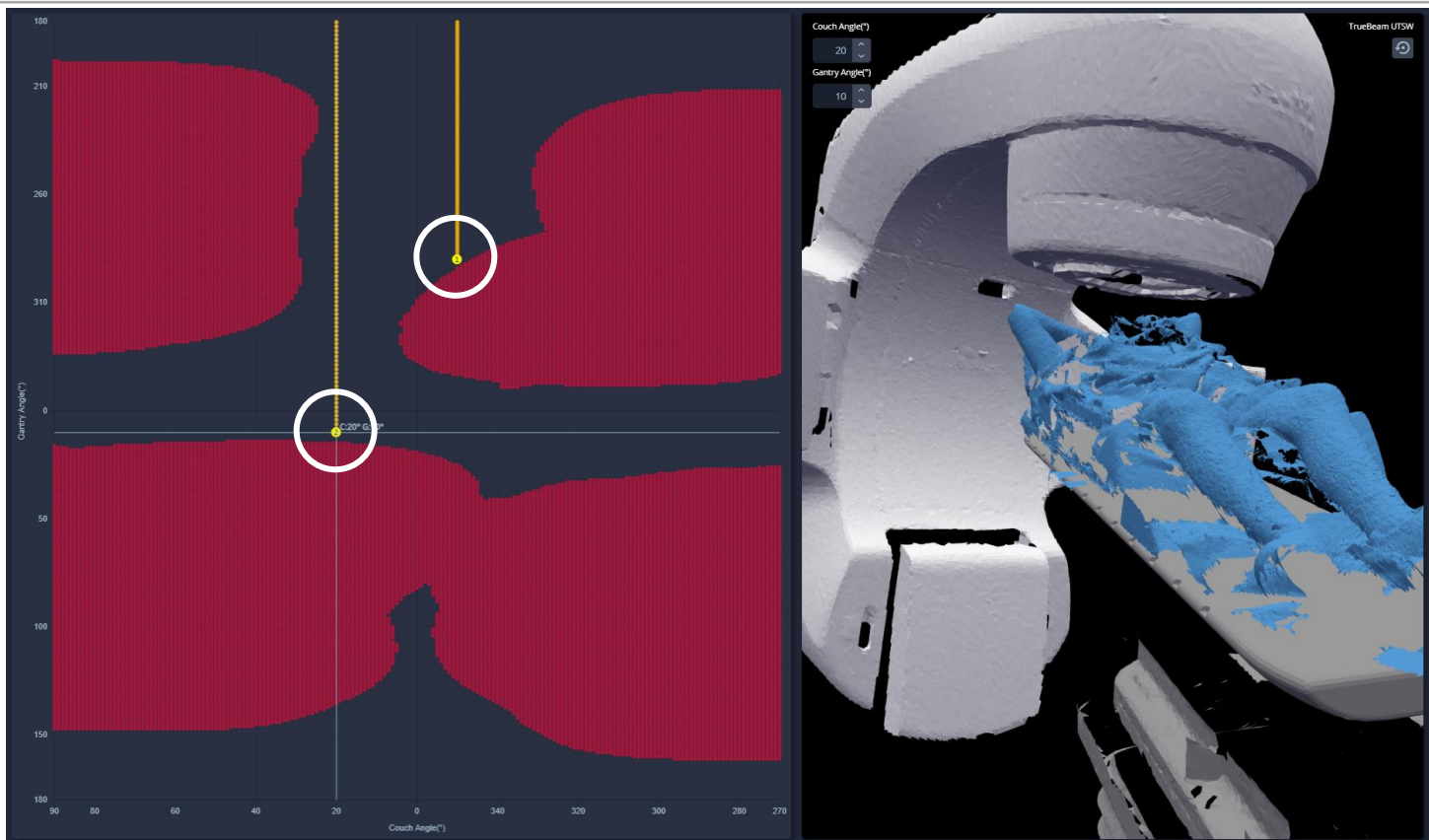
Identify the trouble spots



Adjust the areas of interest



Check the revise the field arrangement



Resulting comparison

Coplanar

$CI_{\text{Paddick}} = 0.89$

$GI_{50\%} = 4.54$

$GI_{25\%} = 28.5$

5688 MU

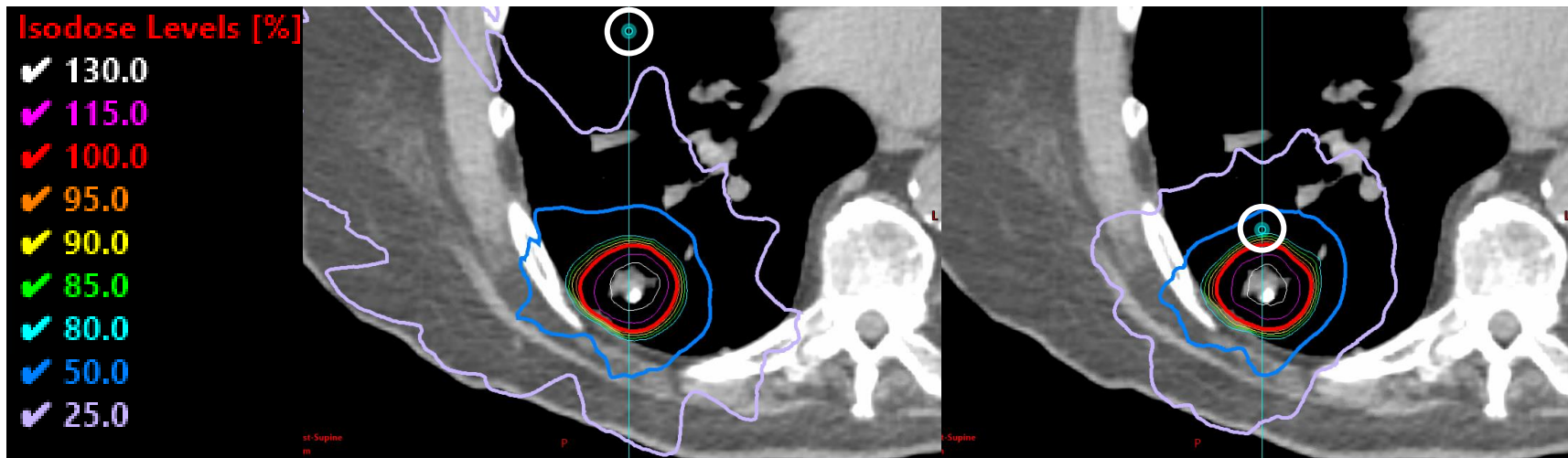
Non-coplanar

$CI_{\text{Paddick}} = 0.91$

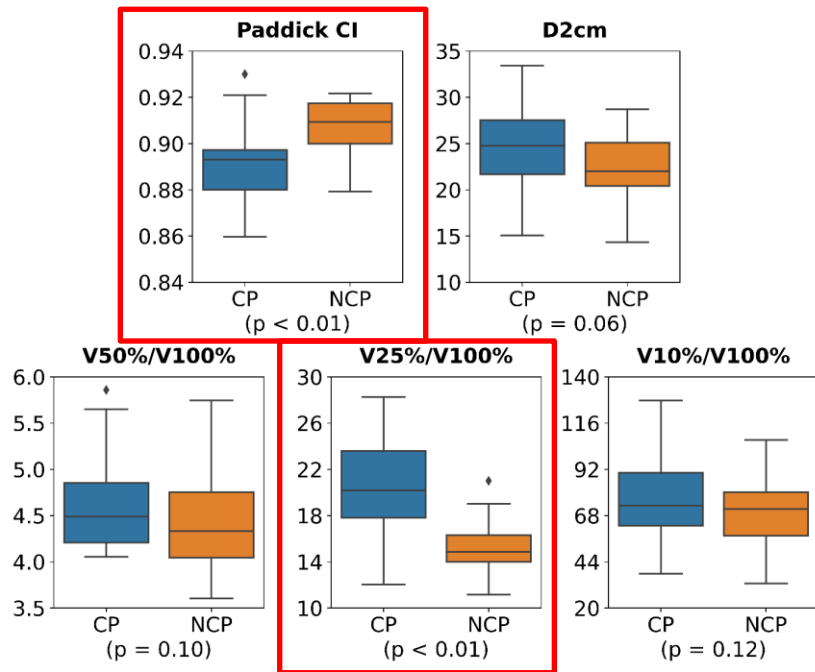
$GI_{50\%} = 4.30$

$GI_{25\%} = 15.1$

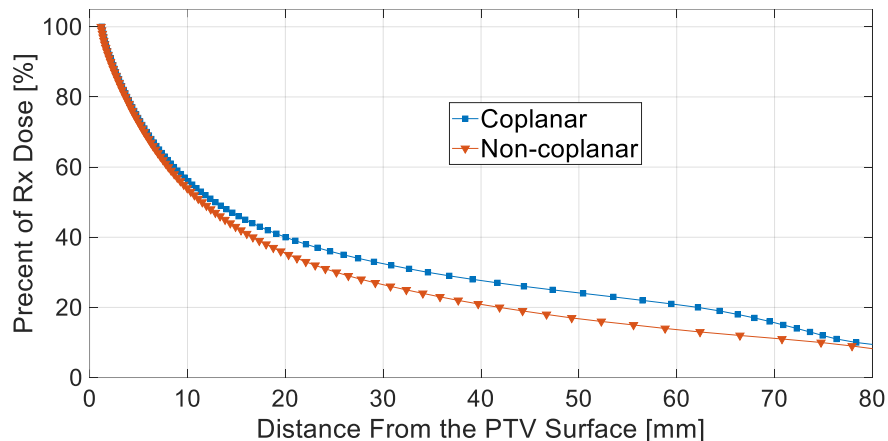
4061 MU



Over 20 lung SBRT patients

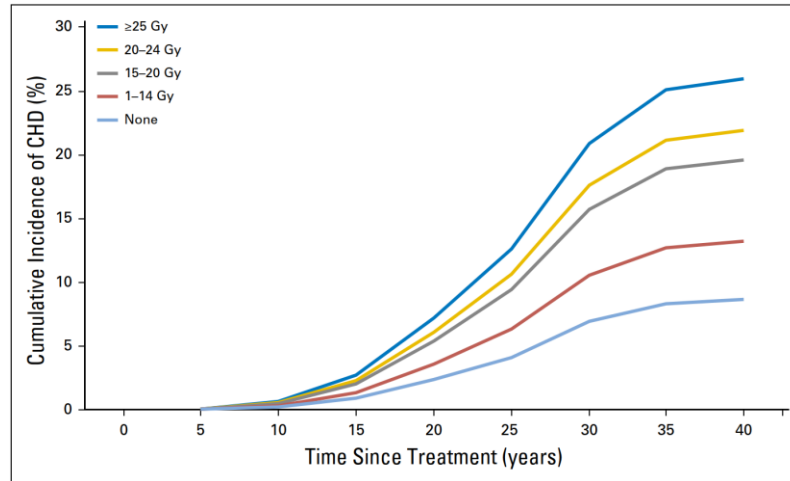


- NCP plans are **more conformal**
- **Significantly lower $V_{25\%}$**
- **Less low dose spillage over a large distance from PTV range**

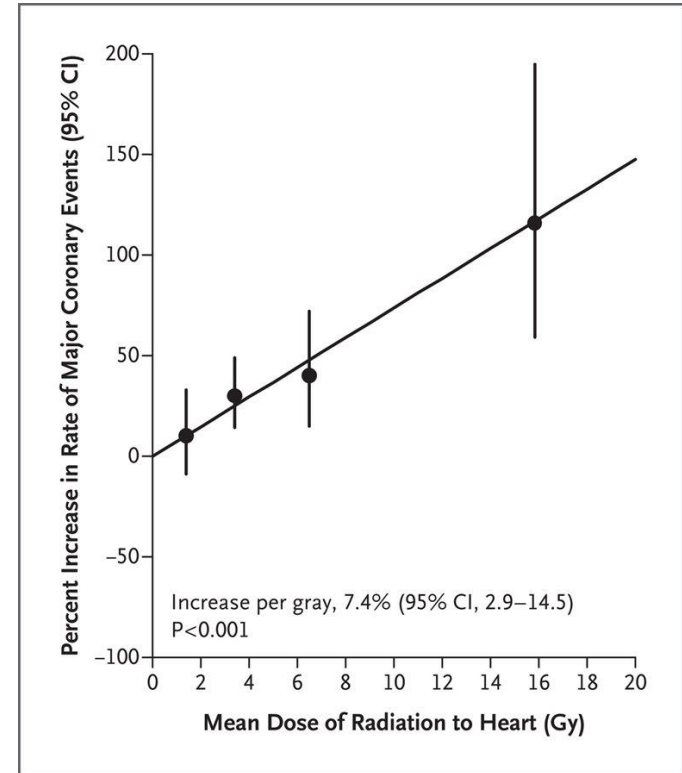


Breast sPBI: Why is heart dose critical?

- Long life expectancy for breast cancer patients
- Every 1 Gy increase in mean heart dose results in an excessive 7.4% increased risk of major coronary events in their lifetime
- Potentially no threshold dose



van Nimwegen et al. J Clin Oncol 2015;34(3).



Darby SC et al. N Engl J Med 2013;368:987-998.

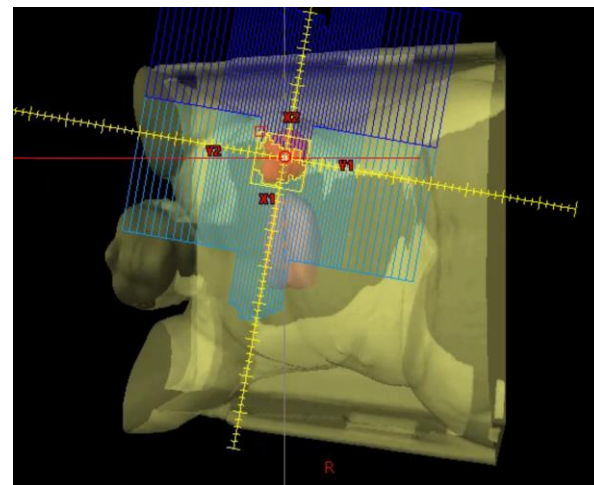
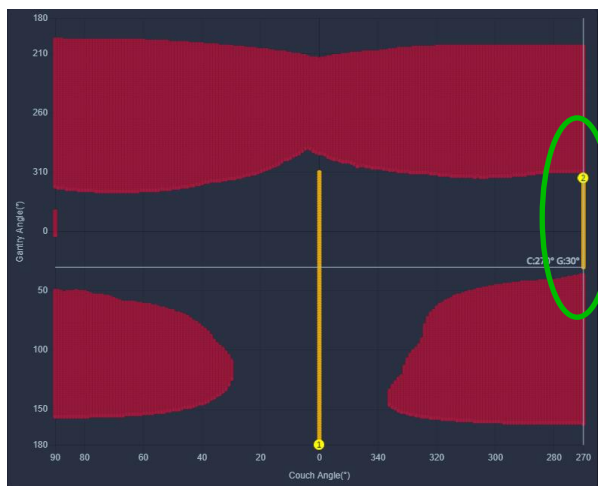
Planning with MapRT for Lung SBRT

- Case #2
- 59-year-old female
- 84 cm³ left breast CTV
- Very close and **coplanar** to heart
- sPBI with 30 Gy in 5 Fx

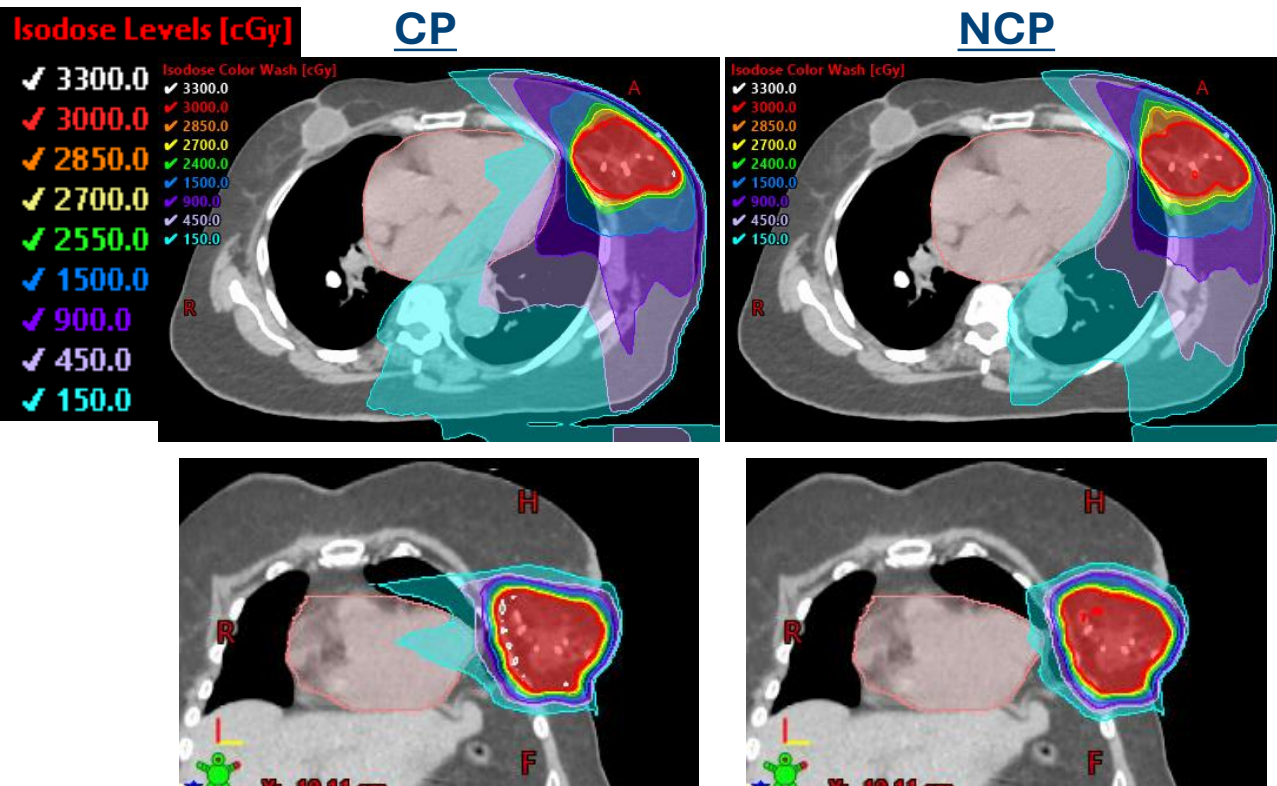


Leveraging MapRT for Breast NCP planning

Adding a vertex field



CP vs. NCP Plans



CP

Heart $D_{\text{mean}} = 113.67 \text{ cGy}$

Heart $V_{150\text{cGy}} = 19.97\%$

LAD $D_{\text{mean}} = 101.15 \text{ cGy}$

Lung_{ipsi} $V_{900\text{cGy}} = 6.89\%$

NCP

Heart $D_{\text{mean}} = 59.43 \text{ cGy}$

Heart $V_{150\text{cGy}} = 6.53\%$

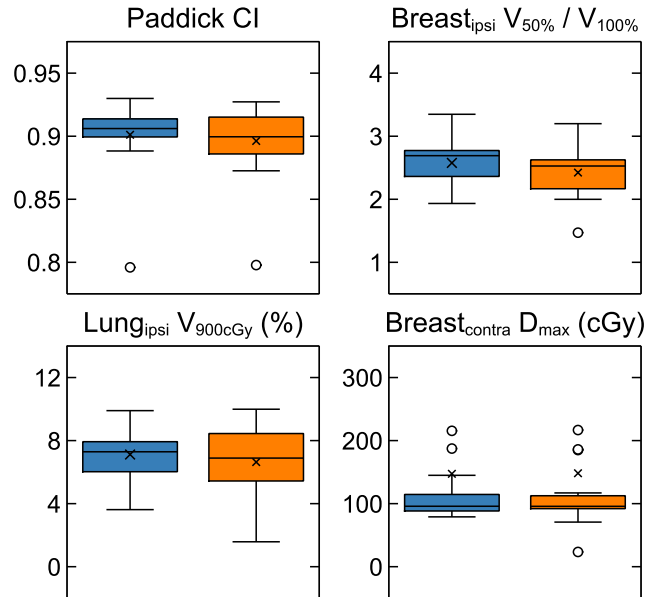
LAD $D_{\text{mean}} = 54.63 \text{ cGy}$

Lung_{ipsi} $V_{900\text{cGy}} = 5.04\%$

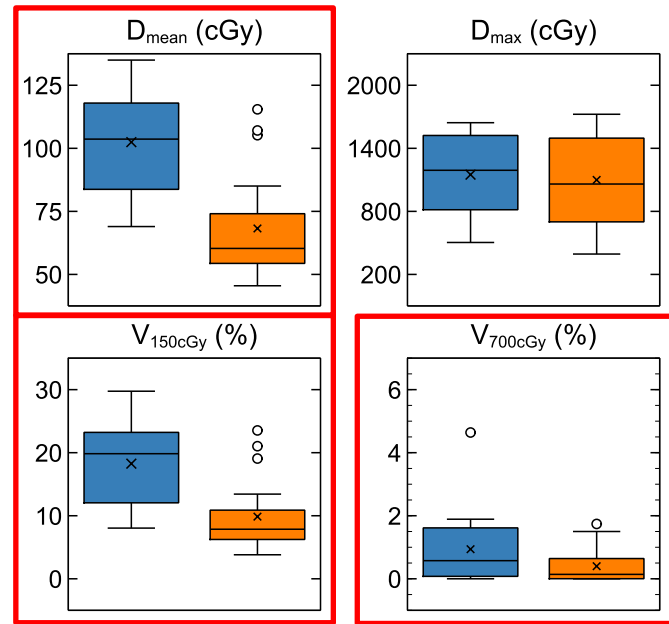
18 breast sPBI patients

- Lower heart and LAD doses
- Similar plan quality otherwise

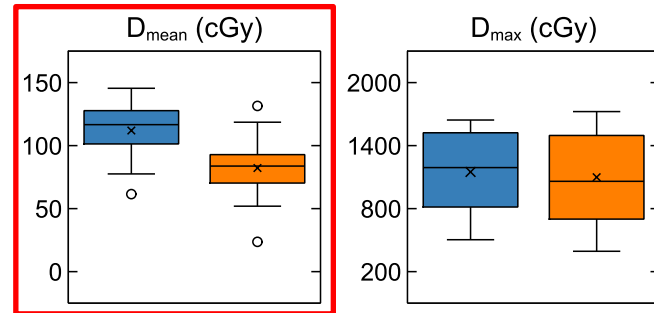
Plan Quality Indices



Heart



LAD



Summary

- MapRT is a novel SGRT clearance mapping software
- **More accurate** than manual clearance checks
- **Greatly reduces** the planning time
- Non-coplanar gives **better plans**
- Enables **efficient and effective beam selection** in non-coplanar treatments

Acknowledgments

- Andrew Godley
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- Lindsy Seaux
- Phu Ho
- Rashad Campbell
- Gannon Arnold
- Jordan Getchell
- Weihan Lee
- Jeff Dubas
- Romona Frame
- Hung Ho

Questions?

