



End-to-End VMAT-TBI Workflow

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RUTGERS

Overview



Simulation

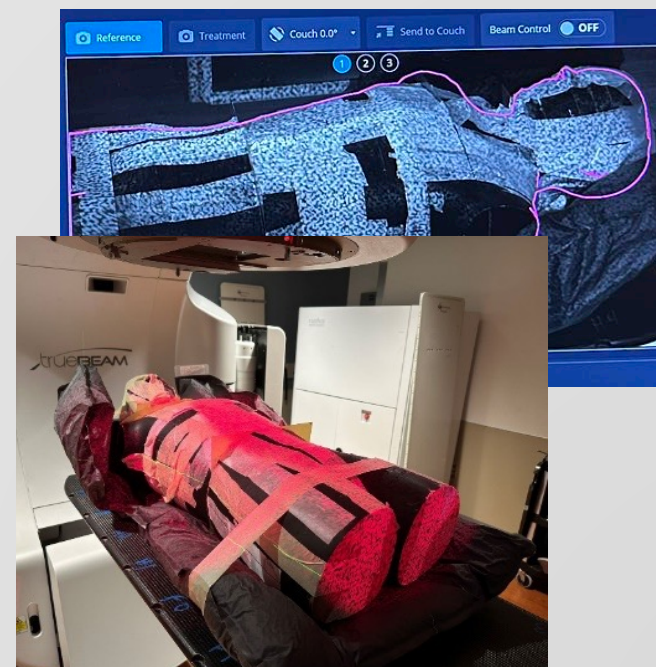
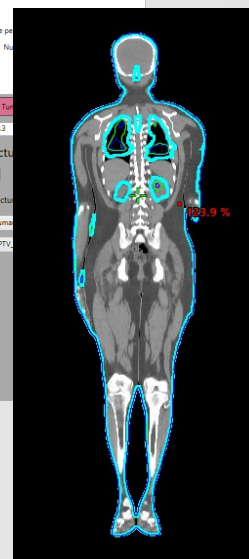
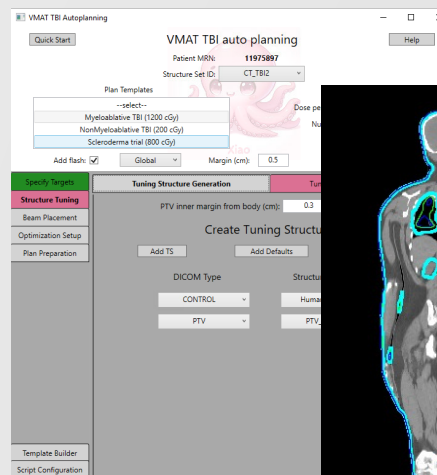
2 patients
1 phantom

Planning

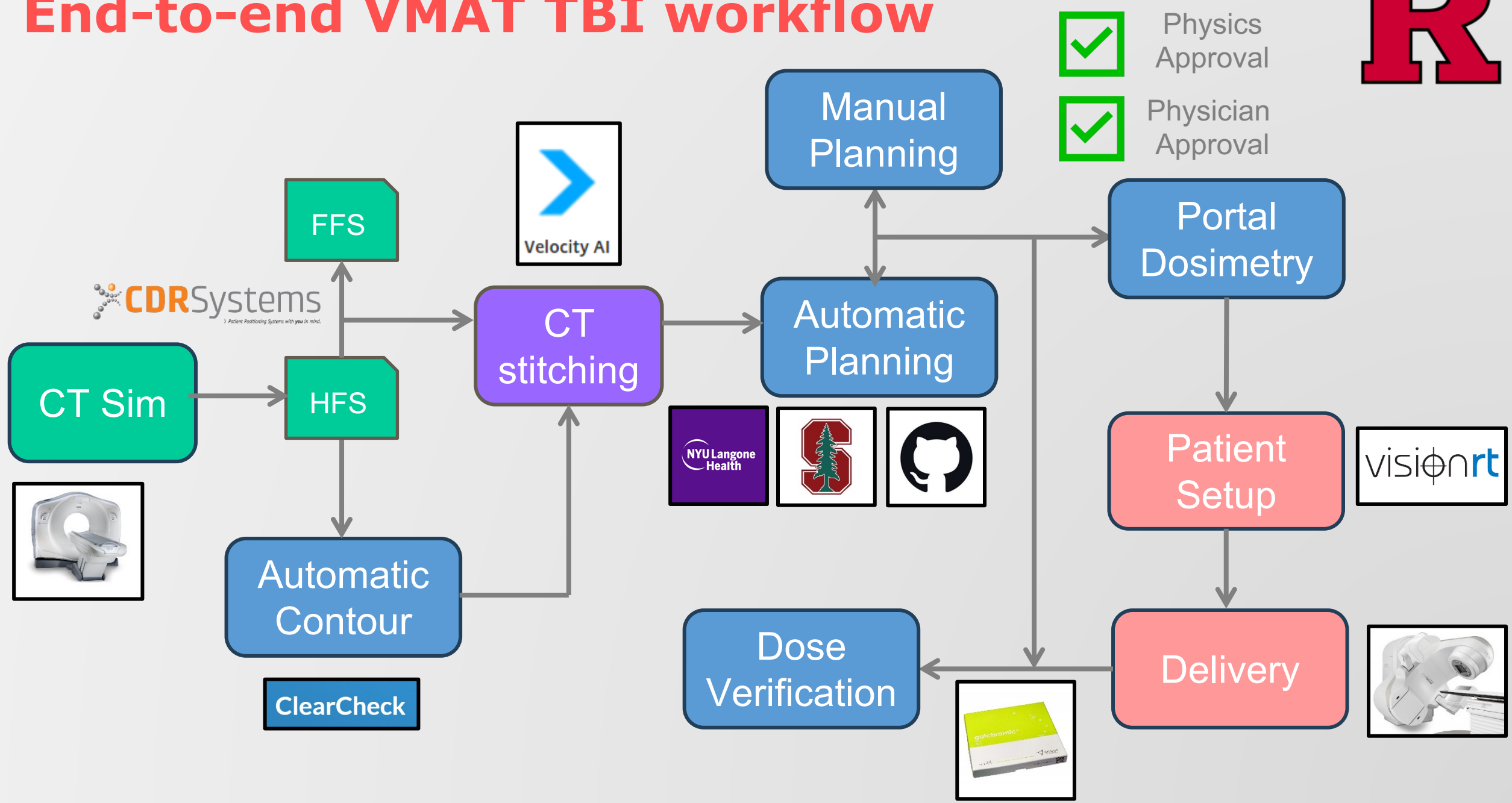
2 patients
3 phantom
2 algorithms

Delivery

1 phantom



End-to-end VMAT TBI workflow



Simulation Technique



*Use Vac-Loc Bag
+ Breast Board*



Use a Spinning Couch



Whole-body CT Acquisition

R

Rando



Patient M



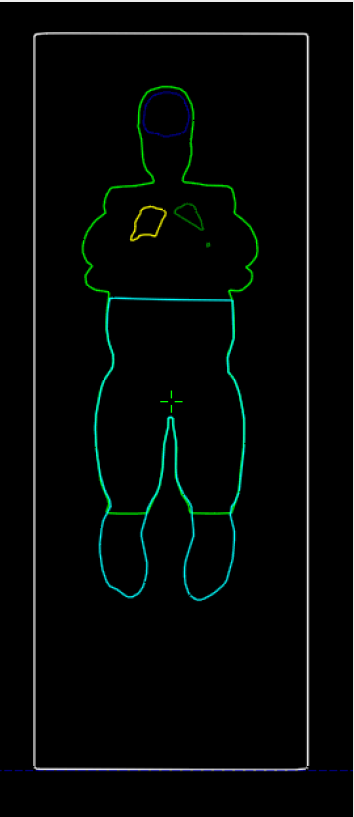
Patient F



Whole-body CT acquisition workflow



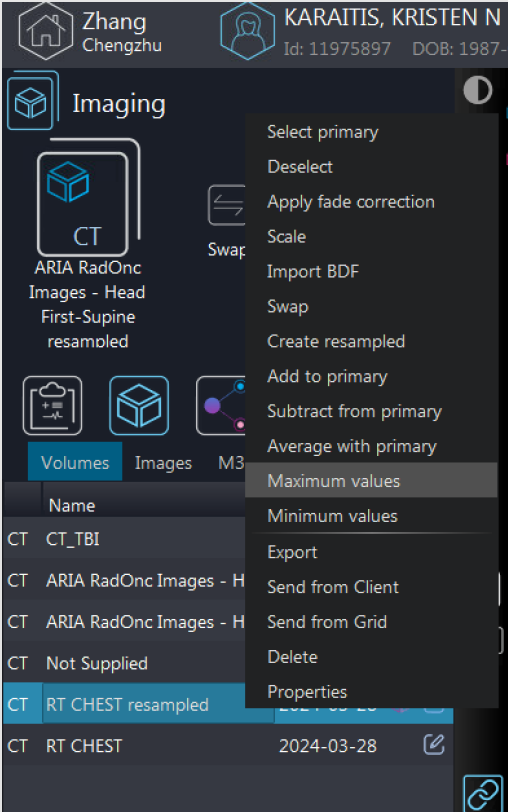
New Series



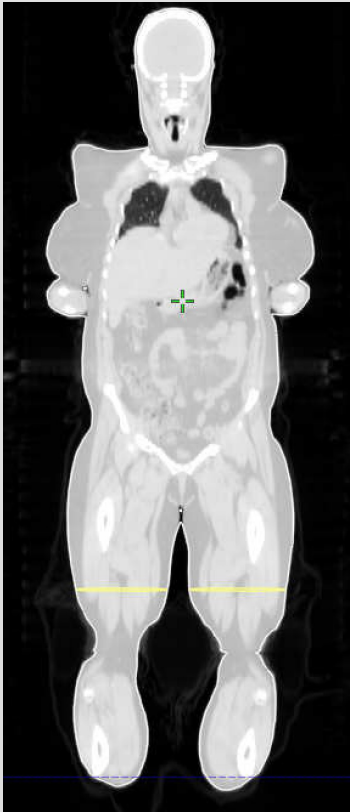
Chain Registration



Resample & Merge



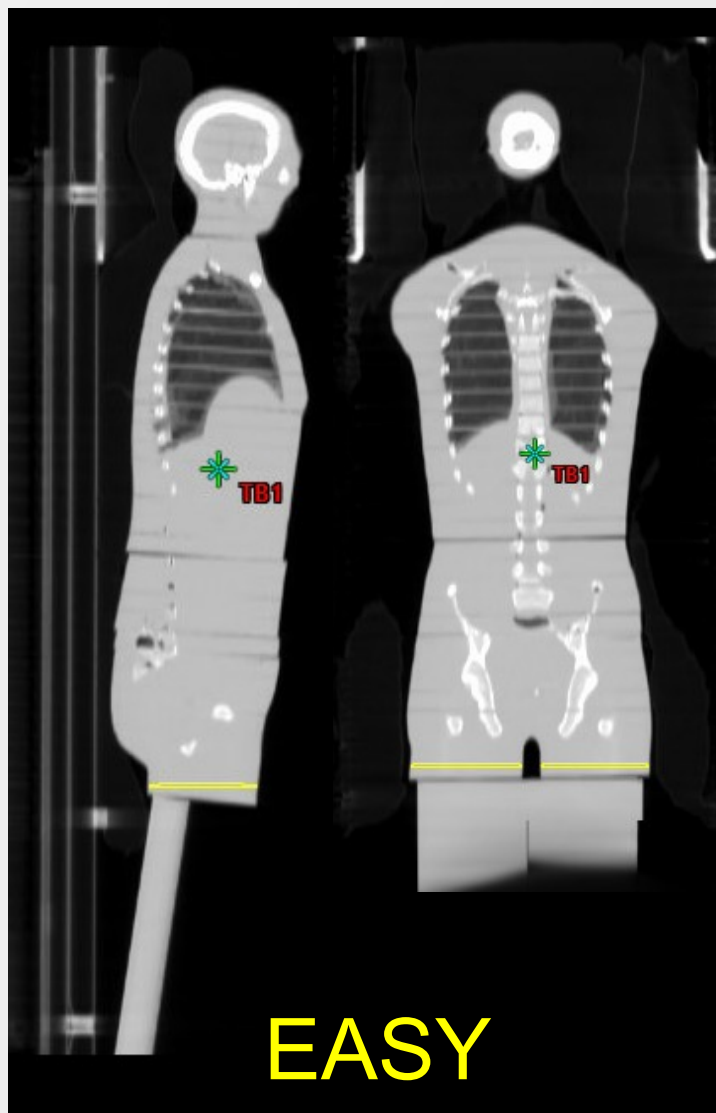
Import



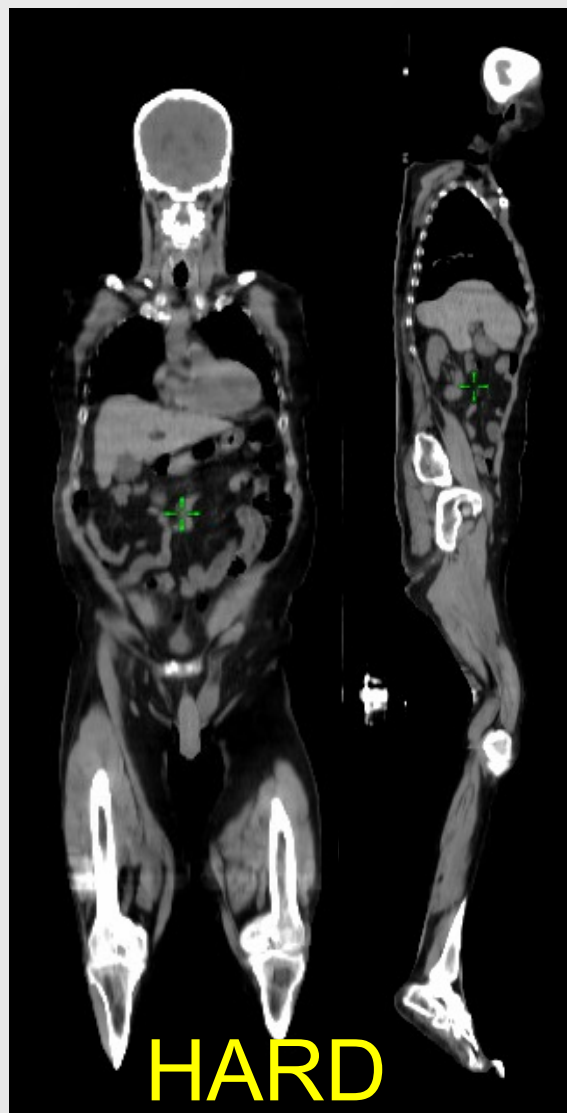
Whole-body CT Result

R

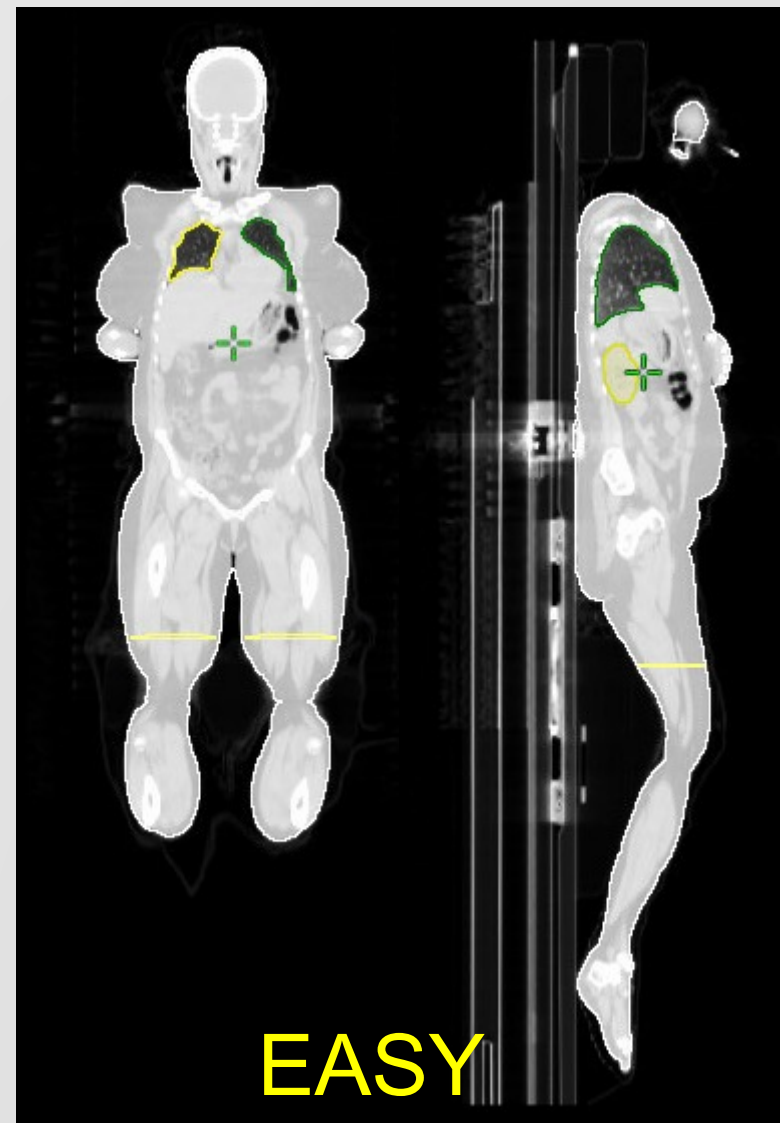
Rando



Patient M



Patient F



Caveat: Maximum Intensity Projection

Misregistration under inter-scan patient motion

R

Patient M

Artifacts



Treatment planning options

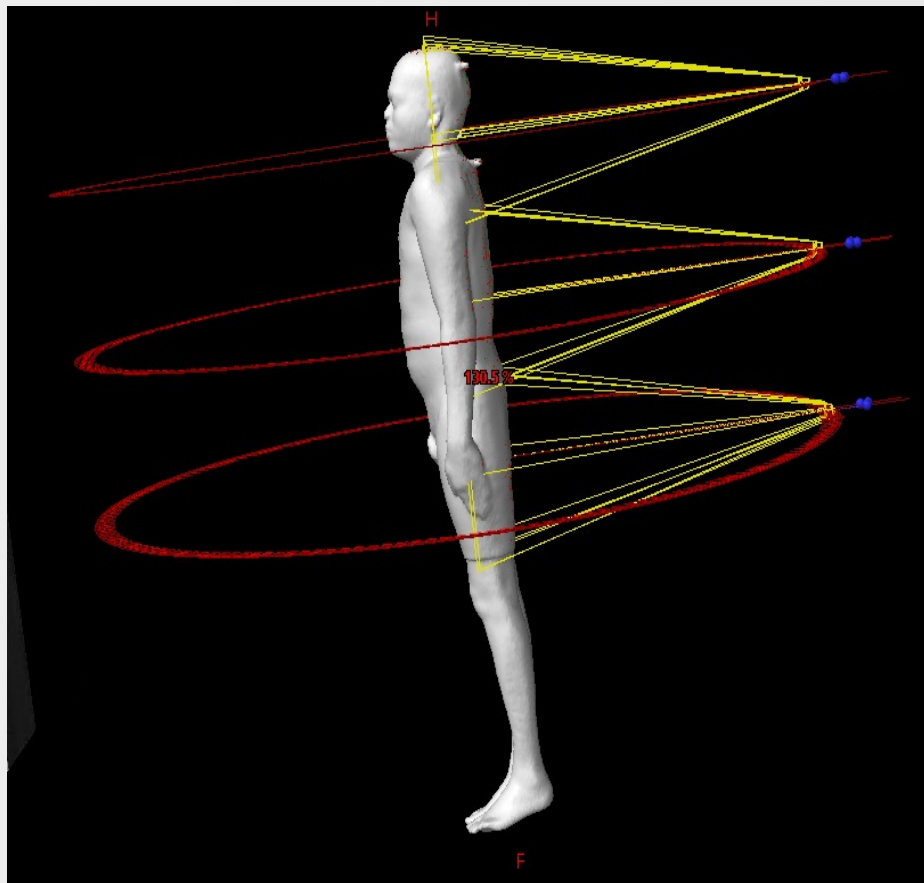


	Stanford Approach	NYU approach
#Iso-centers	3~4 + 1~2	7~10
Total Fields	11~12	11~12
Automation (Customization)	Yes (Yes)	Yes (No)
Planning Time	5 hours (CPU) Unknown (GPU)	Not Available (CPU) 1 hour (GPU)
Treatment Time	Estimated 1~1.5 hrs	Estimated 1~1.5 hrs

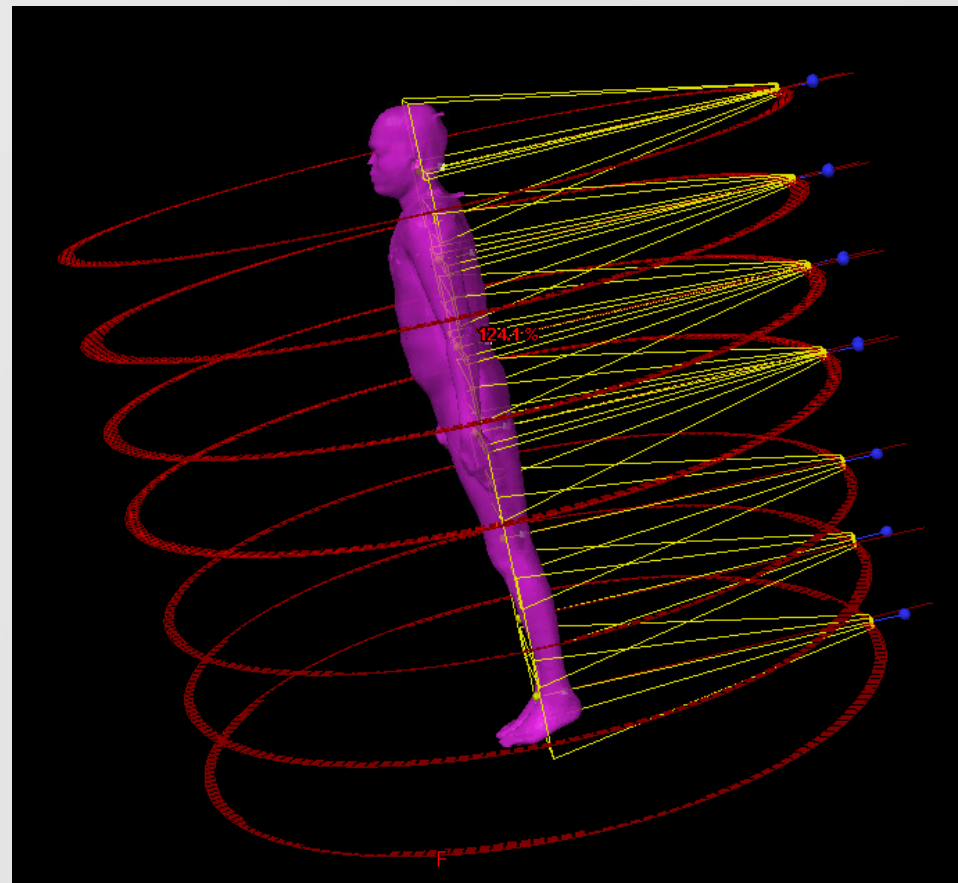
Iso-center placement



Stanford



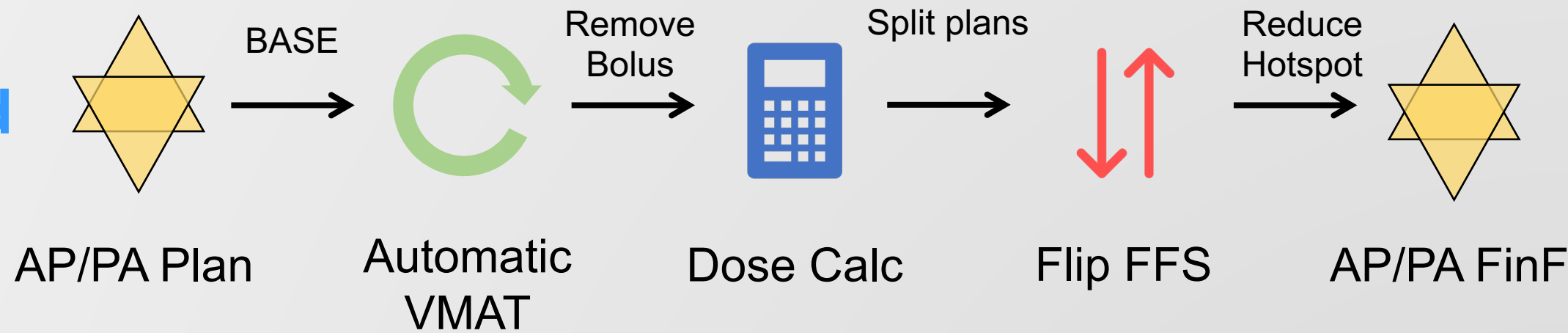
NYU



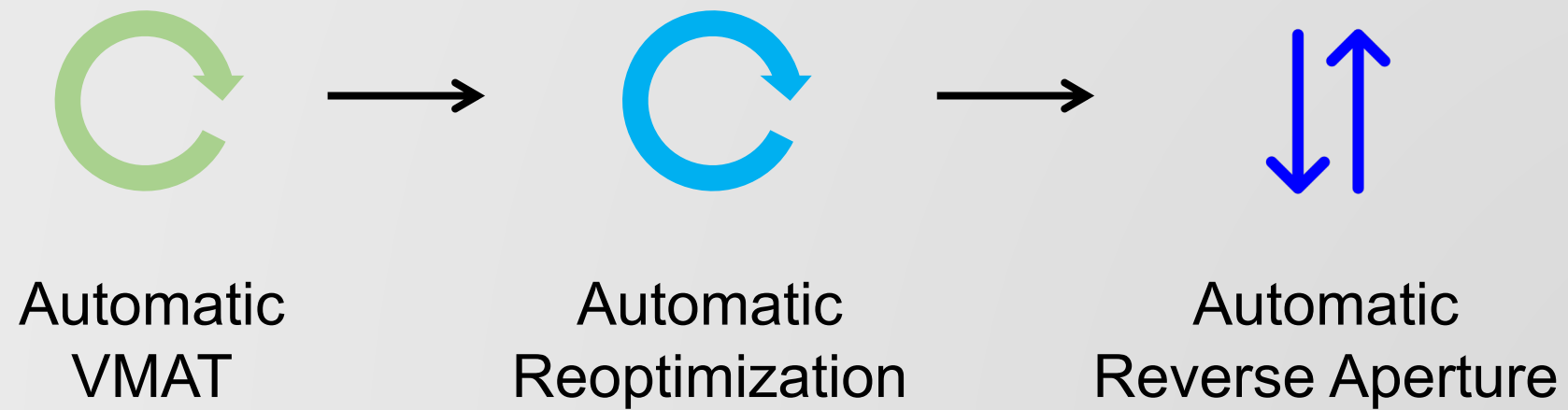
Planning workflow



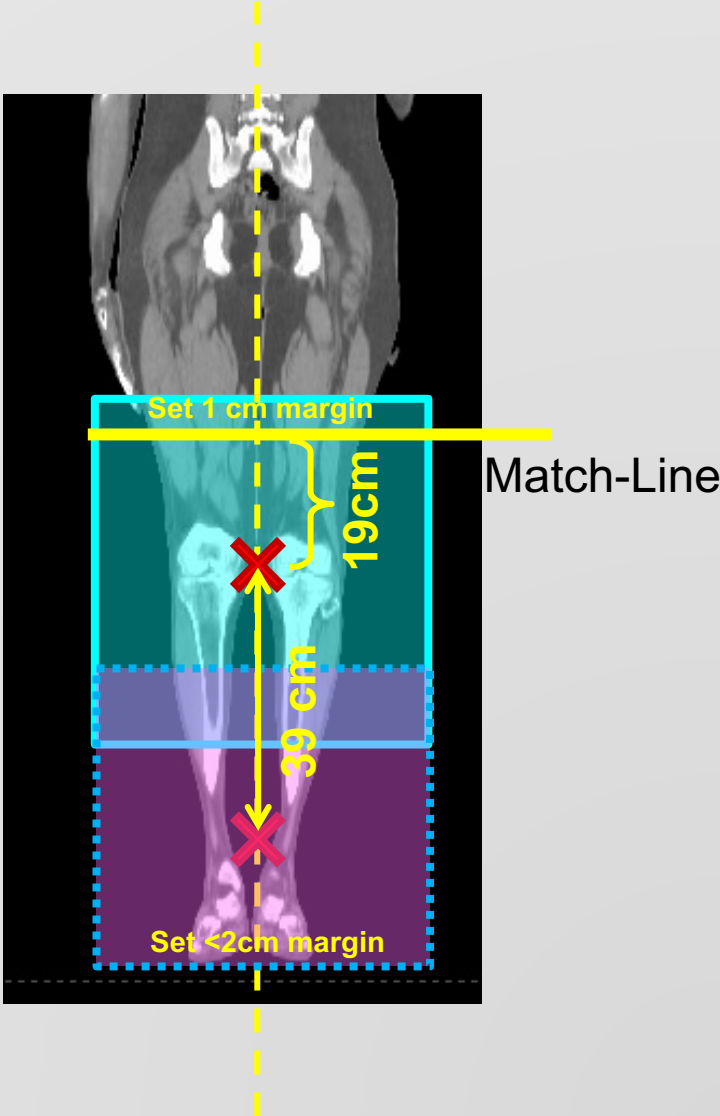
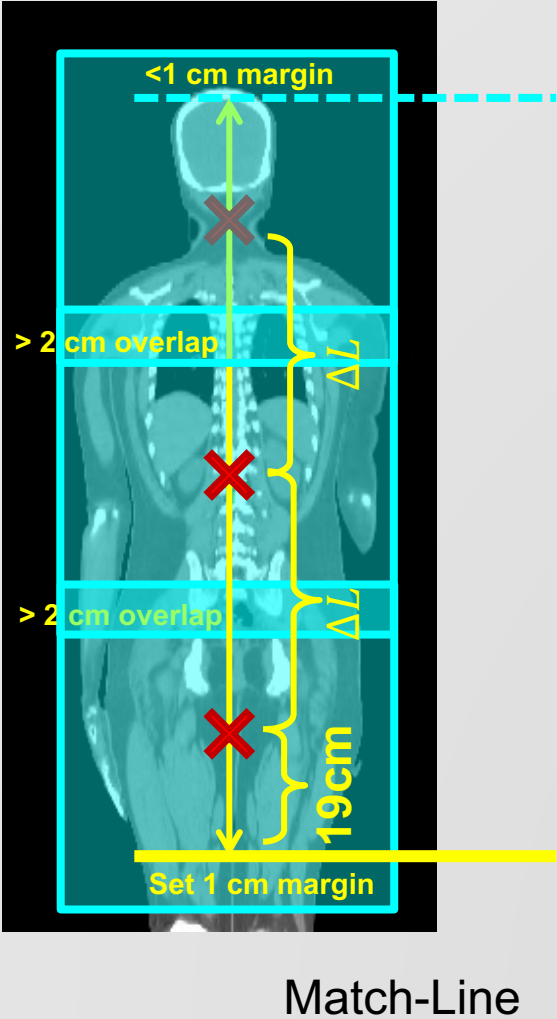
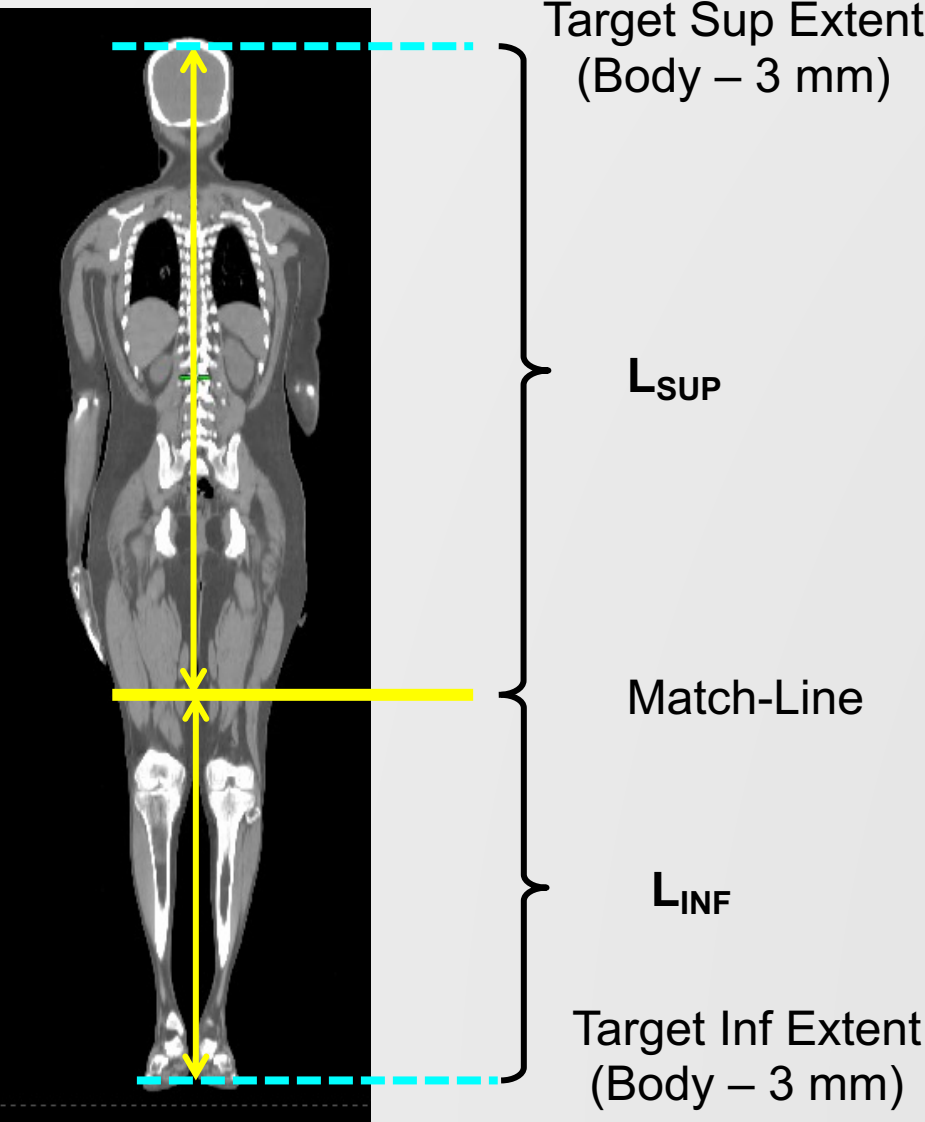
Stanford



NYU



A recap: Stanford approach



Script: Stanford approach



Planning Structure + Beam Placement

VMAT TBI AutoPlanning

Quick Start

Help

VMAT TBI auto planning

Patient MRN: 11975897

Structure Set ID: CT_TBI2

Plan Templates

--select--

Myeloablative TBI (1200 cGy)

NonMyeloablative TBI (200 cGy)

Scleroderma trial (800 cGy)

TBI Plan Rx

Dose per fraction (cGy/fx): 200

Number of fractions: 6

Rx dose (cGy): 1200

Add flash: ☒

Global

Margin (cm): 0.5

Specify Targets

Structure Tuning

Beam Placement

Optimization Setup

Plan Preparation

Template Builder

Script Configuration

Tuning Structure Generation

Tuning Structure Manipulation

PTV inner margin from body (cm): 0.3

?

Create Tuning Structures

?

Add TS

Add Defaults

Clear List

DICOM Type

CONTROL

PTV

Structure Name

Human_Body

PTV_Body

Clear

Clear

VMAT Optimization

VMAT Optimization Loop

Quick Start

Help

VMAT Optimization loop script

Select Patient

Patient MRN: 11975897

Plan type: VMAT_TBI

Plan Templates

Myeloablative TBI (1200 cGy)

NonMyeloablative TBI (200 cGy)

Scleroderma trial (800 cGy)

Dose per fraction (cGy/fraction): 200

Number of fractions: 6

Rx dose (cGy): 1200

Normalization volumes: TS_PTV_FLAS

Run coverage check: ☐

Copy and save each optimized plan: ☐

Max number optimizations: 3

Run additional optimization to lower hotspots: ☒

PTV V100% (in %): 90

?

Base plan:

Boost plan:

Plan Objectives

Optimization Setup

Optimization Parameters

Add Constraint

Get Constraints From Plan

Get Constraints From Logs

Clear List

Plan Id: VMAT-TBI

Structure	Constraint	V (%)	D (cGy)	Priority	
lungs-2.0cm	Mean	0	200	58	Clear
lungs-1.0cm	Mean	0	300	69	Clear
lungs_lowRes	Mean	0	600	67	Clear
lenses_lowRes	Mean	0	1140	37	Clear
kidneys-1.0cm	Mean	0	400	47	Clear
kidneys_lowRes	Mean	0	750	58	Clear
TS_jnx2	Lower	100	1200	105	Clear
TS_jnx2	Upper	0	1212	120	Clear
TS_jnx1	Lower	100	1051.5	124	Clear

Script Configuration

Confirm and Begin Optimization

Script: Treatment Planning: NYU approach



Integrated script workflow

configuration

VMAT-TBI Planning Tool

Configuration

Auto Plan

Cooler & Heater

Reverse FFS

TemplateViewerWindow

TEMPLATE PARAMETERS	VALUES	
Template ID	NYU VMAT	
Linac ID	NBR_TB2	
Energy ID	6X	
MLC ID	ML1279	
Calculation Algorithm ID	AAA_1610	
Grid Resolution (cm)	0.5	
Total Dose (cGy)	1200	
Number of Fractions	6	
Dose Rate (MU/min)	600	
PTV margin from body (mm)	3	
	<div>OAR / Sparing</div>	<div>Margin (mm)</div>
Lungs Sparing	Yes	3
Kidneys Sparing	Yes	0
Liver Sparing	No	

Phantom study: NYU approach



Rx: 12 Gy,
6 fx, 2 Gy/fx

HOT SOPT 126%

V120 = 0.1%

V110 = 15%

D90 = 99%

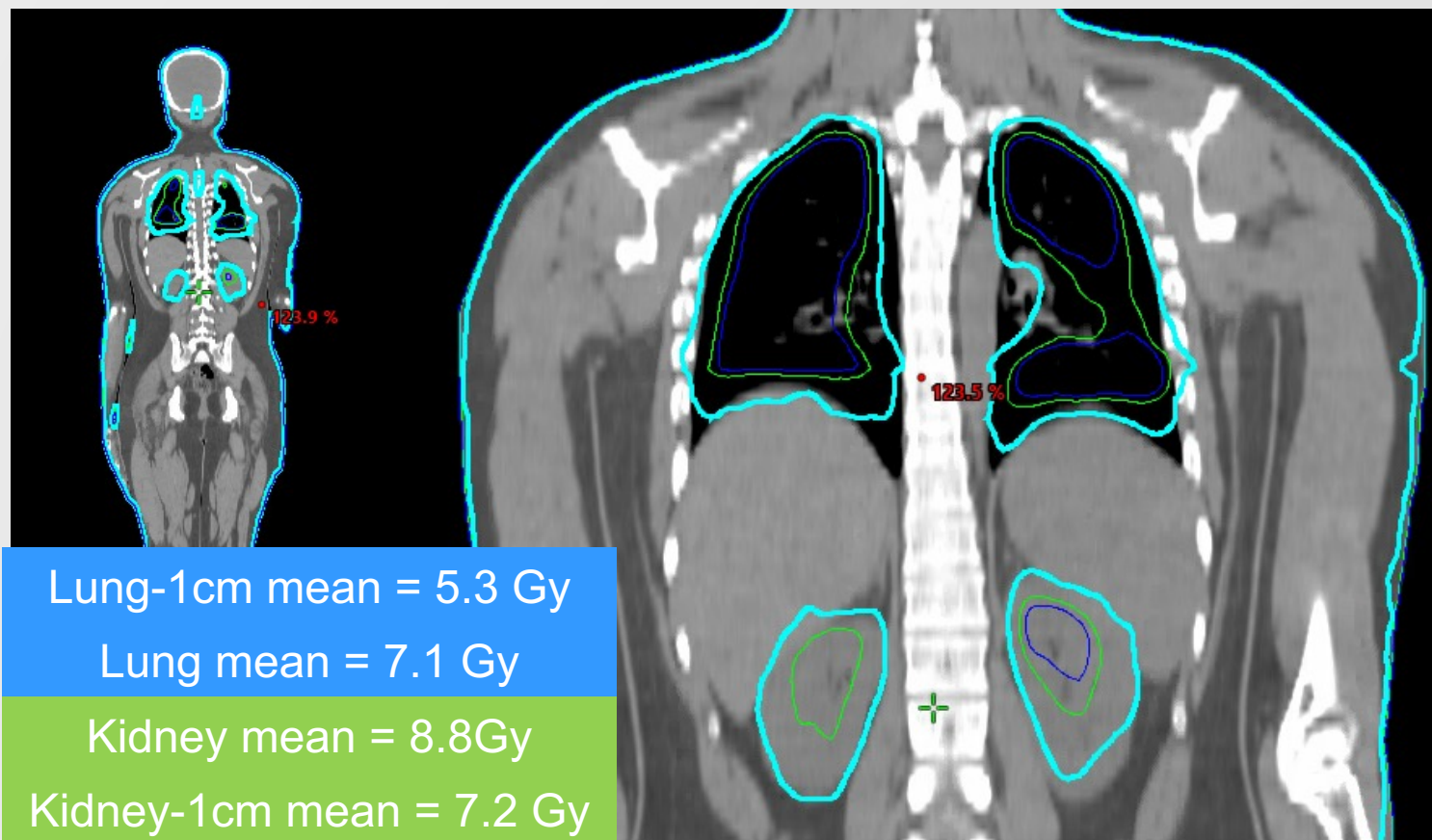
D95 = 97%

D90 = 100%

V95 = 97.2%

V100 = 90%

90% 60% 50%



Phantom study: Stanford approach



Rx: 12 Gy,
6 fx, 2 Gy/fx

HOT SOPT 126%

V120 = 0.1%

V110 = 15%

D90 = 99%

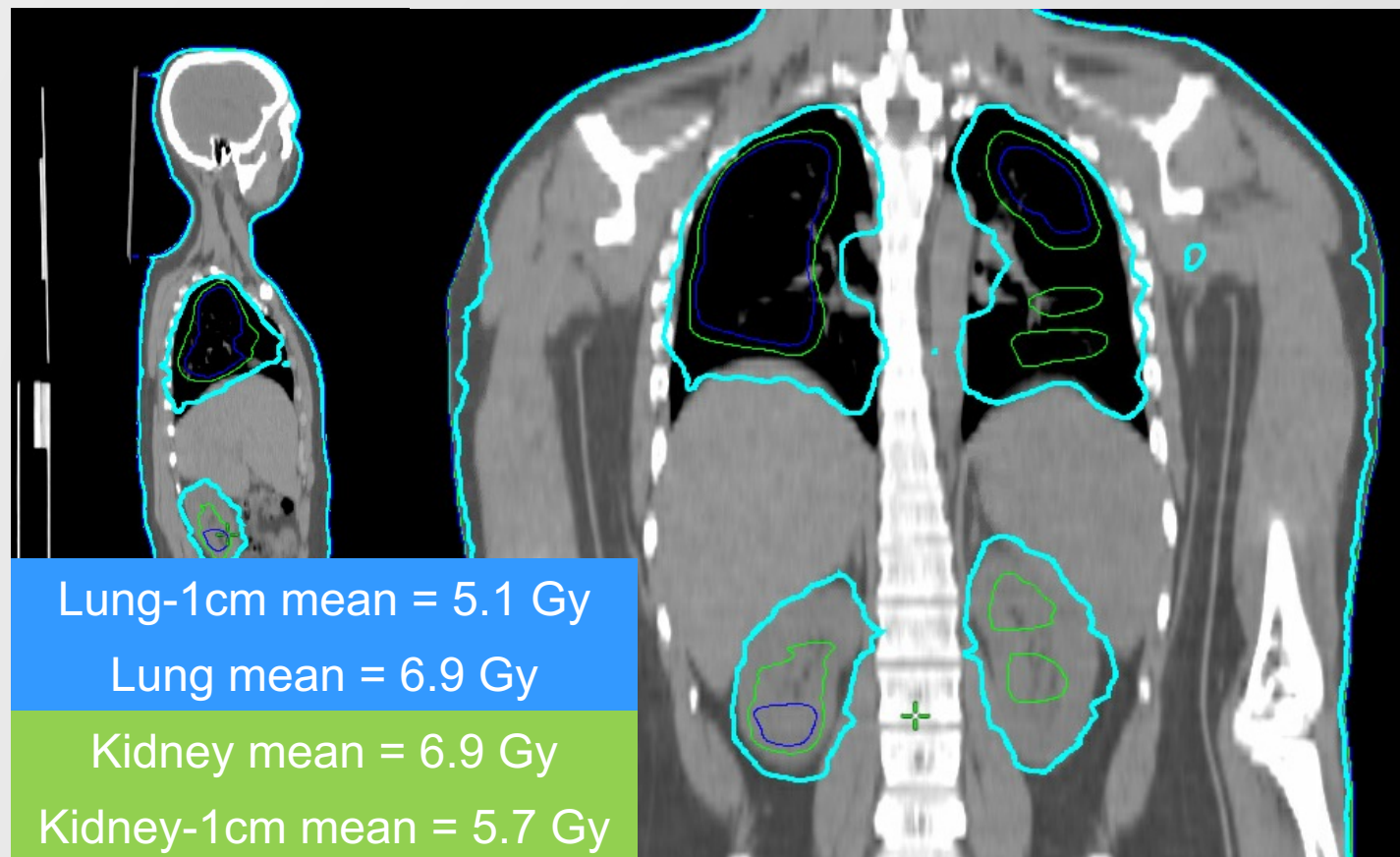
D95 = 97%

D90 = 100%

V95 = 97%

V100 = 88%

90% 60% 50%



Real patient case: Stanford approach

R

Rx: 12 Gy,
6 fx, 2 Gy/fx

HOT SOPT 126%

V120 = 0.1%

V110 = 18.0%

D90 = 98%

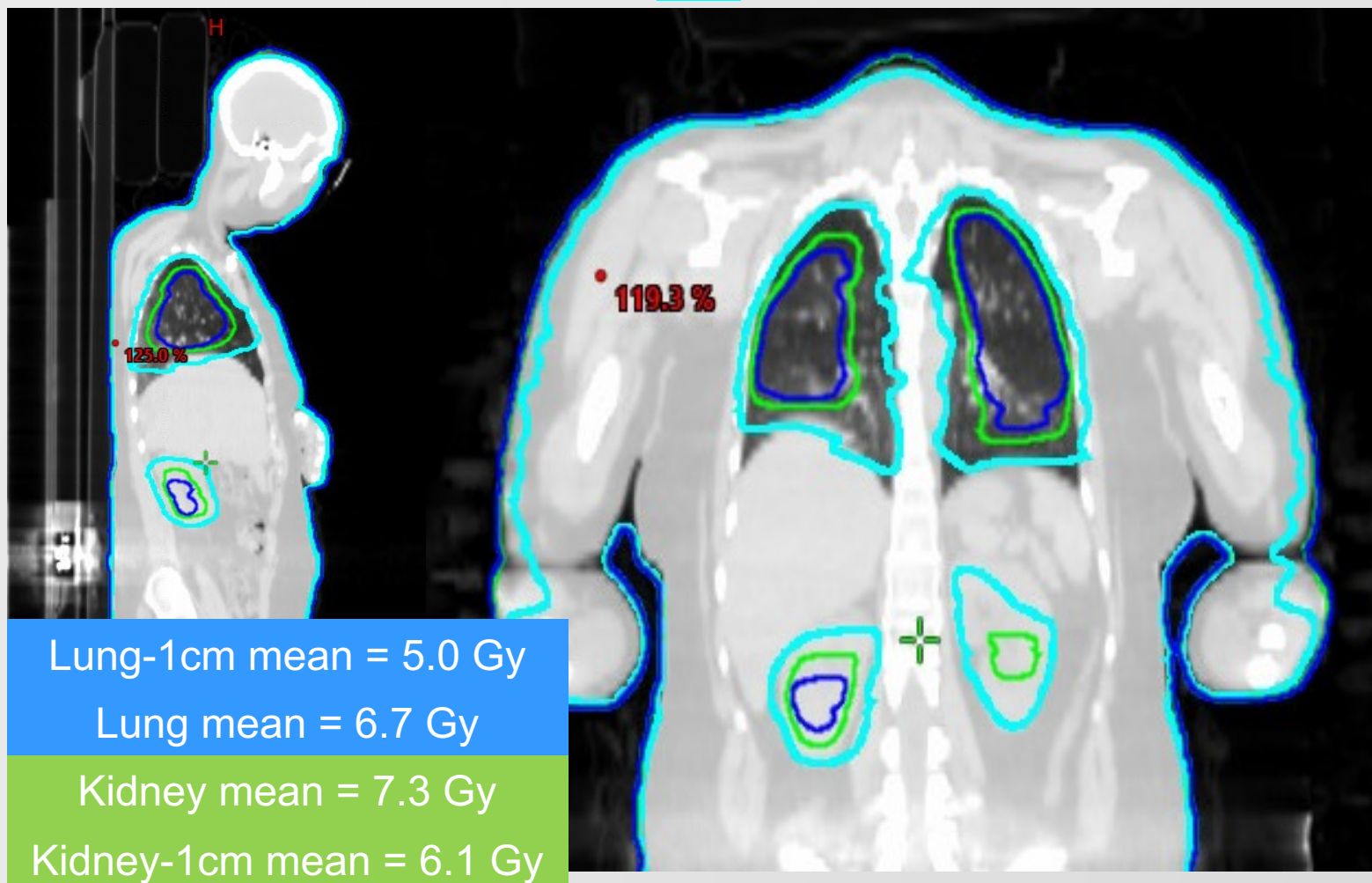
D95 = 96%

D90 = 100%

V95 = 98%

V100 = 91%

90% 60% 70%



End-to-end Treatment on Rando



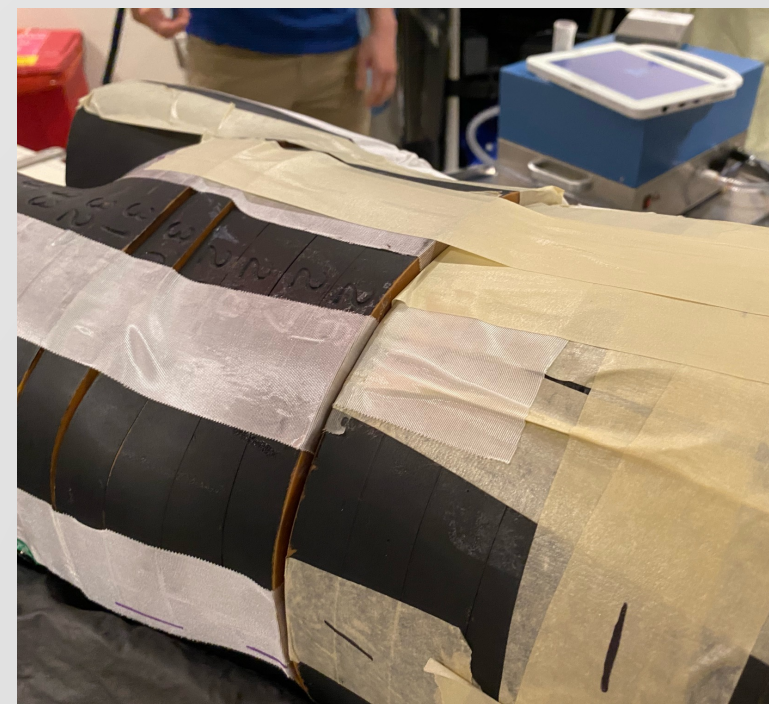
Vac-Loc



Breast board



Displacement
@ junctions



Water Slab
as legs

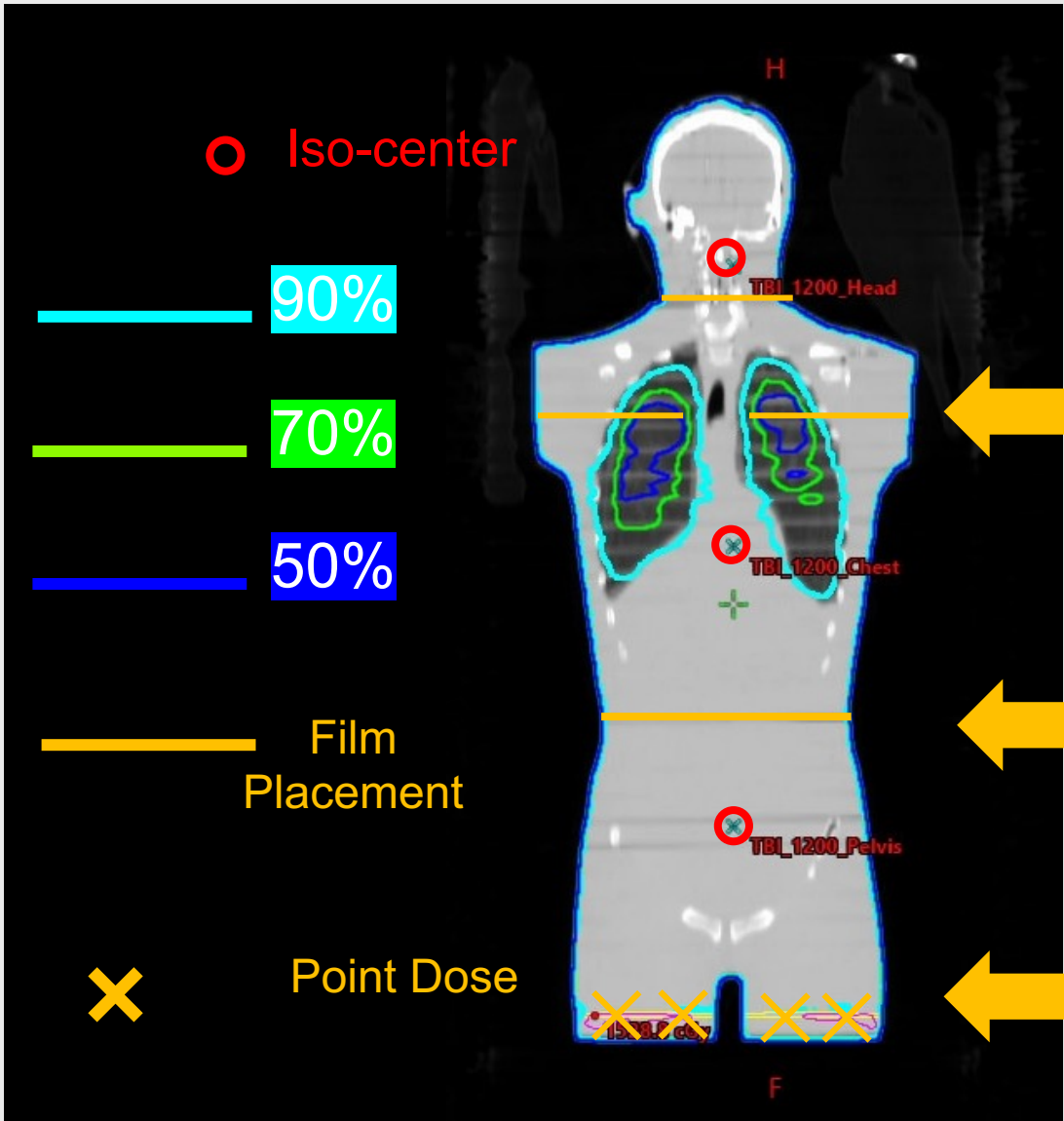
4-iso plan VMAT + APPA

R

Rx: 12 Gy,
6 fx, 2 Gy/fx

HOT SOPT 130%
V120 = 0.1%
V110 = 18.0%

D90 = 98%
D95 = 96%
D90 = 100%
V95 = 98%
V100 = 91%



Lung dose sparing

Pelvis dose uniformity

Matchline dose control

Portal Dosimetry QA



Chest

Head

Predicted

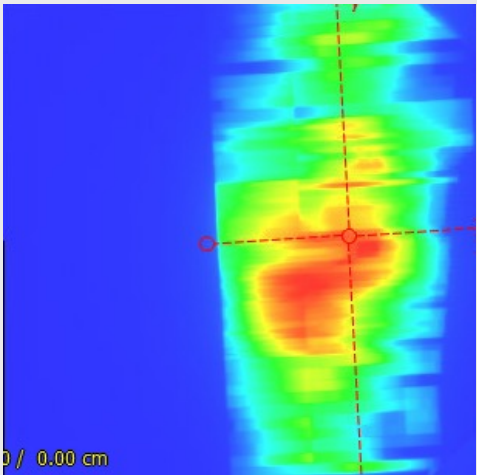
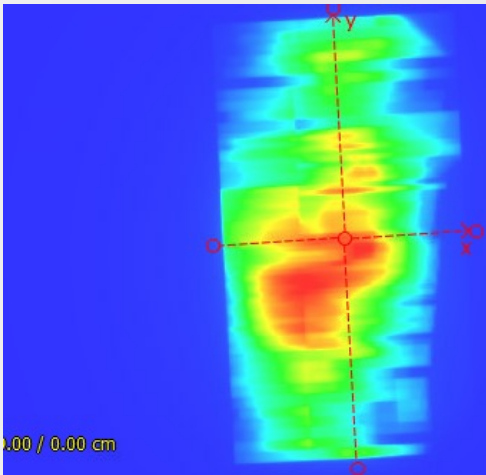
Measured

Predicted

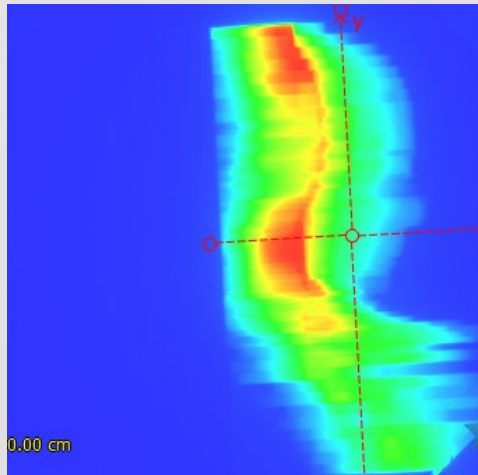
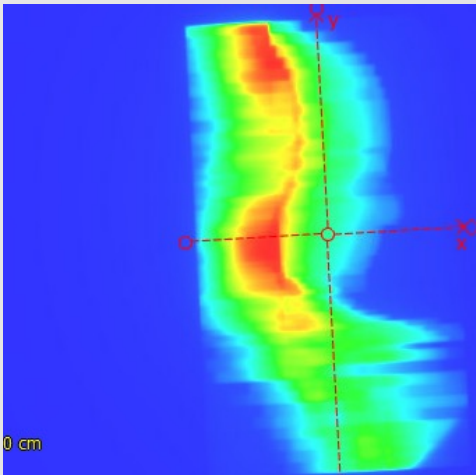
Measured



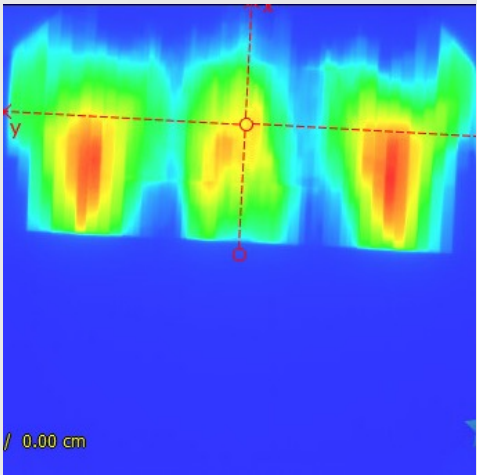
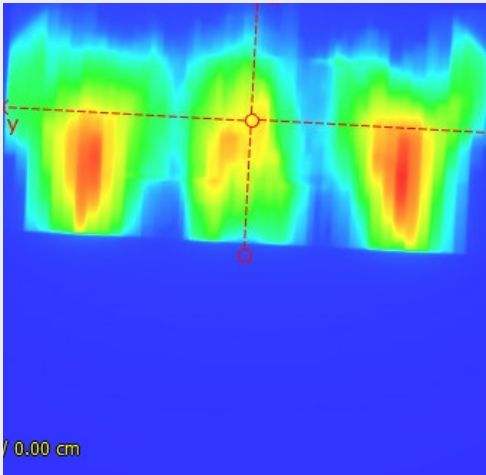
3 mm
3 %



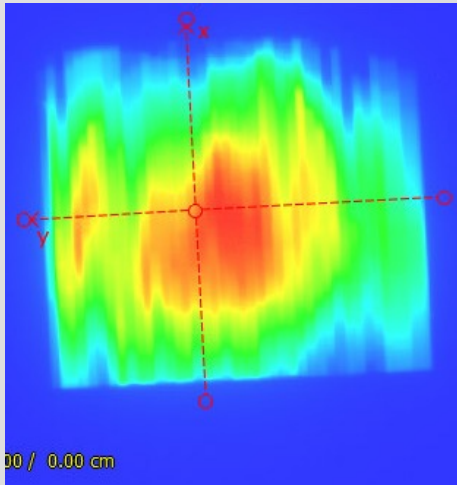
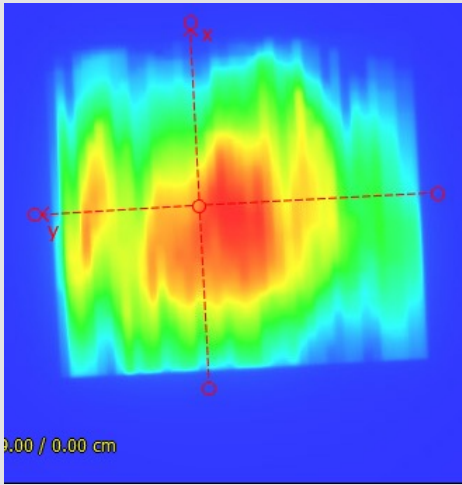
3 mm
3 %



3 mm
3 %



3 mm
3 %



Setup and OSMS contour



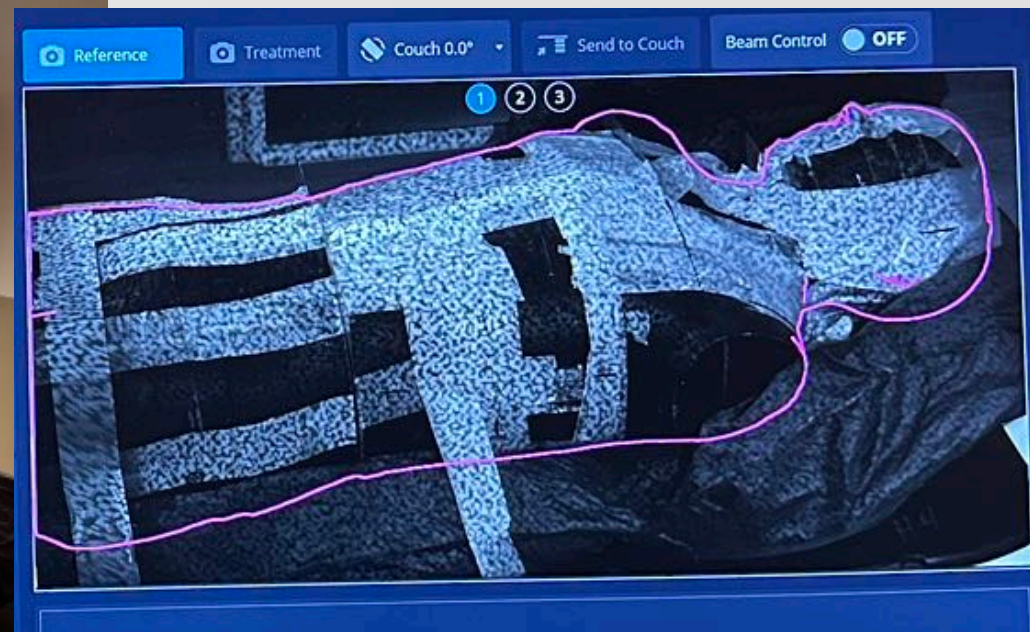
Film Setup



Treatment setup



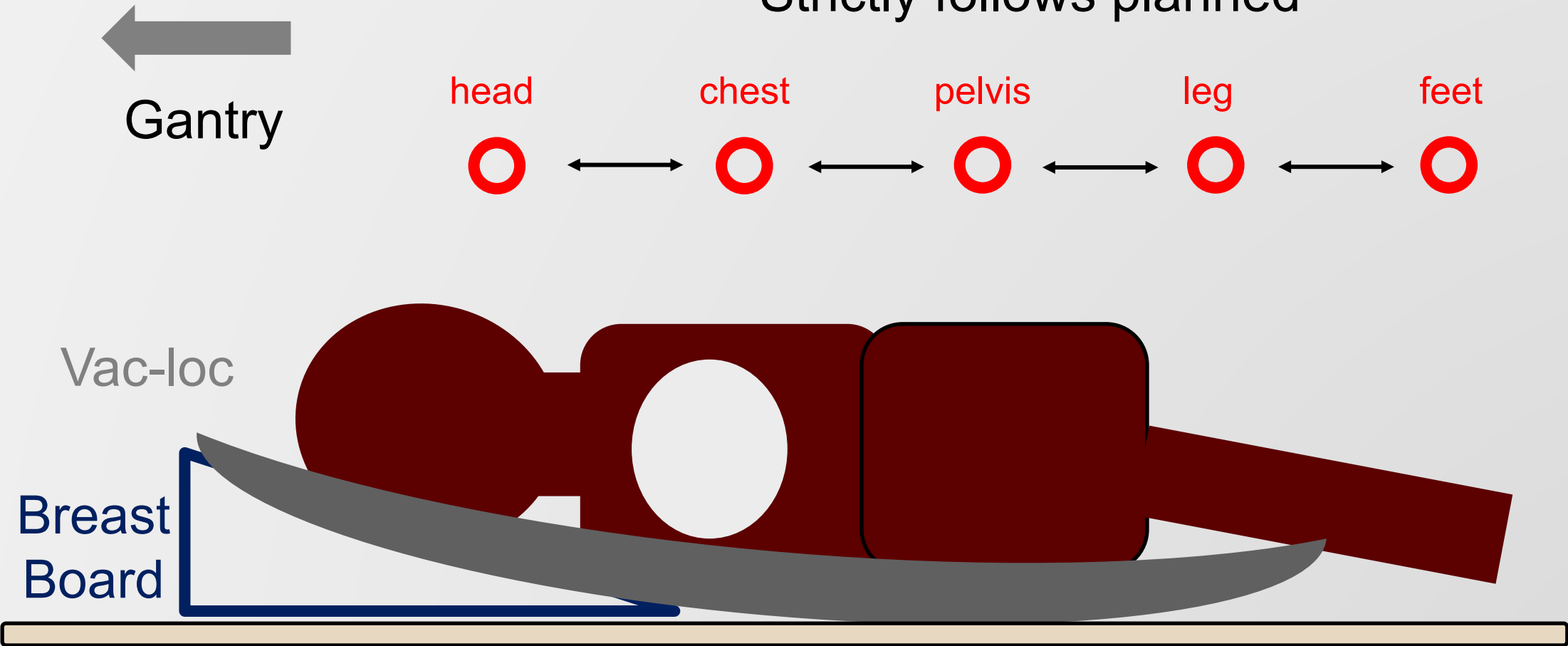
Posture video



Delivery: VMAT

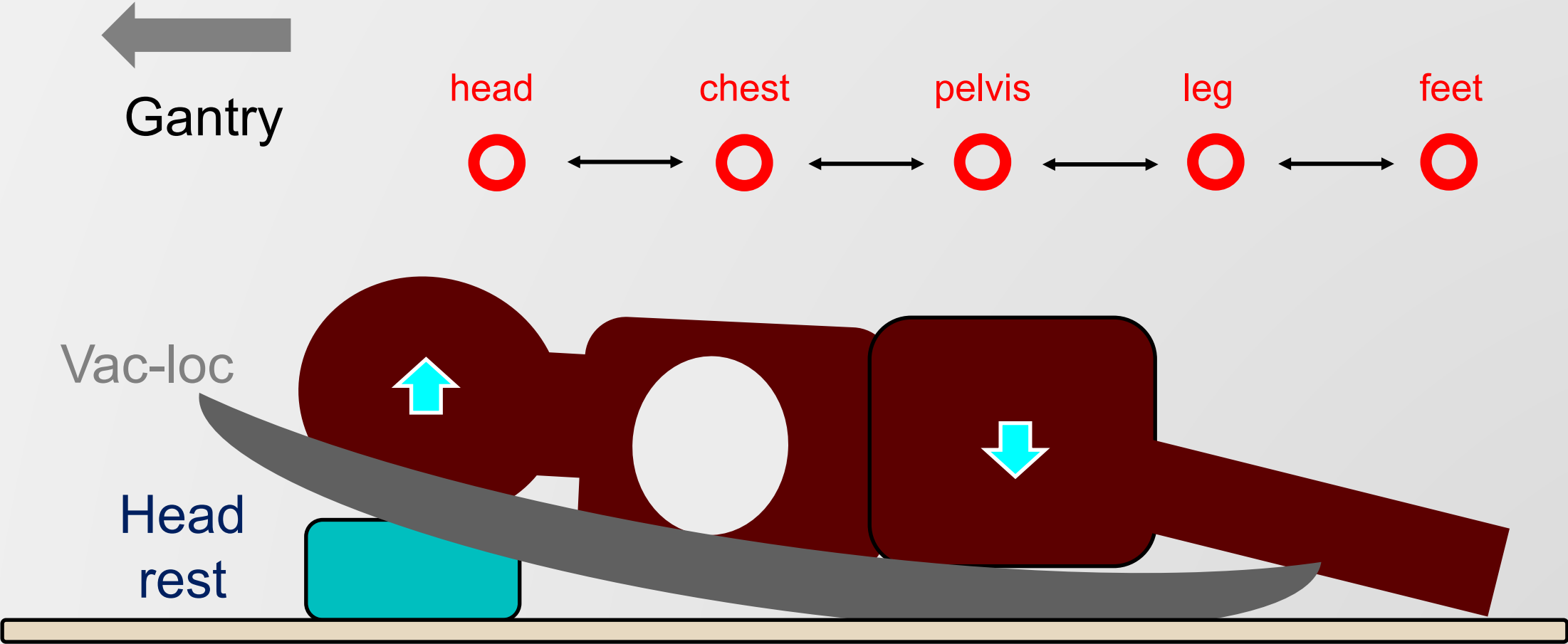
R

Strictly follows planned



Delivery: VMAT

R



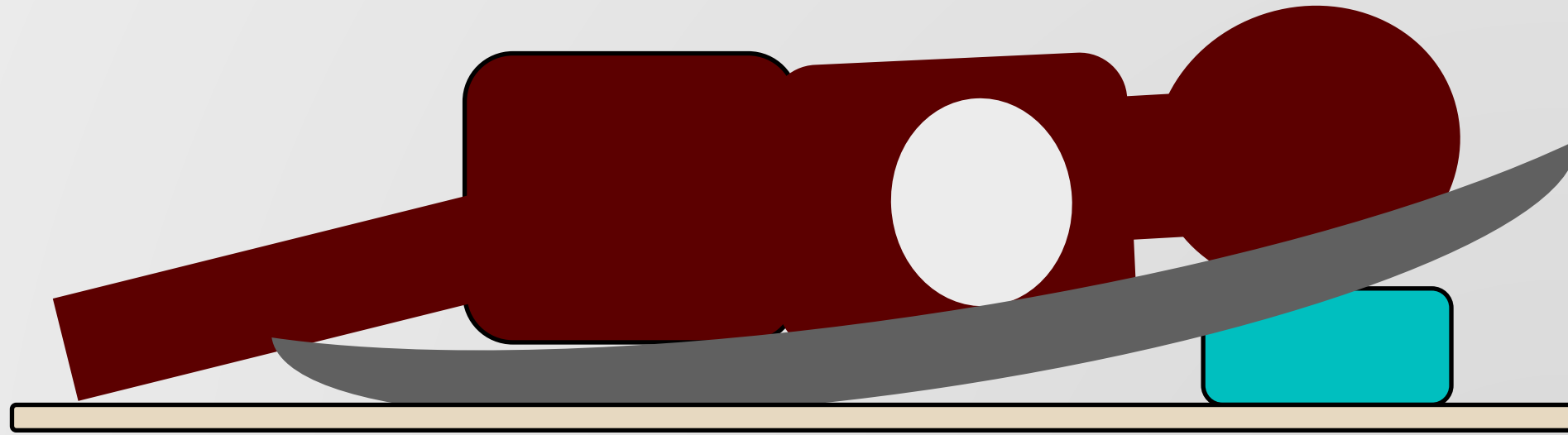
Delivery: VMAT

R

←
Gantry

feet leg pelvis chest head

○ ○ ○ ○ ○



kV/OSMS Setup Report



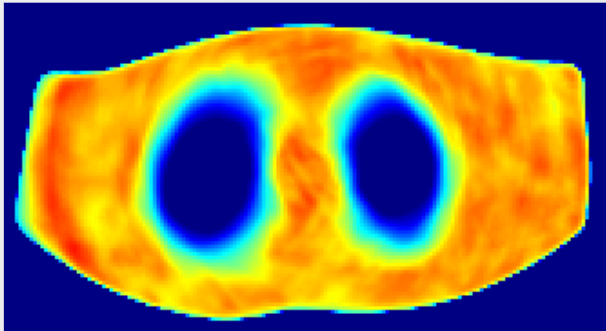
	IGRT before shift (cm)	kVCBCT shift (cm)	IGRT after shift (cm)
Chest	(0.01, -0.02) 0.04	(0.03, 0.01) 0.03	(-0.02, 0.01) 0.04
Head	(0.10, -0.04) 0.24	(-0.24, -0.1) 0.26*	(0.35, -0.04) 0.41*
Pelvis	(0.34, 0.26) 0.44	(0.27, 0.20) 0.33	(0.07, 0,06) 0.12
Leg	(-0.01, 0) 0.07	(0, 0) 0	(0.01, 0) 0.07

Dosimetric Evaluation

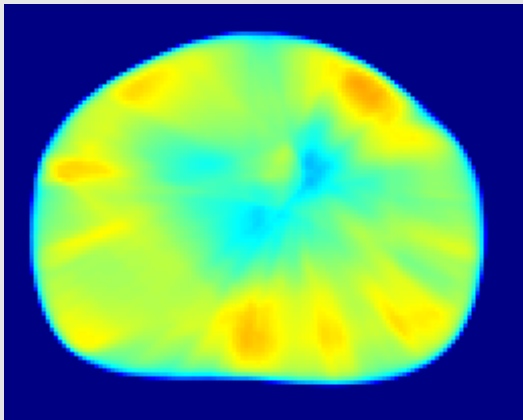
Point dose <5%



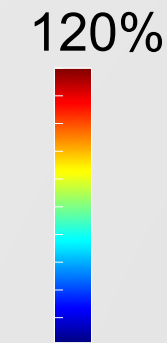
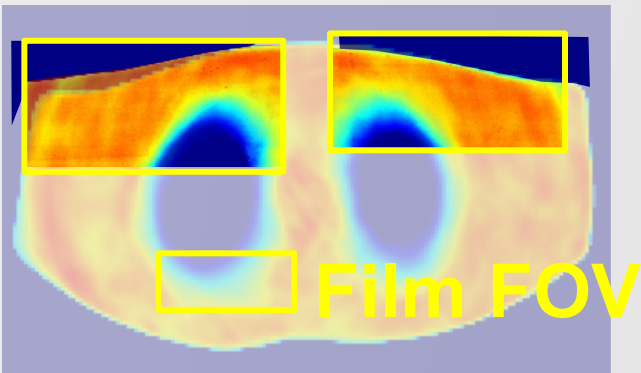
Planned Lung Dose



Planned Pelvis Dose

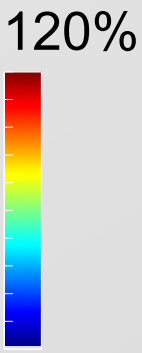
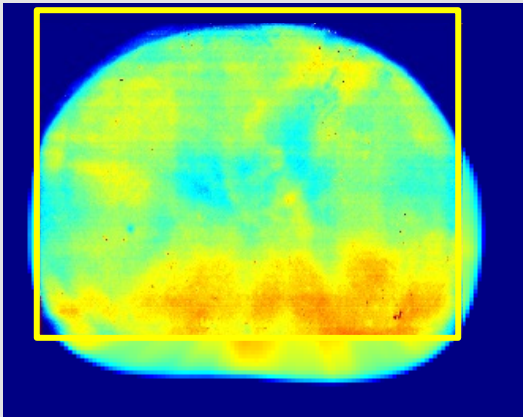


Measured Planar Dose



<50%

Measured Planar Dose



80%

Discussion

- Leg Posture – Matchline underdose?
- Arms at chest, or at sides?
- Immobilization – vac-lock, mask?
- OSMS Tolerance – setup uncertainty?
- Spinning couch attenuation – how much?
- Boost plans – additional constraint

R





Robert Wood Johnson | **RWJBarnabas**
University Hospital | **HEALTH**

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