



# End-to-End VMAT-TBI Workflow

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RUTGERS

# Overview

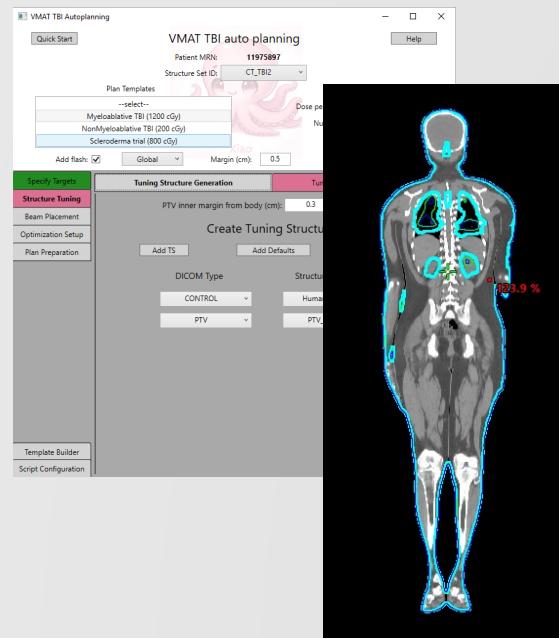
## Simulation

2 patients  
1 phantom



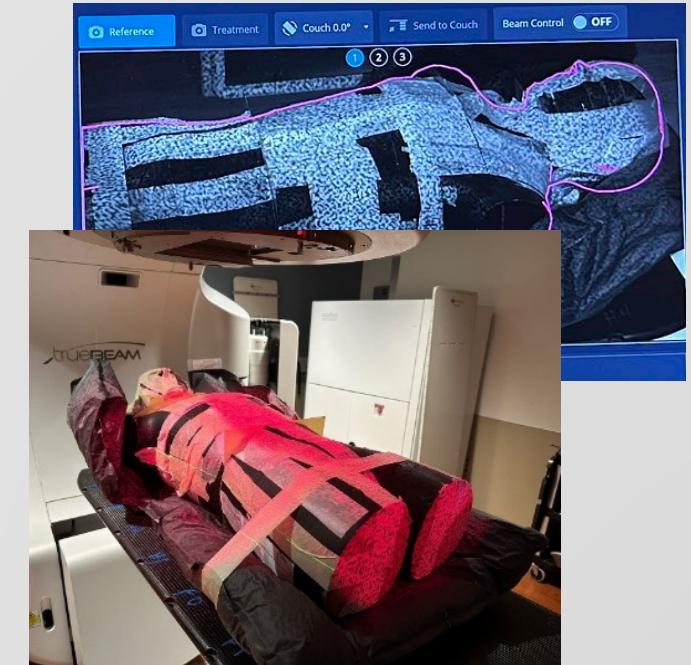
## Planning

2 patients  
3 phantom  
2 algorithms



## Delivery

1 phantom



# End-to-end VMAT TBI workflow

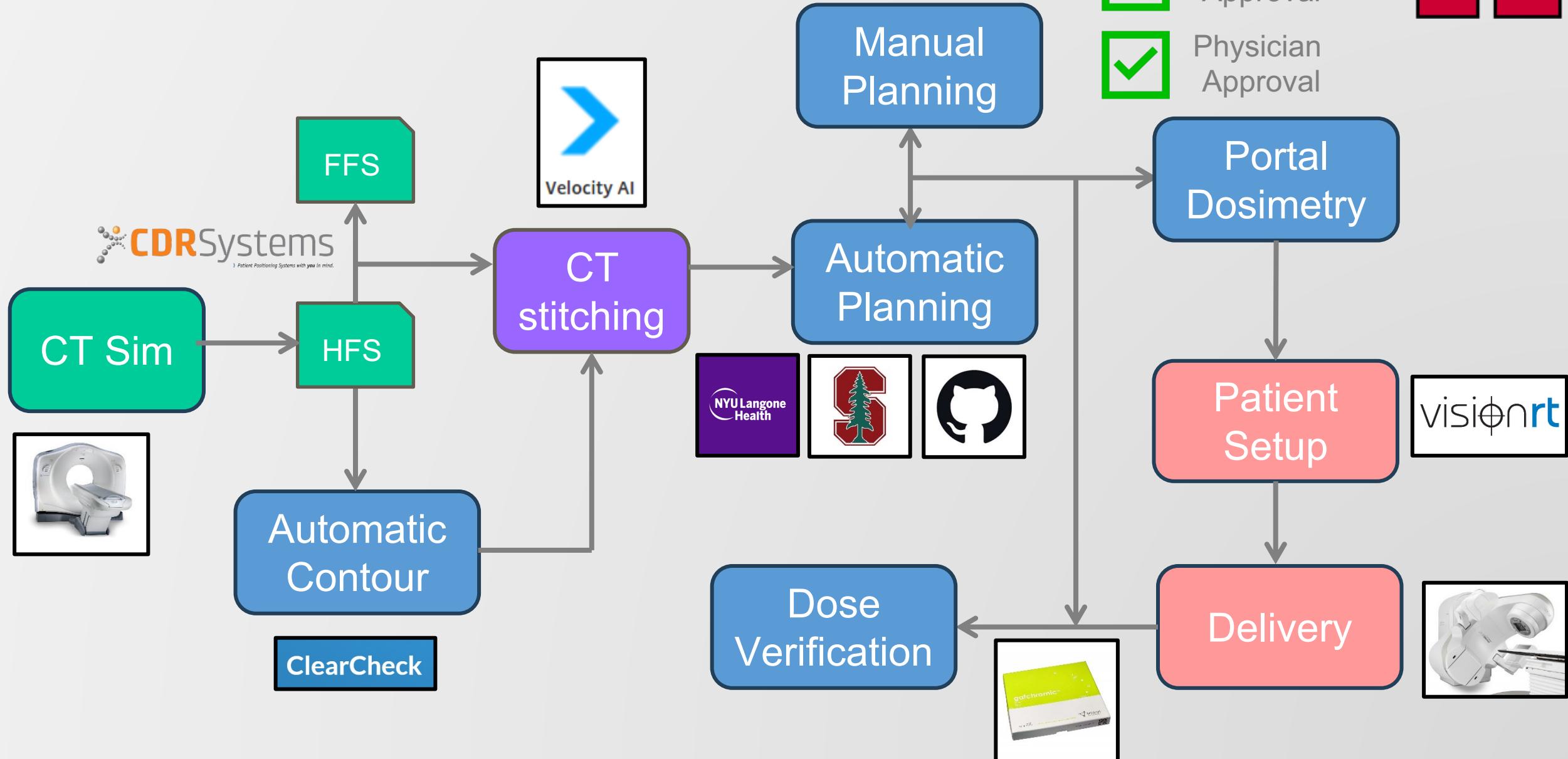
R



Physics  
Approval



Physician  
Approval



R

# Simulation Technique

*Use Vac-Loc Bag  
+ Breast Board*



*Use a Spinning Couch*



R

# Whole-body CT Acquisition

Rando



Patient M



No Rotation  
Couch

Patient F

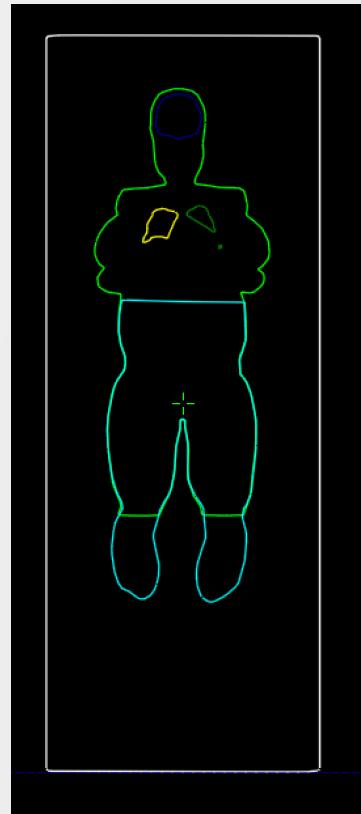


With Couch

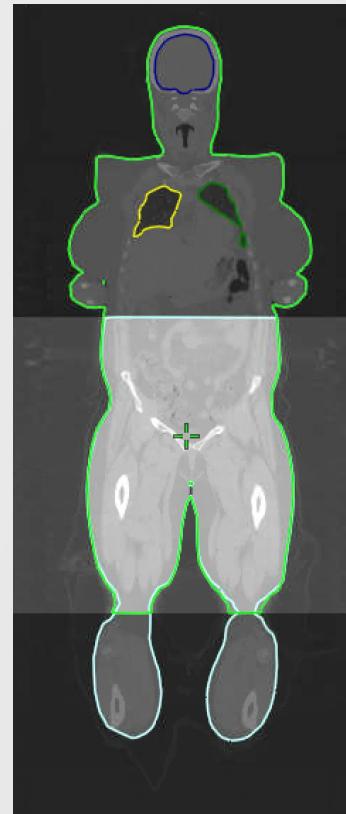
# Whole-body CT acquisition workflow

R

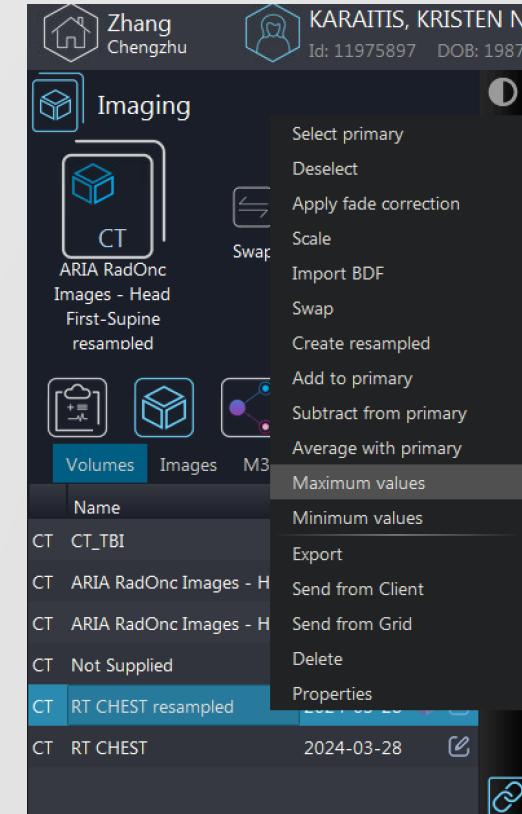
## New Series



## Chain Registration



## Resample & Merge



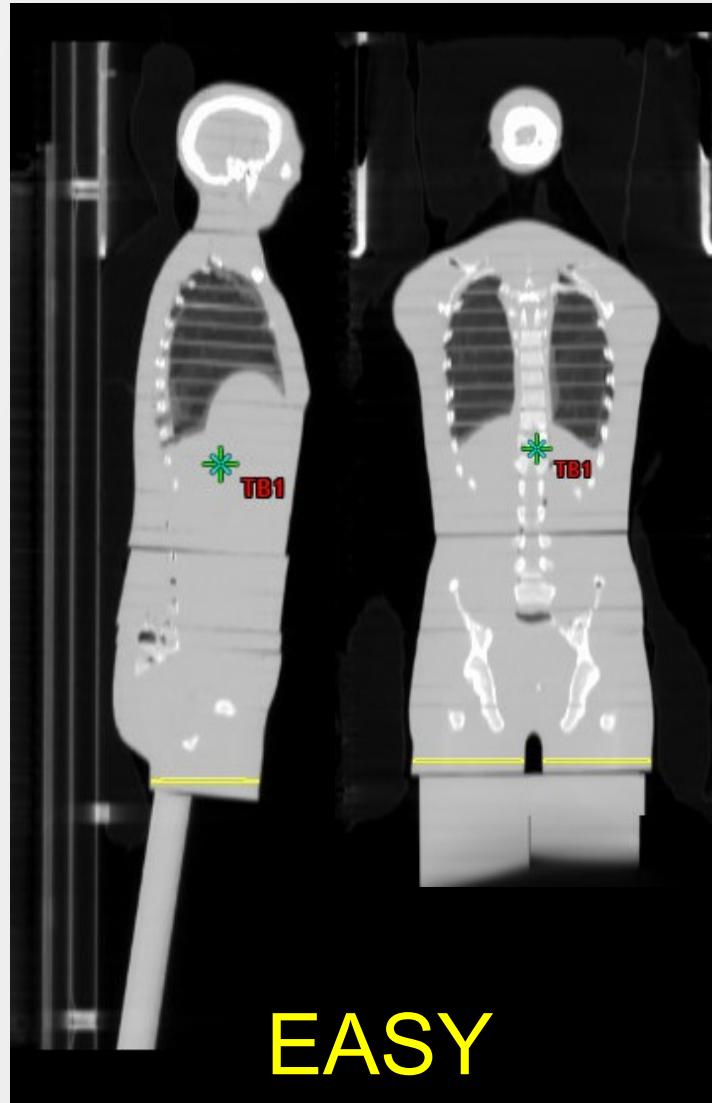
## Import



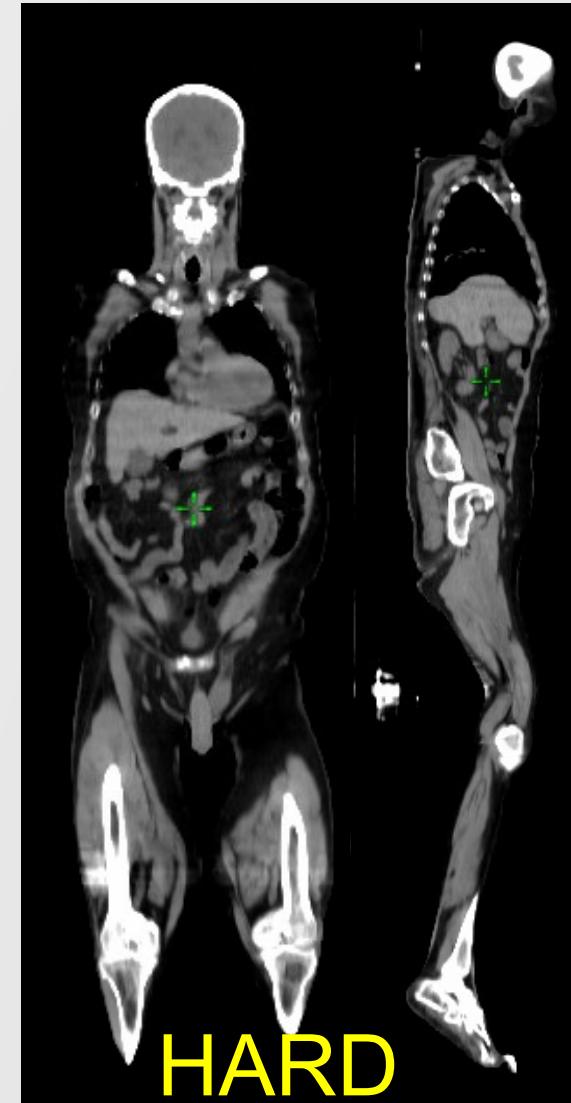
# Whole-body CT Result

R

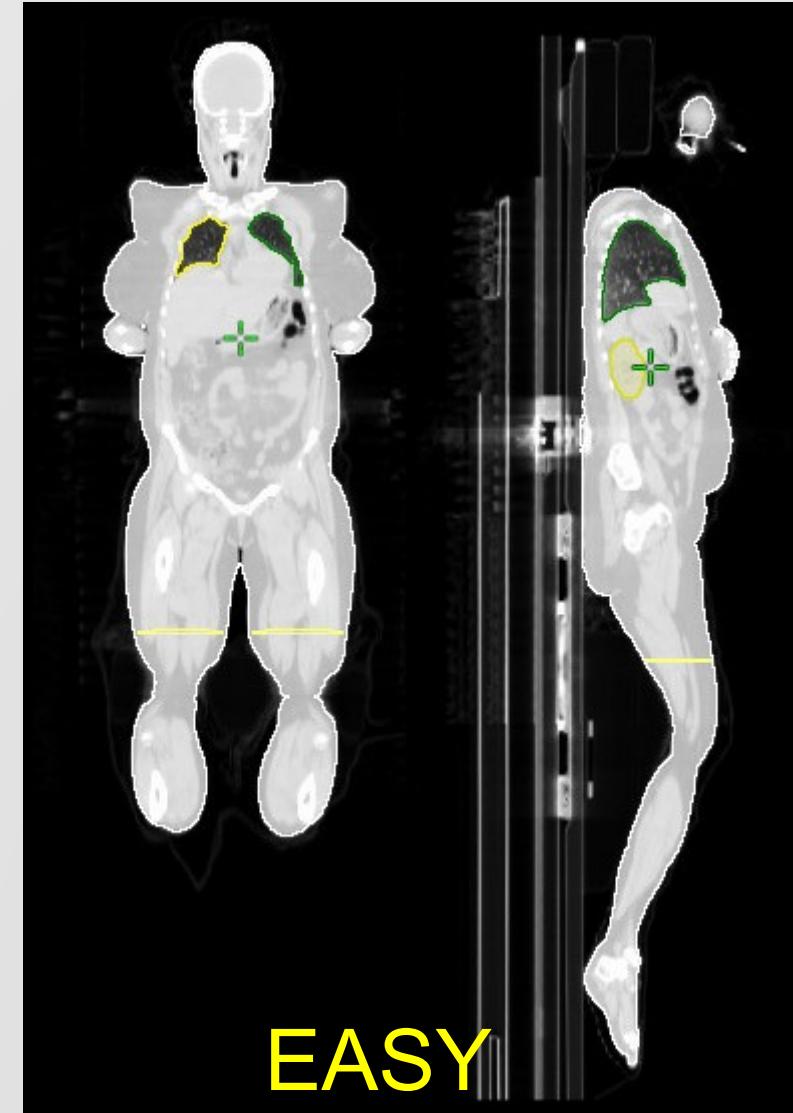
Rando



Patient M



Patient F



# Caveat: Maximum Intensity Projection

Misregistration under inter-scan patient motion



Patient M

Artifacts



# Treatment planning options

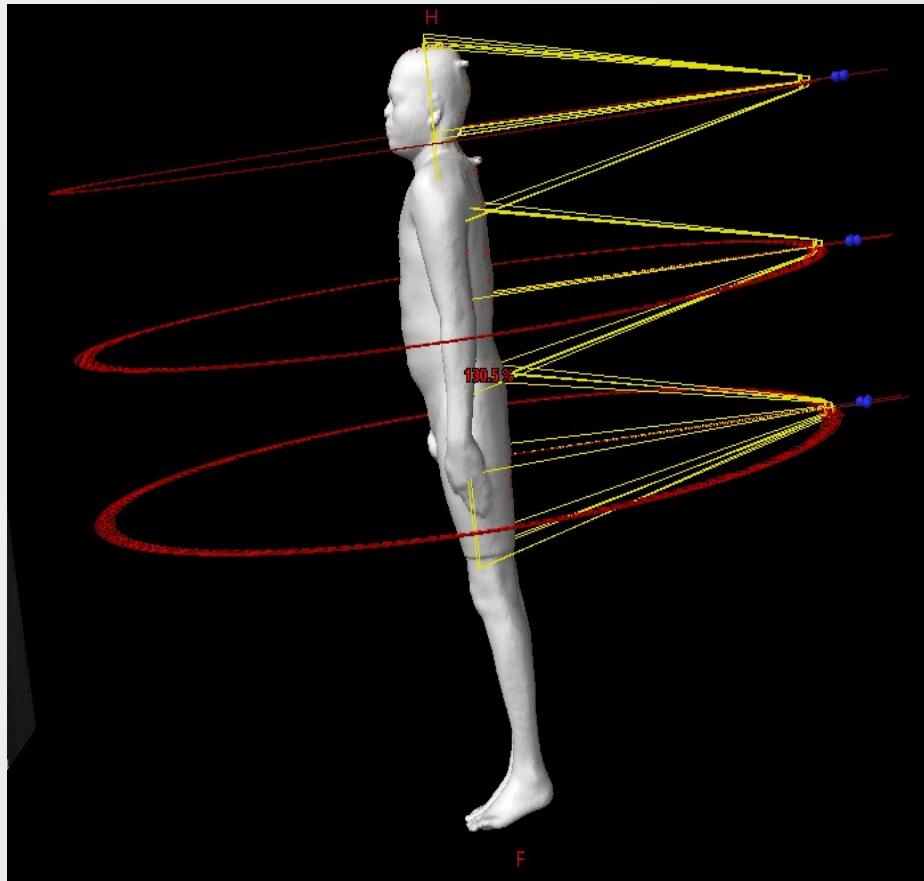


	Stanford Approach	NYU approach
#Iso-centers	3~4 + 1~2	7~10
Total Fields	11~12	11~12
Automation (Customization)	Yes (Yes)	Yes (No)
Planning Time	5 hours (CPU) Unknown (GPU)	Not Available (CPU) 1 hour (GPU)
Treatment Time	Estimated 1~1.5 hrs	Estimated 1~1.5 hrs

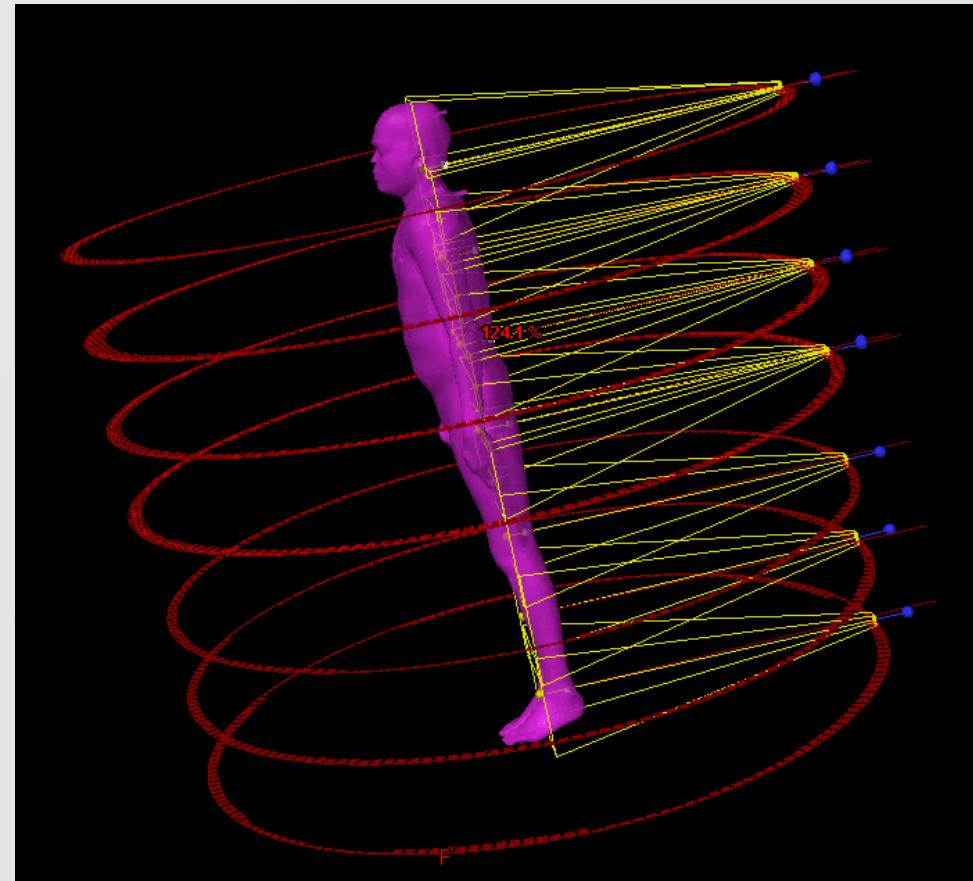
# Iso-center placement

R

Stanford



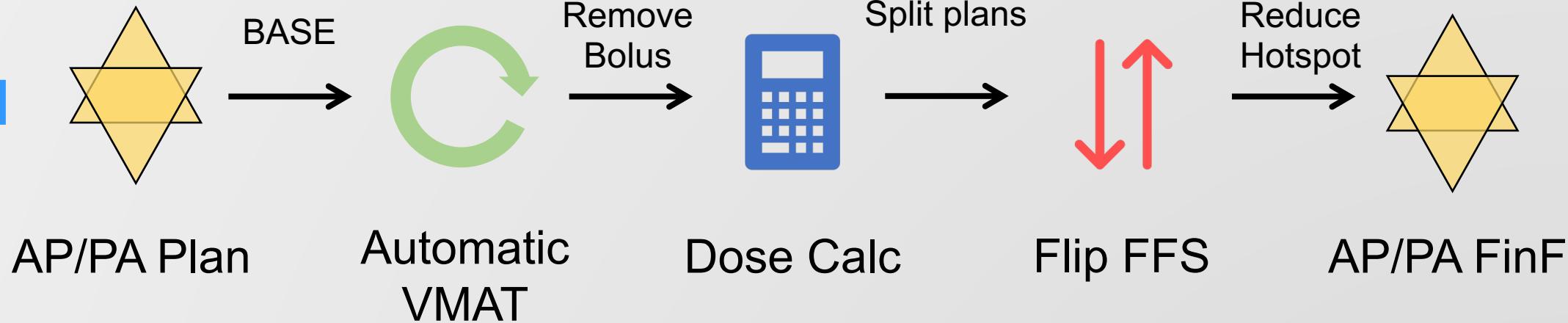
NYU



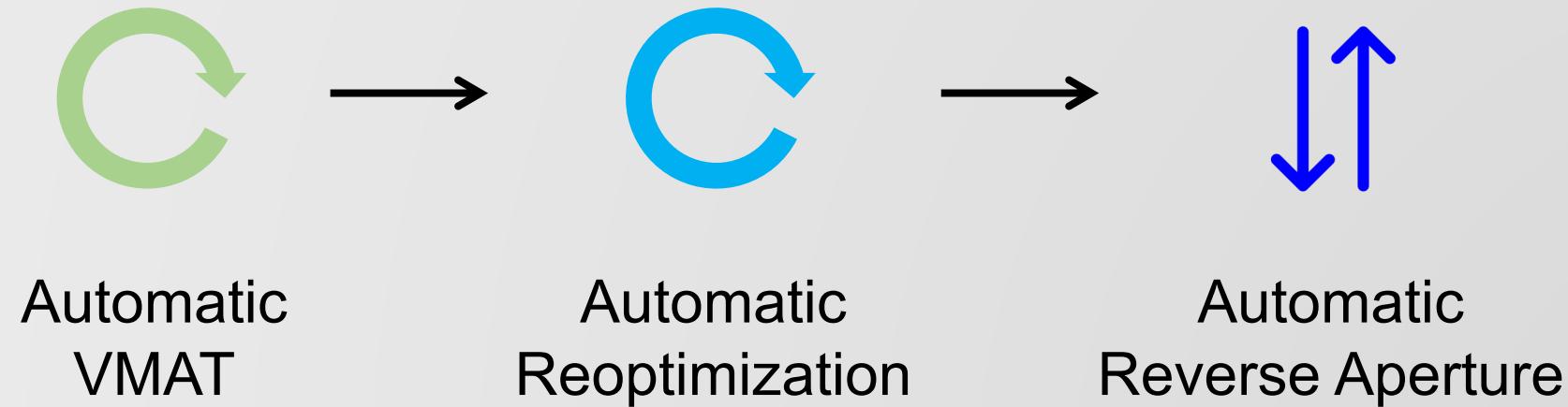
# Planning workflow

R

Stanford

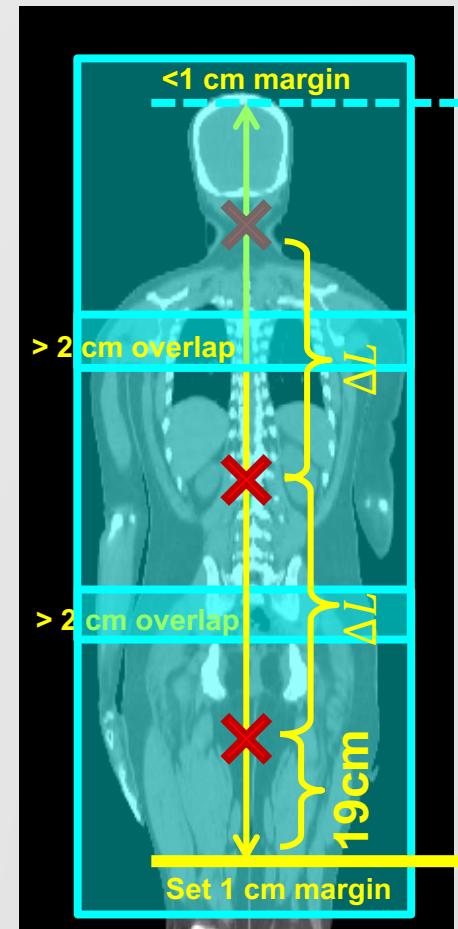
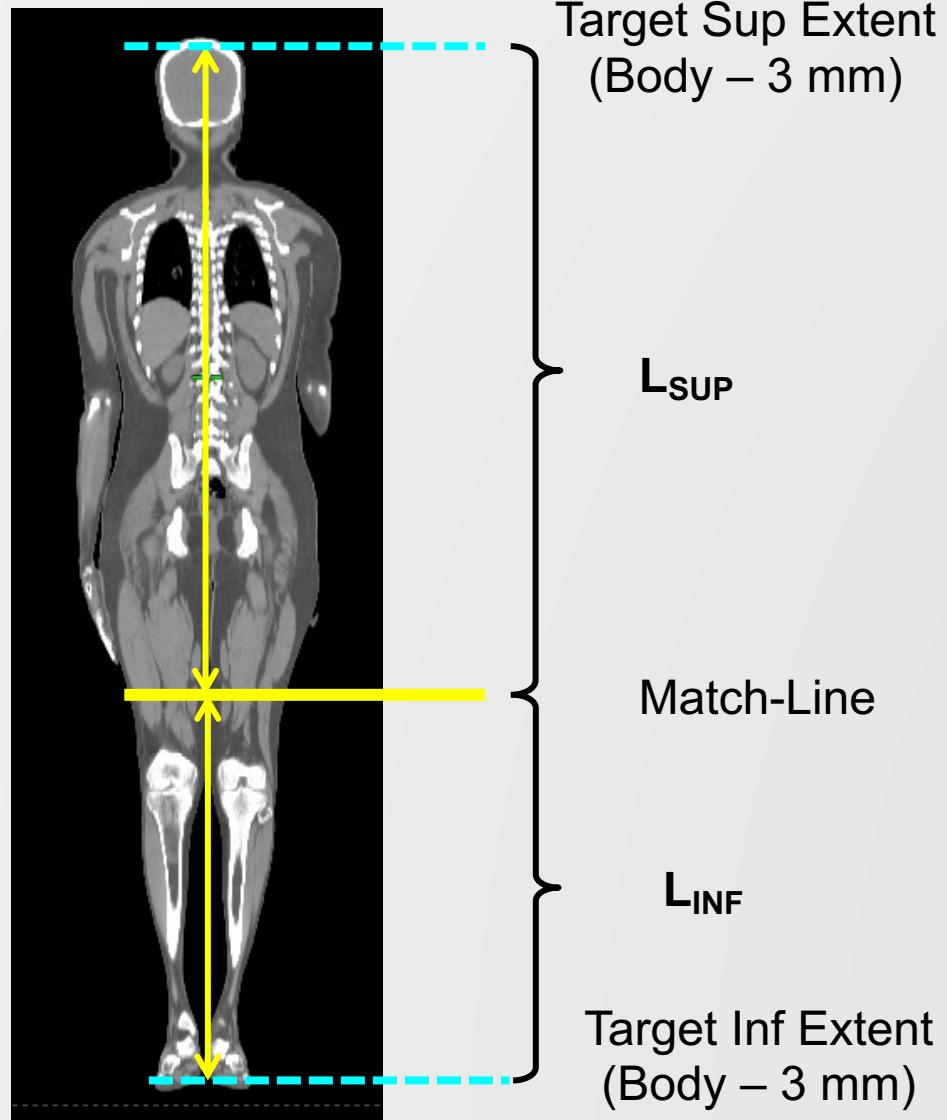


NYU

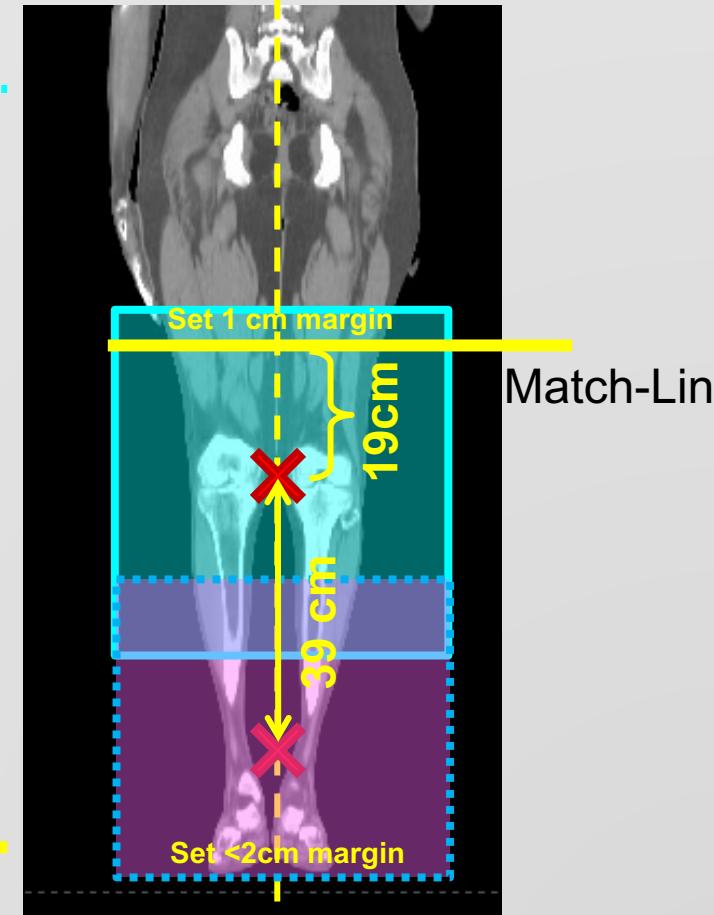


R

# A recap: Stanford approach



Match-Line

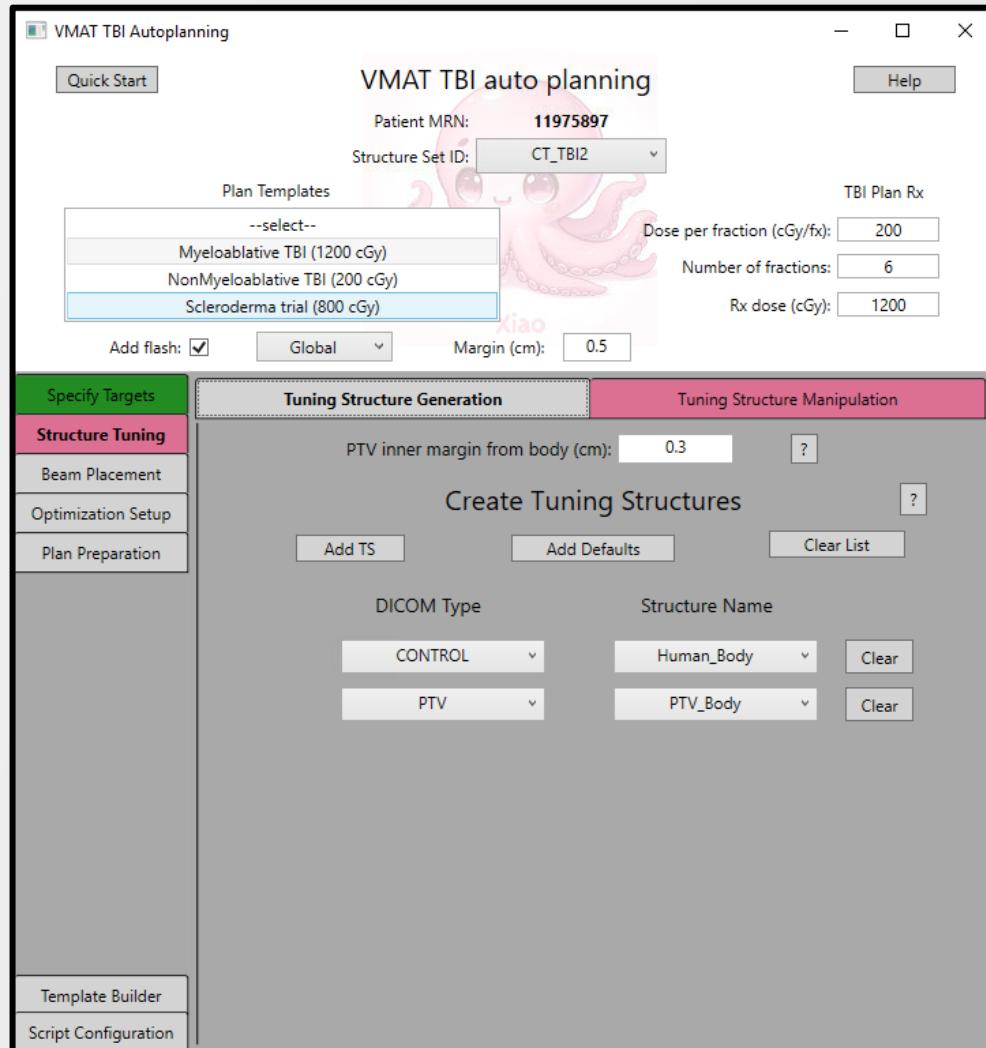


Match-Line

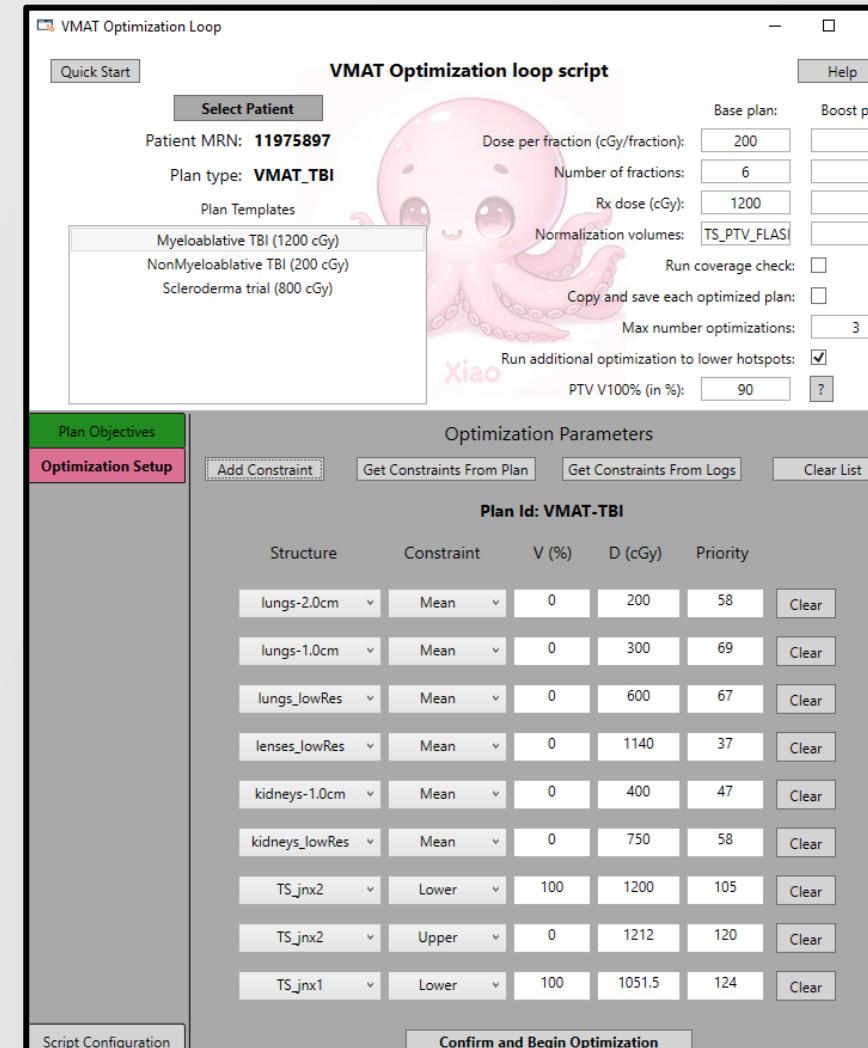
# R

# Script: Stanford approach

## Planning Structure + Beam Placement



## VMAT Optimization



# Script: Treatment Planning: NYU approach



Integrated script workflow

configuration

VMAT-TBI Planning Tool				TemplateViewerWindow		
Configuration	Auto Plan	Cooler & Heater	Reverse FFS	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	
				OAR / Sparing	Margin (mm)	
				Lungs Sparing	Yes	3
				Kidneys Sparing	Yes	0
				Liver Sparing	No	

# Phantom study: NYU approach

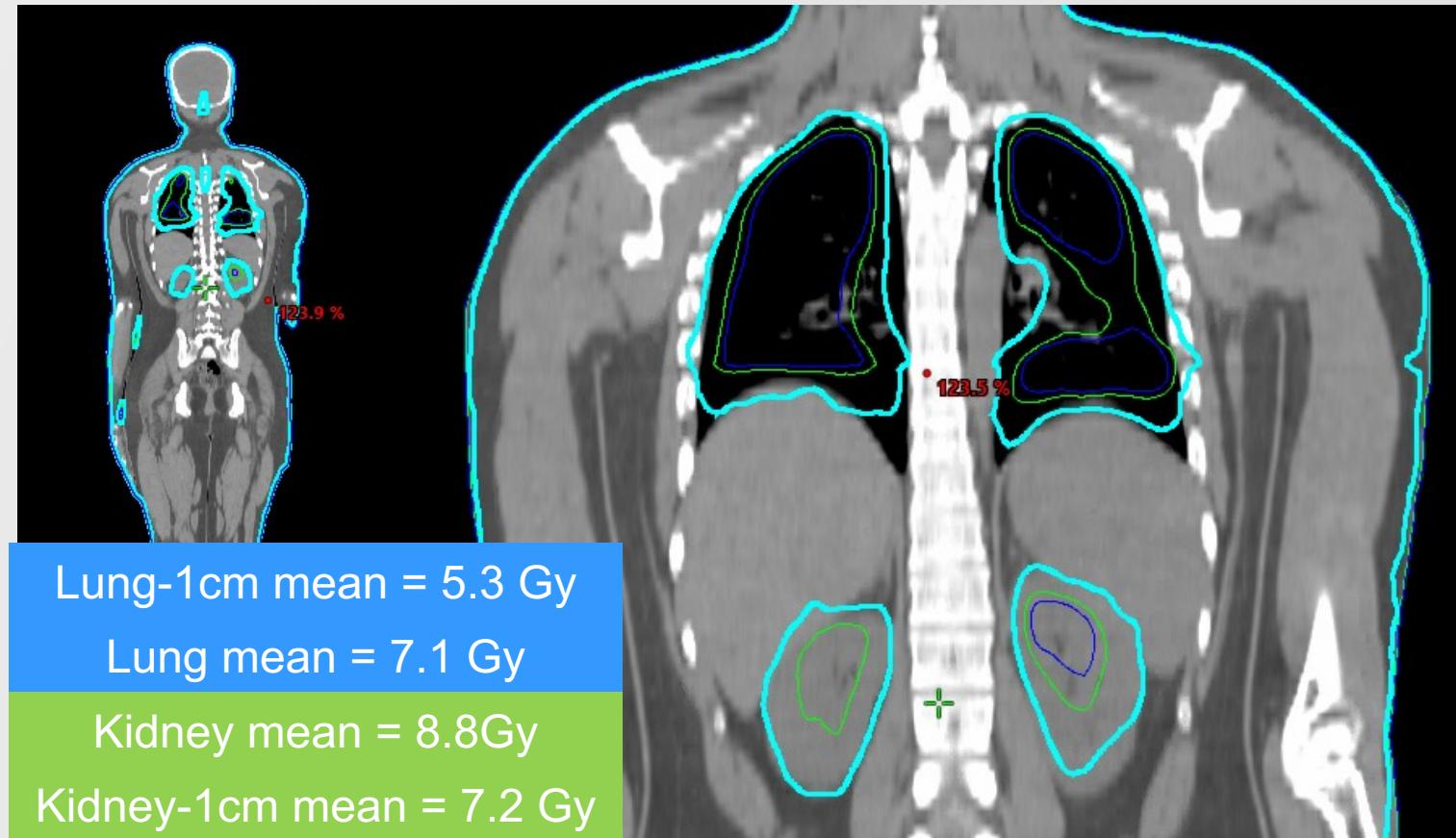
R

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%



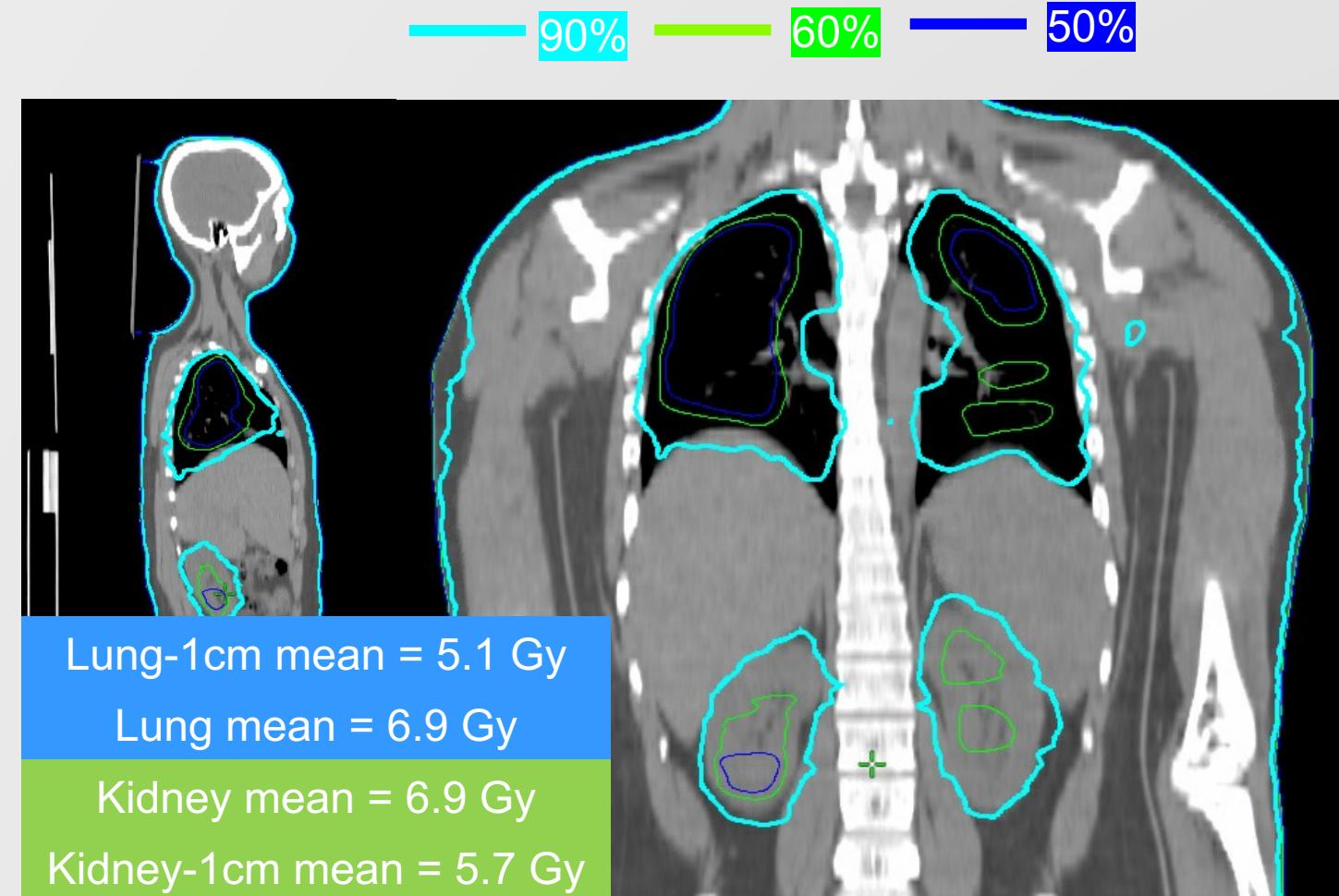
# Phantom study: Stanford approach

R

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%



# Real patient case: Stanford approach

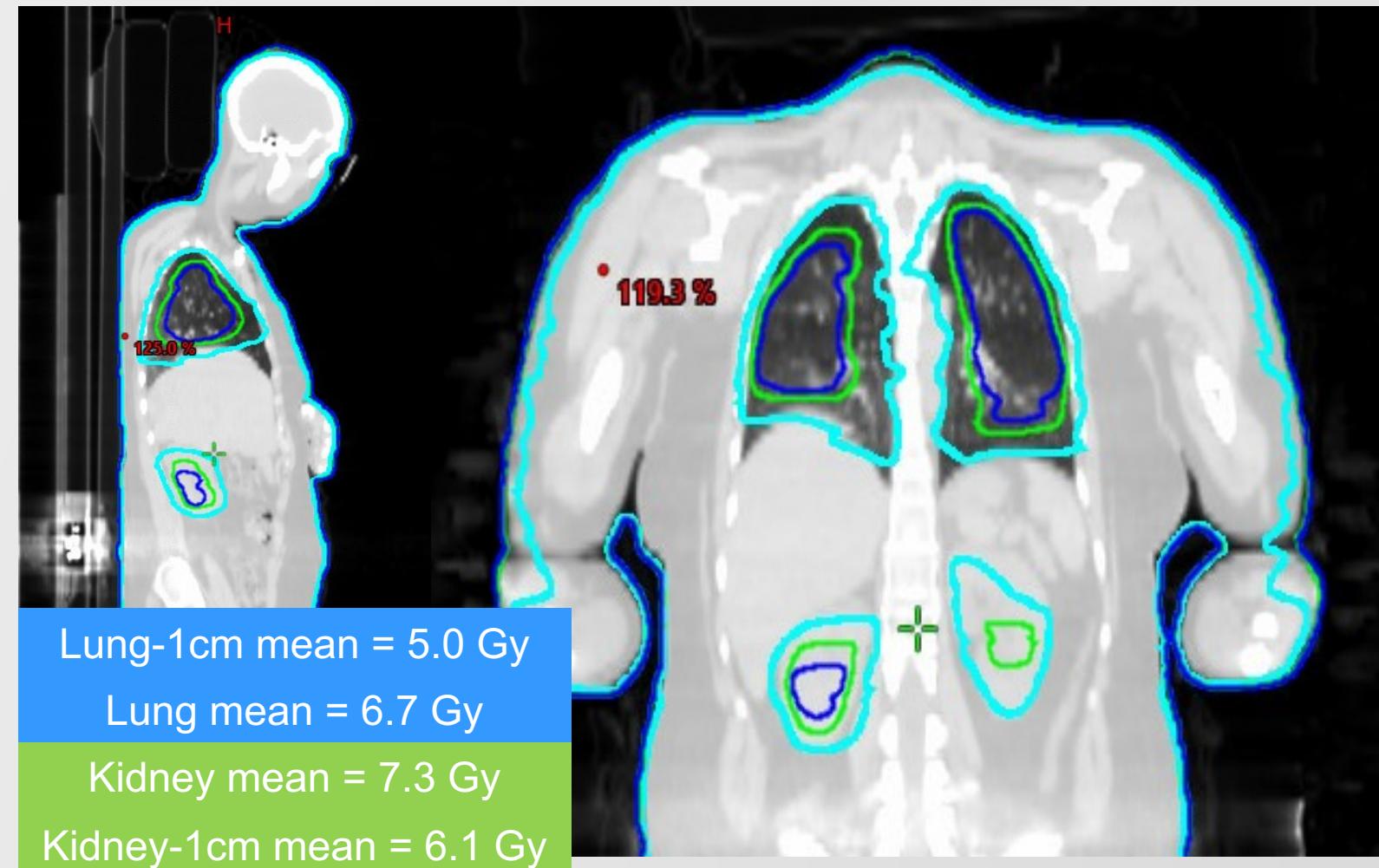
R

— 90% — 60% — 70%

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%



# End-to-end Treatment on Rando

R

Vac-Loc

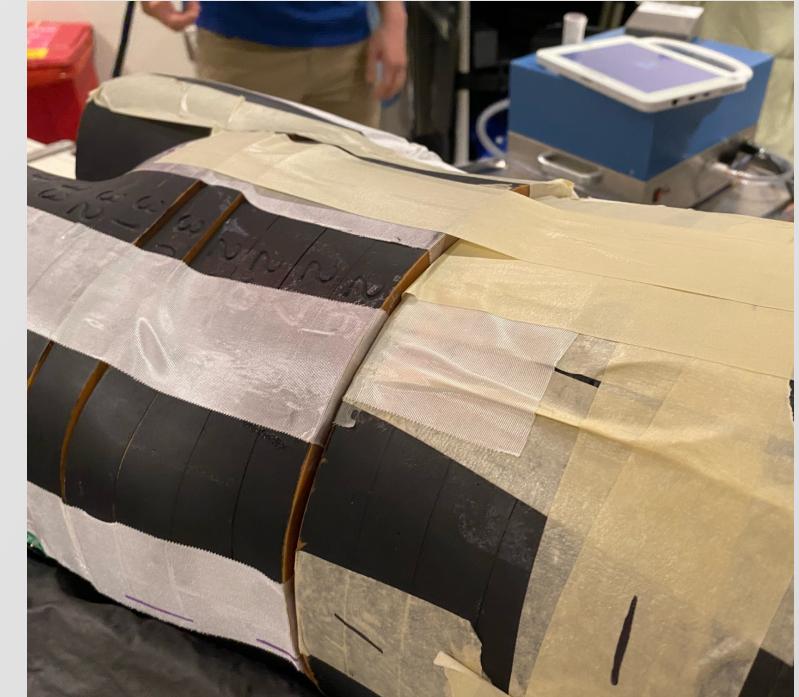


Water Slab  
as legs

Breast board



Displacement  
@ junctions



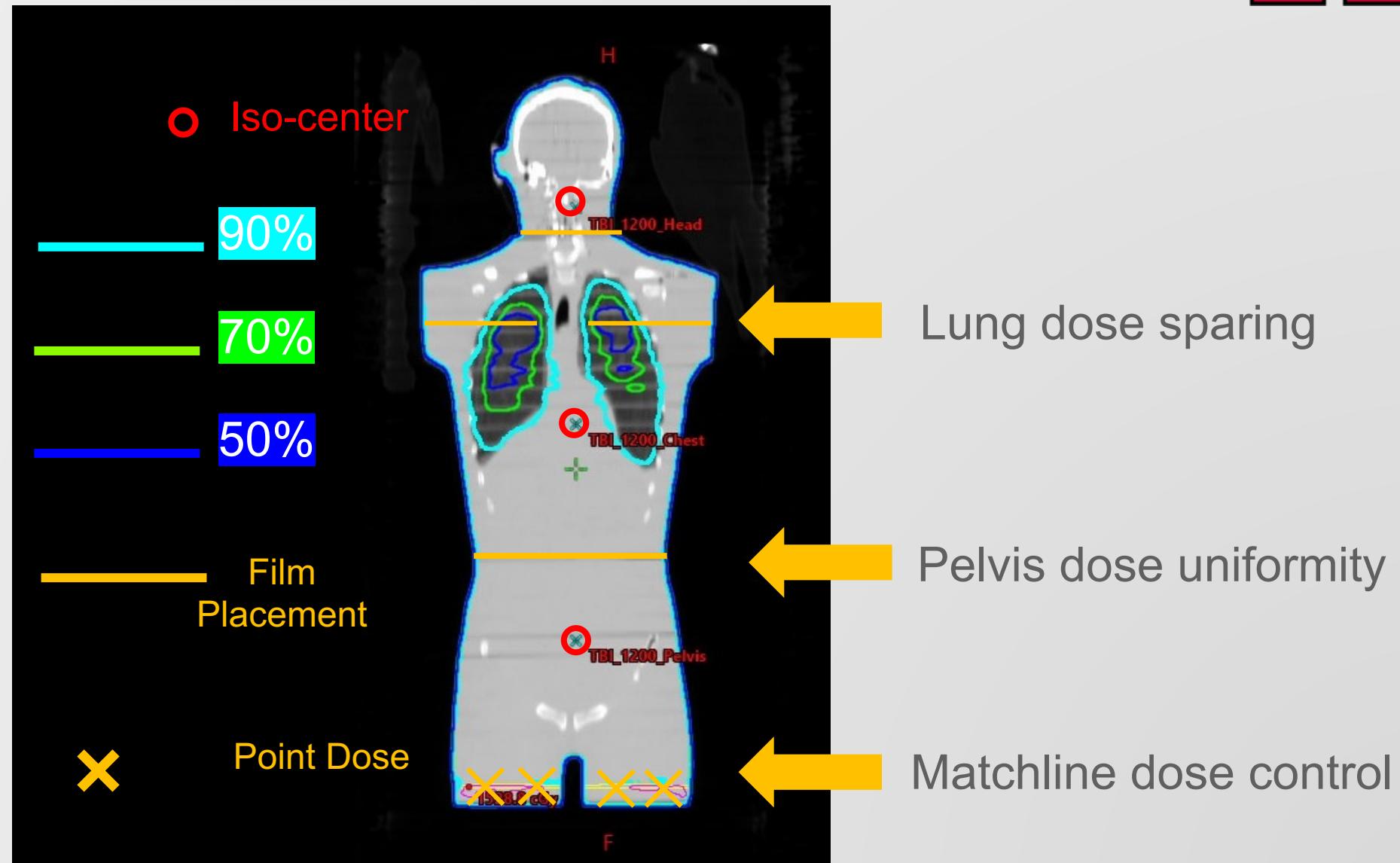
# 4-iso plan VMAT + APPA

R

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

HOT SOPT 130%  
 $V_{120} = 0.1\%$   
 $V_{110} = 18.0\%$

$D_{90} = 98\%$   
 $D_{95} = 96\%$   
 $D_{90} = 100\%$   
 $V_{95} = 98\%$   
 $V_{100} = 91\%$

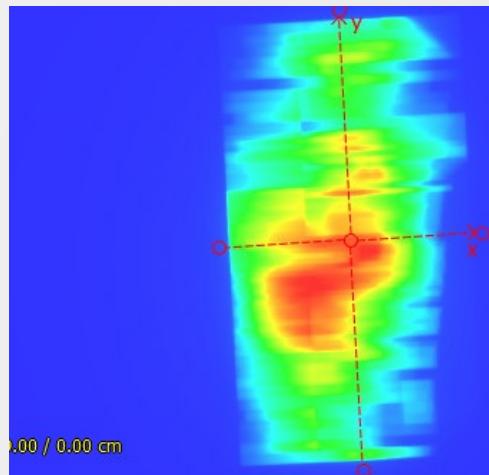


# Portal Dosimetry QA

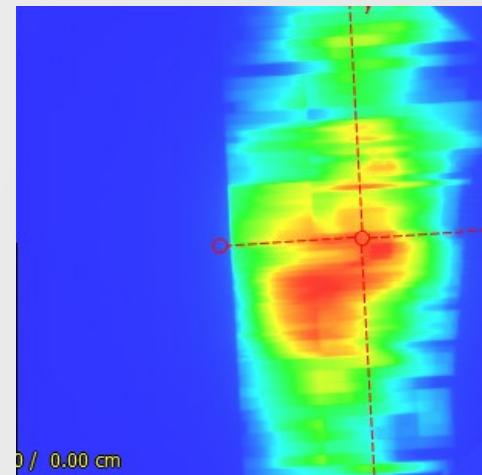
R

## Chest

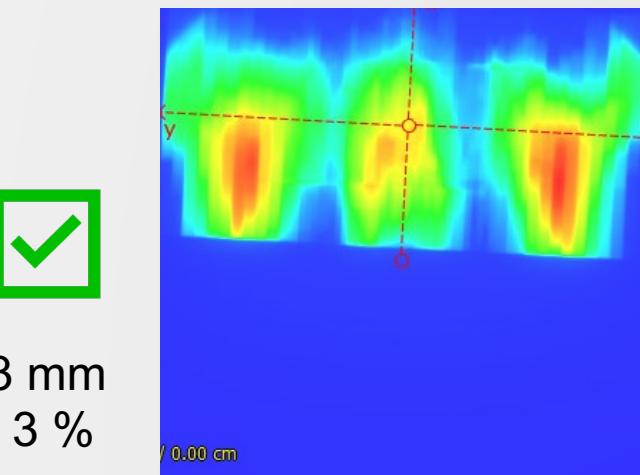
Predicted



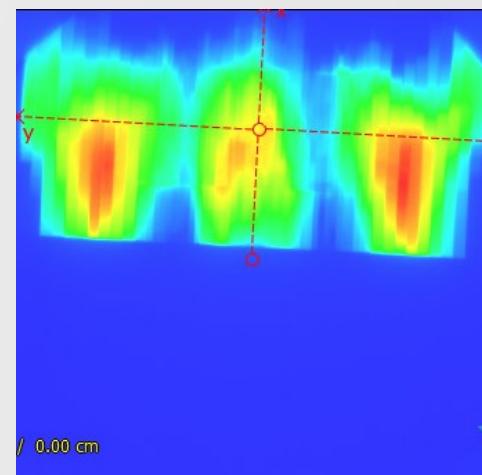
Measured



3 mm  
3 %

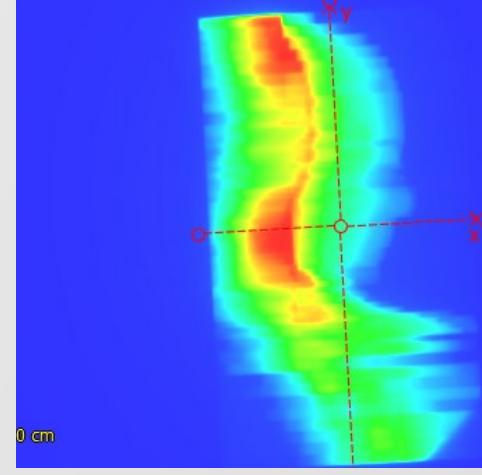


3 mm  
3 %

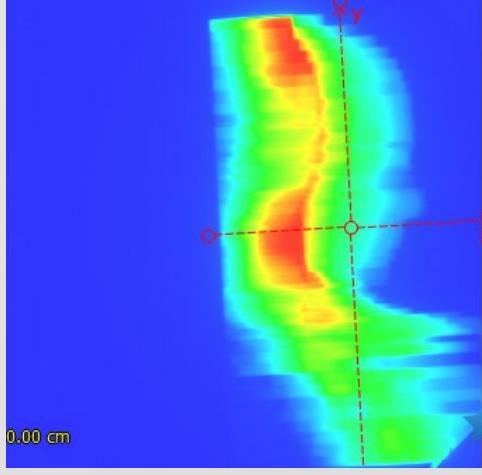


## Head

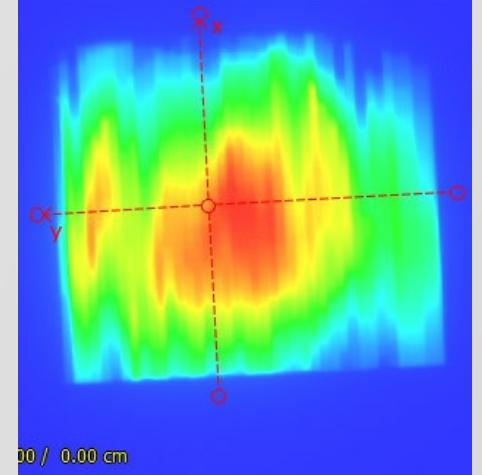
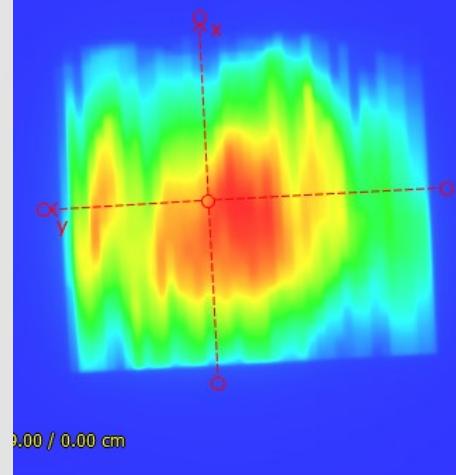
Predicted



Measured



3 mm  
3 %



# Setup and OSMS contour

R

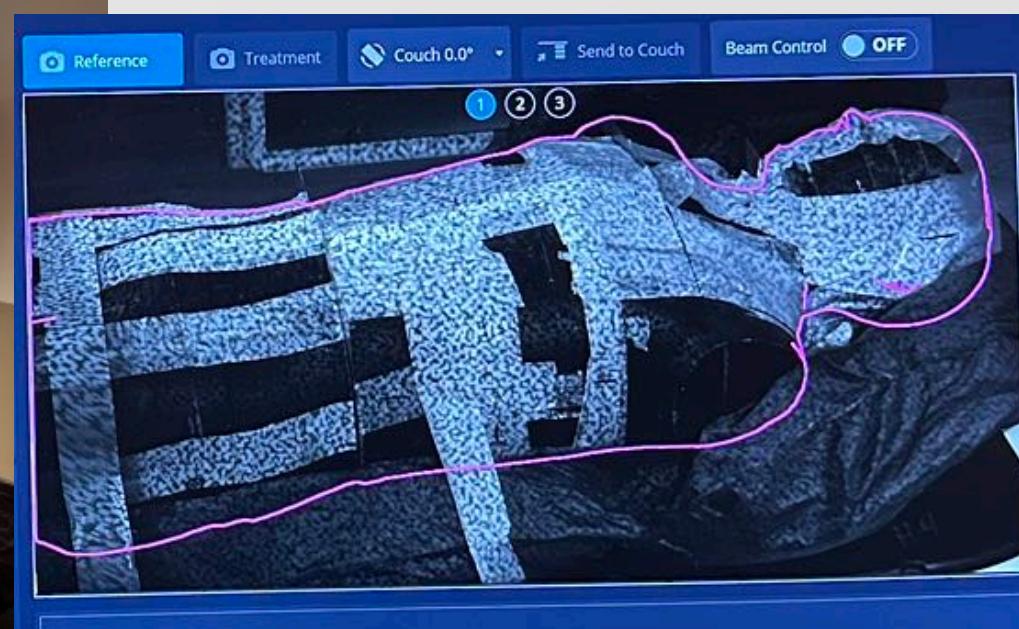
Film Setup



Treatment setup



Posture video



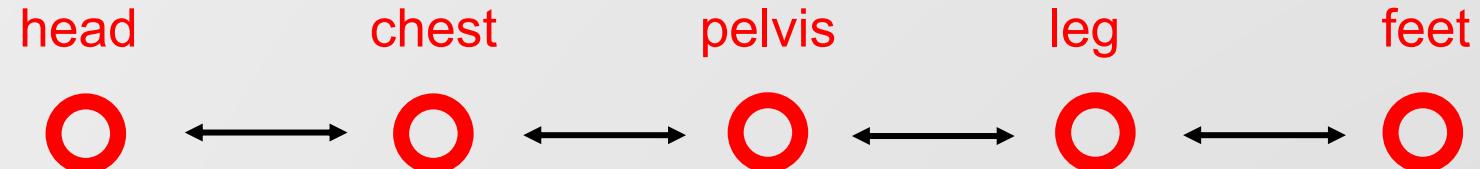
# Delivery: VMAT

R



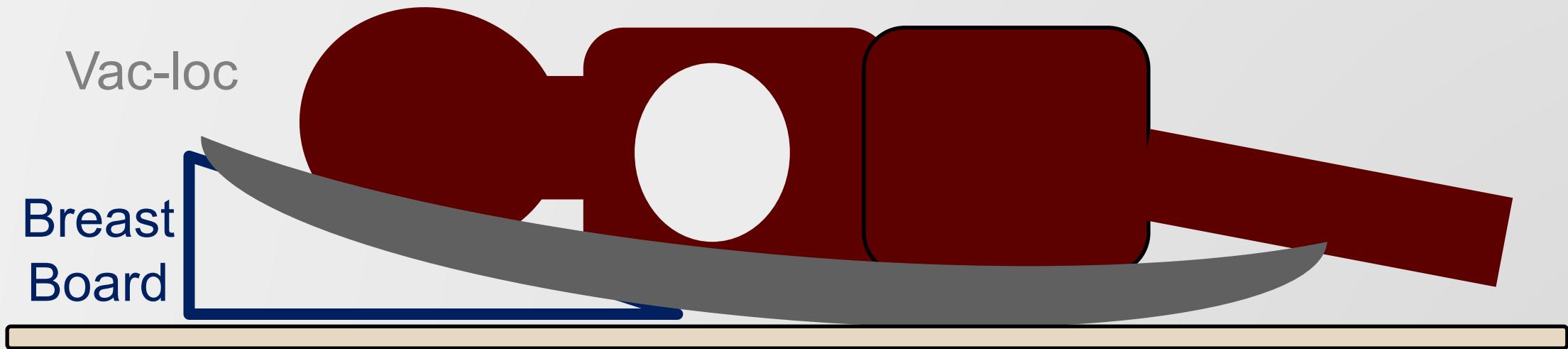
Gantry

Strictly follows planned



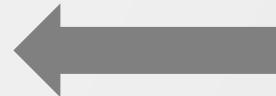
Vac-loc

Breast  
Board



# Delivery: VMAT

R



Gantry

head



chest



pelvis



leg

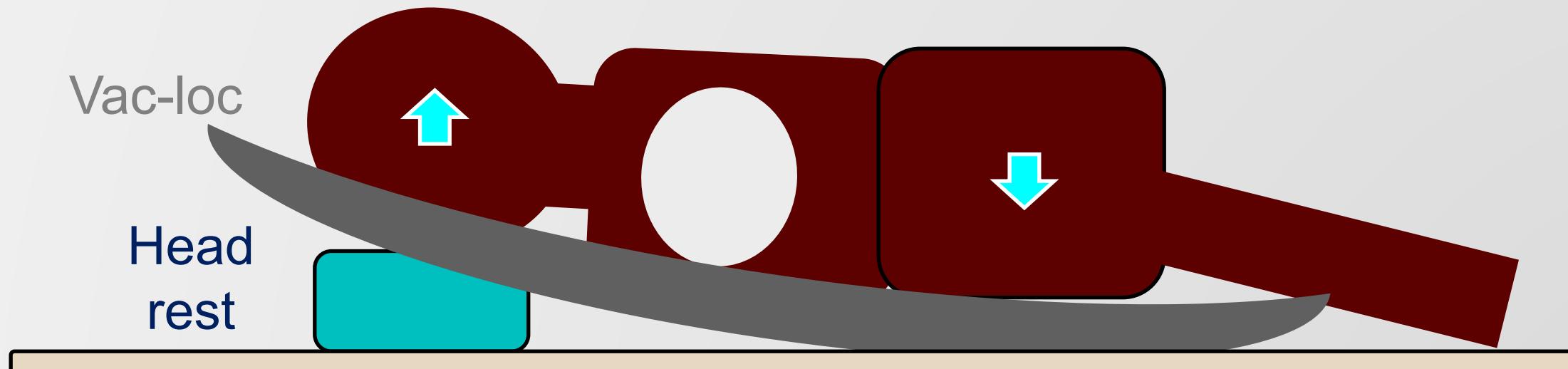


feet



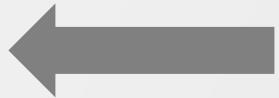
Vac-loc

Head  
rest



# Delivery: VMAT

R



Gantry

feet



leg



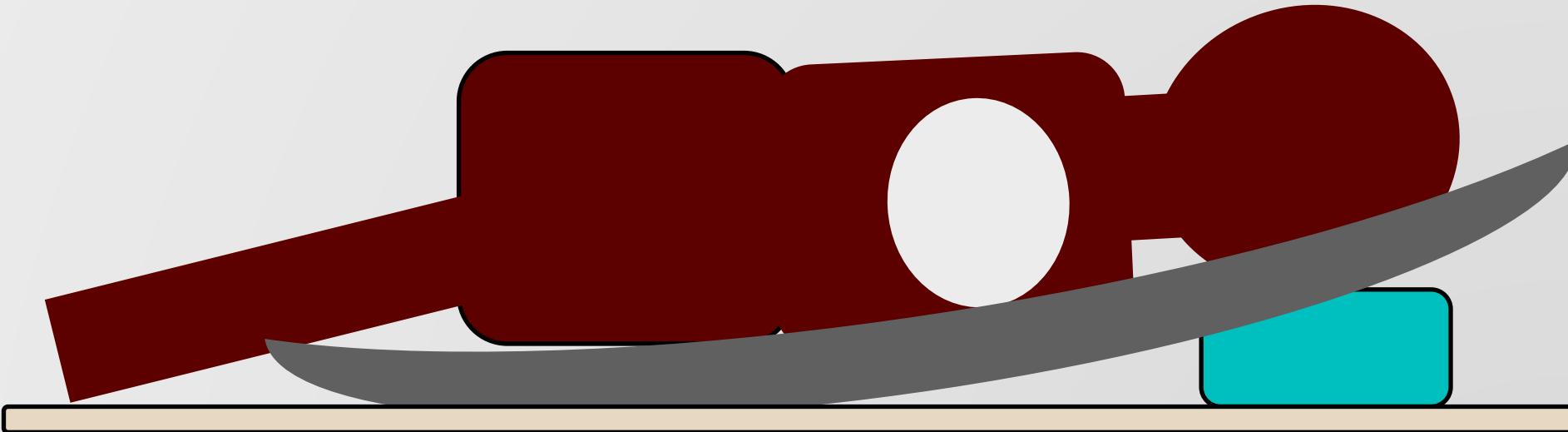
pelvis



chest



head



# kV/OSMS Setup Report



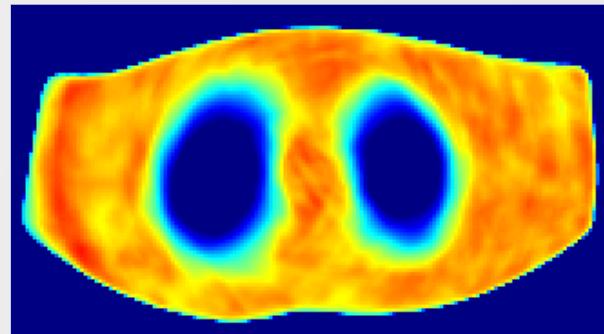
	IGRT before shift (cm)	kVCBCT shift (cm)	IGRT after shift (cm)
Chest	(0.01, -0.02) <b>0.04</b>	(0.03, 0.01) <b>0.03</b>	(-0.02, 0.01) <b>0.04</b>
Head	(0.10, -0.04) <b>0.24</b>	(-0.24, -0.1) 0.26*	(0.35, -0.04) 0.41*
Pelvis	(0.34, 0.26) <b>0.44</b>	(0.27, 0.20) <b>0.33</b>	(0.07, 0.06) <b>0.12</b>
Leg	(-0.01, 0) <b>0.07</b>	(0, 0) <b>0</b>	(0.01, 0) <b>0.07</b>

# Dosimetric Evaluation

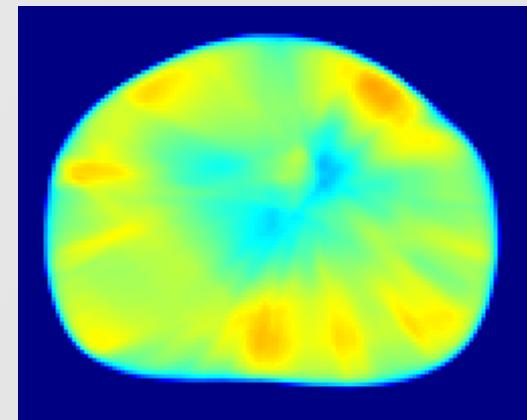
R

Point dose <5%

Planned Lung Dose



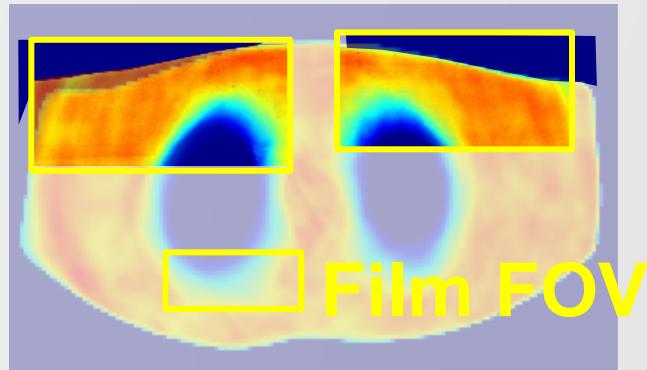
Planned Pelvis Dose



120%

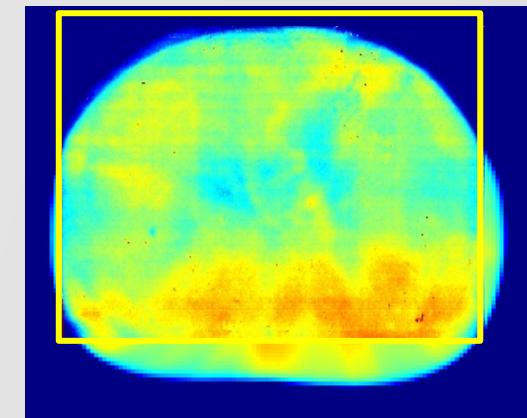


Measured Planar Dose



Film FOV

<50%



120%

80%

Measured Planar Dose

# Discussion

R

- 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





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

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