Benchmark & FAQ for NRG-BR001: A Phase 1 Study of SBRT for the Treatment of Multiple Metastases

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Credentialing Requirements (SECTION 5)

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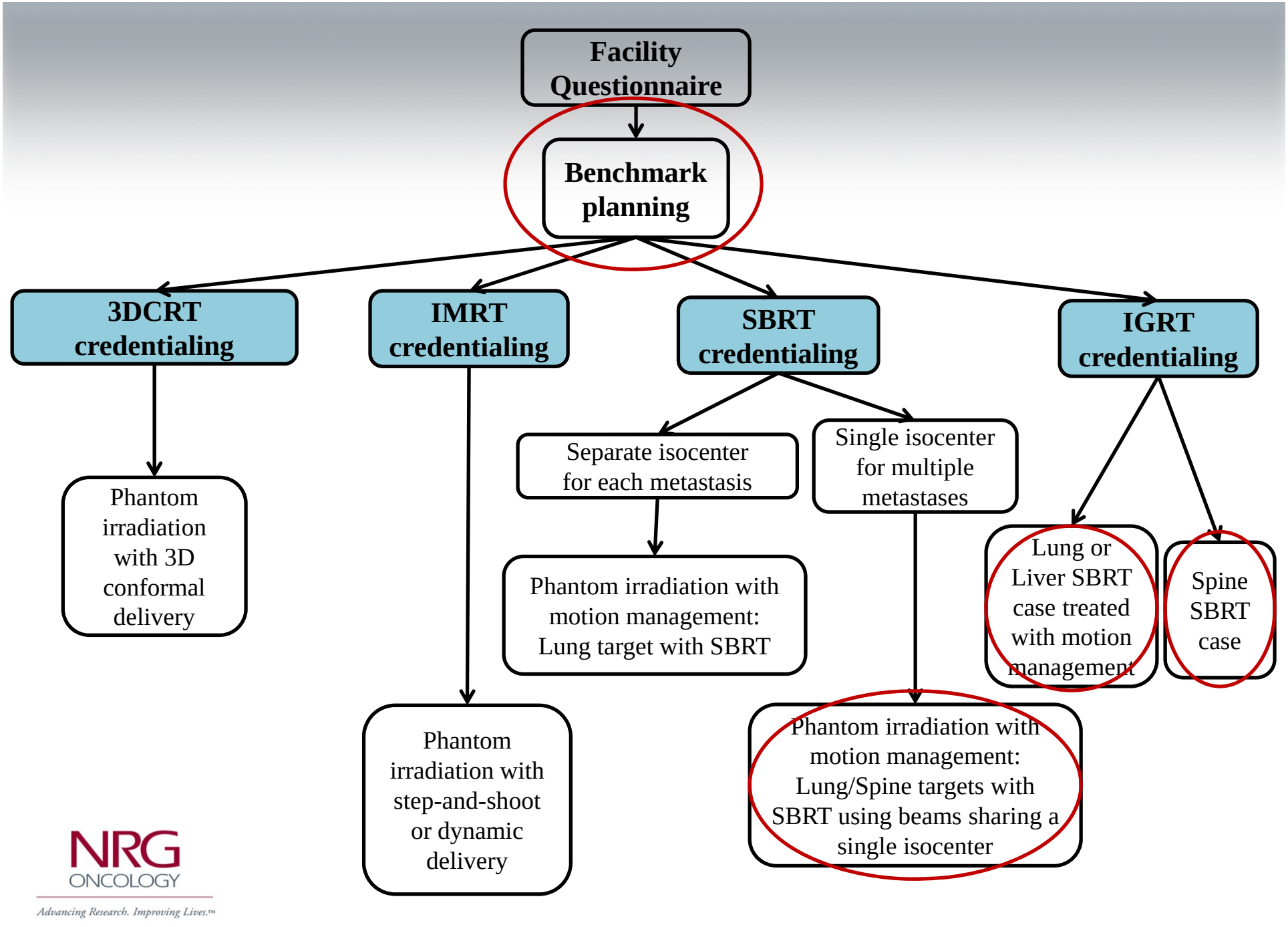

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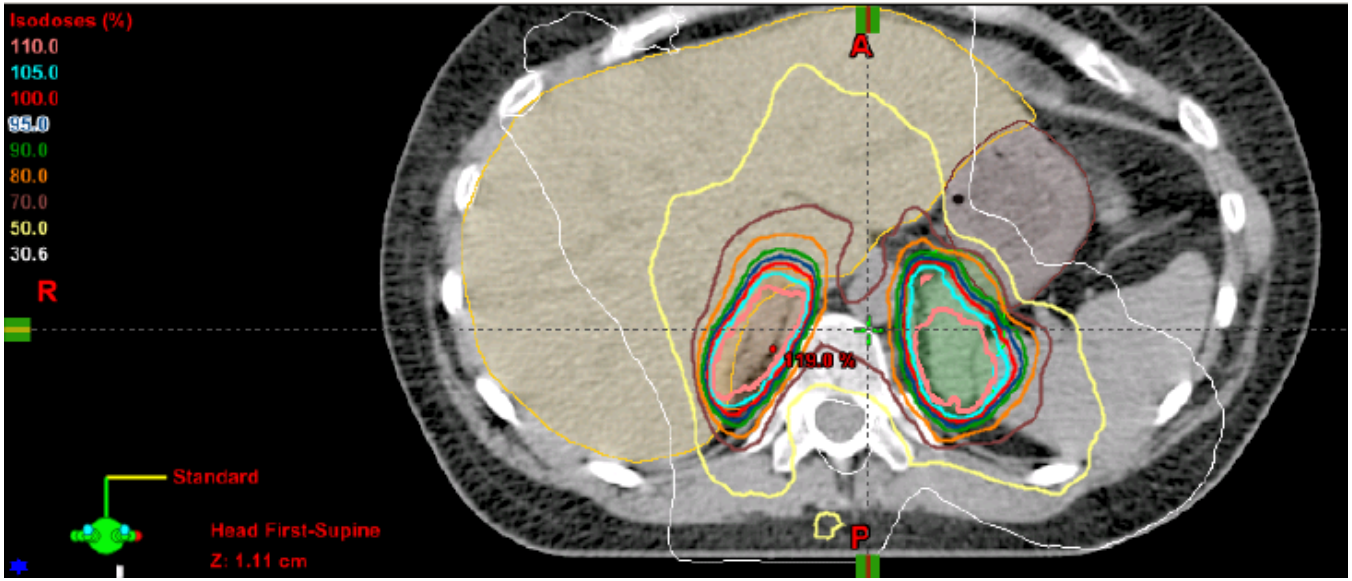
Benchmark Planning

- Planning tool by which to familiarize each institution with the specific planning goals of the protocol
- *Pre-enrollment* review versus *pre-treatment* review



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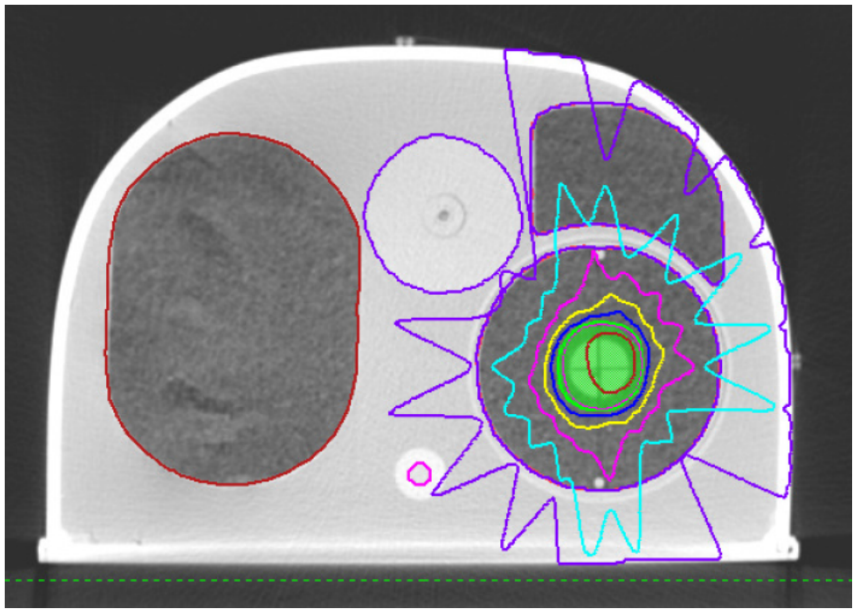
NRG BR001: IROC Phantoms

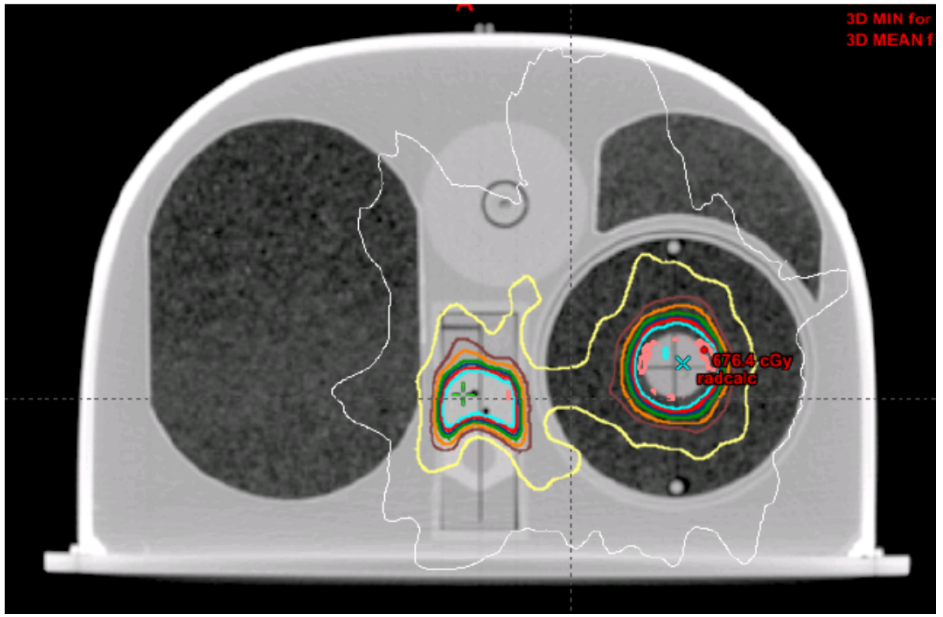
- Institutions need to credential for only the most complex modality they intend to use! (3D → IMRT → VMAT)
- The following techniques must be included in credentialing prior to use in patients enrolled onto BR001:
  - Motion management technique
  - FFF beams
- Techniques may be combined
  - Ex: IMRT using FFF delivered with motion management

NRG BR001: IROC SBRT Phantoms

Lung



Lung & Spine Irradiation



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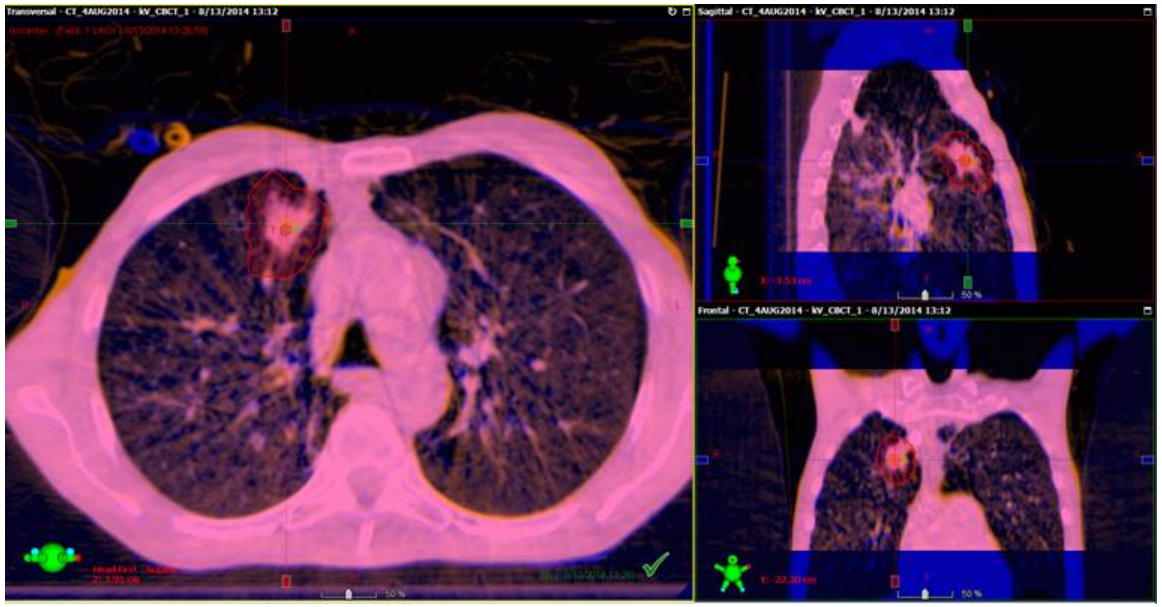
NRG BR001: IGRT Credentialing

- Data from 2 anatomical sites:
  - **Lung/Liver** with same motion management technique your institution will utilize for BR001
  - **Spine**



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Benchmark Planning

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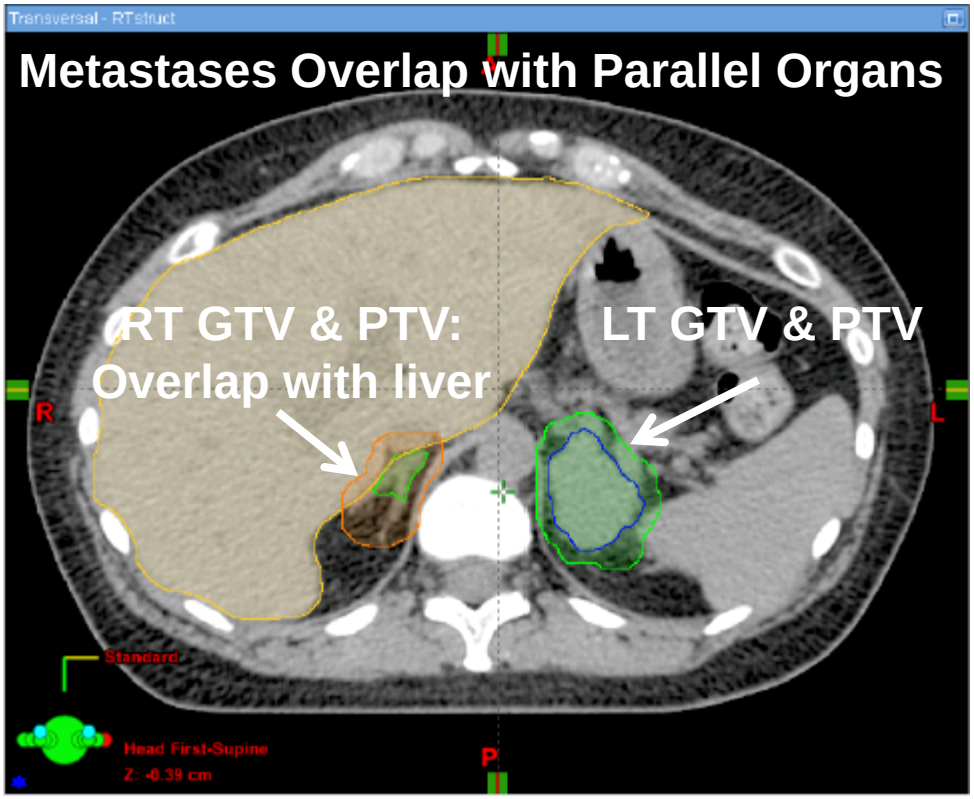
BR001 Benchmark Case: Bilateral Adrenal Metastases



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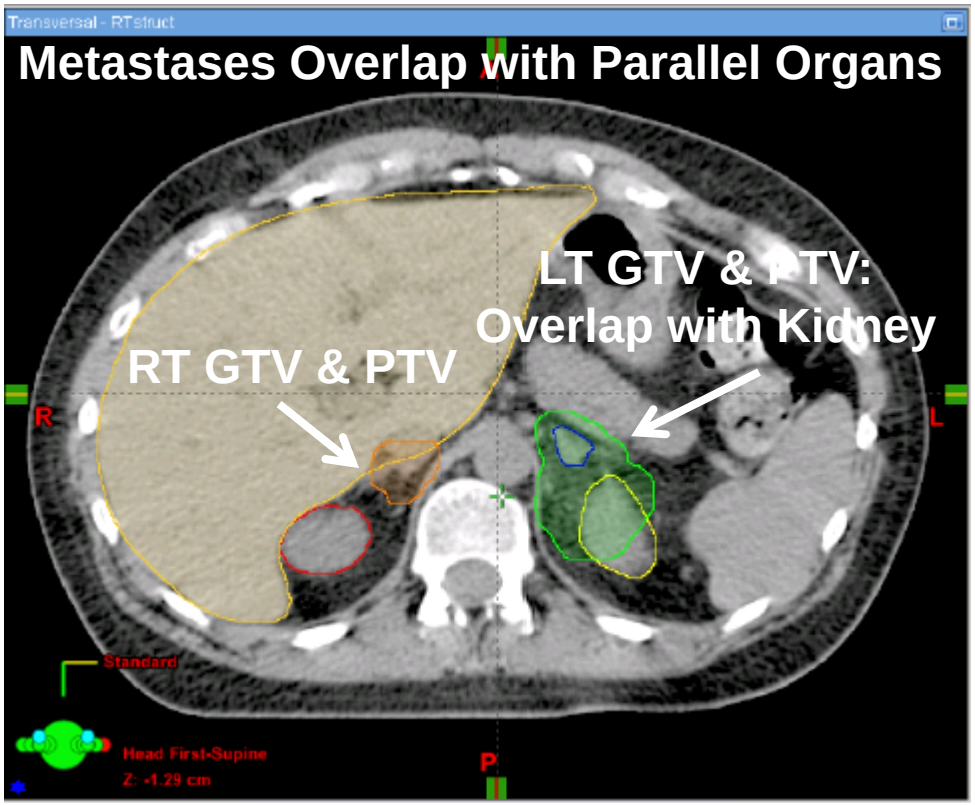
BR001 Benchmark Case: Bilateral Adrenal Metastases



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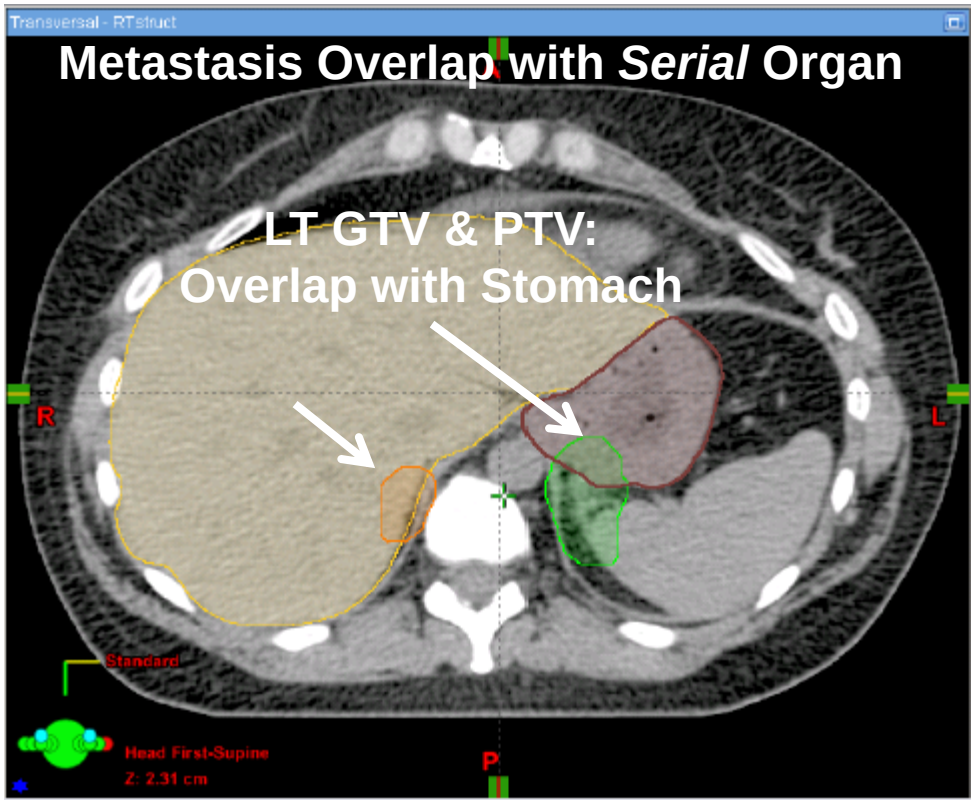
BR001 Benchmark Case: Bilateral Adrenal Metastases



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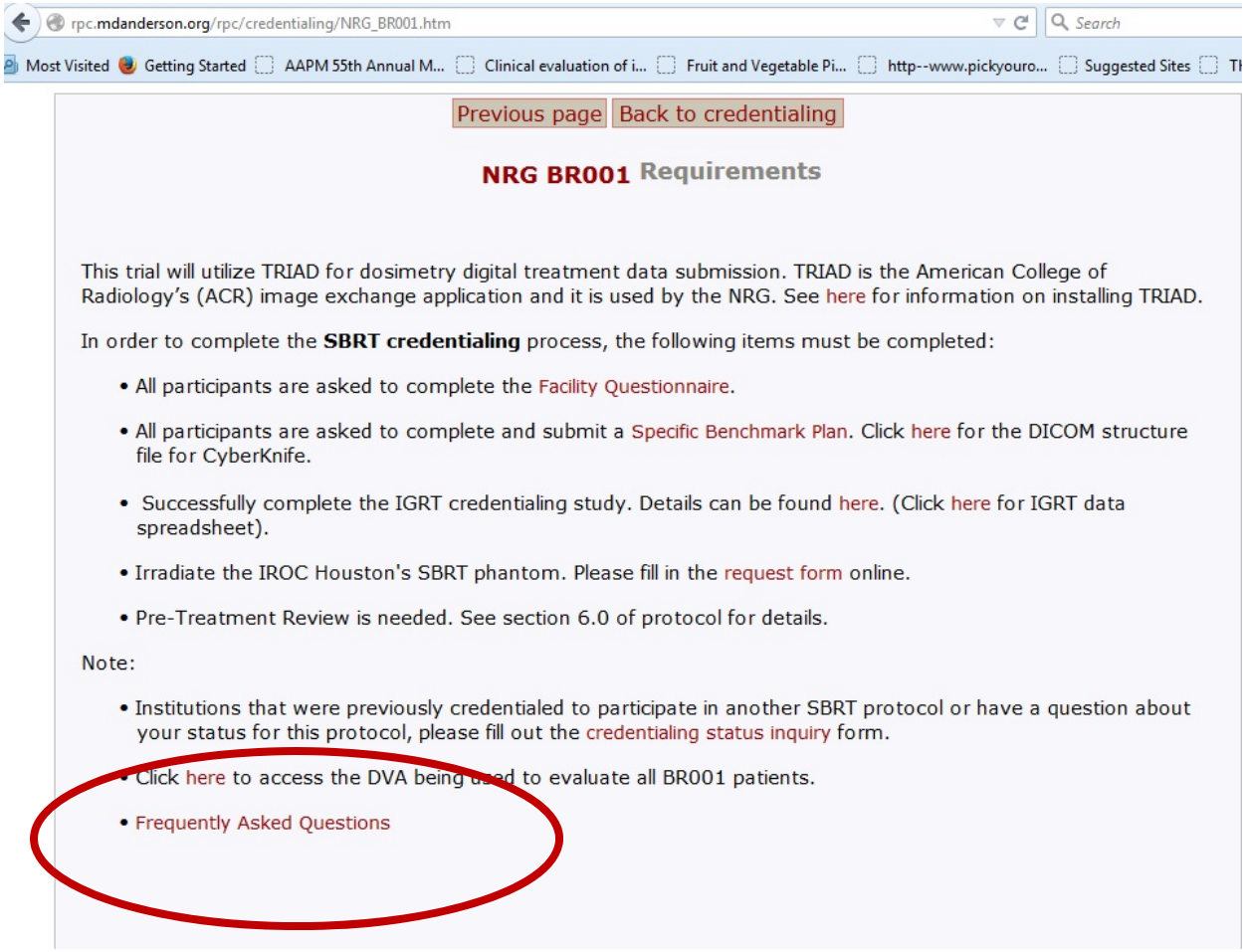
NRG BR001: FAQ



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NRG BR001: FAQ

- Can my institution plan the benchmark with a single isocenter even though my institution has not yet credentialed to deliver treatment to 2 metastases using a single isocenter?
  - *Yes*
- What should I do if an OAR is not in the structure set?
  - *Contour it if you would like to use it for planning*
- What QA measurements are required?
  - *None*
- Should the benchmark plan be reviewed by our physician?
  - *Absolutely! To ensure it's clinically acceptable*

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NRG BR001: FAQ

- If the plan is intended to treat both lesions simultaneously on the same day, am I required to submit separate dose grids for each lesion?
  - *No (e.g., single VMAT plan)*
- For an IMRT/VMATplan, is a normalization of 60-90% required?
  - *No, but ensure conformality is high*
- How should the conformality of the plan be assessed?
  - *See Table 6-4*
  - *80% isodose should break up between 2 lesions*

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NRG BR001: FAQ

- I cannot meet the PTV coverage requirements while also meeting all the OAR constraints in Table 6-6. How should these competing constraints be balanced?
  - *BR001 provides guidance on the "planning priorities" (SECTION 6.4.5):*
    1. *Spinal dose constraints, as assessed on the composite dose map, must always be met.*
    2. *PTV coverage may not fall below 70% of the 45 Gy prescription dose in regions overlapping with OAR.*
    3. *No dose >47.25Gy may exist outside PTV. In addition, no dose >47.25Gy may exist in PTV volumes that overlap directly with OAR (e.g., Liver, Kidney_L, Stomach, Bowel). See SECTIONS 6.4.3 & 6.5.4.*
  - *It is left to the discretion of the institution as to whether they will prioritize PTV coverage over OAR (e.g., stomach) constraints.*

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NRG BR001: Benchmark Evaluation

- How will the benchmark be evaluated?
  - Dose Volume Analysis (DVA) will be used to tabulate data
  - Composite dose will be used to evaluate all OAR constraints including 105% hotspot location
  - If each metastasis is planned for treatment on separate days, individual dose maps will be evaluated for PTV coverage

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NRG BR001: Dose Volume Analysis (DVA) for Benchmark Evaluation

NRG-BR001 QA Review
Dose-Volume Analysis
Record case specific parameters in blanks (light yellow) below

Site ID# :		Site Name:	
Case # :		Technique:	
		Rx Dose (45 Gy)	Gy
		# of Fractions (3)	

NOTE: if OAR receive dose from metastatic sites treated with both 3 and 5 fractions, use 3 fraction OAR constraints

Normal Structure Constraints and Compliance Criteria For 3 Fractions

Name of Structure		Dosimetric parameter	(1) Per Protocol	(2) Variation Acceptable	(3) Deviation Unacceptable	Value	Score
SpinalCord	Spinal Cord	D0.03 cc (Gy)	<=22.5 Gy		>22.5 Gy		
SpinalCord	Spinal Cord	D1.2 cc (Gy)	<=13 Gy		>13.0 Gy		
Esophagus	Esophagus (Non Adjacent Wall)	D					
Esophagus	Esophagus (Non Adjacent Wall)	D					
BrachialPlexus	Ipsilateral Brachial Plexus	D					
BrachialPlexus	Ipsilateral Brachial Plexus	D					
Heart	Heart/Pericardium	D					
Heart	Heart/Pericardium	D					
GreatVessels	Great vessels (non Adjacent wall)	D					
GreatVessels	Great vessels (non Adjacent wall)	D					
Trachea	Trachea(non Adjacent wall)	D					
Trachea	Trachea(non Adjacent wall)	D					
Stomach	Stomach	D					
Stomach	Stomach	D					
Duodenum	Duodenum	D					
Duodenum	Duodenum	D					

NRG-BR001 QA Review
Dose-Volume Analysis
Record case specific parameters in blanks (light yellow) below

Site ID# :		Site Name:		
Case # :	benchmark	Technique:	VMAT	Abdmonial
		Rx Dose (45 Gy)	45 Gy	
		# of Fractions (3)	3	
Target Volume Constraints and Compliance Criteria		70%Rx	31.5 Gy	

Name of Structure	Description	Dosimetric parameter*	(1) Per Protocol	(2) Variation Acceptable	(3) Deviation Unacceptable	Value	Score
PTV_4500_7a	3 Fractions	D95%	45.0 Gy	42.5 Gy to 45.5 Gy	<42.5 Gy or≥ 45.5 Gy	45.43	
PTV_4500_7a	3 Fractions	V70%Rx(%)		99.5		100	1
PTV_4500_7a	3 Fractions	Conformality Index (Rx volume/PTV_4500 volume)	< 1.2	1.2-1.5	> 1.5		999

Name of Structure	Description	Dosimetric parameter*	(1) Per Protocol	(2) Variation Acceptable	(3) Deviation Unacceptable	Value	Score
PTV_4500_7b	3 Fractions	D95%	45.0 Gy	42.5 Gy to 45.5 Gy	<42.5 Gy or≥ 45.5 Gy	39.76	
PTV_4500_7b	3 Fractions	V70%Rx(%)		99.5		100	2
PTV_4500_7b	3 Fractions	Conformality Index (Rx volume/PTV_4500 volume)	< 1.2	1.2-1.5	> 1.5		999

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Benchmark Examples & Reviews

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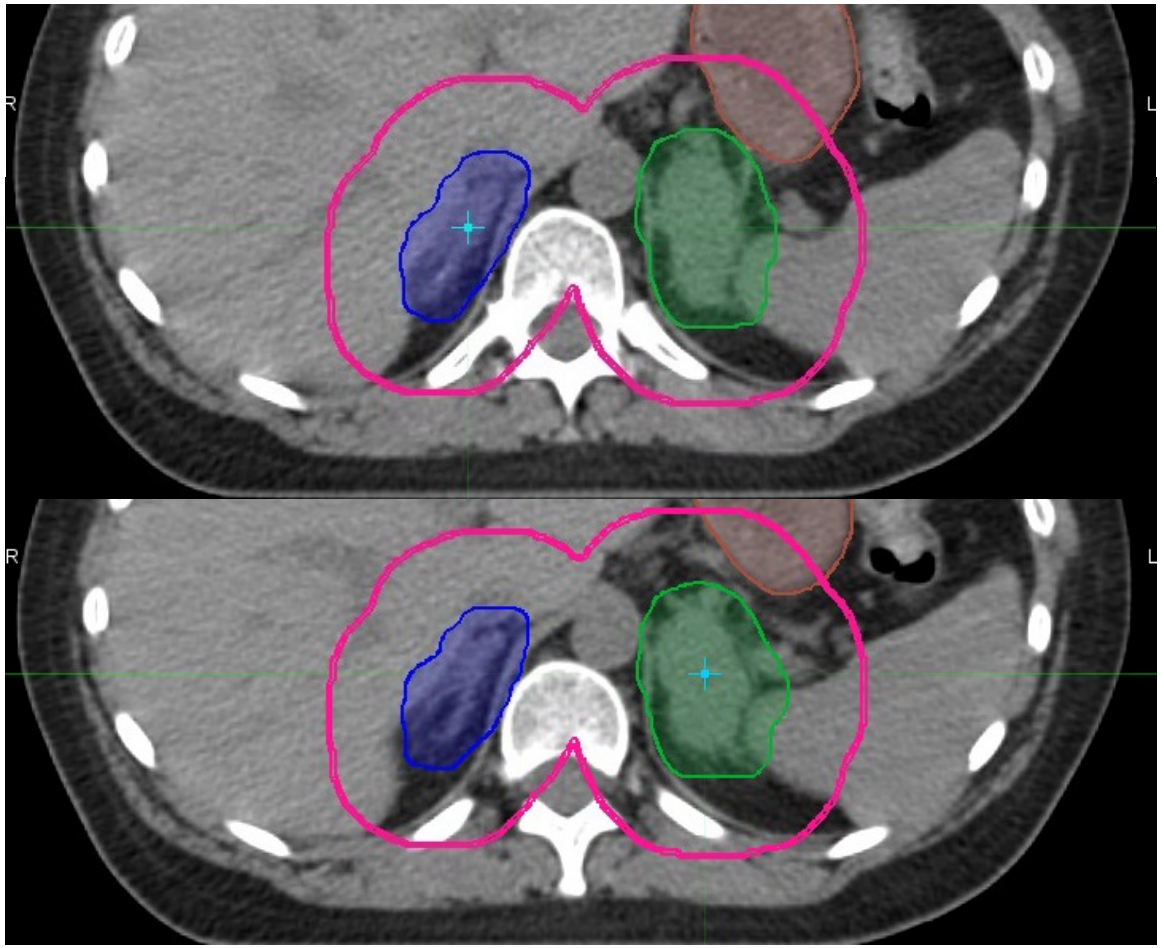
NRG BR001: Benchmark Case 1

2 Isocenter Plan passed on 2nd Try.



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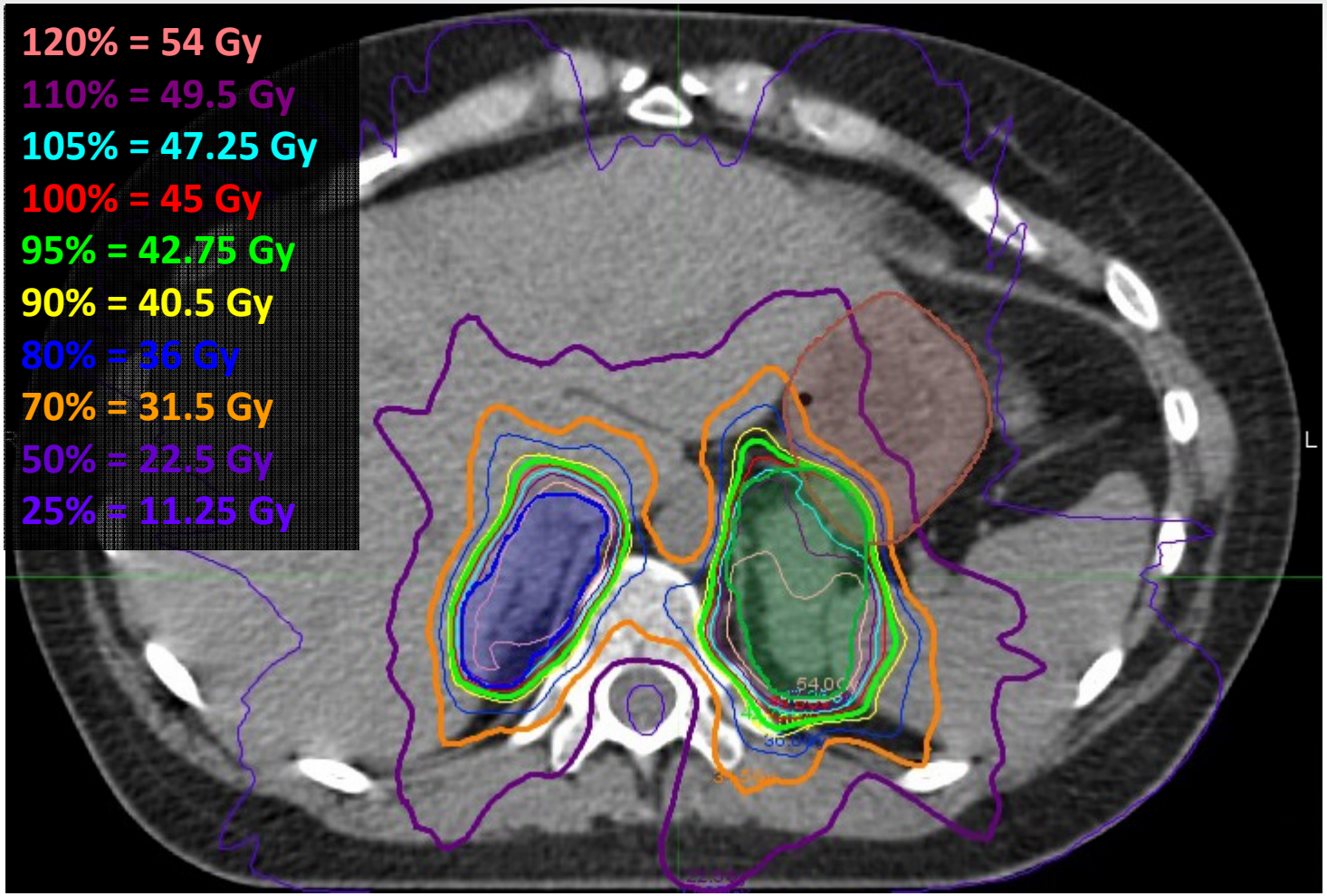
NRG BR001: Benchmark Case 1



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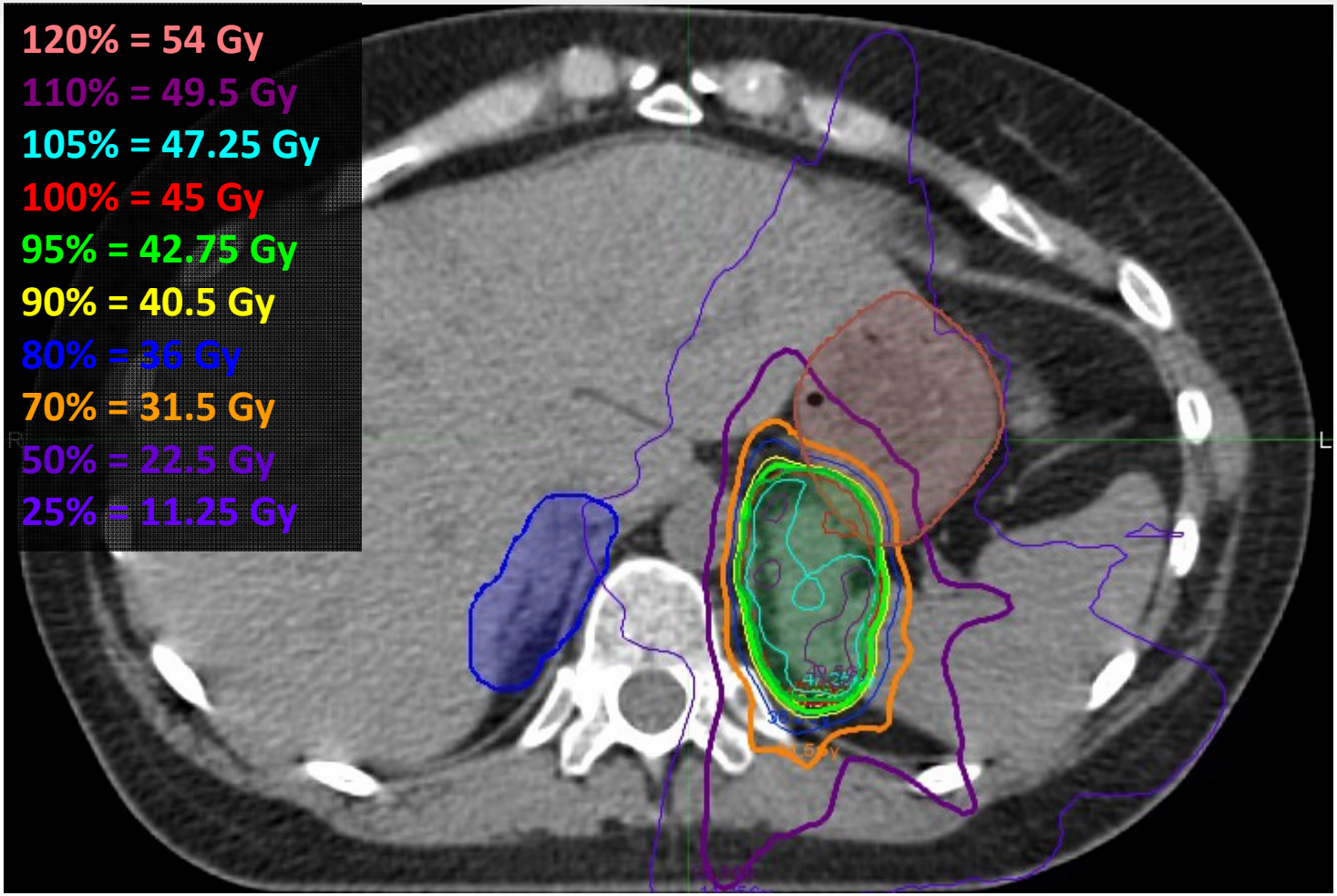
2 isocenters: passed on 2nd try.

NRG BR001: Benchmark Case 1



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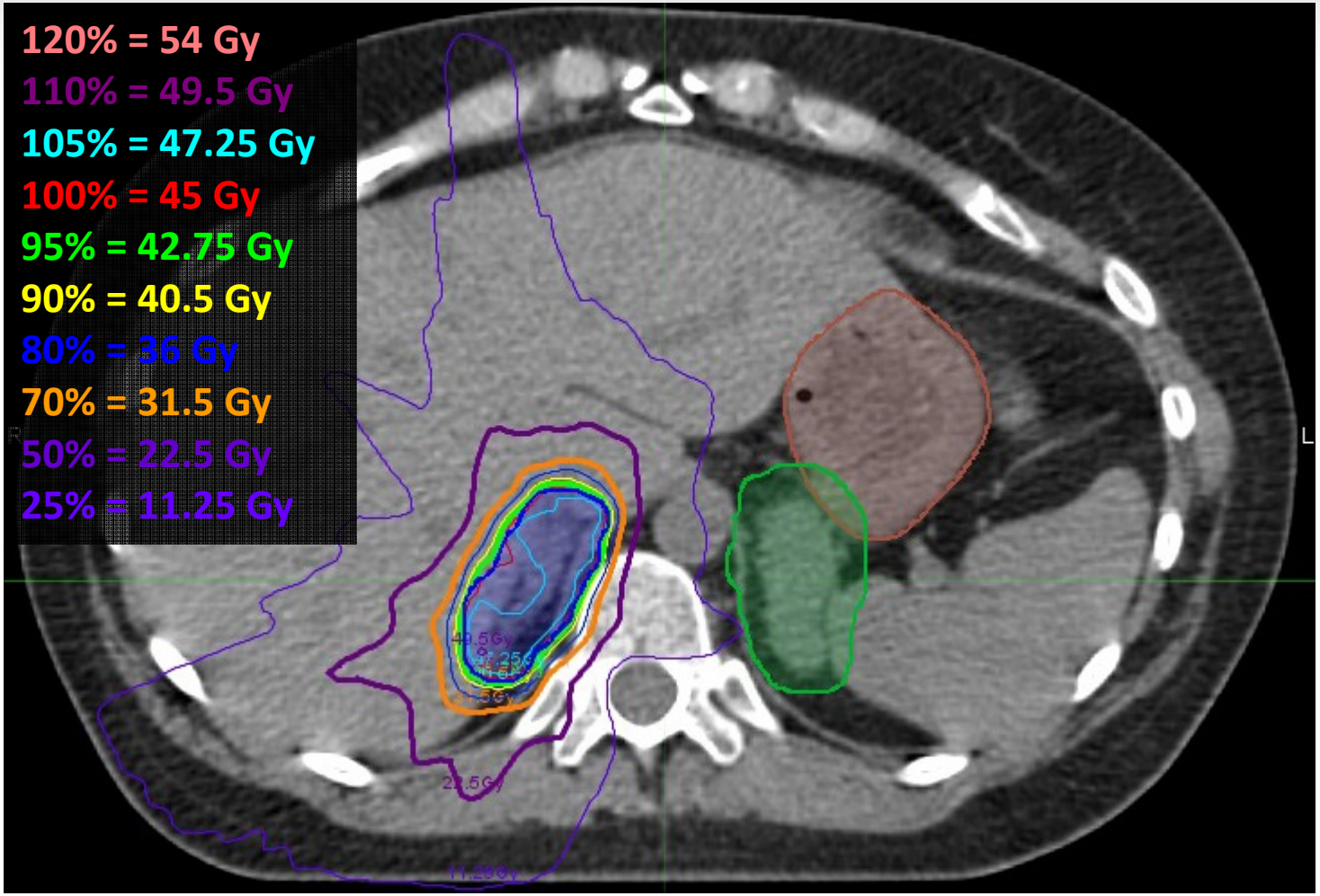
2 isocenters: passed on 2nd try.

NRG BR001: Benchmark Case 1



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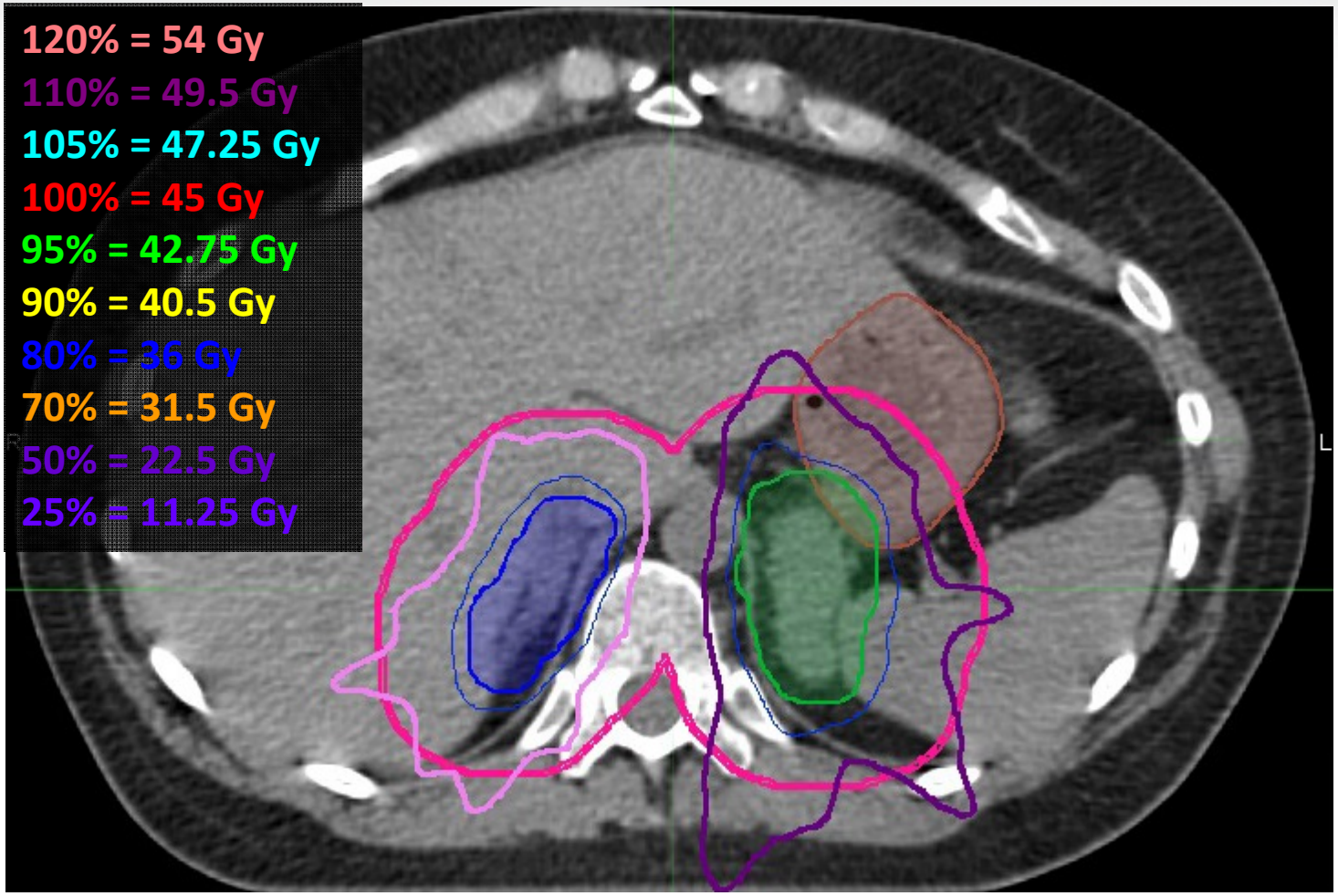
2 isocenters: passed on 2nd try.

NRG BR001: Benchmark Case 1



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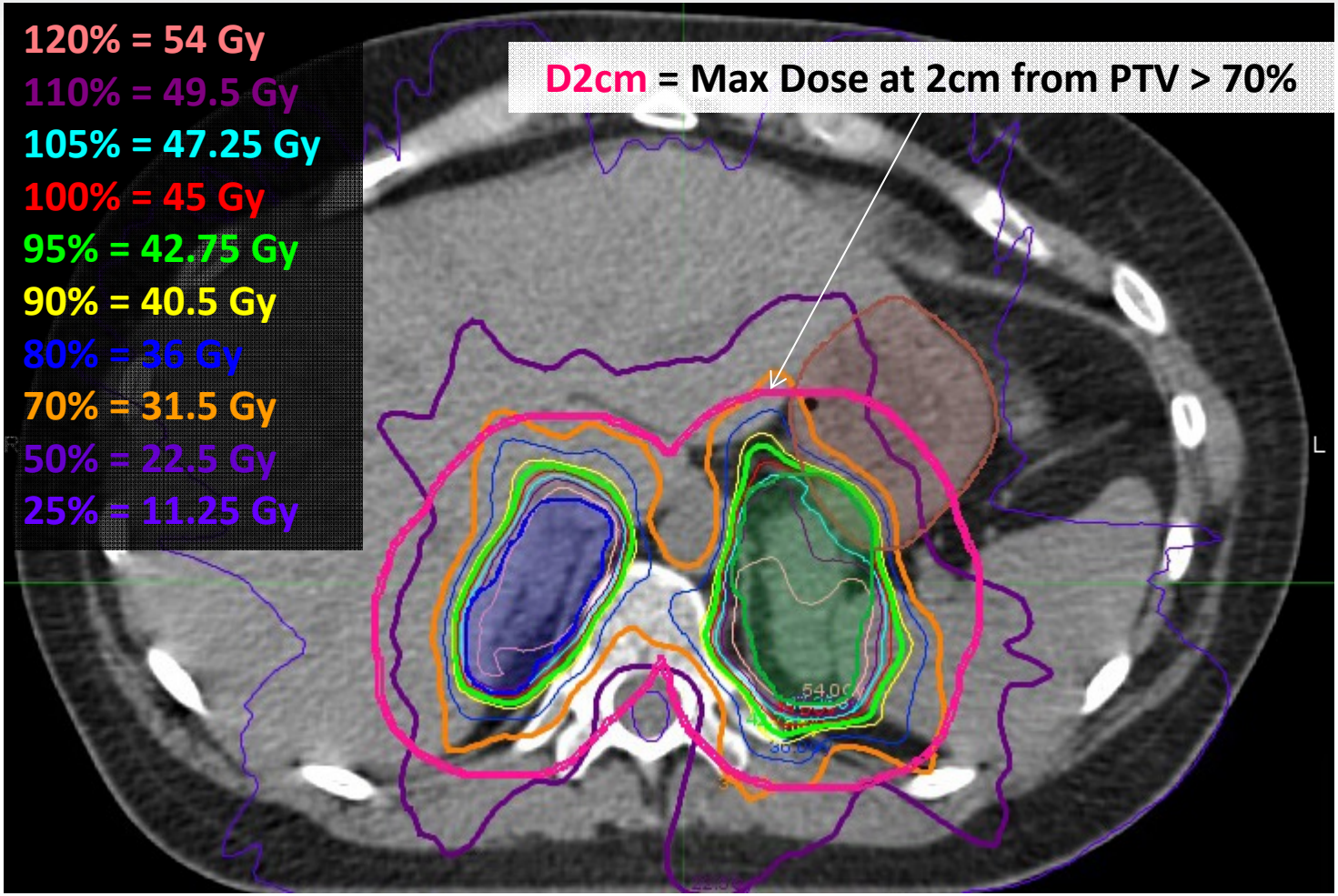
2 isocenters: passed on 2nd try.

NRG BR001: Benchmark Case 1



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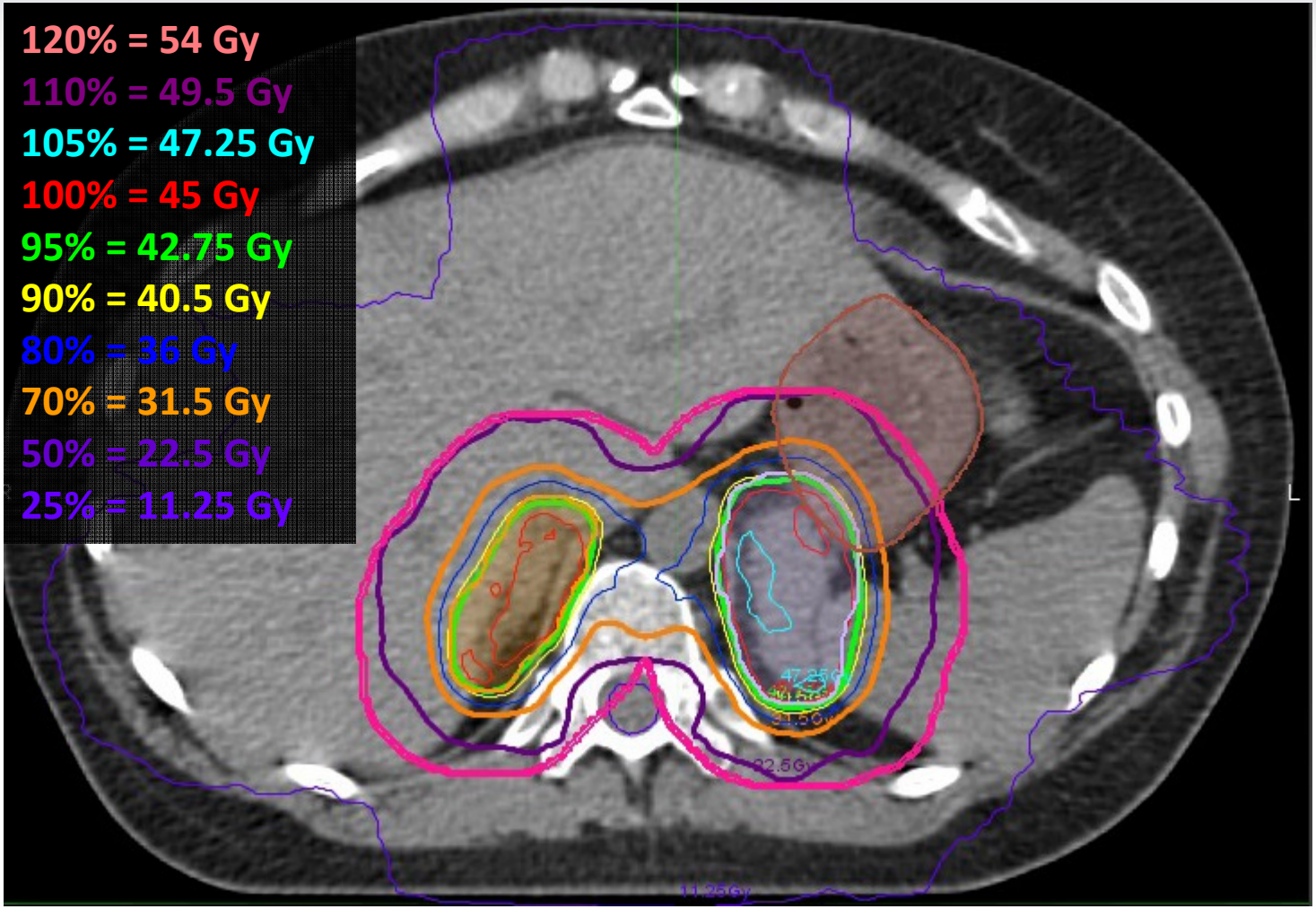
2 isocenters: passed on 2nd try.

NRG BR001: Benchmark Case 15



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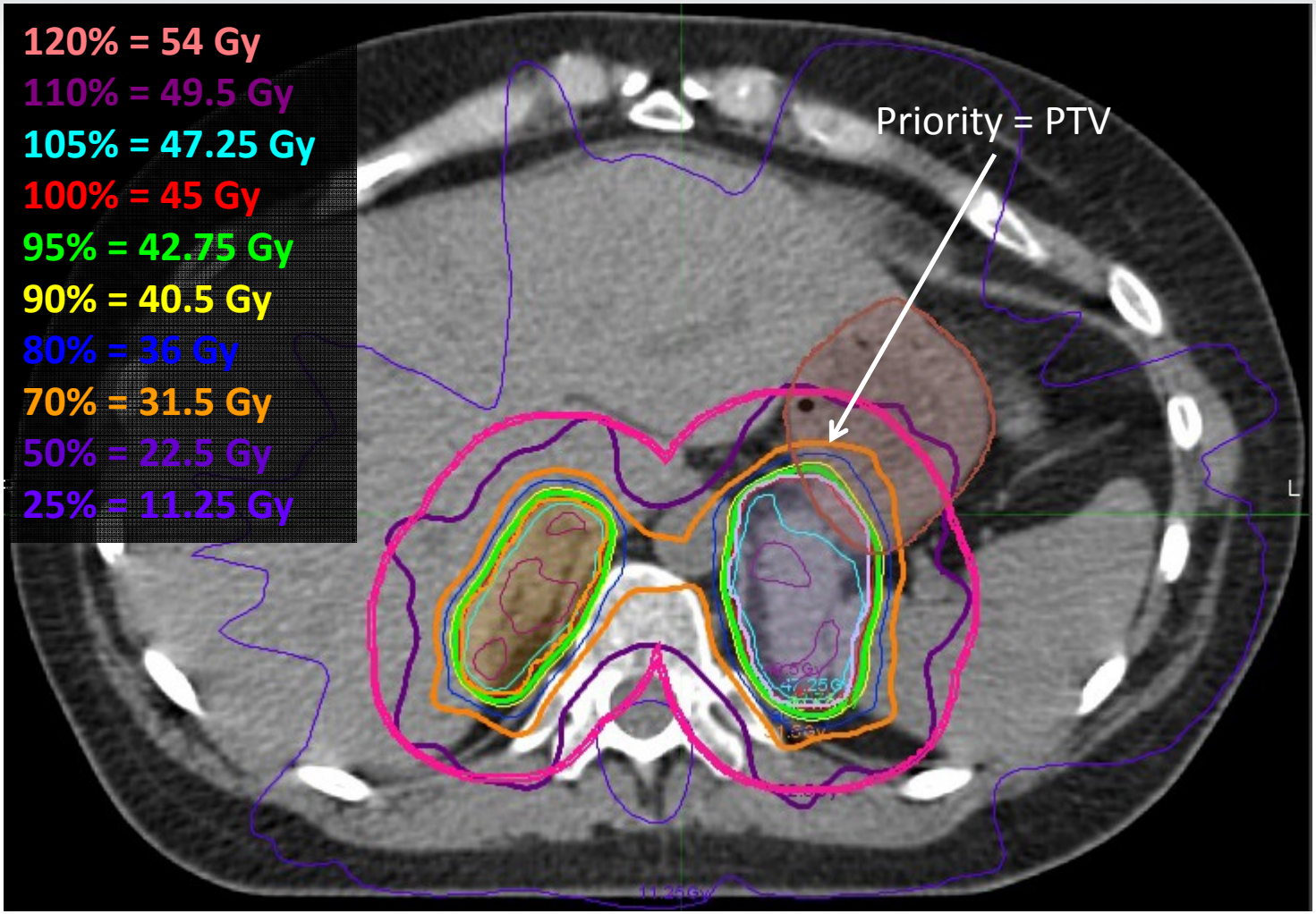
Passed on 1st try using VMAT.

NRG BR001: Benchmark Case 6



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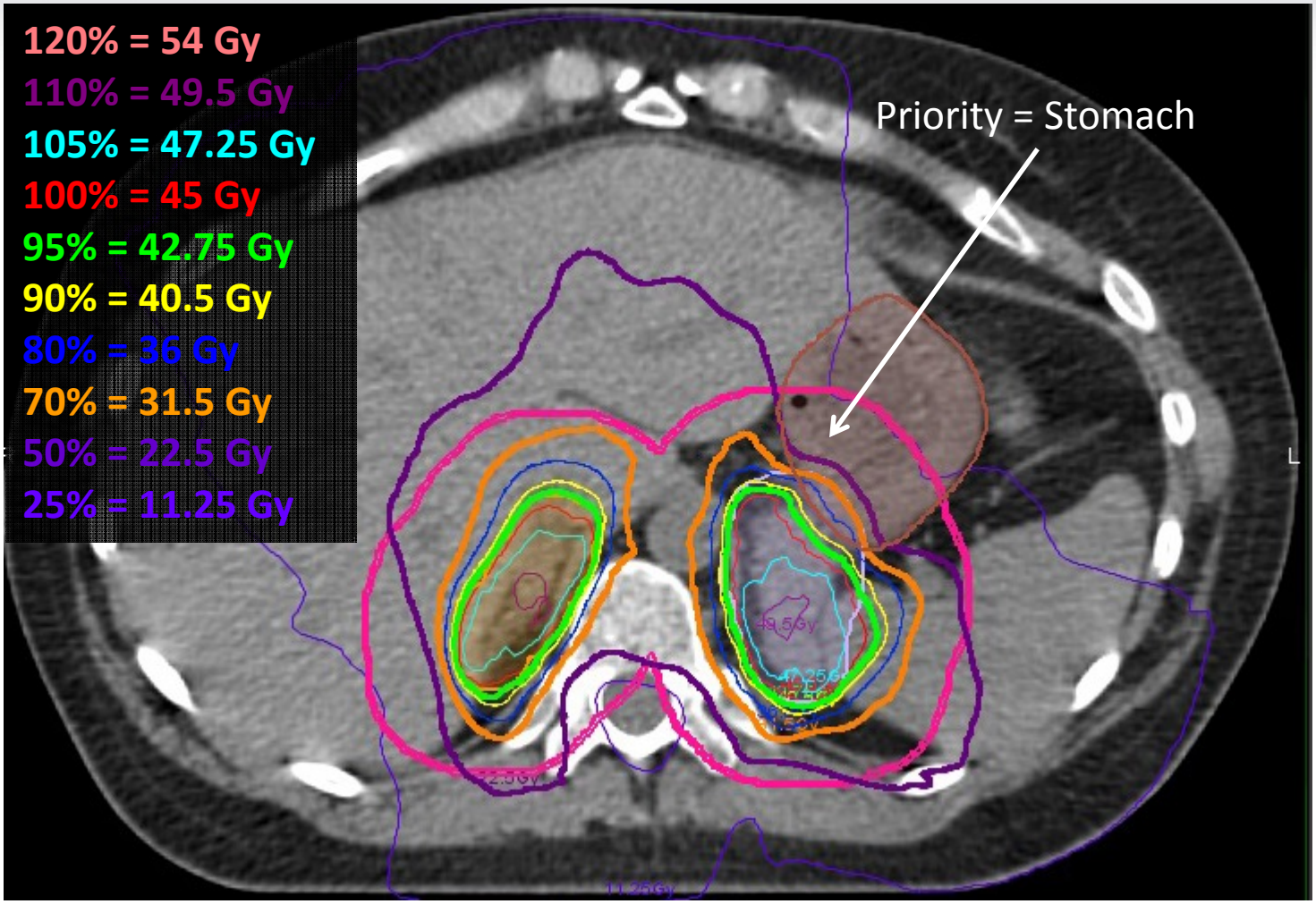
Passed on 1st try using VMAT.

NRG BR001: Benchmark Case 3



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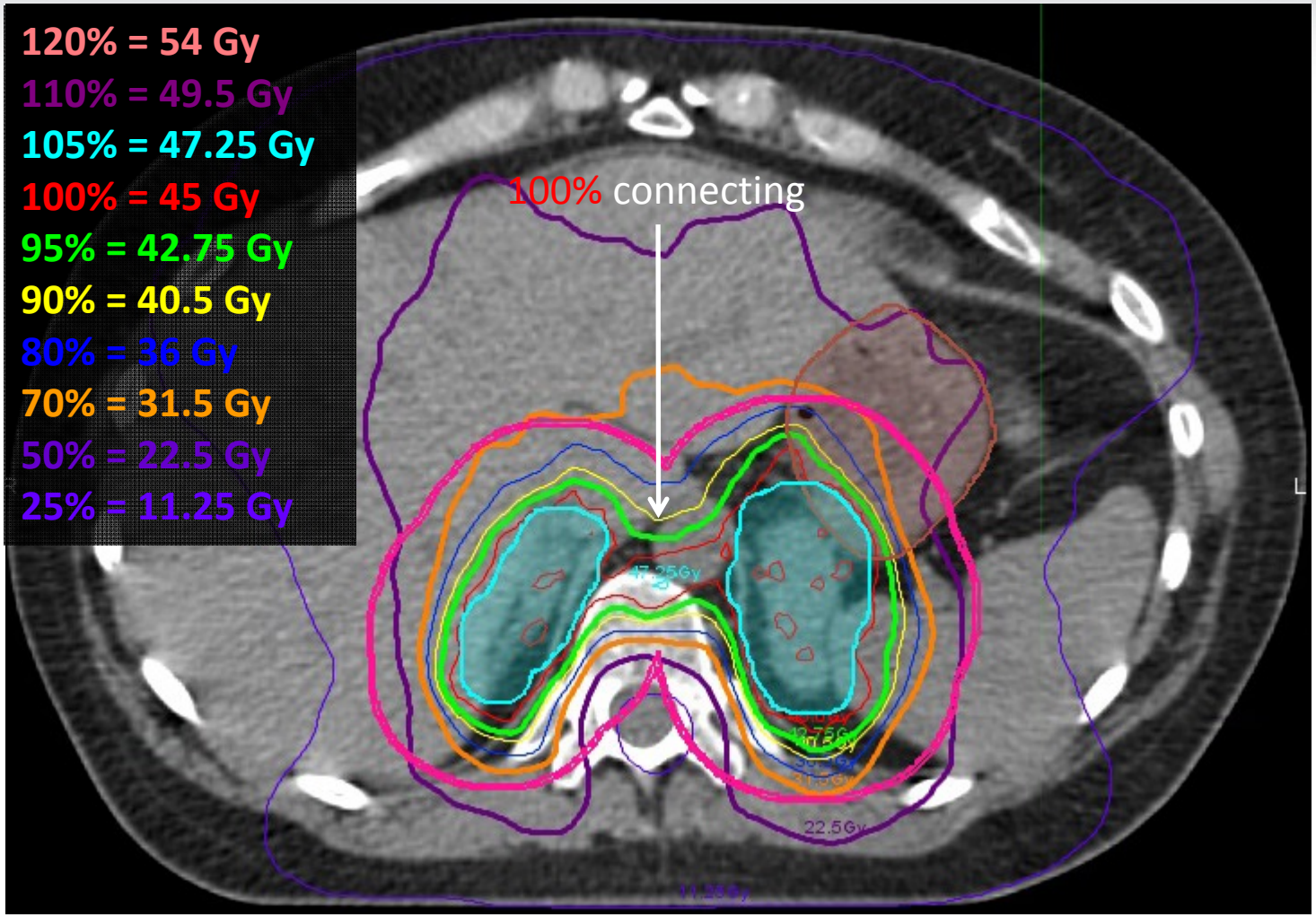
Passed on 1st try using VMAT.

NRG BR001: Benchmark Case 11



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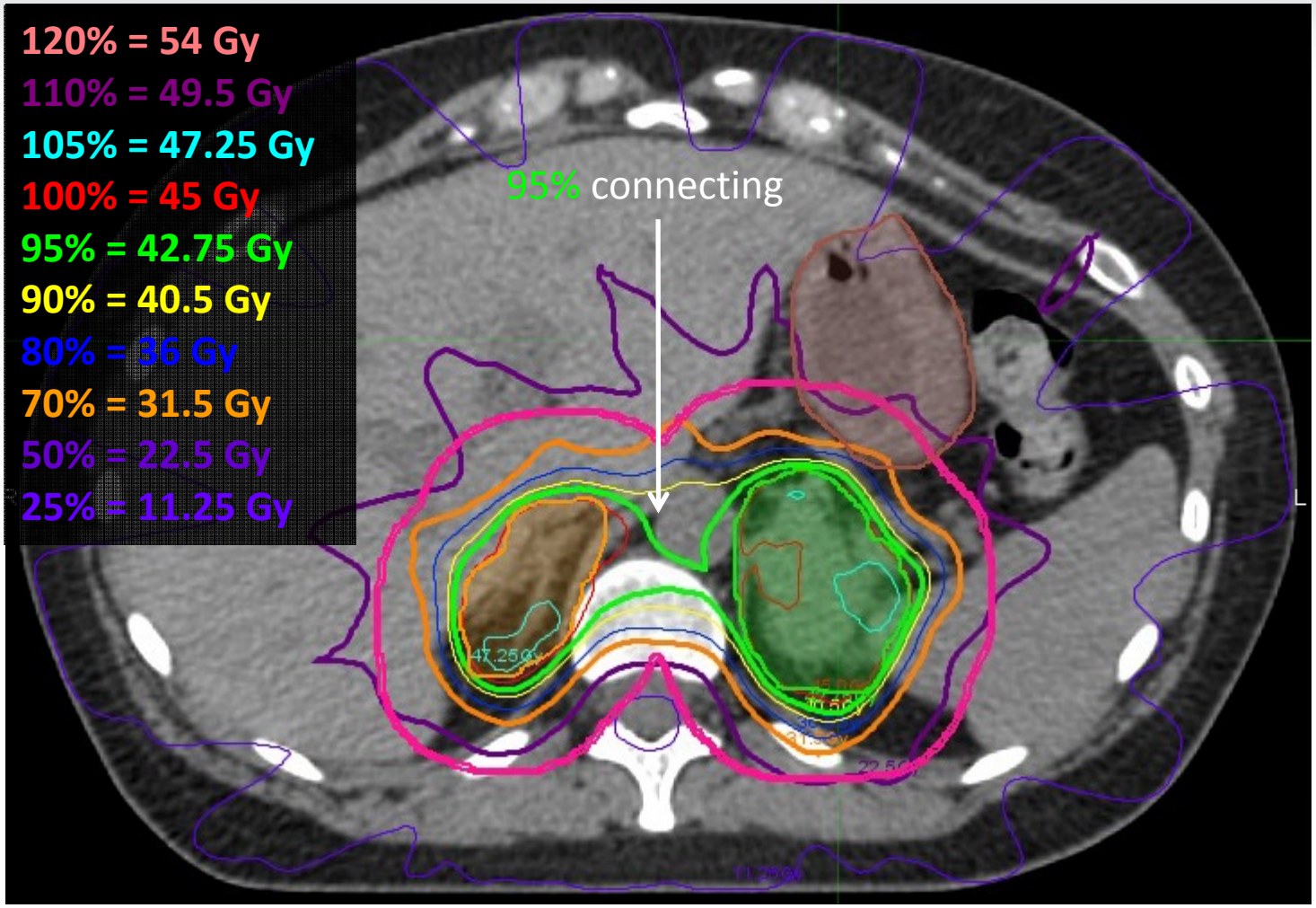
Met DVA criteria but did not pass.

NRG BR001: Benchmark Case 19



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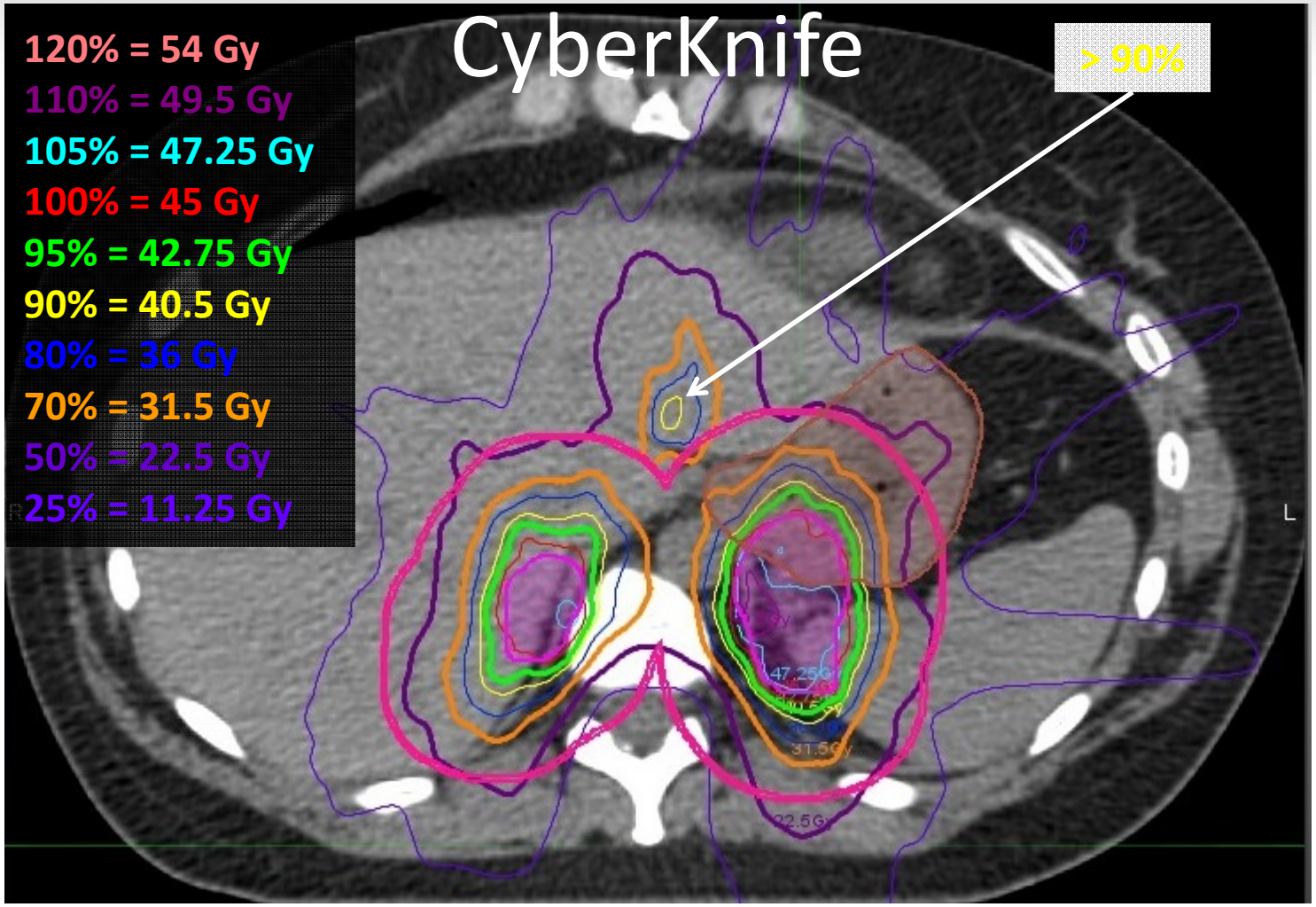
Met DVA criteria but did not pass.

NRG BR001: Benchmark Case 20



Did not pass.

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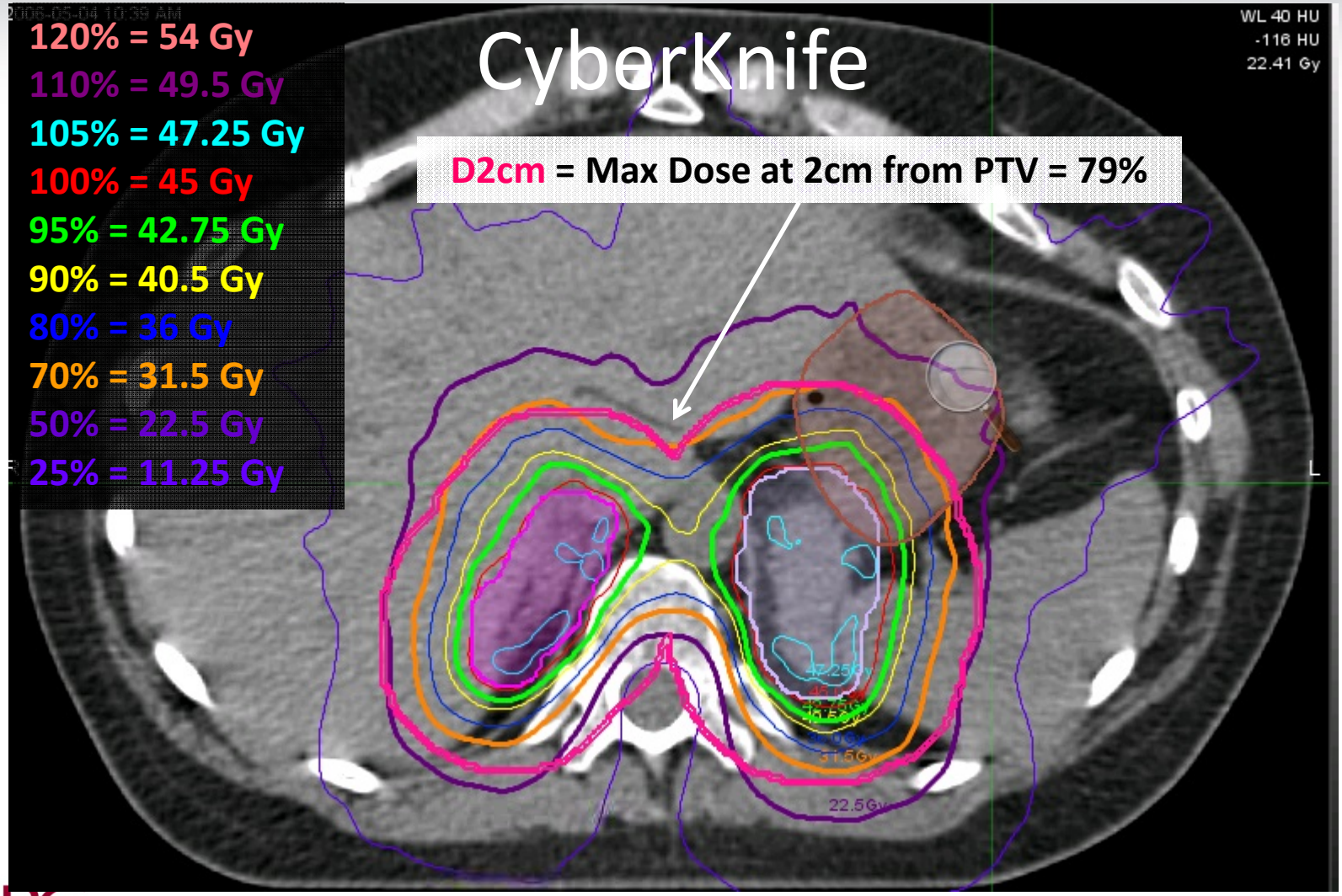
NRG BR001: Benchmark Case 21



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Passed on 1st try.

IGRT Credentialing Review

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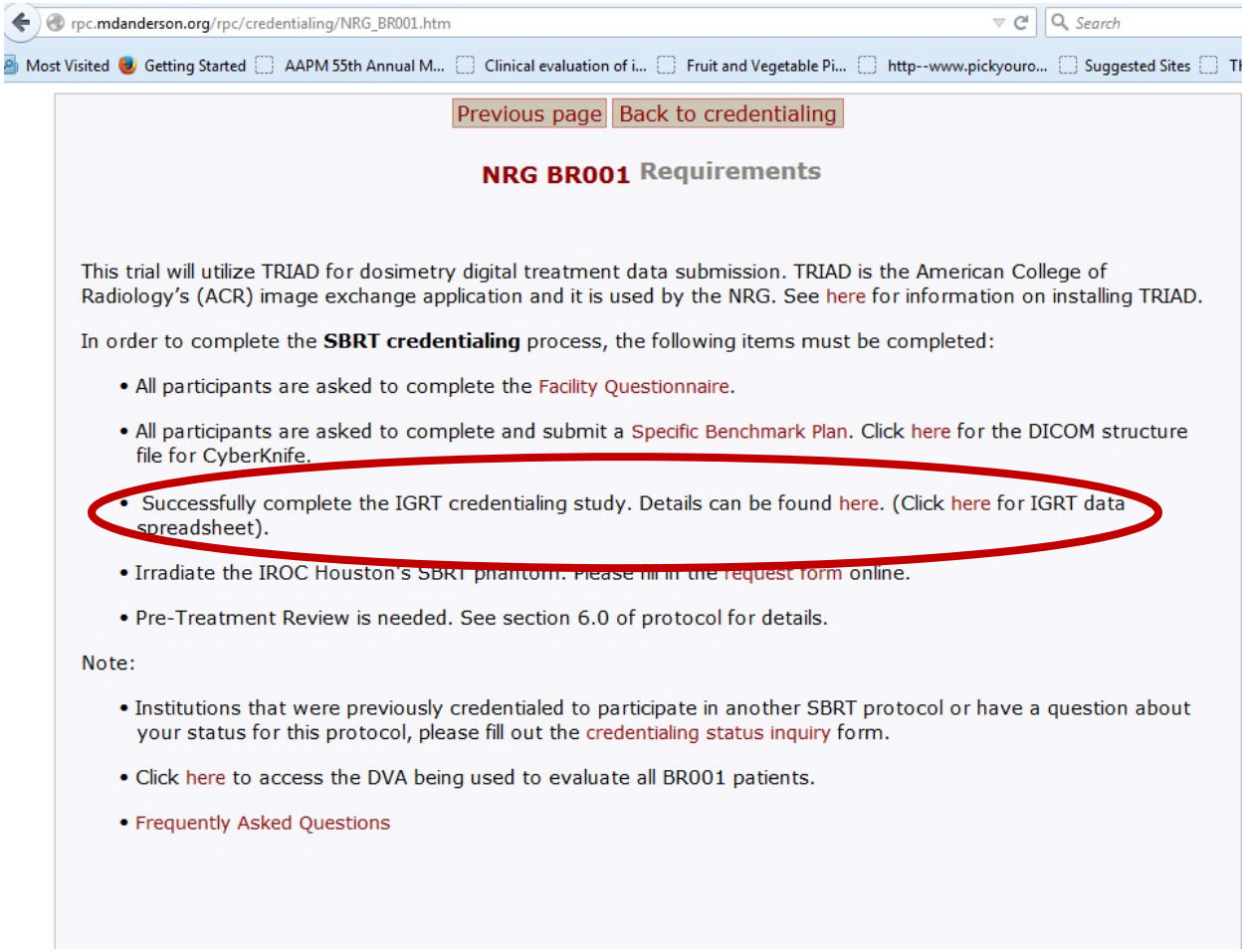
NRG BR001: IGRT Credentialing



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NRG BR001: IGRT Credentialing

IGRT Credentialing Submission Requirements

2D IGRT

1. Brief description of registration technique used in submitted data. Include type of IGRT technology, method of motion management, registration surrogate, correction threshold, and any use of verification imaging.
2. Spreadsheet describing shifts performed.
3. Image files of screen captures displaying the registration from two consecutive treatment fractions.

3D IGRT

1. Brief description of registration technique used in submitted data. Include type of IGRT technology, method of motion management, registration surrogate, correction threshold, and any use of verification imaging.
2. Spreadsheet describing shifts performed
3. DICOM export of the treatment plan data
4. DICOM export of data from two consecutive treatment fractions is required.

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NRG BR001: IGRT Credentialing

- Purpose:
  - To assess whether positioning with image-guidance will ensure accurate PTV coverage
- How is this accomplished?
  - Assess description of IGRT workflow including *threshold for correction of translations & rotations*
  - Assess image quality (technique, FOV)
  - Assess final treatment position relative to PTV margin required for protocol

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NRG BR001: IGRT Credentialing

Physics Contribution

Implementation of Remote 3-Dimensional Image Guided Radiation Therapy Quality Assurance for Radiation Therapy Oncology Group Clinical Trials

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- Potential issues encountered with 3D registration:
  - Table movement prior to acquiring CBCT
  - Inter-observer variation

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NRG BR001: IGRT Credentialing

- Recommended data for 2D IGRT:
  - 2D screenshots in addition to 2D DICOM images:
    - Reticule or scale
    - PTV contours
    - OAR contours (e.g., lung, spine)
  - 2D OBI screenshots at final treatment position helpful
- Recommended data for 3D IGRT:
  - Screenshots of in-house registration between CBCT & planning CT
    - Reticule or scale
    - 3D blending/subtraction

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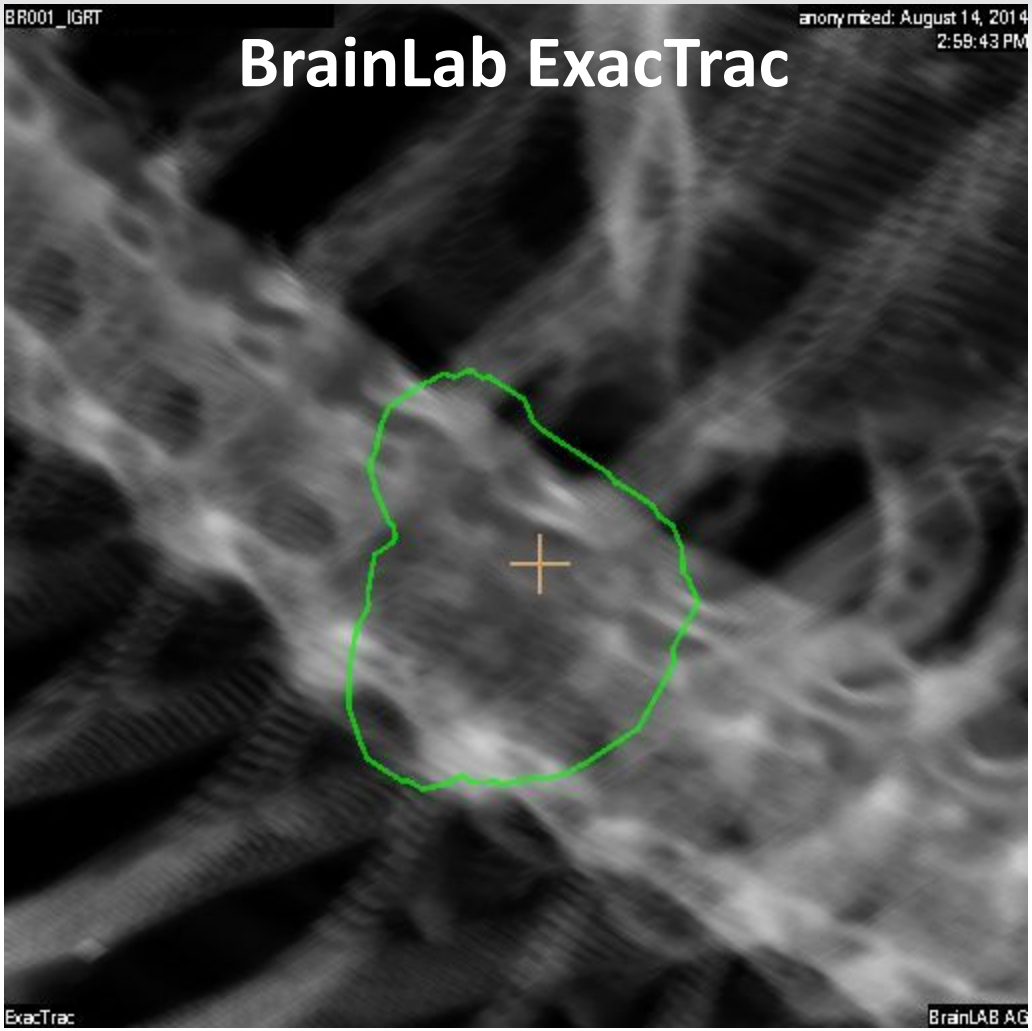
NRG BR001: 3D Spine IGRT Case 3



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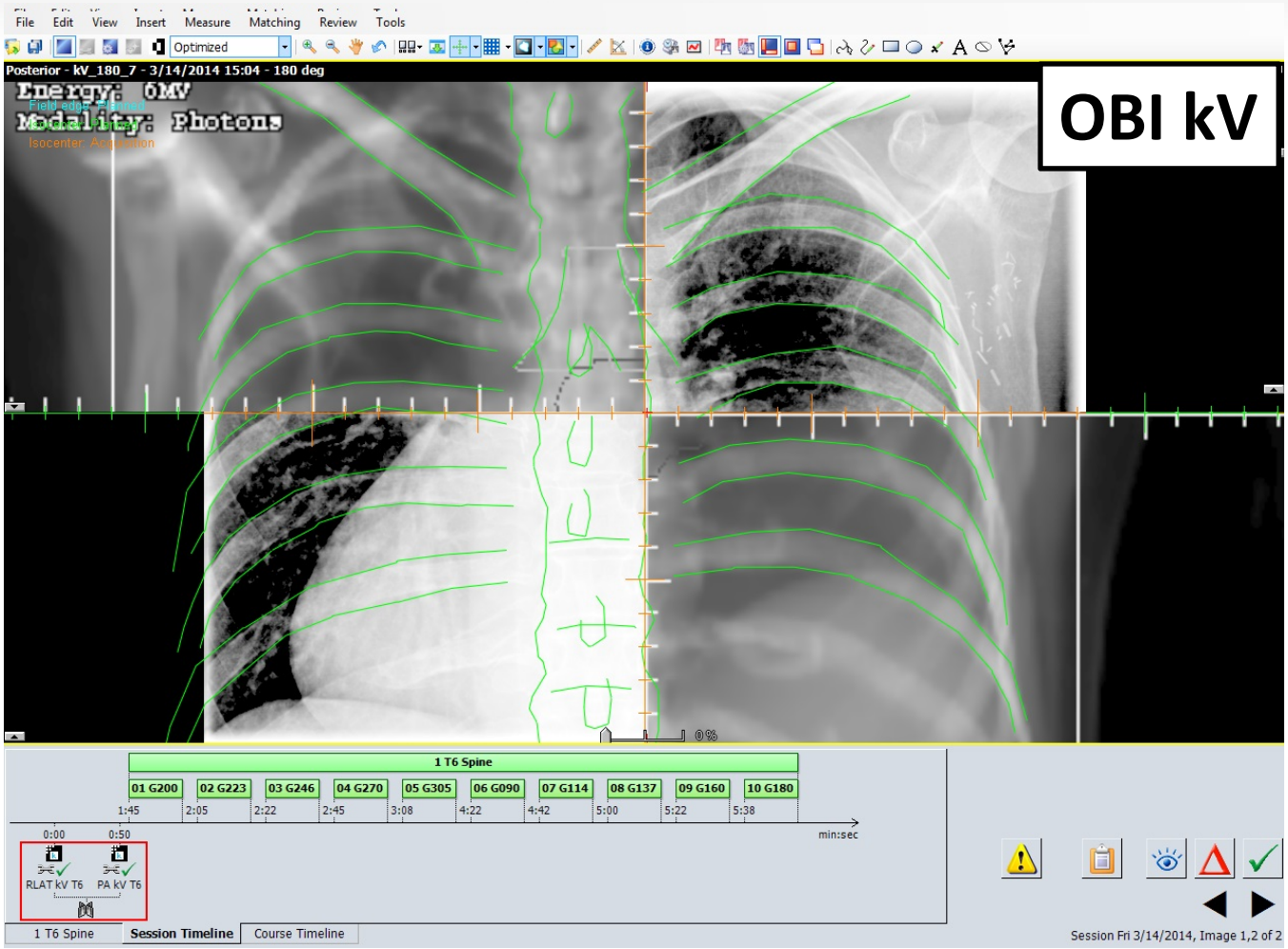
NRG BR001: 3D Spine IGRT Case 3



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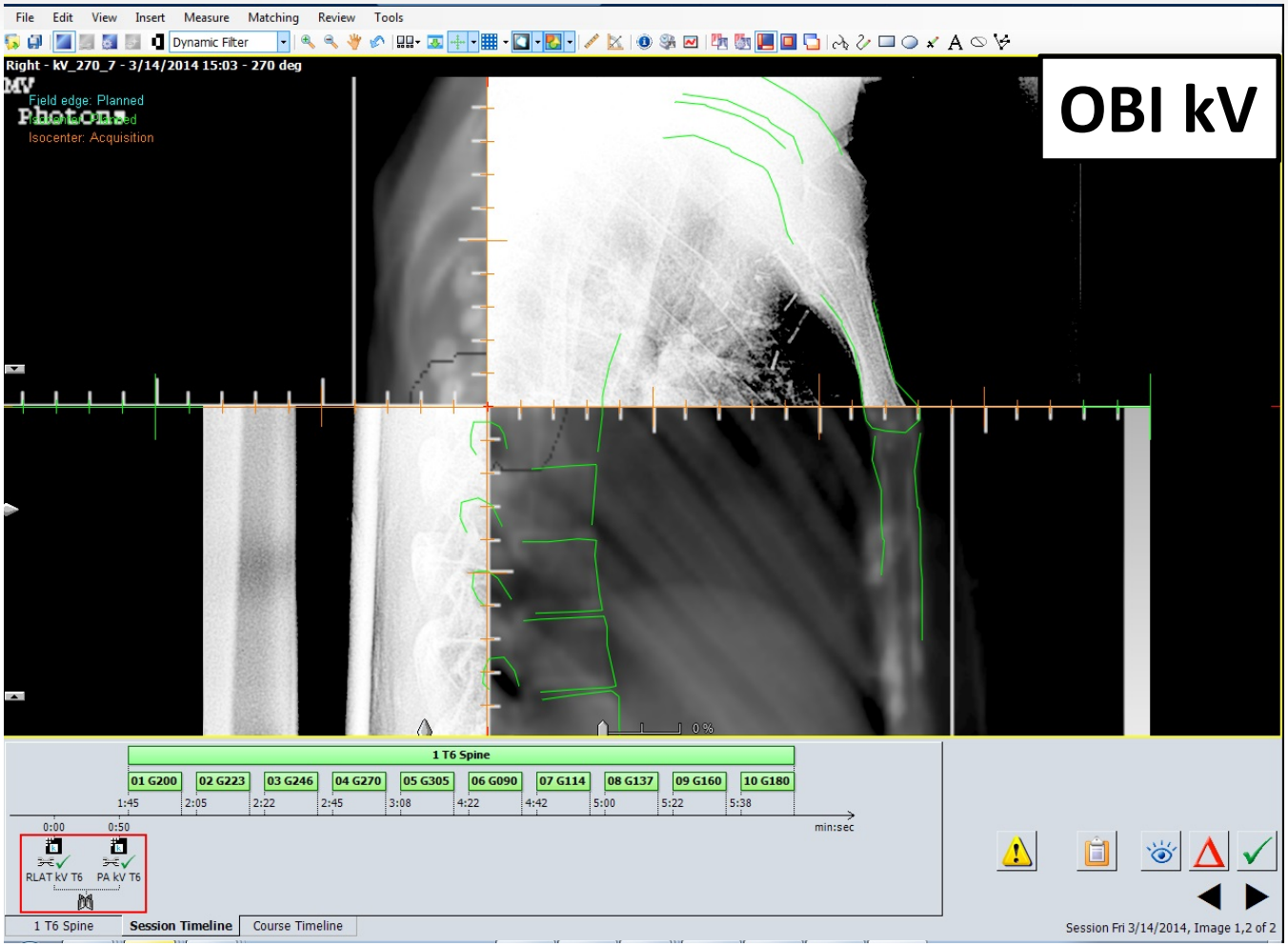
NRG BR001: 3D Spine IGRT Case 3



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NRG BR001: 3D Spine IGRT Case 3

Spreadsheet for IGRT Data Collection

Protocol Number: NRG-BR001 RTOG Inst#:

Case Number: _____ (when applicable) IGRT data from: TrueBeam-1 (specify accelerator)

Date	Tr #	IGRT technique[2]	Isocenter shift X (mm)[1]	Isocenter shift Y (mm)[1]	Isocenter shift Z (mm)[1]	Couch rotation around X (◦)[1]	Couch rotation around Y (◦)[1]	Couch rotation around Z (◦)[1]	IGRT time pt[3]	Was a repositioning made pre-rx?
03/13/14	6	kVorth	-0.66	6.14	8.01	-1.1	-0.2	-1.0	A	yes
03/14/14	7	kVorth	0.32	5.33	5.79	-2.6	-0.4	1.1	A	yes

* Please provide any information of the registration process that can help to assess the registration results (e.g., if the registration is a fully automatic result from the software; if any specific structure is used for alignment; if any specific ROI is used during registration; if any manual adjustment is involved; etc. Please provide another sheet if the space in this form is not enough.)

Registration for spine is performed with automatic registration to an ROI defined manually to match the PTV (i.e., vertebral bodies)

Our workflow is the following: 1) position the patient to external alignment marks 2) acquire kV orthogonal images with ExacTrac

3) auto-register PTV 4) review then apply shifts including rotations using 6-degree couch 5) obtain orthogonal kV with ExacTrac to verify residual shifts are less than half of the PTV margin & less than 1 degree 6) obtain verification orthogonal kV images using Varian OBI

7) auto-register PTV to confirm shifts are less than half of the PTV margin & less than 1 degree

Tolerance for shifting is set to 1/2 of PTV margin; for 3mm margin tolerance is 1.5mm and for 2mm margin tolerance is 1mm

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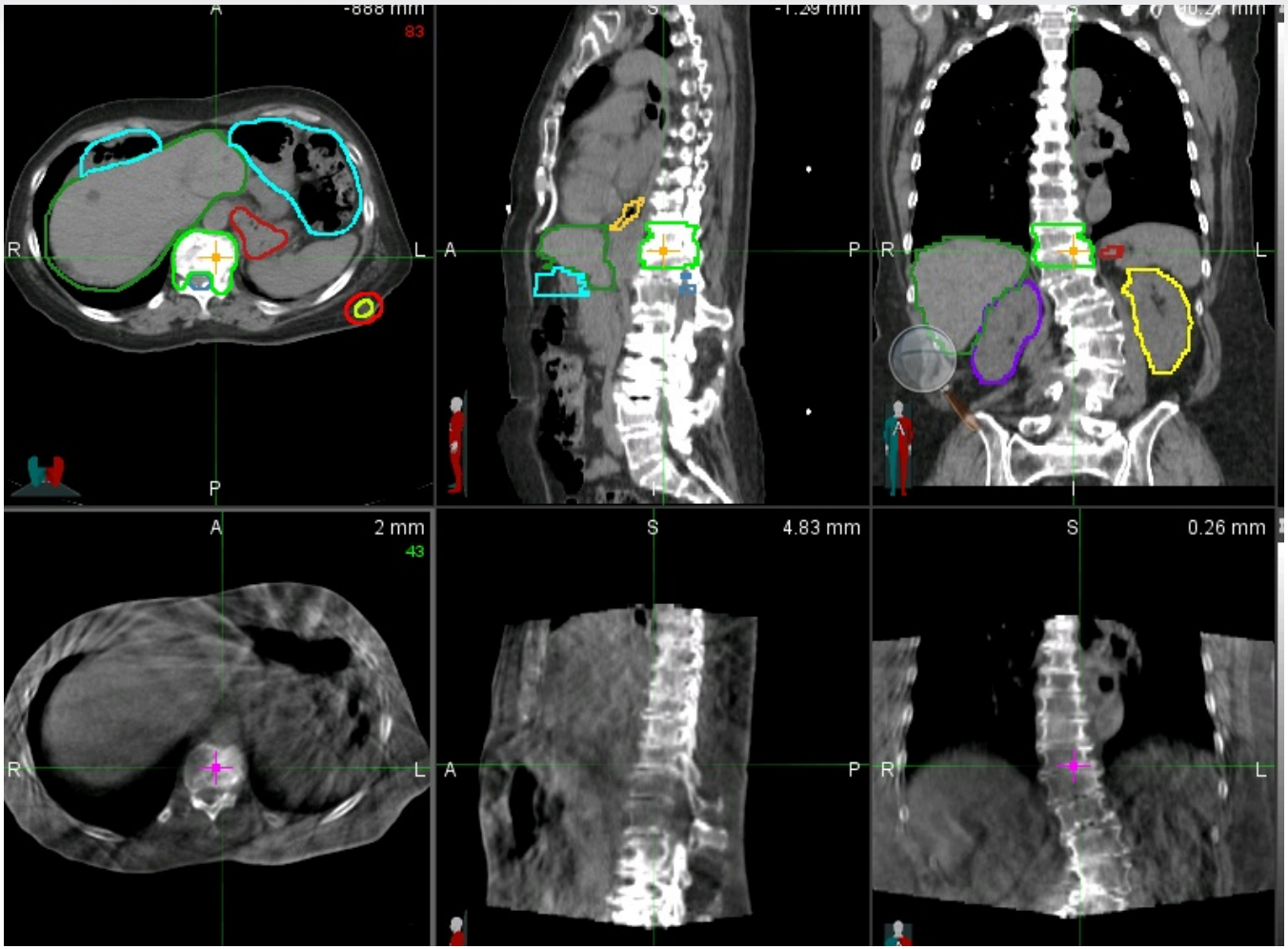
NRG BR001: 3D Spine IGRT Case 9



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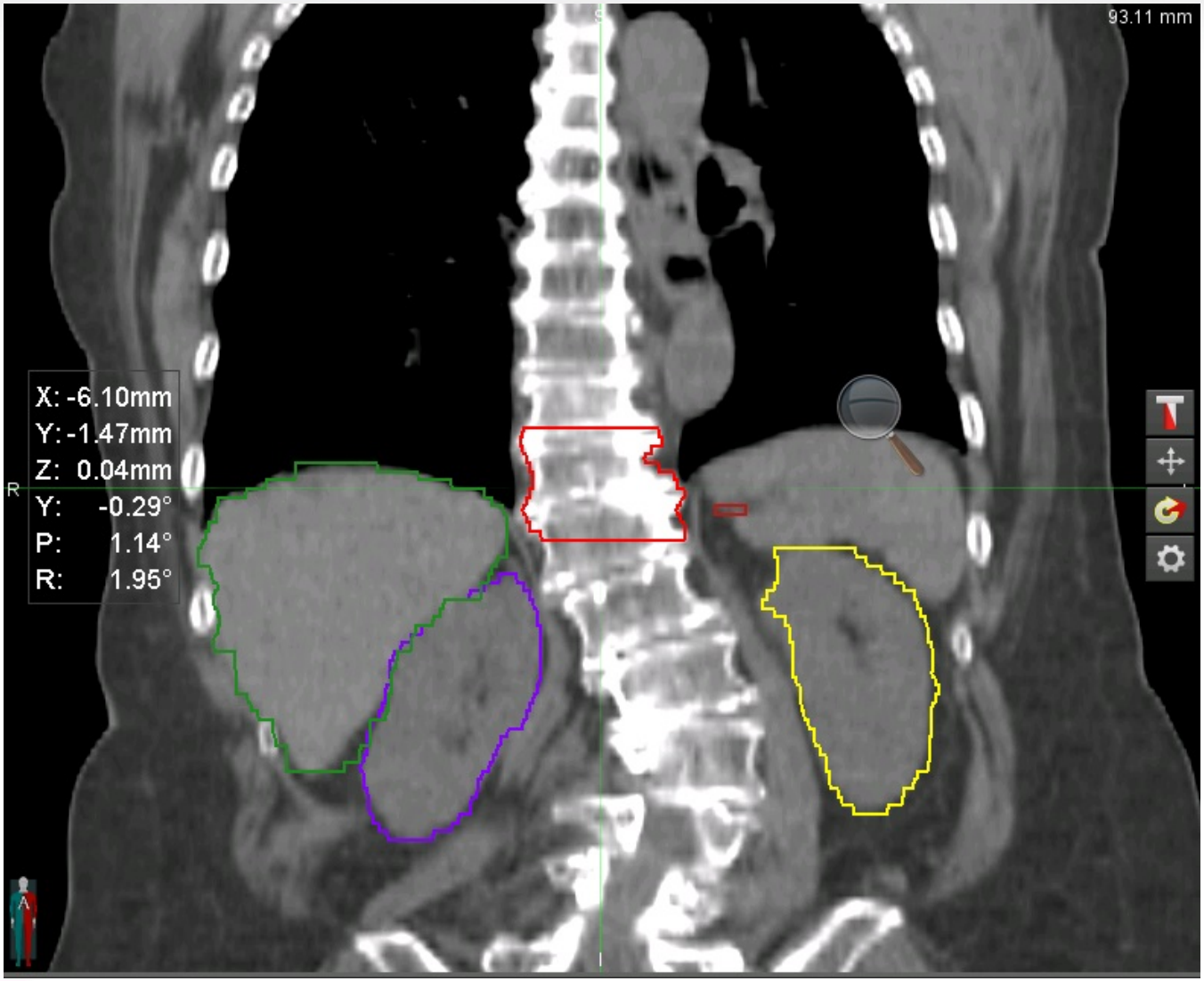
NRG BR001: 3D Spine IGRT Case 9



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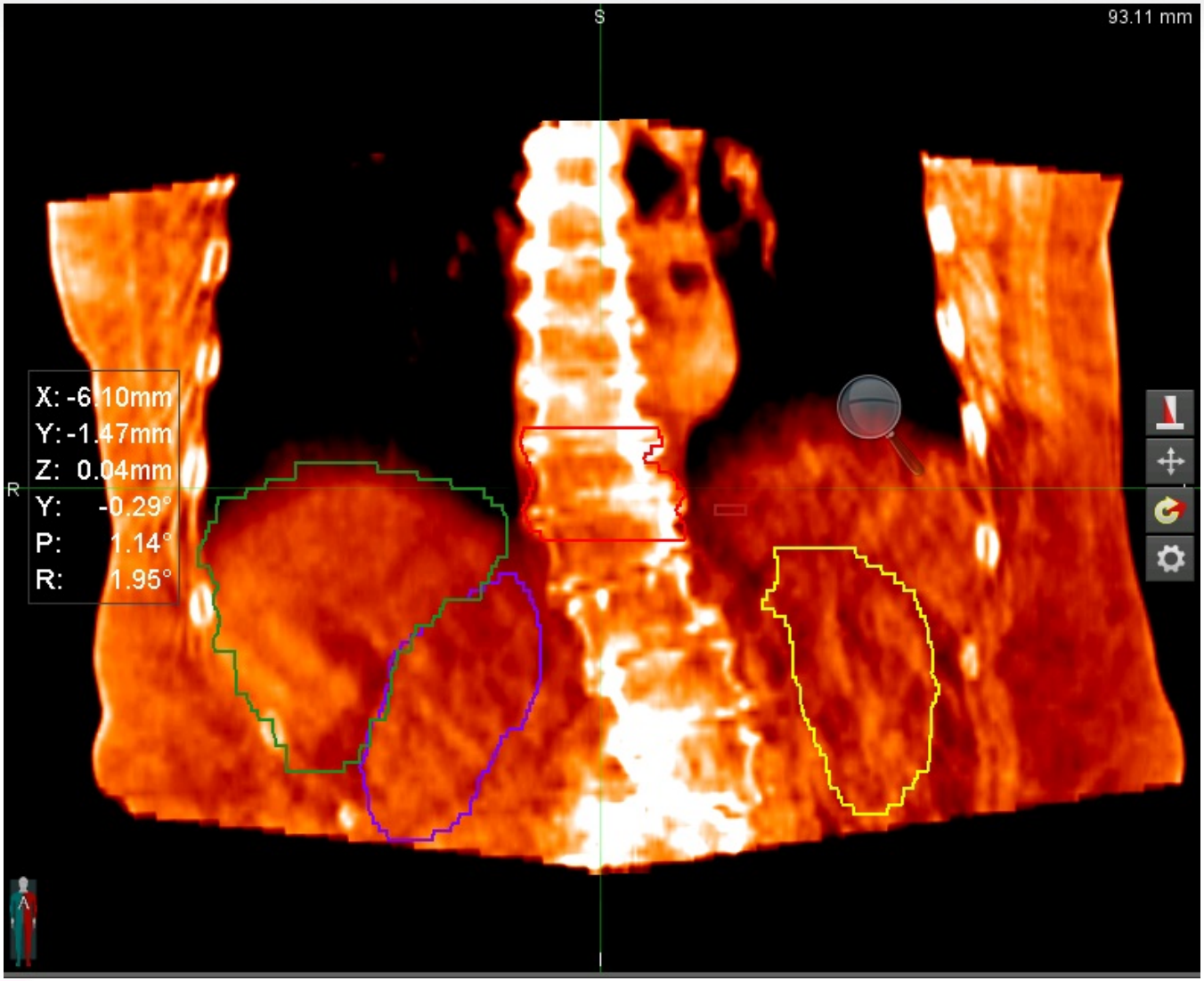
NRG BR001: 3D Spine IGRT Case 9



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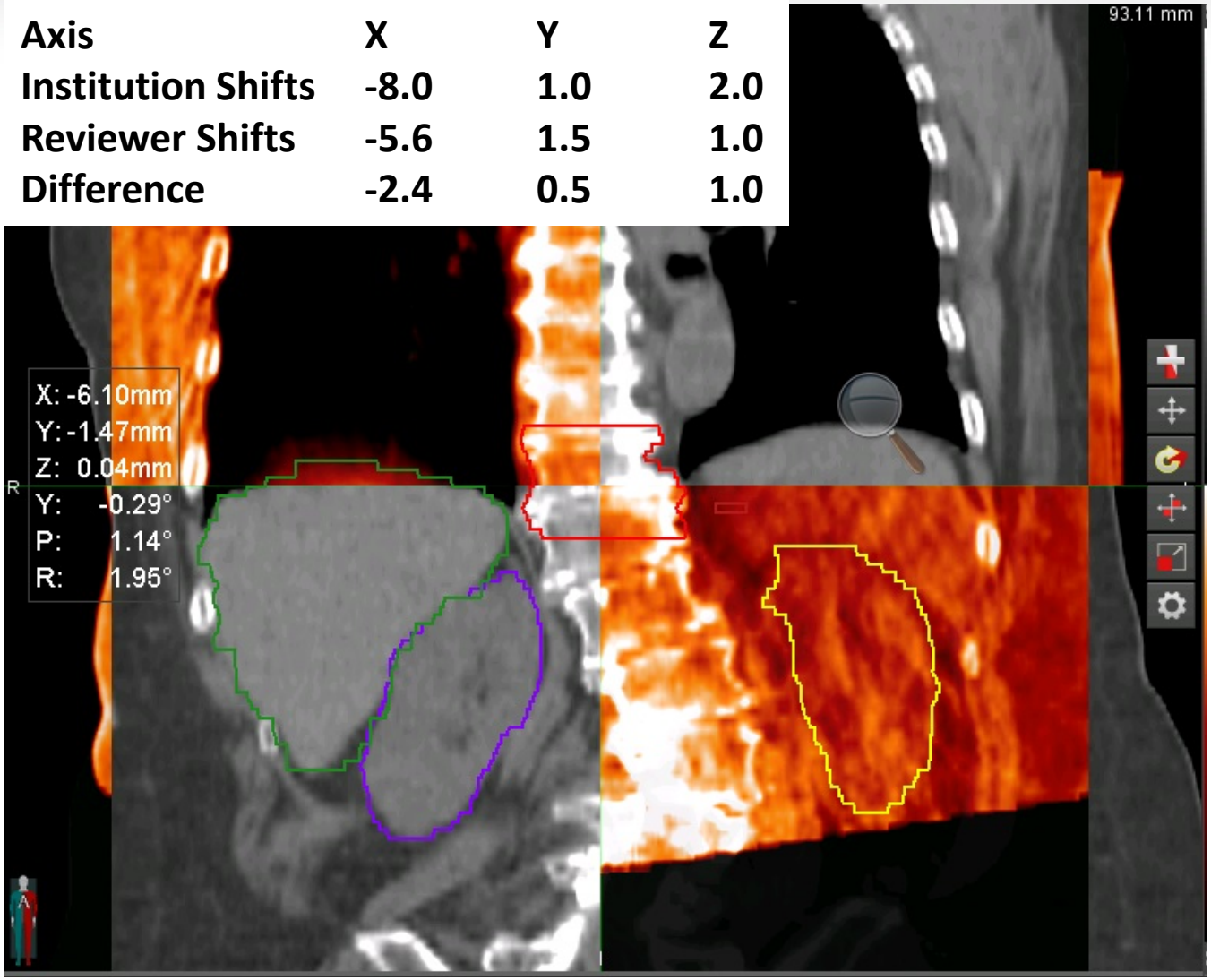
NRG BR001: 3D Spine IGRT Case 9

Axis	X	Y	Z
Institution Shifts	-8.0	1.0	2.0
Reviewer Shifts	-5.6	1.5	1.0
Difference	-2.4	0.5	1.0



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NRG BR001: 3D Spine IGRT Case 9

Axis	X (mm)	Y (mm)	Z (mm)
Institution's Shifts	-8.0	1.0	2.0
Reviewer's Shifts	-5.6	1.5	1.0
Difference	-2.4	0.5	1.0

Rotational Differences < 2 degrees

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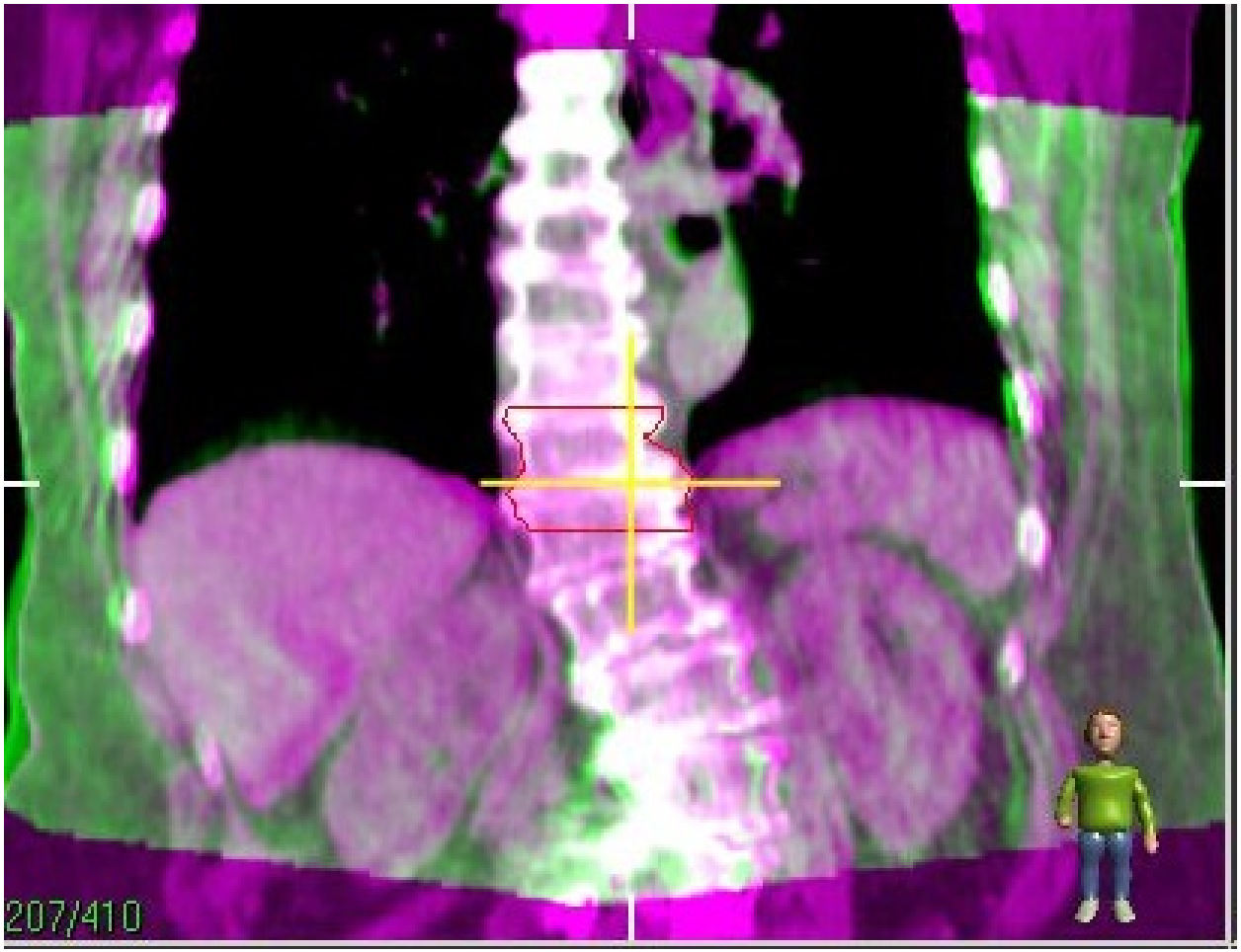

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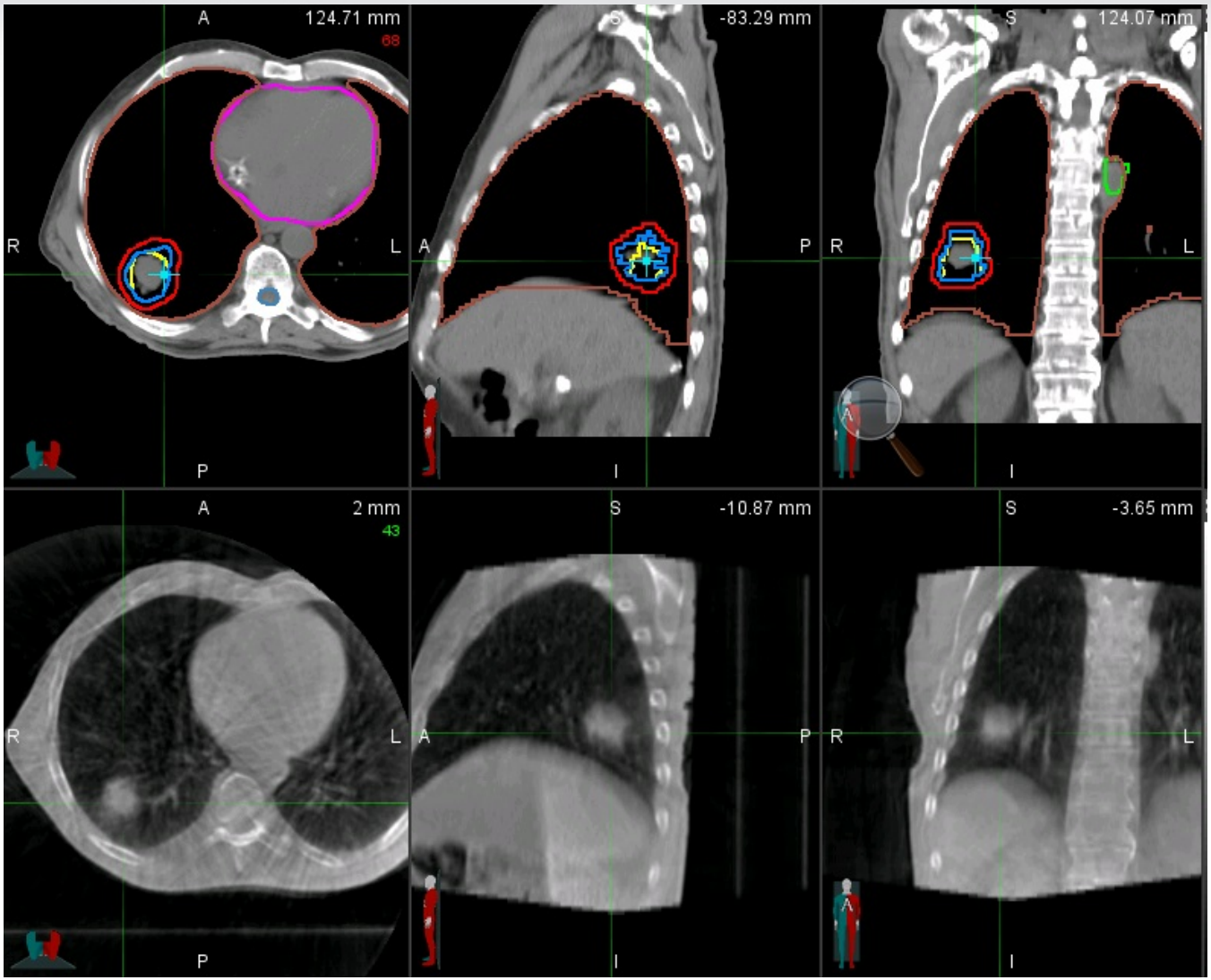
NRG BR001: 3D Lung IGRT Case 9



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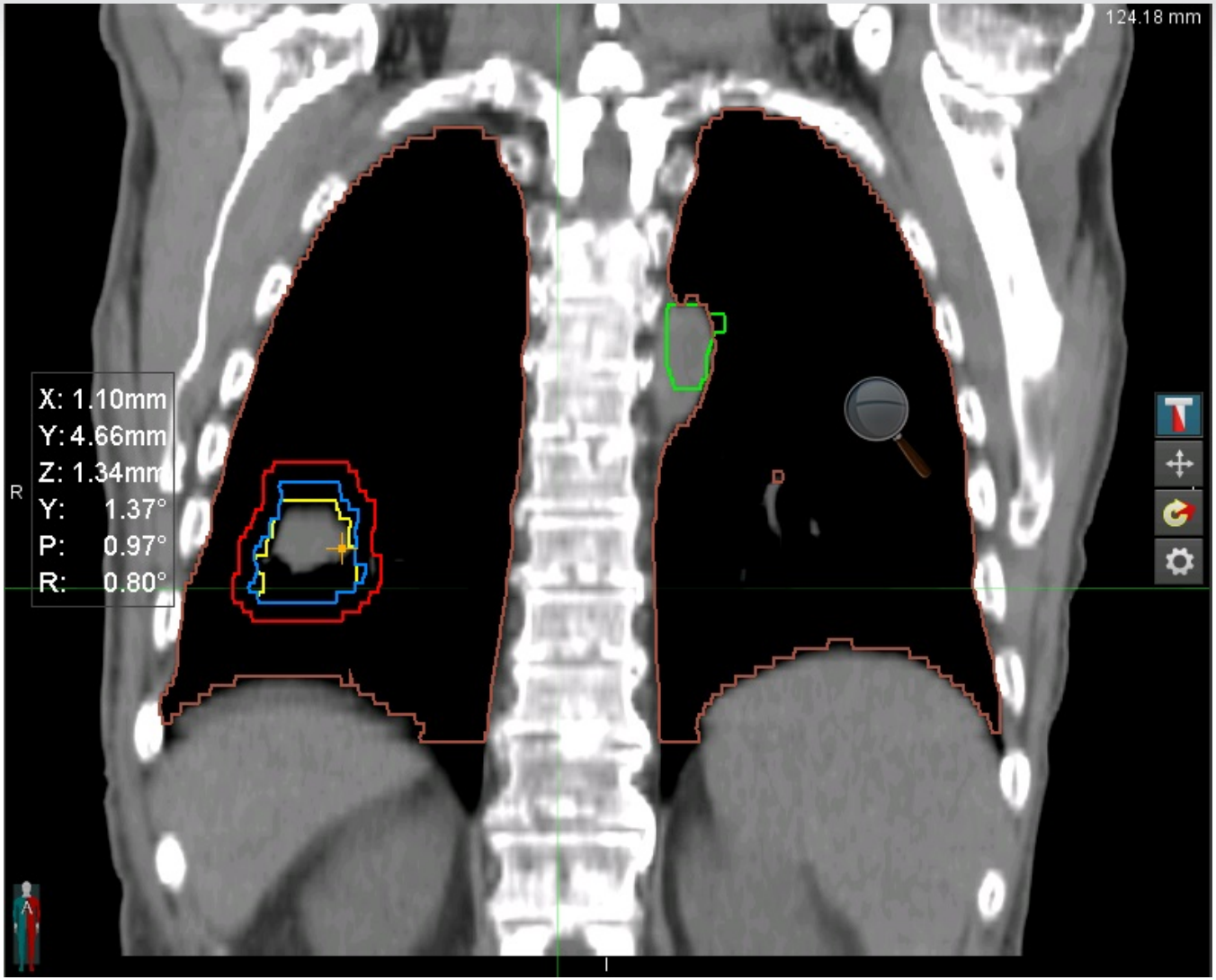
NRG BR001: 3D Lung IGRT Case 9



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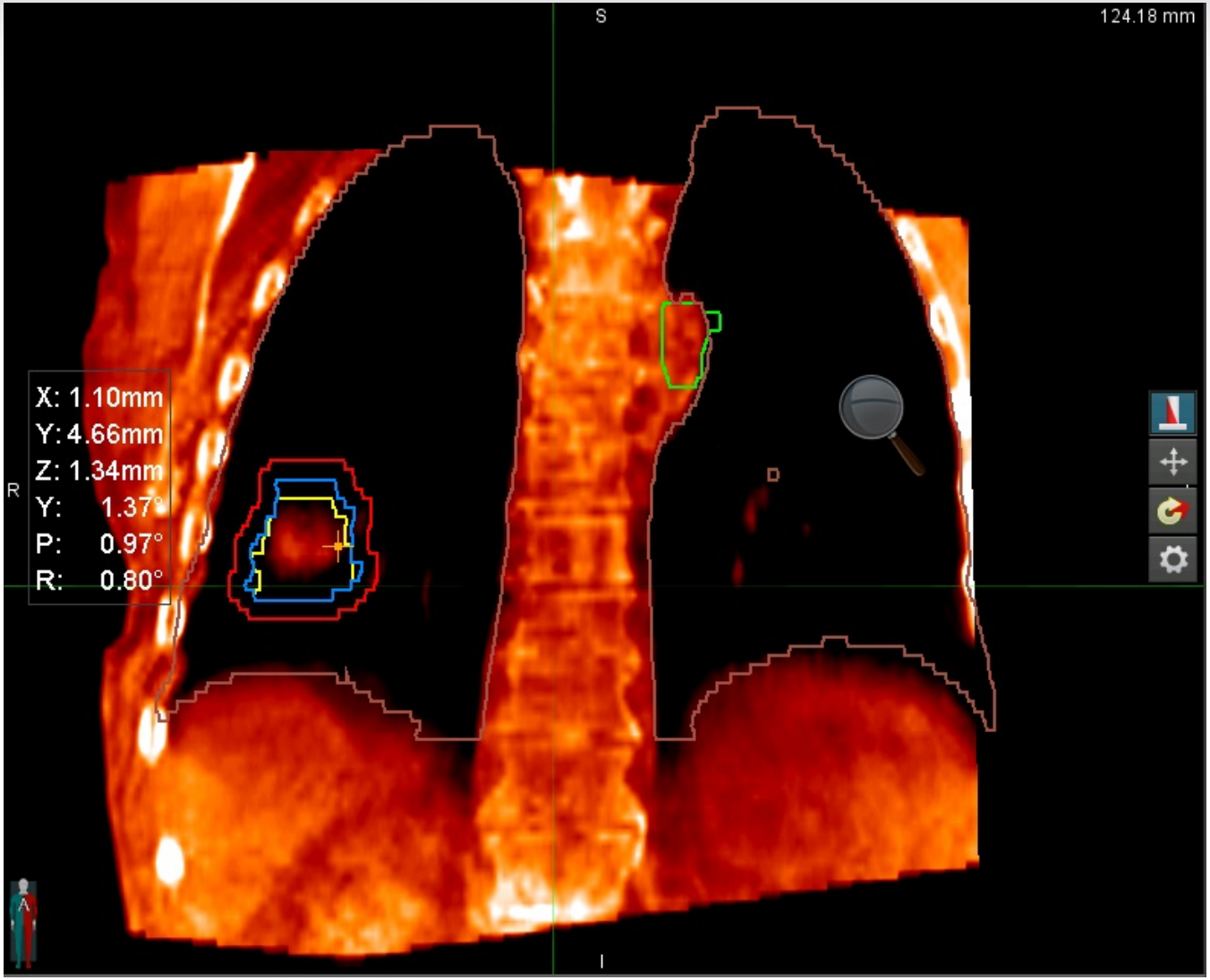
NRG BR001: 3D Lung IGRT Case 9



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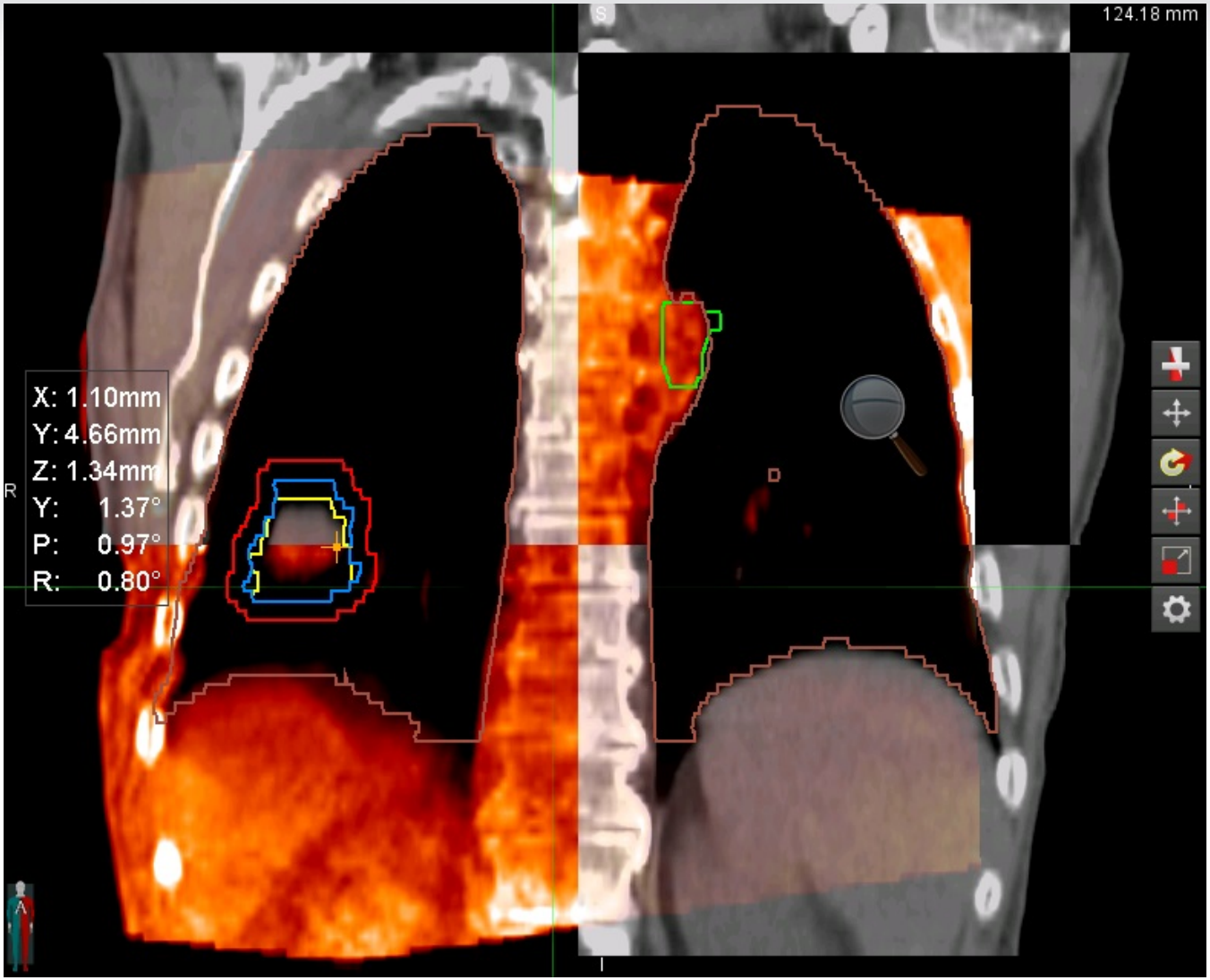
NRG BR001: 3D Lung IGRT Case 9



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NRG BR001: 3D Lung IGRT Case 9

Axis	X (mm)	Y (mm)	Z (mm)
Institution's Shifts	2.3	-4.6	6.5
Reviewer's Shifts	1.6	0.1	-5.2
Difference	0.7	-4.7	-1.3

Rotational Differences < 2 degrees

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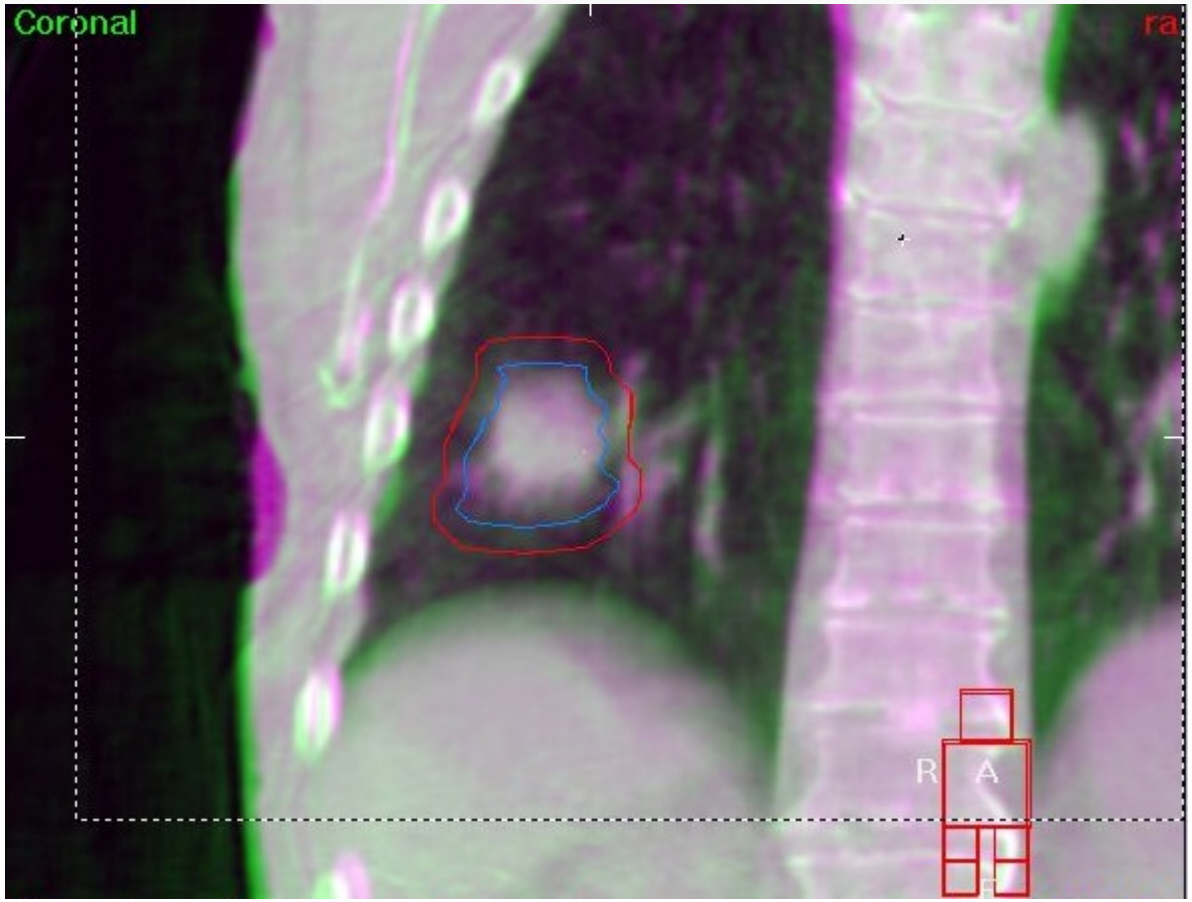

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Available Resources & Guidelines

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NRG BR001: Resources

- IROC website with DVA & FAQ documents
- Email PIs or physics PIs
- Feedback is welcomed!

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