

## **Lung Phantom**

### **3D CRT / IMRT**

Guidelines for **Planning and Irradiating** the Lung Phantom.  
Revised July 2025

#### **GENERAL INFORMATION:**

Each institution may keep the phantom for a period of time no more than 2 weeks. During this two-week period, the institution will image, plan, and treat the phantom and return. Thank you for your cooperation.

The Lung Phantom contains an imaging and dosimetric insert. The insert, which is part of the left lung, contains a centrally located target (approximate 3 cm x 5 cm). There are three orthogonal sheets of radiochromic film passing through the center of the target and two TLD capsules within 0.5 cm of the center of the target. The phantom also contains normal structures: the right lung, the heart, with one TLD capsule in its center, and the spinal cord, with one TLD in its center.

If you have any questions, please contact the appropriate person.

Nickolas Pajot (713)-745-8989 [NBPajot@mdanderson.org](mailto:NBPajot@mdanderson.org)  
Paige Taylor (713)-745-8989 [PATaylor@mdanderson.org](mailto:PATaylor@mdanderson.org)  
Andrea Molineu (713) 745-8989 [amolineu@mdanderson.org](mailto:amolineu@mdanderson.org)

#### **DOSIMETRY INFORMATION TO BE SUBMITTED:**

The following information is to be submitted when returning the phantom:

- Original hard copy isodose distribution in coronal and sagittal planes through target center.
- Treatment plan report or summary.
- Screen shots showing the contour of the TLD (similar to the figure below).
- **Data to be upload to OneDrive** - A folder has been created with your institution name on OneDrive and it will be shared with you via email. Please upload the digital treatment planning data in the DICOM format which include all CT slices with 3D composite Dose, RTStructure and RTPlan. **Please compress the file before upload to avoid the file corrupt during the process.**
- Please inform phantom team by email, [NBPajot@mdanderson.org](mailto:NBPajot@mdanderson.org), when you finished the upload.

- **\*\*Highlighted and red text wording are very IMPORTANT to follow, please feel free to ask questions if you need for any of these special notes.\*\***

- **Please note, if unable to do the above please send a CD with all the requested data with the phantom.**

- **DICOM data submit for analysis must be with CT images. We cannot process the data with MR images.**

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**The Phantom should be imaged, planned, and irradiated as if it were an actual protocol patient, incorporating all of your customary quality assurance checks. \*\*\*Please note, that the NCI Lung phantom MUST be irradiated with motion table, Lung Phantoms with motion techniques are now required for credentialing of any protocol requiring the Lung/Thorax Phantom. Examples of this include; ITV, Gating, Tracking and Breath Hold\*\*\***

**DOSE PRESCRIPTION (If you are using a Varian Voucher to receive the phantom, please do not use these instructions.):**

The target located in the left lung is the CTV.

Only photon beams with nominal accelerating potential between 4 and 10 MV are allowed. You may only use one beam energy to treat the phantom.

When static beams are used, a minimum of 7 non-opposing beams should be used.

The prescribed dose to the phantom is 6 Gy. It should be delivered in 1 fraction with the following constraints:

- PTV:
  - CTV = GTV.
  - Define ITV based on the institution's method of accounting for respiratory motion.
  - PTV = ITV + 0.5 cm in axial plane + 1 cm in longitudinal plane.
  - Prescribed dose of 6 Gy to at least 95% of the PTV
  - Minimum dose of 5.4 Gy to at least 99% of the PTV,

- Hotspots must be manipulated to occur only within the PTV,
- Critical Normal Structures (spinal cord, heart, lungs):
- Constraints over the normal structures are specified in the following table

Normal structure	Volume	Dose
Spinal Cord	Any point	≤ 5.0 Gy
Heart	< 33% total vol.	≤ 6.0 Gy
	< 66% total vol.	≤ 4.5 Gy
	< 100% total vol.	≤ 4.0 Gy
Whole Lung (Right & Left)	< 37% total vol.	< 2.0 Gy

**\*\*Please note: if using the motion table, consider this device as part of the patient during the planning process.\*\***

**\*\*\*Please make sure the lung insert is completely pushed down with irradiating the lung phantom. This can result in a failure; the lung insert should be push completed down, turned and LOCKED into place. If there is any issues please feel free to contact IROC Houston either by email (NBPajot@mdanderson.org) or phone (713-745-8989).\*\*\***

## IRRADIATING THE PHANTOM

- Material included in box for the phantom:  
Lung Phantom, with 3 set of TLD capsules taped to the shell (2 on left side, 2 on right side and 2 on anterior side)  
Dosimetric/Imaging insert  
Rubber hose  
Two acrylic cylinders containing TLD in one of the ends,
- Material included in box for the reciprocating platform:  
Motor driver  
Motor to platform linkage  
2D Reciprocating platform

### Procedures:

1. Fill the phantom with water:
  - 1.1. Thread the rubber hose into the filler hole placed on the base of the phantom.
  - 1.2. Fill slowly with water (the rubber hose stretches over most faucets). There is a breathing hole on the phantom, make sure it is open, to allow the pressure to release. You may need to jiggle the phantom to release air trapped inside the cavity.
  - 1.3. Remove hose and replace acrylic screw.
2. Allow the phantom to sit with water in it for 10 min. to check for leaks.
3. Look in the insert space and check for water leakage. If you find any water, please contact our office at 713-745-8989. If not, proceed to the next step.
4. Position the insert. Follow the marks added to the insert and shell of the phantom. **Make sure that the insert is in its correct position by making small rotations of the insert around its central axis. When it is in the correct position it will lock in place by an indentation at the base of the insert. Also, please make sure the lung insert is PUSH COMPLETELY DOWN. It MUST be push fully down in the left lung. Example on Figure 1 - Figure 3 below.**
5. Position the acrylic cylinder labeled “spinal cord cylinder” in the hole labeled “spinal cord”. You will see a TLD capsule in the cavity closed with a screw. The end with the TLD should be inserted first.
6. Position the acrylic cylinder labeled “heart cylinder” in the hole labeled “heart”. You will see a TLD capsule in the cavity closed with a screw. The end with the TLD should be inserted first.
7. Assemble the 2D reciprocating platform and motor drive system per the attached instructions. Do this on the CT couch so that the phantom and the platform can be imaged.
8. The motor driver for the platform will have been programmed to simulate the manner in which your institution instructs its patients to breathe during the 4D CT.
9. Position and CT the phantom as you would a patient. **You may wish to scan with 1.5 mm slices especially near the target to better identify the TLD capsules.** NOTE: There are TLD on the external shell of the phantom to give us an estimate of the CT dose to the target.
10. Turn on the motor drive and acquire your CT images for treatment planning. Turn off motor driver once CT process is completed. Disassemble the reciprocating platform.
11. Remove insert from the phantom during planning process. Store insert in a dry place. **REMOVE WATER FROM PHANTOM.** Store insert and phantom where they will not be irradiated.
12. Segment the phantom images contouring the skin, lungs, heart, spinal cord and PTV. Also contour all the 4 TLD volumes. Please use the following names for these contours:
  - PTV\_TLD\_sup for the superior TLD in the target,
  - PTV\_TLD\_inf for the inferior TLD in the target,
  - HEART\_TLD for TLD in the heart
  - CORD\_TLD for the TLD in the spinal cord
  - The dimensions of the TLD volume are approximately 10 mm long by 2 mm diameter
  - The outside dimensions of the TLD capsules are 15 mm long by 4 mm diameter; the TLD axis is normal to the axial plane. (The capsules and the TLD should be visible on CT image)
13. Plan the treatment as specified in the DOSE PRESCRIPTION above. Try to avoid positioning the axial film at the abutment of adjacent MLC leaves or adjacent arcs. Abutting fields or leaves on the film may increase the uncertainty of the measurement.
14. Perform your customary patient specific QA prior to irradiating the phantom.
15. Repeat steps 1 and 2.
16. Look in the insert space and check for water leakage. If you find any water, please contact our office at 713-745-8989. If not, follow the instructions in step 4 to 6 to position the insert again and proceed to the next step.
17. Assemble the 2D reciprocating platform and motor drive system per the attached instructions. Do this on the treatment machine couch so that the phantom and the platform can be irradiated.
18. Position the phantom as you would a protocol patient.
19. Turn on the motor drive.
20. Perform all the verification needed to confirm the final position of the phantom.

22. **\*\*Remove the Background TLD's on the outside of the lung after imaging and alignment (KV, CBCT) are completed before radiation treatment begins.\*\*** Put them into the designated container.
23. Irradiate the phantom with the developed plan.
24. Turn off the motor drive and put each part of the motion table into its shipping box.
25. Remove the insert and place it in the box.
26. Remove the acrylic cylinders from holes and place them in the box.
27. Please verify that there is no water in the insert space. If you find any water, please call our office.
28. Remove the screw on the base of the phantom and drain the water from the phantom.
29. Put the empty phantom in the box.
30. Make sure that the container with the external TLD's and the rubber hose are in the box.
31. Include the dosimetry data discussed above. Complete the attached forms. Be sure to include the scale used on the images coming from your TPS.
32. Return the complete package to our office using the prepaid label.

## Lung Phantom- Institution Information

Institution: \_\_\_\_\_

Address: \_\_\_\_\_

### **Treatment Unit used for irradiation:**

Manufacturer: \_\_\_\_\_ Model (Head model if Elekta): \_\_\_\_\_

Serial number: \_\_\_\_\_

Photon Energy Nom \_\_\_\_\_ (MV)

Is this a: FFF beam \_\_\_\_\_ or SRS beam \_\_\_\_\_

Person performing irradiation: \_\_\_\_\_

Irradiation date (**REQUIRED**) : \_\_\_\_\_

### **IMRT Technique for this irradiation:**

\_\_\_ Segmental (step and shoot) MLC      \_\_\_ Dynamic MLC      \_\_\_ Tomotherapy

\_\_\_ VMAT      Other: \_\_\_\_\_

### **Intensity Modulation Device for this irradiation:**

\_\_\_ Multileaf Collimator Model: \_\_\_\_\_

### **TPS information for this irradiation**

Manufacturer \_\_\_\_\_ Model \_\_\_\_\_ Algorithm \_\_\_\_\_

Version number \_\_\_\_\_

### **Contact Information for this irradiation**

Physicist to receive report: \_\_\_\_\_

Person to call in case of questions: \_\_\_\_\_

Phone Number: \_\_\_\_\_ Email address: \_\_\_\_\_

**Method to Account for Respiratory Induced Target Motion used for phantom (if applicable):**

- Gating    Breath hold    ITV    Tracking    Abdominal Compression

Please describe your method:

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**Please enclose original copies of your treatment plan report.**

**Include the axial, coronal and sagittal planes through the target center.**

**Treatment of Phantom:**

Indicate the dose delivered to the TLD as determined by your treatment planning computer

TLD	Mean Dose (cGy)	Min. Dose (cGy)	Max. Dose (cGy)
PTV_TLD_sup			
PTV_TLD_inf			
CORD_TLD			
HEART_TLD			

Results of the QA: \_\_\_\_\_

\_\_\_\_\_

Did you adjust the MU based on these results? \_\_\_\_\_ If so, how much? \_\_\_\_\_

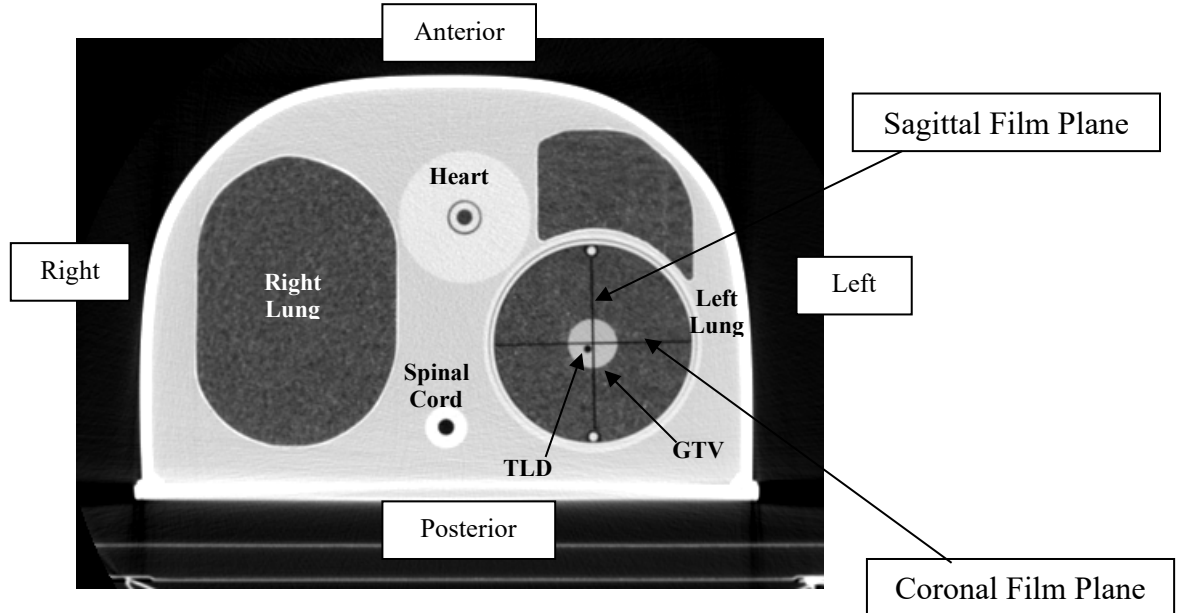
Attach copies of the treatment plan including slices in the sagittal, axial and coronal film planes.

Comments: \_\_\_\_\_

\_\_\_\_\_

For Office Use Only	TLD Batch <b>B-20</b>	Motion Table: MT- _____	Film Batch <b>EBT4 03042502</b>	Phantom ID # L - _____	Code Inst# _____	Date Sent _____ NP	Date Rec'd
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This is a CT cross sectional view of the lung phantom (axial film plane).



**Note:** Please ignore all markings on the external shell of the phantom, use your own system to position the phantom and remove when done.

**Note:**

1. You need to deliver 6.0 Gy to the PTV in 1 fraction. Total dose to the PTV 6.0 Gy
2. If utilizing reciprocating platform, please take it into account during planning.
3. If you are using a Varian Voucher to receive the phantom, please do not use these instructions.