

Lung Phantom

3D CRT / IMRT

Guidelines for **Planning and Irradiating** the Lung Phantom.
Revised September 2024

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.

We require that each institution to keep the phantom for no more than 2 weeks. During this two-week period, the institution will image, plan, irradiate the phantom and return it to our office. Thank you for your cooperation with this constraint.

If you have any questions, please contact the Radiation Quality Assurance Laboratory at:

Phone: (713)-745-8989

Email: RQALab@mdanderson.org

DOSIMETRY INFORMATION TO BE SUBMITTED:

The following information is required to be submitted when the phantom is returned (should be included in the shipping box):

- Original hard copy of the Summary of the treatment plan from the treatment planning system (TPS)
- Original hard copy isodose distributions in the axial, coronal and sagittal planes through the target center. Please ensure that each plane fills an entire page and that a scale is printed on the page.
- A completed **Lung Phantom Institution Information** form.
- A copy of results patient specific QA measurements.

Data to be uploaded to OneDrive - A folder has been created with your institution name on OneDrive. It will be shared with you via email. Please upload digital treatment planning data in the DICOM format which include CT images along with 3D composite RTDose, RTStructure and RTPlan. **Please compress the file before upload to avoid the file corrupt during the process.**

- **Please note, if unable to do the above please send a CD with all the requested data with the phantom.**
- **DICOM data submitted for analysis must be with CT images. We cannot process the data with MR images.**

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.**

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,
Envelope with background film and TLD (hidden from your view; please don't try to find it)
The TLD block and platform for output check (please look for instructions). Please irradiate this TLD block at the time you irradiate the phantom. **Not applicable for TomoTherapy delivery**
- Material included in box for the reciprocating platform (If needed by institution):
Motor driver
Motor to platform linkage
2D Reciprocating platform

If reciprocating platform is not used, avoid procedures 7, 8, 10, 18, 20, 24

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.
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. Irradiate the TLD block according to the instructions provided. **Not applicable for TomoTherapy delivery**
18. 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.
19. Position the phantom as you would a protocol patient.
20. Turn on the motor drive.
21. Perform all the verification needed to confirm the final position of the phantom.
22. **REMOVE THE TLD CAPSULES LOCATED ON THE EXTERNAL SHELL.**
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: _____

Person performing irradiation: _____

Person to receive report: _____

Email address: _____

Phone Number: _____

Person to call in case of questions: _____

Phone Number: _____ Fax Number: _____

Email address: _____

Treatment Unit:

Manufacturer: _____ Model (add head model for Elekta): _____

In-house specification: _____ Serial Number: _____

Photon Energy Nominal _____ (MV) FFF beam _____ SRS beam _____

Technique used: 3D-CRT IMRT

Collimator System

Solid Attenuator Modulation Cone Other: _____

Multileaf Collimator : Model: _____

If IMRT, IMRT Technique:

Segmental (step and shoot) MLC Dynamic MLC CyberKnife

TomoTherapy VMAT Other: _____

Please enclose original copies of your treatment plan report, copy of isodose distribution of the axial, coronal and sagittal planes through the target center.

Treatment Planning System:

Manufacturer: _____ Model: _____

Software: _____ TPS Version: _____

Algorithm used for dose calculation: _____

If Acuros or MC is used, do you calculate dose to medium or water: _____

Total number of MU's: _____ Total number of segments: _____

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

Gating Breath hold ITV Tracking Abdominal Compression

Please describe your method:

Treatment of Phantom:

Date of Irradiation: _____

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: _____

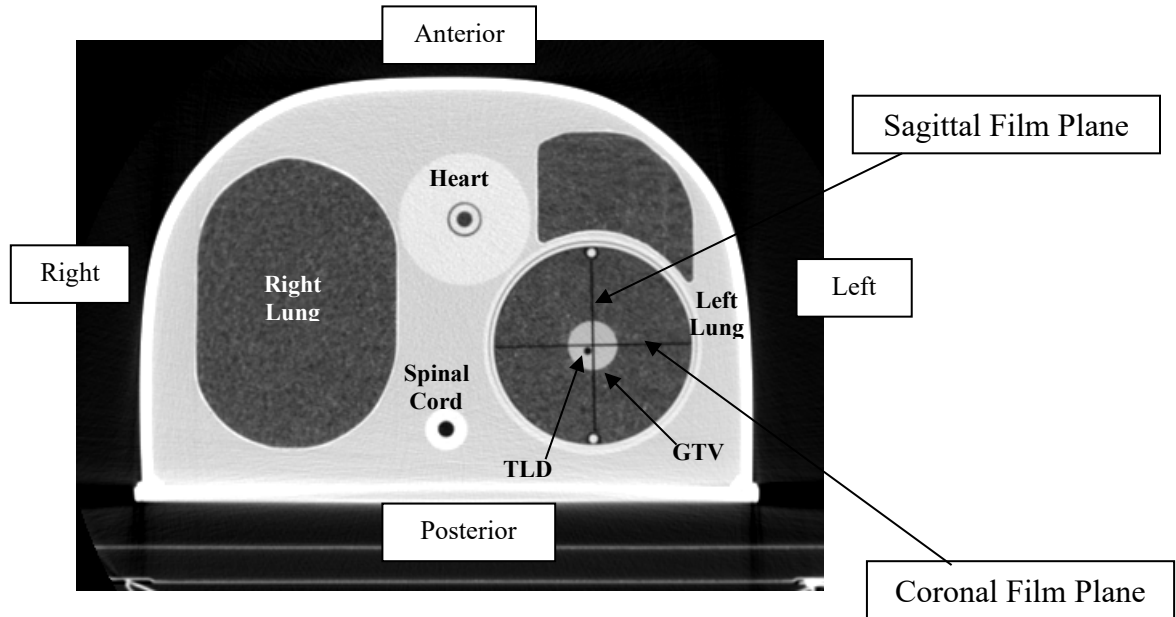
Did you adjust the MU based on these results? _____ If so, how much? _____

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

Comments: _____

For Office Use Only	TLD Batch	Motion Table: MT-	Film Batch	Phantom ID # L -	Code Inst#	Date Sent	Date Rec'd
---------------------	-----------	----------------------	------------	---------------------	---------------	-----------	------------

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.