Proton Lung Phantom

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

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

The phantom contains an insert used for both imaging and dosimetry. The insert, which is part of the left lung, contains a centrally located GTV (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 a normal structure, the heart.

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

Phone: (713) 745-8989
Email: RQALab@mdanderson.org

DOSIMETRY INFORMATION TO BE SUBMITTED:

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

- Original hard copy isodose distributions applying correction for tissue heterogeneity in the axial, sagittal, and coronal planes through the center of the target volume. Please ensure that each plane fills an entire page and that a scale is printed on the page.
- A completed **Proton Lung Phantom Institution Information** form.
- A copy of results of all film and ion chamber QA measurements.
- Please upload the phantom digital data. A folder has been created with your institution name on OneDrive and it will be shared with you. The files to upload are the digital data for your phantom irradiation in DICOM format, and include all CT slices, 3D composite dose file, structure file and plan file.
- **(When uploading Digital data, please keep the Dose File under 90MB)**

DOSE PRESCRIPTION:

Use correction for tissue heterogeneity when planning and calculating MU.
Field aperture size and shape should correspond nearly identically to the projection of the PTV along a beam's eye view.

The prescribed dose to the phantom is 6 Gy(RBE) to the isodose line circumscribing the PTV. It should be delivered in 1 fraction with the following constraints:

- Prescribed dose of 6 Gy (RBE) to at least 95% of the PTV
- Minimum dose of 5.4 Gy (RBE) to at least 99% of the PTV

In this plan, you are free make up your own plan following your own guidelines to contour the structures. The only restrictions are to deliver 6 Gy (RBE) to the target and avoid having the beam enter through angles corresponding to a right lateral or posterior field, as the phantom is not anthropomorphic from these geometries. Otherwise, plan the phantom treatment as you would a patient treatment.

The phantom should be imaged, planned and irradiated as if it were an actual protocol patient, incorporating all of your customary quality assurance checks.

IRRADIATING THE PHANTOM

- Material included in box:
  Lung Phantom, with 3 TLD capsules taped to the shell
  Dosimetric/Imaging insert
  Phantom stand
  Motor/Phantom stand connector
  Motor
  Motor controller
  RPM box holder

Procedures:

Caution: the phantom is fragile! Please treat gently.

1. Place all materials within the box individually on the CT couch.
2. Set the phantom shell in the phantom stand and use two yellow thumb screws to secure the phantom shell to the phantom stand on the upper end.
3. Attach the motor to the motor/phantom stand connector with the green thumb screws.
4. Attach the small lever arm to the motor bed with the yellow screw in the hole furthest from the phantom.
5. Slide insert in from the upper end of the incline at the same angle as the shell and align the motor lever with the insert connector. The insert fits snugly into the shell. Attach acrylic motor arm to insert connection with a yellow thumb screw.
6. Attach RPM box holder to acrylic motor arm with small shite screws.
7. Place your RPM marker box on the platform or affix compression belt that is used to monitor breathing motion.
8. Plug in motor controller to electrical outlet then connect the controller to the motor with both attached cables.
9. Flip the on switch and press the green button on the motor controller. The phantom will home, pause, and then begin its motion pattern. It may make a rattling noise during pauses in the motion – that's normal.
10. CT the phantom as you would a patient, including immobilization techniques. 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.
11. Segment the phantom images contouring the lung, ribs, heart, and PTV.
12. Plan the treatment as specified in the DOSE PRESCRIPTION above.
13. Perform your customary QA of the plan prior to irradiating the phantom.
14. Position the phantom as you would a protocol patient, including immobilization techniques.
15. **REMOVE THE TLD CAPSULES LOCATED ON THE EXTERNAL SHELL**. Put them into the tin marked "TLD."
16. Irradiate the phantom with the developed plan.
17. Disassemble the phantom in reverse order of assembly.
18. **Make sure that the tin with the TLD on the shell is in the box**.
19. Include the dosimetry data discussed above. Complete the attached forms. Be sure to include the scale used on the images coming from your TPS.
20. Return the complete package to our office.

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: _____ Email address: _____

Treatment Unit:

Manufacturer: _____ Model: _____

In-house specification: _____

Proton Energy Nominal _____(MeV) Range: _____ cm

1. For the phantom irradiation, technique used was (check one)
   - ☐ Pencil Beam Scanning (PBS) / IMPT (variable intensity pencil beam scanning).
   - ☐ Uniform Scanning.
   - ☐ Passive Scattering.

2. Collimation technique: ☐ Multileaf ☐ Solid Aperture

3. Range modulation technique:
   - ☐ Range modulator wheel ☐ Range shifters
   - ☐ Both RMW and shifters ☐ Other, please describe: _____

4. Compensator technique:
   - ☐ Solid compensator / bolus ☐ Other, please describe: _____

Please enclose original copies of your treatment plans. Include the axial, coronal and sagittal planes through the target center. Include scaling factors for each plane.

Treatment Planning System:

Manufacturer: _____ Model: _____

Software:_____ Algorithm:_____ TPS Version:_____

Treatment Planning Details:

Beam angles used: _____

For pencil beam scanning - was a range shifter or energy absorber used? □ No □ Yes _____

For pencil beam scanning - was repainting used? □ No □ Yes _____

If yes, #_____ layer repaintings #_____ volume repaintings

Method to Account for Respiratory Induced Target Motion (If applicable):

Please describe your method: □ Gating □ Breath hold □ MIP

_____

_____

_____

_____

Motion management system: _____

IGRT used for phantom setup: _____

Treatment of Phantom:

Date of Irradiation: _____

Dose specified is to: □ Muscle □ Water

and is: □ Physical □ Biological - RBE used is _____

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

TLD	Mean Dose (cGy(RBE))
Superior TLD	
Inferior TLD	

Results of QA:_____

_____

_____

Did you change the MU based on your QA? □ No □Yes If so, how much?_____

Attach copies of the treatment plans including slices in the sagittal and coronal film planes.

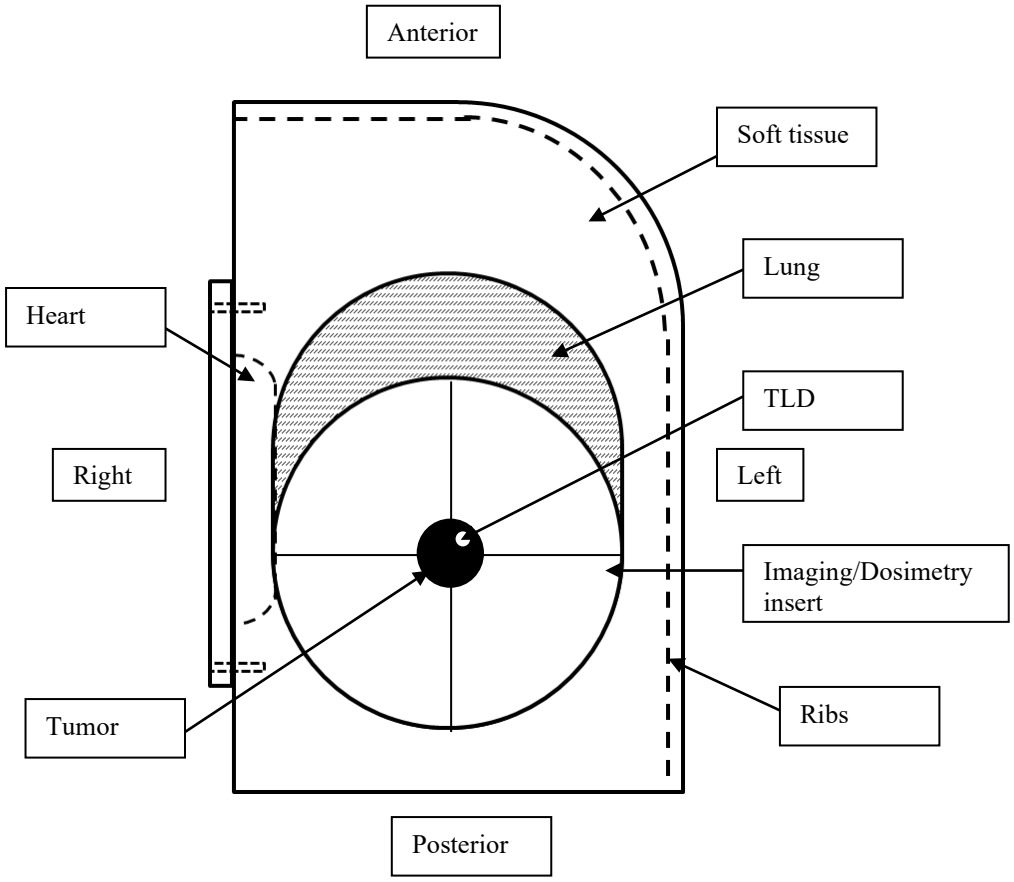
Comments: _____

_____

_____

For Office Use Only	TLD Batch	Film Batch EBT3 LOT #	Phantom ID # **Proton Lung-**	Code	Date Sent	Date Rec'd

Labeled below is a cross sectional view of the phantom.



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

Note: You need to deliver 6.0 Gy(RBE) to the PTV (in 1 or more fraction).
Total dose to the PTV 6.0 Gy(RBE)