IROC Lung Phantom
3D CRT / IMRT

Guidelines for Planning and Irradiating the IROC Lung Phantom.
Revised Dec 2015

The IROC requests that each institution keep the phantom for no more than 2 weeks. During this two-week period, the institution will image, plan, and irradiate the phantom and return it to the Imaging and Radiation Oncology Core Houston (IROC). Thank you for your cooperation with this constraint.

This phantom has been designed and constructed by IROC Houston. The IROC phantom contains an imaging and dosimetric insert. 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 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.
IROC Carrie F. Lujano (713) 745-8989 camador@mdanderson.org
IROC Paola Alvarez (713) 745-8989 palvarez@mdanderson.org
IROC Andrea Molineu (713) 745-8989 amolineu@mdanderson.org

DOSIMETRY INFORMATION TO BE SUBMITTED:

The following information is to be submitted to IROC Houston (include in the shipping box):

- Original hard-copy isodose distributions in the 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 IROC IMRT Lung Phantom Institution Information form.
- A copy of results of all film and ion chamber QA measurements.

The following information is to be submitted to IROC Houston:
Please follow the login URL: https://mdandersonorg.sharefile.com and the log in information below to submit the digital treatment planning data in DICOM format which includes one set of CT slices that produced the plan with one three dimensional dose file (dose grid) (RD), one structure (RS) and one plan files (RP).

Username: trangnguyen@mdanderson.org
Password: Phantom8989

- Click on folder named IROC Lung Folder; select the Add Folder tab on the top right hand side of the screen. In the folder name box, enter your institution name, city and state, as shown in the example, then click Create Folder.
- Select the folder that you have created, then select Upload Files tab on the right hand side. In the Details box please type in phantom type, irradiation date, and physicist name. Follow the instruction and upload your file. Select Send email notification box when done. Lastly Click Upload Files.
- Please log out once you finish and inform the IROC by email camador@mdanderson.org otherwise results will be delayed.

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

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. For arc rotation techniques, a minimum of 340 degrees should be utilized.

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

<table>
<thead>
<tr>
<th>Normal structure</th>
<th>Volume</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spinal Cord</td>
<td>Any point</td>
<td>≤ 5.0 Gy</td>
</tr>
<tr>
<td>Heart</td>
<td>&lt; 33% total vol.</td>
<td>≤ 6.0 Gy</td>
</tr>
<tr>
<td></td>
<td>&lt; 66% total vol.</td>
<td>≤ 4.5 Gy</td>
</tr>
<tr>
<td></td>
<td>&lt; 100% total vol.</td>
<td>≤ 4.0 Gy</td>
</tr>
<tr>
<td>Whole Lung (Right &amp; Left)</td>
<td>&lt; 37% total vol.</td>
<td>&lt; 2.0 Gy</td>
</tr>
</tbody>
</table>

**Please 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 TLD capsules taped to the shell (1 on left side, 1 on right side and 1 on anterior side)
  Dosimetric/Imaging insert
  Rubber hose
  Two acrylic cylinders containing TLD in one of the ends
  Motor driver
  Motor to platform linkage
  2D Reciprocating platform
  Envelope with background film and TLD (hidden from your view; please don’t try to find it)
  Traditional IROC TLD block and irradiation table. (Please irradiate this at the time you irradiate the phantom.)

- 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 call IROC Houston. If not, proceed to the next step.
4. Position the insert. 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 drive 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. Note that the CTV = GTV. PTV = GTV + 0.5 cm in axial plane + 1 cm in longitudinal plane. 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 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.
14. Repeat steps 1 and 2.
15. Look in the insert space and check for water leakage. If you find any water call IROC Houston. If not, follow the instructions in step 5 to position the insert again and proceed to the next step.
16. Perform your customary QA of the plan prior to irradiating the phantom.
17. Irradiate the IROC TLD block according to the instructions provided.
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. 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.
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 call IROC Houston.

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 IROC Houston.
IROC Lung Phantom Institution Information

(Original to IROC)

Institution: _____________________________________________________________

Address: __________________________________________________________________________________________
________________________________________________________________________________________

Person performing irradiation: ________________________________________________

Person to receive report: _______________________________________________________

Oncologist to receive report: _________________________________________________

**Oncologist email to receive report:** __________________________________________

Person to call in case of questions: ____________________________________________

Phone Number: ___________________ Fax Number: ____________________________________

Email address: _______________________________________________________________

**Treatment Unit:**

Manufacturer: __________________________ Model: _________________________________

In-house specification: __________________________ Serial Number: _______________

Photon Energy Nom _______ (MV) _____regular _____SRS _____ FFF

**Technique used:** 3D-CRT:___________ IMRT:______________

**If IMRT, Intensity Modulation Device:**

__MIMIC __Multileaf Collimator __Solid Attenuator Modulation __ Other: _____________

**If IMRT, IMRT Technique:**

☐ Segmental (step and shoot) MLC ☐ Dynamic MLC ☐ Intensity Modulated Arc Therapy (IMAT)

☐ CyberKnife ☐ TomoTherapy ☐ VMAT Other: _________________________________
Please enclose original copies of your treatment plan report. Include the coronal, axial and sagittal planes through the target center. Include scaling factors for each plane. FTP the digital treatment planning data.

**Treatment Planning System:**

Manufacturer: _______________________________       Model: _______________________

Software: _________________________     Version Number: ________________________

Algorithm used for dose calculation: ___________________________________________________

Total number of MU’s: ___________    Total number of segments: _____________________

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

Please describe your method:

____ Gating    ____ Breath hold    ____ MIP    ____ Tracking    ____ Abdominal Compression

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________
Please enclose original copies of your treatment plan report. **Include the coronal, axial and sagittal planes through the target center.** Include scaling factors for each plane. FTP the digital treatment planning data.

**Treatment of Phantom:**

Date of Irradiation: ____________________________________________________________

Dose specified is to: □ Muscle  □ Water

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

<table>
<thead>
<tr>
<th>TLD</th>
<th>Mean Dose (Gy)</th>
<th>Min. Dose (Gy)</th>
<th>Max. Dose (Gy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTV_TLD_sup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PTV_TLD_inf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HEART_TLD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CORD_TLD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>TLD Batch</th>
<th>Film Batch</th>
<th>Phantom ID #</th>
<th>Code</th>
<th>Date Sent</th>
<th>Date Rec'd</th>
</tr>
</thead>
</table>

Web Copy
This is a CT cross sectional view of the lung phantom.

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.

Good Luck from the
Phantom team @ IROC HOUSTON