## IROC Houston Lung Phantom

# 3D CRT / IMRT

Guidelines for ***Planning and Irradiating*** the IROC Houston Lung Phantom.

Revised March 2010

Credentialing for these protocols requires several steps including the irradiation of this phantom. The purpose of this test is to confirm that the dose distribution planned by each institution complies for the most part with the protocol and can be delivered by that institution.

The IROC Houston 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 IROC Houston QA Center. Thank you for your cooperation with this constraint.

This phantom has been designed and constructed by the IROC Houston. The IROC Houston 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.

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**DOSIMETRY INFORMATION TO BE SUBMITTED:**

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

* Original hard-copy of the plan and isodose distributions with correction for tissue heterogeneity in the sagittal, axial 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 **IROC Houston Lung Phantom Institution Information** form.

The following information is required to be submitted to the Advanced Technology Consortium (ATC, <http://itc@wustl.edu>) (see protocol for additional submissions) **(results will not be analyzed until the digital treatment plan is received):**

* The digital treatment planning data with correction for tissue heterogeneity, in the RTOG Data Exchange format using either FTP or tape (see the ATC web site for details).

Please cc the IROC Houston ([IROCHouston@mdanderson.org](mailto:IROCHouston@mdanderson.org)) when you inform the ATC of the electronic submission.  This will allow us to keep better track of who has and has not submitted the benchmark electronically.

* Original hard copy isodose distributions with correction for tissue heterogeneity in the sagittal, axial and coronal plane through the target center (identical to those sent to the IROC Houston)
* A copy of the completed **IROC Houston Lung Phantom-Institution** **Information** form that was sent to the IROC Houston
* Send the hard copy data (isodoses and forms) to:

Bill Straube, M.S.

Image Guided Therapy Center

Washington University

4511 Forest Park Ave, Suite 200

St Louis, MO 63108

**DOSE PRESCRIPTION:**

Only photon beams with nominal accelerating potential between 4 and 10 MV are allowed.

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. PTV = GTV + 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.  < 66% total vol.  < 100% total vol. | ≤ 6.0 Gy  ≤ 4.5 Gy  ≤ 4.0 Gy |
| Whole Lung  (Right & Left) | < 37% total vol. | < 2.0 Gy |

**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 Houston 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. Thread the rubber hose into the filler hole placed on the base of the phantom.
   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.
   3. Remove hose and replace acrylic screw.
2. Allow the phantom to sit with water in it for 20 min. to check for leaks**.**
3. Look in the insert space and check for water leakage. If you find any water call the IROC Houston. If not, proceed to the next step**.**
4. Position the insert. The end labeled “bottom of insert” should be inserted first. Align the red mark. 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 be locked in place by an indentation at the end of the insert.
5. Position the acrylic cylinder labeled “spinal cord cylinder” in the hole labeled “spinal cord”. The hole and the cylinder are marked in blue. 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”. The hole and the cylinder are marked in green. 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 irradiate.
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 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)

1. Plan the treatment as specified in the DOSE PRESCRIPTION above.
2. Repeat steps 2 and 3.
3. Look in the insert space and check for water leakage. If you find any water call the IROC Houston. If not, follow the instructions in step 5 to position the insert again and proceed to the next step.
4. Perform your customary QA of the plan prior to irradiating the phantom.
5. Irradiate the IROC Houston TLD block according to the instructions provided.
6. 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.
7. 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.
8. Turn on the motor drive.
9. Perform all the verification needed to confirm the final position of the phantom.
10. **REMOVE THE TLD CAPSULES LOCATED ON THE EXTERNAL SHELL**. Put them into the designated container.
11. Irradiate the phantom with the developed plan.
12. Turn off the motor drive and put each part of the motion table into its shipping box.
13. Remove the insert and place it in the box.
14. Remove the acrylic cylinders from holes and place them in the box.
15. Please verify that there is no water in the insert space. If you find any water call the IROC Houston.
16. Remove the screw on the base of the phantom and drain the water from the phantom.
17. Put the empty phantom in the box.
18. Make sure that the envelope with the TLD on the shell and the rubber hose are 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 the IROC Houston.

###### IROC Houston Lung Phantom Institution Information

(Original to IROC Houston, copy to ITC)

Institution:

Address:

Person performing irradiation:

Person to receive report:

Oncologist 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) IR (TMR 20/TMR 10): \_\_\_\_\_\_ %dd(10)x \_\_\_\_\_\_\_

## Technique used: 3D-CRT:\_\_\_\_\_\_\_\_\_\_\_\_ IMRT:\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## If IMRT, Intensity Modulation Device:

\_\_\_ MIMIC \_\_\_ Multileaf Collimator \_\_\_ Solid Attenuator Modulation

## If IMRT, IMRT Technique:

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

Rapid Arc TomoTherapy VMAT Other: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Please enclose original copies of your treatment plans. 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: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Please enclose original copies of your treatment plans. 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

| TLD | Mean Dose (Gy) | Min. Dose (Gy) | Max. Dose (Gy) |
| --- | --- | --- | --- |
| PTV\_TLD\_sup |  |  |  | |
| PTV\_TLD\_inf |  |  |  | |
| HEART\_TLD |  |  |  | |
| CORD\_TLD |  |  |  | |

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

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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  **CFA** | TLD Batch  **A12041005B** | Film Batch  **B11** | Phantom ID #  **L-** | Code | Date Sent | Date Rec'd |

This is a cross sectional view of the phantom.

Anterior

Posterior

Left

Right

Right

Lung

Left

Lung

Spinal

Cord

Heart

GTV

Coronal Film Plane

Sagittal Film Plane

• Position of TLD

Axial Film Plane

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

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