

Proton Brain Phantom

Guidelines for ***Planning and Treating*** Proton Brain Phantom.

Revised September 2024

The irradiation of this phantom is part of the credentialing process for proton therapy in clinical trials. The purpose of the phantom treatment experiment is to confirm that the dose distribution planned by each institution can be delivered by that institution, and correctly submitted to our office.

We ask that each institution 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 it to our office. Thank you for your cooperation.

The phantom contains two inserts. The water fillable imaging insert contains the GTV (tumor target). The dosimetric insert contains TLD at 2 locations and perpendicular sheets of film to evaluate the dose to target.

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 (include it in the shipping box):

- A completed **Proton Brain Phantom Institution Information** form.
- Original hard copy of the plans and isodose distributions in the sagittal and coronal plane through the target center.
- Please upload the proton brain phantom digital data. A folder had 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 proton brain phantom irradiation in DICOM format, and include all CT slices, 3D composite dose file, structure file and plan file.

Please make sure you upload the digital correspondent to the dosimetry insert and CT/Imaging insert.

DOSE PRESCRIPTION:

The total dose to the phantom is 6 Gy (RBE), with the following constraints:

- The target (GTV) should be treated as the PTV
 - Total dose of 6.0 Gy (RBE) to at least 95% of the PTV,
 - A minimum dose of 5.1 Gy (RBE) to the PTV and
 - A maximum dose of 6.6 Gy (RBE) may be given to < 0.03 cc of the PTV.

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 phantom case:

- Brain Phantom
- Solid Dosimetric insert
- Hollow Imaging insert
- Envelope with background film (hidden from your view; please don't try to find it)
- Mailing label to return case

Procedures:

1. Fill the imaging insert with water:
 - 1.1. Remove the plug from the top of the insert.
 - 1.2. Fill slowly with water. You may need to jiggle the insert to release air trapped inside the cavity.
 - 1.3. Replace the plug.
2. Position the imaging insert. The side without plug and hole should be inserted toward the top of the head. Align the black lines on the inferior end of the insert and 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 be locked in place by an indentation at the end of the insert.
3. Position and CT the phantom as you would a patient. You may wish to scan with thin slices, especially near the center to better identify the target. Remove the imaging insert. Drain the water from the insert. Place the insert in the box.
4. Position the dosimetric insert. The side without a handle should be inserted. Align the two black lines. As in step 2, be sure that the insert is in its correct position.
5. CT the phantom again with the same scan protocol as the previous scan.
6. Fuse the two CT image sets in your treatment planning system.
7. Segment the phantom images contouring the target, the TLD, and the outline of the dosimetry insert.
Please see Proton Treatment Planning Addendum for further instruction.
8. For treatment, ensure that the dosimetric insert is still in the proper position from the CT scan.
9. Perform your customary QA of the proton plan prior to irradiating the phantom. Include in the form values and all the information you consider relevant for analysis.
10. Treat the phantom with the developed plan as you would a protocol patient.
11. Remove the dosimetric insert and place it in the box.
12. Put the empty phantom in the box.
13. Include the dosimetry data discussed above. Complete the attached forms. Be sure to include the scale used on the images coming from your TPS.
14. **Return the complete package to our office.**

Proton Brain Phantom Institution Information

Institution: _____

Address: _____

Person performing irradiation: _____

Physicist to receive report: _____

Email address: _____

Phone Number: _____

Person to call in case of questions: _____

Phone Number: _____ Fax Number: _____

Email address: _____

Treatment Unit:

Manufacturer: _____ Model: _____

In-house specification: _____ Serial # _____

Proton Energy: Nom _____ (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 coronal and sagittal planes through the target center. Include scaling factors for each plane.

Treatment Planning System:

Manufacturer: _____ Model: _____

Software: _____ Algorithm: _____ TPS Version: _____

Treatment of Phantom:

Date of Irradiation: _____

Dose specified is to: ☐ Muscle ☐ Water
and is : ☐ Physical ☐ Biological - RBE used is _____

Indicate the dose delivered to these specific points as determined by your treatment planning computer

Position	Mean Dose (cGy(RBE))
TLD position – Right Anterior	
TLD position – Left Posterior	

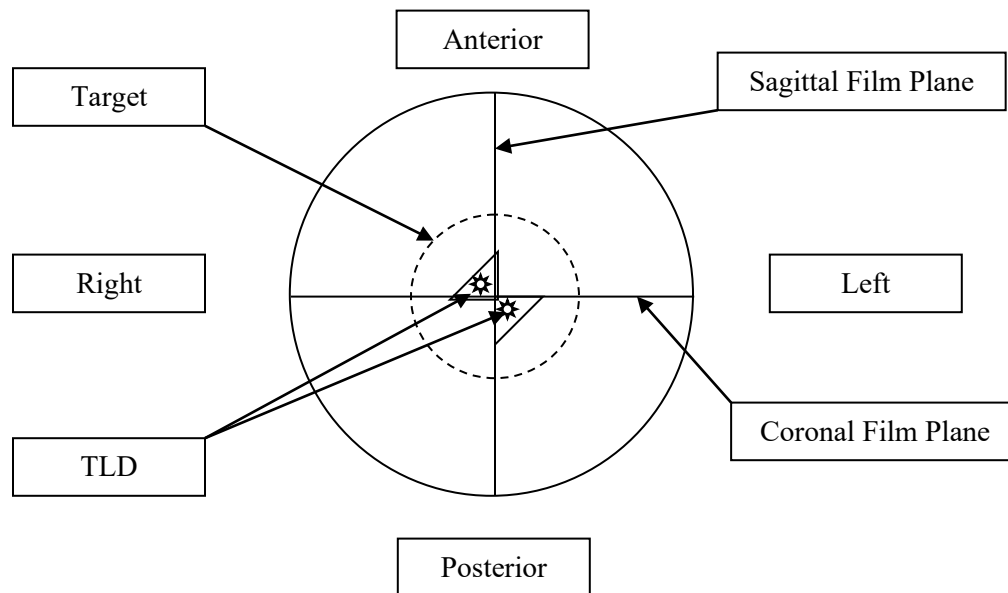
Results of QA: _____

Did you change the M.U. based on your QA? ☐No ☐Yes _____

Comments: _____

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

This is a cross-sectional view of the phantom with the dosimetry insert.



Notes:

- You need to deliver 6.0 Gy(RBE) to the PTV (in 1 or more fractions).
- Please ignore all markings on the external shell of the phantom, use your own system to position the phantom.

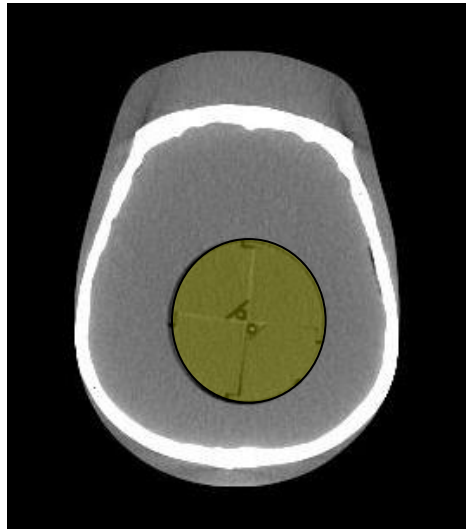
Proton Treatment Planning Addendum

Please create a plan using the following guidelines:

The total dose to the phantom is 6.0 Gy(RBE), with the following constraints:

- Tumor GTV – you may use this structure as the PTV
 - Total dose of 6.0 Gy(RBE) to at least 95% of the PTV
 - A minimum dose of 5.1 Gy(RBE) to the PTV and
 - A maximum dose of 6.6 Gy(RBE) may be given to < 0.03 cc of the PTV.

Please note that the relative stopping power of the dosimetry insert is **0.997**. If your planning system predicts a different relative stopping power for this region, you may wish to override the RSP or Hounsfield to correspond with the value provided above.



The yellow overlay depicts the location of the insert for this phantom. The imaging insert contains the anatomy while the separate polyethylene dosimetry insert contains the film and TLD.