Proton Prostate Phantom

Guidelines for ***Planning and Treating*** the Proton Prostate Phantom.
Revised October 2023

We require that each institution keeps the phantom for **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 CTV (prostate) and critical normal structures (bladder and rectum). The dosimetric insert contains TLD at 2 locations and perpendicular sheets of film to evaluate the dose to the center of the prostate. There are 2 more TLD to evaluate the dose to each femoral head.

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 to be submitted when returning the phantom:

- Original hard copy isodose distribution in coronal and sagittal planes through target center.
- A completed **Proton Prostate Phantom Institution Information** form.
- A copy of results of all film and ion chamber QA measurements.
- Treatment plan report or summary.
- Screen shots showing the contour of the TLD.
- Digital treatment planning data in the DICOM format which include all CT slices with 3D composite Dose, RTStructure and RTPlan. **Please compress the file before upload to avoid the file corrupt during the process.**
- A folder has been created with your institution name on OneDrive and it will be shared with you via email. Please upload the files to the shared folder.

DOSE PRESCRIPTION:

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

- Prostate CTV.
  - Total dose of 6 Gy(RBE) to at least 98% of the PTV and
  - A maximum dose of 6.4 Gy(RBE) may be given to < 2% of the PTV. This maximum dose volume must not be shared by critical normal structures.
- Critical Normal Structures (bladder, rectum and femoral head):
  - No part of these normal organs shall receive more than 6.7 Gy(RBE)
  - Constraints over the normal structure are specified in the following table:

Normal Organs	No more than 15% volume receives dose that exceeds	No more than 25% volume receives dose that exceeds	No more than 35% volume receives dose that exceeds	No more than 50% volume receives dose that exceeds
Bladder	6.7 Gy(RBE)	6.3 Gy(RBE)	6.0 Gy(RBE)	5.7 Gy(RBE)
Rectum	6.3 Gy(RBE)	6.0 Gy(RBE)	5.7 Gy(RBE)	5.0 Gy(RBE)

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:

Prostate Phantom
Dosimetric insert
Imaging insert
Rubber hose
Two acrylic cylinders containing TLD in one of the ends, labeled "dosimetric cylinders"
Envelope with background film (hidden from your view; please don't try to find it)

Procedures:

1. Fill the phantom with water:
   - **1.1.** Thread the rubber hose into one of the filler holes placed on the base of the phantom.
   - **1.2.** Fill slowly with water (the rubber hose stretches over most faucets). You may need to jiggle the phantom to release air trapped inside the cavity.
   - **1.3.** Remove hose and replace acrylic screws.
2. Allow the phantom to sit with water in it for 20 min. to check for leaks**.**
3. Fill the imaging insert with water:
   - **3.1.** Remove both plugs from the top of the insert.
   - **3.2.** Thread the rubber hose into one of the filler holes.
   - **3.3.** Fill slowly with water (the rubber hose stretches over most faucets). You may need to jiggle the head to release air trapped between the different structures.
   - **3.4.** Remove hose and replace plugs.
5. Look in the insert space and check for water leakage. If you find any water call our office at 713-745-8989. If not, proceed to the next step.
6. Position the imaging insert. The side without plugs and holes should be inserted. Align the two red lines. This places the rectum posterior to the prostate. 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.
7. Position the "dosimetric cylinders" in each one of the holes in the femoral heads following the color code.
8. Position and CT the phantom as you would a patient. You may wish to scan with 1.5 mm slices especially near the center to better identify the edges of each organ. Remove the imaging insert.
9. Drain the water from the insert. Place the insert in the box.
10. Look in the insert space and check for water leakage. If you find any water call our office at 713-745-8989. If not, proceed to the next step.
11. Position the dosimetry insert. The side without a handle should be inserted. Align the two red lines. As in step 6 be sure that the insert is in its correct position.
12. Position and CT the phantom as you did with the imaging insert.
13. Fuse the two CT images.
14. Segment the phantom images contouring the skin, prostate, bladder, rectum, acrylic, and target TLD.
15. To record dose to the target TLD, please use the dose volume information from the contours.
16. **Please see Treatment Planning Addendum for further instruction.**
17. Perform your customary QA of the proton plan prior to irradiating the phantom. Include in the form values and all the information you consider are relevant for it analysis**.**
18. Treat the phantom with the developed plan as you would a protocol patient.
19. Remove the dosimetric insert and place it in the box.
20. Remove the acrylic legs from holes in the femoral head and place them in the box.
21. Please verify that there is no water in the insert space. If you find any water call our office at 713-745-8989.
22. Remove the screw on the base of the phantom and drain the water in the phantom.
23. Put the empty phantom in the box.
24. Make sure that the rubber hose and the plastic screws are in the box.
25. Include the dosimetry data discussed above. Complete the attached forms. Be sure to include the scale used on the images coming from your TPS.
26. **Return the complete package to our office.**

Proton Prostate Phantom Institution Information

Institution: _____

Address: _____

_____

Person performing irradiation: _____

Physicist 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 # _____

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, isodose distribution of coronal and sagittal planes through the target center. Include scaling factors for each plane.

Treatment Planning System:

Manufacturer: _____ Model: _____

Software:_____Algorithm:_____ 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 system

Point	Dose (cGy(RBE))
Center of the prostate	
TLD position on femoral head (Left)*	
TLD position on femoral head (Right)*	

* Dose to the center of the TLD position on the femoral head, on the axial plane through the center of the prostate.

Results of QA:_____

_____

Did you change the MU based on your QA? ☐No ☐Yes _____

Comments: _____

_____

_____

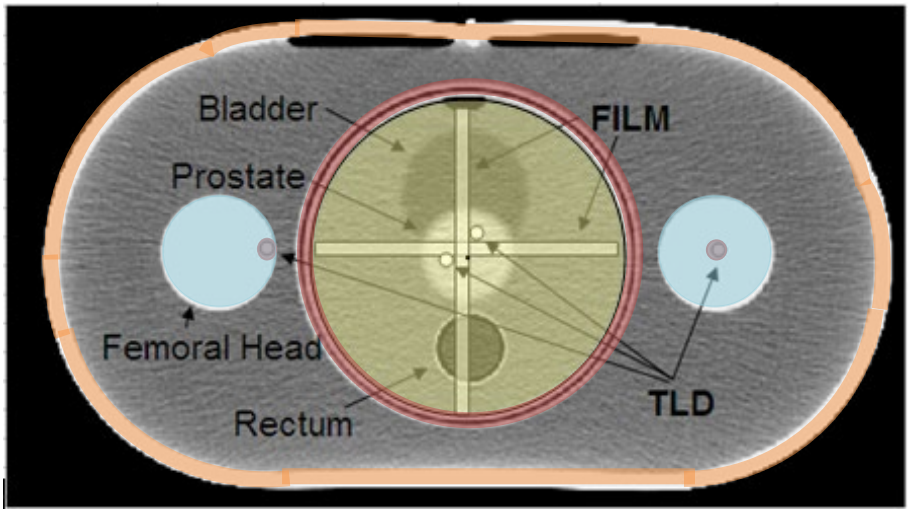
For Office Use Only	TLD Batch	Film Batch	Phantom ID #	Code	Date Sent	Date Rec'd
CFL	B20	EBT3	P-			

Proton Treatment Planning Addendum

The CT scan of the imaging insert will be used to contour the prostate, bladder, and rectum. The CT scan of the dosimetry insert will be used to calculate the dose for the plan. The dosimetry insert may need to be overridden to the correct relative stopping power value. If you deem this necessary, please contour the entire insert highlighted in yellow (see overlay below) and change the relative stopping power to **1.02**.

The above below lists the measured relative stopping powers of each material within the pelvis phantom. You may need to override the PVC shell and PBT bone as well if your planning system predicts a stopping power different from that listed in the chart.

Material	Mass Density (g/cm^3)	Relative Stopping Power
PVC - Shell	1.38	1.25
PBT - Bone	1.31	1.21
HI Polystyrene - Dosimetry Insert	1.04	1.02
Acrylic – femoral head TLD rods and hollow cylinder surrounding insert	1.18	1.21



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

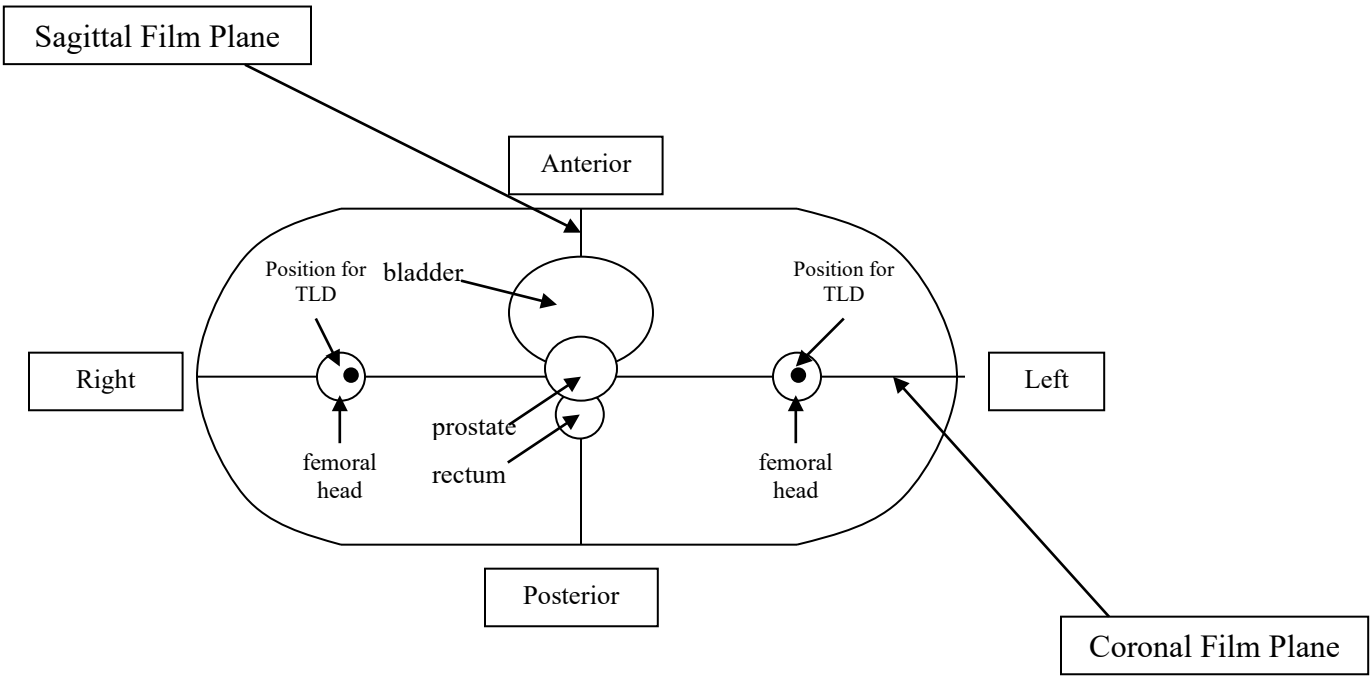
Proton Treatment Planning Addendum (cont.)

After the RSP overrides have been applied, please create a plan using the following guidelines: The total dose to the phantom is 6 Gy(RBE), with the following constraints:

- Prostate CTV.
  - Total dose of 6 Gy(RBE) to at least 98% of the PTV and
  - A maximum dose of 6.4 Gy(RBE) may be given to < 2% of the PTV. This maximum dose volume must not be shared by critical normal structures.
- Critical Normal Structures (bladder, rectum and femoral head):
  - No part of these normal organs shall receive more than 6.7 Gy(RBE)
  - Constraints over the normal structure are specified in the following table

Normal Organs	No more than 15% volume receives dose that exceeds	No more than 25% volume receives dose that exceeds	No more than 35% volume receives dose that exceeds	No more than 50% volume receives dose that exceeds
Bladder	6.7 Gy(RBE)	6.3 Gy(RBE)	6.0 Gy(RBE)	5.7 Gy(RBE)
Rectum	6.3 Gy(RBE)	6.0 Gy(RBE)	5.7 Gy(RBE)	5.0 Gy(RBE)

This is a cross sectional view of the phantom with the imaging insert in place.



Notes:

- **You need to deliver 6 Gy(RBE) to the CTV (in 1 or more fractions).**
- **Please ignore all markings on the external shell of the phantom, use your own system to position the phantom**