DOS 771

Planning Assignment – Rectum

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Prescription: 4500 cGy in 25 fractions of 180 cGy.

Organ at risk	**Desired Objective**	**Achieved objective**
Bladder	V40Gy < 40% V45Gy < 15% Max dose < 50Gy	9.7% 2.2% Max 46.9Gy
Bowel	V35Gy < 180cc V40Gy < 100cc V45Gy < 65cc Max dose < 50Gy	0.7cc 0.3cc 0.0cc Max 44.0Gy
Right Femur (proximal[1])	V40Gy < 40% V45Gy < 25% Max dose < 50Gy	9.1% 4.5% Max 47.4Gy
Left Femur (proximal[1])	V40Gy < 40% V45Gy < 25% Max dose < 50Gy	8.9% 4.3% Max 47.3%

A) With a single posterior/anterior (PA) 6 MV beam, the 95% of prescription isodose line (green, Figure 1) fully encompasses the PTV contour, while the 100% isodose line (yellow) mostly covers the CTV. On the slice shown in Figure 1, the 100% line appears to fully cover the CTV, there are areas above and below that are not fully covered. The isodose lines appear as successive bow or fan shaped distal shapes, with relatively straight and flat sides.

B) When the beam is changed to 23 MV, the spacing of the isodose lines increases (Figure 2). The highest curve shown in the 6 MV plan (150%) is not present in the 23 MV dose

distribution. The 50% isodose line now reaches all the way to the patient's abdominal surface.

C) When the PA beam is set back to 6 MV and opposed lateral fields are added, the nested wave pattern can be seen in the isodose lines near the entrance points of the lateral beams (Figure 3). There is a distinct lean to the curves, with the more anterior parts of the beam exhibiting a lean towards the medial plane. The region where all three beams overlap is outlined by the 90% isodose line. The 100% and 105% isodose lines are V-shaped, inside the 90% box, with the points going in the posterior direction.

D) With the two lateral beams set to 23 MV and the PA beam still at 6 MV, the isodose lines in the beam path towards the overlap region are more spread out, with the highest values disappearing (Figure 4). The 100% and 105% isodose lines still have an angular appearance, but the angle is more obtuse.

E) When the PA beam is changed to 23 MV to match the laterals, the shape of the 100% line does not change appreciably, but the area encompassed by the 105% line shrinks to the point where it breaks into two pieces residing the posterior corners of the overlap box (Figure 5).

F) The lateral beams can be wedged such that the dose gradient across their combined profile complements the dose falloff with depth exhibited in the PA beam. To do this, the heel of each wedge must be placed facing posteriorly, and the narrow edge therefore faces anteriorly (Figure 6, visible at lateral beam entrance points). The effect of the wedging is the make the dose distribution within the overlap box more uniform. In this case, the 105% isodose lines are no longer visible after 15 degree wedges are applied to the lateral beams.

G) The linear accelerator was commissioned with 15, 30, 45, and 60 degree wedge options. The uniformity is best with 30 degree wedges, while 45 degree wedges cause the 105% isodose line to reappear in the anterior corners, and 60 degree wedges show even more 105% across the anterior edge of the box.

H) Wedges set at 30 degrees provided the best uniformity within the overlap box. Adjusting the weight of the beams to the left and right allowed the slightly hotter isodose line in the right hip to disappear, but this caused the femoral heads to be slightly imbalanced, so they were set back to equal weighting (Figure 7). Reducing the weight of the PA beam

increased the femoral head doses, and increasing it reduced the femoral head dose while dumping dose into the bladder and bowel. In discussion with a dosimetrist (Teresa Kent, Oral communication, May 6, 2015), the relative merits of sparing femoral heads versus minimizing bladded and bowel dose were discussed. The conclusion with regard to adjusting weighting was that there is no single "right answer" if all of the structures are below their tolerance doses. The relative importance of an organ may be more a important consideration than the proximity to tolerance dose. After trying lightly and heavily weighted PA beams, the distribution was set back to being equal with the lateral beams.

I) Three planes of the final plan can be found in Figure 7, 8, 9, and 10.

Four-field Pelvis

Adding a fourth anterior/posterior (AP) field that opposes the PA beam removes the necessity of having wedges on the lateral beams. The result of the fourth field is high uniformity within the overlap box (Figure 11), although depending on the weighting, this approach can deliver much higher doses to the bladder and bowel as the AP beam passes through them towards the rectum. This approach would be very useful near the upper portions of the sacrum, where the angle of the bone increases the path length through dense tissue, reducing coverage distal to the bone. An opposing beam can fill out the low dose region. A disadvantage, as already mentioned, is the bladder and bowel get more dose.

References

1. Gay HA, Barthold HJ, O'Meara E et al. Female pelvis normal tissue RTOG consensus contouring guidelines. Radiation Therapy Oncology Group Website. http://www.rtog.org/LinkClick.aspx?fileticket=P5eAjYB90Ow%3d&tabid=355. Updated 1/3/2012. Accessed 5/6/2015.

Figures

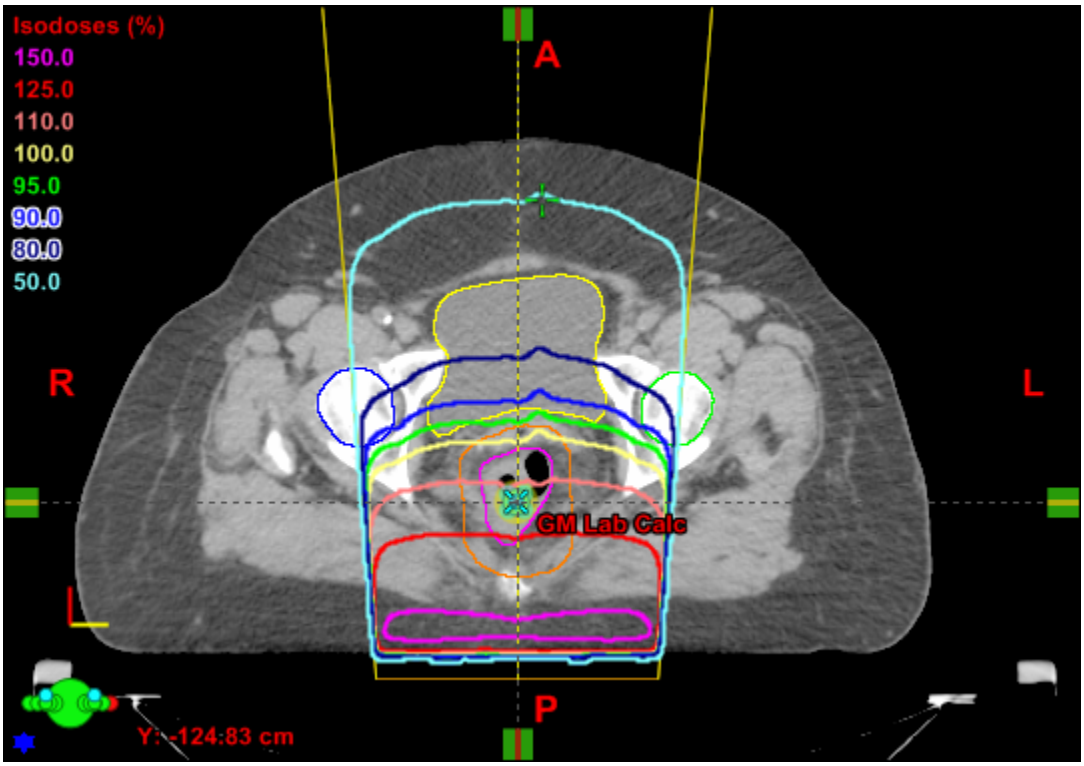

Figure 1. A single 6 MV PA beam

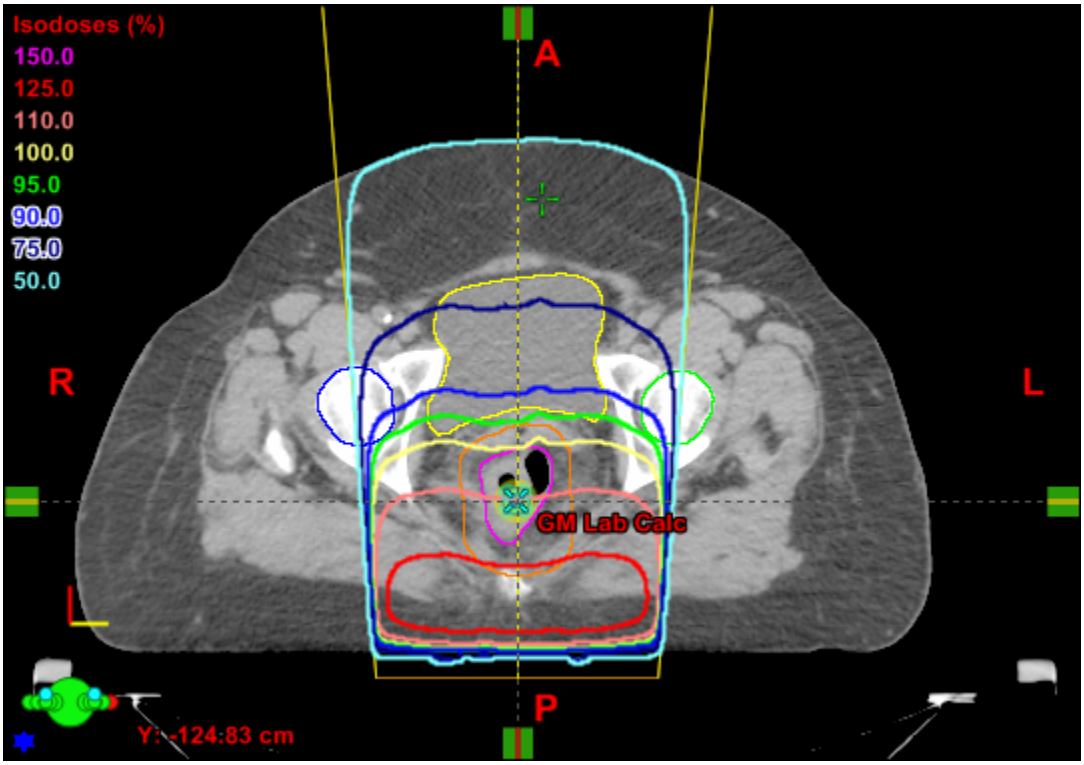

Figure 2. A single 23 MV PA beam

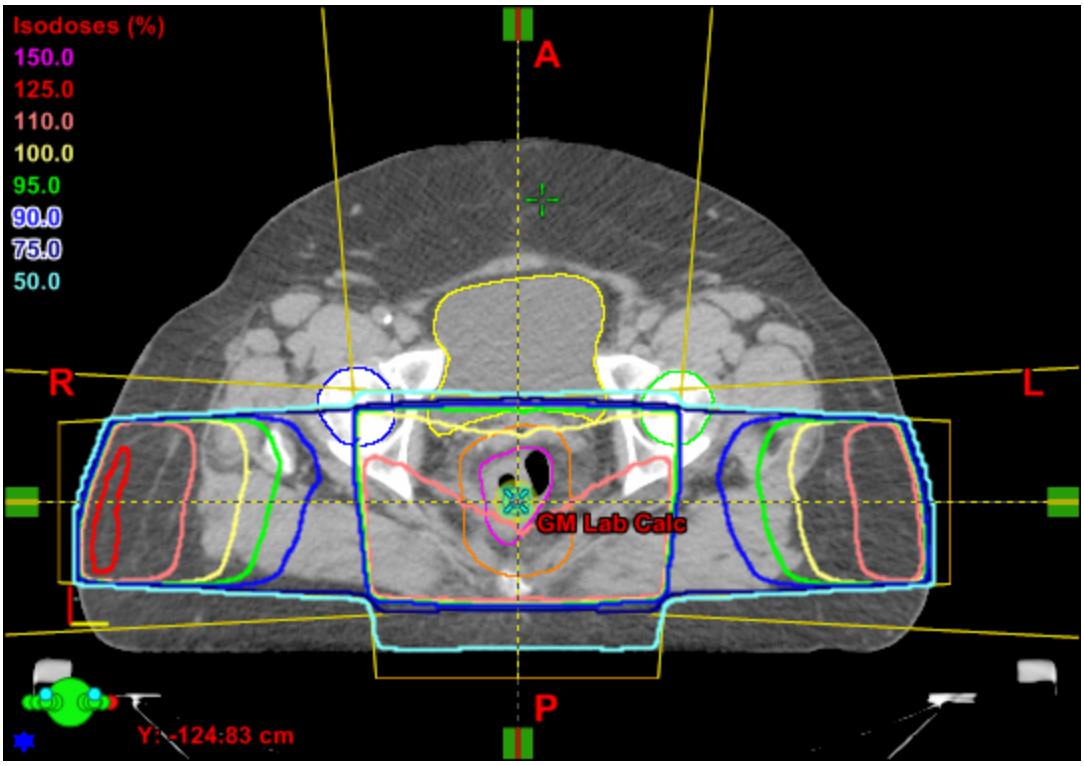

Figure 3. Equally weighted 6 MV 3-field plan.

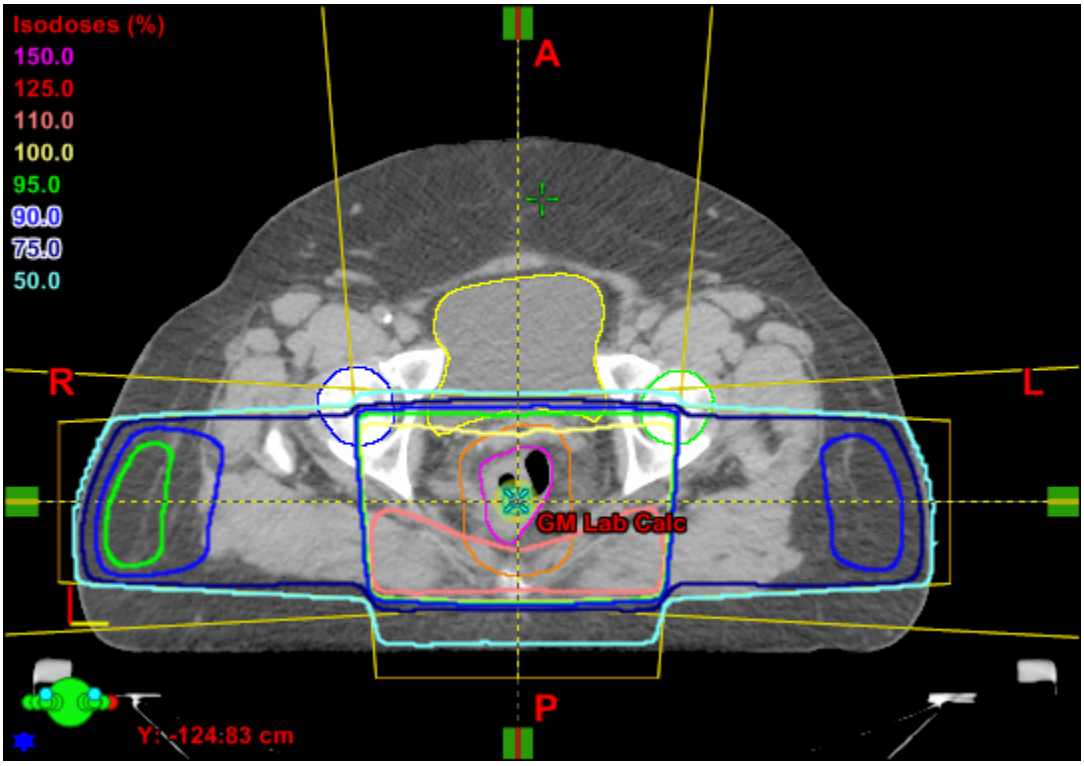

Figure 4. Equally weighted 6 MV PA and 23 MV lateral beams.

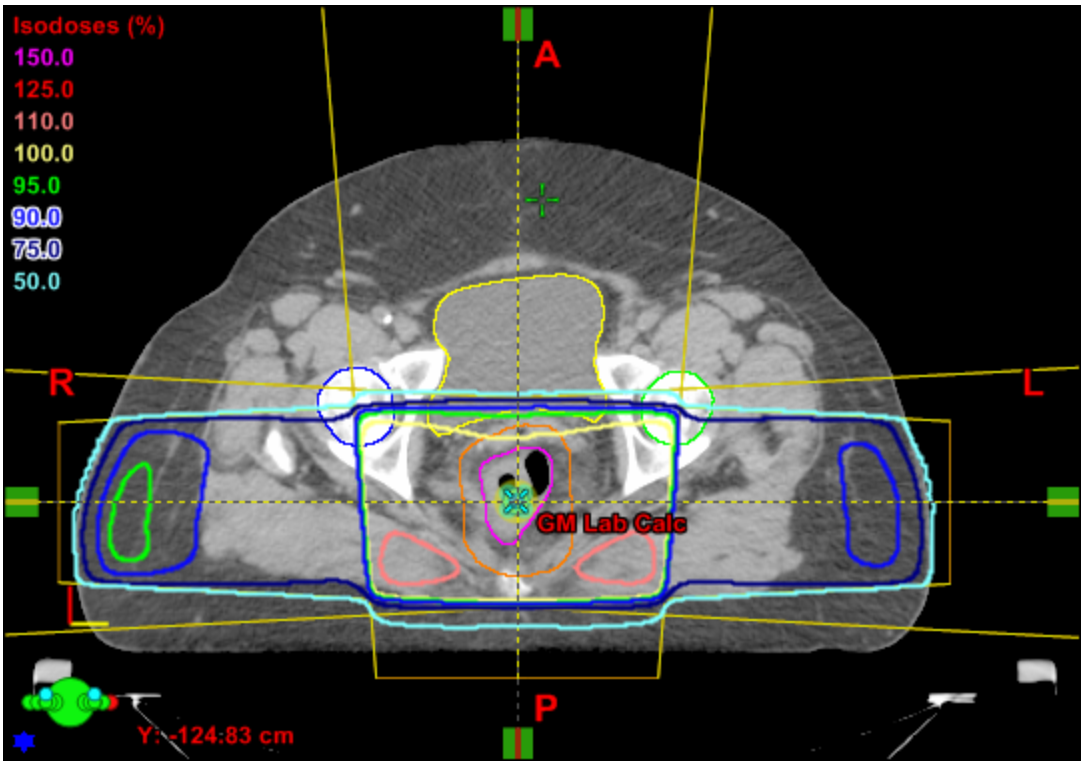

Figure 5. Equally weighted 23 MV beams.

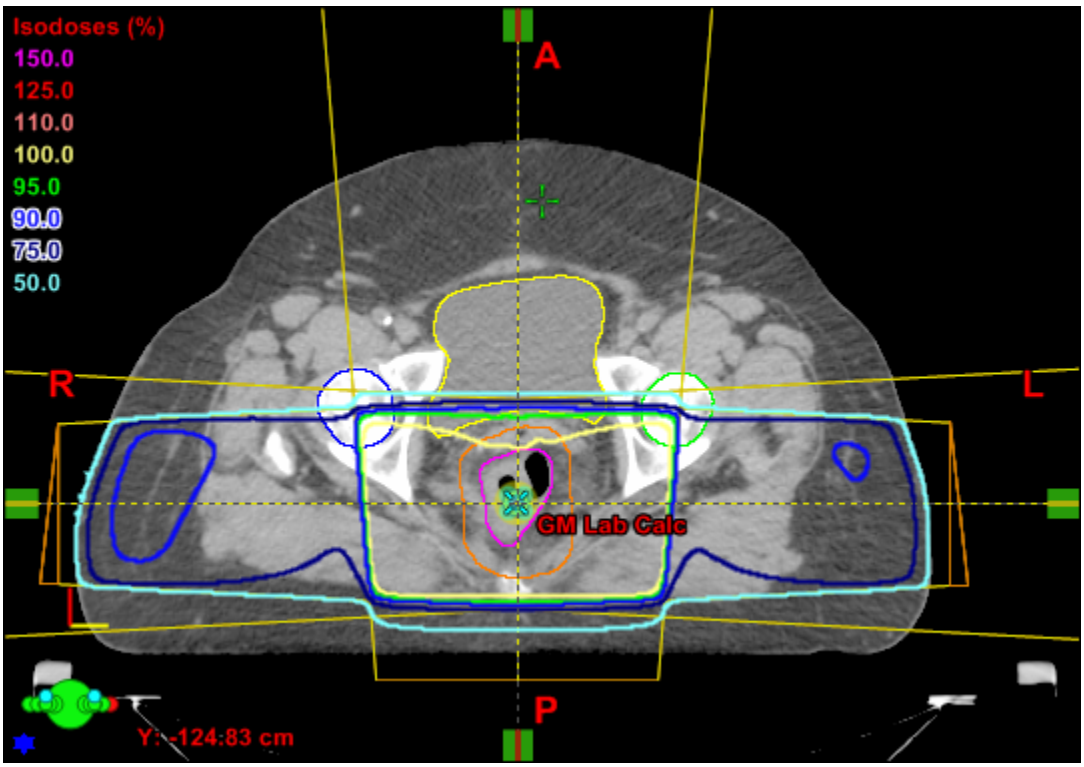

Figure 6. Equally weighted 23 MV beams with 15 degree wedges on lateral beams.

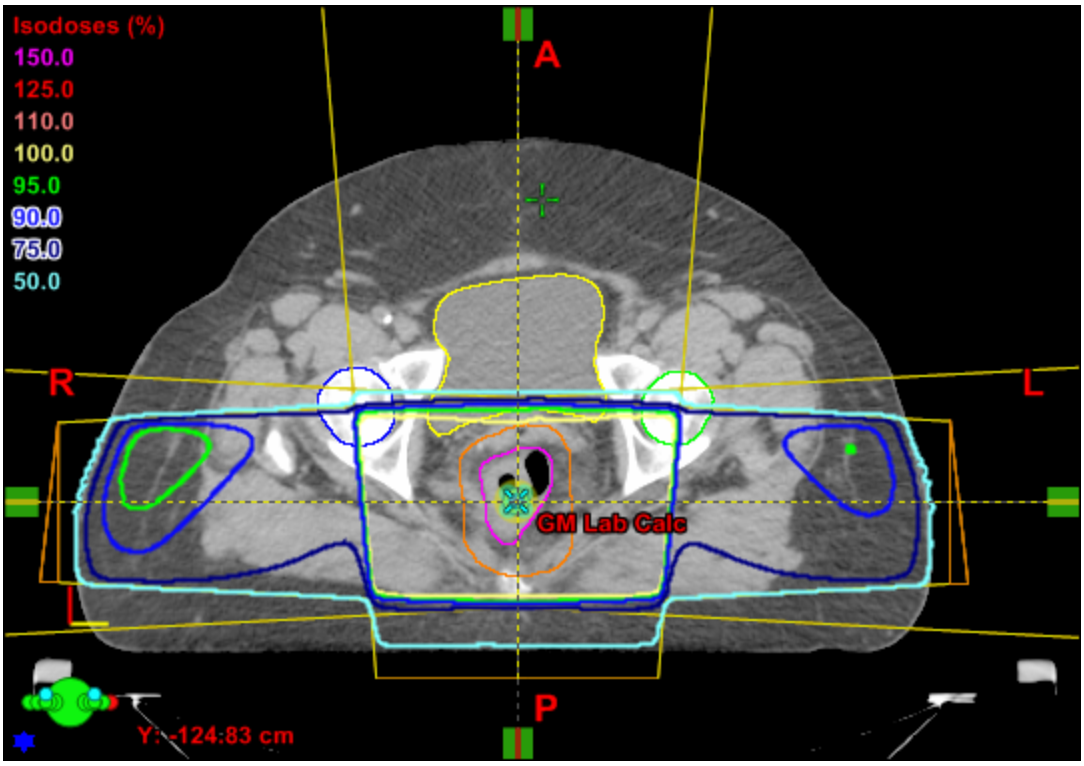

Figure 7. Final plan axial view.

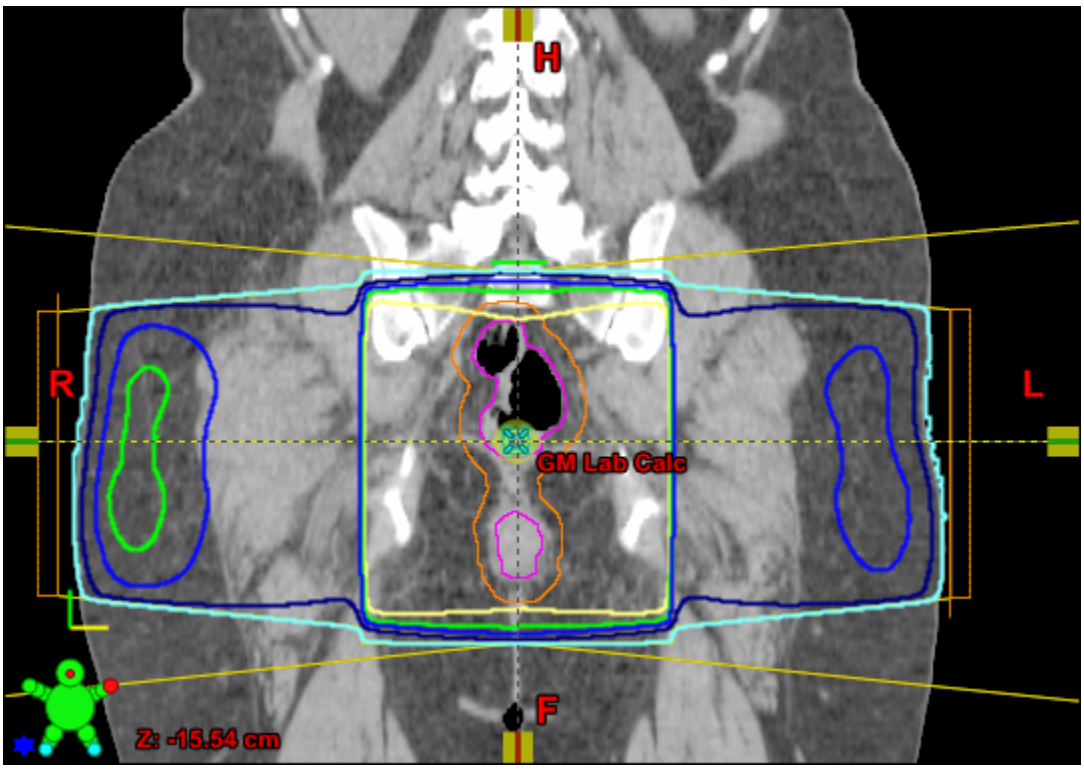

Figure 8. Final plan coronal view.

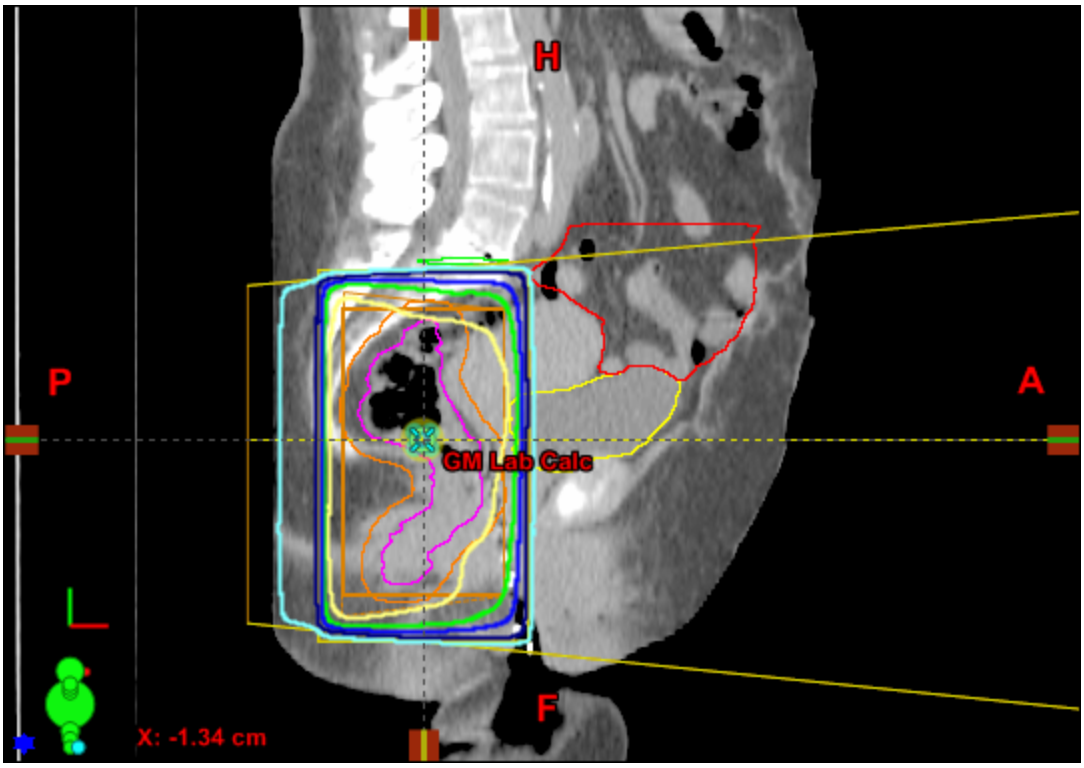

Figure 9. Final plan sagittal view.

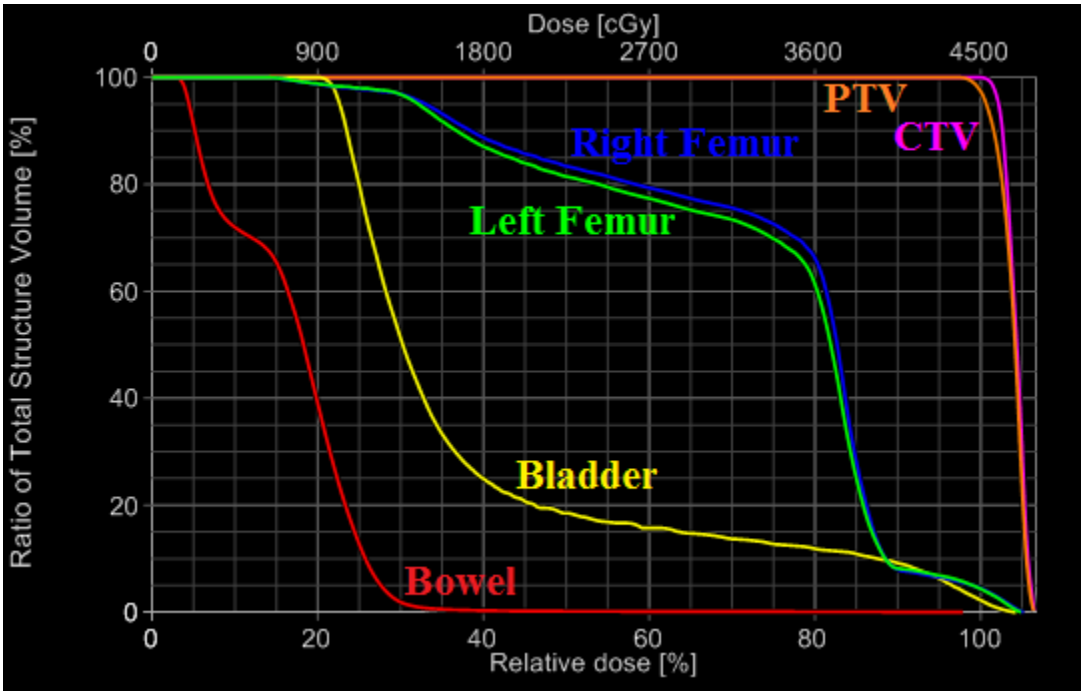

Figure 10. Final plan DVH.

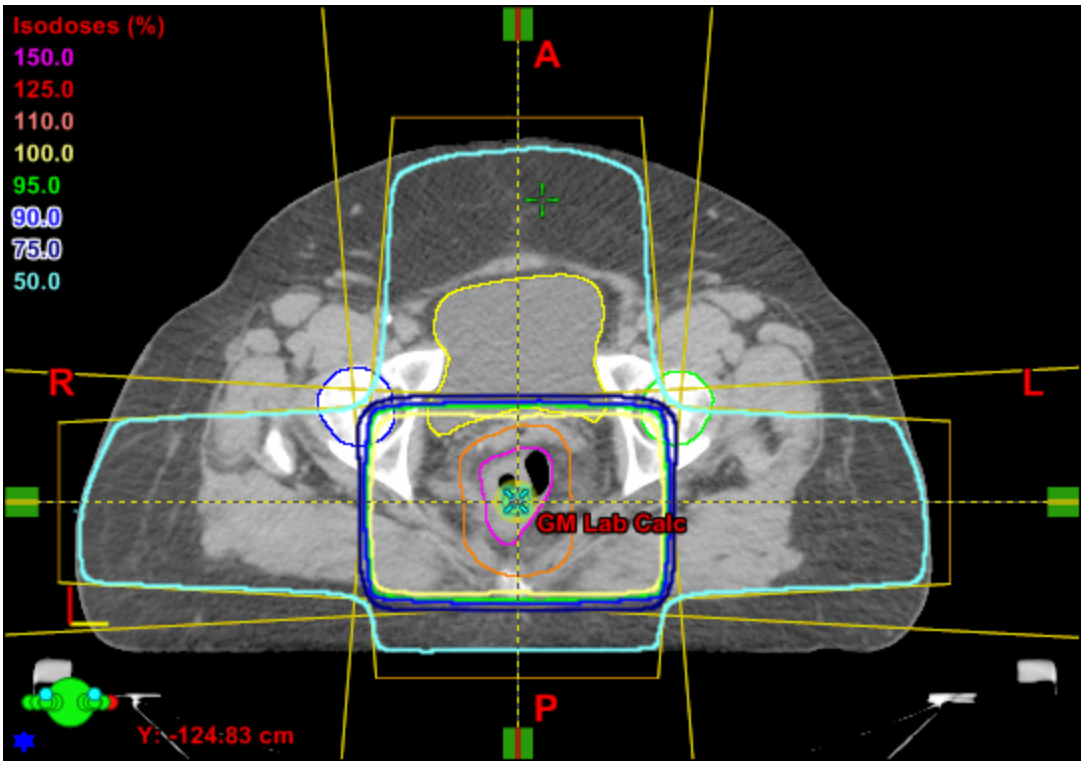

Figure 11. Equally weighted 4 field box.