# Planning Assignment (Lung)

Target organ(s) or tissue being treated: **Right lung**
Prescription:

| Total Dose (Gy) | Number of Fractions | Dose per Fraction (Gy) |
|---|---|---|
| 30 | 10 | 3 |

Organs at risk (OR) in the treatment area (list organs and desired objectives in the table below):

| Organ at risk | Desired objective(s) | Achieved objective(s) |
|---|---|---|
| Spinal Cord | Max Dose < 45 Gy | Max Dose = 26.6 Gy |
| Heart | $V_{40\ Gy}$ < 60%<br>$V_{45\ Gy}$ < 40%<br>$V_{60\ Gy}$ < 20%<br>$D_{mean}$ < 30 Gy | $V_{40\ Gy}$ = 0%<br>$V_{45\ Gy}$ = 0%<br>$V_{60\ Gy}$ = 0%<br>$D_{mean}$ = 5.5 Gy |
| Esophagus | $V_{60\ Gy}$ < 20%<br>$V_{50\ Gy}$ < 30%<br>$D_{mean}$ < 30 Gy | $V_{60\ Gy}$ = 0%<br>$V_{50\ Gy}$ = 0%<br>$D_{mean}$ = 15.32 Gy |
| Lungs-PTV | $V_{5\ Gy}$ < 60%<br>$V_{20\ Gy}$ < 30%<br>$D_{mean}$ < 30 Gy | $V_{5\ Gy}$ = 0%<br>$V_{20\ Gy}$ = 0%<br>$D_{mean}$ = 4.58 Gy |

Contour all critical structures on the dataset. Place the isocenter in the center of the PTV (make sure it isn't in air). Create a single AP field using the lowest photon energy in your clinic. Create a block on the AP beam with a 1.5 cm margin around the PTV. From there, apply the following changes (one at a time) to see how the changes affect the plan (copy and paste plans or create separate trials for each change so you can look at all of them).

**Plan 1:** Create a beam directly opposed to the original beam (PA) (assign 50/50 weighting to each beam)

a. What does the dose distribution look like?

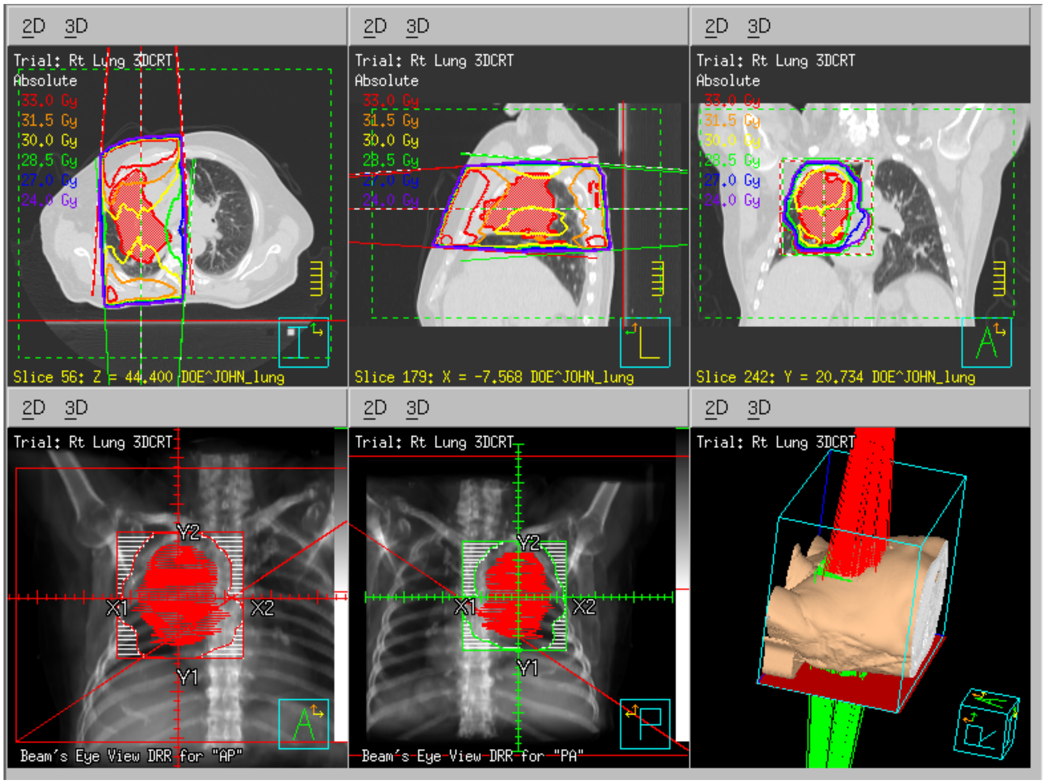
   **The dose distribution is rectangular with an hourglass shape for the higher dose lines that bow inward slightly. The areas of higher dose are anterior and posterior in the patient with the anterior having a larger high dose area than the posterior.**

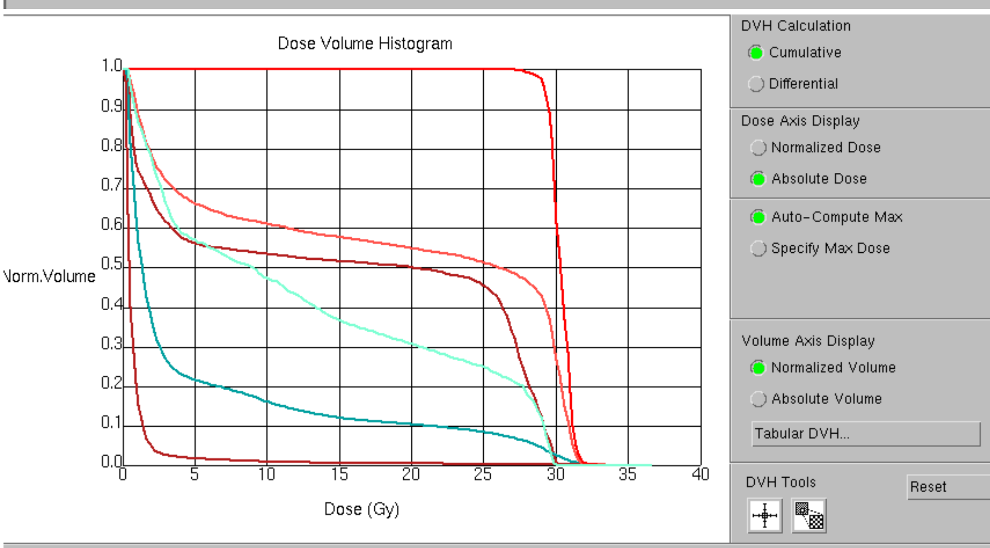
b. Is the PTV covered entirely by the 95% isodose line?

   **Not entirely. 98.4% of the PTV is covered by the 95% isodose line.**

c. Where is the region of maximum dose ("hot spot")? What is it?

   **The region of maximum dose is on the anterior of the patient with the "hot spot" to the right of the inferior portion of the body of the sternum. The "hot spot" is 36.7 Gy.**




**ROI Statistics**

Compute

| Line Type | ROI | Trial or Record | Min. | Max. | Mean | Std. Dev. | % Outside Grid | % > Max | Generalized EUD |
|---|---|---|---|---|---|---|---|---|---|
| | Esophagus | Rt Lung 3DCRT | 0.413 | 30.333 | 15.013 | 12.790 | 0.00 % | 0.00 % | -- |
| | Heart | Rt Lung 3DCRT | 0.210 | 33.554 | 5.045 | 8.412 | 0.00 % | 0.00 % | -- |
| | Lung_L | Rt Lung 3DCRT | 0.027 | 32.417 | 0.848 | 1.959 | 0.00 % | 0.00 % | -- |
| | Lung_R | Rt Lung 3DCRT | 0.303 | 33.553 | 17.964 | 13.057 | 0.00 % | 0.00 % | -- |
| | PTV | Rt Lung 3DCRT | 26.409 | 32.898 | 30.303 | 0.721 | 0.00 % | 0.00 % | -- |
| | SpinalCord | Rt Lung 3DCRT | 0.439 | 30.165 | 12.315 | 11.053 | 0.00 % | 0.00 % | -- |

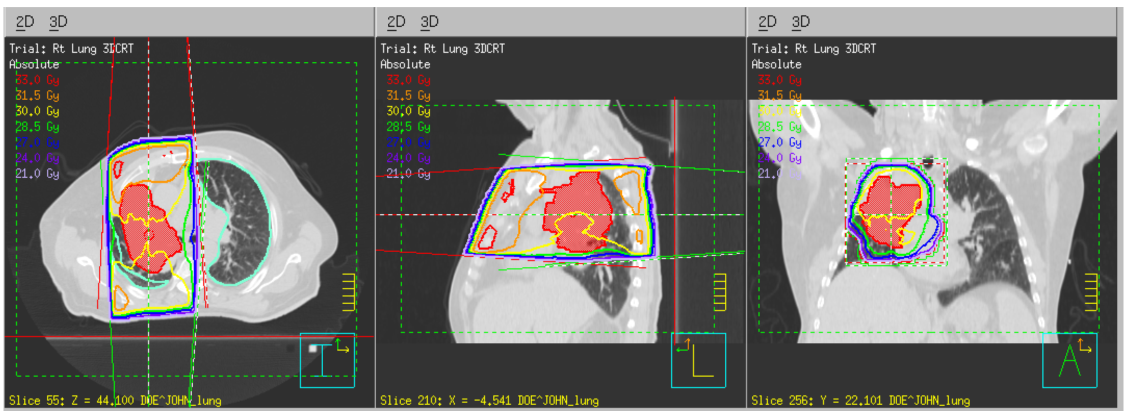
**Plan 2:** Increase the beam energy for each field to the highest photon energy available.

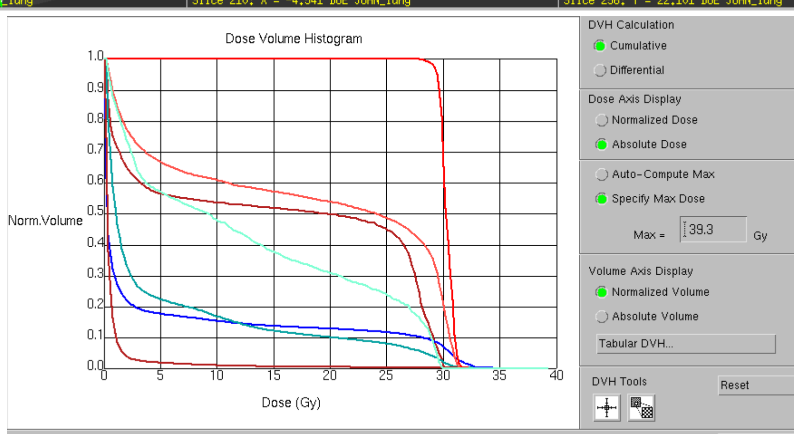
a. What happened to the isodose lines when you increased the beam energy?

**The shapes of the 10MV beam energy isodose lines are very similar to those of the 6MV beam energy isodose lines. One distinct difference is that there is no longer a region of 110% near the posterior of the patient and the 110% region near the anterior of the patient is noticeably smaller.**

d. Where is the region of maximum dose ("hot spot")? Is it near the surface of the patient? Why?

**The "hot spot" is in relatively the same area as the 6MV beam energy, but it is now just slightly further from the exterior of the patient. By increasing the beam energy from 6MV to 10MV, the "hot spot" went from 36.7 Gy to 34.5 Gy. I think the "hot spot" is near the anterior surface because the isocenter is more posterior in the patient as opposed to midline.**




**ROI Statistics** Compute

| Line Type | ROI | Trial or Record | Min. | Max. | Mean | Std. Dev. | % Outside Grid | % > Max | Generalized EUD |
|---|---|---|---|---|---|---|---|---|---|
| | Esophagus | Rt Lung 3DCRT | 0.262 | 30.277 | 14.961 | 12.887 | 0.00 % | 0.00 % | -- |
| | External | Rt Lung 3DCRT | -- | 34.429 | 4.413 | 9.595 | 6.33 % | 0.00 % | -- |
| | Heart | Rt Lung 3DCRT | 0.135 | 32.631 | 4.911 | 8.374 | 0.00 % | 0.00 % | -- |
| | Lung_L | Rt Lung 3DCRT | 0.017 | 31.681 | 0.686 | 1.958 | 0.00 % | 0.00 % | -- |
| | Lung_R | Rt Lung 3DCRT | 0.195 | 32.207 | 17.484 | 12.806 | 0.00 % | 0.00 % | -- |
| | PTV | Rt Lung 3DCRT | 27.130 | 32.226 | 30.288 | 0.584 | 0.00 % | 0.00 % | -- |
| | SpinalCord | Rt Lung 3DCRT | 0.305 | 30.002 | 12.207 | 11.016 | 0.00 % | 0.00 % | -- |

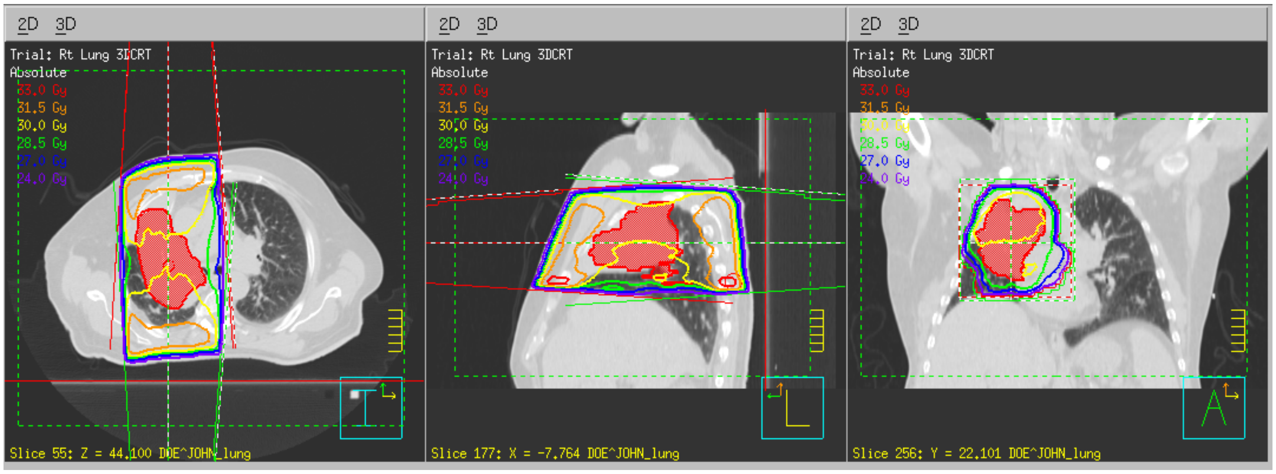
**Plan 3:** Adjust the weighting of the beams to try and decrease your "hot spot".

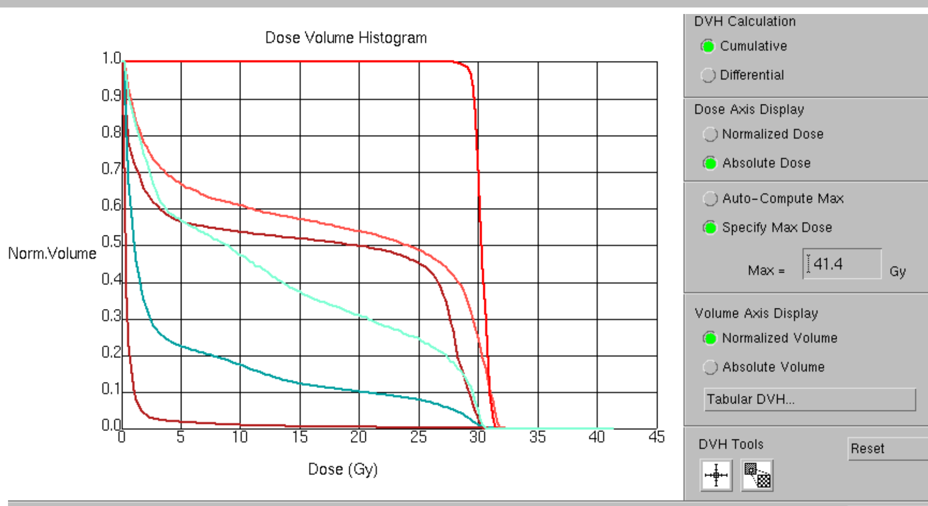
a. What ratio of beam weighting decreases the "hot spot" the most?

**I was able to decrease the "hot spot" from 34.5 Gy to 33.6 Gy by weighting the AP beam 46.7% and the PA beam 53.3%.**

b. How is the PTV coverage affected when you adjust the beam weights?

**PTV coverage increased ever so slightly. With equal beam weighting, 99.05% of the PTV was covered by the 95% isodose line. With AP/PA weighting of 46.7%/53.3%, 99.13% of the PTV is covered by the 95% isodose line.**




**ROI Statistics**

| Line Type | ROI | Trial or Record | Min. | Max. | Mean | Std. Dev. | % Outside Grid | % > Max | Generalized EUD |
|---|---|---|---|---|---|---|---|---|---|
| | Esophagus | Rt Lung 3DCRT | 0.263 | 30.411 | 15.017 | 12.947 | 0.00 % | 0.00 % | -- |
| | Heart | Rt Lung 3DCRT | 0.137 | 31.711 | 4.929 | 8.304 | 0.00 % | 0.00 % | -- |
| | Lung_L | Rt Lung 3DCRT | 0.017 | 30.794 | 0.686 | 1.943 | 0.00 % | 0.00 % | -- |
| | Lung_R | Rt Lung 3DCRT | 0.191 | 32.266 | 17.583 | 12.916 | 0.00 % | 0.00 % | -- |
| | PTV | Rt Lung 3DCRT | 27.177 | 31.699 | 30.277 | 0.540 | 0.00 % | 0.00 % | -- |
| | SpinalCord | Rt Lung 3DCRT | 0.297 | 30.650 | 12.270 | 11.219 | 0.00 % | 0.00 % | -- |

**Plan 4:** Using the highest photon energy available, add in a 3rd beam to the plan (maybe a lateral or oblique) and assign it a weight of 20%

a. When you add the third beam, try to avoid the cord (if it is being treated with the other 2 beams). How can you do that?

i. Adjust the gantry angle?

**By adding a right posterior oblique (RPO) beam at an angle of 295° I was able to avoid the cord which was in the field of the PA beam.**

ii. Tighter blocked margin along the cord

**I started with a uniform margin of 1.5 cm around my PTV, but there was just a small amount of spinal cord in the RPO field. I edited my block to just cover the spinal cord which dropped my max dose to the cord from 25.7 Gy to 24.9 Gy.**

iii. Decrease the jaw along side of the cord

**By moving the jaw in to block the spinal cord part of my PTV was also blocked. Although the max dose to my cord decreased from 25.7 Gy to 24.8 Gy, PTV coverage of the 95% isodose decreased from 98.54% covered to 95.88% covered.**

b. Alter the weights of the fields and see how the isodose lines change in response to the weighting.

**I achieved better coverage (98.27% was covered by the 95% isodose line) by weighting the AP 38.9%, the PA 44.87%, and the RPO 16.23%.**

c. Would wedges help even out the dose distribution? If you think so, try inserting one for at least one beam and watch how the isodose lines change.

**The patient has sloping anatomy in the areas that the beams enter the body so wedges helped my coverage. I tried many different combinations of wedges on all of the fields and found that using a 15° wedge on the AP beam and a 30° wedge on the RPO gave me the best coverage (98.82% was covered by the 95% isodose line).**

- Which treatment plan covers the target the best? What is the "hot spot" for that plan?

  **Although the coverage using 10 MV AP/PA weighted fields gave the best coverage with 99.05% of the PTV covered by the 95% isodose line the "hot spot" was 33.6 Gy (12%). Typically, "hot spots" should try to be kept under 10%. The coverage using 10 MV, 3 weighted fields with wedges was a good balance between coverage (the 95% isodose line was covering 98.82% of the PTV) and "hot spot" (9%).**

- Did you achieve the OR constraints as listed above? List them in the table above.

  **Yes, I was able to achieve all the desired objectives. I feel that some of the constraints would be more difficult to achieve if my prescription was going to a higher dose.**

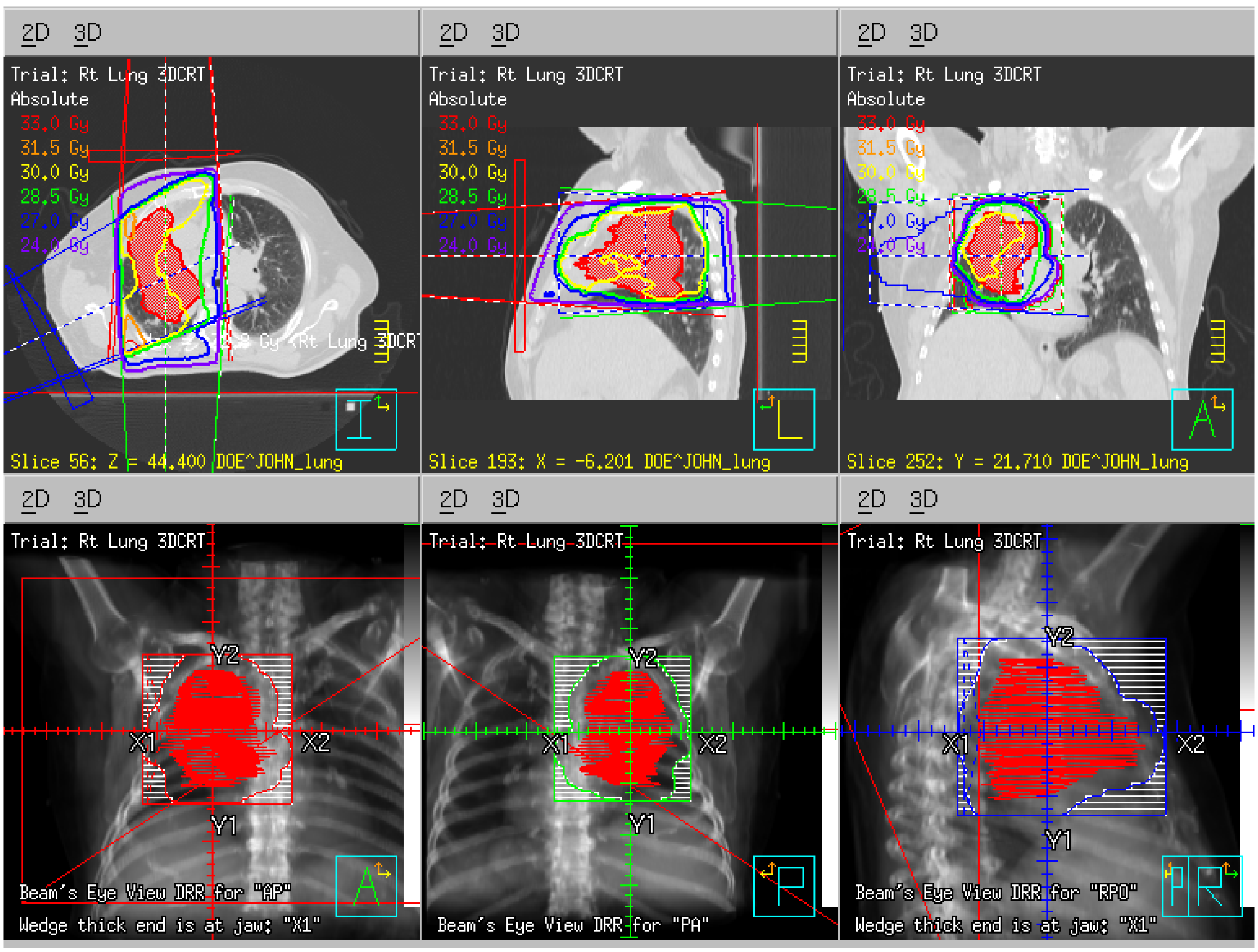
- What did you gain from this planning assignment?

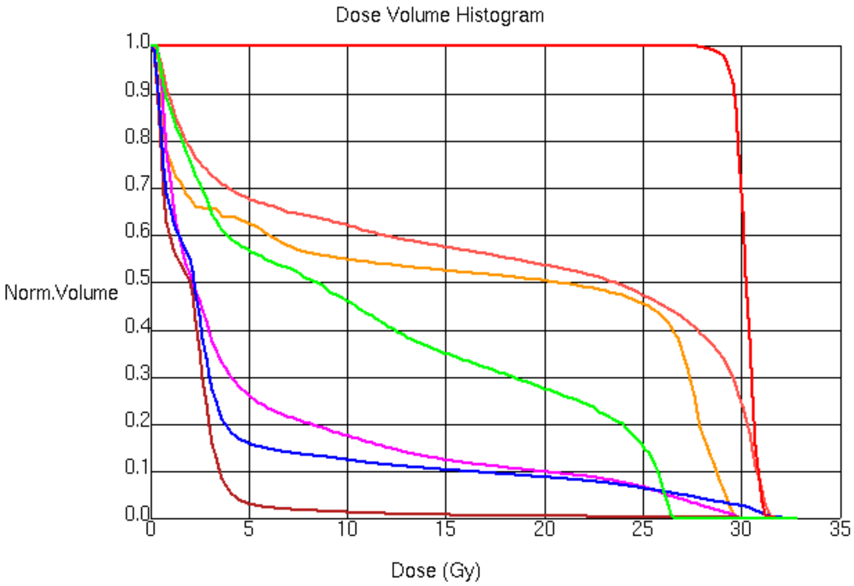
**I really enjoyed how this lab walked you through creating a plan and seeing how adding beams, changing angles, implementing wedges, and blocking can change the coverage and "hot spot". I feel that I gained an understanding of how these modifications can affect a plan and can implement what I learned as I go forward in planning.**

- What will you do differently next time?

  **The treatment volume was rather large for this lab. I'd be very interested to use the different modifications presented in this lab to plan for smaller treatment volumes that are either very posterior or very anterior in the patient. Next time, I might try adding an off cord boost to see how it compares to using a block with a tighter margin or decreasing the jaw along the cord. I would also play with normalization to see if I could further improve my coverage.**

3 Field using 10 MV and wedges






DVH Calculation

- Cumulative
- Differential

Dose Axis Display

- Normalized Dose
- Absolute Dose

- Auto-Compute Max
- Specify Max Dose

Volume Axis Display

- Normalized Volume
- Absolute Volume

Tabular DVH...

DVH Tools

Reset

**ROI Statistics**

Compute

| Line Type | ROI | Trial or Record | Min. | Max. | Mean | Std. Dev. | % Outside Grid | % > Max | Generalized EUD |
|---|---|---|---|---|---|---|---|---|---|
| | Esophagus | Rt Lung 3DCRT | 0.408 | 29.898 | 15.315 | 12.482 | 0.00 % | 0.00 % | -- |
| | Heart | Rt Lung 3DCRT | 0.325 | 29.951 | 5.481 | 7.721 | 0.00 % | 0.00 % | -- |
| | Lung_L | Rt Lung 3DCRT | 0.060 | 29.945 | 2.006 | 2.243 | 0.00 % | 0.00 % | -- |
| | Lung_R | Rt Lung 3DCRT | 0.231 | 32.076 | 17.581 | 12.656 | 0.00 % | 0.00 % | -- |
| | Lungs-PTV | Rt Lung 3DCRT | 0.060 | 32.160 | 4.581 | 7.581 | 0.00 % | 0.00 % | -- |
| | PTV | Rt Lung 3DCRT | 27.071 | 31.827 | 30.199 | 0.512 | 0.00 % | 0.00 % | -- |
| | SpinalCord | Rt Lung 3DCRT | 0.357 | 26.617 | 11.049 | 9.660 | 0.00 % | 0.00 % | -- |