MDS Instructor

VMAT Prostate Treatment Planning

This course will give an overview of the radiation planning process for a VMAT Prostate treatment. We will use VMAT treatment planning techniques and walk through some of the fundamentals of

- Simulation
- Contouring
- Beam Setup
- Treatment Planning
- Plan Evaluation

Simulation

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Simulation is a process that allows radiation treatment . elds to be delivered in a reproducible manner. The simulator is a large-bore computed tomography (CT) scanner. The CT images are used to delineate targets as well as organs at risk, which allows the dosimetrist or physician to arrange the radiation beams and make a customized plan. It is here that special care is taken to make the patient as comfortable as possible, to ensure treatment can be delivered in the same position each day.

- Imaging: CT simulation, ≤ 0.3cm thickness
- Position: Supine
- Immobilization: Vac-Lock or leg cushion that fixes the patients anatomy
- Scanning limits: At/above iliac crest to the perineum
- Other: Empty rectum, full bladder, urethrogram recommended

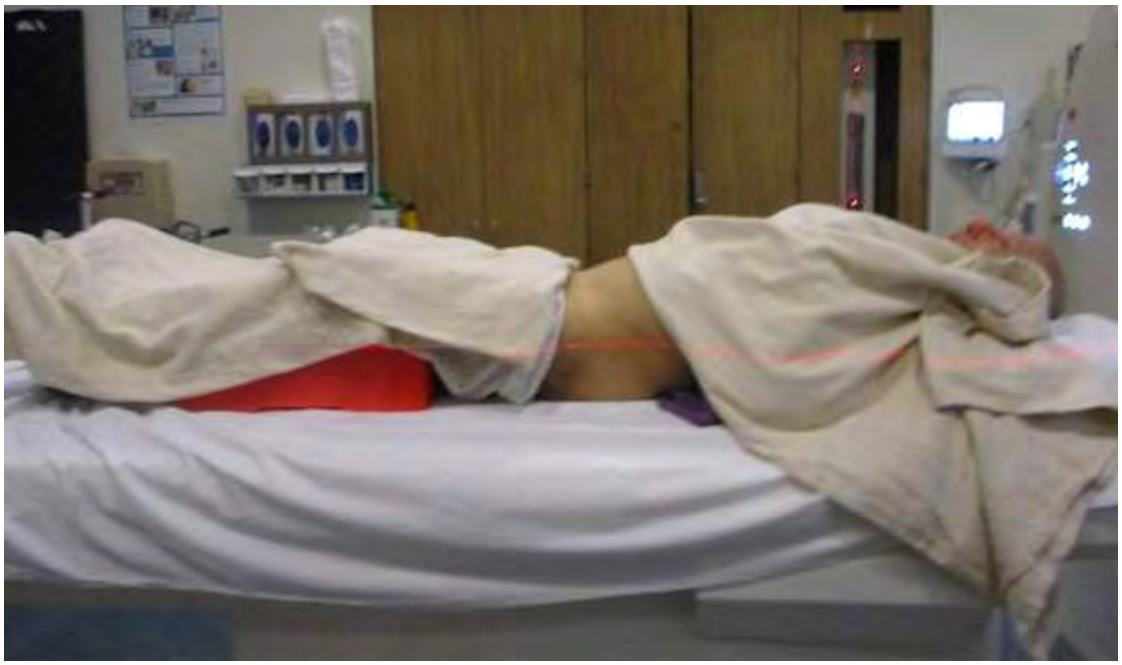
CT Simulation

Immobilization

Two commercially available pelvic immobilization devices.

(A) The Vac-Lok system, a patient-speci. c radio translucent cushion that fixes the patient's anatomy from the upper thighs to the feet.

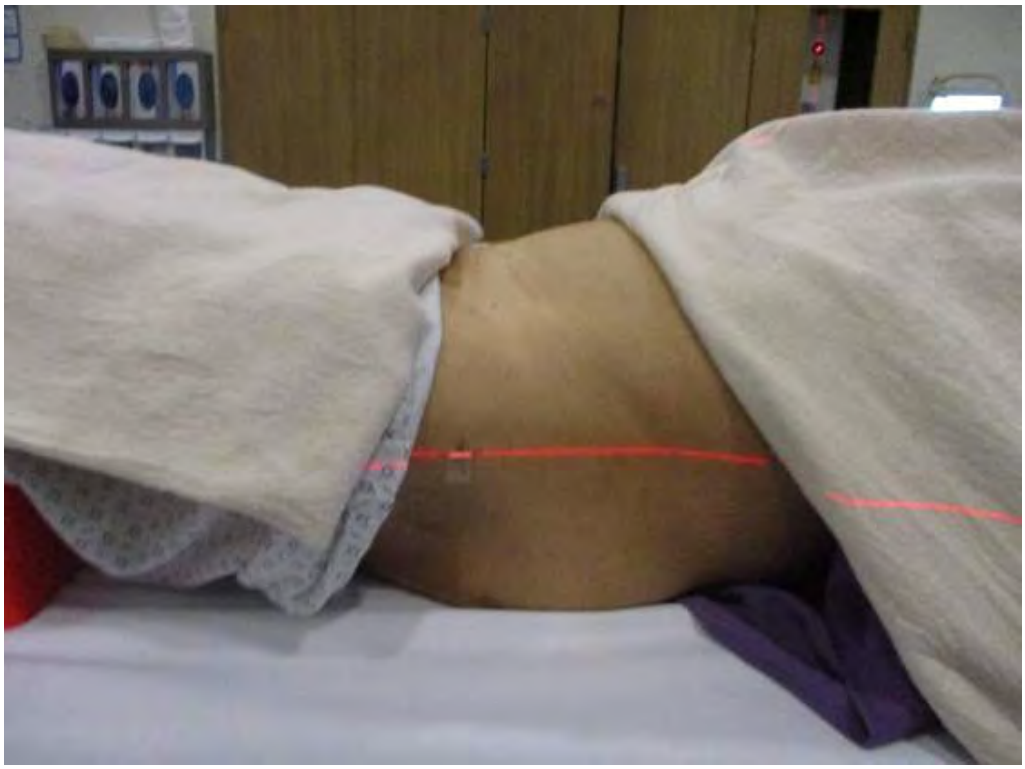
(B) The Dual Leg Positioner system, a non-patient-specific vinyl-covered foam immobilization device.



Simulation

Mask or Skin markings (tattoos)

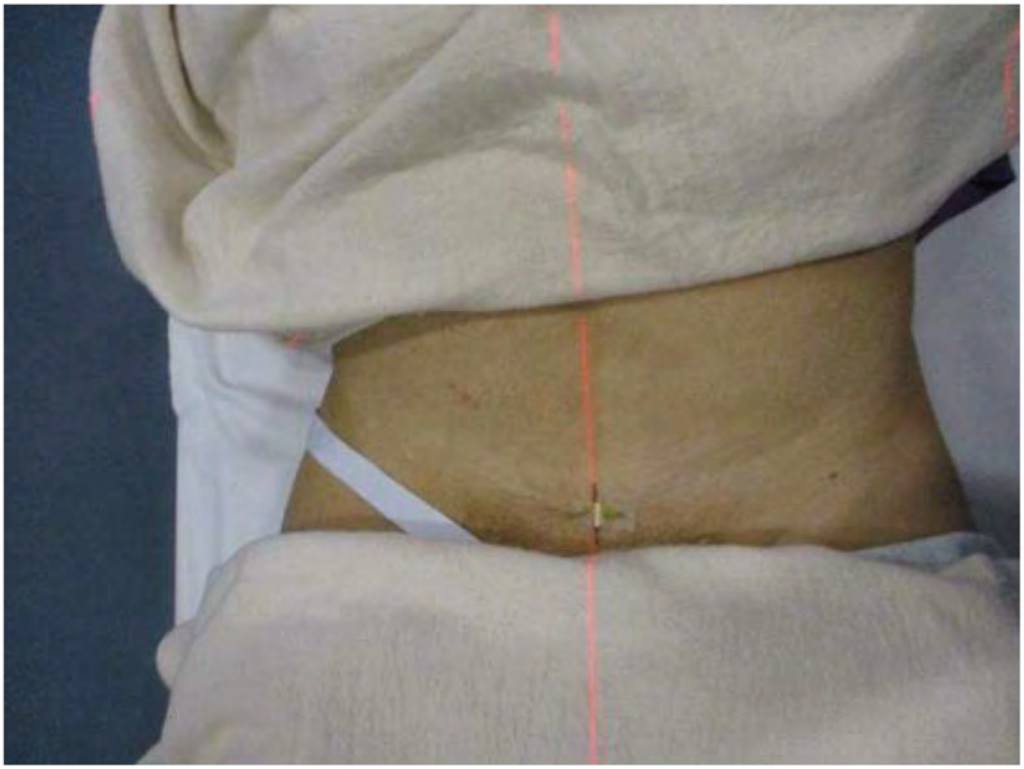
Pelvis tattoos are marked at depth of levelers. Right Lat, Left Lat and AP bbs are placed for patient localization.



Simulation

Mask or Skin markings (tattoos)

The isocenter or reference markers will be set to these landmarks.



Lesson 2 of 5

Contouring

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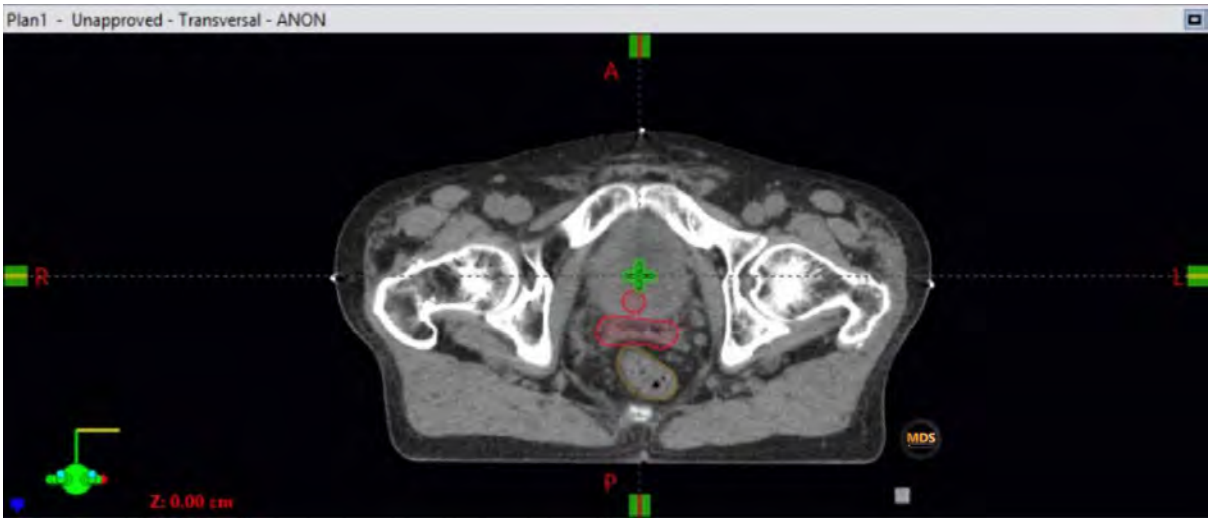
Import & Localization

Each patient starts with the Importing and Localization of the CT images into the treatment planning system.

Step 1

Importing and Localization



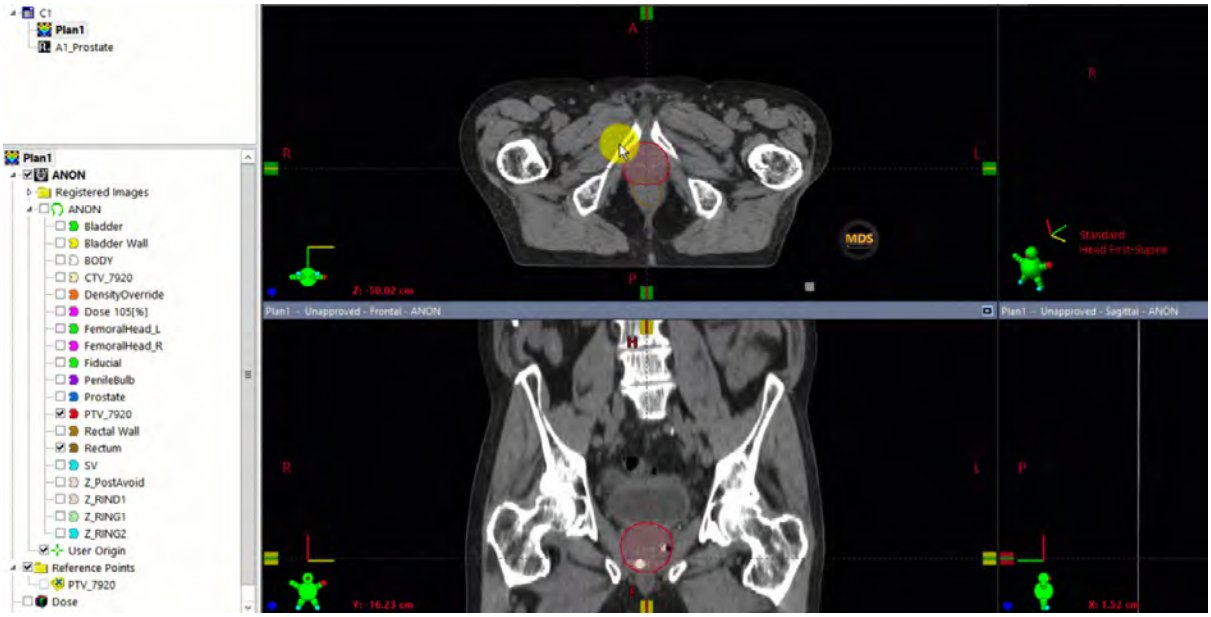
After a patient is simulated, the CT data set is imported into the Treatment Planning System. These images are in DICOM format and you may hear people referring to this folder as the DICOM import folder.

Once imported, the CT scan is used to localize the patient in a system of coordinates/markings is used to track the patient's geometric location in space.

At the time of sim, a patient is often marked to facilitate set up during treatment, BBs are often used to mark this setup location in a triangular fashion, generally 3 points (anterior and laterally). We will set the user origin or localization at this location.

Step 2

Set User Origin Eclipse (Localization)

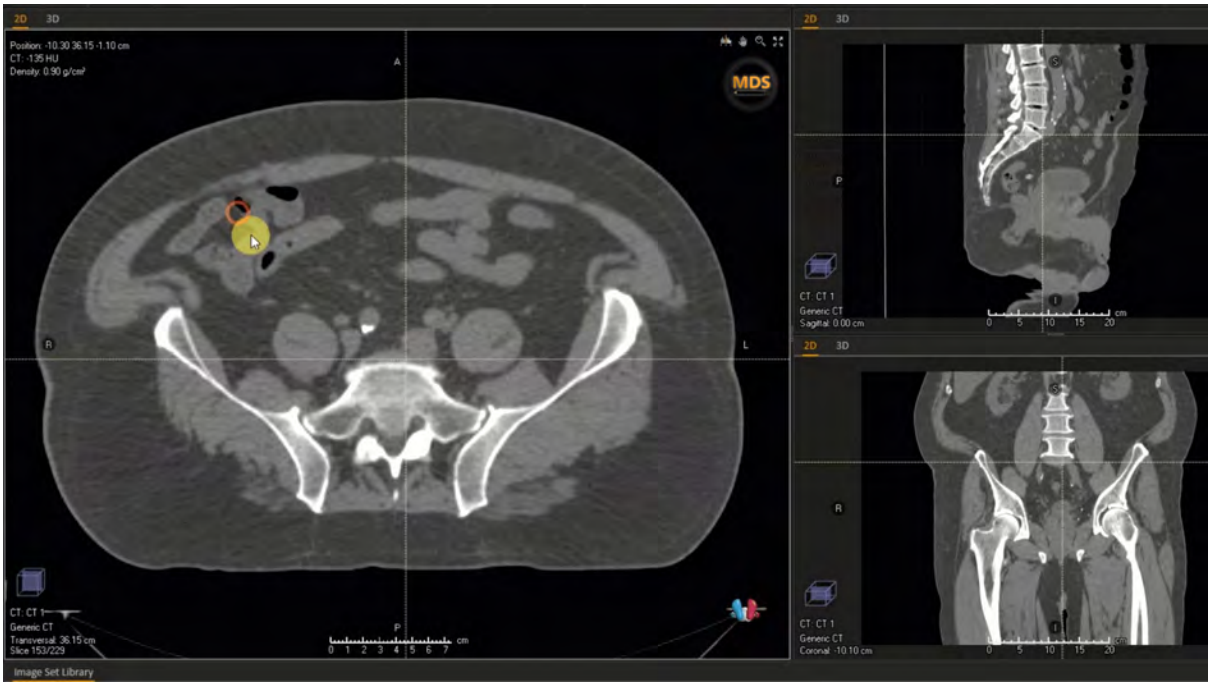


Next, we will set the user origin for the image. This will localize the coordinate systems to the TPS.

To Localize the patient, scroll to the slice of the bbs and set user origin to viewing plane intersection

Step 3

Set User Origin RayStation (Localization)

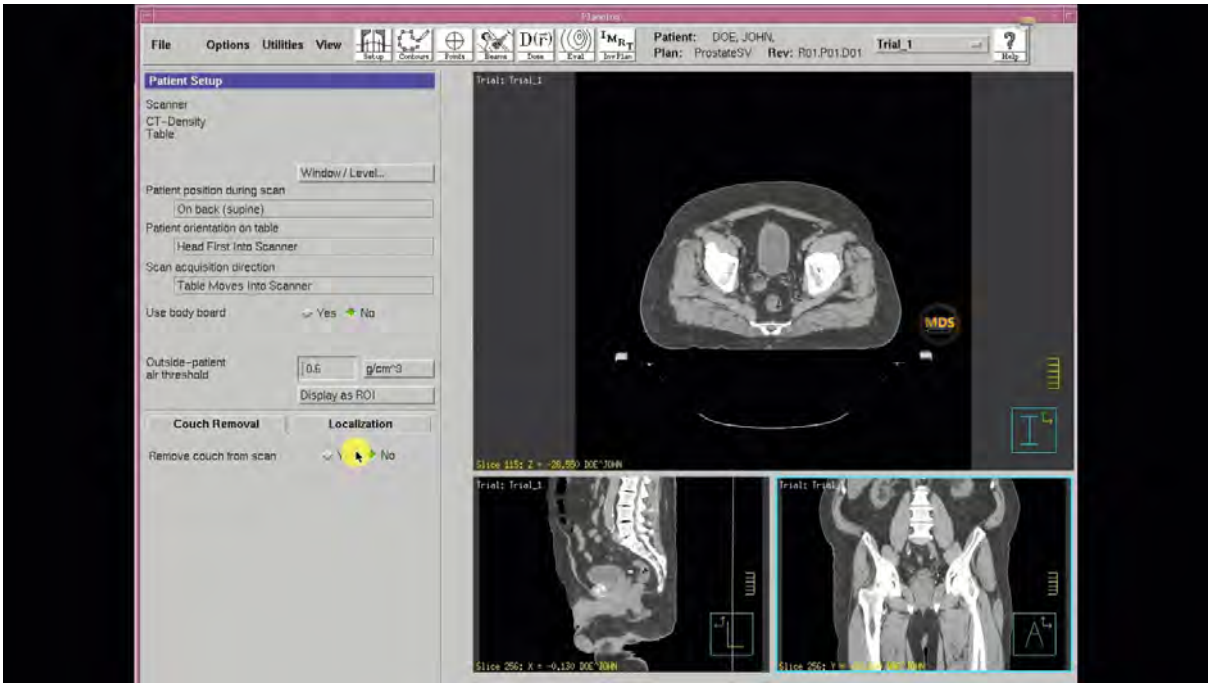


Set the Localization for the image. This will localize the coordinate systems to the TPS.

To Localize the patient, scroll to the slice of the bbs and set user origin to viewing plane intersection

Step 4

Set User Origin Pinnacle (Localization)



Set the Localization for the image. This will localize the coordinate systems to the TPS.

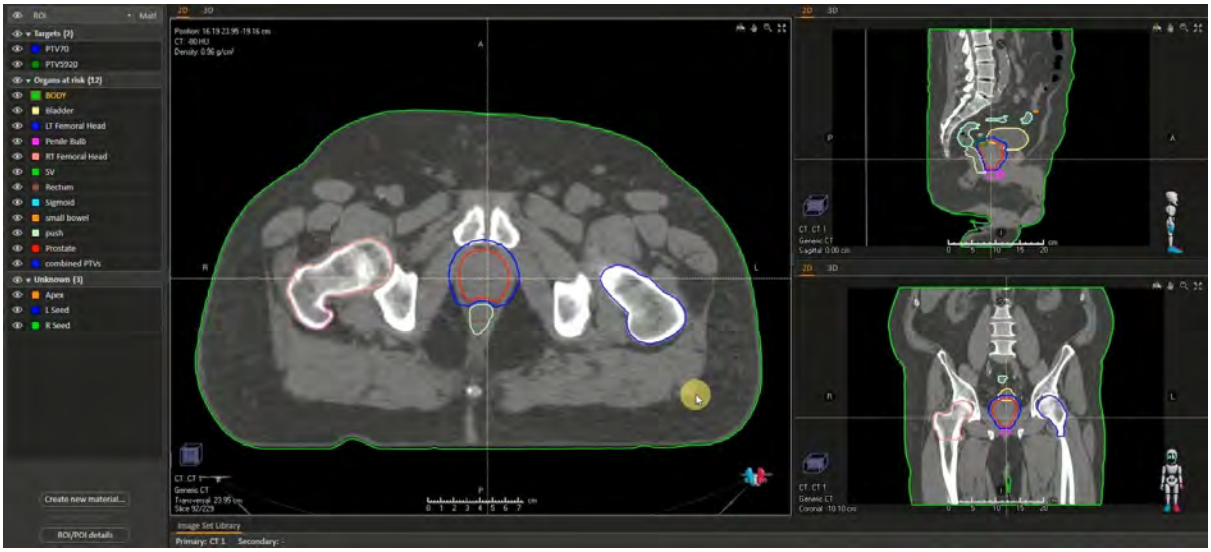
To Localize the patient, scroll to the slice of the bbs and set user origin to viewing plane intersection

Summary

You can use this work. ow for other treatment sites as well. (Brain, Thorax, Abdomen, Pelvis, and Extremities).

Just import the DICOM images, scroll to the setup marks and set the user origin to the triagulation location.

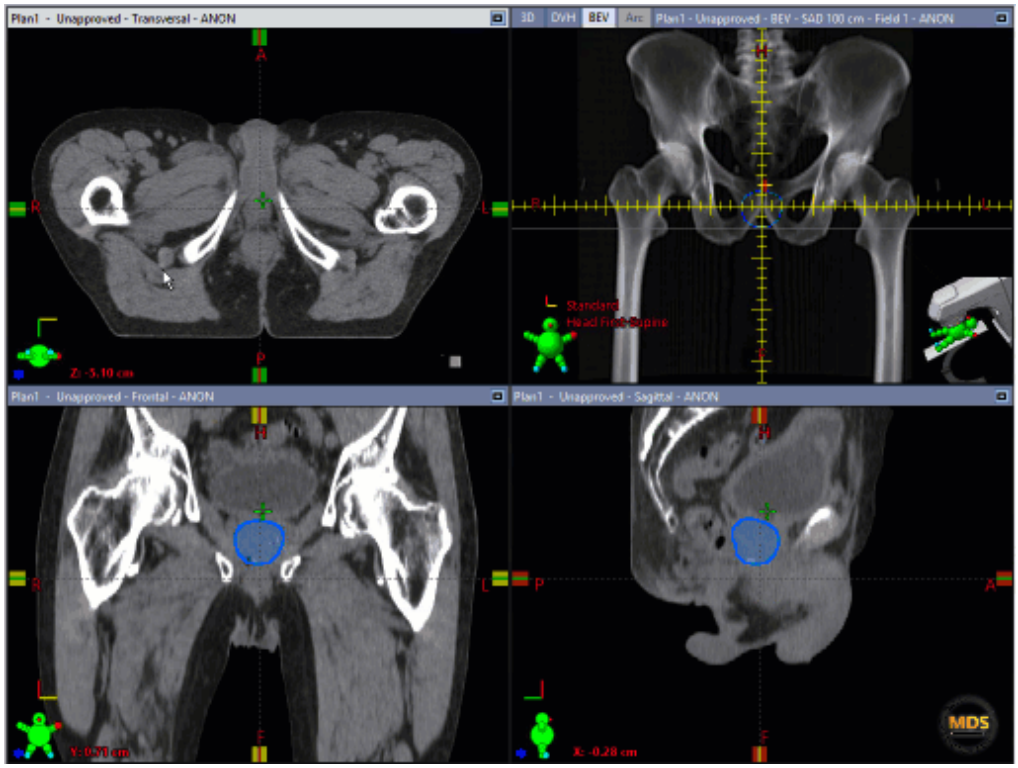
Contouring



Here we'll contour in the structures relevant to the Prostate treatment plan.

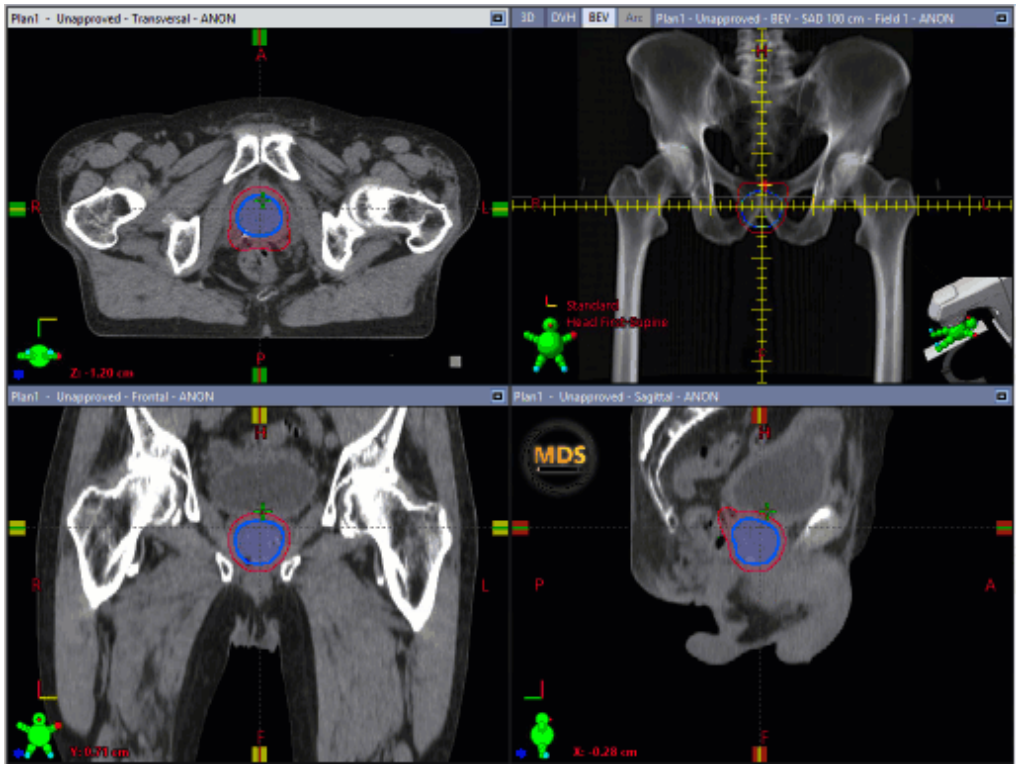
Step 1

Prostate



Step 2

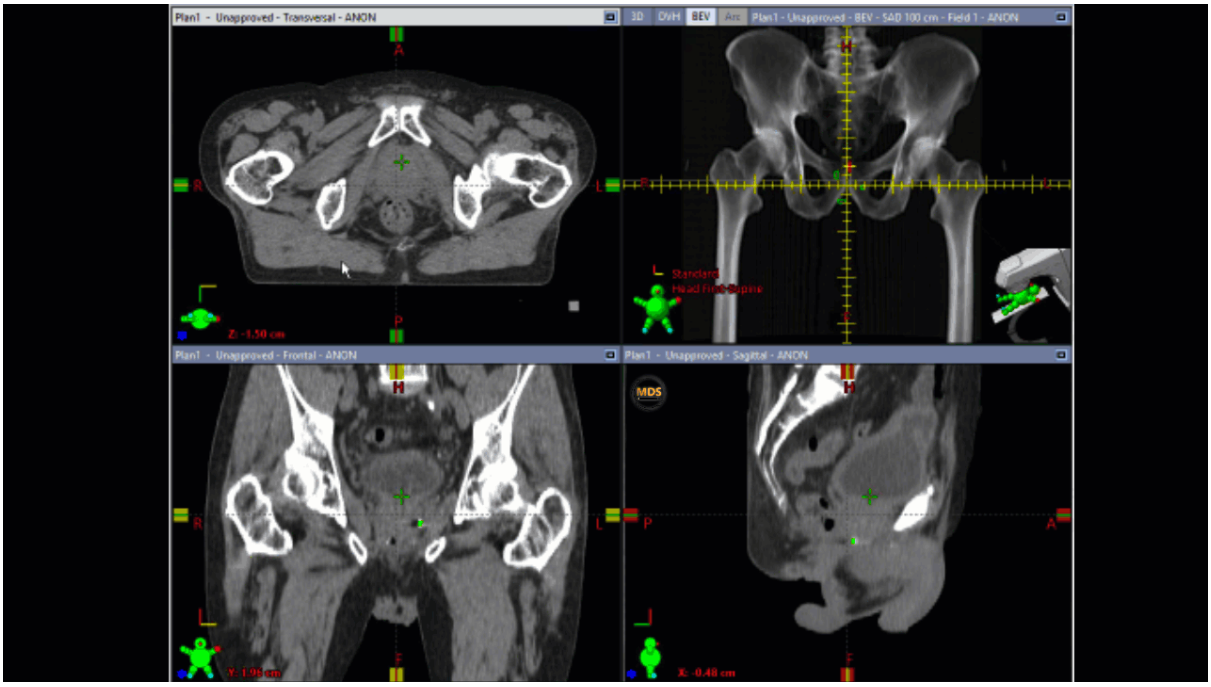
PTV



The PTV will have a margin to the Prostate, GTV or CTV. Sometimes 5mm margin is adequate, but in some cases physicians will expand non-uniformly. Such as 7mm sup, ant, left, right but 4mm post and Inf. Check with the physician for expansion margins.

Step 3

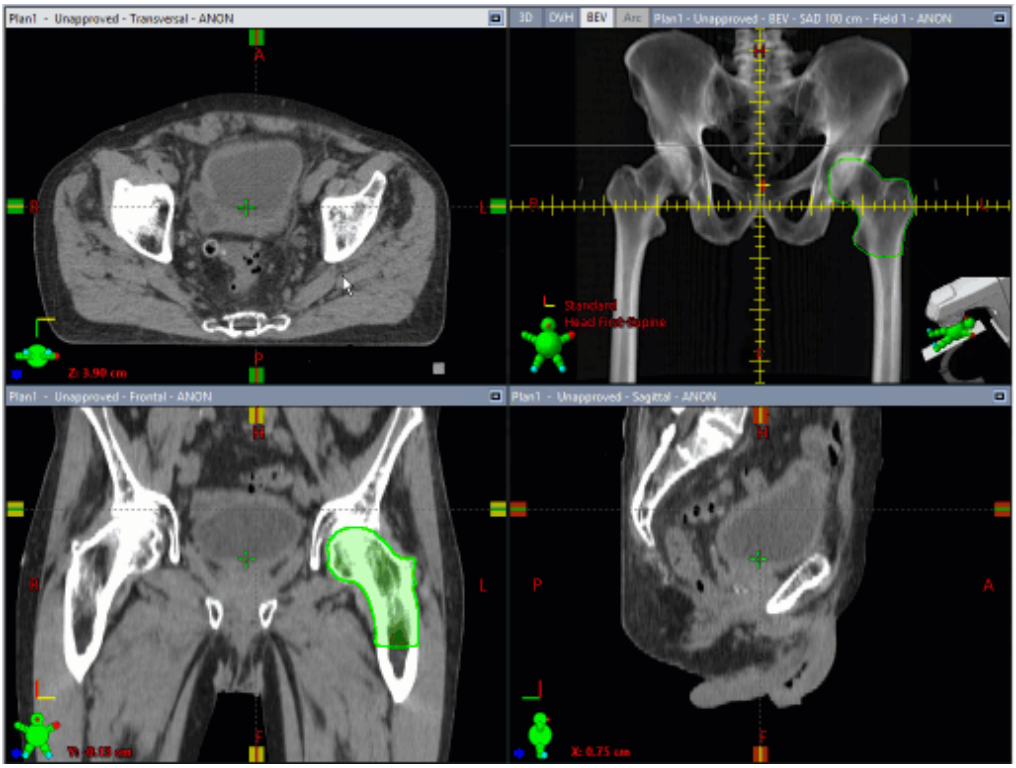
Fiducials



Contour the prostate . ducial, seeds or beacons.

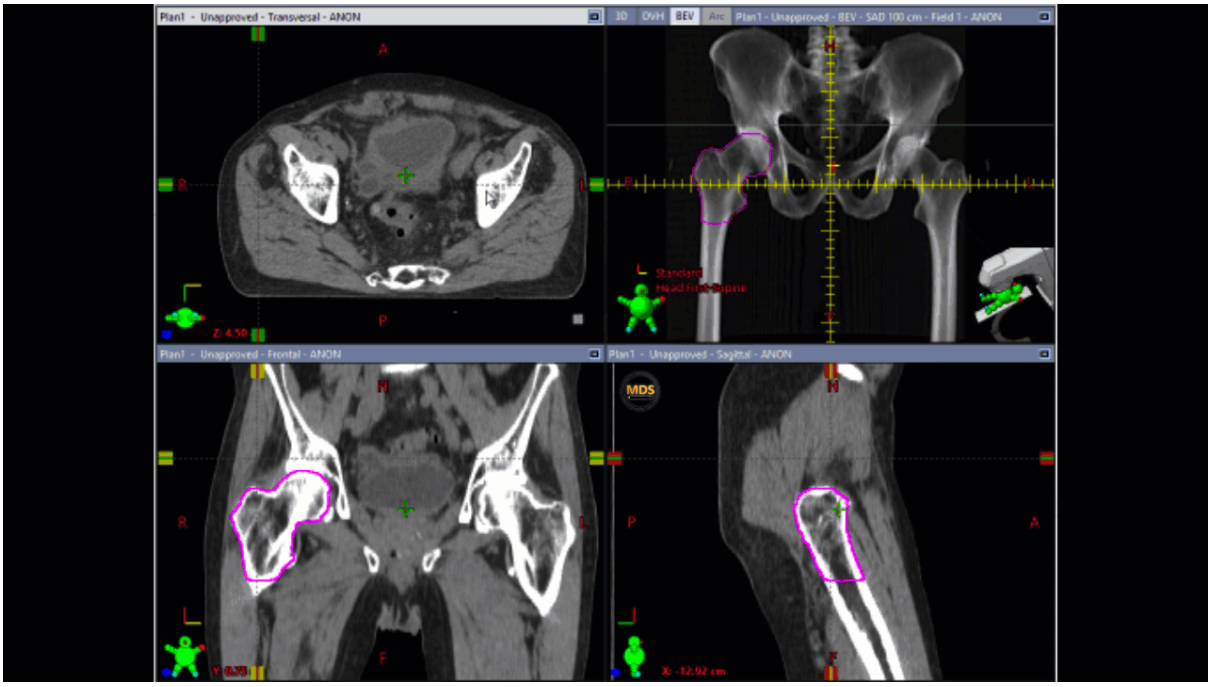
Step 4

Femur_L



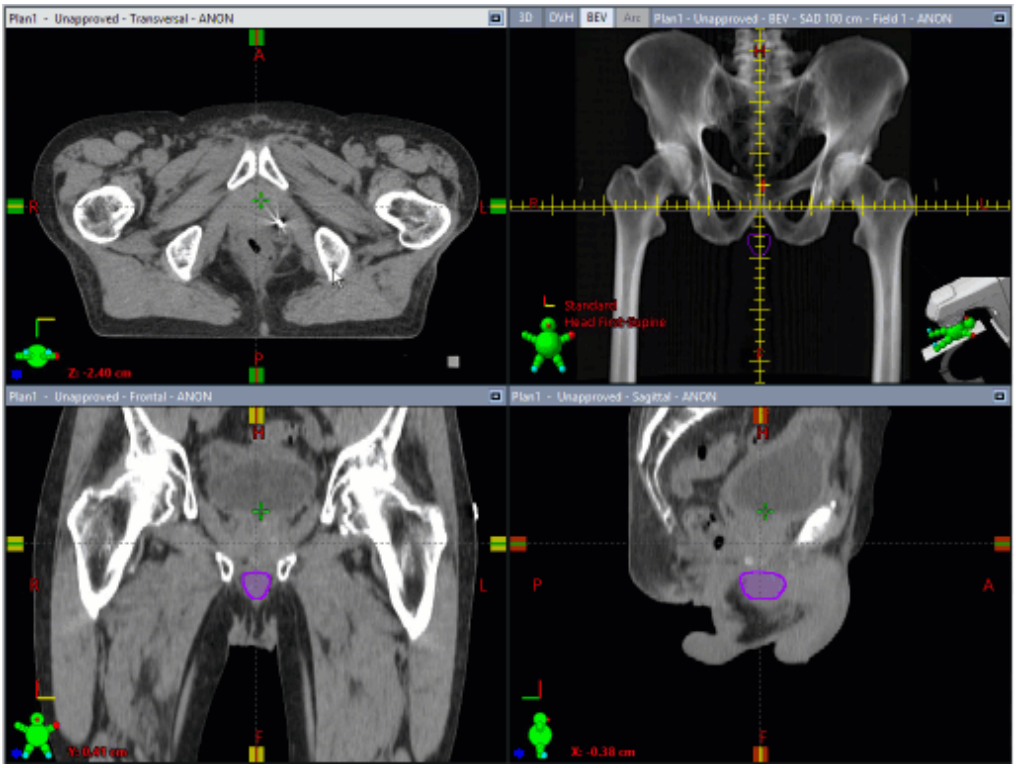
Step 5

Femur_R



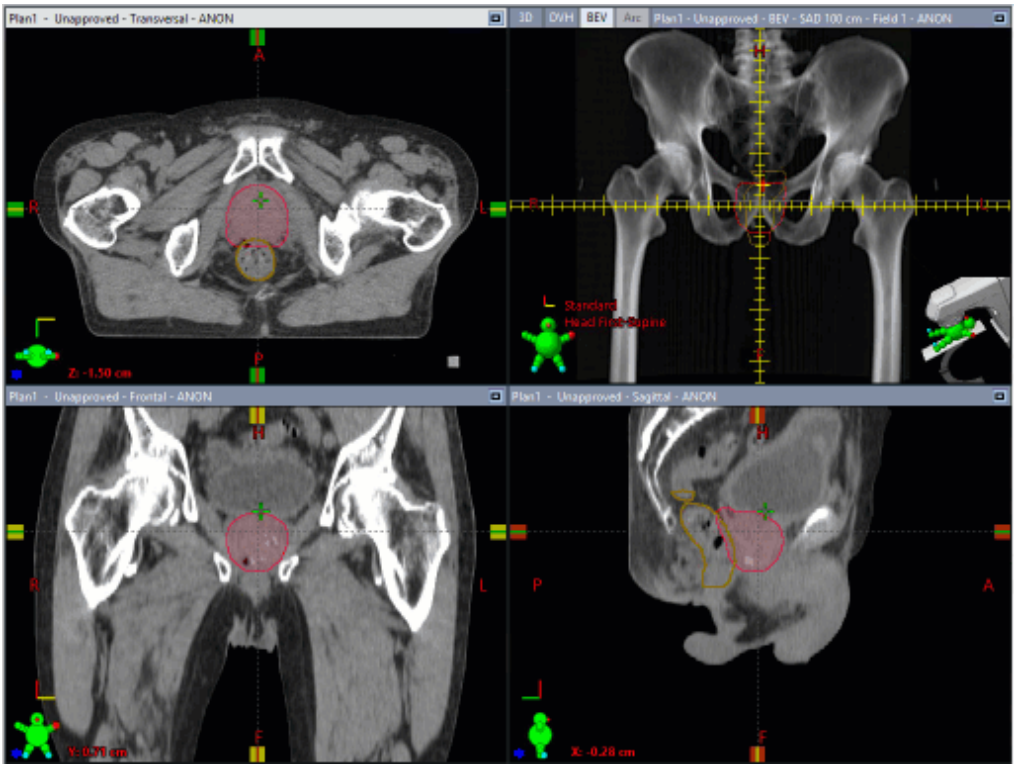
Step 6

Penile Bulb



Step 7

RING1 Structure



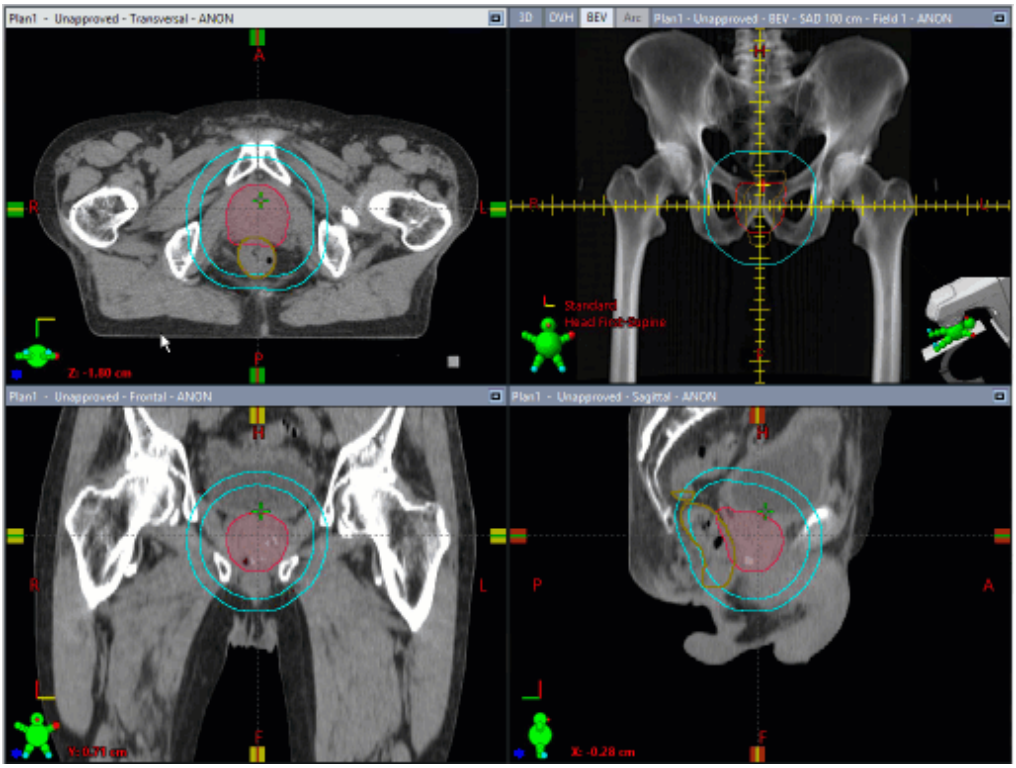
The RING1 Structure is an optimization structure

Category: Control Structure

Purpose: Dose fall off from 100-90%

Step 8

RING2 Structure



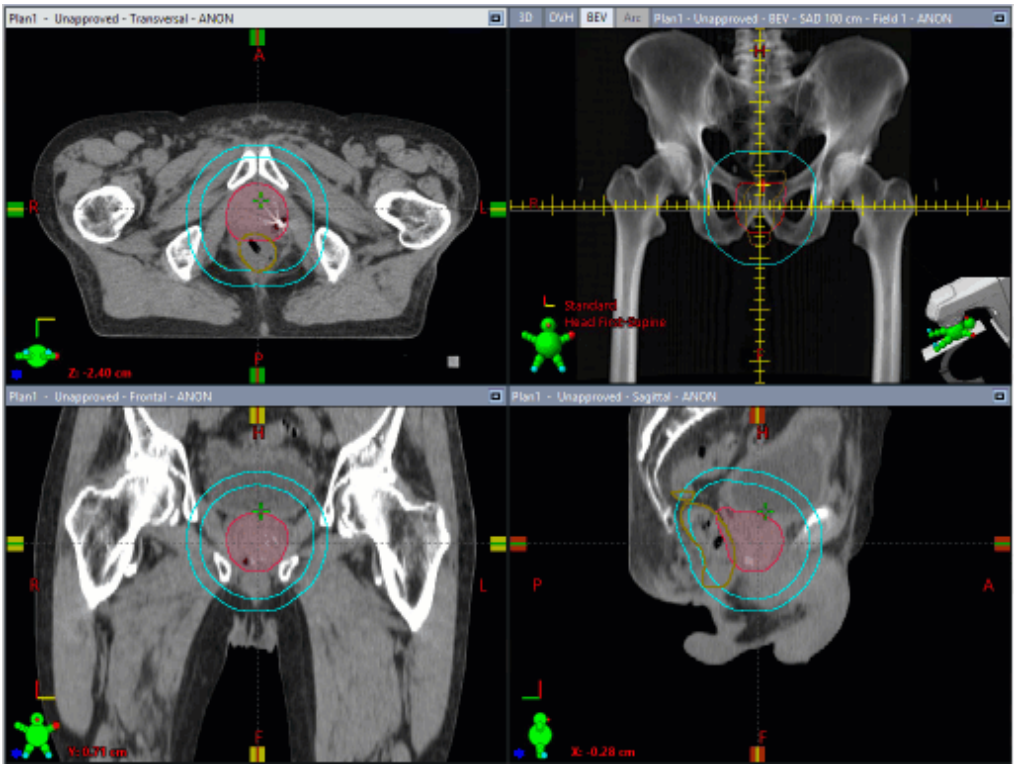
The RING2 structure is an optimization structure

Category: Control Structure

Purpose: Helps control dose fall off from to 50% isodose line

Step 9

RIND1



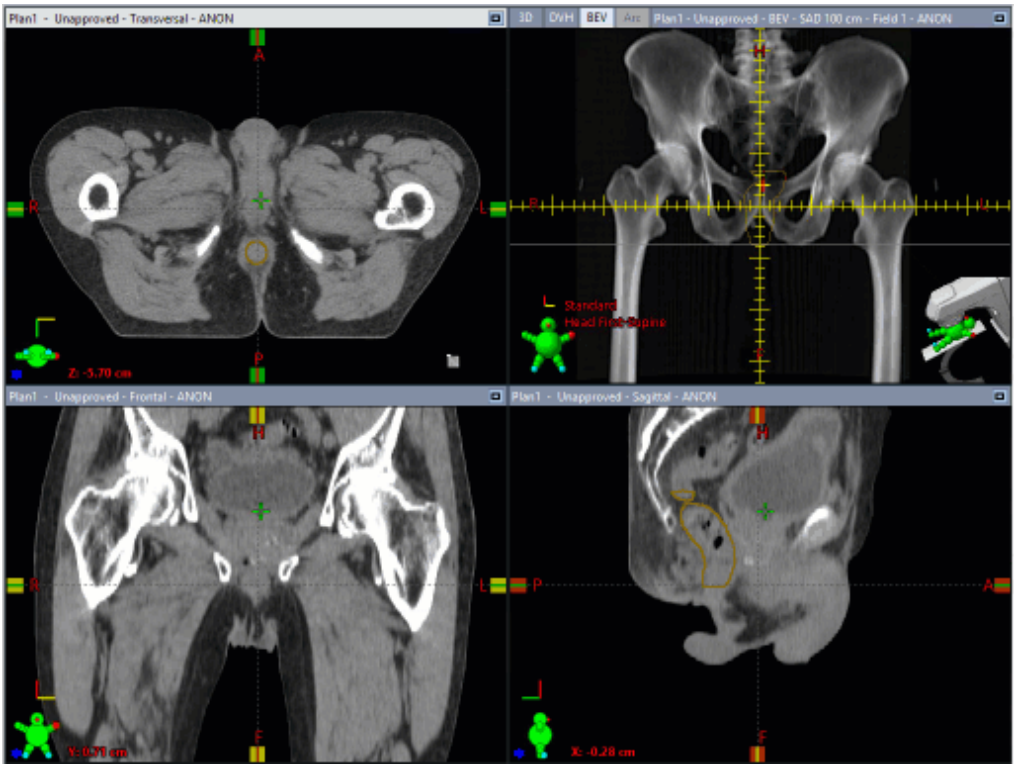
The RIND1 structure is an optimization structure

Category: Control Structure

Purpose: helps control low dose <50%. Also, helps controls dose to normal tissue

Step 10

Post Avoid Structure



The Posterior Avoid structure is an optimization structure

Category: Avoidance Structure

Purpose: Help avoid entrance dose to protect underlying structures

Step 11

Any Critical Structures?

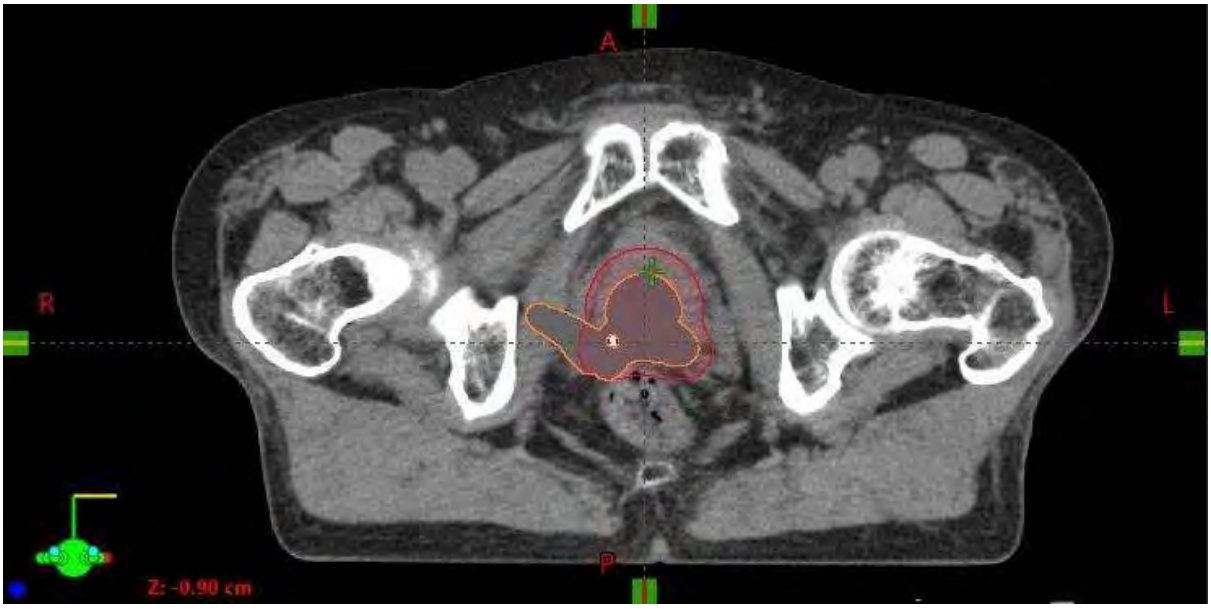
Contour any additional critical structures relevant to the case.

Sigmoid? SmallBowel? LargeBowel?

Check with the physician and your department standards for anything necessary for planning or reporting.

Step 12

Density Overrides



If there are artifact, or materials that need to be overridden this is a good time to do so.

Summary

Ok now that we've completed our list of contours, We're ready to start planning.

Complete the content above before moving on.

Takeaway

Remember to review automated contours such as the Body and have a second pair of eyes review your contours.

Beam Setup

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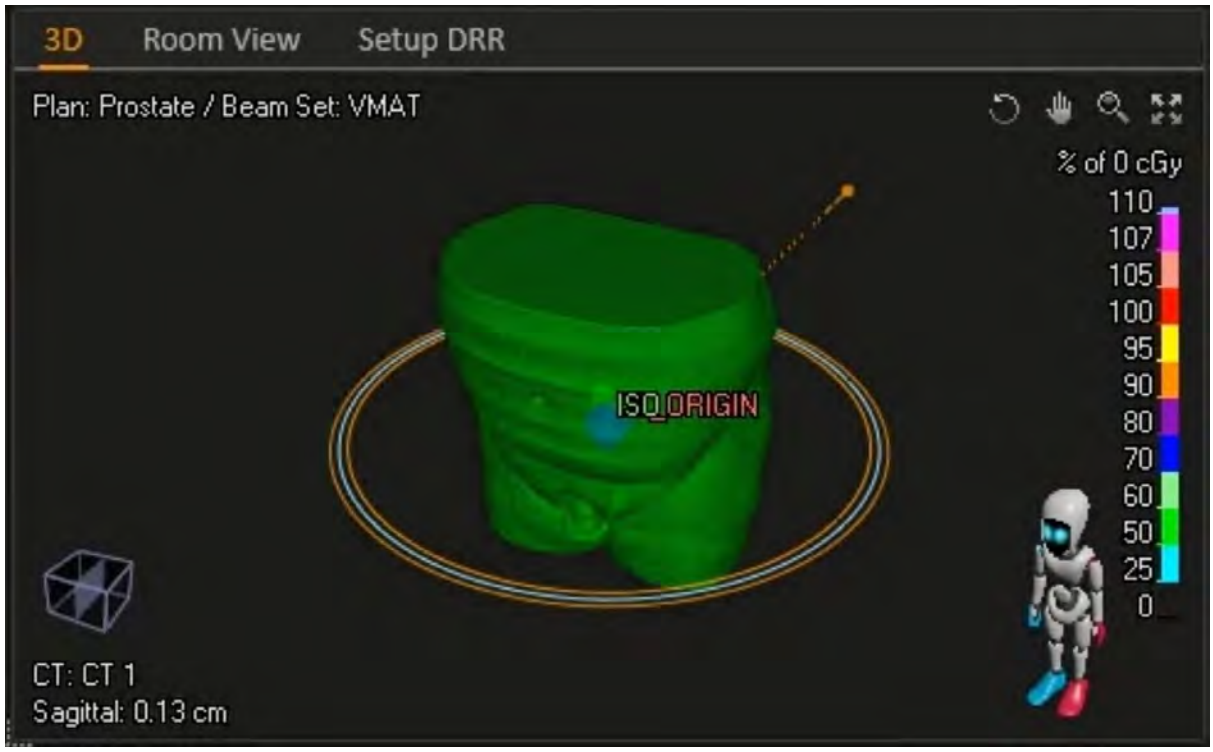
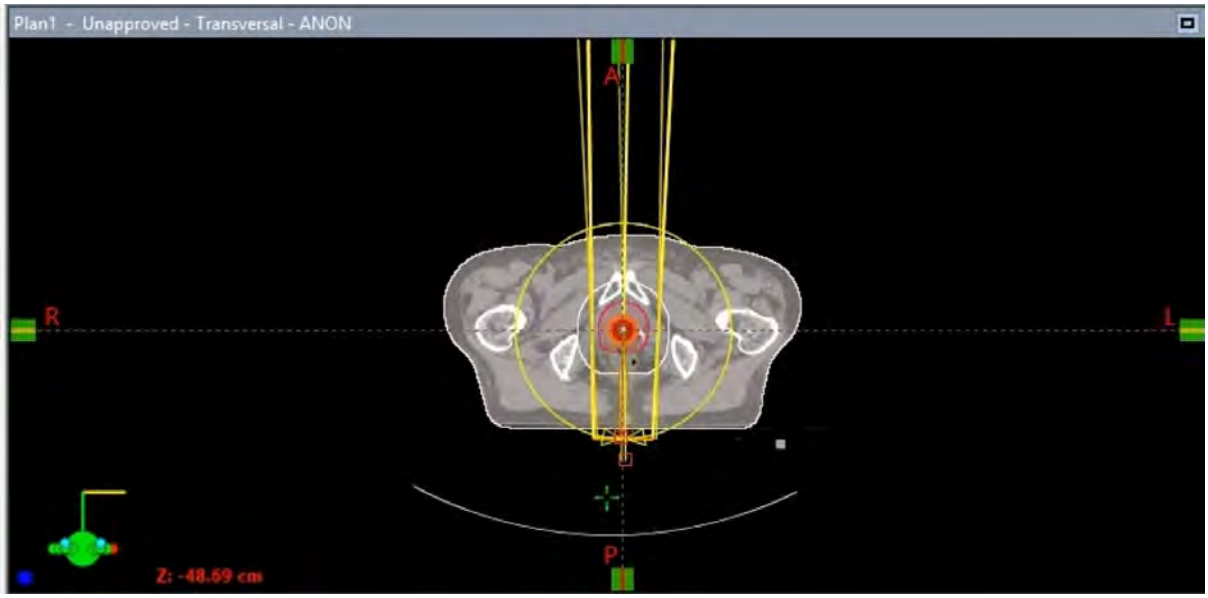
Beam Arrangement & Field Placement



VMAT Prostate cases commonly use 2 full arcs. Less common scenarios would use 1 arc, or 3 arcs. Partial arcs are used for special cases when there are areas to avoid, such as a protheses.

Step 1

VMAT 2 Full Arcs



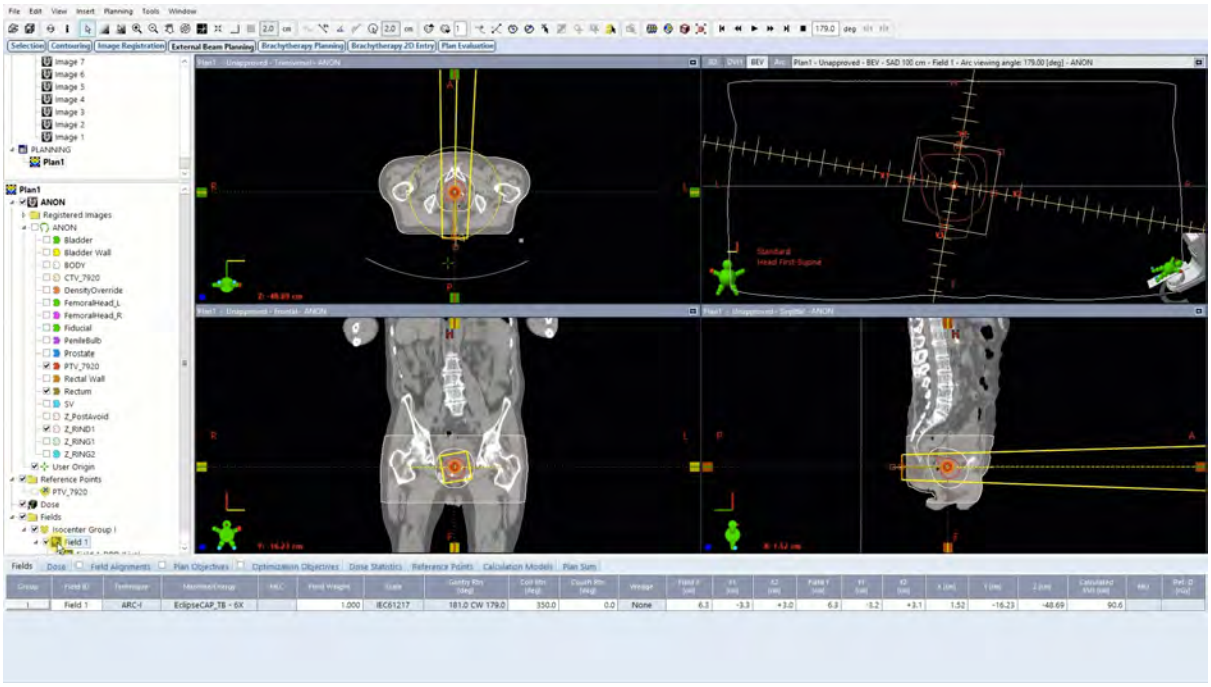
Field Arrangement 2 full Arcs

01 CW ARC: 181-179, Collimator: 350 deg, Couch: 0 deg

02 CCW ARC: 179-181 Collimator: 10 deg, Couch: 0 deg

Step 2

VMAT 2 Full Arcs Setup

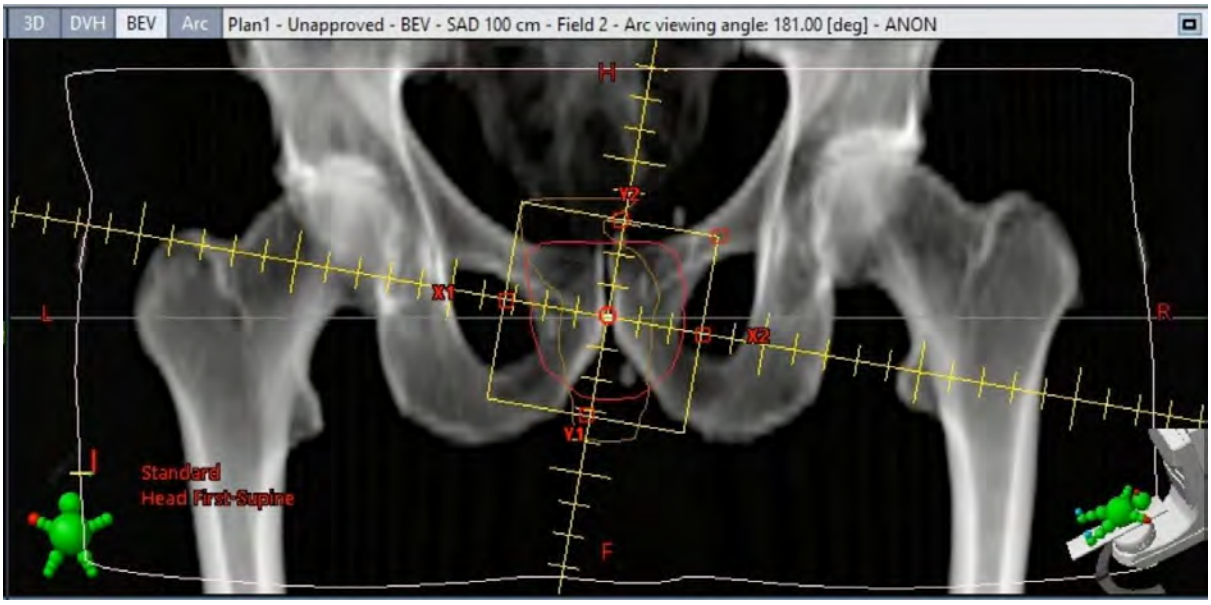


Often the . rst field is created, copied and reversed. The collimator is rotated 10 deg to help with limit the leakage due to the tongue and grove effect. Although minimal, this is a good habit learn.

Here's a demonstration.

Step 3

Field Margins

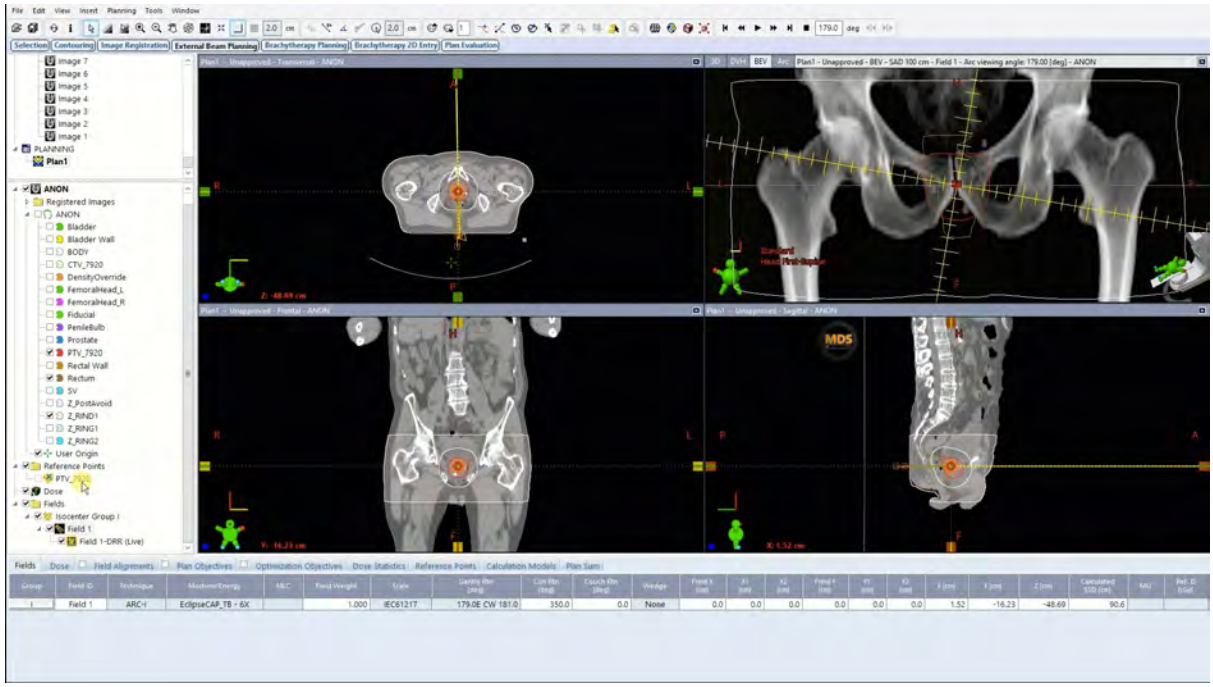


As the arc rotates through, the projection of the PTV volume needs to be within the treatment . eld. Ideally we want 100% of the time for the the PTV to be in the BEV with adequate margin to account for the field edge and penumbra. To Achieve this we try to place the PTV within the center of the field and a 5mm margin around the PTV is set.

Prostate cases often use IGRT during time of treatment. Fiducial's, gold seeds or beacons are used to aid setup/localization. The Isocenter of the field can either be at the center of the PTV or at the center of all three fiducial (Apex, Left & Right fiducial)

Step 4

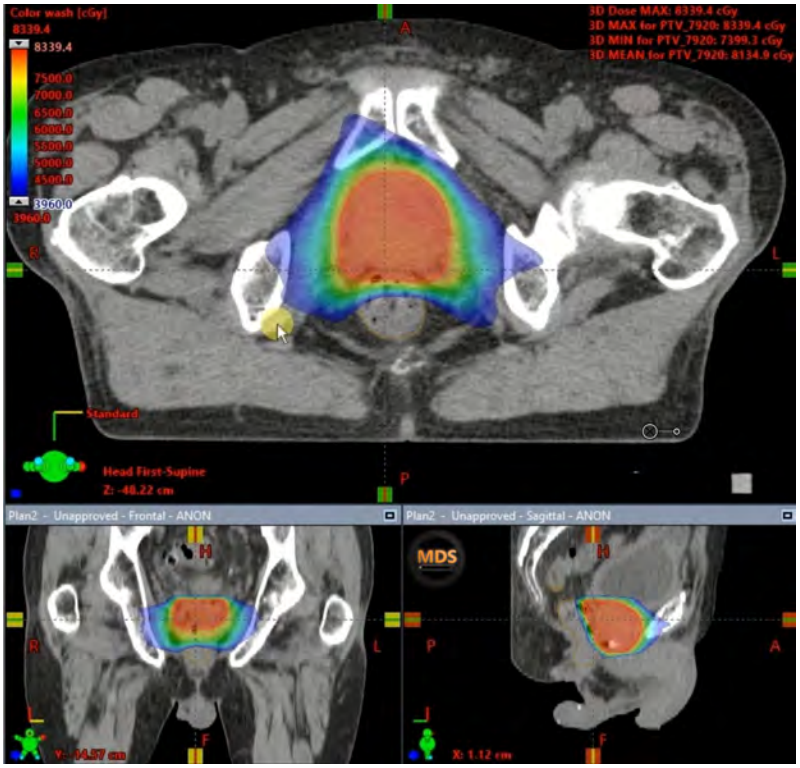
Set Field Margin



While setting up the . eld borders please keep in mind.

■ Treat the PTV with adequate margin.

Summary



Now things are setup and we'll create a plan similar to the one shown.

Lesson 4 of 5

Treatment Planning

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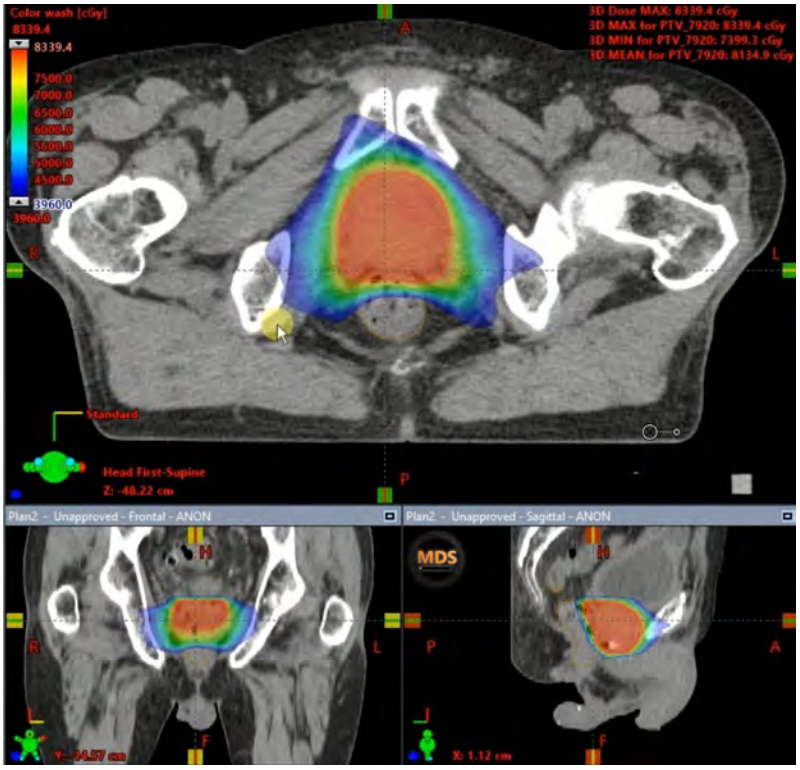
Introduction

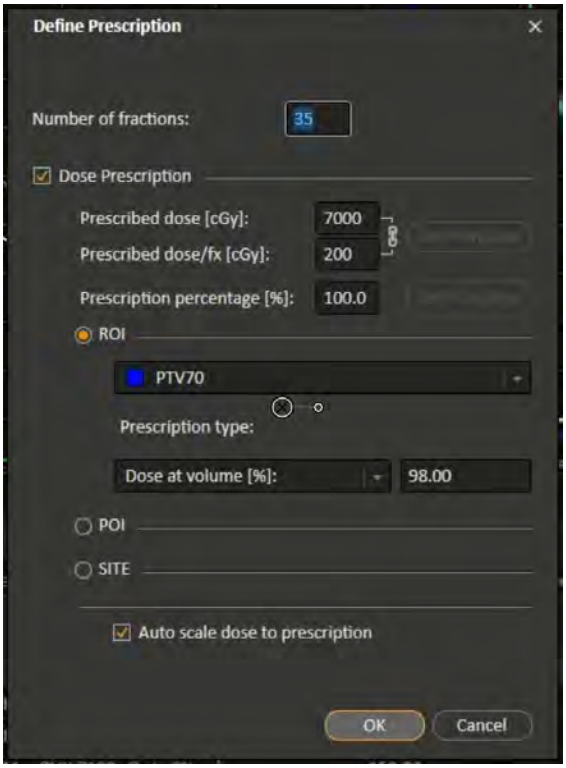


Once we place . elds and teachnique selected. We need to calculate the dose and look at the dose distribution. Here are some items to keep in mind for planning.

- Maximum PTV homogeneity. +/-7%
- Minimum PTV dose (encompassing ≥ 95% of PTV)
- Minimum CTV dose (encompassing ≥ 100% CTV)

Step 1

Calculation Volume



For Prostate Treatments we set the prescription to the PTV volume, and try to maintain a 95% coverage or better.

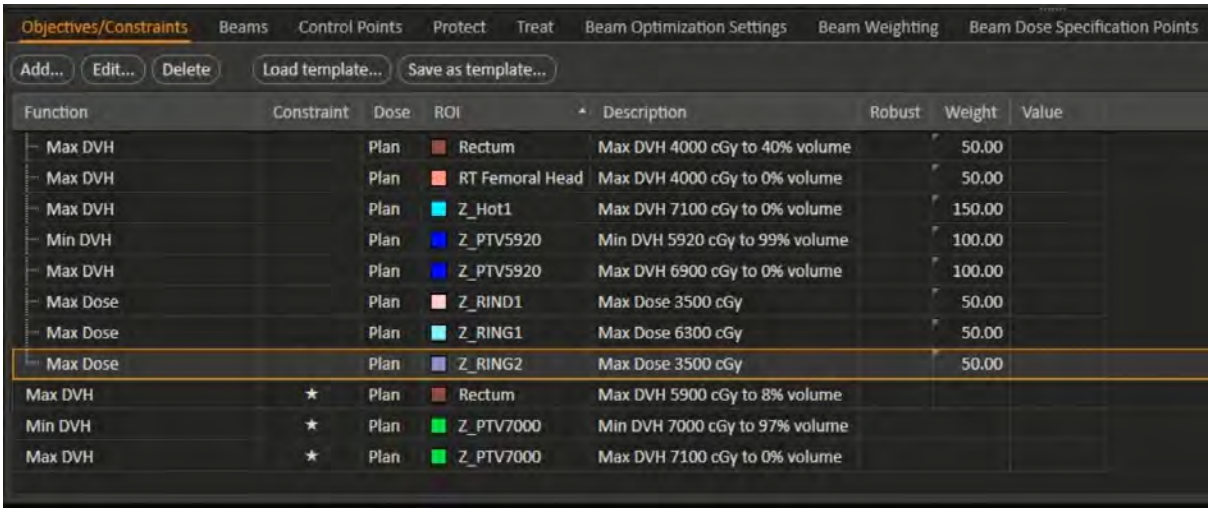
Step 2

Normalize the plan

Normalizing the plan to the PTV volume prescribing to cover >95% of the PTV to 100% of the Rx Dose.

Step 3

Optimization Parameters PTV



Here is an example of the optimization parameters used to create our dose distribution, cover the PTV, and spare the OARs.

In this example, the optimization is trying to cover 97% of the PTV to 70Gy while limiting the max dose to 0% >71Gy. A weight of 100 or constraint parameter may be used to give a high importance.

Step 4

Optimization Parameters OARs

In this example the optimization is trying to achieve the following goals for optimization.

Rectum ~V40<40% Weight 50 (less importance relative to the PTV)

Bladder ~V20<15% Weight 50 (less importance relative to the PTV)

FemoralHead_L ~V25<0% Weight 50 (less importance relative to the PTV)

FemoralHead_R ~V25<0% Weight 50 (less importance relative to the PTV)

PenileBulb ~mean < 15Gy Weight 50 (less importance relative to the PTV)

Step 5

Optimization Parameters Opti Structures

RING1 V90%Rx < 0% (less importance relative to the PTV, goal to limit the dose falloff from 100-90% within the ring)

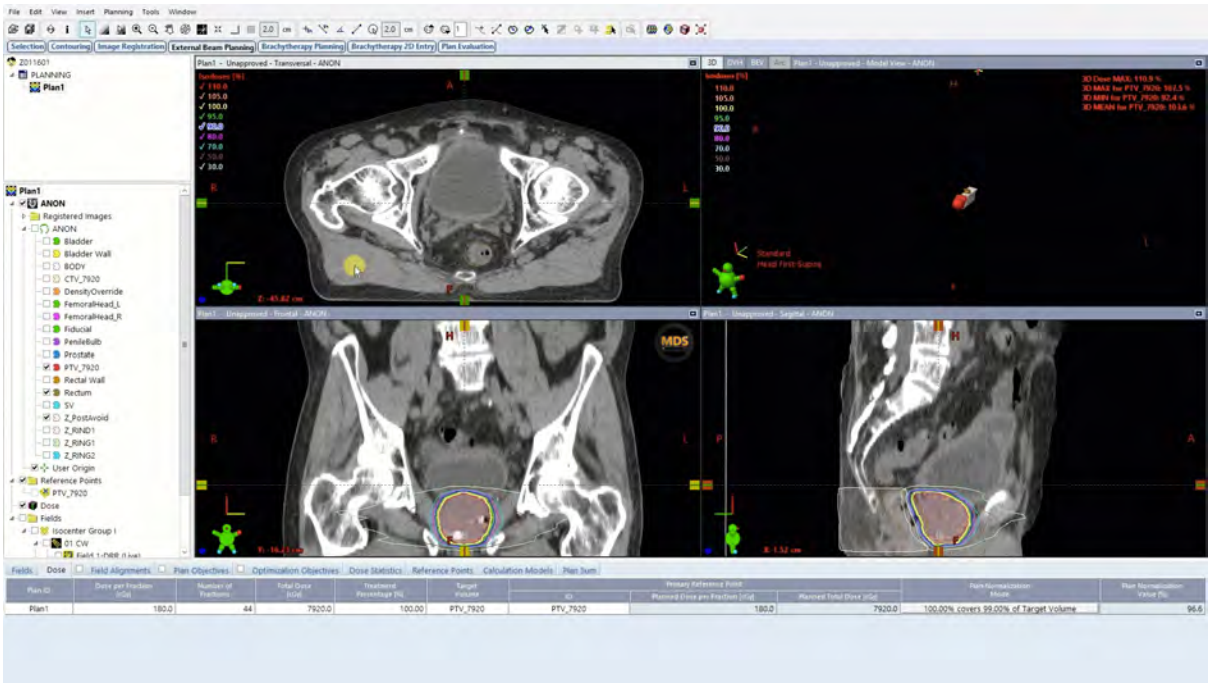
RING2 V50%Rx < 0% (less importance relative to the PTV, goal to limit the dose falloff from 100-50% within the ring)

RIND1 V50%Rx < 0% (less importance relative to the PTV, goal to limit the dose falloff from 100-50% within the ring)

The RIND structure is also commonly referred to as the normal tissue.

Step 6

Review Dose Distribution

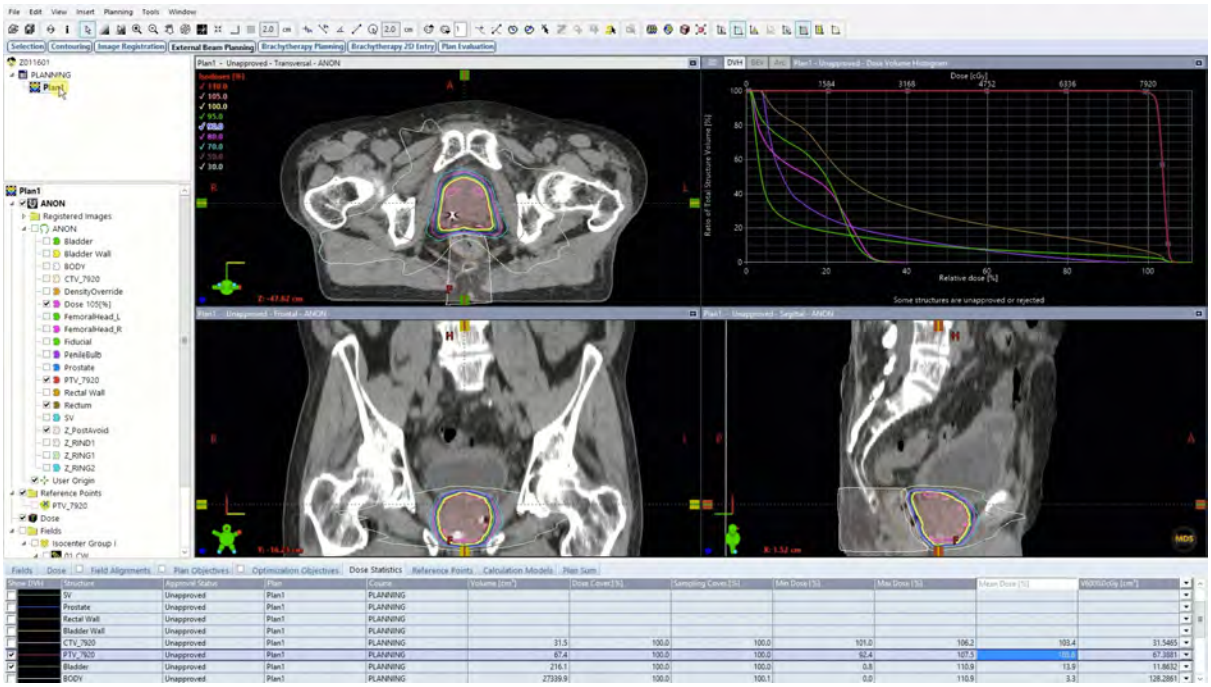


Once complete a dose distribution is created. We will review dose distribution for coverage and conformality.

In this example we have hotspots of 105% Rx, which we can create a isodose volume from. (Dose 105[%]) is the hotpot structure created from the isodose volume. We will then use this structure to re-optimize and decrease the hotpot.

Step 7

Re-Optimization and x hotspots.



After initial review, if we nd problem areas in the dose distribution, DVH, or hotpots/cold spots in the plan, we can create new volumes to correct x the issues and improve the plan.

Treatment planning is an iterative process, and optimizing multiple trials/plans is recommended in order to improve the quality of the plan.

In this example, the hotspot is added to the optimization and objective weights for the PTV and Hotpot is increased to increase the importance of those objectives in the optimization.

Summary

Next let's evaluate the plan to see if it achieves the dose distribution we're looking for. We'll also check the max dose of the plan and OAR dose statistics.

Lesson 5 of 5

Plan Evaluation

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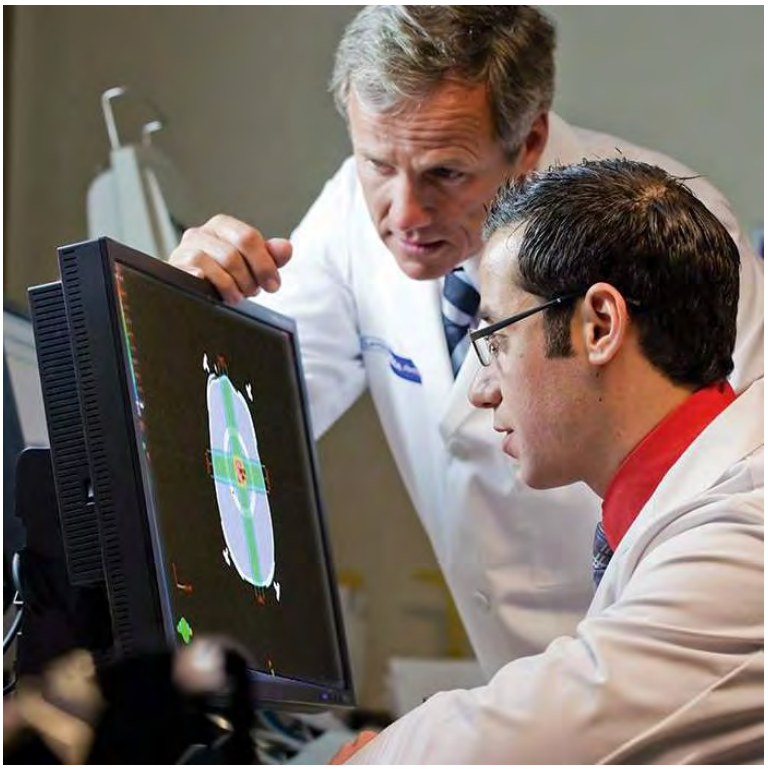
Introduction



Once we have good plans for review, we'll begin the plan evaluation with the physician.

In most cases treatment planners will have multiple trials or plans for comparison. This ensures the patient receives the best plan possible.

While reviewing with the physician in some cases they may ask to improve dose to either the PTVs, or spare dose to speci c OARs. This is part of the communication process to improve the plan's quality.

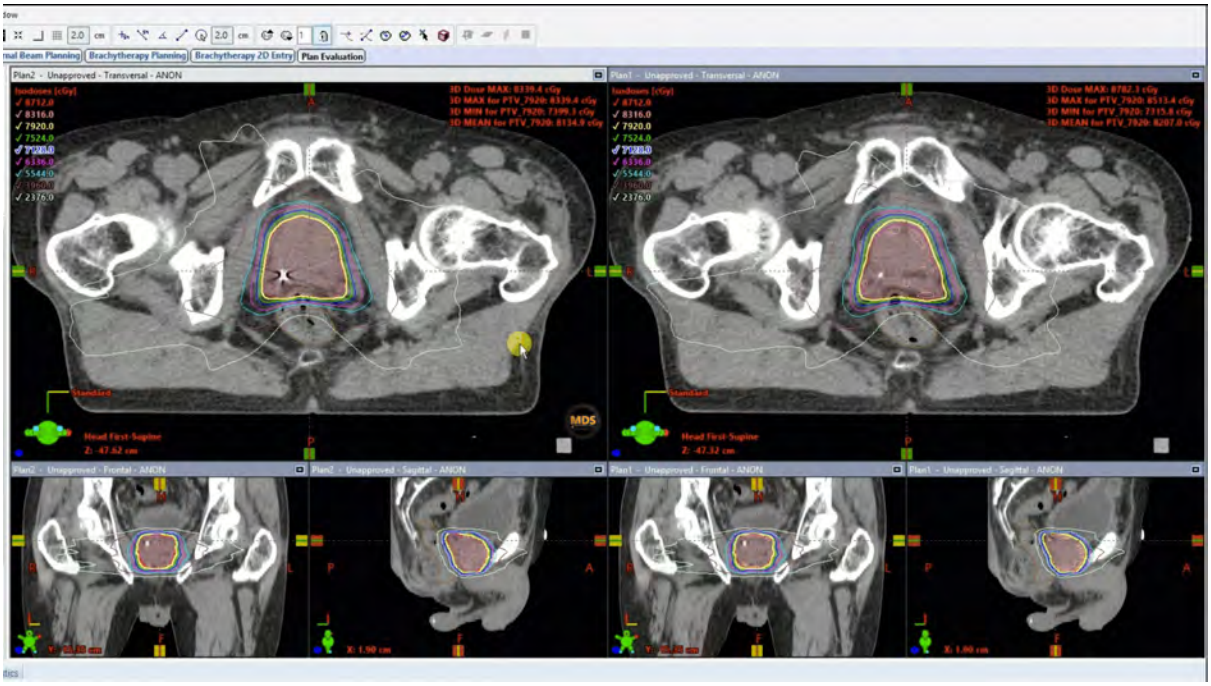
Step 1

Dose Distribution RayStation

Here are some of the items we are looking for during the plan evaluation. This is done by scrolling up and down the scan and reviewing the dose distribution. While doing this we note hotspots, max dose of the plan, location of max dose, cold spots, Coverage of the isodose lines around the target.

Step 2

Dose Distribution Eclipse

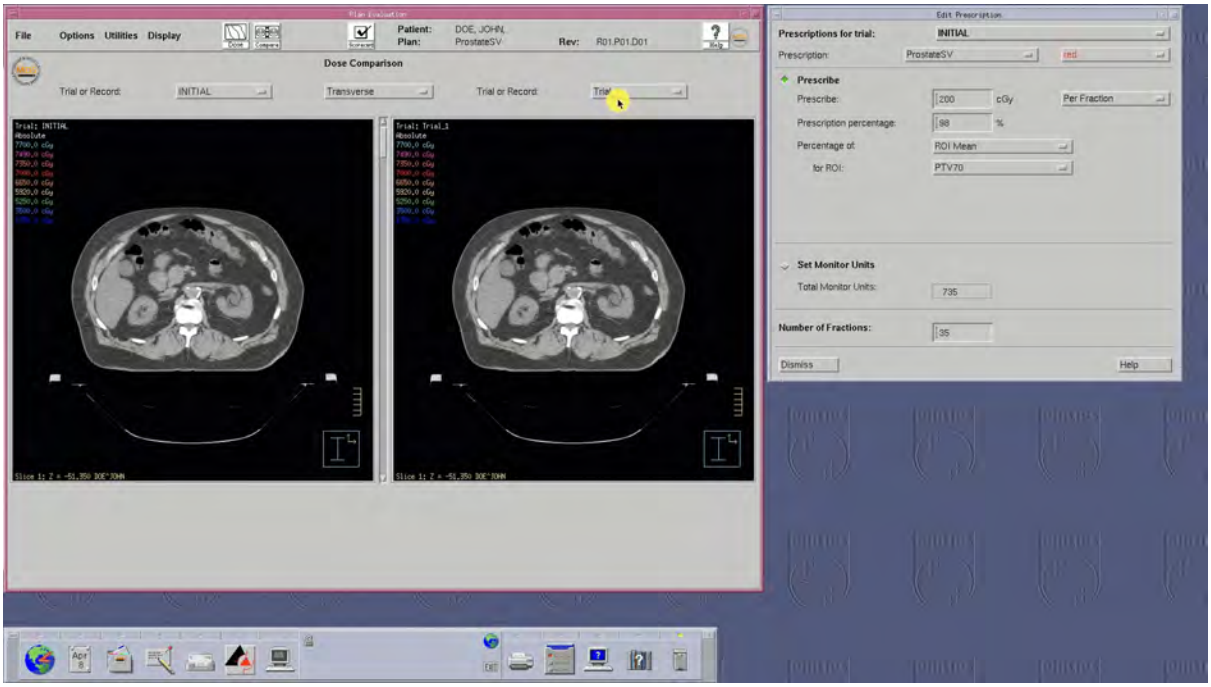


(Continued)

Look out for hotspots, max dose of the plan, location of max dose, cold spots, Coverage of the isodose lines around the target.

Step 3

Dose Distribution Pinnacle

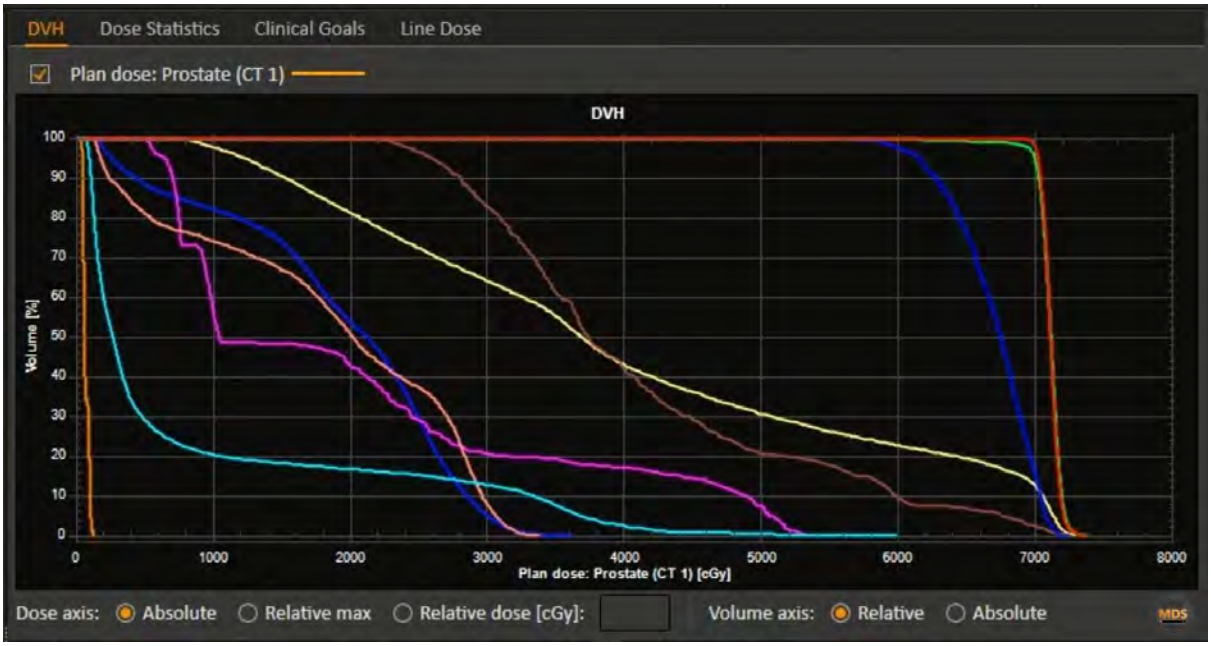


(Continued)

Look out for hotspots, max dose of the plan, location of max dose, cold spots, Coverage of the isodose lines around the target.

Step 4

Clinical Goals and Metrics



The Dose Volume Histogram (DVH) provides a quick review of clinical goals and metrics.

Example of some data points to look for in this DVH would be

PTV >95% Coverage

Plan Max Dose <110%

Rectum V60 <10%

Small Bowel Max Dose <60Gy

Sigmoid Max Dose <60Gy

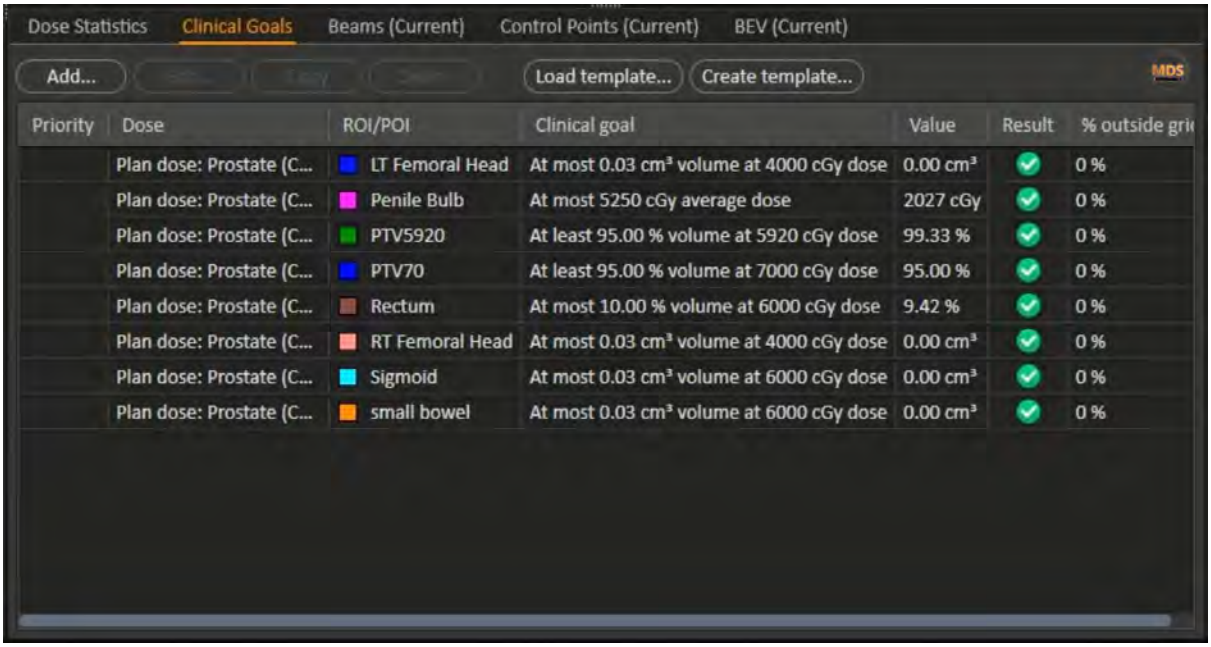
Femoral Head_L max dose <40Gy

Femoral Head_R max dose <40Gy

Penile Bulb mean <5250 cGy

Step 5

Clinical Goals and Metrics



Priority	Dose	ROI/POI	Clinical goal	Value	Result	% outside gri
	Plan dose: Prostate (C...	LT Femoral Head	At most 0.03 cm³ volume at 4000 cGy dose	0.00 cm³	✓	0 %
	Plan dose: Prostate (C...	Penile Bulb	At most 5250 cGy average dose	2027 cGy	✓	0 %
	Plan dose: Prostate (C...	PTV5920	At least 95.00 % volume at 5920 cGy dose	99.33 %	✓	0 %
	Plan dose: Prostate (C...	PTV70	At least 95.00 % volume at 7000 cGy dose	95.00 %	✓	0 %
	Plan dose: Prostate (C...	Rectum	At most 10.00 % volume at 6000 cGy dose	9.42 %	✓	0 %
	Plan dose: Prostate (C...	RT Femoral Head	At most 0.03 cm³ volume at 4000 cGy dose	0.00 cm³	✓	0 %
	Plan dose: Prostate (C...	Sigmoid	At most 0.03 cm³ volume at 6000 cGy dose	0.00 cm³	✓	0 %
	Plan dose: Prostate (C...	small bowel	At most 0.03 cm³ volume at 6000 cGy dose	0.00 cm³	✓	0 %

Clinical goals, clinical protocols or scorecards are a good tool for quickly identifying if plan metrics and goals have been met. In this example all the clinical goals have been met in this plan.

PTV >95% Coverage

Plan Max Dose <110%

Rectum V60 <10%

Small Bowel Max Dose <60Gy

Sigmoid Max Dose <60Gy

Femoral Head_L max dose <40Gy

Femoral Head_R max dose <40Gy

Penile Bulb mean <5250 cGy

Summary

This wraps up treatment planning for VMAT Prostate Radiation therapy.

We covered the simulation, beam arrangement, field margins, optimization and we learned how to evaluate a plan.

Please watch the treatment planning video demonstrations and take the post quiz to test what you've learned.