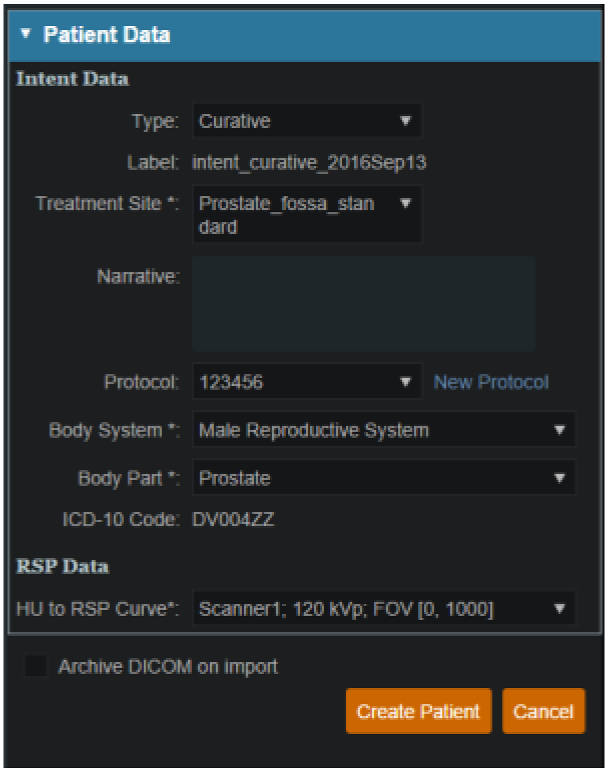
Prostate Plan Walkthrough

Patient Creation

1. Select the CT image set from the list of available files for import
2. Ensure that the MR is correct
    1. If MR needs to be changed you may edit it by choosing the *Edit* button to the left
3. Click the *Create New Patient* button to start the import process
4. Fill in the Patient Intent information and select the appropriate HU to RSP curve (as shown below)



Intent Data

Type: Curative

Label: intent_curative_2016Sep13

Treatment Site *: Prostate_fossa_standard

Narrative:

Protocol: 123456 New Protocol

Body System *: Male Reproductive System

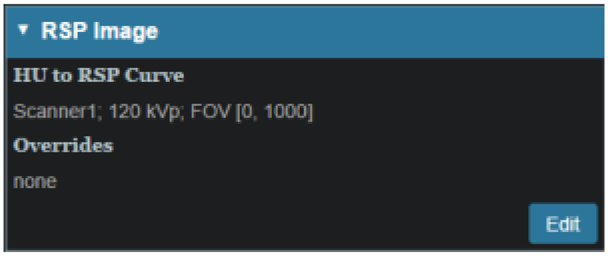
Body Part *: Prostate

ICD-10 Code: DV004ZZ

RSP Data

HU to RSP Curve*: Scanner1; 120 kVp; FOV [0, 1000]

☐ Archive DICOM on import

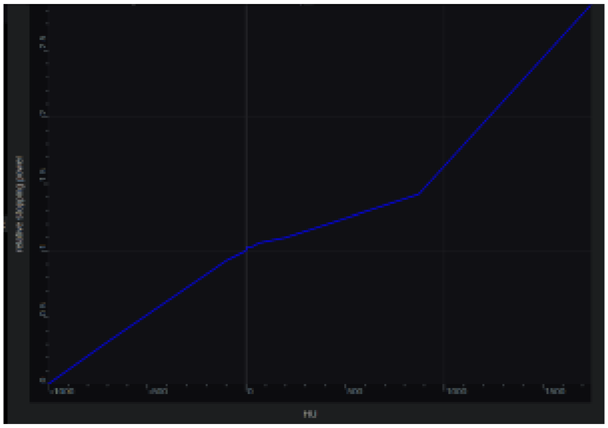


HU to RSP Curve

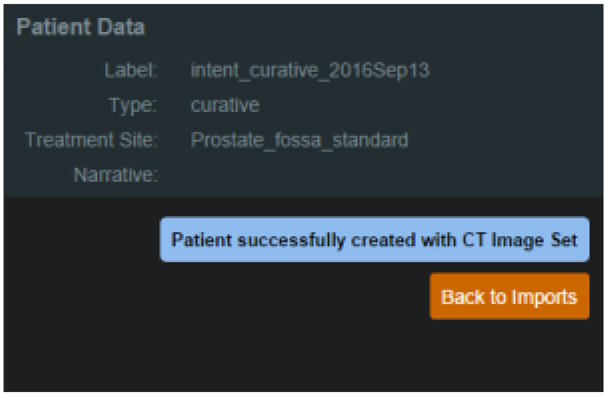
Scanner1; 120 kVp; FOV [0, 1000]

Overrides

none



5. Click the *Create Patient* button and wait for the import to complete
6. Click the *Back to Imports* button



Label: intent_curative_2016Sep13

Type: curative

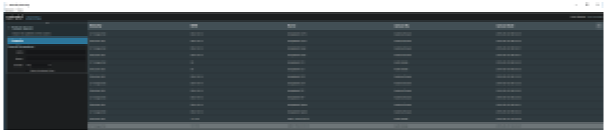
Treatment Site: Prostate_fossa_standard

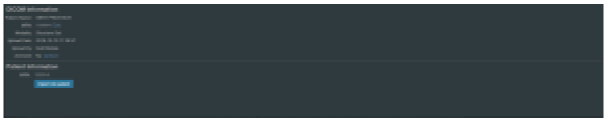
Narrative:

Patient successfully created with CT Image Set

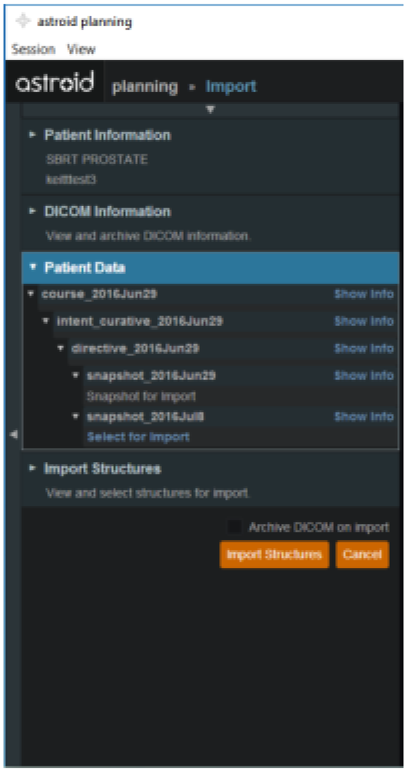
7. Select the Structure Set file that is associated with this patient

    1. Make sure Structure Set MR matches CT image set MR (make any edits to the MRN that are needed)
8. Click the *Import into Patient* button in the patient information window



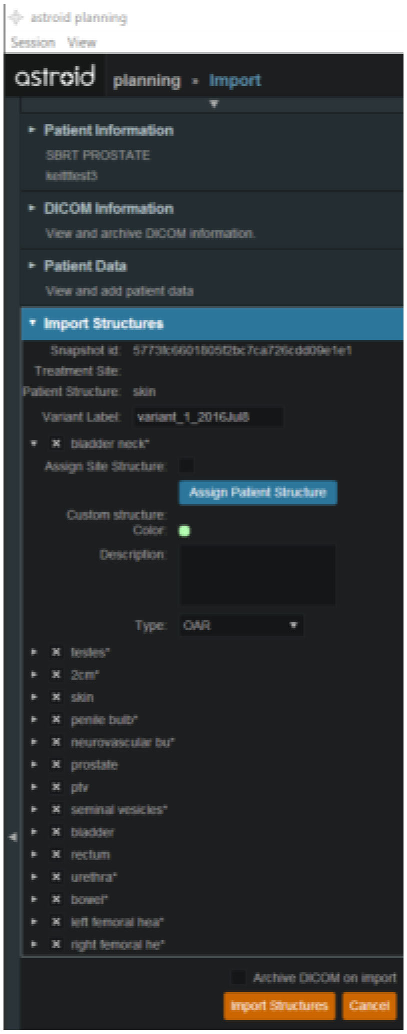


1. In the control pane on the left hand side, the image snapshot will be automatically selected based on the structure set DICOM UID information, and then the *Import Structure* block will automatically expand. **Fix Me!** : Also show image with the expansion complete (as being mentioned)



2. You will see a list of the imported structures. Here you may choose whether or not to import each structure by checking or unchecking the box beside each structure name.
    1. For this case, we will import all available structures and there is nothing to change on this page
3. You also have the ability to assign or edit any structures that are shown as *custom*, which indicates the name did not exactly match a directive structure from the treatment site template list you specified during patient creation.

    1. Matched, Assigned, and Custom structures are designated with corresponding tags at the end of the structure name in the structure list.
    2. Assigning a custom structure to a defined directive structure will result in the imported structure inheriting all the predefined structure properties (e.g. name, type, color)
    3. For all custom structures the type is by default set to “Other” unless it contains the letters “TV” (as in PTV or CTV), in which case it is assigned the type of “Target”; this may be changed here if needed
4. Once you have completed explored this feature, make sure all structures are back to their default states and click the orange “Import Structures” button 🔧 **Fix Me!** : This image is old



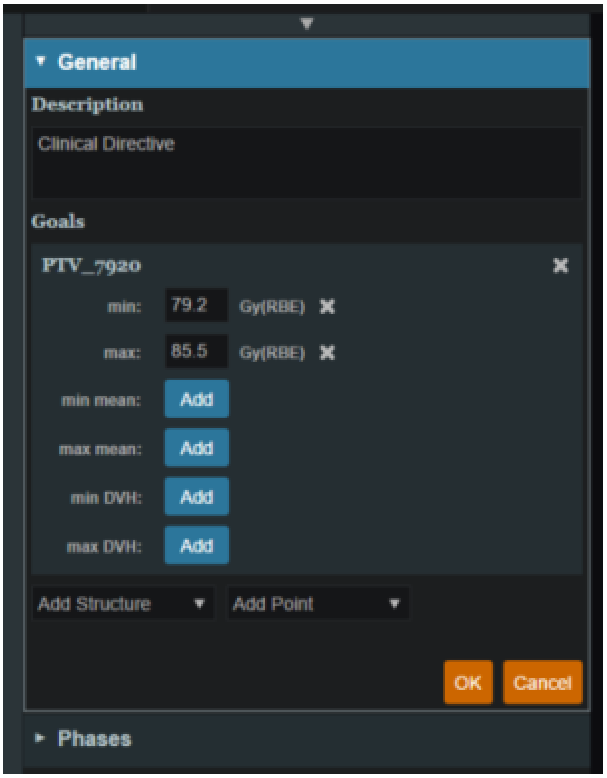
Snapshot id: 5773fc6601805f2bc7ca726cdd09e1e1
Treatment Site:
Patient Structure: skin
Variant Label: variant_1_2016Jul8

Type: OAR

Prescription

1. The patient is now created and all available data has been imported, so it is time to proceed with entering the prescription information
2. Click on the *Back to Import* button
3. Click the *Planning* task
4. Click the entry from the table of patients that corresponds to your newly imported patient
5. Prescription information is stored in the *Directive*

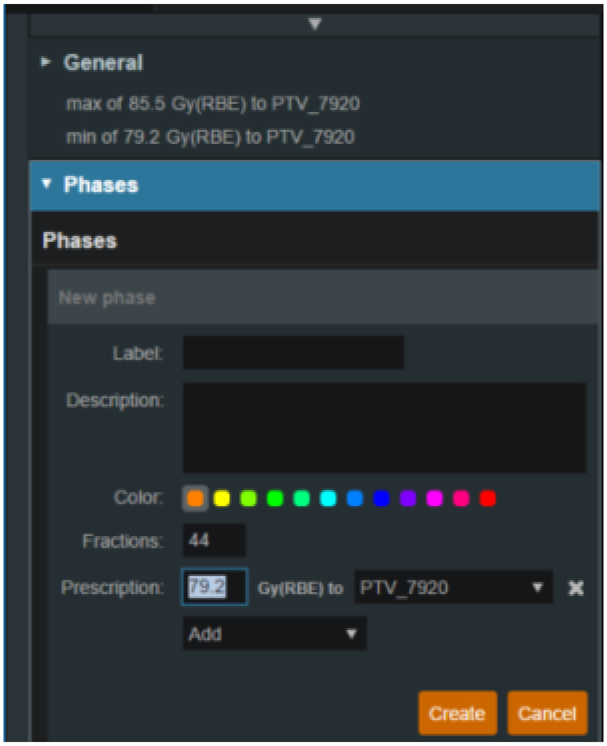
6. Click *Open* under the *Directive* entry in the patient overview tree
7. Under *General* fill in *Goals*
    1. In this example we will set a minimum dose to the PTV7920 at 79.2Gy and the maximum dose at 85.5Gy as shown below



Description
Clinical Directive

PTV_7920
min: 79.2 Gy(RBE)
max: 85.5 Gy(RBE)

8. Next proceed to *Phases* and fill in *Fractions* and *Prescription*
    1. For this example the dose will be 79.2Gy in 44 fractions to the PTV7920



max of 85.5 Gy(RBE) to PTV_7920
min of 79.2 Gy(RBE) to PTV_7920

Label:
Description:
Color:
Fractions: 44
Prescription: 79.2 Gy(RBE) to PTV_7920
Add

   2. *Label* and *Description* are free text fields that allow you to “name” each Phase and provide any description or notes necessary to distinguish between each phase in the case of multiple phases. You are free to enter your own values in these fields for this walthrough

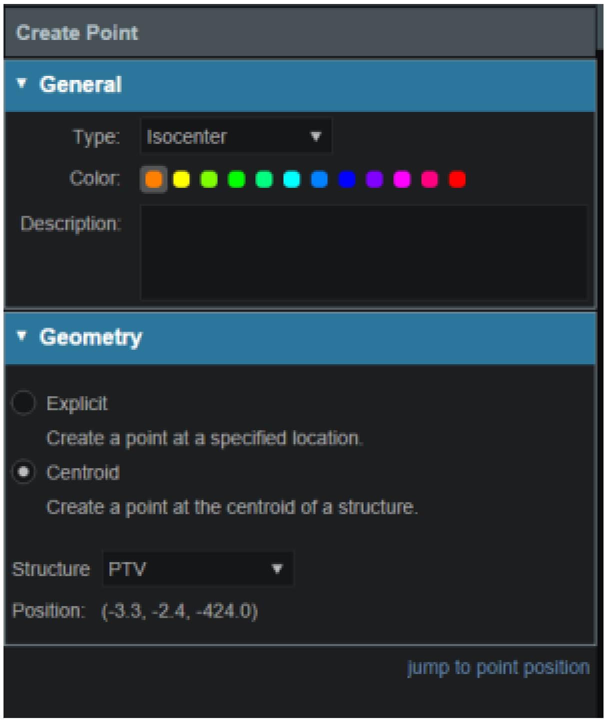
9. Click *Create* to complete the phase
10. Click *Done* to complete the *Directive* editing and return to the Patient Overview tree

Plan Creation

1. The required *Intent*, *Course*, and *Snapshot* information was selected during import, so now we can move to creation of a *Request* and *Plan*
2. From the Patient Overview tree, click the *Add Request* button
   1. If a plan will only fulfill a portion of the prescription, then the *Request* should be edited to reflect this, otherwise just proceed to adding a plan
   2. In this case, we will be fulfilling the entire prescription with a single plan, so no editing of the Request is needed
3. Now click the *Add Plan* button under the newly created Request entry
   1. Name the plan and click *Save*
4. Now open the new plan by clicking the *Open* button under the new plan entry in the Patient Overview tree

General Plan Parameters

1. Creating our plan will begin in the *Patient Geometry* block, where we will create any points or planning structures that are needed (if not created in contouring software), such as a combination of the left and right femoral heads (see Structure Geometry for details on how to Create structures)
   1. We will create a point to use for the isocenter (note this step is done for illustration purposes and is not necessary for most plans)
      1. Select a type of isocenter and create the point at the centroid of the prostate



Create Point

General

Type: Isocenter

Color: ● ● ● ● ● ● ● ● ● ● ● ●

Description:

Geometry

○ Explicit

Create a point at a specified location.

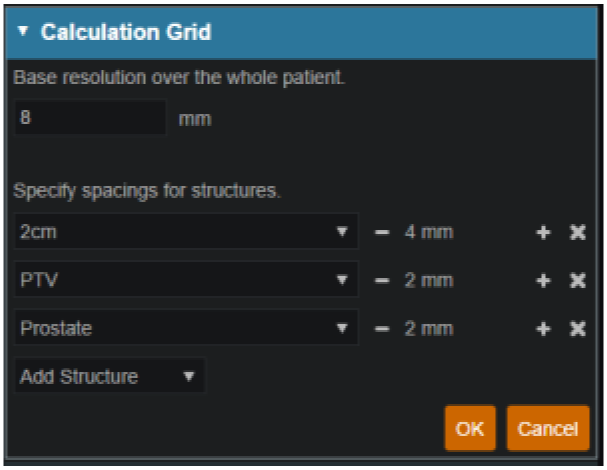
● Centroid

Create a point at the centroid of a structure.

Structure: PTV

Position: (-3.3, -2.4, -424.0)

2. Next will will move on to defining the HU to Proton Relative Stopping Power (RSP) conversion
3. Click to open the *RSP Image* block
    1. If any density overrides are needed they are entered here in the *RSP Image* block
    2. If the HU to RSP curve was not chosen upon patient import the user may do so at this point
    3. We do have any density overrides to apply for this case and the proper HU curve has already been selected, so we can move past this block for this example, so click *Cancel* to close this block
4. We are now ready to define the dose calculation grid (see Defining the Dose Grid for a detailed explanation)
5. Click to open the *Calculation Grid* block
    1. Create a grid by performing the following steps:
        1. Set the base grid resolution to 8 mm
        2. Click *Add Structure* and select the “2cm” structure
            1. Set the size to 4 mm
        3. Add the PTV and the Prostate each in the same manner and set their sizes to 2 mm


Calculation Grid

Base resolution over the whole patient.

8 mm

Specify spacings for structures.

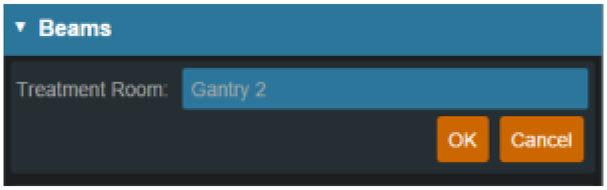
2cm ▾ − 4 mm + ✖

PTV ▾ − 2 mm + ✖

Prostate ▾ − 2 mm + ✖

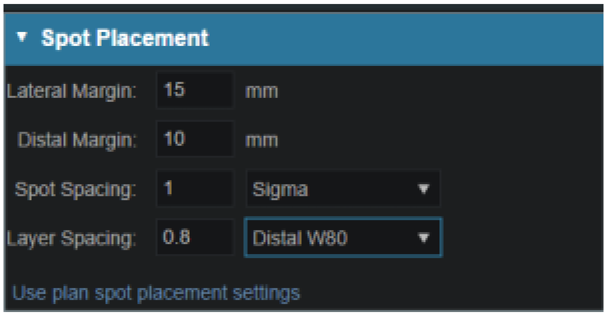
Beams

1. We are now ready to begin defining the treatment beams
2. Click to expand the *Beams* block (see Creating a New Beam for detailed explanation)
    1. Before defining individual beams, we will first set some shared beam properties
    2. Set the *Treatment Room* by choosing “Gantry 2” from the dropdown


Beams

Treatment Room: Gantry 2

    3. Expand the *Spot Placement* sub-block and set the following values (note these are the plan level spot placement parameters, so it will apply to all our beams, unless we specifically override the values within an individual beam)
        1. Lateral margin- 15 mm
        2. Distal margin- 10 mm
        3. Spot spacing- 1 sigma
        4. Layer spacing- .8 Distal 80


Spot Placement

Lateral Margin: 15 mm

Distal Margin: 10 mm

Spot Spacing: 1 Sigma ▾

Layer Spacing: 0.8 Distal W80 ▾

    4. Now we are ready to make our beams
    5. Start by clicking *Create New Beam*
        1. Enter the following for each beam
            1. General
                1. Select the PTV as the target and if desired, enter a description for the beam, for other selections leave the defaults (see Structure Geometry)

Color:

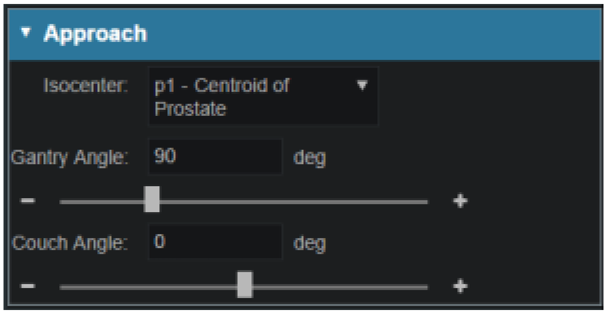
Label: G90 C0; 25 cm; no shifter;

☒ automatically generate label

Target: PTV

Description:

2. Approach
    1. At this point the use will specify the geometry of the beam by setting the isocenter as well as the gantry and couch angles
    2. Two beams at gantry angles of 90 and 270, respectively, will be used here, which is typical (+/- 5 degrees) for standard prostate plans such as this example
    3. Couch angle of 0 is used here for each beam
        1. You may use the sliders, the +/- buttons, or simply type in the values to adjust these angles

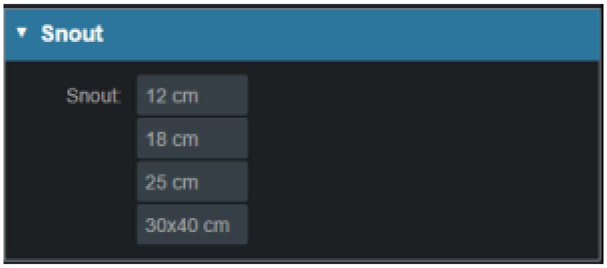


Isocenter: p1 - Centroid of Prostate

Gantry Angle: 90 deg

Couch Angle: 0 deg

3. Snout
    1. Depending on the size of the prostate a 10-12cm snout should be adequate, in this example select the 12cm Snout option
    2. If the pelvic nodes need to be included, the user may need to increase the snout size to the 18 or 25cm snout



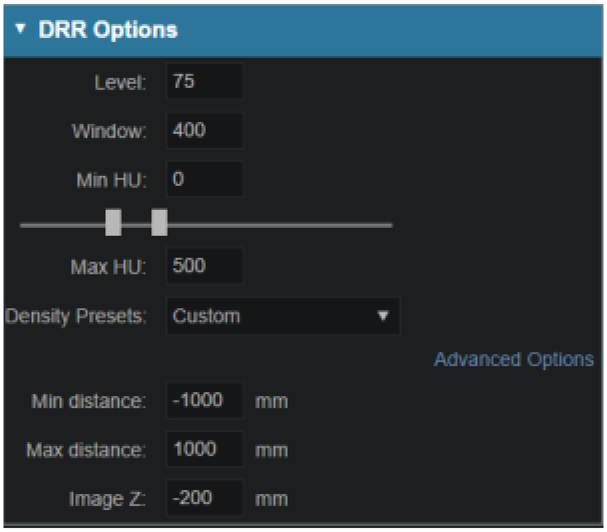
4. Aperture (if desired)
    1. If there is the need to use an Aperture for sharper penumbra the user can do so at this time (see Creating an Aperture)
    2. Note that Astroid has the ability to utilize an Aperture with pencil beam scanning for both SFO and IMPT plans
    3. For this plan, no apertures are necessary
5. Shifter

      1. Simply choose a shifter from the list if one is needed
      2. For this plan, no shifters are necessary

Shifter

Shifter: none

   6. Air gap
      1. The air gap is specified as the distance from the final beamline device (aperture or shifter) or the snout end if no devices are present)
      2. The view automatically shifts to the 3D view when entering this sub-block and you can adjust the air gap to ensure patient collisions are avoided
      3. The default air gap of 30 mm is sufficient for both beams in this example
   7. Spot placement
      1. Since we want both beams to use the same spot settings, we have those at the plan level and there is no need to edit the spot placements here for the beams
   8. DRR options
      1. The Proton DRRs shown in the *Beam* task are generally used to help determine appropriate treatment angles
      2. In cases such as these, appropriate angles are readily determined and there is no need to utilize the DRR sub-task
         1. If you wish to explore this feature however, you may choose one of the preset *Density Presets* from the drop down or manually set the *level, window, min HU* and *max HU* or go into *Advanced Options* for additional control of the DRR's
         2. These proton DRRs are used only for visualization purposes and will have no effect on the plan construction process



DRR Options

Level: 75
Window: 400
Min HU: 0
Max HU: 500
Density Presets: Custom
Min distance: -1000 mm
Max distance: 1000 mm
Image Z: -200 mm

2. Click *Create* to complete the first beam

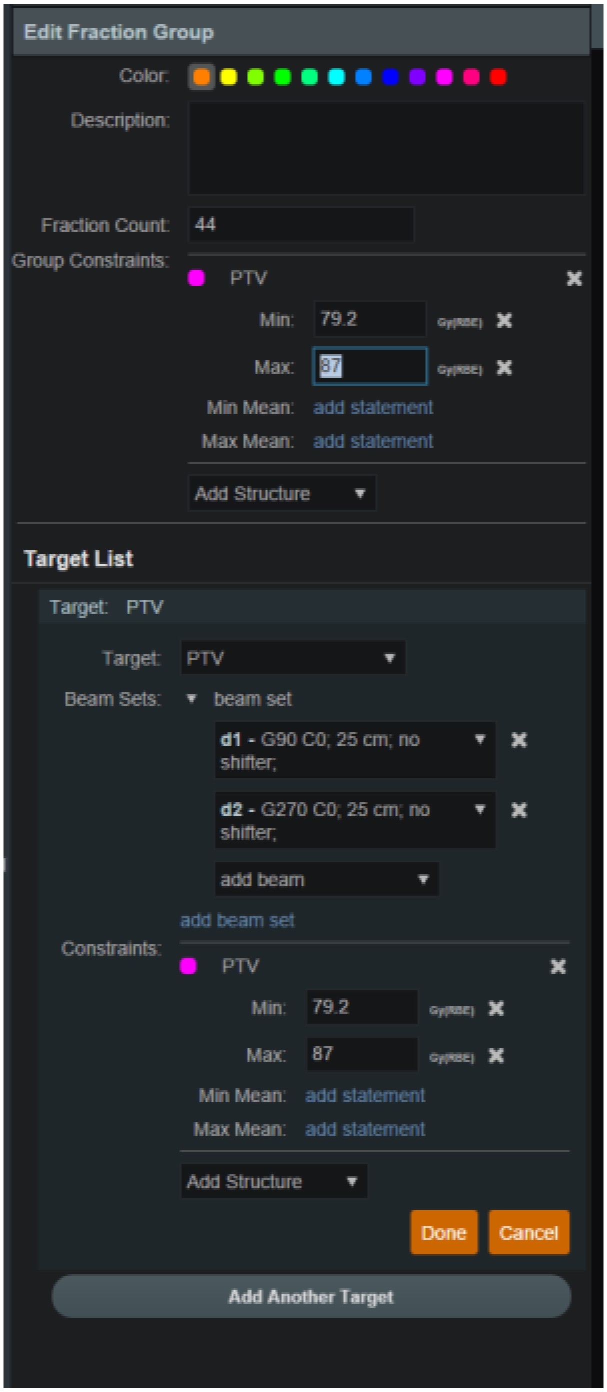
        3. After creating the first beam (at gantry angle 90) it is recommended that you *Clone* it and simply change new beam's ganry angle to save time in creating the second beam (the *Clone* button is available under a beam when it is selected for viewing from the list of beams) FIXM : Add an image of the clone button
            1. Note for more complex plans, there are often additional parameters to change (such as the aperture and the air gap) when creating additional beams via the *Clone* option

Optimization

1. With the two beams completely defined, we can now move on organizing our treatment fraction groups and specifying the constraints and objectives for the treatment
2. Open the *Optimization* block (see Astroid Optimization for a detailed explanation of *Optimization*, *Feasibility* and *Constraints*, as well as *Running the Optimizer*)

Fraction Group

1. *Create a New Fraction Group* under the *Fraction Group* block (See Fraction Groups for a more detailed explanation)
    1. Enter a Fraction Count of 44
    2. Add a new Target to the *Target List* by clicking *Add Another Target*
        1. Set the Target to the PTV
        2. Add the following *Beam Set*
            1. In this case we will use an IMPT approach so add both the G90 and G270 beams in this same beam set
        3. Constraints associated with this target
            1. Click the *Add Structure* drop down and choose the PTV
            2. Add a min dose constraint of 79.2 Gy (1.8 Gy per fx)
            3. Add a max dose constraint of 87 Gy
        4. At this point your *Fraction Group* should appear as shown below 🔧 Fix Me! : Remove the group level constraint in the image



Edit Fraction Group

Color:

Description:

Fraction Count: 44

Group Constraints:

PTV

Min: 79.2 Gy(RBE)

Max: 87 Gy(RBE)

Min Mean: add statement

Max Mean: add statement

Target List

Target: PTV

Target: PTV

Beam Sets: beam set

d1 - G90 C0; 25 cm; no shifter;

d2 - G270 C0; 25 cm; no shifter;

Constraints:

PTV

Min: 79.2 Gy(RBE)

Max: 87 Gy(RBE)

Min Mean: add statement

Max Mean: add statement

3. Click *Create* to complete the Target entry and then *Create* again to complete the *Fraction Group*

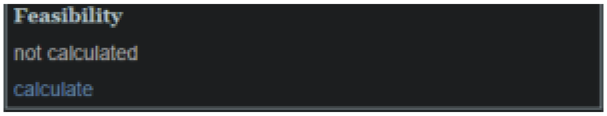
Constraints and Objectives

1. This is our only Fraction Group for this plan, so we'll move on to the plan level constraints and objectives
2. Open the *Plan Constraints/Objectives* block
    1. First we'll enter the *Constraints* for the planning (target) volumes
        1. Remember these are the “hard stops/non negotiables” for the plan
        2. These doses will be decided per the users' department protocols
        3. For this case do the following:

    1. Click *Add Structure* and select the Prostate
        1. Add a min set to 79.2 Gy
        2. Add a max set to 87 Gy
    2. Click *Add Structure* and select the PTV
        1. Add a min set to 75.2 Gy
        2. Add a max set to 87 Gy

> After the target constraints have been entered, it's generally good practice to test the plan feasibility. The Feasibility calculation is run by clicking *calculate* in the Feasibility block at the bottom of the *Plan Constraints/Objectives* sub-block. The Feasibility calculation is based solely on the constraints and it should be used to ensure there is a possible solution (plan) that can meet the specified constraints. The Feasibility calculation may be an iterative processes in order to get appropriate constraints established for a particular plan. In other words, the user may need to enter a constraint, check the feasibility, then progressively tighten the constraint and check the feasibility until the plan is no longer feasible. It is recommended practice to start by obtaining a feasible plan utilizing only target constraints then add OAR constraints as desired. Remember, using a narrow range of constraints can improve the optimizer performance and improve the resolution of the Pareto surface navigation.

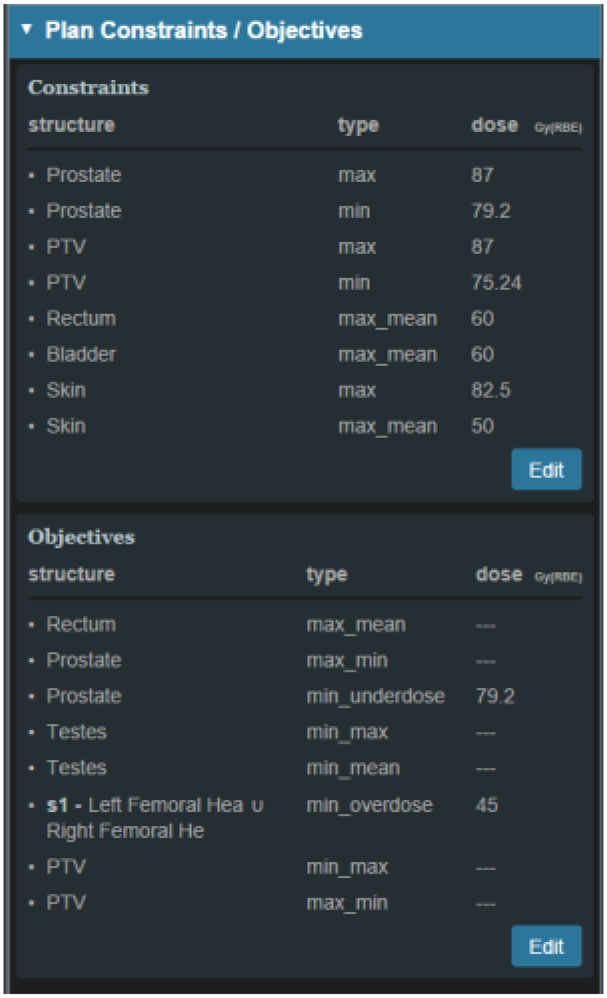
1. Run the *Feasibility* by clicking the *calculate* link



Feasibility
not calculated
calculate

    1. The feasibility should return as passing, if not, please confirm your plan parameters match those shown throughout this walkthrough and try again
2. Now with the target constraints set, we'll move on to our OAR's
    1. Again these will be set per department protocol
    2. For this example create the following OAR constraints:
        1. Rectum max mean 60 Gy
        2. Bladder max mean 60 Gy
        3. Skin max 82.5 Gy
        4. Skin max mean 50 Gy
3. Run *Feasibility* again
    1. The feasibility should return as passing again, if not, please confirm your plan parameters match those shown throughout this walkthrough and try again
4. With narrow constraints set and feasibility established, we will now turn our attention to *Objectives*
    1. *Objectives* are the goals that you would like to achieve and these will be the driving forces for the optimizer
    2. Click *Edit* under the *Objectives* section
    3. For this example we will use the following objectives:
        1. Rectum min_mean (Minimize the mean dose to the Rectum)
        2. Prostate max_min (Maximize the minimum Prostate dose)
        3. Testes min_max (Minimize the maximum dose to the Testes)

    4. Testes min_mean (Minimize the mean dose to the Testes)
    5. Left & Right Femur min_overdose 45 Gy (Minimize the amount of the structure the receives dose above 45 Gy)
    6. PTV min_max (Minimize the maximum dose within the PTV)
    7. PTV max_min (Maximize the minimum dose within the PTV) 🔧 **Fix Me!** : Original objectives did not make sense, try the ones here now and get new image



Plan Constraints / Objectives

Constraints

structure	type	dose Gy(RBE)
Prostate	max	87
Prostate	min	79.2
PTV	max	87
PTV	min	75.24
Rectum	max_mean	60
Bladder	max_mean	60
Skin	max	82.5
Skin	max_mean	50

Objectives

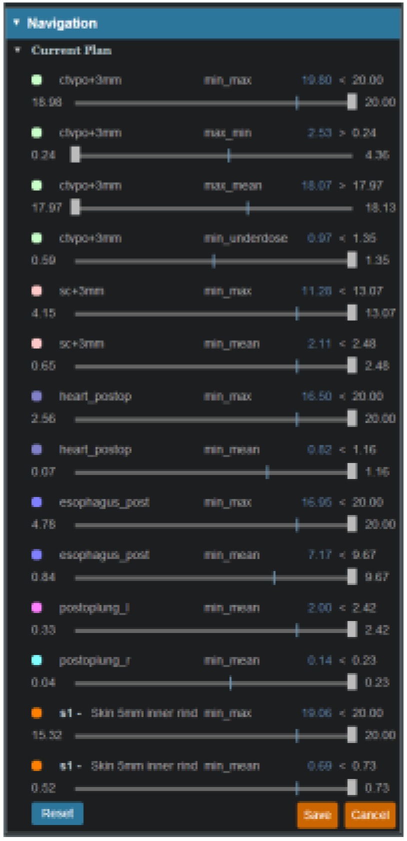
structure	type	dose Gy(RBE)
Rectum	max_mean	—
Prostate	max_min	—
Prostate	min_underdose	79.2
Testes	min_max	—
Testes	min_mean	—
s1 - Left Femoral Hea ∪ Right Femoral He	min_overdose	45
PTV	min_max	—
PTV	max_min	—

5. Click *Done* to complete the *Objectives*
6. We are now ready to run the MCO, by opening the *Navigation* sub-block and clicking the *calculate* link
    1. This may take up to 🔧 **Fix Me!** minutes for this plan depending upon your available cloud services resources

Navigation

1. Once the MCO has been completed, you can adjust the relative importance of the objectives using the slider bars in the *Navigation* block (see Astroid Optimization *Navigating the Solutions* for a detailed explanation of using the slider bars)
    1. Adjust the slider bars in the *Navigation* block to find what you feel is the optimal plan for this case

        1. Note: All of these adjustments are made without having to run a new plan
    2. If you find a plan that you like, but wish to continue exploring further, you can click the *Save* button to save the current slider state and then continue exploring
    3. You may return to the last saved state at any time by clicking the *Reset* button
    4. The *Cancel* button will close the navigation block, reverting back to the last *Saved* state FIME : This image needs to match with the objectives listed above



ctvpo+3mm min_max 19.80 < 20.00
18.98 20.00
ctvpo+3mm max_min 2.53 > 0.24
0.24 4.36
ctvpo+3mm max_mean 18.07 > 17.97
17.97 18.13
ctvpo+3mm min_underdose 0.97 < 1.35
0.59 1.35
sc+3mm min_max 11.28 < 13.07
4.15 13.07
sc+3mm min_mean 2.11 < 2.48
0.65 2.48
heart_postop min_max 16.50 < 20.00
2.56 20.00
heart_postop min_mean 0.82 < 1.16
0.07 1.16
esophagus_post min_max 16.95 < 20.00
4.78 20.00
esophagus_post min_mean 7.17 < 9.67
0.84 9.67
postoplung_l min_mean 2.00 < 2.42
0.33 2.42
postoplung_r min_mean 0.14 < 0.23
0.04 0.23
s1 - Skin 5mm inner rind min_max 19.06 < 20.00
15.32 20.00
s1 - Skin 5mm inner rind min_mean 0.69 < 0.73
0.52 0.73

2. The plan is ready for physician review at this point
    1. Physicians often find it useful to Navigate the solution and explore trade-offs in real time, which can often alter the traditional physician approval process into an interactive, real-time trade-off analysis and on the spot plan approval
3. After the physician has decided on a treatment plan the user may then proceed to export the chosen plan to the EMR
    1. Note that these standard (non-plan specific) features are covered in other guides and not repeated herein

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