

Prostate Plan Walkthrough

Launching Planning

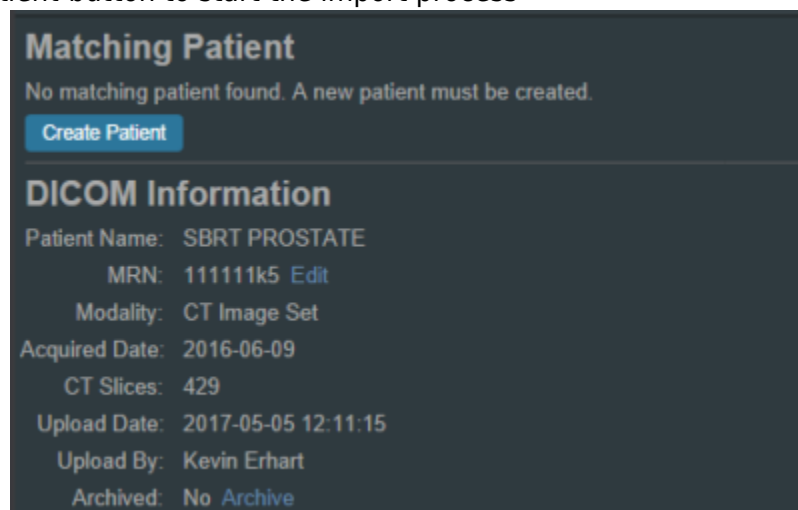
1. Open the Astroid Launcher and login



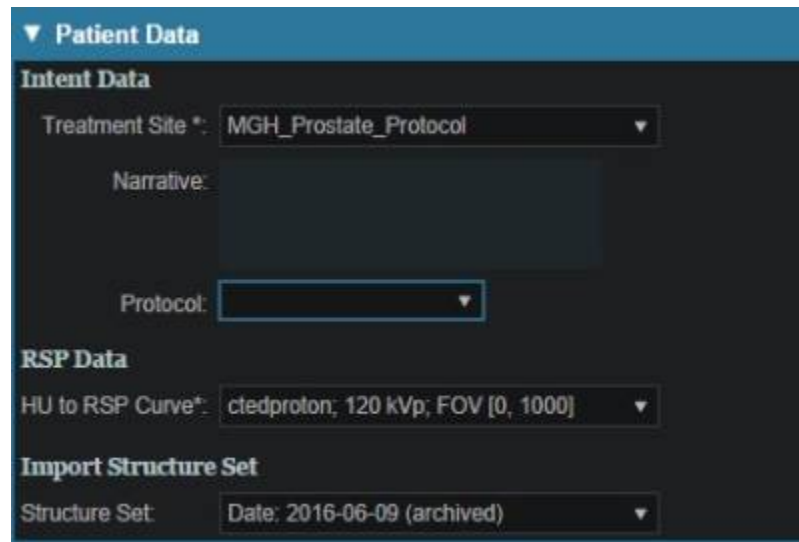
2. Select your realm
3. A list of available apps will be listed on the left, select *Planning* from this list
4. If you see an Install button click it and wait for the version to install. You will know it is installed when you see a LAUNCH button
5. Click the LAUNCH button. The version of planning that is installed in your realm will now open

Creating a Patient

1. From within the Planning App click on the Imports block
2. Select the CT image set (SBRT Prostate) from the list of available files for import
3. Ensure that the MRN is correct
4. Click the *Create Patient* button to start the import process



5. In the control pane on the left hand side, the patient model will be automatically selected based on the structure set DICOM UID information.
6. Fill in the Patient Data and select the appropriate treatment site and HU to RSP curve (as shown below)



The screenshot shows a 'Patient Data' form with the following sections and fields:

- Intent Data**
 - Treatment Site *: MGH_Prostate_Protocol (dropdown menu)
 - Narrative: (text area)
 - Protocol: (dropdown menu)
- RSP Data**
 - HU to RSP Curve*: ctedproton; 120 kVp; FOV [0, 1000] (dropdown menu)
- Import Structure Set**
 - Structure Set: Date; 2016-06-09 (archived) (dropdown menu)

7. 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

Import Structures

Treatment Site: MGH_Prostate_Protocol

Patient Structure: skin

Variant Label: variant_1_2018-08-16

Matched / Assigned (4)

- ☒ skin Importing new structure
- ☒ Bladder Importing new structure
- ☒ Prostate Importing new structure
- ☒ Rectum Importing new structure

Not Matched (custom) (11)

- ☒ 2cm Importing new structure
- ☒ Bladder neck Importing new structure
- ☒ Bowel Importing new structure
- ☒ Left Femoral Hea Importing new structure
- ☒ Neurovascular Bu Importing new structure
- ☒ penile bulb Importing new structure
- ☒ PTV (course) Importing new structure
- ☒ Right Femoral He Importing new structure
- ☒ Seminal Vesicles (course) Importing new structure
- ☒ Testes Importing new structure
- ☒ Urethra Importing new structure

Import Cancel

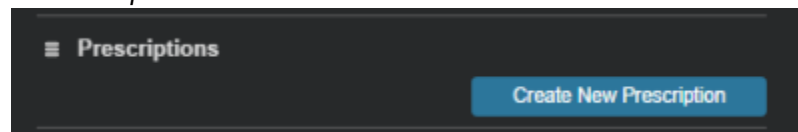
8. You also have the ability to assign or edit any structures that are shown as *custom*, which indicates the name did not exactly match a site structure from the treatment site template list you specified during patient creation.
 1. Matched, Assigned, and Custom structures are designated with corresponding tags at the end of the structure name in the structure list.
 2. Assigning a custom structure to a defined site 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
9. Click the *Import* button to create the patient and import the CT Images and Structures into it.
10. The patient is now created and all available data has been imported, so it is time to proceed with entering the prescription information
11. Click on the *Open Patient* button



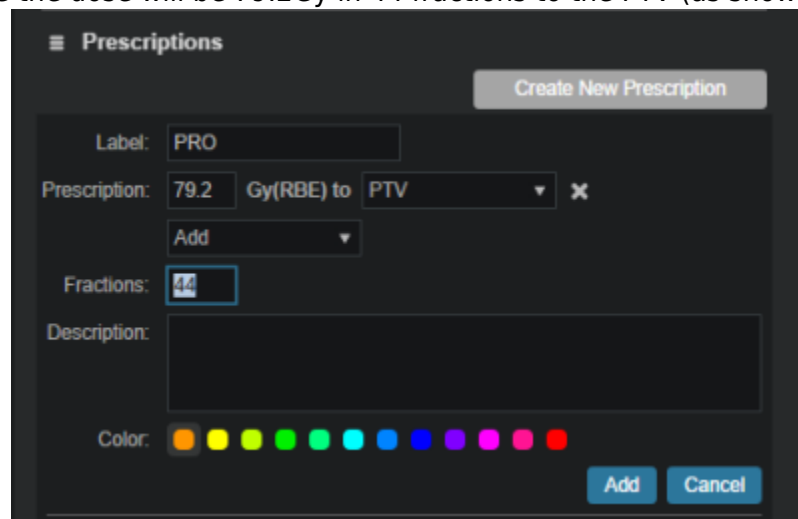
Course Prescription

Prescription information is stored in the *Course* and must be added prior to making a treatment plan for a new patient.

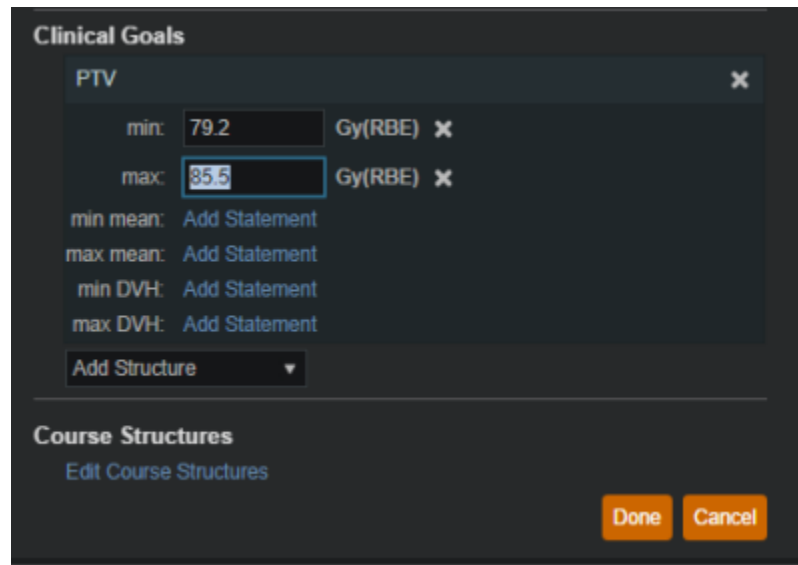
1. The patient opens directly after importing
2. Next proceed to *Prescriptions*
 1. Select *Create New Prescription*



2. Select PTV from the Prescription drop down menu
3. For this example the dose will be 79.2Gy in 44 fractions to the PTV (as shown below)



4. *Label* and *Description* are free text fields that allow you to “name” each Prescription and provide any description or notes necessary to distinguish between each in the case of multiple prescriptions. You must enter a “name” in the *Label* in order to proceed. You are free to enter your own values in these fields for this walkthrough. Click *Add* when completed
3. Fill in the *Clinical Goals*
 1. Choose the structure from the dropdown to add your goal
 2. In this example we will set a minimum dose to the PTV at 79.2Gy and the maximum dose at 85.5Gy as shown below



Clinical Goals

PTV

min: 79.2 Gy(RBE) x

max: 35.5 Gy(RBE) x

min mean: Add Statement

max mean: Add Statement

min DVH: Add Statement

max DVH: Add Statement

Add Structure

Course Structures

[Edit Course Structures](#)

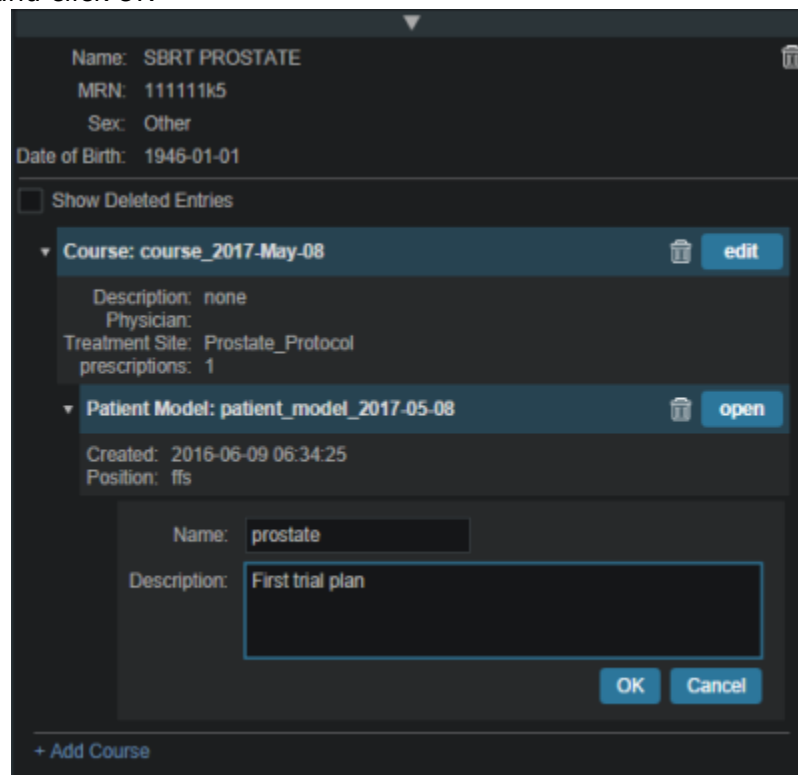
Done Cancel

4. Click *Done* to complete the *Course* editing
5. You can now click on the *Open* button to add a plan

Plan Creation

The required *Course* and *Patient Model* information was selected during import, so now we can move to creation of a treatment *Plan*

1. From the Patient Overview tree, click the *Add Plan* button under the Patient Model entry
 1. Name the plan and click *OK*



Name: SBRT PROSTATE

MRN: 111111k5

Sex: Other

Date of Birth: 1946-01-01

☐ Show Deleted Entries

Course: course_2017-May-08 edit

Description: none

Physician:

Treatment Site: Prostate_Protocol

prescriptions: 1

Patient Model: patient_model_2017-05-08 open

Created: 2016-06-09 06:34:25

Position: ffs

Name: prostate

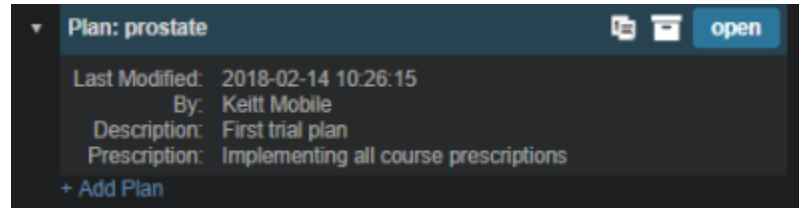
Description: First trial plan

OK Cancel

+ Add Course

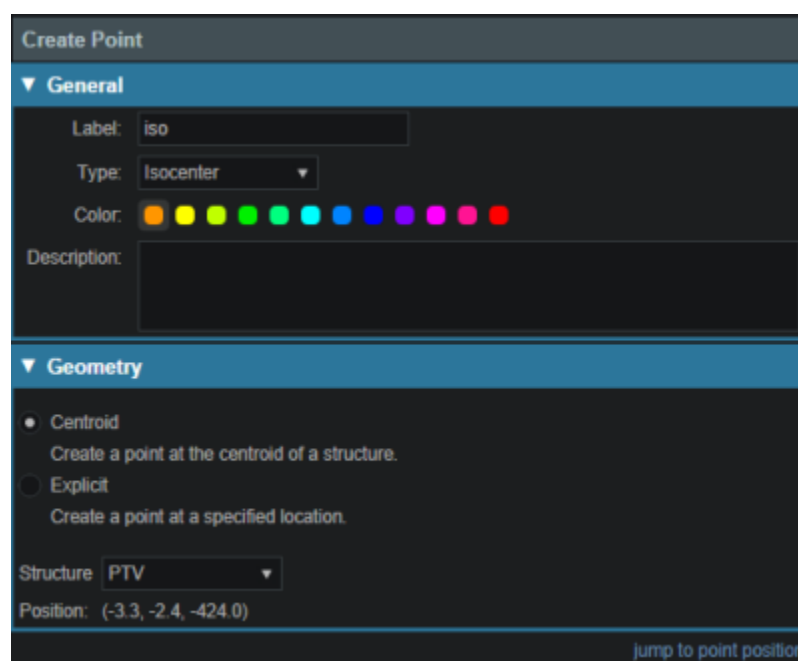
2. This creates an empty plan with its prescription set to fulfill all portions of the Course Prescription

- Now open the new plan by clicking the *Open* button under the new plan entry in the Patient Overview tree



Plan Prescription Implementations

- Click the *General / History* heading to expand this block
 - Notice here that our empty plan starts out with its prescription set to fulfill all portions of the Course Clinical Goals and Prescriptions
 - If a plan will only fulfill a portion of the Prescription, then this information should be edited to reflect this, otherwise just proceed past this block
- In this case, we will be fulfilling the entire prescription with a single plan, so no editing is needed
- Generating our plan will now progress to 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)
- 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)
 - Select a type of isocenter and create the point at the centroid of the PTV



- Click *DONE* at the bottom of the page

HU to RSP

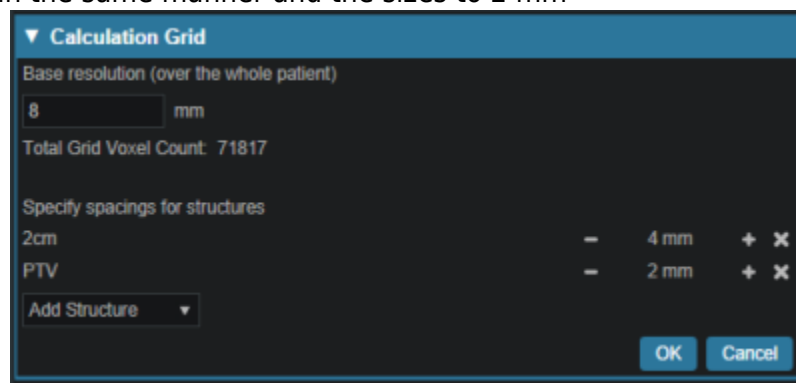
Next we will move on to defining the HU to Proton Relative Stopping Power (RSP) conversion

1. 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 chosen upon patient import needs to be changed 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

Calculation Grid

We are now ready to define the dose calculation grid (see [Defining the Dose Grid](#) for a detailed explanation)

1. Click to open the *Calculation Grid* block
 1. Click the *Edit* button
 2. 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 in the same manner and the sizes to 2 mm



4. The Prostate is included in the PTV volume so there is no need to set a separate grid size
5. Click OK

Beams

We are now ready to begin defining the treatment beams

1. 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 “Proton System Medium_PBS” from the dropdown

3. Click OK
4. 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- 0.8 Distal W80

5. Click OK
6. Now we are ready to make our beams
7. Start by clicking *Create New Beam*

1. Enter the following for each beam
 1. General
 1. Select the PTV as the Geometric Target and if desired, enter a description for the beam, for other selections leave the defaults (see [Structure Geometry](#))

General

Color: [Color selection bar with 12 colored squares]

Label: G0 C0, no snout, no shifter.

☒ automatically generate label

Geometric Target: PTV

Spot Target:

- ☒ use fraction group target
- ☐ use beam geometric target

Description:

2. Approach

1. At this point the user 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

Approach

Isocenter: iso [edit isocenter](#)

Gantry Angle: 90 deg

Couch Angle: 0 deg

3. Snout

1. In this example select the 20x20 snout

Snout

Snout: 20x20

30x30

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 SFUD and IMPT plans and the aperture construction will be based on the Geometric Target selection
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

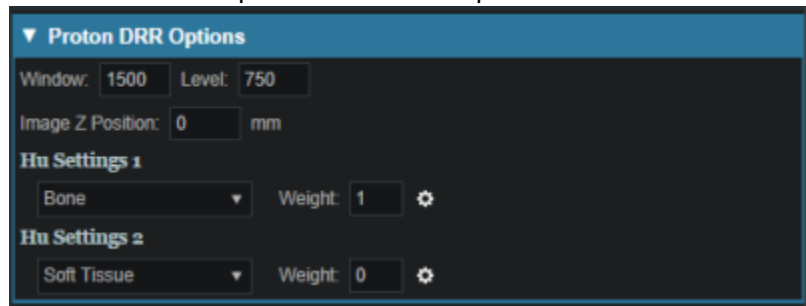
Shifter: none

30 mm

Min WET to Target: 175 mm

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 *HU Settings* 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



2. Click *Done* 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 gantry 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)

The screenshot shows the 'Beams' configuration window. At the top, it displays 'Treatment Room' and 'Proton System: Medium_PBS'. Below this is 'Spot Placement Parameters' set to 'machine defaults'. A section titled 'PBS Beams' contains a single beam entry 'b1 : G90 C0; 20x20; no shifter,' with an orange status indicator. Below the beam name is the 'Beam Information' section, which lists: Description, Isocenter: Iso, Gantry Angle: 90 deg, Couch Angle: 0 deg, Geometric Target: PTV, Spot Target: using fraction group target, Air Gap (snout ext.): 50 mm (251.7mm), Entrance Z: 202 mm, Snout: 20x20, Aperture: none, and Shifter: none. Below this is the 'PBS Spot Placement' section, which says 'using plan settings:'. At the bottom right are buttons for 'Clone', 'Edit', and 'Delete', and a 'Create New PBS Beam' button.

4. Once you have *Cloned* the beam choose the *Edit* button to make changes to the gantry angle

The screenshot shows the 'Beams' configuration window after cloning. It now displays two beam entries: 'b1 : G90 C0; 20x20; no shifter,' (orange indicator) and 'b2 : G90 C0; 20x20; no shifter,' (blue indicator). The 'Beam Information' section for 'b2' is identical to 'b1', listing: Description, Isocenter: Iso, Gantry Angle: 90 deg, Couch Angle: 0 deg, Geometric Target: PTV, Spot Target: using fraction group target, Air Gap (snout ext.): 50 mm (251.7mm), Entrance Z: 202 mm, Snout: 20x20, Aperture: none, and Shifter: none. The 'PBS Spot Placement' section also says 'using plan settings:'. The 'Clone', 'Edit', and 'Delete' buttons are still present at the bottom right, along with the 'Create New PBS Beam' 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

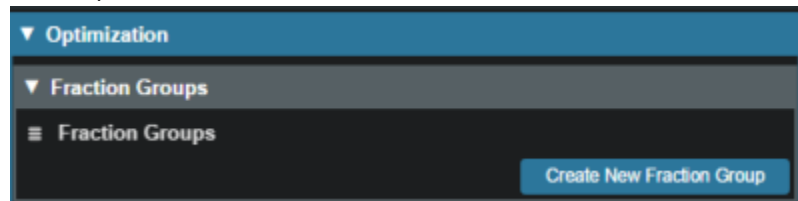
Optimization

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

1. 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. Choose *Create a New Fraction Group* under the *Fraction Group* block (See [Fraction Groups](#) for a more detailed explanation)



1. In the *Prescription* drop down, select the Prescription that was created earlier in the Course ("PRO")
2. Enter 44 for the *Number of Fractions*
3. Select IMPT as the *Type*
4. Set the *Target* to the PTV
5. Add both beams that were created above
6. Next to *Constraints* click the *Add Structure* drop down and choose the PTV
 1. Add a min dose constraint of 79.2 Gy (1.8 Gy per fx)
 2. Add a max dose constraint of 85.5 Gy
7. At this point your *Fraction Group* should appear as shown below

 A screenshot of the 'Create Fraction Group' dialog box. It contains the following fields and options:

- Color:** A row of colored circles (orange, yellow, green, cyan, blue, purple, magenta, red).
- Description:** A text input field.
- Prescription:** A dropdown menu with 'prostate' selected.
- Number of Fractions:** A text input field with '44' and a label 'Total: 44, Remaining: 44'.
- Type:** A dropdown menu with 'IMPT' selected.
- Target:** A dropdown menu with 'PTV' selected.
- Beams:** Two text input fields: 'b1 - G90 C0, 12 cm, no shifter;' and 'b2 - G270 C0, 12 cm, no shifter;'. Each has a delete icon (X) to its right.
- Add Beam:** A dropdown menu.
- Constraints:** A section with a pink circle icon and 'PTV' selected, with a delete icon (X) to its right. Below it are:
 - Min:** 79.2 Gy (1.8 Gy per fx) with a delete icon (X).
 - Max:** 85.5 Gy (1.8 Gy per fx) with a delete icon (X).
 - Min Mean:** add statement
 - Max Mean:** add statement
- Add Structure:** A dropdown menu.

8. Click *Done* to complete the *Fraction Group*

Constraints and Feasibility

1. This is our only Fraction Group for this plan, so we'll move on to the plan level constraints and feasibility
2. Open the *Constraints / Feasibility* sub-block
 1. First we'll enter the *Constraints* for the planning (target) volumes and a global maximum constraint
 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 *External_body (Skin)*
 1. Add a max set to 85.5
 2. Click *OK*
 3. Note that we already have PTV dose constraints at the Fraction Group Target level, so no additional ones are needed here

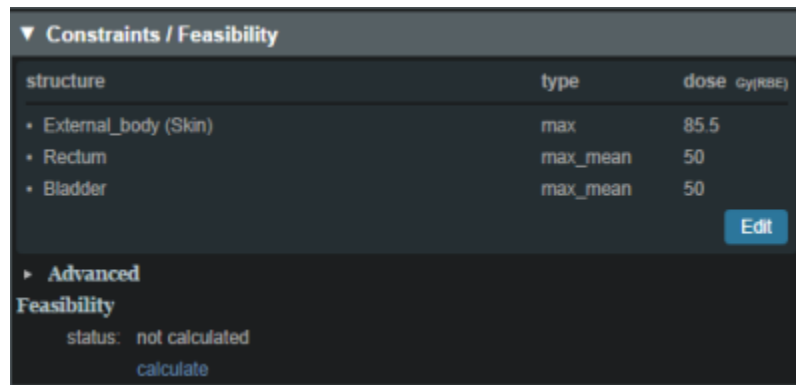


After the target constraints have been entered, it's generally good practice to test the plan feasibility. The Feasibility calculation is run by clicking *calculate* at the bottom of this block. The Feasibility calculation is based solely on the constraints and it should be used to ensure there is a possible solution (plan) that can meet the specified constraints. Establishing Feasibility is often an iterative process 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 (and a global max constraint) 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



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 50 Gy
 2. Bladder max mean 60 Gy

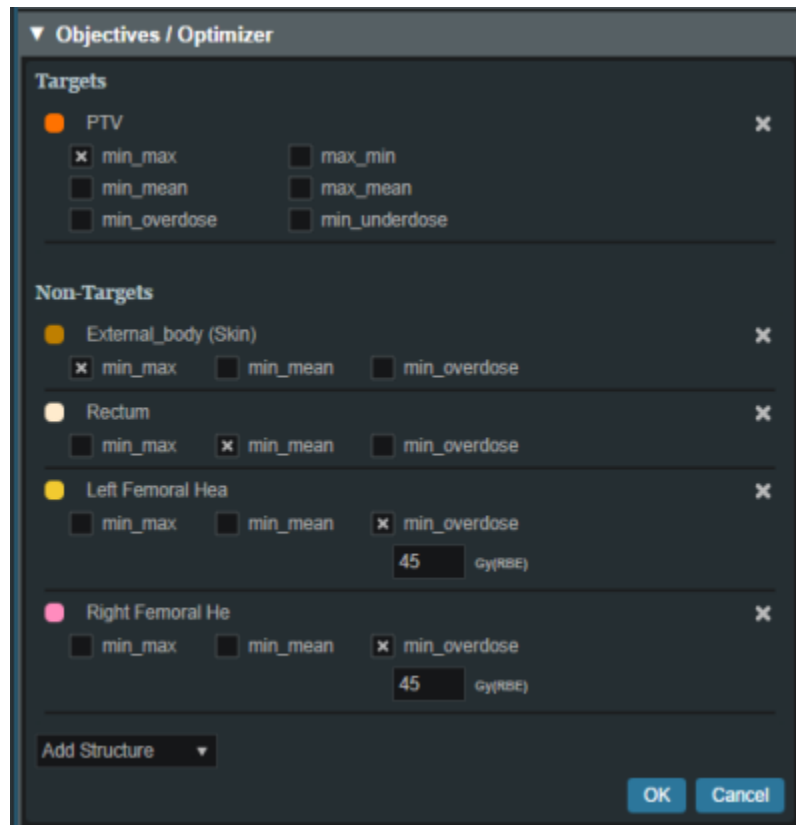


3. Run *Feasibility* as before

1. The feasibility should return as passing again, if not, please confirm your plan parameters match those shown throughout this walkthrough and try again

Objectives and Optimizer

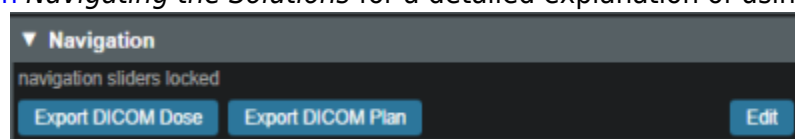
1. With narrow constraints set and feasibility established, we will now turn our attention to *Objectives*
 1. *Objectives* are the goals that you would like to achieve and these will be the driving forces for the *Optimizer*
 2. Expand the *Objectives / Optimizer* sub-block and then click *Edit* under the *Objectives* section
 3. For this example we will use the following objectives:
 1. The External_Body (Skin) will automatically populate
 2. Rectum min_mean (Minimize the mean dose to the Rectum)
 3. Testes min_max (Minimize the maximum dose to the Testes)
 4. Left & Right Femur min_overdose 45 Gy (Minimize the amount of the structure the receives dose above 45 Gy)
 5. PTV min_max (Minimize the maximum dose within the PTV)



2. Click *OK* to complete the *Objectives*
3. 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 10 minutes for this plan depending upon your available cloud services resources
 2. Keep in mind that even though this process may take some time, the planner will be able to make adjustments easily in the Navigation without running a new plan

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 by clicking the *Edit* button 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

Navigation

Max Dose
Value: 81.67 Gy(RBE) jump to

Current Plan

Organ at Risk	Constraint	Value
External_body (Skin)	min_max	81.68 < 85.50
Rectum	min_mean	22.50 < 32.40
Left Femoral Hea	min_overdose	0.00 < 0.01
Right Femoral He	min_overdose	0.00 < 0.01
PTV	min_max	81.68 < 85.50

Buttons: Reset, Save, Cancel

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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