Fraction Groups

Defining *Fraction Groups* is the first step in the PBS Optimization process within Astroid. Most commonly, a fraction group is simply an arrangement of beams that will be used in a typical daily treatment fraction. The Fraction Group contains some basic group information, as well as Fraction Group level constraints and collections of *Beam Sets*, referred to as *Beam Set Groups*. The *Beam Set* and *Beam Set Group* are key concepts within Astroid that allow for high levels of control over the Astroid PBS Optimization engine. Further details of these critical items are provided below and additionally, examples of some common cases and how fraction groups, beam set groups, and beam sets can be constructed to meet the clinical needs of various clinical cases can be found here Prostate Plan Walkthrough.

General Fraction Group Data

- **Color**: Display color of the *Fraction Group*
- **Description**: Optional, user specified text describing the *Fraction Group*
- **Phase**: Phase prescription that the fraction group implements. This is required to be able to select a fraction group target.
- **Fraction Count**: The total number of fractions to be delivered for this *Fraction Group*; this is very important as it will determine the appropriate Monitor Units for the individual beams
- **Group Constraints**: These *Constraints* apply to the total dose across all beams in the *Fraction Group* (For *Constraint* details click here)

Beam Set Groups

Simply speaking, a *Beam Set Group* is just a collection of *Beam Sets* that together will provide a specified dose to a particular target, so in clinical practice each *Beam Set Group* is most commonly associated with a single target structure (i.e. there will be one *Beam Set Group* per target). Most standard single lesion treatments will therefore use only one *Beam Set Group*. More complex prescriptions, such as Simultaneous Integrated Boosts (SIB), are typically split into two groups, one for the primary target and a second for the boost target. Within the *Beam Set Group*, a target is specified along with one or more *Beam Sets* and any beam set level constraints necessary to meet the clinical goals for this target.

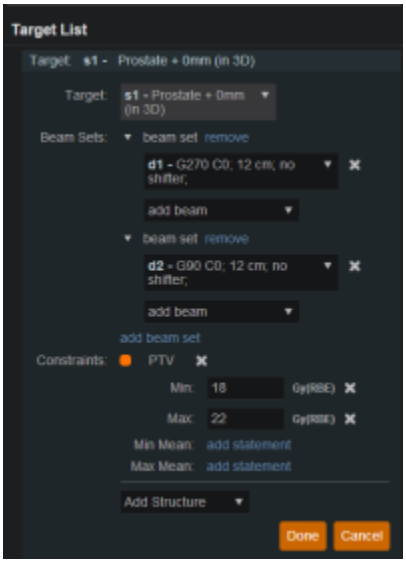
- **Target**: The target structure for this beam set group. This selection will only contain targets with prescriptions specified in the phase the fraction group implements that also exist in the treatment plan.
- **Beam Sets**: A list of Beam Sets that will be used for this beam set group (see below for a detailed description of a *Beam Set*)
- **Constraints**: These *Constraints* are split evenly and applied individually to each *Beam Set*
    - In other words, the Constraint dose is divided by the Beam Sets in the Beam Set Group, so that both SFO and IMPT can be achieved

Beam Sets

The *Beam Set* is the lowest level unit for the Astroid PBS Optimizer and proper arrangement of the beams within a beam set allows for both Single Field Optimized (SFO) and Intensity Modulated Proton Therapy (IMPT) fields to be included within the same fraction. A careful review of the Beam Set Group (BSG) Constraints described above, should reveal how to properly arrange beams within Beam Sets to achieve a desired type of treatment. Since BSG Constraints are equally split and are then applied individually to each Beam Set, SFO beams can easy be achieved by placing each beam in its own Beam Set. Conversely, IMPT beams are created when multiple beams are included within a single Beam Set. Further details of these two cases are presented below.

SFO Beams

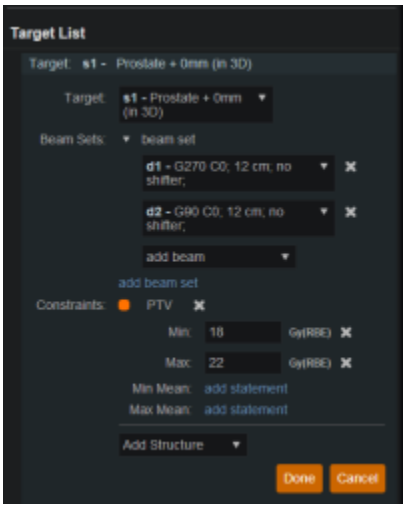
Single Field Optimized treatment beams are produced by including each beam in a separate Beam Set. This is best understood by example. Suppose a target is intended to receive 20 Gy (2 Gy per day for 10 fractions) from a two beam Fraction Group using a SFO approach. This is achieved by specifying a min dose of 18 Gy and a max dose of 22 Gy using Beam Set Group Constraints. Now two beam sets are created, each containing a single beam, as shown below. Since the BSG constraints are split between the beam sets, this actually tells the optimizer that each beam must provide a min dose of 9 Gy and a max dose of 11 Gy (1/2 of the BSG constraint doses). Therefore, each individual beam will be providing coverage to the entire target as is expected for a SFO approach.



IMPT Beams

Intensity Modulated Proton Therapy treatment beams are produced by including all desired beams in a single Beam Set. This is again best understood by example. Suppose a target is intended to receive 20 Gy (2 Gy per day for 10 fractions) from a two beam Fraction Group using an IMPT approach. This is achieved by specifying a min dose of 18 Gy and a max dose of 22 Gy using Beam Set Group Constraints. Now one beam set is created, containing both beams, as shown below. Since there is only Beam Set, the

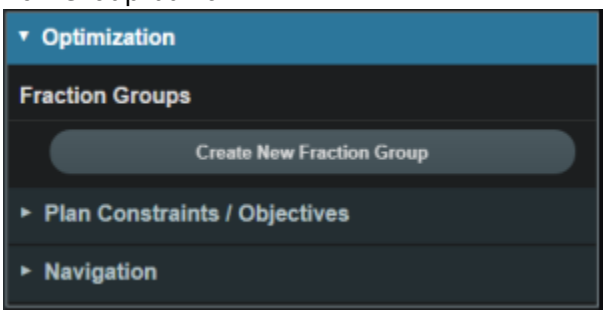
BSG constraints will be applied to the combined dose from the two beams. Therefore, there are no guarantees regarding the uniformity of dose from either beam and instead there is simply the guarantee that the combined dose from the two beams meets the given constraints, thereby producing an IMPT treatment approach.



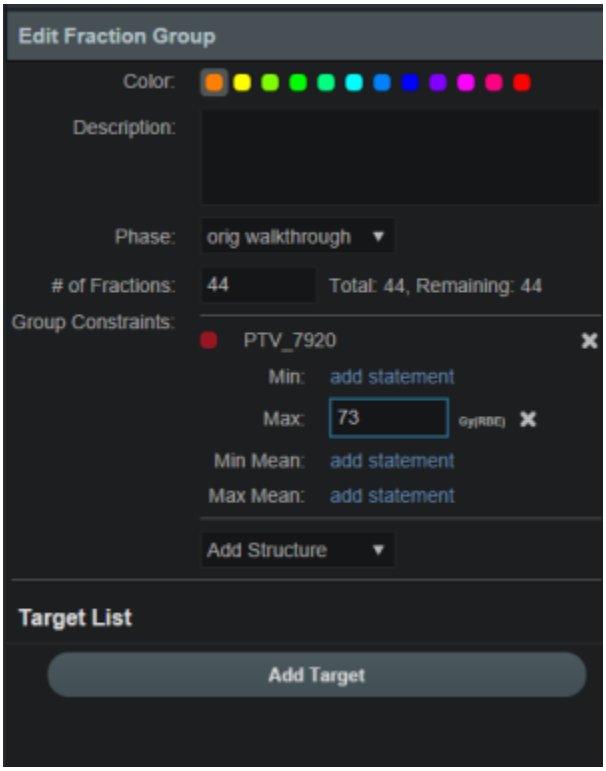
By understanding the notion that Beam Set Group Constraints are equally split among the beam sets, it can also be seen how SFO and IMPT may be mixed within a Beam Set Group and even the most complex of treatment scenarios can be handled directly in Astroid.

Working with Fraction Groups

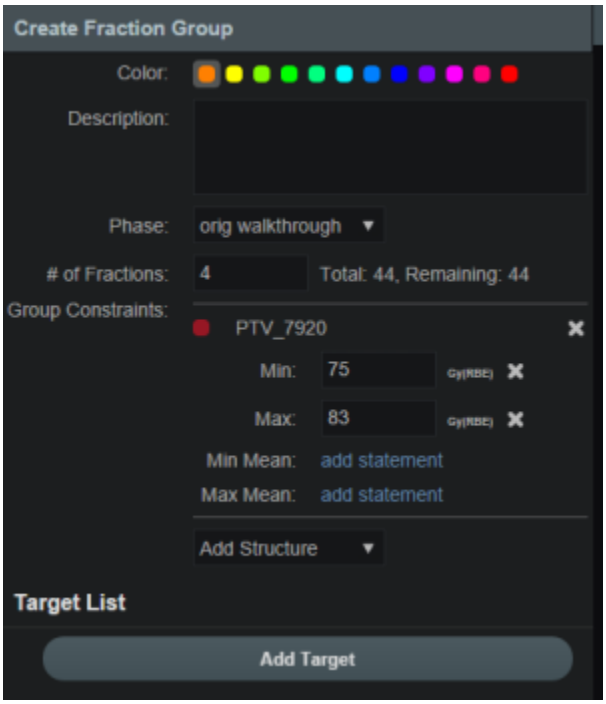
1. Select the Create New Fraction Group button



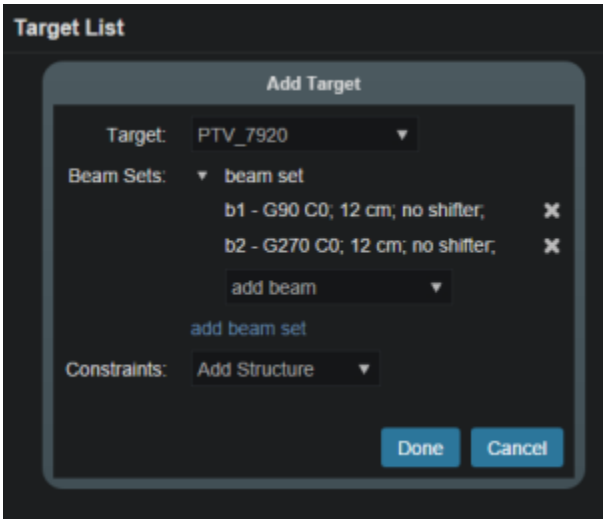
2. In the newly opened block the planner will:
    - Choose the color the fraction will be denoted in
    - Type in any descriptor that may be needed
    - Enter the total number of fractions to be treated
    - Enter the group constraints if desired
        - Group constraints apply to the total dose from the whole fraction group
        - Constraints for multiple structures may be entered at this stage



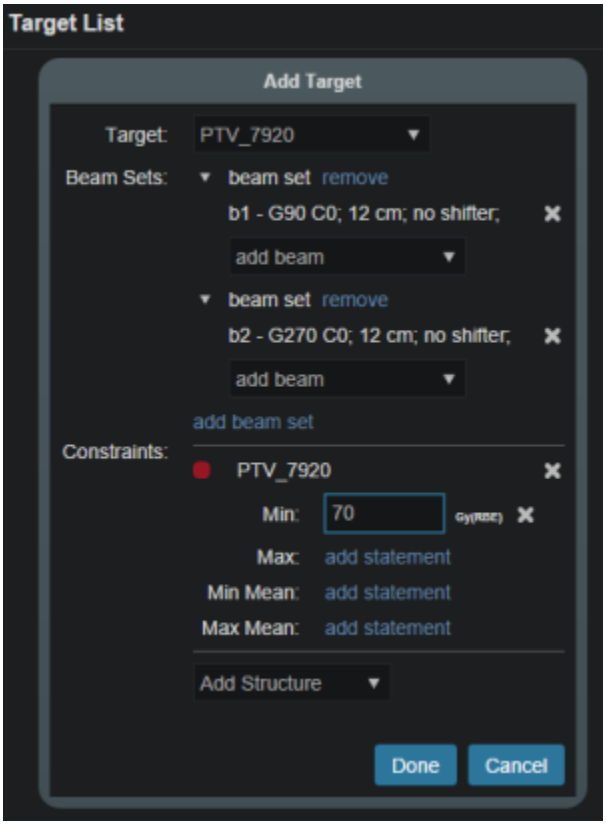
3. Click *Add Target*



   - Select the target of this Beam Set Group
   - Create any Beam Sets that are desired



    - There may be multiple Beam Sets associated to a target to construct SFO or IMPT beam groupings (see above for further details)
- Enter any desired Beam Set Group level constraints
    - The constraints chosen at this point will be evenly divided and applied separately to each Beam Set (see above for further details)



- The user may also have multiple Beam Set Groups, typically with each associated to a distinct target within the *Fraction Group*